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NO. 55

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

by
T. A. Bean
S. A. Bowhill

October 1, 1973
CITATION POLICY

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Aeronomy Laboratory
Department of Electrical Engineering
University of Illinois
Urbana, Illinois
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 2900Å 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 CO$_3^-$ and 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 (1216A) ionizing nitric oxide (NO)
2) 1-8A X-rays ionizing all constituents
3) 1027-1118A ultraviolet radiation ionizing metastable \( \text{O}_2(\Delta_g) \)
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 O_2(^1Δ_g) given by Hunten and McElroy [1968], the main ionization source between 70 and 80 km is 1027-1118 Å UV radiation ionizing O_2(^1Δ_g) [Thomas, 1971]. Somoyajulu and Avadbanulu [1972] pointed out that according to measurements by Huffman, et al. [1971], photoionization of O_2(^1Δ_g) 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) $O_2 + hv \rightarrow O_2^+ + e$

B) $NO + hv \rightarrow NO^+ + e$

C) $N_2 + hv \rightarrow N_2^+ + e$

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$^{-1}$) [Fehrenfeld, 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} \text{ cm}^6 \text{ sec}^{-1}; two-body rate constants are in units of 10^{-9} \text{ cm}^3 \text{ 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 $O_2^+ + O_2 + M + O_4^+ + M$ 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 $O_2^+$ scheme are: it seems to ignore the large NO$^+$ concentration and the ionization of $O_2(^1A_g)$ 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:

E) $e + O_2 + O_2 \rightarrow O_2^- + O_2$.

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

F) $O_2^- + O \rightarrow O_3 + e$

G) $O_2^- + O_2(^1A_g) \rightarrow 2 O_2 + e$

are much faster. Although the formation of $O_4^-$ is rapid, there is rapid return to $O_2^-$. The negative ion chemistry is dependent on atomic oxygen and $O_2(^1A_g)$ 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 $O_2(^1A_g)$ are also greatly reduced [Shimasaki and Laird, 1972]. By
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, Mechty, et al.[1972] shows the possibility of attachment reactions as being the main loss process at totality. This would mean a large reduction in 0 and \(O_2(\Delta_g^1)\), 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:

\[
\frac{d[e]}{dt} = \left(\frac{q}{1+\lambda}\right) - \left(a_D + \lambda a_i\right)[e] - \left(\frac{[e]}{1+\lambda}\right) \frac{\lambda}{dt} \tag{2.1}
\]

where \([e]\) is the electron density, \(\lambda\) is the ratio of negative ion concentrations to electron densities, \(q\) is the ionization rate, \(a_D\) is the ion-electron recombination coefficient, and \(a_i\) is the ion-ion recombination coefficient.

With the assumption that variation in \(\lambda\) is insignificant, then \(\frac{\lambda}{dt} = 0\) and defining an effective recombination coefficient as \(a_{\text{eff}} = a_D + \lambda a_i\), Equation (2.1) reduced to:

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

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

(2.3)

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

\[ a_{\text{eff}} = q/[e]^2(1 + \lambda) \]  

(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
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 [Deeks, 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.

Figure 2.7 Electron-density profiles for the eclipse of July 20, 1963 [Smith, et al., 1965]. 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 $\exp(2\int_0^h k_x-k_o) \text{,}$ 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.
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</th>
<th>Input</th>
<th>Output</th>
<th>Attenuation</th>
<th>Used</th>
</tr>
</thead>
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<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) = 4.890</td>
<td>45DB</td>
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<td>S(3) = 2.394</td>
<td>TU(3) = 6.310</td>
<td>TUO(3) = 5.070</td>
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<td>TU(4) = 7.940</td>
<td>TUO(4) = 5.610</td>
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<td>TU(5) = 8.910</td>
<td>TUO(5) = 6.030</td>
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<td>TU(6) = 10.000</td>
<td>TUO(6) = 6.320</td>
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<td>S(7) = 4.190</td>
<td>TU(7) = 11.220</td>
<td>TUO(7) = 7.010</td>
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<td>TU(8) = 12.590</td>
<td>TUO(8) = 7.690</td>
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<td>TUO(9) = 8.726</td>
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<td>TU(10) = 15.850</td>
<td>TUO(10) = 9.475</td>
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<td>S(11) = 1.946</td>
<td>TU(11) = 17.780</td>
<td>TUO(11) = 10.590</td>
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<td>S(12) = 1.356</td>
<td>TU(12) = 20.000</td>
<td>TUO(12) = 12.389</td>
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<td>S(13) = 1.754</td>
<td>TU(13) = 22.390</td>
<td>TUO(13) = 13.945</td>
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<td>S(14) = 1.012</td>
<td>TU(14) = 25.120</td>
<td>TUO(14) = 15.650</td>
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<td>S(15) = 0.910</td>
<td>TU(15) = 28.180</td>
<td>TUO(15) = 16.161</td>
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<td>S(16) = 1.113</td>
<td>TU(16) = 31.620</td>
<td>TUO(16) = 18.286</td>
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<td>S(17) = 0.699</td>
<td>TU(17) = 35.480</td>
<td>TUO(17) = 20.333</td>
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<tr>
<td>S(18) = 0.910</td>
<td>TU(18) = 39.810</td>
<td>TUO(18) = 20.934</td>
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<tr>
<td>S(19) = 0.632</td>
<td>TU(19) = 44.670</td>
<td>TUO(19) = 23.844</td>
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<td>S(20) = 0.987</td>
<td>TU(20) = 50.120</td>
<td>TUO(20) = 27.594</td>
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<tr>
<td>S(21) = 0.771</td>
<td>TU(21) = 56.240</td>
<td>TUO(21) = 31.694</td>
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<tr>
<td>S(22) = 1.172</td>
<td>TU(22) = 63.100</td>
<td>TUO(22) = 34.925</td>
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<tr>
<td>S(23) = 0.708</td>
<td>TU(23) = 70.830</td>
<td>TUO(23) = 37.734</td>
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<tr>
<td>S(24) = 0.880</td>
<td>TU(24) = 79.430</td>
<td>TUO(24) = 39.544</td>
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<td>S(25) = 0.832</td>
<td>TU(25) = 89.130</td>
<td>TUO(25) = 41.355</td>
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<td>S(26) = 0.980</td>
<td>TU(26) = 100.000</td>
<td>TUO(26) = 43.166</td>
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<tr>
<td>S(27) = 0.980</td>
<td>TU(27) = 112.200</td>
<td>TUO(27) = 44.977</td>
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<tr>
<td>S(28) = 0.789</td>
<td>TU(28) = 125.900</td>
<td>TUO(28) = 46.788</td>
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<tr>
<td>S(29) = 0.900</td>
<td>TU(29) = 141.250</td>
<td>TUO(29) = 50.599</td>
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<tr>
<td>S(30) = 0.918</td>
<td>TU(30) = 158.490</td>
<td>TUO(30) = 54.399</td>
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<tr>
<td>S(31) = 0.944</td>
<td>TU(31) = 177.930</td>
<td>TUO(31) = 58.299</td>
<td>14DB</td>
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<tr>
<td>S(32) = 0.913</td>
<td>TU(32) = 199.530</td>
<td>TUO(32) = 62.199</td>
<td>13DB</td>
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<tr>
<td>S(33) = 0.766</td>
<td>TU(33) = 223.870</td>
<td>TUO(33) = 66.099</td>
<td>12DB</td>
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<tr>
<td>S(34) = 0.900</td>
<td>TU(34) = 248.180</td>
<td>TUO(34) = 70.999</td>
<td>11DB</td>
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<tr>
<td>S(35) = 0.633</td>
<td>TU(35) = 281.840</td>
<td>TUO(35) = 74.899</td>
<td>10DB</td>
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<tr>
<td>S(36) = 1.111</td>
<td>TU(36) = 316.230</td>
<td>TUO(36) = 78.799</td>
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<td>S(37) = 1.250</td>
<td>TU(37) = 354.820</td>
<td>TUO(37) = 82.699</td>
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<td>S(38) = 1.306</td>
<td>TU(38) = 398.110</td>
<td>TUO(38) = 86.599</td>
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<td>S(39) = 1.471</td>
<td>TU(39) = 446.680</td>
<td>TUO(39) = 90.499</td>
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<td>S(40) = 1.809</td>
<td>TU(40) = 491.190</td>
<td>TUO(40) = 94.399</td>
<td>5DB</td>
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</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
40

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>
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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 \( (A_e) \) 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 ($14\pm3$ mV) and general atmospheric noise which is always present ($40\pm10$ 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 usec 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:

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

(3.1)

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 application 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 communication]. A CW signal is inputed into the receiver along with the received data from the antenna. The noise and partially reflected signals are each defined 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]:

\[ v_m = Kp \]  

(3.2)

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

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

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

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 \( v_m \) 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:

\[ [e] = \ln\left[ \left( A_x / A_o \right) / \left( R_x / R_o \right) \right] \frac{h_1}{h_2} \frac{1}{FD} \]  

(3.3)

\[ FD = \frac{5Ahe^2/2mc}{e^m} v_m \left\{ \xi_{5/2} \left( (\omega-\omega_L)/v_m \right) - \xi_{5/2} \left( (\omega+\omega_L)/v_m \right) \right\} \]  

(3.4)

where

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

\( \epsilon = m\nu^2/2kT \)

\([e] = \text{electron density} \)

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

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

\( \varepsilon_o = \text{permittivity of free space} = 8.85 \times 10^{-12} \text{ F m}^{-1} \)
Figure 3.14 The collision frequencies used in the program CALC to obtain electron-density profiles.
\[ \omega = \text{angular frequency of the transmitted wave} \]
\[ \omega_L = \text{gyro-frequency of the electron} \]
\[ h_1 = \text{lower height} \]
\[ h_2 = \text{higher height} \]
\[ \Delta h = h_2 - h_1 \]
\[ k = \text{Boltzmann constant} = 1.38 \times 10^{-23} \text{ J} \text{ K}^{-1} \]
\[ T = \text{temperature} \]
\[ V = \text{electron velocity} \]
\[ R_o = \text{ordinary mode reflection coefficient} \]
\[ R_x = \text{extraordinary mode reflection coefficient} \]

This equation required a set of collision frequency constants which are given in the program CALC (FORTRAN IV). The ratio \( \left( \frac{R_x}{R_o} \right)_{h_2} / \left( \frac{R_x}{R_o} \right)_{h_1} \) 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)

\[
[e] = \ln \left( \frac{\text{RATIO}_2 \times \left( \frac{A_x}{A_o} \right)_{h_1}}{\left( \frac{A_x}{A_o} \right)_{h_2}} \right) / \text{FD}
\]

where \( \text{RATIO}_2 = \left( \frac{R_x}{R_o} \right)_{h_2} / \left( \frac{R_x}{R_o} \right)_{h_1} \).

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>Output Voltage</th>
<th>Input Voltage</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>307.057</td>
<td>600.075 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>400.883 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>100.758 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>80.000 mV</td>
<td>80 mV</td>
</tr>
<tr>
<td>35.208</td>
<td>70.000 mV</td>
<td>70 mV</td>
</tr>
<tr>
<td>30.844</td>
<td>60.000 mV</td>
<td>60 mV</td>
</tr>
<tr>
<td>25.769</td>
<td>50.330 mV</td>
<td>50 mV</td>
</tr>
<tr>
<td>20.022</td>
<td>40.000 mV</td>
<td>40 mV</td>
</tr>
<tr>
<td>15.022</td>
<td>30.000 mV</td>
<td>30 mV</td>
</tr>
<tr>
<td>10.200</td>
<td>20.000 mV</td>
<td>20 mV</td>
</tr>
<tr>
<td>4.830</td>
<td>10.000 mV</td>
<td>10 mV</td>
</tr>
<tr>
<td>3.857</td>
<td>9.000 mV</td>
<td>9 mV</td>
</tr>
<tr>
<td>3.233</td>
<td>8.000 mV</td>
<td>8 mV</td>
</tr>
<tr>
<td>3.010</td>
<td>7.000 mV</td>
<td>7 mV</td>
</tr>
<tr>
<td>2.847</td>
<td>6.000 mV</td>
<td>6 mV</td>
</tr>
<tr>
<td>2.443</td>
<td>5.000 mV</td>
<td>5 mV</td>
</tr>
<tr>
<td>2.054</td>
<td>4.000 mV</td>
<td>4 mV</td>
</tr>
<tr>
<td>1.404</td>
<td>3.000 mV</td>
<td>3 mV</td>
</tr>
<tr>
<td>0.659</td>
<td>2.000 mV</td>
<td>2 mV</td>
</tr>
<tr>
<td>0.125</td>
<td>1.000 mV</td>
<td>1 mV</td>
</tr>
<tr>
<td>0.010</td>
<td>0.000 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 $A_x/A_o$ 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 $A_x/A_o$ 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 $A_x/A_o$ 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 $A_2/A_0$ 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 \([e]\) and \(\alpha_{\text{eff}}\). Equation (3.1)

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

(3.1)

where \(q\) = electron production rate in \(\text{cm}^{-3} \text{sec}^{-1}\)

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

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

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

\(F_o\) = 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.

\[
\tau = \sigma_a(\text{O}_2) \ [\text{O}_2] \ H \sec \chi
\]  

(3.2)

\([\text{O}_2]\) = number density of molecular oxygen in \(\text{cm}^{-3}\)

\(H\) = 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 \(\alpha_{\text{eff}}\) being chosen to give the best fit to the experimental results. A value of \(2 \times 10^{-6}\) for \(\alpha_{\text{eff}}\) 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 \(\alpha_{\text{eff}}\) was found to be \(8.46 \times 10^{-7}\). These values for \(\alpha_{\text{eff}}\) are similar to ones given by Mitra [1968]. Figure 4.11 shows a comparison between the theoretical \([e]\) during the eclipse and without the eclipse using \(\alpha_{\text{eff}}\) 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 \(a_{\text{eff}}\) 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 $\alpha_{\text{eff}}$ 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 $1 \times 10^{-3} \text{ erg cm}^{-2} \text{ sec}^{-1}$.

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.
REFERENCES

Aikin, A. C. (1972), The relationship of theory and experiment in the D region, 

Barth, C. A. (1966), Rocket measurement of nitric oxide in the upper atmosphere, 
*Planet. Space Sci.* 14, 623-630.

Belrose, J. S. and M. J. Burke (1964), Study of the lower ionosphere using 

Birley, M. H. and C. F. Sechrist, Jr. (1971), Partial-reflection data collection 

*COSPAR International Reference Atmosphere* (1965), North Holland Publishing 
Company, Amsterdam.

Deeks, D. G. (1966), D-region electron distributions in middle latitudes deduced 

Denny, B. W. and S. A. Bowhill (1973), D-region electron densities for the 
Univ. Ill., Urbana-Champaign

Donahue, T. M. (1972), Positive ion chemistry of the D and E regions, *Radio 
Sci. 7*, 73-80.

