DETERMINATION & CONTROL OF OPTICAL & X-RAY WAVE FRONTS
Final Report

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1. SUMMARY

A successful design of a space-based or ground-based optical system requires an iterative procedure which includes the kinematics and dynamics of the system in operating environment, control synthesis and verification. Most optical systems are comprised of an arbitrary topology of multi-bodies that could yield undesirable vibration due to disturbances that could deteriorate the performance of the optical system. Therefore, the control system must interact favorably to suppress these disturbances using active controllers and/or damping devices. The favorable interaction of an optical system is determined by the accurate mathematical dynamics model of the mechanical system, and the subsequent control synthesis and performance analysis. However, the conventional modeling and dynamic simulation, obtained by deriving equations of motion of the multi-body optical system is very time-consuming and can be a difficult job for each optical system design project. Once the dynamic characteristics of the optical system are known, the control system must be designed to satisfy the performance requirement of the optical system. Iterative modification of the dynamics and control system, numerical simulation, and performance verification are needed. Therefore, under this NASA contract, a multi-discipline dynamics and control tool has been developed for work-stations of the Control Division to facilitate the task of designing optical wave front control systems for NASA/MSFC.

This multi-discipline dynamics and control tool utilizes TREETOPS, NASTRAN, and MATLAB. TREETOPS is a simulation program for analysis of the dynamics and control-related issues of multi-body structural system developed by Dynacs, Inc. with NASA sponsor. Modal data for flexible bodies may be determined from NASTRAN using a DMAP sequence to interface with a TREETOPS model. Single-precision of TREETOPS codes were converted into double-precision codes and implemented on Unix work-stations and PC Windows machines. Post-processing MATLAB files were written to interface the numerical results obtained from TREETOPS to commercial version of MATLAB. This tool has been used for mathematical modeling and dynamics and control simulation to support such projects as Advanced X-Ray Astrophysics Facility (AXAF), Solar X-Ray Imager (SXI), Gravity Probe-B (GPB), Shooting Star Experiment (SSE), Suppression of Transient Acceleration By Levitation Evaluation (STABLE), and Active Rack Isolation System (ARIS).

To support the SXI project, a pointing accuracy and stability analysis of the SXI telescope with the interaction of the solar array of the GOES (Geostationary Operational Environmental Satellite) spacecraft was performed with three stepping (single, double, and quadruple stepping) methods for the Solar Array Drive Assembly (SADA). For the AXAF-I project, a preliminary TREETOPS dynamic model of AXAF-I that includes flexible solar arrays, Reaction Wheels (RW), and Reaction Wheel Isolator Assembly (RWIA) was developed to investigate the effect of the disturbance on RW with the

RWIA's fundamental rocking frequency on the AXAF-I pointing accuracy. For the STABLE and ARIS projects, detailed mathematical models were developed for TREETOPS simulation, and dynamics and control analysis were completed with cooperation of Dr. Jerry Nurre and Mr. Mark Whorton of NASA/MSFC. The description of TREETOPS dynamics and control models of STABLE and ARIS, and their simulation results are described in Section 2 and 3, respectively.

2. Control/Dynamics Simulation of STABLE System

2.1 Introduction

For several years, an extensive effort has been underway to develop isolation systems for μ-gravity science experiments. A joint effort by McDonnell Douglas Aerospace (MDA) and the Marshall Space Flight Center (MSFC) culminated in the design and flight test of the STABLE (Suppression of Transient Accelerations By Levitation Evaluation) system. STABLE was the first successful flight test of an active isolation device for μ-gravity science payloads and was flown on STS-73/USML-2 in October 1995 [1].

In order to verify the control system design and estimate on-orbit performance of the STABLE, a high fidelity, nonlinear, multi-body simulation was developed using TREETOPS [2]. This section describes the details of TREETOPS model of the STABLE dynamics and control system, and presents the results of the performance analysis of the STABLE system using TREETOPS simulation. For detailed information on the analytical formulation and modeling aspects of TREETOPS, the reader is referred to the user's guide [2].

2.2 Description of STABLE TREETOPS Simulation

STABLE is comprised of a mid-deck locker, an isolated platform on which a thermal fluid convection experiment is mounted on, three actuator assemblies, nine acceleration sensors, three position sensors, and associated electronics and control boards. The configuration of STABLE hardware, successfully flown on STS-73, is shown in Figure 2.2-1 [1]. The platform is suspended from the base of locker box by three electromagnetic actuators developed by MDA. The flexible umbilical cables that provide power and signal lines to the components on the platform are the only mechanical connection between the floater and the base.

The actuator is composed of a passive permanent magnet that is attached to the platform and a coil assembly that is rigidly bolted to the base. The coil assembly contains two independent coils such that when a current is passed through them two independent orthogonal forces are produced in the plane normal to the field lines of the permanent magnet. Six accelerometers are used to sense the isolated platform motion. The accelerometers are mounted in pairs on each of the three actuator mounting brackets and oriented to measure acceleration along the actuator force directions. Three additional accelerometers are mounted on the base and provide a measure of the base environment. The accelerometers used on both the platform and the base are the model QA-2000 made by Sunstrand. The STABLE system has three position sensors that measure the relative motion of the platform with respect to the base. Each of the three sensors measures position at its particular location in two orthogonal axes. It is composed of a laser illuminator, mounted on the platform, that projects a laser image across the rattle space onto a photo-resistive detector fixed to the base. The position of the platform with respect to the base is determined by processing the signals from the detector which indicate the location of the laser image on the face of the detector.

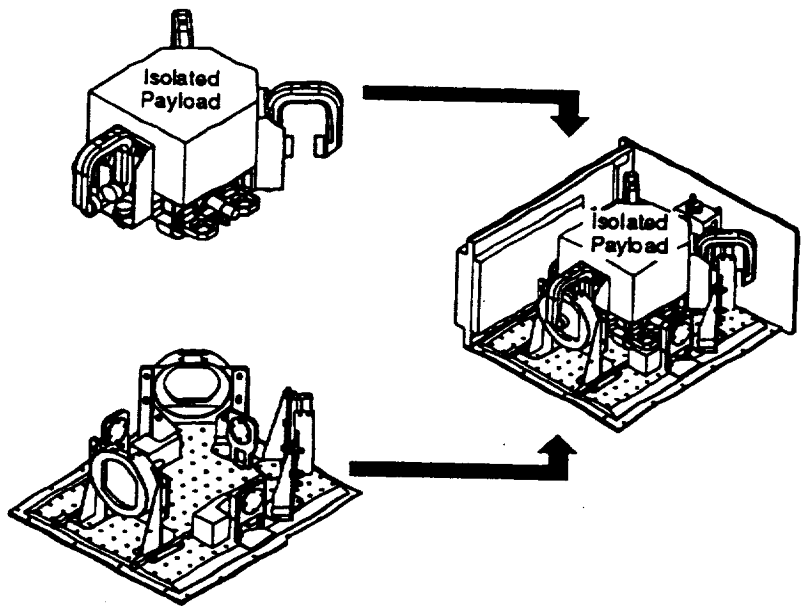

Figure 2.2-1: Configuration of STABLE Hardware

In order to verify the control system and estimate the performance of the STABLE in the orbital environment, a detailed structural and control model of the STABLE was developed for the TREETOPS. Since the platform of the STABLE is floating freely within the STABLE locker box that is rigidly attached to the space shuttle, the STABLE system was modeled as two rigid bodies (first body for the space shuttle and rigidly attached locker box and second body for the platform). The only physical connections between the platform and bases are the umbilical cables (that transfers data and power between the platform and base) which are modeled six degree of freedom (DOF) hinge connection with spring stiffness specified to match the dynamic properties of the umbilical cables.

The TREETOPS model of the STABLE system must accurately model of all of the actual flight hardware components (six actuators, six accelerometer sensors and six position sensors, and umbilicals) to precisely represent the flight STABLE system. The STABLE actuator that yields two orthogonal forces can be modeled using two TREETOPS JET actuators and each STABLE accelerometer sensor can be modeled using the TREETOPS ACCELEROMETER sensor. Actuator and sensor models are idealized and do not include high frequency dynamics. Since there is no built-in TREETOPS position sensor model that exactly corresponds to the STABLE position sensor, a mathematical position sensor model was developed using the built-in TREETOPS POSITION VECTOR sensor and

STAR sensor. This position sensor model was implemented in a user defined discrete controller subroutine and incorporated with main TREETOPS dynamics simulation. The convention of the local coordinates and locations of the actuators and sensors are shown in Figure 2.2-2. In this figure F_{ij}, A_{ij}, and e_{ij} denote *j*th force component of *i*th actuator, *j*th acceleration component of *i*th accelerometer, and *j*th position error component of *i*th position sensor, respectively. (1st, 2nd, and 3rd components stand for x, y and z axis components, respectively.)

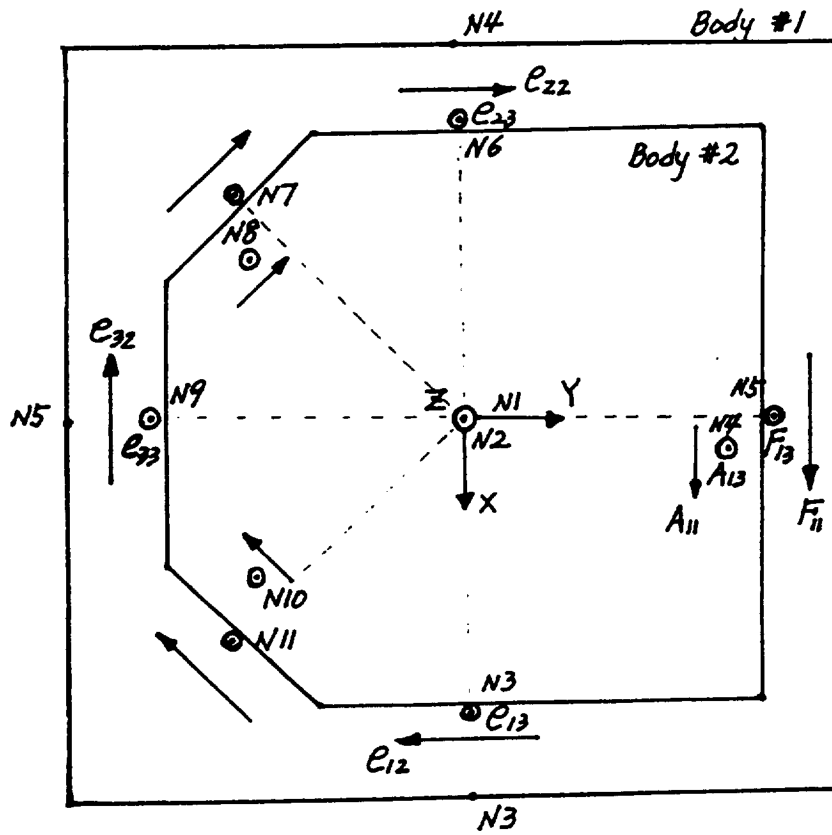

Figure 2.2-2: STABLE Coordinate Systems

With supplied mass properties (mass and moments of inertia) of two bodies and the locations of center of mass, actuators, accelerometers, position sensors, and umbilical cords connection, TREETOPS determines the kinematics and dynamics of the STABLE system. The fast continuous acceleration control loop was implemented in the STABLE TREETOPS model using the built-in TREETOPS continuous block diagram controller and the slow digital position control loop was implemented in the STABLE TREETOPS model using a user defined discrete controller subroutine.

2.2.1 STABLE Structural Model

The STABLE system including the space shuttle was modeled as two rigid bodies dynamics system connected by linear and nonlinear quadratic springs. Since the objective of the STABLE controller is to achieve the good attenuation of acceleration disturbance from the locker box to the platform of the STABLE, the space shuttle and attached locker box was modeled as one arbitrary rigid body that gives a disturbance to the STABLE platform through umbilical cables.

According to the TREETOPS tree topology, the space shuttle and attached locker box is defined by Body #1 and linked by Hinge #1 with six degrees of freedom (three rotational and three translational) with respect to the origin of the inertial coordinate system. The platform floating inside the locker box is defined by Body #2 and connected to Body #1 through Hinge #2 with six D.O.F. The umbilical connection between the platform and locker box are modeled as the combination of six linear spring devices and two quadratic spring devices with a 10 meter undeformed length.

For Body #1, twelve nodal points are chosen to represent the center of mass, origin of local coordinate system of Body #1, three position sensor detector attaching points, one corresponding point to the center of mass of the Body #2, and six umbilical cords attaching points. For Body #2, sixteen nodal points are chosen to represent the center of mass, origin of local coordinate system of Body #2, three actuator attaching points, six accelerometer attaching points, three position sensor laser attaching points, and two umbilical attaching points. Table 2.2.1-1 summarized the nodes of Body #1 (for example, B1N2 denotes node #2 of Body #1). And the nodes of Body #2 are summarized in Table 2.2.1-2 (for example, B2N2 denotes node #2 of Body #2).

Table 2.2.1-1: Nodes Definition of TREETOPS STABLE Body #1

Node	Description	Location in body coordinates (meter)
B1N1	C.M. of Body #1	(0,0,0.02)
B1N2	Origin of Body #1 coordinate	(0,0,0)
B1N3	Position sensor laser #1	(0.1537,0,0)
B1N4	Position sensor laser #2	(-0.1537,0,0)
B1N5	Position sensor laser #3	(0,-0.1537,0)
B1N6	C.M. of Body #2	(0.004,-0.02,0.067)
B1N7	X umbilical #1	(10.0686,-0.0787,-0.0205)
B1N8	Y umbilical #1	(0.0686,9.9213,-0.0205)
B1N9	Z umbilical #1	(0.0686,-0.0787,9.9795)
B1N10	X umbilical #2	(9.9314,-0.0787,-0.0205)
B1N11	Y umbilical #2	(-0.0686,9.9213,-0.0205
B1N12	Z umbilical #2	(-0.0686,-0.0787,9.9795)

Table 2.2.1-2: Nodes Definition of TREETOPS STABLE Body #2

Node	Description	Location in body coordinates (meter)
B2N1	C.M. of Body #2	(0.004,-0.020,0.067)
B2N2	Origin of Body #2 coordinate	(0,0,0)
B2N3	Position detector #1	(0.139,0,0)
B2N4	Accelerometer #1	(0.0411,0.0942,0.0754)
B2N5	Actuator #1	(0,0.1433,0.0423)
B2N6	Position detector #2	(-0.139,0,0)
B2N7	Actuator #2	(-0.1218,-0.1735,0.0423)
B2N8	Accelerometer #3	(-0.0582,-0.1696,0.0754)
B2N9	Position detector #3	(0,-0.139,0)
B2N10	Accelerometer #5	(0.0582,-0.1696,0.0754)
B2N11	Actuator #3	(0.1218,-0.1735,0.0423)
B2N12	Umbilical #1	(0.0686,-0.787,-0.0205)
B2N13	Umbilical #2	(-0.0686,-0.787,-0.0205)
B2N14	Accelerometer #2	(0,0.0942,-0.0206)
B2N15	Accelerometer #4	(-0.0918,-0.1388,-0.0206)
B2N16	Accelerometer #6	(0.0918,-0.1388,-0.0206)

The definitions of all hinges of STABLE TREETOPS model are summarized in Table 2.2.1-3.

Table 2.2.1-3: Hinges Definition of STABLE TREETOPS Model

Hinge	Connecting nodes	No. of DOF	L1_in - L1_out	L3_in - L3_out
1	B0N0 - B1N2	3RDOF, 3TDOF	(1,0,0) - (1,0,0)	(0,0,1) - (0,0,1)
2	B1N6 - B2N1	3RDOF, 3TDOF	(1,0,0) - (1,0,0)	(0,0,1) - (0,0,1)

2.2.2 STABLE Sensors Model

STABLE has six QA-2000 accelerometers on the floating platform to measure acceleration at the attached nodes. This accelerometer was modeled as TREETOPS ACCELEROMETER (AC) sensor that measures the acceleration of body at the specified node to the specified direction. Therefore, six AC sensors are attached on the nodes #4,8,10,14,15,16 of Body #2. STABLE has three position sensor assemblies to measure the relative position errors between the floating platform and locker base at three position sensor locations. The measured position errors are sent to the digital computer to compute the position error at the actuator gap, which is the input top the position control law. Each STABLE position sensor assembly consists of a laser attached on the platform and an image detector attached on the locker base. The image detector measures two orthogonal displacements projected on the detector by the laser.

