

**SPACE SOLAR POWER MULTI-BODY DYNAMICS AND CONTROLS,
CONCEPTS FOR THE INTEGRATED SYMMETRICAL CONCENTRATOR
CONFIGURATION**

FINAL REPORT

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1.0 INTRODUCTION

Orbiting space solar power systems are currently being investigated for possible flight in the time frame of 2015-2020 and later. Such space solar power (SSP) satellites must be extremely large to make practical the process of collection, microwave conversion, and reconversion to electrical power at an earth station or at a remote location in space. Many different configurations have been proposed by various study groups over several years of study. We will not review these concepts but instead, will concentrate on the one which has been defined to be our focus for this study, the Integrated Symmetrical Concentrator (ISC). The Integrated Symmetrical Concentrator (ISC) is composed of two very large, segmented reflectors, shaped like clamshells. Each reflector is a flat mirror and each clamshell contains 36 such reflectors. These are individually mounted and aimed to concentrate the reflected sunlight onto two centrally located photovoltaic arrays. The sunlight is converted to electrical energy and transmitted by cabling to a large transmitter, which in turn converts the electrical energy to RF energy and beams it to a dedicated rectenna site on Earth. The transmitter is suspended between the two PV arrays, providing an adequate view of space from the back of the transmitter to manage the thermal loads. The metering structure, which maintains the positions of the clamshell

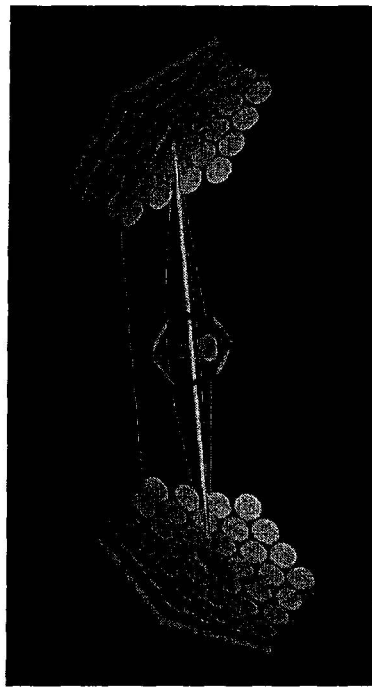


Figure 1.0.1 Artist concept of Integrated Symmetrical Concentrator, courtesy of NASA.

reflectors, is a long, flexible beam aligned with the orbit normal. Bearings and drives at each end rotate the clamshells to track the sun throughout the orbit, and tip them for beta tracking. The ISC is to operate in geosynchronous equatorial orbit. An artist sketch of the ISC configuration is shown in figure 1.0.1. The expected power output from the radiating antenna at GEO will be approximately 2 gigawatts. With conversion and radiation losses this is expected to result in 1.2 gigawatts at the output of the earth station. From this discussion it is evident that the operating attitude of the ISC satellite is to be perpendicular-to-the-orbit-plane, the POP attitude. The sunlight collector sections must point toward the sun and since the

sun motion relative to the earth completes one revolution in a year, the collectors must rotate approximately one degree per day. In addition, they also are tracking the sun's northerly and southerly excursions of $\pm 23.5^\circ$ per year relative to the equatorial plane. Meanwhile, the radiator section must track the earth station location, rotating once around per day. For purposes of these studies, the earth station is assumed to be a point on the earth's equator. Any earth station latitudes other than zero are to be reached by use of electronic beam steering. All power conversion for the ISC configuration is envisioned to occur at the center section in order to minimize the requirement for cabling and power transfer from one section to another. From this discussion, it is clear that the concentrators must be hinged relative to the center section to accommodate these different rotational motions. Two concentrators are provided for symmetry and must be sufficiently separated from the center section for proper focus. The boom is required to position the clamshells, maintaining their focus and providing support. The clamshells are umbrella shaped structures which reflect the sunlight onto photovoltaic arrays near the center of the ISC. The clamshell normal unit vectors bisect the angles between the sun line of sight vector and the orbit normal vectors. This is required to keep the sunlight directed onto the PV arrays. The planes of the PV arrays are not perpendicular to the boom but are rotated 20 degrees so that they have a sufficient view of deep space for proper thermal radiative cooling. The entire central section called the central body in the following, rotates once per orbit (one orbit = one day, 24 hours) maintaining the power beam pointed at the earth station and carrying the PV arrays along with it. The boom structure rotates with the central body in all control concepts except concept 1. In concept 1 there is a single relative degree of rotational freedom about the central body's Z axis. All control concepts 1, 2A, 2B, and 3 will be described in more detail in later sections of this report.

1.1 STATEMENT OF WORK

The National Aeronautics and Space Administration notified bd Systems in April of 2000 that our NRA8-23 proposal number PL90059A entitled "Multi Body Dynamics & Controls", submitted May 12, 1999 was selected for funding with a reduced scope. Specifically, tasks 2 and 4 from that proposal were selected. Task 2 calls for the Analysis of a sample problem to be provided by NASA and Task 4 for documentation. For purposes of this study, the sample problem of interest to NASA is the dynamics and control of the Integrated Symmetrical Concentrator configuration described in the following paragraph:

An understanding of the on-orbit dynamics of this configuration is necessary for concept feasibility assessment, the preliminary design of an attitude control system and an estimate of stationkeeping requirements. The sample problem dynamics and controls studies have been worked according to the subtasks below:

1.1.1 Subtask 1 – Dynamics Model Development

Develop a dynamics model of the Integrated Symmetrical Concentrator in geosynchronous orbit. A minimum model would consist of two rigid bodies representing the clamshells that track the sun, attached by flexible beams to a central rigid body that tracks a fixed point on Earth. Quantify the pertinent disturbance torques and forces (gravity gradient, solar radiation pressure, gyroscopic, etc).

1.1.2 Subtask 2 – Attitude Control Concept

Propose an attitude control system concept that will maintain clamshell solar tracking and transmitter array tracking of the rectenna-site on Earth. Perform trades on centralized vs. distributed or hybrid control architectures. For the 1.2 GW configuration to be built after 2020, develop estimates of torque/momentum requirements, identify suitable actuator locations and develop a top-level mass estimate for an attitude control system, with propellant mass estimates. Identify risks and feasibility issues ("tall poles") with the proposed attitude control concept.

1.1.3 Subtask 3 – Documentation/Deliverables

The dynamics and control model (developed in TREETOPS or another suitable modeling computer code) for the Integrated Symmetrical Concentrator with flexible booms including any additional modifications or enhancements to TREETOPS will be delivered to NASA in the form of a CDROM. This will contain a PC version of the operational TREETOPS software accompanied by source code and data files.

A final report that documents the dynamics and control model development for the Integrated Symmetrical Concentrator, and documents the trades, mass estimates, recommendations and risks for the proposed attitude control system. Microsoft Word and Power Point will be employed to describe in detail the dynamics and control model development and simulations, etc.

1.2 STUDY GROUND RULES AND GUIDELINES

TREETOPS is a general purpose multi-body flexible spacecraft dynamics simulation computer program which was used as the modeling tool for performance of this study. Previous to the study, an enhancement was made to the orbital environment model to a general, non-spherical earth model. During the study enhancements were also made to the sensor models to provide features required by our candidate SSP such as an earth target pointing error sensor, a line of sight 3 axis attitude error sensor, and a sun/star presence flag. NASA/MSFC provided ISC geometry and mass properties to us early in the study. In addition, it was agreed that we would freeze this configuration for study purposes. Dr. Stephen Canfield's work for MSFC as a Summer Faculty Fellow would be the basis for our flexible boom model. Bd Systems built a NASTRAN flexible body model of the boom using inputs obtained from reference 1. This flexible body model was reduced to 24 flexible modes and was incorporated into the ISC model.

The controllers defined for the ISC configuration were all conventional continuous, linear controllers. Conservatism in design and implementation was a guiding principle in this study. This allowed all controllers to be built using standard TREETOPS features without requiring the use of any special, user-defined functions or subroutines. TREETOPS standard sensor and actuator models were employed to define the controller implementations. This included, in some cases new TREETOPS coding to add or modify a sensor model to fulfill a specific requirement for certain functionality not provided in the previous version.

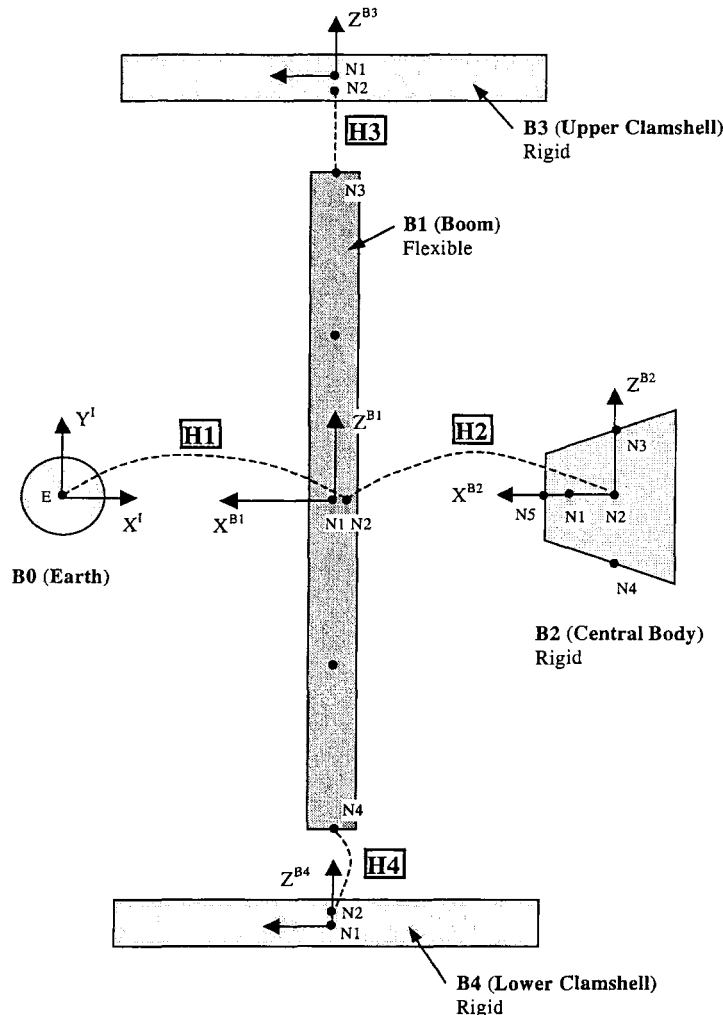
1.3 GOALS AND LIMITATIONS

The goal of this study is to develop a range of controllers for the ISC SSP configuration, which demonstrate control capabilities and allow the requirement for consumables and/or momentum storage capacity to be quantified. A total of 4 control concepts were defined and implemented in the TREETOPS ISC simulation. These covered the range from entirely conventional, centralized control to a multi-body distributed control and demonstrated a range of performance levels showing the features, advantages and disadvantages of each. Detailed description and simulation results will be presented in later sections for each. It must be stated that out of necessity, the ISC configuration, which we have used and for which our results are valid, represents a snapshot in the evolution of the ISC configuration. In the larger NRA activities ISC development has continued. It was necessary for the concept we studied to be frozen in order for the study to be performed and the configuration taken represented a consensus compromise.

1.4 ANALYTICAL TOOLS

As mentioned previously, the primary analysis tool employed for this study was the multi-body modeling code TREETOPS, version 10P2 with capability enhancements developed by bd Systems Control Dynamics Division under several NASA contracts including the present one. Secondary analysis tools included the structural modeling, finite element analysis system known as NASTRAN, the CSA NASTRAN variation. We also employed the Math Works Matlab® version 5.3 for processing the data and generating the plots.

The ISC configuration is illustrated in figure 2.0.1 below as it is laid out for TREETOPS modeling. The model consists of four bodies: 1. The metering structure boom or simply the boom; 2. The solar collector, power converter and radiator, alias the central body; 3. The upper solar concentrator or clamshell; and 4. The lower clamshell. These bodies are described for modeling purposes by their geometry and mass properties shown in the table to the right of the figure. The basic operation of this configuration is to point the central body radiating antenna at the earth station while keeping the clamshells properly pointed to



Body Descriptions	
Body 0 - Earth w.r.t. Geocentric Origin and ECI CS	
Body 1 - Boom Mass Info w.r.t. B1 CM and B1 CS	
Mass (kg)	1.6168633E5
Ixx (kg-m ²)	6.2852173E11
Iyy (kg-m ²)	6.2852173E11
Izz (kg-m ²)	6.7057352E8
Ixy, Ixz, Iyz (kg-m ²)	0. 0. 0.
Nodes w.r.t. B1 Origin and B1 CS	
N1	0 0 0 (CM)
N2	0 0 0
N3	0 0 3188.8
N4	0 0 -3188.8
Body 2 - Central Body Mass Info w.r.t. B2 CM and B2 CS	
Mass (kg)	12666300
Ixx (kg-m ²)	8543E12
Iyy (kg-m ²)	1.5601E12
Izz (kg-m ²)	1.3822E12
Ixy, Ixz, Iyz (kg-m ²)	0. 0. 0.
Nodes w.r.t. B2 Origin and B2 CS	
N1	298.323 0 0
N2	0 0 0
N3	0 0 300
N4	0 0 -300
N5	500 0 0
Body 3 - Upper Clamshell Mass Info w.r.t. B3 CM and B3 CS	
Mass (kg)	2046600
Ixx (kg-m ²)	1.7E12
Iyy (kg-m ²)	1.7E12
Izz (kg-m ²)	3.4E12
Ixy, Ixz, Iyz (kg-m ²)	0. 0. 0.
Nodes w.r.t. B3 Origin and B3 CS	
N1	0 0 0
N2	0 0 0
Body 4 - Lower Clamshell Mass Info w.r.t. B4 CM and B4 CS	
Mass (kg)	2046600
Ixx (kg-m ²)	1.7E12
Iyy (kg-m ²)	1.7E12
Izz (kg-m ²)	3.4E12
Ixy, Ixz, Iyz (kg-m ²)	0. 0. 0.
Nodes w.r.t. B4 Origin and B4 CS	
N1	0 0 0
N2	0 0 0

Description	H1	H2	H3	H4
Concept 1A	3- L1(X ¹), L2(Y ¹), L3(Z ¹)	1- L1(Z ^{B1})	0	0
Concept 2A	3- L1(X ¹), L2(Y ¹), L3(Z ¹)	0	2- L1(X ^{B1}), L2(Y ^{B1})	2- L1(X ^{B1}), L2(Y ^{B1})
Concept 2B	3- L1(X ¹), L2(Y ¹), L3(Z ¹)	0	2- L1(Z ^{B1}), L2(X ^{B1})	2- L1(Z ^{B1}), L2(X ^{B1})
Concept 3	3- L1(X ¹), L2(Y ¹), L3(Z ¹)	0	3- L1(Z ^{B1}), L2(X ^{B1}), L3(Y ^{B1})	3- L1(Z ^{B1}), L2(X ^{B1}), L3(Y ^{B1})

Figure 2.0.1 TREETOPS Model of SSP Integrated Symmetrical Concentrator.

beam solar energy onto the PV arrays. Each clamshell contains 36 flat mirrors that are set at proper angles to focus a spot of light on the PV array. Each is positioned uniquely such that focus is degraded significantly if the clamshell is rotated about the boom even though the plane of the clamshell is maintained. An early control concept (now referenced as concept 2a) was eventually ruled unacceptable

because it did just that. It was maintained in the study for comparison purposes to study performance and propellant consumption.

2.1 CONFIGURATION AND ASSUMPTIONS

The reference coordinate system employed for TREETOPS analysis is shown in figure 2.1.1. This is the inertial coordinates system used for dynamic calculations. In this reference frame, the position of the sun relative to the earth changes over the course of the year. In the spring, at the time of the Vernal Equinox

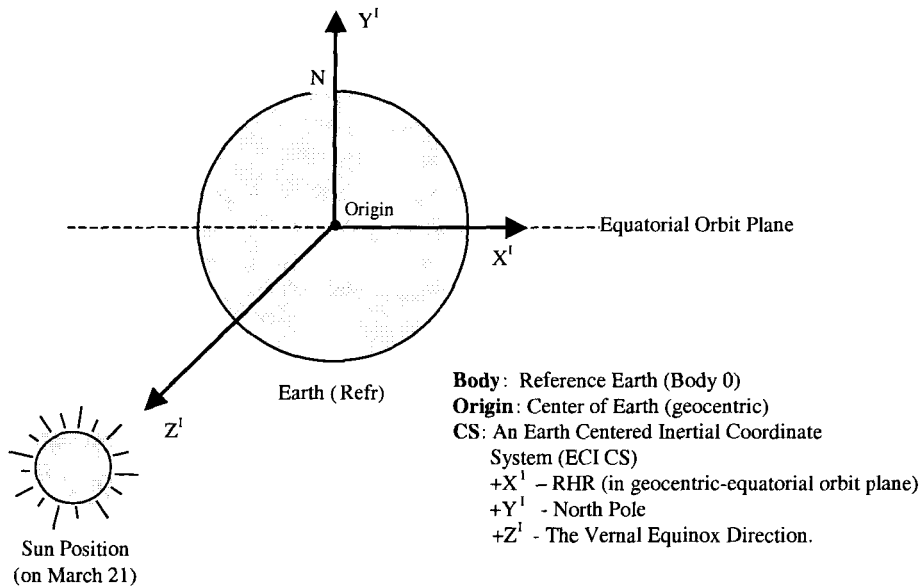


Figure 2.1.1 TREETOPS Inertial Coordinate System.

(VE), around March 21, of the year, is the time of year when the sun appears to pass from the southern to the northern celestial hemisphere through the equatorial plane. Other significant times are June 21, Summer Solstice (SS), sun most northward (23.5° north celestial latitude), September 21, Autumnal Equinox (AE), north to south through the plane and December 21, Winter Solstice (WS), sun most southward (-23.5° celestial latitude). These times provide samples of the different attitudes the ISC must operate in over the course of the year. The first body defined for the ISC is the boom. The boom body axis system is defined with its long axis along Z. The two transverse axes are X and Y respectively and are assumed to be symmetric.

A set of 3 Euler angles defines the TREETOPS hinge 1 rotational degrees of freedom. Figure 2.1.2 shows the orientation of the intermediate axis Z' after rotation through the 1st Euler angle defined about inertial X which rotates the boom Z axis along the inertial Y. The second Euler angle defined is about the intermediate Y' axis. The third Euler angle is about the second intermediate axis Z". The initial position of

the boom, body 1 relative to the TREETOPS inertial frame is specified by the 1-2-3 Euler angle sequence from the TREETOPS inertial frame to the body 1 frame with the angles -90° , 0° , 90° respectively. Figure 2.1.2 shows the initial rotational position of the body 1 frame and the TREETOPS inertial frame. Three translational degrees of freedom are also defined for body 1 and the initial translation position and velocity places the system into a geosynchronous, equatorial orbit. Body 2 is the central body and is positioned by hinge 2 relative to body 1. Only in control concept 1 does hinge 2 have any degrees of freedom defined.

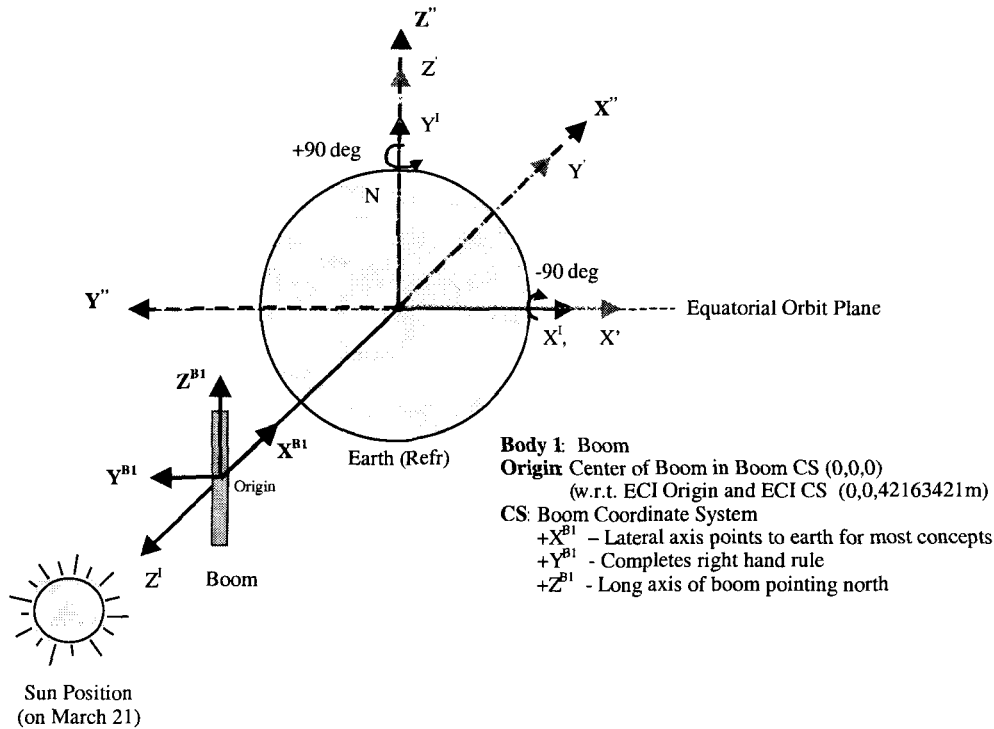


Figure 2.1.2 TREETOPS Body 1 (Boom) coordinate system at Vernal Equinox. Boom CS at Vernal Equinox initial condition = $[90^\circ]_3 [0^\circ]_2 [-90^\circ]_1$ expressed as Euler angle sequence.

Concepts 2a, 2b and 3 have all degrees of freedom locked at this hinge. For concept 1, a single rotational degree of freedom is defined for Z axis relative motion. Body 1 and body 2 are aligned initially at the Vernal Equinox. Since body 2, i.e. the central body tracks the earth station, it must rotate at orbital rate, once per day. Thus, except for control concept 1, the boom also rotates once per day.

The clamshells are attached to the upper and lower ends of the boom. The upper clamshell is TREETOPS body 3 and attached to the boom at hinge 3. The lower clamshell is TREETOPS body 4, attached to the boom at hinge 4. Hinges 3 and 4 are defined similarly to each other but are different for each control concept. They range from 0 defined degrees of freedom for concept 1 to 3 defined degrees of freedom for concept 3.

The concepts introduced above are several control scenarios simulated to provide attitude and pointing control for the several components of the ISC. They will be defined in greater detail in a later section. Concept 1 is also occasionally referenced as concept 1A as there was originally a concept 1B. Concept 1B was eventually dropped because we judged it to be insufficiently different from concept 1A.

2.2 GEOMETRY AND MASS PROPERTIES

Figure 2.0.1 summarizes the structure of the TREETOPS model of the ISC as well as its geometry and mass properties. Addition of the component masses yields the total mass of the ISC configuration: 16.921×10^6 kilograms, nearly 17,000 metric tons. The dimensions expressed in figure 2.0.1 were provided by NASA/MSFC in reference 2 along with the component masses. Each major component mass was idealized as a disk, a rod or an assembly of disks and rods. From these assumptions, the moments of inertia were calculated. The results of these calculations are summarized in the table of the figure. The moment of inertia of a rod about its center of mass is

$$I = \frac{1}{12}ml^2. \quad [1]$$

Similarly, the moment of inertia of a disk about an axis through its center of mass and normal to the surface of the disk is

$$I = \frac{1}{2}ml^2. \quad [2]$$

The moments of inertia about the two transverse axes in the plane of the disk are each half the moment of inertia about the normal, equation 2. These facts are sufficient to estimate moments of inertia for bodies 1, 3 and 4. The moments of inertia of body 2 are computed by adding moments of inertia of 3 disk like structures, representing the two PV arrays and the radiating antenna.

The TREETOPS model description input files for all the control concepts and all the seasonal runs are contained in Appendix A.

2.3 FLEXIBILITY MODELING

The boom was deemed the critical member of the structure from the flexibility perspective and was the only body in the TREETOPS model defined as flexible. Dr. Canfield's study, reference 1, was used as a basis from which we developed a NASTRAN finite element model of the boom structure. Structural modes were generated from this NASTRAN model and the frequencies from this model are contained in Appendix D. The boom flexibility model is developed as a free-free model using the Craig-Bampton reduction technique. A total of 30 modes are calculated and the 24 flexibility modes are taken into TREETOPS to describe the boom flexibility.

The TREETOPS model for the ISC including boom flexibility varied among the different control concepts due differences in the hinge degrees of freedom defined for each. TREETOPS generated mass and stiffness matrices were used to compute combined system modes and frequencies for the uncontrolled systems. These results are presented in Appendix C.

2.4 DISTURBANCE MODELING

The principle disturbances affecting the ISC configuration at synchronous orbit altitude are gravitation and solar radiation pressure. Gravitation determines the orbital motion and the gradient of the gravitational force field causes tidal forces and torques that load the structure and perturb the attitude. These forces/torques are built-into TREETOPS. Reference 3 includes a description of the development of the enhanced gravitation and solar pressure models added to TREETOPS along with the verification of these changes. Especially important in this process is the inclusion of these loading effects on body flexibility and flexible body deformations.

2.4.1 THE GRAVITATIONAL FORCE

The Earth gravitational force field is modeled in TREETOPS by the default field model, which includes field expansion terms through J4 (see Reference 4). Gravity gradient (GG) torques and flexible body

generalized forces are also modeled through this order. Reference 3 contains a detailed development of these expressions. Concerns were expressed regarding the ability of the ISC structures to withstand the GG loading. Simulations did not show this to be a significant problem.

2.4.2 SOLAR RADIATION PRESSURE

The relatively lightweight structures and large surface areas required to capture the solar energy sufficient to radiate approximately 2 gigawatts at the output of the radiator after conversion losses in several stages of conversion makes solar radiation pressure a significant disturbance source along with GG. The clamshells possess the largest surface areas of the ISC structure. Based on the dimensions given in reference 2, 10,400,000 m² was the area of each clamshell. These were modeled as planar areas having a normal along the z axis of the clamshell body, a centroid at the attach point of the solar collection/reflection surface and a reflectivity of 100 percent. The boom was modeled in solar pressure as 4 planar surfaces in successive 90 degree positions around its circumference. Each surface was subdivided into 3 segments, a center segment an upper and an lower segment. The center segment had an area of 638,000 m², the upper and lower each had areas of 319,000 m². These 12 total surfaces areas were attached at the center node of the boom and the upper and lower end nodes of the boom. This model somewhat exaggerated the boom solar pressure area and was deliberately done this way for conservatism and simplicity. The 12 surfaces were used to allow the radiation pressure to act on the separate nodes of the flexible boom and to include to this degree the effects of boom flexibility interacting with the solar radiation pressure. The total area of the boom was still only a small fraction of the area of the clamshells. The central body PV arrays were each modeled by an area of 785,000 m² and the microwave radiating antenna was modeled by an area of 196,000 m². The boom radiation pressure model with its 90 degree planar surfaces does produce effects which are occasionally noticeable. These will be pointed out later in our discussion of simulation results.

2.5 CONTROL CONCEPTS

The successful operation of the ISC configuration requires that the clamshells concentrate sunlight on the photovoltaic arrays. The PV arrays must then convert this sunlight into electrical power. This electrical power is then transferred to another converter where it is transformed once more into microwave energy and beamed by a microwave radiator through an antenna to a station on Earth. This process implies several control processes relating to ISC spacecraft attitude and stationkeeping. For operations purposes, it has been decided to maintain the boom in an orientation perpendicular to the orbital plane a so-called POP attitude. From the POP attitude the clamshells must be oriented so that sunlight is collected and reflected onto the PV arrays. This means that each clamshell's normal must be such that the angle of reflection onto the PV array equals the angle of incidence of sunlight onto the clamshell and all three, the sun, the clamshell normal and the PV array lie in the same plane. Thus, the clamshell normal must be pointed in a direction halfway between the sun and the PV array, which by above assumptions lies in the direction of the orbit normal relative to the clamshell. The clamshell pointing must be sufficiently accurate that the migration of its reflection spot stays on the surface of the PV array. Thirty arc minutes of clamshell motion can cause as much as 1 degree of spot motion and at 3190m separation of clamshell and PV array amounts to approximately 56m of motion. Simultaneously, the energy beam of the central body must point to the Earth station. Electronic beam steering will be used to keep the beam pointed properly, but this can only be used as long as the mechanical antenna pointing is within a small separation of the target. Thus, mechanical pointing of the antenna is required to keep the beam pointed to the earth, which for our application, must be within 30 arc minutes. Based on this discussion, mechanical pointing is required to keep the central body pointed at the Earth while the ISC flies in an equatorial, earth synchronous orbit. Simultaneously, the boom must be maintained aligned with the orbit normal, and the clamshells pointed halfway between the Sun's position and the south or north poles respectively for the upper and lower clamshells. Several concepts have been studied to achieve these control requirements. Also, the ISC's orbital position must be maintained over a particular longitude of earth in a process called stationkeeping. The accuracy required for stationkeeping is understood to be 0.5° of longitude. The focus of this study is spacecraft attitude control. Stationkeeping has not been studied in detail. The propellant estimates given for stationkeeping are made assuming instantaneous balancing of disturbance forces. The following control concepts address attitude control of the ISC configuration only.

The most centralized control concept studied in this activity is concept 1. In this concept, the central body is controlled by a pointing and attitude control system. This system points the antenna at the Earth and holds the roll angle around the antenna line of sight such that the boom is maintained along the orbit normal by virtue of its being structurally hinged to the central body. An Earth target sensor is provided by TREETOPS and is employed in this concept and all the other concepts to provide an error signal for central body pointing control. A star sensor and an idealized pole star target provides a roll error source. The TREETOPS hinge between the boom and the central body has a single degree of freedom such that the central body can rotate about the boom Z axis (see figure 2.1.2). A torque motor actuator provides control torques at hinge 2 from an error signal based on output from a sun sensor. The clamshells are each hinged to the boom with a single degree of freedom hinge to allow raising and lowering them to track the north-south annual sun motion. For TREETOPS implementation of concept 1, this degree of freedom is ignored. It is assumed to operate open loop, maintaining clamshell pointing at the proper north-south angle. Boom yaw is maintained to track the annual solar motion. The detail of instantaneous motion of the sun is not currently modeled in TREETOPS and is ignored in all the concepts.

2.5.2 CONCEPTS 2A AND 2B

The next concept studied in this activity is concept 2A. This was actually the first concept studied. The 2 indicates that 2 axes of clamshell rotational motion are controlled. The A indicates it was the first considered of this type. Clamshell pointing is independently controlled by a controller using sensors and actuators located on the clamshell. The sensor is a special 3-axis line of sight (LOS) sensor that employs 2 guide stars to define a pointing direction and a reference for roll about the LOS. As in concept 1, the actuators employed are moment actuators which produce a pure torque with zero force on the body being controlled. Such an actuator could be realized as pair of thrusters of equal thrust producing forces in opposite directions, whose force lines of action are separated by a nonzero distance or moment arm. In this concept, control of the clamshell pointing depends only on clamshell mounted sensors and actuators, whereas in concept 1, clamshell pointing depended on central body control. Thus, this concept is more distributed than concept 1. The distinguishing feature between concept 2A and concept 2B is the definition of the degrees of freedom defining the hinges between the boom and the clamshells. In concept 2A, TREETOPS hinges 3 and 4 are defined by X and Y gimbal angles, i.e. two angles perpendicular to the long axis of the boom. In concept 2B, hinges 3 and 4 are defined by X and Z gimbal angles. The effect of this subtle difference is that the clamshell rotates about the pointing line of sight in concept 2A but not in concept 2B. The clamshell pointing controller operates the same in both. The rotation in concept 2A results from the rotation of the central body and boom which must rotate once per day to track the Earth target. Since the hinge between boom and clamshell in concept 2A only allows relative rotation about boom transverse axes, the clamshells must rotate with the boom. Hence, the flat mirrors on the clamshells are continuously changing their separation and angular relationship with the PV arrays causing an amount of motion of the reflection spot that was deemed unacceptably large. Thus, concept 2A was eliminated from consideration but is retained for discussion and comparison purposes. This led to concepts 2B and concept 3. In concept 2B, the hinge or gimbal structure between boom and clamshell is first a rotation about the boom Z axis, followed by a rotation about the displaced X axis which is fixed in the clamshell. Thus, the boom once per day rotation is accommodated by the Z axis gimbal and the X axis gimbal accommodates the clamshell north-south tracking of the sun. Both concepts allow residual rotational motions of the boom to perturb clamshell pointing. Hence, some potential for controller interactions exists in these control concepts. For this reason, concept 3 was developed.

2.5.3 CONCEPT 3

In concept 3, the clamshell control is made a full, 3 axis attitude control using the same LOS sensor as in concepts 2A and 2B but now adding a roll torque actuator and employing the roll reference error signal for roll axis control. Again, the control actuators are moment actuators modeled conceptually as force couples. In this concept, the booms are decoupled from the clamshells except for the gravity gradient force. This is accomplished by giving the hinges between boom and clamshells, full, 3 degrees of freedom. This prevents

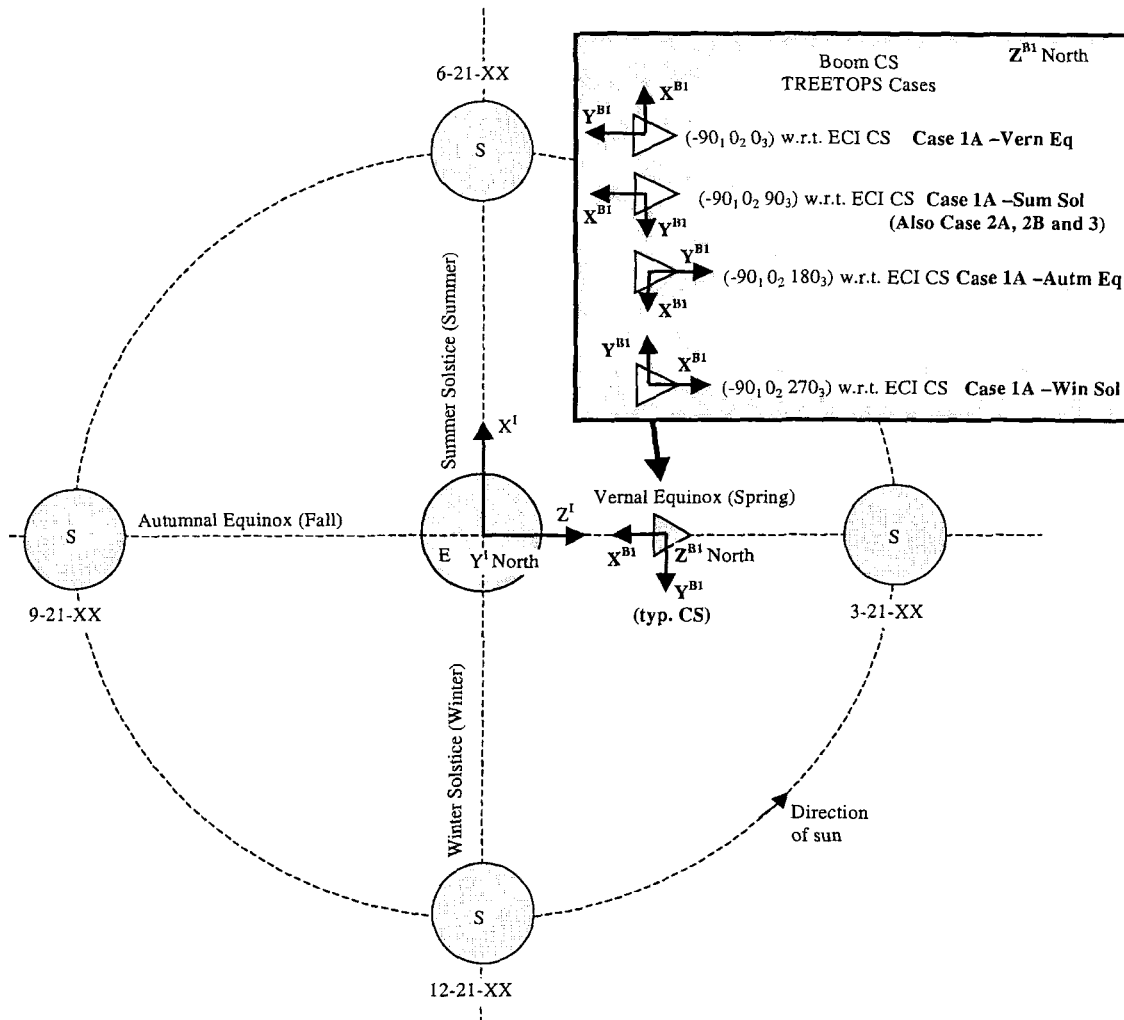


Figure 2.6.1: Body 1 (Boom) Initial CS wrt ECI CS and the Position of the Sun with Respect to the Earth at the Beginning of Each Season (Northern Hemisphere)(Plan View)

torques from being transferred between clamshells and boom and is the most robust ISC controller concept studied.

2.6 SIMULATION STUDIES: FOUR SEASONS AND EARTH SHADOW TRANSIENT PASSAGE

The simulation studies performed on the ISC configuration and the various control concepts were run at various times of the year expected to represent the extremes for the gravity gradient and solar radiation pressure disturbances. These times are the transitional times between the 4 seasons, i.e. Vernal Equinox, Summer Solstice, Autumnal Equinox and Winter Solstice. The Vernal Equinox is the passage of the sun through the equatorial plane going from southern to northern celestial hemispheres and is the first day of spring in the Northern Hemisphere of Earth. The Summer Solstice is the maximum northward motion of the sun in the sky and is the first day of summer. The Autumnal Equinox is the passage of the sun through the equatorial plane going from northern to southern celestial hemispheres and is the first day of autumn or fall. The Winter Solstice is the southernmost motion of the sun in the sky and is the first day of winter. Figure 2.6.1 shows these positions in terms of motion of the sun with respect to the Earth. Figure 2.6.2 shows the same process in side view and represents relationship between the equatorial plane and the ecliptic plane. Also shown in figure 2.6.1 are the approximate dates in the year of the seasonal changes and the initial conditions appropriate for the boom angles in each of the control concepts. At the time of the equinoxes, the upper clamshell normal is pointed downward at 135° from north and the lower clamshell

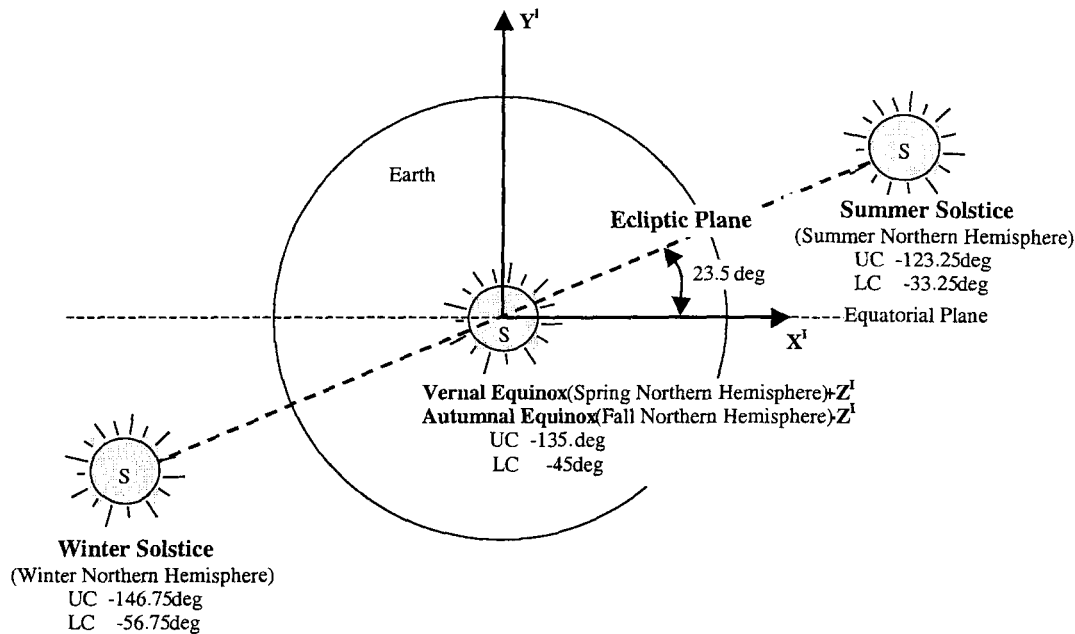


Figure 2.6.2: Position of the Sun with Respect to the Earth at the Beginning of Each Season (Elevation View). Inclination of Ecliptic plane relative to Equatorial plane.

normal is pointed upward at 45° from north. Figure 2.6.2 shows the clamshell angles at each of the seasons. The negative signs on these angles in the figure represents the sense of rotation required to properly position the clamshells. The clamshells redirect and concentrate the sunlight onto the upper and lower PV arrays respectively, with a 90° change of direction of the sunlight at the equinoxes and varying between 113.5 and 67.5 at the other seasons.

The transitions through the Earth's shadow were also studied. Near the equinoxes, the ISC passes through the Earth's shadow once per day. The period of passage lasts somewhat longer than one hour at its longest. This daily passage into the shadow occurs approximately from 1 month before to 1 month after the equinoxes with the duration of shadowing becoming shorter, going to zero when the sun exceeds 8.5° above or below the equatorial plane. The power beam radiation is accompanied by a thrust force of 7 N acting on the central body opposite the pointing direction of the beam, i.e. the negative central body X-axis. This thrust force persists as long as power is flowing in the beam and is appropriate to 2.1 gigawatts. Actual operational scenarios for shadow passage have not been defined but as a worst case condition it was assumed that there was insufficient storage to maintain the power transmission without direct sunlight. The power beam thrust force is cut off as the ISC passes into the Earth shadow and turned on again with passage out. These step force transitions with passage into and out of shadow were considered to be worst case for structure and control excitation. Examination of the Vernal and Autumnal Equinox simulations will reveal this effect. It is most visible in the disturbance forces and torques and the accelerometer sensor outputs.

2.7 CONTROL MOMENT GYROS (CMGS) VS. ION THRUSTERS

The control actuators were modeled in TREETOPS as moment actuators. These are most faithfully realized as pairs of thruster with equal and opposite thrusts at a finite moment arm, which is the perpendicular distance between the force lines of action. These thrusters are assumed to be ion thrusters having a specific impulse appropriate to such devices. Our guidelines for this study are to assume a specific impulse or I_{sp} of 2500 seconds. The moment arms are assumed to be the maximum dimension available in the appropriate axis on the structure being controlled. These assumptions will be employed to estimate the propellant required for control of the various concepts studied. As an alternative, some consideration is given here to momentum storage devices which we shall call CMG's for convenience. We

recognize, however, that these may be momentum wheels or reaction wheels, single or double gimbal CMG's or other devices including flywheels used in the energy storage process. A literature search was performed in search of such devices and their state of development. Little was found, especially in the large size range considered appropriate for space solar power applications. International Space Station (ISS) size devices, approximately 3000 to 3500 Nms stored angular momentum, are considered a starting point size requirement for such systems. Periodic control torque levels in excess of 20,000 Nm with a periods of 12 and 24 hours are typical of levels required and there are occasional control torques in excess of 50,000 Nm. This implies 100,000 or more ISS size CMG's are required for each clamshell and a comparable number are required for central body control. Thus, approximately 300,000 units are required. Each has a mass in excess of 100 kg, so that the total CMG mass exceeds the mass of the ISC. It is clear from this top level discussion that development is required in this area to facilitate utilization of momentum storage technology. This extra structural weight must be traded with the logistical requirements for resupply of thruster propellants to maintain attitude control and stationkeeping. A supplementary consideration is the additional complexity of momentum management techniques required to maintain total stored angular momentum within storage requirements. Significant maneuvering of such a large structure for momentum management purposes would seem to be out of the question. Large scale magnetic torquing also seems impractical. Thus, thrusting for momentum dumping seems the most likely approach. Perhaps such momentum dumping thrust could be held to approximately 10% of that required to control entirely with thrusters. This would result in significant savings but since stationkeeping is also required and appears to be impossible using any other method than periodic thrusting, the value of momentum storage technology for control is reduced. Logistics for propellant resupply is still required.

3.0 RESULTS

It was considered essential to simulate a whole day of operation to assure that at least one cycle of the primary disturbances would be experienced by the systems. Typical simulation runs were 100,000 seconds. This allowed at least 15,000 seconds of time at the beginning of the run for initialization transients to decay so that the steady state motion could be studied. This study was not primarily interested in transient responses due to initialization errors but other transients such as passage through the Earth shadow were of interest because they were repetitive and sure to recur at regular intervals throughout the life of the ISC. Some simulations were run for times as long as 1,000,000 seconds primarily to study the shadow passage transient's longer-term effects. It was only possible to run a small number of such cases because the 10-12 hours of execution time required.

3.1 COMPARISON OF RESULTS FOR ALL CONTROL CONCEPTS OVER FOUR SEASONS -- SYNOPSIS

An extensive set of plots from all the simulation runs for the four control concepts run at each of the four seasonal transition dates is contained in Appendix B. Samples of the data will be discussed in this section to highlight the important results. The Summer Solstice simulations were the most extensively run. In the early phases of the study, all runs were made at this time because of our assessment that it was the time period of the worst case disturbances. Later, it was decided to examine the other seasonal transitions to balance the results and to get a broader sampling of the propellant usage over a typical year for a better estimate of annual totals. A comparison of control concept performance at Summer Solstice is available in section B.3- Figures B.3-1a, B.3-1b, B.3-1c, and B.3-1d show performance of the central body controller for each of the four concepts. Three of the four concepts yield acceptable error performances on the order of a few arc minutes or less. Concept 2A performance showing a yaw axis error repeatedly approaching 19 arc minutes which is marginal at best is shown in figure B.3-1b. It is apparent from the frequency of the yaw axis error oscillation that boom yaw axis flexibility and the direct coupling of this to the clamshell moment of inertia is a principal factor. An equally important factor is that the boom/central body hinge is attached at a point away from the central body center of mass. Thus, boom lateral oscillations couple into central body yaw rotational motion. Boom yaw axis control errors are shown in figure B.3-2a. There are no comparable plots for B.3-2b, etc. since the boom is rigidly attached to the central body in control concepts 2A, 2B and 3. Clamshell pointing errors are shown in figures B.3-3a through B.3-3d. Concept 1 shows a clamshell pointing error in excess of 15 arc minutes which is marginally acceptable. The series of plots in figures B.3-5a through B.3-5d shows the non-gravitational accelerations of the central body. This

vector quantity when multiplied by the total system mass of nearly 17,000 metric tons yields the value of the force that would be required to balance all disturbance forces for perfect stationkeeping control. This calculation yields the total thrust impulse for stationkeeping as determined in this study. The results of this calculation are shown later. Control torques are plotted in figures B.3-6a through B.3-9d for the Summer Solstice cases.

Control concept 1 was run at each of the 4 seasonal transition dates over the year. However, the initial conditions assigning pointing directions to the clamshells were recently discovered to be in error for all except Summer Solstice cases. Thus, results for VE, AE, and WS are not of value for calculating propellant usage. Since no controller is actively processing their error information, they were not being actively driven to proper pointing. This passive control, relying on open loop operation was the attractive feature for this concept, expected to reduce requirements for propellant and minimize complexity. The adverse aspect of the concept was the expected reduction in pointing accuracy and reliance on structural rigidity of the system and the control loads which were being transferred through the boom. Since the boom is extremely flexible in rotation about its slender axis, design of a controller acting in this degree of freedom must be extremely low gain so that the structure is not overstressed and no instabilities are created. In spite of the erroneous IC's behavior of the central body controller and the boom controller results are judged to still be of value. The nature of the initialization error at AE, WS, and VE is that yaw angle of the clamshells is 90°, 180°, or -90° from where they should be. This makes the calculations of solar radiation pressure and gravity gradient torques and the propellant required in error. No statements can be made relating to worst cases here. A valid technique here is to compare the SS results for concept 1 with SS results for concept 3.

The next section summarizes these results to estimate the amount of propellant required to maintain control of the ISC configuration for a year and provide stationkeeping.

3.2 THRUST REQUIREMENTS COMPARISON

The total propellant required for one year's operations is calculated in a series of tables presented as part of Appendix B. Table B.1-1 through B.1-4 presents results for concept 1. As stated above, the values presented as daily totals for AE, WS, and VE are not valid. Thus, the annual total is also not valid.

Table 3.2.1 Predicted Thrust Requirements for Concept 1, Concept 2A, Concept 2B, Concept 3 and Stationkeeping						
Description	Daily Total					Est. Annual Total ave x 365.25
	VE	SS	AE	WS	ave	
C1	97.	440.	101.	440.	270.	98475.
C2A	795.	1669.	808.	1637.	1227.	448217.
C2B	135.	478.	139.	480.	308.	112453.
C3	133.	474.	137.	474.	305.	111243.
Stationkeeping C1	389.	415.	400.	415.	405.	147917.
Stationkeeping C2A	342.	376.	356.	376.	363.	132444.
Stationkeeping C2B	342.	375.	355.	376.	362.	132296.
Stationkeeping C3	342.	376.	355.	376.	362.	132337.
Notes:						
1) See Table B.4-1						
2) Control based on predictions in tables B.1-5 (for C1), B.3-1 (for C2A), B.3-5 (for C2B) and B.2-1 (for C3)						
3) Stationkeeping based on predictions in tables B.1-6 (for C1), B.3-2 (for C2A), B.3-6 (for C2B) and B.2-2 (C3).						

However, SS results are valid. At the Summer Solstice, concept 1 requires 440 kg of propellant for pointing and attitude control and 415 kg are required for perfect stationkeeping control. Concept 3 requires 474 kg of propellant for pointing and attitude control and 376 kg for perfect stationkeeping. Since concept 1 results for AE, WS, and VE are not valid, estimates for usage over a year are made by prorating the SS usages to the other dates relative to concept 3 which is valid over all the dates. The same method is used for the other concepts 2A and 2B. Table 3.2.1 summarizes the results for propellant consumption for the four concepts. An additional point needs to be made with respect to stationkeeping estimates.

Stationkeeping disturbance forces are assumed to be the same over all the concepts since they only depend on position and orientation of components, and these must be virtually the same for all concepts. The results in tables B.1-1 through B3-8 show that concepts 2A, 2B and 3 require virtually identical amounts of propellant while concept 1 requires a somewhat greater amount. This is related to the placement of the 3 axis accelerometer on body 1 at node 2 for concept 1 and on body 2 at node 2 for the other concepts.

Nodes 2 on bodies 1 and 2 are constrained to be co-located. This forces the accelerations to be the same vectorially. However, body 1 in concept 1 is controlled to point to the sun while body 2 is controlled to point to the Earth. As a result, body 2 rotates once per day, while body 1 is non-rotating. The vector force required for stationkeeping is the same but it is resolved along two different axis systems. This makes the thruster forces which are assumed to be aligned with the coordinate axes different in the two cases. As an example to illustrate this, consider the case where the stationkeeping force is constant in the inertial frame, directed along one of the thrusters. In the second body, rotating once per day, the stationkeeping force varies sinusoidally along two of the thrusters. Comparing the two, one finds that the total propellant usage in the rotating body is $4/\pi$ times propellant usage in the stationary body. In the ISC stationkeeping case, the stationkeeping force is not constant in either inertial or rotating bodies so the problem is more complex. Our table of results show that concept 1 usage is approximately 10% higher than the other concepts. Based on this discussion it is clear that the 10% difference is due to the difference in the rotation state of the thrusting body. In this analysis, it was assumed that all stationkeeping thrust was applied at either the central body or the boom. A detailed design for stationkeeping would likely distribute the stationkeeping force as closely as possible to match the distribution of stationkeeping disturbances to minimize any structural deformations due to differential loading effects. It is assumed here that most of the solar pressure loading would be on the clamshells. If this were balanced by a stationkeeping force applied at the central body, a structural deformation of the boom would result.

Pointing and attitude control in TREETOPS is based on the use of force couples, which produce zero net force acting on the body being controlled. These thruster pairs are assumed to be separated by the maximum dimension available on the controlled body. Since two thrusters are firing at the same time, each separately contributes half the moment. Consequently, the appropriate moment arm to employ for propellant consumption calculations is half the maximum separation distance between thrusters. For example, the clamshell thruster moment arm is the clamshell radius which is taken from clamshell sketches as 1800m and from central body sketches as 500m. The moment arms must be divided into our control torque estimates to determine the thrust force required. In addition, the thruster's specific impulse or I_{sp} also must be divided into the thrust force to calculate the weight flow rate of propellant in N/s which in turn must be divided by $g = 9.81 \text{ m/s}^2$ to calculate kg/s of propellant flow. Our guidelines for this study were to use 2500 sec as the thruster specific impulse appropriate to expected ion thruster level of technology available for the ISC. The above calculations employed these assumptions.

As a secondary consideration, it is worth noting that our calculations of total propellant required for control and stationkeeping assume no advantage is taken of opportunities to combine these processes. This is quite conservative. For example, consider the case where stationkeeping requires a force along X of 50N and pointing and attitude control requires a pair of thrusters firing at 25N along + and - X respectively. A single thruster producing 50N along + X could simultaneously satisfy both requirements if placed at the position of the pointing and attitude control 25N thruster with no additional use of propellant for stationkeeping. It is probable that most or all of the stationkeeping force could be combined with attitude and pointing control. Alternatively, it may not be necessary to continuously balance the stationkeeping acceleration forces. Half a degree of error in geosynchronous orbit position is allowed before any correction is required and since much of the stationkeeping accelerations are periodic, much of the stationkeeping drift may balance over time. Thus, the total propellant usage will be strongly dominated by attitude and pointing control requirements. More study of this phenomenon is required to more accurately

estimate its impact on propellant usage. Our scope does not permit us to delve into this phenomenon. Interestingly, our results indicate that pointing/attitude control and stationkeeping propellant requirements when considered separately are roughly equal. Thus, we can probably combine the requirements for both by taking the larger of the two and adding 10%. It appears to be quite conservative to take the two separately and add. Perhaps for now that is the thing to do until more study reveals better estimates.

From the previous discussion, the SS propellant daily total for control and stationkeeping in concepts 1 and 3 were each approximately 850 kg. Concept 3 annual consumption is most accurately calculated over the year and according to tables B.2-3 and B.2-4 in Appendix B yields an annual total of 243,600 kg or 244 metric tons. We can infer from the above that concept 1 propellant usage is the same. <<<<rewrite>>>>

3.3 WEIGHT REQUIREMENTS COMPARISON

Propellant does not appear to be a significant discriminating factor in the weight considerations. The primary differences between concepts for weight considerations is the number of degrees of freedom at hinges H2, H3 and H4. Recall that H2 is the hinge between the central body and the boom and that H3 and H4 are the connections between the boom and the two clamshells. Concept 1 may require a simpler hinge structure at H3 and H4 but will likely more than make up for this simplicity by the complexity and weight of the actuator structure required at H2. Concept 2A has been identified as unacceptable because of the rotational motion induced on the clamshells about their surface normals as well as the unacceptable pointing oscillation and related propellant usage shown above. Concept 2B, which is a modest variation of the 2 degrees of freedom at hinges H3 and H4 from concept 2A, produces significantly better performance than 2A and propellant consumption that is comparable to 1A and 3. Overall there does not appear to be a significant weight differentiation between acceptable control concepts.

3.4 IMPLEMENTATION COMPLEXITY COMPARISON

Concept 3 appears to be the most complex control concept defined in this study since it has more axes being controlled. Examination of the control performance indicates that it also produces the best overall performance of all the concepts. In addition, it produces the least loading on the boom, isolating it from any disturbance torques from the clamshell. In our model, no frictional torques were generated at hinges H3 or H4. The realization of such a hinge may require actively controlled devices such as magnetic suspension. The loads required to be supported at these joints appear to be modest, perhaps of the order of 100-200 N. Adjusting to include a safety factor may drive this to 500N. This would appear to be within achievable levels of magnetic bearing technology, though perhaps other technologies should be examined.

Sensor requirements would appear to be within present state of the art for star trackers and sun sensors. The LOS sensor assumed for pointing the clamshells could be realized by combinations of these devices or perhaps a sun sensor measuring the position of the sun and an artificial star on the PV array being tracked by a tracker on the clamshell. Roll error sensing requirements would be quite modest for this operation. Our controllers were purposely made quite simple, not applying any pressure to the boundaries of control state of the art.

3.5 OVERALL ASSESSMENT COMPARISON

It appears that control of the ISC configuration is feasible as long as ion thrusters of sufficient size for stationkeeping application are available. This implies thruster of several Newtons in thrust and throttleable, although the throttling effect may be achieved by turning on or off individual thrusters in large clusters of these devices. The plumbing requirements for such a system may be a challenging problem, especially the inclusion of the necessary redundancy. Of the control concepts studied, concept 1 is the simplest and concept 3 is the overall best. It does not appear that concept 1 is sufficiently simpler nor uses sufficiently less propellant to be judged preferable. Concept 3 has the best performance, therefore the most margin and seems to present the least risk.

4.0 SUMMARY AND CONCLUSIONS

The Integrated Symmetrical Concentrator Space Solar Power Satellite configuration has been analyzed and simulated in a multi-body, flexible body analysis. This analysis and simulation included the effects of body structural flexibility, gravitation and solar radiation pressure disturbances. Four control concepts were developed and implemented for this configuration.

4.1 CONTROLLERS

The controllers developed for the ISC configuration were conventional and analog in their implementation. Angular position sensors were used to compute errors and analytically derived rates based on the sensed errors were used in PD (position and derivative) feedback linear controllers. These controllers employing moment actuators on the controlled bodies were implemented through the built-in TREETOPS linear control architecture. The input files that accomplish this are included in Appendix A. Issues related to discrete processes and sampling were bypassed and ignored by the assumption of continuous, analog control. Digital implementation and related issues are not expected to be a problem as these techniques have been standard for many years and such issues are well understood. Controllers were purposely kept simple and basic to preclude concerns related to realizability. No consideration was given to problems related to construction or erection of the ISC system into POP attitude, though this is expected to be a considerable problem in its own right. Also, no consideration was given to maneuvers and little consideration to transient responses. Initialization transients were present in most simulation runs and inadvertent errors in initialization revealed robust behavior in most cases in ability to take out such errors though the torques required to do so were in many instances unrealistically high since no limiting was applied to the actuators. Complete results in plot form are contained in Appendix B.

4.2 MODELS

The principal analysis tool employed for this study is an enhanced form of the multi-body analysis and simulation code TREETOPS. This has been enhanced as explained elsewhere in this report body. Three of the four bodies in the ISC model were treated as rigid. The fourth, the long slender boom used as the metering structure for the clamshells, was modeled in its flexibility. A Nastran model was developed for this purpose. The flexible mode frequencies are presented in appendix C for the boom in various loaded conditions as defined by TREETOPS, which calculated an appropriate mass and stiffness matrix from the inputs. The details of the Nastran model are presented in Appendix D.

4.3 DISTURBANCES

The enhanced TREETOPS provides for detailed modeling of gravitational forces and moments as well as for solar radiation pressure. Additionally, included in TREETOPS though not considered significant for this study are aerodynamics and magnetic fields. A full gravity model is implemented supplementing the circular and near circular orbit models previously available. The gravity enhancement included a treatment of flexible body loading, which was previously ignored. Power beam radiation force was also included because of its potential for significant transients as it is turned off and on and also for its ability to contribute to the stationkeeping disturbance environment.

4.4 FEASIBILITY ISSUES

Feasibility of the control concepts studied in this report seems to be virtually assured by the conservative and conventional nature of the controllers defined. Perhaps the biggest question would be the feasibility of producing sufficiently large ion thrusters and gathering and storing sufficient propellant to drive them. Questions related to alternative control methodologies such as momentum management exist related to feasibility and these have been discussed in the report. In summary, momentum management techniques would seem to offer only marginal ability to reduce propellant required and would not seem to offer any significant opportunities to save weight. In fact, additional weight appears to be required and/or considerable development to achieve efficiencies in momentum storage perhaps through combining

momentum storage with flywheel energy storage may offer some hope. Current literature does not seem to offer much hope here.

5.0 FUTURE WORK

As the ISC or other configurations are carried forward into more detailed designs, opportunities exist to revisit and enhance the control concepts developed in this study or to add new ones. Significant issues related to construction/erection of the ISC and the dynamics associated with resupply and routine maintenance are fertile areas for analysis and modeling. Greater fidelity in the modeling process, more consideration of body flexibility are other areas of future work and study. Digital control/sampling effects may be added and more exotic controllers are other areas for future study when the number of configurations is narrowed and the geometry and mass properties are better known and firmed up. Combined effects due to thermal heating and cooling and structural interactions are also areas needing study.

6.0 REFERENCES

1. **Design of Structural Elements for the Integrated Symmetrical Concentrator**, August 2000, Dr. Stephen Canfield, Assistant Professor, Tennessee Technological University, Department of Mechanical Engineering. Sponsored by Dr. Connie Carrington/FD02, NASA/MSFC
2. **ISC_Mass.PPT**, July, 21, 2000, e-mail, received from Dr. Connie Carrington/FD02, NASA/MSFC.
3. **Space Solar Power Multi-Body Dynamics Modeling Final Report**, TCD20000119A, May 30, 2000, Prepared for Purchase Order No. H-31973D, Prepared by John R. Glaese.
4. **Orbital Motion, Third Edition**, A. E. Roy, Published under the Adam Hilger imprint by IOP Publishing Ltd, ISBN 0-85274-228-2, 1988, p. 511.

Appendix A

TREETOPS Model Descriptions

TREETOPS model descriptions of the SSP ISC Configuration for concept 1, concept 2A, concept 2B and concept 3 are given herein. Specifically, the following files are provided herein.

INPUT:

- .int file – Problem Definition (data entered using TREESET)
define bodies, hinges, sensors, actuators, interconnects, etc.
- .lin file – Defines the A, B, C, D matrix for
$$\dot{x} = Ax + Bu$$
$$y = Cx + Du$$
- los.dat – Used for locating a los vector between two star position vectors
- solar_pressure.dat – Solar Pressure Definition: body, node, area, reflectivity factor, outward normal, centroid
- .flx file – Flex data file [SSP Boom (Body 1) modeled as flexible]
An excerpt is given herein. A full flex file is provided in delivered data package.

OUTPUT:

- .CRF file – Cross-reference variables (used to interpret results)
- .MAT file – TREETOPS matrix format data file (read into MATLAB) –
not given here, but provided in delivered data package

This appendix is organized as follows:

First, some general figures and tables are given. Then, information specific to each concept is given.

A.1 Concept 1 Definitions and TREETOPS files

Sensor Definitions

Actuator Definitions

Interconnect Definitions

TREETOPS files:

- Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx
- Vernal Equinox (VE): .int
- Autumnal Equinox (AE): .int
- Winter Solstice (WS): .int

A.2 Concept 2A Definitions and TREETOPS files

Sensor Definitions

Actuator Definitions

Interconnect Definitions

TREETOPS files:

- Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx

A.3 Concept 2B Definitions and TREETOPS files

Sensor Definitions

Actuator Definitions

Interconnect Definitions

TREETOPS files:

- Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx

A.4 Concept 3 Definitions and TREETOPS files

Sensor Definitions

Actuator Definitions

Interconnect Definitions

TREETOPS files:

Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx

Vernal Equinox (VE): .int

Autumnal Equinox (AE): .int

Winter Solstice (WS): .int

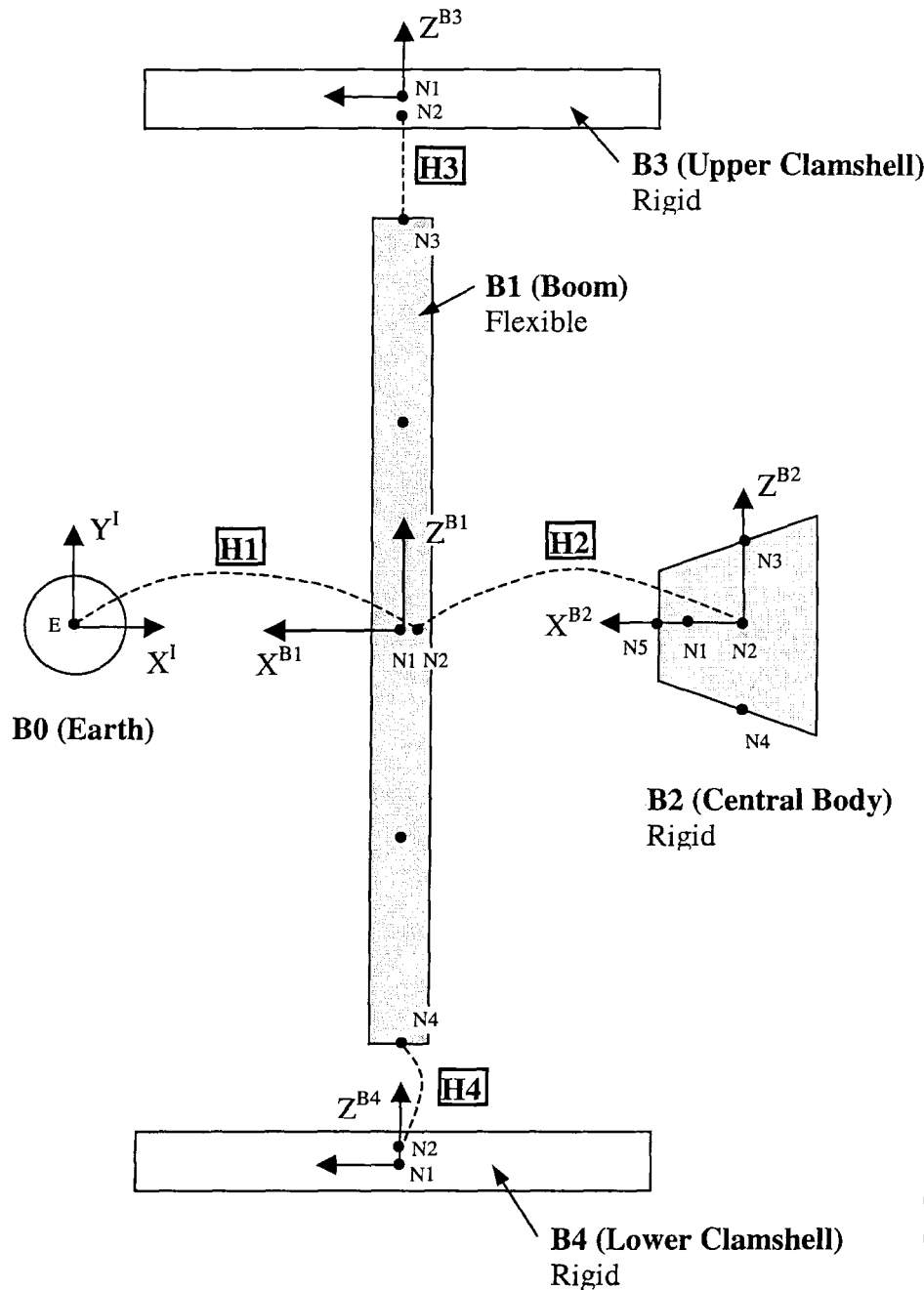
In order to edit TREETOPS use treesel.bat.. For example,

```
treesel.bat isc3_flex_sol
```

In order to run TREETOPS use treetops.bat. For example

```
treetops.bat isc3_flex_sol
```

A graphical sketch of the TREETOPS model of the SSP ISC configuration is provided in Figure A.1 for convenience. The TREETOPS inertial coordinate system is given in Figure A.2. A typical TREETOPS body 1 (boom) coordinate system at vernal equinox, typical boom orientation for case 1 SS, case 2A, 2B and 3, is given in Figure A.3. The body 1 (boom) initial coordinate system with respect to the earth centered inertial coordinate system (ECI CS) and the position of the sun with respect to the earth at the beginning of each season (northern hemisphere)(plan view) is given in Figure A.4. The position of the sun with respect to the earth at the beginning of each season (northern hemisphere) (elevation view) is given in Figure A.5. The initial condition pitch angles of the upper and lower clamshells is given in Figure A.6. The initial conditions in TREETOPS for body 1 (boom), body 2 (central body), body 3 (upper clamshell), and body 4 (lower clamshell) for concept 1, concept 2A, concept 2B and concept 3 are given in Tables A.1a and A.1b. (Later, it was realized that the initial conditions for body 3 and 4 (UC and LC) for concept 1 VE, AE, and WS were not entirely correct. For concept 1 VE, AE and WS, the initial conditions for UC and LC pitch angle were correct, but the initial condition for the UC and LC yaw angle with respect to the boom was not correct.)



Body Descriptions

Body 0 – Earth
w.r.t. Geocentric Origin and ECI CS

Body 1 – Boom

Mass Info w.r.t. B1 CM and B1 CS

Mass (kg) 1.6168633E5

Ixx (kg-m²) 6.2852173E11

Iyy (kg-m²) 6.2852173E11

Izz (kg-m²) 6.7057352E8

Ixy, Ixz, Iyz (kg-m²) 0. 0. 0.

Nodes w.r.t. B1 Origin and B1 CS

N1 0 0 0 (CM)

N2 0 0 0

N3 0 0 3188.8

N4 0 0 -3188.8

Body 2 – Central Body

Mass Info w.r.t. B2 CM and B2 CS

Mass (kg) 12666300

Ixx (kg-m²) .8543E12

Iyy (kg-m²) 1.5601E12

Izz (kg-m²) 1.3822E12

Ixy, Ixz, Iyz (kg-m²) 0. 0. 0.

Nodes w.r.t. B2 Origin and B2 CS

N1 298.323 0 0

N2 0 0 0

N3 0 0 300

N4 0 0 -300

N5 500 0 0

Body 3 – Upper Clamshell

Mass Info w.r.t. B3 CM and B3 CS

Mass (kg) 2046600

Ixx (kg-m²) 1.7E12

Iyy (kg-m²) 1.7E12

Izz (kg-m²) 3.4E12

Ixy, Ixz, Iyz (kg-m²) 0. 0. 0.

Nodes w.r.t. B3 Origin and B3 CS

N1 0 0 0

N2 0 0 0

Body 4 – Lower Clamshell

Mass Info w.r.t. B4 CM and B4 CS

Mass (kg) 2046600

Ixx (kg-m²) 1.7E12

Iyy (kg-m²) 1.7E12

Izz (kg-m²) 3.4E12

Ixy, Ixz, Iyz (kg-m²) 0. 0. 0.

Nodes w.r.t. B4 Origin and B4 CS

N1 0 0 0

N2 0 0 0

Description	H1	H2	H3	H4
Concept 1	3- L1(X ^I), L2(Y ^I), L3(Z ^I)	1- L1(Z ^{B1})	0	0
Concept 2A	3- L1(X ^I), L2(Y ^I), L3(Z ^I)	0	2- L1(X ^{B1}), L2(Y ^{B1})	2- L1(X ^{B1}), L2(Y ^{B1})
Concept 2B	3- L1(X ^I), L2(Y ^I), L3(Z ^I)	0	2- L1(Z ^{B1}), L2(X ^{B1})	2- L1(Z ^{B1}), L2(X ^{B1})
Concept 3	3- L1(X ^I), L2(Y ^I), L3(Z ^I)	0	3- L1(Z ^{B1}), L2(X ^{B1}), L3(Y ^{B1})	3- L1(Z ^{B1}), L2(X ^{B1}), L3(Y ^{B1})

Figure A.1: TREETOPS Model of SSP Integrated Symmetrical Concentrator

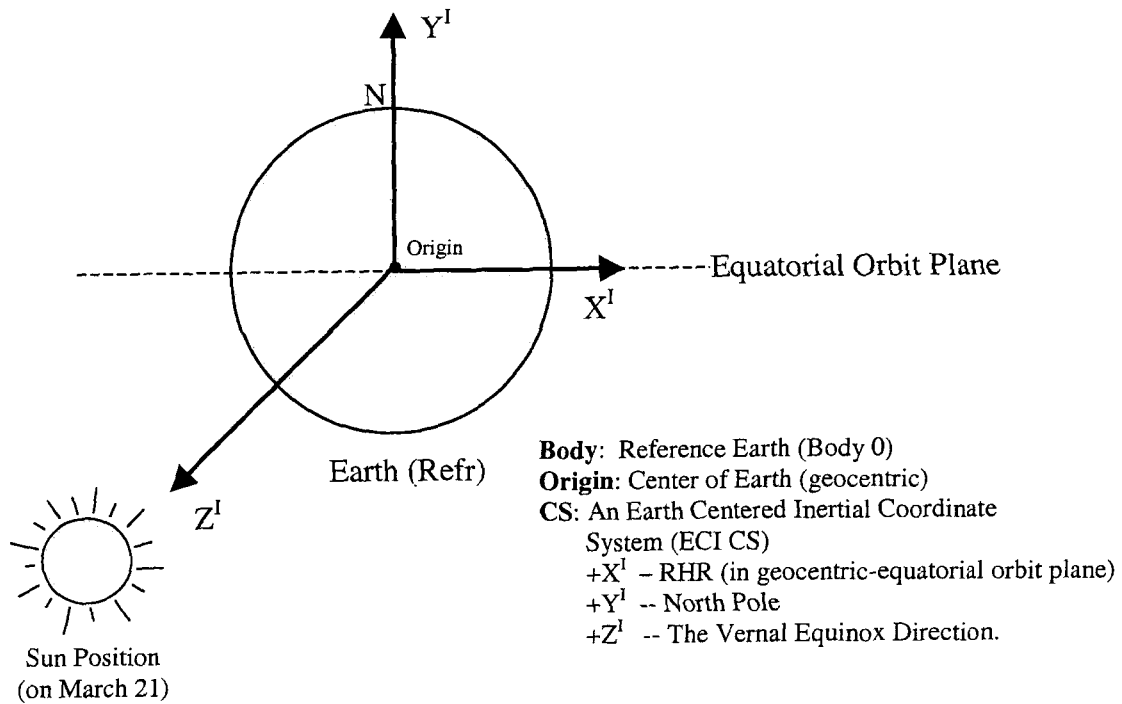


Figure A.2: TREETOPS Inertial Coordinate System

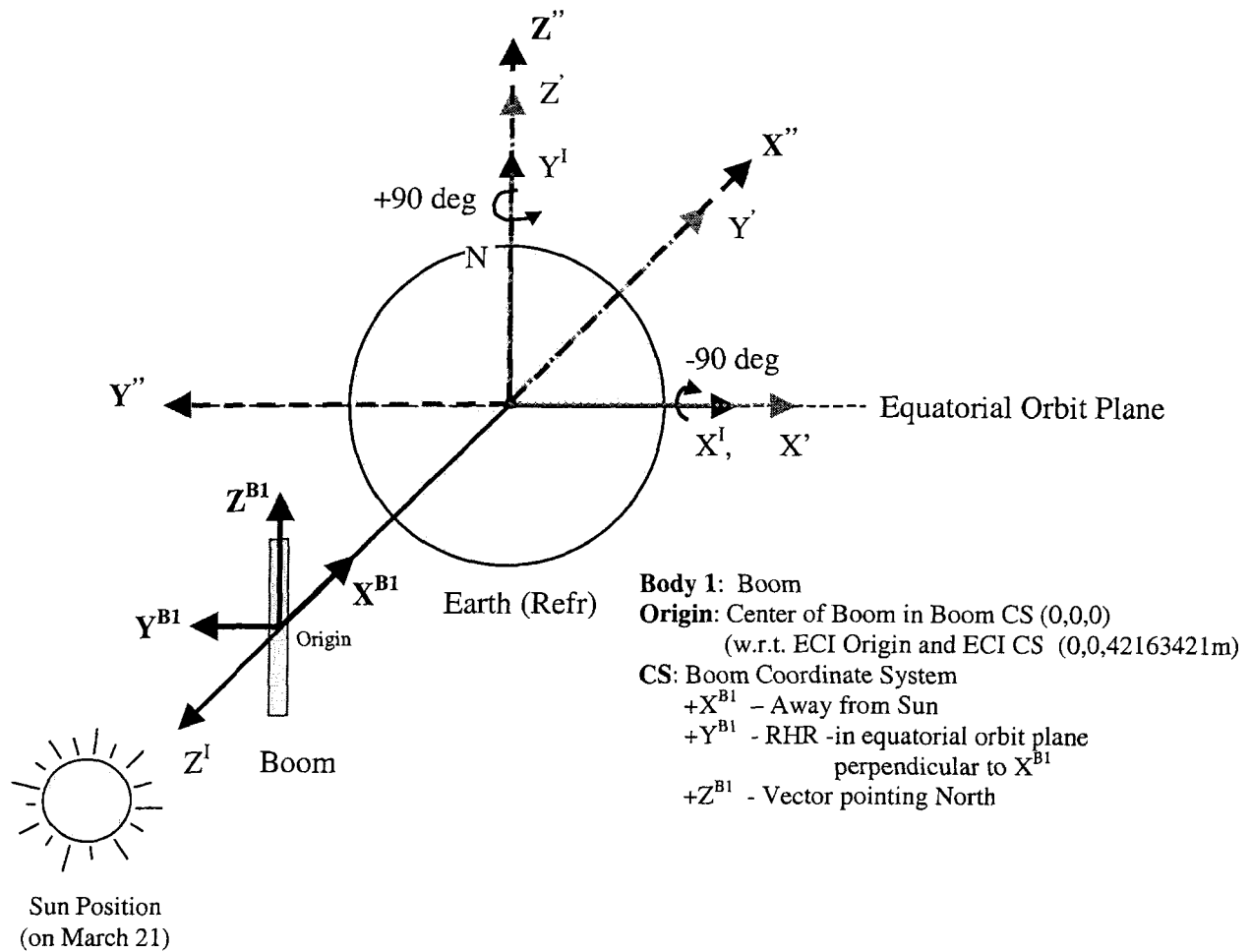


Figure A.3: Typical TREETOPS Body 1 (Boom) Coordinate System at Vernal Equinox
 (Typical Boom Orientation for Case 1 SS, Case 2A, 2B and 3)
 Boom CS at Vernal Equinox = $[90]_3[0]_2[-90]_1 * \text{ECI CS}$

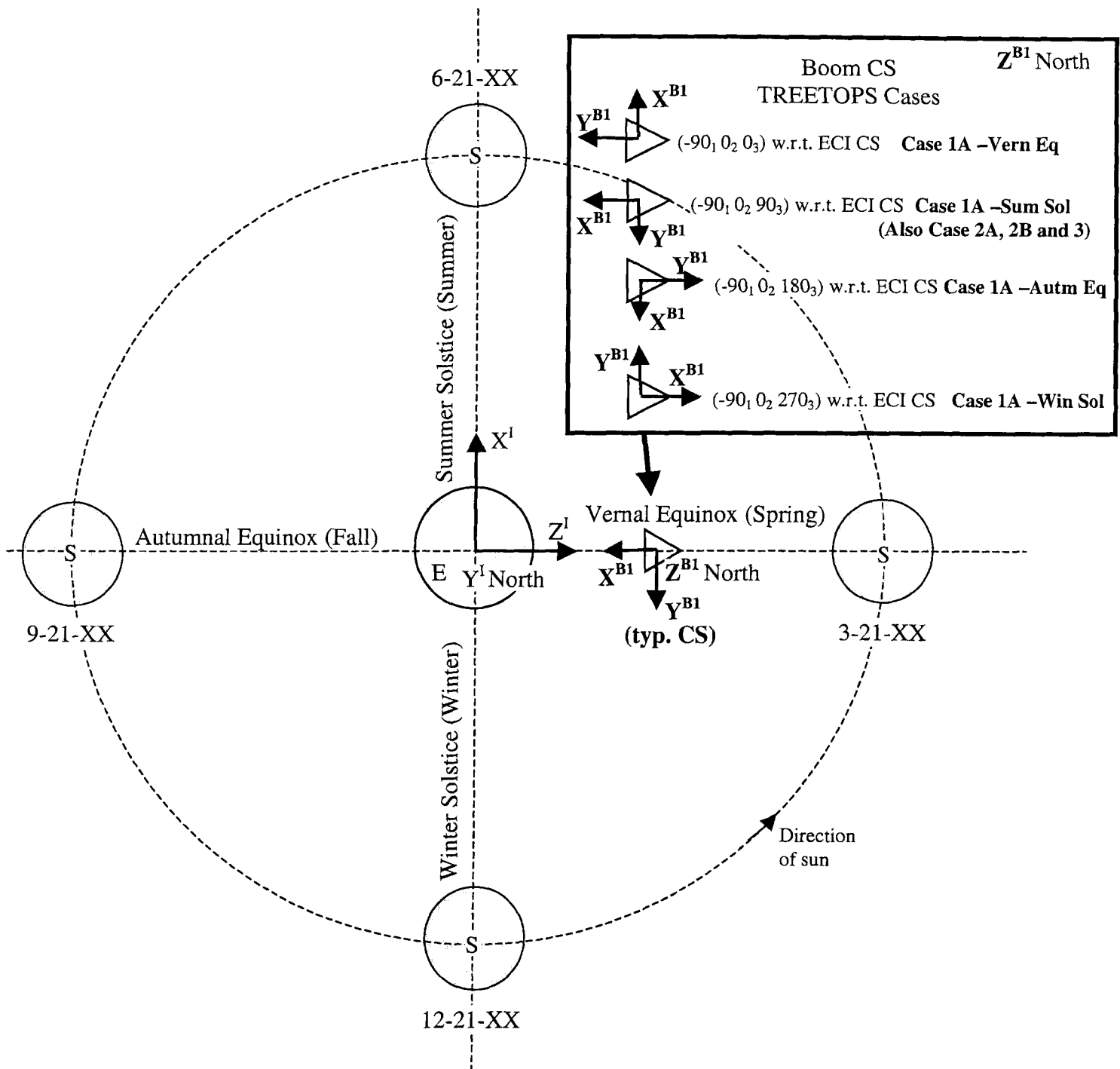


Figure A.4: Body 1 (Boom) Initial Coordinate System with respect to the Earth Centered Inertial Coordinate System (ECI CS) and the Position of the Sun with Respect to the Earth at the Beginning of Each Season (Northern Hemisphere)(Plan View)

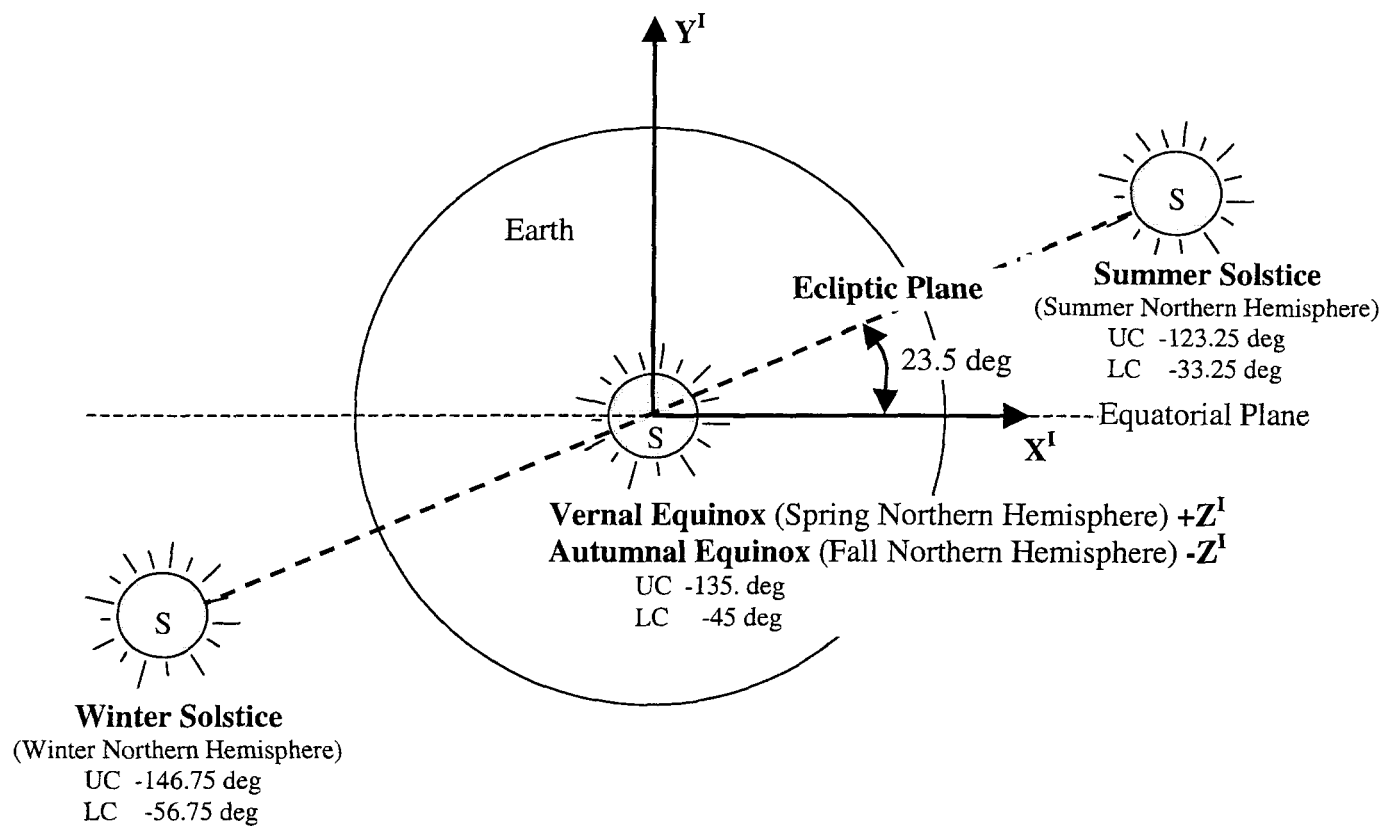


Figure A.5: Position of the Sun with Respect to the Earth at the Beginning of Each Season (Northern Hemisphere) (Elevation View)

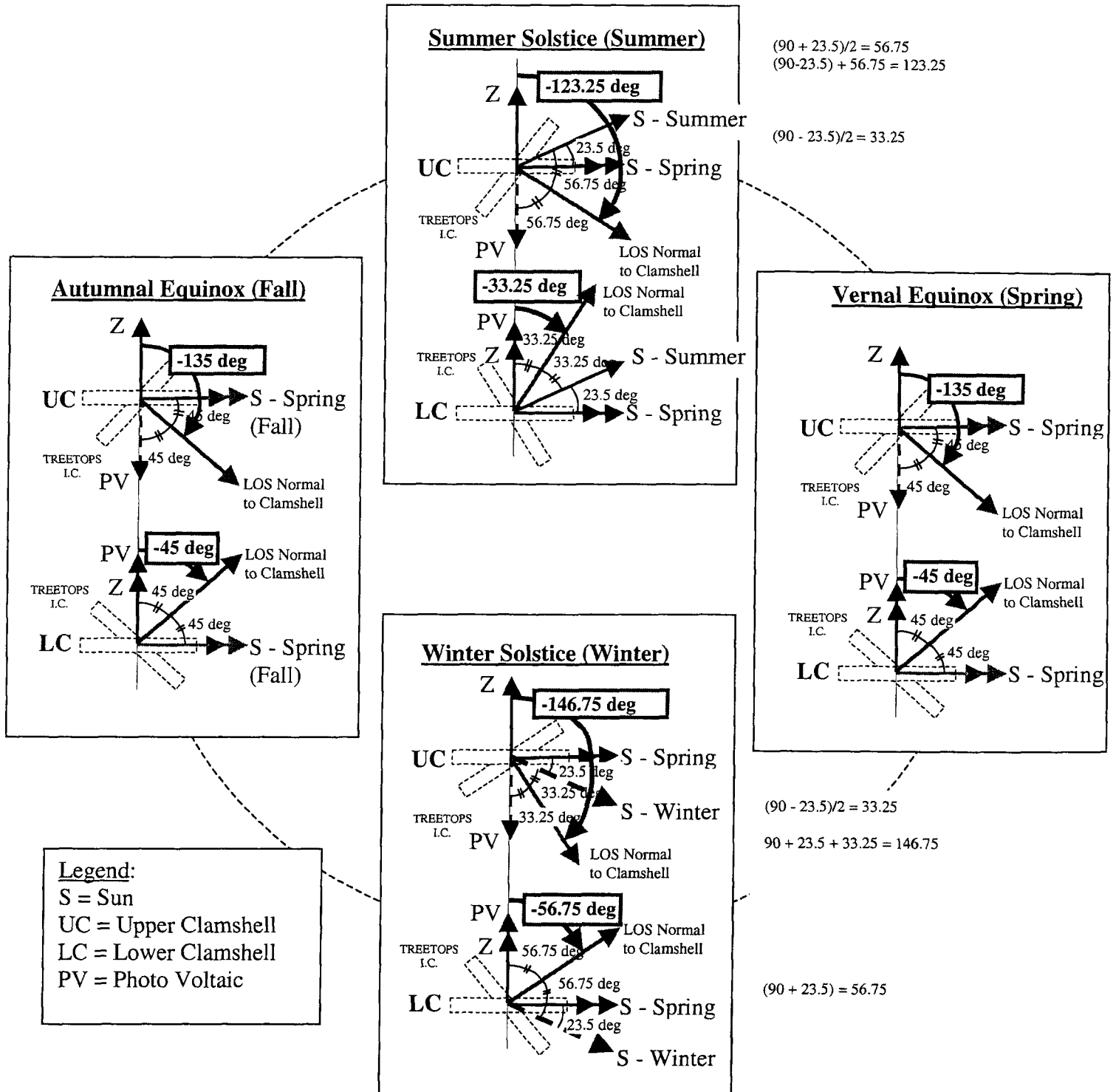


Figure A.6: Initial Condition Pitch Angles of the Upper and Lower Clamshells

Table A.1a: Initial Conditions in TREETOPS for Body 1 (Boom) and Body 2 (Central Body)
Concept 1, Concept 2A, Concept 2B and Concept 3

Description	Body 1 (Boom -Flexible)						Body 2 (Central Body - Rigid)					
	H1 Free Rotational DOF between Body 0 (Earth) & Body 1 (Boom)	Reference axis for Euler Angles	Initial Euler Rotation Angles (deg) w.r.t. geocentric origin in ECI CS	Initial Rotation Rate (deg/sec) w.r.t. geocentric origin in ECI CS	Initial Translation (m) w.r.t. geocentric origin in ECI CS	Initial Translation Velocity (m/sec) w.r.t. geocentric origin in ECI CS	H2 Free Rotational DOF between Body 1 (Boom) & Body 2 (Central Body)	Reference axis for Euler Angles	Initial Euler Rotation Angles (deg) w.r.t. boom origin in boom CS	Initial Rotation Rate (deg/sec) w.r.t. boom origin in boom CS	Initial Translation (m) w.r.t. boom origin in boom CS	Initial Translation Velocity (m/sec) w.r.t. boom origin in boom CS
Concept 1												
Vern Eq	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 0, 0	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	1- L1(Z ^B)	L1(Z ^B), L2(Y ^B), L3(X ^B)	90.0, 0.0	(ω)	(0.0, 0.0)	--
Sum Sol	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	1- L1(Z ^B)	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	(ω)	(0.0, 0.0)	--
Autm Eq	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 180	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	1- L1(Z ^B)	L1(Z ^B), L2(Y ^B), L3(X ^B)	-90.0, 0.0	(ω)	(0.0, 0.0)	--
Win Sol	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 270	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	1- L1(Z ^B)	L1(Z ^B), L2(Y ^B), L3(X ^B)	180.0, 0.0	(ω)	(0.0, 0.0)	--
Concept 2A												
Vern Eq	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--
Sum Sol	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--
Autm Eq	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--
Win Sol	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--
Concept 2B												
Vern Eq	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--
Sum Sol	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--
Autm Eq	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--
Win Sol	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--
Concept 2C												
Vern Eq	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--
Sum Sol	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--
Autm Eq	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--
Win Sol	3- L1(X ^B), L2(Y ^B), L3(Z ^B)	L1(X ^B), L2(Y ^B), L3(Z ^B)	-90.0, 90	(0.0, 0.0)	(0.0, 0.0)	(v 0.0)	0	L1(Z ^B), L2(Y ^B), L3(X ^B)	0.0, 0.0	--	(0.0, 0.0)	--

Notes

1) Constants Used in Table:

$$\omega = [1 + (1/365.25)] (360 \text{ deg} / (24 \text{ hr} \times 3600 \text{ sec/hr})) = 0.04178 \text{ deg/sec}$$

$$R = 42163421. \text{ m}$$

$$v = 2\pi R / 86161.975 = 3074.681 \text{ m/sec}$$

$$I = \text{ECI CS} \quad B = B1 = \text{Boom CS}$$

Table A.1b: Initial Conditions in TREETOPS for Body 3 (Upper Clamshell) and Body 4 (Lower Clamshell)
Concept 1, Concept 2A, Concept 2B and Concept 3

Body 3 (Upper Clamshell - Rigid)												Body 4 (Lower Clamshell – Rigid)																		
Description	H3			Reference axis for Euler Angles			Initial Euler Rotation Angles (deg) w.r.t boom origin in boom CS			Initial Rotation Rate (deg/sec) w.r.t boom origin in boom CS			Initial Translation (m) w.r.t boom origin in boom CS			H4			Reference axis for Euler Angles			Initial Euler Rotation Angles (deg) w.r.t boom origin in boom CS			Initial Rotation Rate (deg/sec) w.r.t boom origin in boom CS			Initial Translation (m) w.r.t boom origin in boom CS		
	Free Rotational DOF between: Body 1 (Boom) & Body 3 (Upper Clamshell)																													
Concept 1																														
Vern Eq	0																													
Sum Sol	0																													
Autm Eq	0																													
Win Sol	0																													
Concept 2A																														
Vern Eq	2- L1(X ^B), L2(Y ^B)																													
Sum Sol	2- L1(X ^B), L2(Y ^B)																													
Autm Eq	2- L1(X ^B), L2(Y ^B)																													
Win Sol	2- L1(X ^B), L2(Y ^B)																													
Concept 2B																														
Vern Eq	2- L1(Z ^B), L2(X ^B)																													
Sum Sol	2- L1(Z ^B), L2(X ^B)																													
Autm Eq	2- L1(Z ^B), L2(X ^B)																													
Win Sol	2- L1(Z ^B), L2(X ^B)																													
Concept 2C																														
Vern Eq	3- L1(Z ^B), L2(X ^B), L3(Y ^B)																													
Sum Sol	3- L1(Z ^B), L2(X ^B), L3(Y ^B)																													
Autm Eq	3- L1(Z ^B), L2(X ^B), L3(Y ^B)																													
Win Sol	3- L1(Z ^B), L2(X ^B), L3(Y ^B)																													

Notes

I=ECI CS B=B1=Boom CS

- 1) Constants Used in Table: :
 $\omega = [1 + (1/365.25)] [360 \text{ deg}/(24 \text{ hr} \times 3600 \text{ sec/hr})] = 0.04178 \text{ deg/sec}$; $R = 42163421 \text{ m}$; $v = 2\pi R/86161.975 = 3074.681 \text{ m/sec}$
- 2) ITV - Initial Translation Velocity (m/sec) w.r.t. boom origin in boom CS
- 3) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z^B) should have been 90 deg for all cases.

A.1 Concept 1 Definitions and TREETOPS files

Sensor Definitions
Actuator Definitions
Interconnect Definitions
TREETOPS files:

Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx
Vernal Equinox (VE): .int
Autumnal Equinox (AE): .int
Winter Solstice (WS): .int

TableA.1.1 Sensor Definitions (Concept 1)

Global Sensor Output No.	TREETOPS Sensor Designation	Local Sensor Output No.	Sensor Mount Loc.	Type	used	DOF
RP 1	SE 1	1	B2-N2	Earth Target (ET)		Pitch (Y^{B2}) Error – Overall System (Central Body)
RP 2	SE 1	2	B2-N2	(LOS Along X^{B2})		Yaw (Z^{B2}) Error – Overall System (Central Body)
RP 3	SE 2	1	B2-N2	Star Tracker (ST)		Roll (X^{B2}) Error – Overall System (Central Body)
RP 4	SE 2	2	B2-N2	(LOS Along Z^{B2})		Not used in control (Pitch (Y^{B2}) Error) Central Body
RP 5	SE 2	3	B2-N2			Not used in control (Validity Flag on(1) off(0))
RP 6	SE 3	1	B1-N2	Star Tracker (ST)		Yaw (Z^{B1}) Error – Boom
RP 7	SE 3	2	B1-N2	(LOS Along Y^{B1})		Not used in control, Roll (X^{B1}) Error – Boom
RP 8	SE 3	3	B1-N2			Validity Flag on(1) off(0) Used for Rad Pres Disturb
RP 9	SE 4	1	B1-N2	3 Axis Accelerometer		Not used in control, For Output Only, ACCEL (X^{B1})
RP 10	SE 4	2	B1-N2	(A3) with		Not used in control, For Output Only, ACCEL (Y^{B1})
RP 11	SE 4	3	B1-N2	gravity removed		Not used in control, For Output Only, ACCEL (Z^{B1})
RP 12	SE 5	1	B1-N2	Local Vertical (LV) BJ_LVLH Transform Columns (Direction Cosine Matrix)		Not used in control, For Output Only, DCM (1,1)
RP 13	SE 5	2	B1-N2			Not used in control, For Output Only, DCM (2,1)
RP 14	SE 5	3	B1-N2			Not used in control, For Output Only, DCM (3,1)
RP 15	SE 5	4	B1-N2			Not used in control, For Output Only, DCM (1,2)
RP 16	SE 5	5	B1-N2			Not used in control, For Output Only, DCM (2,2)
RP 17	SE 5	6	B1-N2			Not used in control, For Output Only, DCM (3,2)
RP 18	SE 5	7	B1-N2			Not used in control, For Output Only, DCM (1,3)
RP 19	SE 5	8	B1-N2			Not used in control, For Output Only, DCM (2,3)
RP 20	SE 5	9	B1-N2			Not used in control, For Output Only, DCM (3,3)
RP 21	SE 6	1	B3-N2	LOS Sensor (L) (LOS Along $-Y^I$) (Negative Polar Axis) see .los file		Not used in control, Roll (X^{B3}) Error – UC
RP 22	SE 6	2	B3-N2			Not used in control, Pitch (Y^{B3}) Error – UC
RP 23	SE 6	3	B3-N2			Not used in control, Yaw (Z^{B3}) Error – UC
RP 24	SE 6	4	B3-N2			Not used in control
RP 25	SE 6	5	B3-N2			Not used in control
RP 26	SE 6	6	B3-N2			Not used in control
RP 27	SE 6	7	B3-N2			Not used in control
RP 28	SE 7	1	B4-N2	LOS Sensor (L) (LOS Along $+Y^I$) (Positive Polar Axis) see .los file		Not used in control, Roll (X^{B4}) Error – LC
RP 29	SE 7	2	B4-N2			Not used in control, Pitch (Y^{B4}) Error – LC
RP 30	SE 7	3	B4-N2			Not used in control, Yaw (Z^{B4}) Error – LC
RP 31	SE 7	4	B4-N2			Not used in control
RP 32	SE 7	5	B4-N2			Not used in control
RP 33	SE 7	6	B4-N2			Not used in control
RP 34	SE 7	7	B4-N2			Not used in control

Table A.1.2 Actuator Definitions (Concept 1)

Global Actuator Input No.	TREETOPS Actuator Designation	Sensor Mount Loc.	Type	DOF
UP 1	AC 1	B2-N2	Moment Actuator (MO)*	Pitch (Y^{B2}) Ext. Torque – Overall System (Central Body)
UP 2	AC 2	B2-N2	Moment Actuator (MO)*	Yaw (Z^{B2}) Ext. Torque – Overall System (Central Body)
UP 3	AC 3	B2-N2	Moment Actuator (MO)*	Roll (X^{B2}) Ext. Torque – Overall System (Central Body)
UP 4	AC 4	H2-A1	Motor Torque (T)**	Yaw (Z^{B1}) Torque, equal and opposite, on Boom/Central Body
UP 5	AC 5	B2-N5	Reaction Jet (J) Radiation Pressure Disturbance	$-X^{B2}$ Force at Central Body Transmitter

Notes:
 * 1) Moment Actuator (MO) in TREETOPS is an External Moment applied to a Body (Reacts against Space) Used in Control
 ** 2) Motor Torque (T) in TREETOPS produces equal and opposite torques on the bodies adjacent to the hinge with the magnitude of the torque equal to the applied command level. A positive torque tends to increase the Euler angle associated with the mounting axis in a right hand sense.
 3) H2-A1 is hinge 2 axis 1

Table A.1.3:
Interconnect Data and Significant Parameters for
TREETOPS Continuous Matrix (CM) Controller
(Concept 1)

Interconnect Data						Significant Parameters in Continuous Matrix (CM) Controller in .lin file xdot = Ax + Bu y = Cx + Du				
Inter- connect	Description	S C C A	S No. C No. C No. A No.	S Out No. C In No. C Out No. A In No.	Gain N-m or N	Subset of A Matrix	Subset of B Matrix	Subset of C Matrix ω^2 $2\zeta\omega$	Subset of D Matrix	
IC 1	Pitch (Y^{B2}) of Overall System	S	1	1	4.41E13	0. 1.	0	.000025 .007	0	
IC 2		C	1	1	1.0	-1. -1.4	1			
		C	1	1						
		A	1	1						
IC 3	Yaw (Z^{B2}) of Overall System	S	1	2	1.67E12	0. 1.	0	.000025 .007	0	
IC 4		C	1	2	1.0	-1. -1.4	1			
		C	1	2						
		A	2	1						
IC 5	Roll (X^{B2}) of Overall System	S	2	1	4.31E13	0. 1.	0	.000025 .007	0	
IC 6		C	1	3	1.0	-1. -1.4	1			
		C	1	3						
		A	3	1						
IC 7	Yaw (Z^{B1}) of Boom	S	3	1	6.7E8	0. 1.	0	1.E-6 1.4E-3	0	
IC 8		C	1	4	-1.0	-1. -1.4	1			
		C	1	4						
		A	4	1						
IC 9	$-X^{B2}$ of Radiation Pres Disturb	S	3	3	7.0					
	A	5	1							

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SIM CONTROL

1 SI	0 Title	ISC MODEL, THIRD VERSION
2 SI	0 Simulation stop time	100000
3 SI	0 Plot data interval	20
4 SI	0 Integration type (R,S,U, OR V)	R
5 SI	0 Step size (sec)	.1
6 SI	0 Sandia ODE solver absolute and relative error	
7 SI	0 RK78 ODE solver absolute error and first step size	
8 SI	0 Linearization option (L,Z or N)	N
9 SI	0 Restart option (Y/N)	N
10 SI	0 Contact force computation option (Y/N)	Y
11 SI	0 Constraint force computation option (Y/N)	N
12 SI	0 Small angle speedup option (All,Bypass,First,Nth)	A
13 SI	0 Mass matrix speedup option (All,Bypass,First,Nth)	A
14 SI	0 Non-Linear speedup option (All,Bypass,First,Nth)	A
15 SI	0 Constraint speedup option (All,Bypass,First,Nth)	A
16 SI	0 Constraint stabilization option (Y/N)	N
17 SI	0 Stabilization epsilon	

GENGRAV

18 GG	0 Gravity, earth sphere/nonsphere/user (S/N/U)?	N
19 GG	1 Input gravity constants: GME, ERAD, EMAS	
20 GG	1 Spherical or Nonspherical (S/N)?	
21 GG	1 Gravity Potential Harmonics J2,J3,J4	
22 GG	0 English (ft-slug-s) or metric (m-kg-s) (E/M)?	M
23 GG	0 Day, Month, Year,	20 6 2020
24 GG	0 GMT @ sim time 0 (minutes past midnight,	360
25 GG	0 Solar Pressure forces Y/N?	Y
26 GG	0 Input new data for aero model? (Y/N)	N
27 GG	1 Solar flux F10 for aero model	
28 GG	1 Solar flux, 81 day average F10B	
29 GG	1 Geomagnetic index, GEAP	

BODY

30 BO	1 Body ID number	1
31 BO	1 Type (Rigid,Flexible,NASTRAN)	F
32 BO	1 Number of modes	24
33 BO	1 Modal calculation option (0, 1 or 2)	2
34 BO	1 Foreshortening option (Y/N)	
35 BO	1 Model reduction method (NO,MS,MC,CC,QM,CV)	
36 BO	1 NASTRAN data file FORTRAN unit number (40 - 60)	
37 BO	1 Number of augmented nodes (0 if none)	
38 BO	1 Damping matrix option (NS,CD,HL,SD)	
39 BO	1 Constant damping ratio	
40 BO	1 Low frequency, High frequency ratios	
41 BO	1 Mode ID number, damping ratio	
42 BO	1 Conversion factors: Length,Mass,Force	
43 BO	1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
44 BO	1 Moments of inertia (kg-m2) Ixx,Iyy,Izz	6.2852173E11 6.2852173E11
6.7057352E8		
45 BO	1 Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
46 BO	1 Mass (kg)	1.6168633E5
47 BO	1 Number of Nodes	4
48 BO	1 Node ID, Node coord. (meters) x,y,z	1 0 0 0
49 BO	1 Node ID, Node coord. (meters) x,y,z	2 0 0 0
50 BO	1 Node ID, Node coord. (meters) x,y,z	3 0 0 3188.8
51 BO	1 Node ID, Node coord. (meters) x,y,z	4 0 0 -3188.8
52 BO	1 Node ID, Node structural joint ID	

53 BO	2	Body ID number	2
54 BO	2	Type (Rigid,Flexible,NASTRAN)	R
55 BO	2	Number of modes	
56 BO	2	Modal calculation option (0, 1 or 2)	
57 BO	2	Foreshortening option (Y/N)	
58 BO	2	Model reduction method (NO,MS,MC,CC,QM,CV)	
59 BO	2	NASTRAN data file FORTRAN unit number (40 - 60)	
60 BO	2	Number of augmented nodes (0 if none)	
61 BO	2	Damping matrix option (NS,CD,HL,SD)	
62 BO	2	Constant damping ratio	
63 BO	2	Low frequency, High frequency ratios	
64 BO	2	Mode ID number, damping ratio	
65 BO	2	Conversion factors: Length,Mass,Force	
66 BO	2	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
67 BO	2	Moments of inertia (kg-m2) Ixx,Iyy,Izz	.8543E12 1.5601E12
1.3822E12			
68 BO	2	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
69 BO	2	Mass (kg)	12666300
70 BO	2	Number of Nodes	5
71 BO	2	Node ID, Node coord. (meters) x,y,z	1 298.323 0 0
72 BO	2	Node ID, Node coord. (meters) x,y,z	2 0 0 0
73 BO	2	Node ID, Node coord. (meters) x,y,z	3 0 0 300
74 BO	2	Node ID, Node coord. (meters) x,y,z	4 0 0 -300
75 BO	2	Node ID, Node coord. (meters) x,y,z	5 500 0 0
76 BO	2	Node ID, Node structural joint ID	
77 BO	3	Body ID number	3
78 BO	3	Type (Rigid,Flexible,NASTRAN)	R
79 BO	3	Number of modes	
80 BO	3	Modal calculation option (0, 1 or 2)	
81 BO	3	Foreshortening option (Y/N)	
82 BO	3	Model reduction method (NO,MS,MC,CC,QM,CV)	
83 BO	3	NASTRAN data file FORTRAN unit number (40 - 60)	
84 BO	3	Number of augmented nodes (0 if none)	
85 BO	3	Damping matrix option (NS,CD,HL,SD)	
86 BO	3	Constant damping ratio	
87 BO	3	Low frequency, High frequency ratios	
88 BO	3	Mode ID number, damping ratio	
89 BO	3	Conversion factors: Length,Mass,Force	
90 BO	3	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
91 BO	3	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
92 BO	3	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
93 BO	3	Mass (kg)	2046600
94 BO	3	Number of Nodes	2
95 BO	3	Node ID, Node coord. (meters) x,y,z	1 0 0 0
96 BO	3	Node ID, Node coord. (meters) x,y,z	2 0 0 0
97 BO	3	Node ID, Node structural joint ID	
98 BO	4	Body ID number	4
99 BO	4	Type (Rigid,Flexible,NASTRAN)	R
100 BO	4	Number of modes	
101 BO	4	Modal calculation option (0, 1 or 2)	
102 BO	4	Foreshortening option (Y/N)	
103 BO	4	Model reduction method (NO,MS,MC,CC,QM,CV)	
104 BO	4	NASTRAN data file FORTRAN unit number (40 - 60)	
105 BO	4	Number of augmented nodes (0 if none)	
106 BO	4	Damping matrix option (NS,CD,HL,SD)	
107 BO	4	Constant damping ratio	
108 BO	4	Low frequency, High frequency ratios	
109 BO	4	Mode ID number, damping ratio	
110 BO	4	Conversion factors: Length,Mass,Force	
111 BO	4	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
112 BO	4	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
113 BO	4	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
114 BO	4	Mass (kg)	2046600
115 BO	4	Number of Nodes	2
116 BO	4	Node ID, Node coord. (meters) x,y,z	1 0 0 0
117 BO	4	Node ID, Node coord. (meters) x,y,z	2 0 0 0
118 BO	4	Node ID, Node structural joint ID	

119 HI	1 Hinge ID number	1
120 HI	1 Inboard body ID, Outboard body ID	0 1
121 HI	1 "p" node ID, "q" node ID	0 2
122 HI	1 Number of rotation DOFs, Rotation option (F or G)	3 F
123 HI	1 L1 unit vector in inboard body coord. x,y,z	1 0 0
124 HI	1 L1 unit vector in outboard body coord. x,y,z	1 0 0
125 HI	1 L2 unit vector in inboard body coord. x,y,z	
126 HI	1 L2 unit vector in outboard body coord. x,y,z	
127 HI	1 L3 unit vector in inboard body coord. x,y,z	0 0 1
128 HI	1 L3 unit vector in outboard body coord. x,y,z	0 0 1
129 HI	1 Initial rotation angles (deg)	-90 0 90
130 HI	1 Initial rotation rates (deg/sec)	0 0 0
131 HI	1 Rotation stiffness (newton-meters/rad)	0 0 0
132 HI	1 Rotation damping (newton-meters/rad/sec)	0 0 0
133 HI	1 Null torque angles (deg)	0 0 0
134 HI	1 Number of translation DOFs	3
135 HI	1 First translation unit vector g1	1 0 0
136 HI	1 Second translation unit vector g2	0 1 0
137 HI	1 Third translation unit vector g3	0 0 1
138 HI	1 Initial translation (meters)	0 0 42163421
139 HI	1 Initial translation velocity (meters/sec)	3074.681 0 0
140 HI	1 Translation stiffness (newtons/meters)	0 0 0
141 HI	1 Translation damping (newtons/meter/sec)	0 0 0
142 HI	1 Null force translations	0 0 0
143 HI	2 Hinge ID number	2
144 HI	2 Inboard body ID, Outboard body ID	1 2
145 HI	2 "p" node ID, "q" node ID	2 2
146 HI	2 Number of rotation DOFs	1
147 HI	2 L1 unit vector in inboard body coord. x,y,z	0 0 1
148 HI	2 L1 unit vector in outboard body coord. x,y,z	0 0 1
149 HI	2 L2 unit vector in inboard body coord. x,y,z	
150 HI	2 L2 unit vector in outboard body coord. x,y,z	
151 HI	2 L3 unit vector in inboard body coord. x,y,z	1 0 0
152 HI	2 L3 unit vector in outboard body coord. x,y,z	1 0 0
153 HI	2 Initial rotation angles (deg)	0 0 0
154 HI	2 Initial rotation rates (deg/sec)	0.00417807
155 HI	2 Rotation stiffness (newton-meters/rad)	0
156 HI	2 Rotation damping (newton-meters/rad/sec)	0
157 HI	2 Null torque angles (deg)	0
158 HI	2 Number of translation DOFs	0
159 HI	2 First translation unit vector g1	1 0 0
160 HI	2 Second translation unit vector g2	0 1 0
161 HI	2 Third translation unit vector g3	0 0 1
162 HI	2 Initial translation (meters)	0 0 0
163 HI	2 Initial translation velocity (meters/sec)	
164 HI	2 Translation stiffness (newtons/meters)	
165 HI	2 Translation damping (newtons/meter/sec)	
166 HI	2 Null force translations	
167 HI	3 Hinge ID number	3
168 HI	3 Inboard body ID, Outboard body ID	1 3
169 HI	3 "p" node ID, "q" node ID	3 2
170 HI	3 Number of rotation DOFs	0
171 HI	3 L1 unit vector in inboard body coord. x,y,z	0 0 1
172 HI	3 L1 unit vector in outboard body coord. x,y,z	0 0 1
173 HI	3 L2 unit vector in inboard body coord. x,y,z	
174 HI	3 L2 unit vector in outboard body coord. x,y,z	
175 HI	3 L3 unit vector in inboard body coord. x,y,z	0 1 0
176 HI	3 L3 unit vector in outboard body coord. x,y,z	0 1 0
177 HI	3 Initial rotation angles (deg)	90 0 -123.25
178 HI	3 Initial rotation rates (deg/sec)	
179 HI	3 Rotation stiffness (newton-meters/rad)	
180 HI	3 Rotation damping (newton-meters/rad/sec)	
181 HI	3 Null torque angles (deg)	
182 HI	3 Number of translation DOFs	0
183 HI	3 First translation unit vector g1	1 0 0
184 HI	3 Second translation unit vector g2	0 1 0

185 HI	3	Third translation unit vector	g3	0 0 1
186 HI	3	Initial translation (meters)		0 0 0
187 HI	3	Initial translation velocity (meters/sec)		
188 HI	3	Translation stiffness (newtons/meters)		
189 HI	3	Translation damping (newtons/meter/sec)		
190 HI	3	Null force translations		
191 HI	4	Hinge ID number		4
192 HI	4	Inboard body ID, Outboard body ID		1 4
193 HI	4	"p" node ID, "q" node ID		4 2
194 HI	4	Number of rotation DOFs		0
195 HI	4	L1 unit vector in inboard body coord.	x,y,z	0 0 1
196 HI	4	L1 unit vector in outboard body coord.	x,y,z	0 0 1
197 HI	4	L2 unit vector in inboard body coord.	x,y,z	
198 HI	4	L2 unit vector in outboard body coord.	x,y,z	
199 HI	4	L3 unit vector in inboard body coord.	x,y,z	0 1 0
200 HI	4	L3 unit vector in outboard body coord.	x,y,z	0 1 0
201 HI	4	Initial rotation angles (deg)		90 0 -33.25
202 HI	4	Initial rotation rates (deg/sec)		
203 HI	4	Rotation stiffness (newton-meters/rad)		
204 HI	4	Rotation damping (newton-meters/rad/sec)		
205 HI	4	Null torque angles (deg)		
206 HI	4	Number of translation DOFs		0
207 HI	4	First translation unit vector	g1	1 0 0
208 HI	4	Second translation unit vector	g2	0 1 0
209 HI	4	Third translation unit vector	g3	0 0 1
210 HI	4	Initial translation (meters)		0 0 0
211 HI	4	Initial translation velocity (meters/sec)		
212 HI	4	Translation stiffness (newtons/meters)		
213 HI	4	Translation damping (newtons/meter/sec)		
214 HI	4	Null force translations		

