ANALYSIS OF PARTIAL-REFLECTION DATA
FROM THE SOLAR ECLIPSE OF JULY 10, 1972

by
T. A. Bean
S. A. Bowhill

October 1, 1973

Supported by
National Aeronautics and Space Administration
Grant NGR 14-005-181

Aeronomy Laboratory
Department of Electrical Engineering
University of Illinois
Urbana, Illinois
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AERONOMY REPORT
NO. 55

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ABSTRACT

Partial-reflection data collected for the eclipse of July 10, 1972 as well as for July 9 and 11, 1972, are analyzed to determine eclipse effects on D-region electron densities. The partial-reflection experiment was set up to collect data using an on-line PDP-15 computer and DECtape storage. Except for a couple of changes, the experiment was the same setup as used by Birley and Sechrist [1971]. The electron-density profiles show good agreement with results from other eclipses. The partial-reflection programs were changed after the eclipse data collection to improve the operation of the partial-reflection system. These changes were mainly due to expanded computer hardware and have simplified the operations of the system considerably.
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1. INTRODUCTION

A solar eclipse can be thought of as the obscuration of solar radiation by the intervention of the moon between the sun and a point on the earth. This obscuring of the sun is a function of time which varies with the location on the earth, altitude, and the type of radiation. Depending on the wavelength of solar radiation and the ionospheric constituents, solar radiation can cause three chemical processes known as dissociation, ionization and excitation [Whitten and Poppoff, 1971]. The variation in solar radiation with time during a solar eclipse is given as an obscuration function and varies according to the different wavelengths of radiation. The obscuration function for visible light is easily calculated, being just that for the visible disk. Figure 1.1 shows this obscuration function for the eclipse of July 10, 1972 at 75 km altitude above the University of Illinois Aeronomy Field Station located near Urbana. At this location the eclipse was partial, with about 60% maximum obscuration. The obscuration functions for various other radiations during a total eclipse are shown in Figure 1.2 [Sears, 1972]. Notice the large difference between the obscuration functions for ultraviolet radiation and X-rays.

Solar radiation with wavelengths less than 2900A causes various chemical reactions in the ionosphere [Whitten and Poppoff, 1971] with the most pronounced effects occurring in the D-region (50 to 90 km). For example, Turco and Sechrist [1970] show two orders of magnitude change in the electron density and more than three orders of magnitude change in $\mathrm{CO}_3^-$ and $\mathrm{CO}_4^-$ at 75 km during sunrise. Certain solar radiations greatly enhance the concentration of positive ions as well as the electron density so that during the daytime, except for during enhanced particle precipitation [Lauter and Knuth, 1967], the main ionization source above 70 km
Figure 1.1 The obscuration function of visible light at a height of 75 km for the eclipse of July 10, 1972, near Urbana, Illinois.
Figure 1.2 Obscuration functions for visible light (V), Lyman alpha (Lα), ultraviolet (UV), and X-ray (X) ionizing fluxes for the 1966 solar eclipse from Sears [1972].
is solar radiation as given in Section 2.1. Therefore by correlating the electron densities with the obscuration function for the ionizing radiation in a solar eclipse, values for the production and loss of positive ions and confirmation of the ionizing sources can be obtained.

Data from the D region have been obtained by both rocket measurements and ground-based techniques. Although rocket measurements seem to be more accurate [Mechtly, et al., 1967], the amount of data is limited by cost. Ground-based techniques can be set up anywhere and can gather large amounts of data, although the accuracy is not as great, and they are primarily limited to evaluating electron densities. One type of ground-based technique which is discussed in this paper is called the partial-reflection experiment. Data are collected using vertical incident radio waves which are partially reflected from the D region. The information obtained can be in one of two forms: differential absorption [Pirnat and Bowhill, 1968] and differential phase [Wiersma and Sechrist, 1972]. Partial-reflection data using the differential absorption method were collected from 1200 to 1700 CST for the solar eclipse of July 10, 1972, as well as July 9 and 11 as control days. The experiment was set up as described by Birley and Sechrist [1971] with two exceptions as described in Chapter 3. The solar and ionospheric conditions for this experiment are given in Chapter 2.
2. PRODUCTION AND LOSS OF THE D-REGION IONIZATION

Recently several papers have summarized the knowledge of the D region of the ionosphere. Thomas [1971] presents an overall review of the D region while theoretical models of the D region are presented by Sechrist [1972], Ferguson [1971], Donahue [1972], and Radicella and Stowe [1970]. The D region is perhaps the most complicated part of the ionosphere as well as the most difficult part from which to obtain accurate data. The chemical composition is dependent on height and solar zenith angle [Thomas, 1971]; although it consists of neutral constituents, positive ions, negative ions, and free electrons, this chapter is mainly concerned with the processes of formation and loss of free electrons during the daytime (solar zenith angles less than 90°) and during a solar eclipse. Using results obtained from measurements on other eclipses, the expected results from the partial-reflection experiment are given.

2.1 Ionization Sources

Although there is general agreement on what ionizes the neutral D-region constituents, there is some doubt as to the relative importance of each source. The ionization sources for the daytime D region at midlatitudes, as given by Mitra and Rowe [1972] and by Aikin [1972] are:

1) Lyman-α (1216Å) ionizing nitric oxide (NO)
2) 1-8Å X-rays ionizing all constituents
3) 1027-1118Å ultraviolet radiation ionizing metastable $^12\Delta_g$ (NO)
4) Galactic cosmic rays ionizing all constituents.

Along with these sources precipitating electrons may be considered another source of free electrons, but is of prime importance only in the polar regions, at night, or after a magnetic storm [Lauter and Knuth, 1967] and will not be considered in this paper.
The primary ionization source below 70 km is considered to be galactic cosmic rays [Sechrist, 1972], although its effect may extend as high as 75 km [Keneshea, 1967]. The primary ionization source above 70 km is either (1) or (3) depending upon the nitric oxide distribution adopted. Few measurements of nitric oxide have been made, so most distributions available are from theoretical models. Distributions measured by Barth [1966] and Pearoe [1969] are at least an order of magnitude greater than distributions calculated from theoretical models of the ionosphere [Mitra, 1966], but distributions measured by Meira [1971] below 85 km are about the same as those calculated by Shimazaki and Laird [1970]. Using distribution by Barth [1966] for NO, the primary ionization source between 70 and 80 km is Lyman-α ionizing NO, but using nitric oxide distributions given by Shimazaki and Laird [1972] and photoionization rates for O₂(1Δg) given by Hunten and MoElroy [1968], the main ionization source between 70 and 80 km is 1027-1118 Å UV radiation ionizing O₂(1Δg) [Thomas, 1971]. Somoyajulu and Avadbanulu [1972] pointed out that according to measurements by Huffman, et al. [1971], photoionization of O₂(1Δg) is important only above 80 km making Lyman-α the main ionization source. Figure 2.1 from Sechrist [1972] shows ion-pair production rates for various radiation during solar minimum. In any case the distribution of NO is important to the rate of production of free electrons between 70 and 80 km, and the distribution by Meira [1971] is used in this paper.

The variation of ionization sources (1) and (3) with respect to solar activity is small [Thomas, 1971], but 2-8 Å X-ray flux can change by several orders of magnitude. Typical X-ray fluxes for different solar activity as given by Aikin [1972] are less than 4 x 10^{-3} ergs cm^{-2} sec^{-1} for a quiet sun, between 4 x 10^{-4} and 4 x 10^{-3} ergs cm^{-2} sec^{-1} for moderate sun, and greater than 4 x 10^{-3} ergs cm^{-2} sec^{-1} for an active sun. A solar flare on July 11 at
Figure 2.1 Ion-pair production rates from various $D$-region ionization sources as given by Sechrist [1972].
8:10 AM CST produced a 2-8 Å X-ray flux of $1.5 \times 10^{-2}$ ergs cm$^{-2}$ sec$^{-1}$. With an active sun or a solar flare 2-8 Å X-ray ionization can become the primary source of ionization. The 2-8 Å flux for July 9, 10, 11 in Figure 2.2 from the Solar Geophysical Data, 1973 (U. S. Department of Commerce) shows the solar activity to be quiet to moderate. The X-ray flux is expected to have little or no correlation with the electron density of the upper $D$ region except for the X-ray burst near 1435 on July 11.

2.2 Formation of Ions in the D Region

The electron density between 70 and 85 km is dependent on the formation of positive ions. The three main ionization reactions for this region are:

A) $O_2 + h\nu \rightarrow O_2^+ + e$

B) $NO + h\nu \rightarrow NO^+ + e$

C) $N_2 + h\nu \rightarrow N_2^+ + e$

as seen in Figure 2.3 adapted from Mitra and Rowe [1972] and Donahue [1972], which is a block diagram of the positive-ion chemistry at 75 km. The main loss process for $N_2^+$ is by the charge-exchange reaction:

D) $N_2^+ + O_2 \rightarrow N_2 + O_2.$

This reaction is very fast ($1 \times 10^{-10}$ cm$^3$ sec$^{-1}$) [Fehsenfeld, et al., 1965]. Therefore concentrations of $N_2^+$ are small and the production of $O_2^+$ is either by photoionization or by charge transfer. Electron production, therefore can be determined by the production of $NO^+$ and $O_2^+$ minus the formation of $NO^+$ by charge exchange reactions shown in Figure 2.3. Since the production of $NO^+$ is dependent on NO distributions, the production rate of the free electrons also depends on the NO distribution which can differ by at least an order of magnitude (Section 2.1).

The main positive ions between 70 and 80 km are hydrated ions of the form $H^+(H_2O)_n^+$, $n$ being some number greater than zero [Narcisi and Bailey, 1965].
Figure 2.2 Average variations in 2-8 Å X-ray flux during which partial-reflection data were collected on July 9, 10, and 11, 1972.
Figure 2.3 Flow diagram of the formation of positive ions including conversion rates [Donahue, 1972]. Three-body rate constants are in units of 10^-28 cm^6 sec^-1; two-body rate constants are in units of 10^-9 cm^3 sec^-1. Rate constants not given by Donahue are from Good, et al. [1970].
Two basic reaction schemes for the formation of water cluster ions as presented by Fehsenfeld and Ferguson [1969] are from NO\(^{+}\) and beginning with the reaction

\[ \text{NO}^{+} + \text{O}_2 + M \rightarrow \text{NO}_2^{+} + M \]

where \( M \) is a third body. Both schemes are given in Figure 2.3. Each scheme raised several questions which are dealt with by Donahue [1972]. According to Figure 2.3, NO\(^{+}\) creates hydrates with masses of 55 and higher, yet 19\(^{+}\) and 37\(^{+}\) are the dominant hydrates detected. Also the first three reactions with NO\(^{+}\) are too slow relative to the loss rate. Problems with the \( \text{O}_2^{+} \) scheme are: it seems to ignore the large NO\(^{+}\) concentration and the ionization of \( \text{O}_2(1\text{\,A}_g) \) seems to be an overestimation according to Huffman, et al. [1971], but this may be the main source of water clusters between 77 and 85 km [Donahue, 1972]. Even with the large number of hydrated ions, the rapid recombination rate competes with the formation of hydrated ions [Thomas, 1971]. This recombination represents the main loss process for free electrons between 70 and 80 km.

The formation of negative ions would constitute a loss of free electrons by the attachment reaction:

\[ \text{E)} \quad e + \text{O}_2 + \text{O}_2 \rightarrow \text{O}_2^{-} + \text{O}_2. \]

Figure 2.4 by Thomas [1971], giving a scheme for the daytime negative electrons at 65 km, shows reaction (E) to be fast, but the loss reactions

\[ \text{F)} \quad \text{O}_2^{-} + \text{O} \rightarrow \text{O}_3 + e \]

\[ \text{G)} \quad \text{O}_2^{-} + \text{O}_2(1\text{\,A}_g) \rightarrow 2 \text{O}_2 + e \]

are much faster. Although the formation of \( \text{O}_4^{-} \) is rapid, there is rapid return to \( \text{O}_2^{-} \). The negative ion chemistry is dependent on atomic oxygen and \( \text{O}_2(1\text{\,A}_g) \) concentrations. At night these concentrations decrease so that reaction (E) constitutes an important loss process for free electrons.

At eclipse totality free electron production is reduced to that comparable of nighttime electron production, and the production of atomic oxygen and metastable \( \text{O}_2(1\text{\,A}_g) \) are also greatly reduced [Shimasaki and Laird, 1972].
Figure 2.4 Block diagram [Thomas, 1971] showing the negative ion chemistry during the day. The lifetimes of electrons and each ion are for a height of 65 km.
comparison of eclipse data, Mechely, et al. [1972] shows the possibility of attachment reactions as being the main loss process at totality. This would mean a large reduction in $O$ and $O_2(\Delta_g)$, but the reduction measured by Hunt [1965] during an eclipse shows less than an order of magnitude change in atomic oxygen. More measurements of atomic oxygen are needed during eclipses to determine more accurately the loss process for free electrons during totality of a solar eclipse.

2.3 Recombination

Above 70 km during the daytime, negative-ion chemistry is not important; so the main loss process of free electrons above 70 km is by recombination with positive ions. The continuity equation for electrons as given by Whitten and Poppoff [1971] is:

$$\frac{d[e]}{dt} = \left(\frac{q}{1 + \lambda}\right) - \left(\alpha_D + \lambda \alpha_i\right)[e] - \left(\frac{[e]}{1 + \lambda}\right) \frac{d\lambda}{dt}$$  \hspace{1cm} (2.1)$$

where $[e]$ is the electron density, $\lambda$ is the ratio of negative ion concentrations to electron densities, $q$ is the ionization rate, $\alpha_D$ is the ion-electron recombination coefficient, and $\alpha_i$ is the ion-ion recombination coefficient.

With the assumption that variation in $\lambda$ is insignificant, then $d\lambda/dt = 0$ and defining an effective recombination coefficient as $\alpha_{\text{eff}} = \alpha_D + \lambda \alpha_i$, Equation (2.1) reduced to:

$$\frac{d[e]}{dt} = \left(\frac{q}{1 + \lambda}\right) - \alpha_{\text{eff}} [e]^2$$  \hspace{1cm} (2.2)$$

During a solar eclipse at totality, the electron production decreases by several orders of magnitude. Using an ionization rate of zero ($q = 0$), $\alpha_{\text{eff}}$ can be obtained from Equation (2.3) for short intervals of time.
\[ \alpha_{\text{eff}} = \frac{\Delta[e]}{\Delta t} - [e]^2 \] (2.3)

With small changes in the electron density \( \alpha_{\text{eff}} \) can be obtained by the approximation [Mitra and Rowe, 1972]

\[ \alpha_{\text{eff}} = \frac{q}{[e]^2(1 + \lambda)} \] (2.4)

Below 70 km the problem is complicated by the presence of negative ions [Mitra and Rowe, 1972] for which a time dependent analysis of the negative reaction scheme has to be used [Thomas, 1971]. As discussed in Section 2.2, there is the possibility of loss by attachment. Many problems about the loss process still remain unsolved including the question of the NO distribution.

2.4 Expected Results

Figure 1.2 by Sears [1972] gives the obscuration function for different D-region solar ionization sources from the eclipse of 1966. Lyman-\( \alpha \) and visible light have the same obscuration function but not so with UV and X-rays. The obscuration function for visible light at Urbana, Illinois for July 10, 1972 (Figure 1.1) is therefore expected to be different from the obscuration function for ultraviolet radiation and X-rays. Using the maps of the sun given in Solar-Geophysical Data, 1972 (U.S. Department of Commerce) and the moon's movement across the sun's disk, an idea of the obscuration function for different solar radiations can be obtained. Since the solar activity during the eclipse was quiet to moderate, the predominate ionization source between 70 and 80 km is expected to be Lyman-\( \alpha \).

The total obscuration is about 60\%, therefore data is used from previous eclipses with a similar obscuration and about the same solar zenith angle. The
solar zenith angle is shown in Figure 2.5 to be about 37°. Figure 2.6 by Deeks [1966] gives various electron densities for an eclipse during March equinox noon at sunspot minimum. Figure 2.7 by Smith, et al. [1965] gives electron density distributions for various obscurations of the eclipse of July 20, 1963. In Figure 2.6 the electron density for 60% obscuration shows little change until above 70 km. For Figure 2.7 at 40% obscuration the electron density at 75 km has no change while above and below this altitude show marked changes. Below 75 km the change is, therefore, expected to be no larger than above 75 km and the change is expected to be approximately 36% (from equation (2.4)). Due to the changing solar zenith angle, the magnitude of the slope of the changing electron densities before the maximum obscuration of the sun is expected to be greater than the slope after maximum obscuration.

2.5 Statement of the Problem

The purpose of this paper is to present the setting up, collection, and analysis of the partial-reflection data taken before, during and after a solar eclipse and to present changes made in the partial-reflection computer programs in order to simplify the operation and more effectively reject noise.
Figure 2.5 The variation of the solar zenith angle for July 10, 1972. The partial-reflection data collected period is shown as well as the time of maximum obscuration for the eclipse.
Figure 2.6 Variation of electron density during a solar eclipse at March equinox, mid-day, and sunspot minimum at middle latitudes [Deeke, 1966].
Profiles 1, 2, 3, and 4 refer to obscurations of 92%, 86%, 40%, and 2%, respectively. The solar zenith angle was 55° at totality and 61° at 40% obscuration.
3. EXPERIMENTAL TECHNIQUE

The partial-reflection experiment was first performed by Gardner and Pawsey [1953]. Electron densities were deduced for 65 to 82 km from partially reflected, circularly polarized radio waves. The transmitter operated at 1 kw during each 30 μsec pulse with a center frequency of 2.28 MHz, and the partially reflected signals were displayed on an A-scan oscilloscope. Several improvements have been made in the experiment and are discussed by Pirnat and Bowhill [1968].

Gregory [1956] used an increase in transmitter power of 4 kw and a decrease in the transmitter pulse width to 9 μsec. These changes improved the amplitude and resolution of the partial reflections. Fejer and Vice [1959] developed an improved receiving and storing method using a dual-beam cathode-ray tube oscilloscope and camera. The system was operated at 1.83 and 2.63 MHz. Belrose and Burke [1964] also operated at two different frequencies (2.66 and 6.275 MHz) and transmitter power of 1 Mw, were able to obtain electron densities from the D and E region. Belrose and Burke [1964] were the first to use the generalized Appleton-Hartree formulas by Sen and Wyller [1960] for partial-reflection application.

Using the generalized Appleton-Hartree formulas and several approximations, the ratios of partially reflected extraordinary waves \( A_x \) to the partially reflected ordinary wave \( A_o \) for two heights can be used to calculate electron densities [Pirnat and Bowhill, 1968 and Reynolds and Sechrist, 1970]. The ratio \( A_x/A_o \) at each height is inversely related to the absorption by the expression \( \exp(2\pi f h_{k_x} - k_o) \) from which the name differential absorption originates. At the University of Illinois the electron density was calculated directly from these ratios, and as seen in Chapter 4, small changes in these ratios can produce large variations in the electron densities.
Henry [1966] designed and built the hardware for the partial-reflection experiment at the University of Illinois. The transmitter that is presently being used was built for the purpose of making shipboard measurements. This transmitter operates at 40 kw during each 20 μsec pulse and with 5 pulses per second. The center frequency is 2.66 MHz with a 50-ohm unbalanced output. Figure 3.1 shows a block diagram of the transmitter. The reduction of power from the initial 50 kw used is to give longer life to the tubes used, and the pulse is shortened from 50 μsec used by Henry [1966] for better height resolution.

Figure 3.2 shows the two antenna arrays used to transmit and receive circularly polarized signals. Each array consists of 30 half-wave dipoles in the north-south direction and 30 in the east-west direction [Wiersma and Sechrist, 1972]. Each direction has matching networks that differ by 90° from the other direction of the same array to give a circularly polarized radio wave as shown in Figure 3.3. Each array gives approximately 22 dB gain with the main beam in the vertical direction. The first sidelobe is down 14 dB. Since both arrays are the same, this is a decrease of approximately 30 dB in the sidelobes relative to the main signal which has 44 dB gain. Further details on the antennas are given by Pirnat and Bowhill [1968] and Reynolds and Sechrist [1970].

3.1 Development of Receiving and Storing Data

The receiver, storage and timing controls have had two main changes in the development of the partial-reflection system. The experiment was originally set up using photographic film to store the partially reflected signals as displayed on an oscilloscope (see Figure 3.4). The controlling circuitry or pulser sent pulses of 30 volts to the transmitter, receiver, and camera. The pulser has remained the same with the exception of the addition of extra control circuitry depending on the storage method. The amplitudes of the received signals
Figure 3.1 Block diagram of the partial-reflection transmitter.
Figure 3.2 Partial-reflection antenna arrays for the Aeronomy Field Station.
Figure 3.3 Block diagram of the partial-reflection system.
Figure 3.4 Typical frame of data as collected by Henry [1966].
were later measured visually and electron densities were obtained. Pirnat and Bowhill [1968] shows that there is good correlation between electron densities calculated from the partial-reflection data and from rocket measurements with the transmitter operating at 25 kw of power during a 50 µsec pulse. This system of collection and storage is inexpensive, but the processing of the data to obtain electron densities is very slow and preparation and operation are complicated.

Reynolds and Sechrist [1970] set up data storage on paper tape. Ordinary and extraordinary samples were punched on paper tape for heights corresponding to 75 km and 80 km. Data can be stored at a rate of 30 values of each sample in one minute. From the paper tape the data can then be read into a computer and processed. This data on paper can be used to obtain an electron density for between 75 and 80 km. Reynolds and Sechrist [1970] show the results using paper tape compares favorably with results from rocket measurements and with the results published by Belrose and Burke [1964]. Although the system has a faster operation than the original system, it produces only one electron density and the added control circuitry is very complex.

Birley and Sechrist [1971] set up the partial-reflection experiment using a PDP-15 computer. The received signals were transmitted to the computer via an analog to digital converter and stored on DECTape to be processed later. The data consisted of four noise samples from 45 to 49.5 km and 21 data samples from 60 to 90 km in 1.5 km increments. The collection rate is 5 sets of 26 samples sec\(^{-1}\). This collection is done alternating between ordinary partial reflection and extraordinary partial reflections. Electron densities obtained by Birley and Sechrist [1971] show good agreement with electron densities obtained from rocket measurements between 67.5 and 82.5 km. The other heights suffered
from too many rejections due to noise and saturation of the analog to digital converter, small signal to noise ratios, or inaccurate $A_x/A_o$ ratios. Computer storage offers several advantages:

1) A fast rate of data collection (presently limited to the transmitter speed)
2) Data can be stored more compactly and in much larger quantities
3) The controlling circuitry is greatly simplified
4) The data processing is faster
5) $[e]$ can be obtained for every 1.5 km

This type of system also poses several disadvantages:

1) High cost
2) Development of computer software
3) Loss of accuracy in digitizing the data
4) Development of new circuitry and modification of the old for adaption to the A/D converter
5) More complicated operations (operator must know computer operation)

These disadvantages have been reduced with additional equipment and development as given in Section 3.3.

3.2 Partial-Reflection Data Collection for the Solar Eclipse

The partial-reflection receiver was interfaced into the PDP-15 computer to obtain data to be processed as described by Birley and Sechrist [1971]. Several changes in the receiver and controlling circuitry and the addition of an analog-to-digital converter were required prior to using the computer. A block diagram of the original receiver is shown on page 18 of Aeronomy Report.
No. 13, [Henry, 1966]. The analog-to-digital converter saturates with an input of one volt or greater and will be damaged with inputs greater than five volts. The maximum output of the receiver was therefore reduced from 10 volts to 1.5 volts by one of the IF amplifiers, and the full-wave bridge diode detector was replaced by a single diode to reduce the nonlinearity of the receiver. A second blanking gate was inserted with the mixer in the RF amplifier module to more completely remove the initial effects of the transmitter pulse. The polarity reversal circuitry was not used but was left intact while the differential amplifier and inverter were replaced by two DC amplifiers on integrated chips.

The block diagram of the modified receiver is shown in Figure 3.5. Figure 3.6 shows the RF module with the extra blanking gate and Figure 3.7 shows the IF amplifier/DC amplifier module with the revisions. Both modules were modifications of the RF-3 module and IF-6 module respectively, given by Henry [1966]. The receiver power supply was unchanged as set up by Henry [1966]. Encode pulses as shown in Figure 3.8 were used to control the operation of the A/D converter after Birley and Sechrist [1971]. The encode pulse circuitry consists of a 5-volt power supply and 4 monostable multivibrators (Figure 3.9) with a variable timing for length of noise and signal pulses and the delay of each.

