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Received Signal Level (RSL) Measurement and Analysis With A Desk-Top Computer

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RECEIVED SIGNAL LEVEL (RSL) MEASUREMENT AND ANALYSIS WITH A DESK-TOP COMPUTER

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A software package of programs has been developed which automatically measures and analyzes the received signal level of four microwave communication receivers. The package will run on the Test and Acceptance Calculator Instrumentation which the USAF 1842 Electronics Engineering Group is using to automate most of the long lines communication system acceptance tests. An initial manual calibration directed by the program is stored on a data tape cartridge. The software controls one instrument using the IEEE 488-1975 bus to run the test unattended for one month. Data are sampled on each receiver four times per second with a typical resolution of 3 dB over a 60-dB dynamic range. In addition to a "quick look" analysis during the test for each hour of data, a set of programs may be run after the test to list and plot cumulative distributions and hourly medians on a peripheral graphic plotter. The graphs, including axes and scales, are drawn and annotated completely under software control.

Key words: Automation; calculator based instrumentation; desk-top computer software; IEEE 488-1975 bus; microwave LOS communications; RSL; TACI

1. INTRODUCTION

1.1. Background

The mid 1970's brought a major revolution to test instrumentation. Two significant advances have occurred whose impacts may not be completely recognized until the end of this decade. The first is the acceptance of a digital instrumentation interface bus by the IEEE as standard 488-1975, commonly called the General Purpose Interface Bus (GPIB) (IEEE, 1975). The second

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major advance was the introduction of programmable calculators and desk-top computers which made addressing the bus instruments an easy task. In addition the computers have interrupt capability so that a GPIB instrument may get the attention of the controller. Less than two years after the adoption of the IEEE bus standard, there were at least 50 bus-compatible instruments on the market from at least 10 manufacturers, and the number has increased rapidly (Loughry, 1974; Santoni, 1976; Nelson and Ricci, 1974). The capabilities of the bus-compatible instruments are almost unlimited as they will generate or measure parameters (such as frequency, intensity, etc.) over almost all of the currently attainable ranges. Other instruments provide clock time, pacing, format conversions, operation of relays, and measurement of all types of parameters; i.e., peak signals, envelope delay, impulse noise counts, phase, etc. Several controllers are now on the market which make the GPIB very easy to use. Some are aimed at small, portable systems which must be transported into the field or hand carried. Others are designed for the laboratory or engineering office with a graphics CRT screen and a powerful graphics command set.

The controller and instruments utilized for military communications equipment testing had to meet the requirements of being rugged, portable, and reliable. The initial use of these new programmable devices was aimed at test and acceptance type measurements; however, it is likely that this is only the first step, since eventually these same devices will make their impact felt in operations, quality assurance testing and even in fault isolation of communication systems (Lindberg, 1976). Their advantages are that they, for the most part, may be used as stand-alone test modules under manual control, or as part of an automatic or semiautomatic test system.

1.2. Controller and Instrumentation

The specific equipment chosen to perform the RSL measurement and analysis is identical to some of the equipment chosen by the USAF 1842 Electronic Engineering Group (EEG) for their

test and acceptance field work. The equipment for RSL test and analysis basically is as follows:

1) Controller-programmable desk-top computer, with 24 k bytes of memory, built-in printer, keyboard, display, and mass-storage tape cartridge.
2) Digital clock - a calendar clock with date and time which may be read (or set) via the computer. It will maintain the time for one month without external power. Its resolution is one millisecond and its maximum range is 115 days in the counter mode, hence it may be used to time long-duration tests. It has four independent counter-timers, which may cause an interrupt at programmed times or intervals.
3) Analog-digital (A-D) converter - a four channel device with 11-bit bipolar resolution (10 bits plus a sign bit) and four jumper selectable ranges with maximum values of ±10 V, ±5 V, ±3 V, ±1.3 V dc. The A-D also has a built-in pacer which can function at speeds to 20 times per second. It is entirely programmable via the GPIB.
4) Digital Plotter - this is a microprocessor based digital X-Y plotter which serves as a hard-copy output for documentation of the data after they are analyzed. The maximum plotter area is 28 by 40 cm, and labels may be printed under program control in any orientation or size. Disposable ink pens (in a variety of colors) are used. Since the data to be plotted have been stored on magnetic cartridge, the plotter may be used to reproduce the results of any test at a later date. Thus, the plotter will not be used in the field.

1.3. Requirements of Long-Term RSL Tests

The purpose of this test is to gather data on the variations of the RSL of microwave radio signals. This test is normally part of a multiple recording test such as the T1 test (DCAC 310-70-57, 1974); however, for long line-of-sight (LOS) microwave links it is very desirable to obtain long-term RSL data to confirm the solidity of the link. The phrase "long-term" is rather loose, however, it will denote here a period of at least one month. Accordingly, the test was designed to operate and record data onto tape for one month without any change of paper or tape cartridge. Two parameters are generally monitored in this type of test. The first parameter of interest is the signal median or distribution of hourly medians for a given radio path, and the second parameter is the percent of time that the instantaneous signal faded below some specified value.

To acquire a meaningful collection of data it is desirable to sample as fast as the instrumentation permits, and not any slower than once per second. Although atmospheric conditions seem to indicate a 100-200 Hz sampling rate should "freeze" the signal fluctuations, some work has raised the possibility of the occurrence of very short "fast fades" over certain paths (Brennan, 1959). However, if the sample window of the measurement instrument is small, in the range of tens of microseconds to a few milliseconds, then a large number of samples over a long term should produce a collection of data with equivalent statistical properties whether the sample rate was one per second or 100 per second. The instrumentation used here combined with the computer's speed of processing the data, allowed four samples of data to be taken on each of the four channels every second. This means over ten million data samples per channel will be processed and stored on a tape cartridge each month in hourly histograms.

2. DESIGN PHILOSOPHY

2.1. General Design Philosophy

The use of commercial test instruments, desk-top computer, and GPIB can completely eliminate hardware design and interface problems. The software advantage also lies in the fact that the system software for desk-top computers is generally built into the machine and is generally well documented. Thus, the user need be concerned only with application software to make the instruments function automatically and according to specifications.

A test to be automated should be run (or simulated) manually to uncover any incompatibilities, such as mismatches, ground loops, guarding problems, etc., between the measuring device and the unit under test. Next, any calibrations to relate electrical parameters to physical parameters must be performed and stored in memory. After obtaining at least one good set of data (or simulated data) from the instrumentation, it then becomes necessary to develop the data processing or handling routines and to estimate the amount of time required to perform the data handling. Then formatted outputs to hard-copy and mass storage need to be developed. These could also include graphical presentation of the data.

Finally, post-experiment analysis of the data is developed, using what has been recorded on the mass-storage medium. These programs are generally slow because large amounts of data manipulation, retrieval, sorting, etc. are required. These programs are extremely valuable because they generally do in minutes what would require one person hours, days, or even weeks to do.

2.2. RSL Test Design Philosophy

The received signal level (RSL) acquisition and analysis test followed the general guidelines of the previous section in the development of the software. The equipment modules used for the measurements were the computer, calendar-clock,

and A-D converter, and, for the post-experiment analysis and presentation of data summary, the computer and plotter were used. A block diagram of the equipment is shown in Figure 2-1. Not included in the diagram is a generator to inject a calibration signal into the radio prior to running the test.

The RSL test is designed to run unattended for one month after the initial start-up. When the computer is powered, the first file on the program track is loaded and run. This program loads the computer's special function keys and the RSL data acquisition program.

The acquisition program checks the first file of the second track on the tape for the presence of a calibration curve. If the second track, which is used as the data track for the test, is blank, then an initialization program is loaded and run so that calibration curves may be obtained and stored on the tape's data track. The initialization program is highly interactive with the engineer's input in setting up the test and the parameters to be used. The program will direct the engineer to set the various levels on the calibration generator and then will automatically print and store the corresponding voltage from the A-D converter. At the conclusion of the calibrations, the transfer curves are stored in the first file of the tape's data track, and the acquisition program is automatically reloaded and run.

The acquisition program sets the clock to provide interrupts every 0.25 seconds. At each of these 1/4-second clock ticks, data are sampled on each of the four channels and then sorted and stored in a histogram. Each channel histogram has 20 bins, whose values are determined by the calibration curves.

At the end of each hour, a quick analysis and summary printout occurs on the thermal printer. The "quick look", as it is called, provides four RSL levels for each channel which are exceeded by 50, 90, 99, and 99.9 percent of the hour's data. Thus the first of these values provides the hourly median. At exactly 12 noon and midnight each day, all the hourly histograms

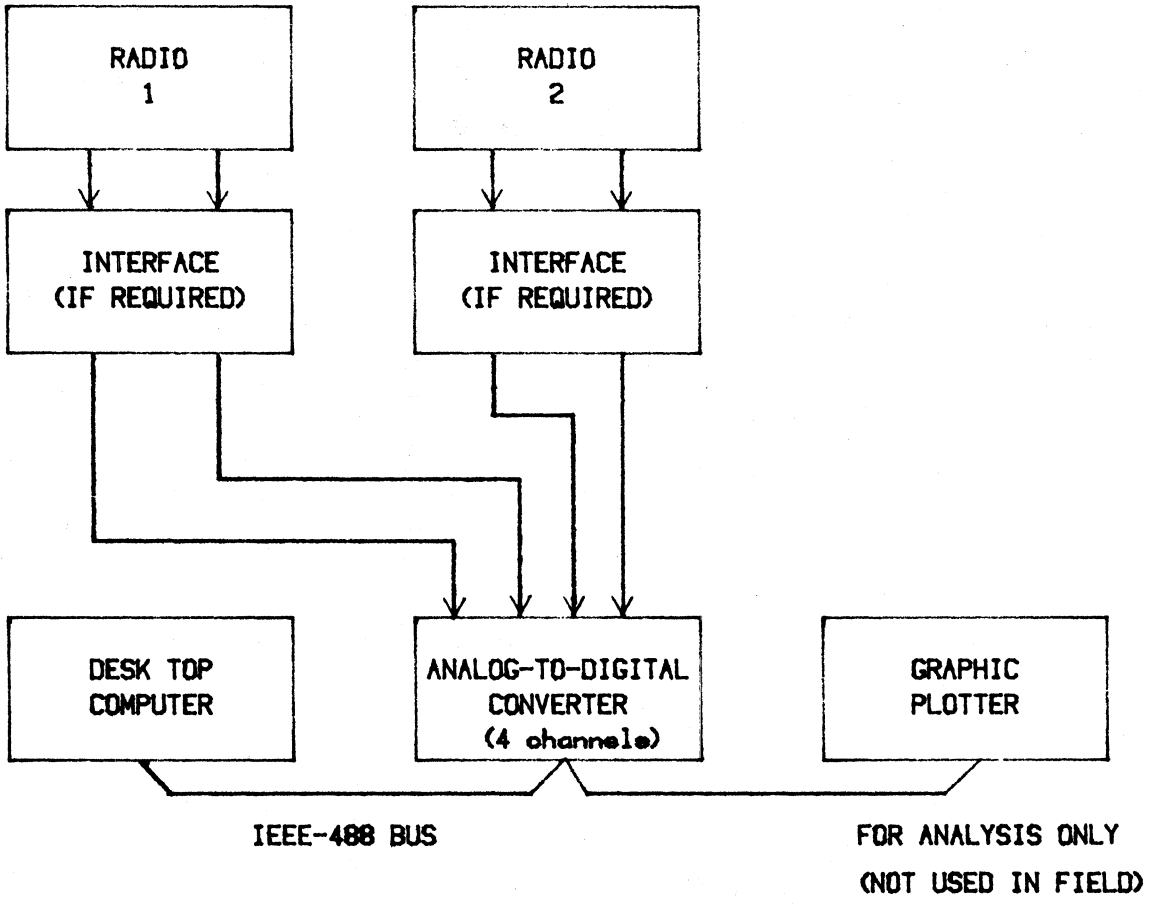

Figure 2-1. Block diagram of equipment used in RSL test and analysis.

from the past 12 hours are recorded into the next available file on the data track. The data track will accommodate 63 files after the initial calibration file. Thus the processed data for a 31-day month will fit onto one tape track. The last file (the 64th) is reserved for storing a summation of the data for each channel on the entire track. This summary will be obtained by the first analysis program, after the completion of the test. Since the desk-top computer uses solid-state random access memory (RAM), all data not recorded on tape will be lost if a power line interruption occurs. There existed a design tradeoff between the number of files to be recorded and the interval of the recording. Ideally, the interval would have been one hour, but due to file heading, end of file marks, and interfile gaps, the additional overhead would not have allowed one month's data on the cartridge. By choosing twice a day recording, the data files fit neatly onto a single track. In the event of power interruption, the computer follows the initial power-up routine and resumes normal operation without human assistance.

Three programs were developed to aid in immediate off-line field analysis of the data without the use of the plotter. These programs should be utilized on tests that are to be several months long to ensure that all components of the signal-conditioning and measurement equipment are properly functioning.

The first program is a tape directory program for checking the amount of data from each channel stored in each file. The long version of the directory prints on the thermal printer the file number, the date and time when recorded, any operator comments entered during the 12-hour period, and the number of hours and data points recorded for each of the channels. If there were no interruptions during the period, there should be nearly 172,800 data points on each channel.

The second program, named "Data I", sums the histogram data for any block of time periods chosen and stores this sum in the last data file. Then the number of data points in each

histogram bin for each channel may be printed, as well as a cumulative summation by bins. The previous two printouts may be normalized into percentages (by dividing by the total number of data points) and printed if selected.

The third program, Data II, determines the hourly medians for the entire tape. The output may be printed on the thermal printer or if the plotter is available, plotted on paper.

The desk-top computer chosen for this test has 12 special-function buttons which may be defined by the programmer to enhance operation of the controller by creating useful features relating to the test. Three of these buttons affect the normal display while the controller is in the data-acquisition mode. Normally the date and clock time are shown with the number of sets of A-D converter readings taken during the hour. However, depressing one button will convert the display to show the four sets of voltages read from the A-D converter. Depressing a second button will convert the four voltages into their true RSL values (in dBm) based on an interpolation of the stored calibration curve. Pressing the third button will restore the machine to the normal date-time display. Additional buttons will be described in a later section. A layout of the key board is shown in the Appendix, Figure A-25.

The test automatically concludes when 62 files are recorded onto tape. The tape is rewound, and the computer beeps and flashes a message to remove the tape. The machine should be turned off after the tape is removed so that the memory is cleared.

3. SOFTWARE DESCRIPTION

3.1. Overview

The programs written to perform the RSL measurement and analysis are stored on track 0 of the RSL tapes. The programs vary in length from 60 bytes to 5292 bytes. These represent 3 lines of code and 230 lines of code, respectively.

The data for the RSL measurements are stored on track 1 of the tape cartridge. Each tape is 140 feet long and has a storage capacity of about 125,000 bytes per track. By tightly packing the data, a full month's set of measurements can be stored on one track. The first file on the data track contains initialization constants and calibration curves. The next 62 files each contain 12 hours of data for up to 31 days of recording, When the analysis program is run, a summary of all the data is stored in the last file on the data track.

A file for special-function key implementation is loaded by the automatic start file which is the first file on the program track. One of the special-function keys allows the operator to select and load a program which has an index of all the other programs on the tape. This is commonly called the menu program. Execution of most of the software is self explanatory since a large effort went into applying human engineering to design of the input/output (I/O) phases of operator interaction. A description of each of the programs through file 11 is given in Section 3.2. The remainder of track 0 contains miscellaneous programs as desired for special applications, and will not be documented in this report. The operator's use of the system and his interactions are described in a general manner in Section 3.3. A step-by-step detailed execution of the program, with a commentary explaining the printout, is given in Appendix A. Flowcharts of the software are found in Appendix B, and the program listings and cross reference listing for variables, flags, registers, and labels are given in Appendix C.

3.2. Program Description

3.2.1. AutoStart

File 0 is automatically loaded and run when power is restored, if the program tape is in the transport. AutoStart is simply used to load the special-function keys, and then load and run the main (RSL) program.

3.2.2. Special-function keys

File 1 contains the special functions, which must be reloaded into the keys after a power failure, or on a new start. The AutoStart program handles this automatically, so that the keys are always available. Appendix Table C-1 and Figure C-1 present the special-function keys and their use.

3.2.3. Initialization

AutoStart loads the main program from file 3 immediately after power is turned on. If a new test is being started, i.e., no data are on the data track, then file 2 (containing the Initialization program) is loaded to allow the operator to enter the necessary information for the test.

Each parameter should be entered as it is requested by the Initialization program. The operator is asked to enter the year and time, which is then used to set the clock, if necessary. Then he is asked (for each channel) whether or not it is to be used. If so, the operator must enter the range for the A-D converter, the dBm zero reference level and bin step size, (in dB) and the transmitting station's designator. After this information has been entered for all channels to be used, the operator then enters the receiving station's designator (which is the same for every channel).

Each channel to be used is calibrated through the A-D converter. The operator sets the level requested by the computer on the calibrating generator, and then presses the CONTINUE button on the computer. This causes the corresponding voltage to be read from the A-D converter, and to be recorded in the calibration array. Then, the next lower calibration level is displayed, and the process is continued until 19 levels have been calibrated. When all channels have been calibrated in the same manner, the time of the calibration, the calibration data, and other information are recorded in the first data file on track 1. The main program is then loaded, and the test begins.

3.2.4. Main program (RSL) test

When this file is automatically loaded by the AutoStart program, the program checks to see if there are any previously recorded data. If so, the AutoStart was run after a power failure. The test is then resumed. If not, the computer loads the initialization program. After the initialization program has been run, the program is resumed.

At the start of a new test, the computer will print out all of the necessary header information, the test title and the time of the calibration. On a restart, the operator comments from the last file recorded are printed out before the test proceeds.

The clock-timer is programmed to tick four times per second, and the interrupts on the GPIB are enabled. This allows the timer to request service from the computer. When this occurs, the computer branches to the interrupt routine which reads all 4 channels of the A-D converter. The data are then sorted, and placed in the proper variables. For the rest of the time, the computer remains in the monitor loop which will display either the date-time group, the A-D voltage readings, or the RSL levels, depending on the selection of the operator. At the end of each hour, the monitor sets the proper flags which then cause the computer to branch to the proper subroutines.

On each hour, the computer runs a "quick look", which prints a short statistical analysis of the hour's data on the 16-column printer. The past hour's data are then packed into a string array and stored. Every 12 hours, the 12-hour data array is recorded along with other identifying information, and the 12-hour array is cleared.

3.2.5. Data-tape directory

This program prints out a directory of the data files on the tape. If the short directory is run, just the file number and the time at which it was recorded are printed out. If the long directory is selected, the send and receive stations are printed out for file zero; the number of data points, along

with the number of complete hours and any operator comments are printed out for each file.

3.2.6. Data analysis I - statistical analysis

Data I totals all the points in each bin over the duration of the entire test. This forms a histogram from which a cumulative distribution, a running percentage, and a cumulative percentage of the data can be calculated. The histogram of all points on one data tape is stored in the last file on the tape.

Each of the distributions is printed as requested by the operator. If it is selected, the Rayleigh plot program is run using the data stored at the end of the tape.

3.2.7. Data analysis II - hourly medians

Data II calculates the median RSL for each hour for the duration of the test. The program allows the operator to delete unwanted or meaningless data files. (It is assumed that the File Directory program has already been run, to determine which files will be usable in this program.) The operator may choose to have the results printed, plotted, or both. If neither method of output is selected, the selection program is loaded and run.

During calculation, information that is to be printed is sent to the printer immediately, while information to be plotted is stored and retained until the plot routine is entered. While computation is taking place, the date-time group is flashed on the display to indicate that the computer is functioning.

In the plot routine, each median is plotted as a discreet point. Since there are only 19 calibration levels, there will be at most 20 discreet levels at which the dots will appear. (The twentieth level comes from all data points below the last calibration value.)

3.2.8 Rayleigh plots

This program loads the data processed by Data I, and plots it on a Rayleigh scale. The program forms a cumulative distribution from the data, and then plots it on a sheet of plain

white paper. The routine draws its own scale, and plots the data consistent with that scale. A Rayleigh distribution will appear on the scale as a straight line with a slope of -1.

3.2.9. Selection program

This program is loaded by an operator request to the main program, and is also loaded after the completion of any of the supporting programs. It allows the operator to select from any of the immediately executable programs on the tape.

3.2.10 New Tape Generation

This program duplicates all of the programs on track 0 of the master tape onto track 0 of the duplicate. Then it marks track 1 of the duplicate to accept data from the RSL test.

3.2.11. A-D test

This test instructs the operator to set up the analog-to-digital convertor for calibration, and then the program monitors and displays the four readings from the A to D, allowing the operator to adjust the gains and circuit conditioning on each channel.

3.3. Functioning of the Programs

3.3.1. Procedures for operation of the RSL test

The program tape should be placed in the computer's transport, and the special function overlay placed over the keys. The power should then be turned on by pushing the switch near the rear of the computer on the right-hand side away from the front of the machine. File 0 will be automatically loaded and run, and will, in turn, load and run the main program.

If this is a new test, the computer will immediately branch to the initialization program to enter the necessary information. If this is a restart of a test which has already been initialized, the instructions in Section 3.3.3 "Running the RSL Test" will apply here.

3.3.2. Initialization

This program sets up the instrumentation and initial data required by the RSL test. Enter parameters as requested by the program, and follow each response by depressing the

"CONTINUE" button. On entry of the initialization program, "RSL Initialize," is printed out. The current year is requested, and may be entered as either a two-digit or a four-digit number.

Setting the clock

The initialization program will enter the clock-setting routine. If the digital clock has already printed the correct time on the thermal printer, the routine may be exited by answering the first question with a "yes". A "yes" may be easily entered by pressing the special-function key f1. Otherwise, a "yes" is indicated by entering a 1, and pressing "CONTINUE". To enter a "no", use key f0, or a 0 followed by a CONTINUE will serve. If the previous time showing was close to the correct time, the enter questions for each of the time units may be defaulted to the correct value simply by pressing "CONTINUE", and the new setting for the clock will default to the previous one. Otherwise, the corrected value for the time unit must be entered at the keyboard if a change is desired. The computer will set all the time elements on the clock after the minutes are entered. There will be "please wait for clock to set" message for about one minute until the circuitry is updated. At the end of the routine, the computer prints out the current time according to the clock reading.

Channel information

Certain parameters must be entered for each channel so that operation of the RSL test can proceed in a properly documented manner.

The A-D range is defaulted to be HI(-5 to +5 volts). If the A-D has been changed, the change must also be recorded in the computer, so that the proper divisor is used in converting the 11-bit reading from the A-D to volts. If these default values need to be changed, the computer will enter a subroutine to handle the alteration.

For each channel, the operator is asked whether or not that channel is to be used. If not, the channel will be "down"

for the duration of the test. For the remaining "up" channels, the maximum calibration level, and the dB step size must be entered. The default values will be printed, and may be changed by entering another value. The default value will be used if, when the question appears, the CONTINUE button is pressed. A transmitter designator for each channel must be entered, the designator being the three-letter DCS site designator. For example, the transmitter station might be Heidelberg (HDG). Then, the designator would be HDG. The transmit frequency in GHz is entered also.

This information is entered for each channel, and then a receiver designator is entered for all of them. The receiver designator is the same for all channels and is entered only once (in the same format as for the transmitter designators).

A calibration should then be run for each of the up channels. This entails setting a signal generator to the reference value shown on the computer display, and pressing CONTINUE. That will record the present voltage reading from the A-D converter and the next lower calibration level will be shown on the computer display. The process is repeated until 19 levels have been calibrated. The calibration should be performed for each of the up channels.

After that, a test title of up to 50 characters should be entered. This test title will appear on the plot of data when the analysis is performed after the test. The initialization data are now ready to be recorded into the first data file. If the computer finds that there are already data in the initialization file, it will print and display a warning message. If it is intended to write over these data, and all other data on the tape, then a go-ahead may be given to the computer. Otherwise, a new RSL tape should be put in the transport before pushing the YES key.

Software details for the A-D converter and calibration curve

Each of the four channels has a status as determined by the initial calibration. If no data are to be recorded on that

channel, then a flag for that channel is set to zero. If the channel is active, then the flag is set to either +1 or -1. A positive sign on the flag indicates monotonically increasing calibration voltage values with increasing rf signal strength. A negative flag denotes an inverted calibration curve. This small amount of software housekeeping makes sorting data against the stored calibration curve an automatic process with no procedural differences, regardless of the manner in which the radio/AGC system operates. The sorting of acquired data is done by a five-step decision tree, which has the advantage of taking a fixed amount of time to determine in which histogram bin the datum belongs, regardless of the signal level. The decision tree is shown in Figure B-22 and its flowchart is Figure B-13. The A-D range is set by a jumper inside the device. Depending on which range is selected, an appropriate constant must be used to obtain dc volts from the value obtained by converting the bit pattern to decimal. The value of the factor is shown in Table 2-1.

Table 2-1. A-D Range Factor

Range	Max. Volts	Factor, R[I]
Low	±1.28	800
Medium	±3.42	300
High	±5.12	200
High-High	±10.24	100

There are four range factors R[1] thru R[4] for each of the four channels.

The 10-bit mantissa from the A-D divided by R[I] (where I is the channel number) is the correct relationship to determine the voltage. The initialization constants are stored in the A array for storage on tape. The constants are shown in Table 2-2. The recording of data onto tape, which occurs twice per day, saves each hour of the 12 hours' data, saves operator's comments, and saves the A array. The

first file on tape contains a test title, the A array, the calibration voltages, the A-D range factors, the receive and send station names, and the 4-link frequencies. Once these data are recorded the RSL test may be considered successfully complete, however the directory, analysis, and plotting programs make the data useful by compiling the results in usable forms. Additional programs may be added for further treatment of the data at any future time.

Table 2-2. RSL Test Initialization Constants

I	A[I] Array
1	Calibration reference level (dBm), Channel 1
2	" " " " Channel 2
3	" " " " Channel 3
4	" " " " Channel 4
5	Attenuation step size (dB) Channel 1
6	" " " " Channel 2
7	" " " " Channel 3
8	" " " " Channel 4
9	Channel 1 status and sense (-1, 0, +1)
10	" 2 " " " "
11	" 3 " " " "
12	" 4 " " " "
13	Flag status = $\sum_{0}^{15} 2^n \cdot (\text{flag}_n \text{ value})$
14	Number of files recorded on tape = F
15	Current year = U
16	Current Time: T (Mo Da Hr Mi Se)

3.3.3. Running the RSL test

After completion, the initialization program will load the RSL test. The main program will then load the initialization information from file 0 of the data track on the tape, and begin the test. It will first print out useful header information at the top of the printer tape. This tape should be preserved as a part of the RSL test documentation.

The test is then commenced. On each interrupt from the clock-timer, the computer reads and bins the data from the A-D converter. After each set of conversions, the conversion count is incremented.

The display

At the beginning of the test, the Date-Time Group (DTG) is shown on the display along with the current conversion count. Since the timer is set to interrupt four times a second, the displayed count should increment in the same manner. For a complete hour, the conversion count should be 14,400, or a few less.

Another display that is available is the A-D display. This shows the DC voltages on each channel of the A-D converter. To select the A-D display, press the special-function key labeled "f7". To return to the DTG display, press key f6.

The third display available is the RSL value of each of the four channels. The value in dBm to the closest dB is obtained by pressing f8 while the test is running. To return to the DTG display press key f6. The values shown in the RSL display are obtained by an actual interpolation of the measured voltages compared with the calibration curve. The function of each key is labeled on the overlay.

Run-time functions

While the test is running, there are certain functions that may be executed without interrupting the test. Although a "quick look" will be printed every hour, an instant "quick look" may be printed by pressing special-function key f2. A "quick look" in the standard form will be printed out without disturbing the test process.

The data from an uncompleted time segment less than 12 hours at the end of the test will not be recorded on the data tape unless the operator requests the action by pressing f3. This should always be done at the test's conclusion to prevent loss of the data in last 12-hour time block.

Power Failure

If the power to the computer is interrupted during the test, the programs and data in the computer's memory will be lost, and the test program must be reloaded. This will be completed by the Autoload feature on the computer, and the test will resume. If the operator wishes to log the reason why the power failed, he should press f5, which allows entry of such comments. The comment may be up to 50 characters long, and will be recorded on the tape along with the current 12 hours of data. Only one such comment is allowed per 12 hours.

When a power failure occurs, the digital clock will maintain the correct time up to one month if the Nickel-Cadmium battery is fully charged. The year is not maintained in the clock and must be obtained from the tape. No software routines were developed to index the year after December 31. Also the user should refer to the clock manual for February leap year settings.