SENSOR

215 SE	1	Sensor ID number		1
216 SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET	
217 SE	1	Mounting point body ID, Mounting point node ID		2 2
218 SE	1	Second mounting point body ID, Second node ID		
219 SE	1	Input axis unit vector (IA)	x,y,z	
220 SE	1	Mounting point Hinge index, Axis index		
221 SE	1	First focal plane unit vector (Fp1)	x,y,z	0 0 -1
222 SE	1	Second focal plane unit vector (Fp2)	x,y,z	0 1 0
223 SE	1	Sun/Star unit vector (Us)	x,y,z	
224 SE	1	Velocity Aberration Option (Y/N)		
225 SE	1	Euler Angle Sequence (1-6)		
226 SE	1	CMG ID number and Gimbal number		
227 SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])		6378000 0 0 4.178074D-3
228 SE	2	Sensor ID number		2
229 SE	2	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST	
230 SE	2	Mounting point body ID, Mounting point node ID		2 2
231 SE	2	Second mounting point body ID, Second node ID		
232 SE	2	Input axis unit vector (IA)	x,y,z	
233 SE	2	Mounting point Hinge index, Axis index		
234 SE	2	First focal plane unit vector (Fp1)	x,y,z	0 -1 0
235 SE	2	Second focal plane unit vector (Fp2)	x,y,z	1 0 0
236 SE	2	Sun/Star unit vector (Us)	x,y,z	0 1 0
237 SE	2	Velocity Aberration Option (Y/N)		N
238 SE	2	Euler Angle Sequence (1-6)		
239 SE	2	CMG ID number and Gimbal number		
240 SE	2	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])		
241 SE	3	Sensor ID number		3
242 SE	3	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST	
243 SE	3	Mounting point body ID, Mounting point node ID		1 2
244 SE	3	Second mounting point body ID, Second node ID		
245 SE	3	Input axis unit vector (IA)	x,y,z	
246 SE	3	Mounting point Hinge index, Axis index		
247 SE	3	First focal plane unit vector (Fp1)	x,y,z	-1 0 0
248 SE	3	Second focal plane unit vector (Fp2)	x,y,z	0 0 1

249 SE	3 Sun/Star unit vector (Us) x,y,z	0 0 0
250 SE	3 Velocity Aberration Option (Y/N)	N
251 SE	3 Euler Angle Sequence (1-6)	
252 SE	3 CMG ID number and Gimbal number	
253 SE	3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
254 SE	4 Sensor ID number	4
255 SE	4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	A3
256 SE	4 Mounting point body ID, Mounting point node ID	1 2
257 SE	4 Second mounting point body ID, Second node ID	
258 SE	4 Input axis unit vector (IA) x,y,z	
259 SE	4 Mounting point Hinge index, Axis index	
260 SE	4 First focal plane unit vector (Fp1) x,y,z	
261 SE	4 Second focal plane unit vector (Fp2) x,y,z	
262 SE	4 Sun/Star unit vector (Us) x,y,z	
263 SE	4 Velocity Aberration Option (Y/N)	
264 SE	4 Euler Angle Sequence (1-6)	
265 SE	4 CMG ID number and Gimbal number	
266 SE	4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
267 SE	5 Sensor ID number	5
268 SE	5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	LV
269 SE	5 Mounting point body ID, Mounting point node ID	1 2
270 SE	5 Second mounting point body ID, Second node ID	
271 SE	5 Input axis unit vector (IA) x,y,z	
272 SE	5 Mounting point Hinge index, Axis index	
273 SE	5 First focal plane unit vector (Fp1) x,y,z	
274 SE	5 Second focal plane unit vector (Fp2) x,y,z	
275 SE	5 Sun/Star unit vector (Us) x,y,z	
276 SE	5 Velocity Aberration Option (Y/N)	
277 SE	5 Euler Angle Sequence (1-6)	
278 SE	5 CMG ID number and Gimbal number	
279 SE	5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
280 SE	6 Sensor ID number	6
281 SE	6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	L
282 SE	6 Mounting point body ID, Mounting point node ID	3 2
283 SE	6 Second mounting point body ID, Second node ID	
284 SE	6 Input axis unit vector (IA) x,y,z	1 0 0
285 SE	6 Mounting point Hinge index, Axis index	
286 SE	6 First focal plane unit vector (Fp1) x,y,z	
287 SE	6 Second focal plane unit vector (Fp2) x,y,z	
288 SE	6 Sun/Star unit vector (Us) x,y,z	
289 SE	6 Velocity Aberration Option (Y/N)	
290 SE	6 Euler Angle Sequence (1-6)	
291 SE	6 CMG ID number and Gimbal number	
292 SE	6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
293 SE	7 Sensor ID number	7
294 SE	7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	L
295 SE	7 Mounting point body ID, Mounting point node ID	4 2
296 SE	7 Second mounting point body ID, Second node ID	
297 SE	7 Input axis unit vector (IA) x,y,z	1 0 0
298 SE	7 Mounting point Hinge index, Axis index	
299 SE	7 First focal plane unit vector (Fp1) x,y,z	
300 SE	7 Second focal plane unit vector (Fp2) x,y,z	
301 SE	7 Sun/Star unit vector (Us) x,y,z	
302 SE	7 Velocity Aberration Option (Y/N)	
303 SE	7 Euler Angle Sequence (1-6)	
304 SE	7 CMG ID number and Gimbal number	
305 SE	7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
ACTR		
306 AC	1 Actuator ID number	1
307 AC	1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
308 AC	1 Actuator location; Node or Hinge (N or H)	
309 AC	1 Mounting point body ID number, node ID number	2 2
310 AC	1 Second mounting point body ID, second node ID	
311 AC	1 Output axis unit vector x,y,z	0 1 0

312 AC	1 Mounting point Hinge index, Axis index	
313 AC	1 Rotor spin axis unit vector x,y,z	
314 AC	1 Initial rotor momentum, H	
315 AC	1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
316 AC	1 Outer gimbal axis unit vector x,y,z	
317 AC	1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
318 AC	1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
319 AC	1 Inner gimbal axis unit vector x,y,z	
320 AC	1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
321 AC	1 Initial length and rate, y(to) and ydot(to)	
322 AC	1 Constants; K1 or wo, n or zeta, Kg, Jm	
323 AC	1 Non-linearities; TLim, Tco, Dz	
324 AC	2 Actuator ID number	2
325 AC	2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
326 AC	2 Actuator location; Node or Hinge (N or H)	
327 AC	2 Mounting point body ID number, node ID number	2 2
328 AC	2 Second mounting point body ID, second node ID	
329 AC	2 Output axis unit vector x,y,z	0 0 1
330 AC	2 Mounting point Hinge index, Axis index	
331 AC	2 Rotor spin axis unit vector x,y,z	
332 AC	2 Initial rotor momentum, H	
333 AC	2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
334 AC	2 Outer gimbal axis unit vector x,y,z	
335 AC	2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
336 AC	2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
337 AC	2 Inner gimbal axis unit vector x,y,z	
338 AC	2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
339 AC	2 Initial length and rate, y(to) and ydot(to)	
340 AC	2 Constants; K1 or wo, n or zeta, Kg, Jm	
341 AC	2 Non-linearities; TLim, Tco, Dz	
342 AC	3 Actuator ID number	3
343 AC	3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
344 AC	3 Actuator location; Node or Hinge (N or H)	
345 AC	3 Mounting point body ID number, node ID number	2 2
346 AC	3 Second mounting point body ID, second node ID	
347 AC	3 Output axis unit vector x,y,z	1 0 0
348 AC	3 Mounting point Hinge index, Axis index	
349 AC	3 Rotor spin axis unit vector x,y,z	
350 AC	3 Initial rotor momentum, H	
351 AC	3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
352 AC	3 Outer gimbal axis unit vector x,y,z	
353 AC	3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
354 AC	3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
355 AC	3 Inner gimbal axis unit vector x,y,z	
356 AC	3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
357 AC	3 Initial length and rate, y(to) and ydot(to)	
358 AC	3 Constants; K1 or wo, n or zeta, Kg, Jm	
359 AC	3 Non-linearities; TLim, Tco, Dz	
360 AC	4 Actuator ID number	4
361 AC	4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	T
362 AC	4 Actuator location; Node or Hinge (N or H)	
363 AC	4 Mounting point body ID number, node ID number	
364 AC	4 Second mounting point body ID, second node ID	
365 AC	4 Output axis unit vector x,y,z	
366 AC	4 Mounting point Hinge index, Axis index	2 1
367 AC	4 Rotor spin axis unit vector x,y,z	
368 AC	4 Initial rotor momentum, H	
369 AC	4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
370 AC	4 Outer gimbal axis unit vector x,y,z	
371 AC	4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
372 AC	4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
373 AC	4 Inner gimbal axis unit vector x,y,z	
374 AC	4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
375 AC	4 Initial length and rate, y(to) and ydot(to)	
376 AC	4 Constants; K1 or wo, n or zeta, Kg, Jm	
377 AC	4 Non-linearities; TLim, Tco, Dz	
378 AC	5 Actuator ID number	5

379 AC	5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	J
380 AC	5 Actuator location; Node or Hinge (N or H)	
381 AC	5 Mounting point body ID number, node ID number	2 5
382 AC	5 Second mounting point body ID, second node ID	
383 AC	5 Output axis unit vector x,y,z	-1 0 0
384 AC	5 Mounting point Hinge index, Axis index	
385 AC	5 Rotor spin axis unit vector x,y,z	
386 AC	5 Initial rotor momentum, H	
387 AC	5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
388 AC	5 Outer gimbal axis unit vector x,y,z	
389 AC	5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
390 AC	5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
391 AC	5 Inner gimbal axis unit vector x,y,z	
392 AC	5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
393 AC	5 Initial length and rate, y(to) and ydot(to)	
394 AC	5 Constants; K1 or wo, n or zeta, Kg, Jm	
395 AC	5 Non-linearities; TLim, Tco, Dz	

CONTROLLER

396 CO	1 Controller ID number	1
397 CO	1 Controller type (CB,CM,DB,DM,UC,UD)	CM
398 CO	1 Sample time (sec)	
399 CO	1 Number of inputs, Number of outputs	4 4
400 CO	1 Number of states	
401 CO	1 Output No., Input type (I,S,T), Input ID, Gain	

INTERCONNECT

402 IN	1 Interconnect ID number	1
403 IN	1 Source type(S,C, or F),Source ID,Source row #	S 1 1
404 IN	1 Destination type(A or C),Dest ID,Dest row #	C 1 1
405 IN	1 Gain	4.41E13
406 IN	2 Interconnect ID number	2
407 IN	2 Source type(S,C, or F),Source ID,Source row #	C 1 1
408 IN	2 Destination type(A or C),Dest ID,Dest row #	A 1 1
409 IN	2 Gain	1
410 IN	3 Interconnect ID number	3
411 IN	3 Source type(S,C, or F),Source ID,Source row #	S 1 2
412 IN	3 Destination type(A or C),Dest ID,Dest row #	C 1 2
413 IN	3 Gain	1.67E12
414 IN	4 Interconnect ID number	4
415 IN	4 Source type(S,C, or F),Source ID,Source row #	C 1 2
416 IN	4 Destination type(A or C),Dest ID,Dest row #	A 2 1
417 IN	4 Gain	1
418 IN	5 Interconnect ID number	5
419 IN	5 Source type(S,C, or F),Source ID,Source row #	S 2 1
420 IN	5 Destination type(A or C),Dest ID,Dest row #	C 1 3
421 IN	5 Gain	4.31E13
422 IN	6 Interconnect ID number	6
423 IN	6 Source type(S,C, or F),Source ID,Source row #	C 1 3
424 IN	6 Destination type(A or C),Dest ID,Dest row #	A 3 1
425 IN	6 Gain	1
426 IN	7 Interconnect ID number	7
427 IN	7 Source type(S,C, or F),Source ID,Source row #	S 3 1
428 IN	7 Destination type(A or C),Dest ID,Dest row #	C 1 4
429 IN	7 Gain	6.7E8
430 IN	8 Interconnect ID number	8
431 IN	8 Source type(S,C, or F),Source ID,Source row #	C 1 4
432 IN	8 Destination type(A or C),Dest ID,Dest row #	A 4 1
433 IN	8 Gain	1

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434 IN	9 Interconnect ID number	9
435 IN	9 Source type(S,C, or F),Source ID,Source row #	S 3 3
436 IN	9 Destination type(A or C),Dest ID,Dest row #	A 5 1
437 IN	9 Gain	7

isc3_flex_sol.lin (Concept 1) Summer Solstice

* Controller for integrated symmetrical concentrator

system CONT1 8,4,4,0,0,0.0

*A

0 1 0 0 0 0 0 0
-1 -1.4 0 0 0 0 0 0
0 0 0 1 0 0 0 0
0 0 -1 -1.4 0 0 0 0
0 0 0 0 0 1 0 0
0 0 0 0 -1 -1.4 0 0
0 0 0 0 0 0 0 1
0 0 0 0 0 0 -1 -1.4

*B

0 0 0 0
1 0 0 0
0 0 0 0
0 1 0 0
0 0 0 0
0 0 1 0
0 0 0 0
0 0 0 1

*C

.000025 .007 0 0 0 0 0 0
0 0 .000025 .007 0 0 0 0
0 0 0 0 .000025 .007 0 0
0 0 0 0 0 0 1e-2 1.4e-1

*D

0 0 0 0
0 0 0 0
0 0 0 0
0 0 0 0

*H

*M

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```
6,      ! Sensor number of 1st FGS (clamshell) sensor
0.d0,0.d0,0.d0,      ! Defaults to sun as a target for zero input vector
0.d0, -1.d0,0.d0,      ! Target star along negative polar axis
0.d0, -1.d0,0.d0,      ! Focal plane vector 1
1.d0,0.d0,0.d0,      ! Focal plane vector 2
1.d0,0.d0,0.d0,      ! Focal plane vector 3

7,      ! Sensor number of 2nd FGS (clamshell) sensor
0.d0,0.d0,0.d0,      ! Defaults to sun as a target for zero input vector
0.d0, 1.d0,0.d0,      ! Target star along positive polar axis
0.d0, -1.d0,0.d0,      ! Focal plane vector 1
1.d0,0.d0,0.d0,      ! Focal plane vector 2
-1.d0,0.d0,0.d0,      ! Focal plane vector 3
```

solar_pressure.dat (Concept 1) Summer Solstice

```
22, 'm',      ! number of panels, units English or Metric ***Updated 11/15/00***
1,2,638000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0,0.1736d0,0.d0,0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0,-0.1736d0,1.d0,-0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0,0.1736d0,0.d0,-0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0,-0.1736d0,-1.d0,0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
```

isc3_flex_sol.flx (Concept 1) Summer Solstice (An excerpt)

flag, revision number

XXXXXX

1

body id

1

modes, nodes, modal options

24	4	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

phi_t for node #

2

.31310941E-02	-.16357954E-03	.19158607E-08	.68659216E-04	.31346273E-02
.14949358E-08	-.33409338E-09	-.17910070E-08	-.62130721E-04	.10048928E-08
.74260327E-10	-.81693812E-09	.66744219E-10	-.57300403E-09	.56292416E-10
-.31109642E-09	.51999889E-08	.41569313E-10	.36697769E-02	.69502051E-03
.85567197E-10	-.10557893E-02	.35826871E-02	.65924560E-10	.61553749E-03
.11085623E-08	-.67301328E-05	.49549244E-10	-.49437998E-08	-.60865848E-11
.10484816E-08	.39239830E-10	-.17858973E-09	.46440350E-10	.23145265E-09
.76239104E-11	-.98486197E-09	-.52382674E-09	.30708566E-12	.12143532E-10
-.10722701E-09	.94529479E-03	.17735129E-08	.15323995E-09	.13868812E-12
-.13390485E-02	-.55272105E-04	-.82202021E-12	.55317399E-04	-.13390483E-02
.27552836E-11	.29149021E-10	-.27567962E-12	-.44865972E-10	.48584658E-11
.10595799E-10	-.31919479E-08	-.19937738E-10	.14255509E-09	-.23770452E-02
-.45933446E-03	-.19673179E-04	.63985161E-12	-.19675549E-04	.45933391E-03
-.74265281E-12	-.34874105E-11	-.12587102E-11	.59687765E-09	-.12099360E-11
-.69004494E-11	.19524343E-08			

phi_t prime for node #

2

.17177767E-11	-.22808543E-11	-.45683561E-10	.19817016E-10	.56718933E-12
.31514104E-09	.17463000E-11	-.27057756E-13	-.60467460E-12	.11400599E-06
-.42543750E-05	-.11919737E-10	.42546793E-05	.10153760E-06	-.34352434E-10
.41859459E-11	-.37080794E-11	.59234151E-04	.45504345E-11	-.70844966E-12
.15588470E-10	.13593377E-10	.68741697E-12	.87795145E-10	-.28497036E-11
.31909564E-13	-.69421743E-15	.38765922E-11	-.41335440E-11	-.44983453E-04
.22473012E-05	-.13022411E-04	.41075666E-11	-.13101519E-04	-.17274113E-05
-.98017672E-11	-.14778531E-12	-.42275125E-13	-.96071643E-06	-.25440820E-11
.54200130E-11	.41425181E-12	-.51084189E-13	.98880082E-15	.14899414E-06
-.49351318E-14	.15066380E-14	-.42969795E-10	-.54223125E-14	.27635772E-15
-.79851673E-11	.23444071E-06	-.40722409E-05	-.13017710E-13	.40722809E-05
.23382333E-06	.64327760E-12	-.80030821E-11	.19070818E-11	.27557384E-13
.67193209E-14	.15459451E-13	.15489036E-10	.28188639E-13	.15021236E-15
.22611633E-11	-.61243211E-07	.17482812E-05	.30019490E-13	-.17482739E-05
-.61449314E-07	-.27684414E-12			

phi_t for node #

3

-.42404714E-02	.49480955E-03	.19835813E-08	-.36612814E-03	-.42534660E-02
.96750031E-09	.42209027E-09	.30963712E-08	.40516924E-04	.38549281E-02
-.52714285E-03	-.87737477E-09	.53843743E-03	.38533672E-02	-.10363838E-09
.38623427E-08	-.71743451E-08	.24131659E-03	.31427071E-02	-.10270931E-03
.15812594E-09	-.20969267E-03	.31373775E-02	.44642715E-09	.28790083E-09
.88009461E-09	.18408168E-03	-.17813513E-08	-.27431844E-08	.15957166E-04
-.19242852E-02	.34087019E-03	-.22330623E-09	.41716037E-03	.19091971E-02
-.71605887E-10	.95016675E-09	-.81490514E-09	.32861442E-02	-.18116747E-08
.55541036E-09	.79551900E-03	-.41608643E-08	-.26069981E-09	.94036451E-02
.21682867E-02	-.12127210E-02	.85710915E-08	.12126479E-02	.21683282E-02
-.39141685E-08	.18971552E-02	-.12009168E-02	.43705940E-08	.12012029E-02
.18969745E-02	.16937062E-07	-.67726532E-08	-.66549206E-08	.11440634E-01
.49982895E-02	-.24804966E-02	.39527267E-09	-.24804686E-02	-.49983050E-02
-.34622476E-08	-.50056020E-02	.25440974E-02	-.23331468E-08	-.25435047E-02
-.50059046E-02	-.85708461E-08			

phi_t prime for node #

3

-.50525028E-06	-.31564387E-05	-.80521842E-10	.31702786E-05	-.40940183E-06
.57389171E-09	-.26678138E-11	.65900274E-12	-.58046889E-04	.10244708E-05
.47674564E-05	.15531760E-10	-.47644389E-05	.10384376E-05	.44257276E-10
.11200572E-10	.49389619E-11	-.61429724E-04	.68382965E-06	.54576833E-05
-.20073106E-10	-.54985919E-05	.13880871E-06	-.11950858E-09	-.12906028E-11
.35486701E-12	-.77274292E-04	.61171041E-11	-.56114520E-11	-.65377923E-04
-.17172111E-05	-.54788611E-05	.24079039E-11	-.54062017E-05	.19338345E-05
.41797610E-11	.67570000E-11	.20000043E-10	.51675836E-06	-.99163146E-11
-.24536147E-10	.16113741E-05	-.24387637E-10	-.45291231E-10	.14474359E-04
.40550997E-04	.55846277E-04	-.22605263E-10	-.55847708E-04	.40549096E-04
-.12064872E-11	.40806300E-04	.51925447E-04	-.22326921E-10	-.51919351E-04

```
.40814113E-04 .35521932E-10 .15828591E-09 -.16771401E-09 .21209458E-04
.16987298E-03 .27619447E-03 .11975439E-09 .27619558E-03 -.16987148E-03
-.57982074E-10 -.17376694E-03 -.27781790E-03 -.11765510E-09 .27783862E-03
-.17373409E-03 -.70075300E-10
phi_t for node # 4
-.42404802E-02 .49480360E-03 .18585028E-08 -.36612933E-03 -.42535396E-02
.21036956E-08 .39723035E-09 -.14786269E-09 .40516905E-04 -.38549306E-02
.52714303E-03 -.77214743E-09 -.53843745E-03 -.38533660E-02 .20798890E-09
-.73886299E-08 -.15978809E-07 -.24131650E-03 .31427093E-02 -.10270436E-03
.13801450E-10 -.20968938E-03 .31373931E-02 -.39914612E-09 .41931685E-11
.99616139E-10 .18408168E-03 .35438059E-09 -.17390277E-08 -.15957178E-04
.19242857E-02 -.34087031E-03 -.23866856E-09 -.41716036E-03 -.19091972E-02
-.19395891E-10 .94356214E-09 -.84924469E-09 -.32861442E-02 .18078300E-08
-.56604075E-09 .79551900E-03 -.41738415E-08 -.28114281E-09 -.94036451E-02
.21682868E-02 -.12127209E-02 -.85410786E-08 .12126480E-02 .21683284E-02
.38256346E-08 -.18971552E-02 .12009169E-02 .43704936E-08 -.12012030E-02
-.18969746E-02 .17005110E-07 .67789071E-08 .66775796E-08 .11440634E-01
.49982897E-02 -.24804968E-02 -.39492666E-09 -.24804688E-02 -.49983053E-02
.34827434E-08 .50056020E-02 -.25440973E-02 -.23324836E-08 .25435049E-02
.50059050E-02 -.85841247E-08
phi_t prime for node # 4
.50524725E-06 .31564441E-05 -.82070494E-10 -.31703213E-05 .40940604E-06
.62154334E-09 .34011412E-12 -.27858908E-12 .58046878E-04 .10244712E-05
.47674599E-05 .13355611E-10 -.47644372E-05 .10384375E-05 .44054122E-10
-.22077045E-10 .11247290E-10 -.61429722E-04 -.68382100E-06 -.54576879E-05
-.24245181E-10 .54986198E-05 -.13881681E-06 -.15347238E-09 .50958361E-12
-.41824742E-12 .77274292E-04 -.42833617E-11 .34928804E-12 -.65377921E-04
-.17172117E-05 -.54788625E-05 .15891701E-11 -.54062019E-05 .19338345E-05
-.90655410E-11 .71395520E-11 -.19852937E-10 .51675837E-06 -.10061491E-10
-.24464605E-10 -.16113739E-05 .23986931E-10 .45635598E-10 .14474359E-04
-.40550995E-04 .55846279E-04 -.22604313E-10 .55847713E-04 -.40549100E-04
-.14851140E-11 .40806300E-04 .51925447E-04 .22357522E-10 -.51919354E-04
.40814116E-04 .35835384E-10 .15906312E-09 -.16795738E-09 -.21209458E-04
-.16987299E-03 .27619447E-03 .11979215E-09 -.27619560E-03 .16987149E-03
-.57726900E-10 -.17376694E-03 -.27781789E-03 .11764036E-09 .27783864E-03
-.17373411E-03 .70185849E-10
mass matrix
.10000000E+01 -.30291562E-01 -.76876291E-07 .73800796E-06 .32867117E-06
.13158549E-06 -.92633251E-08 -.17952422E-07 .62673968E-08 -.19995321E-07
.20953681E-06 -.61379992E-07 .12006683E-09 -.11753664E-09 .88805322E-10
.18582751E-09 .93589593E-10 .34601899E-08 .12520782E-08 .51220876E-10
-.26895388E-10 -.46932083E-10 -.51456416E-09 -.16699282E-09 -.30291562E-01
.10000000E+01 .26989693E-07 .24701420E-07 .34123181E-05 .19569915E-07
.18126030E-07 -.22083024E-07 -.30895835E-08 -.63797417E-09 .13846796E-06
-.91584230E-06 .28463240E-09 -.92291186E-09 .13196997E-09 -.83498605E-10
-.23061102E-09 .37066771E-09 .14015707E-07 .71524564E-09 -.97352491E-12
-.79781628E-10 -.28504651E-10 -.24628018E-08 -.76876291E-07 .26989693E-07
.10000000E+01 -.12820039E-07 .23873133E-06 .46502856E-07 .48615925E-08
-.31587180E-08 -.94997621E-10 -.56075172E-08 .49113872E-08 -.51914907E-07
-.57636964E-11 .45511296E-10 .45041193E-11 -.28608624E-10 .92163317E-11
-.16290986E-10 .76859350E-09 -.31071312E-10 -.47158520E-11 -.13956592E-11
.40931813E-11 -.13308932E-09 .73800796E-06 .24701420E-07 -.12820039E-07
.10000000E+01 .29302137E-02 .10572523E-05 -.24430484E-06 .68476034E-07
.92720426E-09 -.64534578E-07 .16242822E-07 .86600013E-08 .72440444E-09
.16245107E-08 -.11209088E-09 .55930229E-10 -.44166054E-09 -.10256621E-08
-.50144862E-09 -.15880740E-08 .25789654E-09 -.98514653E-10 -.37720327E-09
.27460623E-09 .32867117E-06 .34123181E-05 .23873133E-06 .29302137E-02
.10000000E+01 .71189247E-06 -.53815780E-06 -.15566832E-05 .83251907E-07
-.45009419E-07 -.44807150E-07 .17705875E-07 .16602525E-08 -.43070508E-08
-.20692528E-09 .20019442E-08 .57241159E-08 -.72556163E-09 .93151063E-09
.18206492E-08 -.13561118E-09 -.12897281E-08 -.25829052E-10 .16156569E-09
.13158549E-06 .19569915E-07 .46502856E-07 .10572523E-05 .71189247E-06
.10000000E+01 -.83160269E-07 .24349543E-07 .11233865E-07 .10028917E-06
-.12313102E-06 .70134651E-07 -.13207290E-08 .28173844E-08 -.11660397E-08
.22882173E-09 -.30171128E-09 -.14728997E-08 -.13109908E-08 .32317686E-09
.12105915E-10 -.55168990E-10 .27914248E-09 .14656790E-09 -.92633250E-08
.18126030E-07 .48615925E-08 -.24430484E-06 -.53815780E-06 -.83160269E-07
.10000000E+01 -.99242756E-01 .22394316E-07 -.39958298E-07 .32234509E-06
-.50160922E-06 .23636843E-09 -.21910738E-09 .14348669E-09 .15847338E-09
.74774558E-10 .3273302E-08 .57239272E-08 .10031900E-09 -.36640911E-10
-.81560611E-10 -.45187655E-09 -.93057423E-09 -.17952422E-07 -.22083024E-07
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-.31587180E-08 .68476034E-07 -.15566832E-05 .24349543E-07 -.99242756E-01
.10000000E+01 -.20074054E-07 .16458235E-07 .15485050E-06 -.15630944E-05
.29386609E-09 -.10163269E-08 .11846928E-09 -.20501990E-09 -.41770205E-09
-.56246450E-09 .16797163E-07 .78252621E-09 .33675344E-11 -.57812240E-10
.11108613E-09 -.29422473E-08 .62673968E-08 -.30895835E-08 -.94997760E-10
.92720426E-09 .83251907E-07 .11233865E-07 .22394316E-07 -.20074054E-07
.10000000E+01 .12712850E-07 -.23627686E-07 .15204590E-06 .96068819E-11
-.66710239E-10 .23252770E-12 .57865057E-10 -.34048646E-10 -.56274547E-10
-.13467924E-08 .57321148E-10 .72512622E-11 .43261077E-11 .42475879E-11
.23009307E-09 -.19995321E-07 -.63797417E-09 -.56075174E-08 -.64534578E-07
-.45009419E-07 .10028917E-06 -.39958298E-07 .16458235E-07 .12712850E-07
.10000000E+01 .34013758E-06 -.19456390E-06 .12276100E-08 -.23143374E-08
.90995226E-09 -.20703316E-09 .26711414E-09 .17484259E-08 .14384415E-08
-.22089987E-09 -.12869248E-10 .38339013E-10 -.31448481E-09 -.18544250E-09
.20953681E-06 .13846796E-06 .49113872E-08 .16242822E-07 -.44807150E-07
-.12313102E-06 .32234509E-06 .15485050E-06 -.23627686E-07 .34013758E-06
.10000000E+01 -.39786267E-01 .17049808E-08 .38885439E-08 -.46588188E-09
.12616452E-08 .13318808E-08 -.42894021E-08 .74108288E-09 -.45855306E-08
.76304756E-09 -.90324773E-09 -.10747486E-08 .61285555E-09 -.61379992E-07
-.91584230E-06 -.51914907E-07 .86600013E-08 .17705875E-07 .70134651E-07
-.50160922E-06 -.15630944E-05 .15204590E-06 -.19456390E-06 -.39786267E-01
.10000000E+01 .62505978E-08 .15167020E-07 .64225500E-09 -.64493380E-08
-.19359751E-08 .14627884E-08 -.39742767E-08 -.61200326E-08 .51696455E-09
.41021165E-07 .38755886E-10 -.28087086E-09 .12006683E-09 .28463240E-09
-.57637523E-11 .72440444E-09 -.16602525E-08 -.13207290E-08 .23636843E-09
.29386609E-09 .96069199E-11 .12276100E-08 .17049808E-08 .62505978E-08
.10000000E+01 .73552646E-10 .38814802E-10 .36872491E-10 .72462767E-10
-.30908303E-09 .78347194E-09 -.80736378E-10 .38873326E-11 -.52248843E-11
.43195040E-10 -.10247581E-09 -.11753664E-09 -.92291186E-09 .45511310E-10
.16245107E-08 -.43070508E-08 .28173844E-08 -.21910738E-09 -.10163269E-08
-.66710219E-10 -.23143374E-08 .38885439E-08 .15167020E-07 .73552316E-10
.10000000E+01 -.15617476E-09 -.61749360E-11 -.26777146E-09 -.10599770E-08
.29161646E-08 -.20094998E-09 .18211917E-10 .26472063E-10 .16702574E-09
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.43195040E-10	.16702574E-09	-.17559408E-10	.24612970E-10	-.10191791E-09
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.10000000E+01	-.11866292E-03	-.16699269E-09	-.24628016E-08	-.13308932E-09
.27460630E-09	.16156571E-09	.14656790E-09	-.93057434E-09	-.29422474E-08
.23009307E-09	-.18544250E-09	.61285545E-09	-.28087069E-09	-.10247581E-09
-.34247066E-09	-.32344202E-10	.46331502E-09	.14986050E-08	.26024357E-09
.50310165E-09	.64933845E-09	-.85539216E-08	-.75550117E-07	-.11866292E-03

.10000000E+01
damping matrix

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.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
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.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.01975800E-00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
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.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.02852600E-00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
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.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.51561286E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
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.18482064E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
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stiffness matrix

44

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*** zeroth order terms ***

alpha

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-.81003566E-13 .43653901E-13
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h matrix

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.26295445E+00 .10634541E-02 .39837270E+00 .24038060E-01 .34138213E-02
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.18275688E-02 .81441214E-01 .37327408E-03 -.11565896E+00 -.94944608E-03
-.86128442E-03 -.44776941E-03 -.16313018E-03 -.15718717E-04 -.10522228E-02
.90631992E-05 .49761828E-04 -.64926039E-04 .27152761E-04 -.19410130E-04
.46028011E-03 .13453022E-03 .19224888E-06 .13666807E-02 .14309527E-03
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.20016096E-03 .90998999E-05 .44426853E-03 .45524403E-04 .33906200E-05
-.32663380E-04 -.43305067E-04 -.94350657E-07 -.31076189E-03 .13804808E-04
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s1

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*** first order terms ***

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.00000000E+00    .00000000E+00    .71852291E-02    .00000000E+00    .28424090E-01
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.33870978E+05    .00000000E+00    .00000000E+00    .00000000E+00    .33870978E+05
.00000000E+00    .24388227E-01    .23658852E-01    .00000000E+00    .31851587E-01
.00000000E+00    .00000000E+00    .00000000E+00    .31851587E-01    .00000000E+00
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.00000000E+00    -.11132880E-03    .00000000E+00    -.11476862E-02    .30969398E-01
.00000000E+00    -.22321987E+05    .00000000E+00    .00000000E+00    .00000000E+00
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.00000000E+00    .00000000E+00    .00000000E+00    -.35882781E-02    .00000000E+00
-.74530641E+04    .60220631E+05    .00000000E+00    .34407691E+06    .00000000E+00
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.84613530E-04    .00000000E+00    -.20271109E-05    .00000000E+00    .00000000E+00
.00000000E+00    -.20271109E-05    .00000000E+00    .60214464E-02    .31309394E-02
.00000000E+00    .21803208E+06    .00000000E+00    .00000000E+00    .00000000E+00
.21803208E+06    .00000000E+00    .35046731E-06    .20448791E-05    .00000000E+00
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-.16399263E-07	.73058140E-08	-.94493068E-01	-.48349038E-07	.22872252E-07
.11390138E+00	.53141657E-01	-.26904645E-01	.94708623E-07	.55451004E-07
.26193636E-06	-.18332552E-07	-.35360159E-06	-.28254188E-07	.38520272E-07
-.19779770E-08	.13203123E-08	-.89135235E-08	-.31354628E-01	.41849538E-02
-.36824273E-07	.16609482E-08	-.44578552E-09	-.79066663E-01	-.54141545E-08

kdyic1

rvtor1

(and more)

TREETOPS REV 10P2 4/10/00

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1 SI 0 Title
2 SI 0 Simulation stop time
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53

3	SI	0	Plot data interval	20
4	SI	0	Integration type (R,S,U, OR V)	R
5	SI	0	Step size (sec)	.1
6	SI	0	Sandia ODE solver absolute and relative error	
7	SI	0	RK78 ODE solver absolute error and first step size	
8	SI	0	Linearization option (L,Z or N)	N
9	SI	0	Restart option (Y/N)	N
10	SI	0	Contact force computation option (Y/N)	Y
11	SI	0	Constraint force computation option (Y/N)	N
12	SI	0	Small angle speedup option (All,Bypass,First,Nth)	A
13	SI	0	Mass matrix speedup option (All,Bypass,First,Nth)	A
14	SI	0	Non-Linear speedup option (All,Bypass,First,Nth)	A
15	SI	0	Constraint speedup option (All,Bypass,First,Nth)	A
16	SI	0	Constraint stabilization option (Y/N)	N
17	SI	0	Stabilization epsilon	

GENGRAV

18	GG	0	Gravity, earth sphere/nonsphere/user (S/N/U)?	N
19	GG	1	Input gravity constants: GME, ERAD, EMAS	
20	GG	1	Spherical or Nonspherical (S/N)?	
21	GG	1	Gravity Potential Harmonics J2,J3,J4	
22	GG	0	English (ft-slug-s) or metric (m-kg-s) (E/M)?	M
23	GG	0	Day, Month, Year,	20 3 2020
24	GG	0	GMT @ sim time 0 (minutes past midnight,	360
25	GG	0	Solar Pressure forces Y/N?	Y
26	GG	0	Input new data for aero model? (Y/N)	N
27	GG	1	Solar flux F10 for aero model	
28	GG	1	Solar flux, 81 day average F10B	
29	GG	1	Geomagnetic index, GEAP	

BODY

30	BO	1	Body ID number	1
31	BO	1	Type (Rigid,Flexible,NASTRAN)	F
32	BO	1	Number of modes	24
33	BO	1	Modal calculation option (0, 1 or 2)	2
34	BO	1	Foreshortening option (Y/N)	
35	BO	1	Model reduction method (NO,MS,MC,CC,QM,CV)	
36	BO	1	NASTRAN data file FORTRAN unit number (40 - 60)	
37	BO	1	Number of augmented nodes (0 if none)	
38	BO	1	Damping matrix option (NS,CD,HL,SD)	
39	BO	1	Constant damping ratio	
40	BO	1	Low frequency, High frequency ratios	
41	BO	1	Mode ID number, damping ratio	
42	BO	1	Conversion factors: Length,Mass,Force	
43	BO	1	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
44	BO	1	Moments of inertia (kg-m2) Ixx,Iyy,Izz	6.2852173E11 6.2852173E11
45	BO	1	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
46	BO	1	Mass (kg)	1.6168633E5
47	BO	1	Number of Nodes	4
48	BO	1	Node ID, Node coord. (meters) x,y,z	1 0 0 0
49	BO	1	Node ID, Node coord. (meters) x,y,z	2 0 0 0
50	BO	1	Node ID, Node coord. (meters) x,y,z	3 0 0 3188.8
51	BO	1	Node ID, Node coord. (meters) x,y,z	4 0 0 -3188.8
52	BO	1	Node ID, Node structural joint ID	
53	BO	2	Body ID number	2
54	BO	2	Type (Rigid,Flexible,NASTRAN)	R
55	BO	2	Number of modes	
56	BO	2	Modal calculation option (0, 1 or 2)	
57	BO	2	Foreshortening option (Y/N)	
58	BO	2	Model reduction method (NO,MS,MC,CC,QM,CV)	
59	BO	2	NASTRAN data file FORTRAN unit number (40 - 60)	

60 BO	2	Number of augmented nodes (0 if none)	
61 BO	2	Damping matrix option (NS,CD,HL,SD)	
62 BO	2	Constant damping ratio	
63 BO	2	Low frequency, High frequency ratios	
64 BO	2	Mode ID number, damping ratio	
65 BO	2	Conversion factors: Length,Mass,Force	
66 BO	2	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
67 BO	2	Moments of inertia (kg-m2) Ixx,Iyy,Izz	.8543E12 1.5601E12
1.3822E12			
68 BO	2	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
69 BO	2	Mass (kg)	12666300
70 BO	2	Number of Nodes	5
71 BO	2	Node ID, Node coord. (meters) x,y,z	1 298.323 0 0
72 BO	2	Node ID, Node coord. (meters) x,y,z	2 0 0 0
73 BO	2	Node ID, Node coord. (meters) x,y,z	3 0 0 300
74 BO	2	Node ID, Node coord. (meters) x,y,z	4 0 0 -300
75 BO	2	Node ID, Node coord. (meters) x,y,z	5 500 0 0
76 BO	2	Node ID, Node structural joint ID	
77 BO	3	Body ID number	3
78 BO	3	Type (Rigid,Flexible,NASTRAN)	R
79 BO	3	Number of modes	
80 BO	3	Modal calculation option (0, 1 or 2)	
81 BO	3	Foreshortening option (Y/N)	
82 BO	3	Model reduction method (NO,MS,MC,CC,QM,CV)	
83 BO	3	NASTRAN data file FORTRAN unit number (40 - 60)	
84 BO	3	Number of augmented nodes (0 if none)	
85 BO	3	Damping matrix option (NS,CD,HL,SD)	
86 BO	3	Constant damping ratio	
87 BO	3	Low frequency, High frequency ratios	
88 BO	3	Mode ID number, damping ratio	
89 BO	3	Conversion factors: Length,Mass,Force	
90 BO	3	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
91 BO	3	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
92 BO	3	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
93 BO	3	Mass (kg)	2046600
94 BO	3	Number of Nodes	2
95 BO	3	Node ID, Node coord. (meters) x,y,z	1 0 0 0
96 BO	3	Node ID, Node coord. (meters) x,y,z	2 0 0 0
97 BO	3	Node ID, Node structural joint ID	
98 BO	4	Body ID number	4
99 BO	4	Type (Rigid,Flexible,NASTRAN)	R
100 BO	4	Number of modes	
101 BO	4	Modal calculation option (0, 1 or 2)	
102 BO	4	Foreshortening option (Y/N)	
103 BO	4	Model reduction method (NO,MS,MC,CC,QM,CV)	
104 BO	4	NASTRAN data file FORTRAN unit number (40 - 60)	
105 BO	4	Number of augmented nodes (0 if none)	
106 BO	4	Damping matrix option (NS,CD,HL,SD)	
107 BO	4	Constant damping ratio	
108 BO	4	Low frequency, High frequency ratios	
109 BO	4	Mode ID number, damping ratio	
110 BO	4	Conversion factors: Length,Mass,Force	
111 BO	4	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
112 BO	4	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
113 BO	4	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
114 BO	4	Mass (kg)	2046600
115 BO	4	Number of Nodes	2
116 BO	4	Node ID, Node coord. (meters) x,y,z	1 0 0 0
117 BO	4	Node ID, Node coord. (meters) x,y,z	2 0 0 0
118 BO	4	Node ID, Node structural joint ID	
HINGE			
119 HI	1	Hinge ID number	1
120 HI	1	Inboard body ID, Outboard body ID	0 1
121 HI	1	"p" node ID, "q" node ID	0 2
122 HI	1	Number of rotation DOFs, Rotation option (F or G)	3 F
123 HI	1	L1 unit vector in inboard body coord. x,y,z	1 0 0

124 HI	1 L1 unit vector in outboard body coord. x,y,z	1 0 0
125 HI	1 L2 unit vector in inboard body coord. x,y,z	
126 HI	1 L2 unit vector in outboard body coord. x,y,z	
127 HI	1 L3 unit vector in inboard body coord. x,y,z	0 0 1
128 HI	1 L3 unit vector in outboard body coord. x,y,z	0 0 1
129 HI	1 Initial rotation angles (deg)	-90. 0. 0.
130 HI	1 Initial rotation rates (deg/sec)	0 0 0
131 HI	1 Rotation stiffness (newton-meters/rad)	0 0 0
132 HI	1 Rotation damping (newton-meters/rad/sec)	0 0 0
133 HI	1 Null torque angles (deg)	0 0 0
134 HI	1 Number of translation DOFs	3
135 HI	1 First translation unit vector g1	1 0 0
136 HI	1 Second translation unit vector g2	0 1 0
137 HI	1 Third translation unit vector g3	0 0 1
138 HI	1 Initial translation (meters)	0 0 42163421
139 HI	1 Initial translation velocity (meters/sec)	3074.681 0 0
140 HI	1 Translation stiffness (newtons/meters)	0 0 0
141 HI	1 Translation damping (newtons/meter/sec)	0 0 0
142 HI	1 Null force translations	0 0 0
143 HI	2 Hinge ID number	2
144 HI	2 Inboard body ID, Outboard body ID	1 2
145 HI	2 "p" node ID, "q" node ID	2 2
146 HI	2 Number of rotation DOFs	1
147 HI	2 L1 unit vector in inboard body coord. x,y,z	0 0 1
148 HI	2 L1 unit vector in outboard body coord. x,y,z	0 0 1
149 HI	2 L2 unit vector in inboard body coord. x,y,z	
150 HI	2 L2 unit vector in outboard body coord. x,y,z	
151 HI	2 L3 unit vector in inboard body coord. x,y,z	1 0 0
152 HI	2 L3 unit vector in outboard body coord. x,y,z	1 0 0
153 HI	2 Initial rotation angles (deg)	90. 0. 0.
154 HI	2 Initial rotation rates (deg/sec)	0.00417807
155 HI	2 Rotation stiffness (newton-meters/rad)	0
156 HI	2 Rotation damping (newton-meters/rad/sec)	0
157 HI	2 Null torque angles (deg)	0
158 HI	2 Number of translation DOFs	0
159 HI	2 First translation unit vector g1	1 0 0
160 HI	2 Second translation unit vector g2	0 1 0
161 HI	2 Third translation unit vector g3	0 0 1
162 HI	2 Initial translation (meters)	0 0 0
163 HI	2 Initial translation velocity (meters/sec)	
164 HI	2 Translation stiffness (newtons/meters)	
165 HI	2 Translation damping (newtons/meter/sec)	
166 HI	2 Null force translations	
167 HI	3 Hinge ID number	3
168 HI	3 Inboard body ID, Outboard body ID	1 3
169 HI	3 "p" node ID, "q" node ID	3 2
170 HI	3 Number of rotation DOFs	0
171 HI	3 L1 unit vector in inboard body coord. x,y,z	0 0 1
172 HI	3 L1 unit vector in outboard body coord. x,y,z	0 0 1
173 HI	3 L2 unit vector in inboard body coord. x,y,z	
174 HI	3 L2 unit vector in outboard body coord. x,y,z	
175 HI	3 L3 unit vector in inboard body coord. x,y,z	0 1 0
176 HI	3 L3 unit vector in outboard body coord. x,y,z	0 1 0
177 HI	3 Initial rotation angles (deg)	0. 0. -135.
178 HI	3 Initial rotation rates (deg/sec)	
179 HI	3 Rotation stiffness (newton-meters/rad)	
180 HI	3 Rotation damping (newton-meters/rad/sec)	
181 HI	3 Null torque angles (deg)	
182 HI	3 Number of translation DOFs	0
183 HI	3 First translation unit vector g1	1 0 0
184 HI	3 Second translation unit vector g2	0 1 0
185 HI	3 Third translation unit vector g3	0 0 1
186 HI	3 Initial translation (meters)	0 0 0
187 HI	3 Initial translation velocity (meters/sec)	
188 HI	3 Translation stiffness (newtons/meters)	
189 HI	3 Translation damping (newtons/meter/sec)	
190 HI	3 Null force translations	
191 HI	4 Hinge ID number	4

192 HI	4 Inboard body ID, Outboard body ID	1 4
193 HI	4 "p" node ID, "q" node ID	4 2
194 HI	4 Number of rotation DOFs	0
195 HI	4 L1 unit vector in inboard body coord. x,y,z	0 0 1
196 HI	4 L1 unit vector in outboard body coord. x,y,z	0 0 1
197 HI	4 L2 unit vector in inboard body coord. x,y,z	
198 HI	4 L2 unit vector in outboard body coord. x,y,z	
199 HI	4 L3 unit vector in inboard body coord. x,y,z	0 1 0
200 HI	4 L3 unit vector in outboard body coord. x,y,z	0 1 0
201 HI	4 Initial rotation angles (deg)	0. 0. -45.
202 HI	4 Initial rotation rates (deg/sec)	
203 HI	4 Rotation stiffness (newton-meters/rad)	
204 HI	4 Rotation damping (newton-meters/rad/sec)	
205 HI	4 Null torque angles (deg)	
206 HI	4 Number of translation DOFs	0
207 HI	4 First translation unit vector g1	1 0 0
208 HI	4 Second translation unit vector g2	0 1 0
209 HI	4 Third translation unit vector g3	0 0 1
210 HI	4 Initial translation (meters)	0 0 0
211 HI	4 Initial translation velocity (meters/sec)	
212 HI	4 Translation stiffness (newtons/meters)	
213 HI	4 Translation damping (newtons/meter/sec)	
214 HI	4 Null force translations	

SENSOR

215 SE	1 Sensor ID number	1
216 SE	1 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET
217 SE	1 Mounting point body ID, Mounting point node ID	2 2
218 SE	1 Second mounting point body ID, Second node ID	
219 SE	1 Input axis unit vector (IA) x,y,z	
220 SE	1 Mounting point Hinge index, Axis index	
221 SE	1 First focal plane unit vector (Fp1) x,y,z	0 0 -1
222 SE	1 Second focal plane unit vector (Fp2) x,y,z	0 1 0
223 SE	1 Sun/Star unit vector (Us) x,y,z	
224 SE	1 Velocity Aberration Option (Y/N)	
225 SE	1 Euler Angle Sequence (1-6)	
226 SE	1 CMG ID number and Gimbal number	
227 SE	1 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	6378000 0 0 4.178074D-3
228 SE	2 Sensor ID number	2
229 SE	2 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
230 SE	2 Mounting point body ID, Mounting point node ID	2 2
231 SE	2 Second mounting point body ID, Second node ID	
232 SE	2 Input axis unit vector (IA) x,y,z	
233 SE	2 Mounting point Hinge index, Axis index	
234 SE	2 First focal plane unit vector (Fp1) x,y,z	0 -1 0
235 SE	2 Second focal plane unit vector (Fp2) x,y,z	1 0 0
236 SE	2 Sun/Star unit vector (Us) x,y,z	0 1 0
237 SE	2 Velocity Aberration Option (Y/N)	N
238 SE	2 Euler Angle Sequence (1-6)	
239 SE	2 CMG ID number and Gimbal number	
240 SE	2 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
241 SE	3 Sensor ID number	3
242 SE	3 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
243 SE	3 Mounting point body ID, Mounting point node ID	1 2
244 SE	3 Second mounting point body ID, Second node ID	
245 SE	3 Input axis unit vector (IA) x,y,z	
246 SE	3 Mounting point Hinge index, Axis index	
247 SE	3 First focal plane unit vector (Fp1) x,y,z	-1 0 0
248 SE	3 Second focal plane unit vector (Fp2) x,y,z	0 0 1
249 SE	3 Sun/Star unit vector (Us) x,y,z	0 0 0
250 SE	3 Velocity Aberration Option (Y/N)	N
251 SE	3 Euler Angle Sequence (1-6)	
252 SE	3 CMG ID number and Gimbal number	
253 SE	3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
254 SE	4 Sensor ID number	4
255 SE	4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	A3

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256 SE 4 Mounting point body ID, Mounting point node ID 1 2
257 SE 4 Second mounting point body ID, Second node ID
258 SE 4 Input axis unit vector (IA) x,y,z
259 SE 4 Mounting point Hinge index, Axis index
260 SE 4 First focal plane unit vector (Fp1) x,y,z
261 SE 4 Second focal plane unit vector (Fp2) x,y,z
262 SE 4 Sun/Star unit vector (Us) x,y,z
263 SE 4 Velocity Aberration Option (Y/N)
264 SE 4 Euler Angle Sequence (1-6)
265 SE 4 CMG ID number and Gimbal number
266 SE 4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE 5 Sensor ID number 5
268 SE 5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) LV
269 SE 5 Mounting point body ID, Mounting point node ID 1 2
270 SE 5 Second mounting point body ID, Second node ID
271 SE 5 Input axis unit vector (IA) x,y,z
272 SE 5 Mounting point Hinge index, Axis index
273 SE 5 First focal plane unit vector (Fp1) x,y,z
274 SE 5 Second focal plane unit vector (Fp2) x,y,z
275 SE 5 Sun/Star unit vector (Us) x,y,z
276 SE 5 Velocity Aberration Option (Y/N)
277 SE 5 Euler Angle Sequence (1-6)
278 SE 5 CMG ID number and Gimbal number
279 SE 5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE 6 Sensor ID number 6
281 SE 6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV L
282 SE 6 Mounting point body ID, Mounting point node ID 3 2
283 SE 6 Second mounting point body ID, Second node ID
284 SE 6 Input axis unit vector (IA) x,y,z 1 0 0
285 SE 6 Mounting point Hinge index, Axis index
286 SE 6 First focal plane unit vector (Fp1) x,y,z
287 SE 6 Second focal plane unit vector (Fp2) x,y,z
288 SE 6 Sun/Star unit vector (Us) x,y,z
289 SE 6 Velocity Aberration Option (Y/N)
290 SE 6 Euler Angle Sequence (1-6)
291 SE 6 CMG ID number and Gimbal number
292 SE 6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

293 SE 7 Sensor ID number 7
294 SE 7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV L
295 SE 7 Mounting point body ID, Mounting point node ID 4 2
296 SE 7 Second mounting point body ID, Second node ID
297 SE 7 Input axis unit vector (IA) x,y,z 1 0 0
298 SE 7 Mounting point Hinge index, Axis index
299 SE 7 First focal plane unit vector (Fp1) x,y,z
300 SE 7 Second focal plane unit vector (Fp2) x,y,z
301 SE 7 Sun/Star unit vector (Us) x,y,z
302 SE 7 Velocity Aberration Option (Y/N)
303 SE 7 Euler Angle Sequence (1-6)
304 SE 7 CMG ID number and Gimbal number
305 SE 7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

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ACTR

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306 AC 1 Actuator ID number 1
307 AC 1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) MO
308 AC 1 Actuator location; Node or Hinge (N or H)
309 AC 1 Mounting point body ID number, node ID number 2 2
310 AC 1 Second mounting point body ID, second node ID
311 AC 1 Output axis unit vector x,y,z 0 1 0
312 AC 1 Mounting point Hinge index, Axis index
313 AC 1 Rotor spin axis unit vector x,y,z
314 AC 1 Initial rotor momentum, H
315 AC 1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
316 AC 1 Outer gimbal axis unit vector x,y,z
317 AC 1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
318 AC 1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
319 AC 1 Inner gimbal axis unit vector x,y,z

```

320 AC	1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
321 AC	1 Initial length and rate, y(to) and ydot(to)	
322 AC	1 Constants; K1 or wo, n or zeta, Kg, Jm	
323 AC	1 Non-linearities; TLim, Tco, Dz	
324 AC	2 Actuator ID number	2
325 AC	2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
326 AC	2 Actuator location; Node or Hinge (N or H)	
327 AC	2 Mounting point body ID number, node ID number	2 2
328 AC	2 Second mounting point body ID, second node ID	
329 AC	2 Output axis unit vector x,y,z	0 0 1
330 AC	2 Mounting point Hinge index, Axis index	
331 AC	2 Rotor spin axis unit vector x,y,z	
332 AC	2 Initial rotor momentum, H	
333 AC	2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
334 AC	2 Outer gimbal axis unit vector x,y,z	
335 AC	2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
336 AC	2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
337 AC	2 Inner gimbal axis unit vector x,y,z	
338 AC	2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
339 AC	2 Initial length and rate, y(to) and ydot(to)	
340 AC	2 Constants; K1 or wo, n or zeta, Kg, Jm	
341 AC	2 Non-linearities; TLim, Tco, Dz	
342 AC	3 Actuator ID number	3
343 AC	3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
344 AC	3 Actuator location; Node or Hinge (N or H)	
345 AC	3 Mounting point body ID number, node ID number	2 2
346 AC	3 Second mounting point body ID, second node ID	
347 AC	3 Output axis unit vector x,y,z	1 0 0
348 AC	3 Mounting point Hinge index, Axis index	
349 AC	3 Rotor spin axis unit vector x,y,z	
350 AC	3 Initial rotor momentum, H	
351 AC	3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
352 AC	3 Outer gimbal axis unit vector x,y,z	
353 AC	3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
354 AC	3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
355 AC	3 Inner gimbal axis unit vector x,y,z	
356 AC	3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
357 AC	3 Initial length and rate, y(to) and ydot(to)	
358 AC	3 Constants; K1 or wo, n or zeta, Kg, Jm	
359 AC	3 Non-linearities; TLim, Tco, Dz	
360 AC	4 Actuator ID number	4
361 AC	4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	T
362 AC	4 Actuator location; Node or Hinge (N or H)	
363 AC	4 Mounting point body ID number, node ID number	
364 AC	4 Second mounting point body ID, second node ID	
365 AC	4 Output axis unit vector x,y,z	
366 AC	4 Mounting point Hinge index, Axis index	2 1
367 AC	4 Rotor spin axis unit vector x,y,z	
368 AC	4 Initial rotor momentum, H	
369 AC	4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
370 AC	4 Outer gimbal axis unit vector x,y,z	
371 AC	4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
372 AC	4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
373 AC	4 Inner gimbal axis unit vector x,y,z	
374 AC	4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
375 AC	4 Initial length and rate, y(to) and ydot(to)	
376 AC	4 Constants; K1 or wo, n or zeta, Kg, Jm	
377 AC	4 Non-linearities; TLim, Tco, Dz	
378 AC	5 Actuator ID number	5
379 AC	5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	J
380 AC	5 Actuator location; Node or Hinge (N or H)	
381 AC	5 Mounting point body ID number, node ID number	2 5
382 AC	5 Second mounting point body ID, second node ID	
383 AC	5 Output axis unit vector x,y,z	-1 0 0
384 AC	5 Mounting point Hinge index, Axis index	
385 AC	5 Rotor spin axis unit vector x,y,z	
386 AC	5 Initial rotor momentum, H	

387 AC 5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
388 AC 5 Outer gimbal axis unit vector x,y,z
389 AC 5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
390 AC 5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
391 AC 5 Inner gimbal axis unit vector x,y,z
392 AC 5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
393 AC 5 Initial length and rate, y(to) and ydot(to)
394 AC 5 Constants; K1 or wo, n or zeta, Kg, Jm
395 AC 5 Non-linearities; TLim, Tco, Dz

CONTROLLER

396 CO 1 Controller ID number 1
397 CO 1 Controller type (CB,CM,DB,DM,UC,UD) CM
398 CO 1 Sample time (sec)
399 CO 1 Number of inputs, Number of outputs 4 4
400 CO 1 Number of states
401 CO 1 Output No., Input type (I,S,T), Input ID, Gain

INTERCONNECT

402 IN 1 Interconnect ID number 1
403 IN 1 Source type(S,C, or F),Source ID,Source row # S 1 1
404 IN 1 Destination type(A or C),Dest ID,Dest row # C 1 1
405 IN 1 Gain 4.41E13

406 IN 2 Interconnect ID number 2
407 IN 2 Source type(S,C, or F),Source ID,Source row # C 1 1
408 IN 2 Destination type(A or C),Dest ID,Dest row # A 1 1
409 IN 2 Gain 1

410 IN 3 Interconnect ID number 3
411 IN 3 Source type(S,C, or F),Source ID,Source row # S 1 2
412 IN 3 Destination type(A or C),Dest ID,Dest row # C 1 2
413 IN 3 Gain 1.67E12

414 IN 4 Interconnect ID number 4
415 IN 4 Source type(S,C, or F),Source ID,Source row # C 1 2
416 IN 4 Destination type(A or C),Dest ID,Dest row # A 2 1
417 IN 4 Gain 1

418 IN 5 Interconnect ID number 5
419 IN 5 Source type(S,C, or F),Source ID,Source row # S 2 1
420 IN 5 Destination type(A or C),Dest ID,Dest row # C 1 3
421 IN 5 Gain 4.31E13

422 IN 6 Interconnect ID number 6
423 IN 6 Source type(S,C, or F),Source ID,Source row # C 1 3
424 IN 6 Destination type(A or C),Dest ID,Dest row # A 3 1
425 IN 6 Gain 1

426 IN 7 Interconnect ID number 7
427 IN 7 Source type(S,C, or F),Source ID,Source row # S 3 1
428 IN 7 Destination type(A or C),Dest ID,Dest row # C 1 4
429 IN 7 Gain 6.7E8

430 IN 8 Interconnect ID number 8
431 IN 8 Source type(S,C, or F),Source ID,Source row # C 1 4
432 IN 8 Destination type(A or C),Dest ID,Dest row # A 4 1
433 IN 8 Gain 1

434 IN 9 Interconnect ID number 9
435 IN 9 Source type(S,C, or F),Source ID,Source row # S 3 3
436 IN 9 Destination type(A or C),Dest ID,Dest row # A 5 1
437 IN 9 Gain 7

TREETOPS REV 10P2 4/10/00

SIM CONTROL

1 SI	0 Title	ISC MODEL, THIRD VERSION
2 SI	0 Simulation stop time	100000
3 SI	0 Plot data interval	20
4 SI	0 Integration type (R,S,U, OR V)	R
5 SI	0 Step size (sec)	.1
6 SI	0 Sandia ODE solver absolute and relative error	
7 SI	0 RK78 ODE solver absolute error and first step size	
8 SI	0 Linearization option (L,Z or N)	N
9 SI	0 Restart option (Y/N)	N
10 SI	0 Contact force computation option (Y/N)	Y
11 SI	0 Constraint force computation option (Y/N)	N
12 SI	0 Small angle speedup option (All,Bypass,First,Nth)	A
13 SI	0 Mass matrix speedup option (All,Bypass,First,Nth)	A
14 SI	0 Non-Linear speedup option (All,Bypass,First,Nth)	A
15 SI	0 Constraint speedup option (All,Bypass,First,Nth)	A
16 SI	0 Constraint stabilization option (Y/N)	N
17 SI	0 Stabilization epsilon	

GENGRAV

18 GG	0 Gravity, earth sphere/nonsphere/user (S/N/U)?	N
19 GG	1 Input gravity constants: GME, ERAD, EMASS	
20 GG	1 Spherical or Nonspherical (S/N)?	
21 GG	1 Gravity Potential Harmonics J2,J3,J4	
22 GG	0 English (ft-slug-s) or metric (m-kg-s) (E/M)?	M
23 GG	0 Day, Month, Year,	20 9 2020
24 GG	0 GMT @ sim time 0 (minutes past midnight,	360
25 GG	0 Solar Pressure forces Y/N?	Y
26 GG	0 Input new data for aero model? (Y/N)	N
27 GG	1 Solar flux F10 for aero model	
28 GG	1 Solar flux, 81 day average F10B	
29 GG	1 Geomagnetic index, GEAP	

BODY

30 BO	1 Body ID number	1
31 BO	1 Type (Rigid,Flexible,NASTRAN)	F
32 BO	1 Number of modes	24
33 BO	1 Modal calculation option (0, 1 or 2)	2
34 BO	1 Foreshortening option (Y/N)	
35 BO	1 Model reduction method (NO,MS,MC,CC,QM,CV)	
36 BO	1 NASTRAN data file FORTRAN unit number (40 - 60)	
37 BO	1 Number of augmented nodes (0 if none)	
38 BO	1 Damping matrix option (NS,CD,HL,SD)	
39 BO	1 Constant damping ratio	
40 BO	1 Low frequency, High frequency ratios	
41 BO	1 Mode ID number, damping ratio	
42 BO	1 Conversion factors: Length,Mass,Force	
43 BO	1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
44 BO	1 Moments of inertia (kg-m2) Ixx,Iyy,Izz	6.2852173E11 6.2852173E11
6.7057352E8		
45 BO	1 Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
46 BO	1 Mass (kg)	1.6168633E5
47 BO	1 Number of Nodes	4
48 BO	1 Node ID, Node coord. (meters) x,y,z	1 0 0 0
49 BO	1 Node ID, Node coord. (meters) x,y,z	2 0 0 0
50 BO	1 Node ID, Node coord. (meters) x,y,z	3 0 0 3188.8
51 BO	1 Node ID, Node coord. (meters) x,y,z	4 0 0 -3188.8
52 BO	1 Node ID, Node structural joint ID	
53 BO	2 Body ID number	2
54 BO	2 Type (Rigid,Flexible,NASTRAN)	R

55 BO	2	Number of modes	
56 BO	2	Modal calculation option (0, 1 or 2)	
57 BO	2	Foreshortening option (Y/N)	
58 BO	2	Model reduction method (NO,MS,MC,CC,QM,CV)	
59 BO	2	NASTRAN data file FORTRAN unit number (40 - 60)	
60 BO	2	Number of augmented nodes (0 if none)	
61 BO	2	Damping matrix option (NS,CD,HL,SD)	
62 BO	2	Constant damping ratio	
63 BO	2	Low frequency, High frequency ratios	
64 BO	2	Mode ID number, damping ratio	
65 BO	2	Conversion factors: Length,Mass,Force	
66 BO	2	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
67 BO	2	Moments of inertia (kg-m2) Ixx,Iyy,Izz	.8543E12 1.5601E12
1.3822E12			
68 BO	2	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
69 BO	2	Mass (kg)	12666300
70 BO	2	Number of Nodes	5
71 BO	2	Node ID, Node coord. (meters) x,y,z	1 298.323 0 0
72 BO	2	Node ID, Node coord. (meters) x,y,z	2 0 0 0
73 BO	2	Node ID, Node coord. (meters) x,y,z	3 0 0 300
74 BO	2	Node ID, Node coord. (meters) x,y,z	4 0 0 -300
75 BO	2	Node ID, Node coord. (meters) x,y,z	5 500 0 0
76 BO	2	Node ID, Node structural joint ID	
77 BO	3	Body ID number	3
78 BO	3	Type (Rigid,Flexible,NASTRAN)	R
79 BO	3	Number of modes	
80 BO	3	Modal calculation option (0, 1 or 2)	
81 BO	3	Foreshortening option (Y/N)	
82 BO	3	Model reduction method (NO,MS,MC,CC,QM,CV)	
83 BO	3	NASTRAN data file FORTRAN unit number (40 - 60)	
84 BO	3	Number of augmented nodes (0 if none)	
85 BO	3	Damping matrix option (NS,CD,HL,SD)	
86 BO	3	Constant damping ratio	
87 BO	3	Low frequency, High frequency ratios	
88 BO	3	Mode ID number, damping ratio	
89 BO	3	Conversion factors: Length,Mass,Force	
90 BO	3	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
91 BO	3	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
92 BO	3	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
93 BO	3	Mass (kg)	2046600
94 BO	3	Number of Nodes	2
95 BO	3	Node ID, Node coord. (meters) x,y,z	1 0 0 0
96 BO	3	Node ID, Node coord. (meters) x,y,z	2 0 0 0
97 BO	3	Node ID, Node structural joint ID	
98 BO	4	Body ID number	4
99 BO	4	Type (Rigid,Flexible,NASTRAN)	R
100 BO	4	Number of modes	
101 BO	4	Modal calculation option (0, 1 or 2)	
102 BO	4	Foreshortening option (Y/N)	
103 BO	4	Model reduction method (NO,MS,MC,CC,QM,CV)	
104 BO	4	NASTRAN data file FORTRAN unit number (40 - 60)	
105 BO	4	Number of augmented nodes (0 if none)	
106 BO	4	Damping matrix option (NS,CD,HL,SD)	
107 BO	4	Constant damping ratio	
108 BO	4	Low frequency, High frequency ratios	
109 BO	4	Mode ID number, damping ratio	
110 BO	4	Conversion factors: Length,Mass,Force	
111 BO	4	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
112 BO	4	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
113 BO	4	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
114 BO	4	Mass (kg)	2046600
115 BO	4	Number of Nodes	2
116 BO	4	Node ID, Node coord. (meters) x,y,z	1 0 0 0
117 BO	4	Node ID, Node coord. (meters) x,y,z	2 0 0 0
118 BO	4	Node ID, Node structural joint ID	

HINGE

119 HI	1 Hinge ID number	1
120 HI	1 Inboard body ID, Outboard body ID	0 1
121 HI	1 "p" node ID, "q" node ID	0 2
122 HI	1 Number of rotation DOFs, Rotation option (F or G)	3 F
123 HI	1 L1 unit vector in inboard body coord. x,y,z	1 0 0
124 HI	1 L1 unit vector in outboard body coord. x,y,z	1 0 0
125 HI	1 L2 unit vector in inboard body coord. x,y,z	
126 HI	1 L2 unit vector in outboard body coord. x,y,z	
127 HI	1 L3 unit vector in inboard body coord. x,y,z	0 0 1
128 HI	1 L3 unit vector in outboard body coord. x,y,z	0 0 1
129 HI	1 Initial rotation angles (deg)	-90. 0. 180.
130 HI	1 Initial rotation rates (deg/sec)	0 0 0
131 HI	1 Rotation stiffness (newton-meters/rad)	0 0 0
132 HI	1 Rotation damping (newton-meters/rad/sec)	0 0 0
133 HI	1 Null torque angles (deg)	0 0 0
134 HI	1 Number of translation DOFs	3
135 HI	1 First translation unit vector g1	1 0 0
136 HI	1 Second translation unit vector g2	0 1 0
137 HI	1 Third translation unit vector g3	0 0 1
138 HI	1 Initial translation (meters)	0 0 42163421
139 HI	1 Initial translation velocity (meters/sec)	3074.681 0 0
140 HI	1 Translation stiffness (newtons/meters)	0 0 0
141 HI	1 Translation damping (newtons/meter/sec)	0 0 0
142 HI	1 Null force translations	0 0 0
143 HI	2 Hinge ID number	2
144 HI	2 Inboard body ID, Outboard body ID	1 2
145 HI	2 "p" node ID, "q" node ID	2 2
146 HI	2 Number of rotation DOFs	1
147 HI	2 L1 unit vector in inboard body coord. x,y,z	0 0 1
148 HI	2 L1 unit vector in outboard body coord. x,y,z	0 0 1
149 HI	2 L2 unit vector in inboard body coord. x,y,z	
150 HI	2 L2 unit vector in outboard body coord. x,y,z	
151 HI	2 L3 unit vector in inboard body coord. x,y,z	1 0 0
152 HI	2 L3 unit vector in outboard body coord. x,y,z	1 0 0
153 HI	2 Initial rotation angles (deg)	-90. 0. 0.
154 HI	2 Initial rotation rates (deg/sec)	0.00417807
155 HI	2 Rotation stiffness (newton-meters/rad)	0
156 HI	2 Rotation damping (newton-meters/rad/sec)	0
157 HI	2 Null torque angles (deg)	0
158 HI	2 Number of translation DOFs	0
159 HI	2 First translation unit vector g1	1 0 0
160 HI	2 Second translation unit vector g2	0 1 0
161 HI	2 Third translation unit vector g3	0 0 1
162 HI	2 Initial translation (meters)	0 0 0
163 HI	2 Initial translation velocity (meters/sec)	
164 HI	2 Translation stiffness (newtons/meters)	
165 HI	2 Translation damping (newtons/meter/sec)	
166 HI	2 Null force translations	
167 HI	3 Hinge ID number	3
168 HI	3 Inboard body ID, Outboard body ID	1 3
169 HI	3 "p" node ID, "q" node ID	3 2
170 HI	3 Number of rotation DOFs	0
171 HI	3 L1 unit vector in inboard body coord. x,y,z	0 0 1
172 HI	3 L1 unit vector in outboard body coord. x,y,z	0 0 1
173 HI	3 L2 unit vector in inboard body coord. x,y,z	
174 HI	3 L2 unit vector in outboard body coord. x,y,z	
175 HI	3 L3 unit vector in inboard body coord. x,y,z	0 1 0
176 HI	3 L3 unit vector in outboard body coord. x,y,z	0 1 0
177 HI	3 Initial rotation angles (deg)	180. 0. -135.
178 HI	3 Initial rotation rates (deg/sec)	
179 HI	3 Rotation stiffness (newton-meters/rad)	
180 HI	3 Rotation damping (newton-meters/rad/sec)	
181 HI	3 Null torque angles (deg)	
182 HI	3 Number of translation DOFs	0
183 HI	3 First translation unit vector g1	1 0 0
184 HI	3 Second translation unit vector g2	0 1 0
185 HI	3 Third translation unit vector g3	0 0 1
186 HI	3 Initial translation (meters)	0 0 0

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187 HI 3 Initial translation velocity (meters/sec)
188 HI 3 Translation stiffness (newtons/meters)
189 HI 3 Translation damping (newtons/meter/sec)
190 HI 3 Null force translations

191 HI 4 Hinge ID number 4
192 HI 4 Inboard body ID, Outboard body ID 1 4
193 HI 4 "p" node ID, "q" node ID 4 2
194 HI 4 Number of rotation DOFs 0
195 HI 4 L1 unit vector in inboard body coord. x,y,z 0 0 1
196 HI 4 L1 unit vector in outboard body coord. x,y,z 0 0 1
197 HI 4 L2 unit vector in inboard body coord. x,y,z
198 HI 4 L2 unit vector in outboard body coord. x,y,z
199 HI 4 L3 unit vector in inboard body coord. x,y,z 0 1 0
200 HI 4 L3 unit vector in outboard body coord. x,y,z 0 1 0
201 HI 4 Initial rotation angles (deg) 180. 0 -45.
202 HI 4 Initial rotation rates (deg/sec)
203 HI 4 Rotation stiffness (newton-meters/rad)
204 HI 4 Rotation damping (newton-meters/rad/sec)
205 HI 4 Null torque angles (deg)
206 HI 4 Number of translation DOFs 0
207 HI 4 First translation unit vector g1 1 0 0
208 HI 4 Second translation unit vector g2 0 1 0
209 HI 4 Third translation unit vector g3 0 0 1
210 HI 4 Initial translation (meters) 0 0 0
211 HI 4 Initial translation velocity (meters/sec)
212 HI 4 Translation stiffness (newtons/meters)
213 HI 4 Translation damping (newtons/meter/sec)
214 HI 4 Null force translations

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SENSOR

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215 SE 1 Sensor ID number 1
216 SE 1 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ET
217 SE 1 Mounting point body ID, Mounting point node ID 2 2
218 SE 1 Second mounting point body ID, Second node ID
219 SE 1 Input axis unit vector (IA) x,y,z
220 SE 1 Mounting point Hinge index, Axis index
221 SE 1 First focal plane unit vector (Fp1) x,y,z 0 0 -1
222 SE 1 Second focal plane unit vector (Fp2) x,y,z 0 1 0
223 SE 1 Sun/Star unit vector (Us) x,y,z
224 SE 1 Velocity Aberration Option (Y/N)
225 SE 1 Euler Angle Sequence (1-6)
226 SE 1 CMG ID number and Gimbal number
227 SE 1 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s]) 6378000 0 0 4.178074D-3

228 SE 2 Sensor ID number 2
229 SE 2 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ST
230 SE 2 Mounting point body ID, Mounting point node ID 2 2
231 SE 2 Second mounting point body ID, Second node ID
232 SE 2 Input axis unit vector (IA) x,y,z
233 SE 2 Mounting point Hinge index, Axis index
234 SE 2 First focal plane unit vector (Fp1) x,y,z 0 -1 0
235 SE 2 Second focal plane unit vector (Fp2) x,y,z 1 0 0
236 SE 2 Sun/Star unit vector (Us) x,y,z 0 1 0
237 SE 2 Velocity Aberration Option (Y/N) N
238 SE 2 Euler Angle Sequence (1-6)
239 SE 2 CMG ID number and Gimbal number
240 SE 2 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

241 SE 3 Sensor ID number 3
242 SE 3 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ST
243 SE 3 Mounting point body ID, Mounting point node ID 1 2
244 SE 3 Second mounting point body ID, Second node ID
245 SE 3 Input axis unit vector (IA) x,y,z
246 SE 3 Mounting point Hinge index, Axis index
247 SE 3 First focal plane unit vector (Fp1) x,y,z -1 0 0
248 SE 3 Second focal plane unit vector (Fp2) x,y,z 0 0 1
249 SE 3 Sun/Star unit vector (Us) x,y,z 0 0 0
250 SE 3 Velocity Aberration Option (Y/N) N

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251 SE	3 Euler Angle Sequence (1-6)	
252 SE	3 CMG ID number and Gimbal number	
253 SE	3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
254 SE	4 Sensor ID number	4
255 SE	4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	A3
256 SE	4 Mounting point body ID, Mounting point node ID	1 2
257 SE	4 Second mounting point body ID, Second node ID	
258 SE	4 Input axis unit vector (IA) x,y,z	
259 SE	4 Mounting point Hinge index, Axis index	
260 SE	4 First focal plane unit vector (Fp1) x,y,z	
261 SE	4 Second focal plane unit vector (Fp2) x,y,z	
262 SE	4 Sun/Star unit vector (Us) x,y,z	
263 SE	4 Velocity Aberration Option (Y/N)	
264 SE	4 Euler Angle Sequence (1-6)	
265 SE	4 CMG ID number and Gimbal number	
266 SE	4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
267 SE	5 Sensor ID number	5
268 SE	5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	LV
269 SE	5 Mounting point body ID, Mounting point node ID	1 2
270 SE	5 Second mounting point body ID, Second node ID	
271 SE	5 Input axis unit vector (IA) x,y,z	
272 SE	5 Mounting point Hinge index, Axis index	
273 SE	5 First focal plane unit vector (Fp1) x,y,z	
274 SE	5 Second focal plane unit vector (Fp2) x,y,z	
275 SE	5 Sun/Star unit vector (Us) x,y,z	
276 SE	5 Velocity Aberration Option (Y/N)	
277 SE	5 Euler Angle Sequence (1-6)	
278 SE	5 CMG ID number and Gimbal number	
279 SE	5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
280 SE	6 Sensor ID number	6
281 SE	6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	L
282 SE	6 Mounting point body ID, Mounting point node ID	3 2
283 SE	6 Second mounting point body ID, Second node ID	
284 SE	6 Input axis unit vector (IA) x,y,z	1 0 0
285 SE	6 Mounting point Hinge index, Axis index	
286 SE	6 First focal plane unit vector (Fp1) x,y,z	
287 SE	6 Second focal plane unit vector (Fp2) x,y,z	
288 SE	6 Sun/Star unit vector (Us) x,y,z	
289 SE	6 Velocity Aberration Option (Y/N)	
290 SE	6 Euler Angle Sequence (1-6)	
291 SE	6 CMG ID number and Gimbal number	
292 SE	6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
293 SE	7 Sensor ID number	7
294 SE	7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	L
295 SE	7 Mounting point body ID, Mounting point node ID	4 2
296 SE	7 Second mounting point body ID, Second node ID	
297 SE	7 Input axis unit vector (IA) x,y,z	1 0 0
298 SE	7 Mounting point Hinge index, Axis index	
299 SE	7 First focal plane unit vector (Fp1) x,y,z	
300 SE	7 Second focal plane unit vector (Fp2) x,y,z	
301 SE	7 Sun/Star unit vector (Us) x,y,z	
302 SE	7 Velocity Aberration Option (Y/N)	
303 SE	7 Euler Angle Sequence (1-6)	
304 SE	7 CMG ID number and Gimbal number	
305 SE	7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
ACTR		
306 AC	1 Actuator ID number	1
307 AC	1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
308 AC	1 Actuator location; Node or Hinge (N or H)	
309 AC	1 Mounting point body ID number, node ID number	2 2
310 AC	1 Second mounting point body ID, second node ID	
311 AC	1 Output axis unit vector x,y,z	0 1 0
312 AC	1 Mounting point Hinge index, Axis index	
313 AC	1 Rotor spin axis unit vector x,y,z	

314 AC	1 Initial rotor momentum, H	
315 AC	1 Outer gimbal- angle(deg), inertia, friction(D, S, B, N)	
316 AC	1 Outer gimbal axis unit vector x, y, z	
317 AC	1 Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)	
318 AC	1 Inner gimbal- angle(deg), inertia, friction(D, S, B, N)	
319 AC	1 Inner gimbal axis unit vector x, y, z	
320 AC	1 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)	
321 AC	1 Initial length and rate, y(to) and ydot(to)	
322 AC	1 Constants; K1 or wo, n or zeta, Kg, Jm	
323 AC	1 Non-linearities; TLim, Tco, Dz	
324 AC	2 Actuator ID number	2
325 AC	2 Type(J, H, MO, T, B, MA, SG, DG, W, L, M1-M7)	MO
326 AC	2 Actuator location; Node or Hinge (N or H)	
327 AC	2 Mounting point body ID number, node ID number	2 2
328 AC	2 Second mounting point body ID, second node ID	
329 AC	2 Output axis unit vector x, y, z	0 0 1
330 AC	2 Mounting point Hinge index, Axis index	
331 AC	2 Rotor spin axis unit vector x, y, z	
332 AC	2 Initial rotor momentum, H	
333 AC	2 Outer gimbal- angle(deg), inertia, friction(D, S, B, N)	
334 AC	2 Outer gimbal axis unit vector x, y, z	
335 AC	2 Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)	
336 AC	2 Inner gimbal- angle(deg), inertia, friction(D, S, B, N)	
337 AC	2 Inner gimbal axis unit vector x, y, z	
338 AC	2 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)	
339 AC	2 Initial length and rate, y(to) and ydot(to)	
340 AC	2 Constants; K1 or wo, n or zeta, Kg, Jm	
341 AC	2 Non-linearities; TLim, Tco, Dz	
342 AC	3 Actuator ID number	3
343 AC	3 Type(J, H, MO, T, B, MA, SG, DG, W, L, M1-M7)	MO
344 AC	3 Actuator location; Node or Hinge (N or H)	
345 AC	3 Mounting point body ID number, node ID number	2 2
346 AC	3 Second mounting point body ID, second node ID	
347 AC	3 Output axis unit vector x, y, z	1 0 0
348 AC	3 Mounting point Hinge index, Axis index	
349 AC	3 Rotor spin axis unit vector x, y, z	
350 AC	3 Initial rotor momentum, H	
351 AC	3 Outer gimbal- angle(deg), inertia, friction(D, S, B, N)	
352 AC	3 Outer gimbal axis unit vector x, y, z	
353 AC	3 Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)	
354 AC	3 Inner gimbal- angle(deg), inertia, friction(D, S, B, N)	
355 AC	3 Inner gimbal axis unit vector x, y, z	
356 AC	3 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)	
357 AC	3 Initial length and rate, y(to) and ydot(to)	
358 AC	3 Constants; K1 or wo, n or zeta, Kg, Jm	
359 AC	3 Non-linearities; TLim, Tco, Dz	
360 AC	4 Actuator ID number	4
361 AC	4 Type(J, H, MO, T, B, MA, SG, DG, W, L, M1-M7)	T
362 AC	4 Actuator location; Node or Hinge (N or H)	
363 AC	4 Mounting point body ID number, node ID number	
364 AC	4 Second mounting point body ID, second node ID	
365 AC	4 Output axis unit vector x, y, z	
366 AC	4 Mounting point Hinge index, Axis index	2 1
367 AC	4 Rotor spin axis unit vector x, y, z	
368 AC	4 Initial rotor momentum, H	
369 AC	4 Outer gimbal- angle(deg), inertia, friction(D, S, B, N)	
370 AC	4 Outer gimbal axis unit vector x, y, z	
371 AC	4 Out gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)	
372 AC	4 Inner gimbal- angle(deg), inertia, friction(D, S, B, N)	
373 AC	4 Inner gimbal axis unit vector x, y, z	
374 AC	4 In gim fric (Tfi, Tgfo, GAM) / (Tfi, M, D, Kf) / (m, M, B, k)	
375 AC	4 Initial length and rate, y(to) and ydot(to)	
376 AC	4 Constants; K1 or wo, n or zeta, Kg, Jm	
377 AC	4 Non-linearities; TLim, Tco, Dz	
378 AC	5 Actuator ID number	5
379 AC	5 Type(J, H, MO, T, B, MA, SG, DG, W, L, M1-M7, US)	J
380 AC	5 Actuator location; Node or Hinge (N or H)	

381 AC	5 Mounting point body ID number, node ID number	2 5
382 AC	5 Second mounting point body ID, second node ID	
383 AC	5 Output axis unit vector x,y,z	-1 0 0
384 AC	5 Mounting point Hinge index, Axis index	
385 AC	5 Rotor spin axis unit vector x,y,z	
386 AC	5 Initial rotor momentum, H	
387 AC	5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
388 AC	5 Outer gimbal axis unit vector x,y,z	
389 AC	5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
390 AC	5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
391 AC	5 Inner gimbal axis unit vector x,y,z	
392 AC	5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
393 AC	5 Initial length and rate, y(to) and ydot(to)	
394 AC	5 Constants; K1 or wo, n or zeta, Kg, Jm	
395 AC	5 Non-linearities; TLim, Tco, Dz	

CONTROLLER

396 CO	1 Controller ID number	1
397 CO	1 Controller type (CB,CM,DB,DM,UC,UD)	CM
398 CO	1 Sample time (sec)	
399 CO	1 Number of inputs, Number of outputs	4 4
400 CO	1 Number of states	
401 CO	1 Output No., Input type (I,S,T), Input ID, Gain	

INTERCONNECT

402 IN	1 Interconnect ID number	1
403 IN	1 Source type(S,C, or F),Source ID,Source row #	S 1 1
404 IN	1 Destination type(A or C),Dest ID,Dest row #	C 1 1
405 IN	1 Gain	4.41E13
406 IN	2 Interconnect ID number	2
407 IN	2 Source type(S,C, or F),Source ID,Source row #	C 1 1
408 IN	2 Destination type(A or C),Dest ID,Dest row #	A 1 1
409 IN	2 Gain	1
410 IN	3 Interconnect ID number	3
411 IN	3 Source type(S,C, or F),Source ID,Source row #	S 1 2
412 IN	3 Destination type(A or C),Dest ID,Dest row #	C 1 2
413 IN	3 Gain	1.67E12
414 IN	4 Interconnect ID number	4
415 IN	4 Source type(S,C, or F),Source ID,Source row #	C 1 2
416 IN	4 Destination type(A or C),Dest ID,Dest row #	A 2 1
417 IN	4 Gain	1
418 IN	5 Interconnect ID number	5
419 IN	5 Source type(S,C, or F),Source ID,Source row #	S 2 1
420 IN	5 Destination type(A or C),Dest ID,Dest row #	C 1 3
421 IN	5 Gain	4.31E13
422 IN	6 Interconnect ID number	6
423 IN	6 Source type(S,C, or F),Source ID,Source row #	C 1 3
424 IN	6 Destination type(A or C),Dest ID,Dest row #	A 3 1
425 IN	6 Gain	1
426 IN	7 Interconnect ID number	7
427 IN	7 Source type(S,C, or F),Source ID,Source row #	S 3 1
428 IN	7 Destination type(A or C),Dest ID,Dest row #	C 1 4
429 IN	7 Gain	6.7E8
430 IN	8 Interconnect ID number	8
431 IN	8 Source type(S,C, or F),Source ID,Source row #	C 1 4
432 IN	8 Destination type(A or C),Dest ID,Dest row #	A 4 1
433 IN	8 Gain	1
434 IN	9 Interconnect ID number	9
435 IN	9 Source type(S,C, or F),Source ID,Source row #	S 3 3

436 IN	9	Destination type(A or C),Dest ID, Dest row #	A 5 1
437 IN	9	Gain	7

isc3_flex_winsol.int (Concept 1) Winter Solstice

TREETOPS REV 10P2 4/10/00

SIM CONTROL

1 SI	0	Title	ISC MODEL, THIRD VERSION
2 SI	0	Simulation stop time	100000
3 SI	0	Plot data interval	20
4 SI	0	Integration type (R,S,U, OR V)	R
5 SI	0	Step size (sec)	.1
6 SI	0	Sandia ODE solver absolute and relative error	
7 SI	0	RK78 ODE solver absolute error and first step size	
8 SI	0	Linearization option (L,Z or N)	N
9 SI	0	Restart option (Y/N)	N
10 SI	0	Contact force computation option (Y/N)	Y
11 SI	0	Constraint force computation option (Y/N)	N
12 SI	0	Small angle speedup option (All,Bypass,First,Nth)	A
13 SI	0	Mass matrix speedup option (All,Bypass,First,Nth)	A
14 SI	0	Non-Linear speedup option (All,Bypass,First,Nth)	A
15 SI	0	Constraint speedup option (All,Bypass,First,Nth)	A
16 SI	0	Constraint stabilization option (Y/N)	N
17 SI	0	Stabilization epsilon	

GENGRAV

18 GG	0	Gravity, earth sphere/nonsphere/user (S/N/U)?	N
19 GG	1	Input gravity constants: GME, ERAD, EMASS	
20 GG	1	Spherical or Nonspherical (S/N)?	
21 GG	1	Gravity Potential Harmonics J2,J3,J4	
22 GG	0	English (ft-slug-s) or metric (m-kg-s) (E/M)?	M
23 GG	0	Day, Month, Year,	20 12 2020
24 GG	0	GMT @ sim time 0 (minutes past midnight,	360
25 GG	0	Solar Pressure forces Y/N?	Y
26 GG	0	Input new data for aero model? (Y/N)	N
27 GG	1	Solar flux F10 for aero model	
28 GG	1	Solar flux, 81 day average F10B	
29 GG	1	Geomagnetic index, GEAP	

BODY

30 BO	1	Body ID number	1
31 BO	1	Type (Rigid,Flexible,NASTRAN)	F
32 BO	1	Number of modes	24
33 BO	1	Modal calculation option (0, 1 or 2)	2
34 BO	1	Foreshortening option (Y/N)	
35 BO	1	Model reduction method (NO,MS,MC,CC,QM,CV)	
36 BO	1	NASTRAN data file FORTRAN unit number (40 - 60)	
37 BO	1	Number of augmented nodes (0 if none)	
38 BO	1	Damping matrix option (NS,CD,HL,SD)	
39 BO	1	Constant damping ratio	
40 BO	1	Low frequency, High frequency ratios	
41 BO	1	Mode ID number, damping ratio	
42 BO	1	Conversion factors: Length,Mass,Force	
43 BO	1	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
44 BO	1	Moments of inertia (kg-m2) Ixx,Iyy,Izz	6.2852173E11 6.2852173E11
6.7057352E8			
45 BO	1	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
46 BO	1	Mass (kg)	1.6168633E5
47 BO	1	Number of Nodes	4

48 BO	1 Node ID, Node coord. (meters) x,y,z	1 0 0 0
49 BO	1 Node ID, Node coord. (meters) x,y,z	2 0 0 0
50 BO	1 Node ID, Node coord. (meters) x,y,z	3 0 0 3188.8
51 BO	1 Node ID, Node coord. (meters) x,y,z	4 0 0 -3188.8
52 BO	1 Node ID, Node structural joint ID	
53 BO	2 Body ID number	2
54 BO	2 Type (Rigid,Flexible,NASTRAN)	R
55 BO	2 Number of modes	
56 BO	2 Modal calculation option (0, 1 or 2)	
57 BO	2 Foreshortening option (Y/N)	
58 BO	2 Model reduction method (NO,MS,MC,CC,QM,CV)	
59 BO	2 NASTRAN data file FORTRAN unit number (40 - 60)	
60 BO	2 Number of augmented nodes (0 if none)	
61 BO	2 Damping matrix option (NS,CD,HL,SD)	
62 BO	2 Constant damping ratio	
63 BO	2 Low frequency, High frequency ratios	
64 BO	2 Mode ID number, damping ratio	
65 BO	2 Conversion factors: Length,Mass,Force	
66 BO	2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
67 BO	2 Moments of inertia (kg-m2) Ixx,Iyy,Izz	.8543E12 1.5601E12
1.3822E12		
68 BO	2 Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
69 BO	2 Mass (kg)	12666300
70 BO	2 Number of Nodes	5
71 BO	2 Node ID, Node coord. (meters) x,y,z	1 298.323 0 0
72 BO	2 Node ID, Node coord. (meters) x,y,z	2 0 0 0
73 BO	2 Node ID, Node coord. (meters) x,y,z	3 0 0 300
74 BO	2 Node ID, Node coord. (meters) x,y,z	4 0 0 -300
75 BO	2 Node ID, Node coord. (meters) x,y,z	5 500 0 0
76 BO	2 Node ID, Node structural joint ID	
77 BO	3 Body ID number	3
78 BO	3 Type (Rigid,Flexible,NASTRAN)	R
79 BO	3 Number of modes	
80 BO	3 Modal calculation option (0, 1 or 2)	
81 BO	3 Foreshortening option (Y/N)	
82 BO	3 Model reduction method (NO,MS,MC,CC,QM,CV)	
83 BO	3 NASTRAN data file FORTRAN unit number (40 - 60)	
84 BO	3 Number of augmented nodes (0 if none)	
85 BO	3 Damping matrix option (NS,CD,HL,SD)	
86 BO	3 Constant damping ratio	
87 BO	3 Low frequency, High frequency ratios	
88 BO	3 Mode ID number, damping ratio	
89 BO	3 Conversion factors: Length,Mass,Force	
90 BO	3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
91 BO	3 Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
92 BO	3 Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
93 BO	3 Mass (kg)	2046600
94 BO	3 Number of Nodes	2
95 BO	3 Node ID, Node coord. (meters) x,y,z	1 0 0 0
96 BO	3 Node ID, Node coord. (meters) x,y,z	2 0 0 0
97 BO	3 Node ID, Node structural joint ID	
98 BO	4 Body ID number	4
99 BO	4 Type (Rigid,Flexible,NASTRAN)	R
100 BO	4 Number of modes	
101 BO	4 Modal calculation option (0, 1 or 2)	
102 BO	4 Foreshortening option (Y/N)	
103 BO	4 Model reduction method (NO,MS,MC,CC,QM,CV)	
104 BO	4 NASTRAN data file FORTRAN unit number (40 - 60)	
105 BO	4 Number of augmented nodes (0 if none)	
106 BO	4 Damping matrix option (NS,CD,HL,SD)	
107 BO	4 Constant damping ratio	
108 BO	4 Low frequency, High frequency ratios	
109 BO	4 Mode ID number, damping ratio	
110 BO	4 Conversion factors: Length,Mass,Force	
111 BO	4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
112 BO	4 Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
113 BO	4 Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
114 BO	4 Mass (kg)	2046600

115 BO	4	Number of Nodes	2
116 BO	4	Node ID, Node coord. (meters) x,y,z	1 0 0 0
117 BO	4	Node ID, Node coord. (meters) x,y,z	2 0 0 0
118 BO	4	Node ID, Node structural joint ID	
HINGE			
119 HI	1	Hinge ID number	1
120 HI	1	Inboard body ID, Outboard body ID	0 1
121 HI	1	"p" node ID, "q" node ID	0 2
122 HI	1	Number of rotation DOFs, Rotation option (F or G)	3 F
123 HI	1	L1 unit vector in inboard body coord. x,y,z	1 0 0
124 HI	1	L1 unit vector in outboard body coord. x,y,z	1 0 0
125 HI	1	L2 unit vector in inboard body coord. x,y,z	
126 HI	1	L2 unit vector in outboard body coord. x,y,z	
127 HI	1	L3 unit vector in inboard body coord. x,y,z	0 0 1
128 HI	1	L3 unit vector in outboard body coord. x,y,z	0 0 1
129 HI	1	Initial rotation angles (deg)	-90. 0. -90.
130 HI	1	Initial rotation rates (deg/sec)	0 0 0
131 HI	1	Rotation stiffness (newton-meters/rad)	0 0 0
132 HI	1	Rotation damping (newton-meters/rad/sec)	0 0 0
133 HI	1	Null torque angles (deg)	0 0 0
134 HI	1	Number of translation DOFs	3
135 HI	1	First translation unit vector g1	1 0 0
136 HI	1	Second translation unit vector g2	0 1 0
137 HI	1	Third translation unit vector g3	0 0 1
138 HI	1	Initial translation (meters)	0 0 42163421
139 HI	1	Initial translation velocity (meters/sec)	3074.681 0 0
140 HI	1	Translation stiffness (newtons/meters)	0 0 0
141 HI	1	Translation damping (newtons/meter/sec)	0 0 0
142 HI	1	Null force translations	0 0 0
143 HI	2	Hinge ID number	2
144 HI	2	Inboard body ID, Outboard body ID	1 2
145 HI	2	"p" node ID, "q" node ID	2 2
146 HI	2	Number of rotation DOFs	1
147 HI	2	L1 unit vector in inboard body coord. x,y,z	0 0 1
148 HI	2	L1 unit vector in outboard body coord. x,y,z	0 0 1
149 HI	2	L2 unit vector in inboard body coord. x,y,z	
150 HI	2	L2 unit vector in outboard body coord. x,y,z	
151 HI	2	L3 unit vector in inboard body coord. x,y,z	1 0 0
152 HI	2	L3 unit vector in outboard body coord. x,y,z	1 0 0
153 HI	2	Initial rotation angles (deg)	180. 0. 0.
154 HI	2	Initial rotation rates (deg/sec)	0.00417807
155 HI	2	Rotation stiffness (newton-meters/rad)	0
156 HI	2	Rotation damping (newton-meters/rad/sec)	0
157 HI	2	Null torque angles (deg)	0
158 HI	2	Number of translation DOFs	0
159 HI	2	First translation unit vector g1	1 0 0
160 HI	2	Second translation unit vector g2	0 1 0
161 HI	2	Third translation unit vector g3	0 0 1
162 HI	2	Initial translation (meters)	0 0 0
163 HI	2	Initial translation velocity (meters/sec)	
164 HI	2	Translation stiffness (newtons/meters)	
165 HI	2	Translation damping (newtons/meter/sec)	
166 HI	2	Null force translations	
167 HI	3	Hinge ID number	3
168 HI	3	Inboard body ID, Outboard body ID	1 3
169 HI	3	"p" node ID, "q" node ID	3 2
170 HI	3	Number of rotation DOFs	0
171 HI	3	L1 unit vector in inboard body coord. x,y,z	0 0 1
172 HI	3	L1 unit vector in outboard body coord. x,y,z	0 0 1
173 HI	3	L2 unit vector in inboard body coord. x,y,z	
174 HI	3	L2 unit vector in outboard body coord. x,y,z	
175 HI	3	L3 unit vector in inboard body coord. x,y,z	0 1 0
176 HI	3	L3 unit vector in outboard body coord. x,y,z	0 1 0
177 HI	3	Initial rotation angles (deg)	-90. 0. -146.75
178 HI	3	Initial rotation rates (deg/sec)	
179 HI	3	Rotation stiffness (newton-meters/rad)	

180 HI	3	Rotation damping (newton-meters/rad/sec)	
181 HI	3	Null torque angles (deg)	
182 HI	3	Number of translation DOFs	0
183 HI	3	First translation unit vector g1	1 0 0
184 HI	3	Second translation unit vector g2	0 1 0
185 HI	3	Third translation unit vector g3	0 0 1
186 HI	3	Initial translation (meters)	0 0 0
187 HI	3	Initial translation velocity (meters/sec)	
188 HI	3	Translation stiffness (newtons/meters)	
189 HI	3	Translation damping (newtons/meter/sec)	
190 HI	3	Null force translations	
191 HI	4	Hinge ID number	4
192 HI	4	Inboard body ID, Outboard body ID	1 4
193 HI	4	"p" node ID, "q" node ID	4 2
194 HI	4	Number of rotation DOFs	0
195 HI	4	L1 unit vector in inboard body coord. x,y,z	0 0 1
196 HI	4	L1 unit vector in outboard body coord. x,y,z	0 0 1
197 HI	4	L2 unit vector in inboard body coord. x,y,z	
198 HI	4	L2 unit vector in outboard body coord. x,y,z	
199 HI	4	L3 unit vector in inboard body coord. x,y,z	0 1 0
200 HI	4	L3 unit vector in outboard body coord. x,y,z	0 1 0
201 HI	4	Initial rotation angles (deg)	-90. 0. -56.75
202 HI	4	Initial rotation rates (deg/sec)	
203 HI	4	Rotation stiffness (newton-meters/rad)	
204 HI	4	Rotation damping (newton-meters/rad/sec)	
205 HI	4	Null torque angles (deg)	
206 HI	4	Number of translation DOFs	0
207 HI	4	First translation unit vector g1	1 0 0
208 HI	4	Second translation unit vector g2	0 1 0
209 HI	4	Third translation unit vector g3	0 0 1
210 HI	4	Initial translation (meters)	0 0 0
211 HI	4	Initial translation velocity (meters/sec)	
212 HI	4	Translation stiffness (newtons/meters)	
213 HI	4	Translation damping (newtons/meter/sec)	
214 HI	4	Null force translations	

SENSOR

215 SE	1	Sensor ID number	1
216 SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET
217 SE	1	Mounting point body ID, Mounting point node ID	2 2
218 SE	1	Second mounting point body ID, Second node ID	
219 SE	1	Input axis unit vector (IA) x,y,z	
220 SE	1	Mounting point Hinge index, Axis index	
221 SE	1	First focal plane unit vector (Fp1) x,y,z	0 0 -1
222 SE	1	Second focal plane unit vector (Fp2) x,y,z	0 1 0
223 SE	1	Sun/Star unit vector (Us) x,y,z	
224 SE	1	Velocity Aberration Option (Y/N)	
225 SE	1	Euler Angle Sequence (1-6)	
226 SE	1	CMG ID number and Gimbal number	
227 SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	6378000 0 0 4.178074D-3
228 SE	2	Sensor ID number	2
229 SE	2	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
230 SE	2	Mounting point body ID, Mounting point node ID	2 2
231 SE	2	Second mounting point body ID, Second node ID	
232 SE	2	Input axis unit vector (IA) x,y,z	
233 SE	2	Mounting point Hinge index, Axis index	
234 SE	2	First focal plane unit vector (Fp1) x,y,z	0 -1 0
235 SE	2	Second focal plane unit vector (Fp2) x,y,z	1 0 0
236 SE	2	Sun/Star unit vector (Us) x,y,z	0 1 0
237 SE	2	Velocity Aberration Option (Y/N)	N
238 SE	2	Euler Angle Sequence (1-6)	
239 SE	2	CMG ID number and Gimbal number	
240 SE	2	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
241 SE	3	Sensor ID number	3
242 SE	3	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
243 SE	3	Mounting point body ID, Mounting point node ID	1 2

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244 SE  3 Second mounting point body ID, Second node ID
245 SE  3 Input axis unit vector (IA) x,y,z
246 SE  3 Mounting point Hinge index, Axis index
247 SE  3 First focal plane unit vector (Fp1) x,y,z      -1 0 0
248 SE  3 Second focal plane unit vector (Fp2) x,y,z      0 0 1
249 SE  3 Sun/Star unit vector (Us) x,y,z                0 0 0
250 SE  3 Velocity Aberration Option (Y/N)                N
251 SE  3 Euler Angle Sequence (1-6)
252 SE  3 CMG ID number and Gimbal number
253 SE  3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

254 SE  4 Sensor ID number                                4
255 SE  4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) A3
256 SE  4 Mounting point body ID, Mounting point node ID  1 2
257 SE  4 Second mounting point body ID, Second node ID
258 SE  4 Input axis unit vector (IA) x,y,z
259 SE  4 Mounting point Hinge index, Axis index
260 SE  4 First focal plane unit vector (Fp1) x,y,z
261 SE  4 Second focal plane unit vector (Fp2) x,y,z
262 SE  4 Sun/Star unit vector (Us) x,y,z
263 SE  4 Velocity Aberration Option (Y/N)
264 SE  4 Euler Angle Sequence (1-6)
265 SE  4 CMG ID number and Gimbal number
266 SE  4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE  5 Sensor ID number                                5
268 SE  5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) LV
269 SE  5 Mounting point body ID, Mounting point node ID  1 2
270 SE  5 Second mounting point body ID, Second node ID
271 SE  5 Input axis unit vector (IA) x,y,z
272 SE  5 Mounting point Hinge index, Axis index
273 SE  5 First focal plane unit vector (Fp1) x,y,z
274 SE  5 Second focal plane unit vector (Fp2) x,y,z
275 SE  5 Sun/Star unit vector (Us) x,y,z
276 SE  5 Velocity Aberration Option (Y/N)
277 SE  5 Euler Angle Sequence (1-6)
278 SE  5 CMG ID number and Gimbal number
279 SE  5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE  6 Sensor ID number                                6
281 SE  6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV L
282 SE  6 Mounting point body ID, Mounting point node ID  3 2
283 SE  6 Second mounting point body ID, Second node ID
284 SE  6 Input axis unit vector (IA) x,y,z                1 0 0
285 SE  6 Mounting point Hinge index, Axis index
286 SE  6 First focal plane unit vector (Fp1) x,y,z
287 SE  6 Second focal plane unit vector (Fp2) x,y,z
288 SE  6 Sun/Star unit vector (Us) x,y,z
289 SE  6 Velocity Aberration Option (Y/N)
290 SE  6 Euler Angle Sequence (1-6)
291 SE  6 CMG ID number and Gimbal number
292 SE  6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

293 SE  7 Sensor ID number                                7
294 SE  7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV L
295 SE  7 Mounting point body ID, Mounting point node ID  4 2
296 SE  7 Second mounting point body ID, Second node ID
297 SE  7 Input axis unit vector (IA) x,y,z                1 0 0
298 SE  7 Mounting point Hinge index, Axis index
299 SE  7 First focal plane unit vector (Fp1) x,y,z
300 SE  7 Second focal plane unit vector (Fp2) x,y,z
301 SE  7 Sun/Star unit vector (Us) x,y,z
302 SE  7 Velocity Aberration Option (Y/N)
303 SE  7 Euler Angle Sequence (1-6)
304 SE  7 CMG ID number and Gimbal number
305 SE  7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

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ACTR

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306 AC  1 Actuator ID number                                1

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307 AC	1	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
308 AC	1	Actuator location; Node or Hinge (N or H)	
309 AC	1	Mounting point body ID number, node ID number	2 2
310 AC	1	Second mounting point body ID, second node ID	
311 AC	1	Output axis unit vector x,y,z	0 1 0
312 AC	1	Mounting point Hinge index, Axis index	
313 AC	1	Rotor spin axis unit vector x,y,z	
314 AC	1	Initial rotor momentum, H	
315 AC	1	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
316 AC	1	Outer gimbal axis unit vector x,y,z	
317 AC	1	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
318 AC	1	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
319 AC	1	Inner gimbal axis unit vector x,y,z	
320 AC	1	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
321 AC	1	Initial length and rate, y(to) and ydot(to)	
322 AC	1	Constants; K1 or wo, n or zeta, Kg, Jm	
323 AC	1	Non-linearities; TLim, Tco, Dz	
324 AC	2	Actuator ID number	2
325 AC	2	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
326 AC	2	Actuator location; Node or Hinge (N or H)	
327 AC	2	Mounting point body ID number, node ID number	2 2
328 AC	2	Second mounting point body ID, second node ID	
329 AC	2	Output axis unit vector x,y,z	0 0 1
330 AC	2	Mounting point Hinge index, Axis index	
331 AC	2	Rotor spin axis unit vector x,y,z	
332 AC	2	Initial rotor momentum, H	
333 AC	2	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
334 AC	2	Outer gimbal axis unit vector x,y,z	
335 AC	2	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
336 AC	2	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
337 AC	2	Inner gimbal axis unit vector x,y,z	
338 AC	2	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
339 AC	2	Initial length and rate, y(to) and ydot(to)	
340 AC	2	Constants; K1 or wo, n or zeta, Kg, Jm	
341 AC	2	Non-linearities; TLim, Tco, Dz	
342 AC	3	Actuator ID number	3
343 AC	3	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
344 AC	3	Actuator location; Node or Hinge (N or H)	
345 AC	3	Mounting point body ID number, node ID number	2 2
346 AC	3	Second mounting point body ID, second node ID	
347 AC	3	Output axis unit vector x,y,z	1 0 0
348 AC	3	Mounting point Hinge index, Axis index	
349 AC	3	Rotor spin axis unit vector x,y,z	
350 AC	3	Initial rotor momentum, H	
351 AC	3	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
352 AC	3	Outer gimbal axis unit vector x,y,z	
353 AC	3	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
354 AC	3	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
355 AC	3	Inner gimbal axis unit vector x,y,z	
356 AC	3	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
357 AC	3	Initial length and rate, y(to) and ydot(to)	
358 AC	3	Constants; K1 or wo, n or zeta, Kg, Jm	
359 AC	3	Non-linearities; TLim, Tco, Dz	
360 AC	4	Actuator ID number	4
361 AC	4	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	T
362 AC	4	Actuator location; Node or Hinge (N or H)	
363 AC	4	Mounting point body ID number, node ID number	
364 AC	4	Second mounting point body ID, second node ID	
365 AC	4	Output axis unit vector x,y,z	
366 AC	4	Mounting point Hinge index, Axis index	2 1
367 AC	4	Rotor spin axis unit vector x,y,z	
368 AC	4	Initial rotor momentum, H	
369 AC	4	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
370 AC	4	Outer gimbal axis unit vector x,y,z	
371 AC	4	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
372 AC	4	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
373 AC	4	Inner gimbal axis unit vector x,y,z	
374 AC	4	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	

375 AC	4 Initial length and rate, $y(t_0)$ and $\dot{y}(t_0)$	
376 AC	4 Constants; K_1 or ω_0 , n or ζ , K_g , J_m	
377 AC	4 Non-linearities; T_{Lim} , T_{co} , D_z	
378 AC	5 Actuator ID number	5
379 AC	5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	J
380 AC	5 Actuator location; Node or Hinge (N or H)	
381 AC	5 Mounting point body ID number, node ID number	2 5
382 AC	5 Second mounting point body ID, second node ID	
383 AC	5 Output axis unit vector x,y,z	-1 0 0
384 AC	5 Mounting point Hinge index, Axis index	
385 AC	5 Rotor spin axis unit vector x,y,z	
386 AC	5 Initial rotor momentum, H	
387 AC	5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
388 AC	5 Outer gimbal axis unit vector x,y,z	
389 AC	5 Out gim fric (T_{fi} , T_{gfo} , GAM)/(T_{fi} , M , D , K_f)/(m , M , B , k)	
390 AC	5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
391 AC	5 Inner gimbal axis unit vector x,y,z	
392 AC	5 In gim fric (T_{fi} , T_{gfo} , GAM)/(T_{fi} , M , D , K_f)/(m , M , B , k)	
393 AC	5 Initial length and rate, $y(t_0)$ and $\dot{y}(t_0)$	
394 AC	5 Constants; K_1 or ω_0 , n or ζ , K_g , J_m	
395 AC	5 Non-linearities; T_{Lim} , T_{co} , D_z	

CONTROLLER

396 CO	1 Controller ID number	1
397 CO	1 Controller type (CB,CM,DB,DM,UC,UD)	CM
398 CO	1 Sample time (sec)	
399 CO	1 Number of inputs, Number of outputs	4 4
400 CO	1 Number of states	
401 CO	1 Output No., Input type (I,S,T), Input ID, Gain	

INTERCONNECT

402 IN	1 Interconnect ID number	1
403 IN	1 Source type(S,C, or F),Source ID,Source row #	S 1 1
404 IN	1 Destination type(A or C),Dest ID,Dest row #	C 1 1
405 IN	1 Gain	4.41E13
406 IN	2 Interconnect ID number	2
407 IN	2 Source type(S,C, or F),Source ID,Source row #	C 1 1
408 IN	2 Destination type(A or C),Dest ID,Dest row #	A 1 1
409 IN	2 Gain	1
410 IN	3 Interconnect ID number	3
411 IN	3 Source type(S,C, or F),Source ID,Source row #	S 1 2
412 IN	3 Destination type(A or C),Dest ID,Dest row #	C 1 2
413 IN	3 Gain	1.67E12
414 IN	4 Interconnect ID number	4
415 IN	4 Source type(S,C, or F),Source ID,Source row #	C 1 2
416 IN	4 Destination type(A or C),Dest ID,Dest row #	A 2 1
417 IN	4 Gain	1
418 IN	5 Interconnect ID number	5
419 IN	5 Source type(S,C, or F),Source ID,Source row #	S 2 1
420 IN	5 Destination type(A or C),Dest ID,Dest row #	C 1 3
421 IN	5 Gain	4.31E13
422 IN	6 Interconnect ID number	6
423 IN	6 Source type(S,C, or F),Source ID,Source row #	C 1 3
424 IN	6 Destination type(A or C),Dest ID,Dest row #	A 3 1
425 IN	6 Gain	1
426 IN	7 Interconnect ID number	7
427 IN	7 Source type(S,C, or F),Source ID,Source row #	S 3 1
428 IN	7 Destination type(A or C),Dest ID,Dest row #	C 1 4
429 IN	7 Gain	6.7E8

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430 IN	8	Interconnect ID number	8
431 IN	8	Source type(S,C, or F),Source ID,Source row #	C 1 4
432 IN	8	Destination type(A or C),Dest ID,Dest row #	A 4 1
433 IN	8	Gain	1
434 IN	9	Interconnect ID number	9
435 IN	9	Source type(S,C, or F),Source ID,Source row #	S 3 3
436 IN	9	Destination type(A or C),Dest ID,Dest row #	A 5 1
437 IN	9	Gain	7

A.2 Concept 2A Definitions and TREETOPS files

Sensor Definitions

Actuator Definitions

Interconnect Definitions

TREETOPS files:

Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx

Table A.2.1 Sensor Definitions (Concept 2A and 2B)

Global Sensor Output No.	TREETOPS Sensor Designation	Local Sensor Output No.	Sensor Mount Loc.	Type	used	DOF
RP1	SE 1	1	B2-N2	Earth Target (ET)		Pitch (Y^{B2}) Error – Overall System
RP2	SE 1	2	B2-N2	(LOS Along X^{B2})		Yaw (Z^{B2}) Error – Overall System
RP3	SE 2	1	B2-N2	Star Tracker (ST)		Roll (X^{B2}) Error – Overall System
RP4	SE 2	2	B2-N2	(LOS Along Z^{B2})		Not used in control (Pitch (Y^{B2}) Error)
RP5	SE 2	3	B2-N2			Not used in control (Validity Flag on(1) off(0))
RP6	SE 3	1	B3-N2	LOS Sensor (L) (LOS Along $-Y^1$) (Negative Polar Axis) see .los file		Roll (X^{B3}) Error – Upper Clamshell
RP7	SE 3	2	B3-N2			Pitch (Y^{B3}) Error – Upper Clamshell
RP8	SE 3	3	B3-N2			Not used in control, Yaw (Z^{B3}) Error – Upper Clamshell
RP9	SE 3	4	B3-N2			Not used in control
RP10	SE 3	5	B3-N2			Not used in control
RP11	SE 3	6	B3-N2			Not used in control
RP12	SE 3	7	B3-N2			Not used in control
RP13	SE 4	1	B4-N2	LOS Sensor (L) (LOS Along $+Y^1$) (Positive Polar Axis) see .los file		Roll (X^{B4}) Error – Lower Clamshell
RP14	SE 4	2	B4-N2			Pitch (Y^{B4}) Error – Lower Clamshell
RP15	SE 4	3	B4-N2			Not used in control, Yaw (Z^{B4}) Error – Lower Clamshell
RP16	SE 4	4	B4-N2			Not used in control
RP 17	SE 4	5	B4-N2			Not used in control
RP 18	SE 4	6	B4-N2			Not used in control
RP 19	SE 4	7	B4-N2			Not used in control
RP 20	SE 5	1	B2-N5	Star Tracker (ST)		Not used in control (Yaw (Z^{B2}) Error)
RP 21	SE 5	2	B2-N5	(LOS Along $-X^{B2}$)		Not used in control (Pitch (Y^{B2}) Error)
RP 22	SE 5	3	B2-N5	(Towards Sun)		Validity Flag on(1) off(0) Used for Rad Pres Disturb
RP 23	SE 6	1	B2-N2	3 Axis Accelerometer (A3) with gravity removed		Not used in control, For Output Only, ACCEL (X^{B2})
RP 24	SE 6	2	B2-N2			Not used in control, For Output Only, ACCEL (Y^{B2})
RP 25	SE 6	3	B2-N2			Not used in control, For Output Only, ACCEL (Z^{B2})

Table A.2.2 Actuator Definitions (Concept 2A and 2B)

Global Actuator Input No.	TREETOPS Actuator Designation	Sensor Mount Loc.	Type	DOF
UP 1	AC 1	B2-N2	Moment Actuator (MO)*	Pitch (Y^{B2}) Ext. Torque – Overall System
UP 2	AC 2	B2-N2	Moment Actuator (MO)*	Yaw (Z^{B2}) Ext. Torque – Overall System
UP 3	AC 3	B2-N2	Moment Actuator (MO)*	Roll (X^{B2}) Ext. Torque – Overall System
UP 4	AC 4	B3-N2	Moment Actuator (MO)*	Roll (X^{B3}) Ext. Torque – Upper Clamshell
UP 5	AC 5	B3-N2	Moment Actuator (MO)*	Pitch (Y^{B3}) Ext. Torque – Upper Clamshell
UP 6	AC 6	B4-N2	Moment Actuator (MO)*	Roll (X^{B4}) Ext. Torque – Lower Clamshell
UP 7	AC 7	B4-N2	Moment Actuator (MO)*	Pitch (Y^{B4}) Ext. Torque – Lower Clamshell
UP 8	AC 8	B2-N5	Reaction Jet (J) Radiation Pressure Disturbance	$-X^{B2}$ Force at Central Body Transmitter

Notes:

* Moment Actuator (MO) in TREETOPS is an External Moment applied to a Body (Reacts against Space)
Used in Control

Table A.2.3:
Interconnect Data and Significant Parameters for
TREETOPS Continuous Matrix (CM) Controller
(Concept 2A and 2B)

Interconnect Data						Significant Parameters in Continuous Matrix (CM) Controller in .lin file $\dot{x} = Ax + Bu$ $y = Cx + Du$				
Inter- connect	Description	S C C A	S No. C No. C No. A No.	S Out No. C In No. C Out No. A In No.	Gain N-m or N	Subset of A Matrix	Subset of B Matrix	Subset of C Matrix ω^2 $2\zeta\omega$	Subset of D Matrix	
IC 1	Pitch (Y^{B2}) of Overall System	S	1	1	4.41E13	0. 1.	0	.000025 .007	0	
		C	1	1	1.0	-1. -1.4	1			
IC 2		C	1	1						
		A	1	1						
IC 3	Yaw (Z^{B2}) of Overall System	S	1	2	1.67E12	0. 1.	0	.000025 .007	0	
		C	1	2	1.0	-1. -1.4	1			
IC 4		C	1	2						
		A	2	1						
IC 5	Roll (X^{B2}) of Overall System	S	2	1	4.31E13	0. 1.	0	.000025 .007	0	
		C	1	3	1.0	-1. -1.4	1			
IC 6		C	1	3						
		A	3	1						
IC 7	Roll (X^{B3}) of Upper Clamshell	S	3	1	1.7E12	0. 1.	0	.0001 .014	0	
		C	1	4	1.0	-1. -1.4	1			
IC 8		C	1	4						
		A	4	1						
IC 9	Pitch (Y^{B3}) of Upper Clamshell	S	3	2	1.7E12	0. 1.	0	.0001 .014	0	
		C	1	5	1.0	-1. -1.4	1			
IC 10		C	1	5						
		A	5	1						
IC 11	Roll (X^{B4}) of Lower Clamshell	S	4	1	1.7E12	0. 1.	0	.0001 .014	0	
		C	1	6	1.0	-1. -1.4	1			
IC 12		C	1	6						
		A	6	1						
IC 13	Pitch (Y^{B4}) of Lower Clamshell	S	4	2	1.7E12	0. 1.	0	.0001 .014	0	
		C	1	7	1.0	-1. -1.4	1			
IC 14		C	1	7						
		A	7	1						
IC 15	$-X^{B2}$ of Radiation Pres Disturb	S	5	3	7.0					
		A	8	1						

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.SIM CONTROL

1 SI	0 Title	ISC MODEL, THIRD VERSION
2 SI	0 Simulation stop time	100000
3 SI	0 Plot data interval	20
4 SI	0 Integration type (R,S,U, OR V)	R
5 SI	0 Step size (sec)	.1
6 SI	0 Sandia ODE solver absolute and relative error	
7 SI	0 RK78 ODE solver absolute error and first step size	
8 SI	0 Linearization option (L,Z or N)	N
9 SI	0 Restart option (Y/N)	N
10 SI	0 Contact force computation option (Y/N)	Y
11 SI	0 Constraint force computation option (Y/N)	N
12 SI	0 Small angle speedup option (All,Bypass,First,Nth)	A
13 SI	0 Mass matrix speedup option (All,Bypass,First,Nth)	A
14 SI	0 Non-Linear speedup option (All,Bypass,First,Nth)	A
15 SI	0 Constraint speedup option (All,Bypass,First,Nth)	A
16 SI	0 Constraint stabilization option (Y/N)	N
17 SI	0 Stabilization epsilon	

GENGRAV

18 GG	0 Gravity, earth sphere/nonsphere/user (S/N/U)?	N
19 GG	1 Input gravity constants: GME, ERAD, EMASS	
20 GG	1 Spherical or Nonspherical (S/N)?	
21 GG	1 Gravity Potential Harmonics J2,J3,J4	
22 GG	0 English (ft-slug-s) or metric (m-kg-s) (E/M)?	M
23 GG	0 Day, Month, Year,	21 6 2020
24 GG	0 GMT @ sim time 0 (minutes past midnight,	0
25 GG	0 Solar Pressure forces Y/N?	Y
26 GG	0 Input new data for aero model? (Y/N)	N
27 GG	1 Solar flux F10 for aero model	
28 GG	1 Solar flux, 81 day average F10B	
29 GG	1 Geomagnetic index, GEAP	

BODY

30 BO	1 Body ID number	1
31 BO	1 Type (Rigid,Flexible,NASTRAN)	F
32 BO	1 Number of modes	24
33 BO	1 Modal calculation option (0, 1 or 2)	2
34 BO	1 Foreshortening option (Y/N)	
35 BO	1 Model reduction method (NO,MS,MC,CC,QM,CV)	
36 BO	1 NASTRAN data file FORTRAN unit number (40 - 60)	
37 BO	1 Number of augmented nodes (0 if none)	
38 BO	1 Damping matrix option (NS,CD,HL,SD)	
39 BO	1 Constant damping ratio	
40 BO	1 Low frequency, High frequency ratios	
41 BO	1 Mode ID number, damping ratio	
42 BO	1 Conversion factors: Length,Mass,Force	
43 BO	1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
44 BO	1 Moments of inertia (kg-m2) Ixx,Iyy,Izz	6.2852173E11 6.2852173E11
6.7057352E8		
45 BO	1 Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
46 BO	1 Mass (kg)	1.6168633E5
47 BO	1 Number of Nodes	4
48 BO	1 Node ID, Node coord. (meters) x,y,z	1 0 0 0
49 BO	1 Node ID, Node coord. (meters) x,y,z	2 0 0 0
50 BO	1 Node ID, Node coord. (meters) x,y,z	3 0 0 3188.8
51 BO	1 Node ID, Node coord. (meters) x,y,z	4 0 0 -3188.8
52 BO	1 Node ID, Node structural joint ID	

53 BO	2	Body ID number	2
54 BO	2	Type (Rigid,Flexible,NASTRAN)	R
55 BO	2	Number of modes	
56 BO	2	Modal calculation option (0, 1 or 2)	
57 BO	2	Foreshortening option (Y/N)	
58 BO	2	Model reduction method (NO,MS,MC,CC,QM,CV)	
59 BO	2	NASTRAN data file FORTRAN unit number (40 - 60)	
60 BO	2	Number of augmented nodes (0 if none)	
61 BO	2	Damping matrix option (NS,CD,HL,SD)	
62 BO	2	Constant damping ratio	
63 BO	2	Low frequency, High frequency ratios	
64 BO	2	Mode ID number, damping ratio	
65 BO	2	Conversion factors: Length,Mass,Force	
66 BO	2	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
67 BO	2	Moments of inertia (kg-m2) Ixx,Iyy,Izz	.8543E12 1.5601E12
1.3822E12			
68 BO	2	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
69 BO	2	Mass (kg)	12666300
70 BO	2	Number of Nodes	5
71 BO	2	Node ID, Node coord. (meters) x,y,z	1 298.323 0 0
72 BO	2	Node ID, Node coord. (meters) x,y,z	2 0 0 0
73 BO	2	Node ID, Node coord. (meters) x,y,z	3 0 0 300
74 BO	2	Node ID, Node coord. (meters) x,y,z	4 0 0 -300
75 BO	2	Node ID, Node coord. (meters) x,y,z	5 500 0 0
76 BO	2	Node ID, Node structural joint ID	
77 BO	3	Body ID number	3
78 BO	3	Type (Rigid,Flexible,NASTRAN)	R
79 BO	3	Number of modes	
80 BO	3	Modal calculation option (0, 1 or 2)	
81 BO	3	Foreshortening option (Y/N)	
82 BO	3	Model reduction method (NO,MS,MC,CC,QM,CV)	
83 BO	3	NASTRAN data file FORTRAN unit number (40 - 60)	
84 BO	3	Number of augmented nodes (0 if none)	
85 BO	3	Damping matrix option (NS,CD,HL,SD)	
86 BO	3	Constant damping ratio	
87 BO	3	Low frequency, High frequency ratios	
88 BO	3	Mode ID number, damping ratio	
89 BO	3	Conversion factors: Length,Mass,Force	
90 BO	3	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
91 BO	3	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
92 BO	3	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
93 BO	3	Mass (kg)	2046600
94 BO	3	Number of Nodes	2
95 BO	3	Node ID, Node coord. (meters) x,y,z	1 0 0 0
96 BO	3	Node ID, Node coord. (meters) x,y,z	2 0 0 0
97 BO	3	Node ID, Node structural joint ID	
98 BO	4	Body ID number	4
99 BO	4	Type (Rigid,Flexible,NASTRAN)	R
100 BO	4	Number of modes	
101 BO	4	Modal calculation option (0, 1 or 2)	
102 BO	4	Foreshortening option (Y/N)	
103 BO	4	Model reduction method (NO,MS,MC,CC,QM,CV)	
104 BO	4	NASTRAN data file FORTRAN unit number (40 - 60)	
105 BO	4	Number of augmented nodes (0 if none)	
106 BO	4	Damping matrix option (NS,CD,HL,SD)	
107 BO	4	Constant damping ratio	
108 BO	4	Low frequency, High frequency ratios	
109 BO	4	Mode ID number, damping ratio	
110 BO	4	Conversion factors: Length,Mass,Force	
111 BO	4	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
112 BO	4	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
113 BO	4	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
114 BO	4	Mass (kg)	2046600
115 BO	4	Number of Nodes	2
116 BO	4	Node ID, Node coord. (meters) x,y,z	1 0 0 0
117 BO	4	Node ID, Node coord. (meters) x,y,z	2 0 0 0
118 BO	4	Node ID, Node structural joint ID	

119 HI	1 Hinge ID number	1
120 HI	1 Inboard body ID, Outboard body ID	0 1
121 HI	1 "p" node ID, "q" node ID	0 2
122 HI	1 Number of rotation DOFs, Rotation option (F or G)	3 F
123 HI	1 L1 unit vector in inboard body coord. x,y,z	1 0 0
124 HI	1 L1 unit vector in outboard body coord. x,y,z	1 0 0
125 HI	1 L2 unit vector in inboard body coord. x,y,z	
126 HI	1 L2 unit vector in outboard body coord. x,y,z	
127 HI	1 L3 unit vector in inboard body coord. x,y,z	0 0 1
128 HI	1 L3 unit vector in outboard body coord. x,y,z	0 0 1
129 HI	1 Initial rotation angles (deg)	-90 0 90
130 HI	1 Initial rotation rates (deg/sec)	0 0 0.00417807
131 HI	1 Rotation stiffness (newton-meters/rad)	0 0 0
132 HI	1 Rotation damping (newton-meters/rad/sec)	0 0 0
133 HI	1 Null torque angles (deg)	0 0 0
134 HI	1 Number of translation DOFs	3
135 HI	1 First translation unit vector g1	1 0 0
136 HI	1 Second translation unit vector g2	0 1 0
137 HI	1 Third translation unit vector g3	0 0 1
138 HI	1 Initial translation (meters)	0 0 42163421
139 HI	1 Initial translation velocity (meters/sec)	3074.681 0 0
140 HI	1 Translation stiffness (newtons/meters)	0 0 0
141 HI	1 Translation damping (newtons/meter/sec)	0 0 0
142 HI	1 Null force translations	0 0 0
143 HI	2 Hinge ID number	2
144 HI	2 Inboard body ID, Outboard body ID	1 2
145 HI	2 "p" node ID, "q" node ID	2 2
146 HI	2 Number of rotation DOFs	0
147 HI	2 L1 unit vector in inboard body coord. x,y,z	0 0 1
148 HI	2 L1 unit vector in outboard body coord. x,y,z	0 0 1
149 HI	2 L2 unit vector in inboard body coord. x,y,z	
150 HI	2 L2 unit vector in outboard body coord. x,y,z	
151 HI	2 L3 unit vector in inboard body coord. x,y,z	1 0 0
152 HI	2 L3 unit vector in outboard body coord. x,y,z	1 0 0
153 HI	2 Initial rotation angles (deg)	0 0 0
154 HI	2 Initial rotation rates (deg/sec)	
155 HI	2 Rotation stiffness (newton-meters/rad)	
156 HI	2 Rotation damping (newton-meters/rad/sec)	
157 HI	2 Null torque angles (deg)	
158 HI	2 Number of translation DOFs	0
159 HI	2 First translation unit vector g1	1 0 0
160 HI	2 Second translation unit vector g2	0 1 0
161 HI	2 Third translation unit vector g3	0 0 1
162 HI	2 Initial translation (meters)	0 0 0
163 HI	2 Initial translation velocity (meters/sec)	
164 HI	2 Translation stiffness (newtons/meters)	
165 HI	2 Translation damping (newtons/meter/sec)	
166 HI	2 Null force translations	
167 HI	3 Hinge ID number	3
168 HI	3 Inboard body ID, Outboard body ID	1 3
169 HI	3 "p" node ID, "q" node ID	3 2
170 HI	3 Number of rotation DOFs	2
171 HI	3 L1 unit vector in inboard body coord. x,y,z	1 0 0
172 HI	3 L1 unit vector in outboard body coord. x,y,z	1 0 0
173 HI	3 L2 unit vector in inboard body coord. x,y,z	0 1 0
174 HI	3 L2 unit vector in outboard body coord. x,y,z	0 1 0
175 HI	3 L3 unit vector in inboard body coord. x,y,z	
176 HI	3 L3 unit vector in outboard body coord. x,y,z	
177 HI	3 Initial rotation angles (deg)	123.25 0. 0.
178 HI	3 Initial rotation rates (deg/sec)	0 0
179 HI	3 Rotation stiffness (newton-meters/rad)	0 0
180 HI	3 Rotation damping (newton-meters/rad/sec)	0 0
181 HI	3 Null torque angles (deg)	0 0
182 HI	3 Number of translation DOFs	0
183 HI	3 First translation unit vector g1	1 0 0
184 HI	3 Second translation unit vector g2	0 1 0

185 HI	3	Third translation unit vector	g3	0 0 1
186 HI	3	Initial translation (meters)		0 0 0
187 HI	3	Initial translation velocity (meters/sec)		
188 HI	3	Translation stiffness (newtons/meters)		
189 HI	3	Translation damping (newtons/meter/sec)		
190 HI	3	Null force translations		
191 HI	4	Hinge ID number		4
192 HI	4	Inboard body ID, Outboard body ID		1 4
193 HI	4	"p" node ID, "q" node ID		4 2
194 HI	4	Number of rotation DOFs		2
195 HI	4	L1 unit vector in inboard body coord.	x,y,z	1 0 0
196 HI	4	L1 unit vector in outboard body coord.	x,y,z	1 0 0
197 HI	4	L2 unit vector in inboard body coord.	x,y,z	0 1 0
198 HI	4	L2 unit vector in outboard body coord.	x,y,z	0 1 0
199 HI	4	L3 unit vector in inboard body coord.	x,y,z	
200 HI	4	L3 unit vector in outboard body coord.	x,y,z	
201 HI	4	Initial rotation angles (deg)		33.25 0. 0.
202 HI	4	Initial rotation rates (deg/sec)		0 0
203 HI	4	Rotation stiffness (newton-meters/rad)		0 0
204 HI	4	Rotation damping (newton-meters/rad/sec)		0 0
205 HI	4	Null torque angles (deg)		0 0
206 HI	4	Number of translation DOFs		0
207 HI	4	First translation unit vector	g1	1 0 0
208 HI	4	Second translation unit vector	g2	0 1 0
209 HI	4	Third translation unit vector	g3	0 0 1
210 HI	4	Initial translation (meters)		0 0 0
211 HI	4	Initial translation velocity (meters/sec)		
212 HI	4	Translation stiffness (newtons/meters)		
213 HI	4	Translation damping (newtons/meter/sec)		
214 HI	4	Null force translations		

SENSOR

215 SE	1	Sensor ID number		1
216 SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET	
217 SE	1	Mounting point body ID, Mounting point node ID		2 2
218 SE	1	Second mounting point body ID, Second node ID		
219 SE	1	Input axis unit vector (IA)	x,y,z	
220 SE	1	Mounting point Hinge index, Axis index		
221 SE	1	First focal plane unit vector (Fp1)	x,y,z	0 0 -1
222 SE	1	Second focal plane unit vector (Fp2)	x,y,z	0 1 0
223 SE	1	Sun/Star unit vector (Us)	x,y,z	
224 SE	1	Velocity Aberration Option (Y/N)		
225 SE	1	Euler Angle Sequence (1-6)		
226 SE	1	CMG ID number and Gimbal number		
227 SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])		6378000 0 0 4.178074D-3
228 SE	2	Sensor ID number		2
229 SE	2	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST	
230 SE	2	Mounting point body ID, Mounting point node ID		2 2
231 SE	2	Second mounting point body ID, Second node ID		
232 SE	2	Input axis unit vector (IA)	x,y,z	
233 SE	2	Mounting point Hinge index, Axis index		
234 SE	2	First focal plane unit vector (Fp1)	x,y,z	0 -1 0
235 SE	2	Second focal plane unit vector (Fp2)	x,y,z	1 0 0
236 SE	2	Sun/Star unit vector (Us)	x,y,z	0 1 0
237 SE	2	Velocity Aberration Option (Y/N)		N
238 SE	2	Euler Angle Sequence (1-6)		
239 SE	2	CMG ID number and Gimbal number		
240 SE	2	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])		
241 SE	3	Sensor ID number		3
242 SE	3	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	L	
243 SE	3	Mounting point body ID, Mounting point node ID		3 2
244 SE	3	Second mounting point body ID, Second node ID		
245 SE	3	Input axis unit vector (IA)	x,y,z	1 2 3
246 SE	3	Mounting point Hinge index, Axis index		
247 SE	3	First focal plane unit vector (Fp1)	x,y,z	
248 SE	3	Second focal plane unit vector (Fp2)	x,y,z	