Two main modifications were made in the software set up by Birley and Sechrist [1971]. For the first change D. R. Ward [private communication] set up a computer-controlled synchronization with the external pulser. The timing shown in Figure 3.9 is used to determine which radio wave mode has been received. The computer programs are set up to store only pairs of sets of 26 numbers read from the A/D converter. A set of numbers is read in and assumed to be from a radio wave of ordinary mode. The computer's clock is set for 150 μsec and the computer waits for another set of numbers. If another set is not read in prior
Figure 3.5 Block diagram of the revised receiver used to operate with a PDP-15 computer.
Figure 3.6 The RF amplifier module for the receiver.
Figure 3.7 The IF and DC amplifier module.
Figure 3.8 The encode pulses as set up by Birley and Sechrist [1971] used to collect data during the eclipse, and the revised encode pulses used by the present programs.
Figure 3.9 The encode pulse circuitry used to produce the former and present encode pulses.
to the 150 μsec, the set was from an extraordinary radio wave and is rejected. Otherwise, both sets are accepted and the computer is synchronized with the pulser. This process is done only when the computer has a possibility of being out of synchronization with the pulser which are:

1) Beginning of every file
2) After the transfer of a block of data to disk
3) After collection is stopped and restarted by console control switch
4) During a timing error (no longer a terminal error, see Section 3.3)
5) When the computer "forgets to read" (discussed in Section 3.3)

The second change is to account for the nonlinearity of the receiver as seen in Figure 3.10 and was initially set up to adjust the data during processing [Wiersma and Sechrist, 1972]. Due to the time needed for the calibrating operation (approximately a half day), the computer is used which increases the speed of the process while making it possible to account for inaccuracies in the analog to digital converter. This process takes about 40 minutes (including 30 minutes for the receiver warm up). The adjustment to the data is done by using a table look-up method in the collection programs. Since the data stored on the disk are linearized data, the table is not needed after the collection is done and can be deleted after all the data are stored. The method is to convert the A/D converter output to the corresponding normalized receiver input. This is done by injecting a CW signal of a known value using an attenuator with one dB increments and storing the output in the computer using the set up shown in Figure 3.11. Straight line segment approximations to the curve in Figure 3.10 are obtained as shown in Table 3.1. Using outputs from 0 to 511 the corresponding inputs are determined normalized to 511 maximum, stored in a table as shown in
Figure 3.10 Graphs of the input versus output of the receiver used for eclipse data collection (old receiver) and the receiver presently being used. The input and output values have been normalized to the maximum of the A/D converter (511).
Figure 3.11 The wiring diagram used to calibrate the receiver. The voltmeter is used in setting the initial signal level prior to calibrating.
Table 3.1

Straight line segment approximation to the relationship of receiver input to receiver output.

<table>
<thead>
<tr>
<th>Slope (S)</th>
<th>Input (TU)</th>
<th>Output (TUO)</th>
<th>Attenuation (Used)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S(1) = 50.906</td>
<td>TU(1) = 0.000</td>
<td>TUO(1) = 4.786</td>
<td>99DB</td>
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<tr>
<td>S(2) = 3.912</td>
<td>TU(2) = 5.620</td>
<td>TUO(2) = 4.896</td>
<td>45DB</td>
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<td>S(3) = 2.394</td>
<td>TU(3) = 6.310</td>
<td>TUO(3) = 5.073</td>
<td>40DB</td>
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<td>S(4) = 7.762</td>
<td>TU(4) = 7.940</td>
<td>TUO(4) = 5.611</td>
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<td>S(5) = 9.151</td>
<td>TU(5) = 4.786</td>
<td>TUO(5) = 5.073</td>
<td>42DB</td>
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<td>S(6) = 2.576</td>
<td>TU(6) = 8.910</td>
<td>TUO(6) = 6.034</td>
<td>42DB</td>
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<td>S(7) = 4.190</td>
<td>TU(7) = 10.000</td>
<td>TUO(7) = 6.326</td>
<td>39DB</td>
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<td>S(8) = 1.754</td>
<td>TU(8) = 11.220</td>
<td>TUO(8) = 7.011</td>
<td>38DB</td>
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<tr>
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<td>TU(9) = 12.590</td>
<td>TUO(9) = 7.699</td>
<td>37DB</td>
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<td>S(10) = 1.946</td>
<td>TU(10) = 17.780</td>
<td>TUO(10) = 8.726</td>
<td>36DB</td>
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<tr>
<td>S(11) = 1.356</td>
<td>TU(11) = 22.390</td>
<td>TUO(11) = 9.475</td>
<td>35DB</td>
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<tr>
<td>S(12) = 1.754</td>
<td>TU(12) = 25.120</td>
<td>TUO(12) = 10.590</td>
<td>34DB</td>
</tr>
<tr>
<td>S(13) = 1.381</td>
<td>TU(13) = 28.180</td>
<td>TUO(13) = 11.616</td>
<td>33DB</td>
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<tr>
<td>S(14) = 0.969</td>
<td>TU(14) = 31.620</td>
<td>TUO(14) = 12.389</td>
<td>32DB</td>
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<tr>
<td>S(15) = 0.910</td>
<td>TU(15) = 35.480</td>
<td>TUO(15) = 13.945</td>
<td>31DB</td>
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<tr>
<td>S(16) = 1.113</td>
<td>TU(16) = 39.810</td>
<td>TUO(16) = 15.661</td>
<td>30DB</td>
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<td>S(17) = 1.987</td>
<td>TU(17) = 44.670</td>
<td>TUO(17) = 16.161</td>
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<td>S(18) = 0.987</td>
<td>TU(18) = 47.070</td>
<td>TUO(18) = 17.509</td>
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<td>S(19) = 0.910</td>
<td>TU(19) = 50.120</td>
<td>TUO(19) = 18.886</td>
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<td>S(20) = 1.113</td>
<td>TU(20) = 53.000</td>
<td>TUO(20) = 19.509</td>
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<td>S(21) = 0.771</td>
<td>TU(21) = 56.240</td>
<td>TUO(21) = 20.509</td>
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<td>S(22) = 1.172</td>
<td>TU(22) = 59.480</td>
<td>TUO(22) = 21.509</td>
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<td>S(23) = 0.880</td>
<td>TU(23) = 62.720</td>
<td>TUO(23) = 22.509</td>
<td>23DB</td>
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<td>S(24) = 0.926</td>
<td>TU(24) = 65.960</td>
<td>TUO(24) = 23.509</td>
<td>22DB</td>
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<tr>
<td>S(25) = 0.987</td>
<td>TU(25) = 69.200</td>
<td>TUO(25) = 24.509</td>
<td>21DB</td>
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<td>S(26) = 0.987</td>
<td>TU(26) = 72.440</td>
<td>TUO(26) = 25.509</td>
<td>20DB</td>
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<tr>
<td>S(27) = 0.987</td>
<td>TU(27) = 75.680</td>
<td>TUO(27) = 26.509</td>
<td>19DB</td>
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<td>S(28) = 0.987</td>
<td>TU(28) = 78.920</td>
<td>TUO(28) = 27.509</td>
<td>18DB</td>
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<td>S(29) = 0.987</td>
<td>TU(29) = 82.160</td>
<td>TUO(29) = 28.509</td>
<td>17DB</td>
</tr>
<tr>
<td>S(30) = 0.987</td>
<td>TU(30) = 85.400</td>
<td>TUO(30) = 29.509</td>
<td>16DB</td>
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<tr>
<td>S(31) = 0.987</td>
<td>TU(31) = 88.640</td>
<td>TUO(31) = 30.509</td>
<td>15DB</td>
</tr>
<tr>
<td>S(32) = 0.987</td>
<td>TU(32) = 91.880</td>
<td>TUO(32) = 31.509</td>
<td>14DB</td>
</tr>
<tr>
<td>S(33) = 0.987</td>
<td>TU(33) = 95.120</td>
<td>TUO(33) = 32.509</td>
<td>13DB</td>
</tr>
<tr>
<td>S(34) = 0.987</td>
<td>TU(34) = 98.360</td>
<td>TUO(34) = 33.509</td>
<td>12DB</td>
</tr>
<tr>
<td>S(35) = 0.987</td>
<td>TU(35) = 101.600</td>
<td>TUO(35) = 34.509</td>
<td>11DB</td>
</tr>
<tr>
<td>S(36) = 0.987</td>
<td>TU(36) = 104.840</td>
<td>TUO(36) = 35.509</td>
<td>10DB</td>
</tr>
<tr>
<td>S(37) = 0.987</td>
<td>TU(37) = 108.080</td>
<td>TUO(37) = 36.509</td>
<td>9DB</td>
</tr>
<tr>
<td>S(38) = 0.987</td>
<td>TU(38) = 111.320</td>
<td>TUO(38) = 37.509</td>
<td>8DB</td>
</tr>
<tr>
<td>S(39) = 0.987</td>
<td>TU(39) = 114.560</td>
<td>TUO(39) = 38.509</td>
<td>7DB</td>
</tr>
<tr>
<td>S(40) = 0.987</td>
<td>TU(40) = 117.800</td>
<td>TUO(40) = 39.509</td>
<td>6DB</td>
</tr>
<tr>
<td>S(41) = 0.987</td>
<td>TU(41) = 121.040</td>
<td>TUO(41) = 40.509</td>
<td>5DB</td>
</tr>
</tbody>
</table>
Table 3.2, and placed on a storage device (normally a disk). The program DLOGF (given in the Appendix in MACRO language) reads Table 3.2 into the computer, and the table is used during collection of the received partial-reflection signal. Using the table, the MACRO subroutine LIN does the linearization of the numbers read from the analog to digital converter. The programs responsible for the formation of these two tables are TBFORL (FORTRAN IV), LINAP (FORTRAN IV), RADC (MACRO), and TTM (MACRO).

The system as it has been described was used to collect and process the partial-reflection data for the three-day eclipse period of July 9, 10, and 11, 1972. The rest of this chapter will describe further changes and developments of the system. These changes have been due to an increase of 16 K core memory, the addition of 2 disk units capable of storing 262,144 words each, and the changing from a single user monitor system to a background/foreground monitor disk system.

3.3 Real-Time Data Storage and Automatic Processing

A computer operates on its own timing system and if this timing system operates along with events outside the computer that affect the operation of the computer, then the computer is said to be operating in real time. For instance, if the computer reads in a set of 26 samples and is able to manipulate or process them before the next set of samples is read in, the computer is doing real-time processing; as opposed to saving the data on tape and processing it later, as done by Reynolds and Sechrist [1970]. With high-speed access on the disk (16 msec access time), the background/foreground system made possible real-time collection and processing of partial-reflection data. Due to the complicated timing, slow print-out, and the noise algorithm (discussed in Section 3.4), processing of the data is postponed until after the file is stored on the disk.

The background/foreground monitor system is a double monitor, multi-priority level, software system. The two monitors are separate software systems
Table 3.2

The output of the A/D converter are numbers between 1 and 511. The input for each output is given in this table.

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sharing the same hardware with programs operating in the foreground system having priority. Each system has 8 automatic priority (API) levels and a mainstream level. There are four hardware levels which have highest priority. The software levels are labeled 4, 5, 6, 7, and 0 where 4 is the highest and 0 is the mainstream, the lowest. When a program initially starts running in either background or foreground, it begins on mainstream. Certain commands require a special subroutine called a real-time subroutine and is designated a priority level from 0 to 4 and stops all operation on lower priority levels (background is lower than foreground) until it exists from the level or performs an I/O operation.

With this system the partial-reflection collection and processing programs as mentioned could operate in real-time, but due to several problems in the processing of data, the data could not easily be saved except in processed form. The solution used is to collect one file of data and process that file while the next file of data is being collected. After each file is collected, the operator is told what the next attenuator setting is. The collection program also checks the setting of the switches on the console to allow the operator to control parts of the collection program. Switch 0 acts as an on/off switch which causes collection to stop collecting and wait in a loop if set to 1. Switch 1 allows the background system to share the collection and processing storage device (1 disk) if the switch is set to 1. This sharing is necessary if the collected files are to be stored on DECTape. Switch 3 allows the processed data which are printed out onto the teletype to also be punched onto paper tape if the switch is set to 0. This option is presently used to allow for later plotting of the data using a programmable calculator. Switches 2 and 5 are not used at the present. The rest of the switches are used for determining the length of each file (default length is 513 pairs of sets of
26 numbers). The time of day is determined by using the clock within the computer to give the time in hours and minutes.

The flow diagram of the programs is shown in Figure 3.12. The programs are loaded into the computer and the computer's clock is set to the time of day. The operator is given the option of calibration of the receiver. The linearization table is stored on a disk and some initial information is read in. If the table read in is erroneous the operator must re-do the calibration procedures. The collection is started on priority level 6 and processing waits for the first file to be collected. After collection of the number of sets of samples set on the console switches and the operator changes the attenuator setting, the second file is collected while the first is processed and printed out. This process continues until stopped by the operator. Information used to calculate the noise threshold as described in Section 3.4 is transferred to the processing program after each file is collected and is not stored on the disk. The processing program therefore must remain faster than the collection or this information will be lost.

The processing of files involves rejecting sets of samples that are too noisy (discussed in Section 3.4), summing the squares of unsaturated data, subtracting off the sum of the squared acceptable data, and taking the square root. The resulting data are two sets of 21 samples, one of ordinary modes ($A_o$) and one of extraordinary mode ($A_e$) radio waves. This process is done in the main processing program PROC (given in the Appendix). The electron densities are calculated in CALC2 which is discussed in Section 3.5. The results are typed out on the teletype in tabular form as shown in Table 3.3.

The first line of the print-out of processed data is the heading. This gives the time the collection of the file stopped, the date, the reason for the run, and the attenuator setting for the file. The next line contains the noise threshold and the square of the multiplying constant used in the
Figure 3.12 A diagram of the control flow of the partial-reflection programs. The programs operate on the API level of the preceding program unless otherwise stated. The collection and processing program operated in parallel with the collection programs operating on API levels 5 and 6, whereas everything else operates serially.
### TABLE 3.3

**Results of CALC2**

#### DAILY RUN

1215 8-14-73

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513 SAMPLES

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maximum noise criterion discussed in Section 3.4. The next two lines are the ordinary and extraordinary mode noise before (number 1) and after (number 2) rejections due to excessive noise. The next line gives the number of pairs of sets of 26 samples collected and the number of these pairs rejected due to saturation. The first column of the table is the number of rejections due to both saturation and excessive noise for each height. The next column gives the height of the reflected signals for each row. The next two columns give RMS of the ordinary \( A_o \) and extraordinary \( A_{eo} \) signals. The fifth column gives the ratios of extraordinary partial reflections to ordinary partial reflections from the fourth and third column respectively. The last column gives the electron density for between the heights. The last electron density is given as zero since only one height is available to calculate it.

The present method of collection and processing of partial-reflection data is fast, efficient, and easy to operate, but two problems needed to be removed. The increase of input/output operations have increased timing errors which are discussed by Birley and Sechrist [1971], and the A/D converter sometimes fails to respond to read commands.

The A/D converter transfers data to the computer using multicycle block transfer as described by Birley and Sechrist [1971]. The process is a three cycle operation for each word transferred. After each transfer, the A/D converter interface is tested for synchronization. If the timing between the interface and the I/O processor is altered, transfer is stopped resulting in a timing error. With the present system, this error can result from hardware malfunction or excessive I/O operation occurring. If the latter is the reason, the problem is only temporary and can be remedied by issuing another read. Care is taken to keep the computer synchronized with the pulser. If the error is a hardware problem, the condition will not clear up and collection must stop. The error
will usually occur when data are being collected, processed data are being printed out, and a tape is being copied onto the disk in background, all simultaneously.

The second problem has to do with the A/D converter's interface refusal to transmit data. The problem has been traced to failure in the A/D converter interface logic. The collection program will issue an A/D converter read, but not receive control back and no data are transferred. This problem occurs only with the background/foreground system and it occurs infrequently (once in about every 10,000 read commands). One solution is to issue a double read, but the problem could still occur. The solution used is for the processing to check for this stoppage, restart the collection in an orderly fashion if it has stopped and to ring the teletype bell to let the operator know of the stoppage. This solution does not prevent the failure of the A/D converter interface to transfer data, and the problem will have to be removed for faster ratio of collection, but presently the operator need not be concerned with this problem. The rest of the data is unaltered by this problem.

3.4 Noise Rejection

The partially reflected radio waves from the D region are usually small in amplitude on the order of 10 to 1000 mvolts at the output of the 80 dB gain receiver. Noise amplitudes vary between 30 to 1000 mvolts. For the purpose of the noise algorithm, noise is considered to be any interference which is part of the receiver output signal that is not attributed to the partially reflected waves from the vertically transmitted pulse. This noise is divided into two types: background noise and noise bursts. Background noise is noise caused by the receiver (14±3 mV) and general atmospheric noise which is always present (40±10 mV). Noise bursts are caused by lightning and other radio transmitters, and the amplitude of this noise is dependent on the location of the source. Lightning noise will usually last for the duration of one encode pulse while noise due to other
transmitters will last for at least 1/2 second which is several encode pulses (see Figure 3.8) and the noise will be increased usually by 10 to 1000 mvolts. Both types of noise are rejected in the processing program PROC(FORTRAN IV) as shown in the block diagram of this program in Figure 3.13.

Data are collected in pairs of sets of 26 numbers. Each set contains 5 noise samples and 21 samples of partially reflected signals. Each pair contains a set of ordinary mode samples and a set of extraordinary mode samples. In PROC a noise threshold is determined and the square of this multiplied by five is compared to the sum of the squares of the five noise samples of each set. This method of comparison is faster than comparing the RMS of the noise as set up by Birley and Sechrist [1971] since square root operations take approximately 1 msec and squaring takes 70 μsec on the PDP-15, and the squaring need only be done once per file. If the noise of either mode is greater than the noise threshold, both sets of 21 signal samples are rejected and the next pair of sets are tested. If the noise of both modes is less than this threshold, the noise of both sets are considered acceptable and saved for later processing. The partially reflected signals with acceptable noise for each mode are checked for A/D converter saturation (.997 volts receiver output) at each height. If either of the two samples (one of each mode) is saturated at a height the two samples are rejected; otherwise the data are considered acceptable. This processing of pairs of 26 samples continues until the end of the file is reached. After the file of collected data has gone through this processing, the average of the sum of the squared acceptable noise for each mode is subtracted from the average of the sum of the squared acceptable partially reflected samples of the same mode at each height, and the square roots are printed out as shown in Table 3.3 and as described in Section 3.3.
Figure 3.13 A flow chart of the processing program PROC.
Originally, the noise threshold was determined by the operator typing in a value chosen by him as seen in the program PROC73 in the Appendix. This was later changed to an automatic determination based on the attenuator setting used as given at the beginning of a run. This method did not account for the day-to-day variation in noise nor in an erroneous attenuator setting. The noise threshold value is presently determined by the following equation:

\[ M = (K(\sum_{0}^{45} N)/45)^2 \]  

where \( M \) = maximum allowable noise value

\( K \) = arbitrary constant

\( N \) = certain noise samples collected as explained in the following paragraph.

In the collection programs RSUB and LIN, the maximum and sum of each group of 45 noise samples are stored, and the maximum values are compared. The sum of the group with the lowest maximum value is transferred to the processing program PROC and is used in equation (3.1). The constant \( K \) has been chosen by trial and error, and values between 2.5 and 3.5 seem to give the best results (equation 3.1 is being used).

Other algorithms have been tried, but none seem to give any obvious improvement in the resulting electron densities. One method is to split 5 noise samples collected with each set of data into 2 for comparison with the noise threshold value and 3 subtracted from the reflected signals. This method works on the theory that the noise within the 5 noise samples is not the same amplitude as the noise within the 21 data samples for each set of 26 data samples, but is statistically the same over the number of samples collected.
for one file. With the present system, when the number of rejections due to
noise is large, (greater than 200 out of 513 pairs of sets of samples), the
noise within the noise gate is restricted to a lower level than the noise in
the data frame. Therefore, the noise in the data frame would not be completely
subtracted off; as it would be with splitting the noise samples. The applica-
tion of this technique using 4 noise samples showed no improvement in the
results. Two possible causes are too few noise samples being used and the noise
samples being too close together.

Another method has been developed and tested by D. R. Ward [private com-
munication]. A CW signal is inputed into the receiver along with the received
data from the antenna. The noise and partially reflected signals are each
de fined as \( A \cos \theta \); where \( A \) is the amplitude and \( \theta \) is the phase. The noise is
assumed to be random while the partially reflected signals are assumed to have
only a small variation between two sets of samples. Using an algorithm developed
by D. R. Ward [private communication], the phase and the amplitude of the noise
portion of each signal average to zero while the phase and amplitude of the
signals do not. This method is used to reject the noise from the partially
reflected signals at each height. This method fails to reject interference
caused by other transmitted signals since this type of noise does not have
random phase. D. R. Ward [private communication] has obtained useful electron-
density profiles from the method but generally found no improvement over the
present system. Further study and development of either method may improve the
processing and should not be discarded.

3.5 Converting \( A_x/A_o \) Ratios to Electron-Density Profiles

The partial-reflection programs assume a constant collision frequency for
each height with seasonal variation. The values used were determined from the
following equation [Birley and Sechrist, 1971]:

\[ \nu_m = Kp \]  

(3.2)

where \( K = \text{constant} = 7.3 \times 10^5 \)

\( p = \text{pressure in pascals} \)

\( \nu_m = \text{collision frequency in sec}^{-1} \)

The pressures used are from the mean atmospheric model from COSPAR International Reference Atmosphere (1965) with seasonal variations given by U. S. Standard Atmospheric Supplements (1966). Using these pressures, experimentally the values calculated for \( K \) vary by as much as \( 2 \times 10^5 \) [Lodato and Mechtly, 1971]. The seasonal variations in the collision frequency (Figure 3.14) can vary by as much as 20%. This 20% variation in \( \nu_m \) can cause the calculated \([e]\) to vary by a factor of 1.2. The electron densities are calculated using the refractive index equation given by Sen and Wyller [1960] and several approximations as discussed by Pirnat and Bowhill [1968]. The resulting equation given by Reynolds and Sechrist [1970] is:

\[ [e] = \ln \left( \frac{(A_x/A_o)}{(R_x/R_o)} \right) h_1 / \left( \frac{(A_x/A_o)}{(R_x/R_o)} \right) h_2 / FD \]  

(3.3)

\[ FD = (5\Delta h e^2 / 2mc e_o \nu_m) \left\{ \xi_{5/2} \left( (\omega - \omega_L) / \nu_m \right) - \xi_{5/2} \left( (\omega + \omega_L) / \nu_m \right) \right\} \]  

(3.4)

where

\[ \xi_y(x) = \frac{1}{y^4} \int_0^\infty \frac{e^{y\epsilon}}{\epsilon^2 + x^2} e^{-\epsilon} d\epsilon \]

\( \epsilon = mv^2 / 2kT \)

\([e]\) = electron density

\( e = \text{electron charge} = 1.6 \times 10^{-19} \text{ C} \)

\( m = \text{electron mass} = 9.1 \times 10^{-31} \text{ kg} \)

\( \epsilon_o = \text{permittivity of free space} = 8.85 \times 10^{-12} \text{ F m}^{-1} \)
Figure 3.14 The collision frequencies used in the program CALC to obtain electron-density profiles.
\[ \omega = \text{angular frequency of the transmitted wave} \]

\[ \omega_L = \text{gyro-frequency of the electron} \]

\[ h_1 = \text{lower height} \]

\[ h_2 = \text{higher height} \]

\[ \Delta h = h_2 - h_1 \]

\[ k = \text{Boltzmann constant} = 1.38 \times 10^{-23} \text{ J K}^{-1} \]

\[ T = \text{temperature} \]

\[ V = \text{electron velocity} \]

\[ R_o = \text{ordinary mode reflection coefficient} \]

\[ R_x = \text{extraordinary mode reflection coefficient} \]

This equation required a set of collision frequency constants which are given in the program CALC (FORTRAN IV). The ratio \( (R_x/R_o)_{h_2} / (R_x/R_o)_{h_1} \) and FD (equation (3.4)) are calculated in ELDEN (FORTRAN IV). CAL2 (called by PROC) uses these values (which vary only with \( v_m \)) as constants for each pair of heights to calculate the electron densities according to Equation (3.5)

\[ [e] = \ln\left( R_{\text{ATIO2}} \times \left( A_{x}/A_o \right)_{h_1} / \left( A_{x}/A_o \right)_{h_2} \right) / \text{FD} \]

where \( R_{\text{ATIO2}} = (R_x/R_o)_{h_2} / (R_x/R_o)_{h_1} \).

This method is used to reduce the amount of core memory required and increase speed of execution of the program. A new CALC2 can be obtained by revising the collision frequencies and running the program CALC which writes the program CALC2. The electron densities are printed out as shown in Table 3.3 and described in Section 3.3

3.6 Equipment Testing

The equipment needs to be tested periodically to determine if it is in operating order. The transmitter is tested by observing and keeping a log of
the voltage and current at various locations via meters and an oscilloscope. The antennas are tested by transmitting and receiving signals at various times during the day. At noon the extraordinary signal should be absorbed and at night the ordinary signal should be absorbed. By transmitting and receiving ordinary and extraordinary signals as described in Progress Report 73-1 [Edwards, 1973], the phase and attenuation of each antenna of each array can be set and checked for possible damage. This process is also a partial check for the transmitter and receiver. A spot check of 30 dB difference in ordinary and extraordinary reflections from the $E$ region at noon is done on a daily basis.

