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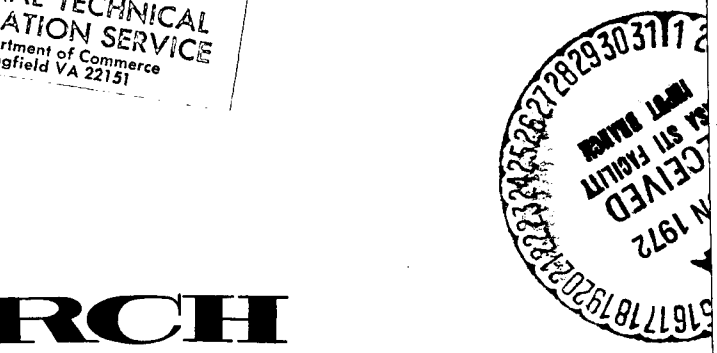

WOLF RESEARCH AND DEVELOPMENT CORPORATION

AN EG&G COMPANY

Antenna Control System

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ABSTRACT

The objective of the Antenna Control System is to utilize the analysis and software development performed for the simulated 40-foot antenna system to produce a unified software package providing complete computer control of the 40-foot antenna system at the NTTF.

The control system comprises a position programmer, scan generator and a digital controller.

The programs developed under this contract were meant to prove certain concepts with the emphasis placed on achieving operational status.

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SECTION 1.0
INTRODUCTION

This final report covers work performed under task order NAS 5-9756-192. During the period, beginning in April 1969 and ending in November 1970, a real-time antennna control system was developed and tested at the NTTF facilites. Programs developed under task orders NAS 5-9756-103, -112 and -117 were incorporated, some in substantially modified form, into the final version.

1.1 PURPOSE AND SCOPE OF WORK

The object of this work is to design, develop and test a real-time antenna control system, utilizing a digital computer and related peripherals, for the 40-ft antenna at NTTF. The control system comprises a position programmer, scan generator and a digital controller. The digital controller may be used to replace the servo-amplifier. When the digital controller is selected the antenna is completely controlled by the real-time program in all its modes of operation.

1.2 DESIGN PHILOSOPHY

By definition, digital systems are discrete as opposed to continuous for analog systems. For controlling analog devices, there is a lower bound to the frequency at which the digital device must operate. This will be determined in another section. The frequency of operation shall be referred to as the sampling frequency. A simple method to insure this condition is achieved by executing the necessary operations at the occurrence of an interrupt at the specified frequency.

The totality of operations to be performed make up the real-time program. It is divided into modules according to function. When the interrupt becomes active, a 12 entry schedule is executed. Each slot in the schedule references a particular module. Some entries are permanent while others are selected according to the mode of operation desired. The updating of the schedule is the function of the mode control program, while the executive program handles the interrupt and executes the current schedule.

It is obvious that one of the permanent entries must be the mode control program. Another is the display program which updates the real-time display to be found on the antenna console. These displays show the command time, real position and command position. Still another permanent entry will be discussed in the section on program mode.

SECTION 2.0
GENERAL DESCRIPTION OF THE SYSTEM

2.1 SYSTEM BLOCK DIAGRAM

Figure 1 shows the block diagram of the real-time system. The dotted line represents the boundary between the analog and digital components. Inputs to the program are handled by A/D converters and the outputs by D/A's. The time and position bias are transmitted by discrete inputs. This applies also to status information from the antenna console. Limit indicators as well as type I or type II operation are transmitted to the console via discrete outputs.

Moving from left to right the first block encountered in Figure 1 is the tape input to the predict interpolation program. The start address of this program is permanently stored in the schedule table. Essentially, this program outputs predict angles interpolated from data acquired from previous passes of the specific satellite or from knowledge of intended orbit before launch. This data is received in ENV coordinates. The ENV to XY conversion program prior to a pass reduces this data to XY angles one second apart. During a pass the data is interpolated to produce predict X and Y angles every 1/20 of a second. This program is always executed regardless of the mode of operation desired.

If stow mode is selected then the stow program is executed. It produces command angles corresponding to the stow position of the antenna.

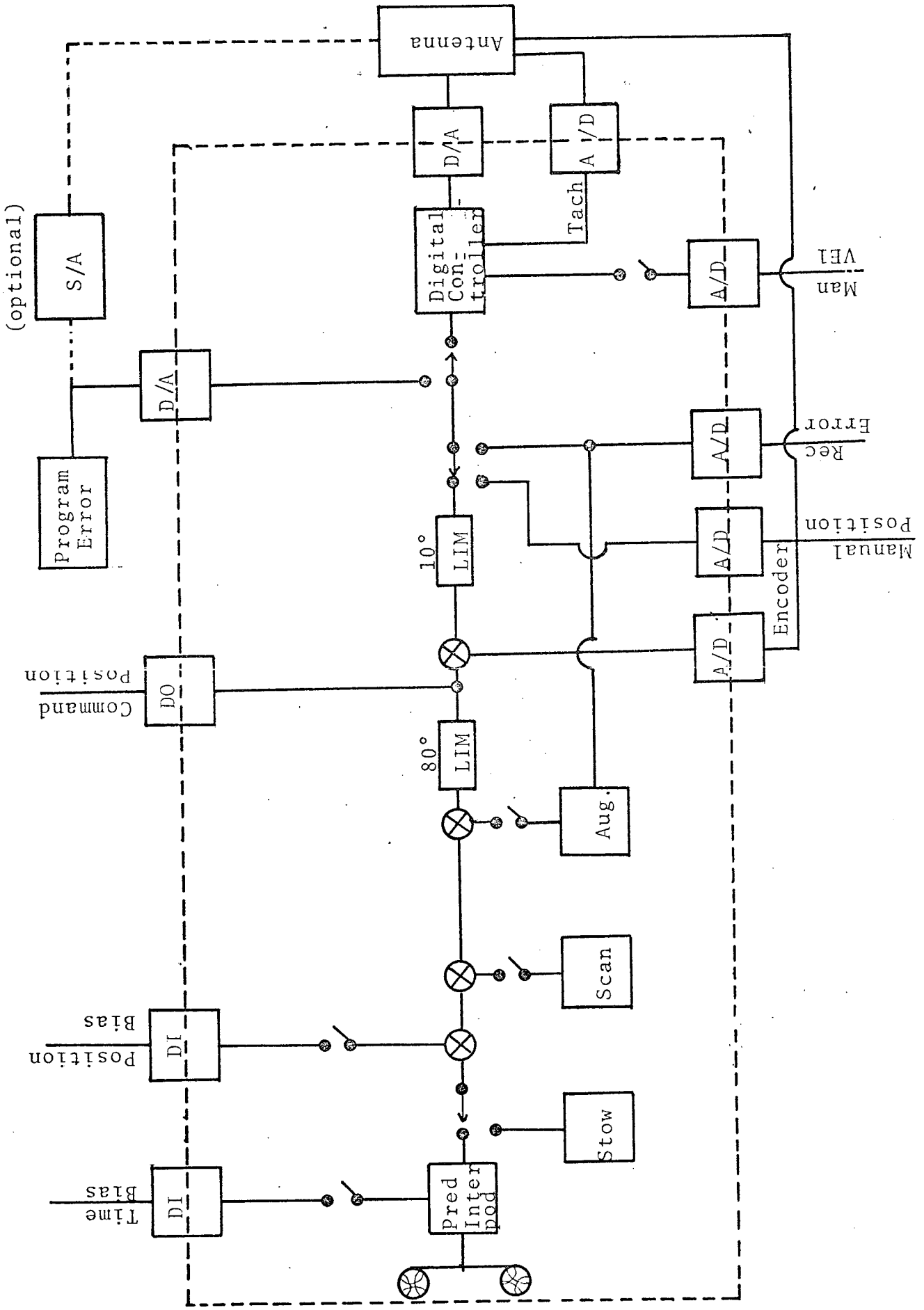

Figure 1. System Block Diagram (One axis)

At this point three options can be exercised. A position bias can be added to the command angle, scan can be superimposed over the predicts or augmentation may be added.

The modified command angle is then checked to insure its validity. The limits on the X and Y command angles are derived from the contour limits of the antenna.

The servo error is calculated next as the difference between the command angle and the real position of the antenna. This error is limited to 10°. If any of the position modes are selected then this error is used to point the antenna.

If manual position is selected the output of the joy stick after suitable processing by the demodulator is fed by an A/D to the real-time program. The angle is set to this value.

However, in the autotrack mode the receiver error is used to drive the antenna. The error can be fed either to the analog servo-amplifier or to the digital controller. The functions of both of these devices will be discussed in a later section. The outputs of either is a valve voltage, which operates the hydraulics that move the antenna.

SECTION 3.0
CONTROL PROGRAMS

The executive and the mode control programs define the operation of the system. The executive program executes the appropriate programs according to a priority scheme previously determined by the mode control program. The mode of operation is selected at the antenna console. Then mode control reinitializes the schedule table to reflect the status of the console.

3.1 ANTENNA EXECUTIVE

When the program interrupt occurs the Σ5 operating system branches to the starting address of the antenna executive program. At this point, the interrupt is said to be in the active state. So long as the interrupt is active no lower priority operation will be executed by the computer.

The first task is to update the interface. This is performed by the subroutine APIO. The interface holds the previous values until it is updated. The inputs are read and used to calculate the appropriate outputs which are subsequently written to the interface.

Next, the real-time is obtained in BCD format and converted to seconds by the subroutine ASTIME. This time is used by the predict interpolation program in finding the correct predicts from the tape.

The schedule table is executed next. Typical schedules are discussed under mode control. Finally, the interrupt is reset and control is returned to the Σ5. The execution time varies according to the mode of operation. The maximum time measured is less than 20 ms. Since the interrupt occurs every 50 ms, this allows 30 ms to be used in executing other programs until the next interrupt occurs.

3.2 MODE CONTROL

As described earlier, the schedule table (Table 1) contains several permanent entries, one of which must be mode control. The function of this program is to update the schedule to reflect the current status of the antenna console. The program is in two parts. The first part checks the discrete status function #1 (Table 2) for any changes. If no change is indicated the schedule is not updated. However, if the status has changed the second part is executed. The status function is scanned and the appropriate programs are entered into the schedule table.

Five modes are presently implemented, namely, program, manual velocity, manual position, autotrack and stow.

For program mode the antenna is driven according to data obtained from previous passes or projected orbits. Since this data is not necessarily exact, provisions are incorporated that allow improvements in tracking accuracy. Scan is used as an aid to acquisition of the satellite. Augmentation improves tracking by forcing a receiver null. Moreover, the add or subtract time, add X and add Y bias switches, allow manipulations of orbit data to improve tracking.

Manual velocity drives the antenna at a velocity proportional to the output of the joy stick. Similarly, in the manual position mode, the output of the joy stick is used to drive the antenna to the position indicated by the console synchroes.

For the Autotrack mode, the receiver error determines velocity of antenna. The stow mode drives the antenna to predetermined angles corresponding to the stow position of the antenna.

A proposed new schedule is shown in Table 3.

TABLE 1

SCHEDULE TABLE

APSCHDLE	APPRED
+ 1	Stow
+ 2	N/U*
+ 3	Apsec, Manual Position
+ 4	N/U*
+ 5	Aprjoy, Aprslav, AUTOTRAK
+ 6	N/U*
+ 7	N/U*
+ 8	Ap@dcompl
+ 9	Ap@dcomp5, Apsaout
+10	APPMODE
+11	APDISPLY

* Not Used

Entries in Capital Letters are Permanent

TABLE 2

DISCRETE STATUS FUNCTION #1
AISTAT1 (APSTAT1)

BIT POSITION	
16	Digital Controller
17	Servo-Amplifier
20	Manual Position Mode
21	Manual Velocity Mode
22	Slave Mode (Not Implemented)
24	Stow Mode
25	Autotrack Mode
26	Program Mode

TABLE 3

PROPOSED NEW SCHEDULE TABLE

0	MODE CONTROL
1	STATION TIME
2	Add Time or Subtract Time
3	PROGRAM MODE
4	Manual Program Mode (Predicts = 0)
5	Add X Bias
6	Add Y Bias
7	Scan or Augmentation
8	Stow or Manual Position
9	Position Limit Check
10	Servo Error Calculation or Autotrack
11	Error Limit Check
12	Digital Position Loop or Manual Velocity
13	Digital Velocity Loop
14	Output to S/A or Value Driver
15	OUTPUT to DISPLAYS and INTERFACE I/O

SECTION 4.0
MODES OF OPERATION

4.1 PROGRAM MODE

Command angles generated by this program are derived from data obtained from a predict tape. The format of this data is shown in Figure 2. The predicts are read, ten records at a time, and written into either of two buffers, as shown in Figures 3 and 4. The choice of buffer depends on the mode of operation, which is itself determined by the location of the buffer pointer. If the pointer points to a record in the second buffer, the program is in mode 1 operation. Consequently, the data in buffer 1 is old and is replaced with new data from the predict tape. When the buffer pointer locates a record in the first buffer, the data in the second buffer is updated. The data in either buffer is exhausted in 10 seconds, which is much greater than the time needed to perform the I/O operations necessary to fill the other buffer. Once a buffer has been filled, a flag is set to guard against it being filled again until it has been used. This flag is reset when the other buffer is filled. Since the I/O is performed simultaneously with program processing the effective I/O time is negligible.

Assuming that the data in the buffers is current, then the buffer pointer is obtained as follows:

> Assume that the station time is 00:10:23 or 623 secs. The difference between this quantity and the time in the first record of buffer 1 is calculated. Referring to Figure 3 we find that this difference is 623 - 610 = 13. This will be the buffer pointer in mode 0 operation. In mode 1 operation, the predict time of the first record

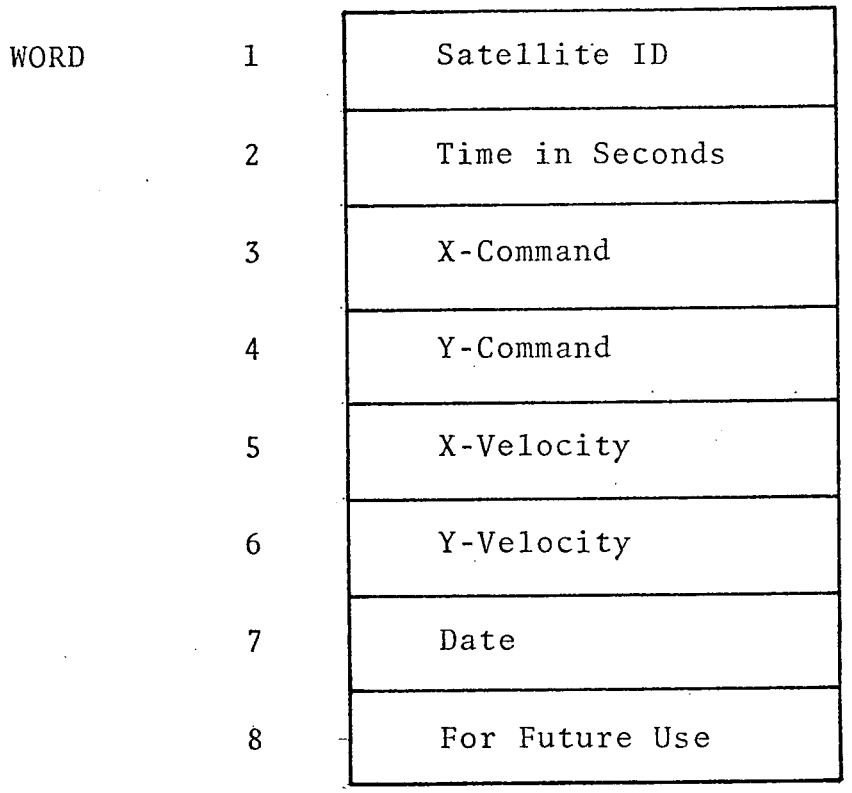

Figure 2. Predict Tape Format

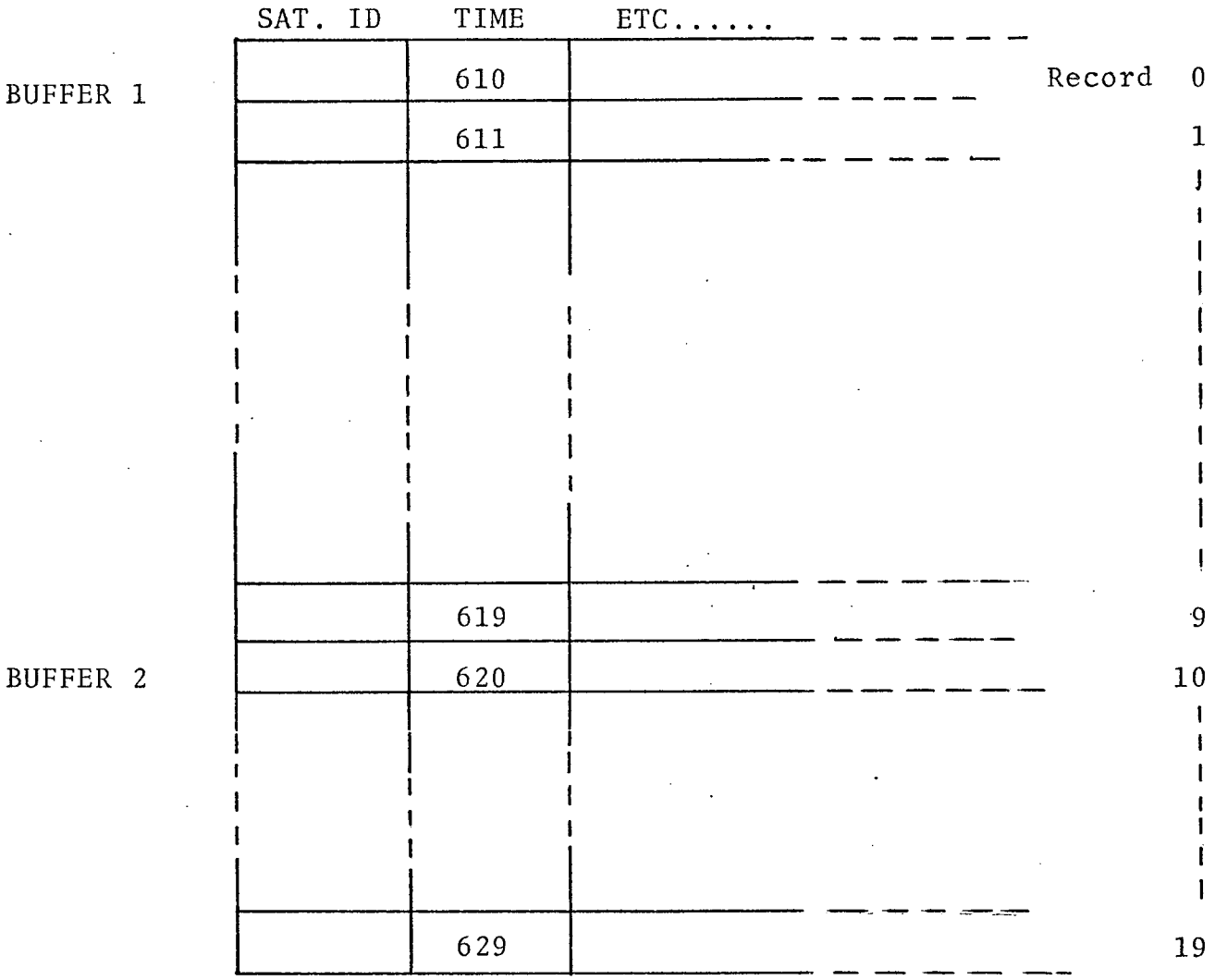

Figure 3. Predict Buffers - Mode 0

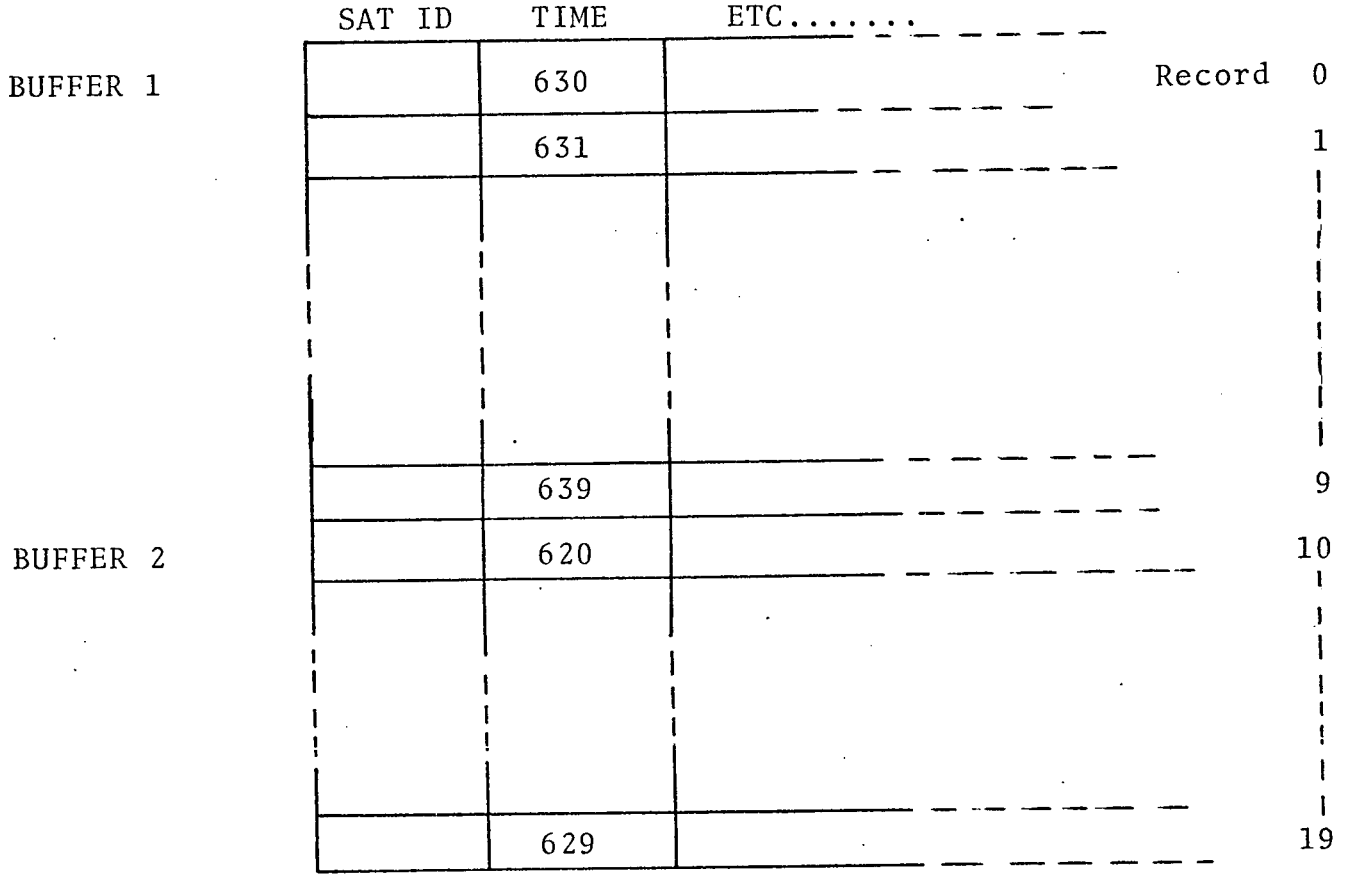

Figure 4. Predict Buffers - Mode 1

of buffer 1 is 630 (Figure 4). The difference between the station time and the predict time is then 623 - 630 = -7. To obtain the buffer pointer, we add 20 to -7 and the pointer is 13 as before.

The buffer pointer locates the proper record which contains the current command angles. Since successive records contain coordinates corresponding to times 1 second apart and since the sampling frequency is 20 times a second, interpolation is necessary. The coordinate increments are calculated by taking the difference between the coordinates at time t and those at time t + 1 and dividing by 20. These increments are added to the previous X and Y command angles. New increments are calculated every time the buffer pointer changes.

Besides providing command angles corresponding to predicts, this program has provisions for searching the predict tape for the appropriate records and safeguards against tape mishaps.

When the initial position switch is pressed on the console, the predict tape is rewound and positioned at the first record if the initial predict time is ahead of the station time. Otherwise, it searches for a predict time in coincidence with station time.

4.1.1 Scan

As an aid in acquiring satellites a scan function is provided. It is of the form

$$X = \alpha\,\gamma \cos \omega\,\gamma \tag{1}$$

$$Y = \alpha\,\gamma \sin \omega\,\gamma \tag{2}$$

where X and Y are the scan offsets in degrees, $\alpha\,\gamma$ is the effective scan radius and ω is the radial velocity in radians/sec; also

$$\gamma = \gamma\,(\tau)$$

These are the equations of a spiral. It is desirable that the instantaneous tangential velocity be constant. This velocity is given by

$$v = \sqrt{\dot{X}^2 + \dot{Y}^2} \tag{3}$$

and

$$\dot{X} = \alpha\,\dot{\gamma} \cos \omega\,\gamma - \alpha\,\omega\,\gamma\,\dot{\gamma} \sin \omega\,\gamma \tag{4}$$

$$\dot{Y} = \alpha\,\dot{\gamma} \sin \omega\,\gamma + \alpha\,\omega\,\gamma\,\dot{\gamma} \cos \omega\,\gamma \tag{5}$$

Therefore,

$$\nu = \sqrt{\alpha^2\gamma^2 + \alpha^2\omega^2\gamma^2\dot{\gamma}^2}$$

$$= \sqrt{\alpha^2\dot{\gamma}^2(1+\omega^2\gamma^2)}$$

$$= \alpha\,\dot{\gamma}\,\sqrt{1 + \omega^2\gamma^2} \qquad (6)$$

To simplify matters, we ignore the "1" under the square sign in the last expression and we will explore the consequences of this action later. Thus,

$$\nu' = \alpha\,\omega\,\gamma\,\dot{\gamma} = \text{constant} = k \qquad (7)$$

Explicity,

$$\gamma\frac{d\gamma}{dt} = \frac{k}{\alpha\omega}$$

and

$$\int \gamma d\gamma = \int \frac{k\,dt}{\alpha\omega}$$

or

$$\frac{\gamma^2}{2} = \frac{kt}{\alpha\omega} + C$$

Since γ must be zero at $t = 0$ then $C = 0$, therefore,

$$\gamma = \sqrt{\frac{2kt}{\alpha\omega}} \tag{8}$$

The distance along the spiral is given by:

$$D = \int_0^{t_{max}} v' dt = \int_0^{\gamma_{max}} \alpha\omega\gamma\dot{\gamma} dt$$

$$= \int_0^{\gamma_{max}} \alpha\omega\gamma d\gamma$$

$$= \frac{\alpha\omega\gamma_{max}^2}{2}$$

$$= \frac{\alpha\gamma_{max} \cdot \omega\gamma_{max}}{2} \tag{9}$$

Comparing equation 9 with equations 1 and 2 one concludes that,

$$\alpha\gamma_{max} = R_{max} \qquad \text{maximum scan radius} \tag{10}$$

and

$$\omega\gamma_{max} = 5\pi \qquad 2\ 1/2 \text{ turns} \tag{11}$$

Consequently

$$D = \frac{5\pi}{2} R_{max} \tag{12}$$

Since ν' is constant then the time necessary to traverse the distance D is simply

$$t_{max} = \frac{D}{\nu'} = \frac{D}{k} = \frac{5\pi}{2k} R_{max} \tag{13}$$

From equation 8 we obtain

$$\gamma_{max} = \sqrt{\frac{2k}{\alpha\omega} t_{max}} \tag{14}$$

Since α and ω are defined in terms of γ_{max} (eq. 10 and 11) then one can choose γ_{max} at will. Let

$$\gamma_{max} = t_{max} \tag{15}$$

Then it follows that:

$$\gamma_{max} = \frac{5\pi}{2k} R_{max} \tag{16}$$

$$\alpha = \frac{R_{max}}{\gamma_{max}} \tag{17}$$

$$\omega = \frac{5\pi}{\gamma_{max}} \tag{18}$$

and from equation 8 we have

$$\gamma = \sqrt{\gamma_{max}\, t} \tag{19}$$

We note, at this point, that equations 1 and 2 describe the same spiral regardless of the functional form of γ. The dependence of γ on t determines only the rate of the execution of the spiral. The definitions 16 through 19 were obtained as a result of an approximation to equation 6. To illustrate the consequence of this approximation, we consider a typical case, where R_{max} = 1 deg., k = 0.5 deg/sec. The velocity is found to be:

$$\nu = \frac{1}{32}\left[\frac{16}{t} + 256\right]^{1/2}$$

The first term in the brackets is proportional to the error. In Figure 5 the velocity is plotted as a function of time. It is found that at t = 0.1 secs the velocity is 0.656 and at t = 0.1 ν is 0.515 and at t = 3 secs ν is very nearly 0.500. One concludes that this error is tolerable, expecially in view of the fact that the error occurs at the "eye" of the spiral.

The scan program reads the scan radius from the antenna console and executes four spirals as shown in Figure 6. If hold-scan is selected the spiral is stopped and the last values held. When scan is selected the scan angles are added to the predicts.

4.1.2 Augmentation

Though predict data is normally quite good, it still contains a prediction error that can be nulled out by using augmentation. This scheme consists of adding the receiver error in an appropriate fashion to the predict data. As implemented, the augmentation scheme consists of a low-pass filter and an integrator. The operation of the filter and integrator will be discussed under Section 5. The characteristics of the filter are shown in Figure 7.

The filter is necessary since the receiver error signal can be excessively noisy. The integrator is used to force a receiver null. The output of the integrator is added to the predict data when augmentation is selected.

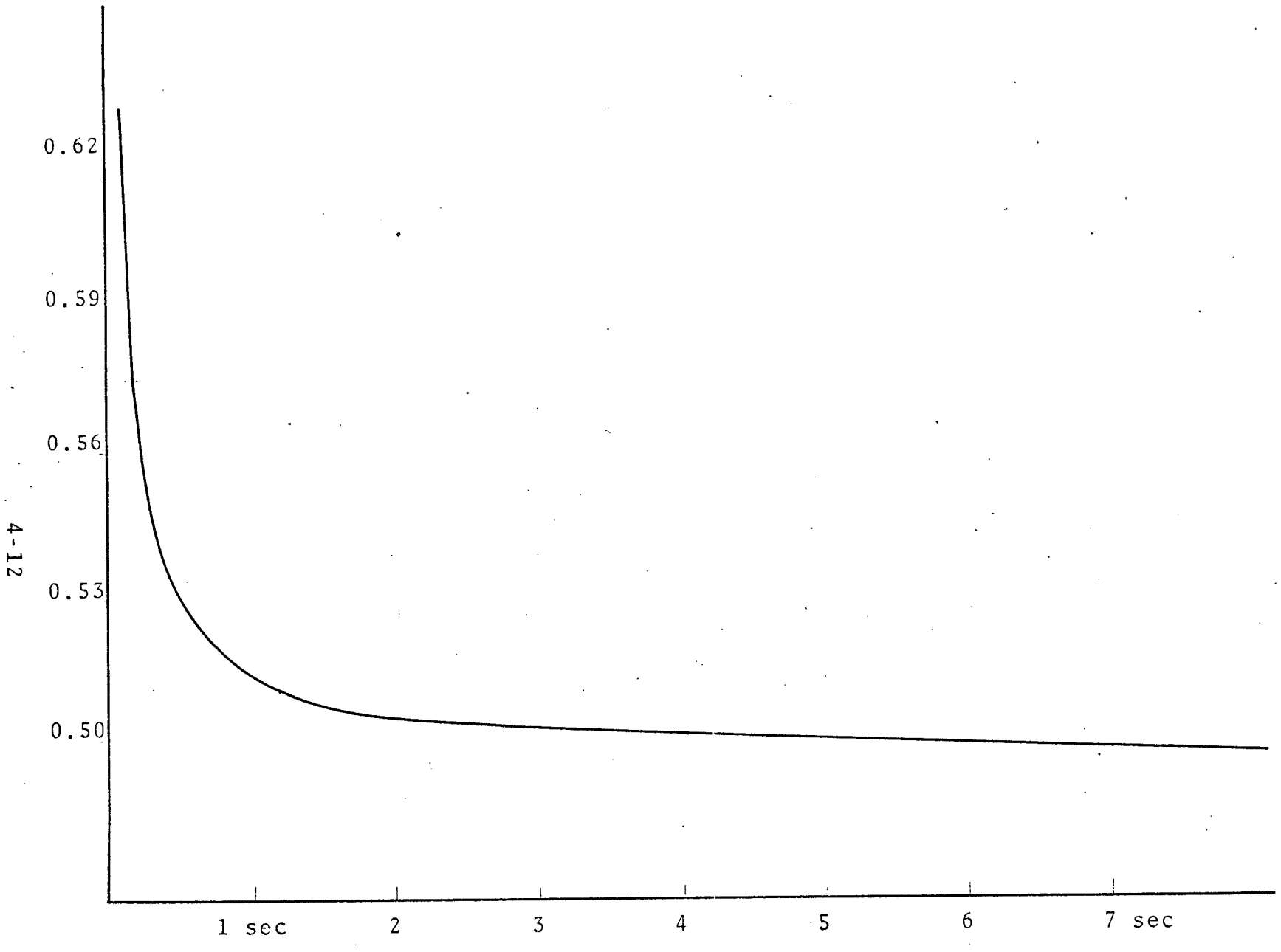

Figure 5. Spiral velocity vs. time

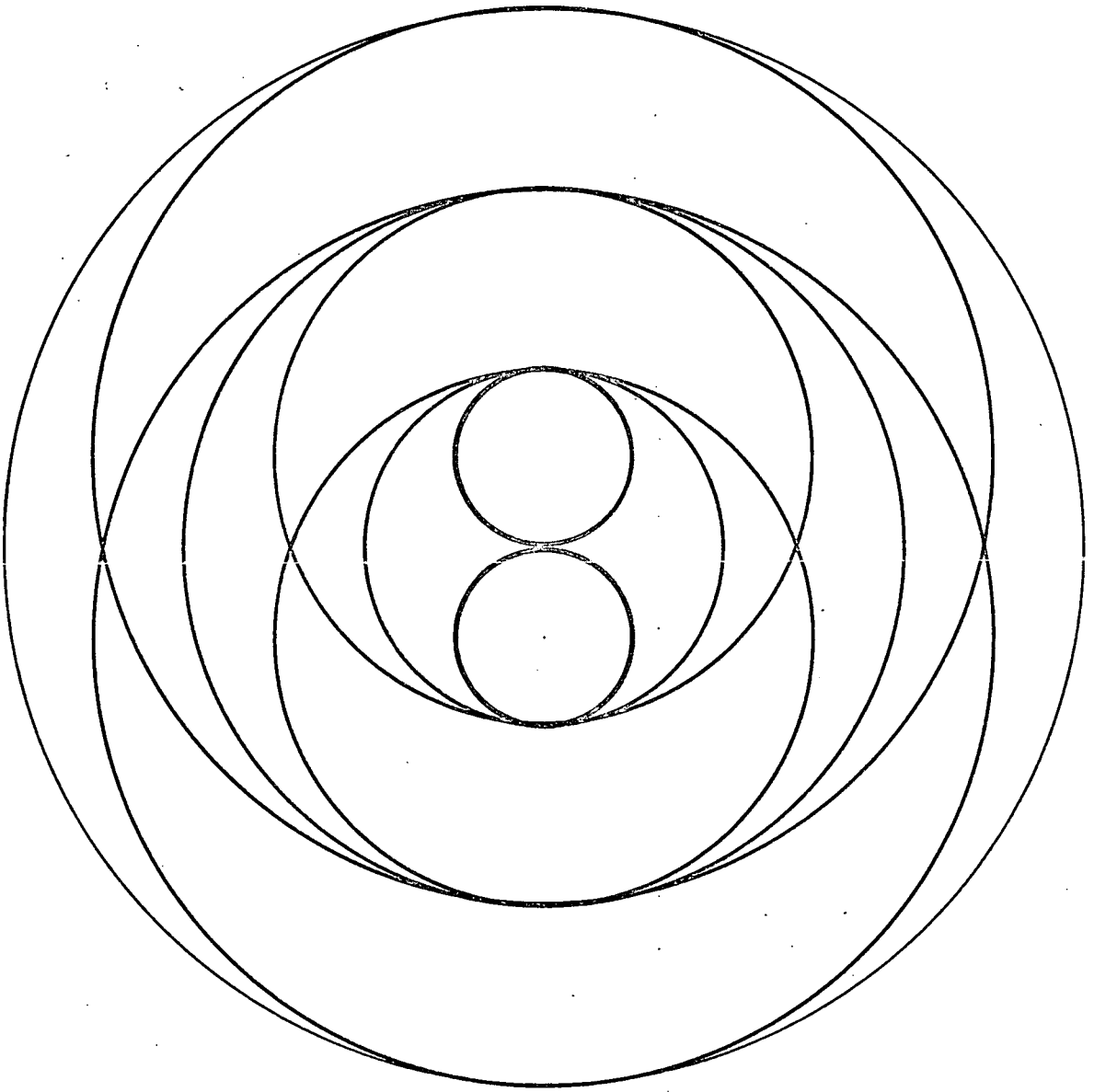

Figure 6. Scan Pattern

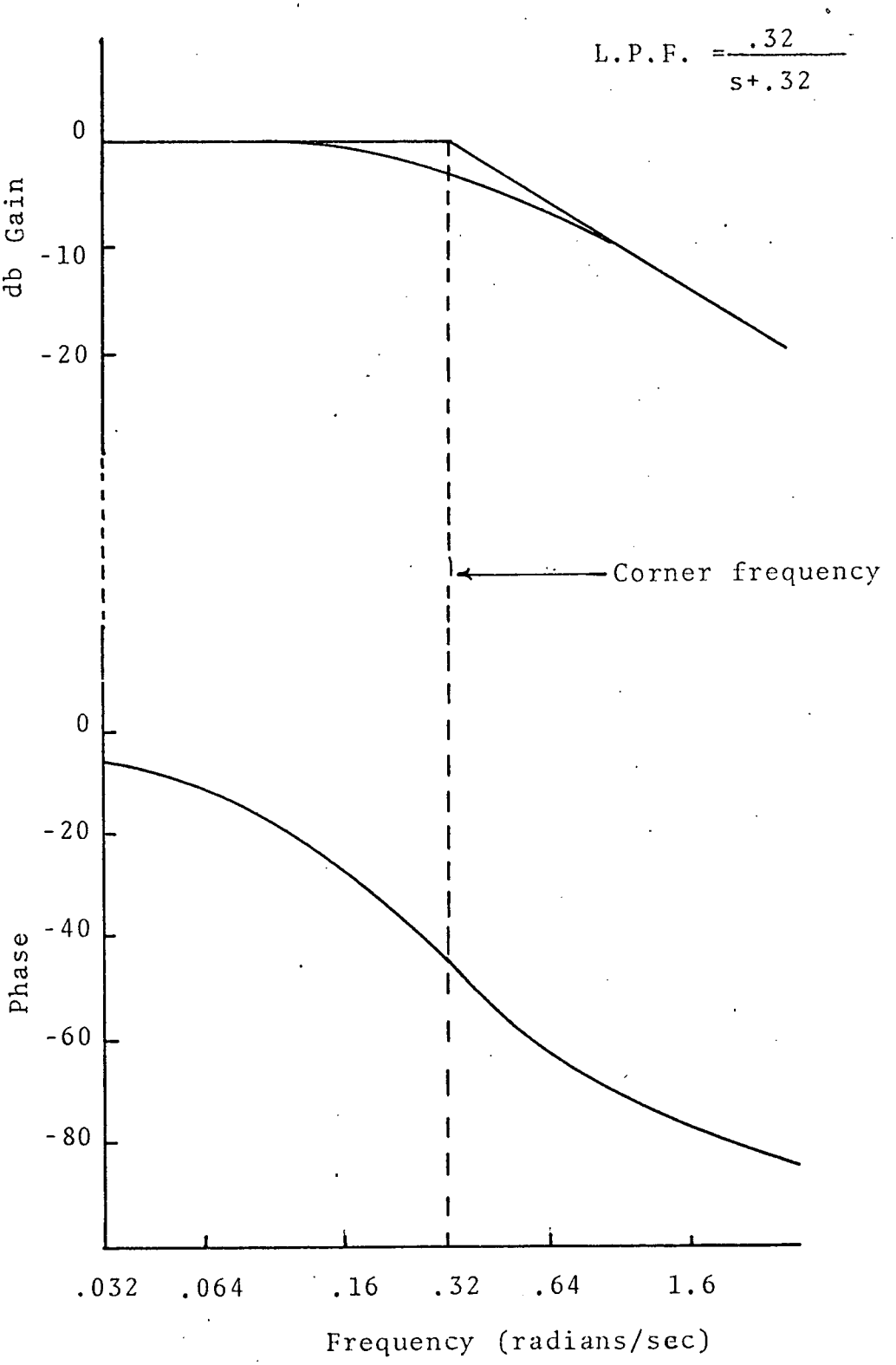

Figure 7. Low Pass Filter Characteristics

4.1.3 Manual Program Mode

In this mode the predicts are set to zero and the command angles are determined by the setting of the X and Y Bias digit switches.

4.2 MANUAL VELOCITY

The output of the joy stick is interpreted as a velocity command and fed to the velocity loop of the digital controller.

4.3 MANUAL POSITION

The output of the joy stick is interpreted as position error and is transmitted to the position loop of the digital controller.

4.4 STOW

Predetermined angles, corresponding to the stow position of the antenna (normally X = Y = 0), are fed to the position loop of the digital controller.

4.5 AUTOTRACK

The receiver error is a position error and is inserted into the position loop, which will be discussed in Section 5.

SECTION 5.0
SERVO-AMPLIFIER AND DIGITAL CONTROLLER

Both the servo-amplifier and the digital controller serve the same function, viz., to convert an input error signal into an appropriate drive voltage to the antenna hydraulic system. There are two types of errors: position and velocity errors. They are handled respectively by the by the position and velocity loops of either device. The digital controller is a program for a general purpose computer that performs the functions of the servo-amplifier. The method used to design the digital controller will be discussed later.

5.1 SERVO-AMPLIFIER OPTIONS

Either the analog servo-amplifier or the digital controller may be selected. This is indicated by the setting of the bits 16 and 17 of the discrete status function #1 (Table 1). In the first case, the position error is transmitted to the S/A and, in the other case, a voltage corresponding to the position error is applied by the digital controller to the hydraulic valve system.

5.2 DIGITAL CONTROLLER*

In Figure 9 we present a simplified circuit diagram of the servo-amplifier. It is composed of impedance elements and operational amplifiers. An operational amplifier is best described in terms of its characteristics. It is a d.c. amplifier designed such that:

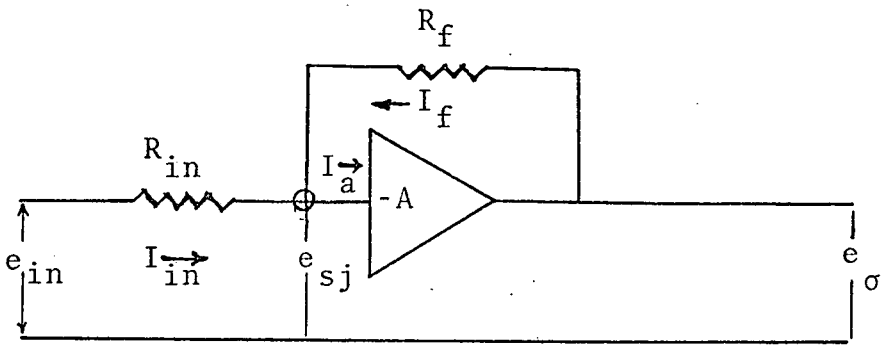

Figure 8. Simplified Amplifier Circuit

1) $e_o = -Ae_{sj}$ (within a specified range) (1)

2) $I_a \simeq 10^{-9}$ amps. - negligible (2)

3) $A \simeq 10^8$ at d.c. (3)

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* The material discussed in this section is treated in greater detail in the books by B.C. Kuo. 1. "Automatic Control Systems." 2. "Analysis and Synthesis of Sampled-Data Control Systems."

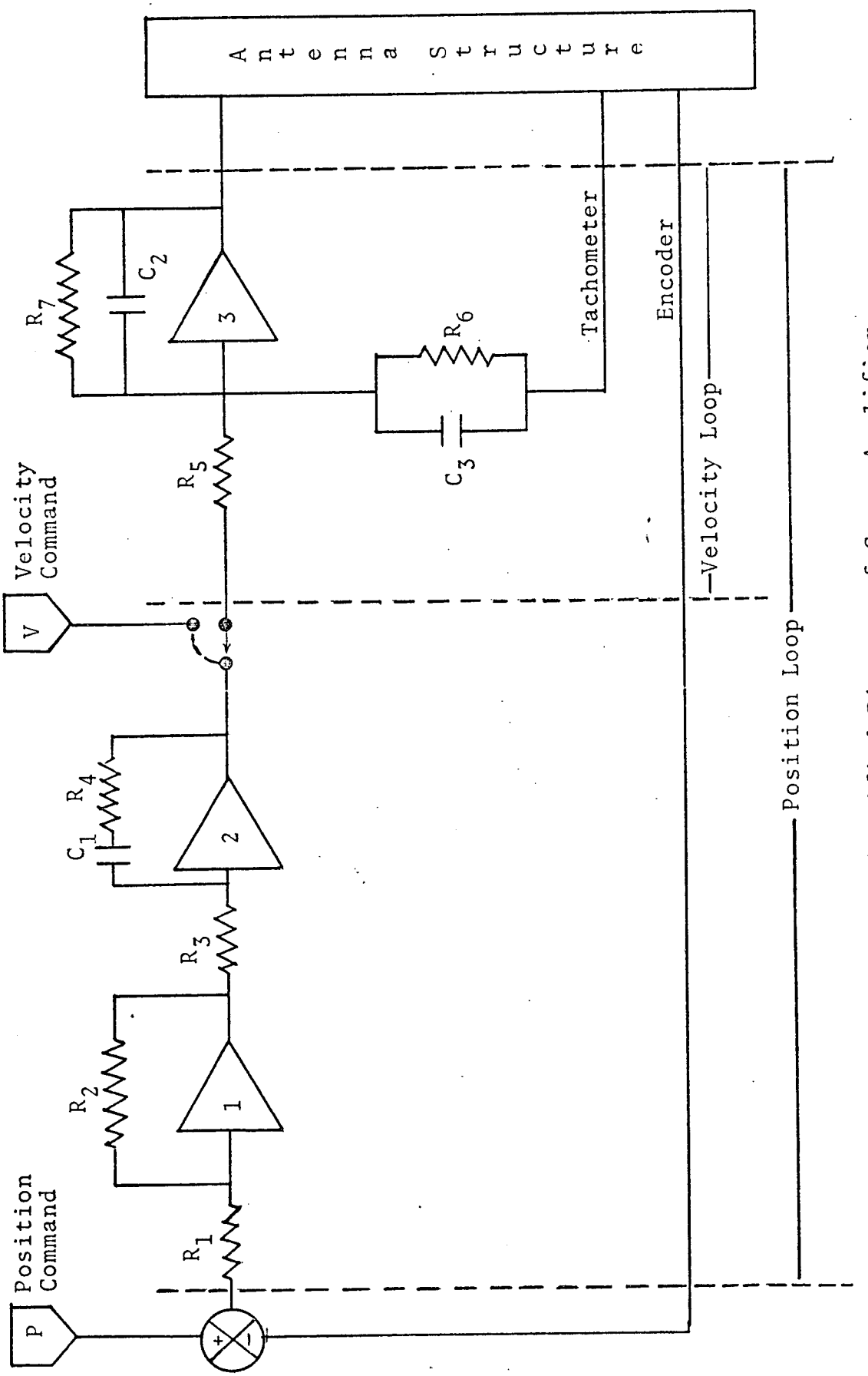


Figure 9. Simplified Diagram of Servo-Amplifier

By Kirchoff's rules, the currents at the summing junction (i.e., ⊕) must add up to zero. Therefore,

$$I_a = I_{in} + I_f \simeq 0$$

or

$$I_f = -I_{in} \tag{4}$$

and

$$\frac{e_o - e_{sj}}{R_f} = \frac{(e_{in} - e_{sj})}{R_{in}} \tag{5}$$

Solving for e_o we obtain:

$$e_o = \frac{-R_f}{R_{in}} e_{in} \quad ; e_{sj} \simeq 0 \tag{6}$$

We have neglected $e_{sj} \simeq -10^{-9}\, e_o$. Thus, for an operational amplifier, the only important parameters are the input and output resistances. It can be shown that, in general,

$$e_o = \frac{-Z_f}{Z_{in}}\, e_{in} \tag{7}$$

Where Z_f and Z_{in} are the feedback and input impedences. In addition, for multiple inputs we have

$$e_o = -Z_f \sum_k \frac{e_{in}^{(k)}}{Z_{in}^{(k)}} \tag{8}$$

Laplace transform theory simplifies the analysis of physical systems. We will be concerned here with only two theorems, viz.:

$$(1)\quad L\,[Kf(t)] = KL[f(t)] = KF(s) \tag{9}$$

$$(2)\quad L\left[\int_o^t f(\tau)\, d\tau\right] = \frac{F(s)}{s} \tag{10}$$

The Laplace transform is a linear operator, i.e.

$$L[f(t) + g(t)] = F(s) + G(s) \tag{11}$$

Returning to the discussion of the operational amplifier we note that the results 6, 7 and 8 imply the following equivalent circuit:

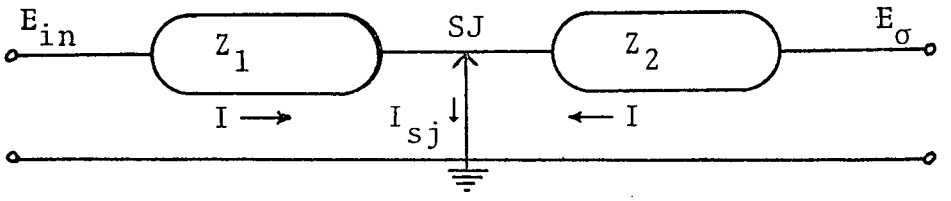


Figure 10. Equivalent Circuit *

The summing junction (SJ) is a virtual ground. This circuit is described by the relations

$$I_{sj} = 0$$
$$E_{in} = IZ_1 \tag{12}$$

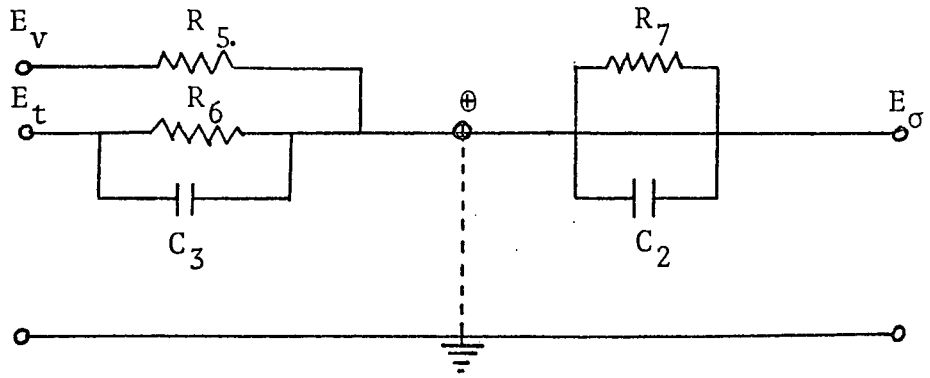
$$E_o = -IZ_2 \tag{13}$$

The transfer function for this circuit is given by:

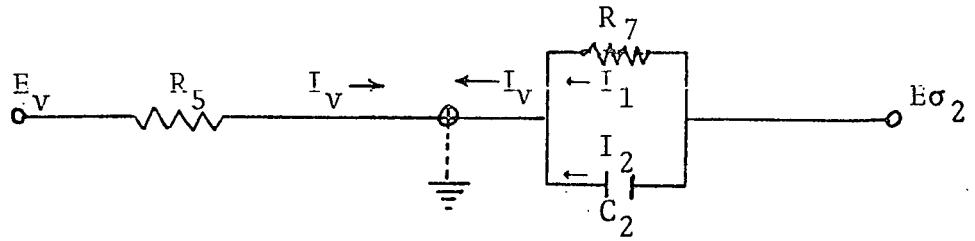
$$T(s) = \frac{E_o(s)}{E_{in}(s)} \tag{14}$$

* Millman, "Vacuum and Semiconductor Electronics," p. 466, McGraw-Hill Book Co., N.Y., 1958.