Since there is no built-in TREETOPS sensor corresponding to the STABLE position sensor assembly, a mathematical model of corresponding position sensor assembly was developed using the TREETOPS POSITION VECTOR (P3) sensor and STAR (ST) sensor. For example, to model the STABLE position sensor assembly at #1 position, a P3 sensor is added on the laser location of the platform to measure three displacement components between the laser attached on the platform and the image detector attached on the locker base, *i.e.* (x_{p1}, y_{p1}, z_{p1}). Two ST sensors are also added at the laser location of the platform and the detector location of the locker base to measure two relative rotational angles of the laser with respect to the detector about *z* and *y* axis, *i.e.* $(\theta_{1z}, \theta_{1y})$. Then, the output of the TREETOPS position sensor #1 corresponding to the STABLE position sensor assembly #1 can be given by

$$y_1 = -y_{p1} + |x_{p1}| * \tan\theta_{1z} \qquad (2.2.2\text{-}1)$$

$$z_1 = z_{p1} - |x_{p1}| * \tan\theta_{1y} \qquad (2.2.2\text{-}2)$$

Similarly, the outputs of the TREETOPS STABLE position sensor #2 and #3 can be given by

$$y_2 = y_{p2} - |x_{p2}| * \tan\theta_{2z} \qquad (2.2.2\text{-}3)$$

$$z_2 = z_{p2} - |x_{p2}| * \tan\theta_{2y} \qquad (2.2.2\text{-}4)$$

$$y_3 = -x_{p3} + |y_{p3}| * \tan\theta_{3z} \qquad (2.2.2\text{-}5)$$

$$z_3 = z_{p3} - |y_{p3}| * \tan\theta_{3x} \qquad (2.2.2\text{-}6)$$

Although not part of the STABLE flight hardware, for the purpose of performance evaluation, one P3 sensor is attached on the C.M. of Body #1 (B1N1) to measure the relative movement of the C.M. of the platform with respect to the locker base. Also, two IMU SENSOR (IM) sensors are used to measure the Euler angles of local frames of Bodies #1 and #2. These sensors are summarized in Table 2.2.2-1.

Table 2.2.2-1: Definition of TREETOPS STABLE Sensors Model

Sensor ID No. (Type)	Measurement Quantity	Location (Direction)
SE 101 (AC)	Acceleration #1	B2N4 (1,0,0)
SE 102 (AC)	Acceleration #2	B2N14 (0,0,1)
SE 201 (AC)	Acceleration #3	B2N8 (-0.707,0.707,0)
SE 202 (AC)	Acceleration #4	B2N15 (0,0,1)
SE 301 (AC)	Acceleration #5	B2N10 (-0.707,-0.707,0)
SE 302 (AC)	Acceleration #6	B2N16 (0,0,1)
SE 401 (ST)	θ_2 & θ_3 of laser #1	B2N3 (0,1,0) & (0,0,1)
SE 402 (ST)	θ_2 & θ_3 of detector #1	B1N3 (0,1,0) & (0,0,1)
SE 501 (ST)	θ_2 & θ_3 of laser #2	B2N6 (0,1,0) & (0,0,1)
SE 502 (ST)	θ_2 & θ_3 of detector #2	B1N4 (0,1,0) & (0,0,1)
SE 601 (ST)	θ_1 & θ_3 of laser #3	B2N6 (1,0,0) & (0,0,1)
SE 602 (ST)	θ_1 & θ_3 of detector #3	B1N4 (1,0,0) & (0,0,1)
SE 701 (P3)	x_{p1}, y_{p1}, z_{p1}	(B1N3)-(B2N3)
SE 801 (P3)	x_{p2}, y_{p2}, z_{p2}	(B1N4)-(B2N6)
SE 901 (P3)	x_{p3}, y_{p3}, z_{p3}	(B1N5)-(B2N9)
SE 911 (P3)	Relative movement of Body #2 C.M. w.r.t Body #1	(B1N6)-(B2N1)
SE 921 (P3)	Movement of Body #1 C.M.	(B1N6)-(B2N1)
SE 912 (IM)	Euler angles of Body #2 frame	B2N1
SE 922 (IM)	Euler angles of Body #1 frame	B1N2

2.2.3 STABLE Actuator Model

The STABLE has three MDA dual-axis actuators which generate two orthogonal and is modeled as two TREETOPS JET (J) actuators. The actuator applies a force at the node of the platform where the actuator is attached. Each JET actuator gives constant force that is defined using a FUNCTION GENERATOR (FU) at the specified node to the specified direction. Therefore, six JET actuators are attached on the nodes #5,7,11 of Body #2. For the purpose of performance analysis, disturbance can be given by applying force on the C.M. of Body # 1 using a separate JET actuator. These actuators are summarized in Table 2.2.3-1.

Table 2.2.3-1: Definition of TREETOPS STABLE Actuators Model

Actuator ID No. (Type)	Measurement Quantity	Location (Direction)
AC 101 (J)	Actuator force #1	B2N5 (1,0,0)
AC 102 (J)	Actuator force #2	B2N5 (0,0,1)
AC 201 (J)	Actuator force #3	B2N7 (-0.707,0.707,0)
AC 202 (J)	Actuator force #4	B2N7 (0,0,1)
AC 301 (J)	Actuator force #5	B2N11 (-0.707,-0.707,0)
AC 302 (J)	Actuator force #6	B2N11 (0,0,1)

2.2.4 STABLE Controller Implementation

The high performance characteristics of the isolator are the result of active feedback loops involving actuators, sensors, and electronics. The STABLE controls the platform by means of six independent control channels, one for each actuator force direction. Each STABLE control channel consists of one fast inner acceleration control loop and one slow outer position control loop.

The inner loop is the acceleration controller with a nominal control bandwidth of 50 Hz. This fast inner acceleration control loop attempts to cancel the measured acceleration measured by generating a force command to the corresponding actuator force axis based on the designed analog control law. The performance of this loop is limited by its bandwidth, accelerometer noise and resolution, and the nature of the disturbance coming from the base through the umbilicals. The outer loop is the very low bandwidth position controller, which is designed to keep the platform centered, countering the effects of constant and very low frequency disturbances for which for which the rattle space is not adequate. Since the position sensors are not located with coincident with the accelerometers, they do not provide a direct measure of displacement at the point of application of the control force, and additional computations are performed in the digital processor to determine the displacement at the actuator gap. Once computed they are passed onto the position controller, also in the digital processor, which calculates acceleration commands for the platform. These are summed with the accelerometer signals and form the input to the acceleration loop control law.

In order to implement this STABLE controller in the TREETOPS dynamics model, three TREETOPS control modules (CBDC, USDC, USCC) were used. The inner acceleration controller loop was modeled using CBDC (Continuos Block Diagram Controller) and the outer position controller loop was modeled using USDC (User Defined Discrete Controller) subroutine. USCC (User Defined Continuous Controller) subroutine was used to connect the inner acceleration controller loop and the outer position controller loop.

USCC and USDC subroutines are attached in Appendix A. The hierarchy of STABLE TREETOPS dynamics and control system is shown in Figure 2.2.4-1.

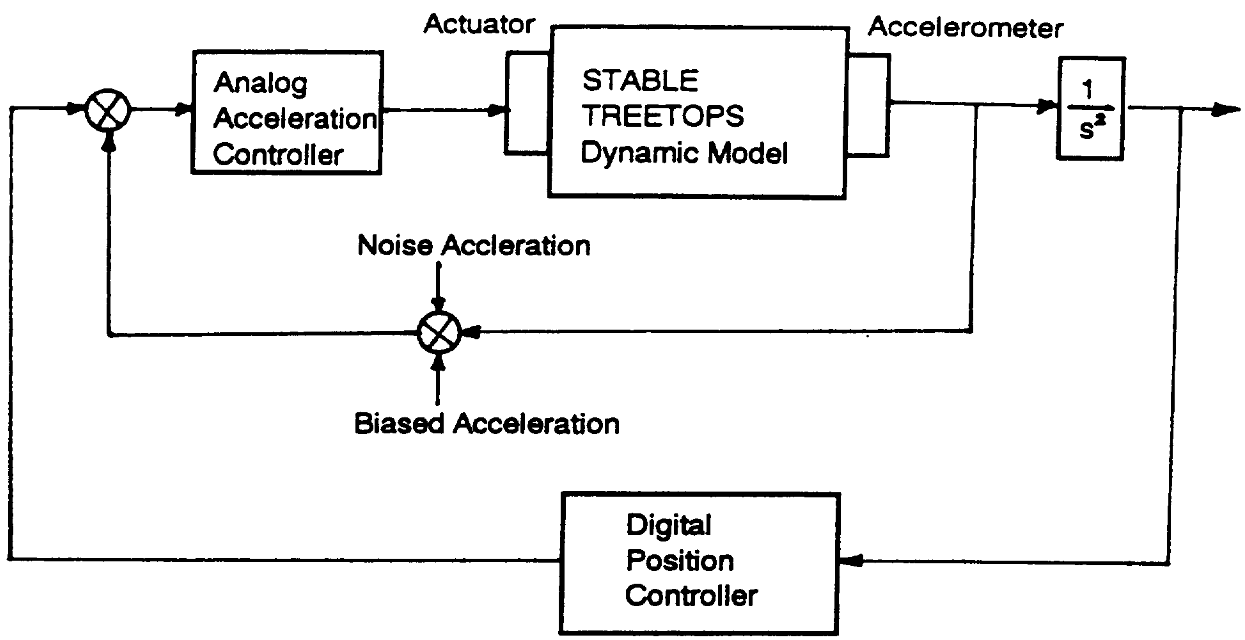

Figure 2.2.4-1: STABLE TREETOPS Dynamics and Control Model Layout

2.2.4.1 Position Control Loop

The position loop is a digital PID controller which uses position measurements to compute the position of the actuator with respect to a nominal centered position. Since the position sensors are coincident with the actuators, they do not provide a direct measure of displacement in the input axis of the accelerometer, and additional computations are performed in the digital processor to determine the position errors at the actuator gap. Once computed they are passed to the position controller, also in the digital processor, which calculates acceleration commands to each actuator. These are summed with the accelerometer signals and form the input to the acceleration loop control law.

The position controller operates in two modes. While the gap position error is small, a set of low PID gains are used so as to provide a very small restoring force which will not violate the acceleration requirements. If the gap error becomes large, a set of high gains will be used which effectively increases the spring constant of the control law to keep the platform from contacting the mechanical stops.

Figure 2.2.4.1-1 illustrates the logic employed for mode selection. Given the set of position error measurements, the high or low gain mode is determined by checking the magnitude of each error δ_i $(i = 1,\cdots,6)$, for all 6 channels as follows:

- If during the previous sample period the high gain mode was in effect and the magnitude of any δ_i is less than RL, switch to low gain mode.
- If during the previous sample period the low gain mode was in effect and the magnitude of any δ_i is greater than RH, switch to high gain mode.

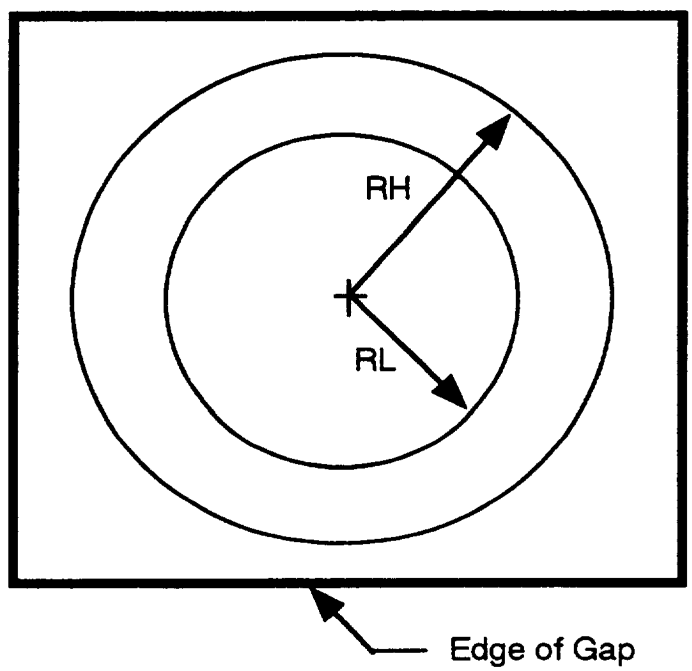

Figure 2.2.4.1-1: Mode Switch Regions for Position Controller

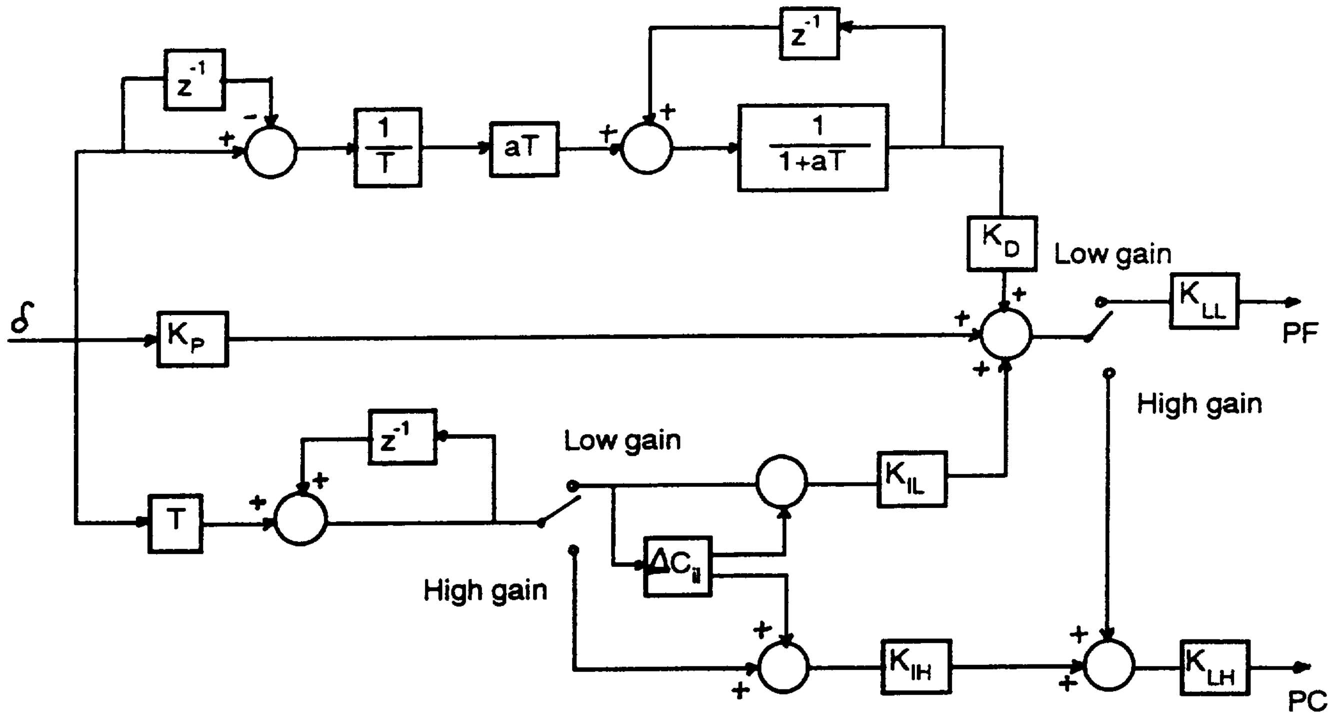

Figure 2.2.4.1-2: Block Diagram of The STABLE Digital Position Control Law

Figure 2.2.4.1-2 is a block diagram of the STABLE digital position control law. The gap error signal is input, which is passed through proportional, derivative, and integral channels. Two D/A converters with different resolutions are used for the output. Fine resolution output signals are sent through a 12 bit D/A convert with a resolution of 0.1 micro-g (200 micro-g full-scale) and coarse output signals use a larger range 12 bit D/A converter with a 10 micro-g resolution (20,000 micro-g full-scale). The derivative channel is low pass filtered to reduce high frequency noise generated by differentiation. Logic is employed in the integral channel to reduce the excess that may be present due to build up of large errors. While in low gain mode the integral channel signal may become larger than can be adequately dealt with by the fine resolution output D/A converter, and thus the channel may be incrementally unloaded through the coarse channel D/A converter. The integral channel signal is compared with a maximum allowable value and if the signal is too large, an integer multiple of the coarse D/A converter least significant bit (10 micro-g) is subtracted from the fine channel and added to the coarse channel output. The integral channel for both fine and coarse outputs are checked for saturation prior to summing with other signals.