Edwards, B. (1972), Research in Aeronomy: October 1, 1972 - March 31, 1973, 
*Prog. Rep. 73-1, Aeron. Lab.*, Dep. Elec. Eng., Univ. Ill., Urbana- 
Champaign.

Fehsenfeld, F. C., A. L. Schmeltekopf, and E. E. Ferguson (1965), Correction 
in the laboratory measurement of the rate constant for $N_2^+ + O_2 \rightarrow N_2 + O_2^+$ 
at 300° K *Planet. Space Sci.* 13, 919-920.


Huffman, R. E., D. E. Paulsen, J. C. Larrabee, and R. B. Cairns (1971), Decrease in D-region O_2(^1A_g) photoionization rates resulting from CO_2 absorption, J. Geophys. Res. 76, 1028-1038.

Hunt, B. G. (1965), A theoretical study of the changes occurring in the ozonosphere during a total eclipse of the sun, Tellus XVII, 516-523.

Hunten, D. M. and M. B. McElroy (1968), Metastable O_2(^1A) as a major source of ions in the D region, J. Geophys. Res. 73, 2421-2428.


Shimazaki, T. and A. R. Laird (1972), Seasonal effects on distributions of minor neutral constituents in the mesosphere and lower thermosphere, *Radio Sci.* 7, 23-44.


APPENDIX

.DTITLE DLOGFI
/DLOGFI 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. A/PROC. PARAM.*
/READM READS UNFORMATTED CHAR. FROM TTY
/TOD INCREMENTS THE TIME OF DAY
/CALIBRATION:
/NADC READS SAMPLES FROM A/D CONVERTER
/FOR FORTHAN PROGRAMS
/TIM WRITES LIN. TABLE OUT ON DISK
/COLLECTION:
/BEGIN MAIN COLL. PROG.--A REAL TIME
/SUBROUTINE API LEVEL 6
/VTL GIVES TIME TO LOWER API LEVELS
/RSUB SETS UP DATA PACK & CHECKS NOISE
/--- R=T SUB. AT API LEVEL 5
/PAC PACKS DATA DOUBLE
/DDTRANS WRITES DATA ON STORAGE DEVICE
/CKONV CHECKS FOR ENOUGH DATA
/CHECK SEES IF AX & AO IS IN THE RIGHT
/ORDER AND ARE COLL. IN PABLES=YES API 5
/LIN. DATA INI #=0, & CHECKS NOISE
/READ PREPARES A/D CONVERTER READ
/ADINT A/D INTERRUPT SERVICE ROUTINE
/PROCESSING:
/CHNG INIT. DEV. & CHECKS FOR COLL.-FILE
/CONT. WAITS FOR FILE TO BE COLLECTED
/ADITI ALLOWS TIME FOR BACKGROUND
/CLKCOL CHECKS FOR UNWANTED COLL.+STOP
/SVIT USED TO SWITCH DISKS
/DUMPT READS DATA, UNPACKS IT & PUTS
/IT INTO A FORTRAN ARRAY

DATA IS COLLECTED ALTERNATELY ORDINARY AND EXTRAORDINARY
AS DESCRIBED BY BIRLEY (AEONOMY 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 ASF 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 OVERMAXIMUM STORAGE ON THE DISK.

TU=4
TT=1
TH=10
OUTP2=2
OUTP2=1
DATIN=5
DATIN=3
OUTI=1
IN=
ASC=2
IA=3
DUMP=4
SKAR=5
TNSAM=37
NSAM=TNSAM-SKAR
NSAMP=NSAM/#=2
DATA=DATA+TNSAM=2
DTBLK=374
DATS=DTBLK/NSAMP
NBLK=10
MNGO=11
NFG=6
NDFC=NSAMP/2
DP=NRDC+1
MAP=500800/NSAMP
MAX=6 FRAMES PER DEVICE
NDFD=1

THE FOLLOWING SUBROUTINE IS USED TO PREPARE THE
/COLLECTION AND PROCESSING PROGRAMS FOR MANIPULATION OF DATA.
/THE VARIABLES OF THE MACRO PROGRAMS ARE STORED IN THIS SUBROUTINE
/THEREFORE AFTER THIS SUBROUTINE IS EXECUTED IT IS WRITTEN OVER
/AND SHOULD NOT BE REENTERED (FOR IT WILL NOT EXIST).
DLOGF 0             /SET SUBROUTINE PARAMETERS' ADDRESSES
TCS  JMS  +DA     /JUMP AROUND PARAMETER LIST
SUN4  JMP  +4      /ADDR. OF THE ADDR. OF THE DB SETTINGS
DB  0             
DGC  0             
TCS  0             
RMSGI  LAC  MSGI+3 /SET UP RESET FOR TELETYPE
TC1  DAC  RMSG1    /MESSAGE
DSTA5  JMP  QNGA   /GO TO NEXT EXECUTABLE STATEMENT
CTI  LAW  NPF1    /COUNTS # OF NOISE PER FRAME
CTS  LAW  NPF2    /COUNTS GROUPS OF NOISE FOR MAX. NOI.
CTT3  LAW  -2     /USED TO SWITCH STORAGE DEVICES (IF
CTT4  LAW  -2     /NEEDED) FOR COLL. AND PROC.
CTT5  LAW  NPF2   /USED TO SKIP AROUND "SKR" DATA # S
CTT6  LAW  -2     /USED TO SWITCH BUFFERS IN COLL.
CTT7  0             
CTT8  LAW  -DATSTH /COUNTS # OF DATA # S PER BUFFER
CT9  LAW  -1      /ALLOWS PROC. TO READ DATA
CIT10 0             /TELLS PROC. TO RESTORE A FILE 1
CIT11 0             /TELLS PROC. END OF RUN
ALF  51004        /USED TO PUT A LINE FEED IN THE
                  20100        87 MIDDLE OF A FORTRAN OUTPUT LINE
TST1  0             /SAVE ID TO TEST FOR COLL. STOPPAGE
SAVAC  0           /SAVES AC DURING PROC. OPERATION
                  /SAVES AC FOR API LEVEL 6
TCS10  LAW  -2     /USED TO UNPACK 2 WORDS
CN1  0             /STORES # OF FRAMES FOR ONE FILE
CN2  0             /STORES # OF FRAMES FOR ONE DISK
CNT  0             /ODD FOR O-FRAMES, EVEN FOR X-FRAMES
CNT2 0             
DUM1  0             /SET TO -1 FOR O-FRAMES
DUM2  0             /GETS & STORES 1 LINEARIZED DATA WORD
DUM3  0             /STORES THE MAX. NOISE IN A FRAME
DUM4  0             /STORES THE SUM OF THE NOISE PER FRAME
DUM5  0             /STORES THE MAX. OF 45 NOISE SAMPLES
MAX  777             /STORES THE SMALLEST MAX. OF "DUM4"
TBUF  +DSA  BUF1   /STORES NAME OF BUF. TO BE OUTPUTED
IDOCV  0             /STORES THE ID NUMBER
TRANP  0             /DATA IS TRANSFERRED WHEN NON-ZERO
COUNTP  LAW  -NDPC /COUNTS # OF DATA PER FRAME TO PACK
DPOINT  +DSA  BUF1  /POINTER FOR "BUF"
COUNT  LAW  -NDPC  /COUNTS # OF POINTS TO UNPACK
ER2  0             /STORES TIMING ERROR FOR A-D CONVERTER
                  /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
SRAO  0             /SAVES AC DURING TIME ROUTINE (TOO)
MIN  0             /STORES THE MIN. IN DURING EACH HOUR
MCR1  0             /STORES # OF MIN. OF RUN
LETCHG  +DSA  NBLK /ADDRESS OF SUB."READ" BUFFER
BUF11  +DSA  BUF1   /ADDRESS OF BUF1
BUF21  +DSA  BUF2   /ADDRESS OF BUF2
DUM31  +DSA  BUF3   /ADDRESS OF DUM3
SEVN  37950         /13235: LEDs FUNCTION
                  /DEC
MIN  599         /MAX. # OF .1 MIN.'S IN 1 HOUR
CH1  33999       /#1 & #2 OF TIME IN DEC.:
                  /USED TO INCREMENT TIME BY 1 HOUR
                  /OCT
DRB  +DSA  DRO    /POINTER FOR THE DBS
DBK  0             /DB'S STORAGE BLOCK
38540         /ASCII DEFAULT SETTINGS
31152         /ARE 0,16,25 (DEC)
LAW  -1             /TELLS END OF DB SETTINGS
ST1  0             /LIN. TABLE
POINT  +DSA  SEVN  /POINTER FOR COLLECTION BUFFERS
BUF1  +BLOCK  DTLK=303 /FIRST COLLECTION BUFFER
STT  +SIXBT "TABLEDAT" /NAME OF FILE TO BE READ IN
MSG7  2000        0
LAST  +ASCII "SET CONSOLE SWITCHES, TURN ON PULSER AND ENCODE PU"
                  +ASCII "LSE"<15>
MSG8  2000        0
                  +ASCII "DISCONNECT WIRE FROM PULSED OSCILLATOR"<15>
MSG9  2000        0
                  +ASCII "SET ATTENUATOR TO 0DB"<15>
MSG10  2000       0
                  +ASCII "TYPE # OF HOURS FOR THE RUN AND C.R."<15>
MSG10  2000       0
ERRCAL 2000

*/ASCI "DB SETTING"<15>*

DMV1 JMP BLK2  / USED TO DELETE COL. HEAD
DMV2 204  / LOC. TO DETERMINE WHICH TTY CONFIRMS +C
DMV3 177  / LOC. USED TO ALLOW SHARE
DMV4 116  / ADDR. OF LOC. OF FOREGN +DAT SLOT 0
DMV5 117  / ADDR. OF LOC. OF BACKEND +DAT SLOT 0
DMV6 113  / ADDR. OF THE +JOIN TABLE
SRPO 0  / USED TO SURPRESS CALIBRATION
FDAT1 0  / THESE LOCATIONS ARE USED
FDAT2 0  / TO STORE THE
FDAT3 0  / FOREGROUND +DAT SLOT
FDAT5 0  / ADDRESSES FOR 1,2,3,4,5
FDAT10 0  / AND 10
MINEQ • DSA MINEQ  / USED TO DETERMINE LENGTH OF RUN
       / DEC
MINEQ 6000  / CONVERTS INPUT NUMBERS TO
       / THE EQUIVALENT
       / 60  / BCD # OF MINUTES
       / OCT
CNI 0  / USED TO DETERMINE MULTIPLES OF 10
DBP1 0  / TEMP. STORAGE FOR DB SETTING
DBP2 0  / TEMP. STORAGE FOR DB IN ASCII CODE
DBCN1 0  / COUNTER FOR # OF DB TO BE USED
DBCN2 LAJ -2  / ALLOWS NO MORE THAN 2 2 DIGIT DB'S
DBCN3 LAJ -4  / ALLOWS ONLY 4 DB SETTINGS
CODE1 777723  / +55 TO CEC FOR CARRIAGE RETURN
CODE2 + DSA MINEQ+2  / FOR LESS THAN 10 HOUR RUN
CODE3 1000  / ASCII SPACE AND A ZERO
CODE4 15  / CHECK FOR CARRIAGE RETURN
CODE5 LAJ -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 777756  / +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 10  / USED TO DETERMINE VALUES OF ASCII # 5
CODE13 1000  / LOOKS FOR DEVICE # 5 (DISK)
CODE14 1000  / LOOKS FOR THE DEVICE # 4 (DECTAPE)
CODE15 160000  / USED TO FIND THE UNIT # FOR A DEVICE
CODE16 16  / CHECKS FOR DECIMAL POINT
CODE17 LAJ -32  / USED TO CHECK FOR NONNUMBER ASCII CHAR.
CODE18 - MXPD  / SETS MAXIMUM AMOUNT COLL. ON A DISK
CODE19 + DSA DECN  / INIT. MULTIPIERS FOR BCD # 5
CODE20 + DSA MINEQ  / INIT. MULT. TO CONVERT TIME TO MIN
CODE21 NOFUK  / SETS UP # OF DISKS TO BE USED
CODE22 30000  / CHECKS FOR UNIT 1
CODE23 20000  / CHECKS FOR UNIT 3
CODE24 -310000  / CHECK FOR ASCII "1" IN DATE
CODE25 -14000  / USED TO CHECK FOR ASCII "5" TO "9"
CODE26 3760  / 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 LETTERS
CODE30 -200000  / USED TO INCREMENT 4 ASCII LETTERS
CODE31 -400000  / USED TO INCREMENT 1 ASCII LETTER
CODE32 20000  / CHECKS FOR ASCII "A"
CODE33 7  / USED TO MASK ALL HIGHER BITS
CODE34 3  / CHECKS FOR FIRST HALF ASCII "Y"
CODE35 +4340  / DEFAULT VALUE FOR TIME OF DAY (H.HH)
CODE36 -100000  / CHECKS FOR UNITS LESS THAN 4
CODE37 101000  / HUNDAY CODE FOR +JOIN TABLE
CODE38 498574  / SECOND WORD FOR +JOIN TABLE
CODE39 1600  / LOOKS FOR DEVICE #7 (+P.PUNCH)
CODE40 233300  / USED TO GET CONSOLE SWITCH 1

/*END*/

/$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$/
/ DB SETTING OF THE PARTIAL REFLECTION PROGRAMS/
/ THIS PART INITIALIZES THE +DAT SLOTS+ SETS UP NEW /
/ DIRECTORIES ALLOWS SHARE MODE AND SETS AND INITIATES THE /
/ CLOCK TO GIVE THE TIME OF DAY. /
/
INTIM + INIT TI0.OUT.INTIM  / STY QJT
     + INIT TTL.ININT  / STY 81N
     + DCE  / SET ADDR. OF FOREGN +DAT SLOTS
LAC  / DCE
DAC  / ONE

/*END*/
IAC DAC FDAT2 / TWO
IAC DAC FDAT3 / THREE
IAC DAC FDAT5 / FIVE
TAD CODE3A DAC FDAT18 / EIGHT
LAC* FDAT2 / SET .DAT SLOT 5 EQUAL
DAC* FDAT5 / TO .DAT SLOT 2
LAC* 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 DAC* FDAT5 / DEVICES - REQUIRED?
JMP NDK11 / NO, OMIT FOLLOWING CODE
LAC MDUM1 / YES, CLEAR JUMP AROUND INSTRUCTIONS
DAC NDK2 / TO USE A SECOND DISK
DAC NDK3 / FOR STORAGE
*INIT DATIN8, OUT, INTIM / PREPARE SECOND DEVICE FOR USE
*CLEAR DATIN2 / REMOVE ALL FILES FROM IT
JMP *3