The program CHECK (FORTRAN IV) has proved valuable in checking the receiver and the analog to digital converter. CHECK performs a modified dump of the A/D converter as read by the computer. If the number 31 is typed, the output is in the form of partial-reflection data (ordinary and extraordinary pairs), patterned after the new encode pulse shown in Figure 3.8. If any other number is typed in an average of that number rounded to the next higher multiple of 50 is printed out. The 31 pairs of samples are printed out in millivolts only, while the averages are printed out in millivolts and as represented in the A/D converter. This program has had many applications; it showed the blanking gate on a new receiver to be too long. It was used to calibrate the A/D converter using an input from a standard source. Table 3.4 shows the accuracy of the A/D converter as the standard voltage source was varied from 1.0 volts to .1 in .1, .01, and .001 volt increments. It was used in comparing the paper punch system set up by Reynolds and Sechrist [1970] with the computer storing method presented in Section 3.3. CHECK has also been used to determine the number of samples required to have less than 10% error due to noise (at least 100 samples are required). The program is easy to operate and has become important in testing and checking the receiver and the analog to digital converter.
Table 3.4
The output of the A/D converter using a calibrated input source

<table>
<thead>
<tr>
<th>Average</th>
<th>Voltage</th>
<th>Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>511.204</td>
<td>998.444 mV</td>
<td>1000 mV</td>
</tr>
<tr>
<td>460.558</td>
<td>899.527 mV</td>
<td>900 mV</td>
</tr>
<tr>
<td>409.625</td>
<td>800.050 mV</td>
<td>800 mV</td>
</tr>
<tr>
<td>358.528</td>
<td>700.250 mV</td>
<td>700 mV</td>
</tr>
<tr>
<td>307.650</td>
<td>600.040 mV</td>
<td>600 mV</td>
</tr>
<tr>
<td>256.020</td>
<td>500.040 mV</td>
<td>500 mV</td>
</tr>
<tr>
<td>205.252</td>
<td>400.040 mV</td>
<td>400 mV</td>
</tr>
<tr>
<td>154.082</td>
<td>300.941 mV</td>
<td>300 mV</td>
</tr>
<tr>
<td>102.787</td>
<td>200.756 mV</td>
<td>200 mV</td>
</tr>
<tr>
<td>51.076</td>
<td>100.756 mV</td>
<td>100 mV</td>
</tr>
<tr>
<td>46.349</td>
<td>90.525 mV</td>
<td>90 mV</td>
</tr>
<tr>
<td>40.843</td>
<td>80.772 mV</td>
<td>80 mV</td>
</tr>
<tr>
<td>35.208</td>
<td>70.766 mV</td>
<td>70 mV</td>
</tr>
<tr>
<td>30.844</td>
<td>60.242 mV</td>
<td>60 mV</td>
</tr>
<tr>
<td>25.769</td>
<td>50.330 mV</td>
<td>50 mV</td>
</tr>
<tr>
<td>19.976</td>
<td>40.016 mV</td>
<td>40 mV</td>
</tr>
<tr>
<td>15.022</td>
<td>30.339 mV</td>
<td>30 mV</td>
</tr>
<tr>
<td>10.200</td>
<td>20.922 mV</td>
<td>20 mV</td>
</tr>
<tr>
<td>4.830</td>
<td>10.433 mV</td>
<td>10 mV</td>
</tr>
<tr>
<td>3.857</td>
<td>9.533 mV</td>
<td>9 mV</td>
</tr>
<tr>
<td>3.233</td>
<td>8.315 mV</td>
<td>8 mV</td>
</tr>
<tr>
<td>3.010</td>
<td>7.880 mV</td>
<td>7 mV</td>
</tr>
<tr>
<td>2.847</td>
<td>6.560 mV</td>
<td>6 mV</td>
</tr>
<tr>
<td>2.443</td>
<td>5.771 mV</td>
<td>5 mV</td>
</tr>
<tr>
<td>2.054</td>
<td>4.012 mV</td>
<td>4 mV</td>
</tr>
<tr>
<td>1.494</td>
<td>2.743 mV</td>
<td>3 mV</td>
</tr>
<tr>
<td>.659</td>
<td>1.286 mV</td>
<td>2 mV</td>
</tr>
<tr>
<td>.125</td>
<td>0.244 mV</td>
<td>1 mV</td>
</tr>
<tr>
<td>.010</td>
<td>0.024 mV</td>
<td>0 mV</td>
</tr>
</tbody>
</table>
3.7 Future Development

Several improvements are being made to the system. A new receiver is being made using a linear detector and new RF and IF stages to reduce the receiver noise. Figure 3.10 shows a comparison of the input versus output between the new receiver and the old one. With no input signal, the noise level of the new receiver is 2.5 mV and the level of the older receiver is 14 mV. The circuitry and discussion of it are given in the Aeronomy Progress Report 73-1 [Edwards, 1973].

A digital input/output device is presently being sought which would improve the calibration time and free the operator for other tasks as well as simplify the operation of the system. The purchase of such a device would also reduce the amount of paper presently required.

Another asset would be a line printer. One could reduce the processing time by at least half and allow for more sophisticated processing (with possibly better noise rejection) if such a line printer were purchased.

As mentioned by Birley and Sechrist [1971], an increase of transmitter power is also needed. This would improve the signal-to-noise ratio and give better data below 70 km.

The noise problem should be studied more carefully. Perhaps a combination of the method discussed in Section 3.4 would improve the results. Another possibility would be to reject extremely low values of reflected signals.

An additional program to transfer collected data to tape would be helpful. The original programs set up by Birley and Sechrist [1971] saved data on tape for future processing. With the present system, collected data can be stored on tape by using a system program called PIP. This requires knowledge in operation of the computer, and the transferring of files can get complicated.
4. EXPERIMENTAL RESULTS

This chapter describes the results from partial-reflection data which was collected and processed by the computer on July 9, 10, and 11, 1972. A solar eclipse occurred on July 10, 1972. The obscuration function shown in Figure 1.1 shows the first contact to be at 1319 CST and the last contact to be at 1536 CST with 60% of the solar disk obscured. The data were collected from 1200 to 1700 CST to show the effects of the solar eclipse on the electron density and collected between the same times on July 9 and 11 to be used as control data. Data were collected in blocks called files. Each file of data, consisting of 1026 sets of 26 numbers, was collected and stored on DECtape every 3.8 minutes. The signal prior to entering the receiver was attenuated with four attenuator settings (0, 10, 20, and 30 dB). Each file was collected beginning with the lowest attenuator setting of 0 dB with each subsequent file collected at the next attenuator settings; 10, 20, and 30 dB, respectively. This process was then repeated. This process was used to obtain the very small echoes as well as the very large ones. The files of data are divided into approximately 15 minute intervals, corresponding to the four attenuator settings.

The data between 1400 and 1430 on July 9 was lost due to an erasure of the disk before it could be processed. These data have been interpolated. The data from July 10 between 1200 and 1300 was erroneous and therefore has been eliminated from the results. The computer results were processed further combining the files with different attenuator settings.

4.1 Reduction of Data

Individual results shown in Figure 4.1 show valid electron densities but are limited height range; therefore, multiple attenuator settings were used to obtain usable data over a greater range of heights. The computer processes
Figure 4.1 Comparison of electron-density profiles on July 10 and 11, 1972. The data were taken at 1432 CST with the attenuator set at 30 dB.
only one file at a time; therefore, further processing was necessary to combine four files corresponding to the four attenuator settings into one set of results. Three methods have been developed to accomplish this. The first method was originally used but problems developed in determining acceptable data and method two was used. Using method two, some acceptable data were being ignored and the 20 and 30 dB settings were found to give similar results. Therefore, method three was developed to utilize much of this acceptable data that were being ignored.

1. In method one, the results with the lowest attenuator setting (0 dB) were used for 60 km up to the height where 5% of the ordinary and extraordinary data was rejected due to saturation (see Section 3.4). The electron densities for the higher heights were obtained from the next higher attenuator setting under the same restrictions of saturations. This process continued until the last electron density was obtained. The results of this method seemed to be satisfactory except for above 81 km and below 66 km.

2. Method two is the same as method one, but accounts for inaccuracies in the receiver by rejecting electron densities that used $A_x/A_0$ ratios that were less than .09. Electron densities were rejected also if the signal to noise ratio was less than 1. These two revisions eliminated much of the results below 65 km and above 85 km.

3. Method three is similar to method two except for the way the multiple attenuators are combined. The electron densities are considered acceptable if the $A_x/A_0$ ratios for both heights are greater than .08, the signal to noise ratio is above 1 for both heights, and the rejections due to saturations were less than 5% for both heights used to calculate the
electron density. If more than one attenuator setting had acceptable electron densities for between two heights, then the median of the acceptable electron densities was used. Using these three methods, the computer results were combined to give one electron-density profile for every 4 attenuator settings. Using either average or medians, electron densities of different heights or of different times were combined as discussed in Section 4.2.

4.2 Electron-Density Results

The results are presented in two forms: by the total differential absorption below each height \( \frac{A_x}{A_o} \) ratios and by electron densities. The \( \frac{A_x}{A_o} \) ratios given in Figures 4.2, 4.3, and 4.4 are plotted using a sixth order polynomial approximation of the ratio as calculated by method one. The eclipse shows a reduction in absorption which indicated a reduction in electron density as expected. The third day shows irregular absorption with a large increase in absorption. Referring to Figure 2.2, the increase in absorption is related to the X-ray flux burst. The electron density for above 75 km for the three days given in Figure 4.5 shows a good correlation between the large increase in electron density on July 11 and the burst of X-ray flux. Due to this obvious contamination, the second control day is not used for comparison during the burst period.

Figure 4.6 gives the \( \frac{A_x}{A_o} \) ratios versus height. The ratios were determined using method one and taking the median of the groups within the hour corresponding to the maximum obscuration of the solar eclipse (1400-1500 CST). Due to the much larger absorption in the control days than during the eclipse, the electron densities above 81 km (approximately) are not valid according to method two and three, but with the eclipse day, the values should be acceptable up to 85 km.
Figure 4.2 Comparison of the $A_x/A_0$ ratio at 72 km for July 9, 10, and 11.
Figure 4.3 Comparison of the $A_x/A_o$ ratio at 75 km for July 9, 10, and 11.
Figure 4.4 Comparison of the $A_x/A_o$ ratio at 78 km for July 9, 10, and 11.
Figure 4.5 Median electron densities between 75 and 82.5 km.
Figure 4.6 Median $A_x/A_0$ profiles between 1400 and 1500 CST for each day.
Figure 4.7 gives the electron density variation with time. The electron densities are averages between 70.5 and 78 km and between 78 and 87.5 km with the electron densities obtained by using method one for processing the computer result. Figure 4.5 and 4.8 give the electron-density median for 75 to 82.5 km and 67.5 and 75 km, respectively, as each varies with time. These electron densities were obtained using method three. At the lower altitudes, the median electron densities show no effect from the eclipse while the average electron densities do show a slight effect. This difference, though, is mainly attributed to the higher heights the averages were taken from rather than to the method used. The highest heights show large effects due to the eclipse. Figure 4.7 shows a minimum electron density near maximum obscuration of the eclipse while Figure 4.5 shows the minimum being delayed by half an hour. This is attributed to the variation in the data due to the inaccuracies in the partial-reflection equipment. The X-ray burst shown in Figure 2.2 seems to have no effect at the lower altitudes.

Median electron-density variations with height are given in Figure 4.9. These values are the median obtained by processing the computer results utilizing method two and finding the median value between 1400 and 1500 CST. Below 75 km the eclipse does not seem to have much effect on the electron density as shown in Figure 4.9, but above 75 km, the electron density decreases by 45 to 65%. The upper height for this comparison is 81 km due to the small \( \frac{A_x}{A_o} \) ratios (shown in Figure 4.6). The electron-density profile shows some conformity to the expectation given in Section 2.4.

4.3 Theoretical Applications

Since the eclipse never reached totality, the electron production \( (q) \) cannot be assumed to be zero, but equation (2.4) can be used as an approximation
Figure 4.7  Average electron densities between the altitudes 78.0 - 82.5 km and 70.5 - 78.0 km.
Figure 4.8 Median electron densities between 67.5 and 75 km.
Figure 4.9 Median electron-density profiles between 1400 and 1500 CST.
to $[\varepsilon]$ and $a_{\text{eff}}$. Equation (3.1)

$$q = \sigma_z(\text{NO}) [\text{NO}] I_\infty e^{-\tau} F_o$$

(3.1)

where $q$ = electron production rate in cm$^{-3}$ sec$^{-1}$

$\sigma_z(\text{NO})$ = ionization cross-section of nitric oxide = $2 \times 10^{-18}$ cm$^2$

$[\text{NO}]$ = number density of nitric oxide in cm$^{-3}$

$I_\infty$ = incident Lyman-alpha flux at the top of the atmosphere = $3.1 \times 10^{11}$ photons cm$^{-2}$ sec$^{-1}$

$F_o$ = the function of the unobscured solar disk

$\tau$ = optical depth

given by Sechrist [1966], was used to approximate the electron production rate and equation (3.2) was used to approximate the optical depth.

$$\tau = \sigma(a_0) [O_2] H \sec \chi$$

(3.2)

$[O_2]$ = number density of molecular oxygen in cm$^{-3}$

$H$ = scale height

$\chi$ = solar zenith angle

Figure 4.10 shows the variation of $q$ during the eclipse as compared to the variation without the eclipse. The electron production rates were used to obtain theoretical electron densities with $a_{\text{eff}}$ being chosen to give the best fit to the experimental results. A value of $2 \times 10^{-6}$ for $a_{\text{eff}}$ was determined for the eclipse day between 75 and 82.5 km and $1.77 \times 10^{-6}$ for the same height range on the control days. For the heights 78 to 87.5 km $a_{\text{eff}}$ was found to be $8.46 \times 10^{-7}$. These values for $a_{\text{eff}}$ are similar to ones given by Mitra [1968]. Figure 4.11 shows a comparison between the theoretical $[\varepsilon]$ during the eclipse and without the eclipse using $a_{\text{eff}}$ of $1.77 \times 10^{-6}$. 
Figure 4.10 Electron production rate between 75 and 82.5 km during the eclipse and during the control days. The NO distribution used is from Meira [1971].
Figure 4.11 Theoretical electron densities between 75 and 82.5 km for eclipse and control day; calculated using an $\alpha_{\text{eff}}$ of $1.77 \times 10^{-6}$. 
The electron density of the eclipse was divided by average electron density of the control data and compared to the obscuration function as seen in Figure 4.12. The comparison of the experimental \([e]\) during the eclipse and the theoretical \([e]\) without the eclipse using equation (2.4) was also made and is shown in Figure 4.13.

The electron density for July 9 shows a good correlation with the solar zenith angle (Figure 4.14) and was therefore divided by the theoretical \([e]\) to eliminate the effects of the solar zenith angle and to determine the variability of the experimental \([e]\) (Figure 4.15). The same comparison is made with the eclipse \([e]\) (Figure 4.15) and shows a similar but greater variability.

Generally, the eclipse electron densities show a decrease that is greater than expected from the equation (2.4). Other than the possibility that this is caused by variabilities due to inaccuracies in the experiment, there are three reasons why this may occur:

1. The obscuration function of the ionization source (Lyman-\(\alpha\)) is different than the uniform-disk obscuration function used.
2. The \(\alpha_{eff}\) increased during the eclipse. This could be caused by a change in the hydrated-ion composition between 75 and 81 km.
3. Loss by attachment is increased by the eclipse.

The electron-density profiles in Figure 4.10 show good comparison with the profile with 40% obscuration given in Figure 2.7 and with 60% obscuration shown in Figure 2.6. Smith, et al. [1965] described small changes below 70 km as the \(C\)-layer caused by cosmic rays which disappear as the eclipse reaches totality. The effect can be seen up to 69 km in Figure 4.9.

4.4 Summary

Comparing Figure 4.9 Figures 2.6 and 2.7, the electron-density profiles of this eclipse are similar to previous eclipses for the same obscuration. Generally, similar conclusions can be drawn. The difficulty in interpreting the
Figure 4.12 The ratio of electron densities for the average of the control day as compared to the unobscured sun.
Figure 4.13 The graph of the ratios of the theoretical \([e]\) for the unobscured sun to the experimental \([e]\) for the eclipse as compared to the unobscured sun. The \(a_{\text{eff}}\) used for 75 to 82.5 km is \(1.77 \times 10^{-6}\) and for 78 to 87.5 km is \(8.46 \times 10^{-7}\).
Figure 4.14 Scatter plot correlating the electron density for July 9, 1972 between 75 and 82.5 km to the solar zenith angle.
Figure 4.15 The graph of the ratio of theoretical electron densities to the experimental electron densities for July 9, 10, 1972.
results lies in the variation of the electron density of the eclipse with time. In Figures 4.12 and 4.13 a small decrease in electron density precedes the obscuration of the sun. An error of 20% can be expected due to the equipment and 20% error can be expected in the collision frequencies. Errors due to collision frequencies will cancel in Figure 4.12 but the errors due to the equipment will increase. For Figure 4.13, the reverse is true, but there are also errors due to the approximations made in equations (2.4), (3.1), and (3.2). With these possibilities of errors and observing that the ratio after the eclipse can get as low as .8 in Figure 4.12, the initial decrease can be interpreted as experimental error. The errors in Figure 4.13 can be seen in the variations in Figure 4.15.

No correlation could be seen between the X-ray flux and the electron density on the third day except during the X-ray burst period. Therefore, Lyman-α is assumed to be the main ionization source and the theoretical calculations were made on that assumption.

Of the three reasons for the large decrease in \([e]\), the effects due to changes in hydrated ions is the most likely. During the day electron loss by attachment is insignificant above 75 km. Since the obscuration of the sun was only 60% which corresponded to a production rate similar to that of 65° solar zenith angle, the loss process would still be by recombination.

The larger concentrations of Lyman-α on the solar disk were in the southern hemisphere and were not obscured and the intensity of 1-8 A X-ray flux was too small to have any large effect. Therefore, the obscuration function of the ionizing source would have the same obscuration or less. This leaves the only possibility for the larger decrease in free electron as being due to changes in the hydrated ions.
5. CONCLUSIONS

The solar eclipse provides a good opportunity to study several processes of the D region and to develop its theoretical model. Accurate interpretation of the eclipse data is required to determine exactly the D-region ion production and loss processes, the variation of $a_{\text{eff}}$, formation of hydrated ions, and negative ion chemistry. A brief theory of the D-region chemistry is presented in Chapter 2 and used to analyze the data in Chapter 4. The equipment used in the collecting and processing of the partially reflected waves, as well as the refinements made in the collection process are given in Chapter 3. The newer partial-reflection system, discussed in Chapter 3, has been in use for the daily collection of data. Results from this newer system are given by Denny and Bowhill [1973]. This chapter reviews the results of the partial-reflection data taken during the eclipse and suggests further developments of the partial-reflection system.

5.1 Review of Results

The effect of the eclipse below 75 km is below the experimental errors. These errors are due to the variability of receiver gain caused by temperature fluctuations, the 40 μsec pulse width of the transmitter, inaccuracies in the collision frequencies, and inaccuracies in noise reduction. In comparing the $[\theta]$ profiles for July 9 and 10, 1972 in Figure 4.8, the beginning of the formation of a C layer can be seen resulting from cosmic rays. From Section 2.1, the main ionization source between 70 and 80 km is Lyman-α since the X-ray source effects were not observed below 81 km except when the X-ray flux increased above $1 \times 10^{-3}$ erg cm$^{-2}$ sec$^{-1}$.

The decrease between the electron density from July 9 and from July 10 is dependent on the height and is very marked between 79 and 81 km. Near 80 km,
this change in electron density is as much as 55% between the results of July 9 and 10, which was not expected according to equation (2.4). The most probably answer given in Chapter 4 is that it is due to an initial large decrease in hydrated positive ions which are the major ions between 75 and 80 km during the daytime (as seen in Figure 5.1 by Krankowsky, et al. [1972]).

The theoretical [e] were used to compare with the experimental [e] in Figure 4.13 to remove any electron density variability not due to the eclipse. The results in Figures 4.12 and 4.13 show unexpected initial decreases in [e] prior to the eclipse and larger decreases than would be expected during the eclipse, but allowing for 20% error in these results, these variations are within the error limits. In general, there is good agreement with the data from Smith, et al., [1927] and Deeks [1966].

5.2 Suggestions for Further Work

The present partial-reflection system has proved invaluable in presenting variations in electron densities diurnally and from day-to-day as presented by Denny and Bowhill [1973]. The system has several limitations, though. Either the signal-to-noise-ratio should be increased or the rates of data collection increased. Both of these changes would require alterations in the transmitter. By doubling the peak power of the transmitter, meaningful partial reflections could be obtained at lower altitudes without excessively disturbing the ionosphere due to the slow pulse rate as is done in the cross modulation experiment. By increasing the pulse rate, more data could be collected in the same interval of time, allowing for a more accurate statistical evaluation of the noise.

A new receiver has been built as mentioned in Chapter 3. The initial results obtained using it show an improvement in the results, but the problem of eliminating atmospheric noise remains. The main problem lies in defining the noise.
Figure 5.1 Rocket measurements of the positive-ion chemistry by Krankowsky, et al. [1972].
A study should be done on the specific types of noise received and the algorithms required to reject each. This would include receiving and storing noise on DECtape for later evaluation of the amplitude and phase.

A digital input/output would increase the efficiency of the collection and process. Presently the system requires the assistance of the operator every 3-1/2 minutes and uses one page of computer paper for every page of data. With a digital input/output, the computer could set the attenuators and control other switching which would free the operator for other tasks. This would also improve the usefulness of taking differential phase measurements as described by Wiersma and Sechrist [1972].

Using a line printer for outputting the data would allow for more sophisticated and complicated processing of data. This would also be required if the rate of collection is increased. To collect one file of data takes 3.5 minutes, to process one, about 45 sec, but to print out the results on the teletype and paper tape takes 2.6 minutes. Therefore, the processing would not be able to keep up with a faster collection unless the speed of printing the results increased.
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APPENDIX

.TITLE DLOGF1
// DLOGF1 IS A COMBINATION OF ALL THE PARTIAL REFLECTION
// MACRO PROGRAMS USED IN COLLECTING AND PROCESSING DATA. THE
// PROGRAMS CONTAINED IN THIS VERSION ARE:
//
// INITIALIZATION:
// DLOGF INITIALIZES COLL. & PROC. PARAM.
// READM READS UNFORMATTED CHAR. FROM TTY
// IOD INCREMENTS THE TIME OF DAY
//
// CALIBRATION:
// RADG READS SAMPLES FROM A/D CONVERTER
// FOR FORTHAN PROGRAMS
// TTM WRITES LIN. TABLE OUT ON DISK
//
// COLLECTION:
// BEGIN MAIN COLL. PROG.--A REAL TIME
// SUBROUTINE API LEVEL 6
// WTI GIVES TIME TO LOWER API LEVELS
// NSUB SETS UP DATA PACK & CHECKS NOISE
//---R-T- SUB. AT API LEVEL 5
// PAC PACKS DATA DOUBLE
// DTRANS WRITES DATA ON STORAGE DEVICE
// CHKOUT CHECKS FOR ENOUGH DATA
// CHECK SEES IF AX & AO IS IN THE RIGHT
// ORDER AND ARE COLL. IN PAIRS--API 5
// LIN LIN. DATA NEB. #0, & CHECKS NOISE
// ADREAD PREPARES A/D CONVERTER READ
// ADINT A/D INTERRUPT SERVICE ROUTINE
//
// PROCESSING:
// CHNG INIT. DEV. & CHECKS FOR COLL. FILE
// CONTW WAITS FOR FILE TO BE COLLECTED
// DATCOL CHECKS FOR UNWANTED COLL. STOP
// SVIT USED TO SWITCH DISKS
// DUMP READS DATA, UNPACKS IT &, PUTS
// IT INTO A FORTHAN ARRAY
//
// DATA IS COLLECTED ALTERNATELY ORDINARY AND EXTRAORDINARY
// AS DESCRIBED BY BIRLEY (AERONOMY REPORT 42). THE TIMING OF THE
// DATA IS DETERMINED BY AN EXTERNAL ENCODE PULSE. THE MODE OF THE
// DATA INPUTED INTO THE COMPUTER IS DETERMINED BY A TIMING PROGRAM
// (CHECK) SET UP BY D. WARD. ESSENTIALLY HOW IT WORKS IS AFTER 4
// FRAME OF DATA HAS BEEN READ IN THE COMPUTER'S CLOCK IS SET FOR 9/64
// OF A SECOND (9 PULSES). IF NO OTHER DATA IS READ IN BEFORE THE
// TIME EXPIRES THE DATA FRAME AS EXTRAORDINARY MODE AND IS REJECTED.
// OTHERWISE BOTH FRAMES ARE ACCEPTED. THIS CHECK IS MADE AT THE
// BEGINNING, AFTER EACH DATA TRANSFER, AND WHENEVER THE COLLECTION
// IS RESTARTED OR AN ERROR CONDITION EXIST. THE PROGRAM IS SET SO
// AS TO NOT OVER MAXIMUM STORAGE ON THE DISK.
//

TTL=4  // TELETYPE IN
TTO=6  // TELETYPE OUT
THI=10 // DAT SLOT OF LIN. TABLE
OUTP=2 // PLACE TO STORE DATA
OUTP+#1 // SECOND PLACE TO STORE DATA
DATIN=5 // DAT SLOT TO READ DATA
DATIN+#3 // SECOND-DAT SLOT TO READ DATA
OUT=1 // OUTPUT TO I/O DEVICE
IN=0 // INPUT FROM I/O DEVICE
ASC=2 // TYPE OF I/O MODE
IA=1  // TYPE OF I/O MODE
DUMP=4 // TYPE OF I/O MODE
SKAR=5 // # OF DATA TO BE DELETED
NSAM=37 // # OF SAMPLES PER FRAME TO BE STORED
NSAMP=NSAM+2+1 // SIZE OF ONE FRAME PACKED DOUBLE
DAT=NSAM+2 // SIZE OF INITIAL DATA BLOCK
DAT=3T7A // SIZE OF 1 BLOCK OF STORAGE
DAT=+DAT/NSAMP // # OF FRAMES FOR 1 BLOCK OF STORAGE
XBLK=10 // SIZE OF BLOCK FOR TTL READ
MNCO=11 // COUNT. FOR # OF NOISE FOR MAX. NOISE
NPFC=#6 // MINUS (#+1) OF NOISE PER FRAME
NDPC=NSAM/#2 // # OF DATA PER FRAME
DPR=NDPC+1 // RESET FOR POINTER TO DATA
MAXP=MOB000/NSAMP // MAX. # FRAMES PER DEVICE
MAXD=1 // # OF DISKS TO BE USED