Other functions

A few other functions are available through the special-function keys. The current data histogram on any of the four channels may be examined by pressing f14 (the shift of f2). This will simply print out a histogram of the data points in the channel selected.

If there is some question about the accuracy of the A-D converter or interface signal conditioning equipment, pressing f19 (the shift of f7) will show the readings of the A-D without storing them. This would allow minor adjustment of the A-D without disturbing the data already taken. WARNING: The calibration should be rerun if changes are made in the system. The storage of data is resumed by pressing f6, f7, or f9.

3.3.4. Other programs

After the final RSL test data have been recorded, programs for processing the stored data may be entered by pressing f4. This must be done while the DTG, A-D or RSL display are on the screen. It will not function after file 62 has been recorded. This will stop the main program, and ask the operator whether or not he wishes to terminate the test. If he answers "yes", the selection program will be loaded and run.

The selection program simply prints out a list of the available data processing programs, and allows him to choose from them. This may also be loaded and run by pressing the four keys RESET, LOAD, 9, RUN.

3.3.5. Data tape directory

The data tape directory will print out a list of files on the data track, including time the file was recorded. The selection of the long directory will print out operator comments, the number of points recorded per hour, and whether or not the file was complete. After the program encounters three null files, it will terminate and return to the selection program.

The only question asked by this program is whether the long or short directory is to be produced. The tape to be reviewed should be in the transport before running this directory program. At this point, it is a good idea to have the data tape protected against over writing.

3.3.6. Data Analysis I - a statistical analysis

Statistical analysis will be made on the contents of the data tape. After the tape directory has been run, there may be some files which appear to the operator to be invalid. The program will automatically remove files which were labeled "Null File", or "Invalid Data" by the file directory program. However, a file which was recorded while the equipment was malfunctioning might contain invalid data although the file would appear normal to the computer program.

The edit routine (for removing these files), is entered if requested, before the processing begins. If there is no need

to omit files, the initial question should be answered "no", and the program will process all data files until three null files, or the end of the tape is encountered.

In the edit routine, the program asks for a starting file. This question should be answered with the number of the first good data file. It then asks for an ending file. This should be answered with the number of the last good file in that block. The computer will examine and process all files between and including the specified files. Then it will return to the keyboard with a "Done?". If the answer to this question is "yes", it will go on to the printout section of the program. If the answer is "no", it will return to the edit routine, to allow the operator to append another block of files to the data already processed.

The printouts

There are four forms in which the data may be printed out. All are equivalent in the information they contain, but each presents the data from a different aspect. All four of the forms may be useful for some aspect of data analysis, but they may be selected individually, if only one or two of the forms is desired.

The histogram is simply the number of points in each bin that are equal to or above the given dBm level, and below the next higher one. The number appearing in each bin is the number of samples of the signal level that fell within that bin.

A cumulative distribution includes the number of sample points stored in that bin and all of the bins above it. This shows the number of points with RSL equal to or above the specified level. The number in the last (bottom) bin will be the total number of points sampled during the test.

A percentage histogram will show the percentage of the total number of points sampled, which have fallen in each bin. A cumulative percentage will show the percentage of points that fill the bins at that level and above. The last bin should always contain 100%.

Printing on the thermal printer will be the manner of displaying the processed data in the field, but at the base station, a plot of the data may be produced. If the plotter is available, the plot question may be answered with a "yes" if a plot is desired. If no plotter is available, the question should be answered "no", to prevent an error. If no plot is to be made, the computer will return to the selection program.

Rayleigh Plots

The data from the aforementioned statistical analysis program is stored at the end of the data track, and reloaded when the Rayleigh program is run. A sheet of standard sized (8 x 10 ½" minimum) white paper should be placed in the vertical position on the plotter, and smoothed down with the chart hold on. The paper is now ready, and the first question may be answered with a "yes".

The program will draw a Rayleigh scale, and will label it. The entire drawing of the scale will take a few minutes. When the scale is complete, the pen will move to the upper right corner, and "which channel" will be displayed. Entering a channel number will cause the distribution plot for that channel's data to be plotted. The color of the pen will be automatically changed, so that different channels may be easily distinguished. If a channel was down, it will be skipped. Entering a channel number greater than 4 or less than 1 will cause the computer to return to the selection program.

3.3.7. Data analysis II - hourly medians

This program will print and plot the hourly medians for each hour and each channel for the entire tape. The program allows the operator to select whether he wants the results printed, plotted, or both. If neither is selected, the computer returns to the selection program.

As with Data Analysis I, there is the capability of deleting bad files, but in this program, one can also delete

individual hours. If the edit routine is not used, the computer will automatically delete those files that contain invalid data. The processing will stop after three null files are encountered. The process can also be terminated by pressing f5 at any time during the computation. After f5 has been pressed, the program will continue processing until it comes to the end of a file.

If the editing routine is used, one may choose to edit files, or both files and hours. Editing files is faster than editing to the accuracy of hours. The file editing capability is present in either mode. The edit routine forms a masking matrix, which determines which hours are to be skipped. To omit an entire file, the routine simply blocks out that 12-hour portion of the matrix. The questions asked by the program may seem to appear in reverse order, but the program assumes that file zero will be the first file read, and everything after that follows the pattern set up at the start. If the operator answers the questions as they arise, proper results will be obtained. (For definition purposes: The ending file, i.e. the number entered, the ending hour, and starting file and hour will be included in the calculations. Only the hours between the ending and starting hours will be omitted.)

The processing then begins. The time at which the file being processed was recorded is displayed along with an indicator which shows that the machine is processing the data. After each hour is processed, another line will be printed if a printout was selected. Otherwise, just the time at which the file was recorded will be printed.

At the end of the processing, the operator will be asked if he is finished with the present tape. This question allows a loop back to the edit routine, if further processing is necessary. If he answers that he is finished, the program will allow him to remove the tape after it has been rewound. The computer will then ask if there is "Any more analysis" to be done. This is an opportunity to link the present data to data on another tape.

If a plot is selected, the program will enter the plot routine. Otherwise, it will return to the selection program. For the plot, the standard white paper is to be placed in the horizontal position. After the scale has been drawn and labeled, the pen will move to the upper right corner of the paper and a channel number will be requested. The program automatically changes the pen color, to distinguish channels. Entering a channel number less than 1 or greater than 4 will return the operator to the selection program.

Each one of the hourly medians must be plotted as a discrete point, which makes the plotting routine rather noisy. The finished plot will appear as a distribution.

3.3.8. The selection program

The selection program will print a list of the programs available on the program tape, and will allow selection of the program needed. The program number should be entered and the CONTINUE key depressed. This loads the proper program. If at any time the operator becomes "lost", and does not know which step to execute next, pressing the STOP and RUN button will return him to the program. Pressing f4 will usually return him to the selection program. Otherwise, typing "ldp 9" and then pressing EXECUTE will reload the selection program.

3.3.9. New-tape generation

The new-tape generation program will permit straightforward duplication of RSL programs from an old tape to a new tape. This is especially valuable in the field to obtain more RSL tapes for continued testing past one month. The original RSL tape must be write-protected (by sliding the record tab on the cartridge to the correct position). The data track on the new tape will be marked, but be left empty, ready for a new test.

3.3.10. A-D converter test

This program is very useful in the initial set-up and alignment of the signal conditioning equipment prior to beginning the RSL test. It permits the A-D to function as a

four-channel voltmeter with the same type of display as in the RSL test when f7 is pressed. It is also useful to align the zero and gain of the A-D converter if the range jumpers are changed.

4. SUMMARY

4.1. Features of the System

A long-term test to measure and analyze received signal levels of four microwave radios has been developed using commercial instrumentation and a programmable desk-top computer which uses the IEEE 488-1975 GPIB. Each radio channel is sampled four times a second and data are compared against a calibration curve and stored in one of 20 bins to form a histogram of a signal distribution. Each hour a set of "quick look" statistics is printed for the four channels, the data are stored in memory, and the histogram bins are reset to zero for the start of the next hour's data. Twice per day all the data in memory are recorded on a tape cartridge. The test will run for 31 days unattended and then it will stop.

Use of a digital X-Y plotter with the computer after the test is complete will produce labeled graphs on standard-size, plain paper. Either of two different analysis programs may be selected. One program plots the hourly medians for each of the channels' 744 hours (or less if the test was terminated prematurely). A sample plot is shown in Figure A-23. The other program plots the distribution of the four signals as a percent of the total test time the signal level exceeded a given value (e.g., -25 to -85 dBm). The scales and axes which are drawn on the paper will be true Rayleigh. A sample plot is shown in Figure A-18.

The entire development was software. No special equipment or hardware was needed. The instruments and controller are off-the-shelf stock. Running the test merely requires connecting the equipment, placing a small tape cartridge in the computer, and turning the computer on. After the operator

answers the initial questions, and performs a calibration as instructed by the program for each channel (using AGC or a logarithmic amplifier), the test will continue for one month. In case of a power failure, the test will stop, and when power is available, the test will automatically restart. Even the digital clock will keep correct time for one month with its NiCad battery without power.

4.2. Future of the System

This software package should prove very useful for testing new or special interest microwave paths. This package is typical of the modern instrumentation concepts where emphasis has been shifted from a hardware development to a software program that may be modified, embellished, and expanded as needs require. The hardware with the GPIB interface may be used for many other tests and purposes when the RSL test is not being used.

A logical sequel to this package is a package of multiple parameter measurements where several different types of inputs are correlated in real time and then the statistics are computed to show any interaction of the parameters. Such data can show the most sensitive parameters to monitor in a system and can serve as predictors of performance. For modern communication systems using PCM-TDM, such parameters could be BER, framing errors, three-level errors, a degradation monitor voltage, channel noise, and RSL. Other sequels to this package could be the monitoring of RSL from two different receivers on the same path and the instantaneous comparison of the RSL values to determine the effect of the diversity scheme and total system availability.

5. REFERENCES

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APPENDIX A. SAMPLE OPERATIONAL INFORMATION

A.1. Program Interaction

Figure A-1 is a flow chart for the operator showing how the various programs interact and call each other during the RSL test and the data analysis after the test.

A.2. Sample Printouts

This appendix contains samples of the typical printouts of the various RSL and related programs. The comments in the right-hand column of Figures A-2 through A-17, A-19 through A-22, and A-24 are to give an indication of what is required at that point in the program. Normally the operator is prompted by the L.E.D. display to enter data via the keyboard. The comments alongside the printout include mention of these prompts and entries in Figures A-2 through A-11. A feature of the computer permits all displays to be printed, and this feature was involved for the analysis process in Figures A-12 and following in the appendix.

The typical order of execution of the programs is first, to run the initialization program, followed by the RSL test. Then, the selection program is run, to permit the selection among the data analysis programs. The data analysis programs have no set order of execution, but the majority of them need to to be executed only once or twice per test.

Figures A-2 through A-5 deal with the Auto restart and Initialization programs. Figures A-5 through A-8 show the execution of the RSL test. Figures A-9 through A-11 show a sample execution of the file directory program. Figures A-12 through A-16 show the execution of the statistical analysis program. The Rayleigh plot program and a sample result are shown in Figures A-17 and A-18. The execution of Data Analysis II (hourly medians), is shown in Figures A-19 through A-23. Figure A-24 is a sample run of the A-D test used in the initial set-up. All data in this appendix have been simulated for the sake of format, and do not represent actual values.

A.3. Computer Keyboard

To facilitate the reading of the sample printouts referenced in A.2, a layout of the keyboard for the desk-top computer is shown in Figure A-25. The special-function keys mentioned previously are the 12 keys in the upper right-hand portion of the figure labeled f0 through f11. The CONTINUE key is used like a RETURN key commonly found on many computer terminals, i.e., it is depressed at the end of each set of data entry during program execution.

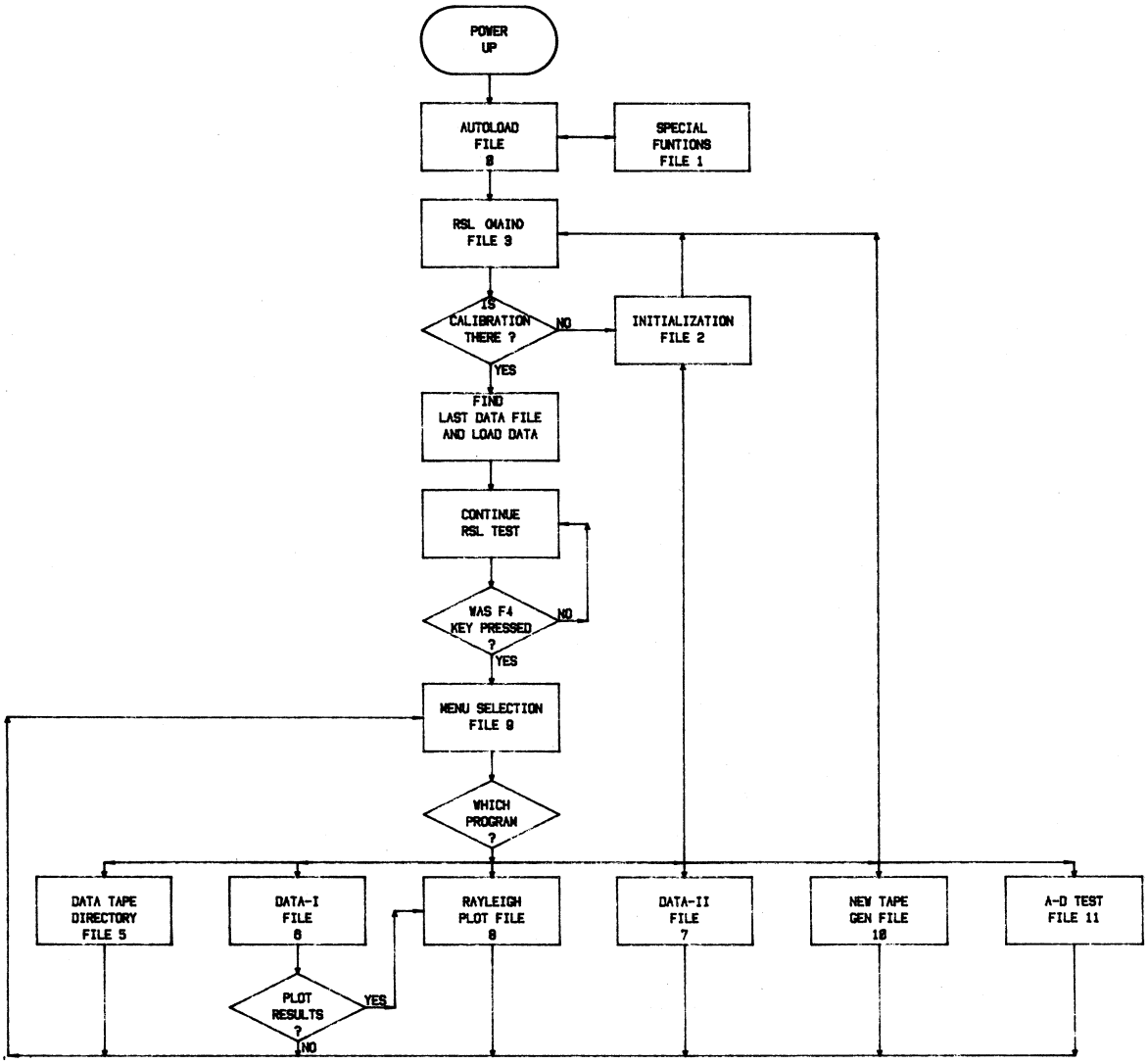
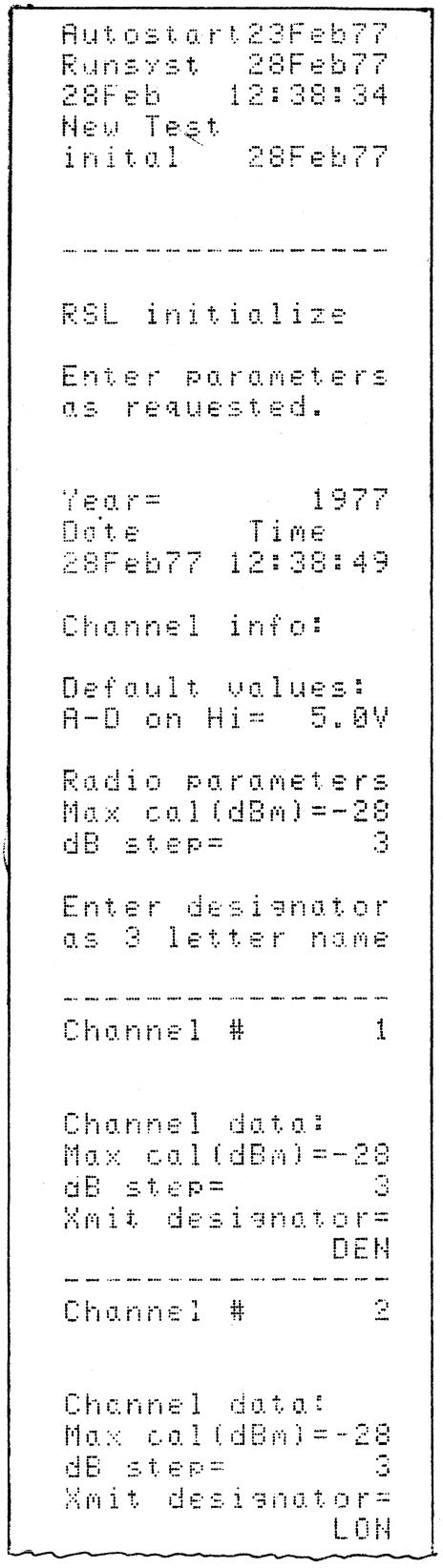


Figure A-1. Program interaction.



On a power up condition, file #0 is automatically loaded and run. It loads the RSL main program, which in turn loads the initialization program if no data is found in data file 0.

The operator is to enter each value as it is requested by the initialization program.

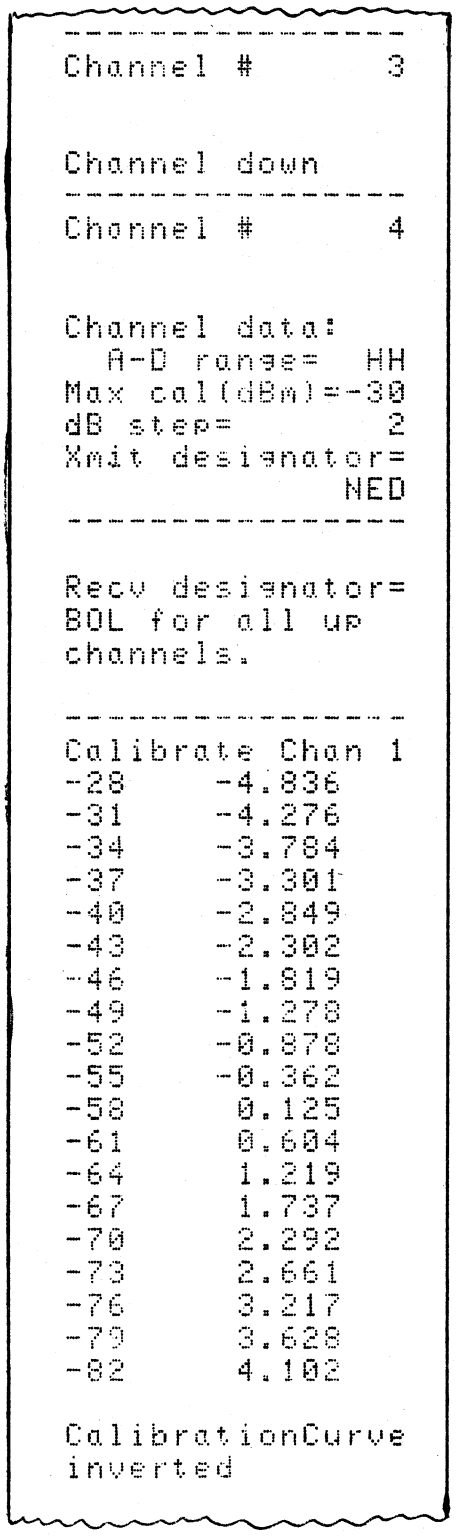
Operator enters the year number and sets the clock.

Default values are present as shown. The A-D is assumed to be set on range shown. The calibration signal is assumed to be -28 dBm, with 3 dB steps.

When asked, enter the station designator.

If present default values are to be changed, respond to display questions accordingly, otherwise default values will be stored.

Figure A-2. Run AutoStart and initialize.



```
-----------------
Channel #       3


Channel down
-----------------
Channel #       4


Channel data:
  A-D range=   HH
Max cal(dBm)=-30
dB step=        2
Xmit designator=
              NED
-----------------

Recv designator=
BOL for all up
channels.

-----------------
Calibrate Chan 1
-28      -4.836
-31      -4.276
-34      -3.784
-37      -3.301
-40      -2.849
-43      -2.302
-46      -1.819
-49      -1.278
-52      -0.878
-55      -0.362
-58       0.125
-61       0.604
-64       1.219
-67       1.737
-70       2.292
-73       2.661
-76       3.217
-79       3.628
-82       4.102

CalibrationCurve
inverted
```

For each channel, the proper information is entered. The operator responded here that Channel 3 is not in service.

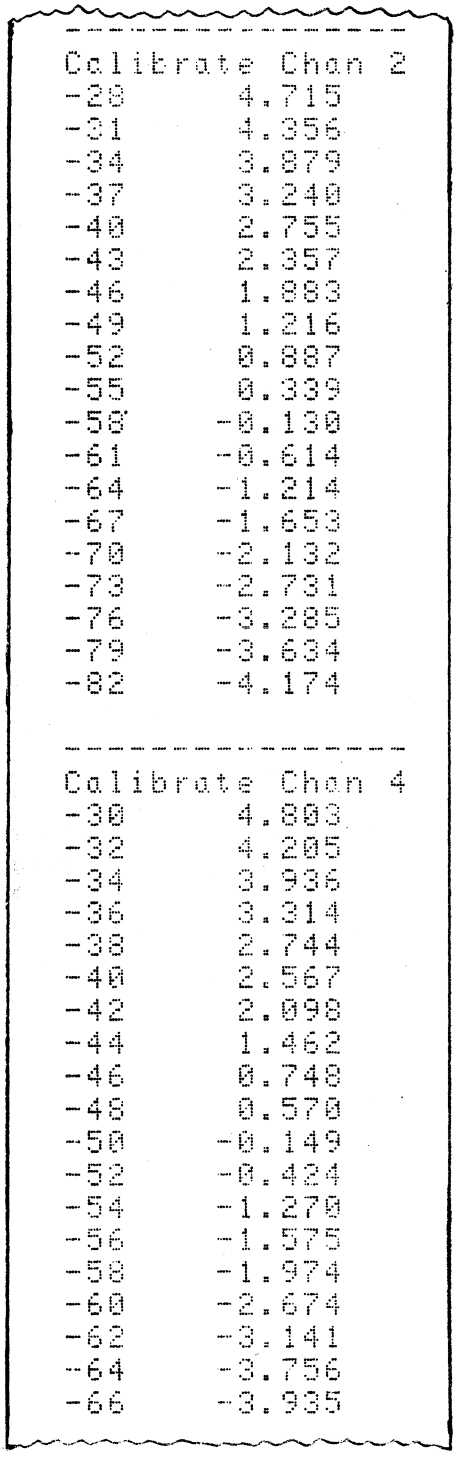
Then, the information is printed out on the printer for a record of what was entered. Notice the default values were changed.

A calibration is run for each of the up channels.

The operator must set the proper dBm level on input to the measurement equipment, and then press 'Continue'. The calculator then prints out the corresponding voltage as read from the A-D Converter.

Since the voltage increases as the RSL decreases, the curve is inverted from normal, and the calculator notes this fact and then continues normally.

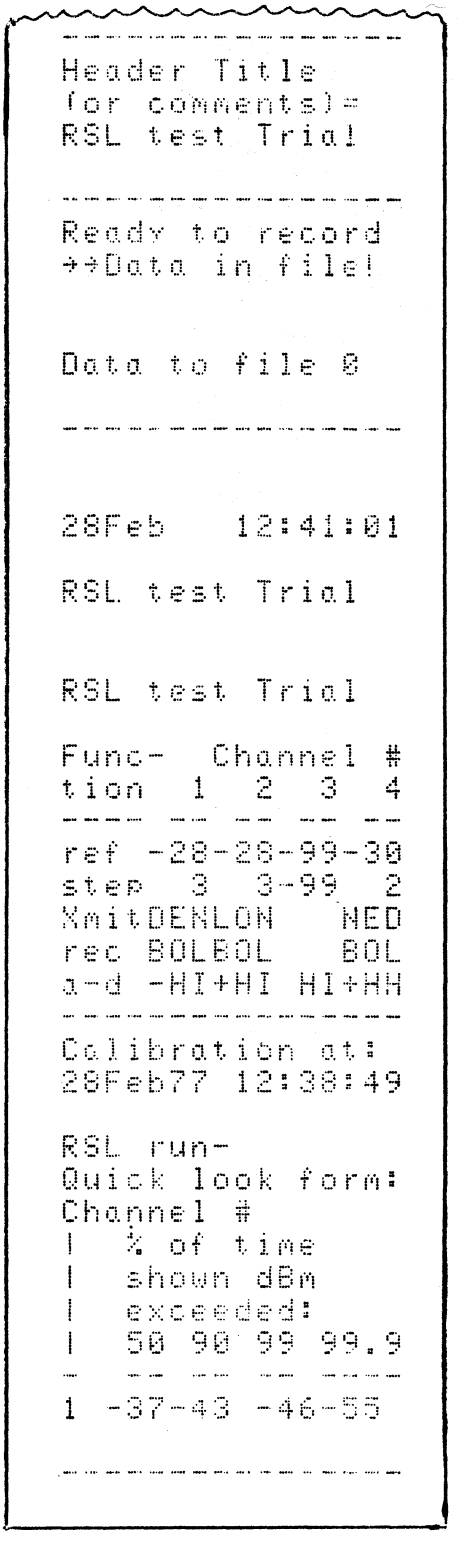
Figure A-3. Run of initialize.



```
-----------------
Calibrate Chan 2
-28        4.715
-31        4.356
-34        3.879
-37        3.240
-40        2.755
-43        2.357
-46        1.883
-49        1.216
-52        0.887
-55        0.339
-58       -0.130
-61       -0.614
-64       -1.214
-67       -1.653
-70       -2.132
-73       -2.731
-76       -3.285
-79       -3.634
-82       -4.174

-----------------
Calibrate Chan 4
-30        4.803
-32        4.205
-34        3.936
-36        3.314
-38        2.744
-40        2.567
-42        2.098
-44        1.462
-46        0.748
-48        0.570
-50       -0.149
-52       -0.424
-54       -1.270
-56       -1.575
-58       -1.974
-60       -2.674
-62       -3.141
-64       -3.756
-66       -3.935
```

Each channel may be calibrated and even repeated if desired. Entering a channel number less than or equal to 0 will end the calibration process.

Figure A-4. Sample calibration.



Then, the operator should enter a test title, which will identfy the test.

If there are already data in file zero, the calculator displays a warning. In this case, the test was a rerun, so it could be recorded over the old file 0.

BEGINNING OF RSL TEST

The RSL Main program is reloaded and resumed.

The header information and other test information is read from file zero and printed out.
For a down channel, any dBm level is printed out as -99.
If the calibration curve is inverted a minus (-) sign appears before the range designation.

The information at left is printed only at the beginning of the test.

Figure A-5. Sample start of RSL test.

