N84-33773

FINAL REPORT

NASA CONTRACT NO. NAS8-34529

PINHOLE/CORONOGRAPH POINTING CONTROL SYSTEM INTEGRATION AND NOISE REDUCTION ANALYSIS

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National Aeronautics and Space Administration
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BER Report No. 274-100

September 1981

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Submitted to

National Aeronautics and Space Administration
Marshall Space Flight Center
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From

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September 1981

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I. Introduction

The Pinhole Occulter Facility(P/OF) is a Space Shuttle based experiment for the production of solar coronographics and hard x-ray images. The system is basically a pinhole camera utilizing a deployable 50-m flexible boom for separating the pinholes and coronograph shields from the recording devices located in the Shuttle bay. At the distal end of the boom from the Shuttle is a 25 kg mask containing pinholes and coronograph shields. At the proximal end the detectors are located and mounted, along with the deployable boom, to the ASPS gimbal pointing system (AGS).

The mask must be pointed at the sun with a high degree of pointing stability and accuracy to align the axes of the detectors with the pinholes and shields. Failure to do so will result in a blurring of the images on the detectors and a loss of resolution. Being a Shuttle based experiment, the system will be subjected to the disturbances of the Shuttle. The worst of these is thruster firing for orbit correction; the Shuttle uses a bang-bang thruster control system to maintain orbit to within preset limits. Other disturbances include man motion, motion induced by other systems, and gravity gradient torques.

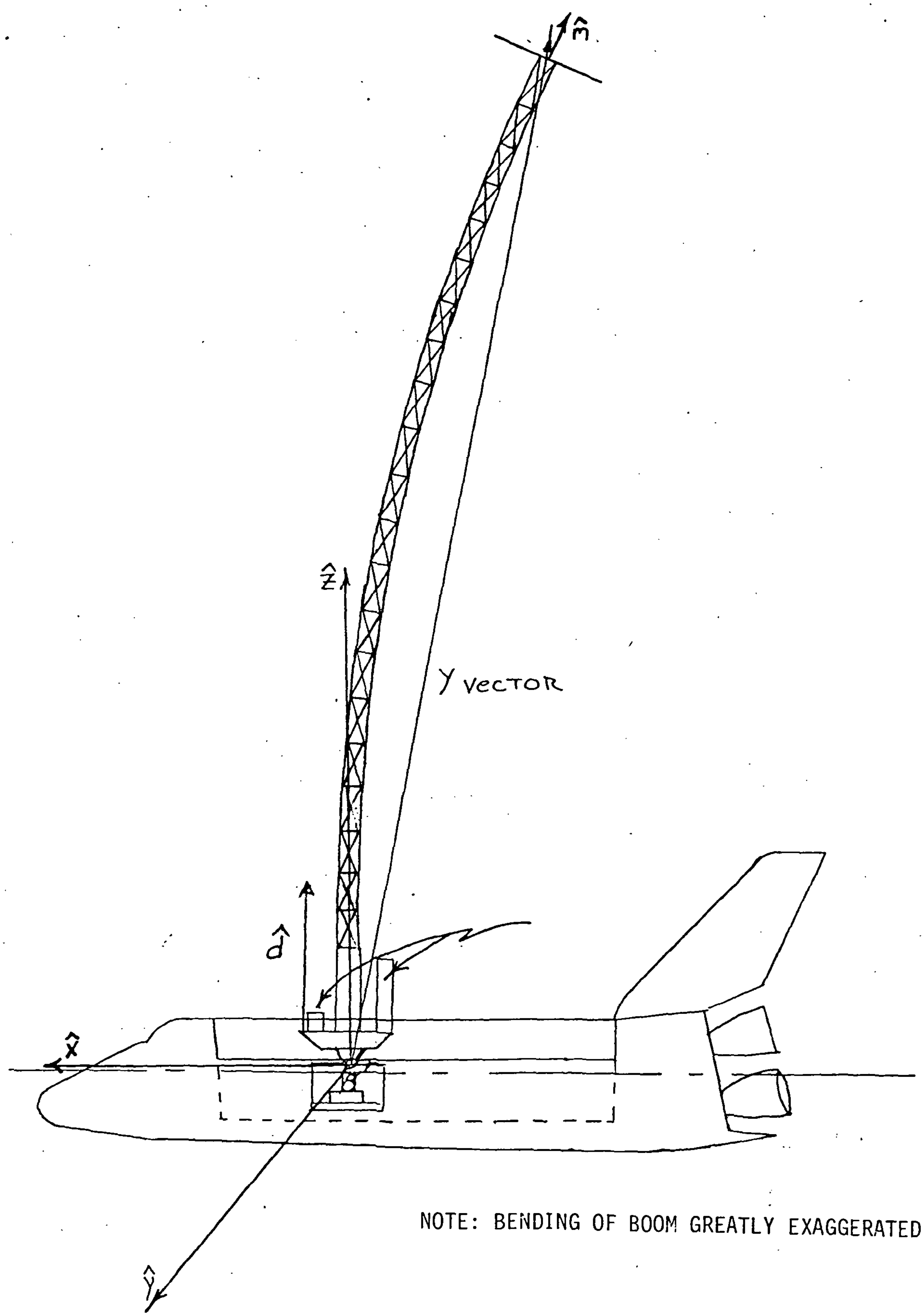
The control system of the pointing mount can sense both position of the mask tip relative to the base and pointing error and uses these to accurately estimate the flexible body modes of the system and point the boom. An optimal control/suppression scheme is then used to control the flexible modes. Acceleration feedback is used to point the system. Disturbances are detected by accelerometers in the AGS and are used as negating commands to drive the system and reduce disturbance effects.

An overall layout of the P/OF system is shown in Figure 1. Motions of the boom are measured in the $\hat{x}$, $\hat{y}$, $\hat{z}$ coordinate system which is centered on the gimbal axes. The AGS is mounted 2.2 m forward and .75 m above the Shuttle cm. The vector y is the total pointing vector of the system; the difference between vector y and the vector command is the total pointing error of the system. The vector $\hat{d}$ is the pointing of the base of the boom (AGS mounting plate). The vector $\hat{m}$ is (assuming rigid boom-mask mounting) $y - \hat{d}$.

The simulation of this system will be by state space analysis. The boom maintains vibrational states called flexible modes as well as rigid rotational modes. The Shuttle is modeled by rigid rotational and rigid translational modes. The AGS is modeled by use of phase variables and random noise. The sensors are modeled as constant gains with random noise. The states used in this study are defined in Table 1.

FIGURE 1

P/OF SYSTEM LAYOUT



NOTE: BENDING OF BOOM GREATLY EXAGGERATED.

TABLE 1

SYSTEM STATE DEFINITION

X_c - CONTROLLED STATES (8 total)

- These are the states which define the flexible body positions and velocities (modes) of the experiment. They are acted on (or controlled) by the inner loop controller $-KX_c$.

X_R - RIGID BODY STATES (6 total)

- These are the states which define the rigid body positions and velocities (modes) of the experiment. Physically they represent the angular displacements and velocities of the experiment. They are acted on by the PID controller.

X_S - SUPPRESSED STATES (8 total)

These states represent additional flexible body positions and velocities (modes) of the experiment. These states are not physically suppressed by the inner loop controller; the design of the inner loop controller is such that its effect on these states is minimized.

X_{sh} - SHUTTLE STATES (12 total)

- These are the states that define the shuttle orbiter. Physically they are the linear and angular positions and velocities of the Shuttle.

X_G - AGS STATES (13 total)

- These states define the modal filters of AGS plus the proportional-integral-derivative (PID) controller.

II. Gimbal (AGS) System

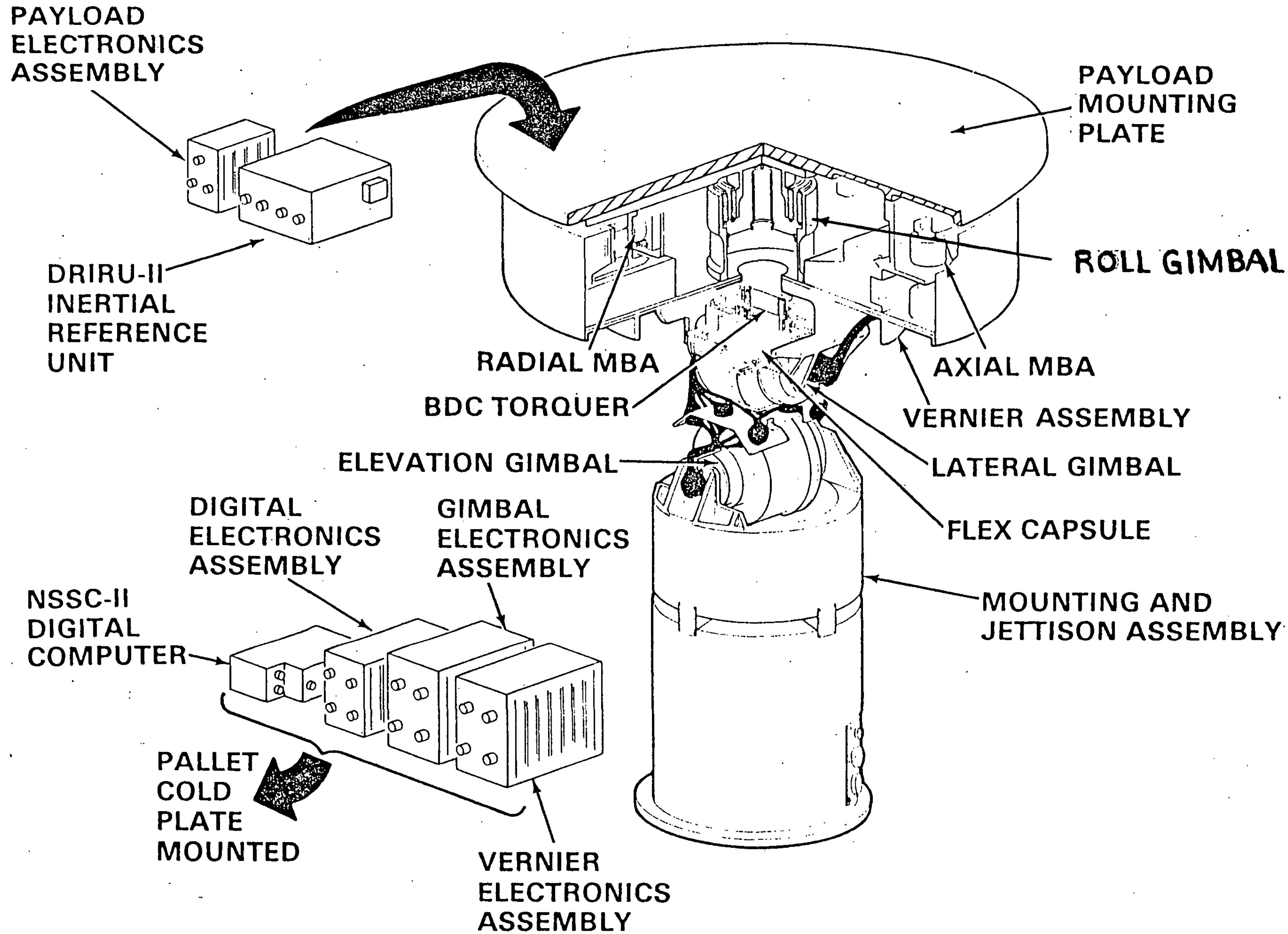
In the P/OF system, all instruments, boom and mask must be pointed at the sun. All motions of the Shuttle (linear and angular) are angular changes as seen by the instruments. This enables a three dimensional angular pointing mount system to be used. For reduced pointing errors the angular suspension pointing system (ASPS) can be used. The ASPS gimbal pointing system (AGS) was used in this study.

II.1 AGS Layout

Figure 2 illustrates the layout of the major elements comprising AGS.[1] Two identical gimbal assemblies are stacked to form an elevation and a lateral gimbal pair. The lower (elevation) gimbal provides an angular range of ± 100 degrees (from vertical), and the upper (lateral) gimbal provides cross-axis positioning of ± 60 degrees. The gimbals are mechanically limited by an adjustable stop arrangement to prevent contact with the Shuttle. A Mounting and Jettison Assembly (MJA) is used to connect the gimbal pair with the underlying mounting structure. During launch and landing, a separation device within the MJA physically disconnects the mounting base from the AGS gimbals which are independently caged with the experiment to the mounting structure. This approach prevents indeterminant load paths from occurring across the gimbal bearings due to static deflection of the mounting structure and launch or landing environmental loads. The MJA also contains a pyrotechnically actuated jettison system, which provides for total separation (and jettisoning) of the experiment/AGS gimbals in the event of a multiple failure in orbit. An accelerometer unit mounted on the MJA senses orbiter motion for use in a feedforward decoupling control law.[2]

FIGURE 2

AGS LAYOUT



The gimbals are connected to the experiment through a Payload Mounting Structure (PMS) and an Experiment Mounting Structure. The PMS consists of a nominal 1 meter diameter mounting plate and an adapter section which connects with the lateral gimbal. An optional third gimbal to permit rotation about the payload line of sight (roll axis) can be inserted at this location. Since the payload mounting plate is removable, experiment integration can be accomplished independently of the pointing system. Also, the flat end-mount configuration of the mounting plate permits overhanging to accommodate the large POF boom, coronographs and x-ray detectors.[2]

Each of the Coarse Gimbal Assemblies contains a permanent magnet, brushless two-phase dc torquer, a multispeed wound rotor resolver for commutation of the torquer drive signal and a single-speed wound rotor resolver for position readout and control of the gimbal angle. Since both elevation and lateral gimbals have a limited rotational freedom, electrical connections are carried across the rotating gimbals through flex capsules. The flex capsules contain flat flex tapes which are looped between concentric cylinders in the center of each gimbal. Duplex gimbal bearing pairs are used in each gimbal assembly in a fixed/floating cartridge arrangement. The cartridges permit the bearing preload to be set by tolerances within the cartridge itself; dimensional changes which result from temperature variations cause the sliding cartridge to move axially without inducing mechanical stresses or upsetting the bearing preloads.[2]

The AGS inertial sensors will be mounted on the experiment mounting structure for coalignment with the experiment. These sensors include the DRIRU-II (on all missions) and one or more angular error sensors as discussed in the Sensor Study Section (III). Control and data interfaces with the sensors are provided by a Payload Electronics Assembly (PEA) which is connected to the remainder of the AGS electronics through a multiplexed serial data system. The PEA is a general purpose microprocessor-controlled interface unit which provides a Remote Interface Unit (RIU) compatible serial interface with the position sensors, and a special purpose interface with the DRIRU-II. Experiment control and data is handled by a standard Remote Acquisition Unit (RAU) which connects to the Spacelab Command and Data Measurement System (CDMS). Additional lines are also provided to the experiment for high speed data, control and power. Both the PEA and RAU are located on the payload side of the AGS gimbals.[2]

Primary AGS electronics consist of a Gimbal Electronics Assembly (GEA), Digital Electronics Assembly (DEA) and NASA Standard Spacecraft Computer (NSSC-II), all of which are mounted to a Spacelab cold plate on the same Spacelab pallet as the AGS mechanical hardware. The GEA contains analog electronics for modulation and demodulation of the gimbal angle resolvers and for power drive of the two-phase, brushless dc torquers used to position the gimbals. The interfaces with these electronics are analog, and they are connected directly to A/D and D/A converters within the DEA. A discrete system for driving an independent set of backup coils in the torquers and for determining gimbal position using separate discrete type optical sensors is also provided by the GEA. When connected through hard wiring to a contingency panel in the Orbiter or alternatively to the subsystem CDMS, this system provides a fully redundant backup caging capability for the AGS. The GEA also contains electronics which operate the experiment launch locks and power switching for all of the AGS electronics (sensors, PEA, DEA and NSSC-II).[2]

The DEA is a microprocessor-controlled general purpose interface unit which provides data input and output to the NSSC-II. Interface modules permit serial data transfer to and from the PEA, analog input and output signals to the GEA and Accelerometer Unit, discrete I/O with the GEA, serial I/O with the Spacelab CDMS via a coldplate-mounted RAU and serial output to the Spacelab High Rate Multiplexer (HRM).[2]

Flight software is organized into functional modules which are relatively independent, as indicated in Figure 3. The Attitude Control Module provides the servo error compensation and torque distribution for the two gimbal control systems and is described first. Two ACS modes are provided on the AGS depending on whether the gimbal resolver or the IRU is used for feedback control of the attitude. These are defined as the Gimbal Pointing ACS Mode and the Payload Pointing ACS Mode, respectively.[2]

Gimbal (resolver) pointing will normally be used only during the initial erection, holding or stowage maneuvers which involve a sequence of individual gimbal axis rotations. All other operations will use the Payload (IRU) Pointing Mode.

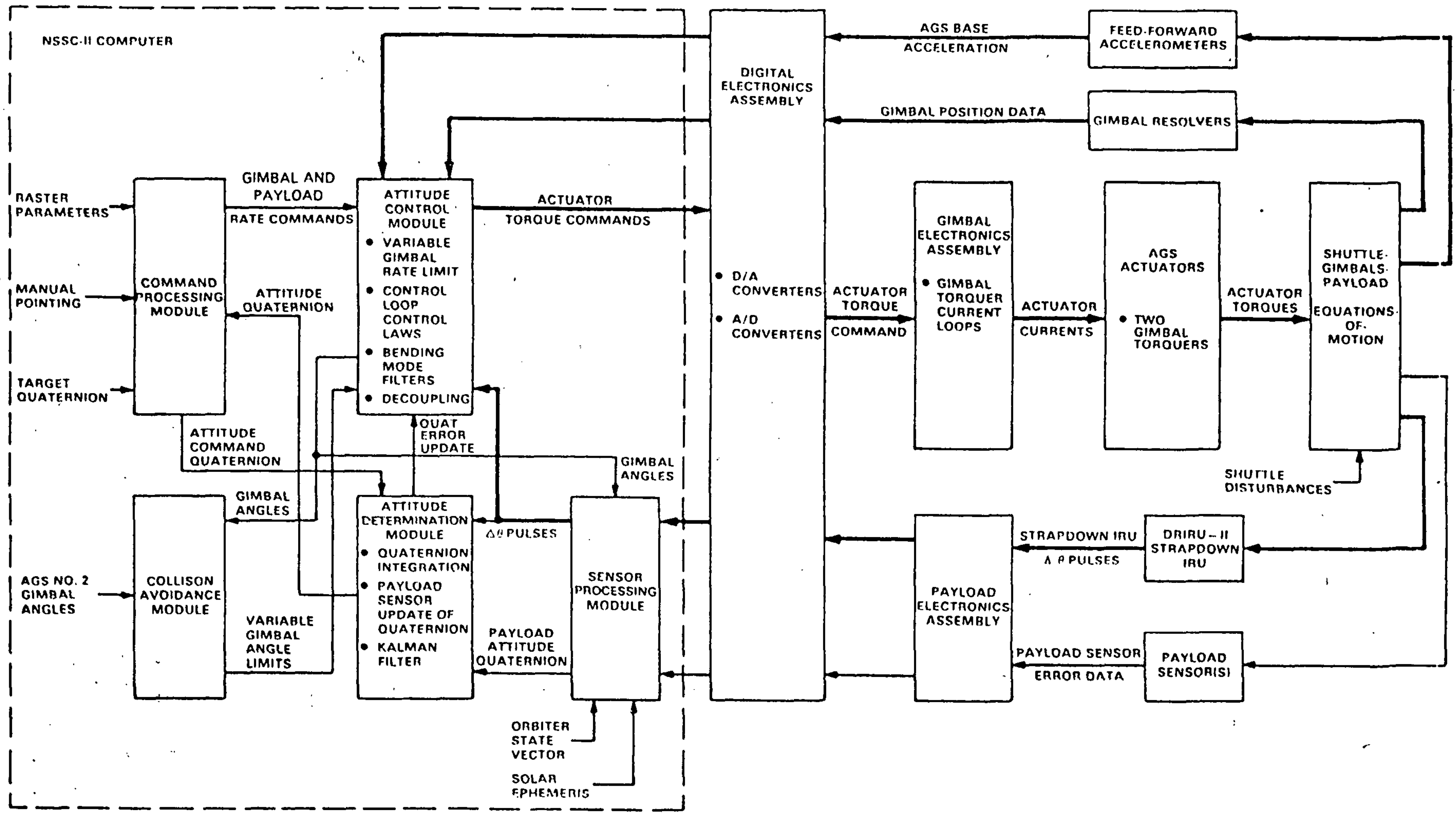
II.2 AGS Interfacing

The AGS is accessible through the output sensors and Payload Electronic Assembly (PEA) and the NSSC-II computer. These access the regular torquer coils and can be used for rigid body control. Command inputs to the gimbal originate in the NSCC-II which as seen in Figure 4 outputs to the DEA which in turn activates the GEA and the gimbal.[1]

In addition, a separate access is available. This path is through the GEA directly to the two sets of coils in the torquers. This path could be used if multiloop control is necessary such as modal control of

FIGURE 3

AGS SOFTWARE/INTERFACING



flexible bodies. For POF, this access appears to be promising.

II. 3 AGS Noise, Errors and Accuracy

For the purposes of this study all quiescent stability errors and pointing inaccuracies shall be considered as noise. Pointing error defines the total angular error that is allowed by the AGS. Pointing error is the sum of pointing accuracy and pointing stability.

Pointing accuracy defines how close the AGS initially points the experiment line of sight to the desired target. Pointing accuracy applies at the beginning of an experiment observation period following an in-orbit calibration of the alignment errors, maneuverability to the desired target and convergence of the altitude determination system over the specific settling time. Examples of errors that contribute to pointing accuracy are sensor readout errors and thermal distortion occurring after the in-orbit calibration. The numeric values of pointing accuracy are considered to be 3σ values (3 standard deviations) to insure probability of target acquisition.

Pointing stability defines how close the AGS stays pointed to the initial point during an experiment. Pointing stability is usually thought of as two conditions: quiescent stability and disturbance response. Quiescent stability is the case where no external disturbances are acting on the AGS or experiment and steady state condition have been reached by the Altitude Control System (ACS). Quiescent stability values are considered as 1σ. A pictorial view of these errors is shown in Figure 4. Table 2 contains a summary of the AGS pointing errors.[2]

FIGURE 4

AGS POINTING ERRORS

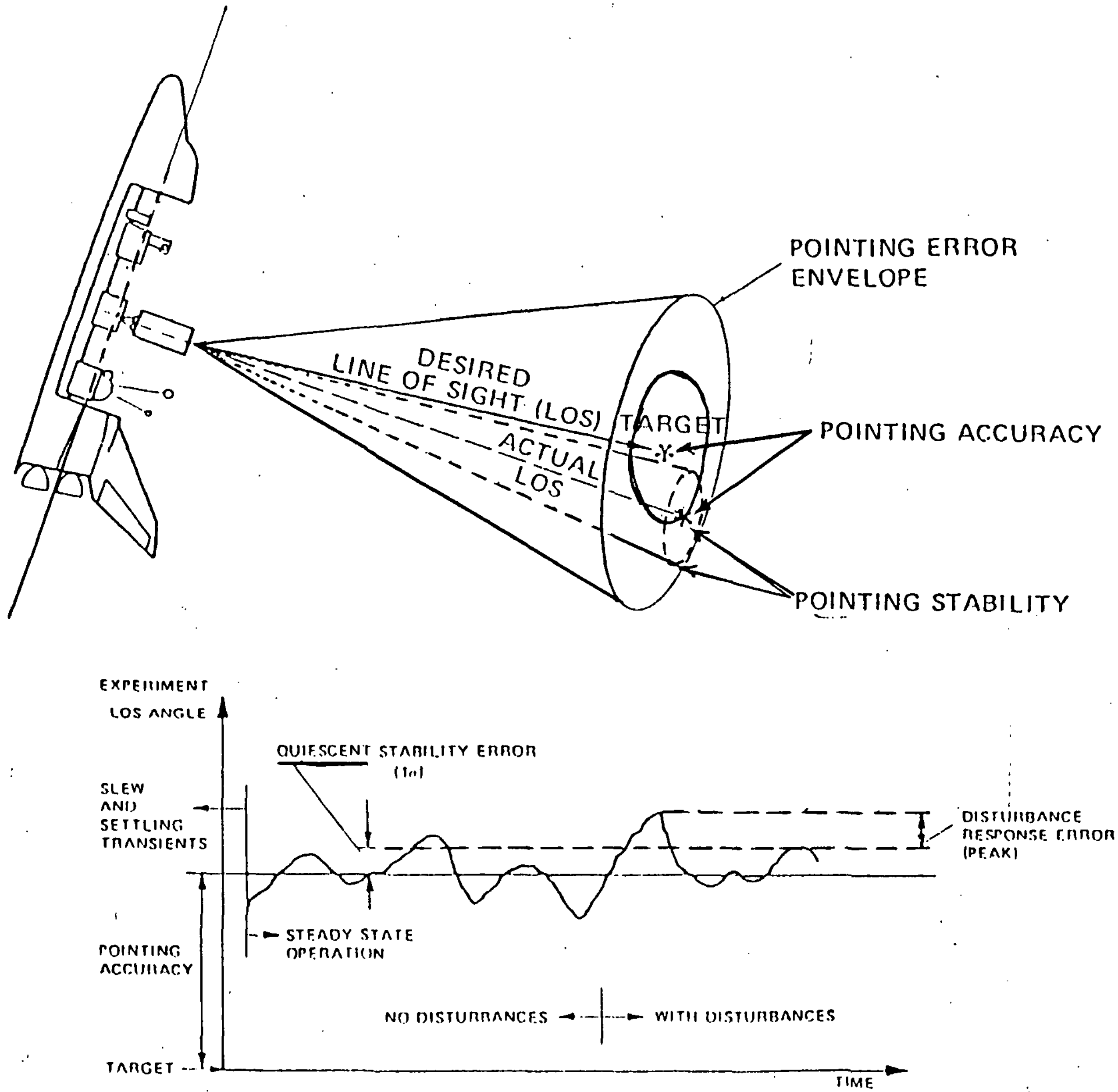


TABLE 2

AGS POINTING ERRORS			ORBITER
	AGS	ASPS	
Quiescent stability (1σ)	.2 arc sec	.01 arc sec	360 arc sec
Pointing accuracy (3σ) payload	.1 arc sec	.1 arc sec	1080 arc sec

II. 4 AGS Disturbances

The Shuttle VRCS limit cycle disturbance is the most significant disturbance input to the AGS ACS. Six thrusters are utilized in the VRCS each having 111.2 N. thrust. These disturbances are modeled as ideal pulses of force of finite duration.

The Shuttle VRCS limit cycle disturbances are summarized in Table 3 for roll, pitch and yaw limit cycles. Also indicated are the axes of the POF boom for each Shuttle limit cycle. The table indicates the thrusters operating, pulse width, Y and Z axis forces and torques applied to the Shuttle for each axis cycle. The Shuttle's angular and translational acceleration due to the limit cycle are also listed. From this table, it can be seen that <u>roll is the most significant limit cycle</u> disturbance.

The effects of a limit cycle disturbance on the POF boom are not those listed in Table 3 but must first be reflected through the gimbal and accelerometer feed forward. A planar model was used for lateral gimbal/roll and elevation gimbal/pitch VRCS disturbances.[2] Each was developed assuming the other axis was 0^{o} away from vertical.

Figure 5 shows the development of the expression for acceleration perpendicular to the AGS line of sight (LOS) for roll. The first of the two equations at the bottom of the figure gives the acceleration as a function of angular and translational accelerations. The second uses the values of Table 3. Figure 6 shows the same development for the elevation gimbal/pitch VRCS limit. The two equations at the bottom of Figure 6 are as above.

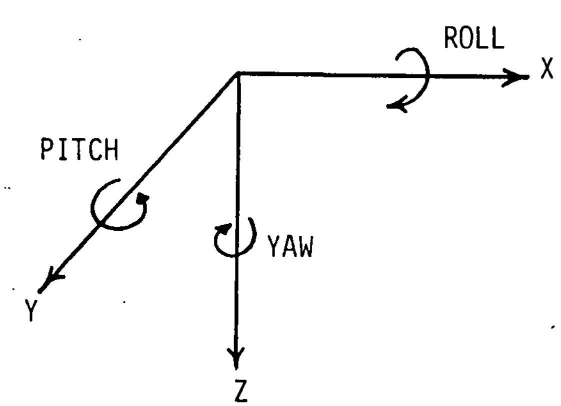
Figure 7 shows the net acceleration perpendicular ($A_{\perp LOS}$) to the LOS in m/sec^2 for both elevation gimbal/pitch and lateral gimbal/roll VRCS

TABLE 3

SHUTTLE VRCS LIMIT CYCLE DISTURBANCES[2]

BOOM AXIS	SHUTTLE AXIS	THRUSTERS OPERATING	BURN TIME (SEC)	F_Y (N)	F_Z (N)	VRCS TORQUE (N-M)	VRCS ANGULAR ACCELERATION (DEG/SEC^2)	VRCS ANGULAR ACCELERATION ($\widehat{SEC}/SEC^2$)	VRCS TRANSLATIONAL ACCELERATION (M/SEC^2) $\ddot{Y}s$	VRCS TRANSLATIONAL ACCELERATION (M/SEC^2) $\ddot{Z}s$
YAW	ROLL	2, 4, 6	0.20	-184	196	682.4	0.03561	128	-0.002176	0.002318
PITCH	PITCH	5, 6	0.52	0	222.4	-2487.5	-0.01672	-60	0	0.00263
ROLL	YAW	2, 3	0.48	38.2	84.9	2592.6	0.01673	+60	0.0004518	0.001004

SHUTTLE AXES



BOOM AXES

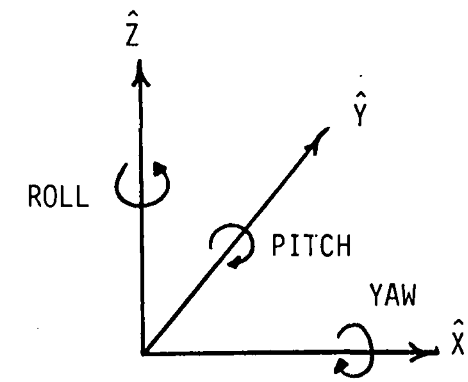
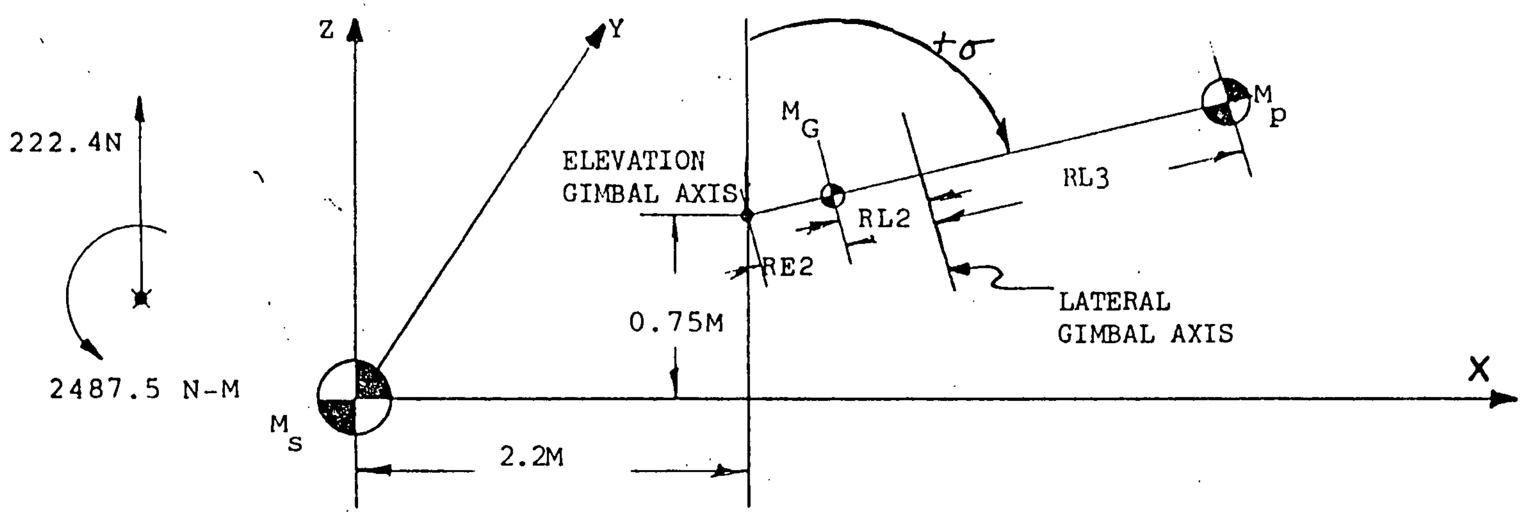


FIGURE 5

SHUTTLE ACCELERATION PERPENDICULAR TO AGS LOS,
ELEVATION GIMBAL/PITCH VRCS DISTURBANCE MODEL

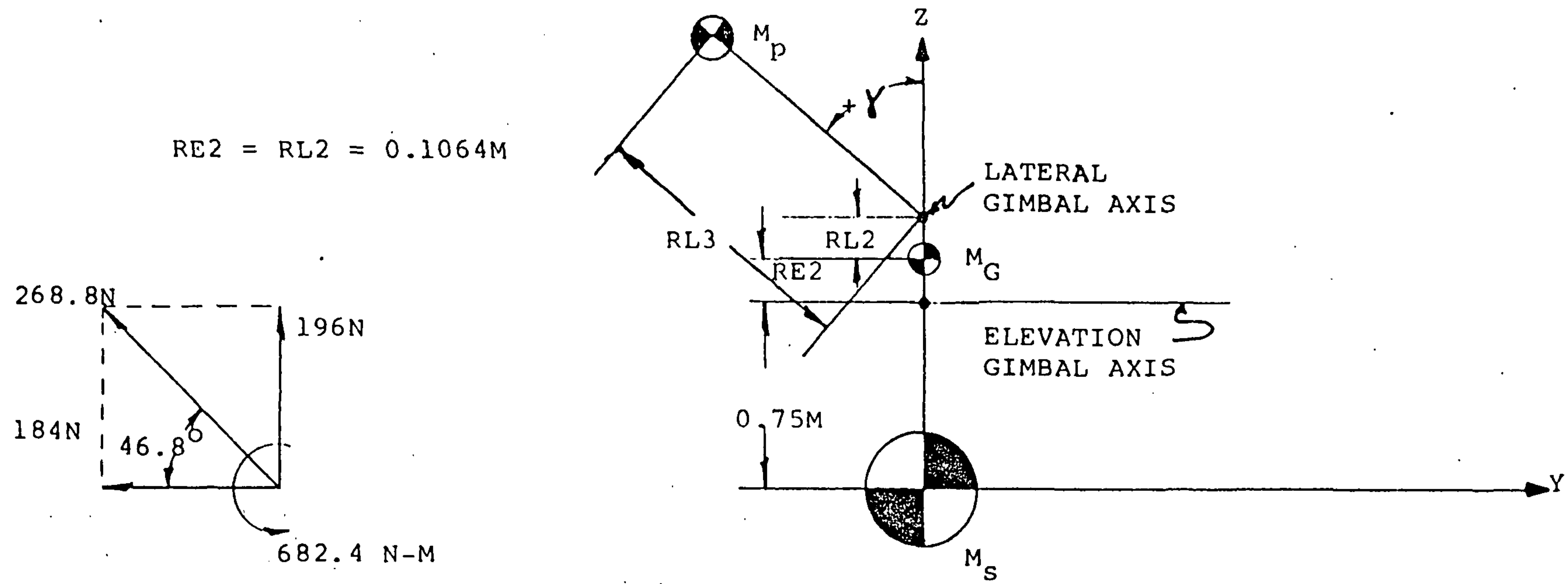


$$A_{\perp LOS} = +\ddot{Z}_S \sin\sigma - 2.2\,\ddot{\theta}_{YS} \sin\sigma - 0.75\ddot{\theta}_{YS} \cos\sigma$$

$$A_{\perp LOS} = +\left[0.003272 \sin\sigma + 0.000219 \cos\sigma\right]$$

FIGURE 6

SHUTTLE ACCELERATION PERPENDICULAR TO AGS LOS,
LATTERAL GIMBAL/ROLL VRCS DISTURBANCE MODEL

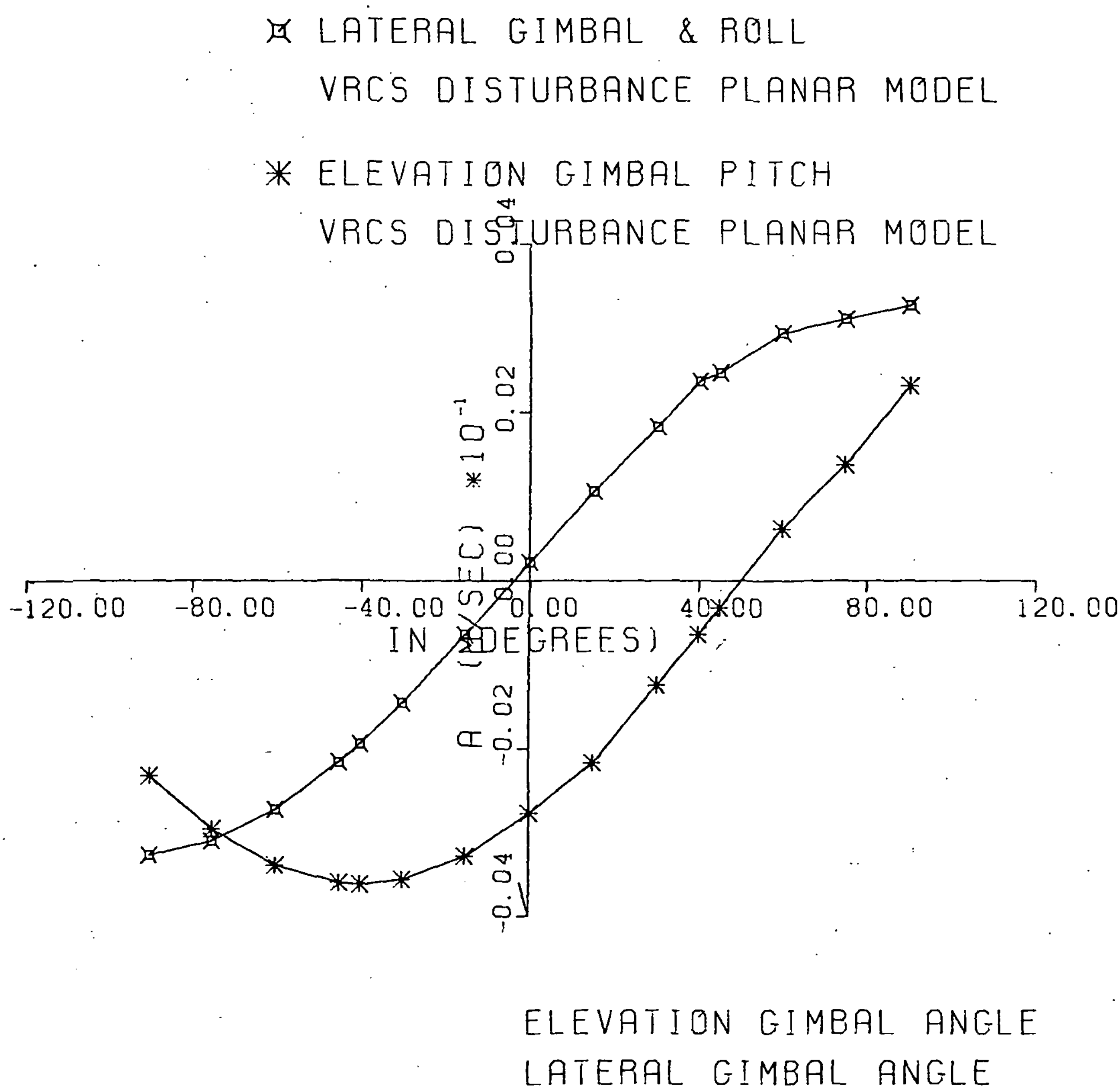


$$A_{\perp LOS} = +\ddot{Y}_S \cos\gamma + \ddot{Z}_S \sin\gamma - (0.75 + 0.1064 + 0.1064)\,\ddot{\theta}_{XS} \cos\gamma$$

$$A_{\perp LOS} = +0.002318 \sin\gamma - 0.002774 \cos\gamma$$

FIGURE 7

SHUTTLE ACCELERATION PERPENDICULAR TO AGS LOS



disturbances resulting from the planar model. For POF boom the $A_{\perp LOS}$ are those nearest 0^o. The worst of these disturbances can clearly be seen as a roll VRCS firing resulting in an $A_{\perp LOS} = .0028\ m/sec^2$.

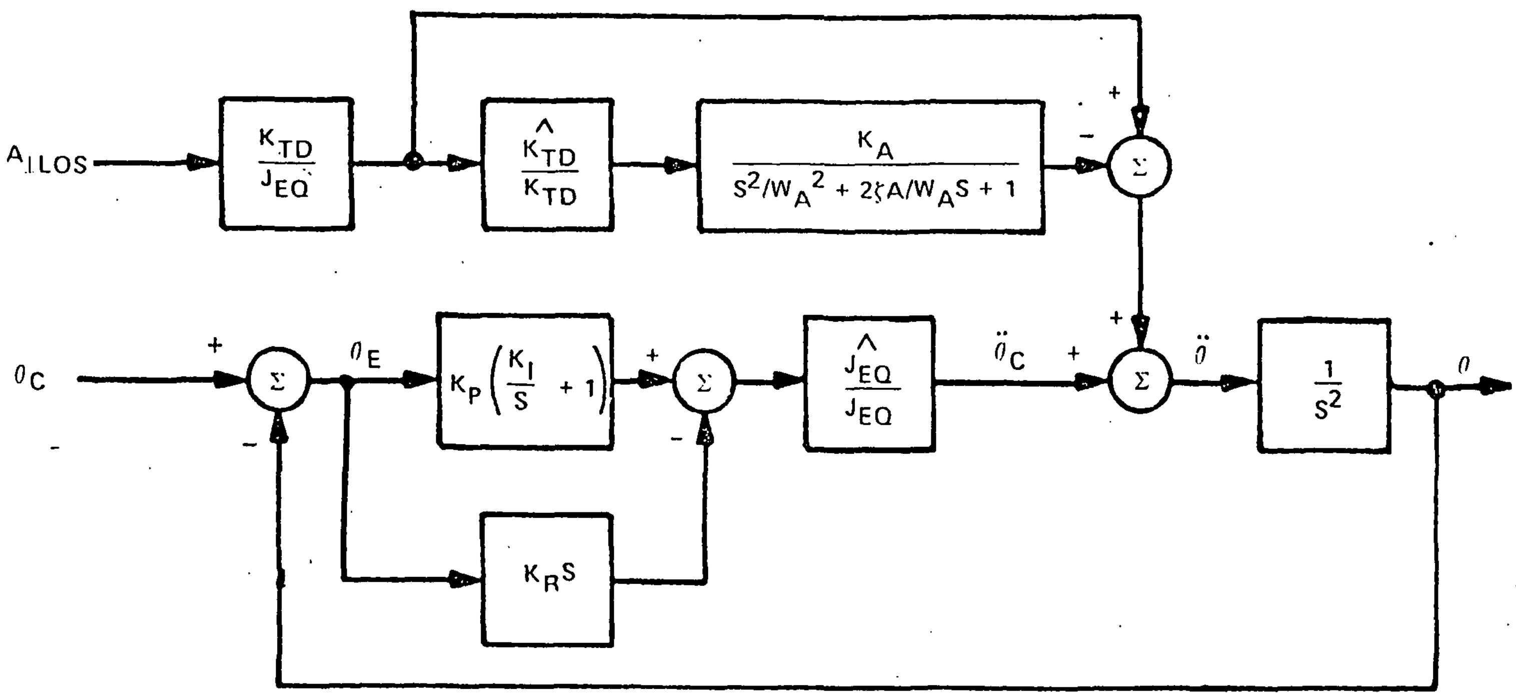
This $A_{\perp LOS}$ is then reflected to the load as shown in Figure 8. Not only is this disturbance passed forward through the gain conversion from m/sec^2 to RAD/sec^2 but it is picked up by the accelerometer which tries to negate this signal. Figure 9 shows the resulting angular acceleration disturbances at the base of the POF boom for an accelerometer of 20 Hz bandpass $K_A = 1$ and $\frac{K_{TD}}{J_{EQ}} = .05167$ RAD/m(roll) and $\frac{K_{TD}}{T_{EQ}} = .05239$ RAD/m (pitch). The bandpass of the accelerometer was set at 20 Hz. in this study so that gravity gradients would be decoupled and the effects of thruster firing on the large inertia of the POF system would be minimized. The response of the accelerometer can be modeled as impulses as shown in Figure 9.

II. 5 AGS Limitations

The chief limitation to the AGS is the total available torque per gimbal axis of 33.9 NT-MT[2]. If this torque limit is not adequate for both rigid body pointing and active mode damping the future development of larger AGS torquers[1] may be required. In addition the AGS pointing accuracy of .1/arc sec (3σ) may not be adequate.

FIGURE 8

AGS ACCELEROMETER MODEL



ELEVATION GIMBAL/PITCH VRCS DISTURBANCE

$$\frac{K_{TD}}{J_{EQ}} = \frac{\left[M_G\,(RE2) + M_P\,(RE2 + RL2 + RL3)\right]}{\left[J_{GY} + J_{PY} + M_G\,(RE2)^2 + M_P(RE2 + RL2 + RL3)^2\right]}$$

LATERAL GIMBAL/ROLL VRCS DISTURBANCE

$$\frac{K_{TD}}{J_{EQ}} \quad \frac{M_P\,(RL3)}{\left[J_{PX} + M_P\,(RL3)^2\right]}$$

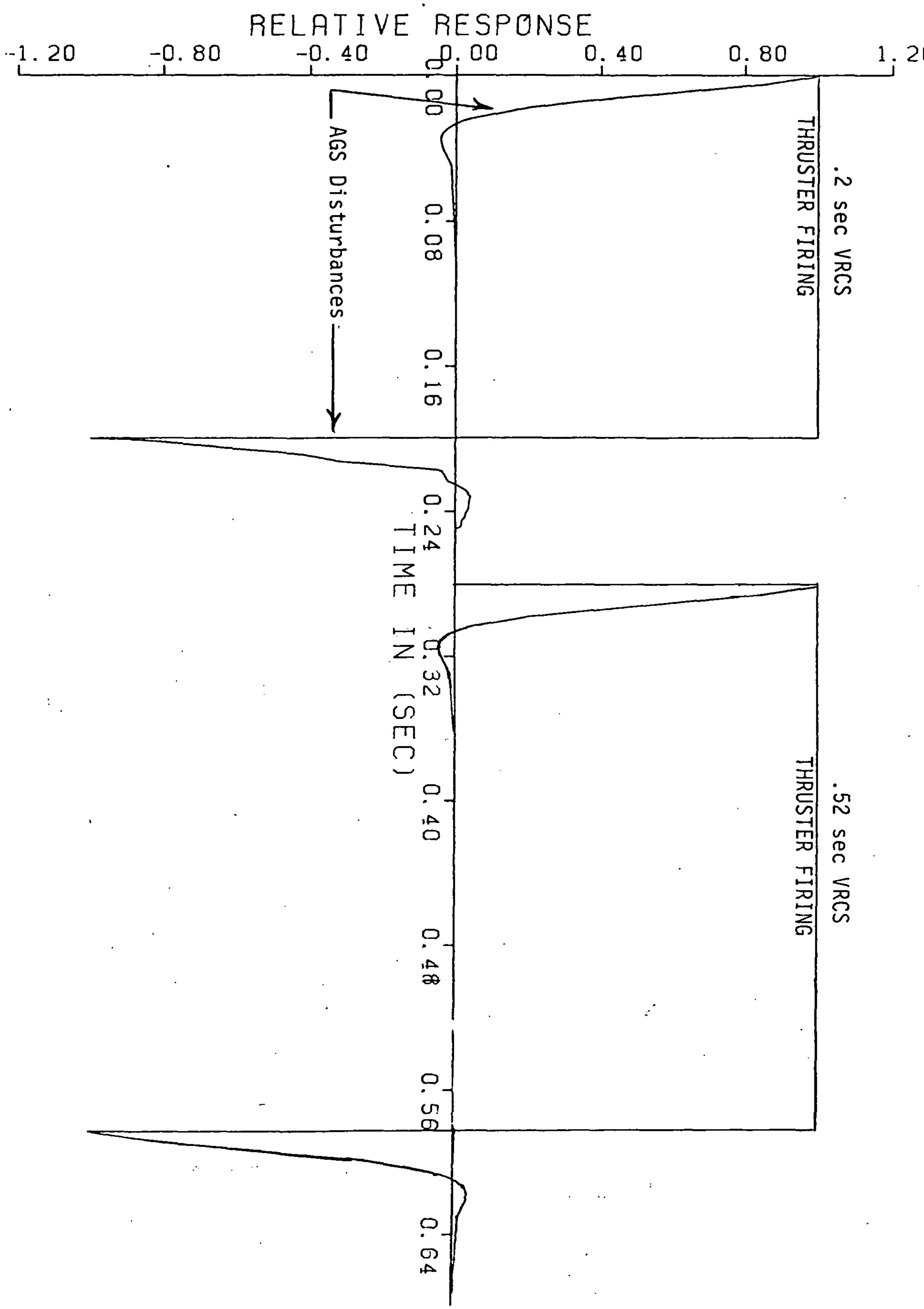


FIGURE 9
AGS DISTURBANCES

III. Aspect Sensing System

The Aspect Sensing System (ASS) for P/OF must yield fine measurements of: 1. modal vibrations about each of the three boom coordinate axis, and 2. rigid body rotations about each boom axis. In addition, coarse measurements must be available for deployment and target acquisition. This report will deal only with fine measurements.

The following system is proposed: A fine LOS sun sensor, a laser interferometer and a star tracker. The fine LOS sun sensors would yield a combination of the error in rigid body rotations plus modal vibrations about boom pitch and yaw. This sensor could not detect boom roll.

The laser interferometers would detect the relative angles between the boom base and tip. These angles are the result of modal vibrations. The flexible body modes can be estimated from these measurements. The output of the interferometer system subtracted from the fine LOS sun sensor would yield the error in rigid body rotations.

The star tracker would be used to measure rigid body boom roll. From the star tracker, error in rigid body roll can be obtained.

III. 1 LOS Fine Sun Sensor

A configuration which allows the sun sensor to view the sun through a small window in the mask is shown in Figure 11[4]. The required four sectors of the solar limb are viewed through the window by four pentaprisms, each of which relays the view to a corresponding pentaprism located over the sun sensor objective lens. (Only two pairs of the four pairs of pentaprisms are shown in this figure). Pentaprisms are used here for their constant deviation characteristic, which simplifies the alignment and mechanical stability requirements. The angular deviation of a ray by a pentaprism in a plane mutually perpendicular to entrance and exit faces is a constant, regardless of minor tilts and misalignments of the prism itself. Pentaprisms are commonly made with deviation angles equal to 90^{o}, ± 1 arc second. The purpose of the bandpass filter over the window in the occulter is to prevent radiation passing through the window in the occulter from raising the stray light levels in the White Light Coronagraph. The nominal bandpass of this filter is 8250 Å to 8750 Å. A similar filter is placed over the objective lens of the sun sensor to decrease the effects of stray light on the aspect signals from this sensor.

The spacing between the outer pentaprisms will be approximately equal to the boom length times the angular diameter of the sun. Thus, it would be 46.5 cm for a 50 meter boom. Nominal apertures for the window, the pentaprisms, and the objective lens are 5 cm, 2.5 cm, and 8.0 cm, respectively.

The four sectors of the limb are imaged onto the field stop by the objective lens, as shown in Figures 10 and 11. The field stop contains four cross-shaped cutouts, behind each of which is a separate detector. Nominally, the image of the solar limb will lie along the centerline of those arms of each cross which are tangent to the limb when the sensor is pointed at the center of the sun, as shown.

Initially, the signal rises slowly from zero as the image of the solar disk fills more and more of the inner radial arm of the cross of Figure 11. Then, the slope of the curve suddenly increases as the image begins to fill the tangential arms of the cross, with the signal equal to S_C when the image of the limb lies at an angular position θ_C along the centerline of the cross. Finally, the slope decreases again as the image begins to fill the outer radial arm of the cross. The purpose of the radial arms, of course, is to increase the angular dynamic

FIGURE 10

LOS SUN SENSOR LAYOUT

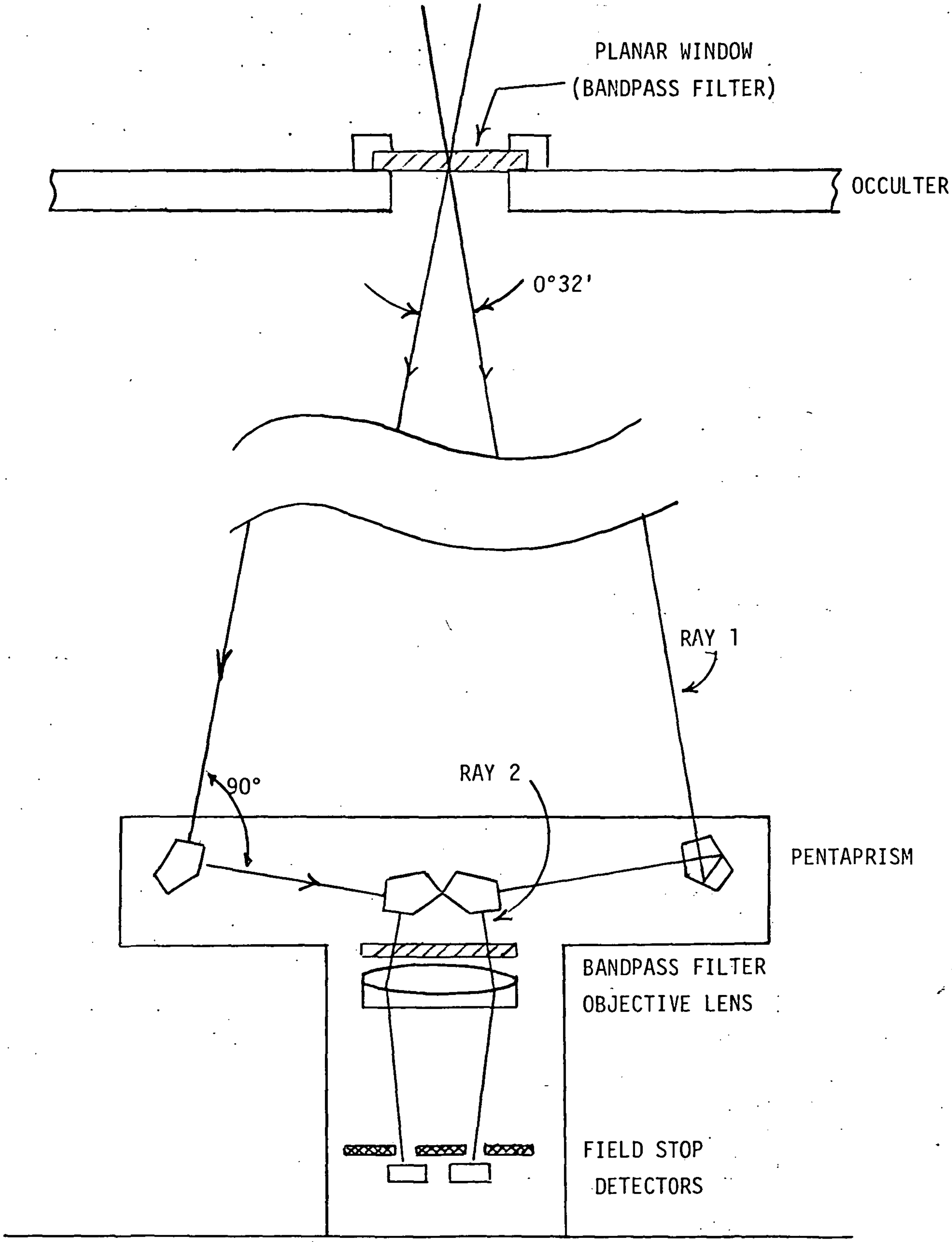
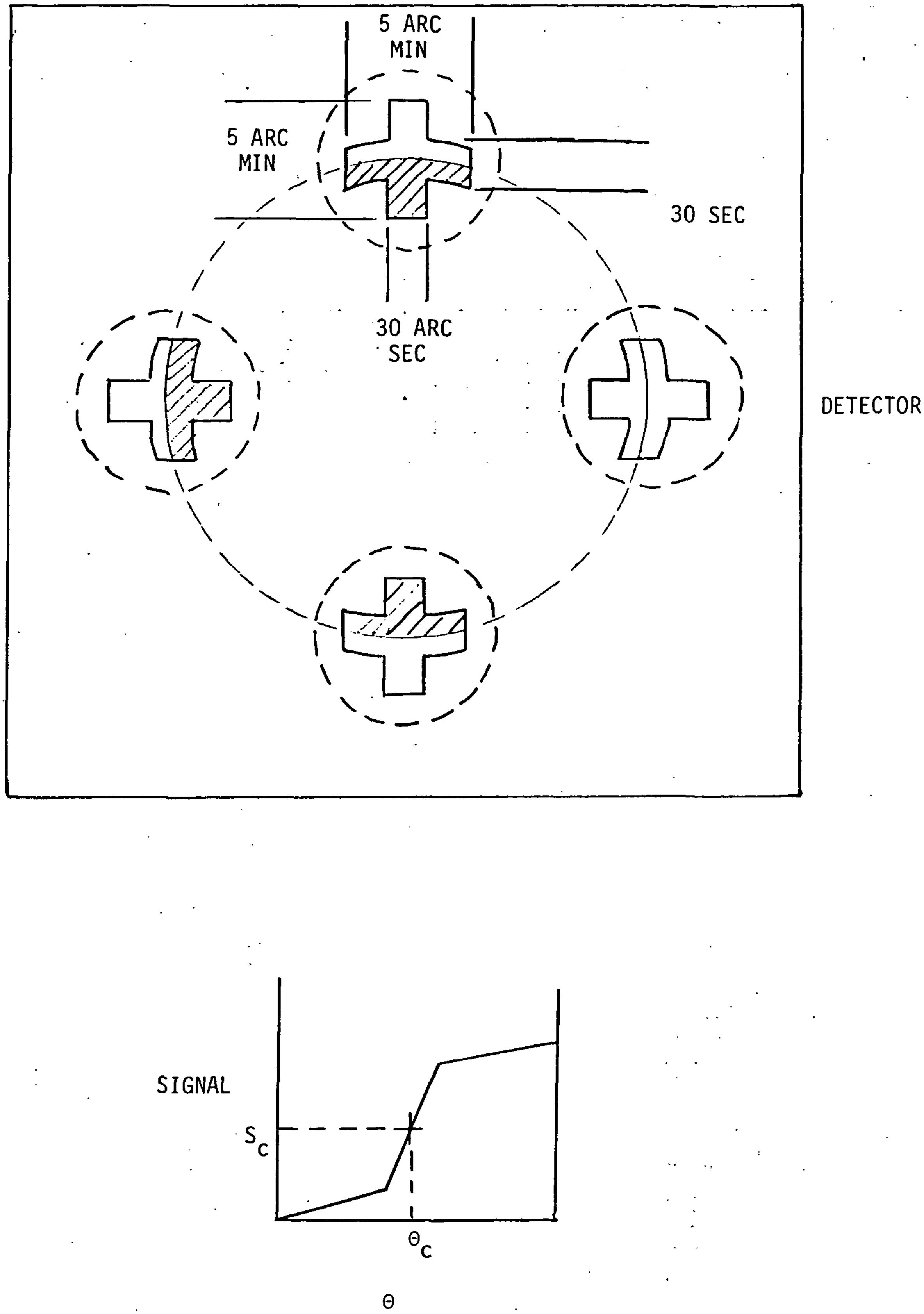


FIGURE 11

LOS SUN SENSOR FIELD STOP



range of the sensor. The purpose of the tangential arms is to increase the slope of the error signals when the sensor approaches the orientation at which it is centered on the sun.

Typical dimensions for the cross-shaped cutouts are shown in Figure 11. The arms are 30 arc seconds wide and a total of 5 arc minutes long, giving a total angular area of 4.75 square arc minutes for each cross. When nominally centered on the sun, one half the area or 3.38 sq. min. of a cross will be filled with radiation from the solar disk. Then, a change in the angular orientation θ of 5 arc seconds corresponds to change in illuminated area in the cross of .42 sq. arc min., or to an 18% change in signal level. Similarly, a change in θ of 0.3 arc seconds results in a signal change of 1.1%. Signal changes of these amounts should be readily detectable, and should also be large compared to the shifts in sensitivity of most stable types of detectors which might be used here. Even a change in θ of 0.05 arc seconds corresponds to a readily detectable signal change of 0.18%. Table 4 summarizes the characteristics of the proposed LOS fine sun sensor as well as the other components of the ASS.

III.2. Laser Interferometer

The laser interferometer measures the six coordinates necessary to know the position of the mask (boom tip) relative to its base. A preliminary configuration for this system is shown in Figure 12[5]. One laser with beam splitters provides the source of all six measurements. In Figure 13, beam splitter would be located at A, D, P and Q, and detectors at B, R, S, D and A. Interferometers are located along with each detector. The six differences in distance are measured then (q_1 - q_6). With these measurements, the relative positions and orientations of the mask are

TABLE 4

ASPECT SENSING SYSTEM			
INSTRUMENT	LOS SUN SENSOR	LASER INTERFEROMETER	STAR TRACKER *
MEASURES	RIGID BODY PITCH, YAW	MODAL VIBRATIONS	RIGID BODY ROLL
RESOLUTION	.05 ARC SEC	.01 ARC SEC	.6 ARC SEC
S/N	1000	2×10^6	3000
ACCURACY	±.0025 ARC SEC	±.005 ARC SEC	±.3 ARC SEC
WEIGHT	1.4 kg	22 kg	35.4 kg
ERROR IN $\Delta X, \Delta Y$	----	.005 mm	----

* For a 10 inch tracker

given by

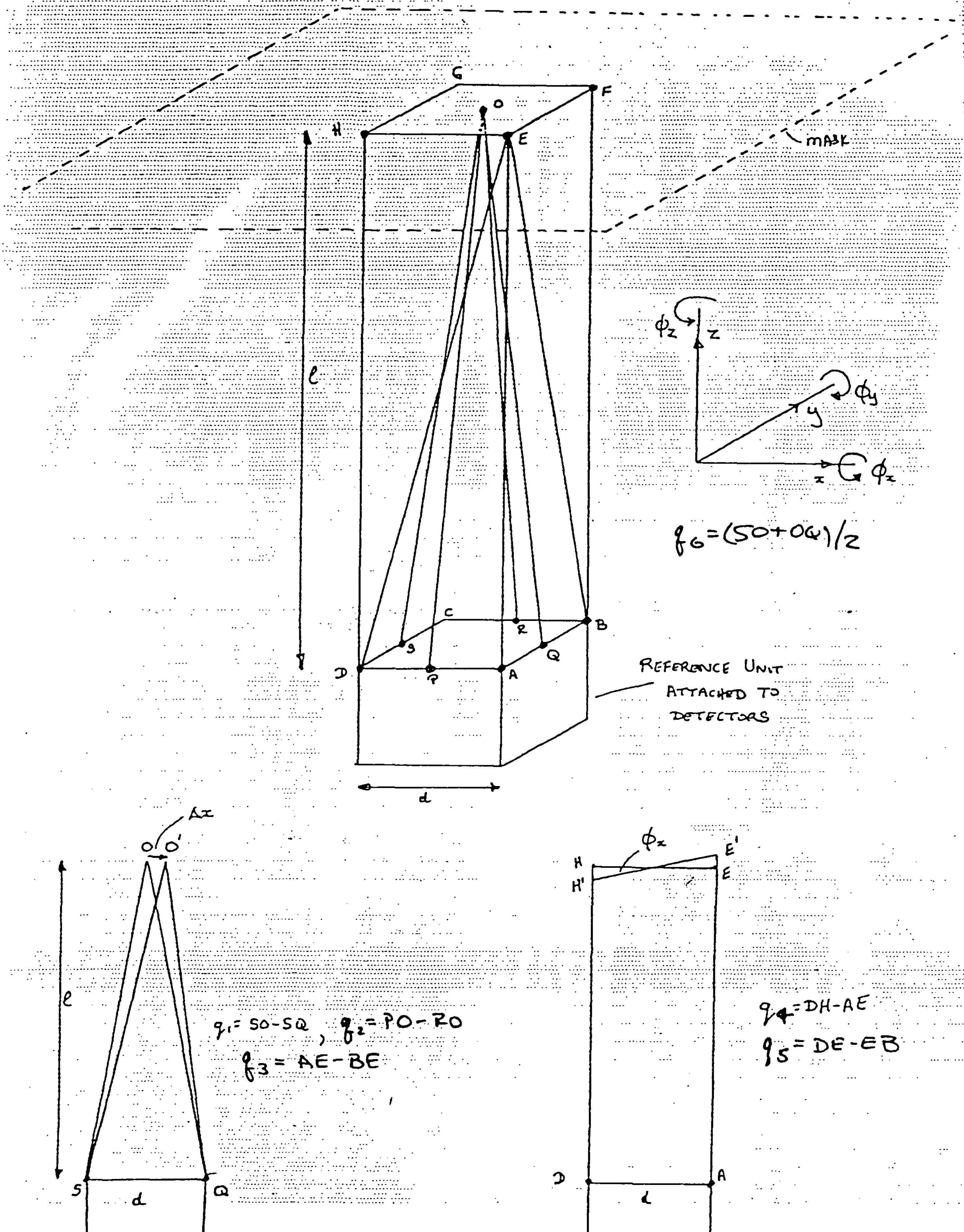
$$D_x = l\, q_1/d$$
$$D_y = l\, q_2/d$$
$$D_z = D(q^2 + d^2)^{\frac{1}{2}}$$
$$\phi_x = q_3 d$$
$$\phi_y = q_4/d$$
$$\phi_z = l\, q_6/d^2$$

These motions (q's) can be measured with a .1μm typical accuracy[6]. Resolution can be extended electronically down to .0016 μm with conventional interferometers[7]. This corresponds to .0003 arc sec for a 50 m boom.

In addition, AC Laser Interferometers (ACLI) have high repeatability and high accuracy[6,7]. Accuracies of .5 parts per million are routine. Long range optical paths are also typically in use (60 m). The Hewlitt-Packard HP 5526 A has a range of 60 m and accuracies as stated above. In addition, ACLI's can have bandwidths as high as 10Hz allowing for the measurement of modal vibrations. Table 4 summarizes the characteristics of proposed ACLI's as well as the other components of the ASS.

FIGURE 12

LASER INTERFEROMETER LAYOUT



III.3. Star Tracker

The star tracker is used to measure rigid body rotations about the longitudinal axis (roll) of the boom. An additional measurement of the rigid rotations, as measured by the LOS fine sun sensor, is possible. If targets other than the sun are studied, the star tracker would be the only source of the measurement of rigid body rotations.

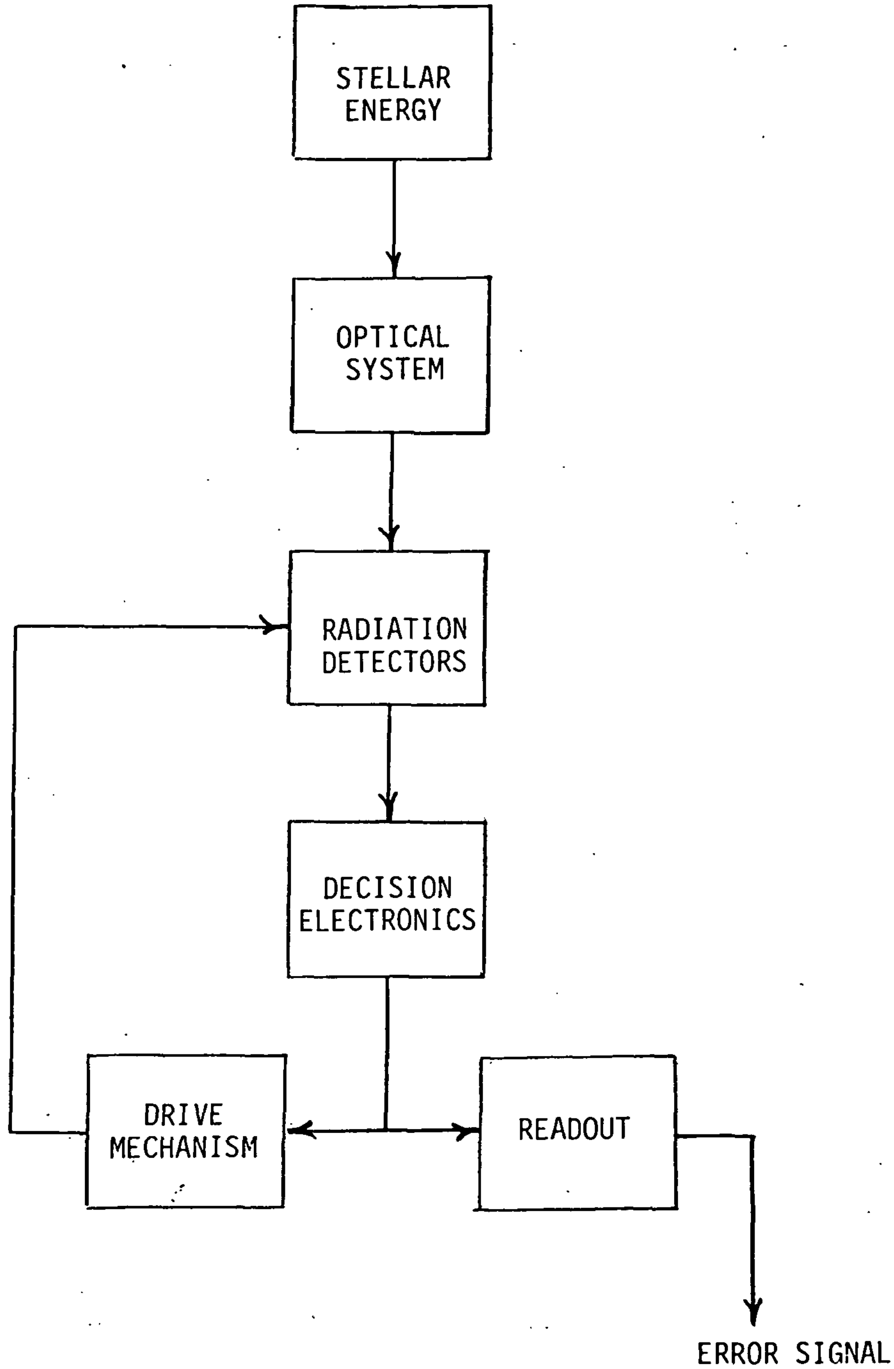
The basic functional elements of a star tracker and scanner are shown in Figure 13. The optical system collects and focuses collimated energy from a star and transmits it to the detector. The major optical design consideration are aperture size, angular field of view, optical resolution, aberration, distortion and spectral transmissive efficiency.[8] The three types of optical systems generally employed are reflecting, refracting and hybrid.

The radiation detectors are usually photomultipliers, vidicons or photodiode arrays and the decision electronics are generally integrators over a fixed period which increases the signal to noise (S/N) ratio. The noise effect, which appears primarily as random shot noise at the detector output, is minimized by extending the integrative time for star error signals.[9] This, in practice, means a reduction of the tracker bandwidth to below 1 HZ.

The drive mechanisms in the cases of the photodiode array or vidicon are electronic signals used to scan the detector and there are no moving parts in the tracker itself. The electronic outputs are error signals in tracking about the axes under study. These signals can be used to drive the rigid body system error to zero. A summary of the star trackers characteristics[10] as well as other components of the ASS are shown in Table 4.

FIGURE 13

STAR TRACKER FUNCTIONAL ELEMENTS



IV. Control System

The Control System of the P/OF uses the gimbals of Section I as actuators and the sensors of Section II. The plant to be controlled is described in Section IV.1. The control laws are described in detail in Section IV.2 and IV.3.

The Control System consists of two control loops as shown in Figure 14. The inner loop is a modal controller whose function is to actively add damping to the flexible boom. This is accomplished by measuring the modes of the system at the boom tip (mask), adding phase to them and actuating the base with this signal. The resulting vibrations tend to cancel those vibrations present in the boom and it appears that the damping of the boom is much greater than in actuality. The main benefit of this method is the insensitivity of the controller to the actual damping factor[11] of the plant model.

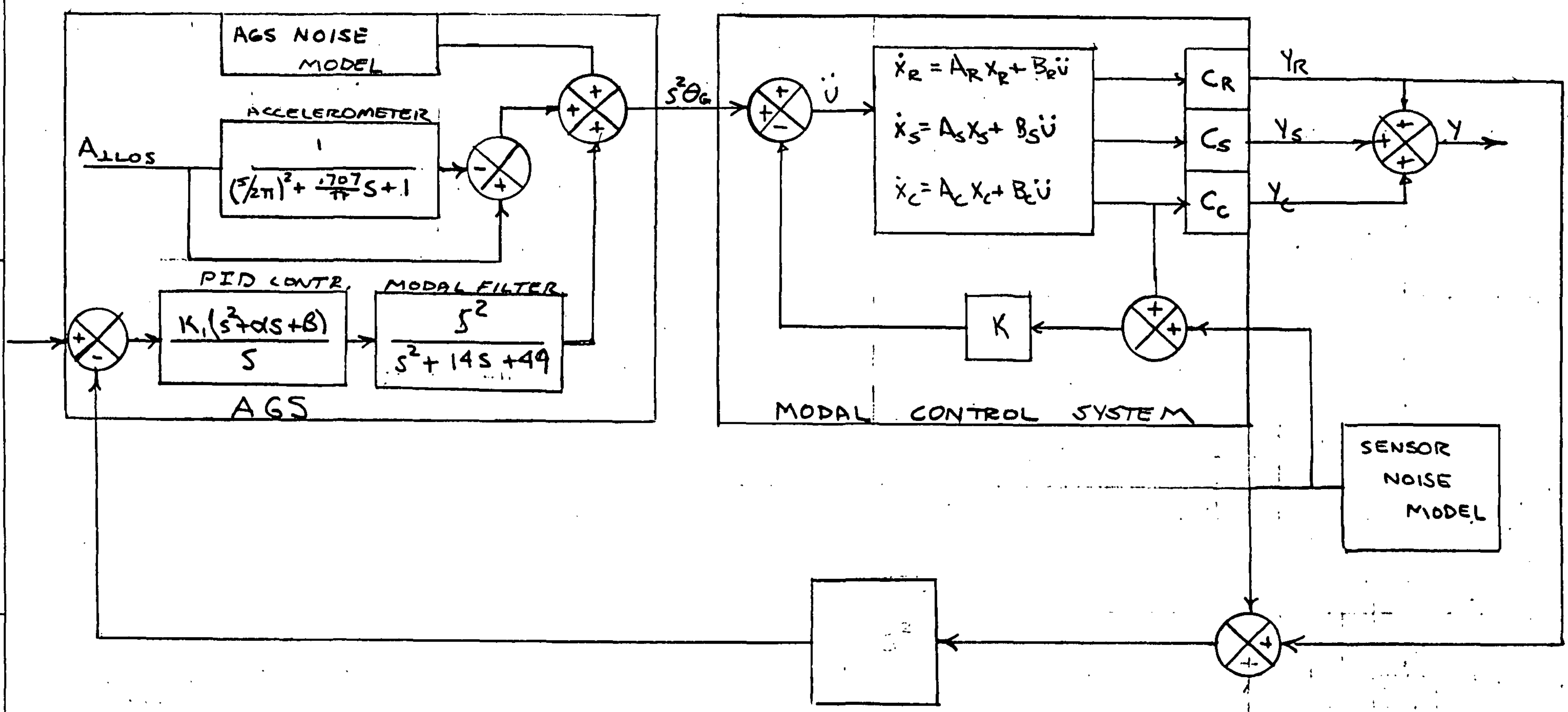
The outer loop controller of Figure 14 is the rigid body controller that actually points the boom as if it were rigid. This controller affects the modal controller only minimally and sets the bandpass of the system. This system tracks the target using the Proportional-Integral-Derivative (PID) controller of the AGS as well as other components of the AGS controller. Noise reduction is accomplished by severely limiting the overall bandpass of the system.

IV.1 The Plant Model

The model of the plant has been detailed extensively[12,13,14]. These models will be reviewed and extended as required. The boom is modeled as a flexible + rigid body. These are the first three sets of states of Table 1. The equations of motion are then,

FIGURE 14

P/OF CONTROL SYSTEM



$$\begin{bmatrix} \dot{X}_C \\ \dot{X}_S \\ \dot{X}_R \end{bmatrix} = \begin{bmatrix} A_C & 0 & 0 \\ 0 & A_S & 0 \\ 0 & 0 & A_R \end{bmatrix} \begin{bmatrix} X_C \\ X_S \\ X_R \end{bmatrix} + \begin{bmatrix} B_C \\ B_S \\ B_R \end{bmatrix} \ddot{U} \tag{1}$$

where $\ddot{U}$ is the 3 x 1 rotational acceleration matrix at the base of the boom and

$$\begin{bmatrix} Y_C \\ Y_S \\ Y_R \end{bmatrix} = \begin{bmatrix} C_C & 0 & 0 \\ 0 & C_S & 0 \\ 0 & 0 & C_R \end{bmatrix} \begin{bmatrix} X_C \\ X_S \\ X_R \end{bmatrix} \tag{2}$$

$$Y = Y_C + Y_S + Y_R \tag{3}$$

where Y_C is the tip deflection due to the controlled modes, Y_S the tip deflection due to the suppressed modes and Y_R the tip deflection due to the rigid modes. Note that Y_R is also the deflection of the base of the boom and Y is the total tip deflection.

The flexible body modes (natural frequencies) are functions of boom length, width, mass and tip mass[12,15]. The first eight (8) modes were used in this study and resulted from a 50 meter x 1 meter boom with a 25 kg tip mass. These boom frequencies and shapes are summarized in Table A-1 of Appendix A. The damping factor for the boom appears to be in the 1-2% region[15] as measured by the SEPS boom test.

Using these data, the resultant A_C and A_S matrices can be derived and are listed in Appendix A. The rigid body motions are simply double integrations of base accelerations and result in the A_R matrix of Appendix A. The input (B_C, B_S) and output (C_C, C_S) matrices for the flexible modes were derived from NASTRAN analysis[12,14] and are also listed in Appendix A. The input (B_r) and output (C_R) matrices for the rigid modes are ones and zeros which simply reflect the double integration[14]. These matrices are also shown in Appendix A.

Equations (1), (2) and (3) completely describe the motion of the tip and base of boom due to accelerations at the base. These equations do not however describe the effects that the actuator has on the system. These equations are discussed in Section IV.3.

The scientific instruments to be used[16,17,18] are summarized in Table 5 along with their respective masses, sizes and mounting locations. The instruments consist of two (2) coronographs - one ultraviolet and one white light, and two x-ray detectors on x-y tables. In addition to these instruments, the LOS fine sun sensor, laser interferometers and star tracker of Table 4 must also be mounted on the AGS mounting plate along with the boom deployment canister.

Since the torque capabilities of the AGS actuator are limited to 33.9 NT-m (see Section II) a knowledge of the moments of inertia about each of the gimbal axes is necessary. The moments of inertia are a result not only of the boom-mask but also of the scientific instruments loaded onto the AGS platform as well as the other gimbal drives and mechanisms mounted above the axis under consideration. The moments of inertia about each boom axis are listed in Table 6 for the boom perpendicular to the mounting platform. The torque required if the system was totally rigid would be the total angular acceleration about each gimbal axis times the moment of inertia about that axis. Since the system is not rigid but flexible, the total required torque has an upper bound of the torque calculated assuming a rigid body.

TABLE 5

SCIENTIFIC INSTRUMENTS					
Instrument	Weight (kg)	Size (m)	Center of Mass*		
			X	Y	Z
U.V. Coronograph	180	1.5x1.5x6	1.75	1.75	2
White Light Coronograph	80	.6Dx2	1.3	1.3	1
X-ray Detector 1	100	1x1x.5	1.5†	1.5†	.25
X-ray Detector 2	100	1x1x.5	1.5†	1.5†	.25

* (0,0,0) is located in the center of the mounting plate, top surface.

† Movable X-Y table allows the cm to be changed in X & Y. These figures are for the detector abutting the boom deployment canister.

TABLE 6

MOMENTS OF INERTIA					
AXIS		J_P (1)	M_P (2)	r_P (3)	J_{EQ} (4)
BOOM	SHUTTLE	(KG-m^2)	(KG)	(m)	
X	X	57230*	685	6.5	86,171
Y	-Y	57230*	1013**	6.7	88,429
Z	-Z	4250	685	2.6	8,880

* From Nastran Analysis[14].

**Includes 328 kg for the X and Z gimbal assemblies.

(1) $J_P \triangleq$ Moment of inertia of the payload about its own center of mass (C.M.)

(2) $M_P \triangleq$ Mass of the payload

(3) $r_P \triangleq$ Location of the payload C.M. relative to the gimbal axis

(4) $J_{EQ} \triangleq$ Total inertia about each gimbal axis $= J_P + J_G + M_P r_P^2$

IV.2 Modal Controller

The partioning of the state vectors in Equation 1 reflects the objectives of the modal control system design. The controlled states, x_c, must be controlled to achieve satisfactory system damping off line while the suppressed states, x_s, are known but not critical to the control design[19,20].

What we would like to do is effect changes in x_c and no changes in either x_s or x_R. The effect of the controller on the rigid modes or suppressed modes is called control spillover. We wish on one hand to optimize the system for the controlled states and limit the control spillover: the controlled states are actively damped while the suppressed states are not excited by the controller and the rigid states are unaffected by it.

We have an optimum controller

$$\ddot{u}^0 = - Kx_c \tag{4}$$

determined by using an index of performance

$$PI = \int_0^\infty (x_c^T Q_c x_c + \ddot{u}^T R_c \ddot{u})\, dt \quad . \tag{5}$$

which results in the modified plant equations:

$$\begin{bmatrix} \dot{x}_c \\ \dot{x}_s \\ \dot{x}_R \end{bmatrix} = \begin{bmatrix} A_c - B_c K , & 0 , & 0 \\ - B_s K , & A_s , & 0 \\ - B_R K , & 0 , & A_R \end{bmatrix} \cdot \begin{bmatrix} x_c \\ x_s \\ x_R \end{bmatrix} \tag{6}$$

Clearly, we would like to have for no control spillover:

$$B_1 K = \begin{bmatrix} B_s \\ B_R \end{bmatrix} \cdot K = 0 , \tag{7}$$

which merely implies the orthogonality of B_1 and K.

By modifying the performance index to include spillover terms $(B_1\ddot{u})$ we can simultaneously minimize the PI and the product B_1K. Including these spillover terms in the PI, we have:

$$PI = \int_0^\infty [x_c^T\ Q_c\ x_c + \ddot{u}^T\ R_c\ \ddot{u} + (B_1 u)^T\ R_s\ (B_1\ \ddot{u})]\ dt \tag{8}$$

$$= \int_0^\infty [x_c^T\ Q_c\ x_c + \ddot{u}^T\ (R_c + B_1^T\ R_s\ B_1)\ \ddot{u}]\ dt\ . \tag{9}$$

Now by heavily penalizing the PI to suppressed state spillover $(R_S >>> R_C)$, we can force the maximization of the orthogonality of B_1 and K. The feedback coefficient matrix can now be solved from the familiar matrix riccati[14].

The control spillover into the rigid body states cannot be avoided, but represents only steady state following errors. These errors can be removed by the proper selection of controller gains for command inputs and rigid body feedback. The design of a rigid body controller is detailed in Section IV.3.

The output of the modal controller (Equation 4) can be added to the output of the AGS feedforward accelerometor (see Figure 14) and the AGS driven by the resultant signal via the DEA-GEA. The modes themselves must first be measured. This represents a more difficult task.

Due to the nature of the system (the forms of the matrices C_c and C_s) an observer for the first eight modes which does not have signal present from the suppressed modes could not be designed. This observation spillover could cause serious stability problems[19,20]. Two promising techniques are available, however. The first technique is to bandlimit the sensors detecting the modal vibrations and construct an optimal controller which is unaffected by the filter but yet does not undo the filter's effects.[21] Another technique is to use a comb filter which is phase-locked to the modal frequencies and "combs" out the individual components.[22] The relative components are then readily determined. The value of the second approach is that the comb filters can be realized in hardware which may now be less expensive than software.[23]

The modal controller is strictly an active damping system. The original eigenvalves for the controller states were for 2% damping:

$$\lambda_{1,2} = \lambda_{3,4} = .0217 \pm j\ 1.086 \quad \text{RAD/SEC}$$
$$\lambda_{5,6} = \lambda_{7,8} = .150 \pm j\ 7.50 \quad \text{RAD/SEC} \quad .$$

While the eigenvalves for the controlled states under the effects of the modal controller are:

$$\lambda_{1,2} = \lambda_{3,4} = 1.3785 \pm j\ 1.0894 \quad \text{RAD/SEC}$$
$$\lambda_{5,6} = \lambda_{7,8} = 1.2508 \pm j\ 7.4484 \quad \text{RAD/SEC} \quad .$$

The effective damping ratio for the first four eigenvalves was increased from 2% to 126.5% and the effective damping ratio for the second four controlled eigenvalves increased from 2% to 16%. This yields time constants (the inverse of real part of the eigenvalves) for all modes on the boom of under 1 sec.

IV.3. Rigid Body Controller

The rigid body controller consists of the outer loop of Figure 14. This loop is comprised of the PID controller and modal filters of the AGS, the plant, sensors with noise and unity feedback. Only the rigid body modes (with modal spillover) are detected (as discussed in Section III) and fedback with this controller.

The philosophy of design of this controller was to bandpass limit the system to reduce noise but not to significantly affect the pole placement resulting from the modal controller. The AGS has two areas for design: the PID controller and the modal filter. The gains for the PID controller were chosen for optimal tracking[24] and were:

$$G_{PIDX} = \frac{K_X(s^2 + 2.02s + 2.08)}{s}$$

$$G_{PIDY} = \frac{K_Y(s^2 + 4.116s + 3.62)}{s}$$

$$G_{PIDZ} = \frac{K_Z(0.s^2 + 0.s + 1)}{s} \tag{10}$$

The PID controller gains determine the placement of zeros of the system. The gains selected resulted in zeros being placed close to but not canceling the poles of the first two modes. With the rigid loop closed, the modal roots cannot migrate significantly for the first two modes.

The remainder of the rigid body controller was designed using root locus techniques. For this technique the transfer functions must be known. The plant equations are[14]:

$$Y_c(s) = C_c\,\Phi_o\,B_c\,(s^2\,\theta_G(s))$$

$$\simeq s\begin{bmatrix} \frac{2.668}{s^2+2.69s+2.99} + \frac{.267}{s^2+2.05s+56.3}, & 0, & 0 \\ 0, & \frac{-1.092}{s^2+2.69s+2.99} + \frac{.108}{s^2+2.05s+56.3}, & 0 \\ 0, & 0, & 0 \end{bmatrix}(s^2\theta_G(s)), \quad (11)$$

$$Y_s(s) = C_s\,\Phi_s\,B_s\,[I_3 - K\Phi_o\,B_c]\,(s^2\,\theta_G(s)$$

$$\simeq s\frac{\begin{bmatrix} .05s^4+.052s^3+2.521s^2-.1074s+2.83, & 0, & 0 \\ 0, & .03s^4+.028s^3+1.505s^2-.232s+1.695, & 0 \\ 0, & 0, & 0 \end{bmatrix}}{(s^2+2.69s+2.99)\,(s^2+2.05s+56.3)(s^2+2.2s+475.9)}(s^2\theta_G(s), \quad (12)$$

and,

$$Y_R(s) = C_R\,\Phi_R\,B_R\,[I - K\Phi_o\,B_c]\,(s^2\,\theta_G(s))$$

$$= \frac{1}{s^2}\frac{\begin{bmatrix} s^4+1.04s^3+50.39s^2-1.94s+56.39 & 0, & 0 \\ 0, & s^4+.94s^3+50.18s^2-7.5s+56.39, & 0 \\ 0, & 0, & 0 \end{bmatrix}}{(s^2+2.69s+2.99)\,(s^2+2.05s+56.3)}(s^2\theta_G(s), \quad (13)$$

The overall gimbal transfer function is

$$G_G = \frac{s^2\theta_G}{\theta_E} = G_{PID}\cdot G_M \quad (14)$$

where G_M is the modal filter transfer function.

The modal filters were chosen for X and Y to be:

$$G_M = \frac{s^2(s^2+2s+401)}{(s^2+8s+16)(s^2+40s+400)}$$

$$= \left(\frac{s}{s+4}\right)^2 \frac{s^2+2s+401}{(s^2+20)^2} \tag{15}$$

The first term represents a bandpass limited differentiator so that the rigid body system is type 1. The second term prevents the migration of the suppressed modes to the right half s-plane and prevents instability.

The root locus plots for the rigid body controller are shown in Appendix B. Plots are shown for the controlled and suppressed modes for X and Y and the rigid modes for $\hat{X}$, $\hat{Y}$ and $\hat{Z}$. The Bode plots for the rigid body modes are shown in Appendix C for $\hat{X}$, $\hat{Y}$ and $\hat{Z}$.

V. System Simulations

The system was simulated using a Univac 1100/digital computer. All equations of motion were first order state variable notation equations and were integrated using the fourth order Runge-Kutta numerical integrator of Appendix D. Integration stepsize was varied between .01 sec/step and .1 sec/step.

The computer programs which simulate the system along with their respective flow charts are listed in Appendix D. All the plant/control equations are computed in subroutine FUNC. The subroutine RKSUB is the Runge-Kutta integrator. The main program handles the input-output and timing. All data related to the simulation is in Appendix A.

V.1. Plant (Boom-Mask) Simulation

The plant was simulated using the model of section IV.1. Equations (1)-(3) of section IV.1 are repeated below. The first order state variable equations are:

$$\begin{bmatrix} \dot{X}_C \\ \dot{X}_S \\ \dot{X}_R \end{bmatrix} = \begin{bmatrix} A_C & 0 & 0 \\ 0 & A_S & 0 \\ 0 & 0 & A_R \end{bmatrix} \begin{bmatrix} X_C \\ X_S \\ X_R \end{bmatrix} + \begin{bmatrix} B_C \\ B_S \\ B_R \end{bmatrix} \ddot{U} , \tag{1}$$

$$\begin{bmatrix} Y_C \\ Y_S \\ Y_R \end{bmatrix} = \begin{bmatrix} C_S & 0 & 0 \\ 0 & C_S & 0 \\ 0 & 0 & C_R \end{bmatrix} \begin{bmatrix} X_C \\ X_S \\ X_R \end{bmatrix} , \tag{2}$$

and

$$Y = Y_C + Y_S + Y_R \tag{3}$$

where Y_R is the rigid body deflection (both base and tip), Y_C the tip deflection due to the controlled modes (X_c) and Y_s the tip deflection due to the suppressed modes (X_s).

V.2. AGS Simulation

The AGS was simulated using the frequency response equations of Section IV.3. These equations were transformed into the time domain using phase variables and resulted in the following state equations.

$$\dot{X}_G = A_{MAT} X_G + B_G \ddot{\theta}_E \tag{16}$$

where the X_G's are the AGS states and

$$\ddot{\theta}_E = \ddot{R}_{com} - \ddot{Y}_R \, . \tag{17}$$

The matrices A_{MAT} and B_G are listed in Appendix A.

V.3. Control Simulation

The P/OF control system is a two loop controller (as seen in Figure 14). The driving functions for the plant (Boom-Mask) is the 3x1 $\ddot{U}$ vector. This vector is the sum of modal control + noise, the output of the AGS + the disturbances + noise (see Section IV.4). The control law is, neglecting the additive noises and disturbances

$$\ddot{U} = - KX_c + C_G X_G \tag{18}$$

where the X_c's are driven by the $\ddot{\theta}_E$ of Equation (17).

V.4 Disturbance, Noise Simulation

The disturbance model used was the AGS VRCS disturbance model of Section II.4. Both man-motion and thruster firing result in doublet impulses being impressed on the boom base (see Section II.4). The disturbances, $\ddot{\theta}_D$, are additive to the control equation (18) resulting in the following modified $\ddot{U}$:

$$\ddot{U} = - KX_c + C_G X_G + \ddot{\theta}_D \; . \tag{19}$$

The noise was modeled as a random stationary process of mean zero. The standard deviation of each noise (N_1 - N_4 of Figure 14) was determined as follows. N_3 and N_4, the sensor noise, has the standard deviation of Table 4 ($\pm$ ½ resolution) while N_1 is the pointing accuracy of the AGS and N_2 is the quiescent pointing stability of the AGS. N_1, N_2, N_3 and N_4 are all 3x1 vectors.

These noise vectors further modify the control law of Equations (18) and (19) yielding

$$\ddot{U} = - K(X_c + N_3) + C_G X_G + \ddot{\theta}_D + N_1 + N_2 \tag{20}$$

while the forcing function for the AGS controller of Equation (17) becomes

$$\ddot{\theta}_E = \ddot{R}_{com} - \ddot{Y}_R + N_4 \tag{21}$$

VI. Results

The flight of the P/OF can be considered to be in three phases: deployment, noise/drifting, and response to VRCS thruster firings. The feedforward accelerometer decouples the shuttle gravity gradient (G.G.) accelerations from the boom and no estimate of the boom G.G. rates are attempted. The boom G.G. rates should be an order of magnitude less than the shuttle rates and the results of earlier studies demonstrated the ability of the P/OF to follow even the shuttle G.G. rates[14,24].

The shuttle drifting simulation results are shown in Appendix E for three deadbands: 1°, 2° and 5°. For a 1° deadband the mean period between thruster firings is 40 sec but the thruster will fire in bursts of 15 times to alter the shuttle's course. All data for the shuttle G.G. rates was obtained from STS-1 data[25]. The period of the plots (3000 sec) is one-half an orbit. For a 5° deadband the thrusters fired in bursts every 160 sec.

The results of the total system simulation which incorporated the shuttle, AGS, P/OF, controllers, noise and disburbances are shown in Appendix F. The shuttle drifting of Appendix E is verified in Appendix F. These plots show tip response, base response (both in arc sec) and control effort (arc sec/sec^2). A summary of results is shown in Table 7.

VI.1 Deployment

Deployment of the boom involves extending the boom from its canister, initial pointing, and calibration. To the simulation this means initial boom displacements and velocities must be damped out and the boom pointed at the sun. All of the deployment activities must be carried out in the presence of noise. A typical deployment sequence can be seen in Figures 15 to 20. Figure 15 shows the initial damping out of modal displacements and velocities. The initial conditions of these figures were

TABLE 7

RESULTS SUMMARY		
	MAXIMUM	RMS
NOISE	.06 ARC SEC	.015 ARC SEC
VRCS DISTURBANCE *		
ROLL $\hat{x}$	.5 ARC SEC	.36 ARC SEC
$\hat{y}$	.065 ARC SEC	.015 ARC SEC
$\hat{z}$	.065 ARC SEC	.015 ARC SEC
PITCH $\hat{x}$	.065 ARC SEC	.015 ARC SEC
$\hat{y}$	.09 ARC SEC	.035 ARC SEC
$\hat{z}$	.065 ARC SEC	.015 ARC SEC
YAW $\hat{x}$	.065 ARC SEC	.015 ARC SEC
$\hat{y}$	.065 ARC SEC	.015 ARC SEC
$\hat{z}$	.19 ARC SEC	.12 ARC SEC
DISTURBANCE SETTLING TIME	1 SEC	----
DEPLOYMENT SETTLING TIME	10 SEC	----
TORQUE		
$\hat{x}$	14.9 N-m	----
$\hat{y}$	5.7 N-m	----
$\hat{z}$	.8 N-m	----
SHUTTLE DEADBAND	1°	1°

* INCLUDES NOISE

FIGURE 15

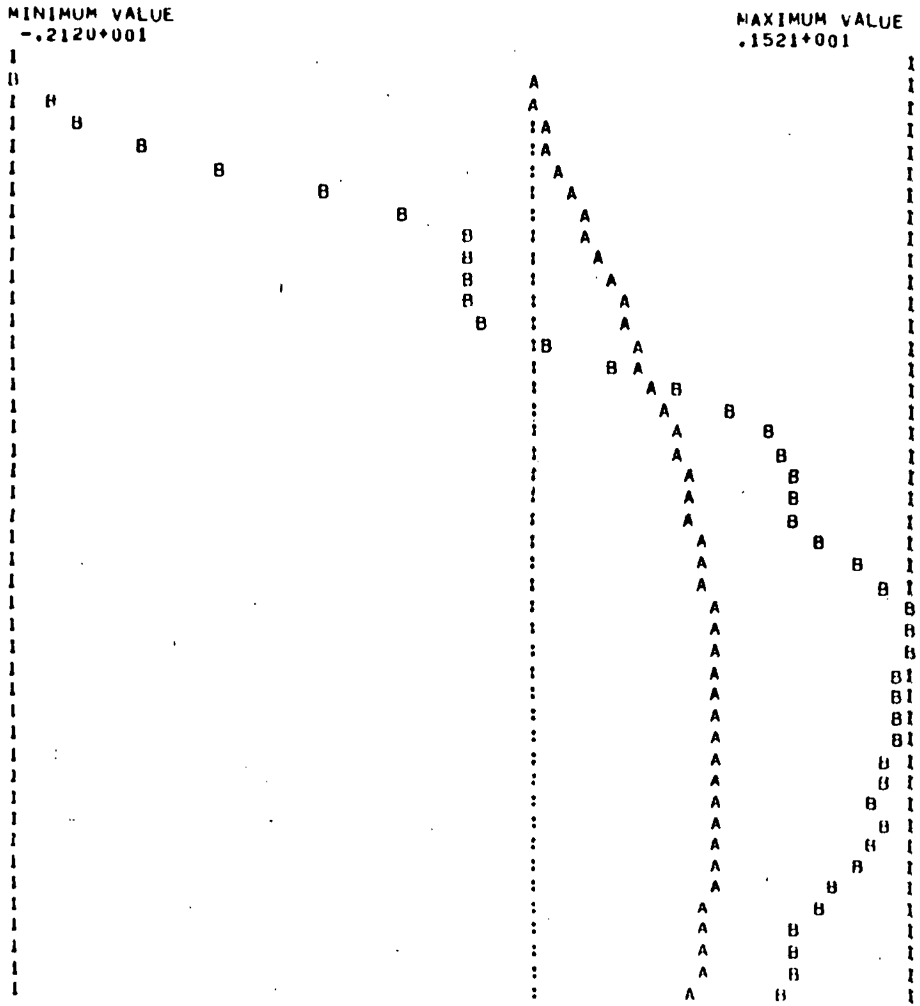
BOOM DEPLOYMENT SEQUENCE

(DISPLACEMENTS IN ARC SEC)

DATA FOR THE X-AXIS

CURVE 'A' IS A PLOT OF BASE VERSUS TIME

CURVE 'B' IS A PLOT OF TIP VERSUS TIME

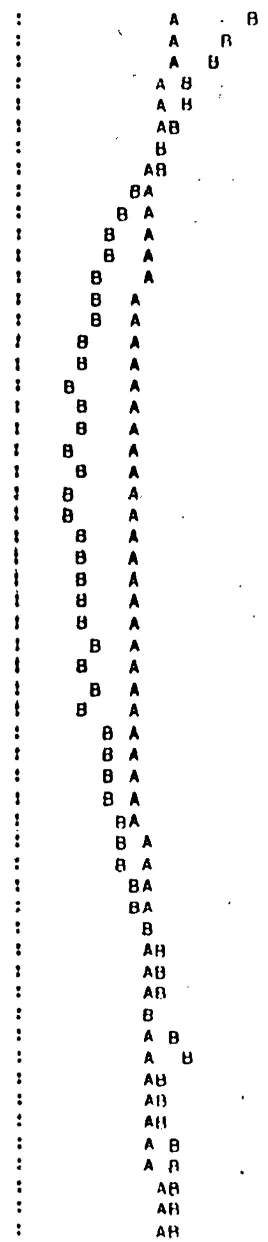


TIME	BASE	TIP
.0000	.0000	-.2120+001
.1000+000	.4429-002	-.1932+001
.2000+000	.1635-001	-.1836+001
.3000+000	.3878-001	-.1594+001
.4000+000	.7377-001	-.1250+001
.5000+000	.1195+000	-.8207+000
.6000+000	.1706+000	-.5149+000
.7000+000	.2210+000	-.2914+000
.8000+000	.2646+000	-.2721+000
.9000+000	.2989+000	-.2951+000
.1000+001	.3270+000	-.2846+000
.1100+001	.3535+000	-.2143+000
.1200+001	.3829+000	.2140-001
.1300+001	.4175+000	.3047+000
.1400+001	.4565+000	.5736+000
.1500+001	.4961+000	.7856+000
.1600+001	.5336+000	.9487+000
.1700+001	.5665+000	.1001+001
.1800+001	.5929+000	.1023+001
.1900+001	.6147+000	.1041+001
.2000+001	.6326+000	.1051+001
.2100+001	.6492+000	.1139+001
.2200+001	.6664+000	.1273+001
.2300+001	.6838+000	.1381+001
.2400+001	.7006+000	.1487+001
.2500+001	.7148+000	.1521+001
.2600+001	.7253+000	.1487+001
.2700+001	.7312+000	.1462+001
.2800+001	.7342+000	.1458+001
.2900+001	.7352+000	.1432+001
.3000+001	.7347+000	.1446+001
.3100+001	.7335+000	.1412+001
.3200+001	.7297+000	.1371+001
.3300+001	.7245+000	.1349+001
.3400+001	.7184+000	.1374+001
.3500+001	.7115+000	.1340+001
.3600+001	.7027+000	.1267+001
.3700+001	.6921+000	.1181+001
.3800+001	.6803+000	.1122+001
.3900+001	.6679+000	.1037+001
.4000+001	.6552+000	.1027+001
.4100+001	.6435+000	.1006+001
.4200+001	.6317+000	.9675+000

FIGURE 16

BOOM DEPLOYMENT SEQUENCE

(DISPLACEMENTS IN ARC SEC)



.4300+001	.6194+000	.9043+000
.4400+001	.6064+000	.8432+000
.4500+001	.5936+000	.7726+000
.4600+001	.5800+000	.6760+000
.4700+001	.5668+000	.6486+000
.4800+001	.5544+000	.6340+000
.4900+001	.5434+000	.5793+000
.5000+001	.5324+000	.5381+000
.5100+001	.5218+000	.4490+000
.5200+001	.5109+000	.4126+000
.5300+001	.5004+000	.3713+000
.5400+001	.4909+000	.3593+000
.5500+001	.4822+000	.3201+000
.5600+001	.4743+000	.2927+000
.5700+001	.4672+000	.2978+000
.5800+001	.4615+000	.2514+000
.5900+001	.4559+000	.2321+000
.6000+001	.4507+000	.1949+000
.6100+001	.4465+000	.2315+000
.6200+001	.4441+000	.2385+000
.6300+001	.4423+000	.2077+000
.6400+001	.4414+000	.2397+000
.6500+001	.4403+000	.1871+000
.6600+001	.4400+000	.2141+000
.6700+001	.4412+000	.2409+000
.6800+001	.4428+000	.2364+000
.6900+001	.4449+000	.2415+000
.7000+001	.4469+000	.2415+000
.7100+001	.4493+000	.2563+000
.7200+001	.4525+000	.2754+000
.7300+001	.4555+000	.2539+000
.7400+001	.4581+000	.2791+000
.7500+001	.4606+000	.2725+000
.7600+001	.4639+000	.3336+000
.7700+001	.4677+000	.3467+000
.7800+001	.4713+000	.3475+000
.7900+001	.4746+000	.3572+000
.8000+001	.4786+000	.4020+000
.8100+001	.4832+000	.4213+000
.8200+001	.4869+000	.4188+000
.8300+001	.4904+000	.4343+000
.8400+001	.4938+000	.4733+000
.8500+001	.4975+000	.5285+000
.8600+001	.5029+000	.5651+000
.8700+001	.5077+000	.5476+000
.8800+001	.5114+000	.5366+000
.8900+001	.5143+000	.5214+000
.9000+001	.5171+000	.5894+000
.9100+001	.5213+000	.6405+000
.9200+001	.5251+000	.5713+000
.9300+001	.5268+000	.5669+000
.9400+001	.5286+000	.5831+000
.9500+001	.5305+000	.6114+000
.9600+001	.5323+000	.5902+000
.9700+001	.5337+000	.6278+000
.9800+001	.5350+000	.5958+000
.9900+001	.5362+000	.6113+000

FIGURE 17

BOOM DEPLOYMENT SEQUENCE

(DISPLACEMENTS IN ARC SEC)

.1000+002	B	.5357+000	.5758+000
.1010+002	AB	.5346+000	.5404+000
.1020+002	AB	.5343+000	.6033+000
.1030+002	AB	.5339+000	.6059+000
.1040+002	AB	.5336+000	.6178+000
.1050+002	AB	.5333+000	.6187+000
.1060+002	AB	.5337+000	.6177+000
.1070+002	AB	.5334+000	.5972+000
.1080+002	A B	.5343+000	.6831+000
.1090+002	A B	.5363+000	.6558+000
.1100+002	B	.5367+000	.5790+000
.1110+002	AB	.5360+000	.5991+000
.1120+002	B	.5358+000	.5717+000
.1130+002	B	.5346+000	.5550+000
.1140+002	B	.5333+000	.5708+000
.1150+002	AB	.5325+000	.5588+000
.1160+002	AB	.5314+000	.5421+000
.1170+002	B	.5299+000	.4995+000
.1180+002	B	.5277+000	.5310+000
.1190+002	AB	.5269+000	.5524+000
.1200+002	AB	.5273+000	.5514+000
.1210+002	B	.5271+000	.5096+000
.1220+002	B	.5256+000	.4933+000
.1230+002	B	.5246+000	.4944+000
.1240+002	B	.5242+000	.5106+000
.1250+002	B	.5233+000	.4906+000
.1260+002	BA	.5225+000	.4721+000
.1270+002	BA	.5214+000	.4744+000
.1280+002	BA	.5201+000	.4754+000
.1290+002	B	.5195+000	.5112+000
.1300+002	B	.5195+000	.4851+000
.1310+002	B A	.5147+000	.1694+000
.1320+002	B A	.5031+000	.2438+000
.1330+002	B	.4990+000	.5204+000
.1340+002	A B	.5018+000	.6601+000
.1350+002	A B	.5062+000	.6042+000
.1360+002	BA	.5079+000	.4796+000
.1370+002	BA	.5076+000	.4394+000
.1380+002	B A	.5059+000	.4133+000
.1390+002	BA	.5037+000	.4363+000
.1400+002	BA	.5016+000	.4692+000
.1410+002	BA	.4990+000	.4455+000
.1420+002	BA	.4954+000	.4598+000
.1430+002	BA	.4920+000	.4328+000
.1440+002	B A	.4887+000	.4236+000
.1450+002	BA	.4861+000	.4581+000
.1460+002	B	.4859+000	.5219+000
.1470+002	B	.4864+000	.5226+000
.1480+002	B	.4866+000	.5227+000
.1490+002	B	.4857+000	.5182+000
.1500+002	B	.4836+000	.5166+000
.1510+002	B	.4814+000	.5145+000
.1520+002	AB	.4794+000	.5123+000
.1530+002	B	.4767+000	.4803+000
.1540+002	AB	.4745+000	.5234+000
.1550+002	A B	.4739+000	.5473+000
.1560+002	A B	.4737+000	.5551+000

12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890***SEQ.NO.01

FIGURE 18

BOOM DEPLOYMENT SEQUENCE

(DISPLACEMENTS IN ARC SEC)

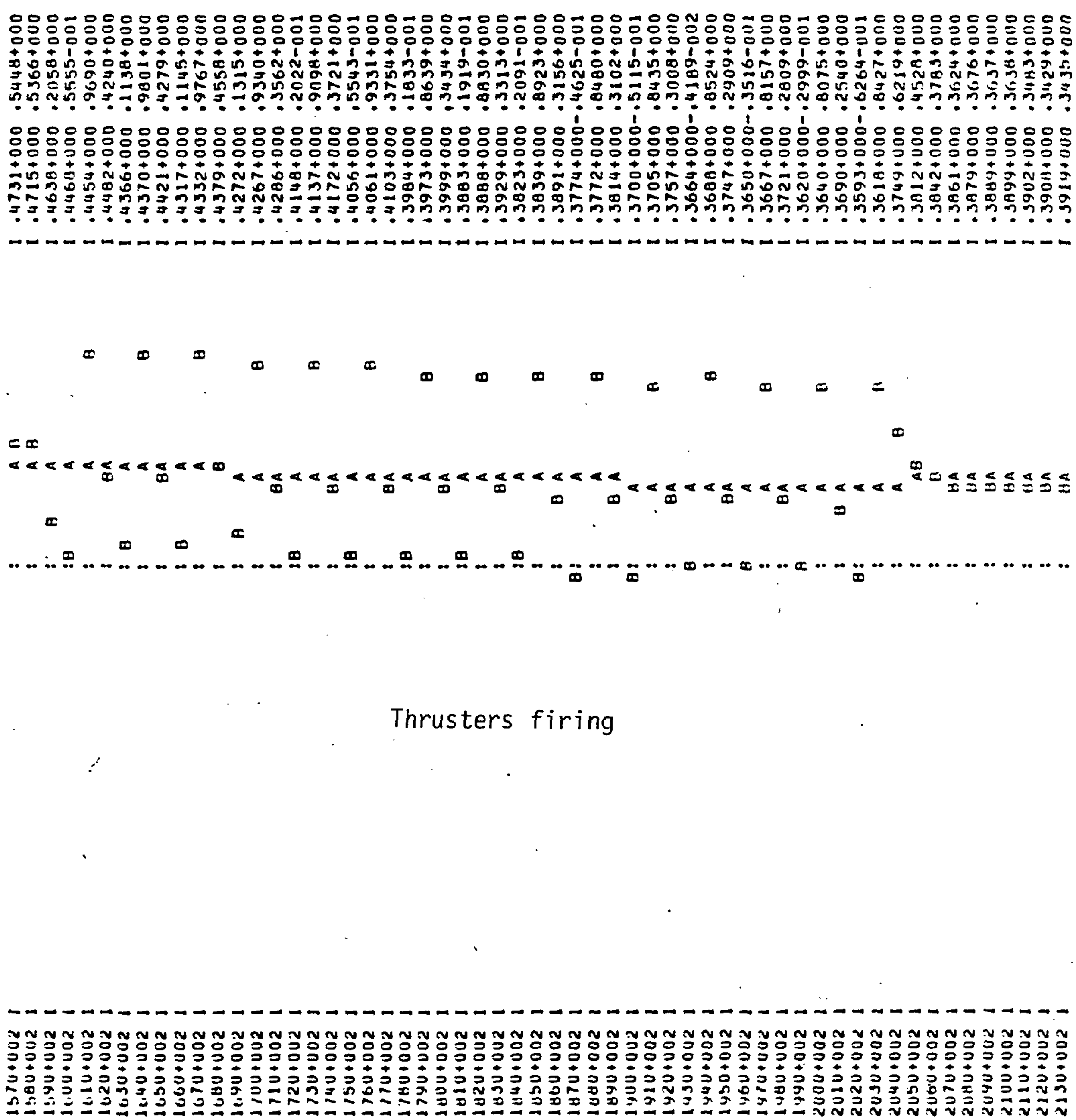


FIGURE 19

BOOM DEPLOYMENT SEQUENCE

(DISPLACEMENTS IN ARC SEC)

.2140+002	BA	.3933+000	.3362+000
.2150+002	BA	.3950+000	.3270+000
.2160+002	BA	.3968+000	.3657+000
.2170+002	B	.4003+000	.3941+000
.2180+002	BA	.4031+000	.3743+000
.2190+002	BA	.4049+000	.3457+000
.2200+002	BA	.4058+000	.3340+000
.2210+002	B A	.4059+000	.3016+000
.2220+002	B A	.4056+000	.2914+000
.2230+002	B A	.4058+000	.3147+000
.2240+002	B A	.4065+000	.3226+000
.2250+002	BA	.4076+000	.3677+000
.2260+002	BA	.4097+000	.3748+000
.2270+002	B	.4117+000	.3836+000
.2280+002	BA	.4128+000	.3561+000
.2290+002	BA	.4133+000	.3675+000
.2300+002	B	.4145+000	.3887+000
.2310+002	B	.4161+000	.4149+000
.2320+002	B	.4183+000	.4170+000
.2330+002	B	.4199+000	.4052+000
.2340+002	B	.4208+000	.4040+000
.2350+002	B	.4219+000	.4050+000
.2360+002	B	.4225+000	.4001+000
.2370+002	B	.4229+000	.4267+000
.2380+002	AB	.4243+000	.4574+000
.2390+002	AB	.4256+000	.4707+000
.2400+002	AB	.4262+000	.4312+000
.2410+002	AB	.4265+000	.4443+000
.2420+002	AB	.4273+000	.4687+000
.2430+002	AB	.4282+000	.4570+000
.2440+002	AB	.4280+000	.4535+000
.2450+002	AB	.4276+000	.4460+000
.2460+002	AB	.4273+000	.4742+000
.2470+002	A B	.4279+000	.4861+000
.2480+002	AB	.4281+000	.4645+000
.2490+002	AB	.4284+000	.4716+000
.2500+002	AB	.4283+000	.4702+000
.2510+002	B A	.4245+000	.2179+000
.2520+002	B A	.4151+000	.2509+000
.2530+002	A B	.4113+000	.4859+000
.2540+002	A B	.4121+000	.5687+000
.2550+002	A B	.4137+000	.5104+000
.2560+002	B	.4131+000	.4215+000
.2570+002	B	.4109+000	.4108+000
.2580+002	BA	.4086+000	.3755+000
.2590+002	B	.4052+000	.3888+000
.2600+002	B	.4021+000	.4129+000
.2610+002	B	.3985+000	.3871+000
.2620+002	B	.3948+000	.4075+000
.2630+002	B	.3901+000	.3871+000
.2640+002	B	.3864+000	.3940+000
.2650+002	B	.3836+000	.3988+000
.2660+002	B	.3811+000	.4107+000
.2670+002	AB	.3793+000	.4506+000
.2680+002	AB	.3784+000	.4509+000
.2690+002	A B	.3771+000	.4414+000
.2700+002	AB	.3745+000	.3963+000

1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890...SF0.N0.01

FIGURE 20

BOOM DEPLOYMENT SEQUENCE

(DISPLACEMENTS IN ARC SEC)

```
.2710+002 I                         :    B              I .3706+000 .3713+000
.2720+002 I                         :    AB             I .3666+000 .3874+000
.2730+002 I                         :    AB             I .3636+000 .3949+000
.2740+002 I                         :    AB             I .3614+000 .3946+000
.2750+002 I                         :    AB             I .3595+000 .4260+000
.2760+002 I                         :    AB             I .3576+000 .4014+000
.2770+002 I                         :    AB             I .3562+000 .4055+000
.2780+002 I                         :    AB             I .3543+000 .3840+000
.2790+002 I                         :    B              I .3512+000 .3509+000
.2800+002 I                         :    B              I .3478+000 .3487+000
.2810+002 I                         :    B              I .3441+000 .3288+000
.2820+002 I                         :    B              I .3402+000 .3256+000
.2830+002 I                         :   BA              I .3364+000 .3125+000
.2840+002 I                         :    B              I .3335+000 .3435+000
.2850+002 I                         :    B              I .3314+000 .3470+000
.2860+002 I                         :    B              I .3295+000 .3377+000
.2870+002 I                         :    B              I .3277+000 .3491+000
.2880+002 I                         :    B              I .3263+000 .3502+000
.2890+002 I                         :   AB              I .3245+000 .3319+000
.2900+002 I                         :   AB              I .3227+000 .3436+000
.2910+002 I                         :   B               I .3203+000 .2847+000
.2920+002 I                         :   AB              I .3184+000 .3309+000
.2930+002 I                         :   B               I .3170+000 .3181+000
.2940+002 I                         :   B               I .3158+000 .3198+000
.2950+002 I                         :   B               I .3143+000 .3210+000
.2960+002 I                         :   B               I .3128+000 .2895+000
.2970+002 I                         :   B               I .3114+000 .2891+000
.2980+002 I                         :   B               I .3104+000 .3182+000
.2990+002 I                         :   B               I .3093+000 .3078+000
.3000+002 I                         :   B               I .3081+000 .3063+000
```

chosen at random. Figures 16-20 show the calibration and initial pointing of the boom. The torque required to initially damp the boom, point and calibrate it did not exceed the 33.9 N-m capability of the AGS torques and was limited to 14.9 N-m in $\hat{x}$ and 5.7 N-m in $\hat{y}$. $\hat{z}$ did not possess modal dynamics due to the low tip mass[14]. Extended plots and data of deployment are shown in Appendix F, Figures F1 to F43 including torque plots. All tip and base plots are in ARC SEC and all torque plots are in N-m.

VI.2 Thruster Firings

The typical responses of the boom tip and base to thruster firings are shown in Figures 21 to 23. Figure 21 shows a typical response to a roll axis VRCS thruster firing. The maximum tip error was .6 arc sec while the maximum base error was .048 arc sec. The maximum control effort was 28.9 arc sec/sec^2 resulting in a torque demand of 8.1 N-m. A complete thruster sequence is shown in Appendix F, Figures F44 to F61.