```

249 SE 3 Sun/Star unit vector (Us) x,y,z
250 SE 3 Velocity Aberration Option (Y/N)
251 SE 3 Euler Angle Sequence (1-6)
252 SE 3 CMG ID number and Gimbal number
253 SE 3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

254 SE 4 Sensor ID number 4
255 SE 4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) L
256 SE 4 Mounting point body ID, Mounting point node ID 4 2
257 SE 4 Second mounting point body ID, Second node ID
258 SE 4 Input axis unit vector (IA) x,y,z 3 2 1
259 SE 4 Mounting point Hinge index, Axis index
260 SE 4 First focal plane unit vector (Fp1) x,y,z
261 SE 4 Second focal plane unit vector (Fp2) x,y,z
262 SE 4 Sun/Star unit vector (Us) x,y,z
263 SE 4 Velocity Aberration Option (Y/N)
264 SE 4 Euler Angle Sequence (1-6)
265 SE 4 CMG ID number and Gimbal number
266 SE 4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE 5 Sensor ID number 5
268 SE 5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ST
269 SE 5 Mounting point body ID, Mounting point node ID 2 5
270 SE 5 Second mounting point body ID, Second node ID
271 SE 5 Input axis unit vector (IA) x,y,z
272 SE 5 Mounting point Hinge index, Axis index
273 SE 5 First focal plane unit vector (Fp1) x,y,z 0 0 1
274 SE 5 Second focal plane unit vector (Fp2) x,y,z 0 -1 0
275 SE 5 Sun/Star unit vector (Us) x,y,z 0 0 0
276 SE 5 Velocity Aberration Option (Y/N) N
277 SE 5 Euler Angle Sequence (1-6)
278 SE 5 CMG ID number and Gimbal number
279 SE 5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE 6 Sensor ID number 6
281 SE 6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV A3
282 SE 6 Mounting point body ID, Mounting point node ID 2 2
283 SE 6 Second mounting point body ID, Second node ID
284 SE 6 Input axis unit vector (IA) x,y,z
285 SE 6 Mounting point Hinge index, Axis index
286 SE 6 First focal plane unit vector (Fp1) x,y,z
287 SE 6 Second focal plane unit vector (Fp2) x,y,z
288 SE 6 Sun/Star unit vector (Us) x,y,z
289 SE 6 Velocity Aberration Option (Y/N)
290 SE 6 Euler Angle Sequence (1-6)
291 SE 6 CMG ID number and Gimbal number
292 SE 6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

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ACTR

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293 AC 1 Actuator ID number 1
294 AC 1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) MO
295 AC 1 Actuator location; Node or Hinge (N or H)
296 AC 1 Mounting point body ID number, node ID number 2 2
297 AC 1 Second mounting point body ID, second node ID
298 AC 1 Output axis unit vector x,y,z 0 1 0
299 AC 1 Mounting point Hinge index, Axis index
300 AC 1 Rotor spin axis unit vector x,y,z
301 AC 1 Initial rotor momentum, H
302 AC 1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
303 AC 1 Outer gimbal axis unit vector x,y,z
304 AC 1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
305 AC 1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
306 AC 1 Inner gimbal axis unit vector x,y,z
307 AC 1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
308 AC 1 Initial length and rate, y(to) and ydot(to)
309 AC 1 Constants; K1 or wo, n or zeta, Kg, Jm
310 AC 1 Non-linearities; TLim, Tco, Dz

311 AC 2 Actuator ID number 2

```

312 AC	2	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
313 AC	2	Actuator location; Node or Hinge (N or H)	
314 AC	2	Mounting point body ID number, node ID number	2 2
315 AC	2	Second mounting point body ID, second node ID	
316 AC	2	Output axis unit vector x,y,z	0 0 1
317 AC	2	Mounting point Hinge index, Axis index	
318 AC	2	Rotor spin axis unit vector x,y,z	
319 AC	2	Initial rotor momentum, H	
320 AC	2	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
321 AC	2	Outer gimbal axis unit vector x,y,z	
322 AC	2	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
323 AC	2	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
324 AC	2	Inner gimbal axis unit vector x,y,z	
325 AC	2	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
326 AC	2	Initial length and rate, y(to) and ydot(to)	
327 AC	2	Constants; K1 or wo, n or zeta, Kg, Jm	
328 AC	2	Non-linearities; TLim, Tco, Dz	
329 AC	3	Actuator ID number	3
330 AC	3	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
331 AC	3	Actuator location; Node or Hinge (N or H)	
332 AC	3	Mounting point body ID number, node ID number	2 2
333 AC	3	Second mounting point body ID, second node ID	
334 AC	3	Output axis unit vector x,y,z	1 0 0
335 AC	3	Mounting point Hinge index, Axis index	
336 AC	3	Rotor spin axis unit vector x,y,z	
337 AC	3	Initial rotor momentum, H	
338 AC	3	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
339 AC	3	Outer gimbal axis unit vector x,y,z	
340 AC	3	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
341 AC	3	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
342 AC	3	Inner gimbal axis unit vector x,y,z	
343 AC	3	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
344 AC	3	Initial length and rate, y(to) and ydot(to)	
345 AC	3	Constants; K1 or wo, n or zeta, Kg, Jm	
346 AC	3	Non-linearities; TLim, Tco, Dz	
347 AC	4	Actuator ID number	4
348 AC	4	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
349 AC	4	Actuator location; Node or Hinge (N or H)	
350 AC	4	Mounting point body ID number, node ID number	3 2
351 AC	4	Second mounting point body ID, second node ID	
352 AC	4	Output axis unit vector x,y,z	1 0 0
353 AC	4	Mounting point Hinge index, Axis index	
354 AC	4	Rotor spin axis unit vector x,y,z	
355 AC	4	Initial rotor momentum, H	
356 AC	4	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
357 AC	4	Outer gimbal axis unit vector x,y,z	
358 AC	4	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
359 AC	4	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
360 AC	4	Inner gimbal axis unit vector x,y,z	
361 AC	4	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
362 AC	4	Initial length and rate, y(to) and ydot(to)	
363 AC	4	Constants; K1 or wo, n or zeta, Kg, Jm	
364 AC	4	Non-linearities; TLim, Tco, Dz	
365 AC	5	Actuator ID number	5
366 AC	5	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
367 AC	5	Actuator location; Node or Hinge (N or H)	
368 AC	5	Mounting point body ID number, node ID number	3 2
369 AC	5	Second mounting point body ID, second node ID	
370 AC	5	Output axis unit vector x,y,z	0 1 0
371 AC	5	Mounting point Hinge index, Axis index	
372 AC	5	Rotor spin axis unit vector x,y,z	
373 AC	5	Initial rotor momentum, H	
374 AC	5	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
375 AC	5	Outer gimbal axis unit vector x,y,z	
376 AC	5	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
377 AC	5	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
378 AC	5	Inner gimbal axis unit vector x,y,z	
379 AC	5	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	

380 AC	5 Initial length and rate, $y(t_0)$ and $\dot{y}(t_0)$	
381 AC	5 Constants; K_1 or w_0 , n or ζ , K_g , J_m	
382 AC	5 Non-linearities; T_{Lim} , T_{co} , D_z	
383 AC	6 Actuator ID number	6
384 AC	6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
385 AC	6 Actuator location; Node or Hinge (N or H)	
386 AC	6 Mounting point body ID number, node ID number	4 2
387 AC	6 Second mounting point body ID, second node ID	
388 AC	6 Output axis unit vector x,y,z	1 0 0
389 AC	6 Mounting point Hinge index, Axis index	
390 AC	6 Rotor spin axis unit vector x,y,z	
391 AC	6 Initial rotor momentum, H	
392 AC	6 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)	
393 AC	6 Outer gimbal axis unit vector x,y,z	
394 AC	6 Out gim fric (T_{fi}, T_{gfo}, GAM) / (T_{fi}, M, D, K_f) / (m, M, B, k)	
395 AC	6 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)	
396 AC	6 Inner gimbal axis unit vector x,y,z	
397 AC	6 In gim fric (T_{fi}, T_{gfo}, GAM) / (T_{fi}, M, D, K_f) / (m, M, B, k)	
398 AC	6 Initial length and rate, $y(t_0)$ and $\dot{y}(t_0)$	
399 AC	6 Constants; K_1 or w_0 , n or ζ , K_g , J_m	
400 AC	6 Non-linearities; T_{Lim} , T_{co} , D_z	
401 AC	7 Actuator ID number	7
402 AC	7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
403 AC	7 Actuator location; Node or Hinge (N or H)	
404 AC	7 Mounting point body ID number, node ID number	4 2
405 AC	7 Second mounting point body ID, second node ID	
406 AC	7 Output axis unit vector x,y,z	0 1 0
407 AC	7 Mounting point Hinge index, Axis index	
408 AC	7 Rotor spin axis unit vector x,y,z	
409 AC	7 Initial rotor momentum, H	
410 AC	7 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)	
411 AC	7 Outer gimbal axis unit vector x,y,z	
412 AC	7 Out gim fric (T_{fi}, T_{gfo}, GAM) / (T_{fi}, M, D, K_f) / (m, M, B, k)	
413 AC	7 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)	
414 AC	7 Inner gimbal axis unit vector x,y,z	
415 AC	7 In gim fric (T_{fi}, T_{gfo}, GAM) / (T_{fi}, M, D, K_f) / (m, M, B, k)	
416 AC	7 Initial length and rate, $y(t_0)$ and $\dot{y}(t_0)$	
417 AC	7 Constants; K_1 or w_0 , n or ζ , K_g , J_m	
418 AC	7 Non-linearities; T_{Lim} , T_{co} , D_z	
419 AC	8 Actuator ID number	8
420 AC	8 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	J
421 AC	8 Actuator location; Node or Hinge (N or H)	
422 AC	8 Mounting point body ID number, node ID number	2 5
423 AC	8 Second mounting point body ID, second node ID	
424 AC	8 Output axis unit vector x,y,z	-1 0 0
425 AC	8 Mounting point Hinge index, Axis index	
426 AC	8 Rotor spin axis unit vector x,y,z	
427 AC	8 Initial rotor momentum, H	
428 AC	8 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)	
429 AC	8 Outer gimbal axis unit vector x,y,z	
430 AC	8 Out gim fric (T_{fi}, T_{gfo}, GAM) / (T_{fi}, M, D, K_f) / (m, M, B, k)	
431 AC	8 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)	
432 AC	8 Inner gimbal axis unit vector x,y,z	
433 AC	8 In gim fric (T_{fi}, T_{gfo}, GAM) / (T_{fi}, M, D, K_f) / (m, M, B, k)	
434 AC	8 Initial length and rate, $y(t_0)$ and $\dot{y}(t_0)$	
435 AC	8 Constants; K_1 or w_0 , n or ζ , K_g , J_m	
436 AC	8 Non-linearities; T_{Lim} , T_{co} , D_z	

CONTROLLER

437 CO	1 Controller ID number	1
438 CO	1 Controller type (CB,CM,DB,DM,UC,UD)	CM
439 CO	1 Sample time (sec)	
440 CO	1 Number of inputs, Number of outputs	7 7
441 CO	1 Number of states	
442 CO	1 Output No., Input type (I,S,T), Input ID, Gain	

INTERCONNECT

443 IN	1 Interconnect ID number	1
444 IN	1 Source type(S,C, or F),Source ID,Source row #	S 1 1
445 IN	1 Destination type(A or C),Dest ID,Dest row #	C 1 1
446 IN	1 Gain	4.41E13
447 IN	2 Interconnect ID number	2
448 IN	2 Source type(S,C, or F),Source ID,Source row #	C 1 1
449 IN	2 Destination type(A or C),Dest ID,Dest row #	A 1 1
450 IN	2 Gain	1.
451 IN	3 Interconnect ID number	3
452 IN	3 Source type(S,C, or F),Source ID,Source row #	S 1 2
453 IN	3 Destination type(A or C),Dest ID,Dest row #	C 1 2
454 IN	3 Gain	1.67E12
455 IN	4 Interconnect ID number	4
456 IN	4 Source type(S,C, or F),Source ID,Source row #	C 1 2
457 IN	4 Destination type(A or C),Dest ID,Dest row #	A 2 1
458 IN	4 Gain	1
459 IN	5 Interconnect ID number	5
460 IN	5 Source type(S,C, or F),Source ID,Source row #	S 2 1
461 IN	5 Destination type(A or C),Dest ID,Dest row #	C 1 3
462 IN	5 Gain	4.31E13
463 IN	6 Interconnect ID number	6
464 IN	6 Source type(S,C, or F),Source ID,Source row #	C 1 3
465 IN	6 Destination type(A or C),Dest ID,Dest row #	A 3 1
466 IN	6 Gain	1
467 IN	7 Interconnect ID number	7
468 IN	7 Source type(S,C, or F),Source ID,Source row #	S 3 1
469 IN	7 Destination type(A or C),Dest ID,Dest row #	C 1 4
470 IN	7 Gain	1.7E12
471 IN	8 Interconnect ID number	8
472 IN	8 Source type(S,C, or F),Source ID,Source row #	C 1 4
473 IN	8 Destination type(A or C),Dest ID,Dest row #	A 4 1
474 IN	8 Gain	1
475 IN	9 Interconnect ID number	9
476 IN	9 Source type(S,C, or F),Source ID,Source row #	S 3 2
477 IN	9 Destination type(A or C),Dest ID,Dest row #	C 1 5
478 IN	9 Gain	1.7E12
479 IN	10 Interconnect ID number	10
480 IN	10 Source type(S,C, or F),Source ID,Source row #	C 1 5
481 IN	10 Destination type(A or C),Dest ID,Dest row #	A 5 1
482 IN	10 Gain	1
483 IN	11 Interconnect ID number	11
484 IN	11 Source type(S,C, or F),Source ID,Source row #	S 4 1
485 IN	11 Destination type(A or C),Dest ID,Dest row #	C 1 6
486 IN	11 Gain	1.7E12
487 IN	12 Interconnect ID number	12
488 IN	12 Source type(S,C, or F),Source ID,Source row #	C 1 6
489 IN	12 Destination type(A or C),Dest ID,Dest row #	A 6 1
490 IN	12 Gain	1
491 IN	13 Interconnect ID number	13
492 IN	13 Source type(S,C, or F),Source ID,Source row #	S 4 2
493 IN	13 Destination type(A or C),Dest ID,Dest row #	C 1 7
494 IN	13 Gain	1.7E12
495 IN	14 Interconnect ID number	14
496 IN	14 Source type(S,C, or F),Source ID,Source row #	C 1 7
497 IN	14 Destination type(A or C),Dest ID,Dest row #	A 7 1

498 IN 14 Gain

1

499 IN 15 Interconnect ID number
500 IN 15 Source type(S,C, or F),Source ID,Source row #
501 IN 15 Destination type(A or C),Dest ID,Dest row #
502 IN 15 Gain

15
S 5 3
A 8 1
7.0

isc3_flex_sol.lin (Concept 2A) Summer Solstice

* Controller for integrated symmetrical concentrator
system CONT1 14,7,7,0,0,0.0

*A

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
-1 -1.4 0 0 0 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 -1.4 0 0 0 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 -1.4 0 0 0 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 -1.4 0 0 0 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 -1.4 0 0 0 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 -1.4 0 0
0 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 -1.4

*B

0 0 0 0 0 0 0
1 0 0 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
0 0 1 0 0 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 0 0 1 0 0
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 0 0 1
0 0 0 0 0 0 1

*C

.000025 .007 0 0 0 0 0 0 0 0 0 0 0 0
0 0 .000025 .007 0 0 0 0 0 0 0 0 0 0
0 0 0 0 .000025 .007 0 0 0 0 0 0 0 0
0 0 0 0 0 0 .0001 .014 0 0 0 0 0 0
0 0 0 0 0 0 0 0 .0001 .014 0 0 0 0
0 0 0 0 0 0 0 0 0 0 .0001 .014 0 0
0 0 0 0 0 0 0 0 0 0 0 .0001 .014

*D

0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0

*H

*M

29 December 2000

Final Report

1os.dat (Concept 2A) Summer Solstice

```
3,      ! Sensor number of 1st FGS (clamshell) sensor
0.d0,0.d0,0.d0,      ! Defaults to sun as a target for zero input vector
0.d0,-1.d0,0.d0,      ! Target star along negative polar axis
0.d0,-1.d0,0.d0,      ! Focal plane vector 1
1.d0,0.d0,0.d0,      ! Focal plane vector 2
1.d0,0.d0,0.d0,      ! Focal plane vector 3

4,      ! Sensor number of 2nd FGS (clamshell) sensor
0.d0,0.d0,0.d0,      ! Defaults to sun as a target for zero input vector
0.d0,1.d0,0.d0,      ! Target star along positive polar axis
0.d0,-1.d0,0.d0,      ! Focal plane vector 1
1.d0,0.d0,0.d0,      ! Focal plane vector 2
-1.d0,0.d0,0.d0,      ! Focal plane vector 3
```

solar_pressure.dat (Concept 2A) Summer Solstice

```
22, 'm',      ! number of panels, units English or Metric ***Updated 11/15/00***
1,2,638000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0,0.1736d0,0.d0,0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0,-0.1736d0,1.d0,-0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0,0.1736d0,0.d0,-0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0,-0.1736d0,-1.d0,0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
```

isc3 flex sol.flx (Concept 2A) Summer Solstice (An Excerpt)

flag, revision number

XXXXXX

1

body id

1

modes, nodes, modal options

24	4	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

phi_t for node #

2

.31310941E-02	-.16357954E-03	.19158607E-08	.68659216E-04	.31346273E-02
.14949358E-08	-.33409338E-09	-.17910070E-08	-.62130721E-04	.10048928E-08
.74260327E-10	-.81693812E-09	.66744219E-10	-.57300403E-09	.56292416E-10
-.31109642E-09	.51999889E-08	.41569313E-10	.36697769E-02	.69502051E-03
.85567197E-10	-.10557893E-02	.35826871E-02	.65924560E-10	.61553749E-10
.11085623E-08	-.67301328E-05	.49549244E-10	-.49437998E-08	-.60865848E-11
.10484816E-08	.39239830E-10	-.17858973E-09	.46440350E-10	.23145265E-09
.76239104E-11	-.98486197E-09	-.52382674E-09	.30708566E-12	.12143532E-10
-.10722701E-09	.94529479E-03	.17735129E-08	.15323995E-09	.13868812E-12
-.13390485E-02	-.55272105E-04	-.82202021E-12	.55317399E-04	-.13390483E-02
.27552836E-11	.29149021E-10	-.27567962E-12	-.44865972E-10	.48584658E-11
.10595799E-10	-.31919479E-08	-.19937738E-10	.14255509E-09	-.23770452E-02
-.45933446E-03	-.19673179E-04	.63985161E-12	-.19675549E-04	.45933391E-03
-.74265281E-12	-.34874105E-11	-.12587102E-11	.59687765E-09	-.12099360E-11
-.69004494E-11	.19524343E-08			

phi_t prime for node #

2

.17177767E-11	-.22808543E-11	-.45683561E-10	.19817016E-10	.56718933E-12
.31514104E-09	.17463000E-11	-.27057756E-13	-.60467460E-12	.11400599E-06
-.42543750E-05	-.11919737E-10	.42546793E-05	.10153760E-06	-.34352434E-10
.41859459E-11	-.37080794E-11	.59234151E-04	.45504345E-11	-.70844966E-12
.15588470E-10	.13593377E-10	.68741697E-12	.87795145E-10	-.28497036E-11
.31909564E-13	-.69421743E-15	.38765922E-11	-.41335440E-11	-.44983453E-04
.22473012E-05	-.13022411E-04	.41075666E-11	-.13101519E-04	-.17274113E-05
-.98017672E-11	-.14778531E-12	-.42275125E-13	-.96071643E-06	-.25440820E-11
.54200130E-11	.41425181E-12	-.51084189E-13	.98880082E-15	.14899414E-06
-.49351318E-14	.15066380E-14	-.42969795E-10	-.54223125E-14	.27635772E-15
-.79851673E-11	.23444071E-06	-.40722409E-05	-.13017710E-13	.40722809E-05
.23382333E-06	.64327760E-12	-.80030821E-11	.19070818E-11	.27557384E-13
.67193209E-14	.15459451E-13	.15489036E-10	.28188639E-13	.15021236E-15
.22611633E-11	-.61243211E-07	.17482812E-05	.30019490E-13	-.17482739E-05
-.61449314E-07	-.27684414E-12			

phi_t for node #

3

-.42404714E-02	.49480955E-03	.19835813E-08	-.36612814E-03	-.42534660E-02
.96750031E-09	.42209027E-09	.30963712E-08	.40516924E-04	.38549281E-02
-.52714285E-03	-.87737477E-09	.53843743E-03	.38533672E-02	-.10363838E-09
.38623427E-08	-.71743451E-08	.24131659E-03	.31427071E-02	-.10270931E-03
.15812594E-09	-.20969267E-03	.31373775E-02	.44642715E-09	.28790083E-09
.88009461E-09	.18408168E-03	-.17813513E-08	-.27431844E-08	.15957166E-04
-.19242852E-02	.34087019E-03	-.22330623E-09	.41716037E-03	.19091971E-02
-.71605887E-10	.95016675E-09	-.81490514E-09	.32861442E-02	-.18116747E-08
.55541036E-09	.79551900E-03	-.41608643E-08	-.26069981E-09	.94036451E-02
.21682867E-02	-.12127210E-02	.85710915E-08	.12126479E-02	.21683282E-02
-.39141685E-08	.18971552E-02	-.12009168E-02	.43705940E-08	.12012029E-02
.18969745E-02	.16937062E-07	-.67726532E-08	-.66549206E-08	.11440634E-01
.49982895E-02	-.24804966E-02	.39527267E-09	-.24804686E-02	-.49983050E-02
-.34622476E-08	-.50056020E-02	.25440974E-02	-.23331468E-08	-.25435047E-02
-.50059046E-02	-.85708461E-08			

phi_t prime for node #

3

-.50525028E-06	-.31564387E-05	-.80521842E-10	.31702786E-05	-.40940183E-06
.57389171E-09	-.26678138E-11	.65900274E-12	-.58046889E-04	.10244708E-05
.47674564E-05	.15531760E-10	-.47644389E-05	.10384376E-05	.44257276E-10
.11200572E-10	.49389619E-11	-.61429724E-04	.68382965E-06	.54576833E-05
-.20073106E-10	-.54985919E-05	.13880871E-06	-.11950858E-09	-.12906028E-11
.35486701E-12	-.77274292E-04	.61171041E-11	-.56114520E-11	-.65377923E-04
-.17172111E-05	-.54788611E-05	.24079039E-11	-.54062017E-05	.19338345E-05
.41797610E-11	.67570000E-11	.20000043E-10	.51675836E-06	-.99163146E-11
-.24536147E-10	.16113741E-05	-.24387637E-10	-.45291231E-10	.14474359E-04
.40550997E-04	.55846277E-04	-.22605263E-10	-.55847708E-04	.40549096E-04

```
- .12064872E-11 .40806300E-04 .51925447E-04 -.22326921E-10 -.51919351E-04
.40814113E-04 .35521932E-10 .15828591E-09 -.16771401E-09 .21209458E-04
.16987298E-03 .27619447E-03 .11975439E-09 .27619558E-03 -.16987148E-03
-.57982074E-10 -.17376694E-03 -.27781790E-03 -.11765510E-09 .27783862E-03
-.17373409E-03 -.70075300E-10
phi_t for node # 4
-.42404802E-02 .49480360E-03 .18585028E-08 -.36612933E-03 -.42535396E-02
.21036956E-08 .39723035E-09 -.14786269E-09 .40516905E-04 -.38549306E-02
.52714303E-03 -.77214743E-09 -.53843745E-03 -.38533660E-02 .20798890E-09
-.73886299E-08 -.15978809E-07 -.24131650E-03 .31427093E-02 -.10270436E-03
.13801450E-10 -.20968938E-03 .31373931E-02 -.39914612E-09 .41931685E-11
.99616139E-10 .18408168E-03 .35438059E-09 -.17390277E-08 -.15957178E-04
.19242857E-02 -.34087031E-03 -.23866856E-09 -.41716036E-03 -.19091972E-02
-.19395891E-10 .94356214E-09 -.84924469E-09 -.32861442E-02 .18078300E-08
-.56604075E-09 .79551900E-03 -.41738415E-08 -.28114281E-09 -.94036451E-02
.21682868E-02 -.12127209E-02 -.85410786E-08 .12126480E-02 .21683284E-02
.38256346E-08 -.18971552E-02 .12009169E-02 .43704936E-08 -.12012030E-02
-.13869746E-02 .17005110E-07 .67789071E-08 .66775796E-08 .11440634E-01
.49982897E-02 -.24804968E-02 -.39492666E-09 -.24804688E-02 -.49983053E-02
.34827434E-08 .50056020E-02 -.25440973E-02 -.23324836E-08 .25435049E-02
.50059050E-02 -.85841247E-08
phi_t prime for node # 4
.50524725E-06 .31564441E-05 -.82070494E-10 -.31703213E-05 .40940604E-06
.62154334E-09 .34011412E-12 -.27858908E-12 .58046878E-04 .10244712E-05
.47674599E-05 .13355611E-10 -.47644372E-05 .10384375E-05 .44054122E-10
-.22077045E-10 .11247290E-10 -.61429722E-04 -.68382100E-06 -.54576879E-05
-.24245181E-10 .54986198E-05 -.13881681E-06 -.15347238E-09 .50958361E-12
-.41824742E-12 .77274292E-04 -.42833617E-11 .34928804E-12 -.65377921E-04
-.17172117E-05 .54788625E-05 .15891701E-11 -.54062019E-05 .19338345E-05
-.90655410E-11 -.71395520E-11 -.19852937E-10 .51675837E-06 -.10061491E-10
-.24464605E-10 -.16113739E-05 .23986931E-10 .45635598E-10 .14474359E-04
-.40550995E-04 -.55846279E-04 -.22604313E-10 .55847713E-04 -.40549100E-04
-.14851140E-11 .40806300E-04 .51925447E-04 .22357522E-10 -.51919354E-04
.40814116E-04 -.35835384E-10 .15906312E-09 -.16795738E-09 .21209458E-04
.16987299E-03 -.27619447E-03 .11979215E-09 -.27619560E-03 .16987149E-03
-.57726900E-10 -.17376694E-03 -.27781789E-03 .11764036E-09 .27783864E-03
-.17373411E-03 .70185849E-10
mass matrix
.10000000E+01 -.30291562E-01 -.76876291E-07 .73800796E-06 .32867117E-06
.13158549E-06 -.92633251E-08 -.17952422E-07 .62673968E-08 -.19995321E-07
.20953681E-06 -.61379992E-07 .12006683E-09 -.11753664E-09 .88805322E-10
.18582751E-09 .93589593E-10 .34601899E-08 .12520782E-08 .51220876E-10
-.26895388E-10 -.46932083E-10 -.51456416E-09 -.16699282E-09 -.30291562E-01
.10000000E+01 .26989693E-07 .24701420E-07 .34123181E-05 .19569915E-07
.18126030E-07 -.22083024E-07 -.30895835E-08 -.63797417E-09 .13846796E-06
-.91584230E-06 .28463240E-09 -.92291186E-09 .13196997E-09 -.83498605E-10
-.23061102E-09 .37066771E-09 .14015707E-07 .71524564E-09 -.97352491E-12
-.79781628E-10 -.28504651E-10 -.24628018E-08 -.76876291E-07 .26989693E-07
.10000000E+01 -.12820039E-07 .23873133E-06 .46502856E-07 .48615925E-08
-.31587180E-08 -.94997621E-10 -.56075172E-08 .49113872E-08 -.51914907E-07
-.57636964E-11 .45511296E-10 .45041193E-11 -.28608624E-10 .92163317E-11
-.16290986E-10 .76859350E-09 -.31071312E-10 -.47158520E-11 -.13956592E-11
.40931813E-11 -.13308932E-09 .73800796E-06 .24701420E-07 -.12820039E-07
.10000000E+01 .29302137E-02 .10572523E-05 -.24430484E-06 .68476034E-07
.92720426E-09 -.64534578E-07 .16242822E-07 .86600013E-08 .72440444E-09
.16245107E-08 -.11209088E-09 .55930229E-10 -.44166054E-09 -.10256621E-08
-.50144862E-09 -.15880740E-08 .25789654E-09 -.98514653E-10 -.37720327E-09
.27460623E-09 .32867117E-06 .34123181E-05 .23873133E-06 .29302137E-02
.10000000E+01 .71189247E-06 -.53815780E-06 -.15566832E-05 .83251907E-07
-.45009419E-07 -.44807150E-07 .17705875E-07 -.16602525E-08 -.43070508E-08
-.20692528E-09 .20019442E-08 .57241159E-08 -.72556163E-09 .93151063E-09
.18206492E-08 -.13561118E-09 -.12897281E-08 -.25829052E-10 .16156569E-09
.13158549E-06 .19569915E-07 .46502856E-07 .10572523E-05 .71189247E-06
.10000000E+01 .83160269E-07 .24349543E-07 .11233865E-07 .10028917E-06
-.12313102E-06 .70134651E-07 -.13207290E-08 .28173844E-08 -.11660397E-08
.22882173E-09 -.30171128E-09 -.14728997E-08 -.13109908E-08 .32317686E-09
.12105915E-10 -.55168990E-10 .27914248E-09 .14656790E-09 -.92633250E-08
.18126030E-07 .48615925E-08 -.24430484E-06 -.53815780E-06 -.83160269E-07
.10000000E+01 -.99242756E-01 .22394316E-07 -.39958298E-07 .32234509E-06
-.50160922E-06 .23636843E-09 -.21910738E-09 .14348669E-09 .15847338E-09
.74774558E-10 .32733302E-08 .57239272E-08 .10031900E-09 -.36640911E-10
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-.81560611E-10 -.45187655E-09 -.93057423E-09 -.17952422E-07 -.22083024E-07
-.31587180E-08 -.68476034E-07 -.15566832E-05 -.24349543E-07 -.99242756E-01
.10000000E+01 -.20074054E-07 .16458235E-07 .15485050E-06 -.15630944E-05
.29386609E-09 -.10163269E-08 .11846928E-09 -.20501990E-09 -.41770205E-09
-.56246450E-09 .16797163E-07 .78252621E-09 .33675344E-11 -.57812240E-10
.11108613E-09 -.29422473E-08 .62673968E-08 -.30895835E-08 -.94997760E-10
.92720426E-09 .83251907E-07 .11233865E-07 .22394316E-07 -.20074054E-07
.10000000E+01 .12712850E-07 -.23627686E-07 .15204590E-06 .96068819E-11
-.66710239E-10 -.23527708E-12 .57865057E-10 -.34048646E-10 -.56274547E-10
-.13467924E-08 .57321148E-10 .72512622E-11 .43261077E-11 .42475879E-11
.23009307E-09 -.19995321E-07 -.63797417E-09 -.56075174E-08 -.64534578E-07
-.45009419E-07 .10028917E-06 -.39958298E-07 .16458235E-07 .12712850E-07
.10000000E+01 .34013758E-06 -.19456390E-06 .12276100E-08 -.23143374E-08
.90995226E-09 -.20703316E-09 .26711414E-09 .17484259E-08 .14384415E-08
-.22089987E-09 -.12869248E-10 .38339013E-10 -.31448481E-09 -.18544250E-09
.20953681E-06 .13846796E-06 .49113872E-08 .16242822E-07 -.44807150E-07
-.12313102E-06 .32234509E-06 .15485050E-06 -.23627686E-07 .34013758E-06
.10000000E+01 -.39786267E-01 .17049808E-08 .38885439E-08 -.46588188E-09
.12616452E-08 .13318808E-08 -.42894021E-08 .74108288E-09 -.45855306E-08
.76304756E-09 -.90324773E-09 -.10747486E-08 .61285555E-09 -.61379992E-07
-.91584230E-06 -.51914907E-07 .86600013E-08 .17705875E-07 .70134651E-07
-.50160922E-06 -.15630944E-05 .15204590E-06 -.19456390E-06 -.39786267E-01
.10000000E+01 .62505978E-08 .15167020E-07 .64225500E-09 -.64493380E-08
-.19359751E-07 .14627884E-08 -.39742767E-08 -.61200326E-08 .51696455E-09
.41021165E-08 .38755886E-10 -.28087086E-09 .12006683E-09 .28463240E-09
-.57637523E-11 .72440444E-09 -.16602525E-08 -.13207290E-08 .23636843E-09
.29386609E-09 .96069199E-11 .12276100E-08 .17049808E-08 .62505978E-08
.10000000E+01 .73552646E-10 .38814802E-10 .36872491E-10 .72462767E-10
-.30908303E-09 .78347194E-09 -.80736378E-10 .38873326E-11 -.52248843E-11
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stiffness matrix

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.18224390E-11	.91230355E-12	.33761495E-10	.12195177E-10	.39046523E-12
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.17684183E-09	-.21551112E-09	-.30152319E-10	-.62306491E-11	.13513914E-08
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.78883295E-08 - .63574471E-08 .21010657E-07 - .96293667E-08 - .35136868E-08
- .11741684E-07 - .11054520E-08 .15883512E-07 .51376341E-07 .89214834E-08
.17247322E-07 .22259068E-07 - .29325792E-06 - .25901072E-05 - .40681582E-02
.34283314E+02
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*** zeroth order terms ***

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alpha
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- .98124081E-10 .42222814E-08 .46766094E-10 - .23190343E-08 - .21012612E-09
.84068331E-10 .67994729E-09 - .13698436E-08 .62753410E-10 .11096251E-10
.39006386E-10 .73868759E-11 .27987870E-11 - .62247277E-09 - .59775470E-11
.17590884E-09 .76219460E-11 - .26366890E-09 .11876573E-10 .28290161E-10
- .27201298E-10 .89869863E-12 - .15751250E-11 - .33157375E-12 .70866876E-12
- .24551181E-11 - .42785452E-10 .34373229E-12 .11944186E-12 - .30843212E-12
.15203202E-10 .15923719E-12 - .27557073E-12 - .68722572E-12 .78199706E-11
- .53600279E-12 .35222275E-11 - .10833770E-12 - .38667210E-11 .24012255E-12
- .22349588E-13 .72325799E-13 - .72369183E-12 .14903493E-11 .24910814E-10
.17123480E-11 .30860344E-13 .45896282E-13 .35510380E-13 - .12439625E-11
.66833265E-13 - .45804903E-12 - .82105459E-14 .84237205E-12 .62945655E-13
- .81003566E-13 .43653901E-13
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.31621688E+00 - .15658688E+00 - .17361672E-01 - .21636943E-02 - .21186125E-01
.26295445E+00 .10634541E-02 .39837270E+00 .24038060E-01 .34138213E-02
.72810429E-01 - .66125938E-01 - .14508666E-01 - .87470672E-01 .13982584E-01
.20325687E-02 - .26138318E+00 - .13271355E-01 .17000778E-01 .16625637E-01
- .30466702E-03 .92471384E-04 - .13678233E-01 .14351589E-01 .35179758E-02
.18275688E-02 .81441214E-01 .37327408E-03 - .11565896E+00 - .94944608E-03
- .86128442E-03 - .44776941E-03 - .16313018E-03 - .15718717E-04 - .10522228E-02
.90631992E-05 .49761828E-04 - .64926039E-04 .27152761E-04 - .19410130E-04
.46028011E-03 .13453022E-03 .19224888E-06 .13666807E-02 .14309527E-03
- .11088438E-03 - .18934576E-03 .15159582E-02 .53961923E-05 .20500426E-02
.20016096E-03 .90999899E-05 .44426853E-03 .45524403E-04 .33906200E-05
- .32663380E-04 - .43305067E-04 - .94350657E-07 - .31076189E-03 .13804808E-04
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- .13655382E-03 - .30751912E-05
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*** first order terms ***

95

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.00000000E+00
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-.30068531E-10 -.41762028E-01 .54019335E-08 -.52857311E-07 .69439023E-07
.39767875E-07 .76296204E-08 -.21121434E-08 .11553120E-06 .45920329E-07
-.21718772E-07 .44647683E-09 .16416114E-08 -.28098883E-01 -.16609482E-08
.44578552E-09 .79066663E-01 .24235997E-06 -.10887613E-07 .13773702E-06
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-.14175266E-07 .11126326E-08 -.49737407E-08 .53923648E+00 .90587906E-08
-.40903232E-08 .40597617E-01 -.19571357E-01 .43996180E-02 .78227017E-06
.88506639E-09 .26291127E-07 -.93122118E-07 -.30067542E-06 .20275997E-08
-.86886469E-07 .70395759E-09 .24600259E-09 .61037343E-08 -.72639356E-01
.89484432E-03 -.11343359E-06 .20017513E-08 .22674296E-08 -.18271839E+00
-.15690317E-08 .10989807E-09 .15406299E-02 .35642111E+00 .15252056E-01
-.15551538E-09 .11525644E-08 .22841308E-08 .53271028E-07 -.28914783E+00
.99735803E-02 -.80529120E-11 -.39209234E-06 .26942708E-07 -.40357060E-08
-.23699116E-07 -.12256696E-08 .39578955E-08 .13718954E-08 .23672818E-08
-.42889921E-01 -.19728023E-08 .12993543E-08 -.27395597E-01 .10482756E-07
-.36015513E-08 .59618938E-07 -.98494637E-07 .30215091E-07 .83151351E-09
.11154142E-06 -.12729912E-07 -.22012824E-08 -.20575968E-08 -.54136933E-08
.80118470E-01 .54141545E-08 -.20376560E-08 .24921274E-01 .74355275E-06
-.86344820E-06 .86348556E-08 .78571358E-05 .80752560E-06 .22489195E-06
.23010227E-06 .98727685E-07 -.43416653E-13 .94714179E-01 .64899273E+00
.34678836E-08 -.64871410E+00 .96615212E-01 .60262836E-09 -.96672133E-06
.11372652E-05 .81782833E-13 .70112029E-06 -.18615170E-06 .27093746E-06
.21444915E-05 -.11187428E-06 .77099669E-07 -.20879089E-06 .14299961E-07
.29220077E-13 .16459085E-06 -.21258826E-06 -.17755656E-12 .29420640E-01
-.35553316E+00 -.10890627E-08 -.35642111E+00 -.15252056E-01 .15551538E-09
.19702911E-08 .17067919E-09 -.67397229E-14 .43502667E-06 .23008021E-06
-.18534110E-15 -.31921334E-09 -.49233010E-09 -.98795752E-14 -.46272789E-08
.32747580E-08 .41693501E-08 -.86543027E-08 .51209400E-08 -.21513879E-08
-.12962772E+00 -.22610792E+00 -.55780767E-10 .22608848E+00 -.12966222E+00
-.46893542E-10 -.63686977E-06 .54634427E-06 .37138548E-15 .86753266E-08
.74221774E-08 .46945470E-08 .16797908E-07 -.91574736E-08 .19556552E-08
.19954144E+00 .51982556E+00 .11311457E-09 -.51984922E+00 .19947944E+00
.51066096E-10 .10594211E+00 .72922176E-01 -.12741219E-07 -.76105503E-01
.10368437E+00 -.15769748E-08 .24898360E-06 -.91483883E-07 .77664092E-13
.10559694E-07 .39960159E-06 -.37782460E-06 .18891624E-06 .98396479E-08
-.89202189E-07 -.37524982E-05 .34633772E-06 -.73163584E-12 .11513953E+00
-.10016519E+01 -.10444111E-07 .98527966E+00 .21397787E+00 .14263427E-08
.15107758E-06 -.17930787E-07 -.35600382E-13 -.50741177E-06 .65700277E-07
.13810761E-12 .22036796E-08 -.72972846E-07 .18535266E-06 -.11525644E-08
-.22841308E-08 -.53271028E-07 -.43502667E-06 -.23008021E-06 .18534110E-15

.12392972E-07 -.12119306E-08 -.18085362E-13 -.25448515E-06 -.24080342E-06
.72100480E-15 .42365812E-01 .22743214E+00 .53395066E-09 -.22743389E+00
.42358362E-01 .13756098E-09 -.34009417E-09 -.36617465E-08 -.44502412E-08
.50488788E-08 -.25689226E-08 .32032115E-08 .14881036E-07 .20788290E-08
.53416876E-14 .49700530E-01 .27168256E+00 .17278504E-09 .27168278E+00
.49698521E-01 -.46204715E-10 -.72402280E-09 -.51155317E-09 .66103844E-08
.10387562E-07 .27226537E-08 -.73095770E-08 .80583169E-06 -.12968028E-05
.14501437E-06 .10568617E-04 -.57565891E-06 -.76217949E-06 .45284969E-06
.42741722E-07 .21249170E-12 -.13940018E+00 -.12146079E+01 .12958433E-08
.12141936E+01 -.14295856E+00 -.23050185E-09 .14240023E-05 -.16913358E-05
.853114857E-12 -.66967927E-06 .22081894E-06 -.29618344E-06 -.20740004E-05
.23288741E-06 -.46545419E-07 .18459429E-06 -.73257490E-07 -.32197615E-13
.12668197E-06 .19034335E-06 .24898461E-12 -.15383984E-02 .28931664E+00
.30106500E-09 .28914783E+00 -.99735803E-02 .80529120E-11 .31921334E-09
.49233010E-09 .98795752E-14 .25448515E-06 -.24080342E-06 .72100480E-15
.80857846E-09 -.65913199E-09 -.89837874E-14 -.40276693E-08 .23299565E-08
.33531355E-09 -.74204357E-08 .35521019E-08 .62833350E-08 -.82095560E-01
.12224359E+00 -.26190706E-11 .12223122E+00 -.82113856E-01 -.75550354E-12
.49434274E-06 .52138355E-06 -.36084625E-15 .72258733E-08 .45094717E-08
.82984545E-09 .11398262E-07 -.86245755E-08 -.84823258E-08 .20012965E+00
.34933873E+00 .29523672E-11 -.34936258E+00 .20008846E+00 -.35514320E-11
.91143541E-07 -.15942143E-06 .12557840E+00 .74044170E-07 -.11391547E-06
.46976639E+00 .13278546E-01 .52285061E-01 -.14719014E-06 -.19372121E-06
.13219075E-05 -.14943658E-08 .14209128E-05 -.23416354E-06 -.35761913E-07
.30146541E-08 -.35978002E-08 .45661113E-06 .36225913E-08 -.85213715E-08
.40353386E-01 -.87483772E-09 -.17211154E-07 .12561504E+00 .11934809E-01
.24773363E-01 .28562365E-07 -.48485096E-09 .38632258E-09 -.20325780E-06
.35186887E-07 .34894224E-06 .12497649E-08 .39209234E-06 -.26942708E-07
.40357060E-08 .46272789E-08 -.32747580E-08 -.41693501E-08 -.42365812E-01
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.13190608E-09 -.42992791E-09 .53549523E-03 .44221408E-09 -.15144278E-09
.50250104E-02 -.53621168E-07 -.78323735E-07 -.76419772E-10 .67488837E-07
.40301963E-07 .71900559E-10 -.38245326E-02 .95707833E-02 .28472227E-09
.26263013E-09 -.59806850E-09 .30586106E-02 -.60005167E-09 .27669342E-09
.65749091E-02 .13037445E-06 .21701737E-06 .12705909E-09 -.21430064E-06
.12189418E-06 -.18933107E-09 .16085783E-06 .84422487E-07 -.47379413E+00
.12058674E-06 .175683469E-07 .13985513E+00 -.52285564E-01 .13276810E-01
.63399074E-08 -.80698553E-07 .19053734E-06 -.77887080E-07 -.15420580E-06
.19440207E-07 -.14128991E-08 .42909184E-08 .19153162E-08 -.50616539E-07
.80313089E-08 .50214583E-08 -.13026438E+00 .15869406E-07 -.14981146E-08
.53077809E-01 -.24773764E-01 .11933949E-01 -.10299928E-08 -.53522249E-09
.18948680E-10 -.27623676E-08 .41746864E-07 -.22875467E-07 -.45437189E-07
.23699116E-07 .12256696E-08 -.39578955E-08 .86543027E-08 -.51209400E-08
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.35521019E-08 -.62833350E-08 -.44221408E-09 .15144278E-09 .50250104E-02
.10011899E-08 .39672401E-09 .53548366E-03 .35302623E-07 .45619868E-07
.18324191E-09 -.58945067E-07 .24482274E-07 -.14363279E-09 -.95706411E-02
.38248253E-02 .52950837E-10 .80178997E-09 .17350601E-08 .65747891E-02
.17209949E-08 -.80376640E-09 -.30587738E-02 -.65962710E-07 -.12765379E-06
.24445245E-09 .13611625E-06 -.63215067E-07 .27202374E-09 .16763984E-06
.73009900E-06 -.48745525E-06 -.10506104E-05 -.54053200E-06 -.30253741E-05
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.20183313E-01 .54931006E-07 .79053746E-07 -.70869914E-06 -.84282940E-07
.69826092E-06 .93248306E-07 -.23220378E-06 -.93398544E-10 -.13727412E-09
.23093011E-07 -.84150598E-02 -.17168433E-01 -.34115338E-07 .42673819E-09
.78136072E-09 -.29073755E-01 -.13718954E-08 -.23672818E-08 .42889921E-01
.12962772E+00 .22610792E+00 .55780767E-10 .34009417E-09 .36617465E-08
.44502412E-08 .82095560E-01 .12224359E+00 .26190706E-11 .53621168E-07
.78323735E-07 .76419772E-10 -.35302623E-07 -.45619868E-07 .18324191E-09
.16412533E-11 .21384164E-11 .32021163E-03 .58936241E-11 -.14505988E-10
.33385669E-02 -.42306378E-10 -.13863650E-08 .83012671E-08 -.56730240E-07
.96467007E-07 -.10535633E-09 -.91711930E-07 .55460535E-07 -.51525169E-09
.43381873E-11 -.92974491E-11 -.29258756E-02 .76083731E-11 .16981023E-11
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.12619873E-06 -.20116967E-05 -.35017562E-08 .20853839E-08 -.83171247E-07
.67860925E-08 -.11108030E-08 .36522737E-04 .16434235E-07 -.11524456E-07
.19691541E-01 -.20181394E-01 .12759081E-01 -.42808564E-07 -.96353235E-10
.81235041E-06 -.18225686E-07 .86409724E-06 .81421980E-07 -.11449558E-06
.54977989E-09 -.38611032E-09 .12072820E-07 .17167179E-01 -.84177208E-02
.13940941E-07 -.83848781E-09 .30068531E-10 .41762028E-01 .19728023E-08

-.12993543E-08	.27395597E-01	-.22608848E+00	.12966222E+00	.46893542E-10
-.50488788E-08	.25689226E-08	-.32032115E-08	-.12223122E+00	.82113856E-01
.75550354E-12	-.67488837E-07	.40301963E-07	-.71900559E-10	.58945067E-07
-.24482274E-07	.14363279E-09	-.58936241E-11	.14505988E-10	.33385669E-02
-.45134366E-09	.30239391E-09	.32020344E-03	.31906173E-09	.34199546E-11
-.81669645E-08	-.30329414E-06	-.66271809E-06	-.35363609E-09	-.66144997E-06
.30804574E-06	.20159786E-09	-.57170319E-09	-.11035564E-08	-.72527212E-02
.10976139E-08	-.57328140E-09	-.29238966E-02	.21301848E+00	.18980035E+01
.16449225E-07	-.19035792E+01	.15542683E+00	.27743136E-08	.65246642E-06
-.17160470E-06	.41382889E-12	.71710619E-08	.46661594E-06	-.20025118E-06
.22074571E-06	.15404011E-07	.27221783E-06	-.36247494E-05	.29293728E-06
.11631316E-12	-.92446699E-02	-.36511561E+00	.12675867E-07	.36422996E+00
.27036148E-01	-.14001264E-08	.34175860E-07	-.90726267E-08	-.25781137E-13
.51059035E-07	.57298172E-07	-.20698406E-13	-.54019335E-08	.52857311E-07
-.69439023E-07	-.10482756E-07	.36015513E-08	-.59618938E-07	.63686977E-06
-.54634427E-06	-.37138548E-15	-.14881036E-07	-.20788290E-08	.53416876E-14
.49434274E-06	-.52138355E-06	.36084625E-15	.38245326E-02	-.95707833E-02
-.28472227E-09	.95706411E-02	.38248253E-02	-.52950837E-10	.42306378E-10
.13863650E-08	-.83012671E-08	-.31906173E-09	-.34199546E-11	.81669645E-08
-.87485007E-08	-.13865777E-08	.21238779E-14	-.17696591E+00	-.39083612E+00
-.84602464E-10	-.39083720E+00	.17696374E+00	.30775127E-10	.12256099E-08
.79443691E-09	.63405973E-08	.15032889E-07	-.80204827E-08	.24197572E-08
.15146456E-06	.22667613E-06	.27864015E+00	.12645160E-06	.20146267E-06
.74812742E+00	.23320671E-01	.71358750E-01	-.15696020E-06	-.65869035E-07
-.31119132E-06	.19170180E-07	.28954207E-06	-.78314182E-07	-.29898828E-08
.31447785E-08	.59196241E-08	-.10223336E-07	.57668967E-08	.84437859E-08
.19320351E-01	-.48725385E-08	-.12206505E-07	.11866768E+00	.30017386E-01
.48004147E-01	.21394263E-07	-.94233533E-10	-.50069943E-09	-.11013082E-06
-.39767875E-07	-.76296204E-08	.21121434E-08	.98494637E-07	-.30215091E-07
-.83151351E-09	-.86753266E-08	-.74221774E-08	-.46945470E-08	-.49700530E-01
-.27168256E+00	-.17278504E-09	-.72258733E-08	-.45094717E-08	-.82984545E-09
.26263013E-09	.59806850E-09	-.30586106E-02	-.80178997E-09	-.17350601E-08
-.65747891E-02	.56730240E-07	.96467007E-07	.10535633E-09	.30329414E-06
.66271809E-06	.35363609E-09	.17696591E+00	.39083612E+00	.84602464E-10
.34515937E-11	.11639133E-10	.11823240E-03	.78122412E-12	-.14089096E-10
-.72836582E-02	-.46789915E-08	-.15892413E-07	.65356843E-10	.31383227E-07
.10485630E-07	.42666551E-09	.22686122E-06	-.15001301E-06	.75692354E+00
.20000508E-06	-.12631014E-06	-.30143385E+00	.71358882E-01	-.23320214E-01
.38814806E-07	.48891040E-08	.41439984E-06	.18152134E-07	-.42591726E-06
.27558297E-07	.32855064E-08	.49032229E-08	-.29885627E-08	-.83085912E-07
.83112891E-08	-.55592945E-08	.12118342E+00	-.12399628E-07	.47190946E-08
-.31250391E-01	.48004340E-01	-.30017176E-01	.16597444E-08	-.50976879E-11
.19275352E-09	-.15874235E-08	-.11553120E-06	-.45920329E-07	.21718772E-07
-.11154142E-06	.12729912E-07	.22012824E-08	-.16797908E-07	.91574736E-08
-.19556552E-08	-.27168278E+00	.49698521E-01	.46204715E-10	-.11398262E-07
.86245755E-08	.84823258E-08	.60005167E-09	-.27669342E-09	-.65749091E-02
-.17209949E-08	.80376640E-09	.30587738E-02	.91711930E-07	-.55460535E-07
.51525169E-09	.66144997E-06	-.30804574E-06	-.20159786E-09	.39083720E+00
-.17696374E+00	.30775127E-10	-.78122412E-12	.14089096E-10	.72836582E-02
-.14618963E-09	.69521649E-10	.11823684E-03	-.73228149E-08	-.29478674E-07
.22679544E-09	.44642344E-07	-.22809491E-07	.59107460E-10	-.85227134E-07
-.54382657E-06	.11012196E-05	.10593951E-05	.15030137E-05	.77536846E-05
-.47261019E-08	-.11104159E-07	.25209767E-06	.76837879E-08	.16366625E-07
.11419001E+00	.22910605E-07	.48721700E-07	.94812449E-01	-.26910936E-01
-.53138454E-01	.10396571E-06	-.37021885E-07	.17801169E-06	.12499195E-06
-.23088390E-06	.32957092E-07	.37125093E-06	-.15204283E-09	.22344016E-10
-.41855726E-07	.41887505E-02	.31354146E-01	.46431865E-07	-.44647683E-09
-.16416114E-08	.8098883E-01	.20575968E-08	.54136933E-08	-.80118470E-01
-.19954144E+00	-.51982556E+00	-.11311457E-09	.72402280E-09	.51155317E-09
-.66103844E-08	-.20012965E+00	-.34933873E+00	-.29523672E-11	-.13037445E-06
-.21701737E-06	-.12705909E-09	.65962710E-07	.12765379E-06	-.24445245E-09
.43381873E-11	.92974491E-11	.29258756E-02	.57170319E-09	.11035564E-08
.72527212E-02	-.12256099E-08	-.79443691E-09	-.63405973E-08	.46789915E-08
.15892413E-07	-.65356843E-10	.73228149E-08	.29478674E-07	-.22679544E-09
-.20205244E-11	-.39891324E-11	.87155679E-04	.84364044E-11	.86915796E-11
.68614717E-02	-.35436475E-07	-.14708492E-05	-.62332048E-06	-.10054546E-06
.52218327E-06	.39275247E-05	.82271192E-08	-.34017979E-08	.17927404E-06
-.16399263E-07	.73058140E-08	-.94493068E-01	-.48349038E-07	.22872252E-07
.11390138E+00	.53141657E-01	-.26904645E-01	.94708623E-07	.55451004E-07
.26193636E-06	-.18332552E-07	-.35360159E-06	-.28254188E-07	.38520272E-07
-.19779770E-08	.13203123E-08	-.89135235E-08	-.31354628E-01	.41849538E-02

kdyic1

rvtor1

(and more)

A.3 Concept 2B Definitions and TREETOPS files

Sensor Definitions

Actuator Definitions

Interconnect Definitions

TREETOPS files:

Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx

Table A.3.1 Sensor Definitions (Concept 2A and 2B)

Global Sensor Output No.	TREETOPS Sensor Designation	Local Sensor Output No.	Sensor Mount Loc.	Type	used	DOF
RP1	SE 1	1	B2-N2	Earth Target (ET)		Pitch (Y^{B2}) Error – Overall System
RP2	SE 1	2	B2-N2	(LOS Along X^{B2})		Yaw (Z^{B2}) Error – Overall System
RP3	SE 2	1	B2-N2	Star Tracker (ST)		Roll (X^{B2}) Error – Overall System
RP4	SE 2	2	B2-N2	(LOS Along Z^{B2})		Not used in control (Pitch (Y^{B2}) Error)
RP5	SE 2	3	B2-N2			Not used in control (Validity Flag on(1) off(0))
RP6	SE 3	1	B3-N2	LOS Sensor (L) (LOS Along $-Y^1$) (Negative Polar Axis) see .los file		Roll (X^{B3}) Error – Upper Clamshell
RP7	SE 3	2	B3-N2			Pitch (Y^{B3}) Error – Upper Clamshell
RP8	SE 3	3	B3-N2			Not used in control, Yaw (Z^{B3}) Error – Upper Clamshell
RP9	SE 3	4	B3-N2			Not used in control
RP10	SE 3	5	B3-N2			Not used in control
RP11	SE 3	6	B3-N2			Not used in control
RP12	SE 3	7	B3-N2			Not used in control
RP13	SE 4	1	B4-N2	LOS Sensor (L) (LOS Along $+Y^1$) (Positive Polar Axis) see .los file		Roll (X^{B4}) Error – Lower Clamshell
RP14	SE 4	2	B4-N2			Pitch (Y^{B4}) Error – Lower Clamshell
RP15	SE 4	3	B4-N2			Not used in control, Yaw (Z^{B4}) Error – Lower Clamshell
RP16	SE 4	4	B4-N2			Not used in control
RP 17	SE 4	5	B4-N2			Not used in control
RP 18	SE 4	6	B4-N2			Not used in control
RP 19	SE 4	7	B4-N2			Not used in control
RP 20	SE 5	1	B2-N5	Star Tracker (ST)		Not used in control (Yaw (Z^{B2}) Error
RP 21	SE 5	2	B2-N5	(LOS Along $-X^{B2}$)		Not used in control (Pitch (Y^{B2}) Error)
RP 22	SE 5	3	B2-N5	(Towards Sun)		Validity Flag on(1) off(0) Used for Rad Pres Disturb
RP 23	SE 6	1	B2-N2	3 Axis Accelerometer (A3) with gravity removed		Not used in control, For Output Only, ACCEL (X^{B2})
RP 24	SE 6	2	B2-N2			Not used in control, For Output Only, ACCEL (Y^{B2})
RP 25	SE 6	3	B2-N2			Not used in control, For Output Only, ACCEL (Z^{B2})

Table A.3.2 Actuator Definitions (Concept 2A and 2B)

Global Actuator Input No.	TREETOPS Actuator Designation	Sensor Mount Loc.	Type	DOF
UP 1	AC 1	B2-N2	Moment Actuator (MO)*	Pitch (Y^{B2}) Ext. Torque – Overall System
UP 2	AC 2	B2-N2	Moment Actuator (MO)*	Yaw (Z^{B2}) Ext. Torque – Overall System
UP 3	AC 3	B2-N2	Moment Actuator (MO)*	Roll (X^{B2}) Ext. Torque – Overall System
UP 4	AC 4	B3-N2	Moment Actuator (MO)*	Roll (X^{B3}) Ext. Torque – Upper Clamshell
UP 5	AC 5	B3-N2	Moment Actuator (MO)*	Pitch (Y^{B3}) Ext. Torque – Upper Clamshell
UP 6	AC 6	B4-N2	Moment Actuator (MO)*	Roll (X^{B4}) Ext. Torque – Lower Clamshell
UP 7	AC 7	B4-N2	Moment Actuator (MO)*	Pitch (Y^{B4}) Ext. Torque – Lower Clamshell
UP 8	AC 8	B2-N5	Reaction Jet (J) Radiation Pressure Disturbance	$-X^{B2}$ Force at Central Body Transmitter

Notes:
* Moment Actuator (MO) in TREETOPS is an External Moment applied to a Body (Reacts against Space)
Used in Control

Table A.3.3:
Interconnect Data and Significant Parameters for
TREETOPS Continuous Matrix (CM) Controller
(Concept 2A and 2B)

Interconnect Data						Significant Parameters in Continuous Matrix (CM) Controller in .lin file $\dot{x} = Ax + Bu$ $y = Cx + Du$			
Inter- connect	Description	S C C A	S No. C No. C No. A No.	S Out No. C In No. C Out No. A In No.	Gain N-in or N	Subset of A Matrix	Subset of B Matrix	Subset of C Matrix ω^2 $2\zeta\omega$	Subset of D Matrix
IC 1	Pitch (Y^{B2}) of Overall System	S	1	1	4.41E13	0. 1.	0	.000025 .007	0
IC 2		C	1	1	1.0	-1. -1.4	1		
		C	1	1					
		A	1	1					
IC 3	Yaw (Z^{B2}) of Overall System	S	1	2	1.67E12	0. 1.	0	.000025 .007	0
IC 4		C	1	2	1.0	-1. -1.4	1		
		C	1	2					
		A	2	1					
IC 5	Roll (X^{B2}) of Overall System	S	2	1	4.31E13	0. 1.	0	.000025 .007	0
IC 6		C	1	3	1.0	-1. -1.4	1		
		C	1	3					
		A	3	1					
IC 7	Roll (X^{B3}) of Upper Clamshell	S	3	1	1.7E12	0. 1.	0	.0001 .014	0
IC 8		C	1	4	1.0	-1. -1.4	1		
		C	1	4					
		A	4	1					
IC 9	Pitch (Y^{B3}) of Upper Clamshell	S	3	2	1.7E12	0. 1.	0	.0001 .014	0
IC 10		C	1	5	1.0	-1. -1.4	1		
		C	1	5					
		A	5	1					
IC 11	Roll (X^{B4}) of Lower Clamshell	S	4	1	1.7E12	0. 1.	0	.0001 .014	0
IC 12		C	1	6	1.0	-1. -1.4	1		
		C	1	6					
		A	6	1					
IC 13	Pitch (Y^{B4}) of Lower Clamshell	S	4	2	1.7E12	0. 1.	0	.0001 .014	0
IC 14		C	1	7	1.0	-1. -1.4	1		
		C	1	7					
		A	7	1					
IC 15	$-X^{B2}$ of Radiation Pres Disturb	S	5	3	7.0				
	A	8	1						

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SIM CONTROL

1 SI	0 Title	ISC MODEL, THIRD VERSION
2 SI	0 Simulation stop time	100000
3 SI	0 Plot data interval	20
4 SI	0 Integration type (R,S,U, OR V)	R
5 SI	0 Step size (sec)	.1
6 SI	0 Sandia ODE solver absolute and relative error	
7 SI	0 RK78 ODE solver absolute error and first step size	
8 SI	0 Linearization option (L,Z or N)	N
9 SI	0 Restart option (Y/N)	N
10 SI	0 Contact force computation option (Y/N)	Y
11 SI	0 Constraint force computation option (Y/N)	N
12 SI	0 Small angle speedup option (All,Bypass,First,Nth)	A
13 SI	0 Mass matrix speedup option (All,Bypass,First,Nth)	A
14 SI	0 Non-Linear speedup option (All,Bypass,First,Nth)	A
15 SI	0 Constraint speedup option (All,Bypass,First,Nth)	A
16 SI	0 Constraint stabilization option (Y/N)	N
17 SI	0 Stabilization epsilon	

GENGRAV

18 GG	5 Gravity, earth sphere/nonsphere/user (S/N/U)?	N
19 GG	1 Input gravity constants: GME, ERAD, EMASS	
20 GG	1 Spherical or Nonspherical (S/N)?	
21 GG	1 Gravity Potential Harmonics J2,J3,J4	
22 GG	5 English (ft-slug-s) or metric (m-kg-s) (E/M)?	M
23 GG	5 Day, Month, Year,	21 6 2020
24 GG	5 GMT @ sim time 0 (minutes past midnight,	0
25 GG	5 Solar Pressure forces Y/N?	Y
26 GG	5 Input new data for aero model? (Y/N)	N
27 GG	1 Solar flux F10 for aero model	
28 GG	1 Solar flux, 81 day average F10B	
29 GG	1 Geomagnetic index, GEAP	

BODY

30 BO	1 Body ID number	1
31 BO	1 Type (Rigid,Flexible,NASTRAN)	F
32 BO	1 Number of modes	24
33 BO	1 Modal calculation option (0, 1 or 2)	2
34 BO	1 Foreshortening option (Y/N)	
35 BO	1 Model reduction method (NO,MS,MC,CC,QM,CV)	
36 BO	1 NASTRAN data file FORTRAN unit number (40 - 60)	
37 BO	1 Number of augmented nodes (0 if none)	
38 BO	1 Damping matrix option (NS,CD,HL,SD)	
39 BO	1 Constant damping ratio	
40 BO	1 Low frequency, High frequency ratios	
41 BO	1 Mode ID number, damping ratio	
42 BO	1 Conversion factors: Length,Mass,Force	
43 BO	1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
44 BO	1 Moments of inertia (kg-m2) Ixx,Iyy,Izz	6.2852173E11 6.2852173E11
6.7057352E8		
45 BO	1 Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
46 BO	1 Mass (kg)	1.6168633E5
47 BO	1 Number of Nodes	4
48 BO	1 Node ID, Node coord. (meters) x,y,z	1 0 0 0
49 BO	1 Node ID, Node coord. (meters) x,y,z	2 0 0 0
50 BO	1 Node ID, Node coord. (meters) x,y,z	3 0 0 3188.8
51 BO	1 Node ID, Node coord. (meters) x,y,z	4 0 0 -3188.8
52 BO	1 Node ID, Node structural joint ID	

53 BO	2	Body ID number	2
54 BO	2	Type (Rigid,Flexible,NASTRAN)	R
55 BO	2	Number of modes	
56 BO	2	Modal calculation option (0, 1 or 2)	
57 BO	2	Foreshortening option (Y/N)	
58 BO	2	Model reduction method (NO,MS,MC,CC,QM,CV)	
59 BO	2	NASTRAN data file FORTRAN unit number (40 - 60)	
60 BO	2	Number of augmented nodes (0 if none)	
61 BO	2	Damping matrix option (NS,CD,HL,SD)	
62 BO	2	Constant damping ratio	
63 BO	2	Low frequency, High frequency ratios	
64 BO	2	Mode ID number, damping ratio	
65 BO	2	Conversion factors: Length,Mass,Force	
66 BO	2	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
67 BO	2	Moments of inertia (kg-m2) Ixx,Iyy,Izz	.8543E12 1.5601E12
1.3822E12			
68 BO	2	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
69 BO	2	Mass (kg)	12666300
70 BO	2	Number of Nodes	5
71 BO	2	Node ID, Node coord. (meters) x,y,z	1 298.323 0 0
72 BO	2	Node ID, Node coord. (meters) x,y,z	2 0 0 0
73 BO	2	Node ID, Node coord. (meters) x,y,z	3 0 0 300
74 BO	2	Node ID, Node coord. (meters) x,y,z	4 0 0 -300
75 BO	2	Node ID, Node coord. (meters) x,y,z	5 500 0 0
76 BO	2	Node ID, Node structural joint ID	
77 BO	3	Body ID number	3
78 BO	3	Type (Rigid,Flexible,NASTRAN)	R
79 BO	3	Number of modes	
80 BO	3	Modal calculation option (0, 1 or 2)	
81 BO	3	Foreshortening option (Y/N)	
82 BO	3	Model reduction method (NO,MS,MC,CC,QM,CV)	
83 BO	3	NASTRAN data file FORTRAN unit number (40 - 60)	
84 BO	3	Number of augmented nodes (0 if none)	
85 BO	3	Damping matrix option (NS,CD,HL,SD)	
86 BO	3	Constant damping ratio	
87 BO	3	Low frequency, High frequency ratios	
88 BO	3	Mode ID number, damping ratio	
89 BO	3	Conversion factors: Length,Mass,Force	
90 BO	3	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
91 BO	3	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
92 BO	3	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
93 BO	3	Mass (kg)	2046600
94 BO	3	Number of Nodes	2
95 BO	3	Node ID, Node coord. (meters) x,y,z	1 0 0 0
96 BO	3	Node ID, Node coord. (meters) x,y,z	2 0 0 0
97 BO	3	Node ID, Node structural joint ID	
98 BO	4	Body ID number	4
99 BO	4	Type (Rigid,Flexible,NASTRAN)	R
100 BO	4	Number of modes	
101 BO	4	Modal calculation option (0, 1 or 2)	
102 BO	4	Foreshortening option (Y/N)	
103 BO	4	Model reduction method (NO,MS,MC,CC,QM,CV)	
104 BO	4	NASTRAN data file FORTRAN unit number (40 - 60)	
105 BO	4	Number of augmented nodes (0 if none)	
106 BO	4	Damping matrix option (NS,CD,HL,SD)	
107 BO	4	Constant damping ratio	
108 BO	4	Low frequency, High frequency ratios	
109 BO	4	Mode ID number, damping ratio	
110 BO	4	Conversion factors: Length,Mass,Force	
111 BO	4	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
112 BO	4	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
113 BO	4	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
114 BO	4	Mass (kg)	2046600
115 BO	4	Number of Nodes	2
116 BO	4	Node ID, Node coord. (meters) x,y,z	1 0 0 0
117 BO	4	Node ID, Node coord. (meters) x,y,z	2 0 0 0
118 BO	4	Node ID, Node structural joint ID	

119 HI	1 Hinge ID number	1
120 HI	1 Inboard body ID, Outboard body ID	0 1
121 HI	1 "p" node ID, "q" node ID	0 2
122 HI	1 Number of rotation DOFs, Rotation option (F or G)	3 F
123 HI	1 L1 unit vector in inboard body coord. x,y,z	1 0 0
124 HI	1 L1 unit vector in outboard body coord. x,y,z	1 0 0
125 HI	1 L2 unit vector in inboard body coord. x,y,z	
126 HI	1 L2 unit vector in outboard body coord. x,y,z	
127 HI	1 L3 unit vector in inboard body coord. x,y,z	0 0 1
128 HI	1 L3 unit vector in outboard body coord. x,y,z	0 0 1
129 HI	1 Initial rotation angles (deg)	-90 0 90
130 HI	1 Initial rotation rates (deg/sec)	0 0 0.00417807
131 HI	1 Rotation stiffness (newton-meters/rad)	0 0 0
132 HI	1 Rotation damping (newton-meters/rad/sec)	0 0 0
133 HI	1 Null torque angles (deg)	0 0 0
134 HI	1 Number of translation DOFs	3
135 HI	1 First translation unit vector g1	1 0 0
136 HI	1 Second translation unit vector g2	0 1 0
137 HI	1 Third translation unit vector g3	0 0 1
138 HI	1 Initial translation (meters)	0 0 42163421
139 HI	1 Initial translation velocity (meters/sec)	3074.681 0 0
140 HI	1 Translation stiffness (newtons/meters)	0 0 0
141 HI	1 Translation damping (newtons/meter/sec)	0 0 0
142 HI	1 Null force translations	0 0 0
143 HI	2 Hinge ID number	2
144 HI	2 Inboard body ID, Outboard body ID	1 2
145 HI	2 "p" node ID, "q" node ID	2 2
146 HI	2 Number of rotation DOFs	0
147 HI	2 L1 unit vector in inboard body coord. x,y,z	0 0 1
148 HI	2 L1 unit vector in outboard body coord. x,y,z	0 0 1
149 HI	2 L2 unit vector in inboard body coord. x,y,z	
150 HI	2 L2 unit vector in outboard body coord. x,y,z	
151 HI	2 L3 unit vector in inboard body coord. x,y,z	1 0 0
152 HI	2 L3 unit vector in outboard body coord. x,y,z	1 0 0
153 HI	2 Initial rotation angles (deg)	0 0 0
154 HI	2 Initial rotation rates (deg/sec)	
155 HI	2 Rotation stiffness (newton-meters/rad)	
156 HI	2 Rotation damping (newton-meters/rad/sec)	
157 HI	2 Null torque angles (deg)	
158 HI	2 Number of translation DOFs	0
159 HI	2 First translation unit vector g1	1 0 0
160 HI	2 Second translation unit vector g2	0 1 0
161 HI	2 Third translation unit vector g3	0 0 1
162 HI	2 Initial translation (meters)	0 0 0
163 HI	2 Initial translation velocity (meters/sec)	
164 HI	2 Translation stiffness (newtons/meters)	
165 HI	2 Translation damping (newtons/meter/sec)	
166 HI	2 Null force translations	
167 HI	3 Hinge ID number	3
168 HI	3 Inboard body ID, Outboard body ID	1 3
169 HI	3 "p" node ID, "q" node ID	3 2
170 HI	3 Number of rotation DOFs	2
171 HI	3 L1 unit vector in inboard body coord. x,y,z	0 0 1
172 HI	3 L1 unit vector in outboard body coord. x,y,z	0 0 1
173 HI	3 L2 unit vector in inboard body coord. x,y,z	1 0 0
174 HI	3 L2 unit vector in outboard body coord. x,y,z	1 0 0
175 HI	3 L3 unit vector in inboard body coord. x,y,z	
176 HI	3 L3 unit vector in outboard body coord. x,y,z	
177 HI	3 Initial rotation angles (deg)	0. 123.25 0.
178 HI	3 Initial rotation rates (deg/sec)	-.004178 0
179 HI	3 Rotation stiffness (newton-meters/rad)	0 0
180 HI	3 Rotation damping (newton-meters/rad/sec)	0 0
181 HI	3 Null torque angles (deg)	0 0
182 HI	3 Number of translation DOFs	0
183 HI	3 First translation unit vector g1	1 0 0
184 HI	3 Second translation unit vector g2	0 1 0

185 HI	3	Third translation unit vector	g3	0 0 1
186 HI	3	Initial translation (meters)		0 0 0
187 HI	3	Initial translation velocity (meters/sec)		
188 HI	3	Translation stiffness (newtons/meters)		
189 HI	3	Translation damping (newtons/meter/sec)		
190 HI	3	Null force translations		
191 HI	4	Hinge ID number		4
192 HI	4	Inboard body ID, Outboard body ID		1 4
193 HI	4	"p" node ID, "q" node ID		4 2
194 HI	4	Number of rotation DOFs		2
195 HI	4	L1 unit vector in inboard body coord.	x,y,z	0 0 1
196 HI	4	L1 unit vector in outboard body coord.	x,y,z	0 0 1
197 HI	4	L2 unit vector in inboard body coord.	x,y,z	1 0 0
198 HI	4	L2 unit vector in outboard body coord.	x,y,z	1 0 0
199 HI	4	L3 unit vector in inboard body coord.	x,y,z	
200 HI	4	L3 unit vector in outboard body coord.	x,y,z	
201 HI	4	Initial rotation angles (deg)		0. 33.25 0.
202 HI	4	Initial rotation rates (deg/sec)		-.004178 0
203 HI	4	Rotation stiffness (newton-meters/rad)		0 0
204 HI	4	Rotation damping (newton-meters/rad/sec)		0 0
205 HI	4	Null torque angles (deg)		0 0
206 HI	4	Number of translation DOFs		0
207 HI	4	First translation unit vector	g1	1 0 0
208 HI	4	Second translation unit vector	g2	0 1 0
209 HI	4	Third translation unit vector	g3	0 0 1
210 HI	4	Initial translation (meters)		0 0 0
211 HI	4	Initial translation velocity (meters/sec)		
212 HI	4	Translation stiffness (newtons/meters)		
213 HI	4	Translation damping (newtons/meter/sec)		
214 HI	4	Null force translations		

SENSOR

215 SE	1	Sensor ID number		1
216 SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET	
217 SE	1	Mounting point body ID, Mounting point node ID		2 2
218 SE	1	Second mounting point body ID, Second node ID		
219 SE	1	Input axis unit vector (IA)	x,y,z	
220 SE	1	Mounting point Hinge index, Axis index		
221 SE	1	First focal plane unit vector (Fp1)	x,y,z	0 0 -1
222 SE	1	Second focal plane unit vector (Fp2)	x,y,z	0 1 0
223 SE	1	Sun/Star unit vector (Us)	x,y,z	
224 SE	1	Velocity Aberration Option (Y/N)		
225 SE	1	Euler Angle Sequence (1-6)		
226 SE	1	CMG ID number and Gimbal number		
227 SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])		6378000 0 0 4.178074D-3
228 SE	2	Sensor ID number		2
229 SE	2	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST	
230 SE	2	Mounting point body ID, Mounting point node ID		2 2
231 SE	2	Second mounting point body ID, Second node ID		
232 SE	2	Input axis unit vector (IA)	x,y,z	
233 SE	2	Mounting point Hinge index, Axis index		
234 SE	2	First focal plane unit vector (Fp1)	x,y,z	0 -1 0
235 SE	2	Second focal plane unit vector (Fp2)	x,y,z	1 0 0
236 SE	2	Sun/Star unit vector (Us)	x,y,z	0 1 0
237 SE	2	Velocity Aberration Option (Y/N)		N
238 SE	2	Euler Angle Sequence (1-6)		
239 SE	2	CMG ID number and Gimbal number		
240 SE	2	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])		
241 SE	3	Sensor ID number		3
242 SE	3	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	L	
243 SE	3	Mounting point body ID, Mounting point node ID		3 2
244 SE	3	Second mounting point body ID, Second node ID		
245 SE	3	Input axis unit vector (IA)	x,y,z	1 2 3
246 SE	3	Mounting point Hinge index, Axis index		
247 SE	3	First focal plane unit vector (Fp1)	x,y,z	
248 SE	3	Second focal plane unit vector (Fp2)	x,y,z	

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249 SE 3 Sun/Star unit vector (Us) x,y,z
250 SE 3 Velocity Aberration Option (Y/N)
251 SE 3 Euler Angle Sequence (1-6)
252 SE 3 CMG ID number and Gimbal number
253 SE 3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

254 SE 4 Sensor ID number 4
255 SE 4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) L
256 SE 4 Mounting point body ID, Mounting point node ID 4 2
257 SE 4 Second mounting point body ID, Second node ID
258 SE 4 Input axis unit vector (IA) x,y,z 3 2 1
259 SE 4 Mounting point Hinge index, Axis index
260 SE 4 First focal plane unit vector (Fp1) x,y,z
261 SE 4 Second focal plane unit vector (Fp2) x,y,z
262 SE 4 Sun/Star unit vector (Us) x,y,z
263 SE 4 Velocity Aberration Option (Y/N)
264 SE 4 Euler Angle Sequence (1-6)
265 SE 4 CMG ID number and Gimbal number
266 SE 4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE 5 Sensor ID number 5
268 SE 5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ST
269 SE 5 Mounting point body ID, Mounting point node ID 2 5
270 SE 5 Second mounting point body ID, Second node ID
271 SE 5 Input axis unit vector (IA) x,y,z
272 SE 5 Mounting point Hinge index, Axis index
273 SE 5 First focal plane unit vector (Fp1) x,y,z 0 0 1
274 SE 5 Second focal plane unit vector (Fp2) x,y,z 0 -1 0
275 SE 5 Sun/Star unit vector (Us) x,y,z 0 0 0
276 SE 5 Velocity Aberration Option (Y/N) N
277 SE 5 Euler Angle Sequence (1-6)
278 SE 5 CMG ID number and Gimbal number
279 SE 5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE 6 Sensor ID number 6
281 SE 6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV A3
282 SE 6 Mounting point body ID, Mounting point node ID 2 2
283 SE 6 Second mounting point body ID, Second node ID
284 SE 6 Input axis unit vector (IA) x,y,z
285 SE 6 Mounting point Hinge index, Axis index
286 SE 6 First focal plane unit vector (Fp1) x,y,z
287 SE 6 Second focal plane unit vector (Fp2) x,y,z
288 SE 6 Sun/Star unit vector (Us) x,y,z
289 SE 6 Velocity Aberration Option (Y/N)
290 SE 6 Euler Angle Sequence (1-6)
291 SE 6 CMG ID number and Gimbal number
292 SE 6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

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ACTR

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293 AC 1 Actuator ID number 1
294 AC 1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7) MO
295 AC 1 Actuator location; Node or Hinge (N or H)
296 AC 1 Mounting point body ID number, node ID number 2 2
297 AC 1 Second mounting point body ID, second node ID
298 AC 1 Output axis unit vector x,y,z 0 1 0
299 AC 1 Mounting point Hinge index, Axis index
300 AC 1 Rotor spin axis unit vector x,y,z
301 AC 1 Initial rotor momentum, H
302 AC 1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
303 AC 1 Outer gimbal axis unit vector x,y,z
304 AC 1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
305 AC 1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
306 AC 1 Inner gimbal axis unit vector x,y,z
307 AC 1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
308 AC 1 Initial length and rate, y(to) and ydot(to)
309 AC 1 Constants; K1 or wo, n or zeta, Kg, Jm
310 AC 1 Non-linearities; TLim, Tco, Dz

311 AC 2 Actuator ID number 2

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312 AC	2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
313 AC	2 Actuator location; Node or Hinge (N or H)	
314 AC	2 Mounting point body ID number, node ID number	2 2
315 AC	2 Second mounting point body ID, second node ID	
316 AC	2 Output axis unit vector x,y,z	0 0 1
317 AC	2 Mounting point Hinge index, Axis index	
318 AC	2 Rotor spin axis unit vector x,y,z	
319 AC	2 Initial rotor momentum, H	
320 AC	2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
321 AC	2 Outer gimbal axis unit vector x,y,z	
322 AC	2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
323 AC	2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
324 AC	2 Inner gimbal axis unit vector x,y,z	
325 AC	2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
326 AC	2 Initial length and rate, y(to) and ydot(to)	
327 AC	2 Constants; K1 or wo, n or zeta, Kg, Jm	
328 AC	2 Non-linearities; TLim, Tco, Dz	
329 AC	3 Actuator ID number	3
330 AC	3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
331 AC	3 Actuator location; Node or Hinge (N or H)	
332 AC	3 Mounting point body ID number, node ID number	2 2
333 AC	3 Second mounting point body ID, second node ID	
334 AC	3 Output axis unit vector x,y,z	1 0 0
335 AC	3 Mounting point Hinge index, Axis index	
336 AC	3 Rotor spin axis unit vector x,y,z	
337 AC	3 Initial rotor momentum, H	
338 AC	3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
339 AC	3 Outer gimbal axis unit vector x,y,z	
340 AC	3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
341 AC	3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
342 AC	3 Inner gimbal axis unit vector x,y,z	
343 AC	3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
344 AC	3 Initial length and rate, y(to) and ydot(to)	
345 AC	3 Constants; K1 or wo, n or zeta, Kg, Jm	
346 AC	3 Non-linearities; TLim, Tco, Dz	
347 AC	4 Actuator ID number	4
348 AC	4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
349 AC	4 Actuator location; Node or Hinge (N or H)	
350 AC	4 Mounting point body ID number, node ID number	3 2
351 AC	4 Second mounting point body ID, second node ID	
352 AC	4 Output axis unit vector x,y,z	1 0 0
353 AC	4 Mounting point Hinge index, Axis index	
354 AC	4 Rotor spin axis unit vector x,y,z	
355 AC	4 Initial rotor momentum, H	
356 AC	4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
357 AC	4 Outer gimbal axis unit vector x,y,z	
358 AC	4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
359 AC	4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
360 AC	4 Inner gimbal axis unit vector x,y,z	
361 AC	4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
362 AC	4 Initial length and rate, y(to) and ydot(to)	
363 AC	4 Constants; K1 or wo, n or zeta, Kg, Jm	
364 AC	4 Non-linearities; TLim, Tco, Dz	
365 AC	5 Actuator ID number	5
366 AC	5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
367 AC	5 Actuator location; Node or Hinge (N or H)	
368 AC	5 Mounting point body ID number, node ID number	3 2
369 AC	5 Second mounting point body ID, second node ID	
370 AC	5 Output axis unit vector x,y,z	0 1 0
371 AC	5 Mounting point Hinge index, Axis index	
372 AC	5 Rotor spin axis unit vector x,y,z	
373 AC	5 Initial rotor momentum, H	
374 AC	5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
375 AC	5 Outer gimbal axis unit vector x,y,z	
376 AC	5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
377 AC	5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
378 AC	5 Inner gimbal axis unit vector x,y,z	
379 AC	5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	

380 AC	5 Initial length and rate, $y(to)$ and $ydot(to)$	
381 AC	5 Constants; Kl or wo , n or $zeta$, Kg , Jm	
382 AC	5 Non-linearities; $TLim$, Tco , Dz	
383 AC	6 Actuator ID number	6
384 AC	6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
385 AC	6 Actuator location; Node or Hinge (N or H)	
386 AC	6 Mounting point body ID number, node ID number	4 2
387 AC	6 Second mounting point body ID, second node ID	
388 AC	6 Output axis unit vector x,y,z	1 0 0
389 AC	6 Mounting point Hinge index, Axis index	
390 AC	6 Rotor spin axis unit vector x,y,z	
391 AC	6 Initial rotor momentum, H	
392 AC	6 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
393 AC	6 Outer gimbal axis unit vector x,y,z	
394 AC	6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
395 AC	6 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
396 AC	6 Inner gimbal axis unit vector x,y,z	
397 AC	6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
398 AC	6 Initial length and rate, $y(to)$ and $ydot(to)$	
399 AC	6 Constants; Kl or wo , n or $zeta$, Kg , Jm	
400 AC	6 Non-linearities; $TLim$, Tco , Dz	
401 AC	7 Actuator ID number	7
402 AC	7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
403 AC	7 Actuator location; Node or Hinge (N or H)	
404 AC	7 Mounting point body ID number, node ID number	4 2
405 AC	7 Second mounting point body ID, second node ID	
406 AC	7 Output axis unit vector x,y,z	0 1 0
407 AC	7 Mounting point Hinge index, Axis index	
408 AC	7 Rotor spin axis unit vector x,y,z	
409 AC	7 Initial rotor momentum, H	
410 AC	7 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
411 AC	7 Outer gimbal axis unit vector x,y,z	
412 AC	7 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
413 AC	7 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
414 AC	7 Inner gimbal axis unit vector x,y,z	
415 AC	7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
416 AC	7 Initial length and rate, $y(to)$ and $ydot(to)$	
417 AC	7 Constants; Kl or wo , n or $zeta$, Kg , Jm	
418 AC	7 Non-linearities; $TLim$, Tco , Dz	
419 AC	8 Actuator ID number	8
420 AC	8 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	J
421 AC	8 Actuator location; Node or Hinge (N or H)	
422 AC	8 Mounting point body ID number, node ID number	2 5
423 AC	8 Second mounting point body ID, second node ID	
424 AC	8 Output axis unit vector x,y,z	-1 0 0
425 AC	8 Mounting point Hinge index, Axis index	
426 AC	8 Rotor spin axis unit vector x,y,z	
427 AC	8 Initial rotor momentum, H	
428 AC	8 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
429 AC	8 Outer gimbal axis unit vector x,y,z	
430 AC	8 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
431 AC	8 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
432 AC	8 Inner gimbal axis unit vector x,y,z	
433 AC	8 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
434 AC	8 Initial length and rate, $y(to)$ and $ydot(to)$	
435 AC	8 Constants; Kl or wo , n or $zeta$, Kg , Jm	
436 AC	8 Non-linearities; $TLim$, Tco , Dz	

CONTROLLER

437 CO	1 Controller ID number	1
438 CO	1 Controller type (CB,CM,DB,DM,UC,UD)	CM
439 CO	1 Sample time (sec)	
440 CO	1 Number of inputs, Number of outputs	7 7
441 CO	1 Number of states	
442 CO	1 Output No., Input type (I,S,T), Input ID, Gain	

INTERCONNECT

443 IN	1 Interconnect ID number	1
444 IN	1 Source type(S,C, or F),Source ID,Source row #	S 1 1
445 IN	1 Destination type(A or C),Dest ID,Dest row #	C 1 1
446 IN	1 Gain	4.41E13
447 IN	2 Interconnect ID number	2
448 IN	2 Source type(S,C, or F),Source ID,Source row #	C 1 1
449 IN	2 Destination type(A or C),Dest ID,Dest row #	A 1 1
450 IN	2 Gain	1.
451 IN	3 Interconnect ID number	3
452 IN	3 Source type(S,C, or F),Source ID,Source row #	S 1 2
453 IN	3 Destination type(A or C),Dest ID,Dest row #	C 1 2
454 IN	3 Gain	1.67E12
455 IN	4 Interconnect ID number	4
456 IN	4 Source type(S,C, or F),Source ID,Source row #	C 1 2
457 IN	4 Destination type(A or C),Dest ID,Dest row #	A 2 1
458 IN	4 Gain	1
459 IN	5 Interconnect ID number	5
460 IN	5 Source type(S,C, or F),Source ID,Source row #	S 2 1
461 IN	5 Destination type(A or C),Dest ID,Dest row #	C 1 3
462 IN	5 Gain	4.31E13
463 IN	6 Interconnect ID number	6
464 IN	6 Source type(S,C, or F),Source ID,Source row #	C 1 3
465 IN	6 Destination type(A or C),Dest ID,Dest row #	A 3 1
466 IN	6 Gain	1
467 IN	7 Interconnect ID number	7
468 IN	7 Source type(S,C, or F),Source ID,Source row #	S 3 1
469 IN	7 Destination type(A or C),Dest ID,Dest row #	C 1 4
470 IN	7 Gain	1.7E12
471 IN	8 Interconnect ID number	8
472 IN	8 Source type(S,C, or F),Source ID,Source row #	C 1 4
473 IN	8 Destination type(A or C),Dest ID,Dest row #	A 4 1
474 IN	8 Gain	1
475 IN	9 Interconnect ID number	9
476 IN	9 Source type(S,C, or F),Source ID,Source row #	S 3 2
477 IN	9 Destination type(A or C),Dest ID,Dest row #	C 1 5
478 IN	9 Gain	1.7E12
479 IN	10 Interconnect ID number	10
480 IN	10 Source type(S,C, or F),Source ID,Source row #	C 1 5
481 IN	10 Destination type(A or C),Dest ID,Dest row #	A 5 1
482 IN	10 Gain	1
483 IN	11 Interconnect ID number	11
484 IN	11 Source type(S,C, or F),Source ID,Source row #	S 4 1
485 IN	11 Destination type(A or C),Dest ID,Dest row #	C 1 6
486 IN	11 Gain	1.7E12
487 IN	12 Interconnect ID number	12
488 IN	12 Source type(S,C, or F),Source ID,Source row #	C 1 6
489 IN	12 Destination type(A or C),Dest ID,Dest row #	A 6 1
490 IN	12 Gain	1
491 IN	13 Interconnect ID number	13
492 IN	13 Source type(S,C, or F),Source ID,Source row #	S 4 2
493 IN	13 Destination type(A or C),Dest ID,Dest row #	C 1 7
494 IN	13 Gain	1.7E12
495 IN	14 Interconnect ID number	14
496 IN	14 Source type(S,C, or F),Source ID,Source row #	C 1 7
497 IN	14 Destination type(A or C),Dest ID,Dest row #	A 7 1

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498 IN 14 Gain

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499 IN	15	Interconnect ID number	15
500 IN	15	Source type(S,C, or F),Source ID,Source row #	S 5 3
501 IN	15	Destination type(A or C),Dest ID,Dest row #	A 8 1
502 IN	15	Gain	7.0

isc3_flex_sol.lin (Concept 2B) Summer Solstice

* Controller for integrated symmetrical concentrator
system CONT1 14,7,7,0,0,0.0

*A

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
-1 -1.4 0 0 0 0 0 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
0 0 -1 -1.4 0 0 0 0 0 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 0 0 -1 -1.4 0 0 0 0 0 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 0 0 -1 -1.4 0 0 0 0 0 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 0 0 -1 -1.4 0 0 0 0 0 0
0 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 -1.4 0 0 0 0
0 0 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 0 -1 -1.4

*B

0 0 0 0 0 0 0
1 0 0 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
0 0 1 0 0 0 0
0 0 0 0 0 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 0 0 0 0 0
0 0 0 0 1 0 0
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 0 0 1

*C

.000025 .007 0 0 0 0 0 0 0 0 0 0 0 0
0 0 .000025 .007 0 0 0 0 0 0 0 0 0 0
0 0 0 0 .000025 .007 0 0 0 0 0 0 0 0
0 0 0 0 0 0 .0001 .014 0 0 0 0 0 0
0 0 0 0 0 0 0 0 .0001 .014 0 0 0 0
0 0 0 0 0 0 0 0 0 0 .0001 .014 0 0
0 0 0 0 0 0 0 0 0 0 0 0 .0001 .014