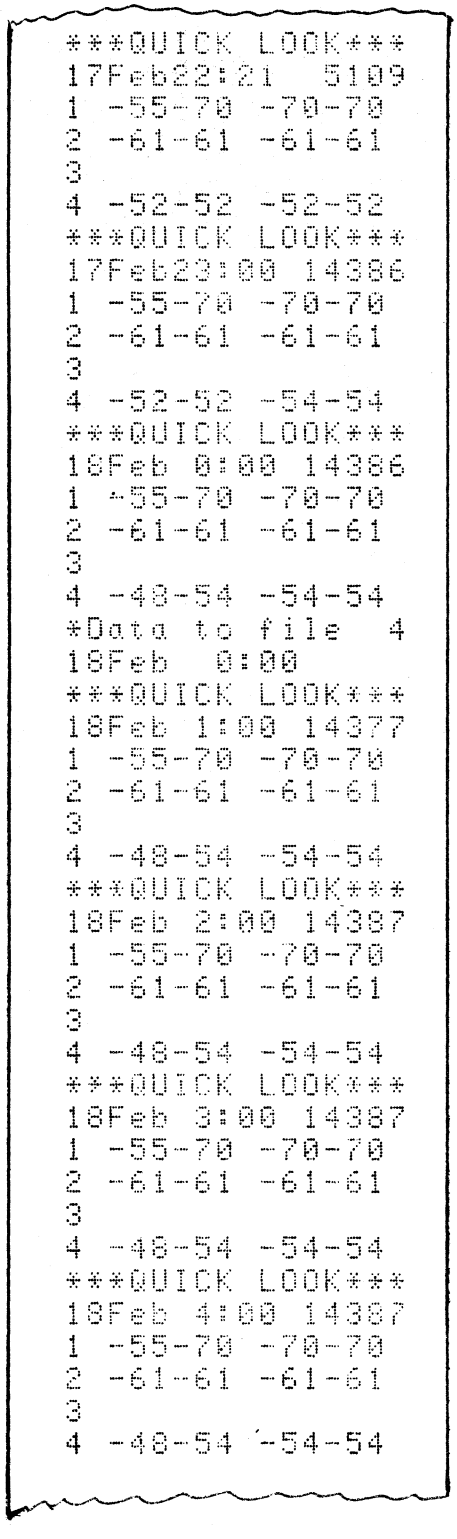
```
Autostart23Feb77
Restart  25Feb77
26Feb     2:19:08

OT/ITS test for
RSL (Wortendyke)


***Comments....
26Feb  2:19
Test restarted f
or weekend
***QUICK LOOK***
26Feb 3:00  9615
1 -55-70 -70-70
2 -55-64 -64-64
3
4 -52-52 -52-52
***QUICK LOOK***
26Feb 4:00 14386
1 -55-70 -70-70
2 -55-64 -64-64
3
4 -52-52 -52-52
***QUICK LOOK***
26Feb 5:00 14385
1 -55-70 -70-70
2 -55-64 -64-64
3
4 -52-52 -52-52
***QUICK LOOK***
26Feb 6:00 14385
1 -55-70 -70-70
2 -55-64 -64-64
3
4 -52-52 -52-52
***QUICK LOOK***
26Feb 7:00 14387
1 -55-70 -70-70
2 -55-64 -64-64
3
4 -52-52 -52-52
***QUICK LOOK***
26Feb 8:00 14385
1 -55-70 -70-70
2 -55-64 -64-64
3
4 -52-52 -52-52
```

The calculator was turned off and restarted, as if the power had failed. In this case, not all of the header infomation is printed out, and the test is resumed as quickly as possible.
The operator stopped the test to enter a comment. Perhaps to tell why the power failed.

The test now runs by itself and prints out a "quick look", a short analysis of the hour's data, for each hour of the test.

Note that Channel 3 is not in service as directed by the operator at the beginning of the test.

Figure A-6. Sample RSL output.



```
***QUICK LOOK***
17Feb22:21  5109
1 -55-70 -70-70
2 -61-61 -61-61
3
4 -52-52 -52-52
***QUICK LOOK***
17Feb23:00 14386
1 -55-70 -70-70
2 -61-61 -61-61
3
4 -52-52 -54-54
***QUICK LOOK***
18Feb 0:00 14386
1 -55-70 -70-70
2 -61-61 -61-61
3
4 -48-54 -54-54
*Data to file  4
18Feb  0:00
***QUICK LOOK***
18Feb 1:00 14377
1 -55-70 -70-70
2 -61-61 -61-61
3
4 -48-54 -54-54
***QUICK LOOK***
18Feb 2:00 14387
1 -55-70 -70-70
2 -61-61 -61-61
3
4 -48-54 -54-54
***QUICK LOOK***
18Feb 3:00 14387
1 -55-70 -70-70
2 -61-61 -61-61
3
4 -48-54 -54-54
***QUICK LOOK***
18Feb 4:00 14387
1 -55-70 -70-70
2 -61-61 -61-61
3
4 -48-54 -54-54
```

This page is included to show the recording of data into the next empty data file on track 1. Recordings normally occur at noon and midnight.

Figure A-7. Sample RSL output.

```
***List Data***
Bin  dBm   Chan# 1
 1   -28        0
 2   -31        0
 3   -34        0
 4   -37        0
 5   -40        0
 6   -43       20
 7   -46       16
 8   -49       10
 9   -52        9
10   -55       12
11   -58        9
12   -61        9
13   -64       11
14   -67       14
15   -70       17
16   -73       19
17   -76        0
18   -79        0
19   -82        0
20   -99        0

***List Data***
Bin  dBm   Chan# 2
 1   -28        0
 2   -31        0
 3   -34        0
 4   -37        0
 5   -40        0
 6   -43        0
 7   -46        0
 8   -49        1
 9   -52       43
10   -55       30
11   -58       23
12   -61       25
13   -64       56
14   -67        8
15   -70        0
16   -73        0
17   -76        0
18   -79        0
19   -82        0
20   -99        0
```

At any point, the test may be interrupted to obtain a printout of the current data histograms for any channel. This printout might yield information on why a channel seems to be down, or how signals are fading.

Figure A-8. Sample run of Listdata routine.

```
selecPrg  7Nov78


-------------

Which program?

 1) Initialize
 2) Run RSL test
 3) File Directy
 4) Data anal I
 5) Data anal II
 6) PlotRayleigh
 7) New Tape Gen
 8) A-D Test
 9) End

TapeDir   7Mar77

RSL data tape
Directory trk 1
----------------
File  0
11Mar77 15:15:00
RSL instrument t
est data (Thomas
)
----------------
File  1
12Mar77  0:00:00
----------------
File  2
12Mar77 12:00:00
----------------
File  3
13Mar77  0:00:00
----------------
File  4
13Mar77 12:00:00
----------------
File .5
14Mar77  0:00:00
----------------
Null file      6
----------------
Null file      7
----------------
Null file      8
----------------
end of files
```

After Initialization and the RSL test have been run, the operator may choose to load one of the other programs through the Selection program.

In this case, the operator chooses the program which produces a data tape directory.

This program loads file 0 from track 1, and prints out the test title, and the time at which the test was started.

For subsequent files, it simply prints out the time at which the data in the file was recorded.

If no data is found in a file, the program tags it as a null file.

After three null files have been found, the program stops, and turns to the selection program.

Figure A-9. Run of select and file directory.

```
TapeDir    7Mar77

RSL data tape
Directory trk 1
-----------------
File  0
16Feb77  8:53:10
OT/ITS test for
RSL (Wortendyke)

Ch Xmit    Recv
1   DEN to BOL
2   LON to BOL
4   NED to BOL
-----------------
File  1
16Feb77 12:00:00
OT/ITS test for
RSL (Wortendyke)
 1    2hr    20862
 2    2hr    20866
 4    2hr    20872
-----------------
File  2
17Feb77  0:00:00
OT/ITS test for
RSL (Wortendyke)
 1    2hr    25683
 2    2hr    25687
 4    2hr    25694
-----------------
File  3
17Feb77 10:37:23
Signal added to
Chan 2 and also
4 from sine wave
 1   10hr   143936
 2   10hr   143951
 4   10hr   143987
-----------------
File  4
18Feb77  0:00:00
"Data for analys
is"
 1   12hr   160987
 2   12hr   161004
 4   12hr   161050
-----------------
```

The operator may also select a long directory, in which any operator comments, and other useful information is printed out along with the time of recording.

The number of hours and number of data points recorded is shown for each up channel.

Figure A-10. Sample run, long file directory.

```
File   5
18Feb77 12:00:00

 1   12hr   172730
 2   12hr   172743
 4   12hr   172782
-----------------
File   6
24Feb77  0:00:00

 1   12hr   172056
 2   12hr   172074
 4   12hr   172112
-----------------
File   7
24Feb77  8:21:34

 1    8hr   105910
 2    8hr   105924
 4    8hr   105952
-----------------
File   8
25Feb77  9:09:35

 1    9hr   111126
 2    9hr   111140
 4    9hr   111170
-----------------
File   9
25Feb77 23:42:16

 1   11hr   146128
 2   11hr   146146
 4   11hr   146186
-----------------
File  10
26Feb77 12:00:00
Test restarted f
or weekend
 1   12hr   161633
 2   12hr   161652
 4   12hr   161695
-----------------
File  11
28Feb77  0:00:00
Test restarted f
or weekend
 1   12hr   148686
 2   12hr   148705
 4   12hr   148748
```

Figure A-11. Long file directory (cont.).

```
selecPrg  7Nov78


--------------

Which program?

 1) Initialize
 2) Run RSL test
 3) File Directy
 4) Data anal I
 5) Data anal II
 6) PlotRayleigh
 7) New Tape Gen
 8) A-D Test
 9) End

Enter program #?
4
Data I    10Mar77
press f8 to stop
 analysis.
Press 'CONTINUE'
 now

Do you wish to e
dit files
1
Starting file?
0
Ending file?
5
File   1 no hr 13
File   1 no hr 14
File   1 no hr 15
File   2 complete
File   3 complete
File   4 complete
File   5 complete
1
Histogram?
1
```

In this case, the operator selects Data Analysis I, a statistical analysis of the data. If the operator wishes to terminate execution in the middle of the program, he must press special function key 8. The program stops to make certain he sees the message. The operator is allowed to enter a file editing routine in order to remove from the calculation files containing invalid or inconsistent data.

The computer expects to see twelve hours of data in a file, and prints out an appropriate message if one or more are missing Otherwise, a list of the complete files is printed out as they are processed.

Done? is displayed on the calculator, and the operator answers yes, Otherwise, the program

Figure A-12. Sample run, Data I.

Histogram of all data points

Bin	dBm	#Points
Ch 1 DEN to BOL		
1	-35	7
2	-38	0
3	-41	0
4	-44	1
5	-47	0
6	-50	0
7	-53	0
8	-56	0
9	-59	17121
10	-62	156257
11	-65	313895
12	-68	235978
13	-71	91382
14	-74	937
15	-77	0
16	-80	0
17	-83	0
18	-86	0
19	-89	0
20	-99	0
Ch 2 LON to BOL		
1	-35	0
2	-38	0
3	-41	0
4	-44	0
5	-47	0
6	-50	0
7	-53	0
8	-56	1948
9	-59	16293
10	-62	179878
11	-65	220746
12	-68	246557
13	-71	144661
14	-74	5495
15	-77	0
16	-80	0
17	-83	0
18	-86	0
19	-89	0
20	-99	0

branches back to the beginning of the edit routine. When asked if he would like a histogram of the compiled data, the operator answers yes, and it is printed out.

Figure A-13. Data I.

```
Print cumulative
 distribution?
1
Cumulative
  distribution

Bin dBm  #Points

Ch 1  DEN to BOL
----------------
 1 -35          7
 2 -38          7
 3 -41          7
 4 -44          8
 5 -47          8
 6 -50          8
 7 -53          8
 8 -56          8
 9 -59      17129
10 -62     173386
11 -65     487281
12 -68     723259
13 -71     814641
14 -74     815578
15 -77     815578
16 -80     815578
17 -83     815578
18 -86     815578
19 -89     815578
20 -99     815578

Ch 2  LON to BOL
----------------
 1 -35          0
 2 -38          0
 3 -41          0
 4 -44          0
 5 -47          0
 6 -50          0
 7 -53          0
 8 -56       1948
 9 -59      18241
10 -62     198119
11 -65     418865
12 -68     665422
13 -71     810083
14 -74     815578
15 -77     815578
16 -80     815578
17 -83     815578
18 -86     815578
19 -89     815578
20 -99     815578
```

The operator also may request a cumulative distribution, which is then printed on the thermal printer.

Figure A-14. Data I.

```
Percentages of d
ata points?
1
Percent RSL data
points at level

Ch 1  DEN to BOL
-----------------
 1 -35    0.0009%
 2 -38    0.0000%
 3 -41    0.0000%
 4 -44    0.0001%
 5 -47    0.0000%
 6 -50    0.0000%
 7 -53    0.0000%
 8 -56    0.0000%
 9 -59    2.0992%
10 -62   19.1591%
11 -65   38.4874%
12 -68   28.9338%
13 -71   11.2046%
14 -74    0.1149%
15 -77    0.0000%
16 -80    0.0000%
17 -83    0.0000%
18 -86    0.0000%
19 -89    0.0000%
20 -99    0.0000%

Ch 2  LON to BOL
-----------------
 1 -35    0.0000%
 2 -38    0.0000%
 3 -41    0.0000%
 4 -44    0.0000%
 5 -47    0.0000%
 6 -50    0.0000%
 7 -53    0.0000%
 8 -56    0.2388%
 9 -59    1.9977%
10 -62   22.0553%
11 -65   27.0662%
12 -68   30.2310%
13 -71   17.7372%
14 -74    0.6738%
15 -77    0.0000%
16 -80    0.0000%
17 -83    0.0000%
18 -86    0.0000%
19 -89    0.0000%
20 -99    0.0000%
```

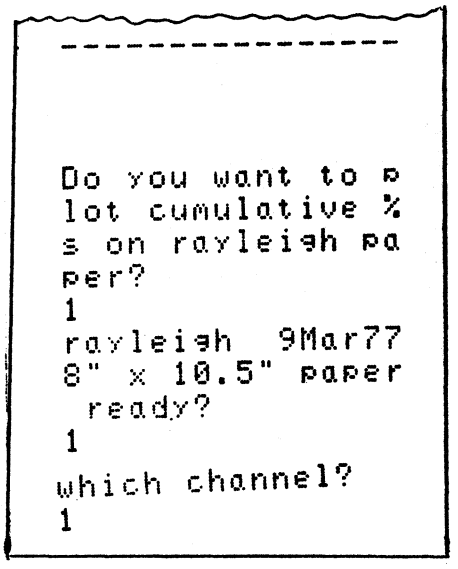
The program also shows the percentage of the total number of points that fell in each bin.

Figure A-15. Data I.

```
Cumulative Perce
ntages?
1
Percent RSL data
above level

Ch 1  DEN to BOL
-----------------
 1 -35    0.0009%
 2 -38    0.0009%
 3 -41    0.0009%
 4 -44    0.0010%
 5 -47    0.0010%
 6 -50    0.0010%
 7 -53    0.0010%
 8 -56    0.0010%
 9 -59    2.1002%
10 -62   21.2593%
11 -65   59.7467%
12 -68   88.6805%
13 -71   99.8851%
14 -74  100.0000%
15 -77  100.0000%
16 -80  100.0000%
17 -83  100.0000%
18 -86  100.0000%
19 -89  100.0000%
20 -99  100.0000%

Ch 2  LON to BOL
-----------------
 1 -35    0.0000%
 2 -38    0.0000%
 3 -41    0.0000%
 4 -44    0.0000%
 5 -47    0.0000%
 6 -50    0.0000%
 7 -53    0.0000%
 8 -56    0.2388%
 9 -59    2.2366%
10 -62   24.2919%
11 -65   51.3581%
12 -68   81.5890%
13 -71   99.3262%
14 -74  100.0000%
15 -77  100.0000%
16 -80  100.0000%
17 -83  100.0000%
18 -86  100.0000%
19 -89  100.0000%
20 -99  100.0000%
```

A cumulative percentage of all the points may be listed also.

Figure A-16. Data I.



At this point, the operator can branch to a program which plots the cumulative percentages out on a Rayleigh scale, or return to the selection program.

Rayleigh first draws a Rayleigh vs. dB scale on a blank sheet of paper, and then plots the data from the Statistical Analysis on the graph.

Figure A-17. Sample run of Rayleigh.

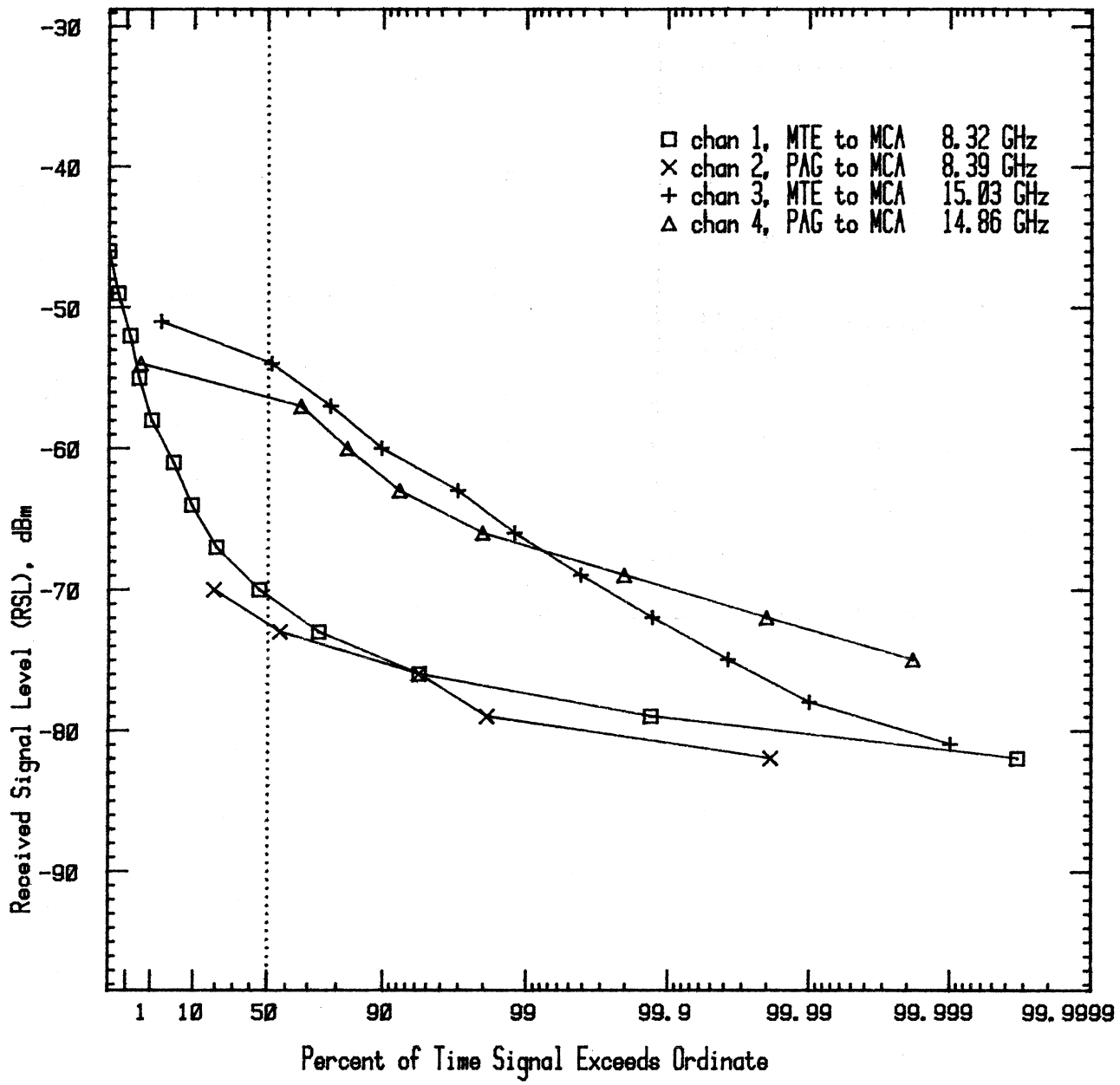
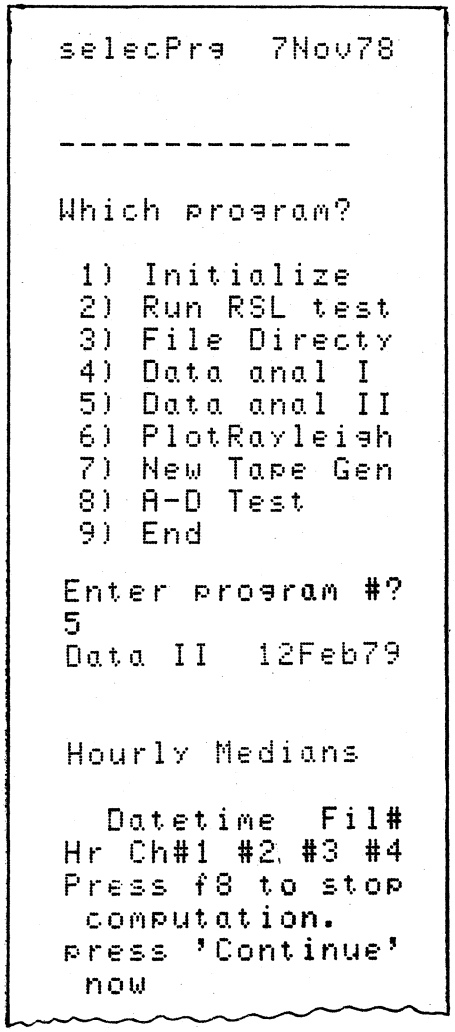


Figure A-18. Sample output from Rayleigh.



Next, the selection program is again loaded and run.

This time, the operator selects Data Analysis II, a tabulation of the median dBm value in each of the hours for the entire test.

Header information is printed in case the operator chooses to have the results output on the thermal printer.
He must press special-function key 8 in order to terminate computation prematurely. The program stops to be certain he sees the message.

Figure A-19. Sample run, hourly medians.

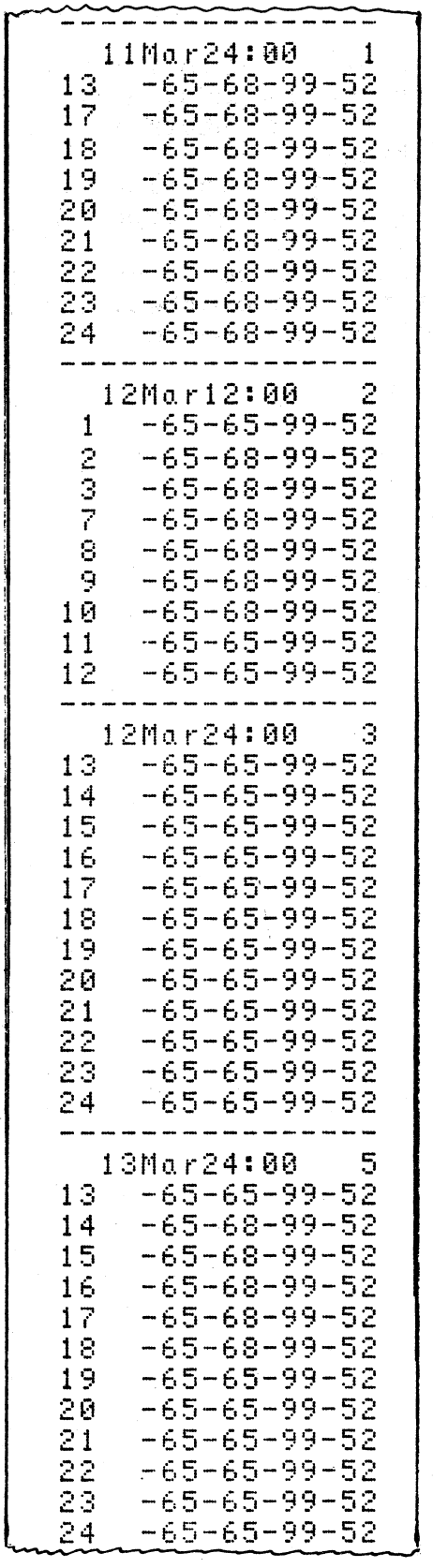
```
Print out hourly
 medians?
1
Plot hourly medi
ans?
1
Do you wish to e
dit files?
1
do you wish to e
dit hours?
1
1st ending file?
 must read file0
2
last hour of las
t file?
3
Done with editin
g?
0
next starting fi
le?
2
starting hour of
 next file
7
next ending file
?
3
last hour of las
t file?
24
Done with editin
g?
0
next starting fi
le?
5
starting hour of
 next file
13
next ending file
?
5
last hour of las
t file?
24
Done with editin
g?
1
```

The operator may choose whether he wants the results printed out, plotted, or both.

If neither is selected, the program returns to the select program.

The operator is allowed to edit just files, or files and hours, so he may get the median of just one hour, or pick out and eliminate a bad hour from a file. He can also eliminate an entire file or a set of them with equal ease.

Figure A-20. Editing routine, hourly medians.

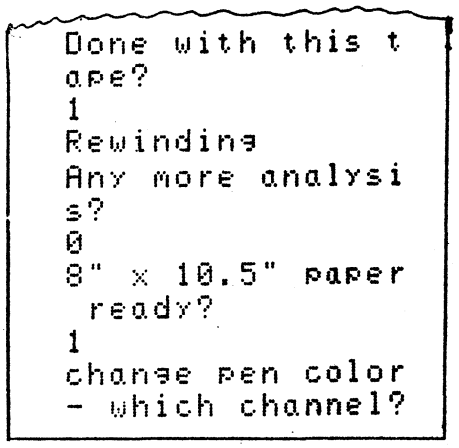


```
----------------
  11Mar24:00   1
13  -65-68-99-52
17  -65-68-99-52
18  -65-68-99-52
19  -65-68-99-52
20  -65-68-99-52
21  -65-68-99-52
22  -65-68-99-52
23  -65-68-99-52
24  -65-68-99-52
----------------
  12Mar12:00   2
 1  -65-65-99-52
 2  -65-68-99-52
 3  -65-68-99-52
 7  -65-68-99-52
 8  -65-68-99-52
 9  -65-68-99-52
10  -65-68-99-52
11  -65-65-99-52
12  -65-65-99-52
----------------
  12Mar24:00   3
13  -65-65-99-52
14  -65-65-99-52
15  -65-65-99-52
16  -65-65-99-52
17  -65-65-99-52
18  -65-65-99-52
19  -65-65-99-52
20  -65-65-99-52
21  -65-65-99-52
22  -65-65-99-52
23  -65-65-99-52
24  -65-65-99-52
----------------
  13Mar24:00   5
13  -65-65-99-52
14  -65-68-99-52
15  -65-68-99-52
16  -65-68-99-52
17  -65-68-99-52
18  -65-68-99-52
19  -65-65-99-52
20  -65-65-99-52
21  -65-65-99-52
22  -65-65-99-52
23  -65-65-99-52
24  -65-65-99-52
```

The operator may wish to run this program more than once, since one run will expose those files and hours which might contain bad data.

The output is in this format. The time at which the last hour in a file was recorded, is printed out at the head of a file block. The individual hours are printed on the left of the following rows, and the median dBm values for the four channels in that hour are printed on the right.

Figure A-21. Sample output, hourly medians.



When all that is finished, this question appears, allowing the operator to return for further editing.
The operator is also able to link to another tape through this question.
If the operator wants to have the results plotted, the plot routine is entered.

Figure A-22. Hourly medians.