Figure 22 shows a typical response to a pitch axis VRCS thruster firing. The maximum tip error was .03 arc sec while the maximum base error was .02 arc sec. The maximum control effort was .8 arc sec/sec^2 resulting in a torque demand of .337 N-m. A complete thruster sequence is shown in Appendix F, Figures F62 to F100.

A typical response to a yaw axes VRCS thruster firing is shown in Figure 23. The maximum control effort required was .0008 arc sec/sec^2 or a torque of .01 N-m. The maximum tip and base errors were .19 arc sec and .19 arc sec respectively. A complete thruster sequence can be seen in Appendix F, Figures F101 to F139.

VI.3 Noise

Of considerable interest in the P/OF is the system noise. Noise appears as random excursions of the boom tip (primary effect) and base

FIGURE 21

ROLL DISTURBANCE RESPONSE

A = BASE

B = BOOM TIP

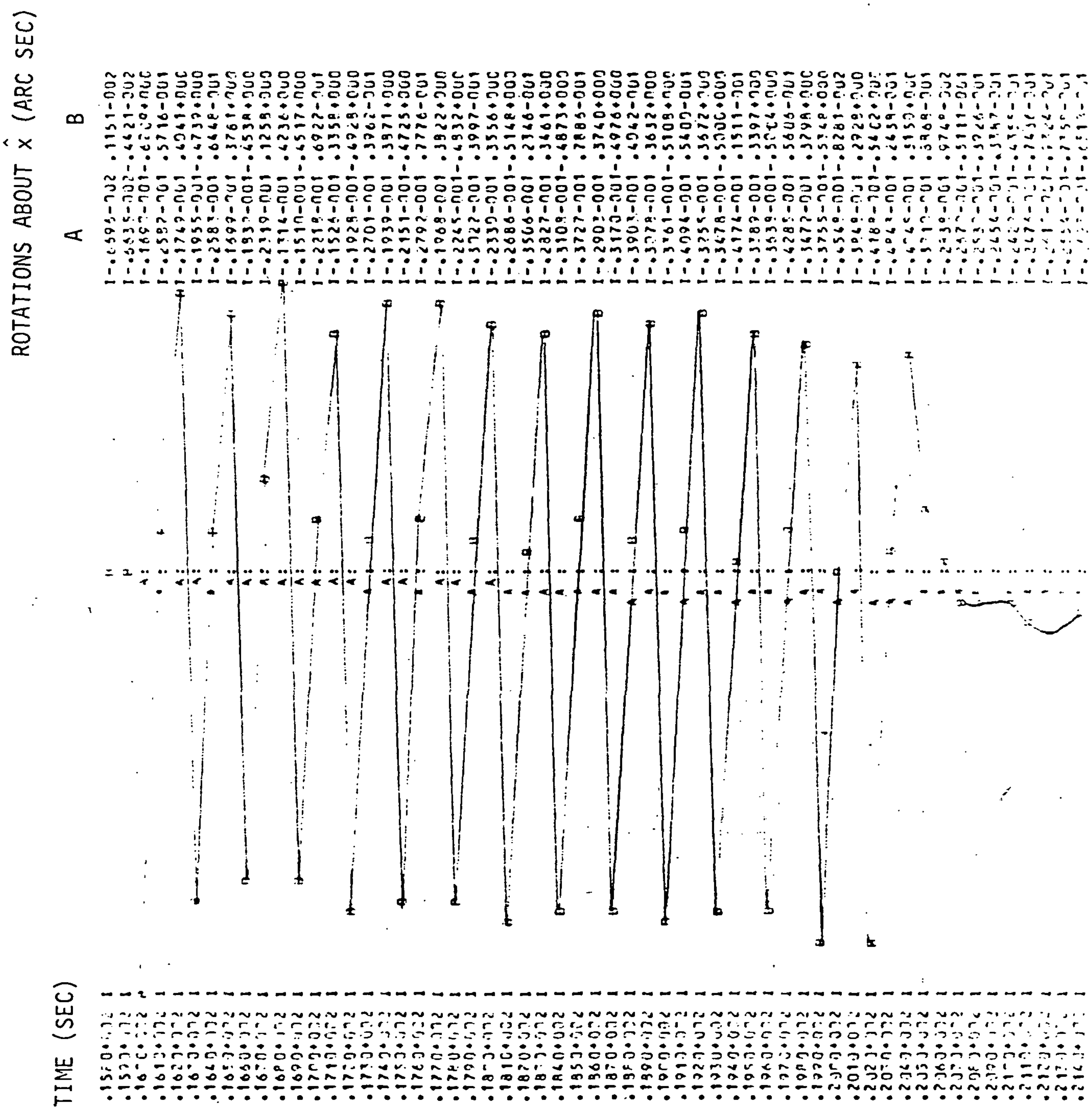


FIGURE 22

PITCH DISTURBANCE RESPONSE

A = BASE

B = BOOM TIP

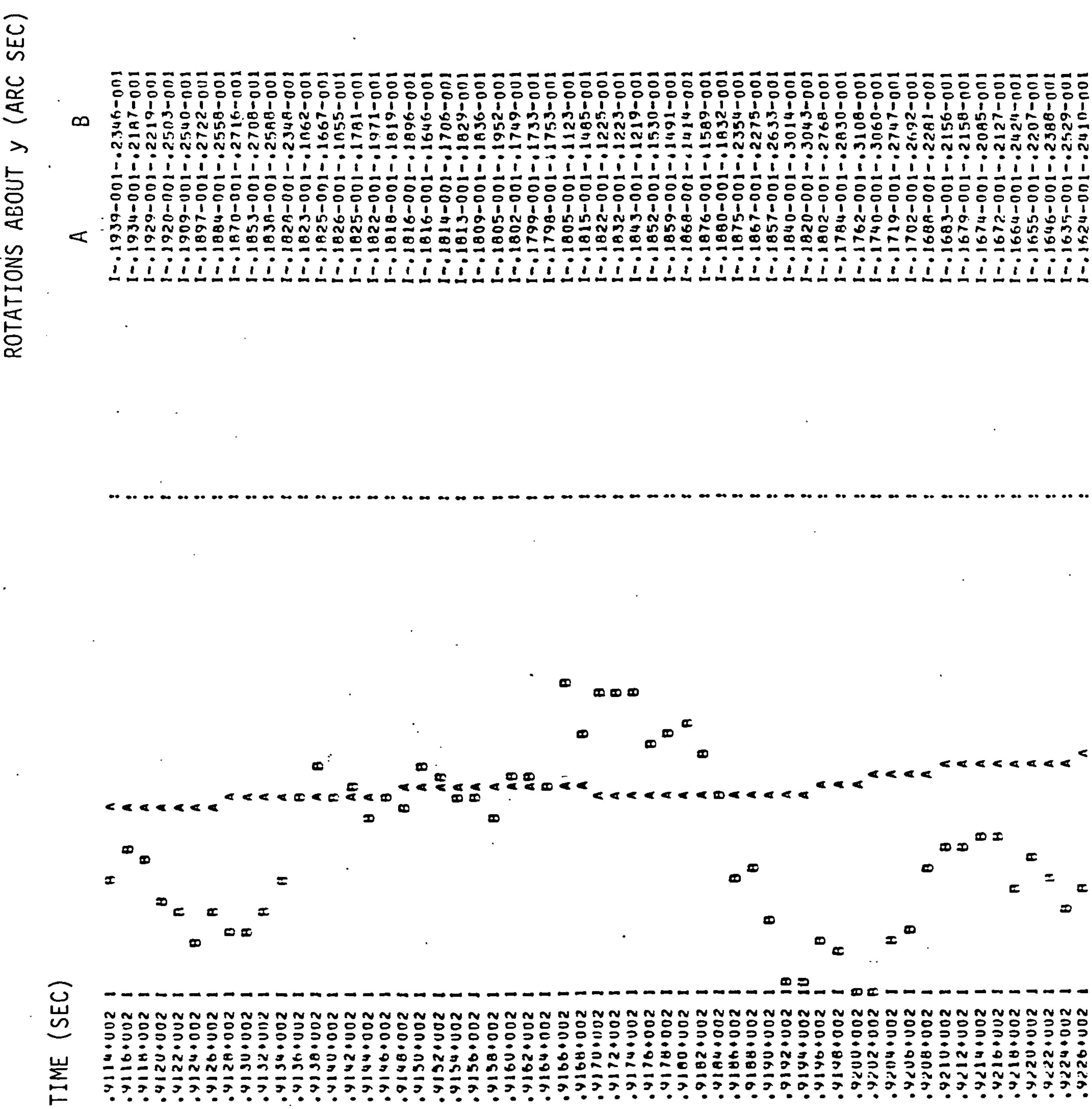


FIGURE 23

YAW DISTURBANCE RESPONSE

A = B = BASE = BOOM TIP

ROTATIONS ABOUT $\hat{z}$ (ARC SEC)

TIME (SEC)		A	B
.2300+003 :	B I	.1870+000	.1870+000
.2300+003 :	B I	.1875+000	.1875+000
.2300+003 :	B I	.1880+000	.1880+000
.2301+003 :	B I	.1884+000	.1884+000
.2301+003 :	B I	.1888+000	.1888+000
.2301+003 :	B I	.1891+000	.1891+000
.2301+003 :	B I	.1895+000	.1895+000
.2301+003 :	B I	.1899+000	.1899+000
.2302+003 :	B I	.1902+000	.1902+000
.2302+003 :	B I	.1904+000	.1904+000
.2302+003 :	B I	.1906+000	.1906+000
.2302+003 :	B I	.1908+000	.1908+000
.2302+003 :	B I	.1910+000	.1910+000
.2303+003 :	B I	.1913+000	.1913+000
.2303+003 :	BI	.1915+000	.1915+000
.2303+003 :	BI	.1917+000	.1917+000
.2303+003 :	BI	.1920+000	.1920+000
.2303+003 :	BI	.1922+000	.1922+000
.2304+003 :	BI	.1925+000	.1925+000
.2304+003 :	BI	.1926+000	.1926+000
.2304+003 :	BI	.1927+000	.1927+000
.2304+003 :	BI	.1927+000	.1927+000
.2304+003 :	BI	.1928+000	.1928+000
.2305+003 :	BI	.1929+000	.1929+000
.2305+003 :	BI	.1931+000	.1931+000
.2305+003 :	BI	.1932+000	.1932+000
.2305+003 :	BI	.1934+000	.1934+000
.2305+003 :	BI	.1935+000	.1935+000
.2306+003 :	BI	.1937+000	.1937+000
.2306+003 :	BI	.1938+000	.1938+000
.2306+003 :	BI	.1940+000	.1940+000
.2306+003 :	BI	.1942+000	.1942+000
.2306+003 :	B	.1944+000	.1944+000
.2307+003 :	B	.1946+000	.1946+000
.2307+003 :	B	.1948+000	.1948+000
.2307+003 :	B	.1950+000	.1950+000
.2307+003 :	B	.1952+000	.1952+000
.2307+003 :	B	.1953+000	.1953+000
.2308+003 :	B	.1955+000	.1955+000
.2308+003 :	B	.1956+000	.1956+000
.2308+003 :	B	.1957+000	.1957+000
.2308+003 :	B	.1959+000	.1959+000
.2308+003 :	B	.1960+000	.1960+000
.2309+003 :	B	.1962+000	.1962+000
.2309+003 :	B	.1963+000	.1963+000
.2309+003 :	B	.1965+000	.1965+000
.2309+003 :	B	.1966+000	.1966+000
.2309+003 :	B	.1966+000	.1966+000
.2310+003 :	B	.1968+000	.1968+000
.2310+003 :	B	.1969+000	.1969+000
.2310+003 :	B	.1970+000	.1970+000
.2310+003 :	B	.1971+000	.1971+000
.2310+003 :	B	.1971+000	.1971+000
.2311+003 :	B	.1971+000	.1971+000
.2311+003 :	B	.1971+000	.1971+000
.2311+003 :	B	.1970+000	.1970+000
.2311+003 :	B	.1970+000	.1970+000

(secondary effect). Figures 24 and 25 show a typical on target noise time course. The maximum noise was bounded by .1 arc sec for the boom tip and an order of magnitude less for the base. The rms noise was approximately .015 arc sec for the boom tip in $\hat{x}$, $\hat{y}$ and $\hat{z}$ (boom roll). Complete noise characteristics about the $\hat{x}$ axis are shown in Appendix F Figures F140 - 153 over a 15 sec time period.

FIGURE 24

NOISE CHARACTERISTICS

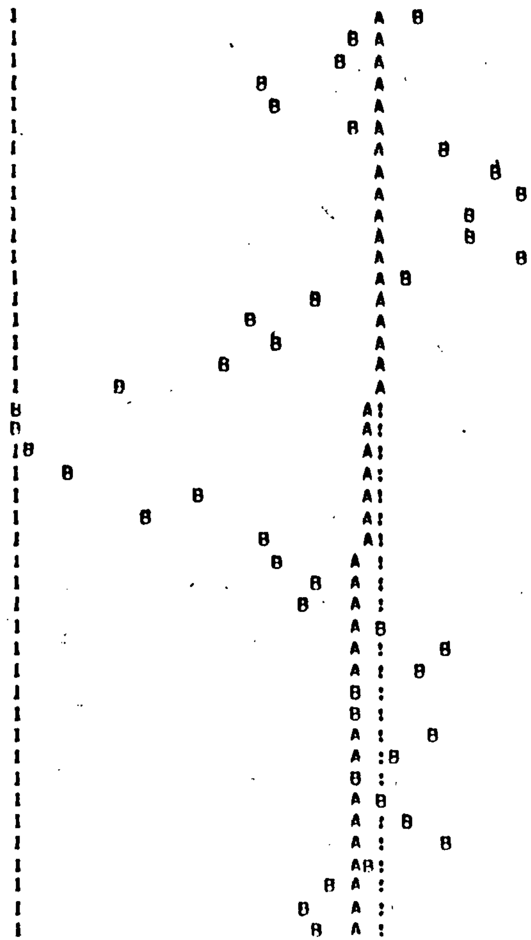
DATA FOR THE X-AXIS

CURVE 'A' IS A PLOT OF BASE VERSUS TIME

CURVE 'B' IS A PLOT OF TIP VERSUS TIME

MINIMUM VALUE -.4088-001

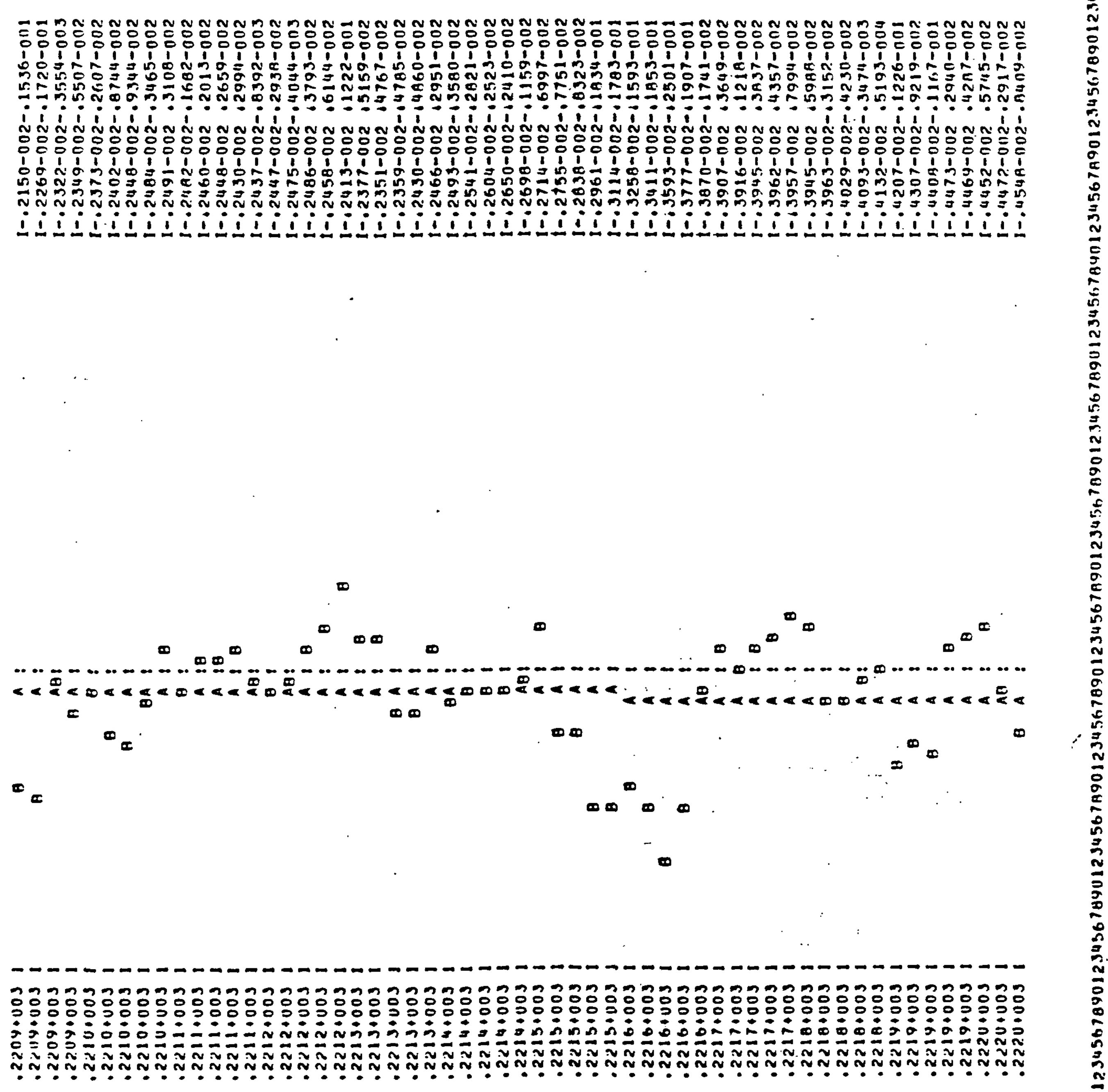
MAXIMUM VALUE .6077-001



TIME	BASE	TIP
.2200+003	.4255-005	.4758-002
.2200+003	.9006-005	-.3123-002
.2201+003	-.1016-004	-.3344-002
.2201+003	-.7895-004	-.1280-001
.2201+003	-.1621-003	-.1080-001
.2201+003	-.2146-003	-.2825-002
.2201+003	-.1979-003	.7679-002
.2202+003	-.1213-003	.1327-001
.2202+003	-.2222-004	.1585-001
.2202+003	.5272-004	.1088-001
.2202+003	.1322-003	.1069-001
.2202+003	.2277-003	.1654-001
.2203+003	.2973-003	.3202-002
.2203+003	.2894-003	-.6370-002
.2203+003	.2171-003	-.1415-001
.2203+003	.1431-003	-.1077-001
.2203+003	.4755-004	-.1702-001
.2204+003	-.1029-003	-.2856-001
.2204+003	-.3408-003	-.4088-001
.2204+003	-.6257-003	-.4047-001
.2204+003	-.8915-003	-.3914-001
.2204+003	-.1135-002	-.3440-001
.2205+003	-.1330-002	-.2016-001
.2205+003	-.1499-002	-.2572-001
.2205+003	-.1631-002	-.1246-001
.2205+003	-.1740-002	-.1050-001
.2205+003	-.1801-002	-.7482-002
.2206+003	-.1856-002	-.8217-002
.2206+003	-.1896-002	.8836-003
.2206+003	-.1898-002	.7077-002
.2206+003	-.1878-002	.5287-002
.2206+003	-.1893-002	-.2522-002
.2207+003	-.1937-002	-.2582-002
.2207+003	-.1927-002	.6942-002
.2207+003	-.1922-002	.2160-002
.2207+003	-.1933-002	-.1746-002
.2207+003	-.1950-002	.5792-003
.2208+003	-.1953-002	.2783-002
.2208+003	-.1923-002	.7382-002
.2208+003	-.1913-002	-.1542-002
.2208+003	-.1959-002	-.5031-002
.2208+003	-.2011-002	-.8386-002
.2209+003	-.2078-002	-.7346-002

FIGURE 25

NOISE CHARACTERISTICS



VII. Conclusions

As the results show, the P/OF is asymptotically stable (returns to rest at no displacement after an initial displacement). In addition the P/OF has good pointing accuracy (1σ = .03 arc sec.), good pointing stability (1σ = .015 arc sec quiescent) and low disturbance responses (.5 arc sec maximum). The controllers utilized were an inner loop modal controller which actively damped the P/OF boom and an outer loop rigid body controller utilizing the PID controller of the AGS + the AGS modal filters. The state of the art sensors proposed allow the system to work within error tolerances. The AGS torquer appear to be sufficient to move and control the P/OF's large inertia. Disturbances, either VRCS thruster firings or man motion, do not have significant effects on the pointing stability of the system.

The main problem with a system of this type is cost.[23] The inner loop controller requires filters plus an eight order estimator which could cost as much as 3-4 million dollars alone. The implementation of the rigid body controller plus modal filter could easily run just as much. Clearly, a less expensive way of achieving the same results would be of great benefit.

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IX. Appendices

IX.A. Plant Data

APPENDIX A PLANT DATA

A.1. MATRICES

$$
\underset{(8\times8)}{A_c} = \begin{bmatrix}
0 & 1 & & & & & & \\
-1.188 & -.0436 & & & & & 0 & \\
 & & 0 & 1 & & & & \\
 & & -1.188 & -.0436 & & & & \\
 & & & & 0 & 1 & & \\
 & 0 & & & -55.48 & -.298 & & \\
 & & & & & & 0 & 1 \\
 & & & & & & -55.48 & -.298
\end{bmatrix} \qquad \text{(A-1)}
$$

$$
\underset{(8\times8)}{A_s} = \begin{bmatrix}
0 & 1 & & & & & & \\
-475.9 & -.872 & & & & & 0 & \\
 & & 0 & 1 & & & & \\
 & & -475.9 & -.872 & & & & \\
 & & & & 0 & 1 & & \\
 & 0 & & & -1958 & -1.77 & & \\
 & & & & & & 0 & 1 \\
 & & & & & & -1958 & -1.77
\end{bmatrix} \qquad \text{(A-2)}
$$

$$
\underset{(6\times6)}{A_R} = \begin{bmatrix}
0 & 1 & & & & \\
0 & 0 & & & 0 & \\
 & & 0 & 1 & & \\
 & & 0 & 0 & & \\
 & 0 & & & 0 & 1 \\
 & & & & 0 & 0
\end{bmatrix} \qquad \text{(A-3)}
$$

$$
A_{SH} = \begin{bmatrix}
0 & \emptyset & & & & & & & & & & \\
0 & 0 & & & & & & & & & & \\
& & 0 & \emptyset & & & & & 0 & & & \\
& & 0 & 0 & & & & & & & & \\
& & & & 0 & \emptyset & & & & & & \\
& & & & 0 & 0 & & & & & & \\
& & & & & & 0 & \emptyset & & & & \\
& & & & & & 0 & 0 & & & & \\
& & 0 & & & & & & 0 & \emptyset & & \\
& & & & & & & & 0 & 0 & & \\
& & & & & & & & & & 0 & \emptyset \\
& & & & & & & & & & 0 & 0
\end{bmatrix} \qquad \text{(A-4)}
$$

$$
\underset{(7\times 7)}{A_G} = \begin{bmatrix}
0 & 1 & & & & & \\
0 & 0 & 1 & & 0 & & \\
& & & 0 & 1 & & \\
& 0 & & 0 & 0 & 1 & \\
& & & & & & 0
\end{bmatrix} \qquad \text{(A-5)}
$$

$$
\underset{(8\times 3)}{B_c} = \begin{bmatrix}
0 & 0 & 0 \\
466.4 & -1175 & 0 \\
0 & 0 & 0 \\
-1175 & -466.4 & 0 \\
0 & 0 & 0 \\
-123.5 & 142.8 & 0 \\
0 & 0 & 0 \\
142.8 & 123.5 & 0
\end{bmatrix} \qquad \text{(A-6)}
$$

$$B_s = \begin{bmatrix} 0 & 0 & 0 \\ -69.45 & -2.523 & 0 \\ 0 & 0 & 0 \\ -2.523 & 69.45 & 0 \\ 0 & 0 & 0 \\ 5.204 & 34.88 & 0 \\ 0 & 0 & 0 \\ +34.88 & -5.205 & 0 \end{bmatrix} \quad (8\text{x}3) \tag{A-7}$$

$$B_R = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad (6\text{x}3) \tag{A-8}$$

$$B_{SH} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad (12\text{x}6) \qquad \text{(A}$$

$$B_G = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ K_x & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & K_y & 0 \\ 0 & 0 & K_z \end{bmatrix} \tag{A-10}$$

$$C_c = \begin{bmatrix} 0 \,, & 7.82E\text{-}4 \,, & 0 \,, & -1.96E\text{-}3 \,, & 0 \,, & -9.2E\text{-}4 \,, & 0 \,, & 1.07E\text{-}3 \\ 0 \,, & 8.03E\text{-}4 \,, & 0 \,, & 3.19E\text{-}4 \,, & 0 \,, & 4.3E\text{-}4 \,, & 0 \,, & 3.7E\text{-}4 \\ 0 \,, & 0 \,, & 0 \,, & 0 \,, & 0 \,, & 0 \,, & 0 \,, & 0 \end{bmatrix} \tag{A-11}$$

$$C_s = \begin{bmatrix} 0 \,, & -7.1E\text{-}4 \,, & 0 \,, & -2.8E\text{-}5 \,, & 0 \,, & 7.5E\text{-}5 \,, & 0 \,, & 4.8E\text{-}4 \\ 0 \,, & 1.5E\text{-}5 \,, & 0 \,, & -4.3E\text{-}4 \,, & 0 \,, & 3.3E\text{-}4 \,, & 0 \,, & -4.9E\text{-}5 \\ 0 \,, & 0 \,, & 0 \,, & 0 \,, & 0 \,, & 0 \,, & 0 \,, & 0 \end{bmatrix} \tag{A-12}$$

$$C_R = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \tag{A-13}$$

$$C_{SH} \quad \begin{bmatrix} 1 & 0 & & & & & & & & & & & & \\ 0 & 0 & 1 & & & & & & & & & & & \\ 0 & 0 & 0 & 0 & 1 & & & & & 0 & & & & \\ & & & & 0 & 0 & 1 & & & & & & & \\ & & & & & & 0 & 0 & 1 & & & & & \\ & & 0 & & & & & & 0 & 0 & 1 & & & \\ & & & & & & & & & & 0 & 0 & 1 & 0 \end{bmatrix} \tag{A-14}$$

$$C_G = \begin{bmatrix} 1, & -2.02, & -2.08, & 0, & 0, & 0, & 0 \\ 0, & 0, & 0, & 1, & -4.116, & -3.62, & 0 \\ 0, & 0, & 0, & 0, & 0, & 0, & 1 \end{bmatrix} \tag{A-15}$$

$$R = \begin{bmatrix} 5.15E-4, & 7.77E-4, & -1.29E-3, & -1.96E-3, & -1.49E-2, & -4.26E-3, & 1.72E-2, & 4.92E-3 \\ -1.29E-3, & -1.96E-3, & -5.15E-4, & -7.77E-4, & 1.72E-2, & 4.93E-3, & 1.49E-2, & 4.26E-3 \\ 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0 \end{bmatrix} \tag{A-16}$$

A.2. MOMENTS OF INERTIA

for Roll (x-axis) Gimbal

$$\frac{K_{TD}}{J_{EQ}} = \frac{M_p RL3}{J_{px} + M_p RL3^2}$$

$$= \frac{685(6.5)}{75230+685(6.5)^2} = \frac{4,452.5 \text{ kgm}}{(57230+28,941)\text{kgm}^2} = \frac{4452.5}{86,171.25} = 0.05167 \text{ m}^{-1}$$

for Pitch (y-axis) Gimbal

$$\frac{K_{TD}}{J_{EQ}} = \frac{M_G(RE2)+M_P(RE2+RC2+RC3)}{[J_{GY}+J_{PY}+M_G(RE2)^2+M_P(RE2+RC2+RC3)^2]}$$

$$= \frac{328(.1064)+685(2(.1064)+6.5)}{[(328+57,230)+328(.1064)^2+685(2(.1064)+6.5)^2]}$$

$$= \frac{4633.2}{88428.9} = .05239 \text{ m}^{-1}$$

for Y_{GY}, assume entire mass of Gimbal is a 'thin' disk 1m in dia.

then $J_{GY} = mr^2 = 328(1)^2 = 328 \text{ kgm}^2$

$-M_P$ = 685 kg; c.m. = 6.5m

SPERRY REPORT, April 1980 "Design & Performance of AGS" pg. 44

- TOTAL AGS WEIGHT w/ROLL(z-axis) $\rightarrow$ 328 kg = M_G

From Sperry $J_{PY} = J_{PX}$ = 57,230 kgm^2

RE2 = RC2 = .1064m RL3 = c.m. = 6.5m

IX.B. Root Locus Plots

FIGURE B-1: Y_{cx} ROOT LOCUS

TRACKER: $\dfrac{K_x(s^2 + 2.02s + 2.08)}{S}$

MODAL CONTROL: $-Kx_c$

Y_R FEEDBACK

MODAL FILTER: $\dfrac{s^2}{s^2 + 8s + 16}$

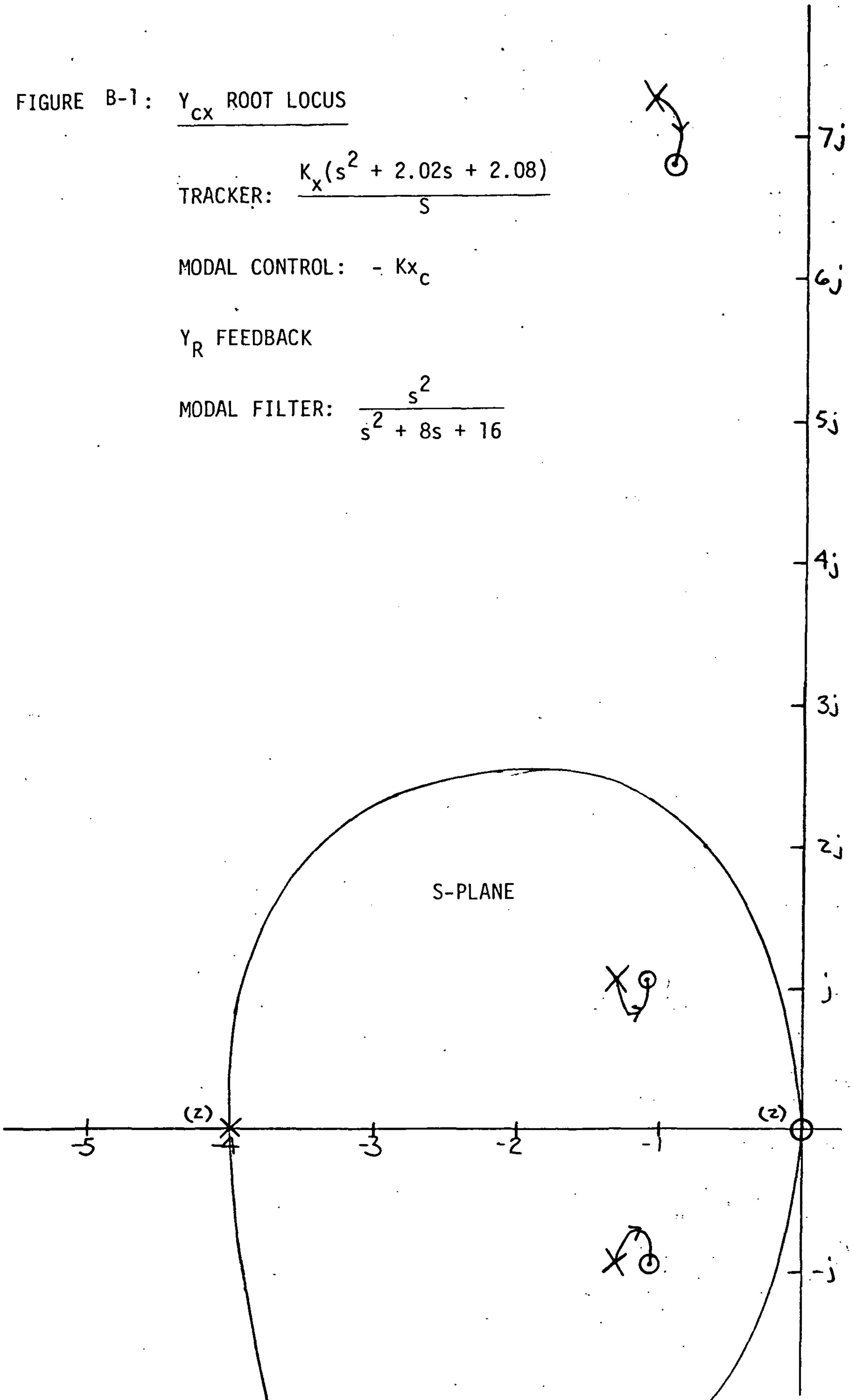


FIGURE B-2: Y_{sx} ROOT LOCUS

TRACKER: $\dfrac{K_x(s^2 + 2.02s + 2.08)}{S}$

MODAL CONTROL: $-\ Kx_c$

Y_R FEEDBACK

MODAL FILTER: $\dfrac{(s^2 + 2s + 401)s^2}{(s^2 + 8s + 16)(s^2 + 40s + 400)}$

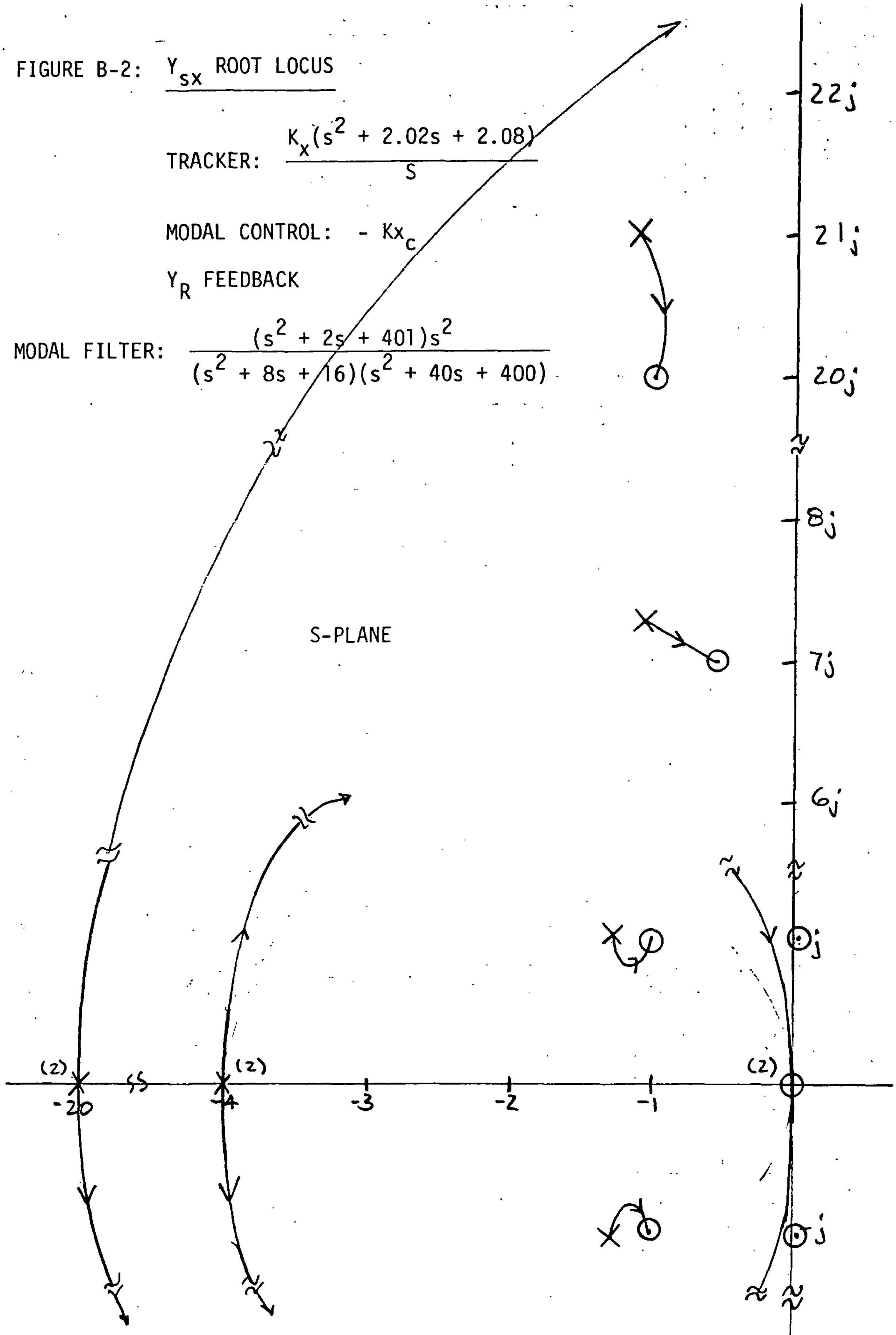


FIGURE B-3: Y_{Rx} ROOT LOCUS

TRACKER: $\frac{K_x(s^2 + 2.02s + 2.08)}{S}$

MODAL CONTROL: $-K x_c$

Y_R FEEDBACK

MODAL FILTER: $\frac{s^2}{s^2 + 8s + 16}$

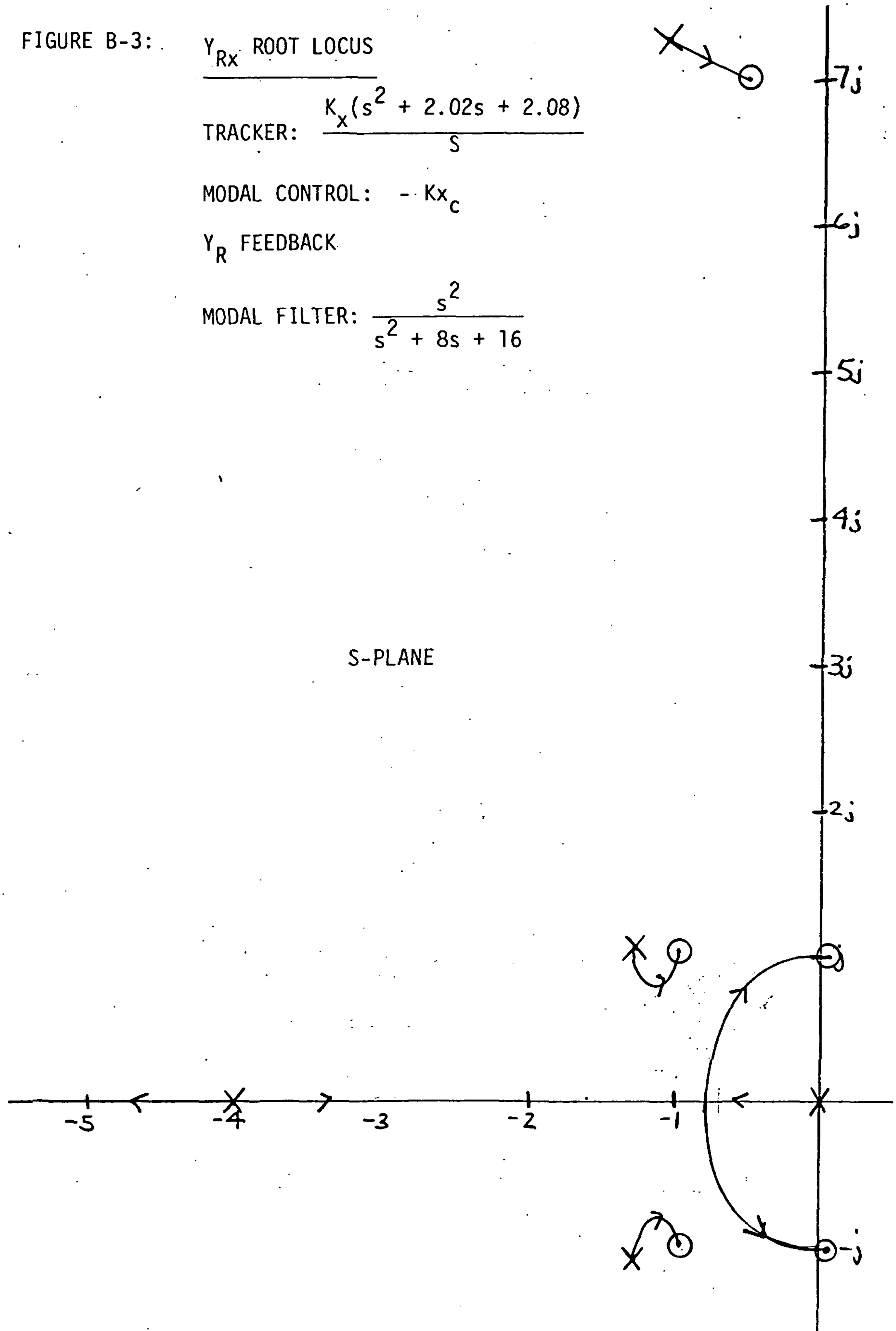


FIGURE B-4: Y_{cy} ROOT LOCUS

TRACKER: $\dfrac{K_y(s^2 + 4.116s + 3.62)}{S}$

MODAL CONTROL: $-\ Kx_c$

Y_R FEEDBACK

MODAL FILTER: $\dfrac{s^2}{(s^2 + 8s + 16)}$

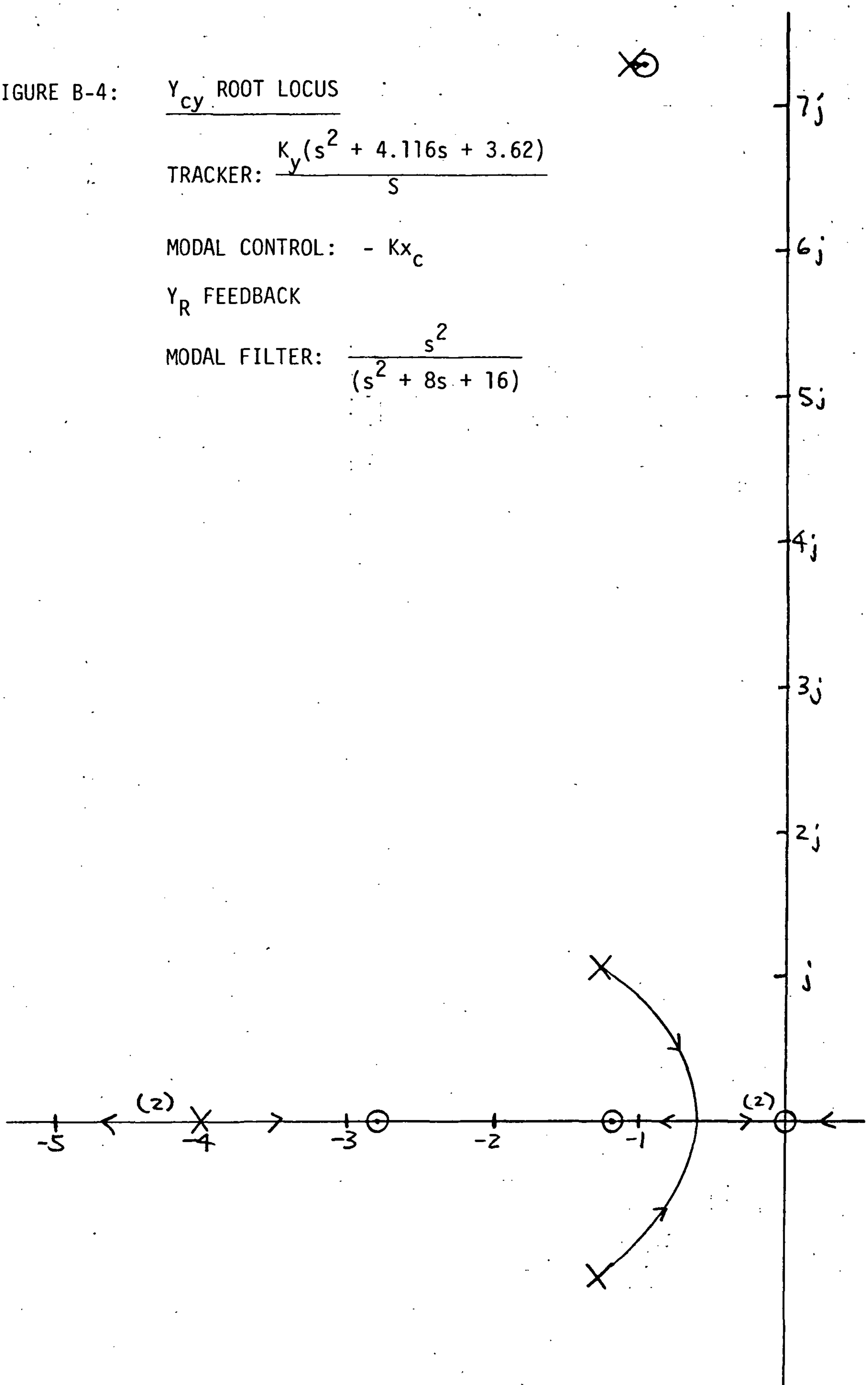


FIGURE B-5: Y_{sy} ROOT LOCUS

TRACKER: $\dfrac{K_y(s^2 + 4.116s + 3.62)}{S}$

MODAL CONTROL: $- Kx_c$

Y_R FEEDBACK

MODAL FILTER: $\dfrac{s^2\ (s^2 + 2s + 401)}{(s^2 + 8s + 16)(s^2 + 40s + 400)}$

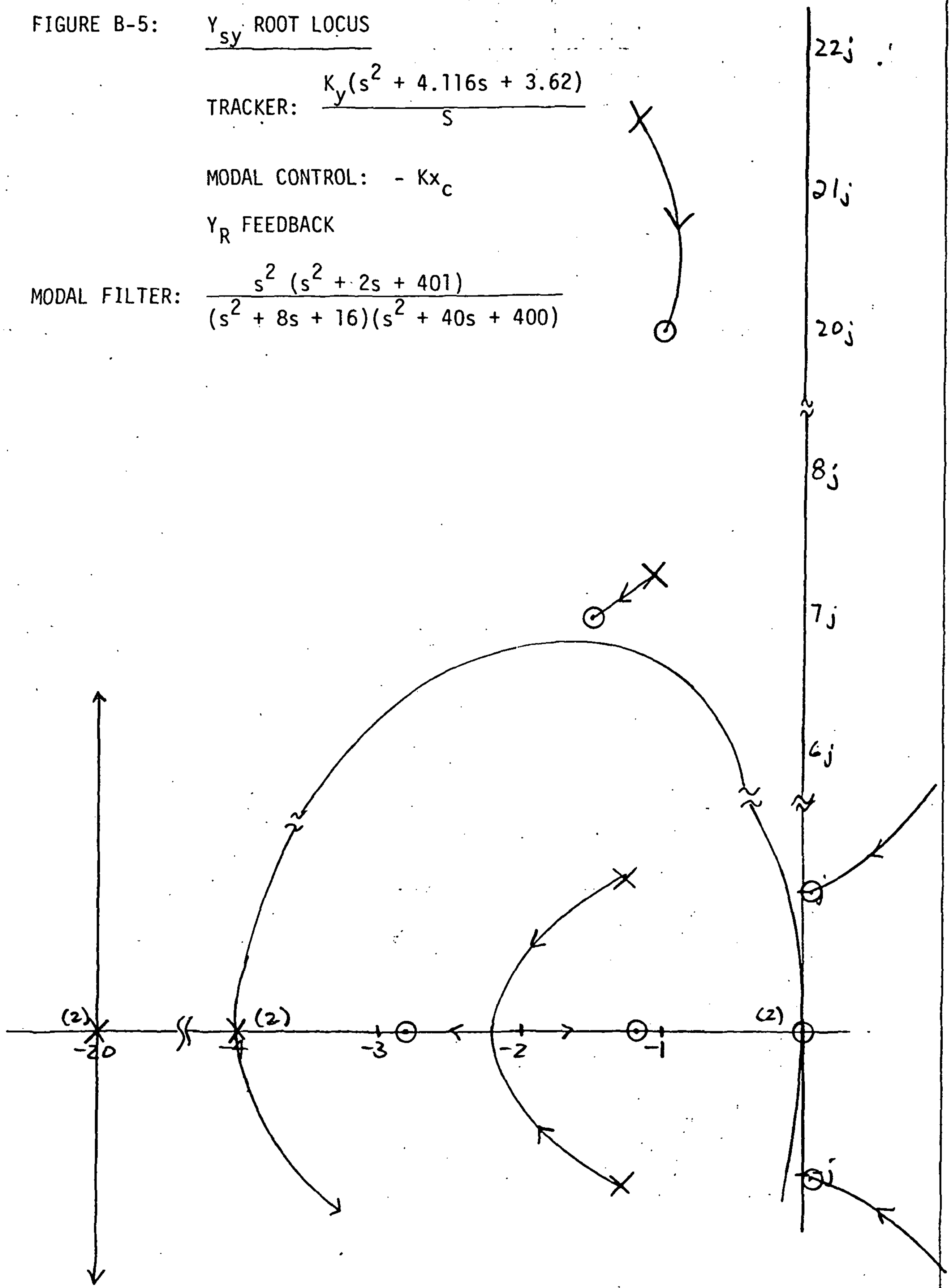


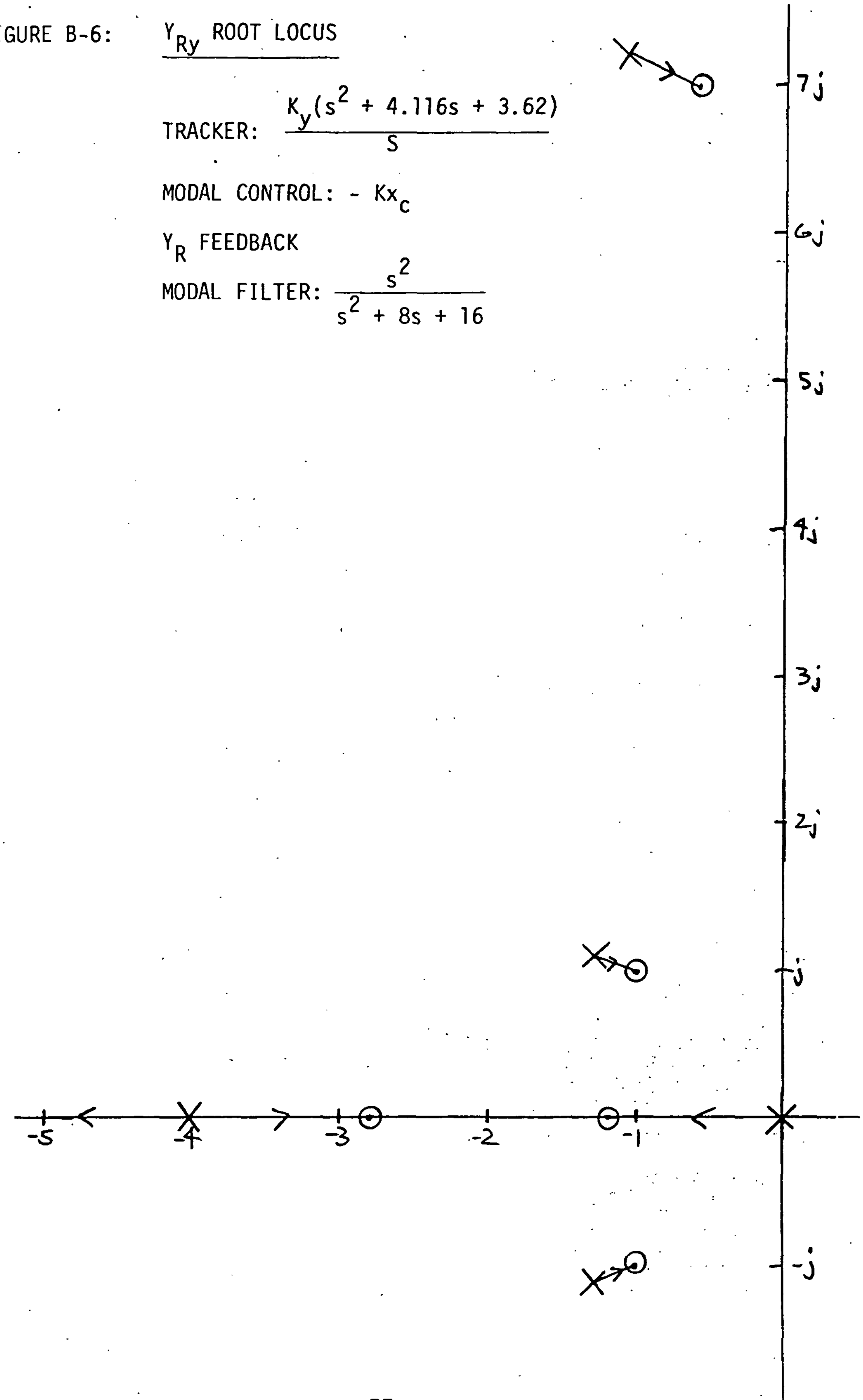
FIGURE B-6: $\underline{Y_{Ry}\text{ ROOT LOCUS}}$

TRACKER: $\dfrac{K_y(s^2 + 4.116s + 3.62)}{S}$

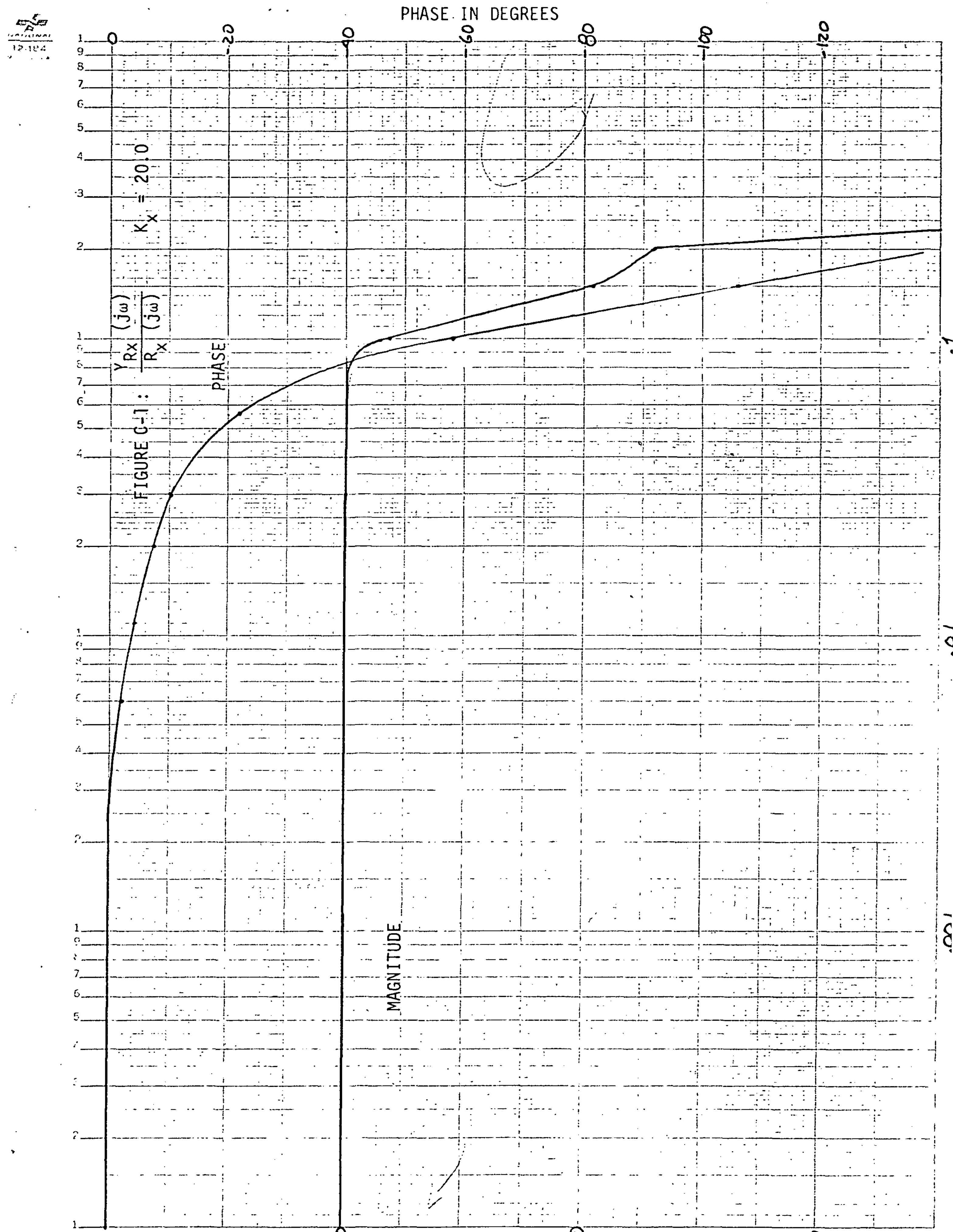
MODAL CONTROL: $- Kx_c$

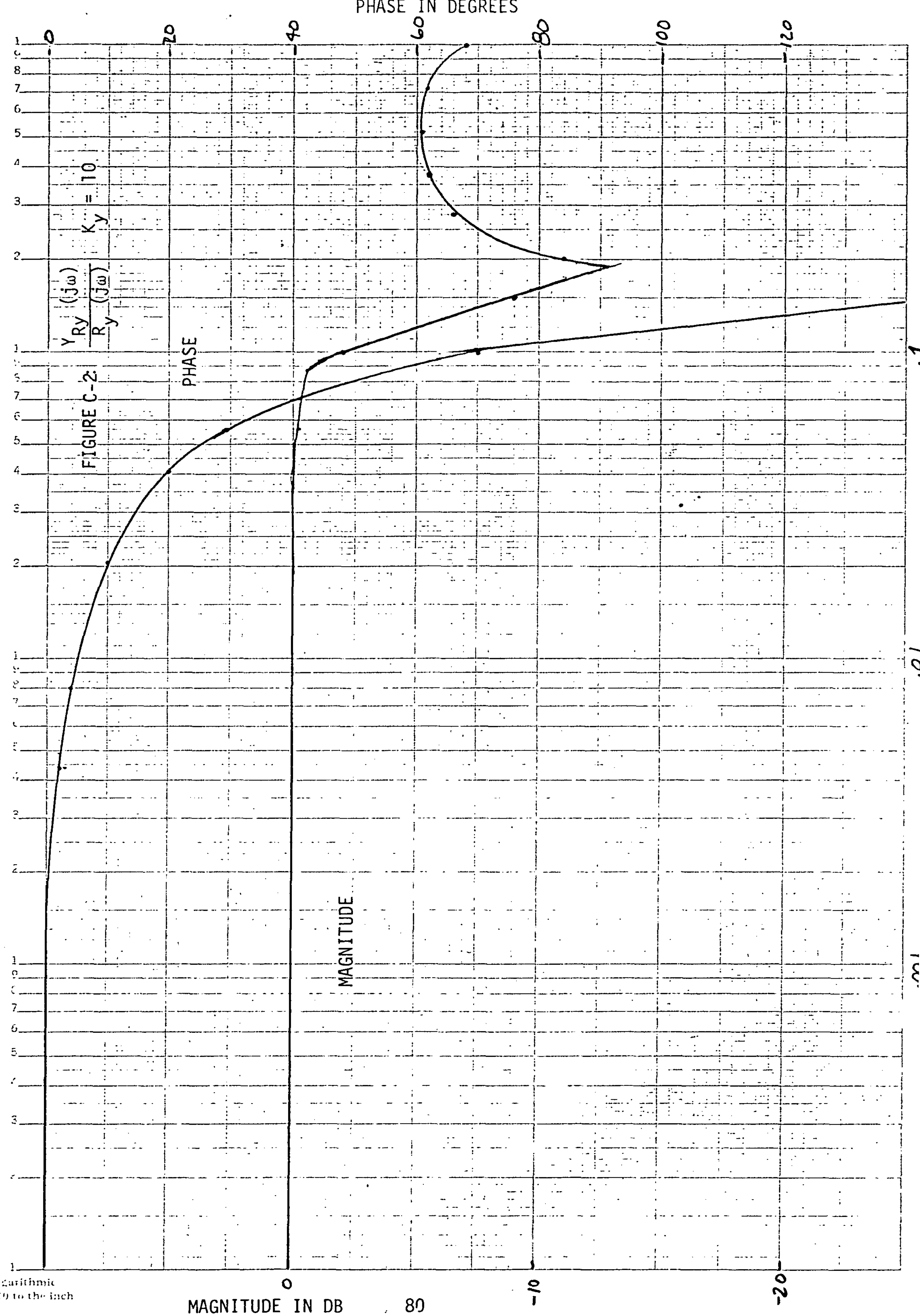
Y_R FEEDBACK

MODAL FILTER: $\dfrac{s^2}{s^2 + 8s + 16}$



IX.C. Bode Plots


PHASE IN DEGREES
0
-20
-40
-60
-80
-100
-120
FIGURE C-1: $\frac{Y_{Rx}(j\omega)}{R_x(j\omega)}$ $K_x = 20.0$
PHASE
MAGNITUDE
.1
.01
.001
0
-10
-20
MAGNITUDE IN DB
Semi-Logarithmic
3 Cycles x 10 to the inch



80

Semi-Logarithmic
3 Cycles x 70 to the inch

IX.D. Simulation Programs/Flowcharts

```
BR*Y.FORFLO,S EE.AGS/SIM
FLOWCHARTED BY  FORFLO /XB?B/ ON 1? AUG 81 AT ?8:0?:51

          SUBROUTINE AGS(XNOISE)
C...SUBROUTINE DEFINES A GAUSSIAN SIGNAL FOR THE NOISE
C...IN THE AGS.
          COMMON/RANDOM/ JAY
          DIMENSION XNOISE(3),XQS(3),XPA(3)
          XQS(1)=NRAND(JAY)
          XPA(1)=NRAND(JAY)
C...FOR THE QUIESENT STABILITY
          CALL RANDN(XQS,3,0.,9.7E-7)
C...FOR THE POINTING ACCURACY
          CALL RANDN(XPA,3,0.,1.60C5E-7)
C...ALGEBRAIC SUM IS THE TOTAL NOISE
          DO 1 I=1,3
    1     XNOISE(I)=XQS(I)+XPA(I)
          RETURN
          END
```

```
      ..............................................
      \            SUBROUTINE AGS(XNOISE)          /
       \............................................/
                              I
                              I---[...SUBROUTINE DEFINES A GAUSSIAN]
                              I   [SIGNAL FOR THE NOISE            ]
                              I   [...IN THE AGS.                  ]
                              I
                              I
       ............................................
       :          COMMON/RANDOM/ JAY              :
       :   DIMENSION XNOISE(3),XQS(3),XPA(3)      :
       :          XQS(1)=NRAND(JAY)               :
       :          XPA(1)=NRAND(JAY)               :
       ............................................
                              I
                              I---[...FOR THE QUIESENT STABILITY   ]
                              I
                              I
       ............................................
       : :    CALL RANDN(XQS,3,0.,[illegible].7E-7)          : :
       ............................................
                              I
                              I---[...FOR THE POINTING ACCURACY    ]
                              I
                              I
       ............................................
       : :   CALL RANDN(XPA,3,0.,1.6005E-7)     : :
       ............................................
                              I
                              I---[...ALGEBRAIC SUM IS THE TOTAL   ]
                              I   [NOISE                           ]
                              I
                              I
A------------------>............................................
A                  :            DO 1 I=1,3                 :
A                  ............................................
A                             I
A                  [     1]   I
A                  ............................................
-------------------:      XNOISE(I)=XQS(I)+XPA(I)          :
                   ............................................
                              I
                              I
                   /.....................\
                   :        RETURN        :
                   \...................../
```

ЭR*Y.FORFLO,S EE.ALOSXY/SIM
FLOWCHARTED BY FORFLO /X838/ ON 13 AUG 81 AT 08:03:54

```
      SUBROUTINE ALOS
C...SUBROUTINE TO COMPUTE THE INPUT DISTURBANCE AT THE
C...BASE OF THE BOOM DUE TO THE THRUSTER FIRINGS. THE
C...ACCELERATION IN THE DIRECTIONS PERPINDICULAR TO
C...THE LINE OF SIGHT ARE DETERMINED AND USED TO SCALE
C...A DETERMINED PULSE RESPONSE.
      COMMON/CLOCK/T,DT,TRX,TRY,TRZ
      COMMON/PASS1/EHTET(3,3),F6(8,3),F7(8,3),F8(8,3)
     &,F9(12,12),F10(3,3),F11(3,3)
      COMMON/PASS3/UDDCT(3,1),RK(3,8),RC(3,1),X(40,1)
      COMMON/PASS4/SAMPLE(12,1),UDIST(3,1),IS
      DATA TRX,TRY,TRZ/0.,0.,0./
      GAINX=0.05167
      GAINY=.05239
      OX=F10(1,3)
      OZ=F10(2,1)
C...CHECK X-AXIS FIRST--IF TRX > 0., GO TO X RESPONSE
      IF(TRX.GT.0.)GO TO 2
C...CHECK SAMPLE(8,1). IF NON ZERO GO TO X RESPONSE
      IF(SAMPLE(8,1).NE.0.)GO TO 2
C...IF NO X RESPONSE, GO TO Y-AXIS RESPONSE
      UDIST(1,1)=0.
      GO TO 4
2     TRX=TRX+DT
      IF(TRX.GT.DT.AND.TRX.LT..2)THEN
          UDIST(1,1)=0.
          GO TO 4
      END IF
      SIGMA=X(9,1)
C...COMPUTE ALOS FOR THE LATERAL GIMBAL/ROLL (X-AXIS)
      ALOSX=((OZ+.2128)*6.2E-4-.002176)*COS(SIGMA)+.002318*SIN(SIGMA)
C...CHECK FOR END OF X-THRUSTER FIRING SEQUENCE
      IF(TRX.GE..2)THEN
          TRX=0.
          ALOSX=-ALOSX
      END IF
      UDIST(1,1)=ALOSX*GAINX
C...ARRIVE HERE FOR Y AXIS. CHECK IF TRY > 0.
4     IF(TRY.GT.0.)GO TO 5
C...CHECK SAMPLE(10,1)--IF ZERO, UDIST=0 AND GO TO Z-AXIS
      IF(SAMPLE(10,1).NE.0.)GO TO 5
      UDIST(2,1)=0.
      GOTO6
C...ARRIVE HER FOR Y RESPONSE
5     TRY=TRY+DT
      IF(TRY.GT.DT.AND.TRY.LT..52)THEN
          UDIST(2,1)=0.
          GO TO 6
      END IF
      GAMMA=X(11,1)
C...COMPUTE ALOS FOR THE ELEVATION GIMBAL/PITCH (Y-AXIS)
```

```
      ALOSY=(.00263*CX+2.9E-4)*SIN(GAMMA)+ DZ*2.9E-4*SIN(GAMMA)
C...CHECK FOR END OF Y-THRUSTER FIRING SEQUENCE
      IF(TRY.GE..52)THEN
           TRY=0.
           ALOSY=-ALOSY
      END IF
      UDIST(2,1)=ALOSY*GAINY
C...ARRIVE HERE FOR THE Z-AXIS
6     IF(TRZ.GT.0.)GO TO 8
      IF(SAMPLE(12,1).NE.0.)GO TO 8
      UDIST(3,1)=0.
      RETURN
8     TRZ=TRZ+DT
      IF(TRZ.GT.DT.AND.TRZ.LT..48)THEN
           UDIST(3,1)=0.
           RETURN
      END IF
      UDIST(3,1)=SAMPLE(12,1)
      IF(TRZ.GE..48)THEN
           TRZ=0.
           UDIST(3,1)=-UDIST(3,1)
      END IF
      RETURN
      END
```

```
        /.........................................\
       \             SUBROUTINE ALOS               /
        \.........................................../
                             I
                             I---[...SUBROUTINE TO COMPUTE THE      ]
                             I   [INPUT DISTURBANCE AT THE          ]
                             I   [...BASE OF THE BOOM DUE TO THE    ]
                             I   [THRUSTER FIRINGS, THE             ]
                             I   [...ACCELERATION IN THE DIRECTION]
                             I   [ PERPINDICULAR TO                 ]
                             I   [...THE LINE OF SIGHT ARE          ]
                             I   [DETERMINED AND USED TO SCALE      ]
                             I   [...A DETERMINED PULSE RESPONSE.   ]
                             I
                             I
 ................................................
 :     COMMON/CLOCK/T,DT,TRX,TRY,TRZ             :
 : COMMON/PASS1/EHTET(3,3),F6(8,3),F7(8,3),      :
 : F8(8,3),F9(12,12),F10(3,3),F11(3,3)           :
 : COMMON/PASS3/UDDOT(3,1),RK(3,8),RC(3,1),      :
 : X(40,1)                                       :
 : COMMON/PASS4/SAMPLE(12,1),UDIST(3,1),IS       :
 :        DATA TRX,TRY,TRZ/0.,0.,0./             :
 :              GAINX=0.05167                    :
 :               GAINY=.05239                    :
 :                OX=F10(1,3)                    :
 :                OZ=F10(2,1)                    :
 :...............................................:
                             I
                             I---[...CHECK X-AXIS FIRST--IF TRX > ]
                             I   [0., GO TO X RESPONSE            ]
                             I
                             I
 /.............................................\  TRUE
<          IF(TRX.GT.0.)GO TO 2                 >------------------------------0
 \............................................./                               Z
                             I  FALSE                                          Z
                             I                                                 Z
                             I---[...CHECK SAMPLE(8,1), IF NON    ]            Z
                             I   [ZERO GO TO X RESPONSE           ]            Z
                             I                                                 Z
                             I                                                 Z
 /.............................................\  TRUE                         Z
<      IF(SAMPLE(8,1).NE.0.)GO TO 2             >------------------------------V
 \............................................./                               Z
                             I  FALSE                                          Z
                             I                                                 Z
                             I---[...IF NO X RESPONSE, GO TO Y-   ]            Z
                             I   [AXIS RESPONSE                   ]            Z
                             I                                                 Z
                             I                                                 Z
 ................................................                              Z
 :              UDIST(1,1)=0.                    :                             Z
 :...............................................:                             Z
                             I                                                 Z
                             I                                                 Z
                  /..................\                                         Z
                 :      GO TO 4       :-------------------------------------0  Z
                  \................../                                      X  Z
                                                                            X  Z
```

```
                          C<------------------------------------------------------------0 Z
  [     2]                I                                                           X
 .............................................                                        X
 :              TRX=TRX+DT                   :                                        X
 :...........................................:                                        X
                          I                                                           X
 /-------------------------------------------\                                        X
<     IF(TRX.GT.DT.AND.TRX.LT..2)THEN         >----     ------0                       X
 \...........................................                                         X
                     aaaa I                                                           X
 .............................................                                        X
 :              UDIST(1,1)=0.                :                                        X
 :...........................................:                                        X
                          I                                                           X
            /-------------------\                                                     X
           :       GC TO 4       :--------------------------------------------------->V
            \.................../                                                     X
                                                                                      X
 .............................................                                        X
 :               END IF                      :                                        X
 :            SIGMA=X(9,1)                   :                                        X
 :...........................................:                                        X
                          I                                                           X
                          I---[...COMPUTE ALCS FOR THE LATERAL ]                      X
                          I   [GIMBAL/ROLL (X-AXIS)            ]                      X
                          I                                                           X
 .............................................                                        X
 : ALCSX=(((Z+.2128)*6.2E-4-.002176)*COS(     :                                       X
 : SIGMA)+.002318*SIN(SIGMA)                 :                                        X
 :...........................................:                                        X
                          I                                                           X
                          I---[...CHECK FOR END OF X-THRUSTER  ]                      X
                          I   [FIRING SEQUENCE                 ]                      X
                          I                                                           X
 /-------------------------------------------\                                        X
<          IF(TRX.GE..2)THEN                  >----     ------0                       X
 \...........................................                                         X
                     aaaa I                                                           X
 .............................................                                        X
 :                TRX=0.                     :                                        X
 :            ALOSX=-ALOSX                   :                                        X
 :               END IF                      :                                        X
 :        UDIST(1,1)=ALOSX*GAINX             :                                        X
 :...........................................:                                        X
                          I                                                           X
                          I---[...ARRIVE HERE FOR Y AXIS. CHECK]                      X
                          I   [IF TRY > 0.                     ]                      X
                          I                                                           X
                          C<----------------------------------------------------------0
  [     4]                I
 /-------------------------------------------\  TRUE
<          IF(TRY.GT.0.)GO TO 5               >---------------------------------------0
 \...........................................                                         Z
                          I  FALSE                                                    Z
                          I                                                           Z
```

```
I---[...CHECK SAMPLE(1?,1)--IF ZERO, ]
I   [UDIST=0 AND GC TO Z-AXIS        ]

IF(SAMPLE(10,1).NE.0.)GO TO 5        TRUE
FALSE

UDIST(2,1)=0.

GOTO6

I---[...ARRIVE HER FOR Y RESPONSE    ]

[    5]
TRY=TRY+DT

IF(TRY.GT.DT.AND.TRY.LT..52)THEN
aaaa

UDIST(2,1)=0.

GC TO 6

END IF
GAMMA=X(11,1)

I---[...COMPUTE ALCS FOR THE            ]
I   [ELEVATION GIMBAL/PITCH (Y-AXIS)    ]

ALCSY=(.00253+CX*2.9E-4)*SIN(GAMMA)+ 0Z*
?.?E-4*SIN(GAMMA)

I---[...CHECK FOR END OF Y-THRUSTER  ]
I   [FIRING SEQUENCE                 ]

IF(TRY.GE..52)THEN
```

```
 aaaa I
      I
      I
      TRY=0.
      ALOSY=-ALOSY
      END IF
      UDIST(2,1)=ALOSY*GAINY
      I
      I---[...ARRIVE HERE FOR THE Z-AXIS   ]
      I
      0<-----------------------------------------------0
[   6]
      IF(TRZ.GT.0.)GO TO 8                  TRUE  >----0
      FALSE
      IF(SAMPLE(12,1).NE.0.)GO TO 8         TRUE  >----V
      FALSE
      UDIST(3,1)=0.
      I
      RETURN

      0<-----------------------------------------------0
[   8]
      TRZ=TRZ+DT
      I
      IF(TRZ.GT.DT.AND.TRZ.LT..48)THEN   >----    ------0
 aaaa I
      UDIST(3,1)=0.
      I
      RETURN

      END IF
      UDIST(3,1)=SAMPLE(12,1)
      I
```

```
                 I
 /---------------------------------------\
<       IF(TRZ.EE..48)THEN                >----      ------0
 \.......................................:/
             aaaa I
                  I
                  I
:.........................................:
:              TRZ=0.                      :
:      UDIST(3,1)=-UDIST(3,1)              :
:              END IF                      :
:.........................................:
                  I
                  I
        /--------------------\
       :       RETURN         :
        \....................../
```

ARAY.FORFLO,S EE.ETHETA/SIM
FLOWCHARTED BY FORFLO /X808/ ON 13 AUG 81 AT 08:04:08

```
      SUBROUTINE ETHETA
      COMMON/PASS1/ ETHET(3,3)
      COMMON/PASS3/ UDDOT(3,1),RK(3,8),RC(3,1),X(26,1)
      DIMENSION U(3,1)
      DO 1 I=1,3
      U(I,1)=X(20+(2*I-1),1)-X(8+(2*I-1),1)
    1 ETHET(I,I)=1.
      ETHET(1,2)=U(3,1)
      ETHET(2,1)=-ETHET(1,2)
      ETHET(1,3)=-U(2,1)
      ETHET(3,1)=-ETHET(1,3)
      ETHET(2,3)=U(1,1)
      ETHET(3,2)=-ETHET(2,3)
      RETURN
      END
```

```
ETHETA        SIM            FLOWCHARTED BY  FORFLO /X838/ ON 13 AUG 81 AT 08:04:10

                      ...............................................
                      \            SUBROUTINE ETHETA               /
                       \.........................................../
                                          I
                                          I
                      ...............................................
                      :          COMMON/PASS1/ ETHET(3,3)           :
                      : COMMON/PASS3/ UDDOT(3,1),RK(3,8),RC(3,1),   :
                      : X(26,1)                                     :
                      :              DIMENSION U(3,1)               :
                      :.............................................:
                                          I
                                          I
                      ...............................................
  A------------------>:               DO 1 I=1,3                    :
  A                   :.............................................:
  A                                       I
  A                                       I
  A                   ...............................................
  A                   : U(I,1)=X(20+(2*I-1),1)-X(8+(2*I-1),1)       :
  A                   :.............................................:
  A                                       I
  A                     [    1]           I
  A                   ...............................................
  ------------------- :              ETHET(I,I)=1.                  :
                      :.............................................:
                                          I
                                          I
                      ...............................................
                      :            ETHET(1,2)=U(3,1)                :
                      :           ETHET(2,1)=-ETHET(1,2)            :
                      :            ETHET(1,3)=-U(2,1)               :
                      :           ETHET(3,1)=-ETHET(1,3)            :
                      :            ETHET(2,3)=U(1,1)                :
                      :           ETHET(3,2)=-ETHET(2,3)            :
                      :.............................................:
                                          I
                                          I
                                /....................\
                               :       RETURN         :
                                \..................../
```

@R*Y.FORFLO,S FE.FUNC/SIM-NEW
FLOWCHARTED BY FORFLO /X303/ ON 17 AUG 81 AT 08:04:21

```
      SUBROUTINE FUNC(X,XDOT,O,N)
C...SUBROUTINE COMPUTES COMPONENTS (BOOM,R.B.,SHUTTLE)
C   SEPARATELY.  THE ARTIFICIAL STATES XG ARE INTRODUCED TO
C   REPRESENT THE DYNAMICS OF THE TRACKER AND THE MODAL
C   AND RIGID BODY FILTERS.
      INTEGER O
      DIMENSION X(O,N),XDOT(O,N)
      DIMENSION XCDOT(8,1),XSHDOT(12,1),XGDOT(4,1)
      DIMENSION XR(6,1),XSH(12,1),XG(4,1)
      COMMON/PASS1/ ETHET(3,3),F6(8,3),F7(8,3),F8(8,3)
     &,F9(12,12),F10(3,3),F11(3,3),ANE(12,3),AEN(12,3)
     &,ANET(3,12),AENT(3,12)
      COMMON/PASS2/ A(8,8),B(8,3),BC(8,3)
     &,UR(6,3),AR(6,6),ASH(12,12)
      COMMON/PASS3/ UDDOT(3,1),RK(3,8),RC(3,1),XC(40,1)
      COMMON/PASS4/ SAMPLE(12,1),UDIST(3,1),IS
      COMMON/PASS6/GR(12,1),XRDOT(6,1)
      COMMON/PASS7/AA(3,1),BB(3,1)
      DIMENSION W1(8,12),W2(8,12),W3(8,12),SIGMA(8,12)
     &,USH(12,3),W4(8,3),W5(12,3),W6(8,3),W7(12,3),W8(8,1)
     &,W9(12,8),W10(12,1),W11(8,8),W12(8,1),W14(8,1),W15(6,1)
     &,W16(6,1),W20(12,1)
     &,JC(9),V(2),SIGMAT(12,8)
      DIMENSION AMAT(4,4),CG(3,4),XSENS3(3),XAGS(3)
      DATA((AMAT(I,J),J=1,4),I=1,4)/0.,1.,2*0.,-16.,-8.,
     &5*0.,1.,2*0.,-16.,-8./
      DATA ((CG(I,J),J=1,4),I=1,3)/2.08,2.02,4*0.,3.62,4.116,
     &4*0./
C...COPY X INTO XCOMMON
      DO 9 I=1,37
      IF(I.GT.8.AND.I.LT.15)THEN
          XR(I-8,1)=X(I,1)
      ELSE IF(I.GT.14.AND.I.LT.27)THEN
          XSH(I-14,1)=X(I,1)
      ELSE IF(I.GT.26.AND.I.LT.38)THEN
          XG(I-26,1)=X(I,1)
      END IF
    9 XC(I,1)=X(I,1)
C...UPDATE THE ETHET MATRIX
      CALL ETHETA
C...COMPUTE THE SIGMA MATRIX
      CALL MXMLT(F8,ETHET,W4,8,3,3,8,3)
      CALL MXMLT(W4,ANET,W2,8,3,12,8,3)
      CALL MXMLT(F7,ETHET,W4,8,3,3,8,3)
      CALL MXMLT(W4,ANET,W3,8,3,12,8,3)
      CALL MXSUB(W2,W3,SIGMA,8,12,8)
      CALL MXMLT(F6,ETHET,W4,8,3,3,8,3)
      CALL MXMLT(W4,AENT,W2,8,3,12,8,3)
      CALL MXSUB(SIGMA,W2,SIGMA,8,12,8)
      CALL MXMLT(W4,F10,W6,8,3,3,8,3)
      CALL MXMLT(W6,ANET,W3,8,3,12,8,3)
```

```
      CALL MXADD(W7,SIGMA,SIGMA,8,12,3)
C...COMPUTE THE SIGMAT MATRIX
      CALL MXTRN(SIGMA,SIGMAT,8,12,3,12)
C...COMPUTE THE NEW BSH MATRIX
      CALL MXMLT(F3,ANE,W5,12,12,3,12,12)
      CALL MXMLT(W5,ETHET,W7,12,3,3,12,3)
      CALL MXMLT(W7,F11,BSH,12,3,3,12,3)
C...CALL FOR THE NOISE FOR THE R. B. MEASUREMENTS
      CALL SENSE3(XSENS3)
C...COMPUTE THE XGDOT TERMS FOR THE TRACKER
      AA(1,1)=RC(1,1)-XR(2,1)-XSENS3(1)
      AA(2,1)=RC(2,1)-XR(4,1)-XSENS3(2)
      AA(3,1)=RC(3,1)-XR(6,1)-XSENS3(3)
      CALL MXMLT(AMAT,XG,XGDOT,4,4,1,4,4)
      XGDOT(2,1)=XGDOT(2,1)+20.*AA(1,1)
      XGDOT(4,1)=XGDOT(4,1)+10.*AA(2,1)
C...COMPUTE THE RIGID BODY CONTROL (=CG*XG+XGDOT(4,8,9,1)
      CALL MXMLT(CG,XG,BB,3,4,1,3,4)
      BB(1,1)=BB(1,1)+XGDOT(2,1)
      BB(2,1)=BB(2,1)+XGDOT(4,1)
C...NOTE THAT BB(3,1)=0. NOW DUE TO ZERO ROW IN CG
      BB(3,1)=BB(3,1)+2.*AA(3,1)
C...CALL SUBROUTINE UDOT TO COMPUTE THE MODAL CONTROL
      CALL UDOT
C...CALL SUBROUTINE ALOS TO COMPUTE DISTURBANCE DUE
C...TO THRUSTER FIRINGS.
      CALL ALOS
C...CALL SUBROUTINE AGS TO DETERMINE THE NOISE
      CALL AGS(XAGS)
C...COMPUTE THE TOTAL INPUT REQUIRED
      DO 9398 KK=1,3
      UDDOT(KK,1)=UDDOT(KK,1)+BB(KK,1)+XAGS(KK)
C...CHECK FOR TORQUER LIMITS (SATURATION)
      IF(UDDOT(KK,1)*F11(KK,KK).GT.33.9)UDDOT(KK,1)=33.9/F11(KK,KK)
 9898 IF(UDDOT(KK,1)*F11(KK,KK).LT.-33.9)UDDOT(KK,1)=-33.9/F11(KK,KK)
C...ADD IN THE DISTURBANCE FROM ALOS
      DO 9399 KK=1,3
 9399 UDDOT(KK,1)=UDDOT(KK,1)+UDIST(KK,1)
C...COMPUTE THE RIGID BODY TERMS
      CALL MXMLT(AR,XR,W15,6,6,1,6,6)
      CALL MXMLT(BR,UDDOT,W16,6,3,1,6,3)
      CALL MXADD(W15,W16,XRDOT,6,1,6)
C...COMPUTE THE DOCM DERIVATIVES
      CALL MXMLT(A,X,W8,8,8,1,8,40)
      CALL MXMLT(B,UDDOT,W12,8,3,1,8,3)
      CALL MXADD(W8,W12,W8,8,1,8)
      DO 222 J=1,8
  222 XCDOT(J,1)=W8(J,1)
C...COMPUTE THE SHUTTLE TERMS
      CALL MXMLT(BSH,UDDOT,W10,12,3,1,12,3)
      CALL MXADD(W10,SAMPLE,W20,12,1,12)
      CALL MXMLT(ASH,XSH,W10,12,12,1,12,12)
      CALL MXADD(W10,W20,W20,12,1,12)
      CALL MXADD(G3,W20,W20,12,1,12)
C...W20 NOW CONTAINS BSH*UDOT+ASH*XSH+SAMPLE+G3
      CALL MXMLT(F3,SIGMAT,W9,12,12,8,12,12)
      CALL MXMLT(W9,XCDOT,W17,12,8,1,12,8)
```

```
      CALL MXADD(W10,W20,XSHDOT,12,1,12)
C...COPY THE DERIVATIVES INTO XDOT
      DO 21 I=1,8
21    XDOT(I,1)=XCDOT(I,1)
      DO 22 I=9,14
22    XDOT(I,1)=XRDOT(I-8,1)
      DO 23 I=15,26
23    XDOT(I,1)=XSHDOT(I-14,1)
      DO 24 I=27,30
24    XDOT(I,1)=XGDOT(I-26,1)
C...CHECK FOR SOLAR INERTIAL FLIGHT.  IF YES, SUBTRACT
C...THE REQUIRED .06 DEG/SEC FROM THE SHUTTLE'S Y-AXIS
C...ROTATIONAL VELOCITY
      IF(IS.EQ.1)XDOT(23,1)=XDOT(23,1)-(.06*3.14159)/180.
      RETURN
1000  PRINT*,"ERROR IN FUNCTION SUBROUTINE--TERMINATE"
      STOP
      END
```

```
 ..........................................
 \      SUBROUTINE FUNC(X,XDOT,O,N)       /
  \......................................../
                     I
                     I---[...SUBROUTINE COMPUTES COMPONENT]
                     I   [ (BOOM,R.B.,SHUTTLE)            ]
                     I   [ SEPARATELY. THE ARTIFICIAL     ]
                     I   [STATES XG ARE INTRODUCED TO     ]
                     I   [ REPRESENT THE DYNAMICS OF THE  ]
                     I   [TRACKER AND THE MODAL           ]
                     I   [ AND RIGID BODY FILTERS.        ]
                     I
                     I
 ..........................................
 :           INTEGER O                    :
 :      DIMENSION X(O,N),XDOT(O,N)        :
 : DIMENSION XCDOT(8,1),XSHDOT(12,1),XGDOT(  :
 : 4,1)                                   :
 : DIMENSION XR(6,1),XSH(12,1),XG(4,1)    :
 : COMMON/PASS1/ ETHET(3,3),F6(8,3),F7(3,3), :
 : F8(8,3),F9(12,12),F10(3,3),F11(3,3),ANE(  :
 : 12,3),AEN(12,3),ANET(3,12),AENT(3,12)  :
 : COMMON/PASS2/ A(8,8),B(8,3),BC(8,3),BR(6, :
 : 3),AR(6,6),ASH(12,12)                  :
 : COMMON/PASS3/ UDDOT(3,1),RK(3,8),RC(3,1), :
 : XC(40,1)                               :
 : COMMON/PASS4/ SAMPLE(12,1),UDIST(3,1),IS :
 :     COMMON/PASS6/GR(12,1),XRDOT(6,1)   :
 :       COMMON/PASS7/AA(3,1),BB(3,1)     :
 : DIMENSION W1(8,12),W2(8,12),W3(8,12),  :
 : SIGMA(8,12),BSH(12,3),W4(8,3),W5(12,3), :
 : W6(8,3),W7(12,3),W8(8,1),W9(12,8),W10(12, :
 : 1),W11(8,8),W12(8,1),W14(8,1),W15(6,1), :
 : W16(6,1),W20(12,1),J(8),V(2),SIGMA1(12, :
 : 3)                                     :
 : DIMENSION AMAT(4,4),CG(3,4),XSENS3(3), :
 : XAGS(3)                                :
 : DATA((AMAT(I,J),J=1,4),I=1,4)/0.,1.,2*0., :
 : -16.,-3.,5*0.,1.,2*0.,-16.,-3./        :
 : DATA ((CG(I,J),J=1,4),I=1,3)/2.08,2.02,4* :
 : 0.,3.62,4.116,4*0./                    :
 :........................................:
                     I
                     I---[...COPY X INTO XCOMMON        ]
                     I
                     I
 ..........................................
A--------->:         DO 9 I=1,30          :
A          :..............................:
A                    I
A                    I
A   /''''''''''''''''''''''''''''''''''''''\
A  <     IF(I.GT.3.AND.I.LT.15)THEN         >----     ------0
A   \....................................../
A               0008 I
A                    I
```

```
ELSE IF(I.GT.26.AND.I.LT.38)THEN
     XG(I-26,1)=X(I,1)
        END IF

[    9]

XC(I,1)=X(I,1)

I---[...UPDATE THE ETHET MATRIX      ]

CALL ETHETA

I---[...COMPUTE THE SIGMA MATRIX      ]

CALL MXMLT(F8,ETHET,W4,8,3,3,8,3)

CALL MXMLT(W4,ANET,W2,8,3,12,8,3)

CALL MXMLT(F7,ETHET,W4,8,3,3,8,3)

CALL MXMLT(W4,ANET,W3,8,3,12,8,3)

CALL MXSUB(W2,W3,SIGMA,8,12,8)

CALL MXMLT(F6,ETHET,W4,8,3,3,8,3)

CALL MXMLT(W4,AENT,W2,8,3,12,8,3)

CALL MXSUB(SIGMA,W2,SIGMA,8,12,8)

CALL MXMLT(W4,F1[illegible],W5,8,3,3,3,3)
```

```
...............................................
: : CALL MXMLT(W5,ANET,W3,8,3,12,8,3)       : :
:.:.......................................:.:
                    I
                    I
...............................................
: : CALL MXADD(W3,SIGMA,SIGMA,8,12,8)       : :
:.:.......................................:.:
                    I
                    I---[...COMPUTE THE SIGMAT MATRIX     ]
                    I
                    I
...............................................
: : CALL MXTRN(SIGMA,SIGMAT,8,12,8,12)      : :
:.:.......................................:.:
                    I
                    I---[...COMPUTE THE NEW BSH MATRIX    ]
                    I
                    I
...............................................
: : CALL MXMLT(F9,ANE,W5,12,12,3,12,12)     : :
:.:.......................................:.:
                    I
                    I
...............................................
: : CALL MXMLT(W5,ETHET,W7,12,3,3,12,3)     : :
:.:.......................................:.:
                    I
                    I
...............................................
: : CALL MXMLT(W7,F11,BSH,12,3,3,12,3)      : :
:.:.......................................:.:
                    I
                    I---[...CALL FOR THE NOISE FOR THE R.]
                    I   [B. MEASUREMENTS                 ]
                    I
                    I
...............................................
: :          CALL SENSE3(XSENS3)            : :
:.:.......................................:.:
                    I
                    I---[...COMPUTE THE XGDOT TERMS FOR  ]
                    I   [THE TRACKER                     ]
                    I
                    I
...............................................
:    AA(1,1)=RC(1,1)-XR(2,1)-XSENS3(1)        :
:    AA(2,1)=RC(2,1)-XR(4,1)-XSENS3(2)        :
:    AA(3,1)=RC(3,1)-XR(6,1)-XSENS3(3)        :
:.............................................:
                    I
                    I
...............................................
: : CALL MXMLT(AMAT,XG,XGDOT,4,4,1,4,4)     : :
:.:.......................................:.:
                    I
                    I
...............................................
:    XGDOT(2,1)=XGDOT(2,1)+2?.*AA(1,1)        :
:    XGDOT(4,1)=XGDOT(4,1)+1?.*AA(2,1)        :
:.............................................:
                    I
                    I---[...COMPUTE THE RIGID BODY       ]
                    I   [CONTROL (=CG*XG+XGDOT(4,8,9,1)  ]
```

```
: :     CALL XMALT(CG,XG,BB,3,4,1,3,4)          : :
:.:.............................................:.:
                          I
                          I
.................................................
:        BE(1,1)=BB(1,1)+XGDOT(2,1)             :
:        BB(2,1)=BB(2,1)+XGDOT(4,1)             :
:...............................................:
                          I
                          I---[...NOTE THAT BB(3,1)=0. NOW DUE ]
                          I   [TO ZERO ROW IN CG               ]
                          I
                          I
.................................................
:        BB(3,1)=BB(3,1)+2.*AA(3,1)             :
:...............................................:
                          I
                          I---[...CALL SUBROUTINE UDOT TO      ]
                          I   [COMPUTE THE MODAL CONTROL       ]
                          I
                          I
.................................................
: :              CALL UDOT                      : :
:.:.............................................:.:
                          I
                          I---[...CALL SUBROUTINE ALOS TO      ]
                          I   [COMPUTE DISTURBANCE DUE         ]
                          I   [...TO THRUSTER FIRINGS.         ]
                          I
                          I
.................................................
: :              CALL ALOS                      : :
:.:.............................................:.:
                          I
                          I---[...CALL SUBROUTINE AGS TO       ]
                          I   [DETERMINE THE NOISE             ]
                          I
                          I
.................................................
: :            CALL AGS(XAGS)                   : :
:.:.............................................:.:
                          I
                          I---[...COMPUTE THE TOTAL INPUT      ]
                          I   [REQUIRED                        ]
                          I
                          I
A---------------->.................................................
A                 :            DO 9898 KK=1,3                     :
A                 :...............................................:
A                                         I
A                                         I
A                 .................................................
A                 : UDDOT(KK,1)=UDDOT(KK,1)+BB(KK,1)+XAGS(KK)     :
A                 :...............................................:
A                                         I
A                                         I---[...CHECK FOR TORQUER LIMITS (  ]
A                                         I   [SATURATION)                    ]
A                                         I
A                                         I
A                 /.........................................\  FALSE
A                <    IF(UDDOT(KK,1)*F11(KK,KK).GT.33.9)     >--------------I
A                 \........................................./               I
A                                         I  TRUE                            I
A                                         I                                  I
A                 .................................................          I
```

```
: UDDOT(KK,1)=33.9/F11(KK,KK)

[ 9898]
IF(UDDOT(KK,1)*F11(KK,KK).LT.-33.9)        FALSE
TRUE

: UDDOT(KK,1)=-33.9/F11(KK,KK)

I---[...ADD IN THE DISTURBANCE FROM
    [ALOS

DO 9899 KK=1,3

[ 9899]
UDDOT(KK,1)=UDDOT(KK,1)+UDIST(KK,1)

I---[...COMPUTE THE RIGID BODY TERMS ]

: : CALL MXMLT(AR,XR,W15,6,6,1,6,6)

: : CALL MXMLT(BR,UDDOT,W16,6,3,1,6,3)

: : CALL MXADD(W15,W16,XRDOT,6,1,6)

I---[...COMPUTE THE BOOM DERIVATIVES ]

: :     CALL MXMLT(A,X,W8,8,8,1,8,40)

: : CALL MXMLT(B,UDDOT,W12,3,3,1,8,3)

: :     CALL MXADD(W8,W12,W8,8,1,8)
```

```
[  222]
X(DOT(J,1)=W8(J,1)

I---[...COMPUTE THE SHUTTLE TERMS      ]

CALL MXMLT(BSH,UDDCT,W10,12,3,1,12,3)

CALL MXADD(W10,SAMPLE,W20,12,1,12)

CALL MXMLT(ASH,XSH,W10,12,12,1,12,12)

CALL MXADD(W10,W20,W20,12,1,12)

CALL MXADD(GR,W20,W20,12,1,12)

I---[...W20 NOW CONTAINS BSH*UDOT+ASH]
I   [XSH+SAMPLE+GR                    ]

CALL MXMLT(F9,SIGMAT,W9,12,12,8,12,
12)

CALL MXMLT(W9,XCDOT,W10,12,8,1,12,8)

CALL MXADD(W10,W20,XSHDOT,12,1,12)

I---[...COPY THE DERIVATIVES INTO     ]
I   [XDOT                             ]

DO 21 I=1,2

[   21]
XDOT(I,1)=XCDOT(I,1)
```

```
A---------------->:              DO 22 I=9,14                    :
A                 :..............................................:
A                                      I
A                 [    22]             I
A                 :..............................................:
------------------:         XDOT(I,1)=XRDOT(I-8,1)               :
                  :..............................................:
                                       I
                                       I
                  :..............................................:
A---------------->:              DO 23 I=15,26                   :
A                 :..............................................:
A                                      I
A                 [    23]             I
A                 :..............................................:
------------------:        XDOT(I,1)=XSHDOT(I-14,1)              :
                  :..............................................:
                                       I
                                       I
                  :..............................................:
A---------------->:              DO 24 I=27,30                   :
A                 :..............................................:
A                                      I
A                 [    24]             I
A                 :..............................................:
------------------:        XDOT(I,1)=XGDOT(I-26,1)               :
                  :..............................................:
                                       I
                                       I---[...CHECK FOR SOLAR INERTIAL     ]
                                       I   [FLIGHT. IF YES, SUBTRACT        ]
                                       I   [...THE REQUIRED .06 DEG/SEC FROM]
                                       I   [THE SHUTTLE'S Y-AXIS            ]
                                       I   [...ROTATIONAL VELOCITY          ]
                                       I
                                       I
                 /---------------------------------------\  FALSE
                <             IF(IS.EQ.1)                 >---------------I
                 \.......................................                 I
                                       I  TRUE                            I
                                       I                                  I
                  :..............................................:        I
                  : XDOT(23,1)=XDOT(23,1)-(.06*3.14159)/180.     :        I
                  :..............................................:        I
                                       I                                  I
                                       O<---------------------------------
                                       I
                          /-------------------\
                          :      RETURN       :
                          \.................../

                  [ 1000]
                  /---------------------------------------------/
                 /   PRINT*,' ERROR IN FUNCTION SUBROUTINE-    /
                /    TERMINATE'                               /
               /............................................./
                                       I
                                       I
                          /-------------------\
                          :       STOP        :
                          \.................../
```