*D

0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0

*H

*M

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1os.dat (Concept 2B) Summer Solstice

```
3,      ! Sensor number of 1st FGS (clamshell) sensor
0.d0,0.d0,0.d0,
! Defaults to sun as a target for zero input vector
0.d0,-1.d0,0.d0,
! Target star along negative polar axis
0.d0,-1.d0,0.d0,
! Focal plane vector 1
1.d0,0.d0,0.d0,
! Focal plane vector 2
1.d0,0.d0,0.d0,
! Focal plane vector 3

4,      ! Sensor number of 2nd FGS (clamshell) sensor
0.d0,0.d0,0.d0,
! Defaults to sun as a target for zero input vector
0.d0,1.d0,0.d0,
! Target star along positive polar axis
0.d0,-1.d0,0.d0,
! Focal plane vector 1
1.d0,0.d0,0.d0,
! Focal plane vector 2
-1.d0,0.d0,0.d0,
! Focal plane vector 3
```

solar_pressure.dat (Concept 2B) Summer Solstice

```
22, 'm',      ! number of panels, units English or Metric ***Updated 11/15/00***
1.2,638000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
1.2,638000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
1.2,638000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
1.2,638000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
1.3,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
1.3,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
1.3,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
1.3,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
1.4,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
1.4,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
1.4,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
1.4,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
2.3,785000.d0,0.0d0,0.1736d0,0.d0,0.9848d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
2.3,785000.d0,0.0d0,-0.1736d0,1.d0,-0.9848d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
2.4,785000.d0,0.0d0,0.1736d0,0.d0,-0.9848d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
2.4,785000.d0,0.0d0,-0.1736d0,-1.d0,0.9848d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
2.5,196000.d0,0.0d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
2.5,196000.d0,0.0d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
3.2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
3.2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
4.2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
4.2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0, ! body, node, area, reflectivity factor,outward normal,centroid
```

isc3_flex_sol.flx (Concept 2B) Summer Solstice (An Excerpt)

```

flag, revision number
XXXXXX      1
  body id
    1
  modes, nodes, modal options
    24      4      0      0      0      0      0      0
    0      0      0      0      0      0      0      0
    0      0      0      0      0      0      0      0
    0      0      0      0      0      0      0      0
  phi_t for node #      2
    .31310941E-02 -.16357954E-03 .19158607E-08 .68659216E-04 .31346273E-02
    .14949358E-08 -.33409338E-09 -.17910070E-08 -.62130721E-04 .10048928E-08
    .74260327E-10 -.81693812E-09 .66744219E-10 -.57300403E-09 .56292416E-10
    -.31109642E-09 .51999889E-08 .41569313E-10 .36697769E-02 .69502051E-03
    .85567197E-10 -.10557893E-02 .35826871E-02 .65924560E-10 .61553749E-10
    .11085623E-08 -.67301328E-05 .49549244E-10 -.49437998E-08 -.60865848E-11
    .10484816E-08 .39239830E-10 -.17858973E-09 .46440350E-10 .23145265E-09
    .76239104E-11 -.98486197E-09 -.52382674E-09 .30708566E-12 .12143532E-10
    -.10722701E-09 .94529479E-03 .17735129E-08 .15323995E-09 .13868812E-12
    -.13390485E-02 -.55272105E-04 -.82202021E-12 .55317399E-04 -.13390483E-02
    .27552836E-11 .29149021E-10 -.27567962E-12 -.44865972E-10 .48584658E-11
    .10595799E-10 -.31919479E-08 -.19937738E-10 .14255509E-09 -.23770452E-02
    -.45933446E-03 -.19673179E-04 .63985161E-12 -.19675549E-04 .45933391E-03
    -.74265281E-12 -.34874105E-11 -.12587102E-11 .59687765E-09 -.12099360E-11
    -.69004494E-11 .19524343E-08
  phi_t prime for node #      2
    .17177767E-11 -.22808543E-11 -.45683561E-10 .19817016E-10 .56718933E-12
    .31514104E-09 .17463000E-11 -.27057756E-13 -.60467460E-12 .11400599E-06
    -.42543750E-05 -.11919737E-10 .42546793E-05 .10153760E-06 -.34352434E-10
    .41859459E-11 -.37080794E-11 .59234151E-04 .45504345E-11 -.70844966E-12
    .15588470E-10 .13593377E-10 .68741697E-12 .87795145E-10 -.28497036E-11
    .31909564E-13 -.69421743E-15 .38765922E-11 -.41335440E-11 -.44983453E-04
    .22473012E-05 -.13022411E-04 .41075666E-11 -.13101519E-04 -.17274113E-05
    -.98017672E-11 -.14778531E-12 -.42275125E-13 .96071643E-06 -.25440820E-11
    .54200130E-11 .41425181E-12 -.51084189E-13 .98880082E-15 .14899414E-06
    -.49351318E-14 .15066380E-14 -.42969795E-10 -.54223125E-14 .27635772E-15
    -.79851673E-11 .23444071E-06 -.40722409E-05 -.13017710E-13 .40722809E-05
    .23382333E-06 .64327760E-12 -.80030821E-11 .19070818E-11 .27557384E-13
    .67193209E-14 .15459451E-13 .15489036E-10 .28188639E-13 .15021236E-15
    .22611633E-11 -.61243211E-07 .17482812E-05 .30019490E-13 -.17482739E-05
    -.61449314E-07 -.27684414E-12
  phi_t for node #      3
    -.42404714E-02 .49480955E-03 .19835813E-08 -.36612814E-03 -.42534660E-02
    .96750031E-09 .42209027E-09 .30963712E-08 .40516924E-04 .38549281E-02
    -.52714285E-03 -.87737477E-09 .53843743E-03 .38533672E-02 -.10363838E-09
    .38623427E-08 -.71743451E-08 .24131659E-03 .31427071E-02 -.10270931E-03
    .15812594E-09 -.20969267E-03 .31373775E-02 .44642715E-09 .28790083E-09
    .88009461E-09 .18408168E-03 -.17813513E-08 -.27431844E-08 .15957166E-04
    -.19242852E-02 .34087019E-03 -.22330623E-09 .41716037E-03 .19091971E-02
    -.71605887E-10 .95016675E-09 -.81490514E-09 .32861442E-02 -.18116747E-08
    .55541036E-09 .79551900E-03 -.41608643E-08 -.26069981E-09 .94036451E-02
    .21682867E-02 -.12127210E-02 .85710915E-08 .12126479E-02 .21683282E-02
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    .41797610E-11 .67570000E-11 .20000043E-10 .51675836E-06 -.99163146E-11
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.96499772E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
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.23420782E+00				
stiffness matrix				
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.12842036E-08	-.90451014E-10	-.17520828E-09	.61166345E-10	-.19514395E-09
.20449663E-08	-.59903455E-09	.11734955E-11	-.11566431E-11	.82897331E-12
.18224390E-11	.91230355E-12	.33761495E-10	.12195177E-10	.39046523E-12
-.23182122E-12	-.45045983E-12	-.50303460E-11	-.16273291E-11	-.29563182E-03
.97595435E-02	.26340700E-09	.24106267E-09	.33302668E-07	.19099210E-09
.17684183E-09	-.21551112E-09	-.30152319E-10	-.62306491E-11	.13513914E-08
-.89381996E-08	.28259460E-11	-.90398944E-11	.13342475E-11	-.81528791E-12
-.22587225E-11	.35773535E-11	.13680596E-09	.72885717E-11	.13210152E-12
-.79094623E-12	-.24557427E-12	-.23989233E-10	-.15639020E-08	.54905123E-09
.20343024E-01	-.26079975E-09	.48565154E-08	.94600863E-09	.98901407E-10
-.64254611E-10	-.19314411E-11	-.11407272E-09	.99913434E-10	-.10561077E-08

-.12958944E-12 .94279651E-12 .10015730E-12 -.57997122E-12 .18743726E-12
-.33130988E-12 .15637630E-10 -.59105368E-12 -.93439414E-13 -.27921324E-13
.81773561E-13 -.27093940E-11 .49050780E-07 .16417779E-08 -.85207293E-09
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.43543590E+00 .14810812E-06 -.84720111E-07 .53455607E-09 -.10077465E-08
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.85943274E-09 .90728701E-09 -.29221317E-08 .50490366E-09 -.31241205E-08
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.13827771E+02 .21047759E-02 -.11938795E-06 .63495967E-08 -.28372832E-08
-.12322523E-07 .35987854E-08 .17313572E-07 .19380609E-06 .10627946E-07
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*** zeroth order terms ***

alpha

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.84068331E-10 .67994729E-09 -.13698436E-08 .62753410E-10 .11096251E-10
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.17590884E-09 .76219460E-11 -.26366890E-09 .11876573E-10 .28290161E-10
-.27201298E-10 .89869863E-12 -.15751250E-11 -.33157375E-12 .70866876E-12
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.15203202E-10 .15923719E-12 -.27557073E-12 -.68722572E-12 .78199706E-11
-.53600279E-12 .35222275E-11 -.10833770E-12 -.38667210E-11 .24012255E-12
-.22349588E-13 .72325799E-13 -.72369183E-12 .14903493E-11 .24910814E-10
.17123480E-11 .30860344E-13 .45896282E-13 .35510380E-13 -.12439625E-11
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-.81003566E-13 .43653901E-13

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h matrix

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.26295445E+00 .10634541E-02 .39837270E+00 .24038060E-01 .34138213E-02
.72810429E-01 -.66125938E-01 -.14508666E-01 -.87470672E-01 .13982584E-01
.20325687E-02 -.26138318E+00 -.13271355E-01 .17000778E-01 .16625637E-01
-.30466702E-03 .92471384E-04 -.13678233E-01 .14351589E-01 .35179758E-02
.18275688E-02 .81441214E-01 .37327408E-03 -.11565896E+00 -.94944608E-03
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.46028011E-03 .13453022E-03 .19224888E-06 .13666807E-02 .14309527E-03
-.11088438E-03 -.18934576E-03 .15159582E-02 .53961923E-05 .20500426E-02
.20016096E-03 .90999899E-05 .44426853E-03 .45524403E-04 .33906200E-05
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sl

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*** first order terms ***

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.00000000E+00	-.10551282E-01	.00000000E+00	-.40492477E+05	-.23515802E+04
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-.46893542E-10 -.63686977E-06 .54634427E-06 .37138548E-15 .86753266E-08
.74221774E-08 .46945470E-08 .16797908E-07 -.91574736E-08 .19556552E-08
.19954144E+00 .51982556E+00 .11311457E-09 -.51984922E+00 .19947944E+00
.51066096E-10 .10594211E+00 .72922176E-01 -.12741219E-07 -.76105503E-01
.10368437E+00 -.15769748E-08 .24898360E-06 -.91483883E-07 .77664092E-13
.10559694E-07 .39960159E-06 -.37782460E-06 .18891624E-06 .98396479E-08
-.89202189E-07 -.37524982E-05 .34633772E-06 -.73163584E-12 .11513953E+00
-.10016519E+01 -.10444111E-07 .98527966E+00 .21397787E+00 .14263427E-08
.15107758E-06 -.17930787E-07 -.35600382E-13 -.50741177E-06 .65700277E-07
.13810761E-12 .22036796E-08 -.72972846E-07 .18535266E-06 -.11525644E-08
-.22841308E-08 -.53271028E-07 -.43502667E-06 -.23008021E-06 .18534110E-15

-.12392972E-07 -.12119306E-08 -.18085362E-13 -.25448515E-06 -.24080342E-06
-.72100480E-15 .42365812E-01 .22743214E+00 .53395066E-09 -.22743389E+00
.42358362E-01 .13756098E-09 -.34009417E-09 -.36617465E-08 -.44502412E-08
.50488788E-08 -.25689226E-08 .32032115E-08 .14881036E-07 .20788290E-08
-.53416876E-14 .49700530E-01 .27168256E+00 .17278504E-09 .27168278E+00
-.49698521E-01 -.46204715E-10 -.72402280E-09 -.51155317E-09 .66103844E-08
-.10387562E-07 .27226537E-08 -.73095770E-08 .80583169E-06 -.12968028E-05
.14501437E-06 .10568617E-04 -.57565891E-06 -.76217949E-06 .45284969E-06
-.42741722E-07 .21249170E-12 -.13940018E+00 -.12146079E+01 .12958433E-08
.12141936E+01 -.14295856E+00 -.23050185E-09 .14240023E-05 -.16913358E-05
-.85314857E-12 -.66967927E-06 .22081894E-06 -.29618344E-06 -.20740004E-05
.23288741E-06 -.46545419E-07 .18459429E-06 -.73257490E-07 -.32197615E-13
-.12668197E-06 .19034335E-06 .24898461E-12 -.15383984E-02 .28931664E+00
-.30106500E-09 .28914783E+00 -.99735803E-02 .80529120E-11 .31921334E-09
.49233010E-09 .98795752E-14 .25448515E-06 .24080342E-06 .72100480E-15
.80857846E-09 -.65913199E-09 -.89837874E-14 -.40276693E-08 .23299565E-08
.33531355E-09 -.74204357E-08 .35521019E-08 .62833350E-08 -.82095560E-01
-.12224359E+00 -.26190706E-11 .12223122E+00 -.82113856E-01 -.75550354E-12
-.49434274E-06 .52138355E-06 -.36084625E-15 .72258733E-08 .45094717E-08
.82984545E-09 .11398262E-07 -.86245755E-08 -.84823258E-08 .20012965E+00
.34933873E+00 .29523672E-11 -.34936258E+00 .20008846E+00 -.35514320E-11
.91143541E-07 -.15942143E-06 .12557840E+00 .74044170E-07 -.11391547E-06
.46976639E+00 .13278546E-01 .52285061E-01 -.14719014E-06 -.19372121E-06
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.30146541E-08 -.35978002E-08 .45661113E-06 .36225913E-08 -.85213715E-08
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.40357060E-08 .46272789E-08 -.32747580E-08 -.41693501E-08 -.42365812E-01
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-.13190608E-09 -.42992791E-09 .53549523E-03 .44221408E-09 -.15144278E-09
-.50250104E-02 -.53621168E-07 -.78323735E-07 -.76419772E-10 .67488837E-07
-.40301963E-07 .71900559E-10 -.38245326E-02 .95707833E-02 .28472227E-09
-.26263013E-09 -.59806850E-09 .30586106E-02 -.60005167E-09 .27669342E-09
.65749091E-02 .13037445E-06 .21701737E-06 .12705909E-09 -.21430064E-06
.12189418E-06 -.18933107E-09 .16085783E-06 .84422487E-07 -.47379413E+00
.12058674E-06 .75683469E-07 .13985513E+00 -.52285564E-01 .13276810E-01
.63399074E-08 -.80698553E-07 .19053734E-06 -.77887080E-07 -.15420580E-06
.19440207E-07 -.14128991E-08 .42909184E-08 .19153162E-08 -.50616539E-07
.80313089E-08 .50214583E-08 -.13026438E+00 .15869406E-07 -.14981146E-08
.53077809E-01 .24773764E-01 .11933949E-01 -.10299928E-08 -.53522249E-09
-.18948680E-10 -.27623676E-08 .41746864E-07 -.22875467E-07 -.45437189E-07
.23699116E-07 .12256696E-08 -.39578955E-08 .86543027E-08 -.51209400E-08
.21513879E-08 .22743389E+00 -.42358362E-01 -.13756098E-09 .74204357E-08
-.35521019E-08 -.62833350E-08 -.44221408E-09 .15144278E-09 .50250104E-02
-.10011899E-08 .39672401E-09 .53548366E-03 .35302623E-07 .45619868E-07
-.18324191E-09 -.58945067E-07 .24482274E-07 -.14363279E-09 -.95706411E-02
-.38248253E-02 .52950837E-10 .80178997E-09 .17350601E-08 .65747891E-02
.17209949E-08 -.80376640E-09 -.30587738E-02 -.65962710E-07 -.12765379E-06
.24445245E-09 .13611625E-06 -.63215067E-07 .27202374E-09 .16763984E-06
.73009900E-06 -.48745525E-06 -.10506104E-05 -.54053200E-06 -.30253741E-05
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-.19692464E-01 -.11873660E-07 -.19292084E-07 -.96879863E-04 .12756037E-01
.20183313E-01 .54931006E-07 .79053746E-07 -.70869914E-06 -.84282940E-07
.69826092E-06 .93248306E-07 -.23220378E-06 -.93398544E-10 -.13727412E-09
.23093011E-07 -.84150598E-02 -.17168433E-01 -.34115338E-07 .42673819E-09
.78136072E-09 -.29073755E-01 -.13718954E-08 -.23672818E-08 .42889921E-01
.12962772E+00 .22610792E+00 .55780767E-10 .34009417E-09 .36617465E-08
.44502412E-08 .82095560E-01 .12224359E+00 .26190706E-11 .53621168E-07
.78323735E-07 .76419772E-10 -.35302623E-07 -.45619868E-07 .18324191E-09
.16412533E-11 .21384164E-11 .32021163E-03 .58936241E-11 -.14505988E-10
-.33385669E-02 -.42306378E-10 -.13863650E-08 .83012671E-08 -.56730240E-07
-.96467007E-07 -.10535633E-09 -.91711930E-07 .55460535E-07 -.51525169E-09
-.43381873E-11 -.92974491E-11 -.29258756E-02 .76083731E-11 .16981023E-11
.72526267E-02 .27553639E-06 .28304144E-05 .20161874E-06 -.21515236E-05
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.67860925E-08 -.11108030E-08 .36522737E-04 .16434235E-07 -.11524456E-07
-.19691541E-01 -.20181394E-01 .12759081E-01 -.42808564E-07 -.96353235E-10
-.81235041E-06 -.18225686E-07 .86409724E-06 .81421980E-07 -.11449558E-06
.54977989E-09 -.38611032E-09 .12072820E-07 .17167179E-01 -.84177208E-02
.13940941E-07 -.83848781E-09 .30068531E-10 .41762028E-01 .19728023E-08

-.12993543E-08	.27395597E-01	-.22608848E+00	.12966222E+00	.46893542E-10
-.50488788E-08	.25689226E-08	-.32032115E-08	-.12223122E+00	.82113856E-01
.75550354E-12	-.67488837E-07	.40301963E-07	-.71900559E-10	.58945067E-07
-.24482274E-07	.14363279E-09	-.58936241E-11	.14505988E-10	.33385669E-02
-.45134366E-09	.30239391E-09	.32020344E-03	.31906173E-09	.34199546E-11
-.81669645E-08	-.30329414E-06	-.66271809E-06	-.35363609E-09	-.66144997E-06
.30804574E-06	.20159786E-09	-.57170319E-09	-.11035564E-08	-.72527212E-02
.10976139E-08	-.57328140E-09	-.29238966E-02	.21301848E+00	.18980035E+01
.16449225E-07	-.19035792E+01	.15542683E+00	.27743136E-08	.65246642E-06
-.17160470E-06	.41382889E-12	.71710619E-08	.46661594E-06	-.20025118E-06
.22074571E-06	.15404011E-07	.27221783E-06	-.36247494E-05	.29293728E-06
.11631316E-12	-.92446699E-02	-.36511561E+00	.12675867E-07	.36422996E+00
.27036148E-01	-.14001264E-08	.34175860E-07	-.90726267E-08	-.25781137E-13
.51059035E-07	.57298172E-07	-.20698406E-13	-.54019335E-08	.52857311E-07
-.69439023E-07	-.10482756E-07	.36015513E-08	-.59618938E-07	.63686977E-06
-.54634427E-06	-.37138548E-15	-.14881036E-07	-.20788290E-08	.53416876E-14
.49434274E-06	-.52138355E-06	.36084625E-15	.38245326E-02	-.95707833E-02
-.28472227E-09	.95706411E-02	.38248253E-02	-.52950837E-10	.42306378E-10
.13863650E-08	-.83012671E-08	-.31906173E-09	-.34199546E-11	.81669645E-08
-.87485007E-08	-.13865777E-08	.21238779E-14	-.17696591E+00	-.39083612E+00
-.84602464E-10	-.39083720E+00	.17696374E+00	.30775127E-10	.12256099E-08
.79443691E-09	.63405973E-08	.15032889E-07	-.80204827E-08	.24197572E-08
.15146456E-06	.22667613E-06	.27864015E+00	.12645160E-06	.20146267E-06
.74812742E+00	.23320671E-01	.71358750E-01	-.15696020E-06	-.65869035E-07
-.31119132E-06	.19170180E-07	.28954207E-06	-.78314182E-07	-.29898828E-08
.31447785E-08	.59196241E-08	-.10223336E-07	.57668967E-08	.84437859E-08
.19320351E-01	-.48725385E-08	-.12206505E-07	.11866768E+00	.30017386E-01
.48004147E-01	.21394263E-07	-.94233533E-10	-.50069943E-09	-.11013082E-06
-.39767875E-07	-.76296204E-08	.21121434E-08	.98494637E-07	-.30215091E-07
-.83151351E-09	-.86753266E-08	-.74221774E-08	-.46945470E-08	-.49700530E-01
-.27168256E+00	-.17278504E-09	-.72258733E-08	-.45094717E-08	-.82984545E-09
.26263013E-09	.59806850E-09	-.30586106E-02	-.80178997E-09	-.17350601E-08
-.65747891E-02	.56730240E-07	.96467007E-07	.10535633E-09	.30329414E-06
.66271809E-06	.35363609E-09	.17696591E+00	.39083612E+00	.84602464E-10
.34515937E-11	.11639133E-10	.11823240E-03	.78122412E-12	-.14089096E-10
-.72836582E-02	-.46789915E-08	-.15892413E-07	.65356843E-10	.31383227E-07
.10485630E-07	.42666551E-09	.22686122E-06	-.15001301E-06	.75692354E+00
.20000508E-06	-.12631014E-06	-.30143385E+00	.71358882E-01	-.23320214E-01
.38814806E-07	.48891040E-08	.41439984E-06	.18152134E-07	-.42591726E-06
.27558297E-07	.32855064E-08	.49032229E-08	-.29885627E-08	-.83085912E-07
.83112891E-08	-.55592945E-08	.12118342E+00	-.12399628E-07	.47190946E-08
-.31250391E-01	.48004340E-01	-.30017176E-01	.16597444E-08	-.50976879E-11
.19275352E-09	-.15874235E-08	-.11553120E-06	-.45920329E-07	.21718772E-07
-.11154142E-06	.12729912E-07	.22012824E-08	-.16797908E-07	.91574736E-08
-.19556552E-08	-.27168278E+00	.49698521E-01	.46204715E-10	-.11398262E-07
.86245755E-08	.84823258E-08	.60005167E-09	-.27669342E-09	-.65749091E-02
-.17209949E-08	.80376640E-09	.30587738E-02	.91711930E-07	-.55460535E-07
.51525169E-09	.66144997E-06	-.30804574E-06	-.20159786E-09	.39083720E+00
-.17696374E+00	.30775127E-10	-.78122412E-12	.14089096E-10	.72836582E-02
-.14618963E-09	.69521649E-10	.11823684E-03	-.73228149E-08	-.29478674E-07
.22679544E-09	.44642344E-07	-.22809491E-07	.59107460E-10	-.85227134E-07
-.54382657E-06	.11012196E-05	.10593951E-05	.15030137E-05	.77536846E-05
-.47261019E-08	-.11104159E-07	.25209767E-06	.76837879E-08	.16366625E-07
.11419001E+00	.22910605E-07	.48721700E-07	.94812449E-01	-.26910936E-01
-.53138454E-01	.10396571E-06	-.37021885E-07	.17801169E-06	.12499195E-06
-.23088390E-06	.32957092E-07	.37125093E-06	-.15204283E-09	.22344016E-10
-.41855726E-07	.41887505E-02	.31354146E-01	.46431865E-07	-.44647683E-09
-.16416114E-08	.28098883E-01	.20575968E-08	.54136933E-08	-.80118470E-01
-.19954144E+00	-.51982556E+00	-.11311457E-09	.72402280E-09	.51155317E-09
-.66103844E-08	-.20012965E+00	-.34933873E+00	-.29523672E-11	-.13037445E-06
-.21701737E-06	-.12705909E-09	.65962710E-07	.12765379E-06	-.24445245E-09
.43381873E-11	.92974491E-11	.29258756E-02	.57170319E-09	.11035564E-08
.72527212E-02	-.12256099E-08	-.79443691E-09	-.63405973E-08	.46789915E-08
.15892413E-07	-.65356843E-10	.73228149E-08	.29478674E-07	-.22679544E-09
-.20205244E-11	-.39891324E-11	.87155679E-04	.84364044E-11	.86915796E-11
.68614717E-02	-.35436475E-07	-.14708492E-05	-.62332048E-06	-.10054546E-06
.52218327E-06	.39275247E-05	.82271192E-08	-.34017979E-08	.17927404E-06
-.16399263E-07	.73058140E-08	-.94493068E-01	-.48349038E-07	.22872252E-07
.11390138E+00	.53141657E-01	-.26904645E-01	.94708623E-07	.55451004E-07
.26193636E-06	-.18332552E-07	-.35360159E-06	-.28254188E-07	.38520272E-07
-.19779770E-08	.13203123E-08	-.89135235E-08	-.31354628E-01	.41849538E-02

kdyic1

rvtor1

svtor2

Bd Systems®
TCD20000222A
29 December 2000

Contract No.
NAS8-00151
Final Report

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(and more)

A.4 Concept 3 Definitions and TREETOPS files

Sensor Definitions

Actuator Definitions

Interconnect Definitions

TREETOPS files:

Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx

Vernal Equinox (VE): .int

Autumnal Equinox (AE): .int

Winter Solstice (WS): .int

Table A.4.1 Sensor Definitions (Concept 3)

Global Sensor Output No.	TREETOPS Sensor Designation	Local Sensor Output No.	Sensor Mount Loc.	Type	u s e d	DOF
RP1	SE 1	1	B2-N2	Earth Target (ET) (LOS Along X^{B2})		Pitch (Y^{B2}) Error – Overall System
RP2	SE 1	2	B2-N2			Yaw (Z^{B2}) Error – Overall System
RP3	SE 2	1	B2-N2	Star Tracker (ST) (LOS Along Z^{B2})		Roll (X^{B2}) Error – Overall System
RP4	SE 2	2	B2-N2			Not used in control (Pitch (Y^{B2}) Error)
RP5	SE 2	3	B2-N2			Not used in control (Validity Flag on(1) off(0))
RP6	SE 3	1	B3-N2	LOS Sensor (L) (LOS Along $-Y^1$) (Negative Polar Axis) see .los file		Roll (X^{B3}) Error – Upper Clamshell
RP7	SE 3	2	B3-N2			Pitch (Y^{B3}) Error – Upper Clamshell
RP8	SE 3	3	B3-N2			Yaw (Z^{B3}) Error – Upper Clamshell
RP9	SE 3	4	B3-N2			Not used in control
RP10	SE 3	5	B3-N2			Not used in control
RP11	SE 3	6	B3-N2			Not used in control
RP12	SE 3	7	B3-N2			Not used in control
RP13	SE 4	1	B4-N2	LOS Sensor (L) (LOS Along $+Y^1$) (Positive Polar Axis) see .los file		Roll (X^{B4}) Error – Lower Clamshell
RP14	SE 4	2	B4-N2			Pitch (Y^{B4}) Error – Lower Clamshell
RP15	SE 4	3	B4-N2			Yaw (Z^{B4}) Error – Lower Clamshell
RP16	SE 4	4	B4-N2			Not used in control
RP 17	SE 4	5	B4-N2			Not used in control
RP 18	SE 4	6	B4-N2			Not used in control
RP 19	SE 4	7	B4-N2			Not used in control
RP 20	SE 5	1	B2-N5	Star Tracker (ST) (LOS Along $-X^{B2}$) (Towards Sun)		Not used in control (Yaw (Z^{B2}) Error)
RP 21	SE 5	2	B2-N5			Not used in control (Pitch (Y^{B2}) Error)
RP 22	SE 5	3	B2-N5		///	Validity Flag on(1) off(0) Used for Rad Pres Disturb
RP 23	SE 6	1	B2-N2	3 Axis Accelerometer (A3) with gravity removed		Not used in control, For Output Only, ACCEL (X^{B2})
RP 24	SE 6	2	B2-N2			Not used in control, For Output Only, ACCEL (Y^{B2})
RP 25	SE 6	3	B2-N2			Not used in control, For Output Only, ACCEL (Z^{B2})
RP 26	SE 7	1	B2-N2	1 Axis Accelerometer (AC) with gravity removed		Not used in control, For Output Only, ACCEL (X^{B2})

Table A.4.2 Actuator Definitions (Concept 3)

Global Actuator Input No.	TREETOPS Actuator Designation	Sensor Mount Loc.	Type	DOF
UP 1	AC 1	B2-N2	Moment Actuator (MO)*	Pitch (Y^{B2}) Ext. Torque – Overall System
UP 2	AC 2	B2-N2	Moment Actuator (MO)*	Yaw (Z^{B2}) Ext. Torque – Overall System
UP 3	AC 3	B2-N2	Moment Actuator (MO)*	Roll (X^{B2}) Ext. Torque – Overall System
UP 4	AC 4	B3-N2	Moment Actuator (MO)*	Roll (X^{B3}) Ext. Torque – Upper Clamshell
UP 5	AC 5	B3-N2	Moment Actuator (MO)*	Pitch (Y^{B3}) Ext. Torque – Upper Clamshell
UP 6	AC 6	B3-N2	Moment Actuator (MO)*	Yaw (Z^{B3}) Ext. Torque – Upper Clamshell
UP 7	AC 7	B4-N2	Moment Actuator (MO)*	Roll (X^{B4}) Ext. Torque – Lower Clamshell
UP 8	AC 8	B4-N2	Moment Actuator (MO)*	Pitch (Y^{B4}) Ext. Torque – Lower Clamshell
UP 9	AC 9	B4-N2	Moment Actuator (MO)*	Yaw (Z^{B4}) Ext. Torque – Lower Clamshell
UP 10	AC 10	B2-N5	Reaction Jet (J) Radiation Pressure Disturbance	$-X^{B2}$ Force at Central Body Transmitter
Notes: * Moment Actuator (MO) in TREETOPS is an External Moment applied to a Body (Reacts against Space) Used in Control				

Table A.4.3:
Interconnect Data and Significant Parameters for
TREETOPS Continuous Matrix (CM) Controller
(Concept 3)

Interconnect Data					Significant Parameters in Continuous Matrix (CM) Controller in .lin file $\dot{x} = Ax + Bu$ $y = Cx + Du$				
Inter- connect	Description	S C C A	S No. C No. C No. A No.	S Out No. C In No. C Out No. A In No.	Gain N-m or N	Subset of A Matrix	Subset of B Matrix	Subset of C Matrix ω^2 $2\zeta\omega$	Subset of D Matrix
IC 1	Pitch (Y^{B2}) of Overall System	S	1	1	4.41E13	0. 1.	0	.000025 .007	0
		C	1	1					
IC 2		C	1	1	1.0	-1. -1.4	1		
		A	1	1					
IC 3	Yaw (Z^{B2}) of Overall System	S	1	2	1.67E12	0. 1.	0	.000025 .007	0
		C	1	2					
IC 4		C	1	2	1.0	-1. -1.4	1		
		A	2	1					
IC 5	Roll (X^{B2}) of Overall System	S	2	1	4.31E13	0. 1.	0	.000025 .007	0
		C	1	3					
IC 6		C	1	3	1.0	-1. -1.4	1		
		A	3	1					
IC 7	Roll (X^{B3}) of Upper Clamshell	S	3	1	1.7E12	0. 1.	0	.0001 .014	0
		C	1	4					
IC 8		C	1	4	1.0	-1. -1.4	1		
		A	4	1					
IC 9	Pitch (Y^{B3}) of Upper Clamshell	S	3	2	1.7E12	0. 1.	0	.0001 .014	0
		C	1	5					
IC 10		C	1	5	1.0	-1. -1.4	1		
		A	5	1					
IC 11	Yaw (Z^{B3}) of Upper Clamshell	S	3	3	3.4E12	0. 1.	0	.0001 .014	0
		C	1	6					
IC 12		C	1	6	1.0	-1. -1.4	1		
		A	6	1					
IC 13	Roll (X^{B4}) of Lower Clamshell	S	4	1	1.7E12	0. 1.	0	.0001 .014	0
		C	1	7					
IC 14		C	1	7	1.0	-1. -1.4	1		
		A	7	1					
IC 15	Pitch (Y^{B4}) of Lower Clamshell	S	4	2	1.7E12	0. 1.	0	.0001 .014	0
		C	1	8					
IC 16		C	1	8	1.0	-1. -1.4	1		
		A	8	1					
IC 17	Yaw (Z^{B4}) of Lower Clamshell	S	4	3	3.4E12	0. 1.	0	.0001 .014	0
		C	1	9					
IC 18		C	1	9	1.0	-1. -1.4	1		
		A	9	1					
IC 19	$-X^{B2}$ of Radiation Pres Disturb	S	5	3	7.0				
		A	10	1					

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SIM CONTROL

1 SI	0 Title	ISC MODEL, THIRD VERSION
2 SI	0 Simulation stop time	100000
3 SI	0 Plot data interval	20
4 SI	0 Integration type (R,S,U, OR V)	R
5 SI	0 Step size (sec)	.1
6 SI	0 Sandia ODE solver absolute and relative error	
7 SI	0 RK78 ODE solver absolute error and first step size	
8 SI	0 Linearization option (L,Z or N)	N
9 SI	0 Restart option (Y/N)	N
10 SI	0 Contact force computation option (Y/N)	Y
11 SI	0 Constraint force computation option (Y/N)	N
12 SI	0 Small angle speedup option (All,Bypass,First,Nth)	A
13 SI	0 Mass matrix speedup option (All,Bypass,First,Nth)	A
14 SI	0 Non-Linear speedup option (All,Bypass,First,Nth)	A
15 SI	0 Constraint speedup option (All,Bypass,First,Nth)	A
16 SI	0 Constraint stabilization option (Y/N)	N
17 SI	0 Stabilization epsilon	

GENGRAV

18 GG	0 Gravity, earth sphere/nonsphere/user (S/N/U)?	N
19 GG	1 Input gravity constants: GME, ERAD, EMASS	
20 GG	1 Spherical or Nonspherical (S/N)?	
21 GG	1 Gravity Potential Harmonics J2,J3,J4	
22 GG	0 English (ft-slug-s) or metric (m-kg-s) (E/M)?	M
23 GG	0 Day, Month, Year,	21 6 2020
24 GG	0 GMT @ sim time 0 (minutes past midnight,	0
25 GG	0 Solar Pressure forces Y/N?	Y
26 GG	0 Input new data for aero model? (Y/N)	N
27 GG	1 Solar flux F10 for aero model	
28 GG	1 Solar flux, 81 day average F10B	
29 GG	1 Geomagnetic index, GEAP	

BODY

30 BO	1 Body ID number	1
31 BO	1 Type (Rigid,Flexible,NASTRAN)	F
32 BO	1 Number of modes	24
33 BO	1 Modal calculation option (0, 1 or 2)	2
34 BO	1 Foreshortening option (Y/N)	
35 BO	1 Model reduction method (NO,MS,MC,CC,QM,CV)	
36 BO	1 NASTRAN data file FORTRAN unit number (40 - 60)	
37 BO	1 Number of augmented nodes (0 if none)	
38 BO	1 Damping matrix option (NS,CD,HL,SD)	
39 BO	1 Constant damping ratio	
40 BO	1 Low frequency, High frequency ratios	
41 BO	1 Mode ID number, damping ratio	
42 BO	1 Conversion factors: Length,Mass,Force	
43 BO	1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
44 BO	1 Moments of inertia (kg-m2) Ixx,Iyy,Izz	6.2852173E11 6.2852173E11
6.7057352E8		
45 BO	1 Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
46 BO	1 Mass (kg)	1.6168633E5
47 BO	1 Number of Nodes	4
48 BO	1 Node ID, Node coord. (meters) x,y,z	1 0 0 0
49 BO	1 Node ID, Node coord. (meters) x,y,z	2 0 0 0
50 BO	1 Node ID, Node coord. (meters) x,y,z	3 0 0 3188.8
51 BO	1 Node ID, Node coord. (meters) x,y,z	4 0 0 -3188.8
52 BO	1 Node ID, Node structural joint ID	
53 BO	2 Body ID number	2

54 BO	2	Type (Rigid,Flexible,NASTRAN)	R	
55 BO	2	Number of modes		
56 BO	2	Modal calculation option (0, 1 or 2)		
57 BO	2	Foreshortening option (Y/N)		
58 BO	2	Model reduction method (NO,MS,MC,CC,QM,CV)		
59 BO	2	NASTRAN data file FORTRAN unit number (40 - 60)		
60 BO	2	Number of augmented nodes (0 if none)		
61 BO	2	Damping matrix option (NS,CD,HL,SD)		
62 BO	2	Constant damping ratio		
63 BO	2	Low frequency, High frequency ratios		
64 BO	2	Mode ID number, damping ratio		
65 BO	2	Conversion factors: Length,Mass,Force		
66 BO	2	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1	
67 BO	2	Moments of inertia (kg-m2) Ixx,Iyy,Izz		.8543E12 1.5601E12
1.3822E12				
68 BO	2	Products of inertia (kg-m2) Ixy,Ixz,Iyz		0 0 0
69 BO	2	Mass (kg)		12666300
70 BO	2	Number of Nodes		5
71 BO	2	Node ID, Node coord. (meters) x,y,z		1 298.323 0 0
72 BO	2	Node ID, Node coord. (meters) x,y,z		2 0 0 0
73 BO	2	Node ID, Node coord. (meters) x,y,z		3 0 0 300
74 BO	2	Node ID, Node coord. (meters) x,y,z		4 0 0 -300
75 BO	2	Node ID, Node coord. (meters) x,y,z		5 500 0 0
76 BO	2	Node ID, Node structural joint ID		
77 BO	3	Body ID number	3	
78 BO	3	Type (Rigid,Flexible,NASTRAN)	R	
79 BO	3	Number of modes		
80 BO	3	Modal calculation option (0, 1 or 2)		
81 BO	3	Foreshortening option (Y/N)		
82 BO	3	Model reduction method (NO,MS,MC,CC,QM,CV)		
83 BO	3	NASTRAN data file FORTRAN unit number (40 - 60)		
84 BO	3	Number of augmented nodes (0 if none)		
85 BO	3	Damping matrix option (NS,CD,HL,SD)		
86 BO	3	Constant damping ratio		
87 BO	3	Low frequency, High frequency ratios		
88 BO	3	Mode ID number, damping ratio		
89 BO	3	Conversion factors: Length,Mass,Force		
90 BO	3	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1	
91 BO	3	Moments of inertia (kg-m2) Ixx,Iyy,Izz		1.7E12 1.7E12 3.4E12
92 BO	3	Products of inertia (kg-m2) Ixy,Ixz,Iyz		0 0 0
93 BO	3	Mass (kg)		2046600
94 BO	3	Number of Nodes		2
95 BO	3	Node ID, Node coord. (meters) x,y,z		1 0 0 0
96 BO	3	Node ID, Node coord. (meters) x,y,z		2 0 0 0
97 BO	3	Node ID, Node structural joint ID		
98 BO	4	Body ID number	4	
99 BO	4	Type (Rigid,Flexible,NASTRAN)	R	
100 BO	4	Number of modes		
101 BO	4	Modal calculation option (0, 1 or 2)		
102 BO	4	Foreshortening option (Y/N)		
103 BO	4	Model reduction method (NO,MS,MC,CC,QM,CV)		
104 BO	4	NASTRAN data file FORTRAN unit number (40 - 60)		
105 BO	4	Number of augmented nodes (0 if none)		
106 BO	4	Damping matrix option (NS,CD,HL,SD)		
107 BO	4	Constant damping ratio		
108 BO	4	Low frequency, High frequency ratios		
109 BO	4	Mode ID number, damping ratio		
110 BO	4	Conversion factors: Length,Mass,Force		
111 BO	4	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1	
112 BO	4	Moments of inertia (kg-m2) Ixx,Iyy,Izz		1.7E12 1.7E12 3.4E12
113 BO	4	Products of inertia (kg-m2) Ixy,Ixz,Iyz		0 0 0
114 BO	4	Mass (kg)		2046600
115 BO	4	Number of Nodes		2
116 BO	4	Node ID, Node coord. (meters) x,y,z		1 0 0 0
117 BO	4	Node ID, Node coord. (meters) x,y,z		2 0 0 0
118 BO	4	Node ID, Node structural joint ID		

HINGE

119 HI	1 Hinge ID number	1
120 HI	1 Inboard body ID, Outboard body ID	0 1
121 HI	1 "p" node ID, "q" node ID	0 2
122 HI	1 Number of rotation DOFs, Rotation option (F or G)	3 F
123 HI	1 L1 unit vector in inboard body coord. x,y,z	1 0 0
124 HI	1 L1 unit vector in outboard body coord. x,y,z	1 0 0
125 HI	1 L2 unit vector in inboard body coord. x,y,z	
126 HI	1 L2 unit vector in outboard body coord. x,y,z	
127 HI	1 L3 unit vector in inboard body coord. x,y,z	0 0 1
128 HI	1 L3 unit vector in outboard body coord. x,y,z	0 0 1
129 HI	1 Initial rotation angles (deg)	-90 0 90
130 HI	1 Initial rotation rates (deg/sec)	0 0 0.00417807
131 HI	1 Rotation stiffness (newton-meters/rad)	0 0 0
132 HI	1 Rotation damping (newton-meters/rad/sec)	0 0 0
133 HI	1 Null torque angles (deg)	0 0 0
134 HI	1 Number of translation DOFs	3
135 HI	1 First translation unit vector g1	1 0 0
136 HI	1 Second translation unit vector g2	0 1 0
137 HI	1 Third translation unit vector g3	0 0 1
138 HI	1 Initial translation (meters)	0 0 42163421
139 HI	1 Initial translation velocity (meters/sec)	3074.681 0 0
140 HI	1 Translation stiffness (newtons/meters)	0 0 0
141 HI	1 Translation damping (newtons/meter/sec)	0 0 0
142 HI	1 Null force translations	0 0 0
143 HI	2 Hinge ID number	2
144 HI	2 Inboard body ID, Outboard body ID	1 2
145 HI	2 "p" node ID, "q" node ID	2 2
146 HI	2 Number of rotation DOFs	0
147 HI	2 L1 unit vector in inboard body coord. x,y,z	0 0 1
148 HI	2 L1 unit vector in outboard body coord. x,y,z	0 0 1
149 HI	2 L2 unit vector in inboard body coord. x,y,z	
150 HI	2 L2 unit vector in outboard body coord. x,y,z	
151 HI	2 L3 unit vector in inboard body coord. x,y,z	1 0 0
152 HI	2 L3 unit vector in outboard body coord. x,y,z	1 0 0
153 HI	2 Initial rotation angles (deg)	0 0 0
154 HI	2 Initial rotation rates (deg/sec)	
155 HI	2 Rotation stiffness (newton-meters/rad)	
156 HI	2 Rotation damping (newton-meters/rad/sec)	
157 HI	2 Null torque angles (deg)	
158 HI	2 Number of translation DOFs	0
159 HI	2 First translation unit vector g1	1 0 0
160 HI	2 Second translation unit vector g2	0 1 0
161 HI	2 Third translation unit vector g3	0 0 1
162 HI	2 Initial translation (meters)	0 0 0
163 HI	2 Initial translation velocity (meters/sec)	
164 HI	2 Translation stiffness (newtons/meters)	
165 HI	2 Translation damping (newtons/meter/sec)	
166 HI	2 Null force translations	
167 HI	3 Hinge ID number	3
168 HI	3 Inboard body ID, Outboard body ID	1 3
169 HI	3 "p" node ID, "q" node ID	3 2
170 HI	3 Number of rotation DOFs	3
171 HI	3 L1 unit vector in inboard body coord. x,y,z	0 0 1
172 HI	3 L1 unit vector in outboard body coord. x,y,z	0 0 1
173 HI	3 L2 unit vector in inboard body coord. x,y,z	
174 HI	3 L2 unit vector in outboard body coord. x,y,z	
175 HI	3 L3 unit vector in inboard body coord. x,y,z	0 1 0
176 HI	3 L3 unit vector in outboard body coord. x,y,z	0 1 0
177 HI	3 Initial rotation angles (deg)	90 0 -123.25
178 HI	3 Initial rotation rates (deg/sec)	-0.004178 0 0
179 HI	3 Rotation stiffness (newton-meters/rad)	0 0 0
180 HI	3 Rotation damping (newton-meters/rad/sec)	0 0 0
181 HI	3 Null torque angles (deg)	0 0 0
182 HI	3 Number of translation DOFs	0
183 HI	3 First translation unit vector g1	1 0 0
184 HI	3 Second translation unit vector g2	0 1 0
185 HI	3 Third translation unit vector g3	0 0 1
186 HI	3 Initial translation (meters)	0 0 0

187 HI	3	Initial translation velocity (meters/sec)	
188 HI	3	Translation stiffness (newtons/meters)	
189 HI	3	Translation damping (newtons/meter/sec)	
190 HI	3	Null force translations	
191 HI	4	Hinge ID number	4
192 HI	4	Inboard body ID, Outboard body ID	1 4
193 HI	4	"p" node ID, "q" node ID	4 2
194 HI	4	Number of rotation DOFs	3
195 HI	4	L1 unit vector in inboard body coord. x,y,z	0 0 1
196 HI	4	L1 unit vector in outboard body coord. x,y,z	0 0 1
197 HI	4	L2 unit vector in inboard body coord. x,y,z	
198 HI	4	L2 unit vector in outboard body coord. x,y,z	
199 HI	4	L3 unit vector in inboard body coord. x,y,z	0 1 0
200 HI	4	L3 unit vector in outboard body coord. x,y,z	0 1 0
201 HI	4	Initial rotation angles (deg)	90 0 -33.25
202 HI	4	Initial rotation rates (deg/sec)	-0.004178 0 0
203 HI	4	Rotation stiffness (newton-meters/rad)	0 0 0
204 HI	4	Rotation damping (newton-meters/rad/sec)	0 0 0
205 HI	4	Null torque angles (deg)	0 0 0
206 HI	4	Number of translation DOFs	0
207 HI	4	First translation unit vector g1	1 0 0
208 HI	4	Second translation unit vector g2	0 1 0
209 HI	4	Third translation unit vector g3	0 0 1
210 HI	4	Initial translation (meters)	0 0 0
211 HI	4	Initial translation velocity (meters/sec)	
212 HI	4	Translation stiffness (newtons/meters)	
213 HI	4	Translation damping (newtons/meter/sec)	
214 HI	4	Null force translations	

SENSOR

215 SE	1	Sensor ID number	1
216 SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET
217 SE	1	Mounting point body ID, Mounting point node ID	2 2
218 SE	1	Second mounting point body ID, Second node ID	
219 SE	1	Input axis unit vector (IA) x,y,z	
220 SE	1	Mounting point Hinge index, Axis index	
221 SE	1	First focal plane unit vector (Fp1) x,y,z	0 0 -1
222 SE	1	Second focal plane unit vector (Fp2) x,y,z	0 1 0
223 SE	1	Sun/Star unit vector (Us) x,y,z	
224 SE	1	Velocity Aberration Option (Y/N)	
225 SE	1	Euler Angle Sequence (1-6)	
226 SE	1	CMG ID number and Gimbal number	
227 SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	6378000 0 0 4.178074D-3
228 SE	2	Sensor ID number	2
229 SE	2	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
230 SE	2	Mounting point body ID, Mounting point node ID	2 2
231 SE	2	Second mounting point body ID, Second node ID	
232 SE	2	Input axis unit vector (IA) x,y,z	
233 SE	2	Mounting point Hinge index, Axis index	
234 SE	2	First focal plane unit vector (Fp1) x,y,z	0 -1 0
235 SE	2	Second focal plane unit vector (Fp2) x,y,z	1 0 0
236 SE	2	Sun/Star unit vector (Us) x,y,z	0 1 0
237 SE	2	Velocity Aberration Option (Y/N)	N
238 SE	2	Euler Angle Sequence (1-6)	
239 SE	2	CMG ID number and Gimbal number	
240 SE	2	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
241 SE	3	Sensor ID number	3
242 SE	3	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	L
243 SE	3	Mounting point body ID, Mounting point node ID	3 2
244 SE	3	Second mounting point body ID, Second node ID	
245 SE	3	Input axis unit vector (IA) x,y,z	1 2 3
246 SE	3	Mounting point Hinge index, Axis index	
247 SE	3	First focal plane unit vector (Fp1) x,y,z	
248 SE	3	Second focal plane unit vector (Fp2) x,y,z	
249 SE	3	Sun/Star unit vector (Us) x,y,z	
250 SE	3	Velocity Aberration Option (Y/N)	

251 SE	3 Euler Angle Sequence (1-6)	
252 SE	3 CMG ID number and Gimbal number	
253 SE	3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
254 SE	4 Sensor ID number	4
255 SE	4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	L
256 SE	4 Mounting point body ID, Mounting point node ID	4 2
257 SE	4 Second mounting point body ID, Second node ID	
258 SE	4 Input axis unit vector (IA) x,y,z	3 2 1
259 SE	4 Mounting point Hinge index, Axis index	
260 SE	4 First focal plane unit vector (Fp1) x,y,z	
261 SE	4 Second focal plane unit vector (Fp2) x,y,z	
262 SE	4 Sun/Star unit vector (Us) x,y,z	
263 SE	4 Velocity Aberration Option (Y/N)	
264 SE	4 Euler Angle Sequence (1-6)	
265 SE	4 CMG ID number and Gimbal number	
266 SE	4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
267 SE	5 Sensor ID number	5
268 SE	5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
269 SE	5 Mounting point body ID, Mounting point node ID	2 5
270 SE	5 Second mounting point body ID, Second node ID	
271 SE	5 Input axis unit vector (IA) x,y,z	
272 SE	5 Mounting point Hinge index, Axis index	
273 SE	5 First focal plane unit vector (Fp1) x,y,z	0 0 1
274 SE	5 Second focal plane unit vector (Fp2) x,y,z	0 -1 0
275 SE	5 Sun/Star unit vector (Us) x,y,z	0 0 0
276 SE	5 Velocity Aberration Option (Y/N)	N
277 SE	5 Euler Angle Sequence (1-6)	
278 SE	5 CMG ID number and Gimbal number	
279 SE	5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
280 SE	6 Sensor ID number	6
281 SE	6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	A3
282 SE	6 Mounting point body ID, Mounting point node ID	2 2
283 SE	6 Second mounting point body ID, Second node ID	
284 SE	6 Input axis unit vector (IA) x,y,z	
285 SE	6 Mounting point Hinge index, Axis index	
286 SE	6 First focal plane unit vector (Fp1) x,y,z	
287 SE	6 Second focal plane unit vector (Fp2) x,y,z	
288 SE	6 Sun/Star unit vector (Us) x,y,z	
289 SE	6 Velocity Aberration Option (Y/N)	
290 SE	6 Euler Angle Sequence (1-6)	
291 SE	6 CMG ID number and Gimbal number	
292 SE	6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
293 SE	7 Sensor ID number	7
294 SE	7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	AC
295 SE	7 Mounting point body ID, Mounting point node ID	2 2
296 SE	7 Second mounting point body ID, Second node ID	
297 SE	7 Input axis unit vector (IA) x,y,z	1 0 0
298 SE	7 Mounting point Hinge index, Axis index	
299 SE	7 First focal plane unit vector (Fp1) x,y,z	
300 SE	7 Second focal plane unit vector (Fp2) x,y,z	
301 SE	7 Sun/Star unit vector (Us) x,y,z	
302 SE	7 Velocity Aberration Option (Y/N)	
303 SE	7 Euler Angle Sequence (1-6)	
304 SE	7 CMG ID number and Gimbal number	
305 SE	7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
ACTR		
306 AC	1 Actuator ID number	1
307 AC	1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
308 AC	1 Actuator location; Node or Hinge (N or H)	
309 AC	1 Mounting point body ID number, node ID number	2 2
310 AC	1 Second mounting point body ID, second node ID	
311 AC	1 Output axis unit vector x,y,z	0 1 0
312 AC	1 Mounting point Hinge index, Axis index	
313 AC	1 Rotor spin axis unit vector x,y,z	

314 AC	1 Initial rotor momentum, H	
315 AC	1 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)	
316 AC	1 Outer gimbal axis unit vector x,y,z	
317 AC	1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
318 AC	1 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)	
319 AC	1 Inner gimbal axis unit vector x,y,z	
320 AC	1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
321 AC	1 Initial length and rate, y(to) and ydot(to)	
322 AC	1 Constants; K1 or wo, n or zeta, Kg, Jm	
323 AC	1 Non-linearities; TLim, Tco, Dz	
324 AC	2 Actuator ID number	2
325 AC	2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
326 AC	2 Actuator location; Node or Hinge (N or H)	
327 AC	2 Mounting point body ID number, node ID number	2 2
328 AC	2 Second mounting point body ID, second node ID	
329 AC	2 Output axis unit vector x,y,z	0 0 1
330 AC	2 Mounting point Hinge index, Axis index	
331 AC	2 Rotor spin axis unit vector x,y,z	
332 AC	2 Initial rotor momentum, H	
333 AC	2 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)	
334 AC	2 Outer gimbal axis unit vector x,y,z	
335 AC	2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
336 AC	2 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)	
337 AC	2 Inner gimbal axis unit vector x,y,z	
338 AC	2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
339 AC	2 Initial length and rate, y(to) and ydot(to)	
340 AC	2 Constants; K1 or wo, n or zeta, Kg, Jm	
341 AC	2 Non-linearities; TLim, Tco, Dz	
342 AC	3 Actuator ID number	3
343 AC	3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
344 AC	3 Actuator location; Node or Hinge (N or H)	
345 AC	3 Mounting point body ID number, node ID number	2 2
346 AC	3 Second mounting point body ID, second node ID	
347 AC	3 Output axis unit vector x,y,z	1 0 0
348 AC	3 Mounting point Hinge index, Axis index	
349 AC	3 Rotor spin axis unit vector x,y,z	
350 AC	3 Initial rotor momentum, H	
351 AC	3 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)	
352 AC	3 Outer gimbal axis unit vector x,y,z	
353 AC	3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
354 AC	3 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)	
355 AC	3 Inner gimbal axis unit vector x,y,z	
356 AC	3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
357 AC	3 Initial length and rate, y(to) and ydot(to)	
358 AC	3 Constants; K1 or wo, n or zeta, Kg, Jm	
359 AC	3 Non-linearities; TLim, Tco, Dz	
360 AC	4 Actuator ID number	4
361 AC	4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
362 AC	4 Actuator location; Node or Hinge (N or H)	
363 AC	4 Mounting point body ID number, node ID number	3 2
364 AC	4 Second mounting point body ID, second node ID	
365 AC	4 Output axis unit vector x,y,z	1 0 0
366 AC	4 Mounting point Hinge index, Axis index	
367 AC	4 Rotor spin axis unit vector x,y,z	
368 AC	4 Initial rotor momentum, H	
369 AC	4 Outer gimbal- angle(deg), inertia, friction(D,S,B,N)	
370 AC	4 Outer gimbal axis unit vector x,y,z	
371 AC	4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
372 AC	4 Inner gimbal- angle(deg), inertia, friction(D,S,B,N)	
373 AC	4 Inner gimbal axis unit vector x,y,z	
374 AC	4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
375 AC	4 Initial length and rate, y(to) and ydot(to)	
376 AC	4 Constants; K1 or wo, n or zeta, Kg, Jm	
377 AC	4 Non-linearities; TLim, Tco, Dz	
378 AC	5 Actuator ID number	5
379 AC	5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
380 AC	5 Actuator location; Node or Hinge (N or H)	

381 AC	5 Mounting point body ID number, node ID number	3 2
382 AC	5 Second mounting point body ID, second node ID	
383 AC	5 Output axis unit vector x,y,z	0 1 0
384 AC	5 Mounting point Hinge index, Axis index	
385 AC	5 Rotor spin axis unit vector x,y,z	
386 AC	5 Initial rotor momentum, H	
387 AC	5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
388 AC	5 Outer gimbal axis unit vector x,y,z	
389 AC	5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
390 AC	5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
391 AC	5 Inner gimbal axis unit vector x,y,z	
392 AC	5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
393 AC	5 Initial length and rate, y(to) and ydot(to)	
394 AC	5 Constants; K1 or wo, n or zeta, Kg, Jm	
395 AC	5 Non-linearities; TLim, Tco, Dz	
396 AC	6 Actuator ID number	6
397 AC	6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
398 AC	6 Actuator location; Node or Hinge (N or H)	
399 AC	6 Mounting point body ID number, node ID number	3 2
400 AC	6 Second mounting point body ID, second node ID	
401 AC	6 Output axis unit vector x,y,z	0 0 1
402 AC	6 Mounting point Hinge index, Axis index	
403 AC	6 Rotor spin axis unit vector x,y,z	
404 AC	6 Initial rotor momentum, H	
405 AC	6 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
406 AC	6 Outer gimbal axis unit vector x,y,z	
407 AC	6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
408 AC	6 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
409 AC	6 Inner gimbal axis unit vector x,y,z	
410 AC	6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
411 AC	6 Initial length and rate, y(to) and ydot(to)	
412 AC	6 Constants; K1 or wo, n or zeta, Kg, Jm	
413 AC	6 Non-linearities; TLim, Tco, Dz	
414 AC	7 Actuator ID number	7
415 AC	7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
416 AC	7 Actuator location; Node or Hinge (N or H)	
417 AC	7 Mounting point body ID number, node ID number	4 2
418 AC	7 Second mounting point body ID, second node ID	
419 AC	7 Output axis unit vector x,y,z	1 0 0
420 AC	7 Mounting point Hinge index, Axis index	
421 AC	7 Rotor spin axis unit vector x,y,z	
422 AC	7 Initial rotor momentum, H	
423 AC	7 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
424 AC	7 Outer gimbal axis unit vector x,y,z	
425 AC	7 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
426 AC	7 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
427 AC	7 Inner gimbal axis unit vector x,y,z	
428 AC	7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
429 AC	7 Initial length and rate, y(to) and ydot(to)	
430 AC	7 Constants; K1 or wo, n or zeta, Kg, Jm	
431 AC	7 Non-linearities; TLim, Tco, Dz	
432 AC	8 Actuator ID number	8
433 AC	8 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
434 AC	8 Actuator location; Node or Hinge (N or H)	
435 AC	8 Mounting point body ID number, node ID number	4 2
436 AC	8 Second mounting point body ID, second node ID	
437 AC	8 Output axis unit vector x,y,z	0 1 0
438 AC	8 Mounting point Hinge index, Axis index	
439 AC	8 Rotor spin axis unit vector x,y,z	
440 AC	8 Initial rotor momentum, H	
441 AC	8 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
442 AC	8 Outer gimbal axis unit vector x,y,z	
443 AC	8 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
444 AC	8 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
445 AC	8 Inner gimbal axis unit vector x,y,z	
446 AC	8 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
447 AC	8 Initial length and rate, y(to) and ydot(to)	
448 AC	8 Constants; K1 or wo, n or zeta, Kg, Jm	

449 AC 8 Non-linearities; TLim, Tco, Dz

450 AC 9 Actuator ID number 9
451 AC 9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) MO
452 AC 9 Actuator location; Node or Hinge (N or H)
453 AC 9 Mounting point body ID number, node ID number 4 2
454 AC 9 Second mounting point body ID, second node ID
455 AC 9 Output axis unit vector x,y,z 0 0 1
456 AC 9 Mounting point Hinge index, Axis index
457 AC 9 Rotor spin axis unit vector x,y,z
458 AC 9 Initial rotor momentum, H
459 AC 9 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
460 AC 9 Outer gimbal axis unit vector x,y,z
461 AC 9 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
462 AC 9 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
463 AC 9 Inner gimbal axis unit vector x,y,z
464 AC 9 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
465 AC 9 Initial length and rate, y(to) and ydot(to)
466 AC 9 Constants; K1 or wo, n or zeta, Kg, Jm
467 AC 9 Non-linearities; TLim, Tco, Dz

468 AC 10 Actuator ID number 10
469 AC 10 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US) J
470 AC 10 Actuator location; Node or Hinge (N or H)
471 AC 10 Mounting point body ID number, node ID number 2 5
472 AC 10 Second mounting point body ID, second node ID
473 AC 10 Output axis unit vector x,y,z -1 0 0
474 AC 10 Mounting point Hinge index, Axis index
475 AC 10 Rotor spin axis unit vector x,y,z
476 AC 10 Initial rotor momentum, H
477 AC 10 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
478 AC 10 Outer gimbal axis unit vector x,y,z
479 AC 10 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
480 AC 10 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
481 AC 10 Inner gimbal axis unit vector x,y,z
482 AC 10 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
483 AC 10 Initial length and rate, y(to) and ydot(to)
484 AC 10 Constants; K1 or wo, n or zeta, Kg, Jm
485 AC 10 Non-linearities; TLim, Tco, Dz

CONTROLLER

486 CO 1 Controller ID number 1
487 CO 1 Controller type (CB,CM,DB,DM,UC,UD) CM
488 CO 1 Sample time (sec)
489 CO 1 Number of inputs, Number of outputs 9 9
490 CO 1 Number of states
491 CO 1 Output No., Input type (I,S,T), Input ID, Gain

INTERCONNECT

492 IN 1 Interconnect ID number 1
493 IN 1 Source type(S,C, or F),Source ID,Source row # S 1 1
494 IN 1 Destination type(A or C),Dest ID,Dest row # C 1 1
495 IN 1 Gain 4.41E13

496 IN 2 Interconnect ID number 2
497 IN 2 Source type(S,C, or F),Source ID,Source row # C 1 1
498 IN 2 Destination type(A or C),Dest ID,Dest row # A 1 1
499 IN 2 Gain 1

500 IN 3 Interconnect ID number 3
501 IN 3 Source type(S,C, or F),Source ID,Source row # S 1 2
502 IN 3 Destination type(A or C),Dest ID,Dest row # C 1 2
503 IN 3 Gain 1.67E12

504 IN 4 Interconnect ID number 4
505 IN 4 Source type(S,C, or F),Source ID,Source row # C 1 2
506 IN 4 Destination type(A or C),Dest ID,Dest row # A 2 1

507 IN	4 Gain	1
508 IN	5 Interconnect ID number	5
509 IN	5 Source type(S,C, or F),Source ID,Source row #	S 2 1
510 IN	5 Destination type(A or C),Dest ID,Dest row #	C 1 3
511 IN	5 Gain	4.31E13
512 IN	6 Interconnect ID number	6
513 IN	6 Source type(S,C, or F),Source ID,Source row #	C 1 3
514 IN	6 Destination type(A or C),Dest ID,Dest row #	A 3 1
515 IN	6 Gain	1
516 IN	7 Interconnect ID number	7
517 IN	7 Source type(S,C, or F),Source ID,Source row #	S 3 1
518 IN	7 Destination type(A or C),Dest ID,Dest row #	C 1 4
519 IN	7 Gain	1.7E12
520 IN	8 Interconnect ID number	8
521 IN	8 Source type(S,C, or F),Source ID,Source row #	C 1 4
522 IN	8 Destination type(A or C),Dest ID,Dest row #	A 4 1
523 IN	8 Gain	1
524 IN	9 Interconnect ID number	9
525 IN	9 Source type(S,C, or F),Source ID,Source row #	S 3 2
526 IN	9 Destination type(A or C),Dest ID,Dest row #	C 1 5
527 IN	9 Gain	1.7E12
528 IN	10 Interconnect ID number	10
529 IN	10 Source type(S,C, or F),Source ID,Source row #	C 1 5
530 IN	10 Destination type(A or C),Dest ID,Dest row #	A 5 1
531 IN	10 Gain	1
532 IN	11 Interconnect ID number	11
533 IN	11 Source type(S,C, or F),Source ID,Source row #	S 3 3
534 IN	11 Destination type(A or C),Dest ID,Dest row #	C 1 6
535 IN	11 Gain	3.4E12
536 IN	12 Interconnect ID number	12
537 IN	12 Source type(S,C, or F),Source ID,Source row #	C 1 6
538 IN	12 Destination type(A or C),Dest ID,Dest row #	A 6 1
539 IN	12 Gain	1
540 IN	13 Interconnect ID number	13
541 IN	13 Source type(S,C, or F),Source ID,Source row #	S 4 1
542 IN	13 Destination type(A or C),Dest ID,Dest row #	C 1 7
543 IN	13 Gain	1.7E12
544 IN	14 Interconnect ID number	14
545 IN	14 Source type(S,C, or F),Source ID,Source row #	C 1 7
546 IN	14 Destination type(A or C),Dest ID,Dest row #	A 7 1
547 IN	14 Gain	1
548 IN	15 Interconnect ID number	15
549 IN	15 Source type(S,C, or F),Source ID,Source row #	S 4 2
550 IN	15 Destination type(A or C),Dest ID,Dest row #	C 1 8
551 IN	15 Gain	1.7E12
552 IN	16 Interconnect ID number	16
553 IN	16 Source type(S,C, or F),Source ID,Source row #	C 1 8
554 IN	16 Destination type(A or C),Dest ID,Dest row #	A 8 1
555 IN	16 Gain	1
556 IN	17 Interconnect ID number	17
557 IN	17 Source type(S,C, or F),Source ID,Source row #	S 4 3
558 IN	17 Destination type(A or C),Dest ID,Dest row #	C 1 9
559 IN	17 Gain	3.4E12
560 IN	18 Interconnect ID number	18
561 IN	18 Source type(S,C, or F),Source ID,Source row #	C 1 9
562 IN	18 Destination type(A or C),Dest ID,Dest row #	A 9 1
563 IN	18 Gain	1

564 IN	19	Interconnect ID number	19
565 IN	19	Source type(S,C, or F),Source ID,Source row #	S 5 3
566 IN	19	Destination type(A or C),Dest ID,Dest row #	A 10 1
567 IN	19	Gain	7

isc3_flex_sol.lin (Concept 3) Summer Solstice

* Controller for integrated symmetrical concentrator
system CONT1 18,9,9,0,0,0.0

```

*A
0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
-1 -1.4 0 0 0 0 0 0 0 0 0 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 0 0 0 0
0 0 -1 -1.4 0 0 0 0 0 0 0 0 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 0 0
0 0 0 0 -1 -1.4 0 0 0 0 0 0 0 0 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 0 0 0 0 0 -1 -1.4 0 0 0 0 0 0 0 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 0 0 0 0 -1 -1.4 0 0 0 0 0 0 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 0 0 0 -1 -1.4 0 0 0 0
0 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 0 0 -1 -1.4 0 0
0 0 0 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 0 0 -1 -1.4

*B
0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 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 0 0 0 0
0 0 1 0 0 0 0 0 0
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 0 0
0 0 0 0 1 0 0 0 0
0 0 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
0 0 0 0 0 0 1 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0 0

*C
.000025 .007 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 .000025 .007 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 .000025 .007 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 .0001 .014 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 .0001 .014 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 .0001 .014 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 .0001 .014 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 .0001 .014 0 0
0 0 0 0 0 0 0 0 0 0 0 0 .0001 .014

*D
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0

*H
*M

```

29 December 2000

Contract No.
NAS8-00151

Final Report

los.dat (Concept 3) Summer Solstice

```
3,      ! Sensor number of 1st FGS (clamshell) sensor
0.d0,0.d0,0.d0,
0.d0,-1.d0,0.d0,      ! Defaults to sun as a target for zero input vector
0.d0,-1.d0,0.d0,      ! Target star along negative polar axis
1.d0,0.d0,0.d0,      ! Focal plane vector 1
1.d0,0.d0,0.d0,      ! Focal plane vector 2
1.d0,0.d0,0.d0,      ! Focal plane vector 3

4,      ! Sensor number of 2nd FGS (clamshell) sensor
0.d0,0.d0,0.d0,
0.d0,1.d0,0.d0,      ! Defaults to sun as a target for zero input vector
0.d0,-1.d0,0.d0,      ! Target star along positive polar axis
1.d0,0.d0,0.d0,      ! Focal plane vector 1
1.d0,0.d0,0.d0,      ! Focal plane vector 2
-1.d0,0.d0,0.d0,      ! Focal plane vector 3
```

solar_pressure.dat (Concept 3) Summer Solstice

```
22, 'm',      ! number of panels, units English or Metric ***Updated 11/15/00***
1.2,638000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1.2,638000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1.2,638000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1.2,638000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
1.3,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1.3,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1.3,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1.3,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,-7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1.4,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1.4,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1.4,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
1.4,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,      ! body, node, area, reflectivity factor,outward normal,centroid
2.3,785000.d0,0.0d0,0.1736d0,0.d0,0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2.3,785000.d0,0.0d0,-0.1736d0,1.d0,-0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2.4,785000.d0,0.0d0,0.1736d0,0.d0,-0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2.4,785000.d0,0.0d0,-0.1736d0,-1.d0,0.9848d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2.5,196000.d0,0.0d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
2.5,196000.d0,0.0d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
3.2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
3.2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
4.2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
4.2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
```

isc3_flex_sol.flx (Concept 3) Summer Solstice (An excerpt)

flag, revision number
XXXXXX 1

body id
1

modes, nodes, modal options

24	4	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

phi_t for node #

2

.31310941E-02	-.16357954E-03	.19158607E-08	.68659216E-04	.31346273E-02
.14949358E-08	-.33409338E-09	-.17910070E-08	-.62130721E-04	.10048928E-08
.74260327E-10	-.81693812E-09	.66744219E-10	-.57300403E-09	.56292416E-10
-.31109642E-09	.51999889E-08	.41569313E-10	.36697769E-02	.69502051E-03
.85567197E-10	-.10557893E-02	.35826871E-02	.65924560E-10	.61553749E-10
.11085623E-08	-.67301328E-05	.49549244E-10	-.49437998E-08	-.60865848E-11
.10484816E-08	.39239830E-10	-.17858973E-09	.46440350E-10	.23145265E-09
.76239104E-11	-.98486197E-09	-.52382674E-09	.30708566E-12	.12143532E-10
-.10722701E-09	.94529479E-03	.17735129E-08	.15323995E-09	.13868812E-12
-.13390485E-02	-.55272105E-04	-.82202021E-12	.55317399E-04	-.13390483E-02
.27552836E-11	.29149021E-10	-.27567962E-12	-.44865972E-10	.48584658E-11
.10595799E-10	-.31919479E-08	-.19937738E-10	.14255509E-09	-.23770452E-02
-.45933446E-03	-.19673179E-04	.63985161E-12	-.19675549E-04	.45933391E-03
-.74265281E-12	-.34874105E-11	-.12587102E-11	.59687765E-09	-.12099360E-11
-.69004494E-11	.19524343E-08			

phi_t prime for node #

2

.17177767E-11	-.22808543E-11	-.45683561E-10	.19817016E-10	.56718933E-12
.31514104E-09	.17463000E-11	-.27057756E-13	-.60467460E-12	.11400599E-06
-.42543750E-05	-.11919737E-10	.42546793E-05	.10153760E-06	-.34352434E-10
.41859459E-11	-.37080794E-11	.59234151E-04	.45504345E-11	-.70844966E-12
.15588470E-10	.13593377E-10	.68741697E-12	.87795145E-10	-.28497036E-11
.31909564E-13	-.69421743E-15	.38765922E-11	-.41335440E-11	-.44983453E-04
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.54200130E-11	.41425181E-12	-.51084189E-13	.98880082E-15	.14899414E-06
-.49351318E-14	.15066380E-14	-.42969795E-10	-.54223125E-14	.27635772E-15
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.23382333E-06	.64327760E-12	-.80030821E-11	.19070818E-11	.27557384E-13
.67193209E-14	.15459451E-13	.15489036E-10	.28188639E-13	.15021236E-15
.22611633E-11	-.61243211E-07	.17482812E-05	.30019490E-13	-.17482739E-05
-.61449314E-07	-.27684414E-12			

phi_t for node #

3

-.42404714E-02	.49480955E-03	.19835813E-08	-.36612814E-03	-.42534660E-02
.96750031E-09	.42209027E-09	.30963712E-08	.40516924E-04	.38549281E-02
-.52714285E-03	-.87737477E-09	.53843743E-03	.38533672E-02	-.10363838E-09
.38623427E-08	-.71743451E-08	.24131659E-03	.31427071E-02	-.10270931E-03
.15812594E-09	-.20969267E-03	.31373775E-02	.44642715E-09	.28790083E-09
.88009461E-09	.18408168E-03	-.17813513E-08	-.27431844E-08	.15957166E-04
-.19242852E-02	.34087019E-03	-.22330623E-09	.41716037E-03	.19091971E-02
-.71605887E-10	.95016675E-09	-.81490514E-09	.32861442E-02	-.18116747E-08
.55541036E-09	.79551900E-03	-.41608643E-08	-.26069981E-09	.94036451E-02
.21682867E-02	-.12127210E-02	.85710915E-08	.12126479E-02	.21683282E-02
-.39141685E-08	.18971552E-02	-.12009168E-02	.43705940E-08	.12012029E-02
.18969745E-02	.16937062E-07	-.67726532E-08	-.66549206E-08	.11440634E-01
.49982895E-02	-.24804966E-02	.39527267E-09	-.24804686E-02	-.49983050E-02
-.34622476E-08	-.50056020E-02	.25440974E-02	-.23331468E-08	-.25435047E-02
-.50059046E-02	-.85708461E-08			

phi_t prime for node #

3

-.50525028E-06	-.31564387E-05	-.80521842E-10	.31702786E-05	-.40940183E-06
.57389171E-09	-.26678138E-11	.65900274E-12	-.58046889E-04	.10244708E-05
.47674564E-05	.15531760E-10	-.47644389E-05	.10384376E-05	.44257276E-10
.11200572E-10	.49389619E-11	-.61429724E-04	.68382965E-06	.54576833E-05
-.20073106E-10	-.54985919E-05	.13880871E-06	-.11950858E-09	-.12906028E-11
.35486701E-12	-.77274292E-04	.61171041E-11	-.56114520E-11	-.65377923E-04
-.17172111E-05	-.54788611E-05	.24079039E-11	-.54062017E-05	.19338345E-05
.41797610E-11	.67570000E-11	.20000043E-10	.51675836E-06	-.99163146E-11
-.24536147E-10	.16113741E-05	-.24387637E-10	-.45291231E-10	.14474359E-04
.40550997E-04	.55846277E-04	-.22605263E-10	-.55847708E-04	.40549096E-04

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-.12064872E-11 .40806300E-04 .51925447E-04 -.22326921E-10 -.51919351E-04
.40814113E-04 .35521932E-10 .15828591E-09 -.16771401E-09 .21209458E-04
.16987298E-03 .27619447E-03 .11975439E-09 .27619558E-03 -.16987148E-03
-.57982074E-10 -.17376694E-03 -.27781790E-03 -.11765510E-09 .27783862E-03
-.17373409E-03 -.70075300E-10
phi_t for node # 4
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.21036956E-08 .39723035E-09 -.14786269E-09 .40516905E-04 -.38549306E-02
.52714303E-03 -.77214743E-09 -.53843745E-03 -.38533660E-02 .20798890E-09
-.73886299E-08 -.15978809E-07 -.24131650E-03 .31427093E-02 -.10270436E-03
.13801450E-10 -.20968938E-03 .31373931E-02 -.39914612E-09 .41931685E-11
.99616139E-10 .18408168E-03 .35438059E-09 -.17390277E-08 -.15957178E-04
.19242857E-02 -.34087031E-03 -.23866856E-09 -.41716036E-03 -.19091972E-02
-.19395891E-10 .94356214E-09 -.84924469E-09 -.32861442E-02 .18078300E-08
-.56604075E-09 .79551900E-03 -.41738415E-08 -.28114281E-09 -.94036451E-02
.21682868E-02 -.12127209E-02 -.85410786E-08 .12126480E-02 .21683284E-02
.38256346E-08 -.18971552E-02 .12009169E-02 .43704936E-08 -.12012030E-02
-.18969746E-02 .17005110E-07 .67789071E-08 .66775796E-08 .11440634E-01
.49982897E-02 -.24804968E-02 -.39492666E-09 -.24804688E-02 -.49983053E-02
.34827434E-08 .50056020E-02 -.25440973E-02 -.23324836E-08 .25435049E-02
.50059050E-02 -.85841247E-08
phi_t prime for node # 4
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.62154334E-09 .34011412E-12 -.27858908E-12 .58046878E-04 .10244712E-05
.47674599E-05 .13355611E-10 -.47644372E-05 .10384375E-05 .44054122E-10
-.22077045E-10 .11247290E-10 -.61429722E-04 -.68382100E-06 -.54576879E-05
-.24245181E-10 .54986198E-05 -.13881681E-06 -.15347238E-09 .50958361E-12
-.41824742E-12 .77274292E-04 -.42833617E-11 .34928804E-12 -.65377921E-04
-.17172117E-05 -.54788625E-05 .15891701E-11 -.54062019E-05 .19338345E-05
-.90655410E-11 -.71395520E-11 -.19852937E-10 .51675837E-06 -.10061491E-10
-.24464605E-10 -.16113739E-05 .23986931E-10 .45635598E-10 .14474359E-04
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-.17373411E-03 .70185849E-10
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.18582751E-09 .93589593E-10 .34601899E-08 .12520782E-08 .51220876E-10
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-.91584230E-06 .28463240E-09 -.92291186E-09 .13196997E-09 -.83498605E-10
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.43195040E-10 .16702574E-09 -.17559408E-10 .24612970E-10 -.10191791E-09
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.23009307E-09 -.18544250E-09 .61285545E-09 -.28087069E-09 -.10247581E-09
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.23420782E+00
stiffness matrix
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.12842036E-08 -.90451014E-10 -.17520828E-09 .61166345E-10 -.19514395E-09
.20449663E-08 -.59903455E-09 .11734955E-11 -.11566431E-11 .82897331E-12
.18224390E-11 .91230355E-12 .33761495E-10 .12195177E-10 .39046523E-12
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.97595435E-02 .26340700E-09 .24106267E-09 .33302668E-07 .19099210E-09
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-.89381996E-08 .28259460E-11 -.90398944E-11 .13342475E-11 -.81528791E-12
-.22587225E-11 .35773535E-11 .13680596E-09 .72885717E-11 .13210152E-12
-.79094623E-12 -.24557427E-12 -.23989233E-10 -.15639020E-08 .54905123E-09
.20343024E-01 -.26079975E-09 .48565154E-08 .94600863E-09 .98901407E-10
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.81773561E-13 -.27093940E-11 .49050780E-07 .16417779E-08 -.85207293E-09
.66464133E-01 .19475411E-03 .70269359E-07 -.16237297E-07 .45511788E-08
.61626102E-10 -.42892336E-08 .10795968E-08 .57553439E-09 .48250404E-10
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.18277811E-10 .21845110E-07 .22679724E-06 .15867112E-07 .19475462E-03
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.19655470E-10 -.25911887E-10 -.12651469E-09 -.11260067E-09 .27711122E-10
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.12821483E+02 -.41877293E-03 -.56342791E-07 -.31992622E-06 .10454387E-08
.43863811E-09 .49179440E-09 .31556405E-09 .59403734E-08 .11999282E-08
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.94000040E-09 -.13067391E-08 .19214341E-07 .47846913E-07 .51256077E-08
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- .77773881E-08 - .77815894E-09 .24176875E-07 ~ .59312892E-07 .20227043E-07
- .42740708E-08 - .14657279E-07 .34081278E-08 - .60764954E-07 .58492524E-07
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- .12322523E-07 .35987854E-08 .17313572E-07 .19380609E-06 .10627946E-07
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- .30612494E-08 .13646379E-08 ~ .17478437E-07 ~ .14452064E-06 .16213823E-06
.16738775E+02 ~ .13945359E-08 ~ .16103805E-08 ~ .12679180E-07 .10869214E-07
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- .27153113E-08 ~ .47502223E-10 ~ .33529005E-08 ~ .43896635E-07 ~ .18777036E-08
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- .30551212E-07 ~ .57376276E-08 ~ .25966143E-07 .50277715E-06 ~ .20493817E-06
.34283278E+02 ~ .40681539E-02 ~ .57248771E-08 ~ .84432571E-07 ~ .45627666E-08
.94143010E-08 .55387795E-08 .50248116E-08 ~ .31901744E-07 ~ .10086897E-06
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- .11741684E-07 ~ .11054520E-08 .15883512E-07 .51376341E-07 .89214834E-08
.17247322E-07 .22259068E-07 ~ .29325792E-06 ~ .25901072E-05 ~ .40681582E-02
.34283314E+02
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*** zeroth order terms ***

alpha

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- .42285318E-07 .22032523E-08 .19103434E-08 ~ .46164709E-09 ~ .25254923E-07
.15319234E-08 ~ .92689514E-10 ~ .41002187E-09 ~ .56423913E-10 .53935514E-09
.39637933E-10 ~ .80781973E-09 .34687579E-10 ~ .27100970E-09 .57689693E-10
- .98124081E-10 .42222814E-08 .46766094E-10 ~ .23190343E-08 ~ .21012612E-09
.84068331E-10 .67994729E-09 ~ .13698436E-08 .62753410E-10 .11096251E-10
.39006386E-10 .73868759E-11 .27987870E-11 ~ .62247277E-09 ~ .59775470E-11
.17590884E-09 .76219460E-11 ~ .26366890E-09 .11876573E-10 .28290161E-10
- .27201298E-10 .89869863E-12 ~ .15751250E-11 ~ .33157375E-12 .70866876E-12
- .24551181E-11 ~ .42785452E-10 .34373229E-12 .11944186E-12 ~ .30843212E-12
.15203202E-10 .15923719E-12 ~ .27557073E-12 ~ .68722572E-12 .78199706E-11
- .53600279E-12 .35222275E-11 ~ .10833770E-12 ~ .38667210E-11 .24012255E-12
- .22349588E-13 .72325799E-13 ~ .72369183E-12 .14903493E-11 .24910814E-10
.17123480E-11 .30860344E-13 .45896282E-13 .35510380E-13 ~ .12439625E-11
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- .81003566E-13 .43653901E-13
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h matrix

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- .41919760E+00 .56538237E+00 ~ .43485534E-01 ~ .48726399E+01 ~ .14092839E+00
.31621688E+00 ~ .15658688E+00 ~ .17361672E-01 ~ .21636943E-02 ~ .21186125E-01
.26295445E+00 .10634541E-02 .39837270E+00 .24038060E-01 .34138213E-02
.72810429E-01 ~ .66125938E-01 ~ .14508666E-01 ~ .87470672E-01 .13982584E-01
.20325687E-02 ~ .26138318E+00 ~ .13271355E-01 .17000778E-01 .16625637E-01
- .30466702E-03 .92471384E-04 ~ .13678233E-01 .14351589E-01 .35179758E-02
.18275688E-02 .81441214E-01 .37327408E-03 ~ .11565896E+00 ~ .94944608E-03
- .86128442E-03 ~ .44776941E-03 ~ .16313018E-03 ~ .15718717E-04 ~ .10522228E-02
.90631992E-05 .49761828E-04 ~ .64926039E-04 .27152761E-04 ~ .19410130E-04
.46028011E-03 .13453022E-03 .19224888E-06 .13666807E-02 .14309527E-03
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- .20016096E-03 .90999899E-05 .44426853E-03 .45524403E-04 .33906200E-05
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.88506639E-09 .26291127E-07 -.93122118E-07 -.30067542E-06 .20275997E-08
-.86886469E-07 .70395759E-09 .24600259E-09 .61037343E-08 -.72639356E-01
.89484432E-03 -.11343359E-06 .20017513E-08 .22674296E-08 -.18271839E+00
-.15690317E-08 .10989807E-09 .15406299E-02 .35642111E+00 .15252056E-01
-.15551538E-09 .11525644E-08 .22841308E-08 .53271028E-07 -.28914783E+00
.99735803E-02 -.80529120E-11 -.39209234E-06 .26942708E-07 -.40357060E-09
-.23699116E-07 -.12256696E-08 .39578955E-08 .13718954E-08 .23672818E-08
-.42889921E-01 -.19728023E-08 .12993543E-08 -.27395597E-01 .10482756E-07
-.36015513E-08 .59618938E-07 -.98494637E-07 .30215091E-07 .83151351E-09
.11154142E-06 -.12729912E-07 -.22012824E-08 -.20575968E-08 -.54136933E-08
.80118470E-01 .54141545E-08 -.20376560E-08 .24921274E-01 .74355275E-06
-.86344820E-06 .86348556E-08 .78571358E-05 .80752560E-06 .22489195E-06
.23010227E-06 .98727685E-07 -.43416653E-13 .94714179E-01 .64899273E+00
.34678836E-08 -.64871410E+00 .96615212E-01 .60262836E-09 -.96672133E-06
.11372652E-05 .81782833E-13 .70112029E-06 -.18615170E-06 .27093746E-06
.21444915E-05 -.11187428E-06 .77099669E-07 -.20879089E-06 .14299961E-07
.29220077E-13 .16459085E-06 -.21258826E-06 -.17755656E-12 .29420640E-01
-.35553316E+00 -.10890627E-08 -.35642111E+00 -.15252056E-01 .15551538E-09
.19702911E-08 .17067919E-09 -.67397229E-14 .43502667E-06 .23008021E-06
-.18534110E-15 -.31921334E-09 -.49233010E-09 -.98795752E-14 -.46272789E-08
.32747580E-08 .41693501E-08 -.86543027E-08 .51209400E-08 -.21513879E-08
-.12962772E+00 -.22610792E+00 -.55780767E-10 .22608848E+00 -.12966222E+00
-.46893542E-10 -.63686977E-06 .54634427E-06 .37138548E-15 .86753266E-08
.74221774E-08 .46945470E-08 .16797908E-07 -.91574736E-08 .19556552E-08
.19954144E+00 .51982556E+00 .11311457E-09 -.51984922E+00 .19947944E+00
.51066096E-10 .10594211E+00 .72922176E-01 -.12741219E-07 -.76105503E-01
.10368437E+00 -.15769748E-08 .24898360E-06 -.91483883E-07 .77664092E-13
.10559694E-07 .39960159E-06 -.37782460E-06 .18891624E-06 .98396479E-08
-.89202189E-07 -.37524982E-05 .34633772E-06 -.73163584E-12 .11513953E+00
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.15107758E-06 -.17930787E-07 -.35600382E-13 -.50741177E-06 .65700277E-07
.13810761E-12 .22036796E-08 -.72972846E-07 .18535266E-06 -.11525644E-08
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-.12392972E-07 -.12119306E-08 -.18085362E-13 -.25448515E-06 -.24080342E-06
-.72100480E-15 .42365812E-01 .22743214E+00 .53395066E-09 -.22743389E+00
.42358362E-01 .13756098E-09 -.34009417E-09 -.36617465E-08 -.44502412E-08
.50488788E-08 -.25689226E-08 .32032115E-08 .14881036E-07 .20788290E-08
-.53416876E-14 .49700530E-01 .27168256E+00 .17278504E-09 .27168278E+00
-.49698521E-01 -.46204715E-10 -.72402280E-09 -.51155317E-09 .66103844E-08
-.10387562E-07 .27226537E-08 -.73095770E-08 .80583169E-06 -.12968028E-05
.14501437E-06 .10568617E-04 -.57565891E-06 -.76217949E-06 .45284969E-06
-.42741722E-07 .21249170E-12 -.13940018E+00 -.12146079E+01 .12958433E-08
.12141936E+01 -.14295856E+00 -.23050185E-09 .14240023E-05 -.16913358E-05
-.85314857E-12 -.66967927E-06 .22081894E-06 -.29618344E-06 -.20740004E-05
.23288741E-06 -.46545419E-07 .18459429E-06 -.73257490E-07 -.32197615E-13
-.12668197E-06 .19034335E-06 .24898461E-12 -.15383984E-02 .28931664E+00
-.30106500E-09 .28914783E+00 -.99735803E-02 .80529120E-11 .31921334E-09
.49233010E-09 .98795752E-14 .25448515E-06 .24080342E-06 .72100480E-15
.80857846E-09 -.65913199E-09 -.89837874E-14 -.40276693E-08 .23299565E-08
.33531355E-09 -.74204357E-08 .35521019E-08 .62833350E-08 -.82095560E-01
-.12224359E+00 -.26190706E-11 .12223122E+00 -.82113856E-01 -.75550354E-12
-.49434274E-06 .52138355E-06 -.36084625E-15 .72258733E-08 .45094717E-08
.82984545E-09 .11398262E-07 -.86245755E-08 -.84823258E-08 .20012965E+00
.34933873E+00 .29523672E-11 -.34936258E+00 .20008846E+00 -.35514320E-11
.91143541E-07 -.15942143E-06 .12557840E+00 .74044170E-07 -.11391547E-06
.46976639E+00 .13278546E-01 .52285061E-01 -.14719014E-06 -.19372121E-06
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.30146541E-08 -.35978002E-08 .45661113E-06 .36225913E-08 -.85213715E-08
.40353386E-01 -.87483772E-09 -.17211154E-07 .12561504E+00 .11934809E-01
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.40357060E-08 .46272789E-08 -.32747580E-08 -.41693501E-08 -.42365812E-01
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-.13190608E-09 -.42992791E-09 .53549523E-03 .44221408E-09 -.15144278E-09
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-.26263013E-09 -.59806850E-09 .30586106E-02 -.60005167E-09 .27669342E-09
.65749091E-02 .13037445E-06 .21701737E-06 .12705909E-09 -.21430064E-06
.12189418E-06 -.18933107E-09 .16085783E-06 .84422487E-07 -.47379413E+00
.12058674E-06 .75683469E-07 .13985513E+00 -.52285564E-01 .13276810E-01
.63399074E-08 -.80698553E-07 .19053734E-06 -.77887080E-07 -.15420580E-06
.19440207E-07 -.14128991E-08 .42909184E-08 .19153162E-08 -.50616539E-07
.80313089E-08 .50214583E-08 -.13026438E+00 .15869406E-07 -.14981146E-08
.53077809E-01 -.24773764E-01 .11933949E-01 -.10299928E-08 -.53522249E-09
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.23699116E-07 .12256696E-08 -.39578955E-08 .86543027E-08 -.51209400E-08
.21513879E-08 .22743389E+00 -.42358362E-01 -.13756098E-09 .74204357E-08
-.35521019E-08 -.62833350E-08 -.44221408E-09 .15144278E-09 .50250104E-02
-.10011899E-08 .39672401E-09 .53548366E-03 .35302623E-07 .45619868E-07
-.18324191E-09 -.58945067E-07 .24482274E-07 -.14363279E-09 -.95706411E-02
-.38248253E-02 .52950837E-10 .80178997E-09 .17350601E-08 .65747891E-02
.17209949E-08 -.80376640E-09 -.30587738E-02 -.65962710E-07 -.12765379E-06
.24445245E-09 .13611625E-06 -.63215067E-07 .27202374E-09 .16763984E-06
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.26217801E-08 .39483112E-08 -.92799969E-07 -.39680923E-08 -.64423900E-08
-.19692464E-01 -.11873660E-07 -.19292084E-07 -.96879863E-04 .12756037E-01
.20183313E-01 .54931006E-07 .79053746E-07 -.70869914E-06 -.84282940E-07
.69826092E-06 .93248306E-07 -.23220378E-06 -.93398544E-10 -.13727412E-09
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.12962772E+00 .22610792E+00 .55780767E-10 .34009417E-09 .36617465E-08
.44502412E-08 .82095560E-01 .12224359E+00 .26190706E-11 .53621168E-07
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.16412533E-11 .21384164E-11 .32021163E-03 .58936241E-11 -.14505988E-10
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-.96467007E-07 -.10535633E-09 -.91711930E-07 .55460535E-07 -.51525169E-09
-.43381873E-11 -.92974491E-11 -.29258756E-02 .76083731E-11 .16981023E-11
.72526267E-02 .27553639E-06 .28304144E-05 .20161874E-06 .21515236E-05
-.12619873E-06 -.20116967E-05 -.35017562E-08 .20853839E-08 -.83171247E-07
.67860925E-08 -.11108030E-08 .36522737E-04 .16434235E-07 -.11524456E-07
-.19691541E-01 -.20181394E-01 .12759081E-01 -.42808564E-07 -.96353235E-10
-.81235041E-06 -.18225686E-07 .86409724E-06 .81421980E-07 -.11449558E-06
.54977989E-09 -.38611032E-09 .12072820E-07 .17167179E-01 -.84177208E-02
.13940941E-07 -.83848781E-09 .30068531E-10 .41762028E-01 .19728023E-08

-.12993543E-08	.27395597E-01	-.22608848E+00	.12966222E+00	.46893542E-10
-.50488788E-08	.25689226E-08	-.32032115E-08	-.12223122E+00	.82113856E-01
.75550354E-12	-.67488837E-07	.40301963E-07	-.71900559E-10	.58945067E-07
-.24482274E-07	.14363279E-09	-.58936241E-11	.14505988E-10	.33385669E-02
-.45134366E-09	.30239391E-09	.32020344E-03	.31906173E-09	.34199546E-11
-.81669645E-08	-.30329414E-06	-.66271809E-06	-.35363609E-09	-.66144997E-06
.30804574E-06	.20159786E-09	-.57170319E-09	-.11035564E-08	-.72527212E-02
.10976139E-08	-.57328140E-09	-.29238966E-02	.21301848E+00	.18980035E+01
.16449225E-07	-.19035792E+01	.15542683E+00	.27743136E-08	.65246642E-06
-.17160470E-06	.41382889E-12	.71710619E-08	.46661594E-06	-.20025118E-06
.22074571E-06	.15404011E-07	.27221783E-06	-.36247494E-05	.29293728E-06
.11631316E-12	-.92446699E-02	-.36511561E+00	.12675867E-07	.36422996E+00
.27036148E-01	-.14001264E-08	.34175860E-07	-.90726267E-08	-.25781137E-13
.51059035E-07	.57298172E-07	-.20698406E-13	-.54019335E-08	.52857311E-07
-.69439023E-07	-.10482756E-07	.36015513E-08	-.59618938E-07	.63686977E-06
-.54634427E-06	-.37138548E-15	-.14881036E-07	-.20788290E-08	.53416876E-14
.49434274E-06	-.52138355E-06	.36084625E-15	.38245326E-02	-.95707833E-02
-.28472227E-09	.95706411E-02	.38248253E-02	-.52950837E-10	.42306378E-10
.13863650E-08	-.83012671E-08	-.31906173E-09	-.34199546E-11	.81669645E-08
-.87485007E-08	.13865777E-08	.21238779E-14	-.17696591E+00	-.39083612E+00
-.84602464E-10	-.39083720E+00	.17696374E+00	.30775127E-10	.12256099E-08
.79443691E-09	.63405973E-08	.15032889E-07	-.80204827E-08	.24197572E-08
.15146456E-06	.22667613E-06	.27864015E+00	.12645160E-06	.20146267E-06
.74812742E+00	.23320671E-01	.71358750E-01	-.15696020E-06	-.65869035E-07
-.31119132E-06	.19170180E-07	.28954207E-06	-.78314182E-07	-.29898828E-08
.31447785E-08	.59196241E-08	-.10223336E-07	.57668967E-08	.84437859E-08
.19320351E-01	-.48725385E-08	-.12206505E-07	.11866768E+00	.30017386E-01
.48004147E-01	.21394263E-07	-.94233533E-10	-.50069943E-09	-.11013082E-06
-.39767875E-07	-.76296204E-08	.21121434E-08	.98494637E-07	-.30215091E-07
-.83151351E-09	-.86753266E-08	-.74221774E-08	-.46945470E-08	-.49700530E-01
-.27168256E+00	-.17278504E-09	-.72258733E-08	-.45094717E-08	-.82984545E-09
.26263013E-09	.59806850E-09	-.30586106E-02	-.80178997E-09	-.17350601E-08
-.65747891E-02	.56730240E-07	.96467007E-07	.10535633E-09	.30329414E-06
.66271809E-06	.35363609E-09	.17696591E+00	.39083612E+00	.84602464E-10
.34515937E-11	.11639133E-10	.11823240E-03	.78122412E-12	-.14089096E-10
-.72836582E-02	-.46789915E-08	-.15892413E-07	.65356843E-10	.31383227E-07
.10485630E-07	.42666551E-09	.22686122E-06	-.15001301E-06	.75692354E+00
.20000508E-06	-.12631014E-06	-.30143385E+00	.71358882E-01	-.23320214E-01
.38814806E-07	.48891040E-08	.41439984E-06	.18152134E-07	-.42591726E-06
.27558297E-07	.32855064E-08	.49032229E-08	-.29885627E-08	-.83085912E-07
.83112891E-08	-.55592945E-08	.12118342E+00	-.12399628E-07	.47190946E-08
-.31250391E-01	.48004340E-01	-.30017176E-01	.16597444E-08	-.50976879E-11
.19275352E-09	-.15874235E-08	-.11553120E-06	-.45920329E-07	.21718772E-07
-.11154142E-06	.12729912E-07	.22012824E-08	-.16797908E-07	.91574736E-08
-.19556552E-08	-.27168278E+00	.49698521E-01	.46204715E-10	-.11398262E-07
.86245755E-08	.84823258E-08	.60005167E-09	-.27669342E-09	-.65749091E-02
-.17209949E-08	.80376640E-09	.30587738E-02	.91711930E-07	-.55460535E-07
.51525169E-09	.66144997E-06	-.30804574E-06	-.20159786E-09	.39083720E+00
-.17696137E+00	-.30775127E-10	-.78122412E-12	.14089096E-10	.72836582E-07
-.14618963E-09	.69521649E-10	.11823684E-03	-.73228149E-08	-.29478674E-07
.22679544E-09	.44642344E-07	-.22809491E-07	.59107460E-10	-.85227134E-07
-.54382657E-06	.11012196E-05	.10593951E-05	.15030137E-05	.77536846E-05
-.47261019E-08	-.11104159E-07	.25209767E-06	.76837879E-08	.16366625E-07
.11419001E+00	.22910605E-07	.48721700E-07	.94812449E-01	-.26910936E-01
-.53138454E-01	.10396571E-06	-.37021885E-07	.17801169E-06	.12499195E-06
-.23088390E-06	.32957092E-07	.37125093E-06	-.15204283E-09	.22344016E-10
-.41855782E-07	.41887505E-02	.31354146E-01	.46431865E-07	-.44647683E-09
-.16416114E-08	.28098883E-01	.20575968E-08	.54136933E-08	-.80118470E-01
-.19954144E+00	-.51982556E+00	-.11311457E-09	.72402280E-09	.51155317E-09
-.66103844E-08	-.20012965E+00	-.34933873E+00	-.29523672E-11	-.13037445E-06
-.21701737E-06	-.12705909E-09	.65962710E-07	.12765379E-06	-.24445245E-09
.43381873E-11	.92974491E-11	.29258756E-02	.57170319E-09	.11035564E-08
.72527212E-02	-.12256099E-08	-.79443691E-09	-.63405973E-08	.46789915E-08
.15892413E-07	-.65356843E-10	.73228149E-08	.29478674E-07	-.22679544E-09
-.20205244E-11	-.39891324E-11	.87155679E-04	.84364044E-11	.86915796E-11
.68614717E-02	-.35436475E-07	-.14708492E-05	-.62332048E-06	-.10054546E-06
.52218327E-06	.39275247E-05	.82271192E-08	-.34017979E-08	.17927404E-06
-.16399263E-07	.73058140E-08	-.94493068E-01	-.48349038E-07	.22872252E-07
.11390138E+00	.53141657E-01	-.26904645E-01	.94708623E-07	.55451004E-07
.26193636E-06	-.18332552E-07	-.35360159E-06	-.28254188E-07	.38520272E-07
-.19779770E-08	.13203123E-08	-.89135235E-08	-.31354628E-01	.41849538E-02

kdyic1

rvtor1

svtor2

.00000000E+00 .00000000E+00 .00000000E+00 .00000000E+00 .00000000E+00
.00000000E+00 .00000000E+00 .00000000E+00 .00000000E+00 .00000000E+00
.00000000E+00 .00000000E+00 .00000000E+00 .00000000E+00 .00000000E+00

(and more)

isc3_flex_verneq.int (Concept 3) Vernal Equinox

TREETOPS REV 10P2 4/10/00

SIM CONTROL

1 SI	0 Title	ISC MODEL, THIRD VERSION
2 SI	0 Simulation stop time	1000000
3 SI	0 Plot data interval	20
4 SI	0 Integration type (R,S,U, OR V)	R
5 SI	0 Step size (sec)	.1
6 SI	0 Sandia ODE solver absolute and relative error	
7 SI	0 RK78 ODE solver absolute error and first step size	
8 SI	0 Linearization option (L,Z or N)	N
9 SI	0 Restart option (Y/N)	N
10 SI	0 Contact force computation option (Y/N)	Y
11 SI	0 Constraint force computation option (Y/N)	N
12 SI	0 Small angle speedup option (All,Bypass,First,Nth)	A
13 SI	0 Mass matrix speedup option (All,Bypass,First,Nth)	A
14 SI	0 Non-Linear speedup option (All,Bypass,First,Nth)	A
15 SI	0 Constraint speedup option (All,Bypass,First,Nth)	A
16 SI	0 Constraint stabilization option (Y/N)	N
17 SI	0 Stabilization epsilon	

GENGRAV

18 GG	4 Gravity, earth sphere/nonsphere/user (S/N/U)?	N
19 GG	1 Input gravity constants: GME, ERAD, EMASS	
20 GG	1 Spherical or Nonspherical (S/N)?	
21 GG	1 Gravity Potential Harmonics J2,J3,J4	
22 GG	4 English (ft-slug-s) or metric (m-kg-s) (E/M)?	M
23 GG	4 Day, Month, Year,	20 3 2020
24 GG	4 GMT @ sim time 0 (minutes past midnight,	360
25 GG	4 Solar Pressure forces Y/N?	Y
26 GG	4 Input new data for aero model? (Y/N)	N
27 GG	1 Solar flux F10 for aero model	
28 GG	1 Solar flux, 81 day average F10B	
29 GG	1 Geomagnetic index, GEAP	

BODY

30 BO	1 Body ID number	1
31 BO	1 Type (Rigid,Flexible,NASTRAN)	F
32 BO	1 Number of modes	24
33 BO	1 Modal calculation option (0, 1 or 2)	2
34 BO	1 Foreshortening option (Y/N)	
35 BO	1 Model reduction method (NO,MS,MC,CC,QM,CV)	
36 BO	1 NASTRAN data file FORTRAN unit number (40 - 60)	
37 BO	1 Number of augmented nodes (0 if none)	
38 BO	1 Damping matrix option (NS,CD,HL,SD)	
39 BO	1 Constant damping ratio	
40 BO	1 Low frequency, High frequency ratios	
41 BO	1 Mode ID number, damping ratio	
42 BO	1 Conversion factors: Length,Mass,Force	
43 BO	1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1

44 BO	1	Moments of inertia (kg-m2) Ixx,Iyy,Izz	6.2852173E11 6.2852173E11
6.7057352E8			
45 BO	1	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
46 BO	1	Mass (kg)	1.6168633E5
47 BO	1	Number of Nodes	4
48 BO	1	Node ID, Node coord. (meters) x,y,z	1 0 0 0
49 BO	1	Node ID, Node coord. (meters) x,y,z	2 0 0 0
50 BO	1	Node ID, Node coord. (meters) x,y,z	3 0 0 3188.8
51 BO	1	Node ID, Node coord. (meters) x,y,z	4 0 0 -3188.8
52 BO	1	Node ID, Node structural joint ID	
53 BO	2	Body ID number	2
54 BO	2	Type (Rigid,Flexible,NASTRAN)	R
55 BO	2	Number of modes	
56 BO	2	Modal calculation option (0, 1 or 2)	
57 BO	2	Foreshortening option (Y/N)	
58 BO	2	Model reduction method (NO,MS,MC,CC,QM,CV)	
59 BO	2	NASTRAN data file FORTRAN unit number (40 - 60)	
60 BO	2	Number of augmented nodes (0 if none)	
61 BO	2	Damping matrix option (NS,CD,HL,SD)	
62 BO	2	Constant damping ratio	
63 BO	2	Low frequency, High frequency ratios	
64 BO	2	Mode ID number, damping ratio	
65 BO	2	Conversion factors: Length,Mass,Force	
66 BO	2	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
67 BO	2	Moments of inertia (kg-m2) Ixx,Iyy,Izz	.8543E12 1.5601E12
1.3822E12			
68 BO	2	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
69 BO	2	Mass (kg)	12666300
70 BO	2	Number of Nodes	5
71 BO	2	Node ID, Node coord. (meters) x,y,z	1 298.323 0 0
72 BO	2	Node ID, Node coord. (meters) x,y,z	2 0 0 0
73 BO	2	Node ID, Node coord. (meters) x,y,z	3 0 0 300
74 BO	2	Node ID, Node coord. (meters) x,y,z	4 0 0 -300
75 BO	2	Node ID, Node coord. (meters) x,y,z	5 500 0 0
76 BO	2	Node ID, Node structural joint ID	
77 BO	3	Body ID number	3
78 BO	3	Type (Rigid,Flexible,NASTRAN)	R
79 BO	3	Number of modes	
80 BO	3	Modal calculation option (0, 1 or 2)	
81 BO	3	Foreshortening option (Y/N)	
82 BO	3	Model reduction method (NO,MS,MC,CC,QM,CV)	
83 BO	3	NASTRAN data file FORTRAN unit number (40 - 60)	
84 BO	3	Number of augmented nodes (0 if none)	
85 BO	3	Damping matrix option (NS,CD,HL,SD)	
86 BO	3	Constant damping ratio	
87 BO	3	Low frequency, High frequency ratios	
88 BO	3	Mode ID number, damping ratio	
89 BO	3	Conversion factors: Length,Mass,Force	
90 BO	3	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
91 BO	3	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
92 BO	3	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
93 BO	3	Mass (kg)	2046600
94 BO	3	Number of Nodes	2
95 BO	3	Node ID, Node coord. (meters) x,y,z	1 0 0 0
96 BO	3	Node ID, Node coord. (meters) x,y,z	2 0 0 0
97 BO	3	Node ID, Node structural joint ID	
98 BO	4	Body ID number	4
99 BO	4	Type (Rigid,Flexible,NASTRAN)	R
100 BO	4	Number of modes	
101 BO	4	Modal calculation option (0, 1 or 2)	
102 BO	4	Foreshortening option (Y/N)	
103 BO	4	Model reduction method (NO,MS,MC,CC,QM,CV)	
104 BO	4	NASTRAN data file FORTRAN unit number (40 - 60)	
105 BO	4	Number of augmented nodes (0 if none)	
106 BO	4	Damping matrix option (NS,CD,HL,SD)	
107 BO	4	Constant damping ratio	
108 BO	4	Low frequency, High frequency ratios	
109 BO	4	Mode ID number, damping ratio	

110 BO	4	Conversion factors: Length,Mass,Force	
111 BO	4	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
112 BO	4	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
113 BO	4	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
114 BO	4	Mass (kg)	2046600
115 BO	4	Number of Nodes	2
116 BO	4	Node ID, Node coord. (meters) x,y,z	1 0 0 0
117 BO	4	Node ID, Node coord. (meters) x,y,z	2 0 0 0
118 BO	4	Node ID, Node structural joint ID	

HINGE

119 HI	1	Hinge ID number	1
120 HI	1	Inboard body ID, Outboard body ID	0 1
121 HI	1	"p" node ID, "q" node ID	0 2
122 HI	1	Number of rotation DOFs, Rotation option (F or G)	3 F
123 HI	1	L1 unit vector in inboard body coord. x,y,z	1 0 0
124 HI	1	L1 unit vector in outboard body coord. x,y,z	1 0 0
125 HI	1	L2 unit vector in inboard body coord. x,y,z	
126 HI	1	L2 unit vector in outboard body coord. x,y,z	
127 HI	1	L3 unit vector in inboard body coord. x,y,z	0 0 1
128 HI	1	L3 unit vector in outboard body coord. x,y,z	0 0 1
129 HI	1	Initial rotation angles (deg)	-90 0 90
130 HI	1	Initial rotation rates (deg/sec)	0 0 0.00417807
131 HI	1	Rotation stiffness (newton-meters/rad)	0 0 0
132 HI	1	Rotation damping (newton-meters/rad/sec)	0 0 0
133 HI	1	Null torque angles (deg)	0 0 0
134 HI	1	Number of translation DOFs	3
135 HI	1	First translation unit vector g1	1 0 0
136 HI	1	Second translation unit vector g2	0 1 0
137 HI	1	Third translation unit vector g3	0 0 1
138 HI	1	Initial translation (meters)	0 0 42163421
139 HI	1	Initial translation velocity (meters/sec)	3074.681 0 0
140 HI	1	Translation stiffness (newtons/meters)	0 0 0
141 HI	1	Translation damping (newtons/meter/sec)	0 0 0
142 HI	1	Null force translations	0 0 0
143 HI	2	Hinge ID number	2
144 HI	2	Inboard body ID, Outboard body ID	1 2
145 HI	2	"p" node ID, "q" node ID	2 2
146 HI	2	Number of rotation DOFs	0
147 HI	2	L1 unit vector in inboard body coord. x,y,z	0 0 1
148 HI	2	L1 unit vector in outboard body coord. x,y,z	0 0 1
149 HI	2	L2 unit vector in inboard body coord. x,y,z	
150 HI	2	L2 unit vector in outboard body coord. x,y,z	
151 HI	2	L3 unit vector in inboard body coord. x,y,z	1 0 0
152 HI	2	L3 unit vector in outboard body coord. x,y,z	1 0 0
153 HI	2	Initial rotation angles (deg)	0 0 0
154 HI	2	Initial rotation rates (deg/sec)	
155 HI	2	Rotation stiffness (newton-meters/rad)	
156 HI	2	Rotation damping (newton-meters/rad/sec)	
157 HI	2	Null torque angles (deg)	
158 HI	2	Number of translation DOFs	0
159 HI	2	First translation unit vector g1	1 0 0
160 HI	2	Second translation unit vector g2	0 1 0
161 HI	2	Third translation unit vector g3	0 0 1
162 HI	2	Initial translation (meters)	0 0 0
163 HI	2	Initial translation velocity (meters/sec)	
164 HI	2	Translation stiffness (newtons/meters)	
165 HI	2	Translation damping (newtons/meter/sec)	
166 HI	2	Null force translations	
167 HI	3	Hinge ID number	3
168 HI	3	Inboard body ID, Outboard body ID	1 3
169 HI	3	"p" node ID, "q" node ID	3 2
170 HI	3	Number of rotation DOFs	3
171 HI	3	L1 unit vector in inboard body coord. x,y,z	0 0 1
172 HI	3	L1 unit vector in outboard body coord. x,y,z	0 0 1
173 HI	3	L2 unit vector in inboard body coord. x,y,z	
174 HI	3	L2 unit vector in outboard body coord. x,y,z	

175 HI	3	L3 unit vector in inboard body coord. x,y,z	0 1 0
176 HI	3	L3 unit vector in outboard body coord. x,y,z	0 1 0
177 HI	3	Initial rotation angles (deg)	0. 0. -135.
178 HI	3	Initial rotation rates (deg/sec)	-0.004178 0 0
179 HI	3	Rotation stiffness (newton-meters/rad)	0 0 0
180 HI	3	Rotation damping (newton-meters/rad/sec)	0 0 0
181 HI	3	Null torque angles (deg)	0 0 0
182 HI	3	Number of translation DOFs	0
183 HI	3	First translation unit vector g1	1 0 0
184 HI	3	Second translation unit vector g2	0 1 0
185 HI	3	Third translation unit vector g3	0 0 1
186 HI	3	Initial translation (meters)	0 0 0
187 HI	3	Initial translation velocity (meters/sec)	
188 HI	3	Translation stiffness (newtons/meters)	
189 HI	3	Translation damping (newtons/meter/sec)	
190 HI	3	Null force translations	
191 HI	4	Hinge ID number	4
192 HI	4	Inboard body ID, Outboard body ID	1 4
193 HI	4	"p" node ID, "q" node ID	4 2
194 HI	4	Number of rotation DOFs	3
195 HI	4	L1 unit vector in inboard body coord. x,y,z	0 0 1
196 HI	4	L1 unit vector in outboard body coord. x,y,z	0 0 1
197 HI	4	L2 unit vector in inboard body coord. x,y,z	
198 HI	4	L2 unit vector in outboard body coord. x,y,z	
199 HI	4	L3 unit vector in inboard body coord. x,y,z	0 1 0
200 HI	4	L3 unit vector in outboard body coord. x,y,z	0 1 0
201 HI	4	Initial rotation angles (deg)	0. 0. -45.
202 HI	4	Initial rotation rates (deg/sec)	-0.004178 0 0
203 HI	4	Rotation stiffness (newton-meters/rad)	0 0 0
204 HI	4	Rotation damping (newton-meters/rad/sec)	0 0 0
205 HI	4	Null torque angles (deg)	0 0 0
206 HI	4	Number of translation DOFs	0
207 HI	4	First translation unit vector g1	1 0 0
208 HI	4	Second translation unit vector g2	0 1 0
209 HI	4	Third translation unit vector g3	0 0 1
210 HI	4	Initial translation (meters)	0 0 0
211 HI	4	Initial translation velocity (meters/sec)	
212 HI	4	Translation stiffness (newtons/meters)	
213 HI	4	Translation damping (newtons/meter/sec)	
214 HI	4	Null force translations	

SENSOR

215 SE	1	Sensor ID number	1
216 SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET
217 SE	1	Mounting point body ID, Mounting point node ID	2 2
218 SE	1	Second mounting point body ID, Second node ID	
219 SE	1	Input axis unit vector (IA) x,y,z	
220 SE	1	Mounting point Hinge index, Axis index	
221 SE	1	First focal plane unit vector (Fp1) x,y,z	0 0 -1
222 SE	1	Second focal plane unit vector (Fp2) x,y,z	0 1 0
223 SE	1	Sun/Star unit vector (Us) x,y,z	
224 SE	1	Velocity Aberration Option (Y/N)	
225 SE	1	Euler Angle Sequence (1-6)	
226 SE	1	CMG ID number and Gimbal number	
227 SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	6378000 0 0 4.178074D-3
228 SE	2	Sensor ID number	2
229 SE	2	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
230 SE	2	Mounting point body ID, Mounting point node ID	2 2
231 SE	2	Second mounting point body ID, Second node ID	
232 SE	2	Input axis unit vector (IA) x,y,z	
233 SE	2	Mounting point Hinge index, Axis index	
234 SE	2	First focal plane unit vector (Fp1) x,y,z	0 -1 0
235 SE	2	Second focal plane unit vector (Fp2) x,y,z	1 0 0
236 SE	2	Sun/Star unit vector (Us) x,y,z	0 1 0
237 SE	2	Velocity Aberration Option (Y/N)	N
238 SE	2	Euler Angle Sequence (1-6)	
239 SE	2	CMG ID number and Gimbal number	

240 SE	2	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
241 SE	3	Sensor ID number	3
242 SE	3	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	L
243 SE	3	Mounting point body ID, Mounting point node ID	3 2
244 SE	3	Second mounting point body ID, Second node ID	
245 SE	3	Input axis unit vector (IA) x,y,z	1 2 3
246 SE	3	Mounting point Hinge index, Axis index	
247 SE	3	First focal plane unit vector (Fp1) x,y,z	
248 SE	3	Second focal plane unit vector (Fp2) x,y,z	
249 SE	3	Sun/Star unit vector (Us) x,y,z	
250 SE	3	Velocity Aberration Option (Y/N)	
251 SE	3	Euler Angle Sequence (1-6)	
252 SE	3	CMG ID number and Gimbal number	
253 SE	3	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
254 SE	4	Sensor ID number	4
255 SE	4	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	L
256 SE	4	Mounting point body ID, Mounting point node ID	4 2
257 SE	4	Second mounting point body ID, Second node ID	
258 SE	4	Input axis unit vector (IA) x,y,z	3 2 1
259 SE	4	Mounting point Hinge index, Axis index	
260 SE	4	First focal plane unit vector (Fp1) x,y,z	
261 SE	4	Second focal plane unit vector (Fp2) x,y,z	
262 SE	4	Sun/Star unit vector (Us) x,y,z	
263 SE	4	Velocity Aberration Option (Y/N)	
264 SE	4	Euler Angle Sequence (1-6)	
265 SE	4	CMG ID number and Gimbal number	
266 SE	4	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
267 SE	5	Sensor ID number	5
268 SE	5	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
269 SE	5	Mounting point body ID, Mounting point node ID	2 5
270 SE	5	Second mounting point body ID, Second node ID	
271 SE	5	Input axis unit vector (IA) x,y,z	
272 SE	5	Mounting point Hinge index, Axis index	
273 SE	5	First focal plane unit vector (Fp1) x,y,z	0 0 1
274 SE	5	Second focal plane unit vector (Fp2) x,y,z	0 -1 0
275 SE	5	Sun/Star unit vector (Us) x,y,z	0 0 0
276 SE	5	Velocity Aberration Option (Y/N)	N
277 SE	5	Euler Angle Sequence (1-6)	
278 SE	5	CMG ID number and Gimbal number	
279 SE	5	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
280 SE	6	Sensor ID number	6
281 SE	6	Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	A3
282 SE	6	Mounting point body ID, Mounting point node ID	2 2
283 SE	6	Second mounting point body ID, Second node ID	
284 SE	6	Input axis unit vector (IA) x,y,z	
285 SE	6	Mounting point Hinge index, Axis index	
286 SE	6	First focal plane unit vector (Fp1) x,y,z	
287 SE	6	Second focal plane unit vector (Fp2) x,y,z	
288 SE	6	Sun/Star unit vector (Us) x,y,z	
289 SE	6	Velocity Aberration Option (Y/N)	
290 SE	6	Euler Angle Sequence (1-6)	
291 SE	6	CMG ID number and Gimbal number	
292 SE	6	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
293 SE	7	Sensor ID number	7
294 SE	7	Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	AC
295 SE	7	Mounting point body ID, Mounting point node ID	2 2
296 SE	7	Second mounting point body ID, Second node ID	
297 SE	7	Input axis unit vector (IA) x,y,z	1 0 0
298 SE	7	Mounting point Hinge index, Axis index	
299 SE	7	First focal plane unit vector (Fp1) x,y,z	
300 SE	7	Second focal plane unit vector (Fp2) x,y,z	
301 SE	7	Sun/Star unit vector (Us) x,y,z	
302 SE	7	Velocity Aberration Option (Y/N)	
303 SE	7	Euler Angle Sequence (1-6)	
304 SE	7	CMG ID number and Gimbal number	
305 SE	7	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	

ACTR

306 AC	1 Actuator ID number	1
307 AC	1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
308 AC	1 Actuator location; Node or Hinge (N or H)	
309 AC	1 Mounting point body ID number, node ID number	2 2
310 AC	1 Second mounting point body ID, second node ID	
311 AC	1 Output axis unit vector x,y,z	0 1 0
312 AC	1 Mounting point Hinge index, Axis index	
313 AC	1 Rotor spin axis unit vector x,y,z	
314 AC	1 Initial rotor momentum, H	
315 AC	1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
316 AC	1 Outer gimbal axis unit vector x,y,z	
317 AC	1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
318 AC	1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
319 AC	1 Inner gimbal axis unit vector x,y,z	
320 AC	1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
321 AC	1 Initial length and rate, y(to) and ydot(to)	
322 AC	1 Constants; K1 or wo, n or zeta, Kg, Jm	
323 AC	1 Non-linearities; TLim, Tco, Dz	
324 AC	2 Actuator ID number	2
325 AC	2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
326 AC	2 Actuator location; Node or Hinge (N or H)	
327 AC	2 Mounting point body ID number, node ID number	2 2
328 AC	2 Second mounting point body ID, second node ID	
329 AC	2 Output axis unit vector x,y,z	0 0 1
330 AC	2 Mounting point Hinge index, Axis index	
331 AC	2 Rotor spin axis unit vector x,y,z	
332 AC	2 Initial rotor momentum, H	
333 AC	2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
334 AC	2 Outer gimbal axis unit vector x,y,z	
335 AC	2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
336 AC	2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
337 AC	2 Inner gimbal axis unit vector x,y,z	
338 AC	2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
339 AC	2 Initial length and rate, y(to) and ydot(to)	
340 AC	2 Constants; K1 or wo, n or zeta, Kg, Jm	
341 AC	2 Non-linearities; TLim, Tco, Dz	
342 AC	3 Actuator ID number	3
343 AC	3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
344 AC	3 Actuator location; Node or Hinge (N or H)	
345 AC	3 Mounting point body ID number, node ID number	2 2
346 AC	3 Second mounting point body ID, second node ID	
347 AC	3 Output axis unit vector x,y,z	1 0 0
348 AC	3 Mounting point Hinge index, Axis index	
349 AC	3 Rotor spin axis unit vector x,y,z	
350 AC	3 Initial rotor momentum, H	
351 AC	3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
352 AC	3 Outer gimbal axis unit vector x,y,z	
353 AC	3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
354 AC	3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
355 AC	3 Inner gimbal axis unit vector x,y,z	
356 AC	3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
357 AC	3 Initial length and rate, y(to) and ydot(to)	
358 AC	3 Constants; K1 or wo, n or zeta, Kg, Jm	
359 AC	3 Non-linearities; TLim, Tco, Dz	
360 AC	4 Actuator ID number	4
361 AC	4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
362 AC	4 Actuator location; Node or Hinge (N or H)	
363 AC	4 Mounting point body ID number, node ID number	3 2
364 AC	4 Second mounting point body ID, second node ID	
365 AC	4 Output axis unit vector x,y,z	1 0 0
366 AC	4 Mounting point Hinge index, Axis index	
367 AC	4 Rotor spin axis unit vector x,y,z	
368 AC	4 Initial rotor momentum, H	
369 AC	4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	

370 AC	4	Outer gimbal axis unit vector x,y,z	
371 AC	4	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
372 AC	4	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
373 AC	4	Inner gimbal axis unit vector x,y,z	
374 AC	4	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
375 AC	4	Initial length and rate, y(to) and ydot(to)	
376 AC	4	Constants; K1 or wo, n or zeta, Kg, Jm	
377 AC	4	Non-linearities; TLim, Tco, Dz	
378 AC	5	Actuator ID number	5
379 AC	5	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
380 AC	5	Actuator location; Node or Hinge (N or H)	
381 AC	5	Mounting point body ID number, node ID number	3 2
382 AC	5	Second mounting point body ID, second node ID	
383 AC	5	Output axis unit vector x,y,z	0 1 0
384 AC	5	Mounting point Hinge index, Axis index	
385 AC	5	Rotor spin axis unit vector x,y,z	
386 AC	5	Initial rotor momentum, H	
387 AC	5	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
388 AC	5	Outer gimbal axis unit vector x,y,z	
389 AC	5	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
390 AC	5	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
391 AC	5	Inner gimbal axis unit vector x,y,z	
392 AC	5	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
393 AC	5	Initial length and rate, y(to) and ydot(to)	
394 AC	5	Constants; K1 or wo, n or zeta, Kg, Jm	
395 AC	5	Non-linearities; TLim, Tco, Dz	
396 AC	6	Actuator ID number	6
397 AC	6	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
398 AC	6	Actuator location; Node or Hinge (N or H)	
399 AC	6	Mounting point body ID number, node ID number	3 2
400 AC	6	Second mounting point body ID, second node ID	
401 AC	6	Output axis unit vector x,y,z	0 0 1
402 AC	6	Mounting point Hinge index, Axis index	
403 AC	6	Rotor spin axis unit vector x,y,z	
404 AC	6	Initial rotor momentum, H	
405 AC	6	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
406 AC	6	Outer gimbal axis unit vector x,y,z	
407 AC	6	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
408 AC	6	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
409 AC	6	Inner gimbal axis unit vector x,y,z	
410 AC	6	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
411 AC	6	Initial length and rate, y(to) and ydot(to)	
412 AC	6	Constants; K1 or wo, n or zeta, Kg, Jm	
413 AC	6	Non-linearities; TLim, Tco, Dz	
414 AC	7	Actuator ID number	7
415 AC	7	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
416 AC	7	Actuator location; Node or Hinge (N or H)	
417 AC	7	Mounting point body ID number, node ID number	4 2
418 AC	7	Second mounting point body ID, second node ID	
419 AC	7	Output axis unit vector x,y,z	1 0 0
420 AC	7	Mounting point Hinge index, Axis index	
421 AC	7	Rotor spin axis unit vector x,y,z	
422 AC	7	Initial rotor momentum, H	
423 AC	7	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
424 AC	7	Outer gimbal axis unit vector x,y,z	
425 AC	7	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
426 AC	7	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
427 AC	7	Inner gimbal axis unit vector x,y,z	
428 AC	7	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
429 AC	7	Initial length and rate, y(to) and ydot(to)	
430 AC	7	Constants; K1 or wo, n or zeta, Kg, Jm	
431 AC	7	Non-linearities; TLim, Tco, Dz	
432 AC	8	Actuator ID number	8
433 AC	8	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
434 AC	8	Actuator location; Node or Hinge (N or H)	
435 AC	8	Mounting point body ID number, node ID number	4 2
436 AC	8	Second mounting point body ID, second node ID	

437 AC	8 Output axis unit vector x,y,z	0 1 0
438 AC	8 Mounting point Hinge index, Axis index	
439 AC	8 Rotor spin axis unit vector x,y,z	
440 AC	8 Initial rotor momentum, H	
441 AC	8 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
442 AC	8 Outer gimbal axis unit vector x,y,z	
443 AC	8 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
444 AC	8 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
445 AC	8 Inner gimbal axis unit vector x,y,z	
446 AC	8 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
447 AC	8 Initial length and rate, y(to) and ydot(to)	
448 AC	8 Constants; K1 or wo, n or zeta, Kg, Jm	
449 AC	8 Non-linearities; TLim, Tco, Dz	
450 AC	9 Actuator ID number	9
451 AC	9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	MO
452 AC	9 Actuator location; Node or Hinge (N or H)	
453 AC	9 Mounting point body ID number, node ID number	4 2
454 AC	9 Second mounting point body ID, second node ID	
455 AC	9 Output axis unit vector x,y,z	0 0 1
456 AC	9 Mounting point Hinge index, Axis index	
457 AC	9 Rotor spin axis unit vector x,y,z	
458 AC	9 Initial rotor momentum, H	
459 AC	9 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
460 AC	9 Outer gimbal axis unit vector x,y,z	
461 AC	9 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
462 AC	9 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
463 AC	9 Inner gimbal axis unit vector x,y,z	
464 AC	9 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
465 AC	9 Initial length and rate, y(to) and ydot(to)	
466 AC	9 Constants; K1 or wo, n or zeta, Kg, Jm	
467 AC	9 Non-linearities; TLim, Tco, Dz	
468 AC	10 Actuator ID number	10
469 AC	10 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	J
470 AC	10 Actuator location; Node or Hinge (N or H)	
471 AC	10 Mounting point body ID number, node ID number	2 5
472 AC	10 Second mounting point body ID, second node ID	
473 AC	10 Output axis unit vector x,y,z	-1 0 0
474 AC	10 Mounting point Hinge index, Axis index	
475 AC	10 Rotor spin axis unit vector x,y,z	
476 AC	10 Initial rotor momentum, H	
477 AC	10 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
478 AC	10 Outer gimbal axis unit vector x,y,z	
479 AC	10 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
480 AC	10 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
481 AC	10 Inner gimbal axis unit vector x,y,z	
482 AC	10 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
483 AC	10 Initial length and rate, y(to) and ydot(to)	
484 AC	10 Constants; K1 or wo, n or zeta, Kg, Jm	
485 AC	10 Non-linearities; TLim, Tco, Dz	

CONTROLLER

486 CO	1 Controller ID number	1
487 CO	1 Controller type (CB,CM,DB,DM,UC,UD)	CM
488 CO	1 Sample time (sec)	
489 CO	1 Number of inputs, Number of outputs	9 9
490 CO	1 Number of states	
491 CO	1 Output No., Input type (I,S,T), Input ID, Gain	

INTERCONNECT

492 IN	1 Interconnect ID number	1
493 IN	1 Source type(S,C, or F),Source ID,Source row #	S 1 1
494 IN	1 Destination type(A or C),Dest ID,Dest row #	C 1 1
495 IN	1 Gain	4.41E13
496 IN	2 Interconnect ID number	2

497 IN	2	Source type(S,C, or F),Source ID,Source row #	C 1 1
498 IN	2	Destination type(A or C),Dest ID,Dest row #	A 1 1
499 IN	2	Gain	1
500 IN	3	Interconnect ID number	3
501 IN	3	Source type(S,C, or F),Source ID,Source row #	S 1 2
502 IN	3	Destination type(A or C),Dest ID,Dest row #	C 1 2
503 IN	3	Gain	1.67E12
504 IN	4	Interconnect ID number	4
505 IN	4	Source type(S,C, or F),Source ID,Source row #	C 1 2
506 IN	4	Destination type(A or C),Dest ID,Dest row #	A 2 1
507 IN	4	Gain	1
508 IN	5	Interconnect ID number	5
509 IN	5	Source type(S,C, or F),Source ID,Source row #	S 2 1
510 IN	5	Destination type(A or C),Dest ID,Dest row #	C 1 3
511 IN	5	Gain	4.31E13
512 IN	6	Interconnect ID number	6
513 IN	6	Source type(S,C, or F),Source ID,Source row #	C 1 3
514 IN	6	Destination type(A or C),Dest ID,Dest row #	A 3 1
515 IN	6	Gain	1
516 IN	7	Interconnect ID number	7
517 IN	7	Source type(S,C, or F),Source ID,Source row #	S 3 1
518 IN	7	Destination type(A or C),Dest ID,Dest row #	C 1 4
519 IN	7	Gain	1.7E12
520 IN	8	Interconnect ID number	8
521 IN	8	Source type(S,C, or F),Source ID,Source row #	C 1 4
522 IN	8	Destination type(A or C),Dest ID,Dest row #	A 4 1
523 IN	8	Gain	1
524 IN	9	Interconnect ID number	9
525 IN	9	Source type(S,C, or F),Source ID,Source row #	S 3 2
526 IN	9	Destination type(A or C),Dest ID,Dest row #	C 1 5
527 IN	9	Gain	1.7E12
528 IN	10	Interconnect ID number	10
529 IN	10	Source type(S,C, or F),Source ID,Source row #	C 1 5
530 IN	10	Destination type(A or C),Dest ID,Dest row #	A 5 1
531 IN	10	Gain	1
532 IN	11	Interconnect ID number	11
533 IN	11	Source type(S,C, or F),Source ID,Source row #	S 3 3
534 IN	11	Destination type(A or C),Dest ID,Dest row #	C 1 6
535 IN	11	Gain	3.4E12
536 IN	12	Interconnect ID number	12
537 IN	12	Source type(S,C, or F),Source ID,Source row #	C 1 6
538 IN	12	Destination type(A or C),Dest ID,Dest row #	A 6 1
539 IN	12	Gain	1
540 IN	13	Interconnect ID number	13
541 IN	13	Source type(S,C, or F),Source ID,Source row #	S 4 1
542 IN	13	Destination type(A or C),Dest ID,Dest row #	C 1 7
543 IN	13	Gain	1.7E12
544 IN	14	Interconnect ID number	14
545 IN	14	Source type(S,C, or F),Source ID,Source row #	C 1 7
546 IN	14	Destination type(A or C),Dest ID,Dest row #	A 7 1
547 IN	14	Gain	1
548 IN	15	Interconnect ID number	15
549 IN	15	Source type(S,C, or F),Source ID,Source row #	S 4 2
550 IN	15	Destination type(A or C),Dest ID,Dest row #	C 1 8
551 IN	15	Gain	1.7E12
552 IN	16	Interconnect ID number	16
553 IN	16	Source type(S,C, or F),Source ID,Source row #	C 1 8

554 IN	16	Destination type(A or C),Dest ID, Dest row #	A 8 1
555 IN	16	Gain	1
556 IN	17	Interconnect ID number	17
557 IN	17	Source type(S,C, or F),Source ID,Source row #	S 4 3
558 IN	17	Destination type(A or C),Dest ID, Dest row #	C 1 9
559 IN	17	Gain	3.4E12
560 IN	18	Interconnect ID number	18
561 IN	18	Source type(S,C, or F),Source ID,Source row #	C 1 9
562 IN	18	Destination type(A or C),Dest ID, Dest row #	A 9 1
563 IN	18	Gain	1
564 IN	19	Interconnect ID number	19
565 IN	19	Source type(S,C, or F),Source ID,Source row #	S 5 3
566 IN	19	Destination type(A or C),Dest ID, Dest row #	A 10 1
567 IN	19	Gain	7

isc3_flex_autmeq.int (Concept 3) Autumnal Equinox

TREETOPS REV 10P2 4/10/00

SIM CONTROL

1 SI	0	Title	ISC MODEL, THIRD VERSION
2 SI	0	Simulation stop time	100000
3 SI	0	Plot data interval	20
4 SI	0	Integration type (R,S,U, OR V)	R
5 SI	0	Step size (sec)	.1
6 SI	0	Sandia ODE solver absolute and relative error	
7 SI	0	RK78 ODE solver absolute error and first step size	
8 SI	0	Linearization option (L,Z or N)	N
9 SI	0	Restart option (Y/N)	N
10 SI	0	Contact force computation option (Y/N)	Y
11 SI	0	Constraint force computation option (Y/N)	N
12 SI	0	Small angle speedup option (All,Bypass,First,Nth)	A
13 SI	0	Mass matrix speedup option (All,Bypass,First,Nth)	A
14 SI	0	Non-Linear speedup option (All,Bypass,First,Nth)	A
15 SI	0	Constraint speedup option (All,Bypass,First,Nth)	A
16 SI	0	Constraint stabilization option (Y/N)	N
17 SI	0	Stabilization epsilon	

GENGRAV

18 GG	4	Gravity, earth sphere/nonsphere/user (S/N/U)?	N
19 GG	1	Input gravity constants: GME, ERAD, EMASS	
20 GG	1	Spherical or Nonspherical (S/N)?	
21 GG	1	Gravity Potential Harmonics J2,J3,J4	
22 GG	4	English (ft-slug-s) or metric (m-kg-s) (E/M)?	M
23 GG	4	Day, Month, Year,	20 9 2020
24 GG	4	GMT @ sim time 0 (minutes past midnight,	360
25 GG	4	Solar Pressure forces Y/N?	Y
26 GG	4	Input new data for aero model? (Y/N)	N
27 GG	1	Solar flux F10 for aero model	
28 GG	1	Solar flux, 81 day average F10B	
29 GG	1	Geomagnetic index, GEAP	

BODY

30 BO	1	Body ID number	1
31 BO	1	Type (Rigid,Flexible,NASTRAN)	F
32 BO	1	Number of modes	24

33 BO	1	Modal calculation option (0, 1 or 2)	2
34 BO	1	Foreshortening option (Y/N)	
35 BO	1	Model reduction method (NO,MS,MC,CC,QM,CV)	
36 BO	1	NASTRAN data file FORTRAN unit number (40 - 60)	
37 BO	1	Number of augmented nodes (0 if none)	
38 BO	1	Damping matrix option (NS,CD,HL,SD)	
39 BO	1	Constant damping ratio	
40 BO	1	Low frequency, High frequency ratios	
41 BO	1	Mode ID number, damping ratio	
42 BO	1	Conversion factors: Length,Mass,Force	
43 BO	1	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
44 BO	1	Moments of inertia (kg-m2) Ixx,Iyy,Izz	6.2852173E11 6.2852173E11
6.7057352E8			
45 BO	1	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
46 BO	1	Mass (kg)	1.6168633E5
47 BO	1	Number of Nodes	4
48 BO	1	Node ID, Node coord. (meters) x,y,z	1 0 0 0
49 BO	1	Node ID, Node coord. (meters) x,y,z	2 0 0 0
50 BO	1	Node ID, Node coord. (meters) x,y,z	3 0 0 3188.8
51 BO	1	Node ID, Node coord. (meters) x,y,z	4 0 0 -3188.8
52 BO	1	Node ID, Node structural joint ID	
53 BO	2	Body ID number	2
54 BO	2	Type (Rigid,Flexible,NASTRAN)	R
55 BO	2	Number of modes	
56 BO	2	Modal calculation option (0, 1 or 2)	
57 BO	2	Foreshortening option (Y/N)	
58 BO	2	Model reduction method (NO,MS,MC,CC,QM,CV)	
59 BO	2	NASTRAN data file FORTRAN unit number (40 - 60)	
60 BO	2	Number of augmented nodes (0 if none)	
61 BO	2	Damping matrix option (NS,CD,HL,SD)	
62 BO	2	Constant damping ratio	
63 BO	2	Low frequency, High frequency ratios	
64 BO	2	Mode ID number, damping ratio	
65 BO	2	Conversion factors: Length,Mass,Force	
66 BO	2	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
67 BO	2	Moments of inertia (kg-m2) Ixx,Iyy,Izz	.8543E12 1.5601E12
1.3822E12			
68 BO	2	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
69 BO	2	Mass (kg)	12666300
70 BO	2	Number of Nodes	5
71 BO	2	Node ID, Node coord. (meters) x,y,z	1 298.323 0 0
72 BO	2	Node ID, Node coord. (meters) x,y,z	2 0 0 0
73 BO	2	Node ID, Node coord. (meters) x,y,z	3 0 0 300
74 BO	2	Node ID, Node coord. (meters) x,y,z	4 0 0 -300
75 BO	2	Node ID, Node coord. (meters) x,y,z	5 500 0 0
76 BO	2	Node ID, Node structural joint ID	
77 BO	3	Body ID number	3
78 BO	3	Type (Rigid,Flexible,NASTRAN)	R
79 BO	3	Number of modes	
80 BO	3	Modal calculation option (0, 1 or 2)	
81 BO	3	Foreshortening option (Y/N)	
82 BO	3	Model reduction method (NO,MS,MC,CC,QM,CV)	
83 BO	3	NASTRAN data file FORTRAN unit number (40 - 60)	
84 BO	3	Number of augmented nodes (0 if none)	
85 BO	3	Damping matrix option (NS,CD,HL,SD)	
86 BO	3	Constant damping ratio	
87 BO	3	Low frequency, High frequency ratios	
88 BO	3	Mode ID number, damping ratio	
89 BO	3	Conversion factors: Length,Mass,Force	
90 BO	3	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
91 BO	3	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
92 BO	3	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
93 BO	3	Mass (kg)	2046600
94 BO	3	Number of Nodes	2
95 BO	3	Node ID, Node coord. (meters) x,y,z	1 0 0 0
96 BO	3	Node ID, Node coord. (meters) x,y,z	2 0 0 0
97 BO	3	Node ID, Node structural joint ID	
98 BO	4	Body ID number	4

99 BO	4 Type (Rigid,Flexible,NASTRAN)	R
100 BO	4 Number of modes	
101 BO	4 Modal calculation option (0, 1 or 2)	
102 BO	4 Foreshortening option (Y/N)	
103 BO	4 Model reduction method (NO,MS,MC,CC,QM,CV)	
104 BO	4 NASTRAN data file FORTRAN unit number (40 - 60)	
105 BO	4 Number of augmented nodes (0 if none)	
106 BO	4 Damping matrix option (NS,CD,HL,SD)	
107 BO	4 Constant damping ratio	
108 BO	4 Low frequency, High frequency ratios	
109 BO	4 Mode ID number, damping ratio	
110 BO	4 Conversion factors: Length,Mass,Force	
111 BO	4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
112 BO	4 Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
113 BO	4 Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
114 BO	4 Mass (kg)	2046600
115 BO	4 Number of Nodes	2
116 BO	4 Node ID, Node coord. (meters) x,y,z	1 0 0 0
117 BO	4 Node ID, Node coord. (meters) x,y,z	2 0 0 0
118 BO	4 Node ID, Node structural joint ID	

HINGE

119 HI	1 Hinge ID number	1
120 HI	1 Inboard body ID, Outboard body ID	0 1
121 HI	1 "p" node ID, "q" node ID	0 2
122 HI	1 Number of rotation DOFs, Rotation option (F or G)	3 F
123 HI	1 L1 unit vector in inboard body coord. x,y,z	1 0 0
124 HI	1 L1 unit vector in outboard body coord. x,y,z	1 0 0
125 HI	1 L2 unit vector in inboard body coord. x,y,z	
126 HI	1 L2 unit vector in outboard body coord. x,y,z	
127 HI	1 L3 unit vector in inboard body coord. x,y,z	0 0 1
128 HI	1 L3 unit vector in outboard body coord. x,y,z	0 0 1
129 HI	1 Initial rotation angles (deg)	-90 0 90
130 HI	1 Initial rotation rates (deg/sec)	0 0 0.00417807
131 HI	1 Rotation stiffness (newton-meters/rad)	0 0 0
132 HI	1 Rotation damping (newton-meters/rad/sec)	0 0 0
133 HI	1 Null torque angles (deg)	0 0 0
134 HI	1 Number of translation DOFs	3
135 HI	1 First translation unit vector g1	1 0 0
136 HI	1 Second translation unit vector g2	0 1 0
137 HI	1 Third translation unit vector g3	0 0 1
138 HI	1 Initial translation (meters)	0 0 42163421
139 HI	1 Initial translation velocity (meters/sec)	3074.681 0 0
140 HI	1 Translation stiffness (newtons/meters)	0 0 0
141 HI	1 Translation damping (newtons/meter/sec)	0 0 0
142 HI	1 Null force translations	0 0 0
143 HI	2 Hinge ID number	2
144 HI	2 Inboard body ID, Outboard body ID	1 2
145 HI	2 "p" node ID, "q" node ID	2 2
146 HI	2 Number of rotation DOFs	0
147 HI	2 L1 unit vector in inboard body coord. x,y,z	0 0 1
148 HI	2 L1 unit vector in outboard body coord. x,y,z	0 0 1
149 HI	2 L2 unit vector in inboard body coord. x,y,z	
150 HI	2 L2 unit vector in outboard body coord. x,y,z	
151 HI	2 L3 unit vector in inboard body coord. x,y,z	1 0 0
152 HI	2 L3 unit vector in outboard body coord. x,y,z	1 0 0
153 HI	2 Initial rotation angles (deg)	0 0 0
154 HI	2 Initial rotation rates (deg/sec)	
155 HI	2 Rotation stiffness (newton-meters/rad)	
156 HI	2 Rotation damping (newton-meters/rad/sec)	
157 HI	2 Null torque angles (deg)	
158 HI	2 Number of translation DOFs	0
159 HI	2 First translation unit vector g1	1 0 0
160 HI	2 Second translation unit vector g2	0 1 0
161 HI	2 Third translation unit vector g3	0 0 1
162 HI	2 Initial translation (meters)	0 0 0
163 HI	2 Initial translation velocity (meters/sec)	
164 HI	2 Translation stiffness (newtons/meters)	

165 HI	2	Translation damping (newtons/meter/sec)	
166 HI	2	Null force translations	
167 HI	3	Hinge ID number	3
168 HI	3	Inboard body ID, Outboard body ID	1 3
169 HI	3	"p" node ID, "q" node ID	3 2
170 HI	3	Number of rotation DOFs	3
171 HI	3	L1 unit vector in inboard body coord. x,y,z	0 0 1
172 HI	3	L1 unit vector in outboard body coord. x,y,z	0 0 1
173 HI	3	L2 unit vector in inboard body coord. x,y,z	
174 HI	3	L2 unit vector in outboard body coord. x,y,z	
175 HI	3	L3 unit vector in inboard body coord. x,y,z	0 1 0
176 HI	3	L3 unit vector in outboard body coord. x,y,z	0 1 0
177 HI	3	Initial rotation angles (deg)	180. 0 -135.
178 HI	3	Initial rotation rates (deg/sec)	-0.004178 0 0
179 HI	3	Rotation stiffness (newton-meters/rad)	0 0 0
180 HI	3	Rotation damping (newton-meters/rad/sec)	0 0 0
181 HI	3	Null torque angles (deg)	0 0 0
182 HI	3	Number of translation DOFs	0
183 HI	3	First translation unit vector g1	1 0 0
184 HI	3	Second translation unit vector g2	0 1 0
185 HI	3	Third translation unit vector g3	0 0 1
186 HI	3	Initial translation (meters)	0 0 0
187 HI	3	Initial translation velocity (meters/sec)	
188 HI	3	Translation stiffness (newtons/meters)	
189 HI	3	Translation damping (newtons/meter/sec)	
190 HI	3	Null force translations	
191 HI	4	Hinge ID number	4
192 HI	4	Inboard body ID, Outboard body ID	1 4
193 HI	4	"p" node ID, "q" node ID	4 2
194 HI	4	Number of rotation DOFs	3
195 HI	4	L1 unit vector in inboard body coord. x,y,z	0 0 1
196 HI	4	L1 unit vector in outboard body coord. x,y,z	0 0 1
197 HI	4	L2 unit vector in inboard body coord. x,y,z	
198 HI	4	L2 unit vector in outboard body coord. x,y,z	
199 HI	4	L3 unit vector in inboard body coord. x,y,z	0 1 0
200 HI	4	L3 unit vector in outboard body coord. x,y,z	0 1 0
201 HI	4	Initial rotation angles (deg)	180. 0 -45.
202 HI	4	Initial rotation rates (deg/sec)	-0.004178 0 0
203 HI	4	Rotation stiffness (newton-meters/rad)	0 0 0
204 HI	4	Rotation damping (newton-meters/rad/sec)	0 0 0
205 HI	4	Null torque angles (deg)	0 0 0
206 HI	4	Number of translation DOFs	0
207 HI	4	First translation unit vector g1	1 0 0
208 HI	4	Second translation unit vector g2	0 1 0
209 HI	4	Third translation unit vector g3	0 0 1
210 HI	4	Initial translation (meters)	0 0 0
211 HI	4	Initial translation velocity (meters/sec)	
212 HI	4	Translation stiffness (newtons/meters)	
213 HI	4	Translation damping (newtons/meter/sec)	
214 HI	4	Null force translations	

SENSOR

215 SE	1	Sensor ID number	1
216 SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET
217 SE	1	Mounting point body ID, Mounting point node ID	2 2
218 SE	1	Second mounting point body ID, Second node ID	
219 SE	1	Input axis unit vector (IA) x,y,z	
220 SE	1	Mounting point Hinge index, Axis index	
221 SE	1	First focal plane unit vector (Fp1) x,y,z	0 0 -1
222 SE	1	Second focal plane unit vector (Fp2) x,y,z	0 1 0
223 SE	1	Sun/Star unit vector (Us) x,y,z	
224 SE	1	Velocity Aberration Option (Y/N)	
225 SE	1	Euler Angle Sequence (1-6)	
226 SE	1	CMG ID number and Gimbal number	
227 SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	6378000 0 0 4.178074D-3
228 SE	2	Sensor ID number	2

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229 SE  2 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ST
230 SE  2 Mounting point body ID, Mounting point node ID      2 2
231 SE  2 Second mounting point body ID, Second node ID
232 SE  2 Input axis unit vector (IA) x,y,z
233 SE  2 Mounting point Hinge index, Axis index
234 SE  2 First focal plane unit vector (Fp1) x,y,z           0 -1 0
235 SE  2 Second focal plane unit vector (Fp2) x,y,z          1 0 0
236 SE  2 Sun/Star unit vector (Us) x,y,z                     0 1 0
237 SE  2 Velocity Aberration Option (Y/N)                    N
238 SE  2 Euler Angle Sequence (1-6)
239 SE  2 CMG ID number and Gimbal number
240 SE  2 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

241 SE  3 Sensor ID number                                     3
242 SE  3 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) L
243 SE  3 Mounting point body ID, Mounting point node ID      3 2
244 SE  3 Second mounting point body ID, Second node ID
245 SE  3 Input axis unit vector (IA) x,y,z                   1 2 3
246 SE  3 Mounting point Hinge index, Axis index
247 SE  3 First focal plane unit vector (Fp1) x,y,z
248 SE  3 Second focal plane unit vector (Fp2) x,y,z
249 SE  3 Sun/Star unit vector (Us) x,y,z
250 SE  3 Velocity Aberration Option (Y/N)
251 SE  3 Euler Angle Sequence (1-6)
252 SE  3 CMG ID number and Gimbal number
253 SE  3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

254 SE  4 Sensor ID number                                     4
255 SE  4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) L
256 SE  4 Mounting point body ID, Mounting point node ID      4 2
257 SE  4 Second mounting point body ID, Second node ID
258 SE  4 Input axis unit vector (IA) x,y,z                   3 2 1
259 SE  4 Mounting point Hinge index, Axis index
260 SE  4 First focal plane unit vector (Fp1) x,y,z
261 SE  4 Second focal plane unit vector (Fp2) x,y,z
262 SE  4 Sun/Star unit vector (Us) x,y,z
263 SE  4 Velocity Aberration Option (Y/N)
264 SE  4 Euler Angle Sequence (1-6)
265 SE  4 CMG ID number and Gimbal number
266 SE  4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE  5 Sensor ID number                                     5
268 SE  5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ST
269 SE  5 Mounting point body ID, Mounting point node ID      2 5
270 SE  5 Second mounting point body ID, Second node ID
271 SE  5 Input axis unit vector (IA) x,y,z
272 SE  5 Mounting point Hinge index, Axis index
273 SE  5 First focal plane unit vector (Fp1) x,y,z           0 0 1
274 SE  5 Second focal plane unit vector (Fp2) x,y,z          0 -1 0
275 SE  5 Sun/Star unit vector (Us) x,y,z                     0 0 0
276 SE  5 Velocity Aberration Option (Y/N)                    N
277 SE  5 Euler Angle Sequence (1-6)
278 SE  5 CMG ID number and Gimbal number
279 SE  5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE  6 Sensor ID number                                     6
281 SE  6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV A3
282 SE  6 Mounting point body ID, Mounting point node ID      2 2
283 SE  6 Second mounting point body ID, Second node ID
284 SE  6 Input axis unit vector (IA) x,y,z
285 SE  6 Mounting point Hinge index, Axis index
286 SE  6 First focal plane unit vector (Fp1) x,y,z
287 SE  6 Second focal plane unit vector (Fp2) x,y,z
288 SE  6 Sun/Star unit vector (Us) x,y,z
289 SE  6 Velocity Aberration Option (Y/N)
290 SE  6 Euler Angle Sequence (1-6)
291 SE  6 CMG ID number and Gimbal number
292 SE  6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

293 SE  7 Sensor ID number                                     7
294 SE  7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV AC