NDK11 LAC* FDAT3 / CLEAR .DAT SLOTS FOR THE
DAC* FDAT1 / SECOND STORAGE DEVICE
LAS AND CODE48 / GET THE VALUE OF CONSOLE
DAC SLP2 / SET ADDR. TO THIS VALUE
LAV -1 / SWITCH #1
DAC* DMV3 / ALLOW SHARE
DAC* DMV2 / SET TO TO ACKNOWLEDGE IC
JMP NDK2 / JUMP AROUND SECOND BUFFER

BUP2 *BLOCK DTHK-390 / SECOND COLLECTION BUFFER

\[\text{\#DECLARE LAC CODE19 / INITIALIZE BCD}
\text{DAC HAC / POINTER}
\text{ISZ CTM1 / HAS FOUR NUMBERS BEEN}
\text{SKP / READ}
\text{JMP OTLP / YES, EXIT FROM ROUTINE}
\text{WHITE TTO:ASC,MSG1:O}
\text{WAIT TTO}
\text{JMS READM / READ IN TIME}
\text{DT 0 / CONTAINS THE ADDR. OF CHAN. READ IN}
\text{LAW -5 / INITIALIZE COUNTER TO EXIT THE}
\text{DAC CTM1 / ROUTINE AFTER FIVE #'S}
\text{LAW -3 / INITIALIZE COUNTER TO GET THE MINUTES}
\text{DAC CTM2 / THE MINUTES}
\text{LAC MIN / INITIALIZE LOC. THAT SAVE}
\text{DEM HL / THE TIME AND MINUTES}
\text{NXT1 JMS CHKN / GET NEXT NUMBER}
\text{JMS* AD / MULTIPLY BY POWERS OF TEN}
\text{LAC HAC / TO GET BCD EQUIVALENT}
\text{DAC SAV0 / SAVES THE MINUTES}
\text{TAD HR / SETS UP THE NUMBERS READ IN}
\text{DAC HA / AS THE PRESENT TIME}
\text{ISZ CTM2 / IS THE NUMBER PART OF THE MIN?}
\text{JMP JPAR / NO, FIRST TWO #'S ARE THE HOURS}
\text{LAW -1 / HESET COUNTER TO GET ALL THE}
\text{DAC CTM2 / MIN. (REST OF THE #'S)}
\text{LAC SAV2 / GET MINUTES AND}
\text{TAD MIN / SET INTO AN ADDR.}
\text{DAC MIN / WHICH SAVES MIN.}
\text{JPAR ISZ HAC / GET NEXT MULTIPLYING #}
\text{ISZ CTM1 / OBTAINED 5 NUMBERS ?}
\text{JMP NKT1 / NO, GET NEXT NUMBER}
\text{DAC MMIN / CHECK THE MINUTES}
\text{TCA / IS THE MINUTES GREATER THAN}
\text{TAD MIN / THE MAX. NUMBER OF MINUTES}
\text{SMA / IN AN HOUR ?}
\text{JMP ADERR / YES, ASK FOR THE TIME AGAIN}
\text{DAC CHR / NO, CHECK THE TOTAL TIME}
\text{TCA / IS THE TIME OF DAY ?}
\text{TAD HR / LARGER THAN THE BIGGEST #}
\text{SMA / ALLOW FOR THE TIME OF DAY ?}
\text{JMP ADERR / YES, ASK FOR TIME AGAIN}
\text{DAC MH / NO, PUT THE TIME INTO THE}
\text{DAC TIME / ADDHS WHICH GIVE THE}
\text{DAC TIME / TIME OF DAY}
\text{-TIMER 360-TOD, S / SET UP THE TIMING R. T. SUB.}
\text{JMS CONTL / TRANSFER CONTROL TO CONTROL PROGRAM
\text{JMP ++2}
ADDRESS FOR CALIBRATION SURRESSION

/ASCII "TIME"<15>

/LOC. WHICH COUNTS 5 NUMBERS

/LOG. TO IGNORE THE HOURS

/LOG. TO SAVE THE MIN. # S

/LOG. TO SAVE THE TIME

/POINTER FOR THE BCD MULTIPLIERS

/BCD MULTIPLIERS 10000 1000 100 10 I

*OCT

/SUB. TO SEPARATE OUT THE NUMBERS

/BCD MULTIPLIERS 10000 1000 100 10 I

/EJECT

/ADDITION OF ADDH. OF LINT. TABLE

/BCD MULTIPLIERS
SMA IS THE NUMBER < 8?
JMP ONC3 /YES, SET TIME OF YEAR LOC. TO SUM.

WINT AND CODE26 /GET SECOND NUMBER
SAD CODE27 /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 ONC3 /YES, EXIT
TAD CODE29 /NO, IS THE FIRST LETTER
SPA /A "M"?
JMP WINTL /YES, WINTER MONTH
TAD CODE30 /NO, IS THE FIRST LETTER
SPA /A "F"?
JMP ONC3 /YES, EXIT
TAD CODE31 /NO, IS THE FIRST LETTER
SPA /A "J"?
JMP SWDIS /YES, SET TIME OF YEAR LOC.
TAD CODE32 /TO SUMMER
JMP ONC3 /EXIT

SWDIS AND CODE26 /CHECK IF SECOND LETTER
SAD CODE32 /IS AN "A"
JMP WINTL /YES, A WINTER MONTH
SAD SUM4 /NO, SET TIME OF YEAR LOC. TO SUMMER
JMP ONC3 /EXIT

EVDIS AND CODE33 /IS THE THIRD LETTER
SAD CODE34 /A "Y"?
JMP ONC3 /YES, EXIT
TAD CODE35 /NO, SET TIME OF YEAR TO SUMMER
JMP ONC3 /EXIT

EJECT

SUBROUTINE CLEARS I/O DEVICES FROM MEMORY TO BE ABLE TO DISALLOW SHARING THE DATA COLLECTION DEVICES
FRDT

LAC* DM6 /GET LOC. OF THE JOIN 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 #
HAL /2 WORDS PER DEVICE USED
DAC DM2 /AND USE AS THE COUNTER

RED01 LAC* DM1 /GET FIRST WORD FOR THE FOREGROUND DEV.
AND CODE7 /CHECK FOR THE DEVICE #
SAD CODE13 /IS IT A 5 (DISK)?
JMP DLTD /YES, CHECK WHICH DISK
SAD CODE14 /NO, IS IT A 6 (DECTAPE)?
JMP DCTP /YES, CHECK WHICH DECTAPE
SAD CODE39 /NO, IS IT A 7 (P. PUNCH)?
JMP SAUNI /YES, SAVE IT

DLTD 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

ANO1 ISZ DM1 /GO TO NEXT DEVICE
LAC CODE38 /HAS ALL THE DEVICES BEEN CHECK?
JMP RED01 /YES, CONTINUE
JMP FRDT /NO, RETURN

DKS LAC* DM1 /GET FIRST WORD
AND CODE15 /LOOK AT UNIT NUMBER
SAD CODE28 /IS IT A 1?
JMP DLTD /YES, DELETE THE DEVICE WORDS
SAD CODE23 /IS IT A 3?
SKP SAUNI /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

+WRITE ITO*ASC,*ERHCAL,0 /LIN. TABLE ERROR
+WAIT ITO
+TES* TPRLB /RECALIBRATE

/LOCATION OF THE RESPONSE
/SET ASCII CHAR. LESS THAN
/PREPARE FOR NEXT CHAR
/IS CHAR > 40 ?
/NO, THERE ARE NO MORE CHAR.
/NO, IS THE ASCII # LESS THAN
/THAN 72 ?
/YES, USE ONLY ONE NUMBER, AV
/ASCII # (>57) ?
/YES, IS THIS THE SECOND # ?
/NO, CONTINUE
/YES, PROCESS THE TWO #'S
/SAVE THE FIRST #
/AND GET SECOND #
/HAS ONE # BEEN OBTAINED ?
/NO, RESET COUNTER
/GET THE NUMBER AND
/SET INTO FORTRAN ARRAY
/SET THE NUMBER UP AS A SPACE
/AND A # IN ASCII FORMAT
/USED TO PRINT OUT DB MESSAGE
/prepare FOR NEXT DB
/RESET COUNTER FOR
/2 NUMBERS
/Try AGAIN
/SAVE SECOND # IN FORTRAN ARRAY
/SET UP NUMBER IN
/ASCII CODE
/AND STORE
/GET FIRST NUMBER
/SET UP THE BCD
/EQUIVALENT
/ADD TO THE SECOND #
/AND STORE IN FORTRAN PROGRAM
/GET FIRST NUMBER AGAIN
/SET UP THE NUMBER
/IN ASCII
/ADD TO PRVIOUS # TO FORM
/RESET COUNTER FOR THE
/NEXT 2 NUMBERS
/NEXT LOC. IN THE FORTRAN ARRAY
/NEXT LOC. IN THE MACRO ARRAY
/COUNTER TELLING # OF DB SETTING
/HAS FOUR DB SETTINGS BEEN OBTAINED ?
/NO, GET NEXT SETTING
/CHECK--HAS ANY NUMBERS

/PROCESSING'S BUFFER
/WHITE --HAS ANY NUMBERS
/NEXT LOC. IN FORTRAN PROGRAM
/USE DEFAULT DB SETTING
/DONE
/USE DEFAULT DB SETTING
/YES, USE ONLY ONE NUMBER
/ASCII # (>57) ?
/YES, IS THIS THE SECOND # ?
/NO, CONTINUE
/YES, PROCESS THE TWO #'S
/SAVE THE FIRST #
/AND GET SECOND #
/HAS ONE # BEEN OBTAINED ?
/NO, RESET COUNTER
/GET THE NUMBER AND
/ADD TO THE SECOND #
/AND STORE IN FORTRAN PROGRAM
/GET FIRST NUMBER AGAIN
/SET UP THE NUMBER
/IN ASCII
/ADD TO PRVIOUS # TO FORM
/RESET COUNTER FOR THE
/NEXT 2 NUMBERS
/NEXT LOC. IN THE FORTRAN ARRAY
/NEXT LOC. IN THE MACRO ARRAY
/COUNTER TELLING # OF DB SETTING
/HAS FOUR DB SETTINGS BEEN OBTAINED ?
/NO, GET NEXT SETTING
/CHECK--HAS ANY NUMBERS
DECPT    JMP       CNUM       /YES* EXIT
         /SET COUNTER TO GET ONLY
DAC      LAW      -1       / ONE MORE NUMBER
LAW      DAC      TCQ       /CHECK THE NUMBER
TAD      DSMR     / COUNTER
JMP      CNUM     /HAS TWO NUMBERS BEEN OBTAINED ?
JMP      GETHR    /YES, GET THE LAST NUMBER
LAC      TC1      /NO IF THERE WAS A NUMBER, IT IS
CLL      TC1      /OFF BY A FACTOR OF TEN TOO HIGH
IDIV     TC1      /THEREFORE REDUCE THE NUMBER BY A 10
          /FACTOR OF TEN (ZERO IS UNAFFECTED)
LACQ     /GET THE QUOTIENT
DAC      TC1      /REPLACE WITH CORRECTED #
DAC      CODE2    /SET THE BCD POINTER TO
DAC      MINSC    /THE LAST MULTIPLIER
ISZ      DSMR     /INCRMENT NUMBER COUNTER
JMP      GETHR    /GET NEXT NUMBER

FNUM     LAW      -2       /CHECK THE NUMBER
TAD      DSMR     / COUNTER
JMP      CNUM     /HAS 2 NUMBERS BEEN READ IN ?
JMP      CONM     /YES, IGNORE THE FOLLOWING CODE
IAC      DSMR     /HAS EVEN ONE NUMBER BEEN
JMP      DSMR     /READ IN ?
JMP      DSMR     /NO, USE THE DEFAULT VALUE (13.65)
LAC      TC1      /YES, THERE IS ONE NUMBER BUT
CLL      TC1      / IT IS THE WRONG BCD
IDIV     TC1      /EQUIVALENT SO REDUCE IT BY
          /A FACTOR OF TEN
LACQ     /GET THE INTEGER ANSWER
DAC      TC1      /SAVE CORRECTED NUMBER
DAC      TC1      /GET LENGTH OF RUN NUMBER
TGA      /COMPLIMENT IT
DAC      TCJ      /AND SAVE THE NEGATIVE

NONUM    DSMR     TC1      /INITIALIZE LOC* TO DETERMINE
DSMR     TC2      / THE END OF THE RUN
DSMR     MONTTH    /INITIALIZE BINARY TIME OF DAY
LAC      CODE18    /SET UP MAX* STORAGE FOR
DAC      DSMR     / STORAGE DEVICE
JMS      ADDT     /FREE BACKGROUND DEVICES
         /SET UP MAIN REAL TIME SUB*
JMS*     PROC      /START PROCESSING PROG*
JMP      ^^*m      */# OF PARAMETERS +1
JMP      DSMR     /THE SEASON OF THE YEAR
JMP      DSMR     /LINE FEED
JMP      DSMR     /TIME AT THE END OF EACH FILE

//XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
/ONE LETTER WRITE ROUTINE
JMS WRT
/RETURN TO CALLING ADDR+2
JMP* READM
DLT LAC (INBLK /RESET POINT TO THE BEGINING
DAC NUMB /OF THE BLOCK
LAC (100 /SET UP TO WRITE
JMP +11 /AN # CHAR.

/WRITE CHAR. RETURN INTO THE
ROU LAC (15 /PRESENT LOC. OF THE CHAR. BLOCK
DACK Numb /PRESENT LOC. OF THE CHAR. BLOCK
TAD NUMB /THE PREVIOUS CHAR.
SAD (NUMB /IS THE POINTE AT THE BEGINING?
JMP CONR /YES, DO NOT PRINT OUT ANYTHING
DAC Numb /NO. RESET POINTER BACK 1 LOC.
LAC (134 /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.

/WRITE ONE IMAGE ALPHANUM. CHAR.
WRT 0
*WAIT TTO
JMP* WRT /RETURN

/RUBOUT 2003 /IMAGE A. OUT PUT
0 /MESSAGE
0 /LOC. TO STORE CHAR. TO OUTPUT

/BLOCK CHAR. IS READ
NBLK *BLOCK 3 /BLOCK CHAR. IS READ INTO.
NUMB *SPEC 4 /BLOCK CHAR. IS READ INTO.
DAC (NUMB /CHARACTER BLOCK POINTER

/A-D CONVERTER
DAC (NUMB /READN OF THE NUMBER OF TENTHS OF MINUTES THAT HAS PAST IS
DAC (NUMB /TO STORE CHAR. TO
DAC (NUMB /RESTART TIME ONCE
DAC (NUMB /AND SAVE CHAR.
DAC (NUMB /TO STORE ALL THE READ IN CHAR.