GLOB CHNG, DA, AD, DUMP, DLOGF, CLOC, CONTL, PROC, RADG, TTM
GLOB TPOL, PTP, YPPL
IOEV 12356  // DAT TO BE USED

THE FOLLOWING SUBROUTINE IS USED TO PREPARE THE
// COLLECTION AND PROCESSING PROGRAMS FOR MANIPULATION OF DATA.
// THE VARIABLES OF THE MACRO PROGRAMS STORED IN THIS SUBROUTINE
// THEREFORE AFTER THIS SUBROUTINE IS EXECUTED IT IS WRITTEN OVER
// AND SHOULD NOT BE REENTERED (FOR IT WILL NOT EXIST).
MSGDB 0
JMP * +DA
/GET SUBROUTINE PARAMETERS' ADDRESSES
SUM4 0 JMP +4
/ JUMP AROUND PARAMETER LIST
DB 0
ADDR OF THE ADDR OF THE DB SETTNGS
DBC 0
TCI 0
HMSG1 LAC M$G1+3
/SET UP RESET FOR TELETYPE
TCl DAC RM$G1
/MESSAGE
DSTOR JMP ONGA
/GO TO NEXT EXECUTABLE STATEMENT
CTI LAW NPFC
/COUNTS # OF NOISE PER FRAME
CTI9 LAW M$NC
/COUNTS GROUPS OF NOISE FOR MAX. NOI.
CTI0 LAW -2
/USED TO SWITCH STORAGE DEVICES (IF
CTI4 LAW -2
/NEEDED) FOR COLL. AND PROC.
CTI5 LAW NPFC
/USED TO SKIP AROUND "SKAP" DATA #'S
CTI6 LAW -2
/USED TO SWITCH BUFFERS IN COLL.
CTI8 LAW -DATSTK
/TRENDS # OF UNWANTED STOPS IN COLL.
CTI9 LAW -1
/ALLWS PROC. TO READ DATA
CT10 LAW
/TURNS PROC. TO RESTART A FILE 1
CT11 LAW
/TURNS PROC. END OF RUN
ALF 51004
/USED TO PUT A LINE FEED IN THE
20100
/MIDDLE OF A FORTRAN OUTPUT LINE
TST1 0
/SAVE ID TO TEST FOR COLL. STOPAGE
SAVAC 0
/SAVES AC DURING PROC. OPERATION
SAVAC 0
/SAVES AC FOR API LEVEL 6
TC10 LAW -2
/USED TO UNPACK 2 WORDS
CN1 0
/STORES # OF FRAMES FOR ONE FILE
CN2 0
/STORES # OF FRAMES FOR ONE DISK
CMT 0
/ADD FOR 0-FRAMES, EVEN FOR X-FRAMES
CMT9 0
/SET TO -1 FOR 0-FRAMES
DUM1 0
/GETS & STORES 1 LINEARIZED DATA WORD
DUM2 0
/STORES MAX. NOISE IN A FRAME
DUM3 0
/STORES THE SUM OF THE NOISE PER FRAME
DUM4 0
/STORES THE MAX. OF 45 NOISE SAMPLES
DUM5 0
/STORES THE SUM OF 45 NOISE SAMPLES
MAX 777
/STORES THE SMALLEST MAX. OF "DUM4"
TBUF +DSA BUFI
/STORES NAME OF BUFI TO BE OUTPUTED
TICOU 0
/STORES THE ID NUMBER
TRANS 0
/DATA IS TRANSFERED WHEN NON-ZERO
COUNTL LAW +NDPC
/POINTS # OF DATA PER FRAME TO PACK
DPOINT +DSA BUF
/POINTER FOR "BUF"
COUNTL LAW +NDPC
/COINS # OF POINTS TO UNPACK
ER2 0
/STORES TIMING ERROR FOR A-D CONVERTER
INFLAG 0
/TIMING ERROR FLAG
INSUB 0
/STORES R- T. SUB. & API LEVEL FOR A/D
TIME 0
/STORES TIME (RESET EVERY 1 MIN.)
TIMR 0
/STORES TIME USED IN DATA HEADING
JUIC 0
/SAVES AC DURING TIME ROUTINE (TOP)
JUL 0
/STORES THE MIN. IN DURING EACH HOUR
MCNTR 0
/STORES # OF MIN. OF RUN
LETC6H +DSA NBLK
/ADDRESS OF SUB 'READIN' BUFFER
BUFI1 +DSA BUFI
 ADDRESS OF BUFI
BUF2 +DSA BUFI
 ADDRESS OF BUFI
BUKF1 +DSA BUFI
 ADDRESS OF BUFI
BUK2 +DSA BUFI
 ADDRESS OF BUFI
BKM 377 0
/377 MSB ADDRESS
-DEC
KMIN 599
/MAX # OF -1 MIN.'S IN 1 HOUR
CN1 33999
/MAX. # OF TIMES IN 1 HOUR
MIB 1000-599
/USED TO INCREMENT TIMES BY 1 HOUR
-DCT
DBP +DSA D90
/POINTER FOR THE DB'S
DBOG 38540
/DB'S STORAGE BLOCK
3152 /ASCII DEFAULT SETTINGS
LAW -1
/TELLS END OF DB SETTNGS
-9
STI -BLOCK 1000
/LIN. TABLE
POINT +DSA SEVN
/POINTER FOR COLLECTION BUFFERS
BUFI1 -BLOCK DLMA=393
/FIRST COLLECTION BUFFER
BUFI1 - SIXBY "TABLEDAT"
/NAME OF FILE TO BE READ IN
MSG7 2000
LAST +ASCII "SET CONSOLE SWITCHES, TURN ON PULSER AND ENCODE PU"
-ASCII "LSE"<15>
-ASCII "DISCONNECT WIRE FROM PULSED OSCILLATOR"<15>
MSG9 2000
-ASCII "SET ATTENUATOR TO 0DB"<15>
MSG8 2000
-ASCII "TYPE # OF HOURS FOR THE RUN AND C.R."<15>
 MSG9 2000

ERRCAL 2000

\[\text{ASCII "DB SETTING"<15>}\]

DMV1 JMP BLK2 /USED TO DELETE COL. HEAD
DMV2 204 /LOC. TO DETERMINE WHICH TTY CONFIRMS 1C
DMV3 177 /LOC. USED TO ALLOW SHARE
DMV4 114 /ADDR. OF LOC. OF FOREGROUND *DAT SLOT 8
DMV5 117 /ADDR. OF LOC. OF BACKGROUND *DAT SLOT 8
DMV6 113 /ADDR. OF THE *JOIN TABLE
SRPO 0 /USED TO SURPRESS CALIBRATION
FDT1 0 /THESE LOCATIONS ARE USED
FDT2 0 /TO STORE THE
FDT3 0 /FOREGROUND *DAT SLOT
FDT4 0 /ADDRESSES FOR 1,2,3,4,5
FDT5 0 /AND 10
MINEQ *DSA MINEQ /USED TO DETERMINE LENGTH OF RUN
H DEC
MINEQ 6000 /CONVERTS INPUT NUMBERS TO
/ THE EQUIVALENT
/ BCD # OF MINUTES
/ OCT
CNTH1 0 /USED TO DETERMINE MULTIPLES OF 10
DBP1 0 /TEMP. STORAGE FOR DB SETTING
DBP2 0 /TEMP. STORAGE FOR DB IN ASCII CODE
DBCNT1 0 /COUNTER FOR # OF DB TO BE USED
DBCNT2 LAV -2 /ALLOWS NO MORE THAN 2 DIGIT DB'S
DBCNT3 LAV -4 /ALLOWS ONLY 4 DB SETTINGS
CODE1 777723 /55 TO CHECK FOR CARRIAGE RETURN
CODE2 777766 /FOR LESS THAN 10 HOUR RUN
CODE3 1000 /ASCI SPACE AND A ZERO
CODE4 15 /CHECKS FOR CARRIAGE RETURN
CODE5 LAV -2 /CHECKS FOR MULTI-DB SETTINGS
CODE6 28140 /ASCII DEFAULT DB FOR 0 DB SETTING
CODE7 7700 /USED TO FIND THE DEVICE # IN *JOIN
CODE8 777766 /12 TO FIND BCD # MULTIPLE OF 10
CODE9 72 /SETS THE DB SETTING
CODE10 60 /TO ASCII CODE
CODE11 11 /INITIALIZES *JOIN TABLE POINTER
CODE12 40 /USED TO DETERMINE VALUES OF ASCII #S
CODE13 1000 /LOOKS FOR DEVICE # 5 (DISK)
CODE14 1000 /LOOKS FOR THE DEVICE # 4 (DECTAPE)
CODE15 100000 /USED TO FIND THE UNIT # FOR A DEVICE
CODE16 16 /CHECKS FOR DECIMAL POINT
CODE17 LAV -32 /USED TO CHECK NONNUMBER ASCII CHAR.
CODE18 -15 Palestinian /SETS MAXIMUM AMOUNT COLL* ON A DISK
CODE19 *DSA DECN /INIT. MULTIPLIES FOR BCD #S
CODE20 *DSA MINEQ /INIT. MULT. TO CONVERT TIME TO MIN
CODE21 NOFUK /SETS UP # OF DISKS TO BE USED
CODE22 80000 /CHECKS FOR UNIT 1
CODE23 90000 /CHECKS FOR UNIT 3
CODE24 -310000 /CHECK FOR ASCII "1" IN DATE
CODE25 -14000 /USED TO CHECK FOR ASCII "5" TO "9"
CODE26 3700 /USED TO GET SECOND CHAR. IN ASCII WORD
CODE27 1000 /CHECKS FOR AN ASCII ZERO
CODE28 360000 /USED TO CHECK FOR AN ASCII "A"
CODE29 -100000 /USED TO INCREMENT 2 ASCII CHAR
CODE30 -300000 /USED TO INCREMENT 4 ASCII CHAR
CODE31 4000 /CHECKS FOR AN ASCII "A"
CODE32 200000 /CHECKS FOR FIRST HALF ASCII "Y"
CODE33 7 /CHECKS FOR FIRST HALFS ASCII "Y"
CODE34 3 /CHECKS FOR FIRST HALF ASCII "Y"
CODE35 -20340 /CHECKS FOR UINTS LESS THAN 4
CODE36 -100300 /CHECKS FOR UNITS LESS THAN 4
CODE37 101204 /CHECKS FOR UNIT 1 JOIN TABLE
CODE38 400294 /SECOND WORD FOR *JOIN TABLE
CODE39 1600 /LOOKS FOR DEVICE #7 (P. 158)
CODE40 255300 /USED TO SET CONSOLE SWITCH 1

---

ERRCAL 2000

\[\text{ASCII "ERROR IN CALIBRATION TABLE"<15>}\]

---

INITS

\[\text{INIT TTO.OUT.INIM}\]

\[\text{INIT TTI.INIM}\]

\[\text{STY OUT}\]

\[\text{STY IN}\]

LAC* DMV4 /SET ADDR. OF FGND* DAT SLOTS
IAC DAC FDAT1 /ONE
IAC
DAC FDAT2  /  TWO
IAC
DAC FDAT3  /  THREE
IAC
DAC FDAT5  /  FIVE
TAD CODE2A
DAC FDAT18  /  EIGHT
LAC* FDAT2  /  SET .DAT SLOT 5 EQUAL
DAC* FDAT5  /  TO .DAT SLOT 2
DAC* FDAT3  /  SET .DAT SLOT 1 EQUAL
DAC* FDAT1  /  TO .DAT SLOT 3
*INIT OUTPT,OUT,INTIM / PREPARE FIRST STORAGE DEVICE
.*CLEAR OUTPT
LAV -2  /  ARE TWO STORAGE
TAD CODE21  /  DEVICES - REQUIRED?
JMP NDK1  /  NO, OMIT FOLLOWING CODE
LAC MDUM1  /  YES, CLEAR JUMP AROUND INSTRUCTIONS
DAC NDK2  /  TO USE A SECOND DISK
DAC NDK3  /  FOR STORAGE
*INIT DATIN,OUT,INTIM / PREPARE SECOND DEVICE FOR USE
.*CLEAR DATIN2  /  REMOVE ALL FILES FROM IT
JMP +3
NDK11
LAC* FDAT1  /  CLEAR .DAT SLOTS FOR THE
LAC* FDAT3  /  SECOND STORAGE DEVICE
LAC MDUM2  /  GET THE VALUE OF CONSOLE
AND CODE40  /  SWITCH #1
DAC SNPO  /  SET ADDR. TO THIS VALUE
LAV -1  /  SWITCH #1
DAC* DMV3  /  ALLOW SHARE
DAC* DMV2  /  SET TO TO ACKNOWLEDGE IT
JMP  /  JUMP AROUND SECOND BUFFER

#BLOCK DBHKL-390  /  SECOND COLLECTION BUFFER

hDERH
LAC CODE29  /  INITIALIZE BCD
DAC HAC  /  POINTER
ISZ CTM1  /  HAS FOUR NUMBERS BEEN
SKP  /  READ
JMP DTLP  /  YES, EXIT FROM ROUTINE
*WRITE TTO#ASC,MSG1,0  /  NO, ASK FOR TIME
*WAIT TTO  /  READ IN TIME
JMS READM  /  CONTAINS THE ADDR. OF CHAN. READ IN
LAV -5  /  INITIALIZE COUNTER TO EXIT THE
DAC CTM1  /  ROUTINE AFTER FIVE #5'S
LAW -3  /  INITIALIZE COUNTER TO GET
DAC CTM2  /  THE MINUTES
LAC MIN  /  INITIALIZE LOG. THAT SAVE
DEM HL  /  THE TIME AND MINUTES
NXT1
JMS CHKMN  /  GET NEXT NUMBER
JMS+ AD  /  MULTIPLY BY POWERS OF TEN
LAC HAC  /  TO GET BCD EQUIVALENT
DAC SAV3  /  SAVE THE MINUTES
TAD HR  /  SET UP THE NUMBERS READ IN
DAC HA  /  AS THE PRESENT TIME
ISZ CTM2  /  IS THE NUMBER PART OF THE MIN. ?
JMP JPAR  /  NO, FIRST TWO #5'S ARE THE HOURS
LAW -1  /  RESET COUNTER TO GET ALL THE
DAC CTM2  /  MIN. (REST OF THE #5'S)
LAC SAV2  /  SET MINUTES AND
TAD MIN  /  SET INTO AN ADDH.
DAC MIN  /  WHICH SAVES MIN.
JAJP ISZ HAC  /  GET NEXT MULTIPLYING #
ISZ CTM2  /  OBTAINED 5 NUMBERS ?
JMP NXT1  /  NO, GET NEXT NUMBER
OTLP
LAC MMIN  /  CHECK THE MINUTES
TCA MIN  /  IS THE MINUTES GREATER THAN
TAD MIN  /  THE MAX. NUMBER OF MINUTES
SMA  /  IN AN HOUR ?
JMP ADEHR  /  YES, ASK FOR THE TIME AGAIN
LAC CHR  /  NO, CHECK THE TOTAL TIME
TCA  /  IS THE TIME OF DAY #
TAD HR  /  LARGER THAN THE BIGGEST #
SMA  /  ALLOW FOR THE TIME OF DAY ?
JMP ADEHR  /  YES, ASK FOR THE TIME AGAIN
LAC HR  /  NO, PUT THE TIME INTO THE
DAC TIME  /  ADDH. WHICH GIVE THE
DAC TIME  /  TIME OF DAY
+TIMER 360,TOD,5  /  SET UP THE TIMING R. T. SUB.
MNS CONTL  /  TRANSFER CONTROL TO CONTROL PROGRAM
JMP +2
ADDRESS FOR CALIBRATION SUPRESSION

/msgt 2000 0
.asci "TIME"<15>
/log, which counts 5 numbers
/message: used to ignore the hours
/save2 0
/log: to save the min. #'s
/hr 0
/log: to save the time
/rad 2 dec
/pointer for the bcd multipliers

/decn 10000
/1000
/100
/10
/1
/8 oct

/chkn 0
/ctr -72
/prepare to look at character
/tad* dt
/head in
/sad code1
/is char. a carriage return?
/jmp rdem
/yes: check for possible error
/lsz dt
/no: prepare for next char.
/jmp -4
/no: get next character
/tad code12
/yes: is character
/spa
/larger than 57?
/jmp -7
/no: get next character
/jmp chkn
/yes: char. is a # so exit

/"*************************************************************************
/eject
noticed
**************************************************************************/

/radc 0
/jms* da
/get variables and place addresses below
/jmp +4
/jump around variables
/nbia 0
/address of the buffer address
/nb2c 0
/address of the word count
/nb3f 0
/address of the flag
/dzm* nb3f
/zero flag--wait for read in
/lac* nb1a
/insert buffer address into the
/dac nb5
/a/d call routine
/lac* nb2c
/insert the word count into the
/dac nb4
/a/d call routine
/lac nb3f
/insert the flag address into the
/dac nb6
/a/d call routine
/jms adread
/the a/d call routine (to init: read):1
/nb4 0
/number of samples to take
/nb5 0
/buf: address in which to store samples
/nb6 0
/completion and error flag address
/nb1 f-sub: for int. serv. hout to go to
/lac sta
/puit address of table into
/dac
/write command
/jmp radc
/return to fortran program
/jmp ttm
/yes, check for words
/jmp -5
/no, get next character
/jmp chkn
/yes: char. is a # so exit
/jmp ttm
/characters?
/jmp +2
/get next character
/sta 0
/address of addr. of lin. table
/hep lac sta
/set addr. of lin.
/dac sta
/table
/init tbi out ttm
/prepare storage device
/jmp tbi sit
/open file for table
/lac sta
/put address of table into
/dac +3
/white command
/write tbi, dump, 0, 514
/write table on storage device
/jait tbi
/stop
/jmp ttm
/yes, check for winter months
/jmp -4
/no: get next character
/jmp onc3
/no: exit
/tad code25
/yes

/**************************************************************************
/eject
**************************************************************************/

/onc4 dac
/initialize time of year loc.
/lac* tc3
/get address of the
/dac tc3
/date
/lac* tc3
/first 2 1/2 characters
/spa
/are they letters?
/jmp lemon
/yes: check for words
/tad code24
/no: check the numbers
/spa
/is the first # a one?
/jmp code25
/yes: check for winter months
/tad code25
/no: check for summer months
/spa
/is the # > 4?
/jmp onc3
/no: exit
/tad code25
/yes
SMA IS THE NUMBER < 8 ?
JMP ONC3 /YES, EXIT
ISZ* SUM4 /NO, SET TIME OF YEAR LOC. TO SUM.
JMP ONC3 /EXIT
WINT AND CODE26 /GET SECOND NUMBER
SAD CODE37 /IS THE NUMBER AN ASCII ZERO (60)?
JMP ONC3 /YES, EXIT
LAW -1 /NO, SET TIME OF YEAR LOC.
DAC* SUM4 / TO WINTER
JMP ONC3 /EXIT
LETMON TAD CODE28 /IS THE FIRST LETTER
SPA ONC3 /AN "A"?
JMP CODE29 /YES, EXIT
TAD CODE28 /AN "D"?
JMP CODE30 /NO, IS THE FIRST LETTER
SPA ONC3 /A "F"?
JMP CODE31 /YES, EXIT
TAD CODE28 /A "J"?
JMP SWDIS /YES, LOOK AT SECOND CHARACTER
TAD CODE28 /NO, IS THE FIRST LETTER
SPA ONC3 /A "N"?
JMP SWDIS /YES, EXIT
TAD CODE28 /A "T"?
JMP SWDIS /YES, LOOK AT THIRD LETTER
TAD CODE31 /NO, IS THE FIRST LETTER
SMA SWDIS /A "W"?
JMP SWDIS /YES, EXIT
TAD CODE31 /A "X"?
JMP SWDIS /YES, EXIT
TAD CODE31 /A "Y"?
JMP SWDIS /YES, EXIT
TAD CODE31 /A "Z"?
JMP SWDIS /YES, EXIT

/*************************************************************************/
/ EJECT                                                                       /
/ DISALLOW SHARING THE DATA COLLECTION DEVICES                                /
/*************************************************************************/
LAC* DM6 /GET LOC. OF THE I/OIN TABLE
DAC DM2 /SAVE THE LOCATION
TAD CODE11 /GO TO FOREGROUND DEVICES
DAC DM1 /AND SAVE THAT LOC.
LAC* DM2 /GET THE NEG. OF THE # FOREGROUND
TAD CODE34 /DEVICES AND DOUBLE THE #
RAL DM2 / (2 WORDS PER DEVICE USED)
DAC DM2 /AND USE AS THE COUNTER
HEDO1 LAC* DM1 /GET FIRST WORD FOR THE FOREGROUND DEV.
AND CODE7 /CHECK FOR THE DEVICE #
SAD CODE13 /IS IT A 5 (DISK) ?
JMP DM3 /YES, CHECK WHICH DISK
SAD CODE14 /NO, IS IT A 4 (DECTAPE)?
JMP DM4 /YES, CHECK WHICH DECTAPE
DAC CODE39 /NO, IS IT A 7 (P. PUNCH) ?
JMP SAVN1 /YES, SAVE IT
JMP SAVN1 /NO, CONTINUE
JMP SAVN1 /YES, RETURN
DLTDS LAC CODE37 /DELETE ALL OTHER DEVICES
DAC DM1 /BY INSERTING A DUMMY NAME
TAD CODE32 /SET UP THE NEXT DUMMY
DAC CODE37 /NAME
ISZ DM1 /GO TO NEXT WORD
LAC CODE38 /INSERT SECOND DUMMY
DAC DM1 /NAME INTO THE TABLE
ISZ DM1 /GO TO NEXT DEVICE
LAC CODE38 /HAS ALL THE DEVICES BEEN CHECK ?
SAD CODE39 /NO, CONTINUE
JMP FRDT /YES, RETURN
AN01 LAC* DM1 /GET FIRST WORD
AND CODE15 /LOOK AT UNIT NUMBER
SAD CODE52 /IS IT A 1 ?
JMP DKS /YES, DELETE THE DEVICE WORDS
JMP SAVN1 /NO, SAVE THE TWO WORDS
JMP SAVN1 /NO, SAVE THE TWO WORDS
/HAS THE LOC. BEEN CHANGED
/ TO USE 2 DEVICES ?
/YES. SAVE
/NO. DELETE LOCATIONS
/GET FIRST WORD AGAIN
/CHECK THE UNIT NUMBER
/IS THE UNIT # LESS
/THAN 4 ?
/YES: DELETE IT
/NO. GO TO NEXT WORD
/GO TO NEXT DEVICE

*DICT LAC /HAS
THE LOC. BEEN CHANGED
SAD MDUM1
/JMP SAUNI
JMP DLTD5
/AND CODE15
/TAD CODE36
/SPA
JMP /JMP DLTDS
/N0, DELETE LOCATIONS
SAUNI ISZ DUM1
/JMP DUMI
/NO. GO TO NEXT WORD
JNP ANO1

*EJECT
/CALERR
*WRITE TTO ASC, ERHCAL /LIN. TABLE ERROR
+WAIT TTO
JMP TPORL
/RECALIBRATE
JMP CALTB

-----Processing's Buffer-----

*INIT TBI, INRES /LINEARIZATION TABLE IN

LAC DB /GET ADDR. OF DB SETTINGS FOR
DAC DB /THE FORTRAN PROG.
LAS /CHECK CONSOLE SWITCH
AND CODE40
#1
SZA /IS IT SET ?
JMP ENDBD
/YES: USE DEFAULT DB SETTING
*WRITE TTO ASC, MSGDB, 0
/JMP READM /DB MESSAGE

DBO 0
/Locations of the Response
LAV -40
/TAD DBB
ISZ DBB
/IS CHAR. > 40 ?
JMP ENDBB
/NO. THERE ARE NO MORE CHAR.
TAD CODE17 /NO. IS THE ASCII # LESS THAN
SMA /THAN 72 ?
JMP NUM1 /NO. USE ONLY ONE NUMBER.
TAD CODE12 /YES: IS THE ASCII CHAR. AN
SPG /ASCII # (=57) ?
JMP NUM1
/NO. USE ONLY ONE NUMBER
ISZ DBCNT2
/YES: IS THIS THE SECOND # ?
SPE
/NO. CONTINUE
JMP NUM2
/YES: PROCESS THE TWO #'S
DAC DBP1 /SAVE THE FIRST #
JMP CKDB /AND GET SECOND #
ISZ DBCNT2
/HAS ONE # BEEN OBTAINED ?
JMP RESETD
/NO. RESET COUNTER
TAD DBP1 /YES: GET THE NUMBER AND
DAC DB /SET INTO FORTRAN ARRAY
CALL IRAL
/DAC DB /SET THE NUMBER UP AS A SPACE
AND A # IN ASCII FORMAT
JMP DBINC /USED TO PRINT OUT DB MESSAGE
RESETD LAV -2
/DAC DBCNT2
/JMP CKDB
/NUMBAYS