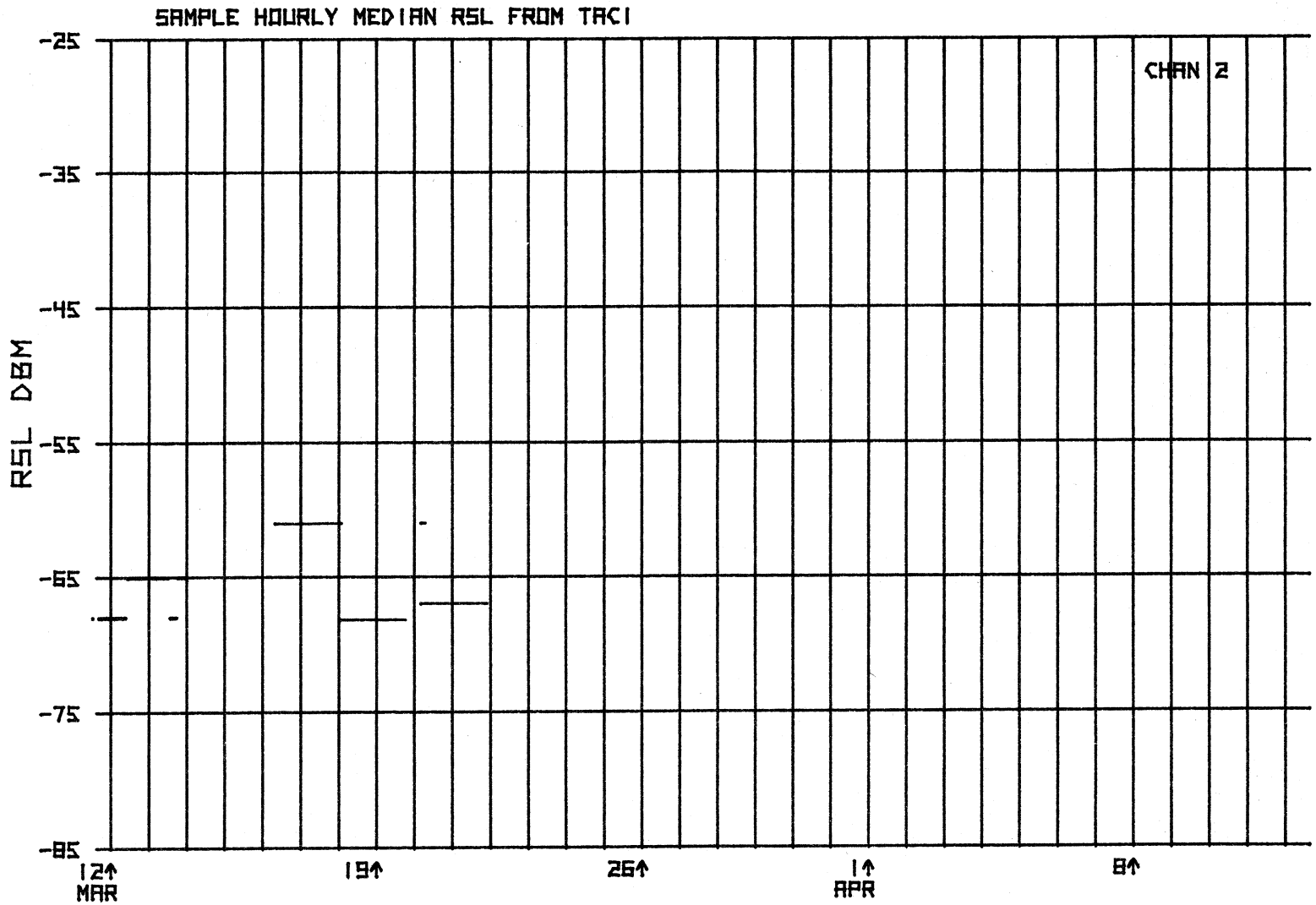


Figure A-23. Sample plot, hourly medians.

```
A-D Test 12Feb79

-----------------
HP 47310A
A/D Converter
Test
-----------------

Address set @ 06
ie:
CONTROL SWITCHES
   0000110

-----------------

Pg 2-4:AD manual
shows jumpers &
how to set for
range.
#   Range      Vmax
1   Low         1.3
2   Medium      3.5
3   High        5.0
4   Hi-Hi      10.3

Set all same
for this test.

Remove all input
jacks from A/D;
Set CAL switch
to            0 Vdc
Adjust chan ZERO

Then CAL switch
to           -5 Vdc
Adjust chan GAIN
```

Software for test is set up for address switch setting of 6.

Operator should set all the jumpers to the proper range.

Operator is to set CAL switch to Ø volts and adjust to ZERO setting on each channel.

Operator is to set CAL switch to -5 and adjust the GAIN setting for each channel.

Figure A-24. Sample run, A-D test.

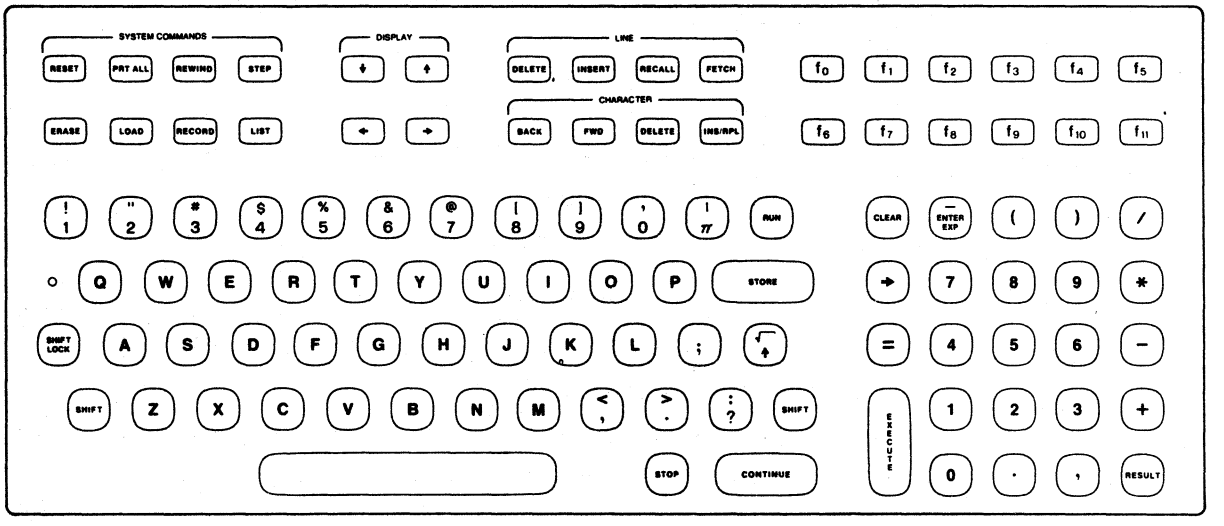


Figure A-25. Desk-top computer keyboard.

APPENDIX B. FLOWCHARTS

B.1. Tape Listing

Table B-1 shows the location of each of the principle programs on the program tape. Note that all of these programs are on track 0. The second track (number 1) is reserved for data.

B.2. Flowcharts

Table B-2 is a directory of flowcharts which appear in this section. This section contains a continuous (self-referencing) set of flowcharts. When another page of the flowcharts is referenced, the new flowchart number appears in parentheses below the branching label. When a new program is entered, the file containing it, and its title are shown in the upper left corner of the page. The flowcharts are shown in Figures B-1 through B-21. The decision tree for "sortData" routine is shown in Figure B-22.

Table B-1. Program Locations on Track 0

Name	Tape File #
Auto Start	0
Initialization	2
RSL Test (Main Program)	3
Data Tape Directory	5
Data I (Statistical Analysis)	6
Data II (Hourly Medians)	7
Rayleigh (Plot)	8
Selection (Menu Program)	9

Table B-2. Flowchart Directory

Name	Chart #	File #
Autoload	1	0
Initialization	2	2
RSL Main Program	3-5	3
Data File Directory	6	5
Data I (Statistical Analysis)	7-8	6
Data II (Hourly Medians)	9,10	7
Rayleigh (Plot)	11	8
Select (Menu Program)	12	9
"sortData"	13	-
"setclk"	14	-
"readclk"	15	-
"calibrate"	16	-
"compute"	17	-
"Quicklook"	18	-
"comment"	19	-
"record"	20	-
"Listdata"	21	-

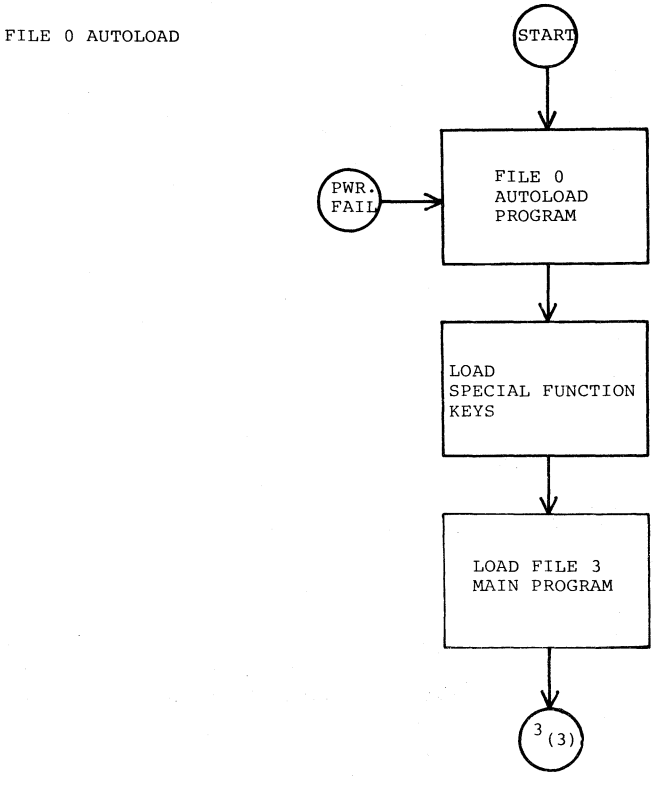


Figure B-1. Flowchart 1, Autoload.

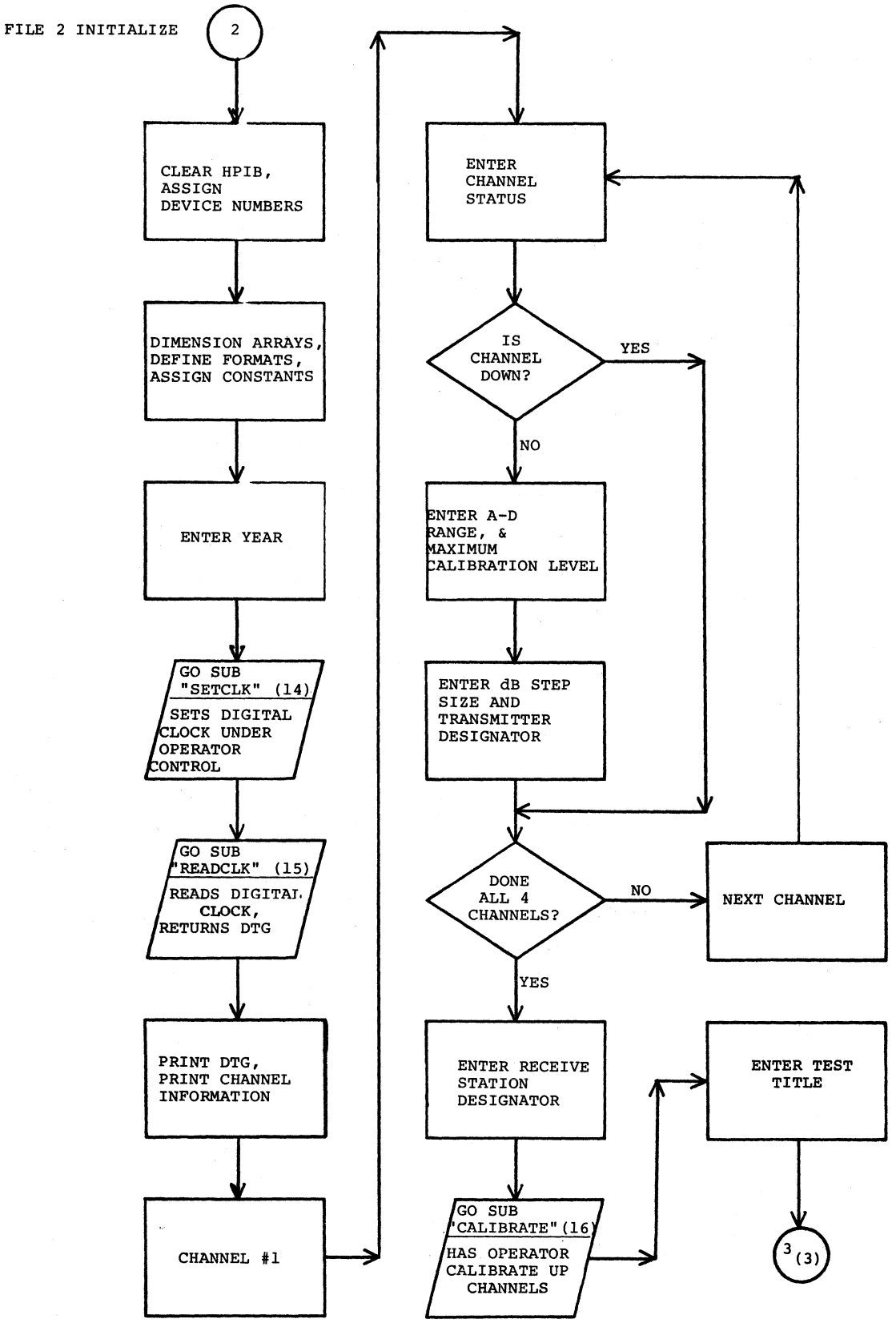


Figure B-2. Flowchart 2, initialization.

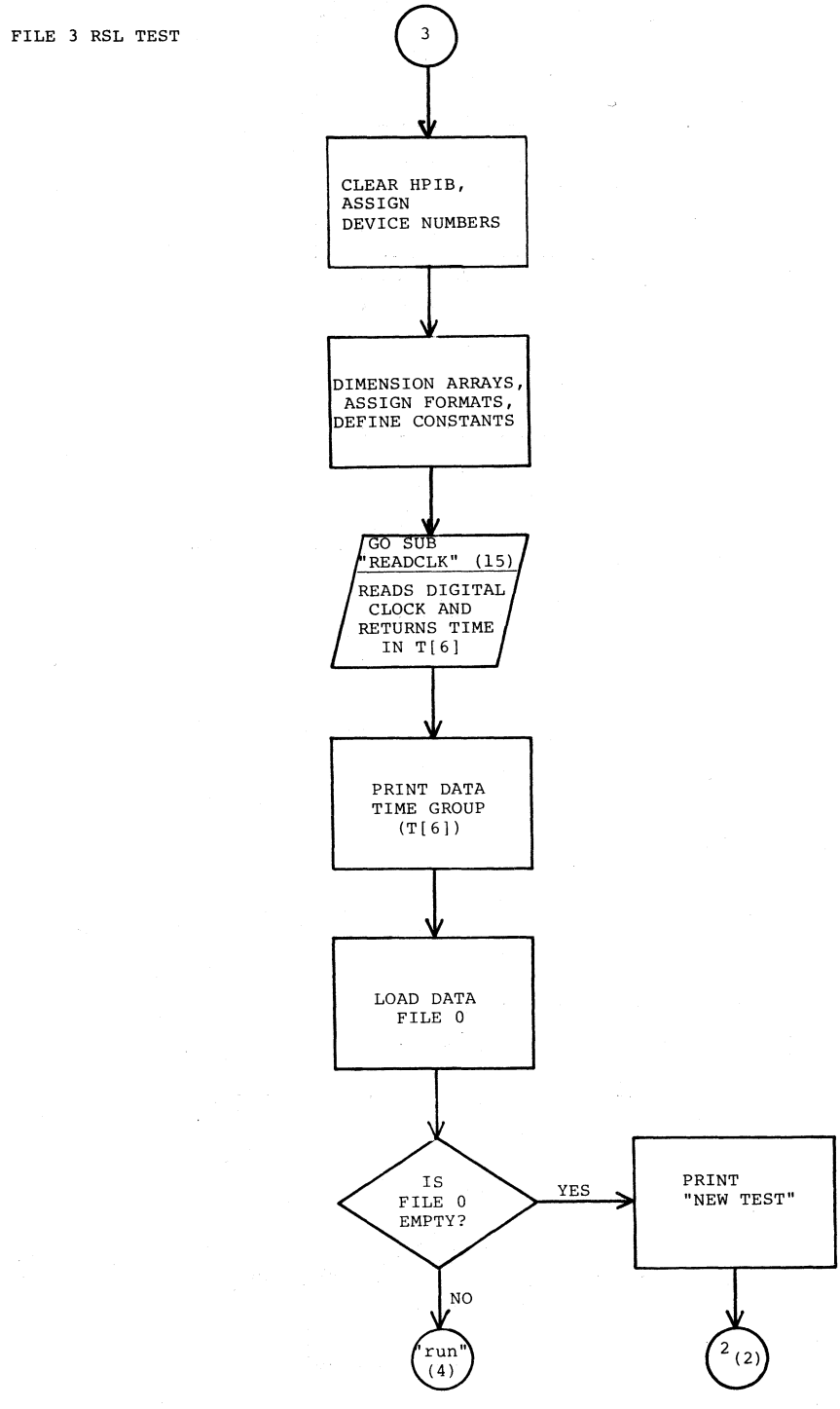


Figure B-3. Flowchart 3, RSL main program housekeeping.

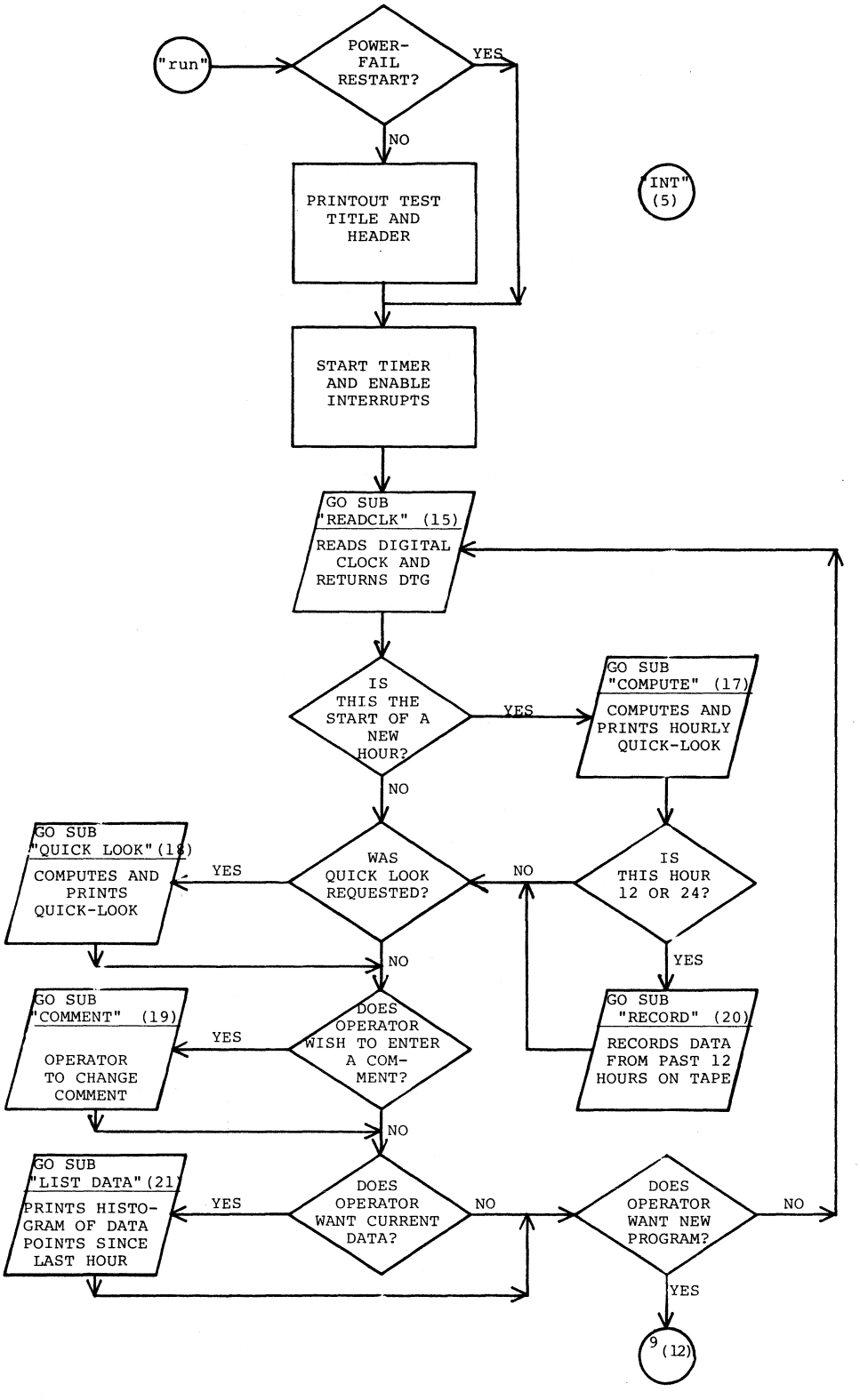


Figure B-4. Flowchart 4, RSL main program housekeeping.

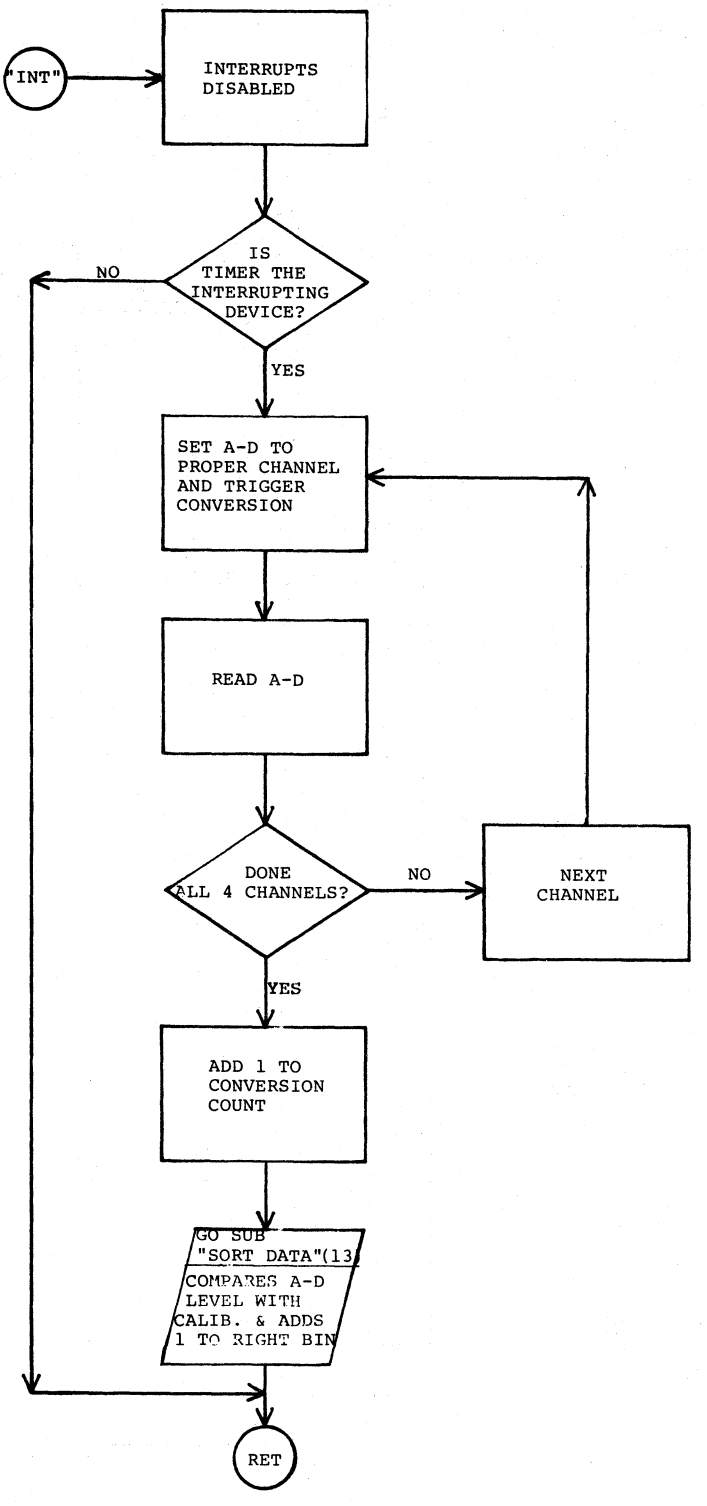


Figure B-5. Flowchart 5, interrupt routine.

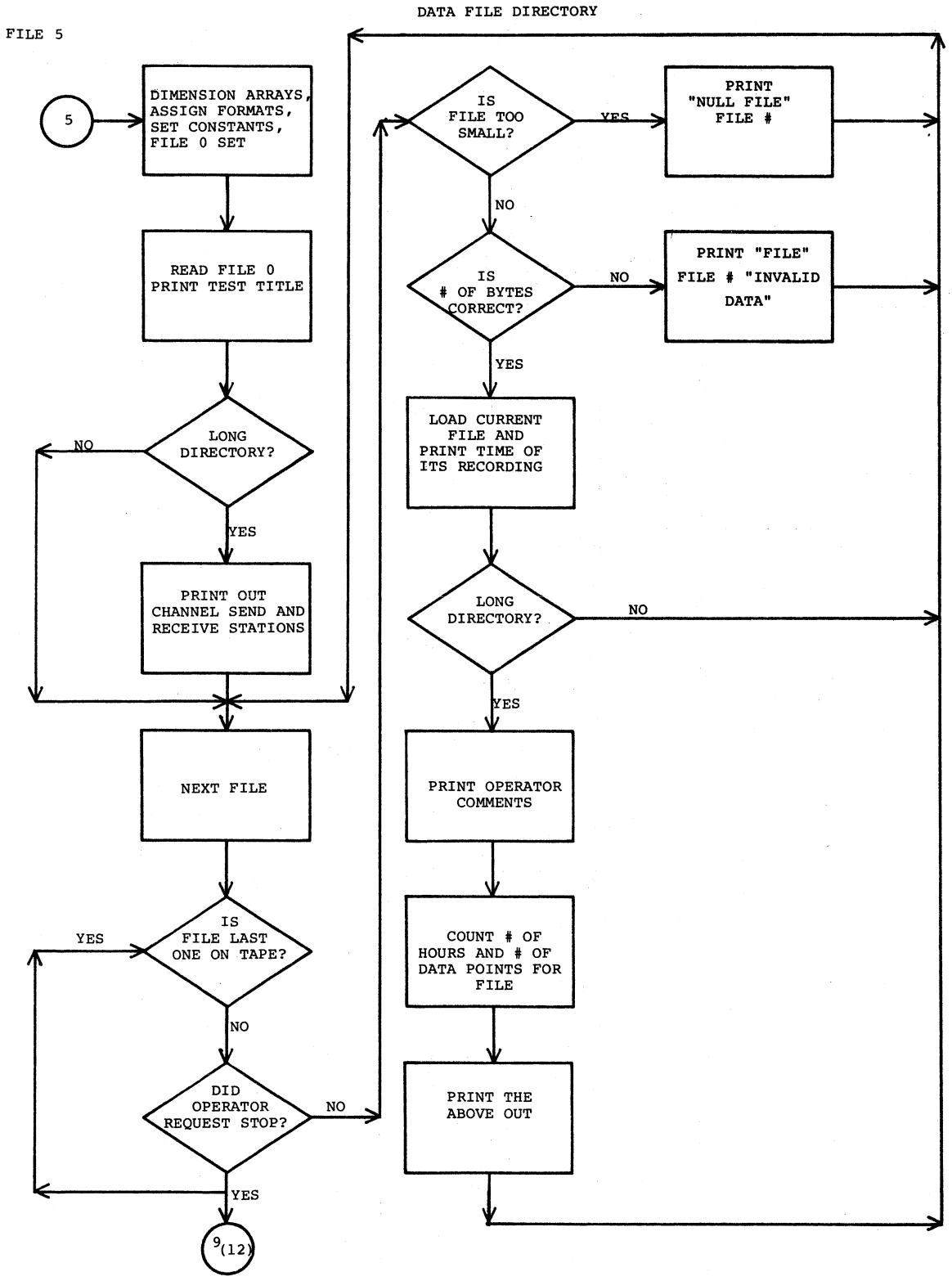


Figure B-6. Flowchart 6, data file directory.

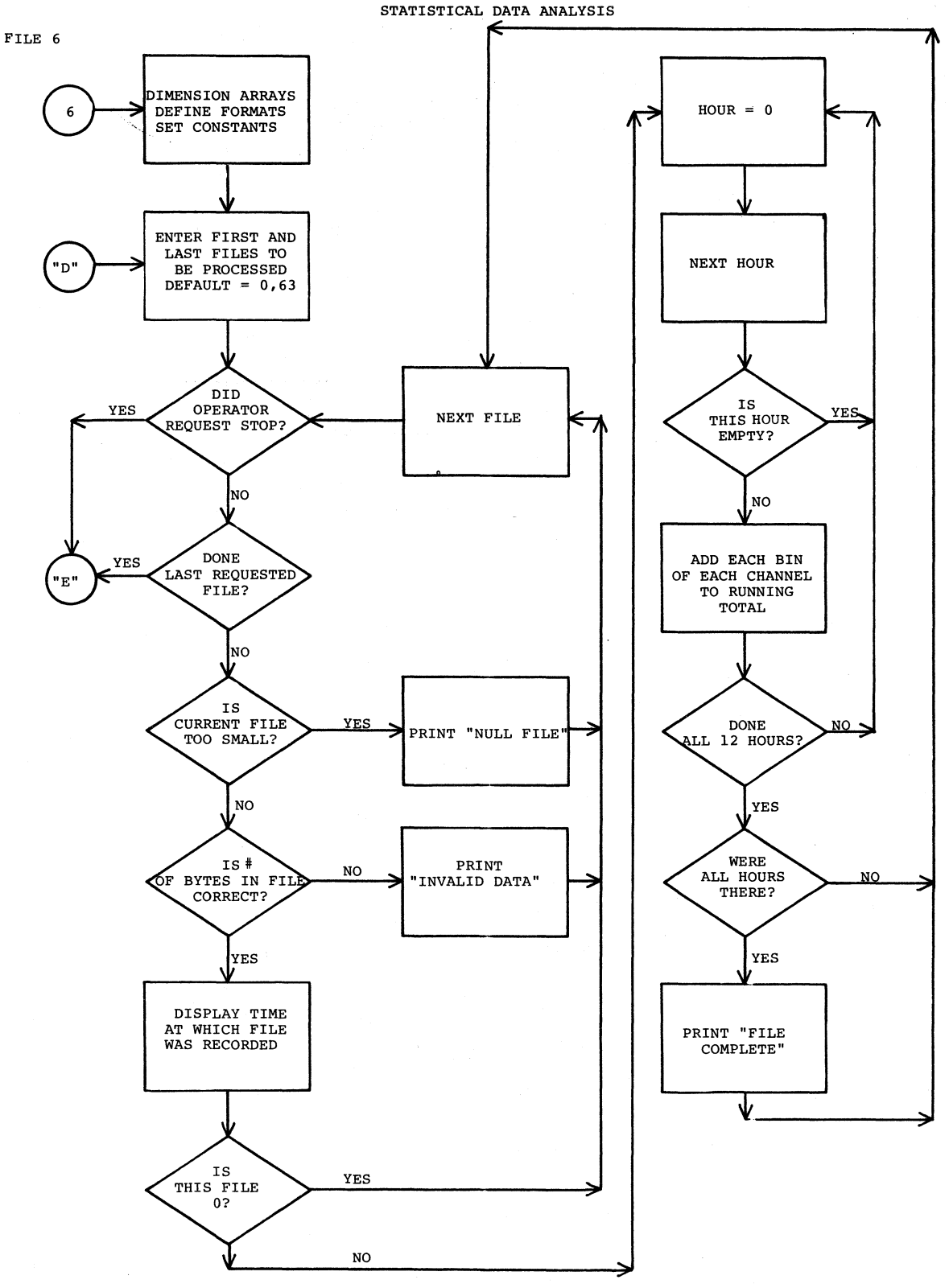


Figure B-7. Flowchart 7, statistical data analysis.