/SAVE CHAR. FROM LOWER AP LEVELS
TOD 0
DAC SVAC
*TIME 368+TOD+5
ISZ MCNT
LAC MINT /INCREMENT BINARY COUNTER
SAD MIN /CHECK THE MINUTE ADDR.
JMP CHIN /IS IT SET TO 59*9 MINUTES?
ISZ MIN /NO, INCREMENT THE MINUTE COUNTER
ISZ TIME /AND TIME OF DAY COUNTER

/BLOCK CHAR. IS READ INTO.
RESTOR LAC SVAC /RESTOR AC FOR LOWER LEVEL PROGRAM
*HALT TOD /EXIT FROM PHQ. AND API LEVEL

/CHECK TIME OF DAY
CHIN DN MIN /RESET MINUTES TO ZERO
LAC TIME /CHECK TIME OF DAY
SAD CHA /IS THE TIME AT THE END OF THE DAY?
JMP CTIME /YES, START A NEW DAY
TAD NHK /NO, CHANGE TO NEXT HOUR
DAC TIME / AND SAVE THE TIME
JMP RESTOR /EXIT

/RESTART TIME TO A NEW DAY
CTIME DN TIME /RESTART TIME TO A NEW DAY
JMP RESTOR /AND EXIT

/RESTART THE PROCESSING PROGRAMS
PSTART DNX BEGIN /RESET R.+T. SUB. BEGIN TO BE REENTERED
DAC MDUMI /PREPARE TO REINITIALIZE THE STORAGE
DAC START /DEVICE AND BEGIN A NEW FILE
DAC ILOCU /HAS THE COLLECTION FINISHED COLLECTING
SPA /THE PRESENT FILE?
JMP +3 /YES, LEAVE AS SET UP
DAC (JMP RESTAR /NO, PREPARE TO CLOSE THE
DAC START /OLD FILE
*TIME 0:BEGIN+6 /RESTART THE COLLECTION
JMP DUMP+1 /RESTART THE PROCESSING PROGRAMS

/MAIN PROGRAM
/ENTERANCE TO THE MAIN REAL TIME SUB.
BEGIN 0
DAC SAVAC
START 0
CI *INIT OUTPT+OUT+RESTART /DT OUT
JMP INIT /GO TO INITIALIZING ROUTINE
ADO DDS ADREAD /PREPARE TO READ FROM A-D CONVERTER
TNSAM /# OF DATA NUMBERS TO READ
BUFF /ADDR. TO STORE DATA #5
ERS /COMPLETION AND ERROR TIMING FLA3
500000*RSUB /PRIORITY LEVEL * R.+T SUBR. TO EXEC.
RET3  LAW -1  /LOAD -1 INTO MEMORY TO KEEP TRACK OF
DAC  CNT2  / THE SAMPLE THAT HAS BEEN COLL.
LAC  SAVDAC  /RESTORE ACCUMULATOR
END1  *RLXIT  BEIN  /RELINQUISH CONTROL TO LOWER PRIORITY
ONCE  NOP
PK0  JMS  ADHEAD  /A-D CONV. READ FOR X-SAMPLES
INSAM  /THE VARIABLES USED
BUFF  / ARE THE SAME ONES USED FOR
ENR  / THE O-SAMPLE AND ARE
SS0030+R5UB  / EXPLAINED ABOVE
LAC  SAVDAC
EN02  *RLXIT  BEIN  /RELINQUISH CONTROL
RET2  LAC  TNYF  /GET DECTAPE TRANSFER FLAG
SMA  / AND TEST IT
A  CTAICLL  /CLEAR AC TO READ CONSOLE SWITCHES
LAC  *(JMP  A  /SET UP TO RECHECK CONSOLE SWITCHES
DAC  START  /AND PUT INTO START
LAC  SAVDAC
*TIMEx  0+BEIN  /RETURN TO R.-T. SUB. BEGIN
+RLXIT  WT1  /LOWER LEVEL BEFORE RECHECKING SWITCH

DAC  SAUDAC  /PUT CLOCK BACK INTO
LAC  MDJMI  /OPERATION
DAC  ONCE  /TELLS PROC. COLL. HAS STOPPED
DZM  CNT  /ID 0
LAC  (JMP  A  /START COLLECTING A FILE
DAC  TNYF  /PUT INTO START
LAC  SAVDAC
*TIMEx  0+BEIN  /RETURN TO R.-T. SUB. BEGIN
+RLXIT  WT1  /END OF MAIN PROGRAM

BUFF  BLOCK DATBLK  /BUFFER TO STORE AD SAMPLES
NAME  *SIXBT  "DATAFIDAT"  /NAME OF FILE TO STORE DATA
INIT  DAC  (BUFI  /POINTER IN DECTAPE BUFFER
DAC  TBUF  /NAME OF DECTAPE BUFFER IN USE
LAC  IORDJ  /SAVE THE ID # (THE #
DAC  CNT  /OF FRAMES PER FILE)
DZM  IORDJ  /ID NUMBER
DZM  TANF  /DECTAPE TRANSFER FLAG
DZM  CNT  /COUNTER FOR CLOCK
LAC  MDJMI  /PUT CLOCK INTO OPERATION
DAC  ONCE  /TELLS PROCESSING THAT COLLECTION HAS STARTED COLLECTING A FILE
LAW -2  /SET BUFI AS THE FIRST
DAC  CNT6  /BUFFER TO BE USED
LAC  077  /INIT. NOISE MAX.
DAC  MAX4  /LOCATION
LAW  MNUM  /INITIALIZE COUNTER FOR MAXIMUM
DAC  GNT2  /ALLOWABLE NOISE
LAC  CNT  /GET THE LENGTH OF TIME REQUIRED
TAD  TC1  /COLLECT THE PREVIOUS FILE
DAC  BAC  /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

DAC  REPL  /HAS STARTED COLLECTING A FILE
JMP  RDO  /RETURN

/ DECTAPE FILE ROUTINE
/ STORE DATA IN FILE ACCORDING TO RESPONSE

UP  *FSTAT  OUTPT+NAME  /CHECK FOR COLLECTED FILE
UP1  SKP  UPDATE  /REPLACED BY "SMA" IS FILE PRESENT?
WRITE  LAC  MCTR  /YES, ACKNOWLEDGE THE PRESENCE
TGG  /GET THE BEGINNING TIME FROM
DAC  TC1  /THE BINARY CLOCK COUNTER
LAC  TC1  /TO DETERMINE THE COLL. TIME
DAC  MDUM  /DELETE FILE IF PRESENT
LAC  REPL  /OPEN FILE
JMS  DTRANS  /DELETE OUTPT+NAME
JMS  DTRANS  /WRITE DUMMY BLOCK
LAC  MDUM  /TWICE
LAC  MDUM  /TELLS PROCESSING THAT COLLECTION
JMP  RDO  /HAS STARTED COLLECTING A FILE
/RETURN
UPDATE LAC TIME
/SETS THE TIME TO THE END
TAD (S)
/OF THE COLLECTED FILE AND
DAC TIMR
/AND ROUNDS OFF TO THE NEAREST MIN.
*WRITE TTO ASC MSG10
/FILE PRESENT
*WAIT TTO

UPDATE1 NOP
/*REPLACED BY "JMP BLK2" FOR 1 DB SET.
*WRITE TTO ASC MSG34
/KEEP IT?
*WAIT TTO

BLK1 JMS READM
/READ RESPONSE
COM 0
/ADDRESS OF THE RESPONSE
GETCH1 LAC COM
/GET READ IN CHARACTER
DZM COM
/AND ZERO THE LOC.
SAD (116)
/IS CHARACTER A "N"?
JMP STAGN
/CHECK IF NUM. IS LESS
TAD (7-28)
/THAN 78 OCTAL
SPA
/NO, CONTINUE
JMP BLK3
/TAD (12)
/YES, IS NUM. GREATER THAN
SPA
/ST OCTAL?
JMP BLK3
/NO, CONTINUE
DAC COM
/YES, SAVE
ISZ COM
/NEXT CHARACTER
JMP GETCH1
/REPEAT

BLK3 LAC LETCHG
/INITIALIZE THE BLOCK
DAC COM
/CONTAINING THE INPUT CHAR.
LAC COM
/GET FIRST CHAR.
SNA
/IS IT A ZERO?
JMP CONDB
/YES, IGNORE IT
DAC CH3
/PASS TO PROC THE DB CHANGE
TAD (-1)
/OFFSET THE # BY -1
CALLRASH
/DIVIDE BY TWO AND SAVE REMAINDER
TAD (60)
/SET UP AS ASCII CHAR.
SVA
/YES, SAVE
DAC DBP
/SAVE NUMBER
LAC (140)
/ASCII FOR ZERO
SZL
LAC (152)
/ASCII FOR NUMBER 5
TAD DBP
/ADD TO OTHER DB SETTING
CALLRASH
/SET UP AS CHAR 445 IN ASCII WORDS
DAC DBP
/SAVE NEW DB SETTING
CONDB ISZ DBP
/GET NEXT CHAR.
LAC COM
/SET UP NEXT CHAR.
SAD (15)
/IS CHAR A CARRIAGE RETURN?
JMP 4+3
/YES, EXIT
SZA
/NO, IS IT A ZERO?
DAC CMULC
/NO, SET UP MUL. CONSTANT CHANGE
DZM COM
/CLEAR CHAR.
JMS DBSUB
/SET UP NEXT DB MESSGE
LAC CN2
/GET STORAGE ALREADY USED
TAD CNI
/ADD STORAGE SIZE OF LAST
DAC CN2
/FILE AND SAVE
TAD TEM+1
/ADD IT AGAIN AND CHECK--
TAD DSTOK
/WILL ANOTHER FILE OF THE SAME
SMA
/LENGTH OVERFLOW THE STORAGE ALLOW?
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
/HMOVE THE SIZE OF
TCA
/ THE LAST FILE
TAD CN2
/FROM THE
DAC CN8
/STORAGE COUNTER
LAC DBC
/HMOVE THE AMOUNT OF
TCA
/TIME Used
TAD TCA
/ BY THE PRECEEDING
DAC TCB
/FILE
JMP WRITE
/RECOLLECT FILE
/DBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDBDB
/ SUBROUTINE TO CHANGE THE DB MESSAGE TO BE PRINTED OUT
/

Dbsub 0
ISZ DBP
/GET NEXT DB
LAC DBP
/MESSAGE
SMA
/IS IT THE END OF THE DB MESSAGES?
JMP 4+4
/NO, USE THIS MESSAGE
LAC DBB9
/YES, REPEAT THE
DAC DBP
/FIRST DB
LAC DBB9
/SETTING GIVEN
DAC MSG2+11
/INSERT MESSAGE
JMP DBSUB
/RETURN
AN ID IS ASSIGNED AND 26 SAMPLES ARE PACKED WO
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
RSUB
B
DAC
SAV
/SAVE AC
ISZ
CNT
/INCREMENTS COUNTER
MDUM1
NOP
/REMOVES AGAINST A 1 IN "CNT"
DEM
DUM2
/INITIALIZES THE VARIABLES USED
DEM
DUM3
/TO DETERMINE THE NOISE
LAW
NPFC
/USE FIRST 5 NOISE SAMPLES TO SET
DAC
CTT1
/MAK. ALLOWED NOISE FOR PROC.
IAC
/SKIP NOISE AFTER THE 5TH
DAC
CTT5
/NOISE SAMPLE
LAW
-1001
/IS THERE A DISK TIMING ERROR?
JMP
ERSI
/YES. PRINT MESSAGE
NOISE
ISZ
IDC0U
/NO. INCREMENT ID NUMBER
LAC
IDCN
/ASSIGNED ID NUMBER
ISZ
POINT
/TO BE PLACED ON STORAGE DEVICE
DATA
LAW
-NPFC
/COUNTER SO THAT 13 WORDS ARE PACKED
JMS
PAC
/GO TO PACKING ROUTINE
LAC
DUM3
/SET SUM OF THE NEW 4 NOISE SAMPLES
TAD
DUM5
/ADD TO THE 72 NOISE SAMPLE GROUP
DAC
DUM5
/USE NEW SUM
LAC
DUM2
/SET NEW MAX. FOR THE 4 NOISE SAMPLES
TCA
/COMPARE NEW MAX. WITH OLD MAX.
TAD
DUM4
/KEEP THE OLD MAX.
SMA
/IS THE NEW MAX. LARGER?
JMP
-3
/NO, KEEP THE OLD MAX.
DAC
DUM2
/REPLACE THE OLD MAX.
DAC
DUM4
/JU THE NEW MAX.
ISZ
CTT2
/HAS 72 NOISE SAMPLES BEEN COLLECTED?
JMP
SKP4
/YES. PREPARE TO COLLECT MORE SAMPLES
COMP
LAC
NPCC
/RESET COUNTER
DAC
CTT2
/NOISE DETERMINATION
LAC
DUM4
/YES. SET MAX. OF NEW 72 NOISE SAMP.
TAD
MAX4
/OF THE PREVIOUS SET
SPA
/IS THE NEW ONE LESS THAN THE OLD ONE?
JMP
SKP3
/30. PREPARE FOR ANOTHER COLLECTION
LAC
DUM4
/YES, REPLACE THE OLD MAX. WITH
DAC
MAX4
/NEW MAX.
DAC
DUM5
/REPLACE THE OLD SUM WITH
DAC
DUM4
/NEW SUM
SKP3
BDM
DUM4
/RESET NOISE SAMPLING
BDM
DUM5
/LOCATIONS
SMP
LAC
CMP
/ONE TIME
LAC
DUM2
/REPRE VIEW TO REENTER R-T SUB. "BEGIN"
LAC
CMP
/REPRE VIEW TO REENTER R-T SUB. "BEGIN"
LAC
START
/COUNT WHICH TYPE OF SAMPLE
LAC
SAV
/TIME(S) 0+RE31N6
+3MXT R-T SUB. "BEGIN"
PAC
0
DAC
GONTP
/LAST WORD NUMBER BEING PACKED
LAC
(BUF-1)
DAC
BPOINT
/POINT POINTER
PACH
JMS
LIN
/HAVE TABLE ROUTINE
LAC
DUM1
/STORE TO LEFT HALF
DAC
POINT
/STORE
JMS
LIN
LAC
DUM1
TAD* POINT /PACK INTO PREVIOUS ONE
DAC* POINT /STORE IN BUF1
ISZ POINT /MOVE POINTER UP ONE WORD
ISZ COUNT /ONE WORD HAS BEEN PACKED
JMP PAKNI /13 WORDS HAVE NOT BEEN PACKED
LAC* POINT /13 WORDS HAVE BEEN PACKED
ISZ CTT8 /END OF BUFFER ?
JMP* PAC /NO, CONTINUE COLLECTION
LAV -DATSTR /YES, RESET THE BUFFER
DAC CTT8 /COUNTER
LAC BUF1 /SET POINTER TO SECOND
DAC BUF1 /BUF1
LAC CTT6 /GET FIRST BUFFER ADDRESS
ISZ CTT6 /JUST FINISHED FILLING BUF1 ?
JMP +*5 /YES, PREPARE TO STORE
DAC CTT6 /BUFI
LAC BUF1 /NO, SET POINTER TO BUF1
DAC CTT6 /WHICH BUFFER TO TRANSFER
LAC BUF1 /WHICH BUFFER TO TRANSFER
DAC TBUF /BUF2
DAC TRAF /SET TRANSFER FLAG
JMP* PAC /CONTINUE COLLECTION
ERS1 *WRITE TTO*ASC*MS35,0 /TIMING ERROR
LAC MDMU /PUT CLOCK OPERATION BACK
DAC ONCE /IN PROGRAM
ISZ CNT /PREPARE TO REJECT 0-X PAIR
LAC (JMP HD0 /REJECT NEXT X-SAMPLE
ISZ CNT /NO, WAS THE LAST 0-X SAMPLE ?
LAC (JMP ONCE /NO, REJECT THE FORMER 0-X SAMPLE
DAC START /YES, REJECT NEXT SAMPLE
*TIMER 0.BEGIN,6 /RETURN TO COLLECTION
HLXIT RSUB /SUBROUTINE TRANSFERS I BLOCK OF DATA FROM A DESIGNATED BUFFER
TO THE STORAGE DEVICE BEING USED.
DTRANS 0 /SUBROUTINE TO CHECK WHICH DATA CONSOLE SWITCHES ARE SET.
TOO LARGE SETTINGS AND TOO SMALL SETTINGS ARE GUARDED AGAINST. THE DEFAULT SETTING IS 2000.
CKCNT 0 /LOAD DATA SWITCHES FROM CONSOLE
RTL /PUT AC BIT I INTO LINK
CLA /TO DISALLOW SHARING
SZL -1 /YES, DO ALLOW
DAC* (177 /SHARING
LAX (17777 /RELOAD DATA SWITCHES
AND (7 /IGNORE TOP 5 BITS
SPA /ARE THE SWITCHES SET TO 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
TAD (10007 /NO, RESET THE AC BACK
DAC TEMO /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 TEMO /FILL THE SIZE OF
TAD D2STOR /THIS FILE
TAD D2STOR /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