DAC DB /SAVE SECOND # IN FORTRAN ARRAY
TAD CODE10 /SET UP NUMBER IN
CALL IRAL
/DAC DBP2 /ASCII CODE
LAC DBP1 /AND STORE
JMS +AD /SET UP THE BCD
LAC CODE12 /EQUIVALENT
TAD DB /ADD TO THE SECOND #
DAC DB /AND STORE IN FORTRAN PROG.
LAC DBP1 /GET FIRST NUMBER AGAIN
TAD CODE10
/SVA
/IN ASCII
CALL IRAL
/TAD DBP2
DAC DBP /ADD TO PRVIOUS # TO FORM
TAD DB /THE DB SETTING IN ASCII CODE
RESET COUNTER FOR THE
DAC DB /NEXT 2 NUMBERS
ISZ DB
/NEXT LOC. IN THE FORTRAN ARRAY
ISZ DBP
/NEXT LOC. IN THE MACRO ARRAY
ISZ DBCNT1 /COUNTER TELLING # OF DB SETTINGS
ISZ DBCNT3
/JMP CKDB
/NO. GET NEXT SETTING
ENDDB LAC DBO
/CHECK--HAS ANY NUMBERS
SNA DEFDB / BEEN READ IN ?
JMP -1 / YES, USE DEFAULT DB
LAW DBCNT3 / YES, ALLOW POSSIBLY ONE MORE
DAC DBCNT2 / DB SETTING
LAC DBCNT1 / IS ONE # STILL UNPROCESSED ?
SMP / NO, CONTINUE THE EXIT
JMP NUMI+2 / YES, PROCESS THE LAST #
DAC DB / SET THE LAST LOC. TO A NEG.
LAC DBCNT1 / SET THE FORTHAN COUNTER
DAC / TO THE # OF DB SETTINGs
TAD CODE6 / IF THERE IS ONLY ONE DB
BAL / SETTING SET THE LINK
LAC OMV / SET UP JUMP AROUND COLL. READ IN
SIZ / IS THERE MORE THAN ONE DB SETTING ?
DAC UPN1 / NO, INSERT JUMP AROUND
MMP *+3 / USE INPUTED DB SETTINGs
DEFDB LAC CODE6 / SET UP ASCII CODE FOR
DAC DBO / ZERO DB SETTING

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LAC CODE68 / NO, INITIALIZE MULTIPLIER
DAC MINHC / TO CONVERT #’S TO MIN.
DZM TCI / INITIALIZE STORAGE ADDR. FOR CONVERTING
LAC (D90) / INITIALIZE DB SETTINGs TO
DAC D90 / THE BEGINNING
LAC* D90 / SET UP COLLECTION’S DB
DAC MSG9+11 / MESSAGE
CALTB SEEK TBI, STT
READ TBI; DUMP, STI, 512 / READ TABLE IN
VAIT TBI
CLOSE TBI
LAV -775 / PREPARES COUNTER TO CHECK
DAC DUM2 / THE VALIDITY OF THE LIN. TABLE
LAC (STI+1) / SET POINTER TO THE SECOND
DAC DUM3 / LOCATION OF THE TABLE
LAC STI / GET THE FIRST NUMBER AND
CALLP TCA / COMPLIMENT
TAD* DUM3 / IS THE PREVIOUS NUMBER
SPA / LARGE?
JMP CALER / YES, ERRONEOUS TABLE
LAC* DUM3 / GET PHENSENT LIN. NUMBER
ISZ DUM3 / GO TO NEXT NUMBER
ISZ DUMB / IS IT THE END OF THE TABLE ?
JMP CALBP / NO, CHECK NEXT NUMBER
DZM* FDA18 / YES, DELETE *DAT SLOT 10
LAS / GET THE # 1 DATA SWICH FROM
AND CODE40 / CONSOLE
SZA / IS IT SET ?
JMP DLWT / YES, SUPPRESS PRINT OUT
* WRITE TTO ASC,M377+3
* WRITE TTO ASC,M3518+0
* WRITE TTO ASC,M359+3
* WRITE TTO ASC,M319+3 / NUMBER OF HOURS
DLWT / READ IN # OF HOURS
HUNTMI / CONTAINS ADDRESS OF THE #’S READ IN
* INIT TTO;OUT;PSTART / RESET THE IP RESTART
* INIT TTI;IN;START / ADDRESS
LAC CODE35 / DEFAULT VALUE FOR THE LENGTH
DAC T93 / OF HU (20 HOURS)
DZM DSTRK / CHECKS # OF #’S READ IN
LAV -3 / PREPARE TO USE NO MINS
DAC T92 / THAN THREE MINS
JETHK LAV -49 / CHECK IF CHARACTER READ IN
TAD* HUNTMI / IS AN ASCII # OR PERIOD
DZ* HUNTMI / RESET LOC. IN CHAR. BLOCK
ISZ HUNTMI / GO TO NEXT CHARACTER
SPA / ASCII CHARACTER < 49 ?
JMP FNU6 / YES, EXIT
SAD CODE46 / YES, IT IS A DECIMAL POINT ?
JMP DSGPT / OK, GO TO DECIMAL POINT HOURS
TAD CODE47 / NO, CHECK FOR AN ASCII NUMBER
SMA / IS THE CHAR. < 72 ?
JMP GETHR / NO, GET NEXT CHAR.
TAD CODE42 / YES, IS CHARACTER BINARY?
SPA / THAN 7 OCTAL ?
JMP GETHR / NO. GET NEXT CHARACTER
JMS* +AD / YES, GET THE BINARY CODED DECIMAL
LAC MINHC / EQUIVALENT OF THE NUMBER
TAD T91 / ADD TO THE PRECEDING NUMBERS
DAC T91 / AND SAVE
ISZ MINEQC / SET UP NEXT MULTIPLIER
ISZ DSTRK / INCREMENT NUMBER COUNTER
ISZ T92 / HAS ENOUGH #’S BEEN OBTAINED ?
JMP GETHR / NO. GET NEXT NUMBER
JMP CNUM /YES* EXIT
DAC TC2 / ONE MORE NUMBER
LAW *2 /CHECK THE NUMBER
TAD DSTOR / COUNTER
SMA /HAS TWO NUMBERS BEEN OBTAINED ?
JMP GETHR /YES* GET THE LAST NUMBER
CALL TC1 /OFF BY A FACTOR OF TEN TOO HIGH
IDIV / THEREFORE REDUCE THE NUMBER BY A 10
/ FACTORS OF TEN (ZERO IS UNAFFECTED)
LAC /GET THE QUOTIENT
DAC TC1 /REPLACE WITH CORRECTED #
LAC CODE2 /SET THE BCD POINTER TO
DAC MINSEC / THE LAST MULTIPLIER
ISZ DSTOR /INCREMENT NUMBER COUNTER
JMP GETHR /GET NEXT NUMBER

DECPT

FNUM
LAW *2 /CHECK THE NUMBER
TAD DSTOR / COUNTER
SMA /HAS 2 NUMBERS BEEN READ IN ?
JMP CNUM /YES* IGNORE THE FOLLOWING CODE
IAC /HAS EVEN ONE NUMBER BEEN
SZA / READ IN ?
JMP TC1 /NO* USE THE DEFAULT VALUE (13.65 HH)
CALL /IT IS THE WRONG BCD
IDIV / EQUIVALENT SO REDUCE IT BY
LAC / GET THE INTEGER ANSWER
DAC TC1 /SAVE CORRECTED NUMBER

NONUM
DZN TC1 /INITIALIZE LOC. TO DETERMINE
DZM TC2 / THE END OF THE RUN
DZM MONTH /INITIALIZE BINARY TIME OF DAY
LAC CODE18 /SET UP MAX. STORAGE FOR
DAC DSTOR / STORAGE DEVICE
JMS FRDT / FREE BACKGROUND DEVICES
* TIMER =BEGIN=6
JMS PROC / START PROCESSING PHW
JMP *4 / # OF PARAMETERS +1
+DSA SUM4 /THE SEASON OF THE YEAR
+DSA ALF /LINE FEED
+DSA TIMR /TIME AT THE END OF EACH FILE
* IDELE

END 2000
0
*ASCII <14>"***END OF PROCESSING***"<1S>
STPM 2000
0
*ASCII <7><7><15>
/*RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR*/
/* THIS SUBROUTINE IS USED TO READ IN CHARACTERS FROM THE
/* TELETYPewriter AT A TIME UNTIL A CARRIAGE RETURN IS FOUND. THE
/* CHARACTERS ARE STORED IN "NBLK" (A BLOCK OF LENGTH 30). THE
*/ADDRESS OF "NBLK" IS PUT INTO THE LOCATION AFTER THE "JMS READM" 
*/INSTRUCTION USED TO CALL THIS ROUTINE. THE PROGRAM CONTROL IS
*/ THEN RETURNED TO TWO LOCATIONS AFTER THE CALLING INSTRUCTION.
READM 0
LAC NUMB /SET THE ADDR. OF THE BLOCK CONTAINING
DAC* READM / THE READ IN CHAR. INTO THE CALLING
ISZ READM /LOC.+1 AND RETURN TO LOC.+2
CONR .READ TTI, IA+MTI.3 /READ IN ONE CHARACTER
.WAIT TTI
LAC MTI+2 /GET THE CHARACTER
DAC* NUMB /STORE IN THE CHAR. BLOCK
SAD (177) /IS THE CHAR. A RUBOUT ?
JMP NOU /YES* DELETE PREVIOUS CHAR.
+SE NUMB /NO* PREPARE FOR NEXT CHAR.
SML (95) /IS THE CHAR. A +U ?
JMP DLT /YES* DELETE THE LINE
SAD (15) /NO* IS THE CHAR. A CARRIAGE RETURN ?
SRP /YES* EXIT FROM THE READ LOOP
JMP CONR /NO* GET NEXT CHAR.
LAC (NBLK) /INITIALIZE CHARACTER BLOCK
DAC NUMB / POINTER
LAC (+8 /WRITE OUT ON TTY
DAC ABOT+8 / A LINE FEED
BEGIN 0 READM /RETURN TO CALLING ADDRS+8
DLT LAC (NBLK /RESET POINTER TO THE BEGINING
DAC NUMB /OF THE BLOCK
LAC (100 /SET UP TO WRITE
JMP +11 /AN @ CHAR.

ROU LAC (15 /SET A CARRIAGE RETURN INTO THE
DAC NUMB /PRESENT LOC. OF THE CHAR. BLOCK
LAW -1 /GO BACK TO WRITE OVER
TAD NUMB /THE PREVIOUS CHAR.
SAD NUMB /IS THE POINTET AT THE BEGINING?
JMP CONR /YES, DO NOT PRINT OUT ANYTHING
DAC NUMB /NO, RESET POINTER BACK 1 LOC.
LAC (124 /PREPARE TO WRITE A "RUBOUT" CHAR.
DAC RBOT+8 /SET IN OUTPUT ADDR.
JMS WRT /WRITE OUT THE ONE CHAR.
JMP CONA /READ NEXT CHAR.

WRT 0 /WRITE TO IA,RBOT+3 /WRITE ONE IMAGE ALPHANUM. CHAR.
WRT ITO /WAIT TTO
RBOT 2003 /IMAGE A*, OUT PUT
0 /MESSAGE
0 /LOC* TO STORE CHAR* TO OUTPUT
MTTI *BLOCK 3 /BLOCK CHAR* IS READ INTO.
NUMB *DSA NBLK /CHARACTER BLOCK POINTER
NBLK *BLOCK 30 /BLOCK TO STORE ALL THE READ IN CHAR.

//RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
DAC CNT2 / THE SAMPLE THAT HAS BEEN COLL.
DAC SAUCAC /RESTORE ACCUMULATOR

END1 /RELINQUISH CONTROL TO LOWER PRIORITY
ONEC WOP

PK0 /SET CLOCK TO WAIT 9/60 SECONDS
JMS ADHEAD /A-D CONV. READ FOR X-SAMPLES
INSAM /THE VARIABLES USED
BUF / ARE THE SAME ONES USED FOR
EXR / THE 0-SAMPLE AND ARE
S300000+RSUB / EXPLAINED ABOVE
LAC SAUCAC

END2 /RELINQUISH CONTROL
RET2 LAC THAYF /GET DECTAPE TRANSFER FLAG
ZEA / AND TEST IT
JMS DTRANS /CLEAR AC TO READ CONSOLE SWITCHES
LAC (JMP A /SET UP TO RECHECK CONSOLE SWITCHES
DACK START / AND PUT INTO START
LAC SAUCAC / LOWER LEVEL BEFORE RECHECKING SWITCH

WT1 0
DAC SAUCAC /PUT CLOCK BACK INTO
DACK ONCE / OPERATION
DMZ CNT /TELLS PROC. COLL. HAS STOPPED
LAC (JMP A /SET UP TO RECHECK CONSOLE SWITCHES
DACK START / AND PUT INTO START
LAC SAUCAC /RETURN TO R.-T. SUB. BEGIN

/END OF MAIN PROGRAM
BUFL BLOCK DATBLK /BUFFER TO STORE AD SAMPLES
NAME *SIXBT "DATAFIDAT" /NAME OF FILE TO STORE DATA
/ INITIALIZING ROUTINE
/ INIT LAC (BUF1 /POINTER IN DECTAPE BUFFER
DAC TIBU /NAME OF DECTAPE BUFFER IN USE
LAC IDC01 /SAVE THE ID # (THE #
DAC CNI / OF FRAMES PER FILE)
DMZ IDC04 /ID NUMBER
DMZ T-ANF /DECTAPE TRANSFER FLAG
DMZ CNT /COUNTER FOR CLOCK
LAC MDJ01 /PUT CLOCK INTO OPERATION
DAC ONCE /OPERATION
LAW -2 /SET BUF1 AS THE FIRST
DAC C776 / BUFFER TO BE USED
DAC C77 /INIT. NOISE MAX.
DAC MAX4 /LOCATION
LAW MNC0 /INITIALIZE COUNTER FOR MAXIMUM
DAC C772 /ALLOWABLE NOISE
LAC MNC0 /GET THE LENGTH OF TIME REQUIRED
TAD TC1 /COLLECT THE PREVIOUS FILE
DAC DBC /SAVE IT
TAD TC2 /ADD TO ALL OTHER PREVIOUS TIMES TO
DAC TC2 /COLLECT THE OTHER FILES; SAVE AND
TAD TC3 /COMPARE TO THE MAXIMUM TIME
SMA /ARE THE FILE TIMES LARGER?
JMP EXTIP /YES, STOP COLLECTION
/ DECTAPE FILE ROUTINE
/ STORE DATA IN FILE ACCORDING TO RESPONSE
/ UP *FSTAT OUTPT#NAME /CHECK FOR COLLECTED FILE
UP1 SKP *REPLACED BY "ZEA"IS FILE PRESENT?
WRITE LAC MCTR /YES, ACKNOWLEDGE THE PRESENCE
TGA /GET THE BEGINNING TIME FROM
DAC TC1 /THE BINARY CLOCK COUNTER
LAC TC1 /TO DETERMINE THE COLL. TIME
C3 *DELETE OUTPT#NAME /DELETE FILE IF PRESENT
JMS DTRANS /OPEN FILE
JMS DTRANS /WRITE DUMMY BLOCK
LAC MDUM2 /TELLS PROCESSING THAT COLLECTION
JMP RDO /HAS STARTED COLLECTING A FILE
/RETURN
UPDATE LAC TIME
/SETS THE TIME TO THE END
TAD CS
/OF THE COLLECTED FILE AND
DAC TIMR
/AND ROUNDS OFF TO THE NEAREST MIN.
*WRITE TTO ASC MSG1 0
/FILE PRESENT
*WAIT TTO

UPDATE NOP
/REPLACED BY "JMP BLK2" FOR 1 DB SET.
*WRITE TTO ASC MSG1 34
/KEEP IT?
*
BLK1 JMS HEADM
/READ RESPONSE
COM 0
/ADDRESS OF THE RESPONSE
GETCH1 LAC COM
/GET READ IN CHARACTER
DEM COM
/AND ZERO THE LOC.
SAD 116
/IS CHARACTER A "N"?
JMP STAGN
/CHECK IF NUM. IS LESS
TAD -72
/THAN 72 OCTAL
SPA BLK3
/NO, CONTINUE
JMP BLK3
/YES, IS NUM. GREATER THAN
SPA
/57 OCTAL?
DAC COM
/NO, CONTINUE
JMP BLK3
/YES, SAVE
SIZ COM
/NEXT CHARACTER
JMP GETCH1
/REPEAT

BLK3 LAC LETCHG
/INITIALIZE THE BLOCK
DAC COM
/CONTAINING THE INPUT CHAR.
LAC COM
/GET FIRST CHAR.
SNA COM
/IS IT A ZERO?
JMP CONDB
/YES, IGNORE IT
DAC CH3
/PASS TO PROC THE DB CHANGE
TAD -1
/OFFSET THE # BY -1
CALLRAR
/DIVIDE BY TWO AND SAVE REMAINDER
TAD 60
/SET UP AS ASCII CHA-
SVA
/PREPARE FOR MESSAGE
DAC DBP
/SAVE NUMBER
LAC (148
/ASCII FOR ZERO
SZL
LAC (152
/ASCII FOR NUMBER 5
TAD DBP
/ADD TO OTHER DB SETTING
CLLARAR
/SET UP AS CHAR. 443 IN ASCII WORDS
DAC DBP
/SAVE NEW DB SETTING
CONDB ISZ DBP
/GET NEXT DB
LAC DBP
/MESSAGE
SAD 15
/IS CHAR. A CARRIAGE RETURN ?
JMP +4
/YES, EXIT
SZA
/NO, IS IT A ZERO ?
DAC CMULC
/NO, SET UP MUL. CONSTANT CHANGE
DEM COM
/CLEAR CHAR.
JMS DBSUB
/SET UP NEXT DB MESSAGE
LAC CN2
/GET STORAGE ALREADY USED
DAC CN2
/ADD STORAGE SIZE OF LAST
TAD CN1
/FILE AND SAVE
DAC CN2
/Add IT AGAIN AND CHECK---
TAD TEM1
/WILL ANOTHER FILE OF THE SAME
TAD DSTOH
/LENGTH OVERFLOW THE STORAGE ALLOW?
SMA
MDUM3 JMP RPTI
/YES, RESTART THE COUNTING
ISZ NAME +1
/NO, INCREMENT NAME
ISZ MSG1 +3
/INCREMENT TELETYPE
ISZ MSG1 +3
/MESSAGE TWICE
JMP WRITE
/RETURN TO NEW FILE
STAGN LAC CN1
/REMOVE THE SIZE OF
TCA
/THE LAST FILE
TAD CN2
/FROM THE
DAC CN8
/STORAGE COUNTER
LAC DBC
/REMOVE THE AMOUNT OF
TCA
/TIME USED
TAD TCA
/BY THE PRECEDING
DAC TCA
/FILE
JMP WRITE
/RECOLLECT FILE
/DDBBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDB
/ISUBROUTINE TO CHANGE THE DB MESSAGE TO BE PRINTED OUT
/DSUB 0
ISZ DBP
/GET NEXT DB
LAC DBP
/MESSAGE
SMA
/IS IT THE END OF THE DB MESSAGES?
JMP +4
/NO, USE THIS MESSAGE
LAC (DBO)
/YES, REPEAT THE
DAC DBP
/FIRST DB
DAC DBP
/SETTING GIVEN
DAC MSG12 +11
/INSERT MESSAGE
JMP DBSUB
/RETURN
THE BUFFERS ARE LOCATED IN DLOGF AND PACKING ROUTINE

MESSAGE 2000

ALTERNATES HIGHEST
A TOTAL OF AN ID IS ASSIGNED AND

LAC (JMP TIMER DAC TAD TCA DAC LAC ISZ SMA TCA TAD DUM5 LAC IDCOU /ASSIGN ID

MSG1 2000

SET ATTENUATOR TO 0000 AND C.R."<15>

PACKING ROUTINE
AND ID IS ASSIGNED AND 26 SAMPLES ARE PACKED TWO PER WORD
A TOTAL OF 14 WORDS ARE PUT INTO A DECTAPE BUFFER FOR EACH CALL
HIGHEST ORDER BIT IS LOST AND NEG NUMBERS ARE SET TO ZERO
ALTERNATES BETWEEN TWO DECTAPE BUFFERS-
WHEN ONE IS FULL THE OTHER IS USED FOR STORAGE
THE BUFFERS ARE LOCATED IN DLOGF AND WRITE OVER PART OF IT

RSUB 0

DAC SAV /SAVE AC
ISZ CNT /INCREMENT COUNTER
NOP /AWARDS AGAINST A -1 IN "CNT"
DUM2 /INITIALIZE THE VARIABLES USED
DUM3 / TO DETERMINE THE NOISE
NPFC /USE FIRST 5 NOISE SAMPLES TO SET
CTT1 / MAX ALLOWED NOISE FOR PROC.
CTT5 / NOISE SAMPLE
LAW -1001 /IS THERE A DISK TIMING
ER2 / ERROR?
JMP EHS1 /YES, PRINT MESSAGE
IDCOU /NO, INCREMENT ID NUMBER
IDC0U /ASSIGN ID NUMBER
ISZ POINT /TO BE PLACED ON STORAGE DEVICE
ISZ COUNT TO NEXT LOCATION
LAW -NPFC /COUNTER SO THAT 13 WORDS ARE PACKED
IDCOU /TO PACKING ROUTINE
DUM3 /SET SUM OF THE NEW 4 NOISE SAMPLES
DUM5 /AND ADD TO THE 72 NOISE SAMPLE GROUP
DUM5 /USE NEW SUM
DUM2 /SET NEW MAX FOR THE 4 NOISE SAMPLES
CTT1 /COMPARE NEW MAX
DUM4 /WITH OLD MAX.
SMA /IS THE NEW MAX LARGER?
JMP *3 /NO, KEEP THE OLD MAX.
DUM2 /PLACE THE OLD MAX.
DUM4 /WITH THE NEW MAX.
ISZ CTT2 /HAS 72 NOISE SAMPLES BEEN COLLECTED?
JMP SKIP4 /YES, PREPARE TO COLLECT MORE SAMPLES
LAW NMCC /RESIST CORRECT FUM
CTT2 /NOISE DETERMINATION
DUM4 /YES, SET MAX. OF NEW 72 NOISE SAM.
CTT1 /AND COMPARE IT WITH THE MAX.
MAX4 /OF THE PREVIOUS SET
JMP SKIP3 /IS THE NEW ONE LESS THAN THE OLD ONE?
DUM4 /YES, REPLACE THE OLD MAX. WITH
MAX4 /THE NEW MAX.
DUM4 /REPLACE THE OLD SUM WITH
DUM4 /THE NEW SUM
DUM4 /THE NEW SUM
SKIP3 SIM DUM4 /RESET NOISE SAMPLING
DUMM /LOCATIONS
DUM4 /PREPARE TO ENTER R-T SUB. "BEGIN"
IDCOU /BY INSERTING INTO LOG. START
CTT2 /A JUMP STATEMENT DEPENDING ON
CTT2 /WHICH TYPE OF SAMPLE)
LAC SAV /ENTER R-T SUB. "BEGIN"
TIME *8-EHS1,6
+HLS1 RS38

PAC 0
DAC CNT2 /STORE WORD NUMBER BEING PACKED
LAC (BUF-1)
DAC BP @/BUFF POINTER
LAC DUM1 /ZO TO TABLE ROUTINE
PAC 0
DAC 1MS LIN @/STORE POINTER
LAC DUM1 /ROTATE TO LEFT HALF
TAD*  POINT  /PACK INTO PREVIOUS ONE
DAC*  POINT  /STORE IN BUFI
ISZ  POINT  /MOVE POINTER UP ONE WORD
ISZ  COUNT  /ONE WORD HAS BEEN PACKED
JMP  PAKIN  /13 WORDS HAVE NOT BEEN PACKED
LAC*  COUNT  /END OF BUFFER ?
ISZ  CTT8  /YES, CONTINUE COLLECTION
LAV  -DATSTR  /NO, CONTINUE COLLECTION
DAC  CTT8  /MOVE POINTER UP ONE WORD
LAC  BUFI  /YES, CONTINUE COLLECTION
DAC  BUFI  /NO, SET POINTER TO BUFI
LAC  COUNT  /13 WORDS HAVE BEEN PACKED
JMP  PAKIN  /13 WORDS HAVE NOT BEEN PACKED
LAC  BUFI  /YES, CONTINUE COLLECTION
LAC  BUFI  /NO, SET POINTER TO BUFI
JMP  PAKIN  /YES, PREPARE TO STORE BUFI
LAC  BUFI  /YES, PREPARE TO TRANSFER
DAC  TBUF  /SET TRANSFER FLAG
JMP*  PAC  /CONTINUE COLLECTION

ERS1  *WRITE  T0*ASC+MS35,0  /TIMING ERROR
LAC  MDUMI  /PUT CLOCK OPERATION BACK
DAC  ONCE  /IN PROGRAM
ISZ  CNT  /PREPARE TO REJECT 0-X PAIR
LAC  (JMP  AND  /REJECT NEXT X-SAMPLE
ISZ  CNT  /WAS THE LAST 0-X SAMPLE ?
DAC  CNT  /NO, REJECT THE FORMER 0-X SAMPLE
JMP  CNT  /YES, REJECT NEXT SAMPLE
JMP  CNT  /RETURN TO COLLECTION
INXIT  RSUB  "TIMING ERROR"<15>

SUBROUTINE TRANSFERS 1 BLOCK OF DATA FROM A DESIGNATED BUFFER
TO THE STORAGE DEVICE BEING USED.