GR*Y.FORFLO,S EE.GG/SIM
FLOWCHARTED BY FORFLO /X303/ ON 17 AUG 81 AT 08:04:31

```
      SUBROUTINE GG
C...SUBROUTINE DEFINES THE GRAVITY GRADIENTS ACTING
C...ON THE SHUTTLE AS A FUNCTION OF TIME.   THE EQUATIONS
C...ARE BASED ON EXPERIMENTAL DATA.
      COMMON/CLOCK/T
      COMMON/PASS6/GRGR(12,1)
      PI=3.14159
      R=PI/180.
      W=PI/3000.
      DO 1 I=1,6
    1 GRGR(I,1)=0.
      WT=W*T
      GRGR(7,1)=0.
      GRGR(8,1)=-60.*W*W*SIN(WT)*R
      GRGR(9,1)=0.
      GRGR(10,1)=-11.*W*W*SIN(WT)*R
      GRGR(11,1)=0.
      GRGR(12,1)=-4.2*W*W*SIN(WT)*R
      RETURN
      END
```

```
         ............................................
         \             SUBROUTINE GG                /
          \........................................./
                            I
                            I---[...SUBROUTINE DEFINES THE          ]
                            I   [GRAVITY GRADIENTS ACTING            ]
                            I   [...ON THE SHUTTLE AS A FUNCTION     ]
                            I   [OF TIME. THE EQUATIONS              ]
                            I   [...ARE BASED ON EXPERIMENTAL        ]
                            I   [DATA.                               ]
                            I
                            I
          ..........................................
          :              COMMON/CLOCK/T            :
          :          COMMON/PASS6/GRGR(12,1)        :
          :              PI=3.14159                :
          :              R=PI/180.                 :
          :              W=PI/3000.                :
          :........................................:
                            I
                            I
A-------------->..........................................
A               :              DO 1 I=1,6              :
A               :......................................:
A                           I
A         [     1]          I
A               ..........................................
-----------------:             GRGR(I,1)=0.             :
                :......................................:
                            I
                            I
          ..........................................
          :              WT=W*T                    :
          :              GRGR(7,1)=0.              :
          :       GRGR(8,1)=-60.*W*W*SIN(WT)*R     :
          :              GRGR(9,1)=0.              :
          :      GRGR(10,1)=-11.*W*W*SIN(WT)*R     :
          :              GRGR(11,1)=0.             :
          :      GRGR(12,1)=-4.2*W*W*SIN(WT)*R     :
          :........................................:
                            I
                            I
                  /''''''''''''''''''\
                  :      RETURN      :
                  \................../
```

```
@R*Y.FORFLO,S EE.MAIN3/SIM-NEW
FLOWCHARTED BY  FORFLO /XB79/ ON 13 AUG 81 AT 08:04:34

C...MAIN PROGRAM TO INTEGRATE SYSTEM OF EQUATIONS
C...CALLS SUBROUTINE RCOMM TO DETERMINE ACCELERATION INPUTS
C...READS IN CC AND OUTPUTS THE TIP RESPONSE AS
C          Y = CC*XC + CR*XR
C...USES SUBROUTINES SAMPLE, GE, AND UDOT.  COUPLING IN THROUGH
C...THE EQUATIONS FOR THE SHUTTLE TERMS.
           DIMENSION X(40,1),XDOT(40,1),CC(3,8),CR(3,6),XSH(12,1)
           EXTERNAL FUNC
           DIMENSION P1(3,1),P2(3,1),Y(3,1),XR(6,1),T(3,1)
           DIMENSION OUT(1500,2)
           COMMON/RANDOM/ JAY
           COMMON/TIMES/TXI,TYI,TZI,NX,NY,NZ
           COMMON/THRUST/XTIME(500,2),YTIME(200,2),ZTIME(200,2),IXT,IYT,IZT
           COMMON/PRNT/ YX(1500,3),YY(1500,3),YZ(1500,3),YSH(1500,3),INUM
          &,IPRINT
           CHARACTER*1 C(3)
           CHARACTER*6 XNAM,YNAM(3),YSHNAM(3)
           CHARACTER*20 TITLE(4)
           COMMON/ANGLES/THEX,THEY,THEZ
           COMMON/CLOCK/TIME,DT,TRX,TRY,TRZ
           COMMON/KEEP/TX,TY,TZ,IX,IY,IZ
           COMMON/PASS7/AA(3,1),BB(3,1)
           COMMON/PASS6/GR(12,1),XRDOT(6,1)
           COMMON/PASS4/ SAMPL(12,1),UDIST(3,1),IS,DB
           COMMON/PASS3/UDDCT(3,1),RK(3,8),RCOM(3,1),XC(40,1)
           COMMON/PASS2/A(8,8),B(8,3),BC(8,3)
          &,BR(6,3),AR(6,6),ASH(12,12)
           COMMON/PASS1/ETHET(3,3),F6(8,3),F7(8,3),F8(8,3)
          &,F9(12,12),F10(3,3),F11(3,3),ANE(12,3),AEN(12,3)
          &,ANET(3,12),AENT(3,12)
           DATA A,B,INUM/64*0.,24*0.,0/
           DATA IXT,IYT,IZT/0,0,0/
           DATA NX,NY,NZ/3*0/
           DATA AR,ASH/36*0.,144*0./
           C1=1./4.85E-6
           C(1)='*'
           C(2)='A'
           C(3)='B'
           XNAM=' TIME'
           YNAM(1)='TORQUE'
           YNAM(2)=' BASE '
           YNAM(3)=' TIP  '
           YSHNAM(1)='THETAX'
           YSHNAM(2)='THETAY'
           YSHNAM(3)='THETAZ'
           TITLE(1)=' DATA FOR THE X-AXIS'
           TITLE(2)=' DATA FOR THE Y-AXIS'
           TITLE(3)=' DATA FOR THE Z-AXIS'
           TITLE(4)=' SHUTTLE ROTATIONS '
           PRINT*,' ENTER THE RC MATRIX ROW-WISE'
           PRINT101
```

```
      DO 1 I=1,8
      READ*,(A(I,J),J=1,8)
1     WRITE(6,100)(A(I,J),J=1,8)
      PRINT102
100   FORMAT(3(2X,1PE11.4))
101   FORMAT(/)
102   FORMAT(//)
      PRINT*,' ENTER THE BC MATRIX ROW-WISE'
      PRINT101
      DO 3 I=1,8
      READ*,(BC(I,J),J=1,3)
3     WRITE(6,100)(BC(I,J),J=1,3)
      PRINT102
      DO 4 I=1,8
      DO 4 J=1,3
4     B(I,J)=BC(I,J)
      DATA ((BR(I,J),J=1,3),I=1,6)/3*0.,1.,6*0.,1.,6*0.,1./
      PRINT*,' ENTER THE F6 MATRIX ROW-WISE'
      PRINT101
      DO 7 I=1,8
      READ*,(F6(I,J),J=1,3)
7     WRITE(6,100)(F6(I,J),J=1,3)
      PRINT 102
      PRINT*,' ENTER THE F7 MATRIX ROW-WISE'
      PRINT101
      DO 8 I=1,8
      READ*,(F7(I,J),J=1,3)
8     WRITE(6,100)(F7(I,J),J=1,3)
      PRINT102
      PRINT*,' ENTER THE F8 MATRIX ROW-WISE'
      PRINT101
      DO 9 I=1,8
      READ*,(F8(I,J),J=1,3)
9     WRITE(6,100)(F8(I,J),J=1,3)
      PRINT102
      PRINT*,' ENTER THE F9 MATRIX ROW-WISE'
      PRINT101
      DO 10 I=1,12
      READ*,(F9(I,J),J=1,12)
10    WRITE(6,100)(F9(I,J),J=1,12)
      PRINT102
      PRINT*,' ENTER THE F10 MATRIX ROW-WISE'
      PRINT101
      DO 11 I=1,3
      READ*,(F10(I,J),J=1,3)
11    WRITE(6,100)(F10(I,J),J=1,3)
      PRINT102
      PRINT*,' ENTER THE F11 MATRIX ROW-WISE'
      PRINT101
      DO 12 I=1,7
      READ*,(F11(I,J),J=1,7)
12    WRITE(6,100)(F11(I,J),J=1,3)
      PRINT102
      DATA ((ANE(I,J),J=1,3),I=1,12)/21*0.,1.,6*0.,1.,6*0.,1./
      DATA((AEN(I,J),J=1,3),I=1,12)/7*0.,1.,5*0.,1.,6*0.,1.,18*0./
      CALL MXTRN(ANE,ANET,12,3,12,3)
      CALL MXTRN(AEN,AENT,12,3,12,3)
```

```
      PRINT*,' ENTER THE INITIAL STATE VECTOR'
      PRINT101
      READ*,(X(I,1),I=1,30)
      WRITE(6,100)(X(I,1),I=1,30)
      PRINT102
C...COPY THE INITIAL SHUTTLE ANGLES INTO COMMON/ANGLES/
      THEX=X(21,1)
      THEY=X(23,1)
      THEZ=X(25,1)
      PRINT*,' ENTER THE INITIAL TIME, THE FINAL TIME, '
      PRINT*,' THE STEP SIZE FOR THE INTEGRATION ROUTINE,'
      PRINT*,' AND THE PRINT FREQUENCY FOR OUTPUT. '
      READ*,TI,TF,DT,NPRINT
      PRINT101
      PRINT*,TI,TF,DT,NPRINT
      PRINT101
      NUM=(TF-TI)/DT +1
C...INITIALIZE
      PRINT102
      PRINT*,' ENTER THE FEEDBACK MATRIX RK'
      PRINT101
      DO 15 I=1,3
      READ*,(RK(I,J),J=1,8)
15    WRITE(6,100)(RK(I,J),J=1,8)
      PRINT102
      PRINT*,' ENTER THE CC MATRIX (CC(3,8))'
      DO 17 I=1,3
      READ*,(CC(I,J),J=1,8)
17    WRITE(6,100)(CC(I,J),J=1,8)
      PRINT102
      PRINT*,' ENTER A 1 IF THE SIMULATION IS SOLAR '
      PRINT*,' INERTIAL, OTHERWISE ENTER A 0'
      READ*,IS
      PRINT101
      PRINT*,IS
      PRINT102
      PRINT*,' ENTER THE DEADBAND FOR THE SHUTTLE IN DEGREES'
      READ*,DB
      PRINT101
      PRINT*,DB
      PRINT102
      PRINT*,' ENTER A 1 TO SUPRESS DATA PRINTING'
      PRINT*,' (PLOTTED OUTPUT ONLY) OR ENTER A ZERO'
      PRINT*,' TO SEE ALL DATA PRINTED WITH PLOTS'
      PRINT101
      READ*,IPRINT
      PRINT*,IPRINT
      PRINT102
      PRINT*,' ENTER THE INITAL RANDOM NUMBER FROM THE'
      PRINT*,' INTERVAL 0 TO 2**35 FOR THE NOISE GENERATORS'
      PRINT101
      READ*,JAY
      PRINT*,JAY
      PRINT102
      DATA CR/1.,6*0.,1.,6*0.,1.,3*0./
      DO 16 I=2,24,2
      IF(I.GE.9.AND.I.LE.12)THEN
```

```
            AR(I-7,I-5)=1.
         ELSE IF(I.GT.12)THEN
            ASH(I-13,I-12)=1.
         END IF
16       CONTINUE
         TIME=TI
         ICOUNT=0
         PRINT111
111      FORMAT('1')
         CALL PRINT(TIME,RCCM,UDDCT,F11,X,CC,CR)
C...BEGIN THE INTEGRATIONS
         DO 20 I=1,NUM
         CALL RCOMM
         CALL SAMPLE
         CALL GG
         CALL RKSUB1(FUNC,X,XDOT,30,1,DT)
         TIME=TIME+DT
         ICOUNT=ICOUNT+1
         IF(ICOUNT.LT.NPRINT)GOTO20
         CALL PRINT(TIME,RCCM,UDDCT,F11,X,CC,CR)
         ICOUNT=0
20       CONTINUE
         DO 190 II=1,NX
190      OUT(II,1)=YX(II,1)
         CALL PLOTS(OUT,XNAM,YNAM,TITLE(1),TXI,NPRINT*DT,C,NX,1,1)
         DO 191 II=1,NX
         OUT(II,1)=YX(II,2)
191      OUT(II,2)=YX(II,3)
         CALL PLOTS(OUT,XNAM,YNAM(2),TITLE(1),TXI,NPRINT*DT,C(2),NX,2,1)
         DO 192 II=1,NY
192      OUT(II,1)=YY(II,1)
         CALL PLOTS(OUT,XNAM,YNAM,TITLE(2),TYI,NPRINT*DT,C,NY,1,1)
         DO 193 II=1,NY
         OUT(II,1)=YY(II,2)
193      OUT(II,2)=YY(II,3)
         CALL PLOTS(OUT,XNAM,YNAM(2),TITLE(2),TYI,NPRINT*DT,C(2),NY,2,1)
         DO 194 II=1,NZ
194      OUT(II,1)=YZ(II,1)
         CALL PLOTS(OUT,XNAM,YNAM,TITLE(3),TZI,NPRINT*DT,C,NZ,1,1)
         DO 195 II=1,NZ
         OUT(II,1)=YZ(II,2)
195      OUT(II,2)=YZ(II,3)
         CALL PLOTS(OUT,XNAM,YNAM(2),TITLE(3),TZI,NPRINT*DT,C(2),NZ,2,1)
         CALL PLOTS(YSH,XNAM,YSHNAM,TITLE(4),TI,NPRINT*DT,C,INUM,3,1)
         CALL SUMMRY
         STOP
         END
```

```
                 /'''''''''''''''''''\
                :       BEGIN         :
                 \.................../
                          I
                          I---[...MAIN PROGRAM TO INTEGRATE    ]
                          I   [SYSTEM OF EQUATIONS             ]
                          I   [...CALLS SUBROUTINE RCOMM TO    ]
                          I   [DETERMINE ACCELERATION INPUTS   ]
                          I   [...READS IN CC AND OUTPUTS THE  ]
                          I   [TIP RESPONSE #S                 ]
                          I   [ Y = CC*XC + CR*XR              ]
                          I   [...USES SUBROUTINES SAMPLE, GG, ]
                          I   [AND UDOT, COUPLING IN THROUGH   ]
                          I   [...THE EQUATIONS FOR THE SHUTTLE]
                          I   [TERMS.                          ]
                          I
                          I
..............................................
: DIMENSION X(40,1),XDOT(40,1),CC(3,8),CR(   :
: 3,6),XSH(12,1)                             :
:              EXTERNAL FUNC                 :
: DIMENSION F1(3,1),F2(3,1),Y(3,1),XR(6,1),  :
: T(3,1)                                     :
:          DIMENSION OUT(1500,2)             :
:             COMMON/RANDOM/ JAY             :
:     COMMON/TIMES/TXI,TYI,TZI,NX,NY,NZ      :
: COMMON/THRUST/XTIME(500,2),YTIME(200,2),   :
: ZTIME(200,2),IXT,IYT,IZT                   :
: COMMON/PRNT/ YX(1500,3),YY(1500,3),YZ(     :
: 1500,3),YSH(1500,3),INUM,IPRINT            :
:              CHARACTER*1 C(3)              :
: CHARACTER*6 XNAM,YNAM(3),YSHNAM(3)         :
:          CHARACTER*20 TITLE(4)             :
:       COMMON/ANGLES/THEX,THEY,THEZ         :
:     COMMON/CLOCK/TIME,DT,TRX,TRY,TRZ       :
:      COMMON/KEEP/TX,TY,TZ,IX,IY,IZ         :
:        COMMON/PASS7/AA(3,1),BB(3,1)        :
:     COMMON/PASS6/GR(12,1),XRDOT(6,1)       :
: COMMON/PASS4/ SAMPL(12,1),UDIST(3,1),IS,   :
: DB                                         :
: COMMON/PASS3/UDDOT(3,1),RK(3,8),RCOM(3,1)  :
: ,XC(40,1)                                  :
: COMMON/PASS2/A(8,8),B(8,3),BC(8,3),BR(6,   :
: 3),AR(6,6),ASH(12,12)                      :
: COMMON/PASS1/ETHET(3,3),F6(8,3),F7(8,3),   :
: F8(8,3),F9(12,12),F10(3,3),F11(3,3),ANE(   :
: 12,3),AEN(12,3),ANET(3,12),AENT(3,12)      :
:       DATA A,B,INUM/64*0.,24*0.,0/         :
:         DATA IXT,IYT,IZT/0,0,0/            :
:            DATA NX,NY,NZ/3*0/              :
:        DATA AR,ASH/36*0.,144*0./           :
:               C1=1./4.35E-6                :
:                 C(1)='*'                   :
:                 C(2)='A'                   :
:                 C(3)='B'                   :
:               XNAM=' TIME'                 :
:              YNAM(1)='TORQUE'              :
:              YNAM(2)=' BASE '              :
:              YNAM(3)=' TIP  '              :
:             YSHNAM(1)='THETAX'             :
```

```
YSHNAM(2)='THETAY'
YSHNAM(3)='THETAZ'
TITLE(1)=' DATA FOR THE X-AXIS'
TITLE(2)=' DATA FOR THE Y-AXIS'
TITLE(3)=' DATA FOR THE Z-AXIS'
TITLE(4)=' SHUTTLE ROTATIONS '

PRINT*,' ENTER THE AC MATRIX ROW-WISE'

PRINT101

DO 1 I=1,8

READ*,(A(I,J),J=1,8)

[ 1]
WRITE(6,100)(A(I,J),J=1,8)

PRINT102

[100 FORMAT(8(2X,1PE11.4))   ]
[101 FORMAT(/)               ]
[102 FORMAT(//)              ]

PRINT*,' ENTER THE BC MATRIX ROW-WISE'

PRINT101

DO 3 I=1,3

READ*,(BC(I,J),J=1,3)

[ 3]
```

```
PRINT102
DO 4 I=1,3
DO 4 J=1,3
[ 4]
B(I,J)=BC(I,J)
DATA ((UR(I,J),J=1,3),I=1,6)/3*0.,1.,6*0.
,1.,6*0.,1./
PRINT*,' ENTER THE F6 MATRIX ROW-WISE'
PRINT101
DO 7 I=1,8
READ*,(F6(I,J),J=1,3)
[ 7]
WRITE(6,100)(F6(I,J),J=1,3)
PRINT 102
PRINT*,' ENTER THE F7 MATRIX ROW-WISE'
PRINT101
```

```
                                        I
                                        I
                  ..........................................
A---------------->:                DO 8 I=1,8             :
A                 :.......................................:
A                                       I
A                                       I
A                  /........................................./
A                 /          READ*,(F7(I,J),J=1,3)          /
A                /........................................./
A                                       I
A                  [    8]              I
A                  /........................................./
 -----------------/       WRITE(6,100)(F7(I,J),J=1,3)      /
                 /........................................./
                                        I
                                        I
                   /........................................./
                  /              PRINT102                  /
                 /........................................./
                                        I
                                        I
                   /........................................./
                  /  PRINT*,' ENTER THE F8 MATRIX ROW-WISE'/
                 /........................................./
                                        I
                                        I
                   /........................................./
                  /              PRINT101                  /
                 /........................................./
                                        I
                                        I
                  ..........................................
A---------------->:                DO 9 I=1,8             :
A                 :.......................................:
A                                       I
A                                       I
A                  /........................................./
A                 /          READ*,(F8(I,J),J=1,3)          /
A                /........................................./
A                                       I
A                  [    9]              I
A                  /........................................./
 -----------------/       WRITE(6,100)(F8(I,J),J=1,3)      /
                 /........................................./
                                        I
                                        I
                   /........................................./
                  /              PRINT102                  /
                 /........................................./
                                        I
                                        I
                   /........................................./
                  /  PRINT*,' ENTER THE F9 MATRIX ROW-WISE'/
                 /........................................./
                                        I
                                        I
                   /........................................./
                  /              PRINT101                  /
                 /........................................./
                                        I
                                        I
                  ..........................................
A---------------->:                DO 10 I=1,12           :
A                 :.......................................:
```

```
               READ*,(F9(I,J),J=1,12)
                         I
      [  10]             I
               WRITE(6,100)(F9(I,J),J=1,12)
                         I
                         I
                     PRINT102
                         I
                         I
      PRINT*,' ENTER THE F10 MATRIX ROW-WISE
                         I
                         I
                     PRINT101
                         I
                         I
                   DO 11 I=1,3
                         I
                         I
               READ*,(F10(I,J),J=1,3)
                         I
      [  11]             I
               WRITE(6,100)(F10(I,J),J=1,3)
                         I
                         I
                     PRINT102
                         I
                         I
      PRINT*,' ENTER THE F11 MATRIX ROW-WISE
                         I
                         I
                     PRINT101
                         I
                         I
                   DO 12 I=1,3
                         I
                         I
               READ*,(F11(I,J),J=1,3)
                         I
```

```
WRITE(6,100)(F11(I,J),J=1,3)

PRINT102

DATA ((ANE(I,J),J=1,3),I=1,12)/21*0.,1.,
6*0.,1.,6*0.,1./
DATA((AEN(I,J),J=1,3),I=1,12)/3*0.,1.,6*
0.,1.,6*0.,1.,18*0./

CALL MXTRN(ANE,ANET,12,3,12,3)

CALL MXTRN(AEN,AENT,12,3,12,3)

PRINT*,' ENTER THE INITIAL STATE
VECTOR'

PRINT101

READ*,(X(I,1),I=1,30)

WRITE(6,100)(X(I,1),I=1,30)

PRINT102

[...COPY THE INITIAL SHUTTLE ]
[ANGLES INTO COMMON/ANGLES/ ]

THEX=X(21,1)
THEY=X(22,1)
THEZ=X(23,1)
```

```
/.........................................../
                      I
                      I
   /'''''''''''''''''''''''''''''''''''''''''''/
  /   PRINT*,' THE STEP SIZE FOR THE           /
 /   INTEGRATION ROUTINE,'                    /
/.........................................../
                      I
                      I
   /'''''''''''''''''''''''''''''''''''''''''''/
  /   PRINT*,' AND THE PRINT FREQUENCY FOR    /
 /   OUTPUT.'                                 /
/.........................................../
                      I
                      I
   /'''''''''''''''''''''''''''''''''''''''''''/
  /          READ*,TI,TF,DT,NPRINT            /
 /.........................................../
                      I
                      I
   /'''''''''''''''''''''''''''''''''''''''''''/
  /               PRINT101                    /
 /.........................................../
                      I
                      I
   /'''''''''''''''''''''''''''''''''''''''''''/
  /          PRINT*,TI,TF,DT,NPRINT           /
 /.........................................../
                      I
                      I
   /'''''''''''''''''''''''''''''''''''''''''''/
  /               PRINT101                    /
 /.........................................../
                      I
                      I
 :...........................................:
 :          NUM=(TF-TI)/DT +1                :
 :...........................................:
                      I
                      I---[...INITIALIZE
                      I
                      I
   /'''''''''''''''''''''''''''''''''''''''''''/
  /               PRINT102                    /
 /.........................................../
                      I
                      I
   /'''''''''''''''''''''''''''''''''''''''''''/
  /   PRINT*,' ENTER THE FEEDBACK MATRIX RK'  /
 /.........................................../
                      I
                      I
   /'''''''''''''''''''''''''''''''''''''''''''/
  /               PRINT101                    /
 /.........................................../
                      I
                      I
 .............................................
A---------------->:        DO 15 I=1,3                :
A                 :...........................................:
A                     I
A                     I
A  /'''''''''''''''''''''''''''''''''''''''''''/
A /          READ*,(RK(I,J),J=1,3)            /
 ........................................../
```

```
[ 15]
WRITE(6,100)(RK(I,J),J=1,8)

PRINT102

PRINT*,' ENTER THE CC MATRIX (CC(3,8))

DO 17 I=1,3

READ*,(CC(I,J),J=1,8)

[ 17]
WRITE(6,100)(CC(I,J),J=1,8)

PRINT102

PRINT*,' ENTER A 1 IF THE SIMULATION
IS SOLAR '

PRINT*,' INERTIAL, OTHERWISE ENTER A 0

READ*,IS

PRINT101

PRINT*,IS

PRINT102
```

```
PRINT*,' ENTER THE DEADBAND FOR THE
SHUTTLE IN DEGREES'

READ*,DB

PRINT101

PRINT*,DB

PRINT102

PRINT*,' ENTER # 1 TO SUPRESS DATA
PRINTING'

PRINT*,' (PLOTTED OUTPUT ONLY) OR
ENTER A ZERO'

PRINT*,' TO SEE ALL DATA PRINTED WITH
PLOTS'

PRINT101

READ*,IPRINT

PRINT*,IPRINT

PRINT102
```

```
     /*****************************************/
    /   PRINT*,' ENTER THE INITIAL RANDOM    /
   /    NUMBER FROM THE'                    /
  /...........................................
                      I
                      I
     /*****************************************/
    /   PRINT*,' INTERVAL 0 TO 2**35 FOR THE /
   /    NOISE GENERATORS'                   /
  /...........................................
                      I
                      I
     /*****************************************/
    /               PRINT101                 /
  /...........................................
                      I
                      I
     /*****************************************/
    /               READ*,JAY                /
  /...........................................
                      I
                      I
     /*****************************************/
    /               PRINT*,JAY               /
  /...........................................
                      I
                      I
     /*****************************************/
    /               PRINT102                 /
  /...........................................
                      I
                      I
  ............................................
  :     DATA CR/1.,6*0.,1.,6*0.,1.,3*0./     :
  :..........................................:
                      I
                      I
  ............................................
A---------->:         DO 16 I=8,24,2         :
A           :................................:
A                     I
A                     I
A    /*****************************************\
A   <      IF(I.GE.3.AND.I.LE.12)THEN          >----    ------0
A    \.........................................
A                @@@@ I
A                     I
A                     I
A ............................................
A :             AR(I-7,I-6)=1.               :
A :         ELSE IF(I.GT.12)THEN             :
A :           *SH(I-13,I-12)=1.              :
A :              END IF                      :
A :..........................................:
A                     I
A    [   16]          I
A ............................................
----------:          CONTINUE                :
  :..........................................:
                      I
                      I
  ............................................
  :               TIME=TI                    :
  :               ICOUNT=0                   :
```

```
             /.........................................../
            /                 PRINT111                  /
           /.........................................../
                                 I
                                 I---[111 FORMAT('1')                ]
                                 I
                                 I
           ..............................................
           : : CALL PRINT(TIME,RCOM,UDDOT,F11,X,CC,   : :
           : : CR)                                    : :
           :.:........................................:.:
                                 I
                                 I---[...BEGIN THE INTEGRATIONS      ]
                                 I
                                 I
A---------------->..............................................
A                :             DO 20 I=1,NUM                   :
A                :.............................................:
A                                I
A                                I
A                ..............................................
A                : :            CALL RCOMM                   : :
A                :.:.........................................:.:
A                                I
A                                I
A                ..............................................
A                : :           CALL SAMPLE                   : :
A                :.:.........................................:.:
A                                I
A                                I
A                ..............................................
A                : :            CALL GG                      : :
A                :.:.........................................:.:
A                                I
A                                I
A                ..............................................
A                : : CALL RKSUB1(FUNC,X,XDOT,30,1,DT)        : :
A                :.:.........................................:.:
A                                I
A                                I
A                ..............................................
A                :             TIME=TIME+DT                    :
A                :           ICOUNT=ICOUNT+1                   :
A                :.............................................:
A                                I
A                                I
A                /............................................\   TRUE
A               <        IF(ICOUNT.LT.NPRINT)GOTO20            >-------------------0
A                \............................................/                    Z
A                                I   FALSE                                         Z
A                                I                                                 Z
A                                I                                                 Z
A                ..............................................                    Z
A                : : CALL PRINT(TIME,RCOM,UDDOT,F11,X,CC,    : :                   Z
A                : : CR)                                     : :                   Z
A                :.:.........................................:.:                   Z
A                                I                                                 Z
A                                I                                                 Z
A                ..............................................                    Z
A                :              ICOUNT=0                       :                   Z
A                :.............................................:                   Z
A                                I                                                 Z
A                                C<------------------------------------------------0
A                 [    20]       I
A                ...............................................
```

```
CONTINUE

DO 190 II=1,NX

[ 190]
OUT(II,1)=YX(II,1)

CALL PLOTS(OUT,XNAM,YNAM,TITLE(1),
TXI,NPRINT*DT,C,NX,1,1)

DO 191 II=1,NX

OUT(II,1)=YX(II,2)

[ 191]
OUT(II,2)=YX(II,3)

CALL PLOTS(OUT,XNAM,YNAM(2),TITLE(1),
TXI,NPRINT*DT,C(2),NX,2,1)

DO 192 II=1,NY

[ 192]
OUT(II,1)=YY(II,1)

CALL PLOTS(OUT,XNAM,YNAM,TITLE(2),
TYI,NPRINT*DT,C,NY,1,1)

DO 193 II=1,NY

OUT(II,1)=YY(II,2)
```

```
^      [ 193]                 I
A  ..............................................
---------------:      OUT(II,2)=YY(II,3)             :
               :.............................................:
                              I
                              I
               ...............................................
               : : CALL PLOTS(OUT,XNAM,YNAM(2),TITLE(2),  : :
               : : TYI,NPRINT*DT,C(2),NY,2,1)              : :
               :.:.........................................:.:
                              I
                              I
               ...............................................
A------------->:          DO 194 II=1,NZ                     :
A              :.............................................:
A                             I
A      [ 194]                 I
A              ...............................................
---------------:      OUT(II,1)=YZ(II,1)                     :
               :.............................................:
                              I
                              I
               ...............................................
               : : CALL PLOTS(OUT,XNAM,YNAM,TITLE(3),     : :
               : : TZI,NPRINT*DT,C,NZ,1,1)                 : :
               :.:.........................................:.:
                              I
                              I
               ...............................................
A------------->:          DC 195 II=1,NZ                     :
A              :.............................................:
A                             I
A                             I
A              ...............................................
A              :      OUT(II,1)=YZ(II,2)                     :
A              :.............................................:
A                             I
A      [ 195]                 I
A              ...............................................
---------------:      OUT(II,2)=YZ(II,3)                     :
               :.............................................:
                              I
                              I
               ...............................................
               : : CALL PLOTS(OUT,XNAM,YNAM(2),TITLE(3),  : :
               : : TZI,NPRINT*DT,C(2),NZ,2,1)              : :
               :.:.........................................:.:
                              I
                              I
               ...............................................
               : : CALL PLOTS(YSH,XNAM,YSHNAM,TITLE(4),   : :
               : : TI,NPRINT*DT,C,INUM,3,1)                : :
               :.:.........................................:.:
                              I
                              I
               ...............................................
               : :          CALL SUMMRY                    : :
               :.:.........................................:.:
                              I
                              I
                      /-------------------\
                      :       STOP         :
                      \.................../
```

```
@R*Y.FORFLO,S EE.PLOTS
FLOWCHARTED BY  FORFLO /X808/ ON 13 AUG 81 AT 08:04:52

              SUBROUTINE PLOTS(Y,XLBL,YLBL,TITLE,XST,XD,C,N,NP,SS)
              DIMENSION Y(1500,N),YL(5),YS(5),YD(5)
              CHARACTER LINE*1(70),C*1(1),BLK*1
              INTEGER SS,IY
              CHARACTER*6 XLBL,YLBL(1)
              CHARACTER*20 TITLE
C             SS=SCALE SHIFT:  SS EQUAL TO 0,INDIVIDUAL SCALING
C                              SS NOT EQUAL TO 0,UNIFORM SCALING
              DATA BLK/' '/
              WRITE(6,1001) TITLE,(C(I),YLBL(I),XLBL,I=1,NP)
         1001 FORMAT(1H1,//T41,A20//
             1(T10,7HCURVE ',A1,15H' IS A PLOT OF ,A6,8H VERSUS ,A6/))
              IF(SS.EQ.0) GO TO 7
              YLL=Y(1,1)
              YSS=Y(1,1)
              DO 1 I=1,N
              DO 1 J=1,NP
              IF(Y(I,J).GT.YLL) YLL=Y(I,J)
            1 IF(Y(I,J).LT.YSS) YSS=Y(I,J)
              WRITE(6,1002) YSS,YLL,XLBL,(YLBL(I),I=1,NP)
         1002 FORMAT(////T13,13HMINIMUM VALUE,T69,13HMAXIMUM VALUE/
             1T13,E11.4,T67,E11.4/
             2T3,A6,T13,1HI,68X,1HI,5(4X,A6))
              YDD=(YLL-YSS)/70.
              GO TO 8
            7 DO 9 J=1,NP
              YS(J)=Y(1,J)
              YL(J)=Y(1,J)
              DO 9 I=1,N
              IF(Y(I,J).LT.YS(J)) YS(J)=Y(I,J)
            9 IF(Y(I,J).GT.YL(J)) YL(J)=Y(I,J)
              DO 6 J=1,NP
            6 YD(J)=(YL(J)-YS(J))/70.
              WRITE(6,1004) XLBL,(YLBL(I),I=1,NP)
         1004 FORMAT(////
             $T3,A6,T13,1HI,68X,1HI,5(4X,A6))
              IF(SS.EQ.0) GO TO 10
            8 DO 4 I=1,N
              DO 2 K=2,69
            2 LINE(K)=' '
              LINE(1)='I'
              LINE(70)='I'
              X=XST+(I-1)*XD
              IF(YLL.GE.0..AND.YSS.LE.0.)THEN
                   IY=IFIX((0.0-YSS)/YDD+1.)
              IF(IY.GT.70)IY=70
                   LINE(IY)=':'
              END IF
5             DO 3 J=1,NP
              IY=IFIX((Y(I,J)-YSS)/YDD+1.)
              IF(IY.GT.70)IY=70
```

```
    3 LINE(IY)=C(J)
    4 WRITE(6,1003) X,(LINE(K),K=1,70),(Y(I,J),J=1,NP)
      GO TO 99
   10 DO 13 I=1,N
      DO 17 K=2,69
   17 LINE(K)=' '
      LINE(1)='I'
      LINE(70)='I'
      X=XST+(I-1)*XD
      DO 11 L=1,NP
      J=(NP+1)-L
      IY=IFIX((Y(I,J)-YS(J))/YD(J) +1.)
      IF(IY.GT.70) IY=70
   11 LINE(IY)=C(J)
   13 WRITE(6,1003) X,(LINE(K),K=1,70),(Y(I,J),J=1,NP)
 1003 FORMAT(E11.4,1X,70(A1),5(E10.4))
   99 RETURN
      END
```

```
     ..............................................
     \   SUBROUTINE PLOTS(Y,XLBL,YLBL,TITLE,      /
      \  XST,XD,C,M,NP,SS)                        /
       \........................................./
                            I
                            I
     ..............................................
     : DIMENSION Y(1500,N),YL(5),YS(5),YD(5)      :
     :    CHARACTER LINE*1(70),C*1(1),BLK*1       :
     :             INTEGER SS,IY                  :
     :        CHARACTER*6 XLBL,YLBL(1)            :
     :           CHARACTER*20 TITLE               :
     :............................................:
                            I
                            I---[ SS=SCALE SHIFT: SS EQUAL TO 0, ]
                            I   [INDIVIDUAL SCALING              ]
                            I   [ SS NOT EQUAL TO 0,UNIFORM      ]
                            I   [SCALING                         ]
                            I
                            I
     ..............................................
     :             DATA BLK/' '/                  :
     :............................................:
                            I
                            I
      /............................................/
     /   WRITE(6,1001) TITLE,(C(I),YLBL(I),XLBL/
    /   I=1,NP)                                   /
   /............................................./
                            I
                            I---[ 1001 FORMAT(1H1,//T41,A20// 1( ]
                            I   [T10,7HCURVE ',A1,15H' IS A PLOT ]
                            I   [OF ,A6,8H VERSUS ,A6/))         ]
                            I
                            I
      /.........................................\  TRUE
     <           IF(SS.EQ.0) GO TO 7              >-----------------------------0
      \........................................./                               Z
                            I  FALSE                                            Z
                            I                                                   Z
                            I                                                   Z
     ..............................................                             Z
     :               YLL=Y(1,1)                   :                             Z
     :               YSS=Y(1,1)                   :                             Z
     :............................................:                             Z
                            I                                                   Z
                            I                                                   Z
A------------------->..............................................             Z
A                    :           DO 1 I=1,N                       :             Z
A                    :............................................:             Z
A                                   I                                           Z
A                                   I                                           Z
A B----------------->..............................................             Z
A B                  :           DO 1 J=1,NP                      :             Z
A B                  :............................................:             Z
A B                                 I                                           Z
A B                                 I                                           Z
A B                   /.........................................\  FALSE        Z
                                                                 >-----------1  Z
```

```
                 TRUE
                  I
      YLL=Y(I,J)
                  I
                  C<-----------------
   [     1]       I
      IF(Y(I,J).LT.YSS)          FALSE
                  I  TRUE
                  I
      YSS=Y(I,J)
                  I
                  C<-----------------
                  I
      WRITE(6,1002) YSS,YLL,XLBL,(YLBL(I),I=
      1,NP)
                  I
                  I---[ 1002 FORMAT(////T13,13HMINIMUM ]
                  I   [VALUE,T69,13HMAXIMUM VALUE/ 1T13]
                  I   [E11.4,T67,E11.4/ 2T3,A6,T13,1HI,]
                  I   [69X,1HI,5(4X,A6))               ]
                  I
                  I
      YDD=(YLL-YSS)/70.
                  I
                  I
            GO TO 8
                  C<-----------------
   [     7]       I
      DO 9 J=1,NP
                  I
                  I
      YS(J)=Y(1,J)
      YL(J)=Y(1,J)
                  I
                  I
      DO 9 I=1,N
                  I
                  I
      IF(Y(I,J).LT.YS(J))        FALSE
                  I  TRUE
                  I
      YS(J)=Y(I,J)
```

```
 [    9]
 IF(Y(I,J).GT.YL(J))          FALSE
        TRUE
 YL(J)=Y(I,J)

 DO 6 J=1,NP
 [    6]
 YD(J)=(YL(J)-YS(J))/70.

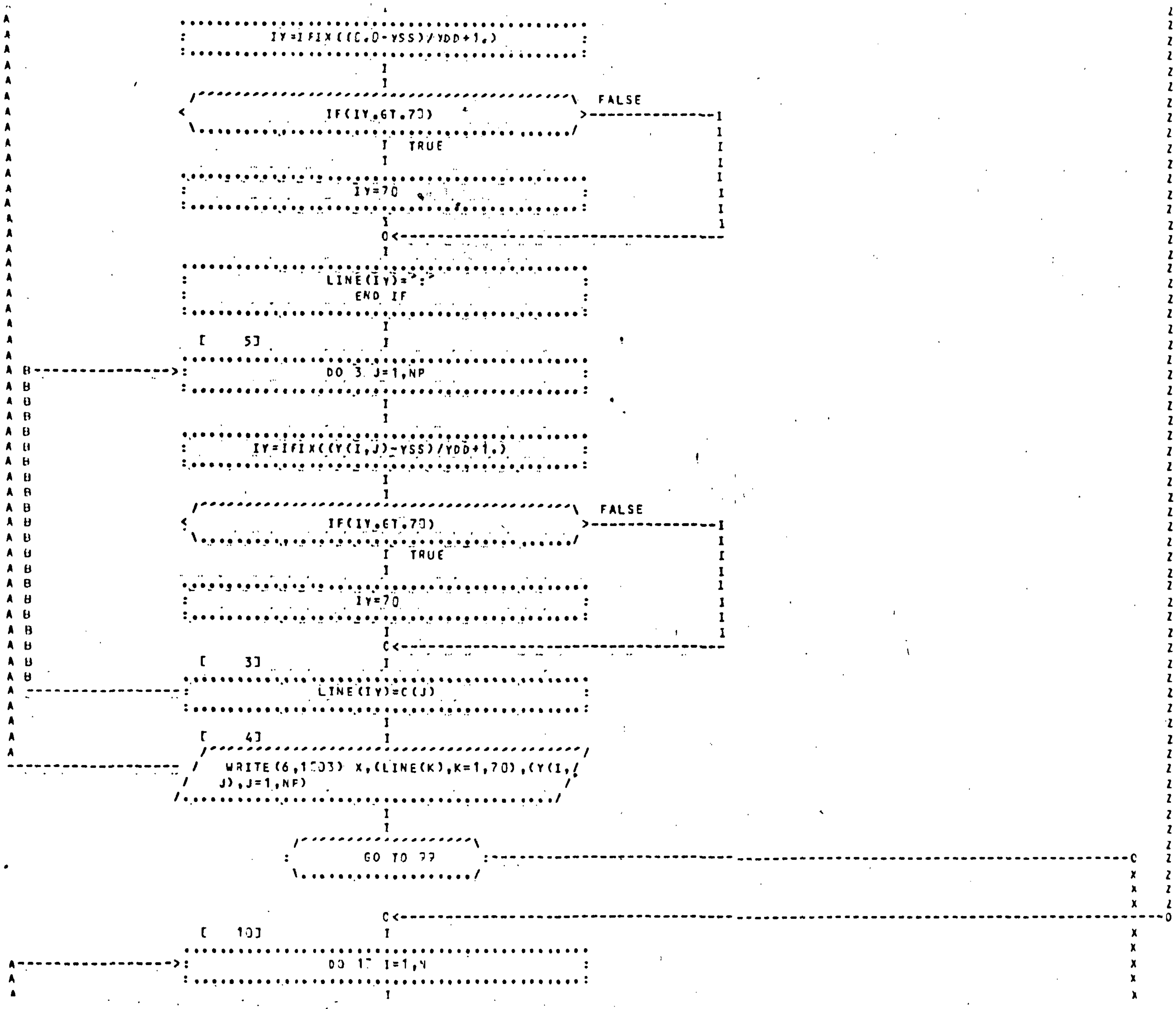
 WRITE(6,1004) XLBL,(YLBL(I),I=1,NP)
    [ 1004 FORMAT(////,5T3,A6,T13,1HI]
    [68X,1HI,5(4X,A6))               ]

 IF(SS.EQ.0) GO TO 10          TRUE
        FALSE
 [    8]
 DO 4 I=1,N

 DO 2 K=2,69
 [    2]
 LINE(K)=' '

 LINE(1)='I'
 LINE(70)='I'
 X=XST+(I-1)*XD

 IF(YLL.GE.0..AND.YSS.LE.0.)THEN
```


IY=IFIX((C.0-YSS)/YDD+1.)
IF(IY.GT.70)
FALSE
TRUE
IY=70
LINE(IY)=' '
END IF
[5]
DO 3 J=1,NP
IY=IFIX((Y(I,J)-YSS)/YDD+1.)
IF(IY.GT.70)
FALSE
TRUE
IY=70
[3]
LINE(IY)=C(J)
[4]
WRITE(6,1003) X,(LINE(K),K=1,70),(Y(I,J),J=1,NP)
GO TO 77
[10]
DO 10 I=1,N

```
DO 17 K=2,59
[ 17]
LINE(K)=' '
LINE(1)='I'
LINE(70)='I'
X=XST+(I-1)*XD
DO 11 L=1,NP
J=(NP+1)-L
IY=IFIX((Y(I,J)-YS(J))/YD(J) +1.)
IF(IY.GT.70)   FALSE
TRUE
IY=70
[ 11]
LINE(IY)=C(J)
[ 13]
WRITE(6,1003) X,(LINE(K),K=1,70),(Y(I,
J),J=1,NP)
[ 1003 FORMAT(E11.4,1X,70(A1),5( ]
[E10.4)) ]
[ 99]
RETURN
```

.BR*Y.FORFLO,S EE.PRINT/SIM-NEW
FLOWCHARTED BY FORFLO /X838/ ON 13 AUG 81 AT 08:34:59

```
      SUBROUTINE PRINT(TIME,RCOM,UDDOT,F11,X,CC,CR)
      DIMENSION RCOM(3,1),UDDOT(3,1),F11(3,3),X(40,1),CC(3,8),CR(3,8)
      DIMENSION T(3,1),P1(3,1),P2(3,1),Y(3,1),XR(6,1),XSH(12,1)
      COMMON/PRNT/ YX(1500,3),YY(1500,3),YZ(1500,3),YSH(1500,3),I,IP
      COMMON/TIMES/TXI,TYI,TZI,NX,NY,NZ
      I=I+1
      C1=1./4.85E-6
      IF(IP.EQ.1)GO TO 30
100   FORMAT(3(2X,1PE11.4))
101   FORMAT(/)
102   FORMAT(//)
99    FORMAT(' ***************** TIME=',F6.2,'SEC  *****************')
      PRINT99,TIME
      PRINT*,' '
      CALL MXSCA(RCOM,3,1,3,C1)
      PRINT97,(RCOM(J,1),J=1,3)
      PRINT101
30    CALL MXMLT(F11,UDDOT,T,3,3,1,3,3)
      CALL MXSCA(UDDOT,3,1,3,C1)
      IF(IP.EQ.1)GO TO 31
      PRINT98,(UDDOT(J,1),J=1,3)
      PRINT101
      PRINT96,(T(J,1),J=1,3)
96    FORMAT(' TRQE =',3(1X,1PE11.4),' NEWTON-METERS')
97    FORMAT(' RCOM =',3(1X,1PE11.4),' ARC-SECONDS/SEC**2')
98    FORMAT(' UDOT =',3(1X,1PE11.4),' ARC-SECONDS/SEC**2')
      PRINT101
      PRINT*,'      X(1)  X(2)  X(3)   ...  X(26)'
      WRITE(6,100)(X(J,1),J=1,30)
      PRINT101
31    CALL MXMLT(CC,X,P1,3,8,1,3,40)
      DO 18 J=1,6
18    XR(J,1)=X(8+J,1)
      CALL MXMLT(CR,XR,P2,3,6,1,3,6)
      CALL MXADD(P1,P2,Y,3,3,3)
      CALL MXSCA(Y,3,1,3,C1)
      IF(IP.EQ.1)GO TO 32
      PRINT*,' TIP RESPONSE Y - ARC SECONDS'
      WRITE(6,100) (Y(J,1),J=1,3)
      PRINT101
32    CALL MXSCA(XR,6,1,6,C1)
      IF(IP.EQ.1)GO TO 33
      PRINT*,' BASE ROTATIONS - ARC SECONDS'
      WRITE(6,100)(XR(J,1),J=1,5,2)
      PRINT101
33    DO 19 J=1,12
19    XSH(J,1)=X(14+J,1)
      DO 45 J=7,12
45    XSH(J,1)=XSH(J,1)*C1
      IF(IP.EQ.1)GO TO 34
      PRINT*,' SHUTTLE DISPLACEMENTS - METERS'
```

```
      WRITE(4,100)(XSH(J,1),J=1,5,2)
      PRINT101
      PRINT*,' SHUTTLE ROTATIONS - ARC SECONDS'
      WRITE(6,100)(XSH(J,1),J=7,11,2)
      PRINT101
C...COPY VALUES INTO YX , YY , YZ
      IF(NX.GT.0)GO TO 50
34    IF(UDDOT(1,1).EQ.0..AND.XR(1,1).EQ.0..AND.Y(1,1).EQ.0.)GOTO35
50    NX=NX+1
      IF(NX.EQ.1)TXI=TIME
      YX(NX,1)=T(1,1)
      YX(NX,2)=XR(1,1)
      YX(NX,3)=Y(1,1)
35    IF(NY.GT.0)GO TO 51
      IF(UDDOT(2,1).EQ.0..AND.XR(3,1).EQ.0..AND.Y(2,1).EQ.0.)GOTO36
51    NY=NY+1
      IF(NY.EQ.1)TYI=TIME
      YY(NY,1)=T(2,1)
      YY(NY,2)=XR(3,1)
      YY(NY,3)=Y(2,1)
36    IF(NZ.GT.0)GOTO52
      IF(UDDOT(3,1).EQ.0..AND.XR(5,1).EQ.0..AND.Y(3,1).EQ.0.)GOTO37
52    NZ=NZ+1
      IF(NZ.EQ.1)TZI=TIME
      YZ(NZ,1)=T(3,1)
      YZ(NZ,2)=XR(5,1)
      YZ(NZ,3)=Y(3,1)
37    YSH(I,1)=XSH(7,1)
      YSH(I,2)=XSH(9,1)
      YSH(I,3)=XSH(11,1)
      RETURN
      END
```

```
SUBROUTINE PRINT(TIME,RCCM,UDDOT,F11,
X,CC,CR)

DIMENSION RCCM(3,1),UDDOT(3,1),F11(3,3),
X(40,1),CC(3,3),CR(3,8)
DIMENSION T(3,3),P1(3,1),P2(3,1),Y(3,1),
XR(6,1),XSH(12,1)
COMMON/PRNT/ YX(1500,3),YY(1500,3),YZ(
1500,3),YSH(1500,3),I,IP
   COMMON/TIMES/TXI,TYI,TZI,NX,NY,NZ
          I=I+1
       C1=1./4.85E-6

IF(IP.EQ.1)GO TO 30          TRUE -> 30
  FALSE

[100 FORMAT(8(2X,1PE11.4))
[101 FORMAT(/)
[102 FORMAT(//)
[99 FORMAT(' *****************
[TIME=',F6.2,'SEC ***************
[*')

PRINT99,TIME

PRINT*,' '

CALL MXSCA(RCCM,3,1,3,C1)

PRINT97,(RCCM(J,1),J=1,3)

PRINT101

[   30]
CALL MXMLT(F11,UDDOT,Y,3,3,1,3,3)
```

```
CALL MXSCA(UDDOT,3,1,3,C1)

IF(IP.EQ.1)GO TO 31          TRUE --> 31
   FALSE

PRINT98,(UDDOT(J,1),J=1,3)

PRINT101

PRINT96,(T(J,1),J=1,3)

[96 FORMAT(' TRQE =',3(1X,1PE11.4]
[,' NEWTON-METERS')              ]
[97 FORMAT(' RCOM =',3(1X,1PE11.4]
[,' ARC-SECONDS/SEC**2')         ]
[98 FORMAT(' UDOT =',3(1X,1PE11.4]
[,' ARC-SECONDS/SEC**2')         ]

PRINT101

PRINT*,' X(1) X(2) X(3) ... X(26)'

WRITE(6,100)(X(J,1),J=1,30)

PRINT101

[    31]
CALL MXMLT(CC,X,P1,7,7,1,7,40)

A ---------------> DO 13 J=1,6
```

```
XR(J,1)=X(2+J,1)

CALL MXMLT(CR,XR,P2,3,6,1,3,6)

CALL MXADD(P1,P2,Y,3,3,3)

CALL MXSCA(Y,3,1,3,C1)

IF(IP.EQ.1)GO TO 32          TRUE
   FALSE

PRINT*,' TIP RESPONSE Y - ARC SECONDS'

WRITE(6,100) (Y(J,1),J=1,3)

PRINT101

[   32]
CALL MXSCA(XR,6,1,6,C1)

IF(IP.EQ.1)GO TO 33          TRUE
   FALSE

PRINT*,' BASE ROTATIONS - ARC SECONDS'

WRITE(6,100)(XR(J,1),J=1,5,2)

PRINT101
```

```
 /............................................/
                       I
                       C<-------------------------------------------------------------0
        [   33]        I
A------>:..............................................:
A       :            DO 19 J=1,12                      :
A       :..............................................:
A                      I
A       [   19]        I
--------:..............................................:
        :          XSH(J,1)=X(14+J,1)                  :
        :..............................................:
                       I
                       I
A------>:..............................................:
A       :            DO 45 J=7,12                      :
A       :..............................................:
A                      I
A       [   45]        I
--------:..............................................:
        :          XSH(J,1)=XSH(J,1)*C1                :
        :..............................................:
                       I
                       I
         /.............................................\  TRUE
        <        IF(IP.EQ.1)GO TO 34                    >-------------------------0
         \............................................./                         Z
                       I  FALSE                                                    Z
                       I                                                           Z
                       I                                                           Z
         /............................................./                          Z
        /  PRINT*,' SHUTTLE DISPLACEMENTS -           /                           Z
       /   METERS'                                   /                            Z
      /............................................./                             Z
                       I                                                           Z
                       I                                                           Z
         /............................................./                          Z
        /     WRITE(6,100)(XSH(J,1),J=1,5,2)          /                           Z
       /............................................./                            Z
                       I                                                           Z
                       I                                                           Z
         /............................................./                          Z
        /               PRINT101                      /                           Z
       /............................................./                            Z
                       I                                                           Z
                       I                                                           Z
         /............................................./                          Z
        /  PRINT*,' SHUTTLE ROTATIONS - ARC           /                           Z
       /   SECONDS'                                  /                            Z
      /............................................./                             Z
                       I                                                           Z
                       I                                                           Z
         /............................................./                          Z
        /     WRITE(6,100)(XSH(J,1),J=7,11,2)         /                           Z
       /............................................./                            Z
                       I                                                           Z
                       I                                                           Z
         /............................................./                          Z
        /               PRINT101                      /                           Z
       /............................................./                            Z
                       I                                                           Z
                       I---[...COPY VALUES INTO YX , YY , YZ]                      Z
                       I                                                           Z
```

```
                  I  FALSE
                  I
                  0<----------------------------------------------------------0
  [   34]         I
 /..............................................\  TRUE
< IF(UDDOT(1,1).EQ.0..AND.XR(1,1).EQ.C..         >------------------------------0
< AND.Y(1,1).EQ.C.)GOTO35                        >
 \............................................../
                  I  FALSE
                  I
                  0<----------------------------------------------------------0
  [   50]         I
:..............................................:
:                 NX=NX+1                      :
:..............................................:
                  I
                  I
 /..............................................\  FALSE
<               IF(NX.EQ.1)                      >---------I
 \............................................../          I
                  I  TRUE                                  I
                  I                                        I
:..............................................:           I
:                 TXI=TIME                     :           I
:..............................................:           I
                  I                                        I
                  C<---------------------------------------
                  I
:..............................................:
:             YX(NX,1)=T(1,1)                  :
:             YX(NX,2)=XR(1,1)                 :
:             YX(NX,3)=Y(1,1)                  :
:..............................................:
                  I
                  C<----------------------------------------------------------0
  [   35]         I
 /..............................................\  TRUE
<         IF(NY.GT.0)GO TO 51                    >------------------------------0
 \............................................../
                  I  FALSE
                  I
                  I
 /..............................................\  TRUE
< IF(UDDOT(2,1).EQ.0..AND.XR(3,1).EQ.C..         >----------------------------0
< AND.Y(2,1).EQ.C.)GOTO36                        >
 \............................................../
                  I  FALSE
                  I
                  C<----------------------------------------------------------0
  [   51]         I
:..............................................:
:                 NY=NY+1                      :
:..............................................:
                  I
                  I
 /..............................................\  FALSE
<               IF(NY.EQ.1)                      >---------I
 \............................................../          I
                  I  TRUE                                  I
                  I                                        I
:..............................................:           I
:                 TYI=TIME                     :           I
:..............................................:           I
                  I                                        I
                  C<---------------------------------------
```

```
                        I
  ..............................................
  :            YY(NY,1)=T(2,1)                 :
  :            YY(NY,2)=XR(3,1)                :
  :            YY(NY,3)=Y(2,1)                 :
  ..............................................
                        I
                        C<-------------------------------------------------0
 [   36]                I
 /------------------------------------------\  TRUE
<         IF(NZ.GT.C)GOTO52                  >-------------------------------0
 \............................................/
                        I  FALSE
                        I
 /------------------------------------------\  TRUE
< IF(UDDOT(3,1).EQ.0..AND.XR(5,1).EQ.C..     >--------------------------0
< AND.Y(3,1).EQ.C.)GCTC37                    >
 \............................................/
                        I  FALSE
                        I
                        0<--------------------------------------------------0
 [   52]                I
  ..............................................
  :               NZ=NZ+1                      :
  ..............................................
                        I
                        I
 /------------------------------------------\  FALSE
<            IF(NZ.EQ.1)                     >---------------I
 \............................................/               I
                        I  TRUE                               I
                        I                                     I
  ..............................................              I
  :               TZI=TIME                     :              I
  ..............................................              I
                        I                                     I
                        C<------------------------------------
                        I
  ..............................................
  :            YZ(NZ,1)=T(3,1)                 :
  :            YZ(NZ,2)=XR(5,1)                :
  :            YZ(NZ,3)=Y(3,1)                 :
  ..............................................
                        I
                        C<-------------------------------------------------0
 [   37]                I
  ..............................................
  :          YSH(1,1)=XSH(7,1)                 :
  :          YSH(1,2)=XSH(9,1)                 :
  :          YSH(1,3)=XSH(11,1)                :
  ..............................................
                        I
                        I
               /-------------------\
              :       RETURN        :
               \.................../
```

```
@R*Y.FORFLO,S EE.SAMPLEXY/ACTIVE
FLOWCHARTED BY  FORFLO /X838/ ON 13 AUG 81 AT 08:05:08

      SUBROUTINE SAMPLE
C...SUBROUTINE DEFINING THE FORCES AND TORQUES ACTING
C...ON THE SHUTTLE DUE TO THRUSTER FIRINGS. THE ROUTINE
C...IS DYNAMIC IN THE SENSE THAT IT MONITORS THE SHUTTLE
C...ROTATIONS AND INITIATES THE PROPER AXIS SEQUENCE IF
C...ANY OR ALL OF THE SHUTTLE ROTATIONS EXCEED THE DEAD-
C...BAND LIMIT WHICH IS IN THE COMMON BLOCK.
      COMMON/PASS4/ SAMPL(12,1),UDIST(3,1),IS,DB
C...IS=1 FOR SOLAR INERTIAL, =0 OTHERWISE
      COMMON/PASS3/ UDDOT(3,1),RK(3,8),RC(3,1),X(40,1)
      COMMON/PASS2/ A(8,8),B(8,3)
      COMMON/CLOCK/ TIME,DT
      COMMON/KEEP/ TX,TY,TZ,IX,IY,IZ
      COMMON/ANGLES/ THEX,THEY,THEZ
      COMMON/THRUST/XTIME(500,2),YTIME(200,2),ZTIME(200,2),IXT,IYT,IZT
      DTOR=3.14159/180.
C...CONVERT THE DEADBAND TO RADIANS
      VAL=DB*DTOR
C...INITIALLY SET THE SAMPLE TO ZERO
      DO 1 I=1,12
1     SAMPL(I,1)=0.
C...CHECK TO SEE IF X-THRUSTER FIRING IS IN PROGRESS
      IF(TX.GT.0.)THEN
C...IF TIME CYCLE FOR X-THRUSTER IS EXCEEDED, SET TX=0.
            IF(TX.GE..2)THEN
                  TX=0.
                  XTIME(IXT,2)=TIME
                  GO TO 30
            END IF
            TX=TX+DT
C...CHECK THE VALUE OF IX (=1 FOR + THRUST, =2 FOR - THRUST)
            GO TO (3,4),IX
3           SAMPL(4,1)=SAMPL(4,1) -.002176
            SAMPL(6,1)=SAMPL(6,1) +.002318
            SAMPL(8,1)=6.2E-4
            GO TO 30
4           SAMPL(4,1)=SAMPL(4,1) +.002176
            SAMPL(6,1)=SAMPL(6,1) -.002318
            SAMPL(8,1)=-6.2E-4
            GO TO 30
      END IF
C...ARRIVE HERE IF NO X-THRUSTER IS IN PROGRESS TO TEST
C...THE DEVIATION OF THE SHUTTLE'S X-ANGLE FROM ITS
C...INITIAL CONDITION AGAINST THE DEADBAND IN COMMON BLOCK
      ANGX=X(21,1)-THEX
C...DETERMINE DIRECTION OF DEVIATION (-, 0, OR +)
      IF(ANGX) 11,12,13
C...SET IX=1 FOR +VE THRUSTER FIRING
11    IX=1
C...CHECK IF DEADBAND LIMIT IS EXCEEDED
      IF(ANGX.LT.-VAL)THEN
```

```
            SAMPL(4,1)=SAMPL(4,1)-.002176
            SAMPL(6,1)=SAMPL(6,1)+.002318
            SAMPL(8,1)=6.2E-4
            TX=DT
            IXT=IXT+1
            XTIME(IXT,1)=TIME
         END IF
C...IF ANGX IS ZERO GO TO Y-AXIS
12       GO TO 30
C...SET IX=2 IF -VE THRUSTER FIRING
13       IX=2
         IF(ANGX.GT.VAL)THEN
            SAMPL(4,1)=SAMPL(4,1)+.002176
            SAMPL(6,1)=SAMPL(6,1)-.002318
            SAMPL(8,1)=-6.2E-4
            TX=DT
            IXT=IXT+1
            XTIME(IXT,1)=-TIME
         END IF
C...ARRIVE HERE TO CHECK THE Y-AXIS.  FIRST CHECK TO SEE
C...IF A THRUSTER FIRING IS IN PROGRESS.
30       IF(TY.GT.0.)THEN
            IF(TY.GE..52)THEN
               TY=0.
               YTIME(IYT,2)=TIME
               GO TO 32
            END IF
            TY=TY+DT
            GO TO (6,7),IY
6           SAMPL(6,1)=SAMPL(6,1) +.00263
            SAMPL(10,1)=-2.9E-4
            GO TO 32
7           SAMPL(6,1)=SAMPL(6,1)-.00263
            SAMPL(10,1)=2.9E-4
            GO TO 32
         END IF
C...ARRIVE HERE IF NO Y-THRUSTER IS FIRING TO TEST THE
C...Y-ANGLE AGAINST THE DEADBAND LIMIT.
         ANGY=X(23,1)-THEY
C...CHECK FOR SOLAR INERTIAL FLIGHT.  IF YES, INCREASE
C...ANGY TO ALLOW FOR REQUIRED RATE OF ROTATION.
         IF(IS.EQ.1)ANGY=ANGY+.06*DTOR*TIME
         IF(ANGY) 15,16,17
15       IY=2
         IF(ANGY.LT.-VAL)THEN
            SAMPL(6,1)=SAMPL(6,1)-.00263
            SAMPL(10,1)=-2.9E-4
            TY=DT
            IYT=IYT+1
            YTIME(IYT,1)=TIME
         END IF
16       GO TO 32
17       IY=1
         IF(ANGY.GT.VAL)THEN
            SAMPL(6,1)=SAMPL(6,1)+.00263
            SAMPL(10,1)=-2.9E-4
            TY=DT
```

```
                IYT=IYT+1
                YTIME(IYT,1)=-TIME
            END IF
C...ARRIVE HERE TO CHECK THE Z-AXIS
32          IF(TZ.GT.0.)THEN
                IF(TZ.GE..48)THEN
                    TZ=0.
                    ZTIME(IZT,2)=TIME
                    GO TO 33
                END IF
                TZ=TZ+DT
                GO TO (9,10),IZ
9               SAMPL(4,1)=SAMPL(4,1)+.000452
                SAMPL(6,1)=SAMPL(6,1)+.001004
                SAMPL(12,1)=2.9E-4
                GO TO 33
10              SAMPL(4,1)=SAMPL(4,1)-.000452
                SAMPL(6,1)=SAMPL(6,1)-.001004
                SAMPL(12,1)=-2.9E-4
                GO TO 33
            END IF
C...ARRIVE HERE IF NO Z-THRUSTER IS FIRING TO CHECK ANGLE
            ANGZ=X(25,1)-THEZ
18          IF(ANGZ) 19,20,21
19          IZ=1
            IF(ANGZ.LT.-VAL)THEN
                SAMPL(4,1)=SAMPL(4,1)+.000452
                SAMPL(6,1)=SAMPL(6,1)+.001004
                SAMPL(8,1)=2.9E-4
                TZ=DT
                IZT=IZT+1
                ZTIME(IZT,1)=TIME
            END IF
20          GO TO 33
21          IZ=2
            IF(ANGZ.GT.VAL)THEN
                SAMPL(4,1)=SAMPL(4,1)-.000452
                SAMPL(6,1)=SAMPL(6,1)-.001004
                SAMPL(8,1)=-2.9E-4
                TZ=DT
                IZT=IZT+1
                ZTIME(IZT,1)=-TIME
            END IF
33          RETURN
            END
```

```
      .............................................
       \            SUBROUTINE SAMPLE             /
        \........................................./
                             I
                             I---[...SUBROUTINE DEFINING THE      ]
                             I   [FORCES AND TORQUES ACTING       ]
                             I   [...ON THE SHUTTLE DUE TO        ]
                             I   [THRUSTER FIRINGS. THE ROUTINE   ]
                             I   [...IS DYNAMIC IN THE SENSE THAT ]
                             I   [IT MONITORS THE SHUTTLE         ]
                             I   [...ROTATIONS AND INITIATES THE  ]
                             I   [PROPER AXIS SEQUENCE IF         ]
                             I   [...ANY OR ALL OF THE SHUTTLE    ]
                             I   [ROTATIONS EXCEED THE DEAD-      ]
                             I   [...BANDLIMIT WHICH IS IN THE    ]
                             I   [COMMON BLOCK.                   ]
                             I
                             I
      .............................................
      : COMMON/PASS4/ SAMPL(12,1),UDIST(3,1),IS,  :
      : DB                                        :
      .............................................
                             I
                             I---[...IS=1 FOR SCLAR INERTIAL, =0  ]
                             I   [OTHERWISE                       ]
                             I
                             I
      .............................................
      : COMMON/PASS3/ UDDOT(3,1),RK(3,8),RC(3,1), :
      : X(40,1)                                   :
      :        COMMON/PASS2/ A(8,8),B(8,3)        :
      :           COMMON/CLOCK/ TIME,DT           :
      :      COMMON/KEEP/ TX,TY,TZ,IX,IY,IZ       :
      :      COMMON/ANGLES/ THEX,THEY,THEZ        :
      : COMMON/THRUST/XTIME(500,2),YTIME(200,2),  :
      : ZTIME(200,2),IXT,IYT,IZT                  :
      :              DTOR=3.14159/180.            :
      .............................................
                             I
                             I---[...CONVERT THE DEADBAND TO      ]
                             I   [RADIANS                         ]
                             I
                             I
      .............................................
      :               VAL=DB*DTOR                 :
      .............................................
                             I
                             I---[...INITIALLY SET THE SAMPLE TO  ]
                             I   [ZERO                            ]
                             I
                             I
      .............................................
A------------->:              DO 1 I=1,12                 :
A     .............................................
A                            I
A     [    1]                I
A     .............................................
--------------:              SAMPL(I,1)=0.                :
```

```
          I    [FIRING IS IN PROGRESS              ]
          I
          I
 /.......................................\
<          IF(TX.GT.0.)THEN               >----      ------0
 \.......................................
        @@@@ I
          I
          I---[...IF TIME CYCLE FOR X-THRUSTER ]
          I    [IS EXCEEDED, SET TX=0.          ]
          I
          I
 /.......................................\
<          IF(TX.GE..2)THEN               >----      ------0
 \......................................./
        @@@@ I
          I
          I
:.........................................:
:                TX=0.                    :
:          XTIME(IXT,2)=TIME              :
:.........................................:
          I
          I
      /..................\
     :     GO TO 30        :---------------------------------------0
      \................../                                        Z
                                                                  Z
:.........................................:                       Z
:              END IF                     :                       Z
:             TX=TX+DT                    :                       Z
:.........................................:                       Z
          I                                                       Z
          I---[...CHECK THE VALUE OF IX (=1 FOR]                  Z
          I    [+ THRUST, =2 FOR - THRUST)      ]                 Z
          I                                                       Z
          I                                                       Z
 /.......................................\                        Z
:          GO TO (3,4),IX                 :                       Z
 \......................................./                        Z
                                                                  Z
 [     3]                                                         Z
:.........................................:                       Z
:    SAMPL(4,1)=SAMPL(4,1) -.002176       :                       Z
:    SAMPL(5,1)=SAMPL(6,1) +.002313       :                       Z
:          SAMPL(8,1)=6.2E-4              :                       Z
:.........................................:                       Z
          I                                                       Z
          I                                                       Z
      /..................\                                        Z
     :     GO TO 30        :---------------------------------------V
      \................../                                        Z
                                                                  Z
 [     4]                                                         Z
:.........................................:                       Z
:    SAMPL(4,1)=SAMPL(4,1) +.002176       :                       Z
:    SAMPL(5,1)=SAMPL(6,1) -.002313       :                       Z
:          SAMPL(8,1)=-6.2E-4             :                       Z
:.........................................:                       Z
          I                                                       Z
          I                                                       Z
```

```
GO TO 30

END IF

I---[...ARRIVE HERE IF NO X-THRUSTER ]
I   [IS IN PROGRESS TO TEST          ]
I   [...THE DEVIATION OF THE SHUTTLE']
I   [S X-ANGLE FROM ITS              ]
I   [...INITIAL CONDITION AGAINST THE]
I   [DEADBAND IN COMMON BLOCK        ]

ANGX=X(21,1)-THEX

I---[...DETERMINE DIRECTION OF       ]
I   [DEVIATION (-, 0, OR +)          ]

( ) .EQ.
    .GT.
.LT.

I---[...SET IX=1 FOR +VE THRUSTER    ]
I   [FIRING                          ]

[   11]
IX=1

I---[...CHECK IF DEADBAND LIMIT IS   ]
I   [EXCEEDED                        ]

IF(ANGX.LT.-VAL)THEN
@@@@

SAMPL(4,1)=SAMPL(4,1)-.002176
SAMPL(6,1)=SAMPL(6,1)+.002318
SAMPL(8,1)=6.2E-4
TX=DT
IXT=IXT+1
XTIME(IXT,1)=TIME
END IF

I---[...IF ANGX IS ZERO GO TO Y-AXIS ]

[   12]
GO TO 30
```

```
I---[...SET IX=2 IF -VE THRUSTER     ]
I   [FIRING                          ]
I
C<------------------------------------------------------------0
[   13]  I
:                 IX=2                 :

        I
        I
<        IF(ANGX.GT.VAL)THEN        >----    ------0
              aaaa I
                   I
                   I
:     SAMPL(4,1)=SAMPL(4,1)+.002176     :
:     SAMPL(6,1)=SAMPL(6,1)-.002318     :
:         SAMPL(8,1)=-6.2E-4            :
:              TX=DT                    :
:            IXT=IXT+1                  :
:        XTIME(IXT,1)=-TIME             :
:              END IF                   :
                   I
                   I---[...ARRIVE HERE TO CHECK THE Y-  ]
                   I   [AXIS. FIRST CHECK TO SEE        ]
                   I   [...IF A THRUSTER FIRING IS IN   ]
                   I   [PROGRESS.                       ]
                   I
                   C<-----------------------------------------0
[   30]            I
<          IF(TY.GT.0.)THEN         >----    ------0
              aaaa I
                   I
                   I
<          IF(TY.GE..52)THEN        >----    ------0
              aaaa I
                   I
                   I
:               TY=0.                   :
:          YTIME(IYT,2)=TIME            :
                   I
                   I
:          GO TO 32          :--------------------------------0

:              END IF                   :
:             TY=TY+DT                  :
                   I
                   I
          GO TO (6,7),IY                :
```

```
[    6]
SAMPL(6,1)=SAMPL(6,1) +.00263
SAMPL(10,1)=-2.9E-4

GO TO 32

[    7]
SAMPL(6,1)=SAMPL(6,1)-.00263
SAMPL(10,1)=2.9E-4

GO TO 32

END IF

I---[...ARRIVE HERE IF NO Y-THRUSTER ]
I   [IS FIRING TO TEST THE           ]
I   [...Y-ANGLE AGAINST THE DEADBAND ]
I   [LIMIT.                          ]

ANGY=X(23,1)-THEY

I---[...CHECK FOR SOLAR INERTIAL     ]
I   [FLIGHT, IF YES, INCREASE        ]
I   [...ANGY TO ALLOW FOR REQUIRED   ]
I   [RATE OF ROTATION.               ]

IF(IS.EQ.1)          FALSE
I TRUE

ANGY=ANGY+.06*DTOR*TIME

.EQ.
.GT.
.LT.

[   15]
```

```
IF(ANGY.LT.-VAL)THEN
@@@@
SAMPL(6,1)=SAMPL(6,1)-.00263
SAMPL(10,1)=-2.9E-4
TY=DT
IYT=IYT+1
YTIME(IYT,1)=TIME
END IF

[ 16]
GO TO 32

[ 17]
IY=1

IF(ANGY.GT.VAL)THEN
@@@@
SAMPL(6,1)=SAMPL(6,1)+.00263
SAMPL(10,1)=-2.9E-4
TY=DT
IYT=IYT+1
YTIME(IYT,1)=-TIME
END IF

[...ARRIVE HERE TO CHECK THE Z- ]
[AXIS                           ]

[ 32]
IF(TZ.GT.0.)THEN
@@@@
IF(TZ.GE..48)THEN
@@@@
TZ=0.
```

```
:              ZTIME(IZT,2)=TIME              :
:.............................................:
                      I
                      I
           /'''''''''''''''''\
          :     GU TO 33      :----------------------------------------------------0
           \................./                                                     Z
                                                                                   Z
...............................................                                    Z
:                   END IF                    :                                    Z
:                  TZ=TZ+DT                   :                                    Z
:.............................................:                                    Z
                      I                                                            Z
                      I                                                            Z
 /'''''''''''''''''''''''''''''''''''''''''''\                                     Z
:           GO TO (9,10),IZ                   :                                    Z
 \.........................................../                                     Z
                                                                                   Z
  [    9]                                                                          Z
...............................................                                    Z
:      SAMPL(4,1)=SAMPL(4,1)+.0C0452          :                                    Z
:      SAMPL(6,1)=SAMPL(6,1)+.0C1004          :                                    Z
:          SAMPL(12,1)=2.9E-4                 :                                    Z
:.............................................:                                    Z
                      I                                                            Z
                      I                                                            Z
           /'''''''''''''''''\                                                     Z
          :     GO TO 33      :----------------------------------------------------V
           \................./                                                     Z
                                                                                   Z
  [   10]                                                                          Z
...............................................                                    Z
:      SAMPL(4,1)=SAMPL(4,1)-.0C0452          :                                    Z
:      SAMPL(6,1)=SAMPL(6,1)-.0C1004          :                                    Z
:          SAMPL(12,1)=-2.9E-4                :                                    Z
:.............................................:                                    Z
                      I                                                            Z
                      I                                                            Z
           /'''''''''''''''''\                                                     Z
          :     GO TO 33      :----------------------------------------------------V
           \................./                                                     Z
                                                                                   Z
...............................................                                    Z
:                   END IF                    :                                    Z
:.............................................:                                    Z
                      I                                                            Z
                      I---[...ARRIVE HERE IF NO Z-THRUSTER ]                       Z
                      I   [IS FIRING TO CHECK ANGLE        ]                       Z
                      I                                                            Z
                      I                                                            Z
...............................................                                    Z
:              ANGZ=X(25,1)-THEZ              :                                    Z
:.............................................:                                    Z
                      I                                                            Z
  [   13]             I                                                            Z
 /'''''''''''''''''''''''''''''''''''''''''''\ ----.EQ.----------------------------0  Z
 \.........................................../     .GT.     \------------------0   X  Z
                   .LT. I                                                      U   X  Z
                        I                                                      U   X  Z
```

```
                    IZ=1
                      I
                      I
        IF (ANGZ.LT.-VAL)THEN          >----      ------0
                 @@@@ I
                      I
                      I
        SAMPL(4,1)=SAMPL(4,1)+.000452
        SAMPL(6,1)=SAMPL(6,1)+.001004
             SAMPL(8,1)=2.9E-4
                   TZ=DT
                 IZT=IZT+1
              ZTIME(IZT,1)=TIME
                  END IF
                      I
                      C<----------------------------------------0
[   20]               I
                  GO TO 33    ------------------------------------V

                      C<--------------------------------------0
[   21]               I
                    IZ=2
                      I
                      I
        IF(ANGZ.GT.VAL)THEN            >----      ------0
                 @@@@ I
                      I
                      I
        SAMPL(4,1)=SAMPL(4,1)-.000452
        SAMPL(6,1)=SAMPL(6,1)-.001004
             SAMPL(8,1)=-2.9E-4
                   TZ=DT
                 IZT=IZT+1
              ZTIME(IZT,1)=-TIME
                  END IF
                      I
                      C<------------------------------------------0
[   33]               I
                   RETURN
```

```
ØR•Y.FORFLO,S EE.SENSOR3/SIM
FLOWCHARTED BY  FORFLO /X808/ ON 13 AUG 81 AT 08:05:22

          SUBROUTINE SENSE3(XNOISE)
C...SUBROUTINE DEFINES A GAUSSIAN NOISE SIGNAL FOR THE
C...RIGID BODY SENSORS.
          COMMON/RANDOM/ JAY
          DIMENSION XNOISE(3)
          XNOISE(1)=NRAND(JAY)
          CALL RANDN(XNOISE,3,0.,1.2125E-7)
          RETURN
          END
```

```
 ............................................
 \          SUBROUTINE SENSE3(XNOISE)        /
  \.........................................../
                         I
                         I---[...SUBROUTINE DEFINES A GAUSSIAN]
                         I   [NOISE SIGNAL FOR THE            ]
                         I   [...RIGID BODY SENSORS.          ]
                         I
                         I
 ..........................................
 :             COMMON/RANDOM/ JAY         :
 :            DIMENSION XNOISE(3)         :
 :            XNOISE(1)=NRAND(JAY)        :
 :........................................:
                         I
                         I
 ..........................................
 : : CALL RANDN (XNOISE,3,0.,1.2125E-7)  : :
 :.:....................................:.:
                         I
                         I
             /''''''''''''''''''\
            :      RETURN        :
             \................../
```

@R*Y.FORFLO,S EE.SENSOR8/SIM
FLOWCHARTED BY FORFLO /X833/ ON 13 AUG 81 AT 08:05:24

```
      SUBROUTINE SENSE2(XNOISE)
C...SUBROUTINE DEFINES A GAUSSIAN NOISE SIGNAL FOR THE
C...MODAL SENSORS.
      COMMON/RANDOM/ JAY
      DIMENSION XNOISE(8)
      XNOISE(1)=NRAND(JAY)
      CALL RANDN(XNOISE,8,0.,2.425E-9)
      RETURN
      END
```

```
 ..............................................
 \        SUBROUTINE SENSE8(XNOISE)          /
  \.........................................../
                      I
                      I---[...SUBROUTINE DEFINES A GAUSSIAN]
                      I   [NOISE SIGNAL FOR THE            ]
                      I   [...MODAL SENSORS.               ]
                      I
                      I
  ............................................
  :           COMMON/RANDOM/ JAY             :
  :          DIMENSION XNOISE(8)             :
  :          XNOISE(1)=NRAND(JAY)            :
  :..........................................:
                      I
                      I
  ............................................
  : : CALL RANDN(XNOISE,8,0.,2.425E-8)     : :
  :.:......................................:.:
                      I
                      I
             /'''''''''''''''''''\
            :       RETURN        :
             \.................../
```

```
@R*Y.FORFLO,S EE.SUMMRY/SIM
FLOWCHARTED BY  FORFLO /X808/ ON 13 AUG 81 AT 08:05:25
```

```
          SUBROUTINE SUMMRY
C...PROGRAM TO OUTPUT THE TIMES OF THE THRUSTER FIRINGS
C...ACCUMULATED IN SAMPLE AND SAVED IN COMMON/THRUST/
1         FORMAT('1')
          COMMON/THRUST/XTIME(500,2),YTIME(200,2),ZTIME(200,2),IXT,IYT,IZT
2         FORMAT(5X,'      SUMMARY OF THRUSTER FIRING TIMES',/
         &,5X,' NEGATIVE ON TIME IDICATES -VE THRUST SEQUENCE'/)
3         FORMAT(' ',T10,' X',/,T6,' ON',T12,' OFF'/)
4         FORMAT(' ',T10,' Y',/,T6,' ON',T12,' OFF'/)
5         FORMAT(' ',T10,' Z',/,T6,' ON',T12,' OFF'/)
6         FORMAT(' ',2(F7.2,1X))
          PRINT1
          PRINT2
          PRINT3
7         FORMAT(//)
          DO 10 I=1,IXT
10        PRINT6, XTIME(I,1),XTIME(I,2)
          PRINT7
          PRINT4
          DO 11 I=1,IYT
11        PRINT6, YTIME(I,1),YTIME(I,2)
          PRINT7
          PRINT5
          DO 12 I=1,IZT
12        PRINT6, ZTIME(I,1),ZTIME(I,2)
          RETURN
          END
```

```
 ...............................................
 \              SUBROUTINE SUMMRY              /
  \.........................................../
                      I
                      I---[...PROGRAM TO OUTPUT THE TIMES  ]
                      I   [OF THE THRUSTER FIRINGS         ]
                      I   [...ACCUMULATED IN SAMPLE AND    ]
                      I   [SAVED IN COMMON/THRUST/         ]
                      I   [1 FORMAT('1')                   ]
                      I
                      I
 ...............................................
 : COMMON/THRUST/XTIME(500,2),YTIME(200,2),   :
 : ZTIME(200,2),IXT,IYT,IZT                   :
 :                            2 FORMAT(5X,' SUMMARY OF
 :                            THRUSTER FIRING TIMES',/ &,5X,'
 :                            NEGATIVE ON TIME INDICATES -VE
 :                            THRUST SEQUENCE'/:
 :                            3 FORMAT(' ',T10,: X',/,T6,' ON',
 :                            4 FORMAT(' ',T10,: Y',/,T6,' ON',
 :                            5 FORMAT(' ',T10,: Z',/,T6,' ON',
 :                            6 FORMAT(' ',2(F7:2,1X))
 :.............................................:
                      I
                      I
   /.........................................../
  /                 PRINT1                    /
 /.........................................../
                      I
                      I
   /.........................................../
  /                 PRINT2                    /
 /.........................................../
                      I
                      I
   /.........................................../
  /                 PRINT3                    /
 /.........................................../
                      I
                      I---[7 FORMAT(//)                    ]
                      I
                      I
 ...............................................
A--------------->:          DO 10 I=1,IXT              :
A                :.....................................:
A                     I
A        [   10]      I
A          /.........................................../
-------------- /   PRINT6, XTIME(I,1),XTIME(I,2)     /
             /.........................................../
                      I
                      I
   /.........................................../
  /                 PRINT7                    /
 /.........................................../
                      I
                      I
   /.........................................../
  /                 PRINT4                    /
 /.........................................../
```

```
                              I
                              I
          ..........................................
A--------->:            DC 11 I=1,IYT             :
A          :......................................:
A                             I
A          [   11]            I
A          /''''''''''''''''''''''''''''''''''''''/
----------/     PRINT6, YTIME(I,1),YTIME(I,2)    /
         /......................................../
                              I
                              I
          /''''''''''''''''''''''''''''''''''''''/
         /              PRINT7                  /
        /......................................../
                              I
                              I
          /''''''''''''''''''''''''''''''''''''''/
         /              PRINT5                  /
        /......................................../
                              I
                              I
          ..........................................
A--------->:            DO 12 I=1,IZT             :
A          :......................................:
A                             I
A          [   12]            I
A          /''''''''''''''''''''''''''''''''''''''/
----------/     PRINT6, ZTIME(I,1),ZTIME(I,2)    /
         /......................................../
                              I
                              I
                   /''''''''''''''''''\
                  :      RETURN        :
                   \................../
```

```
aR*Y.FORFLO,S EE.UDOT/SIM
FLOWCHARTED BY  FORFLO /X838/ ON 13 AUG 81 AT 08:05:28

      SUBROUTINE UDOT
C...ROUTINE COMPUTES THE VALUE OF U-DOUBLE-DOT.
C...WHICH IS IN THE COMMON BLOCK
C...ROUTINE CALLS SUBROUTINE SENSE8 TO DETERMINE MEASUREMENT NOISE
      COMMON/PASS3/ UDDOT(3,1),RK(3,8),RCOM(3,1),X(40,1)
      DIMENSION W1(3,1),RO(3,3),XNOISE(8),XC(8,1)
      DATA RO/9*0./
      CALL SENSE8(XNOISE)
      DO 1 II=1,8
1     XC(II,1)=X(II,1)+XNOISE(II)
      CALL MXMLT(RK,XC,W1,3,8,1,3,8)
      CALL MXSUB(RO,W1,UDDOT,3,1,3)
      RETURN
      END
```

```
     ..................................................
      \               SUBROUTINE UDOT                /
       \............................................/
                            I
                            I---[...ROUTINE COMPUTES THE VALUE OF]
                            I   [U-DOUBLE-DOT                    ]
                            I   [...WHICH IS IN THE COMMON BLOCK ]
                            I   [...ROUTINE CALLS SUBROUTINE     ]
                            I   [SENSE8 TO DETERMINE MEASUREMENT ]
                            I   [NOISE                           ]
                            I
                            I
      ................................................
      : COMMON/PASS3/ UDDOT(3,1),RK(3,8),RCCM(3,    :
      : 1),X(40,1)                                   :
      : DIMENSION W1(3,1),RO(3,3),XNOISE(8),XC(8,   :
      : 1)                                           :
      :              DATA RO/9*0./                   :
      :..............................................:
                            I
                            I
      ................................................
      : :           CALL SENSE8(XNOISE)            : :
      :.:..........................................:.:
                            I
                            I
A---->................................................
A     :              DO 1 II=1,8                     :
A     :..............................................:
A                           I
A      [     1]             I
A     ................................................
------:         XC(II,1)=X(II,1)+XNOISE(II)          :
      :..............................................:
                            I
                            I
      ................................................
      : :   CALL MXMLT(RK,XC,W1,3,8,1,3,8)         : :
      :.:..........................................:.:
                            I
                            I
      ................................................
      : :   CALL MXSUB(RO,W1,UDDOT,3,1,3)          : :
      :.:..........................................:.:
                            I
                            I
                  /...................\
                 :        RETURN        :
                  \.................../
```

IX.E. Shuttle Drift/Deadband

[illegible]

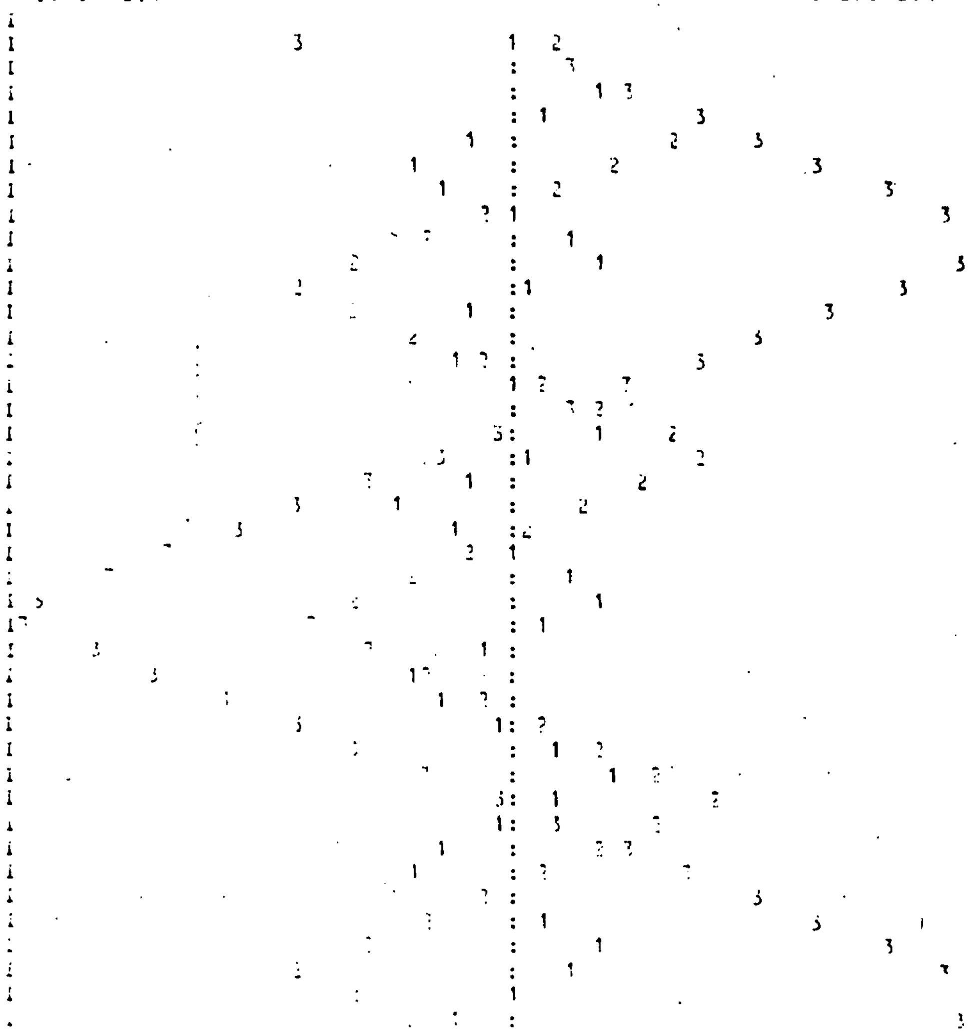
CURVE "1" IS A PLOT OF ONE° VERSUS TIME

CURVE "2" IS A PLOT OF TWO° VERSUS TIME

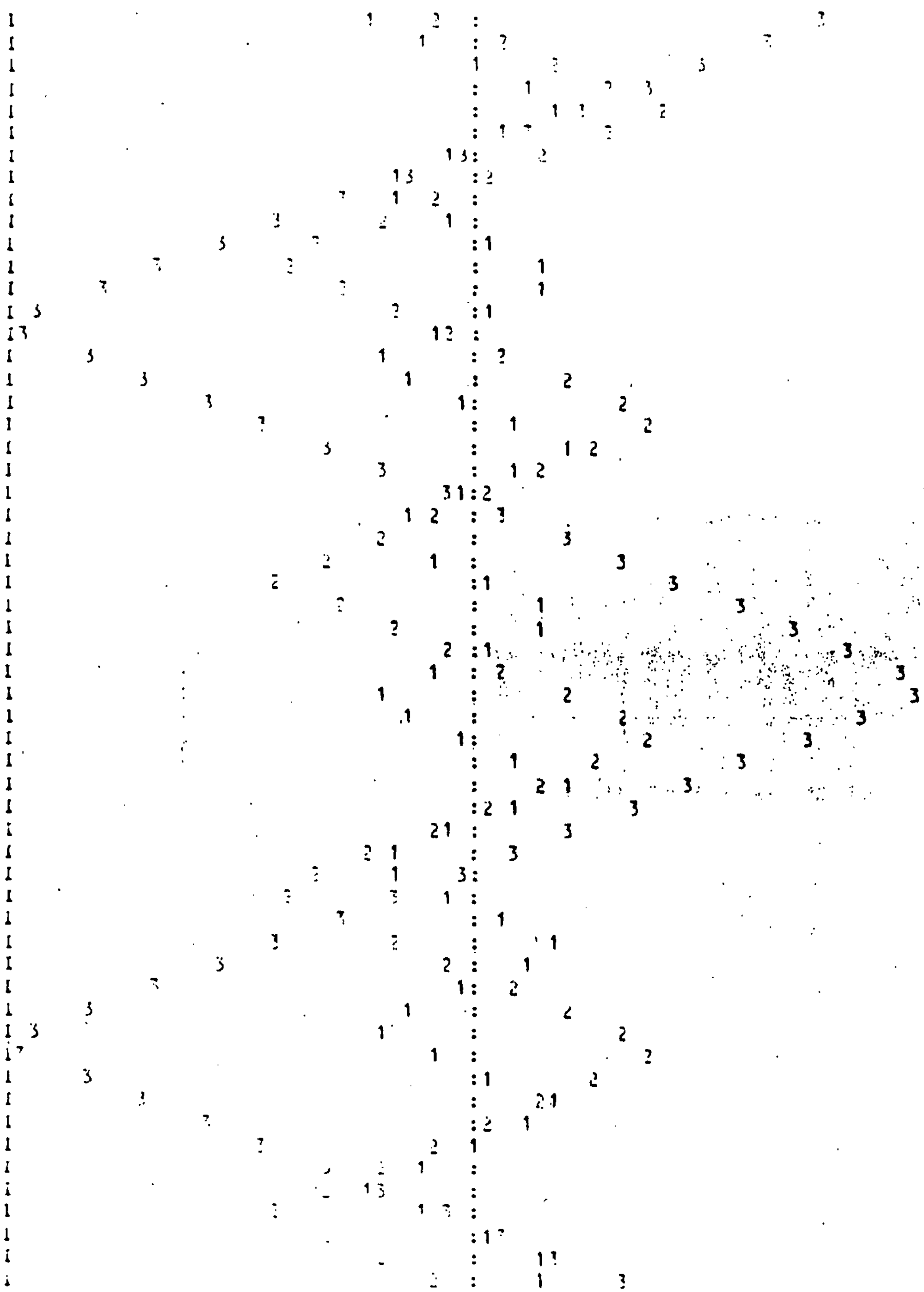
CURVE "3" IS A PLOT OF FIVE° VERSUS TIME

MINIMUM VALUE -.5164+001

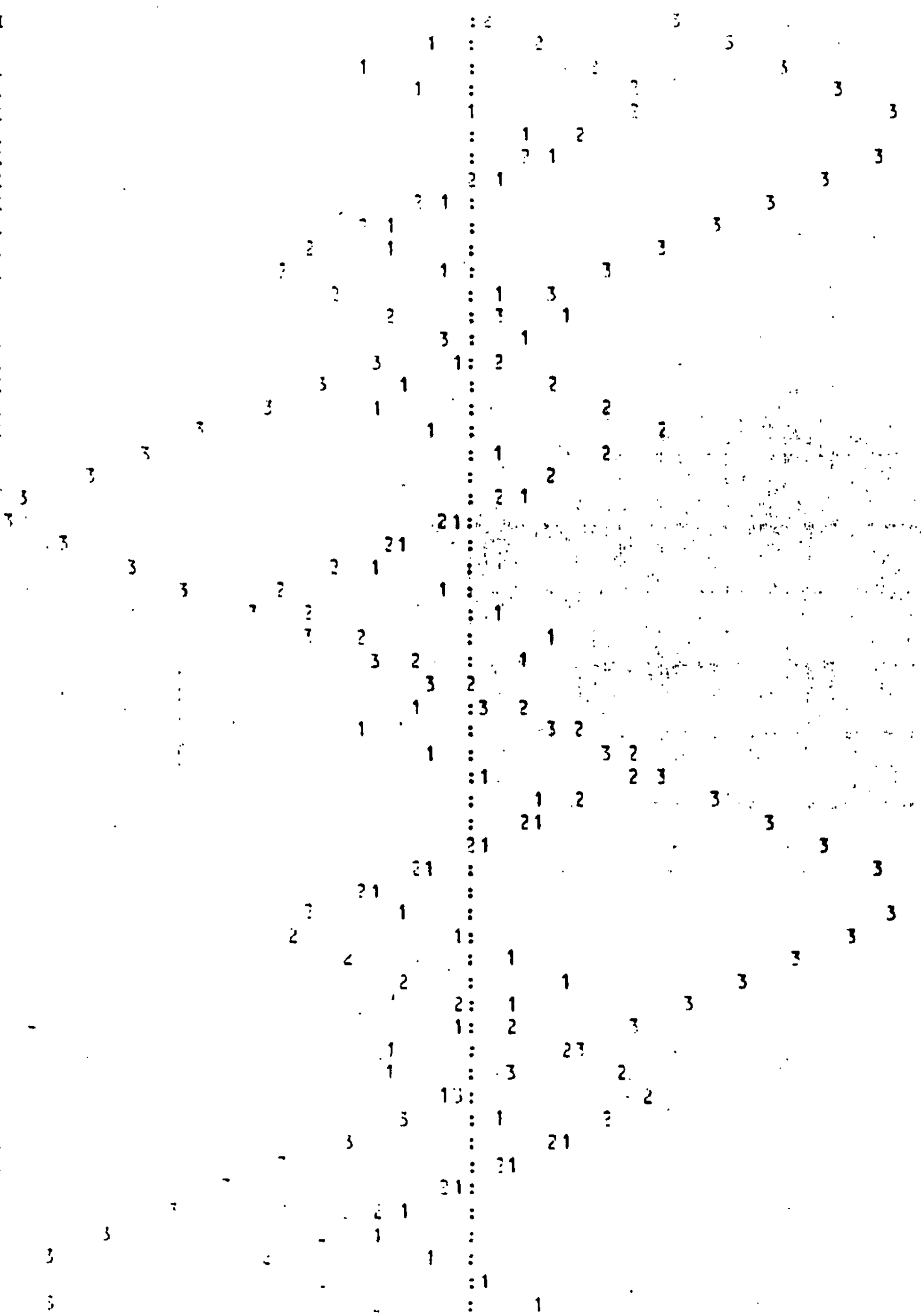
MAXIMUM VALUE .5056+001



TIME	ONE	TWO	FIVE
.0000	.0000	.5688+000	-.2048+001
.1000+002	.6280+000	.6280+000	.6280+000
.2000+002	.9697+000	.1256+001	.1256+001
.3000+002	.3159+000	.1884+001	.1884+001
.4000+002	-.3382+000	.1706+001	.2511+001
.5000+002	-.9925+000	.1076+001	.3139+001
.6000+002	-.6028+000	.4447+000	.3766+001
.7000+002	.4743-001	-.1866+000	.4392+001
.8000+002	.6972+000	-.8184+000	.5017+001
.9000+002	.8894+000	-.1451+001	.4563+001
.1000+003	.2564+000	-.2051+001	.3906+001
.1100+003	-.3773+000	-.1510+001	.3249+001
.1200+003	-.1011+001	-.8964+000	.2591+001
.1300+003	-.5747+000	-.2638+000	.1932+001
.1400+003	.7075-001	.3579+000	.1272+001
.1500+003	.7152+000	.9787+000	.6108+000
.1600+003	.8760+000	.1593+001	-.5105-001
.1700+003	.2367+000	.1991+001	-.7140+000
.1800+003	-.4037+000	.1398+001	-.1378+001
.1900+003	-.1035+001	.8040+000	-.2044+001
.2000+003	-.5561+000	.2085+000	-.2710+001
.2100+003	.5742-001	-.3883+000	-.3378+001
.2200+003	.6696+000	-.9866+000	-.4048+001
.2300+003	.9332+000	-.1586+001	-.4719+001
.2400+003	.3319+000	-.2009+001	-.4959+001
.2500+003	-.2711+000	-.1426+001	-.4160+001
.2600+003	-.8753+000	-.8440+000	-.3504+001
.2700+003	-.7238+000	-.2638+000	-.2928+001
.2800+003	-.1216+000	.3146+000	-.2155+001
.2900+003	.4785+000	.8910+000	-.1484+001
.3000+003	.1050+001	.1466+001	-.8143+000
.3100+003	.5191+000	.2031+001	-.1468+000
.3200+003	-.9720-001	.1562+001	.5185+000
.3300+003	-.7157+000	.9670+000	.1182+001
.3400+003	-.8797+000	.3701+000	.1843+001
.3500+003	-.2686+000	-.2292+000	.2501+001
.3600+003	.3402+000	-.8308+000	.3157+001
.3700+003	.9466+000	-.1435+001	.3811+001
.3800+003	.6605+000	-.2034+001	.4463+001
.3900+003	.7515-001	-.1552+001	.5056+001
.4000+003	-.5124+000	-.9296+000	.4460+001

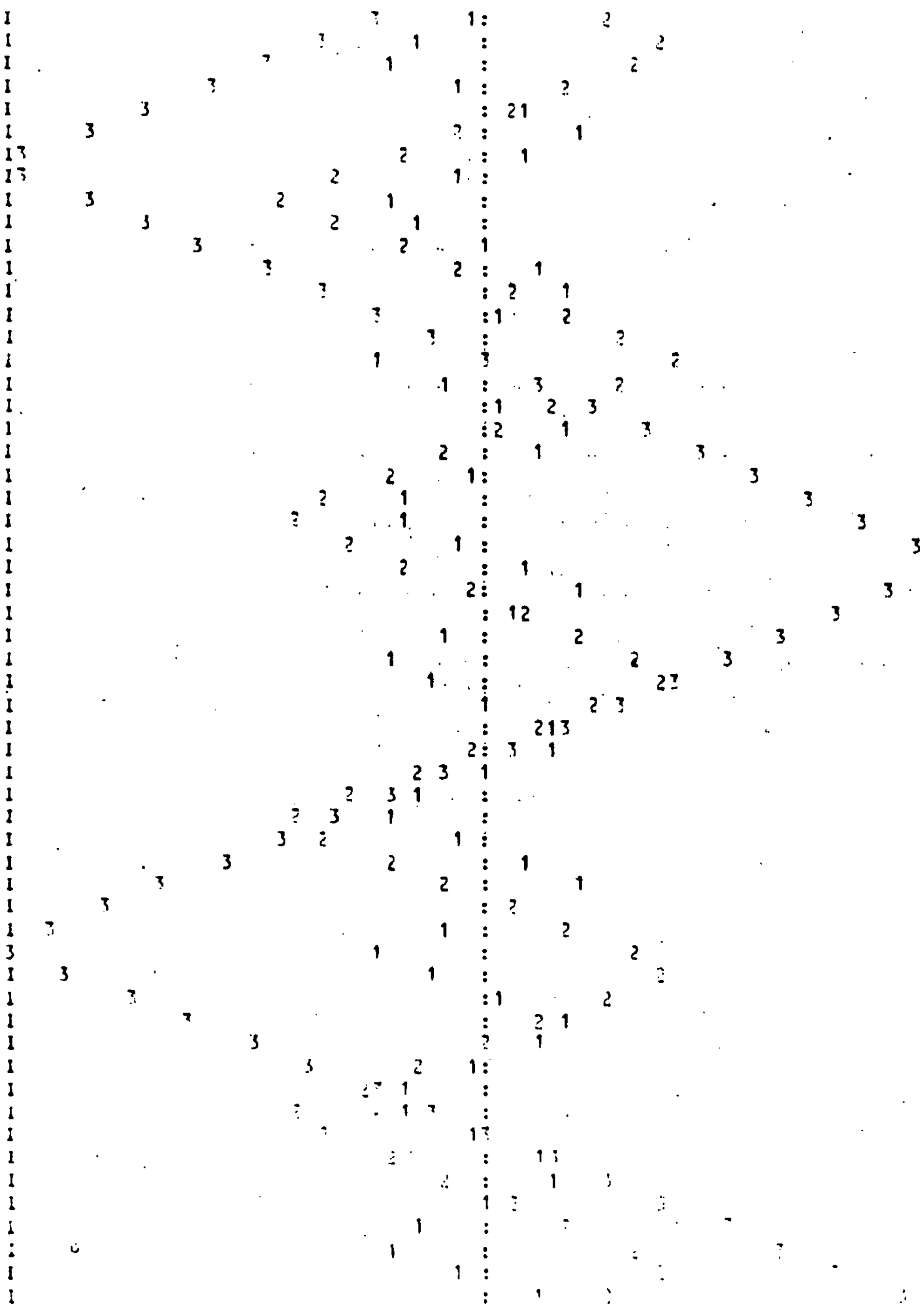


.4100+003	-.1743+001	-.5093+000	.3842+001
.4200+003	-.4982+000	.3072+000	.3201+001
.4300+003	.9225-001	.9215+000	.2558+001
.4400+003	.6799+000	.1533+001	.1911+001
.4500+003	.9265+000	.2042+001	.1262+001
.4600+003	.3592+000	.1456+001	.6094+000
.4700+003	-.1914+000	.8477+000	-.4605-001
.4800+003	-.7550+000	.2366+000	-.7046+000
.4900+003	-.8623+000	-.3777+000	-.1366+001
.5000+003	-.2932+000	-.9952+000	-.2031+001
.5100+003	.2727+000	-.1616+001	-.2700+001
.5200+003	.8352+000	-.1981+001	-.3371+001
.5300+003	.7754+000	-.1374+001	-.4046+001
.5400+003	.1918+000	-.7713+000	-.4725+001
.5500+003	-.3952+000	-.1717+000	-.4857+001
.5600+003	-.9859+000	.4243+000	-.4189+001
.5700+003	-.6190+000	.1017+001	-.3526+001
.5800+003	-.3034-001	.1605+001	-.2866+001
.5900+003	.5546+000	.2004+001	-.2210+001
.6000+003	.1036+001	.1422+001	-.1557+001
.6100+003	.4864+000	.8366+000	-.9090+000
.6200+003	-.7953-001	.2470+000	-.2645+000
.6300+003	-.6494+000	-.3466+000	.3760+000
.6400+003	-.9675+000	-.9442+000	.1013+001
.6500+003	-.3825+000	-.1546+001	.1645+001
.6600+003	.1983+000	-.2046+001	.2273+001
.6700+003	.7749+000	-.1441+001	.2897+001
.6800+003	.8355+000	-.8215+000	.3517+001
.6900+003	.2407+000	-.2060+000	.4133+001
.7000+003	-.3586+000	.4051+000	.4744+001
.7100+003	-.9622+000	.1012+001	.4858+001
.7200+003	-.6423+000	.1614+001	.4250+001
.7300+003	-.4448-001	.1987+001	.3638+001
.7400+003	.5488+000	.1393+001	.3021+001
.7500+003	.1038+001	.7952+000	.2399+001
.7600+003	.4517+000	.1925+000	.1772+001
.7700+003	-.1557+000	-.4149+000	.1141+001
.7800+003	-.7678+000	-.1027+001	.5055+000
.7900+003	-.8293+000	-.1644+001	-.1352+000
.8000+003	-.2170+000	-.1957+001	-.7806+000
.8100+003	.3905+000	-.1350+001	-.1431+001
.8200+003	.9931+000	-.7471+000	-.2086+001
.8300+003	.6062+000	-.1495+000	-.2747+001
.8400+003	-.1167-001	.4430+000	-.3412+001
.8500+003	-.6346+000	.1030+001	-.4082+001
.8600+003	-.9608+000	.1613+001	-.4758+001
.8700+003	-.3361+000	.1989+001	-.4825+001
.8800+003	.2834+000	.1422+001	-.4158+001
.8900+003	.8976+000	.8492+000	-.3497+001
.9000+003	.6996+000	.2714+000	-.2940+001
.9100+003	.9286-001	-.3116+000	-.2169+001
.9200+003	-.5193+000	-.9000+000	-.1543+001
.9300+003	-.1048+001	-.1494+001	-.9030+000
.9400+003	-.4640+000	-.2049+001	-.2681+000
.9500+003	.1417+000	-.1523+001	.3613+000
.9600+003	.7418+000	-.9466+000	.9852+000
.9700+003	.8603+000	-.3757+000	.1604+001

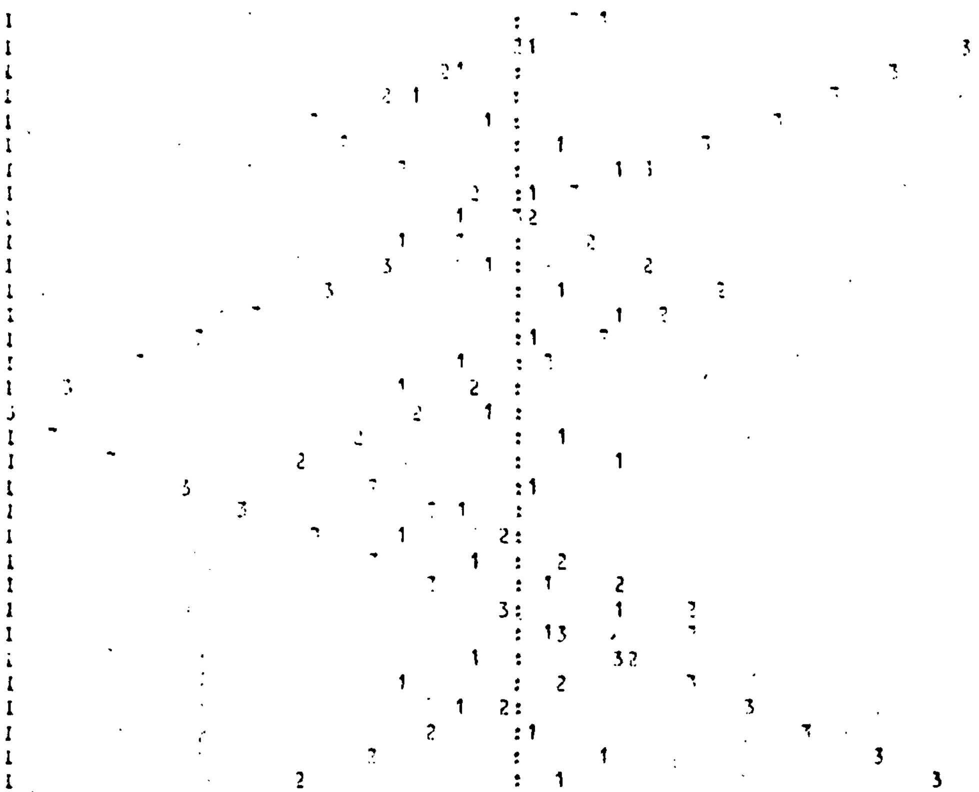


.9800+003	.2397+000	.1895+000	.2216+001
.9900+003	-.3281+000	.7492+000	.2823+001
.1000+004	-.1018+001	.1303+001	.3425+001
.1010+004	-.5774+000	.1851+001	.4021+001
.1020+004	.3635-001	.1772+001	.4611+001
.1030+004	.6443+000	.1217+001	.4994+001
.1040+004	.9499+000	.6560+000	.4433+001
.1050+004	.3595+000	.8939-001	.3866+001
.1060+004	-.2366+000	-.4831+000	.3294+001
.1070+004	-.8387+000	-.1061+001	.2716+001
.1080+004	-.7608+000	-.1646+001	.2131+001
.1090+004	-.1644+000	-.1963+001	.1541+001
.1100+004	.4261+000	-.1372+001	.9449+000
.1110+004	.1010+001	-.7880+000	.3427+000
.1120+004	.5803+000	-.2096+000	-.2655+000
.1130+004	-.3401-001	.3627+000	-.8799+000
.1140+004	-.6544+000	.9290+000	-.1500+001
.1150+004	-.9435+000	.1489+001	-.2127+001
.1160+004	-.2945+000	.2033+001	-.2759+001
.1170+004	.3482+000	.1565+001	-.3398+001
.1180+004	.9848+000	.9909+000	-.4043+001
.1190+004	.6089+000	.4109+000	-.4694+001
.1200+004	-.2486-001	-.1754+000	-.4887+001
.1210+004	-.6649+000	-.7679+000	-.4221+001
.1220+004	-.9224+000	-.1367+001	-.3562+001
.1230+004	-.2934+000	-.1972+001	-.2910+001
.1240+004	.3293+000	-.1631+001	-.2263+001
.1250+004	.9457+000	-.1038+001	-.1623+001
.1260+004	.6520+000	-.4522+000	-.9893+000
.1270+004	.4520-001	.1277+000	-.3619+000
.1280+004	-.5680+000	.7012+000	.2591+000
.1290+004	-.1024+001	.1268+001	.8736+000
.1300+004	-.4189+000	.1829+001	.1482+001
.1310+004	.1828+000	.1781+001	.2084+001
.1320+004	.7781+000	.1213+001	.2679+001
.1330+004	.8319+000	.6391+000	.3268+001
.1340+004	.2513+000	.5853-001	.3850+001
.1350+004	-.3358+000	-.5286+000	.4426+001
.1360+004	-.9293+000	-.1122+001	.4995+001
.1370+004	-.6660+000	-.1722+001	.4621+001
.1380+004	-.6224-001	-.1877+001	.4062+001
.1390+004	.5350+000	-.1280+001	.3496+001
.1400+004	.1042+001	-.6890+000	.2924+001
.1410+004	.4539+000	-.1048+000	.2345+001
.1420+004	-.1451+000	.4728+000	.1760+001
.1430+004	-.7607+000	.1044+001	.1168+001
.1440+004	-.8294+000	.1608+001	.5697+000
.1450+004	-.2003+000	.2010+001	-.3528-001
.1460+004	.4223+000	.1446+001	-.6468+000
.1470+004	.1031+001	.8754+000	-.1265+001
.1480+004	.5664+000	.2981+000	-.1890+001
.1490+004	-.4115-001	-.2857+000	-.2521+001
.1500+004	-.6553+000	-.8761+000	-.3159+001
.1510+004	-.9428+000	-.1473+001	-.3803+001
.1520+004	-.3359+000	-.2050+001	-.4454+001
.1530+004	.2643+000	-.1514+001	-.5064+001
.1540+004	.8580+000	-.8970+000	-.4459+001

.1550+004	.7450+000	-.2861+000	-.3777+001
.1560+004	.1163+000	.3182+000	-.3102+001
.1570+004	-.4733+000	.9159+000	-.2433+001
.1580+004	-.1057+001	.1507+001	-.1771+001
.1590+004	-.4943+000	.2048+001	-.1115+001
.1600+004	.1649+000	.1495+001	-.4655+000
.1610+004	.8075+000	.3796+000	.1772+000
.1620+004	.7816+000	.2579+000	.8134+000
.1630+004	.1297+000	-.3703+000	.1443+001
.1640+004	-.5288+000	-.1005+001	.2066+001
.1650+004	-.1037+001	-.1646+001	.2683+001
.1660+004	-.3901+000	-.1940+001	.3293+001
.1670+004	.2610+000	-.1312+001	.3897+001
.1680+004	.9056+000	-.6913+000	.4494+001
.1690+004	.6884+000	-.7687-001	.5048+001
.1700+004	.6226-001	.5311+000	.4529+001
.1710+004	-.5703+000	.1133+001	.3944+001
.1720+004	-.1023+001	.1728+001	.3352+001
.1730+004	-.3667+000	.1877+001	.2754+001
.1740+004	.2868+000	.1273+001	.2150+001
.1750+004	.9339+000	.6623+000	.1539+001
.1760+004	.6562+000	.4518-001	.9222+000
.1770+004	.9080-002	-.5782+000	.2988+000
.1780+004	-.6444+000	-.1208+001	-.3310+000
.1790+004	-.9453+000	-.1844+001	-.9670+000
.1800+004	-.2823+000	-.1747+001	-.1609+001
.1810+004	.3745+000	-.1114+001	-.2258+001
.1820+004	.1023+001	-.4875+000	-.2913+001
.1830+004	.5714+000	.1331+000	-.3574+001
.1840+004	-.7207-001	.7475+000	-.4241+001
.1850+004	-.7217+000	.1356+001	-.4914+001
.1860+004	-.8641+000	.1958+001	-.4665+001
.1870+004	-.2207+000	.1642+001	-.3998+001
.1880+004	.4166+000	.1021+001	-.3337+001
.1890+004	.1037+001	.3948+000	-.2682+001
.1900+004	.5410+000	-.2378+000	-.2033+001
.1910+004	-.9759-001	-.8765+000	-.1390+001
.1920+004	-.7422+000	-.1521+001	-.7526+000
.1930+004	-.8446+000	-.2048+001	-.1216+000
.1940+004	-.1957+000	-.1418+001	.5035+000
.1950+004	.4472+000	-.7755+000	.1123+001
.1960+004	.1051+001	-.1384+000	.1736+001
.1970+004	.5080+000	.4928+000	.2344+001
.1980+004	-.1244+000	.1118+001	.2945+001
.1990+004	-.7626+000	.1738+001	.3541+001
.2000+004	-.8279+000	.1860+001	.4132+001
.2010+004	-.2195+000	.1258+001	.4716+001
.2020+004	.3829+000	.6497+000	.4889+001
.2030+004	.9799+000	.3627-001	.4323+001
.2040+004	.6110+000	-.5828+000	.3751+001
.2050+004	-.1356-001	-.1207+001	.3174+001
.2060+004	-.6437+000	-.1837+001	.2591+001
.2070+004	-.9503+000	-.1751+001	.2003+001
.2080+004	-.3097+000	-.1110+001	.1410+001
.2090+004	.3255+000	-.4753+000	.8108+000
.2100+004	.9553+000	.1545+000	.2064+000
.2110+004	.6271+000	.7790+000	-.4032+000



.2120+004	-.3529-001	.1399+001	-.1518+001
.2130+004	-.7029+000	.2012+001	-.1638+001
.2140+004	-.8797+000	.1596+001	-.2264+001
.2150+004	-.2049+000	.9393+000	-.2994+001
.2160+004	.4648+000	.3774+000	-.3530+001
.2170+004	.1061+001	-.2396+000	-.4170+001
.2180+004	.4467+000	-.8616+000	-.4816+001
.2190+004	-.2278+000	-.1489+001	-.4779+001
.2200+004	-.9071+000	-.2052+001	-.4153+001
.2210+004	-.6691+000	-.1474+001	-.3532+001
.2220+004	.1829-001	-.8580+000	-.2916+001
.2230+004	.7009+000	-.2466+000	-.2304+001
.2240+004	.8828+000	.3601+000	-.1698+001
.2250+004	.2032+000	.9621+000	-.1096+001
.2260+004	-.4811+000	.1559+001	-.4984+000
.2270+004	-.1065+001	.2035+001	.9438-001
.2280+004	-.4181+000	.1447+001	.6826+000
.2290+004	.2605+000	.8438+000	.1266+001
.2300+004	.9347+000	.2364+000	.1845+001
.2310+004	.6394+000	-.3755+000	.2420+001
.2320+004	-.4796-001	-.9917+000	.2991+001
.2330+004	-.7397+000	-.1612+001	.3557+001
.2340+004	-.8437+000	-.1985+001	.4119+001
.2350+004	-.1673+000	-.1356+001	.4677+001
.2360+004	.5049+000	-.7317+000	.4940+001
.2370+004	.1056+001	-.1110+000	.4374+001
.2380+004	.3942+000	.5056+000	.3804+001
.2390+004	-.2984+000	.1118+001	.3230+001
.2400+004	-.9950+000	.1727+001	.2652+001
.2410+004	-.5752+000	.1875+001	.2071+001
.2420+004	.1208+000	.1242+001	.1485+001
.2430+004	.8131+000	.6055+000	.8956+000
.2440+004	.7721+000	-.3503-001	.3026+000
.2450+004	.8048-001	-.6792+000	-.2941+000
.2460+004	-.6147+000	-.1327+001	-.8943+000
.2470+004	-.9669+000	-.1978+001	-.1498+001
.2480+004	-.2451+000	-.1615+001	-.2105+001
.2490+004	.4733+000	-.9675+000	-.2716+001
.2500+004	.1065+001	-.3237+000	-.3330+001
.2510+004	.3857+000	.3169+000	-.3947+001
.2520+004	-.3295+000	.9542+000	-.4568+001
.2530+004	-.1041+001	.1588+001	-.5028+001
.2540+004	-.5248+000	.2010+001	-.4379+001
.2550+004	.1981+000	.1357+001	-.3727+001
.2560+004	.9181+000	.7000+000	-.3078+001
.2570+004	.6507+000	.4046-001	-.2432+001
.2580+004	-.3290-001	-.6219+000	-.1789+001
.2590+004	-.8193+000	-.1267+001	-.1149+001
.2600+004	-.7491+000	-.1955+001	-.5117+000
.2610+004	-.1235-001	-.1629+001	.1231+000
.2620+004	.7077+000	-.9729+000	.7553+000
.2630+004	.8554+000	-.3196+000	.1365+001
.2640+004	.1089+000	.3313+000	.2012+001
.2650+004	-.6429+000	.9797+000	.2637+001
.2660+004	-.9262+000	.1665+001	.3259+001
.2670+004	-.1659+000	.1966+001	.3879+001
.2680+004	.5054+000	.1726+001	.4457+001



[illegible]	.9747+000	.6839+000	.5053+001
[illegible]	.2117+000	.3959-001	.4480+001
[illegible]	-.5533+000	-.6768+000	.3857+001
[illegible]	-.1211+001	-.1255+001	.3232+001
[illegible]	-.2380+000	-.1905+001	.2606+001
.2740+004	.5340+000	-.1690+001	.1978+001
[illegible]	.1024+001	-.1062+001	.1347+001
[illegible]	.2523+000	-.4363+000	.7157+000
[illegible]	-.5235+000	.1381+000	.8227-001
[illegible]	-.1033+001	.8109+000	-.5327+000
[illegible]	-.2576+000	.1432+001	-.1189+001
[illegible]	.5285+000	.2040+001	-.1927+001
.2810+004	.1033+001	.1549+001	-.2466+001
[illegible]	.2534+000	.9308+000	-.3107+001
[illegible]	-.5308+000	.3127+000	-.3749+001
[illegible]	-.1027+001	-.3065+000	-.4392+001
[illegible]	-.2492+000	-.9269+000	-.5030+001
[illegible]	.5297+000	-.1548+001	-.4558+001
[illegible]	.1028+001	-.2034+001	-.3922+001
[illegible]	.2643+000	-.1410+001	-.3287+001
[illegible]	-.5022+000	-.7765+000	-.2654+001
[illegible]	-.1043+001	-.1435+000	-.2021+001
.2910+004	-.3228+000	.4889+000	-.1388+001
[illegible]	.4038+000	.1121+001	-.7565+000
[illegible]	.1074+001	.1752+001	-.1253+000
[illegible]	.4282+000	.1840+001	.5054+000
[illegible]	-.3180+000	.1189+001	.1136+001
[illegible]	-.1052+001	.5369+000	.1766+001
[illegible]	-.5057+000	-.1150+000	.2395+001
[illegible]	.2424+000	-.7672+000	.3025+001
[illegible]	.9904+000	-.1419+001	.3654+001
[illegible]	.5689+000	-.2048+001	.4283+001

THRUSTER SUMMARY FOR 1. DEGREE DEADBAND

-16.00	-88.20	192.80	335.00	-446.80	562.79	-677.39
-16.20	-88.40	-225.60	335.20	-447.00	562.99	710.79
-16.40	120.00	-225.80	335.40	-447.20	563.19	710.99
-16.60	120.20	-226.00	335.60	-447.40	563.39	711.19
-16.80	120.40	-226.20	335.80	-447.60	563.59	711.39
-17.00	120.60	-226.40	336.00	-447.80	-597.79	711.59
-17.20	120.80	-226.60	336.20	-448.00	-597.99	711.79
-17.40	121.00	-226.80	336.40	-448.20	-598.19	711.99
-17.60	121.20	-227.00	336.60	-448.40	-598.39	712.19
-17.80	121.40	-227.20	336.80	-448.60	-598.59	712.39
-18.00	121.60	-227.40	337.00	-448.80	-598.79	712.59
-18.20	121.80	-227.60	337.20	484.40	-598.99	712.79
-18.40	122.00	-227.80	337.40	484.60	-599.19	712.99
-18.60	122.20	-228.00	337.60	484.80	-599.39	713.19
-18.80	122.40	-228.20	337.80	485.00	-599.59	713.39
-19.00	122.60	-228.40	338.00	485.20	-599.79	713.59
-19.20	122.80	-228.60	338.20	485.40	-599.99	713.79
-19.40	123.00	-228.80	-371.00	485.60	-600.19	713.99
-19.60	123.20	-229.00	-371.20	485.80	-600.39	714.19
50.20	123.40	262.20	-371.40	486.00	-600.59	-747.79
50.40	123.60	262.40	-371.60	486.20	-600.79	-747.99
50.60	-154.60	262.60	-371.80	486.40	-600.99	-748.19
50.80	-154.80	262.80	-372.00	486.60	636.19	-748.39
51.00	-155.00	263.00	-372.20	486.80	636.39	-748.59
51.20	-155.20	263.20	-372.40	487.00	636.59	-748.79
51.40	-155.40	263.40	-372.60	487.20	636.79	-748.99
51.60	-155.60	263.60	-372.80	487.40	636.99	-749.19
51.80	-155.80	263.80	-373.00	487.60	637.19	-749.39
52.00	-156.00	264.00	-373.20	-523.00	637.39	-749.59
52.20	-156.20	264.20	-373.40	-523.20	637.59	-749.79
52.40	-156.40	264.40	-373.60	-523.40	637.79	-749.99
52.60	-156.60	264.60	-373.80	-523.60	637.99	-750.19
52.80	-156.80	264.80	-374.00	-523.80	638.19	-750.39
53.00	-157.00	265.00	-374.20	-524.00	638.39	-750.59
53.20	-157.20	265.20	408.40	-524.20	638.59	-750.79
53.40	-157.40	265.40	408.60	-524.40	638.79	-750.99
53.60	-157.60	265.60	408.80	-524.60	638.99	783.79
53.80	-157.80	-298.80	409.00	-524.80	639.19	783.99
54.00	-158.00	-299.00	409.20	-525.00	639.39	784.19
-84.80	-158.20	-299.20	409.40	-525.20	639.59	784.39
-85.00	189.40	-299.40	409.60	-525.40	-673.99	784.59
-85.20	189.60	-299.60	409.80	-525.60	-674.19	784.79
-85.40	189.80	-299.80	410.00	-525.80	-674.39	784.99
-85.60	190.00	-300.00	410.20	-526.00	-674.59	785.19
-85.80	190.20	-300.20	410.40	-526.20	-674.79	785.39
-86.00	190.40	-300.40	410.60	560.39	-674.99	785.59
-86.20	190.60	-300.60	410.80	560.59	-675.19	785.79
-86.40	190.80	-300.80	411.00	560.79	-675.39	785.99
-86.60	191.00	-301.00	411.20	560.99	-675.59	786.19
-86.80	191.20	-301.20	411.40	561.19	-675.79	786.39
-87.00	191.40	-301.40	411.60	561.39	-675.99	786.59
-87.20	191.60	-301.60	-445.60	561.59	-676.19	786.79
-87.40	191.80	-301.80	-445.80	561.79	-676.39	786.99
-87.60	192.00	-302.00	-446.00	561.99	-676.59	787.19
-87.80	192.20	-302.20	-446.20	562.19	-676.79	787.39
-88.00	192.40	334.60	-446.40	562.39	-676.99	-820.19
	192.60	334.80	-446.60	562.59	-677.19	-820.39

THRUSTER SUMMARY FOR [illegible]. DEGREE COMMAND

-32.00	238.20	-449.60	659.79	-869.39
-32.20	238.40	-449.80	659.99	-869.59
-32.40	238.60	-450.00	660.19	-869.79
-32.60	238.80	-450.20	660.39	-869.99
-32.80	239.00	-450.40	660.59	938.59
-33.00	239.20	-450.60	660.79	
-33.20	239.40	-450.80	660.99	
-33.40	239.60	-451.00	661.19	
-33.60	239.80	-451.20	-726.59	
-33.80	240.00	516.20	-726.79	
-34.00	240.20	516.40	-726.99	
-34.20	-309.40	516.60	-727.19	
-34.40	-309.60	516.80	-727.39	
-34.60	-309.80	517.00	-727.59	
-34.80	-310.00	517.20	-727.79	
-35.00	-310.20	517.40	-727.99	
-35.20	-310.40	517.60	-728.19	
-35.40	-310.60	517.80	-728.39	
98.80	-310.80	518.00	-728.59	
99.00	-311.00	518.20	-728.79	
99.20	-311.20	518.40	-728.99	
99.40	-311.40	518.60	-729.19	
99.60	-311.60	518.80	-729.39	
99.80	-311.80	519.00	-729.59	
100.00	-312.00	519.20	-729.79	
100.20	-312.20	519.40	795.79	
100.40	-312.40	519.60	795.99	
100.60	-312.60	519.80	796.19	
100.80	-312.80	-586.79	796.39	
101.00	379.40	-586.99	796.59	
101.20	379.60	-587.19	796.79	
101.40	379.80	-587.39	796.99	
101.60	380.00	-587.59	797.19	
101.80	380.20	-587.79	797.39	
102.00	380.40	-587.99	797.59	
102.20	380.60	-588.19	797.79	
-166.60	380.80	-588.39	797.99	
-166.80	381.00	-588.59	798.19	
-167.00	381.20	-588.79	798.39	
-167.20	381.40	-588.99	798.59	
-167.40	381.60	-589.19	798.79	
-167.60	381.80	-589.39	798.99	
-167.80	382.00	-589.59	799.19	
-168.00	382.20	-589.79	799.39	
-168.20	382.40	-589.99	-866.79	
-168.40	382.60	-590.19	-866.99	
-168.60	382.80	657.59	-867.19	
-168.80	383.00	657.79	-867.39	
-169.00	-447.80	657.99	-867.59	
-169.20	-448.00	658.19	-867.79	
-169.40	-448.20	658.39	-867.99	
-169.60	-448.40	658.59	-868.19	
-169.80	-448.60	658.79	-868.39	
-170.00	-448.80	658.99	-868.59	
237.00	-449.00	659.19	-868.79	
237.20	-449.20	659.39	-868.99	
237.40	-449.40	659.59	-869.19	
237.60				
237.80				
238.00				

THRUSTER SUMMARY FOR 3. DOUBLE QUADRANT

-79.80
-80.00
-80.20
-80.40
-80.60
-80.80
-81.00
-81.20
-81.40
-81.60
-81.80
-82.00
-82.20
-82.40
-82.60
-82.80
-83.00

-83.20
-83.40
234.20
234.40
234.60
234.80
235.00
235.20
235.40
235.60
235.80
236.00
236.20
236.40
236.60
236.80
237.00
237.20
237.40
237.60
237.80
238.00
-388.40
-388.60
-388.80
-389.00
-389.20
-389.40
-389.60
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-390.00
-390.20
-390.40
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-390.80
-391.00
-391.20
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-391.60
-391.80
-392.00
544.19
544.39
544.59
544.79
544.99
545.19
545.39
545.59
545.79
545.99
546.19
546.39
546.59
546.79
546.99
547.19

547.39
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547.79
547.99
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864.99
865.19
865.39
865.59
865.79
865.99
866.19
866.39
866.59
866.79
866.99
867.19
867.39

IX.F. Simulation Results

IX.F.1. Boom Deployment Sequence

Figures F1 - F43

DATA FOR THE X-AXIS

CURVE '*' IS A PLOT OF TORQUE VERSUS TIME

MINIMUM VALUE -.6395+000

MAXIMUM VALUE .7125+001

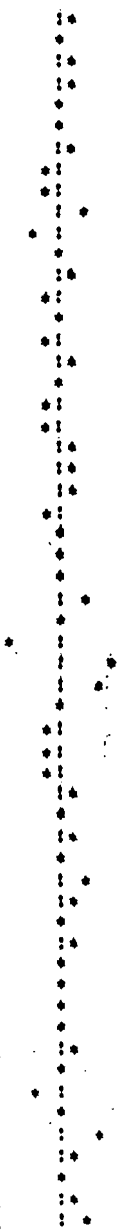
TIME	TORQUE
.0000	.0000
.1000+000	.3126+000
.2000+000	.4370+000
.3000+000	.3680+000
.4000+000	.4865+000
.5000+000	.2598+000
.6000+000	-.1141+000
.7000+000	-.3083+000
.8000+000	-.5530+000
.9000+000	-.2475+000
.1000+001	-.2130-001
.1100+001	.8573-003
.1200+001	.2017+000
.1300+001	.2566+000
.1400+001	-.3109-001
.1500+001	-.1116+000
.1600+001	-.1858+000
.1700+001	-.4026+000
.1800+001	-.1515+000
.1900+001	-.1023+000
.2000+001	-.6936-001
.2100+001	.1691+000
.2200+001	-.2771-001
.2300+001	-.2391+000
.2400+001	-.1896+000
.2500+001	-.2212+000
.2600+001	-.1070+000
.2700+001	-.1218-001
.2800+001	-.1404+000
.2900+001	-.1477+000
.3000+001	-.3402-001
.3100+001	-.1221+000
.3200+001	.1827+000
.3300+001	-.2454-001
.3400+001	-.2815-001
.3500+001	-.8354-001
.3600+001	.1229-002
.3700+001	-.1224+000
.3800+001	.1733-001
.3900+001	-.1124+000
.4000+001	-.9114-002
.4100+001	-.1773+000
.4200+001	-.9390-001
.4300+001	-.5383-002
.4400+001	-.3781-002

FIGURE F1

FIGURE F2

```
.4500+001 I   *:    I-.8886-001
.4600+001 I    *    I .1843-001
.4700+001 I    *    I-.5142-001
.4800+001 I    :*   I .5749-001
.4900+001 I    *    I-.1665-001
.5000+001 I   *:    I-.1111+000
.5100+001 I    *    I-.6305-001
.5200+001 I    :*   I .4629-001
.5300+001 I    :*   I .6719-001
.5400+001 I    *    I-.1715-001
.5500+001 I    :*   I .7948-001
.5600+001 I    : *  I .1884+000
.5700+001 I    :*   I .4292-001
.5800+001 I   *:    I-.1225+000
.5900+001 I    :*   I .8240-001
.6000+001 I    *    I-.1692-002
.6100+001 I    : *  I .1777+000
.6200+001 I    *    I-.9901-002
.6300+001 I    *    I-.1717-001
.6400+001 I    *    I .1358-001
.6500+001 I    *    I-.5671-002
.6600+001 I   *:    I-.8725-001
.6700+001 I   *:    I-.1594+000
.6800+001 I    : *  I .1825+000
.6900+001 I    *    I-.1570-002
.7000+001 I    :*   I .9775-001
.7100+001 I    :*   I .1112+000
.7200+001 I    *    I-.6335-001
.7300+001 I    :*   I .8698-001
.7400+001 I    *    I-.5834-001
.7500+001 I    :*   I .9727-001
.7600+001 I    *    I-.2991-001
.7700+001 I    :*   I .8205-001
.7800+001 I    *    I .2585-002
.7900+001 I    *    I .1399-001
.8000+001 I    *    I-.4450-001
.8100+001 I    *    I-.8477-001
.8200+001 I    *    I-.1245-001
.8300+001 I    *    I-.7479-002
.8400+001 I    *    I-.5667-001
.8500+001 I    :*   I .1129+000
.8600+001 I    *    I-.7110-001
.8700+001 I    *    I-.8089-001
.8800+001 I   *:    I-.1317+000
.8900+001 I    *    I .1050-001
.9000+001 I    :*   I .6126-001
.9100+001 I    :*   I .1088+000
.9200+001 I    *    I-.5451-002
.9300+001 I    :*   I .3585-001
.9400+001 I   *:    I-.1521+000
.9500+001 I    *    I .3291-002
.9600+001 I   *:    I-.1826+000
.9700+001 I    *    I .1086-001
.9800+001 I    *    I .1971-001
.9900+001 I    *    I-.2714-001
.1000+002 I    :*   I .3999-001
.1010+002 I    :*   I .1038+000
```

FIGURE F3



.1020+002	.5033-001
.1030+002	-.6992-001
.1040+002	.7565-001
.1050+002	.3464-001
.1060+002	-.4293-001
.1070+002	-.4258-001
.1080+002	.2871-001
.1090+002	-.9433-001
.1100+002	-.1215+000
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.1120+002	-.2181+000
.1130+002	-.1666-001
.1140+002	.3095-001
.1150+002	-.1328+000
.1160+002	-.1196-001
.1170+002	-.1101+000
.1180+002	.9953-001
.1190+002	.7661-003
.1200+002	-.1038+000
.1210+002	-.1481+000
.1220+002	.3840-001
.1230+002	.4714-001
.1240+002	.3072-001
.1250+002	-.1847+000
.1260+002	-.1289-001
.1270+002	.1145-001
.1280+002	.6955-002
.1290+002	.1990+000
.1300+002	.1796-001
.1310+002	-.4665+000
.1320+002	.4102+000
.1330+002	.2656+000
.1340+002	-.5359-001
.1350+002	-.1930+000
.1360+002	-.1376+000
.1370+002	-.1258+000
.1380+002	.4697-001
.1390+002	-.7262-002
.1400+002	.1340+000
.1410+002	-.6712-001
.1420+002	.1471+000
.1430+002	.3645-001
.1440+002	-.5681-001
.1450+002	.1054+000
.1460+002	-.1163-001
.1470+002	-.6283-001
.1480+002	-.8322-001
.1490+002	-.4447-001
.1500+002	.5923-001
.1510+002	.1265-001
.1520+002	-.2367+000
.1530+002	-.1899-001
.1540+002	.2500+000
.1550+002	.1199+000
.1560+002	.9980-002
.1570+002	.4097-001
.1580+002	.2254+000