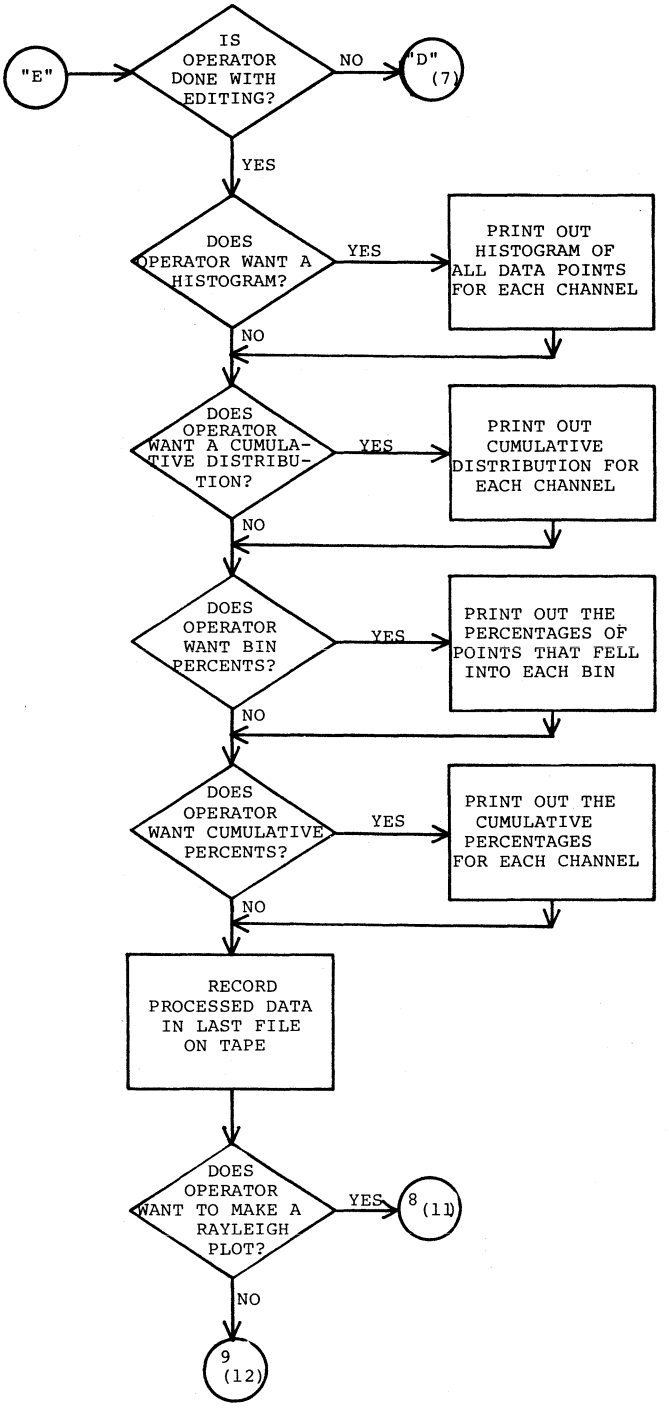


Figure B-8. Flowchart 8, statistical data analysis (cont.).

FILE 7 HOURLY MEDIANS

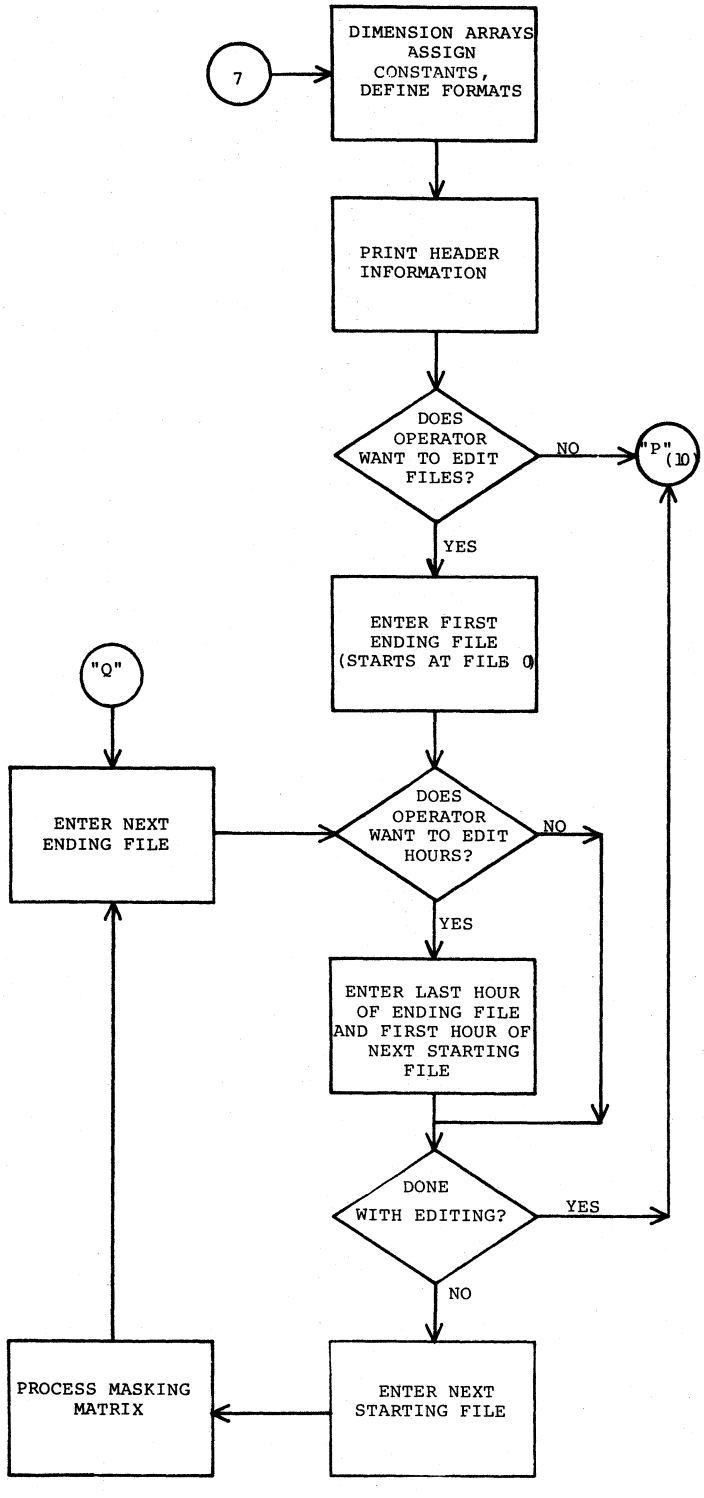


Figure B-9. Flowchart 9, hourly medians.

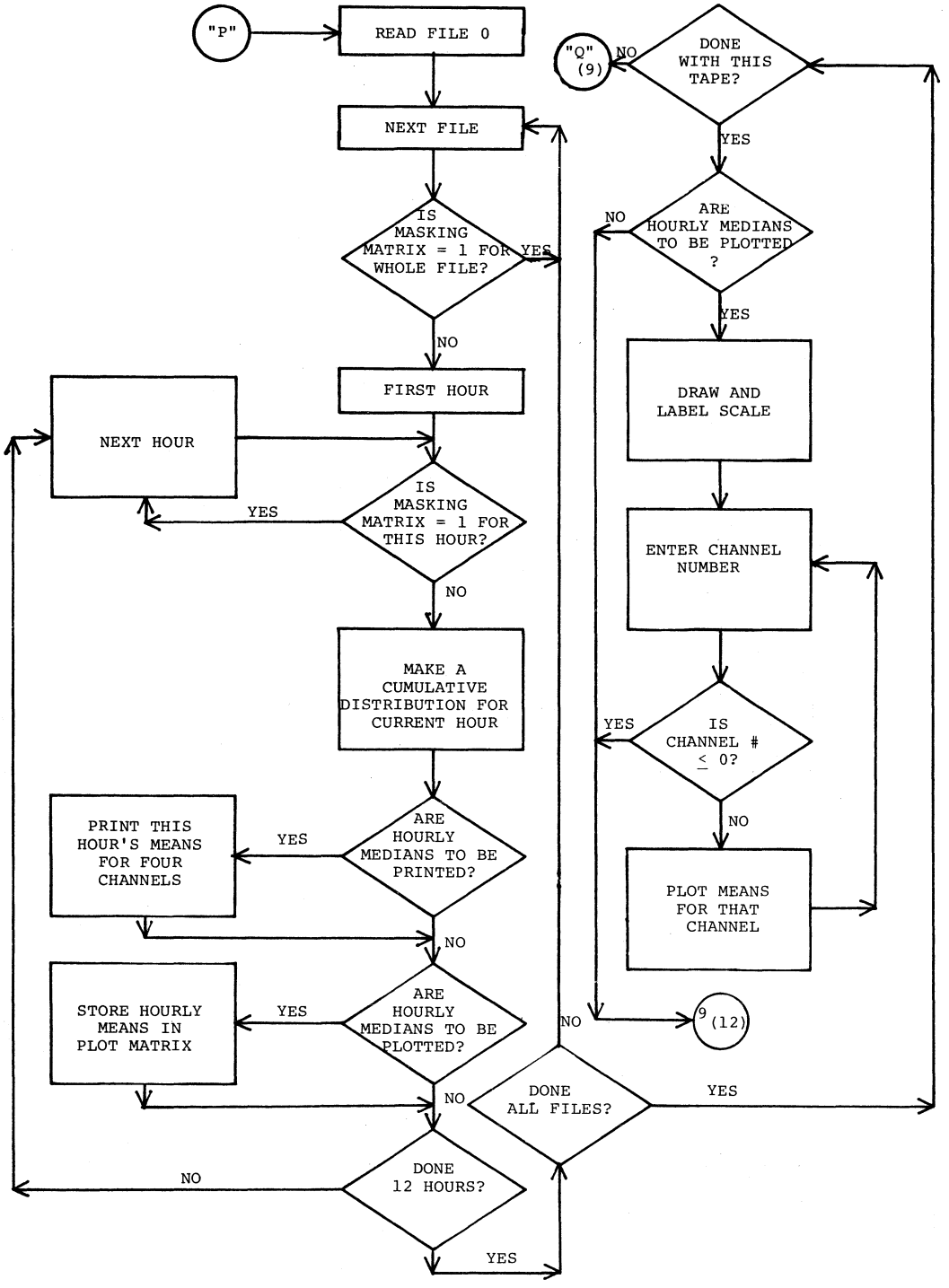


Figure B-10. Flowchart 10, hourly medians (cont.).

FILE 8 RAYLEIGH GRAPH

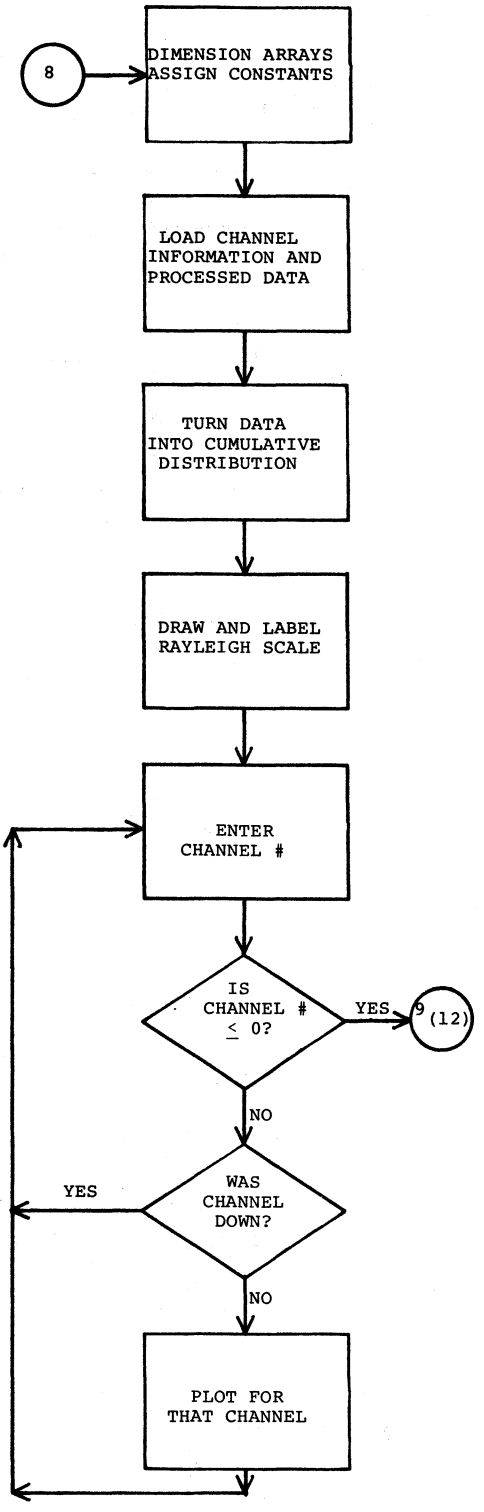


Figure B-11. Flowchart 11, Rayleigh plot.

FILE 9 MENU PROGRAM

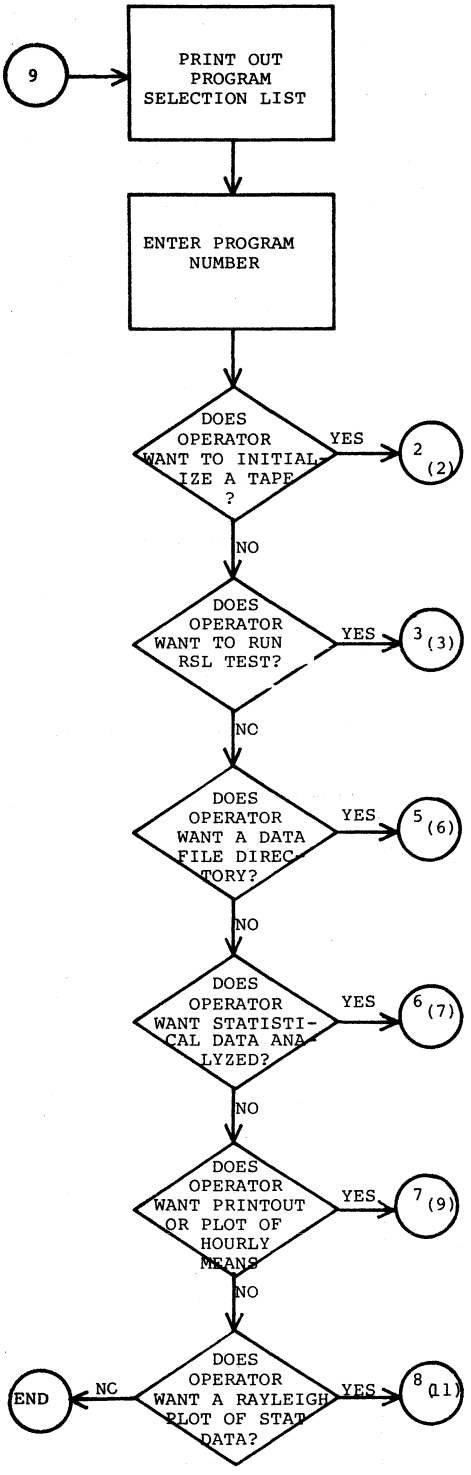


Figure B-12. Flowchart 12, select program.

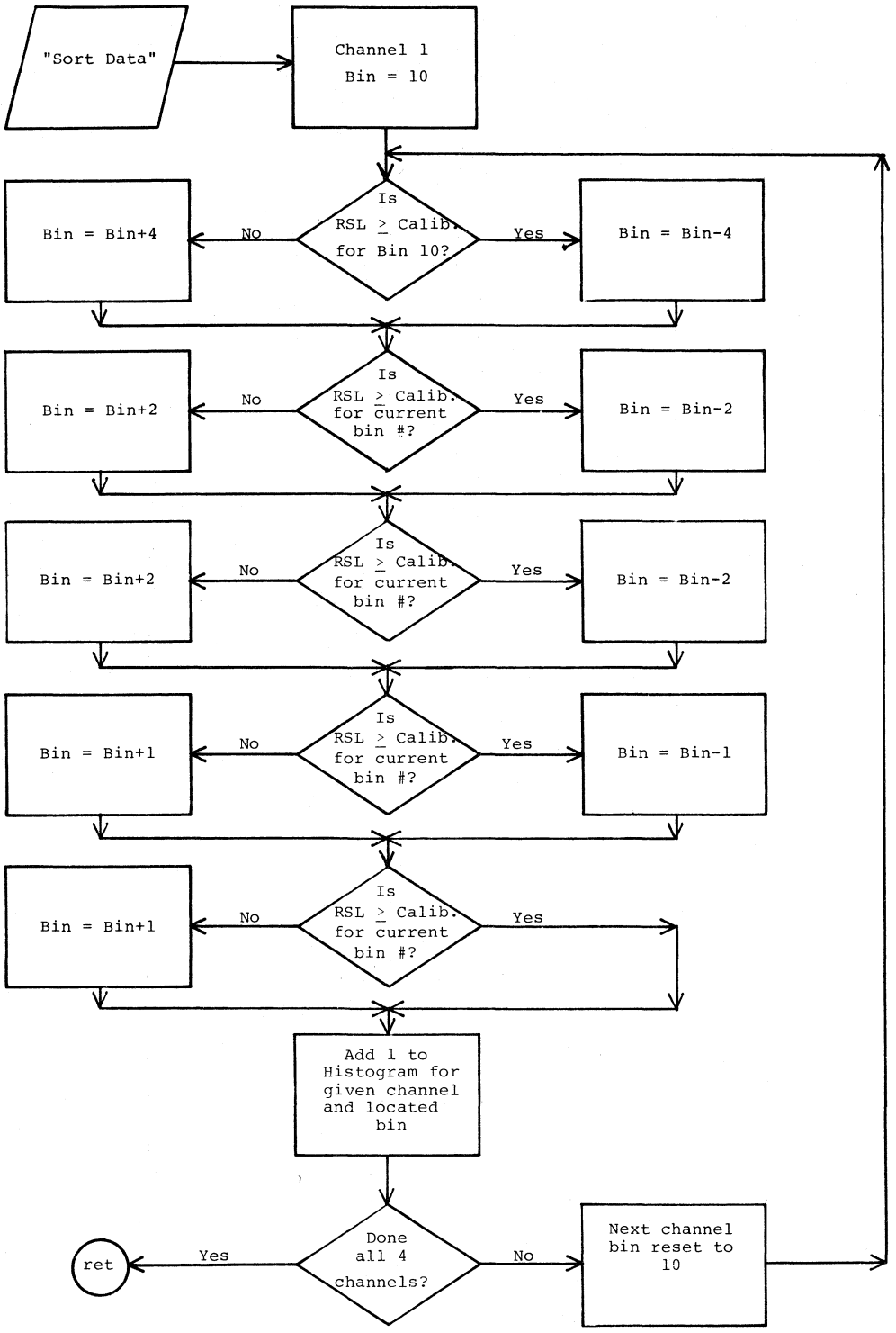


Figure B-13. Flowchart 13, "sortData".

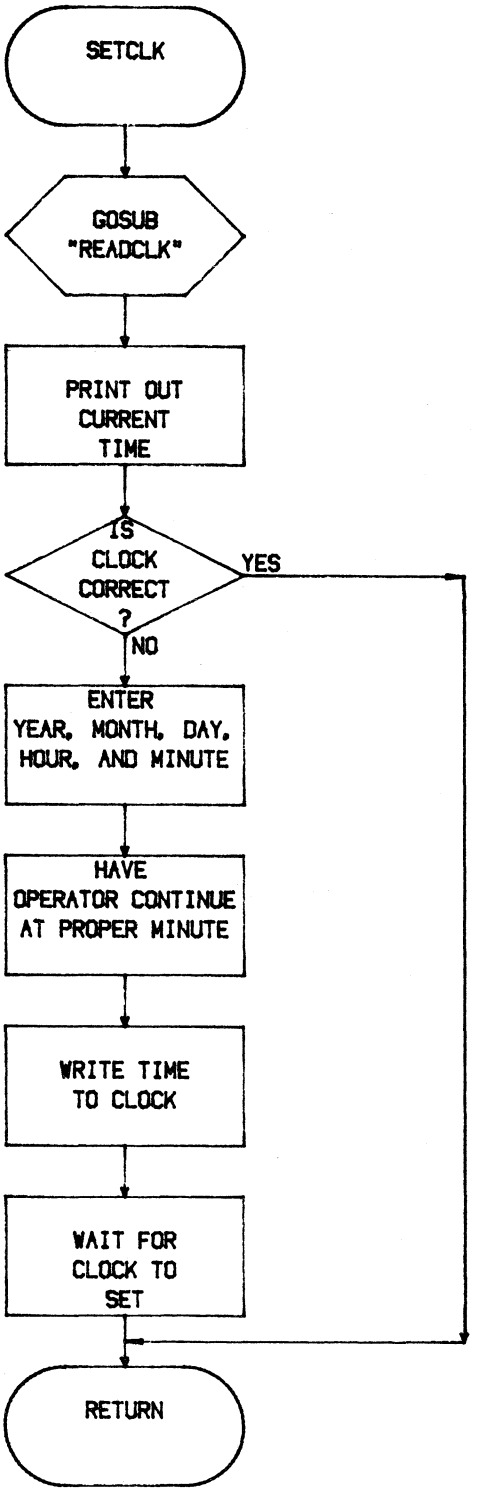


Figure B-14. Flowchart 14, "setclk".

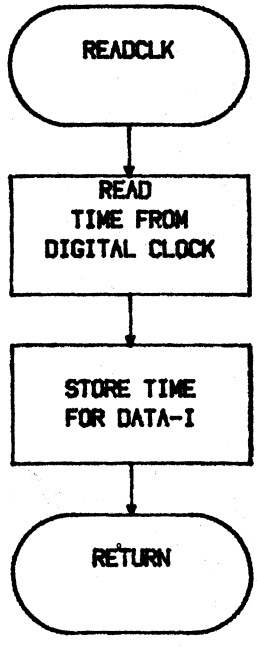
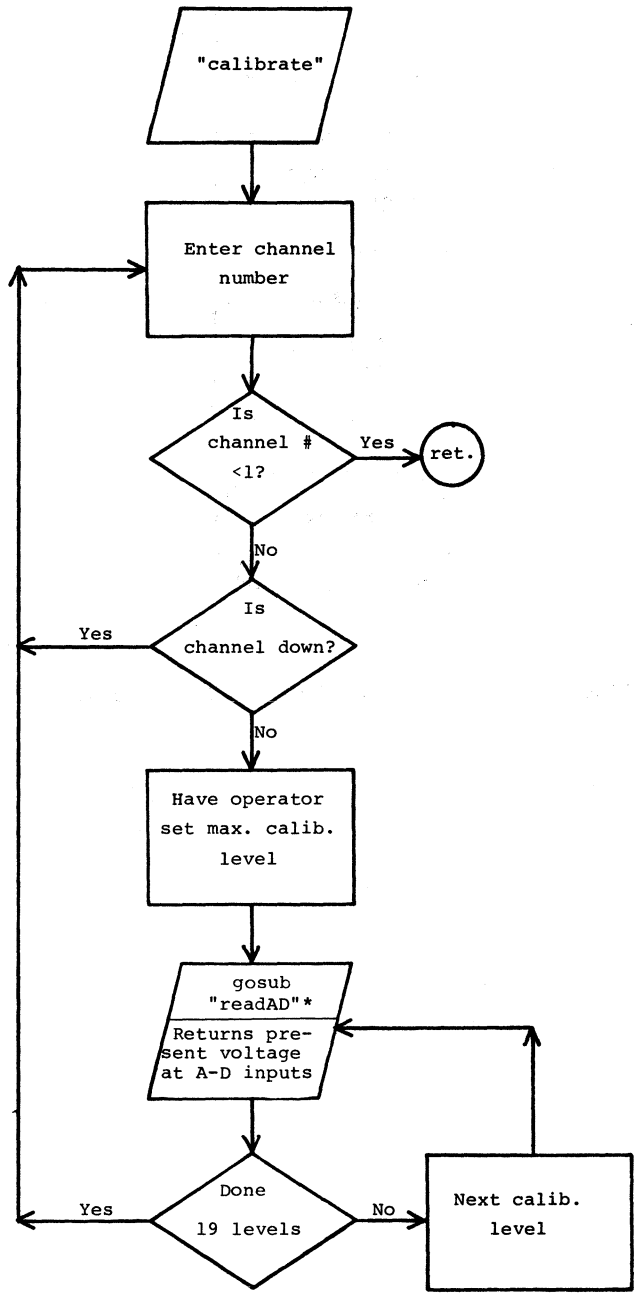


Figure B-15. Flowchart 15, "readclk".



*readAd, see "int" routine (p.5), all but the last 2 boxes.

Figure B-16. Flowchart 16, "calibrate".

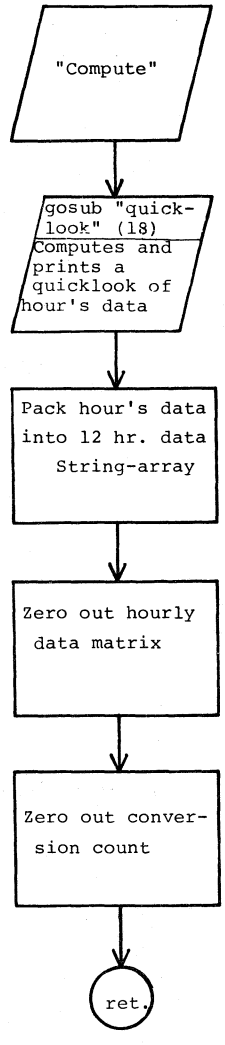


Figure B-17. Flowchart 17, "compute".