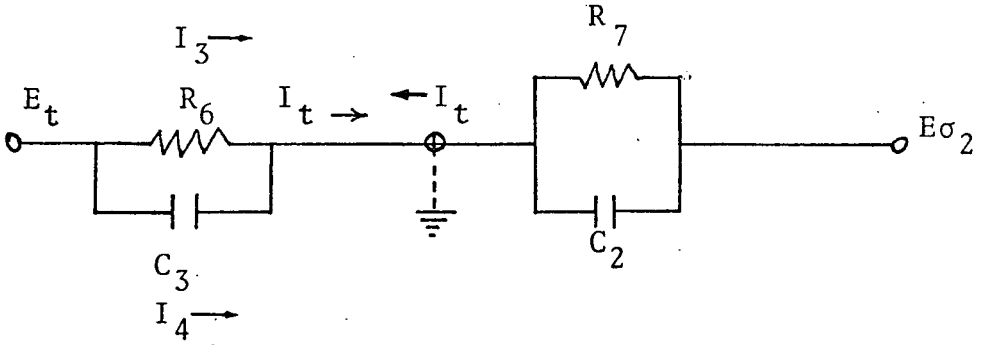
To illustrate how T(s) is calculated we consider the velocity loop in Figure 8. The equivalent circuit is:



which can be divided into two separate circuits:



and



where $E_o = E_{o_1} + E_{o_2}$. The transform of E_v is simply:

$$E_v(s) = I_v(s)\ R_5 \tag{15}$$

For E_T we have

$$E_T = I_3\ R_6 \tag{16}$$

$$= \frac{1}{C_3} \int_o^\tau I_4 dt \tag{17}$$

and

$$E_T(s) = I_3(s)\ R_6 \tag{18}$$

$$= \frac{I_4(s)}{C_3\ s} \tag{19}$$

from which we conclude that:

$$I_4(s) = I_3(s)\ R_6 C_3 s \tag{20}$$

and

$$I_T(s) = I_3 (1 + R_6 C_3 s) \tag{21}$$

Since

$$E_T(s) = I_T(s) \; Z_T(s) \tag{22}$$

we must have using 16,

$$Z_T(s) = \frac{I_3 \; R_6}{I_3 \; (1 + R_6 C_3 s)}$$

$$= \frac{R_6}{1 + R_6 C_3 s} \tag{23}$$

Similarly

$$E_{o_1}(s) = -I_\nu(s) \quad Z_{o_1}(s) \tag{24}$$

where

$$Z_{o_1}(s) = \frac{R_7}{1 + R_7 C_2 s} \tag{25}$$

and

$$E_{o_2}(s) = -I_T(s)\ Z_{o_2}(s) \tag{26}$$

with

$$Z_{o_2}(s) = \frac{R_7}{1 + R_7 C_2 s} \tag{27}$$

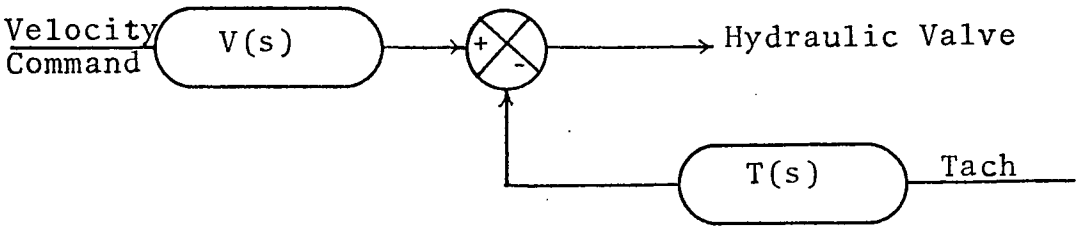
We define two transfer functions, viz.;

$$V(s) = \frac{E_{o_1}(s)}{E_v(s)} + - \frac{R_7/R_5}{1 + R_7 C_2 s} \tag{28}$$

and

$$T(s) = \frac{E_{o_2}(s)}{E_T(s)} = - \frac{R_7}{R_6} \quad \frac{1 + R_6 C_3 s}{1 + R_7 C_2 s} \tag{29}$$

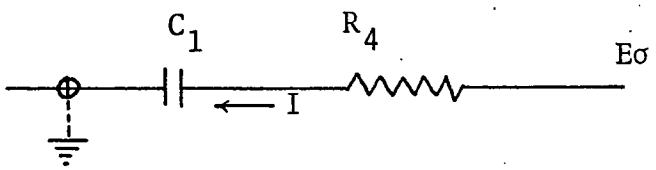
The velocity loop is then given by:



Amplifier #1 in Figure 8 is hooked up as a simple d.c. amplifier. Its transfer function is obtained directly from 6, i.e.:

$$G(s) = \frac{c_{in}}{e_o} = -\frac{R_2}{R_1} \qquad (30)$$

Amplifier #2 is connected as a combination amplifier-integrator and the impedance of the feedback network is obtained as follows:



$$E_o = -I R_4 - \frac{1}{C_1} \int_o^\tau T \, dt$$

or

$$E_o(s) = -I(s) R_4 - \frac{I(s)}{C_1 s}$$

On the other hand:

$$E_{in}(s) = I(s) R_3$$

The transfer function of the integrator-amplifier is then:

$$IA(s) = \frac{E_o(s)}{E_{in}(s)} = - \frac{R_4}{R_3} - \frac{1}{R_3 C_1 s} \tag{31}$$

$$= - \frac{(R_4 C_1 s + 1)}{R_3 C_1 s}$$

The s-transform equivalent of the servo-amplifier in Figure 9 is shown in Figure 11.

Since the servo-amplifier is to be duplicated on a digital computer, we will examine the nature of continuous and discrete data.

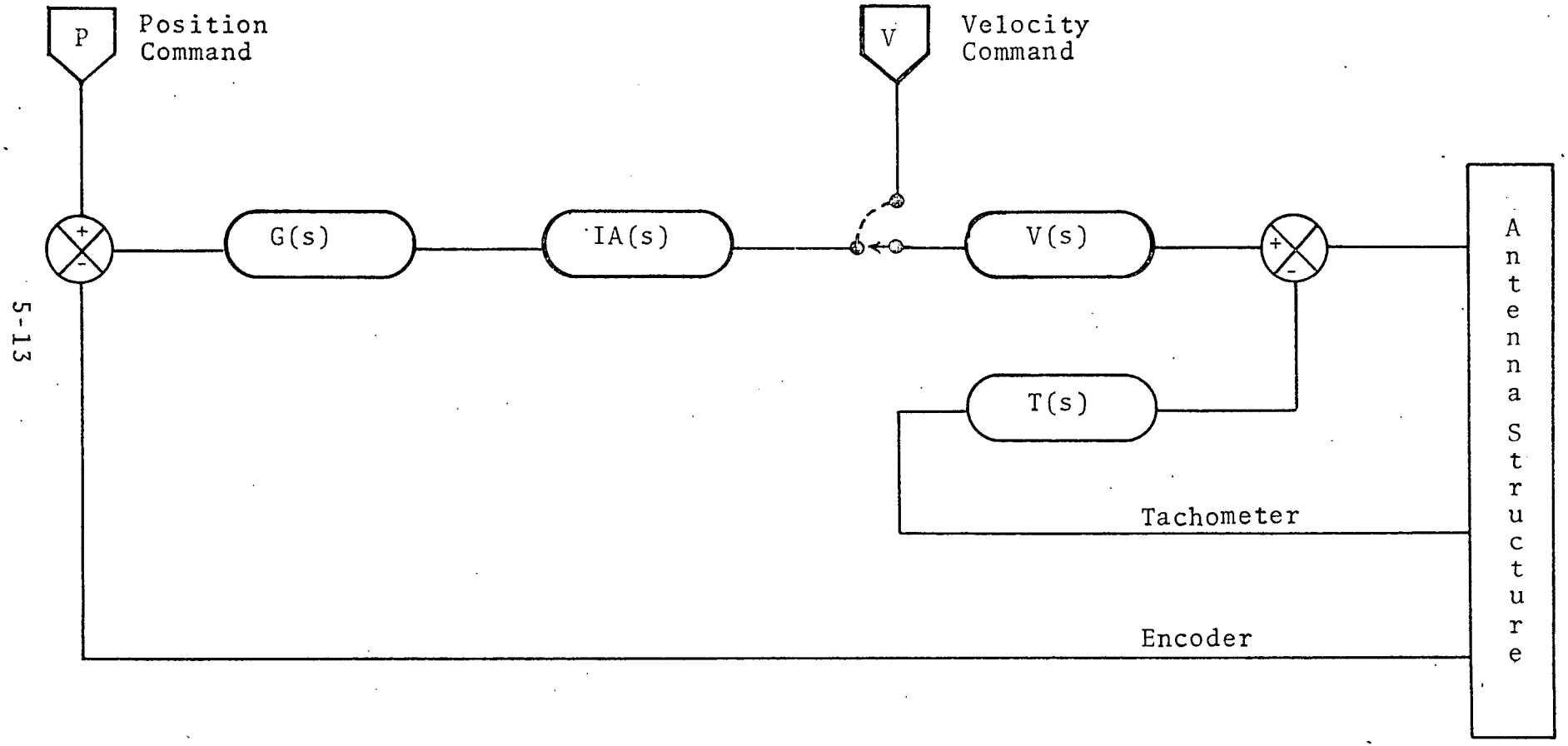
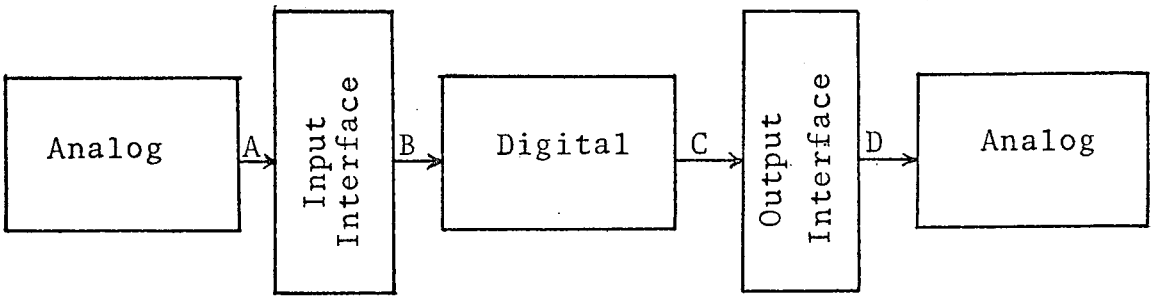


Figure 11. Servo-Amplifier (S-Form)

In a hybrid device the analog and digital components are connected together via an interface.



On input, the digital device will sample the interface at prescribed intervals separated by a period T. On output, the interface holds the last value until it is altered at the following interval. This is illustrated in Figure 12, where an analog signal is shown as it appears at the point A, followed by the digital input at the sampling moments nT.. For the sake of simplicity the digital device merely transmits these values to the output interface at C. Finally, the resultant analog signal is shown as it appears at D. It is immediately obvious that a high sampling frequency is desirable to maintain the integrity of the signal.

In any case, we need a mathematical device to make the transition from A to D in Figure 12. This is the Z-transform. If the analog signal at A is described by the function e(t) then the digital signal at B is given by

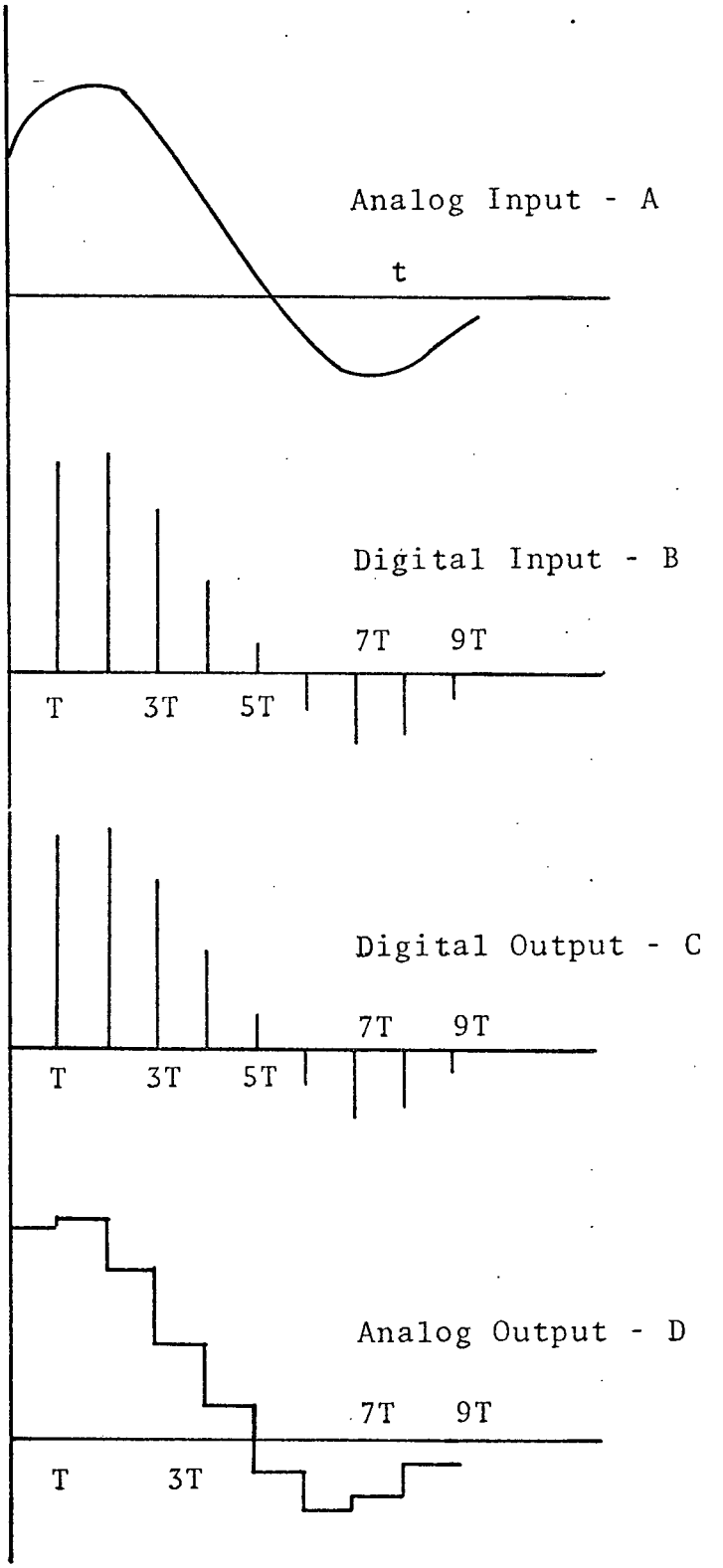


Figure 12. Digital Reconstruction of Analog Signal

$$e^*(t) = \sum_{0}^{\infty} e(t)\ \delta\ (t - nT) \tag{32}$$

where $\delta(x)$ is the Dirac delta function. Equation 32 can be simplified to read:

$$e^*(t) = \sum_{0}^{\infty} e(nT)\ \ \delta\ (t - nT) \tag{33}$$

The Laplace transform of the above is then:

$$E^*(s) = \sum_{0}^{\infty} e(nT)\ \ L[\delta(t-nT)] \tag{34}$$

$$= \sum_{0}^{\infty} e(nT)\ E^{-nT_s}$$

If we define

$$z = e^{Ts} \tag{35}$$

then

$$E^*(s) = E(z) = \sum_{0}^{\infty} e(nT)\ z^{-n} \tag{36}$$

This is called the Z-transform of e(t), which is in contrast to the Laplace transform

$$E(s) = \int_{0}^{\infty} e(t)\ e^{-st}\ dt \tag{37}$$

In general, it can be said that any time function that possesses a Laplace transform will also have a z-transform. It is important to note that the inverse z-transform is not unique, i.e., there exists a class of time functions e(t) that have the same z-transform. This follows from the fact that the z-transform is computed according to the behavior of e(t) at the sampling instants only. As an example, we show in Figure 13 two time functions

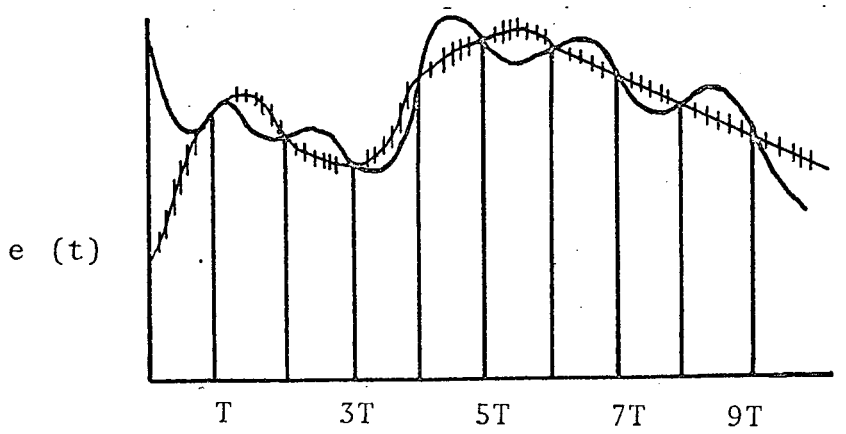


Figure 13. Non-Uniqueness of Z Transform

that have the same digital form; in other words, the value of the two functions coincide at the sampling instants.

One does not compute the z-transforms, usually, since z-transform tables are available. A digital circuit, whose z-transforms are obtained in this manner, does not necessarily have the same frequency response as the equivalent analog circuit. We, therefore, choose another method that ensures a closer correspondence between the frequency response of the digital and that of the analog system. It may be called the equal corner frequency approach.

It was shown earlier that, $z = e^{Ts}$ (eq. 35). Since the frequency response of an analog system is obtained by setting $s = i\omega$ we then have

$$z = e^{i\omega T} \tag{38}$$

Define the transformation

$$\omega = \frac{z-1}{z+1} \tag{39}$$

Then

$$\omega = \frac{e^{i\omega T}-1}{e^{i\omega T}+1} \tag{40}$$

Multiply both denominator and numerator by $e^{-i\omega T/2}$, thus:

$$\omega = \frac{e^{i\omega T/2} - e^{-i\omega T/2}}{e^{i\omega T/2} + e^{-i\omega T/2}} \tag{41}$$

$$= i \tan (\omega T/2)$$

To analyze the response of the digital system in ω-space we set $\omega = i\gamma$ then:

$$\omega = i\gamma = i \tan\left(\frac{\omega T}{2}\right)$$

or

$$\gamma = \tan\left(\frac{\omega T}{2}\right) \tag{42}$$

The digital corner frequency γ is related to the analog corner frequency by equation 42. All of the transfer functions encountered in the analyis of the servo-amplifier can be reduced to the form $\frac{1}{s+\omega}$. To obtain the z-transfer function we calculate γ from the relation 42, substitute ω for S and finally use the relation 39, i.e.,

$$\frac{1}{S+\omega} \rightarrow \frac{1}{\omega+\gamma} = \frac{1}{\frac{z-1}{z+1} + \gamma}$$

or

$$T(z) = \frac{z+1}{(1+\gamma)z-(1-\gamma)} \tag{43}$$

As an example consider the filter used in the augmentation program, viz.:

$$\frac{.32}{s+.32} \rightarrow \frac{.32}{\omega+.008}$$

or

$$A(z) = \frac{.32(z+1)}{1.008\ Z-.992}$$

$$A(z) = \frac{.317(z+1)}{Z-.984} \qquad (44)$$

The final value theorem for Laplace transforms states that the final value is given by:

$$\lim_{t\to\infty} f(t) = \lim_{s\to o} s\ F(s) \qquad (45)$$

A transfer function is the ratio of two transforms, for example,

$$G(s) = \frac{A(s)}{B(s)}$$

and the final value of "d.c. gain" will be

$$[G(s)] \text{ final value} = \lim_{s\to o} s\ A(s) / \lim_{s\to o} s\ B(s)$$

$$= \lim_{s\to o} \frac{A(s)}{B(s)}$$

or

$$\text{d.c. gain} = \lim_{s \to o} G(s) \tag{46}$$

Since $z = e^{Ts}$ then at $s = 0$, $z = 1$. Therefore

$$\text{d.c. gain} = \lim_{z \to 1} G(z) \tag{47}$$

Similarly

$$\text{d.c. gain} = \lim_{\omega \to o} G(\omega) \tag{48}$$

A special case is the integrator, whose Laplace transform is 1/S. Using equation 46 one finds that its gain is infinite. For a unit step input, the output of the integrator is a ramp with a slope of 1 (Figure 14).

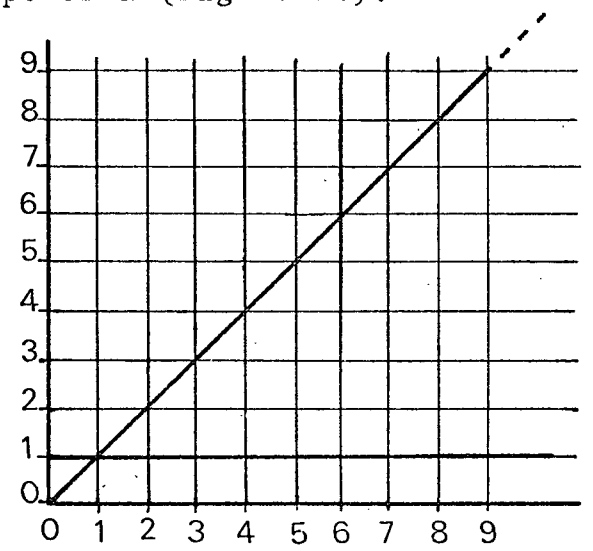


Figure 14. Integrator

Having obtained the z-transfer functions we are left with the task of implementing them on a digital computer. A physically realizable transfer function D(z), i.e., one which can be realized by RC elements, may be expressed in the form

$$D(z) = \frac{E_2(z)}{E_1(z)} = \frac{A_o + A_1 z^{-1} + \ldots\ldots + A_m z^{-n}}{b_o + b_1 z^{-1} + \ldots\ldots + b_m z^{-m}} \qquad (49)$$

where $b_o \neq 0$ and m and n are positive integers. An alternate form is:

$$D(z) = \frac{A_o \prod_{k=1}^{m} (1+C_k z^{-1})}{b_o \prod_{k=1}^{m} (1+d_k z^{-1})} \qquad (50)$$

This represents the product of n transfer functions as shown in Figure 15(b). The output of the one is the input of the next. Thus, it is only necessary to program $D_k(z)$, which is given by:

$$D_k(z) = \frac{E_{2k}(z)}{E_{1k}(z)} = \frac{1 + C_k z^{-1}}{1 + d_k z^{-1}} \qquad (51)$$

Before we proceed to program $D_k(z)$, let us examine the z-transfer function of a delayed time function. From equation 32 we write:

$$e^*(t-kT) = \sum_{n=o}^{\infty} e(t-kT)\ \delta(t-nT) \tag{52}$$

where k is a positive integer. This can be simplified to read:

$$e^*(t-kT) = \sum_{n=o}^{\infty} e(nT-kT)\ \delta(t-nT) \tag{53}$$

Taking the Laplace transform we obtain:

$$L[e^*(t-kT)] = \sum_{n=o}^{\infty} e(nT-kT)\ e^{-nTs} \tag{54}$$

$$= \sum_{n=o}^{\infty} e(nT-kT)\ z^{-n} \tag{55}$$

$$= z^{-k} \sum_{n=o}^{\infty} e(nT-kT)\ z^{-(n-k)} \tag{56}$$

Since e(t) is zero for $T<0$ then

$$L[e^*(t-kT)] = z^{-k} \sum_{n=k}^{\infty} e(nT-kT)\ z^{-(n-k)} \qquad (57)$$

Define a new integer variable m = n-k, then:

$$L[e^*(t-kT)] = z^{-k} \sum_{m=o}^{\infty} e(mT)\ z^{-m} \qquad (58)$$

On comparison with equation 36 we conclude that

$$L[e^*(t-kT)] = z^{-k}\ E(z) \qquad (59)$$

Returning to our main problem we cross-multiply in equation 51 to obtain:

$$E_{2k}(z) + d_k\ z^{-1}\ E_{2k}(z) = E_{1k}(z) + C_k\ z^{-1}\ E_{1k}(z) \qquad (60)$$

which may be written; if we take equation 59 into account:

$$L[e^*_{2k}(t) + d_k\ e^*_{2k}(t-T)] = L[e^*_{1k}(t) + C_k\ e^*_{1k}(t-T)] \qquad (61)$$

Upon taking the inverse transform of the above we have,

$$e^*_{2k}(t) + d_k\, e^*_{2k}(t-T) = e^*_{1k}(t) + C_k\, e^*_{1k}(t-T) \qquad (62)$$

Setting t = nT we write:

$$e^*_{2k}(nT) + d_k\, e^*_{2k}[(n-1)T] = e^*_{1k}(nT) + C_k\, e^*_{1k}[(n-1)T] \qquad (63)$$

Define $IN_k = e^*_{1k}$ and $OUT_k = e^*_{2k}$ we then have:

$$OUT_k(n) = IN_k(n) + C_k\, IN_k(n-1) - d_k\, OUT_k(n-1) \qquad (64)$$

This result is illustrated in Figure 15(d).

The last item to be discussed is the sampling frequency, 1/T. As can be seen from Figure 12, the signal wave form input to a digital device can be reconstructed more faithfully at higher sampling frequencies. However, there is an upper bound due to the finite speed of computers and due to the number of operations to be performed in addition to sampling. A lower bound is placed on this frequency since there obviously exists a minimum below which signal reconstruction is virtually impossible. This minimum is determined according to the sampling theorem (see footnote at beginning of this section), which states

that if a signal contains no frequency higher than ω_e radians per second, it is completely characterized by the values of the signal measured at instants of time separated by $T = 1/2 \left(\frac{2\pi}{\omega_e}\right)$ seconds.

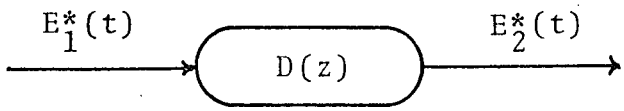
In order to determine the minimum sampling frequency we must examine the time constants and natural frequencies of the 40-ft antenna.

It can be shown that a transfer function may be written in the form:

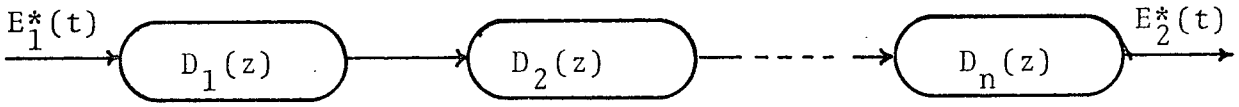
$$\frac{OUT(s)}{I_N(s)} = A(s) = \frac{K \prod_{j=1}^{m} (s + \gamma_j)}{\prod_{i=1}^{k} (s + \sigma_i) \prod_{\rho=1}^{\ell} (s^2 + 2\alpha_\rho s + \omega_{n\rho}^2)} \tag{65}$$

Let us examine the response of this system to a unit step input, whose transform is $\frac{1}{s}$. Then,

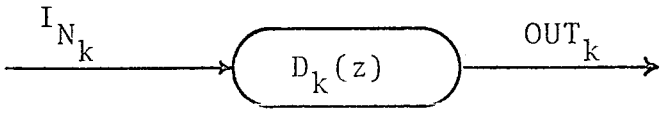
$$OUT(s) = \frac{K \prod_{j=1}^{m} (s + \gamma_j)}{s \prod_{i=1}^{k} (s + \sigma_i) \prod_{\rho=1}^{\ell} (s^2 + 2\alpha_\rho s + \omega_{n\rho}^2)} \tag{66}$$



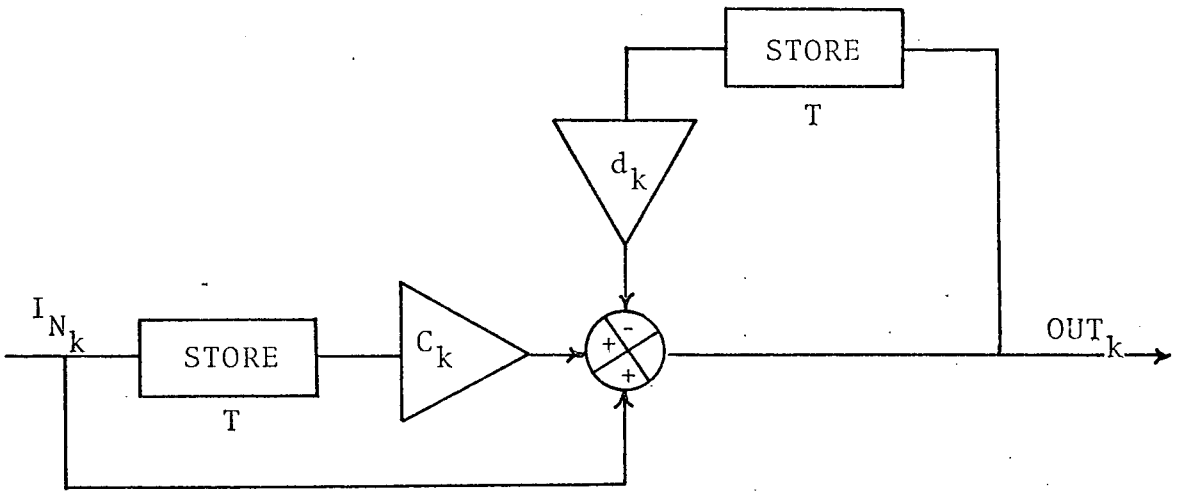
(a)



(b)



(c)



(d)

Figure 15. Cascade Programming for Z-transfer Function

Expanding by partial fractions one obtains:

$$OUT(s) = \frac{A}{S} + \sum_{i=1}^{k} \frac{B_i}{S + \sigma_i} + \sum_{\rho=1}^{\ell} \frac{C_\rho S + D_\rho}{S^2 + 2\alpha_\rho S + \omega_{n\rho}^2} \tag{67}$$

The inverse transform yields:

$$OUT(t) = Au(t) + \sum_{i=1}^{k} B_i e^{-\sigma_1 t} + \sum_{\rho=1}^{\ell} D_\rho E_\rho e^{-\alpha_\rho} \sin\left(\sqrt{\omega_{n\rho}^2 - \alpha_\rho^2}\, t - \phi\right) \tag{68}$$

where A, B_i, D_ρ, and E_ρ are constants depending on the poles and zeroes of $A(s)$. The function $u(t)$ is the Heaviside unit step.

The first term in (68) is the response to the step function. If the σ's and α's are all positive real numbers, then the exponential terms will decay to zero as time increases. Thus, the first term is the steady-state response and the others represent the transient response. The quantities $\frac{1}{\sigma_i}$ are the time constants of the system and $\omega_{n\rho}$ are the natural frequencies. In Figure 16 transient response to a unit step is shown.

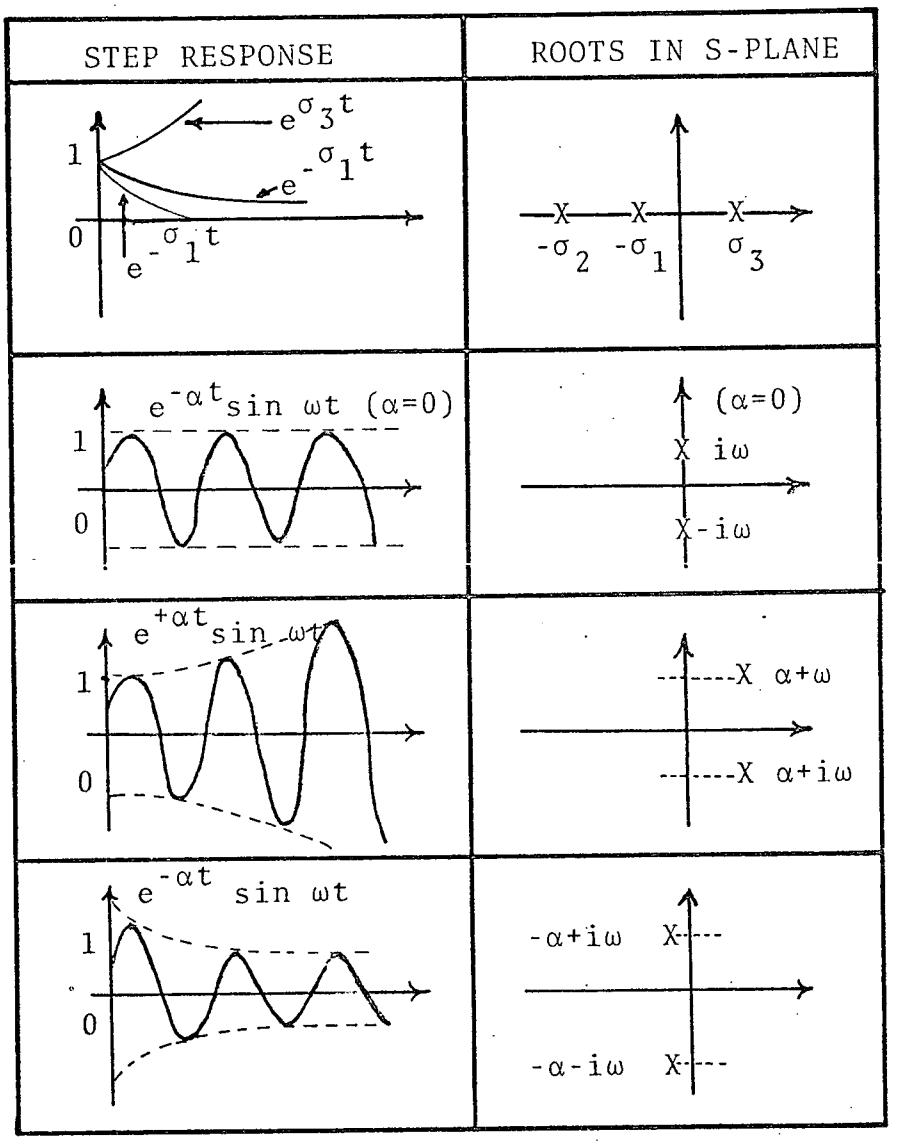


Figure 16. Response for Various Root Locations In the S-Plane

The design for the NTTF 40 ft. antenna lists the following approximation to the antenna system transfer function:

$$A(s) = \frac{1.6 \times 10^{-4} s^2 + 1}{(0.0875 s+1)(6.69 \times 10^{-4} s^2+9.6 \times 10^{=3} s+1)} \quad (69)$$

$$= \frac{2.74 (s^2+6250)}{(s+11.42)(s^2+14.37 s+1500)} \quad (70)$$

Comparison with equation 66 yields the following results:

$$\sigma = 11.42 \quad (71)$$

and

$$T_\sigma = \frac{1}{11.42} = 0.0875 \text{ sec.} \quad (72)$$

also

$$\omega_n^2 = 1500$$

or

$$\omega_n = 38.7 \text{ rad/sec.} \tag{73}$$

The roots of the quadratic in equation 66 are:

$$s = -\alpha \pm i\sqrt{\omega_n^2 - \alpha^2}$$

$$= -\alpha \pm i\,\omega$$

Therefore

$$\omega = \sqrt{1500 - \left(\frac{14.37}{2}\right)^2}$$

$$= 37.9 \text{ rad/sec} \tag{74}$$

This is the actual frequency of oscillation; the period of oscillation is given by

$$\tau = \frac{2\pi}{37.9} = 0.166 \text{ sec} \tag{75}$$

The time constant governing the decay of the transient oscillation is

$$T_\alpha = \frac{1}{\alpha} = \frac{1}{14.37/2}$$

or

$$T_\alpha = \frac{1}{7.18} = 0.138 \text{ sec} \tag{76}$$

The smallest time constant is given by

$$\min(T_\sigma, T_\alpha, \tau) = 0.0875 \text{ sec.} \tag{77}$$

and the corresponding frequency is 11.42. Then by the sampling theorem the sampling frequency should be at least 23 cps. We have chosen 20 cps and it seems to be practical enough.

5.3 DIGITAL CONTROLLER PROGRAMS

There are two programs that handle the digital controller functions. The first manages position errors, while the other handles velocity inputs. In the position modes there are two types of operation. Type I operation concerns large position errors. In this case the integrator (IA) in Figure 11 is replaced by a gain factor (equivalent to a d.c. amplifier). In Type II operation, which is used for small

errors, the integrator is used to force a servo null. Indicators on the antenna console are activated to reflect the type of operation. The output of this program is a velocity signal, which is used by the second program. This program accepts either a velocity command from the joy stick on the antenna console or the output of the previous program. The output is a voltage that is applied to the hydraulic valve.

SECTION 6.0
UTILITY PROGRAMS

These programs perform subsidiary functions such as decoding data from the antenna interface or calculating real-time. They are divided into three categories: prepass, pass and postpass.

6.1 PREPASS PROGRAMS

These routines are not part of the real-time program. They are executed before a pass. The two programs in this series provide a listing of the passes contained on the NASA provided ENV predict tape and produce XY predict tapes for use with the real-time program.

6.1.1 Predict Listing

The data on the NASA tape is scanned and a listing is produced, which identifies the data by satellite identification number, orbit number, date and pass duration.

6.1.2 ENV to XY Conversion

Data on the NASA tape is in the form of ENV coordinates. Since the NTTF 40-ft antenna is of the XY variety, the data must be converted. The relationship between ENV and XY coordinates is illustrated in the figure below:

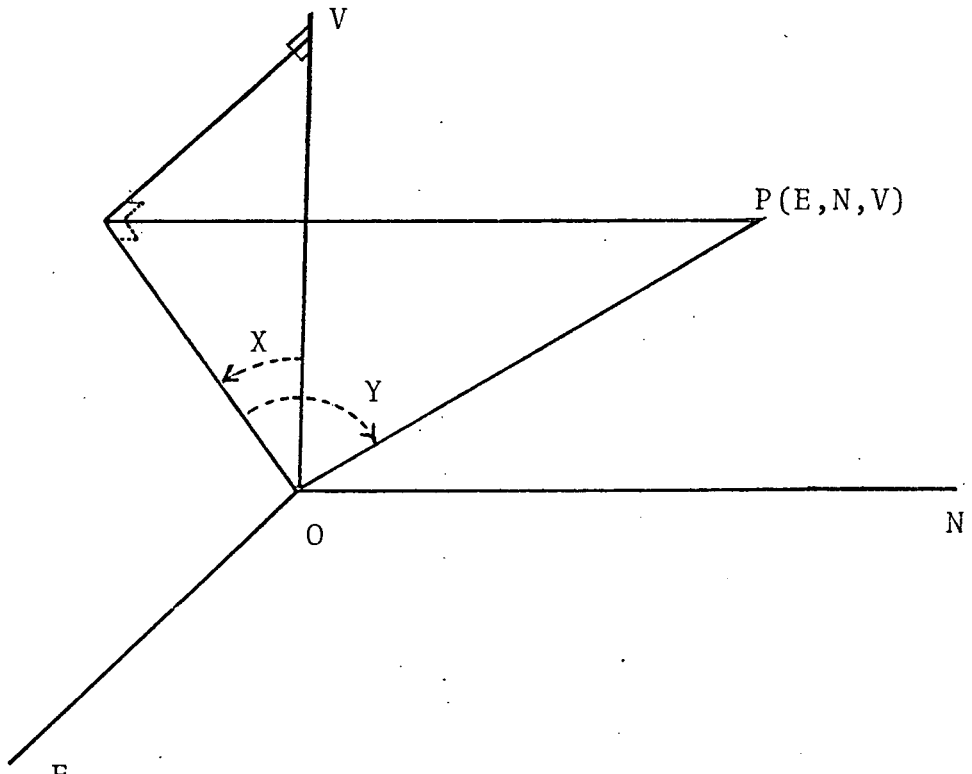


Figure 17. XY Coordinates - 40-foot Antenna

The ENV coordinates are referred to the origin 0, which is the location of the NTTF 40-ft antenna. The relationships between the two sets of coordinates are found, by inspection, to be:

$$X = \arctan\left[\frac{E}{V}\right] \qquad (1)$$

and

$$Y = \arctan\left[\frac{N}{\sqrt{E^2+V^2}}\right] \qquad (2)$$

The ENV coordinates are provided at intervals of one minute or more. Since the real-time program needs new coordinates every 1/20 second, it was decided to interpolate, in the ENV to XY program, to provide predicts every second. Then in the real-time program a linear interpolation scheme is used to obtain coordinates at the required frequency.

The method used in this program is a polynomial interpolation method. We assume that

$$f(t_o+ph) = f(t_o) + a(ph) + b(ph)^2 + c(ph)^3 + d(ph)^4 \qquad (3)$$

where h is the time interval between points (usually 1 minute minute) and p is any number such that

$$-2 \leq p \leq 2 \qquad (4)$$

For any five data points we can write

$$f(t_o-2h) = f(t_o) - 2ah + 4bh^2 - 8ch^3 + 16dh^4 \qquad (5)$$

$$f(t_o-h) = f(t_o) - ah + bh^2 - ch^3 + dh^4 \quad (6)$$

$$f(t_o) = f(t_o) \quad (7)$$

$$f(t_o+h) = f(t_o) + ah + bh^2 + ch^3 + dh^4 \quad (8)$$

$$f(t_o+2h) = f(t_o) = 2ah^2 + 4bh^2 + 8ch^3 + 16dh^4 \quad (9)$$

The first differences are then given by:

$$\Delta_1 = f(t_o-h) - f(t_o-2h) = ah - 3bh^2 + 7ch^3 - 15dh^4 \quad (10)$$

$$\Delta_2 = f(t_o) - f(t_o-h) = ah - bh^2 + ch^3 - dh^4 \quad (11)$$

$$\Delta_3 = f(t_o+h) - f(t_o) = ah + bh^2 + ch^3 + dh^4 \quad (12)$$

$$\Delta_4 = f(t_o+2h) - f(t_o+h) = ah + 3bh^2 + 7ch^3 + 15dh^4 \quad (13)$$

It follows that:

$$\Delta_1 + \Delta_4 = 2ah + 14ch^3 \quad (14)$$

$$\Delta_2 + \Delta_3 = 2ah + 2ch^3 \tag{15}$$

$$\Delta_3 - \Delta_2 = 2bh^2 + 2dh^4 \tag{16}$$

$$\Delta_4 - \Delta_1 = 6bh^2 + 30dh^4 \tag{17}$$

Solving for a, b, c and d we obtain:

$$a = \frac{\Delta_2 + \Delta_3 - 2ch^3}{2h} \tag{18}$$

$$b = \frac{\Delta_3 - \Delta_2 - 2dh^4}{2h^2} \tag{19}$$

$$c = \frac{\Delta_1 + \Delta_4 - \Delta_2 - \Delta_3}{12h^3} \tag{20}$$

$$d = \frac{\Delta_4 - \Delta_1 - 3\Delta_3 + 3\Delta_2}{24h^4} \tag{21}$$

Using the values of the coefficients from above one can calculate the value of the function for any time in the interval $(t_o-2h) \leq t \leq (t_o+2h)$ from equation 3.

In addition, range, range rate and (X,Y) velocities are calculated from the following relations:

$$R = (E^2 + N^2 + V^2)^{1/2} \tag{22}$$

$$\dot{R} = \frac{R(t+\Delta t) - R(t)}{\Delta t} \tag{23}$$

$$\dot{X} = \frac{X(t+\Delta t) - X(t)}{\Delta t} \tag{24}$$

and

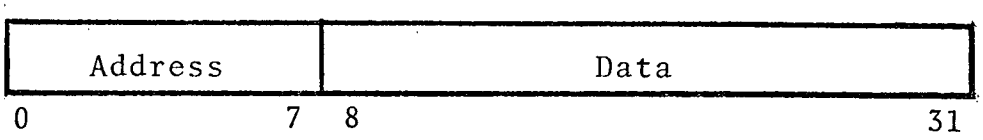
$$\dot{Y} = \frac{Y(t+\Delta t) - Y(t)}{\Delta t} \tag{25}$$

6.2 PASS PROGRAMS

These routines are part of the real-time program and perform secondary functions. A complete list with individual descriptions follows.

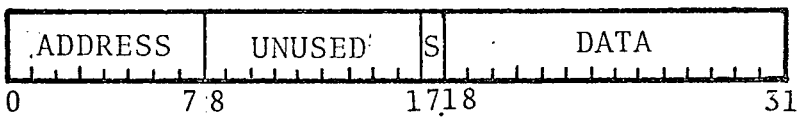
6.2.1 Interface I/O Program

Communication between the real-time program and the antenna is performed via the interface. This is performed by transmitting one or more 32 bit words to the interface in the form:



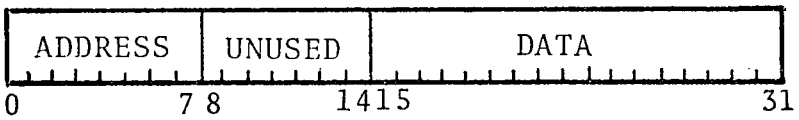
If bit "0" is set (i.e., "1") the address corresponds to an input, in which case the data bits are set to reflect the current status of that input. If bit "0" is reset, the address is interpreted as output. The data is transmitted to the antenna console. It is either discrete or analog. Discrete data is used, for example, to reflect the status of the real-time program and antenna or to operate indicator lights on the console. Analog data is used, for instance, to drive the antenna. Data input to the real-time program is shown in Table 4.

The analog to digital converter converts analog signals into a 15-bit integer, which is consequently placed into the command word according to the format below:



Since the data in positions 0 - 16 is not usable and since we use word arithmetic, the sign bit (17) is extended all the way to the left producing a properly signed 32 bit integer.

The encoder data has the format:



Since the encoder data is always positive but positions o - 14 are simply zeroed.