The STABLE position PID controller was implemented in the TREETOPS STABLE model using a USDC (User Defined Discrete Controller) attached on Appendix A. This USDC routine generates the acceleration command based on position error and prints out the intermediate results for the purpose of performance analysis. This routine also provides a procedure that determine the output of the TREETOPS position sensor model corresponding to the STABLE position sensor assembly using equations 2.2.2-1 through 2.2.2-6. The displacements of the platform C.M. ($x_{cg}, y_{cg}, z_{cg}, \theta_{x_{cg}}, \theta_{y_{cg}}, \theta_{z_{cg}}$) may be determined using the following relationship between the outputs of STABLE position sensors and the displacements of the platform C.M. derived in Reference [3].

$$\theta_{z_{cg}} = -(y_1 + y_2)/(2*(s+d)) \qquad (2.2.4.1\text{-}1)$$

$$\theta_{y_{cg}} = -(z_1 - z_2)/(2*(s+d)) \qquad (2.2.4.1\text{-}2)$$

$$\Gamma_1 = -z_3 + (z_1 + z_2)/2 + y_3*\theta_{y_{cg}} - r_3*\theta_{y_{cg}}{}^2 + (s_3 + d + r_2)*\theta_{y_{cg}}*\theta_{z_{cg}}$$

$$\Gamma_2 = (y_2 - y_1)/2 + r_1*\theta_{z_{cg}} + \theta_{z_{cg}}*(-y_3 + r_3*\theta_{y_{cg}} - (s_3 + d + r_2)*\theta_{z_{cg}})$$

$$\Lambda_1 = 1 + \theta_{z_{cg}}{}^2$$

$$\Lambda_2 = (s_3 + d)*\Lambda_1 + r_3*\theta_{y_{cg}}*\theta_{z_{cg}} - \Gamma_2$$

$$\Lambda_3 = r_3*\Gamma_1 - \Gamma_2*(s_3 + d)$$

$$y_{cg} = (-\Lambda_2 + \sqrt{\Lambda_2^2 - 4*\Lambda_1*\Lambda_3})/(2*\Lambda_1) \qquad (2.2.4.1\text{-}3)$$

$$x_{cg} = -y_3 + r_3*\theta_{y_{cg}} - (s_3 + d + r_2)*\theta_{z_{cg}} - y_{cg}*\theta_{z_{cg}} \qquad (2.2.4.1\text{-}4)$$

$$\theta_{x_{cg}} = (\Gamma_1 + \theta_{y_{cg}}*\theta_{z_{cg}}*y_{cg})/(s_3 + d + y_{cg}) \qquad (2.2.4.1\text{-}5)$$

$$z_{cg} = (z_1 + z_2)/2 + r_2*\theta_{x_{cg}} - r_1*\theta_{y_{cg}} - \theta_{x_{cg}}*\theta_{y_{cg}} \qquad (2.2.4.1\text{-}6)$$

The displacements at the actuator gap may be determined using the following relationship between the above displacements of the platform C.M. and the displacements at the actuator gap derived in [3].

$$\begin{bmatrix}\delta_1\\ \delta_2\\ \delta_3\\ \delta_4\\ \delta_5\\ \delta_6\end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & (R_{13}-r_3) & -(R_{12}-r_2) \\ 0 & 0 & 1 & -(R_{12}-r_2) & -(R_{11}-r_1) & 0 \\ -a & a & 0 & -a(R_{23}-r_3) & -a(R_{23}-r_3) & a(R_{21}-r_1+R_{22}-r_2) \\ 0 & 0 & 1 & (R_{22}-r_2) & -(R_{21}-r_1) & 0 \\ -a & -a & 0 & a(R_{33}-r_3) & -a(R_{33}-r_3) & a(R_{32}-r_2-R_{31}+r_1) \\ 0 & 0 & 1 & (R_{32}-r_2) & -(R_{31}-r_1) & 0 \end{bmatrix} \begin{bmatrix} x_{cg}\\ y_{cg}\\ z_{cg}\\ \theta_{x_{cg}}\\ \theta_{y_{cg}}\\ \theta_{z_{cg}}\end{bmatrix} \qquad (2.2.4.1\text{-}7)$$

The discrete position control loop computes an acceleration command which will force the position error at the actuator gap to tend to zero.

2.2.4.2 Acceleration Control Loop

Prior to implementing the acceleration control law in CBDC, the USCC sets the control gain and performs part of the acceleration control law computation. Inputs to the USCC are the high or low gain flag (determined by the mode switching logic in the position control law), acceleration command from the position loop ($\ddot{x}_c$), and the measured acceleration ($\ddot{x}$). USCC is used to select and output the proper (high or low) acceleration control gain (K_a) and products ($K_a * \ddot{x}$) and ($K_a * \ddot{x}_c$). These quantities are output for use by CBDC. (In the flight system, the acceleration command and measurement are summed to form the error signal which is multiplied by the acceleration gain and process by analog acceleration control law. To realize this operation in TREETOPS controller block structure, the gain is multiplied by acceleration command and measurement prior to summation.)

The STABLE inner acceleration controller has six independent channels for six actuator forces and is modeled using TREETOPS CBDC (Continuos Block Diagram Controller). The STABLE employs an analog Single-Input/Single-output acceleration control architecture. Based on the collocated acceleration measurement, a control force is computed to reduce the inertial motion of the platform. Each channel has the same control law and continuously determines control force to compensate acceleration error at the actuator attaching point. CBDC generates a control force for each actuator force direction by summing the outputs of USCC ($K_a * \ddot{x}$ and $K_a * \ddot{x}_c$) and processing the error signal by the transfer function representing the analog control circuitry.

For TREETOPS model total thirty inputs, six for each channel, are read into CBDC. The inputs of each channel are two FUNCTION GENERATORs (FU) that provide a dc bias and white noise acceleration component, an acceleration measured by AC sensor, and two outputs of USCC, $K_a * \ddot{x}$ and $K_a * \ddot{x}_c$. CBDC generates a control force for each actuator output direction by computing ($-K_a * \ddot{x} - K_a * \ddot{x}_c$) and processing the error signal by the transfer function representing the analog control circuitry. This CBDC generates twelve outputs, two for each channel; the actuator control force and the total acceleration from acceleration control loop.

2.3 STABLE Simulation Results

This subsection describes numerical results of STABLE stability and attenuation performance analysis obtained from TREETOPS simulation. The input file of STABLE TREETOPS simulation is attached in Appendix B. For the stability analysis two cases are considered: one is to check stability of the STABLE system by measuring the transient response of the platform with given initial movement of platform and the other is to check stability of the STABLE system by measuring the transient response of the platform with a given pulse-type disturbance on base. The attenuation performance analysis was done to determine the acceleration attenuation curve by measuring the acceleration at the platform C.M. due to the various frequencies of sinusoidal disturbances given to the base. Mass properties of the STABLE platform were described in Table 2.3-1.

Table 2.3-1: Mass Properties of The STABLE Platform

Mass (Kg)	12.646
$I_{xx}, I_{yy}, I_{zz}, I_{xy}, I_{xz}, I_{yz}$ $(Kg-m^2)$	0.167, 0.108, 0.179, 0, 0, 0

As explained in Section 2.2.1, the umbilicals are modeled as combinations of linear and quadratic spring devices. Based on the measured spring stiffness, the linear spring stiffness coefficients used for TREETOPS STABLE model are 18 N/m in the positive X-axis direction, 13.5 N/m in the positive Y-axis direction and 20 N/m in the positive Z-axis direction. The quadratic spring stiffness coefficient used for TREETOPS STABLE model is -672 N/m^2 to the positive Z-axis direction.

Final control parameters used for the acceleration controller and PID position controller of the flight STABLE system were determined through iterative design and performance simulation and summarized in the following Table 2.3-2.

Table 2.3-2: STABLE Control Parameters

Control Parameters	Low Gain Mode	High Gain Mode
K_A $(N*\sec^2/m)$	5.5e+4	5.5e+4
Lead-lag filter Transfer Function	$\frac{1}{10}\left(\frac{s+2\pi*10}{s+2\pi}\right)$	$\frac{1}{10}\left(\frac{s+2\pi*10}{s+2\pi}\right)$
K_D $(1/\sec)$	8.8e-2	2.
K_P $(1/\sec^2)$	4e-3	4e-1
K_I $(1/\sec^3)$	4e-5	4e-2
$Max.\, C_{il}$ (μg)	20	
RL (mm)	2	
RH (mm)		9
LSB (μg)	0.2	10
ΔC_{il} (μg)	10	
K_L	2	1
T_s	0.1	0.1
N_s		100

2.3.1 Stability Analysis Results

2.3.1.1 Transient Response Analysis with Initial Displacement

In order to investigate the stability of STABLE system with acceleration and position control, the STABLE platform was initially displaced from the nominal resting position by 10 *mm* in each axis direction. Biased acceleration and white noise are added to the accelerometer outputs to represent the hardware characteristics of the STABLE accelerometers. High gain mode was set initially and the transient response was then calculated from the TREETOPS simulation. The acceleration biases for the six accelerometers were chosen arbitrarily for this simulation as shown in Table 2.3.1.1-1.

Table 2.3.1.1-1: Acceleration Biases of Six Accelerometers

Acc. Bias	A11	A13	A21	A23	A31	A33
μg	105	-155	85	-125	25	115

The white noise acceleration were generated multiplying random number by the following transfer function and implemented into CBDC.

$$T_{wh} = \frac{K\omega_n^2(s+a)}{a(s^2+2\xi\omega_n s+\omega_n^2)}$$

where $K = 2\times10^{-5}\ m/\sec^2$, $a = 2\pi(20)\ rad/\sec$, $\omega_n = 2\pi(100)\ rad/\sec$ and $\xi = 0.85$.

Numerical simulation results of the STABLE transient response analysis are shown in Figures 2.31.1-1 through 2.3.1.1-7. The gains of PID controller were selected based on the switching logic and shown in Table 2.3-2.

Figure 2.3.1.1-1 shows the output of the six PID position controller's channels. A11, A21, A31 are accelerations parallel to the direction of accelerometers #1, #3, #5, respectively and A13, A23, A33 are Z-axis directional acceleration parallel to the direction of accelerometers #2, #4, #6, respectively. As shown in this figure, high gain loop was active first for about 40 seconds and when all six channels satisfied low gain criteria explained Section 2.2.4.1 for more than N_s sampling time period simultaneously, the position controller changed into low gain mode to get precise control of position. It should be noted that all six channels show outputs with opposite signs of the acceleration biases of accelerometers given in Table 2.3.1.1-1.

Each channel of the position controller has two output signals; coarse acceleration (PC) quantized with 10 μg least significant bits (LSB) and fine acceleration (PF) quantized with 1 μg LSB. Defining A_1 and A_2 be acceleration output without and with quantization, respectively, the equation of quantization may be given as follows.

$$A_2 = \text{int}\left[\left(|A_1| + \frac{LSB}{2}\right) / LSB\right] * LSB * sign(A_1)$$

The sum of PF and PC is the output of the PID position controller and is to fed back to the acceleration controller implemented in CBDC at every sampling time. These results are shown in Figure 2.3.1.1-2.

Detailed output of the sixth channel of position controller are presented in Figure 2.3.1.1-3. In this figure, the first row of plots show position error, position error rate, and integrated position error in the Z-axis direction at the gap of actuator #3. Multiplying these error signals by the PID gains given in Table 2.3-2 yields cp, cr, ci_low, and ci_high. The coarse acceleration output (PC) is the sum of cp, cr, and ci_high. The fine acceleration output (PF) is the sum of cp, cr, and ci_low. The last row of plots show indication of PID position high or low gain mode.

Figure 2.3.1.1-4 shows the outputs of six accelerometers. A11, A13, A21, A23, A31, A33 are the measured accelerations of the accelerometers #1, #2, #3, #4, #5, and #6, respectively. It is noted that the acceleration controller immediately senses abrupt changes of several hundreds of μg accelerations of STABLE motion, which is yielded by position controller command to move the STABLE platform from the initially displaced position to the nominal rest position, and reduces the acceleration levels to the given output noise level of accelerometer. Therefore, the acceleration controller is operating as designed.

Figure 2.3.1.1-5 shows the position errors measured by the STABLE position sensors described in Section 2.2.2. In Figure 2.3.1.1-5, Y1 and Z1, Y2 and Z2, and Y3 and Z3 are Y-axis and Z-axis directional position errors of the STABLE position sensors #1, #2, and #3, respectively. It is shown that PID position controller brings down position error of the STABLE platform from initial 10 *mm* to zero *mm* in a timely manner.

The controller position errors at the C.M. of the STABLE platform, shown in Figure 2.3.1.1-6, are calculated using Equation 2.2.4.1-1 through 2.2.4.1-6 together with the position errors measured by position sensors. To check the validity of Equations 2.2.4.1-1 through 2.2.4.1-6, the position errors at the C.M. of the STABLE platform were obtained from TREETOPS' built-in position sensor at the C.M. of STABLE platform and Hinge #1's output, and plotted using dotted line in Figure 2.3.1.1-6. These results confirm the validity of Equation 2.2.4.1-1 through 2.2.4.1-6 and the effectiveness of the STABLE PID position controller.

Figure 2.3.1.1-7 shows the position errors at the actuators' gap determined using Equation 2.2.4.1-7. In this figure, outer dotted lines denote RH ($\pm 9\,mm$) and inner dotted lines denote RL ($\pm 2\,mm$) ,and these results verify the switching logic for the high/low gains of the PID position controller explained in Section 2.2.4.1.