FIGURE F4

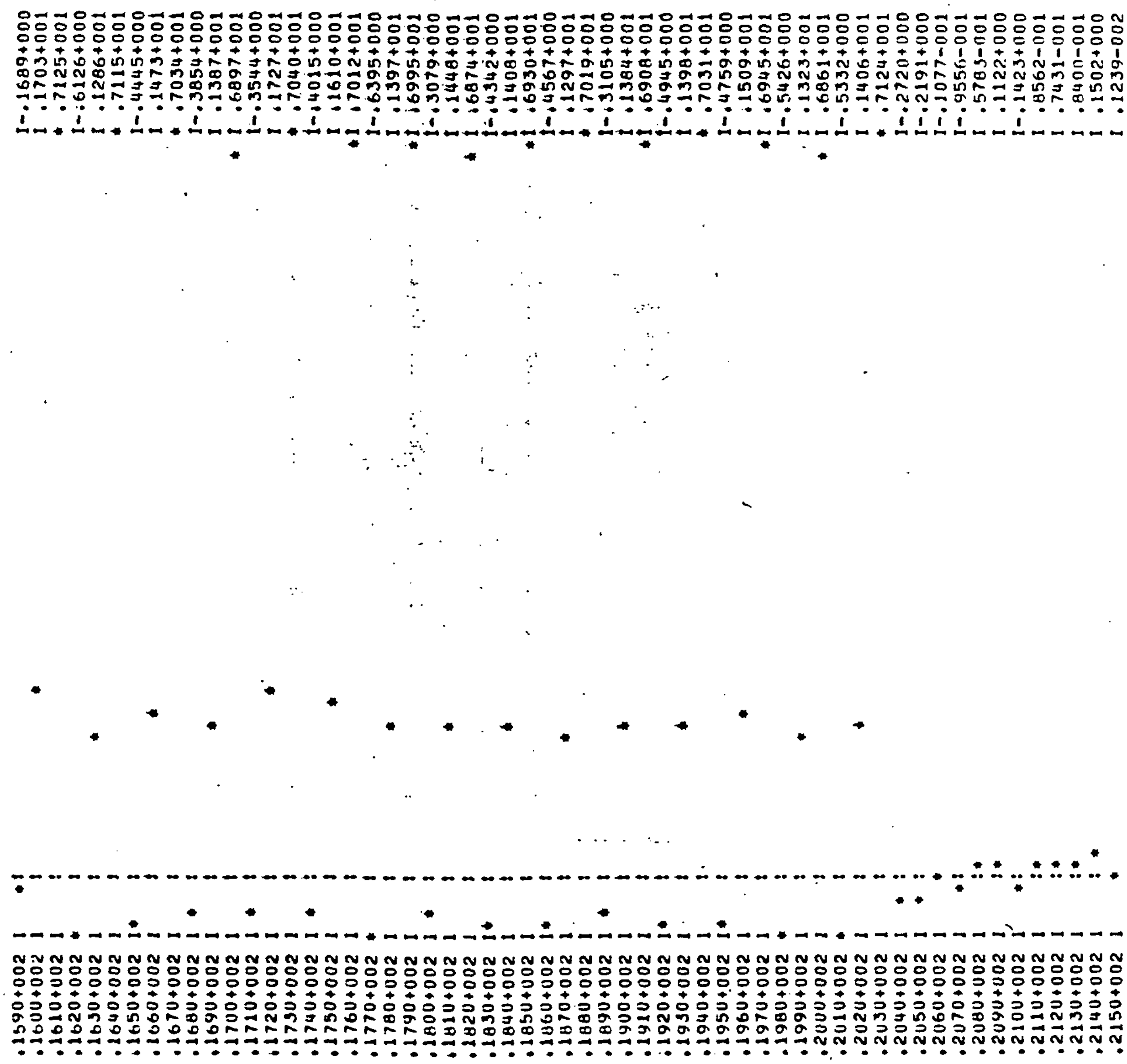

.1590+002 -.1689+000
.1600+002 .1703+001
.1610+002 .7125+001
.1620+002 -.6126+000
.1630+002 .1286+001
.1640+002 .7115+001
.1650+002 -.4445+000
.1660+002 .1473+001
.1670+002 .7034+001
.1680+002 -.3854+000
.1690+002 .1387+001
.1700+002 .6897+001
.1710+002 -.3544+000
.1720+002 .1727+001
.1730+002 .7040+001
.1740+002 -.4015+000
.1750+002 .1610+001
.1760+002 .7012+001
.1770+002 -.6395+000
.1780+002 .1397+001
.1790+002 .6995+001
.1800+002 -.3079+000
.1810+002 .1448+001
.1820+002 .6874+001
.1830+002 -.4342+000
.1840+002 .1408+001
.1850+002 .6930+001
.1860+002 -.4567+000
.1870+002 .1297+001
.1880+002 .7019+001
.1890+002 -.3105+000
.1900+002 .1384+001
.1910+002 .6908+001
.1920+002 -.4945+000
.1930+002 .1398+001
.1940+002 .7031+001
.1950+002 -.4759+000
.1960+002 .1509+001
.1970+002 .6945+001
.1980+002 -.5426+000
.1990+002 .1323+001
.2000+002 .6861+001
.2010+002 -.5332+000
.2020+002 .1406+001
.2030+002 .7124+001
.2040+002 -.2720+000
.2050+002 -.2191+000
.2060+002 -.1077-001
.2070+002 -.9556-001
.2080+002 .5783-001
.2090+002 .1122+000
.2100+002 -.1423+000
.2110+002 .8562-001
.2120+002 .7431-001
.2130+002 .8400-001
.2140+002 .1502+000
.2150+002 .1239-002

FIGURE F5

.2160+002	.6487-001
.2170+002	-.8299-001
.2180+002	-.1577+000
.2190+002	-.8851-001
.2200+002	.4946-001
.2210+002	.9044-001
.2220+002	.3388-001
.2230+002	-.1313-001
.2240+002	.8836-001
.2250+002	-.3228-001
.2260+002	-.2595-001
.2270+002	.1290+000
.2280+002	.6349-001
.2290+002	.1539+000
.2300+002	-.4575-002
.2310+002	-.3293-001
.2320+002	-.2104-001
.2330+002	-.1170+000
.2340+002	.4300-001
.2350+002	-.1135-001
.2360+002	-.1350+000
.2370+002	.3815-001
.2380+002	-.3572-001
.2390+002	-.9111-001
.2400+002	-.8309-001
.2410+002	.3940-001
.2420+002	.7610-001
.2430+002	.6687-001
.2440+002	.3560-001
.2450+002	.3966-001
.2460+002	.2941-001
.2470+002	-.3280-001
.2480+002	-.1308+000
.2490+002	-.1999+000
.2500+002	.1355+000
.2510+002	-.3984+000
.2520+002	.3813+000
.2530+002	.2424+000
.2540+002	-.4894-001
.2550+002	-.5213-001
.2560+002	-.6523-001
.2570+002	.5875-001
.2580+002	-.1005+000
.2590+002	.4519-001
.2600+002	-.6726-001
.2610+002	-.5362-001
.2620+002	-.1868-001
.2630+002	.1131+000
.2640+002	-.1841-001
.2650+002	-.1274+000
.2660+002	.7966-001
.2670+002	.1828+000
.2680+002	-.5315-001
.2690+002	-.1208-001
.2700+002	-.9786-001
.2710+002	-.3735-001
.2720+002	-.8944-001

12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890

FIGURE F6

```
.2730+002 I     *                                    I-.3546-001
.2740+002 I     *                                    I-.6960-001
.2750+002 I     : *                                  I .1515+000
.2760+002 I     : *                                  I .1850+000
.2770+002 I    *:                                    I-.1851+000
.2780+002 I     :*                                   I .1036+000
.2790+002 I     *                                    I-.5434-001
.2800+002 I   * :                                    I-.2206+000
.2810+002 I     *                                    I-.4490-001
.2820+002 I     :*                                   I .3810-001
.2830+002 I     *                                    I-.7651-001
.2840+002 I     :*                                   I .1063+000
.2850+002 I     *                                    I .1830-001
.2860+002 I    *:                                    I-.1127+000
.2870+002 I     *                                    I-.7205-001
.2880+002 I     :*                                   I .6929-001
.2890+002 I     : *                                  I .1747+000
.2900+002 I    *:                                    I-.1796+000
.2910+002 I     :*                                   I .7184-001
.2920+002 I    *:                                    I-.1400+000
.2930+002 I     *                                    I-.2218-001
.2940+002 I     *                                    I-.8054-001
.2950+002 I     :*                                   I .1123+000
.2960+002 I     :*                                   I .1310+000
.2970+002 I     *                                    I-.7310-002
.2980+002 I     *                                    I-.5062-001
.2990+002 I     *                                    I .1632-001
.3000+002 I     *                                    I-.5181-001
```

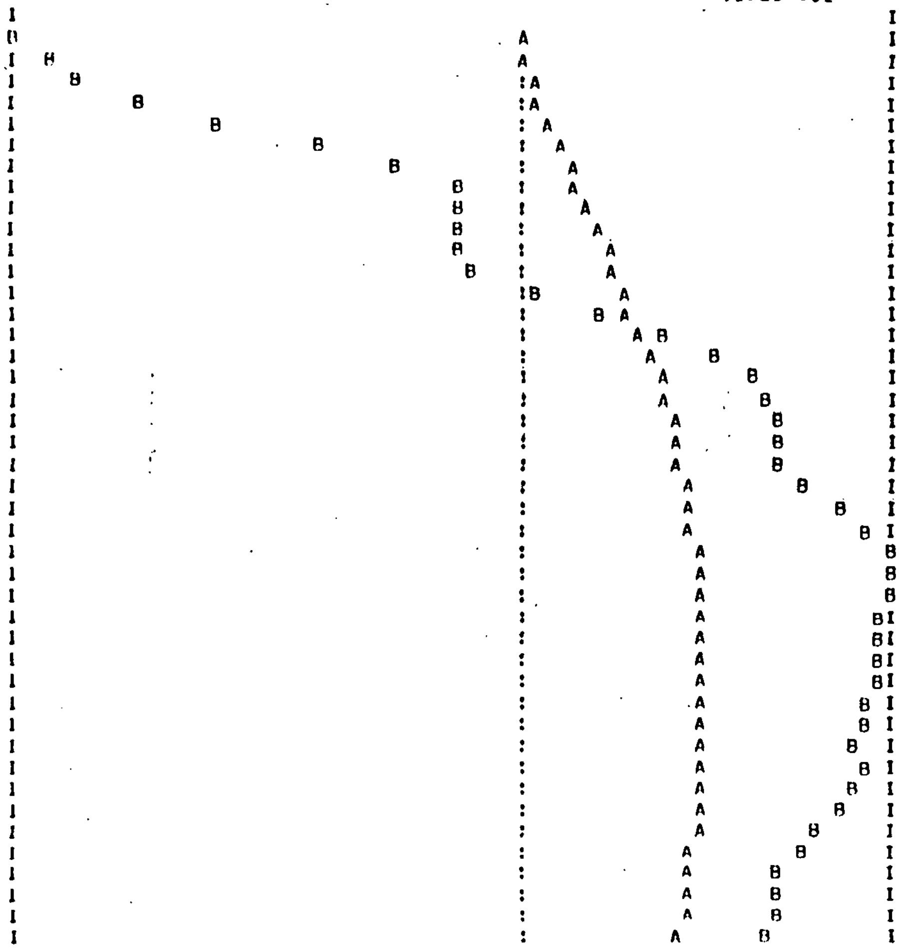
FIGURE F7

DATA FOR THE X-AXIS

CURVE 'A' IS A PLOT OF BASE VERSUS TIME

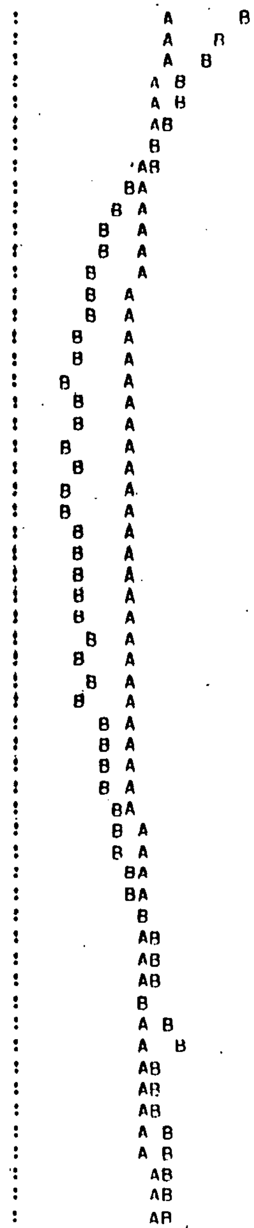
CURVE 'B' IS A PLOT OF TIP VERSUS TIME

MINIMUM VALUE -.2120+001 MAXIMUM VALUE .1521+001



TIME	BASE	TIP
.0000	.0000	-.2120+001
.1000+000	.4429-002	-.1932+001
.2000+000	.1635-001	-.1836+001
.3000+000	.3878-001	-.1594+001
.4000+000	.7377-001	-.1250+001
.5000+000	.1195+000	-.8207+000
.6000+000	.1706+000	-.5149+000
.7000+000	.2210+000	-.2914+000
.8000+000	.2646+000	-.2721+000
.9000+000	.2989+000	-.2951+000
.1000+001	.3270+000	-.2846+000
.1100+001	.3535+000	-.2143+000
.1200+001	.3829+000	.2140-001
.1300+001	.4175+000	.3047+000
.1400+001	.4565+000	.5736+000
.1500+001	.4961+000	.7856+000
.1600+001	.5336+000	.9487+000
.1700+001	.5665+000	.1001+001
.1800+001	.5929+000	.1023+001
.1900+001	.6147+000	.1041+001
.2000+001	.6326+000	.1051+001
.2100+001	.6492+000	.1139+001
.2200+001	.6664+000	.1273+001
.2300+001	.6838+000	.1381+001
.2400+001	.7006+000	.1487+001
.2500+001	.7148+000	.1521+001
.2600+001	.7253+000	.1487+001
.2700+001	.7312+000	.1462+001
.2800+001	.7342+000	.1458+001
.2900+001	.7352+000	.1432+001
.3000+001	.7347+000	.1446+001
.3100+001	.7335+000	.1412+001
.3200+001	.7297+000	.1371+001
.3300+001	.7245+000	.1349+001
.3400+001	.7184+000	.1374+001
.3500+001	.7115+000	.1340+001
.3600+001	.7027+000	.1267+001
.3700+001	.6921+000	.1181+001
.3800+001	.6803+000	.1122+001
.3900+001	.6679+000	.1037+001
.4000+001	.6552+000	.1027+001
.4100+001	.6435+000	.1006+001
.4200+001	.6317+000	.9675+000

FIGURE F8



.4300+001	.6194+000	.9043+000
.4400+001	.6064+000	.8432+000
.4500+001	.5936+000	.7726+000
.4600+001	.5800+000	.6760+000
.4700+001	.5668+000	.6486+000
.4800+001	.5544+000	.6340+000
.4900+001	.5434+000	.5793+000
.5000+001	.5324+000	.5381+000
.5100+001	.5218+000	.4490+000
.5200+001	.5109+000	.4126+000
.5300+001	.5004+000	.3713+000
.5400+001	.4909+000	.3593+000
.5500+001	.4822+000	.3201+000
.5600+001	.4743+000	.2927+000
.5700+001	.4672+000	.2978+000
.5800+001	.4615+000	.2514+000
.5900+001	.4559+000	.2321+000
.6000+001	.4507+000	.1949+000
.6100+001	.4465+000	.2315+000
.6200+001	.4441+000	.2385+000
.6300+001	.4423+000	.2077+000
.6400+001	.4414+000	.2397+000
.6500+001	.4403+000	.1871+000
.6600+001	.4400+000	.2141+000
.6700+001	.4412+000	.2409+000
.6800+001	.4428+000	.2364+000
.6900+001	.4449+000	.2415+000
.7000+001	.4469+000	.2415+000
.7100+001	.4493+000	.2563+000
.7200+001	.4525+000	.2754+000
.7300+001	.4555+000	.2539+000
.7400+001	.4581+000	.2791+000
.7500+001	.4606+000	.2725+000
.7600+001	.4639+000	.3336+000
.7700+001	.4677+000	.3467+000
.7800+001	.4713+000	.3475+000
.7900+001	.4746+000	.3572+000
.8000+001	.4786+000	.4020+000
.8100+001	.4832+000	.4213+000
.8200+001	.4869+000	.4188+000
.8300+001	.4904+000	.4343+000
.8400+001	.4938+000	.4733+000
.8500+001	.4975+000	.5285+000
.8600+001	.5029+000	.5651+000
.8700+001	.5077+000	.5476+000
.8800+001	.5114+000	.5366+000
.8900+001	.5143+000	.5214+000
.9000+001	.5171+000	.5894+000
.9100+001	.5213+000	.6405+000
.9200+001	.5251+000	.5713+000
.9300+001	.5268+000	.5669+000
.9400+001	.5286+000	.5831+000
.9500+001	.5305+000	.6114+000
.9600+001	.5323+000	.5902+000
.9700+001	.5337+000	.6278+000
.9800+001	.5350+000	.5958+000
.9900+001	.5362+000	.6113+000

FIGURE F9

.1000+002	B	.5357+000	.5758+000
.1010+002	AB	.5346+000	.5904+000
.1020+002	AB	.5343+000	.6033+000
.1030+002	AB	.5339+000	.6059+000
.1040+002	AB	.5336+000	.6178+000
.1050+002	AB	.5333+000	.6187+000
.1060+002	AB	.5337+000	.6177+000
.1070+002	AB	.5334+000	.5972+000
.1080+002	A B	.5343+000	.6831+000
.1090+002	A B	.5363+000	.6558+000
.1100+002	B	.5367+000	.5790+000
.1110+002	AB	.5360+000	.5991+000
.1120+002	B	.5358+000	.5717+000
.1130+002	B	.5346+000	.5550+000
.1140+002	B	.5333+000	.5708+000
.1150+002	AB	.5325+000	.5588+000
.1160+002	AB	.5314+000	.5421+000
.1170+002	B	.5299+000	.4995+000
.1180+002	B	.5277+000	.5310+000
.1190+002	AB	.5269+000	.5524+000
.1200+002	AB	.5273+000	.5514+000
.1210+002	B	.5271+000	.5096+000
.1220+002	B	.5256+000	.4933+000
.1230+002	B	.5246+000	.4944+000
.1240+002	B	.5242+000	.5106+000
.1250+002	B	.5233+000	.4906+000
.1260+002	BA	.5225+000	.4721+000
.1270+002	BA	.5214+000	.4744+000
.1280+002	BA	.5201+000	.4754+000
.1290+002	B	.5195+000	.5112+000
.1300+002	B	.5195+000	.4851+000
.1310+002	B A	.5147+000	.1694+000
.1320+002	B A	.5031+000	.2438+000
.1330+002	B	.4990+000	.5204+000
.1340+002	A B	.5018+000	.6601+000
.1350+002	A B	.5062+000	.6042+000
.1360+002	BA	.5079+000	.4796+000
.1370+002	BA	.5076+000	.4394+000
.1380+002	B A	.5059+000	.4133+000
.1390+002	BA	.5037+000	.4363+000
.1400+002	BA	.5016+000	.4692+000
.1410+002	BA	.4990+000	.4455+000
.1420+002	BA	.4954+000	.4598+000
.1430+002	BA	.4920+000	.4328+000
.1440+002	B A	.4887+000	.4236+000
.1450+002	BA	.4861+000	.4581+000
.1460+002	B	.4859+000	.5219+000
.1470+002	B	.4864+000	.5226+000
.1480+002	B	.4866+000	.5227+000
.1490+002	B	.4857+000	.5182+000
.1500+002	B	.4836+000	.5166+000
.1510+002	B	.4814+000	.5145+000
.1520+002	AB	.4794+000	.5123+000
.1530+002	B	.4767+000	.4803+000
.1540+002	AB	.4745+000	.5234+000
.1550+002	A B	.4739+000	.5473+000
.1560+002	A B	.4737+000	.5551+000

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FIGURE F10

```
.1570+002 I                                          :        A B                  I .4731+000 .5448+000
.1580+002 I                                          :        A B                  I .4715+000 .5366+000
.1590+002 I                                          :   B    A                    I .4638+000 .2058+000
.1600+002 I                                          :B       A                    I .4468+000 .5555-001
.1610+002 I                                          :        A          B         I .4454+000 .9690+000
.1620+002 I                                          :       BA                    I .4482+000 .4240+000
.1630+002 I                                          : B      A                    I .4366+000 .1138+000
.1640+002 I                                          :        A          B         I .4370+000 .9801+000
.1650+002 I                                          :       BA                    I .4421+000 .4279+000
.1660+002 I                                          : B      A                    I .4317+000 .1145+000
.1670+002 I                                          :        A          B         I .4332+000 .9767+000
.1680+002 I                                          :        B                    I .4379+000 .4558+000
.1690+002 I                                          :  B    A                     I .4272+000 .1315+000
.1700+002 I                                          :       A          B          I .4267+000 .9340+000
.1710+002 I                                          :      BA                     I .4286+000 .3562+000
.1720+002 I                                          :B      A                     I .4148+000 .2022-001
.1730+002 I                                          :       A          B          I .4137+000 .9098+000
.1740+002 I                                          :      BA                     I .4172+000 .3721+000
.1750+002 I                                          :B      A                     I .4056+000 .5543-001
.1760+002 I                                          :       A          B          I .4061+000 .9331+000
.1770+002 I                                          :      BA                     I .4103+000 .3754+000
.1780+002 I                                          :B      A                     I .3984+000 .1833-001
.1790+002 I                                          :       A         B           I .3973+000 .8639+000
.1800+002 I                                          :      BA                     I .3999+000 .3434+000
.1810+002 I                                          :B      A                     I .3883+000 .1919-001
.1820+002 I                                          :       A         B           I .3888+000 .8830+000
.1830+002 I                                          :      BA                     I .3929+000 .3313+000
.1840+002 I                                          :B      A                     I .3823+000 .2091-001
.1850+002 I                                          :       A         B           I .3839+000 .8923+000
.1860+002 I                                          :     B A                     I .3891+000 .3156+000
.1870+002 I                                         B:       A                     I .3774+000-.4625-001
.1880+002 I                                          :       A         B           I .3772+000 .8480+000
.1890+002 I                                          :     B A                     I .3814+000 .3102+000
.1900+002 I                                         B:      A                      I .3700+000-.5115-001
.1910+002 I                                          :      A         B            I .3705+000 .8435+000
.1920+002 I                                          :     BA                      I .3757+000 .3008+000
.1930+002 I                                          B      A                      I .3664+000-.4189-002
.1940+002 I                                          :      A          B           I .3688+000 .8524+000
.1950+002 I                                          :     BA                      I .3747+000 .2909+000
.1960+002 I                                          B      A                      I .3650+000-.3516-001
.1970+002 I                                          :      A         B            I .3667+000 .8157+000
.1980+002 I                                          :     BA                      I .3721+000 .2809+000
.1990+002 I                                          B      A                      I .3620+000-.2999-001
.2000+002 I                                          :      A         B            I .3640+000 .8075+000
.2010+002 I                                          :    B A                      I .3690+000 .2540+000
.2020+002 I                                         B:      A                      I .3593+000-.6264-001
.2030+002 I                                          :      A         B            I .3618+000 .8427+000
.2040+002 I                                          :      A     B                I .3749+000 .6219+000
.2050+002 I                                          :       AB                    I .3812+000 .4528+000
.2060+002 I                                          :       B                     I .3842+000 .3783+000
.2070+002 I                                          :      BA                     I .3861+000 .3624+000
.2080+002 I                                          :      BA                     I .3879+000 .3676+000
.2090+002 I                                          :      BA                     I .3889+000 .3637+000
.2100+002 I                                          :      BA                     I .3899+000 .3638+000
.2110+002 I                                          :      BA                     I .3902+000 .3483+000
.2120+002 I                                          :      BA                     I .3908+000 .3429+000
.2130+002 I                                          :      BA                     I .3919+000 .3435+000
```

FIGURE F11

.2140+002	BA	.3933+000	.3362+000
.2150+002	BA	.3950+000	.3270+000
.2160+002	BA	.3968+000	.3657+000
.2170+002	B	.4003+000	.3941+000
.2180+002	BA	.4031+000	.3743+000
.2190+002	BA	.4049+000	.3457+000
.2200+002	BA	.4058+000	.3340+000
.2210+002	B A	.4059+000	.3016+000
.2220+002	B A	.4056+000	.2914+000
.2230+002	B A	.4058+000	.3147+000
.2240+002	B A	.4065+000	.3226+000
.2250+002	BA	.4076+000	.3677+000
.2260+002	BA	.4097+000	.3748+000
.2270+002	B	.4117+000	.3836+000
.2280+002	BA	.4128+000	.3561+000
.2290+002	BA	.4133+000	.3675+000
.2300+002	B	.4145+000	.3887+000
.2310+002	B	.4161+000	.4149+000
.2320+002	B	.4183+000	.4170+000
.2330+002	B	.4199+000	.4052+000
.2340+002	B	.4208+000	.4040+000
.2350+002	B	.4219+000	.4050+000
.2360+002	B	.4225+000	.4001+000
.2370+002	B	.4229+000	.4267+000
.2380+002	AB	.4243+000	.4574+000
.2390+002	AB	.4256+000	.4707+000
.2400+002	AB	.4262+000	.4312+000
.2410+002	AB	.4265+000	.4443+000
.2420+002	AB	.4273+000	.4687+000
.2430+002	AB	.4282+000	.4570+000
.2440+002	AB	.4280+000	.4535+000
.2450+002	AB	.4276+000	.4460+000
.2460+002	AB	.4273+000	.4742+000
.2470+002	A B	.4279+000	.4861+000
.2480+002	AB	.4281+000	.4645+000
.2490+002	AB	.4284+000	.4716+000
.2500+002	AB	.4283+000	.4702+000
.2510+002	B A	.4245+000	.2179+000
.2520+002	B A	.4151+000	.2509+000
.2530+002	A B	.4113+000	.4859+000
.2540+002	A B	.4121+000	.5687+000
.2550+002	A B	.4137+000	.5104+000
.2560+002	B	.4131+000	.4215+000
.2570+002	B	.4109+000	.4108+000
.2580+002	BA	.4086+000	.3755+000
.2590+002	B	.4052+000	.3888+000
.2600+002	B	.4021+000	.4129+000
.2610+002	B	.3985+000	.3871+000
.2620+002	B	.3948+000	.4075+000
.2630+002	B	.3901+000	.3871+000
.2640+002	B	.3864+000	.3940+000
.2650+002	B	.3836+000	.3988+000
.2660+002	B	.3811+000	.4107+000
.2670+002	AB	.3793+000	.4506+000
.2680+002	AB	.3784+000	.4509+000
.2690+002	A B	.3771+000	.4414+000
.2700+002	AB	.3745+000	.3963+000

FIGURE F12

.2710+002	B	.3706+000	.3713+000
.2720+002	AB	.3666+000	.3874+000
.2730+002	AB	.3636+000	.3949+000
.2740+002	AB	.3614+000	.3946+000
.2750+002	AB	.3595+000	.4260+000
.2760+002	AB	.3576+000	.4014+000
.2770+002	AB	.3562+000	.4055+000
.2780+002	AB	.3543+000	.3840+000
.2790+002	B	.3512+000	.3509+000
.2800+002	B	.3478+000	.3487+000
.2810+002	B	.3441+000	.3288+000
.2820+002	B	.3402+000	.3256+000
.2830+002	BA	.3364+000	.3125+000
.2840+002	B	.3335+000	.3435+000
.2850+002	B	.3314+000	.3470+000
.2860+002	B	.3295+000	.3377+000
.2870+002	B	.3277+000	.3491+000
.2880+002	B	.3263+000	.3502+000
.2890+002	AB	.3245+000	.3319+000
.2900+002	AB	.3227+000	.3436+000
.2910+002	B	.3203+000	.2847+000
.2920+002	AB	.3184+000	.3309+000
.2930+002	B	.3170+000	.3181+000
.2940+002	B	.3158+000	.3198+000
.2950+002	B	.3143+000	.3210+000
.2960+002	B	.3128+000	.2895+000
.2970+002	B	.3114+000	.2891+000
.2980+002	B	.3104+000	.3182+000
.2990+002	B	.3093+000	.3078+000
.3000+002	B	.3081+000	.3063+000

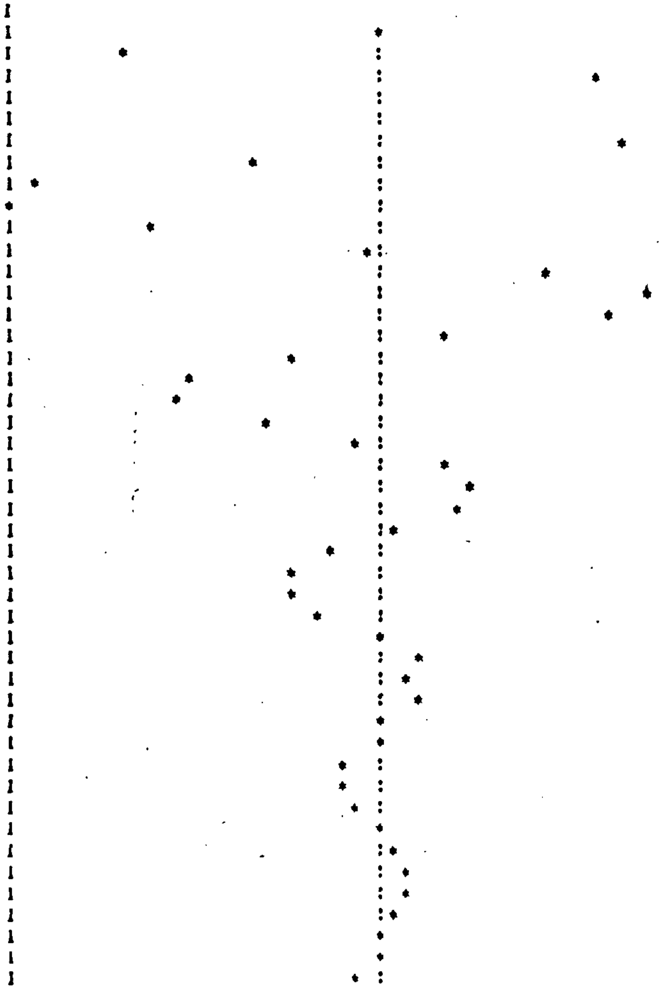
FIGURE F13

DATA FOR THE Y-AXIS

CURVE '*' IS A PLOT OF TORQUE VERSUS TIME

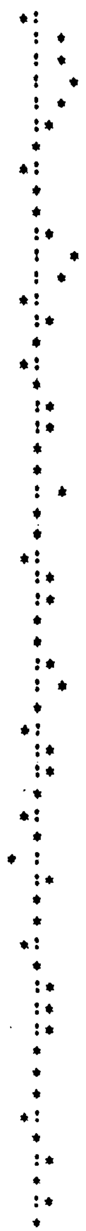
MINIMUM VALUE -.4244+001

MAXIMUM VALUE .5736+001



TIME	TORQUE
.0000	.0000
.1000+000	-.2943+001
.2000+000	.2328+001
.3000+000	.5709+001
.4000+000	.5736+001
.5000+000	.2620+001
.6000+000	-.1418+001
.7000+000	-.3884+001
.8000+000	-.4244+001
.9000+000	-.2665+001
.1000+001	-.1608+000
.1100+001	.1877+001
.1200+001	.2905+001
.1300+001	.2561+001
.1400+001	.6498+000
.1500+001	-.9756+000
.1600+001	-.2178+001
.1700+001	-.2326+001
.1800+001	-.1308+001
.1900+001	-.2612+000
.2000+001	.6748+000
.2100+001	.9992+000
.2200+001	.7858+000
.2300+001	.1595+000
.2400+001	-.6412+000
.2500+001	-.1087+001
.2600+001	-.9952+000
.2700+001	-.7599+000
.2800+001	-.9406-001
.2900+001	.4274+000
.3000+001	.2626+000
.3100+001	.3267+000
.3200+001	-.4895-001
.3300+001	-.1027+000
.3400+001	-.3973+000
.3500+001	-.4893+000
.3600+001	-.3752+000
.3700+001	-.3664-002
.3800+001	.5316-001
.3900+001	.2175+000
.4000+001	.2591+000
.4100+001	.1175+000
.4200+001	-.5271-001
.4300+001	-.4682-003
.4400+001	-.2639+000

FIGURE F14



.4500+001	-.1114+000
.4600+001	.1894+000
.4700+001	.2943+000
.4800+001	.3887+000
.4900+001	.1884+000
.5000+001	.1478+000
.5100+001	-.2895-001
.5200+001	-.1712+000
.5300+001	.1595-001
.5400+001	-.1663-002
.5500+001	.1687+000
.5600+001	.3309+000
.5700+001	.2053+000
.5800+001	-.1104+000
.5900+001	.1398+000
.6000+001	-.9231-001
.6100+001	-.1393+000
.6200+001	-.8078-001
.6300+001	.7704-001
.6400+001	.8404-001
.6500+001	-.2102-001
.6600+001	-.3670-001
.6700+001	.2635+000
.6800+001	-.2916-001
.6900+001	.2929-001
.7000+001	-.1427+000
.7100+001	.7950-001
.7200+001	.7827-001
.7300+001	-.1042+000
.7400+001	.2291-001
.7500+001	.1292+000
.7600+001	.2096+000
.7700+001	.2152-001
.7800+001	-.1108+000
.7900+001	.1089+000
.8000+001	.4461-001
.8100+001	-.1988-001
.8200+001	-.1107+000
.8300+001	-.2262-002
.8400+001	-.2817+000
.8500+001	.1226+000
.8600+001	.1500-001
.8700+001	-.1019-001
.8800+001	-.1954+000
.8900+001	-.9132-001
.9000+001	.4687-001
.9100+001	.7635-001
.9200+001	.6459-001
.9300+001	-.2400-001
.9400+001	-.7020-001
.9500+001	-.6601-001
.9600+001	-.1510+000
.9700+001	.2460-001
.9800+001	.1550+000
.9900+001	-.9806-001
.1000+002	.5305-001
.1010+002	-.1263-001

FIGURE F15

```
.1020+002 I                    *                    I-.9609-001
.1030+002 I                    *                    I-.1436-002
.1040+002 I                    *                    I-.5757-001
.1050+002 I                    *                    I-.7742-001
.1060+002 I                    *                    I .2364-001
.1070+002 I                    *                    I-.5723-001
.1080+002 I                    :*                   I .4191-001
.1090+002 I                    *                    I .1891-001
.1100+002 I                    *                    I .2992-001
.1110+002 I                    :*                   I .1005+000
.1120+002 I                    *                    I-.6771-001
.1130+002 I                    *                    I-.5617-001
.1140+002 I                    *                    I-.6306-001
.1150+002 I                   *:                    I-.1411+000
.1160+002 I                    *                    I-.9641-001
.1170+002 I                    *                    I-.3375-001
.1180+002 I                    *                    I-.5262-001
.1190+002 I                    *                    I .4440-002
.1200+002 I                    :*                   I .6107-001
.1210+002 I                    *                    I-.4062-002
.1220+002 I                   *:                    I-.1628+000
.1230+002 I                    *                    I-.6279-001
.1240+002 I                    :*                   I .1131+000
.1250+002 I                    :*                   I .1662+000
.1260+002 I                    :*                   I .1443+000
.1270+002 I                    :*                   I .4227-001
.1280+002 I                    :*                   I .7993-001
.1290+002 I                    :*                   I .5301-001
.1300+002 I                    *                    I-.1143-001
.1310+002 I                    *                    I-.4644-002
.1320+002 I                    *                    I-.2962-001
.1330+002 I                   *:                    I-.1279+000
.1340+002 I                    *                    I-.4100-001
.1350+002 I                    *                    I-.6859-001
.1360+002 I                    :*                   I .3448-001
.1370+002 I                    *                    I .4989-003
.1380+002 I                    *                    I-.1028+000
.1390+002 I                    *                    I .1293-001
.1400+002 I                    :*                   I .4288-001
.1410+002 I                    :*                   I .7180-001
.1420+002 I                    :*                   I .7747-001
.1430+002 I                   *:                    I-.1149+000
.1440+002 I                    :*                   I .1493+000
.1450+002 I                    *                    I .3181-001
.1460+002 I                    *                    I .2626-002
.1470+002 I                    *                    I .2574-001
.1480+002 I                    :*                   I .7095-001
.1490+002 I                    *                    I .2897-002
.1500+002 I                    *                    I-.3126-001
.1510+002 I                    *                    I-.4093-001
.1520+002 I                    *                    I-.2677-002
.1530+002 I                    *                    I .9319-002
.1540+002 I                    *                    I-.6681-001
.1550+002 I                    *                    I-.1977-001
.1560+002 I                    *                    I-.7821-002
.1570+002 I                    :*                   I .1374+000
.1580+002 I                    *                    I-.8407-001

1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890***SEQ.NO.01
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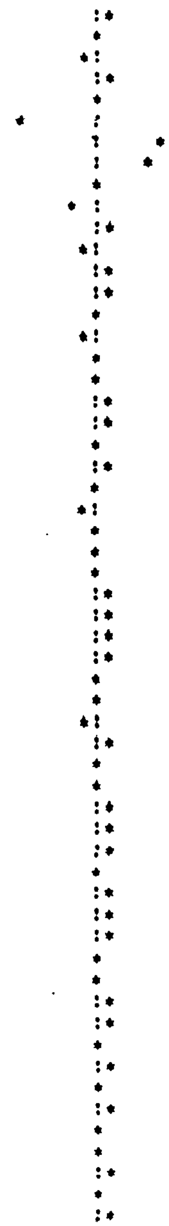
FIGURE F16



.1590+002	.1260+000
.1600+002	.2331-001
.1610+002	-.1141+000
.1620+002	.7156-001
.1630+002	.2770-001
.1640+002	-.9092+000
.1650+002	.6886+000
.1660+002	.4714+000
.1670+002	-.6707-001
.1680+002	-.3216+000
.1690+002	.4581-001
.1700+002	-.1975+000
.1710+002	.1314+000
.1720+002	.1572+000
.1730+002	-.2447-001
.1740+002	-.1490+000
.1750+002	-.4363-002
.1760+002	-.5541-001
.1770+002	.1522+000
.1780+002	.7037-001
.1790+002	-.6145-001
.1800+002	.1641+000
.1810+002	-.5479-001
.1820+002	-.1206+000
.1830+002	-.8786-001
.1840+002	-.5984-001
.1850+002	-.1950-003
.1860+002	.4884-001
.1870+002	.9469-001
.1880+002	.4556-001
.1890+002	.7154-001
.1900+002	-.6125-001
.1910+002	-.1002+000
.1920+002	-.1509+000
.1930+002	.1191+000
.1940+002	-.9998-002
.1950+002	-.8809-001
.1960+002	.6210-001
.1970+002	.6848-001
.1980+002	.5894-001
.1990+002	.5394-002
.2000+002	.4316-001
.2010+002	.4761-001
.2020+002	.9653-001
.2030+002	.7868-002
.2040+002	.2845-001
.2050+002	.5146-001
.2060+002	.9308-001
.2070+002	.1070-001
.2080+002	.8162-001
.2090+002	.2903-001
.2100+002	.8355-001
.2110+002	-.8984-003
.2120+002	-.4507-001
.2130+002	.9396-001
.2140+002	-.7882-001
.2150+002	.8562-001

FIGURE F17

```
.2160+002 I     *       I-.3121-001
.2170+002 I     *       I-.2212-001
.2180+002 I     *       I-.9791-001
.2190+002 I     :*      I .1033+000
.2200+002 I     :*      I .1276+000
.2210+002 I     :*      I .4189-001
.2220+002 I     *       I .1807-001
.2230+002 I     *       I-.1104-001
.2240+002 I    *:       I-.1103+000
.2250+002 I    *:       I-.1653+000
.2260+002 I     *       I-.4281-001
.2270+002 I     : *     I .2970+000
.2280+002 I     :*      I .5795-001
.2290+002 I     *       I-.3867-001
.2300+002 I     :*      I .4616-001
.2310+002 I     :*      I .4477-001
.2320+002 I  *  :       I-.8214+000
.2330+002 I     :    *  I .8091+000
.2340+002 I     :  *    I .3377+000
.2350+002 I     *       I-.6444-001
.2360+002 I    *:       I-.1989+000
.2370+002 I    *:       I-.1461+000
.2380+002 I     *       I .6870-002
.2390+002 I     :*      I .9591-001
.2400+002 I     *       I-.1504-001
.2410+002 I     :*      I .6390-001
.2420+002 I     :*      I .1637+000
.2430+002 I     *       I-.1995-002
.2440+002 I    *:       I-.2151+000
.2450+002 I     :*      I .3648-001
.2460+002 I     *       I .2698-001
.2470+002 I     :*      I .1510+000
.2480+002 I     *       I-.1046+000
.2490+002 I    *:       I-.1293+000
.2500+002 I     *       I .1586-002
.2510+002 I     *       I .3761-002
.2520+002 I    *:       I-.1218+000
.2530+002 I     :*      I .7945-001
.2540+002 I     : *     I .2202+000
.2550+002 I     *       I-.6298-001
.2560+002 I     :*      I .8343-001
.2570+002 I     *       I-.1725-001
.2580+002 I     :*      I .7037-001
.2590+002 I     *       I-.2315-001
.2600+002 I     *       I-.2516-001
.2610+002 I     :*      I .1111+000
.2620+002 I     :*      I .5553-001
.2630+002 I     *       I-.1086-001
.2640+002 I     *       I-.1194-001
.2650+002 I     :*      I .1221+000
.2660+002 I     *       I .1339-001
.2670+002 I     *       I-.5390-001
.2680+002 I     *       I-.5344-001
.2690+002 I     :*      I .1519+000
.2700+002 I     *       I-.4628-001
.2710+002 I     :*      I .1348+000
.2720+002 I    *:       I-.1644+000
```

12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890***SEQ.NO.01

FIGURE F18

.2730+002	-.5669-001
.2740+002	.1508+000
.2750+002	-.1301-001
.2760+002	.1060+000
.2770+002	.2539-001
.2780+002	.4837-001
.2790+002	.1910-001
.2800+002	-.6830-001
.2810+002	.3686-001
.2820+002	.1012+000
.2830+002	-.5579-002
.2840+002	.1043+000
.2850+002	-.6044-001
.2860+002	-.6436-001
.2870+002	.7874-001
.2880+002	-.3391-001
.2890+002	-.3192-001
.2900+002	-.5568+000
.2910+002	.3162+000
.2920+002	.1249+000
.2930+002	-.6756-001
.2940+002	-.1261+000
.2950+002	-.2933+000
.2960+002	-.4057-001
.2970+002	-.2141-001
.2980+002	.2157+000
.2990+002	.1750-001
.3000+002	-.8567-001

FIGURE F19

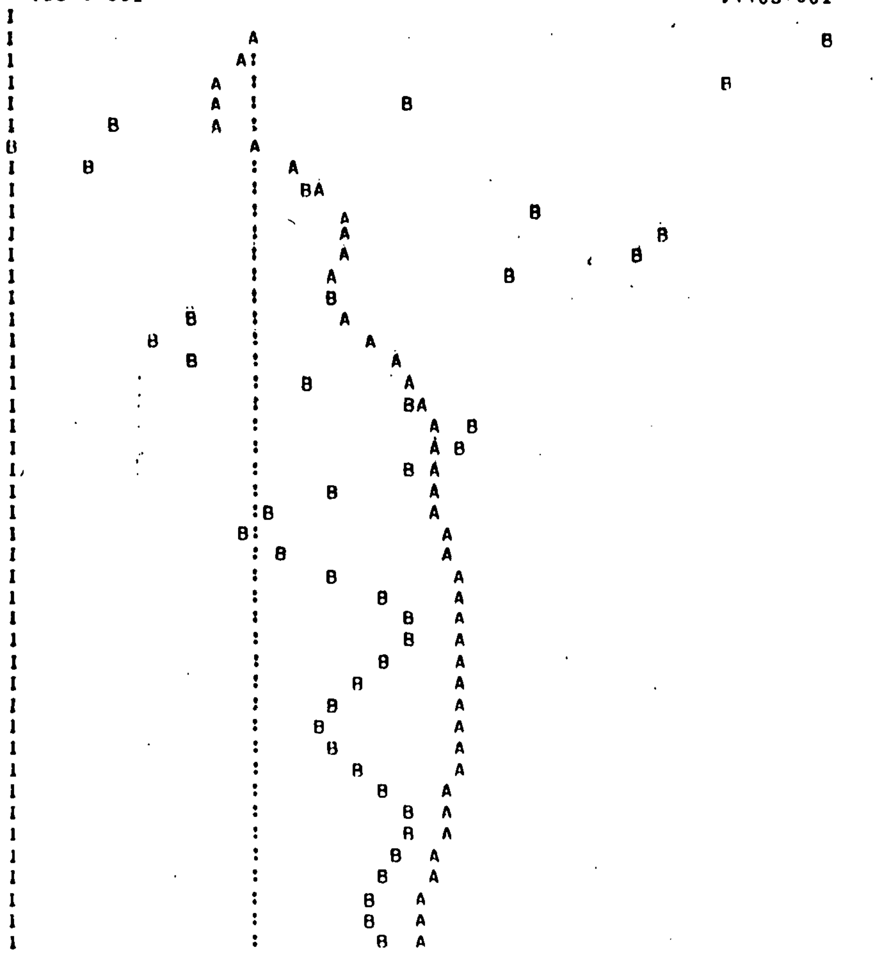
DATA FOR THE Y-AXIS

CURVE 'A' IS A PLOT OF BASE VERSUS TIME

CURVE 'B' IS A PLOT OF TIP VERSUS TIME

MINIMUM VALUE -.1645+001

MAXIMUM VALUE .4403+001



TIME	BASE	TIP
.0000	.0000	.3963+001
.1000+000	-.6003-001	.4403+001
.2000+000	-.1792+000	.3206+001
.3000+000	-.2442+000	.1056+001
.4000+000	-.1803+000	-.8736+000
.5000+000	.9205-002	-.1645+001
.6000+000	.2564+000	-.1047+001
.7000+000	.4742+000	.4249+000
.8000+000	.6041+000	.1947+001
.9000+000	.6361+000	.2791+001
.1000+001	.6076+000	.2667+001
.1100+001	.5760+000	.1766+001
.1200+001	.5907+000	.5696+000
.1300+001	.6735+000	-.3728+000
.1400+001	.8105+000	-.6760+000
.1500+001	.9647+000	-.3510+000
.1600+001	.1096+001	.3721+000
.1700+001	.1180+001	.1094+001
.1800+001	.1213+001	.1500+001
.1900+001	.1214+001	.1460+001
.2000+001	.1208+001	.1069+001
.2100+001	.1219+001	.5377+000
.2200+001	.1257+001	.1321+000
.2300+001	.1316+001	-.4128-002
.2400+001	.1379+001	.1742+000
.2500+001	.1428+001	.5303+000
.2600+001	.1452+001	.8685+000
.2700+001	.1451+001	.1079+001
.2800+001	.1432+001	.1084+001
.2900+001	.1408+001	.9148+000
.3000+001	.1391+001	.6997+000
.3100+001	.1384+001	.5366+000
.3200+001	.1384+001	.4891+000
.3300+001	.1385+001	.5824+000
.3400+001	.1381+001	.7418+000
.3500+001	.1366+001	.9158+000
.3600+001	.1338+001	.1034+001
.3700+001	.1302+001	.1053+001
.3800+001	.1264+001	.9887+000
.3900+001	.1229+001	.8987+000
.4000+001	.1199+001	.8281+000
.4100+001	.1174+001	.8249+000
.4200+001	.1149+001	.8729+000

FIGURE F20

.4300+001	I	B A	I	.1124+001 .9272+000
.4400+001	I	BA	I	.1096+001 .1013+001
.4500+001	I	B	I	.1063+001 .1065+001
.4600+001	I	AB	I	.1029+001 .1058+001
.4700+001	I	B	I	.9960+000 .1022+001
.4800+001	I	B	I	.9654+000 .9993+000
.4900+001	I	AB	I	.9378+000 .9636+000
.5000+001	I	B	I	.9152+000 .9452+000
.5100+001	I	AB	I	.8949+000 .9730+000
.5200+001	I	AB	I	.8756+000 .9946+000
.5300+001	I	A B	I	.8565+000 .1024+001
.5400+001	I	A B	I	.8367+000 .1045+001
.5500+001	I	A B	I	.8175+000 .1041+001
.5600+001	I	A B	I	.7997+000 .1019+001
.5700+001	I	A B	I	.7852+000 .9920+000
.5800+001	I	A B	I	.7740+000 .9801+000
.5900+001	I	A B	I	.7653+000 .9605+000
.6000+001	I	A B	I	.7591+000 .9692+000
.6100+001	I	A B	I	.7537+000 .9828+000
.6200+001	I	A B	I	.7488+000 .9895+000
.6300+001	I	A B	I	.7442+000 .9841+000
.6400+001	I	A B	I	.7419+000 .9660+000
.6500+001	I	A B	I	.7420+000 .9486+000
.6600+001	I	A B	I	.7433+000 .9452+000
.6700+001	I	A B	I	.7459+000 .9208+000
.6800+001	I	A B	I	.7514+000 .9071+000
.6900+001	I	A B	I	.7579+000 .9078+000
.7000+001	I	A B	I	.7650+000 .9117+000
.7100+001	I	A B	I	.7724+000 .9176+000
.7200+001	I	AB	I	.7803+000 .9144+000
.7300+001	I	AB	I	.7889+000 .9032+000
.7400+001	I	AB	I	.7972+000 .9132+000
.7500+001	I	AB	I	.8051+000 .9119+000
.7600+001	I	AB	I	.8134+000 .9008+000
.7700+001	I	AB	I	.8219+000 .8973+000
.7800+001	I	AB	I	.8308+000 .8994+000
.7900+001	I	AB	I	.8395+000 .8865+000
.8000+001	I	AB	I	.8491+000 .8804+000
.8100+001	I	AB	I	.8590+000 .8788+000
.8200+001	I	B	I	.8679+000 .8822+000
.8300+001	I	B	I	.8768+000 .8769+000
.8400+001	I	B	I	.8861+000 .8696+000
.8500+001	I	B	I	.8945+000 .8793+000
.8600+001	I	B	I	.9021+000 .8756+000
.8700+001	I	B	I	.9097+000 .8824+000
.8800+001	I	B	I	.9166+000 .8863+000
.8900+001	I	B	I	.9230+000 .8834+000
.9000+001	I	B	I	.9288+000 .8847+000
.9100+001	I	B	I	.9336+000 .8843+000
.9200+001	I	B	I	.9379+000 .8824+000
.9300+001	I	B	I	.9420+000 .8818+000
.9400+001	I	B	I	.9460+000 .8867+000
.9500+001	I	BA	I	.9486+000 .8956+000
.9600+001	I	BA	I	.9503+000 .8975+000
.9700+001	I	BA	I	.9513+000 .8986+000
.9800+001	I	BA	I	.9526+000 .8860+000
.9900+001	I	BA	I	.9542+000 .8885+000

FIGURE F21

.1000+002	BA	.9547+000	.8957+000
.1010+002	BA	.9548+000	.8822+000
.1020+002	BA	.9554+000	.8942+000
.1030+002	BA	.9545+000	.8996+000
.1040+002	BA	.9527+000	.9125+000
.1050+002	BA	.9513+000	.9057+000
.1060+002	BA	.9498+000	.8960+000
.1070+002	BA	.9488+000	.8960+000
.1080+002	BA	.9475+000	.8995+000
.1090+002	B	.9460+000	.8946+000
.1100+002	B	.9443+000	.8993+000
.1110+002	B	.9427+000	.8932+000
.1120+002	B	.9412+000	.9174+000
.1130+002	B	.9373+000	.9318+000
.1140+002	B	.9334+000	.9273+000
.1150+002	B	.9294+000	.9320+000
.1160+002	B	.9257+000	.9257+000
.1170+002	B	.9222+000	.9256+000
.1180+002	B	.9190+000	.9163+000
.1190+002	B	.9162+000	.9078+000
.1200+002	B	.9144+000	.9011+000
.1210+002	B	.9127+000	.9066+000
.1220+002	B	.9111+000	.9140+000
.1230+002	B	.9086+000	.9169+000
.1240+002	B	.9060+000	.9218+000
.1250+002	B	.9025+000	.9398+000
.1260+002	B	.8986+000	.9300+000
.1270+002	B	.8962+000	.9140+000
.1280+002	B	.8954+000	.9020+000
.1290+002	B	.8942+000	.9098+000
.1300+002	B	.8930+000	.9021+000
.1310+002	B	.8923+000	.9010+000
.1320+002	B	.8919+000	.9000+000
.1330+002	B	.8916+000	.9064+000
.1340+002	B	.8907+000	.9094+000
.1350+002	B	.8908+000	.8936+000
.1360+002	B	.8920+000	.8893+000
.1370+002	B	.8936+000	.8906+000
.1380+002	B	.8949+000	.8940+000
.1390+002	B	.8962+000	.8948+000
.1400+002	B	.8970+000	.9037+000
.1410+002	B	.8969+000	.9202+000
.1420+002	B	.8965+000	.9255+000
.1430+002	B	.8953+000	.9364+000
.1440+002	B	.8940+000	.9244+000
.1450+002	B	.8938+000	.9133+000
.1460+002	B	.8940+000	.9179+000
.1470+002	B	.8945+000	.8946+000
.1480+002	B	.8962+000	.8932+000
.1490+002	B	.8976+000	.9020+000
.1500+002	B	.8990+000	.9009+000
.1510+002	B	.9001+000	.9095+000
.1520+002	B	.9009+000	.9100+000
.1530+002	B	.9015+000	.9128+000
.1540+002	B	.9017+000	.9207+000
.1550+002	B	.9015+000	.9159+000
.1560+002	B	.9017+000	.9101+000

FIGURE F22

.1570+002	B	.9020+000	.9001+000
.1580+002	B	.9030+000	.9010+000
.1590+002	B	.9040+000	.8951+000
.1600+002	B	.9053+000	.8971+000
.1610+002	B	.9070+000	.8967+000
.1620+002	B	.9078+000	.9124+000
.1630+002	B	.9077+000	.9101+000
.1640+002	A B	.9008+000	.1068+001
.1650+002	AB	.8829+000	.1020+001
.1660+002	B	.8783+000	.8619+000
.1670+002	BA	.8845+000	.8181+000
.1680+002	BA	.8905+000	.8377+000
.1690+002	B	.8918+000	.8688+000
.1700+002	B	.8892+000	.8919+000
.1710+002	B	.8843+000	.8931+000
.1720+002	B	.8796+000	.9002+000
.1730+002	B	.8747+000	.9156+000
.1740+002	B	.8689+000	.9295+000
.1750+002	B	.8617+000	.9220+000
.1760+002	AB	.8539+000	.9055+000
.1770+002	B	.8467+000	.8508+000
.1780+002	B	.8420+000	.8127+000
.1790+002	B	.8395+000	.7876+000
.1800+002	BA	.8379+000	.7734+000
.1810+002	B	.8374+000	.7785+000
.1820+002	B	.8356+000	.7956+000
.1830+002	B	.8323+000	.8121+000
.1840+002	B	.8280+000	.8123+000
.1850+002	B	.8228+000	.8084+000
.1860+002	B	.8170+000	.7948+000
.1870+002	BA	.8119+000	.7709+000
.1880+002	BA	.8081+000	.7607+000
.1890+002	BA	.8043+000	.7573+000
.1900+002	BA	.8008+000	.7526+000
.1910+002	BA	.7977+000	.7589+000
.1920+002	BA	.7939+000	.7572+000
.1930+002	BA	.7893+000	.7620+000
.1940+002	BA	.7849+000	.7608+000
.1950+002	BA	.7803+000	.7493+000
.1960+002	BA	.7762+000	.7411+000
.1970+002	B	.7728+000	.7350+000
.1980+002	B	.7694+000	.7485+000
.1990+002	B	.7648+000	.7504+000
.2000+002	B	.7606+000	.7492+000
.2010+002	B	.7558+000	.7549+000
.2020+002	B	.7512+000	.7471+000
.2030+002	B	.7473+000	.7411+000
.2040+002	B	.7434+000	.7389+000
.2050+002	B	.7393+000	.7377+000
.2060+002	B	.7356+000	.7364+000
.2070+002	B	.7324+000	.7291+000
.2080+002	B	.7293+000	.7331+000
.2090+002	B	.7259+000	.7351+000
.2100+002	B	.7222+000	.7453+000
.2110+002	B	.7178+000	.7465+000
.2120+002	B	.7135+000	.7389+000
.2130+002	B	.7094+000	.7386+000

FIGURE F23

.2140+002	B	.7059+000	.7311+000
.2150+002	B	.7023+000	.7267+000
.2160+002	B	.6993+000	.7215+000
.2170+002	B	.6967+000	.7104+000
.2180+002	B	.6951+000	.7028+000
.2190+002	B	.6933+000	.7087+000
.2200+002	B	.6916+000	.6989+000
.2210+002	B	.6906+000	.6962+000
.2220+002	B	.6892+000	.6955+000
.2230+002	B	.6882+000	.6962+000
.2240+002	AB	.6869+000	.6994+000
.2250+002	AB	.6858+000	.6942+000
.2260+002	AB	.6847+000	.6963+000
.2270+002	B	.6835+000	.6840+000
.2280+002	AB	.6831+000	.6916+000
.2290+002	AB	.6819+000	.6924+000
.2300+002	B	.6811+000	.6846+000
.2310+002	B	.6811+000	.6781+000
.2320+002	A B	.6760+000	.8028+000
.2330+002	AB	.6615+000	.7675+000
.2340+002	B	.6567+000	.6622+000
.2350+002	B	.6596+000	.6108+000
.2360+002	B	.6635+000	.6318+000
.2370+002	B	.6644+000	.6517+000
.2380+002	B	.6619+000	.6629+000
.2390+002	B	.6578+000	.6734+000
.2400+002	AB	.6530+000	.6886+000
.2410+002	B	.6479+000	.6829+000
.2420+002	AB	.6429+000	.6909+000
.2430+002	AB	.6370+000	.6890+000
.2440+002	B	.6311+000	.6683+000
.2450+002	B	.6251+000	.6451+000
.2460+002	B	.6198+000	.6080+000
.2470+002	BA	.6164+000	.5780+000
.2480+002	BA	.6157+000	.5641+000
.2490+002	BA	.6149+000	.5771+000
.2500+002	BA	.6122+000	.5936+000
.2510+002	BA	.6088+000	.5941+000
.2520+002	BA	.6052+000	.5923+000
.2530+002	B	.6011+000	.5846+000
.2540+002	B	.5972+000	.5634+000
.2550+002	B	.5943+000	.5515+000
.2560+002	B	.5909+000	.5568+000
.2570+002	B	.5873+000	.5573+000
.2580+002	B	.5839+000	.5509+000
.2590+002	B	.5809+000	.5442+000
.2600+002	B	.5787+000	.5418+000
.2610+002	B	.5754+000	.5473+000
.2620+002	B	.5717+000	.5445+000
.2630+002	B	.5682+000	.5372+000
.2640+002	B	.5649+000	.5292+000
.2650+002	B	.5619+000	.5284+000
.2660+002	B	.5592+000	.5342+000
.2670+002	B	.5557+000	.5458+000
.2680+002	B	.5520+000	.5473+000
.2690+002	B	.5485+000	.5367+000
.2700+002	B	.5458+000	.5230+000

FIGURE F24

.2710+002	B	.5439+000	.5302+000
.2720+002	B	.5413+000	.5329+000
.2730+002	B	.5382+000	.5356+000
.2740+002	B	.5353+000	.5316+000
.2750+002	B	.5326+000	.5459+000
.2760+002	B	.5290+000	.5486+000
.2770+002	B	.5258+000	.5363+000
.2780+002	B	.5237+000	.5401+000
.2790+002	B	.5217+000	.5261+000
.2800+002	B	.5194+000	.5395+000
.2810+002	B	.5165+000	.5331+000
.2820+002	AB	.5136+000	.5333+000
.2830+002	AB	.5118+000	.5254+000
.2840+002	AB	.5099+000	.5387+000
.2850+002	AB	.5071+000	.5497+000
.2860+002	AB	.5038+000	.5425+000
.2870+002	AB	.5013+000	.5270+000
.2880+002	AB	.5000+000	.5161+000
.2890+002	B	.4999+000	.4989+000
.2900+002	AB	.4961+000	.5908+000
.2910+002	AB	.4860+000	.5652+000
.2920+002	B	.4829+000	.4837+000
.2930+002	B	.4852+000	.4672+000
.2940+002	B	.4881+000	.4692+000
.2950+002	B	.4892+000	.4894+000
.2960+002	B	.4876+000	.4966+000
.2970+002	B	.4854+000	.4930+000
.2980+002	B	.4831+000	.4991+000
.2990+002	B	.4809+000	.4991+000
.3000+002	B	.4785+000	.5068+000

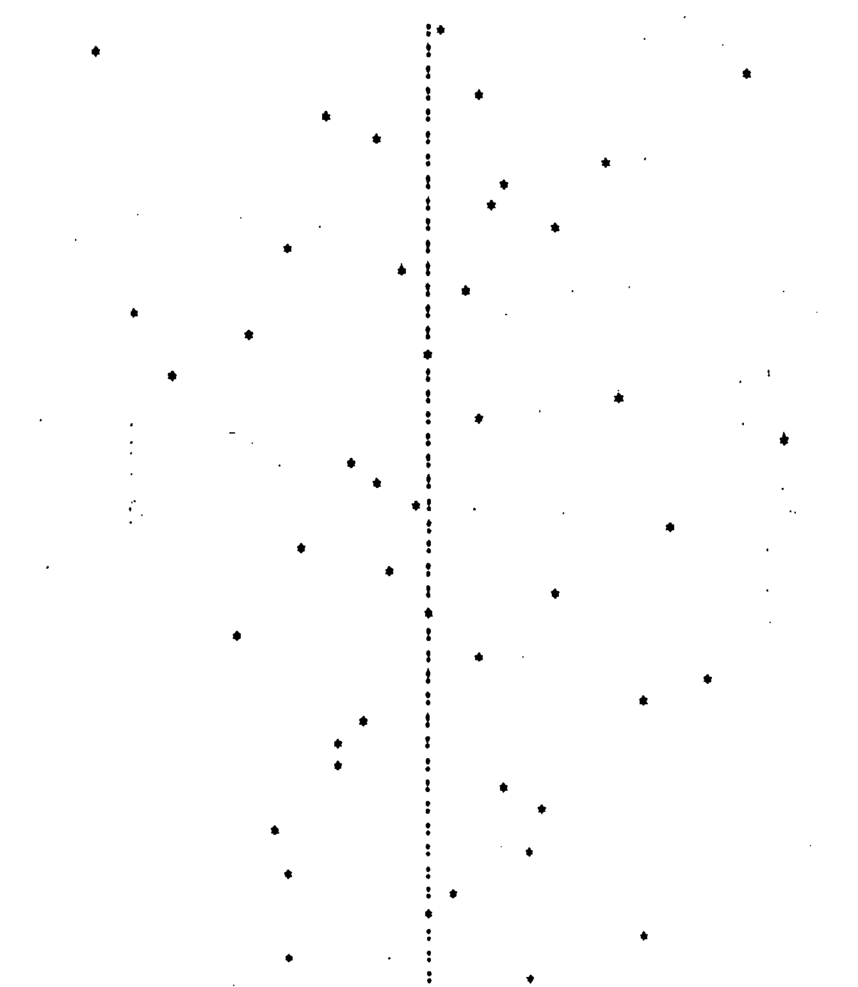
FIGURE F25

DATA FOR THE Z-AXIS

CURVE '*' IS A PLOT OF TORQUE VERSUS TIME

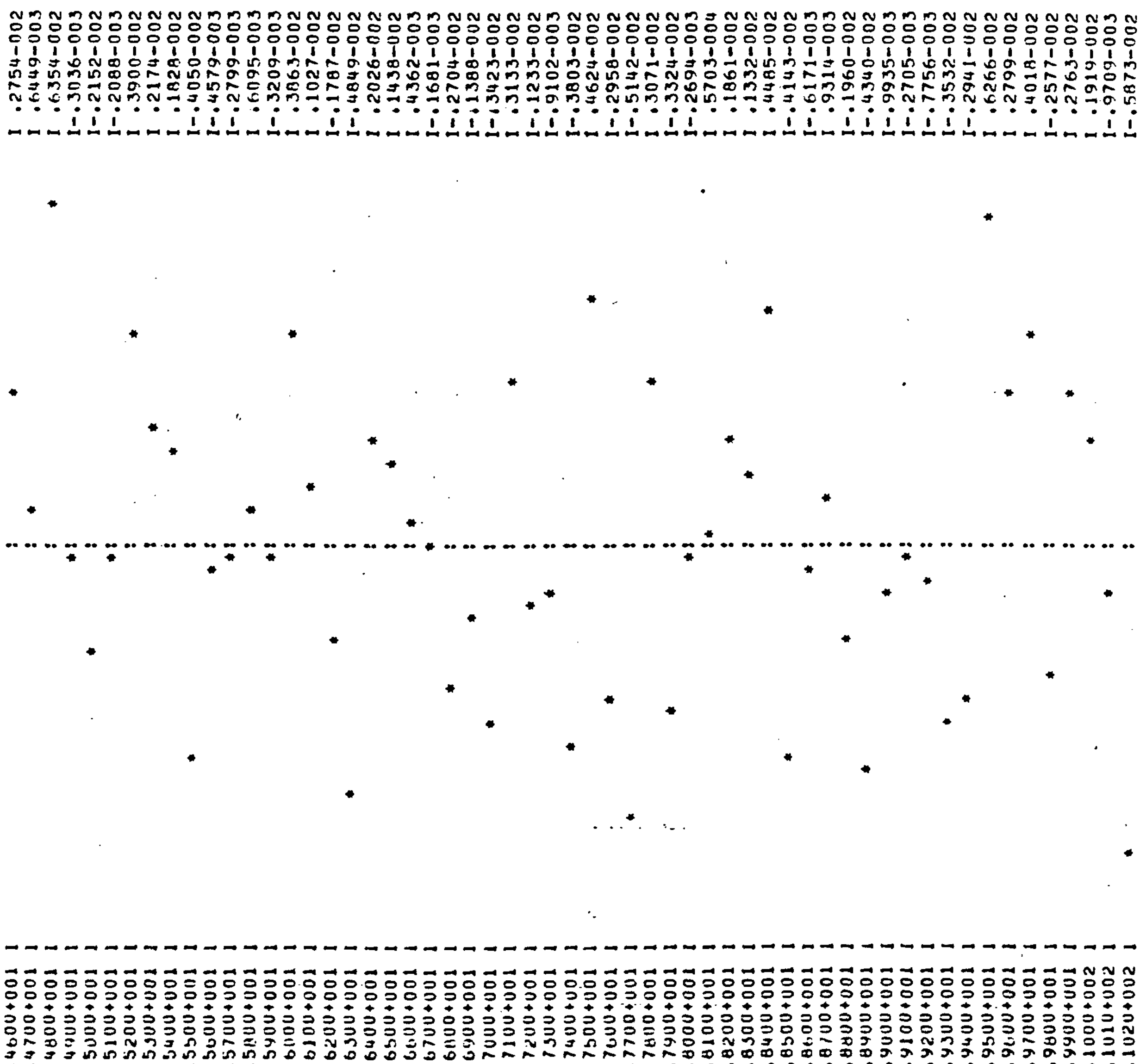
MINIMUM VALUE -.7812-002

MAXIMUM VALUE .7889-002



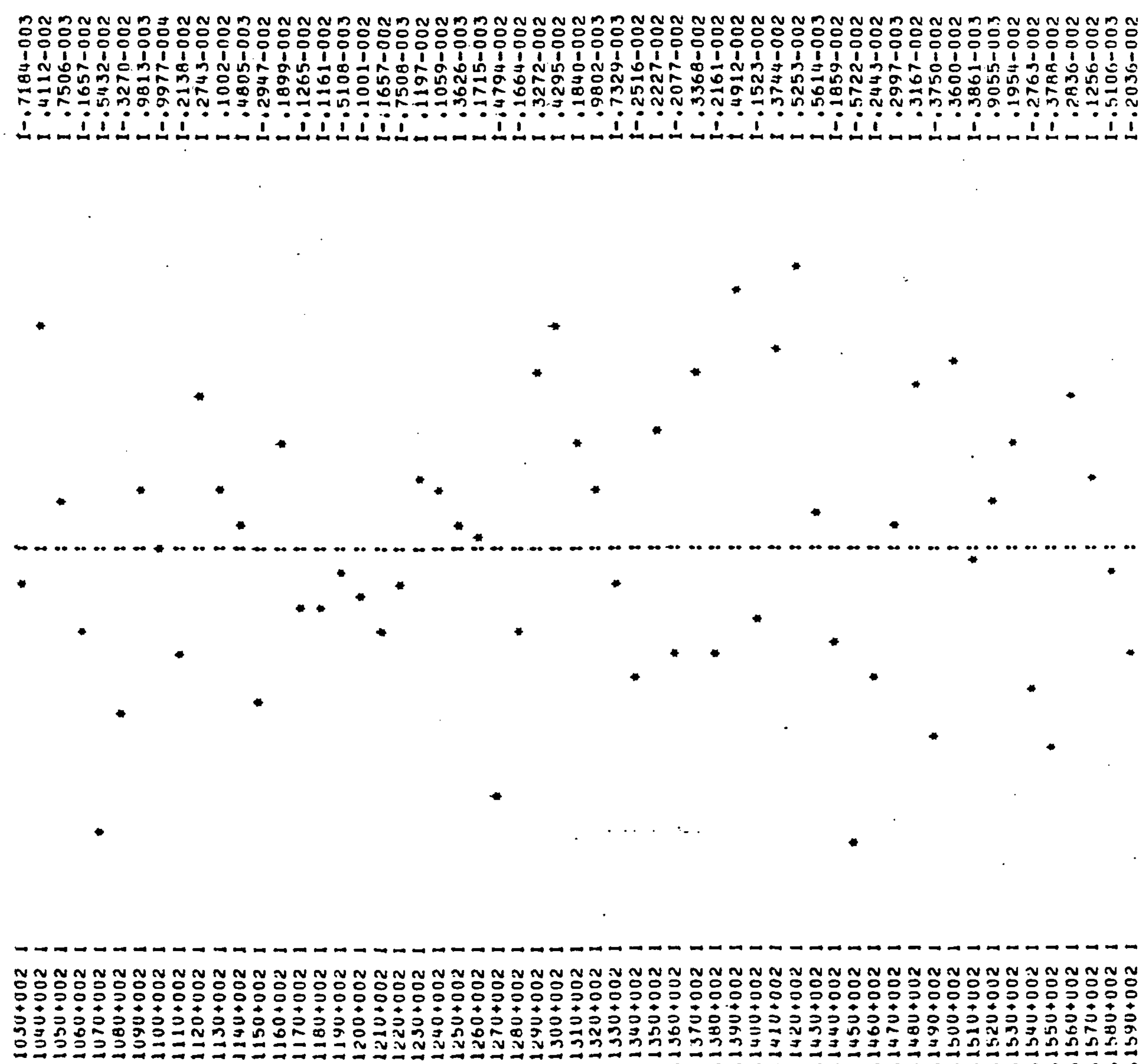
TIME	TORQUE
.1000+000	.1363-003
.2000+000	-.5927-002
.3000+000	.5432-002
.4000+000	.7632-003
.5000+000	-.1849-002
.6000+000	-.1053-002
.7000+000	.2978-002
.8000+000	.1312-002
.9000+000	.9603-003
.1000+001	.2174-002
.1100+001	-.2624-002
.1200+001	-.6131-003
.1300+001	.5945-003
.1400+001	-.5145-002
.1500+001	-.3179-002
.1600+001	-.1053-003
.1700+001	-.4522-002
.1800+001	.3344-002
.1900+001	.8876-003
.2000+001	.6227-002
.2100+001	-.1420-002
.2200+001	-.8764-003
.2300+001	-.2778-003
.2400+001	.4257-002
.2500+001	-.2364-002
.2600+001	-.8263-003
.2700+001	.2257-002
.2800+001	-.1246-003
.2900+001	-.3532-002
.3000+001	.7377-003
.3100+001	.4965-002
.3200+001	.3783-002
.3300+001	-.1178-002
.3400+001	-.1752-002
.3500+001	-.1554-002
.3600+001	.1185-002
.3700+001	.1912-002
.3800+001	-.2680-002
.3900+001	.1670-002
.4000+001	-.2484-002
.4100+001	.3624-003
.4200+001	-.1841-003
.4300+001	.3763-002
.4400+001	-.2562-002
.4500+001	.1808-002

FIGURE F26



.4600+001 I I .2754-002
.4700+001 I I .6449-003
.4800+001 I I .6354-002
.4900+001 I I-.3036-003
.5000+001 I I-.2152-002
.5100+001 I I-.2088-003
.5200+001 I I .3900-002
.5300+001 I I .2174-002
.5400+001 I I .1828-002
.5500+001 I I-.4050-002
.5600+001 I I-.4579-003
.5700+001 I I-.2799-003
.5800+001 I I .6095-003
.5900+001 I I-.3209-003
.6000+001 I I .3863-002
.6100+001 I I .1027-002
.6200+001 I I-.1787-002
.6300+001 I I-.4849-002
.6400+001 I I .2026-002
.6500+001 I I .1438-002
.6600+001 I I .4362-003
.6700+001 I I-.1681-003
.6800+001 I I-.2704-002
.6900+001 I I-.1388-002
.7000+001 I I-.3423-002
.7100+001 I I .3133-002
.7200+001 I I-.1233-002
.7300+001 I I-.9102-003
.7400+001 I I-.3803-002
.7500+001 I I .4624-002
.7600+001 I I-.2958-002
.7700+001 I I-.5142-002
.7800+001 I I .3071-002
.7900+001 I I-.3324-002
.8000+001 I I-.2694-003
.8100+001 I I .5703-004
.8200+001 I I .1861-002
.8300+001 I I .1332-002
.8400+001 I I .4485-002
.8500+001 I I-.4143-002
.8600+001 I I-.6171-003
.8700+001 I I .9314-003
.8800+001 I I-.1960-002
.8900+001 I I-.4340-002
.9000+001 I I-.9935-003
.9100+001 I I-.2705-003
.9200+001 I I-.7756-003
.9300+001 I I-.3532-002
.9400+001 I I-.2941-002
.9500+001 I I .6266-002
.9600+001 I I .2799-002
.9700+001 I I .4018-002
.9800+001 I I-.2577-002
.9900+001 I I .2763-002
.1000+002 I I .1919-002
.1010+002 I I-.9709-003
.1020+002 I I-.5873-002

FIGURE F27



.1030+002 I I-.7184-003
.1040+002 I I .4112-002
.1050+002 I I .7506-003
.1060+002 I I-.1657-002
.1070+002 I I-.5432-002
.1080+002 I I-.3270-002
.1090+002 I I .9813-003
.1100+002 I I-.9977-004
.1110+002 I I-.2138-002
.1120+002 I I .2743-002
.1130+002 I I .1002-002
.1140+002 I I .4805-003
.1150+002 I I-.2947-002
.1160+002 I I .1899-002
.1170+002 I I-.1265-002
.1180+002 I I-.1161-002
.1190+002 I I-.5108-003
.1200+002 I I-.1001-002
.1210+002 I I-.1657-002
.1220+002 I I-.7508-003
.1230+002 I I .1197-002
.1240+002 I I .1059-002
.1250+002 I I .3626-003
.1260+002 I I .1715-003
.1270+002 I I-.4794-002
.1280+002 I I-.1664-002
.1290+002 I I .3272-002
.1300+002 I I .4295-002
.1310+002 I I .1840-002
.1320+002 I I .9802-003
.1330+002 I I-.7329-003
.1340+002 I I-.2516-002
.1350+002 I I .2227-002
.1360+002 I I-.2077-002
.1370+002 I I .3368-002
.1380+002 I I-.2161-002
.1390+002 I I .4912-002
.1400+002 I I-.1523-002
.1410+002 I I .3744-002
.1420+002 I I .5253-002
.1430+002 I I .5614-003
.1440+002 I I-.1859-002
.1450+002 I I-.5722-002
.1460+002 I I-.2443-002
.1470+002 I I .2997-003
.1480+002 I I .3167-002
.1490+002 I I-.3750-002
.1500+002 I I .3600-002
.1510+002 I I-.3861-003
.1520+002 I I .9055-003
.1530+002 I I .1954-002
.1540+002 I I-.2763-002
.1550+002 I I-.3788-002
.1560+002 I I .2836-002
.1570+002 I I .1256-002
.1580+002 I I-.5106-003
.1590+002 I I-.2036-002

FIGURE F28

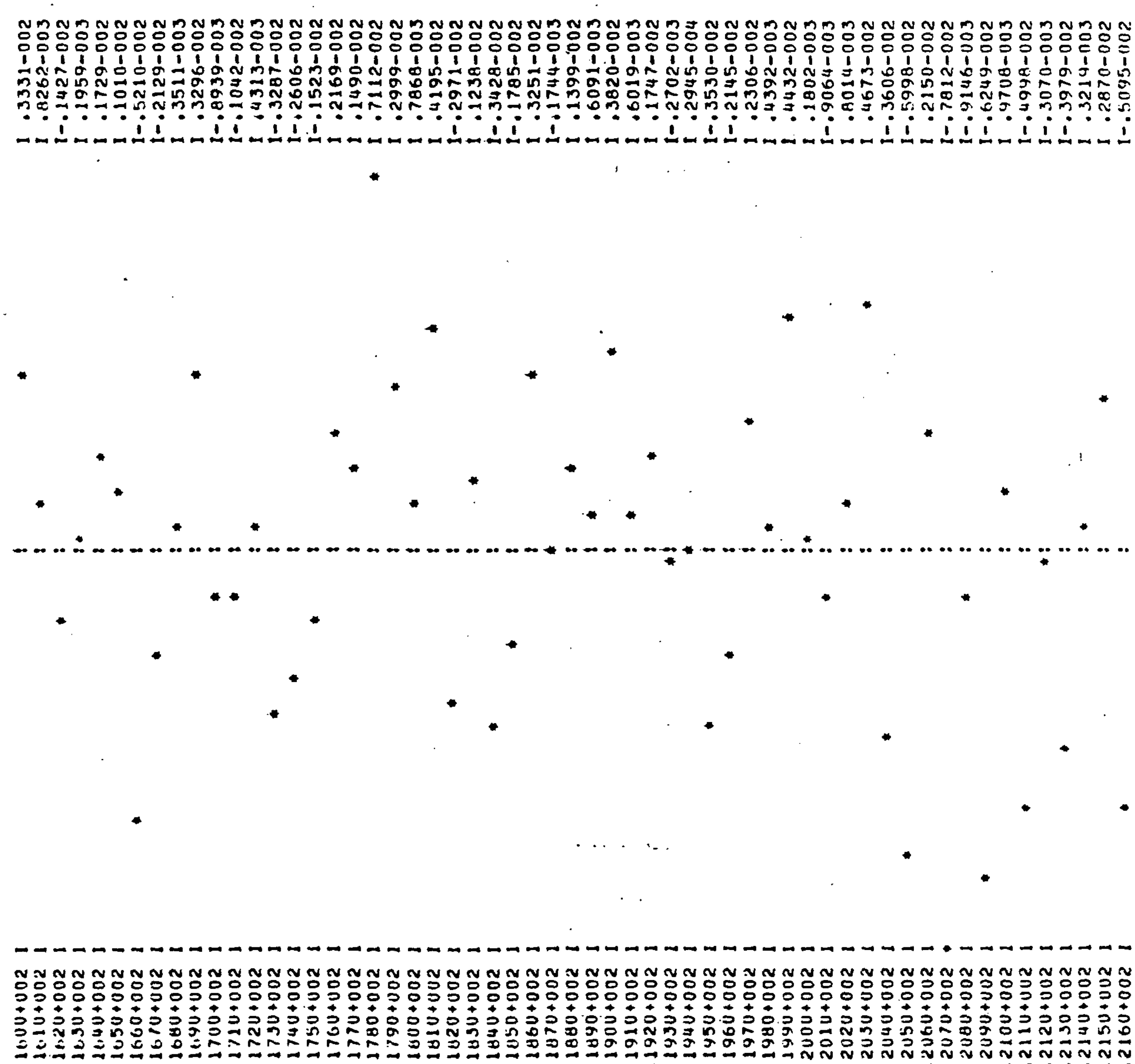
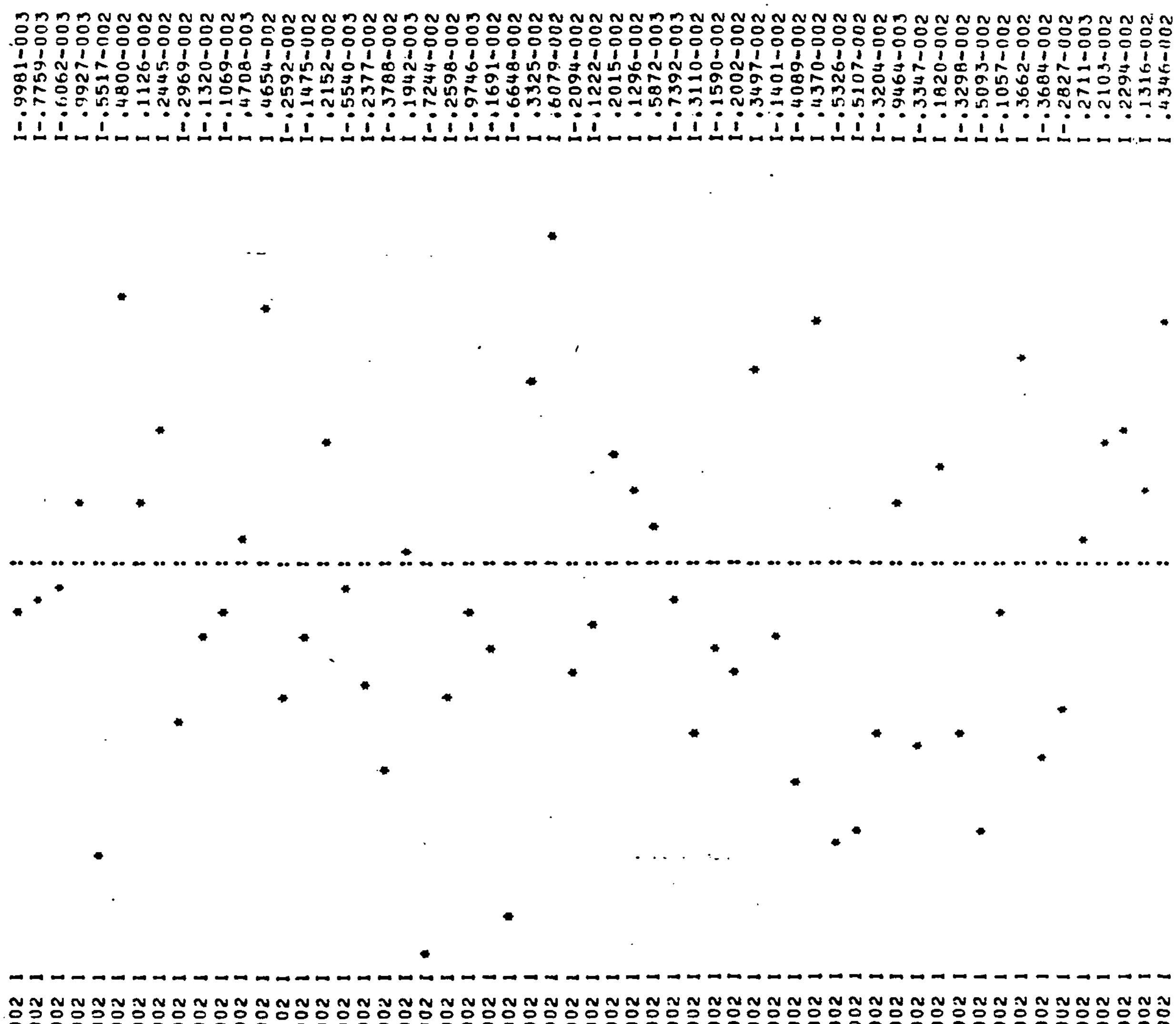

.1600+002 I I .3331-002
.1610+002 I I .8262-003
.1620+002 I I-.1427-002
.1630+002 I I .1959-003
.1640+002 I I .1729-002
.1650+002 I I .1010-002
.1660+002 I I-.5210-002
.1670+002 I I-.2129-002
.1680+002 I I .3511-003
.1690+002 I I .3296-002
.1700+002 I I-.8939-003
.1710+002 I I-.1042-002
.1720+002 I I .4313-003
.1730+002 I I-.3287-002
.1740+002 I I-.2606-002
.1750+002 I I-.1523-002
.1760+002 I I .2169-002
.1770+002 I I .1490-002
.1780+002 I I .7112-002
.1790+002 I I .2999-002
.1800+002 I I .7868-003
.1810+002 I I .4195-002
.1820+002 I I-.2971-002
.1830+002 I I .1238-002
.1840+002 I I-.3428-002
.1850+002 I I-.1785-002
.1860+002 I I .3251-002
.1870+002 I I-.1744-003
.1880+002 I I .1399-002
.1890+002 I I .6091-003
.1900+002 I I .3820-002
.1910+002 I I .6019-003
.1920+002 I I .1747-002
.1930+002 I I-.2702-003
.1940+002 I I .2945-004
.1950+002 I I-.3530-002
.1960+002 I I-.2145-002
.1970+002 I I .2306-002
.1980+002 I I .4392-003
.1990+002 I I .4432-002
.2000+002 I I .1802-003
.2010+002 I I-.9064-003
.2020+002 I I .8014-003
.2030+002 I I .4673-002
.2040+002 I I-.3606-002
.2050+002 I I-.5998-002
.2060+002 I I .2150-002
.2070+002 * I-.7812-002
.2080+002 I I-.9146-003
.2090+002 I I-.6249-002
.2100+002 I I .9708-003
.2110+002 I I-.4998-002
.2120+002 I I-.3070-003
.2130+002 I I-.3979-002
.2140+002 I I .3219-003
.2150+002 I I .2870-002
.2160+002 I I-.5095-002

FIGURE F29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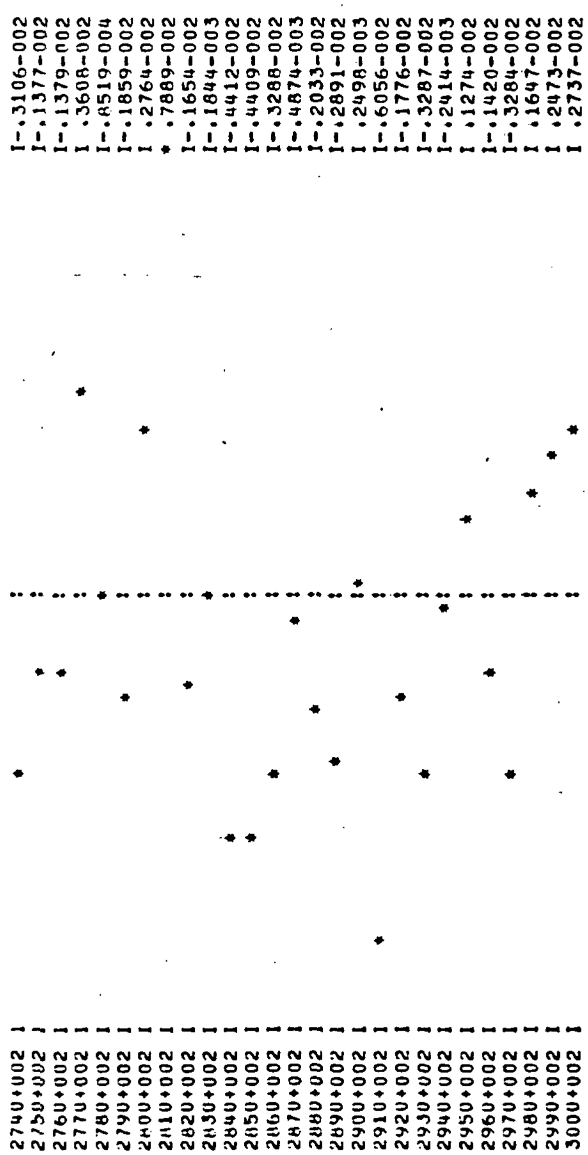
.2180+002 I I-.7759-003
.2190+002 I I-.6062-003
.2200+002 I I .9927-003
.2210+002 I I-.5517-002
.2220+002 I I .4800-002
.2230+002 I I .1126-002
.2240+002 I I .2445-002
.2250+002 I I-.2969-002
.2260+002 I I-.1320-002
.2270+002 I I-.1069-002
.2280+002 I I .4708-003
.2290+002 I I .4654-002
.2300+002 I I-.2592-002
.2310+002 I I-.1475-002
.2320+002 I I .2152-002
.2330+002 I I-.5540-003
.2340+002 I I-.2377-002
.2350+002 I I-.3788-002
.2360+002 I I .1942-003
.2370+002 I I-.7244-002
.2380+002 I I-.2598-002
.2390+002 I I-.9746-003
.2400+002 I I-.1691-002
.2410+002 I I-.6648-002
.2420+002 I I .3325-002
.2430+002 I I .6079-002
.2440+002 I I-.2094-002
.2450+002 I I-.1222-002
.2460+002 I I .2015-002
.2470+002 I I .1296-002
.2480+002 I I .5872-003
.2490+002 I I-.7392-003
.2500+002 I I-.3110-002
.2510+002 I I-.1590-002
.2520+002 I I-.2002-002
.2530+002 I I .3497-002
.2540+002 I I-.1401-002
.2550+002 I I-.4089-002
.2560+002 I I .4370-002
.2570+002 I I-.5326-002
.2580+002 I I-.5107-002
.2590+002 I I-.3204-002
.2600+002 I I .9464-003
.2610+002 I I-.3347-002
.2620+002 I I .1820-002
.2630+002 I I-.3298-002
.2640+002 I I-.5093-002
.2650+002 I I-.1057-002
.2660+002 I I .3662-002
.2670+002 I I-.3684-002
.2680+002 I I-.2827-002
.2690+002 I I .2711-003
.2700+002 I I .2103-002
.2710+002 I I .2294-002
.2720+002 I I .1316-002
.2730+002 I I .4346-002

FIGURE F30



I-.3106-002
I-.1377-002
I-.1379-002
I .3608-002
I-.8519-004
I-.1859-002
I .2764-002
* .7889-002
I-.1654-002
I-.1844-003
I-.4412-002
I-.4409-002
I-.3288-002
I-.4874-003
I-.2033-002
I-.2891-002
I .2498-003
I-.6056-002
I-.1776-002
I-.3287-002
I-.2414-003
I .1274-002
I-.1420-002
I-.3284-002
I .1647-002
I .2473-002
I .2737-002
.2740+002 I
.2750+002 I
.2760+002 I
.2770+002 I
.2780+002 I
.2790+002 I
.2800+002 I
.2810+002 I
.2820+002 I
.2830+002 I
.2840+002 I
.2850+002 I
.2860+002 I
.2870+002 I
.2880+002 I
.2890+002 I
.2900+002 I
.2910+002 I
.2920+002 I
.2930+002 I
.2940+002 I
.2950+002 I
.2960+002 I
.2970+002 I
.2980+002 I
.2990+002 I
.3000+002 I

FIGURE F31

DATA FOR THE Z-AXIS

CURVE 'A' IS A PLOT OF BASE VERSUS TIME

CURVE 'B' IS A PLOT OF TIP VERSUS TIME

MINIMUM VALUE -.2840-001

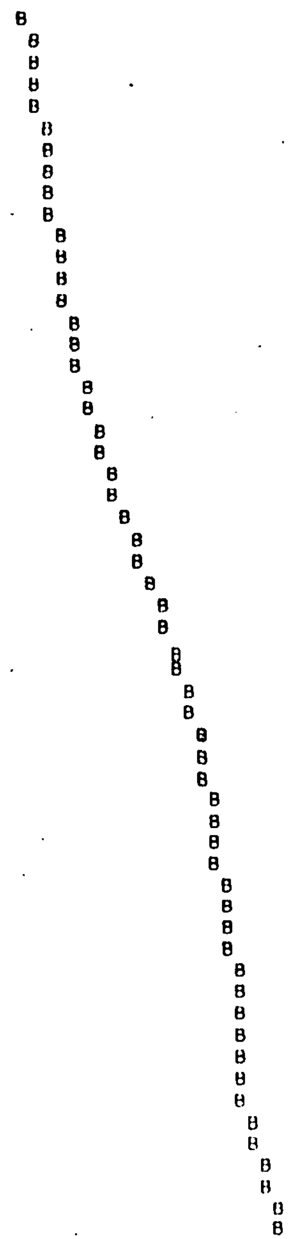
MAXIMUM VALUE .4225+000

TIME	I	BASE	TIP
.1000+000	I B	.2014-003	.2014-003
.2000+000	I B	.9315-003	.9315-003
.3000+000	I B	.2195-002	.2195-002
.4000+000	I :B	.4041-002	.4041-002
.5000+000	I :B	.5232-002	.5232-002
.6000+000	I :B	.5746-002	.5746-002
.7000+000	I :B	.5591-002	.5591-002
.8000+000	I :B	.4305-002	.4305-002
.9000+000	I B	.2678-002	.2678-002
.1000+001	I B	.6870-003	.6870-003
.1100+001	I B	-.1088-003	-.1088-003
.1200+001	I B	.4272-003	.4272-003
.1300+001	I B	.1301-002	.1301-002
.1400+001	I B	.1501-002	.1501-002
.1500+001	I B	.8597-003	.8597-003
.1600+001	I B	.2768-003	.2768-003
.1700+001	I B	-.9946-003	-.9946-003
.1800+001	I B	-.2253-002	-.2253-002
.1900+001	I B:	-.3298-002	-.3298-002
.2000+001	I B:	-.5049-002	-.5049-002
.2100+001	I B:	-.6527-002	-.6527-002
.2200+001	I B:	-.7328-002	-.7328-002
.2300+001	I B:	-.8030-002	-.8030-002
.2400+001	I B :	-.9225-002	-.9225-002
.2500+001	I B :	-.1023-001	-.1023-001
.2600+001	I B :	-.1080-001	-.1080-001
.2700+001	I B :	-.1176-001	-.1176-001
.2800+001	I B :	-.1209-001	-.1209-001
.2900+001	I B :	-.1188-001	-.1188-001
.3000+001	I B :	-.1235-001	-.1235-001
.3100+001	I B :	-.1334-001	-.1334-001
.3200+001	I B :	-.1455-001	-.1455-001
.3300+001	I B :	-.1509-001	-.1509-001
.3400+001	IB :	-.1567-001	-.1567-001
.3500+001	IB :	-.1581-001	-.1581-001
.3600+001	I B :	-.1514-001	-.1514-001
.3700+001	I B :	-.1493-001	-.1493-001
.3800+001	I B :	-.1550-001	-.1550-001
.3900+001	IB :	-.1635-001	-.1635-001
.4000+001	IB :	-.1638-001	-.1638-001
.4100+001	IB :	-.1609-001	-.1609-001
.4200+001	IB :	-.1627-001	-.1627-001
.4300+001	IB :	-.1673-001	-.1673-001

FIGURE F32

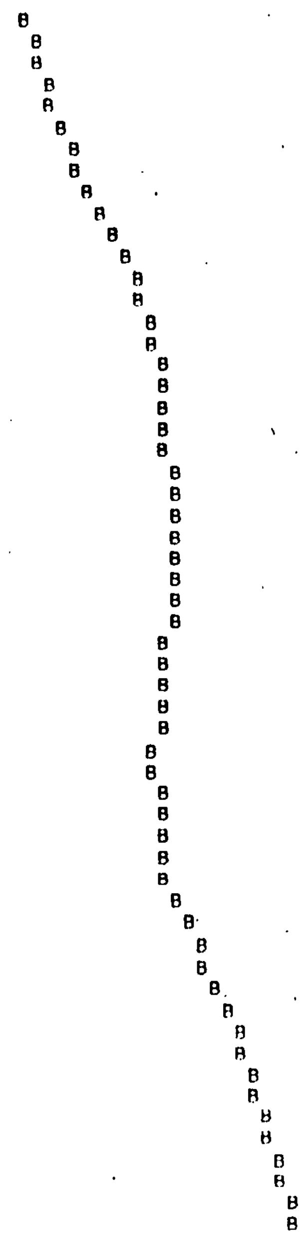
```
.4400+001 IB   :                                    I-.1684-001-.1684-001
.4500+001 IB   :                                    I-.1741-001-.1741-001
.4600+001 IB   :                                    I-.1879-001-.1879-001
.4700+001 IB   :                                    I-.2045-001-.2045-001
.4800+001 IB   :                                    I-.2166-001-.2166-001
.4900+001 B    :                                    I-.2227-001-.2227-001
.5000+001 B    :                                    I-.2309-001-.2309-001
.5100+001 B    :                                    I-.2338-001-.2338-001
.5200+001 B    :                                    I-.2404-001-.2404-001
.5300+001 B    :                                    I-.2441-001-.2441-001
.5400+001 B    :                                    I-.2526-001-.2526-001
.5500+001 B    :                                    I-.2591-001-.2591-001
.5600+001 B    :                                    I-.2627-001-.2627-001
.5700+001 B    :                                    I-.2697-001-.2697-001
.5800+001 B    :                                    I-.2746-001-.2746-001
.5900+001 B    :                                    I-.2832-001-.2832-001
.6000+001 B    :                                    I-.2840-001-.2840-001
.6100+001 B    :                                    I-.2718-001-.2718-001
.6200+001 B    :                                    I-.2507-001-.2507-001
.6300+001 B    :                                    I-.2217-001-.2217-001
.6400+001 IB   :                                    I-.1912-001-.1912-001
.6500+001 IB   :                                    I-.1602-001-.1602-001
.6600+001 I B  :                                    I-.1247-001-.1247-001
.6700+001 I B  :                                    I-.9359-002-.9359-002
.6800+001 I   B:                                    I-.6357-002-.6357-002
.6900+001 I   B:                                    I-.3629-002-.3629-002
.7000+001 I    B                                    I-.4155-003-.4155-003
.7100+001 I    B                                    I .2257-002 .2257-002
.7200+001 I    :B                                   I .4924-002 .4924-002
.7300+001 I    :B                                   I .7430-002 .7430-002
.7400+001 I    : B                                  I .1042-001 .1042-001
.7500+001 I    : B                                  I .1336-001 .1336-001
.7600+001 I    : B                                  I .1636-001 .1636-001
.7700+001 I    :  B                                 I .1847-001 .1847-001
.7800+001 I    :  B                                 I .1952-001 .1952-001
.7900+001 I    :  B                                 I .2087-001 .2087-001
.8000+001 I    :  B                                 I .2303-001 .2303-001
.8100+001 I    :   B                                I .2527-001 .2527-001
.8200+001 I    :   B                                I .2696-001 .2696-001
.8300+001 I    :   B                                I .2889-001 .2889-001
.8400+001 I    :    B                               I .3070-001 .3070-001
.8500+001 I    :    B                               I .3320-001 .3320-001
.8600+001 I    :    B                               I .3549-001 .3549-001
.8700+001 I    :     B                              I .3852-001 .3852-001
.8800+001 I    :     B                              I .4244-001 .4244-001
.8900+001 I    :      B                             I .4638-001 .4638-001
.9000+001 I    :       B                            I .4965-001 .4965-001
.9100+001 I    :       B                            I .5189-001 .5189-001
.9200+001 I    :       B                            I .5435-001 .5435-001
.9300+001 I    :        B                           I .5628-001 .5628-001
.9400+001 I    :        B                           I .5714-001 .5714-001
.9500+001 I    :        B                           I .5836-001 .5836-001
.9600+001 I    :        B                           I .5936-001 .5936-001
.9700+001 I    :        B                           I .6021-001 .6021-001
.9800+001 I    :        B                           I .6168-001 .6168-001
.9900+001 I    :         B                          I .6369-001 .6369-001
.1000+002 I    :         B                          I .6541-001 .6541-001
```

FIGURE F33



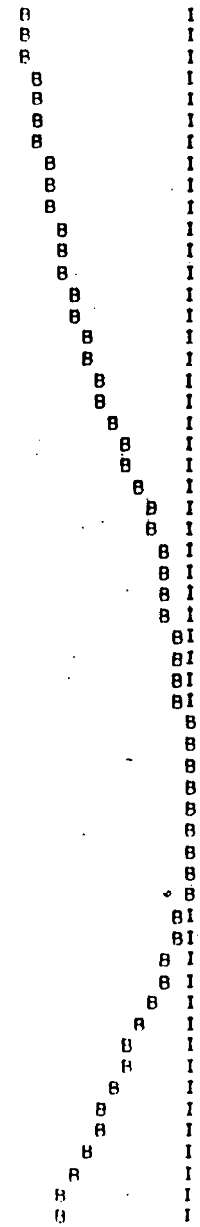
.1010+002	.6675-001	.6675-001
.1020+002	.6841-001	.6841-001
.1030+002	.7021-001	.7021-001
.1040+002	.7194-001	.7194-001
.1050+002	.7390-001	.7390-001
.1060+002	.7519-001	.7519-001
.1070+002	.7611-001	.7611-001
.1080+002	.7695-001	.7695-001
.1090+002	.7792-001	.7792-001
.1100+002	.7935-001	.7935-001
.1110+002	.8177-001	.8177-001
.1120+002	.8324-001	.8324-001
.1130+002	.8556-001	.8556-001
.1140+002	.8752-001	.8752-001
.1150+002	.8952-001	.8952-001
.1160+002	.9131-001	.9131-001
.1170+002	.9312-001	.9312-001
.1180+002	.9484-001	.9484-001
.1190+002	.9738-001	.9738-001
.1200+002	.1006+000	.1006+000
.1210+002	.1044+000	.1044+000
.1220+002	.1086+000	.1086+000
.1230+002	.1129+000	.1129+000
.1240+002	.1163+000	.1163+000
.1250+002	.1203+000	.1203+000
.1260+002	.1253+000	.1253+000
.1270+002	.1298+000	.1298+000
.1280+002	.1342+000	.1342+000
.1290+002	.1383+000	.1383+000
.1300+002	.1414+000	.1414+000
.1310+002	.1436+000	.1436+000
.1320+002	.1468+000	.1468+000
.1330+002	.1501+000	.1501+000
.1340+002	.1527+000	.1527+000
.1350+002	.1548+000	.1548+000
.1360+002	.1568+000	.1568+000
.1370+002	.1585+000	.1585+000
.1380+002	.1604+000	.1604+000
.1390+002	.1615+000	.1615+000
.1400+002	.1630+000	.1630+000
.1410+002	.1649+000	.1649+000
.1420+002	.1664+000	.1664+000
.1430+002	.1674+000	.1674+000
.1440+002	.1695+000	.1695+000
.1450+002	.1718+000	.1718+000
.1460+002	.1730+000	.1730+000
.1470+002	.1735+000	.1735+000
.1480+002	.1741+000	.1741+000
.1490+002	.1752+000	.1752+000
.1500+002	.1757+000	.1757+000
.1510+002	.1770+000	.1770+000
.1520+002	.1791+000	.1791+000
.1530+002	.1822+000	.1822+000
.1540+002	.1859+000	.1859+000
.1550+002	.1890+000	.1890+000
.1560+002	.1911+000	.1911+000
.1570+002	.1928+000	.1928+000

FIGURE F34



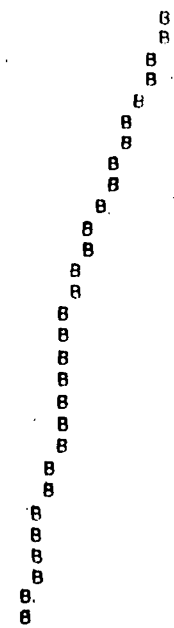
.1580+002	.1946+000	.1946+000
.1590+002	.1977+000	.1977+000
.1600+002	.2010+000	.2010+000
.1610+002	.2040+000	.2040+000
.1620+002	.2080+000	.2080+000
.1630+002	.2123+000	.2123+000
.1640+002	.2171+000	.2171+000
.1650+002	.2224+000	.2224+000
.1660+002	.2281+000	.2281+000
.1670+002	.2334+000	.2334+000
.1680+002	.2385+000	.2385+000
.1690+002	.2438+000	.2438+000
.1700+002	.2491+000	.2491+000
.1710+002	.2541+000	.2541+000
.1720+002	.2579+000	.2579+000
.1730+002	.2605+000	.2605+000
.1740+002	.2616+000	.2616+000
.1750+002	.2622+000	.2622+000
.1760+002	.2638+000	.2638+000
.1770+002	.2654+000	.2654+000
.1780+002	.2668+000	.2668+000
.1790+002	.2680+000	.2680+000
.1800+002	.2688+000	.2688+000
.1810+002	.2691+000	.2691+000
.1820+002	.2690+000	.2690+000
.1830+002	.2691+000	.2691+000
.1840+002	.2694+000	.2694+000
.1850+002	.2695+000	.2695+000
.1860+002	.2692+000	.2692+000
.1870+002	.2678+000	.2678+000
.1880+002	.2663+000	.2663+000
.1890+002	.2647+000	.2647+000
.1900+002	.2631+000	.2631+000
.1910+002	.2620+000	.2620+000
.1920+002	.2604+000	.2604+000
.1930+002	.2601+000	.2601+000
.1940+002	.2617+000	.2617+000
.1950+002	.2629+000	.2629+000
.1960+002	.2644+000	.2644+000
.1970+002	.2657+000	.2657+000
.1980+002	.2677+000	.2677+000
.1990+002	.2713+000	.2713+000
.2000+002	.2757+000	.2757+000
.2010+002	.2809+000	.2809+000
.2020+002	.2867+000	.2867+000
.2030+002	.2920+000	.2920+000
.2040+002	.2973+000	.2973+000
.2050+002	.3023+000	.3023+000
.2060+002	.3064+000	.3064+000
.2070+002	.3097+000	.3097+000
.2080+002	.3126+000	.3126+000
.2090+002	.3159+000	.3159+000
.2100+002	.3192+000	.3192+000
.2110+002	.3227+000	.3227+000
.2120+002	.3257+000	.3257+000
.2130+002	.3283+000	.3283+000
.2140+002	.3303+000	.3303+000

FIGURE F35



.2150+002	.3325+000	.3325+000
.2160+002	.3354+000	.3354+000
.2170+002	.3380+000	.3380+000
.2180+002	.3395+000	.3395+000
.2190+002	.3410+000	.3410+000
.2200+002	.3423+000	.3423+000
.2210+002	.3442+000	.3442+000
.2220+002	.3460+000	.3460+000
.2230+002	.3481+000	.3481+000
.2240+002	.3501+000	.3501+000
.2250+002	.3527+000	.3527+000
.2260+002	.3546+000	.3546+000
.2270+002	.3567+000	.3567+000
.2280+002	.3592+000	.3592+000
.2290+002	.3623+000	.3623+000
.2300+002	.3663+000	.3663+000
.2310+002	.3700+000	.3700+000
.2320+002	.3733+000	.3733+000
.2330+002	.3771+000	.3771+000
.2340+002	.3816+000	.3816+000
.2350+002	.3859+000	.3859+000
.2360+002	.3901+000	.3901+000
.2370+002	.3938+000	.3938+000
.2380+002	.3968+000	.3968+000
.2390+002	.3999+000	.3999+000
.2400+002	.4032+000	.4032+000
.2410+002	.4061+000	.4061+000
.2420+002	.4075+000	.4075+000
.2430+002	.4082+000	.4082+000
.2440+002	.4096+000	.4096+000
.2450+002	.4112+000	.4112+000
.2460+002	.4127+000	.4127+000
.2470+002	.4147+000	.4147+000
.2480+002	.4173+000	.4173+000
.2490+002	.4196+000	.4196+000
.2500+002	.4210+000	.4210+000
.2510+002	.4213+000	.4213+000
.2520+002	.4222+000	.4222+000
.2530+002	.4225+000	.4225+000
.2540+002	.4222+000	.4222+000
.2550+002	.4215+000	.4215+000
.2560+002	.4192+000	.4192+000
.2570+002	.4160+000	.4160+000
.2580+002	.4126+000	.4126+000
.2590+002	.4090+000	.4090+000
.2600+002	.4048+000	.4048+000
.2610+002	.4006+000	.4006+000
.2620+002	.3955+000	.3955+000
.2630+002	.3902+000	.3902+000
.2640+002	.3854+000	.3854+000
.2650+002	.3805+000	.3805+000
.2660+002	.3754+000	.3754+000
.2670+002	.3715+000	.3715+000
.2680+002	.3675+000	.3675+000
.2690+002	.3627+000	.3627+000
.2700+002	.3579+000	.3579+000
.2710+002	.3534+000	.3534+000

FIGURE F36



.2720+002	.3492+000	.3492+000
.2730+002	.3456+000	.3456+000
.2740+002	.3427+000	.3427+000
.2750+002	.3392+000	.3392+000
.2760+002	.3356+000	.3356+000
.2770+002	.3319+000	.3319+000
.2780+002	.3282+000	.3282+000
.2790+002	.3239+000	.3239+000
.2800+002	.3197+000	.3197+000
.2810+002	.3158+000	.3158+000
.2820+002	.3125+000	.3125+000
.2830+002	.3093+000	.3093+000
.2840+002	.3057+000	.3057+000
.2850+002	.3021+000	.3021+000
.2860+002	.2996+000	.2996+000
.2870+002	.2974+000	.2974+000
.2880+002	.2959+000	.2959+000
.2890+002	.2949+000	.2949+000
.2900+002	.2949+000	.2949+000
.2910+002	.2956+000	.2956+000
.2920+002	.2940+000	.2940+000
.2930+002	.2911+000	.2911+000
.2940+002	.2881+000	.2881+000
.2950+002	.2857+000	.2857+000
.2960+002	.2834+000	.2834+000
.2970+002	.2817+000	.2817+000
.2980+002	.2809+000	.2809+000
.2990+002	.2806+000	.2806+000
.3000+002	.2807+000	.2807+000

SHUTTLE ROTATIONS

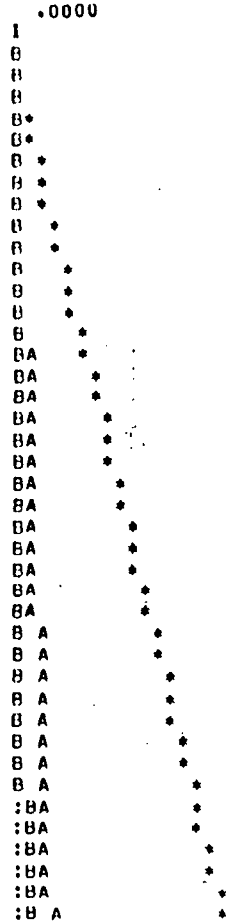
CURVE '*' IS A PLOT OF THETAX VERSUS TIME

CURVE 'A' IS A PLOT OF THETAY VERSUS TIME

CURVE 'B' IS A PLOT OF THETAZ VERSUS TIME

MINIMUM VALUE .0000

MAXIMUM VALUE .3847+004



TIME	THETAX	THETAY	THETAZ
.0000	.0000	.0000	.0000
.1000+000	.2269+002	.4137+001	.1584+001
.2000+000	.4541+002	.8262+001	.3167+001
.3000+000	.6816+002	.1238+002	.4751+001
.4000+000	.9094+002	.1651+002	.6334+001
.5000+000	.1137+003	.2066+002	.7917+001
.6000+000	.1365+003	.2481+002	.9501+001
.7000+000	.1593+003	.2896+002	.1108+002
.8000+000	.1820+003	.3312+002	.1267+002
.9000+000	.2048+003	.3726+002	.1425+002
.1000+001	.2275+003	.4140+002	.1583+002
.1100+001	.2503+003	.4554+002	.1742+002
.1200+001	.2730+003	.4968+002	.1900+002
.1300+001	.2958+003	.5382+002	.2058+002
.1400+001	.3186+003	.5797+002	.2217+002
.1500+001	.3414+003	.6213+002	.2375+002
.1600+001	.3642+003	.6629+002	.2533+002
.1700+001	.3870+003	.7044+002	.2692+002
.1800+001	.4098+003	.7459+002	.2850+002
.1900+001	.4325+003	.7874+002	.3008+002
.2000+001	.4553+003	.8289+002	.3167+002
.2100+001	.4781+003	.8704+002	.3325+002
.2200+001	.5009+003	.9119+002	.3483+002
.2300+001	.5237+003	.9534+002	.3642+002
.2400+001	.5465+003	.9950+002	.3800+002
.2500+001	.5693+003	.1037+003	.3958+002
.2600+001	.5921+003	.1078+003	.4117+002
.2700+001	.6149+003	.1120+003	.4275+002
.2800+001	.6376+003	.1161+003	.4433+002
.2900+001	.6604+003	.1203+003	.4592+002
.3000+001	.6832+003	.1244+003	.4750+002
.3100+001	.7060+003	.1286+003	.4908+002
.3200+001	.7288+003	.1327+003	.5067+002
.3300+001	.7516+003	.1369+003	.5225+002
.3400+001	.7744+003	.1410+003	.5383+002
.3500+001	.7972+003	.1452+003	.5542+002
.3600+001	.8200+003	.1493+003	.5700+002
.3700+001	.8427+003	.1535+003	.5858+002
.3800+001	.8655+003	.1576+003	.6017+002
.3900+001	.8883+003	.1618+003	.6175+002
.4000+001	.9111+003	.1659+003	.6333+002

FIGURE F37

FIGURE F38

.4100+001	:B A	*	I	.9339+003	.1701+003	.6492+002
.4200+001	:B A	*	I	.9567+003	.1742+003	.6650+002
.4300+001	:B A	*	I	.9794+003	.1784+003	.6808+002
.4400+001	:B A	*	I	.1002+004	.1825+003	.6967+002
.4500+001	:B A	*	I	.1025+004	.1867+003	.7125+002
.4600+001	:B A	*	I	.1048+004	.1908+003	.7283+002
.4700+001	:B A	*	I	.1071+004	.1950+003	.7442+002
.4800+001	:B A	*	I	.1093+004	.1991+003	.7600+002
.4900+001	:B A	*	I	.1116+004	.2033+003	.7758+002
.5000+001	:B A	*	I	.1139+004	.2074+003	.7917+002
.5100+001	:B A	*	I	.1162+004	.2115+003	.8075+002
.5200+001	:B A	*	I	.1184+004	.2157+003	.8233+002
.5300+001	:B A	*	I	.1207+004	.2198+003	.8392+002
.5400+001	:B A	*	I	.1230+004	.2240+003	.8550+002
.5500+001	:B A	*	I	.1253+004	.2281+003	.8708+002
.5600+001	:B A	*	I	.1276+004	.2323+003	.8867+002
.5700+001	:B A	*	I	.1298+004	.2364+003	.9025+002
.5800+001	:B A	*	I	.1321+004	.2406+003	.9183+002
.5900+001	:B A	*	I	.1344+004	.2447+003	.9342+002
.6000+001	:B A	*	I	.1367+004	.2489+003	.9500+002
.6100+001	:B A	*	I	.1389+004	.2530+003	.9658+002
.6200+001	:B A	*	I	.1412+004	.2571+003	.9817+002
.6300+001	:B A	*	I	.1435+004	.2613+003	.9975+002
.6400+001	:B A	*	I	.1458+004	.2654+003	.1013+003
.6500+001	:B A	*	I	.1480+004	.2696+003	.1029+003
.6600+001	:B A	*	I	.1503+004	.2737+003	.1045+003
.6700+001	:B A	*	I	.1526+004	.2779+003	.1061+003
.6800+001	:B A	*	I	.1549+004	.2820+003	.1077+003
.6900+001	:B A	*	I	.1572+004	.2862+003	.1093+003
.7000+001	: B A	*	I	.1594+004	.2903+003	.1108+003
.7100+001	: B A	*	I	.1617+004	.2945+003	.1124+003
.7200+001	: B A	*	I	.1640+004	.2986+003	.1140+003
.7300+001	: B A	*	I	.1663+004	.3028+003	.1156+003
.7400+001	: B A	*	I	.1685+004	.3069+003	.1172+003
.7500+001	: B A	*	I	.1708+004	.3110+003	.1188+003
.7600+001	: B A	*	I	.1731+004	.3152+003	.1203+003
.7700+001	: B A	*	I	.1754+004	.3193+003	.1219+003
.7800+001	: B A	*	I	.1776+004	.3235+003	.1235+003
.7900+001	: B A	*	I	.1799+004	.3276+003	.1251+003
.8000+001	: B A	*	I	.1822+004	.3318+003	.1267+003
.8100+001	: B A	*	I	.1845+004	.3359+003	.1283+003
.8200+001	: B A	*	I	.1868+004	.3401+003	.1298+003
.8300+001	: B A	*	I	.1890+004	.3442+003	.1314+003
.8400+001	: B A	*	I	.1913+004	.3484+003	.1330+003
.8500+001	: B A	*	I	.1936+004	.3525+003	.1346+003
.8600+001	: B A	*	I	.1959+004	.3567+003	.1362+003
.8700+001	: B A	*	I	.1981+004	.3608+003	.1377+003
.8800+001	: B A	*	I	.2004+004	.3650+003	.1393+003
.8900+001	: B A	*	I	.2027+004	.3691+003	.1409+003
.9000+001	: B A	*	I	.2050+004	.3733+003	.1425+003
.9100+001	: B A	*	I	.2073+004	.3774+003	.1441+003
.9200+001	: B A	*	I	.2095+004	.3815+003	.1457+003
.9300+001	: B A	*	I	.2118+004	.3857+003	.1472+003
.9400+001	: B A	*	I	.2141+004	.3898+003	.1488+003
.9500+001	: B A	*	I	.2164+004	.3940+003	.1504+003
.9600+001	: B A	*	I	.2186+004	.3981+003	.1520+003
.9700+001	: B A	*	I	.2209+004	.4023+003	.1536+003

FIGURE F39

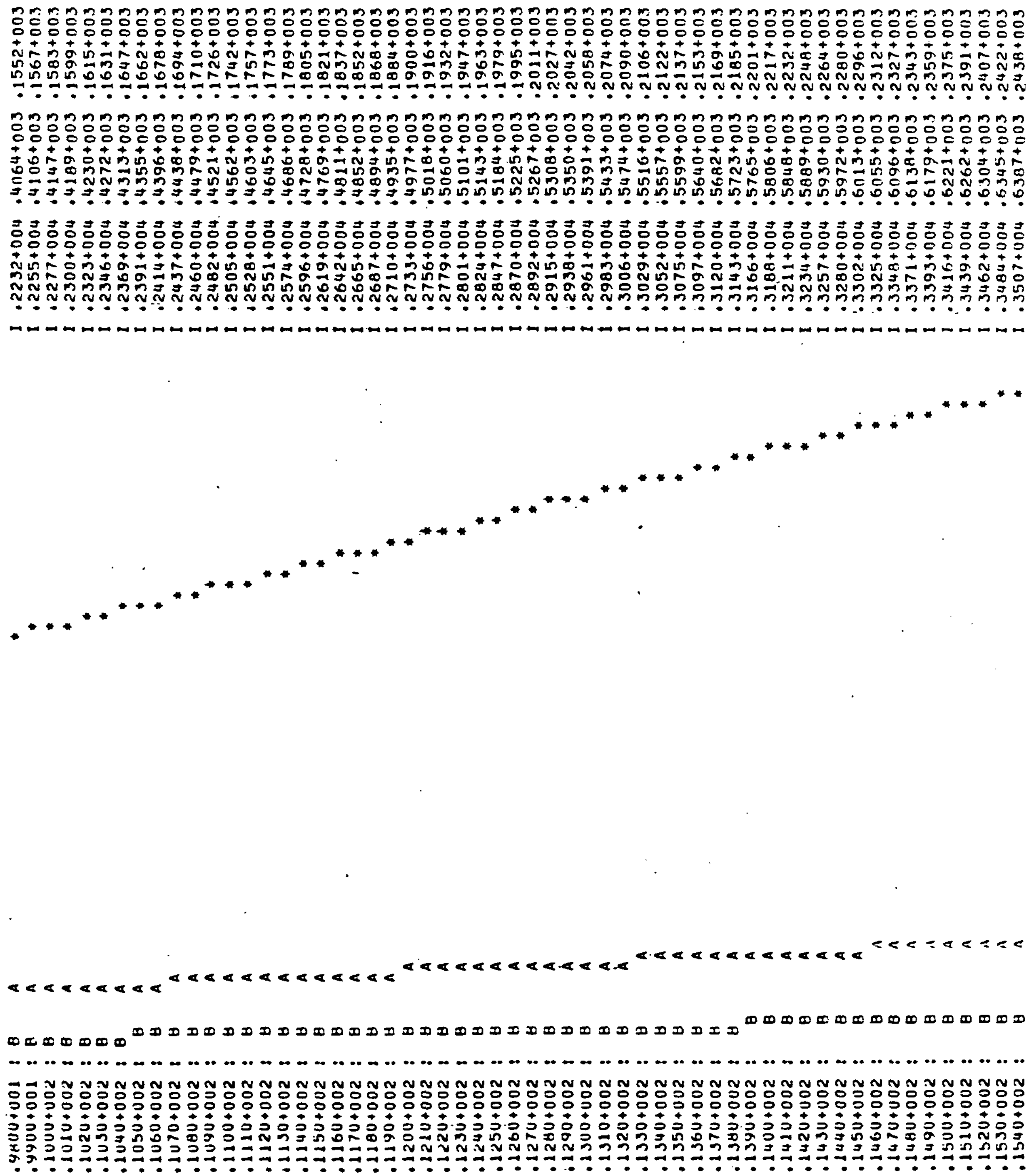
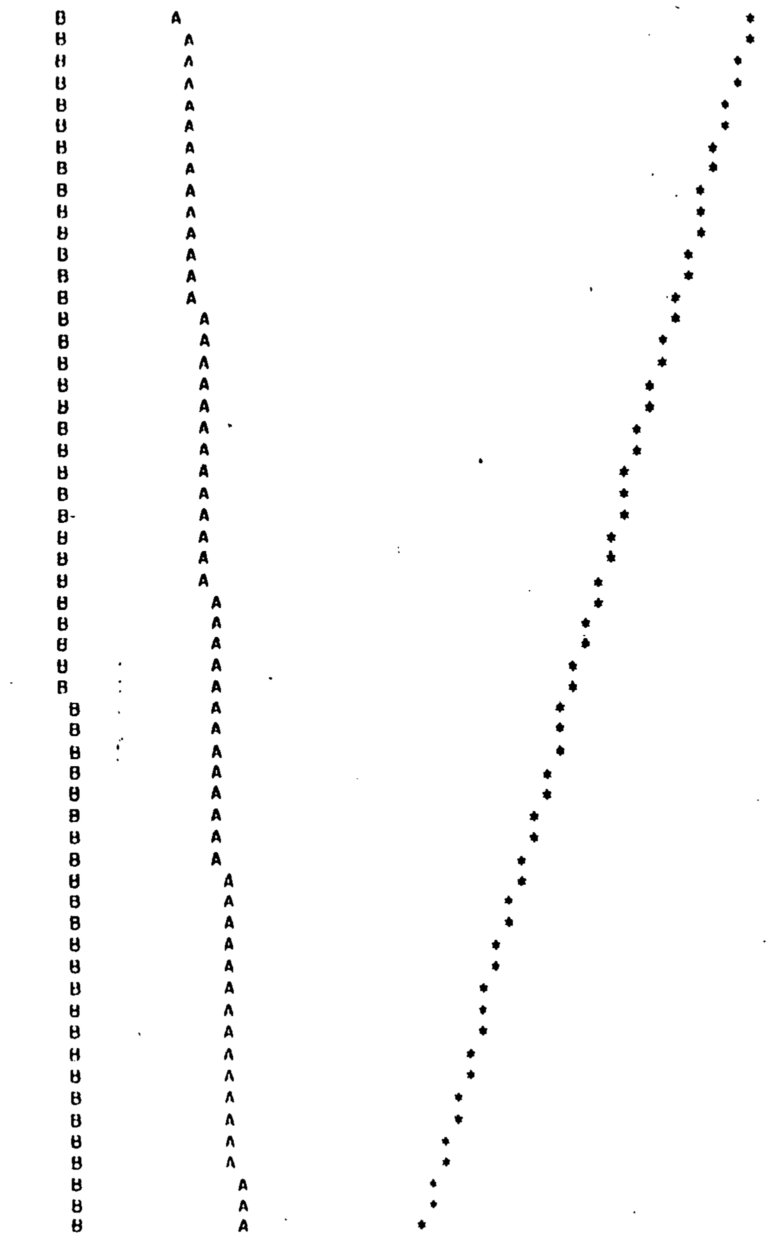


FIGURE F40

.1550+002	.3530+004	.6428+003	.2454+003
.1560+002	.3553+004	.6470+003	.2470+003
.1570+002	.3576+004	.6511+003	.2486+003
.1580+002	.3598+004	.6552+003	.2502+003
.1590+002	.3621+004	.6594+003	.2517+003
.1600+002	.3642+004	.6635+003	.2533+003
.1610+002	.3663+004	.6677+003	.2549+003
.1620+002	.3682+004	.6718+003	.2565+003
.1630+002	.3700+004	.6760+003	.2581+003
.1640+002	.3717+004	.6801+003	.2597+003
.1650+002	.3734+004	.6843+003	.2612+003
.1660+002	.3749+004	.6884+003	.2628+003
.1670+002	.3763+004	.6926+003	.2644+003
.1680+002	.3776+004	.6967+003	.2660+003
.1690+002	.3787+004	.7009+003	.2676+003
.1700+002	.3798+004	.7050+003	.2692+003
.1710+002	.3808+004	.7091+003	.2707+003
.1720+002	.3817+004	.7133+003	.2723+003
.1730+002	.3824+004	.7174+003	.2739+003
.1740+002	.3831+004	.7216+003	.2755+003
.1750+002	.3836+004	.7257+003	.2771+003
.1760+002	.3840+004	.7299+003	.2787+003
.1770+002	.3844+004	.7340+003	.2802+003
.1780+002	.3846+004	.7382+003	.2818+003
.1790+002	.3847+004	.7423+003	.2834+003
.1800+002	.3847+004	.7465+003	.2850+003
.1810+002	.3847+004	.7506+003	.2866+003
.1820+002	.3844+004	.7548+003	.2882+003
.1830+002	.3841+004	.7589+003	.2897+003
.1840+002	.3837+004	.7631+003	.2913+003
.1850+002	.3832+004	.7672+003	.2929+003
.1860+002	.3826+004	.7713+003	.2945+003
.1870+002	.3819+004	.7755+003	.2961+003
.1880+002	.3810+004	.7796+003	.2977+003
.1890+002	.3801+004	.7838+003	.2992+003
.1900+002	.3790+004	.7879+003	.3008+003
.1910+002	.3779+004	.7921+003	.3024+003
.1920+002	.3766+004	.7962+003	.3040+003
.1930+002	.3752+004	.8004+003	.3056+003
.1940+002	.3737+004	.8045+003	.3071+003
.1950+002	.3722+004	.8087+003	.3087+003
.1960+002	.3705+004	.8128+003	.3103+003
.1970+002	.3687+004	.8170+003	.3119+003
.1980+002	.3668+004	.8211+003	.3135+003
.1990+002	.3648+004	.8253+003	.3151+003
.2000+002	.3626+004	.8294+003	.3166+003
.2010+002	.3604+004	.8335+003	.3182+003
.2020+002	.3581+004	.8377+003	.3198+003
.2030+002	.3556+004	.8418+003	.3214+003
.2040+002	.3531+004	.8460+003	.3230+003
.2050+002	.3506+004	.8501+003	.3246+003
.2060+002	.3481+004	.8543+003	.3261+003
.2070+002	.3456+004	.8584+003	.3277+003
.2080+002	.3431+004	.8626+003	.3293+003
.2090+002	.3405+004	.8667+003	.3309+003
.2100+002	.3380+004	.8709+003	.3325+003
.2110+002	.3355+004	.8750+003	.3341+003

FIGURE F41



.2120+002	.3330+004	.8792+003	.3356+003
.2130+002	.3305+004	.8833+003	.3372+003
.2140+002	.3280+004	.8874+003	.3388+003
.2150+002	.3254+004	.8916+003	.3404+003
.2160+002	.3229+004	.8957+003	.3420+003
.2170+002	.3204+004	.8999+003	.3436+003
.2180+002	.3179+004	.9040+003	.3451+003
.2190+002	.3154+004	.9082+003	.3467+003
.2200+002	.3129+004	.9123+003	.3483+003
.2210+002	.3103+004	.9165+003	.3499+003
.2220+002	.3078+004	.9206+003	.3515+003
.2230+002	.3053+004	.9248+003	.3531+003
.2240+002	.3028+004	.9289+003	.3546+003
.2250+002	.3003+004	.9331+003	.3562+003
.2260+002	.2978+004	.9372+003	.3578+003
.2270+002	.2952+004	.9413+003	.3594+003
.2280+002	.2927+004	.9455+003	.3610+003
.2290+002	.2902+004	.9496+003	.3626+003
.2300+002	.2877+004	.9538+003	.3641+003
.2310+002	.2852+004	.9579+003	.3657+003
.2320+002	.2826+004	.9621+003	.3673+003
.2330+002	.2801+004	.9662+003	.3689+003
.2340+002	.2776+004	.9704+003	.3705+003
.2350+002	.2751+004	.9745+003	.3721+003
.2360+002	.2726+004	.9787+003	.3736+003
.2370+002	.2701+004	.9828+003	.3752+003
.2380+002	.2675+004	.9869+003	.3768+003
.2390+002	.2650+004	.9911+003	.3784+003
.2400+002	.2625+004	.9952+003	.3800+003
.2410+002	.2600+004	.9994+003	.3815+003
.2420+002	.2575+004	.1004+004	.3831+003
.2430+002	.2550+004	.1008+004	.3847+003
.2440+002	.2524+004	.1012+004	.3863+003
.2450+002	.2499+004	.1016+004	.3879+003
.2460+002	.2474+004	.1020+004	.3895+003
.2470+002	.2449+004	.1024+004	.3910+003
.2480+002	.2424+004	.1028+004	.3926+003
.2490+002	.2399+004	.1033+004	.3942+003
.2500+002	.2373+004	.1037+004	.3958+003
.2510+002	.2348+004	.1041+004	.3974+003
.2520+002	.2323+004	.1045+004	.3990+003
.2530+002	.2298+004	.1049+004	.4005+003
.2540+002	.2273+004	.1053+004	.4021+003
.2550+002	.2248+004	.1057+004	.4037+003
.2560+002	.2222+004	.1062+004	.4053+003
.2570+002	.2197+004	.1066+004	.4069+003
.2580+002	.2172+004	.1070+004	.4085+003
.2590+002	.2147+004	.1074+004	.4100+003
.2600+002	.2122+004	.1078+004	.4116+003
.2610+002	.2097+004	.1082+004	.4132+003
.2620+002	.2071+004	.1086+004	.4148+003
.2630+002	.2046+004	.1091+004	.4164+003
.2640+002	.2021+004	.1095+004	.4180+003
.2650+002	.1996+004	.1099+004	.4195+003
.2660+002	.1971+004	.1103+004	.4211+003
.2670+002	.1946+004	.1107+004	.4227+003
.2680+002	.1920+004	.1111+004	.4243+003

FIGURE F42