```

295 SE	7 Mounting point body ID, Mounting point node ID	2 2
296 SE	7 Second mounting point body ID, Second node ID	
297 SE	7 Input axis unit vector (IA) x,y,z	1 0 0
298 SE	7 Mounting point Hinge index, Axis index	
299 SE	7 First focal plane unit vector (Fp1) x,y,z	
300 SE	7 Second focal plane unit vector (Fp2) x,y,z	
301 SE	7 Sun/Star unit vector (Us) x,y,z	
302 SE	7 Velocity Aberration Option (Y/N)	
303 SE	7 Euler Angle Sequence (1-6)	
304 SE	7 CMG ID number and Gimbal number	
305 SE	7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	

ACTR

306 AC	1 Actuator ID number	1
307 AC	1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
308 AC	1 Actuator location; Node or Hinge (N or H)	
309 AC	1 Mounting point body ID number, node ID number	2 2
310 AC	1 Second mounting point body ID, second node ID	
311 AC	1 Output axis unit vector x,y,z	0 1 0
312 AC	1 Mounting point Hinge index, Axis index	
313 AC	1 Rotor spin axis unit vector x,y,z	
314 AC	1 Initial rotor momentum, H	
315 AC	1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
316 AC	1 Outer gimbal axis unit vector x,y,z	
317 AC	1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
318 AC	1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
319 AC	1 Inner gimbal axis unit vector x,y,z	
320 AC	1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
321 AC	1 Initial length and rate, y(to) and ydot(to)	
322 AC	1 Constants; K1 or wo, n or zeta, Kg, Jm	
323 AC	1 Non-linearities; TLim, Tco, Dz	
324 AC	2 Actuator ID number	2
325 AC	2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
326 AC	2 Actuator location; Node or Hinge (N or H)	
327 AC	2 Mounting point body ID number, node ID number	2 2
328 AC	2 Second mounting point body ID, second node ID	
329 AC	2 Output axis unit vector x,y,z	0 0 1
330 AC	2 Mounting point Hinge index, Axis index	
331 AC	2 Rotor spin axis unit vector x,y,z	
332 AC	2 Initial rotor momentum, H	
333 AC	2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
334 AC	2 Outer gimbal axis unit vector x,y,z	
335 AC	2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
336 AC	2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
337 AC	2 Inner gimbal axis unit vector x,y,z	
338 AC	2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
339 AC	2 Initial length and rate, y(to) and ydot(to)	
340 AC	2 Constants; K1 or wo, n or zeta, Kg, Jm	
341 AC	2 Non-linearities; TLim, Tco, Dz	
342 AC	3 Actuator ID number	3
343 AC	3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
344 AC	3 Actuator location; Node or Hinge (N or H)	
345 AC	3 Mounting point body ID number, node ID number	2 2
346 AC	3 Second mounting point body ID, second node ID	
347 AC	3 Output axis unit vector x,y,z	1 0 0
348 AC	3 Mounting point Hinge index, Axis index	
349 AC	3 Rotor spin axis unit vector x,y,z	
350 AC	3 Initial rotor momentum, H	
351 AC	3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
352 AC	3 Outer gimbal axis unit vector x,y,z	
353 AC	3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
354 AC	3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
355 AC	3 Inner gimbal axis unit vector x,y,z	
356 AC	3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
357 AC	3 Initial length and rate, y(to) and ydot(to)	
358 AC	3 Constants; K1 or wo, n or zeta, Kg, Jm	
359 AC	3 Non-linearities; TLim, Tco, Dz	

360 AC	4 Actuator ID number	4
361 AC	4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
362 AC	4 Actuator location; Node or Hinge (N or H)	
363 AC	4 Mounting point body ID number, node ID number	3 2
364 AC	4 Second mounting point body ID, second node ID	
365 AC	4 Output axis unit vector x,y,z	1 0 0
366 AC	4 Mounting point Hinge index, Axis index	
367 AC	4 Rotor spin axis unit vector x,y,z	
368 AC	4 Initial rotor momentum, H	
369 AC	4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
370 AC	4 Outer gimbal axis unit vector x,y,z	
371 AC	4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
372 AC	4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
373 AC	4 Inner gimbal axis unit vector x,y,z	
374 AC	4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
375 AC	4 Initial length and rate, y(to) and ydot(to)	
376 AC	4 Constants; K1 or wo, n or zeta, Kg, Jm	
377 AC	4 Non-linearities; TLim, Tco, Dz	
378 AC	5 Actuator ID number	5
379 AC	5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
380 AC	5 Actuator location; Node or Hinge (N or H)	
381 AC	5 Mounting point body ID number, node ID number	3 2
382 AC	5 Second mounting point body ID, second node ID	
383 AC	5 Output axis unit vector x,y,z	0 1 0
384 AC	5 Mounting point Hinge index, Axis index	
385 AC	5 Rotor spin axis unit vector x,y,z	
386 AC	5 Initial rotor momentum, H	
387 AC	5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
388 AC	5 Outer gimbal axis unit vector x,y,z	
389 AC	5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
390 AC	5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
391 AC	5 Inner gimbal axis unit vector x,y,z	
392 AC	5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
393 AC	5 Initial length and rate, y(to) and ydot(to)	
394 AC	5 Constants; K1 or wo, n or zeta, Kg, Jm	
395 AC	5 Non-linearities; TLim, Tco, Dz	
396 AC	6 Actuator ID number	6
397 AC	6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
398 AC	6 Actuator location; Node or Hinge (N or H)	
399 AC	6 Mounting point body ID number, node ID number	3 2
400 AC	6 Second mounting point body ID, second node ID	
401 AC	6 Output axis unit vector x,y,z	0 0 1
402 AC	6 Mounting point Hinge index, Axis index	
403 AC	6 Rotor spin axis unit vector x,y,z	
404 AC	6 Initial rotor momentum, H	
405 AC	6 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
406 AC	6 Outer gimbal axis unit vector x,y,z	
407 AC	6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
408 AC	6 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
409 AC	6 Inner gimbal axis unit vector x,y,z	
410 AC	6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
411 AC	6 Initial length and rate, y(to) and ydot(to)	
412 AC	6 Constants; K1 or wo, n or zeta, Kg, Jm	
413 AC	6 Non-linearities; TLim, Tco, Dz	
414 AC	7 Actuator ID number	7
415 AC	7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
416 AC	7 Actuator location; Node or Hinge (N or H)	
417 AC	7 Mounting point body ID number, node ID number	4 2
418 AC	7 Second mounting point body ID, second node ID	
419 AC	7 Output axis unit vector x,y,z	1 0 0
420 AC	7 Mounting point Hinge index, Axis index	
421 AC	7 Rotor spin axis unit vector x,y,z	
422 AC	7 Initial rotor momentum, H	
423 AC	7 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
424 AC	7 Outer gimbal axis unit vector x,y,z	
425 AC	7 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
426 AC	7 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	

427 AC	7 Inner gimbal axis unit vector x,y,z	
428 AC	7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
429 AC	7 Initial length and rate, y(to) and ydot(to)	
430 AC	7 Constants; Kl or wo, n or zeta, Kg, Jm	
431 AC	7 Non-linearities; TLim, Tco, Dz	
432 AC	8 Actuator ID number	8
433 AC	8 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
434 AC	8 Actuator location; Node or Hinge (N or H)	
435 AC	8 Mounting point body ID number, node ID number	4 2
436 AC	8 Second mounting point body ID, second node ID	
437 AC	8 Output axis unit vector x,y,z	0 1 0
438 AC	8 Mounting point Hinge index, Axis index	
439 AC	8 Rotor spin axis unit vector x,y,z	
440 AC	8 Initial rotor momentum, H	
441 AC	8 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
442 AC	8 Outer gimbal axis unit vector x,y,z	
443 AC	8 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
444 AC	8 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
445 AC	8 Inner gimbal axis unit vector x,y,z	
446 AC	8 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
447 AC	8 Initial length and rate, y(to) and ydot(to)	
448 AC	8 Constants; Kl or wo, n or zeta, Kg, Jm	
449 AC	8 Non-linearities; TLim, Tco, Dz	
450 AC	9 Actuator ID number	9
451 AC	9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	MO
452 AC	9 Actuator location; Node or Hinge (N or H)	
453 AC	9 Mounting point body ID number, node ID number	4 2
454 AC	9 Second mounting point body ID, second node ID	
455 AC	9 Output axis unit vector x,y,z	0 0 1
456 AC	9 Mounting point Hinge index, Axis index	
457 AC	9 Rotor spin axis unit vector x,y,z	
458 AC	9 Initial rotor momentum, H	
459 AC	9 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
460 AC	9 Outer gimbal axis unit vector x,y,z	
461 AC	9 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
462 AC	9 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
463 AC	9 Inner gimbal axis unit vector x,y,z	
464 AC	9 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
465 AC	9 Initial length and rate, y(to) and ydot(to)	
466 AC	9 Constants; Kl or wo, n or zeta, Kg, Jm	
467 AC	9 Non-linearities; TLim, Tco, Dz	
468 AC	10 Actuator ID number	10
469 AC	10 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	J
470 AC	10 Actuator location; Node or Hinge (N or H)	
471 AC	10 Mounting point body ID number, node ID number	2 5
472 AC	10 Second mounting point body ID, second node ID	
473 AC	10 Output axis unit vector x,y,z	-1 0 0
474 AC	10 Mounting point Hinge index, Axis index	
475 AC	10 Rotor spin axis unit vector x,y,z	
476 AC	10 Initial rotor momentum, H	
477 AC	10 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
478 AC	10 Outer gimbal axis unit vector x,y,z	
479 AC	10 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
480 AC	10 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
481 AC	10 Inner gimbal axis unit vector x,y,z	
482 AC	10 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
483 AC	10 Initial length and rate, y(to) and ydot(to)	
484 AC	10 Constants; Kl or wo, n or zeta, Kg, Jm	
485 AC	10 Non-linearities; TLim, Tco, Dz	

CONTROLLER

486 CO	1 Controller ID number	1
487 CO	1 Controller type (CB,CM,DB,DM,UC,UD)	CM
488 CO	1 Sample time (sec)	
489 CO	1 Number of inputs, Number of outputs	9 9
490 CO	1 Number of states	

491 CO 1 Output No., Input type (I,S,T), Input ID, Gain

INTERCONNECT

492 IN	1	Interconnect ID number	1
493 IN	1	Source type(S,C, or F),Source ID,Source row #	S 1 1
494 IN	1	Destination type(A or C),Dest ID,Dest row #	C 1 1
495 IN	1	Gain	4.41E13
496 IN	2	Interconnect ID number	2
497 IN	2	Source type(S,C, or F),Source ID,Source row #	C 1 1
498 IN	2	Destination type(A or C),Dest ID,Dest row #	A 1 1
499 IN	2	Gain	1
500 IN	3	Interconnect ID number	3
501 IN	3	Source type(S,C, or F),Source ID,Source row #	S 1 2
502 IN	3	Destination type(A or C),Dest ID,Dest row #	C 1 2
503 IN	3	Gain	1.67E12
504 IN	4	Interconnect ID number	4
505 IN	4	Source type(S,C, or F),Source ID,Source row #	C 1 2
506 IN	4	Destination type(A or C),Dest ID,Dest row #	A 2 1
507 IN	4	Gain	1
508 IN	5	Interconnect ID number	5
509 IN	5	Source type(S,C, or F),Source ID,Source row #	S 2 1
510 IN	5	Destination type(A or C),Dest ID,Dest row #	C 1 3
511 IN	5	Gain	4.31E13
512 IN	6	Interconnect ID number	6
513 IN	6	Source type(S,C, or F),Source ID,Source row #	C 1 3
514 IN	6	Destination type(A or C),Dest ID,Dest row #	A 3 1
515 IN	6	Gain	1
516 IN	7	Interconnect ID number	7
517 IN	7	Source type(S,C, or F),Source ID,Source row #	S 3 1
518 IN	7	Destination type(A or C),Dest ID,Dest row #	C 1 4
519 IN	7	Gain	1.7E12
520 IN	8	Interconnect ID number	8
521 IN	8	Source type(S,C, or F),Source ID,Source row #	C 1 4
522 IN	8	Destination type(A or C),Dest ID,Dest row #	A 4 1
523 IN	8	Gain	1
524 IN	9	Interconnect ID number	9
525 IN	9	Source type(S,C, or F),Source ID,Source row #	S 3 2
526 IN	9	Destination type(A or C),Dest ID,Dest row #	C 1 5
527 IN	9	Gain	1.7E12
528 IN	10	Interconnect ID number	10
529 IN	10	Source type(S,C, or F),Source ID,Source row #	C 1 5
530 IN	10	Destination type(A or C),Dest ID,Dest row #	A 5 1
531 IN	10	Gain	1
532 IN	11	Interconnect ID number	11
533 IN	11	Source type(S,C, or F),Source ID,Source row #	S 3 3
534 IN	11	Destination type(A or C),Dest ID,Dest row #	C 1 6
535 IN	11	Gain	3.4E12
536 IN	12	Interconnect ID number	12
537 IN	12	Source type(S,C, or F),Source ID,Source row #	C 1 6
538 IN	12	Destination type(A or C),Dest ID,Dest row #	A 6 1
539 IN	12	Gain	1
540 IN	13	Interconnect ID number	13
541 IN	13	Source type(S,C, or F),Source ID,Source row #	S 4 1
542 IN	13	Destination type(A or C),Dest ID,Dest row #	C 1 7
543 IN	13	Gain	1.7E12
544 IN	14	Interconnect ID number	14

545 IN	14	Source type(S,C, or F),Source ID,Source row #	C 1 7
546 IN	14	Destination type(A or C),Dest ID,Dest row #	A 7 1
547 IN	14	Gain	1
548 IN	15	Interconnect ID number	15
549 IN	15	Source type(S,C, or F),Source ID,Source row #	S 4 2
550 IN	15	Destination type(A or C),Dest ID,Dest row #	C 1 8
551 IN	15	Gain	1.7E12
552 IN	16	Interconnect ID number	16
553 IN	16	Source type(S,C, or F),Source ID,Source row #	C 1 8
554 IN	16	Destination type(A or C),Dest ID,Dest row #	A 8 1
555 IN	16	Gain	1
556 IN	17	Interconnect ID number	17
557 IN	17	Source type(S,C, or F),Source ID,Source row #	S 4 3
558 IN	17	Destination type(A or C),Dest ID,Dest row #	C 1 9
559 IN	17	Gain	3.4E12
560 IN	18	Interconnect ID number	18
561 IN	18	Source type(S,C, or F),Source ID,Source row #	C 1 9
562 IN	18	Destination type(A or C),Dest ID,Dest row #	A 9 1
563 IN	18	Gain	1
564 IN	19	Interconnect ID number	19
565 IN	19	Source type(S,C, or F),Source ID,Source row #	S 5 3
566 IN	19	Destination type(A or C),Dest ID,Dest row #	A 10 1
567 IN	19	Gain	7

isc3_flex_winsol.int (Concept 3) Winter Solstice

TREETOPS REV 10P2 4/10/00

SIM CONTROL

1 SI	0	Title	ISC MODEL, THIRD VERSION
2 SI	0	Simulation stop time	100000
3 SI	0	Plot data interval	20
4 SI	0	Integration type (R,S,U, OR V)	R
5 SI	0	Step size (sec)	.1
6 SI	0	Sandia ODE solver absolute and relative error	
7 SI	0	RK78 ODE solver absolute error and first step size	
8 SI	0	Linearization option (L,Z or N)	N
9 SI	0	Restart option (Y/N)	N
10 SI	0	Contact force computation option (Y/N)	Y
11 SI	0	Constraint force computation option (Y/N)	N
12 SI	0	Small angle speedup option (All,Bypass,First,Nth)	A
13 SI	0	Mass matrix speedup option (All,Bypass,First,Nth)	A
14 SI	0	Non-Linear speedup option (All,Bypass,First,Nth)	A
15 SI	0	Constraint speedup option (All,Bypass,First,Nth)	A
16 SI	0	Constraint stabilization option (Y/N)	N
17 SI	0	Stabilization epsilon	

GENGRAV

18 GG	0	Gravity, earth sphere/nonsphere/user (S/N/U)?	N
19 GG	1	Input gravity constants: GME, ERAD, EMASS	
20 GG	1	Spherical or Nonspherical (S/N)?	
21 GG	1	Gravity Potential Harmonics J2,J3,J4	
22 GG	0	English (ft-slug-s) or metric (m-kg-s) (E/M)?	M
23 GG	0	Day, Month, Year,	20 12 2020
24 GG	0	GMT @ sim time 0 (minutes past midnight,	360
25 GG	0	Solar Pressure forces Y/N?	Y
26 GG	0	Input new data for aero model? (Y/N)	N

27 GG 1 Solar flux F10 for aero model
28 GG 1 Solar flux, 81 day average F10B
29 GG 1 Geomagnetic index, GEAP

BODY

30 BO	1	Body ID number	1
31 BO	1	Type (Rigid,Flexible,NASTRAN)	F
32 BO	1	Number of modes	24
33 BO	1	Modal calculation option (0, 1 or 2)	2
34 BO	1	Foreshortening option (Y/N)	
35 BO	1	Model reduction method (NO,MS,MC,CC,QM,CV)	
36 BO	1	NASTRAN data file FORTRAN unit number (40 - 60)	
37 BO	1	Number of augmented nodes (0 if none)	
38 BO	1	Damping matrix option (NS,CD,HL,SD)	
39 BO	1	Constant damping ratio	
40 BO	1	Low frequency, High frequency ratios	
41 BO	1	Mode ID number, damping ratio	
42 BO	1	Conversion factors: Length,Mass,Force	
43 BO	1	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
44 BO	1	Moments of inertia (kg-m2) Ixx,Iyy,Izz	6.2852173E11 6.2852173E11
6.7057352E8			
45 BO	1	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
46 BO	1	Mass (kg)	1.6168633E5
47 BO	1	Number of Nodes	4
48 BO	1	Node ID, Node coord. (meters) x,y,z	1 0 0 0
49 BO	1	Node ID, Node coord. (meters) x,y,z	2 0 0 0
50 BO	1	Node ID, Node coord. (meters) x,y,z	3 0 0 3188.8
51 BO	1	Node ID, Node coord. (meters) x,y,z	4 0 0 -3188.8
52 BO	1	Node ID, Node structural joint ID	
53 BO	2	Body ID number	2
54 BO	2	Type (Rigid,Flexible,NASTRAN)	R
55 BO	2	Number of modes	
56 BO	2	Modal calculation option (0, 1 or 2)	
57 BO	2	Foreshortening option (Y/N)	
58 BO	2	Model reduction method (NO,MS,MC,CC,QM,CV)	
59 BO	2	NASTRAN data file FORTRAN unit number (40 - 60)	
60 BO	2	Number of augmented nodes (0 if none)	
61 BO	2	Damping matrix option (NS,CD,HL,SD)	
62 BO	2	Constant damping ratio	
63 BO	2	Low frequency, High frequency ratios	
64 BO	2	Mode ID number, damping ratio	
65 BO	2	Conversion factors: Length,Mass,Force	
66 BO	2	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
67 BO	2	Moments of inertia (kg-m2) Ixx,Iyy,Izz	.8543E12 1.5601E12
1.3822E12			
68 BO	2	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
69 BO	2	Mass (kg)	12666300
70 BO	2	Number of Nodes	5
71 BO	2	Node ID, Node coord. (meters) x,y,z	1 298.323 0 0
72 BO	2	Node ID, Node coord. (meters) x,y,z	2 0 0 0
73 BO	2	Node ID, Node coord. (meters) x,y,z	3 0 0 300
74 BO	2	Node ID, Node coord. (meters) x,y,z	4 0 0 -300
75 BO	2	Node ID, Node coord. (meters) x,y,z	5 500 0 0
76 BO	2	Node ID, Node structural joint ID	
77 BO	3	Body ID number	3
78 BO	3	Type (Rigid,Flexible,NASTRAN)	R
79 BO	3	Number of modes	
80 BO	3	Modal calculation option (0, 1 or 2)	
81 BO	3	Foreshortening option (Y/N)	
82 BO	3	Model reduction method (NO,MS,MC,CC,QM,CV)	
83 BO	3	NASTRAN data file FORTRAN unit number (40 - 60)	
84 BO	3	Number of augmented nodes (0 if none)	
85 BO	3	Damping matrix option (NS,CD,HL,SD)	
86 BO	3	Constant damping ratio	
87 BO	3	Low frequency, High frequency ratios	
88 BO	3	Mode ID number, damping ratio	

89 BO	3	Conversion factors: Length,Mass,Force	
90 BO	3	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
91 BO	3	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
92 BO	3	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
93 BO	3	Mass (kg)	2046600
94 BO	3	Number of Nodes	2
95 BO	3	Node ID, Node coord. (meters) x,y,z	1 0 0 0
96 BO	3	Node ID, Node coord. (meters) x,y,z	2 0 0 0
97 BO	3	Node ID, Node structural joint ID	
98 BO	4	Body ID number	4
99 BO	4	Type (Rigid,Flexible,NASTRAN)	R
100 BO	4	Number of modes	
101 BO	4	Modal calculation option (0, 1 or 2)	
102 BO	4	Foreshortening option (Y/N)	
103 BO	4	Model reduction method (NO,MS,MC,CC,QM,CV)	
104 BO	4	NASTRAN data file FORTRAN unit number (40 - 60)	
105 BO	4	Number of augmented nodes (0 if none)	
106 BO	4	Damping matrix option (NS,CD,HL,SD)	
107 BO	4	Constant damping ratio	
108 BO	4	Low frequency, High frequency ratios	
109 BO	4	Mode ID number, damping ratio	
110 BO	4	Conversion factors: Length,Mass,Force	
111 BO	4	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
112 BO	4	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
113 BO	4	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
114 BO	4	Mass (kg)	2046600
115 BO	4	Number of Nodes	2
116 BO	4	Node ID, Node coord. (meters) x,y,z	1 0 0 0
117 BO	4	Node ID, Node coord. (meters) x,y,z	2 0 0 0
118 BO	4	Node ID, Node structural joint ID	

HINGE

119 HI	1	Hinge ID number	1
120 HI	1	Inboard body ID, Outboard body ID	0 1
121 HI	1	"p" node ID, "q" node ID	0 2
122 HI	1	Number of rotation DOFs, Rotation option (F or G)	3 F
123 HI	1	L1 unit vector in inboard body coord. x,y,z	1 0 0
124 HI	1	L1 unit vector in outboard body coord. x,y,z	1 0 0
125 HI	1	L2 unit vector in inboard body coord. x,y,z	
126 HI	1	L2 unit vector in outboard body coord. x,y,z	
127 HI	1	L3 unit vector in inboard body coord. x,y,z	0 0 1
128 HI	1	L3 unit vector in outboard body coord. x,y,z	0 0 1
129 HI	1	Initial rotation angles (deg)	-90 0 90
130 HI	1	Initial rotation rates (deg/sec)	0 0 0.00417807
131 HI	1	Rotation stiffness (newton-meters/rad)	0 0 0
132 HI	1	Rotation damping (newton-meters/rad/sec)	0 0 0
133 HI	1	Null torque angles (deg)	0 0 0
134 HI	1	Number of translation DOFs	3
135 HI	1	First translation unit vector g1	1 0 0
136 HI	1	Second translation unit vector g2	0 1 0
137 HI	1	Third translation unit vector g3	0 0 1
138 HI	1	Initial translation (meters)	0 0 42163421
139 HI	1	Initial translation velocity (meters/sec)	3074.681 0 0
140 HI	1	Translation stiffness (newtons/meters)	0 0 0
141 HI	1	Translation damping (newtons/meter/sec)	0 0 0
142 HI	1	Null force translations	0 0 0
143 HI	2	Hinge ID number	2
144 HI	2	Inboard body ID, Outboard body ID	1 2
145 HI	2	"p" node ID, "q" node ID	2 2
146 HI	2	Number of rotation DOFs	0
147 HI	2	L1 unit vector in inboard body coord. x,y,z	0 0 1
148 HI	2	L1 unit vector in outboard body coord. x,y,z	0 0 1
149 HI	2	L2 unit vector in inboard body coord. x,y,z	
150 HI	2	L2 unit vector in outboard body coord. x,y,z	
151 HI	2	L3 unit vector in inboard body coord. x,y,z	1 0 0
152 HI	2	L3 unit vector in outboard body coord. x,y,z	1 0 0
153 HI	2	Initial rotation angles (deg)	0 0 0

154 HI	2	Initial rotation rates (deg/sec)	
155 HI	2	Rotation stiffness (newton-meters/rad)	
156 HI	2	Rotation damping (newton-meters/rad/sec)	
157 HI	2	Null torque angles (deg)	
158 HI	2	Number of translation DOFs	0
159 HI	2	First translation unit vector	g1 1 0 0
160 HI	2	Second translation unit vector	g2 0 1 0
161 HI	2	Third translation unit vector	g3 0 0 1
162 HI	2	Initial translation (meters)	0 0 0
163 HI	2	Initial translation velocity (meters/sec)	
164 HI	2	Translation stiffness (newtons/meters)	
165 HI	2	Translation damping (newtons/meter/sec)	
166 HI	2	Null force translations	
167 HI	3	Hinge ID number	3
168 HI	3	Inboard body ID, Outboard body ID	1 3
169 HI	3	"p" node ID, "q" node ID	3 2
170 HI	3	Number of rotation DOFs	3
171 HI	3	L1 unit vector in inboard body coord. x,y,z	0 0 1
172 HI	3	L1 unit vector in outboard body coord. x,y,z	0 0 1
173 HI	3	L2 unit vector in inboard body coord. x,y,z	
174 HI	3	L2 unit vector in outboard body coord. x,y,z	
175 HI	3	L3 unit vector in inboard body coord. x,y,z	0 1 0
176 HI	3	L3 unit vector in outboard body coord. x,y,z	0 1 0
177 HI	3	Initial rotation angles (deg)	-90. 0. -146.75
178 HI	3	Initial rotation rates (deg/sec)	-0.004178 0 0
179 HI	3	Rotation stiffness (newton-meters/rad)	0 0 0
180 HI	3	Rotation damping (newton-meters/rad/sec)	0 0 0
181 HI	3	Null torque angles (deg)	0 0 0
182 HI	3	Number of translation DOFs	0
183 HI	3	First translation unit vector	g1 1 0 0
184 HI	3	Second translation unit vector	g2 0 1 0
185 HI	3	Third translation unit vector	g3 0 0 1
186 HI	3	Initial translation (meters)	0 0 0
187 HI	3	Initial translation velocity (meters/sec)	
188 HI	3	Translation stiffness (newtons/meters)	
189 HI	3	Translation damping (newtons/meter/sec)	
190 HI	3	Null force translations	
191 HI	4	Hinge ID number	4
192 HI	4	Inboard body ID, Outboard body ID	1 4
193 HI	4	"p" node ID, "q" node ID	4 2
194 HI	4	Number of rotation DOFs	3
195 HI	4	L1 unit vector in inboard body coord. x,y,z	0 0 1
196 HI	4	L1 unit vector in outboard body coord. x,y,z	0 0 1
197 HI	4	L2 unit vector in inboard body coord. x,y,z	
198 HI	4	L2 unit vector in outboard body coord. x,y,z	
199 HI	4	L3 unit vector in inboard body coord. x,y,z	0 1 0
200 HI	4	L3 unit vector in outboard body coord. x,y,z	0 1 0
201 HI	4	Initial rotation angles (deg)	-90. 0. -56.75
202 HI	4	Initial rotation rates (deg/sec)	-0.004178 0 0
203 HI	4	Rotation stiffness (newton-meters/rad)	0 0 0
204 HI	4	Rotation damping (newton-meters/rad/sec)	0 0 0
205 HI	4	Null torque angles (deg)	0 0 0
206 HI	4	Number of translation DOFs	0
207 HI	4	First translation unit vector	g1 1 0 0
208 HI	4	Second translation unit vector	g2 0 1 0
209 HI	4	Third translation unit vector	g3 0 0 1
210 HI	4	Initial translation (meters)	0 0 0
211 HI	4	Initial translation velocity (meters/sec)	
212 HI	4	Translation stiffness (newtons/meters)	
213 HI	4	Translation damping (newtons/meter/sec)	
214 HI	4	Null force translations	

SENSOR

215 SE	1	Sensor ID number	1
216 SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET
217 SE	1	Mounting point body ID, Mounting point node ID	2 2
218 SE	1	Second mounting point body ID, Second node ID	

219 SE	1	Input axis unit vector (IA) x,y,z	
220 SE	1	Mounting point Hinge index, Axis index	
221 SE	1	First focal plane unit vector (Fp1) x,y,z	0 0 -1
222 SE	1	Second focal plane unit vector (Fp2) x,y,z	0 1 0
223 SE	1	Sun/Star unit vector (Us) x,y,z	
224 SE	1	Velocity Aberration Option (Y/N)	
225 SE	1	Euler Angle Sequence (1-6)	
226 SE	1	CMG ID number and Gimbal number	
227 SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	6378000 0 0 4.178074D-3
228 SE	2	Sensor ID number	2
229 SE	2	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
230 SE	2	Mounting point body ID, Mounting point node ID	2 2
231 SE	2	Second mounting point body ID, Second node ID	
232 SE	2	Input axis unit vector (IA) x,y,z	
233 SE	2	Mounting point Hinge index, Axis index	
234 SE	2	First focal plane unit vector (Fp1) x,y,z	0 -1 0
235 SE	2	Second focal plane unit vector (Fp2) x,y,z	1 0 0
236 SE	2	Sun/Star unit vector (Us) x,y,z	0 1 0
237 SE	2	Velocity Aberration Option (Y/N)	N
238 SE	2	Euler Angle Sequence (1-6)	
239 SE	2	CMG ID number and Gimbal number	
240 SE	2	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
241 SE	3	Sensor ID number	3
242 SE	3	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	L
243 SE	3	Mounting point body ID, Mounting point node ID	3 2
244 SE	3	Second mounting point body ID, Second node ID	
245 SE	3	Input axis unit vector (IA) x,y,z	1 2 3
246 SE	3	Mounting point Hinge index, Axis index	
247 SE	3	First focal plane unit vector (Fp1) x,y,z	
248 SE	3	Second focal plane unit vector (Fp2) x,y,z	
249 SE	3	Sun/Star unit vector (Us) x,y,z	
250 SE	3	Velocity Aberration Option (Y/N)	
251 SE	3	Euler Angle Sequence (1-6)	
252 SE	3	CMG ID number and Gimbal number	
253 SE	3	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
254 SE	4	Sensor ID number	4
255 SE	4	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	L
256 SE	4	Mounting point body ID, Mounting point node ID	4 2
257 SE	4	Second mounting point body ID, Second node ID	
258 SE	4	Input axis unit vector (IA) x,y,z	3 2 1
259 SE	4	Mounting point Hinge index, Axis index	
260 SE	4	First focal plane unit vector (Fp1) x,y,z	
261 SE	4	Second focal plane unit vector (Fp2) x,y,z	
262 SE	4	Sun/Star unit vector (Us) x,y,z	
263 SE	4	Velocity Aberration Option (Y/N)	
264 SE	4	Euler Angle Sequence (1-6)	
265 SE	4	CMG ID number and Gimbal number	
266 SE	4	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
267 SE	5	Sensor ID number	5
268 SE	5	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
269 SE	5	Mounting point body ID, Mounting point node ID	2 5
270 SE	5	Second mounting point body ID, Second node ID	
271 SE	5	Input axis unit vector (IA) x,y,z	
272 SE	5	Mounting point Hinge index, Axis index	
273 SE	5	First focal plane unit vector (Fp1) x,y,z	0 0 1
274 SE	5	Second focal plane unit vector (Fp2) x,y,z	0 -1 0
275 SE	5	Sun/Star unit vector (Us) x,y,z	0 0 0
276 SE	5	Velocity Aberration Option (Y/N)	N
277 SE	5	Euler Angle Sequence (1-6)	
278 SE	5	CMG ID number and Gimbal number	
279 SE	5	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
280 SE	6	Sensor ID number	6
281 SE	6	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET, LV	A3
282 SE	6	Mounting point body ID, Mounting point node ID	2 2
283 SE	6	Second mounting point body ID, Second node ID	
284 SE	6	Input axis unit vector (IA) x,y,z	

285 SE	6 Mounting point Hinge index, Axis index	
286 SE	6 First focal plane unit vector (Fp1) x,y,z	
287 SE	6 Second focal plane unit vector (Fp2) x,y,z	
288 SE	6 Sun/Star unit vector (Us) x,y,z	
289 SE	6 Velocity Aberration Option (Y/N)	
290 SE	6 Euler Angle Sequence (1-6)	
291 SE	6 CMG ID number and Gimbal number	
292 SE	6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
293 SE	7 Sensor ID number	7
294 SE	7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV AC	
295 SE	7 Mounting point body ID, Mounting point node ID	2 2
296 SE	7 Second mounting point body ID, Second node ID	
297 SE	7 Input axis unit vector (IA) x,y,z	1 0 0
298 SE	7 Mounting point Hinge index, Axis index	
299 SE	7 First focal plane unit vector (Fp1) x,y,z	
300 SE	7 Second focal plane unit vector (Fp2) x,y,z	
301 SE	7 Sun/Star unit vector (Us) x,y,z	
302 SE	7 Velocity Aberration Option (Y/N)	
303 SE	7 Euler Angle Sequence (1-6)	
304 SE	7 CMG ID number and Gimbal number	
305 SE	7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	

ACTR

306 AC	1 Actuator ID number	1
307 AC	1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
308 AC	1 Actuator location; Node or Hinge (N or H)	
309 AC	1 Mounting point body ID number, node ID number	2 2
310 AC	1 Second mounting point body ID, second node ID	
311 AC	1 Output axis unit vector x,y,z	0 1 0
312 AC	1 Mounting point Hinge index, Axis index	
313 AC	1 Rotor spin axis unit vector x,y,z	
314 AC	1 Initial rotor momentum, H	
315 AC	1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
316 AC	1 Outer gimbal axis unit vector x,y,z	
317 AC	1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
318 AC	1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
319 AC	1 Inner gimbal axis unit vector x,y,z	
320 AC	1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
321 AC	1 Initial length and rate, y(to) and ydot(to)	
322 AC	1 Constants; K1 or wo, n or zeta, Kg, Jm	
323 AC	1 Non-linearities; TLim, Tco, Dz	
324 AC	2 Actuator ID number	2
325 AC	2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
326 AC	2 Actuator location; Node or Hinge (N or H)	
327 AC	2 Mounting point body ID number, node ID number	2 2
328 AC	2 Second mounting point body ID, second node ID	
329 AC	2 Output axis unit vector x,y,z	0 0 1
330 AC	2 Mounting point Hinge index, Axis index	
331 AC	2 Rotor spin axis unit vector x,y,z	
332 AC	2 Initial rotor momentum, H	
333 AC	2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
334 AC	2 Outer gimbal axis unit vector x,y,z	
335 AC	2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
336 AC	2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
337 AC	2 Inner gimbal axis unit vector x,y,z	
338 AC	2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
339 AC	2 Initial length and rate, y(to) and ydot(to)	
340 AC	2 Constants; K1 or wo, n or zeta, Kg, Jm	
341 AC	2 Non-linearities; TLim, Tco, Dz	
342 AC	3 Actuator ID number	3
343 AC	3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
344 AC	3 Actuator location; Node or Hinge (N or H)	
345 AC	3 Mounting point body ID number, node ID number	2 2
346 AC	3 Second mounting point body ID, second node ID	
347 AC	3 Output axis unit vector x,y,z	1 0 0
348 AC	3 Mounting point Hinge index, Axis index	

349 AC	3 Rotor spin axis unit vector x,y,z	
350 AC	3 Initial rotor momentum, H	
351 AC	3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
352 AC	3 Outer gimbal axis unit vector x,y,z	
353 AC	3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
354 AC	3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
355 AC	3 Inner gimbal axis unit vector x,y,z	
356 AC	3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
357 AC	3 Initial length and rate, y(to) and ydot(to)	
358 AC	3 Constants; K1 or wo, n or zeta, Kg, Jm	
359 AC	3 Non-linearities; TLim, Tco, Dz	
360 AC	4 Actuator ID number	4
361 AC	4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
362 AC	4 Actuator location; Node or Hinge (N or H)	
363 AC	4 Mounting point body ID number, node ID number	3 2
364 AC	4 Second mounting point body ID, second node ID	
365 AC	4 Output axis unit vector x,y,z	1 0 0
366 AC	4 Mounting point Hinge index, Axis index	
367 AC	4 Rotor spin axis unit vector x,y,z	
368 AC	4 Initial rotor momentum, H	
369 AC	4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
370 AC	4 Outer gimbal axis unit vector x,y,z	
371 AC	4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
372 AC	4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
373 AC	4 Inner gimbal axis unit vector x,y,z	
374 AC	4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
375 AC	4 Initial length and rate, y(to) and ydot(to)	
376 AC	4 Constants; K1 or wo, n or zeta, Kg, Jm	
377 AC	4 Non-linearities; TLim, Tco, Dz	
378 AC	5 Actuator ID number	5
379 AC	5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
380 AC	5 Actuator location; Node or Hinge (N or H)	
381 AC	5 Mounting point body ID number, node ID number	3 2
382 AC	5 Second mounting point body ID, second node ID	
383 AC	5 Output axis unit vector x,y,z	0 1 0
384 AC	5 Mounting point Hinge index, Axis index	
385 AC	5 Rotor spin axis unit vector x,y,z	
386 AC	5 Initial rotor momentum, H	
387 AC	5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
388 AC	5 Outer gimbal axis unit vector x,y,z	
389 AC	5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
390 AC	5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
391 AC	5 Inner gimbal axis unit vector x,y,z	
392 AC	5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
393 AC	5 Initial length and rate, y(to) and ydot(to)	
394 AC	5 Constants; K1 or wo, n or zeta, Kg, Jm	
395 AC	5 Non-linearities; TLim, Tco, Dz	
396 AC	6 Actuator ID number	6
397 AC	6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
398 AC	6 Actuator location; Node or Hinge (N or H)	
399 AC	6 Mounting point body ID number, node ID number	3 2
400 AC	6 Second mounting point body ID, second node ID	
401 AC	6 Output axis unit vector x,y,z	0 0 1
402 AC	6 Mounting point Hinge index, Axis index	
403 AC	6 Rotor spin axis unit vector x,y,z	
404 AC	6 Initial rotor momentum, H	
405 AC	6 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
406 AC	6 Outer gimbal axis unit vector x,y,z	
407 AC	6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
408 AC	6 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
409 AC	6 Inner gimbal axis unit vector x,y,z	
410 AC	6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
411 AC	6 Initial length and rate, y(to) and ydot(to)	
412 AC	6 Constants; K1 or wo, n or zeta, Kg, Jm	
413 AC	6 Non-linearities; TLim, Tco, Dz	
414 AC	7 Actuator ID number	7
415 AC	7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO

416 AC	7	Actuator location; Node or Hinge (N or H)	
417 AC	7	Mounting point body ID number, node ID number	4 2
418 AC	7	Second mounting point body ID, second node ID	
419 AC	7	Output axis unit vector x,y,z	1 0 0
420 AC	7	Mounting point Hinge index, Axis index	
421 AC	7	Rotor spin axis unit vector x,y,z	
422 AC	7	Initial rotor momentum, H	
423 AC	7	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
424 AC	7	Outer gimbal axis unit vector x,y,z	
425 AC	7	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
426 AC	7	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
427 AC	7	Inner gimbal axis unit vector x,y,z	
428 AC	7	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
429 AC	7	Initial length and rate, y(to) and ydot(to)	
430 AC	7	Constants; K1 or wo, n or zeta, Kg, Jm	
431 AC	7	Non-linearities; TLim, Tco, Dz	
432 AC	8	Actuator ID number	8
433 AC	8	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
434 AC	8	Actuator location; Node or Hinge (N or H)	
435 AC	8	Mounting point body ID number, node ID number	4 2
436 AC	8	Second mounting point body ID, second node ID	
437 AC	8	Output axis unit vector x,y,z	0 1 0
438 AC	8	Mounting point Hinge index, Axis index	
439 AC	8	Rotor spin axis unit vector x,y,z	
440 AC	8	Initial rotor momentum, H	
441 AC	8	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
442 AC	8	Outer gimbal axis unit vector x,y,z	
443 AC	8	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
444 AC	8	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
445 AC	8	Inner gimbal axis unit vector x,y,z	
446 AC	8	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
447 AC	8	Initial length and rate, y(to) and ydot(to)	
448 AC	8	Constants; K1 or wo, n or zeta, Kg, Jm	
449 AC	8	Non-linearities; TLim, Tco, Dz	
450 AC	9	Actuator ID number	9
451 AC	9	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	MO
452 AC	9	Actuator location; Node or Hinge (N or H)	
453 AC	9	Mounting point body ID number, node ID number	4 2
454 AC	9	Second mounting point body ID, second node ID	
455 AC	9	Output axis unit vector x,y,z	0 0 1
456 AC	9	Mounting point Hinge index, Axis index	
457 AC	9	Rotor spin axis unit vector x,y,z	
458 AC	9	Initial rotor momentum, H	
459 AC	9	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
460 AC	9	Outer gimbal axis unit vector x,y,z	
461 AC	9	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
462 AC	9	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
463 AC	9	Inner gimbal axis unit vector x,y,z	
464 AC	9	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
465 AC	9	Initial length and rate, y(to) and ydot(to)	
466 AC	9	Constants; K1 or wo, n or zeta, Kg, Jm	
467 AC	9	Non-linearities; TLim, Tco, Dz	
468 AC	10	Actuator ID number	10
469 AC	10	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	J
470 AC	10	Actuator location; Node or Hinge (N or H)	
471 AC	10	Mounting point body ID number, node ID number	2 5
472 AC	10	Second mounting point body ID, second node ID	
473 AC	10	Output axis unit vector x,y,z	-1 0 0
474 AC	10	Mounting point Hinge index, Axis index	
475 AC	10	Rotor spin axis unit vector x,y,z	
476 AC	10	Initial rotor momentum, H	
477 AC	10	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
478 AC	10	Outer gimbal axis unit vector x,y,z	
479 AC	10	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
480 AC	10	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
481 AC	10	Inner gimbal axis unit vector x,y,z	
482 AC	10	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
483 AC	10	Initial length and rate, y(to) and ydot(to)	

484 AC 10 Constants; K1 or wo, n or zeta, Kg, Jm
485 AC 10 Non-linearities; TLim, Tco, Dz

CONTROLLER

486 CO 1 Controller ID number 1
487 CO 1 Controller type (CB,CM,DB,DM,UC,UD) CM
488 CO 1 Sample time (sec)
489 CO 1 Number of inputs, Number of outputs 9 9
490 CO 1 Number of states
491 CO 1 Output No., Input type (I,S,T), Input ID, Gain

INTERCONNECT

492 IN 1 Interconnect ID number 1
493 IN 1 Source type(S,C, or F),Source ID,Source row # S 1 1
494 IN 1 Destination type(A or C),Dest ID,Dest row # C 1 1
495 IN 1 Gain 4.41E13

496 IN 2 Interconnect ID number 2
497 IN 2 Source type(S,C, or F),Source ID,Source row # C 1 1
498 IN 2 Destination type(A or C),Dest ID,Dest row # A 1 1
499 IN 2 Gain 1

500 IN 3 Interconnect ID number 3
501 IN 3 Source type(S,C, or F),Source ID,Source row # S 1 2
502 IN 3 Destination type(A or C),Dest ID,Dest row # C 1 2
503 IN 3 Gain 1.67E12

504 IN 4 Interconnect ID number 4
505 IN 4 Source type(S,C, or F),Source ID,Source row # C 1 2
506 IN 4 Destination type(A or C),Dest ID,Dest row # A 2 1
507 IN 4 Gain 1

508 IN 5 Interconnect ID number 5
509 IN 5 Source type(S,C, or F),Source ID,Source row # S 2 1
510 IN 5 Destination type(A or C),Dest ID,Dest row # C 1 3
511 IN 5 Gain 4.31E13

512 IN 6 Interconnect ID number 6
513 IN 6 Source type(S,C, or F),Source ID,Source row # C 1 3
514 IN 6 Destination type(A or C),Dest ID,Dest row # A 3 1
515 IN 6 Gain 1

516 IN 7 Interconnect ID number 7
517 IN 7 Source type(S,C, or F),Source ID,Source row # S 3 1
518 IN 7 Destination type(A or C),Dest ID,Dest row # C 1 4
519 IN 7 Gain 1.7E12

520 IN 8 Interconnect ID number 8
521 IN 8 Source type(S,C, or F),Source ID,Source row # C 1 4
522 IN 8 Destination type(A or C),Dest ID,Dest row # A 4 1
523 IN 8 Gain 1

524 IN 9 Interconnect ID number 9
525 IN 9 Source type(S,C, or F),Source ID,Source row # S 3 2
526 IN 9 Destination type(A or C),Dest ID,Dest row # C 1 5
527 IN 9 Gain 1.7E12

528 IN 10 Interconnect ID number 10
529 IN 10 Source type(S,C, or F),Source ID,Source row # C 1 5
530 IN 10 Destination type(A or C),Dest ID,Dest row # A 5 1
531 IN 10 Gain 1

532 IN 11 Interconnect ID number 11
533 IN 11 Source type(S,C, or F),Source ID,Source row # S 3 3
534 IN 11 Destination type(A or C),Dest ID,Dest row # C 1 6
535 IN 11 Gain 3.4E12

536 IN	12	Interconnect ID number	12
537 IN	12	Source type(S,C, or F),Source ID,Source row #	C 1 6
538 IN	12	Destination type(A or C),Dest ID,Dest row #	A 6 1
539 IN	12	Gain	1
540 IN	13	Interconnect ID number	13
541 IN	13	Source type(S,C, or F),Source ID,Source row #	S 4 1
542 IN	13	Destination type(A or C),Dest ID,Dest row #	C 1 7
543 IN	13	Gain	1.7E12
544 IN	14	Interconnect ID number	14
545 IN	14	Source type(S,C, or F),Source ID,Source row #	C 1 7
546 IN	14	Destination type(A or C),Dest ID,Dest row #	A 7 1
547 IN	14	Gain	1
548 IN	15	Interconnect ID number	15
549 IN	15	Source type(S,C, or F),Source ID,Source row #	S 4 2
550 IN	15	Destination type(A or C),Dest ID,Dest row #	C 1 8
551 IN	15	Gain	1.7E12
552 IN	16	Interconnect ID number	16
553 IN	16	Source type(S,C, or F),Source ID,Source row #	C 1 8
554 IN	16	Destination type(A or C),Dest ID,Dest row #	A 8 1
555 IN	16	Gain	1
556 IN	17	Interconnect ID number	17
557 IN	17	Source type(S,C, or F),Source ID,Source row #	S 4 3
558 IN	17	Destination type(A or C),Dest ID,Dest row #	C 1 9
559 IN	17	Gain	3.4E12
560 IN	18	Interconnect ID number	18
561 IN	18	Source type(S,C, or F),Source ID,Source row #	C 1 9
562 IN	18	Destination type(A or C),Dest ID,Dest row #	A 9 1
563 IN	18	Gain	1
564 IN	19	Interconnect ID number	19
565 IN	19	Source type(S,C, or F),Source ID,Source row #	S 5 3
566 IN	19	Destination type(A or C),Dest ID,Dest row #	A 10 1
567 IN	19	Gain	7

Appendix B

Comparison of Results for ISC Four Control Concepts over Four Seasonal Transitions

Results for the SSP ISC TREETOPS simulation for four control concepts over seasonal transitions are presented in this appendix. In general, time histories of control errors, accelerations, control torques, power beam force, flexible translations and rotations, hinge forces and hinge torques and relative translations are presented. Concepts reported were concept 1, concept 2A, concept 2B and concept 3. The four seasonal transitions were reported for concept 1 and concept 3: Vernal Equinox, Summer Solstice, Autumnal Equinox and Winter Solstice. For concepts 2A and 2B, only Summer Solstice was reported. The intent was to present the steady-state attributes of the system. Therefore, reported data generally starts at 2 hours, after most of the transients have subsided. Typically, plotted data is reported for 25.8 hrs, just over a day. Also, there are some additional plots with plotted data over a period of approximately 10 days for Vernal Equinox, cases 1 and 3.

In addition, thrust requirements, for control and station keeping, were evaluated and are presented herein. Cumulative thrust curves are presented over a one-day period. Thrust requirements for each control component and for each season are investigated. Tables are also given to summarize the information. One day and one year thrust requirements are presented.

This Appendix is organized as follows:

- B.1 TREETOPS simulation results and Thrust Requirements for Concept 1
- B.2 TREETOPS simulation results and Thrust Requirements for Concept 3
- B.3 TREETOPS simulation results Comparison of Concept 1, 2A, 2B and 3 and Thrust Requirements for Concept 2A and 2B
- B.4 Thrust Requirements Comparison for Concept 1, Concept 2A, Concept 2B, Concept 3 and Stationkeeping

(Later, it was realized that the initial conditions for body 3 and 4 (UC and LC) for concept 1 VE, AE, and WS were not entirely correct. For concept 1 VE, AE and WS, the initial conditions for UC and LC pitch angle were correct, but the initial condition for the UC and LC yaw angle with respect to the boom was not correct. Therefore, Tables B.1-5 through B.1-8 supercede Tables B.1-1 through B.1-4 for concept 1.)

B.1 TREETOPS simulation results and Thrust Requirements for Concept 1

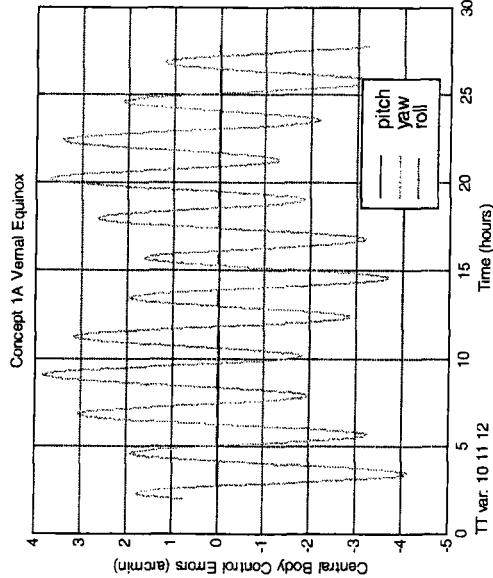


Figure B.1-1a: Central Body Control Errors vs. Time
(Vernal Equinox)

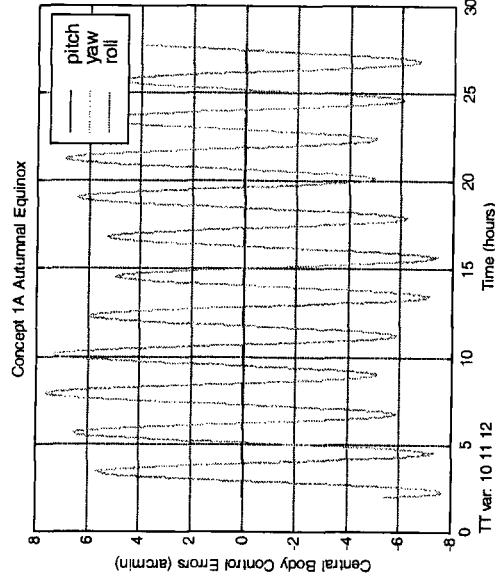


Figure B.1-1c: Central Body Control Errors vs. Time
(Autumnal Equinox)

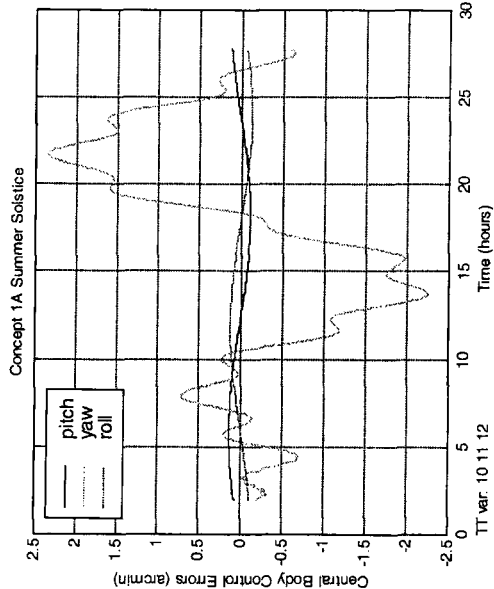


Figure B.1-1b: Central Body Control Errors vs. Time
(Summer Solstice)

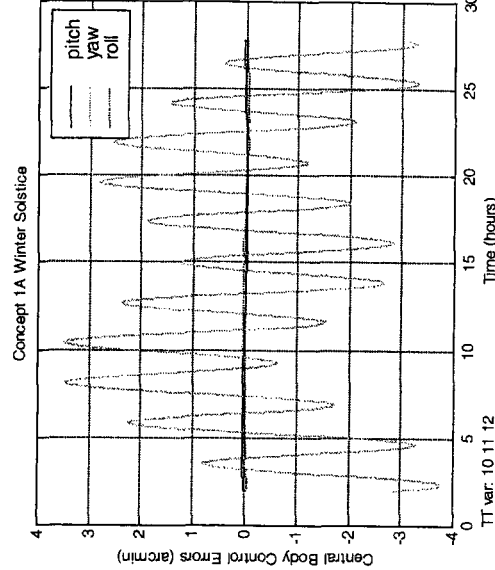


Figure B.1-1d: Central Body Control Errors vs. Time
(Winter Solstice)

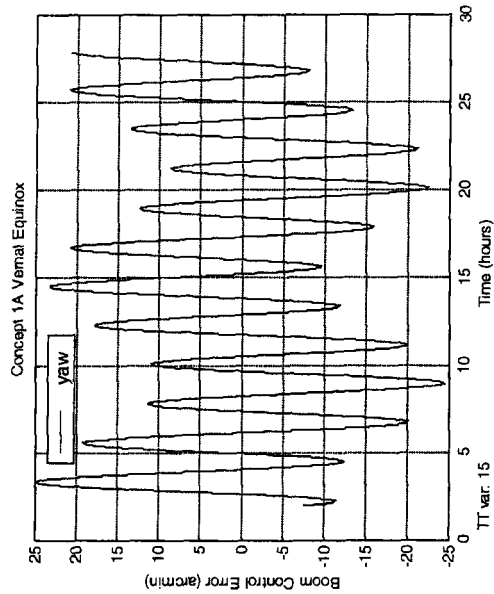


Figure B.1-2a: Boom Control Errors vs. Time
(Vernal Equinox)

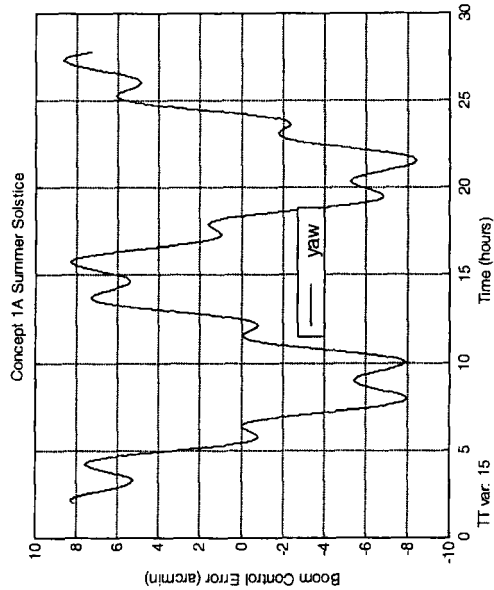


Figure B.1-2b: Boom Control Errors vs. Time
(Summer Solstice)

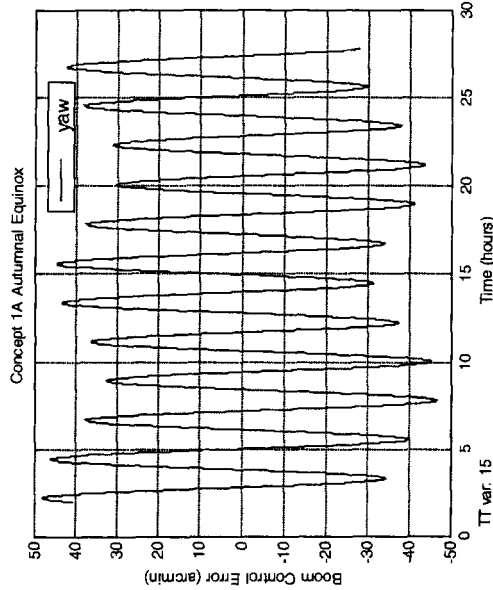


Figure B.1-2c: Boom Control Errors vs. Time
(Autumnal Equinox)

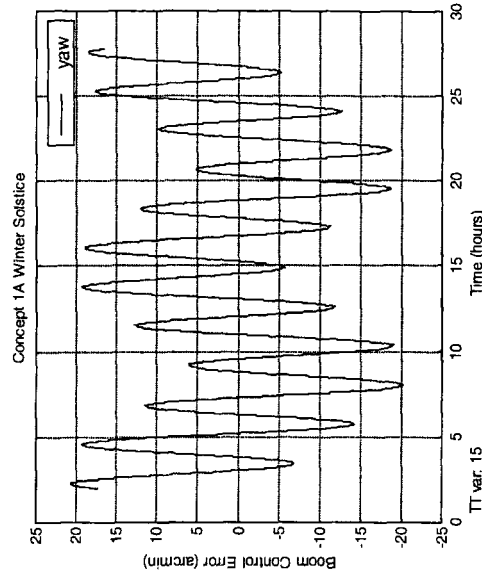


Figure B.1-2d: Boom Control Errors vs. Time
(Winter Solstice)

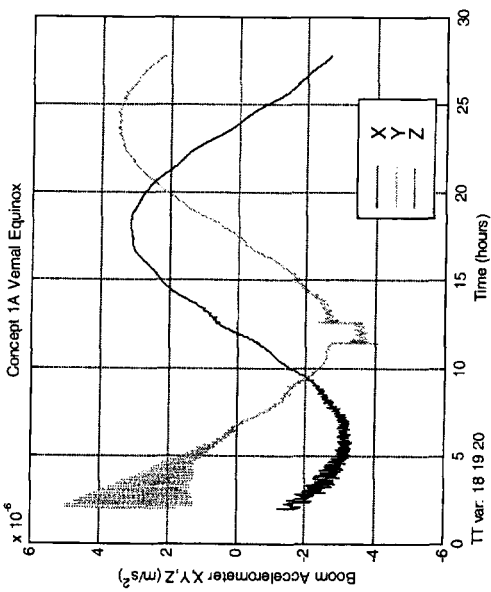


Figure B.1-3a: Boom Accelerometer vs. Time
(Vernal Equinox)

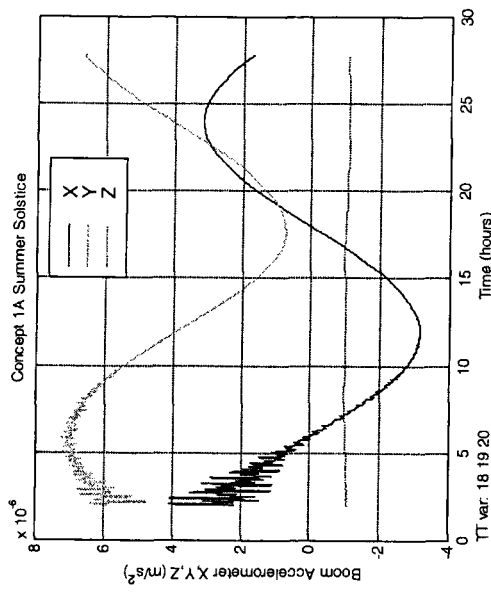


Figure B.1-3b: Boom Accelerometer vs. Time
(Summer Solstice)

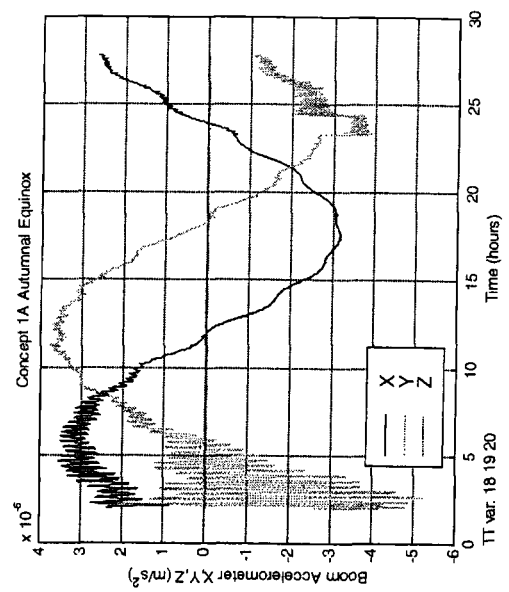


Figure B.1-3c: Boom Accelerometer vs. Time
(Autumnal Equinox)

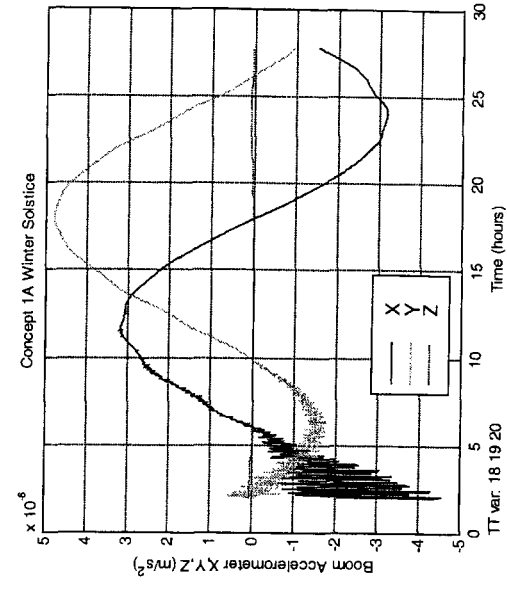


Figure B.1-3d: Boom Accelerometer vs. Time
(Winter Solstice)

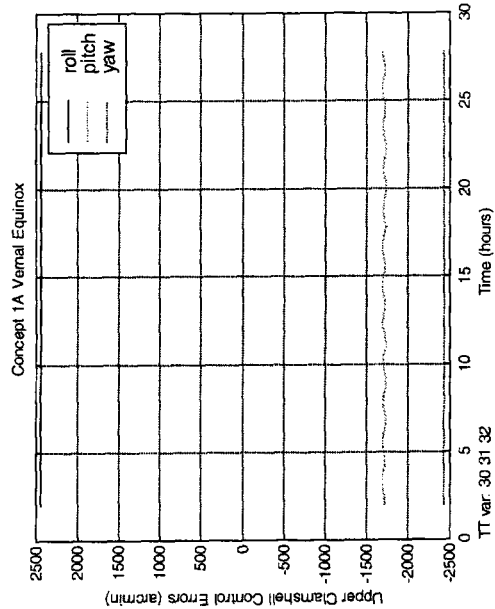


Figure B.1-4a: Upper Clamshell Control Errors vs. Time
(Vernal Equinox)

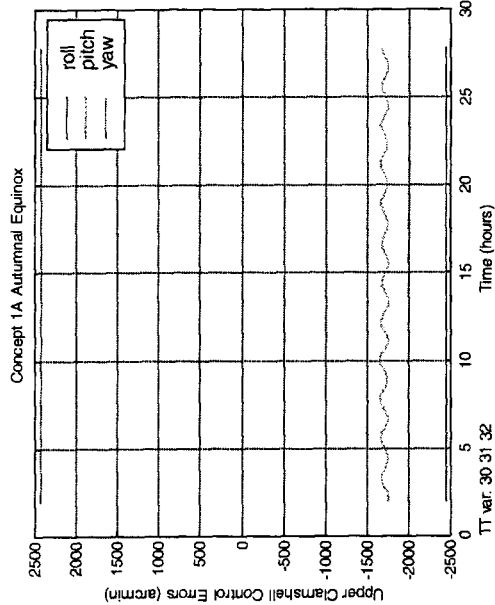


Figure B.1-4c: Upper Clamshell Control Errors vs. Time
(Autumnal Equinox)

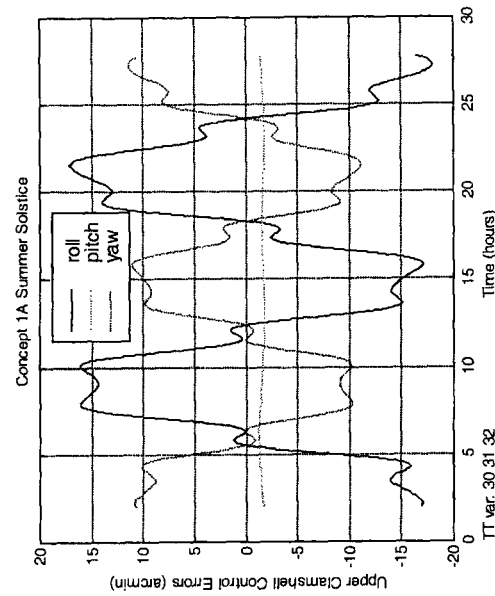


Figure B.1-4b: Upper Clamshell Control Errors vs. Time
(Summer Solstice)

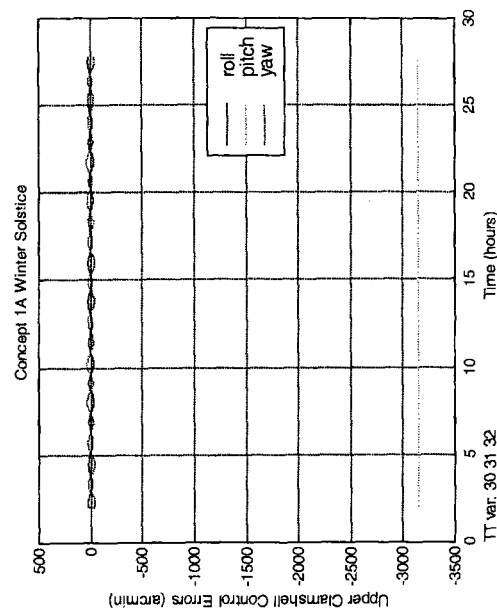


Figure B.1-4d: Upper Clamshell Control Errors vs. Time
(Winter Solstice)

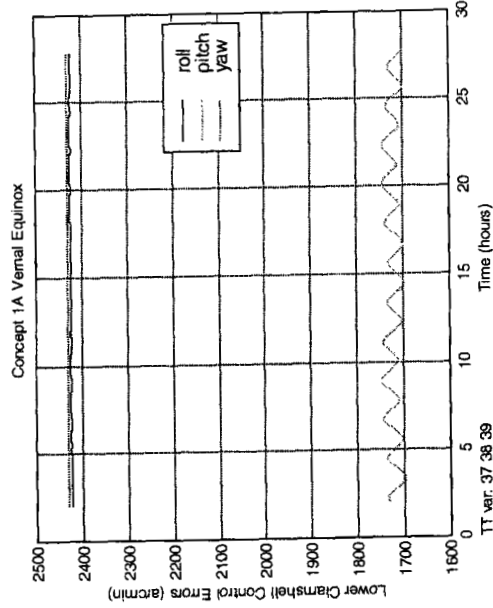


Figure B.1-5a: Lower Clamshell Control Errors vs. Time (Vernal Equinox)

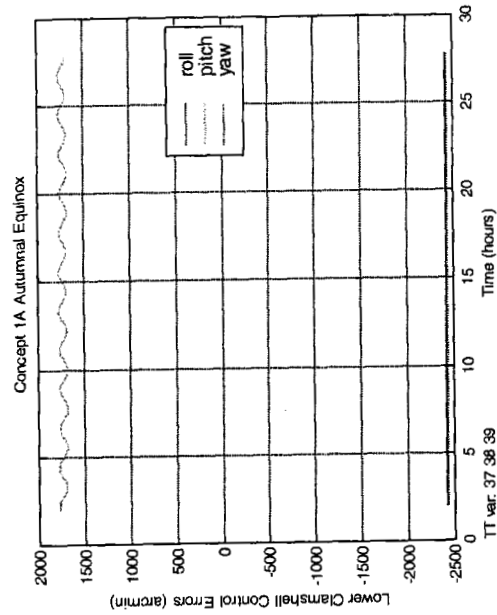


Figure B.1-5c: Lower Clamshell Control Errors vs. Time (Autumnal Equinox)

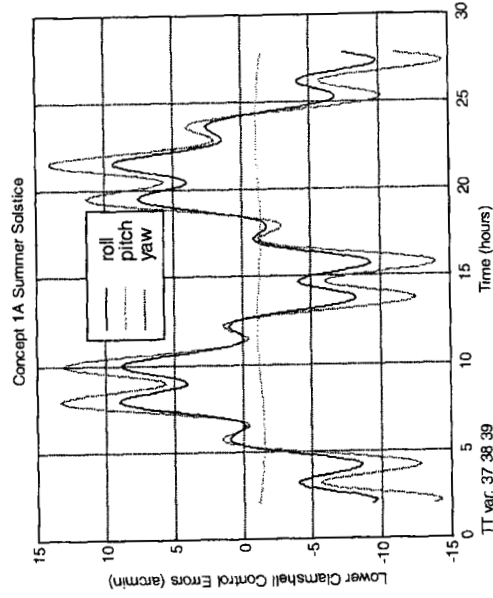


Figure B.1-5b: Lower Clamshell Control Errors vs. Time (Summer Solstice)

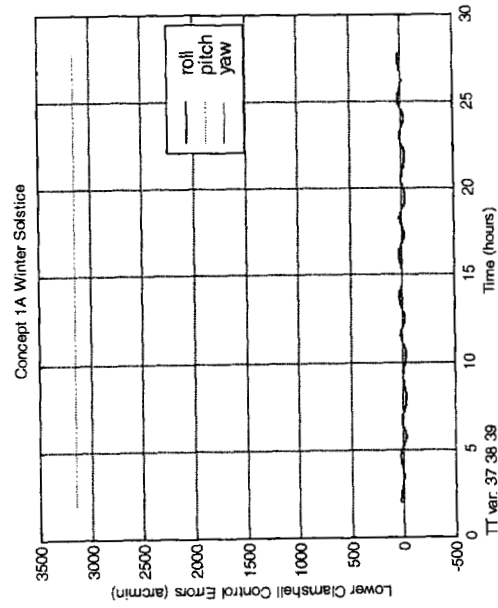


Figure B.1-5d: Lower Clamshell Control Errors vs. Time (Winter Solstice)

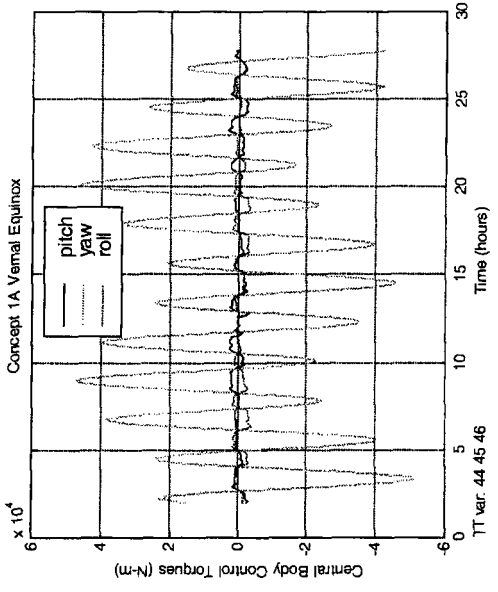


Figure B.1-6a: Central Body Control Torques vs. Time
(Vernal Equinox)

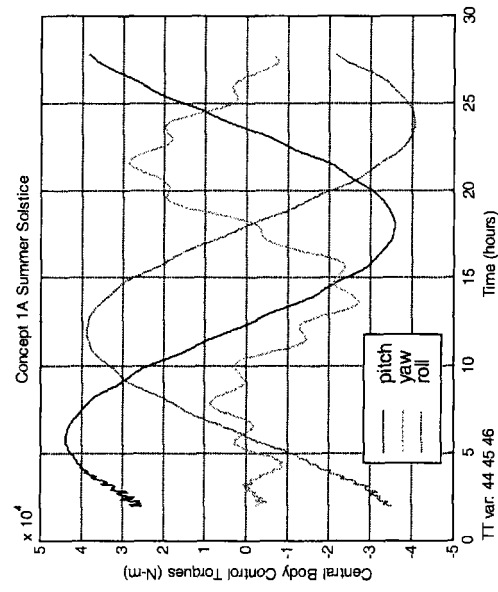


Figure B.1-6b: Central Body Control Torques vs. Time
(Summer Solstice)

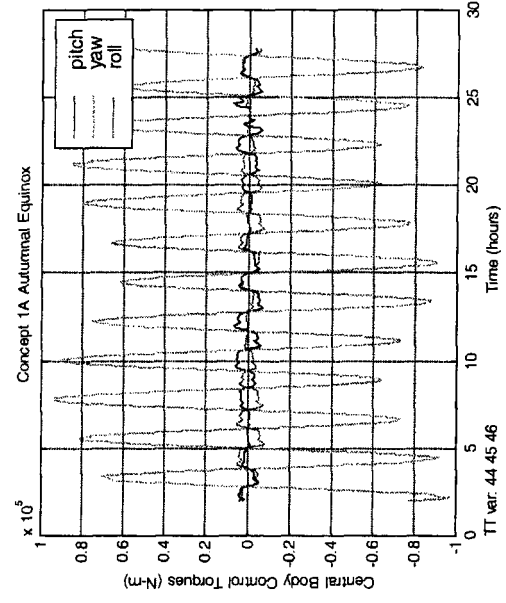


Figure B.1-6c: Central Body Control Torques vs. Time
(Autumnal Equinox)

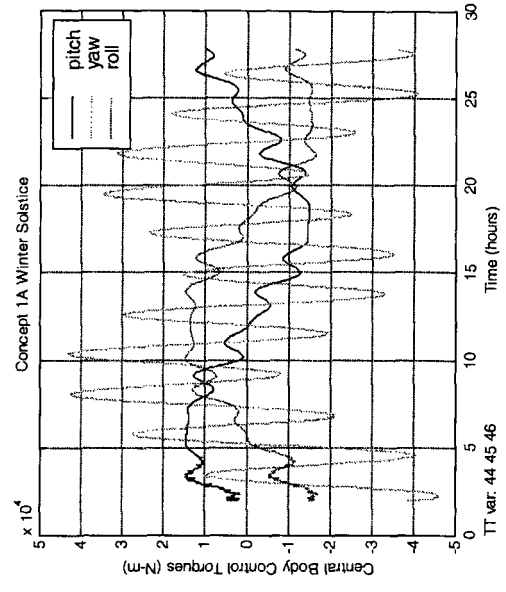


Figure B.1-6d: Central Body Control Torques vs. Time
(Winter Solstice)

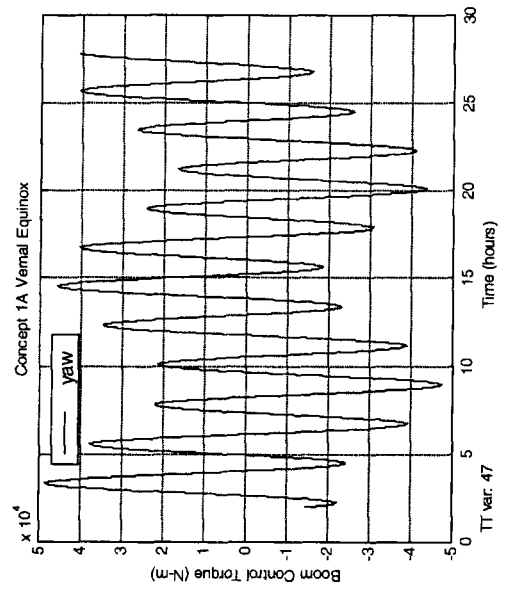


Figure B.1-7a: Boom Control Torques vs. Time
(Vernal Equinox)

Figure B.1-7b: Boom Control Torques vs. Time
(Summer Solstice)

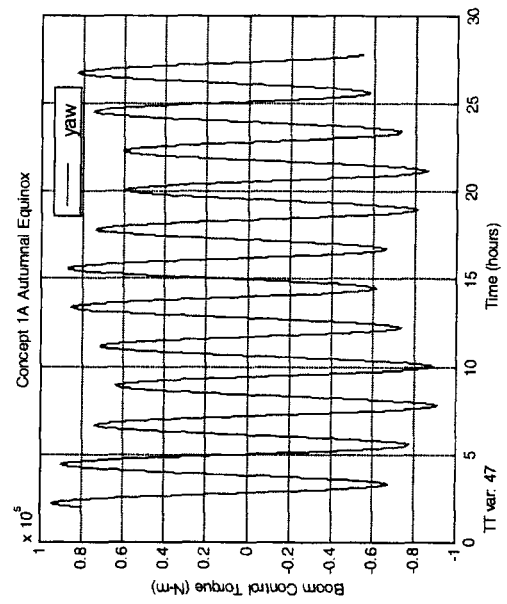
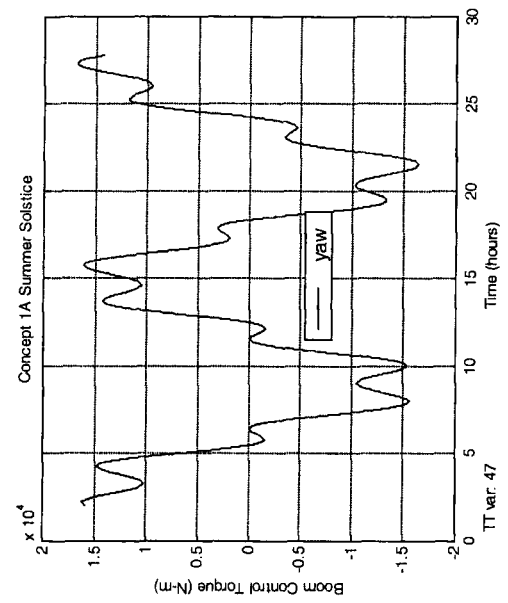


Figure B.1-7c: Boom Control Torques vs. Time
(Autumnal Equinox)

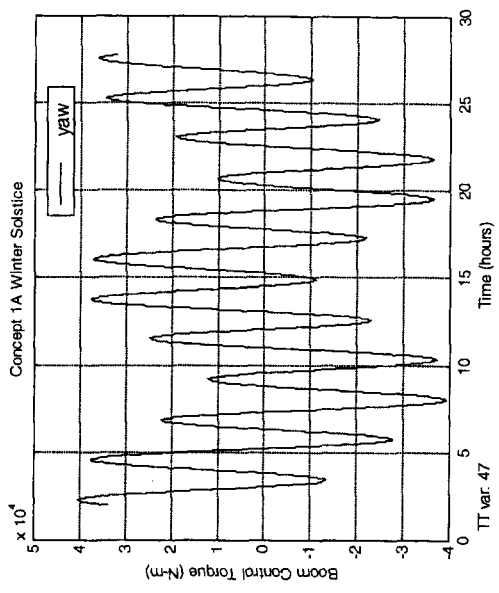


Figure B.1-7d: Boom Control Torques vs. Time
(Winter Solstice)

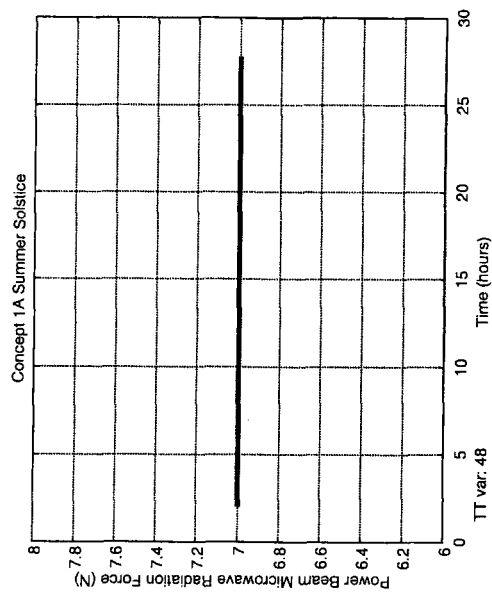


Figure B.1-8b: Power Beam Microwave Radiation Force
vs. Time
(Summer Solstice)

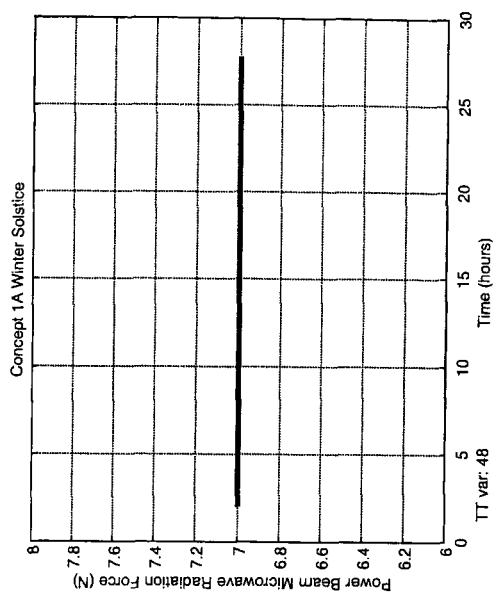


Figure B.1-8d: Power Beam Microwave Radiation Force
vs. Time
(Winter Solstice)

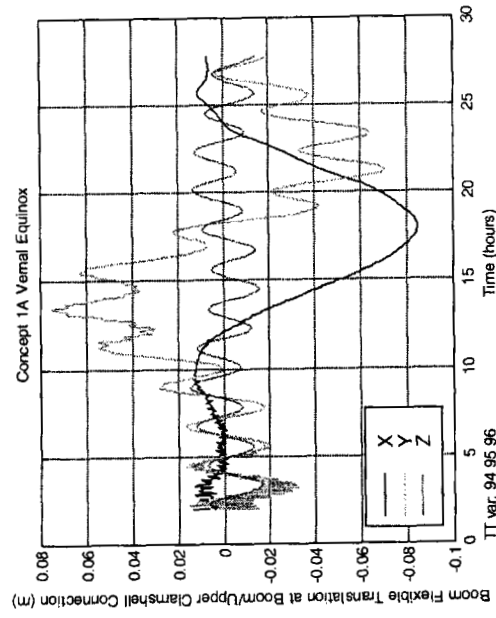


Figure B.1-9a: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

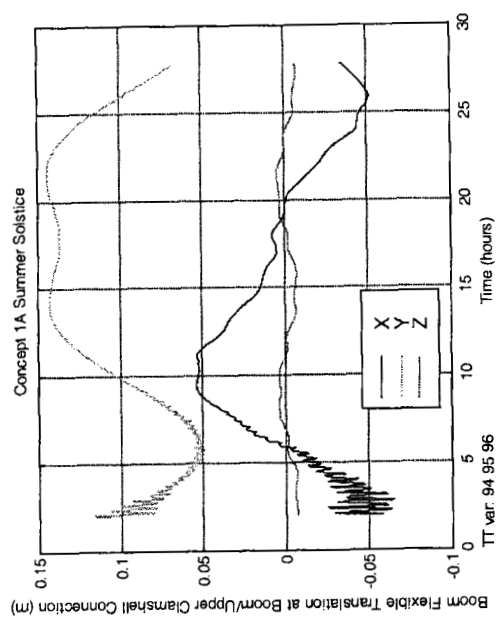


Figure B.1-9b: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Summer Solstice)

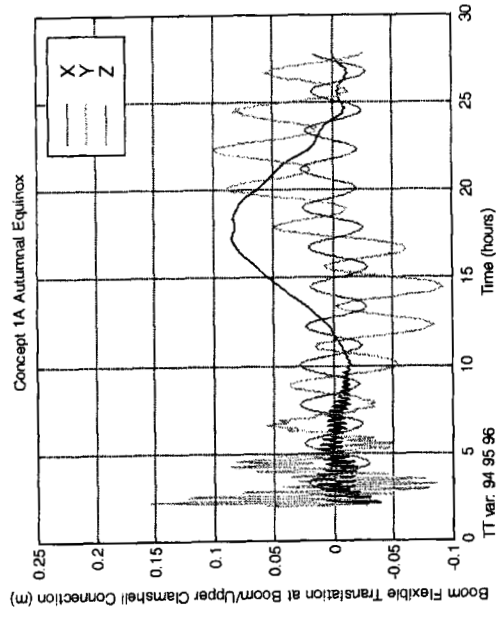


Figure B.1-9c: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Autumnal Equinox)

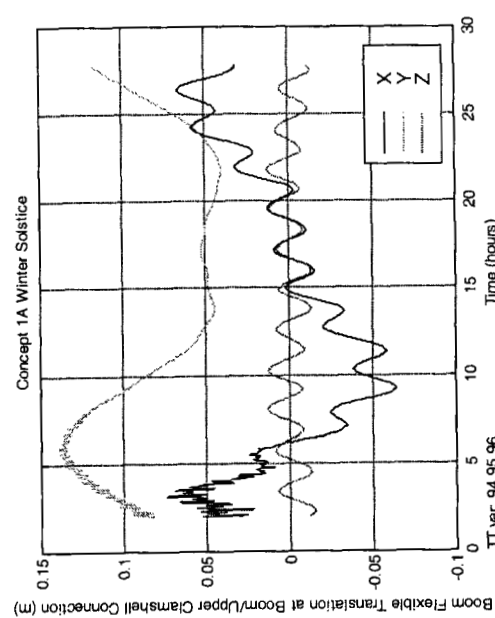


Figure B.1-9d: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Winter Solstice)

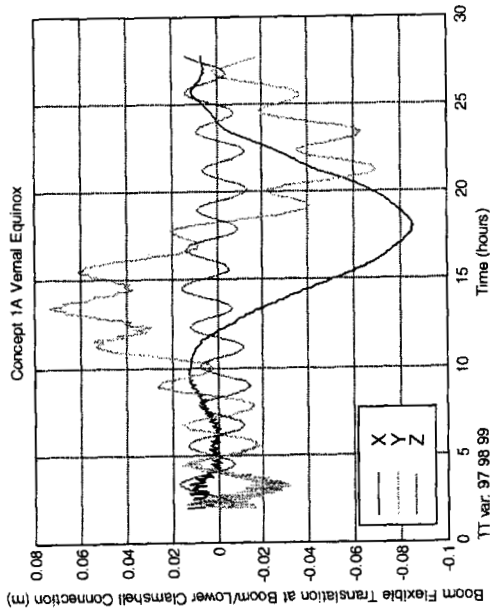


Figure B.1-10a: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

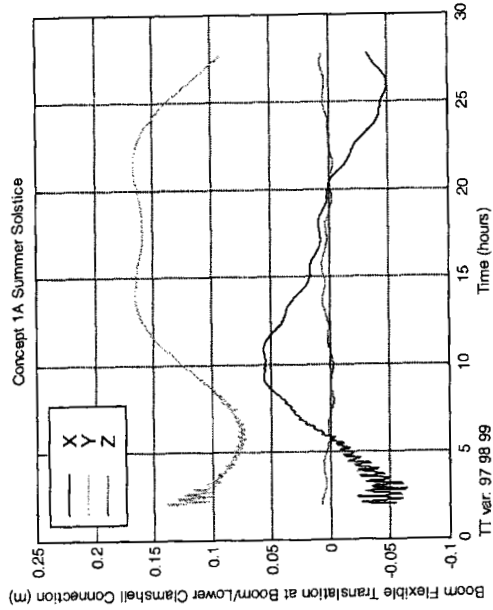


Figure B.1-10b: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Summer Solstice)

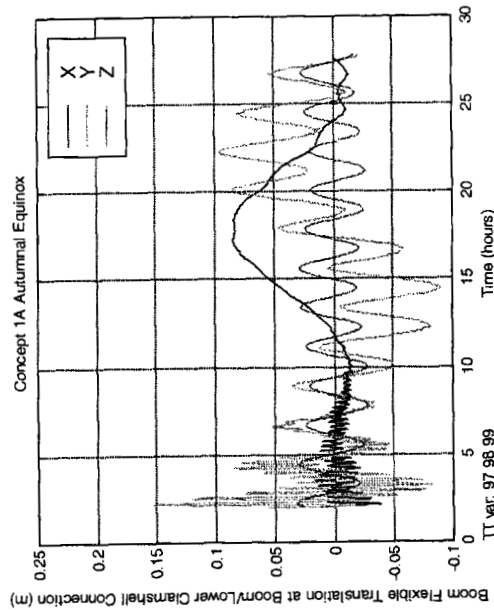


Figure B.1-10c: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Autumnal Equinox)