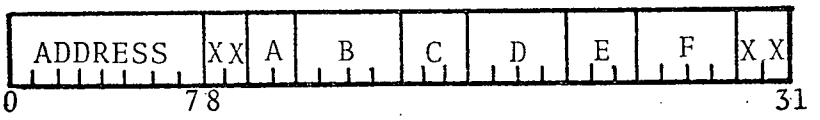
Table 4

INPUT FROM INTERFACE

ADDRESS		SYMBOL	USAGE	RESULT STORED IN
HEX	DEC			
96	150	A1XTACK	X - Tachometer	APDTACHX
97	151	A1YTACK	Y - Tachometer	APDTACHY
98	152	A1XER	X - Receiver Error	APXTRACK
99	153	A1YER	Y - Receiver Error	APYTRACK
9A	154	A1XJOY	X - Velocity Command	APXJOY
9B	155	A1YJOY	Y - Velocity Command	APYJOY
8A	138	A1XSLAV1	X - (Pos.) Joystick	APXSLAV
8B	139	A1YSLAV1	Y - (Pos.) Joystick	APYSLAV
F8	248	A1XENC	X - Encoder	APXENC
F9	249	A1YENC	Y- Encoder	APYENC
FA	250	A1XBIAS	X - Position Bias	APDXBIAS
FB	251	A1YBIAS	Y - Position Bias	APDYBIAS
FF	255	A1TBIAS	Time Bias	APDTBIAS
FE	254	A1STAT1	Status Word #1	APSTAT1
FD	253	A1STAT2	Status Word #2	APSTAT2
FC	252	AiSTAT3	Status Word #3	APSTAT3
E3	227	AITIME	REAL TIME	APSTSEC
E2	226	AIDAY	JULIAN DATE	-------

The status words contain information in all the bits beyond the address. Therefore only the address positions are zeroed.

Real-time is provided according to the format:



where

A = tens of hours
B = hours
C - tens of minutes
D = minutes
E = tens of seconds
F = seconds

in BCD code. Real-time is converted to seconds in the program ASTIME.

The maximum encoder value occurs when all bits (15-31) are set to "1". This is equivalent to the decimal number $2^{17} - 1$. This reading corresponds to 360°. The resolution of the encoder is then

$$R = \frac{360°}{2^{17}-1} = \frac{360}{131071} = 0.00275° \qquad (1)$$

The maximum analog input or output is $\pm$10 volts which corresponds to $2^{14} - 1$ (14 bit and sign). The scale factor used for position error is 1 volt/degree. Then

$$10° = 2^{14} - 1 \quad \text{counts} \tag{2}$$

or

$$1° = \frac{2^{14}-1}{10} = 1638.3 \quad \text{counts} \tag{3}$$

However, for the encoder we have:

$$1°_{enc} = \frac{2^{17}-1}{360} = 364.1 \quad \text{counts} \tag{4}$$

In order to have uniformity of units, one must multiply the encoder reading by the factor:

$$\text{Encoder scale factor} = \frac{1638.3}{364.1} = 4.5 \tag{5}$$

It was noticed that occassionally an encoder reading is abnormally large. An encoder "filter" was incorporated which rejects any reading that exceeds the previous valid reading by more than a degree. Recalling that the sampling frequency is 20 cps, one concludes, that if two successive readings differ by more than a degree, then the antenna must be moving at a velocity of 20°/sec. This is neither possible nor desirable. Thus, it seems that the choice of a maximum 1 degree difference beteen successive readings allows for normal operating speeds as well as reduces the effect of the large encoder error, which occasionally is of the order of 100°.

Since the encoder range is 0° - 360° and the desired range is -90° to +90°, then encoder is set to a reading (encoder zero) anywhere in the range 90° - 270° when the antenna is at zenith. To obtain the true angle the, one subtracts the encoder reading from the encoder zero.

On output the D/A converter recognizes only the bits (17-31). Care is taken to assure that program outputs do note exceed $\pm 2^{14} - 1$. Thus, valid data is inserted into the bit positions (17-31) of the command word which already contains the appropriate interface address.

For discrete input and output, all data bits in the command word are processed.

The outputs to the antenna interface are shown in Table 5.

Table 5

OUTPUTS TO ANTENNA INTERFACE

ADDRESS		SYMBOL	USAGE
HEX	DEC		
00	0	AIMODOUT	Indicator Lights
12	18	A1XRDSP	X - Encoder
13	19	A1YRDSP	Y - Encoder
14	20	A1XCDSP	X - Command
15	21	A1YCDSP	Y - Command
16	22	A1CTDSP	Command Time
28	40	A1XSERVO	X - Valve Signal
29	41	A1YSERVO	Y - Value Signal
2A	42	A1XSAMP	X - Program Error
2B	43	A1YSAMP	Y - Program Error

6.2.2 Station Time (ASTIME)

Real-time is available at the antenna interface according to the format described in the previous section. This program converts real-time from hours, minutes and seconds to its decimal value in seconds.

6.2.3 Add (X,Y) Bias (ADDX)

When add position (X,Y) bias is selected, the setting of the digit switches on the antenna console is interpreted as a BCD number and is converted to units by the program according to 6.2.1 (equation 3). The format of the BCD number is XX.XXX degrees. The resultant bias is added to the command angle.

6.2.4 Add Time Bias (ADDT)

If add or subtract time is selected the setting of the time digit switches is converted to seconds. The format of the BCD output of the time switches is HH MM SS. The time bias is either added or subtracted from command time.

6.2.5 Limit Check (LIMTEST)

This routine checks whether the quantity in question is within certain bounds. If the quantity is outside the specified limits it is set equal to the closer limit. For example, the command angle should not exceed $\pm$ 80 degrees. If the command angle before the limit check is - 84 degrees it will be set to - 80 degrees.

6.2.6 Program Mode Error Output (APSAOUT)

This program forms the interface command word used to transmit the program mode error to the servo-amplifier. The command word is A1XSAMP (A1YSAMP). The 8 most significant bits contain the interface address of the input to the servo-amplifier while the signed program mode error is inserted into the 15 least significant bits.

6.2.7 Hydraulic Value Output (APSOUT)

This program is similar to the APSAOUT with the output of the digital controller substituted for program mode error and A1XSERVO, the output to the hydraulic valve, substituted for A1XSAMP.

6.2.8 Servo Error Calculation (APSEC)

The command angle is the sum of the predict, scan and augmentation. The servo error is calculated as the difference between the command angle and the encoder value (true position of the antenna). Prior to this computation the program ensures that the absolute value of the command angle does not exceed 80 degrees. This test is performed by the routine LIMTEST. There is an additional constraint on the command angles expressed by the equations:

$$\left.\begin{aligned} |Lx| &= 80^\circ && -- \; y < 54.5 \\ |Lx| &= 80^\circ - 1.49\,(\,|y| - 54.5 && -- \; y > 54.5 \end{aligned}\right\} \quad (1)$$

$$\left.\begin{aligned} |Ly| &= 80^\circ && \text{-- } X < 42 \\ |Ly| &= 80^\circ - 0.672\,(|x| - 42) && \text{-- } X > 42 \end{aligned}\right\} \quad (2)$$

The two sets of equations are equivalent. This condition arises due to the mechanical design of the XY antenna. These relations describe a contour within the limits of the design. The X-command angle is checked for compliance with equation (1). If it is greater than the allowable limit expressed by these equations, it will be set equal to this limit.

The servo error is calculated next. The routine LIMTEST is used to limit this error to $\pm$ 10°. The result is stored in APXTF4IN(APYTF4IN).

6.2.9 Console Display Program (APDISPLY)

Command time, (X,Y) command angles as well as (X,Y) real angles are displayed at the antenna console once a second. This program converts these quantities to BCD via the routine AP@4BCD, then prepares the appropriate command words to the antenna interface.

6.2.10 BCD Conversion Program (AP@4BCD)

This routine converts a binary number into a BCD. Each decimal digit will be represented by 4 bits.

6.2.11 Brake-One Program (BRAKEON)

When the brakes are applied this program nulls the output to the hydraulic to prevent the antenna from driving while the brakes are applied.

6.2.12 Zero Predicts Program (APPREDZ)

In manual program mode, this routine is called to set the predicts equal to zero. The command angle will be determined solely by the setting of the Position Bias digit switches.

6.3 POSTPASS PROGRAMS

There is only one postpass program, viz., history analysis. There is an option to output the database onto a magnetic tape. The history analysis program produces a printout of selected items from the database.

SECTION 7.0
CONCLUSIONS AND RECOMMENDATIONS

Although the program ran satisfactorily improvement in speed of execution and in the quality of its performance can be achieved.

Speed of execution can be improved by fragmenting some of the larger programs into smaller subprograms which would be executed only when necessary. This should also prove to be a valuable asset in debugging the programs.

A new augmentation filter should be designed which would provide better performance than program mode. without augmentation or autotrack mode.

Since the programs developed under this contract were meant to prove certain concepts, the main emphasis was placed on achieving operational status. Refinement of these programs should be attempted next.

APPENDIX I

FLOWCHARTS

In the following pages we present flowcharts for all programs and subprograms. Included with each flowchart is a brief description of each routine, together with a list of inputs, outputs, other routines required, and any other per pertinent information.

Entry Name:	ZEEXFM - Calculate output of Z-transfer function.
Other Routines Required:	None.
Input:	Address of input provided in register X7
Output:	Output is stored in address 4 locations above that contained in register X7

Method:

The general form of Z-transfer function used is:

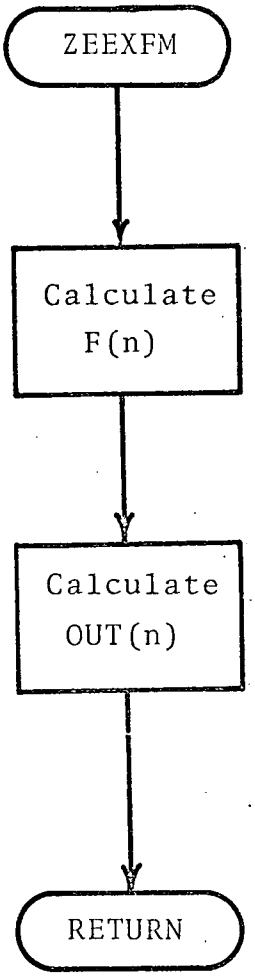
$$\frac{A_o Z + A_1}{Z + b_1}$$

The output is calculated as follows:

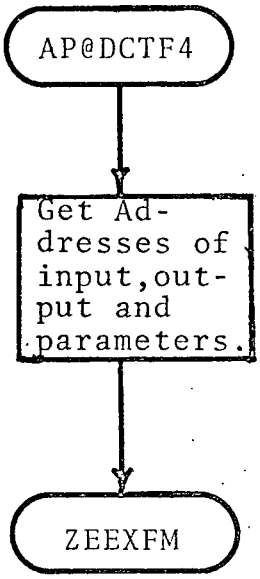
$$F(nT) = \text{Input } (nT) - b_1 F[(n - 1)T]$$

$$\text{Output}(nT) = A_o * F(nT) + A_1 F[(n - 1)T]$$

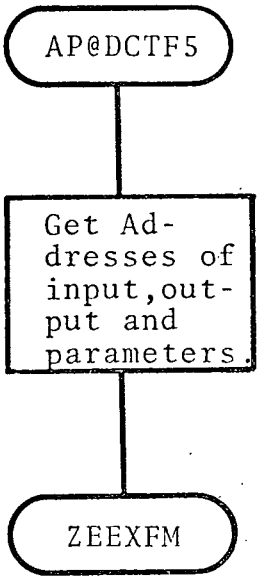
Note that F(o) and F(-kT) are zero.


ZEEXFM
Calculate F(n)
Calculate OUT(n)
RETURN

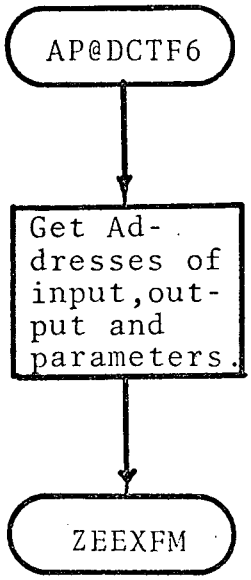
Entry Name:	AP@DCTF4 - TF4
Other Routines Required:	ZEEXFM
Input:	None
Output:	Addresses of input, output and parameters A_o, A_1, and b_1 of the Z-transfer function.
Functions:	Obtains addresses described under output above and transmits them to ZEEXFM.


AP@DCTF4
Get Addresses of input,output and parameters.
ZEEXFM

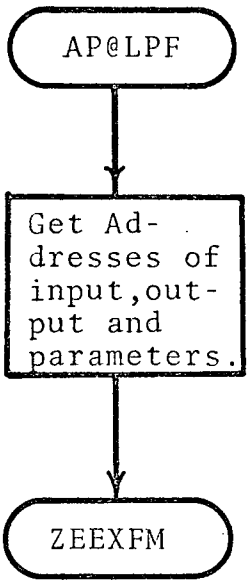
Entry Name:	AP@DCTF5 - TF5 Velocity
Other Routines Required:	ZEEXFM
Input:	None
Output:	Addresses of input, output and parameters A_o, A_1, and b_1 of the Z-transfer function.
Functions:	Obtains addresses described under output above and transmits them to ZEEXFM.


AP@DCTF5
Get Addresses of input,output and parameters.
ZEEXFM

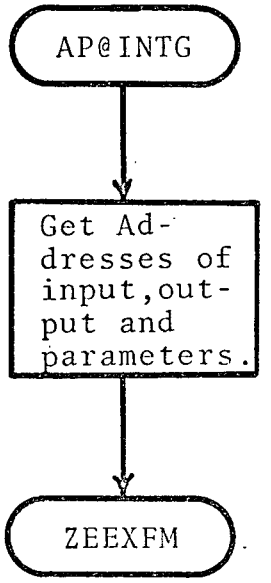
Entry Name:	AP@DCTF6 - TF6 Tachometer
Other Routines Required:	ZEEXFM
Input:	None
Output:	Addresses of input, output and parameters A_o, A_1, and b_1 of the Z-transfer function.
Functions:	Obtains addresses described under output above and transmits them to ZEEXFM.


AP@DCTF6
Get Ad-
dresses of
input,out-
put and
parameters.
ZEEXFM

Entry Name:	AP@LPF - Low Pass Filter
Other Routines Required:	ZEEXFM
Input:	None
Output:	Addresses of input, output and parameters A_o, A_1, and b_1 of the Z-transfer function.
Functions:	Obtains addresses described under output above and transmits them to ZEEXFM.


AP@LPF
Get Ad-
dresses of
input,out-
put and
parameters.
ZEEXFM

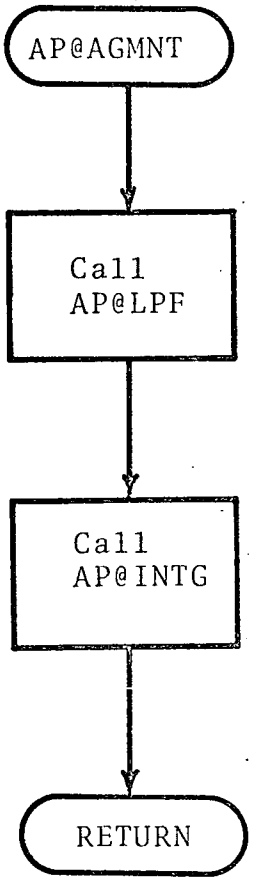
Entry Name:	AP@INTG - Integrator
Other Routines Required:	ZEEXFM
Input:	None
Output:	Addresses of input, output and parameters A_o, A_1, and b_1 of the Z-transfer function.
Functions:	Obtains addresses described under output above and transmits them to ZEEXFM.


AP@INTG
Get Ad-
dresses of
input,out-
put and
parameters.
ZEEXFM

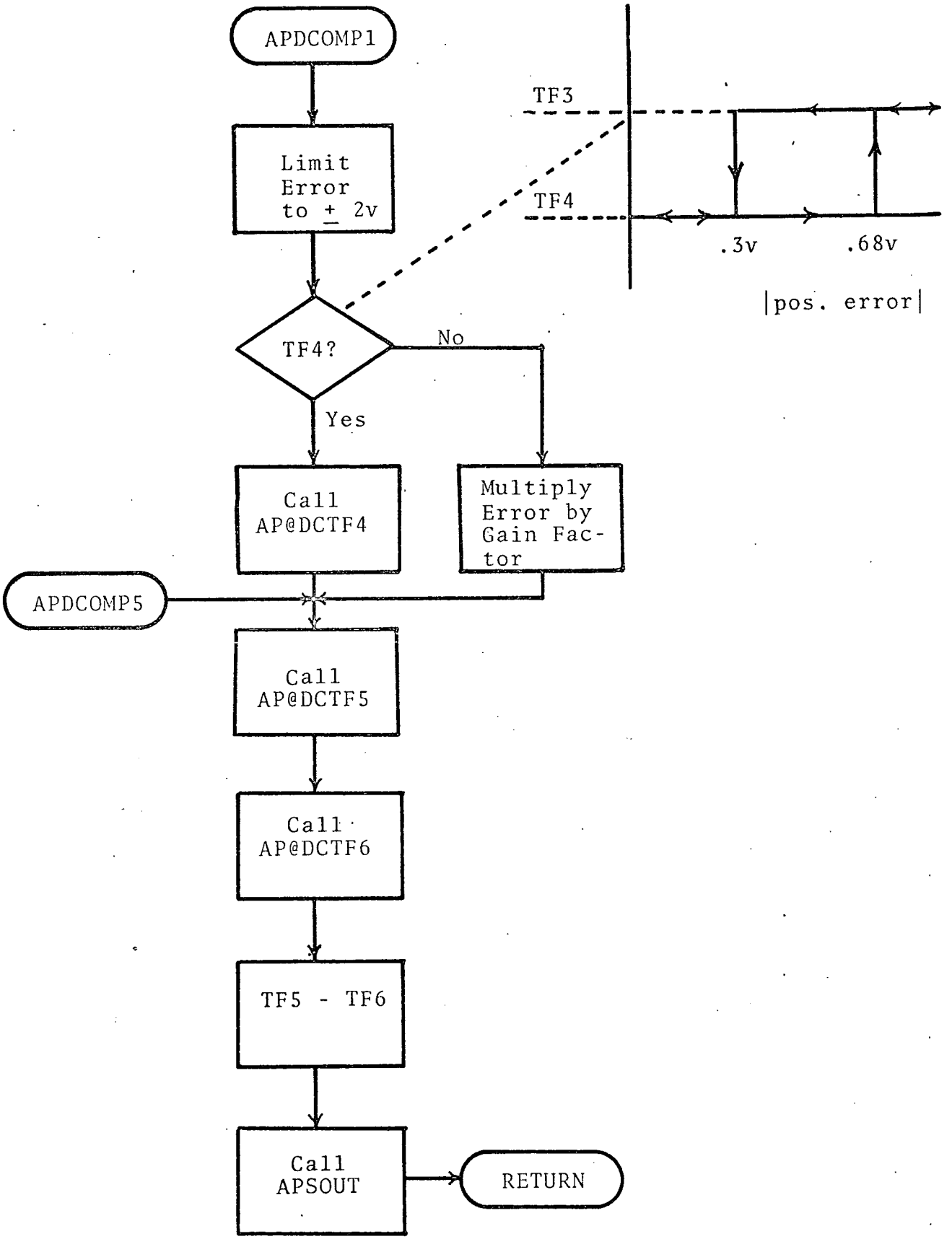
Entry Name:	AP@AGMNT - Augmentation
Other Routines Required:	AP@LPF, AP@INTG
Input:	APXTRACK - Receiver Error
Output:	APXAUG - Augmentation increment to command angle.

Method:

The receiver error is passed through a low pass filter and an integrator, both in Z-transfer function form.


AP@AGMNT
Call
AP@LPF
Call
AP@INTG
RETURN

Entry Name:	APDCOMP1, APDCOMP5 - Digital Controller
Other Routines Required:	AP@DCTF4, AP@DCTF5, AP@DCTF6, APSOUT
Input:	APDCOMP1 - Position Error - APXTF4IN APDCOMP5 - Velocity Error - APXTF5IN
Output:	APDCOMP1 - Velocity Error - APXTF4OT (→APXTF5IN) APDCOMP5 - Hydraulic Value Voltage - APXSOUT
Function:	The routine APDCOMP1 is used in the position modes to produce a velocity error. This error is converted into a velocity command by AP@DCTF5 which is compared to the output of AP@DCTF6, which is related to the true velocity of the antenna. The difference is converted to a command (APXSOUT) to the hydraulic value. APDCOMP5 is also used independently in the manual velocity mode.


APDCOMP1
Limit Error to ± 2v
TF4?
No
Yes
Call AP@DCTF4
Multiply Error by Gain Factor
APDCOMP5
Call AP@DCTF5
Call AP@DCTF6
TF5 - TF6
Call APSOUT
RETURN
TF3
TF4
.3v
.68v
|pos. error|

Entry Name: STRT - Executive routine

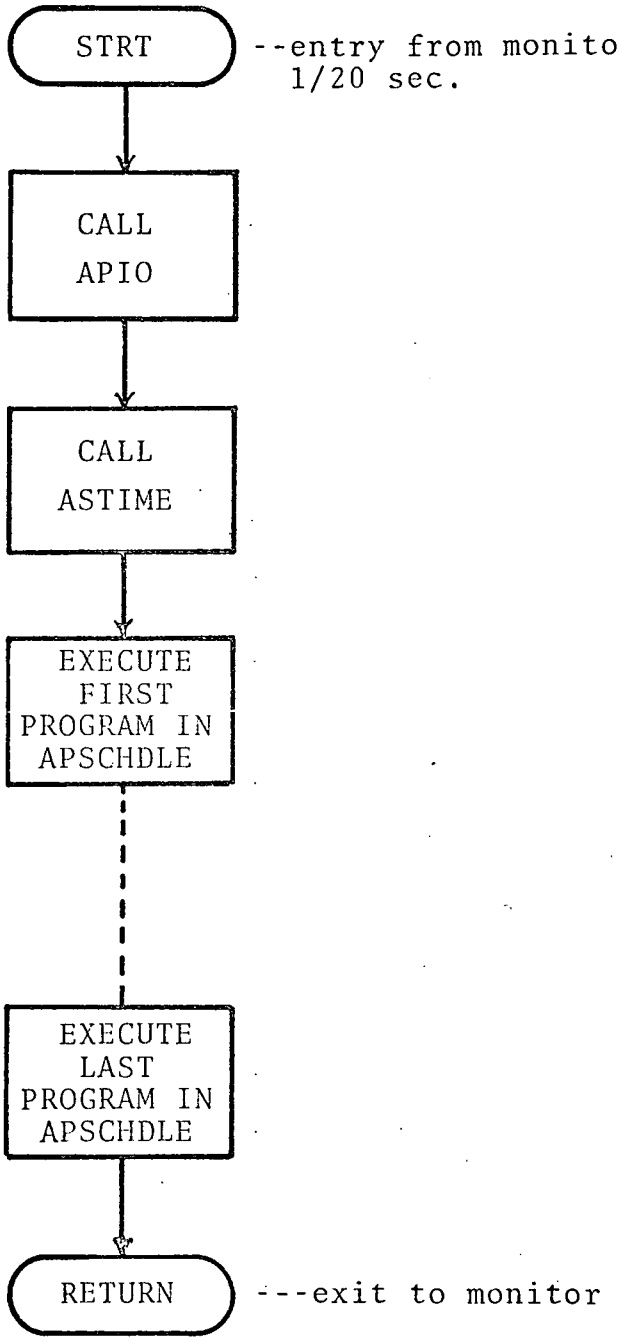
Other Routines Required: APIO, ASTIME

Input: APSCHDLE -- Schedule Table

Output: None

Function: This program executes routines whose entry points are stored in the schedule table APSCHDLE by the mode control program APPMODE. These programs are selected according to the setting of the bits in the status function words APSTAT1 and APSTAT2. The operating system (monitor) activates this program, via an external interrupt every 1/20 sec. After all the routines in the schedule are executed control is returned to the monitor. Prior to the execution of the programs in the schedule, all the necessary I/O is performed via the routine APIO and the real-time is converted to seconds via ASTIME.

EXECUTIVE


STRT
--entry from monitor every 1/20 sec.
CALL APIO
CALL ASTIME
EXECUTE FIRST PROGRAM IN APSCHDLE
EXECUTE LAST PROGRAM IN APSCHDLE
RETURN
---exit to monitor

ENTRY NAME: APSEC

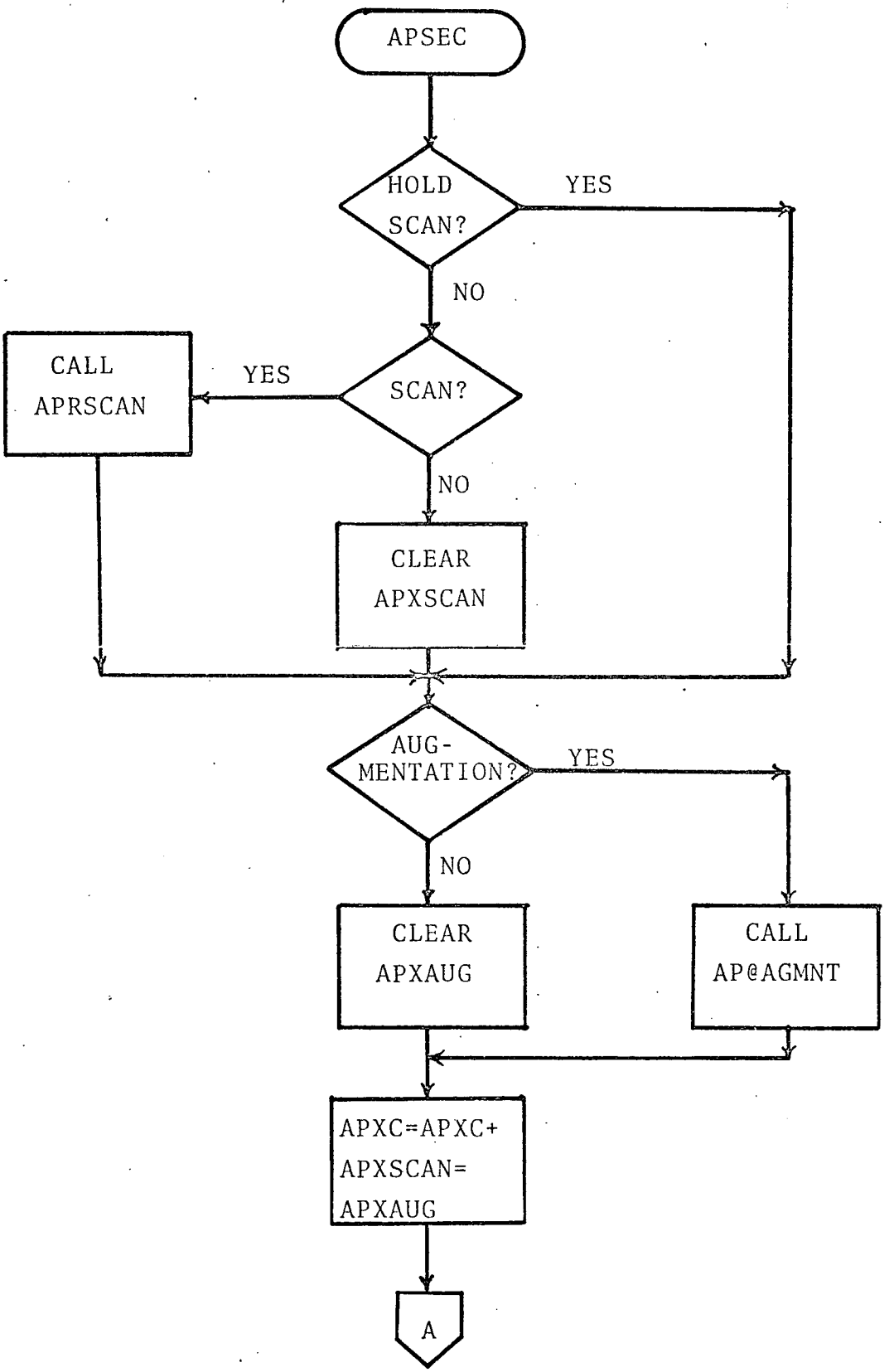
OTHER ROUTINES REQUIRED: APRSCAN, AP@AGMNT, LIMTEST

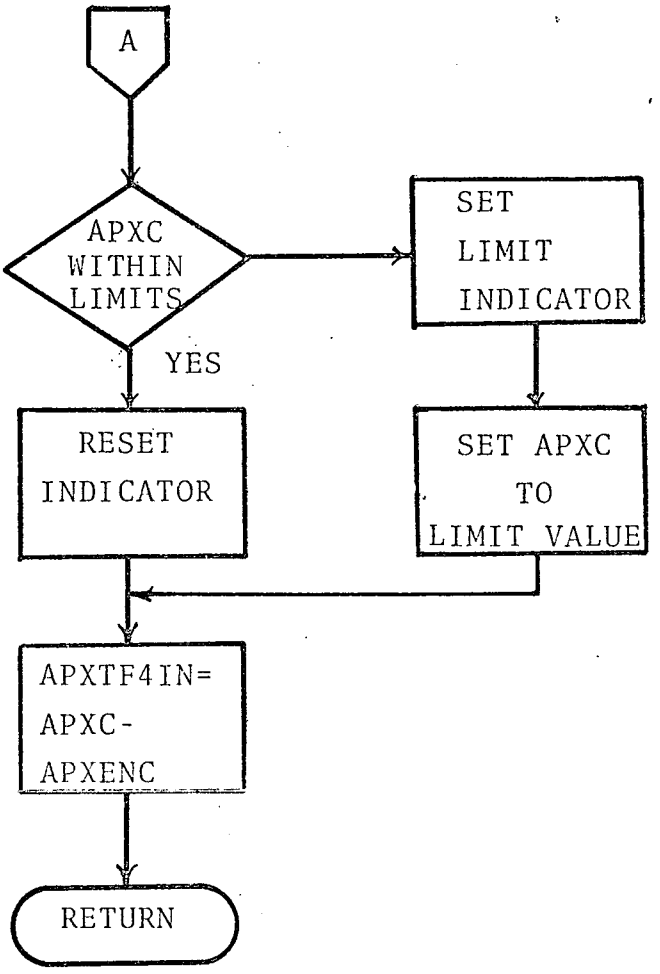
INPUT: APXC, APXSCAN, APXAUG, APXENC

OUTPUT: APXC, APXTF4IN

METHOD:

The command angle APXC is modified by adding the augmentation and scan increments (APXAUG, APXCAN) if these are selected. The modified angle is then limited to the allowable value, if necessary. The position error (APXTF4IN) is calculated as the difference between the command angle and the encoder value (real angle). The limit indicators are set when APXC exceeds the allowable limit and reset when it does not.


APSEC
HOLD SCAN?
YES
NO
CALL APRSCAN
YES
SCAN?
NO
CLEAR APXSCAN
AUG-MENTATION?
YES
NO
CLEAR APXAUG
CALL AP@AGMNT
APXC=APXC+ APXSCAN= APXAUG
A


A
APXC WITHIN LIMITS
SET LIMIT INDICATOR
YES
RESET INDICATOR
SET APXC TO LIMIT VALUE
APXTF4IN= APXC- APXENC
RETURN

ENTRY NAMES: APRJOY
APRJACH
APMNPOS
AUTOTRAK
APRSTO

INPUT: (Corresponds to routines named above)

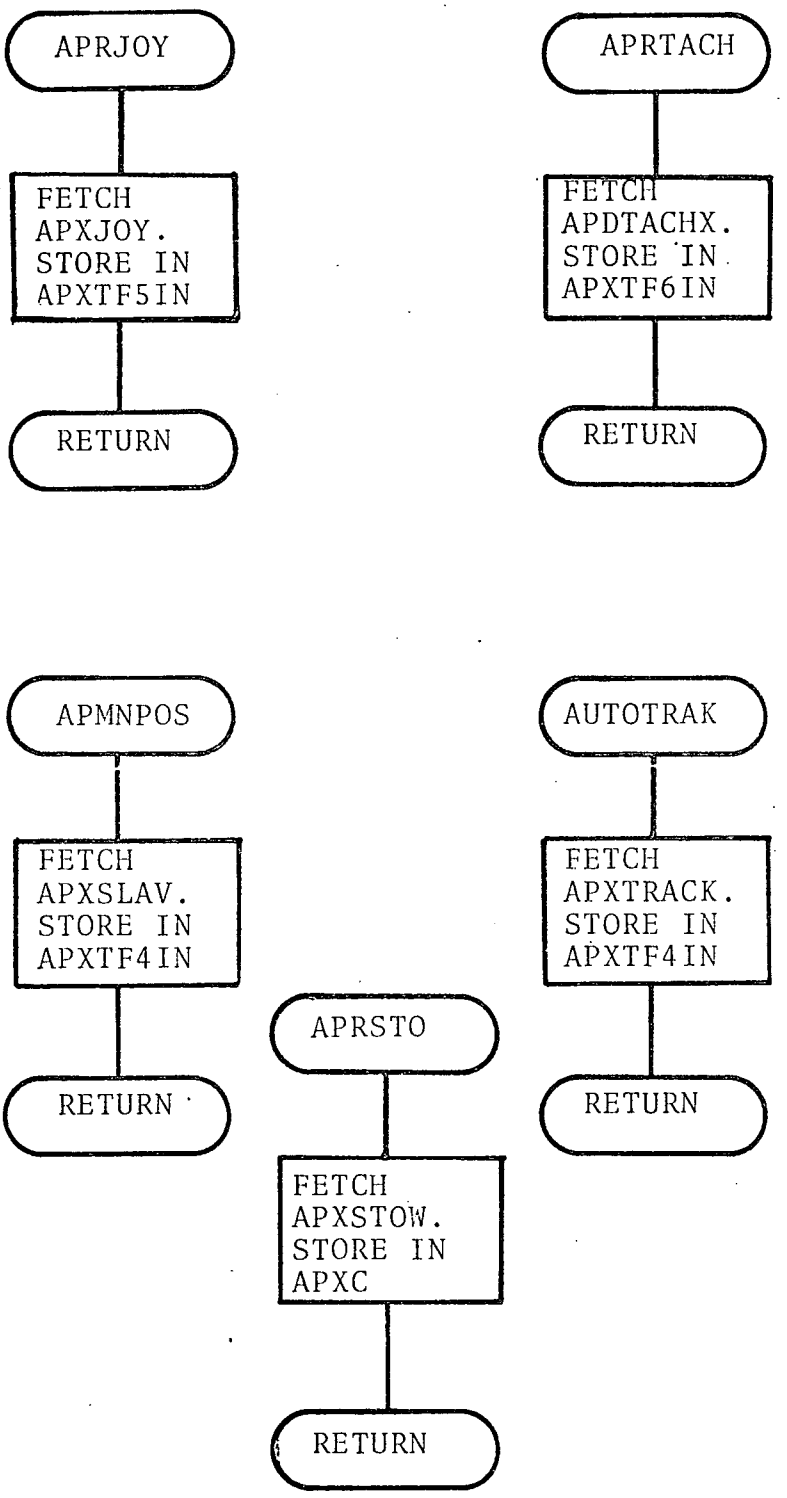
APXJOY
APDTACHX
APXSLAV
APXTRACK
APXSTOW

OUTPUT: (Corresponds to inputs above)

APXTF5IN
APXTF6IN
APXTF4IN
APXTF4IN
APXC

METHOD:

Transfer input from database to output location in database.


APRJOY
FETCH APXJOY. STORE IN APXTF5IN
RETURN
APRTACH
FETCH APDTACHX. STORE IN APXTF6IN
RETURN
APMNPOS
FETCH APXSLAV. STORE IN APXTF4IN
RETURN
APRSTO
FETCH APXSTOW. STORE IN APXC
RETURN
AUTOTRAK
FETCH APXTRACK. STORE IN APXTF4IN
RETURN

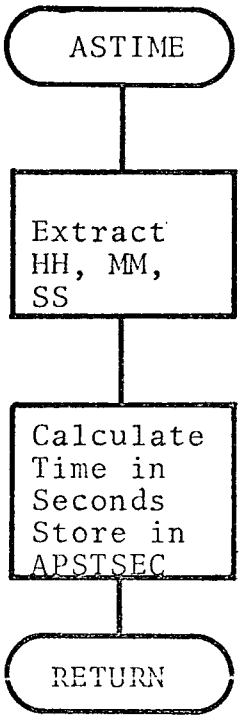
ENTRY NAME: ASTIME

INPUT: AITIME

OUTPUT: APSTSEC

METHOD:

Time in the form HHMMSS is extracted from ALTIME and converted to seconds and stored in APSTSEC.


ASTIME
Extract HH, MM, SS
Calculate Time in Seconds Store in APSTSEC
RETURN

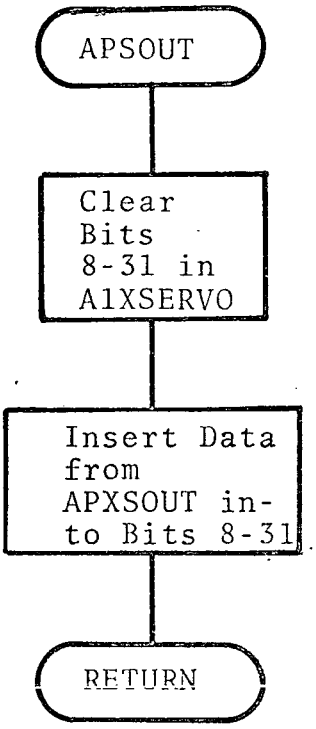
ENTRY NAME: APSOUT
APSAOUT

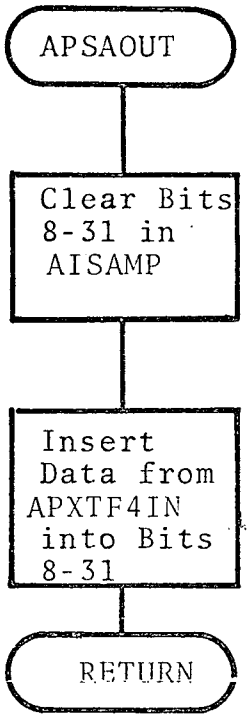
INPUT: APXSOUT, APXTF4IN } Corresponds to entry names above.

OUTPUT: AIXSERVO, AIXSAMP } Corresponds to inputs above.

METHOD:

The input is inserted into the proper bits of the interface output command word AIXSERVO (AIXSAMP).


APSOUT
Clear Bits 8-31 in A1XSERVO
Insert Data from APXSOUT in-to Bits 8-31
RETURN


APSAOUT
Clear Bits 8-31 in AISAMP
Insert Data from APXTF4IN into Bits 8-31
RETURN

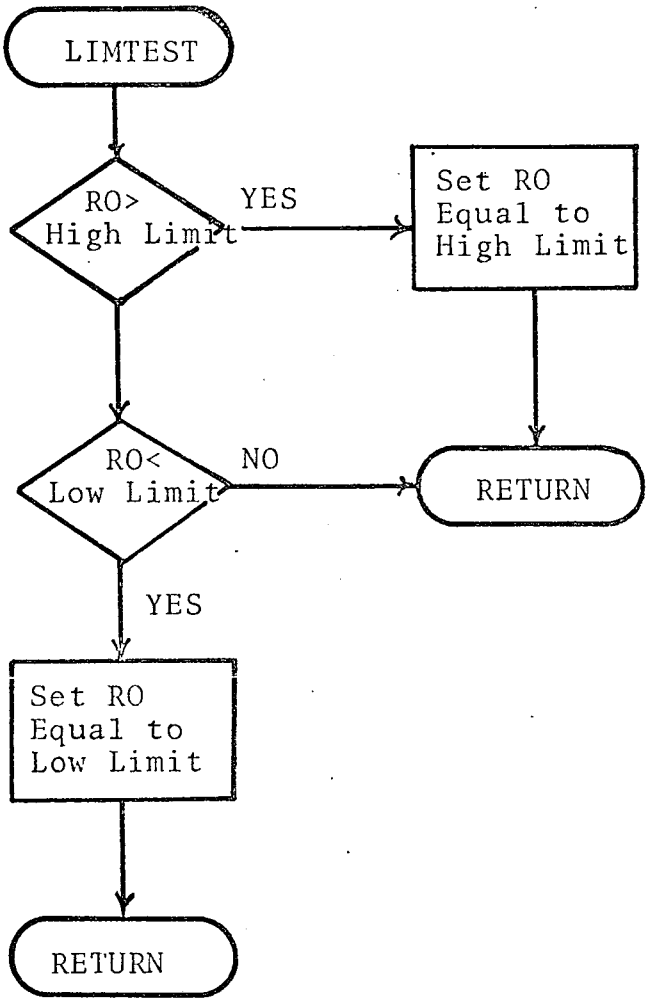
ENTRY NAME: LIMTEST

INPUT: R0, X3

OUTPUT: R0

METHOD:

The quantity to be tested against the limits is contained in R0. The proper test is selected by the value of X3. The output is a value that lies within the limits and is stored in R0.


LIMTEST
RO>
High Limit
YES
Set RO
Equal to
High Limit
RO<
Low Limit
NO
RETURN
YES
Set RO
Equal to
Low Limit
RETURN

X 3-5

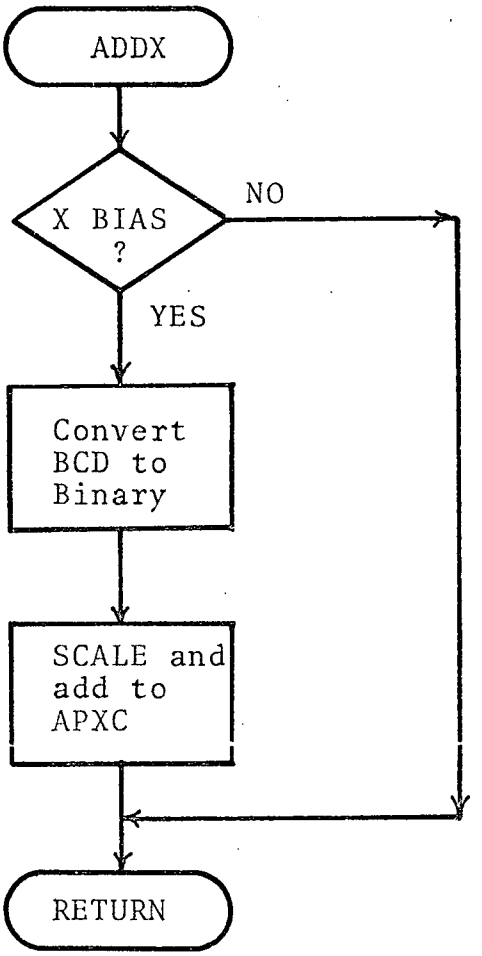
ENTRY NAME: ADDX

INPUT: APXC, APDXBIAS

OUTPUT: APXC

METHOD:

The setting of the X-Position Bias digit switches is stored in APDXBIAS. This value is converted from BCD and added to the command angle APXC, when X-Position Bias is selected.


ADDX
X BIAS ?
NO
YES
Convert BCD to Binary
SCALE and add to APXC
RETURN

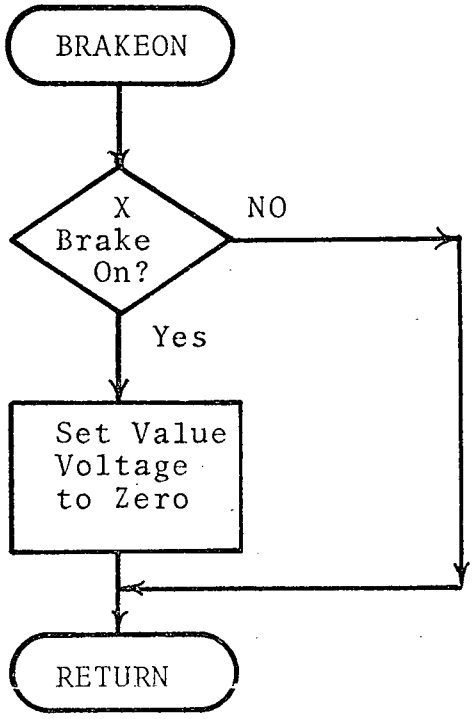
ENTRY NAME: BRAKEON

INPUT: APSTAT3

OUTPUT: AIXSERVO

METHOD:

The status word APSTAT3 is checked to determine if the brakes have been applied. If the brakes are on then the value output voltage AIXSERVO is set to zero, to avoid driving the antenna with the brakes on.


BRAKEON
X
Brake
On?
NO
Yes
Set Value
Voltage
to Zero
RETURN

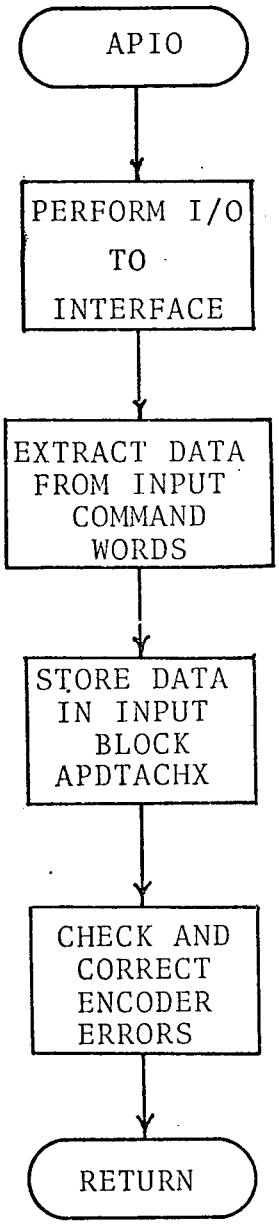
ENTRY NAME: APIO

INPUT: (See Table 4)

OUTPUT: (See Table 5)

METHOD:

I/O to the interface is performed. The input is derived from interface input command words. (See 6.2). An encoder filter is included which disregards the infrequent spurious readings of the encoder. The output to the interface is composed of output command words in which the current values of the outputs to the antenna are inserted.


APIO
PERFORM I/O TO INTERFACE
EXTRACT DATA FROM INPUT COMMAND WORDS
STORE DATA IN INPUT BLOCK APDTACHX
CHECK AND CORRECT ENCODER ERRORS
RETURN

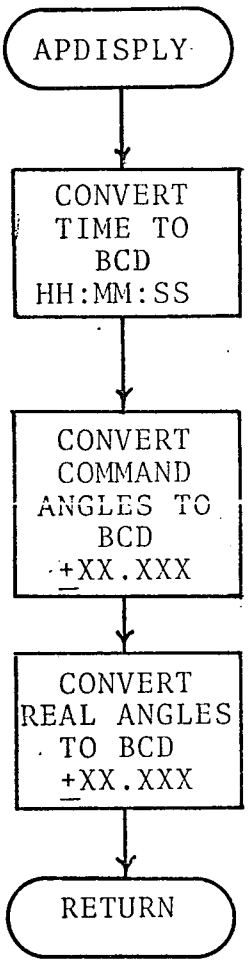
ENTRY NAME: APDISPLY

INPUT: APCTSEC, APXC, APXENC

OUTPUT: AICTDSP1, AIXCDSP1, AIXCDSP1

METHOD:

Command time and angles and real angle are converted to BCD. Then this data is inserted into the output command words to the antenna console displays.