```
.2690+002 :      B             A             *    I .1895+004 .1115+004 .4259+003
.2700+002 :      B             A             *    I .1870+004 .1120+004 .4274+003
.2710+002 :      B             A            *     I .1845+004 .1124+004 .4290+003
.2720+002 :      B             A            *     I .1820+004 .1128+004 .4306+003
.2730+002 :      B             A           *      I .1794+004 .1132+004 .4322+003
.2740+002 :      B             A           *      I .1769+004 .1136+004 .4338+003
.2750+002 :      B             A          *       I .1744+004 .1140+004 .4354+003
.2760+002 :      B             A          *       I .1719+004 .1144+004 .4369+003
.2770+002 :      B             A         *        I .1694+004 .1149+004 .4385+003
.2780+002 :       B            A         *        I .1669+004 .1153+004 .4401+003
.2790+002 :       B             A       *         I .1643+004 .1157+004 .4417+003
.2800+002 :       B             A       *         I .1618+004 .1161+004 .4433+003
.2810+002 :       B             A      *          I .1593+004 .1165+004 .4449+003
.2820+002 :       B             A      *          I .1568+004 .1169+004 .4464+003
.2830+002 :       B             A      *          I .1543+004 .1174+004 .4480+003
.2840+002 :       B             A     *           I .1518+004 .1178+004 .4496+003
.2850+002 :       B             A     *           I .1492+004 .1182+004 .4512+003
.2860+002 :       B             A    *            I .1467+004 .1186+004 .4528+003
.2870+002 :       B             A    *            I .1442+004 .1190+004 .4544+003
.2880+002 :       B             A   *             I .1417+004 .1194+004 .4559+003
.2890+002 :       B             A   *             I .1392+004 .1198+004 .4575+003
.2900+002 :       B             A  *              I .1367+004 .1203+004 .4591+003
.2910+002 :       B             A  *              I .1341+004 .1207+004 .4607+003
.2920+002 :       B              A*               I .1316+004 .1211+004 .4623+003
.2930+002 :       B              A*               I .1291+004 .1215+004 .4638+003
.2940+002 :       B              A*               I .1266+004 .1219+004 .4654+003
.2950+002 :       B              A                I .1241+004 .1223+004 .4670+003
.2960+002 :       B              A                I .1216+004 .1227+004 .4686+003
.2970+002 :       B             *A                I .1190+004 .1232+004 .4702+003
.2980+002 :       B             *A                I .1165+004 .1236+004 .4718+003
.2990+002 :       B            * A                I .1140+004 .1240+004 .4733+003
.3000+002 :       B            * A                I .1115+004 .1244+004 .4749+003
```

FIGURE F43

SUMMARY OF THRUSTER FIRING TIMES
NEGATIVE ON TIME IDICATES -VE THRUST SEQUENCE

X

ON	OFF
-15.85	16.10
-16.15	16.40
-16.45	16.70
-16.75	17.00
-17.05	17.30
-17.35	17.60
-17.65	17.90
-17.95	18.20
-18.25	18.50
-18.55	18.80
-18.85	19.10
-19.15	19.40
-19.45	19.70
-19.75	20.00
-20.05	20.30

Y

ON	OFF
.00	.00

Z

ON	OFF
.00	.00

IX.F.2. Roll Axis VRCS Disturbance Responses

Figures F44 - F61

FIGURE F44

DATA FOR THE X-AXIS

CURVE "*" IS A PLOT OF TORQUE VERSUS TIME

MINIMUM VALUE -.8261+001

MAXIMUM VALUE .7274+000

TIME	TORQUE
.1000+000	-.1375+000
.2000+000	.7773-001
.3000+000	-.1369+000
.4000+000	-.9241-001
.5000+000	-.2799-001
.6000+000	.2524+000
.7000+000	-.1407-001
.8000+000	-.9179-001
.9000+000	-.9387-001
.1000+001	.1338+000
.1100+001	.1286+000
.1200+001	-.6985-001
.1300+001	.4491-001
.1400+001	.4865-001
.1500+001	.7689-001
.1600+001	-.5036-001
.1700+001	.2357+000
.1800+001	.1067+000
.1900+001	-.1502-001
.2000+001	.1483+000
.2100+001	-.2023-001
.2200+001	-.4534-001
.2300+001	-.1433+000
.2400+001	-.1376+000
.2500+001	.9226-001
.2600+001	-.4163-001
.2700+001	-.1452-002
.2800+001	.8871-001
.2900+001	.1250+000
.3000+001	.1128+000
.3100+001	-.1155+000
.3200+001	.5643-001
.3300+001	-.3721-002
.3400+001	.3474-001
.3500+001	.1745+000
.3600+001	-.2654-002
.3700+001	.3352-001
.3800+001	-.1543-001
.3900+001	-.2939-001
.4000+001	.2483+000
.4100+001	.1944+000
.4200+001	-.3357-002
.4300+001	-.4702-001
.4400+001	-.6775-001
.4500+001	.4175-001

FIGURE F45

.4600+001	-.8319-002
.4700+001	-.5442-001
.4800+001	-.3005-001
.4900+001	-.3752-001
.5000+001	.6175-001
.5100+001	-.8726-002
.5200+001	.8636-002
.5300+001	.6296-001
.5400+001	-.1172+000
.5500+001	.1789+000
.5600+001	.1728-001
.5700+001	-.1027+000
.5800+001	.6251-003
.5900+001	.2559-001
.6000+001	-.1181+000
.6100+001	.7557-001
.6200+001	.1409+000
.6300+001	-.6198-001
.6400+001	.1521+000
.6500+001	.1697+000
.6600+001	-.8468-001
.6700+001	.8354-001
.6800+001	-.5208-001
.6900+001	.7406-001
.7000+001	-.2742-001
.7100+001	.4121-003
.7200+001	.1218+000
.7300+001	-.7139-001
.7400+001	.1036+000
.7500+001	.9066-002
.7600+001	-.2435-001
.7700+001	-.1493+000
.7800+001	-.1104-001
.7900+001	.1419-001
.8000+001	.4124-001
.8100+001	-.6276-001
.8200+001	-.1260-001
.8300+001	.1937+000
.8400+001	.1774+000
.8500+001	.1093+000
.8600+001	.1163+000
.8700+001	-.1367+000
.8800+001	.4710-002
.8900+001	.6258-001
.9000+001	-.1322-002
.9100+001	.5005-001
.9200+001	.1723+000
.9300+001	.4560-001
.9400+001	-.8905-001
.9500+001	.5416-002
.9600+001	-.2734-001
.9700+001	.1191+000
.9800+001	.3775-001
.9900+001	.1103+000
.1000+002	-.4402-002
.1010+002	-.4371-002
[illegible]	[illegible]

FIGURE F46

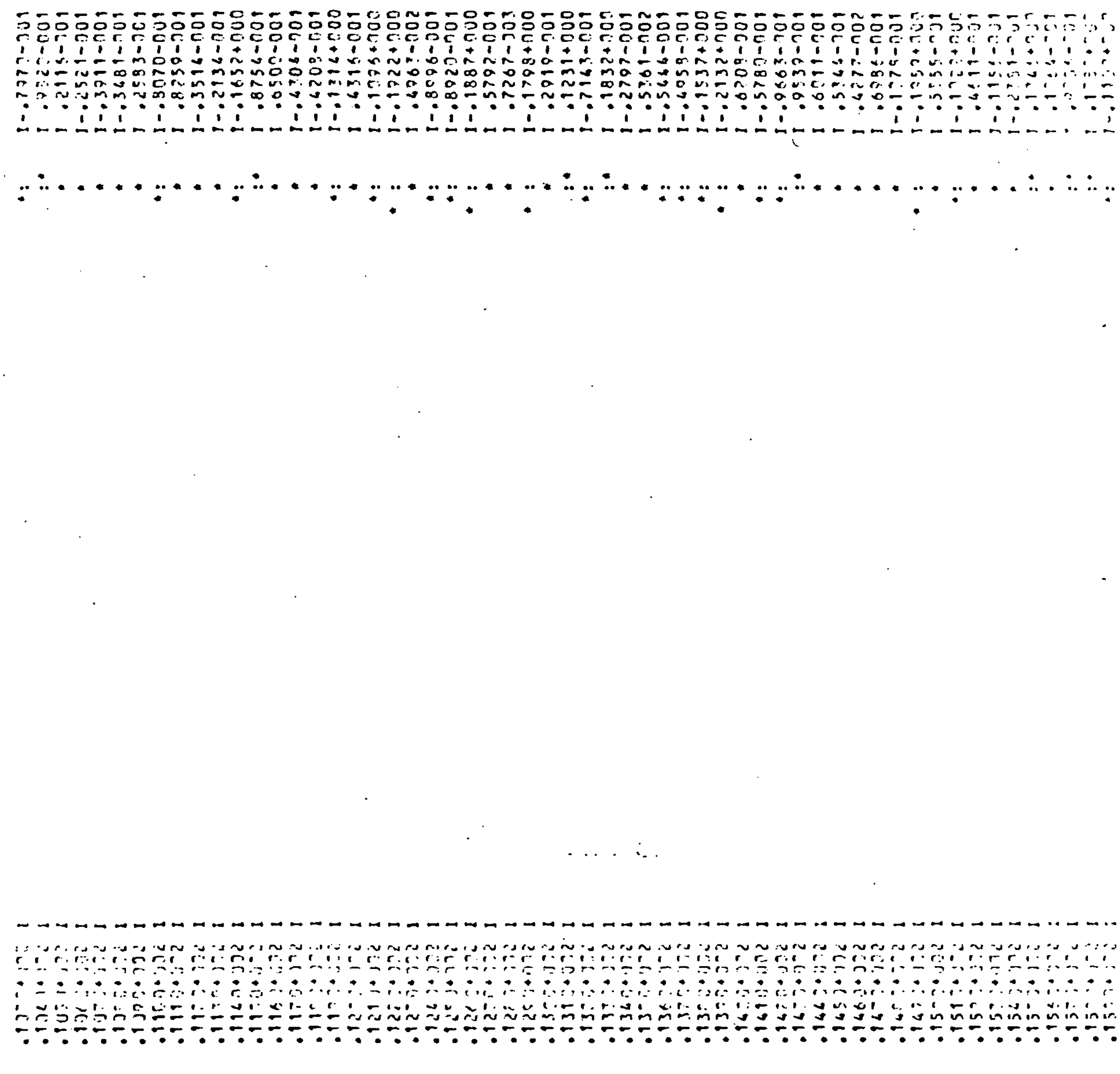


FIGURE F47

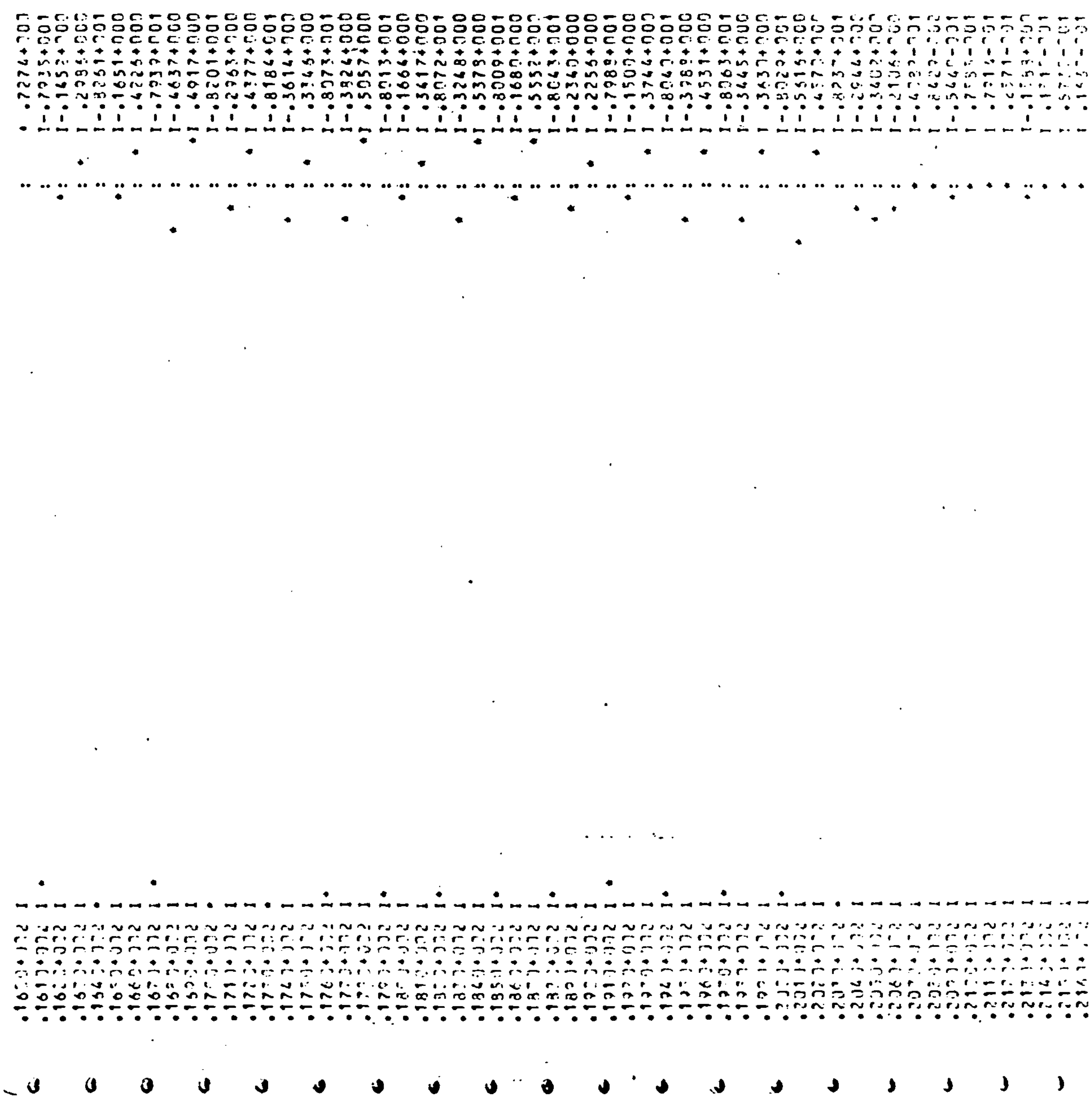


FIGURE F48

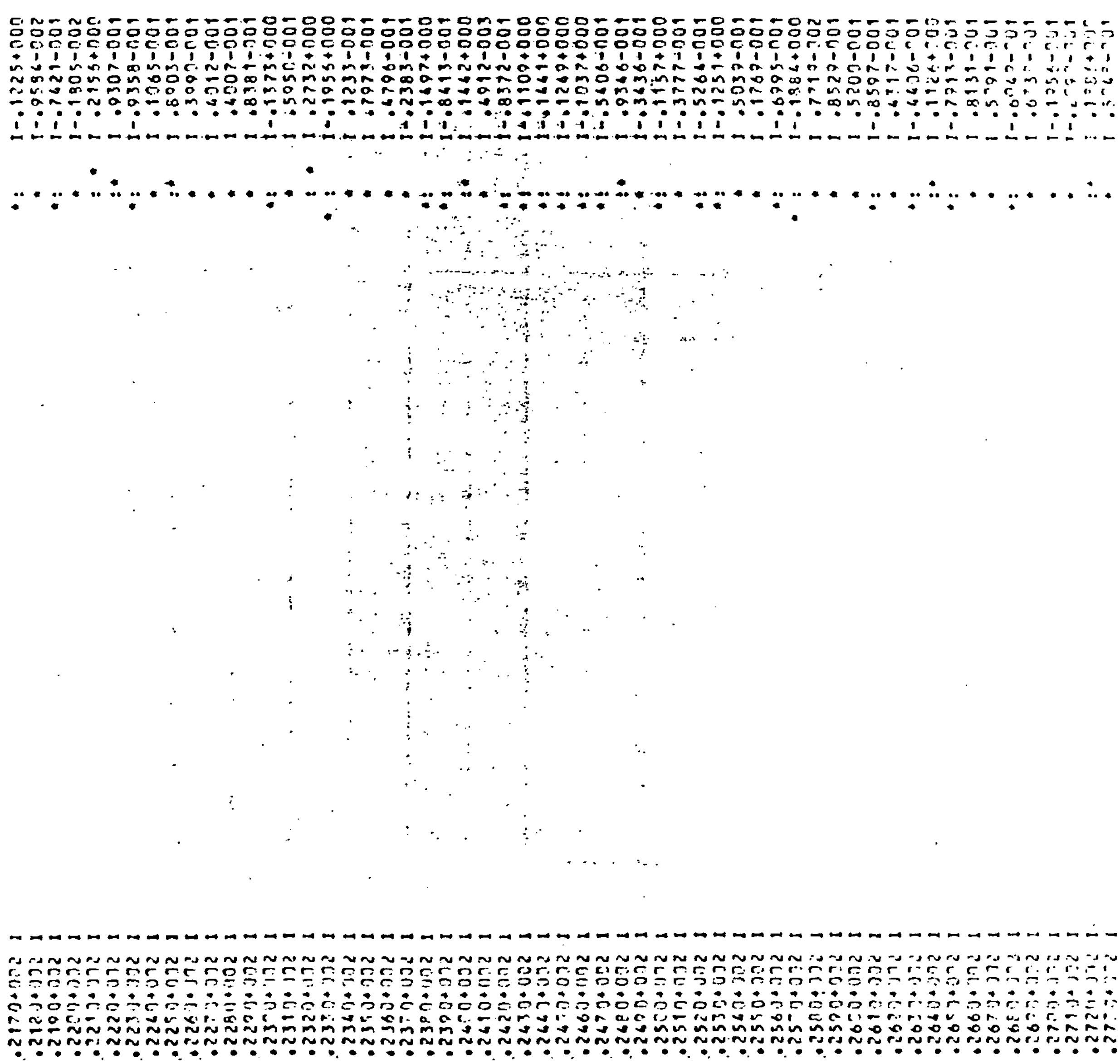
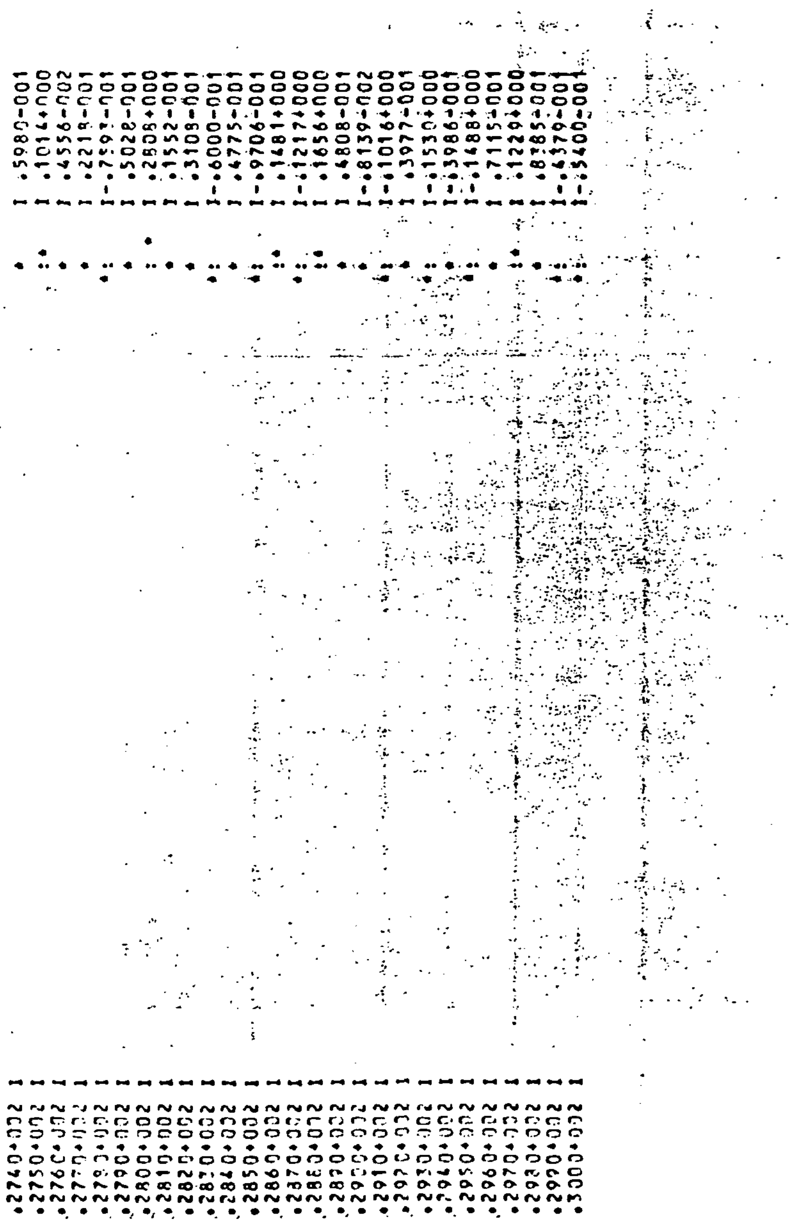


FIGURE F49



DATA FOR THE X-AXIS

CURVE 'A' IS A PLOT OF BASE VERSUS TIME

CURVE 'B' IS A PLOT OF TIP VERSUS TIME

MINIMUM VALUE -.52[illegible]

MAXIMUM VALUE .4236+000

TIME	Plot	BASE	TIP
.1000+000	A B	.5198-003	.2778-001
.2000+000	A B	.1824-002	.3921-001
.3000+000	BA	.2466-002	-.1993-001
.4000+000	BA	.1996-002	-.1297-001
.5000+000	B A	.1491-002	-.5321-001
.6000+000	BA	.5799-003	-.2086-001
.7000+000	BA	-.1596-003	-.2037-001
.8000+000	BA	-.6860-003	-.1619-001
.9000+000	BA	-.1193-002	-.2187-001
.1000+001	B	-.1735-002	-.6601-002
.1100+001	B	-.1597-002	.8320-003
.1200+001	BA	-.1631-002	-.9288-002
.1300+001	BA	-.1932-002	-.1006-001
.1400+001	B	-.2193-002	.3067-002
.1500+001	AB	-.1860-002	.1160-001
.1600+001	AB	-.1934-002	.5933-002
.1700+001	B A	-.2943-002	-.3750-001
.1800+001	B A	-.4604-002	-.3478-001
.1900+001	BA	-.5552-002	-.2292-001
.2000+001	B	-.6368-002	.4129-002
.2100+001	B	-.6428-002	.3017-002
.2200+001	BA	-.6945-002	-.1755-001
.2300+001	B	-.7383-002	-.8660-002
.2400+001	A B	-.6850-002	.4789-001
.2500+001	A B	-.5304-002	.5374-001
.2600+001	A B	-.4860-002	.2530-001
.2700+001	BA	-.5187-002	-.1031-001
.2800+001	AB	-.5438-002	.9066-002
.2900+001	B	-.5797-002	-.1362-002
.3000+001	AB	-.6088-002	.1075-001
.3100+001	A B	-.5446-002	.4262-001
.3200+001	BA	-.5573-002	-.1340-001
.3300+001	BA	-.6344-002	-.1354-001
.3400+001	AB	-.6540-002	.1124-001
.3500+001	AB	-.7043-002	.1337-001
.3600+001	AB	-.6321-002	.2599-001
.3700+001	A B	-.5392-002	.3785-001
.3800+001	B A	-.5573-002	-.3611-001
.3900+001	BA	-.6586-002	-.2352-001
.4000+001	BA	-.7565-002	-.1567-001
.4100+001	BA	-.8484-002	-.1270-001
.4200+001	BA	-.8928-002	-.1301-001
.4300+001	AB	-.8354-002	.1230-001

FIGURE F50

FIGURE F51

.4400+001	B	-.3476-002	.1569-002
.4500+001	AB	-.5139-002	.7711-002
.4600+001	BA	-.7347-002	-.1054-001
.4700+001	A	-.6906-002	.2755-001
.4800+001	AB	-.5755-002	.1200-001
.4900+001	B A	-.5364-002	-.2462-001
.5000+001	B A	-.6959-002	-.2917-001
.5100+001	BA	-.6262-002	-.1464-001
.5200+001	AB	-.6106-002	.5878-002
.5300+001	B	-.5440-002	-.4035-002
.5400+001	B A	-.5312-002	-.2949-001
.5500+001	BA	-.5812-002	-.2287-001
.5600+001	B	-.5096-002	-.2478-002
.5700+001	BA	-.4718-002	-.1964-001
.5800+001	B	-.4407-002	-.4628-002
.5900+001	AB	-.3169-002	.1665-001
.6000+001	BA	-.2675-002	-.2124-001
.6100+001	B A	-.2668-002	-.3968-001
.6200+001	B A	-.3219-002	-.3461-001
.6300+001	B A	-.3710-002	-.4978-001
.6400+001	B A	-.4720-002	-.2531-001
.6500+001	B	-.4665-002	.2248-002
.6600+001	BA	-.3978-002	-.1774-001
.6700+001	BA	-.3682-002	-.1828-001
.6800+001	BA	-.3263-002	-.1540-001
.6900+001	B	-.2663-002	-.3179-002
.7000+001	BA	-.2390-002	-.1167-001
.7100+001	BA	-.1941-002	-.9825-002
.7200+001	B	-.1723-002	.8274-003
.7300+001	B	-.1379-002	.3557-002
.7400+001	B	-.1054-002	.2415-002
.7500+001	AB	-.4464-003	.1018-001
.7600+001	B A	-.8135-003	-.2798-001
.7700+001	B A	-.1375-002	-.3049-001
.7800+001	BA	-.1671-002	-.1672-001
.7900+001	B	-.2040-002	-.6345-002
.8000+001	B A	-.2675-002	-.2498-001
.8100+001	AB	-.2912-002	.1200-001
.8200+001	AB	-.2883-002	.8155-002
.8300+001	AB	-.2827-002	.1293-001
.8400+001	AB	-.2486-002	.1973-001
.8500+001	AB	-.2017-002	.1996-001
.8600+001	A B	-.1618-002	.4027-001
.8700+001	AB	-.9387-003	.7148-002
.8800+001	AB	-.8711-003	.6768-002
.8900+001	BA	-.1661-002	-.1052-001
.9000+001	BA	-.2202-002	-.1031-001
.9100+001	B A	-.3522-002	-.2683-001
.9200+001	BA	-.5364-002	-.1417-001
.9300+001	BA	-.6366-002	-.1077-001
.9400+001	A B	-.6098-002	.5157-001
.9500+001	A B	-.5172-002	.3929-001
.9600+001	A B	-.4143-002	.4247-001
.9700+001	AB	-.3810-002	.1436-001
.9800+001	AB	-.3693-002	.7588-002
.9900+001	BA	-.4769-002	-.1344-001
.1000+002	A B	-.5148-002	.3260-001

FIGURE F52

.1010+002 I	A B	I-.4770-002	.3491-001
.1020+002 I	A	I-.4757-002	-.5716-002
.1030+002 I	B A	I-.5981-002	-.2404-001
.1040+002 I	BA	I-.7277-002	-.1848-001
.1050+002 I	B	I-.7980-002	.1173-002
.1060+002 I	B	I-.7913-002	-.6940-002
.1070+002 I	BA	I-.8507-002	-.1264-001
.1080+002 I	A B	I-.8536-002	.2765-001
.1090+002 I	B	I-.8559-002	-.5965-002
.1100+002 I	BA:	I-.9251-002	-.3448-001
.1110+002 I	BA:	I-.1059-001	-.2658-001
.1120+002 I	B:	I-.1166-001	-.2276-001
.1130+002 I	A:B	I-.1182-001	.1314-001
.1140+002 I	AB	I-.1192-001	-.8587-002
.1150+002 I	AB	I-.1232-001	-.7380-002
.1160+002 I	B:	I-.1229-001	-.1368-001
.1170+002 I	AB	I-.1249-001	-.2154-002
.1180+002 I	A:B	I-.1201-001	.1102-001
.1190+002 I	B:	I-.1179-001	-.2081-001
.1200+002 I	B:	I-.1242-001	-.2253-001
.1210+002 I	BA:	I-.1305-001	-.2442-001
.1220+002 I	B:	I-.1319-001	-.1538-001
.1230+002 I	AB	I-.1317-001	.5735-002
.1240+002 I	A: B	I-.1257-001	.2216-001
.1250+002 I	AB	I-.1147-001	.5412-002
.1260+002 I	B:	I-.1116-001	-.1769-001
.1270+002 I	B:	I-.1111-001	-.1658-001
.1280+002 I	AB	I-.1095-001	-.4148-002
.1290+002 I	BA:	I-.1065-001	-.2617-001
.1300+002 I	B:	I-.1093-001	-.1700-001
.1310+002 I	B A:	I-.1160-001	-.4320-001
.1320+002 I	BA:	I-.1246-001	-.3039-001
.1330+002 I	B:	I-.1296-001	-.1325-001
.1340+002 I	A: B	I-.1213-001	.2152-001
.1350+002 I	A:B	I-.1079-001	.1056-001
.1360+002 I	B:	I-.1004-001	-.2057-001
.1370+002 I	B A:	I-.1013-001	-.4769-001
.1380+002 I	B A:	I-.1016-001	-.4360-001
.1390+002 I	BA:	I-.1083-001	-.3853-001
.1400+002 I	AB	I-.1100-001	-.4508-003
.1410+002 I	BA:	I-.1110-001	-.3412-001
.1420+002 I	BA:	I-.1178-001	-.3493-001
.1430+002 I	B A:	I-.1238-001	-.4322-001
.1440+002 I	B A:	I-.1315-001	-.5371-001
.1450+002 I	BA:	I-.1355-001	-.3060-001
.1460+002 I	B:	I-.1328-001	-.1992-001
.1470+002 I	A:B	I-.1290-001	.1020-001
.1480+002 I	A: B	I-.1166-001	.2772-001
.1490+002 I	AB	I-.1079-001	-.4488-002
.1500+002 I	AB	I-.1055-001	-.3681-002
.1510+002 I	B:	I-.1010-001	-.1049-001
.1520+002 I	A:	I-.9466-002	.2255-001
.1530+002 I	A	I-.8473-002	.2576-001
.1540+002 I	[illegible]	I-.7609-002	-.4179-002
.1550+002 I	[illegible]	I-.7674-002	-.9171-002
.1560+002 I	[illegible]	I-.7713-002	-.5214-002
.1570+002 I	[illegible]	I-.7193-002	.1778-001

FIGURE F53

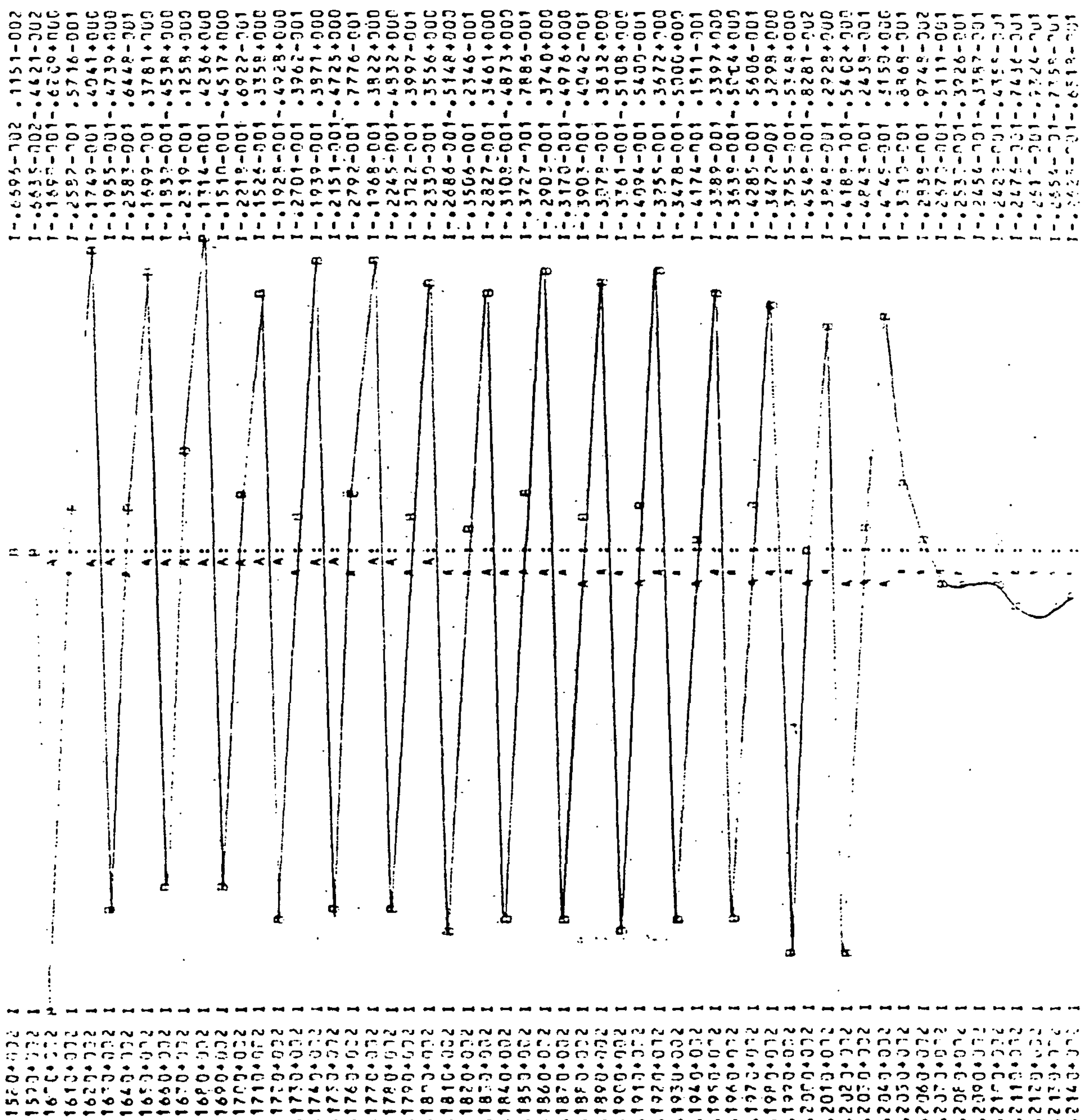


FIGURE F54

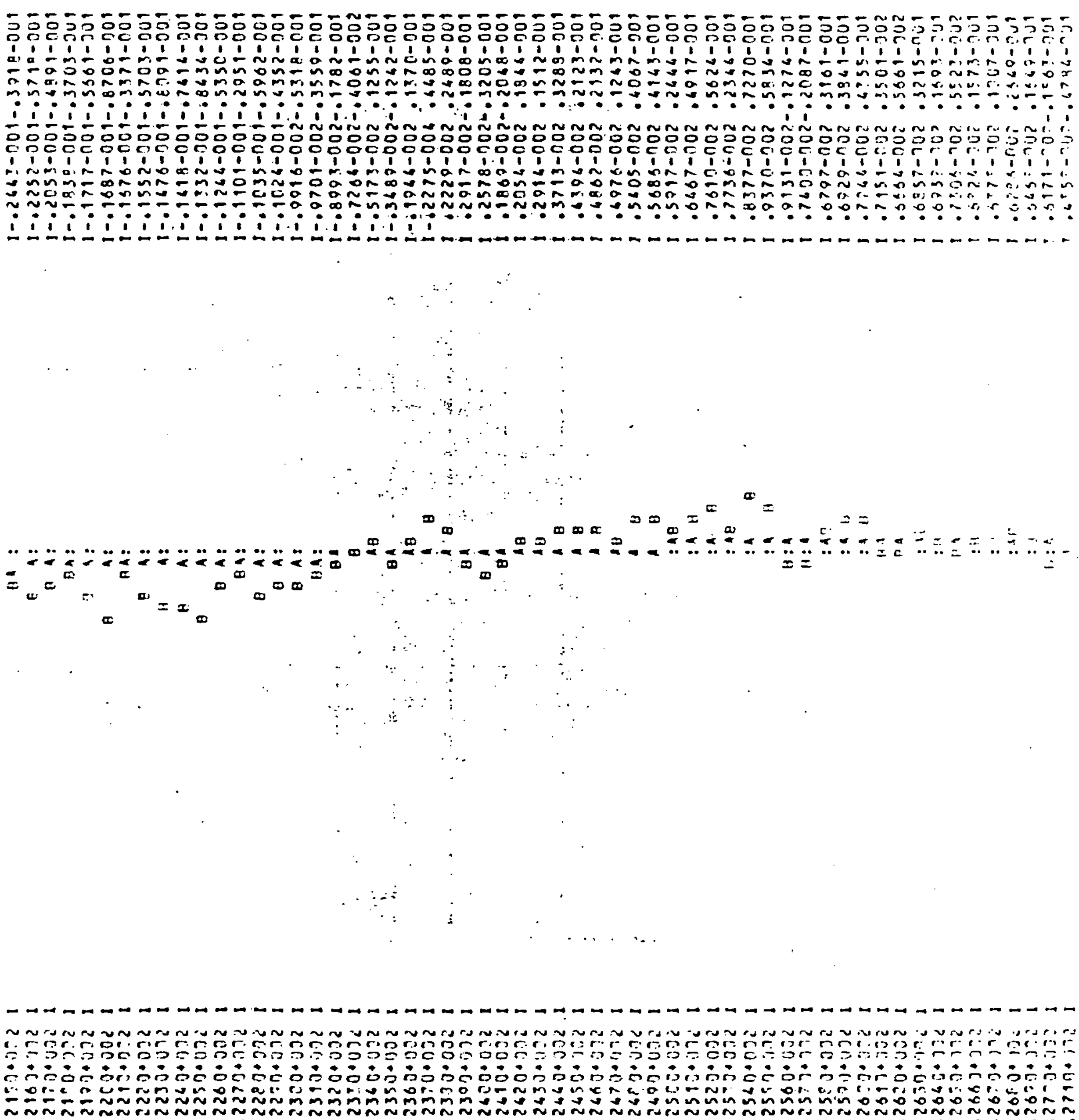


FIGURE F55

```
.2720+002 I       AB           I .3993-002 .2006-001
.2730+002 I       A B          I .4509-002 .2141-001
.2740+002 I       A B          I .4941-002 .2485-001
.2750+002 I       AB           I .5121-002 .8517-002
.2760+002 I      BA            I .5097-002-.1807-001
.2770+002 I   B   A            I .3944-002-.4042-001
.2780+002 I      BA            I .3183-002-.1349-001
.2790+002 I       A B          I .3527-002 .3235-001
.2800+002 I       A   B        I .4632-002 .4372-001
.2810+002 I      :AB           I .6011-002 .2649-001
.2820+002 I    B :A            I .5907-002-.3367-001
.2830+002 I      B             I .5406-002-.4734-002
.2840+002 I     B:A            I .6021-002-.1103-001
.2850+002 I     B:A            I .6179-002-.9387-002
.2860+002 I      B             I .5729-002-.5571-002
.2870+002 I      :B            I .5911-002 .1259-001
.2880+002 I      :B            I .6289-002 .6325-002
.2890+002 I      :B            I .6587-002 .6602-002
.2900+002 I      BA            I .7333-002-.9379-003
.2910+002 I      :B            I .8008-002 .1297-001
.2920+002 I      :AB           I .9316-002 .3410-001
.2930+002 I      :A B          I .1138-001 .3908-001
.2940+002 I      :B            I .1283-001 .7139-002
.2950+002 I      :B            I .1354-001 .1531-001
.2960+002 I      BA            I .1413-001 .1770-002
.2970+002 I      :B            I .1443-001 .1549-001
.2980+002 I      :AB           I .1521-001 .2761-001
.2990+002 I      :AB           I .1665-001 .2272-001
.3000+002 I      :B            I .1779-001 .1938-001
```

FIGURE F56

SHUTTLE ROTATIONS

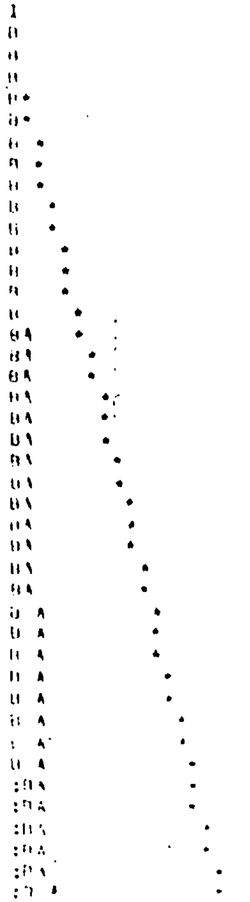
CURVE "B" IS A PLOT OF THETAX VERSUS TIME

CURVE "A" IS A PLOT OF THETAY VERSUS TIME

CURVE "D" IS A PLOT OF THETAZ VERSUS TIME

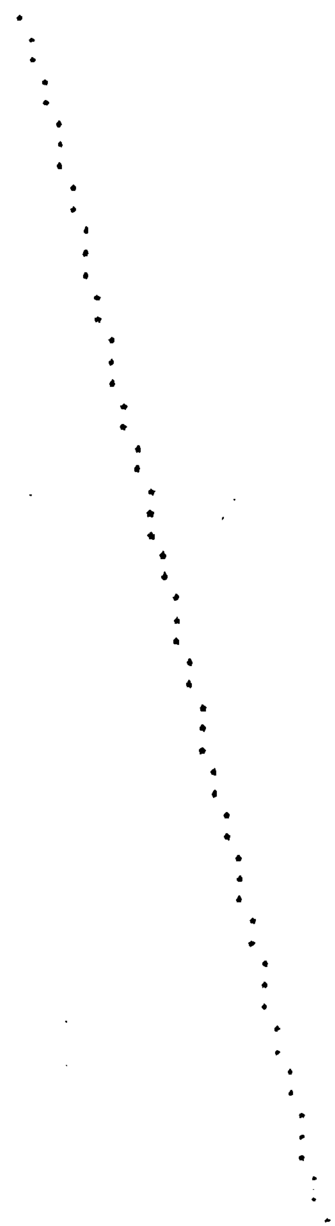
MINIMUM VALUE .0000

MAXIMUM VALUE .9842+004



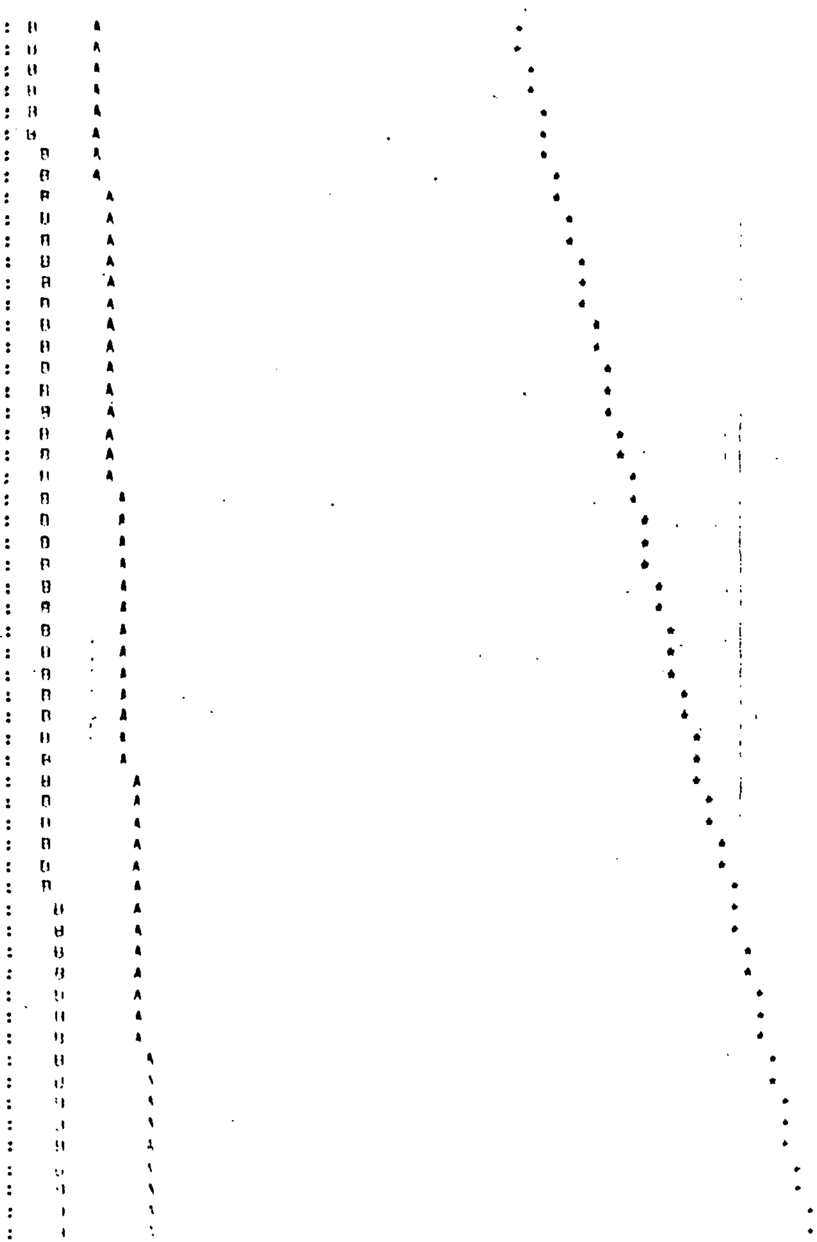
TIME	THETAX	THETAY	THETAZ
.0000	.0000	.0000	.0000
.1000+000	.2263+002	.4144+001	.1584+001
.2000+000	.4536+002	.8289+001	.3167+001
.3000+000	.6804+002	.1243+002	.4751+001
.4000+000	.9072+002	.1658+002	.6334+001
.5000+000	.1134+003	.2072+002	.7918+001
.6000+000	.1361+003	.2487+002	.9501+001
.7000+000	.1588+003	.2901+002	.1108+002
.8000+000	.1814+003	.3316+002	.1267+002
.9000+000	.2041+003	.3730+002	.1425+002
.1000+001	.2268+003	.4144+002	.1584+002
.1100+001	.2495+003	.4559+002	.1742+002
.1200+001	.2722+003	.4973+002	.1900+002
.1300+001	.2948+003	.5388+002	.2059+002
.1400+001	.3175+003	.5802+002	.2217+002
.1500+001	.3402+003	.6217+002	.2375+002
.1600+001	.3629+003	.6631+002	.2534+002
.1700+001	.3856+003	.7045+002	.2692+002
.1800+001	.4082+003	.7460+002	.2850+002
.1900+001	.4309+003	.7874+002	.3009+002
.2000+001	.4536+003	.8289+002	.3167+002
.2100+001	.4763+003	.8703+002	.3325+002
.2200+001	.4990+003	.9118+002	.3484+002
.2300+001	.5216+003	.9532+002	.3642+002
.2400+001	.5443+003	.9946+002	.3800+002
.2500+001	.5670+003	.1036+003	.3959+002
.2600+001	.5897+003	.1078+003	.4117+002
.2700+001	.6124+003	.1119+003	.4275+002
.2800+001	.6350+003	.1160+003	.4434+002
.2900+001	.6577+003	.1202+003	.4592+002
.3000+001	.6804+003	.1243+003	.4751+002
.3100+001	.7031+003	.1285+003	.4909+002
.3200+001	.7258+003	.1326+003	.5067+002
.3300+001	.7485+003	.1368+003	.5226+002
.3400+001	.7711+003	.1409+003	.5384+002
.3500+001	.7938+003	.1451+003	.5542+002
.3600+001	.8165+003	.1492+003	.5701+002
.3700+001	.8392+003	.1533+003	.5859+002
.3800+001	.8618+003	.1575+003	.6017+002
.3900+001	.8845+003	.1616+003	.6175+002
.4000+001	.9072+003	.1658+003	.6334+002

FIGURE F57



.4100+001	.9299+003	.1693+003	.6492+002
.4200+001	.9526+003	.1741+003	.6651+002
.4300+001	.9753+003	.1782+003	.6809+002
.4400+001	.9979+003	.1823+003	.6967+002
.4500+001	.1021+004	.1865+003	.7126+002
.4600+001	.1043+004	.1906+003	.7284+002
.4700+001	.1066+004	.1948+003	.7442+002
.4800+001	.1089+004	.1989+003	.7601+002
.4900+001	.1111+004	.2031+003	.7759+002
.5000+001	.1134+004	.2072+003	.7917+002
.5100+001	.1157+004	.2114+003	.8076+002
.5200+001	.1179+004	.2155+003	.8234+002
.5300+001	.1202+004	.2196+003	.8393+002
.5400+001	.1225+004	.2238+003	.8551+002
.5500+001	.1247+004	.2279+003	.8709+002
.5600+001	.1270+004	.2321+003	.8868+002
.5700+001	.1293+004	.2362+003	.9026+002
.5800+001	.1315+004	.2404+003	.9184+002
.5900+001	.1338+004	.2445+003	.9343+002
.6000+001	.1361+004	.2487+003	.9501+002
.6100+001	.1383+004	.2528+003	.9659+002
.6200+001	.1406+004	.2569+003	.9818+002
.6300+001	.1429+004	.2611+003	.9976+002
.6400+001	.1452+004	.2652+003	.1013+003
.6500+001	.1474+004	.2694+003	.1029+003
.6600+001	.1497+004	.2735+003	.1045+003
.6700+001	.1520+004	.2777+003	.1061+003
.6800+001	.1542+004	.2818+003	.1077+003
.6900+001	.1565+004	.2860+003	.1093+003
.7000+001	.1588+004	.2901+003	.1108+003
.7100+001	.1610+004	.2942+003	.1124+003
.7200+001	.1633+004	.2984+003	.1140+003
.7300+001	.1656+004	.3025+003	.1156+003
.7400+001	.1679+004	.3067+003	.1172+003
.7500+001	.1701+004	.3108+003	.1188+003
.7600+001	.1724+004	.3150+003	.1203+003
.7700+001	.1746+004	.3191+003	.1219+003
.7800+001	.1769+004	.3233+003	.1235+003
.7900+001	.1792+004	.3274+003	.1251+003
.8000+001	.1814+004	.3315+003	.1267+003
.8100+001	.1837+004	.3357+003	.1283+003
.8200+001	.1860+004	.3398+003	.1298+003
.8300+001	.1882+004	.3440+003	.1314+003
.8400+001	.1905+004	.3481+003	.1330+003
.8500+001	.1928+004	.3523+003	.1346+003
.8600+001	.1950+004	.3564+003	.1362+003
.8700+001	.1973+004	.3606+003	.1378+003
.8800+001	.1996+004	.3647+003	.1393+003
.8900+001	.2019+004	.3688+003	.1409+003
.9000+001	.2041+004	.3730+003	.1425+003
.9100+001	.2064+004	.3771+003	.1441+003
.9200+001	.2087+004	.3813+003	.1457+003
.9300+001	.2109+004	.3854+003	.1473+003
.9400+001	.2132+004	.3896+003	.1488+003
.9500+001	.2155+004	.3937+003	.1504+003
.9600+001	.2177+004	.3979+003	.1520+003
.9700+001	.2200+004	.4020+003	.1535+003

FIGURE F58



.9800+001	.2223+004	.4061+003	.1552+003
.9900+001	.2245+004	.4103+003	.1568+003
.1000+002	.2268+004	.4144+003	.1583+003
.1010+002	.2291+004	.4186+003	.1599+003
.1020+002	.2313+004	.4227+003	.1615+003
.1030+002	.2336+004	.4269+003	.1631+003
.1040+002	.2359+004	.4310+003	.1647+003
.1050+002	.2381+004	.4351+003	.1663+003
.1060+002	.2404+004	.4393+003	.1678+003
.1070+002	.2427+004	.4434+003	.1694+003
.1080+002	.2449+004	.4476+003	.1710+003
.1090+002	.2472+004	.4517+003	.1726+003
.1100+002	.2495+004	.4559+003	.1742+003
.1110+002	.2517+004	.4600+003	.1758+003
.1120+002	.2540+004	.4642+003	.1773+003
.1130+002	.2563+004	.4683+003	.1789+003
.1140+002	.2585+004	.4724+003	.1805+003
.1150+002	.2608+004	.4766+003	.1821+003
.1160+002	.2631+004	.4807+003	.1837+003
.1170+002	.2654+004	.4849+003	.1853+003
.1180+002	.2676+004	.4890+003	.1868+003
.1190+002	.2699+004	.4932+003	.1884+003
.1200+002	.2722+004	.4973+003	.1900+003
.1210+002	.2744+004	.5015+003	.1916+003
.1220+002	.2767+004	.5056+003	.1932+003
.1230+002	.2790+004	.5097+003	.1948+003
.1240+002	.2812+004	.5139+003	.1963+003
.1250+002	.2835+004	.5180+003	.1979+003
.1260+002	.2858+004	.5222+003	.1995+003
.1270+002	.2880+004	.5263+003	.2011+003
.1280+002	.2903+004	.5305+003	.2027+003
.1290+002	.2926+004	.5346+003	.2043+003
.1300+002	.2948+004	.5387+003	.2058+003
.1310+002	.2971+004	.5429+003	.2074+003
.1320+002	.2994+004	.5470+003	.2090+003
.1330+002	.3016+004	.5512+003	.2106+003
.1340+002	.3039+004	.5553+003	.2122+003
.1350+002	.3062+004	.5595+003	.2138+003
.1360+002	.3084+004	.5636+003	.2153+003
.1370+002	.3107+004	.5678+003	.2169+003
.1380+002	.3130+004	.5719+003	.2185+003
.1390+002	.3152+004	.5760+003	.2201+003
.1400+002	.3175+004	.5802+003	.2217+003
.1410+002	.3198+004	.5843+003	.2233+003
.1420+002	.3220+004	.5885+003	.2248+003
.1430+002	.3243+004	.5925+003	.2264+003
.1440+002	.3265+004	.5968+003	.2280+003
.1450+002	.3287+004	.6009+003	.2295+003
.1460+002	.3311+004	.6050+003	.2312+003
.1470+002	.3334+004	.6092+003	.2328+003
.1480+002	.3357+004	.6133+003	.2343+003
.1490+002	.3379+004	.6175+003	.2359+003
.1500+002	.3402+004	.6215+003	.2375+003
.1510+002	.3425+004	.6256+003	.2391+003
.1520+002	.3447+004	.6299+003	.2407+003
.1530+002	.3470+004	.6341+003	.2423+003
.1540+002	.3493+004	.6382+003	.2439+003

FIGURE F59

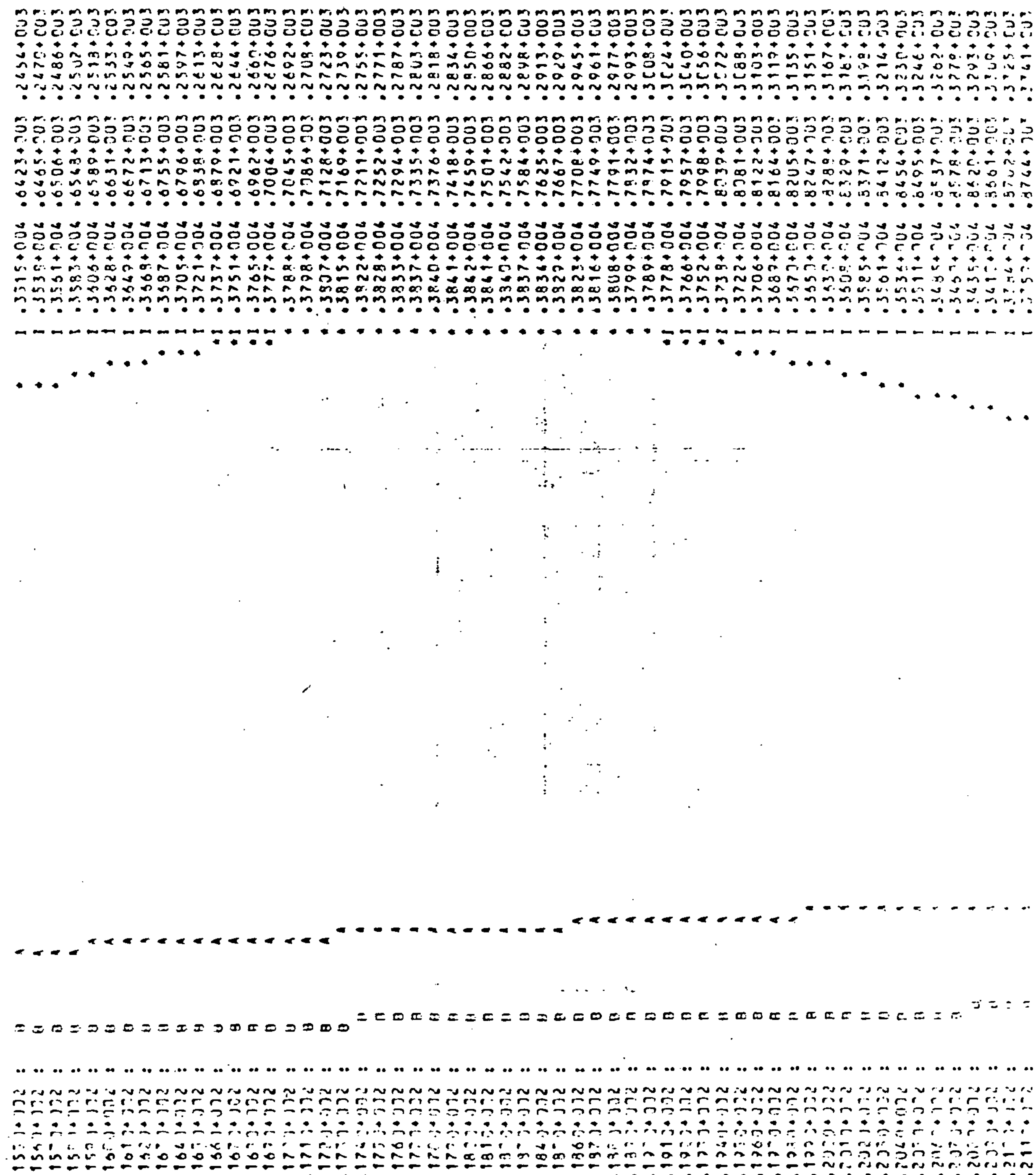


FIGURE F60

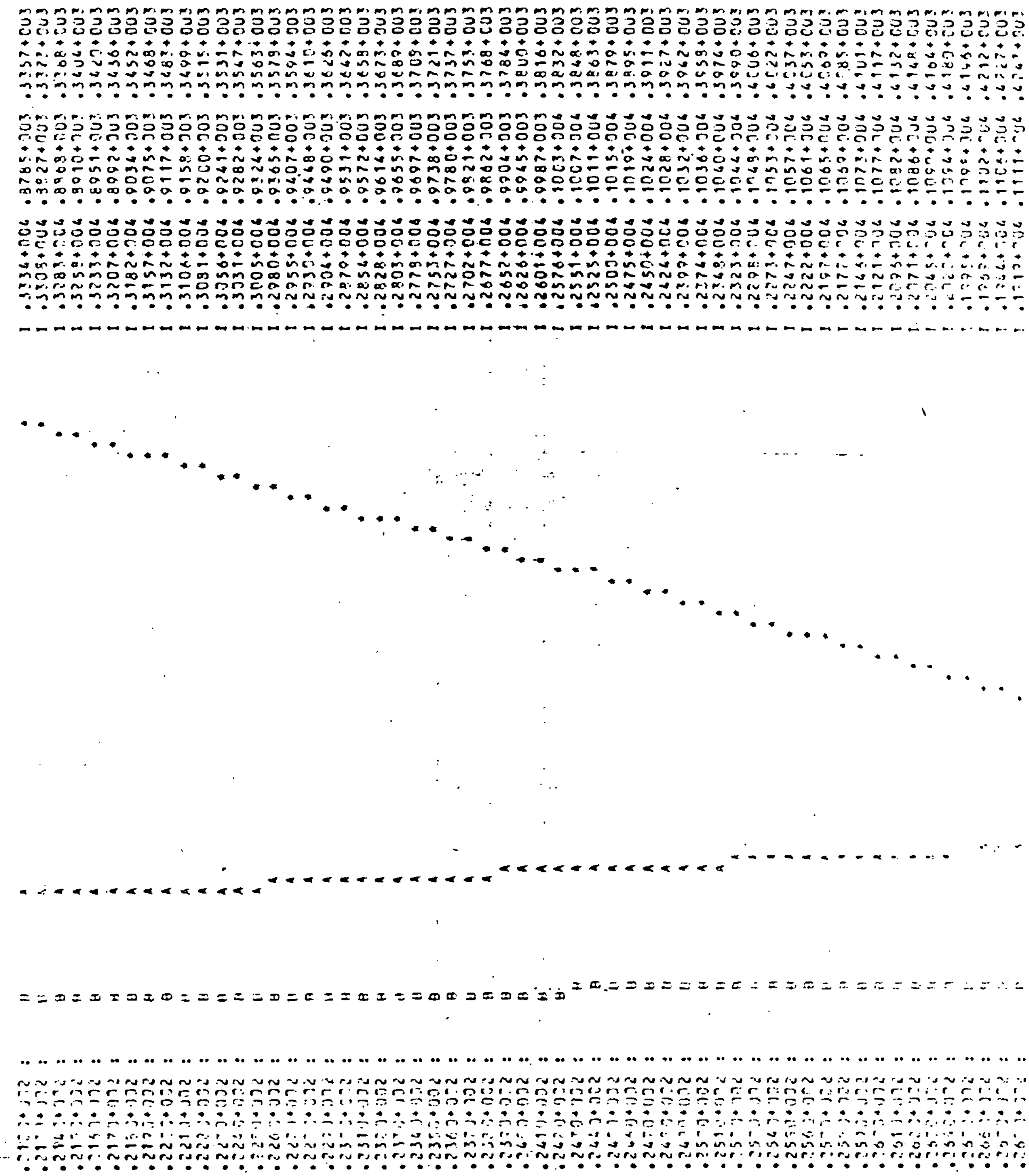
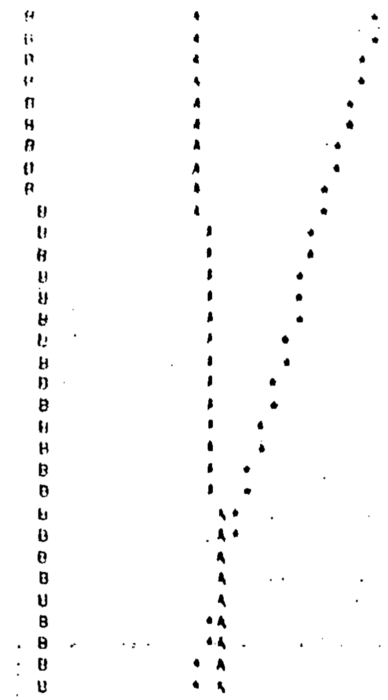


FIGURE F61



.2690+002	.1894+004	.1115+004	.4259+003
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.2710+002	.1843+004	.1123+004	.4291+003
.2720+002	.1818+004	.1127+004	.4307+003
.2730+002	.1793+004	.1131+004	.4322+003
.2740+002	.1767+004	.1135+004	.4338+003
.2750+002	.1742+004	.1140+004	.4354+003
.2760+002	.1717+004	.1144+004	.4370+003
.2770+002	.1692+004	.1148+004	.4386+003
.2780+002	.1666+004	.1152+004	.4402+003
.2790+002	.1641+004	.1156+004	.4417+003
.2800+002	.1616+004	.1160+004	.4433+003
.2810+002	.1590+004	.1164+004	.4449+003
.2820+002	.1565+004	.1169+004	.4465+003
.2830+002	.1540+004	.1173+004	.4481+003
.2840+002	.1515+004	.1177+004	.4496+003
.2850+002	.1489+004	.1181+004	.4512+003
.2860+002	.1464+004	.1185+004	.4528+003
.2870+002	.1439+004	.1189+004	.4544+003
.2880+002	.1414+004	.1193+004	.4560+003
.2890+002	.1388+004	.1198+004	.4576+003
.2900+002	.1363+004	.1202+004	.4591+003
.2910+002	.1338+004	.1206+004	.4607+003
.2920+002	.1313+004	.1210+004	.4623+003
.2930+002	.1287+004	.1214+004	.4639+003
.2940+002	.1262+004	.1218+004	.4655+003
.2950+002	.1237+004	.1222+004	.4671+003
.2960+002	.1211+004	.1227+004	.4686+003
.2970+002	.1186+004	.1231+004	.4702+003
.2980+002	.1161+004	.1235+004	.4718+003
.2990+002	.1136+004	.1239+004	.4734+003
.3000+002	.1110+004	.1243+004	.4750+003

IX.F.3. Pitch Axis VRCS Disturbance Responses

Figures F62 - F100

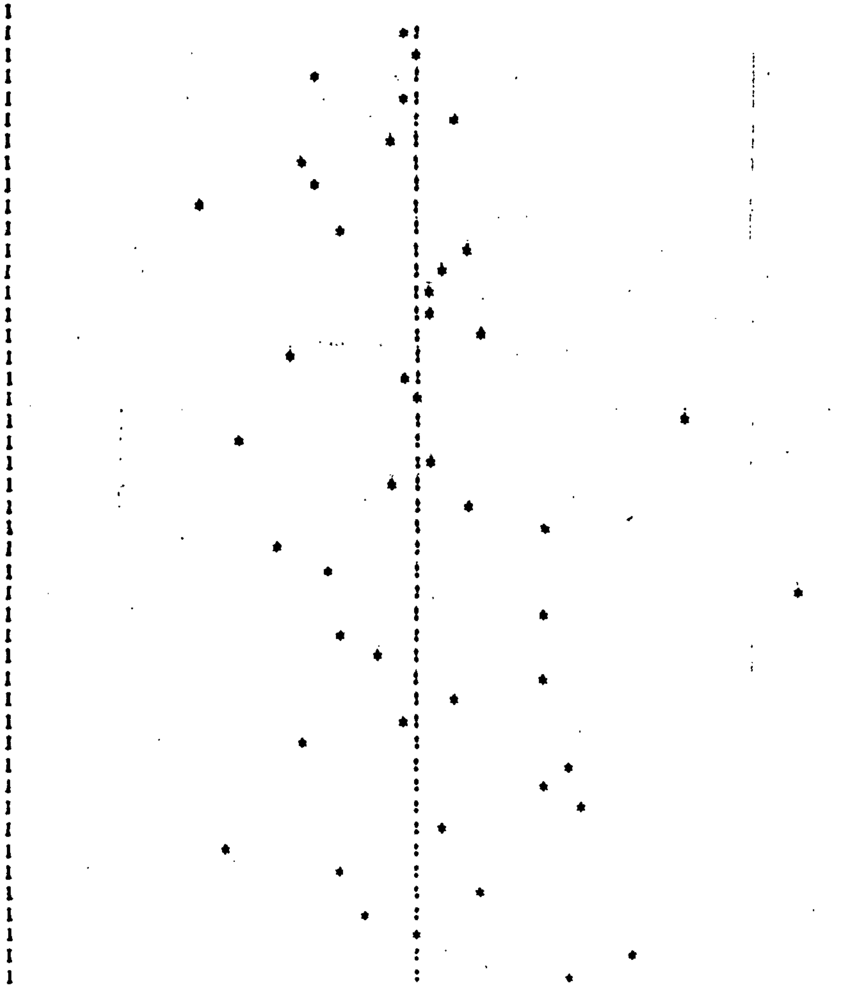
FIGURE F62

DATA FOR THE Y-AXIS

CURVE '*' IS A PLOT OF TORQUE VERSUS TIME

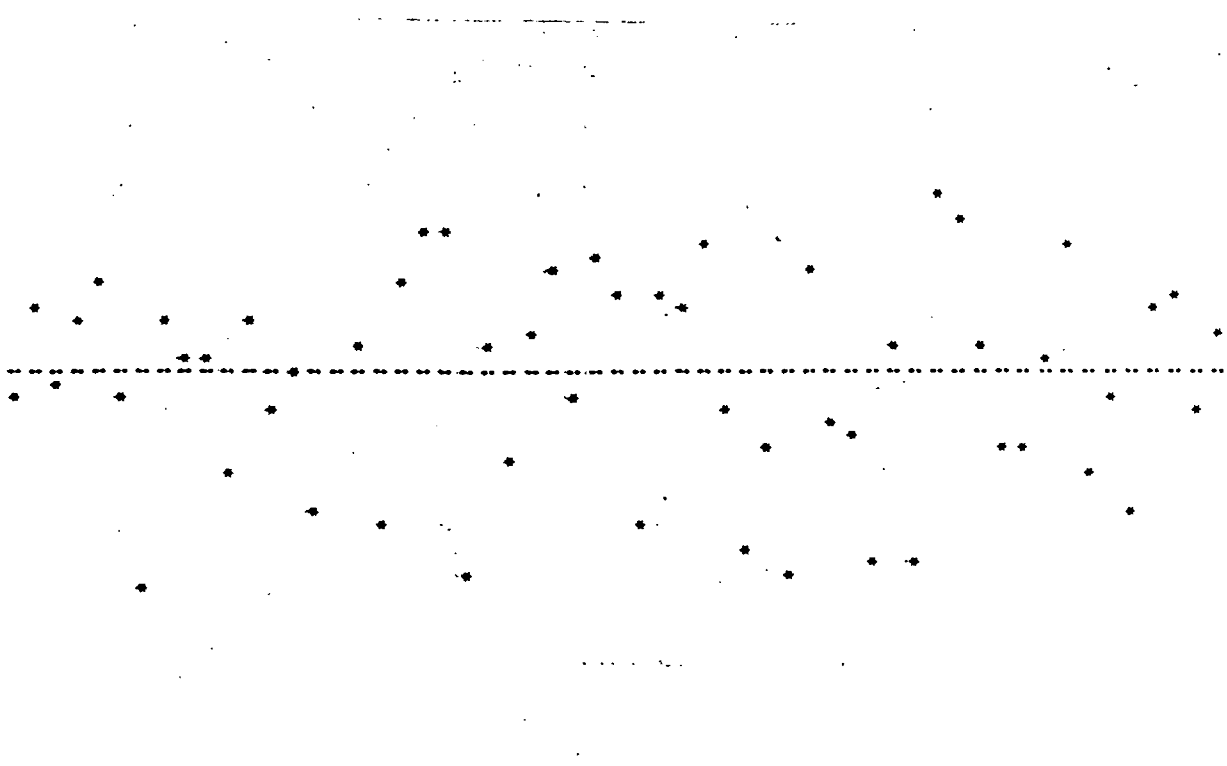
MINIMUM VALUE -.3327+000

MAXIMUM VALUE .3763+000



TIME	TORQUE
.8002+002	-.1471-001
.8004+002	-.6693-002
.8006+002	-.8130-001
.8008+002	-.1320-001
.8010+002	.2294-001
.8012+002	-.2502-001
.8014+002	-.9471-001
.8016+002	-.8605-001
.8018+002	-.1804+000
.8020+002	-.6416-001
.8022+002	.3961-001
.8024+002	.1468-001
.8026+002	.1571-002
.8028+002	.4392-002
.8030+002	.4589-001
.8032+002	-.1094+000
.8034+002	-.1838-001
.8036+002	-.5024-002
.8038+002	.2113+000
.8040+002	-.1407+000
.8042+002	.1107-001
.8044+002	-.2697-001
.8046+002	.4109-001
.8048+002	.1018+000
.8050+002	-.1108+000
.8052+002	-.6986-001
.8054+002	.3046+000
.8056+002	.9442-001
.8058+002	-.6607-001
.8060+002	-.3473-001
.8062+002	.9464-001
.8064+002	.2961-001
.8066+002	-.1190-001
.8068+002	-.9974-001
.8070+002	.1160+000
.8072+002	.9796-001
.8074+002	.1301+000
.8076+002	.1892-001
.8078+002	-.1525+000
.8080+002	-.6594-001
.8082+002	.5033-001
.8084+002	-.4802-001
.8086+002	-.4618-002
.8088+002	.1734+000
.8090+002	.1193+000

FIGURE F63



.8092+002	-.2036-001
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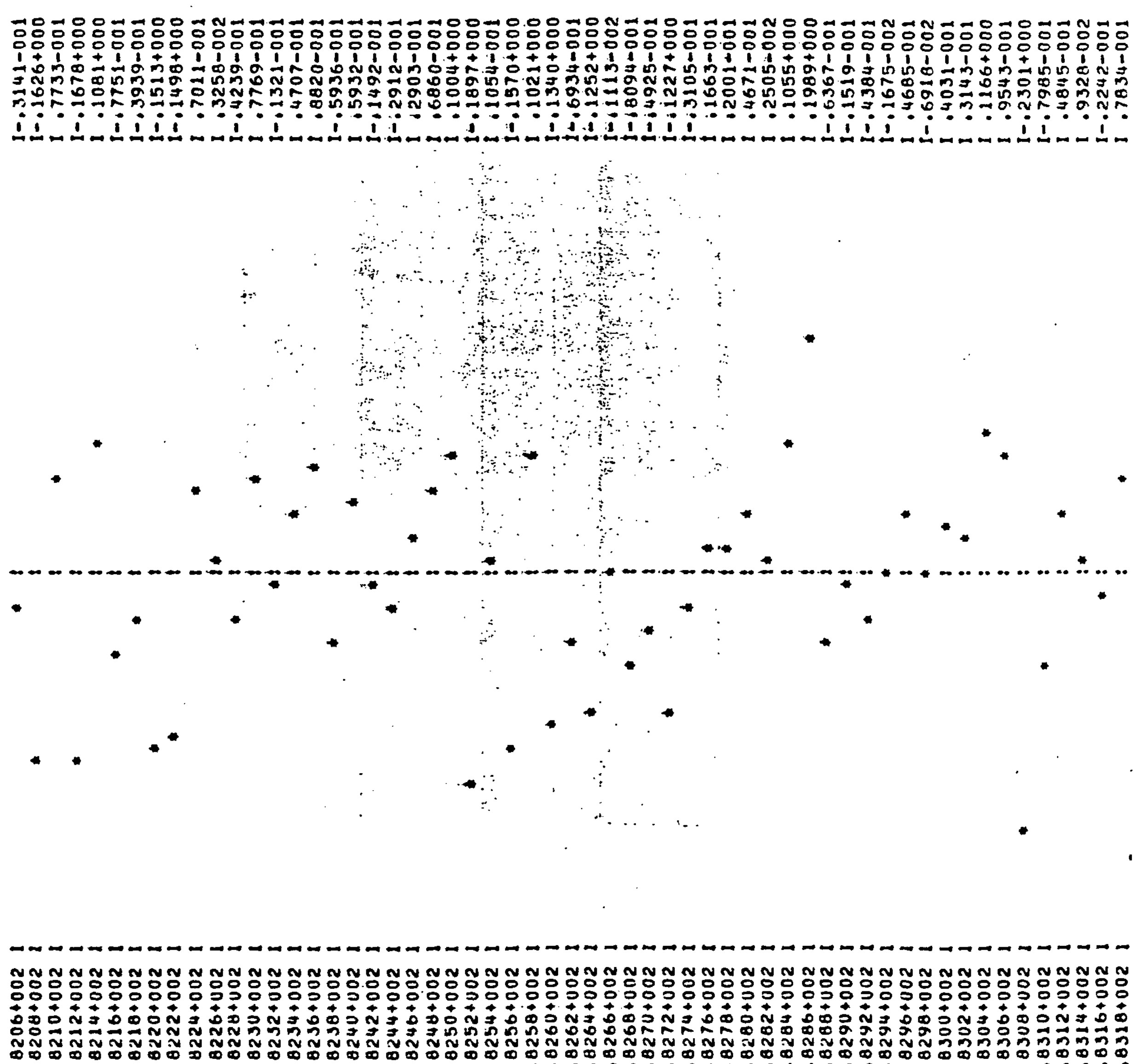
.8096+002	-.1012-001
.8098+002	.3532-001
.8100+002	.6834-001
.8102+002	-.2660-001
.8104+002	-.1713+000
.8106+002	.3334-001
.8108+002	.2686-002
.8110+002	.4429-002
.8112+002	-.8059-001
.8114+002	.3302-001
.8116+002	-.3303-001
.8118+002	-.9647-003
.8120+002	-.1116+000
.8122+002	.3763+000
.8124+002	.1952-001
.8126+002	-.1289+000
.8128+002	.6676-001
.8130+002	.1117+000
.8132+002	.1090+000
.8134+002	-.1621+000
.8136+002	.1661-001
.8138+002	-.7378-001
.8140+002	.2210-001
.8142+002	.7730-001
.8144+002	-.2615-001
.8146+002	.8907-001
.8148+002	.5999-001
.8150+002	-.1201+000
.8152+002	.5747-001
.8154+002	.4599-001
.8156+002	.1026+000
.8158+002	-.3209-001
.8160+002	-.1450+000
.8162+002	-.6769-001
.8164+002	-.1629+000
.8166+002	.7975-001
.8168+002	-.3998-001
.8170+002	-.5622-001
.8172+002	-.1568+000
.8174+002	.1329-001
.8176+002	-.1581+000
.8178+002	.1414+000
.8180+002	.1131+000
.8182+002	.2044-001
.8184+002	-.6647-001
.8186+002	-.6111-001
.8188+002	.2094-002
.8190+002	.9716-001
.8192+002	-.8223-001
.8194+002	-.2244-001
.8196+002	-.1103+000
.8198+002	.4868-001
.8200+002	.6128-001
.8202+002	-.3118-001
.8204+002	.2194-001

FIGURE F64



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I .7733-001
I-.1678+000
I .1081+000
I-.7751-001
I-.3939-001
I-.1513+000
I-.1498+000
I .7011-001
I .3258-002
I-.4239-001
I .7769-001
I-.1321-001
I .4707-001
I .8820-001
I-.5936-001
I .5932-001
I-.1492-001
I-.2912-001
I .2903-001
I .6860-001
I .1004+000
I-.1897+000
I .1054-001
I-.1570+000
I .1021+000
I-.1340+000
I-.6934-001
I-.1252+000
I-.1113-002
I .8094-001
I-.4925-001
I-.1227+000
I-.3105-001
I .1663-001
I .2001-001
I .4671-001
I .2505-002
I .1055+000
I .1989+000
I-.6367-001
I-.1519-001
I-.4384-001
I-.1675-002
I .4685-001
I-.6918-002
I .4031-001
I .3143-001
I .1166+000
I .9543-001
I-.2301+000
I-.7985-001
I .4845-001
I .9328-002
I-.2242-001
I .7834-001
.8206+002 I
.8208+002 I
.8210+002 I
.8212+002 I
.8214+002 I
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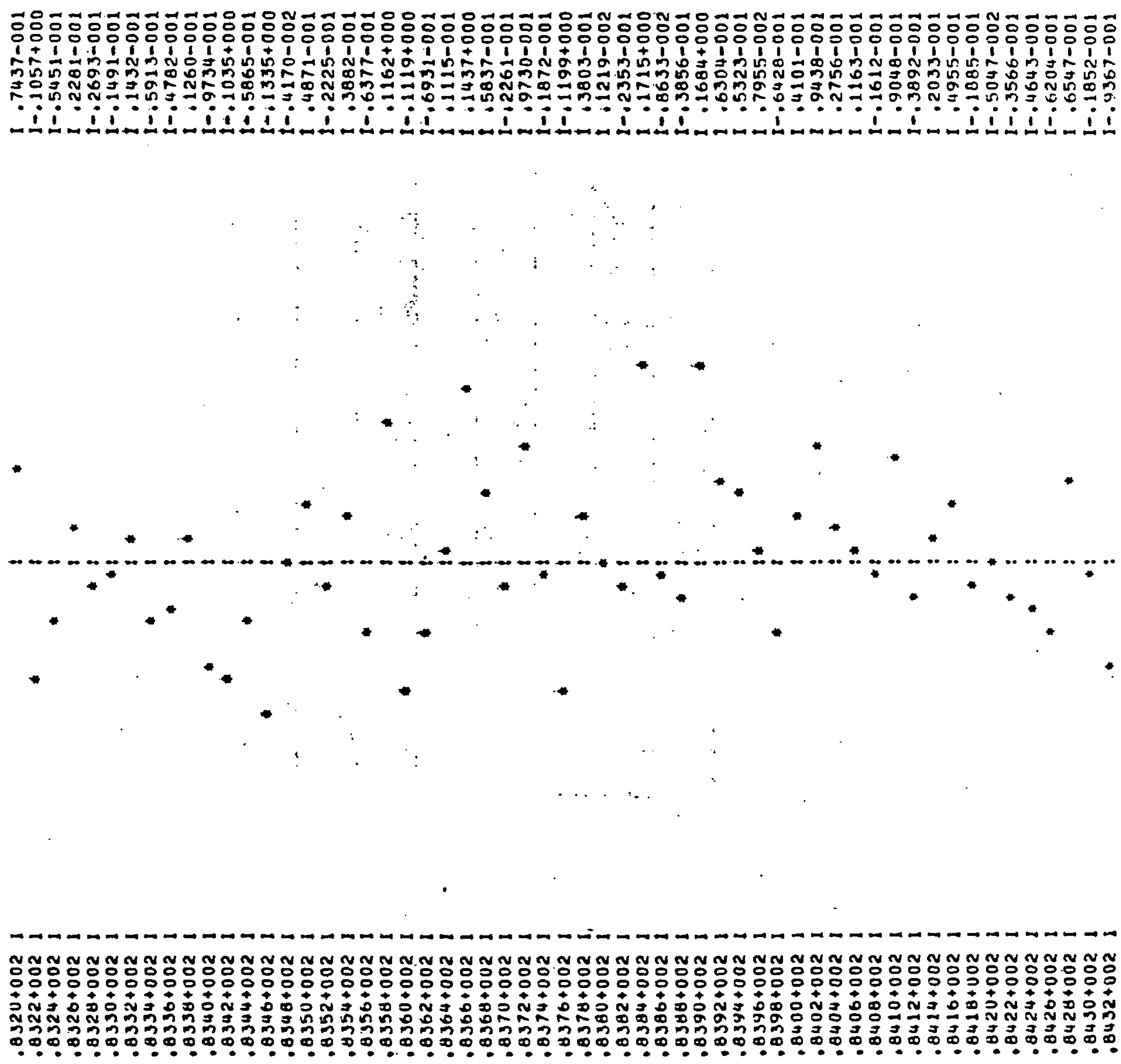
.8316+002 I
.8318+002 I

FIGURE F65



.8320+002 I .7437-001
.8322+002 I-.1057+000
.8324+002 I-.5451-001
.8326+002 I .2281-001
.8328+002 I-.2693-001
.8330+002 I-.1491-001
.8332+002 I .1432-001
.8334+002 I-.5913-001
.8336+002 I-.4782-001
.8338+002 I .1260-001
.8340+002 I-.9734-001
.8342+002 I-.1035+000
.8344+002 I-.5865-001
.8346+002 I-.1335+000
.8348+002 I-.4170-002
.8350+002 I .4871-001
.8352+002 I-.2225-001
.8354+002 I .3882-001
.8356+002 I-.6377-001
.8358+002 I .1162+000
.8360+002 I-.1119+000
.8362+002 I-.6931-001
.8364+002 I .1115-001
.8366+002 I .1437+000
.8368+002 I .5837-001
.8370+002 I-.2261-001
.8372+002 I .9730-001
.8374+002 I-.1872-001
.8376+002 I-.1199+000
.8378+002 I .3803-001
.8380+002 I .1219-002
.8382+002 I-.2353-001
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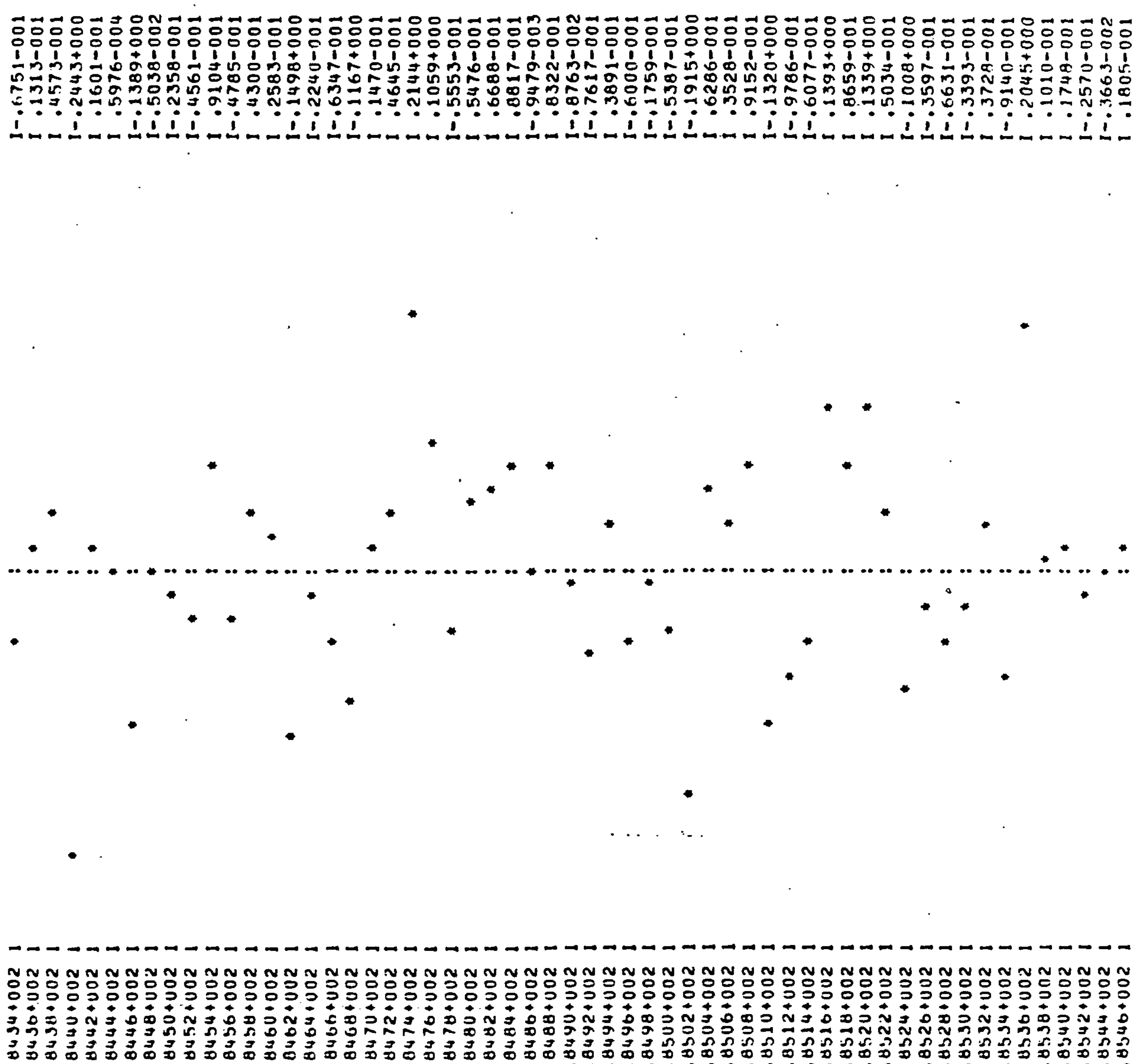
.8386+002 I-.8633-002
.8388+002 I-.3856-001
.8390+002 I .1684+000
.8392+002 I .6304-001
.8394+002 I .5323-001
.8396+002 I .7955-002
.8398+002 I-.6428-001
.8400+002 I .4101-001
.8402+002 I .9438-001
.8404+002 I .2756-001
.8406+002 I .1163-001
.8408+002 I-.1612-001
.8410+002 I .9048-001
.8412+002 I-.3892-001
.8414+002 I .2033-001
.8416+002 I .4955-001
.8418+002 I-.1885-001
.8420+002 I-.5047-002
.8422+002 I-.3566-001
.8424+002 I-.4643-001
.8426+002 I-.6204-001
.8428+002 I .6547-001
.8430+002 I-.1852-001
.8432+002 I-.9367-001

FIGURE F66



.8434+002 I -.6751-001
.8436+002 I .1313-001
.8438+002 I .4573-001
.8440+002 I -.2443+000
.8442+002 I .1601-001
.8444+002 I .5976-004
.8446+002 I -.1389+000
.8448+002 I -.5038-002
.8450+002 I -.2358-001
.8452+002 I -.4561-001
.8454+002 I .9104-001
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.8460+002 I .2583-001
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.8466+002 I -.6347-001
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.8474+002 I .2144+000
.8476+002 I .1059+000
.8478+002 I -.5553-001
.8480+002 I .5476-001
.8482+002 I .6688-001
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.8486+002 I -.9479-003
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.8498+002 I -.1759-001
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.8518+002 I .8659-001
.8520+002 I .1339+000
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.8536+002 I .2045+000
.8538+002 I .1010-001
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.8544+002 I -.3663-002
.8546+002 I .1805-001

FIGURE F67

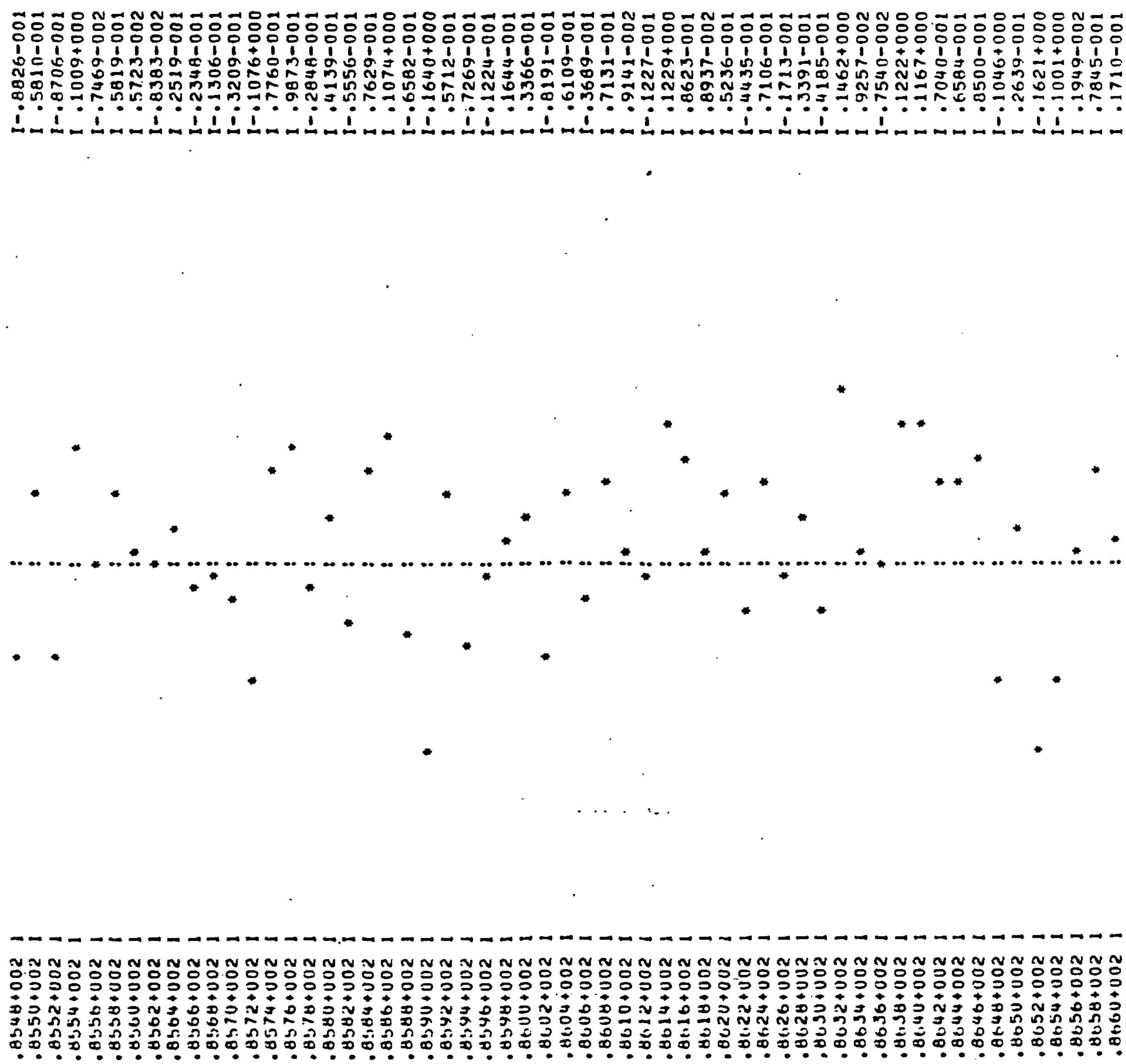
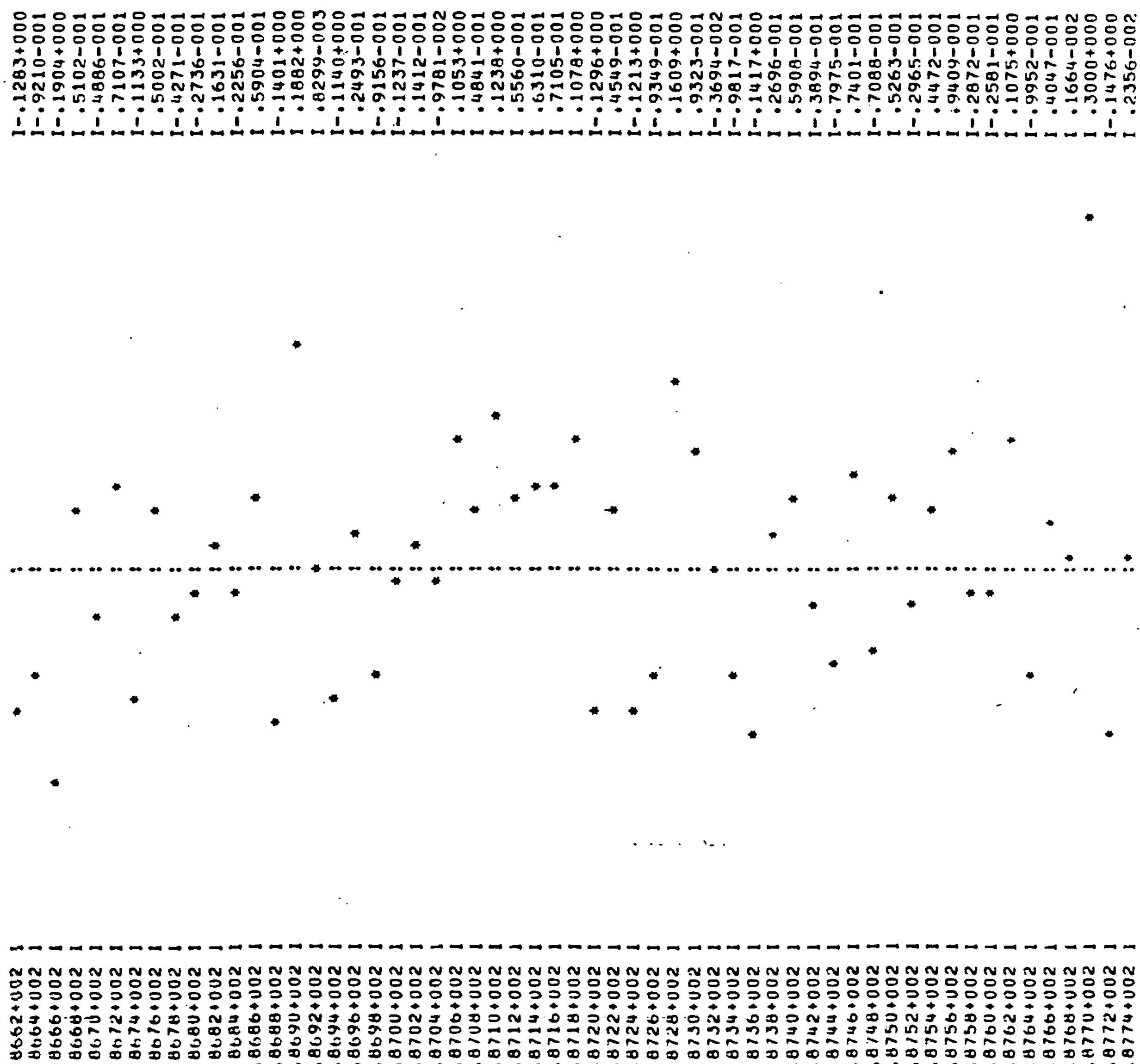


FIGURE F68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I .5102-001
I-.4886-001
I .7107-001
I-.1133+000
I .5002-001
I-.4271-001
I-.2736-001
I .1631-001
I-.2256-001
I .5904-001
I-.1401+000
I .1882+000
I .8299-003
I-.1140+000
I .2493-001
I-.9156-001
I-.1237-001
I .1412-001
I-.9781-002
I .1053+000
I .4841-001
I .1238+000
I .5560-001
I .6310-001
I .7105-001
I .1078+000
I-.1296+000
I .4549-001
I-.1213+000
I-.9349-001
I .1609+000
I .9323-001
I-.3694-002
I-.9817-001
I-.1417+000
I .2696-001
I .5908-001
I-.3894-001
I-.7975-001
I .7401-001
I-.7088-001
I .5263-001
I-.2965-001
I .4472-001
I .9409-001
I-.2872-001
I-.2581-001
I .1075+000
I-.9952-001
I .4047-001
I .1664-002
I .3000+000
I-.1476+000
I .2356-002
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.8664+002
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.8758+002
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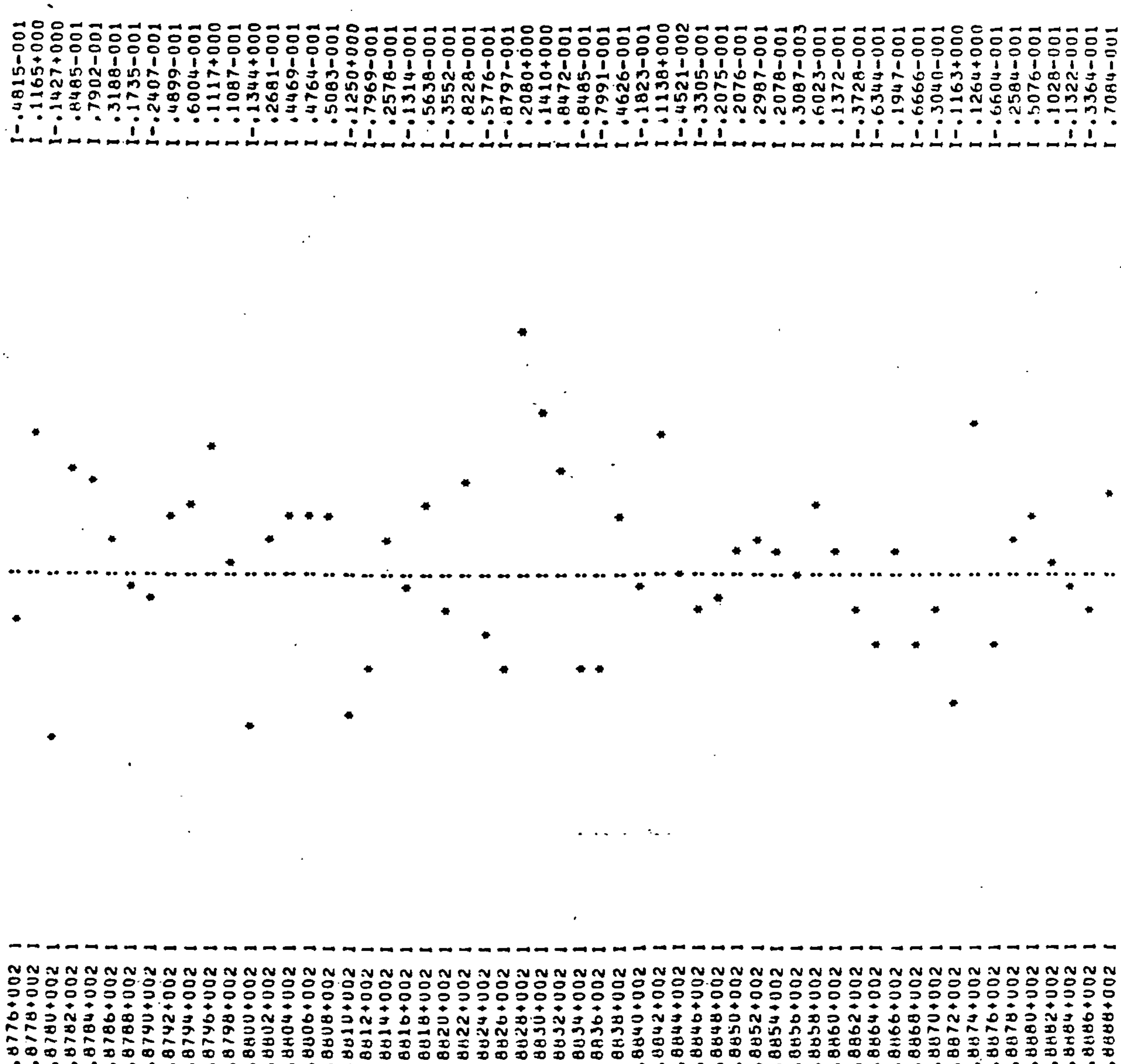
.8764+002
.8766+002
.8768+002
.8770+002
.8772+002
.8774+002

FIGURE F69


.8776+002 I-.4815-001
.8778+002 I .1165+000
.8780+002 I-.1427+000
.8782+002 I .8485-001
.8784+002 I .7902-001
.8786+002 I .3188-001
.8788+002 I-.1735-001
.8790+002 I-.2407-001
.8792+002 I .4899-001
.8794+002 I .6004-001
.8796+002 I .1117+000
.8798+002 I .1087-001
.8800+002 I-.1344+000
.8802+002 I .2681-001
.8804+002 I .4469-001
.8806+002 I .4764-001
.8808+002 I .5083-001
.8810+002 I-.1250+000
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.8816+002 I-.1314-001
.8818+002 I .5638-001
.8820+002 I-.3552-001
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.8828+002 I .2080+000
.8830+002 I .1410+000
.8832+002 I .8472-001
.8834+002 I-.8485-001
.8836+002 I-.7991-001
.8838+002 I .4626-001
.8840+002 I-.1823-001
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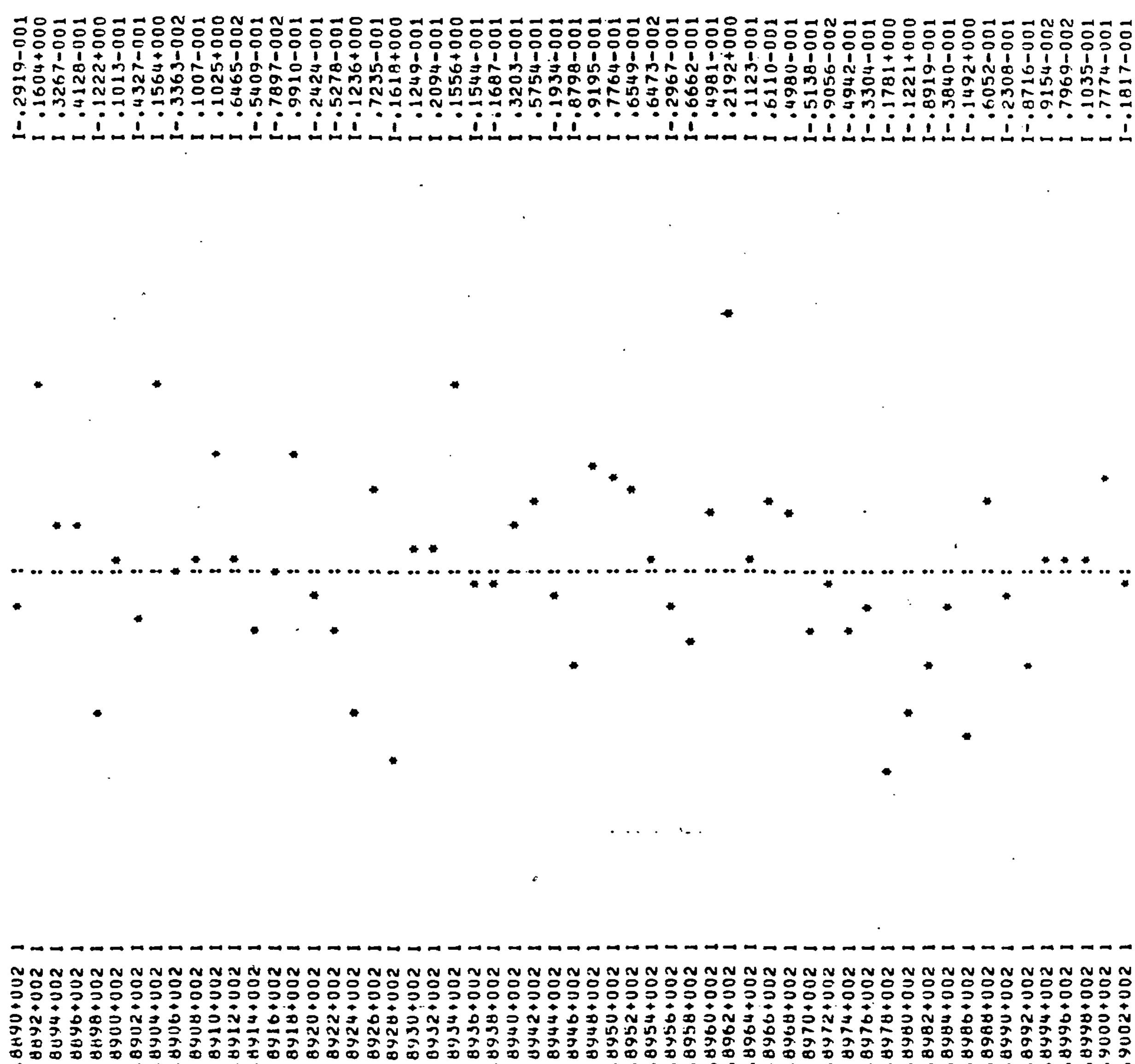
.8844+002 I-.4521-002
.8846+002 I-.3305-001
.8848+002 I-.2075-001
.8850+002 I .2076-001
.8852+002 I .2987-001
.8854+002 I .2078-001
.8856+002 I .3087-003
.8858+002 I .6023-001
.8860+002 I .1372-001
.8862+002 I-.3728-001
.8864+002 I-.6344-001
.8866+002 I .1947-001
.8868+002 I-.6666-001
.8870+002 I-.3040-001
.8872+002 I-.1163+000
.8874+002 I .1264+000
.8876+002 I-.6604-001
.8878+002 I .2584-001
.8880+002 I .5076-001
.8882+002 I .1028-001
.8884+002 I-.1322-001
.8886+002 I-.3364-001
.8888+002 I .7084-001

FIGURE F70


I-.2919-001
I .1604+000
I .3267-001
I .4128-001
I-.1222+000
I .1013-001
I-.4327-001
I .1564+000
I-.3363-002
I .1007-001
I .1025+000
I .6465-002
I-.5409-001
I-.7897-002
I .9910-001
I-.2424-001
I-.5278-001
I-.1236+000
I .7235-001
I-.1618+000
I .1249-001
I .2094-001
I .1556+000
I-.1544-001
I-.1687-001
I .3203-001
I .5754-001
I-.1934-001
I-.8798-001
I .9195-001
I .7764-001
I .6549-001
I .6473-002
I-.2967-001
I-.6662-001
I .4981-001
I .2192+000
I .1123-001
I .6110-001
I .4980-001
I-.5138-001
I-.9056-002
I-.4942-001
I-.3304-001
I-.1781+000
I-.1221+000
I-.8919-001
I-.3840-001
I-.1492+000
I .6052-001
I-.2308-001
I-.8716-001
I .9154-002
I .7969-002
I .1035-001
I .7774-001
I-.1817-001
.8890+002 I
.8892+002 I
.8894+002 I
.8896+002 I
.8898+002 I
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.8902+002 I
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.8916+002 I
.8918+002 I
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.8966+002 I
.8968+002 I
.8970+002 I
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.8988+002 I
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.8998+002 I
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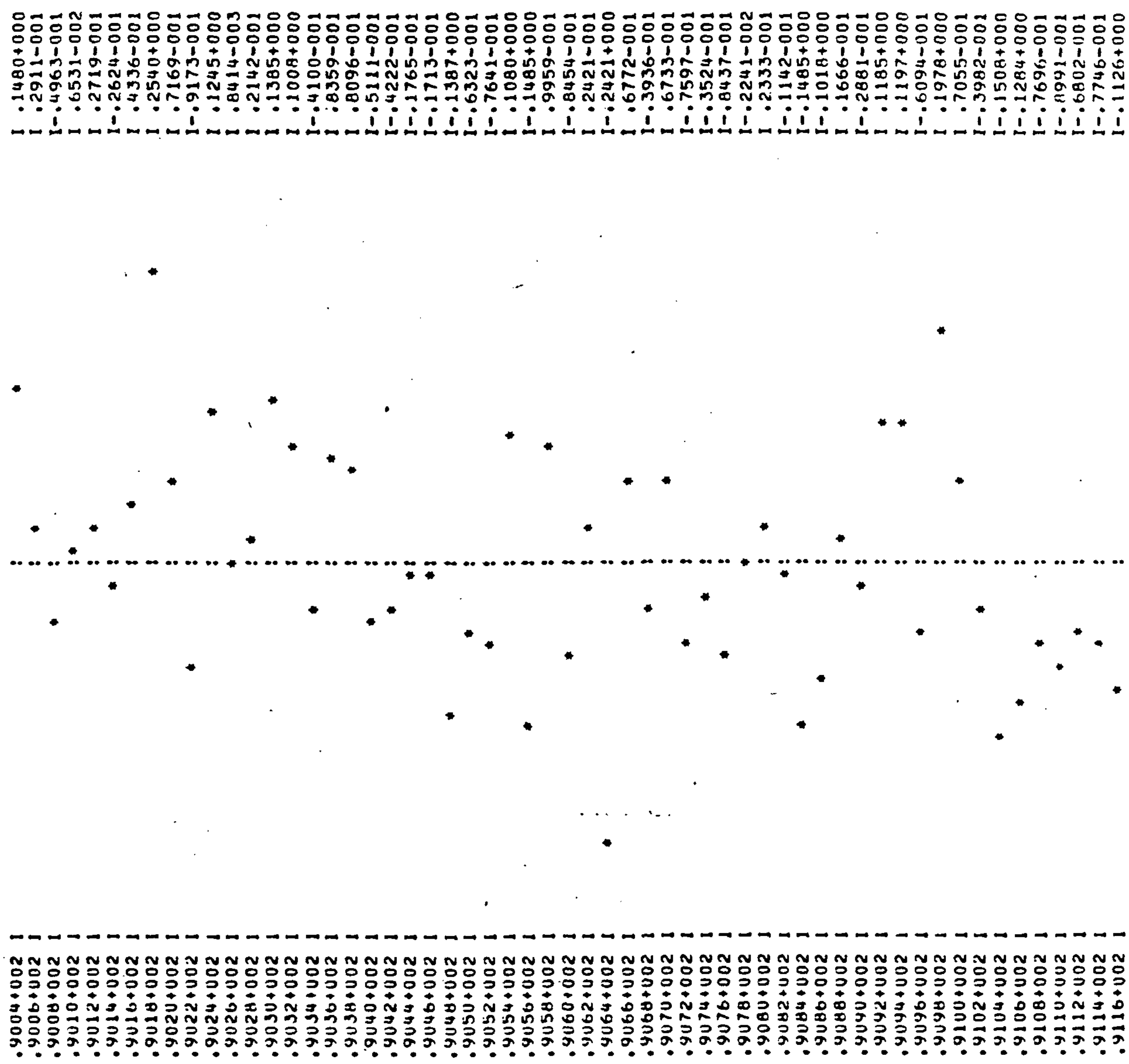
.9002+002 I

FIGURE F71


I .1480+000
I .2911-001
I-.4963-001
I .6531-002
I .2719-001
I-.2624-001
I .4336-001
I .2540+000
I .7169-001
I-.9173-001
I .1245+000
I .8414-003
I .2142-001
I .1385+000
I .1008+000
I-.4100-001
I .8359-001
I .8096-001
I-.5111-001
I-.4222-001
I-.1765-001
I-.1713-001
I-.1387+000
I-.6323-001
I-.7641-001
I .1080+000
I-.1485+000
I .9959-001
I-.8454-001
I .2421-001
I-.2421+000
I .6772-001
I-.3936-001
I .6733-001
I-.7597-001
I-.3524-001
I-.8437-001
I .2241-002
I .2333-001
I-.1142-001
I-.1485+000
I-.1018+000
I .1666-001
I-.2881-001
I .1185+000
I .1197+000
I-.6094-001
I .1978+000
I .7055-001
I-.3982-001
I-.1508+000
I-.1284+000
I-.7696-001
I-.8991-001
I-.6802-001
I-.7746-001
I-.1126+000
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.9006+002 I
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.9026+002 I
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.9030+002 I
.9032+002 I
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.9036+002 I
.9038+002 I
.9040+002 I
.9042+002 I
.9044+002 I
.9046+002 I
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.9050+002 I
.9052+002 I
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.9056+002 I
.9058+002 I
.9060+002 I
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.9096+002 I
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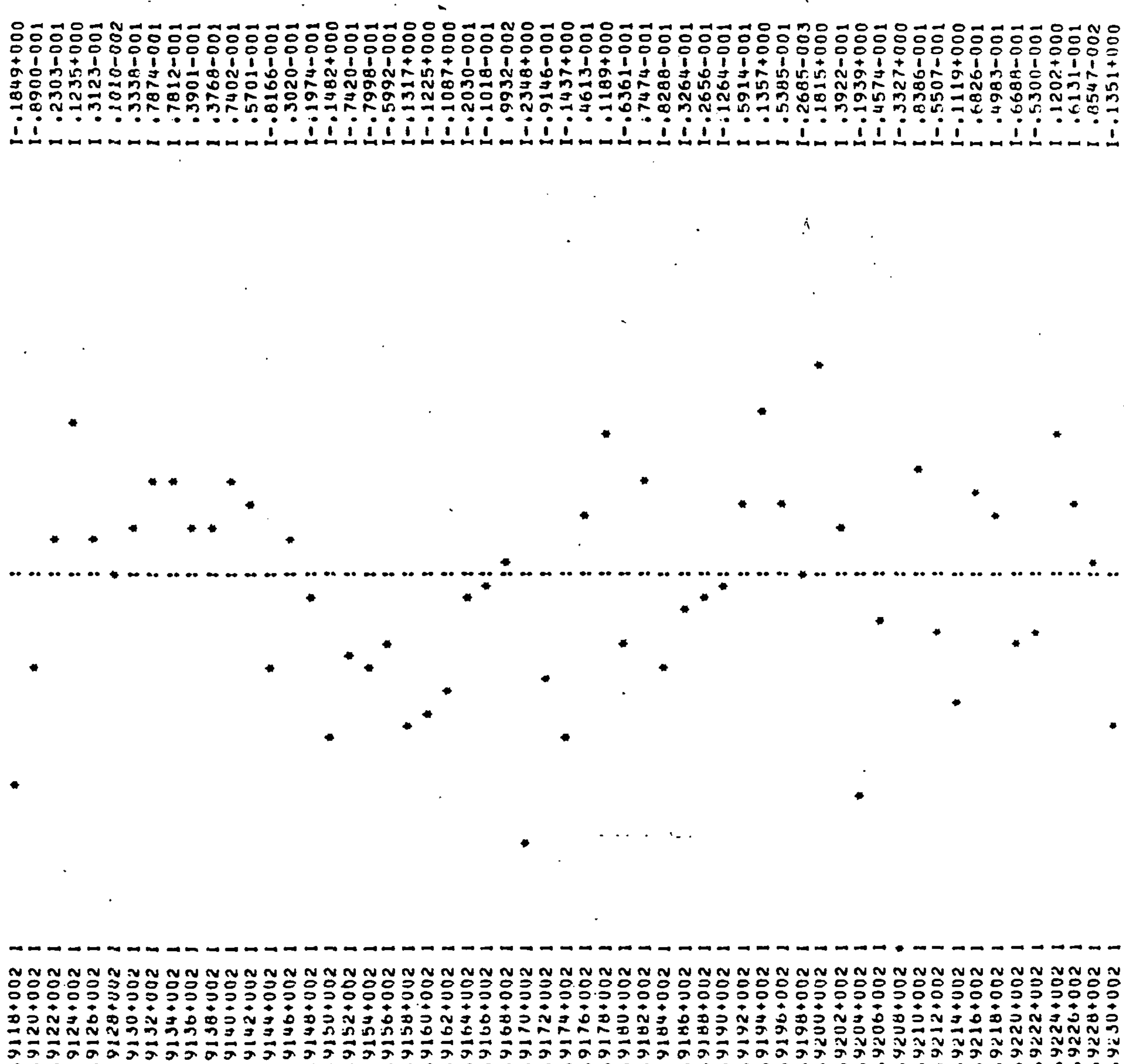
.9100+002 I
.9102+002 I
.9104+002 I
.9106+002 I
.9108+002 I
.9110+002 I
.9112+002 I
.9114+002 I
.9116+002 I

FIGURE F72


.9118+002 I-.1849+000
.9120+002 I-.8900-001
.9122+002 I .2303-001
.9124+002 I .1235+000
.9126+002 I .3123-001
.9128+002 I .1010-002
.9130+002 I .3338-001
.9132+002 I .7874-001
.9134+002 I .7812-001
.9136+002 I .3901-001
.9138+002 I .3768-001
.9140+002 I .7402-001
.9142+002 I .5701-001
.9144+002 I-.8166-001
.9146+002 I .3020-001
.9148+002 I-.1974-001
.9150+002 I-.1482+000
.9152+002 I-.7420-001
.9154+002 I-.7998-001
.9156+002 I-.5992-001
.9158+002 I-.1317+000
.9160+002 I-.1225+000
.9162+002 I-.1087+000
.9164+002 I-.2030-001
.9166+002 I-.1018-001
.9168+002 I .9932-002
.9170+002 I-.2348+000
.9172+002 I-.9146-001
.9174+002 I-.1437+000
.9176+002 I .4613-001
.9178+002 I .1189+000
.9180+002 I-.6361-001
.9182+002 I .7474-001
.9184+002 I-.8288-001
.9186+002 I-.3264-001
.9188+002 I-.2656-001
.9190+002 I-.1264-001
.9192+002 I .5914-001
.9194+002 I .1357+000
.9196+002 I .5385-001
.9198+002 I-.2685-003
.9200+002 I .1815+000
.9202+002 I .3922-001
.9204+002 I-.1939+000
.9206+002 I-.4574-001
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.9210+002 I .8386-001
.9212+002 I-.5507-001
.9214+002 I-.1119+000
.9216+002 I .6826-001
.9218+002 I .4983-001
.9220+002 I-.6688-001
.9222+002 I-.5300-001
.9224+002 I .1202+000
.9226+002 I .6131-001
.9228+002 I .8547-002
.9230+002 I-.1351+000

FIGURE F73

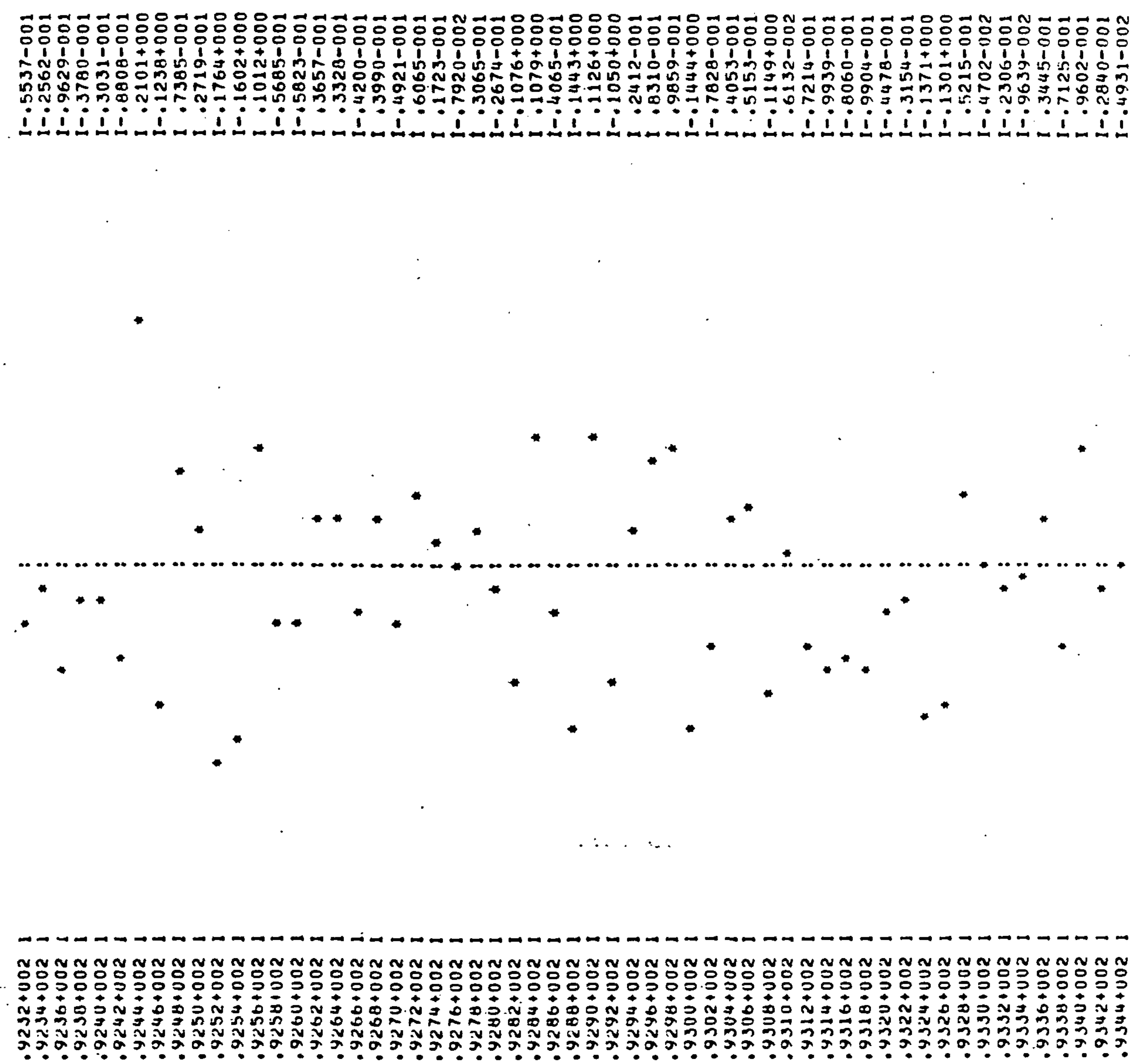
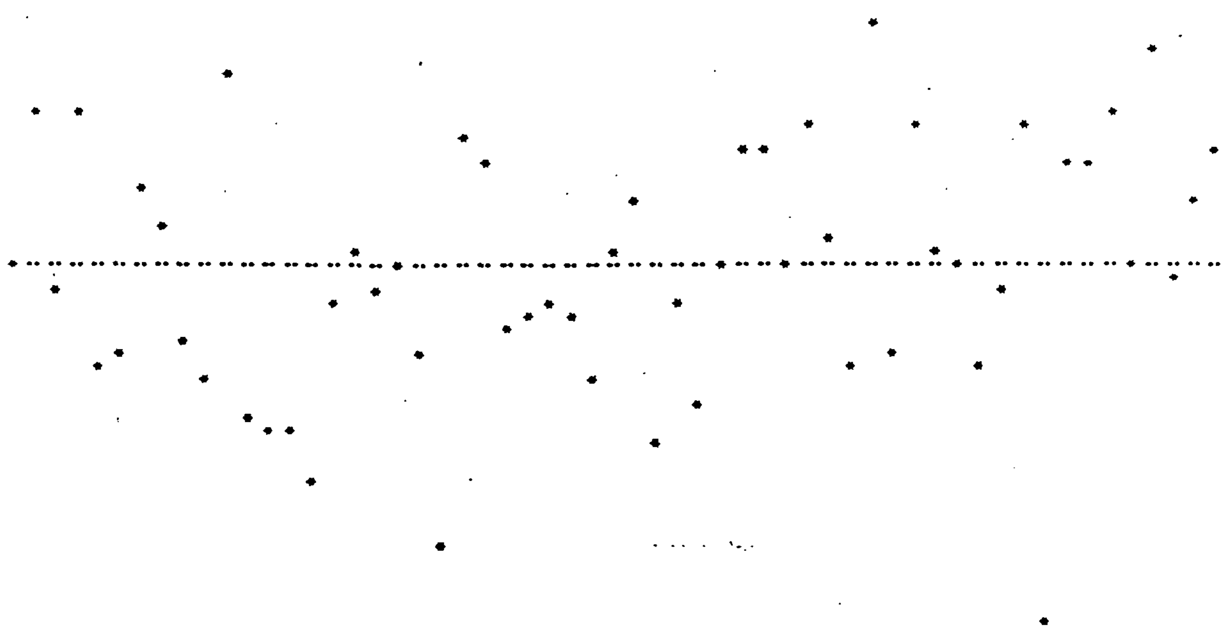
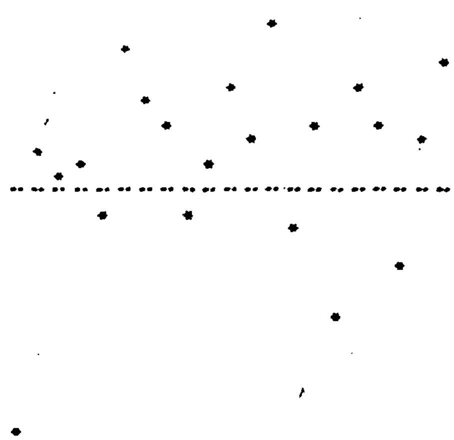

.9232+002 I-.5537-001
.9234+002 I-.2562-001
.9236+002 I-.9629-001
.9238+002 I-.3780-001
.9240+002 I-.3031-001
.9242+002 I-.8808-001
.9244+002 I .2101+000
.9246+002 I-.1238+000
.9248+002 I .7385-001
.9250+002 I .2719-001
.9252+002 I-.1764+000
.9254+002 I-.1602+000
.9256+002 I .1012+000
.9258+002 I-.5685-001
.9260+002 I-.5823-001
.9262+002 I .3657-001
.9264+002 I .3328-001
.9266+002 I-.4200-001
.9268+002 I .3990-001
.9270+002 I-.4921-001
.9272+002 I .6065-001
.9274+002 I .1723-001
.9276+002 I-.7920-002
.9278+002 I .3065-001
.9280+002 I-.2674-001
.9282+002 I-.1076+000
.9284+002 I .1079+000
.9286+002 I-.4065-001
.9288+002 I-.1443+000
.9290+002 I .1126+000
.9292+002 I-.1050+000
.9294+002 I .2412-001
.9296+002 I .8310-001
.9298+002 I .9859-001
.9300+002 I-.1444+000
.9302+002 I-.7828-001
.9304+002 I .4053-001
.9306+002 I .5153-001
.9308+002 I-.1149+000
.9310+002 I .6132-002
.9312+002 I-.7214-001
.9314+002 I-.9939-001
.9316+002 I-.8060-001
.9318+002 I-.9904-001
.9320+002 I-.4478-001
.9322+002 I-.3154-001
.9324+002 I-.1371+000
.9326+002 I-.1301+000
.9328+002 I .5215-001
.9330+002 I-.4702-002
.9332+002 I-.2306-001
.9334+002 I-.9639-002
.9336+002 I .3445-001
.9338+002 I-.7125-001
.9340+002 I .9602-001
.9342+002 I-.2840-001
.9344+002 I-.4931-002

FIGURE F74



.9346+002	-.1988-002
.9348+002	.1171+000
.9350+002	-.2749-001
.9352+002	.1192+000
.9354+002	-.8316-001
.9356+002	-.7913-001
.9358+002	.5636-001
.9360+002	.2993-001
.9362+002	-.6245-001
.9364+002	-.9619-001
.9366+002	.1445+000
.9368+002	-.1219+000
.9370+002	-.1361+000
.9372+002	-.1319+000
.9374+002	-.1776+000
.9376+002	-.3271-001
.9378+002	.2388-002
.9380+002	-.2818-001
.9382+002	-.6991-002
.9384+002	-.7360-001
.9386+002	-.2303+000
.9388+002	.1021+000
.9390+002	.7800-001
.9392+002	-.5549-001
.9394+002	-.4666-001
.9396+002	-.3704-001
.9398+002	-.4566-001
.9400+002	-.8968-001
.9402+002	.6296-002
.9404+002	.5057-001
.9406+002	-.1414+000
.9408+002	-.3481-001
.9410+002	-.1116+000
.9412+002	-.3466-002
.9414+002	.8901-001
.9416+002	.9070-001
.9418+002	-.1011-003
.9420+002	.1064+000
.9422+002	.1582-001
.9424+002	-.8615-001
.9426+002	.1903+000
.9428+002	-.7595-001
.9430+002	.1050+000
.9432+002	.8230-002
.9434+002	-.6731-003
.9436+002	-.8656-001
.9438+002	-.2659-001
.9440+002	.1125+000
.9442+002	-.2850+000
.9444+002	.8034-001
.9446+002	.7865-001
.9448+002	.1179+000
.9450+002	-.3887-002
.9452+002	.1734+000
.9454+002	-.1387-001
.9456+002	.4479-001
.9458+002	.4635-001

FIGURE F75



.9460+002	-.1975+000
.9462+002	.3144-001
.9464+002	.1676-002
.9466+002	.2099-001
.9468+002	-.2614-001
.9470+002	.1111+000
.9472+002	.6238-001
.9474+002	.4851-001
.9476+002	-.2718-001
.9478+002	.2175-001
.9480+002	.7667-001
.9482+002	.4157-001
.9484+002	.1297+000
.9486+002	-.3103-001
.9488+002	.4802-001
.9490+002	-.1065+000
.9492+002	.8019-001
.9494+002	.5211-001
.9496+002	-.6881-001
.9498+002	.3227-001
.9500+002	.9953-001

FIGURE F76

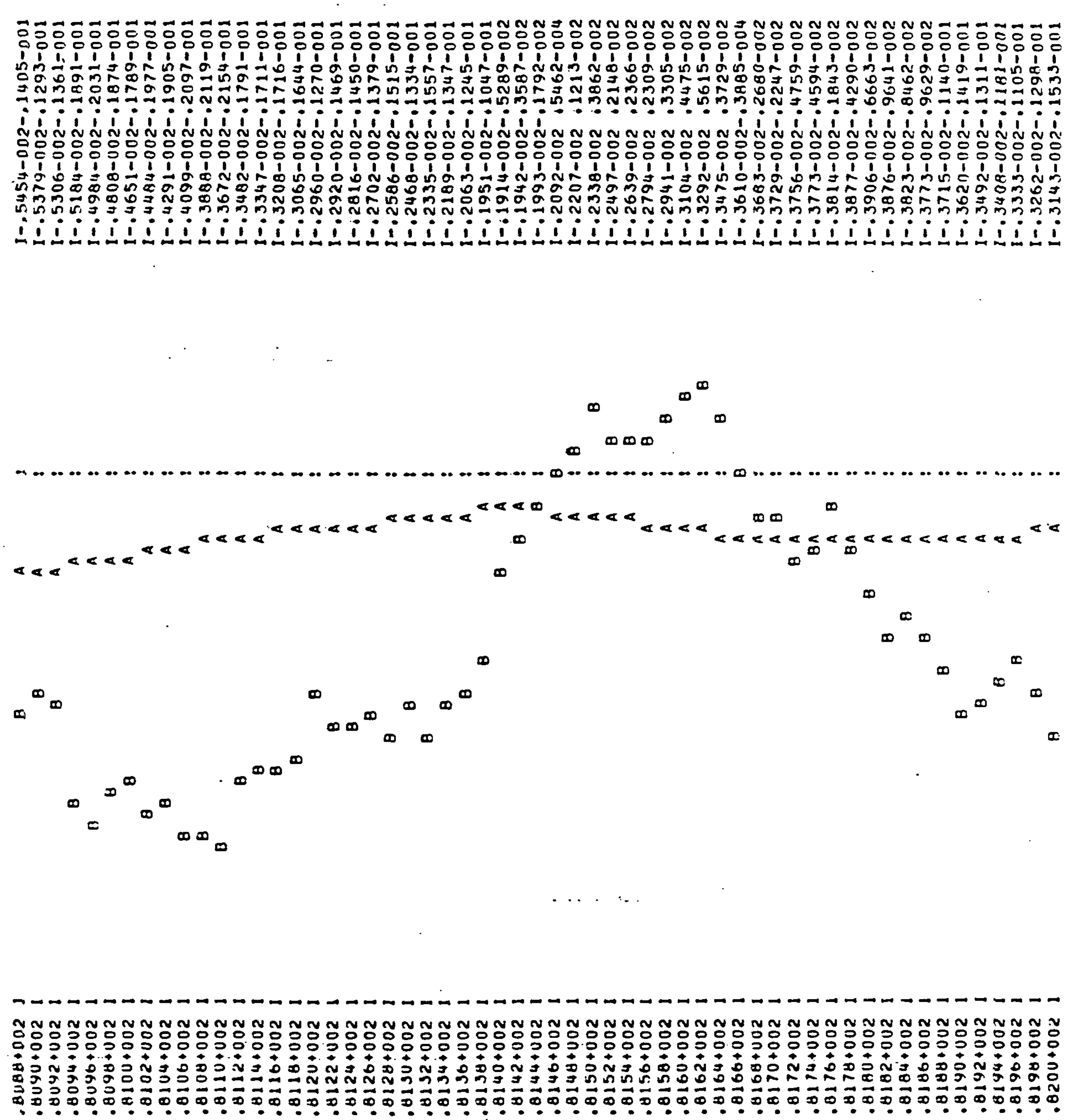
```
                        DATA FOR THE Y-AXIS