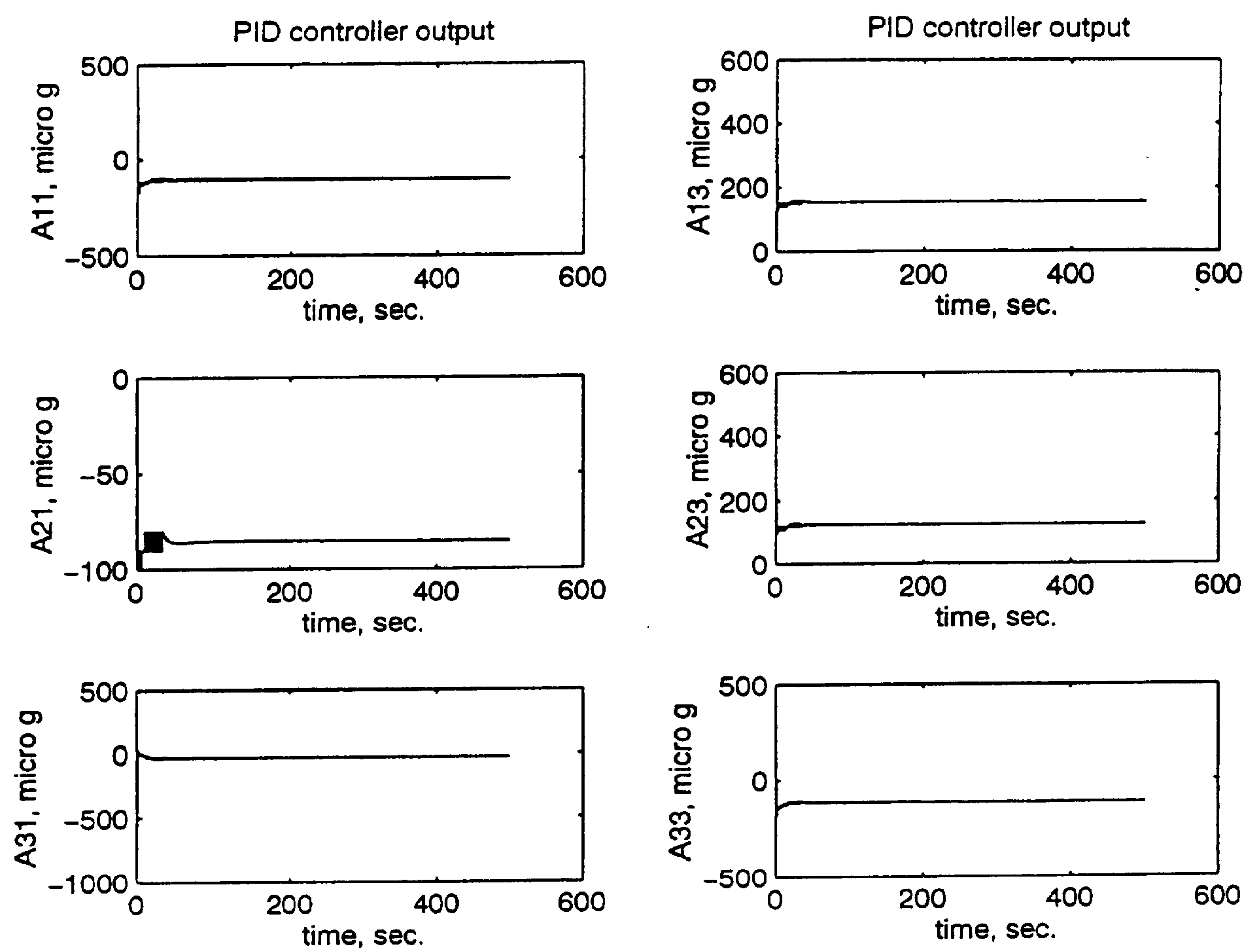

Figure 2.3.1.1-1: PID Position Controller Output with Initial Displacement

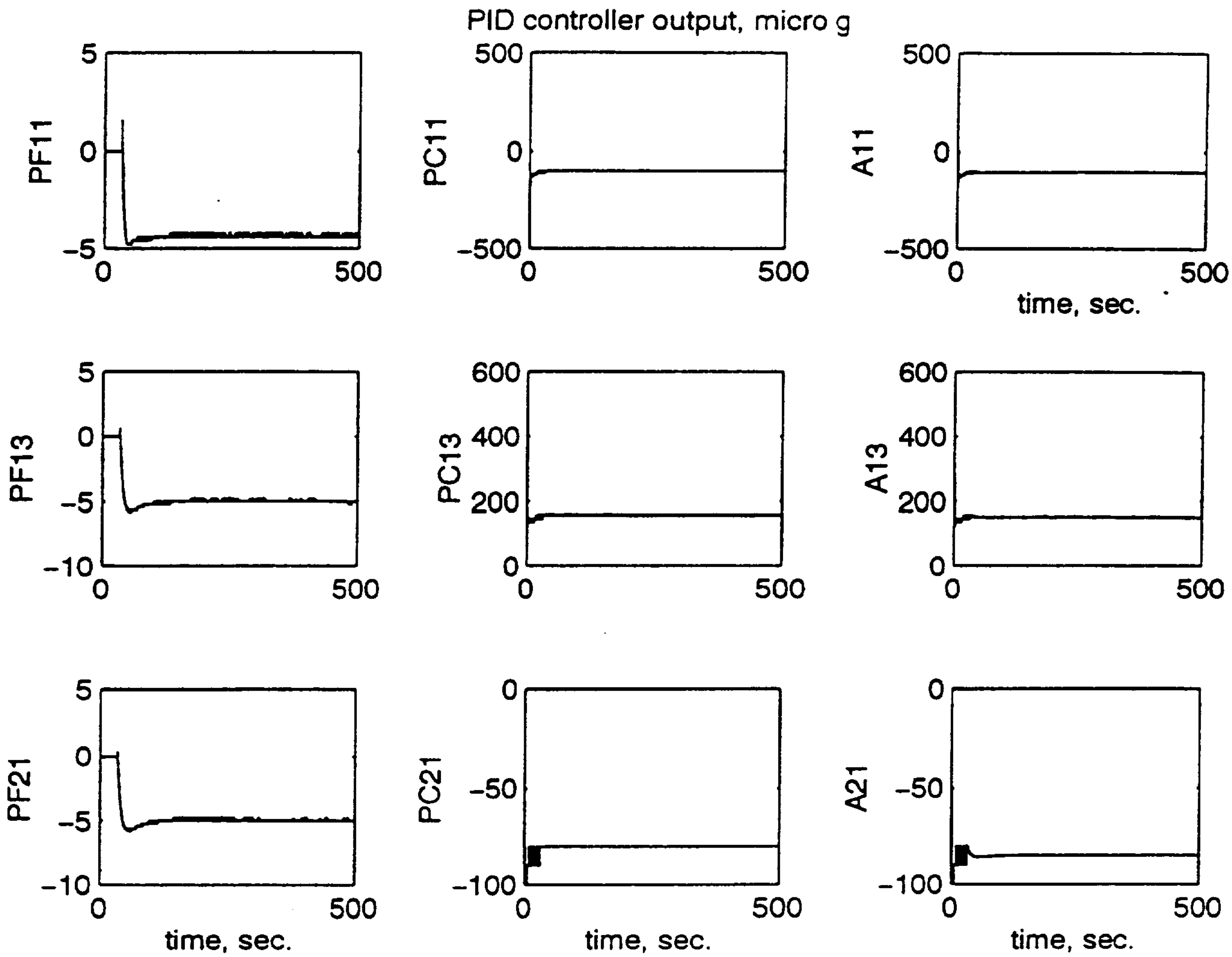

Figure 2.3.1.1-2: Detailed PID Position Controller Output with Initial Displacement

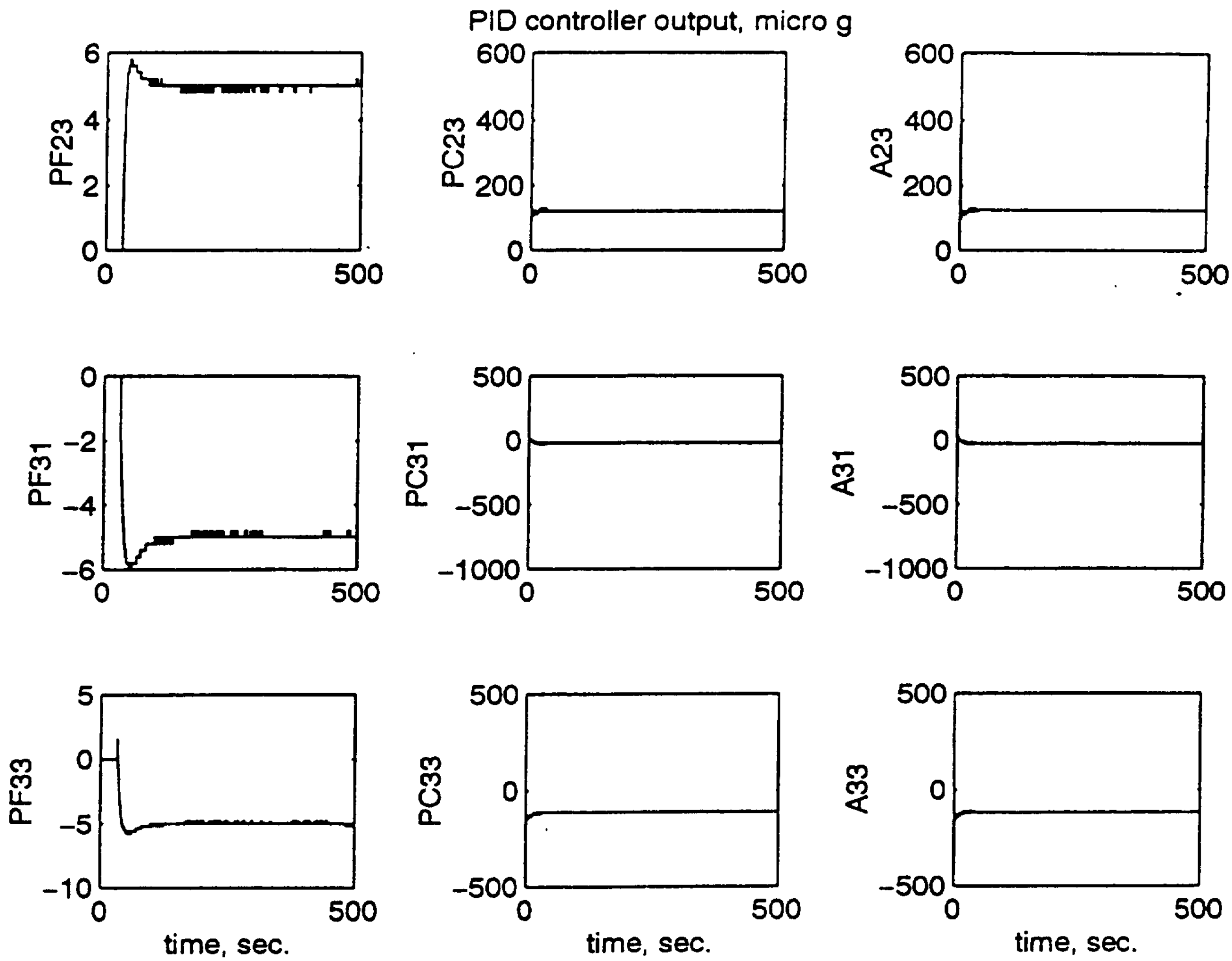

Figure 2.3.1.1-2 Continue: Detailed PID Position Controller Output
with Initial Displacement

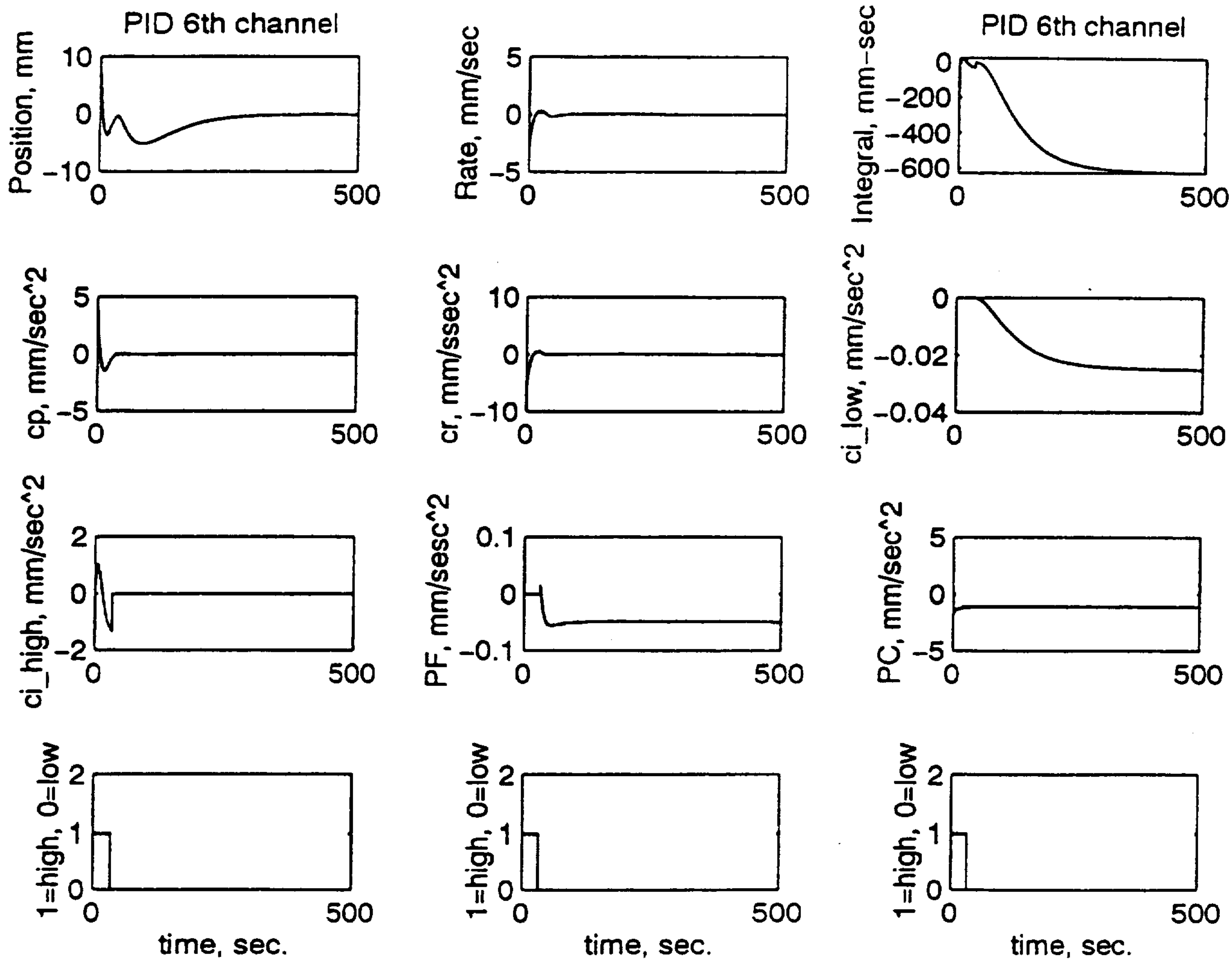

Figure 2.3.1.1-3: Detailed PID Position Controller Output of Sixth Channel with Initial Displacement