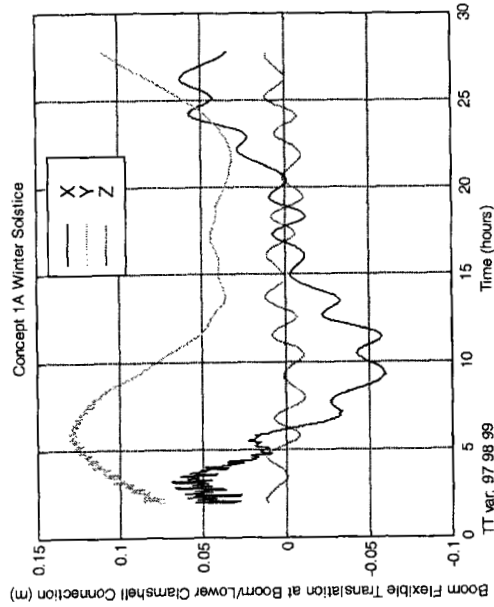


Figure B.1-10d: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Winter Solstice)

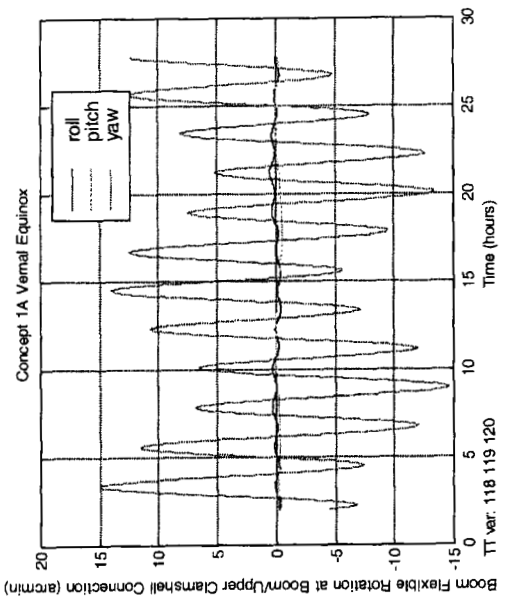


Figure B.1-11a: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

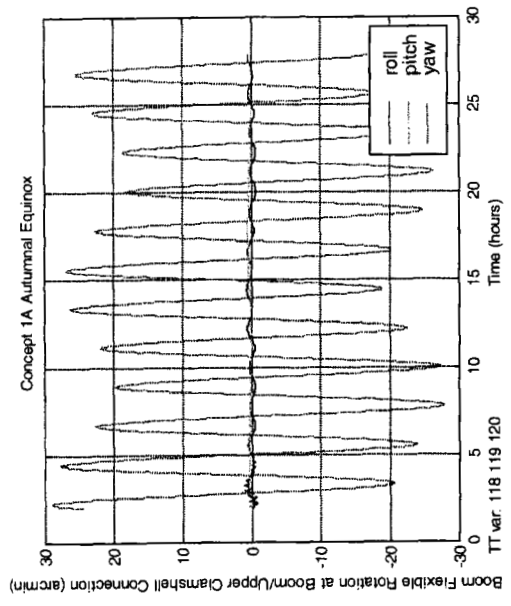


Figure B.1-11c: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Autumnal Equinox)

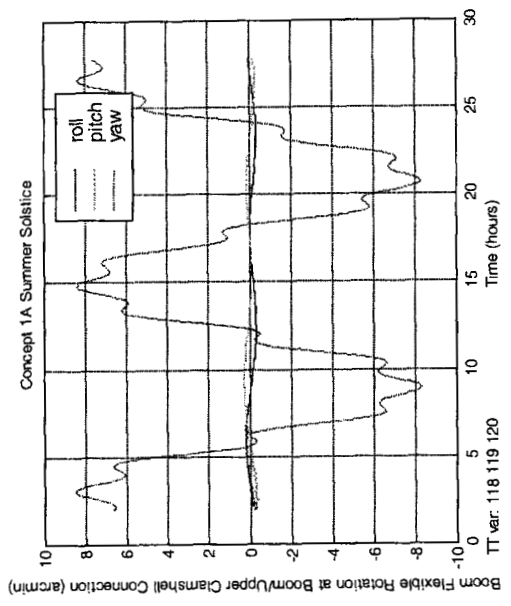


Figure B.1-11b: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Summer Solstice)

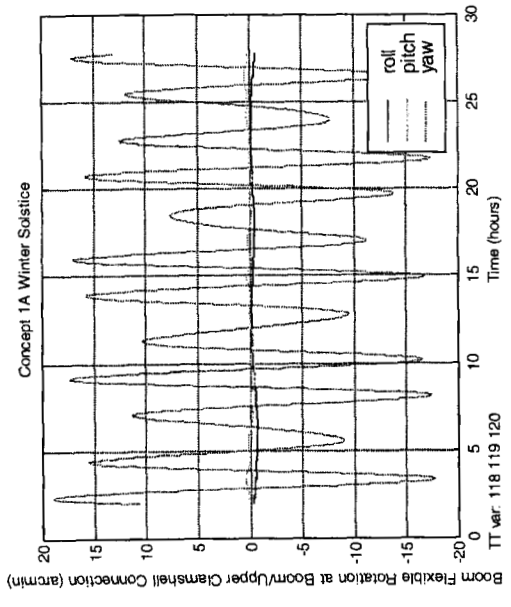


Figure B.1-11d: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Winter Solstice)

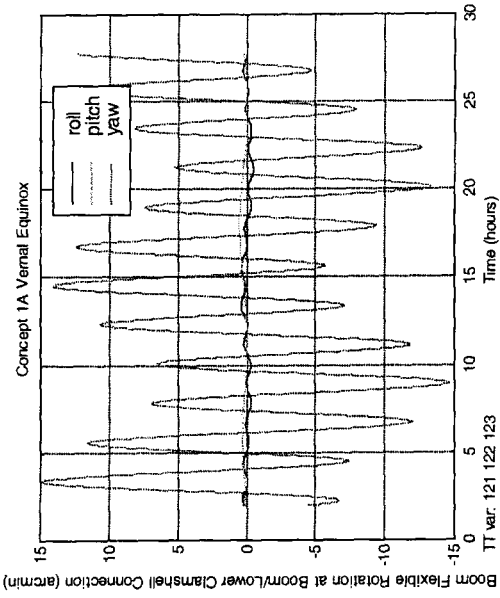


Figure B.1-12a: Boom Flexible Rotation at
Boom/Lower Clamshell Connection vs. Time
(Vernal Equinox)

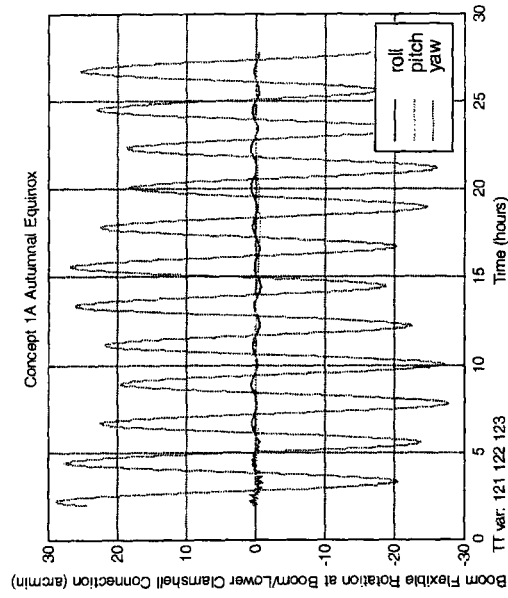


Figure B.1-12c: Boom Flexible Rotation at
Boom/Lower Clamshell Connection vs. Time
(Autumnal Equinox)

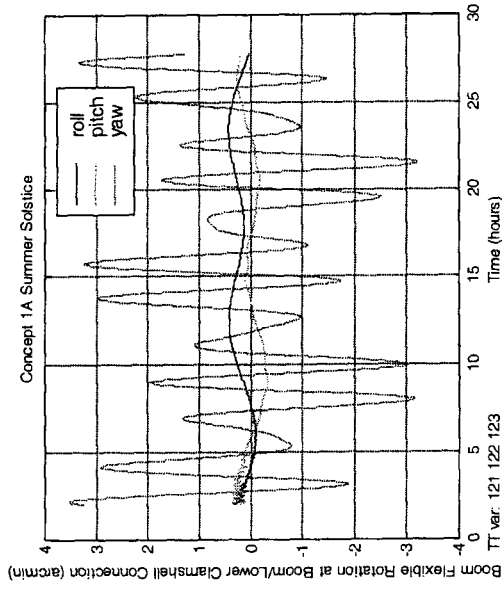


Figure B.1-12b: Boom Flexible Rotation at
Boom/Lower Clamshell Connection vs. Time
(Summer Solstice)

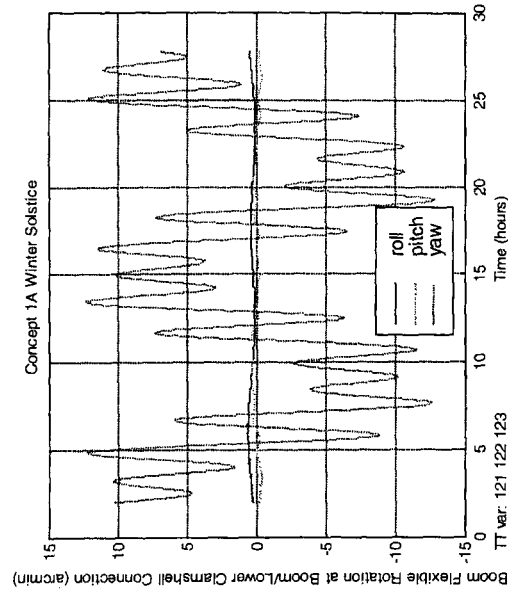


Figure B.1-12d: Boom Flexible Rotation at
Boom/Lower Clamshell Connection vs. Time
(Winter Solstice)

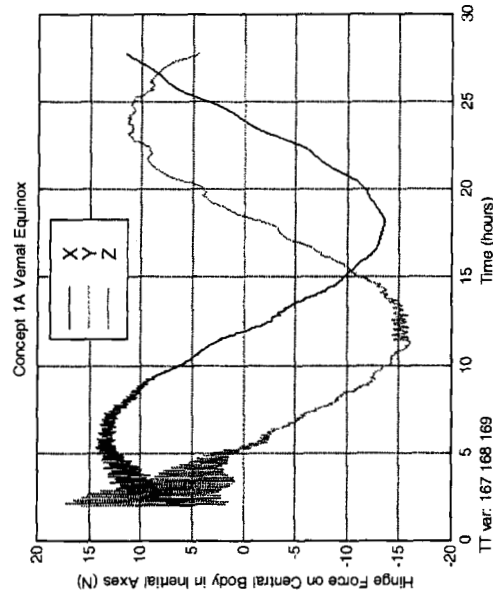


Figure B.1-13a: Hinge Force on Central Body
in Inertial Axes vs. Time
(Vernal Equinox)

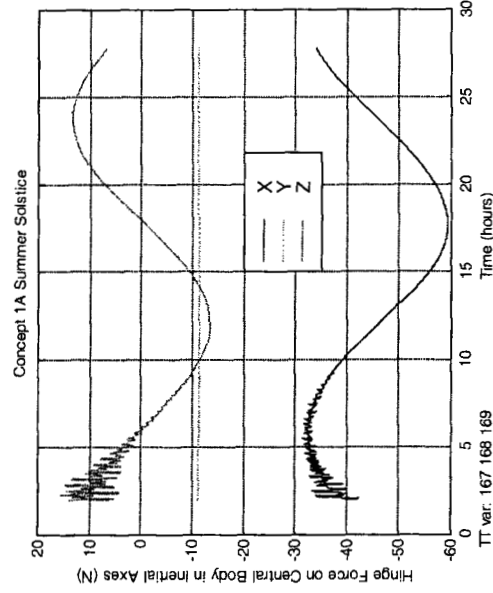


Figure B.1-13b: Hinge Force on Central Body
in Inertial Axes vs. Time
(Summer Solstice)

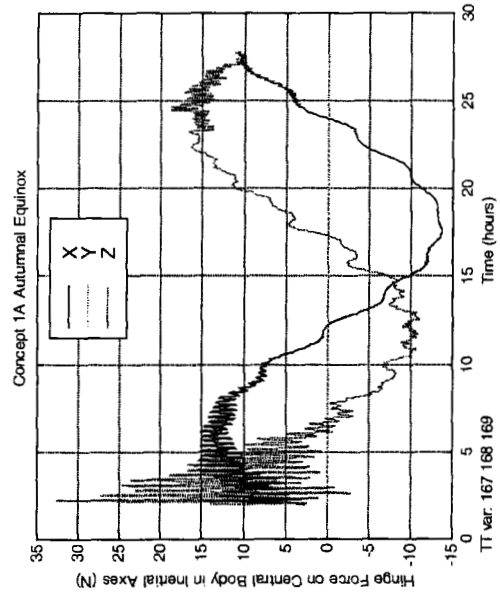


Figure B.1-13c: Hinge Force on Central Body
in Inertial Axes vs. Time
(Autumnal Equinox)

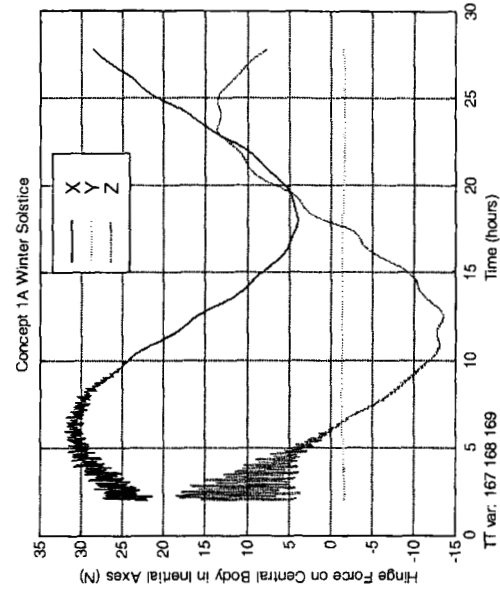


Figure B.1-13d: Hinge Force on Central Body
in Inertial Axes vs. Time
(Winter Solstice)

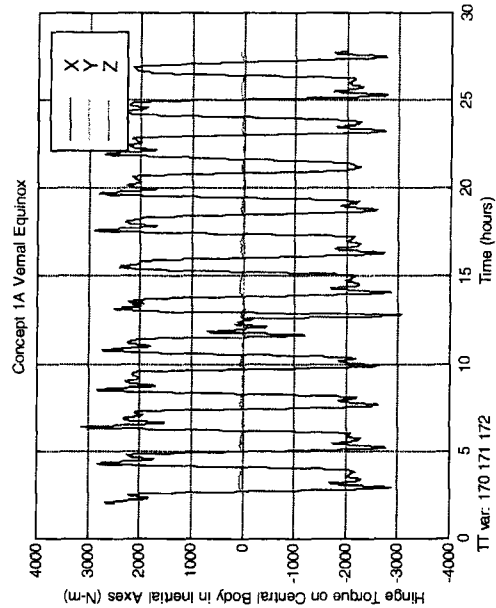


Figure B.1-14a: Hinge Torque on Central Body
 in Inertial Axes vs. Time
 (Vernal Equinox)

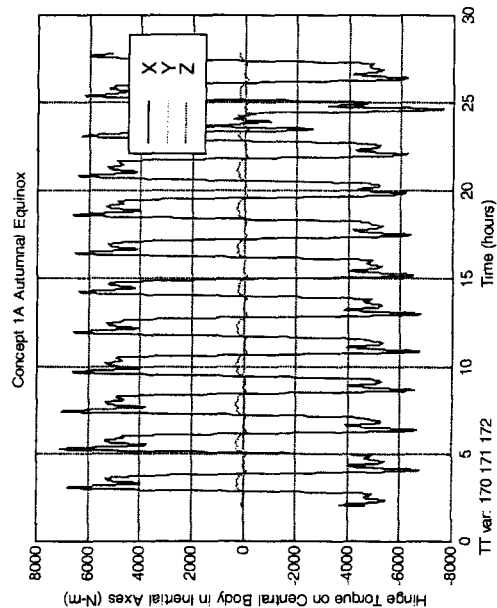


Figure B.1-14c: Hinge Torque on Central Body
 in Inertial Axes vs. Time
 (Autumnal Equinox)

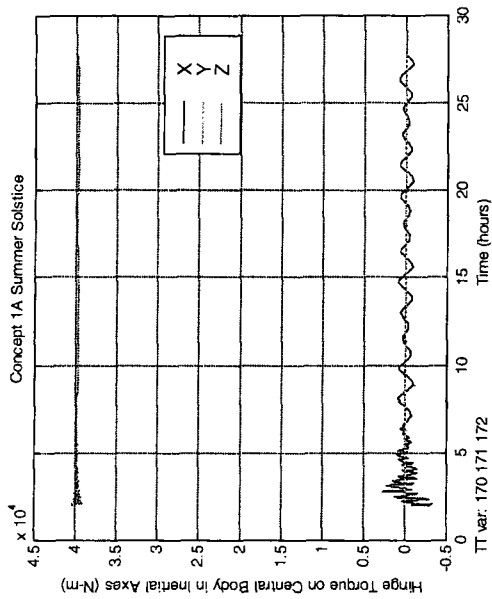


Figure B.1-14b: Hinge Torque on Central Body
 in Inertial Axes vs. Time
 (Summer Solstice)

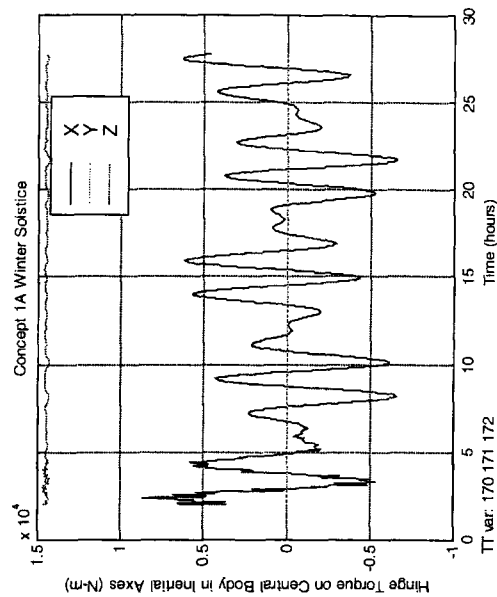


Figure B.1-14d: Hinge Torque on Central Body
 in Inertial Axes vs. Time
 (Winter Solstice)

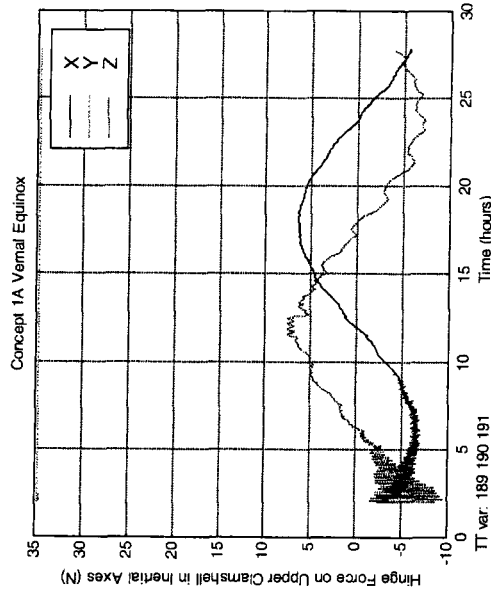


Figure B.1-15a: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

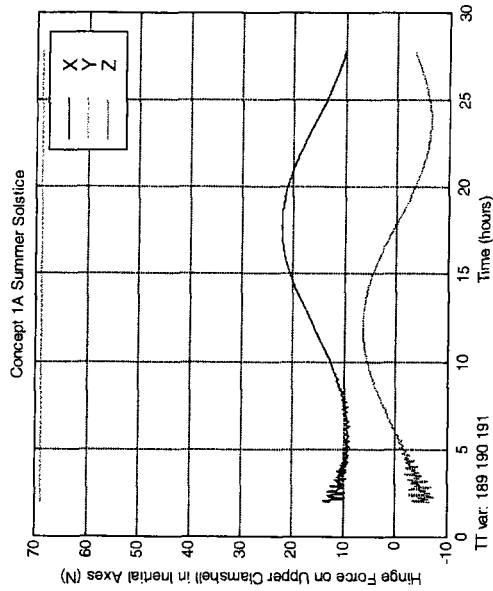


Figure B.1-15b: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Summer Solstice)

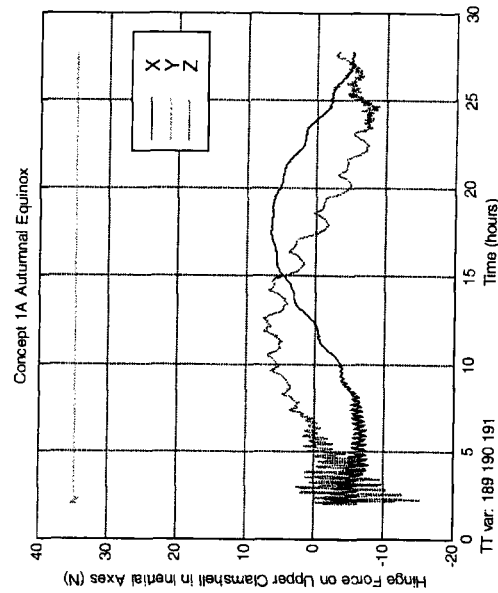


Figure B.1-15c: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Autumnal Equinox)

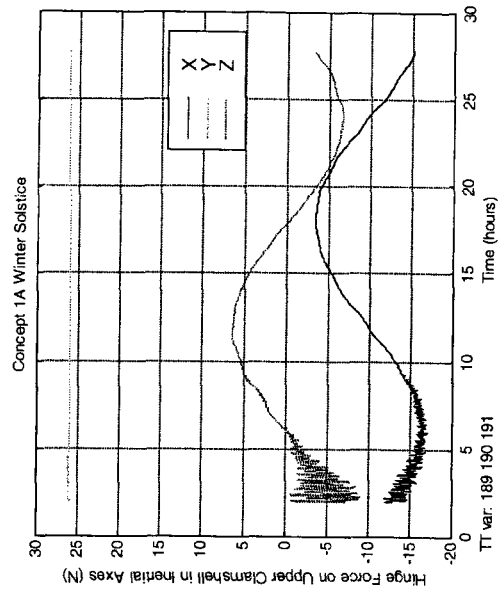


Figure B.1-15d: Hinge Force on Upper clamshell
in Inertial Axes vs. Time
(Winter Solstice)

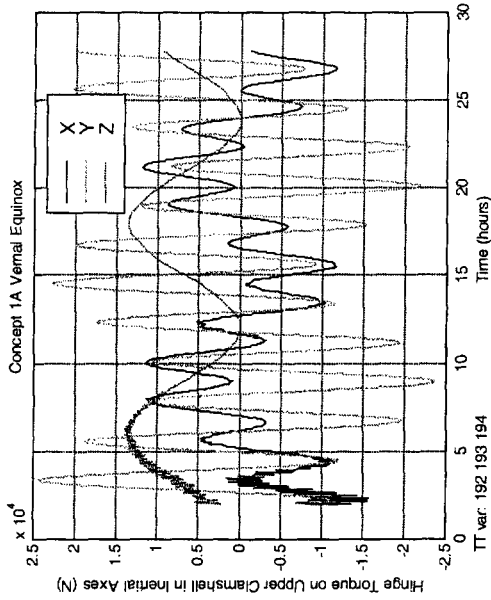


Figure B.1-16a: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Vernal Equinox)

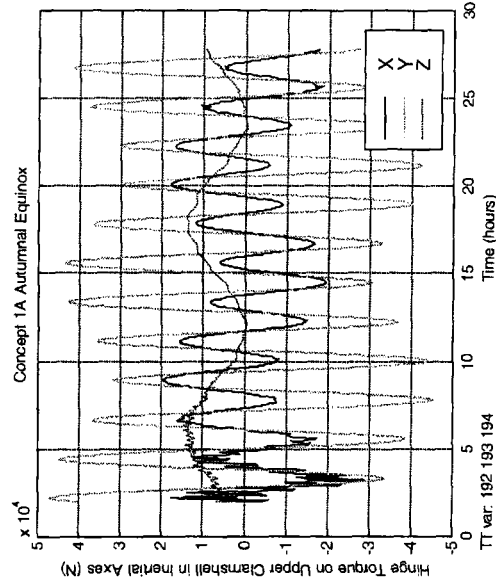


Figure B.1-16c: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Autumnal Equinox)

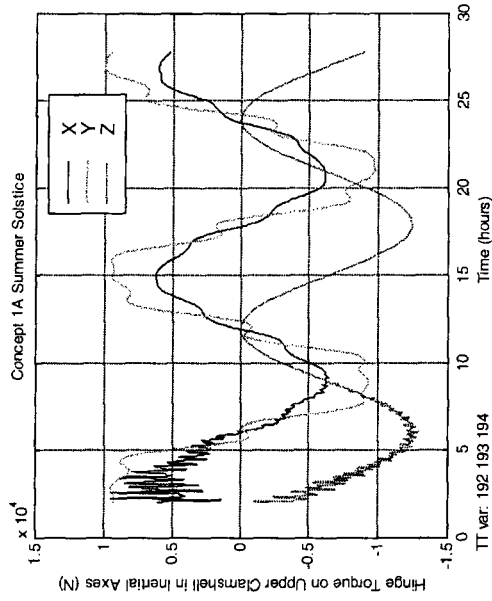


Figure B.1-16b: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Summer Solstice)

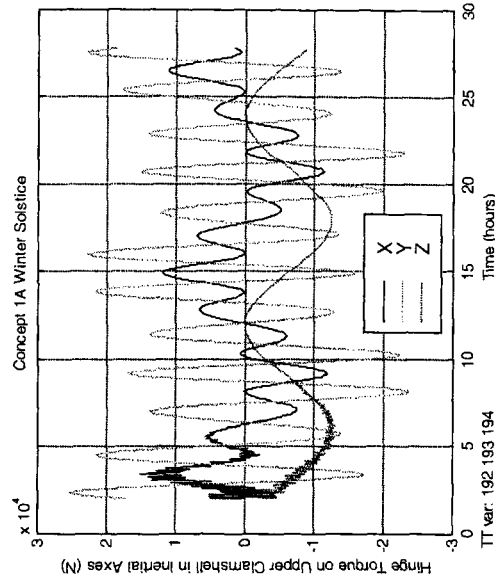


Figure B.1-16d: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Winter Solstice)

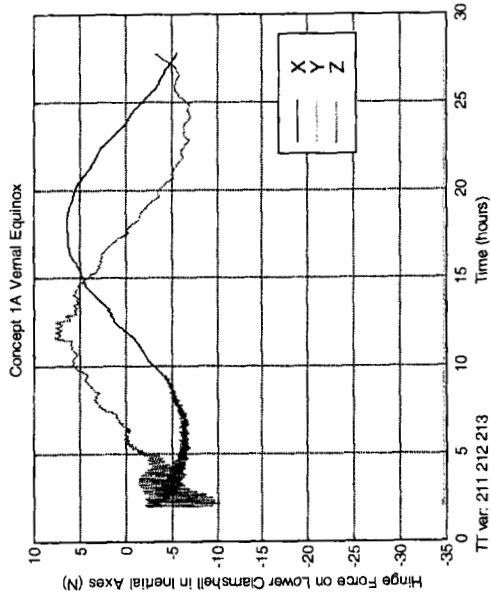


Figure B.1-17a: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

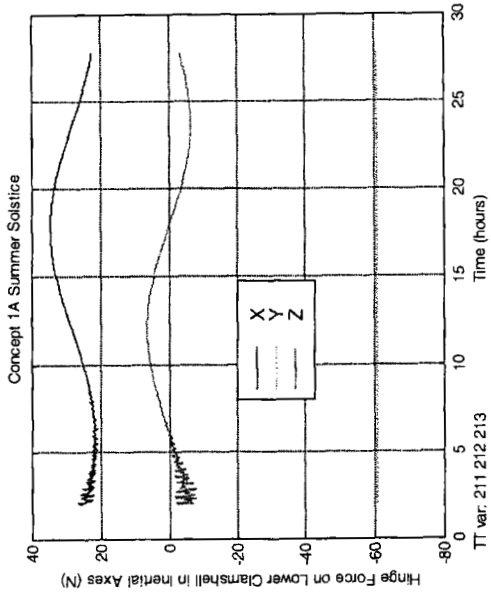


Figure B.1-17b: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Summer Solstice)

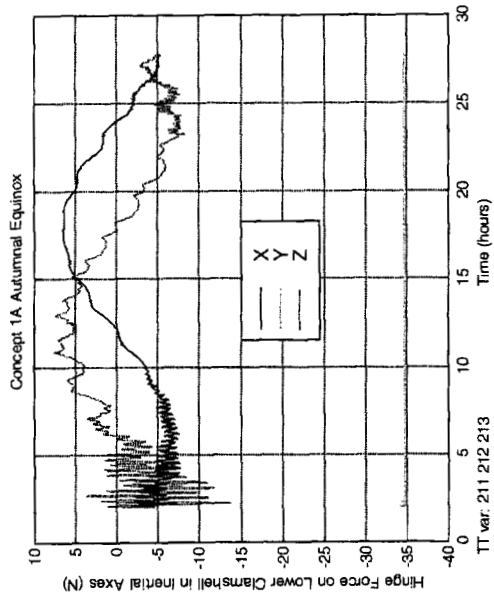


Figure B.1-17c: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Autumnal Equinox)

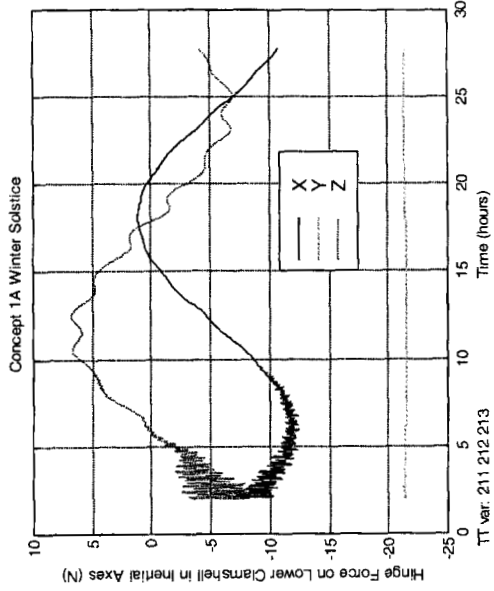


Figure B.1-17d: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Winter Solstice)

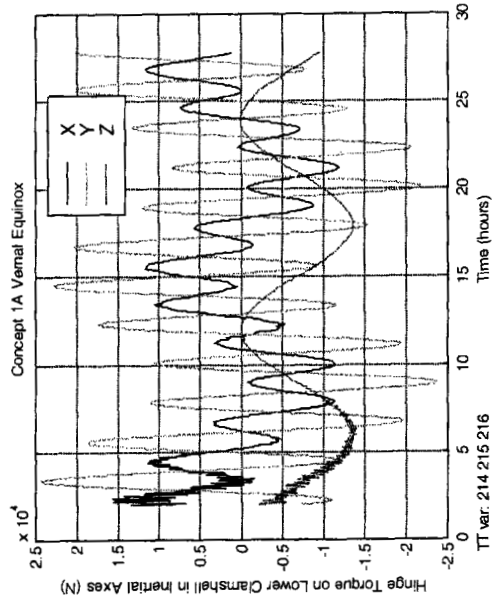


Figure B.1-18a: Hinge Torque on Lower Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

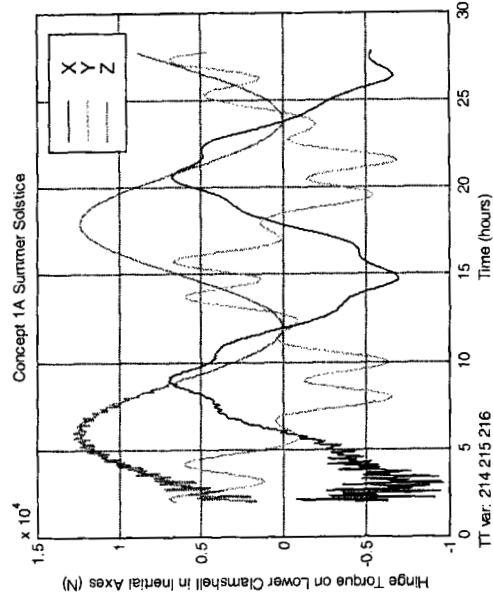


Figure B.1-18b: Hinge Torque on Lower Clamshell
in Inertial Axes vs. Time
(Summer Solstice)

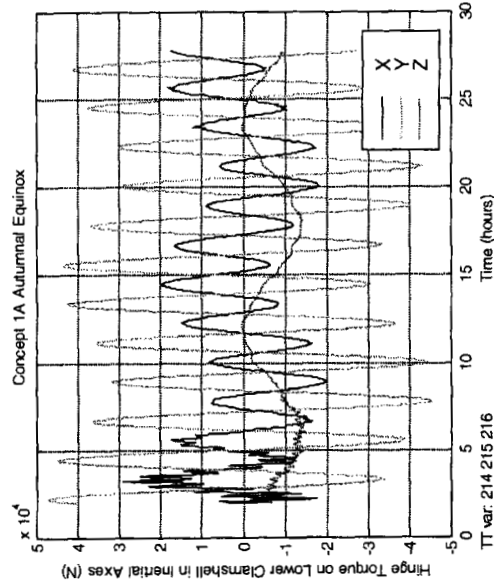


Figure B.1-18c: Hinge Torque on Lower Clamshell
in Inertial Axes vs. Time
(Autumnal Equinox)

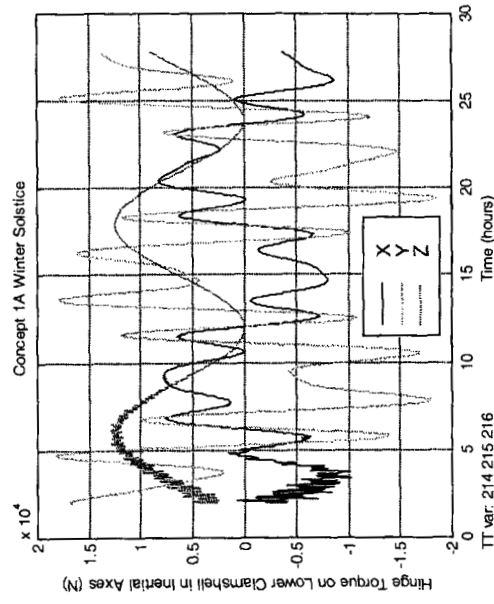


Figure B.1-18d: Hinge Torque on Lower Clamshell
in Inertial Axes vs. Time
(Winter Solstice)

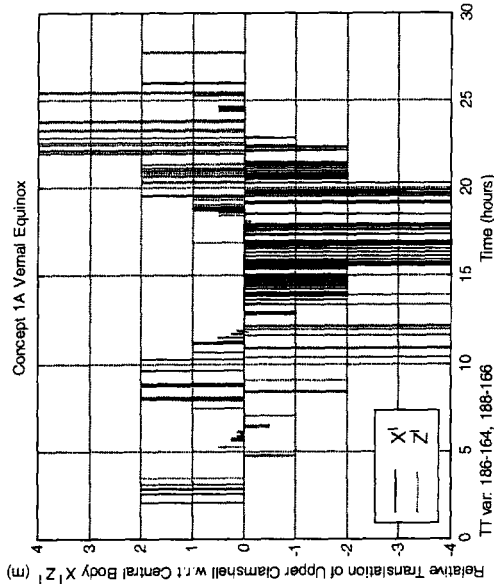


Figure B.1-19a: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

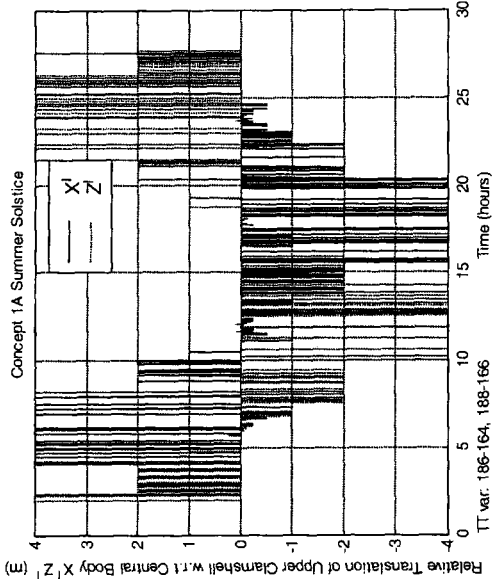


Figure B.1-19b: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Summer Solstice)

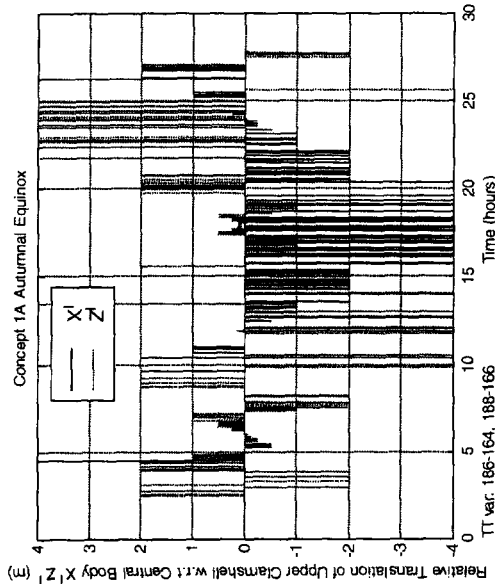


Figure B.1-19c: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Autumnal Equinox)

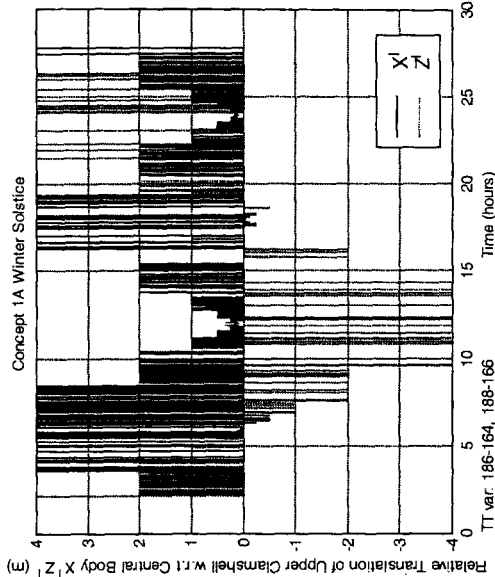


Figure B.1-19d: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Winter Solstice)

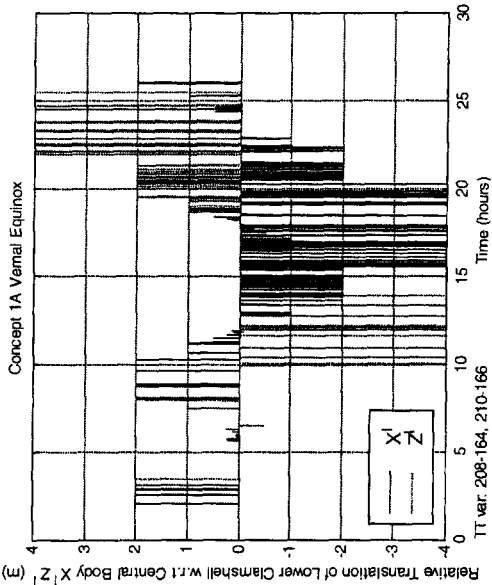


Figure B.1-20a: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

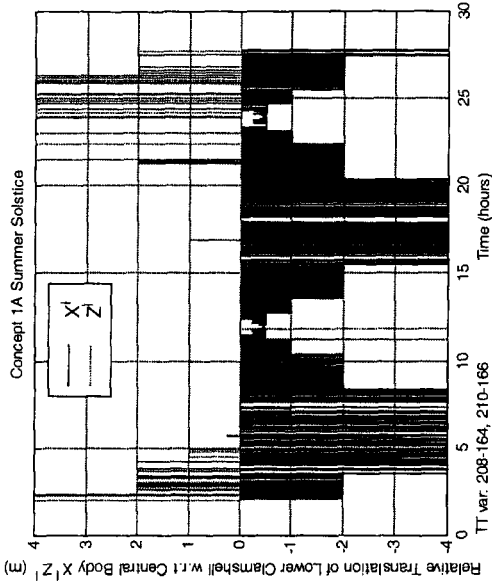


Figure B.1-20b: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Summer Solstice)

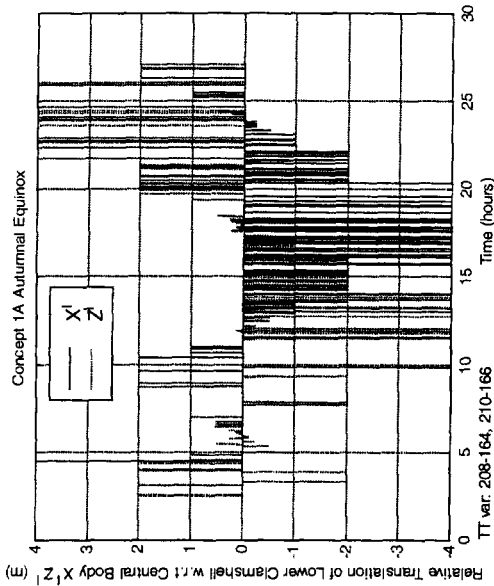


Figure B.1-20c: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Autumnal Equinox)

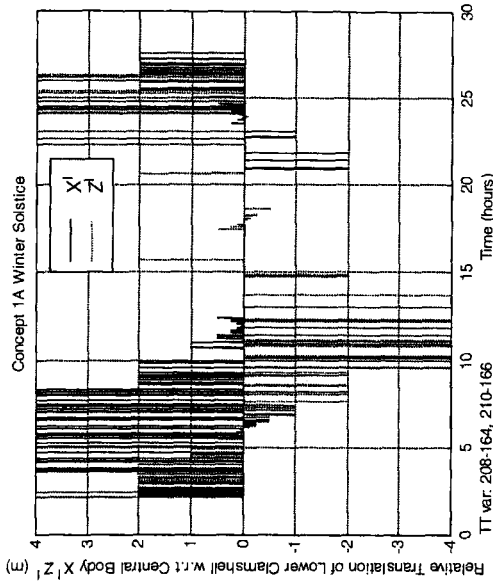


Figure B.1-20d: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Winter Solstice)

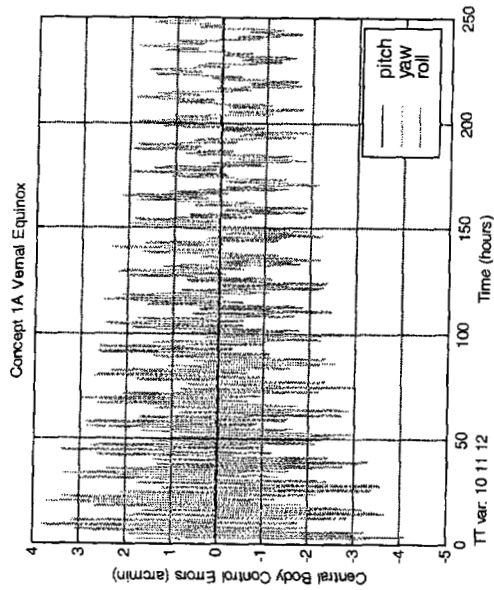


Figure B.1-21: Central Body Control Errors vs. Time
(Vernal Equinox)

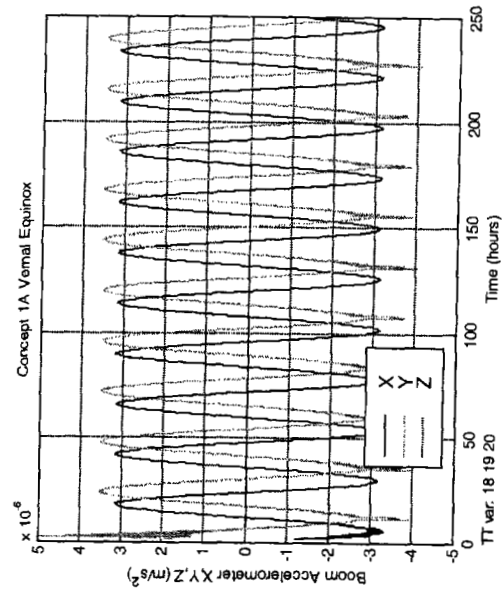


Figure B.1-23: Boom Accelerometer vs. Time
(Vernal Equinox)

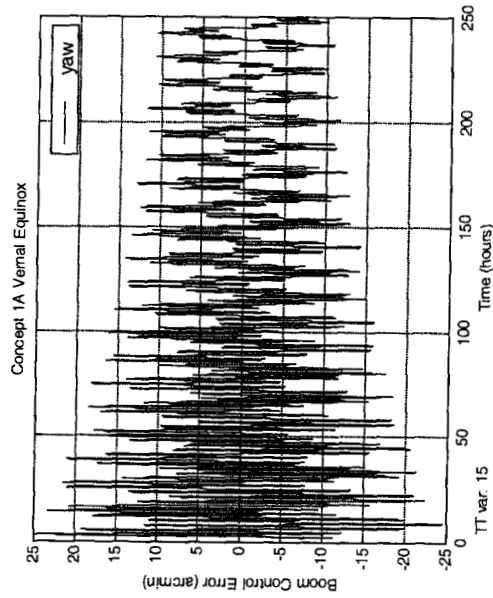


Figure B.1-22: Boom Control Errors vs. Time
(Vernal Equinox)

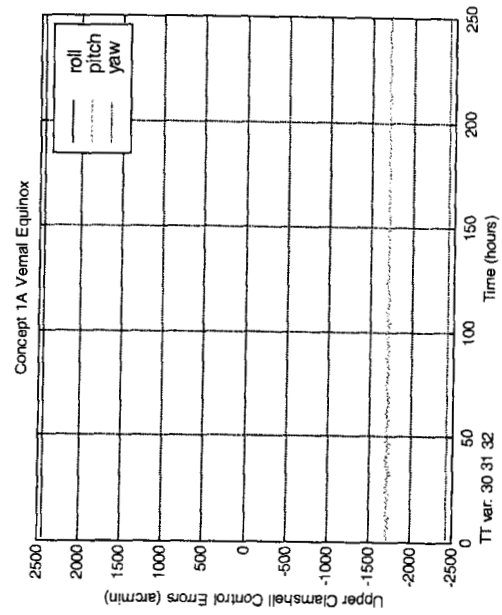


Figure B.1-24: Upper Clamshell Control Errors vs. Time
(Vernal Equinox)

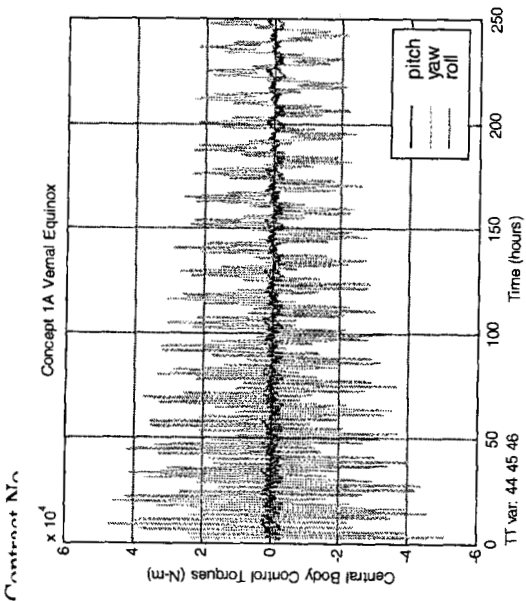


Figure B.1-25: Lower Clamshell Control Errors vs. Time
(Vernal Equinox)

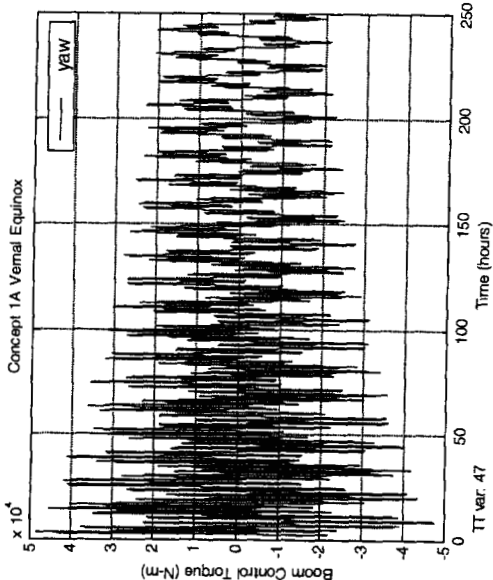


Figure B.1-26: Central Body Control Torques vs. Time
(Vernal Equinox)

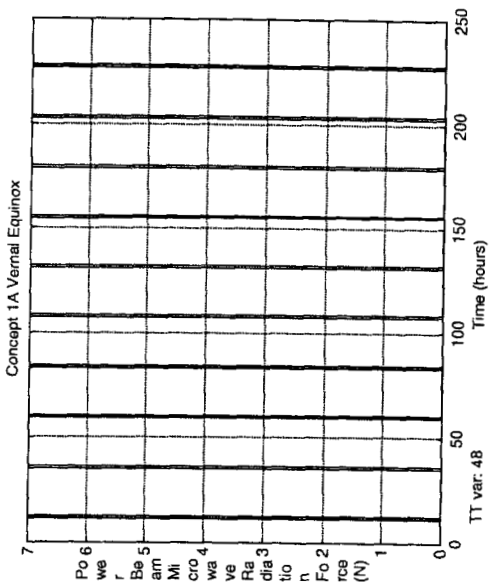


Figure B.1-27: Boom Control Torques vs. Time
(Vernal Equinox)

Figure B.1-28: Power Beam Microwave Radiation Force
vs. Time
(Vernal Equinox)

Concept N1a

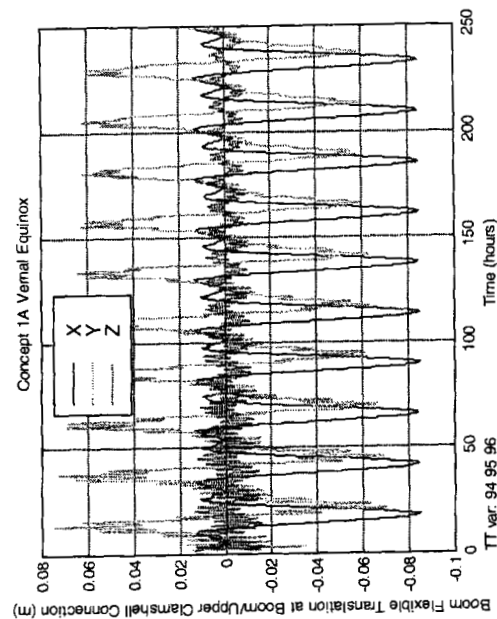


Figure B.1-29: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

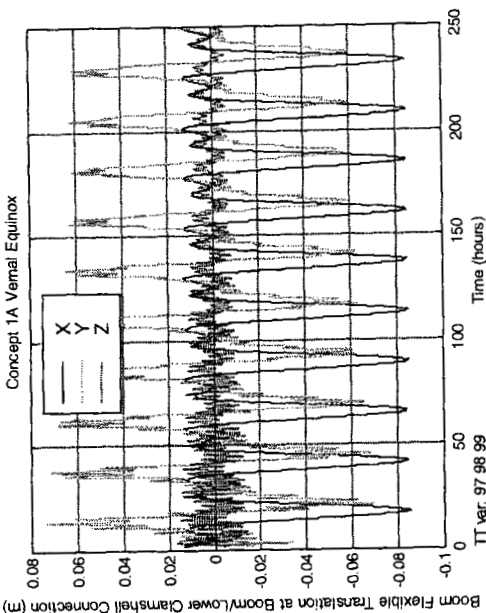


Figure B.1-30: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

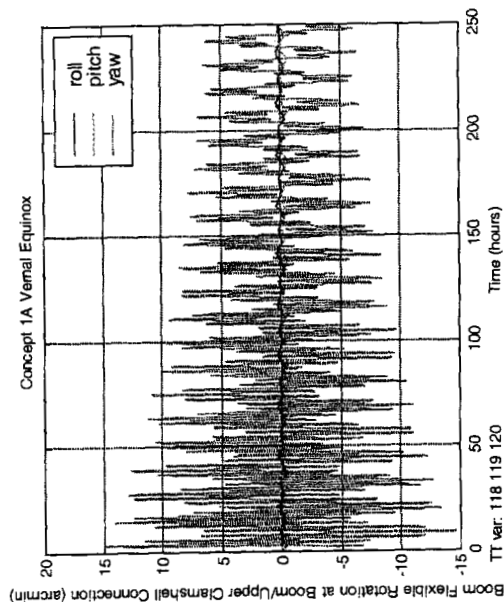


Figure B.1-31: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

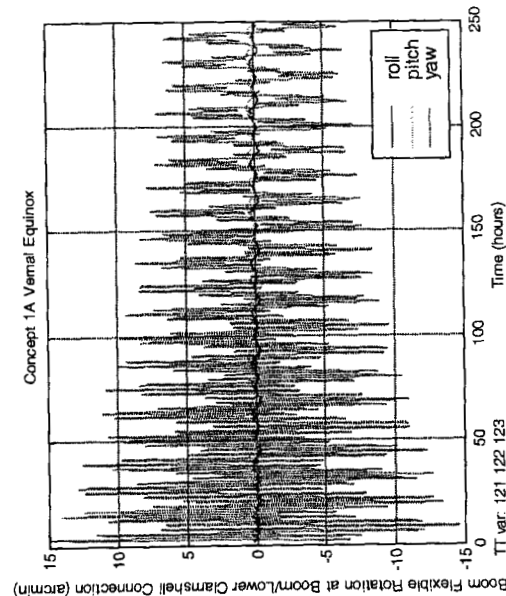


Figure B.1-32: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

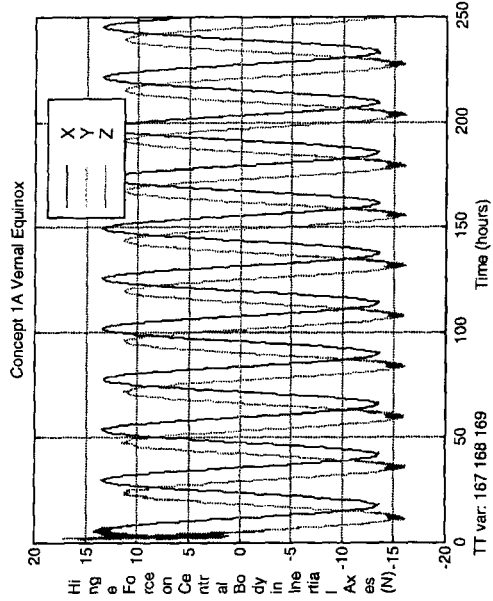


Figure B.1-33: Hinge Force on Central Body
in Inertial Axes vs. Time
(Vernal Equinox)

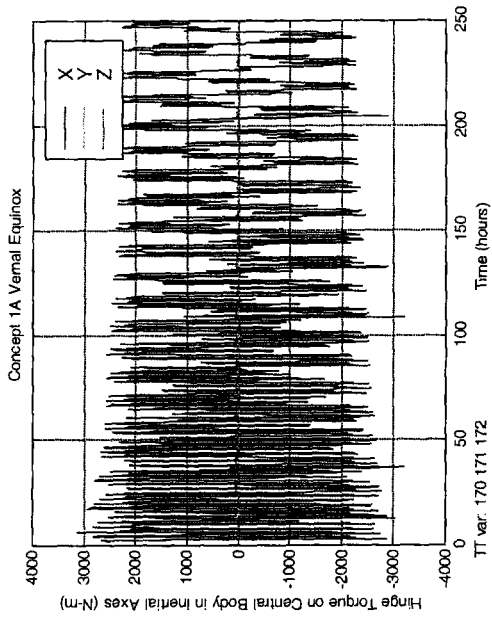


Figure B.1-34: Hinge Torque on Central Body
in Inertial Axes vs. Time
(Vernal Equinox)

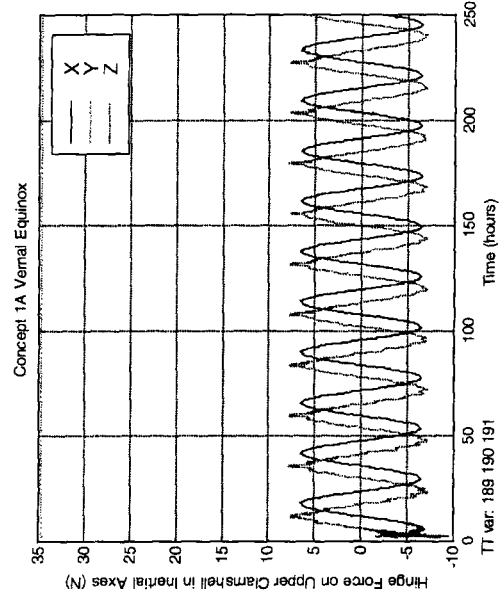


Figure B.1-35: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

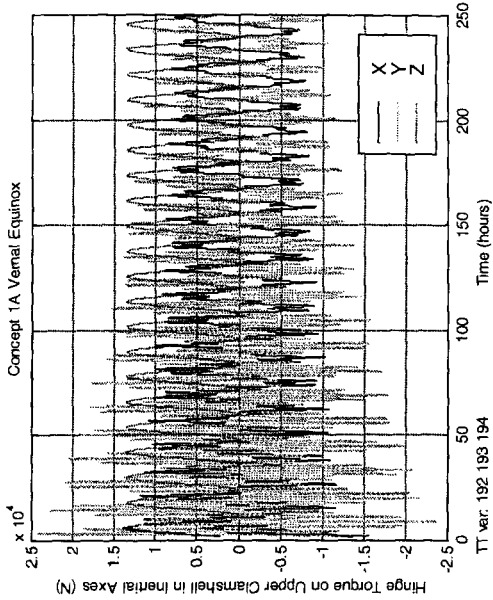


Figure B.1-36: Hinge Torque on Upper Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

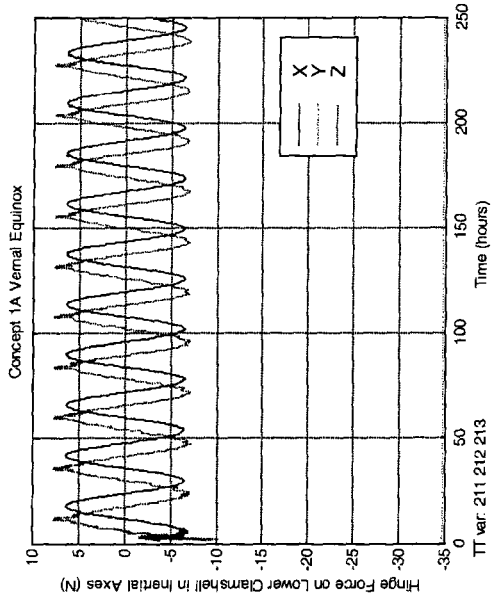


Figure B.1-37: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

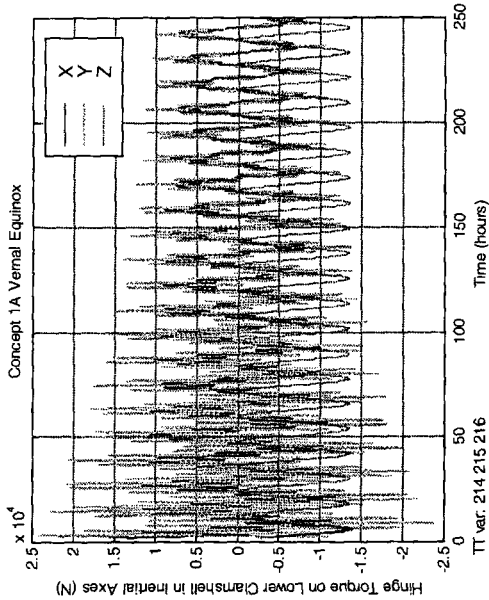


Figure B.1-38: Hinge Torque on Lower Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

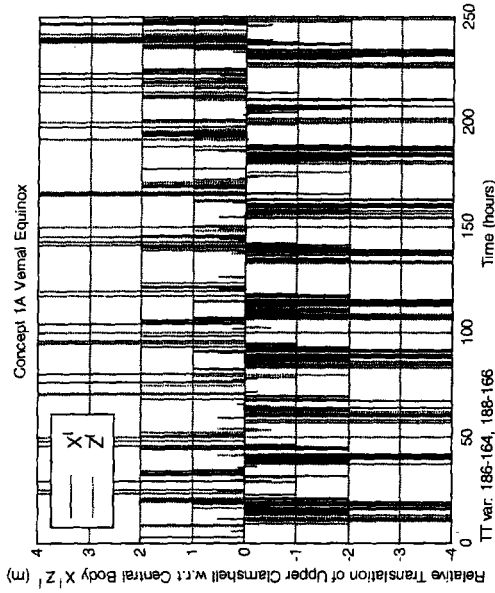


Figure B.1-39: Relative Translation of Upper Clamshell w.r.t. Central
Body vs. Time
(Vernal Equinox)

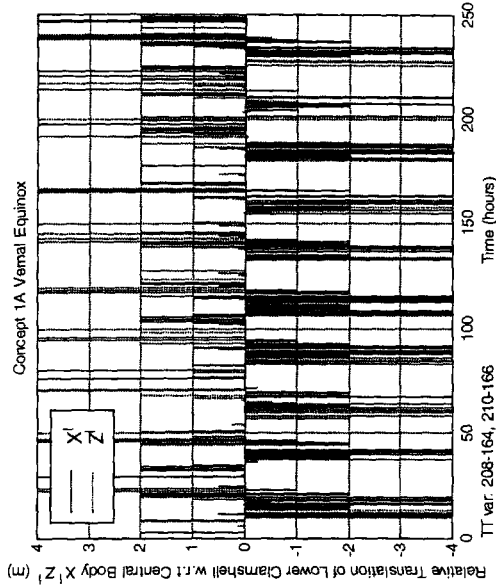


Figure B.1-40: Relative Translation of Lower Clamshell w.r.t. Central
Body vs. Time
(Vernal Equinox)

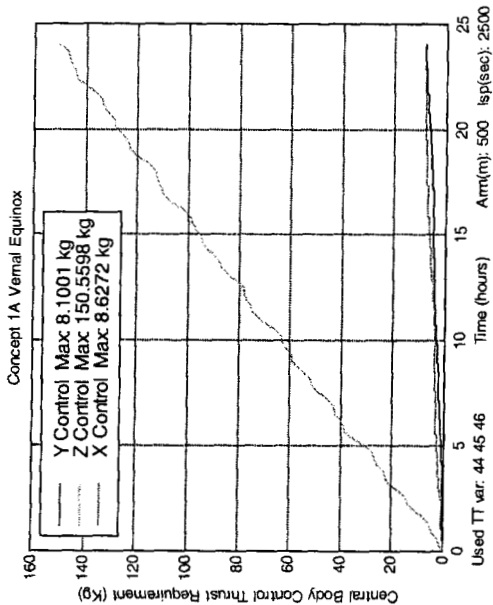


Figure B.1-41a: Central Body Control Thrust Requirement vs. Time for
1 Day
(Vernal Equinox)

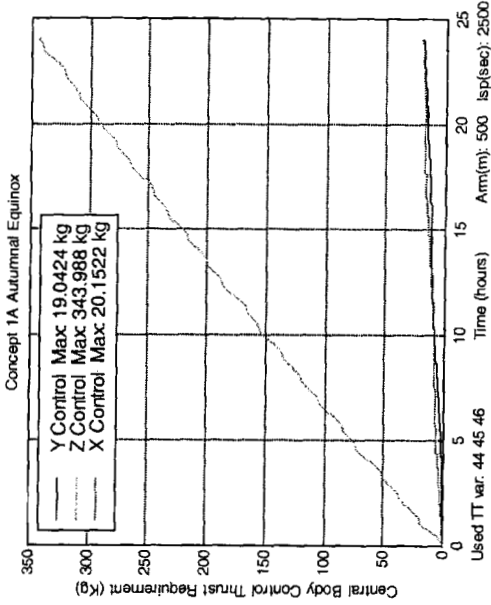


Figure B.1-41c: Central Body Control Thrust Requirement vs. Time for
1 Day
(Autumnal Equinox)

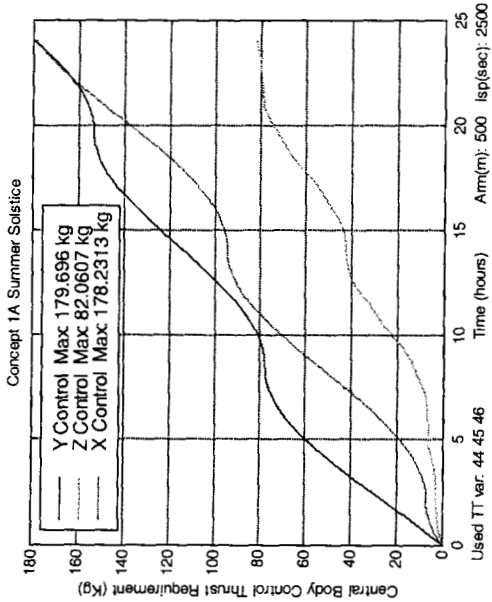


Figure B.1-41a: Central Body Control Thrust Requirement vs. Time for
1 Day
(Summer Solstice)

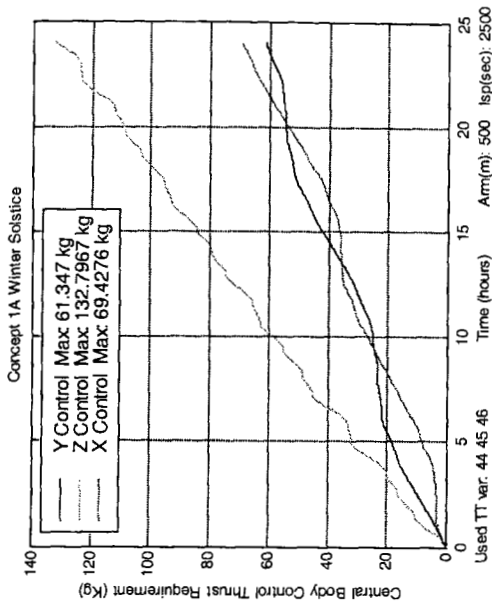


Figure B.1-41d: Central Body Control Thrust Requirement vs. Time for
1 Day
(Winter Solstice)

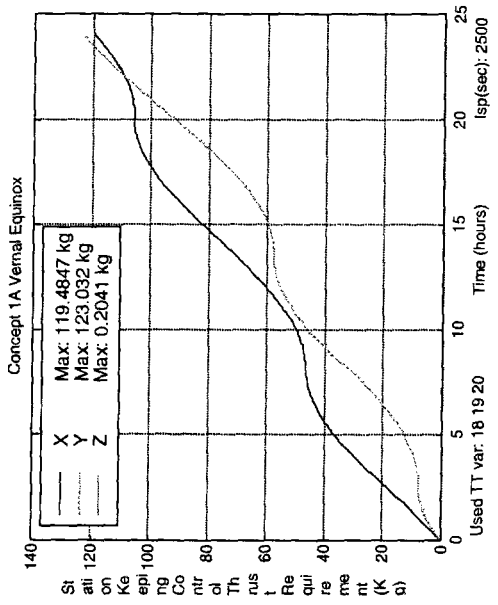


Figure B.1-42a: Station Keeping Control Thrust Requirement vs. Time for 1 Day (Vernal Equinox)

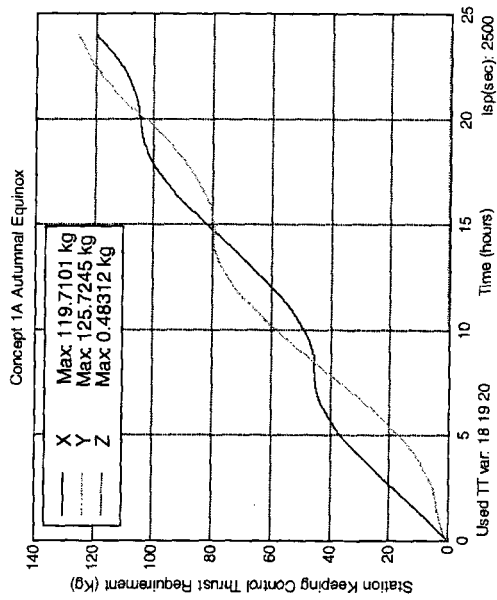


Figure B.1-42c: Station Keeping Control Thrust Requirement vs. Time for 1 Day (Autumnal Equinox)

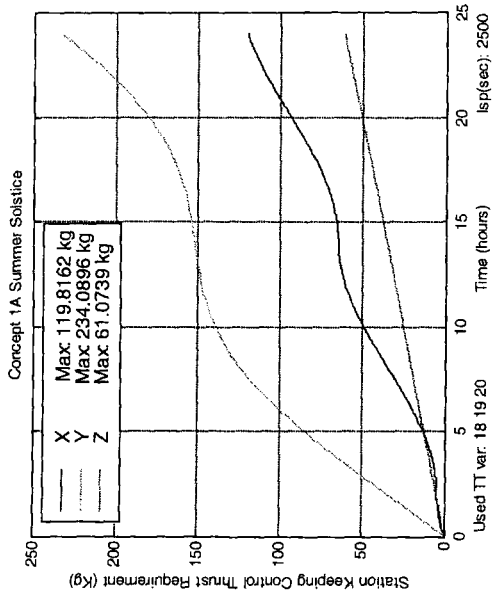


Figure B.1-42b: Station Keeping Clamshell Control Thrust Requirement vs. Time for 1 Day (Summer Solstice)

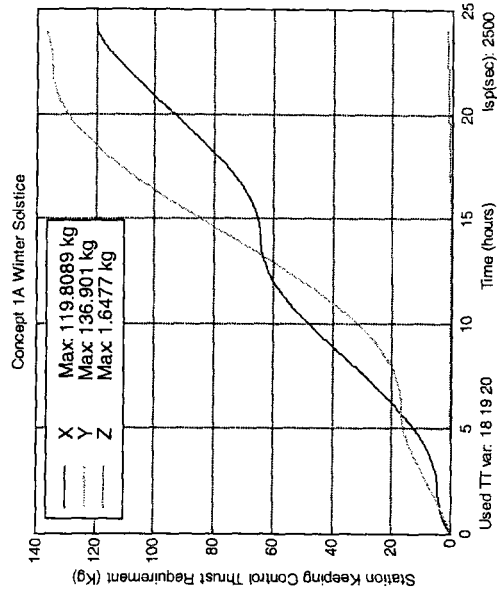


Figure B.1-42d: Station Keeping Control Thrust Requirement vs. Time for 1 Day (Winter Solstice)

Table B.1-1: Predicted Daily Thrust Requirements (Kg) (Concept 1) (Now Obsolete, See Table B.1-5)

Description	Vernal Equinox			Summer Solstice			Autumnal Equinox			Winter Solstice			Daily Average			Total
	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Central Body Control	8.627	8.400	150.560	178.231	179.696	82.061	20.153	19.042	343.988	69.428	61.347	122.797	69.110	67.046	177.353	313.508

Notes:

- 1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m
- 2) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z^B) should have been 90 deg for all cases.

Table B.1-2: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 1) (Now Obsolete, See Table B.1-6)

Description	Vernal Equinox			Summer Solstice			Autumnal Equinox			Winter Solstice			Daily Average			Total
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	
Station Keeping Control	119.485	123.033	204	119.816	234.090	61.074	119.710	125.725	483	119.809	136.901	1.648	119.705	154.937	15.853	290.494

Notes:

- 1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg
- 2) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z^B) should have been 90 deg for all cases.

TABLE B.1-3: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 1) (Now Obsolete, See Table B.1-7)							
Description	Daily Total			Yearly Total			
	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control
Central Body Control	69.110	67.046	177.352	313.508	25242	24489	64779
Notes: 1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m 2) 1 Year = 365.25 days 3) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z ^B) should have been 90 deg for all cases.							

TABLE B.1-4: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 1) (Now Obsolete, See Table B.1-8)							
Description	Daily Total			Yearly Total			
	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control
Station Keeping Control	119.705	154.937	15.852	290.494	43722	56591	5790
Notes: 1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg 2) 1 Year = 365.25 days 3) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z ^B) should have been 90 deg for all cases.							

Table B.1-5: Predicted Daily Thrust Requirements (Kg) (Concept 1)

Description	Vernal Equinox (est.)			Summer Solstice (calc.)			Autumnal Equinox (est.)			Winter Solstice (est.)			Daily Average			Total
	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Central Body Control	3.89	2.88	90.5	178.231	179.696	82.061	5.53	5.31	90.6	178.2	179.5	82.04	91.463	91.847	86.300	269.610
Notes:																
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m																
2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component.																

Table B.1-6: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 1)

Description	Vernal Equinox (est.)			Summer Solstice (calc.)			Autumnal Equinox (est.)			Winter Solstice (est.)			Daily Average			Total
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	
Station Keeping Control	130.2	258.5	.762	119.816	234.090	61.074	139.4	258.9	1.778	120.2	234.11	61.074	127.404	246.400	31.172	404.976
Notes:																
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg																
2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component.																

TABLE B.1-7: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 1)

Description	Daily Total				Yearly Total		
	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control
Central Body Control	91.463	91.847	86.300	269.610	33407.	33547.	31521.
Total (1 Year)							
98475.							

Notes:
 1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m
 2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component.
 3) 1 Year = 365.25 days

TABLE B.1-8: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 1)

Description	Daily Total				Yearly Total		
	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control
Station Keeping Control	127.404	246.400	31.172	404.976	46534.	89998.	11386.
Total (1 Year)							
147918.							

Notes:
 1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg
 2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component.
 3) 1 Year = 365.25 days

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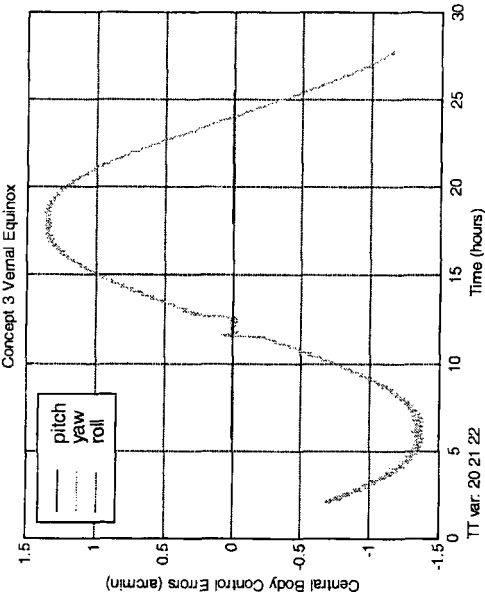


Figure B.2-1a: Central Body Control Errors vs. Time
(Vernal Equinox)

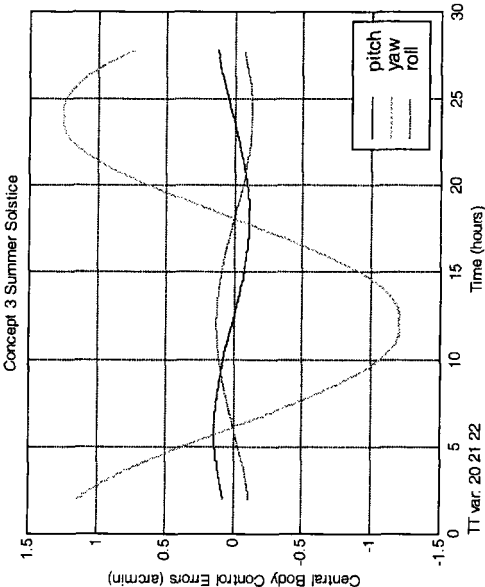


Figure B.2-1b: Central Body Control Errors vs. Time
(Summer Solstice)

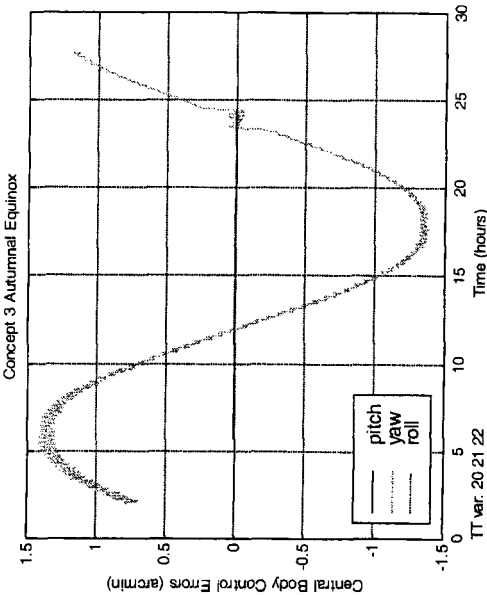


Figure B.2-1c: Central Body Control Errors vs. Time
(Autumnal Equinox)

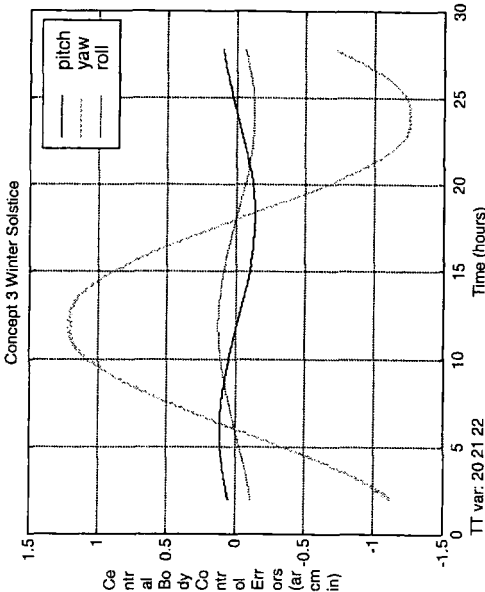


Figure B.2-1d: Central Body Control Errors vs. Time
(Winter Solstice)

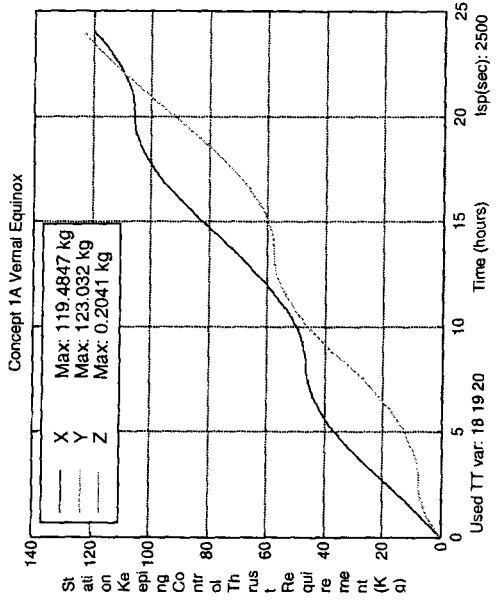


Figure B.1-42a: Station Keeping Control Thrust Requirement vs. Time for 1 Day (Vernal Equinox)

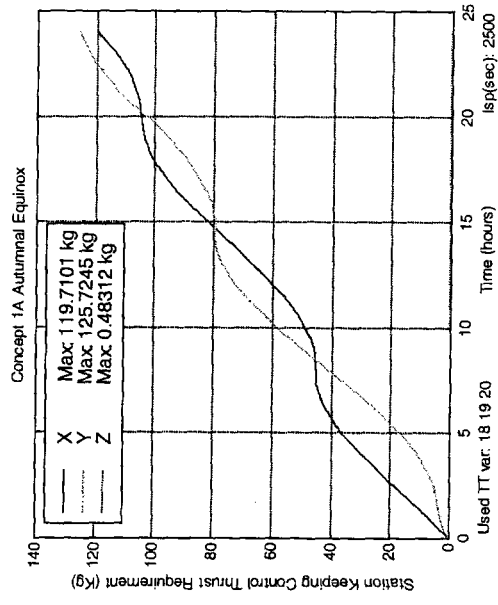


Figure B.1-42c: Station Keeping Control Thrust Requirement vs. Time for 1 Day (Autumnal Equinox)

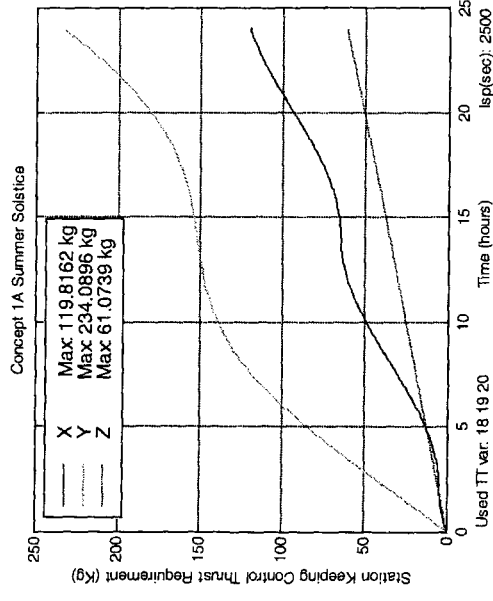


Figure B.1-42b: Station Keeping Clamshell Control Thrust Requirement vs. Time for 1 Day (Summer Solstice)

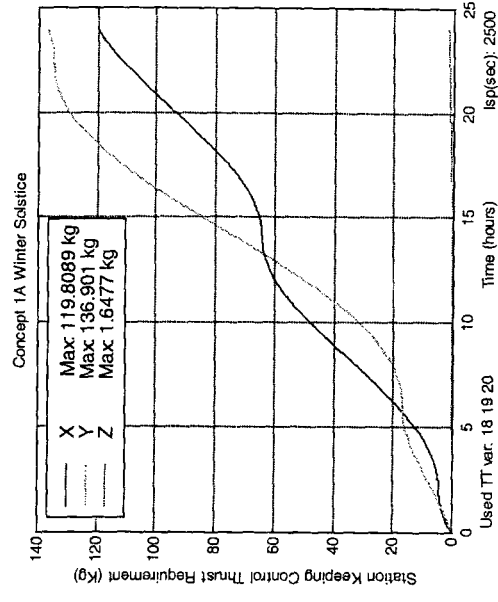


Figure B.1-42d: Station Keeping Control Thrust Requirement vs. Time for 1 Day (Winter Solstice)

Table B.1-1: Predicted Daily Thrust Requirements (Kg) (Concept 1) (Now Obsolete, See Table B.1-5)

Description	Vernal Equinox			Summer Solstice			Autumnal Equinox			Winter Solstice			Daily Average			Total
	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Central Body Control	2.627	8.100	150.560	178.231	179.696	82.061	20.152	19.043	343.988	69.428	64.347	122.797	69.110	67.046	177.352	312.508

Notes:

1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m

2) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z^B) should have been 90 deg for all cases.

Table B.1-2: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 1) (Now Obsolete, See Table B.1-6)

Description	Vernal Equinox			Summer Solstice			Autumnal Equinox			Winter Solstice			Daily Average			Total
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	
Station Keeping Control	119.485	123.032	704	119.816	234.090	61.074	119.710	125.725	483	119.809	126.901	1648	119.705	154.937	15.852	290.494

Notes:

1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg

2) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z^B) should have been 90 deg for all cases.

TABLE B.1-3: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 1) (Now Obsolete, See Table B.1-7)								
Description	Daily Total			Total (1 Day)	Yearly Total			
	X Control	Y Control	Z Control		X Control	Y Control	Z Control	Total (1 Year)
Central Body Control	69.110	67.046	177.352	313.508	25242.7	24489.7	64779.7	114510.7
Notes:								
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m								
2) 1 Year = 365.25 days								
3) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z ^B) should have been 90 deg for all cases.								

TABLE B.1-4: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 1) (Now Obsolete, See Table B.1-8)								
Description	Daily Total			Total (1 Day)	Yearly Total			
	X	Y	Z		X	Y	Z	Total (1 Year)
Station Keeping Control	119.705	154.937	15.852	290.494	43722.	56591.	5790.	106103.
Notes:								
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg								
2) 1 Year = 365.25 days								
3) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z ^B) should have been 90 deg for all cases.								

Table B.1-5: Predicted Daily Thrust Requirements (Kg) (Concept 1)

Description	Vernal Equinox (est.)			Summer Solstice (calc.)			Autumnal Equinox (est.)			Winter Solstice (est.)			Daily Average			Total
	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Central Body Control	3.89	2.88	90.5	178.231	179.696	82.061	5.53	5.31	90.6	178.2	179.5	82.04	91.463	91.847	86.300	269.610

Notes:

1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m

2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component.

Table B.1-6: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 1)

Description	Vernal Equinox (est.)			Summer Solstice (calc.)			Autumnal Equinox (est.)			Winter Solstice (est.)			Daily Average			Total
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	
Station Keeping Control	130.2	258.5	.762	119.816	234.090	61.074	139.4	258.9	1.778	120.2	234.11	61.074	127.404	246.400	31.172	404.976

Notes:

1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg

2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component.

TABLE B.1-7: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 1)							
Description	Daily Total				Yearly Total		
	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control
Central Body Control	91.463	91.847	86.300	269.610	33407.	33547.	31521.
Notes: 1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m 2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component. 3) 1 Year = 365.25 days							
Total (1 Year)							
98475.							

TABLE B.1-8: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 1)							
Description	Daily Total				Yearly Total		
	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control
Station Keeping Control	127.404	246.400	31.172	404.976	46534.	89998.	11386.
Notes: 1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg 2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component. 3) 1 Year = 365.25 days							
Total (1 Year)							
147918.							

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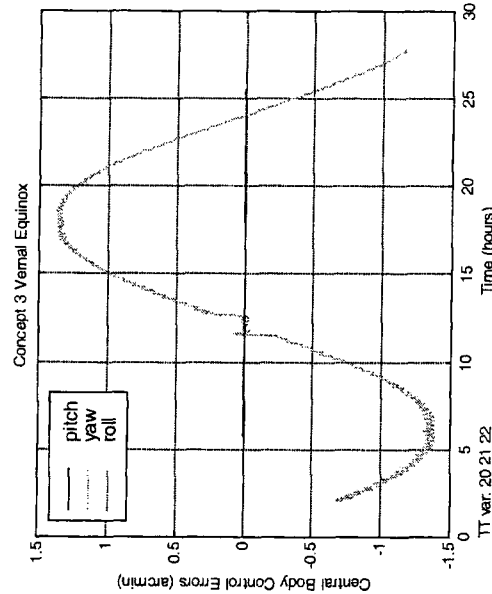


Figure B.2-1a: Central Body Control Errors vs. Time
(Vernal Equinox)

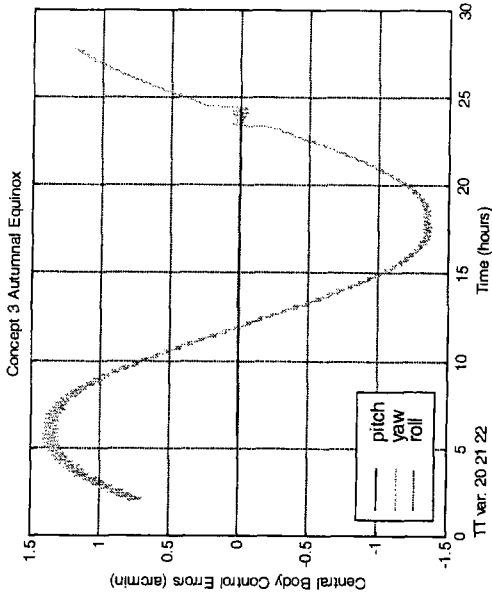


Figure B.2-1c: Central Body Control Errors vs. Time
(Autumnal Equinox)

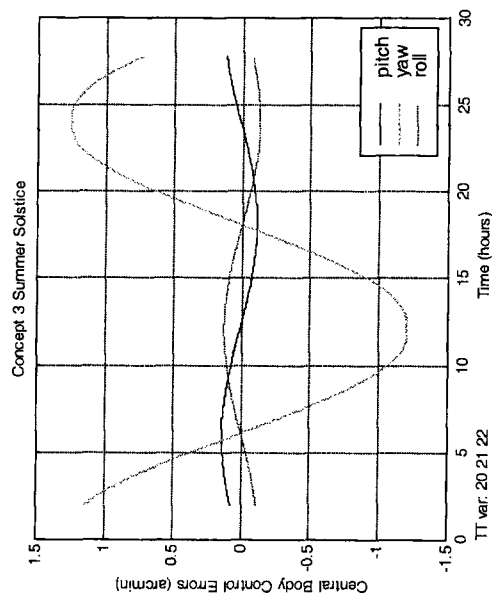


Figure B.2-1b: Central Body Control Errors vs. Time
(Summer Solstice)

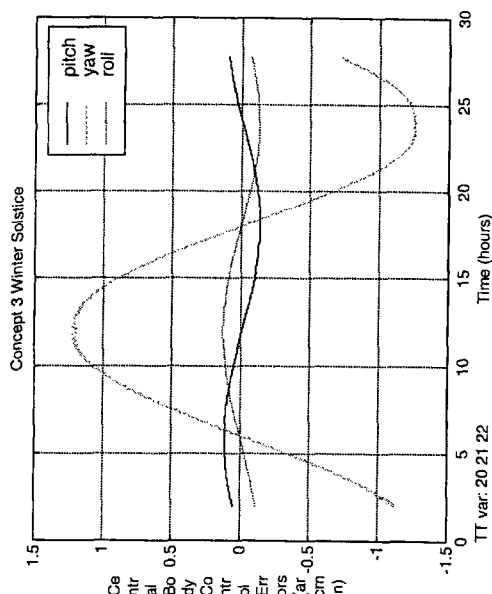


Figure B.2-1d: Central Body Control Errors vs. Time
(Winter Solstice)

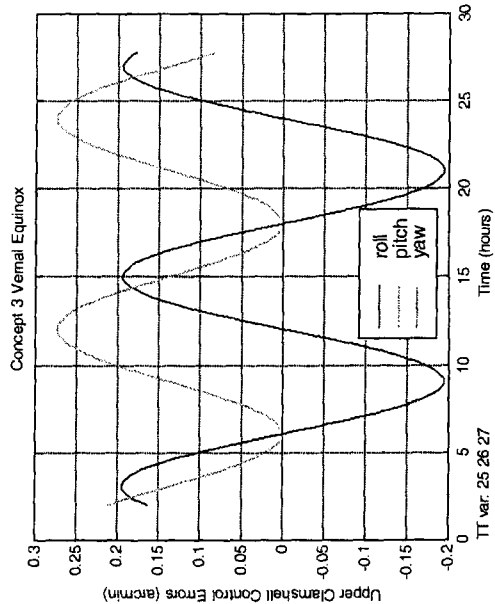


Figure B.2-2a: Upper Clamshell Control Errors vs. Time
(Vernal Equinox)

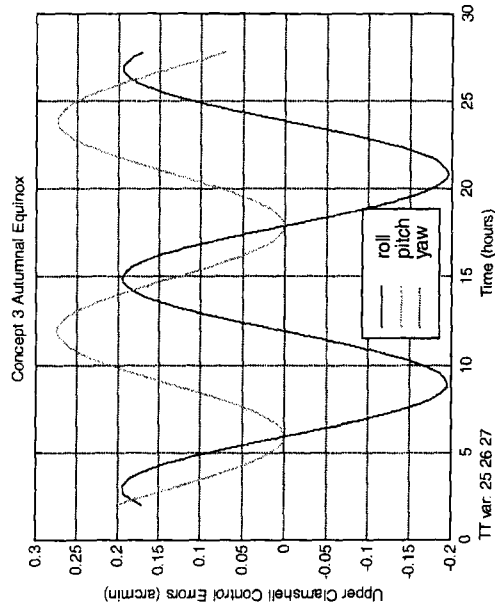


Figure B.2-2c: Upper Clamshell Control Errors vs. Time
(Autumnal Equinox)

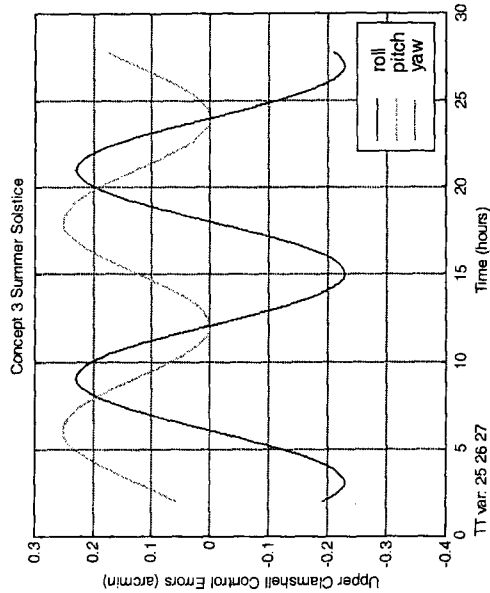


Figure B.2-2b: Upper Clamshell Control Errors vs. Time
(Summer Solstice)

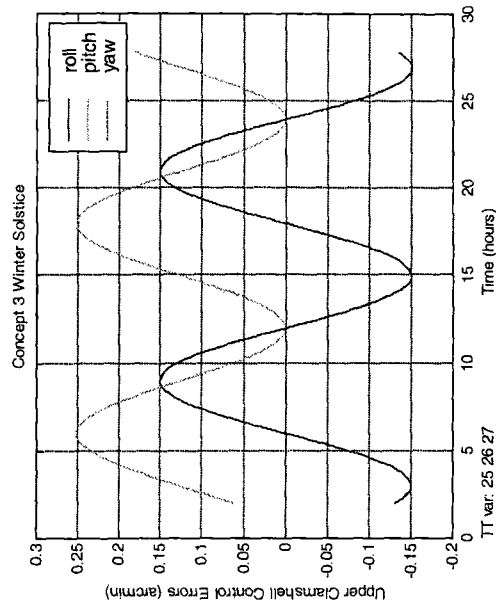


Figure B.2-2d: Upper Clamshell Control Errors vs. Time
(Winter Solstice)

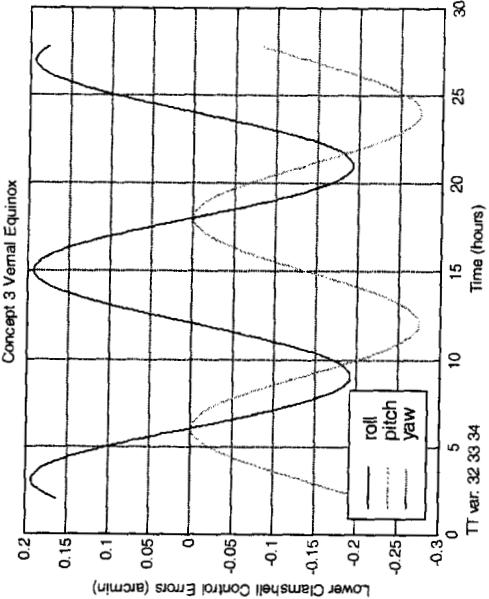


Figure B.2-3a: Lower Clamshell Control Errors vs. Time
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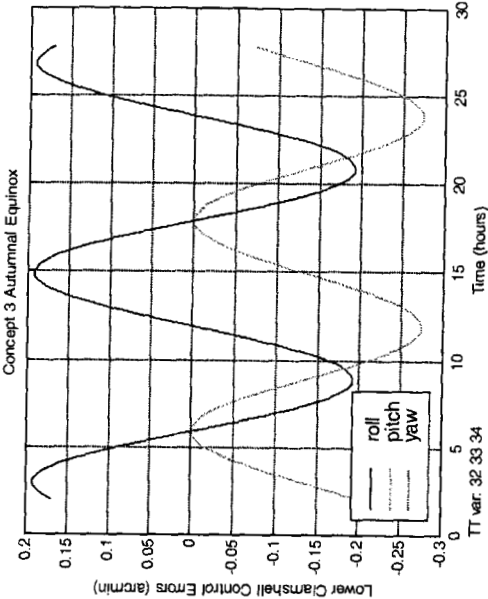


Figure B.2-3c: Lower Clamshell Control Errors vs. Time
(Autumnal Equinox)

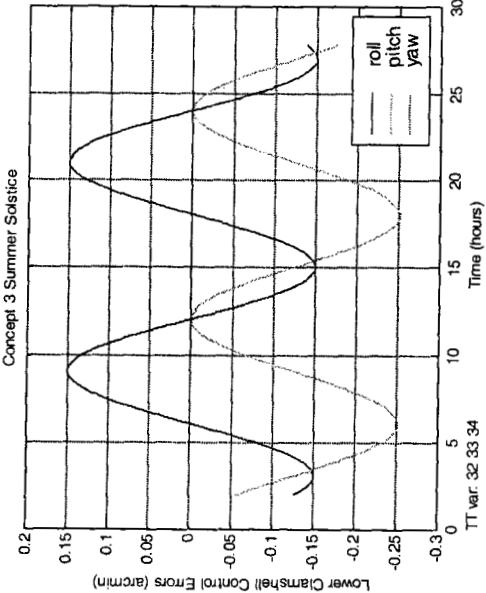


Figure B.2-3b: Lower Clamshell Control Errors vs. Time
(Summer Solstice)

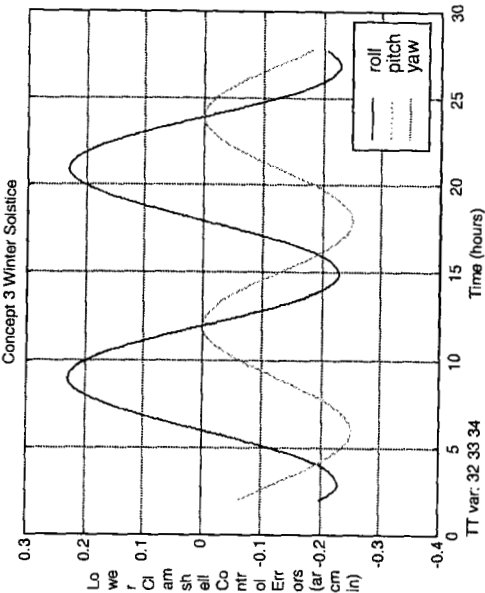


Figure B.2-3d: Lower Clamshell Control Errors vs. Time
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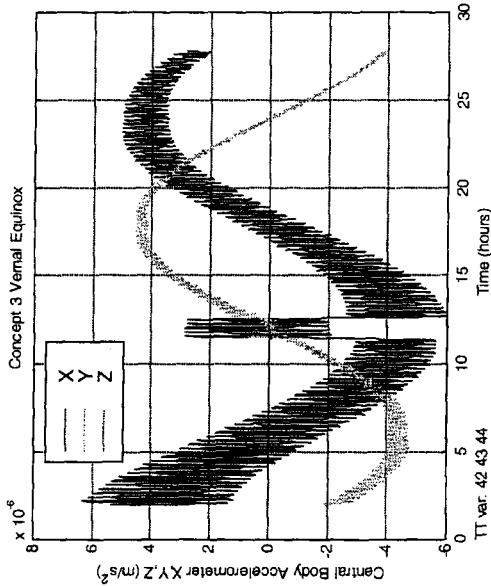


Figure B.2-4a: Central Body Accelerometer vs. Time
(Vernal Equinox)

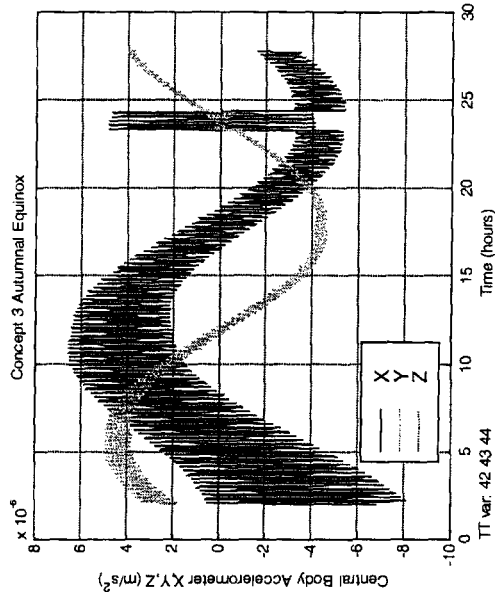


Figure B.2-4c: Central Body Accelerometer vs. Time
(Autumnal Equinox)

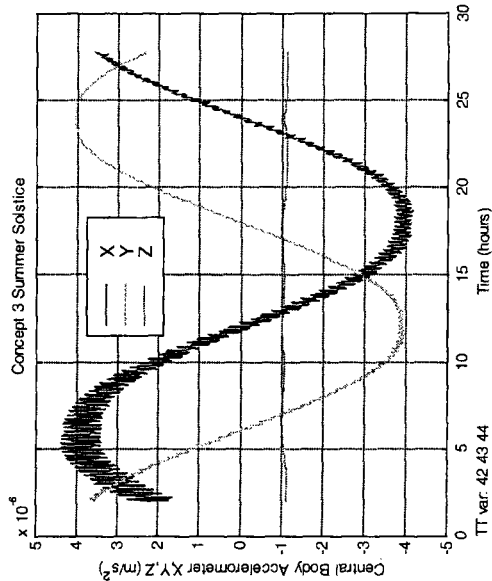


Figure B.2-4b: Central Body Accelerometer vs. Time
(Summer Solstice)

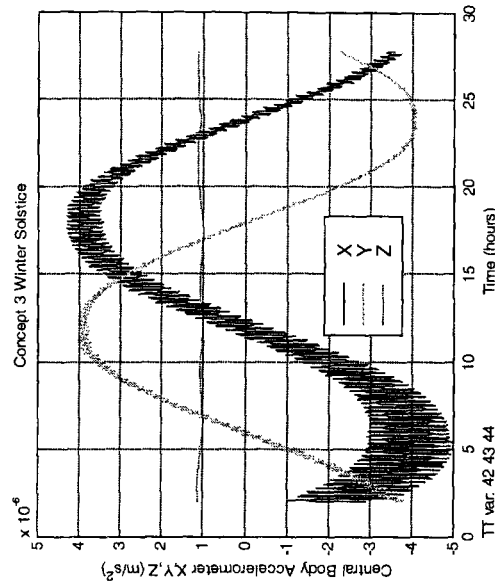


Figure B.2-4d: Central Body Accelerometer vs. Time
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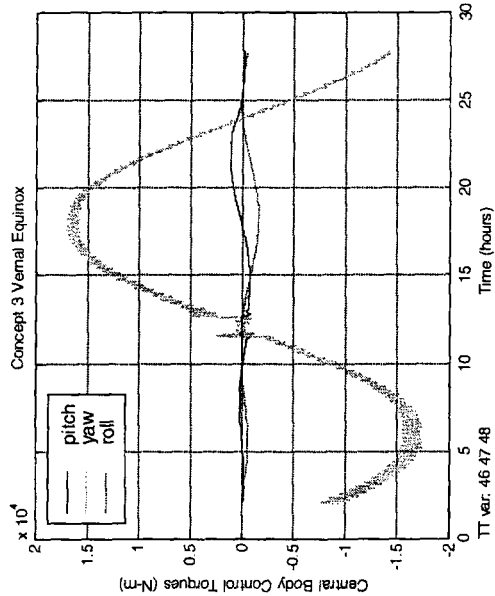


Figure B.2-5a: Central Body Control Torques vs. Time (Vernal Equinox)

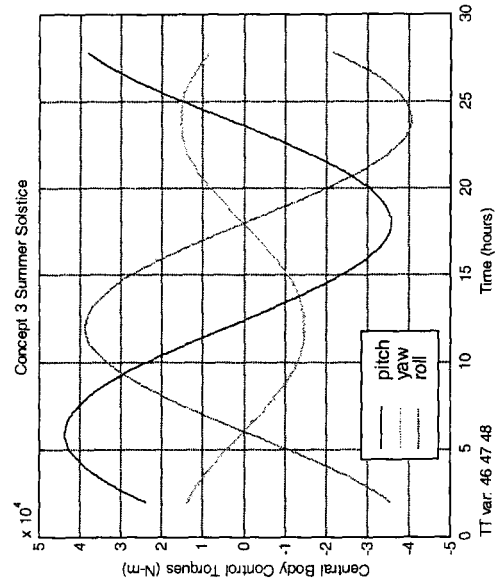


Figure B.2-5b: Central Body Control Torques vs. Time (Summer Solstice)

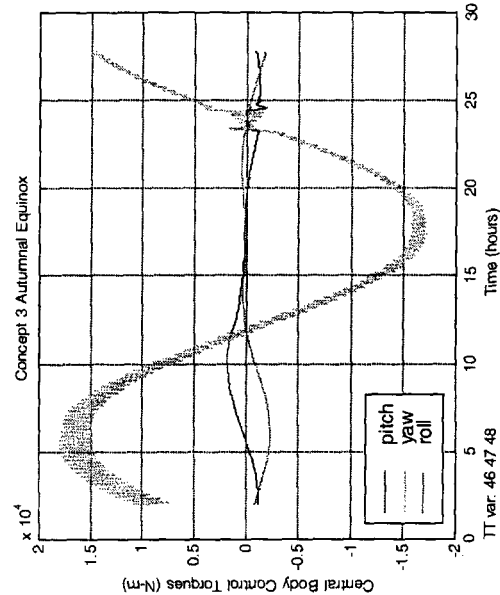


Figure B.2-5c: Central Body Control Torques vs. Time (Autumnal Equinox)

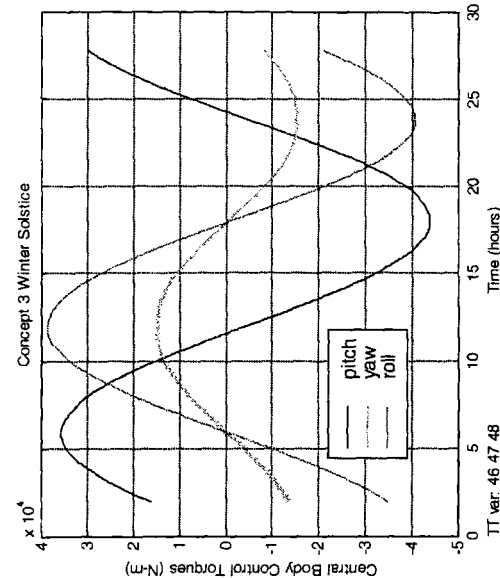


Figure B.2-5d: Central Body Control Torques vs. Time (Winter Solstice)

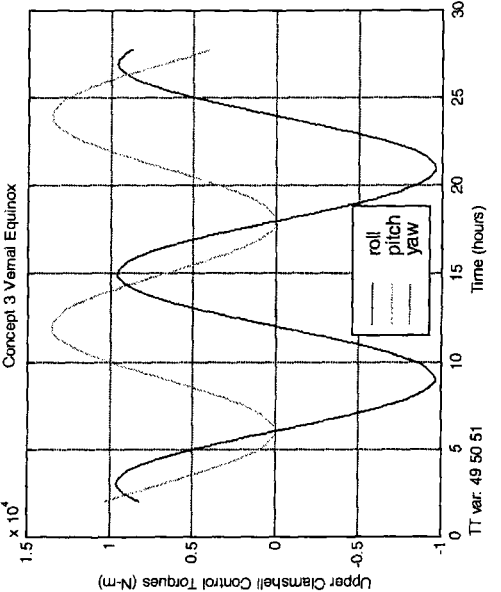


Figure B.2-6a: Upper Clamshell Control Torques vs. Time
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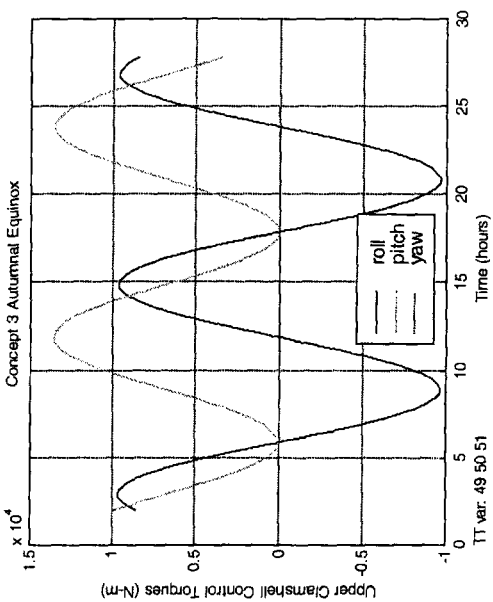


Figure B.2-6c: Upper Clamshell Control Torques vs. Time
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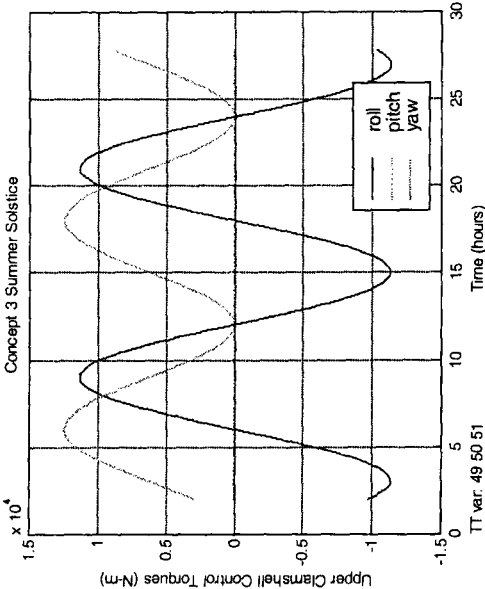


Figure B.2-6b: Upper Clamshell Control Torques vs. Time
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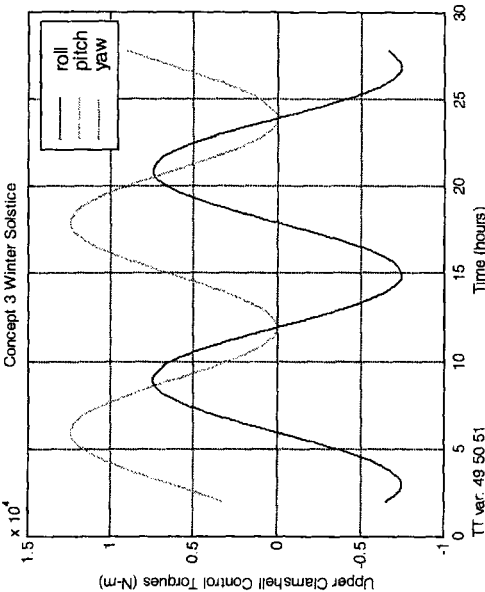


Figure B.2-6d: Upper Clamshell Control Torques vs. Time
(Winter Solstice)

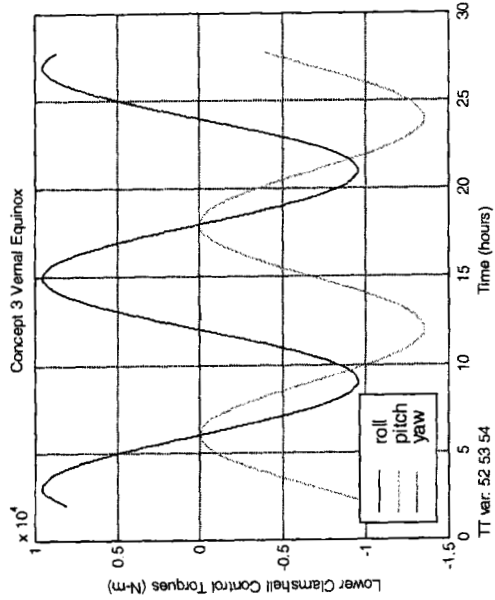


Figure B.2-7a: Lower Clamshell Control Torques vs. Time
(Vernal Equinox)

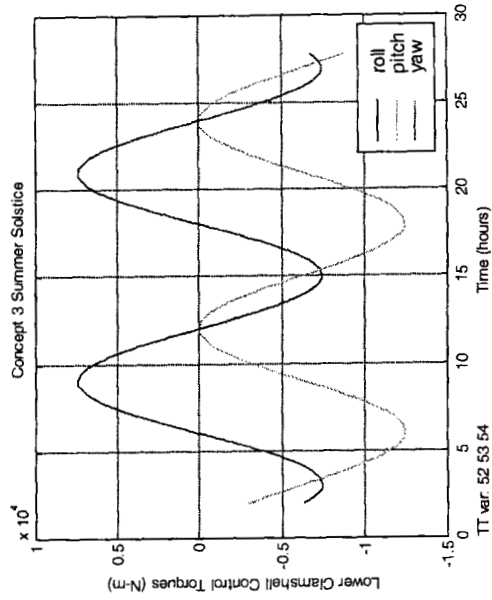


Figure B.2-7b: Lower Clamshell Control Torques vs. Time
(Summer Solstice)

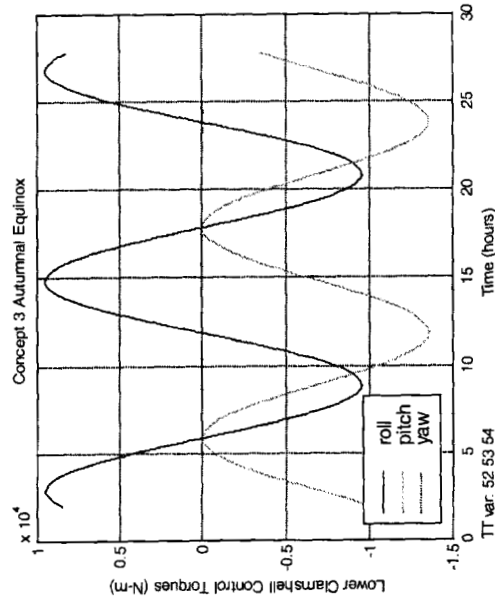


Figure B.2-7c: Lower Clamshell Control Torques vs. Time
(Autumnal Equinox)

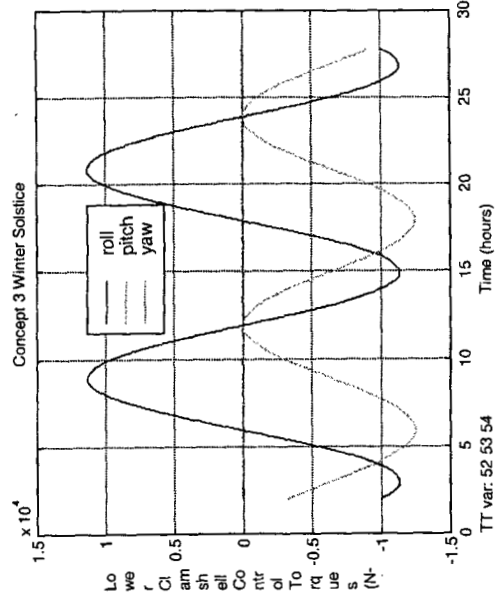


Figure B.2-7d: Lower Clamshell Control Torques vs. Time
(Winter Solstice)

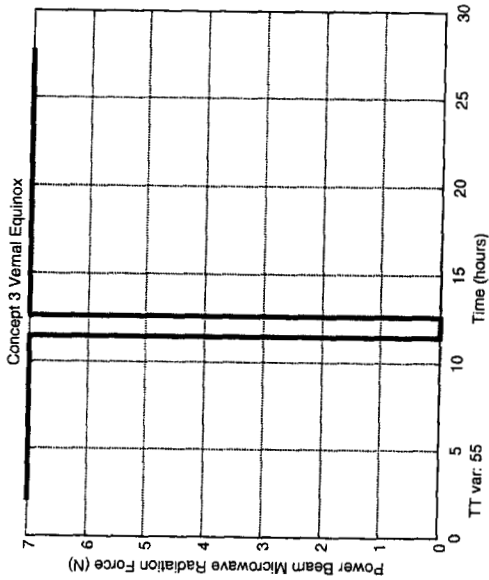


Figure B.2-8a: Power Beam Microwave Radiation Force vs. Time
(Vernal Equinox)