      CURVE 'A' IS A PLOT OF  BASE  VERSUS  TIME

      CURVE 'B' IS A PLOT OF  TIP   VERSUS  TIME


          MINIMUM VALUE                                          MAXIMUM VALUE
           -.3108-001                                            .1410-001
 TIME     I                                                                   I    BASE      TIP
.8002+002 I                                             BA                    I .1006-004-.4570-003
.8004+002 I                                           B  A                    I .4251-004-.1628-002
.8006+002 I                                          B   A                    I .9918-004-.2550-002
.8008+002 I                                         B    A                    I .1444-003-.2854-002
.8010+002 I                                         B    A                    I .2118-003-.3134-002
.8012+002 I                                            B A                    I .2667-003-.8459-003
.8014+002 I                                              A    B               I .2428-003 .3349-002
.8016+002 I                                              A   B                I .2004-003 .3099-002
.8018+002 I                                              A                B   I .7020-004 .1098-001
.8020+002 I                                             A:              B     I-.1365-003 .1004-001
.8022+002 I                                             A:            B       I-.3332-003 .8888-002
.8024+002 I                                             A:           B        I-.5178-003 .7776-002
.8026+002 I                                             A:        B           I-.6560-003 .5913-002
.8028+002 I                                            A :          B         I-.8024-003 .7627-002
.8030+002 I                                            A :             B      I-.9870-003 .9174-002
.8032+002 I                                            A :                B   I-.1201-002 .1125-001
.8034+002 I                                           A  :                B   I-.1446-002 .1121-001
.8036+002 I                                           A  :                  B I-.1709-002 .1232-001
.8038+002 I                                           A  :            B       I-.1972-002 .8862-002
.8040+002 I                                          A   :           B        I-.2150-002 .7816-002
.8042+002 I                                          A   :            B       I-.2354-002 .8805-002
.8044+002 I                                          A   :              B     I-.2576-002 .9878-002
.8046+002 I                                         A    :              B     I-.2821-002 .1003-001
.8048+002 I                                         A    :             B      I-.3076-002 .9260-002
.8050+002 I                                         A    :              B     I-.3309-002 .9704-002
.8052+002 I                                        A     :                B   I-.3569-002 .1150-001
.8054+002 I                                        A     :             B      I-.3856-002 .9356-002
.8056+002 I                                       A      :          B         I-.4105-002 .7366-002
.8058+002 I                                       A      :            B       I-.4329-002 .8463-002
.8060+002 I                                       A      :            B       I-.4573-002 .8574-002
.8062+002 I                                      A       :        B           I-.4801-002 .6274-002
.8064+002 I                                      A       :   B                I-.4976-002 .2950-002
.8066+002 I                                      A       B                    I-.5102-002 .9995-004
.8068+002 I                                      A      B:                    I-.5198-002-.3605-003
.8070+002 I                                     A      B :                    I-.5316-002-.8775-003
.8072+002 I                                     A   B    :                    I-.5393-002-.3022-002
.8074+002 I                                     A    B   :                    I-.5481-002-.2074-002
.8076+002 I                                   B A        :                    I-.5528-002-.6646-002
.8078+002 I                                     AB       :                    I-.5527-002-.4962-002
.8080+002 I                                    BA        :                    I-.5542-002-.6371-002
.8082+002 I                                 B   A        :                    I-.5564-002-.7972-002
.8084+002 I                            B        A        :                    I-.5533-002-.1132-001
.8086+002 I                               B     A        :                    I-.5498-002-.9346-002
```

FIGURE F77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.8092+002 I-.5306-002-.1361-001
.8094+002 I-.5184-002-.1891-001
.8096+002 I-.4984-002-.2031-001
.8098+002 I-.4808-002-.1874-001
.8100+002 I-.4651-002-.1789-001
.8102+002 I-.4484-002-.1977-001
.8104+002 I-.4291-002-.1905-001
.8106+002 I-.4099-002-.2097-001
.8108+002 I-.3888-002-.2119-001
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.8112+002 I-.3482-002-.1791-001
.8114+002 I-.3347-002-.1711-001
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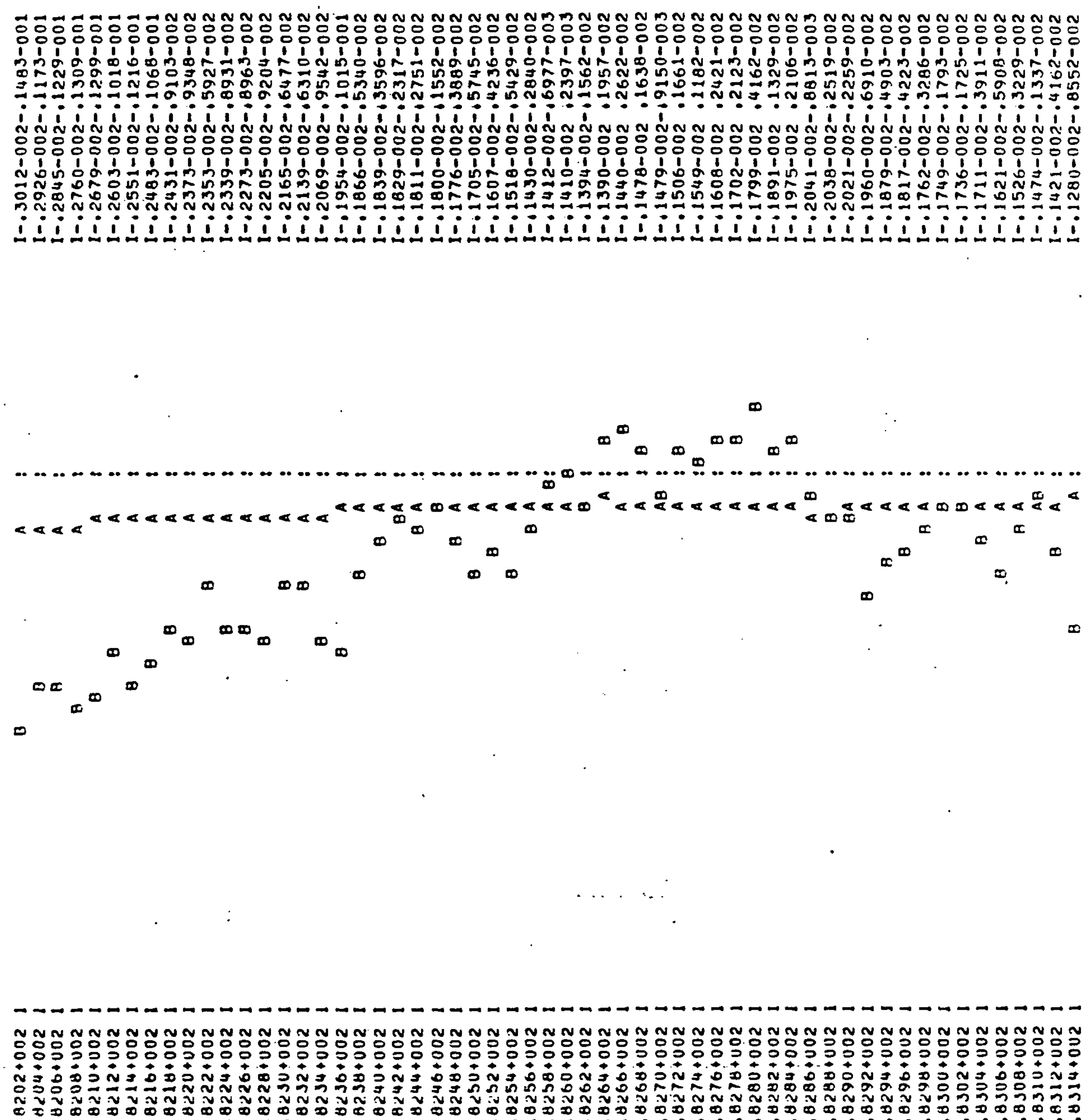
.8118+002 I-.3065-002-.1644-001
.8120+002 I-.2960-002-.1270-001
.8122+002 I-.2920-002-.1469-001
.8124+002 I-.2816-002-.1450-001
.8126+002 I-.2702-002-.1379-001
.8128+002 I-.2586-002-.1515-001
.8130+002 I-.2468-002-.1334-001
.8132+002 I-.2335-002-.1557-001
.8134+002 I-.2189-002-.1347-001
.8136+002 I-.2063-002-.1245-001
.8138+002 I-.1951-002-.1047-001
.8140+002 I-.1914-002-.5289-002
.8142+002 I-.1942-002-.3587-002
.8144+002 I-.1993-002-.1792-002
.8146+002 I-.2092-002 .5462-004
.8148+002 I-.2207-002 .1213-002
.8150+002 I-.2338-002 .3862-002
.8152+002 I-.2497-002 .2148-002
.8154+002 I-.2639-002 .2366-002
.8156+002 I-.2794-002 .2309-002
.8158+002 I-.2941-002 .3305-002
.8160+002 I-.3104-002 .4475-002
.8162+002 I-.3292-002 .5615-002
.8164+002 I-.3475-002 .3729-002
.8166+002 I-.3610-002-.3885-004
.8168+002 I-.3683-002-.2680-002
.8170+002 I-.3729-002-.2247-002
.8172+002 I-.3756-002-.4759-002
.8174+002 I-.3773-002-.4594-002
.8176+002 I-.3814-002-.1843-002
.8178+002 I-.3877-002-.4290-002
.8180+002 I-.3906-002-.6663-002
.8182+002 I-.3876-002-.9641-002
.8184+002 I-.3823-002-.8462-002
.8186+002 I-.3773-002-.9629-002
.8188+002 I-.3715-002-.1140-001
.8190+002 I-.3620-002-.1419-001
.8192+002 I-.3492-002-.1311-001
.8194+002 I-.3408-002-.1181-001
.8196+002 I-.3333-002-.1105-001
.8198+002 I-.3262-002-.1298-001
.8200+002 I-.3143-002-.1533-001

FIGURE F78



.8202+002 I I-.3012-002-.1483-001
.8204+002 I I-.2926-002-.1173-001
.8206+002 I I-.2845-002-.1229-001
.8208+002 I I-.2760-002-.1309-001
.8210+002 I I-.2679-002-.1299-001
.8212+002 I I-.2603-002-.1018-001
.8214+002 I I-.2551-002-.1216-001
.8216+002 I I-.2483-002-.1068-001
.8218+002 I I-.2431-002-.9103-002
.8220+002 I I-.2373-002-.9348-002
.8222+002 I I-.2353-002-.5927-002
.8224+002 I I-.2339-002-.8931-002
.8226+002 I I-.2273-002-.8963-002
.8228+002 I I-.2205-002-.9204-002
.8230+002 I I-.2165-002-.6477-002
.8232+002 I I-.2139-002-.6310-002
.8234+002 I I-.2069-002-.9542-002
.8236+002 I I-.1954-002-.1015-001
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.8242+002 I I-.1829-002-.2317-002
.8244+002 I I-.1811-002-.2751-002
.8246+002 I I-.1800-002-.1552-002
.8248+002 I I-.1776-002-.3889-002
.8250+002 I I-.1705-002-.5745-002
.8252+002 I I-.1607-002-.4236-002
.8254+002 I I-.1518-002-.5429-002
.8256+002 I I-.1430-002-.2840-002
.8258+002 I I-.1412-002-.6977-003
.8260+002 I I-.1410-002 .2397-003
.8262+002 I I-.1394-002-.1562-002
.8264+002 I I-.1390-002 .1957-002
.8266+002 I I-.1440-002 .2622-002
.8268+002 I I-.1478-002 .1638-002
.8270+002 I I-.1479-002-.9150-003
.8272+002 I I-.1506-002 .1661-002
.8274+002 I I-.1549-002 .1182-002
.8276+002 I I-.1608-002 .2421-002
.8278+002 I I-.1702-002 .2123-002
.8280+002 I I-.1799-002 .4162-002
.8282+002 I I-.1891-002 .1329-002
.8284+002 I I-.1975-002 .2106-002
.8286+002 I I-.2041-002-.8813-003
.8288+002 I I-.2038-002-.2519-002
.8290+002 I I-.2021-002-.2259-002
.8292+002 I I-.1960-002-.6910-002
.8294+002 I I-.1879-002-.4903-002
.8296+002 I I-.1817-002-.4223-002
.8298+002 I I-.1762-002-.3286-002
.8300+002 I I-.1749-002-.1793-002
.8302+002 I I-.1736-002-.1725-002
.8304+002 I I-.1711-002-.3911-002
.8306+002 I I-.1621-002-.5908-002
.8308+002 I I-.1526-002-.3229-002
.8310+002 I I-.1474-002-.1337-002
.8312+002 I I-.1421-002-.4162-002
.8314+002 I I-.1280-002-.8552-002

FIGURE F79

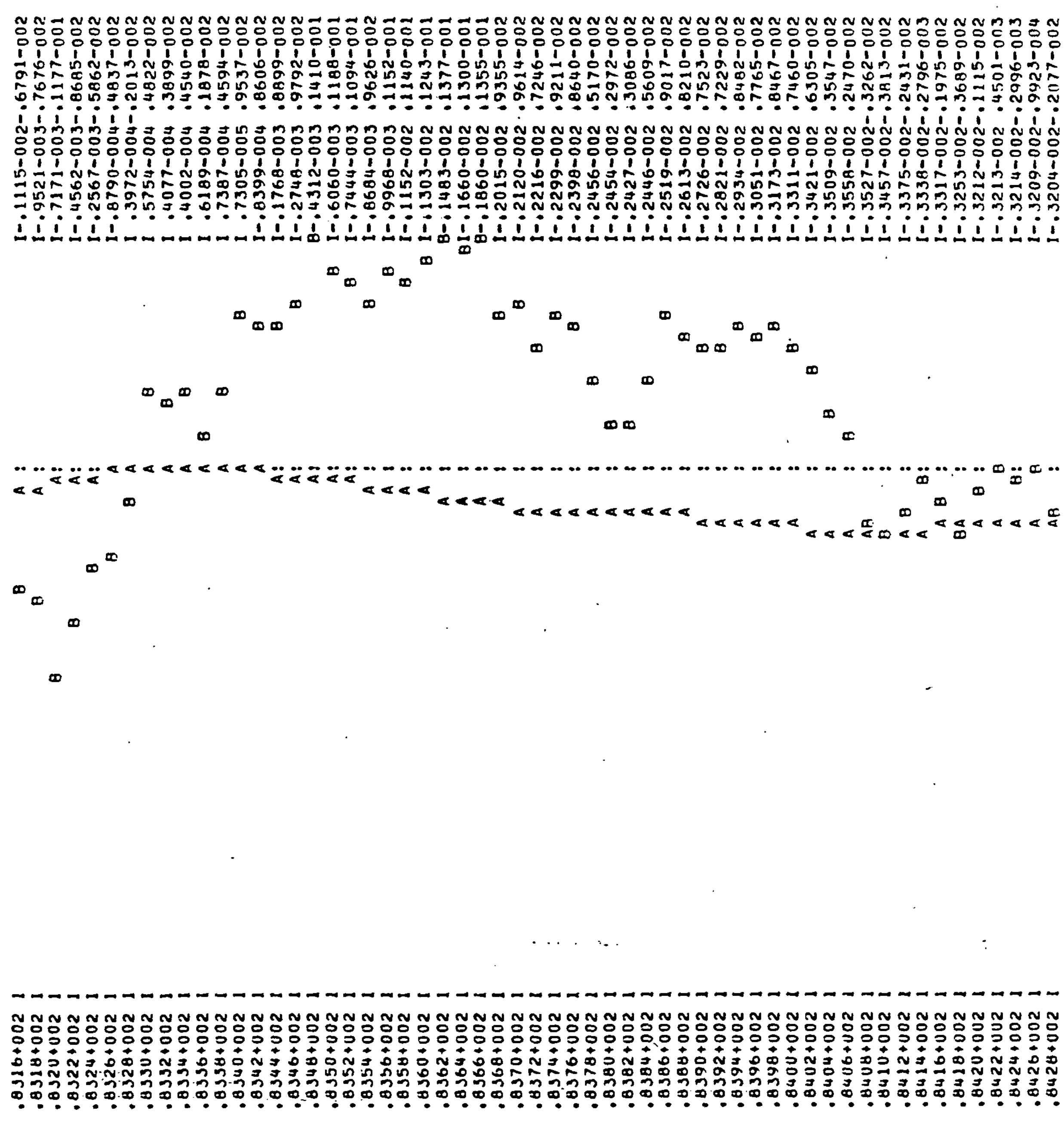
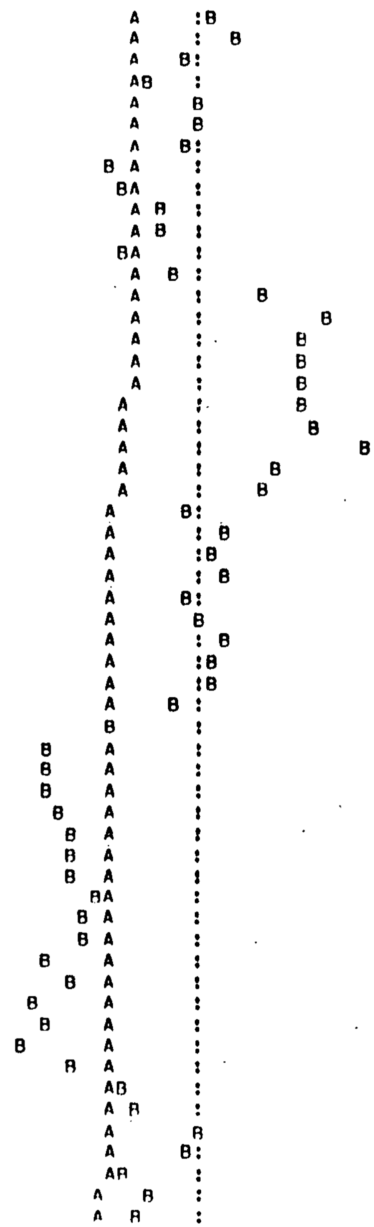
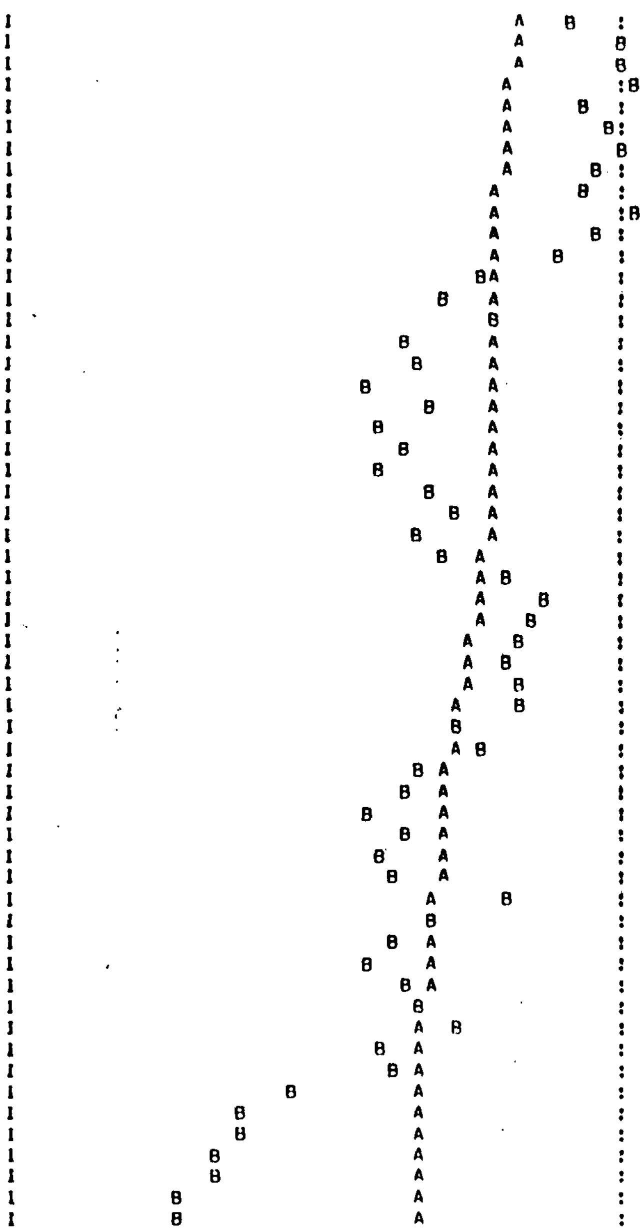


FIGURE F80



.8430+002	-.3198-002	.5655-003
.8432+002	-.3214-002	.2313-002
.8434+002	-.3230-002	-.4192-003
.8436+002	-.3216-002	-.2065-002
.8438+002	-.3200-002	.2467-003
.8440+002	-.3199-002	-.9567-004
.8442+002	-.3206-002	-.3792-003
.8444+002	-.3152-002	-.4613-002
.8446+002	-.3062-002	-.3398-002
.8448+002	-.3008-002	-.1712-002
.8450+002	-.2974-002	-.1738-002
.8452+002	-.2911-002	-.3334-002
.8454+002	-.2869-002	-.1084-002
.8456+002	-.2903-002	.3446-002
.8458+002	-.3014-002	.6652-002
.8460+002	-.3127-002	.5413-002
.8462+002	-.3219-002	.5090-002
.8464+002	-.3314-002	.5399-002
.8466+002	-.3423-002	.5325-002
.8468+002	-.3544-002	.6153-002
.8470+002	-.3714-002	.8656-002
.8472+002	-.3848-002	.3938-002
.8474+002	-.3961-002	.3356-002
.8476+002	-.4021-002	-.1685-003
.8478+002	-.4057-002	.1343-002
.8480+002	-.4123-002	.8968-003
.8482+002	-.4185-002	.1202-002
.8484+002	-.4226-002	-.2328-003
.8486+002	-.4258-002	-.9922-004
.8488+002	-.4333-002	.1423-002
.8490+002	-.4413-002	.9996-003
.8492+002	-.4470-002	.8357-003
.8494+002	-.4526-002	-.1093-002
.8496+002	-.4540-002	-.4016-002
.8498+002	-.4478-002	-.7715-002
.8500+002	-.4405-002	-.7425-002
.8502+002	-.4327-002	-.7577-002
.8504+002	-.4271-002	-.6929-002
.8506+002	-.4230-002	-.6407-002
.8508+002	-.4212-002	-.5928-002
.8510+002	-.4188-002	-.5998-002
.8512+002	-.4171-002	-.5206-002
.8514+002	-.4172-002	-.5338-002
.8516+002	-.4196-002	-.5570-002
.8518+002	-.4193-002	-.7375-002
.8520+002	-.4204-002	-.6101-002
.8522+002	-.4183-002	-.8182-002
.8524+002	-.4147-002	-.7203-002
.8526+002	-.4110-002	-.8948-002
.8528+002	-.4098-002	-.6098-002
.8530+002	-.4136-002	-.3932-002
.8532+002	-.4200-002	-.2791-002
.8534+002	-.4312-002	.1645-003
.8536+002	-.4460-002	-.5990-003
.8538+002	-.4561-002	-.3505-002
.8540+002	-.4652-002	-.2238-002
.8542+002	-.4750-002	-.3028-002

FIGURE F81



.8544+002	I-.4838-002	-.2583-002
.8546+002	I-.4974-002	.9124-004
.8548+002	I-.5127-002	.1482-003
.8550+002	I-.5282-002	.6713-003
.8552+002	I-.5415-002	-.1461-002
.8554+002	I-.5558-002	-.5057-003
.8556+002	I-.5697-002	-.1374-005
.8558+002	I-.5855-002	-.9478-003
.8560+002	I-.5990-002	-.1565-002
.8562+002	I-.6145-002	.1030-002
.8564+002	I-.6310-002	-.9181-003
.8566+002	I-.6437-002	-.2755-002
.8568+002	I-.6499-002	-.6958-002
.8570+002	I-.6518-002	-.8509-002
.8572+002	I-.6526-002	-.6347-002
.8574+002	I-.6542-002	-.1101-001
.8576+002	I-.6528-002	-.1037-001
.8578+002	I-.6488-002	-.1238-001
.8580+002	I-.6468-002	-.9737-002
.8582+002	I-.6448-002	-.1236-001
.8584+002	I-.6423-002	-.1101-001
.8586+002	I-.6417-002	-.1182-001
.8588+002	I-.6427-002	-.9440-002
.8590+002	I-.6475-002	-.8055-002
.8592+002	I-.6544-002	-.1006-001
.8594+002	I-.6612-002	-.8644-002
.8596+002	I-.6747-002	-.5855-002
.8598+002	I-.6937-002	-.3891-002
.8600+002	I-.7137-002	-.4547-002
.8602+002	I-.7346-002	-.4833-002
.8604+002	I-.7558-002	-.5635-002
.8606+002	I-.7764-002	-.4713-002
.8608+002	I-.7979-002	-.5125-002
.8610+002	I-.8164-002	-.8340-002
.8612+002	I-.8348-002	-.6578-002
.8614+002	I-.8523-002	-.9821-002
.8616+002	I-.8662-002	-.1057-001
.8618+002	I-.8774-002	-.1240-001
.8620+002	I-.8888-002	-.1053-001
.8622+002	I-.8992-002	-.1192-001
.8624+002	I-.9092-002	-.1143-001
.8626+002	I-.9256-002	-.5842-002
.8628+002	I-.9425-002	-.9622-002
.8630+002	I-.9544-002	-.1146-001
.8632+002	I-.9655-002	-.1244-001
.8634+002	I-.9759-002	-.1081-001
.8636+002	I-.9872-002	-.1009-001
.8638+002	I-.1003-001	-.8431-002
.8640+002	I-.1018-001	-.1226-001
.8642+002	I-.1030-001	-.1143-001
.8644+002	I-.1037-001	-.1644-001
.8646+002	I-.1037-001	-.1908-001
.8648+002	I-.1032-001	-.1932-001
.8650+002	I-.1027-001	-.2067-001
.8652+002	I-.1020-001	-.2027-001
.8654+002	I-.1012-001	-.2247-001
.8656+002	I-.1003-001	-.2265-001

FIGURE F82

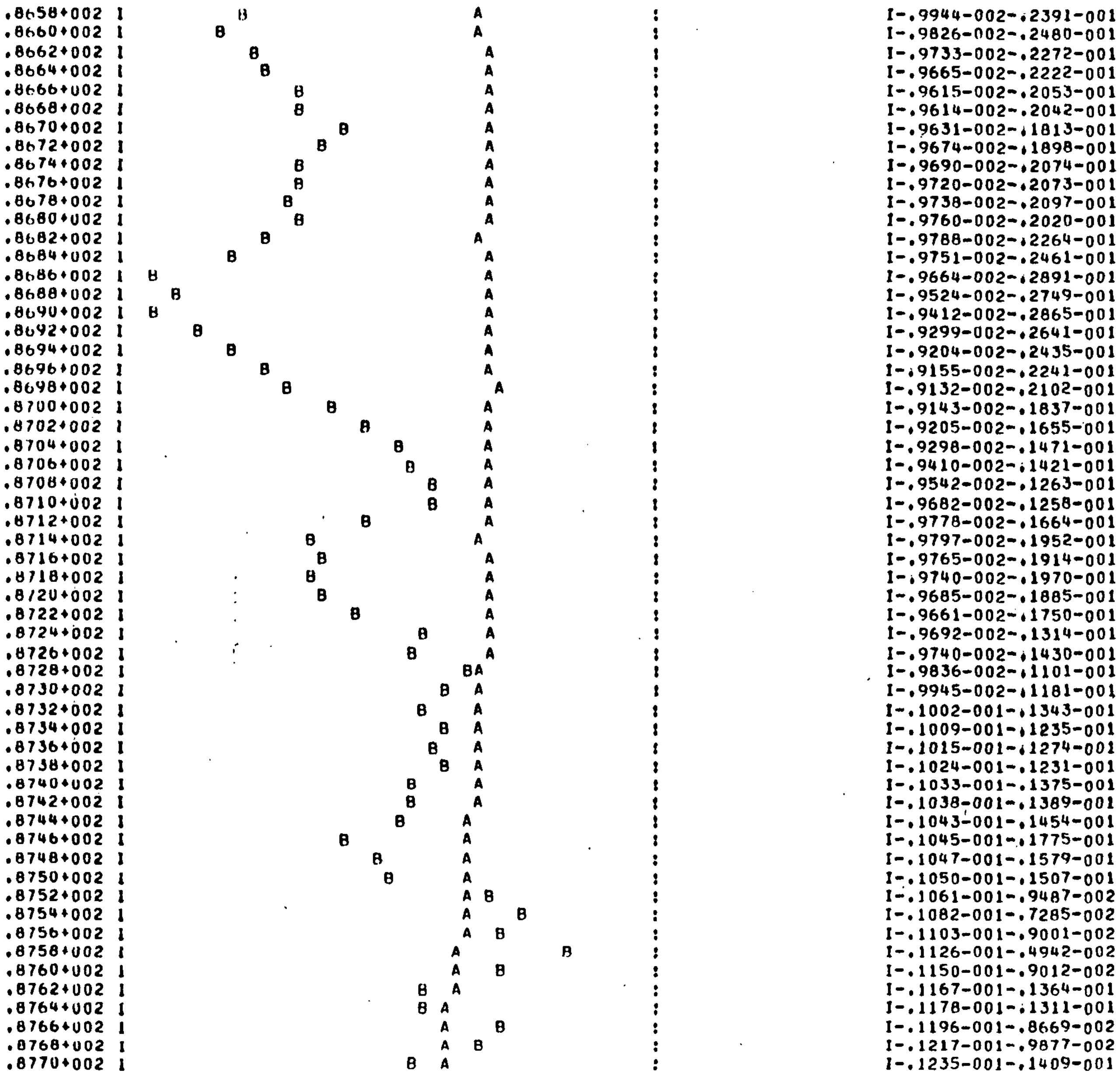
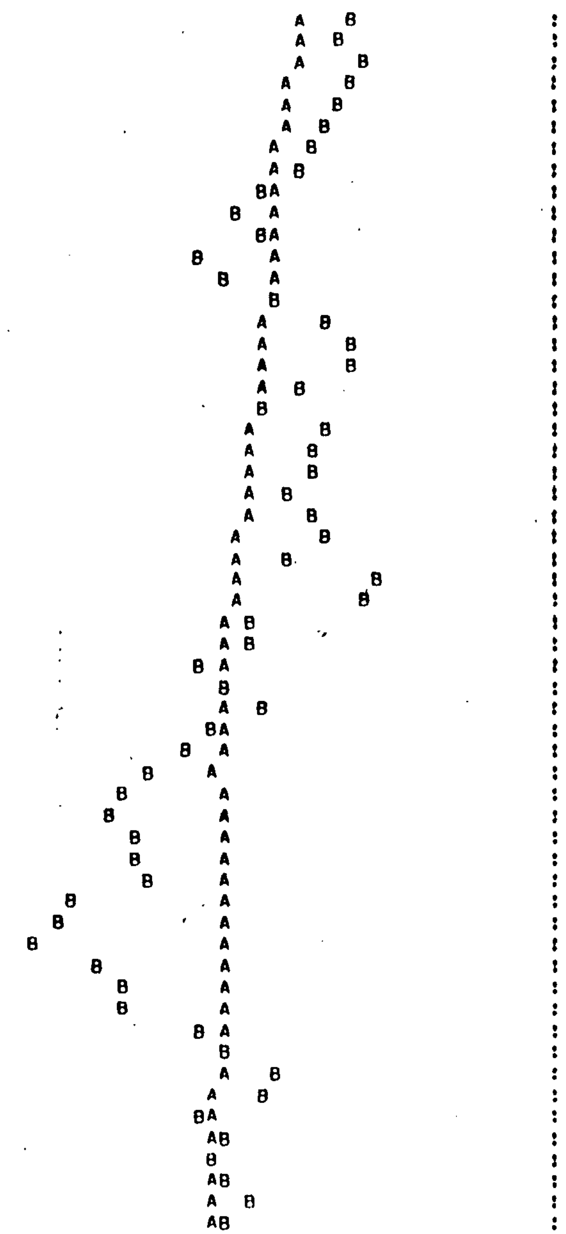

.8658+002 I I-.9944-002-.2391-001
.8660+002 I I-.9826-002-.2480-001
.8662+002 I I-.9733-002-.2272-001
.8664+002 I I-.9665-002-.2222-001
.8666+002 I I-.9615-002-.2053-001
.8668+002 I I-.9614-002-.2042-001
.8670+002 I I-.9631-002-.1813-001
.8672+002 I I-.9674-002-.1898-001
.8674+002 I I-.9690-002-.2074-001
.8676+002 I I-.9720-002-.2073-001
.8678+002 I I-.9738-002-.2097-001
.8680+002 I I-.9760-002-.2020-001
.8682+002 I I-.9788-002-.2264-001
.8684+002 I I-.9751-002-.2461-001
.8686+002 I I-.9664-002-.2891-001
.8688+002 I I-.9524-002-.2749-001
.8690+002 I I-.9412-002-.2865-001
.8692+002 I I-.9299-002-.2641-001
.8694+002 I I-.9204-002-.2435-001
.8696+002 I I-.9155-002-.2241-001
.8698+002 I I-.9132-002-.2102-001
.8700+002 I I-.9143-002-.1837-001
.8702+002 I I-.9205-002-.1655-001
.8704+002 I I-.9298-002-.1471-001
.8706+002 I I-.9410-002-.1421-001
.8708+002 I I-.9542-002-.1263-001
.8710+002 I I-.9682-002-.1258-001
.8712+002 I I-.9778-002-.1664-001
.8714+002 I I-.9797-002-.1952-001
.8716+002 I I-.9765-002-.1914-001
.8718+002 I I-.9740-002-.1970-001
.8720+002 I I-.9685-002-.1885-001
.8722+002 I I-.9661-002-.1750-001
.8724+002 I I-.9692-002-.1314-001
.8726+002 I I-.9740-002-.1430-001
.8728+002 I I-.9836-002-.1101-001
.8730+002 I I-.9945-002-.1181-001
.8732+002 I I-.1002-001-.1343-001
.8734+002 I I-.1009-001-.1235-001
.8736+002 I I-.1015-001-.1274-001
.8738+002 I I-.1024-001-.1231-001
.8740+002 I I-.1033-001-.1375-001
.8742+002 I I-.1038-001-.1389-001
.8744+002 I I-.1043-001-.1454-001
.8746+002 I I-.1045-001-.1775-001
.8748+002 I I-.1047-001-.1579-001
.8750+002 I I-.1050-001-.1507-001
.8752+002 I I-.1061-001-.9487-002
.8754+002 I I-.1082-001-.7285-002
.8756+002 I I-.1103-001-.9001-002
.8758+002 I I-.1126-001-.4942-002
.8760+002 I I-.1150-001-.9012-002
.8762+002 I I-.1167-001-.1364-001
.8764+002 I I-.1178-001-.1311-001
.8766+002 I I-.1196-001-.8669-002
.8768+002 I I-.1217-001-.9877-002
.8770+002 I I-.1235-001-.1409-001

FIGURE F83



.8772+002	-.1250-001	-.1014-001
.8774+002	-.1270-001	-.1064-001
.8776+002	-.1291-001	-.9711-002
.8778+002	-.1313-001	-.9867-002
.8780+002	-.1331-001	-.1071-001
.8782+002	-.1350-001	-.1124-001
.8784+002	-.1368-001	-.1176-001
.8786+002	-.1382-001	-.1289-001
.8788+002	-.1392-001	-.1434-001
.8790+002	-.1400-001	-.1598-001
.8792+002	-.1409-001	-.1449-001
.8794+002	-.1414-001	-.1761-001
.8796+002	-.1419-001	-.1630-001
.8798+002	-.1425-001	-.1385-001
.8800+002	-.1435-001	-.1165-001
.8802+002	-.1451-001	-.9976-002
.8804+002	-.1469-001	-.9892-002
.8806+002	-.1483-001	-.1241-001
.8808+002	-.1492-001	-.1471-001
.8810+002	-.1503-001	-.1112-001
.8812+002	-.1515-001	-.1217-001
.8814+002	-.1528-001	-.1198-001
.8816+002	-.1540-001	-.1365-001
.8818+002	-.1552-001	-.1223-001
.8820+002	-.1565-001	-.1163-001
.8822+002	-.1579-001	-.1352-001
.8824+002	-.1595-001	-.8547-002
.8826+002	-.1616-001	-.9443-002
.8828+002	-.1632-001	-.1532-001
.8830+002	-.1643-001	-.1523-001
.8832+002	-.1651-001	-.1765-001
.8834+002	-.1659-001	-.1624-001
.8836+002	-.1669-001	-.1478-001
.8838+002	-.1679-001	-.1697-001
.8840+002	-.1684-001	-.1877-001
.8842+002	-.1689-001	-.2068-001
.8844+002	-.1688-001	-.2194-001
.8846+002	-.1687-001	-.2214-001
.8848+002	-.1686-001	-.2137-001
.8850+002	-.1687-001	-.2123-001
.8852+002	-.1687-001	-.2068-001
.8854+002	-.1685-001	-.2411-001
.8856+002	-.1677-001	-.2480-001
.8858+002	-.1670-001	-.2603-001
.8860+002	-.1664-001	-.2334-001
.8862+002	-.1660-001	-.2176-001
.8864+002	-.1658-001	-.2140-001
.8866+002	-.1661-001	-.1771-001
.8868+002	-.1668-001	-.1646-001
.8870+002	-.1678-001	-.1381-001
.8872+002	-.1691-001	-.1450-001
.8874+002	-.1700-001	-.1771-001
.8876+002	-.1705-001	-.1641-001
.8878+002	-.1711-001	-.1751-001
.8880+002	-.1716-001	-.1664-001
.8882+002	-.1724-001	-.1555-001
.8884+002	-.1731-001	-.1685-001

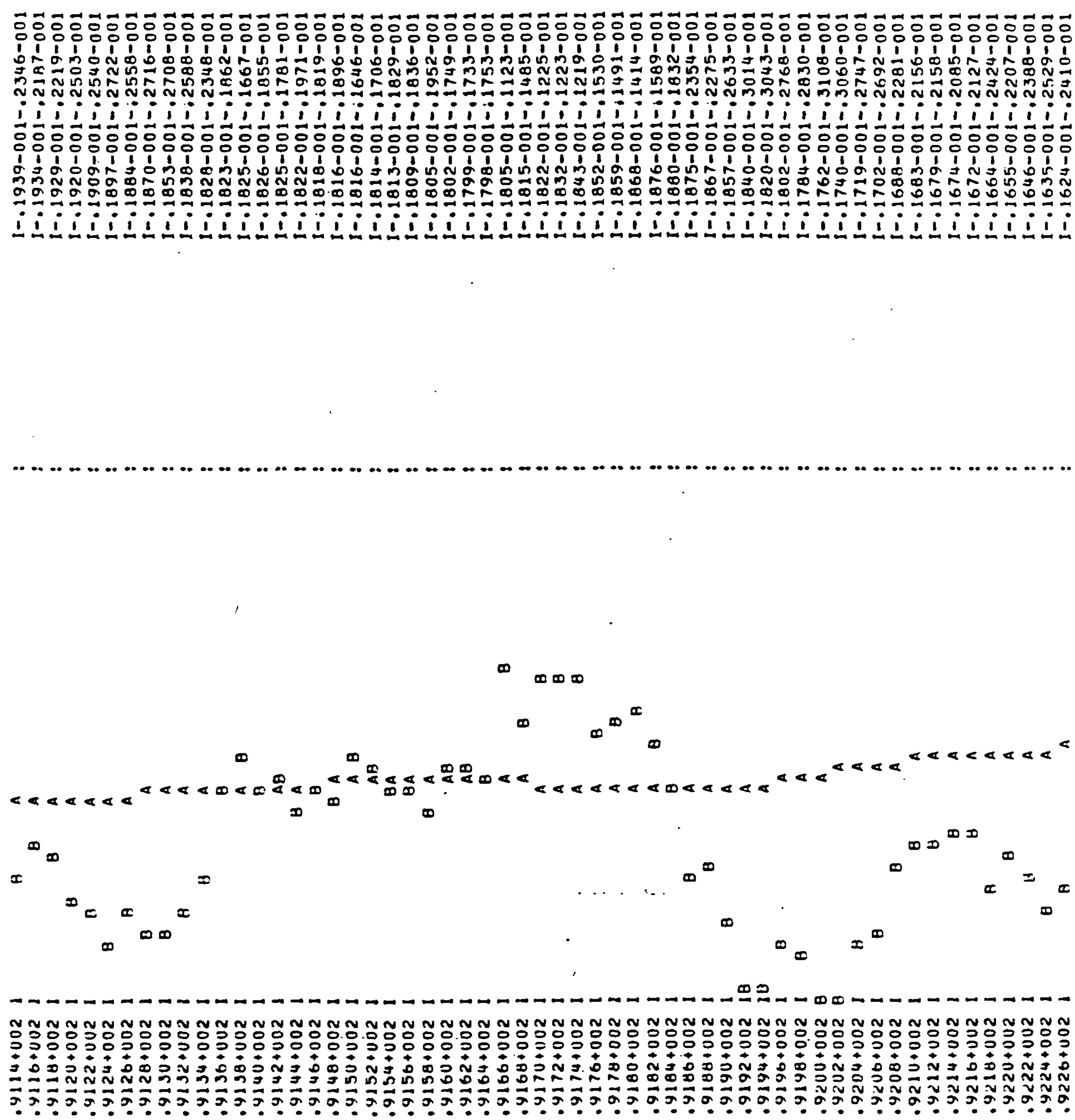
FIGURE F84

.8886+002 I	AB	I-.1735-001-.1648-001
.8888+002 I	AB	I-.1741-001-.1632-001
.8890+002 I	A B	I-.1749-001-.1450-001
.8892+002 I	A B	I-.1760-001-.1314-001
.8894+002 I	A B	I-.1772-001-.1238-001
.8896+002 I	BA	I-.1777-001-.1838-001
.8898+002 I	B A	I-.1772-001-.2082-001
.8900+002 I	B A	I-.1763-001-.2341-001
.8902+002 I	B A	I-.1747-001-.2713-001
.8904+002 I	B A	I-.1728-001-.2651-001
.8906+002 I	B A	I-.1712-001-.2350-001
.8908+002 I	B A	I-.1700-001-.2338-001
.8910+002 I	B A	I-.1691-001-.2191-001
.8912+002 I	B A	I-.1684-001-.2068-001
.8914+002 I	B A	I-.1674-001-.2327-001
.8916+002 I	B A	I-.1665-001-.2052-001
.8918+002 I	B A	I-.1658-001-.2086-001
.8920+002 I	B A	I-.1653-001-.1937-001
.8922+002 I	B A	I-.1648-001-.1873-001
.8924+002 I	A B	I-.1650-001-.1338-001
.8926+002 I	A B	I-.1661-001-.1275-001
.8928+002 I	AB	I-.1666-001-.1611-001
.8930+002 I	A B	I-.1671-001-.1559-001
.8932+002 I	A B	I-.1679-001-.1338-001
.8934+002 I	A B	I-.1687-001-.1524-001
.8936+002 I	BA	I-.1689-001-.1760-001
.8938+002 I	BA	I-.1689-001-.1768-001
.8940+002 I	BA	I-.1688-001-.1767-001
.8942+002 I	B A	I-.1688-001-.1760-001
.8944+002 I	B	I-.1688-001-.1691-001
.8946+002 I	BA	I-.1686-001-.1714-001
.8948+002 I	B A	I-.1684-001-.1879-001
.8950+002 I	B A	I-.1679-001-.1956-001
.8952+002 I	BA	I-.1674-001-.1717-001
.8954+002 I	B A	I-.1668-001-.1888-001
.8956+002 I	BA	I-.1662-001-.1730-001
.8958+002 I	AB	I-.1658-001-.1612-001
.8960+002 I	B	I-.1656-001-.1632-001
.8962+002 I	A B	I-.1656-001-.1427-001
.8964+002 I	A B	I-.1658-001-.1119-001
.8966+002 I	A B	I-.1664-001-.1172-001
.8968+002 I	A B	I-.1668-001-.1198-001
.8970+002 I	A B	I-.1667-001-.1524-001
.8972+002 I	B A	I-.1661-001-.1863-001
.8974+002 I	B	I-.1652-001-.1672-001
.8976+002 I	A B	I-.1646-001-.1410-001
.8978+002 I	A B	I-.1643-001-.1349-001
.8980+002 I	A B	I-.1642-001-.1051-001
.8982+002 I	A B	I-.1643-001-.1267-001
.8984+002 I	A B	I-.1643-001-.1069-001
.8986+002 I	A B	I-.1648-001-.7844-002
.8988+002 I	A B	I-.1653-001-.1186-001
.8990+002 I	A B	I-.1658-001-.9476-002
.8992+002 I	A B	I-.1668-001-.5799-002
.8994+002 I	A B	I-.1682-001-.7289-002
.8996+002 I	A B	I-.1696-001-.5332-002
.8998+002 I	A B	I-.1708-001-.8480-002

FIGURE F85

.9000+002 I	A B	I-.1715-001-.1164-001
.9002+002 I	A B	I-.1718-001-.1088-001
.9004+002 I	A B	I-.1724-001-.1124-001
.9006+002 I	A B	I-.1730-001-.9830-002
.9008+002 I	A B	I-.1738-001-.9707-002
.9010+002 I	A B	I-.1751-001-.5561-002
.9012+002 I	A B	I-.1764-001-.8582-002
.9014+002 I	A B	I-.1776-001-.8129-002
.9016+002 I	A B	I-.1788-001-.8524-002
.9018+002 I	A B	I-.1797-001-.1198-001
.9020+002 I	A B	I-.1803-001-.1079-001
.9022+002 I	A B	I-.1806-001-.1264-001
.9024+002 I	A B	I-.1811-001-.1179-001
.9026+002 I	A B	I-.1819-001-.8659-002
.9028+002 I	A B	I-.1831-001-.7261-002
.9030+002 I	A B	I-.1841-001-.1122-001
.9032+002 I	A B	I-.1847-001-.1268-001
.9034+002 I	A B	I-.1848-001-.1327-001
.9036+002 I	A B	I-.1851-001-.1362-001
.9038+002 I	A B	I-.1856-001-.1061-001
.9040+002 I	A B	I-.1865-001-.8070-002
.9042+002 I	A B	I-.1878-001-.7415-002
.9044+002 I	A B	I-.1891-001-.7303-002
.9046+002 I	A B	I-.1905-001-.8809-002
.9048+002 I	A B	I-.1917-001-.6795-002
.9050+002 I	A B	I-.1933-001-.6071-002
.9052+002 I	A B	I-.1952-001-.5106-002
.9054+002 I	A B	I-.1968-001-.9260-002
.9056+002 I	A B	I-.1982-001-.7193-002
.9058+002 I	A B	I-.2002-001-.5007-002
.9060+002 I	A B	I-.2023-001-.5285-002
.9062+002 I	A B	I-.2039-001-.9035-002
.9064+002 I	A B	I-.2050-001-.1015-001
.9066+002 I	A B	I-.2062-001-.1036-001
.9068+002 I	A B	I-.2074-001-.9946-002
.9070+002 I	A B	I-.2085-001-.1337-001
.9072+002 I	A B	I-.2087-001-.1599-001
.9074+002 I	A B	I-.2089-001-.1702-001
.9076+002 I	A B	I-.2085-001-.1888-001
.9078+002 I	B A	I-.2076-001-.2423-001
.9080+002 I	B A	I-.2064-001-.2278-001
.9082+002 I	BA	I-.2057-001-.2093-001
.9084+002 I	B	I-.2049-001-.2052-001
.9086+002 I	B A	I-.2042-001-.2168-001
.9088+002 I	B A	I-.2034-001-.2176-001
.9090+002 I	B A	I-.2026-001-.2262-001
.9092+002 I	BA	I-.2021-001-.2123-001
.9094+002 I	B A	I-.2017-001-.2165-001
.9096+002 I	AB	I-.2013-001-.1969-001
.9098+002 I	B A	I-.2009-001-.2438-001
.9100+002 I	B A	I-.2000-001-.2384-001
.9102+002 I	B A	I-.1991-001-.2445-001
.9104+002 I	B A	I-.1981-001-.2382-001
.9106+002 I	B A	I-.1972-001-.2515-001
.9108+002 I	B A	I-.1962-001-.2434-001
.9110+002 I	B A	I-.1953-001-.2358-001
.9112+002 I	B A	I-.1947-001-.2325-001

FIGURE F86



I-.1939-001-.2346-001
I-.1934-001-.2187-001
I-.1929-001-.2219-001
I-.1920-001-.2503-001
I-.1909-001-.2540-001
I-.1897-001-.2722-001
I-.1884-001-.2558-001
I-.1870-001-.2716-001
I-.1853-001-.2708-001
I-.1838-001-.2588-001
I-.1828-001-.2348-001
I-.1823-001-.1862-001
I-.1825-001-.1667-001
I-.1826-001-.1855-001
I-.1825-001-.1781-001
I-.1822-001-.1971-001
I-.1818-001-.1819-001
I-.1816-001-.1896-001
I-.1816-001-.1646-001
I-.1814-001-.1706-001
I-.1813-001-.1829-001
I-.1809-001-.1836-001
I-.1805-001-.1952-001
I-.1802-001-.1749-001
I-.1799-001-.1733-001
I-.1798-001-.1753-001
I-.1805-001-.1123-001
I-.1815-001-.1485-001
I-.1822-001-.1225-001
I-.1832-001-.1223-001
I-.1843-001-.1219-001
I-.1852-001-.1530-001
I-.1859-001-.1491-001
I-.1868-001-.1414-001
I-.1876-001-.1589-001
I-.1880-001-.1832-001
I-.1875-001-.2354-001
I-.1867-001-.2275-001
I-.1857-001-.2633-001
I-.1840-001-.3014-001
I-.1820-001-.3043-001
I-.1802-001-.2768-001
I-.1784-001-.2830-001
I-.1762-001-.3108-001
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I-.1719-001-.2747-001
I-.1702-001-.2692-001
I-.1688-001-.2281-001
I-.1683-001-.2156-001
I-.1679-001-.2158-001
I-.1674-001-.2085-001
I-.1672-001-.2127-001
I-.1664-001-.2424-001
I-.1655-001-.2207-001
I-.1646-001-.2388-001
I-.1635-001-.2529-001
I-.1624-001-.2410-001
.9114+002
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.9118+002
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.9122+002
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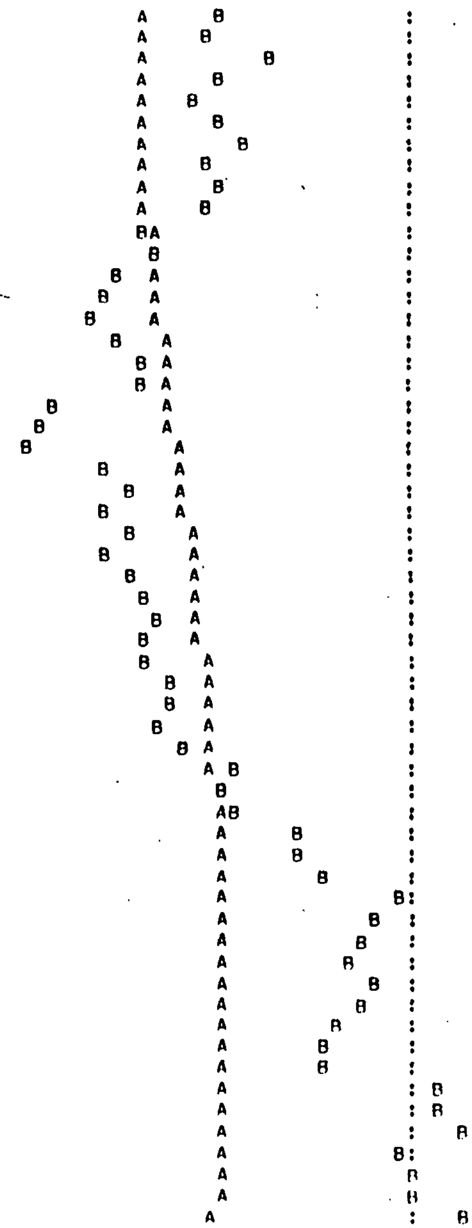
.9204+002
.9206+002
.9208+002
.9210+002
.9212+002
.9214+002
.9216+002
.9218+002
.9220+002
.9222+002
.9224+002
.9226+002

FIGURE F87

```
.9228+002 I            B          A                       :                    I-.1613-001-.2305-001
.9230+002 I           B           A                       :                    I-.1601-001-.2379-001
.9232+002 I              B        A                       :                    I-.1590-001-.2201-001
.9234+002 I             B         A                       :                    I-.1579-001-.2248-001
.9236+002 I                 B     A                       :                    I-.1571-001-.1956-001
.9238+002 I                    B  A                       :                    I-.1567-001-.1793-001
.9240+002 I                       AB                      :                    I-.1566-001-.1534-001
.9242+002 I                       B                       :                    I-.1567-001-.1612-001
.9244+002 I                B      A                       :                    I-.1563-001-.2063-001
.9246+002 I                      B A                      :                    I-.1557-001-.1624-001
.9248+002 I                        B                      :                    I-.1558-001-.1521-001
.9250+002 I                        B                      :                    I-.1559-001-.1549-001
.9252+002 I                       A    B                  :                    I-.1560-001-.1275-001
.9254+002 I                       A    B                  :                    I-.1564-001-.1272-001
.9256+002 I                       A B                     :                    I-.1568-001-.1435-001
.9258+002 I                       AB                      :                    I-.1569-001-.1540-001
.9260+002 I                       A    B                  :                    I-.1570-001-.1248-001
.9262+002 I                       B                       :                    I-.1572-001-.1560-001
.9264+002 I                       A  B                    :                    I-.1572-001-.1430-001
.9266+002 I                       B                       :                    I-.1570-001-.1561-001
.9268+002 I                   B   A                       :                    I-.1564-001-.1860-001
.9270+002 I                       BA                      :                    I-.1558-001-.1616-001
.9272+002 I                     B  A                      :                    I-.1553-001-.1719-001
.9274+002 I                        A B                    :                    I-.1550-001-.1419-001
.9276+002 I                      B A                      :                    I-.1548-001-.1678-001
.9278+002 I             B          A                      :                    I-.1539-001-.2224-001
.9280+002 I               B        A                      :                    I-.1525-001-.2076-001
.9282+002 I               B        A                      :                    I-.1510-001-.2120-001
.9284+002 I                   B    A                      :                    I-.1501-001-.1817-001
.9286+002 I                      B A                      :                    I-.1497-001-.1664-001
.9288+002 I                        BA                     :                    I-.1494-001-.1545-001
.9290+002 I                   B     A                     :                    I-.1490-001-.1829-001
.9292+002 I                  B      A                     :                    I-.1483-001-.1883-001
.9294+002 I                    B    A                     :                    I-.1478-001-.1759-001
.9296+002 I                     B   A                     :                    I-.1474-001-.1752-001
.9298+002 I               B         A                     :                    I-.1465-001-.2129-001
.9300+002 I           B             A                     :                    I-.1450-001-.2341-001
.9302+002 I                  B      A                     :                    I-.1438-001-.1923-001
.9304+002 I                      B  A                     :                    I-.1432-001-.1640-001
.9306+002 I                 B        A                    :                    I-.1426-001-.1991-001
.9308+002 I                 B        A                    :                    I-.1414-001-.1948-001
.9310+002 I            B             A                    :                    I-.1401-001-.2272-001
.9312+002 I             B            A                    :                    I-.1383-001-.2216-001
.9314+002 I                 B        A                    :                    I-.1369-001-.1973-001
.9316+002 I                 B         A                   :                    I-.1357-001-.1991-001
.9318+002 I                      B    A                   :                    I-.1346-001-.1670-001
.9320+002 I                        B  A                   :                    I-.1340-001-.1523-001
.9322+002 I                       B   A                   :                    I-.1334-001-.1561-001
.9324+002 I                          BA                   :                    I-.1328-001-.1429-001
.9326+002 I                           B                   :                    I-.1324-001-.1327-001
.9328+002 I                        B  A                   :                    I-.1319-001-.1516-001
.9330+002 I                           A  B                :                    I-.1316-001-.1166-001
.9332+002 I                           A    B              :                    I-.1318-001-.1036-001
.9334+002 I                           A B                 :                    I-.1317-001-.1207-001
.9336+002 I                           A   B               :                    I-.1317-001-.1081-001
.9338+002 I                           A  B                :                    I-.1315-001-.1111-001
.9340+002 I                         B A                   :                    I-.1311-001-.1437-001
```

FIGURE F88



.9342+002	-.1308-001	-.9197-002
.9344+002	-.1307-001	-.1014-001
.9346+002	-.1309-001	-.6769-002
.9348+002	-.1312-001	-.9199-002
.9350+002	-.1310-001	-.1082-001
.9352+002	-.1308-001	-.9685-002
.9354+002	-.1307-001	-.7980-002
.9356+002	-.1305-001	-.1041-001
.9358+002	-.1303-001	-.9177-002
.9360+002	-.1302-001	-.1013-001
.9362+002	-.1295-001	-.1311-001
.9364+002	-.1286-001	-.1263-001
.9366+002	-.1277-001	-.1439-001
.9368+002	-.1262-001	-.1554-001
.9370+002	-.1246-001	-.1595-001
.9372+002	-.1231-001	-.1485-001
.9374+002	-.1219-001	-.1309-001
.9376+002	-.1211-001	-.1365-001
.9378+002	-.1196-001	-.1792-001
.9380+002	-.1177-001	-.1827-001
.9382+002	-.1156-001	-.1931-001
.9384+002	-.1139-001	-.1507-001
.9386+002	-.1126-001	-.1375-001
.9388+002	-.1115-001	-.1509-001
.9390+002	-.1104-001	-.1425-001
.9392+002	-.1090-001	-.1496-001
.9394+002	-.1078-001	-.1374-001
.9396+002	-.1067-001	-.1318-001
.9398+002	-.1057-001	-.1263-001
.9400+002	-.1046-001	-.1328-001
.9402+002	-.1035-001	-.1303-001
.9404+002	-.1024-001	-.1202-001
.9406+002	-.1013-001	-.1223-001
.9408+002	-.1001-001	-.1266-001
.9410+002	-.9906-002	-.1138-001
.9412+002	-.9823-002	-.8827-002
.9414+002	-.9768-002	-.9606-002
.9416+002	-.9694-002	-.9101-002
.9418+002	-.9636-002	-.5646-002
.9420+002	-.9619-002	-.5287-002
.9422+002	-.9603-002	-.4019-002
.9424+002	-.9624-002	-.5375-003
.9426+002	-.9683-002	-.1705-002
.9428+002	-.9705-002	-.2448-002
.9430+002	-.9712-002	-.3117-002
.9432+002	-.9708-002	-.1724-002
.9434+002	-.9698-002	-.2661-002
.9436+002	-.9668-002	-.3724-002
.9438+002	-.9616-002	-.4124-002
.9440+002	-.9562-002	-.4491-002
.9442+002	-.9546-002	.1626-002
.9444+002	-.9596-002	.1751-002
.9446+002	-.9661-002	.2637-002
.9448+002	-.9714-002	-.7002-003
.9450+002	-.9728-002	.2587-003
.9452+002	-.9774-002	-.1989-004
.9454+002	-.9847-002	.2832-002

FIGURE F89

```
.9456+002 I                              A               : B                 I-.9930-002 .1365-002
.9458+002 I                              A              B:                   I-.9981-002-.2335-003
.9460+002 I                              A             B :                   I-.9995-002-.1326-002
.9462+002 I                              A               :B                  I-.1005-001 .7471-003
.9464+002 I                              A              B:                   I-.1012-001-.5044-003
.9466+002 I                              A         B     :                   I-.1013-001-.3544-002
.9468+002 I                              A       B       :                   I-.1009-001-.5012-002
.9470+002 I                              A        B      :                   I-.1008-001-.4118-002
.9472+002 I                              A          B    :                   I-.1008-001-.3298-002
.9474+002 I                              A      B        :                   I-.1007-001-.5640-002
.9476+002 I                              A    B          :                   I-.1001-001-.6632-002
.9478+002 I                              A       B       :                   I-.9980-002-.5155-002
.9480+002 I                              A        B      :                   I-.9987-002-.4065-002
.9482+002 I                              A       B       :                   I-.9997-002-.5154-002
.9484+002 I                             BA               :                   I-.9927-002-.1084-001
.9486+002 I                              AB              :                   I-.9825-002-.9368-002
.9488+002 I                           B   A              :                   I-.9716-002-.1192-001
.9490+002 I                             B A              :                   I-.9568-002-.1056-001
.9492+002 I                             B A              :                   I-.9453-002-.1079-001
.9494+002 I                               A  B           :                   I-.9369-002-.7341-002
.9496+002 I                             BA               :                   I-.9256-002-.1016-001
.9498+002 I                             BA               :                   I-.9139-002-.1010-001
.9500+002 I                              B A             :                   I-.9023-002-.1036-001
```

FIGURE F90

SHUTTLE ROTATIONS

CURVE '*' IS A PLOT OF THETAX VERSUS TIME

CURVE 'A' IS A PLOT OF THETAY VERSUS TIME

CURVE 'B' IS A PLOT OF THETAZ VERSUS TIME

MINIMUM VALUE .0000 — MAXIMUM VALUE .3938+004

TIME	I (min)		(max) I	THETAX	THETAY	THETAZ
.8000+002	B	A	I	.0000	.3320+004	.0000
.8002+002	B	A	I	.4495+001	.3320+004	.3155+000
.8004+002	B	A	I	.8990+001	.3321+004	.6309+000
.8006+002	B	A	I	.1348+002	.3322+004	.9464+000
.8008+002	B	A	I	.1798+002	.3323+004	.1262+001
.8010+002	B	A	I	.2247+002	.3324+004	.1577+001
.8012+002	B	A	I	.2697+002	.3325+004	.1893+001
.8014+002	B	A	I	.3146+002	.3325+004	.2208+001
.8016+002	B	A	I	.3596+002	.3326+004	.2524+001
.8018+002	B	A	I	.4045+002	.3327+004	.2839+001
.8020+002	B	A	I	.4495+002	.3328+004	.3155+001
.8022+002	B	A	I	.4944+002	.3329+004	.3470+001
.8024+002	B	A	I	.5394+002	.3329+004	.3786+001
.8026+002	B*	A	I	.5843+002	.3330+004	.4101+001
.8028+002	B*	A	I	.6293+002	.3331+004	.4416+001
.8030+002	B*	A	I	.6742+002	.3332+004	.4732+001
.8032+002	B*	A	I	.7192+002	.3333+004	.5047+001
.8034+002	B*	A	I	.7641+002	.3334+004	.5363+001
.8036+002	B*	A	I	.8091+002	.3334+004	.5678+001
.8038+002	B*	A	I	.8540+002	.3335+004	.5994+001
.8040+002	B*	A	I	.8990+002	.3336+004	.6309+001
.8042+002	B*	A	I	.9439+002	.3337+004	.6625+001
.8044+002	B*	A	I	.9889+002	.3338+004	.6940+001
.8046+002	B*	A	I	.1034+003	.3339+004	.7256+001
.8048+002	B*	A	I	.1079+003	.3339+004	.7571+001
.8050+002	B*	A	I	.1124+003	.3340+004	.7886+001
.8052+002	B *	A	I	.1169+003	.3341+004	.8202+001
.8054+002	B *	A	I	.1214+003	.3342+004	.8517+001
.8056+002	B *	A	I	.1259+003	.3343+004	.8833+001
.8058+002	B *	A	I	.1303+003	.3344+004	.9148+001
.8060+002	B *	A	I	.1348+003	.3344+004	.9464+001
.8062+002	B *	A	I	.1393+003	.3345+004	.9779+001
.8064+002	B *	A	I	.1438+003	.3346+004	.1009+002
.8066+002	B *	A	I	.1483+003	.3347+004	.1041+002
.8068+002	B *	A	I	.1528+003	.3348+004	.1073+002
.8070+002	B *	A	I	.1573+003	.3348+004	.1104+002
.8072+002	B *	A	I	.1618+003	.3349+004	.1136+002
.8074+002	B *	A	I	.1663+003	.3350+004	.1167+002
.8076+002	B *	A	I	.1708+003	.3351+004	.1199+002
.8078+002	B *	A	I	.1753+003	.3352+004	.1230+002
.8080+002	B *	A	I	.1798+003	.3353+004	.1262+002

FIGURE F91

```
.8082+002 B *                                            A          I .1843+003 .3353+004 .1293+002
.8084+002 B *                                            A          I .1888+003 .3354+004 .1325+002
.8086+002 B *                                            A          I .1933+003 .3355+004 .1356+002
.8088+002 B *                                            A          I .1978+003 .3356+004 .1388+002
.8090+002 B *                                            A          I .2023+003 .3357+004 .1420+002
.8092+002 B *                                            A          I .2068+003 .3358+004 .1451+002
.8094+002 B *                                            A          I .2112+003 .3358+004 .1483+002
.8096+002 B *                                            A          I .2157+003 .3359+004 .1514+002
.8098+002 B *                                            A          I .2202+003 .3360+004 .1546+002
.8100+002 B *                                            A          I .2247+003 .3361+004 .1577+002
.8102+002 B  *                                           A          I .2292+003 .3362+004 .1609+002
.8104+002 B  *                                           A          I .2337+003 .3362+004 .1640+002
.8106+002 B  *                                           A          I .2382+003 .3363+004 .1672+002
.8108+002 B  *                                           A          I .2427+003 .3364+004 .1703+002
.8110+002 B  *                                           A          I .2472+003 .3365+004 .1735+002
.8112+002 B  *                                           A          I .2517+003 .3366+004 .1767+002
.8114+002 B  *                                           A          I .2562+003 .3367+004 .1798+002
.8116+002 B  *                                           A          I .2607+003 .3367+004 .1830+002
.8118+002 B  *                                           A          I .2652+003 .3368+004 .1861+002
.8120+002 B  *                                           A          I .2697+003 .3369+004 .1893+002
.8122+002 B  *                                           A          I .2742+003 .3370+004 .1924+002
.8124+002 B  *                                           A          I .2787+003 .3371+004 .1956+002
.8126+002 B   *                                          A          I .2832+003 .3372+004 .1987+002
.8128+002 B   *                                          A          I .2877+003 .3372+004 .2019+002
.8130+002 B   *                                          A          I .2921+003 .3373+004 .2050+002
.8132+002 B   *                                          A          I .2966+003 .3374+004 .2082+002
.8134+002 B   *                                          A          I .3011+003 .3375+004 .2113+002
.8136+002 B   *                                           A         I .3056+003 .3376+004 .2145+002
.8138+002 B   *                                           A         I .3101+003 .3376+004 .2177+002
.8140+002 B   *                                           A         I .3146+003 .3377+004 .2208+002
.8142+002 B   *                                           A         I .3191+003 .3378+004 .2240+002
.8144+002 B   *                                           A         I .3236+003 .3379+004 .2271+002
.8146+002 B   *                                           A         I .3281+003 .3380+004 .2303+002
.8148+002 B   *                                           A         I .3326+003 .3381+004 .2334+002
.8150+002 B   *                                           A         I .3371+003 .3381+004 .2366+002
.8152+002 B    *                                          A         I .3416+003 .3382+004 .2397+002
.8154+002 B    *                                          A         I .3461+003 .3383+004 .2429+002
.8156+002 B    *                                          A         I .3506+003 .3384+004 .2460+002
.8158+002 B    *                                          A         I .3551+003 .3385+004 .2492+002
.8160+002 B    *                                          A         I .3596+003 .3386+004 .2524+002
.8162+002 B    *                                          A         I .3641+003 .3386+004 .2555+002
.8164+002 B    *                                          A         I .3685+003 .3387+004 .2587+002
.8166+002 B    *                                          A         I .3730+003 .3388+004 .2618+002
.8168+002 B    *                                          A         I .3775+003 .3389+004 .2650+002
.8170+002 B    *                                          A         I .3820+003 .3390+004 .2681+002
.8172+002 B    *                                          A         I .3865+003 .3391+004 .2713+002
.8174+002 B    *                                          A         I .3910+003 .3391+004 .2744+002
.8176+002 B     *                                         A         I .3955+003 .3392+004 .2776+002
.8178+002 B     *                                         A         I .4000+003 .3393+004 .2807+002
.8180+002 B     *                                         A         I .4045+003 .3394+004 .2839+002
.8182+002 B     *                                         A         I .4090+003 .3395+004 .2870+002
.8184+002 B     *                                         A         I .4135+003 .3395+004 .2902+002
.8186+002 B     *                                         A         I .4180+003 .3396+004 .2934+002
.8188+002 B     *                                         A         I .4225+003 .3397+004 .2965+002
.8190+002 B     *                                         A         I .4270+003 .3398+004 .2997+002
.8192+002 B     *                                         A         I .4315+003 .3399+004 .3028+002
.8194+002 B     *                                         A         I .4360+003 .3400+004 .3060+002
```

FIGURE F92

.8196+002	B	*	A	I	.4405+003	.3400+004	.3091+002
.8198+002	B	*	A	I	.4449+003	.3401+004	.3123+002
.8200+002	B	*	A	I	.4494+003	.3402+004	.3154+002
.8202+002	B	*	A	I	.4539+003	.3403+004	.3186+002
.8204+002	B	*	A	I	.4584+003	.3404+004	.3217+002
.8206+002	B	*	A	I	.4629+003	.3405+004	.3249+002
.8208+002	B	*	A	I	.4674+003	.3405+004	.3281+002
.8210+002	B	*	A	I	.4719+003	.3406+004	.3312+002
.8212+002	B	*	A	I	.4764+003	.3407+004	.3344+002
.8214+002	B	*	A	I	.4809+003	.3408+004	.3375+002
.8216+002	B	*	A	I	.4854+003	.3409+004	.3407+002
.8218+002	B	*	A	I	.4899+003	.3409+004	.3438+002
.8220+002	B	*	A	I	.4944+003	.3410+004	.3470+002
.8222+002	B	*	A	I	.4989+003	.3411+004	.3501+002
.8224+002	B	*	A	I	.5034+003	.3412+004	.3533+002
.8226+002	B	*	A	I	.5079+003	.3413+004	.3564+002
.8228+002	B	*	A	I	.5124+003	.3414+004	.3596+002
.8230+002	B	*	A	I	.5169+003	.3414+004	.3627+002
.8232+002	B	*	A	I	.5213+003	.3415+004	.3659+002
.8234+002	B	*	A	I	.5258+003	.3416+004	.3691+002
.8236+002	B	*	A	I	.5303+003	.3417+004	.3722+002
.8238+002	B	*	A	I	.5348+003	.3418+004	.3754+002
.8240+002	B	*	A	I	.5393+003	.3419+004	.3785+002
.8242+002	B	*	A	I	.5438+003	.3419+004	.3817+002
.8244+002	B	*	A	I	.5483+003	.3420+004	.3848+002
.8246+002	B	*	A	I	.5528+003	.3421+004	.3880+002
.8248+002	B	*	A	I	.5573+003	.3422+004	.3911+002
.8250+002	B	*	A	I	.5618+003	.3423+004	.3943+002
.8252+002	B	*	A	I	.5663+003	.3423+004	.3974+002
.8254+002	B	*	A	I	.5708+003	.3424+004	.4006+002
.8256+002	B	*	A	I	.5753+003	.3425+004	.4037+002
.8258+002	B	*	A	I	.5798+003	.3426+004	.4069+002
.8260+002	B	*	A	I	.5843+003	.3427+004	.4101+002
.8262+002	B	*	A	I	.5888+003	.3428+004	.4132+002
.8264+002	B	*	A	I	.5932+003	.3428+004	.4164+002
.8266+002	B	*	A	I	.5977+003	.3429+004	.4195+002
.8268+002	B	*	A	I	.6022+003	.3430+004	.4227+002
.8270+002	B	*	A	I	.6067+003	.3431+004	.4258+002
.8272+002	B	*	A	I	.6112+003	.3432+004	.4290+002
.8274+002	B	*	A	I	.6157+003	.3433+004	.4321+002
.8276+002	B	*	A	I	.6202+003	.3433+004	.4353+002
.8278+002	B	*	A	I	.6247+003	.3434+004	.4384+002
.8280+002	B	*	A	I	.6292+003	.3435+004	.4416+002
.8282+002	B	*	A	I	.6337+003	.3436+004	.4447+002
.8284+002	B	*	A	I	.6382+003	.3437+004	.4479+002
.8286+002	B	*	A	I	.6427+003	.3438+004	.4511+002
.8288+002	B	*	A	I	.6472+003	.3438+004	.4542+002
.8290+002	B	*	A	I	.6517+003	.3439+004	.4574+002
.8292+002	B	*	A	I	.6562+003	.3440+004	.4605+002
.8294+002	B	*	A	I	.6607+003	.3441+004	.4637+002
.8296+002	B	*	A	I	.6651+003	.3442+004	.4668+002
.8298+002	B	*	A	I	.6696+003	.3442+004	.4700+002
.8300+002	B	*	A	I	.6741+003	.3443+004	.4731+002
.8302+002	B	*	A	I	.6786+003	.3444+004	.4763+002
.8304+002	B	*	A	I	.6831+003	.3445+004	.4794+002
.8306+002	B	*	A	I	.6876+003	.3446+004	.4826+002
.8308+002	B	*	A	I	.6921+003	.3447+004	.4857+002

FIGURE F93

.8310+002	B	.6966+003	.3447+004	.4889+002
.8312+002	B	.7011+003	.3448+004	.4921+002
.8314+002	B	.7056+003	.3449+004	.4952+002
.8316+002	B	.7101+003	.3450+004	.4984+002
.8318+002	B	.7146+003	.3451+004	.5015+002
.8320+002	B	.7191+003	.3452+004	.5047+002
.8322+002	B	.7236+003	.3452+004	.5078+002
.8324+002	B	.7281+003	.3453+004	.5110+002
.8326+002	B	.7326+003	.3454+004	.5141+002
.8328+002	B	.7370+003	.3455+004	.5173+002
.8330+002	B	.7415+003	.3456+004	.5204+002
.8332+002	B	.7460+003	.3456+004	.5236+002
.8334+002	B	.7505+003	.3457+004	.5267+002
.8336+002	B	.7550+003	.3458+004	.5299+002
.8338+002	B	.7595+003	.3459+004	.5331+002
.8340+002	B	.7640+003	.3460+004	.5362+002
.8342+002	B	.7685+003	.3461+004	.5394+002
.8344+002	B	.7730+003	.3461+004	.5425+002
.8346+002	B	.7775+003	.3462+004	.5457+002
.8348+002	B	.7820+003	.3463+004	.5488+002
.8350+002	B	.7865+003	.3464+004	.5520+002
.8352+002	B	.7910+003	.3465+004	.5551+002
.8354+002	B	.7955+003	.3466+004	.5583+002
.8356+002	B	.8000+003	.3466+004	.5614+002
.8358+002	:B	.8044+003	.3467+004	.5646+002
.8360+002	:B	.8089+003	.3468+004	.5677+002
.8362+002	:B	.8134+003	.3469+004	.5709+002
.8364+002	:B	.8179+003	.3470+004	.5741+002
.8366+002	:B	.8224+003	.3470+004	.5772+002
.8368+002	:B	.8269+003	.3471+004	.5804+002
.8370+002	:B	.8314+003	.3472+004	.5835+002
.8372+002	:B	.8359+003	.3473+004	.5867+002
.8374+002	:B	.8404+003	.3474+004	.5898+002
.8376+002	:B	.8449+003	.3475+004	.5930+002
.8378+002	:B	.8494+003	.3475+004	.5961+002
.8380+002	:B	.8539+003	.3476+004	.5993+002
.8382+002	:B	.8584+003	.3477+004	.6024+002
.8384+002	:B	.8629+003	.3478+004	.6056+002
.8386+002	:B	.8674+003	.3479+004	.6087+002
.8388+002	:B	.8718+003	.3480+004	.6119+002
.8390+002	:B	.8763+003	.3480+004	.6150+002
.8392+002	:B	.8808+003	.3481+004	.6182+002
.8394+002	:B	.8853+003	.3482+004	.6214+002
.8396+002	:B	.8898+003	.3483+004	.6245+002
.8398+002	:B	.8943+003	.3484+004	.6277+002
.8400+002	:B	.8988+003	.3485+004	.6308+002
.8402+002	:B	.9033+003	.3485+004	.6340+002
.8404+002	:B	.9078+003	.3486+004	.6371+002
.8406+002	:B	.9123+003	.3487+004	.6403+002
.8408+002	:B	.9168+003	.3488+004	.6434+002
.8410+002	:B	.9213+003	.3489+004	.6466+002
.8412+002	:B	.9258+003	.3489+004	.6497+002
.8414+002	:B	.9303+003	.3490+004	.6529+002
.8416+002	:B	.9348+003	.3491+004	.6560+002
.8418+002	:B	.9392+003	.3492+004	.6592+002
.8420+002	:B	.9437+003	.3493+004	.6623+002
.8422+002	:B	.9482+003	.3494+004	.6655+002

FIGURE F94

.8424+002	:B	*	A	I	.9527+003	.3494+004	.6687+002
.8426+002	:B	*	A	I	.9572+003	.3495+004	.6718+002
.8428+002	:B	*	A	I	.9617+003	.3496+004	.6750+002
.8430+002	:B	*	A	I	.9662+003	.3497+004	.6781+002
.8432+002	:B	*	A	I	.9707+003	.3498+004	.6813+002
.8434+002	:B	*	A	I	.9752+003	.3499+004	.6844+002
.8436+002	:D	*	A	I	.9797+003	.3499+004	.6876+002
.8438+002	:B	*	A	I	.9842+003	.3500+004	.6907+002
.8440+002	:B	*	A	I	.9887+003	.3501+004	.6939+002
.8442+002	:B	*	A	I	.9932+003	.3502+004	.6970+002
.8444+002	:B	*	A	I	.9977+003	.3503+004	.7002+002
.8446+002	:B	*	A	I	.1002+004	.3503+004	.7033+002
.8448+002	:B	*	A	I	.1007+004	.3504+004	.7065+002
.8450+002	:B	*	A	I	.1011+004	.3505+004	.7097+002
.8452+002	:B	*	A	I	.1016+004	.3506+004	.7128+002
.8454+002	:B	*	A	I	.1020+004	.3507+004	.7160+002
.8456+002	:B	*	A	I	.1025+004	.3508+004	.7191+002
.8458+002	:B	*	A	I	.1029+004	.3508+004	.7223+002
.8460+002	:B	*	A	I	.1034+004	.3509+004	.7254+002
.8462+002	:B	*	A	I	.1038+004	.3510+004	.7286+002
.8464+002	:B	*	A	I	.1043+004	.3511+004	.7317+002
.8466+002	:B	*	A	I	.1047+004	.3512+004	.7349+002
.8468+002	:B	*	A	I	.1052+004	.3513+004	.7380+002
.8470+002	:B	*	A	I	.1056+004	.3513+004	.7412+002
.8472+002	:B	*	A	I	.1061+004	.3514+004	.7443+002
.8474+002	:B	*	A	I	.1065+004	.3515+004	.7475+002
.8476+002	:B	*	A	I	.1070+004	.3516+004	.7506+002
.8478+002	:B	*	A	I	.1074+004	.3517+004	.7538+002
.8480+002	:B	*	A	I	.1079+004	.3517+004	.7570+002
.8482+002	:B	*	A	I	.1083+004	.3518+004	.7601+002
.8484+002	:B	*	A	I	.1088+004	.3519+004	.7633+002
.8486+002	:B	*	A	I	.1092+004	.3520+004	.7664+002
.8488+002	:B	*	A	I	.1096+004	.3521+004	.7696+002
.8490+002	:B	*	A	I	.1101+004	.3522+004	.7727+002
.8492+002	:B	*	A	I	.1105+004	.3522+004	.7759+002
.8494+002	:B	*	A	I	.1110+004	.3523+004	.7790+002
.8496+002	:B	*	A	I	.1114+004	.3524+004	.7822+002
.8498+002	:B	*	A	I	.1119+004	.3525+004	.7853+002
.8500+002	:B	*	A	I	.1123+004	.3526+004	.7885+002
.8502+002	:B	*	A	I	.1128+004	.3527+004	.7916+002
.8504+002	:B	*	A	I	.1132+004	.3527+004	.7948+002
.8506+002	:B	*	A	I	.1137+004	.3528+004	.7979+002
.8508+002	:B	*	A	I	.1141+004	.3529+004	.8011+002
.8510+002	:B	*	A	I	.1146+004	.3530+004	.8042+002
.8512+002	:B	*	A	I	.1150+004	.3531+004	.8074+002
.8514+002	:B	*	A	I	.1155+004	.3531+004	.8106+002
.8516+002	:B	*	A	I	.1159+004	.3532+004	.8137+002
.8518+002	:B	*	A	I	.1164+004	.3533+004	.8169+002
.8520+002	:B	*	A	I	.1168+004	.3534+004	.8200+002
.8522+002	:B	*	A	I	.1173+004	.3535+004	.8232+002
.8524+002	:B	*	A	I	.1177+004	.3536+004	.8263+002
.8526+002	:B	*	A	I	.1182+004	.3536+004	.8295+002
.8528+002	:B	*	A	I	.1186+004	.3537+004	.8326+002
.8530+002	:B	*	A	I	.1191+004	.3538+004	.8358+002
.8532+002	:B	*	A	I	.1195+004	.3539+004	.8389+002
.8534+002	:B	*	A	I	.1200+004	.3540+004	.8421+002
.8536+002	:B	*	A	I	.1204+004	.3541+004	.8452+002

FIGURE F95

.8538+002	:B	*	A	I	.1209+004	.3541+004	.8484+002
.8540+002	:B	*	A	I	.1213+004	.3542+004	.8515+002
.8542+002	:B	*	A	I	.1218+004	.3543+004	.8547+002
.8544+002	:B	*	A	I	.1222+004	.3544+004	.8579+002
.8546+002	:B	*	A	I	.1227+004	.3545+004	.8610+002
.8548+002	:B	*	A	I	.1231+004	.3546+004	.8642+002
.8550+002	:B	*	A	I	.1236+004	.3546+004	.8673+002
.8552+002	:B	*	A	I	.1240+004	.3547+004	.8705+002
.8554+002	:B	*	A	I	.1245+004	.3548+004	.8736+002
.8556+002	:B	*	A	I	.1249+004	.3549+004	.8768+002
.8558+002	:B	*	A	I	.1254+004	.3550+004	.8799+002
.8560+002	:B	*	A	I	.1258+004	.3550+004	.8831+002
.8562+002	:B	*	A	I	.1263+004	.3551+004	.8862+002
.8564+002	:B	*	A	I	.1267+004	.3552+004	.8894+002
.8566+002	:B	*	A	I	.1272+004	.3553+004	.8925+002
.8568+002	:B	*	A	I	.1276+004	.3554+004	.8957+002
.8570+002	:B	*	A	I	.1281+004	.3555+004	.8988+002
.8572+002	:B	*	A	I	.1285+004	.3555+004	.9020+002
.8574+002	:B	*	A	I	.1290+004	.3556+004	.9051+002
.8576+002	:B	*	A	I	.1294+004	.3557+004	.9083+002
.8578+002	:B	*	A	I	.1299+004	.3558+004	.9115+002
.8580+002	:B	*	A	I	.1303+004	.3559+004	.9146+002
.8582+002	:B	*	A	I	.1308+004	.3560+004	.9178+002
.8584+002	:B	*	A	I	.1312+004	.3560+004	.9209+002
.8586+002	:B	*	A	I	.1317+004	.3561+004	.9241+002
.8588+002	:B	*	A	I	.1321+004	.3562+004	.9272+002
.8590+002	:B	*	A	I	.1326+004	.3563+004	.9304+002
.8592+002	:B	*	A	I	.1330+004	.3564+004	.9335+002
.8594+002	:B	*	A	I	.1335+004	.3564+004	.9367+002
.8596+002	:B	*	A	I	.1339+004	.3565+004	.9398+002
.8598+002	:B	*	A	I	.1344+004	.3566+004	.9430+002
.8600+002	:B	*	A	I	.1348+004	.3567+004	.9461+002
.8602+002	:B	*	A	I	.1353+004	.3568+004	.9493+002
.8604+002	:B	*	A	I	.1357+004	.3569+004	.9524+002
.8606+002	:B	*	A	I	.1362+004	.3569+004	.9556+002
.8608+002	:B	*	A	I	.1366+004	.3570+004	.9587+002
.8610+002	:B	*	A	I	.1371+004	.3571+004	.9619+002
.8612+002	:B	*	A	I	.1375+004	.3572+004	.9651+002
.8614+002	:B	*	A	I	.1380+004	.3573+004	.9682+002
.8616+002	:B	*	A	I	.1384+004	.3574+004	.9714+002
.8618+002	:B	*	A	I	.1389+004	.3574+004	.9745+002
.8620+002	:B	*	A	I	.1393+004	.3575+004	.9777+002
.8622+002	:B	*	A	I	.1398+004	.3576+004	.9808+002
.8624+002	:B	*	A	I	.1402+004	.3577+004	.9840+002
.8626+002	:B	*	A	I	.1406+004	.3578+004	.9871+002
.8628+002	:B	*	A	I	.1411+004	.3578+004	.9903+002
.8630+002	:B	*	A	I	.1415+004	.3579+004	.9934+002
.8632+002	:B	*	A	I	.1420+004	.3580+004	.9966+002
.8634+002	:B	*	A	I	.1424+004	.3581+004	.9997+002
.8636+002	:B	*	A	I	.1429+004	.3582+004	.1003+003
.8638+002	:B	*	A	I	.1433+004	.3583+004	.1006+003
.8640+002	:B	*	A	I	.1438+004	.3583+004	.1009+003
.8642+002	:B	*	A	I	.1442+004	.3584+004	.1012+003
.8644+002	:B	*	A	I	.1447+004	.3585+004	.1015+003
.8646+002	:B	*	A	I	.1451+004	.3586+004	.1019+003
.8648+002	:B	*	A	I	.1456+004	.3587+004	.1022+003
.8650+002	:B	*	A	I	.1460+004	.3588+004	.1025+003

FIGURE F96

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.8652+002 :B        *                          A     I .1465+004 .3588+004 .1028+003
.8654+002 :B        *                          A     I .1469+004 .3589+004 .1031+003
.8656+002 :B        *                          A     I .1474+004 .3590+004 .1034+003
.8658+002 :B        *                          A     I .1478+004 .3591+004 .1038+003
.8660+002 :B        *                          A     I .1483+004 .3592+004 .1041+003
.8662+002 :B        *                          A     I .1487+004 .3592+004 .1044+003
.8664+002 :B        *                          A     I .1492+004 .3593+004 .1047+003
.8666+002 :B        *                          A     I .1496+004 .3594+004 .1050+003
.8668+002 :B        *                          A     I .1501+004 .3595+004 .1053+003
.8670+002 :B        *                          A     I .1505+004 .3596+004 .1056+003
.8672+002 :B        *                          A     I .1510+004 .3597+004 .1060+003
.8674+002 :B        *                          A     I .1514+004 .3597+004 .1063+003
.8676+002 :B        *                          A     I .1519+004 .3598+004 .1066+003
.8678+002 :B         *                         A     I .1523+004 .3599+004 .1069+003
.8680+002 :B         *                         A     I .1528+004 .3600+004 .1072+003
.8682+002 :B         *                          A    I .1532+004 .3601+004 .1075+003
.8684+002 :B         *                          A    I .1537+004 .3602+004 .1079+003
.8686+002 :B         *                          A    I .1541+004 .3602+004 .1082+003
.8688+002 :B         *                          A    I .1546+004 .3603+004 .1085+003
.8690+002 :B         *                          A    I .1550+004 .3604+004 .1088+003
.8692+002 :B         *                          A    I .1555+004 .3605+004 .1091+003
.8694+002 :B         *                          A    I .1559+004 .3606+004 .1094+003
.8696+002 :B         *                          A    I .1564+004 .3606+004 .1097+003
.8698+002 :B         *                          A    I .1568+004 .3607+004 .1101+003
.8700+002 :B         *                          A    I .1573+004 .3608+004 .1104+003
.8702+002 :B          *                         A    I .1577+004 .3609+004 .1107+003
.8704+002 :B          *                         A    I .1582+004 .3610+004 .1110+003
.8706+002 :B          *                         A    I .1586+004 .3611+004 .1113+003
.8708+002 :B          *                         A    I .1591+004 .3611+004 .1116+003
.8710+002 :B          *                         A    I .1595+004 .3612+004 .1120+003
.8712+002 :B          *                         A    I .1600+004 .3613+004 .1123+003
.8714+002 : B         *                         A    I .1604+004 .3614+004 .1126+003
.8716+002 : B         *                         A    I .1609+004 .3615+004 .1129+003
.8718+002 : B         *                         A    I .1613+004 .3616+004 .1132+003
.8720+002 : B         *                         A    I .1618+004 .3616+004 .1135+003
.8722+002 : B         *                         A    I .1622+004 .3617+004 .1138+003
.8724+002 : B         *                         A    I .1627+004 .3618+004 .1142+003
.8726+002 : B         *                         A    I .1631+004 .3619+004 .1145+003
.8728+002 : B          *                        A    I .1636+004 .3620+004 .1148+003
.8730+002 : B          *                        A    I .1640+004 .3621+004 .1151+003
.8732+002 : B          *                        A    I .1645+004 .3621+004 .1154+003
.8734+002 : B          *                        A    I .1649+004 .3622+004 .1157+003
.8736+002 : B          *                        A    I .1654+004 .3623+004 .1161+003
.8738+002 : B          *                        A    I .1658+004 .3624+004 .1164+003
.8740+002 : B          *                        A    I .1663+004 .3625+004 .1167+003
.8742+002 : B          *                        A    I .1667+004 .3625+004 .1170+003
.8744+002 : B          *                        A    I .1672+004 .3626+004 .1173+003
.8746+002 : B          *                        A    I .1676+004 .3627+004 .1176+003
.8748+002 : B          *                        A    I .1680+004 .3628+004 .1179+003
.8750+002 : B          *                        A    I .1685+004 .3629+004 .1183+003
.8752+002 : B           *                       A    I .1689+004 .3630+004 .1186+003
.8754+002 : B           *                       A    I .1694+004 .3630+004 .1189+003
.8756+002 : B           *                       A    I .1698+004 .3631+004 .1192+003
.8758+002 : B           *                       A    I .1703+004 .3632+004 .1195+003
.8760+002 : B           *                       A    I .1707+004 .3633+004 .1198+003
.8762+002 : B           *                       A    I .1712+004 .3634+004 .1202+003
.8764+002 : B           *                       A    I .1716+004 .3635+004 .1205+003
```