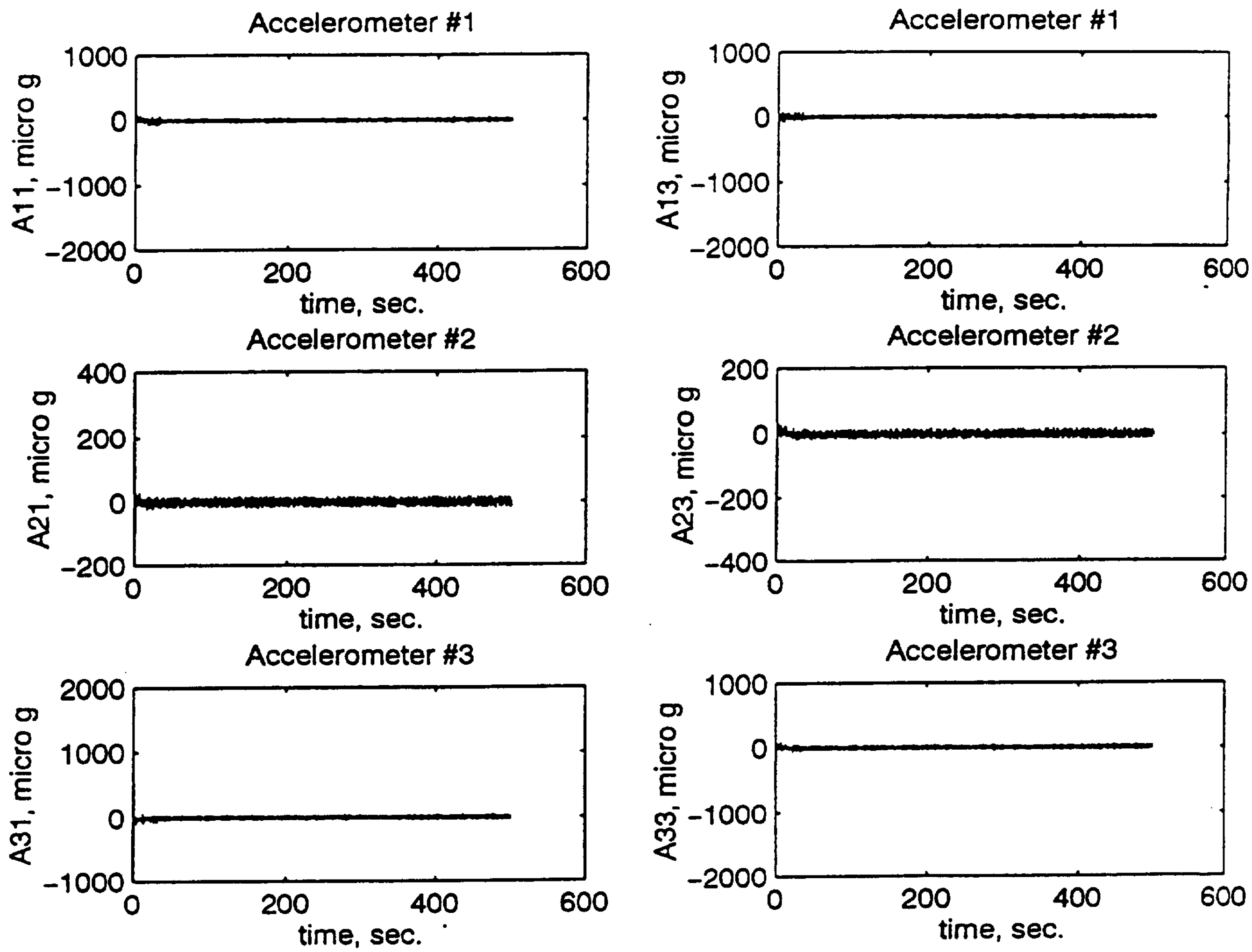

Figure 2.3.1.1-4: Output of Accelerometers with Initial Displacement

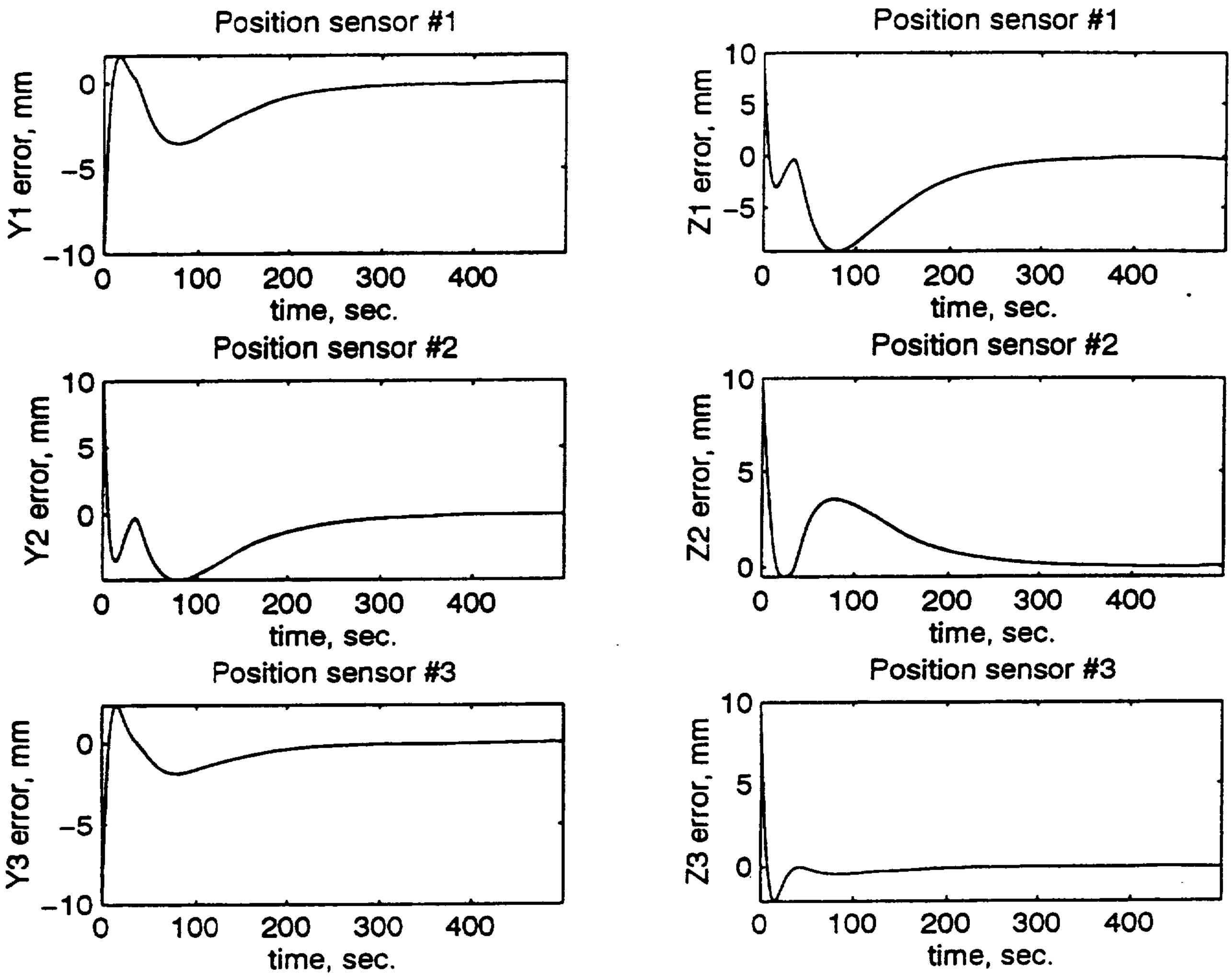

Figure 2.3.1.1-5: Output of Position Sensors with Initial Displacement

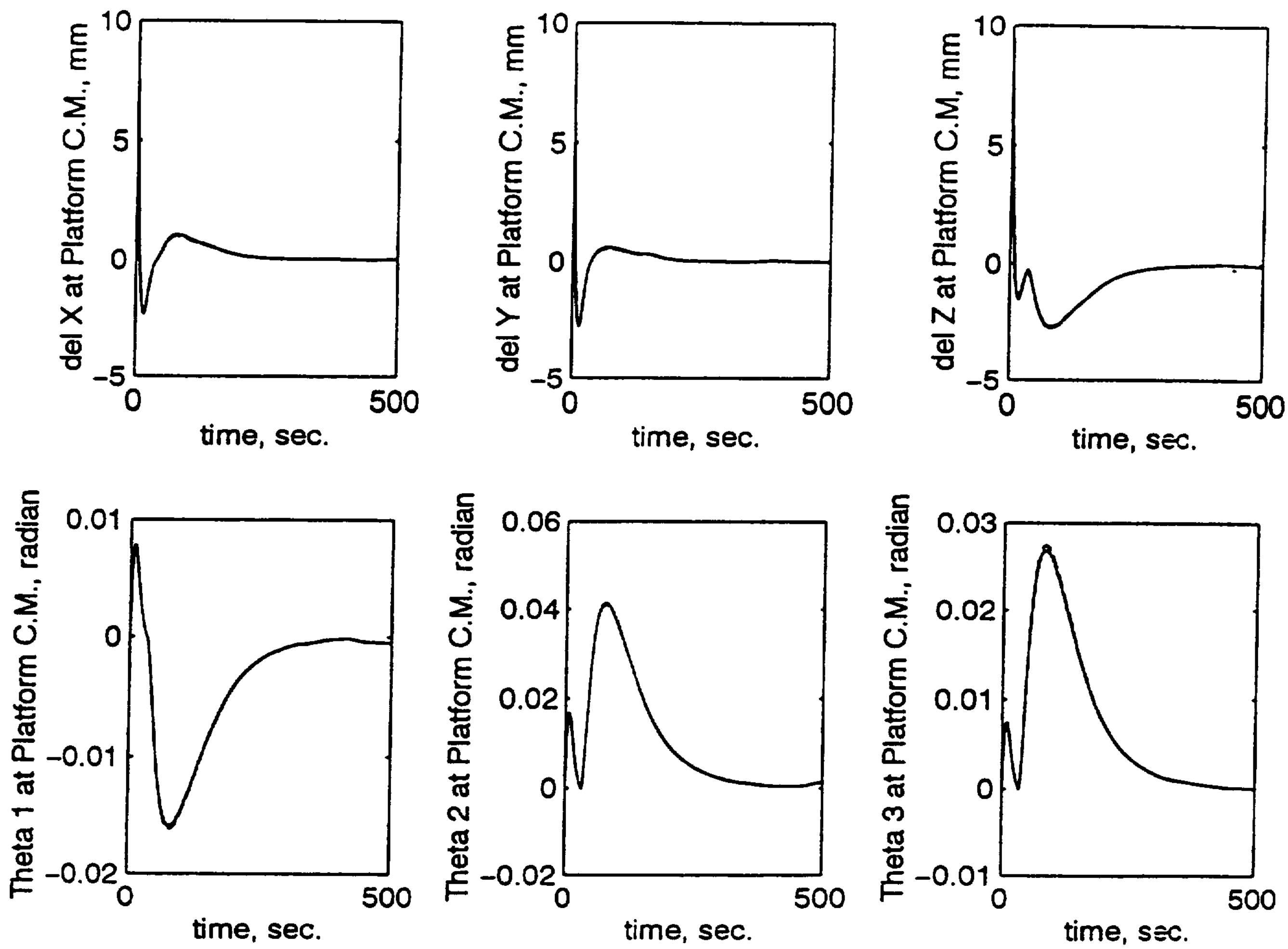

Figure 2.3.1.1-6: Position Error at the C.M. of STABLE Platform
with Initial Displacement

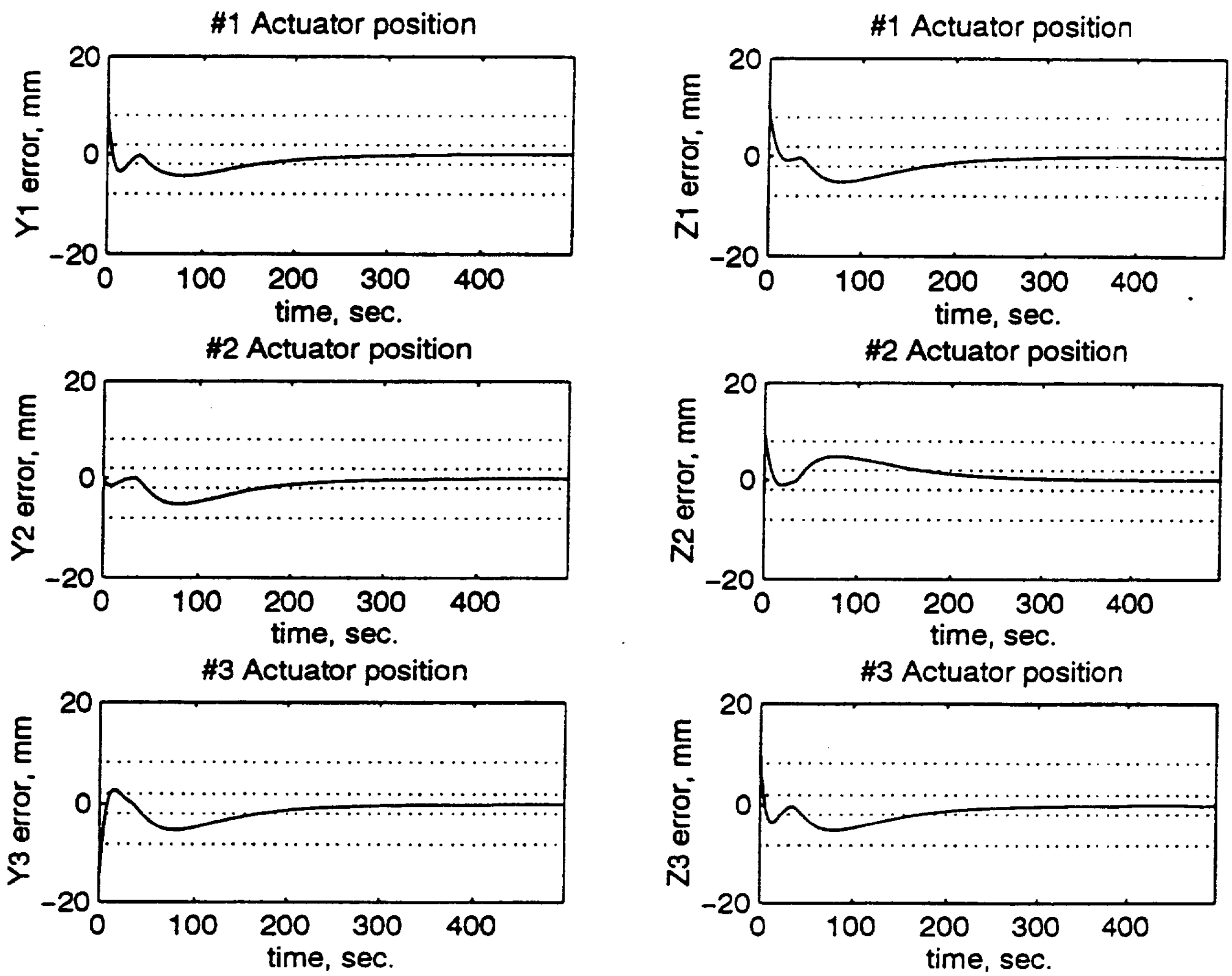

Figure 2.3.1.1-7: Position Error at the Center of Actuators Gap with Initial Displacement

2.3.1.2 Transient Response Analysis with Initial Excitation

In order to demonstrate how well the STABLE system can overcome sudden disturbance, a 1000 μg disturbance was given to the base to the Z-axis direction for 1 second, and then a transient response analysis was performed using input data Table 2.3-1 and 2.3-2 with initial low gain mode. The biased acceleration and white noise of the accelerometers used for this simulation are same as described in Section 2.3.1.1.

The numerical results of this transient response analysis are shown in Figures 2.3.1.2-1 through 2.3.1.2-7. Figures 2.3.1.2-1 and 2.3.1.2-2 show the output of the six PID position controller's channels with detailed output of sixth channel of position controller presented in Figure 2.3.1.2-3. Figure 2.3.1.2-4 shows the measurements of the reference six accelerometers. As shown in these figures, abrupt disturbance are sensed and the controller shifts from low gain mode into high gain mode immediately. The STABLE controller effectively responds to abrupt input accelerations and reduce the output jitter to the noise level acceleration of the accelerometers. It is also noted that the low gain mode may be recovered in about 40 seconds.

Figure 2.3.1.2-5 shows the position errors measured by the STABLE position sensors and the position errors at the C.M. of the STABLE platform are shown in Figure 2.3.1.2-6. Figure 2.3.1.2-7 shows the position errors at the actuators' gap.

2.3.2 Attenuation Performance Analysis

The main objective of the STABLE system is to provide a low acceleration environment across a broad spectrum of frequencies using an active isolation controller, the attenuation performance analysis of STABLE system was performed and its numerical results are presented in this section. The acceleration attenuation of STABLE system was estimated by measuring the accelerations at the platform C.M. for given sinusoidal disturbances of various magnitudes and frequencies. For this analysis the biased acceleration and white noise of accelerometers, and initial displacement are not included. The acceleration attenuation curve was determined by taking 20 times the base 10 logarithms of the ratio of accelerations at the platform C.M. to the given disturbance accelerations across the frequency range of 0.001 Hz through 100 Hz. Figure 2.3.2.-1 shows the calculated acceleration attenuation curve of STABLE system.