SUBROUTINE TO CHECK WHICH DATA CONSOLE SWITCHES ARE SET
AGAINST THE DEFAULT SETTING IS 2000.

CKCNT  3  /LOAD DATA SWITCHES FROM CONSOLE
RTL  /PUT AC BIT 1 INTO LINK
CLA  /TO DISALLOW SHARING
SZL  /IS AC BIT 1 SET ?
LAW  -1  /YES, DO ALLOW
DAC*  <177  /SHARING
LAS  /RELOAD DATA SWITCHES
AND  (17777  /IGNORE TOP 5 BITS
TAD  <7  /ARE THE SWITCHES SET TO
SPA  /LESS THAN SEVEN ?
TAD  (2000  /YES, USE DEFAULT SETTING
TAD  (10000  /NO, ARE THEY SET TO GREATER THAN 10000 (DISK OVERFLOW) ?
TAD  (2000  /YES, USE THE DEFAULT SETTING
DAC  (10007  /NO, RESET THE AC BACK
DAC  TEM01  /TEMPARILY STORE NUMBER
CMA  /COMPARE THE DATA SWITCHES
TAD  IDCOU  /TO THE ID NUMBER
SMA  /IS THE ID LESS ?
JMP  RESTAR  /ID GREATER THAN SWITCH SETTING
LAC  TEM01  /FILL THE SIZE OF
TAD  ONE  /THIS FILE
TAD  DSTOP  /OVERFLOW
SMA  /THE DISK ?
JMP  RESTAR  /YES, CLOSE FILE
JMP*  CKCNT  /ID LESS THAN SWITCH SETTING
ROUTINE TO CLOSE FILE AND SET UP PARAMETERS FOR COLLECTION AND PROCESSING

MDUM2, SM4, DHANS, C6

ROUTINE TO DO A TABLE LOOKUP FOR DATA LINEARIZATION.
ALSO SAVES SUM AND MAXIMUM OF EACH SET OF 5 NOISE SAMPLES,
SETS NEGATIVE NUMBERS TO ZERO, AND IF NECESSARY JUMPS AROUND "SKAR" NUMBER OF DATA NUMBERS BETWEEN THE NOISE AND DATA POINTS.

LIN 9

ISZ DPOINT /DATA STARTS AT 9.7
LAC* BPOINT /GET INPUT DATA WORD
AND (1777) /MASK ANY EXTRAS BIT.
TAD (<1333) /CHECK FOR NEG. #'S
SMA
JMP ERI /NEI # FOUND
TAD (STI.B+30) /LOCATE # IN TABLE
DAC DUM1 /GET ADDRESS OF NUMBER
LAC* DUM1 /LOAD LINEARIZED # INTO AC

SRP

ERI CALLC

DAC DUM1 /STORE LINEARIZED #
ISZ DOT5 /IS THIS THE FIFTH NOISE SAMPLE ?
JMP +5 /NO SKIP AROUND CODE
LAC DOT5 /SKEE AROUND "SKAR" DATA
TAD DPOINT /OF THE FRAME BEING
DAC DPOINT /COLLECTED
LAC DUM1 /RESTORE THE LIN. DATA #
TAD CTT5 /IS IT A NOISE SAMPLE ?
JMP DONOS /YES PROCESS NOISE SAMPLE
LAC -1 /RESET THE TWO COUNTERS
DAC CTT5 /FOR THE DATA OF THE
DONOS
JMP* LIN / RETURN
TAD DUM3 / ADD TO THE OTHER 4
DAC DUM3 / NOISE SAMPLES
LAC DUM1
TCA / IS THE NOISE SAMPLE
TAD DUM2 / GREATER THAN THE
SMA / OTHER 4
JMP* LIN / NO RETURN
LAC DUM1 / YES, SET THIS SAMPLE
DAC DUM2 / AS THE MAX.
JMP* LIN

// ?????????????????????????????????????????????????????????????????????????????????????????
// ROUTINE TO REINITIALIZE VARIABLES AND IF NEEDED TO
// SWITCH STORAGE DEVICES.
/

HP11
LAC AFI / RESET FILE
DAC NAME+1 / NAME
DZM TPR1 / ZERO LOG.
DZM CNR2 / RESET DEVICE STORAGE COUNTER
NDK21 JMP NDK21 / DO NOT SWITCH STORAGE DEVICE
DAC OUTPUT / CHANGE TO SECOND STORAGE
ISZ C1 / DEVICE BY CHANGING THE
DAC OUTPUT2 / DAT SLOTS IN THE COMMANDS:
DAC C3 / ENTER
DAC C2 / WAIT
DAC C5 / WAIT
DAC C7 / CLOSE
TAD (1000) /DELETE
DAC C1 / INIT
TAD (1000) / FSTAT
DAC C4 / WHITE
DAC C6 / WHITE
NDK21 LAC H5301 / RESET TELETYPEx
DAC NS31+3 / MESSAGE
LAC NDKM4 / IGNORE THE FIRST FILE ON
DAC UPL / NEXT STORAGE DEVICE
DAC C11 / CHECK DEVICE SWITCHING CONTROLLERS.
SMA / IS IT STILL NEG.?
LAY -2 / YES, RESET IT
DAC C1 / NO, LEAVE IT ALONE
JMP C1 / NO GO TO INIT.

AFI
+03191 "AFI" / REINITIALIZES "NAME" AND "FILE"
EXTIP DZM TCB / PREPARE TO COLLECT A NEW SET OF DATA
DAC TIME / GET TIME FOR LAST FILE
TAD 15 / 30:00 OFF TO THE NEAREST MINUTE
DAC TIIR / STORE FOR FTANHAN PROGRAM
DAC HPT1 / PREPARE TO START
DAC START / COLLECTION AT FILE 1
ISZ NAME+1 / TELLS PROC TO PROCESS LAST FILE
+03261 TTO.ASC,EDC,8 / END OF COLLECTION
+WAIT TTO / INIT, COLL, TIME COUNTER
DZM TCI / INIT.
LAW -1 / TELLS PROCESSING THAT COLLECTION
+03311 DAC C11 / IS FINISHED COLLECTING
+03387 EDC
+03391 0
+03401 
+03403 ASCII <11><11><11><11><11><11><7><7><7><7>15

// EJECT

******************************************************************************************

BPKM15 VIA SERVICE ROUTINES FOR THE HP 5610A A TO D
CONVERTER. THESE ROUTINES PERMIT INPUT OF ANY SPECIFIED
NUMBER OF SAMPLES INTO A CORE BUFFER. INPUT MAY BE OVER-
LAPPED WITH PROGRAM EXECUTION, AND CONTROL MAY BE REQUISITIONED
TO LOWER PRIORITY PROGRAMS WHILE DATA TRANSFER TAKES PLACE.
MACRO-15 CALLING SEQUENCE:
JMS ABREAD
NUMBER OF SAMPLES REQUIRED
BUFFER ADDRESS
COMPLETION FLAG ADDRESS
REAL-TIME SUBROUTINE ADDRESS, PRIORITY LEVEL IN BITS 9-8
(EXAMPLE: 5608080+HTU3R)
(RETURNS HERE IMMEDIATELY)
IF THE 4TH WORD AFTER THE JMS IS 3, NO REAL-TIME SUBROUTINE
WILL BE ACTIVATED. NOTE! THE PRIOIRITY CODE FOR MAINSTREAM IS 1
THE COMPLETION FLAG IS CLEARED BY THE CALL TO ABREAD.
AND SET TO +1 FOR NORMAL COMPLETION OR -1881 IF A DATA
TIMING ERROR OCCURS.
ADCR=36
ADCD=ADCR+1
S.COM=100
ADVI=783724
ADSO=783701
ADST=783721
ADCO=783704
ADCT=783744

/ ENTRY POINT FOR A-D INTERFACE INITIALIZATION
/ ADREAD 0

JMP INSET /REPLACED BY "LAC ADREAD"

TCA DAC* (ADCD) /SET WORD COUNT
ISZ ADREAD
LAV =1
LAD* ADREAD /BUFFER ADDRESS -1
DAC* (ADCR) /TO CURRENT ADDRESS REG.
ISZ ADREAD
LAC* ADREAD /GET FLAG ADDRESS
DAC INFLAG
DZM* INFLAG /CLEAR FLAG
ISZ ADREAD
LAC* ADREAD /GET REAL-TIME SUBROUTINE ADDRESS
DAC INSUB
ISZ ADREAD /POINT TO RETURN LOCATION
ADWI
JMP* ADREAD /INITIALIZE INTERFACE
/RETURN

/ THE FOLLOWING CODE IS EXECUTED ONLY ONCE
INSET LAC* (+S.COM+55) /GET ENTRY POINT ADDRESS OF .SETUP
ADSV DAC
S.AV LAC* (+S.COM+51) /ENTRY POINT OF REALTP
REALTP DAC
LAC (400010) /RAISE THE API
ISA /LEVEL
JMS ADSVA /CALL .SETUP TO CONNECT
ADCO /THE API
DBK /DEBREAK FROM API LEVEL
LAC (LAC ADREAD) /MODIFY INSTRUCTION
DAC ADREAD+1 /AND JMP TO IT
JMP ADREAD+1 /INTERRUPT SERVICE ROUTINE. EXECUTED IMMEDIATELY AFTER COMPLETION
/OF DATA TRANSFER. DETERMINES STATUS OF A-D INTERFACE, SETS
/COMPLETION FLAG AND ACTIVATES REAL-TIME SUBROUTINE.
/HUNTS AT API LEVEL 0.
/ADINT 0

DBA DAC ADVA /PAGE ADDRESSING MODE
ADST/SAVE AC
ADCT TIMING ERROR
LAV =1001 /NO+1 TO AC
DAC* INFLAG /SET FLAG
ADCO CLEAR
LAC* (+S.COM+102 /INTERFACE FLAGS
ISA /RAISE TO API
LEVEL 3 OR 4
LAC INSUB /REAL-TIME SUBROUTINE ADDRESS
SNA JMP ADXIT /BYPASS MONITOR CALLS IF ZERO
JMS* REALTP /ACTIVATE REAL-TIME SUBROUTINE
ADXIT LAC (40400) /REQUEST AN API INTERRUPT
ISA /AT SOFTWARE LEVEL 4
LAC ADSVA /RESTORE AC
DBK /SET TO LEAVE HARDWARE API LEVEL
JMP* ADI NT /RETURN TO INTERRUPTED PROGRAM

******************************************************************************
* EJECT
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
/ PROCESSING'S MACRO PROGRAMS. THEY INITIALIZE THE SOFTWARE
/ DEVICE WAIT FOR FILE TO BE COLLECTED, CHECK FOR UNWANTED
/ COLECTION STORAGE, SWITCH STORAGE DEVICES IF NECESSARY, TELL
/ WHEN THE PROGRAMS HAVE REACHED THE END OF RUN, GIVES TIME TO
/ BACKGROUND AND READS IN DATA AND UNPACKS IT.

CHNG 0
JMS+..DA /LOAD PARAM. ADDR. IN SUMS AND CHG
JMP +4 /SKIP OVER PARAM. LIST
SUMS 0
CHG 4
CMULC 0
ISZ CTII0 /LOCY. TO CHANGE MUL. CONSTANT
SKP
JMP AGN
/* YES. RESET PARAMETERS TO BEGIN OF DEV.
JMP DUM7
ISZ FIL+1 /CHECK IF COLLECTION IS
JMS CONTR /FINISHED COLLECTING NEW FILE
LAC FIL+1 /IS THE COLLECTION
CMA NAME+1 /RECOLLECTING
TAD /THE FIRST FILE
SPA
LAW -1 /NO, SET THE COUNTER TO JUMP AROUND
LAC CTII9 /YES. SET COUNTER TO A POS. #
DAC CTII0 /PREPARE TO READ
DAC CTII9 /DATA
DAC BUFI1 /RESET BUFI3 POINTER WITH
DAC POINT2 /THE ADDR. OF BUFI3
DAC LOA /DUMMY BLOCKS
C13 *INIT DATIN+0
RT *FSTAT DATIN+0
SNR /CHECK FOR PRESENTS OF NEW FILE
JMP ENR3 /FILE NOT PRESENT
C11 *SEEK DATIN+0
JMP CHNG /RETURN TO FORTRAN PROGRAM
FIL *SIXST "DATAF0DAT" /NAME OF DATA FILE USED BY PROC.
ENR3 *WRITE TIO*ASC+MS6+0 /FILE NOT FOUND
JMP CMULC+1 /ERASED FILE? LOOK FOR NEXT FILE
MS36 2000
0
*ASCII "FILE NOT FOUND"<15>
AGN LAC API /INITIALIZE DATA-FILE
DAC FIL+1 /NAME
NDK3 SKP /DETERMINES # OF STORAGE DEVICES
JMS SWIT /CHANGE STORAGE DEVICES
JMP DUM7+1 /NO. CONTINUE PROCESSING
ENDPH *WRITE TIO*ASC+END+0 /END OF PROC. MESSAGE
*WAIT TIO
JMS REALM /WAIT FOR RESPONSE AND PUT
ANSE 0 /THE ADDR. OF IT HERE
LAC* ANSE
SAD 000 /IS THE RESPONSE A "Y"?
JMP ASTA /YES. SET UP TO RESTART EVERYTHING
*IDLE /GIVE COMPLETE CONTROL TO B.
KSTR *CLEAR DATIN /CLEAR COLLECTION DEVICE
*WRITE TIO*ASC+MS2+0 /DH MESSAGE
*WAIT TIO
JMS DBSUB /SET UP NEXT DB SETTING
JMS REALM /WAIT FOR REPLY
DRMPY 0 /THE REPLY
DM 0 /ZERO BINARY TIMER
TIMEH 0101116 /RESTART COLLECTION
JMP AIN /RESTART PROC.
/ SUBROUTINE USED TO WAIT FOR FILE TO BE COLLECTED AND STORED
/ WHILE GIVING TIME TO BACKGROUND
DOUH 0
WT2 LAC NAME+1 /COLLECTION'S FILE NAME
SAD FIL+1 /IS PROG.'S FILE NAME THE SAME?
MDF4 SKP
JMP* CONT+0 /YES. RETURN TO PROCESS FILE
ISZ CTII1 /END OF THE
SKP /JUN
JMP UNPH /YES. EXIT
*TIMEH 30=WAIT1+0 /YES. RELINQUISH TIME TO B.
LAC SAUAC /STOCK AC
*IDLE /WAIT FOR CLOCK INTERRUPT
/REAL TIME SU3**USED TO ALLOW TIME FOR BACKGROUND
WAIT 0
DAC SAUAC /SAVAC
DZM *WAIT1 /ZERO H-T SUB. ENTRY PT. TO ALLOW NOVITE
JMS CKCOL /CHECK FOR COLLECTION STOPPAGE
JMP #10 /CHECK FOR END OF COLL.
/ SUBROUTINE TO CHECK FOR UNWANTED COLL. STOPPATE
CKCOL 0
LAC -2
TAD CNF /HAS COLL. ENDED ALL COLLECTION?
SPA /FOR TODAY?
JMP* CKCOL /YES. RETURN
LAC TST1 /NO. HAS COLLECTION STOPPED
TCA   / READING
TAD   / IN DAT.
REPL  SZA  / (REPLACED BY "NOP" WHEN COL. IS DONE)
JMP   SETI  / NO. RESET TESTER AND RETURN
LAC   MKM1  / YES, FREE TIMER
DAC   ONCE  / OPTION IN COLI.
ISZ   CT7   / TELLS IF STOPPAGE OCCURED
WHITE T70+ASC,STPM=0  / RING BELL
+TIMER & CHECK 5  / RESTART COLLECTION
SETI LAC IDCOU  / SET ID # INTO
DAC   TSTI  / TESTER FOR STOPPAGE
JMP* CKCOL  / CHECK FOR COL. TO BE FINISH.
LAC MDUMI  / YES, FREE TIMER
DAC ONCE/ OPTION IN COLL.
ISZ   CTT7  / TELLS IF STOPPAGE OCCURED
WHITE T70+ASC,STPM=0  / RING BELL
+TIMER & CHECK 5  / RESTART COLLECTION

/ SUB- TO CHANGE THE *DAT SLOT #'S TO CHANGE STORAGE DEVICES

SWIT 0
LAC  COATIN  / SWITCH STORAGE DEVICES
ISZ   CTT4  / BY CHANGING THE
LAC   COATIN2  / DAT SLOT IN COMMANDS;
DAC   C11  / SEEK
DAC   C13  / INIT
DAC   C15  / WAIT
DAC   C15  / CLOSE
DAC   ASTR  / CLEAR
TAD   C3000  / FSTAT
TAD   C1030  / FSTAT
TAD   C1030  / READ
TAD   LBA  / READ
LAC   CTT4  / IS DEVICE ON *DAT SLOT "DATIN"?
SNA   =2  / YES, RESET DEVICE CONTROLLER
DAC   CTT4  / MAKE ANY CHANGE IN CONTROLLER
JMP* SWIT

PP7 0
LAC  DATIN  / GET THE CONSOLE DATA SWITCH
AND   C48000  / NUMBER 3
SNA   =1  / IS IT A 1 ?
JMS*  WHPP  / NO, PRINT DATA OUT ON PAPER TAPE
JMP* PP7  / RETURN TO PROC

/XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-EJECT
/XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
+READ DUMP MODE FROM DECTAPE ON A VARIABLE *DAT SLOT
+FILL 250 DEC WORD BUFFER AND OUTPUTS 26
+WORDS TO ARRAY IDAT EVERY TIME CALLED.
+THESE ARE UNPACKED FROM 18 WORDS OF THE BUFFER.
+IDAT: WORD 1  I.D. #
+WORD 2-6  NOISE SAMPLES
+WORD 7-27  DATA
+EGF:  SET IF A NEGATIVE NUMBER WAS IN THE DATA
/
DUMP* 0
JMS*  +DA  / PICKUP ADDR OF ADDR
JMP*  +3  / OF ARRAY
A2*  3
FLAG 3
LAC* A2  / SET ON NEXT #
DAC A2  / OF ARRAY
LAW =NDPC  / SET COUNTER OF DATA TO BE
DAC COUNT  / PROCESSED
ISZ  CTT9  / GET POINTER
JMP LBB  / NO, CONTINUE WITH PRESENT SET OF DATA
LAW -DATSTH
LBB LAC* POINT2  / GET ID AND PUT
DAC  CT9  / INTO THE FORTRAN ARRAY
DAC  C14  / READ DATIN,DUMP,_BUF3,DTBLK / GET 1 BLOCK OF DATA
DAC  C14  / WAIT DATIN
LCA  ISZ  SVTIC  / INITIALLY READ TWO DUMMY BLOCKS
JMP LBA  / RESET CONTROL TO READ
LAC  SVTIC  / TWO DUMMY BLOCKS
DAC LAW =3  / READ ONE BLOCK OF DATA
DAC LCA  / AT A TIME
LCA LAC BUF31  / GET ADDRESS OF BUF3
LBB DAC POINT2  / POINT2 TO BUF3
LAC* POINT2  / GET THE ID (FIRST WORD IN DATA SET)
SAD SEVEN  / END OF FILE ID7
JMP ENF  / YES, RESET PARAM'S AND CLOSE FILE
LAC* POINT2  / GET ID AND PUT
DAC A2  / INTO THE FORTRAN ARRAY
ISZ A2  / GO TO NEXT ADDR. OF THE ARRAY
LOOP ISZ POINT2  / GO TO NEXT DATA WORD
LAW =2  / PREPARE TO UNPAC
DAC TCI8  / TWO DATA WORDS
LAC* POINT2  / GET DATA WORDS FROM BUF3
SWHA

FIRST WORD IN LEFT HALF

AND 177
/SAVE ONE DATA WORD

CHECK FOR NEG. NUMBER

FLAG SET IF NEG. NUMBER FOUND

LOAD # INTO FORTRAN ARRAY

GO TO NEXT LOC. IN ARRAY

GO TO NEXT LOC. IN ARRAY

UNPLP /NO LOOP AROUND

NEG NUMBER ISZ FLAG
/SET IF

HAS 3+ DATA W/NUAL BEEN FOUND?

REPEAT UNPACKING PROCESS

GO0 TO NEXT ID

JMP DUMPT /RETURN TO PROC. PROGRAM

END OF FILE ROUTINE

CLOSE DATIN.

RETURN TO PROC. PROGRAM

SUBROUTINE CONTL(ISUP)

INTEGER DB(4) DBC
REAL DATE(2)*REAS(5)
COMMON /STAT/ DB DATEREAS*DBC#DBS.NC4
DATA NR/120784/
REWIND 4

INITIALIZE THE DB SETTINGS USED

DBC=3
DB(2)=10
DB(3)=25
IF(ISUP.NE.0)GO TO 5

GIVE PRECALIBRATION SETUP

WRITE(6,100)
100 FORMAT(46H TURN OFF PULSER AND ENCODE PULSE POWER SUPPLY/)!

SET UP CALIBRATION AND LINEARIZATION TABLE

CALL TBFORL

ASK FOR AND GET THE DATE

WRITE(6,101)NH
101 FORMAT(5H DATE/A2)
READ(4,201)DATE

ASK FOR AND GET THE REASON FOR THE RUN

WRITE(6,102)NH
102 FORMAT(16H REASON FOR DATA/A2)
READ(4,202)REAS

PREPARE FOR COLLECTION AND PROCESSING

CALL DLOGF(DB,DBC,DAC)*
RETURN

END  INTIM

SUBROUTINE TBFORL

INTEGER DAC* A2
REAL DATE(2)*REAS(5)
COMMON /STAT/ DB DATEREAS*DBC#DBS.NC4
DATA NR/120784/
REWIND 4

PREPARE FOR COLLECTION AND PROCESSING

CALL DLOGF(DB,DBC,DAC)*
RETURN

SUBROUTINE DLOGF(DB,DBC,DAC)

INTEGER DB(DAC* A2)
REAL DATE(2)*REAS(5)
COMMON /STAT/ DB DATEREAS*DBC#DBS.NC4
DATA NR/120784/
REWIND 4

CALL DLOGF(DB,DBC,DAC)*
RETURN

END  INTIM

END OF FILE ROUTINE

CLOSE DATIN.

RETURN TO PROC. PROGRAM

THIS PROGRAM SETS UP A LINEAR APPROXIMATION TO THE INPUT OF
THE RECEIVER VERSUS THE OUTPUT OF THE A/D CONVERTER AS READ BY THE
COMPUTER. FROM THIS LINEAR APPROXIMATION, A TABLE IS FORMED BY
USING INPUTS FROM .5 TO 511.5 INCREMENTED BY 1. THE OFFSET OF .5
IS USED FOR BETTER ACCURACY IN THE ROUNDOFF ERROR OF THE A/D CONVER-
TER. ALL THE VALUES OF ZERO IN THE TABLE ARE CHANGED TO 1 SINCE
0 IS USED TO DESIGNATE NEGATIVE NUMBERS DURING THE COLLECTION.
THE PROGRAM CALLS THE SUBRoutines:

RADD---READS #'S FROM THE A/D CONVERTER (MACRO)
LINAP---CONVERTS INPUTS TO OUTPUTS FOR THE FORMATION
OF THE LINEARIZATION TABLE
TMM---WRITES LIN. TABLE ONTO A STORAGE DEVICE

END
SUBROUTINE TBFORL
INTEGER START(512), DLP0, STAT, IAS(44)
REAL K1
COMMON /TA/ S(43), TU(44), TUO(44)
DATA C.CS.CN*NR/IHC, IHS, HN, 120784/

DETERMINE IF CALIBRATION IS NEEDED AND WHICH PRINTOUT TO USE
WRITE(*,105) NR
105 FORMAT('WHICH CALIBRATION/SAM (S-SHORT, R-REGULAR, OR
137H C-COMPLETE PRINT OUT OR N-NO CALIB.)*A2)
READ(4,204) CAL
204 FORMAT(AI)
IERR=0
DLPO=0

SET UP THE WANTED CALIBRATION
IF(CAL.EQ.CN) RETURN
IF(CAL.EQ.CS) DLPO=-1
IF(CAL.EQ.C) DLPO=1

NUMBER OF A/D NUMBERS TO READ PER DB SETTING=NAVI*NAV
NAVI=5
NAV=500
AV=NAV*NAV
ICT=0

NUMBER OF ATTENUATOR SETTINGS=NTI
NTI=42
NT2=NTI-1
NT3=NTI-2

INPUT SIGNALS--FROM 5DB (OF 1000) TO INFINITY
TU(NT1)=562.34
TU(NT2)=501.19
TU(NT3)=446.68
TU(NT1-3)=396.11
TU(NT1-4)=354.82
TU(NT1-5)=316.23
TU(NT1-6)=281.84
TU(NT1-7)=251.19
TU(NT1-8)=223.87
TU(NT1-9)=199.53
TU(NT1-10)=177.83
TU(NT1-11)=156.49
TU(NT1-12)=141.03
TU(NT1-13)=125.39
TU(NT1-14)=112.20
TU(NT1-15)=100.00
TU(NT1-16)=89.13
TU(NT1-17)=79.43
TU(NT1-18)=70.80
TU(NT1-19)=63.10
TU(NT1-20)=56.44
TU(NT1-21)=50.16
TU(NT1-22)=45.67
TU(NT1-23)=40.81
TU(NT1-24)=36.48
TU(NT1-25)=31.62
TU(NT1-26)=28.18
TU(NT1-27)=25.12
TU(NT1-28)=22.39
TU(NT1-29)=20.95
TU(NT1-30)=19.51
TU(NT1-31)=18.18
TU(NT1-32)=16.95
TU(NT1-33)=15.85
TU(NT1-34)=14.13
TU(NT1-35)=12.59
TU(NT1-36)=11.02
TU(NT1-37)=10.00
TU(NT1-38)=9.01
TU(NT1-39)=8.09
TU(NT1-40)=7.94
TU(NT1-41)=7.08
TU(NT1-42)=6.31
TU(NT1-43)=5.62
TU(1)= 3.03
TUO(NT1)=512.