FIGURE F97

.8766+002	: B	*	A	I	.1721+004	.3635+004	.1208+003
.8768+002	: B	*	A	I	.1725+004	.3636+004	.1211+003
.8770+002	: B	*	A	I	.1730+004	.3637+004	.1214+003
.8772+002	: B	*	A	I	.1734+004	.3638+004	.1217+003
.8774+002	: B	*	A	I	.1739+004	.3639+004	.1220+003
.8776+002	: B	*	A	I	.1743+004	.3639+004	.1224+003
.8778+002	: B	*	A	I	.1748+004	.3640+004	.1227+003
.8780+002	: B	*	A	I	.1752+004	.3641+004	.1230+003
.8782+002	: B	*	A	I	.1757+004	.3642+004	.1233+003
.8784+002	: B	*	A	I	.1761+004	.3643+004	.1236+003
.8786+002	: B	*	A	I	.1766+004	.3644+004	.1239+003
.8788+002	: B	*	A	I	.1770+004	.3644+004	.1242+003
.8790+002	: B	*	A	I	.1775+004	.3645+004	.1246+003
.8792+002	: B	*	A	I	.1779+004	.3646+004	.1249+003
.8794+002	: B	*	A	I	.1784+004	.3647+004	.1252+003
.8796+002	: B	*	A	I	.1788+004	.3648+004	.1255+003
.8798+002	: B	*	A	I	.1793+004	.3649+004	.1258+003
.8800+002	: B	*	A	I	.1797+004	.3649+004	.1261+003
.8802+002	: B	*	A	I	.1802+004	.3650+004	.1265+003
.8804+002	: B	*	A	I	.1806+004	.3651+004	.1268+003
.8806+002	: B	*	A	I	.1811+004	.3652+004	.1271+003
.8808+002	: B	*	A	I	.1815+004	.3653+004	.1274+003
.8810+002	: B	*	A	I	.1820+004	.3653+004	.1277+003
.8812+002	: B	*	A	I	.1824+004	.3654+004	.1280+003
.8814+002	: B	*	A	I	.1829+004	.3655+004	.1283+003
.8816+002	: B	*	A	I	.1833+004	.3656+004	.1287+003
.8818+002	: B	*	A	I	.1838+004	.3657+004	.1290+003
.8820+002	: B	*	A	I	.1842+004	.3658+004	.1293+003
.8822+002	: B	*	A	I	.1847+004	.3658+004	.1296+003
.8824+002	: B	*	A	I	.1851+004	.3659+004	.1299+003
.8826+002	: B	*	A	I	.1856+004	.3660+004	.1302+003
.8828+002	: B	*	A	I	.1860+004	.3661+004	.1306+003
.8830+002	: B	*	A	I	.1865+004	.3662+004	.1309+003
.8832+002	: B	*	A	I	.1869+004	.3663+004	.1312+003
.8834+002	: B	*	A	I	.1874+004	.3663+004	.1315+003
.8836+002	: B	*	A	I	.1878+004	.3664+004	.1318+003
.8838+002	: B	*	A	I	.1883+004	.3665+004	.1321+003
.8840+002	: B	*	A	I	.1887+004	.3666+004	.1324+003
.8842+002	: B	*	A	I	.1892+004	.3667+004	.1328+003
.8844+002	: B	*	A	I	.1896+004	.3667+004	.1331+003
.8846+002	: B	*	A	I	.1901+004	.3668+004	.1334+003
.8848+002	: B	*	A	I	.1905+004	.3669+004	.1337+003
.8850+002	: B	*	A	I	.1910+004	.3670+004	.1340+003
.8852+002	: B	*	A	I	.1914+004	.3671+004	.1343+003
.8854+002	: B	*	A	I	.1919+004	.3672+004	.1347+003
.8856+002	: B	*	A	I	.1923+004	.3672+004	.1350+003
.8858+002	: B	*	A	I	.1928+004	.3673+004	.1353+003
.8860+002	: B	*	A	I	.1932+004	.3674+004	.1356+003
.8862+002	: B	*	A	I	.1937+004	.3675+004	.1359+003
.8864+002	: B	*	A	I	.1941+004	.3676+004	.1362+003
.8866+002	: B	*	A	I	.1945+004	.3677+004	.1365+003
.8868+002	: B	*	A	I	.1950+004	.3677+004	.1369+003
.8870+002	: B	*	A	I	.1954+004	.3678+004	.1372+003
.8872+002	: B	*	A	I	.1959+004	.3679+004	.1375+003
.8874+002	: B	*	A	I	.1963+004	.3680+004	.1378+003
.8876+002	: B	*	A	I	.1968+004	.3681+004	.1381+003
.8878+002	: B	*	A	I	.1972+004	.3681+004	.1384+003

FIGURE F98

.8880+002	:	B	*	A	I	.1977+004	.3682+004	.1387+003
.8882+002	:	B	*	A	I	.1981+004	.3683+004	.1391+003
.8884+002	:	B	*	A	I	.1986+004	.3684+004	.1394+003
.8886+002	:	B	*	A	I	.1990+004	.3685+004	.1397+003
.8888+002	:	B	*	A	I	.1995+004	.3686+004	.1400+003
.8890+002	:	B	*	A	I	.1999+004	.3686+004	.1403+003
.8892+002	:	B	*	A	I	.2004+004	.3687+004	.1406+003
.8894+002	:	B	*	A	I	.2008+004	.3688+004	.1410+003
.8896+002	:	B	*	A	I	.2013+004	.3689+004	.1413+003
.8898+002	:	B	*	A	I	.2017+004	.3690+004	.1416+003
.8900+002	:	B	*	A	I	.2022+004	.3691+004	.1419+003
.8902+002	:	B	*	A	I	.2026+004	.3691+004	.1422+003
.8904+002	:	B	*	A	I	.2031+004	.3692+004	.1425+003
.8906+002	:	B	*	A	I	.2035+004	.3693+004	.1428+003
.8908+002	:	B	*	A	I	.2040+004	.3694+004	.1432+003
.8910+002	:	B	*	A	I	.2044+004	.3695+004	.1435+003
.8912+002	:	B	*	A	I	.2049+004	.3696+004	.1438+003
.8914+002	:	B	*	A	I	.2053+004	.3696+004	.1441+003
.8916+002	:	B	*	A	I	.2058+004	.3697+004	.1444+003
.8918+002	:	B	*	A	I	.2062+004	.3698+004	.1447+003
.8920+002	:	B	*	A	I	.2067+004	.3699+004	.1451+003
.8922+002	:	B	*	A	I	.2071+004	.3700+004	.1454+003
.8924+002	:	B	*	A	I	.2076+004	.3700+004	.1457+003
.8926+002	:	B	*	A	I	.2080+004	.3701+004	.1460+003
.8928+002	:	B	*	A	I	.2085+004	.3702+004	.1463+003
.8930+002	:	B	*	A	I	.2089+004	.3703+004	.1466+003
.8932+002	:	B	*	A	I	.2094+004	.3704+004	.1469+003
.8934+002	:	B	*	A	I	.2098+004	.3705+004	.1473+003
.8936+002	:	B	*	A	I	.2103+004	.3705+004	.1476+003
.8938+002	:	B	*	A	I	.2107+004	.3706+004	.1479+003
.8940+002	:	B	*	A	I	.2112+004	.3707+004	.1482+003
.8942+002	:	B	*	A	I	.2116+004	.3708+004	.1485+003
.8944+002	:	B	*	A	I	.2121+004	.3709+004	.1488+003
.8946+002	:	B	*	A	I	.2125+004	.3710+004	.1491+003
.8948+002	:	B	*	A	I	.2130+004	.3710+004	.1495+003
.8950+002	:	B	*	A	I	.2134+004	.3711+004	.1498+003
.8952+002	:	B	*	A	I	.2139+004	.3712+004	.1501+003
.8954+002	:	B	*	A	I	.2143+004	.3713+004	.1504+003
.8956+002	:	B	*	A	I	.2148+004	.3714+004	.1507+003
.8958+002	:	B	*	A	I	.2152+004	.3714+004	.1510+003
.8960+002	:	B	*	A	I	.2157+004	.3715+004	.1514+003
.8962+002	:	B	*	A	I	.2161+004	.3716+004	.1517+003
.8964+002	:	B	*	A	I	.2166+004	.3717+004	.1520+003
.8966+002	:	B	*	A	I	.2170+004	.3718+004	.1523+003
.8968+002	:	B	*	A	I	.2175+004	.3719+004	.1526+003
.8970+002	:	B	*	A	I	.2179+004	.3719+004	.1529+003
.8972+002	:	B	*	A	I	.2184+004	.3720+004	.1532+003
.8974+002	:	B	*	A	I	.2188+004	.3721+004	.1536+003
.8976+002	:	B	*	A	I	.2192+004	.3722+004	.1539+003
.8978+002	:	B	*	A	I	.2197+004	.3723+004	.1542+003
.8980+002	:	B	*	A	I	.2201+004	.3724+004	.1545+003
.8982+002	:	B	*	A	I	.2206+004	.3724+004	.1548+003
.8984+002	:	B	*	A	I	.2210+004	.3725+004	.1551+003
.8986+002	:	B	*	A	I	.2215+004	.3726+004	.1555+003
.8988+002	:	B	*	A	I	.2219+004	.3727+004	.1558+003
.8990+002	:	B	*	A	I	.2224+004	.3728+004	.1561+003
.8992+002	:	B	*	A	I	.2228+004	.3728+004	.1564+003

FIGURE F99

.8994+002	: B	*	A	I	.2233+004	.3729+004	.1567+003
.8996+002	: B	*	A	I	.2237+004	.3730+004	.1570+003
.8998+002	: B	*	A	I	.2242+004	.3731+004	.1573+003
.9000+002	: B	*	A	I	.2246+004	.3732+004	.1577+003
.9002+002	: B	*	A	I	.2251+004	.3733+004	.1580+003
.9004+002	: B	*	A	I	.2255+004	.3733+004	.1583+003
.9006+002	: B	*	A	I	.2260+004	.3734+004	.1586+003
.9008+002	: B	*	A	I	.2264+004	.3735+004	.1589+003
.9010+002	: B	*	A	I	.2269+004	.3736+004	.1592+003
.9012+002	: B	*	A	I	.2273+004	.3737+004	.1596+003
.9014+002	: B	*	A	I	.2278+004	.3738+004	.1599+003
.9016+002	: B	*	A	I	.2282+004	.3738+004	.1602+003
.9018+002	: B	*	A	I	.2287+004	.3739+004	.1605+003
.9020+002	: B	*	A	I	.2291+004	.3740+004	.1608+003
.9022+002	: B	*	A	I	.2296+004	.3741+004	.1611+003
.9024+002	: B	*	A	I	.2300+004	.3742+004	.1614+003
.9026+002	: B	*	A	I	.2305+004	.3742+004	.1618+003
.9028+002	: B	*	A	I	.2309+004	.3743+004	.1621+003
.9030+002	: B	*	A	I	.2314+004	.3744+004	.1624+003
.9032+002	: B	*	A	I	.2318+004	.3745+004	.1627+003
.9034+002	: B	*	A	I	.2323+004	.3746+004	.1630+003
.9036+002	: B	*	A	I	.2327+004	.3747+004	.1633+003
.9038+002	: B	*	A	I	.2332+004	.3747+004	.1636+003
.9040+002	: B	*	A	I	.2336+004	.3748+004	.1640+003
.9042+002	: B	*	A	I	.2341+004	.3749+004	.1643+003
.9044+002	: B	*	A	I	.2345+004	.3750+004	.1646+003
.9046+002	: B	*	A	I	.2350+004	.3751+004	.1649+003
.9048+002	: B	*	A	I	.2354+004	.3752+004	.1652+003
.9050+002	: B	*	A	I	.2359+004	.3752+004	.1655+003
.9052+002	: B	*	A	I	.2363+004	.3753+004	.1659+003
.9054+002	: B	*	A	I	.2368+004	.3754+004	.1662+003
.9056+002	: B	*	A	I	.2372+004	.3755+004	.1665+003
.9058+002	: B	*	A	I	.2377+004	.3756+004	.1668+003
.9060+002	: B	*	A	I	.2381+004	.3756+004	.1671+003
.9062+002	: B	*	A	I	.2386+004	.3757+004	.1674+003
.9064+002	: B	*	A	I	.2390+004	.3758+004	.1677+003
.9066+002	: B	*	A	I	.2395+004	.3759+004	.1681+003
.9068+002	: B	*	A	I	.2399+004	.3760+004	.1684+003
.9070+002	: B	*	A	I	.2404+004	.3761+004	.1687+003
.9072+002	: B	*	A	I	.2408+004	.3761+004	.1690+003
.9074+002	: B	*	A	I	.2413+004	.3762+004	.1693+003
.9076+002	: B	*	A	I	.2417+004	.3763+004	.1696+003
.9078+002	: B	*	A	I	.2422+004	.3764+004	.1700+003
.9080+002	: B	*	A	I	.2426+004	.3765+004	.1703+003
.9082+002	: B	*	A	I	.2430+004	.3766+004	.1706+003
.9084+002	: B	*	A	I	.2435+004	.3766+004	.1709+003
.9086+002	: B	*	A	I	.2439+004	.3767+004	.1712+003
.9088+002	: B	*	A	I	.2444+004	.3768+004	.1715+003
.9090+002	: B	*	A	I	.2448+004	.3769+004	.1718+003
.9092+002	: B	*	A	I	.2453+004	.3770+004	.1722+003
.9094+002	: B	*	A	I	.2457+004	.3770+004	.1725+003
.9096+002	: B	*	A	I	.2462+004	.3771+004	.1728+003
.9098+002	: B	*	A	I	.2466+004	.3772+004	.1731+003
.9100+002	: B	*	A	I	.2471+004	.3773+004	.1734+003
.9102+002	: B	*	A	I	.2475+004	.3774+004	.1737+003
.9104+002	: B	*	A	I	.2480+004	.3775+004	.1740+003
.9106+002	: B	*	A	I	.2484+004	.3775+004	.1744+003

FIGURE F100

```
.9108+002 :  B               *                 A I .2489+004 .3776+004 .1747+003
.9110+002 :  B               *                 A I .2493+004 .3777+004 .1750+003
.9112+002 :  B               *                 A I .2498+004 .3778+004 .1753+003
.9114+002 :  B               *                 A I .2502+004 .3779+004 .1756+003
.9116+002 :  B               *                 A I .2507+004 .3780+004 .1759+003
.9118+002 :  B               *                 A I .2511+004 .3780+004 .1763+003
.9120+002 :  B               *                 A I .2516+004 .3781+004 .1766+003
.9122+002 :  B               *                 A I .2520+004 .3782+004 .1769+003
.9124+002 :  B               *                 A I .2525+004 .3783+004 .1772+003
.9126+002 :  B               *                 A I .2529+004 .3784+004 .1775+003
.9128+002 :  B                *                A I .2534+004 .3784+004 .1778+003
.9130+002 :  B                *                A I .2538+004 .3785+004 .1781+003
.9132+002 :  B                *                A I .2543+004 .3786+004 .1785+003
.9134+002 :  B                *                A I .2547+004 .3787+004 .1788+003
.9136+002 :  B                *                A I .2552+004 .3788+004 .1791+003
.9138+002 :  B                *                A I .2556+004 .3789+004 .1794+003
.9140+002 :  B                *                A I .2561+004 .3789+004 .1797+003
.9142+002 :  B                *                A I .2565+004 .3790+004 .1800+003
.9144+002 :  B                *                A I .2570+004 .3791+004 .1804+003
.9146+002 :  B                *                A I .2574+004 .3792+004 .1807+003
.9148+002 :  B                *                A I .2579+004 .3793+004 .1810+003
.9150+002 :  B                *                A I .2583+004 .3794+004 .1813+003
.9152+002 :  B                 *               A I .2588+004 .3794+004 .1816+003
.9154+002 :  B                 *               A I .2592+004 .3795+004 .1819+003
.9156+002 :  B                 *               A I .2597+004 .3796+004 .1822+003
.9158+002 :  B                 *               A I .2601+004 .3797+004 .1826+003
.9160+002 :  B                 *               A I .2606+004 .3798+004 .1829+003
.9162+002 :  B                 *               A I .2610+004 .3798+004 .1832+003
.9164+002 :  B                 *               A I .2615+004 .3799+004 .1835+003
.9166+002 :  B                 *               A I .2619+004 .3800+004 .1838+003
.9168+002 :  B                 *               A I .2624+004 .3801+004 .1841+003
.9170+002 :  B                 *               A I .2628+004 .3802+004 .1844+003
.9172+002 :  B                 *               A I .2633+004 .3803+004 .1848+003
.9174+002 :  B                 *               A I .2637+004 .3803+004 .1851+003
.9176+002 :  B                 *               A I .2642+004 .3804+004 .1854+003
.9178+002 :  B                  *              A I .2646+004 .3805+004 .1857+003
.9180+002 :  B                  *              A I .2651+004 .3806+004 .1860+003
.9182+002 :  B                  *              A I .2655+004 .3807+004 .1863+003
.9184+002 :  B                  *              A I .2659+004 .3808+004 .1867+003
.9186+002 :  B                  *              A I .2664+004 .3808+004 .1870+003
.9188+002 :  B                  *              A I .2668+004 .3809+004 .1873+003
.9190+002 :  B                  *              A I .2673+004 .3810+004 .1876+003
.9192+002 :  B                  *              A I .2677+004 .3811+004 .1879+003
.9194+002 :  B                  *              A I .2682+004 .3812+004 .1882+003
.9196+002 :  B                  *              A I .2686+004 .3812+004 .1885+003
.9198+002 :  B                  *              A I .2691+004 .3813+004 .1889+003
.9200+002 :  B                  *              A I .2695+004 .3814+004 .1892+003
.9202+002 :  B                  *              A I .2700+004 .3815+004 .1895+003
.9204+002 :  B                   *             A I .2704+004 .3816+004 .1898+003
.9206+002 :  B                   *             A I .2709+004 .3817+004 .1901+003
.9208+002 :  B                   *             A I .2713+004 .3817+004 .1904+003
.9210+002 :  B                   *             A I .2718+004 .3818+004 .1907+003
.9212+002 :  B                   *             A I .2722+004 .3819+004 .1911+003
.9214+002 :  B                   *             A I .2727+004 .3820+004 .1914+003
.9216+002 :  B                   *             A I .2731+004 .3821+004 .1917+003
.9218+002 :  B                   *             A I .2736+004 .3822+004 .1920+003
ERR MODE  ERR-TYPE: 02    ERR-CODE: 4
```

IX.F.4. Yaw Axis VRCS Disturbance Responses

Figures F101 - F139

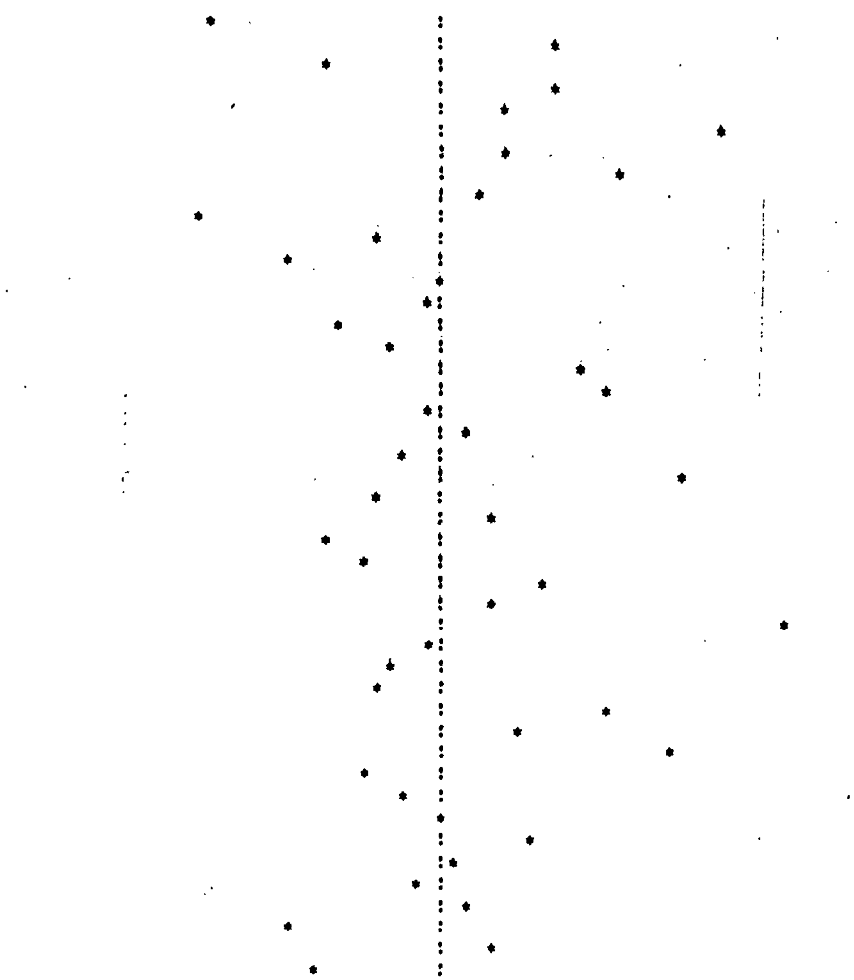
FIGURE F101

DATA FOR THE Z-AXIS

CURVE '*' IS A PLOT OF TORQUE VERSUS TIME

MINIMUM VALUE -.1080-001

MAXIMUM VALUE .1048-001



TIME	TORQUE
.2200+003	-.5476-002
.2200+003	.2742-002
.2201+003	-.2611-002
.2201+003	.2692-002
.2201+003	.1378-002
.2201+003	.6750-002
.2201+003	.1480-002
.2202+003	.4240-002
.2202+003	.9129-003
.2202+003	-.5747-002
.2202+003	-.1431-002
.2202+003	-.3784-002
.2203+003	.2661-004
.2203+003	-.2508-003
.2203+003	-.2445-002
.2203+003	-.1161-002
.2203+003	.3481-002
.2204+003	.4070-002
.2204+003	-.2499-003
.2204+003	.5505-003
.2204+003	-.1069-002
.2204+003	.5848-002
.2205+003	-.1661-002
.2205+003	.1244-002
.2205+003	-.2819-002
.2205+003	-.1878-002
.2205+003	.2295-002
.2206+003	.1078-002
.2206+003	.8049-002
.2206+003	-.3858-003
.2206+003	-.1218-002
.2206+003	-.1455-002
.2207+003	.4035-002
.2207+003	.1686-002
.2207+003	.5516-002
.2207+003	-.1972-002
.2207+003	-.8314-003
.2208+003	-.1321-005
.2208+003	.2223-002
.2208+003	.4234-003
.2208+003	-.7658-003
.2208+003	.5015-003
.2209+003	-.3689-002
.2209+003	.1169-002
.2209+003	-.3082-002

FIGURE F102

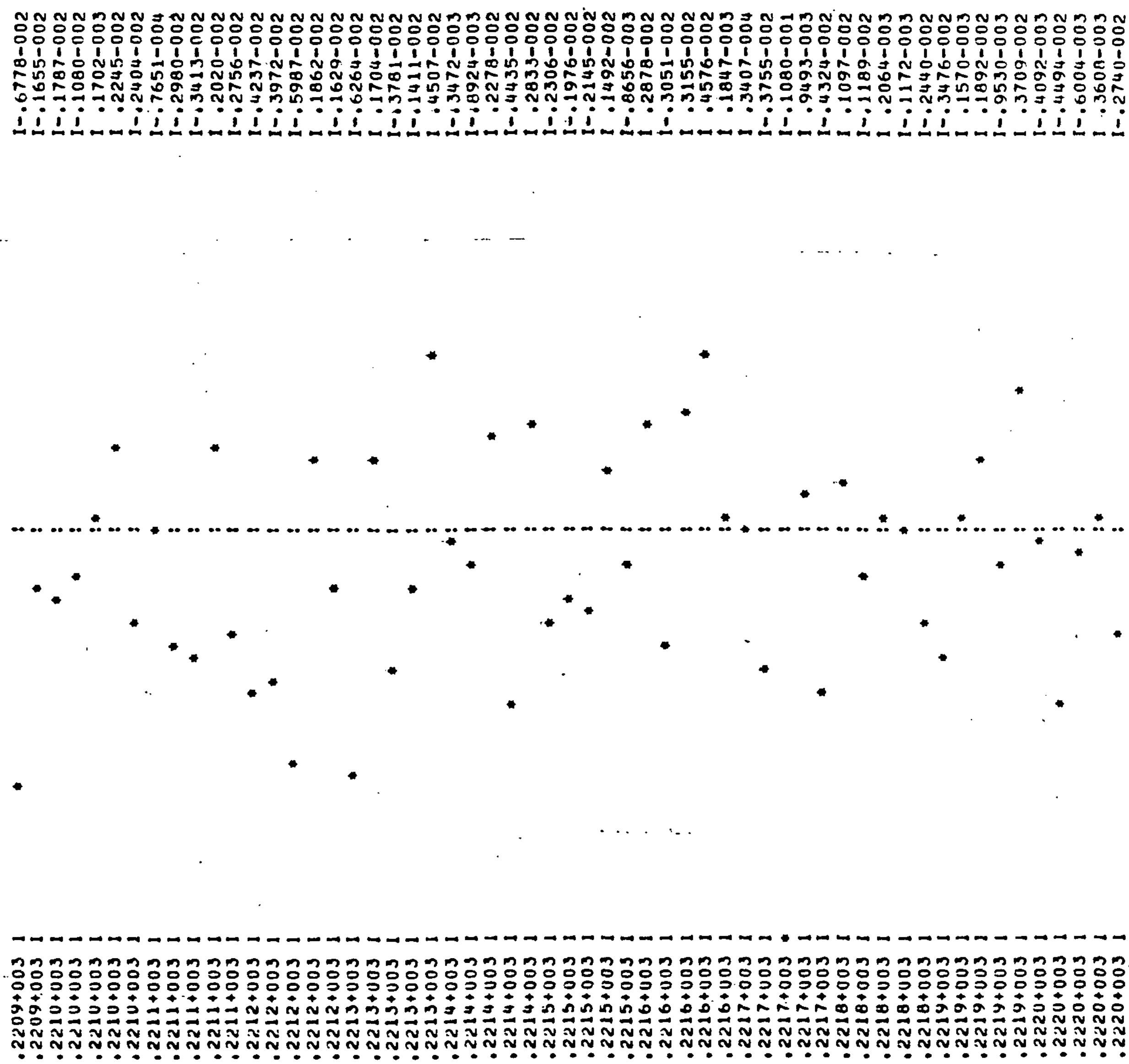
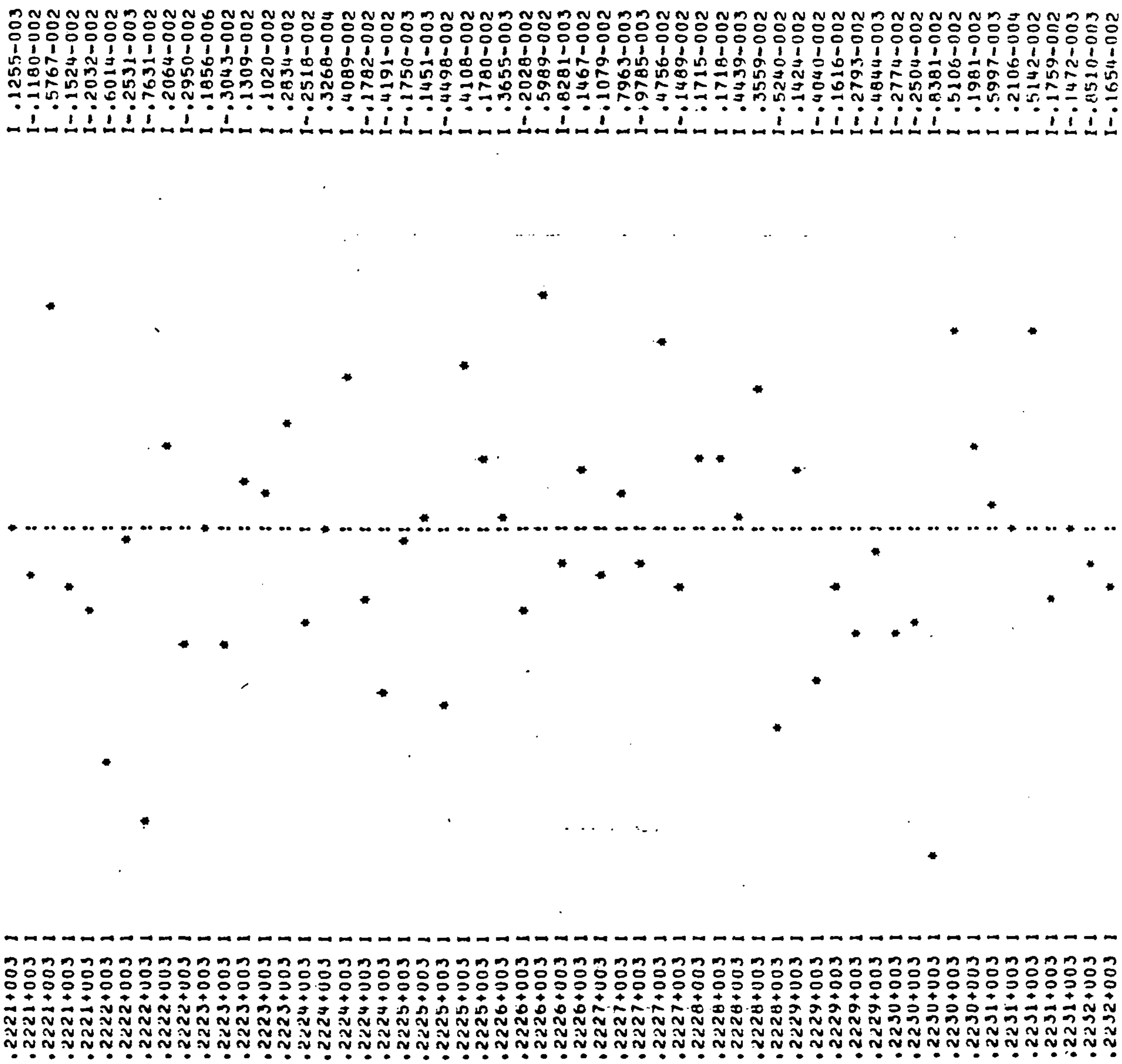


FIGURE F103


I .1255-003
I-.1180-002
I .5767-002
I-.1524-002
I-.2032-002
I-.6014-002
I-.2531-003
I-.7631-002
I .2064-002
I-.2950-002
I .1856-006
I-.3043-002
I .1309-002
I .1020-002
I .2834-002
I-.2518-002
I .3268-004
I .4089-002
I-.1782-002
I-.4191-002
I-.1750-003
I .1451-003
I-.4498-002
I .4108-002
I .1780-002
I .3655-003
I-.2028-002
I .5989-002
I-.8281-003
I .1467-002
I-.1079-002
I .7963-003
I-.9785-003
I .4756-002
I-.1489-002
I .1715-002
I .1718-002
I .4439-003
I .3559-002
I-.5240-002
I .1424-002
I-.4040-002
I-.1616-002
I-.2793-002
I-.4844-003
I-.2774-002
I-.2504-002
I-.8381-002
I .5106-002
I .1981-002
I .5997-003
I .2106-004
I .5142-002
I-.1759-002
I-.1472-003
I-.8510-003
I-.1654-002
.2221+003 I
.2221+003 I
.2221+003 I
.2221+003 I
.2221+003 I
.2222+003 I
.2222+003 I
.2222+003 I
.2222+003 I
.2222+003 I
.2223+003 I
.2223+003 I
.2223+003 I
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.2231+003 I
.2231+003 I
.2232+003 I
.2232+003 I

FIGURE F104

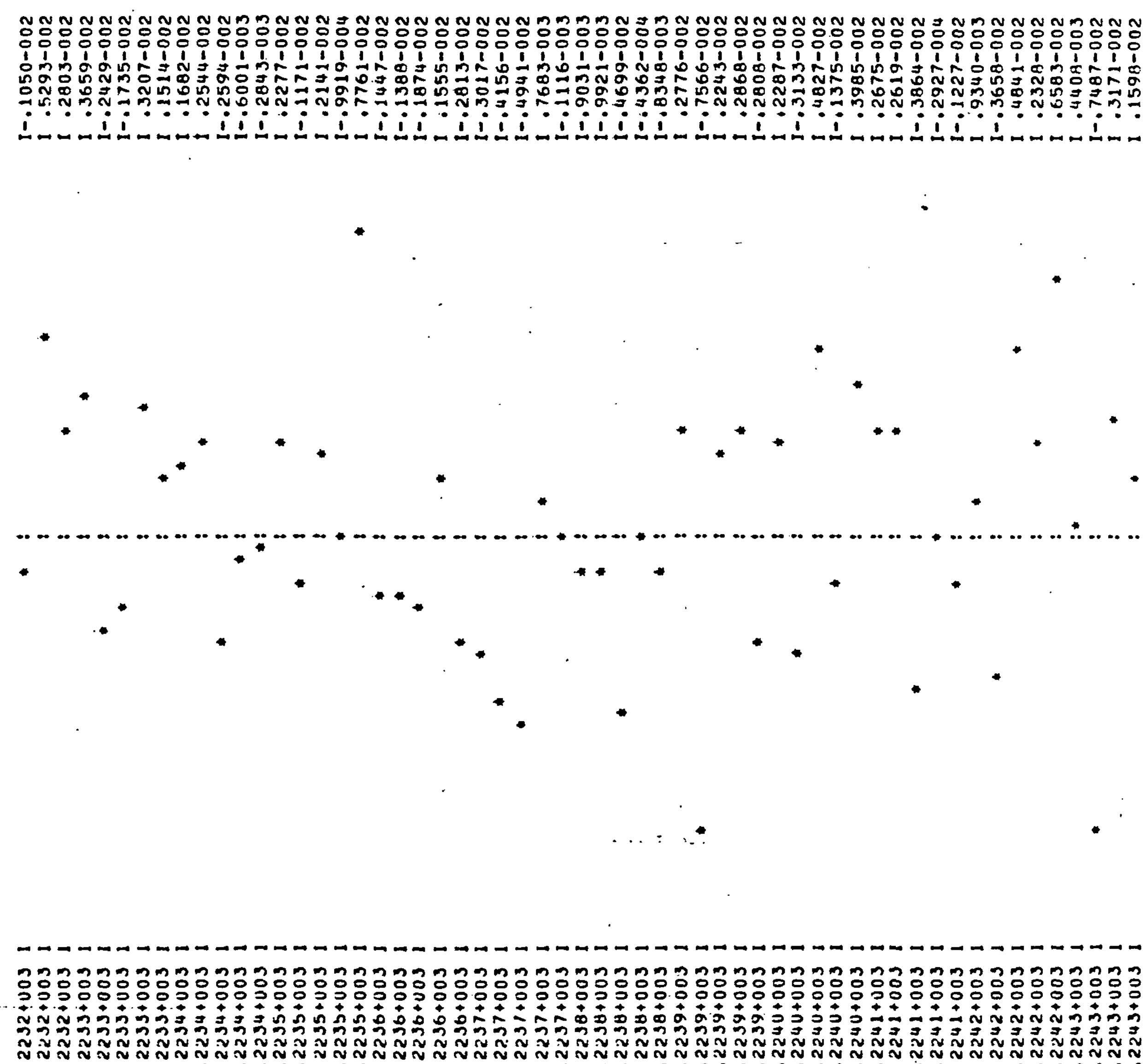
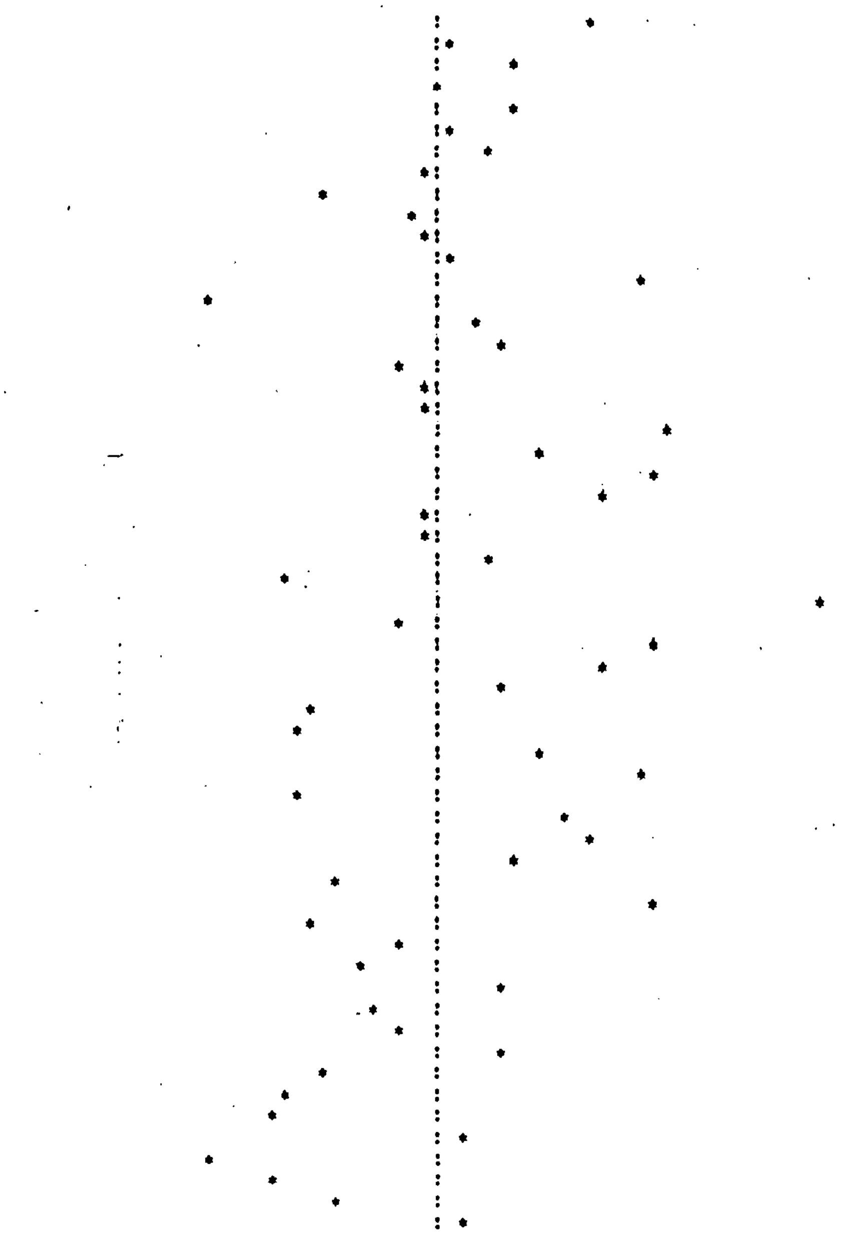
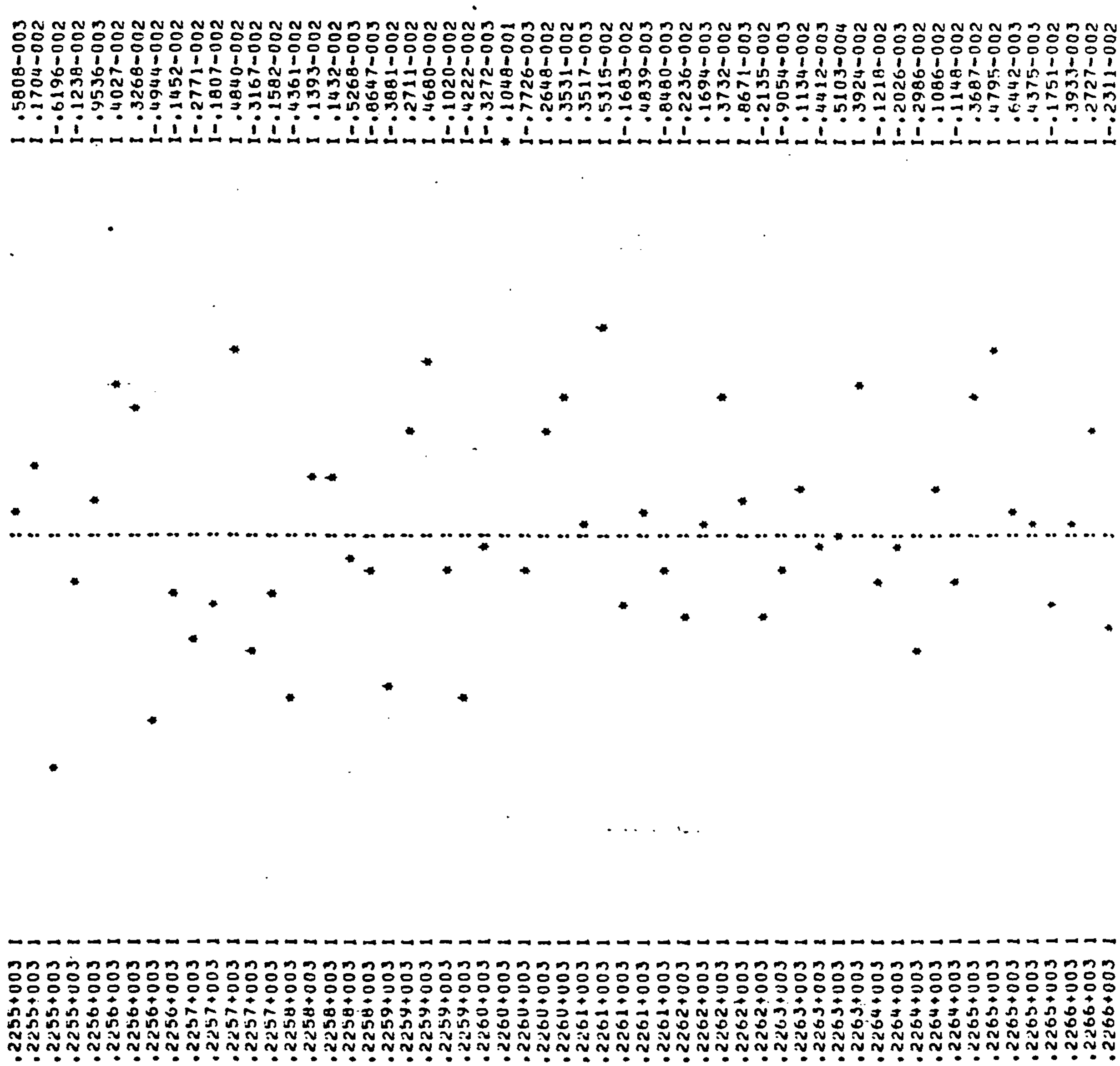


FIGURE F105



.2243+003	.3580-002
.2244+003	.1913-003
.2244+003	.1700-002
.2244+003	-.6737-004
.2244+003	.1817-002
.2244+003	.1818-003
.2245+003	.1224-002
.2245+003	-.2487-003
.2245+003	-.2822-002
.2245+003	-.7232-003
.2245+003	-.2052-003
.2246+003	.1602-003
.2246+003	.4910-002
.2246+003	-.5515-002
.2246+003	.1019-002
.2246+003	.1430-002
.2247+003	-.9489-003
.2247+003	-.3434-003
.2247+003	-.4235-003
.2247+003	.5391-002
.2247+003	.2274-002
.2248+003	.5042-002
.2248+003	.3958-002
.2248+003	-.1840-003
.2248+003	-.3639-003
.2248+003	.1264-002
.2249+003	-.3690-002
.2249+003	.9093-002
.2249+003	-.9598-003
.2249+003	.5124-002
.2249+003	.4070-002
.2250+003	.1369-002
.2250+003	-.3131-002
.2250+003	-.3479-002
.2250+003	.2339-002
.2250+003	.4948-002
.2251+003	-.3240-002
.2251+003	.2888-002
.2251+003	.3711-002
.2251+003	.1837-002
.2251+003	-.2344-002
.2252+003	.5280-002
.2252+003	-.2934-002
.2252+003	-.8588-003
.2252+003	-.1770-002
.2252+003	.1390-002
.2253+003	-.1404-002
.2253+003	-.9330-003
.2253+003	.1429-002
.2253+003	-.2617-002
.2253+003	-.3732-002
.2254+003	-.3994-002
.2254+003	.4796-003
.2254+003	-.5485-002
.2254+003	-.4099-002
.2254+003	-.2353-002
.2255+003	.7234-003

FIGURE F106



I .5808-003
I .1704-002
I-.6196-002
I-.1238-002
I .9536-003
I .4027-002
I .3268-002
I-.4944-002
I-.1452-002
I-.2771-002
I-.1807-002
I .4840-002
I-.3167-002
I-.1582-002
I-.4361-002
I .1393-002
I .1432-002
I-.5268-003
I-.8647-003
I-.3881-002
I .2711-002
I .4680-002
I-.1020-002
I-.4222-002
I-.3272-003
* .1048-001
I-.7726-003
I .2648-002
I .3531-002
I .3517-003
I .5315-002
I-.1683-002
I .4839-003
I-.8480-003
I-.2236-002
I .1694-003
I .3732-002
I .8671-003
I-.2135-002
I-.9054-003
I .1134-002
I-.4412-003
I .5103-004
I .3924-002
I-.1218-002
I-.2026-003
I-.2986-002
I .1086-002
I-.1148-002
I .3687-002
I .4795-002
I .6442-003
I .4375-003
I-.1751-002
I .3933-003
I .2727-002
I-.2311-002

FIGURE F107

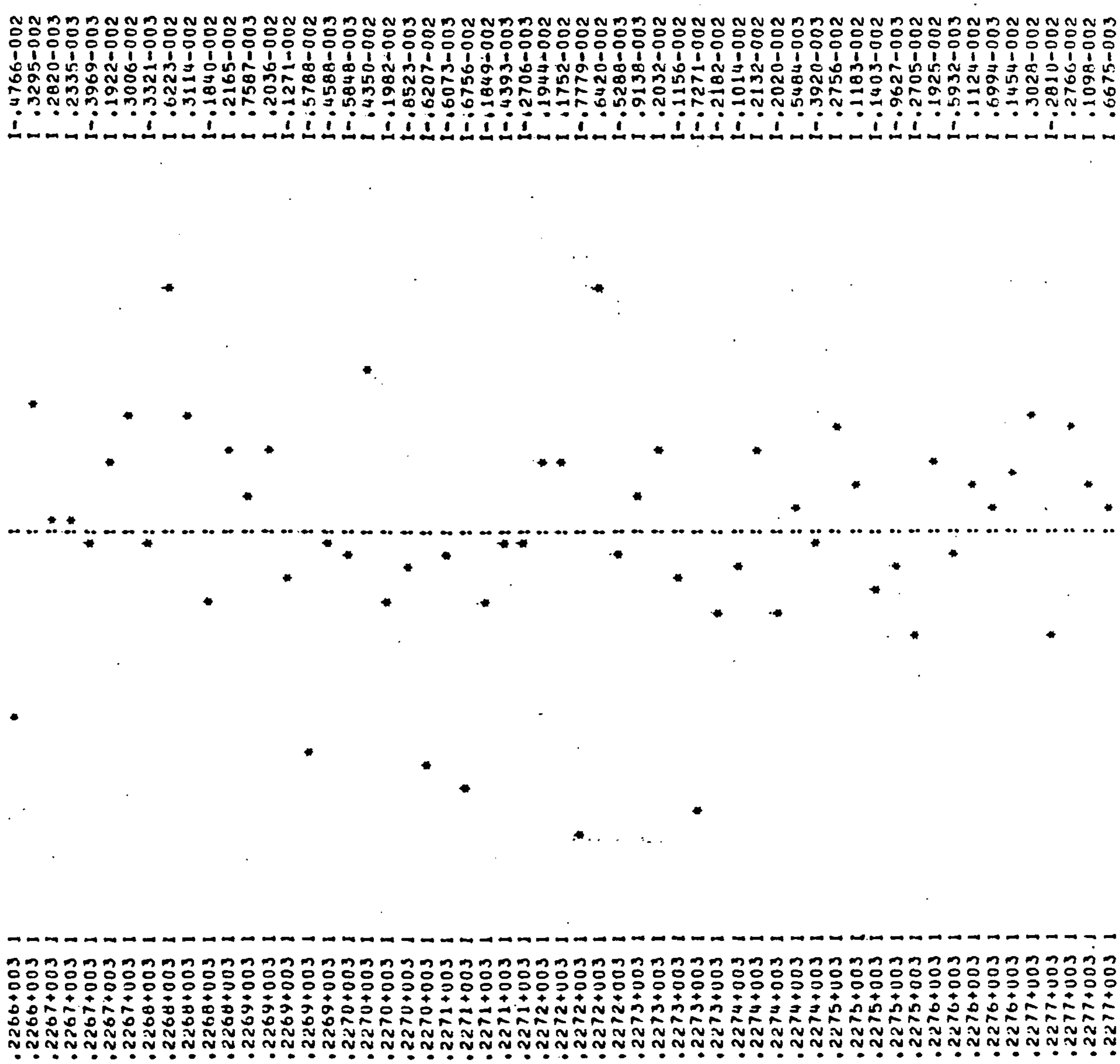

I-.4766-002
I .3295-002
I .2820-003
I .2335-003
I-.3969-003
I .1922-002
I .3006-002
I-.3321-003
I .6223-002
I .3114-002
I-.1840-002
I .2165-002
I .7587-003
I .2036-002
I-.1271-002
I-.5788-002
I-.4588-003
I-.5848-003
I .4350-002
I-.1982-002
I-.8523-003
I-.6207-002
I-.6073-003
I-.6756-002
I-.1849-002
I-.4393-003
I-.2706-003
I .1944-002
I .1752-002
I-.7779-002
I .6420-002
I-.5288-003
I .9138-003
I .2032-002
I-.1156-002
I-.7271-002
I-.2182-002
I-.1014-002
I .2132-002
I-.2020-002
I .5484-003
I-.3920-003
I .2756-002
I .1183-002
I-.1403-002
I-.9627-003
I-.2705-002
I .1925-002
I-.5932-003
I .1124-002
I .6994-003
I .1454-002
I .3028-002
I-.2810-002
I .2766-002
I .1098-002
I .6675-003

FIGURE F108

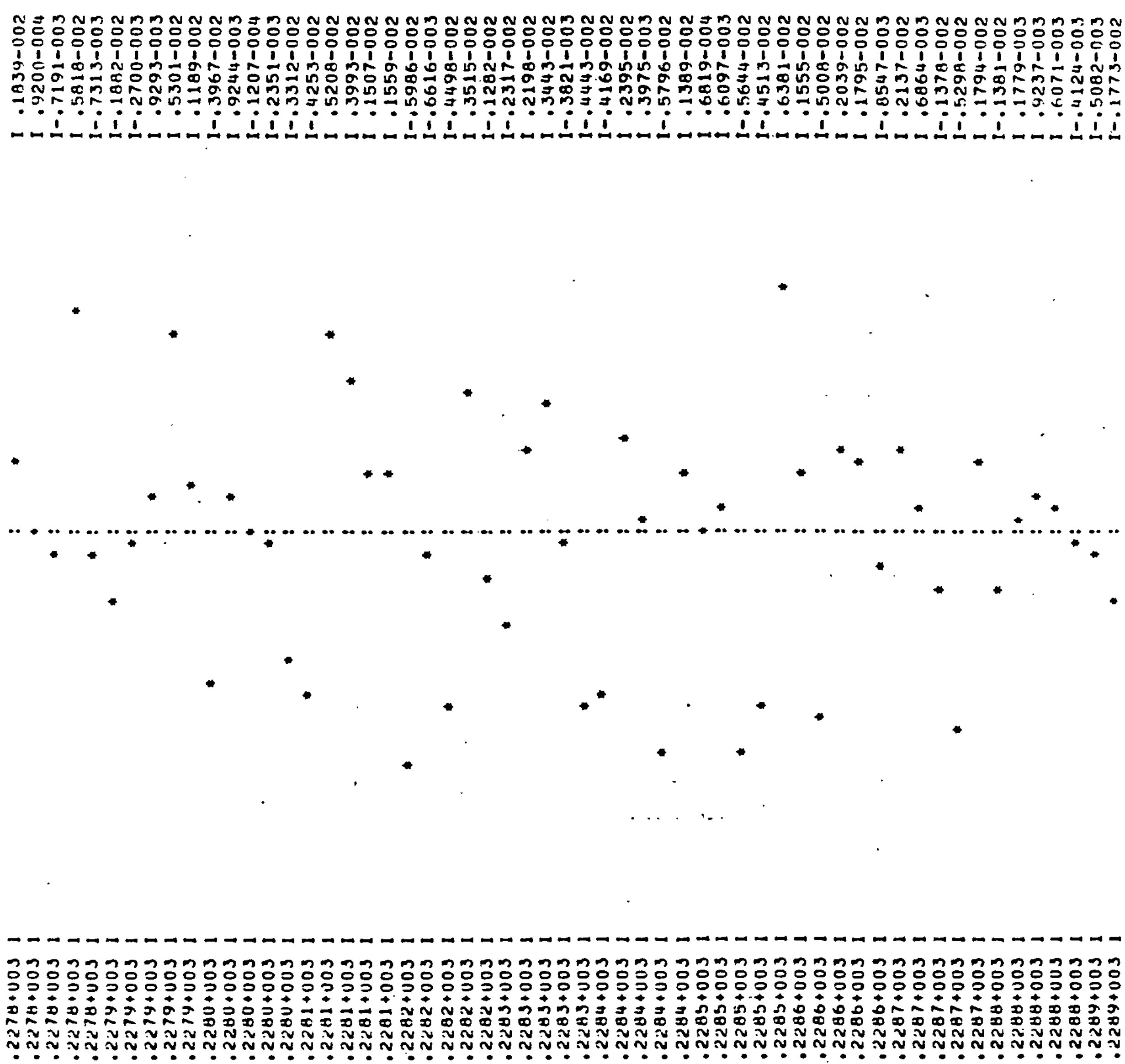
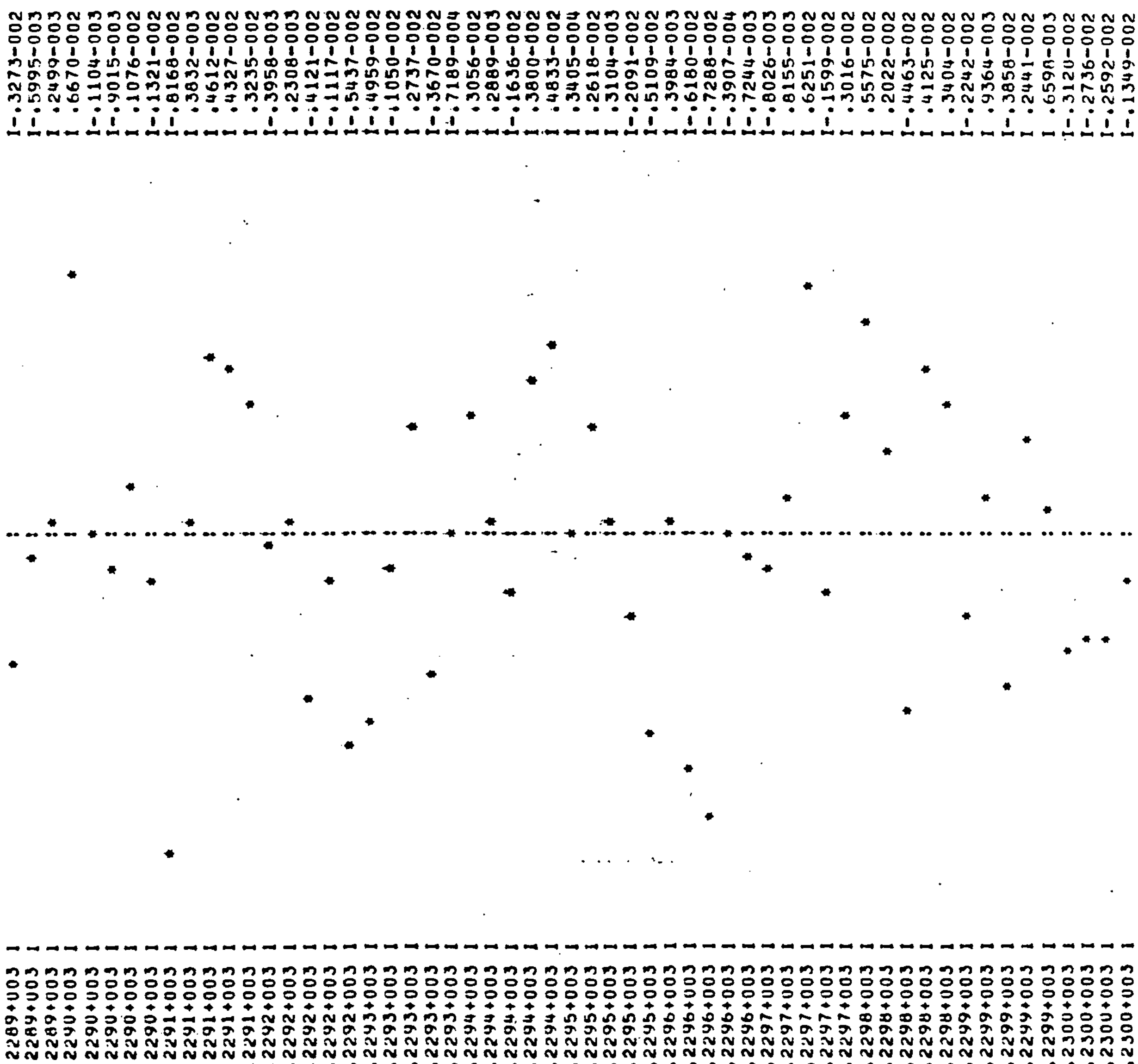


FIGURE F109



.2289+003 I-.3273-002
.2289+003 I-.5995-003
.2289+003 I .2499-003
.2290+003 I .6670-002
.2290+003 I-.1104-003
.2290+003 I-.9015-003
.2290+003 I .1076-002
.2290+003 I-.1321-002
.2291+003 I-.8168-002
.2291+003 I .3832-003
.2291+003 I .4612-002
.2291+003 I .4327-002
.2291+003 I .3235-002
.2292+003 I-.3958-003
.2292+003 I .2308-003
.2292+003 I-.4121-002
.2292+003 I-.1117-002
.2292+003 I-.5437-002
.2293+003 I-.4959-002
.2293+003 I-.1050-002
.2293+003 I .2737-002
.2293+003 I-.3670-002
.2293+003 I-.7189-004
.2294+003 I .3056-002
.2294+003 I .2889-003
.2294+003 I-.1636-002
.2294+003 I .3800-002
.2294+003 I .4833-002
.2295+003 I .3405-004
.2295+003 I .2618-002
.2295+003 I .3104-003
.2295+003 I-.2091-002
.2295+003 I-.5109-002
.2296+003 I .3984-003
.2296+003 I-.6180-002
.2296+003 I-.7288-002
.2296+003 I-.3907-004
.2296+003 I-.7244-003
.2297+003 I-.8026-003
.2297+003 I .8155-003
.2297+003 I .6251-002
.2297+003 I-.1599-002
.2297+003 I .3016-002
.2298+003 I .5575-002
.2298+003 I .2022-002
.2298+003 I-.4463-002
.2298+003 I .4125-002
.2298+003 I .3404-002
.2299+003 I-.2242-002
.2299+003 I .9364-003
.2299+003 I-.3858-002
.2299+003 I .2441-002
.2299+003 I .6598-003
.2300+003 I-.3120-002
.2300+003 I-.2736-002
.2300+003 I-.2592-002
.2300+003 I-.1349-002

FIGURE F110

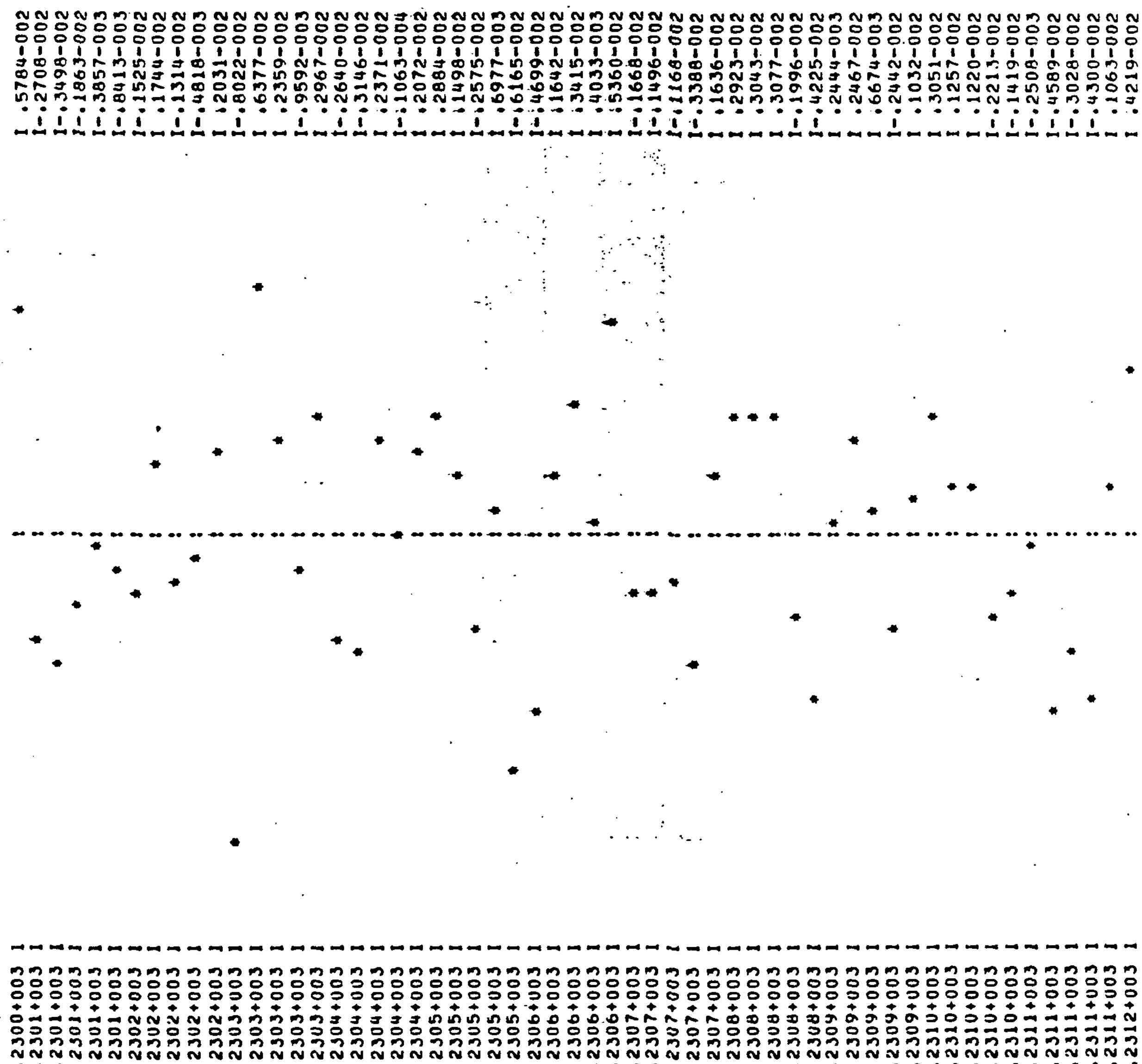

.5784-002
-.2708-002
-.3498-002
-.1863-002
-.3857-003
-.8413-003
-.1525-002
.1744-002
-.1314-002
-.4818-003
.2031-002
-.8022-002
.6377-002
.2359-002
-.9592-003
.2967-002
-.2640-002
-.3146-002
.2371-002
-.1063-004
.2072-002
.2884-002
.1498-002
-.2575-002
.6977-003
-.6165-002
-.4699-002
.1642-002
.3415-002
.4033-003
.5360-002
-.1668-002
-.1496-002
-.1168-002
-.3388-002
.1636-002
.2923-002
.3043-002
.3077-002
-.1996-002
-.4225-002
.2444-003
.2467-002
.6674-003
-.2442-002
.1032-002
.3051-002
.1257-002
.1220-002
-.2213-002
-.1419-002
-.2508-003
-.4589-002
-.3028-002
-.4300-002
.1063-002
.4219-002

FIGURE F111

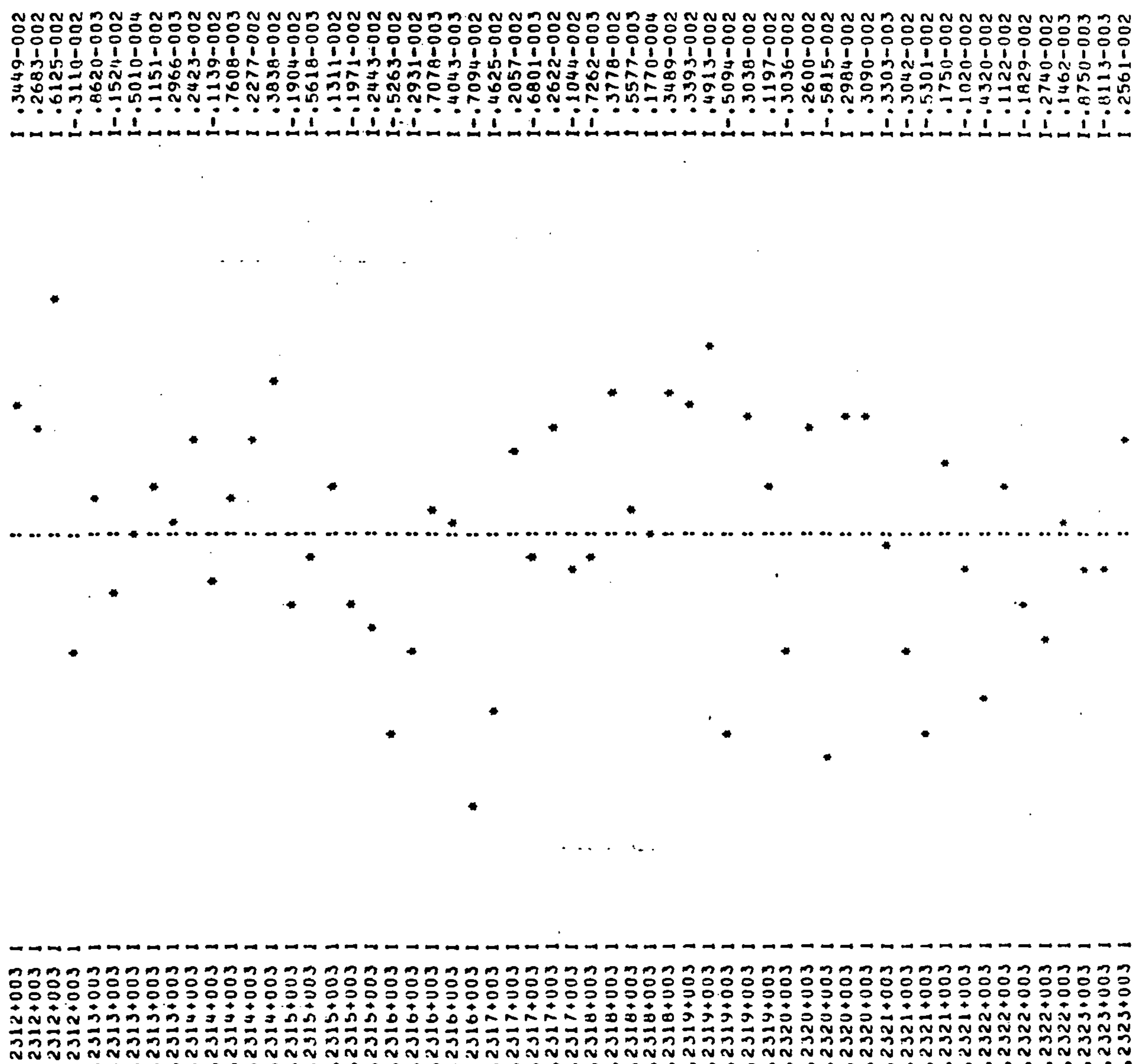
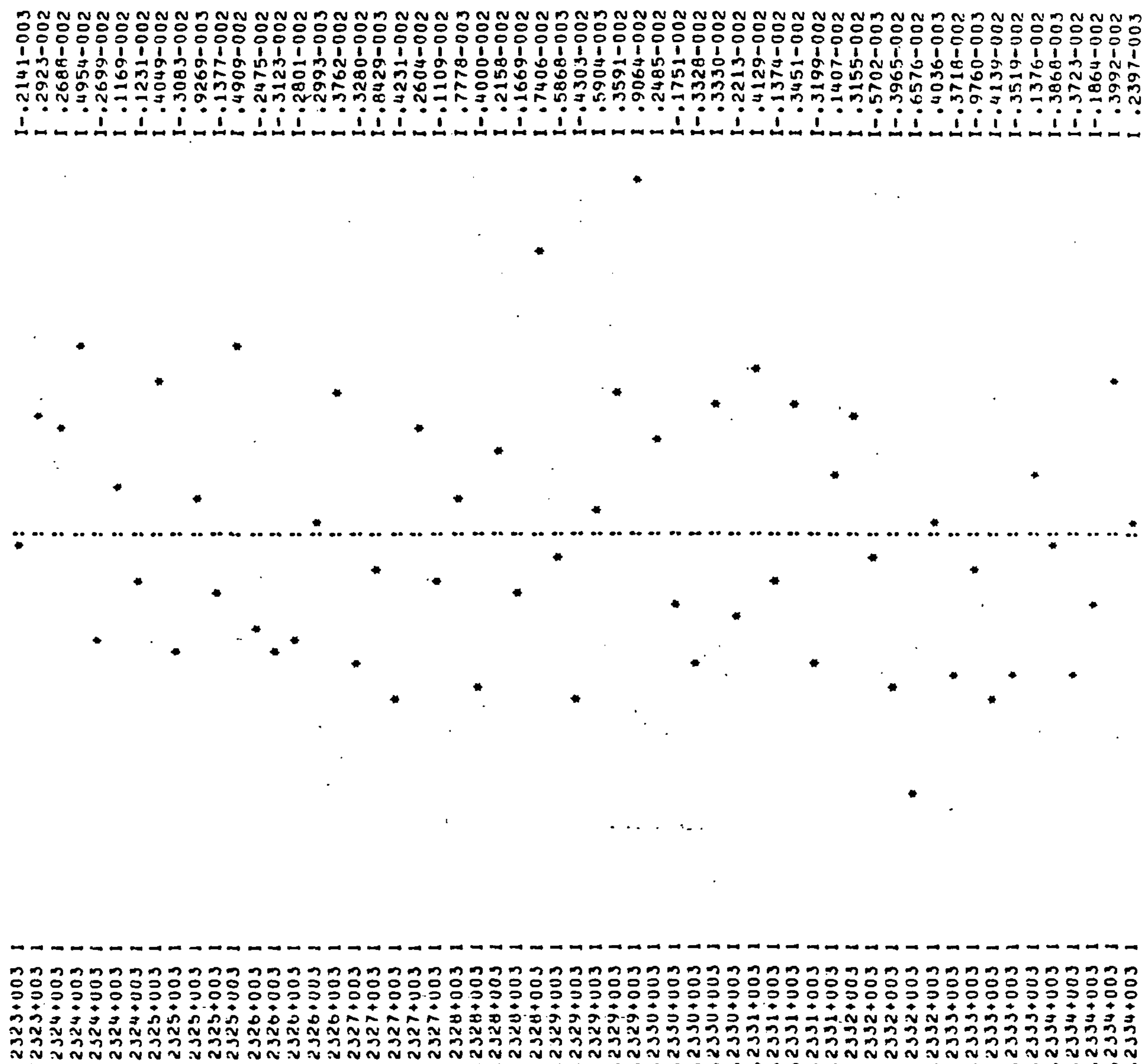


FIGURE F112


I-.2141-003
I .2923-002
I .2688-002
I .4954-002
I-.2699-002
I .1169-002
I-.1231-002
I .4049-002
I-.3083-002
I .9269-003
I-.1377-002
I .4909-002
I-.2475-002
I-.3123-002
I-.2801-002
I .2993-003
I .3762-002
I-.3280-002
I-.8429-003
I-.4231-002
I .2604-002
I-.1109-002
I .7778-003
I-.4000-002
I .2158-002
I-.1669-002
I .7406-002
I-.5868-003
I-.4303-002
I .5904-003
I .3591-002
I .9064-002
I .2485-002
I-.1751-002
I-.3328-002
I .3330-002
I-.2213-002
I .4129-002
I-.1374-002
I .3451-002
I-.3199-002
I .1407-002
I .3155-002
I-.5702-003
I-.3965-002
I-.6576-002
I .4036-003
I-.3718-002
I-.9760-003
I-.4139-002
I-.3519-002
I .1376-002
I-.3868-003
I-.3723-002
I-.1864-002
I .3992-002
I .2397-003
.2323+003 I
.2323+003 I
.2324+003 I
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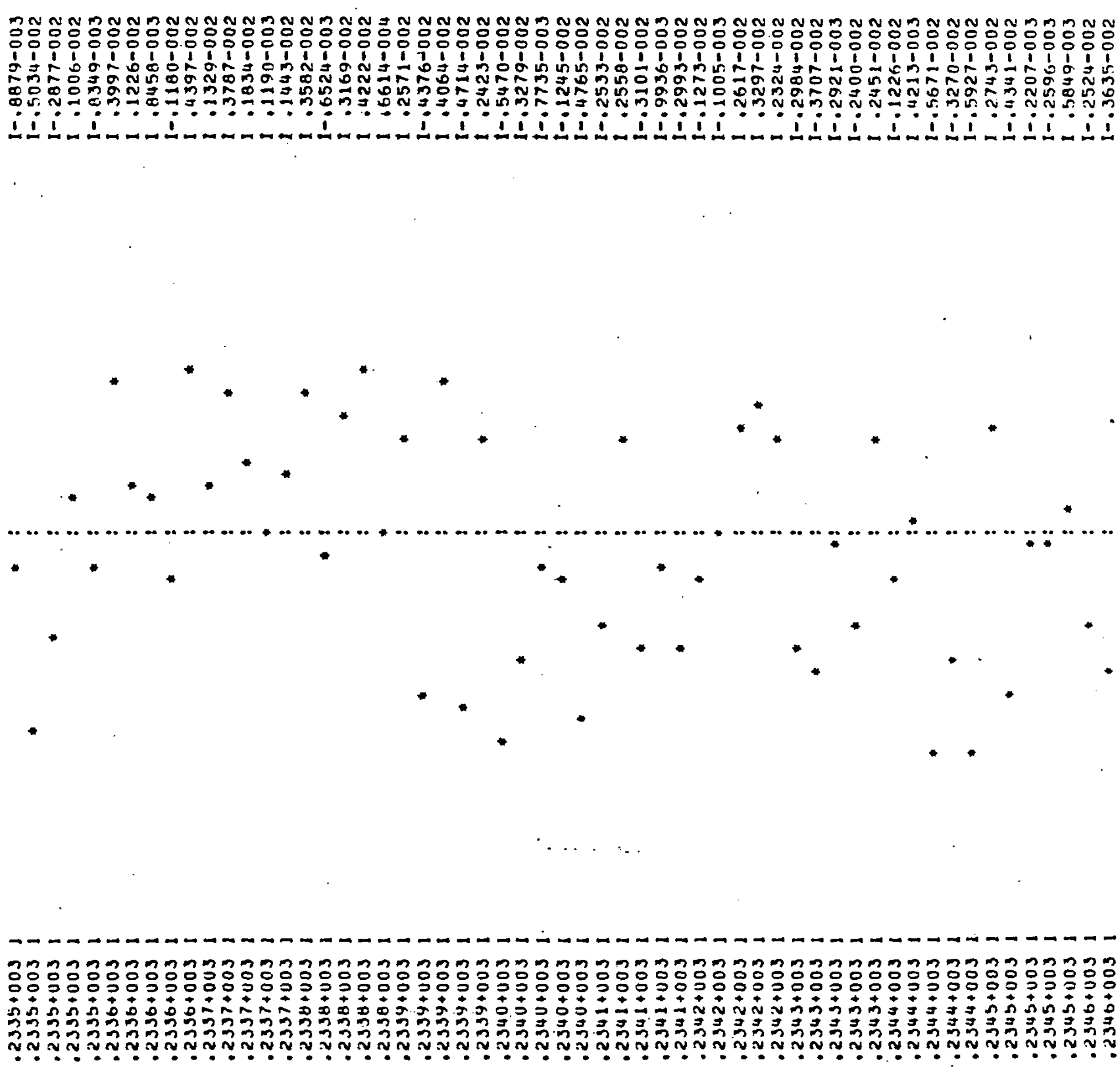
.2334+003 I
.2334+003 I
.2334+003 I
.2334+003 I

FIGURE F113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.2335+003 I-.2877-002
.2335+003 I .1006-002
.2335+003 I-.8349-003
.2336+003 I .3997-002
.2336+003 I .1226-002
.2336+003 I .8458-003
.2336+003 I-.1180-002
.2336+003 I .4397-002
.2337+003 I .1329-002
.2337+003 I .3787-002
.2337+003 I .1834-002
.2337+003 I .1190-003
.2337+003 I .1443-002
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.2338+003 I-.6524-003
.2338+003 I .3169-002
.2338+003 I .4222-002
.2338+003 I .6614-004
.2339+003 I .2571-002
.2339+003 I-.4376-002
.2339+003 I .4064-002
.2339+003 I-.4714-002
.2339+003 I .2423-002
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.2340+003 I-.3279-002
.2340+003 I-.7735-003
.2340+003 I-.1245-002
.2340+003 I-.4765-002
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.2341+003 I .2558-002
.2341+003 I-.3101-002
.2341+003 I-.9936-003
.2341+003 I-.2993-002
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.2342+003 I-.1005-003
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.2342+003 I .2324-002
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.2343+003 I-.3707-002
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.2343+003 I-.2400-002
.2343+003 I .2451-002
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.2344+003 I .4213-003
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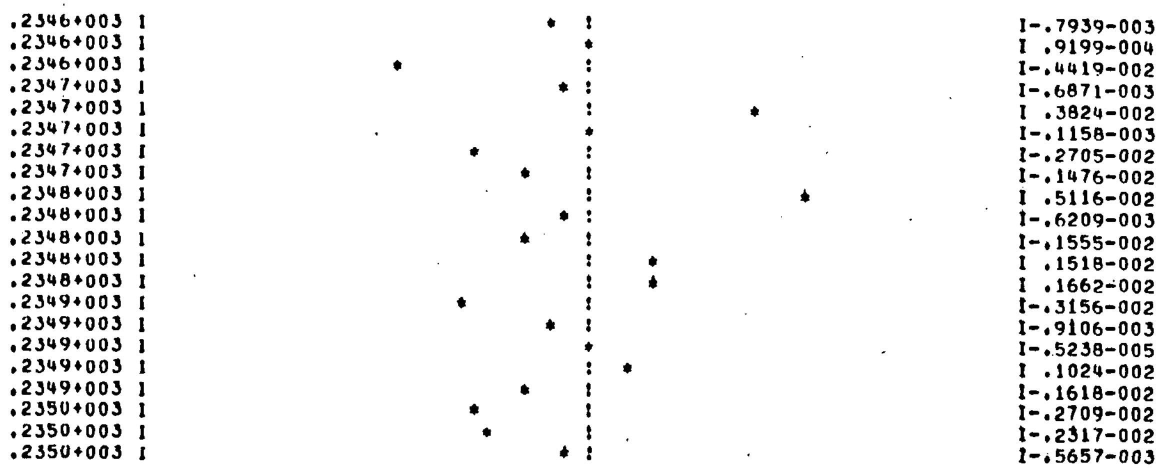
.2344+003 I-.3270-002
.2344+003 I-.5927-002
.2345+003 I .2743-002
.2345+003 I-.4341-002
.2345+003 I-.2207-003
.2345+003 I-.2596-003
.2345+003 I .5849-003
.2346+003 I-.2524-002
.2346+003 I-.3635-002

FIGURE F114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.2349+003 I
.2349+003 I
.2350+003 I
.2350+003 I
.2350+003 I
I-.7939-003
I .9199-004
I-.4419-002
I-.6871-003
I .3824-002
I-.1158-003
I-.2705-002
I-.1476-002
I .5116-002
I-.6209-003
I-.1555-002
I .1518-002
I .1662-002
I-.3156-002
I-.9106-003
I-.5238-005
I .1024-002
I-.1618-002
I-.2709-002
I-.2317-002
I-.5657-003

FIGURE F115

```
                        DATA FOR THE Z-AXIS
CURVE 'A' IS A PLOT OF  BASE  VERSUS  TIME
CURVE 'B' IS A PLOT OF  TIP   VERSUS  TIME

    MINIMUM VALUE                                  MAXIMUM VALUE
     -.9541-004                                    .1971+000
 TIME      I                                                    I     BASE      TIP
.2200+003 B                                                     I-.6851-006-.6851-006
.2200+003 B                                                     I-.3728-004-.3728-004
.2201+003 B                                                     I-.7481-004-.7481-004
.2201+003 B                                                     I-.9291-004-.9291-004
.2201+003 B                                                     I-.9541-004-.9541-004
.2201+003 B                                                     I-.5586-004-.5586-004
.2201+003 B                                                     I .6770-004 .6770-004
.2202+003 B                                                     I .2027-003 .2027-003
.2202+003 B                                                     I .4353-003 .4353-003
.2202+003 B                                                     I .7140-003 .7140-003
.2202+003 B                                                     I .1003-002 .1003-002
.2202+003 B                                                     I .1316-002 .1316-002
.2203+003 B                                                     I .1645-002 .1645-002
.2203+003 B                                                     I .2003-002 .2003-002
.2203+003 B                                                     I .2466-002 .2466-002
.2203+003 :B                                                    I .2987-002 .2987-002
.2203+003 :B                                                    I .3519-002 .3519-002
.2204+003 :B                                                    I .4085-002 .4085-002
.2204+003 :B                                                    I .4693-002 .4693-002
.2204+003 :B                                                    I .5290-002 .5290-002
.2204+003 : B                                                   I .5862-002 .5862-002
.2204+003 : B                                                   I .6419-002 .6419-002
.2205+003 : B                                                   I .7006-002 .7006-002
.2205+003 : B                                                   I .7679-002 .7679-002
.2205+003 :  B                                                  I .8409-002 .8409-002
.2205+003 :  B                                                  I .9093-002 .9093-002
.2205+003 :  B                                                  I .9752-002 .9752-002
.2206+003 :  B                                                  I .1039-001 .1039-001
.2206+003 :  B                                                  I .1096-001 .1096-001
.2206+003 :   B                                                 I .1160-001 .1160-001
.2206+003 :   B                                                 I .1228-001 .1228-001
.2206+003 :   B                                                 I .1298-001 .1298-001
.2207+003 :   B                                                 I .1366-001 .1366-001
.2207+003 :    B                                                I .1433-001 .1433-001
.2207+003 :    B                                                I .1502-001 .1502-001
.2207+003 :    B                                                I .1571-001 .1571-001
.2207+003 :    B                                                I .1638-001 .1638-001
.2208+003 :     B                                               I .1705-001 .1705-001
.2208+003 :     B                                               I .1768-001 .1768-001
.2208+003 :     B                                               I .1828-001 .1828-001
.2208+003 :     B                                               I .1891-001 .1891-001
.2208+003 :     B                                               I .1954-001 .1954-001
.2209+003 :      B                                              I .2015-001 .2015-001
```

FIGURE F116

.2209+003	.2072-001	.2072-001
.2209+003	.2127-001	.2127-001
.2209+003	.2183-001	.2183-001
.2209+003	.2243-001	.2243-001
.2210+003	.2302-001	.2302-001
.2210+003	.2358-001	.2358-001
.2210+003	.2412-001	.2412-001
.2210+003	.2466-001	.2466-001
.2210+003	.2521-001	.2521-001
.2211+003	.2574-001	.2574-001
.2211+003	.2630-001	.2630-001
.2211+003	.2692-001	.2692-001
.2211+003	.2751-001	.2751-001
.2211+003	.2813-001	.2813-001
.2212+003	.2875-001	.2875-001
.2212+003	.2938-001	.2938-001
.2212+003	.3000-001	.3000-001
.2212+003	.3060-001	.3060-001
.2212+003	.3121-001	.3121-001
.2213+003	.3186-001	.3186-001
.2213+003	.3248-001	.3248-001
.2213+003	.3305-001	.3305-001
.2213+003	.3359-001	.3359-001
.2213+003	.3411-001	.3411-001
.2214+003	.3461-001	.3461-001
.2214+003	.3505-001	.3505-001
.2214+003	.3547-001	.3547-001
.2214+003	.3593-001	.3593-001
.2214+003	.3640-001	.3640-001
.2215+003	.3689-001	.3689-001
.2215+003	.3740-001	.3740-001
.2215+003	.3793-001	.3793-001
.2215+003	.3846-001	.3846-001
.2215+003	.3902-001	.3902-001
.2216+003	.3960-001	.3960-001
.2216+003	.4020-001	.4020-001
.2216+003	.4080-001	.4080-001
.2216+003	.4141-001	.4141-001
.2216+003	.4200-001	.4200-001
.2217+003	.4259-001	.4259-001
.2217+003	.4321-001	.4321-001
.2217+003	.4386-001	.4386-001
.2217+003	.4450-001	.4450-001
.2217+003	.4521-001	.4521-001
.2218+003	.4592-001	.4592-001
.2218+003	.4661-001	.4661-001
.2218+003	.4729-001	.4729-001
.2218+003	.4802-001	.4802-001
.2218+003	.4877-001	.4877-001
.2219+003	.4945-001	.4945-001
.2219+003	.5007-001	.5007-001
.2219+003	.5068-001	.5068-001
.2219+003	.5129-001	.5129-001
.2219+003	.5193-001	.5193-001
.2220+003	.5255-001	.5255-001
.2220+003	.5317-001	.5317-001
.2220+003	.5379-001	.5379-001

FIGURE F117

```
.2220+003 :  B                  I .5442-001 .5442-001
.2220+003 :  B                  I .5503-001 .5503-001
.2221+003 :  B                  I .5562-001 .5562-001
.2221+003 :  B                  I .5623-001 .5623-001
.2221+003 :   B                 I .5687-001 .5687-001
.2221+003 :   B                 I .5754-001 .5754-001
.2221+003 :   B                 I .5818-001 .5818-001
.2222+003 :   B                 I .5879-001 .5879-001
.2222+003 :    B                I .5935-001 .5935-001
.2222+003 :    B                I .5993-001 .5993-001
.2222+003 :    B                I .6047-001 .6047-001
.2222+003 :    B                I .6106-001 .6106-001
.2223+003 :    B                I .6168-001 .6168-001
.2223+003 :     B               I .6229-001 .6229-001
.2223+003 :     B               I .6285-001 .6285-001
.2223+003 :     B               I .6340-001 .6340-001
.2223+003 :     B               I .6388-001 .6388-001
.2224+003 :     B               I .6436-001 .6436-001
.2224+003 :      B              I .6475-001 .6475-001
.2224+003 :      B              I .6512-001 .6512-001
.2224+003 :      B              I .6548-001 .6548-001
.2224+003 :      B              I .6579-001 .6579-001
.2225+003 :      B              I .6606-001 .6606-001
.2225+003 :      B              I .6630-001 .6630-001
.2225+003 :      B              I .6653-001 .6653-001
.2225+003 :      B              I .6680-001 .6680-001
.2225+003 :      B              I .6708-001 .6708-001
.2226+003 :      B              I .6739-001 .6739-001
.2226+003 :       B             I .6770-001 .6770-001
.2226+003 :       B             I .6798-001 .6798-001
.2226+003 :       B             I .6829-001 .6829-001
.2226+003 :       B             I .6860-001 .6860-001
.2227+003 :       B             I .6893-001 .6893-001
.2227+003 :       B             I .6922-001 .6922-001
.2227+003 :       B             I .6946-001 .6946-001
.2227+003 :       B             I .6968-001 .6968-001
.2227+003 :       B             I .6995-001 .6995-001
.2228+003 :       B             I .7020-001 .7020-001
.2228+003 :        B            I .7041-001 .7041-001
.2228+003 :        B            I .7067-001 .7067-001
.2228+003 :        B            I .7094-001 .7094-001
.2228+003 :        B            I .7122-001 .7122-001
.2229+003 :        B            I .7146-001 .7146-001
.2229+003 :        B            I .7167-001 .7167-001
.2229+003 :        B            I .7184-001 .7184-001
.2229+003 :        B            I .7196-001 .7196-001
.2229+003 :        B            I .7208-001 .7208-001
.2230+003 :        B            I .7217-001 .7217-001
.2230+003 :        B            I .7222-001 .7222-001
.2230+003 :        B            I .7225-001 .7225-001
.2230+003 :        B            I .7223-001 .7223-001
.2230+003 :        B            I .7224-001 .7224-001
.2231+003 :        B            I .7225-001 .7225-001
.2231+003 :        B            I .7228-001 .7228-001
.2231+003 :        B            I .7230-001 .7230-001
.2231+003 :        B            I .7232-001 .7232-001
.2231+003 :        B            I .7233-001 .7233-001
```

FIGURE F118

.2232+003	:	B	I	.7234-001	.7234-001
.2232+003	:	B	I	.7231-001	.7231-001
.2232+003	:	B	I	.7232-001	.7232-001
.2232+003	:	B	I	.7236-001	.7236-001
.2232+003	:	B	I	.7243-001	.7243-001
.2233+003	:	B	I	.7250-001	.7250-001
.2233+003	:	B	I	.7253-001	.7253-001
.2233+003	:	B	I	.7249-001	.7249-001
.2233+003	:	B	I	.7239-001	.7239-001
.2233+003	:	B	I	.7229-001	.7229-001
.2234+003	:	B	I	.7214-001	.7214-001
.2234+003	:	B	I	.7197-001	.7197-001
.2234+003	:	B	I	.7176-001	.7176-001
.2234+003	:	B	I	.7154-001	.7154-001
.2234+003	:	B	I	.7134-001	.7134-001
.2235+003	:	B	I	.7117-001	.7117-001
.2235+003	:	B	I	.7100-001	.7100-001
.2235+003	:	B	I	.7083-001	.7083-001
.2235+003	:	B	I	.7064-001	.7064-001
.2235+003	:	B	I	.7048-001	.7048-001
.2236+003	:	B	I	.7038-001	.7038-001
.2236+003	:	B	I	.7027-001	.7027-001
.2236+003	:	B	I	.7014-001	.7014-001
.2236+003	:	B	I	.7003-001	.7003-001
.2236+003	:	B	I	.6993-001	.6993-001
.2237+003	:	B	I	.6984-001	.6984-001
.2237+003	:	B	I	.6978-001	.6978-001
.2237+003	:	B	I	.6978-001	.6978-001
.2237+003	:	B	I	.6977-001	.6977-001
.2237+003	:	B	I	.6975-001	.6975-001
.2238+003	:	B	I	.6969-001	.6969-001
.2238+003	:	B	I	.6964-001	.6964-001
.2238+003	:	B	I	.6960-001	.6960-001
.2238+003	:	B	I	.6951-001	.6951-001
.2238+003	:	B	I	.6945-001	.6945-001
.2239+003	:	B	I	.6945-001	.6945-001
.2239+003	:	B	I	.6944-001	.6944-001
.2239+003	:	B	I	.6940-001	.6940-001
.2239+003	:	B	I	.6939-001	.6939-001
.2239+003	:	B	I	.6941-001	.6941-001
.2240+003	:	B	I	.6941-001	.6941-001
.2240+003	:	B	I	.6942-001	.6942-001
.2240+003	:	B	I	.6942-001	.6942-001
.2240+003	:	B	I	.6949-001	.6949-001
.2240+003	:	B	I	.6956-001	.6956-001
.2241+003	:	B	I	.6960-001	.6960-001
.2241+003	:	B	I	.6965-001	.6965-001
.2241+003	:	B	I	.6972-001	.6972-001
.2241+003	:	B	I	.6977-001	.6977-001
.2241+003	:	B	I	.6985-001	.6985-001
.2242+003	:	B	I	.6992-001	.6992-001
.2242+003	:	B	I	.7003-001	.7003-001
.2242+003	:	B	I	.7015-001	.7015-001
.2242+003	:	B	I	.7033-001	.7033-001
.2242+003	:	B	I	.7052-001	.7052-001
.2243+003	:	B	I	.7075-001	.7075-001
.2243+003	:	B	I	.7103-001	.7103-001

FIGURE F119

.2243+003	.7132-001	.7132-001
.2243+003	.7169-001	.7169-001
.2243+003	.7209-001	.7209-001
.2244+003	.7246-001	.7246-001
.2244+003	.7282-001	.7282-001
.2244+003	.7327-001	.7327-001
.2244+003	.7371-001	.7371-001
.2244+003	.7414-001	.7414-001
.2245+003	.7460-001	.7460-001
.2245+003	.7507-001	.7507-001
.2245+003	.7549-001	.7549-001
.2245+003	.7589-001	.7589-001
.2245+003	.7628-001	.7628-001
.2246+003	.7671-001	.7671-001
.2246+003	.7713-001	.7713-001
.2246+003	.7756-001	.7756-001
.2246+003	.7797-001	.7797-001
.2246+003	.7837-001	.7837-001
.2247+003	.7875-001	.7875-001
.2247+003	.7912-001	.7912-001
.2247+003	.7953-001	.7953-001
.2247+003	.7990-001	.7990-001
.2247+003	.8025-001	.8025-001
.2248+003	.8064-001	.8064-001
.2248+003	.8107-001	.8107-001
.2248+003	.8147-001	.8147-001
.2248+003	.8181-001	.8181-001
.2248+003	.8217-001	.8217-001
.2249+003	.8257-001	.8257-001
.2249+003	.8293-001	.8293-001
.2249+003	.8332-001	.8332-001
.2249+003	.8364-001	.8364-001
.2249+003	.8397-001	.8397-001
.2250+003	.8431-001	.8431-001
.2250+003	.8462-001	.8462-001
.2250+003	.8489-001	.8489-001
.2250+003	.8514-001	.8514-001
.2250+003	.8540-001	.8540-001
.2251+003	.8568-001	.8568-001
.2251+003	.8592-001	.8592-001
.2251+003	.8614-001	.8614-001
.2251+003	.8638-001	.8638-001
.2251+003	.8659-001	.8659-001
.2252+003	.8678-001	.8678-001
.2252+003	.8700-001	.8700-001
.2252+003	.8722-001	.8722-001
.2252+003	.8745-001	.8745-001
.2252+003	.8775-001	.8775-001
.2253+003	.8808-001	.8808-001
.2253+003	.8841-001	.8841-001
.2253+003	.8875-001	.8875-001
.2253+003	.8910-001	.8910-001
.2253+003	.8945-001	.8945-001
.2254+003	.8977-001	.8977-001
.2254+003	.9006-001	.9006-001
.2254+003	.9041-001	.9041-001
.2254+003	.9075-001	.9075-001

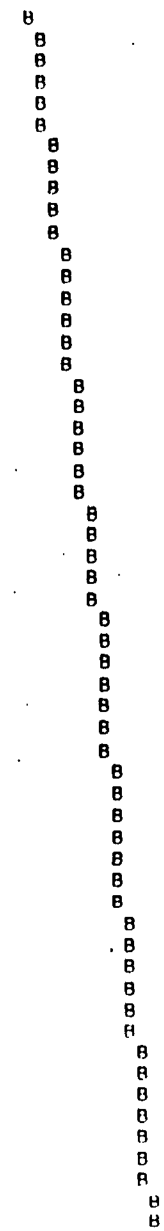
FIGURE F120

.2254+003	:	B	I	.9104-001	.9104-001
.2255+003	:	B	I	.9127-001	.9127-001
.2255+003	:	B	I	.9148-001	.9148-001
.2255+003	:	B	I	.9170-001	.9170-001
.2255+003	:	B	I	.9190-001	.9190-001
.2255+003	:	B	I	.9205-001	.9205-001
.2256+003	:	B	I	.9221-001	.9221-001
.2256+003	:	B	I	.9239-001	.9239-001
.2256+003	:	B	I	.9255-001	.9255-001
.2256+003	:	B	I	.9275-001	.9275-001
.2256+003	:	B	I	.9290-001	.9290-001
.2257+003	:	B	I	.9302-001	.9302-001
.2257+003	:	B	I	.9312-001	.9312-001
.2257+003	:	B	I	.9318-001	.9318-001
.2257+003	:	B	I	.9324-001	.9324-001
.2257+003	:	B	I	.9331-001	.9331-001
.2258+003	:	B	I	.9336-001	.9336-001
.2258+003	:	B	I	.9338-001	.9338-001
.2258+003	:	B	I	.9342-001	.9342-001
.2258+003	:	B	I	.9349-001	.9349-001
.2258+003	:	B	I	.9355-001	.9355-001
.2259+003	:	B	I	.9358-001	.9358-001
.2259+003	:	B	I	.9353-001	.9353-001
.2259+003	:	B	I	.9350-001	.9350-001
.2259+003	:	B	I	.9352-001	.9352-001
.2259+003	:	B	I	.9349-001	.9349-001
.2260+003	:	B	I	.9343-001	.9343-001
.2260+003	:	B	I	.9336-001	.9336-001
.2260+003	:	B	I	.9335-001	.9335-001
.2260+003	:	B	I	.9336-001	.9336-001
.2260+003	:	B	I	.9341-001	.9341-001
.2261+003	:	B	I	.9348-001	.9348-001
.2261+003	:	B	I	.9356-001	.9356-001
.2261+003	:	B	I	.9365-001	.9365-001
.2261+003	:	B	I	.9370-001	.9370-001
.2261+003	:	B	I	.9373-001	.9373-001
.2262+003	:	B	I	.9376-001	.9376-001
.2262+003	:	B	I	.9383-001	.9383-001
.2262+003	:	B	I	.9397-001	.9397-001
.2262+003	:	B	I	.9420-001	.9420-001
.2262+003	:	B	I	.9441-001	.9441-001
.2263+003	:	B	I	.9460-001	.9460-001
.2263+003	:	B	I	.9475-001	.9475-001
.2263+003	:	B	I	.9493-001	.9493-001
.2263+003	:	B	I	.9517-001	.9517-001
.2263+003	:	B	I	.9540-001	.9540-001
.2264+003	:	B	I	.9563-001	.9563-001
.2264+003	:	B	I	.9589-001	.9589-001
.2264+003	:	B	I	.9619-001	.9619-001
.2264+003	:	B	I	.9653-001	.9653-001
.2264+003	:	B	I	.9695-001	.9695-001
.2265+003	:	B	I	.9739-001	.9739-001
.2265+003	:	B	I	.9781-001	.9781-001
.2265+003	:	B	I	.9829-001	.9829-001
.2265+003	:	B	I	.9884-001	.9884-001
.2265+003	:	B	I	.9940-001	.9940-001
.2266+003	:	B	I	.9994-001	.9994-001

FIGURE F121

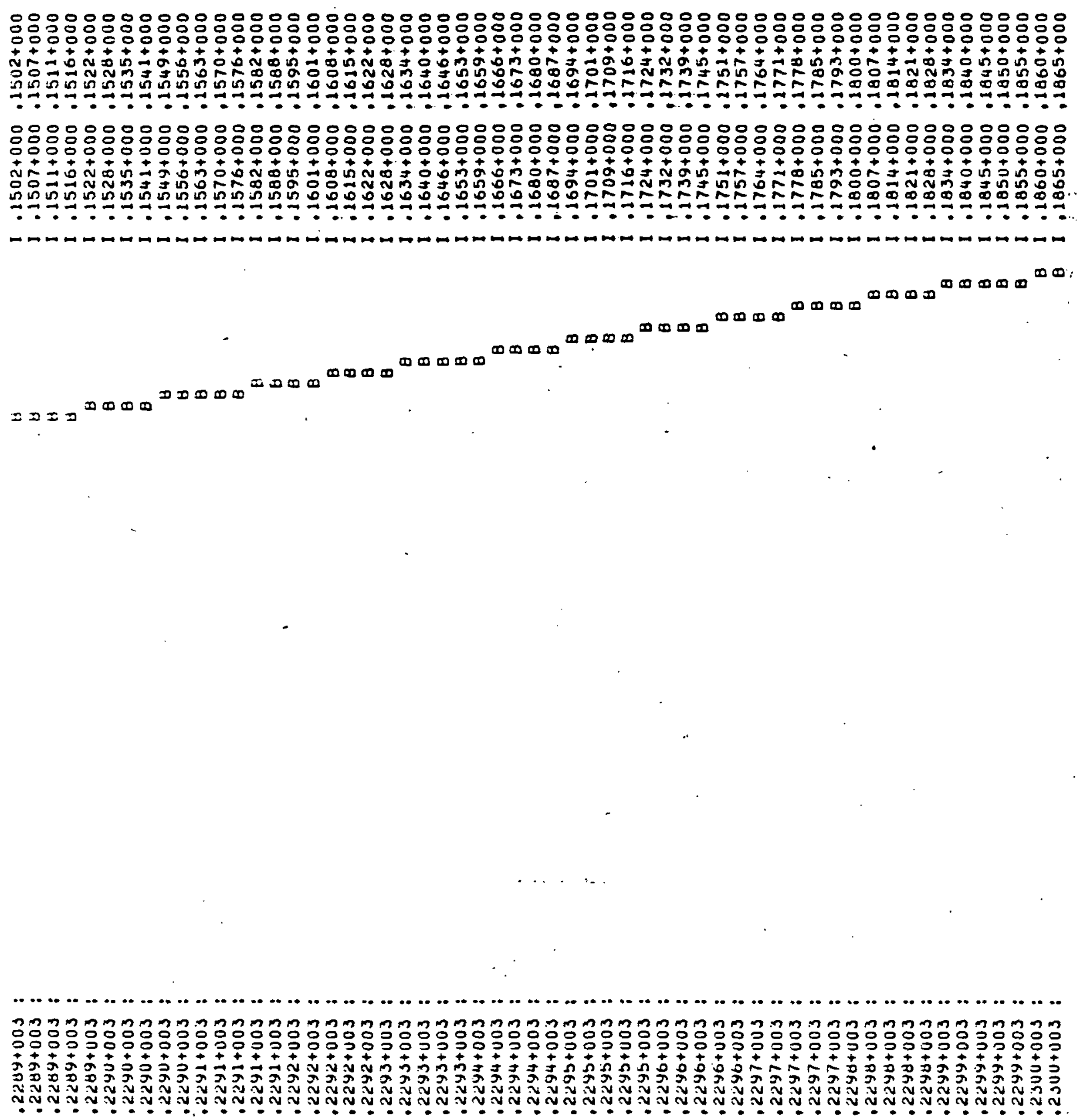
```
.2266+003 :                              B                            I .1004+000 .1004+000
.2266+003 :                              B                            I .1008+000 .1008+000
.2266+003 :                              B                            I .1012+000 .1012+000
.2266+003 :                               B                           I .1016+000 .1016+000
.2267+003 :                               B                           I .1019+000 .1019+000
.2267+003 :                               B                           I .1022+000 .1022+000
.2267+003 :                               B                           I .1026+000 .1026+000
.2267+003 :                               B                           I .1030+000 .1030+000
.2267+003 :                               B                           I .1034+000 .1034+000
.2268+003 :                               B                           I .1038+000 .1038+000
.2268+003 :                                B                          I .1043+000 .1043+000
.2268+003 :                                B                          I .1048+000 .1048+000
.2268+003 :                                B                          I .1052+000 .1052+000
.2268+003 :                                B                          I .1057+000 .1057+000
.2269+003 :                                B                          I .1061+000 .1061+000
.2269+003 :                                B                          I .1066+000 .1066+000
.2269+003 :                                 B                         I .1070+000 .1070+000
.2269+003 :                                 B                         I .1075+000 .1075+000
.2269+003 :                                 B                         I .1079+000 .1079+000
.2270+003 :                                 B                         I .1083+000 .1083+000
.2270+003 :                                 B                         I .1087+000 .1087+000
.2270+003 :                                 B                         I .1091+000 .1091+000
.2270+003 :                                 B                         I .1095+000 .1095+000
.2270+003 :                                  B                        I .1099+000 .1099+000
.2271+003 :                                  B                        I .1104+000 .1104+000
.2271+003 :                                  B                        I .1108+000 .1108+000
.2271+003 :                                  B                        I .1113+000 .1113+000
.2271+003 :                                  B                        I .1116+000 .1116+000
.2271+003 :                                  B                        I .1120+000 .1120+000
.2272+003 :                                  B                        I .1123+000 .1123+000
.2272+003 :                                   B                       I .1127+000 .1127+000
.2272+003 :                                   B                       I .1131+000 .1131+000
.2272+003 :                                   B                       I .1135+000 .1135+000
.2272+003 :                                   B                       I .1140+000 .1140+000
.2273+003 :                                   B                       I .1145+000 .1145+000
.2273+003 :                                   B                       I .1150+000 .1150+000
.2273+003 :                                    B                      I .1154+000 .1154+000
.2273+003 :                                    B                      I .1159+000 .1159+000
.2273+003 :                                    B                      I .1162+000 .1162+000
.2274+003 :                                    B                      I .1166+000 .1166+000
.2274+003 :                                    B                      I .1170+000 .1170+000
.2274+003 :                                    B                      I .1174+000 .1174+000
.2274+003 :                                    B                      I .1178+000 .1178+000
.2274+003 :                                    B                      I .1182+000 .1182+000
.2275+003 :                                     B                     I .1185+000 .1185+000
.2275+003 :                                     B                     I .1190+000 .1190+000
.2275+003 :                                     B                     I .1193+000 .1193+000
.2275+003 :                                     B                     I .1197+000 .1197+000
.2275+003 :                                     B                     I .1201+000 .1201+000
.2276+003 :                                     B                     I .1205+000 .1205+000
.2276+003 :                                     B                     I .1209+000 .1209+000
.2276+003 :                                      B                    I .1213+000 .1213+000
.2276+003 :                                      B                    I .1217+000 .1217+000
.2276+003 :                                      B                    I .1221+000 .1221+000
.2277+003 :                                      B                    I .1225+000 .1225+000
.2277+003 :                                      B                    I .1230+000 .1230+000
.2277+003 :                                      B                    I .1234+000 .1234+000
```

FIGURE F122



.2277+003	.1238+000	.1238+000
.2277+003	.1243+000	.1243+000
.2278+003	.1247+000	.1247+000
.2278+003	.1253+000	.1253+000
.2278+003	.1258+000	.1258+000
.2278+003	.1263+000	.1263+000
.2278+003	.1269+000	.1269+000
.2279+003	.1275+000	.1275+000
.2279+003	.1280+000	.1280+000
.2279+003	.1285+000	.1285+000
.2279+003	.1291+000	.1291+000
.2279+003	.1296+000	.1296+000
.2280+003	.1302+000	.1302+000
.2280+003	.1306+000	.1306+000
.2280+003	.1311+000	.1311+000
.2280+003	.1315+000	.1315+000
.2280+003	.1320+000	.1320+000
.2281+003	.1324+000	.1324+000
.2281+003	.1329+000	.1329+000
.2281+003	.1334+000	.1334+000
.2281+003	.1340+000	.1340+000
.2281+003	.1345+000	.1345+000
.2282+003	.1351+000	.1351+000
.2282+003	.1357+000	.1357+000
.2282+003	.1362+000	.1362+000
.2282+003	.1367+000	.1367+000
.2282+003	.1372+000	.1372+000
.2283+003	.1376+000	.1376+000
.2283+003	.1381+000	.1381+000
.2283+003	.1386+000	.1386+000
.2283+003	.1391+000	.1391+000
.2283+003	.1395+000	.1395+000
.2284+003	.1398+000	.1398+000
.2284+003	.1401+000	.1401+000
.2284+003	.1404+000	.1404+000
.2284+003	.1408+000	.1408+000
.2284+003	.1412+000	.1412+000
.2285+003	.1416+000	.1416+000
.2285+003	.1421+000	.1421+000
.2285+003	.1425+000	.1425+000
.2285+003	.1428+000	.1428+000
.2285+003	.1432+000	.1432+000
.2286+003	.1437+000	.1437+000
.2286+003	.1441+000	.1441+000
.2286+003	.1446+000	.1446+000
.2286+003	.1450+000	.1450+000
.2286+003	.1455+000	.1455+000
.2287+003	.1460+000	.1460+000
.2287+003	.1465+000	.1465+000
.2287+003	.1469+000	.1469+000
.2287+003	.1473+000	.1473+000
.2287+003	.1478+000	.1478+000
.2288+003	.1482+000	.1482+000
.2288+003	.1486+000	.1486+000
.2288+003	.1490+000	.1490+000
.2288+003	.1494+000	.1494+000
.2288+003	.1498+000	.1498+000

FIGURE F123



.2289+003 : B I .1502+000 .1502+000
.2289+003 : B I .1507+000 .1507+000
.2289+003 : B I .1511+000 .1511+000
.2289+003 : B I .1516+000 .1516+000
.2289+003 : B I .1522+000 .1522+000
.2290+003 : B I .1528+000 .1528+000
.2290+003 : B I .1535+000 .1535+000
.2290+003 : B I .1541+000 .1541+000
.2290+003 : B I .1549+000 .1549+000
.2290+003 : B I .1556+000 .1556+000
.2291+003 : B I .1563+000 .1563+000
.2291+003 : B I .1570+000 .1570+000
.2291+003 : B I .1576+000 .1576+000
.2291+003 : B I .1582+000 .1582+000
.2291+003 : B I .1588+000 .1588+000
.2292+003 : B I .1595+000 .1595+000
.2292+003 : B I .1601+000 .1601+000
.2292+003 : B I .1608+000 .1608+000
.2292+003 : B I .1615+000 .1615+000
.2292+003 : B I .1622+000 .1622+000
.2293+003 : B I .1628+000 .1628+000
.2293+003 : B I .1634+000 .1634+000
.2293+003 : B I .1640+000 .1640+000
.2293+003 : B I .1646+000 .1646+000
.2293+003 : B I .1653+000 .1653+000
.2294+003 : B I .1659+000 .1659+000
.2294+003 : B I .1666+000 .1666+000
.2294+003 : B I .1673+000 .1673+000
.2294+003 : B I .1680+000 .1680+000
.2294+003 : B I .1687+000 .1687+000
.2295+003 : B I .1694+000 .1694+000
.2295+003 : B I .1701+000 .1701+000
.2295+003 : B I .1709+000 .1709+000
.2295+003 : B I .1716+000 .1716+000
.2295+003 : B I .1724+000 .1724+000
.2296+003 : B I .1732+000 .1732+000
.2296+003 : B I .1739+000 .1739+000
.2296+003 : B I .1745+000 .1745+000
.2296+003 : B I .1751+000 .1751+000
.2296+003 : B I .1757+000 .1757+000
.2297+003 : B I .1764+000 .1764+000
.2297+003 : B I .1771+000 .1771+000
.2297+003 : B I .1778+000 .1778+000
.2297+003 : B I .1785+000 .1785+000
.2297+003 : B I .1793+000 .1793+000
.2298+003 : B I .1800+000 .1800+000
.2298+003 : B I .1807+000 .1807+000
.2298+003 : B I .1814+000 .1814+000
.2298+003 : B I .1821+000 .1821+000
.2298+003 : B I .1828+000 .1828+000
.2299+003 : B I .1834+000 .1834+000
.2299+003 : B I .1840+000 .1840+000
.2299+003 : B I .1845+000 .1845+000
.2299+003 : B I .1850+000 .1850+000
.2299+003 : B I .1855+000 .1855+000
.2300+003 : B I .1860+000 .1860+000
.2300+003 : B I .1865+000 .1865+000

FIGURE F124

```
.2300+003 :                                              B  I .1870+000 .1870+000
.2300+003 :                                              B  I .1875+000 .1875+000
.2300+003 :                                              B  I .1880+000 .1880+000
.2301+003 :                                              B  I .1884+000 .1884+000
.2301+003 :                                               B I .1888+000 .1888+000
.2301+003 :                                               B I .1891+000 .1891+000
.2301+003 :                                               B I .1895+000 .1895+000
.2301+003 :                                               B I .1899+000 .1899+000
.2302+003 :                                               B I .1902+000 .1902+000
.2302+003 :                                               B I .1904+000 .1904+000
.2302+003 :                                               B I .1906+000 .1906+000
.2302+003 :                                               B I .1908+000 .1908+000
.2302+003 :                                               B I .1910+000 .1910+000
.2303+003 :                                               B I .1913+000 .1913+000
.2303+003 :                                                BI .1915+000 .1915+000
.2303+003 :                                                BI .1917+000 .1917+000
.2303+003 :                                                BI .1920+000 .1920+000
.2303+003 :                                                BI .1922+000 .1922+000
.2304+003 :                                                BI .1925+000 .1925+000
.2304+003 :                                                BI .1926+000 .1926+000
.2304+003 :                                                BI .1927+000 .1927+000
.2304+003 :                                                BI .1927+000 .1927+000
.2304+003 :                                                BI .1928+000 .1928+000
.2305+003 :                                                BI .1929+000 .1929+000
.2305+003 :                                                BI .1931+000 .1931+000
.2305+003 :                                                BI .1932+000 .1932+000
.2305+003 :                                                BI .1934+000 .1934+000
.2305+003 :                                                BI .1935+000 .1935+000
.2306+003 :                                                BI .1937+000 .1937+000
.2306+003 :                                                BI .1938+000 .1938+000
.2306+003 :                                                BI .1940+000 .1940+000
.2306+003 :                                                BI .1942+000 .1942+000
.2306+003 :                                                 B .1944+000 .1944+000
.2307+003 :                                                 B .1946+000 .1946+000
.2307+003 :                                                 B .1948+000 .1948+000
.2307+003 :                                                 B .1950+000 .1950+000
.2307+003 :                                                 B .1952+000 .1952+000
.2307+003 :                                                 B .1953+000 .1953+000
.2308+003 :                                                 B .1955+000 .1955+000
.2308+003 :                                                 B .1956+000 .1956+000
.2308+003 :                                                 B .1957+000 .1957+000
.2308+003 :                                                 B .1959+000 .1959+000
.2308+003 :                                                 B .1960+000 .1960+000
.2309+003 :                                                 B .1962+000 .1962+000
.2309+003 :                                                 B .1963+000 .1963+000
.2309+003 :                                                 B .1965+000 .1965+000
.2309+003 :                                                 B .1966+000 .1966+000
.2309+003 :                                                 B .1966+000 .1966+000
.2310+003 :                                                 B .1968+000 .1968+000
.2310+003 :                                                 B .1969+000 .1969+000
.2310+003 :                                                 B .1970+000 .1970+000
.2310+003 :                                                 B .1971+000 .1971+000
.2310+003 :                                                 B .1971+000 .1971+000
.2311+003 :                                                 B .1971+000 .1971+000
.2311+003 :                                                 B .1971+000 .1971+000
.2311+003 :                                                 B .1970+000 .1970+000
.2311+003 :                                                 B .1970+000 .1970+000
```