RESSTAR LAC TRAF /COMPLETE TRANSFER IF NECESSARY
MOMI2 S2A
JMS DTHANS
C6 WRITE OUTPT>DUMP>SEVN.2 /WRITE END OF FILE ID
C2 WAIT OUTPT
C7 CLOSE OUTPT
LAC MUMI /INITIALIZE THE LOCATIONS
DAC START /"START" FOR COLLECTION
DAC REPL /AND "REPL" FOR PROCESSING
LAC SUM4 /GIVE THE SUMMATION OF THE LOWEST
DAC* SUM5 /NOISE TO THE PROCESSING
DAC* CHM /RESET DB CHANGER
DAC MUMI /IGNORE THE FIRST
DAC UP1 /FILE ONLY
JMP START /GO TO START

CLOCK INTERRUPT ROUTINE FOR AUTOMATIC 0-SAMPLE START

CHECK 0
DAC SAV /SAVE AC
DAC BEGIN /ZERO A-1 SUB TO AVOID POSS. ERROR
LAC CNT /EXAMINE COUNTER
HAL /LOWEST BIT OF CNT IN L
SZL
JMP BKUP /L=1-CNT ODD-HALF FRAME DURING 9/60 SEC
JMP NOHM /L=B-CNT EVEN-FULL FRAME DURING 9/60 SEC
DAC CNT /CLEAR HALF FRAME THAT WAS TAKEN
HAL /RESTORE LINK
LAV -1 /RESET IDGOU BACK ONE FRAME
TAD IDGOU
DAC IDGOU
LAV -1 /RESET BUFFER COUNTER
TAD CTI8 /BACK ONE
DAC CTI8 /FRAME
LAV -BPL /RESET POINT BACK HALF FRAME
THD POINT
LAC MDUMI /PUT CLOCK BACK INTO OPERATION
JMP EXTI /PREPARE TO EXIT
HAL
DAC (JMP PK0 /STOP CLOCK FROM OPERATION
EXTERN
DAC ONCE
DAC (JMP ADD /PREPARE TO COLLECT
DAC START /AN O-FRAME
DAC SAV /RESTORE AC
LAC (CTI5
*TIMEK *BEGIN.6 /RETURN TO POINT AT WHICH INTERRUPT
/START CHECK /OCCURRED

SUBROUTINE 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 BPOINT /DATA STARTS AT 0JF
LAC* BPOINT /GET INPUT DATA WORD
AND (1777 /MASK ANY EXTRA BITS
TAD (1353 /CHECK FOR NEG. #'S
SPA
JMP EN1 /NEI # FOUND
TAD (CTI*1600 /LOCATE # IN TABLE
DAC DUMI /GET ADDRESS OF NUMBER
LAC* DUMI /LOAD LINEARIZED # INTO AC
SPA
EN1 CALL MCIU
DAC DUMI /STORE LINEARIZED
ISZ CTT5 /IS THIS THE FIFTH NOISE SAMPLE?
JMP *5 /AND, SKIP AROUND CODE
LAC CTT5 /SKIP AROUND "SKAR" DATA
TAD BPOINT /OF THE FRAME BEING
DAC BPOINT /COLLECTED
DAC DUMI /RESTORE THE LIN. DATA #
LAC CTTI /IS IT A NOISE SAMPLE?
JMP DONOS /YES, PROCESS NOISE SAMPLE
LAV -1 /RESET THE TWO COUNTERS
DAC CTTI /FOR THE DATA OF THE
DONOS

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.
/
HP1
LAC API /RESET FILE
DAC NAME+1 / NAME
DZM IEO1 / ZER0 LOC.
DZM CN2 /RESET DEVICE STORAGE COUNTER
NOK2 JMP NOK21 /DO NOT SWITCH STORAGE DEVICE
LAC COJP /CHANGE TO SECOND STORAGE
ISZ CT3 / DEVICE BY CHANGING THE
LAC COUP T2 / DAT SLOTS IN THE COMMANDS:
DAC C3 / ENTER
DAC C2 / WAIT
DAC C5 / WAIT
DAC C7 / CLOSE
TAD 1100 / DELETE
DAC C1 / INIT
TAD C003 / FSTAT
TAD 1100 / WRITE
DAC C4 / WRITE
DAC C6 / WRITE

NOK21 LAC H4301 /RESET TELETYPE
DAC MS31+3 / MESSAGE
LAC NOJM4 / IGNORE THE FIRST FILE ON
DAC DPE / NEXT STORAGE DEVICE
LAC CT2 / CHECK DEVICE SWITCHING CONTROLLED
SMA / IS IT STILL NEG?
LAY -2 / YES, RESET IT
DAC CT2 / NO, LEAVE IT ALONE
JMP C1 / NO GO TO INIT.

API /SIXBT "API" / REINITIALIZES "NAME" AND "FILE"
EXTIP DZM TCA / PREPARE TO COLLECT A NEW SET OF DATA
DAC TIME / GET TIME FOR LAST FILE
TAD 15 / 30:RD OFF TO THE NEAREST MINUTE
DAC TMR / STORE FOR POSTPONER PROGRAM
LAC JMP HP1 / PREPARE TO START
DAC START / COLLECTION AT FILE 1
ISZ NAME+1 / TELLS PROG. TO PROCESS LAST FILE
*WHITE TTO ASC EDC 0 / END OF COLLECTION
*WAIT TTO
DZM TCI / INIT. COLL. TIME COUNTER
LAW -1 / TELLS PROCESSING THAT COLLECTION
DAC CT11 / IS FINISHED COLLECTING

EDC 3000 / 0

* ASCII <11><11><11><11><11><7><7><7><7><7>

...EJECT

BPMN15 VISA SERVICE ROUTINES FOR THE HP 5610A A TO D
/ CONVETERS. 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 RELINQUISHED
/ TO LOWER PRIORITY PROGRAMS WHILE DATA TRANSFER TAKES PLACE.
/ MACRO-15 CALLING SEQUENCE:
/ JMS ADREAD
/ NUMBER OF SAMPLES REQUIRED
/ BUFFER ADDRESS
/ COMPLETION FLAG ADDRESS
/ REAL-TIME SUBROUTINE ADDRESS (PRIORITY LEVEL IN BITS 3-2
/ EXAMPLE: SHX0SHX+HITURA)
/ (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 ADREAD.
/ AND SET TO 1 FOR NORMAL COMPLETION OR -1881 IF A DATA
/ TIMING ERROR OCCURS.
ADCR+85 /A-D WORD COUNT
ADCA=ADCR+1 /AND CURRENT ADDRESS REGISTERS
+SCOM+100 /MONITOR'S COMMUNICATION AREA
ADVI=783724 /A-D CONVERTER WRITE INITIALIZE
ADSO=783701 /SKIP ON WORD COUNT OVERFLOW
ADST=783721 /SKIP ON DATA TIMING ERROR
ADCU=783704 /CLEAR OVERFLOW FLAG
ADCT=783744 /CLEAR TIMING FLAG

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

JMP INSET /REPLACED BY "LAC* ADREAD"
TCA
DAC* (ADCR) /SET WORD COUNT
ISZ ADREAD
LAV =1
IAD* ADREAD /BUFFER ADDRESS -1
DAC* (ADCR) /TO CURRENT ADDRESS REG.
ISZ ADREAD
LAC* ADREAD /GET FLAG ADDRESS
DAC INFLAG
DSM* INFLAG /CLEAR FLAG
ISZ ADREAD
LAC* ADREAD /GET REAL-TIME SUBROUTINE ADDRESS
DAC INSUB
ISZ ADREAD /POINT TO RETURN LOCATION
ADJ* ADREAD /INITIALIZE INTERFACE
JMP ADREAD /RETURN

/ THE FOLLOWING CODE IS EXECUTED ONLY ONCE
INSET LAC* (+SCOM+55) /GET ENTRY POINT ADDRESS OF .SETUP
ADSVA DAC
SAV
REALTP DAC
LAC (400010) /ENTRY POINT OF REALTP
ISA /LEVEL
JMS* ADSVA /CALL SETUP TO CONNECT
ADSV ADIO
ADINT /THE API
DBK /DEBRAKE FROM API LEVEL
LAC (LAC* ADREAD)
DAC ADREAD+1 /MODIFY INSTRUCTION
JMP ADREAD+1 /AND JMP 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.
/ HUNKS AT API LEVEL 0.
/
ADINT 0

DBA /PAGE ADDRESSING MODE
DAC ADSVA /SAVE AC
ADST /TIMING ERROR?
SKIP CPI TAC /NO+1 TO AC
LAV =1001 /YES+ ERROR CODE
DAC* INFLAG /SET FLAG
ARCO /CLEAR
ADCT /INTERFACE FLAGS
LAC* (+SCOM+102) /RAISE TO API
ISA /LEVEL 3 OR 1
LAC INSUB /REAL-TIME SUBROUTINE ADDRESS
SMA
JMP ADXIT /BYPASS MONITOR CALLS IF ZERO
JMS* REALTP /ACTIVATE REAL-TIME SUBROUTINE
ADXIT LAC (40000) /REQUEST AN API INTERRUPT
ISA ADISVA /AT SOFTWARE LEVEL 4
DBK
JMP ADINT /SET TO LEAVE HARDWARE API LEVEL
/RETURN TO INTERRUPTED PROGRAM

******* EJECT
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
/ PROCESSOR'S MACRO PROGRAMS. THEY INITIALIZE THE SOFTWARE
/ DEVICE, WAIT FOR FILE TO BE COLLECTED, CHECK FOR UNWANTED
/ COLLECTING STOPS, 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 SMS AND CHG
JMP 14 /SKIP OVER PARAM. LIST

SUMS 0
CHG 0
CMULC 0
ISZ CITI8 /LOC. TO CHANGE MUL. CONSTANT
SMK 0
JMP AGN /YES, RESET PARAMETERS TO BEGIN OF DEV.

DU M7 ISZ FIL+1 /CHECK IF COLLECTION IS
JMS CONT /FINISHED COLLECTING NEW FILE
LAC FIL+1 /IS THE COLLECTION
CMA /NEELECTING
TAD NAME+1 /THE FIRST FILE
SPA /AGAIN ?
LAV -1 /NO, SET THE COUNTER TO JUMP AROUND
DAC CITI8 /YES, SET COUNTER TO A POS. #
LAV -1 /PREPARE TO READ
DAC CIT9 /DATA
LAC BUF31 /RESET BUF3 POINTER WITH
DAC POINT2 /THE ADDR. OF BUF3
LAC (ISZ SWITC /PREPARE TO READ TWO
DAC LOA /DUMMY BLOCKS

C13 *INIT DATIN, IN=0
CT RT *FSTAT DATIN, FIL /CHECK FOR PRESENTS OF NEW FILE
SNA JMP EMR3 /FILE NOT PRESENT
C11 *SEEK DATIN, FIL /PREPARE TO READ
JMP* CHNG /RETURN TO FORTRAN PROGRAM

FIL *SIXBT "DATAFOAT" /NAME OF DATA FILE USED BY PROC.
ENR3 *WRITE TTO+ASC, MS6, 0 /FILE NOT FOUND
JMP CMULC +1 /ERASED FILE ? LOOK FOR NEXT FILE

MS36 24500
0
*ASCII "FILE NOT FOUND"<15>
AGN LAC AFI /INITIALIZE DATA-FILE
DAC FIL+1 /NAME
NDK3 SKP /DETERMINES # OF STORAGE DEVICES
JMS SWIT /CHANGE STORAGE DEVICES
JMP DUMTH +1 /NO, CONTINUE PROCESSING
ENDPH *WRITE TTO+ASC, END, 0 /END OF PROC. MESSAGE

JMP ANSE 0 /THE ADDR. OF IT HERE
LAC* ANSE
SAD (120 /IS THE RESPONSE A "Y" ?
JMP ASTA /YES, SET UP TO RESTART EVERYTHING
*IDLE /GIVE COMPLETE CONTROL TO BS.

HSTR *CLEAR DATIN /CLEAR COLLECTION DEVICE
JMP TTO+ASC, MS2, 0 /DH MESSAGE
WHTT TTO /SET UP NEXT DA SETTING
JMS HEALM /WAIT FOR REPLY

JMP ENUPIT /YES, EXIT

DMPY 1
ZEZ MCHTA /ZERO BINARY TIMER
TIME 9 +836, 6 /RESTART COLLECTION
JMP AIN /RESTART PROC.