APDISPLY
CONVERT TIME TO BCD HH:MM:SS
CONVERT COMMAND ANGLES TO BCD ±XX.XXX
CONVERT REAL ANGLES TO BCD ±XX.XXX
RETURN

ENTRY NAME: APRSCAN

INPUT: APSTAT2 (Contains scan radius)

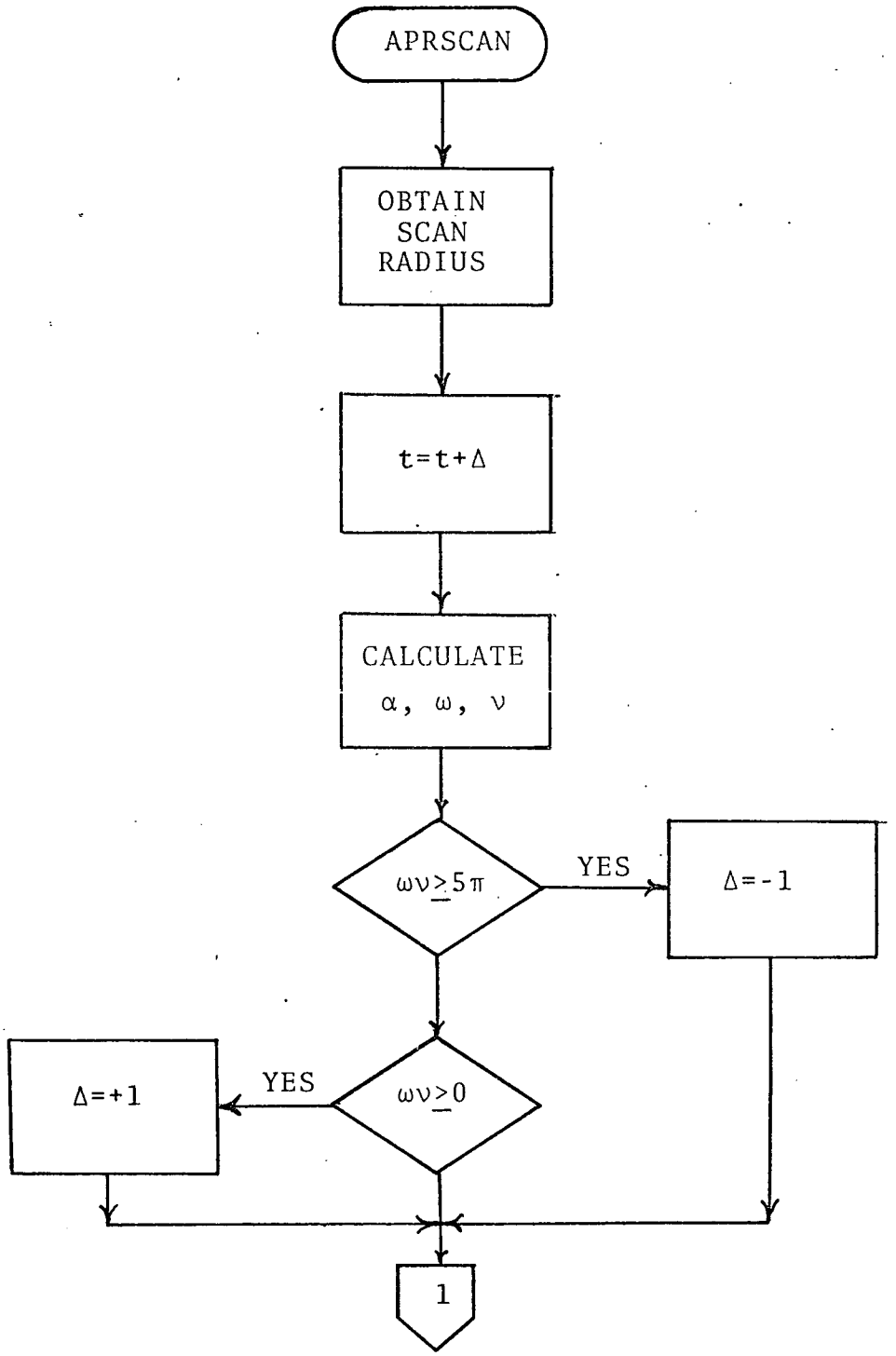
OUTPUT: APXSCAN

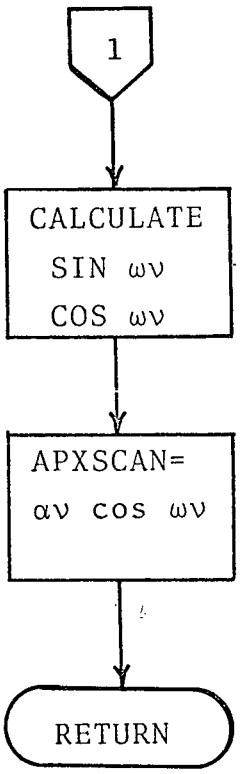
OTHER ROUTINES REQUIRED: SIN, COS

METHOD:

(See Section 4.1.1). When scan is selected the time t is initially zero. At the beginning of each new cycle t is increased by 1/20 sec. When the scan angle reaches 5π (2 1/2 turns) t is decreased by 1/20 sec and the antenna spirals inward. The polarities of the X and Y scan increments are chosen at 0° and 5π° to produce the spiral shown in Figure 5. Since the scan radius is selected via a rotary switch, which outputs a zero between positions, the scan radius is not altered until the new reading (APSTAT2) remains constant for 20 cycles; i.e., 1 sec. When changing scan radii the scan angle is kept constant to achieve the smallest change in antenna pointing attitude.

APXSCAN = $\alpha\nu \cos \omega\nu$


APRSCAN
OBTAIN SCAN RADIUS
t=t+Δ
CALCULATE α, ω, ν
ων≥5π
YES
Δ=-1
ων≥0
YES
Δ=+1
1


1
CALCULATE
SIN ων
COS ων
APXSCAN=
αν cos ων
RETURN

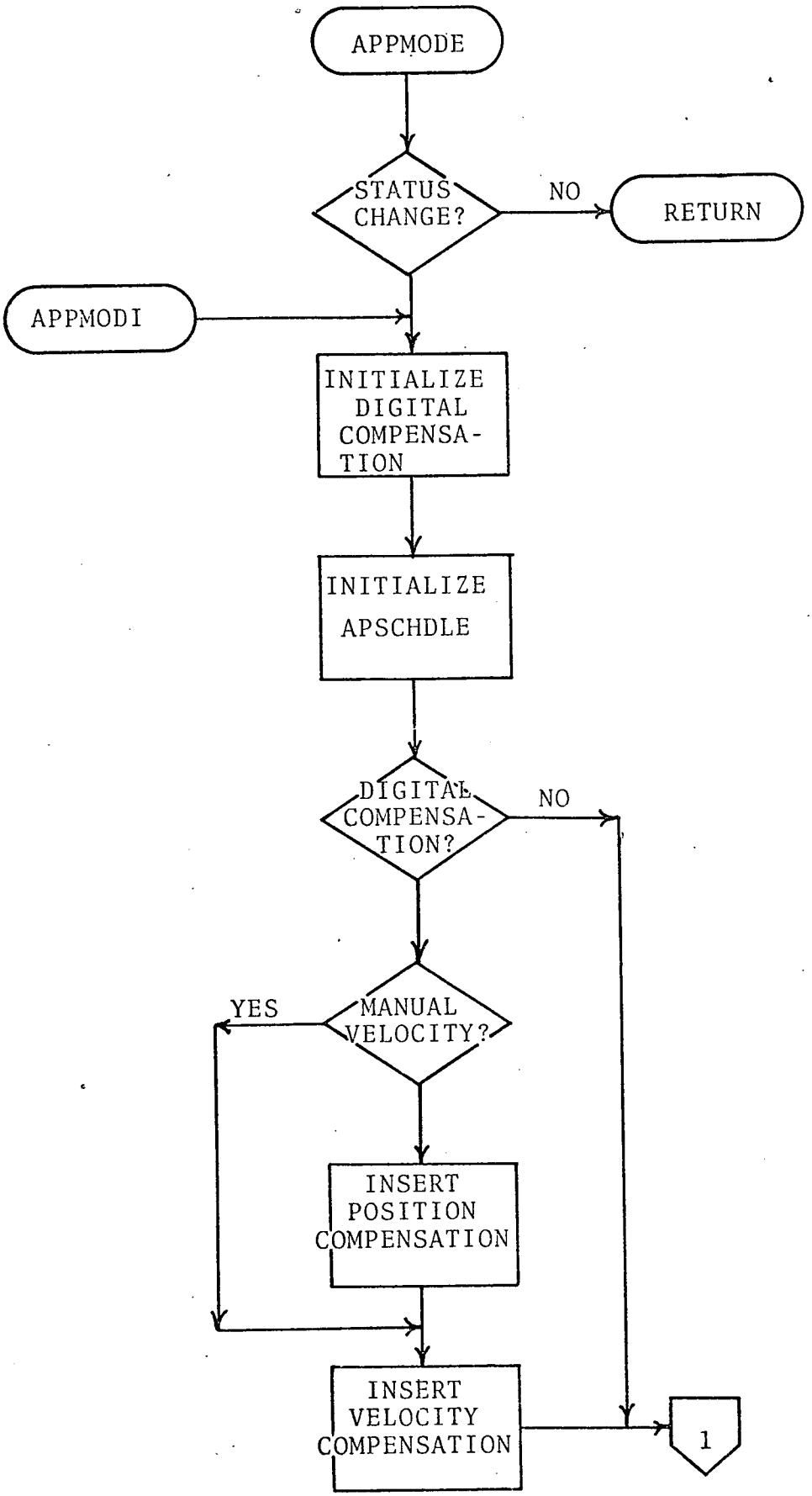
ENTRY NAME: APPMODE, APPMODI

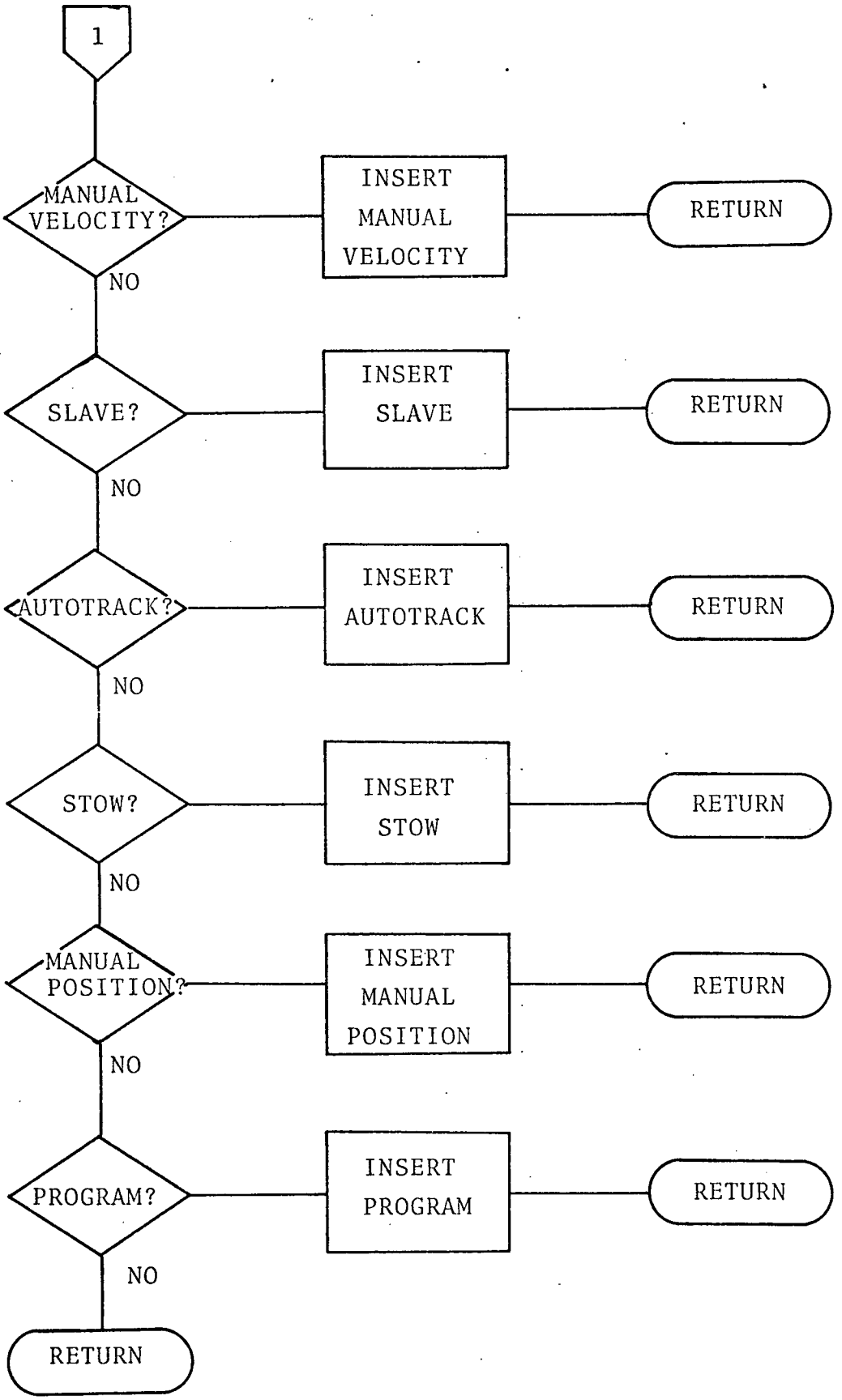
INPUT: APSTAT1, APSTAT2, APSTAT3

OUTPUT: APSCHDLE

METHOD:

If the status indicators remain constant, the program exits immediately. Otherwise, a branch to APPMODI is performed and a new schedule (APSCHDLE) is formed to reflect the new status.


APPMODE
STATUS CHANGE?
NO
RETURN
APPMODI
INITIALIZE DIGITAL COMPENSA-TION
INITIALIZE APSCHDLE
DIGITAL COMPENSA-TION?
NO
YES
MANUAL VELOCITY?
INSERT POSITION COMPENSATION
INSERT VELOCITY COMPENSATION
1


1
MANUAL VELOCITY?
INSERT MANUAL VELOCITY
RETURN
NO
SLAVE?
INSERT SLAVE
RETURN
NO
AUTOTRACK?
INSERT AUTOTRACK
RETURN
NO
STOW?
INSERT STOW
RETURN
NO
MANUAL POSITION?
INSERT MANUAL POSITION
RETURN
NO
PROGRAM?
INSERT PROGRAM
RETURN
NO
RETURN

ENTRY NAME: APPRED

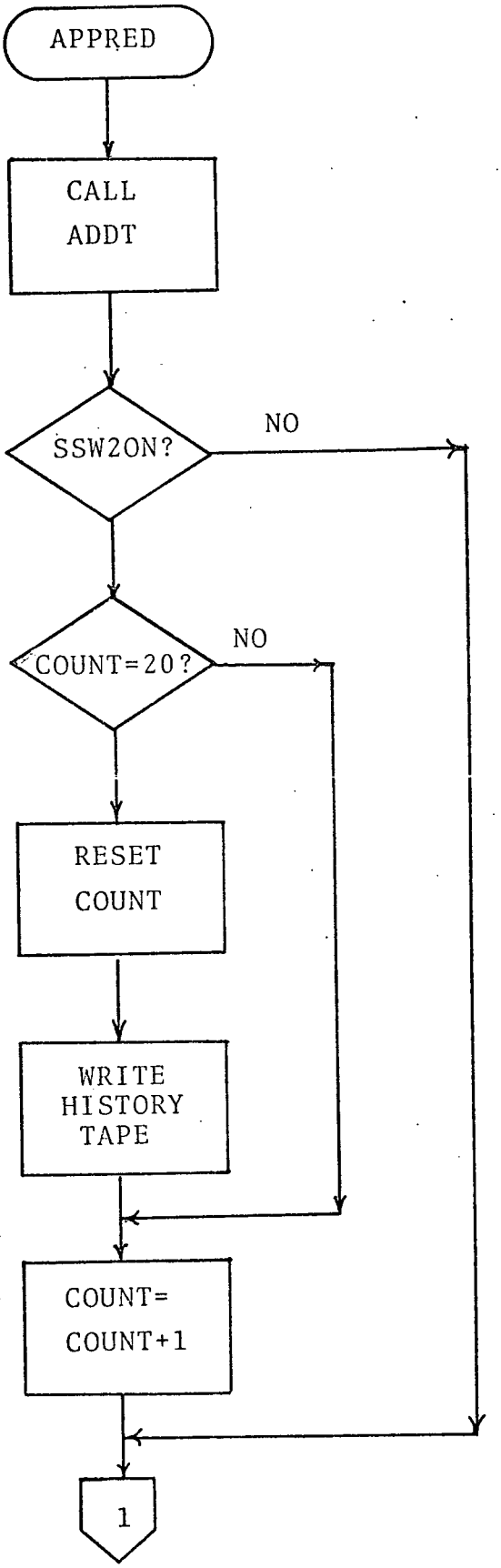
OTHER ROUTINES REQUIRED: ADDT, ADDX, APPREDZ

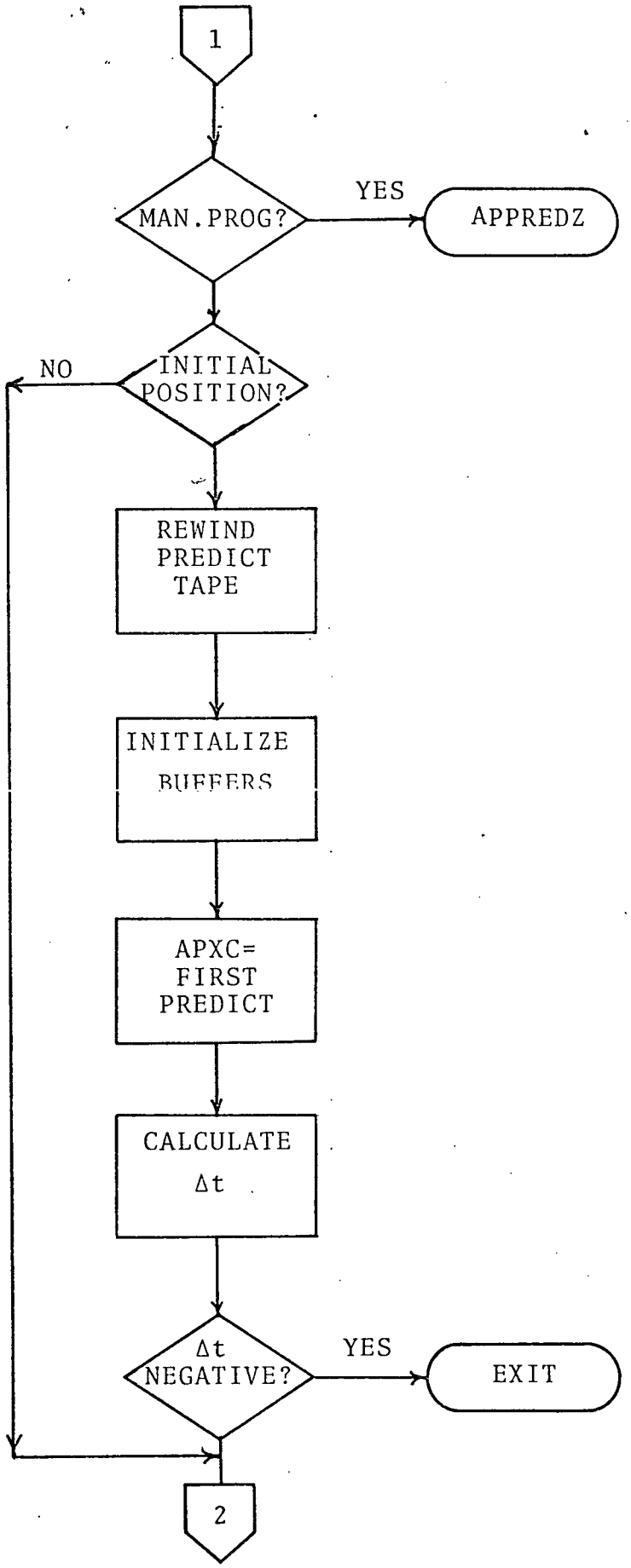
INPUT: APDXBIAS, APDTBIAS, APXPRED

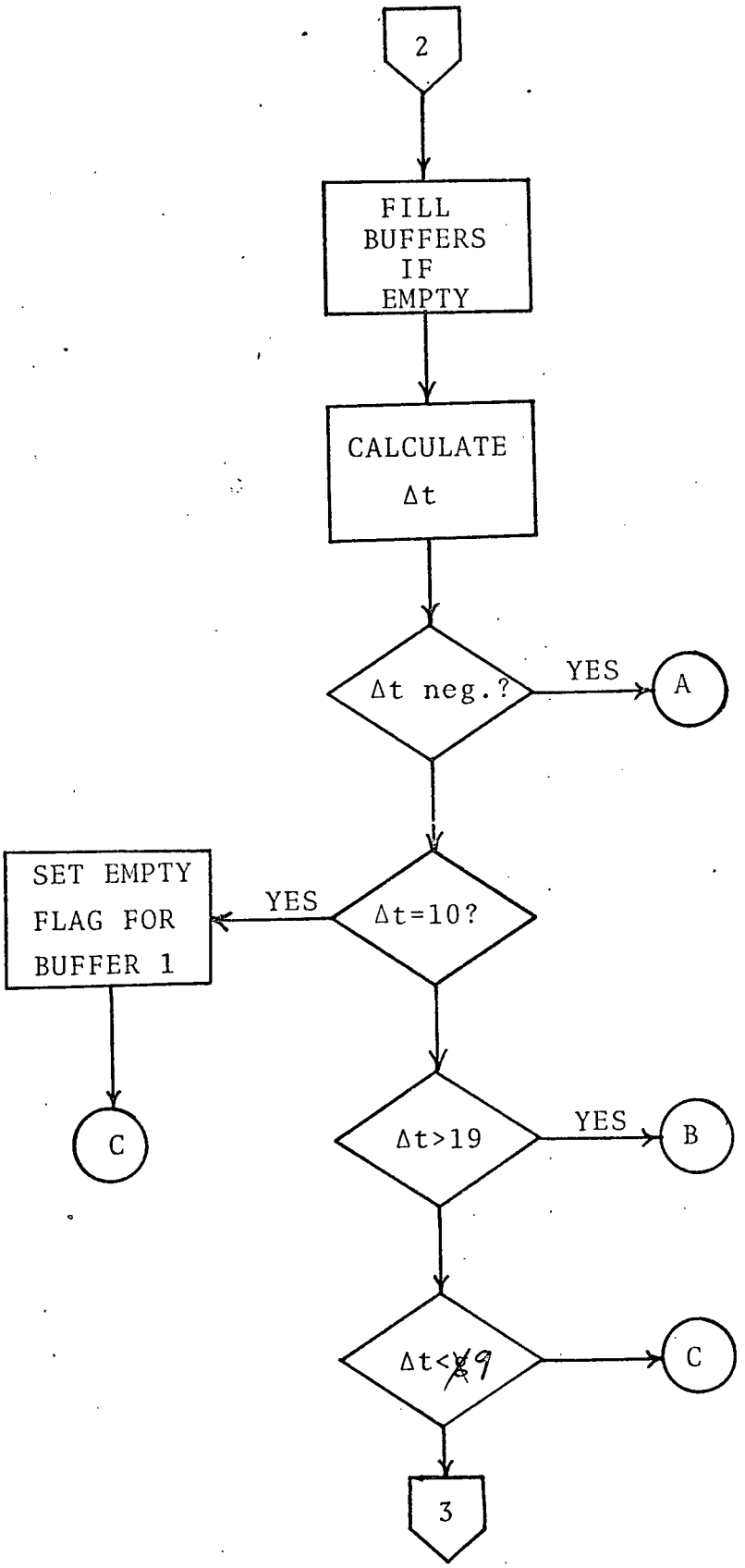
OUTPUT: APXC

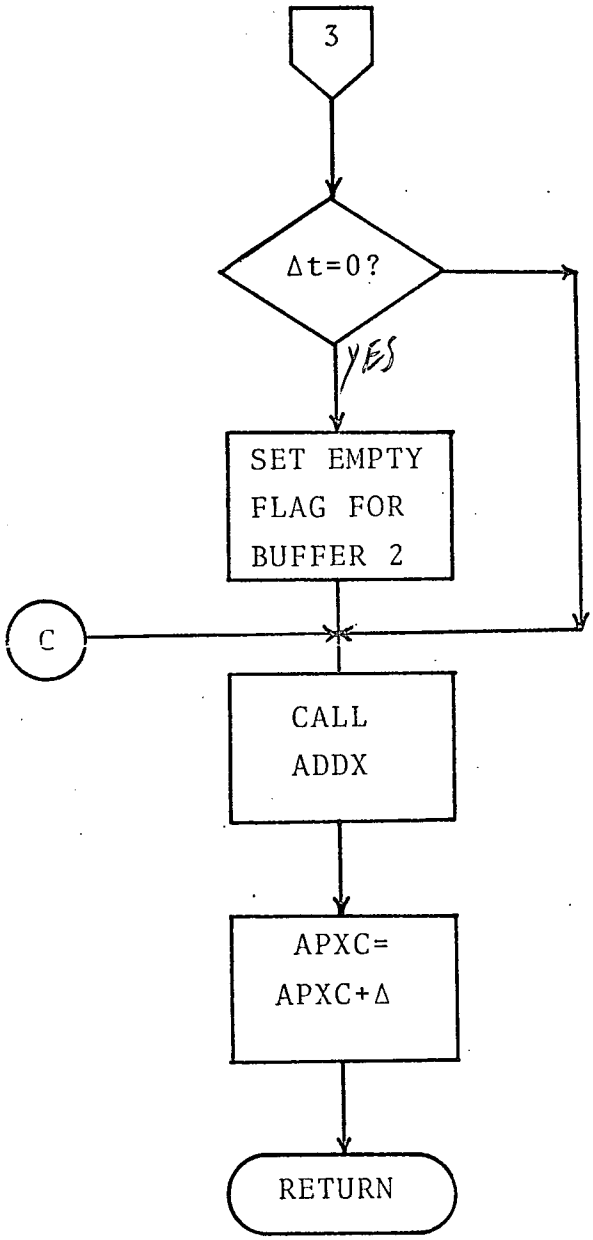
METHOD:

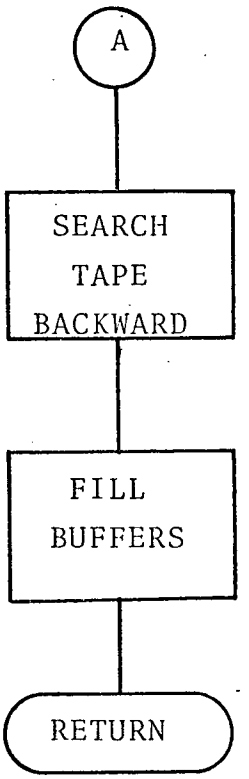
(See Section 4.1). There are two modes of operation: program mode and manual program mode. In the first case the command angle APXC is derived from the appropriate predict angle. In the second case the command angle is equal to the setting of the position bias digit switches.

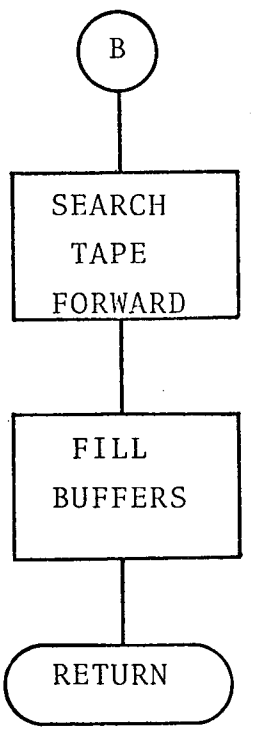

APPRED
CALL
ADDT
SSW2ON?
NO
COUNT=20?
NO
RESET
COUNT
WRITE
HISTORY
TAPE
COUNT=
COUNT+1
1


1
MAN.PROG?
YES
APPREDZ
INITIAL POSITION?
NO
REWIND PREDICT TAPE
INITIALIZE BUFFERS
APXC= FIRST PREDICT
CALCULATE Δt
Δt NEGATIVE?
YES
EXIT
2


2
FILL BUFFERS IF EMPTY
CALCULATE Δt
Δt neg.?
YES
A
SET EMPTY FLAG FOR BUFFER 1
YES
Δt=10?
C
Δt>19
YES
B
Δt<19
C
3


3
Δt=0?
YES
SET EMPTY FLAG FOR BUFFER 2
C
CALL ADDX
APXC= APXC+Δ
RETURN


A
SEARCH TAPE BACKWARD
FILL BUFFERS
RETURN


B
SEARCH TAPE FORWARD
FILL BUFFERS
RETURN

PROGRAM NAME: ENV TO XY CONVERSION

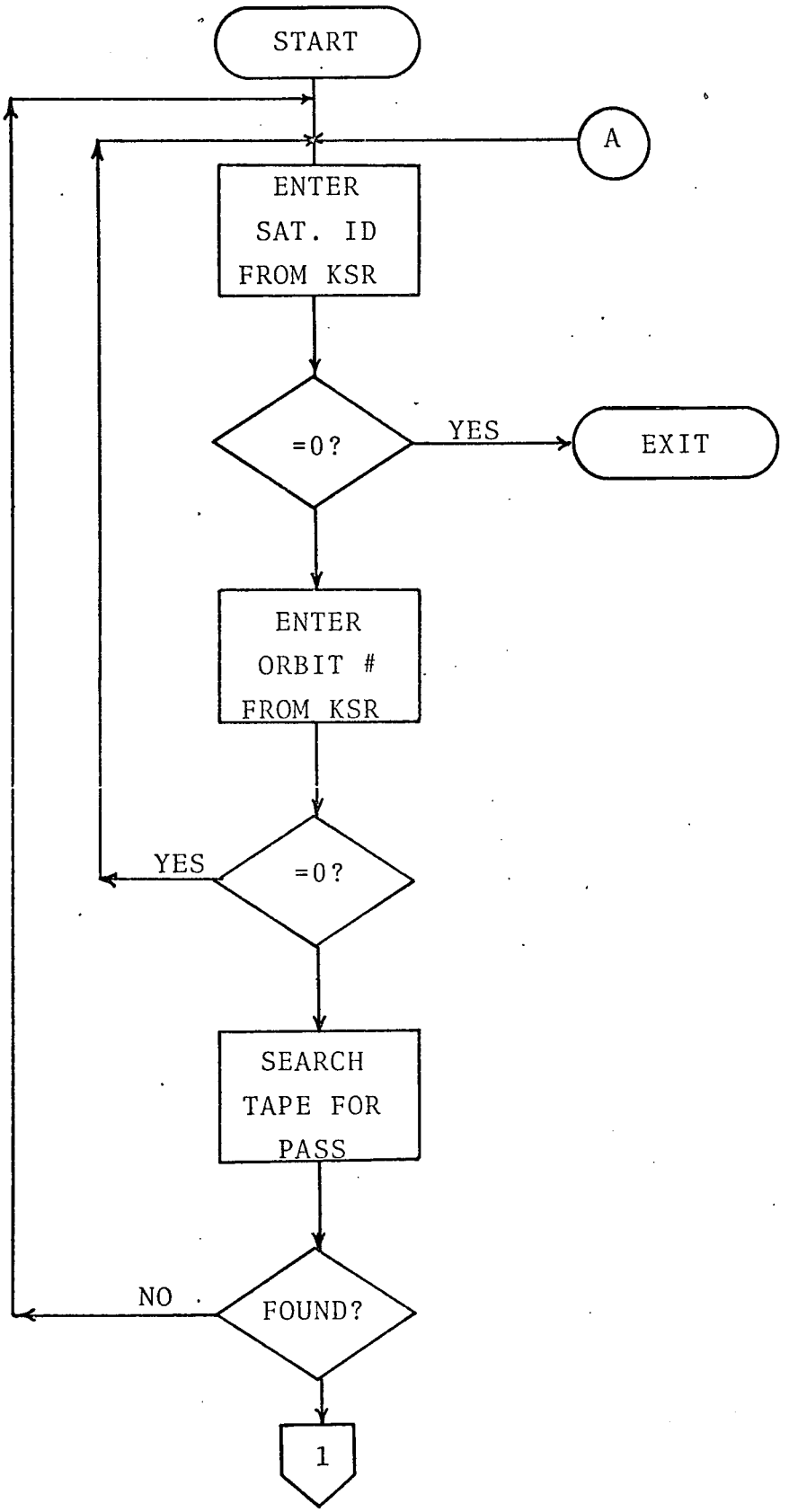
SOURCE LANGUAGE: FORTRAN IV

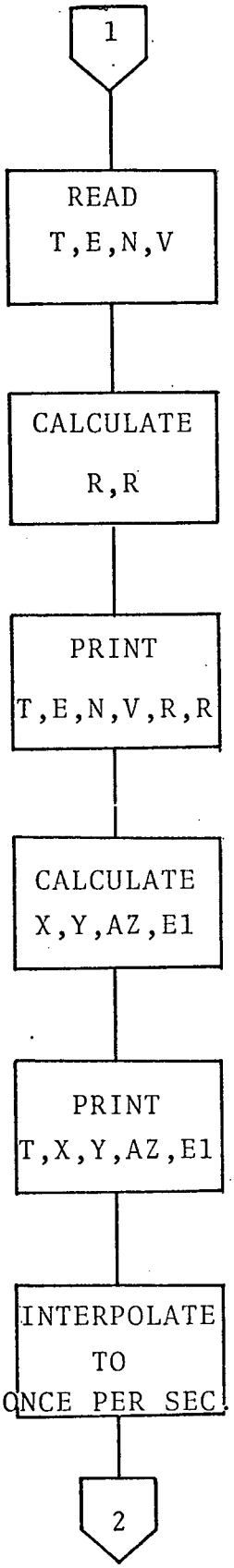
INPUT: ENV predicts

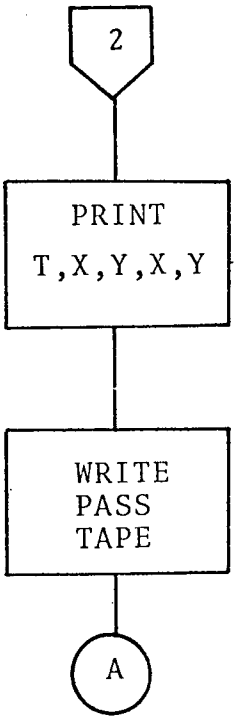
OUTPUT: XY predicts once per second

METHOD: (See Section 6.1.2)

ENV TO XY CONVERSION




1
READ
T,E,N,V
CALCULATE
R,R
PRINT
T,E,N,V,R,R
CALCULATE
X,Y,AZ,El
PRINT
T,X,Y,AZ,El
INTERPOLATE
TO
ONCE PER SEC.
2


2
PRINT
T,X,Y,X,Y
WRITE
PASS
TAPE
A

PROGRAM NAME: Predict Listing

SOURCE LANGUAGE: FORTRAN IV

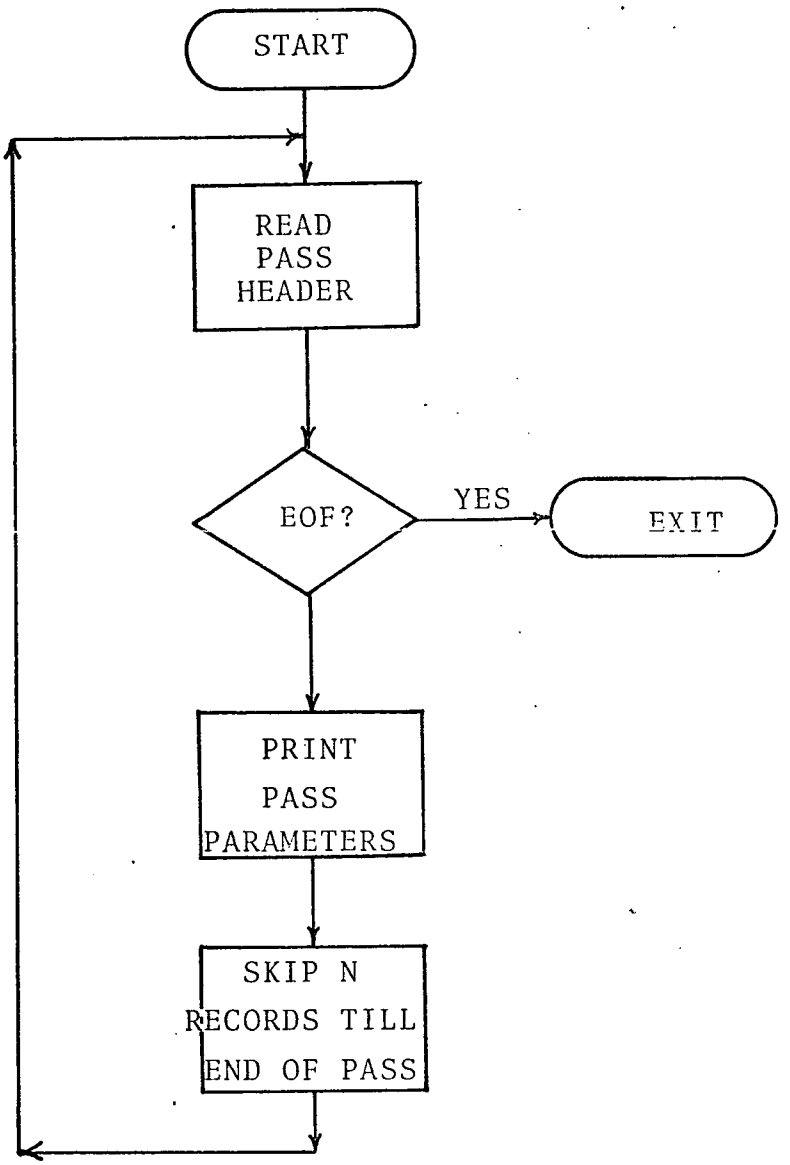
INPUT: OPSCON Pass Data Tape

OUTPUT: Predict Listing

METHOD:

Predict information on OPSCON Tape is listed giving satellite ID, date, orbit #, beginning of pass and pass duration.

PREDICT LISTING



PROGRAM NAME: HISTORY ANALYSIS

SOURCE LANGUAGE: FORTRAN IV

INPUT: History Tape

OUTPUT: Selected information from database

METHOD:

The History Tape contains a one per second dump of the database. Items to be printed are selected as follows:

X=DATABASE(N)

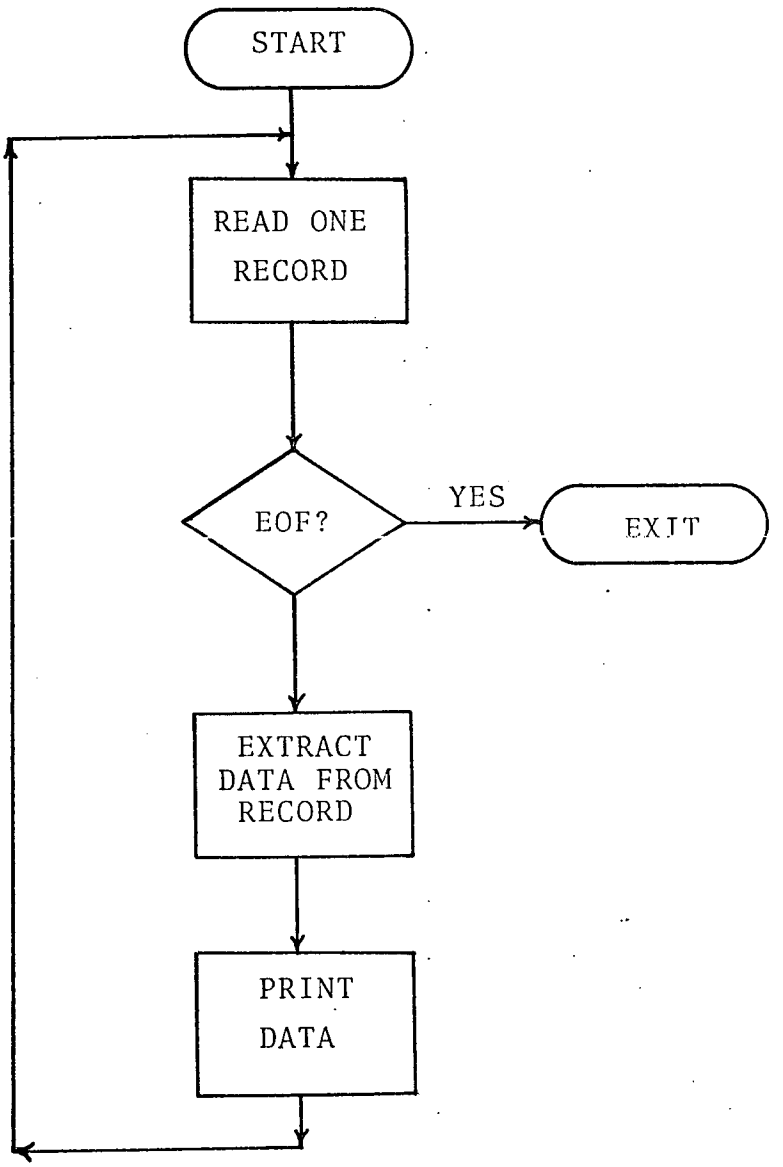
where X corresponds to the N^{th} item in the database (see real-time program listing). If scaling is needed, then the appropriate code is added, for example:

X=X*SF where SF is a scale factor.

Finally a print statement is used to list X; i.e.,

Print FFF,X where FFF is a format statement

HISTORY TAPE ANALYSIS



APPENDIX II

GLOSSARY OF TERMS

The following list of definitions is divided into two parts: database and program names.

Database

Input from interface (command words)

AIXTACK	X - tachometer reading
AIYTACK	Y - tachometer reading
AIXER	X - receiver error
AIYER	Y - receiver error
AIXJOY	X - velocity (Joystick)
AIYJOY	Y - velocity (Joystick)
AIXSLAV1	x - position error (Joystick)
AIYSLAV1	Y - position error (Joystick)
AIXENC	X - binary encoder (real position)
AIYENC	Y - binary encoder (real position)
AIXBIAS	X - BCD position bias (digit switches)
AIYBIAS	Y - BCD position bias (digit switches)
AITBIAS	Time bias (digit switches)
AISTAT1	Status function word 1
AISTAT2	Status function word 2
AISTAT3	Status function word 3

AITIME	Station time
AIDAY	Date

Output to interface (command words)

AIMODOUT	Limit indicators, type II indicators
AIXRDSP1	Real X display
AIYRDSP1	Real Y display
AISTDSP1	Station time
AICTDSP1	Command time
AIXSERVO	X - Valve voltage
AIYSERVO	Y - Valve voltage
AIXSAMP	X - Program mode error
AIYSAMP	Y - Program mode error

Decoded input from interface

The following 16 entries correspond one-to-one to the 16 quantities AIXTACK thru AISTAT3 described earlier under the heading input from interface. The only difference between them is that the following quantities are stripped of the address and any other irrelevant data.

APDTACHX
APDTACHY
APXTRACK
APYTRACK
APXJOY
APYJOY
APXSLAV
APYSLAV
APXENC
APYENC
APDXBIAS
APDYBIAS
APDTBIAS

APSTAT1
APSTAT2
APSTAT3

Antenna Parameters

APXEZCA	X - Encoder setting correspond to zenith
APYEZCA	Y - Encoder setting corresponding to zenith
APXSTOW	X - Stow angle
APYSTOW	Y - Stow angle

Digital Compensation Parameters

To evaluate the output of a Z-transfer function (see flowchart for ZEEXFM) the parameters a_o, a_1, b_1 and a previous value of the function F(MT) are needed. Thus for each transfer function for each axis the following data is provided:

A0	a_o
A1	a_1
B1	b_1
IN	input
OT	output
FN1	F[(n-1)T]

Parameters for Low-pass Filter

APQLPFAO
APQLPFA1
APQLPFB1
APXLPFIN
APXLPFOT
FN1LPFX

Parameters for Integrator

APQINTA0
APQINTA1
APQINTB1
APXINTIN
APXINTOT
FN1INTX

Parameters for position compensation - TF4

APQTF4A0
APQTF4A1
APQTF4B1
APXTF4IN
APXTF4OT
FN1TF4X

Parameters for velocity compensation - TF5

APQTF5A0
APQTF5A1
APQTF5B1
APQTF5IN
APQTF5OT
FN1TF5X

Parameters for tachometer compensation - TF6

APQTF6A0
APQTF6A1
APQTF6B1
APQTF6IN
APQTF6OT
FN1TF6X

Miscellaneous Data

APSTSEC	Station time in seconds
APCTSEC	Command time in seconds
APXC	X - Command angle
APYC	Y - Command angle
APXPRED	X - Predict
APYPRED	Y - Predict
APXER	X - Flag used by encoder filter
APYER	Y - Flag used by encoder filter
APXAUG	X - Augmentation increment
APYAUG	Y - Augmentation increment
APXSCAN	X - Scan increment
APYSCAN	Y - Scan increment
APXSOUT	X - Output of APYSOUT program
APYSOUT	Y - Output of APYSOUT program
APDISPWK	Work area for APDISPY program
BUFF	Double buffer (160 words) for predicts
AISTAT1P	Previous status words (3)
APSCHDLE	Current Schedule Table
SCHEDULE	Initial Schedule

APPENDIX III

OPERATING INSTRUCTIONS

Predict Listing Program

A - Mount OPSCON Tape - ENV #

B - Load Program

ENV to XY Conversion Program

A - Mount OPSCON Tape - ENV #

B - Mount Predict Tape - XY ##

C - Load program

D - Program will ask for satellite id; enter satellite id on KSR - note that a zero will cause program to exit.

E - Program will ask for orbit #; enter orbit # on KSR

If satellite id or orbit # do not match those on ENV #, a diagnostic will be output on KSR and program returns to step D or E.

If the requested pass is found on ENV # the pass is processed and control returns to step D.

History Analysis Program

A - Mount History Tape - HIST

B - Load Program

Real-time Program

It is assumed that the program resides on magnetic tape.

A - Load program (use load-deck)

B - When A is done, keyin:

```
!MEMORY SET, 6
```

C - Load run-deck

If operation in program mode is desired, load XY## and HIST tapes and press "start" on each unit - do not press "attention". Also keyin:

```
!MOUNT B80, XY
!MOUNT B81, HIST
```

Otherwise, continue here:

D - Keyin:

```
!INTC A,+63      (Arm Interrupt)
```

Program should be running at this point.

To terminate the program, keyin:

```
!F WOLF,R
```

To restart, keyin:

```
!F WOLF,L
```

If a history is needed, turn SSW2 on. To bypass history tape at any time, turn SSW2 off. SSW1 is used to exit. After such an exit the program cannot be restarted by an !F keyin. One must start with step C.

If program mode is selected and either of the tapes XY## or HIST are not mounted, program aborts. Since program mode is the default mode of operation, it is advised that the MAN. PROG switch on the antenna console be pressed prior to loading the program.