SET UP MESSAGES FOR TELLING WHICH ATTENUATOR SETTING TO DO
DO 11 I=1,NT3
11 IAS(I)=I+5
IAS(NT2)=99

DO LOOP TO INPUT ALL THE OUTPUTED SIGNALS
DO 12=1,NT2
12 DUM=6
WRITE(6,1101) IAS(I), IAS(I-1)
1101 FORMAT(6H SET TO ,12.23DB ATTENUATION AND C.R.A2)
READ(*,200) F
200 FORMAT(F5.1)

IF THE INPUTED NUMBER IS TWO DIGITS RESTART THE SETTINGS
C ISSUE AN A/D CONVERTER READ "NAVI" TIMES
DO 10 JI=1,NAVI
C READ "NAVI" NUMBERS FROM THE A/D CONVERTER
CALL RADC(START,NAVI,STAT)
IF(STAT+EQ.0)GO TO 400
DO 1 J=1,NAV
C READ "NAV" NUMBERS FROM THE A/D CONVERTER
CALL RADC(START,NAV,STAT)
400 IFCSTAT.EQ.0)GO TO 400
DO 1 J=1,NAV
C AVERAGE THE OUTPUTTED NUMBERS AND GO TO THE NEXT SETTING
T(UO(12)-DUM/AU)
DO 3 I=1,INT2
12=12+1
ICT=ICT+1
13=NTI-II
C SET UP THE SLOPES OF EACH LINE SEGMENT APPROXIMATION
S(I1)=(TU(I1)-TJ(I1))/(TUO(I1)-TUO(IJ))
IFICT=ICT+1
ICT=ICT-1
C POSSIBLE ERROR CONDITIONS FOR THE APPROXIMATION JUST FORMED
3 IF(S(I1)<LT.3.0.AND.S(I1)>7.) IE1=IE1+1
102 IF(SU(J1)<LT.0.128.NAND.SU(J1)>12.8) F8.3X
14RTUO(12,2H)=F8.3X
12,2H)
F8.3X
DUM+FLOAT(START(IJ))
10 CONTINUE
C STORE THE INPUTED NUMBERS IN A REAL VARIABLE
I DUM. DUM+FLOAT(START(IJ))
C GET THE INPUT VALUE AND STORE IN "XF" CALL LINAP(XF)
IF(XF.LE.0.) XF=512
C NORMALIZATION FACTOR OF THE OUTPUT VALUES OF THE LIN. TABLE
XF=51023./XF
C INITIAL OUTPUT USED TO DETERMINE THE INPUT VALUE
X3=511.5/1024
C FIRST INPUT VALUE OF THE TABLE
START(1)=1
DO 4 I=2,512
C NEXT OJT PUT VALUE USED
X3=X3*FLOAT(2*I-1)
C STORE INPUT VALUE IN INTEGER LIN. TABLE
STAT(I)=IFIX(X3)
C ERROR CONDITION FOR LINEARIZATION TABLE
4 IF(STAT(I)+LT.START(I-1)) IE2=IE2+1
C LAST VALUE OF THE TABLE
START(512)=5
IF(DLPO.LT.) GO TO 6
C NEW PAGE
WRITE(6,103)
103 FORMAT(1H1)
C WRITE LINEARIZATION TABLE ON TELETYPewriter
WRITE(6,104) (START(I),I=1,512)
104 FORMAT(10(15.2X))
C NEW PAGE
WRITE(6,106)
106 FORMAT(1H1)
C WRITE TABLE ON A STORAGE DEVICE (DUMP MODE)
CALL TTM(START)
C WRITE OUT ANY ERROR AND ALLOW RECALIBRATION IF NEEDED
IF(IERR.NE.0)GO TO 9
IF(IERR.EQ.0)RETURN
WRITE(6,108)
108 FORMAT(//47H ****CHECK CALIBRATION FOR POSSIBLE ERRORS****///)
GO TO 7
9 WRITE(6,107)
107 FORMAT(37H ++ERROR--BAD CALIBRATION TABLE ++)
GO TO 7
RETURN
END
**SUBROUTINE LINAP**

*LINAP* transforms output voltages into input voltages of the receiver. The calibration data is contained in *SUBROUTINE VALUE*.

**INPUT AND OUTPUT:**
- *A* is the output voltage that is transformed into input voltage
- *NC5* is the number of DB settings

**SUBROUTINE LINAP(A,NC5)**

```fortran
COMMON /TA/ S(43),TU(44),TU0(44)
N=1
NC5=NCS*(NC5+1)/4
NC5=FNC5+2)/4
NC53=NCS/3/4
NC52=(NC5+1)/2
C FInd Where the Inputed Number Lies
IF(A.GT.TUO(NC54))N=NC54
IF(A.GT.TUO(NC52))N=NC52
IF(A.GT.TUO(NC53))N=NC53
C SET the Upper Limit of the Search
W=N+NC54
C Search for the Correct Line Segment
DO 5 I=N,W
J=I+1
IF(A.GT.TUO(I).AND.A.LE.TUO(J)) GO TO 10
5 CONTINUE
C Line Segment Couldn't Be Found
A=0.
RETURN
C Set the Value of the Corresponding Output
10 A=(A-TUO(I))*S(I)+TUO(I)
RETURN
END
```
DO 110 I=1,4
BN00(I)=0.
BNX(I)=0.
110 INITIALIZE STORAGE DEVICE AND
C PREPARE TO READ DATA
CALL CHN2CIBMX, DBCHC IMCC)
IF (IMCC-L.E.0 OR IMCC-6) GO TO 80
IMCC=FLOAT(IMCC)-4.5
RBMX=RNMX+CNO*CNO*.4
20 IF (IBMX.LT.1) IBMX=216
IMCC=0.
C NOISE CRITERION
C IBMX=THE SUM OF THE SET OF 45 NOISE SAMPLES WHICH HAS THE
C MINIMUM OF ALL THE MAXIMUMS OF EACH SET OF 45 NOISE SAMPLES
C THE AVERAGE NOISE FOR THE FIRST 5 IN EACH FRAME HAS
C TO BE LESS THAN SRBMX*IBMX/45. WHERE RBMX IS THE SUPPLIED CONSTANT.
C FOR SPEED RBMX*(IBMX/45)**2*5 IS COMPARED TO THE SUM OF THE
C SQUARES OF THE NOISE
DUMX=FLOAT(IBMX)/45。
IF(DUMX*SRBMX.GT.500.) DUMX=500./SRBMX
BMXNS=RBMX*DUMX*5.*DUMX
KEFO=0.
KEOFX=0.
ID=0.
C GET ORDINARY MODE DATA
eniable=0.
BM0=0.
BM0X=0.
DO 120 I=1,5
BMEANO+BMEANO+BN0(I)*BN0(I)
120 BMEANX=BMEANX+BNX(I)*BNX(I)
IF (BMEANO.GT.BMXNS OR BMEANX.GT.BMXNS) GO TO 50
C NOISE USED TO SUBTRACT FROM DATA SAMPLES
C SUM OF THE SQUARE OF THE UNSATURATED DATA AT EACH HEIGHT
DO 140 1=1,21
35 IF(AO(I).GE.510.. OR AX(I).GE.510.) GO TO 40
AVAO(I)=AVAO(I)+AO(I)*AO(I)
AVAX(I)=AVAX(I)+AX(I)*AX(I)
GO TO 140
C REJECTIONS DUE SATURATIONS OF DATA
40 IRJ(I)=IRJ(I)+1.
GO TO 140
C SET UP CHECK FOR REJECTION BECAUSE OF NOISE CRITERION
BMEAN=0.
BMEANX=0.
DO 180 I=1,5
BMEANO=BMEANO+BN0(I)*BN0(I)
BMEANSX=BMEANSX+BNX(I)*BNX(I)
IF (BMEANO.GT.BMXNS OR BMEANX.GT.BMXNS) GO TO 50
C REJECTIONS DUE TO SATURATIONS OF DATA
50 IRJ(I)=IRJ(I)+1.
GO TO 140
C REJECTIONS FROM NOISE CRITERION
53 IR=IR+1.
C SET UP AVERAGE NOISE USED IN REJECTION CRITERION
SN0=SN0+SN0
SNX=SNX+SNX
GO TO 30
60 ID=ID/2.
ID=ID*5.
C MAXIMUM ALLOWABLE NOISE
BMXNS=BMXNS/(DUMX*5.*SRBMX)
C RMS OF ALL NOISE SAMPLES
AVO=SQRT(SN0/ID)
AVOX=SQRT(SNX/ID)
C NUMBER OF ACCEPTABLE NOISE SAMPLES
HN=5*(ID-IA)
DO 150 I=1,21
C NUMBER OF REJECTIONS AT EACH HEIGHT
IRJ(I)=IRJ(I)+1.
C NUMBER OF ACCEPTABLE DATA AT EACH HEIGHT
HSAM=ID-IRJ(I)
C AVERAGE SUM SQUARED OF ACCEPTABLE DATA FOR EACH HEIGHT MINUS THE
C AVERAGE SUM SQUARED OF THE ACCEPTABLE NOISE
AVOC=AVOC(I)/HSAM*BNO/RN
AVOCX=AVOCX(I)/HSAM*BNX/IN
C THE RMS OF THE ACCEPTABLE DATA AT EACH HEIGHT (PRESERVING THE SIGN)
AVOC(I)=ABS(AVOC/AVOC)SQRT(AVOC3(AVOCX/AVOC3)*SQR(AVOCX3(AVOC))
AVOCX=AVOCX3(AVOCX)/AVOCX3*SQR(AVOCX3(AVOC))
EL(I)=0.
XO(I)=0.
IF(AVOC(I).LE.0. OR AVOCX(I).LE.0.) GO TO 150
XO(I)=AVOCX(I)/AVOC(I)
150 CONTINUE
C THE RMS OF THE ACCEPTABLE NOISE
BM=SQRT(BM/RN)
BMX=SQRT(BMX/RN)
CALL CALC2(XO.120#EL*IA)
C
GET THE TIME OF DAY
DO 155 I=1,4
II=I-1
155 ITIM(I)=ITIME/(13+II)
C WRITE THE HEADING ON THE TELETYP
WRITE(6,1050)ITIM,RA DATA,REAL,IDBN(CN4)
1050 FORMAT(1H8.4,n10.7,2X,4X,2X,4X,2X,1X,2H10.1,1X,3H6.1)
WRITE(6,1100) BMXNS,AMX
1100 FORMAT(/19H MAX. ALLOW. NOISE(1,1,3X MULT. CONST. =F7.3/)
WRITE(6,1200) BMXNS,AMX
1200 FORMAT(1H8.4,2X,4X,2X,1X,2H10.1,1X,3H6.1)
WRITE(6,1300) BMXNS,AMX
1300 FORMAT(1H8.4,2X,4X,2X,1X,2H10.1,1X,3H6.1)
WRITE(6,1400) BMXNS,AMX
1400 FORMAT(1H8.4,2X,4X,2X,1X,2H10.1,1X,3H6.1)
DO 160 J=1,21
C CHECKS FOR COLLECTION STOPPAGE
CALL CKCOL
HT=HT+1.5
WRITE(6,1488)BMXNS,AMX
1488 FORMAT(1H8.4,2X,4X,2X,1X,2H10.1,1X,3H6.1)
CONTINUE
C ALLOWS RESULTS TO BE SAVED ON PAPER TAPE
CALL PP7
C NEXT ATTENUATOR SETTING
NC4=NC4+1
IF(NC4.3T.IDBN)NC4=1
IF(IDBN.GT.3)IDBN(CN4)=5*IDBN
GO TO 10
1500 FORMAT(1HJ)
RETURN
END

C*******************************************************************************
SUBROUTINE DH73******************************************************************************
C READS 21 SAMPLES OF SIGNAL AND 5 SAMPLES OF NOISE
C FROM DECTAPE. THE OUTPUT VOLTAGES HAVE BEEN TRANSFORMED INTO
C INPUT VOLTAGES. THE PROGRAM USES SUBROUTINE DUMPT (MACRO) TO
C READ DATA FROM STORAGE DEVICE.
C*******************************************************************************
C SUBROUTINE DH73(A,BMEAN,IERA,ID,KEOF)
DIMENSION A(21),IDAT(27),BMEAN(5)
KEOF=0
N=5
N2=N+1
N3=NI+21
C GET ONE SET OF DATA (26 VOLTAGES)
CALL DUMPT(IDAT,NEF)
C CHECK ID CONSECUTIVE
IF(ID-IDAT(1)+1).LT.1,15,10
C CHECK FOR END OF FILE
10 IF(IDAT(1).NE.133350) 30 TO 20
C TELL PROC IT'S THE END OF THE FILE
KEOF=1
GETJN
15 ID=IDAT(1)
C SET DATA SAMPLES INTO A REAL ARRAY
DO 40 J=1,N
40 A(J)=IDAT(J)
CONTINUE
C SET NOISE SAMPLES INTO A REAL NUMBER ARRAY
DO 130 J=1,N
JNL=J+1
130 DATA(JNL)=IDAT(JNL)
RETURN
C THE ID IS CONSECUTIVE, IGNORE THE REST OF THE DATA
20 1AJE=IDAT(1),IDAT(1),IDAT(2)
140 FORMAT(4H46 ID WAS NOT CONSECUTIVE AND NOT=133350 J ID=3(17,3X))
KEOF=1
RETURN
END
CALC2 IS A LIST OF CONSTANTS CALCULATED FROM THE PROGRAMS CALC AND ELDEN AND CONTAINS THE FUNCTION THAT CALCULATES THE ELECTRON DENSITIES FOR THE PARTIAL-REFLECTION PROCESSING PROGRAMS. THE PROGRAM CALC WRITES THIS PROGRAM.

SUBROUTINE CALC2(ARRAY.LLLH#FD IA)

DIMENSION ARRAY(21)*RATIO2(21)*FD(21)

C GET THE PREDETERMINED CONSTANTS FOR THE RIGHT SEASON IF(IA)200300 100

C CONSTANTS FOR THE SUMMER 100
RATIO2( 1)= 1.0731158
RATIO2( 2)= 1.0778633
RATIO2( 3)= 1.0841143
RATIO2( 4)= 1.0999986
RATIO2( 5)= 1.0999518
RATIO2( 6)= 1.0901243
RATIO2( 7)= 1.0880302
RATIO2( 8)= 1.0864129
RATIO2( 9)= 1.0768397
RATIO2(10)= 1.0590323
RATIO2(11)= 1.0495014
RATIO2(12)= 1.0393323
RATIO2(13)= 1.0262468
RATIO2(14)= 1.0166022
RATIO2(15)= 1.0117923
RATIO2(16)= 1.0076428
RATIO2(17)= 1.0044388
RATIO2(18)= 1.0015084
RATIO2(19)= 1.0008443
RATIO2(20)= 1.0008443

FD( 1)= 0.170327E-03
FD( 2)= 0.243443E-03
FD( 3)= 0.329813E-03
FD( 4)= 0.427651E-03
FD( 5)= 0.532098E-03
FD( 6)= 0.627513E-03
FD( 7)= 0.720342E-03
FD( 8)= 0.750909E-03
FD( 9)= 0.753246E-03
FD(10)= 0.722645E-03
FD(11)= 0.660879E-03
FD(12)= 0.579908E-03
FD(13)= 0.492934E-03
FD(14)= 0.405772E-03
FD(15)= 0.328260E-03
FD(16)= 0.258602E-03
FD(17)= 0.201748E-03
FD(18)= 0.155429E-03
FD(19)= 0.118415E-03
FD(20)= 0.915812E-04
GO TO 400

C CONSTANTS FOR THE WINTER 200

RATIO2( 1)= 1.0682487
RATIO2( 2)= 1.0890572
RATIO2( 3)= 1.0979884
RATIO2( 4)= 1.0699495
RATIO2( 5)= 1.0692204
RATIO2( 6)= 1.0979884
RATIO2( 7)= 1.0979884
RATIO2( 8)= 1.0979884
RATIO2( 9)= 1.0979884
RATIO2(10)= 1.0979884
RATIO2(11)= 1.0979884
RATIO2(12)= 1.0979884
RATIO2(13)= 1.0979884
RATIO2(14)= 1.0979884
RATIO2(15)= 1.0979884
RATIO2(16)= 1.0979884
RATIO2(17)= 1.0979884
RATIO2(18)= 1.0979884
RATIO2(19)= 1.0979884
RATIO2(20)= 1.0979884

FD( 1)= 0.170327E-03
FD( 2)= 0.319960E-03
FD( 3)= 0.410827E-03
FD( 4)= 0.502861E-03
FD( 5)= 0.592594E-03
FD( 6)= 0.662825E-03
FD( 7)= 0.720342E-03
FD( 8)= 0.750909E-03
FD( 9)= 0.753246E-03
FD(10)= 0.722645E-03
FD(11)= 0.660879E-03
FD(12)= 0.579908E-03
FD(13)= 0.492934E-03
FD(14)= 0.405772E-03
FD(15)= 0.328260E-03
FD(16)= 0.258602E-03
FD(17)= 0.201748E-03
FD(18)= 0.155429E-03
FD(19)= 0.118415E-03
FD(20)= 0.915812E-04
FD(12) = 0.588398E-03
FD(13) = 0.500527E-03
FD(14) = 0.410427E-03
FD(15) = 0.330916E-03
FD(16) = 0.258602E-03
FD(17) = 0.200210E-03
FD(18) = 0.156383E-03
FD(19) = 0.119390E-03
FD(20) = 0.899351E-04

GO TO 400

C CONSTANTS FOR EQUINOX

C

RATIO2(1) = 1.0670392
RATIO2(2) = 1.0803050
RATIO2(3) = 1.0780858
RATIO2(4) = 1.0912947
RATIO2(5) = 1.0914300
RATIO2(6) = 1.0917337
RATIO2(7) = 1.0897206
RATIO2(8) = 1.0825763
RATIO2(9) = 1.0815986
RATIO2(10) = 1.0807970

FD(1) = 0.188515E-03
FD(2) = 0.261225E-03
FD(3) = 0.347697E-03
FD(4) = 0.442169E-03
FD(5) = 0.542672E-03
FD(6) = 0.633402E-03
FD(7) = 0.705094E-03
FD(8) = 0.747132E-03
FD(9) = 0.752781E-03
FD(10) = 0.722645E-03
FD(11) = 0.661807E-03
FD(12) = 0.579908E-03
FD(13) = 0.492934E-03
FD(14) = 0.40105E-03
FD(15) = 0.328260E-03
FD(16) = 0.261505E-03
FD(17) = 0.200210E-03
FD(18) = 0.156383E-03
FD(19) = 0.119390E-03
FD(20) = 0.899351E-04

DO 13 I = 1, N
IF (ARRAY(I).EQ.0.0 .OR. ARRAY(i+1).EQ.0.0) GO TO 50
C THE FUNCTION FOR THE CALCULATION OF ELECTRON DENSITIES
FD(I) = ALOS((ARRAY(I)/ARRAY(I+1))*RATIO2(I))/FD(I)

C WHPP PUNCHES THE PROCESSED PARTIAL REFLECTION DATA
C ON PAPER TAPE

SUBROUTINE WHPP
COMMON /PPC/ AO(21), AX(21), AVAO(21), AVAX(21), ITIM(4),
1 KX(21), JX(21), BM(5), BNX(5), EL(21),
2 VMX, AVNO, AVNX, BMX, ID, IR
COMMON /STAT/ IDB(4), RDATE(2), HEAS(5), IDB(2), BMXNS, NC4
WRITE(7, 1050) ITIM, RATE, HEAS, IDB(2), BMXNS, B, VMX,
1 AVNO, AVNX, BMX, ID, IR
1050 FORMAT (H7, 10E13.6, 5X, 3X, 12HDB, F7.1*, F7.3, F8.1, 4X, 15)
DO 160 I = 1, N
CALL CKCOL
WRITE(7, 1400) IR(J), AVAO(I), AVAX(I), XO(I), EL(I)

1400 FORMAT (14X, X, 6.1*, F6.1, F6.1, F6.0)

160 CONTINUE
RETURN
END
PROC73 EVALUATES COLLECTED PARTIAL-REFLECTION DATA AND
PRINTS OUT THE ELECTRON DENSITY. PROC73 USES THE FOLLOWING PROGRAMS:
- HEAD--SETS UP AND PRINTS THE HEADING (FORTRAN)
- DINIT--INITIALIZES THE STORAGE DEVICE (MACRO)
- FSTAT--LOCATES THE DATA FILE (MACRO)
- SEEK--FINDS THE FILE ON THE STORAGE DEVICE (MACRO)
- DRD73--SETS SAMPLES INTO THE REAL ARRAY (FORTRAN)
- CALC2--CALCULATES THE ELECTRON DENSITY (FORTRAN)

**INTEGER DATIN**
**DIMENSION FNAM(2),AO(21),AX(21),AVAO(21),AVAX(21),**
**1XO(21),IRJ(21),BN0(5),BNX(5),EL(21)**
**WRITE(6,105)**

105 **FORMAT(48H TYPE IN SEASON--(1) FOR SUMMER, (-1) FOR WINTER**
**115H, (0) OTHERWISE)**
**READ(4,200)IA**

200 **FORMAT(12)**

**DATIN=2**
**CALL HEAD(0)**
**C INITIALIZE VARIABLES**

12 **SNO=0, SNX=0, IR=0, IRN=0, BMO=0, BMX=0, DO 16 I=1,21**

16 **AVAO(I)=0, AVAX(I)=0, I=1,21**

**BNO(I)=0, BNX(I)=0, I=1,5**

**DO 17 I=1,4**

17 **BNO(I)=0, BNX(I)=0, I=1,5**

**CALL DINIT**
**C GET THE DATA FILE NAME**
**WRITE(6,20))**

20 **FORMAT(15H WHICH DATAFILE)**
**READ(4,30)FNAM**

30 **FORMAT(2A5)**

**CALL FSTAT(DATIN,FNAM,LOG)**

**IF(LOG.NE.)GO TO 43**

40 **CALL SEEK(DATIN,FNAM)**

**WRITE(6,35)FNAM**

35 **FORMAT(6H FILE NOT FOUND ON DAT 2)**

**GO TO 10**

**C CHECK FOR THE VALIDITY OF THE NAME GIVEN**

13 **CALL SEEK(DATIN,FNAM,LOG)**

**IF(LOG.NE.)GO TO 43**

40 **CALL SEEK(DATIN,FNAM)**

**WRITE(6,35)FNAM**

35 **FORMAT(6H FILE NOT FOUND ON DAT 2)**

**GO TO 10**

**C GET THE MAXIMUM ALLOWABLE NOISE**

50 **WRITE(6,57)**

57 **FORMAT(14H MAXIMUM NOISE)**

**READ(4,56)BMXNS**

56 **FORMAT(F10.0)**

**IF(BMXNS.GE.510)BMXNS=400**

**BMXNS=BMXNS*5**

19 **KEOFX=3**

**KEOFX=3**

**ID=0**

**CALL DRD73(AO,NO,IR,IRH,KEOF,O)**

48 **IF(KEOF=0.EQ.E2+1.9)GO TO 50**

**CALL DRD73(AX,'BNX, IERRtIDsKEOFX)**

47 **IF(KEOFX.EQ.1)GO TO 49**

**C GET THE SUM SQUARED OF THE NOISE**

440 **BMEANO=0., BMEANX=0.**

**DO 460 I=1,5**

460 **BMEANO=BMEANO+BNO(I)*BNO(I)**

**BMEANX=BMEANX+BNX(I)*BNX(I)**

**C CHECK FOR SETS OF SAMPLES THAT ARE TOO NOISY**

480 **IF(BMEANO.GT.BMXNS*OR.BMEANX.GT.BMXNS)GO TO 510**

**C SUM THE SQUARED NOISE SAMPLES FOR THE**

**LAST FOUR NOISE SAMPLES PER 25 TOTAL SAMPLES**

730 **DO 47 I=1,21**

47 **IF(401,GE.510..OR.AX(1),GE.510.)GO TO 46
C SUM OF THE SQUARED GOOD AO AND AX SAMPLES
AVAOCI(I)=AVAOCI(I)+AO(I)*AO(I)
AVAX(I)=AVAX(I)+AX(I)*AX(I)
GO TO 47
C THE TOTAL # OF REJECTIONS DUE TO SATURATION
C PLUS NOISE ABOVE THE GIVEN MAXIMUM
46 IRJ(I)=IRJ(I)+1
47 CONTINUE
GO TO 50
50 IR=IR+1
52 SN=BMEOAO+SN0
SNX=BMEOAX+SNX
GO TO 49
49 ID=ID-1
51 ID=ID/2
BMXNS=BMXNS/DUM4
C THE RMS OF ALL NOISE SAMPLES TAKEN
AVNO=SQR(T(SNO/BID))
AVNX=SQR(T(SNX/BID))
C THE NUMBER OF THE ACCEPTABLE NOISE SAMPLES
RN=4*(ID-IR)
DO 52 I=1,21
C NUMBER OF REJECTED DATA AT EACH HEIGHT
IR(I)=IRJ(I)+IH
C NUMBER OF ACCEPTABLE DATA AT EACH HEIGHT
RSAM=ID-IRJ(I)
C ACCEPTABLE NOISE IS SUBTRACTED OFF
AVOC=AVA01(I)/RSAM-BMO/RN
AVXC=AVAX(I)/RSAM-BMX/RN
C RMS OF GOOD DATA WITH THE SIGN PRESERVED
AVAOCI(I)=(ABS(AVOC)/AVOC)*SQR(T(ABS(AVOC)))
AVAX(I)=(ABS(AVAXC)/AVXC)*SQR(T(ABS(AVAXC)))
EL(I)=0
XO(I)=0
IF(AVO(I).LE.0.0.OR.AVAX(I).LE.0.0)GO TO 52
XO(I)=AVAX(I)/AVOC(I)
52 CONTINUE
C RMS OF ACCEPTABLE NOISE
BMO=SQR(IT(BMO)/RN)
BMX=SQR(IT(BMX)/RN)
C GET ELECTRON DENSITIES
CALL CALC2(XO,1,20,EL,IA)
C WRITE THE HEADING
CALL HEAD(4)
WRITE(6,100) BMXNS,AVNO,BMO,AVNX,BMX
100 FORMAT (25H MAXIMUM ALLOWABLE NOISE=,F6.1//16H NOISE AV.(I),1F8.1*7H (2),1F8.1//16H (2)
WRITE(6,54)ID,IN
54 FORMAT (1X,14,8H SAMPLES,5X,15,12H REJ.(NOISE)///8H REJECTS,
12X,6,HEIGHT,2X,6HAY+, AO,2X,6HAY-, AX,2X,5HAX/AO,4X,8HED)
HT=SB.5
C WRITE OUT TABLE
DO 53 I=1,21
HT=HT+I.5
WRITE(6,58)IRJ(I),HT,AVA01(I),AVAX(I),XO(I),EL(I)
58 FORMAT (14,3X,F5.1,3X,F6.1,2X,F6.1,2X,F6.1,2X,F5.3X,F6.0)
53 CONTINUE
30 TO 10
STOP
END
.TITLE READ DATA IN DUMP MODE