FIGURE F125

```
.2311+003 :                B .1969+000 .1969+000
.2312+003 :                B .1967+000 .1967+000
.2312+003 :                B .1966+000 .1966+000
.2312+003 :                B .1964+000 .1964+000
.2312+003 :                B .1962+000 .1962+000
.2312+003 :                B .1961+000 .1961+000
.2313+003 :                B .1960+000 .1960+000
.2313+003 :                B .1959+000 .1959+000
.2313+003 :                B .1958+000 .1958+000
.2313+003 :                B .1956+000 .1956+000
.2313+003 :                B .1955+000 .1955+000
.2314+003 :                B .1953+000 .1953+000
.2314+003 :                B .1951+000 .1951+000
.2314+003 :                B .1949+000 .1949+000
.2314+003 :                B .1948+000 .1948+000
.2314+003 :                B .1947+000 .1947+000
.2315+003 :                B .1947+000 .1947+000
.2315+003 :                B .1947+000 .1947+000
.2315+003 :                B .1947+000 .1947+000
.2315+003 :                B .1946+000 .1946+000
.2315+003 :                B .1946+000 .1946+000
.2316+003 :                B .1945+000 .1945+000
.2316+003 :                B .1944+000 .1944+000
.2316+003 :               BI .1942+000 .1942+000
.2316+003 :               BI .1940+000 .1940+000
.2316+003 :               BI .1938+000 .1938+000
.2317+003 :               BI .1936+000 .1936+000
.2317+003 :               BI .1933+000 .1933+000
.2317+003 :               BI .1931+000 .1931+000
.2317+003 :               BI .1928+000 .1928+000
.2317+003 :               BI .1925+000 .1925+000
.2318+003 :               BI .1923+000 .1923+000
.2318+003 :               BI .1919+000 .1919+000
.2318+003 :               BI .1916+000 .1916+000
.2318+003 :              B I .1912+000 .1912+000
.2318+003 :              B I .1908+000 .1908+000
.2319+003 :              B I .1904+000 .1904+000
.2319+003 :              B I .1900+000 .1900+000
.2319+003 :              B I .1895+000 .1895+000
.2319+003 :              B I .1891+000 .1891+000
.2319+003 :             B  I .1886+000 .1886+000
.2320+003 :             B  I .1882+000 .1882+000
.2320+003 :             B  I .1878+000 .1878+000
.2320+003 :             B  I .1874+000 .1874+000
.2320+003 :             B  I .1870+000 .1870+000
.2320+003 :             B  I .1866+000 .1866+000
.2321+003 :             B  I .1861+000 .1861+000
.2321+003 :            B   I .1856+000 .1856+000
.2321+003 :            B   I .1851+000 .1851+000
.2321+003 :            B   I .1847+000 .1847+000
.2321+003 :            B   I .1841+000 .1841+000
.2322+003 :            B   I .1836+000 .1836+000
.2322+003 :           B    I .1830+000 .1830+000
.2322+003 :           B    I .1825+000 .1825+000
.2322+003 :           B    I .1820+000 .1820+000
.2322+003 :           B    I .1815+000 .1815+000
.2323+003 :           B    I .1809+000 .1809+000
```

FIGURE F126

.2323+003	.1803+000	.1803+000
.2323+003	.1798+000	.1798+000
.2323+003	.1793+000	.1793+000
.2323+003	.1788+000	.1788+000
.2324+003	.1784+000	.1784+000
.2324+003	.1780+000	.1780+000
.2324+003	.1776+000	.1776+000
.2324+003	.1771+000	.1771+000
.2324+003	.1766+000	.1766+000
.2325+003	.1761+000	.1761+000
.2325+003	.1756+000	.1756+000
.2325+003	.1752+000	.1752+000
.2325+003	.1747+000	.1747+000
.2325+003	.1743+000	.1743+000
.2326+003	.1739+000	.1739+000
.2326+003	.1735+000	.1735+000
.2326+003	.1731+000	.1731+000
.2326+003	.1726+000	.1726+000
.2326+003	.1722+000	.1722+000
.2327+003	.1717+000	.1717+000
.2327+003	.1713+000	.1713+000
.2327+003	.1709+000	.1709+000
.2327+003	.1705+000	.1705+000
.2327+003	.1701+000	.1701+000
.2328+003	.1697+000	.1697+000
.2328+003	.1693+000	.1693+000
.2328+003	.1689+000	.1689+000
.2328+003	.1686+000	.1686+000
.2328+003	.1683+000	.1683+000
.2329+003	.1680+000	.1680+000
.2329+003	.1677+000	.1677+000
.2329+003	.1674+000	.1674+000
.2329+003	.1671+000	.1671+000
.2329+003	.1668+000	.1668+000
.2330+003	.1665+000	.1665+000
.2330+003	.1664+000	.1664+000
.2330+003	.1662+000	.1662+000
.2330+003	.1659+000	.1659+000
.2330+003	.1657+000	.1657+000
.2331+003	.1653+000	.1653+000
.2331+003	.1650+000	.1650+000
.2331+003	.1646+000	.1646+000
.2331+003	.1644+000	.1644+000
.2331+003	.1642+000	.1642+000
.2332+003	.1639+000	.1639+000
.2332+003	.1636+000	.1636+000
.2332+003	.1633+000	.1633+000
.2332+003	.1630+000	.1630+000
.2332+003	.1627+000	.1627+000
.2333+003	.1623+000	.1623+000
.2333+003	.1619+000	.1619+000
.2333+003	.1616+000	.1616+000
.2333+003	.1613+000	.1613+000
.2333+003	.1610+000	.1610+000
.2334+003	.1608+000	.1608+000
.2334+003	.1606+000	.1606+000
.2334+003	.1604+000	.1604+000

FIGURE F127

```
.2334+003 :                                  B          I .1601+000 .1601+000
.2334+003 :                                  B          I .1599+000 .1599+000
.2335+003 :                                  B          I .1597+000 .1597+000
.2335+003 :                                  B          I .1595+000 .1595+000
.2335+003 :                                  B          I .1593+000 .1593+000
.2335+003 :                                  B          I .1591+000 .1591+000
.2335+003 :                                  B          I .1590+000 .1590+000
.2336+003 :                                  B          I .1588+000 .1588+000
.2336+003 :                                  B          I .1587+000 .1587+000
.2336+003 :                                  B          I .1585+000 .1585+000
.2336+003 :                                  B          I .1583+000 .1583+000
.2336+003 :                                  B          I .1581+000 .1581+000
.2337+003 :                                  B          I .1579+000 .1579+000
.2337+003 :                                  B          I .1578+000 .1578+000
.2337+003 :                                  B          I .1577+000 .1577+000
.2337+003 :                                  B          I .1577+000 .1577+000
.2337+003 :                                  B          I .1577+000 .1577+000
.2338+003 :                                 B           I .1577+000 .1577+000
.2338+003 :                                 B           I .1577+000 .1577+000
.2338+003 :                                  B          I .1577+000 .1577+000
.2338+003 :                                  B          I .1578+000 .1578+000
.2338+003 :                                  B          I .1578+000 .1578+000
.2339+003 :                                  B          I .1579+000 .1579+000
.2339+003 :                                  B          I .1580+000 .1580+000
.2339+003 :                                  B          I .1581+000 .1581+000
.2339+003 :                                  B          I .1582+000 .1582+000
.2339+003 :                                  B          I .1583+000 .1583+000
.2340+003 :                                  B          I .1584+000 .1584+000
.2340+003 :                                  B          I .1584+000 .1584+000
.2340+003 :                                  B          I .1585+000 .1585+000
.2340+003 :                                  B          I .1586+000 .1586+000
.2340+003 :                                  B          I .1586+000 .1586+000
.2341+003 :                                  B          I .1587+000 .1587+000
.2341+003 :                                  B          I .1587+000 .1587+000
.2341+003 :                                  B          I .1588+000 .1588+000
.2341+003 :                                  B          I .1589+000 .1589+000
.2341+003 :                                  B          I .1590+000 .1590+000
.2342+003 :                                  B          I .1590+000 .1590+000
.2342+003 :                                  B          I .1590+000 .1590+000
.2342+003 :                                  B          I .1590+000 .1590+000
.2342+003 :                                  B          I .1590+000 .1590+000
.2342+003 :                                  B          I .1590+000 .1590+000
.2343+003 :                                  B          I .1590+000 .1590+000
.2343+003 :                                  B          I .1589+000 .1589+000
.2343+003 :                                  B          I .1588+000 .1588+000
.2343+003 :                                  B          I .1587+000 .1587+000
.2343+003 :                                  B          I .1586+000 .1586+000
.2344+003 :                                  B          I .1586+000 .1586+000
.2344+003 :                                  B          I .1584+000 .1584+000
.2344+003 :                                  B          I .1584+000 .1584+000
.2344+003 :                                  B          I .1583+000 .1583+000
.2344+003 :                                  B          I .1583+000 .1583+000
.2345+003 :                                  B          I .1582+000 .1582+000
.2345+003 :                                  B          I .1582+000 .1582+000
.2345+003 :                                  B          I .1581+000 .1581+000
.2345+003 :                                  B          I .1581+000 .1581+000
.2345+003 :                                  B          I .1581+000 .1581+000
```

FIGURE F128

.2346+003	:	B	I	.1581+000	.1581+000
.2346+003	:	B	I	.1581+000	.1581+000
.2346+003	:	B	I	.1580+000	.1580+000
.2346+003	:	B	I	.1580+000	.1580+000
.2346+003	:	B	I	.1579+000	.1579+000
.2347+003	:	B	I	.1578+000	.1578+000
.2347+003	:	B	I	.1577+000	.1577+000
.2347+003	:	B	I	.1577+000	.1577+000
.2347+003	:	B	I	.1576+000	.1576+000
.2347+003	:	B	I	.1575+000	.1575+000
.2348+003	:	B	I	.1574+000	.1574+000
.2348+003	:	B	I	.1573+000	.1573+000
.2348+003	:	B	I	.1572+000	.1572+000
.2348+003	:	B	I	.1571+000	.1571+000
.2348+003	:	B	I	.1571+000	.1571+000
.2349+003	:	B	I	.1570+000	.1570+000
.2349+003	:	B	I	.1570+000	.1570+000
.2349+003	:	B	I	.1569+000	.1569+000
.2349+003	:	B	I	.1568+000	.1568+000
.2349+003	:	B	I	.1568+000	.1568+000
.2350+003	:	B	I	.1568+000	.1568+000
.2350+003	:	B	I	.1567+000	.1567+000
.2350+003	:	B	I	.1567+000	.1567+000

FIGURE F129

SHUTTLE ROTATIONS

CURVE '*' IS A PLOT OF THETAX VERSUS TIME

CURVE 'A' IS A PLOT OF THETAY VERSUS TIME

CURVE 'B' IS A PLOT OF THETAZ VERSUS TIME

```
          MINIMUM VALUE                                                 MAXIMUM VALUE
             .0000                                                      .3674+004
TIME         I                                                                    I   THETAX     THETAY     THETAZ
.2200+003 A                                                                   B   I .0000      .0000      .3443+004
.2200+003 A                                                                   B   I .4412+001  .8070+000  .3444+004
.2200+003 A                                                                   B   I .8825+001  .1614+001  .3444+004
.2201+003 A                                                                   B   I .1324+002  .2421+001  .3444+004
.2201+003 A                                                                   B   I .1765+002  .3228+001  .3445+004
.2201+003 A                                                                   B   I .2206+002  .4035+001  .3445+004
.2201+003 A                                                                   B   I .2647+002  .4842+001  .3445+004
.2201+003 A                                                                   B   I .3089+002  .5649+001  .3445+004
.2202+003 A                                                                   B   I .3530+002  .6456+001  .3446+004
.2202+003 A                                                                   B   I .3971+002  .7263+001  .3446+004
.2202+003 A                                                                   B   I .4412+002  .8070+001  .3446+004
.2202+003 A                                                                   B   I .4853+002  .8877+001  .3447+004
.2202+003 A*                                                                  B   I .5295+002  .9684+001  .3447+004
.2203+003 A*                                                                  B   I .5736+002  .1049+002  .3447+004
.2203+003 A*                                                                  B   I .6177+002  .1130+002  .3448+004
.2203+003 A*                                                                  B   I .6618+002  .1210+002  .3448+004
.2203+003 A*                                                                  B   I .7060+002  .1291+002  .3448+004
.2203+003 A*                                                                  B   I .7501+002  .1372+002  .3449+004
.2204+003 A*                                                                  B   I .7942+002  .1453+002  .3449+004
.2204+003 A*                                                                  B   I .8383+002  .1533+002  .3449+004
.2204+003 A*                                                                  B   I .8824+002  .1614+002  .3449+004
.2204+003 A*                                                                  B   I .9265+002  .1695+002  .3450+004
.2204+003 A*                                                                  B   I .9707+002  .1775+002  .3450+004
.2205+003 A*                                                                  B   I .1015+003  .1856+002  .3450+004
.2205+003 A *                                                                 B   I .1059+003  .1937+002  .3451+004
.2205+003 A *                                                                 B   I .1103+003  .2017+002  .3451+004
.2205+003 A *                                                                 B   I .1147+003  .2098+002  .3451+004
.2205+003 A *                                                                 B   I .1191+003  .2179+002  .3452+004
.2206+003 A *                                                                 B   I .1235+003  .2259+002  .3452+004
.2206+003 A *                                                                 B   I .1279+003  .2340+002  .3452+004
.2206+003 A *                                                                 B   I .1324+003  .2421+002  .3453+004
.2206+003 A *                                                                 B   I .1368+003  .2502+002  .3453+004
.2206+003 A *                                                                 B   I .1412+003  .2582+002  .3453+004
.2207+003 A *                                                                 B   I .1456+003  .2663+002  .3453+004
.2207+003 A *                                                                 B   I .1500+003  .2744+002  .3454+004
.2207+003 A *                                                                 B   I .1544+003  .2824+002  .3454+004
.2207+003 A  *                                                                B   I .1588+003  .2905+002  .3454+004
.2207+003 A  *                                                                B   I .1632+003  .2986+002  .3455+004
.2208+003 A  *                                                                B   I .1677+003  .3066+002  .3455+004
.2208+003 A  *                                                                B   I .1721+003  .3147+002  .3455+004
.2208+003 A  *                                                                B   I .1765+003  .3228+002  .3456+004
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FIGURE F130

.2208+003	A	*	B	I	.1809+003	.3308+002	.3456+004
.2208+003	A	*	B	I	.1853+003	.3389+002	.3456+004
.2209+003	A	*	B	I	.1897+003	.3470+002	.3457+004
.2209+003	A	*	B	I	.1941+003	.3550+002	.3457+004
.2209+003	A	*	B	I	.1985+003	.3631+002	.3457+004
.2209+003	A	*	B	I	.2029+003	.3712+002	.3457+004
.2209+003	A	*	B	I	.2074+003	.3792+002	.3458+004
.2210+003	A	*	B	I	.2118+003	.3873+002	.3458+004
.2210+003	A	*	B	I	.2162+003	.3954+002	.3458+004
.2210+003	A	*	B	I	.2206+003	.4035+002	.3459+004
.2210+003	A	*	B	I	.2250+003	.4115+002	.3459+004
.2210+003	A	*	B	I	.2294+003	.4196+002	.3459+004
.2211+003	A	*	B	I	.2338+003	.4277+002	.3460+004
.2211+003	A	*	B	I	.2382+003	.4357+002	.3460+004
.2211+003	A	*	B	I	.2426+003	.4438+002	.3460+004
.2211+003	A	*	B	I	.2471+003	.4519+002	.3461+004
.2211+003	A	*	B	I	.2515+003	.4599+002	.3461+004
.2212+003	A	*	B	I	.2559+003	.4680+002	.3461+004
.2212+003	A	*	B	I	.2603+003	.4761+002	.3461+004
.2212+003	A	*	B	I	.2647+003	.4841+002	.3462+004
.2212+003	A	*	B	I	.2691+003	.4922+002	.3462+004
.2212+003	A	*	B	I	.2735+003	.5003+002	.3462+004
.2213+003	A	*	B	I	.2779+003	.5083+002	.3463+004
.2213+003	A	*	B	I	.2823+003	.5164+002	.3463+004
.2213+003	A	*	B	I	.2868+003	.5245+002	.3463+004
.2213+003	:A	*	B	I	.2912+003	.5325+002	.3464+004
.2213+003	:A	*	B	I	.2956+003	.5406+002	.3464+004
.2214+003	:A	*	B	I	.3000+003	.5487+002	.3464+004
.2214+003	:A	*	B	I	.3044+003	.5567+002	.3465+004
.2214+003	:A	*	B	I	.3088+003	.5648+002	.3465+004
.2214+003	:A	*	B	I	.3132+003	.5729+002	.3465+004
.2214+003	:A	*	B	I	.3176+003	.5809+002	.3465+004
.2215+003	:A	*	B	I	.3220+003	.5890+002	.3466+004
.2215+003	:A	*	B	I	.3265+003	.5971+002	.3466+004
.2215+003	:A	*	B	I	.3309+003	.6051+002	.3466+004
.2215+003	:A	*	B	I	.3353+003	.6132+002	.3467+004
.2215+003	:A	*	B	I	.3397+003	.6213+002	.3467+004
.2216+003	:A	*	B	I	.3441+003	.6293+002	.3467+004
.2216+003	:A	*	B	I	.3485+003	.6374+002	.3468+004
.2216+003	:A	*	B	I	.3529+003	.6455+002	.3468+004
.2216+003	:A	*	B	I	.3573+003	.6535+002	.3468+004
.2216+003	:A	*	B	I	.3617+003	.6616+002	.3469+004
.2217+003	:A	*	B	I	.3662+003	.6697+002	.3469+004
.2217+003	:A	*	B	I	.3706+003	.6778+002	.3469+004
.2217+003	:A	*	B	I	.3750+003	.6858+002	.3469+004
.2217+003	:A	*	B	I	.3794+003	.6939+002	.3470+004
.2217+003	:A	*	B	I	.3838+003	.7020+002	.3470+004
.2218+003	:A	*	B	I	.3882+003	.7100+002	.3470+004
.2218+003	:A	*	B	I	.3926+003	.7181+002	.3471+004
.2218+003	:A	*	B	I	.3970+003	.7262+002	.3471+004
.2218+003	:A	*	B	I	.4014+003	.7342+002	.3471+004
.2218+003	:A	*	B	I	.4058+003	.7423+002	.3472+004
.2219+003	:A	*	B	I	.4103+003	.7504+002	.3472+004
.2219+003	:A	*	B	I	.4147+003	.7584+002	.3472+004
.2219+003	:A	*	B	I	.4191+003	.7665+002	.3473+004
.2219+003	:A	*	B	I	.4235+003	.7745+002	.3473+004
.2219+003	:A	*	B	I	.4279+003	.7826+002	.3473+004

FIGURE F131

.2220+003	:A	*	B	I	.4323+003	.7907+002	.3473+004
.2220+003	:A	*	B	I	.4367+003	.7987+002	.3474+004
.2220+003	:A	*	B	I	.4411+003	.8068+002	.3474+004
.2220+003	:A	*	B	I	.4455+003	.8149+002	.3474+004
.2220+003	:A	*	B	I	.4499+003	.8229+002	.3475+004
.2221+003	:A	*	B	I	.4544+003	.8310+002	.3475+004
.2221+003	:A	*	B	I	.4588+003	.8391+002	.3475+004
.2221+003	:A	*	B	I	.4632+003	.8471+002	.3476+004
.2221+003	:A	*	B	I	.4676+003	.8552+002	.3476+004
.2221+003	:A	*	B	I	.4720+003	.8633+002	.3476+004
.2222+003	:A	*	B	I	.4764+003	.8713+002	.3477+004
.2222+003	:A	*	B	I	.4808+003	.8794+002	.3477+004
.2222+003	:A	*	B	I	.4852+003	.8875+002	.3477+004
.2222+003	:A	*	B	I	.4896+003	.8955+002	.3477+004
.2222+003	:A	*	B	I	.4940+003	.9036+002	.3478+004
.2223+003	:A	*	B	I	.4985+003	.9117+002	.3478+004
.2223+003	:A	*	B	I	.5029+003	.9197+002	.3478+004
.2223+003	:A	*	B	I	.5073+003	.9278+002	.3479+004
.2223+003	:A	*	B	I	.5117+003	.9359+002	.3479+004
.2223+003	:A	*	B	I	.5161+003	.9439+002	.3479+004
.2224+003	:A	*	B	I	.5205+003	.9520+002	.3480+004
.2224+003	:A	*	B	I	.5249+003	.9601+002	.3480+004
.2224+003	:A	*	B	I	.5293+003	.9681+002	.3480+004
.2224+003	:A	*	B	I	.5337+003	.9762+002	.3481+004
.2224+003	:A	*	B	I	.5381+003	.9843+002	.3481+004
.2225+003	:A	*	B	I	.5426+003	.9923+002	.3481+004
.2225+003	:A	*	B	I	.5470+003	.1000+003	.3481+004
.2225+003	:A	*	B	I	.5514+003	.1008+003	.3482+004
.2225+003	:A	*	B	I	.5558+003	.1017+003	.3482+004
.2225+003	:A	*	B	I	.5602+003	.1025+003	.3482+004
.2226+003	:A	*	B	I	.5646+003	.1033+003	.3483+004
.2226+003	:A	*	B	I	.5690+003	.1041+003	.3483+004
.2226+003	:A	*	B	I	.5734+003	.1049+003	.3483+004
.2226+003	: A	*	B	I	.5778+003	.1057+003	.3484+004
.2226+003	: A	*	B	I	.5822+003	.1065+003	.3484+004
.2227+003	: A	*	B	I	.5867+003	.1073+003	.3484+004
.2227+003	: A	*	B	I	.5911+003	.1081+003	.3485+004
.2227+003	: A	*	B	I	.5955+003	.1089+003	.3485+004
.2227+003	: A	*	B	I	.5999+003	.1097+003	.3485+004
.2227+003	: A	*	B	I	.6043+003	.1105+003	.3485+004
.2228+003	: A	*	B	I	.6087+003	.1113+003	.3486+004
.2228+003	: A	*	B	I	.6131+003	.1121+003	.3486+004
.2228+003	: A	*	B	I	.6175+003	.1129+003	.3486+004
.2228+003	: A	*	B	I	.6219+003	.1137+003	.3487+004
.2228+003	: A	*	B	I	.6263+003	.1146+003	.3487+004
.2229+003	: A	*	B	I	.6307+003	.1154+003	.3487+004
.2229+003	: A	*	B	I	.6352+003	.1162+003	.3488+004
.2229+003	: A	*	B	I	.6396+003	.1170+003	.3488+004
.2229+003	: A	*	B	I	.6440+003	.1178+003	.3488+004
.2229+003	: A	*	B	I	.6484+003	.1186+003	.3489+004
.2230+003	: A	*	B	I	.6528+003	.1194+003	.3489+004
.2230+003	: A	*	B	I	.6572+003	.1202+003	.3489+004
.2230+003	: A	*	B	I	.6616+003	.1210+003	.3489+004
.2230+003	: A	*	B	I	.6660+003	.1218+003	.3490+004
.2230+003	: A	*	B	I	.6704+003	.1226+003	.3490+004
.2231+003	: A	*	B	I	.6748+003	.1234+003	.3490+004
.2231+003	: A	*	B	I	.6792+003	.1242+003	.3491+004

FIGURE F132

.2231+003	: A	B	I	.6837+003	.1250+003	.3491+004
.2231+003	: A	B	I	.6881+003	.1258+003	.3491+004
.2231+003	: A	B	I	.6925+003	.1267+003	.3492+004
.2232+003	: A	B	I	.6969+003	.1275+003	.3492+004
.2232+003	: A	B	I	.7013+003	.1283+003	.3492+004
.2232+003	: A	B	I	.7057+003	.1291+003	.3493+004
.2232+003	: A	B	I	.7101+003	.1299+003	.3493+004
.2232+003	: A	B	I	.7145+003	.1307+003	.3493+004
.2233+003	: A	B	I	.7189+003	.1315+003	.3493+004
.2233+003	: A	B	I	.7233+003	.1323+003	.3494+004
.2233+003	: A	B	I	.7277+003	.1331+003	.3494+004
.2233+003	: A	B	I	.7322+003	.1339+003	.3494+004
.2233+003	: A	B	I	.7366+003	.1347+003	.3495+004
.2234+003	: A	B	I	.7410+003	.1355+003	.3495+004
.2234+003	: A	B	I	.7454+003	.1363+003	.3495+004
.2234+003	: A	B	I	.7498+003	.1371+003	.3496+004
.2234+003	: A	B	I	.7542+003	.1379+003	.3496+004
.2234+003	: A	B	I	.7586+003	.1387+003	.3496+004
.2235+003	: A	B	I	.7630+003	.1396+003	.3497+004
.2235+003	: A	B	I	.7674+003	.1404+003	.3497+004
.2235+003	: A	B	I	.7718+003	.1412+003	.3497+004
.2235+003	: A	B	I	.7762+003	.1420+003	.3497+004
.2235+003	: A	B	I	.7807+003	.1428+003	.3498+004
.2236+003	: A	B	I	.7851+003	.1436+003	.3498+004
.2236+003	: A	B	I	.7895+003	.1444+003	.3498+004
.2236+003	: A	B	I	.7939+003	.1452+003	.3499+004
.2236+003	: A	B	I	.7983+003	.1460+003	.3499+004
.2236+003	: A	B	I	.8027+003	.1468+003	.3499+004
.2237+003	: A	B	I	.8071+003	.1476+003	.3500+004
.2237+003	: A	B	I	.8115+003	.1484+003	.3500+004
.2237+003	: A	B	I	.8159+003	.1492+003	.3500+004
.2237+003	: A	B	I	.8203+003	.1500+003	.3501+004
.2237+003	: A	B	I	.8247+003	.1508+003	.3501+004
.2238+003	: A	B	I	.8291+003	.1516+003	.3501+004
.2238+003	: A	B	I	.8336+003	.1525+003	.3501+004
.2238+003	: A	B	I	.8380+003	.1533+003	.3502+004
.2238+003	: A	B	I	.8424+003	.1541+003	.3502+004
.2238+003	: A	B	I	.8468+003	.1549+003	.3502+004
.2239+003	: A	B	I	.8512+003	.1557+003	.3503+004
.2239+003	: A	B	I	.8556+003	.1565+003	.3503+004
.2239+003	: A	B	I	.8600+003	.1573+003	.3503+004
.2239+003	: A	B	I	.8644+003	.1581+003	.3504+004
.2239+003	: A	B	I	.8688+003	.1589+003	.3504+004
.2240+003	: A	B	I	.8732+003	.1597+003	.3504+004
.2240+003	: A	B	I	.8776+003	.1605+003	.3505+004
.2240+003	: A	B	I	.8820+003	.1613+003	.3505+004
.2240+003	: A	B	I	.8864+003	.1621+003	.3505+004
.2240+003	: A	B	I	.8909+003	.1629+003	.3505+004
.2241+003	: A	B	I	.8953+003	.1637+003	.3506+004
.2241+003	: A	B	I	.8997+003	.1645+003	.3506+004
.2241+003	: A	B	I	.9041+003	.1654+003	.3506+004
.2241+003	: A	B	I	.9085+003	.1662+003	.3507+004
.2241+003	: A	B	I	.9129+003	.1670+003	.3507+004
.2242+003	: A	B	I	.9173+003	.1678+003	.3507+004
.2242+003	: A	B	I	.9217+003	.1686+003	.3508+004
.2242+003	: A	B	I	.9261+003	.1694+003	.3508+004
.2242+003	: A	B	I	.9305+003	.1702+003	.3508+004

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.2242+003 :  A        *                              B  I .9349+003 .1710+003 .3509+004
.2243+003 :  A        *                              B  I .9393+003 .1718+003 .3509+004
.2243+003 :  A        *                              B  I .9438+003 .1726+003 .3509+004
.2243+003 :  A         *                             B  I .9482+003 .1734+003 .3509+004
.2243+003 :  A         *                             B  I .9526+003 .1742+003 .3510+004
.2243+003 :  A         *                             B  I .9570+003 .1750+003 .3510+004
.2244+003 :  A         *                             B  I .9614+003 .1758+003 .3510+004
.2244+003 :  A         *                             B  I .9658+003 .1766+003 .3511+004
.2244+003 :  A         *                             B  I .9702+003 .1774+003 .3511+004
.2244+003 :  A         *                             B  I .9746+003 .1783+003 .3511+004
.2244+003 :  A         *                             B  I .9790+003 .1791+003 .3512+004
.2245+003 :  A         *                             B  I .9834+003 .1799+003 .3512+004
.2245+003 :  A         *                             B  I .9878+003 .1807+003 .3512+004
.2245+003 :  A         *                             B  I .9922+003 .1815+003 .3513+004
.2245+003 :  A         *                             B  I .9966+003 .1823+003 .3513+004
.2245+003 :  A          *                            B  I .1001+004 .1831+003 .3513+004
.2246+003 :  A          *                            B  I .1005+004 .1839+003 .3513+004
.2246+003 :  A          *                            B  I .1010+004 .1847+003 .3514+004
.2246+003 :  A          *                            B  I .1014+004 .1855+003 .3514+004
.2246+003 :  A          *                            B  I .1019+004 .1863+003 .3514+004
.2246+003 :  A          *                            B  I .1023+004 .1871+003 .3515+004
.2247+003 :  A          *                            B  I .1027+004 .1879+003 .3515+004
.2247+003 :  A          *                            B  I .1032+004 .1887+003 .3515+004
.2247+003 :  A          *                            B  I .1036+004 .1895+003 .3516+004
.2247+003 :  A          *                            B  I .1041+004 .1903+003 .3516+004
.2247+003 :  A          *                            B  I .1045+004 .1911+003 .3516+004
.2248+003 :  A          *                             B I .1050+004 .1920+003 .3517+004
.2248+003 :  A           *                            B I .1054+004 .1928+003 .3517+004
.2248+003 :  A           *                            B I .1058+004 .1936+003 .3517+004
.2248+003 :  A           *                            B I .1063+004 .1944+003 .3517+004
.2248+003 :  A           *                            B I .1067+004 .1952+003 .3518+004
.2249+003 :  A           *                            B I .1072+004 .1960+003 .3518+004
.2249+003 :  A           *                            B I .1076+004 .1968+003 .3518+004
.2249+003 :  A           *                            B I .1080+004 .1976+003 .3519+004
.2249+003 :  A           *                            B I .1085+004 .1984+003 .3519+004
.2249+003 :  A           *                            B I .1089+004 .1992+003 .3519+004
.2250+003 :  A           *                            B I .1094+004 .2000+003 .3520+004
.2250+003 :  A           *                            B I .1098+004 .2008+003 .3520+004
.2250+003 :  A            *                           B I .1102+004 .2016+003 .3520+004
.2250+003 :  A            *                           B I .1107+004 .2024+003 .3521+004
.2250+003 :  A            *                           B I .1111+004 .2032+003 .3521+004
.2251+003 :  A            *                           B I .1116+004 .2040+003 .3521+004
.2251+003 :  A            *                           B I .1120+004 .2049+003 .3521+004
.2251+003 :  A            *                           B I .1124+004 .2057+003 .3522+004
.2251+003 :  A            *                           B I .1129+004 .2065+003 .3522+004
.2251+003 :  A            *                           B I .1133+004 .2073+003 .3522+004
.2252+003 :  A            *                           B I .1138+004 .2081+003 .3523+004
.2252+003 :  A            *                           B I .1142+004 .2089+003 .3523+004
.2252+003 :  A            *                           B I .1146+004 .2097+003 .3523+004
.2252+003 :   A           *                           B I .1151+004 .2105+003 .3524+004
.2252+003 :   A            *                          B I .1155+004 .2113+003 .3524+004
.2253+003 :   A            *                          B I .1160+004 .2121+003 .3524+004
.2253+003 :   A            *                          B I .1164+004 .2129+003 .3525+004
.2253+003 :   A            *                          B I .1169+004 .2137+003 .3525+004
.2253+003 :   A            *                          B I .1173+004 .2145+003 .3525+004
.2253+003 :   A            *                          B I .1177+004 .2153+003 .3525+004
.2254+003 :   A            *                          B I .1182+004 .2161+003 .3526+004
```

FIGURE F133

FIGURE F134

.2254+003	:	A	*	B	I	.1186+004	.2169+003	.3526+004
.2254+003	:	A	*	B	I	.1191+004	.2177+003	.3526+004
.2254+003	:	A	*	B	I	.1195+004	.2186+003	.3527+004
.2254+003	:	A	*	B	I	.1199+004	.2194+003	.3527+004
.2255+003	:	A	*	B	I	.1204+004	.2202+003	.3527+004
.2255+003	:	A	*	B	I	.1208+004	.2210+003	.3528+004
.2255+003	:	A	*	B	I	.1213+004	.2218+003	.3528+004
.2255+003	:	A	*	B	I	.1217+004	.2226+003	.3528+004
.2255+003	:	A	*	B	I	.1221+004	.2234+003	.3529+004
.2256+003	:	A	*	B	I	.1226+004	.2242+003	.3529+004
.2256+003	:	A	*	B	I	.1230+004	.2250+003	.3529+004
.2256+003	:	A	*	B	I	.1235+004	.2258+003	.3529+004
.2256+003	:	A	*	B	I	.1239+004	.2266+003	.3530+004
.2256+003	:	A	*	B	I	.1243+004	.2274+003	.3530+004
.2257+003	:	A	*	B	I	.1248+004	.2282+003	.3530+004
.2257+003	:	A	*	B	I	.1252+004	.2290+003	.3531+004
.2257+003	:	A	*	B	I	.1257+004	.2298+003	.3531+004
.2257+003	:	A	*	B	I	.1261+004	.2306+003	.3531+004
.2257+003	:	A	*	B	I	.1265+004	.2314+003	.3532+004
.2258+003	:	A	*	B	I	.1270+004	.2323+003	.3532+004
.2258+003	:	A	*	B	I	.1274+004	.2331+003	.3532+004
.2258+003	:	A	*	B	I	.1279+004	.2339+003	.3533+004
.2258+003	:	A	*	B	I	.1283+004	.2347+003	.3533+004
.2258+003	:	A	*	B	I	.1287+004	.2355+003	.3533+004
.2259+003	:	A	*	B	I	.1292+004	.2363+003	.3533+004
.2259+003	:	A	*	B	I	.1296+004	.2371+003	.3534+004
.2259+003	:	A	*	B	I	.1301+004	.2379+003	.3534+004
.2259+003	:	A	*	B	I	.1305+004	.2387+003	.3534+004
.2259+003	:	A	*	B	I	.1310+004	.2395+003	.3535+004
.2260+003	:	A	*	B	I	.1314+004	.2403+003	.3535+004
.2260+003	:	A	*	B	I	.1318+004	.2411+003	.3535+004
.2260+003	:	A	*	B	I	.1323+004	.2419+003	.3536+004
.2260+003	:	A	*	B	I	.1327+004	.2427+003	.3536+004
.2260+003	:	A	*	B	I	.1332+004	.2435+003	.3536+004
.2261+003	:	A	*	B	I	.1336+004	.2443+003	.3537+004
.2261+003	:	A	*	B	I	.1340+004	.2451+003	.3537+004
.2261+003	:	A	*	B	I	.1345+004	.2460+003	.3537+004
.2261+003	:	A	*	B	I	.1349+004	.2468+003	.3537+004
.2261+003	:	A	*	B	I	.1354+004	.2476+003	.3538+004
.2262+003	:	A	*	B	I	.1358+004	.2484+003	.3538+004
.2262+003	:	A	*	B	I	.1362+004	.2492+003	.3538+004
.2262+003	:	A	*	B	I	.1367+004	.2500+003	.3539+004
.2262+003	:	A	*	B	I	.1371+004	.2508+003	.3539+004
.2262+003	:	A	*	B	I	.1376+004	.2516+003	.3539+004
.2263+003	:	A	*	B	I	.1380+004	.2524+003	.3540+004
.2263+003	:	A	*	B	I	.1384+004	.2532+003	.3540+004
.2263+003	:	A	*	B	I	.1389+004	.2540+003	.3540+004
.2263+003	:	A	*	B	I	.1393+004	.2548+003	.3541+004
.2263+003	:	A	*	B	I	.1398+004	.2556+003	.3541+004
.2264+003	:	A	*	B	I	.1402+004	.2564+003	.3541+004
.2264+003	:	A	*	B	I	.1406+004	.2572+003	.3541+004
.2264+003	:	A	*	B	I	.1411+004	.2580+003	.3542+004
.2264+003	:	A	*	B	I	.1415+004	.2588+003	.3542+004
.2264+003	:	A	*	B	I	.1420+004	.2596+003	.3542+004
.2265+003	:	A	*	B	I	.1424+004	.2605+003	.3543+004
.2265+003	:	A	*	B	I	.1428+004	.2613+003	.3543+004
.2265+003	:	A	*	B	I	.1433+004	.2621+003	.3543+004

FIGURE F135

```
.2265+003 :   A             *                          B I .1437+004 .2629+003 .3544+004
.2265+003 :   A             *                          B I .1442+004 .2637+003 .3544+004
.2266+003 :   A             *                          B I .1446+004 .2645+003 .3544+004
.2266+003 :   A             *                          B I .1450+004 .2653+003 .3545+004
.2266+003 :   A             *                          B I .1455+004 .2661+003 .3545+004
.2266+003 :   A             *                          B I .1459+004 .2669+003 .3545+004
.2266+003 :   A             *                          B I .1464+004 .2677+003 .3545+004
.2267+003 :   A             *                          B I .1468+004 .2685+003 .3546+004
.2267+003 :   A              *                         B I .1473+004 .2693+003 .3546+004
.2267+003 :   A              *                         B I .1477+004 .2701+003 .3546+004
.2267+003 :   A              *                         B I .1481+004 .2709+003 .3547+004
.2267+003 :   A              *                         B I .1486+004 .2717+003 .3547+004
.2268+003 :   A              *                         B I .1490+004 .2725+003 .3547+004
.2268+003 :   A              *                         B I .1495+004 .2733+003 .3548+004
.2268+003 :   A              *                         B I .1499+004 .2742+003 .3548+004
.2268+003 :   A              *                         B I .1503+004 .2750+003 .3548+004
.2268+003 :   A              *                         B I .1508+004 .2758+003 .3549+004
.2269+003 :   A              *                         B I .1512+004 .2766+003 .3549+004
.2269+003 :   A              *                         B I .1517+004 .2774+003 .3549+004
.2269+003 :   A              *                         B I .1521+004 .2782+003 .3549+004
.2269+003 :   A               *                        B I .1525+004 .2790+003 .3550+004
.2269+003 :   A               *                        B I .1530+004 .2798+003 .3550+004
.2270+003 :   A               *                        B I .1534+004 .2806+003 .3550+004
.2270+003 :   A               *                        B I .1539+004 .2814+003 .3551+004
.2270+003 :   A               *                        B I .1543+004 .2822+003 .3551+004
.2270+003 :   A               *                        B I .1547+004 .2830+003 .3551+004
.2270+003 :   A               *                        B I .1552+004 .2838+003 .3552+004
.2271+003 :   A               *                        B I .1556+004 .2846+003 .3552+004
.2271+003 :   A               *                        B I .1561+004 .2854+003 .3552+004
.2271+003 :   A               *                        B I .1565+004 .2862+003 .3553+004
.2271+003 :   A               *                        B I .1569+004 .2870+003 .3553+004
.2271+003 :   A               *                        B I .1574+004 .2878+003 .3553+004
.2272+003 :   A                *                       B I .1578+004 .2887+003 .3553+004
.2272+003 :   A                *                       B I .1583+004 .2895+003 .3554+004
.2272+003 :   A                *                       B I .1587+004 .2903+003 .3554+004
.2272+003 :   A                *                       B I .1591+004 .2911+003 .3554+004
.2272+003 :   A                *                       B I .1596+004 .2919+003 .3555+004
.2273+003 :   A                *                       B I .1600+004 .2927+003 .3555+004
.2273+003 :   A                *                       B I .1605+004 .2935+003 .3555+004
.2273+003 :   A                *                       B I .1609+004 .2943+003 .3556+004
.2273+003 :   A                *                       B I .1613+004 .2951+003 .3556+004
.2273+003 :   A                *                       B I .1618+004 .2959+003 .3556+004
.2274+003 :   A                *                       B I .1622+004 .2967+003 .3557+004
.2274+003 :   A                *                       B I .1627+004 .2975+003 .3557+004
.2274+003 :   A                 *                      B I .1631+004 .2983+003 .3557+004
.2274+003 :   A                 *                      B I .1635+004 .2991+003 .3557+004
.2274+003 :   A                 *                      B I .1640+004 .2999+003 .3558+004
.2275+003 :   A                 *                      B I .1644+004 .3007+003 .3558+004
.2275+003 :   A                 *                      B I .1649+004 .3015+003 .3558+004
.2275+003 :   A                 *                      B I .1653+004 .3023+003 .3559+004
.2275+003 :   A                 *                      B I .1658+004 .3032+003 .3559+004
.2275+003 :   A                 *                      B I .1662+004 .3040+003 .3559+004
.2276+003 :   A                 *                      B I .1666+004 .3048+003 .3560+004
.2276+003 :   A                 *                      B I .1671+004 .3056+003 .3560+004
.2276+003 :   A                 *                      B I .1675+004 .3064+003 .3560+004
.2276+003 :   A                  *                     B I .1680+004 .3072+003 .3561+004
.2276+003 :   A                  *                     B I .1684+004 .3080+003 .3561+004
```

FIGURE F136

.2277+003	:	A	*	B I	.1688+004	.3088+003	.3561+004
.2277+003	:	A	*	B I	.1693+004	.3096+003	.3561+004
.2277+003	:	A	*	B I	.1697+004	.3104+003	.3562+004
.2277+003	:	A	*	B I	.1702+004	.3112+003	.3562+004
.2277+003	:	A	*	B I	.1706+004	.3120+003	.3562+004
.2278+003	:	A	*	B I	.1710+004	.3128+003	.3563+004
.2278+003	:	A	*	B I	.1715+004	.3136+003	.3563+004
.2278+003	:	A	*	B I	.1719+004	.3144+003	.3563+004
.2278+003	:	A	*	B I	.1724+004	.3152+003	.3564+004
.2278+003	:	A	*	B I	.1728+004	.3160+003	.3564+004
.2279+003	:	A	*	B I	.1732+004	.3168+003	.3564+004
.2279+003	:	A	*	B I	.1737+004	.3177+003	.3565+004
.2279+003	:	A	*	B I	.1741+004	.3185+003	.3565+004
.2279+003	:	A	*	B I	.1746+004	.3193+003	.3565+004
.2279+003	:	A	*	B I	.1750+004	.3201+003	.3565+004
.2280+003	:	A	*	B I	.1754+004	.3209+003	.3566+004
.2280+003	:	A	*	B I	.1759+004	.3217+003	.3566+004
.2280+003	:	A	*	B I	.1763+004	.3225+003	.3566+004
.2280+003	:	A	*	B I	.1768+004	.3233+003	.3567+004
.2280+003	:	A	*	B I	.1772+004	.3241+003	.3567+004
.2281+003	:	A	*	B I	.1776+004	.3249+003	.3567+004
.2281+003	:	A	*	B I	.1781+004	.3257+003	.3568+004
.2281+003	:	A	*	B I	.1785+004	.3265+003	.3568+004
.2281+003	:	A	*	B I	.1790+004	.3273+003	.3568+004
.2281+003	:	A	*	B I	.1794+004	.3281+003	.3569+004
.2282+003	:	A	*	B I	.1798+004	.3289+003	.3569+004
.2282+003	:	A	*	BI	.1803+004	.3297+003	.3569+004
.2282+003	:	A	*	BI	.1807+004	.3305+003	.3569+004
.2282+003	:	A	*	BI	.1812+004	.3313+003	.3570+004
.2282+003	:	A	*	BI	.1816+004	.3321+003	.3570+004
.2283+003	:	A	*	BI	.1820+004	.3330+003	.3570+004
.2283+003	:	A	*	BI	.1825+004	.3338+003	.3571+004
.2283+003	:	A	*	BI	.1829+004	.3346+003	.3571+004
.2283+003	:	A	*	BI	.1834+004	.3354+003	.3571+004
.2283+003	:	A	*	BI	.1838+004	.3362+003	.3572+004
.2284+003	:	A	*	BI	.1842+004	.3370+003	.3572+004
.2284+003	:	A	*	BI	.1847+004	.3378+003	.3572+004
.2284+003	:	A	*	BI	.1851+004	.3386+003	.3573+004
.2284+003	:	A	*	BI	.1856+004	.3394+003	.3573+004
.2284+003	:	A	*	BI	.1860+004	.3402+003	.3573+004
.2285+003	:	A	*	BI	.1864+004	.3410+003	.3573+004
.2285+003	:	A	*	BI	.1869+004	.3418+003	.3574+004
.2285+003	:	A	*	BI	.1873+004	.3426+003	.3574+004
.2285+003	:	A	*	BI	.1878+004	.3434+003	.3574+004
.2285+003	:	A	*	BI	.1882+004	.3442+003	.3575+004
.2286+003	:	A	*	BI	.1886+004	.3450+003	.3575+004
.2286+003	:	A	*	BI	.1891+004	.3458+003	.3575+004
.2286+003	:	A	*	BI	.1895+004	.3466+003	.3576+004
.2286+003	:	A	*	BI	.1900+004	.3474+003	.3576+004
.2286+003	:	A	*	BI	.1904+004	.3483+003	.3576+004
.2287+003	:	A	*	BI	.1909+004	.3491+003	.3577+004
.2287+003	:	A	*	BI	.1913+004	.3499+003	.3577+004
.2287+003	:	A	*	BI	.1917+004	.3507+003	.3577+004
.2287+003	:	A	*	BI	.1922+004	.3515+003	.3577+004
.2287+003	:	A	*	BI	.1926+004	.3523+003	.3578+004
.2288+003	:	A	*	BI	.1931+004	.3531+003	.3578+004
.2288+003	:	A	*	BI	.1935+004	.3539+003	.3578+004

FIGURE F137

.2288+003	:	A	*	BI	.1939+004	.3547+003	.3579+004
.2288+003	:	A	*	BI	.1944+004	.3555+003	.3579+004
.2288+003	:	A	*	BI	.1948+004	.3563+003	.3579+004
.2289+003	:	A	*	BI	.1953+004	.3571+003	.3580+004
.2289+003	:	A	*	BI	.1957+004	.3579+003	.3580+004
.2289+003	:	A	*	BI	.1961+004	.3587+003	.3580+004
.2289+003	:	A	*	BI	.1966+004	.3595+003	.3581+004
.2289+003	:	A	*	BI	.1970+004	.3603+003	.3581+004
.2290+003	:	A	*	BI	.1975+004	.3611+003	.3581+004
.2290+003	:	A	*	BI	.1979+004	.3619+003	.3581+004
.2290+003	:	A	*	BI	.1983+004	.3627+003	.3582+004
.2290+003	:	A	*	BI	.1988+004	.3636+003	.3582+004
.2290+003	:	A	*	BI	.1992+004	.3644+003	.3582+004
.2291+003	:	A	*	BI	.1997+004	.3652+003	.3583+004
.2291+003	:	A	*	BI	.2001+004	.3660+003	.3583+004
.2291+003	:	A	*	BI	.2005+004	.3668+003	.3583+004
.2291+003	:	A	*	BI	.2010+004	.3676+003	.3584+004
.2291+003	:	A	*	BI	.2014+004	.3684+003	.3584+004
.2292+003	:	A	*	BI	.2019+004	.3692+003	.3584+004
.2292+003	:	A	*	BI	.2023+004	.3700+003	.3585+004
.2292+003	:	A	*	BI	.2027+004	.3708+003	.3585+004
.2292+003	:	A	*	BI	.2032+004	.3716+003	.3585+004
.2292+003	:	A	*	BI	.2036+004	.3724+003	.3585+004
.2293+003	:	A	*	BI	.2041+004	.3732+003	.3586+004
.2293+003	:	A	*	BI	.2045+004	.3740+003	.3586+004
.2293+003	:	A	*	BI	.2049+004	.3748+003	.3586+004
.2293+003	:	A	*	BI	.2054+004	.3756+003	.3587+004
.2293+003	:	A	*	BI	.2058+004	.3764+003	.3587+004
.2294+003	:	A	*	BI	.2063+004	.3772+003	.3587+004
.2294+003	:	A	*	BI	.2067+004	.3780+003	.3588+004
.2294+003	:	A	*	BI	.2071+004	.3789+003	.3588+004
.2294+003	:	A	*	BI	.2076+004	.3797+003	.3588+004
.2294+003	:	A	*	BI	.2080+004	.3805+003	.3589+004
.2295+003	:	A	*	BI	.2085+004	.3813+003	.3589+004
.2295+003	:	A	*	BI	.2089+004	.3821+003	.3589+004
.2295+003	:	A	*	BI	.2093+004	.3829+003	.3589+004
.2295+003	:	A	*	BI	.2098+004	.3837+003	.3590+004
.2295+003	:	A	*	BI	.2102+004	.3845+003	.3590+004
.2296+003	:	A	*	BI	.2107+004	.3853+003	.3590+004
.2296+003	:	A	*	BI	.2111+004	.3861+003	.3591+004
.2296+003	:	A	*	BI	.2115+004	.3869+003	.3591+004
.2296+003	:	A	*	BI	.2120+004	.3877+003	.3591+004
.2296+003	:	A	*	BI	.2124+004	.3885+003	.3592+004
.2297+003	:	A	*	BI	.2129+004	.3893+003	.3592+004
.2297+003	:	A	*	BI	.2133+004	.3901+003	.3592+004
.2297+003	:	A	*	BI	.2137+004	.3909+003	.3593+004
.2297+003	:	A	*	BI	.2142+004	.3917+003	.3593+004
.2297+003	:	A	*	BI	.2146+004	.3925+003	.3593+004
.2298+003	:	A	*	BI	.2151+004	.3933+003	.3593+004
.2298+003	:	A	*	BI	.2155+004	.3941+003	.3594+004
.2298+003	:	A	*	BI	.2159+004	.3950+003	.3594+004
.2298+003	:	A	*	BI	.2164+004	.3958+003	.3594+004
.2298+003	:	A	*	BI	.2168+004	.3966+003	.3595+004
.2299+003	:	A	*	BI	.2173+004	.3974+003	.3595+004
.2299+003	:	A	*	BI	.2177+004	.3982+003	.3595+004
.2299+003	:	A	*	BI	.2181+004	.3990+003	.3596+004
.2299+003	:	A	*	BI	.2186+004	.3998+003	.3596+004

FIGURE F138

.2299+003	:	A	*	BI	.2190+004	.4006+003	.3596+004
.2300+003	:	A	*	BI	.2195+004	.4014+003	.3597+004
.2300+003	:	A	*	BI	.2199+004	.4022+003	.3597+004
.2300+003	:	A	*	BI	.2203+004	.4030+003	.3597+004
.2300+003	:	A	*	BI	.2208+004	.4038+003	.3597+004
.2300+003	:	A	*	BI	.2212+004	.4046+003	.3598+004
.2301+003	:	A	*	BI	.2217+004	.4054+003	.3598+004
.2301+003	:	A	*	BI	.2221+004	.4062+003	.3598+004
.2301+003	:	A	*	BI	.2225+004	.4070+003	.3599+004
.2301+003	:	A	*	BI	.2230+004	.4078+003	.3599+004
.2301+003	:	A	*	BI	.2234+004	.4086+003	.3599+004
.2302+003	:	A	*	BI	.2239+004	.4094+003	.3600+004
.2302+003	:	A	*	BI	.2243+004	.4102+003	.3600+004
.2302+003	:	A	*	BI	.2247+004	.4111+003	.3600+004
.2302+003	:	A	*	BI	.2252+004	.4119+003	.3600+004
.2302+003	:	A	*	BI	.2256+004	.4127+003	.3601+004
.2303+003	:	A	*	BI	.2261+004	.4135+003	.3601+004
.2303+003	:	A	*	BI	.2265+004	.4143+003	.3601+004
.2303+003	:	A	*	BI	.2269+004	.4151+003	.3602+004
.2303+003	:	A	*	BI	.2274+004	.4159+003	.3602+004
.2303+003	:	A	*	BI	.2278+004	.4167+003	.3602+004
.2304+003	:	A	*	BI	.2283+004	.4175+003	.3603+004
.2304+003	:	A	*	BI	.2287+004	.4183+003	.3603+004
.2304+003	:	A	*	BI	.2291+004	.4191+003	.3603+004
.2304+003	:	A	*	BI	.2296+004	.4199+003	.3604+004
.2304+003	:	A	*	BI	.2300+004	.4207+003	.3604+004
.2305+003	:	A	*	BI	.2305+004	.4215+003	.3604+004
.2305+003	:	A	*	BI	.2309+004	.4223+003	.3604+004
.2305+003	:	A	*	BI	.2313+004	.4231+003	.3605+004
.2305+003	:	A	*	BI	.2318+004	.4239+003	.3605+004
.2305+003	:	A	*	BI	.2322+004	.4247+003	.3605+004
.2306+003	:	A	*	BI	.2327+004	.4255+003	.3606+004
.2306+003	:	A	*	BI	.2331+004	.4263+003	.3606+004
.2306+003	:	A	*	BI	.2335+004	.4271+003	.3606+004
.2306+003	:	A	*	BI	.2340+004	.4280+003	.3607+004
.2306+003	:	A	*	BI	.2344+004	.4288+003	.3607+004
.2307+003	:	A	*	BI	.2349+004	.4296+003	.3607+004
.2307+003	:	A	*	BI	.2353+004	.4304+003	.3608+004
.2307+003	:	A	*	BI	.2357+004	.4312+003	.3608+004
.2307+003	:	A	*	BI	.2362+004	.4320+003	.3608+004
.2307+003	:	A	*	BI	.2366+004	.4328+003	.3608+004
.2308+003	:	A	*	BI	.2371+004	.4336+003	.3609+004
.2308+003	:	A	*	BI	.2375+004	.4344+003	.3609+004
.2308+003	:	A	*	BI	.2379+004	.4352+003	.3609+004
.2308+003	:	A	*	BI	.2384+004	.4360+003	.3610+004
.2308+003	:	A	*	BI	.2388+004	.4368+003	.3610+004
.2309+003	:	A	*	BI	.2393+004	.4376+003	.3610+004
.2309+003	:	A	*	BI	.2397+004	.4384+003	.3611+004
.2309+003	:	A	*	BI	.2401+004	.4392+003	.3611+004
.2309+003	:	A	*	BI	.2406+004	.4400+003	.3611+004
.2309+003	:	A	*	BI	.2410+004	.4408+003	.3612+004
.2310+003	:	A	*	BI	.2415+004	.4416+003	.3612+004
.2310+003	:	A	*	BI	.2419+004	.4424+003	.3612+004
.2310+003	:	A	*	BI	.2423+004	.4432+003	.3612+004
.2310+003	:	A	*	BI	.2428+004	.4441+003	.3613+004
.2310+003	:	A	*	BI	.2432+004	.4449+003	.3613+004
.2311+003	:	A	*	BI	.2437+004	.4457+003	.3613+004

FIGURE F139

```
.2311+003 :       A                               *                 BI .2441+004 .4465+003 .3614+004
.2311+003 :       A                               *                 BI .2445+004 .4473+003 .3614+004
.2311+003 :       A                               *                 BI .2450+004 .4481+003 .3614+004
.2311+003 :       A                               *                 BI .2454+004 .4489+003 .3615+004
.2312+003 :       A                               *                 BI .2459+004 .4497+003 .3615+004
.2312+003 :       A                               *                 BI .2463+004 .4505+003 .3615+004
.2312+003 :       A                                *                BI .2467+004 .4513+003 .3616+004
.2312+003 :       A                                *                BI .2472+004 .4521+003 .3616+004
.2312+003 :       A                                *                BI .2476+004 .4529+003 .3616+004
.2313+003 :       A                                *                BI .2481+004 .4537+003 .3616+004
.2313+003 :       A                                *                BI .2485+004 .4545+003 .3617+004
.2313+003 :       A                                *                BI .2489+004 .4553+003 .3617+004
.2313+003 :       A                                *                BI .2494+004 .4561+003 .3617+004
.2313+003 :       A                                *                BI .2498+004 .4569+003 .3618+004
.2314+003 :       A                                *                BI .2503+004 .4577+003 .3618+004
.2314+003 :       A                                *                BI .2507+004 .4585+003 .3618+004
.2314+003 :       A                                *                BI .2511+004 .4593+003 .3619+004
.2314+003 :       A                                *                BI .2516+004 .4601+003 .3619+004
.2314+003 :       A                                 *               BI .2520+004 .4609+003 .3619+004
.2315+003 :       A                                 *               BI .2525+004 .4618+003 .3620+004
.2315+003 :       A                                 *               BI .2529+004 .4626+003 .3620+004
.2315+003 :       A                                 *               BI .2533+004 .4634+003 .3620+004
.2315+003 :       A                                 *               BI .2538+004 .4642+003 .3620+004
.2315+003 :       A                                 *               BI .2542+004 .4650+003 .3621+004
.2316+003 :       A                                 *               BI .2547+004 .4658+003 .3621+004
.2316+003 :       A                                 *               BI .2551+004 .4666+003 .3621+004
.2316+003 :       A                                 *                B .2555+004 .4674+003 .3622+004
.2316+003 :       A                                 *                B .2560+004 .4682+003 .3622+004
.2316+003 :       A                                 *                B .2564+004 .4690+003 .3622+004
.2317+003 :       A                                 *                B .2569+004 .4698+003 .3623+004
.2317+003 :       A                                  *               B .2573+004 .4706+003 .3623+004
.2317+003 :       A                                  *               B .2577+004 .4714+003 .3623+004
.2317+003 :       A                                  *               B .2582+004 .4722+003 .3624+004
.2317+003 :        A                                 *               B .2586+004 .4730+003 .3624+004
.2318+003 :        A                                 *               B .2591+004 .4738+003 .3624+004
.2318+003 :        A                                 *               B .2595+004 .4746+003 .3624+004
.2318+003 :        A                                 *               B .2599+004 .4754+003 .3625+004
.2318+003 :        A                                 *               B .2604+004 .4762+003 .3625+004
.2318+003 :        A                                 *               B .2608+004 .4770+003 .3625+004
.2319+003 :        A                                 *               B .2613+004 .4778+003 .3626+004
.2319+003 :        A                                 *               B .2617+004 .4787+003 .3626+004
.2319+003 :        A                                 *               B .2621+004 .4795+003 .3626+004
.2319+003 :        A                                  *              B .2626+004 .4803+003 .3627+004
.2319+003 :        A                                  *              B .2630+004 .4811+003 .3627+004
.2320+003 :        A                                  *              B .2635+004 .4819+003 .3627+004
.2320+003 :        A                                  *              B .2639+004 .4827+003 .3628+004
.2320+003 :        A                                  *              B .2643+004 .4835+003 .3628+004
.2320+003 :        A                                  *              B .2648+004 .4843+003 .3628+004
.2320+003 :        A                                  *              B .2652+004 .4851+003 .3628+004
.2321+003 :        A                                  *              B .2657+004 .4859+003 .3629+004
.2321+003 :        A                                  *              B .2661+004 .4867+003 .3629+004
.2321+003 :        A                                  *              B .2665+004 .4875+003 .3629+004
.2321+003 :        A                                  *              B .2670+004 .4883+003 .3630+004
.2321+003 :        A                                  *              B .2674+004 .4891+003 .3630+004
.2322+003 :        A                                   *             B .2679+004 .4899+003 .3630+004
.2322+003 :        A                                   *             B .2683+004 .4907+003 .3631+004
ERR MODE  ERR-TYPE: 02    ERR-CODE: 4
```

IX.F.5. Noise Characteristics

Figures F140 - F153

DATA FOR THE X-AXIS

CURVE 'A' IS A PLOT OF BASE VERSUS TIME

CURVE 'B' IS A PLOT OF TIP   VERSUS TIME

```
          MINIMUM VALUE                                           MAXIMUM VALUE
          -.4088-001                                              .6077-001
TIME      I                                                                    I     BASE       TIP
.2200+003 I                           A  B                                     I .4255-005 .4758-002
.2200+003 I                         B A                                        I .9006-005-.3123-002
.2201+003 I                        B  A                                        I-.1016-004-.3344-002
.2201+003 I                  B        A                                        I-.7895-004-.1280-001
.2201+003 I                   B       A                                        I-.1621-003-.1080-001
.2201+003 I                         B A                                        I-.2146-003-.2825-002
.2201+003 I                           A    B                                   I-.1979-003 .7679-002
.2202+003 I                           A        B                                I-.1213-003 .1327-001
.2202+003 I                           A          B                             I-.2222-004 .1585-001
.2202+003 I                           A      B                                 I .5272-004 .1088-001
.2202+003 I                           A      B                                 I .1322-003 .1069-001
.2202+003 I                           A          B                             I .2277-003 .1654-001
.2203+003 I                           A B                                      I .2973-003 .3202-002
.2203+003 I                      B    A                                        I .2894-003-.6370-002
.2203+003 I                 B         A                                        I .2171-003-.1415-001
.2203+003 I                   B       A                                        I .1431-003-.1077-001
.2203+003 I               B           A                                        I .4755-004-.1702-001
.2204+003 I       B                   A                                        I-.1029-003-.2856-001
.2204+003 B                          A:                                        I-.3408-003-.4088-001
.2204+003 B                          A:                                        I-.6257-003-.4047-001
.2204+003 IB                         A:                                        I-.8915-003-.3914-001
.2204+003 I   B                      A:                                        I-.1135-002-.3440-001
.2205+003 I             B            A:                                        I-.1330-002-.2016-001
.2205+003 I         B                A:                                        I-.1499-002-.2572-001
.2205+003 I                  B       A:                                        I-.1631-002-.1246-001
.2205+003 I                   B     A :                                        I-.1740-002-.1050-001
.2205+003 I                      B  A :                                        I-.1801-002-.7482-002
.2206+003 I                     B   A :                                        I-.1856-002-.8217-002
.2206+003 I                         A B                                        I-.1896-002 .8836-003
.2206+003 I                         A :    B                                   I-.1898-002 .7077-002
.2206+003 I                         A :  B                                     I-.1878-002 .5287-002
.2206+003 I                         B :                                        I-.1893-002-.2522-002
.2207+003 I                         B :                                        I-.1937-002-.2582-002
.2207+003 I                         A :   B                                    I-.1927-002 .6942-002
.2207+003 I                         A :B                                       I-.1922-002 .2160-002
.2207+003 I                         B :                                        I-.1933-002-.1746-002
.2207+003 I                         A B                                        I-.1950-002 .5792-003
.2208+003 I                         A : B                                      I-.1953-002 .2783-002
.2208+003 I                         A :    B                                   I-.1923-002 .7382-002
.2208+003 I                         AB:                                        I-.1913-002-.1542-002
.2208+003 I                       B A :                                        I-.1959-002-.5031-002
.2208+003 I                     B   A :                                        I-.2011-002-.8386-002
.2209+003 I                      B  A :                                        I-.2078-002-.7346-002
```

FIGURE F140

FIGURE F141

```
.2209+003 I                B        A :            I-.2150-002-.1536-001
.2209+003 I               B         A :            I-.2269-002-.1720-001
.2209+003 I                         AB:            I-.2322-002-.3554-003
.2209+003 I                       B A :            I-.2349-002-.5507-002
.2210+003 I                         B :            I-.2373-002-.2607-002
.2210+003 I                     B   A :            I-.2402-002-.8744-002
.2210+003 I                    B    A :            I-.2448-002-.9344-002
.2210+003 I                        BA :            I-.2484-002-.3465-002
.2210+003 I                         A : B          I-.2491-002 .3108-002
.2211+003 I                         B :            I-.2482-002-.1682-002
.2211+003 I                         A :B           I-.2460-002 .2013-002
.2211+003 I                         A :B           I-.2448-002 .2659-002
.2211+003 I                         A : B          I-.2430-002 .2994-002
.2211+003 I                         AB:            I-.2437-002-.8392-003
.2212+003 I                         B :            I-.2447-002-.2938-002
.2212+003 I                         AB:            I-.2475-002-.4044-003
.2212+003 I                         A : B          I-.2486-002 .3793-002
.2212+003 I                         A :   B        I-.2458-002 .6144-002
.2212+003 I                         A :       B    I-.2413-002 .1222-001
.2213+003 I                         A :  B         I-.2377-002 .5159-002
.2213+003 I                         A :  B         I-.2351-002 .4767-002
.2213+003 I                       B A :            I-.2359-002-.4785-002
.2213+003 I                       B A :            I-.2430-002-.4860-002
.2213+003 I                         A : B          I-.2466-002 .2951-002
.2214+003 I                        BA :            I-.2493-002-.3580-002
.2214+003 I                         B :            I-.2541-002-.2821-002
.2214+003 I                         B :            I-.2604-002-.2523-002
.2214+003 I                         B :            I-.2650-002-.2410-002
.2214+003 I                         AB:            I-.2698-002-.1159-002
.2215+003 I                         A :   B        I-.2714-002 .6997-002
.2215+003 I                     B   A :            I-.2755-002-.7751-002
.2215+003 I                     B   A :            I-.2838-002-.8323-002
.2215+003 I              B          A :            I-.2961-002-.1834-001
.2215+003 I              B          A :            I-.3114-002-.1783-001
.2216+003 I                B       A  :            I-.3258-002-.1593-001
.2216+003 I              B         A  :            I-.3411-002-.1853-001
.2216+003 I         B              A  :            I-.3593-002-.2501-001
.2216+003 I              B         A  :            I-.3777-002-.1907-001
.2216+003 I                        AB :            I-.3870-002-.1741-002
.2217+003 I                        A  : B          I-.3907-002 .3649-002
.2217+003 I                        A  B            I-.3916-002 .1218-002
.2217+003 I                        A  : B          I-.3945-002 .3837-002
.2217+003 I                        A  :  B         I-.3962-002 .4357-002
.2217+003 I                        A  :    B       I-.3957-002 .7994-002
.2218+003 I                        A  :   B        I-.3945-002 .5988-002
.2218+003 I                        B  :            I-.3963-002-.3152-002
.2218+003 I                        B  :            I-.4029-002-.4230-002
.2218+003 I                        A B:            I-.4093-002-.3474-003
.2218+003 I                        A  B            I-.4132-002 .5193-004
.2219+003 I                  B     A  :            I-.4207-002-.1226-001
.2219+003 I                    B   A  :            I-.4307-002-.9219-002
.2219+003 I                   B    A  :            I-.4408-002-.1167-001
.2219+003 I                        A  : B          I-.4473-002 .2940-002
.2219+003 I                        A  :  B         I-.4469-002 .4287-002
.2220+003 I                        A  :   B        I-.4452-002 .5745-002
.2220+003 I                        AB :            I-.4472-002-.2917-002
.2220+003 I                     B  A  :            I-.4548-002-.8409-002
```

1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890***SEQ.NO.04

FIGURE F142

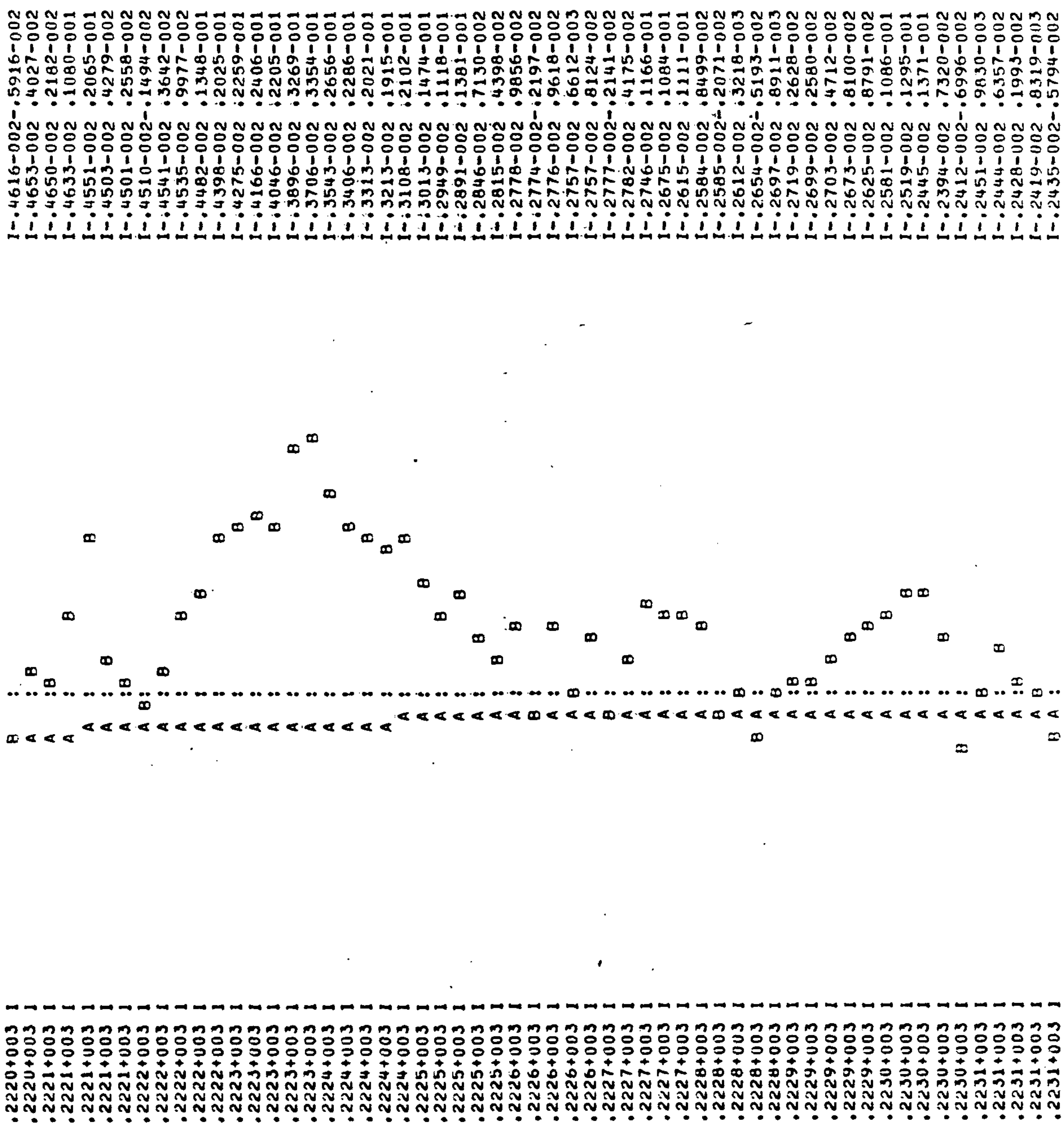


FIGURE F143

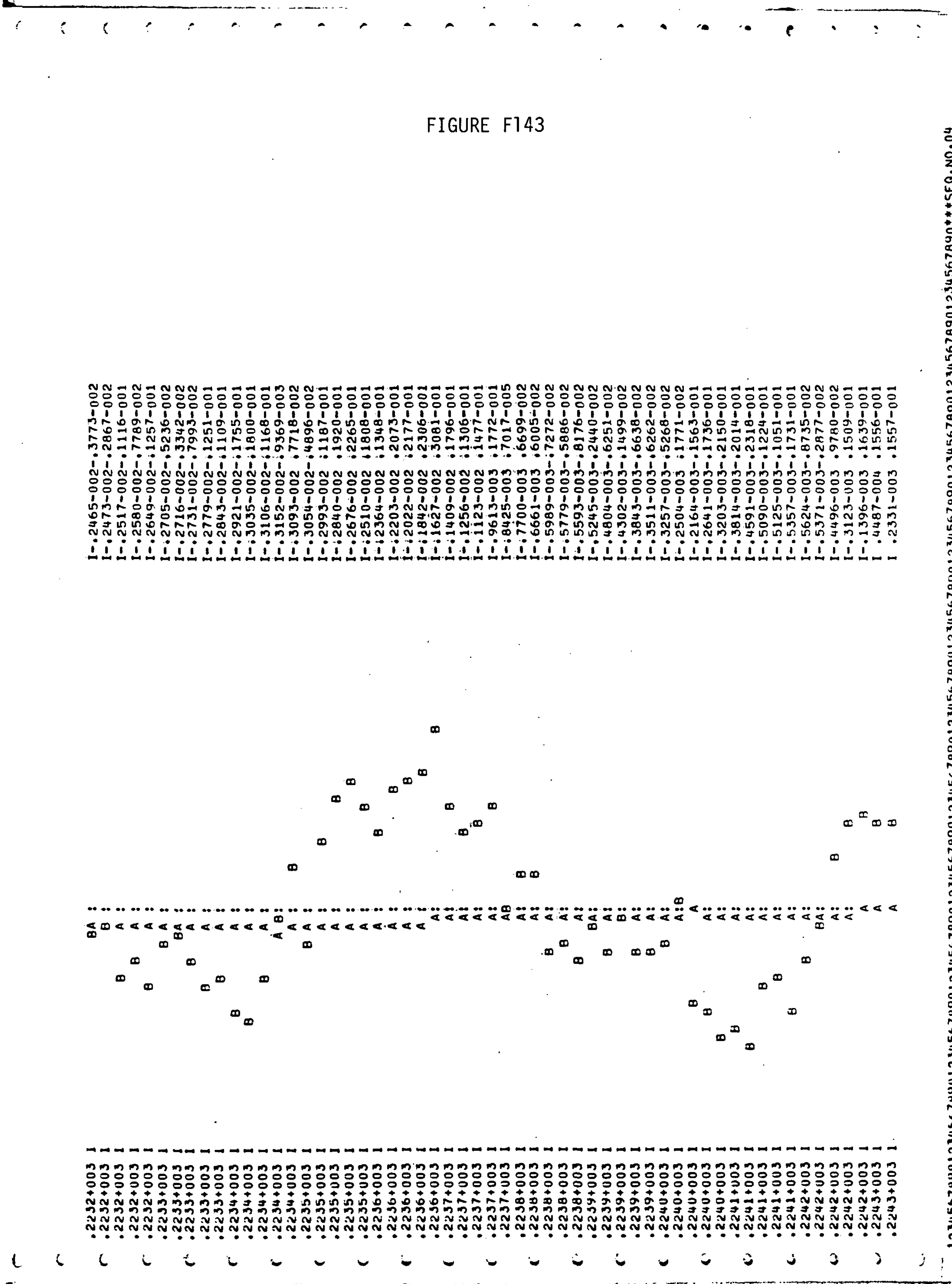
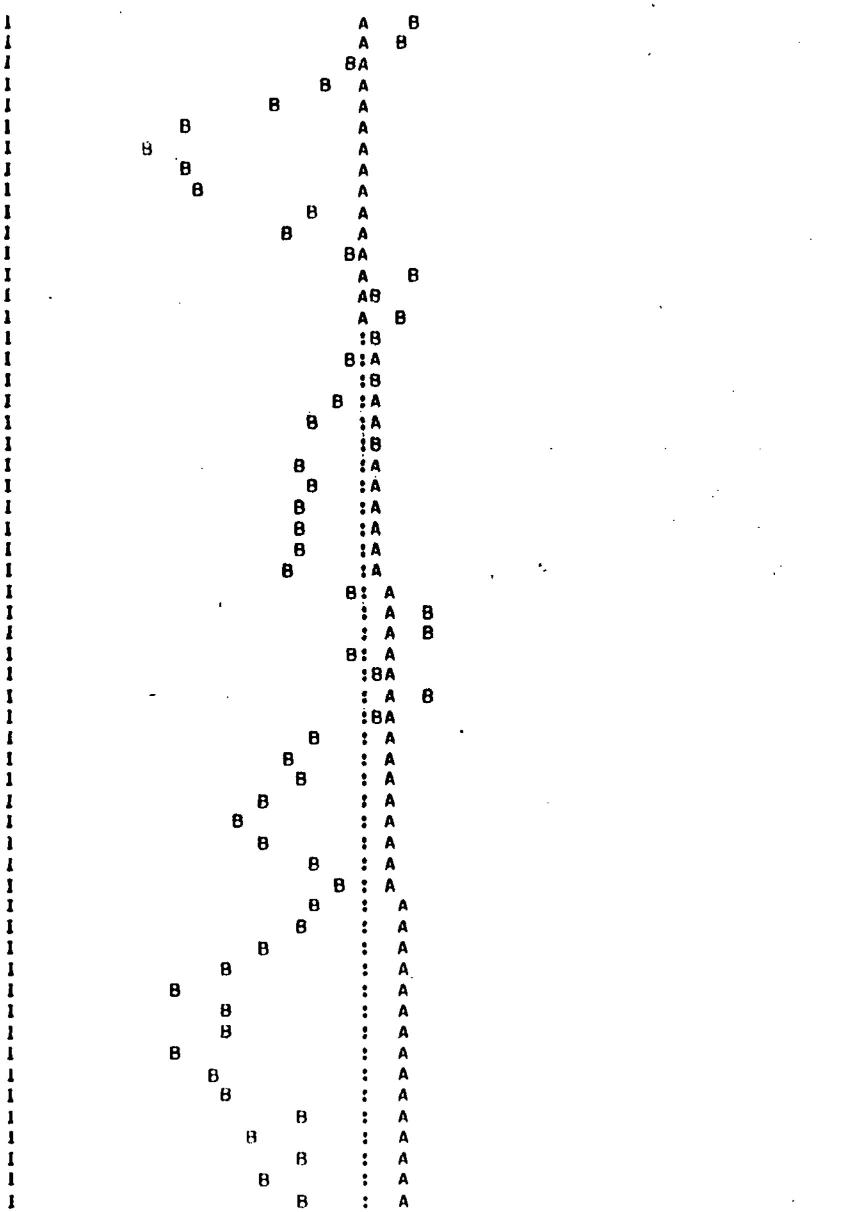
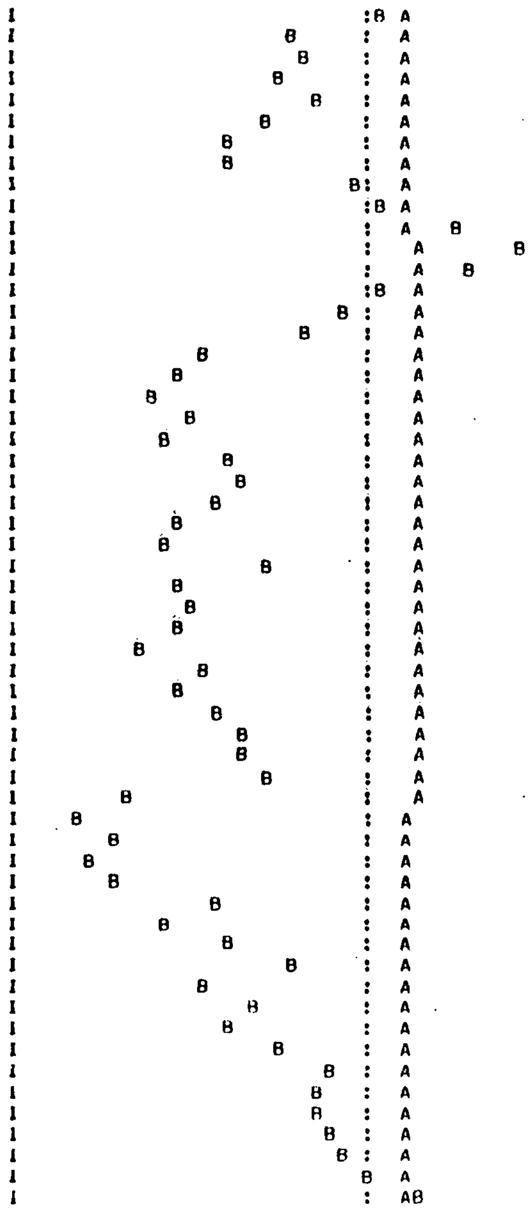


FIGURE F144



.2243+003	.3769-003	.6575-002
.2243+003	.5008-003	.5096-002
.2243+003	.5962-003	-.3163-003
.2244+003	.6536-003	-.3472-002
.2244+003	.7059-003	-.1000-001
.2244+003	.6949-003	-.1973-001
.2244+003	.6600-003	-.2433-001
.2244+003	.5954-003	-.1939-001
.2245+003	.5854-003	-.1779-001
.2245+003	.6266-003	-.4817-002
.2245+003	.7045-003	-.8031-002
.2245+003	.7851-003	-.1648-002
.2245+003	.9252-003	.6881-002
.2246+003	.1083-002	.1759-002
.2246+003	.1209-002	.4822-002
.2246+003	.1353-002	.1738-002
.2246+003	.1474-002	-.1465-002
.2246+003	.1595-002	.2366-002
.2247+003	.1748-002	-.2404-002
.2247+003	.1855-002	-.5239-002
.2247+003	.1999-002	.1945-002
.2247+003	.2124-002	-.6798-002
.2247+003	.2217-002	-.4695-002
.2248+003	.2314-002	-.6399-002
.2248+003	.2410-002	-.6521-002
.2248+003	.2507-002	-.6982-002
.2248+003	.2609-002	-.7714-002
.2248+003	.2715-002	-.6845-003
.2249+003	.2875-002	.8212-002
.2249+003	.3056-002	.7879-002
.2249+003	.3200-002	-.1303-002
.2249+003	.3312-002	.1806-002
.2249+003	.3457-002	.7846-002
.2250+003	.3612-002	.2217-002
.2250+003	.3728-002	-.5071-002
.2250+003	.3794-002	-.8702-002
.2250+003	.3848-002	-.6943-002
.2250+003	.3909-002	-.1123-001
.2251+003	.3943-002	-.1341-001
.2251+003	.3964-002	-.1177-001
.2251+003	.4012-002	-.5938-002
.2251+003	.4094-002	-.3035-002
.2251+003	.4178-002	-.5985-002
.2252+003	.4239-002	-.6410-002
.2252+003	.4289-002	-.1063-001
.2252+003	.4313-002	-.1554-001
.2252+003	.4314-002	-.2112-001
.2252+003	.4298-002	-.1543-001
.2253+003	.4307-002	-.1564-001
.2253+003	.4313-002	-.2143-001
.2253+003	.4295-002	-.1675-001
.2253+003	.4307-002	-.1495-001
.2253+003	.4357-002	-.6050-002
.2254+003	.4427-002	-.1220-001
.2254+003	.4494-002	-.6164-002
.2254+003	.4557-002	-.1139-001
.2254+003	.4599-002	-.6744-002

FIGURE F145



.2254+003	.4719-002	.1643-002
.2255+003	.4818-002	-.8205-002
.2255+003	.4903-002	-.6342-002
.2255+003	.4980-002	-.1027-001
.2255+003	.5052-002	-.4980-002
.2255+003	.5127-002	-.1120-001
.2256+003	.5161-002	-.1494-001
.2256+003	.5191-002	-.1592-001
.2256+003	.5250-002	-.1666-002
.2256+003	.5380-002	.2127-002
.2256+003	.5551-002	.1131-001
.2257+003	.5785-002	.1763-001
.2257+003	.6005-002	.1186-001
.2257+003	.6175-002	.1657-002
.2257+003	.6288-002	-.2813-002
.2257+003	.6397-002	-.7069-002
.2258+003	.6459-002	-.1851-001
.2258+003	.6444-002	-.2150-001
.2258+003	.6402-002	-.2434-001
.2258+003	.6365-002	-.2000-001
.2258+003	.6331-002	-.2284-001
.2259+003	.6314-002	-.1559-001
.2259+003	.6321-002	-.1401-001
.2259+003	.6336-002	-.1622-001
.2259+003	.6328-002	-.2075-001
.2259+003	.6284-002	-.2341-001
.2260+003	.6272-002	-.1108-001
.2260+003	.6243-002	-.2080-001
.2260+003	.6195-002	-.1931-001
.2260+003	.6140-002	-.2131-001
.2260+003	.6063-002	-.2567-001
.2261+003	.5987-002	-.1822-001
.2261+003	.5928-002	-.2131-001
.2261+003	.5863-002	-.1701-001
.2261+003	.5824-002	-.1404-001
.2261+003	.5806-002	-.1359-001
.2262+003	.5787-002	-.1086-001
.2262+003	.5711-002	-.2665-001
.2262+003	.5567-002	-.3281-001
.2262+003	.5407-002	-.2865-001
.2262+003	.5254-002	-.3173-001
.2263+003	.5131-002	-.2869-001
.2263+003	.5029-002	-.1627-001
.2263+003	.4962-002	-.2248-001
.2263+003	.4879-002	-.1524-001
.2263+003	.4846-002	-.8452-002
.2264+003	.4811-002	-.1819-001
.2264+003	.4761-002	-.1215-001
.2264+003	.4718-002	-.1561-001
.2264+003	.4681-002	-.8980-002
.2264+003	.4696-002	-.3469-002
.2265+003	.4701-002	-.5355-002
.2265+003	.4708-002	-.4638-002
.2265+003	.4742-002	-.4513-002
.2265+003	.4769-002	-.2140-002
.2265+003	.4823-002	.1058-002
.2266+003	.4873-002	.6291-002

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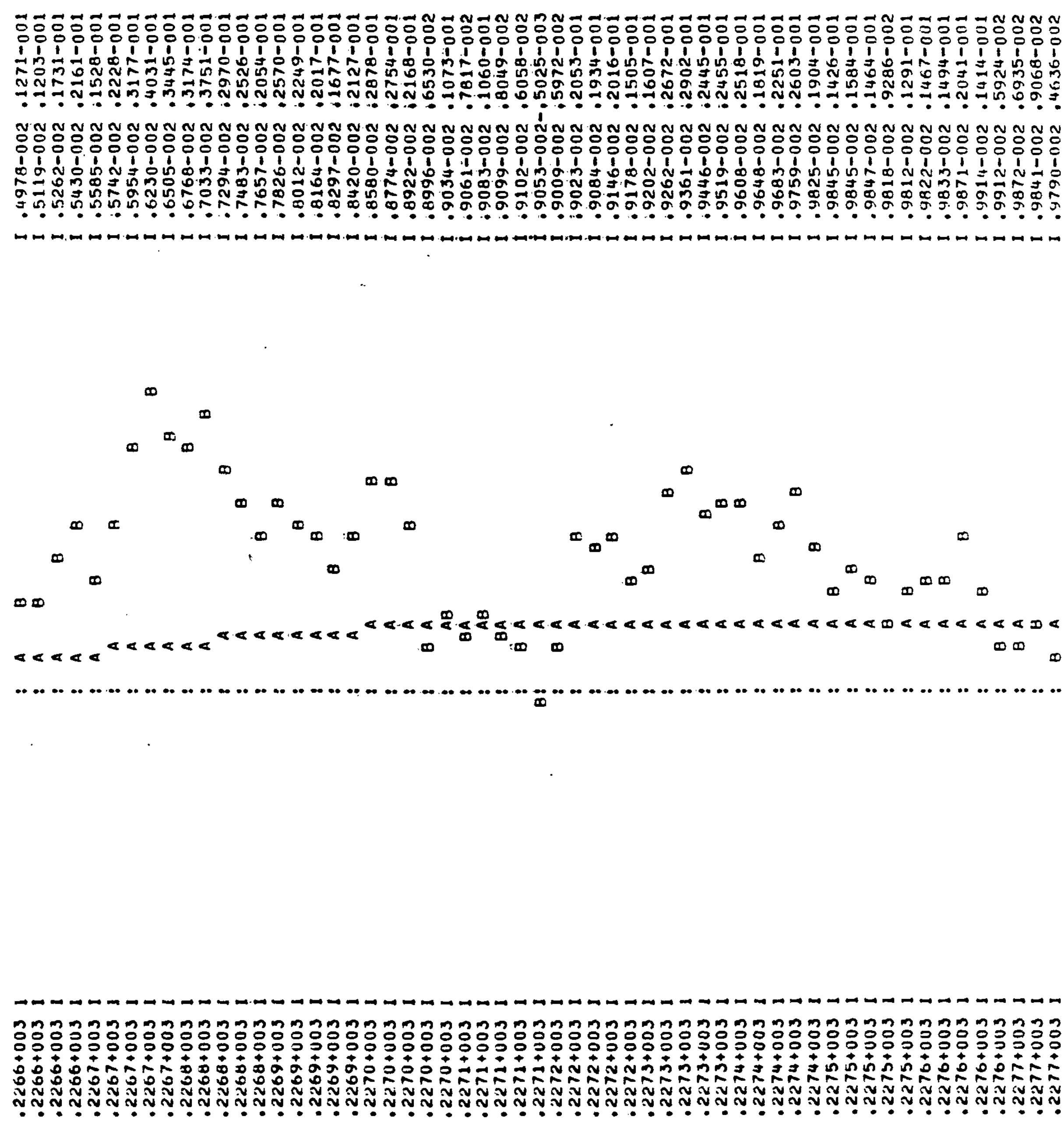
FIGURE F146



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.2277+003 I                           :    BA                                 I .9751-002 .7475-002
.2277+003 I                           :     A  B                              I .9737-002 .1418-001
.2278+003 I                           :     A    B                            I .9742-002 .1642-001
.2278+003 I                           :     A       B                         I .9783-002 .2134-001
.2278+003 I                           :     A            B                    I .9870-002 .2814-001
.2278+003 I                           :     A    B                            I .9929-002 .1706-001
.2278+003 I                           :      A B                              I .9943-002 .1373-001
.2279+003 I                           :      A    B                           I .9959-002 .1740-001
.2279+003 I                           :      A  B                             I .9962-002 .1506-001
.2279+003 I                           :      A    B                           I .9965-002 .1776-001
.2279+003 I                           :      A       B                        I .9987-002 .2211-001
.2279+003 I                           :      A             B                  I .1005-001 .3204-001
.2280+003 I                           :      A               B                I .1018-001 .3538-001
.2280+003 I                           :      A                        B       I .1035-001 .4846-001
.2280+003 I                           :      A                              B I .1058-001 .5656-001
.2280+003 I                           :      A                              B I .1083-001 .5728-001
.2280+003 I                           :      A                           B    I .1107-001 .5326-001
.2281+003 I                           :      A                      B         I .1128-001 .4579-001
.2281+003 I                           :       A              B                I .1143-001 .3476-001
.2281+003 I                           :       A          B                    I .1152-001 .2926-001
.2281+003 I                           :       A     B                         I .1156-001 .2047-001
.2281+003 I                           :       A            B                  I .1162-001 .3107-001
.2282+003 I                           :       A             B                 I .1171-001 .3260-001
.2282+003 I                           :       A             B                 I .1180-001 .3275-001
.2282+003 I                           :       A         B                     I .1186-001 .2600-001
.2282+003 I                           :       A      B                        I .1191-001 .2170-001
.2282+003 I                           :       A      B                        I .1195-001 .2251-001
.2283+003 I                           :       A  B                            I .1197-001 .1608-001
.2283+003 I                           :       A  B                            I .1196-001 .1660-001
.2283+003 I                           :       A     B                         I .1197-001 .2110-001
.2283+003 I                           :      BA                               I .1196-001 .1068-001
.2283+003 I                           : B     A                               I .1190-001 .2915-002
.2284+003 I                          B:       A                               I .1181-001-.7266-003
.2284+003 I                           :    B  A                               I .1170-001 .7665-002
.2284+003 I                           :       A  B                            I .1168-001 .1633-001
.2284+003 I                           :       A            B                  I .1172-001 .3094-001
.2284+003 I                           :       A       B                       I .1181-001 .2369-001
.2285+003 I                           :       A        B                      I .1187-001 .2571-001
.2285+003 I                           :       A          B                    I .1193-001 .2850-001
.2285+003 I                           :       A         B                     I .1199-001 .2598-001
.2285+003 I                           :       A                  B            I .1211-001 .4126-001
.2285+003 I                           :       A                B              I .1227-001 .3893-001
.2286+003 I                           :       A                         B     I .1248-001 .5087-001
.2286+003 I                           :       A                     B         I .1271-001 .4592-001
.2286+003 I                           :        A                          B   I .1294-001 .5377-001
.2286+003 I                           :        A                              B .1322-001 .6077-001
.2286+003 I                           :        A                         B    I .1347-001 .5311-001
.2287+003 I                           :        A                    B         I .1369-001 .4529-001
.2287+003 I                           :        A             B                I .1385-001 .3576-001
.2287+003 I                           :        A      B                       I .1392-001 .2417-001
.2287+003 I                           :        A      B                       I .1399-001 .2395-001
.2287+003 I                           :      B A                              I .1401-001 .1096-001
.2288+003 I                           :    B   A                              I .1398-001 .7217-002
.2288+003 I                       B   :        A                              I .1389-001-.5694-002
.2288+003 I                    B      :        A                              I .1375-001-.8993-002
.2288+003 I                      B    :        A                              I .1360-001-.7377-002
.2288+003 I                  B        :        A                              I .1343-001-.1233-001

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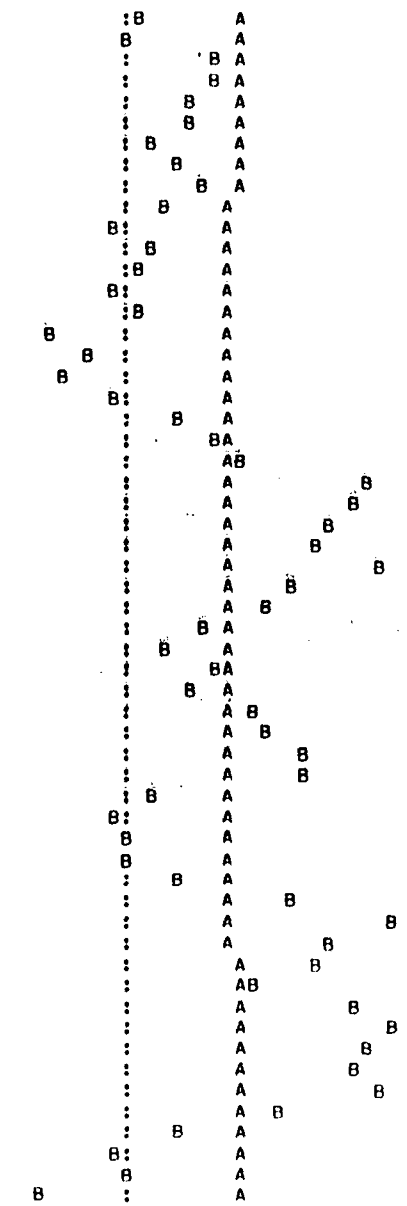
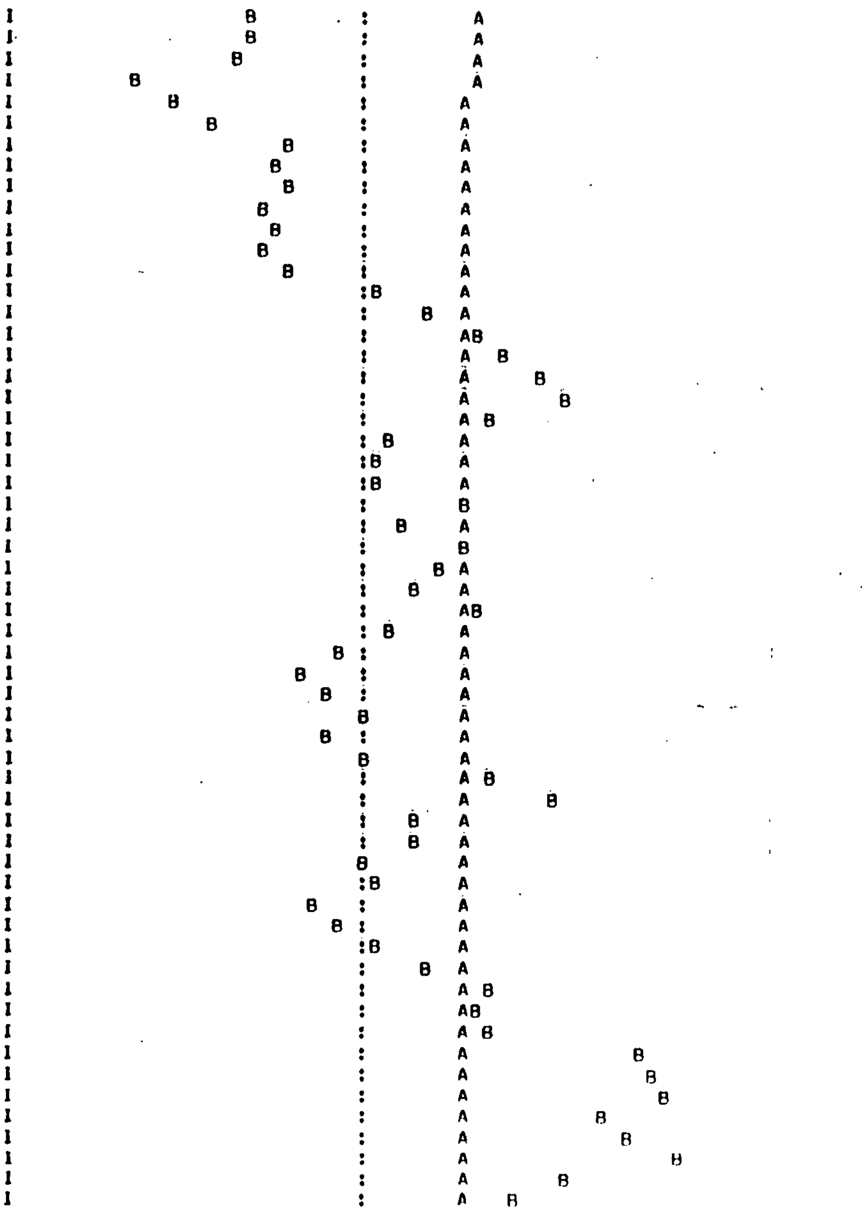
FIGURE F147

FIGURE F148



.2289+003	.1330-001	.1861-002
.2289+003	.1323-001	.1167-002
.2289+003	.1317-001	.1087-001
.2289+003	.1316-001	.1093-001
.2289+003	.1312-001	.8053-002
.2290+003	.1306-001	.7213-002
.2290+003	.1299-001	.3774-002
.2290+003	.1293-001	.5936-002
.2290+003	.1287-001	.8953-002
.2290+003	.1281-001	.4628-002
.2291+003	.1272-001	-.1466-002
.2291+003	.1264-001	.3106-002
.2291+003	.1256-001	.2502-002
.2291+003	.1246-001	-.1340-002
.2291+003	.1234-001	.1541-002
.2292+003	.1220-001	-.8838-002
.2292+003	.1206-001	-.4297-002
.2292+003	.1193-001	-.7349-002
.2292+003	.1180-001	-.1177-002
.2292+003	.1172-001	.5633-002
.2293+003	.1168-001	.1093-001
.2293+003	.1166-001	.1428-001
.2293+003	.1171-001	.2792-001
.2293+003	.1181-001	.2697-001
.2293+003	.1190-001	.2357-001
.2294+003	.1197-001	.2161-001
.2294+003	.1204-001	.2892-001
.2294+003	.1214-001	.1962-001
.2294+003	.1219-001	.1673-001
.2294+003	.1220-001	.8939-002
.2295+003	.1217-001	.4577-002
.2295+003	.1216-001	.1081-001
.2295+003	.1216-001	.7124-002
.2295+003	.1218-001	.1529-001
.2295+003	.1225-001	.1704-001
.2296+003	.1234-001	.2051-001
.2296+003	.1245-001	.2078-001
.2296+003	.1250-001	.3660-002
.2296+003	.1249-001	-.4350-003
.2296+003	.1246-001	.1130-002
.2297+003	.1244-001	.1759-003
.2297+003	.1241-001	.6374-002
.2297+003	.1246-001	.1870-001
.2297+003	.1259-001	.3101-001
.2297+003	.1274-001	.2439-001
.2298+003	.1286-001	.2255-001
.2298+003	.1295-001	.1460-001
.2298+003	.1304-001	.2596-001
.2298+003	.1317-001	.3072-001
.2298+003	.1335-001	.2870-001
.2299+003	.1350-001	.2680-001
.2299+003	.1363-001	.2885-001
.2299+003	.1372-001	.1826-001
.2299+003	.1374-001	.6492-002
.2299+003	.1370-001	-.2566-003
.2300+003	.1364-001	-.9850-004
.2300+003	.1356-001	-.9502-002

FIGURE F149



.2300+003	.1342-001	-.1262-001
.2300+003	.1328-001	-.1293-001
.2300+003	.1313-001	-.1381-001
.2301+003	.1293-001	-.2591-001
.2301+003	.1270-001	-.2178-001
.2301+003	.1250-001	-.1630-001
.2301+003	.1235-001	-.7758-002
.2301+003	.1224-001	-.1017-001
.2302+003	.1211-001	-.7610-002
.2302+003	.1199-001	-.1104-001
.2302+003	.1184-001	-.1028-001
.2302+003	.1169-001	-.1138-001
.2302+003	.1156-001	-.7763-002
.2303+003	.1146-001	.2605-002
.2303+003	.1141-001	.7263-002
.2303+003	.1140-001	.1293-001
.2303+003	.1144-001	.1713-001
.2303+003	.1150-001	.2148-001
.2304+003	.1160-001	.2416-001
.2304+003	.1168-001	.1520-001
.2304+003	.1169-001	.3973-002
.2304+003	.1165-001	.1819-002
.2304+003	.1161-001	.1684-002
.2305+003	.1163-001	.1190-001
.2305+003	.1164-001	.5330-002
.2305+003	.1166-001	.1277-001
.2305+003	.1170-001	.9352-002
.2305+003	.1173-001	.6977-002
.2306+003	.1178-001	.1286-001
.2306+003	.1182-001	.3656-002
.2306+003	.1181-001	-.2437-002
.2306+003	.1175-001	-.6958-002
.2306+003	.1168-001	-.4504-002
.2307+003	.1166-001	.3759-004
.2307+003	.1163-001	-.3208-002
.2307+003	.1161-001	.8828-003
.2307+003	.1165-001	.1514-001
.2307+003	.1176-001	.2192-001
.2308+003	.1183-001	.6040-002
.2308+003	.1184-001	.6361-002
.2308+003	.1184-001	-.1822-003
.2308+003	.1180-001	.1671-002
.2308+003	.1174-001	-.4915-002
.2309+003	.1167-001	-.2975-002
.2309+003	.1162-001	.1458-002
.2309+003	.1158-001	.7970-002
.2309+003	.1161-001	.1485-001
.2309+003	.1164-001	.1346-001
.2310+003	.1166-001	.1531-001
.2310+003	.1175-001	.3256-001
.2310+003	.1190-001	.3453-001
.2310+003	.1207-001	.3547-001
.2310+003	.1220-001	.2857-001
.2311+003	.1235-001	.3061-001
.2311+003	.1250-001	.3741-001
.2311+003	.1262-001	.2360-001
.2311+003	.1266-001	.1782-001

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FIGURE F150

```
.2311+003 I       :       A   B         I .1270-001 .1806-001
.2312+003 I       :       A    B        I .1275-001 .1950-001
.2312+003 I       :      BA             I .1278-001 .1070-001
.2312+003 I       :      BA             I .1279-001 .1044-001
.2312+003 I       :   B   A             I .1278-001 .6196-002
.2312+003 I       :   B   A             I .1275-001 .6357-002
.2313+003 I       :       B             I .1276-001 .1169-001
.2313+003 I       :     B A             I .1277-001 .8619-002
.2313+003 I B     :       A             I .1272-001-.7924-002
.2313+003 I   B   :       A             I .1262-001-.4767-002
.2313+003 I    B  :       A             I .1253-001-.3566-002
.2314+003 I    B  :       A             I .1245-001-.3591-002
.2314+003 I   B   :       A             I .1236-001-.5461-002
.2314+003 I       B       A             I .1229-001 .2035-004
.2314+003 I       :       B             I .1230-001 .1227-001
.2314+003 I       :     B A             I .1232-001 .9189-002
.2315+003 I       :  B    A             I .1232-001 .5099-002
.2315+003 I       :      BA             I .1233-001 .1075-001
.2315+003 I       :B      A             I .1230-001 .1830-002
.2315+003 I       :B      A             I .1226-001 .2035-002
.2315+003 I       :  B    A             I .1222-001 .5514-002
.2316+003 I       :    B  A             I .1221-001 .7614-002
.2316+003 I       :       B             I .1222-001 .1211-001
.2316+003 I       :      BA             I .1224-001 .1134-001
.2316+003 I       :     B A             I .1223-001 .8935-002
.2316+003 I  B    :       A             I .1215-001-.7398-002
.2317+003 I   B   :       A             I .1205-001-.4639-002
.2317+003 I   B   :       A             I .1193-001-.5992-002
.2317+003 I    B  :       A             I .1181-001-.3536-002
.2317+003 I       :   B   A             I .1173-001 .5840-002
.2317+003 I       :      BA             I .1170-001 .1000-001
.2318+003 I       :       AB            I .1168-001 .1350-001
.2318+003 I       :     B A             I .1165-001 .8588-002
.2318+003 I       :     B A             I .1163-001 .9209-002
.2318+003 I       :       B             I .1160-001 .1158-001
.2318+003 I       : B     A             I .1155-001 .3493-002
.2319+003 I      B:       A             I .1144-001-.1447-002
.2319+003 I       :B     A              I .1134-001 .2071-002
.2319+003 I       :B     A              I .1126-001 .2470-002
.2319+003 I       : B    A              I .1116-001 .4125-002
.2319+003 I      B:      A              I .1106-001-.1611-002
.2320+003 I     B :      A              I .1095-001-.1679-002
.2320+003 I       :    B A              I .1087-001 .8226-002
.2320+003 I       :     BA              I .1083-001 .8756-002
.2320+003 I       :B     A              I .1077-001 .2533-002
.2320+003 I       :    B A              I .1070-001 .7820-002
.2321+003 I       :      B              I .1066-001 .1033-001
.2321+003 I       :    B A              I .1062-001 .7458-002
.2321+003 I       :    B A              I .1057-001 .7082-002
.2321+003 I       :      A     B        I .1056-001 .1928-001
.2321+003 I       :      A  B           I .1058-001 .1555-001
.2322+003 I       :      A            B I .1066-001 .3015-001
.2322+003 I       :      A          B   I .1077-001 .2673-001
.2322+003 I       :      A         B    I .1087-001 .2529-001
.2322+003 I       :      A      B       I .1094-001 .2042-001
.2322+003 I       :      B              I .1097-001 .1060-001
.2323+003 I       :      AB             I .1096-001 .1168-001
```

FIGURE F151

```
.2323+003 I                            :      AB                                I .1098-001 .1247-001
.2323+003 I                            :   B  A                                 I .1094-001 .6598-002
.2323+003 I                            :     BA                                 I .1091-001 .9271-002
.2323+003 I                            :      A B                               I .1089-001 .1333-001
.2324+003 I                            :      A    B                            I .1092-001 .1813-001
.2324+003 I                            :      A       B                         I .1097-001 .2219-001
.2324+003 I                            :      A              B                  I .1107-001 .3174-001
.2324+003 I                            :      A             B                   I .1120-001 .3161-001
.2324+003 I                            :      A                   B             I .1135-001 .3901-001
.2325+003 I                            :       A          B                     I .1149-001 .2835-001
.2325+003 I                            :       A      B                         I .1158-001 .2242-001
.2325+003 I                            :      BA                                I .1159-001 .1038-001
.2325+003 I                            :       A  B                             I .1157-001 .1607-001
.2325+003 I                            :       A      B                         I .1158-001 .2296-001
.2326+003 I                            :      BA                                I .1160-001 .1094-001
.2326+003 I                            :       A  B                             I .1158-001 .1692-001
.2326+003 I                            :       A    B                           I .1161-001 .1931-001
.2326+003 I                            :       A    B                           I .1163-001 .1899-001
.2326+003 I                            :       AB                               I .1163-001 .1415-001
.2327+003 I                            :    B  A                                I .1157-001 .8106-002
.2327+003 I                            :B      A                                I .1148-001 .2011-002
.2327+003 I                            : B    A                                 I .1136-001 .3102-002
.2327+003 I                            :  B   A                                 I .1126-001 .4153-002
.2327+003 I                         B  :      A                                 I .1113-001-.3168-002
.2328+003 I                            :   B  A                                 I .1100-001 .6953-002
.2328+003 I                            :      B                                 I .1092-001 .1013-001
.2328+003 I                            :      A    B                            I .1087-001 .1842-001
.2328+003 I                            :      A B                               I .1083-001 .1408-001
.2328+003 I                            :      A    B                            I .1080-001 .1844-001
.2329+003 I                            :      A B                               I .1079-001 .1290-001
.2329+003 I                            :      A   B                             I .1075-001 .1591-001
.2329+003 I                            :     BA                                 I .1069-001 .8526-002
.2329+003 I                            :     BA                                 I .1062-001 .8731-002
.2329+003 I                            :  B   A                                 I .1052-001 .4768-002
.2330+003 I                            :      AB                                I .1045-001 .1264-001
.2330+003 I                           B:      A                                 I .1037-001-.1165-002
.2330+003 I                            B      A                                 I .1025-001 .1110-002
.2330+003 I                            :      AB                                I .1016-001 .1170-001
.2330+003 I                            : B    A                                 I .1007-001 .3479-002
.2331+003 I                            :B     A                                 I .9948-002 .1373-002
.2331+003 I                            :     AB                                 I .9840-002 .1050-001
.2331+003 I                            :     A   B                              I .9775-002 .1477-001
.2331+003 I                            :  B  A                                  I .9716-002 .4587-002
.2331+003 I                            :     BA                                 I .9614-002 .7467-002
.2332+003 I                            :     BA                                 I .9546-002 .7480-002
.2332+003 I                            :     B                                  I .9477-002 .9769-002
.2332+003 I                            :     B                                  I .9421-002 .9794-002
.2332+003 I                            :     B                                  I .9372-002 .8677-002
.2332+003 I                            :    BA                                  I .9305-002 .7882-002
.2333+003 I                            :     A  B                               I .9278-002 .1425-001
.2333+003 I                            :     A B                                I .9240-002 .1146-001
.2333+003 I                            :     A B                                I .9198-002 .1243-001
.2333+003 I                            B     A                                  I .9127-002 .1047-002
.2333+003 I                            :    BA                                  I .9018-002 .7181-002
.2334+003 I                            :     AB                                 I .8951-002 .1083-001
.2334+003 I                            :     A    B                             I .8914-002 .1678-001
.2334+003 I                            :     A          B                       I .8945-002 .2586-001

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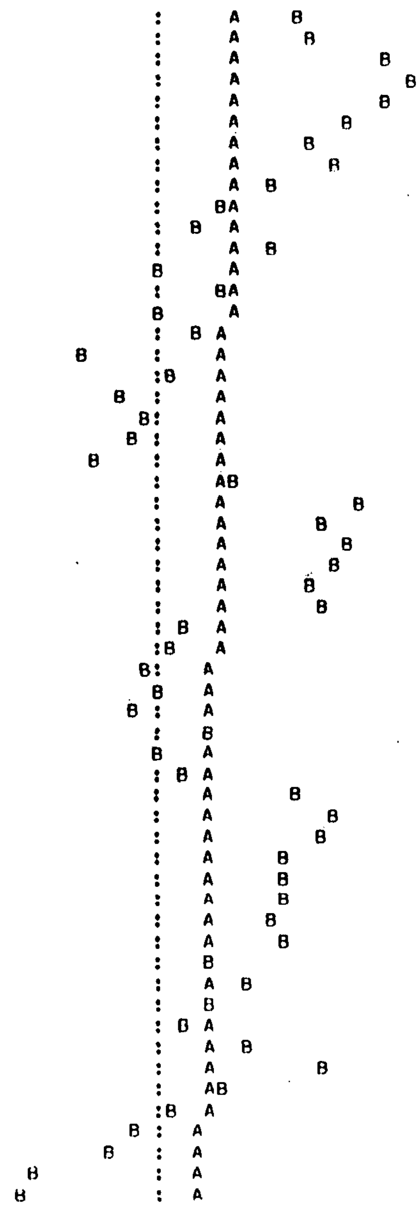
FIGURE F152



.2334+003	.8949-002	.1583-001
.2334+003	.8941-002	.1858-001
.2335+003	.8983-002	.2670-001
.2335+003	.9044-002	.2890-001
.2335+003	.9093-002	.2673-001
.2335+003	.9139-002	.2168-001
.2335+003	.9142-002	.1769-001
.2336+003	.9153-002	.2114-001
.2336+003	.9140-002	.1341-001
.2336+003	.9073-002	.7246-002
.2336+003	.8978-002	.4533-002
.2336+003	.8906-002	.1344-001
.2337+003	.8806-002	-.1725-004
.2337+003	.8702-002	.7828-002
.2337+003	.8592-002	.1215-003
.2337+003	.8472-002	.5439-002
.2337+003	.8331-002	-.7550-002
.2338+003	.8172-002	.1685-002
.2338+003	.8026-002	-.4050-002
.2338+003	.7882-002	-.1212-002
.2338+003	.7727-002	-.3065-002
.2338+003	.7539-002	-.7214-002
.2339+003	.7401-002	.8723-002
.2339+003	.7367-002	.2342-001
.2339+003	.7370-002	.1954-001
.2339+003	.7357-002	.2285-001
.2339+003	.7353-002	.2117-001
.2340+003	.7347-002	.1756-001
.2340+003	.7331-002	.1882-001
.2340+003	.7240-002	.3342-002
.2340+003	.7103-002	.1806-002
.2340+003	.6963-002	-.1298-002
.2341+003	.6824-002	-.4346-004
.2341+003	.6671-002	-.2140-002
.2341+003	.6539-002	.6397-002
.2341+003	.6419-002	.7262-003
.2341+003	.6291-002	.3948-002
.2342+003	.6218-002	.1719-001
.2342+003	.6217-002	.2138-001
.2342+003	.6213-002	.1940-001
.2342+003	.6194-002	.1543-001
.2342+003	.6167-002	.1537-001
.2343+003	.6136-002	.1484-001
.2343+003	.6115-002	.1400-001
.2343+003	.6072-002	.1548-001
.2343+003	.6012-002	.6945-002
.2343+003	.5934-002	.1073-001
.2344+003	.5865-002	.5597-002
.2344+003	.5779-002	.3454-002
.2344+003	.5701-002	.1125-001
.2344+003	.5689-002	.1969-001
.2344+003	.5681-002	.7729-002
.2345+003	.5604-002	.1739-002
.2345+003	.5473-002	-.2310-002
.2345+003	.5332-002	-.5115-002
.2345+003	.5137-002	-.1366-001
.2345+003	.4919-002	-.1508-001

FIGURE F153

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.2346+003 I                      B     :  A                                     I .4711-002-.8187-002
.2346+003 I                            :B A                                     I .4553-002 .1819-002
.2346+003 I                            :  A    B                                I .4466-002 .1241-001
.2346+003 I                            :  A         B                           I .4459-002 .1937-001
.2346+003 I                            :  A          B                          I .4477-002 .2081-001
.2347+003 I                            :  A            B                        I .4507-002 .2407-001
.2347+003 I                            :  A           B                         I .4522-002 .2243-001
.2347+003 I                            :  A          B                          I .4514-002 .2114-001
.2347+003 I                            :  A           B                         I .4534-002 .2180-001
.2347+003 I                            :  A          B                          I .4541-002 .2057-001
.2348+003 I                            :  A        B                            I .4565-002 .1802-001
.2348+003 I                            :  A       B                             I .4549-002 .1689-001
.2348+003 I                            :  A             B                       I .4567-002 .2479-001
.2348+003 I                            :  A       B                             I .4585-002 .1648-001
.2348+003 I                            :  A  B                                  I .4542-002 .8690-002
.2349+003 I                            :  A    B                                I .4483-002 .1277-001
.2349+003 I                            :  A         B                           I .4461-002 .1944-001
.2349+003 I                            :B A                                     I .4422-002 .2411-002
.2349+003 I                            :  B                                     I .4342-002 .4615-002
.2349+003 I                       B    :  A                                     I .4212-002-.6818-002
.2350+003 I                B           : A                                      I .4021-002-.1650-001
.2350+003 I                B           : A                                      I .3802-002-.1721-001
.2350+003 I                   B        : A                                      I .3585-002-.1289-001

1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890***SEQ.NO.04
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IX.G. LOS Sun Sensor Calculations

Fine LOS Sun Sensor Calculation

1. Passband: $\Delta\lambda = .05\ \mu m$ 8250 A° to 8750 A°

   Transmittance = .5 x .5 = .25

2. Assumption: sun is a 5770°k Black Body

   8×10^3 w/cm^2/μm @ λ peak

   5.8×10^3 w/cm^2/μm @ 8500 A°

   1.9×10^3 w/cm^2/μm/sr @ 8500 A°

3. $\Delta\Theta$ = 5 arc min $\Delta\phi$ = 15 arc sec (FIELD STOP)

4. Silicon detector

   .1sec integration, λ peak = 8500 A°

   N.E.P. = 10^{-11}w

5. S/N = 1000

$$= \frac{1.9 \times 10^3 \ \text{w/cm}^2/\mu\text{m/sr} \times .25 \times (.05\ \mu\text{m}) \times 10^{-7}\ \text{sr} \times A \times (.1)}{10^{-11}\text{w}}$$

   Therefore A = .042 cm^2

   Required collecting area.