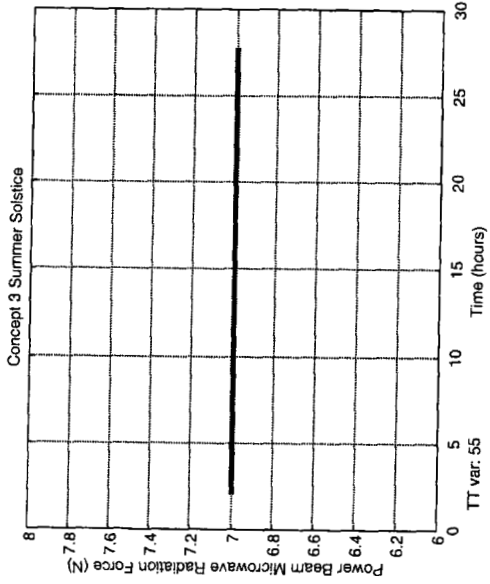


Figure B.2-8b: Power Beam Microwave Radiation Force
vs. Time
(Summer Solstice)

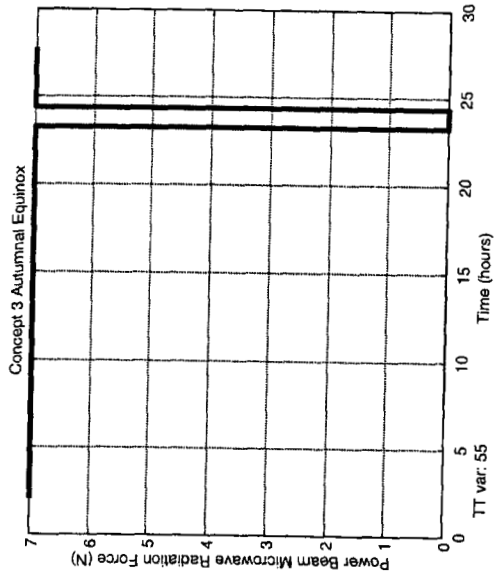


Figure B.2-8c: Power Beam Microwave Radiation Force
vs. Time
(Autumnal Equinox)

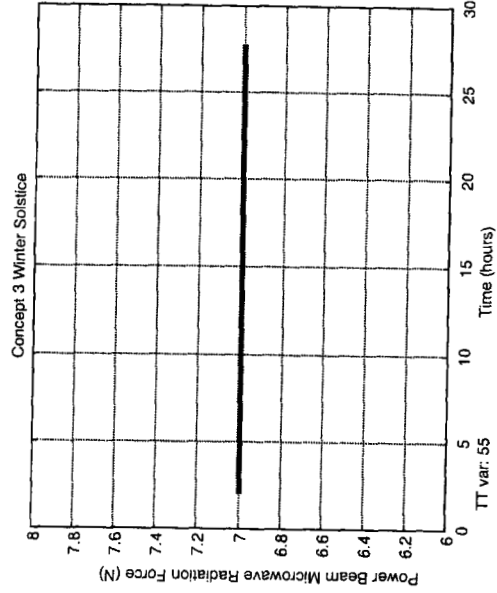


Figure B.2-8d: Power Beam Microwave Radiation Force
vs. Time
(Winter Solstice)

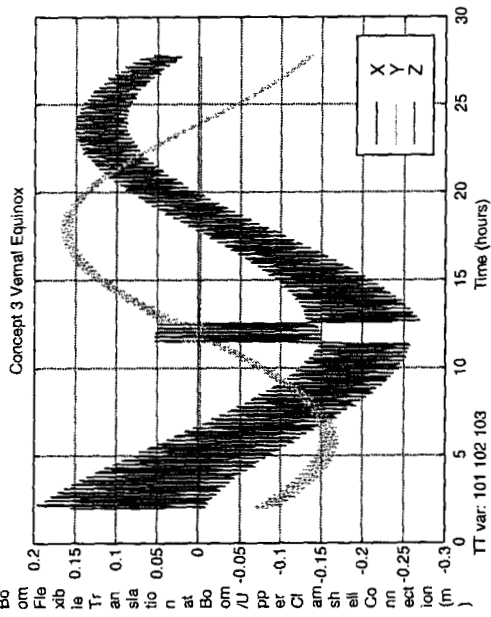


Figure B.2-9a: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

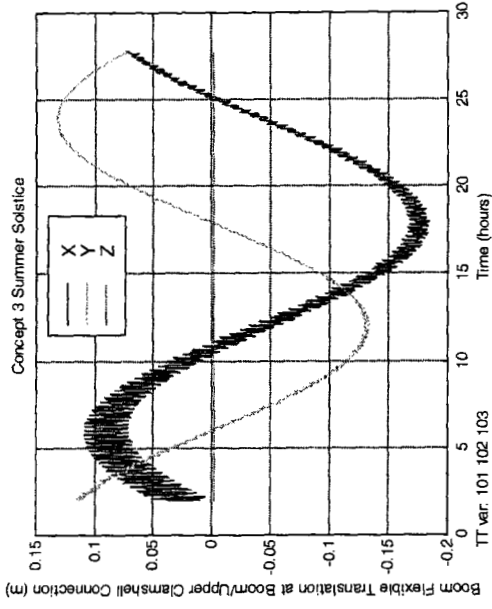


Figure B.2-9b: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Summer Solstice)

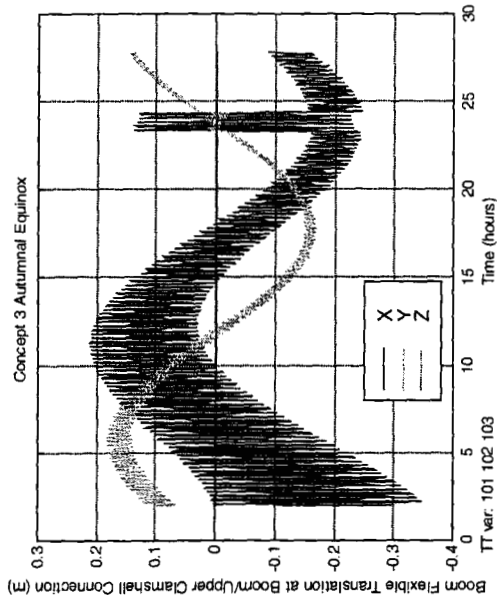


Figure B.2-9c: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Autumnal Equinox)

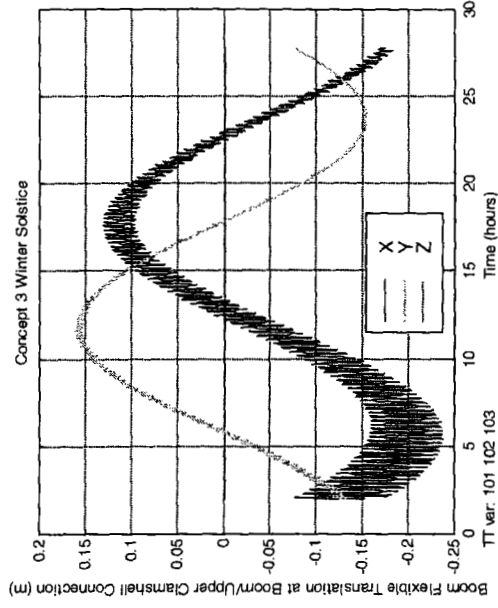


Figure B.2-9d: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Winter Solstice)

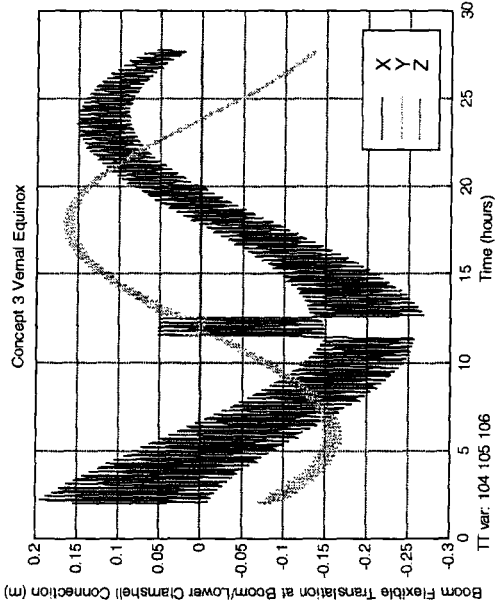


Figure B.2-10a: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

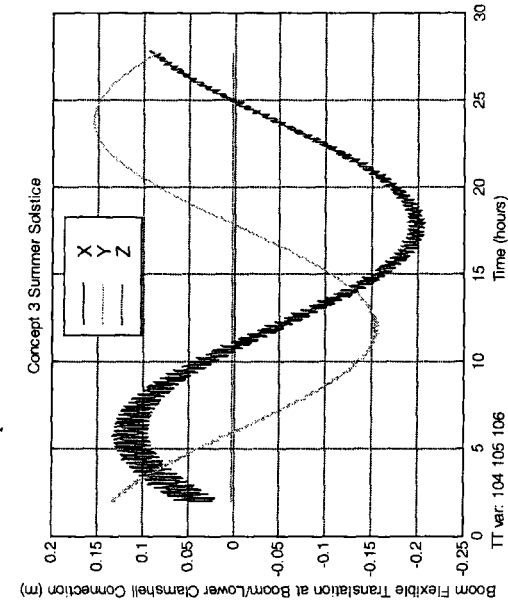


Figure B.2-10b: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Summer Solstice)

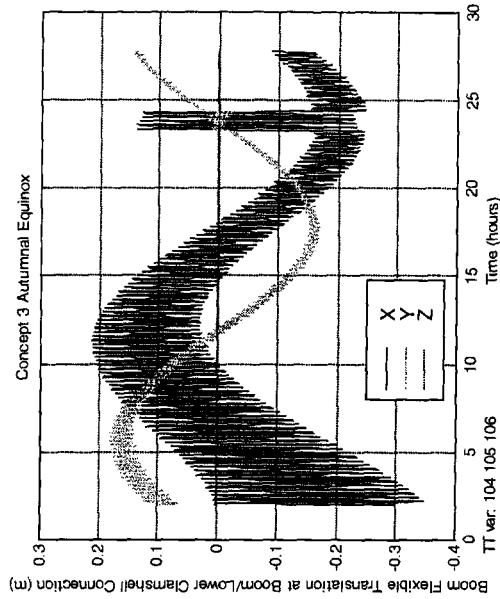


Figure B.2-10c: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Autumnal Equinox)

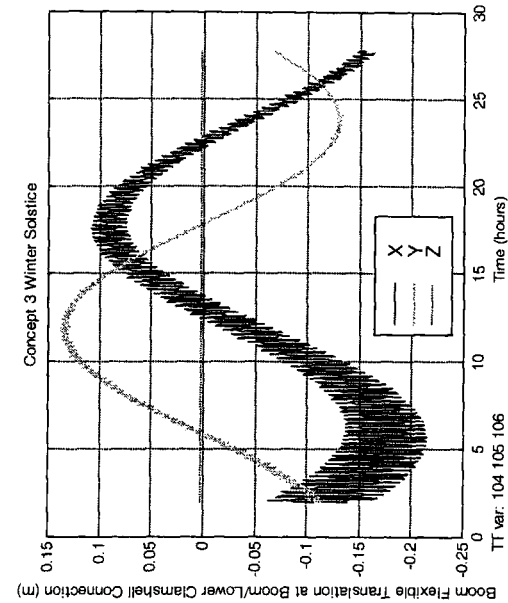


Figure B.2-10d: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Winter Solstice)

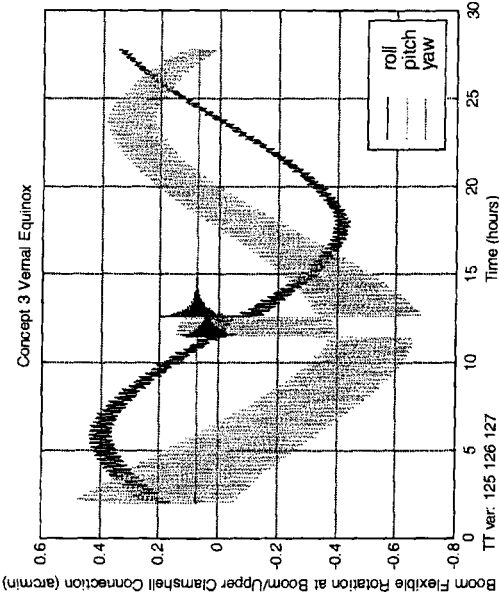


Figure B.2-11a: Boom Flexible Rotation at
Boom/Upper Clamshell Connection vs. Time
(Vernal Equinox)

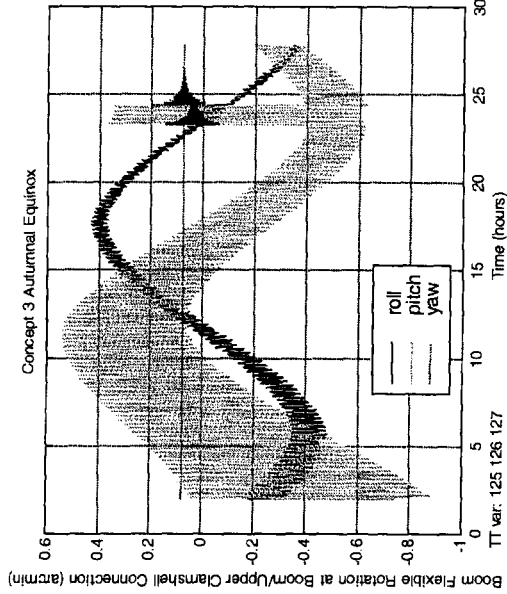


Figure B.2-11c: Boom Flexible Rotation at
Boom/Upper Clamshell Connection vs. Time
(Autumnal Equinox)

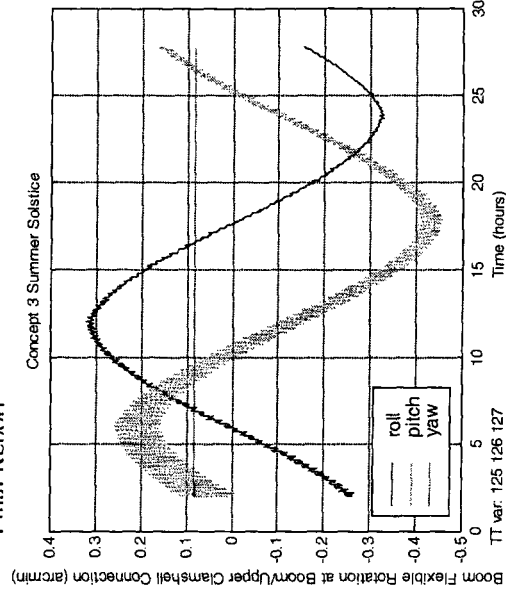


Figure B.2-11b: Boom Flexible Rotation at
Boom/Upper Clamshell Connection vs. Time
(Summer Solstice)

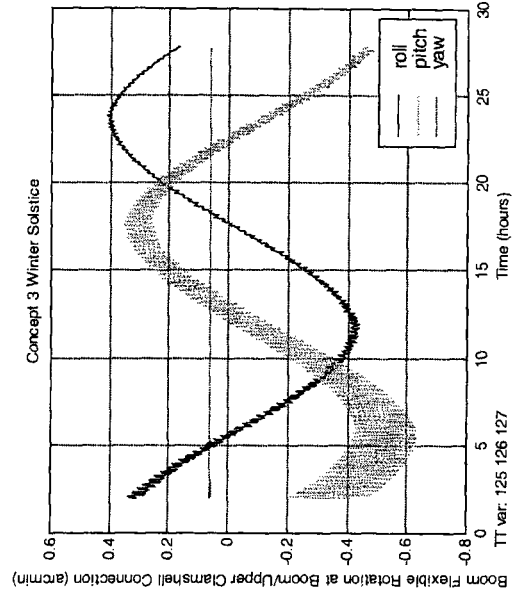


Figure B.2-11d: Boom Flexible Rotation at
Boom/Upper Clamshell Connection vs. Time
(Winter Solstice)

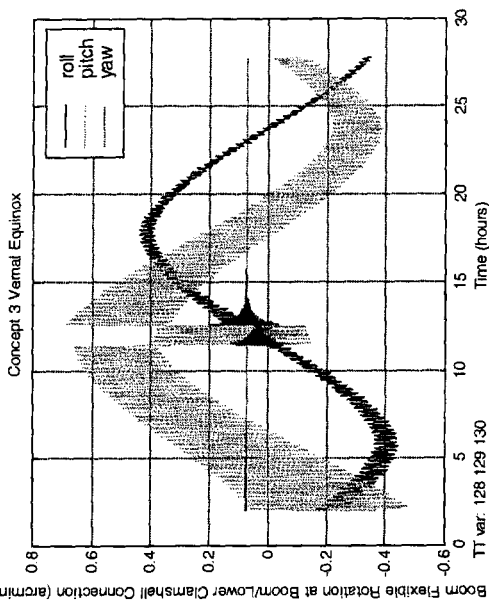


Figure B.2-12a: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

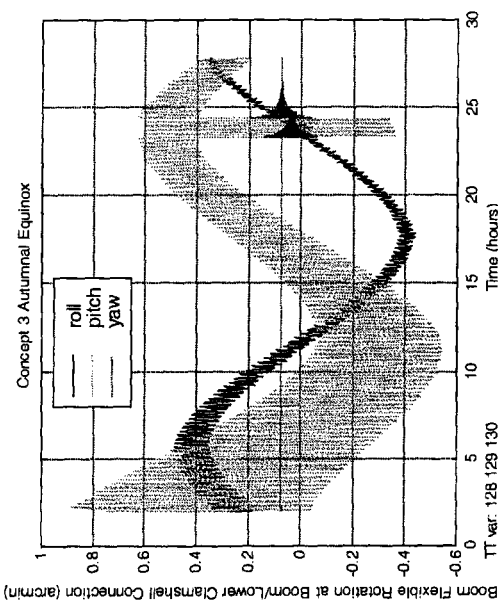


Figure B.2-12c: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Autumnal Equinox)

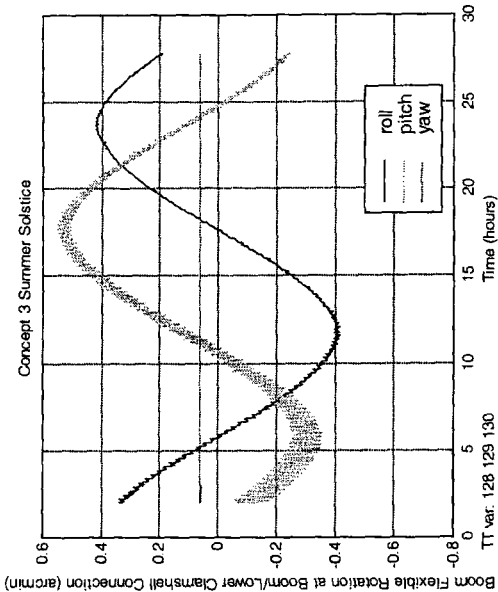


Figure B.2-12b: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Summer Solstice)

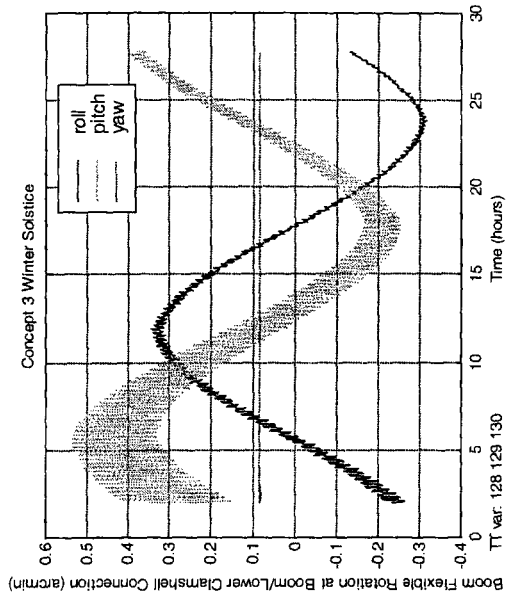


Figure B.2-12d: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Winter Solstice)

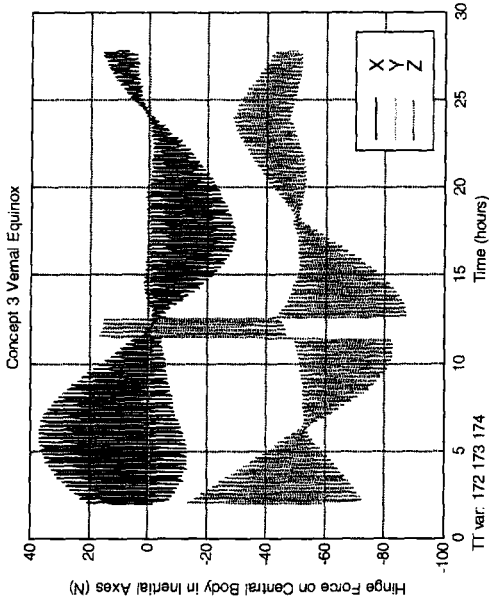


Figure B.2-13a: Hinge Force on Central Body
in Inertial Axes vs. Time
(Vernal Equinox)

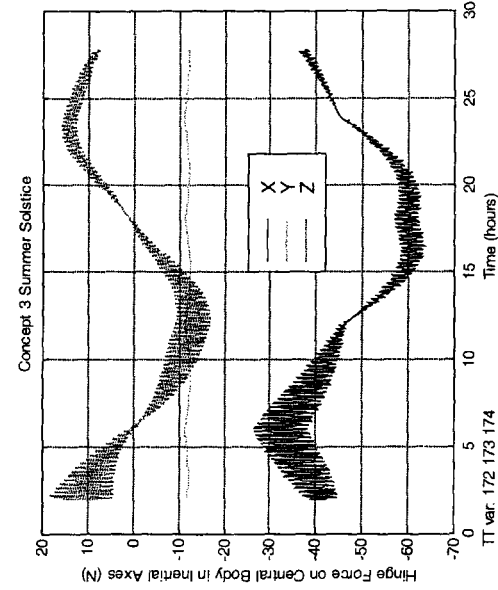


Figure B.2-13b: Hinge Force on Central Body
in Inertial Axes vs. Time
(Summer Solstice)

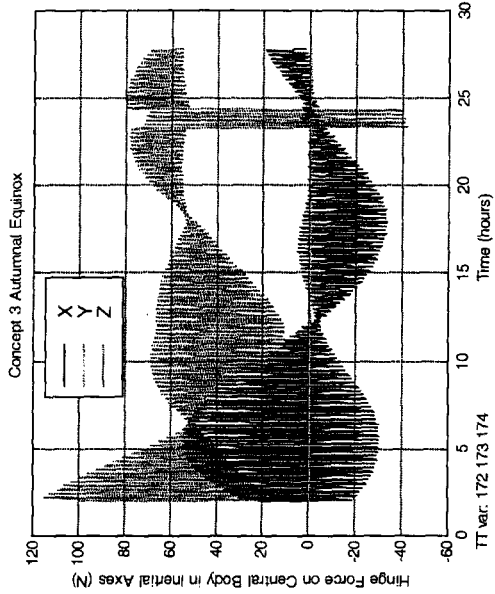


Figure B.2-13c: Hinge Force on Central Body
in Inertial Axes vs. Time
(Autumnal Equinox)

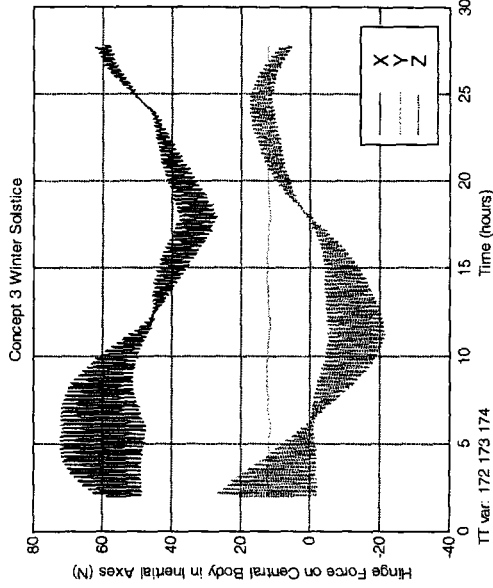


Figure B.2-13d: Hinge Force on Central Body
in Inertial Axes vs. Time
(Winter Solstice)

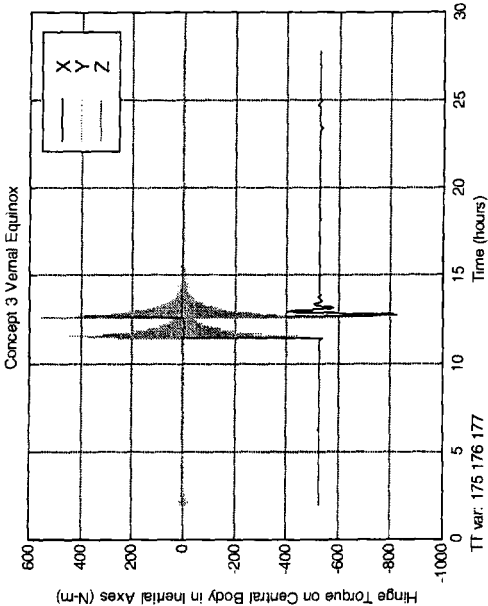


Figure B.2-14a: Hinge Torque on Central Body
in Inertial Axes vs. Time
(Vernal Equinox)

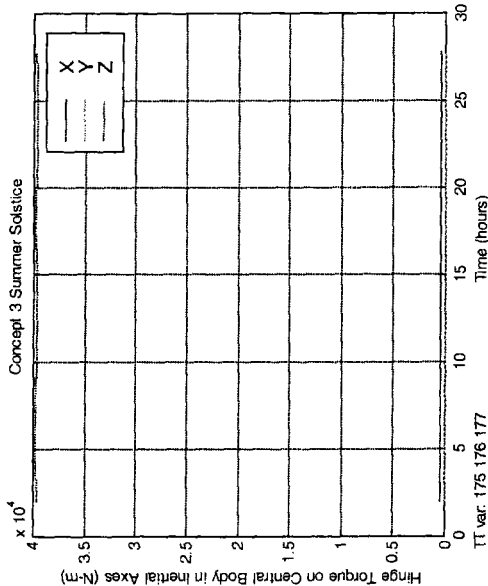


Figure B.2-14b: Hinge Torque on Central Body
in Inertial Axes vs. Time
(Summer Solstice)

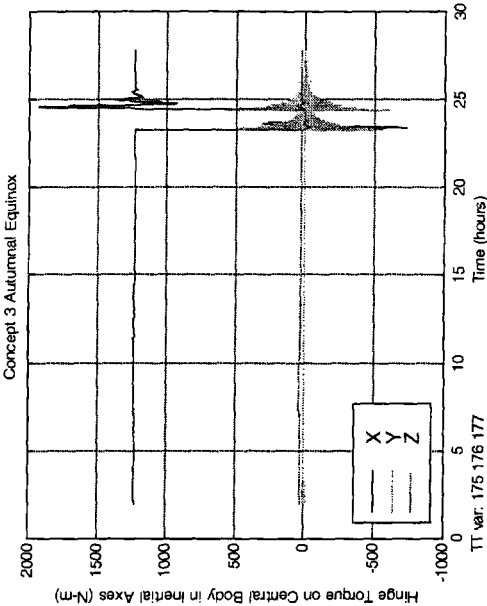


Figure B.2-14c: Hinge Torque on Central Body
in Inertial Axes vs. Time
(Autumnal Equinox)

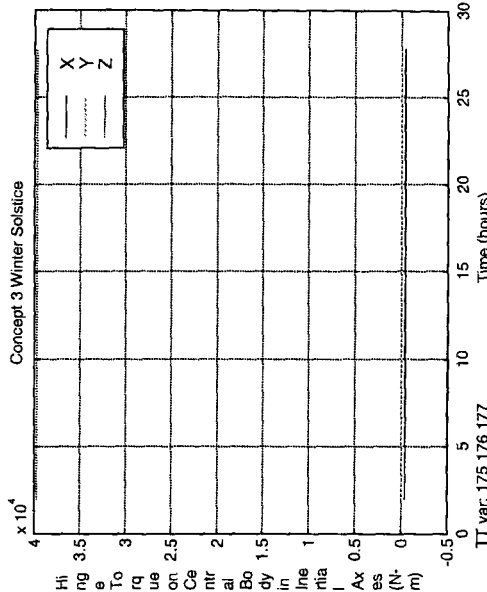


Figure B.2-14d: Hinge Torque on Central Body
in Inertial Axes vs. Time
(Winter Solstice)

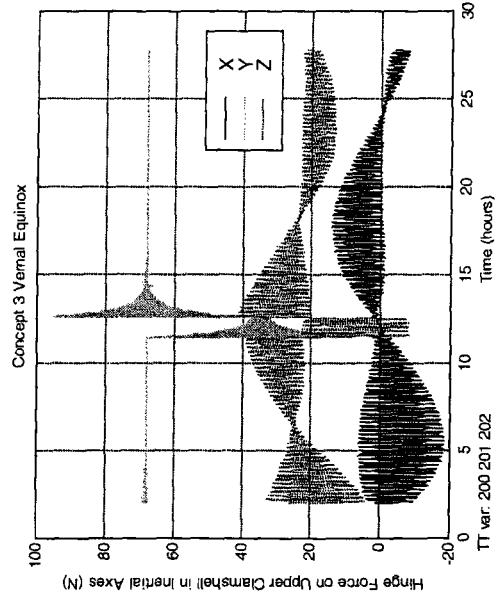


Figure B.2-15a: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

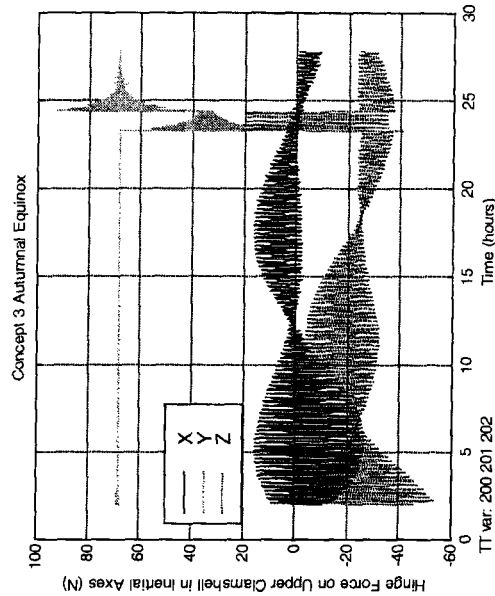


Figure B.2-15c: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Autumnal Equinox)

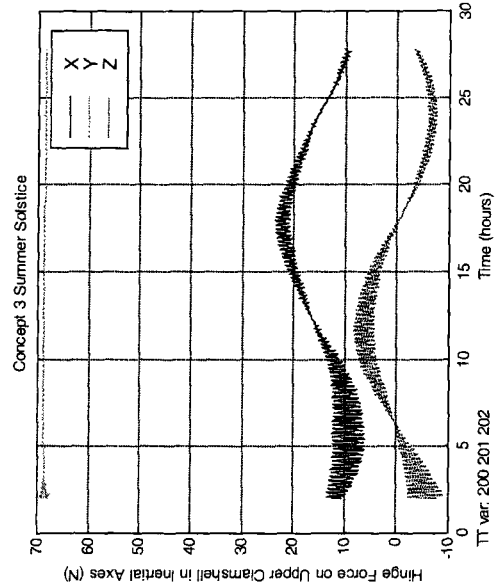


Figure B.2-15b: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Summer Solstice)

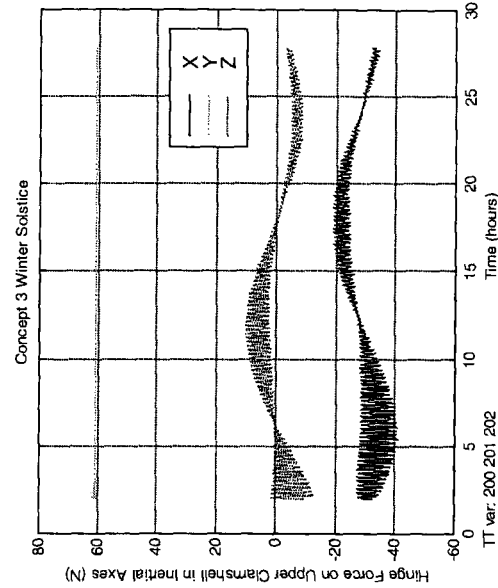


Figure B.2-15d: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Winter Solstice)

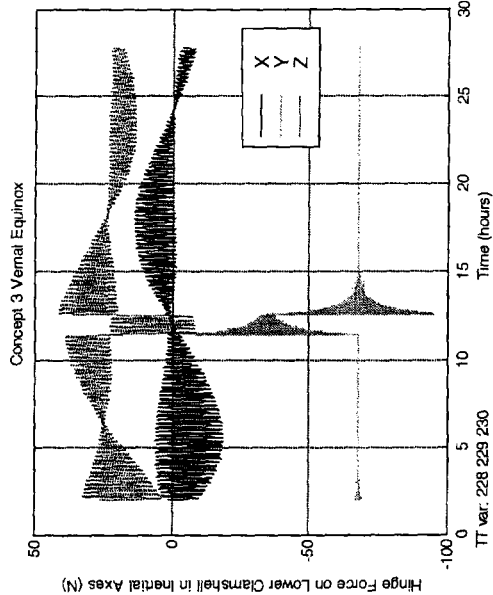


Figure B.2-16a: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

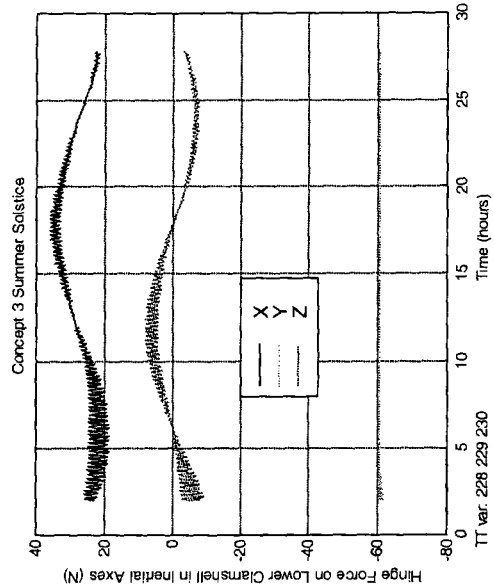


Figure B.2-16b: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Summer Solstice)

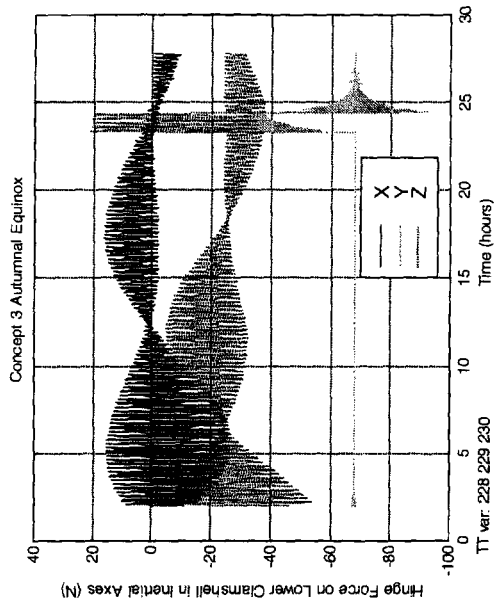


Figure B.2-16c: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Autumnal Equinox)

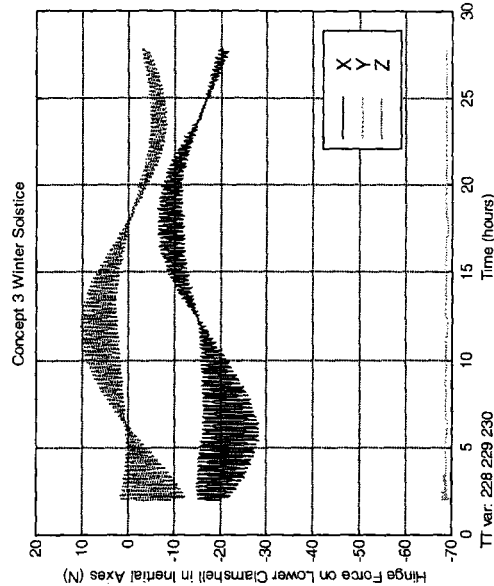


Figure B.2-16d: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Winter Solstice)

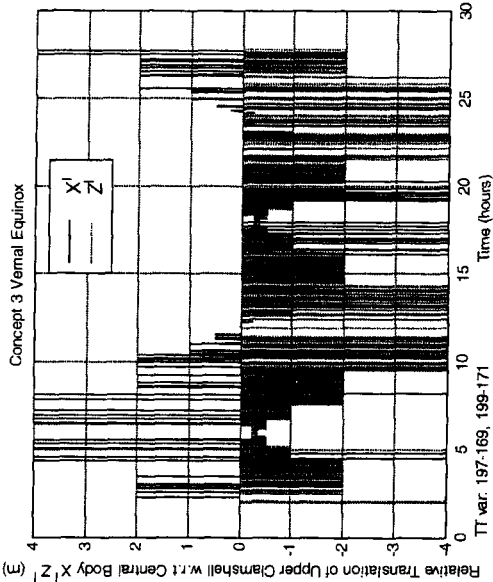


Figure B.2-17a: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

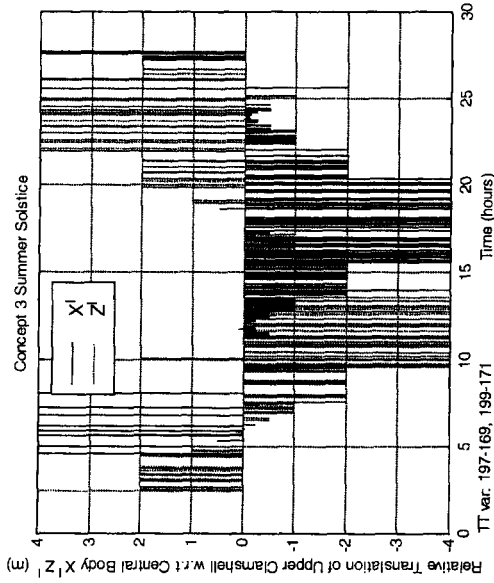


Figure B.2-17b: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Summer Solstice)

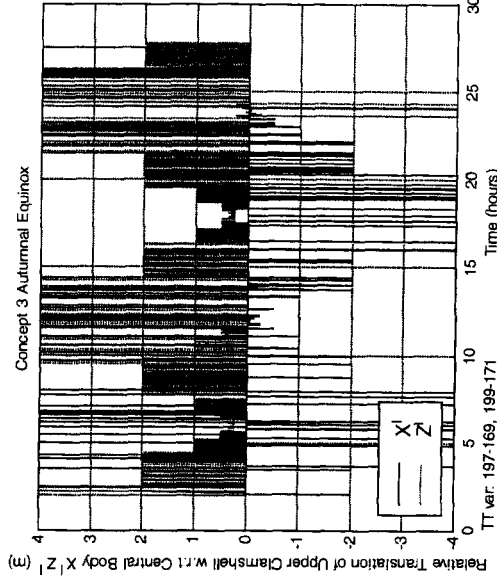


Figure B.2-17c: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Autumnal Equinox)

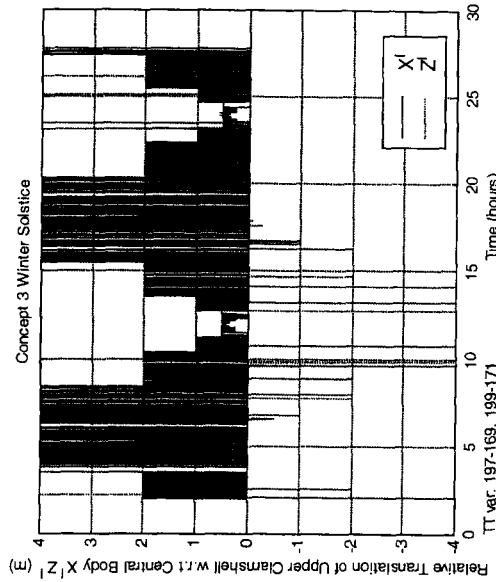


Figure B.2-17d: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Winter Solstice)

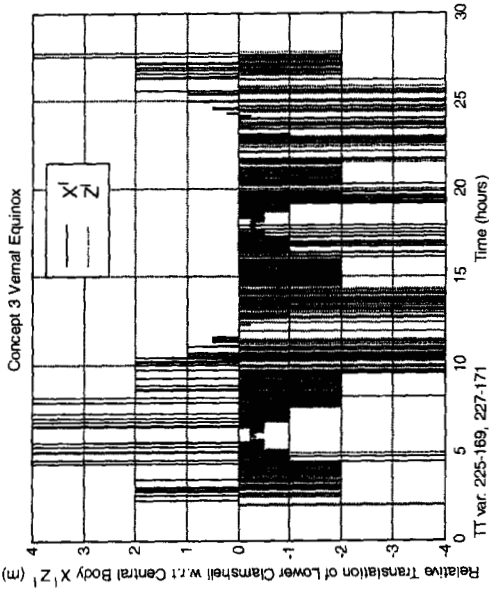


Figure B.2-18a: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

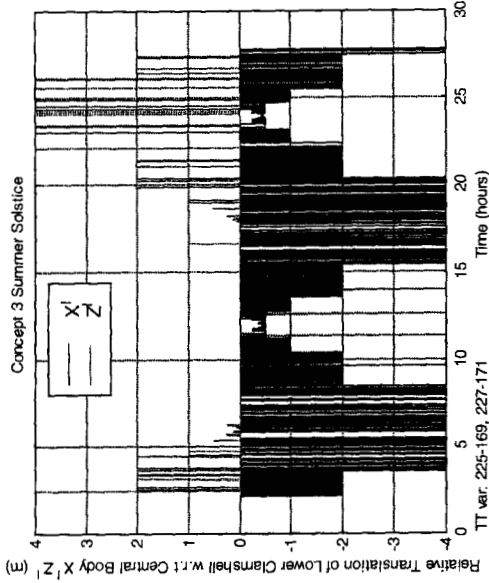


Figure B.2-18b: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Summer Solstice)

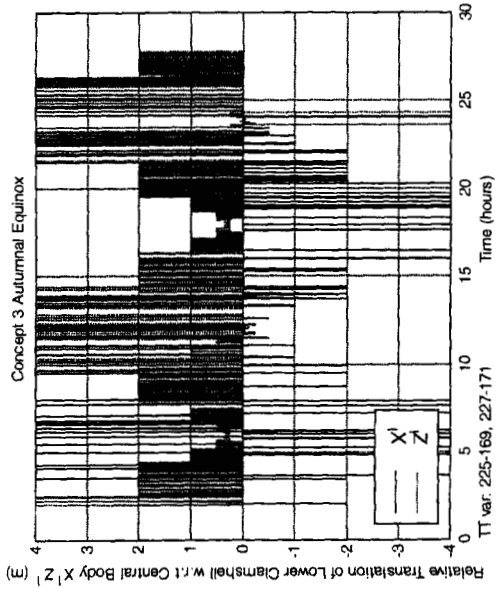


Figure B.2-18c: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Autumnal Equinox)

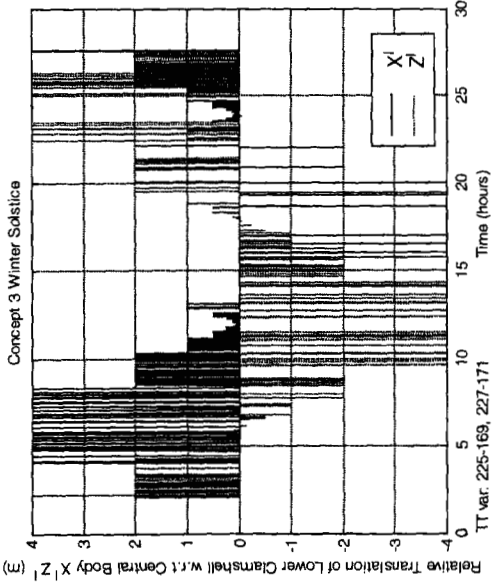


Figure B.2-18d: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Winter Solstice)

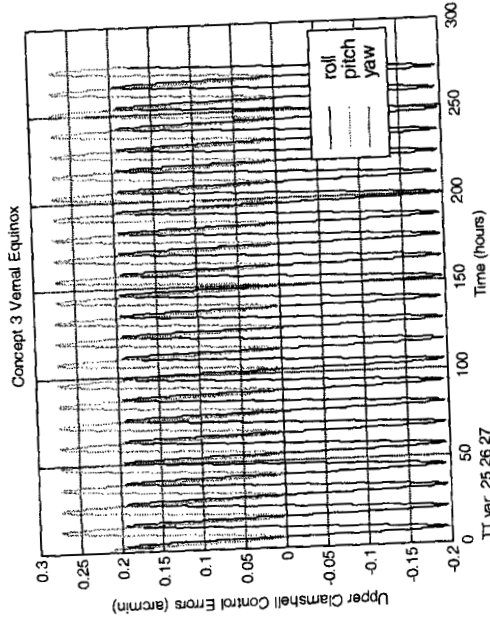


Figure B.2-19: Central Body Control Errors vs. Time
(Vernal Equinox)

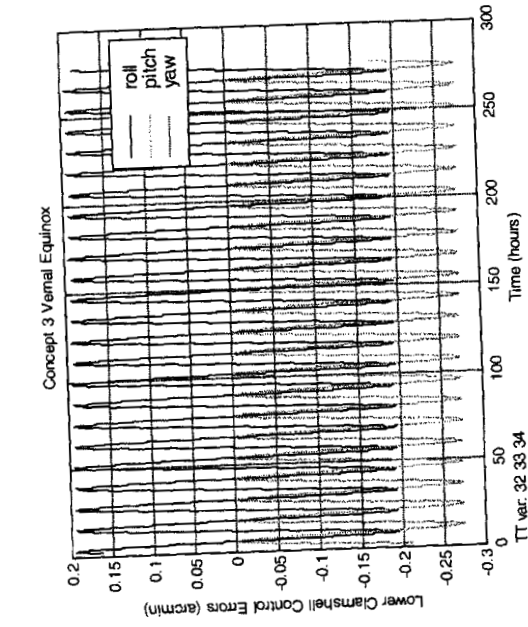


Figure B.2-21: Lower Clamshell Control Errors vs. Time
(Vernal Equinox)

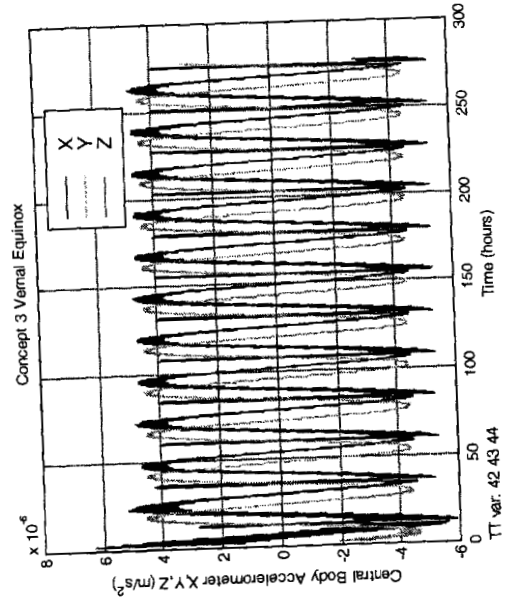


Figure B.2-20: Upper Clamshell Control Errors vs. Time
(Vernal Equinox)

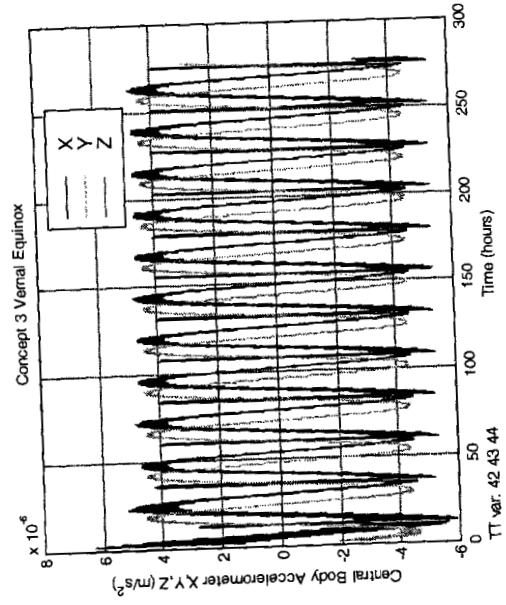


Figure B.2-22: Central Body Accelerometer vs. Time
(Vernal Equinox)

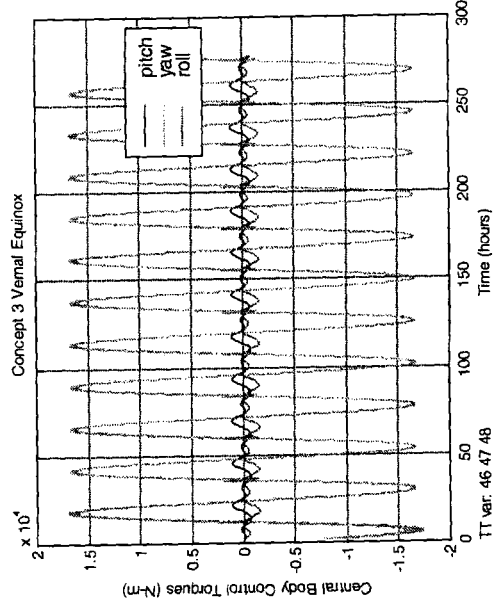


Figure B.2-23: Central Body Control Torques vs. Time
(Vernal Equinox)

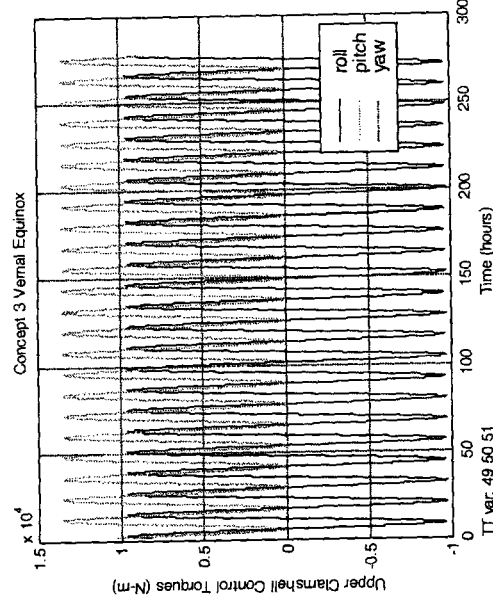


Figure B.2-24: Upper Clamshell Control Torques vs. Time
(Vernal Equinox)

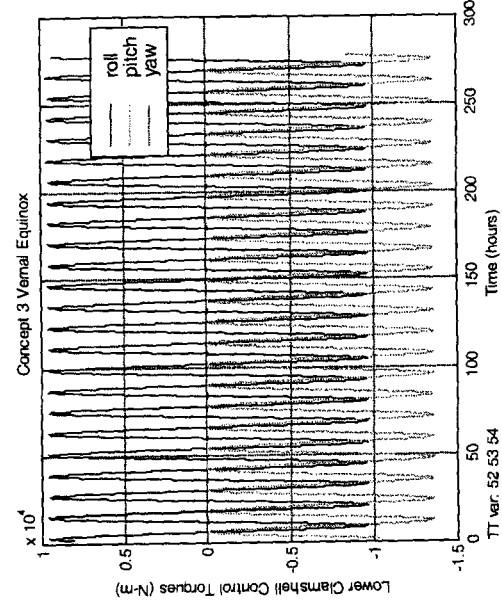


Figure B.2-25: Lower Clamshell Control Torques vs. Time
(Vernal Equinox)

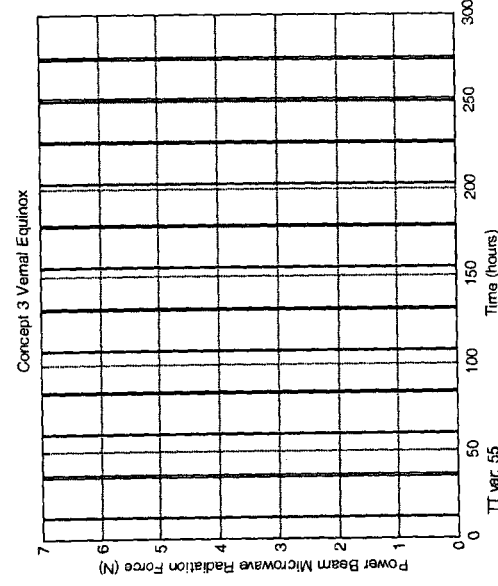


Figure B.2-26: Power Beam Microwave Radiation Force
vs. Time
(Vernal Equinox)

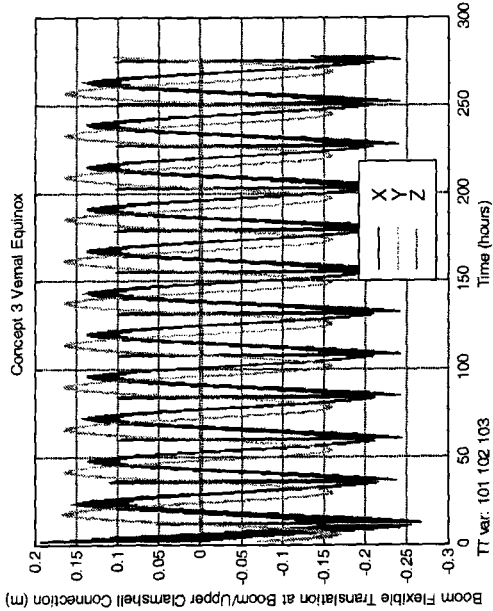


Figure B.2-27: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

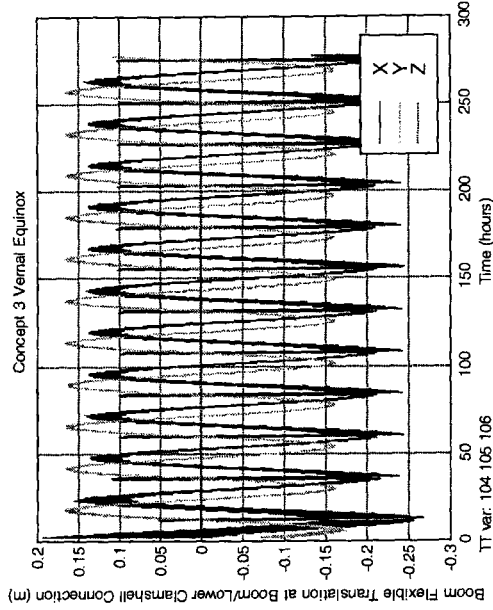


Figure B.2-28: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

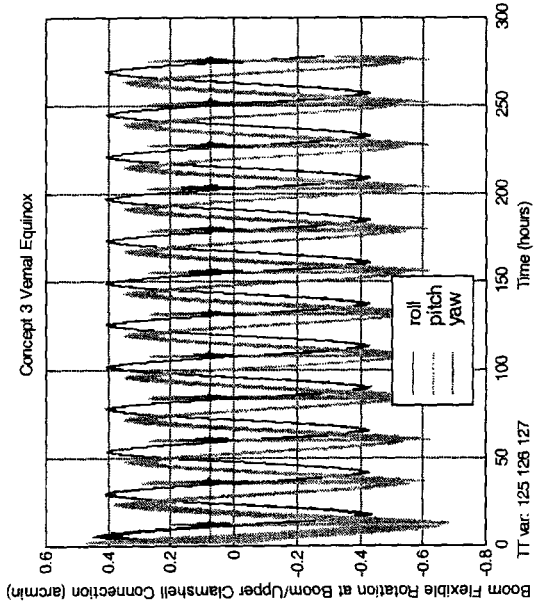


Figure B.2-29: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

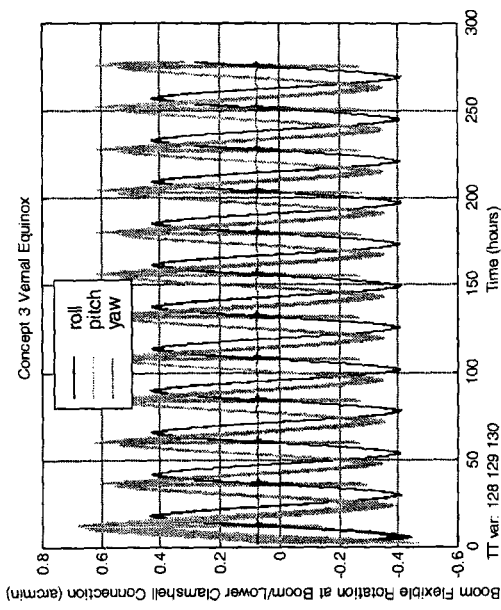


Figure B.2-30: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

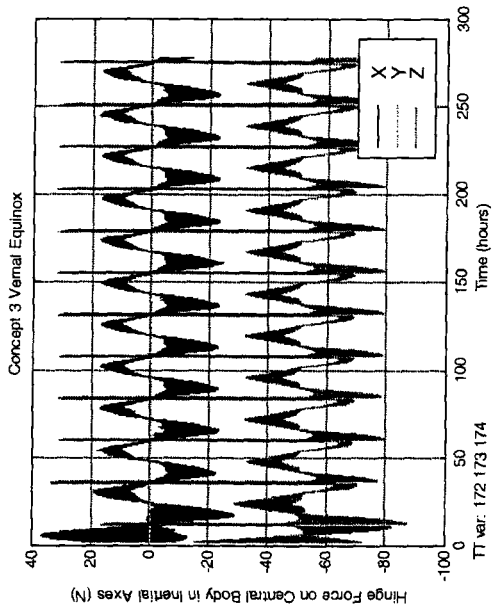


Figure B.2-31: Hinge Force on Central Body
in Inertial Axes vs. Time
(Vernal Equinox)

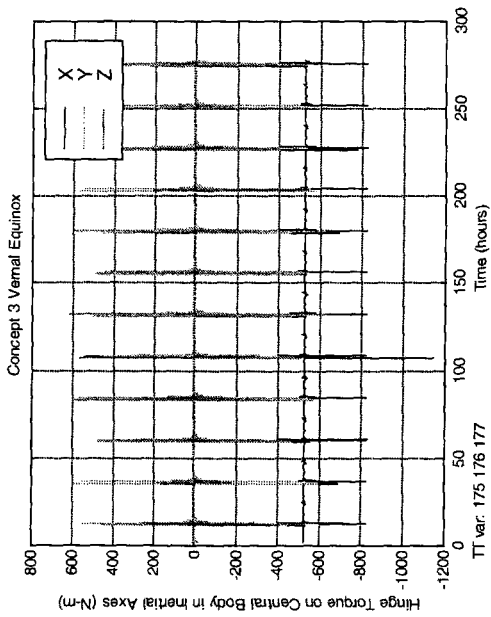


Figure B.2-32: Hinge Torque on Central Body
in Inertial Axes vs. Time
(Vernal Equinox)

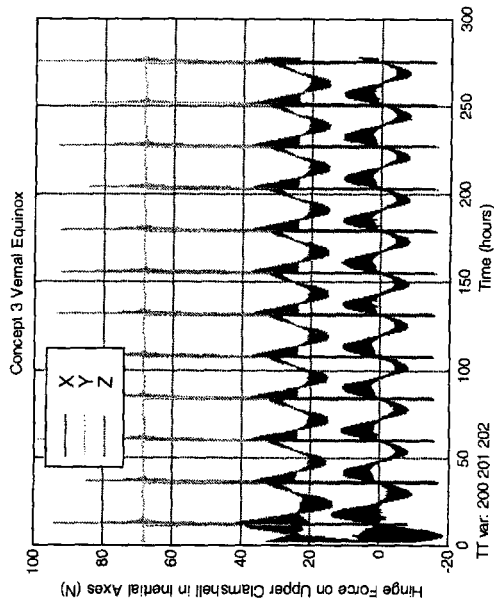


Figure B.2-33: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

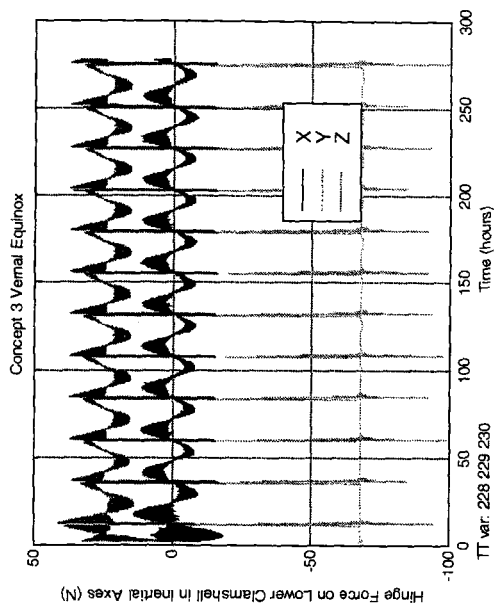


Figure B.2-34: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

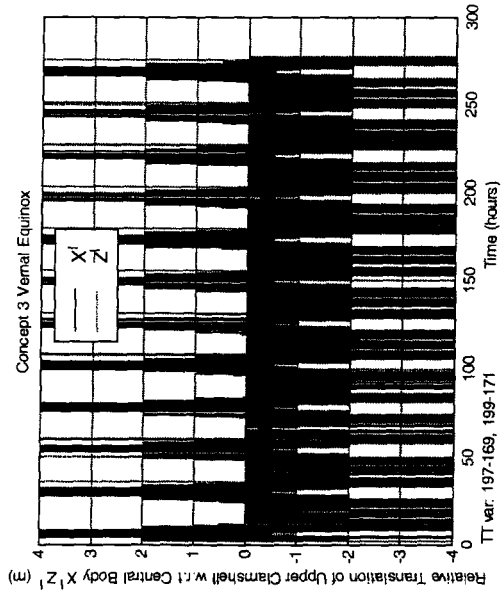


Figure B.2-35: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

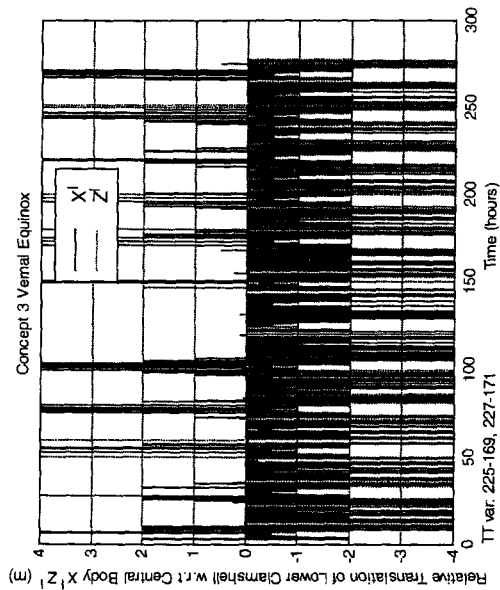


Figure B.2-36: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

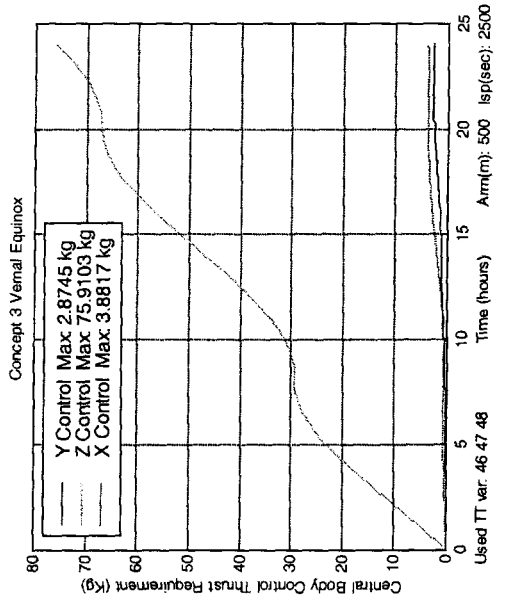


Figure B.2-37a: Central Body Control Thrust Requirement vs. Time for
1 Day
(Vernal Equinox)

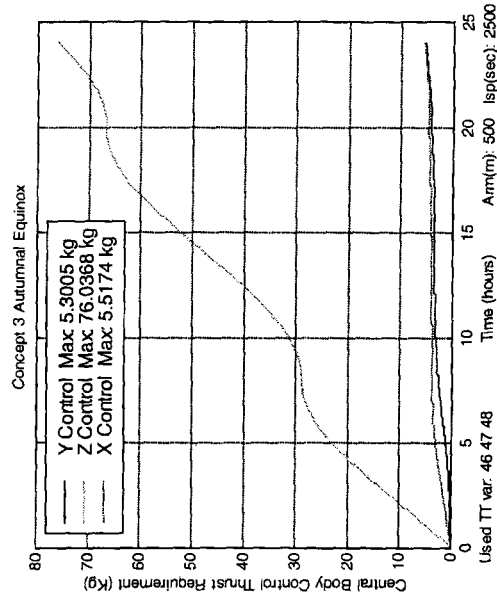


Figure B.2-37c: Central Body Control Thrust Requirement vs. Time for
1 Day
(Autumnal Equinox)

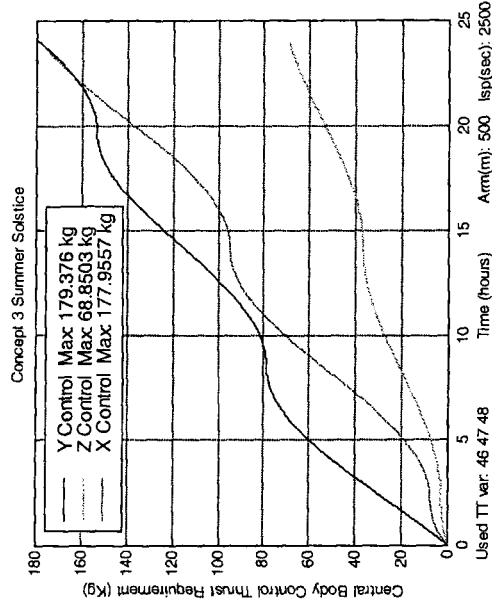


Figure B.2-37b: Central Body Control Thrust Requirement vs. Time for
1 Day
(Summer Solstice)

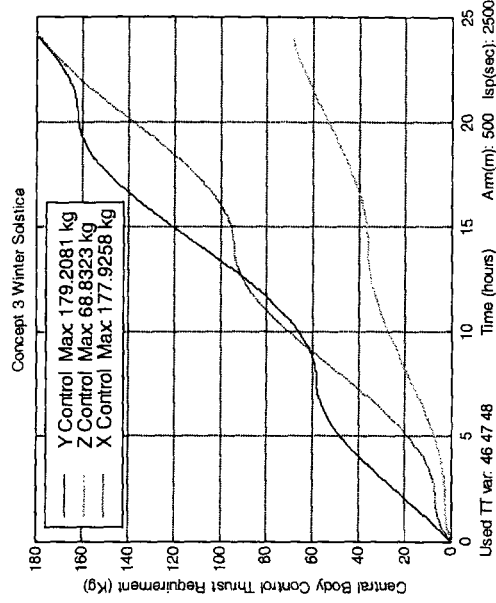


Figure B.2-37d: Central Body Control Thrust Requirement vs. Time for
1 Day
(Winter Solstice)

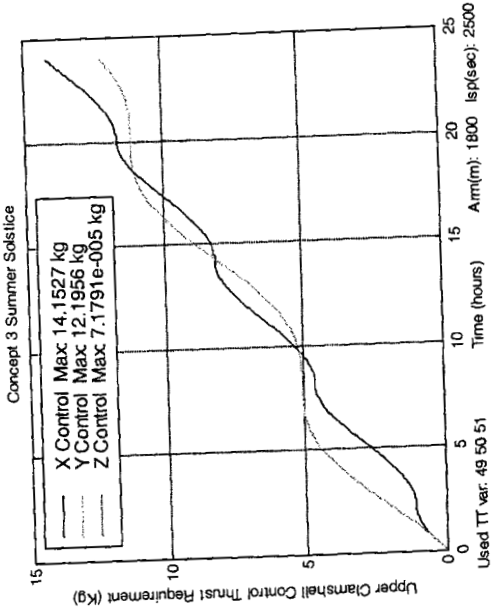


Figure B.2-38b: Upper Clamshell Control Thrust Requirement vs. Time
for 1 Day
(Summer Solstice)

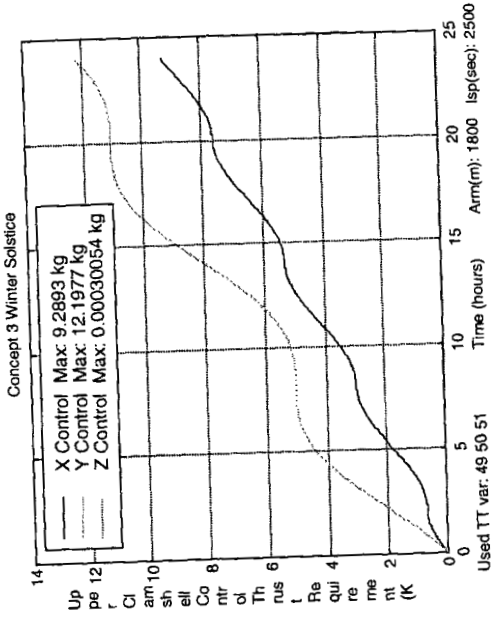


Figure B.2-38d: Upper Clamshell Control Thrust Requirement vs.
Time for 1 Day
(Winter Solstice)

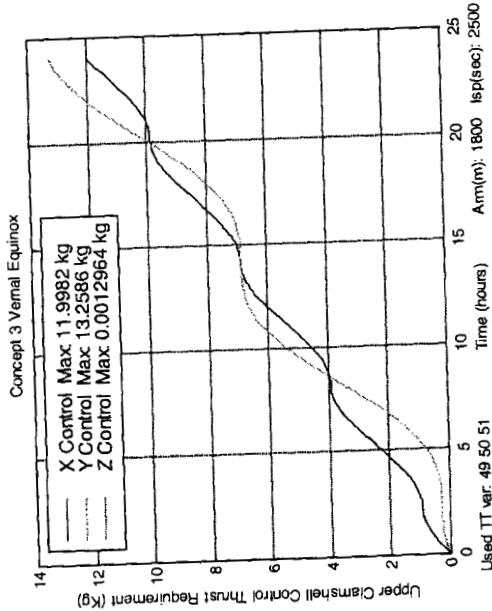


Figure B.2-38a: Upper Clamshell Control Thrust Requirement vs. Time
for 1 Day
(Vernal Equinox)

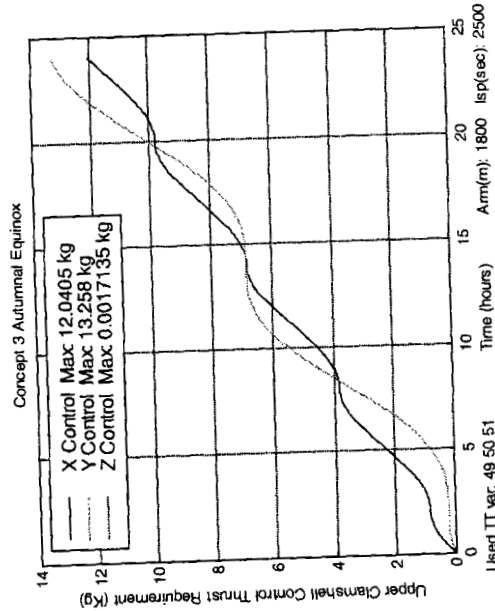


Figure B.2-38c: Upper Clamshell Control Thrust Requirement vs. Time
for 1 Day
(Autumnal Equinox)

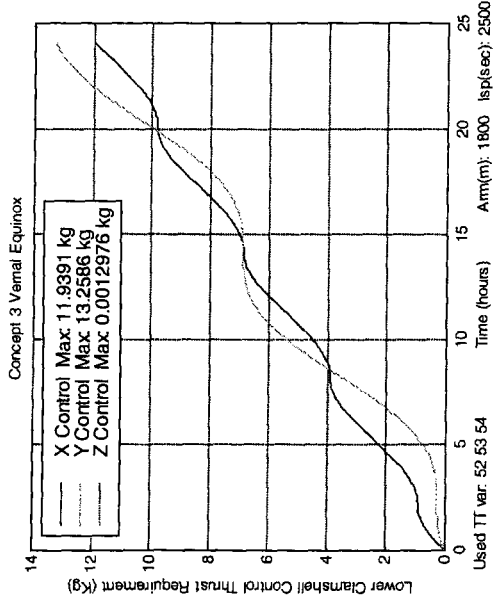


Figure B.2-39a: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day (Vernal Equinox)

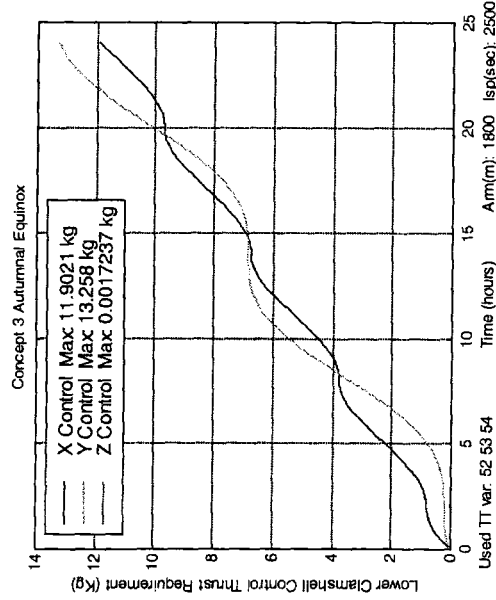


Figure B.2-39c: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day (Autumnal Equinox)

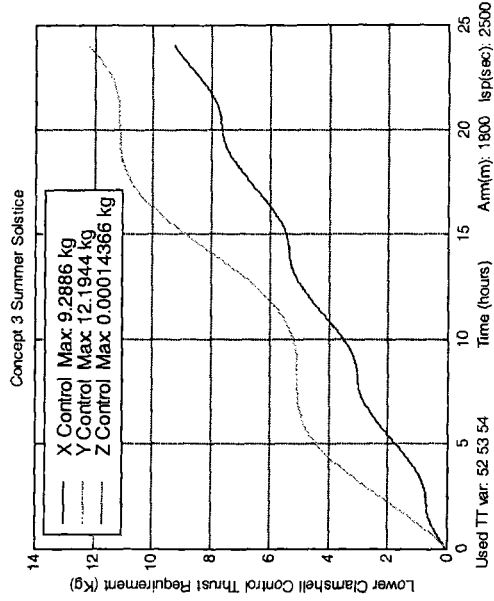


Figure B.2-39b: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day (Summer Solstice)

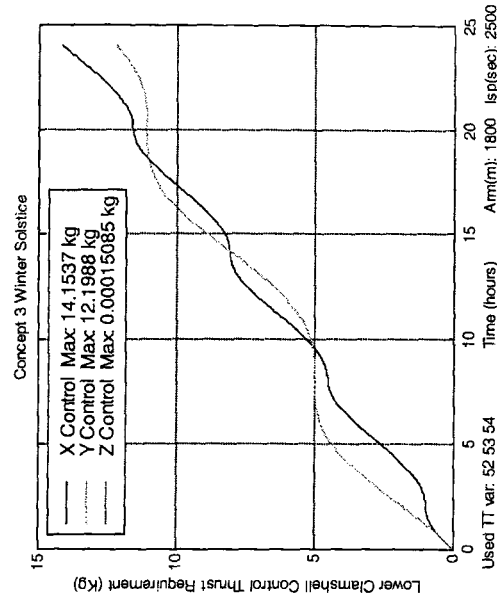


Figure B.2-39d: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day (Winter Solstice)

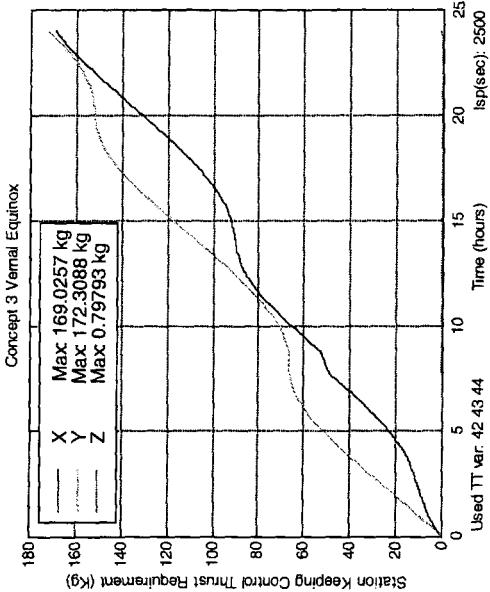


Figure B.2-40a: Estimated Station Keeping Control Thrust Requirement vs. Time for 1 Day (Vernal Equinox)

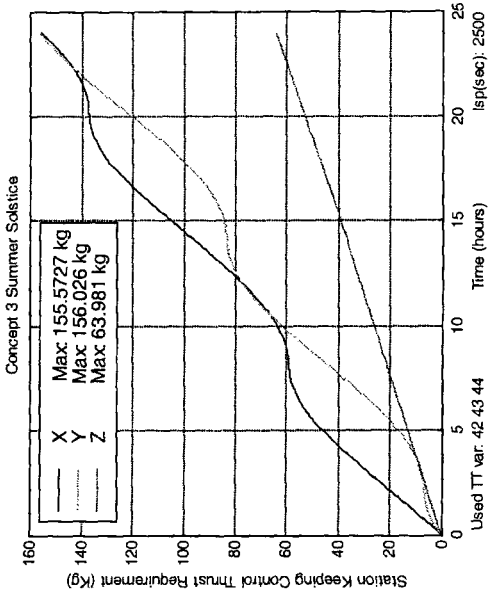


Figure B.2-40b: Estimated Station Keeping Clamshell Control Thrust Requirement vs. Time for 1 Day (Summer Solstice)

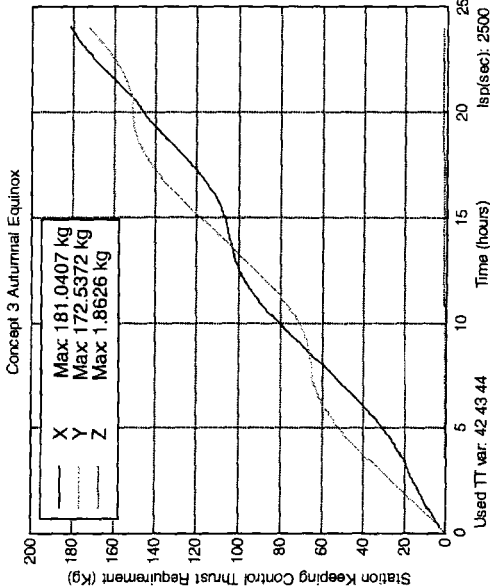


Figure B.2-40c: Estimated Station Keeping Control Thrust Requirement vs. Time for 1 Day (Autumnal Equinox)

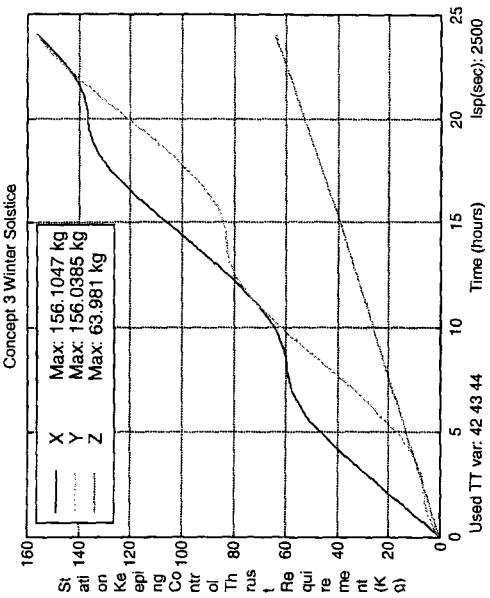


Figure B.2-39d: Estimated Station Keeping Control Thrust Requirement vs. Time for 1 Day (Winter Solstice)

Table B.2-1: Predicted Daily Thrust Requirements (Kg) (Concept 3)

Description	Vernal Equinox			Summer Solstice			Autumnal Equinox			Winter Solstice			Daily Average			Total
	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Central Body Control	3.882	2.875	75.910	177.956	179.376	68.850	5.517	5.301	76.037	177.926	179.208	68.832	91.320	91.690	72.407	255.417
Upper Clamshell Control	11.998	13.259	.00130	14.153	12.196	7.2E-5	12.041	13.258	.00171	9.289	12.198	3.01E-4	11.870	12.728	8.5E-4	24.599
Lower Clamshell Control	11.939	13.259	.00130	9.289	12.194	.00014	11.902	13.258	.00172	14.154	12.199	1.51E-4	11.821	12.728	8.3E-4	24.550
Total	27.819	29.393	75.913	201.398	203.768	68.850	29.460	31.817	76.040	201.369	203.605	68.832	115.011	117.146	72.409	304.566

Notes:
1) Assumptions: lsp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m

Table B.2-2: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 3)

Description	Vernal Equinox			Summer Solstice			Autumnal Equinox			Winter Solstice			Daily Average			Total
	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Station Keeping Control	169.026	172.309	.798	155.573	156.026	63.981	181.041	172.537	1.863	156.105	156.039	63.981	165.436	164.228	32.656	362.320

Notes:
1) Assumptions: lsp = 2500. Sec; Total System Mass = 16921186.33 kg

TABLE B.2-3: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 3)

Description	Daily Total				Yearly Total			
	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control	Total (1 Year)
Central Body Control	91.320	91.690	72.407	255.417	33355.	33490.	26447.	93292.
Upper Clamshell Control	11.870	12.728	8.5E-4	24.599	4336.	4649.	--	8985.
Lower Clamshell Control	11.821	12.728	8.5E-4	24.550	4318.	4649.	--	8967.
Total	115.011	117.146	72.409	304.566	42009.	42788.	26447.	111244.

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m
2) 1 Year = 365.25 days

TABLE B.2-4: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 3)

Description	Daily Total				Yearly Total			
	X	Y	Z	Total (1 Day)	X	Y	Z	Total (1 Year)
Station Keeping Control	165.436	164.228	32.656	362.320	60425.	59984.	11928.	132337.

Notes:
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg
2) 1 Year = 365.25 days

**B.3 – TREETOPS simulation results Comparison of Concept 1, 2A, 2B and 3
and Thrust Requirements for Concept 2A and 2B**

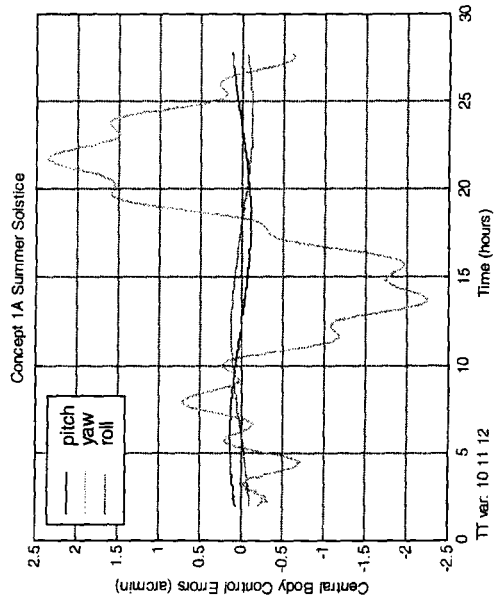


Figure B.3-1a: Central Body Control Errors vs. Time
(Concept 1)

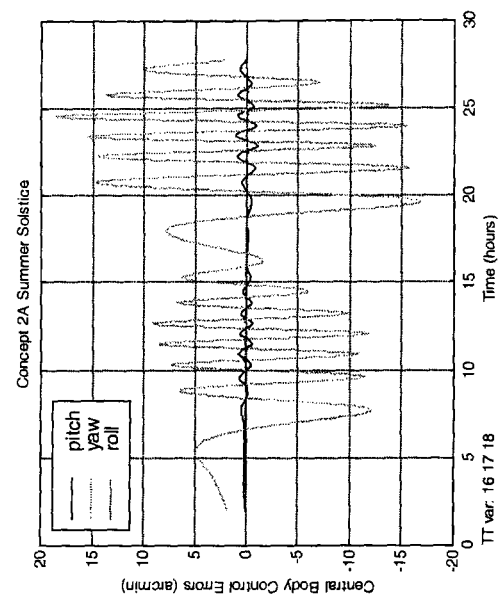


Figure B.3-1b: Central Body Control Errors vs. Time
(Concept 2A)

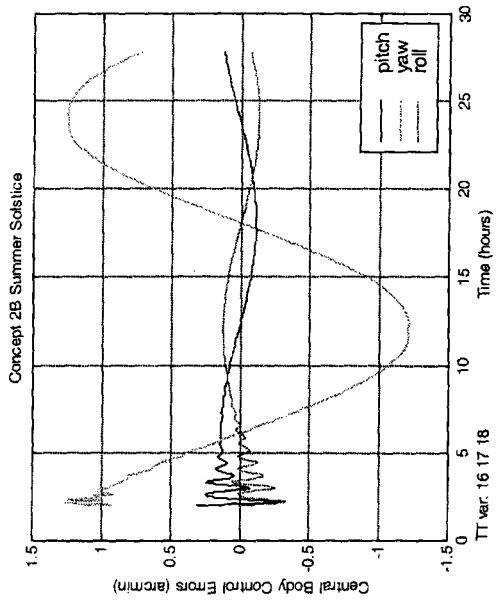


Figure B.3-1c: Central Body Control Errors vs. Time
(Concept 2B)

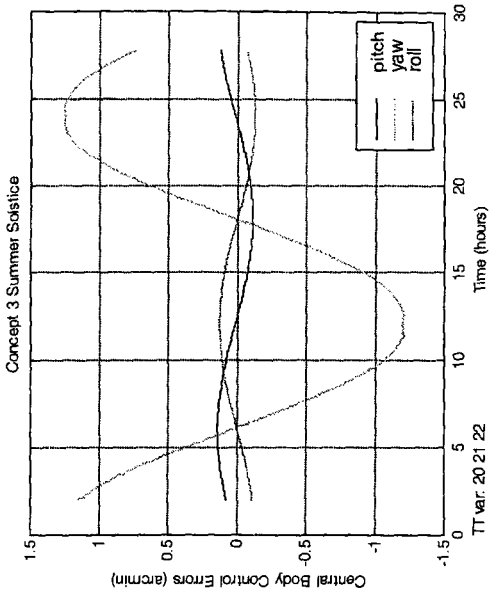
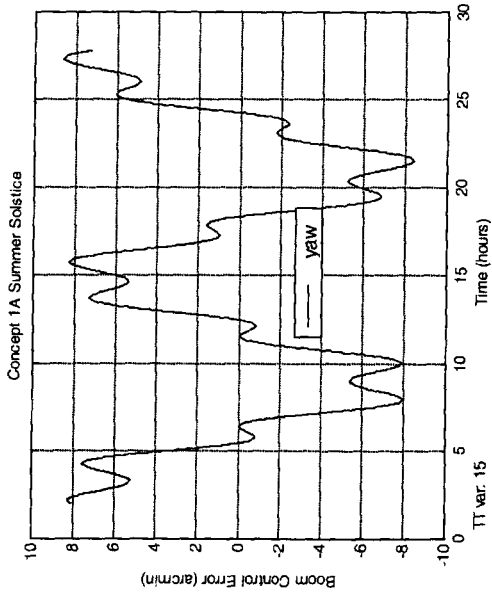


Figure B.3-1d: Central Body Control Errors vs. Time
(Concept 3)



N/A

Figure B.3-2a: Boom Control Errors vs. Time
(Concept 1)

Figure B.3-2b: Boom Control Errors vs. Time
(Concept 2A)

N/A

N/A

Figure B.3-2c: Boom Control Errors vs. Time
(Concept 2B)

Figure B.3-2d: Boom Control Errors vs. Time
(Concept 3)

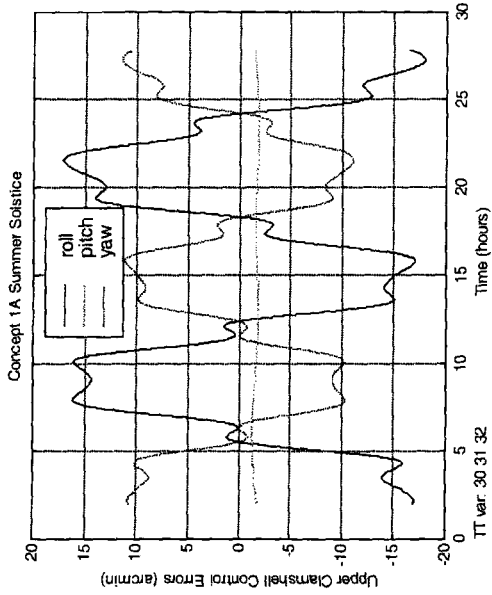


Figure B.3-3a: Upper Clamshell Control Errors vs. Time
(Concept 1)

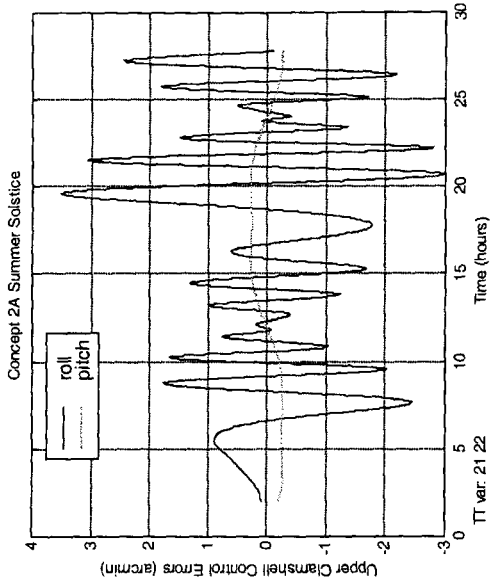


Figure B.3-3b: Upper Clamshell Control Errors vs. Time
(Concept 2A)

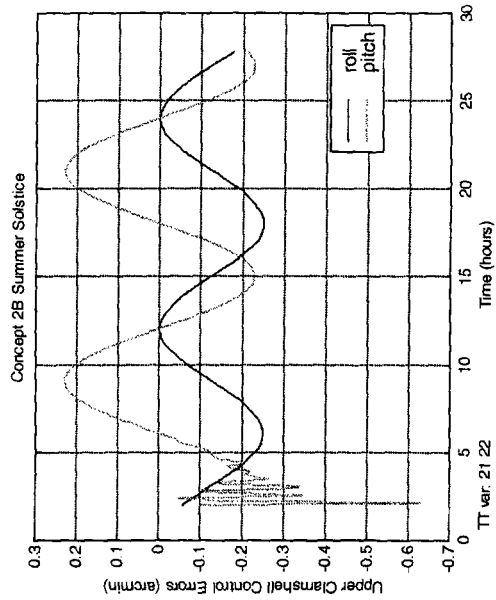


Figure B.3-3c: Upper Clamshell Control Errors vs. Time
(Concept 2B)

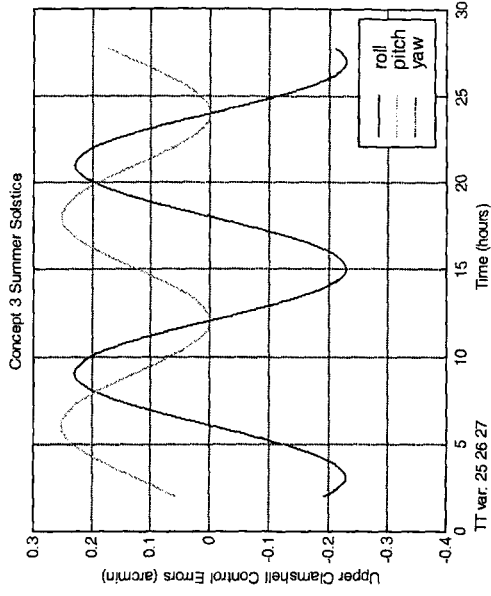


Figure B.3-3d: Upper Clamshell Control Errors vs. Time
(Concept 3)

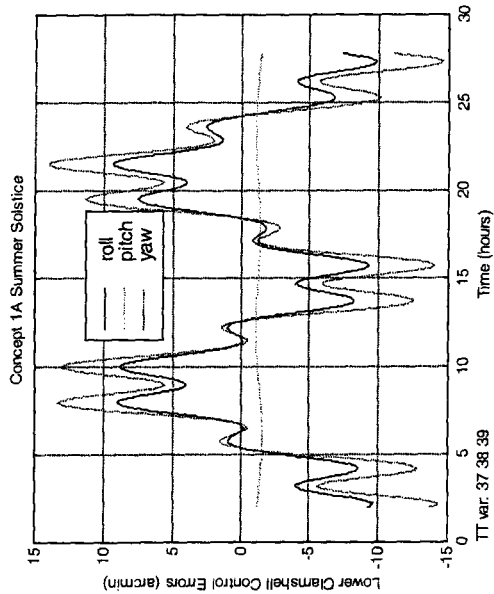


Figure B.3-4a: Lower Clamshell Control Errors vs. Time
(Concept 1)

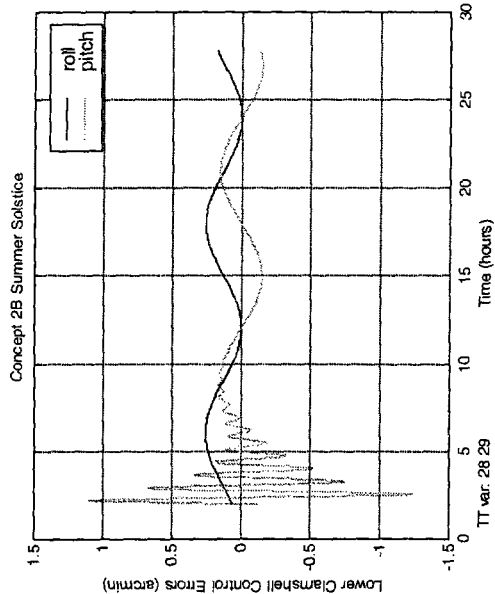


Figure B.3-4c: Lower Clamshell Control Errors vs. Time
(Concept 2B)

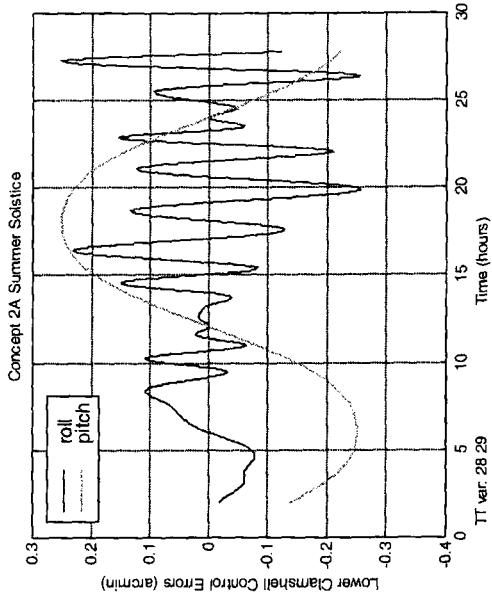


Figure B.3-4b: Lower Clamshell Control Errors vs. Time
(Concept 2A)

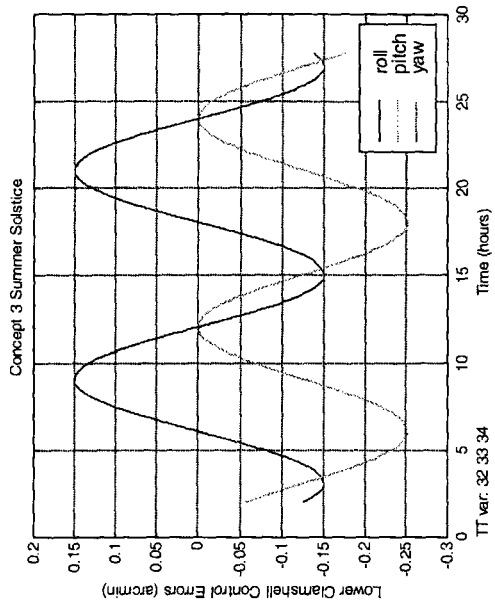


Figure B.3-4d: Lower Clamshell Control Errors vs. Time
(Concept 3)

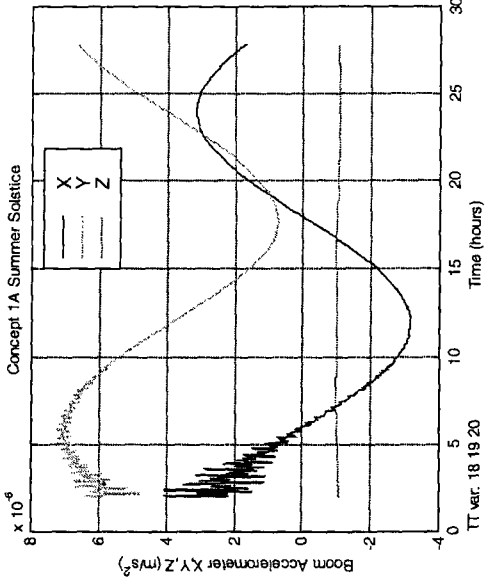


Figure B.3-5a: Central Body Accelerometer vs. Time
(Concept 1)

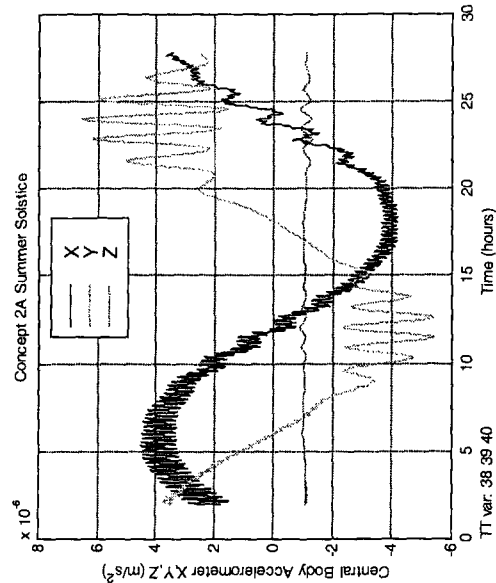


Figure B.3-5b: Central Body Accelerometer vs. Time
(Concept 2A)

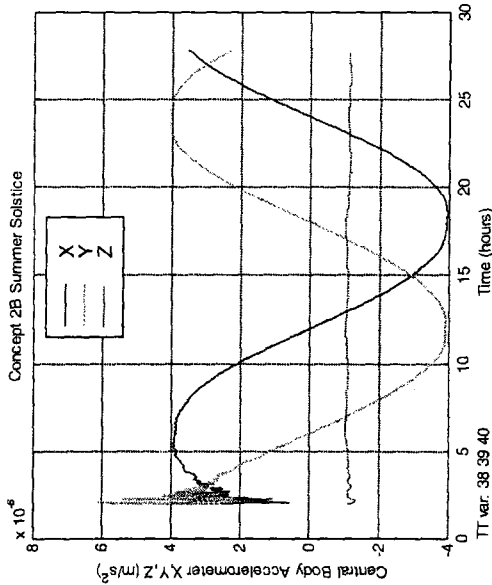


Figure B.3-5c: Central Body Accelerometer vs. Time
(Concept 2B)

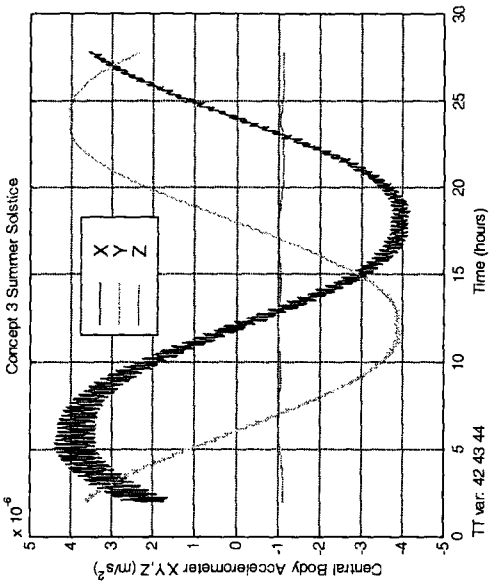


Figure B.3-5d: Central Body Accelerometer vs. Time
(Concept 3)

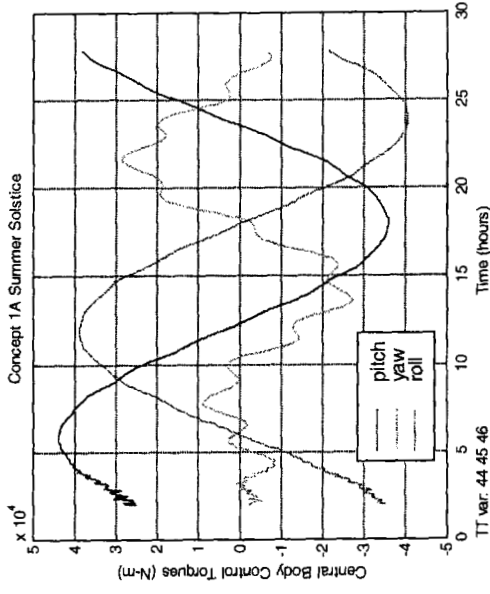


Figure B.3-6a: Central Body Control Torques vs. Time
(Concept 1)

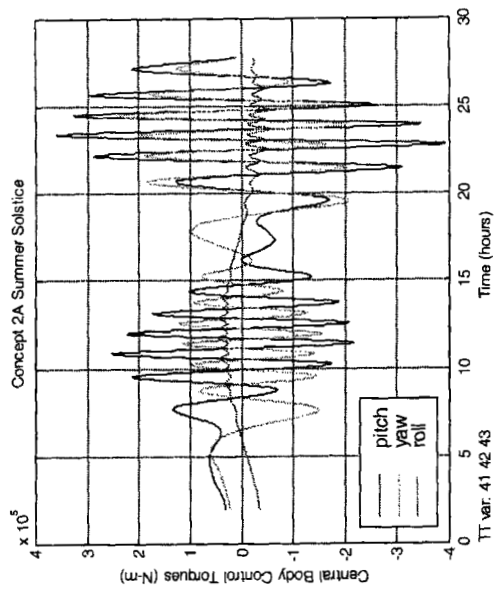


Figure B.3-6b: Central Body Control Torques vs. Time
(Concept 2A)

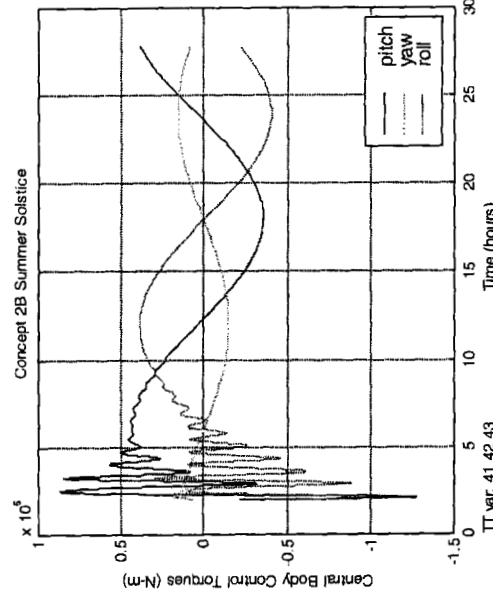


Figure B.3-6c: Central Body Control Torques vs. Time
(Concept 2B)

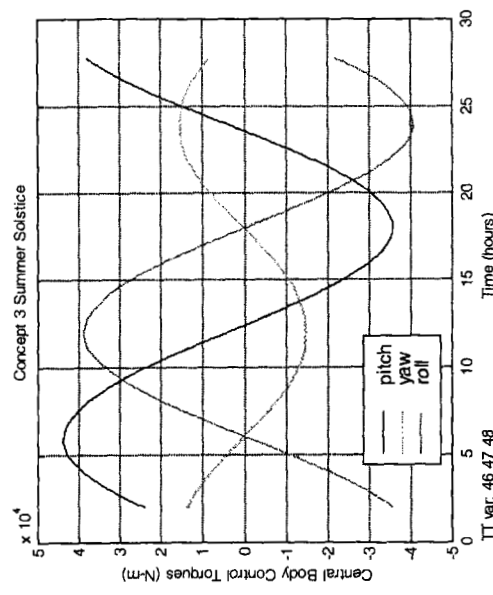
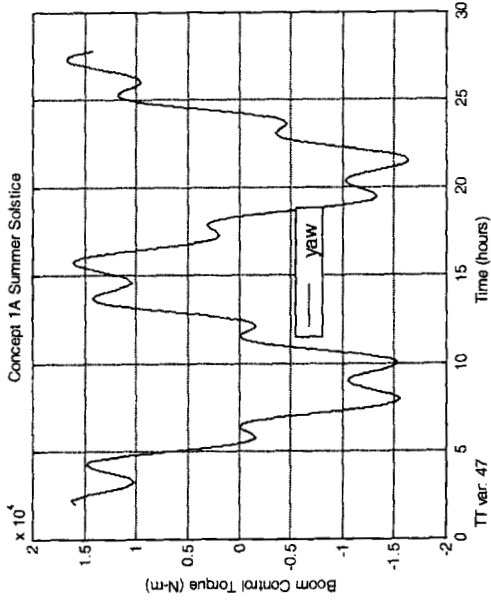


Figure B.3-6d: Central Body Control Torques vs. Time
(Concept 3)



N/A

Figure B.3-7a: Boom Control Torques vs. Time
(Concept 1)

Figure B.3-7b: Boom Control Torques vs. Time
(Concept 2A)

N/A

N/A

Figure B.3-7c: Boom Control Torques vs. Time
(Concept 2B)

Figure B.3-7d: Boom Control Torques vs. Time
(Concept 3)

Not Used for Control in this concept

Figure B.3-8a: Upper Clamshell Control Torques vs. Time
(Concept 1)

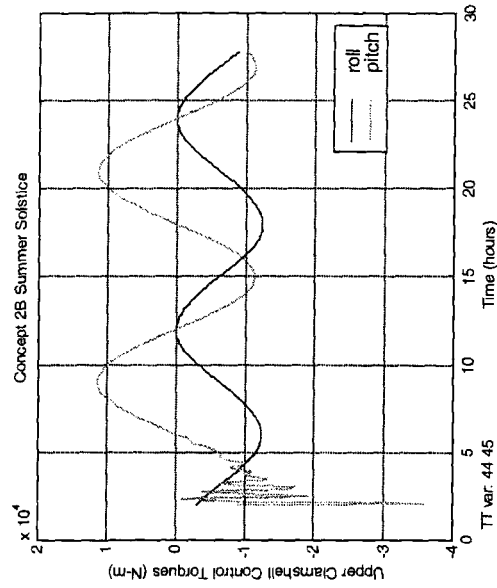


Figure B.3-8c: Upper Clamshell Control Torques vs. Time
(Concept 2B)

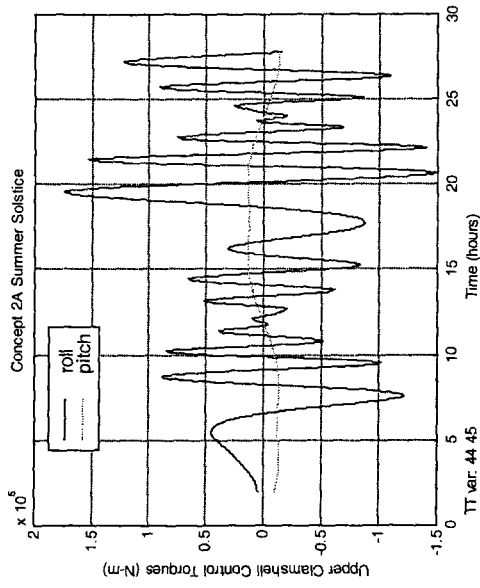


Figure B.3-8b: Upper Clamshell Control Torques vs. Time
(Concept 2A)

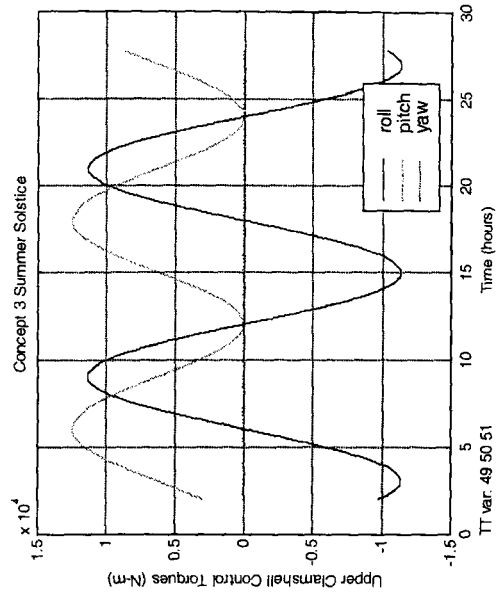


Figure B.3-8d: Upper Clamshell Control Torques vs. Time
(Concept 3)

Not Used in Control

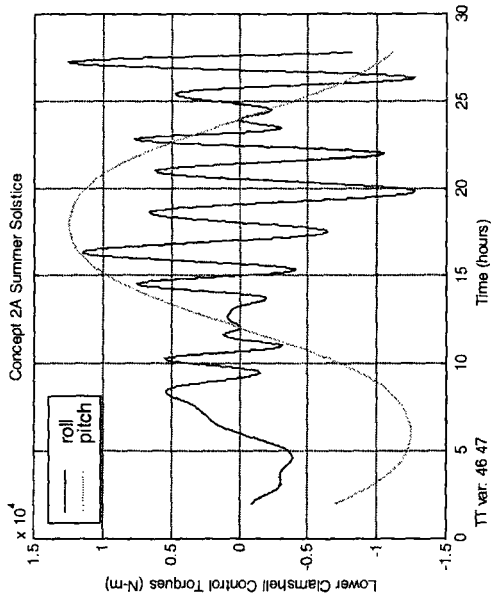


Figure B.3-9a: Lower Clamshell Control Torques vs. Time
(Concept 1)

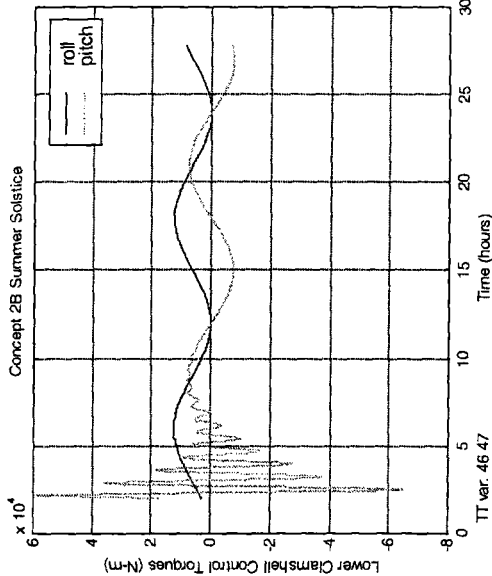


Figure B.3-9c: Lower Clamshell Control Torques vs. Time
(Concept 2B)

Figure B.3-9b: Lower Clamshell Control Torques vs. Time
(Concept 2A)

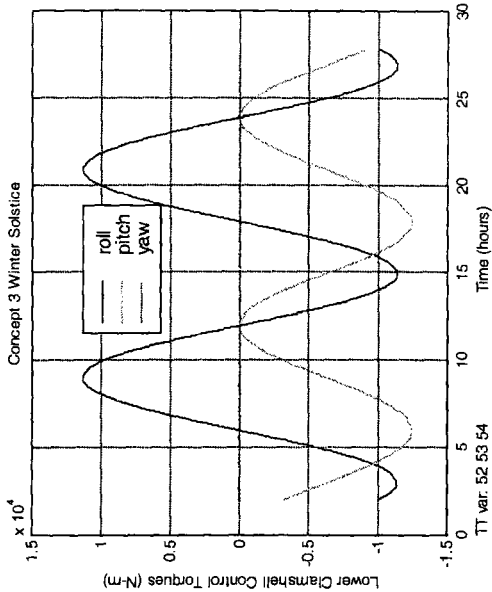


Figure B.3-9d: Lower Clamshell Control Torques vs. Time
(Concept 3)

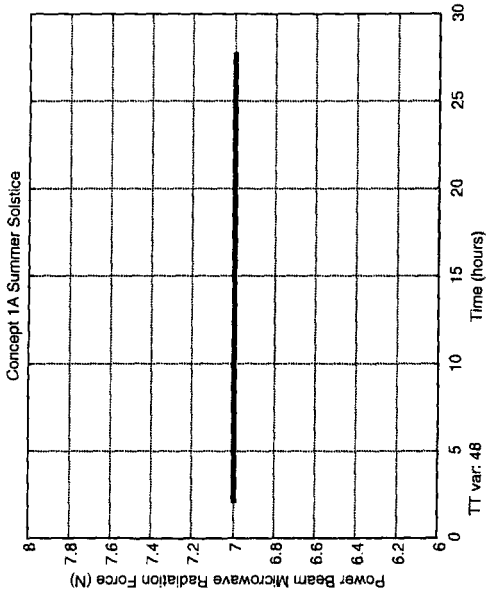


Figure B.3-10a: Power Beam Microwave Radiation Force vs. Time
(Concept 1)

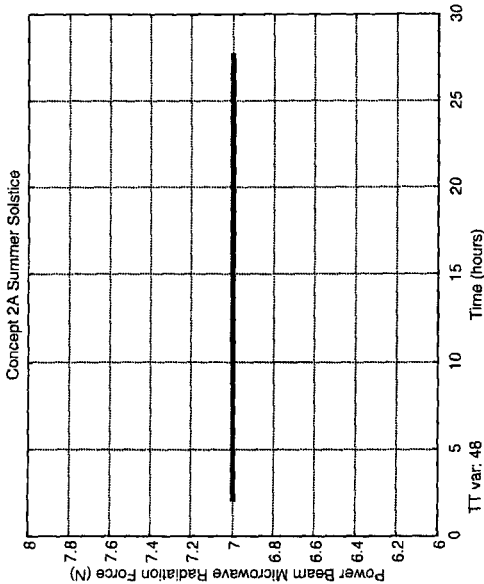


Figure B.3-10b: Power Beam Microwave Radiation Force vs. Time
(Concept 2A)

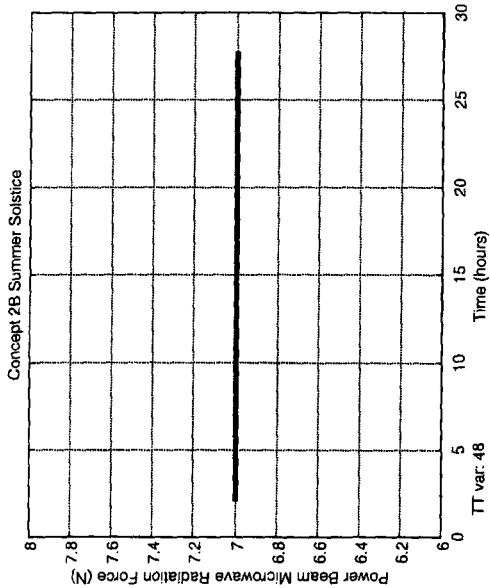


Figure B.3-10c: Power Beam Microwave Radiation Force vs. Time
(Concept 2B)