/READ DUMP MODE FROM DECTAPE ON A VARIABLE .DAT SLOT
/FILLS 256 DEC WORD BUFFER AND OUTPUTS 26
/WORDS TO ARRAY I.DAT EVERY TIME CALLED.
/THOSE ARE UNPACKED FROM 16 WORDS OF THE BUFFER.
/IDAT: WORD 1
/WORD 2-6 NOISE SAMPLES
/WORD 7-27 DATA
/NDEF: SET IF A NEGATIVE NUMBER WAS IN THE DATA

/DUMP=4 /TYPE OF I/O MODE
/DATIN=2 /DAT SLOT TO READ DATA FROM
/NSAM=32 /# OF SAMPLES PER SET
/NSAMP=NSAM/2+1 /# SIZE OF ONE SET PACKED DOUBLE
/DATBLK=378 /SIZE OF ONE BLOCK OF STORAGE
/DATSTR=DATBLK/NSAMP /# OF SETS PER ONE BLOCK OF STORAGE
/NUMDC=NSAM/2 /NUMBER OF STORED DATA PAIRS PER SET

.DEV DATIN

.DINIT

/INIT DATIN,DINIT /INITIALIZE DEVICE STORING THE DATA
/LAW =1 /PREPARE TO READ
/DAC CTT9 /IN ONE BLOCK OF DATA
/LAC BUF3 /RESET THE BUFFER POINTER WITH
/DAC POINT2 /THE ADDR. OF BUF3
/LAC CP SWITC /PREPARE TO READ TWO
/LAC LGA /DUMMY BLOCKS
/JMP DINIT /END OF INITIALIZATION

.DUMP

/JK=0 /PICKUP ADDR OF ADDR
/JMP +3 /OF ARRAY

.A2 0

.FLAG 0

/LAC A2 /SET ON NEG #
/DAC A2 /OF ARRAY
/LAW -DNUM /SET COUNTER OF DATA TO BE
/DAC COUNT /PROCESSED
/ISZ CTT9 /SET POINTER
/JMP LBB /NO CONTINUE WITH PRESENT SET OF DATA
/LAW +DATSTR /RESET COUNTER TO THE NUMBER
/DAC CTT9 /OF SETS PER BLOCK OF STORAGE

.LRA /READ DATIN,DUMP,BUF3,DTBLK /GET 1 BLOCK OF DATA

.C14 /WAIT DATIN

.LCA ISZ SWITC /INITIALLY READ TWO DUMMY BLOCKS
/JMP LBB
/LAW -3 /RESET CONTROL TO READ
/DAC SWITC /TWO DUMMY BLOCKS
/LAC (JMP LGB /READ ONE BLOCK OF DATA
/DAC LCA /AT A TIME

.LGB LAC BUF3 /GET ADDRESS OF BUF3
/DAC POINT2 /POINTER TO BUF3
/LBB LAC* POINT2 /GET THE ID (FIRST WORD IN DATA SET)
/SAD SEV /END OF FILE ID?
/JMP ENP /YES, RESTART PARAMS AND CLOSE FILE
/LAC* POINT2 /GET ID AND PUT
/DAC A2 /INTO THE FORTRAN ARRAY
/ISZ A2 /GO TO NEXT ADDR. OF THE ARRAY

.LOOP ISZ 2 /GO TO NEXT DATA WORD
/LAW -2 /PREPARE TO UNPACK
/DAC TC10 /TWO DATA WORDS
/LAC* POINT2 /GET DATA WORDS FROM BUF3
/SWHA AND (777 /SAVE ONE DATA WORD
/SWA /CHECK FOR NEG. NUMBER
/ISZ* FLAQ /SET IF NEG. NUMBER FOUND
/DAC A2 /LOAD # INTO FORTRAN ARRAY
/LAC* POINT2 /GET DATA WORD AGAIN
/ISZ A2 /GO TO NEXT LOC. IN ARRAY
/ISZ TC10 /UNPACKED TWO WORDS?
/JMP UNLP /NO, LOOP AROUND
/ISZ COUNT /YES, HAS 34 DATA WORDS BEEN UNPACKED?
/JMP LOOP /NO, REPEAT UNPACKING PROCESS

.OUTS ISZ POINT2 /YES, $0 TO NEXT ID
/JMP DUMP /RETURN

.SWITC LAW -3
/COUNT LAW -DNUM
/TT9 LAW -DATSTR
/SEV 376002
/TC10 0
/POINT2 DSA BUF3
/BUF3 DSA BUF3
/BUF3 BLOCK DTBLK
END OF FILE ROUTINE

ENV  LAC  SEVN  /SET LAST ID TO
DAC*  A2   /CLOSE DECIMAL
C15  -CLOSE DATIN   /CLOSE FILE
RT2  JNP*  DUMPT   /RETURN TO PROC. PROGRAM

******************************************************************************

C****************************** CALC **************************************
C FROM GIVEN COLLISION FREQUENCIES: CALC ALONG WITH ELDEN
C CALCULATES THE CONSTANT VALUES USED IN THE ELECTRON DENSITY
C EQUATION GIVEN BY P. H. ELDEN IN AERONOMY REPORT 29 AND WRITES THE
C PROGRAM CALC2 WHICH CALCULATES THE ELECTRON DENSITIES FOR THE
C PARTIAL-REFLECTION PROGRAMS.
C******************************************************************************

DIMENSION ARRAY(21),P(21),C(3),CF(3),EL(20),CALC2(2)
DATA CALC2CI),CALC2(2)/5HCALC2*4H SRC/
I=0
LABL=0
C COLLISION FREQUENCY PROFILES
C COLLISION FREQUENCY PROFILE FOR THE SUMMER
100  P(1)=192.3
   P(2)=155.9
   P(3)=127.5
   P(4)=102.7
   P(5)=82.35
   P(6)=66.25
   P(7)=52.53
   P(8)=41.66
   P(9)=32.81
   P(10)=25.84
   P(11)=20.1
   P(12)=15.53
   P(13)=10.84
   P(14)=9.09
   P(15)=6.91
   P(16)=5.39
   P(17)=4.88
   P(18)=4.37
   P(19)=3.82
   P(20)=3.32
   P(21)=2.83
C WRITE THE PROGRAM HEADING ON TAPE
CALL ENF(IDAT,CALC2)
WRITE(IDAT,10)
10  FORMAT(69H C COLLISION FREQUENCY PROFILES FOR THE SUMMER/
     69H DIMENSION ARRAY(21),RATIO /59H C CALC2 IS A LIST OF CONSTANTS
     59H C GET THE PREDETERMINED CONSTANTS FOR THE
     59H IF(IA)200 330 103/
     128H C CONSTANTS FOR THE SUMMER)
     GO TO 430
C COLLISION FREQUENCY PROFILE FOR THE WINTER
200  P(1)=133.5
   P(2)=107.8
   P(3)=87.12
   P(4)=70.84
   P(5)=56.33
   P(6)=45.28
   P(7)=36.55
   P(8)=29.32
   P(9)=23.52
   P(10)=18.80
   P(11)=14.97
   P(12)=10.97
   P(13)=7.54
   P(14)=6.00
   P(15)=4.74
   P(16)=3.76
   P(17)=2.94
   P(18)=2.32
   P(19)=1.56
   P(20)=1.18
   P(21)=0.83
C WRITE THE PROGRAM HEADING ON TAPE
CALL ENF(IDAT,CALC2)
WRITE(IDAT,10)
10  FORMAT(69H C COLLISION FREQUENCY PROFILES FOR THE WINTER/
     69H DIMENSION ARRAY(21),RATIO /59H C CALC2 IS A LIST OF CONSTANTS
     59H C GET THE PREDETERMINED CONSTANTS FOR THE
     59H IF(IA)200 330 103/
     128H C CONSTANTS FOR THE WINTER)
     GO TO 430
C COLLISION FREQUENCY PROFILE FOR THE EQUINOX

\[ \begin{align*}
P(1) &= 169.2 \\
P(2) &= 138.3 \\
P(3) &= 105.3 \\
P(4) &= 84.90 \\
P(5) &= 68.25 \\
P(6) &= 44.75 \\
P(7) &= 34.31 \\
P(8) &= 27.07 \\
P(9) &= 21.32 \\
P(10) &= 16.82 \\
P(11) &= 13.26 \\
P(12) &= 10.33 \\
P(13) &= 8.062 \\
P(14) &= 6.246 \\
P(15) &= 4.835 \\
P(16) &= 3.758 \\
P(17) &= 2.915 \\
P(18) &= 2.260 \\
P(19) &= 1.733 \\
P(20) &= 1.359 \\
P(21) &= 1.059
\end{align*} \]

WRITE IDAT 11

FORMAT(1H10, 1H GO TO 400/ 
120H C CONSTANTS FOR THE WINTER 
GO TO 400)

C CONSTANTS FOR THE WINTER

\[ \begin{align*}
P(1) &= 160.2 \\
P(2) &= 130.2 \\
P(3) &= 100.3 \\
P(4) &= 84.90 \\
P(5) &= 68.25 \\
P(6) &= 44.75 \\
P(7) &= 34.31 \\
P(8) &= 27.07 \\
P(9) &= 21.32 \\
P(10) &= 16.82 \\
P(11) &= 13.26 \\
P(12) &= 10.33 \\
P(13) &= 8.062 \\
P(14) &= 6.246 \\
P(15) &= 4.835 \\
P(16) &= 3.758 \\
P(17) &= 2.915 \\
P(18) &= 2.260 \\
P(19) &= 1.733 \\
P(20) &= 1.359
\end{align*} \]

WRITE IDAT 12

FORMAT(1H10, 1H GO TO 400/ 
120H C CONSTANTS FOR EQUINOX)

C SET THE COLLISION FREQUENCIES TO THE RIGHT ORDER OF MAGNITUDE

DO 401 1=1,21
   P(I)=P(1)*(11.**5)
CONTINUE

C STATEMENT LABEL FOR THE NEW PROGRAM

LABL=LABEL+100

J=J+4

DO 23 1=1,23
   K(K)=P(K)
   CF(1)=P(K)
   CF(2)=P(K+1)

C CALCULATE CONSTANTS FOR THE ELECTRON DENSITY EQUATION

CALL ELDEN(RCFARHAY(I),AHAY(I),EL(I))

HAYAY(I)=AHAY(I)/AHAY(I+1)

WRITE(IDAT,405)LABL,AHAY(I)

405 FORMAT(1H13, 1H RATIO(1)=*F10.7)

C WRITE THE REST OF THE RO AND RX CONSTANTS

DO 25 I=2,20
   ARHAY(I+1)=ARHAY(I)/AHAY(I)
   WRITE(IDAT,410) I,ARHAY(I)
25 CONTINUE

C WRITE THE CONSTANT DENOMINATORS

DO 30 I=1,20
   WRITE(IDAT,420) I,EL(I)
30 CONTINUE

C CALCULATE THE REST OF THE CONSTANTS

IF(EL(I+1).EQ.0. OR. EL(I+2).EQ.0.)GO TO 400

CALL ELDEN(I/2/12H, AHAY(I), EL(I))

WRITE(IDAT,40) 1,EL(I)

40 FORMAT(1H13, 1H RATIO(1)=*F10.7)

IF(EL(I).EQ.0. OR. EL(I+1).EQ.0.)GO TO 50/59H C THE FUNCTION FOR THE CALCULATION OF ELECTRON DENSITIES

351H FD(I+1)=ALOG((Array(I)/Array(I+1))*RATIO(I))/FD(I)

41H GO TO 10/12H

CALL CLOSE IDAT

STOP

END

SUBROUTINE ELDEN

C::

C SUBROUTINE ELDEN CALCULATES THE CONSTANTS RX, RO, AND FD

C FOR EACH HEIGHT.

C SUBROUTINE ELDEN CALCULATES THE CONSTANTS RX, RO, AND FD

C ELECTRON DENSITY AS GIVEN BY BIRLY (1971) IS:

C ED=LH(((AY(1)/RO(1))*(AY(2)/RO(2)))/(RO(1)+RO(2)))/FD

C WHERE LN IS THE NATURAL LOG AND 1 AND 2 ARE HEIGHT 1 AND 2

C DURING DATA PROCESSING THERE ARE ONLY 2 VARIABLES

C FOR EACH HEIGHT (RO AND AX). THE EQUATION FOR THE

C ELECTRON DENSITY AS GIVEN BY BIRLY (1971) IS:

C ED=LH(((AY(1)/RO(1))*(AY(2)/RO(2)))/(RO(1)+RO(2)))/FD

C WHERE LN IS THE NATURAL LOG AND 1 AND 2 ARE HEIGHT 1 AND 2

C FOR EACH HEIGHT.

C::

C SUBROUTINE ELDEN CALCULATES THE CONSTANTS RX, RO, AND FD

C FOR EACH HEIGHT.

C DURING DATA PROCESSING THERE ARE ONLY 2 VARIABLES

C FOR EACH HEIGHT (RO AND AX). THE EQUATION FOR THE

C ELECTRON DENSITY AS GIVEN BY BIRLY (1971) IS:

C ED=LH(((AY(1)/RO(1))*(AY(2)/RO(2)))/(RO(1)+RO(2)))/FD

C WHERE LN IS THE NATURAL LOG AND 1 AND 2 ARE HEIGHT 1 AND 2

C FOR EACH HEIGHT.
SUBROUTINE ELDEN(AXBYAO,GNU,RXROI,RXRO2,FD)
DIMENSION AXBYAO(3),RXBYRO(3),AX(3),RO(3),GNU(3),RATIO(3)
C APPROX INTEGRAL PARAMETERS
A4=2.3983474E-2
A3=1.1287513E+1
A2=1.1394160E+2
A1=2.4653115E+1
B6=1.806412E-2
B5=9.387732
B4=1.4921254E+2
B3=2.8958085E+2
B2=1.2849512E+2
B1=6.4656119E-2
B0=1.6945939
E5=4.3650732
E4=5.806412E-2
E3=9.387732
E2=1.2849512
E1=6.4656119
AXBYAO(3):RXBYRO(3)
GNU(3) IS MEAN COLLISION FREQUENCY AT THE INTERMEDIATE HEIGHT
C CALCULATE C INTEGRALS AT BOTH HEIGHTS AND FOR AVERAGE GNU
DUM=GNU(1)+GNU(2)
GNU(3):=0.5*DUM
DO 22 K=1,3
X=(2.59614E+7)/GNU(K)
X=7.386E+6/GNU(K)
CTN=O*(O*(O*(O+AI)+A2)+A3)+A4
CTD=O*(O*(O*(O+B1)+B2)+B3)+B4)+B5+B6
CT=CTN/CTD
CTY=O*(O*(O*(O+BI)+B2)+B3)+B4)+B5+B6
CTY=CTN/CTD
CFX=O*(O*(O*(O+EI)+E2)+E3)+E4)+E5
CFX=O*(O*(O*(O+EI)+E2)+E3)+E4)+E5
CFY=O*(O*(O*(O+EI)+E2)+E3)+E4)+E5
C CALCULATE RATIOS
RX(K)=SQRT((X*CTN)**2+(2.5*CFX)**2)
RO(K)=SQRT((O*CTO)**2+(2.5*CFO)**2)
RXBYRO(K)=RX(K)/RO(K)
RATIO(K)=AXBYAO(K)/RXBYRO(K)
C CALCULATE FD FROM FINAL VALUES OF DO LOOP
FO=(5.*3.1824E+3*CFO)/(4.*3.0F+* GNU(3))
FX=(5.*3.1824E+3*CFX)/(4.*3.0F+*GNU(3))
FD=(FX-FO)*3.E+9
RXROI=RXBYRO(1)
RXRO2=RXBYRO(2)
RETURN
END
C**************************************************************-
C PROGRAM READS IN THE NUMBER OF SAMPLES ASKS FOR BY OPERATOR.
C IF THE NUMBER IS ZERO, 31 NUMBERS ARE READ IN AND SET UP AS PARTIAL
C REFLECTION DATA IS (I.E. 5 NOISE SAMPLES AND 21 DATA POINTS & 5 EXTRA)
C DATA IS PRINTED OUT IN THE FORM OF ONE NUMBER PER HEIGHT AFTER EACH
C GROUP OF 26 SAMPLES ARE READ IN. THIS HAS BEEN USE TO CHECK THE
C RECEIVER AND A/D CONVERTER AGAINST THE REYNOLDS SYSTEM AND TO SEE
C IF EVERYTHING IS OPERATING AS IT SHOULD. IF THE NUMBER READ IN IS
C NOT ZERO, THAT NUMBER OF SAMPLES ARE READ FROM THE A/D CONVERTER
C AND AN AVERAGE OF ALL THE NUMBERS ARE TAKEN AND PRINTED OUT.
C**************************************************************-
C DIMENSION IA(50),RAI(50),RA2(50)
MAX=50
III=31
WRITE (6,110)
110 FORMAT(1WH ADC CHECK)
C DEFAULT VALUE FOR THE # OF SAMPLES = 31
4 NR=31
C READ # OF SAMPLE TO BE READ FROM A/D CONVERTER
5 READ (4,210) IDV
210 FORMAT(15)
IF(IDV.NE.3) NR=IDV
IF(NR.NE.31) G0 TO 50
C FOR 31 NUMBERS READ IN, THE FORM USED IS 2 SETS OF 31 SAMPLES
C AS IN THE PARTIAL REFLECTION COLLECTION

II=0

25 ICH=0
II=I+1
CALL INPAD(I,A,NS,ICH)
IF(I.CH.EQ.0) GO TO 6
IF(I.GT.1) II = II+1
DO 13 I=1,13

C CONVERSION ALGORITHM FOR A/D CONVERTER NEG. #'S TO COMPUTER
C NEGATIVE NUMBERS
IF(A(I).LT.511) A(I)=3072+(4096+32768)*7+IA(I)
RA(I)=FLOAT(A(I))/.SII
GO TO 25

11 WRITE(6,181)
C DO LOOP FOR SECOND SET OF NUMBERS READ IN
DO 15 I=1,13
IF(A(I).GT.511) A(I)=3072+(4096+32768)*7+IA(I)
HT=45.+FLOAT(I-1)*.5
IF(I.EQ.6.OR.I.EQ.1) WRITE(6,105)
IF(I .EQ.11) WRITE(6,106)
RA2(I)=FLOAT(A(I))/.11I
GO TO 5

C WRITE OUT THE NUMBERS IN AN ORDERLY WAY
DO 55 I=1,MAX
IF(A(I).GT.511) A(I)=3072+(4096+32768)*7+IA(I)
AV=AV+FLOAT(A(I))
CONTINUE
AV=AV/THS
AVV=AV/.512
WRITE6, 120)AVAVV
GO TO 5

C THE FOLLOWING DUMPS THE AVERAGE OF THE A/D CONVERTER NUMBERS
C AND ALSO GIVES THE VALUE IN MILLIVOLTS
50 INS=(NS-MAX-1)/MAX
THS=NS-MAX
DO 69 J=1,INS
ICH=0
CALL INPAD(I,A,MAY,ICH)
IF(I.CH.EQ.0) GO TO 24
DO 24 I=1,MAY
IF(A(I).LT.511) A(I)=3072+(4096+32768)*7+IA(I)
55 AV=AV+FLOAT(A(I))
CONTINUE
AV=AV/THS
AVV=AV/.512
WRITE6,120)AV,AVV
129 FORMAT(3H AVERAGE:,F7.3,12H VOLTAGE:,F7.3,H MV)
GO TO 5
STOP
END

.TITLE A/D CONVERTER SERVICE ROUTINES FOR B-50,
RFKM15 VGA SERVICE ROUTINES FOR THE HP 5610A A TO D
CONVERTER. THESE ROUTINES PERMIT INPUT OF ANY SPECIFIED
NUMBER OF SAMPLES INTO A CORE BUFFER. INPUT MAY BE OVER-
LAPPED WITH PROGRAM EXECUTION, AND CONTROL MAY BE PREDNISHUED
TO LOWER PRIORITY PROGRAMS WHILE DATA TRANSFER TAKES PLACE.
MACRO-15 CALLING SEQUENCE:
JMS INPAD
NUMBER OF SAMPLES REQUIRED
BUFFER ADDRESS
COMPLETION FLAG ADDRESS
REAL-TIME SUBROUTINE ADDRESS, PRIORITY LEVEL IN BITS 0-2
(EXAMPLE: 500000+RTSURA)
(RETURNS HERE IMMEDIATELY)
IF THE 4TH WORD AFTER THE JMS IS 0, NO REAL-TIME SUBROUTINE
WILL BE ACTIVATED. NOTE: THE PRIORITY CODE FOR MAINSTREAM IS 1
THE COMPLETION FLAG IS CLEARED BY THE CALL TO INPAD,
AND SET TO +1 FOR NORMAL COMPLETION OR -1001 IF A DATA
TIMING ERROR OCCURS.

ADWP=24
ADCB=ADWP+1
SCON=13A
ADVI=781724
ADVI=781724
ADSO=783732
ADSI=783732
ADCO=783734
CLRF
/AD WORD COUNT
/AD CURRENT ADDRESS REGISTERS
/MONITOR'S COMMUNICATION AREA
/AD-D CONVERTER WRITE INITIALIZE
/SKIP ON WORD COUNT OVERFLOW
/SKIP ON DATA TIMING ERROR
/CLEAR OVERFLOW FLAG
/CLEAR TIMING FLAG
ENTRY POINT FOR A-D INTERFACE INITIALIZATION

.globl inpad, .da

inpad r

jms* .da

jmp *+4

inwc r

inflag r

inr

jmp inset /replaced by "lac* inwc"
	ica
dac* (adwcr) /set word count
	law -1

tad* inr /buffer address -1

dac* (adcbr) /to current address reg.

dzm= inflag /clear flag

dzm insub# /clear real-time subroutine

advi /initialize interface

jmp* inpad /return

the following code is executed only once

inset lac* (.scom+55) /get entry point address of .setup

adsva dac

jms* -1 /call .setup to connect adint to api

adso adint

dzm* (204

lac (lac* inwc

dac inr /modify instruction

jmp inr /and jump to it

interrupt service routine. executed immediately after completion
of data transfer. determines status of a-d interface, sets
completion flag and activates real-time subroutine.
flushes at api level r.

adint r

dra /page addressing mode

dac adsva /save ac

adst adsva /timing error?

skpicladiac /no+1 to ac

dac* inflag /set flag

daco /clear

adct /interface flags

advt lac adsva /restore ac

dbd /restore ac

jmp* adint /set to leave hardware api level

.end /return to interrupted program