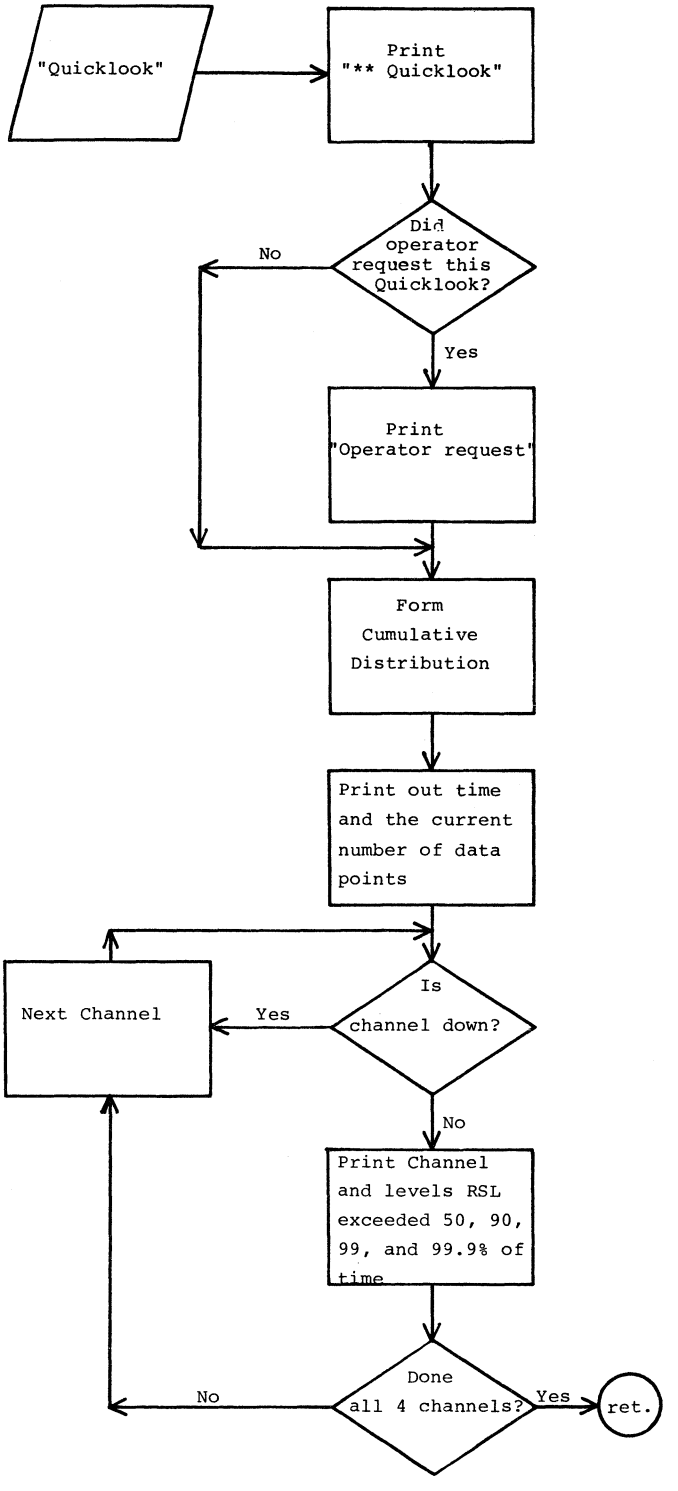


Figure B-18. Flowchart 18, "Quicklook".

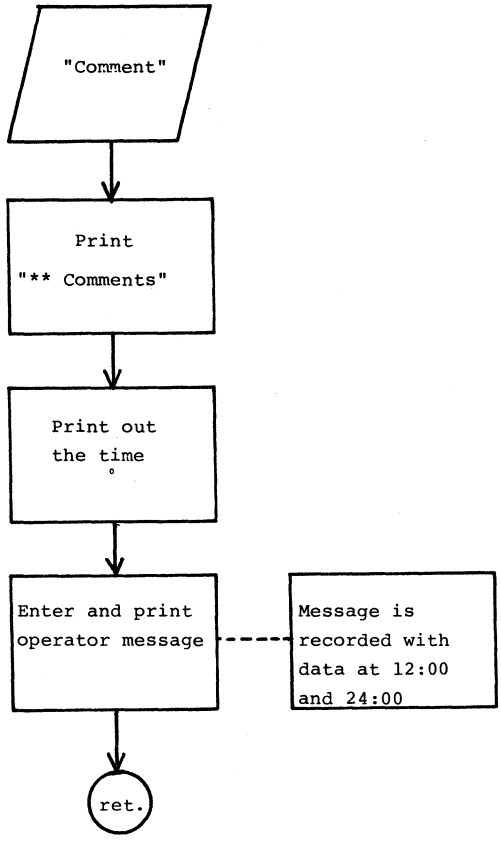


Figure B-19. Flowchart 19, "comment".

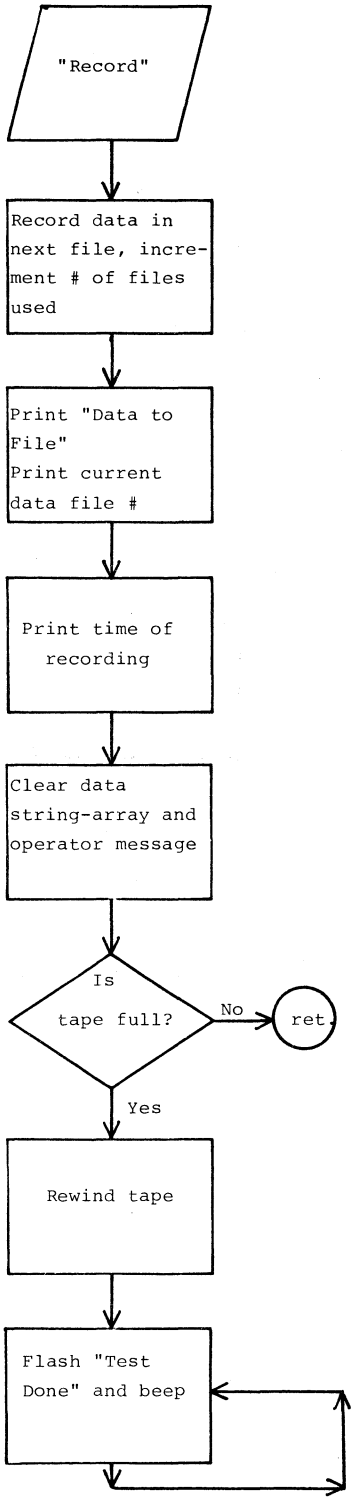


Figure B-20. Flowchart 20, "record".

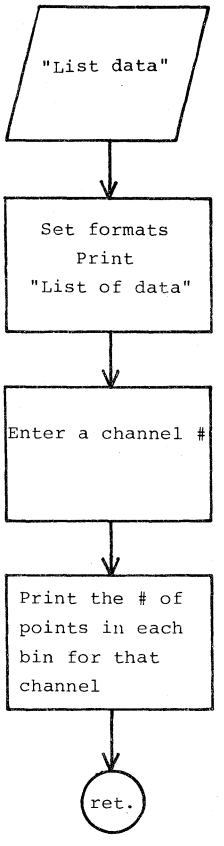


Figure B-21. Flowchart 21, "Listdata".

DECISION TREE FOR SORT DATA 28 JAN 77

BIN #	TYPICAL CALIB LEVEL	DECISION NUMBER					
		1	2	3	4	5	BIN #
1	-28						1
2	-31						2
3	-34						3
4	-37						4
5	-40						5
6	-43						6
7	-46						7
8	-49						8
9	-52						9
10	-55						10
11	-58						11
12	-61						12
13	-64						13
14	-67						14
15	-70						15
16	-73						16
17	-76						17
18	-79						18
19	-82						19
20	(-99)						20

Figure B-22. Decision tree for "SortData".

APPENDIX C. LISTINGS

C.1. Special Function Keys

The special-function keys provide a powerful mechanism to adapt the computer to a dedicated test since they are defined in software. A plastic overlay template shown in Figure C-1 is placed on the computer to identify the keys for the operator. The meaning of each of the keys is given in Table C-1. Since the shift key can be used with each of the 12 keys, there are a total of 24 functions which may be defined. The software for each key is defined in Figure C-2 which is the special-function key listing.

C.2. Variable Assignments

The variable assignments are made during the software design, to prevent conflict with other important values during the execution of the test or subsequent data analysis. The variable assignments used for most of the programs on the RSL tape are shown in Table C-2.

C.3. Listings of the RSL Programs

Figure C-3 is a directory of the RSL tape for track 0. Track 1 is used only for data and, although marked, it contains no data until after the RSL test. Track 0 contains programs and the special-function keys shown in this Appendix. Programs from the RSL tape are listed in the order in which they are stored on tape. Following each listing is a cross reference list, showing the lines each variable or label appears. These listings are Figures C-4 through C-66.

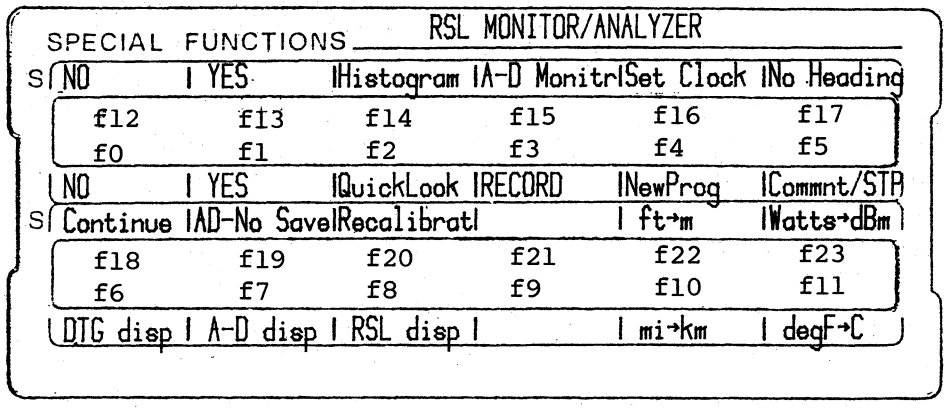


Figure C-1. Special-function template.

Table C-1. Special Functions

Key Stroke	Name	Function
f0	NO	Continue with NO for an answer
f1	YES	Continue with YES for an answer
f2	Quicklook	Print out an instant Quicklook
f3	Record	Record data to tape file
f4	New Prog	Erase present program and load index
f5	Comment/Stop	Enter an operator comment or stop analysis
f6	DTG disp	Normal date time display
f7	A-D disp	Display AD converter voltages
f8	RSL disp	Display RSL values in dBm
f9		
f10	mi→km	Convert miles to kilometers
f11	°F→°C	Convert Farenheight to Celsius
Shift f0	NO	Continue with NO for an answer
Shift f1	YES	Continue with YES for an answer
Shift f2	ListData	Print out the current data histogram
Shift f3	Monitor AD	Used only as pretest set up
Shift f4	SetClock	Used to set the clock prior to test
Shfit f5	Omit Header	Suppress printing of Header information
Shift f6	Continue	
Shift f7	AD no bin	Display AD voltages without storing
Shift f8	Recalibrate	Recalibrate during test
Shift f9		
Shift f10	ft→m	Convert feet to meters
Shift f11	Watts→dBm	Convert watts to dBm

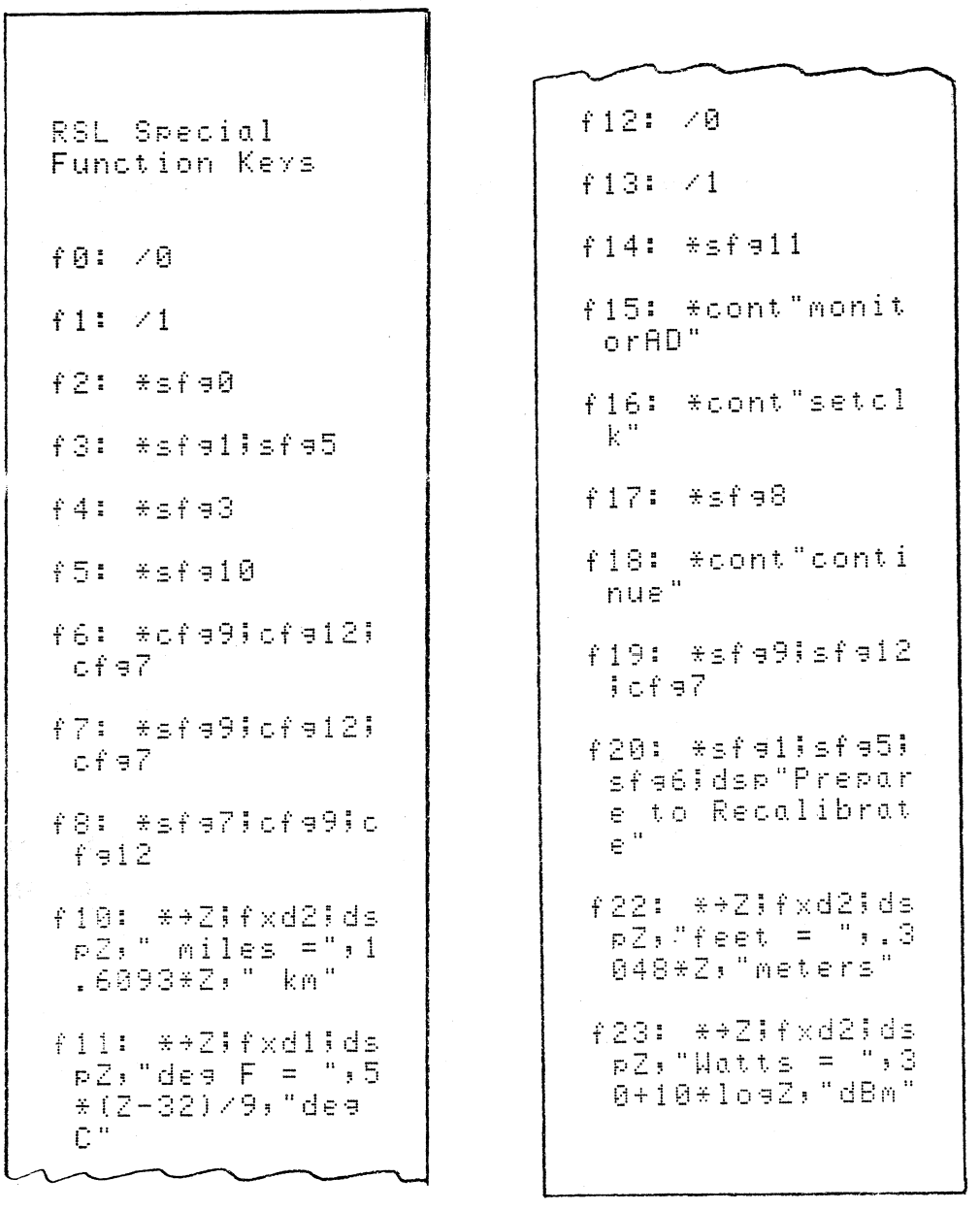


Figure C-2. Special-function key listing.

Table C-2. Variable Assignments for RSL Test

VARIABLE ASSIGNMENTS FOR: RSL-3 & Related Programs Date: 6/6/77

Let.	Simple	Dimensioned		String	
		Dim.	Purpose	Dim.	Purpose
A		16	Constants for tape		
B					
C		4,20	Calibration levels		
D		4,20	Hourly Data	12,160	Packed Data
E					
F	# Data Files Used	4	Frequencies in GHz		
G					
H					
I	Loop index				
J	" "				
K	" "				
L	" " (Interrupt routines)				
M	" " " "			36	Months
N	" " " "				
O					
P					
Q	Conversion count	4	Channel status		
R		4	A/D data divisor	12	Receive stations
S				12	Send stations
T	Time from clock	6	Yr,mo,dy,hr,mn,sc	16	DTG
U	Current Year	5	Quicklook percents		
V				50	Verbose string
W	Temporary Storage			50	Temporary
X	" "	16	Temporary		
Y	" "	4,20	"		
Z	" "	4,20	"		

r-variables		p-variables		FLAGS	
Ran.	Purpose	Ran.	Purpose		
1-4	A-D corrected sense voltages		Call subroutines	0	Run a Quicklook
5-8	A-D voltages, Chan. 1-4			1	Requested Quicklook
9-12	Bin No., Chan. 1-4			2	Done hourly tasks
13-16	True RSL values, Chan.1-4			3	New program
				4	Plot output
				5	Record last hour
				6	Recalibrate
				7	Display RSL values/Long directory
				8	Omit Header
				9	Display A-D
				10	Enter Comments/stop
				11	List data
				12	No data stored
				13	
				14	
				15	

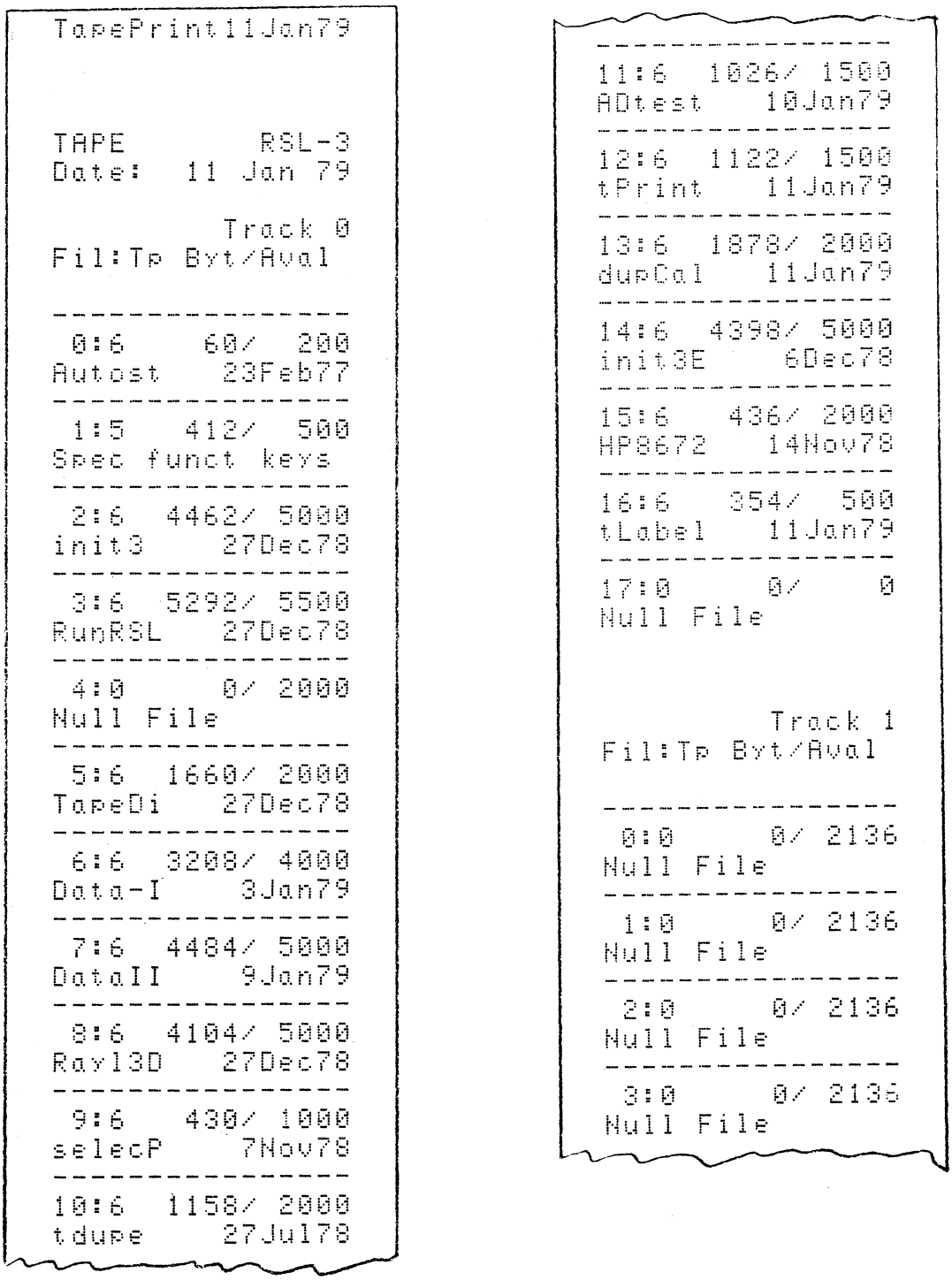


Figure C-3. RSL tape index and directory.

```
0: "Autostart":prt "Autostart23Feb77"
1:    rew;trk 0
2:    ldk 1
3:    ldp 3

     60 bytes    16778 check sum
```

File is automatically loaded and run when power up condition occurs. Loads special-function keys. Loads and runs main RSL Program.

Figure C-4. AutoStart listing.

```
 0: "init3":prt "inital   15Jan79"
 1:    clr 7;rem 7;llo 7;dev "a-d",706,"clock",9,"timer",9
 2:    dim D$[12,160],V$[50],A[16],C[4,20],R[4],R$[12],S$[12],F[4]
 3:    dim D[4,20],T[6],U[5],X[16],Y[4,20],Z[4,20]
 4:    dim M$[36],T$[16],W$[50],X$[12,160]
 5:    ina A:-99,C:-99,R:200,F:-999
 6: "continue":
 7:    fmt 8,3c
 8:    fmt 7,13x,3c
 9:    fmt 6,f2.0,c3,f2.0,":",fz2.0,f6.0
10:    fmt 5,f1.0,1x,2f3.0,1x,2f3.0
11:    fmt 3,"Cmnt",1x,f2.0,c3,1x,f2.0,":",fz2.0
12:    fmt 2,f2.0,c3,f2.0,1x,f2.0,":",fz2.0,":",fz2.0,5x,f3.0
13:    fmt 1,f2.0,c3,f2.0,1x,f2.0,":",fz2.0,":",fz2.0
14:    "JanFebMarAprMayJunJulAugSepOctNovDec"→M$
15:    spc 2
16:
17: "enter all parameters":
18:    gsb "line"
19:    spc ;prt "RSL initialize"
20:    spc ;prt "Enter parameters","as requested.";spc 2
21:    -9999→Z;ent "Enter Year?",Z;if Z<1970;Z+1900→Z
22:    if Z<0;jmp -1
23:    fxd 0;prt "Year=",Z;Z-1900→U→T[1]→A[15]
24:    gsb "setclk"
25:    gsb "readclk"
26:    prt "Date     Time"
27:    wrt 16.1,T[3],M$[3T[2]-2,3T[2]],T[1],T[4],T[5],T[6]
28:
29: "Calibration Default":-28→W;3→X
30:    spc ;prt "Channel info:"
31:    spc ;prt "Default values:","A-D on Hi=  5.0V"
32:    spc ;prt "Radio parameters"
33:    prt "Max cal(dBm)=",W,"dB step=",X
34:    spc ;prt "Enter designator"
```

Figure C-5. Initialization listing, 1.

```
35:     prt "as 3 letter name";spc
36:
37:        for I=1 to 4
38:        fxd 0;gsb "line"
39:        prt "Channel #",I;spc 2
40:        -9999→Z;ent "Is this channel to be used?",Z;if Z#0 and Z#1;jmp 0
41:        Z→A[8+I]
42:        3(I-1)+1→J
43:        if Z=0;prt "Channel down";"   "→S$[J,J+2];gto "next"
44:        prt "Channel data:"
45:        0→Z;ent "Is A-D range OK? (YES/NO)",Z;if Z#1;gsb "ADrange"
46:        W→A[I];ent "Max calibration level(dBm)=?",Z;if not flg13;int(Z)→A[I]
47:        if abs(A[I]+45)>25;beep;dsp "Invalid range";wait 1500;jmp -1
48:        X→A[4+I];ent "dB step size=?",Z;if not flg13;int(Z)→A[4+I]
49:        if abs(A[I+4]-3)>2;beep;dsp "Invalid range";wait 1500;jmp -1
50:        prt "Max cal(dBm)=",A[I],"dB step=",A[4+I]
51:        prt "Xmit designator="
52:        ent "Transmit designator(3char)?",S$[J,J+2]
53:        cap(S$)→S$
54:        wrt 16.7,S$[J,J+2]
55:        ent "Enter Transmiter Freq (GHz) = ?",F[I];if flg13;jmp 0
56:        fxd 3;prt "Freq(GHz)=",F[I]
57:→"next":next I
58:     gsb "line"
59:
60:     spc
61:     prt "Recv designator="
62:     ent "This Station designator(3char)?",W$
63:        for I=1 to 10 by 3
64:        cap(W$[1,3])→R$[I,I+2]
65:        next I
66:        for I=1 to 10 by 3
67:        (I-1)/3+1→J;if A[8+J]=0;"   "→R$[I,I+2];jmp 2
68:        next I
69:     wrt 16.8,R$[1,3]," for all up";prt "channels.";spc
```

Figure C-6. Initialization listing, 2.

```
 70:    gsb "line"
 71:
 72: "calibrate":
 73:→"c":if flg6;prt " *************","**ReCalibrate**"
 74:    gsb "Calibrate"
 75:    0→Z
 76:       for I=0 to 15
 77:       2^I*flgI+Z→Z
 78:       next I
 79:    Z→A[13];if flg6;gto "record to file 0"
 80: "verbose":
 81:    prt "Header Title","(or comments)="
 82:    ent "Enter up to 50 characters",V$
 83:    prt V$;spc
 84:    gsb "line"
 85:
 86:→"record to file 0":
 87:    prt "Ready to record"
 88:    rew;trk 1;fdf 0;idf X[1],X[2],X[3],X[4],X[5]
 89:    if X[3]>0;prt "→→Data in file!";ent "Erase old Calibr.?",Z;if Z#1;gto "c"
 90:    spc 2;gsb "readclk"
 91:    trk 1;rcf 0,V$,A[*],C[*],R[*],R$,S$,F[*];rew;trk 0;prt "Data to file 0"
 92:    spc ;wrt 16.1,T[3],M$[3T[2]-2,3T[2]],T[1],T[4],T[5],T[6]
 93:    gsb "line"
 94:    sfg 8;if flg6;cfg 6;cfg 8
 95:
 96:    dsp "Load main program";trk 0;ldf 3,0,5
 97:
 98:→"line":prt "----------------";ret

 99:
100:→"readAD":
101:    fmt 4,c1,f1.0,f1.0,c2
102:    Q+1→Q;1→M
103:       for L=1 to 4
```

Figure C-7. Initialization listing, 3.

```
104:        wrt "a-d.4","H",M,M,"AJ"
105:        2*M→M
106:        ior(shf(rdb(706),-8),rdb(706))/R[L]→X[L]
107:        next L
108:     wrt "a-d","H";ret

109:
110:→"Calibrate":
111:     beep;fxd 0
112:     ent "Enter Channel # for calibration",I
113:     if I<1;dsp "Calibration done";wait 2000;gto 131
114:     if A[8+I]=0;dsp "Channel",I,"down, renter Chan #";beep;wait 2000;jmp -2
115:     prt "Calibrate Chan",I;fxd 3;prt "Freq(GHz)=",F[I]
116:        for J=1 to 19
117:        dsp "Set level=",A[I]-A[4+I]*(J-1)→Z,"then ´CONTINUE´";stp
118:        gsb "readAD"
119:
120:        X[I]→C[I,J]
121:        fmt 6,f3.0,3x,f7.3,3x
122:        wrt 16.6,Z,X[I]
123:        next J
124:     spc
125:     if C[I,1]<C[I,19];if A[8+I]#0;-1→A[8+I];prt "CalibrationCurve","inverted"
126:        for J=1 to 19
127:        C[I,J]*A[I+8]→C[I,J]
128:        next J
129:     gsb "line"
130:     gto "Calibrate"

131:→    cfg 3;ret

132:
133:→"readclk":fxd 0
134:     wrt "clock","R";red "clock",T[2],T[3],T[4],T[5],T[6]
135:     (((T[2]*100+T[3])*100+T[4])*100+T[5])*100+T[6]→T
```

Figure C-8. Initialization listing, 4.

```
136:
137:     T→A[16]
138:     ret

139:
140:→"ADrange":
141:     fmt 9,2x,2c
142:     ""→W$;ent "Enter range(Lo,Me,Hi,HH)?",W$;cap(W$)→W$
143:     if W$="LO";800→Z;gto "a"
144:     if W$="ME";300→Z;gto "a"
145:     if W$="HI";200→Z;gto "a"
146:     if W$="HH";100→Z;gto "a"
147:     dsp "Invalid A-D range";beep;wait 2000;jmp -5
148:→"a":Z→R[I];wrt 16.9,"A-D range=  ",W$
149:     ret

150:
151:→"setclk":
152:     gsb "readclk"
153:     wrt 16.1,T[3],M$[3T[2]-2,3T[2]],T[1],T[4],T[5],T[6]
154:     ent "Is time on clock correct?",X;if X;gto "T"
155:     beep;dsp "CONTINUE to keep value unchanged";wait 2000
156:     ent "Year (2 digits) = ?",U
157:     ent "Enter Month",T[2]
158:     ent "Enter Day",T[3]
159:     ent "Enter Hour",T[4]
160:     ent "Enter Minute",T[5]
161:     dsp "press 'CONTINUE' at time hack";stp
162:     fmt ,c3,5fz2.0
163:     wrt "clock","Set",T[2],T[3],T[4],T[5],0
164:     dsp "Please wait for Clock to set"
165:     wait 30000;wait 20000
166:→"T":ret

167:
```

Figure C-9. Initialization listing, 5.

```
168: "monitorAD":
169:    gsb "readAD"
170:    fxd 3;dsp "dcV=",X[1],X[2],X[3],X[4]
171:    jmp -3
172:
173:    end

     4466 bytes    18735 check sum
```

Figure C-10. Initialization listing, 6.