/ Subroutine used to WAIT for FILE to be collected and stored
/ while giving time to Background

DUMTH 3
JIT *LAC NAME+1 /COLLECTION'S FILE NAME
SAD FIL+1 /IS PROC.'S FILE NAME THE SAME ?
\MDUMA SKP
\JMP CONT /YES, RETURN TO PROCESS FILE
\ISZ CITI8 /END OF THE
\SKP /RUN ?
\JMP ENUPH /YES, EXIT
\TIME 38 +8WAIT, 3 /YES, RELINQUISH TIME TO BS
\LAC SAVAC /SAVE AC
\IDLE /WAIT FOR CLOCK INTERRUPT

/REAL TIME SUB**USED TO ALLOW TIME FOR BACKGROUND

WAIT 0
DAC SAVAC /SAVE AC
DZW WAITI /ZERO H-T SUB, ENTRY PT. TO ALLOW REENTRY
JMS CKCOL /CHECK FOR COLLECTION STOPPAGE
JMP #18 /CHECK FOR END OF COLL.

/ Subroutine to check for unwanted coll. STOPPAGE

CKCOL 0
LAC -2 /HAS COLL. ENDED ALL COLLECTING
TAD CNF /FOR TODAY ?
SPA /YES, RETURN

JMP CHNG /NO, HAS COLLECTION STOPPED
TCA / READING
TAD IDCOU / IN DATAT

REPL SZA (/REPLACED BY "NOP" WHEN COLL. IS DONE)
JMP SETI / NO. RESET TESTER AND RETURN
LAC MDM1 / YES, FREE TIMER
DAC ONCE / OPTION IN COLL.
ISZ CTT7 / TELLS IF STOPPAGE OCCURRED
*WHITE TTO ASC, STPM, BELL
*TIMER 8 CHECKS / RESTART COLLECTION

SETI LAC IDCOU / SET ID # INTO
DAC TSTI / TESTER FOR STOPPAGE
JMP* CICCOL / CHECK FOR COLL. TO BE FINISH

/ SUB-TO CHANGE THE *DAT SLOT #'S TO CHANGE STORAGE DEVICES
SWIT 0
LAC COTAIN / SWITCH STORAGE DEVICES
ISZ CTT4 / BY CHANGING THE
LAC COTAI2 / *DAT SLOT IN COMMANDS;
DAC C11 / *SEEK
DAC C13 / *INIT
DAC C14 / *WAIT
DAC C15 / *CLOSE
DAC ASTR / *CLEAR
TAD (3030 / *FSTAT
TAD (13030 / *FSTAT
TAD LBA / *READ
LAC CTT4 / IS DEVICE ON *DAT SLOT "DATIN"
SFA / TO BE PROCESSED?
LAW -2 / YES *RESET DEVICE CONTROLLER
DAC CTT4 / MAKE ANY CHANGE IN CONTROLLER
JMP* SWIT

PP7 0
LAS (43000 / NUMBER 3
SNA / IS IT A 1?
JMS* WARP / NO. PRINT DATA OUT ON PAPER TAPE
JMP* PP7 / RETURN TO PROC

/XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
/ EJECT
/XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
/ HEAD DUMP MODE FROM DECTAPE ON A VARIABLE *DAT SLOT
/ FILLS 256 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
/ NEGFI: SET IF A NEGATIVE NUMBER WAS IN THE DATA
/
/DUMPT 0
JMS* *OA / PICKUP ADDR OF ADDR
JMP *+3 / OF ARRAY

A2 0
FLAG 0
LAC* A2 / SET ON NEG #
DAC A2 / OF ARRAY
LAW -HPRC / SET COUNTER OF DATA TO BE
DAC COUNT / PROCESSED
ISZ CTT9 / GET POINTER
JMP LBB / NO, CONTINUE WITH PRESENT SET OF DATA
LAW -DATSTH
DAC CTT9
LBB / GET ADDR OF BUF3
DAC BUF31 / GET ADDRESS OF BUF3
DAC* POINT2 / POINT2 TO BUF3
LAC* POINT2 / GET THE ID (FIRST WORD IN DATA SET)
SAD SEVN / 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 DIS A2 / GO TO NEXT DATA WORD
LAW -2 / PREPARE TO UNPAC
DAC TCI10 / TWO DATA WORDS
LAC* POINT2 / GET DATA WORDS FROM BUF3
SWHA
AND (777)
SAVE ONE DATA WORD
SNP
CHECK FOR NEG. NUMBER
ISZ
SET IF NEG. NUMBER FOUND
DAC
LOAD # INTO FORTRAN ARRAY
LAN
POINT2
GET DATA WORD AGAIN
ISZ
TC10
UNPACED TWO WORDS?
JMP
UNPLP
NO LOOP AROUND
ISZ
COUNT
YES, HAS 34 DATA WORDS BEEN UNPACKED?
JMP
REPEAT UNPACKING PROCESS
OUT2
ISZ
POINT2
YES, GO TO NEXT ID
SWITCH 777775
POINT2
INT2
----------------------------------------------
END OF FILE ROUTINE
ENP
LAG
SET LAST ID TO
DAC
13050 DECIMAL
CLS
CLOSE DGIN
JMP
RETURN TO PROC. PROGRAM

C
PROGRAM SETS UP CALIBRATION AND THE HEADING FOR THE PRINT
C OUT OF THE PROCESSED DATA IN PROC. THE PROGRAM CALLS:
C TBFORL--CALIBRATION PROGRAM
C DLOGF--INITIAL MACRO PROGRAM
CCC
SUBROUTINE CONTL(ISURP)
INTEGER DB(4) DBC
REAL DATE(2) REAS(5)
COMMON /STAT/ DB DATEREAS DBC DBS NC4
DATA NR/120784/
REWIND 4
C INITIALIZE THE DB SETTINGS USED
DBC=3
DB(2)=10
DB(3)=25
IF(ISURP.NE.0)GO TO 5
C GIVE PRECALIBRATION SETUP
WRITE(6,100)
100 FORMAT(46H TURN OFF PULSER AND ENCODE PULSE POWER SUPPLY/)
C SET UP CALIBRATION AND LINEARIZATION TABLE
CALL TBFORL
C ASK FOR AND GET THE DATE
WRITE(6,101)NH
101 FORMAT(5H DATE/A2)
READ(4,201)DATE
201 FORMAT(5A5)
C ASK FOR AND GET THE REASON FOR THE RUN
WRITE(6,102)NH
102 FORMAT(14H REASON FOR DATA/A2)
READ(4,202)REAS
202 FORMAT(5A5)
C PREPARE FOR COLLECTION AND PROCESSING
CALL DLOGF(DB, DBC, DATE)
RETURN
END

CTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
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 ROUND OFF 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:
C RADC--READS #'S FROM THE A/D CONVERTER (MACRO)
C LINAP--CONVERTS INPUTS TO OUTPUTS FOR THE FORMATION
C OF THE LINEARIZATION TABLE
C TTM--WRITES LINE TABLE ONTO A STORAGE DEVICE
CTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
SUBROUTINE TBFORL
INTEGER START(512), DLPO, STATa, IAS(44)
REAL KI
COMMON /TA/ S(43), TU(44), TUO(44)
DATA C.CS.CN*NR/IHC, IHS, HN, 120784/

C DETERMINE IF CALIBRATION IS NEEDED AND WHICH PRINTOUT TO USE
7 WRITE(6,105) NR
105 FORMAT(1EH WHICH CALIBRATION/SOH (S-SHORT, R-REGULAR, OR
137H C-COMPLETE PRINT OUT OR N-NO CALIB.)*A2)
READ(4,204) CAL
204 FORMAT(A)
IERR=0
DLPO=0
C SET UP THE WANTED CALIBRATION
IF(CAL.EQ.CN) RETURN
IF(CAL.EQ.CS) DLPO=1
IF(CAL.EQ.C) DLPO=1
C NUMBER OF A/D NUMBERS TO READ PER DB SETTING=NAVI*NAV
NAVI=5
NA=5*5
AV=NAVI*NAV
CT=8
C NUMBER OF ATTENUATOR SETTINGS=NTI
NT1=42
NT2=NT1-1
NT3=NT1-2
C INPUT SIGNALS--FROM 5DB (OF 1000) TO INFINITY
TU(NT1)=562.34
TU(NT2)=501.19
TU(NT3)=446.88
TU(NT1-3)=398.11
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)=158.49
TU(NT1-12)=141.05
TU(NT1-13)=125.90
TU(NT1-14)=112.20
TU(NT1-15)=100.00
TU(NT1-16)=90.13
TU(NT1-17)=80.43
TU(NT1-18)=70.80
TU(NT1-19)=63.10
TU(NT1-20)=56.24
TU(NT1-21)=50.12
TU(NT1-22)=44.67
TU(NT1-23)=39.81
TU(NT1-24)=35.48
TU(NT1-25)=31.62
TU(NT1-26)=28.18
TU(NT1-27)=25.12
TU(NT1-28)=22.39
TU(NT1-29)=19.95
TU(NT1-30)=17.78
TU(NT1-31)=15.85
TU(NT1-32)=14.13
TU(NT1-33)=12.59
TU(NT1-34)=11.22
TU(NT1-35)=10.00
TU(NT1-36)=8.91
TU(NT1-37)=7.94
TU(NT1-38)=7.08
TU(NT1-39)=6.31
TU(NT1-40)=5.62
TU(NT1-41)=5.00
TU(NT1-42)=4.00
TU(NT1-43)=3.00
TU(NT1-44)=2.00
TU(NT1-45)=1.00
TU(NT1-46)=0.50
TU(NT1-47)=0.25
TU(NT1-48)=0.13
TU(NT1-49)=0.07
TU(NT1-50)=0.04
TU(NT1-51)=0.02
TU(NT1-52)=0.01
TU(NT1-53)=0.00
20
TUO(NT1)=512.
C SET UP MESSAGES FOR TELLING WHICH ATTENUATOR SETTING TO DO
DO 11 I=1, NT2
11 IAS(I)=I+5
IAS(NT2)=99
DO 12 I=1, NT2
12 DUM=0
WRITE(6,100) IAS(I), DUM
100 FORMAT(8H SET #.I2,23HATTENUATION AND C.R.,A2)
READ(4,200) F
200 FORMAT(F5.2)
C IF THE INPUTED NUMBER IS TOO DIGITS RESTART THE SETTINGS
IF(F.*10.+10 TO 2.)
C ISSUE AN A/D CONVERTER READ "NAVI" TIMES
DO 10 JI=1,NAVI
C READ "NAVI" NUMBERS FROM THE A/D CONVERTER
CALL RADCI(START,NAVI,STAT)
400 IF(STAT.EQ.0)GO TO 400
DO 1 J=1,NAV
C READ "NAV" NUMBERS FROM THE A/D CONVERTER
CALL RADCI(START,NAV,STAT)
400 IF(STAT.EQ.0)GO TO 400
DO 1 J=1,NAV
C STORE THE INPUTED NUMBERS IN A REAL VARIABLE
I DUM= DIM+FLOAT(START(I))
10 CONTINUE
C AVERAGE THE OUTPJTED NUMBERS AND GO TO THE NEXT SETTING
2 TUO(J)=DUM/AU
DO 3 J=1,NT
3 ICT=ICT+1
3 ICT=ICT+1
3 ICT=ICT+1
3 ICT=ICT+1
C SET UP THE SLOPES OF EACH LINE SEGMENT APPROXIMATION
S(I)=TU(J)-TU(J-1)
I AIC(I)=IF(J.EQ.1)
C POSSIBLE ERROR CONDITIONS FOR THE APPROXIMATION JJST FORMED
3 IF(ABS(S(I))>3.0)ERR=ERR+1
102 IF(DUM.EQ.0)GO TO 103
103 WRITE(I2,104) (START(I),I=1,512)
104 FORMAT(15X7HTU(I).=F8.3S5X,8HTUO(I)=F8.3X,7HDB///)
C WRITE OUT LAST VALUES OF THE TABLE
WRITE(6,105) START(I),TUO(I)
105 FORMAT(15X7HTU(I).=F8.3S5X,8HTUO(I)=F8.3X,7HDB///)
C FINAL OUTPUT VALUE FOR THE LINEAIZATION TABLE FORMATION
X3=511.5
C GET THE INPUT VALUE AND STORE IN "X3"
CALL LINEAP(X3,TA)
C FIRST INPUT VALUE OF THE TABLE
START(1)=1
DO 4 I=2,512
4 X(I)=X(I-1)+1
C NEXT UJT PUT VALUE USED
X3=X3+FLOAT(2*I-1)
C GET THE INPUT VALUE AND STORE IN "X3"
CALL LINEAP(X3,TA)
C STORE INPUT VALUE IN INTEGER LIN. TABLE
START(I)=IFX3(I)
C ERROR CONDITION FOR LINEARIZATION TABLE
4 IF(START(I)+1.LE.START(I-1))IERR2=IERR2+1
C LAST VALUE OF THE TABLE
START(512)=5
I ERR2=ERR2+1
C NEW PAGE
403 FORMAT(1H1)
C WRITE LINEARIZATION TABLE ON TELETYPE
WRITE(6,404) (START(I),I=1,512)
404 FORMAT(10(15.2X))
C NEW PAGE
WRITE(6,405)
C WRITE TABLE ON A STORAGE DEVIVE (DUMP MODE)
C CALL TIM(START)
C WRITE OUT ANY ERROR AND ALLOW RECALIBRATION IF NEEDED
IF(IERR2.NE.0)GO TO 9
IF(IERR2.EQ.0)RETURN
WRITE(6,406)
406 FORMAT(//7H ****CHECK CALIBRATION FOR POSSIBLE ERRORS****/)
GO TO 7
9 WRITE(6,407)
407 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)**

```
COMMON /TA/ S(43),TU(44),TU0(44)
N1i
C DIVIDE THE STRAIGHT LINE APPROXIMATION INTO 4 AREAS
NC5a=NC5+2/4
NC53=NC5+3/4
NC5b=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
k=N+NC54
C SEARCH FOR THE CORRECT LINE SEGMENT
DO 5 I=NK
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 GET THE VALUE OF THE CORRESPONDING OUTPUT
10 A=(A-TUO(I))*S(I)+TUO(I)
RETURN
END
```
DO 110 I=1,4
BN0(I)=0.
BNX(I)=0.
110 INITIALIZE STORAGE DEVICE AND
PREPARE TO READ DATA
CALL CHNG(IBMX,1DBCH,1MCC)
IF(IMCC.LT.0.OR.IMCC.GT.9)GO TO 88
CMC=FLOAT(IMCC)-4.5
RBMX=RBMX+CMC*CMC*
20 IF(IBMX.LT.1)IBMX=216
IMCX=0
C NOISE CRITERION
C IBMX=THE SUM OF THE SET OF 45 NOISE SAMPLES WHICH HAS THE
MINIMUM MAXIMUM OF ALL THE MAXIMUMS OF EACH SET OF 45 NOISE SAMPLES
C THE AVERAGE NOISE FOR THE FIRST 5 IN EACH FRAME HAS 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
SQUARES OF THE NOISE:
DUMX=FLOAT(IBMX)/45.
IF(DUMX*SRBMX.GT.500.)DUMX=500./SRBMX
BMXNS=RBMX*DUMX*5.*DUMX
KE0=0
KE0F=0
ID=0
C GET ORDINARY MODE DATA
CALL DRD73(AO,IBN0,IERH,IDKEO)
IF(KE0.EQ.1)GO TO 80
C GET EXTRAORDINARY MODE DATA
CALL DRD73(AX,IBNX,IERH,IDKEX)
IF(KEX.EQ.1)GO TO 80
C SET UP CHECK FOR REJECTION BECAUSE OF NOISE CRITERION
BMEANO=0.
BMEANX=0.
DO 120 I=1,5
BMEANO=BMEANO+BNO(I)*BNO(I)
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
BMO=BMO+BMEANO
BMX=BMX+DMEANX
C SUM OF THE SQUARE OF THE UNSATURATED DATA AT EACH HEIGHT
DO 140 I=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 TO SATURATIONS OF DATA
40 IRJ(I)=IRJ(I)+1
C NUMBER OF ACCEPTABLE DATA AT EACH HEIGHT
RSAM=ID-IRJ(I)
C AVERAGE SUM SQUARED OF ACCEPTABLE DATA FOR EACH HEIGHT MINUS THE
C AVERAGE SUM SQUARED OF THE ACCEPTABLE NOISE
AVOC=AVAO(I)/RSAM-BMO/RN
AVXC=AVAX(I)/RSAM-BMX/RN
C THE RMS OF THE ACCEPTABLE DATA AT EACH HEIGHT (RETAINING THE SIGN)
AVAO(I)=(ABSCAVOC)/AVOC)*SQRT(ABS(AVOC))
AVAX(I)=CABS(AVXC)/AVXC)*SQRT(ABS(AVXC))
EL(I)=0.
XO(I)=0.
IF(AVAO(I).LE.0..OR.AVAX(I).LE.0.)GO TO 150
XO(I)=AVAX(I)/AVAO(I)
120 CONTINUE
GO TO 60
C REJECTIONS FROM NOISE CRITERION
50 I=IRJ(I)+1
C SET UP AVERAGE NOISE USED IN REJECTION CRITERION
SN0=SN0+BNO
SNX=SN0+BNX
GO TO 30
60 ID=ID/2
BD=BD*5
C MAXIMUM ALLOWABLE NOISE
BMXNS=BMXNS/(DUMX*5.*SRBMX)
C RMS OF ALL NOISE SAMPLES
AVNO=SQRT(SN0/BID)
AVNX=SQRT(SNX/BID)
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=AVAO(I)/HSAM-BMO/RN
AVXC=AVAX(I)/HSAM-BMX/RN
C THE RMS OF THE ACCEPTABLE DATA AT EACH HEIGHT (REMAINING THE SIGN)
AVAO(I)=ABS(AVOC)/AVOC)*SQR(ABS(AVOC))
AVAX(I)=ABS(AVXC)/AVXC)*SQR(ABS(AVXC))
EL(I)=0.
XO(I)=0.
IF(AVAO(I).LE.0..OR.AVAX(I).LE.0.)GO TO 150
XO(I)=AVAX(I)/AVAO(I)
150 CONTINUE
GO TO 80
CONTINUE
C THE RMS OF THE ACCEPTABLE NOISE
BMO=SQRT(BMO/RN)
BMX=SQRT(BMX/RN)
CALL CALC2(XO,120#EL*IA)
C
WRITE THE HEADING ON THE TELETYPEx
WRITE(6,1050)ITIME/(18**II)
1050 FORMAT(6H14L14X*2A5,3X 5A5,3X* 2 2HDB)
WRITE(6,1100) BMNS, BMX
1100 FORMAT(19H MAX. ALLOW. NOISE,*F7.1s*6H MULT. CONST.*F7.3/
WRITE(6,1200)AVNOBMO, AVNX
1200 FORMAT(16H 0-NOISE AV.(I) *F8.1s7H (2) PF8/*
116H X-NOISE AV.(I) *F8.1/7H (2) *F8.1/
WRITE(6,1300)ID, IR
1300 FORMAT(//XI4,4X*F5.1.F6.1*2X.F6.1,2X.F5.2.A3DF6.0)
CONTINUE
C ALLOWS RESULTS TO BE SAVED ON PAPER TAPE
CALL PP7
C NEXT ATTENUATOR SETTING
NC4=NC4+1
IF(NC4.GT.IDBC)NC4=1
GO TO 10
1500 FORMAT(1H )
RETURN
END