APPENDIX IV

Program Listing

```
   1                                 *
   2         00000002                        SYSTEM   ANTENNA
   3                                         WOLF
****  LEVEL   1DISPLAY OF COMMAND   WOLF
  47                                 *
  48                                 ************************************************************************
  49                                 *                                                                      *
  50                                 * WW        WW   88888   LL       FFFFFFF    RRRRRR    &&&&&  DDDDDD   *
  51                                 * WW   W    WW  88   88  LL       FF         RR   RR   &      DD   DD  *
  52                                 *  WW WWW WW   88     88 LL       FF         RR   RR  & &     DD    DD *
  53                                 *  WWWW WWWW   88     88 LL       FFFFF      RRRRRR   &  &    DD    DD *
  54                                 *   WW   WW     88   88  LL       FF         RR  RR    && &   DD   DD  *
  55                                 *   WW   WW      88888   LLLLLLL  FF         RR   RR       &  DDDDDD   *
  56                                 *                                                                      *
  57                                 *                                                                      *
  58                                 *          SYSTEMS  TECHNOLOGY  DEPT.                                  *
  59                                 *            SPACE  SYSTEMS  GROUP                                     *
  60                                 ************************************************************************
  61                                 *
****  ENDLEVEL   1DISPLAY OF COMMAND   WOLF
   4                                         REGNAME
****  LEVEL   1DISPLAY OF COMMAND   REGNAME
  65         00000001                X1      SET     1         ALL X REGISTERS ARE INDEX REGISTERS
  66         00000002                X2      SET     2
  67         00000003                X3      SET     3
  68         00000004                X4      SET     4
  69         00000005                X5      SET     5
  70         00000006                X6      SET     6
  71         00000007                X7      SET     7
  72         00000008                R0      SET     8         ALL R REGISTERS ARE GENERAL USE REGISTERS
  73         00000009                R1      SET     9
  74         0000000A                R2      SET     10
  75         0000000B                R3      SET     11
  76         0000000C                R4      SET     12
  77         0000000D                R5      SET     13
  78         0000000E                R6      SET     14
  79         0000000F                R7      SET     15
```

```
E00   0 : E  E-     , '                                    DATABASE                                    15
      80          00000000D           FBRH      SET       13          FORTRAN IV-H BRANCH REGISTER
      81          00000000F           FBR       SET       15          FORTRAN IV BRANCH REGISTER
  **** ENDLEVEL   1DISPLAY OF COMMAND   REGNAME
       5                                         SYSTEM    SIG5FP
       6                              *
       7                              *
       8                                         TITLE     'DATABASE'
```

```
E00   0 : E  E-     , '
                    DATABASE
        DEF         STRT
        DEF         BEGIN
        REF         F:8
        REF         F:9
        REF         APSEC
        REF         APDC0MP5
        REF         APDISPLY
        REF         AP@DCTF1
        REF         AP@DCTF2
        REF         APRJ0Y
        REF         APRSLAV
        REF         APSA0UT
        REF         AUT0TRAK
        REF         APPM0DI
        REF         APPRED
        DEF         APPREDZ
        DEF         SCHEDULE
        REF         AP@AGMNT
        REF         APPM0DE
        DEF         DATABASE
        DEF         APN0P
        REF         ASTIME
        DEF         AITIME
        DEF         BUFF
        DEF         ANT1
        DEF         APXEZCA
        DEF         APYEZCA
        DEF         APXST0W
        DEF         APYST0W
        DEF         APDTBIAS
        DEF         AIXENC
        DEF         AIYENC
        DEF         AIXER
        DEF         AIYER
        DEF         AIXBIAS
        DEF         AIYBIAS
        DEF         AITBIAS
```

```
46                      DEF     AIXTACK
47                      DEF     AIYTACK
48                      DEF     AISTAT1
49                      DEF     APSTAT1
50                      DEF     AISTAT2
51                      DEF     APSTAT2
52                      DEF     ADDX
53                      DEF     AISTAT3
54                      DEF     APSTAT3
55                      DEF     AIXJOY
56                      DEF     AIYJOY
57                      DEF     AIXSLAV1
58                      DEF     AIYSLAV1
59                      DEF     APSTIME
60                      DEF     APSTSEC
61                      DEF     APCTIME
62                      DEF     APCTSEC
63                      DEF     APXC
64                      DEF     APYC
65                      DEF     APXPRED
66                      DEF     APYPRED
67                      DEF     APXENC
68                      DEF     APYENC
69                      DEF     APXER
70                      DEF     APYER
71                      REF     APADCTF4
72                      DEF     APCLPFAO
73                      DEF     APXLPFIN
74                      DEF     APYLPFIN
75                      DEF     APCINTAO
76                      DEF     APXINTIN
77                      DEF     APYINTIN
78                      DEF     APCTF4AO
79                      DEF     APXTF4IN
80                      DEF     APYTF4IN
81                      DEF     APCTF5AO
82                      DEF     APXTF5IN
```

```
E00   0 : E  E-    , '
       83                    DEF     APYTF5IN
       84                    DEF     APGTF6A0
       85                    DEF     APXTF6IN
       86                    DEF     APYTF6IN
       87                    DEF     APXTF50T
       88                    DEF     APYTF50T
       89                    DEF     APXSMCIN
       90                    DEF     APYSMCIN
       91                    DEF     APXERBR
       92                    DEF     APYERBR
       93                    DEF     APDXBIAS
       94                    DEF     APDYBIAS
       95                    DEF     APPXBIAS
       96                    DEF     APPYBIAS
       97                    DEF     APDTACHX
       98                    DEF     APDTACHY
       99                    DEF     APXAUG
      100                    DEF     APYAUG
      101                    DEF     APXSCAN
      102                    DEF     APYSCAN
      103                    DEF     APXDBT
      104                    DEF     APYDBT
      105                    DEF     APXJBY
      106                    DEF     APYJBY
      107                    DEF     APXSLAV
      108                    DEF     APYSLAV
      109                    DEF     APDISPWK
      110                    DEF     AIMBDBUT
      111                    DEF     AIXSAMP
      112                    DEF     AIYSAMP
      113                    DEF     AIXSERVB
      114                    DEF     AIYSERVB
      115                    DEF     APXSBUT
      116                    DEF     APYSBUT
      117                    DEF     AIGTDSP1
      118                    DEF     AICTDSP1
      119                    DEF     AIXCDSP1
```

```
                                        DEF     BRAKE0N
                                        DEF     AIYC0SP1
                                        DEF     AIXR0SP1
                                        DEF     AIYR0SP1
                                        DEF     AISTAT1P
                                        DEF     APSCH0LE
                                        DEF     AP0SAVE
                                *
                                        DEF     FG34X
                                        DEF     FG34Y
                                        REF     APDC0MP1
                                *
                                *       ANTENNA SIMULAT0R DATA BASE
                                *
                                *
                                        B0UND   8
                                *
                                *
01 00000    C1D5E3F1 A  ANT1    TEXT    'ANT1'      ANTENNA SIMULAT0R
     01 00000           DATABASE EQU     ANT1
                                *
                                *
                                *       INPUT
                                *
01 00001    96000000 A  AIXTACK DATA    X'96000000'     X TACH0METER
01 00002    97000000 A  AIYTACK DATA    X'97000000'     Y TACH0METER
01 00003    98000000 A  AIXER   DATA    X'98000000'     X TRACKING RECEIVER ERR0R
01 00004    99000000 A  AIYER   DATA    X'99000000'     Y TRACKING RECEIVER ERR0R
01 00005    9A000000 A  AIXJ0Y  DATA    X'9A000000'     X VEL0CITY C0MMAND (J0Y STICK)
01 00006    9B000000 A  AIYJ0Y  DATA    X'9B000000'     Y VEL0CITY C0MMAND (J0Y STICK)
01 00007    8A000000 A  AIXSLAV1 DATA   X'8A000000'    SLAVE/P0S (J0Y STICK)
01 00008    8B000000 A  AIYSLAV1 DATA   X'8B000000'    SLAVE/P0S (J0Y STICK)
01 00009    F8000000 A  AIXENC  DATA    X'F8000000'    X  ENC0DER
01 0000A    F9000000 A  AIYENC  DATA    X'F9000000'    Y  ENC0DER
01 0000B    FA000000 A  AIXBIAS DATA    X'FA000000'    X  P0SITI0N  BIAS
01 0000C    FB000000 A  AIYBIAS DATA    X'FB000000'    Y  P0SITI0N  BIAS
01 0000D    FF000000 A  AITBIAS DATA    X'FF000000'     TIME 0FFSET DIGIT SWITCHES
```

```
157   01 0000E   FE000000 A   AISTAT1   DATA   X'FE000000'   STATUS  WORD  1
158   01 0000F   FD000000 A   AISTAT2   DATA   X'FD000000'   STATUS  WORD  2
159   01 00010   FC000000 A   AISTAT3   DATA   X'FC000000'   STATUS  WORD  3
160   01 00011   E3000000 A   AITIME    DATA   X'E3000000'   STATION  TIME
161   01 00012   E2000000 A   AIDAY     DATA   X'E2000000'
162                           *
163                           *          OUTPUT
164                           *
165   01 00013   00000000 A   AIMODOUT  DATA   X'00000000'   LIMIT LIGHTS AND TYPE II SERVO
166   01 00014   08000000 A   AIXRDSP1  DATA   X'08000000'         REAL X DISPLAY 1
167   01 00015   12000000 A             DATA   X'12000000'         REAL X DISPLAY 2
168   01 00016   09000000 A   AIYRDSP1  DATA   X'09000000'         REAL Y DISPLAY 1
169   01 00017   13000000 A             DATA   X'13000000'         REAL Y DISPLAY 2
170   01 00018   0A000000 A   AISTDSP1  DATA   X'0A000000'         STATION TIME DISPLAY 1
171   01 00019   0C000000 A   AIXCDSP1  DATA   X'0C000000'         COMMAND X DISPLAY 1
172   01 0001A   14000000 A             DATA   X'14000000'         COMMAND X DISPLAY 2
173   01 0001B   0E000000 A   AIYCDSP1  DATA   X'0E000000'         COMMAND Y DISPLAY 1
174   01 0001C   15000000 A             DATA   X'15000000'         COMMAND Y DISPLAY 2
175   01 0001D   0F000000 A   AICTDSP1  DATA   X'0F000000'         COMMAND TIME DISPLAY 1
176   01 0001E   16000000 A             DATA   X'16000000'         COMMAND TIME DISPLAY 2
177   01 0001F   28000000 A   AIXSERVO  DATA   X'28000000'         X SERVO VALVE SIGNAL
178   01 00020   29000000 A   AIYSERVO  DATA   X'29000000'         Y SERVO VALVE SIGNAL
179   01 00021   2A000000 A   AIXSAMP   DATA   X'2A000000'         X PROG.  MODE  ERROR
180   01 00022   2B000000 A   AIYSAMP   DATA   X'2B000000'         Y PROG.  MODE  ERROR
181                           *
182   01 00023   00000000 A   APDTACHX  DATA   0                   TACHOMETER READING X
183   01 00024   00000000 A   APDTACHY  DATA   0                   TACHOMETER READING Y
184   01 00025   00000000 A   APXTRACK  DATA   0                   X TRACKING ERROR
185   01 00026   00000000 A   APYTRACK  DATA   0                   Y TRACKING ERROR
186   01 00027   00000000 A   APXJOY    DATA   0                   VELOCITY COMMAND X
187   01 00028   00000000 A   APYJOY    DATA   0                   VELOCITY COMMAND Y
188   01 00029   00000000 A   APXSLAV   DATA   0                   SLAVE 1
189   01 0002A   00000000 A   APYSLAV   DATA   0                   SLAVE 1
190   01 0002B   00000000 A   APXENC    DATA   0                   ENCODER X
191   01 0002C   00000000 A   APYENC    DATA   0                   ENCODER Y
192   01 0002D   00000000 A   APDXBIAS  DATA   0   X BIAS
193   01 0002E   00000000 A   APDYBIAS  DATA   0   Y BIAS
```

```
194   01 0002F   00000000 A   APOTBIAS  DATA      0   TIME   BIAS
195   01 00030   00000000 A   APSTAT1   DATA
196   01 00031   00000000 A   APSTAT2   DATA
197   01 00032   00000000 A   APSTAT3   DATA
198                            *
199                            *
200                            *         PREPASS INPUT DATA
201                            *
202                            *
203   01 00033   00000000 A   APXEZCA   DATA              X ENCODER ZERO CORRECTION ANGLE
204   01 00034   00000000 A   APYEZCA   DATA              Y ENCODER ZERO CORRECTION ANGLE
205   01 00035   00000000 A   APXSTOW   DATA              X STOW POSITION
206   01 00036   00000000 A   APYSTOW   DATA              Y STOW POSITION
```

```
E00   0 : E  E-
      207
      208
      209
      210
      211
      212
      213
      214
```

PAGE DATABASE

ANTENNA INTERFACE INPUT

252	01	00056	00000000 A	APYLPFIN	DATA	
253	01	00057	00000000 A	APXLPF0T	DATA	
254	01	00058	00000000 A	APYLPF0T	DATA	
255	01	00059	00000000 A	FN1LPFX	DATA	
256	01	0005A	00000000 A	FN1LPFY	DATA	
257	01	0005B	00000000 A	APQINTA0	DATA	
258	01	0005C	00000000 A		DATA	0
259	01	0005D	00000000 A	APQINTA1	DATA	
260	01	0005E	00000000 A		DATA	0
261	01	0005F	00000000 A	APQINTB1	DATA	
262	01	00060	00000000 A		DATA	0
263	01	00061	00000000 A	APXINTIN	DATA	
264	01	00062	00000000 A	APYINTIN	DATA	
265	01	00063	00000000 A	APXINT0T	DATA	
266	01	00064	00000000 A	APYINT0T	DATA	
267	01	00065	00000000 A	FN1INTX	DATA	
268	01	00066	00000000 A	FN1INTY	DATA	
269	01	00067	00000000 A	APQTF4A0	DATA	
270	01	00068	00000000 A		DATA	0
271	01	00069	00000000 A	APQTF4A1	DATA	
272	01	0006A	00000000 A		DATA	0
273	01	0006B	00000000 A	APQTF4B1	DATA	
274	01	0006C	00000000 A		DATA	0
275	01	0006D	00000000 A	APXTF4IN	DATA	0
276	01	0006E	00000000 A	APYTF4IN	DATA	0
277	01	0006F	00000000 A	APXTF40T	DATA	0
278	01	00070	00000000 A	APYTF40T	DATA	0
279	01	00071	00000000 A	FN1TF4X	DATA	0
280	01	00072	00000000 A	FN1TF4Y	DATA	0
281	01	00073	00000000 A	FG34X	DATA	0
282	01	00074	00000000 A	FG34Y	DATA	0
283	01	00075	00000000 A	APQTF5A0	DATA	
284	01	00076	00000000 A		DATA	0
285	01	00077	00000000 A	APQTF5A1	DATA	
286	01	00078	00000000 A		DATA	0
287	01	00079	00000000 A	APQTF5B1	DATA	
288	01	0007A	00000000 A		DATA	0

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289   01 0007B   00000000 A   APXTF5IN  DATA      0
290   01 0007C   00000000 A   APYTF5IN  DATA      0
291   01 0007D   00000000 A   APXTF5BT  DATA      0
292   01 0007E   00000000 A   APYTF5BT  DATA      0
293   01 0007F   00000000 A   FN1TF5X   DATA      0
294   01 00080   00000000 A   FN1TF5Y   DATA      0
295   01 00081   00000000 A   APBTF6A0  DATA
296   01 00082   00000000 A             DATA      0
297   01 00083   00000000 A   APBTF6A1  DATA
298   01 00084   00000000 A             DATA      0
299   01 00085   00000000 A   APBTF6B1  DATA
300   01 00086   00000000 A             DATA      0
301   01 00087   00000000 A   APXTF6IN  DATA      0
302   01 00088   00000000 A   APYTF6IN  DATA      0
303   01 00089   00000000 A   APXTF6BT  DATA      0
304   01 0008A   00000000 A   APYTF6BT  DATA      0
305   01 0008B   00000000 A   FN1TF6X   DATA      0
306   01 0008C   00000000 A   FN1TF6Y   DATA      0
307   01 0008D   00000000 A   APXSBUT   DATA      0          SMC BUTPUT X
308   01 0008E   00000000 A   APYSBUT   DATA      0          SMC BUTPUT Y
309   01 0008F   00000000 A   APDISPWK  DATA      0
310   01 00090   00000000 A             DATA      0
311   01 00091               BUFF      RES       160
312   01 00131   00000000 A             DATA      0
313                          *
314                          *
315                          *         ANTENNA CONTROL BUTPUT
316                          *
317                          *
318   01 00132   00000000 A   AISTAT1P  DATA      0,0,0      LAST STATUS BIT SETTINGS
      01 00133   00000000 A
      01 00134   00000000 A
```

```
319                                     PAGE
320                             *
321                             *
322                             *       ANTENNA PROGRAM SCHEDULE TABLE
323                             *
324                             *
325   01 00135                  APSCHDLE  RES     0
326        00000008                       D0      11
327   01 00135    0000021F               DATA    APN0P
328                                       FIN
      01 00136    0000021F
      01 00137    0000021F
      01 00138    0000021F
      01 00139    0000021F
      01 0013A    0000021F
      01 0013B    0000021F
      01 0013C    0000021F
      01 0013D    0000021F
      01 0013E    0000021F
      01 0013F    0000021F
329                             *
330   01 00140    00000000 N            DATA    APPM0DI
331   01 00141    00000000 N  SCHEDULE  DATA    APPRED
332   01 00142    0000021F    AEN0P     DATA    APN0P           = INITIAL PROGRAM SCHEDULE
333   01 00143    0000021F              DATA    APN0P             TABLE)
334   01 00144    0000021F              DATA    APN0P
335   01 00145    0000021F              DATA    APN0P
336   01 00146    0000021F              DATA    APN0P
337   01 00147    0000021F              DATA    APN0P
338   01 00148    0000021F              DATA    APN0P
339   01 00149    0000021F              DATA    APN0P
340   01 0014A    0000021F              DATA    APN0P
341   01 0014B    00000000 N            DATA    APPM0DE
342   01 0014C    00000000 N            DATA    APDISPLY
343                             *
344   01 0014D    00000000 A  APOSAVE   DATA    0
345                             *
```

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346                                     *
347   01 0014E   55500555 A   AP@DBEND  DATA    X'55500555'
348   01 0014F                          RES     ANT1+512-$
349                                     *
350   01 00200   00000000 A   OPNFLG    DATA    0
351   01 00201   00000000 A   TIMECK    DATA    0,0
      01 00202   00000000 A
352   01 00203   2AE3C9D4 A   TIMCK9T   TEXTC   'TIME USED=       CYCLES 9F 2000 CPS CL9CK'
      01 00204   C540E4E2 A
      01 00205   C5C47E40 A
      01 00206   40404040 A
      01 00207   404040C3 A
      01 00208   E8C3D3C5 A
      01 00209   E240D6C6 A
      01 0020A   40F2F0F0 A
      01 0020B   F0400307 A
      01 0020C   E240C3D3 A
      01 0020D   D6C30240 A
353                                     *
354                                     *
355                                     *
356   01 0020E   32800032       BRAKE9N LW,R0     APSTAT3
357   01 0020F   46800306               AND,R0    =X'8000'
358   01 00210   63300216               BCR,3     YCHECK
359   01 00211   3290001F               LW,R1     AIXSERV0
360   01 00212   25800108 A             SLD,R0    8
361   01 00213   22900000 A             LI,R1     0
362   01 00214   25800178 A             SLD,R0    -8
363   01 00215   3690001F               STW,R1    AIXSERV0
364   01 00216   32800032       YCHECK  LW,R0     APSTAT3
365   01 00217   46800307               AND,R0    =X'2000'
366   01 00218   63300300 A             BCR,3     0,X1
367   01 00219   32900020               LW,R1     AIYSERV0
368   01 0021A   25800108 A             SLD,R0    8
369   01 0021B   22900000 A             LI,R1     0
370   01 0021C   25800178 A             SLD,R0    -8
371   01 0021D   36900020               STW,R1    AIYSERV0
```

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E00   0 : E  E-  , '
 372  01 0021E   68020000 A               B        0,X1
 373                                *
 374                                *
 375                                *     N0 0PERATI0N PR0GRAM
 376                                *
 377  01 0021F                      APN0P    RES      0
 378  01 0021F   68020001 A               B        1,X1      RETURN
 379                                *
 380                                *
 381                                *
 382  01 00220                      BEGIN    RES      0
 383  01 00220   04500000 02               M:ARM    (INT,+99,DISABLE),(START,STRT),MASTER
      02 00000   04100063 A
      02 00001   80000002 A
      02 00002   00000222 01
 384  01 00221   049A0001 A                M:EXIT   5
 385  01 00222                      STRT     RES      0
 386  01 00222   04500003 02               M:ARM    (CL0CK,+90,2000,DISABLE),(START,STRT),(MASTER)
      02 00003   0400005A A
      02 00004   A0000002 A
      02 00005   00000222 01
      02 00006   0000070C A
 387  01 00223   32800200                  LW,8     0PNFLG
 388  01 00224   21800000 A                CI,8     0
 389  01 00225   6930022A                  BCS,3    $+5
 390  01 00226   22800001 A                LI,8     1
 391  01 00227   35800200                  STW,8    0PNFLG
 392  01 00228   6A10025E                  BAL,X1   API0
 393  01 00229   04900001 A                M:EXIT   0
 394                                *
 395                                *
 396  01 0022A                      APEXL00P RES      0
 397  01 0022A   6C000000 A                RD,0     0
 398  01 0022B   69800256                  BCS,8    APEXEND
 399  01 0022C   68200233                  BCR,2    PRNT+1
 400  01 0022D   22D00206                  LI,13    TIMCK0T+3
 401  01 0022E   32C00201                  LW,12    TIMECK
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402   01 0022F   38C00202              SW,12     TIMECK+1
403   01 00230   22E0000C A            LI,14     12
404   01 00231   6AF002F3              BAL,15    BINDEC
405   01 00232   04200007 02  PRNT     M:PRINT   (MESS,TIMCK0T)
      02 00007   01000000 A
      02 00008   80000000 A
      02 00009   00000203 01
406   01 00233   32800054 A        LW,R0    X'54'
407   01 00234   B2800008 A            LW,R0     *R0
408   01 00235   35800201              STW,R0    TIMECK
409                           *
410                           *
411                           *
412   01 00236   6A10025E              BAL,X1    API0
413   01 00237   02000000 A            NOP
414   01 00238   6A100000 X            BAL,X1    ASTIME
415   01 00239               APENTRY1   RES       0
416                           *
417                           *
418                           *
419                           *         ANTENNA LOOP PHILCO
420                           *
421   01 00239   22200000 A            LI,X2     0
422   01 0023A   EA100135              BAL,X1    *APSCHDLE
423   01 0023B   02000000 A            NOP
424                           *
425   01 0023C   EA100136    APENTRY2   BAL,X1    *APSCHDLE+1
426   01 0023D   02000000 A            NOP
427                           *
428   01 0023E   EA100137    APENTRY3   BAL,X1    *APSCHDLE+2
429   01 0023F   02000000 A            NOP
430                           *
431                           *
432   01 00240   EA100138    APENTRY4   BAL,X1    *APSCHDLE+3
433   01 00241   02000000 A            NOP
434                           *
435                           *
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436   01 00242   EA100139      APENTRY5  BAL,X1    *APSCHDLE+4
437   01 00243   02000000 A              NOP
438                           *
439   01 00244   EA10013A      APENTRY6  BAL,X1    *APSCHDLE+5
440   01 00245   02000000 A              NOP
441                           *
442   01 00246   EA10013B      APENTRY7  BAL,X1    *APSCHDLE+6
443   01 00247   02000000 A              NOP
444                           *
445   01 00248   EA10013C      APENTRY8  BAL,X1    *APSCHDLE+7
446   01 00249   02000000 A              NOP
447                           *
448   01 0024A   EA10013D      APENTRY9  BAL,X1    *APSCHDLE+8
449   01 0024B   02000000 A              NOP
450                           *
451   01 0024C   EA10013E      APENTY10  BAL,X1    *APSCHDLE+9
452   01 0024D   02000000 A              NOP
453                           *
454   01 0024E   EA10013F      APENTY11  BAL,X1    *APSCHDLE+10
455   01 0024F   02000000 A              NOP
456                           *
457   01 00250   EA100140      APENTY12  BAL,X1    *APSCHDLE+11
458   01 00251   02000000 A              NOP
459   01 00252   32800054 A          LW,R0    X'54'
460   01 00253   F2800008 A              LW,R0     *R0
461   01 00254   35800202                STW,R0    TIMECK+1
462   01 00255   04900001 A              M:EXIT    0
463   01 00256                  APEXEND.  RES       0
464   01 00256   0410000A 02             M:WEOF    F:9
      02 0000A   02000000 X
465   01 00257   0410000B 02             M:CLOSE   F:8,(REM)
      02 0000B   15000000 X
      02 0000C   80000020 A
      02 0000D   00000000 A
466   01 00258   0410000E 02             M:CLOSF   F:9,(REM)
      02 0000E   15000000 X
      02 0000F   80000020 A
```

```
         02 00010    00000000 A
467      01 00259    04300011 02          M:SNAP    'PROGRAM AREA DUMP',(ANT1-292,ANT1+2779)
         02 00011    00000000 A
         02 00012    7FFFFEDC N
         02 00013    00000ADB 01
         02 00014    D7D9D6C7 A
         02 00015    D9C1D440 A
         02 00016    C1D9C5C1 A
         02 00017    40C4E4D4 A
         02 00018    D7404040 A
         02 00016    02000000 A
         02 00017    6800025A 01
468      01 0025A    04900008 A           M:TERM
469                              *
470                              *
471                              *
472                              *
473                              *
474                              *
475                              *
476                              *
477                              *
478                              *
479                                       TITLE     'API8'
```

```
480                                     DEF     APxTRACK
481                                     DEF     APyTRACK
482                                     DEF     API0
483                                     BRUND_  8
484   01 0025C    01          A  APINTFDW DATA,1  X'01'
485   01 0025C 1  000004      N          DATA,3  BA(AIXTACK)
486   01 0025D    00000088    A          DATA    136
487                             *
488                             *
489                             *
490                             *
491                             *
492   01 0025E    3500014D       API0    STW,0   APOSAVE
493   01 0025F    35100280               STW,X1  RETSAVE
494   01 00260    2200012E               LI,0    DA(APINTFDW) I0 D0UBLEW0RD
495   01 00261    4D800207    A          TI0,R0  X'207'
496   01 00262    69C00261               BCS,12  $-1
497   01 00263    4C800207    A          SI0,R0  X'207'
498                             *
499   01 00264    69C002AD               BCS,12  ERR0R
500                             *
501                             *
502   01 00265    4D800207    A          TI0,R0  X'207'
503   01 00266    69C00265               BCS,12  $-1
504                             *
505                             *
506                             *       CONVERT INPUT DATA
507                             *
508   01 00267    02200000    A          LCI     0
509   01 00268    2A000001               LM,0    AIXTACK
510   01 00269    25000311    A          SAD,0   17
511   01 0026A    2500046F    A          SAS,0   -17
512   01 0026B    2510046F    A          SAS,1   -17
513   01 0026C    25200311    A          SAD,2   17
514   01 0026D    2520046F    A          SAS,2   -17
515   01 0026E    2530046F    A          SAS,3   -17
516   01 0026F    25400311    A          SAD,4   17
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517   01 00270  2540046F A          SAS,4     -17
518   01 00271  2550046F A          SAS,5     -17
519   01 00272  25600511 A          SAD,6     17
520   01 00273  2560046F A          SAS,6     -17
521   01 00274  2570046F A          SAS,7     -17
522   01 00275  258001CF A          SLD,8     15
523   01 00276  25800071 A          SLS,8     -15
524   01 00277  25900071 A          SLS,9     -15
525   01 00278  25A00108 A          SLD,10    8
526   01 00279  25A00078 A          SLS,10    -8
527   01 0027A  25B00078 A          SLS,11    -8
528   01 0027B  25C00008 A          SLS,12    8
529   01 0027C  25C00078 A          SLS,12    -8
530                    *
531                    ********************ENCODER  FILTER **********************
532   01 0027D  02200080 A          LCI       8
533   01 0027E  29000023            STM,0     APDTACHX
534   01 0027F  38800033            SW,8      APXEZCA
535   01 00280  39000034            SW,9      APYEZCA
536   01 00281  32700008 A          LW,7      8
537   01 00282  23700009 A          MI,7      9
538   01 00283  23900009 A          MI,9      9
539   01 00284  25700501 A          DWR,7     =20
      01 00285  36700308
      01 00286  21700000 A
      01 00287  69100289
      01 00288  20700001 A
      01 00289  25700+7F A
540   01 0028A  25900501 A          DWR,9     =20
      01 0028B  36900308
      01 0028C  21900000 A
      01 0028D  6910028F
      01 0028E  20900001 A
      01 0028F  2590047F A
541   01 00290  32500028            LW,5      APXENC
542   01 00291  32600020            LW,6      APYENC
543   01 00292  38500007 A          SW,5      7
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01 00293   36600009 A             SW,6       9
01 00294   35500005 A             LAW,5      5
01 00295   35600006 A             LAW,6      6
01 00296   215000A4 A             CI,5       164
01 00297   6820029D               BCR,2      STRX
01 00298   3200003F               LW,0       APXER
01 00299   20000001 A             AI,0       1
01 0029A   3500003F               STW,0      APXER
01 0029B   21000002 A             CI,0       2
01 0029C   691002A0               BCS,1      CKY
01 0029D   3570002B     STRX      STW,7      APXENC
01 0029E   22000000 A             LI,0       0
01 0029F   3500003F               STW,0      APXER
01 002A0   216000A4 A   CKY       CI,6       164
01 002A1   682002A7               BCR,2      STRY
01 002A2   32000040               LW,0       APYER
01 002A3   20000001 A             AI,0       1
01 002A4   35000040               STW,0      APYER
01 002A5   21000002 A             CI,0       2
01 002A6   691002AA               BCS,1      END
01 002A7   3590002C     STRY      STW,9      APYENC
01 002A8   22000000 A             LI,0       0
01 002A9   35000040               STW,0      APYER
01 002AA   02200060 A   END       LCI        6
01 002AB   2BA0002D               STM,10     APDXBIAS
                        *
01 002AC   22200000 A             LI,2       0
                        *
01 002AD   3200014D     ERROR     LW,0       APOSAVE
01 002AE   321002B0               LW,X1      RETSAVE
01 002AF   68020000 A             B          0,X1
01 002B0   00000000 A   RETSAVE   DATA       0
01 002B1   32800031     ADDX      LW,R0      APSTATP
01 002B2   48800309               AND,R0     =X'00400000'
01 002B3   682002B7               BCR,2      ADDY
01 002B4   3280002D               LW,R0      APDXBIAS
01 002B5   6A4002BE               BAL,X4     CONVXY
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581   01 002B6   6680003B             AWM,R0     APXC
582   01 002B7   32800031     ADDY    LW,R0      APSTAT2
583   01 002B8   4B80030A             AND,R0     =X'00200000'
584   01 002B9   69220000 A           BCR,2      0,X1
585   01 002BA   3280002E             LW,R0      APDYBIAS
586   01 002BB   6A4002BE             BAL,X4     CONVXY
587   01 002BC   6680003C             AWM,R0     APYC
588   01 002BD   68020000 A           B          0,X1
589   01 002BE   22700004 A   CONVXY  LI,X7      4
590   01 002BF   32B00008 A           LW,R3      R0
591   01 002C0   25A00020 A           SLS,R2     32
592   01 002C1   25B0000C A           SLS,R3     12
593   01 002C2   25A00104 A           SLD,R2     4
594   01 002C3   3290000A A           LW,R1      R2
595   01 002C4   2390000A A   L0OP    MI,R1      10
596   01 002C5   25A00020 A           SLS,R2     32
597   01 002C6   25A00104 A           SLD,R2     4
598   01 002C7   3090000A A           AW,R1      R2
599   01 002C8   647002C4             BDR,X7     L0OP
600   01 002C9   32B00009 A           LW,R3      R1
601   01 002CA   22C03FFF A           LI,R4      16383
602   01 002CB   37A0000C A           MW,R2      R4
603   01 002CC   22C186A0 A           LI,R4      100000
604   01 002CD   25A00001 A           DWR,R2     R4
      01 002CE   36A0000C A
      01 002CF   21B00000 A
      01 002D0   691002D2
      01 002D1   20B00001 A
      01 002D2   25B0047F A
605   01 002D3   4B80030B             AND,R0     =X'00100000'
606   01 002D4   3180030B             CW,R0      =X'100000'
607   01 002D5   683002D8             BCR,3      G0
608   01 002D6   3A80000B A           LCW,R0     R3
609   01 002D7   68C80000 A           B          0,X4
610   01 002D8   3280000B A   G0      LW,R0      R3
611   01 002D9   68080000 A           B          0,X4
612   01 002DA   32500001 A   APPREDZ LW,X5      X1
```

```
613   01 002DB   22800000 A   LI,R0     0
614   01 002DC   35800038     STW,R0    APXC
615   01 002DD   3580003C     STW,R0    APYC
616   01 002DE   64100281     BAL,X1    ADDX
617   01 002DF   680A0000 A   B         0,X5
618                           TITLE     'BINDEC'
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*********************************************************************
*********************************************************************
**********    SUBROUTINE BINDEC          ****************************
*
*RETURNS THE EBCDIC EQUIV OF A BINARY NUMBER FOR PRINTING
*                   THE LARGEST NUMBER ACCEPTABLE IS 9999
*
*
*         CALLING SEQUENCE
*
*       * BAL,15    BINDEC
*
*         REG 14 CONTAINS THE ADDRESS OF THE NUMBER TO BE CONVERTED
*
*         REG 13    CONTAINS THE ADDRESS OF THE RESULT
*
*
*********************************************************************
**********    WRITTEN BY J.F. WASIUK     ****************************
*********************************************************************
```

```
640
641
                PAGE
                TITLE       'BINDEC'
```

```
                                          DEF BINDEC
01 002E0    40404040 A   BL       TEXT      '    '
01 002E1    000000F0 A   NUM      DATA      X'F0'
01 002E2    0000000A A   TEN      DATA      10
01 002E3                 REG1     RES       16
       01 002F3          BINDEC   EQU       $
01 002F3    02300000 A            LCFI      0
01 002F4    2B0002E3              STM,0     REG1
01 002F5    3?B002E0              LW,11     BL
01 002F6    227FFFFC A            LI,7      -4
01 002F7    226FFFFE A            LI,6      -2
01 002F8    B230000E A             LW,3      *14
01 002F9    22200000 A            LI,2      0
01 002FA    362002E2     DIV      DW,2      TEN
01 002FB    32A00002 A            LW,10     2
01 002FC    12800002 A            LD,8      2
01 002FD    65300302               BEZ       $+5
01 002FE    49A002E1              OR,10     NUM
01 002FF    25A00178 A            SLD,10    -8
01 00300    22200000 A            LI,2      0
01 00301    657002FA              BIR,7     DIV
01 00302    B5B0000D A             STW,11     *13
01 00303    02300000 A            LCFI      0
01 00304    2AC002E3              LM,0      REG1
01 00305    E800000F A            B         *15
       01 00220                    END        BEGIN
01 00306    00008000 A
01 00307    00002000 A
01 00308    00000014 A
01 00309    00400000 A
01 0030A    00200000 A
01 0030B    00100000 A
```

CONTROL SECTION SUMMARY: 01 0030C   PT 0   02 00019   PT 0

```
*    SYMBOL VALUES
     A/00000001          ADDY/01 002B7       AENDP/01 00142      AIDAY/01 00012
     APENDEND/01 0014E   APENTRY1/01 00239   APENTRY2/01 0023C   APENTRY6/01 00244
     APENTRY5/01 00242   APENTRY4/01 00240   APENTRY3/01 0023E   APENTRY9/01 0024A
     APENTRY8/01 00248   APENTRY7/01 00246   APENTY10/01 0024C   APENTY12/01 00250
     APENTY11/01 0024E   APEXEND/01 00256    APEXLOOP/01 0022A   APINTFDW/01 0025C
     APGINTA1/01 00058   APGINTB1/01 0005F   APGLPFA1/01 00051   APGLPFB1/01 00053
     APGTF4A1/01 00069   APGTF4B1/01 0006B   APGTF5A1/01 00077   APGTF5B1/01 00079
     APGTF6A1/01 00083   APGTF6B1/01 00085   APXINT8T/01 00063   APXLPF0T/01 00057
     APXSL/01 00041      APXTF4DT/01 0006F   APXTF6BT/01 00089   APYINT0T/01 00064
     APYLPF8T/01 00058   APYSL/01 00042      APYTF49T/01 00070   APYTF68T/01 0008A
     B/00000009          BL/01 002E0         CKY/01 002A0        CONVXY/01 002BE
     DIV/01 002FA        END/01 002AA        ERROR/01 002AD      FBR/0000000F
     FBRH/00000000       FN1INTX/01 00065    FN1INTY/01 00066    FN1LPFX/01 00059
     FN1LPFY/01 0005A    FN1TF4X/01 00071    FN1TF4Y/01 00072    FN1TF5X/01 0007F
     FN1TF5Y/01 00080    FN1TF6X/01 0008B    FN1TF6Y/01 0008C    GO/01 002D8
     LOOP/01 002C4       NUM/01 002E1        OPNFLG/01 00200     PRNT/01 00232
     REG1/01 002F3       RETSAVE/01 00230    R0/00000008         R1/00000009
     R2/0000000A         R3/0000000B         R4/0000000C         R5/0000000D
     R6/0000000E         R7/0000000F         STRX/01 0029D       STRY/01 002A7
     TEN/01 002E2        TIMCK8T/01 00203    TIMECK/01 00201     X1/00000001
     X2/00000002         X3/00000003         X4/00000004         X5/00000005
     X6/00000006         X7/00000007         YCHECK/01 00216
*    EXTERNAL DEFINITIONS
     ADDX/01 002B1       AICTDSP1/01 0001D   AIMODOUT/01 00013   AISTAT1/01 0000E
     AISTAT1P/01 00132   AISTAT2/01 0000F   AISTAT3/01 00010    AISTDSP1/01 00018
     AITBIAS/01 0000D    AITIME/01 00011     AIXBIAS/01 0000B    AIXCDSP1/01 00019
     AIXENC/01 00009     AIXER/01 00003      AIXJOY/01 00005     AIXRDSP1/01 00014
     AIXSAMP/01 00021    AIXSERV8/01 0001F   AIXSLAV1/01 00007   AIXTACK/01 00001
     AIYBIAS/01 0000C    AIYCDSP1/01 0001B   AIYENC/01 0000A     AIYER/01 00004
     AIYJOY/01 00006     AIYRDSP1/01 00016   AIYSAMP/01 00022    AIYSERV8/01 00020
     AIYSLAV1/01 00008   AIYTACK/01 00002    ANT1/01 00000       APCTIME/01 00039
     APCTSEC/01 0003A    APDISP4K/01 0003F   APDTACHX/01 00023   APDTACHY/01 00024
     APDTBIAS/01 0002F   APDXBIAS/01 0002D   APDYBIAS/01 0002E   API8/01 0025E
     APNOP/01 0021F      APPREDZ/01 0020A    APPXBIAS/01 00047   APPYBIAS/01 00048
     APQINTAC/01 00058   APQLPFA0/01 0004F   APQTF4A0/01 00067   APQTF5A0/01 00075
     APQTF6A0/01 00081   APSCHDLE/01 00135   APSTAT1/01 00030    APSTAT2/01 00031
```

```
        APSTAT3/01 00032        APSTIME/01 00037        APSTSEC/01 00038        APXAUG/01 00049
        APXC/01 0003B           APXDOT/01 0004D         APXENC/01 0002B         APXER/01 0003F
        APXERBR/01 00045        APXEZCA/01 00033        APXINTIN/01 00061       APXJOY/01 00027
        APXLPFIN/01 00055       APXPRED/01 0003D        APXSCAN/01 0004B        APXSLAV/01 00029
        APXSMCIN/01 00043       APXSOUT/01 0003D        APXSTOW/01 00035        APXTF4IN/01 0006D
        APXTF5IN/01 00073       APXTF5OT/01 0007D       APXTF6IN/01 00087       APXTRACK/01 00025
        APYAUG/01 0004A         APYC/01 0003C           APYDOT/01 0004E         APYENC/01 0002C
        APYER/01 00040          APYERBR/01 00046        APYEZCA/01 00034        APYINTIN/01 00062
        APYJOY/01 00028         APYLPFIN/01 00056       APYPRED/01 0003E        APYSCAN/01 0004C
        APYSLAV/01 0002A        APYSMCIN/01 00044       APYSOUT/01 0003E        APYSTOW/01 00036
        APYTF4IN/01 0006E       APYTF5IN/01 0007C       APYTF5OT/01 0007E       APYTF6IN/01 00088
        APYTRACK/01 00026       APOSAVE/01 0014D        BEGIN/01 00220          BINDEC/01 002F3
        BRAKEON/01 0020E        BUFF/01 00091           DATABASE/01 00000       FG34X/01 00073
        FG34Y/01 00074          SCHEDULE/01 00141       STRT/01 00222
*   PRIMARY REFERENCES
        AP@AGMNT        AP@DCTF1        AP@DCTF4        AP@DCTF2        APDC@MP5        APDC@MP1        APDISPLY
        APPM@DE         APPM@DI         APPRED          APRJOY          APRSLAV         APSA@UT         APSEC
        ASTIME          AUT@TRAK        F:8             F:9             M:LL
* NO SECONDARY REFERENCES
* NO UNDEFINED SYMBOLS
*   ERROR SEVERITY LEVEL: 0
* NO ERROR LINES
```

```
ECO    0 : I  E-      , '                                  STATI9N TIME                                    4
     1          00000D02                      SYSTEM     ANTENNA
     2                                        SYSTEM     SIG5FP
     3                                        W0LF
 ****     LEVEL    1DISPLAY 0F C0MMAND    W0LF
    47                                *
    48                                ******************************************************************
    49                                *                                                                *
    50                                * WW       WW   00000   LL      FFFFFFF    RRRRRR    &&&&&  DDDDDD   *
    51                                * WW   W   WW  00    00  LL      FF         RR   RR   &      DD   DD  *
    52                                *  WW WWW WW  00     00 LL      FF         RR   RR  & &     DD    DD *
    53                                *  WWWW WWWW  00     00 LL      FFFFF      RRRRRR   &  &.   DD    DD *
    54                                *   WW   WW    00   00  LL      FF         RR  RR    && &   DD   DD  *
    55                                *   WW   WW     00000   LLLLLLL FF         RR   RR      &   DDDDDD   *
    56                                *                                                                *
    57                                *                                                                *
    58                                *          SYSTEMS  TECHN0L0GY  DEPT.                            *
    59                                *            SPACE  SYSTEMS  GR0UP                               *
    60                                ******************************************************************
    61                                *
 ****  ENDLEVEL    1DISPLAY 0F C0MMAND    W0LF
     4                                        REGNAME
 ****     LEVEL    1DISPLAY 0F C0MMAND    REGNAME
    65          00000001              X1        SET      1          ALL X REGISTERS ARE INDEX REGISTERS
    66          00000002              X2        SET      2
    67          00000003              X3        SET      3
    68          00000004              X4        SET      4
    69          00000005              X5        SET      5
    70          00000006              X6        SET      6
    71          00000007              X7        SET      7
    72          00000008              R0        SET      8          ALL R REGISTERS ARE GENERAL USE REGISTERS
    73          00000009              R1        SET      9
    74          0000000A              R2        SET      10
    75          0000000B              R3        SET      11
    76          0000000C              R4        SET      12
    77          0000000D              R5        SET      13
    78          0000000E              R6        SET      14
    79          0000000F              R7        SET      15
```

```
     80          0000000D            FBRH      SET       13        FORTRAN IV-H BRANCH REGISTER
     81          0000000F            FBR       SET       15        FORTRAN IV BRANCH REGISTER
**** ENDLEVEL   1DISPLAY OF COMMAND   REGNAME
      5                                         DEF       LIMTEST
      6   01 00000   3186000A        LIMTEST   CW,R0     TEST1,X3
      7   01 00001   68200005                  BCR,2     $+4
      8   01 00002   31860008                  CW,R0     TEST1+1,X3
      9   01 00003   68100007                  BCR,1     $+4
     10   01 00004   68020000 A                B         0,X1
     11   01 00005   3286000A                  LW,R0     TEST1,X3
     12   01 00006   68020000 A                B         0,X1
     13   01 00007   32860008                  LW,R0     TEST1+1,X3
     14   01 00008   68020000 A                B         0,X1
     15                                         BOUND     8
     16   01 00009   FFFFD47C A   TEST1       DATA      -11140,11140      6.8 V  VALVE LIMIT
          01 0000B   00002B84 A
     17   01 0000C   FFFFB334 A               DATA      -19660,19660      12 V  VELOCITY LIMIT
          01 0000D   00004CCC A
     18   01 0000E   FFFFF333 A               DATA      -3277,3277        ACCELERATION  2V
          01 0000F   00000CCD A
     19   01 00010   FFFFCCCE A               DATA      -13106,13106    ANTENNA LIMIT 80 DEG.
          01 00011   00003332 A
     20   01 00012   FFFFC001 A               DATA      -16383,+16383     10V. LIMIT
          01 00013   00003FFF A
     21   01 00014   00000000 A               DATA      0,0
          01 00015   00000000 A
     22   01 00016   00000000 A               DATA      0,0
          01 00017   00000000 A
     23   01 00018   00000000 A               DATA      0,0
          01 00019   00000000 A
     24   01 0001A   00000000 A               DATA      0,0
          01 0001B   00000000 A
     25   01 0001C   00000000 A               DATA      0,0
          01 0001D   00000000 A
     26                                       TITLE     'STATION TIME'
```

```
27                                          DEF     ASTIME
28                                          REF     AITIME
29                                          REF     APSTSEC
30                                          REF     AISTDSP1
31    01 0001E                      ASTIME  RES     0
32    01 0001E  32900000 X                  LW,R1   AITIME
33    01 0001F  3190004C                    CW,R1   TAIM
34    01 00020  68300049                    BCR,3   EXIT
35    01 00021  3590004C                    STW,R1  TAIM
36    01 00022  32400009 A                  LW,X4   R1
37    01 00023  2540007E A                  SLS,X4  -2
38    01 00024  25400179 A                  SLD,X4  -7
39    01 00025  2550007F A                  SLS,X5  -1
40    01 00026  25400179 A                  SLD,X4  -7
41    01 00027  2550007F A                  SLS,X5  -1
42    01 00028  2540017A A                  SLD,X4  -6
43    01 00029  2550007E A                  SLS,X5  -2
44    01 0002A  32400000 X                  LW,X4   AISTDSP1
45    01 0002B  25400068 A                  SLS,X4  -24
46    01 0002C  25400118 A                  SLD,X4  24
47    01 0002D  35400000 X                  STW,X4  AISTDSP1
48    01 0002E  2590000A A                  SLS,R1  10
49    01 0002F  25800020 A                  SLS,R0  32
50    01 00030  25800102 A                  SLD,R0  2
51    01 00031  32B00008 A                  LW,R3   R0
52    01 00032  37B0004A                    MW,R3   TEN
53    01 00033  25800020 A                  SLS,R0  32
54    01 00034  25800104 A                  SLD,R0  4
55    01 00035  30B00008 A                  AW,R3   R0
56    01 00036  25800020 A                  SLS,R0  32
57    01 00037  25800103 A                  SLD,R0  3
58    01 00038  32D00008 A                  LW,R5   R0
59    01 00039  37D0004A                    MW,R5   TEN
60    01 0003A  25800020 A                  SLS,R0  32
61    01 0003B  25800104 A                  SLD,R0  4
62    01 0003C  30D00008 A                  AW,R5   R0
63    01 0003D  25800020 A                  SLS,R0  32
```

```
64  01 0003E  25800103 A          SLD,R0    3
65  01 0003F  32F00008 A          LW,R7     R0
66  01 00040  37F0004A            MW,R7     TEN
67  01 00041  25800020 A          SLS,R0    32
68  01 00042  25800104 A          SLD,R0    4
69  01 00043  30F00008 A          AW,R7     R0
70  01 00044  37B0004B            MW,R3     SIXTY
71  01 00045  30B0000D A          AW,R3     R5
72  01 00046  37B0004B            MW,R3     SIXTY
73  01 00047  30B0000F A          AW,R3     R7
74  01 00048  35B00000 X          STW,R3    APSTSEC
75  01 00049  68020000 A  EXIT    B         0,X1
76  01 0004A  0000000A A  TEN     DATA      10
77  01 0004B  0000003C A  SIXTY   DATA      60
78  01 0004C  00000000 A  TAIM    DATA      0
79                                END
```

CONTROL SECTION SUMMARY: 01 0004D PT 0 02 00000 PT 0

```
*    SYMBOL VALUES
       EXIT/01 00049          FBR/0000000F          FBRH/0000000D          R0/00000008
       R1/00000009            R2/0000000A           R3/0000000B            R4/0000000C
       R5/0000000D            R6/0000000E           R7/0000000F            SIXTY/01 0004B
       TAIM/01 0004C          TEN/01 0004A          TEST1/01 0000A         X1/00000001
       X2/00000002            X3/00000003           X4/00000004            X5/00000005
       X6/00000006            X7/00000007
*    EXTERNAL DEFINITIONS
       ASTIME/01 0001E        LIMTEST/01 00000
*    PRIMARY REFERENCES
       AISTDSP1       AITIME      APSTSEC
* N0 SECONDARY REFERENCES
* N0 UNDEFINED SYMBOLS
*    ERROR SEVERITY LEVEL: 0
* N0 ERROR LINES
```

```
E00   0 :    E-     , '                          P R O G R A M   M O D E                                   9
      1                                         SYSTEM    SIG5FP
      2          00000D02                       SYSTEM    ANTENNA
      3                                         WOLF
****      LEVEL    1DISPLAY OF COMMAND   WOLF
     47                                *
     48                                ****************************************************************************
     49                                *                                                                          *
     50                                * WW       WW   00000   LL     FFFFFFF    RRRRRR    &&&&&  DDDDDD          *
     51                                * WW   W   WW  00   00  LL     FF         RR   RR  &       DD   DD        *
     52                                *  WW WWW WW  00     00 LL     FF         RR   RR  & &     DD    DD       *
     53                                *  WWWW WWWW  00     00 LL     FFFFF      RRRRRR   &  &    DD    DD       *
     54                                *   WW   WW    00   00  LL     FF         RR  RR    && &   DD   DD        *
     55                                *   WW   WW     00000   LLLLLLL FF        RR   RR       &  DDDDDD         *
     56                                *                                                                          *
     57                                *                                                                          *
     58                                *        SYSTEMS  TECHNOLOGY  DEPT.                                        *
     59                                *          SPACE  SYSTEMS  GROUP                                           *
     60                                ****************************************************************************
     61                                *
**** ENDLEVEL    1DISPLAY OF COMMAND   WOLF
      4                                        REGNAME
****      LEVEL    1DISPLAY OF COMMAND   REGNAME
     65          00000001           X1         SET      1         ALL X REGISTERS ARE INDEX REGISTERS
     66          00000002           X2         SET      2
     67          00000003           X3         SET      3
     68          00000004           X4         SET      4
     69          00000005           X5         SET      5
     70          00000006           X6         SET      6
     71          00000007           X7         SET      7
     72          00000008           R0         SET      8         ALL R REGISTERS ARE GENERAL USE REGISTERS
     73          00000009           R1         SET      9
     74          0000000A           R2         SET      10
     75          0000000B           R3         SET      11
     76          0000000C           R4         SET      12
     77          0000000D           R5         SET      13
     78          0000000E           R6         SET      14
     79          0000000F           R7         SET      15
```

```
E00   0 :    E-    , '                                  P R 0 G R A M   M 0 D E                    10
      80          0000000D            FBRH      SET          13        FORTRAN IV-H BRANCH REGISTER
      81          0000000F            FBR       SET          15        FORTRAN IV BRANCH REGISTER
 **** ENDLEVEL   1DISPLAY 0F COMMAND   REGNAME
      5.                                        TITLE     'P R 9 G R A M   M 0 D E '
```

```
                                        REF     F:8
                                        REF     F:9
                                        DEF     APPRED
                                        REF     APXC
                                        REF     APXPRED
                                        REF     APCTSEC
                                        REF     APSTAT2
                                        REF     ANT1
                                        REF     APYPRED
                                        REF     APYC
                                        REF     APIO
                                        REF     AIXSAMP
                                        REF     AIYSAMP
                                        REF     APDTBIAS
                                        REF     ADDX
                                        REF     BUFF
                                        REF     APXENC
                                        REF     APYENC
                                        REF     APSTSEC
                                        REF     APXDOT
                                        REF     APYDOT
                                        REF     APPREDZ
01 00000  32600001 A   'APPRED          LW,X6   X1
01 00001  6A100050                      BAL,X1  ADDT
01 00002  6C000000 A                    RD,0    0
01 00003  68400000C                     BCR,4   $+9
01 00004  3280014F                      LW,R0   COUNT
01 00005  21800014 A                    CI,R0   20
01 00006  6930000A                      BCS,3   $+4
01 00007  22800000 A                    LI,R0   0
01 00008  3580014F                      STW,R0  COUNT
01 00009  04100000 02                   M:WRITE F:9,(BUF,ANT1),(SIZE,2048)
02 00000  11000000 N
          30000000
02 00002  00000000 X
02 00003  00000800 A
01 0000A  22800001 A                    LI,R0   1
```