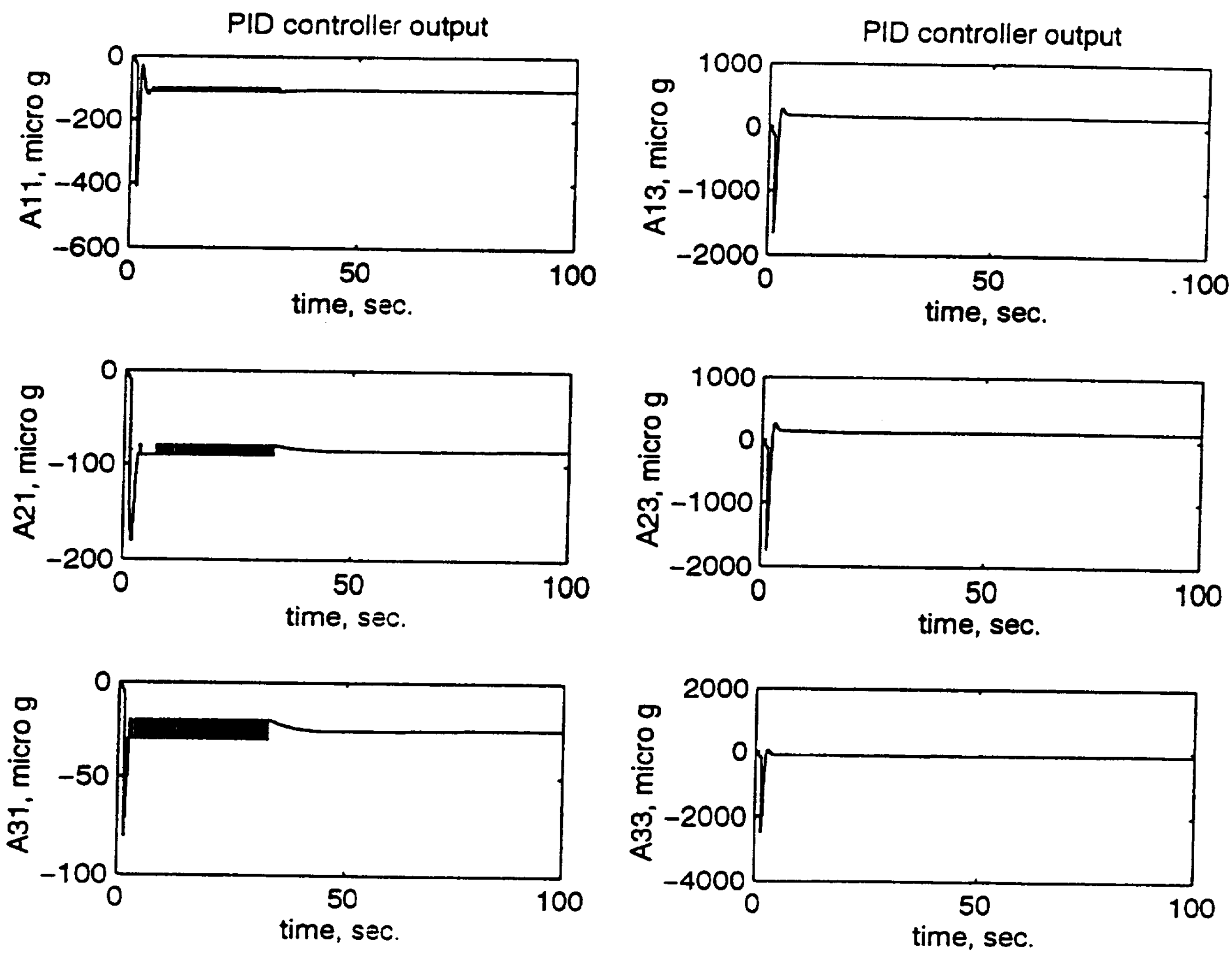

Figure 2.3.1.2-1: PID Position Controller Output with Initial Excitation

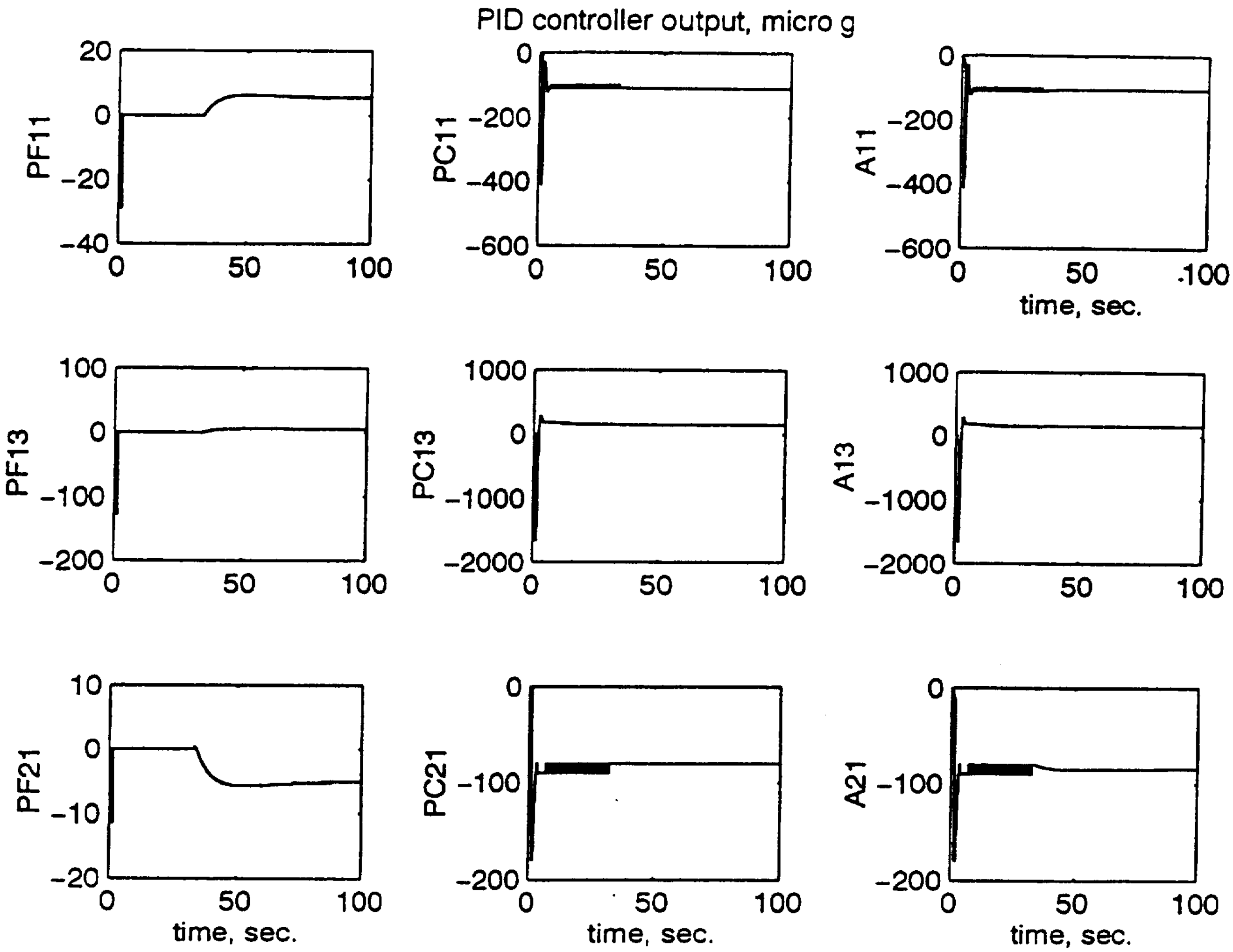

Figure 2.3.1.2-2: Detailed PID Position Controller Output with Initial Excitation

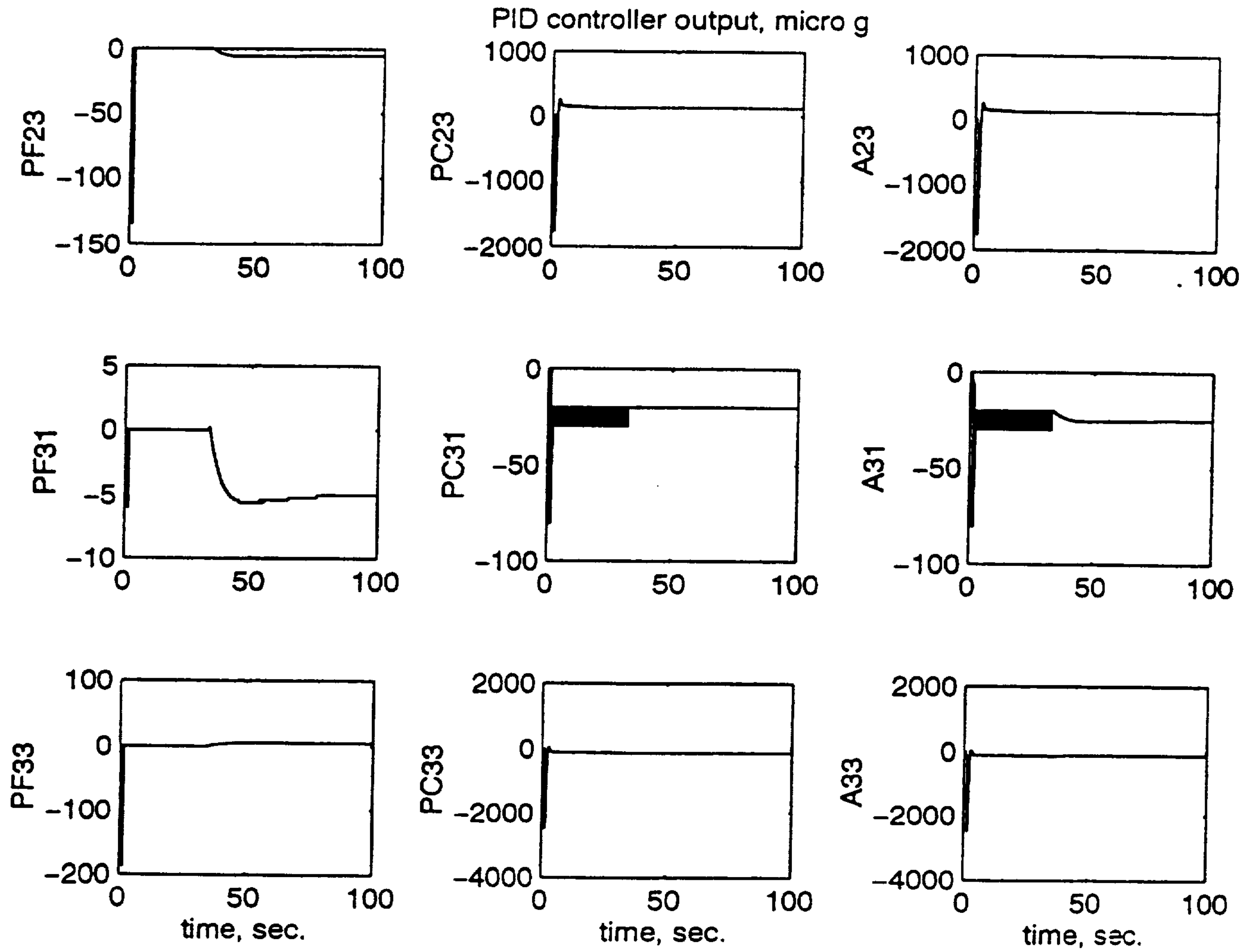

Figure 2.3.1.2-2 Continue: Detailed PID Position Controller Output
with Initial Excitation

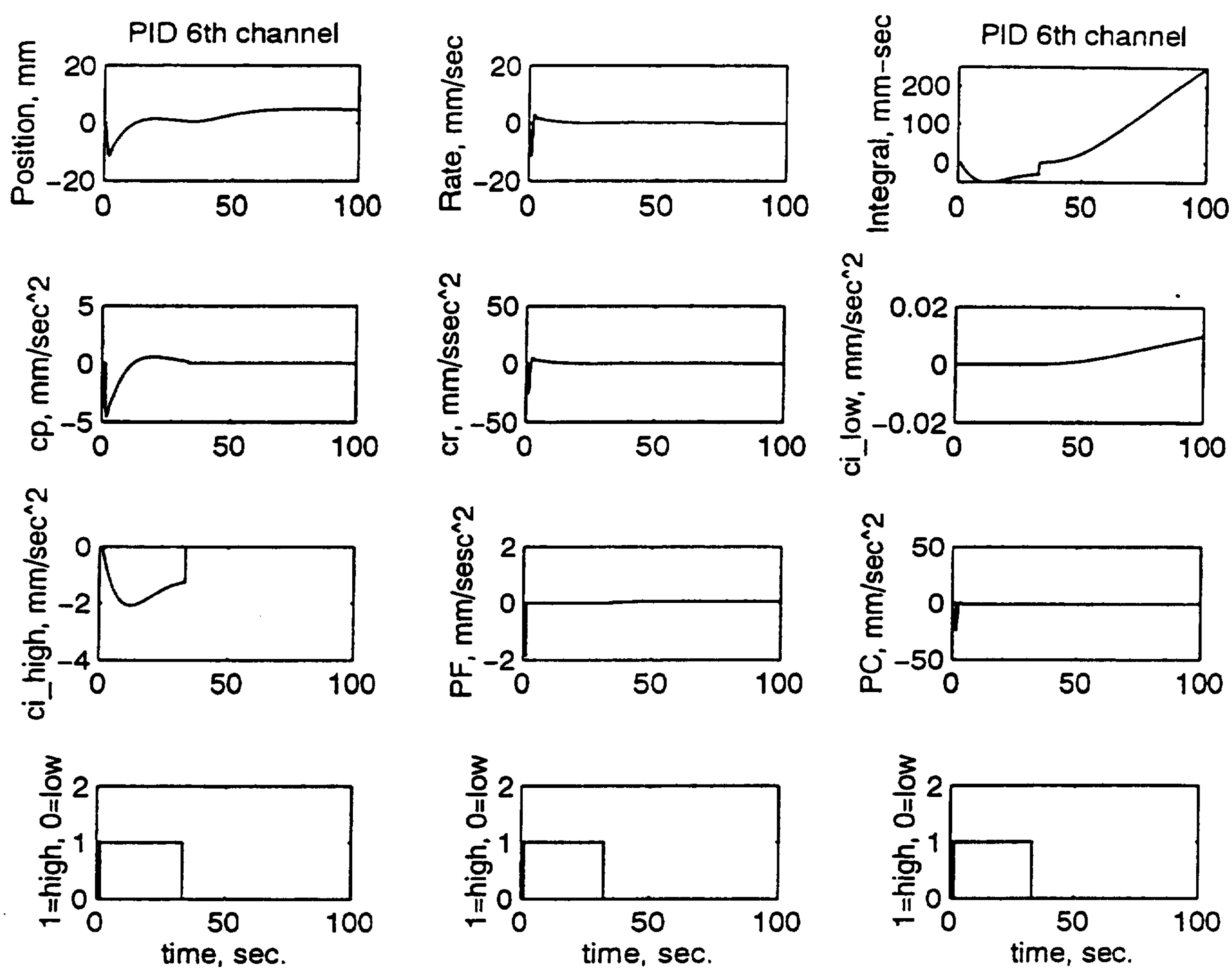

Figure 2.3.1.2-3: Detailed PID Controller Output of Sixth Channel with Initial Excitation