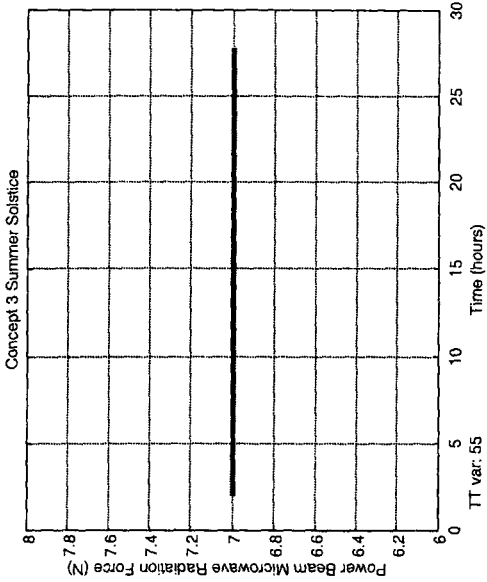


Figure B.3-10d: Power Beam Microwave Radiation Force vs. Time
(Concept 3)

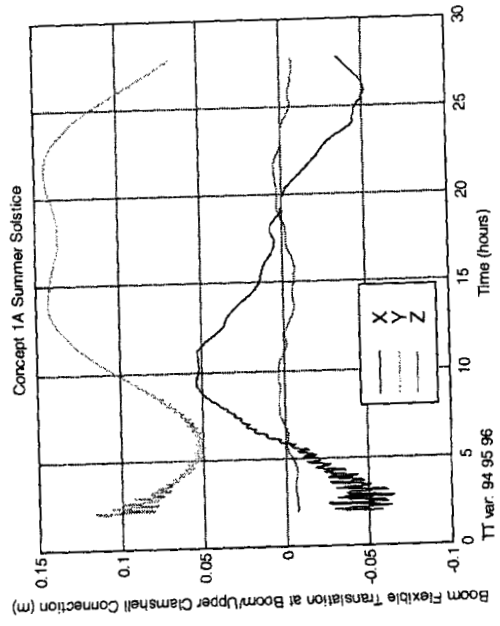


Figure B.3-11a: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Concept 1)

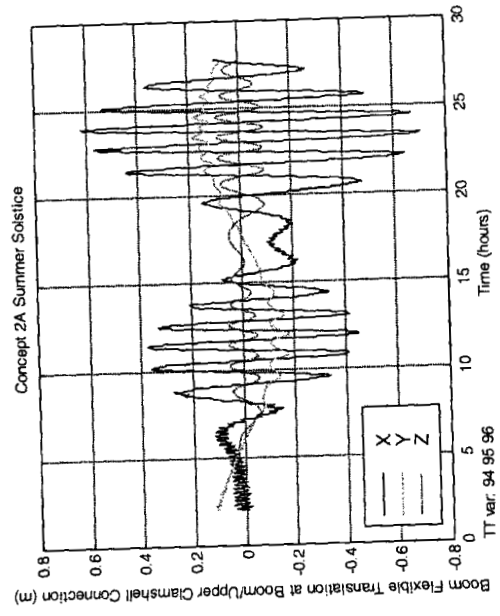


Figure B.3-11b: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Concept 2A)

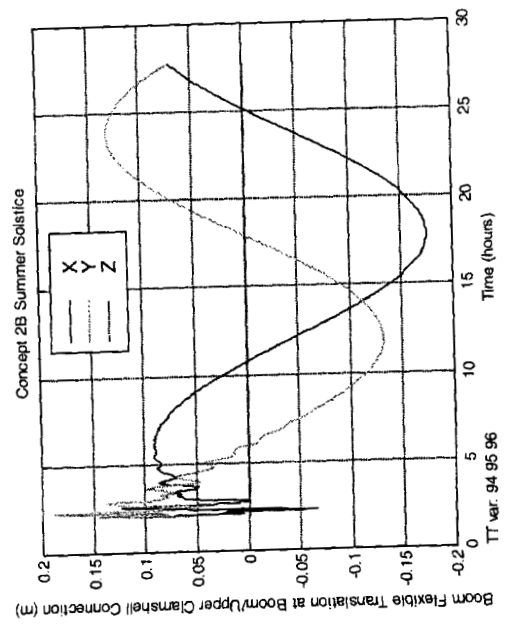


Figure B.3-11c: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Concept 2B)

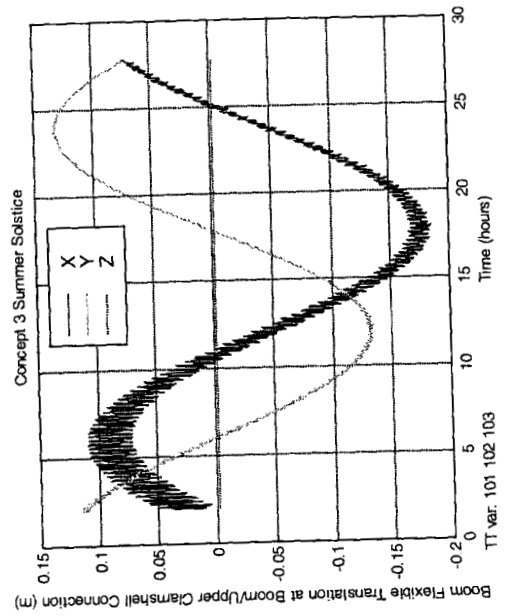


Figure B.3-11d: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Concept 3)

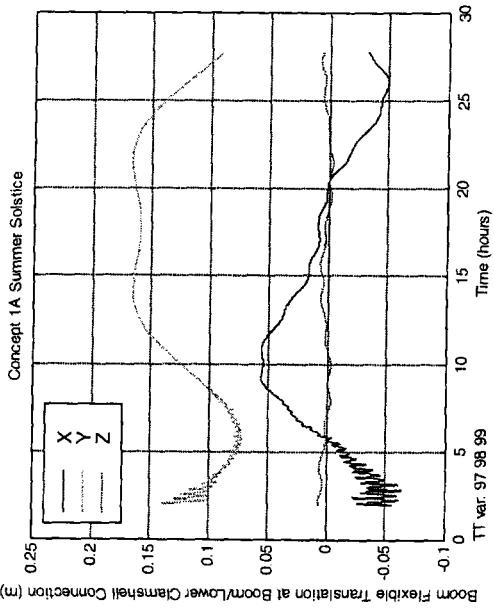


Figure B.3-12a: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Concept 1)

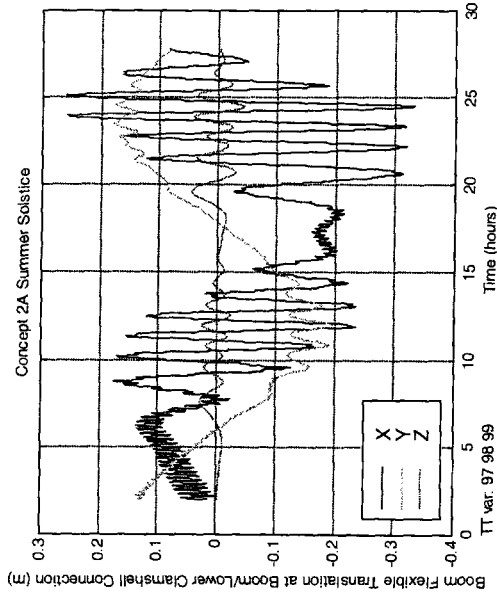


Figure B.3-12b: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Concept 2A)

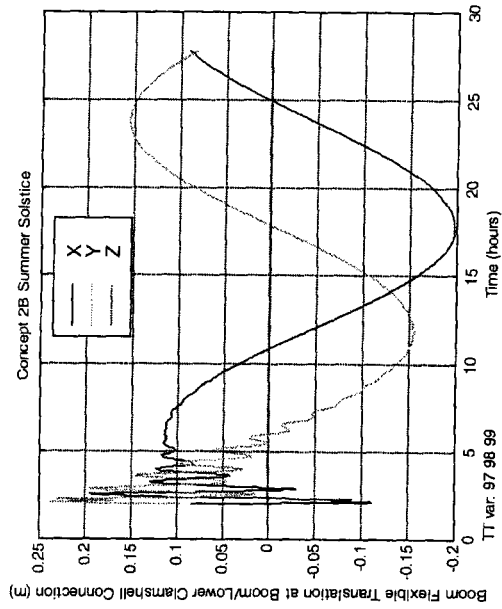


Figure B.3-12c: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Concept 2B)

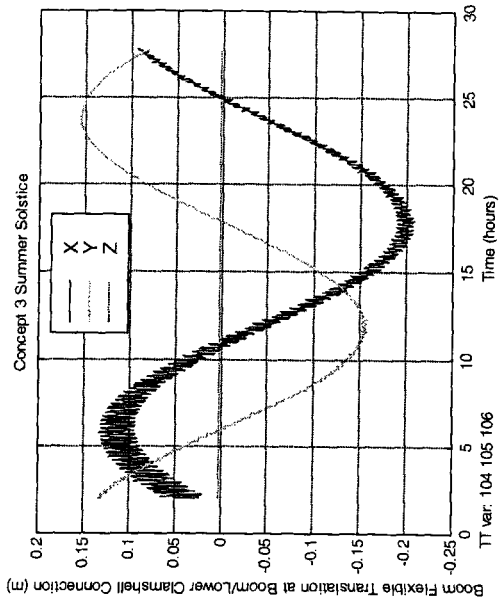


Figure B.3-12d: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Concept 3)

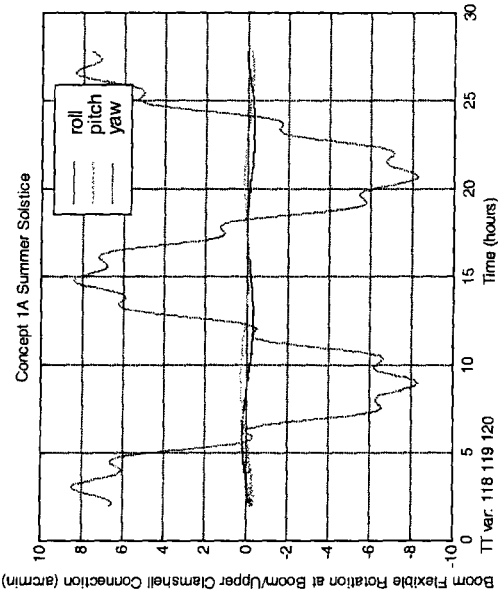


Figure B.3-13a: Boom Flexible Rotation at
Boom/Upper Clamshell Connection vs. Time
(Concept 1)

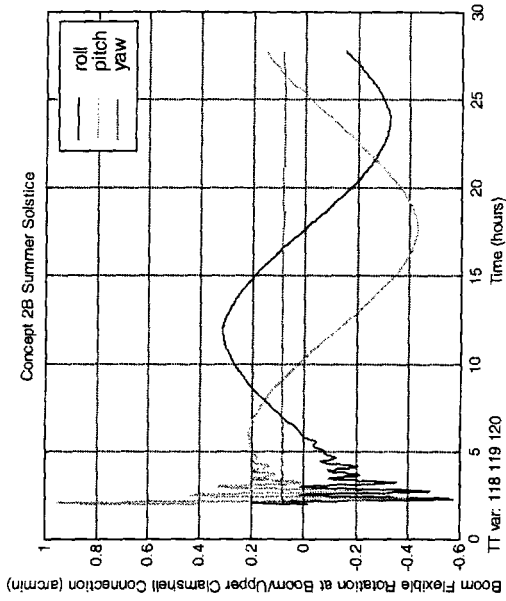


Figure B.3-13c: Boom Flexible Rotation at
Boom/Upper Clamshell Connection vs. Time
(Concept 2B)

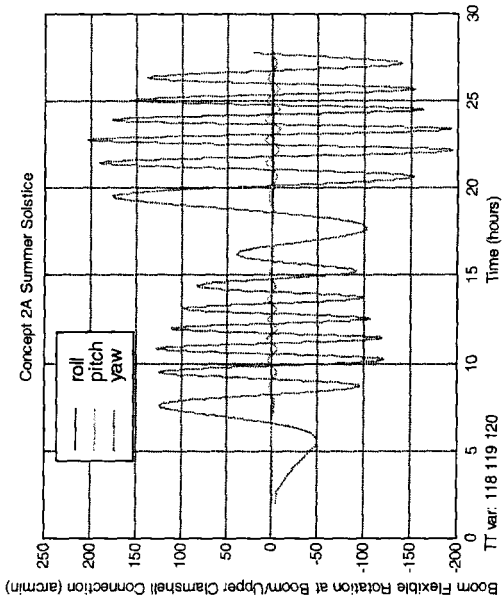


Figure B.3-13b: Boom Flexible Rotation at
Boom/Upper Clamshell Connection vs. Time
(Concept 2A)

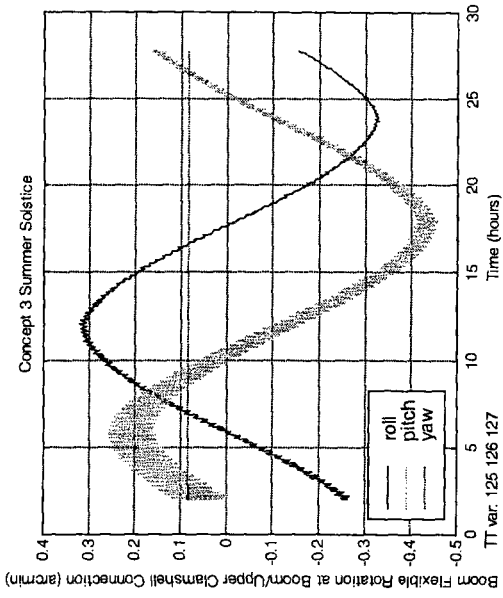


Figure B.3-13d: Boom Flexible Rotation at
Boom/Upper Clamshell Connection vs. Time
(Concept 3)

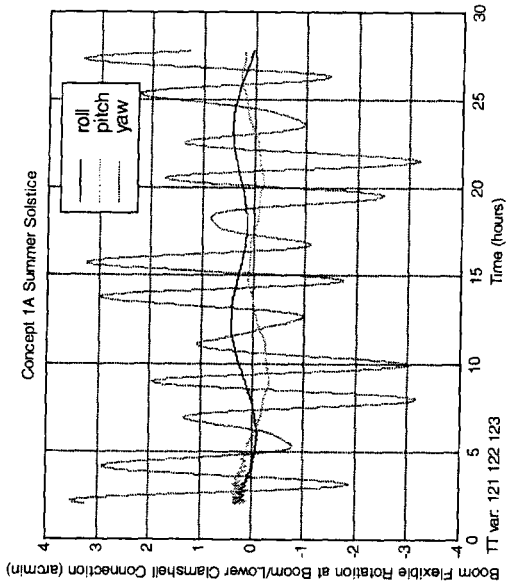


Figure B.3-14a: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Concept 1)

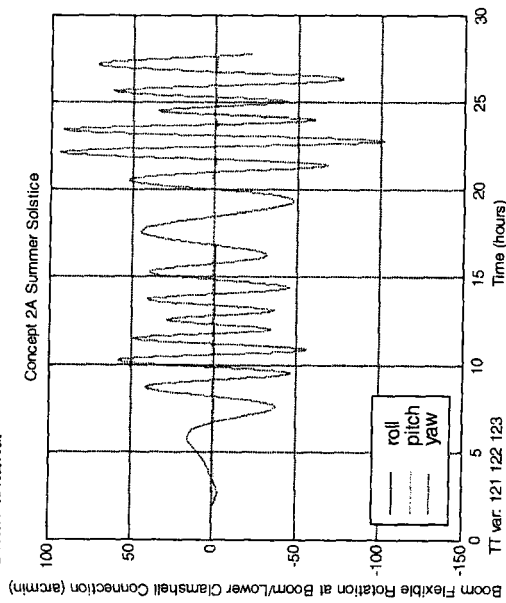


Figure B.3-14b: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Concept 2A)

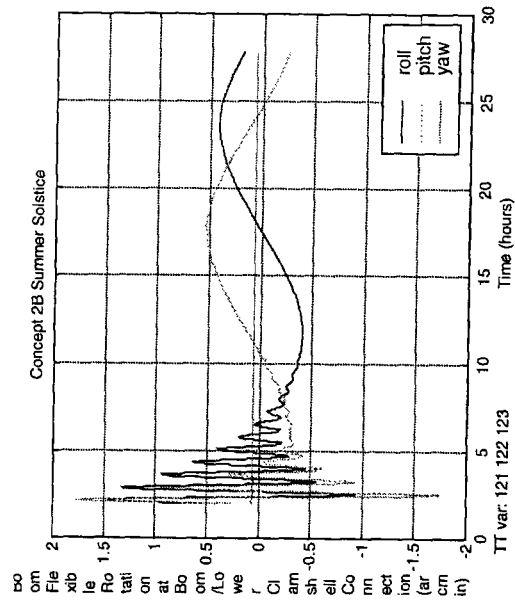


Figure B.3-14c: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Concept 2B)

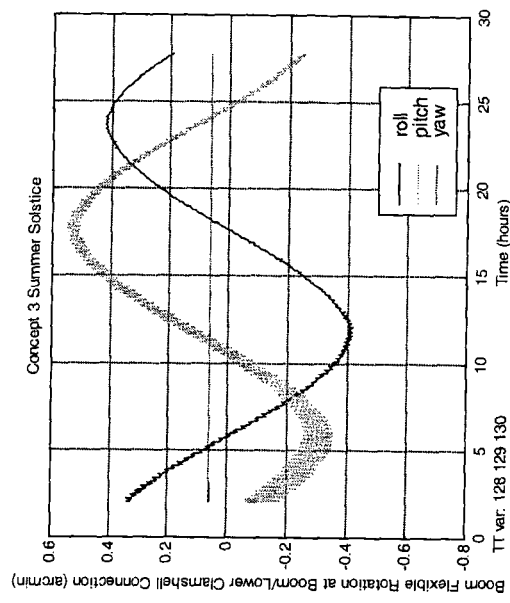


Figure B.3-14d: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Concept 3)

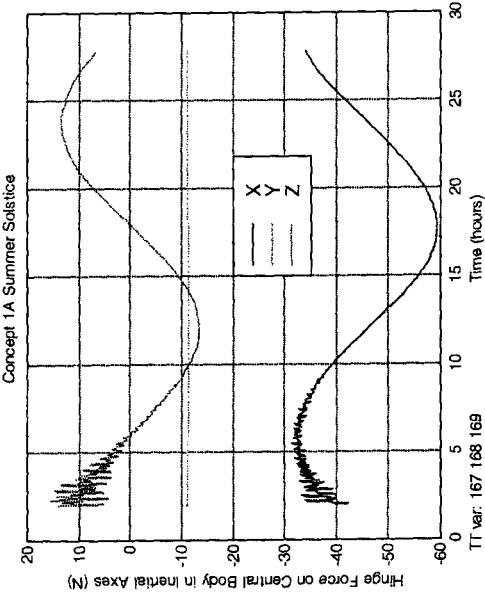


Figure B.3-15a: Hinge Force on Central Body
in Inertial Axes vs. Time
(Concept 1)

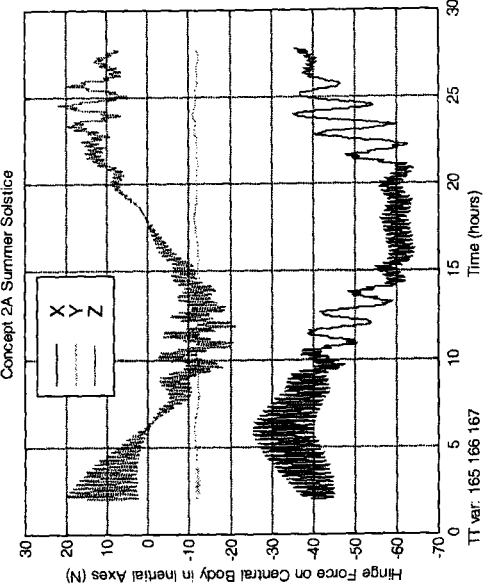


Figure B.3-15b: Hinge Force on Central Body
in Inertial Axes vs. Time
(Concept 2A)

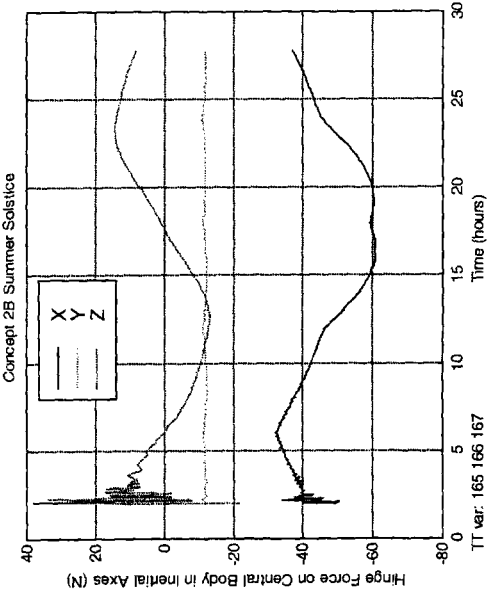


Figure B.3-15c: Hinge Force on Central Body
in Inertial Axes vs. Time
(Concept 2B)

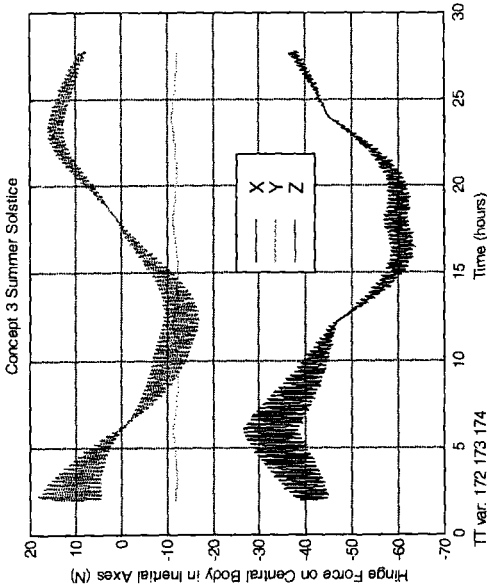


Figure B.3-15d: Hinge Force on Central Body
in Inertial Axes vs. Time
(Concept 3)

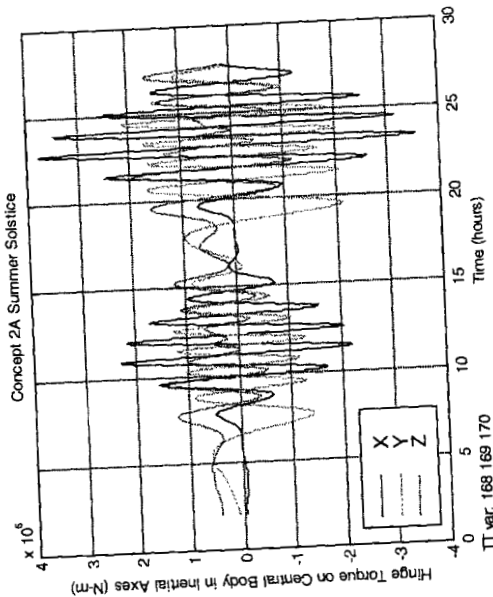


Figure B.3-16a: Hinge Torque on Central Body
in Inertial Axes vs. Time
(Concept 1)

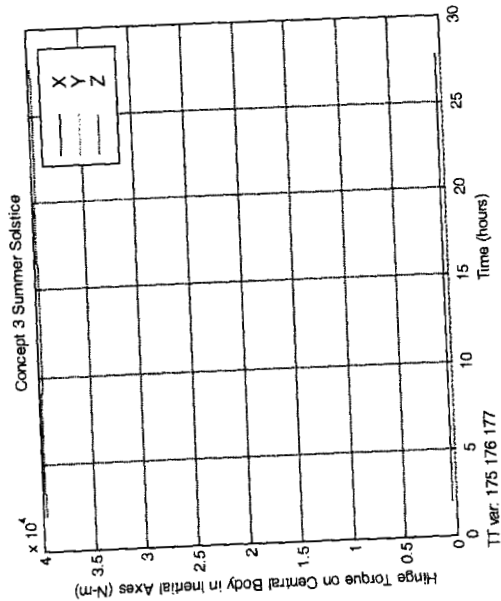


Figure B.3-16b: Hinge Torque on Central Body
in Inertial Axes vs. Time
(Concept 2A)

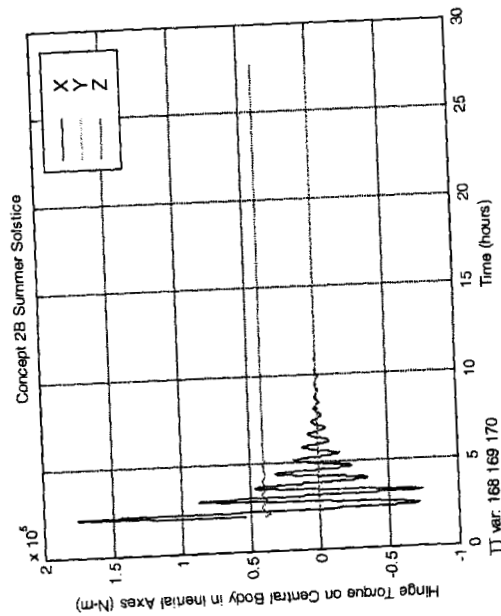


Figure B.3-16c: Hinge Torque on Central Body
in Inertial Axes vs. Time
(Concept 2B)

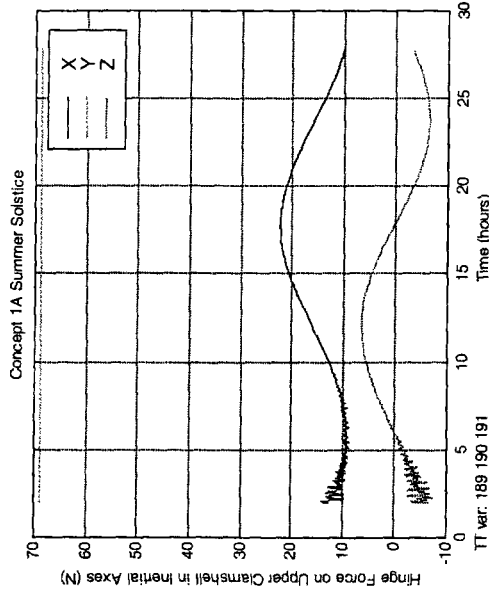


Figure B.3-17a: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Concept 1)

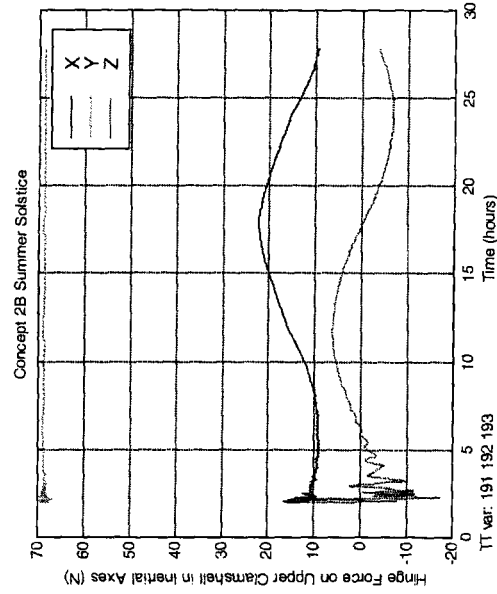


Figure B.3-17c: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Concept 2B)

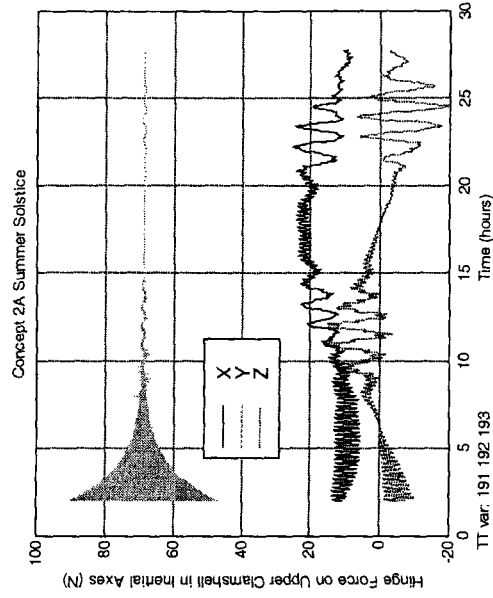


Figure B.3-17b: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Concept 2A)

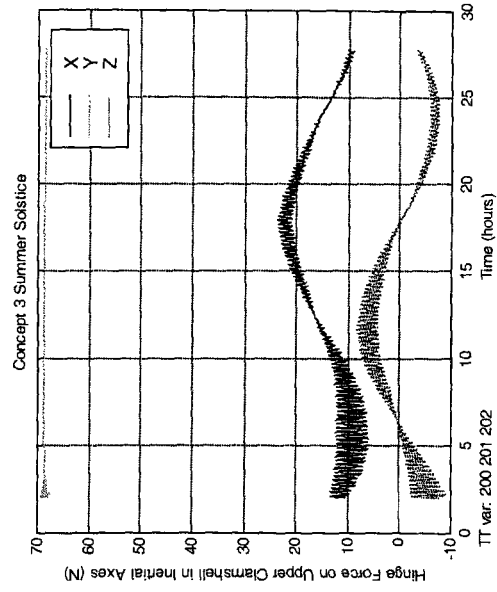


Figure B.3-17d: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Concept 3)

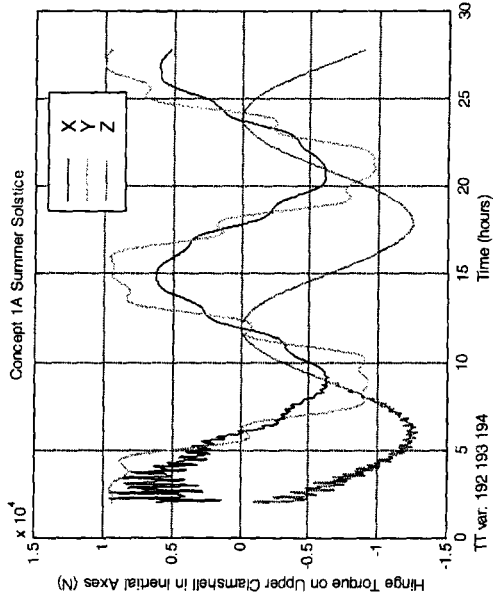


Figure B.3-18a: Hinge Torque on Upper Clamshell
in Inertial Axes vs. Time
(Concept 1)

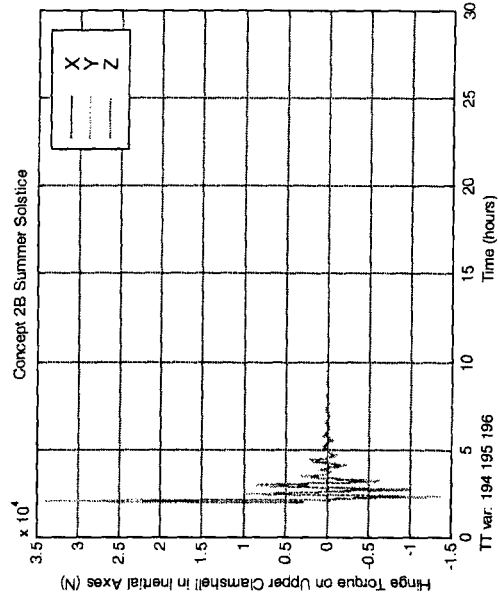


Figure B.3-18c: Hinge Torque on Upper Clamshell
in Inertial Axes vs. Time
(Concept 2B)

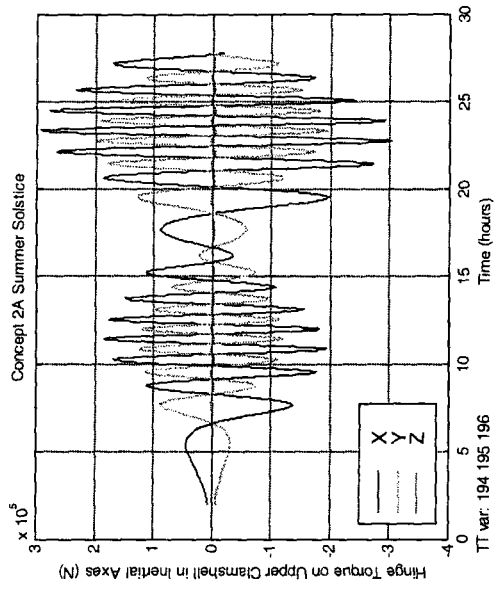


Figure B.3-18b: Hinge Torque on Upper Clamshell
in Inertial Axes vs. Time
(Concept 2A)

Torque Curves are zero for Case 3

Figure B.3-18d: Hinge Torque on Upper Clamshell
in Inertial Axes vs. Time
(Concept 3)

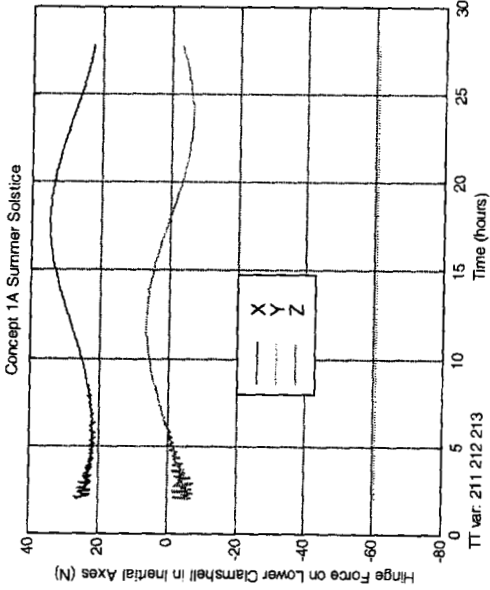


Figure B.3-19a: Hinge Force on Lower Clamshell in Inertial Axes vs. Time (Concept 1)

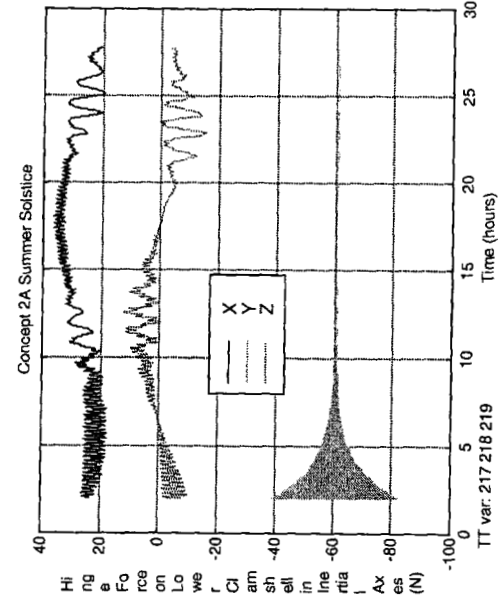


Figure B.3-19b: Hinge Force on Lower Clamshell in Inertial Axes vs. Time (Concept 2A)

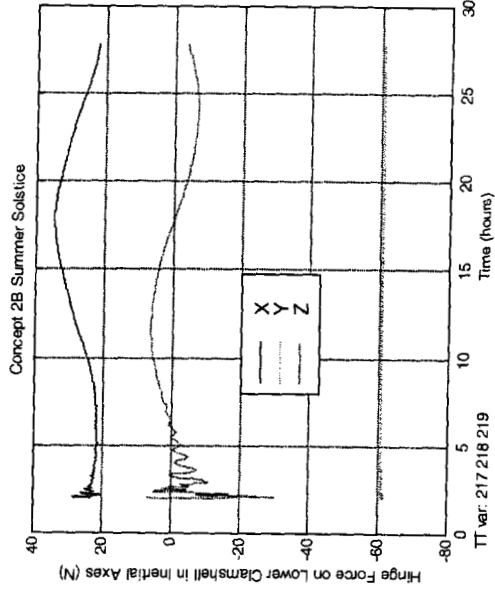


Figure B.3-19c: Hinge Force on Lower Clamshell in Inertial Axes vs. Time (Concept 2B)

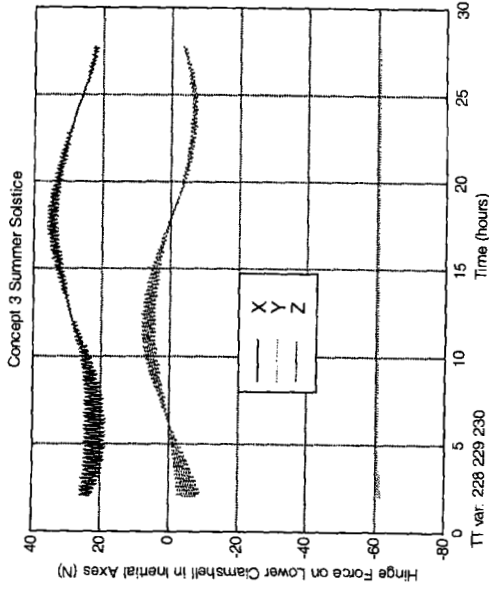


Figure B.3-19d: Hinge Force on Lower Clamshell in Inertial Axes vs. Time (Concept 3)

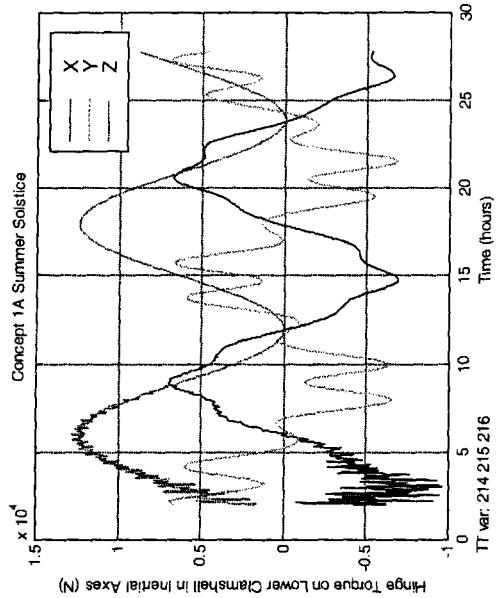


Figure B.3-20a: Hinge Torque on Lower Clamshell
in Inertial Axes vs. Time
(Concept 1)

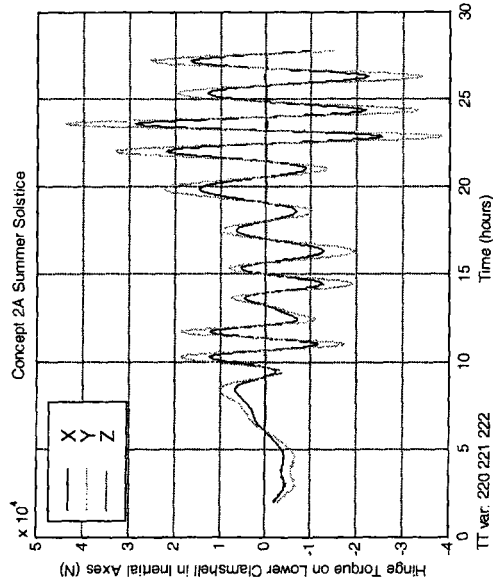


Figure B.3-20b: Hinge Torque on Lower Clamshell
in Inertial Axes vs. Time
(Concept 2A)

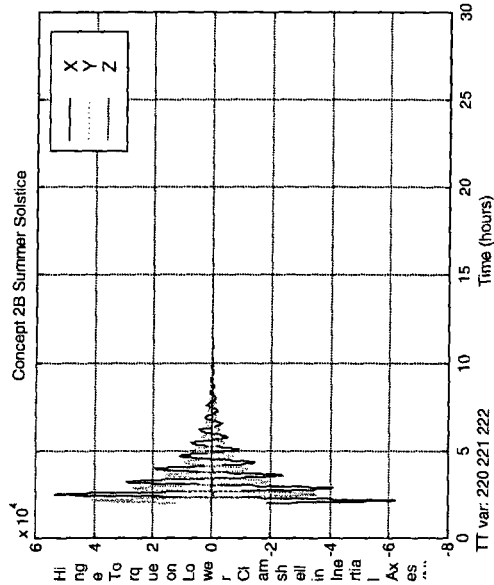


Figure B.3-20c: Hinge Torque on Lower Clamshell
in Inertial Axes vs. Time
(Concept 2B)

Torque Curves are zero for Case 3

Figure B.3-20d: Hinge Torque on Lower Clamshell
in Inertial Axes vs. Time
(Concept 3)

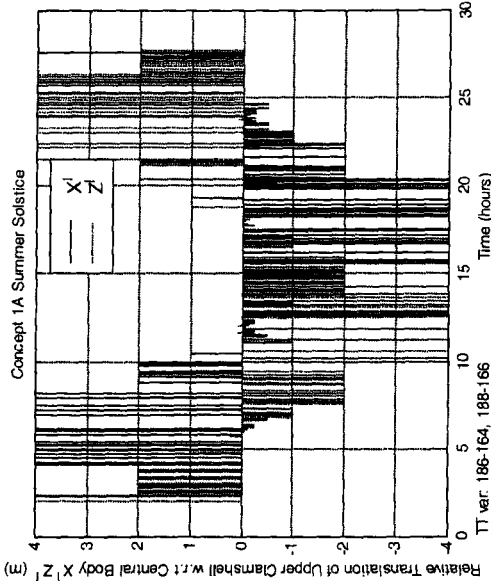


Figure B.3-21a: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Concept 1)

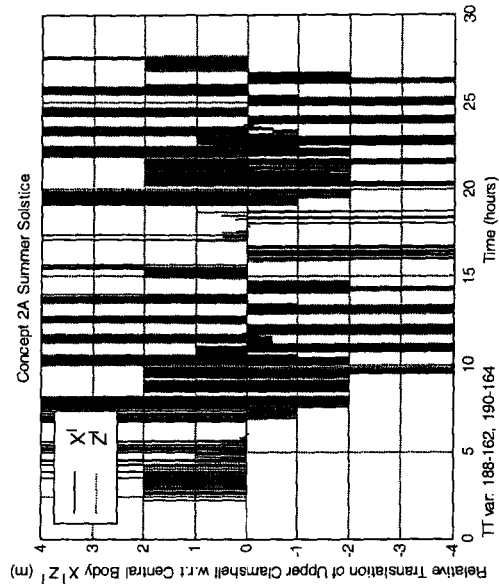


Figure B.3-21b: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Concept 2A)

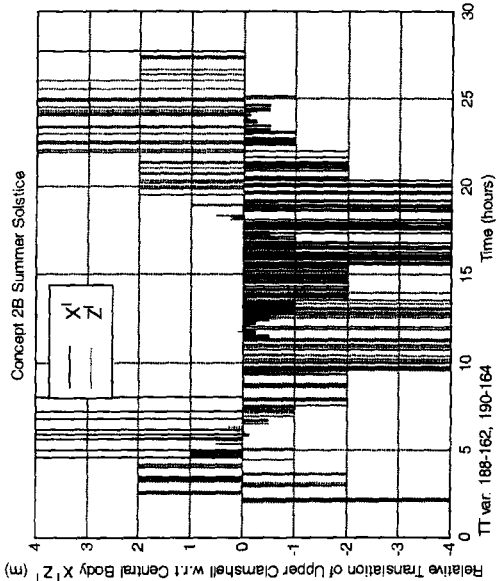


Figure B.3-21c: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Concept 2B)

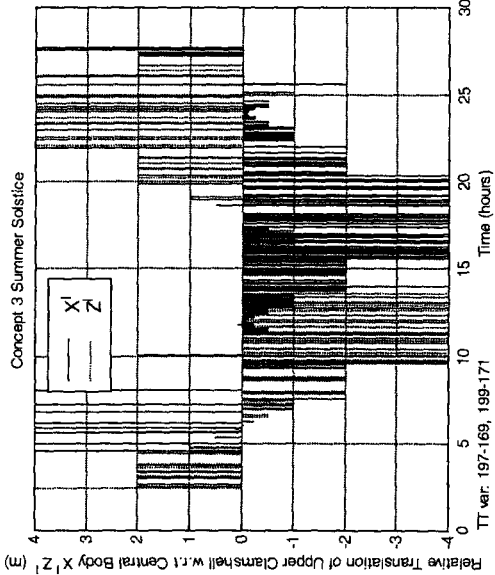


Figure B.3-21d: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Concept 3)

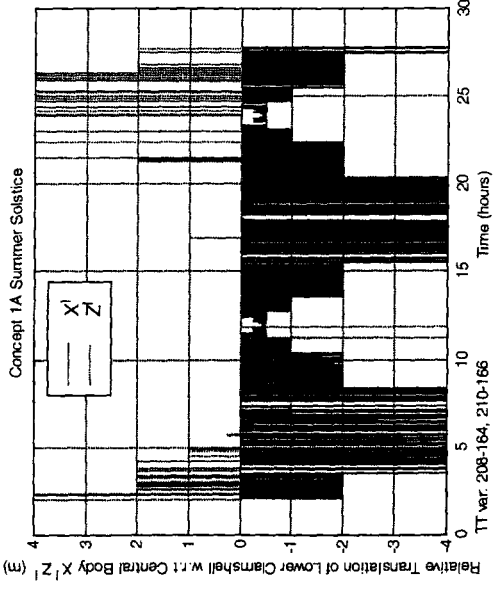


Figure B.3-22a: Relative Translation of Lower Clamshell w.r.t. Central
 Body vs. Time
 (Concept 1)

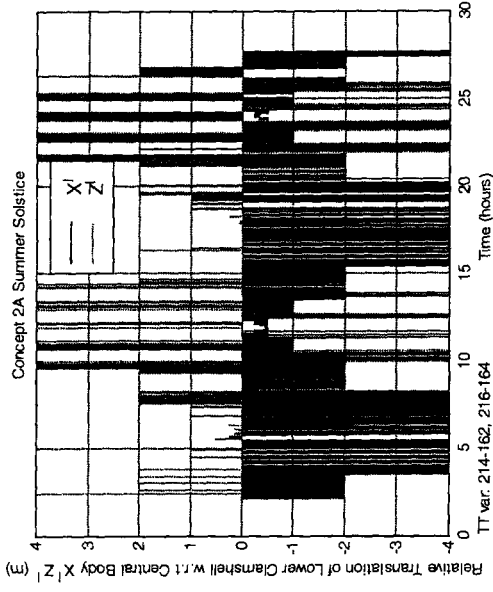


Figure B.3-22b: Relative Translation of Lower Clamshell w.r.t. Central
 Body vs. Time
 (Concept 2A)

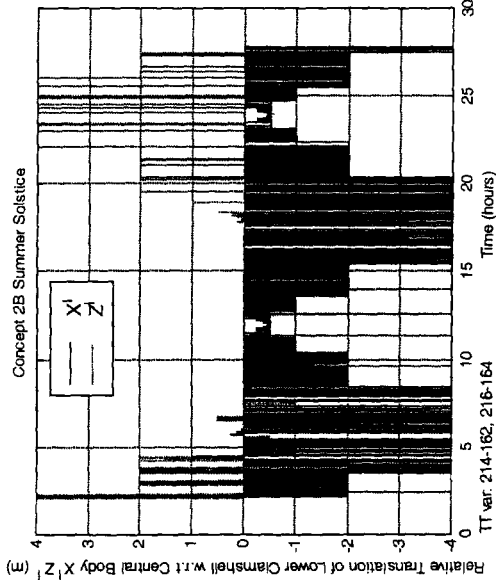


Figure B.3-22c: Relative Translation of Lower Clamshell w.r.t. Central
 Body vs. Time
 (Concept 2B)

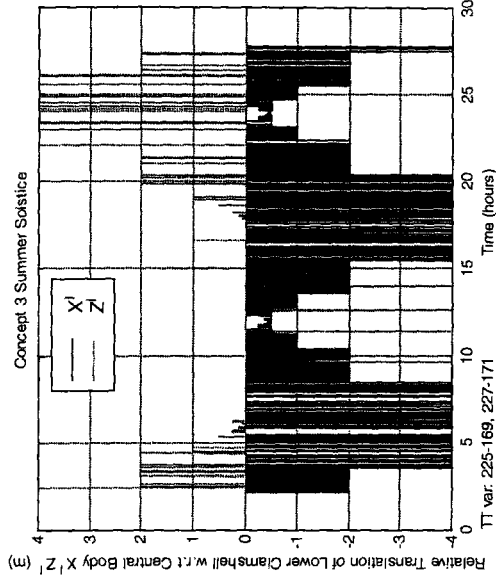


Figure B.3-22d: Relative Translation of Lower Clamshell w.r.t. Central
 Body vs. Time
 (Concept 3)

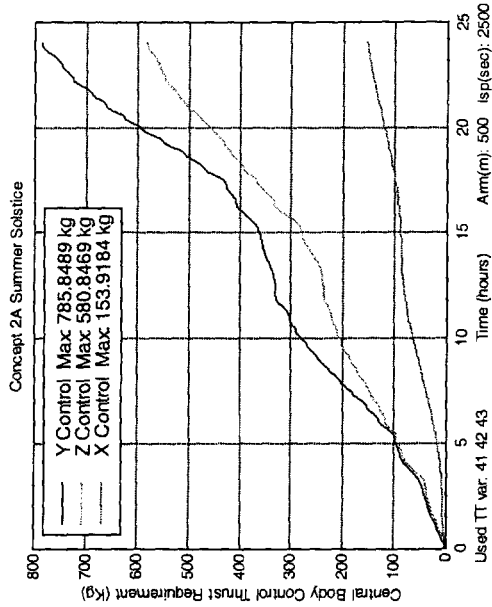


Figure B.3-23a: Central Body Control Thrust Requirement vs. Time for 1 Day (Concept 2A)

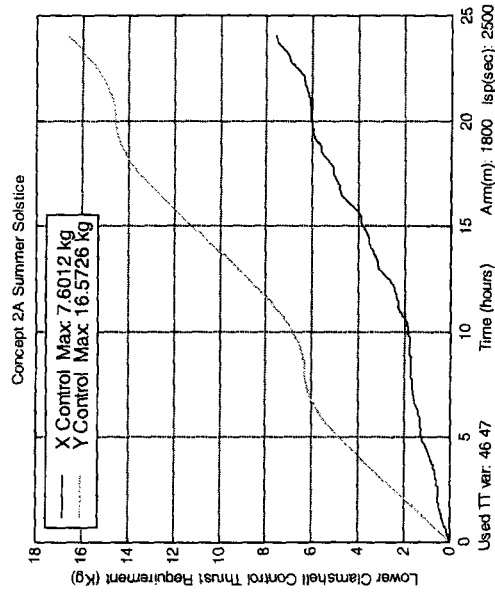


Figure B.3-23c: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day (Concept 2A)

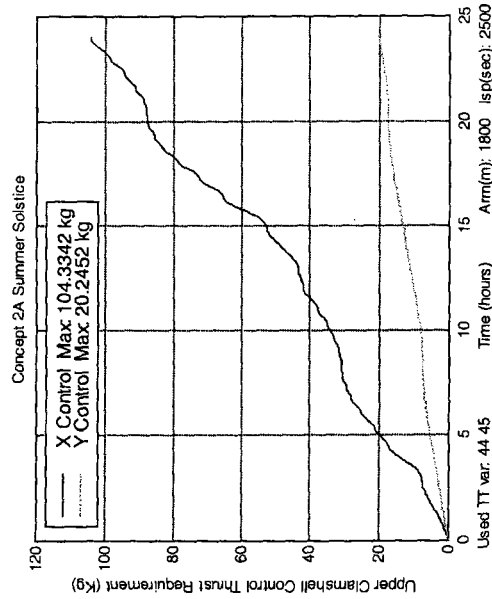


Figure B.3-23b: Upper Clamshell Control Thrust Requirement vs. Time for 1 Day (Concept 2A)

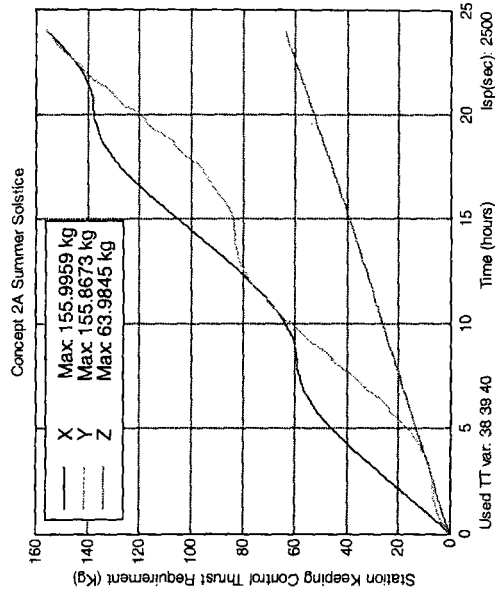


Figure B.3-23d: Station Keeping Control Thrust Requirement vs. Time for 1 Day (Concept 2A)

Table B.3-1: Predicted Daily Thrust Requirements (Kg) (Concept 2A)

Description	Vernal Equinox (Est.)			Summer Solstice (Calc.)			Autumnal Equinox (Est.)			Winter Solstice (Est.)			Daily Average			Total
	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Central Body Control	3.4	12.6	640.4	153.918	785.849	580.847	4.8	23.2	641.5	153.9	785.1	580.7	79.005	401.687	610.862	1091.554
Upper Clamshell Control	88.4	22.0	--	104.334	20.245	--	88.8	22.0	--	68.5	20.24	--	87.509	21.121	--	108.63
Lower Clamshell Control	9.8	18.0	--	7.601	16.573	--	9.7	18.0	--	11.6	16.6	--	9.675	17.293	--	26.968
Total	101.6	52.6	640.4	265.853	822.667	580.847	103.3	63.2	641.5	234.	821.94	580.7	176.188	440.102	610.862	1227.152

Notes:
1) Assumptions: $I_{sp} = 2500$ Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m; Total System Mass = 16921186.33 kg
2) Est. = Estimated using (Summer Solstice calc 2A/Summer Solstice calc 3)(calc 3) for each case and component.

Table B.3-2: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 2A)

Description	Vernal Equinox (Est.)			Summer Solstice (Calc.)			Autumnal Equinox (Est.)			Winter Solstice (Est.)			Daily Average			Total
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	
Station Keeping Control	169.5	172.1	.798	155.996	155.867	63.985	181.5	172.4	1.9	156.5	155.9	64.	165.874	164.067	32.670	362.612

Notes:
1) Assumptions: $I_{sp} = 2500$ Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m; Total System Mass = 16921186.33 kg
2) Est. = Estimated using (Summer Solstice calc 2A/Summer Solstice calc 3)(calc 3) for each case and component.

TABLE B.3-3: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 2A)

	Daily Total		Yearly Total					
Description	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control	Total (1 Year)
Central Body Control	79.005	401.687	610.862	1091.554	28857.	146716.	223117.	398690.
Upper Clamshell Control	87.509	21.121	--	108.630	31963.	7714.	--	39677.
Lower Clamshell Control	9.675	17.293	--	26.968	3534.	6316.	--	9850.
Total	176.188	440.102	610.862	1227.152	64353.	160747.	223117	448217.

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m
2) 1 Year = 365.25 days

TABLE B.3-4: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 2A)

		Daily Total		Yearly Total				
Description	X	Y	Z	Total (1 Day)	X	Y	Z	Total (1 Year)
Station Keeping Control	165.874	164.067	32.670	362.611	60585.	59925.	11933.	132443.

Notes:
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg
2) 1 Year = 365.25 days

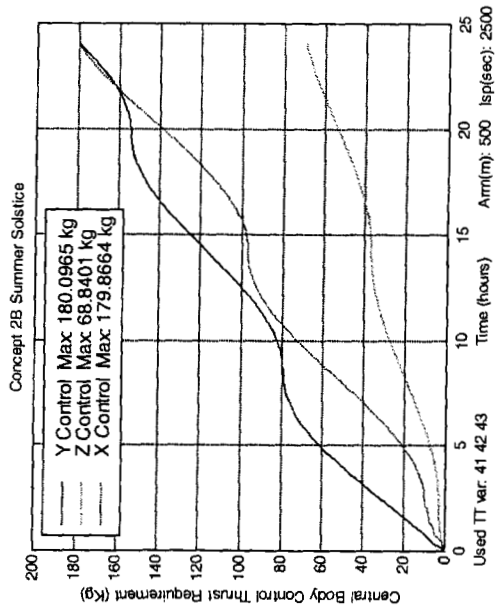


Figure B.3-24a: Central Body Control Thrust Requirement vs. Time for 1 Day (Concept 2B)

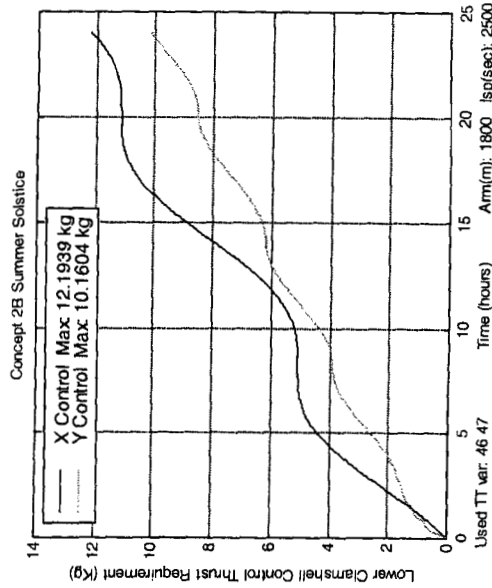


Figure B.3-24c: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day (Concept 2B)

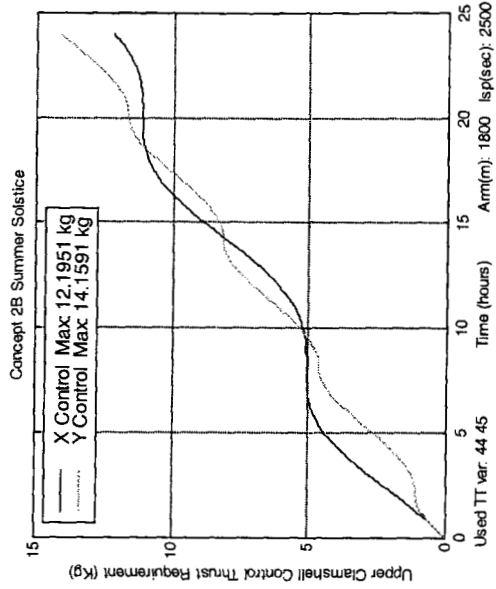


Figure B.3-24b: Upper Clamshell Control Thrust Requirement vs. Time for 1 Day (Concept 2B)

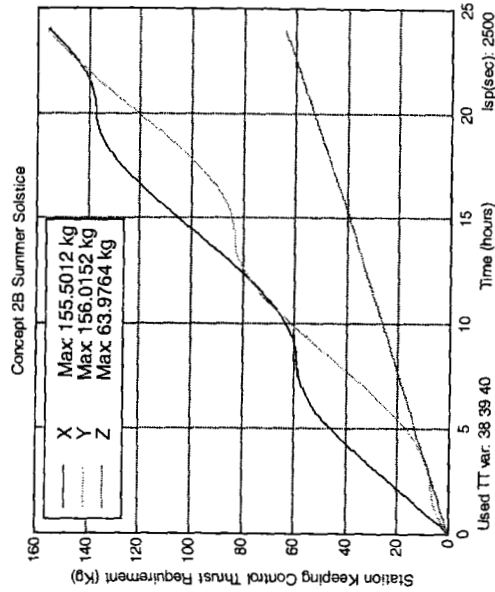


Figure B.3-24d: Station Keeping Control Thrust Requirement vs. Time for 1 Day (Concept 2B)

Table B.3-5: Predicted Daily Thrust Requirements (Kg) (Concept 2B)

Description	Vernal Equinox (Est.)			Summer Solstice (Calc.)			Autumnal Equinox (Est.)			Winter Solstice (Est.)			Daily Average			Total
	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Central Body Control	3.9	2.9	75.9	179.866	180.100	68.840	5.6	5.3	76.0	179.8	180.0	68.8	92.292	92.075	72.385	256.752
Upper Clamshell Control	10.3	15.4	--	12.195	14.159	--	10.4	15.4	--	8.0	14.2	--	10.224	14.790	--	25.014
Lower Clamshell Control	15.7	11.0	--	12.194	10.160	--	15.6	11.0	--	18.6	10.2	--	15.524	10.590	--	26.114
Total	29.9	29.3	75.9	204.255	204.419	68.840	31.6	31.7	76.0	206.4	204.4	68.8	118.04	117.455	72.385	307.880

Notes:

- 1) Assumptions: $I_{sp} = 2500$ Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m
2) Est. = Estimated using (Summer Solstice calc 2B/Summer Solstice calc 3)x(calc 3) for each case and component.

Table B.3-6: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 2B)

Description	Vernal Equinox (Est.)			Summer Solstice (Calc.)			Autumnal Equinox (Est.)			Winter Solstice (Est.)			Daily Average			Total
	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Station Keeping Control	168.9	172.3	.798	155.501	156.015	63.976	181.0	172.5	1.863	156.0	156.0	63.976	165.350	164.203	32.653	362.206

Notes:

- 1) Assumptions: $I_{sp} = 2500$ Sec; Total System Mass = 16921186.33 kg
2) Est. = Estimated using (Summer Solstice calc 2B/Summer Solstice calc 3)x(calc 3) for each case and component.

TABLE B.3-7: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 2B)							
Description	Daily Total				Yearly Total		
	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control
Central Body Control	92.292	92.075	72.385	256.752	33710.	33630.	26439.
Upper Clamshell Control	10.224	14.790	--	25.014	3734.	5402.	--
Lower Clamshell Control	15.524	10.590	--	26.114	5670.	3868.	--
Total	118.040	117.455	72.385	307.880	43114.	42900.	26439.
Notes:							
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m; Total System Mass = 16921186.33 kg							
2) 1 Year = 365.25 days							

TABLE B.3-8: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 2B)							
Description	Daily Total				Yearly Total		
	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control
Station Keeping Control	165.350	164.203	32.653	362.206	60394.	59975.	11927.
Total	165.350	164.203	32.653	362.206	60394.	59975.	11927.
Notes:							
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m; Total System Mass = 16921186.33 kg							
2) 1 Year = 365.25 days							

**B.4 -Thrust Requirements Comparison for Concept 1, Concept 2A, Concept 2B,
Concept 3 and Stationkeeping**

Table B.4-1: Predicted Thrust Requirements for Concept 1, Concept 2A, Concept 2B, Concept 3 and Stationkeeping						
Description	Daily Total					Est. Annual Total ave x 365.25
	VE	SS	AE	WS	ave	
C1	97.27	439.988	101.44	439.74	269.610	98475.
C2A	794.6	1669.367	808.0	1636.64	1227.152	448217.
C2B	135.1	477.514	139.3	479.6	307.880	112453.
C3	133.125	474.016	137.317	473.806	304.566	111243.
Stationkeeping C1	389.462	414.980	400.078	415.384	404.976	147917.
Stationkeeping C2A	342.398	375.848	355.800	376.400	362.612	132444.
Stationkeeping C2B	341.998	375.492	355.363	375.976	362.207	132296.
Stationkeeping C3	342.133	375.580	355.441	376.125	362.320	132337.
Notes:						
1) Control based on predictions in tables B.1-5 (for C1), B.3-1 (for C2A), B.3-5 (for C2B) and B.2-1 (for C3)						
2) Stationkeeping based on predictions in tables B.1-6 (for C1), B.3-2 (for C2A), B.3-6 (for C2B) and B.2-2 (C3).						

Appendix C

System Natural Frequencies

TREETOPS model system natural frequencies for the SSP ISC Configuration for concept 1, concept 2A, concept 2B and concept 3 are given herein. (Set the Z option in TREETOPS to obtain .MDK matrix.)

The steps to determine system natural frequencies are as follows:

- 1) set the Z option in TREETOPS and set to short run time
- 2) run TREETOPS
- 3) edit .MDK file and determine number of dof
- 4) edit run_read_m_d_k.m and update dof
- 5) run_read_m_d_k in MATLAB
- 6) run eig2 to determine frequencies and mode shapes.

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System Natural Frequencies (for Open Loop System) (Concept 1) (Hz):
(6 Rigid Body of System X, Y, Z, Roll, Pitch, Yaw)
(1 Rotations Free at Boom - Yaw)

1	0.0000000	
2	0.0000000	
3	0.0000000	
4	0.0000000	
5	0.0000000	
6	0.0000000	
7	0.0000000	
8	0.0001656	torsion
9	0.0009284	
10	0.0010580	
11	0.0012894	bending
12	0.0014804	bending
13	0.0016188	
14	0.0018034	
15	0.0046267	
16	0.0066675	
17	0.0207451	
18	0.0257265	
19	0.0289167	
20	0.0440772	
21	0.0441270	
22	0.0454749	
23	0.0456797	
24	0.0549901	
25	0.0831593	
26	0.3579221	
27	0.3604716	
28	0.5588000	
29	0.5588353	
30	0.5750994	
31	0.5751568	

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System Natural Frequencies (for Open Loop System) (Concept 2A) (Hz):

(6 Rigid Body of System X, Y, Z, Roll, Pitch, Yaw)

(2 Rotations Free at UC - Roll, Pitch)

(2 Rotations Free at LC - Roll, Pitch)

1	0.0000000	
2	0.0000000	
3	0.0000000	
4	0.0000000	
5	0.0000000	
6	0.0000000	
7	0.0000000	
8	0.0000000	
9	0.0000000	
10	0.0000000	
11	0.0002136	torsion
12	0.0003722	torsion
13	0.0012078	bending
14	0.0013254	bending
15	0.0045433	
16	0.0065539	
17	0.0228855	
18	0.0288667	
19	0.0426760	
20	0.0428621	
21	0.0439833	
22	0.0443653	
23	0.0530351	
24	0.0585215	
25	0.1828217	
26	0.3348567	
27	0.3590667	
28	0.3606646	
29	0.4821389	
30	0.4986634	
31	0.5682767	
32	0.5904600	
33	0.7300594	
34	0.7300973	

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System Natural Frequencies (for Open Loop System) (Concept 2B) (Hz):

(6 Rigid Body of System X, Y, Z, Roll, Pitch, Yaw)

(2 Rotations Free at UC - Yaw, Roll)

(2 Rotations Free at LC - Yaw, Roll)

1	0.0000000	
2	0.0000000	
3	0.0000000	
4	0.0000000	
5	0.0000000	
6	0.0000000	
7	0.0000000	
8	0.0000000	
9	0.0000000	
10	0.0000000	
11	0.0009283	
12	0.0012884	bending
13	0.0013167	bending
14	0.0016190	
15	0.0046238	
16	0.0065571	
17	0.0210080	
18	0.0219939	
19	0.0269741	
20	0.0297571	
21	0.0428616	
22	0.0440796	
23	0.0443568	
24	0.0454910	
25	0.0869754	
26	0.0914758	
27	0.3583247	
28	0.3605240	
29	0.4821389	
30	0.4986634	
31	0.5588121	
32	0.5751222	
33	0.7300594	
34	0.7300973	

System Natural Frequencies (for Open Loop System) (Concept 3) (Hz):

(6 Rigid Body of System X, Y, Z, Roll, Pitch, Yaw)

(3 Rotations Free at UC - Roll, Pitch, Yaw)

(3 Rotations Free at LC - Roll, Pitch, Yaw)

1	0.0000000	
2	0.0000000	
3	0.0000000	
4	0.0000000	
5	0.0000000	
6	0.0000000	
7	0.0000000	
8	0.0000000	
9	0.0000000	
10	0.0000000	
11	0.0000000	
12	0.0000000	
13	0.0012026	bending
14	0.0013171	bending
15	0.0045391	
16	0.0065538	
17	0.0210080	
18	0.0219932	
19	0.0269741	
20	0.0297506	
21	0.0428128	
22	0.0428639	
23	0.0441620	
24	0.0443726	
25	0.0869754	
26	0.0914758	
27	0.3583247	
28	0.3605240	
29	0.4821095	
30	0.4821525	
31	0.4986138	
32	0.4986909	
33	0.7300591	
34	0.7300594	
35	0.7300963	
36	0.7300973	

[Note: If The Upper and Lower Clamshell Rotations were fixed to the boom and all the mass moment of inertia of the clamshells were reacting against the boom, then the first natural frequency would be significantly lower:

f7= .000165 Hz Torsion UC and LC in opposite directions
f8= .000342 Hz Torsion UC and LC in one direction, CB in the other
f9= .000930 Hz
f10= .00106 Hz
f11= .00129 Hz bending
f12= .00148 Hz bending

(based on NASTRAN K123456 at UC and LC)]

Appendix D

A NASTRAN Model Description of the Boom

A NASTRAN model description for the boom for the SSP ISC is given herein. A brief synopsis is provided. NASTRAN data files have been provided with the technical data package.

The NASTRAN boom only model is defined using the following files:

```
ssp5_boom_sf_ng_13loc_dy_aset.dat (Boom Normal Modes Run)
  include: ssp5_boom_top_sf.dat
  include: ssp5_boom_bot_sf.dat
  include: ssp5_connection_main_boom_top_13loc_a.dat
  include: ssp5_connection_main_boom_bot_13loc_a.dat
```

The model is in metric SI units: length=meters(m), mass=kg, force=Newtons, time=seconds. The NASTRAN Basic CS origin is at the intersection of the Boom vertical centerline and the Central Body. The NASTRAN Basic CS axes are: +x is in the direction of the power beam and perpendicular to z axis, +y is RHR, +z along boom centerline toward upper boom (North).

A representation of the SSP ISC Boom modeled in NASTRAN is given in Figures D.1 through D.4.

An excerpt of the top and bottom NASTRAN .dat files are provided for property and material definitions.

Boom only mass properties and boom normal mode frequencies are presented.

Static load deflections are given for the upper end of the upper boom that is fixed at the boom center (assume boom fixed at boom/central body interface) and for a boom that is loaded at the upper end.

Results for full-up verification analysis including a flexible boom with the central body and clamshell mass and inertia are also presented. Specifically, mass and normal mode frequencies are given for two cases:

```
Full-Up System Verification K123 (Clamshell Rotations Free - Roll, Pitch, Yaw)
Full-Up System Verification K123456 (Clamshell Rotations Fixed to Boom)
```

Clamshell orientation for the full-up verification model is given in Figure D.5.

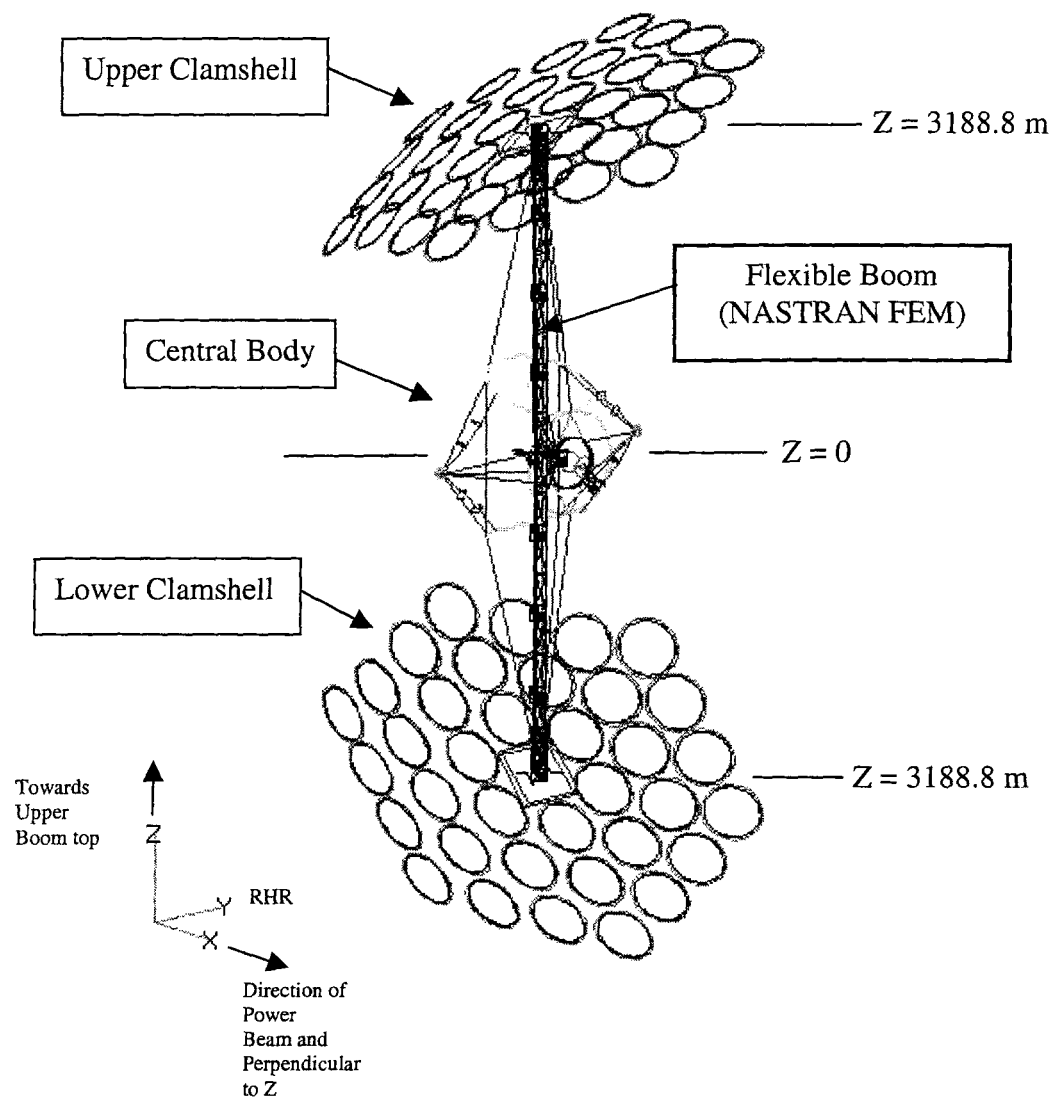
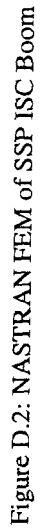


Figure D.1: SSP ISC Concept with NASTRAN Flexible Boom



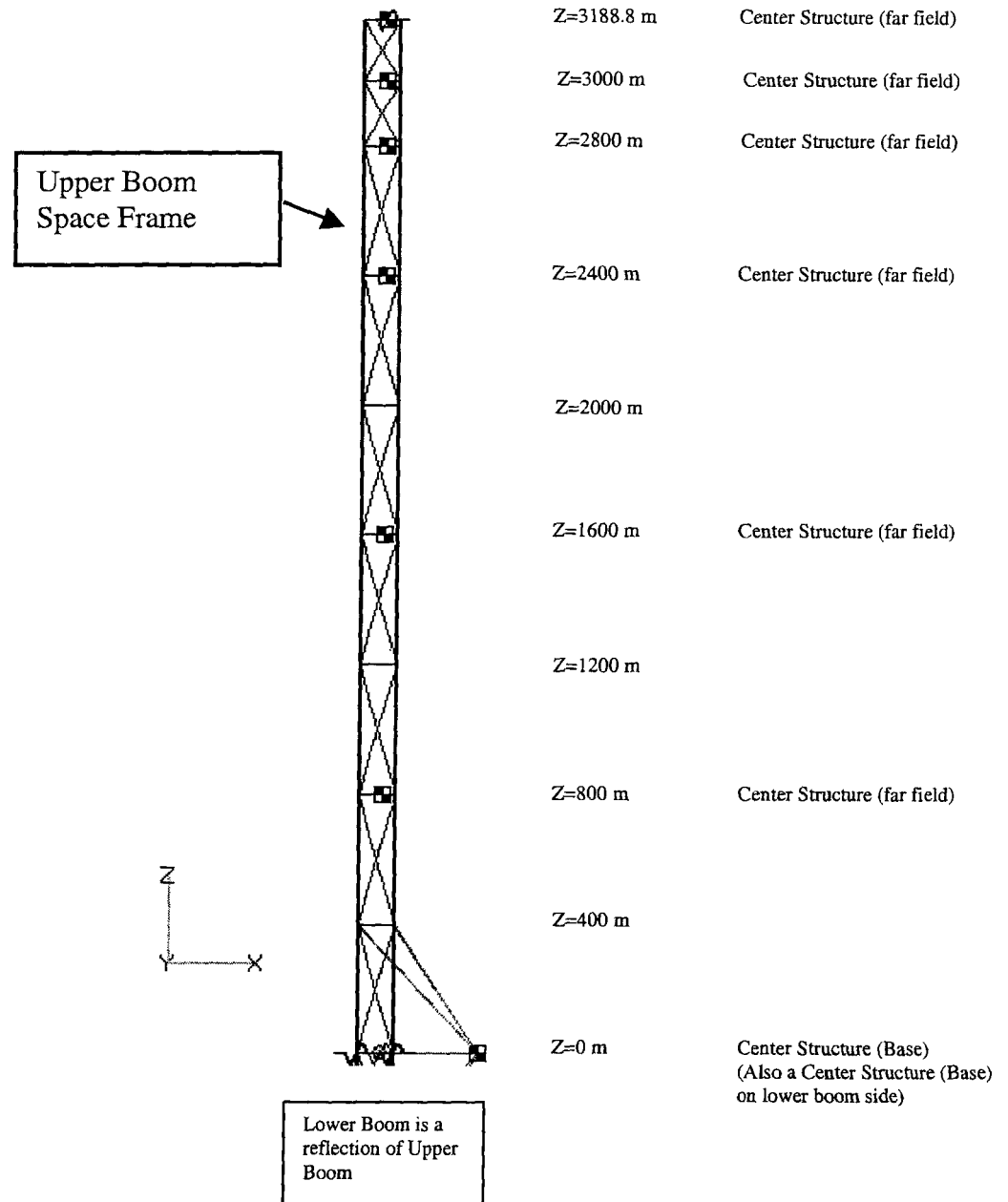


Figure D.3: Upper Boom Space Frame System: Station Designations

PV Array Hole
(200 m)

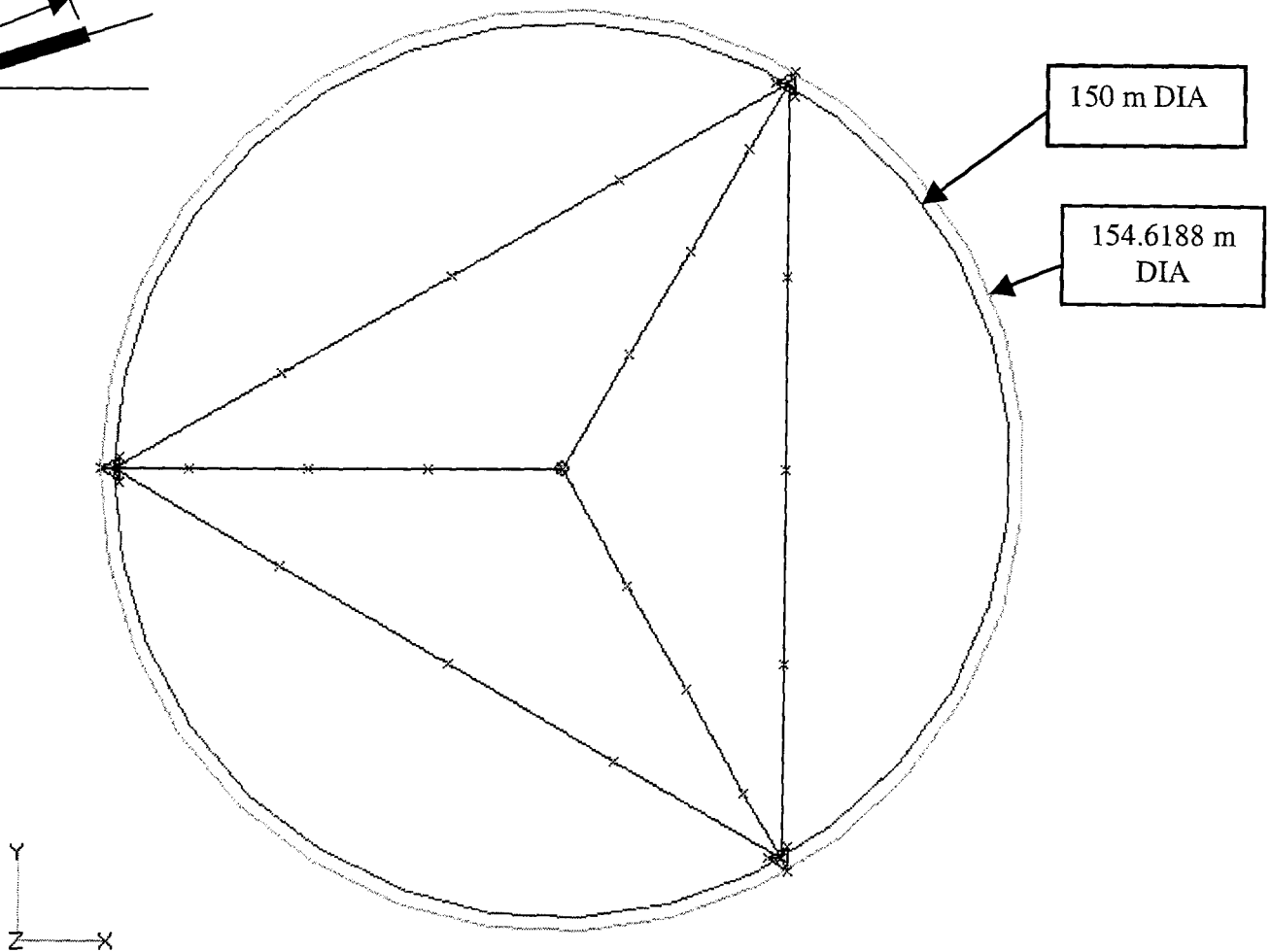


Figure D.4: Clearance Requirements of Boom:

```

#####
$ ssp5_boom_top_sf.dat
$ Emmett McDonald
$ 11 Sept 2000
$
$ SSP Boom, Upper
$ Metric SI Units: Length=meters(m), mass=kg, Force=Newtons, time=seconds
$ (+x - perpendicular to z axis in direction of beam, +y - RHR, +z along boom toward
upper)
$
$ ASSUMPTION:
$   Space Frame Concept - 123456 at cbars
$   Main Vertical: EDGE - 3 composite frame groupings, each grouping consists of
$                       of 3 individual vertical tubes and corresponding
$                       individual horizontal and diagonal tubes
$       1) Individual vertical tubes modeled as cbars
$       2) Individual horizontal tubes modeled as cbars
$       3) Individual diagonal tubes modeled as cbars
$   Main: CENTER - Connects the main vertical edge frames to a center point
$               of boom at key stations along boom
$       1) Composite Frame (assume square frame system) modeled as cbars
$   Main: HORIZONTAL - Connects the 3 composite frame groupings at key stations
$               along the boom
$       1) Composite Frame (assume triangular frame system) modeled as cbars
$   Main: DIAGONAL - Connects the 3 composite frame groupings at key
$               stations along the boom
$       1) Composite Frame (assume triangular frame system) modeled as cbars
$   Interface Plates (Analytical): Massless Interface plates that transition
$               loads of the individual tubes for a specific
$               main vertical frame grouping into a center
$               point for that frame grouping at key stations
$               along the beam.
$
$
$ ORGANIZATION:
$ ...PROPERTIES AND MATERIALS - Boom, Upper...
$ ...CENTER BARS...
$ removed...INTERFACE PLATES - ANALYTICAL...
$ ...CBARS ALONG INTERFACE PLATES - ANALYTICAL...
$ ...MAIN HORZ...
$ ...MAIN DIAG...
$ ...MAIN VERTICAL - EDGE AND CENTER...
$
$
$
#####
$
$-----
$   PROPERTIES AND MATERIALS - Boom, Upper
$-----
$11111112222222333333344444445555555666666677777778888888999999900000000
$
$ BOOM - TOP
$
$ Metric Units A=m2, IXX,IYY,J = m4
$ TUBE: OD = .0508 m (2 in), t =.003175 m (.125 in)
PBAR      101      100 4.75E-4 1.35E-7 1.35E-7 2.71E-7
$ TUBE: OD = .0254 m (1 in), t =.0015875 m (.125 in)
PBAR      102      100 1.19E-4 8.46E-9 8.46E-9 1.69E-8
$ TUBE: OD = .0254 m (1 in), t =.0015875 m (.125 in)
PBAR      103      100 1.19E-4 8.46E-9 8.46E-9 1.69E-8
$
$ CENTER STRUCTURE (AT BASE) - COMPOSITE TRUSS
$ Assume Square tube Pattern: 4 TUBES: .0508 m (2 in), t=.003175 m (.125 in)
$                               +z/-z = +5m/-5m +/-y = +2m/-2m
$                               Assume: A=4*indiv tube area
$                               I=Ad^2
PBAR      111      100 1.9E-3 4.75E-2 7.6E-3 5.51E-2
$
$ CENTER STRUCTURE ("NOT" AT BASE) - COMPOSITE TRUSS (USE 75% of these values)

```

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```
$ Assume Square tube Pattern:  4 TUBES: .0508 m (2 in), t=.003175 m (.125 in)
$                               +z/-z = +5m/-5m  +/-y = +2m/-2m
$                               Assume:  A=4*indiv tube area
$                               I=Ad^2
PBAR      112      100 1.43E-3 3.56E-2  5.7E-3 4.13E-2
$
$
$
$ MAIN HORZ - COMPOSITE TRUSS
PBAR      114      100 3.56E-4  9.5E-4  9.5E-4  1.9E-3
$ MAIN DIAG - COMPOSITE TRUSS
PBAR      115      100 3.56E-4  9.5E-4  9.5E-4  1.9E-3
$
$$$$$ $ Interface plates - Analytical
$$$$$ PSHELL      180      180      .6      180      180
$$$$$ $ CBARS along interface plates (Analytical) - zero mass and .6 m DIA solid
$$$$$ PBAR      181      180      .2827 6.36E-3 6.36E-3 1.27E-2
$ CBARS along interface plates (Analytical) - zero mass and .45 m DIA solid
PBAR      181      180      .1590 2.01E-3 2.01E-3 4.03E-3
$
$
$ Metric Units: I=Kg-m2, E=N/m2, ro=kg/m3
$Aluminum E=7.10E10 N/m2 (10.3E6 lb/in2)  ro=2.71E3 kg/m3 (.098 lb/in3 = 2.538E-4 lb-
s2/in)
MAT1      100 7.10E10      .30 2.71E3
$
$Aluminum - NO DENSITY
MAT1      180 7.10E10      .30 1.0E-1
$
$
$
$ MISC (1.37E3 at 6 locations) and Connection mass (.33E3 at 6 locations)
$1111111222222233333334444444555555566666667777777888888899999999
CONM2      142001 108001      0 1.70E3
CONM2      142002 116001      0 1.70E3
CONM2      142003 124001      0 1.70E3
CONM2      142004 128001      0 1.70E3
CONM2      142005 130001      0 1.70E3
CONM2      142006 131901      0 1.70E3
```


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```

$          +z/-z = +5m/-5m  +/-y = +2m/-2m
$          Assume:  A=4*indiv tube area
$          I=Ad^2
PBAR      212      200 1.43E-3 3.56E-2 5.7E-3 4.13E-2
$
$
$
$ MAIN HORZ - COMPOSITE TRUSS
PBAR      214      200 3.56E-4 9.5E-4 9.5E-4 1.9E-3
$ MAIN DIAG - COMPOSITE TRUSS
PBAR      215      200 3.56E-4 9.5E-4 9.5E-4 1.9E-3
$
$$$$$ $ Interface plates - Analytical
$$$$$ PSHELL      280      280      .6      280      280
$$$$$ $ CBARS along interface plates (Analytical) - zero mass and .6 m DIA solid
$$$$$ PBAR      281      280      .2827 6.36E-3 6.36E-3 1.27E-2
$$$$$ $ CBARS along interface plates (Analytical) - zero mass and .45 m DIA solid
PBAR      281      280      .1590 2.01E-3 2.01E-3 4.03E-3
$
$
$ Metric Units: I=Kg-m2, E=N/m2, ro=kg/m3
$Aluminum E=7.10E10 N/m2 (10.3E6 lb/in2)  ro=2.71E3 kg/m3 (.098 lb/in3 = 2.538E-4 lb-
s2/in)
MAT1      200 7.10E10      .30 2.71E3
$
$Aluminum - NO DENSITY
MAT1      280 7.10E10      .30 1.0E-1
$
$
$
$ MISC (1.37E3 at 6 locations) and Connection mass (.33E3 at 6 locations)
$1111111222222233333333444444445555555566666666777777778888888899999999
CONM2     242001 208001      0 1.70E3
CONM2     242002 216001      0 1.70E3
CONM2     242003 224001      0 1.70E3
CONM2     242004 228001      0 1.70E3
CONM2     242005 230001      0 1.70E3
CONM2     242006 231901      0 1.70E3
$

```

Excerpt of ssp5_boom_sf_ng_13loc_dy_aset.f06, E. McDonald, 23 Oct 2000 (BOOM ONLY)

1 SSP5_BOOM_SF_NG_13LOC_DY_ASET.DAT
NORMAL MODES ANALYSIS

OCT. 18, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 12
MATRIX PROCESSING FOR SUPERELEMENT 0 (RESIDUAL)

O U T P U T F R O M G R I D P O I N T W E I G H T G E N E R A T O R
REFERENCE POINT = 0

MO - RIGID BODY MASS MATRIX IN BASIC COORDINATE SYSTEM

```
***
* 1.616863E+05 -8.488657E-13 0.000000E+00 -5.169879E-26 -2.529123E-08 -3.544972E-05 *
* -1.139673E-12 1.616863E+05 0.000000E+00 3.997411E-08 0.000000E+00 -1.439671E-01 *
* 0.000000E+00 0.000000E+00 1.616863E+05 1.545100E-05 1.439671E-01 0.000000E+00 *
* 0.000000E+00 -2.318702E-07 3.545109E-05 6.285218E+11 -4.041448E-03 4.491835E-09 *
* 1.975422E-07 2.584939E-26 1.439671E-01 -4.042393E-03 6.285218E+11 -2.723725E-09 *
* -3.544975E-05 -1.439671E-01 -2.019484E-28 -2.793968E-09 6.984919E-10 6.705735E+08 *
***
```

S - TRANSFORMATION MATRIX FOR SCALAR MASS PARTITION

```
***
* 1.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 1.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 1.000000E+00 *
***
```

DIRECTION

```
MASS AXIS SYSTEM (S)      MASS      X-C.G.      Y-C.G.      Z-C.G.
X      1.616863E+05      -3.197474E-31  2.192500E-10 -1.564216E-13
Y      1.616863E+05      -8.904096E-07  0.000000E+00 -2.472325E-13
Z      1.616863E+05      -8.904096E-07  2.192579E-10  0.000000E+00
I(S) - INERTIAS RELATIVE TO C.G.
```

```
***
* 6.285218E+11  4.041448E-03 -4.491870E-09 *
* 4.041448E-03  6.285218E+11  2.723725E-09 *
* -4.491870E-09  2.723725E-09  6.705735E+08 *
***
```

I(Q) - PRINCIPAL INERTIAS

```
***
* 6.285218E+11
*
* 6.285218E+11  6.705735E+08 *
***
```

Q - TRANSFORMATION MATRIX

```
I(Q) = QT*IBAR(S)*Q
***
* 1.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 1.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 1.000000E+00 *
***
```

1 SSP5_BOOM_SF_NG_13LOC_DY_ASET.DAT
NORMAL MODES ANALYSIS
0

OCT. 18, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 1860
SUPERELEMENT SOLUTION

R E A L E I G E N V A L U E S

MODE NO.	EXTRACTION ORDER	EIGENVALUE	RADIAN FREQUENCY	CYCLIC FREQUENCY	GENERALIZED MASS	GENERALIZED STIFFNESS
1	1	-1.633329E-07	4.041447E-04	6.432163E-05	1.000000E+00	-1.633329E-07
2	2	-1.309557E-07	3.618780E-04	5.759467E-05	1.000000E+00	-1.309557E-07
3	3	-7.068505E-09	8.407440E-05	1.338086E-05	1.000000E+00	-7.068505E-09
4	4	-5.122070E-09	7.156864E-05	1.139050E-05	1.000000E+00	-5.122070E-09
5	5	1.088080E-08	1.043111E-04	1.660163E-05	1.000000E+00	1.088080E-08
6	6	6.154570E-08	2.480840E-04	3.948380E-05	1.000000E+00	6.154570E-08
7	7	9.759462E-03	9.878999E-02	1.572291E-02	1.000000E+00	9.759462E-03
8	8	9.759543E-03	9.879040E-02	1.572298E-02	1.000000E+00	9.759543E-03
9	9	2.034302E-02	1.426290E-01	2.270010E-02	1.000000E+00	2.034302E-02
10	10	6.646413E-02	2.578064E-01	4.103116E-02	1.000000E+00	6.646413E-02
11	11	6.646430E-02	2.578067E-01	4.103121E-02	1.000000E+00	6.646430E-02
12	12	8.589462E-02	2.930779E-01	4.664478E-02	1.000000E+00	8.589462E-02
13	13	2.134917E-01	4.620516E-01	7.353780E-02	1.000000E+00	2.134917E-01
14	14	2.134918E-01	4.620517E-01	7.353780E-02	1.000000E+00	2.134918E-01
15	15	2.951329E-01	5.432613E-01	8.646273E-02	1.000000E+00	2.951329E-01
16	16	4.354359E-01	6.598757E-01	1.050225E-01	1.000000E+00	4.354359E-01
17	17	6.812542E-01	8.253813E-01	1.313635E-01	1.000000E+00	6.812542E-01
18	18	6.812558E-01	8.253822E-01	1.313636E-01	1.000000E+00	6.812558E-01
19	19	4.527360E+00	2.127759E+00	3.386434E-01	1.000000E+00	4.527360E+00
20	20	5.820129E+00	2.412494E+00	3.839604E-01	1.000000E+00	5.820129E+00
21	21	9.491925E+00	3.080897E+00	4.903399E-01	1.000000E+00	9.491925E+00
22	22	1.282148E+01	3.580710E+00	5.698877E-01	1.000000E+00	1.282148E+01
23	23	1.282150E+01	3.580712E+00	5.698880E-01	1.000000E+00	1.282150E+01
24	24	1.382777E+01	3.718571E+00	5.918289E-01	1.000000E+00	1.382777E+01
25	25	1.382779E+01	3.718573E+00	5.918293E-01	1.000000E+00	1.382779E+01
26	26	1.673878E+01	4.091305E+00	6.511514E-01	1.000000E+00	1.673878E+01
27	27	3.403545E+01	5.833991E+00	9.285085E-01	1.000000E+00	3.403545E+01
28	28	3.403549E+01	5.833994E+00	9.285091E-01	1.000000E+00	3.403549E+01
29	29	3.428328E+01	5.855193E+00	9.318828E-01	1.000000E+00	3.428328E+01
30	30	3.428331E+01	5.855196E+00	9.318833E-01	1.000000E+00	3.428331E+01

0

ssp5_boom_sf_ng_13loc_st.f06 (Static Loads on Upper End of Upper Boom. Upper Boom Base Fixed) (An Excerpt)

1 SSP5_BOOM_SF_NG_13LOC_ST.DAT
STATIC ANALYSIS
0 LOAD FX = 20 N AT BOOM, UPPER END (TOP)
NOV. 21, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 478
DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)
SUBCASE 1001

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
131901	G	2.517928E-01	1.002802E-08	2.008612E-10	6.106400E-06	1.098348E-04	-5.412926E-11
231901	G	-2.704772E-02	1.037041E-09	-1.256144E-11	-2.906610E-07	1.052416E-05	1.819996E-11

1 SSP5_BOOM_SF_NG_13LOC_ST.DAT
STATIC ANALYSIS
0 LOAD FY = 20 N AT BOOM, UPPER END (TOP)
NOV. 21, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 479
DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)
SUBCASE 1002

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
131901	G	1.002802E-08	2.517929E-01	-1.257524E-10	-1.098349E-04	6.106408E-06	2.695994E-11
231901	G	1.038834E-09	-2.704778E-02	9.964591E-12	-1.052418E-05	-2.906613E-07	-2.143183E-11

1 SSP5_BOOM_SF_NG_13LOC_ST.DAT
STATIC ANALYSIS
0 LOAD FZ = 20 N AT BOOM, UPPER END (TOP) (BOOM AXIAL LOADING)
NOV. 21, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 480
DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)
SUBCASE 1003

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
131901	G	2.008612E-10	-1.257524E-10	4.886293E-04	2.960159E-14	7.269726E-13	-1.299740E-05
231901	G	1.295385E-11	-1.367107E-11	-6.568940E-06	-4.560693E-15	-4.104938E-15	1.814090E-08

1 SSP5_BOOM_SF_NG_13LOC_ST.DAT
STATIC ANALYSIS
0 LOAD MX = 10000 N-M AT BOOM, UPPER END (TOP)
NOV. 21, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 481
DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)
SUBCASE 1004

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
131901	G	3.053200E-03	-5.491742E-02	1.480079E-11	9.498738E-05	-5.126904E-13	-1.491296E-11
231901	G	1.453305E-04	5.262089E-03	-1.736071E-12	2.000275E-06	-2.073411E-15	4.012494E-12

1 SSP5_BOOM_SF_NG_13LOC_ST.DAT
STATIC ANALYSIS
0 LOAD MY = 10000 N-M AT BOOM, UPPER END (TOP)
NOV. 21, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 482
DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)
SUBCASE 1005

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
131901	G	5.491740E-02	3.053204E-03	3.634863E-10	-5.126902E-13	9.498736E-05	1.255651E-11

231901 G -5.262078E-03 1.453307E-04 -2.130299E-12 4.086835E-16 2.000271E-06 2.984677E-12
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT NOV. 21, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 483
STATIC ANALYSIS DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)

0 LOAD MZ = 10000 N-M AT BOOM, UPPER END (TOP)

SUBCASE 1006

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
131901	G	-2.706463E-08	1.347998E-08	-6.498701E-03	-1.491296E-11	1.255651E-11	3.563758E-03
231901	G	8.488112E-09	-9.099953E-09	-9.070437E-06	-3.539443E-12	-2.891001E-12	-1.540669E-04
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT					NOV. 21, 19 0	CSA/NASTRAN	IBM PC 07/21/99 PAGE 484
STATIC ANALYSIS DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)							
0	LOAD FX = 20 N AT BOOM, LOWER END (BOT)						

SUBCASE 2001

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
131901	G	-2.704772E-02	1.038834E-09	1.295384E-11	2.906610E-07	-1.052416E-05	1.697622E-11
231901	G	2.517928E-01	9.916226E-09	-1.977961E-10	-6.106400E-06	-1.098348E-04	-5.219564E-11
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT					NOV. 21, 19 0	CSA/NASTRAN	IBM PC 07/21/99 PAGE 485
STATIC ANALYSIS DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)							
0	LOAD FY = 20 N AT BOOM, LOWER END (BOT)						

SUBCASE 2002

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
131901	G	1.037040E-09	-2.704778E-02	-1.367106E-11	1.052418E-05	2.906613E-07	-1.819990E-11
231901	G	9.916227E-09	2.517929E-01	1.246758E-10	1.098349E-04	-6.106408E-06	2.525499E-11
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT					NOV. 21, 19 0	CSA/NASTRAN	IBM PC 07/21/99 PAGE 486
STATIC ANALYSIS DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)							
0	LOAD FZ = 20 N AT BOOM, LOWER END (BOT) (BOOM AXIAL LOADING)						

SUBCASE 2003

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
131901	G	-1.256144E-11	9.964584E-12	-6.568940E-06	-3.472140E-15	-4.260599E-15	-1.814087E-08
231901	G	-1.977961E-10	1.246758E-10	4.886293E-04	2.969441E-14	7.259546E-13	1.299740E-05
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT					NOV. 21, 19 0	CSA/NASTRAN	IBM PC 07/21/99 PAGE 487
STATIC ANALYSIS DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)							
0	LOAD MX = 10000 N-M AT BOOM, LOWER END (BOT)						

SUBCASE 2004

D I S P L A C E M E N T V E C T O R

POINT ID. TYPE T1 T2 T3 R1 R2 R3
131901 G -1.453305E-04 -5.262089E-03 -2.280347E-12 2.000275E-06 4.087172E-16 -3.539443E-12
231901 G -3.053200E-03 5.491742E-02 1.484721E-11 9.498738E-05 -5.096353E-13 1.477201E-11
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT NOV. 21, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 488
STATIC ANALYSIS DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)
0 LOAD MY = 10000 N-M AT BOOM, LOWER END (BOT) SUBCASE 2005

D I S P L A C E M E N T V E C T O R

POINT ID. TYPE T1 T2 T3 R1 R2 R3
131901 G 5.262078E-03 -1.453307E-04 -2.052467E-12 -2.073404E-15 2.000271E-06 -2.891000E-12
231901 G -5.491740E-02 -3.053204E-03 3.629773E-10 -5.096353E-13 9.498736E-05 -1.282914E-11
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT NOV. 21, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 489
STATIC ANALYSIS DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)
0 LOAD MZ = 10000 N-M AT BOOM, LOWER END (BOT) SUBCASE 2006

D I S P L A C E M E N T V E C T O R

POINT ID. TYPE T1 T2 T3 R1 R2 R3
131901 G 9.099987E-09 -1.071592E-08 9.070449E-06 4.012496E-12 2.984678E-12 -1.540669E-04
231901 G -2.609783E-08 1.262750E-08 6.498701E-03 1.477201E-11 -1.282913E-11 3.563758E-03
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT NOV. 21, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 490
STATIC ANALYSIS DATA RECOVERY FOR SUPERELEMENT 0 (RESIDUAL)
0 LOAD FX = 20 N AT BOOM, UPPER END (TOP) SUBCASE 1001

Verification Analysis:

Full-Up System Verification K123 (Clamshell Rotations Free - Roll, Pitch, Yaw) An Excerpt

1 SSP5_MAIN_SF_NG_CLAM_K123_DY_MOD2.DAT NOV. 17, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 10
NORMAL MODES ANALYSIS MATRIX PROCESSING FOR SUPERELEMENT 0 (RESIDUAL)

0 OUTPUT FROM GRID POINT WEIGHT GENERATOR
0 REFERENCE POINT = 0

MO - RIGID BODY MASS MATRIX IN BASIC COORDINATE SYSTEM

* 1.692119E+07 -8.488657E-13 0.000000E+00 -5.169879E-26 -2.529123E-08 -3.544972E-05 *
* -1.139672E-12 1.692119E+07 0.000000E+00 2.025105E+02 0.000000E+00 3.778649E+09 *
* 0.000000E+00 0.000000E+00 1.692119E+07 3.545100E-05 -3.778649E+09 0.000000E+00 *
* 0.000000E+00 2.025104E+02 3.545109E-05 4.650430E+13 -4.041448E-03 4.491835E-09 *
* 1.975422E-07 2.584939E-26 -3.778649E+09 -4.042393E-03 5.003726E+13 -1.139207E+05 *
* -3.544975E-05 3.778649E+09 -2.019484E-28 -2.793968E-09 -1.139207E+05 7.609928E+12 *

S - TRANSFORMATION MATRIX FOR SCALAR MASS PARTITION

* 1.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 1.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 1.000000E+00 *

DIRECTION

MASS AXIS SYSTEM (S) MASS X-C.G. Y-C.G. Z-C.G.
X 1.692119E+07 -3.055270E-33 2.094990E-12 -1.494649E-15
Y 1.692119E+07 2.233087E+02 0.000000E+00 -1.196786E-05
Z 1.692119E+07 2.233087E+02 2.095066E-12 0.000000E+00
I(S) - INERTIAS RELATIVE TO C.G.

* 4.650430E+13 -3.875071E-03 4.522235E+04 *
* -3.875071E-03 4.919346E+13 1.139207E+05 *
* 4.522235E+04 1.139207E+05 6.766123E+12 *

I(Q) - PRINCIPAL INERTIAS

* 4.650430E+13 *
* 4.919346E+13 *
* 6.766123E+12 *

Q - TRANSFORMATION MATRIX

I(Q) = QT*IBAR(S)*Q

* 1.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 1.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 1.000000E+00 *

R E A L E I G E N V A L U E S

MODE NO.	EXTRACTION ORDER	EIGENVALUE	RADIAN FREQUENCY	CYCLIC FREQUENCY	GENERALIZED MASS	GENERALIZED STIFFNESS
1	1	-6.227084E-10	2.495413E-05	3.971572E-06	1.000000E+00	-6.227084E-10
2	2	-3.684854E-10	1.919597E-05	3.055134E-06	1.000000E+00	-3.684854E-10
3	3	-3.099192E-10	1.760452E-05	2.801847E-06	1.000000E+00	-3.099192E-10
4	4	-1.515650E-10	1.231117E-05	1.959384E-06	1.000000E+00	-1.515650E-10
5	5	2.941186E-16	1.714989E-08	2.729489E-09	1.000000E+00	2.941186E-16
6	6	2.941322E-16	1.715028E-08	2.729552E-09	1.000000E+00	2.941322E-16
7	7	5.881085E-16	2.425095E-08	3.859658E-09	1.000000E+00	5.881085E-16
8	8	5.882390E-16	2.425364E-08	3.860086E-09	1.000000E+00	5.882390E-16
9	9	5.882525E-16	2.425392E-08	3.860131E-09	1.000000E+00	5.882525E-16
10	10	5.882712E-16	2.425430E-08	3.860192E-09	1.000000E+00	5.882712E-16
11	11	2.397129E-11	4.896048E-06	7.792303E-07	1.000000E+00	2.397129E-11
12	12	2.314021E-10	1.521191E-05	2.421050E-06	1.000000E+00	2.314021E-10
13	13	5.709955E-05	7.556424E-03	1.202642E-03	1.000000E+00	5.709955E-05
14	14	6.849127E-05	8.275946E-03	1.317158E-03	1.000000E+00	6.849127E-05
15	15	8.134064E-04	2.852028E-02	4.539143E-03	1.000000E+00	8.134064E-04
16	16	1.695564E-03	4.117722E-02	6.553559E-03	1.000000E+00	1.695564E-03
17	17	1.704217E-02	1.305457E-01	2.077699E-02	1.000000E+00	1.704217E-02
18	18	1.785241E-02	1.336129E-01	2.126515E-02	1.000000E+00	1.785241E-02
19	19	2.669046E-02	1.633721E-01	2.600148E-02	1.000000E+00	2.669046E-02
20	20	3.430796E-02	1.852241E-01	2.947933E-02	1.000000E+00	3.430796E-02
21	21	6.357310E-02	2.521371E-01	4.012886E-02	1.000000E+00	6.357310E-02
22	22	6.372374E-02	2.524356E-01	4.017637E-02	1.000000E+00	6.372374E-02
23	23	6.733700E-02	2.594937E-01	4.129971E-02	1.000000E+00	6.733700E-02
24	24	6.794554E-02	2.606637E-01	4.148591E-02	1.000000E+00	6.794554E-02
25	25	1.575687E-01	3.969493E-01	6.317644E-02	1.000000E+00	1.575687E-01

Verification Analysis:

Full-Up System Verification K123456 (Clamshell Rotations Fixed to Boom) An Excerpt

1 SSP5_MAIN_SF_NG_CLAM_K123_DY_MOD2.DAT NOV. 17, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 10
NORMAL MODES ANALYSIS MATRIX PROCESSING FOR SUPERELEMENT 0 (RESIDUAL)

0 OUTPUT FROM GRID POINT WEIGHT GENERATOR
REFERENCE POINT = 0

*** MO - RIGID BODY MASS MATRIX IN BASIC COORDINATE SYSTEM ***
* 1.692119E+07 -8.488657E-13 0.000000E+00 -5.169879E-26 -2.529123E-08 -3.544972E-05 *
* -1.139672E-12 1.692119E+07 0.000000E+00 2.025105E+02 0.000000E+00 3.778649E+09 *
* 0.000000E+00 0.000000E+00 1.692119E+07 3.545100E-05 -3.778649E+09 0.000000E+00 *
* 0.000000E+00 2.025104E+02 3.545109E-05 4.650430E+13 -4.041448E-03 4.491835E-09 *
* 1.975423E-07 2.584939E-26 -3.778649E+09 -4.042393E-03 5.003726E+13 -1.139207E+05 *
* -3.544975E-05 3.778649E+09 -2.019484E-28 -2.793968E-09 -1.139207E+05 7.609928E+12 *

S - TRANSFORMATION MATRIX FOR SCALAR MASS PARTITION ***
* 1.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 1.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 1.000000E+00 *

DIRECTION MASS AXIS SYSTEM (S) X-C.G. Y-C.G. Z-C.G.
X 1.692119E+07 1.692119E+07 -3.055270E-33 2.094990E-12 -1.494649E-15
Y 1.692119E+07 1.692119E+07 2.233087E+02 0.000000E+00 -1.196786E-05
Z 1.692119E+07 1.692119E+07 2.233087E+02 2.095066E-12 0.000000E+00
I(S) - INERTIAS RELATIVE TO C.G. ***

*** I(Q) - PRINCIPAL INERTIAS ***
* 4.650430E+13 -3.875071E-03 4.522235E+04 *
* -3.875071E-03 4.919346E+13 1.139207E+05 *
* 4.522235E+04 1.139207E+05 6.766123E+12 *

*** I(Q) = QT*IBAR(S)*Q ***
* 4.650430E+13 4.919346E+13 6.766123E+12 *
* 4.919346E+13 6.766123E+12 *

Q - TRANSFORMATION MATRIX
I(Q) = QT*IBAR(S)*Q ***
* 1.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 1.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 1.000000E+00 *

1 SSP5_MAIN_SF_NG_CLAM_K123_DY_MOD2.DAT
NORMAL MODES ANALYSIS
0

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SUPERELEMENT SOLUTION

R E A L E I G E N V A L U E S

MODE NO.	EXTRACTION ORDER	EIGENVALUE	RADIAN FREQUENCY	CYCLIC FREQUENCY	GENERALIZED MASS	GENERALIZED STIFFNESS
1	1	-6.211539E-10	2.492296E-05	3.966612E-06	1.000000E+00	-6.211539E-10
2	2	-3.403050E-10	1.844736E-05	2.935988E-06	1.000000E+00	-3.403050E-10
3	3	-1.573186E-10	1.254267E-05	1.996228E-06	1.000000E+00	-1.573186E-10
4	4	-1.267169E-10	1.125686E-05	1.791585E-06	1.000000E+00	-1.267169E-10
5	5	2.600097E-11	5.099114E-06	8.115493E-07	1.000000E+00	2.600097E-11
6	6	2.316233E-10	1.521917E-05	2.422207E-06	1.000000E+00	2.316233E-10
7	7	1.076385E-06	1.037490E-03	1.651216E-04	1.000000E+00	1.076385E-06
8	8	4.630290E-06	2.151811E-03	3.424713E-04	1.000000E+00	4.630290E-06
9	9	3.412004E-05	5.841236E-03	9.296615E-04	1.000000E+00	3.412004E-05
10	10	4.456027E-05	6.675348E-03	1.062415E-03	1.000000E+00	4.456027E-05
11	11	6.563131E-05	8.101315E-03	1.289364E-03	1.000000E+00	6.563131E-05
12	12	8.650443E-05	9.300776E-03	1.480264E-03	1.000000E+00	8.650443E-05
13	13	1.034806E-04	1.017254E-02	1.619010E-03	1.000000E+00	1.034806E-04
14	14	1.287677E-04	1.134759E-02	1.806024E-03	1.000000E+00	1.287677E-04
15	15	8.450979E-04	2.907057E-02	4.626724E-03	1.000000E+00	8.450979E-04
16	16	1.754916E-03	4.189172E-02	6.667274E-03	1.000000E+00	1.754916E-03
17	17	2.071103E-02	1.439133E-01	2.290451E-02	1.000000E+00	2.071103E-02
18	18	3.299847E-02	1.816548E-01	2.891126E-02	1.000000E+00	3.299847E-02
19	19	6.701340E-02	2.588695E-01	4.120035E-02	1.000000E+00	6.701340E-02
20	20	6.716394E-02	2.591601E-01	4.124660E-02	1.000000E+00	6.716394E-02
21	21	7.099716E-02	2.664529E-01	4.240730E-02	1.000000E+00	7.099716E-02
22	22	7.160546E-02	2.675920E-01	4.258858E-02	1.000000E+00	7.160546E-02
23	23	7.839783E-02	2.799961E-01	4.456276E-02	1.000000E+00	7.839783E-02
24	24	9.186188E-02	3.030873E-01	4.823783E-02	1.000000E+00	9.186188E-02
25	25	2.565429E-01	5.065007E-01	8.061208E-02	1.000000E+00	2.565429E-01

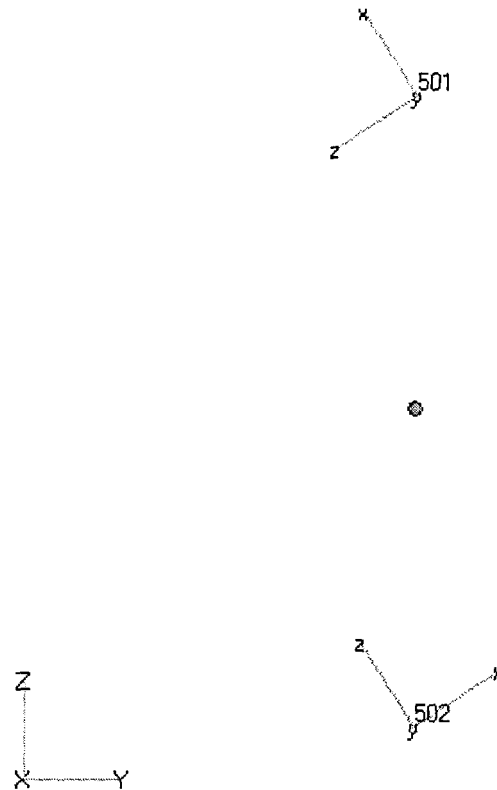


Figure D.5: Orientation of Upper and Lower Clamshells in
NASTRAN Verification Runs:

Contract No: NAS8-00151

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15. Supplementary Notes					
16. Abstract: Orbiting space solar power systems are currently being investigated for possible flight in the time frame of 2015-2020 and later. Such space solar power (SSP) satellites are required to be extremely large in order to make practical the process of collection, conversion to microwave radiation, and reconversion to electrical power at earth stations or at remote locations in space. These large structures are expected to be very flexible presenting unique problems associated with their dynamics and control. The purpose of this project is to apply the expanded TREETOPS multi-body dynamics analysis computer simulation program (with expanded capabilities developed in the previous activity) to investigate the control problems associated with the integrated symmetrical concentrator (ISC) conceptual SSP system. SSP satellites are, as noted, large orbital systems having many bodies (perhaps hundreds) with flexible arrays operating in an orbiting environment where the non-uniform gravitational forces may be the major load producers on the structure so that a high fidelity gravity model is required. The current activity arises from our NRA8-23 SERT proposal (submitted 5-99). Funding, as a supplemental selection, has been provided by NASA with reduced scope from that originally proposed.					
17. Key Words (Suggested by Author(s) Dynamics, Control, Analysis, Simulation, Space Solar Power, Flexibility, Structures, Treetops, Nastran, Multi-body, Modeling				18. Distribution Statement NASA/MSFC Attn: Dr. Connie Carrington Marshall Space Flight Center, AL 35812	
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