```
39  01 0000B  6680014F                AWM,R0   .COUNT
40  01 0000C  32800000 X              LW,R0    APSTAT2
41  01 0000D  4880015F                AND,R0   =X'200'
42  01 0000E  68300013                BCR,3    CKIP0S
43  01 0000F  32800000 X              LW,R0    APSTSEC
44  01 00010  35800000 X              STW,R0   APCTSEC
45  01 00011  6A100000 X              BAL,X1   APPREDZ
46  01 00012  680C0000 A              B        0,X6
47  01 00013  32800000 X  CKIP0S      LW,R0    APSTAT2
48  01 00014  48800160                AND,R0   =X'00040000'
49  01 00015  68300019                BCR,3    INITP0S
51  01 00016  22800000 A              LI,R0    0
52  01 00017  35800042                STW,R0   I0FLG
53  01 00018  35800043                STW,R0   IPFLG
54  01 00019  22800000 A  INITP0S     LI,R0    0
55  01 0001A  31800043                CW,R0    IPFLG
56  01 0001B  69300044                BCS,3    FILL
57  01 0001C  31800042                CW,R0    I0FLG
58  01 0001D  69300034                BCS,3    TEST
59  01 0001E  04100004 02             M:REW    F:8
    02 00004  01000000 X
60  01 0001F  04100005 02             M:READ   F:8,(BUF,BUFF),(SIZE,44),(WAIT)
    02 00005  10000000 N
              30000010
    02 00007  00000000 X
    02 00008  0000002C A
61  01 00020  32800001 N              LW,R0    BUFF+1
62  01 00021  20BFFFD8 A              AI,R0    -40
63  01 00022  35800158                STW,R0   FINTIME
64  01 00023  04100009 02             M:READ   F:8,(BUF,BUFF-1),(SIZE,328),(WAIT)
    02 00009  10000000 N
              30000010
    02 0000B  0001FFFF N
    02 0000C  00000148 A
65  01 00024  32800001 N              LW,R0    BUFF+1
66  01 00025  3580015C                STW,R0   INITIME
67  01 00026  30800157                AW,R0    SAVE
```

```
01 00027   35800000 X            STW,RO    APCTSEC
01 00028   32800002 N            LW,RO     BUFF+2
01 00029   35800000 X            STW,RO    APXC
01 0002A   35800000 X            STW,RO    APXPRED
01 0002B   32800003 N            LW,RO     BUFF+3
01 0002C   35800000 X            STW,RO    APYC
01 0002D   35800000 X            STW,RO    APYPRED
01 0002E   22800001 A            LI,RO     1
01 0002F   35800150              STW,RO    BUF1
01 00030   35800042              STW,RO    IBFLG
01 00031   35800155              STW,RO    SET2
01 00032   22800000 A            LI,RO     0
01 00033   35800151              STW,RO    BUF2
01 00034   32F00000 X   TEST     LW,R7     APSTSEC
01 00035   32800002 N            LW,RO     BUFF+2
01 00036   35800000 X            STW,RO    APXC
01 00037   32800003 N            LW,RO     BUFF+3
01 00038   35800000 X            STW,RO    APYC
01 00039   32E00001 N            LW,R6     BUFF+1
01 0003A   35E0014E              STW,R6    TIIM
01 0003B   35E00000 X            STW,R6    APCTSEC
01 0003C   30E00157              AW,R6     SAVE
01 0003D   31F0000E A            CW,R7     R6
01 0003E   69100000 A            BCS,1     0,X6
01 0003F   22800001 A            LI,RO     1
01 00040   35800043              STW,RO    IPFLG
01 00041   68000044              B         FILL
01 00042   00000000 A   IBFLG    DATA      0
01 00043   00000000 A   IPFLG    DATA      0
01 00044   22A00000 A   FILL     LI,R2     0
01 00045   22300001 A            LI,R3     1
01 00046   31A00150              CW,R2     BUF1
01 00047   6930004A              BCS,3     CK2
01 00048   04100000 02           M:READ    F:8,(BUF,BUFF-1),(SIZE,328)
02 0000D   10000000 N
           30000000
02 0000F   0001FFFF N
```

```
      02 00010   00000148 A
102   01 00049   35800150                STW,R3    BUF1
103   01 0004A   31A00151      CK2       CW,R2     BUF2
104   01 0004B   6930004E                BCS,3     CKT
105   01 0004C   04100011 02             M:READ    F:8,(BUF,BUFF+79),(SIZE,328)
      02 00011   10000000 N
                 30000000
      02 00013   0000004F N
      02 00014   00000148 A
106   01 0004D   35800151                STW,R3    BUF2
107   01 0004E   32F00000 X    CKT       LW,R7     APSTSEC
108   01 0004F   68000060      -         B         N00P
109   01 00050   32800000 X    ADDT      LW,R0     APSTAT2
110   01 00051   48800161                AND,R0    =X'00100000'
111   01 00052   68200056                BCR,2     SUBT
112   01 00053   32800000 X              LW,R0     APDTBIAS
113   01 00054   6A4000CD                BAL,X4    C0NVT
114   01 00055   6800005E                B         TIM0UT
115   01 00056   32800000 X    SUBT      LW,R0     APSTAT2
116   01 00057   48800162                AND,R0    =X'00080000'
117   01 00058   6820005D                BCR,2     END
118   01 00059   32800000 X              LW,R0     APDTBIAS
119   01 0005A   6A4000CD                BAL,X4    C0NVT
120   01 0005B   3A300003 A              LCW,R0    R0
121   01 0005C   6800005E                B         TIM0UT
122   01 0005D   22800000 A    END       LI,R0     0
123   01 0005E   35300157      TIM0UT    STW,R0    SAVE
124   01 0005F   68020000 A              B         0,X1
125   01 00060   34000001 N    N00P      LCW,R5    BUFF+1
126   01 00061   38000157                SW,R5     SAVE
127   01 00062   3000000F A              AW,R5     R7
128   01 00063   69100102                BCS,1     BACK
129   01 00064   2100000A A              CI,R5     10
130   01 00065   69300070                BCS,3     N0TEN
131   01 00066   32800154                LW,R0     SET
132   01 00067   21800000 A              CI,R0     0
133   01 00068   69300070                BCS,3     N0TEN
```

```
134   01 00069   22800000 A          LI,R0    0
135   01 0006A   35800150            STW,R0   BUF1
136   01 0006B   35800155            STW,R0   SET2
137   01 0006C   22800001 A          LI,R0    1
138   01 0006D   35800154            STW,R0   SET
139   01 0006E   32800001 N          LW,R0    BUFF+1
140   01 0006F   3580014E            STW,R0   TIIM
141   01 00070   21D00013 A  NOTEN   CI,R5    19
142   01 00071   69200DE8            BCS,2    F9WD
143   01 00072   22E00000 A          LI,R6    0
144   01 00073   31E00152            CW,R6    MODE
145   01 00074   68300078    -       BCR,3    MODO
146   01 00075   21D0000A A          CI,R5    10
147   01 00076   69100D88            BCS,1    MOD1
148   01 00077   68000130            B        RESET
149   01 00078   3280014E     MODO   LW,R0    TIIM
150   01 00079   31800001 N          CW,R0    BUFF+1
151   01 0007A   6830007D            BCR,3    $+3
152   01 0007B   22800001 A          LI,R0    1
153   01 0007C   35800152            STW,R0   MODE
154   01 0007D   21D00000 A          CI,R5    0
155   01 0007E   69300D8D            BCS,3    POINTER
156   01 0007F   31D00155            CW,R5    SET2
157   01 00080   69300D8D            BCS,3    POINTER
158   01 00081   35D00151            STW,R5   BUF2
159   01 00082   35D00154            STW,R5   SET
160   01 00083   22800001 A          LI,R0    1
161   01 00084   35800155            STW,R0   SET2
162   01 00085   32800051 N          LW,R0    BUFF+81
163   01 00086   3580014E            STW,R0   TIIM
164   01 00087   68000D8D            B        POINTER
165   01 00088   3280014E     MOD1   LW,R0    TIIM
166   01 00089   31800051 N          CW,R0    BUFF+81
167   01 0008A   68300D8D            BCR,3    POINTER
168   01 0008B   22800000 A          LI,R0    0
169   01 0008C   35800152            STW,R0   MODE
170   01 0008D   32E00153     POINTER LW,R6   BPTR
```

```
171  01 0008E  21E00000 A        CI,R6    0
172  01 0008F  68300093          BCR,3    NEWB
173  01 00090  20E00001 A        AI,R6    1
174  01 00091  B1F0000E A        CW,R7    *R6
175  01 00092  68300098          BCR,3    DEL
176  01 00093  32D0000D A  NEWB  LW,R5    R5
177  01 00094  68100096          BCR,1    $+2
178  01 00095  20D00014 A        AI,R5    20
179  01 00096  25D00003 A        SLS,R5   3
180  01 00097  22E00000 N        LI,R6    BUFF
181  01 00098  30E0000D A        AW,R6    R5
182  01 00099  35E00153          STW,R6   BPTR
183  01 0009A  22E00000 A        LI,R6    0
184  01 0009B  35E00156          STW,R6   DFLG
185  01 0009C  22D00000 A  DEL   LI,R5    0
186  01 0009D  31D00156          CW,R5    DFLG
187  01 0009E  69300008          BCS,3    ADD
188  01 0009F  32F00000 X        LW,R7    APXPRED
189  01 000A0  35F00000 X        STW,R7   APXC
190  01 000A1  32B00000 X        LW,R3    APYPRED
191  01 000A2  35B00000 X        STW,R3   APYC
192  01 000A3  32E00153    GET   LW,R6    BPTR
193  01 000A4  20E00001 A        AI,R6    1
194  01 000A5  B2800000E A       LW,R0    *R6
195  01 000A6  35800000 X        STW,R0   APCTSEC
196  01 000A7  20E00001 A        AI,R6    1
197  01 000A8  B2D0000E A        LW,R5    *R6
198  01 000A9  35D00000 X        STW,R5   APXPRED
199  01 000AA  20E00001 A        AI,R6    1
200  01 000AB  B2A0000E A        LW,R2    *R6
201  01 000AC  35A00000 X        STW,R2   APYPRED
202  01 000AD  35A0000B A        SW,R2    R3
203  01 000AE  20E00001 A        AI,R6    1
204  01 000AF  B280000E A        LW,R0    *R6
205  01 000B0  31800163          CW,R0    =X'FFFF'
206  01 000B1  68300144          BCR,3    ENND
207  01 000B2  35800000 X        STW,R0   APXDBT
```

```
01 000B3   20800001 A            AI,R0     1
01 000B4   B2800000E A           LW,R0     *R6
01 000B5   35800000 X            STW,R0    APYDOT
01 000B6   3800000F A            SW,R5     R7
01 000B7   3200000D A            LW,R5     R5
01 000B8   682000BB              BCR,2     $+3
01 000B9   2D00000A A            AI,R5     10
01 000BA   680000BC              B         $+2
01 000BB   20DFFFF6 A            AI,R5     -10
01 000BC   3600015B              DW,R5     TWENTY
01 000BD   35000158              STW,R5    DELTAX
01 000BE   3290000A A            LW,R1     R2
01 000BF   682000C2              BCR,2     $+3
01 000C0   2090000A A            AI,R1     10
01 000C1   680000C3              B         $+2
01 000C2   209FFFF6 A            AI,R1     -10
01 000C3   3690015B              DW,R1     TWENTY
01 000C4   35900159              STW,R1    DELTAY
01 000C5   22900001 A            LI,R1     1
01 000C6   35900156              STW,R1    DFLG
01 000C7   6A100000 X            BAL,X1    ADDX
01 000C8   32000158      ADD     LW,R5     DELTAX
01 000C9   66000000 X            AWM,R5    APXC
01 000CA   32000159              LW,R5     DELTAY
01 000CB   66000000 X            AWM,R5    APYC
01 000CC   68C00000 A    EXIT    B         0,X6
01 000CD   2580017C A    CONVT   SLD,R0    -4
01 000CE   25900064 A            SLS,R1    -28
01 000CF   32800009 A            LW,R3     R1
01 000D0   2580017C A            SLD,R0    -4
01 000D1   25900064 A            SLS,R1    -28
01 000D2   2390000A A            MI,R1     10
01 000D3   30800009 A            AW,R3     R1
01 000D4   2580017C A            SLD,R0    -4
01 000D5   25900064 A            SLS,R1    -28
01 000D6   32D00009 A            LW,R5     R1
01 000D7   2580017C A            SLD,R0    -4
```

```
245  01 000D8  25900064 A          SLS,R1   -28
246  01 000D9  2390000A A          MI,R1    10
247  01 000DA  30D00009 A          AW,R5    R1
248  01 000DB  2300003C A          MI,R5    60
249  01 000DC  30B0000D A          AW,R3    R5
250  01 000DD  2580017C A          SLD,R0   -4
251  01 000DE  25900064 A          SLS,R1   -28
252  01 000DF  32D00009 A          LW,R5    R1
253  01 000E0  2580017C A          SLD,R0   -4
254  01 000E1  25900064 A          SLS,R1   -28
255  01 000E2  2390000A A          MI,R1    10
256  01 000E3  30D00009 A          AW,R5    R1
257  01 000E4  23000E10 A          MI,R5    3600
258  01 000E5  30B0000D A          AW,R3    R5
259  01 000E6  32800008 A          LW,R0    R3
260  01 000E7  68030000 A          B        0,X4
261  01 000E8  32800005 A  FWD     LW,R0    R5
262  01 000E9  30F00001 N          AW,R0    BUFF+1
263  01 000EA  31D0015D            CW,R0    FINTIME
264  01 000EB  691000F5            BCS,1    CLEAR
265  01 000EC  32D0015D            LW,R5    FINTIME
266  01 000ED  38D00001 N          SW,R5    BUFF+1
267  01 000EE  69200002            BCS,2    $+2
268  01 000EF  68000147            B        MARKTIM
269  01 000F0  22800001 A          LI,R0    1
270  01 000F1  3580015E            STW,R0   FLAG
271  01 000F2  3600015A            DW,R5    TEN
272  01 000F3  22300000 A          LI,X3    0
273  01 000F4  68000124            B        IOS
274  01 000F5  22800000 A  CLEAR   LI,R0    0
275  01 000F6  3580015E            STW,R0   FLAG
276  01 000F7  3600015A            DW,R5    TEN
277  01 000F8  22300000 A          LI,X3    0
278  01 000F9  22900000 A          LI,R1    0
279  01 000FA  31900152            CW,R1    MODE
280  01 000FB  683000FE            BCR,3    ZERM
281  01 000FC  20FFFFFF A          AI,R5    -1
```

```
232  01 000FD  68000FF          B       $+2
233  01 000FE  20FFFFFE A ZERM  AI,R5   -2
234  01 000FF  21000000 A       CI,R5   0
235  01 00100  68300130         BCR,3   RESET
236  01 00101  68000124         B       IOS
237  01 00102  21FFFFF5 A BACK  CI,R5   -11
238  01 00103  69200088         BCS,2   MOD1
239  01 00104  32800000 A       LW,R0   R5
240  01 00105  30800001 N       AW,R0   BUFF+1
241  01 00106  3180015C         CW,R0   INITIME
242  01 00107  68100116         BCR,1   KLEAR
243  01 00108  22800001 A -     LI,R0   1
244  01 00109  3580015E         STW,R0  FLAG
245  01 0010A  32D00001 N       LW,R5   BUFF+1
246  01 0010B  38D0015C         SW,R5   INITIME
247  01 0010C  36D0015A         DW,R5   TEN
248  01 0010D  21000000 A       CI,R5   0
249  01 0010E  68300147         BCR,3   MARKTIM
300  01 0010F  32800152         LW,R0   MODE
301  01 00110  21800000 A       CI,R0   0
302  01 00111  68300114         BCR,3   $+3
303  01 00112  20D00003 A       AI,R5   3
304  01 00113  68000124         B       IOS
305  01 00114  20D00002 A       AI,R5   2
306  01 00115  68000124         B       IOS
307  01 00116  22800000 A KLEAR  LI,R0   0
308  01 00117  3580015E         STW,R0  FLAG
309  01 00118  38D00000 A       LAW,R5  R5
310  01 00119  36D0015A         DW,R5   TEN
311  01 0011A  22300001 A       LI,X3   1
312  01 0011B  38D00000 A       LAW,R5  R5
313  01 0011C  22900000 A       LI,R1   0
314  01 0011D  31900152         CW,R1   MODE
315  01 0011E  68300121         BCR,3   ZER
316  01 0011F  20D00002 A       AI,R5   2
317  01 00120  68000122         B       $+2
318  01 00121  20D00003 A ZER   AI,R5   3
```

```
    319   01 00122   21D00000 A            CI,R5     0
    320   01 00123   68300180              BCR,3     RESET
    321   01 00124                 IOS      RES       0
    322   01 00124   22800001 A            LI,R0     1
    323   01 00125   31800156              CW,R0     FLAG
    324   01 00126   68300140              BCR,3     CKZERO
    325   01 00127   21300000 A   IOSS     CI,X3     0
    326   01 00128   6330012C              BCR,3     FD-1
    327   01 00129   35D00017 02           STW,R5    BFPT+2
    328   01 0012A   04100015 02  BAK,BFPT M:PRECORD F:8,(N,1),(REV)
          02 00015   10000000 N
                     80000010
          02 00017   00000001 A
    329   01 00128   6330012E              B         REED
    330   01 0012C   35D0001A 02           STW,R5    FFPT-2
    331   01 0012D   04100018 02  FD,FFPT  M:PRECORD F:8,(N,1),(FWD)
          02 00018   10000000 N
                     80000000
          02 0001A   00000001 A
    332   01 0012E                 REED     RES       0
    333   01 0012E   04100018 02            M:READ    F:8,(BUF,BUFF-1),(SIZE,328),(WAIT)
          02 00018   10000000 N
                     30000010
          02 0001D   0001FFFF N
          02 0001E   00000148 A
    334   01 0012F   0410001F 02            M:READ    F:8,(BUF,BUFF+79),(SIZE,328),(WAIT)
          02 0001F   10000000 N
                     30000010
          02 00021   0000014F N
          02 00022   00000148 A
    335   01 00130   22800000 A   RESET    LI,R3     0
    336   01 00131   35800152              STW,R3    MODE
    337   01 00132   35800156              STW,R3    DFLG
    338   01 00133   35800153              STW,R3    BPTR
    339   01 00134   35800154              STW,R3    SET
    340   01 00135   20300001 A            AI,R3     1
    341   01 00136   35800155              STW,R3    SET2
```

```
342  01 00137  35800150          STW,R3   BUF1
343  01 00138  35800151          STW,R3   BUF2
344  01 00139  32800001 N        LW,R0    BUFF+1
345  01 0013A  3580014E          STW,R0   TIIM
346  01 0013B  32800002 N        LW,R0    BUFF+2
347  01 0013C  32900003 N        LW,R1    BUFF+3
348  01 0013D  35800000 X        STW,R0   APXPRED
349  01 0013E  35900000 X        STW,R1   APYPRED
350  01 0013F  680C0000 A        B        0,X6
351  01 00140  22800000 A CKZERO LI,R0     0
352  01 00141  31800000 A        CW,R0    R5
353  01 00142  69300127          BCS,3    IOSS
354  01 00143  68000147          B        MARKTIM
355  01 00144                 ENND RES     0
356  01 00144  22800001 A        LI,R0    1
357  01 00145  35800150          STW,R0   BUF1
358  01 00146  35800151          STW,R0   BUF2
359  01 00147                 MARKTIM RES  0
360  01 00147  32800001 N        LW,R0    BUFF+1
361  01 00148  35800000 X        STW,R0   APCTSEC
362  01 00149  32800002 N        LW,R0    BUFF+2
363  01 0014A  32900003 N        LW,R1    BUFF+3
364  01 0014B  35800000 X        STW,R0   APXC
365  01 0014C  35900000 X        STW,R1   APYC
366  01 0014D  680C0000 A        B        0,X6
367  01 0014E  00000000 A TIIM   DATA     0
368  01 0014F  00000001 A COUNT  DATA     1
369  01 00150  00000000 A BUF1   DATA     0
370  01 00151  00000000 A BUF2   DATA     0
371  01 00152  00000000 A MODE   DATA     0
372  01 00153  00000000 A BPTR   DATA     0
373  01 00154  00000000 A SET    DATA     0
374  01 00155  00000001 A SET2   DATA     1
375  01 00156  00000000 A DFLG   DATA     0
376  01 00157  00000000 A SAVE   DATA     0
377  01 00158  00000000 A DELTAX DATA     0
378  01 00159  00000000 A DELTAY DATA     0
```

```
379   01 0015A   0000000A A   TEN        DATA    10
380   01 00158   00000014 A   TWENTY     DATA    20
381   01 0015C   00000000 A   INITIME    DATA    0
382   01 0015D   00000000 A   FINTIME    DATA    0
383   01 0015E   00000000 A   FLAG       DATA    0
384                             END
      01 0015F   00000200 A
      01 00160   00040000 A
      01 00161   00100000 A
      01 00162   00080000 A
      01 00163   0000FFFF A

CONTROL SECTION SUMMARY: 01 00164   PT 0     02 00023   PT 0
```

```
*    SYMBOL VALUES
        ADD/01 00008          ADDT/01 00050          BACK/01 00102          BAK/01 0012A
        BFPT/02 00015         BFTR/01 00153          BUF1/01 00150          BUF2/01 00151
        CKIPBS/01 00013       CKT/01 0004E           CKZERB/01 00140        CK2/01 0004A
        CLEAR/01 000F5        CONVT/01 000CD         COUNT/01 0014F         DEL/01 0009C
        DELTAX/01 00158       DELTAY/01 00159        DFLG/01 00156          END/01 0005D
        ENND/01 00144         EXIT/01 000CC          FBR/0000000F           FBRH/0000000D
        FD/01 00120           FFPT/02 00018          FILL/01 00044          FINTIME/01 0015D
        FLAG/01 0015F         FOND/01 000E8          GET/01 000A3           INITIME/01 0015C
        INITBS/01 00019       IBFLG/01 00042         IBS/01 00124           IBSS/01 00127
        IPFLG/01 00043        KLEAR/01 00116         MARKTIM/01 00147       MODE/01 00152
        MSDD/01 00078         MSD1/01 00088          NEWB/01 00093          NOOP/01 00060
        NSTEN/01 00070        POINTER/01 0008D       REED/01 0012E          RESET/01 00130
        R0/00000008           R1/00000009            R2/0000000A            R3/0000000B
        R4/0000000C           R5/0000000D            R6/0000000E            R7/0000000F
        SAVE/01 00157         SET/01 00154           SET2/01 00155          SUBT/01 00056
        TEN/01 0015A          TEST/01 00034          TIIM/01 0014E          TIMOUT/01 0005E
        TWENTY/01 0015B       X1/00000001            X2/00000002            X3/00000003
        X4/00000004           X5/00000005            X6/00000006            X7/00000007
        ZER/01 00121          ZERM/01 000FE
*    EXTERNAL DEFINITIONS
        APPRED/01 00000
*    PRIMARY REFERENCES
        ADDX          AIXSAMP       AIYSAMP       ANT1          APCTSEC       APDTBIAS      APIB
        APPRED2       APSTAT2       APSTSEC       APXC          APXDOT        APXENC        APXPRED
        APYC          APYDOT        APYENC        APYPRED       BUFF          F:8           F:9
* NO SECONDARY REFERENCES
* NO UNDEFINED SYMBOLS
*    ERROR SEVERITY LEVEL: 0
* NO ERROR LINES
```

```
E00    0 : <  E-      , '
        1          00000002                          APDISPLY
        2                                   SYSTEM    ANTENNA
        3                                   SYSTEM    SIG5FP
                                            WOLF
****      LEVEL    1DISPLAY OF COMMAND    WOLF
       47                              *
       48                              ********************************************************************
       49                              *                                                                  *
       50                              * WW      WW   00000   LL      FFFFFFF    RRRRRR   &&&&&  DDDDDD   *
       51                              * WW   W  WW  00   00  LL      FF         RR   RR  &      DD   DD  *
       52                              *  WW WWW WW  00   00  LL      FF         RR   RR  & &    DD   DD  *
       53                              *  WWWW WWWW  00   00  LL      FFFFF      RRRRRR   &  &   DD   DD  *
       54                              *   WW   WW   00   00  LL      FF         RR  RR   && &   DD   DD  *
       55                              *   WW   WW    00000   LLLLLLL FF         RR   RR     &   DDDDDD   *
       56                              *                                                                  *
       57                              *                                                                  *
       58                              *        SYSTEMS  TECHNOLOGY  DEPT..                               *
       59                              *          SPACE  SYSTEMS  GROUP                                   *
       60                              ********************************************************************
       61                              *
****  ENDLEVEL   1DISPLAY OF COMMAND    WOLF
        4                                        REGNAME
****      LEVEL   1DISPLAY OF COMMAND    REGNAME
       65          00000001              X1        SET       1       ALL X REGISTERS ARE INDEX REGISTERS
       66          00000002              X2        SET       2
       67          00000003              X3        SET       3
       68          00000004              X4        SET       4
       69          00000005              X5        SET       5
       70          00000006              X6        SET       6
       71          00000007              X7        SET       7
       72          00000008              R0        SET       8       ALL R REGISTERS ARE GENERAL USE REGISTERS
       73          00000009              R1        SET       9
       74          0000000A              R2        SET       10
       75          0000000B              R3        SET       11
       76          0000000C              R4        SET       12
       77          0000000D              R5        SET       13
       78          0000000E              R6        SET       14
       79          0000000F              R7        SET       15
```

```
EOO  0 :·<  E-     , '
  80        0000000D          FBRH       SET        13         FØRTRAN IV-H BRANCH REGISTER
  81        0000000F          FBR        SET        15         FØRTRAN IV BRANCH REGISTER
**** ENDLEVEL . 1DISPLAY ØF CØMMAND   REGNAME
   5                                     TITLE      'APDISPLY'
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E00   0 : <  E-     , '
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                APDISPLY
        REF     APXJ0Y
        REF     APYJ0Y
        REF     APXC
        REF     APYC
        REF     APXTF4IN
        REF     APYTF4IN
        REF     APXTF5IN
        REF     APYTF5IN
        REF     APXTF6IN
        REF     APYTF6IN
        REF     APDTACHX
        REF     APDTACHY
        REF     APXTRACK
        REF     APYTRACK
        REF     APXSLAV
        REF     APYSLAV
        REF     APXS0UT
        REF     APYS0UT
        REF     APXENC
        REF     APYENC
        REF     AIXSERV0
        REF     AIYSERV0
        REF     AIXSAMP
        REF     APCTSEC
        REF     APSTSEC
        DEF     APRJ0Y
        DEF     APRTACH
        DEF     APRSLAV
        DEF     AUT0TRAK
        DEF     APXNP0S
        DEF     APS0UT
        REF     APYAUG
        REF     AIYSAMP
        DEF     APSAOUT
        DEF     APRST0
        REF     AISTAT3
        REF     APXAUG
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                                                DEF     APSEC
                                                REF     LIMTEST
                                                REF     APSTAT2
                                                REF     APGAGMNT
                                                REF     APXLPFIN
                                                REF     APXINTIN
                                                DEF     APDISPLY
                                                REF     AICTDSP1
                                                REF     AIXCDSP1
                                                REF     AIYCDSP1
                                                REF     AIXRDSP1
                                                REF     AIYRDSP1
                                                REF     APDISPWK
                                                REF     APRSCAN
                                                REF     APXSCAN
                                                REF     APYSCAN
                                                REF     TEE
                                                REF     AIMODOUT
01 00000 3A800000 X  APRJOY     LCW,R0          APXJOY
01 00001 35800000 X              STW,R0          APXTF5IN
01 00002 32800000 X              LW,R0           APYJOY
01 00003 35800000 X              STW,R0          APYTF5IN
01 00004 68020000 A              B               C,X1
01 00005 32800000 X  APRTACH     LW,R0           APDTACHX
01 00006 35800000 X              STW,R0          APXTF6IN
01 00007 3A800000 X              LCW,R0          APDTACHY
01 00008 35800000 X              STW,R0          APYTF6IN
01 00009 68020000 A              B               C,X1
01 0000A 3A800000 X  AUTOTRAK    LCW,R0          APXTRACK
01 0000B 35800000 X              STW,R0          APXTF4IN
01 0000C 3A800000 X              LCW,R0          APYTRACK
01 0000D 35800000 X              STW,R0          APYTF4IN
01 0000E 68020000 A              B               C,X1
01 0000F 32800000 X  APRSLAV     LW,R0           APXSLAV
01 00010 35800000 X              STW,R0          APXC
01 00011 35800000 X              STW,R0          APXTF4IN
01 00012 32800000 X              LW,R0           APYSLAV
```

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 80   01 00013   35800000 X            STW,R0    APYC
 81   01 00014   35800000 X            STW,R0    APYTF4IN
 82   01 00015   68020000 A            B         0,X1
 83   01 00016   32800000 X  APMNP8S   LW,R0     APXSLAV
 84   01 00017   3A900000 X            LCW,R1    APYSLAV
 85   01 00018   35800000 X            STW,R0    APXTF4IN
 86   01 00019   35900000 X            STW,R1    APYTF4IN
 87   01 0001A   68020000 A            B         0,X1
 88   01 0001B   FF000000 A  MASK1     DATA      X'FF000000'
 89   01 0001C   00007FFF A  MASK2     DATA      X'0000/FFF'
 90   01 0001D   32800000 X  APS8UT    LW,R0     APXS8UT
 91   01 0001E   32900000 X            LW,R1     AIXSERV8
 92   01 0001F   4880001C             AND,R0    MASK2
 93   01 00020   4890001B             AND,R1    MASK1
 94   01 00021   30800009 A            AW,R0     R1
 95   01 00022   35800000 X            STW,R0    AIXSERV8
 96   01 00023   32800000 X            LW,R0     APYS8UT
 97   01 00024   32900000 X            LW,R1     AIYSERV8
 98   01 00025   4880001C             AND,R0    MASK2
 99   01 00026   4890001B             AND,R1    MASK1
100   01 00027   30800009 A            AW,R0     R1
101   01 00028   35800000 X            STW,R0    AIYSERV8
102   01 00029   68020000 A            B         0,X1
103   01 0002A   32800000 X  APSA8UT   LW,R0     APXTF4IN
104   01 0002B   35100004 A            STW,X1    X4
105   01 0002C   22300008 A            LI,X3     8
106   01 0002D   6A100000 X            BAL,X1    LIMTEST
107   01 0002E   32900000 X            LW,R1     AIXSAMP
108   01 0002F   4880001C             AND,R0    MASK2
109   01 00030   4890001B             AND,R1    MASK1
110   01 00031   30800009 A            AW,R0     R1
111   01 00032   35800000 X            STW,R0    AIXSAMP
112   01 00033   32800000 X            LW,R0     APYTF4IN
113   01 00034   6A100000 X            BAL,X1    LIMTEST
114   01 00035   35400001 A            STW,X4    X1
115   01 00036   32900000 X            LW,R1     AIYSAMP
116   01 00037   4880001C             AND,R0    MASK2
```

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    117  01 0003B  48900018          AND,R1    MASK1
    118  01 0003C  30800009 A        AW,R0     R1
    119  01 0003A  35800000 X        STW,R0    AIYSAMP
    120  01 0003B  68020000 A        B         0,X1
    121  01 0003C  22800000 A APRST0 LI,R0      0
    122  01 0003D  35800000 X        STW,R0    APXC
    123  01 0003E  35800000 X        STW,R0    APYC
    124  01 0003F  68020000 A        B         0,X1
    125  01 00040  32000001 A APSEC  LW,R4      X1
    126  01 00041  22910000 A HLDSCAN LI,R1     X'10000'
    127  01 00042  44900000 X        AND,R1    APSTAT2
    128  01 00043  69200048          BCS,2     AUG
    129  01 00044  22920000 A        LI,R1     X'20000'
    130  01 00045  44900000 X        AND,R1    APSTAT2
    131  01 00046  6830004A          BCR,3     NBSCAN
    132  01 00047  6A200000 X        BAL,X2    APRSCAN
    133  01 00048  22200000 A        LI,X2     0
    134  01 00049  6800004E          B         AUG
    135  01 0004A  22900000 A NBSCAN  LI,R1     0
    136  01 0004B  35900000 X        STW,R1    APXSCAN
    137  01 0004C  35900000 X        STW,R1    APYSCAN
    138  01 0004D  35900000 X        STW,R1    TEE
    139  01 0004E  22900800 A AUG    LI,R1     X'800'
    140  01 0004F  44900000 X        AND,R1    APSTAT2
    141  01 00050  68300054          BCR,3     ZERO
    142  01 00051  6A200000 X        BAL,X2    APOAGMNT
    143  01 00052  22200000 A        LI,X2     0
    144  01 00053  68000058          B         CON
    145  01 00054  22800000 A ZERO   LI,R0      0
    146  01 00055  35800000 X        STW,R0    APXAUG
    147  01 00056  35800000 X        STW,R0    APYAUG
    148  01 00057  35800004 N        STW,R0    APXLPFIN+4
    149  01 00058  35800005 N        STW,R0    APXLPFIN+5
    150  01 00059  35800004 N        STW,R0    APXINTIN+4
    151  01 0005A  35800005 N        STW,R0    APXINTIN+5
    152  01 0005B  22300006 A CON    LI,X3     6
    153  01 0005C  32800000 X        LW,R0     APXC
```

```
154  01 0005D  30800000 X          AW,R0     APXAUG
155  01 0005E  30800000 X          AW,R0     APXSCAN
156  01 0005F  38B00000 X          LAW,R3    APYENC
157  01 00060  2130221E1 A         CI,R3     8929
158  01 00061  69100077            BCS,1     LIM
159  01 00062  20BFDD1F A          AI,R3     -8929
160  01 00063  23BFFF6B A          MI,R3     -149
161  01 00064  25B00C61 A          DWR,R3    =100
     01 00065  36B00132
     01 00066  21B00000 A
     01 00067  69100069
     01 00068  20B00001 A
     01 00069  25B0047F A
162  01 0006A  20B03332 A          AI,R3     13106
163  01 0006B  35900008 A          LAW,R1    R0
164  01 0006C  31900008 A          CW,R1     R3
165  01 0006D  69100077            BCS,1     XLIMFF
166  01 0006E  32A00000 X          LW,R2     AIMFOUT
167  01 0006F  49A00133            OR,R2     =X'00200000'
168  01 00070  35A00000 X          STW,R2    AIMFOUT
169  01 00071  32800008 A          LW,R0     R0
170  01 00072  69100075            BCS,1     $+3
171  01 00073  35B00008 A          STW,R3    R0
172  01 00074  68000076            B         $+2
173  01 00075  3A800008 A          LCW,R0    R3
174  01 00076  68000082            B         STORX
175  01 00077  6A100000 X  LIM     BAL,X1    LIMTEST
176  01 00078  35900008 A          LAW,R1    R0
177  01 00079  21903332 A          CI,R1     13106
178  01 0007A  69100077            BCS,1     XLIMFF
179  01 0007B  32A00000 X          LW,R2     AIMFOUT
180  01 0007C  49A00133            OR,R2     =X'00200000'
181  01 0007D  35A00000 X          STW,R2    AIMFOUT
182  01 0007E  68000082            B         STORX
183  01 0007F  32A00000 X  XLIMFF  LW,R2     AIMFOUT
184  01 00080  48A00134            AND,R2    =X'FFDFFFFF'
185  01 00081  35A00000 X          STW,R2    AIMFOUT
```

```
186  01 00082  35800000 X  ST0RX     STW,R0     APXC
187  01 00083  32900000 X            LW,R1      APXENC
188  01 00084  35800009 A            SW,R0      R1
189  01 00085  32900008 A            LW,R1      R0
190  01 00086  2390000A A            MI,R1      10
191  01 00087  32800009 A            LW,R0      R1
192  01 00088  22300008 A            LI,X3      8
193  01 00089  6A100000 X            BAL,X1     LIMTEST
194  01 0008A  35800000 X            STW,R0     APXTF4IN
195  01 0008B  22300006 A            LI,X3      6
196  01 0008C  32800000 X            LW,R0      APYC
197  01 0008D  30800000 X            AW,R0      APYAUG
198  01 0008E  30800000 X            AW,R0      APYSCAN
199  01 0008F  6A100000 X            BAL,X1     LIMTEST
200  01 00090  30900008 A            LAN,R1     R0
201  01 00091  21903332 A            CI,R1      13106
202  01 00092  69100098              BCS,1      YLIM0FF
203  01 00093  21803332 A            CI,R0      13106
204  01 00094  32A00000 X            LW,R2      AIM0D0UT
205  01 00095  49A00135              OR,R2      =X'00100000'
206  01 00096  35A00000 X            STW,R2     AIM0D0UT
207  01 00097  68000098              B          ST0RY
208  01 00098  32A00000 X  YLIM0FF   LW,R2      AIM0D0UT
209  01 00099  48A00136              AND,R2     =X'FFEFFFFF'
210  01 0009A  35A00000 X            STW,R2     AIM0D0UT
211  01 0009B  35800000 X  ST0RY     STW,R0     APYC
212  01 0009C  32900000 X            LW,R1      APYENC
213  01 0009D  35800009 A            SW,R0      R1
214  01 0009E  32900008 A            LW,R1      R0
215  01 0009F  239FFFF6 A            MI,R1      -10
216  01 000A0  32800009 A            LW,R0      R1
217  01 000A1  22300008 A            LI,X3      8
218  01 000A2  6A100000 X            BAL,X1     LIMTEST
219  01 000A3  35800000 X            STW,R0     APYTF4IN
220  01 000A4  E5000000 A            B          *R4
221  01 000A5  22500000 A  APDISPLY  LI,X5      0
222  01 000A6  32800000 X            LW,R0      APSTSEC
```

```
223  01 000A7  31800118          CW,R0    CFLG
224  01 000A8  6330011A          BCR,3    BUTT
225  01 000A9  35800118          STW,R0   CFLG
226  01 000AA  35800118          STW,R0   CFLG
227  01 000AB  32440000 X        LW,X4    APCTSEC,X2     LOAD COMMAND TIME IN SECONDS
228  01 000AC  683000AF          BEZ      $+3
229  01 000AD  25400560 A        SAD,X4   -32            SHIFT FOR 64-BIT DIVIDEND
230  01 000AE  36400137          DW,X4    L(60)          DIVIDE BY 60 TO GET MINUTES
231  01 000AF  35440000 X        STW,X4   APDISPWK,X2    STORE REMAINING SECONDS IN MEM.
232  01 000B0  22400000 A        LI,X4    0
233  01 000B1  32500005 A        LW,X5    X5
234  01 000B2  683000B4          BEZ      $+2
235  01 000B3  36400137          DW,X4    L(60)          DIVIDE MIN BY 60 TO GET HRS
236  01 000B4  25500010 A        SLS,X5   16             HOLD REMAINING MIN AND HRS IN
237  01 000B5  25400170 A        SLD,X4   -16             X5 - IN FORM -XXXMINXXXHRS
238  01 000B6  6A7000B8          BAL,X7   APDISPTC       CALL BIN TO EBDIC FOR SECONDS
239  01 000B7  680000C4          B        APDISP2
240  01 000B8  32940000 X  APDISPTC LW,R1 APDISPWK,X2    ROUTINE TO CONVERT TIME ELEMENTS
241  01 000B9  22800000 A        LI,R0    0               TO BCD AND PACK INTO 4-BIT BCD
242  01 000BA  36800138          DW,R0    L(10)           CHARACTERS
243  01 000BB  20800F0 A         AI,R0    X'F0'
244  01 000BC  20900F0 A         AI,R1    X'F0'
245  01 000BD  25900008 A        SLS,R1   8
246  01 000BE  30800009 A        AW,R0    R1
247  01 000BF  33A00008 A        LW,R2    R0
248  01 000C0  25A0017C A        SLD,R2   -4              PACK INTO 4-BIT BCD IN R3
249  01 000C1  25A0007C A        SLS,R2   -4               (2 CHAR)
250  01 000C2  25A0017C A        SLD,R2   -4
251  01 000C3  6B0E0000 A        B        0,X7
252  01 000C4  22400000 A  APDISP2 LI,X4   0
253  01 000C5  26400110 A        SLD,X4   16
254  01 000C6  35440000 X        STW,X4   APDISPWK,X2    STORE MIN IN MEM.
255  01 000C7  25400110 A        SLD,X4   16
256  01 000C8  32500008 A        LW,X5    R3             HOLD CONV. SEC IN H2 OF X5
257  01 000C9  25400170 A        SLD,X4   -16            HOLD BIN. HRS IN H1 OF X5
258  01 000CA  6A7000B8          BAL,X7   APDISPTC       CALL ROUTINE TO CONV MIN
259  01 000CB  25A00108 A        SLD,R2   8
```

```
260   01 000CC   22400000 A        LI,X4     0
261   01 000CD   25400110 A        SLD,X4    16
262   01 000CE   35440000 X        STW,X4    APDISPWK,X2        STORE HRS IN MEM.
263   01 000CF   32400004 A        LW,X4     R2
264   01 000D0   25400178 A        SLD,X4    -8                 HOLD BCD MIN/SEC IN X5 (H1)
265   01 000D1   6A700088          BAL,X7    APDISPTC           CALL ROUTINE TO CONV HRS
266   01 000D2   25A00108 A        SLD,R2    8
267   01 000D3   32400004 A        LW,X4     R2
268   01 000D4   25400178 A        SLD,X4    -8                 STORE BCD CHAR IN DISPLAY
269   01 000D5   32700005 A        LW,X7     X5
270   01 000D6   32440000 X        LW,X4     AICTDSP1,X2          INTERFACE ADDRESS WORDS
271   01 000D7   25400068 A        SLS,X4    -24                (RETAINING ADDRESSES)
272   01 000D8   25400118 A        SLD,X4    24
273   01 000D9   35440000 X        STW,X4    AICTDSP1,X2
274   01 000DA   48400139          AND,X4    =X'00FFFFFF'
275   01 000DB   32800001 N        LW,R0     AICTDSP1+1
276   01 000DC   48800018          AND,R0    MASK1
277   01 000DD   30800004 A        AW,R0     X4
278   01 000DE   35800001 N        STW,R0    AICTDSP1+1
279   01 000DF   32840000 X        LW,R0     APXC,X2
280   01 000E0   32700001 A        LW,X7     X1                    (STORE X1 REGISTER)
281   01 000E1   6A10011C          BAL,X1    AP@4BCD   CONVERT APXC TO 4BCD FOR
282   01 000E2   02000000 A        NOP                            COMMAND-X DISPLAY
283   01 000E3   25800008 A        SLS,R0    8
284   01 000E4   32800008 A        LW,R3     R0
285   01 000E5   32A40000 X        LW,R2     AIXCDSP1,X2
286   01 000E6   25A00068 A        SLS,R2    -24
287   01 000E7   25A00118 A        SLD,R2    24                 STORE BCD CHAR IN DISPLAY1
288   01 000E8   35A40000 X        STW,R2    AIXCDSP1,X2          INTERFACE ADDRESS WORD
289   01 000E9   48A00139          AND,R2    =X'00FFFFFF'
290   01 000EA   32200001 N        LW,R0     AIXCDSP1+1
291   01 000EB   48800018          AND,R0    MASK1
292   01 000EC   30800004 A        AW,R0     R2
293   01 000ED   35800001 N        STW,R0    AIXCDSP1+1
294   01 000EE   32840000 X        LW,R0     APYC,X2
295   01 000EF   6A10011C          BAL,X1    AP@4BCD   CONVERT APYC TO 4BCD FOR
296   01 000F0   02000000 A        NOP                            COMMAND-Y DISPLAY
```

```
297  01 000F1  25800008 A    SLS,R0    8
298  01 000F2  32800008 A    LW,R3     R0
299  01 000F3  32A40000 X    LW,R2     AIYCDSP1,X2
300  01 000F4  25A00068 A    SLS,R2    -24
301  01 000F5  25A00118 A    SLD,R2    24                  STORE BCD CHAR IN DISPLAY1
302  01 000F6  35A40000 X    STW,R2    AIYCDSP1,X2          INTERFACE ADDRESS WORD
303  01 000F7  43A00139      AND,R2    =X'00FFFFFF'
304  01 000F8  32800001 N    LW,R0     AIYCDSP1+1
305  01 000F9  43800018      AND,R0    MASK1
306  01 000FA  30200000A A   AW,R0     R2
307  01 000FB  35800001 N    STW,R0    AIYCDSP1+1
308  01 000FC  32840000 X    LW,R0     APXENC,X2
309  01 000FD  6A10011C      BAL,X1    APB4BCD   CONVERT APXENC TO 4BCD FOR
310  01 000FE  02000000 A    NOP                           REAL-X DISPLAY
311  01 000FF  25800008 A    SLS,R0    8
312  01 00100  32800008 A    LW,R3     R0
313  01 00101  32A40000 X    LW,R2     AIXRDSP1,X2
314  01 00102  25A00068 A    SLS,R2    -24
315  01 00103  25A00118 A    SLD,R2    24                  STORE BCD CHAR IN DISPLAY1
316  01 00104  35A40000 X    STW,R2    AIXRDSP1,X2          INTERFACE ADDRESS WORD
317  01 00105  43A00139      AND,R2    =X'00FFFFFF'
318  01 00106  32800001 N    LW,R0     AIXRDSP1+1
319  01 00107  43800018      AND,R0    MASK1
320  01 00108  30200000A A   AW,R0     R2
321  01 00109  35800001 N    STW,R0    AIXRDSP1+1
322  01 0010A  32840000 X    LW,R0     APYENC,X2
323  01 0010B  6A10011C      BAL,X1    APB4BCD   CONVERT APYENC TO 4BCD FOR
324  01 0010C  02000000 A    NOP                           REAL-Y DISPLAY
325  01 0010D  25800008 A    SLS,R0    8
326  01 0010E  32800008 A    LW,R3     R0
327  01 0010F  32A40000 X    LW,R2     AIYRDSP1,X2
328  01 00110  25A00068 A    SLS,R2    -24
329  01 00111  25A00118 A    SLD,R2    24                  STORE BCD CHAR IN DISPLAY1
330  01 00112  35A40000 X    STW,R2    AIYRDSP1,X2          INTERFACE ADDRESS WORD
331  01 00113  43A00139      AND,R2    =X'00FFFFFF'
332  01 00114  32800001 N    LW,R0     AIYRDSP1+1
333  01 00115  43800018      AND,R0    MASK1
```

```
334   01 00116   30800000A A                AW,R0     R2
335   01 00117   35800001 N                STW,R0    AIYRDSP1+1
336   01 00118   32100007 A                LW,X1     X7              RESTORE X1 REGISTER
337   01 00119   68020001 A                B         1,X1            RETURN
338   01 0011A   68020000 A   OUTT         B         0,X1
339   01 0011B   00000000 A   CFLG         DATA      0
340                                         TITLE     'AP04BCD'
```

```
341                                           DEF        AP@4BCD
342  01 0011C   35B00008 A   AP@4BCD  LAW,R3     R0         USE ABS0LUTE VALUE IN C0NVERSI0N.
343  01 0011D   37A0013A              MW,R2      =100000
344  01 0011E   25A00501 A            DWR,R2     =16383
     01 0011F   36A0013B
     01 00120   21800000 A
     01 00121   69100123
     01 00122   20800001 A
     01 00123   25B0047F A
345  01 00124   22200005 A            LI,X2      5          MAX 0F 5 DIGITS.
346  01 00125   22A00000 A            LI,R2      0          CLEAR REMAINDER TRAP.
347  01 00126   36A00138              DW,R2      =X'A'      DEVIDE BY 10
348  01 00127   35A000CC A            STW,R2     R4         ST0RE REMAINDER
349  01 00128   25C0017C A            SLD,R4     -4         SAVE L0W 0RDER 4 BITS.
350  01 00129   64200125              BDR,X2     $-4
351  01 0012A   22C00001 A            LI,R4      1
352  01 0012B   21800000 A            CI,R0      0              CHECK F0R NEGATIVE SIGN.
353  01 0012C   6810012E              BGEZ       $+2
354  01 0012D   22C00000 A            LI,R4      0
355  01 0012E   25C00174 A            SLD,R4     -12            RIGHT ADJUST SIGNED RESULT.
356  01 0012F   35D00008 A            STW,R5     R0         ST0RE RESULT IN R0
357  01 00130   68020000 A            B          0,X1       RETURN.
358                                   B0UND      8
359
360                                   END
     01 00132   00000064 A
     01 00133   00200000 A
     01 00134   FFDFFFFF A
     01 00135   00100000 A
     01 00136   FFEFFFFF A
     01 00137   0000003C A
     01 00138   0000000A A
     01 00139   00FFFFFF A
     01 0013A   000186A0 A
     01 0013B   00003FFF A