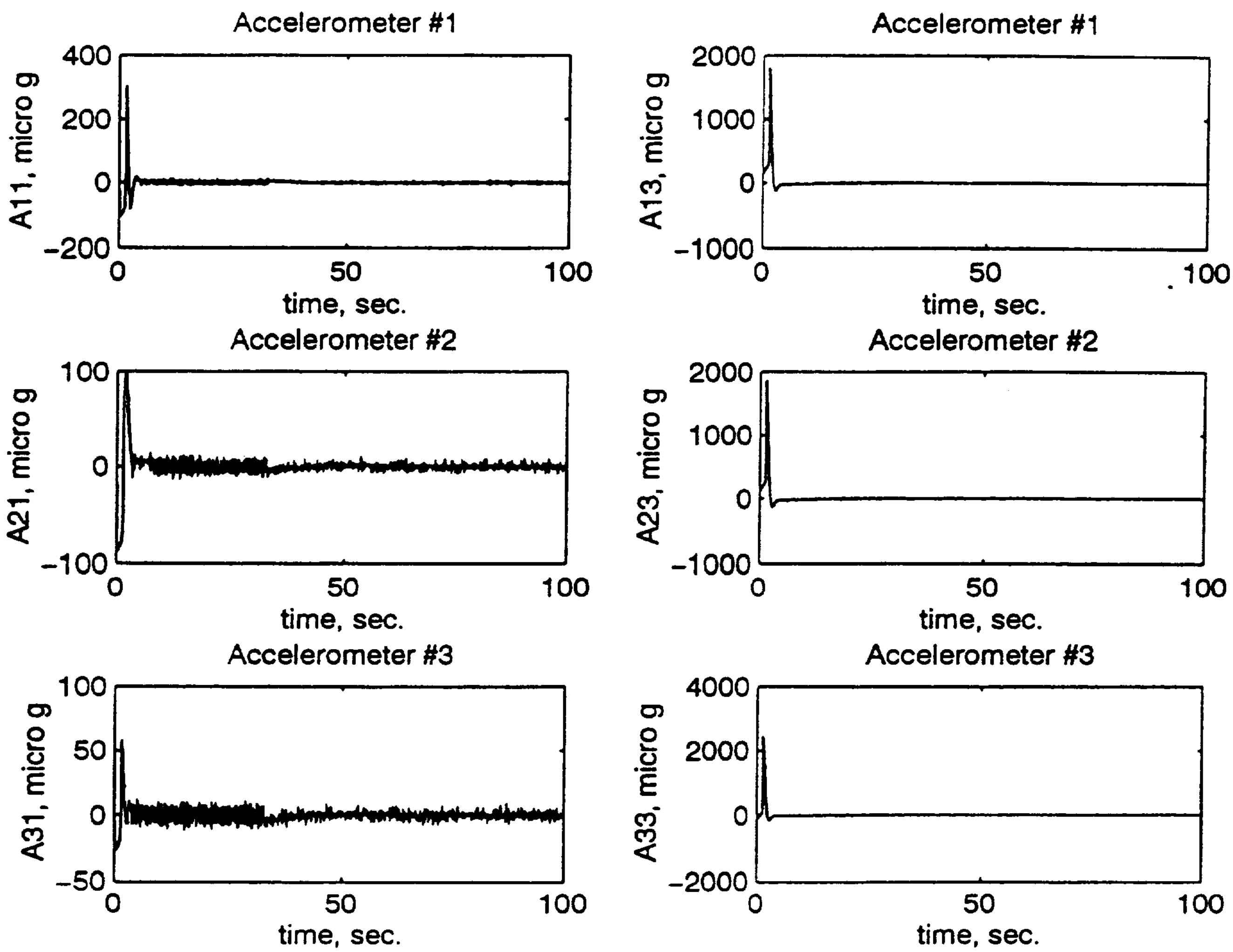

Figure 2.3.1.2-4: Output of Accelerometers with Initial Excitation

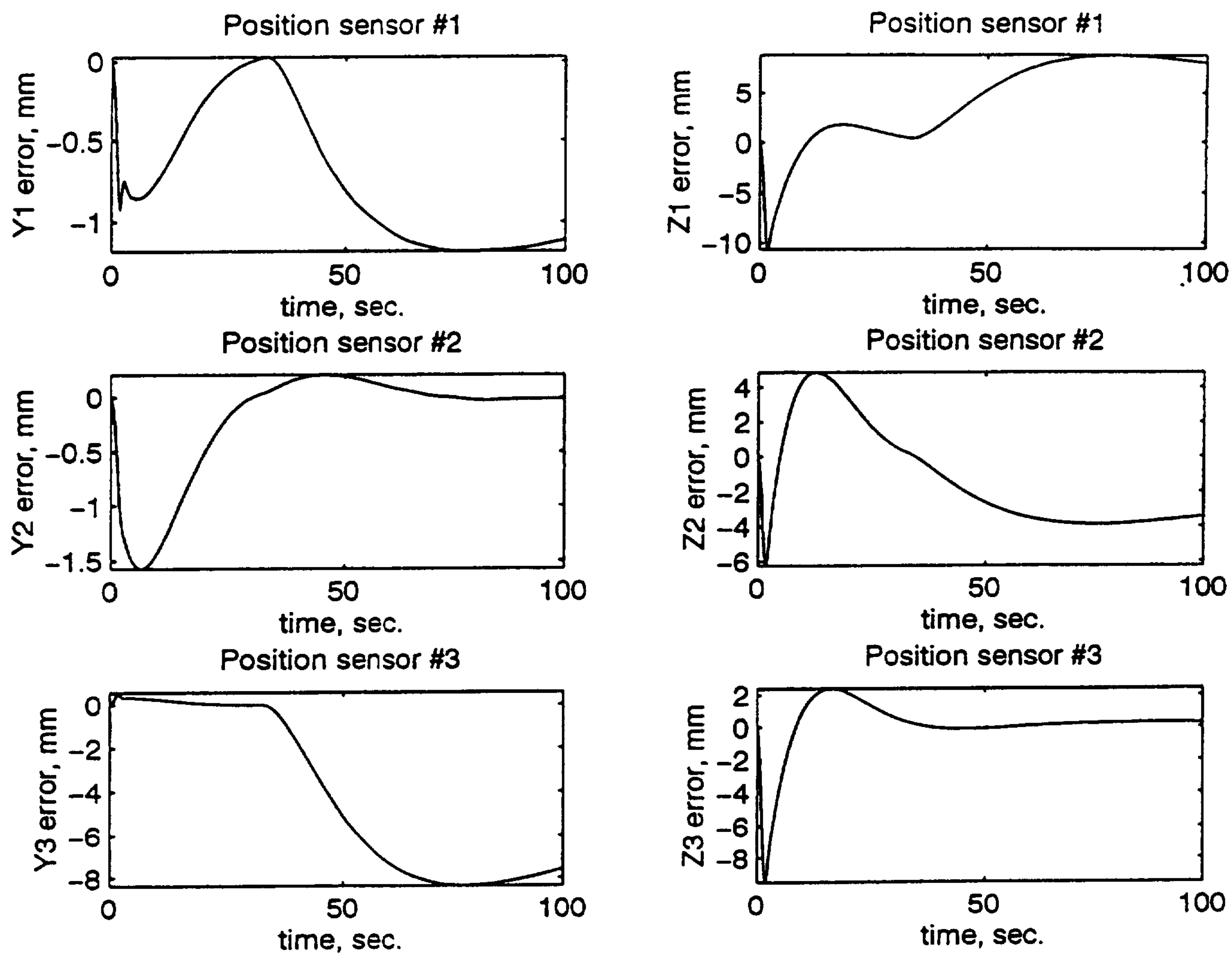

Figure 2.3.1.2-5: Output of Position Sensors with Initial Excitation

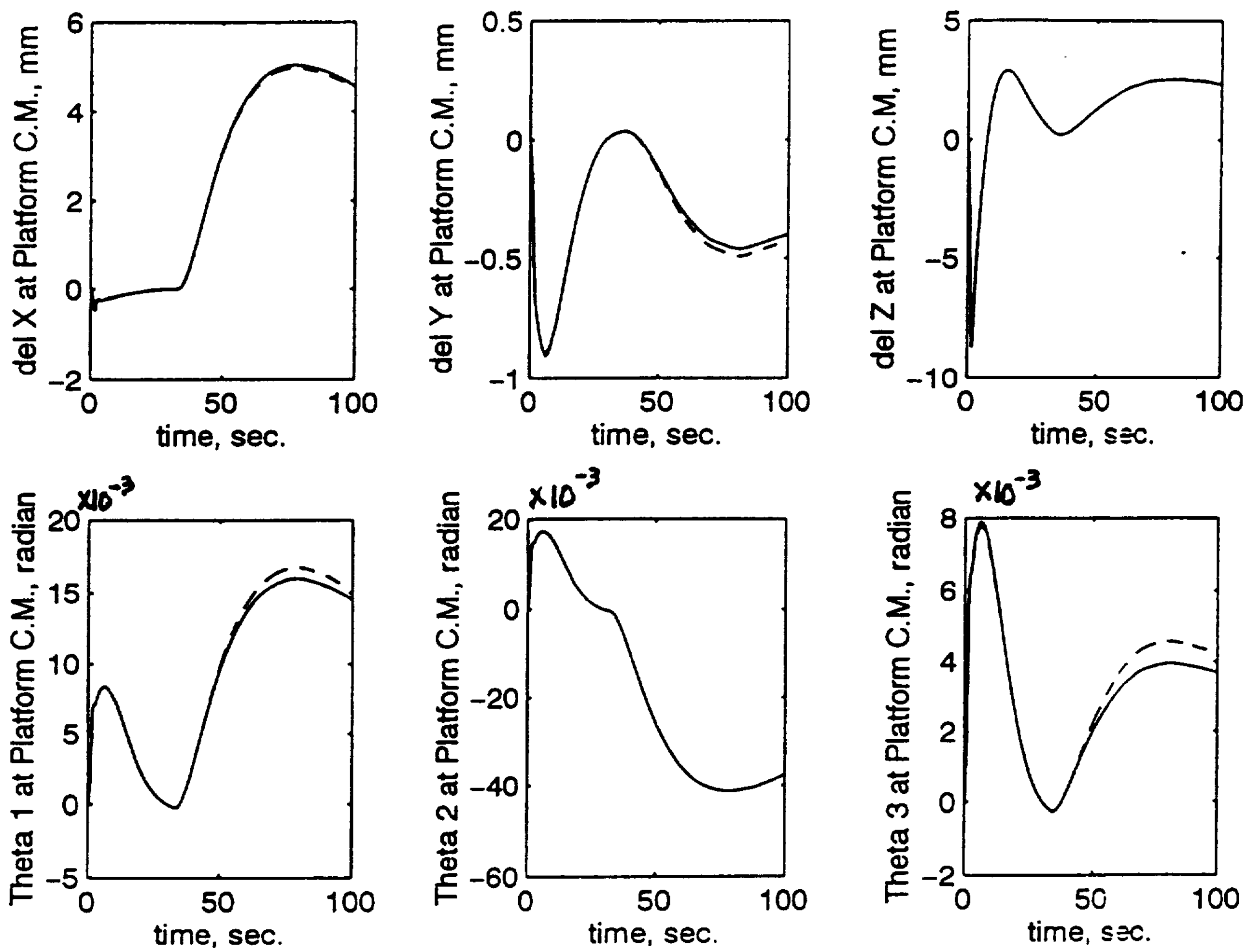

Figure 2.3.1.2-6: Position Error at The C.M. of STABLE Platform with Initial Excitation

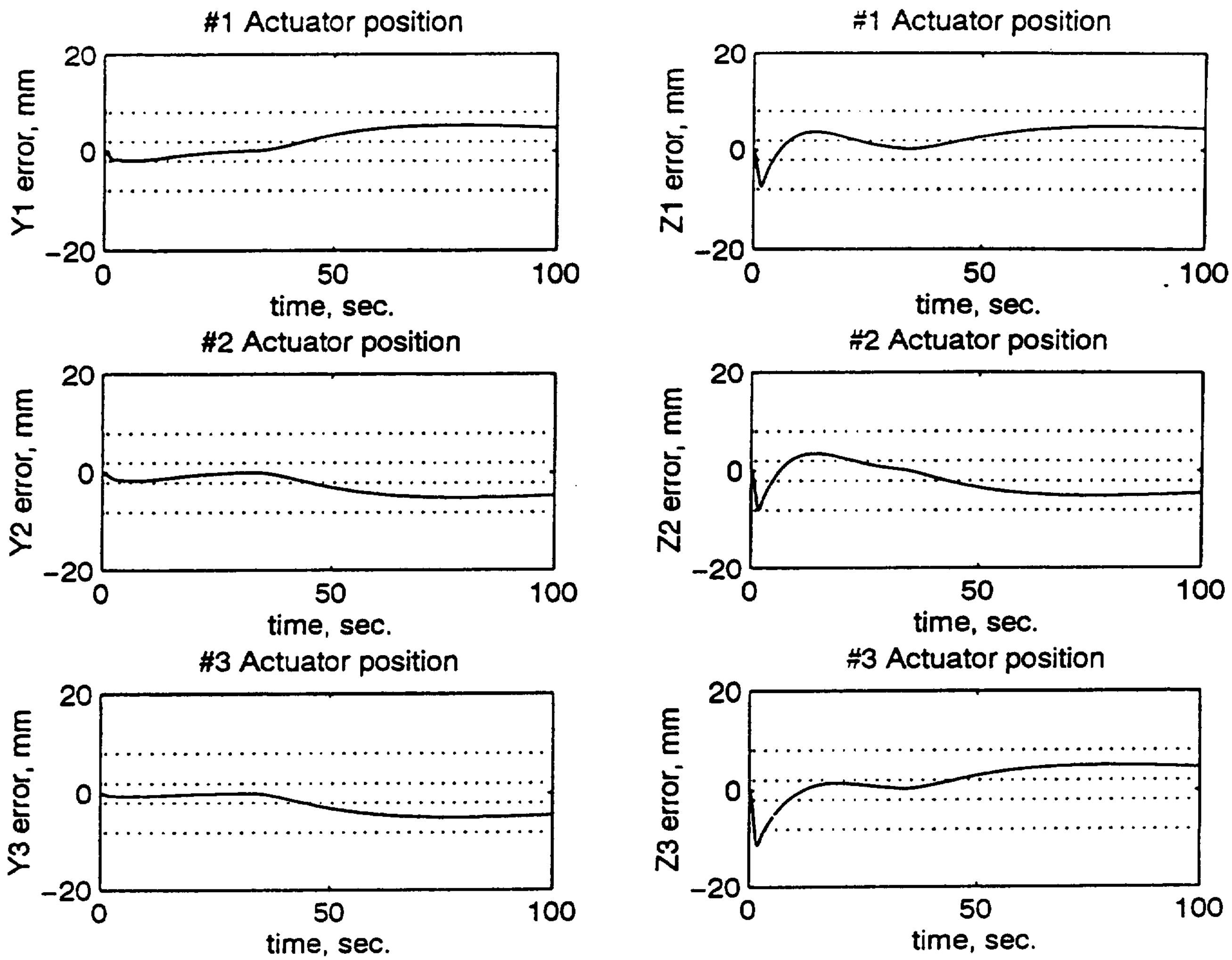

Figure 2.3.1.2-7: Position Error at The Center of Actuators Gap with Initial Excitation