RSL Initialization Program

Variable Cross-Reference, Sheet 1

```
A
    5

C
    5

F
    5

I
   37   39   41   42   46   46   47   48   48   49   50   50
   55   56   57   63   64   64   65   66   67   67   67   68
   76   77   77   78  112  113  114  114  115  115  117  117
  120  120  122  125  125  125  125  127  127  127  148

J
   42   43   43   52   52   54   54   67   67  116  117  120
  123  126  127  127  128

L
  103  106  106  107

M
  102  104  104  105  105

Q
  102  102

R
    5

T
  135  137

U
   23  156
```

Figure C-11. Initialization Xref, 1.

RSL Initialization Program

Variable Cross-Reference, Sheet 2

```
W
   29   33   46

X
   29   33   48  154  154

Z
   21   21   21   21   21   22   23   23   40   40   40   40
   41   43   45   45   45   46   46   48   48   75   77   77
   79   89   89  117  122  143  144  145  146  148

A[
    2   23   41   46   46   47   48   48   49   50   50   67
   79   91  114  117  117  125  125  127  137

C[
    2   91  120  125  125  127  127

D[
    3

F[
    2   55   56   91  115

R[
    2   91  106  148

T[
    3   23   27   27   27   27   27   27   27   92   92   92
   92   92   92   92  134  134  134  134  134  135  135  135
  135  135  153  153  153  153  153  153  153  157  158  159
  160  163  163  163  163

U[
    3
```

Figure C-12. Initialization Xref, 2.

```
RSL Initialization Program

   Variable Cross-Reference, Sheet  3


 X[
     3   88   88   88   88   88   89  106  120  122  170  170
   170  170
 Y[
     3
 Z[
     3
 D$
     2
 M$
     4   14   27   92  153
 R$
     2   64   67   69   91
 S$
     2   43   52   53   53   54   91
 T$
     4
 V$
     2   82   83   91
 W$
     4   62   64  142  142  142  142  143  144  145  146  148
 X$
     4

  131:
  113
```

Figure C-13. Initialization Xref, 3.

```
RSL Initialization Program

   Variable Cross-Reference, Sheet  4


  "line"
     18    38    58    70    84    93   129

  "setclk"
     24

  "readclk"
     25    90   152

  "next"
     43

  "ADrange"
     45

  "Calibrate"
     74   130

  "record to file 0"
     79

  "c"
     89

  "readAD"
    118   169

  "a"
    143   144   145   146

  "T"
    154

  cfg
     94    94   131
```

Figure C-14. Initialization Xref, 4.

```
RSL Initialization Program

   Variable Cross-Reference, Sheet  5


  sfg
     94

  flg
     46    48    55    73    77    79    94
```

Figure C-15. Initialization Xref, 5.

```
 0: "RunRSL":prt "RunRSL-3 27Dec78"
 1:    clr 7;rem 7;llo 7;dev "a-d",706,"clock",9,"timer",9
 2:    dim D$[12,160],V$[50],A[16],C[4,20],R[4],R$[12],S$[12],F[4]
 3:    dim D[4,20],T[6],U[5],X[16],Y[4,20],Z[4,20]
 4:    dim M$[36],T$[16],W$[50],X$[12,160],P$[300]
 5:→"fmt":
 6:    fmt 1,f2.0,c3,f2.0,1x,f2.0,":",fz2.0,":",fz2.0
 7:    fmt 2,f2.0,c3,f2.0,1x,f2.0,":",fz2.0,":",fz2.0,f8.0
 8:    fmt 3,f2.0,c3,1x,f2.0,":",fz2.0
 9:    fmt 5,f1.0,1x,2f3.0,1x,2f3.0
10:    fmt 6,f2.0,c3,f2.0,":",fz2.0,f6.0
11:    fmt 7,f2.0,c3,3x,f2.0,":",fz2.0,":",fz2.0
12:    "JanFebMarAprMayJunJulAugSepOctNovDec"→M$
13:    50→U[1];90→U[2];99→U[3];99.9→U[4]
14:    wrt "clock","AB";gsb "readclk"
15:    wrt 16.7,T[3],M$[3T[2]-2,3T[2]],T[4],T[5],T[6]
16:    dsp "To select program: SPEC FUNCT f4"
17:
18:    trk 1;rew;fdf 0;idf A,B,C,D;if C#930;prt "New Test";trk 0;rew;ldp 2
19:    trk 1;ldf 0,V$,A[*],C[*],R[*],R$,S$,F[*]
20:    A[15]→T[1];A[16]→Y
21:    prt V$;spc
22:
23:       for I=1 to 62
24:       if flg3;cfg 3;trk 0;ldp 9
25:       trk 1;fdf I;idf J,K,L,M;dsp "Read data file #",I
26:       if L#2136;if I>1;ldf I-1→F,D$,V$,A[*];jmp 3
27:       if L#2136;if I=1;jmp 2
28:       next I
29:
30:    if I#1;if V$#"";prt V$;spc
31:    if not flg8;gto "continue"
32:
33:    fmt 9,c4,4f3.0
34:    prt "Func-  Channel #tion  1  2  3  4---- -- -- -- --"
```

Figure C-16. RSL test listing, 1.

```
35:     wrt 16.9,"ref ",A[1],A[2],A[3],A[4]
36:     wrt 16.9,"step",A[5],A[6],A[7],A[8]
37:     fmt 9,c4,c12
38:     wrt 16.9,"Xmit",S$
39:     wrt 16.9,"rec ",R$
40:     "a-d "→W$
41:
42:        for I=1 to 4
43:        if A[8+I]=1;W$&"+"→W$
44:        if A[8+I]=0;W$&" "→W$
45:        if A[I+8]=-1;W$&"-"→W$
46:        if R[I]=100;W$&"HH"→W$
47:        if R[I]=200;W$&"HI"→W$
48:        if R[I]=300;W$&"ME"→W$
49:        if R[I]=800;W$&"LO"→W$
50:        next I
51:     prt W$
52:     gsb "line"
53:     prt "Calibration at:"
54:     6→K;Y→X
55:     100frc(X/100)→T[K];int(X/100)→X;jmp (K-1→K)=1
56:     wrt 16.1,T[3],M$[3T[2]-2,3T[2]],T[1],T[4],T[5],T[6]
57:     spc ;gsb "line"
58:     spc ;gsb "header"
59:     spc ;gsb "line"
60:     spc ;cfg 8
61:
62:→"continue":
63:     eir 9,0
64:     wrt 9,"A,U1=01,U1P250/U1G"
65:     oni 9,"int"
66:     eir 9
67:
68:→"monitor":eir 9
69:     gsb "readclk"
```

Figure C-17. RSL test listing, 2.

```
 70:     if flg2;jmp 3
 71:     if T[4]mod12=0 and T[5]=0;sfg 5
 72:     if T[5]=0;sfg 1
 73:     if T[5]#0;cfg 2
 74:     if flg7;gto "rsl"
 75:     if flg9;jmp 2
 76:     wrt .2,T[3],M$[3T[2]-2,3T[2]],T[1],T[4],T[5],T[6],Q;jmp 2
 77:     fxd 3;dsp "dcV"&char(Qmod2*29+32),r5,r6,r7,r8
 78:     if not flg7;gto "cont"
 79:→"rsl":for I=1 to 4
 80:         r(I+8)→J;I+12→K;if J<=1;A[I]→rK;jmp 3
 81:         A[I]-(J-1)*A[I+4]→rK
 82:         if J<20;rK+(rI-C[I,J])*A[I+4]/C[I,J-1]→rK
 83:         next I
 84:     fxd 0;dsp "RSL(dBm)"&char(Qmod2*29+32),r13,r14,r15,r16
 85:→"cont":if flg0;gsb "Quiklook"
 86:     if flg1;gsb "compute"
 87:     if flg5;gsb "record"
 88:     if flg10;gsb "comment"
 89:     if flg11;gsb "listData"
 90:     if flg6;0→X;cfg 6;ent "Recalibrate?",X;if X;sfg 6;trk 0;ldf 2,0,69
 91:     if flg3;cfg 3;0→X;ent "Stop RSL & load new Program?",X;if X;trk 0;ldp 9
 92:     gto "monitor"

 93:
 94: "int":
 95:     wrt 9,"T";if not rdb(9);jmp 3
 96:     gsb "readAD"
 97:     if not flg12;gsb "sortData"
 98:     eir 9;iret

 99:
100:→"readAD":
101:     fmt 4,c1,f1.0,f1.0,c2
102:     1→M
```

Figure C-18. RSL test listing, 3.

```
103:        for L=1 to 4
104:        wrt "a-d.4","H",M,M,"AJ"
105:        2*M→M
106:        (ior(shf(rdb(706),-8),rdb(706))/R[L]→r(L+4))*A[8+L]→rL
107:        next L
108:     wrt "a-d","H"
109:     ret

110:
111:→"sortData":
112:     Q+1→Q
113:        for L=1 to 4
114:        10→N;if A[8+L]=0;jmp 7
115:        N+sgn(C[L,N]-rL)*4→N
116:        N+sgn(C[L,N]-rL)*2→N
117:        N+sgn(C[L,N]-rL)*2→N
118:        N+sgn(C[L,N]-rL)*1→N
119:        N+(C[L,N]>rL)→N→r(L+8)
120:        D[L,N]+1→D[L,N]
121:        next L
122:     ret

123:
124:→"compute":
125:     gsb "Quiklook"
126:        for I=0 to 3
127:           for J=1 to 20
128:           fti (Y[I+1,J])→D$[(T[4]-1)mod12+1,40I+2J-1,40I+2J]
129:           next J
130:        next I
131:     cfg 1;sfg 2;ret

132:
133:→"Quiklook":
134:     prt "***QUICK LOOK***"
```

Figure C-19. RSL test listing, 4.

```
135:     if flg0;prt "Operator request";ara D→Z;jmp 2
136:     ara D→Z;ara D→Y;ina D;0→Q;fxd 0
137:        for I=1 to 4
138:           for J=1 to 19
139:           Z[I,J]+Z[I,J+1]→Z[I,J+1]
140:           next J
141:        next I
142:     max(Z[1,20],Z[2,20],Z[3,20],Z[4,20])→Z
143:     wrt 16.6,T[3],M$[3T[2]-2,3T[2]],T[4],T[5],Z
144:        for I=1 to 4
145:        1→K;ina X:-99
146:        if A[8+I]=0;fmt 9,f1.0;wrt 16.9,I;gto "A"
147:           for J=1 to 19
148:           if Z[I,J]>=U[K]*Z/100;A[I]-(J-1)*A[I+4]→X[K];if (K+1→K)<5;jmp 0
149:           if K>4;jmp 2
150:           next J
151:        wrt 16.5,I,X[1],X[2],X[3],X[4]
152:→"A":  next I
153:     cfg 0;ret
154:
155:→"comment":spc
156:     prt "***Comments...."
157:     wrt 16.3,T[3],M$[3T[2]-2,3T[2]],T[4],T[5]
158:     dsp "Data acquisition suspended";wait 2000
159:     ent "Enter operator message",V$
160:     prt V$
161:     cfg 10;ret
162:
163:→"readclk":fxd 0
164:     wrt "clock","R";red "clock",T[2],T[3],T[4],T[5],T[6]
165:     (((T[2]*100+T[3])*100+T[4])*100+T[5])*100+T[6]→T
166:
167:
```

Figure C-20. RSL test listing, 5.

```
168:     T→A[16]
169:     ret

170:
171:→"record":
172:     fxd 0;eir 9,0
173:     trk 1;rcf F+1→A[14],D$,V$,A[*];F+1→F
174:     prt "*Data to file",F
175:     wrt 16.3,T[3],M$[3T[2]-2,3T[2]],T[4],T[5]
176:     ""→V$;trk 0
177:        for I=1 to 12;""→D$[I];next I
178:     if F<62;jmp 3
179:     rew;trk 0
180:     dsp " Remove tape-RSL test DONE";beep;wait 500;dsp ;wait 500;jmp 0
181:     cfg 5;sfg 2;if not flg6;eir 9
182:     ret

183:
184: "setclk":
185:     gsb "readclk"
186:     wrt 16.1,T[3],M$[3T[2]-2,3T[2]],T[1],T[4],T[5],T[6]
187:     wrt "clock","AB"
188:     ent "Is time on clock correct?",X;if X;gto "T"
189:     beep;dsp "CONTINUE to keep values same";wait 2000
190:     ent "Year (2 digits) = ?",U;if not flg13;U→T[1]→A[15]
191:     ent "Enter Month",T[2]
192:     ent "Enter Day",T[3]
193:     ent "Enter Hour",T[4]
194:     ent "Enter Minute",T[5]
195:     dsp "press 'CONTINUE' at time hack";stp
196:     fmt ,c3,5fz2.0
197:     wrt "clock","Set",T[2],T[3],T[4],T[5],0
198:     dsp "Please wait while clock sets"
199:     wait 30000;wait 20000
200:     dsp "push RUN"
```

Figure C-21. RSL test listing, 6.

```
201:→"T":gto "fmt";stp

202:
203: "monitorAD":
204:    gsb "readAD"
205:    fxd 3;dsp "dcV=",r1,r2,r3,r4
206:    jmp -3
207:
208:→"listData":
209:    fmt 9,f2.0,2x,f3.0,f8.0
210:    fxd 0;prt "***List Data***"
211:    ent "Which Channel?",J;prt "Bin dBm  Chan# ",J
212:       for I=1 to 20
213:       A[J]-A[J+4]*(I-1)→Z;if I=20;-99→Z
214:       wrt 16.9,I,Z,D[J,I]
215:       next I
216:    spc
217:    cfg 11;ret

218:
219:→"header":
220:    prt "Quick look form:"
221:    prt "Channel #","|  % of time"
222:    prt "|  shown dBm"
223:    prt "|  exceeded:"
224:    prt "|  50 90 99 99.9"
225:    prt "-  -- -- -- ----","1 -37-43 -46-55"
226:    ret

227:
228:→"line":prt "----------------";ret

229:
230:    end


     5292 bytes     6347 check sum
```

Figure C-22. RSL test listing, 7.

RSL Data Acquisition Program

Variable Cross-Reference, Sheet 1

```
A
    18

B
    18

C
    18   18

D
    18  135  136  136  136

F
    26  173  173  173  174  178

I
    23   25   25   26   26   27   28   30   42   43   44   45
    46   47   48   49   50   79   80   80   80   81   81   82
    82   82   82   83  126  128  128  128  130  137  139  139
   139  141  144  146  146  148  148  148  151  152  177  177
   177  212  213  213  214  214  215

J
    25   80   80   81   82   82   82  127  128  128  128  129
   138  139  139  139  140  147  148  148  150  211  211  213
   213  214

K
    25   54   55   55   55   80   80   81   82   82  145  148
   148  148  148  149

L
    25   26   27  103  106  106  106  106  107  113  114  115
```

Figure C-23. RSL test Xref, 1.

RSL Data Acquisition Program

Variable Cross-Reference, Sheet 2

```
  115  116  116  117  117  118  118  119  119  119  120  120
  121

M
   25  102  104  104  105  105

N
  114  115  115  115  116  116  116  117  117  117  118  118
  118  119  119  119  120  120

Q
   76   77   84  112  112  136

T
  165  168

U
  190  190

X
   54   55   55   55   90   90   90   91   91   91  145  188
  188

Y
   20   54  136

Z
  135  136  142  143  148  213  213  214

A[
    2   19   20   20   26   35   35   35   35   36   36   36
   36   43   44   45   80   81   81   82  106  114  146  148
```

Figure C-24. RSL test Xref, 2.

RSL Data Acquisition Program

Variable Cross-Reference, Sheet 3

```
  148   168   173   173   190   213   213

C[
    2    19    82    82   115   116   117   118   119

D[
    3   120   120   214

F[
    2    19

R[
    2    19    46    47    48    49   106

T[
    3    15    15    15    15    15    15    20    55    56    56    56
   56    56    56    56    71    71    72    73    76    76    76    76
   76    76    76   128   143   143   143   143   143   157   157   157
  157   157   164   164   164   164   164   165   165   165   165   165
  175   175   175   175   175   186   186   186   186   186   186   186
  190   191   192   193   194   197   197   197   197

U[
    3    13    13    13    13   148

X[
    3   148   151   151   151   151

Y[
    3   128

Z[
    3   139   139   139   142   142   142   142   148

D$
    2    26   128   173   177
```

Figure C-25. RSL test Xref, 3.

```
RSL Data Acquisition Program

   Variable Cross-Reference, Sheet  4


 M$
      4    12    15    56    76   143   157   175   186

 P$
      4

 R$
      2    19    39

 S$
      2    19    38

 T$
      4

 V$
      2    19    21    26    30    30   159   160   173   176

 W$
      4    40    43    43    44    44    45    45    46    46    47    47
     48    48    49    49    51

 X$
      4

 r1
    205

 r2
    205

 r3
    205

 r4
    205
```

Figure C-26. RSL test Xref, 4.

```
RSL Data Acquisition Program

   Variable Cross-Reference, Sheet  5


  r5
     77

  r6
     77

  r7
     77

  r8
     77

  r13
     84

  r14
     84

  r15
     84

  r16
     84

  "readclk"
     14    69   185

  "continue"
     31

  "line"
     52    57    59

  "header"
     58
```

Figure C-27. RSL test Xref, 5.

```
RSL Data Acquisition Program

   Variable Cross-Reference, Sheet  6


  "rsl"
     74

  "cont"
     78

  "Quiklook"
     85  125

  "compute"
     86

  "record"
     87

  "comment"
     88

  "listData"
     89

  "monitor"
     92

  "readAD"
     96  204

  "sortData"
     97

  "A"
    146

  "T"
    188
```

Figure C-28. RSL test Xref, 6.

RSL Data Acquisition Program

Variable Cross-Reference, Sheet 7

```
"fmt"
  201

cfg
   24    60    73    90    91   131   153   161   181   217

sfg
   71    72    90   131   181

flg
   24    31    70    74    75    78    85    86    87    88    89    90
   91    97   135   181   190
```

Figure C-29. RSL test Xref, 7.

```
 0: "TapeDi":prt "TapeDirec27Dec78"
 1:    dim D$[12,160],V$[50],A[16],C[4,20],R[4],R$[12],S$[12],F[4]
 2:    dim D[4,20],T[6],U[5],X[16],Z[4,20]
 3:    dim M$[36],T$[16],W$[50],X$[12,160]
 4: "continue":fxd 0
 5:    fmt 8,f1.0,x,c3,c2,c3,f6.2
 6:    fmt 7,"File",f3.0
 7:    fmt 6,f2.0,c3,f2.0,":",fz2.0,f6.0
 8:    fmt 5,f1.0,1x,2f3.0,1x,2f3.0
 9:    fmt 3,f2.0,2x,f2.0,"hr",f8.0
10:    fmt 2,f2.0,c3,f2.0,1x,f2.0,":",fz2.0,":",fz2.0,5x,f3.0
11:    fmt 1,f2.0,c3,f2.0,1x,f2.0,":",fz2.0,":",fz2.0,"  ",c3
12:    "JanFebMarAprMayJunJulAugSepOctNovDec"→M$
13:
14:    ent "Long directory?",X;if X;sfg 7
15:    spc ;prt "RSL data tape","Directory trk 1"
16:
17:    trk 1;rew
18:       for I=0 to 69
19:       gsb "line"
20:       dsp "Reading file #",I
21:       trk 1;fdf I;idf N,T,B,A
22:       if A=0 or flg10;gto "e"
23:       if B<800;prt "Null file",I;gto "c"
24:       if I=0;ldf I,V$,A[*],C[*],R[*],R$,S$,F[*]
25:       if I#0 and B=930;prt "file ",I,"Calibration data";gto "c"
26:       if I#0;if B#2136;prt "file ",I,"Invalid data";gto "c"
27:       if I#0;ldf I,D$,V$,A[*]
28:       6→K;A[16]→X;A[15]→T[1]
29:       100frc(X/100)→T[K];int(X/100)→X;jmp (K-1→K)=1
30:       wrt 16.7,I
31:       wrt 16.1,T[3],M$[3T[2]-2,3T[2]],T[1],T[4],T[5],T[6]
32:       if I=0;gsb "zero"
33:       if flg7=0 or I=0;gto "c"
34:       prt V$
```

Figure C-30. Tape directory listing, 1.

```
35:        ina X
36:           for J=0 to 3
37:           if A[J+9]=0;gto "J"
38:              for L=1 to 12
39:              dsp "Processing file",I,", Ch",J+1
40:                 for K=1 to 20
41:                 if D$[L,1,160]="";gto "L"
42:                 itf(D$[L,40J+2K-1,40J+2K])→Z
43:                 Z+X[J+1]→X[J+1]
44:                 next K
45:              X[J+11]+1→X[J+11]
46:→"L":         next L
47:→"J":      next J
48:           for L=1 to 4
49:           if A[8+L]=0;jmp 2
50:           wrt 16.3,L,X[L+10],X[L]
51:           next L
52:→"c":   next I
53:→"e":prt "end of files";spc 3
54:     dsp "Rewinding";trk 0;rew
55:     dsp "Done";ldp 9
56:→"line":prt "----------------";ret

57:
58:→"zero":
59:     prt V$
60:     if not flg7;jmp 5
61:     spc ;prt "# Xmit Recv GHz"
62:        for M=1 to 4
63:        if R$[3M-2→Z,3M]#"    ";wrt 16.8,M,S$[Z,Z+2],"to",R$[Z,Z+2],F[M]
64:        next M
65:     ret

66:
67:     end
```

1660 bytes 8694 check sum

Figure C-31. Tape directory listing, 2

Data File Directory Program

Variable Cross-Reference, Sheet 1

```
A
    21    22

B
    21    23    25    26

I
    18    20    21    23    24    24    25    25    26    26    27    27
    30    32    33    39    52

J
    36    37    39    42    42    43    43    45    45    47

K
    28    29    29    29    40    42    42    44

L
    38    41    42    46    48    49    50    50    50    51

M
    62    63    63    63    63    64

N
    21

T
    21

X
    14    14    28    29    29    29    35

Z
    42    43    63    63    63    63    63

A[
     1    24    27    28    28    37    49
```

Figure C-32. Tape directory Xref, 1.

```
Data File Directory Program

   Variable Cross-Reference, Sheet  2


  C[
       1    24

  D[
       2

  F[
       1    24    63

  R[
       1    24

  T[
       2    28    29    31    31    31    31    31    31    31

  U[
       2

  X[
       2    43    43    45    45    50    50

  Z[
       2

  D$
       1    27    41    42

  M$
       3    12    31

  R$
       1    24    63    63

  S$
       1    24    63
```

Figure C-33. Tape directory Xref, 2.

```
Data File Directory Program

   Variable Cross-Reference, Sheet  3


  T$
       3

  V$
       1    24    27    34    59

  W$
       3

  X$
       3

  "line"
      19

  "e"
      22

  "c"
      23    25    26    33

  "zero"
      32

  "J"
      37

  "L"
      41

  sfg
      14

  flg
      22    33    60
```

Figure C-34. Tape directory Xref, 3.

```
 0: "Data-I":prt "Data-I    3Jan79"
 1:    dim D$[12,160],V$[50],A[16],C[4,20],R[4],R$[12],S$[12],F[4]
 2:    dim D[4,20],T[6],U[5],X[16],Z[4,20]
 3:    dim M$[36],T$[16],W$[50],X$[12,160]
 4:
 5: "continue":fxd 0
 6:    fmt 8,f2.0,c3,f2.0,1x,f2.0,":",fz2.0,":",fz2.0,2x,c8
 7:    fmt 7,f2.0,f4.0,2x,f8.0
 8:    fmt 5,f2.0,f4.0,1x,f8.4,"%"
 9:    fmt 4,"Ch ",f1.0,2x,c3," to ",c3
10:    fmt 3,"File ",f2.0," no hr ",f2.0
11:    fmt 2,f2.0,c3,f2.0,1x,f2.0,":",fz2.0,":",fz2.0
12:    fmt 1,"File ",f2.0," complete"
13:    "think           "→W$
14:    -1→r2
15:    "JanFebMarAprMayJunJulAugSepOctNovDec"→M$
16:
17:    prt "press f5 to stop analysis.";ent "Press ´CONTINUE´ now",X
18:    trk 1;rew
19:    ent "Do you wish to edit files",X
20:    if X=0;0→r1;62→r2;jmp 3
21:→"edit":ent "Starting file?",r1;if r1<=r2;jmp 0
22:    ent "Ending file?",r2;if r2<r1;jmp 0
23:       for I=r1 to r2
24:       trk 1;fdf I;idf N,T,B,A
25:       if flg10;gto "D"
26:       if A=0;gto "e"
27:       if B<930;prt "Null file",I;P+1→P;gto "c"
28:       if I=0;ldf I,V$,A[*],C[*],R[*],R$,S$,F[*]
29:       if I#0 and B#2136;prt "file ",I,"Invalid data";gto "c"
30:       if I#0;ldf I,D$,V$,A[*]
31:       6→K;A[16]→X;A[15]→T[1]
32:       100frc(X/100)→T[K];int(X/100)→X;jmp (K-1→K)=1
33:       if T[4]=0 or T[4]>12;sfg 5
34:       wrt .2,T[3],M$[3T[2]-2,3T[2]],T[1],T[4],T[5],T[6]
```

Figure C-35. Data I listing, 1.

```
35:        if I=0;gto "c"
36:
37:           for L=1 to 12
38:              for J=0 to 3
39:              8(Jmod2+1)→r3
40:              wrt .8,T[3],M$[3T[2]-2,3T[2]],T[1],T[4],T[5],T[6],W$[r3-7,r3]
41:                 for K=1 to 20
42:                 if D$[L,1,160]="";sfg 4;wrt 16.3,I,L+12flg5;gto "d"
43:                 D[J+1,K]+itf(D$[L,40J+2K-1,40J+2K])→D[J+1,K]
44:                 next K
45:              next J
46:→"d":      next L
47:        cfg 5
48:
49:        if flg4;cfg 4;jmp 2
50:        wrt 16.1,I
51:→"c":   if P<3;next I
52:     if I>=62;prt "end of files";gto "Hist"
53:→"D":ent "Done with editing?",X;if X=0;gto "edit"
54:
55:→"Hist":
56:     trk 1;fdf 63;idf X,X,X;if X#0;dsp "Data in file 63";stp
57:     if bit(7,rds(1))=1;dsp "Tape is write protected";stp
58:     trk 1;rcf 63,D[*],T[*];trk 0;rew
59:     ent "Histogram?",X;if X=0;gto "Cum"
60:     spc 3;prt "Histogram of alldata points";spc ;gsb "Bin"
61:        for I=1 to 4
62:        if A[I+8]=0;jmp 7
63:        spc ;wrt 16.4,I,S$[3I-2,3I],R$[3I-2,3I]
64:        gsb "line"
65:           for J=1 to 19
66:           wrt 16.7,J,A[I]-(J-1)*A[I+4],D[I,J]
67:           next J
68:        wrt 16.7,20,-99,D[I,20]
69:        next I
```

Figure C-36. Data I listing, 2.

```
 70:    gsb "line"
 71:
 72:→"Cum":ent "Print cumulative distribution?",X;if X;sfg 5
 73:    if flg5;spc 3;prt "Cumulative        distribution";spc ;gsb "Bin"
 74:    ara D→Z
 75:       for I=1 to 4
 76:       if A[I+8]=0;jmp 8
 77:       if flg5;spc ;wrt 16.4,I,S$[3I-2,3I],R$[3I-2,3I]
 78:       if flg5;gsb "line"
 79:          for J=1 to 19
 80:          Z[I,J+1]+Z[I,J]→Z[I,J+1]
 81:          if flg5;wrt 16.7,J,A[I]-(J-1)*A[I+4],Z[I,J]
 82:          next J
 83:       if flg5;wrt 16.7,20,-99,Z[I,20]
 84:       next I
 85:    gsb "line"
 86:
 87:    ent "Percentages of data points?",X;if X=0;gto "cum%"
 88:    spc 3;prt "Percent RSL datapoints at level"
 89:       for I=1 to 4
 90:       if A[I+8]=0;jmp 7
 91:       spc ;wrt 16.4,I,S$[3I-2,3I],R$[3I-2,3I]
 92:       gsb "line"
 93:          for J=1 to 19
 94:          wrt 16.5,J,A[I]-(J-1)*A[I+4],D[I,J]/Z[I,20]*100
 95:          next J
 96:       wrt 16.5,20,-99,D[I,20]/Z[I,20]*100
 97:       next I
 98:    gsb "line"
 99:
100:→"cum%":ent "Cumulative Percentages?",X;if X=0;gto "end"
101:    spc 3;prt "Percent RSL dataabove level"
102:       for I=1 to 4
103:       if A[I+8]=0;jmp 7
104:       spc ;wrt 16.4,I,S$[3I-2,3I],R$[3I-2,3I]
```

Figure C-37. Data I listing, 3.

```
105:        gsb "line"
106:           for J=1 to 19
107:           wrt 16.5,J,A[I]-(J-1)*A[I+4],Z[I,J]/Z[I,20]*100
108:           next J
109:        wrt 16.5,20,-99,100
110:        next I
111:     gsb "line"
112:→"end":spc 3
113:     ent "Do you want to plot cumulative %s on rayleigh paper?",X
114:     if X;trk 0;ldp 8
115:     trk 0;ldp 9
116:
117:→"line":prt "----------------";ret

118:→"Bin":prt "Bin dBm  #Points";ret

119:     end
```


3208 bytes 18272 check sum

Figure C-38. Data I listing, 4.