C0NTR0L SECTI0N SUMMARY: 01 0013C   PT 0     02 00000   PT 0
```

```
*    SYMBOL VALUES
        A/00000001              APDISPTC/01 000B8       APDISP2/01 000C4        AUG/01 0004E
        B/00000000              CFLG/01 0011B           CON/01 0005B            FBR/0000000F
        FBRR/00000000           HLDSCAN/01 00041        LIM/01 00077            MASK1/01 0001B
        MASK2/01 0001C          NOSCAN/01 0004A         OUTT/01 0011A           R0/00000008
        R1/00000009             R2/0000000A             R3/0000000B             R4/0000000C
        R5/0000000D             R6/0000000E             R7/0000000F             STORX/01 00082
        STORY/01 0009B          XLIMOFF/01 0007F        X1/00000001             X2/00000002
        X3/00000003             X4/00000004             X5/00000005             X6/00000006
        X7/00000007             YLIMOFF/01 00098        ZERO/01 00054
*    EXTERNAL DEFINITIONS
        AP@4BCD/01 0011C        APDISPLY/01 000A5       APMNPOS/01 00016        APRJOY/01 00000
        APRSLAV/01 0000F        APRSTO/01 0003C         APRTACH/01 00005        APSAOUT/01 0002A
        APSEC/01 00040          APSOUT/01 0001D         AUTOTRAK/01 0000A
*    PRIMARY REFERENCES
        AICTDSP1        AIMODOLT        AISTAT3         AIXCDSP1        AIXRDSP1        AIXSAMP         AIXSERVO
        AIYCDSP1        AIYRDSP1        AIYSAMP         AIYSERVO        AP@AGMNT        APCTSEC         APDISPWK
        APDTACHX        APDTACHY        APRSCAN         APSTAT2         APSTSEC         APXAUG          APXC
        APYENC          APXINTIN        APXJOY          APXLPFIN        APXSCAN         APXSLAV         APXSOUT
        APXTF4IN        APXTF5IN        APXTF6IN        APXTRACK        APYAUG          APYC            APYENC
        APYJOY          APYSCAN         APYSLAV         APYSOUT         APYTF4IN        APYTF5IN        APYTF6IN
        APYTRACK        LIMTEST         TEE
* NO SECONDARY REFERENCES
* NO UNDEFINED SYMBOLS
*    ERROR SEVERITY LEVEL: 0
* NO ERROR LINES
```

```
E00    0 : +  E-     , '
       1        0000CD02                         SYSTEM    ANTENNA
       2                                         SYSTEM    .SIG5FF
       3                                         WØLF
****      LEVEL    1DISPLAY ØF COMMAND   WØLF
      47                               *
      48                               **************************************************************************
      49                               *                                                                        *
      50                               * WW       WW    ØØØØØ   LL       FFFFFFF     RRRRRR    &&&&&  DDDDDD    *
      51                               * WW   W   WW   ØØ   ØØ  LL       FF          RR   RR   &      DD   DD   *
      52                               *  WW WWW WW   ØØ     ØØ LL       FF          RR   RR  & &     DD    DD  *
      53                               *  WWWW WWWW   ØØ     ØØ LL       FFFFF       RRRRRR   &  &    DD    DD  *
      54                               *   WW   WW     ØØ   ØØ  LL       FF          RR  RR    && &   DD   DD   *
      55                               *   WW   WW      ØØØØØ   LLLLLLL  FF          RR   RR       &  DDDDDD    *
      56                               *                                                                        *
      57                               *                                                                        *
      58                               *          SYSTEMS  TECHNØLØGY  DEPT.                                    *
      59                               *           SPACE  SYSTEMS  GRØUP                                        *
      60                               **************************************************************************
      61                               *
****   ENDLEVEL   1DISPLAY ØF COMMAND   WØLF
       4                                         REGNAME
****      LEVEL    1DISPLAY ØF COMMAND   REGNAME
      65        00000001                X1       SET        1     ALL X REGISTERS ARE INDEX REGISTERS
      66        00000002                X2       SET        2
      67        00000003                X3       SET        3
      68        00000004                X4       SET        4
      69        00000005                X5       SET        5
      70        00000006                X6       SET        6
      71        00000007                X7       SET        7
      72        00000008                R0       SET        8     ALL R REGISTERS ARE GENERAL USE REGISTERS
      73        00000009                R1       SET        9
      74        0000000A                R2       SET       10
      75        0000000B                R3       SET       11
      76        0000000C                R4       SET       12
      77        0000000D                R5       SET       13
      78        0000000E                R6       SET       14
      79        0000000F                R7       SET       15
```

```
E00    0 : +  E-      , '                                         APDCØMP5                                      8
     80          0000000D           FØRH      SET         13          FØRTRAN IV-H BRANCH REGISTER
     81          0000000F           FØR       SET         15          FØRTRAN IV BRANCH REGISTER
  **** ENDLEVEL   1DISPLAY ØF COMMAND   REGNAME
      5                                         TITLE      'APDCØMP5'
```

```
                                                    HEADER
                                              *
                                                    DEF        APØAGMNT
                                                    REF        APXTRACK
                                                    REF        APXAUG
                                                    REF        APYTRACK
                                                    REF        APYLPFIN
                                                    REF        APYINTIN
                                                    REF        APYAUG
  01 000000                                APØAGMNT RES        0
  01 000000     32600002 A                 -        LW,X6      X2
  01 000001     3A800000 X                          LCW,R0     APXTRACK
  01 000002     35800000 X                          STW,R0     APXLPFIN
  01 000003     22500000 A                          LI,X5      0
  01 000004     6A1000AC                            BAL,X1     APØLPF
  01 000005     32800000 X                          LW,R0      APYTRACK
  01 000006     35800000 X                          STW,R0     APYLPFIN
  01 000007     22500001 A                          LI,X5      1
  01 000008     6A1000AC                            BAL,X1     APØLPF
  01 000009     32800002 N                          LW,R0      APXLPFIN+2
  01 00000A     35800000 X                          STW,R0     APXINTIN
  01 00000B     22500000 A                          LI,X5      0
  01 00000C     6A1000B1                            BAL,X1     APØINTG
  01 00000D     32800002 N                          LW,R0      APYLPFIN+2
  01 00000E     35800000 X                          STW,R0     APYINTIN
  01 00000F     22500001 A                          LI,X5      1
  01 000010     6A1000B1                            BAL,X1     APØINTG
  01 000011     32800002 N                          LW,R0      APXINTIN+2
  01 000012     35800000 X                          STW,R0     APXAUG
  01 000013     32800002 N                          LW,R0      APYINTIN+2
  01 000014     35800000 X                          STW,R0     APYAUG
  01 000015     680C0000 A                          B          0,X6
                                              *
                                                    REF        APRTACH
                                                    REF        AIMØDØUT
                                                    REF        APSØUT
                                                    DEF        APDCØMP5
```

```
43                                          REF     APXTF6IN
44                                          REF     APXTF5IN
45                                          REF     APXSOUT
46                                          REF     APYTF5IN
47                                          REF     APYSOUT
48                                          REF     APSAOUT
49                                          DEF     APDC0MP1
50                                          REF     APXTF4IN
51                                          REF     APYTF4IN
52                                          REF     LIMTEST
53                                          REF     FG34X
54                                          REF     FG34Y
55   01 00016   32600001 A   APDC0MP1    LW,X6   X1
56   01 00017   22300004 A               LI,X3   4
57   01 00018   32840000 X               LW,R0   APXTF4IN,X2
58   01 00019   6A100000 X               BAL,X1  LIMTEST
59   01 0001A   35840000 X               STW,R0  APXTF4IN,X2
60   01 0001B   3DE00008 A               LAW,R6  R0
61   01 0001C   31E00062                 CW,R6   TST1
62   01 0001D   68200020                 BCR,2   TF4X
63   01 0001E   31E00063                 CW,R6   TST1+1
64   01 0001F   68100023                 BCR,1   TF3X
65   01 00020   22000001 A   ALS0X     LI,R1   1
66   01 00021   31840000 X               CW,R1   FG34X,X2
67   01 00022   68200020                 BCR,2   TF4X
68   01 00023   22000000 A   TF3X       LI,R1   0
69   01 00024   35840000 X               STW,R1  FG34X,X2
70   01 00025   32000000 X               LW,R1   AIM0D0UT
71   01 00026   48000001                 AND,R1  =X'FF7FFFFF'
72   01 00027   35000000 X               STW,R1  AIM0D0UT
73   01 00028   32840000 X               LW,R1   APXTF4IN,X2
74   01 00029   37600064                 MW,R0   SCAF
75   01 0002A   36800065                 DW,R0   TEN
76   01 0002B   35840002 N               STW,R1  APXTF4IN+2,X2
77   01 0002C   60000035                 B       WYE
78   01 0002D   22000001 A   TF4X       LI,R1   1
79   01 0002E   35840000 X               STW,R1  FG34X,X2
```

```
   80   01 0002F   32900000 X          LW,R1     AIM0D0UT
   81   01 00030   49900002            0R,R1     =X'00800000'
   82   01 00031   35900000 X          STW,R1    AIM0D0UT
   83   01 00032   22500000 A          LI,X5     0
   84   01 00033   6A10009D            BAL,X1    AP@DCTF4
   85   01 00034   02000000 A          NOP
   86   01 00035   32800000 X  WYE     LW,R0     APYTF4IN
   87   01 00036   22300004 A          LI,X3     4
   88   01 00037   6A100000 X          BAL,X1    LIMTEST
   89   01 00038   35800000 X          STW,R0    APYTF4IN
   90   01 00039   3BE00000 X          LAW,R6    APYTF4IN
   91   01 0003A   31E00062            CW,R6     TST1
   92   01 0003B   6820004C            BCR,2     TF4Y
   93   01 0003C   31E00063            CW,R6     TST1+1
   94   01 0003D   68100041            BCR,1     TF3Y
   95   01 0003E   22900001 A  ALS8Y    LI,R1     1
   96   01 0003F   31940000 X          CW,R1     FG34Y,X2
   97   01 00040   6820004C            BCR,2     TF4Y
   98   01 00041   22900000 A  TF3Y     LI,R1     0
   99   01 00042   35940000 X          STW,R1    FG34Y,X2
  100   01 00043   32900000 X          LW,R1     AIM0D0UT
  101   01 00044   42900003            AND,R1    =X'FFBFFFFF'
  102   01 00045   35900000 X          STW,R1    AIM0D0UT
  103   01 00046   32940000 X          LW,R1     APYTF4IN,X2
  104   01 00047   37800064            MW,R0     SCAF
  105   01 00048   36800065            DW,R0     TEN
  106   01 00049   35940002 N          STW,R1    APYTF4IN+2,X2
  107   01 0004A   35940004 N          STW,R1    APYTF4IN+4
  108   01 0004B   68000054            B         OUT
  109   01 0004C   22900001 A  TF4Y     LI,R1     1
  110   01 0004D   35940000 X          STW,R1    FG34Y,X2
  111   01 0004E   32900000 X          LW,R1     AIM0D0UT
  112   01 0004F   49900004            0R,R1     =X'00400000'
  113   01 00050   35900000 X          STW,R1    AIM0D0UT
  114   01 00051   22500001 A          LI,X5     1
  115   01 00052   6A10009D            BAL,X1    AP@DCTF4
  116   01 00053   02000000 A          NOP
```

```
117   01 00054  32900002 N  0UT       LW,R1    APXTF4IN+2
118   01 00055  23900003 A            MI,R1    3
119   01 00056  22300002 A            LI,X3    2
120   01 00057  32800009 A            LW,R0    R1
121   01 00058  6A100000 X            BAL,X1   LIMTEST
122   01 00059  35800000 X            STW,R0   APXTF5IN
123   01 0005A  32900002 N            LW,R1    APYTF4IN+2
124   01 0005B  23900004 A            MI,R1    4
125   01 0005C  22300002 A            LI,X3    2
126   01 0005D  32800009 A            LW,R0    R1
127   01 0005E  6A100000 X  -         BAL,X1   LIMTEST
128   01 0005F  35800000 X            STW,R0   APYTF5IN
129   01 00060  680C0000 A            B        0,X6
130                                   BOUND    8
131   01 00062  000001F4 A  TST1      DATA     500,1150
      01 00063  0000047E A
132   01 00064  0000000B A  SCAF      DATA     11
133   01 00065  0000000A A  TEN       DATA     10
134   01 00066  000003E8 A  THOUS     DATA     1000
135                         *
136                         *
137                         *
138                         *
139   01 00067  32600001 A  APDC0MP5  LW,X6     X1        PR0GRAM RETURN ADDRESS
140                         *
141   01 00068  22500001 A            LI,X5    1
142   01 00069  6A1000A2             BAL,X1   AP0DCTF5
143   01 0006A  32900002 N            LW,R1    APYTF5IN+2
144   01 0006B  239003D5 A            MI,R1    981
145   01 0006C  25900001 A            DWR,R1   THOUS
      01 0006D  36900066
      01 0006E  21900000 A
      01 0006F  69100071
      01 00070  20900001 A
      01 00071  25900+7F A
146   01 00072  35900002 N            STW,R1   APYTF5IN+2
147   01 00073  6A100000 X            BAL,X1   APRTACH   TACH0METER READ AND SUBTRACT
```

```
148   01 00074   02000000 A          NOP                 ERROR RETURN
149                           *
150   01 00075   32900000 X          LW,R1     APXTF5IN
151   01 00076   35900000 X          STW,R1    APXSOUT
152                           *
153   01 00077   22500001 A          LI,X5     1
154   01 00078   6A1000A7            BAL,X1    APSDCTF6
155   01 00079   22300000 N          LI,X3     WA(APXTF5IN)
156   01 0007A   22700000 N          LI,X7     WA(APXTF6IN)
157   01 0007B   329E0003 A          LW,R1     3,X7
158   01 0007C   23900384 A          MI,R1     900
159   01 0007D   25900001 A          DWR,R1    THOUS
      01 0007E   36900066
      01 0007F   21900000 A
      01 00080   69100082
      01 00081   20900001 A
      01 00082   2590047F A
160   01 00083   30960003 A          AW,R1     3,X3
161   01 00084   35900000 X          STW,R1    APYSOUT
162   01 00085   22300000 A          LI,X3     0
163                           *
164   01 00086   32800000 X          LW,R0     APYSOUT
165   01 00087   6A100000 X          BAL,X1    LIMTEST
166   01 00088   35800000 X          STW,R0    APYSOUT
167   01 00089   6A100000 X          BAL,X1    APSOUT    SERVO OUTPUT
168   01 0008A   32900000 X          LW,R1     APXTF4IN
169   01 0008B   23900003 A          MI,R1     3
170   01 0008C   2590007F A          SLS,R1    -1
171   01 0008D   35900000 X          STW,R1    APXTF4IN
172   01 0008E   32900000 X          LW,R1     APYTF4IN
173   01 0008F   23900003 A          MI,R1     3
174   01 00090   2590007F A          SLS,R1    -1
175   01 00091   35900000 X          STW,R1    APYTF4IN
176   01 00092   22300008 A          LI,X3     8
177   01 00093   32800000 X          LW,R0     APXTF4IN
178   01 00094   6A100000 X          BAL,X1    LIMTEST
179   01 00095   35800000 X          STW,R0    APXTF4IN
```

```
180   01 00096   32800J00 X          LW,R0     APYTF4IN
181   01 00097   6A100000 X          BAL,X1    LINTEST
182   01 00098   35800000 X          STW,R0    APYTF4IN
183   01 00099   6A100000 X          BAL,X1    APSABUT
184                           *
185   01 0009A   680C0000 A          B         0,X6
186                           *
187                           *
188                           *      TITLE     'AP@DCTF5'
```

```
                                       *
                                       *
                                                DEF       AP@DCTF1
                                                DEF       AP@DCTF2
                                                DEF       AP@DCTF4
                                                DEF       AP@DCTF5
                                                DEF       AP@DCTF6
                                                REF       APCTF4AO
                                                REF       APCTF5AO
                                                REF       APCTF6AO
                                                REF       APCLPFAO
                                                REF       APXLPFIN
                                                REF       AP@INTAO
                                                REF       APXINTIN
                                                DEF       AP@LPF
                                                DEF       AP@INTG
 01 0009B     68020001 A    AP@DCTF1            B         1,X1
 01 0009C     68020001 A    AP@DCTF2            B         1,X1
 01 0009D     22300000 N    AP@DCTF4            LI,X3     WA(APCTF4AO)
 01 0009E     22700000 N                        LI,X7     WA(APXTF4IN)
 01 0009F     30700005 A                        AW,X7     X5
 01 000A0     30300005 A                        AW,X3     X5
 01 000A1     68000085                          B         L00P
 01 000A2     22300000 N    AP@DCTF5            LI,X3     WA(APCTF5AO)
 01 000A3     22700000 N                        LI,X7     WA(APXTF5IN)
 01 000A4     30300005 A                        AW,X3     X5
 01 000A5     30700005 A                        AW,X7     X5
 01 000A6     68000085                          B         ZEEXFM
 01 000A7     22300000 N    AP@DCTF6            LI,X3     WA(APCTF6AO)
 01 000A8     22700000 N                        LI,X7     WA(APXTF6IN)
 01 000A9     30300005 A                        AW,X3     X5
 01 000AA     30700005 A                        AW,X7     X5
 01 000AB     680000E5                          B         ZEEXFM
 01 000AC     22300000 N    AP@LPF              LI,X3     WA(APCLPFAO)
 01 000AD     22700000 N                        LI,X7     WA(APXLPFIN)
 01 000AE     30300006 A                        AW,X3     X5
 01 000AF     30700005 A                        AW,X7     X5
```

```
E00    0 : +  E-    , '                                          AP@DCTF5
   226    01 000B0    68000085              B          ZEFXFM
   227    01 000B1    22300000 N  AP@INTG   LI,X3      WA(APQINTAO)
   228    01 000B2    22700000 N            LI,X7      WA(APXINTIN)
   229    01 000B3    30300005 A            AW,X3      X5
   230    01 000B4    30700005 A            AW,X7      X5
   231    01 000B5                ZEEXFM    RES        0
   232    01 000B5    329E0000 A  L0OP      LW,R1      0,X7          INPUT
   233    01 000B6    378000CF              MW,R0      SCALE         INPUT * SCALE
   234    01 000B7    32BE0004 A            LW,R3      4,X7          0LD FN1
   235    01 000B8    37A60004 A            MW,R2      4,X3
   236    01 000B9    1880000A A            SD,R0      R2            INA=INPUT-0LD FN1*B1
   237    01 000BA    25800001 A            DWR,R0     SCALE
          01 000BB    368000CF
          01 000BC    21900000 A
          01 000BD    691000BF
          01 000BE    20900001 A
          01 000BF    2590047F A
   238    01 000C0    35900000              STW,R1     H0LD          H0LD C0NTAINS FN0
   239    01 000C1    37860000 A            MW,R0      0,X3          A0*FN0
   240    01 000C2    32BE0004 A            LW,R3      4,X7          FN1
   241    01 000C3    37A60002 A            MW,R2      2,X3
   242    01 000C4    1080000A A            AD,R0      R2            A0*FN0+A1*FN1=0UTA
   243    01 000C5    25800001 A            DWR,R0     SCALE         0UTPUT
          01 000C6    368000CF
          01 000C7    21900000 A
          01 000C8    691000CA
          01 000C9    20900001 A
          01 000CA    2590047F A
   244    01 000CB    359E0002 A            STW,R1     2,X7
   245    01 000CC    32800000              LW,R3      H0LD
   246    01 000CD    353E0004 A            STW,R3     4,X7
   247    01 000CE    68020000 A            B          0,X1
   248    01 000CF    000003E8 A  SCALE     DATA       1000
   249    01 000D0    00000000 A  H0LD      DATA       0
   250                                      END
          01 000D1    FF7FFFFF A
          01 000D2    00800000 A
```

```
          01 0000B     FF8FFFFF A
          01 0000D4    00400000 A

  CONTROL SECTION SUMMARY: 01 000D5   PT 0     02 00000   PT 0
```

```
*    SYMBOL VALUES
        A/00000001          ALSBX/01 00020      ALSBY/01 0003E      B/00000000
        FBR/0000000F        FBRH/0000000D       HOLD/01 000D0       LOOP/01 000B5
        OUT/01 00054        R0/00000008         R1/00000009         R2/0000000A
        R3/0000000B         R4/0000000C         R5/0000000D         R6/0000000E
        R7/0000000F         SCAF/01 00064       SCALE/01 000CF      TEN/01 00065
        TF3X/01 00023       TF3Y/01 00041       TF4X/01 0002D       TF4Y/01 0004C
        THOUS/01 00066      TST1/01 00062       WYE/01 00035        X1/00000001
        X2/00000002         X3/00000003         X4/00000004         X5/00000005
        X6/00000006         X7/00000007         ZEEXFM/01 000B5
*    EXTERNAL DEFINITIONS
        AP@AGMNT/01 00000   AP@DCTF4/01 0009D   AP@DCTF6/01 000A7   AP@DCTF5/01 000A2
        AP@DCTF2/01 0009C   AP@DCTF1/01 00098   AP@INTG/01 000B1    AP@LPF/01 000AC
        APDCOMP5/01 00067   APDCOMP1/01 00016
*    PRIMARY REFERENCES
        AIMODOUT    APGINTAO    APGLPFAO    APQTF4AO    APQTF5AO    APQTF6AO    APRTACH
        APSAOUT     APSBUT      APXAUG      APXINTIN    APXLPFIN    APXSOUT     APXTF4IN
        APXTF5IN    APXTF6IN    APXTRACK    APYAUG      APYINTIN    APYLPFIN    APYSOUT
        APYTF4IN    APYTF5IN    APYTRACK    FG34X       FG34Y       LIMTEST
* NO SECONDARY REFERENCES
* NO UNDEFINED SYMBOLS
*    ERROR SEVERITY LEVEL: 0
* NO ERROR LINES
```

```
EOO    0 : |  E-     , '                              APPMODI AND APPMODE
       1                                      SYSTEM    SIG5FP
       2        00000002                      SYSTEM    ANTENNA
       3                                      WOLF
****     LEVEL    1DISPLAY OF COMMAND    WOLF
      47                           *
      48                           ***********************************************************************
      49                           *                                                                     *
      50                           * WW       WW   00000    LL      FFFFFFF    RRRRRR    &&&&&  DDDDDD    *
      51                           * WW   W   WW  00   00   LL      FF         RR   RR  &       DD   DD   *
      52                           *  WW WWW WW  00     00  LL      FF         RR   RR  & &     DD    DD  *
      53                           *  WWWW WWWW  00     00  LL      FFFFF      RRRRRR   &  &    DD    DD  *
      54                           *   WW   WW    00   00   LL      FF         RR  RR    && &   DD   DD   *
      55                           *   WW   WW     00000    LLLLLLL FF         RR   RR       &  DDDDDD    *
      56                           *                                                                     *
      57                           *                                                                     *
      58                           *          SYSTEMS  TECHNOLOGY  DEPT.                                 *
      59                           *            SPACE  SYSTEMS  GROUP                                    *
      60                           ***********************************************************************
      61                           *
****  ENDLEVEL   1DISPLAY OF COMMAND   WOLF
       4                                      REGNAME
****     LEVEL    1DISPLAY OF COMMAND    REGNAME
      65        00000001          X1          SET      1        ALL X REGISTERS ARE INDEX REGISTERS
      66        00000002          X2          SET      2
      67        00000003          X3          SET      3
      68        00000004          X4          SET      4
      69        00000005          X5          SET      5
      70        00000006          X6          SET      6
      71        00000007          X7          SET      7
      72        00000008          R0          SET      8        ALL R REGISTERS ARE GENERAL USE REGISTERS
      73        00000009          R1          SET      9
      74        0000000A          R2          SET     10
      75        0000000B          R3          SET     11
      76        0000000C          R4          SET     12
      77        0000000D          R5          SET     13
      78        0000000E          R6          SET     14
      79        0000000F          R7          SET     15
```

```
E00  0 : I  E-     , '                                  APPM0DI AND APPM0DE                                    6
      80          0000000D            FBRH      SET       13          FORTRAN IV-H BRANCH REGISTER
      81          0000000F            FBR       SET       15          FORTRAN IV BRANCH REGISTER
 **** ENDLEVEL    1DISPLAY OF COMMAND   REGNAME
      5                                          TITLE     'APPM0DI AND APPM0DE'
```

```
                                    DEF      APPMØDI
                                    DEF      APPMØDE
                                    REF      APXTF4IN
                                    REF      APXTF5IN
                                    REF      APXTF6IN
                                    REF      APXLPFIN
                                    REF      APXINTIN
                                    REF      SCHEDULE
                                    REF      APSTAT2
                                    REF      APSTAT1
                                    REF      APSCHDLE
                                    REF      APSADJT
                                    REF      APDCØMP1
                                    REF      APDCØMP5
                                    REF      APRJØY
                                    REF      APRSLAV
                                    REF      AUTØTRAK
                                    REF      APRSTØ
                                    REF      APRAGMNT
                                    REF      APRSCAN
                                    REF      APFREDZ
                                    REF      APHNPØS
                                    REF      APSEC
                                    REF      APPRED
                                    REF      AISTAT1P
01 00000   02200060 A   APPMØDI     LCI      6
01 00001   2A80004E                 LM,RO    ZERO
01 00002   28800000 X               STM,RO   APXTF4IN
01 00003   28800000 X               STM,RO   APXTF5IN
01 00004   28800000 X               STM,RO   APXTF6IN
01 00005   28800000 X               STM,RO   APXLPFIN
01 00006   28800000 X               STM,RO   APXINTIN
01 00007   32300000 X               LW,X3    APSTAT1
01 00008   4B300054                 AND,X3   =X'CEEC'
01 00009   32400000 X               LW,X4    APSTAT2
01 0000A   4B400055                 AND,X4   =X'7FF800'
01 0000B   02200030 A   STØR        LCI      3
```

```
43  01 0000C  28300000 X        STM,X3    AISTAT1P
44  01 0000D  022000C0 A        LCI       12
45  01 0000E  2A300000 X        LM,X3     SCHEDULE
46  01 0000F  28300000 X        STM,X3    APSCHDLE
47  01 00010  22800000 N        LI,R0     APSABUT
48  01 00011  35900009 N        STW,R0    APSCHDLE+9
49  01 00012  22908000 A  DIGCOMP LI,R1   X'8000'
50  01 00013  48900000 X        AND,R1    APSTAT1
51  01 00014  6830001C          BCR,3     JOY
52  01 00015  22900400 A        LI,R1     X'400'
53  01 00016  48900000 X        AND,R1    APSTAT1
54  01 00017  6930001A          BCS,3     TF5
55  01 00018  22800000 N        LI,R0     APDCOMP1
56  01 00019  35800006 N        STW,R0    APSCHDLE+8
57  01 0001A  22800000 N  TF5    LI,R0     APDCOMP5
58  01 0001B  35800009 N        STW,R0    APSCHDLE+9
59  01 0001C  22900400 A  JOY    LI,R1     X'400'
60  01 0001D  48900000 X        AND,R1    APSTAT1
61  01 0001E  68300022          BCR,3     SLAVE
62  01 0001F  22800000 N        LI,R0     APRJOY
63  01 00020  35800005 N        STW,R0    APSCHDLE+5
64  01 00021  68020000 A        B         0,X1
65  01 00022  22900200 A  SLAVE  LI,R1     X'200'
66  01 00023  48900000 X        AND,R1    APSTAT1
67  01 00024  68300028          BCR,3     TRAK
68  01 00025  22800000 N        LI,R0     APRSLAV
69  01 00026  35800005 N        STW,R0    APSCHDLE+5
70  01 00027  68020000 A        B         0,X1
71  01 00028  22900040 A  TRAK   LI,R1     X'40'
72  01 00029  48900000 X        AND,R1    APSTAT1
73  01 0002A  6830002E          BCR,3     ST0
74  01 0002B  22800000 N        LI,R0     AUT0TRAK
75  01 0002C  35800005 N        STW,R0    APSCHDLE+5
76  01 0002D  68020000 A        B         0,X1
77  01 0002E  22900080 A  ST0    LI,R1     X'80'
78  01 0002F  48900000 X        AND,R1    APSTAT1
79  01 00030  68300036          BCR,3     MANP0S
```

```
E00    0 : |  E-     ,  '                                    APPMODI AND APPMODE
       01 00031    22800000 N               LI,RO      APRSTP
       01 00032    35800001 N               STW,RO     APSCHDLE+1
       01 00033    22800000 N               LI,RO      APSEC
       01 00034    35800003 N               STW,RO     APSCHDLE+3
       01 00035    68020000 A               B          O,X1
       01 00036    22900800 A    MANPOS     LI,R1      X'800'
       01 00037    48900000 X               AND,R1     APSTAT1
       01 00038    6830003C                 BCR,3      PROG
       01 00039    22800000 N               LI,RO      APMNPOS
       01 0003A    35800003 N               STW,RO     APSCHDLE+3
       01 0003B    68020000 A               B          O,X1
       01 0003C    22900020 A    PROG       LI,R1      X'20'
       01 0003D    48900000 X               AND,R1     APSTAT1
       01 0003E    68320000 A               BCR,3      O,X1
       01 0003F    22800000 N               LI,RO      APPRID
       01 00040    35800000 X               STW,RO     APSCHDLE
       01 00041    22800000 N               LI,RO      APSEC
       01 00042    35800003 N               STW,RO     APSCHDLE+3
       01 00043    68020000 A               B          O,X1
       01 00044    32300000 X    APPMODE    LW,X3      APSTAT1
       01 00045    48300054                 AND,X3     =X'CEEC'
       01 00046    32400000 X               LW,X4      APSTAT2
       01 00047    48400055                 AND,X4     =X'7FF800'
       01 00048    31300000 X               CW,X3      AISTAT1P
       01 00049    68300048                 BCR,3      CONT
       01 0004A    68000000                 B          APPMODI
       01 0004B    31400001 N    CONT       CW,X4      AISTAT1P+1
       01 0004C    68320000 A               BCR,3      O,X1
       01 0004D    68000000                 B          APPMODI
       01 0004E    00000000 A    ZERO       DATA       0,0,0,0,0,0
       01 0004F    00000000 A
       01 00050    00000000 A
       01 00051    00000000 A
       01 00052    00000000 A
       01 00053    00000000 A
                                            END
       01 00054    0000CEEC A
```

CONTROL SECTION SUMMARY: 01 00056 PT 0 02 00000 PT 0

```
*    SYMB0L VALUES
       C0NT/01 0004B          DIGC0MP/01 00012       FBR/0000000F           FBRH/0000000D
       J0Y/01 0001C           MARP0S/01 00036        PR0G/01 0003C          R0/00000008
       R1/00000009            R2/0000000A            R3/0000000B            R4/0000000C
       R5/0000000D            R6/0000000E            R7/0000000F            SLAVE/01 00022
       ST0/01 0002E           ST0R/01 0000B          TF5/01 0001A           TRAK/01 00028
       X1/00000001            X2/00000002            X3/00000003            X4/00000004
       X5/00000005            X6/00000006            X7/00000007            ZER0/01 0004E
*    EXTERNAL DEFINITIONS
       APPM0DE/01 00044       APPM0DI/01 00000
*    PRIMARY REFERENCES
       AISTAT1P      AP@AGMNT      APDC0MP1      APDC0MP5      APMNP0S       APPRED        APPREDZ
       APR0BY        APRSCAN       APRSLAV       APRST0        APSA0UT       APSCHDLE      APSEC
       APSTAT1       APSTAT2       APXINTIN      APXLPFIN      APXTF4IN      APXTF5IN      APXTF6IN
       AUT0TRAK      SCHEDULE
* N0 SEC0NDARY REFERENCES
* N0 UNDEFINED SYMB0LS
*    ERR0R SEVERITY LEVEL: 0
* N0 ERR0R LINES
```

```
E00   0 : & E-     , '                               S ** C ** A** N
      1                                   SYSTEM     SIG5FP
      2        00000C02                   SYSTEM     ANTENNA
      3                                   WOLF
****      LEVEL   1DISPLAY OF COMMAND   WOLF
     47                             *
     48                             **************************************************************
     49                             *                                                            *
     50                             * WW       WW   00000   LL      FFFFFFF    RRRRRR    &&&&&  DDDDDD  *
     51                             * WW   W   WW  00   00  LL      FF         RR   RR   &      DD   DD *
     52                             *  WW WWW WW  00     00 LL      FF         RR   RR  & &     DD    DD *
     53                             *  WWWW WWWW  00     00 LL      FFFFF      RRRRRR  &  &     DD    DD *
     54                             *   WW   WW    00   00  LL      FF         RR  RR    && &   DD   DD *
     55                             *   WW   WW     00000  LLLLLLL FF         RR   RR      &   DDDDDD  *
     56                             *                                                            *
     57                             *                                                            *
     58                             *       SYSTEMS  TECHNOLOGY  DEPT.                           *
     59                             *         SPACE  SYSTEMS  GROUP                              *
     60                             **************************************************************
     61                             *
**** ENDLEVEL   1DISPLAY OF COMMAND   WOLF
      4                                    REGNAME
****      LEVEL   1DISPLAY OF COMMAND   REGNAME
     65        00000001           X1        SET       1      ALL X REGISTERS ARE INDEX REGISTERS
     66        00000002           X2        SET       2
     67        00000003           X3        SET       3
     68        00000004           X4        SET       4
     69        00000005           X5        SET       5
     70        00000006           X6        SET       6
     71        00000007           X7        SET       7
     72        00000008           R0        SET       8      ALL R REGISTERS ARE GENERAL USE REGISTERS
     73        00000009           R1        SET       9
     74        0000000A           R2        SET       10
     75        0000000B           R3        SET       11
     76        0000000C           R4        SET       12
     77        0000000D           R5        SET       13
     78        0000000E           R6        SET       14
     79        0000000F           R7        SET       15
```

```
EOO    0 : &  E-      , !                              S ** C ** A** N                        7
      80        0000000D        FBRH      SET      13        FORTRAN IV-H BRANCH REGISTER
      81        0000000F        FBR       SET      15        FORTRAN IV BRANCH REGISTER
  ****  ENDLEVEL   1DISPLAY OF COMMAND   REGNAME
       5                                  TITLE    'S ** C ** A** N'
```

```
E00   0 : δ  E-     , '                                     S ** C ** A** N                      8
  6                                            DEF       APRSCAN
  7                                            DEF       TEE
  8                                            DEF       RT0I,IT0R
  9                                            REF       SQRT
 10                                            REF       SIN
 11                                            REF       C0S
 12                                            REF       APXSCAN
 13                                            REF       APYSCAN
 14                                            REF       APSTAT2
 15   01 00000   22900000 A   IT0R             LI,R1     0
 16   01 00001   25800578 A                    SAD,R0    -8
 17   01 00002   48800005                      E0R,R0    EXP1
 18   01 00003   2480010E A                    SFL,R0    14
 19   01 00004   63C00000 A                    B         0,6
 20   01 00005   48000000 A   EXP1             DATA      X'48000000'
 21   01 00006   22900000 A   RT0I             LI,R1     0
 22   01 00007   02100001 A                    LFI       1
 23   01 00008   1D80000C                      FAL,R0    EXP2
 24   01 00009   32800009 A                    LW,R0     R1
 25   01 0000A   02100000 A                    LFI       0
 26   01 0000B   680C0000 A                    B         0,6
 27                                            B0UND     8
 28   01 0000C   4E000000 A   EXP2             DATA      X'4E000000',0
      01 0000D   00000000 A
 29   01 0000E   32800099     APRSCAN          LW,R0     TEE
 30   01 0000F   3080009C                      AW,R0     DEL
 31   01 00010   68100013                      BCR,1     T0K
 32   01 00011   22800001 A                    LI,R0     1
 33   01 00012   3580009C                      STW,R0    DEL
 34   01 00013   35800099     T0K              STW,R0    TEE
 35   01 00014   6A600000                      BAL,6     IT0R
 36   01 00015   358000A0                      STW,R0    TEPR
 37   01 00016   32800000 X                    LW,R0     APSTAT2
 38   01 00017   25800010 A                    SLS,R0    16
 39   01 00018   25800064 A                    SLS,R0    -28
 40   01 00019   6A600000                      BAL,6     IT0R
 41   01 0001A   22900001 A                    LI,R1     1
```

```
01 0001B   319000A5            CW,R1     FLAG
01 0001C   69300025            BCS,3     CK
01 0001D   318000A3            CW,R0     RADIUS
01 0001E   6930002C            BCS,3     AGAIN
01 0001F   32A000A6            LW,R2     WTFG
01 00020   21A00014 A          CI,R2     20
01 00021   68300030            BCR,3     0K2
01 00022   20A00001 A          AI,R2     1
01 00023   35A000A6            STW,R2    WTFG
01 00024   68000033            B         0K+1
01 00025   3180009D    CK      CW,R0     RMAX
01 00026   68300032            BCR,3     0K
01 00027   22900001 A          LI,R1     1
01 00028   359000A5            STW,R1    FLAG
01 00029   359000A6            STW,R1    WTFG
01 0002A   358000A3            STW,R0    RADIUS
01 0002B   68000033            B         0K+1
01 0002C   22900001 A  AGAIN   LI,R1     1
01 0002D   359000A6            STW,R1    WTFG
01 0002E   358000A3            STW,R0    RADIUS
01 0002F   68000033            B         0K+1
01 00030   22A00001 A  0K2     LI,R2     1
01 00031   35A000A4            STW,R2    NUFG
01 00032   3580009D    0K      STW,R0    RMAX
01 00033   32B000A7            LW,R3     =X'41F653D1'      5*PI
01 00034   329000A1            LW,R1     VEL0CT
01 00035   3FB0009D            FMS,R3    RMAX
01 00036   3EB00009 A          FDS,R3    R1
01 00037   3DB000A8            FAS,R3    =X'40100000'
01 00038   32A000A4            LW,R2     NUFG
01 00039   21A00001 A          CI,R2     1
01 0003A   69300045            BCS,3     0KK
01 0003B   329000A0            LW,R1     TEPR
01 0003C   3F90000B A          FMS,R1    R3
01 0003D   3E90009F            FDS,R1    NUMAX
01 0003E   359000A0            STW,R1    TEPR
01 0003F   32800009 A          LW,R0     R1
```

```
 79   01 00040   6A600006          BAL,6     RTθI
 80   01 00041   35800099          STW,R0    TEE
 81   01 00042   22900000 A        LI,R1     0
 82   01 00043   359000A4          STW,R1    NUFG
 83   01 00044   359000A5          STW,R1    FLAG
 84   01 00045   35B0009F    GKK   STW,R3    NUMAX
 85   01 00046   329000A9          LW,R1     =X'42A40000'     164=1 DEGREE
 86   01 00047   3F90009D          FMS,R1    RMAX
 87   01 00048   3E90009F          FDS,R1    NUMAX
 88   01 00049   35900098          STW,R1    ALPHA
 89   01 0004A   3FB000A0          FMS,R3    TEPR
 90   01 0004B   3EB000AA          FDS,R3    =X'42140000'
 91   01 0004C   3280000B A        LW,R0     R3
 92   01 0004D   6A600000 X        BAL,6     SQRT
 93   01 0004E   3580009E          STW,R0    NU
 94   01 0004F   32900008 A        LW,R1     R0
 95   01 00050   3F9000A7          FMS,R1    =X'41FB53D1'
 96   01 00051   3E90009F          FDS,R1    NUMAX
 97   01 00052   319000A7          CW,R1     =X'41FB53D1'
 98   01 00053   6810005D          BCR,1     NEG
 99   01 00054   21900000 A        CI,R1     0
100   01 00055   69200073          BCS,2     ANGLE
101   01 00056   22A00001 A  FGS   LI,R2     1
102   01 00057   35A0009C          STW,R2    DEL
103   01 00058   66A0009A          AWM,R2    CTR
104   01 00059   22900000 A        LI,R1     0
105   01 0005A   35900099          STW,R1    TEE
106   01 0005B   3590009E          STW,R1    NU
107   01 0005C   68000073          B         ANGLE
108   01 0005D               NEG   RES       0
109   01 0005D   3280009D          LW,R0     RMAX
110   01 0005E   21800000 A        CI,R0     0
111   01 0005F   69300069          BCS,3     GKA
112   01 00060   35800009 A        STW,R0    R1
113   01 00061   35800098          STW,R0    ALPHA
114   01 00062   22800001 A        LI,R0     1
115   01 00063   35800099          STW,R0    TEE
```

```
    116   01 00064  3530009A              STW,R0    CTR
    117   01 00065  35800J9C              STW,R0    DEL
    118   01 00066  323000AB              LW,R0     =X'7CFFFFFF'
    119   01 00067  3580009F              STW,R0    NUMAX
    120   01 00068  68000073              B         ANGLE
    121   01 00069  22AFFFFF A    0KA     LI,R2     -1
    122   01 0006A  35A0009C              STW,R2    DEL
    123   01 0006B  3AA0J00A A            LCW,R2    R2
    124   01 0006C  66A0J09A              AWM,R2    CTR
    125   01 0006D  3280009F              LW,R0     NUMAX
    126   01 0006E  6A60J006              BAL,6     RT0I
    127   01 0006F  329J0J08 A            LW,R1     R0
    128   01 00070  23900014 A            MI,R1     20
    129   01 00071  35900099              STW,R1    TEE
    130   01 00072  329J00A7              LW,R1     =X'41FB53D1'
    131   01 00073                ANGLE   RES       0
    132   01 00073  32800J09 A            LW,R0     R1
    133   01 00074  35800J0F A            STW,R0    R7
    134   01 00075  6A600000 X            BAL,6     SIN
    135   01 00076  35800J0D A            STW,R0    R5
    136   01 00077  32800J0F A            LW,R0     R7
    137   01 00078  6A600000 X            BAL,6     COS
    138   01 00079  35800J0B A            STW,R0    R3
    139   01 0007A  3FD00098              FMS,R5    ALPHA
    140   01 0007B  3FB00098              FMS,R3    ALPHA
    141   01 0007C  3FD0009E              FMS,R5    NU
    142   01 0007D  3FB0009E              FMS,R3    NU
    143   01 0007E  32800J0B A            LW,R0     R3
    144   01 0007F  6A60J006              BAL,6     RT0I
    145   01 00080  35800J0B A            STW,R0    R3
    146   01 00081  32800J0D A            LW,R0     R5
    147   01 00082  6A60J006              BAL,6     RT0I
    148   01 00083  35800J09 A            STW,R0    R1
    149   01 00084  32400J9A              LW,X4     CTR
    150   01 00085  21400J05 A            CI,X4     5
    151   01 00086  69100089              BCS,1     $+3
    152   01 00087  22400J01 A            LI,X4     1
```

```
153  01 00088  3540009A          STW,X4   CTR
154  01 00089  68080089          B        $,X4
155  01 0008A  6800008E          B        Q1
156  01 0008B  6800008F          B        Q2
157  01 0008C  68000091          B        Q3
158  01 0008D  68000093          B        Q4
159  01 0008E  68000095    Q1    B        OUT
160  01 0008F  3A900009 A  Q2    LCW,R1   R1
161  01 00090  68000095          B        OUT
162  01 00091  3A80000B A  Q3    LCW,R3   R3
163  01 00092  68000095          B        OUT
164  01 00093  3A900009 A  Q4    LCW,R1   R1
165  01 00094  3A80000B A        LCW,R3   R3
166  01 00095  35B000C0 X  OUT   STW,R3   APxSCAN
167  01 00096  35B000C0 X        STW,R1   APYSCAN
168  01 00097  63040000 A        B        0,X2
169  01 00098  00000000 A  ALPHA  DATA     0
170  01 00099  00000000 A  TEE    DATA     0
171  01 0009A  00000001 A  CTR    DATA     1
172  01 0009B  0000000A A  TEN    DATA     10
173  01 0009C  00000001 A  DEL    DATA     1
174  01 0009D  00000000 A  RMAX   DATA     0
175  01 0009E  00000000 A  NU     DATA     0
176  01 0009F  00000000 A  NUMAX  DATA     0
177  01 000A0  00000000 A  TEPR   DATA     0
178  01 000A1  41100000 A  VELOCT DATA     X'41100000'
179  01 000A2  0000000C A  TWELVE DATA     12
180  01 000A3  00000000 A  RADIUS DATA     0
181  01 000A4  00000000 A  NUEG   DATA     0
182  01 000A5  00000000 A  FLAG   DATA     0
183  01 000A6  00000000 A  WTFG   DATA     0
184                        END

     01 000A7  41F553D1 A
     01 000A8  40100000 A
     01 000A9  42A40000 A
     01 000AA  42140000 A
     01 000AB  70FFFFFF A
```

CONTROL SECTION SUMMARY: 01 000AC PT 0 02 00000 PT 0

```
  1                                     SYSTEM    SIG5FP
  2                                     DEF       SIN
  3                                     DEF       C0S
  4                                     REF       8T0
  5                                     REF       8T1
  6                               *
  7            00000004           R2     EQU       4
  8            00000006           R6     EQU       6              LINK
  9            00000008           R8     EQU       8              REAL ACCUMULAT0R
 10            00000009           R9     EQU       R8+1           TEMP
 11                                     SPACE     3


 12                               *  C0NSTANTS
 13                               *
 14   01 00000   3FD3C6A8 A   C0MC0   DATA   X'3FD3C6A8',-X'3FD3C6A8'  +-(120/16**6)**-4=.051703125
      01 00001   C02C3958 A
 15   01 00002   46100000 A   BIG     DATA   X'46100000',X'80'  SCALE, R0UND
      01 00003   00000080 A
 16   01 00004   40A2F983 A   TW00PI  DATA   X'40A2F983',X'6E4E4415'  2/PI=.636619772367581341
      01 00005   6E4E4415 A
 17   01 00006   41100000 A   C0      DATA   X'41100000'        1.0
 18          01 00006         0NE     EQU    C0
 19   01 00007   BEEC42C7 A   C1      DATA   X'BEEC42C7'        -1.233697
 20   01 00008   4040EBD7 A   C2      DATA   X'4040EBD7'        0.2535986
 21   01 00009   C0AC6865 A   C3      DATA   X'C0AC6865'        -0.020408255
 22   01 0000A   3F539798 A   NC3     DATA   X'3F539798'        0.020408255
 23   01 0000B   411921FB A   S0      DATA   X'411921FB'        1.5707963
 24   01 0000C   BF5AA223 A   S1      DATA   X'BF5AA223'        -0.6459635
 25   01 0000D   401465EC A   S2      DATA   X'401465EC'        0.07968022
 26   01 0000E   C0ED2648 A   S3      DATA   X'C0ED2648'        -0.004602163
 27   01 0000F   3F12D9B8 A   NS3     DATA   X'3F12D9B8'        0.004602163
 28   01 00010   BFD55556 A   SIXTH   DATA   -X'402AAAAA'       -1/6 TRUNCATED
 29   01 00011   FFFFFF00 A   MASK    DATA   X'FFFFFF00'        T0 C0MPLEMENT
 30                                   SPACE  3
```

```
31  01 00012                    SIN     RES     0
32  01 00012  22400000 A                LI,R2   0           INDICATE SIN
33  01 00013  19800000                  CLM,R8  COMCO       CHECK FOR VERY SMALL X
34  01 00014  6920001F                  BG      2A4         BRANCH IF LARGE +
35  01 00015  22400002 A                LI,R2   2           INDICATE -
36  01 00016  6940001E                  BCS,4   2A1         BRANCH IF LARGE -
37  01 00017  35800000 X                STW,R8  8T1        X
38  01 00018  3F800000 X                FMS,R8  8T1        FIRST
39  01 00019  3F800010                  FMS,R8  SIXTH       TWO
40  01 0001A  3D800006                  FAS,R8  ONE          TERMS OF
41  01 0001B  3F800000 X                FMS,R8  8T1           SERIES
42  01 0001C  680C0000 A                B       0,R6        RETURN X FOR SIN(SMALL X)
43                                      SPACE   3

44  01 0001D                    COS     RES     0
45  01 0001D  22400001 A                LI,R2   1           INDICATE COS
46  01 0001E  33800008 A        2A1     LAW,R8  R8          ABS
47  01 0001F  22900000 A        2A4     LI,R9   0          CLEAR LSH
48  01 00020  1F800004                  FML,R8  TWOPI      CONVERT TO QUADRANTS
49  01 00021  31800002                  CW,R8   BIG         CHECK FOR NO SIGNIFICANCE
50  01 00022  60100024                  BL      3A1
51  01 00023  680C0000 A                B       0,6
52  01 00024  1D800002          3A1     FAL,R8  BIG         SCALE AND ROUND
53  01 00025  30400008 A                AW,R2   R8          COPY AND MODIFY INTEGER PART
54  01 00026  22800040 A                LI,R8   X'40'       INSERT EXPONENT
55  01 00027  20900000 A                AI,R9   0           FRACTION : 0.5
56  01 00028  6010003E                  BLZ     3A2         BRANCH IF F >= 0.5
57  01 00029  21400001 A                CI,R2   1           CHECK ODD/EVEN QUADRANT
58  01 0002A  68400041                  BAZ     4A6         IF EVEN, BRANCH TO SIN EXPANSION
59  01 0002B                    4A1     RES     0           PLACE
60  01 0002B  25800118 A                SLD,R8  24          POSITION F
61  01 0002C  3F800008 A                FMS,R8  R8          H=F*F
62  01 0002D  35800000 X        4A3     STW,R8  8T1         COPY H
63  01 0002E  21400002 A        4A4     CI,R2   2           CHECK FOR + OR - RESULT
```