C***********************SUBROUTINE DHD73**************************
C
DREAD READS 21 SAMPLES OF SIGNAL AND 5 SAMPLES OF NOISE
FROM DECTAPE. THE OUTPUT VOLTAGES HAVE BEEN TRANSFORMED INTO
INPUT VOLTAGES. THE PROGRAM USES SUBROUTINE DUMPT (MACRO) TO
READ DATA FROM STORAGE DEVICE.
C********************************************************************
C SUBROUTINE DHD73(A,BMEAN,IER,I0,KEOF)
DIMENSION A(21),IDAT(27),BMEAN(5)
KEOF=0
N=5
N2=N+2
N3=NI+21
C GET ONE SET OF DATA (26 NUMBERS)
CALL DUMPT(IU,NEF)
C CHECK ID CONSECUTIVE
IF(I0-IDAT(1)+1).GE.15,10
C CHECK FOR END OF FILE
10 IF(IDAT(1).NE.130050) 30 TO 20
C TELL PROC IT'S THE END OF THE FILE
KEOF=1
GETJN
15 ID=IDAT(1)
C GET DATA SAMPLES INTO A REAL ARRAY
DO 42 MIN=NI,N3
N1=N3-MIN
A(MIN)=IDAT(MIN)
42 CONTINUE
C GET NOISE SAMPLES INTO A REAL NUMBER ARRAY
DO 133 J=1,N
133 JSL=J+1
B(MIN)=IDAT(JSL)
C THE ID IS CONSECUTIVE, IGNORE THE REST OF THE DATA
20 GETJN
195 FORMAT(4H IF ID WAS NOT CONSECUTIVE AND NOT=133350 J ID=,3(I7,3X))
KEOF=1
RETURN
END
CALC2 IS A LIST OF CONSTANTS CALUATED FROM THE PROGRAMS CALC AND ELDEN AND CONTAINS THE FUNCTION THAT CALCULATES THE ELECTRON DENSITIES FOR THE PARTIAL-REFLECTION PROCESSING PROGRAMS.

SUBROUTINE CALC2(ARRAY.LLLH#FDIA)
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
RATIO2( 1)= 1.0731158
RATIO2( 2)= 1.0778633
RATIO2( 3)= 1.0841143
RATIO2( 4)= 1.0909986
RATIO2( 5)= 1.0999818
RATIO2( 6)= 1.1000243
RATIO2( 7)= 1.0880302
RATIO2( 8)= 1.0664129
RATIO2( 9)= 1.0768397
RATIO2(10)= 1.0590323
RATIO2(11)= 1.0495014
RATIO2(12)= 1.0398332
RATIO2(13)= 1.0305014
RATIO2(14)= 1.0215491
RATIO2(15)= 1.0129923
RATIO2(16)= 1.0076428
RATIO2(17)= 1.0044388
RATIO2(18)= 1.0015084
RATIO2(19)= 1.0008443
RATIO2(20)= 1.0000944
FD( 1)= 0.170327E-03
FD( 2)= 0.234440E-03
FD( 3)= 0.329813E-03
FD( 4)= 0.432761E-03
FD( 5)= 0.532098E-03
FD( 6)= 0.627811E-03
FD( 7)= 0.699730E-03
FD( 8)= 0.746750E-03
FD( 9)= 0.759732E-03
FD(10)= 0.762839E-03
FD(11)= 0.766879E-03
FD(12)= 0.770989E-03
FD(13)= 0.775138E-03
FD(14)= 0.779909E-03
FD(15)= 0.784752E-03
FD(16)= 0.789909E-03
FD(17)= 0.795138E-03
FD(18)= 0.799109E-03
FD(19)= 0.803126E-03
FD(20)= 0.807147E-03
GO TO 400
C CONSTANTS FOR THE WINTER
RATIO2( 1)= 1.0862487
RATIO2( 2)= 1.0893572
RATIO2( 3)= 1.0909949
RATIO2( 4)= 1.0979884
RATIO2( 5)= 1.0999820
RATIO2( 6)= 1.1000254
RATIO2( 7)= 1.1000243
RATIO2( 8)= 1.1000243
RATIO2( 9)= 1.1000243
RATIO2(10)= 1.1000243
RATIO2(11)= 1.1000243
RATIO2(12)= 1.1000243
RATIO2(13)= 1.1000243
RATIO2(14)= 1.1000243
RATIO2(15)= 1.1000243
RATIO2(16)= 1.1000243
RATIO2(17)= 1.1000243
RATIO2(18)= 1.1000243
RATIO2(19)= 1.1000243
RATIO2(20)= 1.1000243
FD( 1)= 0.237897E-03
FD( 2)= 0.319906E-03
FD( 3)= 0.410829E-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)= 0.751034E-03
FD(10)= 0.720293E-03
FD(11)= 0.663644E-03
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

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) = 1.0714581
RATIO2(10) = 1.0590323
RATIO2(11) = 1.0482722
RATIO2(12) = 1.0351881
RATIO2(13) = 1.0240435
RATIO2(14) = 1.0176469
RATIO2(15) = 1.0117923
RATIO2(16) = 1.0081480
RATIO2(17) = 1.0048179
RATIO2(18) = 1.0027836
RATIO2(19) = 1.0015986
RATIO2(20) = 1.0007970

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) = 0.705942E-03
FD(8) = 0.747132E-03
FD(9) = 0.752861E-03
FD(10) = 0.726452E-03
FD(11) = 0.668075E-03
FD(12) = 0.579908E-03
FD(13) = 0.492938E-03
FD(14) = 0.40105E-03
FD(15) = 0.328260E-03
FD(16) = 0.261505E-03
FD(17) = 0.236349E-03
FD(18) = 0.201958E-03
FD(19) = 0.17498E-03
FD(20) = 0.160195E-03

DO I = 1, LLH
IF (ARRAY(1) .EQ. 0 .OR. ARRAY(I) .EQ. 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)
GO TO 10
50 FD(I) = 1.1
CONTINUE
RETURN

CPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP--WHPP--PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
C WHPP PUNCHES THE PROCESSED PARTIAL REFLECTION DATA
C ON PAPER TAPE
CPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
C SUBROUTINE WHPP
COMMON /PPC/ AO(21), AX(21), AVG(21), AVGX(21), TIM(4),
1, X(21), Y(21), Z(21), BM0(5), BMX(5), EL(21),
2, BMX, AVNO, AVNX, BMX, ID, IR
COMMON /STAT/ IDB(4), RDATE(2), HEAS(5), IDB(5), BMXNS, NC4
WRITE(7, 1040) TIM, RDATE, HEAS, IDB, BMXNS, NC4
1040 FORMAT( I4, I4, 3X, 5A5, 3X, 5A5, 3X, 2HDB/F7.1, F7.3, F7.1,
1 F8.1, F8.1, F8.1, I4, I5)
DO 160 I = 1, 21
CALL CKCOL
WRITE(7, 1400) IRJ(I), AVG(I), AVGX(I), X0(I), EL(I)
1400 FORMAT (I4, F6.1, F6.1, F6.1, F6.1), F6.0)
160 CONTINUE
RETURN
END
CPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
**PROCEDURE 73**

**PROCEDURE 73** evaluates collected partial-reflection data and prints out the electron density. PROCEDURE 73 uses the following programs:

**DINIT** — sets up and prints the heading (FORTRAN)

**FSTAT** — locates the data file (MACRO)

**SEEK** — finds the file on the storage device (MACRO)

**DRD73** — sets samples into the real $0 \times \text{AVA}_0$ array (FORTRAN)

**CALC2** — calculates the electron density (FORTRAN)

**HEAD** — sets up and prints the heading (FORTRAN)

**DINIT** calls **FSTAT** and **SEEK** to locate the data file.

**CALC2** calculates the electron density from the partial-reflection data.

**HEAD** prints the heading for the output file.
C SUM OF THE SQUARED GOOD AO AND AX SAMPLES
AVAO(I)=AVAO(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 I=IR+1
52 SNO=SNO+SN0
SNX=SNX+SNX
GO TO 49
49 I=I/D5
51 BI=SD5
BMNS=BMNS/DUM4
C THE RMS OF ALL NOISE SAMPLES TAKEN
AVNO=SQRT(SNO/BID)
AVNX=SQRT(SNX/BID)
C THE NUMBER OF THE ACCEPTABLE NOISE SAMPLES
RN=4*(ID-I)
DO 52 I=1,21
C NUMBER OF REJECTED DATA AT EACH HEIGHT
IRJ(I)=IRJ(I)+IH
C NUMBER OF ACCEPTABLE DATA AT EACH HEIGHT
RSAM=ID-IRJ(I)
C ACCEPTABLE NOISE IS SUBTRACTED OFF
AVOC=AVAO(I)/RSAM-BMO/RN
AVXC=AVAX(I)/RSAM-BMX/RN
C RMS OF GOOD DATA WITH THE SIGN PRESEVERED
AVAO(I)=(ABS(AVOC)/AVOC)*SQRT(ABS(AVOC))
AVAX(I)=(ABS(AVXC)/AVXC)*SQRT(ABS(AVXC))
EL(I)=0
X0(I)=0
IF(AVOC(I).LE.0.0.OR.AVAX(I).LE.0.0)GO TO 52
XO(I)=AVAX(I)/AVAO(I)
52 CONTINUE
C RMS OF ACCEPTABLE NOISE
BMO=SQRT(BMO/RN)
BMX=SQRT(BMX/RN)
C GET ELECTRON DENSITIES
CALL CALC2(XO,20,EL,IA)
C WRITE THE HEADING
CALL HEAD(J)
C WRITE OUT TABLE
DO 53 I=1,21
HT=HT+I.5
WRITE(6,58)IRJ(I),HT,AVAO(I),AVAX(I),X0(I),EL(I)
58 FORMAT(3X,14,3X.F5.1,3X,F6.1,2X,F6.1,2X,F5.2,3X,F6.0)
53 CONTINUE
STOP
END
C HEAD SETS UP AND PRINTS OUT ONE LINE OF INFORMATION AS A
C HEADING FOR A NEW PAGE.
C SUBROUTINE HEAD(J)
REAL REAS(12)
IF(J)6,0,1
1 WRITE(6,100) REAS
100 FORMAT(12A9)
RETURN
6 WRITE(6,100)
110 FORMAT(12A9)
RETURN
110 FORMAT(12A9)
READ(4,200) REAS
200 FORMAT(12A9)
RETURN
F ND
CHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH

.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 IDAT EVERY TIME CALLED
/THESE ARE UNPACKED FROM 16 WORDS OF THE BUFFER
/IDAT WORD 1 I+ 1 #
/WORD 2-6 NOISE SAMPLES
/WORD 7-27 DATA
/NESP1  SET IF A NEGATIVE NUMBER WAS IN THE DATA

/GLOBAL DINIT, DUMPT, DA

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 /# OF SETS PER ONE BLOCK OF STORAGE
DTBLK=374 /SIZE OF ONE BLOCK OF STORAGE
DATSTR=DTBLK/NSAMP /# OF SETS PER ONE BLOCK OF STORAGE
NDPC=NSAM/2 /NUMBER OF STORED DATA PAIRS PER SET

IDEV DATIN

DINIT 0

/INIT DATIN, DINIT /INITIALIZE DEVICE STORING THE DATA
LAW -1 /PREPARE TO READ
DAC CT9 /IN ONE BLOCK OF DATA
LAC BUF3 /RESET THE BUFFER POINTER WITH
DAC POINT2 /THE ADDR. OF BUF3
LAC (ISZ Switch) /PREPARE TO READ TWO
DAC LCA /DUMMY BLOCKS
JMP* DINIT /END OF INITIALIZATION

DUMPT 0

JKS= .+DA /PICKUP ADDR OF ADDR
JMP +3 /OF ARRAY
A2 0

FLAG 0

LAC* A2 /SET ONNEG #
DAC A2 /OF ARRAY
LAW -NDPC /SET COUNTER OF DATA TO BE
DAC COUNT /PROCESSED
ISZ CT9 /SET POINTER
JMP LBB /NO CONTINUE WITH PRESENT SET OF DATA
LAW -DATSTR /RESET COUNTER TO THE NUMBER
DAC CT9 /OF SETS PER BLOCK OF STORAGE

LBA +READ DATIN, DUMPT, BUF3, DTBLK /GET 1 BLOCK OF DATA
C14 = WAIT DATIN

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

LCB LAC BUF3 /GET ADDRESS OF BUF3
DAC POINT2 /POINTS TO BUF3
LBB LAC* POINT2 /GET THE ID (FIRST WORD IN DATA SET)
SAD SEVN /END OF FILE ID?
JMP ENP /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 UNPACK
DAC TC10 /TWO DATA WORDS
LAC* POINT2 /GET DATA WORDS FROM BUF3
SWHA AND (777) /SAVE ONE DATA WORD
SBA /CHECK FOR NEG+ NUMBER
ISZ* FLAS /SET IF NEQ+ NUMBER FOUND
DAC* A2 /LOAD # INTO FORTRAN ARRAY
LAC* POINT2 /GET DATA WORD AGAIN
ISZ A2 /GO TO NEXT LOC. IN ARAY
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, GO TO NEXT ID
JMP* DUMPT /RETURN

SWITC LAW -3
COUNT LAV -NDPC
CT9 LAV -DATSTR
SEVN 376092
TC10 0

POIN T* DSA BUF3
BUF31 DSA BUF3
BUF32 BLOCK DTBLK

...
C**********************************************************************
C FROM GIVEN COLLISION FREQUENCIES, CALC ALONG WITH ELDEN
C CALCULATES THE CONSTANT VALUES USED IN THE ELECTRON DENSITY
C EQUATION GIVEN BY PIHAT IN AERONOMY REPORT 29 AND WRITES THE
C PROGRAM CALCC WHICH CALCULATES THE ELECTRON DENSITIES FOR THE
C PARTIAL-REFLECTION PROGRAMS.
C**********************************************************************
DIMENSION ARRAY(21), P(21), CF(3), ELC(30), CALC2(2)
DATA CALC2CI), CALC2(2)/5HCALC2*4H
I
LAML=8
C COLLISION FREQUENCY PROFILES
C COLLISION FREQUENCY PROFILE FOR THE SUMMER
130  
P(1)=192.3
P(2)=156.9
P(3)=137.5
P(4)=123.7
P(5)=112.3
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)=11.89
P(14)=9.057
P(15)=6.917
P(16)=5.399
P(17)=3.827
P(18)=2.562
P(19)=1.24
P(20)=1.563
P(21)=1.183
C 'RITE TH. PROGRAM HEADING ONTO TAPE
CALL ENTEn(IDAT=CALC2)
WRITE(IDAT,10)
   10 FORMAT(69H C CALC2 IS A LIST OF CONSTANTS CALCUATED FROM THE
     PROGRAMS/63H C CALCC AND ELDEN AND USED TO
     CALCULATE THE FUNCTION THAT CALCULATES THE ELECTRON DENSITIES
     FOR THE PARTIAL-REFLECTION PROCESSING PROGRAMS/48H C THE PROGRAM
     PARTIAL-REFLECTION CALC IIILETS THIS PROGRAM/69H C CALC2 AND
     ELDEN CAN BE CHANGED./49H C AT THE END OF THE PROGRAM.
C WRITE THE PROGRAM HEADING ONTO TAPE
CALL ENF(LAC=SEVEN)
WRITE(LAC,20)
   20 FORMAT(69H C COLLISION FREQUENCY PROFILE FOR THE VINTER
     19H C COLLISION FREQUENCY PROFILE FOR THE SUMMER
     19H C COLLISION FREQUENCY PROFILE FOR THE FALL
     19H C COLLISION FREQUENCY PROFILE FOR THE SPRING)
GO TO 400
C ACCIDNTS FOR THE WINTER)
GO TO 600
C C CONSTANTS FOR THE EQUINOX
GO TO 400
C SET THE COLLISION FREQUENCIES TO THE RIGHT ORDER OF MAGNITUDE
DO 401 I=1,21
P(I)=P(I)*(1.**5)
401 CONTINUE
C STATEMENT LABEL FOR THE NEW PROGRAM
LABL=LABEL+100
J=J+4
K=0
DO 23 I=1,23
K=K-1
CP(I)=P(K)
CF(2)=P(K+1)
23 CONTINUE
C CALCULATE CONSTANTS FOR THE ELECTRON DENSITY EQUATION
20 CALL ELDEN(RCFARHAY(I),ARHAY(I+1),EL(I))
C WRITE FIRST CONSTANT WITH A STATEMENT LABEL
WRITE(IDAT,405)LABEL,ARHAY(I)
405 FORMAT(2H 13,12H RATIOS(I)=F10.7)
C WRITE THE REST OF THE RO AND RX CONSTANTS
DO 25 I=2,20
ARHAY(I)=ARHAY(I+1)/ARHAY(I)
25 WRITE(IDAT,410) I,ARHAY(I)
410 FORMAT(C9H RATIOS(I-12H)=*F10.7)
C WRITE THE CONSTANT DENOMINATORS
DO 33 I=1,20
33 WRITE(IDAT,420) I,EL(I)
420 FORMAT(SH FD(I),E13.8)
C CALCULATE THE REST OF THE CONSTANTS
IF(JI.LT.5)GO TO 200
IF(JI.LT.10)GO TO 300
C WRITE THE REST OF THE PROGRAM TO CALCULATE ELECTRON DENSITIES
WRITE(IDAT,48)
48 FORMAT(4H 10 DO I=1,20 IF(ARRAY(I).EQ.0. OR.
 ARRAY(I+1).EQ.0.)GO TO 59/59H C THE FUNCTION FOR THE CALCULATION OF ELECTRON DENSITIES/
351H FD(I)=ALOG(ARRAY(I)/ARRAY(I+1))*RATIO2(I)/FD(I)
410H GO TO 10/12H 50 FD(I)=*F10.7 CONTINUE/8H RETURN)
CALL CLOSE(IDAT)
STOP
END
C::t2t:stststtR -SUBROUTINE ELDEN-
C DURING DATA PROCESSING THERE ARE ONLY 2 VARIABLES
C FOR EACH HEIGHT AO AND AX. THE EQUATION FOR THE
C ELECTRON DENSITY AS GIVEN BY BIRLY (1971) IS:
C ED=LN(((AX(I)/AO(I))/(RX(I)/RO(I)))/((AX(2)/AO(2))/(RX(2)/RO(2))))/FD
C WHERE LN IS THE NATURAL LOG AND I AND 2 ARE HEIGHT 1 AND 2
C SUBROUTINE ELDEN CALCULATES THE CONSTANTS RX,RO,AND FD
C FOR EACH HEIGHT.
SUBROUTINE ELDEN(AXBYAO,GNU,RXROI,RXRO2,FD)
DIMENSION AXBYAO(3),RXBYRO(3),RX(3),RO(3),GNU(3),RATIO(3)

C APPROX INTEGRAL PARAMETERS
A4=2.3983474E-2
A3=1.1287513E+1
A2=1.1394160E+2
A 1=2.4653115E+l
B6=1.806412E-2
B5=9.377372
B4=1.4921254E+2
B3=2.8958085E+2
B2=1.2849512E+2
B1=6.6314497
AXBYAO(3):R
C GNU(3) IS MEAN COLLISION FREQUENCY AT THE INTERMEDIATE HEIGHT
C CALCULATE C INTEGRALS AT BOTH HEIGHTS AND FOR AVERAGE GNU
DUM=DUM(1)+DUM(2)
GNU(3)=.5*DUM
DO 22 K=1,3
C=-(2.59614E+7)/GNU(K)
X=7.3PR6E+6/GNU(K)
CTN=O*(O*(O+AI)+A2)+A3)+A4
CTD=O*(O*(O+O*B1)+B2)+B3)+B4)+B5)+B6
CTO=CTN/CTD
CTY=O*(O*(O+O*C1)+C2)+C3)+C4
CTX=O*(O*(O+O*D1)+D2)+D3)+D4)+D5)+D6
CTY=CTY/CTX
CFY=O*(O*(O+D1)+D2)+D3)+O*(O*(O+O*F1)+F2)+F3)+F4)+F5)+F6)
C CALCULATE RATIOS
RX(K):SRT((X*CTX)**2+(2.5*CFX)**2)
RO(K):SRT((O*CTO)**2+(2.5*CFO)**2)
RXBYRO(K)=RX(K)/RO(K)
RATIO(K):AXBYAO(K)/RXBYRO(K)
CONTINUE
C CALCULATE FD FROM FINAL VALUES OF DO LOOP
FO:(5.*3.124E+3*CFO)/(4.*3.12E+3*GNU(3))
FX=(5.*3.124E+3*CFX)/(4.*3.12E+3*GNU(3))
FD=(FX-FO)*3.E+9
RXROI=RXBYRO(1)
RYRO2=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***********************************************************************

DIMENSION IA(50),RAI(50),RA2(50)
MAX=50
I1=1
WRITE (6,110)
110 FORMAT(1HM 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) GO 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=II+1
CALL INPAD(IA,NS,ICH)
IF(ICH.EQ.0) GO TO 25
IF(II.GT.I)nO TO 11
DO 13 I=1,131
11 WRITE(6,181)
12 C DO LOOP FOR SECOND SET OF NUMBERS READ IN
DO 15 I=1,131
C CONVERSION ALGORITHM FOR A/D CONVERTER NEQ. #5 TO COMPUTER
C NEGATIVE NUMBERS
IF(IA(I).GT.511) IA(I)=.072+(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(IA(I))/TSII
13 GO TO 25
15 WRITE(6,101)
16 C WRITE OUT THE NUMBERS IN AN ORDERLY WAY
DO 55 J=1,INS
ICH=J
CALL INPAD(IA,MAY,ICH)
IF(ICH.EQ.0) GO TO 55
DO 59 I=1,MAY
IF(ICH.EQ.0) WRITE(6,105)
IF(ICH.EQ.11) WRITE(6,106)
RA2(I)=FLOAT(IA(I))/SII
55 CONTINUE
59 WRITE(6,120)AV,AVV
50 C THE FOLLOWING DUMPS THE AVERAGE OF THE A/D CONVERTER CONVERTER
C AND ALSO GIVES THE VALUE IN MILLIVOLTS
INS=(NS-MAX-1)/MAX
TSII=NS-MAX
DO 60 J=1,INS
ICH=J
CALL INPAD(IA,MAY,ICH)
IF(ICH.EQ.0) GO TO 60
DO 69 I=1,MAY
IF(ICH.EQ.0) WRITE(6,105)
IF(ICH.EQ.11) WRITE(6,106)
RA2(I)=FLOAT(IA(I))/SII
60 CONTINUE
69 WRITE(6,120)AV,AVV
65 FORMAT(3X,F4.1,4HKM ,F5.0,4HMV ,F5.0,2HMV)
66 FORMAT(8H --)---)
120 FORMAT(9H AVERAGE=,F7.3,12H VOLTAGE=,F3.3,H MV)
GO TO 5
STOP
END
.TITLE A/D CONVERTER SERVICE ROUTINES FOR 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 PREDUCED
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+RMSU)
(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 -100 IF A DATA
TIMING ERROR OCCURS.

ADVC=29
ADCP=ADVP+1
.SCOM=128
ADVI=789724
ADVI=789724
ADVI=7893731
ADVI=7893731
ADVI=7893734
ADVI=789374
ENTRY POINT FOR A-D INTERFACE INITIALIZATION

.globl inpad,.da

.inpad
  jmp jms* .da
  jmp .+4

.inrac
  jmp inp

.inwc
  jmp inflag

.inflag
  jmp inset

/ REPLACED BY "lac* inwc"

 tca
dac* (adwcr)  /SEt word count
law -1
jad = inar  /BUFFER ADDRESS -1

dac* (adcarr)  / 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* (scm+55)  /GET ENTRY POINT ADDERSS OF .setup

.adsva
dac*  
  jms* .+1  /CALL .setup TO CONNECT ADINT TO API

adso
adint

dzm* (204)

lac (lac* inwc

dac  /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.
/ RUNS AT API LEVEL R.

/ ADINT
  dra  /PAGE ADDRESSING MODE

  dac  adsva  /SAVF AC

  adst  /TIMING ERROR?

  skpicla derivation

  law -1001  /YES, ERROR CODE

  dac* inflag  /SET FLAG

  adgo  /CLEAR

  adct  /INTERFACE FLAGS

  adit

  lac adsva  /RESTORE AC

  dbb  /RESTORE AC

  jmp* adint  /SET TO LEAVE HARDWARE API LEVEL

  .end  /RETURN TO INTERRUPTED PROGRAM