Statistical Data Analysis Program

Variable Cross-Reference, Sheet 1

```
A
    24   26

B
    24   27   29

D
    74

I
    23   24   27   28   28   29   29   30   30   35   42   50
    51   52   61   62   63   63   63   63   63   66   66   66
    68   69   75   76   77   77   77   77   77   80   80   80
    81   81   81   83   84   89   90   91   91   91   91   91
    94   94   94   94   96   96   97  102  103  104  104  104
   104  104  107  107  107  107  110

J
    38   39   43   43   43   43   45   65   66   66   66   67
    79   80   80   80   81   81   81   82   93   94   94   94
    95  106  107  107  107  108

K
    31   32   32   32   41   43   43   43   43   44

L
    37   42   42   43   46

N
    24

P
    27   27   51

T
    24
```

Figure C-39. Data I Xref, 1.

Statistical Data Analysis Program

Variable Cross-Reference, Sheet 2

```
X
    17   19   20   31   32   32   32   53   53   56   56   56
    56   59   59   72   72   87   87  100  100  113  114

Z
    74

A[
     1   28   30   31   31   62   66   66   76   81   81   90
    94   94  103  107  107

C[
     1   28

D[
     2   43   43   58   66   68   94   96

F[
     1   28

R[
     1   28

T[
     2   31   32   33   33   34   34   34   34   34   34   34
    40   40   40   40   40   40   40   58

U[
     2

X[
     2

Z[
     2   80   80   80   81   83   94   96  107  107
```

Figure C-40. Data I Xref, 2.

Statistical Data Analysis Program

Variable Cross-Reference, Sheet 3

```
D$
     1    30    42    43
M$
     3    15    34    40
R$
     1    28    63    77    91   104
S$
     1    28    63    77    91   104
T$
     3
V$
     1    28    30
W$
     3    13    40
X$
     3
r1
    20    21    21    22    23
r2
    14    20    21    22    22    23
r3
    39    40    40
"D"
    25
```

Figure C-41. Data I Xref, 3.

Statistical Data Analysis Program

Variable Cross-Reference, Sheet 4

```
"e"
   26

"c"
   27    29    35

"d"
   42

"Hist"
   52

"edit"
   53

"Cum"
   59

"Bin"
   60    73

"line"
   64    70    78    85    92    98   105   111

"cum%"
   87

"end"
  100

cfg
   47    49

sfg
   33    42    72

flg
   25    42    49    73    77    78    81    83
```

Figure C-42. Data I Xref, 4.

```
 0: "DataII":prt "Data II  15Jan79"
 1:    dim D$[12,160],V$[50],A[16],C[4,20],R[4],R$[12],S$[12],F[4]
 2:    dim D[4,20],T[6],U[5],X[16],Z[4,20],M[0:63,12]
 3:    dim M$[36],T$[16],W$[50],Z$[64,96],W[6]
 4:    "think            "→W$;0→E
 5:    "JanFebMarAprMayJunJulAugSepOctNovDec"→M$
 6:
 7: "continue":fxd 0
 8:    fmt 1,f2.0,c3,f2.0,1x,f2.0,":",fz2.0,":",fz2.0,"  ",c8
 9:    fmt 7,"File",f3.0
10:    fmt 6,2x,f2.0,c3,f2.0,":",fz2.0,f4.0
11:    fmt 4,f2.0,2x,4f3.0
12:    fmt 5,f1.0,1x,2f3.0,1x,2f3.0
13:    fmt 2,f2.0,c3,f2.0,1x,f2.0,":",fz2.0,":",fz2.0,5x,f3.0
14:
15:    spc 2;prt "Hourly Means"
16:    spc ;prt "  Datetime  Fil#","Hr Ch#1 #2 #3 #4"
17:    prt "Press f5 to stop computation.";ent "press 'Continue' now",X
18:    trk 1;rew
19:    ent "Print out hourly means?",X;if X;sfg 3
20:    ent "Plot hourly means?",X;if X;sfg 4
21:    if flg3+flg4=0;trk 0;ldp 9
22:
23:    ent "Do you wish to edit files?",X;if X=0;gto "file"
24:    ent "do you wish to edit hours?",r21
25:    ent "1st ending file? must read file0",Y;jmp 2
26:
27:→"ent":
28:    ent "next ending file?",Y;if X=1;jmp 2
29:    12→U;if r21;ent "last hour of last file?",U;(U-1)mod12+1→U
30:    ent "Done with editing?",X;if X;64→Z;jmp 2
31:    ent "next starting file?",Z
32:    1→W;if not X and r21;ent "starting hour of next file",W;(W-1)mod12+1→W
33:    if Y<Z;jmp 6
34:       for J=U+1 to W-1
```

Figure C-43. Data II listing, 1.

```
35:        1→M[Y,J]
36:        next J
37:     if X=0;gto "ent"
38:     gto "file"

39:        for J=U+1 to 12
40:        1→M[Y,J]
41:        next J
42:        for I=Y+1 to Z-1
43:           for J=1 to 12
44:           1→M[I,J]
45:           next J
46:        next I
47:        for J=1 to W-1
48:        1→M[Z,J]
49:        next J
50:     if X=0;gto "ent"
51:
52:→"file":
53:        for I=E to 63
54:        I-r7E→F
55:        M[F,1] and M[F,2] and M[F,3] and M[F,4] and M[F,5] and M[F,6]→H
56:        M[F,7] and M[F,8] and M[F,9] and M[F,10] and M[F,11] and M[F,12]→G
57:        if G and H;gto "c"
58:        I→Q
59:        trk 1;fdf I-r7E;idf X,T,B,A
60:        if E=I and E>0;gto "c"
61:        if A=0 or flg10;gto "e"
62:        if B<930;prt "Null file",I;P+1→P;gto "c"
63:        if I=0;ldf 0,V$,A[*],C[*],R[*],R$,S$,F[*]
64:        if I#0;if B#2136;prt "file ",I,"Invalid data";gto "c"
65:        if I#0;ldf I-r7E,D$,V$,A[*]
66:        6→K;A[16]→X;A[15]→T[1]
67:        100frc(X/100)→T[K];int(X/100)→X;jmp (K-1→K)=1
68:        if T[4]+T[5]+T[6]=0;24→T[4];T[3]-1→T[3]
```

Figure C-44. Data II listing, 2.

```
 69:        if I=0;gto "c"
 70:        if I=1;ara T→W;0→T[5]→T[6];int((W[4]-1)/12)→W[4]
 71:        if flg3;gsb "line"
 72:        wrt 16.6,T[3],M$[3T[2]-2,3T[2]],T[4],T[5],I
 73:        if int((N+I)/2)+W[3]>=T[3]+1 and (N+I)mod2=int((T[4]-1)/12);jmp 6
 74:        if Z$[N+I]#"";jmp 4
 75:           for J=1 to 96
 76:           Z$[N+I]&char(0)→Z$[N+I]
 77:           next J
 78:        N+1→N;jmp -5
 79:
 80:           for J=1 to 12
 81:           if M[F,J];jmp 2
 82:           if D$[J,1,160]#"";jmp 5
 83:              for L=8J to 8J+7
 84:              Z$[N+I]&char(0)→Z$[N+I]
 85:              next L
 86:           gto "R"
 87:           ina D
 88:
 89:              for K=0 to 3
 90:              8(Jmod2+1)→r41
 91:              wrt .1,T[3],M$[3T[2]-2,3T[2]],T[1],T[4],T[5],T[6],W$[r41-7,r41]
 92:              itf(D$[J,40K+1,40K+2])→D[K+1,1]
 93:                 for L=2 to 20
 94:                 D[K+1,L-1]+itf(D$[J,40K+2L-1,40K+2L])→D[K+1,L]
 95:                 next L
 96:                 for L=1 to 19
 97:                 if D[K+1,L]>=D[K+1,20]/2;A[K+1]-(L-1)*A[K+5]→X[K+1];jmp 2
 98:                 next L
 99:              fti (A[K+1]-(L-1)*A[K+5])→Z$[N+I,8J+2K-7,8J+2K-6]
100:              next K
101:           if flg3;wrt 16.4,12int((T[4]-1)/12)+J,X[1],X[2],X[3],X[4]
102:→"R":
```

Figure C-45. Data II listing, 3.

```
103:          next J
104:
105:→"c":  if P<3;next I
106:    Q-3→Q
107:
108:→"e":ina M;Q→E;ent "Done with this tape?",X;if X=0;gto "ent"
109:    dsp "Rewinding";trk 0;rew
110:→"end":1→r7;ent "Any more analysis?",X;if X;gto "ent"
111:    if flg4;gto "scl"
112:    dsp "Done";trk 0;ldp 9
113:
114:→"scl":pen# 1;wrt 705,"IP0,0,9825,7582";gsb "scale"
115:    plt -.05r7,.45(r8-2r9),1;csiz 1,2,1,90;lbl "RSL dBm";csiz 1
116:    plt .05(r7-2r9),1.02(r8-2r9),1;lbl V$;lim 0,750,0,500
117:→"wh":cfg 4;plt r7-r9,r8-r9,1
118:    ent "Which channel?",C;if C<1;gto "end"
119:    if Z$[C]="";gto "wh"
120:    pen# C;cll 'plot'(3400000,-24-2C,1);lbl "chan",C
121:       for I=1 to N+E
122:          for J=1 to 12
123:          86400(W[3]-1)+43200I+3600(J-1)+60W[5]+W[6]→S
124:          cll 'plot'(S,itf(Z$[I,8J+2C-9,8J+2C-8]),2);iplt 0,0,1
125:          next J
126:       next I
127:    gto "wh"

128:
129:→"line":prt "----------------";ret

130:
131:→"scale":pclr;ent "8"" x 10.5"" paper ready?",X;jmp X
132:    1050→r7
133:    800→r8
134:    150→r9
135:    scl -r9,r7-r9,-r9,r8-r9;fxd 0
```


Figure C-46. Data II listing, 4.

```
136:    86400W[3]+3600W[4]+60W[5]+W[6]→r1;86400*32+r1→r2;31→r3
137:    -85→r4;-25→r5;10→r6
138:    (r2-r1)/(r7-2r9)→Q
139:    (r5-r4)/(r8-2r9)→R
140:    fxd 4
141:       for M=r1 to r2 by 50
142:       if drnd(1+frc(M/86400),3)=2;jmp 2
143:       next M
144:    fxd 0
145:    W[3]→K;sfg 7;sfg 8
146:
147:       for L=M to r2 by 86400
148:       cll 'plot'(L,r5,2);cll 'plot'(L,r4,1)
149:       if K=28+(not W[1]mod4) and W[2]=2;cll 'numo'
150:       if K=30 and (W[2]=4 or W[2]=6 or W[2]=9 or W[2]=11);cll 'numo'
151:       if K=31;cll 'numo'
152:       K+1→K
153:       if flg8 and K=1;cfg 7
154:       if Kmod7#flg7*(W[3]mod7)+1;jmp 3
155:       cplt -(K>9)-2.3,-1.3;lbl K,"^"
156:       if flg8;cfg 8;cplt -3,-1;lbl M$[3W[2]-2,3W[2]]
157:       next L
158:
159:       for M=r4 to r5 by r6
160:       cll 'plot'(r2,M,2);cll 'plot'(r1,M,1)
161:       cplt -4,-.3;lbl M
162:       next M
163:    ret

164:
165:→"plot":
166:    (p1-r1)/Q→X
167:    (p2-r4)/R→Y
168:    plt X,Y,-p3;ret
```

Figure C-47. Data II listing, 5.

```
169:
170:→"numo":0→K;W[2]mod12+1→W[2];sfg 8;ret

      4510 bytes     16308 check sum
```

Figure C-48. Data II listing, 6.

Hourly Median Analysis Program

Variable Cross-Reference, Sheet 1

```
A
   59   61

B
   59   62   64

C
  118  118  119  120  120  120  124  124

D
   87

E
    4   53   54   59   60   60   65  108  121

F
   54   55   55   55   55   55   55   56   56   56   56   56
   56   81

G
   56   57

H
   55   57

I
   42   44   46   53   54   58   59   60   62   63   64   64
   65   65   69   70   72   73   73   74   76   76   84   84
   99  105  121  123  124  126

J
   34   35   36   39   40   41   43   44   45   47   48   49
```

Figure C-49. Data II Xref, 1.

Hourly Median Analysis Program

Variable Cross-Reference, Sheet 2

```
   75   77   80   81   82   83   83   90   92   94   99   99
  101  103  122  123  124  124  125

K
   66   67   67   67   89   92   92   92   94   94   94   94
   97   97   97   97   97   99   99   99   99  100  145  149
  150  151  152  152  153  154  155  155  170

L
   83   85   93   94   94   94   94   95   96   97   97   98
   99  147  148  148  157

M
  108  141  142  143  147  159  160  160  161  162

N
   73   73   74   76   76   78   78   84   84   99  121

P
   62   62  105

Q
   58  106  106  108  138  166

R
  139  167

S
  123  124

T
   59   70

U
   29   29   29   29   34   39
```

Figure C-50. Data II Xref, 2.

Hourly Median Analysis Program

Variable Cross-Reference, Sheet 3

```
W
    32    32    32    32    34    47    70

X
    17    19    19    20    20    23    23    28    30    30    32    37
    50    59    66    67    67    67   108   108   110   110   131   131
   166   168

Y
    25    28    33    35    40    42   167   168

Z
    30    31    33    42    48

A[
     1    63    65    66    66    97    97    99    99

C[
     1    63

D[
     2    92    94    94    97    97

F[
     1    63

M[
     2    35    40    44    48    55    55    55    55    55    55    56
    56    56    56    56    56    81

R[
     1    63

T[
     2    66    67    68    68    68    68    68    68    70    70    72
```

Figure C-51. Data II Xref, 3.

```
Hourly Median Analysis Program

   Variable Cross-Reference, Sheet  4


     72   72   72   72   73   73   91   91   91   91   91   91
     91  101

  U[
      2

  W[
      3   70   70   73  123  123  123  136  136  136  136  145
    149  149  150  150  150  150  154  156  156  170  170

  X[
      2   97  101  101  101  101

  Z[
      2

  D$
      1   65   82   92   94

  M$
      3    5   72   91  156

  R$
      1   63

  S$
      1   63

  T$
      3

  V$
      1   63   65  116

  W$
      3    4   91
```

Figure C-52. Data II Xref, 4.

Hourly Median Analysis Program

Variable Cross-Reference, Sheet 5

```
Z$
    3   74   76   76   84   84   99  119  124
r1
  136  136  138  141  160  166
r2
  136  138  141  147  160
r3
  136
r4
  137  139  148  159  167
r5
  137  139  148  159
r6
  137  159
r7
   54   59   65  110  115  116  117  132  135  138
r8
  115  116  117  133  135  139
r9
  115  116  116  117  117  134  135  135  135  135  138  139
r21
   24   29   32
r41
   90   91   91
```

Figure C-53. Data II Xref, 5.

```
Hourly Median Analysis Program

   Variable Cross-Reference, Sheet  6


  p1
    166

  p2
    167

  p3
    168

  "file"
     23    38

  "ent"
     37    50   108   110

  "c"
     57    60    62    64    69

  "e"
     61

  "line"
     71

  "R"
     86

  "scl"
    111

  "scale"
    114

  "end"
    118
```

Figure C-54. Data II Xref, 6.

Hourly Median Analysis Program

Variable Cross-Reference, Sheet 7

```
"wh"
  119  127

'plot'
  120  124  148  148  160  160

'numo'
  149  150  151

cfg
  117  153  156

sfg
   19   20  145  145  170

flg
   21   21   61   71  101  111  153  154  156
```

Figure C-55. Data II Xref, 7.

```
 0: "Ray13D":prt "rayleigh27Dec78"
 1:    dim V$[50],A[16],C[4,20],R[4],R$[12],S$[12],F[4]
 2:    dim D[4,20],Z[6],M$[36],T[6],Y[2],X[6]
 3:    "JanFebMarAprMayJunJulAugSepOctNovDec"→M$
 4:    fmt 1,c,f4.0,c4,f3.0,f4.0,":",fz2.0
 5:    trk 1;ldf 0,V$,A[*],C[*],R[*],R$,S$,F[*]
 6:    trk 1;ldf 63,D[*],Z[*];trk 0;rew;ara D→C
 7:    6→K;A[16]→X;A[15]→T[1]
 8:    100frc(X/100)→T[K];int(X/100)→X;jmp (K-1→K)=1
 9:       for I=1 to 4
10:          for J=1 to 19
11:          C[I,J]+C[I,J+1]→C[I,J+1]
12:          next J
13:       next I
14:    ent "8"" x 10 1/2"" paper ready?",Z;if Z#1;jmp 0
15:    pen# 1;cll ´paper´
16: "X-axis endpoints":.001→X[1];99.999→X[2]
17:    1-X[1]/100→X[1];1-X[2]/100→X[2]
18: "Median RSL":-30→X[3]
19:    cll ´scale´(X[1],X[2],-X[3])
20:    csiz 1,1.2
21:    gsb "label"
22:    lim 0,150,18,168;pen# 1
23:
24:→"z":plt r1-1.1r3,r2-1.2r3,1;ent "which channel?",C;if C<1 or C>4;ldp 9
25:    if A[C+8]=0;jmp -1
26: "label loc":.991→X[4];1-X[4]→X[4];fxd 2
27:    if C=1;cll ´plot´(X[4],27,1);cll ´box´(1);cplt 1,-.2
28:    if C=1;lbl " chan 1, ",S$[1,3]," to ",R$[1,3],"  ",F[1]," GHz"
29:    if C=2;cll ´plot´(X[4],29,1);cll ´cros´(1);cplt 1,-.2
30:    if C=2;lbl " chan 2, ",S$[4,6]," to ",R$[4,6],"  ",F[2]," GHz"
31:    if C=3;cll ´plot´(X[4],31,1);cll ´plus´(1);cplt 1,-.2
32:    if C=3;lbl " chan 3, ",S$[7,9]," to ",R$[7,9],"  ",F[3]," GHz"
33:    if C=4;cll ´plot´(X[4],33,1);cll ´tri´(1);cplt 1,-.2
34:    if C=4;lbl " chan 4, ",S$[10,12]," to ",R$[10,12],"  ",F[4]," GHz"
```

Figure C-56. Rayleigh listing, 1.

```
35:        for I=1 to 19
36:        dsp
37:        1-C[C,I]/C[C,20]→X
38:        if X>X[1] or X<X[2];gto "n"
39:        cll 'plot'(X,(I-1)A[C+4]-A[C],-2)
40:        if C=1;cll 'box'(-2)
41:        if C=2;cll 'cros'(-2)
42:        if C=3;cll 'plus'(-2)
43:        if C=4;cll 'tri'(-2)
44:→"n":   next I
45:     pen
46:     gto "z"

47:
48:→"box":
49:     iplt -1,-1,1;iplt 2,0,2;iplt 0,2
50:     iplt -2,0;iplt 0,-2,-1;iplt 1,1,pl;ret

51:
52:→"cros":
53:     iplt -1,-1,1;iplt 2,2,2;iplt -2,0,1
54:     iplt 2,-2,2;iplt -1,1,pl;ret

55:
56:→"plus":
57:     iplt -1,0,1;iplt 2,0,2;iplt -1,1,1
58:     iplt 0,-2,2;iplt 0,1,pl;ret

59:
60:→"tri":
61:     iplt -1,-1,1;iplt 2,0,2
62:     iplt -1,2;iplt -1,-2,-1;iplt 1,1,pl;ret

63:
64:        for I=1 to N
```

Figure C-57. Rayleigh listing, 2.

```
65:        cll 'plot'(1-A[I]/100,-B[I],-2)
66:        next I
67:     line ;pen
68:
69:→"label":lim
70:     (r5-r3)/r2→Y[1];(r7-r3)/r2→Y[2]
71:     cll 'yax'(X[1],Y[1],Y[2],1,1)
72:     cll 'xaxr'(Y[1],X[1],X[2],1,1)
73:     cll 'xaxr'(Y[2],X[1],X[2],-1)
74:     cll 'yax'(X[2],Y[1],Y[2],-1)
75:     csiz 1.5;plt 30,6,1;lbl "Percent of Time Signal Exceeds Ordinate"
76:     plt -12,30,1;csiz 1.2,1.5,1,90;lbl "Received Signal Level (RSL), dBm"
77:     plt 10,-3,1;csiz 2;lbl V$;plt 10,-11,1;csiz 1.5
78:     wrt 705.1,"LBData from",T[3],M$[3T[2]-2,3T[2]],T[1],T[4],T[5]
79:     wtb 705,3;plt 10,-18,1
80:     wrt 705.1,"LB       to",Z[3],M$[3Z[2]-2,3Z[2]],Z[1],Z[4],Z[5]
81:     wtb 705,3;plt 10,-25,1;lbl "Approx",max(C[*])/14400," hours";csiz
82:     plt 200,200,1
83:     ret
84:
85:→"paper":
86: "r4=Xmin,r5=Ymin,r6=Xmax,r7=Ymax":
87:     wrt 705,"IP360,760,6960,9720"
88:     scl -15,150,-54,170
89:     0→r4;18→r5;150→r6;168→r7
90:     plt r4,r5,-2;plt r4,r7;plt r6,r7;plt r6,r5;plt r4,r5,-1
91:     ret
92:
93:→"scale":
94: "p1=Xmin,p2=Xmax":
95:     (r6-r4)/('Fx'(p2)-'Fx'(p1))→r0
96:     r4-r0'Fx'(p1)→r1
97:     (r6-r0'Fx'(10p2)-r1)/-10→r2
```

Figure C-58. Rayleigh listing, 3.

```
 98:     r7-r0´Fx´(.5)-r1-r2´Fy´(p3)→r3
 99:     ret

100:
101:→"plot":
102:     plt r0´Fx´(p1)+r1,r2´Fy´(p2)+r3,p3
103:     ret

104:
105:→"xaxr":
106: "p1=y-axis intercept,p2=Xmin,p3=Xmax,p4=tick length,p5=label":
107:     p2→I;-9(1-I)→p6
108:        for I=I to p3 by p6
109:        if I>.9 and I/p6mod10=0;10p6→p6;jmp -1
110:        if I=.9 and p6#-.1;-.1→p6;jmp -2
111:        if I<.9 and I/p6=-1;.1p6→p6;jmp -3
112:        cll ´plot´(I,p1,-2)
113:        iplt 0,p4+2p4((I/p6mod10=0)+(I>.8)+(I=.5)→p7)
114:        if not (p7=1 and I<=.99 and p5);jmp 3
115:        cll ´plot´(I,p1,-2)
116:        fxd max(-1-prnd(log(I√11),0),0)→p7;pen;cplt -2-p7,-1;lbl 100(1-I)
117:        cll ´plot´(I,p1,-2)
118:        next I
119:     pen;ret

120:
121:→"yax":fxd 0;sfg 14
122: "p1=x-axis intercept,p2=Ymin,p3=Ymax,p4=tick length,p5=label":
123:     cll ´plot´(p1,p3,-2)
124:        for I=int(p3)+1 to int(p2)
125:        cll ´plot´(p1,I,-2)
126:        iplt p4+2p4(Imod10=0),0
127:        if p5 and Imod10=0;pen;cplt -6.5-abs(max(0,-prnd(log(I),0))),-.3;lbl -I
128:        cll ´plot´(p1,I,-2)
129:        next I
```

Figure C-59. Rayleigh listing, 4.

```
130:     cll 'plot'(p1,p2,-1);cfg 14;ret

131:
132:→"Fx":
133: "Rayleigh transform":
134:     ret ln(-log(1-p1))

135:
136:→"Fy":
137:     ret p1


     4104 bytes     15612 check sum
```

Figure C-60. Rayleigh listing, 5.

Rayleigh Plot Program

Variable Cross-Reference, Sheet 1

```
C
     6    24    24    24    25    27    28    29    30    31    32    33
    34    37    37    39    39    40    41    42    43

D
     6

I
     9    11    11    11    13    35    37    39    44    64    65    65
    66   107   107   108   108   109   109   110   111   111   112   113
   113   113   114   115   116   116   117   118   124   125   126   127
   127   127   128   129

J
    10    11    11    11    12

K
     7     8     8     8

N
    64

X
     7     8     8     8    37    38    38    39

Z
    14    14

A[
     1     5     7     7    25    39    39    65

B[
    65

C[
     1     5    11    11    11    37    37    81
```

Figure C-61. Rayleigh Xref, 1.

Rayleigh Plot Program

Variable Cross-Reference, Sheet 2

```
D[
     2    6

F[
     1    5   28   30   32   34

R[
     1    5

T[
     2    7    8   78   78   78   78   78   78

X[
     2   16   16   17   17   17   17   18   19   19   19   26
    26   26   27   29   31   33   38   38   71   72   72   73
    73   74

Y[
     2   70   70   71   71   72   73   74   74

Z[
     2    6   80   80   80   80   80   80

M$
     2    3   78   80

R$
     1    5   28   30   32   34

S$
     1    5   28   30   32   34

V$
     1    5   77
```

Figure C-62. Rayleigh Xref, 2.

Rayleigh Plot Program

Variable Cross-Reference, Sheet 3

```
r0
    95    96    97    98   102

r1
    24    96    97    98   102

r2
    24    70    70    97    98   102

r3
    24    24    70    70    98   102

r4
    89    90    90    90    95    96

r5
    70    89    90    90    90

r6
    89    90    90    95    97

r7
    70    89    90    90    98

p1
    50    54    58    62    95    96   102   112   115   117   123   125
   128   130   134   137

p2
    95    97   102   107   124   130

p3
    98   102   108   123   124

p4
   113   113   126   126
```

Figure C-63. Rayleigh Xref, 3.

```
Rayleigh Plot Program

   Variable Cross-Reference, Sheet  4


  p5
    114   127

  p6
    107   108   109   109   109   110   110   111   111   111   113

  p7
    113   114   116   116

  "label"
      21

  "n"
      38

  "z"
      46

  'paper'
      15

  'scale'
      19

  'plot'
      27    29    31    33    39    65   112   115   117   123   125   128
     130

  'box'
      27    40

  'cros'
      29    41

  'plus'
      31    42
```

Figure C-64. Rayleigh Xref, 4.

```
Rayleigh Plot Program

   Variable Cross-Reference, Sheet  5


  'tri'
     33    43

  'yax'
     71    74

  'xaxr'
     72    73

  'Fx'
     95    95    96    97    98   102

  'Fy'
     98   102

  cfg
    130

  sfg
    121
```

Figure C-65. Rayleigh Xref, 5.

```
 0: "selecPrg":prt "selecPrg  7Nov78"
 1:    dsp "Select program"
 2:    spc 2
 3:    prt "--------------";spc 1
 4:    prt "Which program?"
 5:    spc 1
 6:    prt " 1) Initialize"
 7:    prt " 2) Run RSL test"
 8:    prt " 3) File Directy"
 9:    prt " 4) Data anal I"
10:    prt " 5) Data anal II"
11:    prt " 6) PlotRayleigh"
12:    prt " 7) New Tape Gen"
13:    prt " 8) A-D Test"
14:    prt " 9) End"
15:    spc 2;fxd 0
16:    0→Z;ent "Enter program #?",Z
17:    if Z>=9;rew;dsp "Done";stp
18:    if Z<=0;jmp -2
19:    if Z>=3;Z+1→Z;if Z>=7;Z+1→Z
20:    trk 0;ldp Z+1
21:    end

     430 bytes    28050 check sum
```

Figure C-66. Select listing and Xref.

15. ABSTRACT (cont.)

test to list and plot cumulative distributions and hourly medians on a peripheral graphic plotter. The graphs, including axes and scales, are drawn and annotated completely under software control.

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