```
E00   0 : K  E-
   01 0002F   68400037                 BAZ      4A5       BRANCH IF +
   01 00030   3F8000CA                 FMS,R8   MC3       NEG-
   01 00031   3C800008                 FSS,R8   C2          ATIVE
   01 00032   3F800000 X               FMS,R8   8T1           POLY-
   01 00033   3C800007                 FSS,R8   C1              NOMIAL
   01 00034   3F800000 X               FMS,R8   8T1               EX-
   01 00035   3C800006                 FSS,R8   C0                  PANSION
   01 00036   680C0000 A               B        0,R6      RETURN
   01 00037   3F800009        4A5      FMS,R8   C3        POS-
   01 00038   3D800008                 FAS,R8   C2          ITIVE
   01 00039   3F800000 X               FMS,R8   8T1           POLY-
   01 0003A   3D800007                 FAS,R8   C1              NOMIAL
   01 0003B   3F800000 X               FMS,R8   8T1               EX-
   01 0003C   3D800006                 FAS,R8   C0                  PANSION
   01 0003D   680C0000 A               B        0,R6      RETURN
   01 0003E   43900011        3A2      EOR,R9   MASK      1-F
   01 0003F   21400001 A               CI,R2    1         CHECK ODD/EVEN QUADRANT
   01 00040   6840002B                 BAZ      4A1       IF EVEN, BRANCH TO COS EXPANSION
   01 00041                   4A6      RES      0         PLACE
   01 00041   25800118 A      4A8      SLD,R8   24        POSITION F
   01 00042   35800000 X               STW,R8   8T0       COPY F
   01 00043   3F800000 X               FMS,R8   8T0       H=F*F
   01 00044   35800000 X               STW,R8   8T1       COPY H
   01 00045   21400002 A               CI,R2    2         CHECK FOR + OR - RESULT
   01 00046   6840004F                 BAZ      5A1       BRANCH IF +
   01 00047   3F8000CF                 FMS,R8   MS3       NEG-
   01 00048   3C8000CD                 FSS,R8   S2          ATIVE
   01 00049   3F800000 X               FMS,R8   8T1           POLY-
   01 0004A   3C8000CC                 FSS,R8   S1              NOMIAL
   01 0004B   3F800000 X               FMS,R8   8T1               EX-
   01 0004C   3C8000CB                 FSS,R8   S0                  PAN-
   01 0004D   3F800000 X               FMS,R8   8T0                   SION
   01 0004E   680C0000 A               B        0,R6      RETURN
   01 0004F   3F8000CE        5A1      FMS,R8   S3        POS-
   01 00050   3D8000CD                 FAS,R8   S2          ITIVE
   01 00051   3F800000 X               FMS,R8   8T1           POLY-
   01 00052   3D80000C                 FAS,R8   S1              NOMIAL
```

```
E00   0 : K  E-     ,  '
    101   01 00053    3F800000 X            FMS,R8   8T1                    EX
    102   01 00054    3D800008              FAS,R8   S0                       PAN-
    103   01 00055    3F800000 X            FMS,R8   8T0                        SIGN
    104   01 00056    680C0000 A            B        0,R6          RETURN
    105                              5A      END
```

CONTROL SECTION SUMMARY: 01 00057   PT 0

```
E00   0 ; K  E-    , '
*     SYMBOL VALUES
        BIG/01 00002          C0/01 00006          COMC0/01 00000       C1/01 00007
        C2/01 00008           C3/01 00009          MASK/01 00011        MC3/01 0000A
        MS3/01 0000F          BNE/01 00006         R2/00000004          R6/00000006
        R8/00000008           R9/00000009          SIXTH/01 00010       SC/01 0000B
        S1/01 0000C           S2/01 0000D          S3/01 0000E          TWOPI/01 00004
        2A1/01 0001E          2A4/01 0001F         3A1/01 00024         3A2/01 0003E
        4A1/01 00028          4A3/01 0002D         4A4/01 0002E         4A5/01 00037
        4A6/01 00041          4A8/01 00041         5A/01 00057          5A1/01 0004F
*     EXTERNAL DEFINITIONS
        COS/01 0001D          SIN/01 00012
*     PRIMARY REFERENCES
        8T0                   8T1
* N0 SECONDARY REFERENCES
* N0 UNDEFINED SYMBOLS
*     ERROR SEVERITY LEVEL: 0
* N0 ERROR LINES
```

```
                                       SYSTEM    SIG5FP
                                 *
           00000004              R2      EQU      4
           00000006              R6      EQU      6             LINK
           00000008              R8      EQU      8             ACCUMULATOR
           00000009              R9      EQU      9             TEMP
           0000000A              R10     EQU      10            TEMP
                                         SPACE    3

                                 *  CONSTANTS
                                 *
  01 00000  80FFFFFF A   X80F    DATA    X'80FFFFFF'
  01 00001  3F000000 A   X3F     DATA    X'3F000000'
  01 00002  41400000 A   FOUR    DATA    FS'4.0'        4.0
  01 00003  4157D866 A   A       DATA    X'4157D866'    5.4903312
  01 00004  413504F3 A           DATA    X'413504F3'    8(RT(2)-1)=3.3137085
  01 00005  4128AEE4 A           DATA    X'4128AEE4'    8(RT(3)-RT(2))=2.542698
  01 00006  41224C29 A           DATA    X'41224C29'    8(2-RT(3))=2.1435935
  01 00007  3FAFB0CB A   B       DATA    X'3FAFB0CB'    .0428932125
  01 00008  40130789 A           DATA    X'40130789' (12RT(2)-15)/(64(RT(2)-1))=.074333739
  01 00009  40190AAC A           DATA    X'40190AAC' (20RT(6)-47)/(64(RT(3)-RT(2)))=.097819072
  01 0000A  401DC78A A           DATA    X'401DC78A' (56RT(3)-95)/(64(2-RT(3)))=.116326
                                         SPACE    3


                                         DEF      SQRT
                                         DEF      8T0,8T1
  01 0000B                SQRT    RES      0
  01 0000B  72A00008 A            LB,R10   R8
  01 0000C  4B800000              AND,R8   X80F
  01 0000D  6920000F              BGZ      3A1           BRANCH IF X>0
  01 0000E  683C0000 A   1A1      BEZ      0,R6          RETURN 0.0 FOR SQRT(0.0)
  01 0000F  49800001     3A1      OR,R8    X3F
  01 00010  35800023     3A3      STW,R8   8T0           COPY F
```

```
01 00011   52400023          LH,R2     8T0           INDEX
01 00012   2540007A A        SLS,R2    -6              TO A AND B
01 00013   3F89FFC7          FMS,R8    A-252,R2      LINEAR APPROXIMATION
01 00014   3089FF0B          FAS,R8    B-252,R2        TO RESULT
01 00015   35800024          STW,R8    8T1           COPY G
01 00016   32800023          LW,R8     8T0           F
01 00017   3E800024          FDS,R8    8T1           F/G
01 00018   30800024          FAS,R8    8T1           G+F/G
01 00019   46800023          XW,R8     8T0           G<=> F
01 0001A   3F800002          FMS,R8    FOUR          4*F
01 0001B   3E800023          FDS,R8    8T0           4*F/G
01 0001C   30800023          FAS,R8    8T0           G+4*F/G
01 0001D   25A0027F A  3A4   SCS,R10   -1            HALVE EXPONENT,REMAINDER IN BIT 0
01 0001E   20A00020 A        AI,R10    X'20'         FIX BIAS, CHECK REMAINDER
01 0001F   75A00008 A        STB,R10   R8            INSERT EXPONENT
01 00020   681C0000 A        BGEZ      0,R6          RETURN IF NO REMAINDER
01 00021   3F800002          FMS,R8    FOUR          *SQRT(16)
01 00022   680C0000 A        B         0,R6
                             SPACE     3


01 00023   00000000 A  8T0    DATA     0
01 00024   00000000 A  8T1    DATA     0
                       3A    END
```

CONTROL SECTION SUMMARY: 01 00025   PT 0

```
E00   0 : K  E-     , '
*     SYMBOL VALUES
          A/01 00003          B/01 00007          FOUR/01 00002       R10/0000000A
          R2/00000004         R6/00000006         R8/00000008         R9/00000009
          X3F/01 00001        X80F/01 00000       1A1/01 0000E        3A/01 00025
          3A1/01 0000F        3A3/01 00010        3A4/01 0001D
*     EXTERNAL DEFINITIONS
          SQRT/01 00008       8T0/01 00023        8T1/01 00024
* NO PRIMARY REFERENCES
* NO SECONDARY REFERENCES
* NO UNDEFINED SYMBOLS
*     ERROR SEVERITY LEVEL: 0
* NO ERROR LINES
```

```
      DIMENSION IDATA( 50,24)
      DIMENSION XX(300),YY(300),EXX(50),EYE(50),EEE(50),ENN(50)
     *,VEE(50),XCOF(5),YCOF(5),N(8,10),IHR(50),IMN(50)
      DIMENSION RANGE(50),RATE(50),AZ(50),EL(50)
      INTEGER  SATIE,SATID,CAI,DAY,MIN,MIM,HR,HP,SEC,DEL,ORBN1,ORBN2
      DATA ISLASH/4H/    /,IEND/4H MSG/,IBLANK/4H     /
      REWIND 7
      REWIND 8
      CALL   EOFSET(236S)
  200 WRITE(101,1700)
      REWIND 7
      REWIND 8
      READ(101,1710,ERR=200) SATIE
      IF (SATIE.EQ.0) CALL EXIT
  201 WRITE(101,1720)
      READ(101,1730,ERR=201) ORBN1
      IF(ORBN1.EQ.0) GO TO 200
      REWIND 7
      REWIND 8
      READ(8,1500)DAY,YEAR,MON,DAYY
      READ(8,1510) SATID
      IF(SATIE.NE.SATID)GO TO 777
      GO TO 901
  236 WRITE(101,1740)
      GO TO 201
  777 WRITE(101,1750)
      GO TO 200
  900 READ(8,1500)DAY,YEAR,MON,DAYY
      READ(8,1510) SATID
  901 READ(8,801) DAY,HR,MIN,SEC,DEL
      I=1
  902 READ(8,803) (IDATA(I,J),J=1,24)
      IF(IDATA(I,4).EQ.ISLASH) GO TO 903
      I=I+1
      GO TO 902
  903 BACKSPACE 8
      READ(8,107) ORBN2
      IF(ORBN1.EQ.ORBN2) GO TO 202
        READ(8,804) IND
      IF (IND.EQ.IEND) GO TO 900
      GO TO 901
  202 RR=180./3.1416
      IJK=0
      IF(SATID.EQ.6903701) IJK=3
      IF(SATID.EQ.7002501) IJK=4
      PRINT 1000,IJK
      PRINT 1010
      PRINT 1020,SATIE
      PRINT 1030, ORBN1
      ITIM=3600*HR+60*MIN+SEC
      JTIM=ITIM+2*DEL*60
      ITIM=JTIM-1
```

```
      NC=I
      DO 203 IR=1,NC
  203 BACKSPACE 8
      NC=NC-1
      PRINT 1040, DAYY,MON,YEAR
      PRINT 1050, DAY
      HHR=HR
      MMIN=MIN+2
      IF(MMIN.LT.59) GO TO 1530
      HHR=HHR+1
      MMIN=MMIN-60
      IF(HHR.LT.24) GO TO 1530
      HHR=HHR-24
 1530 PRINT 1060, HHR,MMIN,SEC
      PRINT 1100
      PRINT 1110
      PRINT 1120
      PRINT 1130
      PRINT 1600
      DO 604 J4=1,NC
      IHR(J4)=HR
      IMN(J4)=MIN+(J4-1)*DEL
      IF(IMN(J4)-60) 604,603,603
  603 IHR(J4)=IHR(J4)+1
      IMN(J4)=IMN(J4)-60
  604 CONTINUE
      READ (8,101) (EEE(I),ENN(I),VEE(I),I=1,NC)
      RATE(I)=0.
      DO 1145 I=1,NC
      EEE(I)=EEE(I)/10.
      VEE(I)=VEE(I)/10.
      ENN(I)=ENN(I)/10.
      RANGE(I)=SQRT(EEE(I)**2+VEE(I)**2+ENN(I)**2)
      IF(I.EQ.1) GO TO 1135
      RATE(I)=(RANGE(I)-RANGE(I-1))/(60*DEL)
 1135 PRINT 1140, IHR(I),IMN(I),EEE(I),ENN(I),VEE(I),RANGE(I),RATE(I)
 1145 CONTINUE
      PRINT 1200
      PRINT 1210
      PRINT 1220
      PRINT 1230
      PRINT 1600
      DO 205 I=1,NC
      EXX(I)=RR*ATAN(EEE(I),VEE(I))
      WYE(I)=RR*ATAN(ENN(I)/SQRT(EEE(I)**2+VEE(I)**2))
      AZ(I)=RR*ATAN(EEE(I),ENN(I))
      EL(I)=RR*ATAN(VEE(I),SQRT(EEE(I)**2+ENN(I)**2))
  205 PRINT 1240, IHR(I),IMN(I),EXX(I),WYE(I),AZ(I),EL(I)
      PRINT 1300
      PRINT 1310
      PRINT 1320
      PRINT 1330
      PRINT 1600
```

```
106:        REWIND 8
107:        NC=NC-4
108:        NP=60*DEL
109:        ICS=0
110:        KQ=1
111:        NXB=0
112:        NYB=0
113:        NREC=0
114:        DO 206 I=2,NC
115:        KQ=KQ+1
116:        CALL COEF(EXX(KQ),XCOF)
117:        CALL COEF(EYE(KQ),YCOF)
118:        IFLAG=1
119:        CALL INTERPOL (XX,XCOF,NP)
120:        CALL INTERPOL (YY,YCOF,NP)
121:        M=NP/10
122:        DO 209 J=1,M
123:        L=(J-1)*10
124:        DO 207 K=1,10
125:        L=L+1
126:        IF(XX(L)-82.) 300,301,301
127:   301  XX(L)=82.
128:        GO TO 303
129:   300  IF(XX(L)+82.)302,302,303
130:   302  XX(L)=-82.
131:   303  IF(YY(L)-82.) 304,305,305
132:   305  YY(L)=82.
133:        GO TO 307
134:   304  IF(YY(L)+82.)306,306,307
135:   306  YY(L)=-82.
136:   307  ITIM=ITIM+1
137:        IH=ITIM/3600
138:        IM=(ITIM-IH*3600)/60
139:        IS=ITIM-IH*3600-IM*60
140:        AX=ABS(XX(L))
141:        AY=ABS(YY(L))
142:        IF(AX-45.) 712,712,701
143:   701  YL=82.-.614*(AX-45.)
144:   708  IF(AY-YL) 712,712,709
145:   709  IF(ICS) 207,735,207
146:   735  JTIM=ITIM
147:        ICS=1
148:        GO TO 207
149:   712  IF(ICS) 720,730,720
150:   720  ICS=0
151:        NR=(ITIM-JTIM)/10+1
152:        JTIM=10*(JTIM/10)-1
153:   721  L=J*10
154:        IF(XX(L)-82.) 500,501,501
155:   501  XX(L)=82.
156:        GO TO 503
157:   500  IF(XX(L)+82.)502,502,503
158:   502  XX(L)=-82.
```

```
159:    503 IF(YY(L)-82.) 504,505,505
160:    505 YY(L)=82.
161:        GO TO 507
162:    504 IF(YY(L)+82.)506,506,507
163:    506 YY(L)=-82.
164:    507 XXX=XX(L)*164
165:        YYY=YY(L)*164
166:        XAA=XX(L)
167:        YAA=YY(L)
168:        DO 729 JA=1,NR
169:        DO 728 JB=1,10
170:        JTIM=JTIM+1
171:        IH=JTIM/3600
172:        IM=(JTIM-IH*3600)/60
173:        IS=JTIM-IH*3600-IM*60
174:        XDOT=0.
175:        YDOT=0.
176:        IF(IFLAG.EQ.1) GO TO 1345
177:        PRINT 1340, IH,IM,IS,XAA,YAA,XDOT,YDOT
178:        GO TO 1365
179:   1345 PRINT 1350,IH,IM,IS,XAA,YAA,XDOT,YDOT,(XCOF(II),II=1,5)
180:        PRINT 1360,(YCOF(II),II=1,5)
181:        IFLAG=0
182:   1365 CONTINUE
183:        N(1,JB)=SATID
184:        N(2,JB)=JTIM
185:        N(3,JB)=XXX
186:        N(4,JB)=YYY
187:        N(5,JB)=0
188:        N(6,JB)=0
189:    728 N(7,JB)=DAY
190:        NXB=N(3,10)
191:        NYB=N(4,10)
192:        NREC=NREC+1
193:    729 WRITE(7) N
194:        ITIM=JTIM
195:        GO TO 208
196:    730 CONTINUE
197:        N(1,K)=SATID
198:        N(2,K)=ITIM
199:        N(3,K)=XX(L)*164
200:        N(4,K)=YY(L)*164
201:        N(5,K)=N(3,K)-NXB
202:        N(6,K)=N(4,K)-NYB
203:        NXB=N(3,K)
204:        NYB=N(4,K)
205:        N(7,K)=DAY
206:        XDOT=N(5,K)/164.
207:        YDOT=N(6,K)/164.
208:        IF(IFLAG.EQ.1) GO TO 1367
209:        PRINT 1340,IH,IM,IS,XX(L),YY(L),XDOT,YDOT
210:        GO TO 1369
211:   1367 PRINT 1350,IH,IM,IS,XX(L),YY(L),XDOT,YDOT,(XCOF(II),II=1,5)
```

```
212:        PRINT 1360,(YCOF(II),II=1,5)
213:        IFLAG=0
214:   1360 CONTINUE
215:    207 CONTINUE
216:        IF(ICS) 208,397,208
217:    397 WRITE(7) N
218:        NREC=NREC+1
219:    208 CONTINUE
220:    206 CONTINUE
221:    711 DO 658 I=1,10
222:        N(5,I)=0
223:        N(6,I)=0
224:        N(3,I)=N(3,10)
225:    658 N(4,I)=N(4,10)
226:        IF(ICS) 794,795,794
227:    794 ITIM=10*(JTIM/10)-1
228:    795 DO 667 I=1,12
229:        DO 666 J=1,10
230:        ITIM=ITIM+1
231:        N(5,J)=65535
232:    666 N(2,J)=ITIM
233:        NREC=NREC+1
234:    667 WRITE(7) N
235:        PRINT 1400
236:        PRINT 1410
237:        PRINT 1420
238:        PRINT 1430
239:        PRINT 1440
240:        PRINT 1450,N
241:        REWIND 7
242:        ITF=ITIM+1
243:        WRITE (9) ITF
244:        DO  9573 I=1,NREC
245:        READ (7) N
246:   9573 WRITE (9) N
247:        REWIND (9)
248:        WRITE (101,9876)
249:        GO TO 200
250:    100 FORMAT (8I5)
251:    101 FORMAT(3I5)
252:    105 FORMAT(I7/I5)
253:    106 FORMAT('ARRNG PREDICT TAPE----JOB ENDED')
254:    107 FORMAT(4X,I6)
255:    230 FORMAT('ENTER SATELLITE ID AND ORBIT # (I7/I5) ---TO EXIT PUSH NEW
256:       & LINE TWICE',/)
257:    240 FORMAT('      DAY     HOUR      MIN      SEC      DEL')
258:    400 FORMAT(2(2X,I2),2X,3F18.6)
259:    401 FORMAT('   TIME              EAST                NORTH            VERTIC
260:       *AL')
261:    402 FORMAT ('   TIME               X                   Y')
262:    405 FORMAT(////)
263:    407 FORMAT(1X,3(I2,1X),2F15.3)
264:    800 FORMAT (//I7////)
```

```
  801 FORMAT (I5,1X,3I2,1X,I3)
  802 FORMAT (8I8)
  803 FORMAT (24A1)
  804 FORMAT (/4X,A4)
 1000 FORMAT('1                              XY PREDICTS FOR NIMBUS ',I1)
 1010 FORMAT('                              -------------------------')
 1020 FORMAT('0     SATELLITE ID NUMBER: ',I7)
 1030 FORMAT('0     ORBIT NUMBER: ',I5)
 1040 FORMAT('0     DATE (DAY,MONTH,YEAR): ',I2,I3,' 19',I2)
 1050 FORMAT('0     JULIAN DAY: ',I3)
 1060 FORMAT('0     TIME OF PASS (HOURS,MINUTES,SECONDS): ',I2,I3,I3)
 1100 FORMAT('1                              ENV & RANGE DATA')
 1110 FORMAT('                              -----------------')
 1120 FORMAT('0 TIME     EAST      NORTH  VERTICAL   RANGE  RANGERATE')
 1130 FORMAT(' HRS MIN    KM        KM       KM        KM      KM/SEC')
 1140 FORMAT(2(2X,I2),4(2X,F7.1),2X,F7.3)
 1200 FORMAT('1                              XY & AZ/EL DATA')
 1210 FORMAT('                              ----------------')
 1220 FORMAT('0 TIME        X          Y         AZ         EL')
 1230 FORMAT(' HRS MIN   DEGREES    DEGREES   DEGREES    DEGREES ')
 1240 FORMAT(2(2X,I2),4(2X,F8.3))
 1300 FORMAT('1                              DATA FOR XY PASS TAPE')
 1310 FORMAT('                              ----------------------')
 1320 FORMAT('   TIME           X          Y       X DOT     Y DOT    INTERPOL
     X.    INTERPOL.    INTERPOL.    INTERPOL.    INTERPOL.')
 1330 FORMAT(' HRS MIN SEC  DEGREES  DEGREES  DEG/SEC  DEG/SEC  COEFF. 0
     X    COEFF. 1    COEFF. 2    COEFF. 3    COEFF. 4')
 1340 FORMAT(3(2X,I2),4(2X,F7.3))
 1350 FORMAT(3(2X,I2),4(2X,F7.3),5(2X,E10.3),2X,'FOR X COEFFICIENTS')
 1360 FORMAT(48X,5(2X,E10.3),2X,'FOR Y COEFFICIENTS')
 1400 FORMAT('1                              CHECK FOR PASS TAPE FORMAT')
 1410 FORMAT('                              --------------------------')
 1420 FORMAT('0',4X,'1',10X,'2',10X,'3',10X,'4',10X,'5',10X,'6',10X,'7',
     X10X,'8')
 1430 FORMAT(1X,'SATELLITE    TIME       164*X      164*Y     164*X DOT
     X 164*Y DOT    DATE        SPARE')
 1440 FORMAT(1X,'ID NUMBER   SECONDS    DEGREES    DEGREES     DEG/SEC
     X  DEG/SEC    YEAR/DAY')
 1450 FORMAT(8(I8,3X))
 1460 FORMAT('0NOTE: TIME = 3600*HOURS + 60*MINUTES + SECONDS')
 1470 FORMAT('1')
 1500 FORMAT(/I3,1X,3I2)
 1510 FORMAT(I7////)
 1600 FORMAT(/)
 1700 FORMAT('ENTER SATELLITE ID NUMBER (A ZERO WILL ABORT PROGRAM) : '
     *)
 1710 FORMAT(I7)
 1720 FORMAT('ENTER ORBIT NUMBER :  ')
 1730 FORMAT(I5)
 1740 FORMAT('ORBIT CANNOT BE FOUND ')
 1750 FORMAT('WRONG PREDICT TAPE OR WRONG SATELLITE ID NUMBER   ')
 9876 FORMAT('IF ANOTHER PASS DESIRED MOUNT NEW XY##')
      END
```

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
ABS	R	SPROG	INTRIN	
AY	R	SCALR	0098A V	1
CAI	I	UNUSED		
DEL	I	SCALR	0098E V	1
ENN	R	ARRAY	0079E V	50
EXX	R	ARRAY	007C8 V	50
HR	I	SCALR	0098C V	1
IBLANK	I	SCALR	00993 V	1
IEND	I	SCALR	00992 V	1
IHR	I	ARRAY	0085C V	50
IM	I	SCALR	009AE V	1
INTERPOL		SPROG	EXTERN	
ITF	I	SCALR	009BD V	1
JA	I	SCALR	009B8 V	1
J4	I	SCALR	009A2 V	1
L	I	SCALR	009AB V	1
MIN	I	SCALR	0098B V	1
N	I	ARRAY	008CC V	80
NR	I	SCALR	00993 V	1
NYB	I	SCALR	009A7 V	1
RANGE	R	ARRAY	008C0 V	50
SATID	I	SCALR	00989 V	1
SQRT	R	SPROG	INTRIN	
XAA	R	SCALR	009B6 V	1
XX	R	ARRAY	004B0 V	300
YC0F	R	ARRAY	008C7 V	5
YL	R	SCALR	009B2 V	1

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
ATAN	R	SPROG	INTRIN	
AZ	R	ARRAY	00924 V	50
DAY	I	SCALR	0098A V	1
EEE	R	ARRAY	0076C V	50
EOFSET		SPROG	EXTERN	
HHR	R	SCALR	009A0 V	1
I	I	SCALR	00997 V	1
ICS	I	SCALR	009A4 V	1
IFLAG	I	SCALR	009A9 V	1
II	I	SCALR	009BC V	1
IMN	I	ARRAY	0086E V	50
IS	I	SCALR	009AF V	1
ITIM	I	SCALR	0099C V	1
J8	I	SCALR	009B9 V	1
K	I	SCALR	009AC V	1
M	I	SCALR	009AA V	1
MMIN	I	SCALR	009A1 V	1
NC	I	SCALR	0099E V	1
NREC	I	SCALR	009A8 V	1
ORBN1	I	SCALR	0098F V	1
RATE	R	ARRAY	008F2 V	50
SATIE	I	SCALR	00988 V	1
VEE	R	ARRAY	007D0 V	50
XC0F	R	ARRAY	00802 V	5
XXX	R	SCALR	009B4 V	1
YD0T	R	SCALR	009BB V	1
YY	R	ARRAY	005DC V	300

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
AX	R	SCALR	00980 V	1
C0EF		SPROG	EXTERN	
DAYY	R	SCALR	00996 V	1
EL	R	ARRAY	00956 V	50
EXIT		SPROG	EXTERN	
HP	I	UNUSED		
IB	I	SCALR	0099F V	1
IDATA	I	ARRAY	00000 V	1200
IH	I	SCALR	009AD V	1
IJK	I	SCALR	00998 V	1
IND	I	SCALR	00999 V	1
ISLASH	I	SCALR	00991 V	1
J	I	SCALR	00998 V	1
JTIM	I	SCALR	0099D V	1
KQ	I	SCALR	009A5 V	1
MIM	I	UNUSED		
M0N	I	SCALR	00995 V	1
NP	I	SCALR	009A3 V	1
NXB	I	SCALR	009A6 V	1
ORBN2	I	SCALR	00990 V	1
RR	R	SCALR	0099A V	1
SEC	I	SCALR	0098D V	1
WYE	R	ARRAY	0073A V	50
XD0T	R	SCALR	009BA V	1
YAA	R	SCALR	009B7 V	1
YEAR	R	SCALR	00994 V	1
YYY	R	SCALR	00985 V	1

LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC
100	003C5	101	003C6	105	003CB	106	003CE	107	003D8	200	00008
201	00019	202	00087	203	000B8	205	00192	206	0035C	207	0034B
208	00357	236	0003D	239	003DB	240	003EF	300	001FC	301	001F8
302	00200	303	00203	304	00208	305	00207	306	0020F	307	00212
397	00351	400	003FB	401	00401	402	00412	405	0041E	407	00421
500	00257	501	00253	502	0025B	503	0025E	504	00266	505	00262
506	0026A	507	00260	508	000FF	604	00103	658	0036C	666	00382
667	00337	701	0022E	708	00234	709	00237	711	00361	712	0023E
720	00240	721	0024C	728	00207	729	002E2	730	002EF	735	00239
777	00042	794	00372	795	00377	800	00427	801	0042B	802	00431
803	00434	804	00437	900	00047	901	00054	902	0005F	903	00074
1000	0043A	1010	00449	1020	00458	1030	00462	1040	0046A	1050	00477
1060	0047F	1100	0048F	1110	0049C	1120	004A9	1130	00489	1135	00141
1140	004C9	1145	00158	1200	004D2	1210	004DF	1220	004EC	1230	004FA
1240	00509	1300	00510	1310	0051E	1320	0052C	1330	00549	1340	00566
1345	002A5	1350	00560	1360	0057D	1365	002C7	1367	00325	1369	00348
1400	00589	1410	00598	1420	005A8	1430	005BA	1440	005D2	1450	005E8

```
1460  005EC      1470  005FA      1500  005FD      1510  00601      1530  000DE      1600  00604
1700  00606      1710  00617      1720  00619      1730  00621      1740  00623      1750  0062B
9573  003B4      9876  0063A

LOCAL VARIABLES (2494 WORDS):

   00000 IDATA      004B0 XX         005DC YY         00708 EXX        0073A WYE        0076C EEE
   0079E ENN        007D0 VEE        00802 XC0F       00807 YC0F       0080C N          0085C IHR
   0088E IMN        008C0 RANGE      008F2 RATE       00924 AZ         00956 EL         00988 SATIE
   00989 SATID      0098A DAY        0098B MIN        0098C HR         0098D SEC        0098E DEL
   0098F BRBN1      00990 BRBN2      00991 ISLASH     00992 IEND       00993 IBLANK     00994 YEAR
   00995 MBN        00996 DAYY       00997 I          00998 J          00999 IND        0099A RR
   0099B IJK        0099C ITIM       0099D JTIM       0099E NC         0099F IB         009A0 HHR
   009A1 MMIN       009A2 J4         009A3 NP         009A4 ICS        009A5 KQ         009A6 NXB
   009A7 NYB        009A8 NREC       009A9 IFLAG      009AA M          009AB L          009AC K
   009AD IH         009AE IM         009AF IS         009B0 AX         009B1 AY         009B2 YL
   009B3 NR         009B4 XXX        009B5 YYY        009B6 XAA        009B7 YAA        009B8 JA
   009B9 JB         009BA XDOT       009BB YDOT       009BC II         009BD ITF

BLANK COMMON (0 WORDS)

INTRINSIC SUBPROGRAMS USED:

   ABS         ATAN        SQRT

EXTERNAL SUBPROGRAMS REQUIRED:

   COEF.       E0FSET      EXIT        INTERP0L    F:101       F:108       M:D0        9ATAN1
   9ATAN2      9BCDREDEE   9BCDREAD    9BCDWRIT    9BINREAD    9BINWRIT    9BKSPACE    9ENDI0L
   9INITIAL    9I0DATA     9I0LUSA     9IT0R       9PRINT      9REWIND     9RTGI       9SQRT
   9STOP

HIGHEST ERROR SEVERITY: 0 (NO ERRORS)

                    DEC          HEX
                   WORDS        WORDS
                  -------      -------
 GENERATED CODE:    1609         00649
      CONSTANTS:      17         00011
LOCAL VARIABLES:    2494         009BE
          TEMPS:       2         00002
                  -------      -------
  TOTAL PROGRAM:    4122         0101A
```

```
1:        SUBROUTINE INTERPOL(A,COF,NN)
2:        DIMENSION A(900),COF(5)
3:        EN=NN
4:        T=-1
5:        DO 1   I=1,NN
6:        A(I)=COF(1)+COF(2)*T+COF(3)*T*T+COF(4)*T*T*T+COF(5)*T*T*T*T
7:      1 T=T+1./EN
8:        RETURN
9:        END
```

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
A	R	ARRAY	*00004 V	DUMMY
I	I	SCALR	00003 V	1
NN	I	SCALR	*00006 V	DUMMY
COF	R	ARRAY	*00005 V	DUMMY
INTERPOL		SPROG	00000 P	
T	R	SCALR	00002 V	1
EN	R	SCALR	00001 V	1
INTERPOL	I	SCALR	00000 V	1

LABEL	HEX LOC
1	002A

LOCAL VARIABLES (4 WORDS):

00000 INTERPOL 00001 EN 00002 T 00003 I

BLANK COMMON (0 WORDS)

ENTRY POINTS:

00000 INTERPOL

EXTERNAL SUBPROGRAMS REQUIRED:

M:DO 9ITOR 9SETUPN

HIGHEST ERROR SEVERITY: 0 (NO ERRORS)

	DEC WORDS	HEX WORDS
GENERATED CODE:	51	00033
CONSTANTS:	2	00002
LOCAL VARIABLES:	4	00004
TEMPS:	7	00007
TOTAL PROGRAM:	64	00040

```
1:        SUBROUTINE COEFF(B,COF)
2:        DIMENSION B(5),COF(5)
3:        DEL1=B(2)-B(1)
4:        DEL2=B(3)-B(2)
5:        DEL3=B(4)-B(3)
6:        DEL4=B(5)-B(4)
7:        COF(1)=B(3)
8:        COF(4)=(-DEL3-DEL2+DEL1+DEL4)/12.
9:        COF(5)=(-3.*DEL3+3.*DEL2+DEL4-DEL1)/24.
10:       COF(2)=(DEL3+DEL2-2.*COF(4))/2.
11:       COF(3)=(DEL3-DEL2-2.*COF(5))/2.
12:       RETURN
13:       END
```

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
B	R	ARRAY	*00005 V	DUMMY
CUF	R	ARRAY	*00006 V	DUMMY
DEL3	R	SCALR	00003 V	1
C0EF	R	SCALR	00000 V	1
DEL1	R	SCALR	00001 V	1
DEL4	R	SCALR	00004 V	1
C0EF		SPR0G	00000 P	
DEL2	R	SCALR	00002 V	1

LOCAL VARIABLES (5 WORDS):

00000 C0EF 00001 DEL1 00002 DEL2 00003 DEL3 00004 DEL4

BLANK COMMON (0 WORDS)

ENTRY POINTS:

00000 C0EF

EXTERNAL SUBPROGRAMS REQUIRED:

M:D0 9$ETUP2

HIGHEST ERROR SEVERITY: 0 (NO ERRORS)

	DEC WORDS	HEX WORDS
GENERATED CODE:	69	00045
CONSTANTS:	4	00004
LOCAL VARIABLES:	5	00005
TEMPS:	4	00004
TOTAL PROGRAM:	82	00052

```
MESSAGE  TAPE:  ENV#:  GSFC PREDICTION TAPE (ENV)
ASSIGN M:B0,(DEVICE,CPB04)
FORTRAN    SI,GO,RT
```

```
    1:        INTEGER SATID,HR,SEC,DAY,DEL
   55:        END
```

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
DAY	I	SCALR	00003 V	1
EXIT		SPROG	EXTERN	
IDATA	I	ARRAY	00009 V	4800
ISLASH	I	SCALR	00007 V	1
MIN	I	SCALR	012CB V	1
SEC	I	SCALR	00002 V	1
DAYY	I	SCALR	00006 V	1
HR	I	SCALR	00001 V	1
IEND	I	SCALR	00008 V	1
J	I	SCALR	012CD V	1
MON	I	SCALR	012C9 V	1
YEAR	I	SCALR	00005 V	1
DEL	I	SCALR	00004 V	1
I	I	SCALR	012CC V	1
IND	I	SCALR	012CE V	1
KK	I	SCALR	012CA V	1
SATID	I	SCALR	00000 V	1

LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC
100	00096	101	0009A	102	000A0	103	000A3	104	000A6	105	000A9
106	000AC	107	000B8	108	000C1	109	000D1	110	000DD	111	000E8
112	000F8	113	000FB	201	00045	202	00052	203	00067	205	00079
301	00036	305	00104								

LOCAL VARIABLES (4815 WORDS):

00000 SATID	00001 HR	00002 SEC	00003 DAY	00004 DEL	00005 YEAR
00006 DAYY	00007 ISLASH	00008 IEND	00009 IDATA	012C9 MON	012CA KK
012CB MIN	012CC I	012CD J	012CE IND		

BLANK COMMON (0 WORDS)

EXTERNAL SUBPROGRAMS REQUIRED:

EXIT	F:108	M:08	$BCDRDEE	$BCDREAD	$ENDIOL	$INITIAL
$IODATA	$PRINT	$REWIND	$STOP			

HIGHEST ERROR SEVERITY: 0 (NO ERRORS)

	DEC WORDS	HEX WORDS
GENERATED CODE:	266	0010A
CONSTANTS:	2	00002
LOCAL VARIABLES:	4815	012CF
TEMPS:	0	00000
TOTAL PROGRAM:	5083	013DB

HIGHEST ERROR SEVERITY: 0 (NO ERRORS)

	DEC WORDS	HEX WORDS
GENERATED CODE:	266	010A
CONSTANTS:	2	0002
LOCAL VARIABLES:	4815	12CF
TEMPS:	0	0000
TOTAL PROGRAM:	5083	13DB

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
DAY	I	SCALR	00003 V	1
EXIT		SPROG	EXTERN	
IDATA	I	ARRAY	00009 V	4800
ISLASH	I	SCALR	00007 V	1
MIN	I	SCALR	012CB V	1
SEC	I	SCALR	00002 V	1

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
DAYY	I	SCALR	00006 V	1
HR	I	SCALR	00001 V	1
IEND	I	SCALR	00008 V	1
J	I	SCALR	012CD V	1
MON	I	SCALR	012C9 V	1
YEAR	I	SCALR	00005 V	1

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
DEL	I	SCALR	00004 V	1
I	I	SCALR	012CC V	1
IND	I	SCALR	012CE V	1
KK	I	SCALR	012CA V	1
SATID	I	SCALR	00000 V	1

LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC
100	00096	101	0009A	102	000A0	103	000A3	104	000A6	105	000A9
106	000AC	107	000B6	108	000C1	109	000D1	110	000DD	111	000EB
112	000F8	113	000FB	201	00045	202	00052	203	00067	205	00079
301	00036	305	00104								

LOCAL VARIABLES (4815 WORDS):

00000 SATID	00001 HR	00002 SEC	00003 DAY	00004 DEL	00005 YEAR
00006 DAYY	00007 ISLASH	00008 IEND	00009 IDATA	012C9 MON	012CA KK
012CB MIN	012CC I	012CD J	012CE IND		

BLANK COMMON (0 WORDS)

EXTERNAL SUBPROGRAMS REQUIRED:

EXIT	F:10B	M:D0	9BCDRDEE	9BCDREAD	9ENDIOL	9INITIAL	9IODATA
9PRINT	9REWIND	9STOP					

```
53:   305 REWIND 9
54:       CALL EXIT
55:       END
```

```
      GO TO 120
  105 IF (STAT1(23)+STAT1(24)) 115,115,110
  110 MODE1=SLAVE
      IF(STAT1(23).EQ.1) MODE2=ONE
      IF(STAT1(24).EQ.1) MODE2=TWO
      GO TO 120
  115 IF (STAT1(25).EQ.1) MODE1=STOW
      IF(STAT1(26).EQ.1) MODE1=AUTO
      IF(STAT1(27).NE.1) GO TO 120
      MODE1=PROG
      IF (STAT2(21).EQ.1) MODE2=AUG
      IF(STAT2(23).EQ.1) MODE2=MAN
      IF(STAT2(21)+STAT2(23) .EQ.2) MODE2=MANAUG
  120 CONTINUE
      IF(STAT2(15).EQ.1) SCAN=YES
      IF(STAT2(22).EQ.1) RCVR=YES
      IF(IS.NE.0) GO TO 200
      PRINT 10
      PRINT 11
      PRINT 12
  200 PRINT 13,IH,IM,IS,JH,JM,JS,RX,CX,RY,CY,PEX,PEY,REX,REY,MODE1,MODE2
     1,SCAN,RCVR
      MODE1=BLANK
      MODE2=BLANK
      SCAN=NO
      RCVR=NO
      GO TO 20
    4 STOP
   10 FORMAT('1  REAL     COMMAND     REAL    COMMAND     REAL    COMMAND  P
     1ROGRAM  PROGRAM  RECEIVE  RECEIVE  OPERATION  SCAN  RCVR')
   11 FORMAT('    TIME       TIME    X ANGLE  X ANGLE  Y ANGLE  Y ANGLE  X
     1 ERROR  Y ERROR  X ERROR  Y ERROR      MODE      MODE   LOCK')
   12 FORMAT(' H  M  S   H  M  S   DEGREES  DEGREES  DEGREES  DEGREES  D
     1EGREES  DEGREES  DEGREES  DEGREES'/)
   13 FORMAT(3I3,1X,3I3,8F9.3,1X,2(1X,A4),2(2X,A4))
  555 FORMAT (70X,2(5X,I1,4(1X,4I1)),4X,I1)
      END
```

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
AUG	I	SCALR	0024A V	1
BUFFERIN		SPROG	EXTERN	
CY	R	SCALR	00298 V	1
ENCY	I	ARRAY	00270 V	32
IM	I	SCALR	002A2 V	1
J	I	SCALR	00291 V	1
JS	I	SCALR	002A7 V	1
MODE1	I	SCALR	002A8 V	1
N9	I	SCALR	0024D V	1
PEY	R	SCALR	0029D V	1
RCVR	I	SCALR	0024F V	1
RT	R	SCALR	00293 V	1
RY	R	SCALR	00296 V	1
SLAVE	I	SCALR	00242 V	1
STAT2	I	ARRAY	00020 V	32
TW9	I	SCALR	00246 V	1
Z	R	SCALR	00290 V	1

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
AUT9	I	SCALR	00243 V	1
CT	R	SCALR	00294 V	1
DATABASE	I	ARRAY	00040 V	512
FLAG	R	SCALR	00297 V	1
IS	I	SCALR	002A3 V	1
JH	I	SCALR	002A4 V	1
MAN	I	SCALR	00240 V	1
MODE2	I	SCALR	002A9 V	1
8NE	I	SCALR	00247 V	1
P8S	I	SCALR	00245 V	1
REX	R	SCALR	0029E V	1
RX	R	SCALR	00295 V	1
RYPAST	R	SCALR	00299 V	1
SM	R	SCALR	002A5 V	1
ST8W	I	SCALR	00241 V	1
VEL	I	SCALR	00248 V	1

NAME	TYPE	CLASS	HEX LOC	DEC WORDS
BLANK	I	SCALR	00248 V	1
CX	R	SCALR	0029A V	1
ENCX	I	ARRAY	00250 V	32
IH	I	SCALR	002A0 V	1
IX8IT		SPR8G	EXTERN	
JM	I	SCALR	002A6 V	1
MANAUG	I	SCALR	00249 V	1
N	I	SCALR	00292 V	1
PEX	R	SCALR	0029C V	1
PR8G	I	SCALR	00244 V	1
REY	R	SCALR	0029F V	1
RXPAST	R	SCALR	00298 V	1
SCAN	I	SCALR	0024E V	1
STAT1	I	ARRAY	00000 V	32
TM	R	SCALR	002A1 V	1
YES	I	SCALR	0024C V	1

LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC	LABEL	HEX LOC
2	00014	3	0001D	4	00118	10	0011D	11	0013C	12	00158
13	00174	20	0000C	100	000AC	105	00089	110	000BC	115	000C9
120	000E8	200	000FD	555	0017F						

LOCAL VARIABLES (682 WORDS):

00000 STAT1	00020 STAT2	00040 DATABASE	00240 MAN	00241 ST8W	00242 SLAVE
00243 AUT9	00244 PR8G	00245 P8S	00246 TW9	00247 8NE	00248 BLANK
00249 MANAUG	0024A AUG	00248 VEL	0024C YES	0024D N9	0024E SCAN
0024F RCVR	00250 ENCX	00270 ENCY	00290 Z	00291 J	00292 N
00293 RT	00294 CT	00295 RX	00296 RY	00297 FLAG	00298 RXPAST
00299 RYPAST	0029A CX	00298 CY	0029C PEX	0029D PEY	0029E REX
0029F REY	002A0 IH	002A1 TM	002A2 IM	002A3 IS	002A4 JH
002A5 SM	002A6 JM	002A7 JS	002A8 MODE1	002A9 MODE2	

BLANK COMMON (0 WORDS)

EXTERNAL SUBPROGRAMS REQUIRED:

BUFFERIN	IX8IT	F:108	M:D8	9ENDIAL	9INITIAL	9I8DATA	9IT0R
9PRINT	9REWIND	9RT0I	9ST0P				

HIGHEST ERROR SEVERITY: 0 (NO ERRORS)

	DEC WORDS	HEX WORDS
GENERATED CODE:	394	018A
CONSTANTS:	9	0009
LOCAL VARIABLES:	682	02AA
TEMPS:	0	0000
TOTAL PROGRAM:	1085	043D

```
      INTEGER SATID,HR,SEC,DAY,DEL
      INTEGER YEAR,DAYY
      DATA ISLASH/4H/   /,IEND/4H MSG/
      DIMENSION IDATA(200,24)
      READ(9,100) DAY,YEAR,MON,DAYY
      READ(9,105) SATID
      KK=0
      IF(SATID.EQ.6903701) KK=3
      IF(SATID.EQ.7002501) KK=4
      PRINT 106,KK
      PRINT 107,SATID
      PRINT 108,DAYY,MON,YEAR
      PRINT 109,DAY
      PRINT 110
      PRINT 111
      PRINT 112
      GO TO 201
  301 READ(9,100,END=305) DAY,YEAR,MON,DAYY
      READ(9,105) SATID
  201 READ(9,101,END=305) DAY,HR,MIN,SEC,DEL
      I=1
  202 READ(9,103) (IDATA(I,J),J=1,24)
      IF(IDATA(I,4).EQ.ISLASH) GO TO 203
      I=I+1
      GO TO 202
  203 I=I-1
      DEL=DEL*I-4
      MIN=MIN+2
      IF(MIN.LT.60) GO TO 205
      MIN=MIN-60
      HR=HR+1
      IF(HR.LT.24) GO TO 205
      HR=HR-24
      DAY=DAY+1
  205 PRINT 113,DAY, (IDATA(I+1,J),J=6,10),HR,MIN,SEC,DEL
        READ(9,104) IND
      IF (IND.EQ.IEND) GO TO 301
      GO TO 201
  100 FORMAT (/I3,1X,3I2)
  101 FORMAT (2X,I3,1X,3I2,1X,I3)
  102 FORMAT (6I3)
  103 FORMAT (24A1)
  104 FORMAT (/4X,A4)
  105 FORMAT (I7////)
  106 FORMAT ('1                PREDICTS FOR NIMBUS ',I1)
  107 FORMAT ('OSATELLITE ID NUMBER: ',I7)
  108 FORMAT ('OPERIOD STARTING (DAY,MONTH,YEAR): ',I2,1X,I2,1X,'19',I2)
  109 FORMAT('                        JULIAN DAY: ',I3)
  110 FORMAT ('0JULIAN   ORBIT     HOUR  MIN   SEC    DURATION')
  111 FORMAT ('   DAY      NUMBER',21X,'OF PASS (MINUTES)')
  112 FORMAT ('    ')
  113 FORMAT (3X,I3,6X,5A1,3(4X,I2),5X,I2)
```

```
      INTEGER STAT1(32),STAT2(32),DATABASE(512)
      INTEGER MAN/'MAN '/,STOW/'STOW'/,SLAVE/'SLAV'/,
     1AUTO/'AUTO'/,PROG/'PROG'/,POS/'POS'/,TWO/'2 X'/,ONE/'1 X'/
      INTEGER BLANK/'    '/,MANAUG/'MAUG'/,AUG/'AUG'/,VEL/'VEL'/
      INTEGER YES/'YES'/,NO/'NO'/,SCAN,RCVR
      INTEGER ENCX(32),ENCY(32)
      DATA Z/16383/
      PRINT 10
      PRINT 11
      PRINT 12
      REWIND 9
   20 CALL BUFFER IN (9,1,DATABASE,512,J,N)
    2 GO TO (2,3,4,3),J
    3 RT=DATABASE(57)
      CT=DATABASE(59)
      RX=DATABASE(44)
      RY=DATABASE(45)
      FLAG=0
      IF((RX-RXPAST).EQ.0)FLAG=1
      IF((RY-RYPAST).EQ.0)FLAG=2
      RXPAST=RX
      RYPAST=RY
      CX=DATABASE(60)
      CY=DATABASE(61)
      PEX=DATABASE(110)
      PEY=DATABASE(111)
      REX=DATABASE(38)
      REY=DATABASE(39)
      IH=RT/3600
      TM=RT-3600.*IH
      IM=TM/60.
      IS=TM-60.*IM
      JH=CT/3600
      SM=CT-3600.*JH
      JM=SM/60.
      JS=SM-60.*JM
      RX=(RX*100.)/Z
      RY=(RY*100.)/Z
      CX=(CX*100.)/Z
      CY=(CY*100.)/Z
      PEX=(PEX*10.)/Z
      PEY=(PEY*10.)/Z
      REX=(REX*10.)/Z
      REY=(REY*10.)/Z
      CALL IXBIT(1,DATABASE(10),ENCX)
      CALL IXBIT(1,DATABASE(11),ENCY)
      CALL IXBIT (1,DATABASE(49),STAT1)
      CALL IXBIT (1,DATABASE(50),STAT2)
      IF(STAT1(21)+STAT1(22)) 105,105,100
  100 MODE1=MAN
      IF (STAT1(21).EQ.1) MODE2=POS
      IF (STAT1(22).EQ.1) MODE2=VEL
```