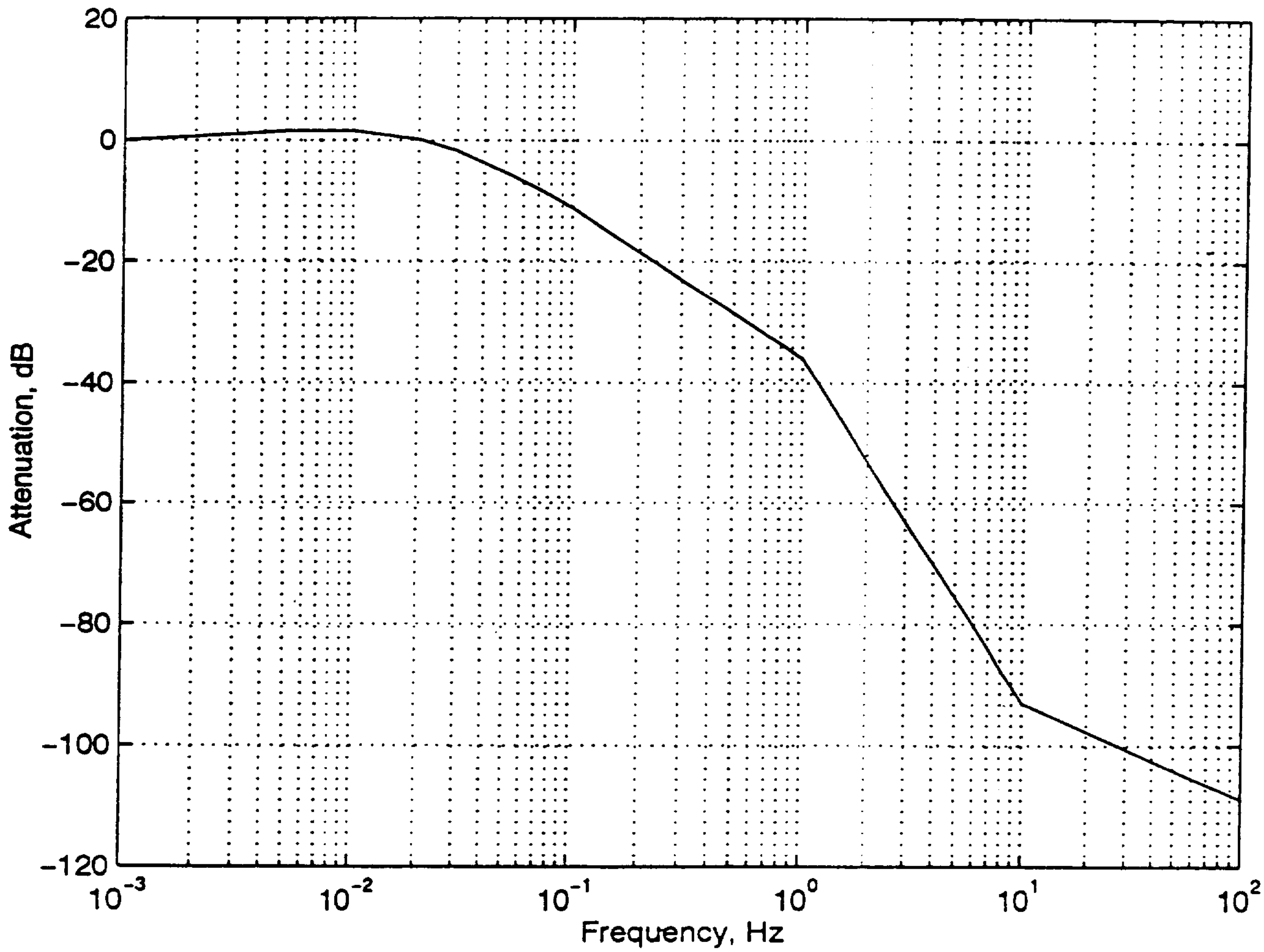

Figure 2.3.2-1: Acceleration Attenuation Curve of STABLE System

2.4 Conclusion

Section 2 documents the details of the mathematical simulation of the control/dynamics equations that was used to design the control laws and define the expected performance of the STABLE isolation system. The multi-body simulation tool, TREETOPS, was used to implement the six DOF dynamics of the floated platform as well as the dynamical models of all sensors, actuators, and the control algorithms in the software. Where possible, models were based on measured data and transfer functions; and, therefore, the simulation should be a good representation of the actual hardware performance. It was noted that the performance prediction in terms of an attenuation transfer function does not meet the requirement that was established for STABLE. This was due to a situation in which, because of schedule pressure, it was necessary to use hardware that was designed for another program, hardware whose electronics characteristics forced a compromise in the design of the bandwidth of the position control loop. An effort is being made at the present time to find another flight opportunity oft a STABLE modified to preclude such limitations and to include other aspects of a practical microgravity isolator. The results in this section will be compared to flight data once that becomes available in a suitable format.

2.5 References

[1] Edberg, D., Boucher, R., Schenck, D., Nurre, G., Whorton, M., Kim, Y., and Alhorn, D., "Results of the STABLE Microgravity Vibration Isolation Flight Experiment," AAS 96-071, Presented to the 19th Annual AAD Guidance and Control Conference, February 7-11, 1996, Breckenridge, CO.

[2] "User's Manual for TREETOPS, A Control System Simulation for Structures With a Tree Topology," NASA Contract NAS-36287, Marshall Space Flight Center, April 1990.

[3] Nurre, G., Working Notes.

3. ARIS Performance Prediction

3.1 Introduction

An Active Rack Isolation System (ARIS) was designed by the Boeing Co. to achieve the International Space Station Alpha (ISSA) μ-gravity requirements. The ARIS Independent Review Team (AIRT) was formed at MSFC/NASA in late June, 1995 to provide an unbiased assessment of the capability of the ARIS to meet the ISSA μ-gravity requirements. The AIRT had reviewed the design and analysis of the Boeing ARIS, and reported a final assessment of the Boeing ARIS in December, 1995 [1].

To support AIRT for predicting the performance of ARIS, a high fidelity mathematical model of the ARIS dynamics and control system with properly modeled eight actuator assemblies was developed for TREETOPS simulation based on configuration data and controller of ARIS system provided by the Boeing Co. [2].

A standard ARIS TREETOPS model was developed first for nominal ARIS configuration that has eight actuator assemblies and then modified for the Space Station Furnace Facility (SSFF) Integrated Configuration One (IC1) that may delete one actuator assembly. This section describes the details of TREETOPS model of the ARIS dynamics and control system, and presents the results of the performance analysis of the ARIS system for SSFF IC1 obtained from TREETOPS simulation. For detailed information on the analytical formulation and modeling aspects of TREETOPS, the reader is referred to the user's guide [3].

3.2 Description of ARIS TREETOPS Simulation

In order to verify the control system and estimate the performance of the ARIS in the orbital environment, a detailed structural and control model of ARIS was developed for TREETOPS. A standard ARIS system consists of an open rack about 100 cm wide, 60 cm deep, 190 cm tall, eight accelerometer sensors, eight actuator assemblies and umbilical cords. A nominal configuration of ARIS rack was shown in Figure 3.2-1 [2].

Each actuator assembly consists of a rotating motor about a pivot fixed on rack and a push rod which connects rotating motor and the base body through a short, thin wire. Also, each actuator assembly has one position sensor which measures displacement along its pushrod. An actuator system was modeled as two rigid body dynamic system including one rotational degree of freedom (DOF) for the pivot joint and three rotational DOFs for the short, thin wire joint connection with corresponding torsional stiffness. Therefore, total ARIS system shown in Figure 3.2-1 was modeled as an eighteen rigid body dynamic system (first body for the space vehicle, second body for the ARIS rack and two bodies for each of eight actuator assemblies).

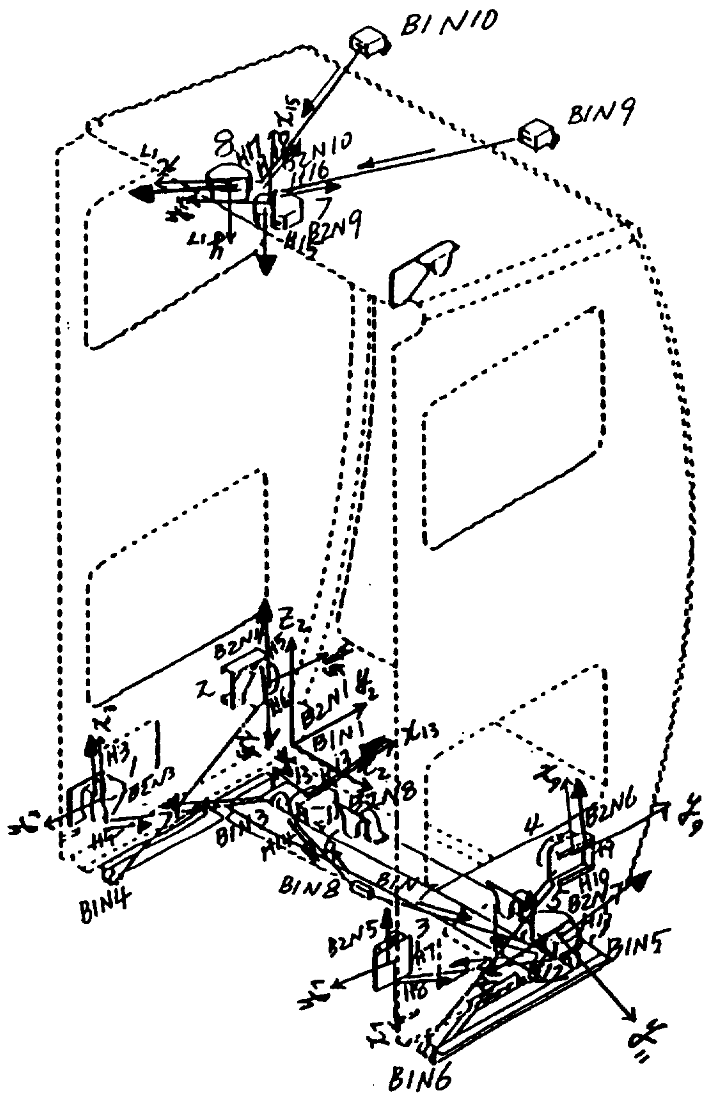

Figure 3.2-1: Configuration of ARIS System

Umbilical cords which connect the ARIS rack and the Spacelab were modeled as six degree of freedom hinge connections with spring stiffness specified to match the dynamic properties of the umbilicals. Because of the design nature, the ARIS rack is physically connected to the Spacelab through each push rod of the eight actuator assemblies. These position constraint conditions were implemented by matching the end location of each push rod with the location of the Spacelab connection points. The action and reaction torque was calculated based on relative rotational angle of each push rod end to the Spacelab connection point with corresponding torsional stiffness in a user defined forcing function subroutine.

In order to precisely analyze the performance of the ARIS system, first of all, accurate geometric modeling of total ARIS system and functional modeling of the actual flight hardware components (eight actuators, eight accelerometer sensors and eight position sensors) are required. It is very important to define accurately the locations of all nodes of each body at initial condition because of position constrains. These nodal locations were calculated from the given configuration of the ARIS rack and hardware components off-line and were verified by comparing the position vectors from the origin of inertial coordinate system through the rack and actuators to the end of push rods and directly to the connection node of the Spacelab calculated from TREETOPS. An ARIS electro-magnetic actuator was modeled as a set of one TREETOPS JET actuator mounted at the center of mass of the of the rotating motor giving an action force and two TREETOPS JET actuators on the corresponding node of the ARIS rack giving a reaction force. Eight ARIS position sensors measure the displacements along each push rod, and the transformation matrix between these measurements and displacement at the center of mass of rack determines the position error of the rack C.M. that is input to the position control loop. However, since there is no built-in TREETOPS position sensor model that exactly corresponds to the ARIS position sensor, the measured pivot angle was used to calculate the position error of the rack C.M. using the transformation matrix between this angle measurement and displacement at the center of mass of rack.

Supplied with the mass properties (mass and moments of inertia) of eighteen bodies and the locations of center of mass and attached nodes of rack and space shuttle, actuators, accelerometers, and umbilical connections, TREETOPS determines the kinematics and dynamics of the ARIS system. The fast continuous acceleration control loop was implemented in the ARIS TREETOPS model using the built-in TREETOPS continuous block diagram controller and the slow continuous position control loop was implemented in the ARIS TREETOPS model using a user defined continuos controller subroutine. A feedforward compensator was added to each TREETOPS continuous block diagram controller to remove adverse effect of the coupling rack dynamics on the stability of ARIS system.

3.2.1 ARIS Structural Model

The ARIS system including the Spacelab was modeled as an eighteen rigid bodies dynamic system connected by linear springs. Since the objective of the ARIS controller is to achieve good attenuation of acceleration disturbances from the base to the ARIS rack for either the Spacelab or the Space Station, in this report the Spacelab was modeled as one arbitrary rigid base body that gives a disturbance to the ARIS rack through umbilical cords and actuators' push rods.

According to the TREETOPS tree topology, the Spacelab is defined by Body #1 and linked by Hinge #1 with six degrees of freedom (three rotational and three translational) with respect to the origin of the inertial coordinate system. ARIS rack of the SSFF Integrated Configuration One (IC1) is defined by Body #2 and connected to Body #1 through Hinge #2 with six DOFs. The umbilical connection between the ARIS rack and the Spacelab are modeled as the combination of three linear spring devices with 10 meter undeformed length. The moving motor and pushrod of actuator assembly #1 are defined by Body #3 and Body #4, respectively. Similarly, the moving motors and pushrods of actuator assemblies #2 through #8 are defined by Body #5 through Body #18. The moving motors of actuator assemblies (Bodies #3, #5, #7, #9, #11, #13, #15 and #17) are linked to Body #2 through Hinges #3, #5, #7, #9, #11, #13, #15 and #17 with one rotational degree of freedom about pivot point using torsional springs, respectively. The one ends of the pushrods of the actuator assemblies (Body #4, #6, #8, #10, #12, #14, #16, #18) are linked to the moving motors of actuator assemblies (Bodies #3, #5, #7, #9, #11, #13, #15 and #17) through Hinges #4, #6, #8, #10, #12, #14, #16, #18 with three rotational DOFs using torsional springs, respectively. The other ends of push rods of actuator assemblies (Body #4, #6, #8, #10, #12, #14, #16, #18) are linked to the Spacelab connection points with TREETOPS Closed-Loop Constrain Devices (CL) by applying the calculated action and reaction torques, that are calculated based on relative rotational angles of the push rods to the Spacelab with corresponding torsional stiffness, to the connecting points of the push rods and the Spacelab.

3.2.1.1 ARIS Body models

In order to develop the accurate dynamic modeling of the ARIS, first of all, it is required to establish a kinematic model that will represent the kinematic relationship of all bodies of total system. Since the geometric configuration of ARIS system shown in Figure 3.2-1 is very complex, it is cumbersome to define each body with respect to inertial coordinate system. However, since TREETOPS automatically connect individual bodies, that are defined with respect to each body coordinate system, and generates the global kinematic system respect to inertial coordinate system according to tree topology based on the hinge information, nodal points of each body are defined with respect to each body coordinate system. A TREETOPS Hinge defines two connecting nodes of inner and outer bodies, the relation between inner body coordinate system and outer body coordinate system, and DOFs of relative motion between two bodies.

For Body #1, fourteen nodal points are chosen to represent the center of mass, origin of local coordinate system of Body #1, eight Spacelab's connecting points to the push rods of actuator assemblies, one corresponding point to the center of mass of the Body #2, and three umbilical cords attaching points. Because of geometric complexity and geometric constraint, it is time-consuming task to determine eight Spacelab's connecting points by off-line calculations. However, the locations of these points can be easily calculated with TREETOPS built-in position sensors by measuring the position vector from the origin of the Spacelab coordinate system through rack and moving motor of actuator assemblies to the far end of push rod of actuator assemblies. The comparison between the provided position and calculated one can confirm the geometric constraint at the connecting points of push rods and the Spacelab attaching points. Table 3.2.1.1-1 summarized the nodes of the space shuttle (Body #1) (for example, B1N2 denotes node #2 of Body #1).

Table 3.2.1.1-1: Nodes Definition of TREETOPS ARIS Body #1

Node	Description	Location in body coordinates (meter)
B1N1	C.M. of Body #1	(0.5989,-0.2901,1.0272)
B1N2	Origin of Body #1 coordinate	(0,0,0)
B1N3	Attaching point of #1 push rod	(0.0593,-0.016285419,-0.21260445)
B1N4	Attaching point of #2 push rod	(0.038,-0.52076156,-0.21280685)
B1N5	Attaching point of #3 push rod	(0.9616,-0.019385419,-0.21260445)
B1N6	Attaching point of #4 push rod	(0.9829,-0.52076156,-0.21280685)
B1N7	Attaching point of #5 push rod	(0.52410219,-0.24324904,-0.13350484)
B1N8	Attaching point of #6 push rod	(0.49679781,-0.24324904,-0.13350484)
B1N9	Attaching point of #7 push rod	(0.77042187,0.17613677,1.8821)
B1N10	Attaching point of #8 push rod	(0.24747813,0.11513677,1.8821)
B1N11	corresponding C.M. of Body #2	(0.5989,-0.2901,1.0272)
B1N12	X umbilical	(10.2595,0,0.0914)
B1N13	Y umbilical	(0.2595,10,0.0914)
B1N14	Z umbilical	(0.2595,0,10.0914)

For Body #2, twenty three nodal points are chosen to represent the center of mass, origin of local coordinate system of Body #2, eight actuator pivot attaching points, four attaching points of eight accelerometer sensors, eight one corresponding points to the center of mass of the moving motors of eight actuator assemblies, and one umbilical attaching point. The nodes of ARIS Rack (Body #2) are summarized in Table 3.2.1.1-2.

Table 3.2.1.1-2: Nodes Definition of TREETOPS ARIS Body #2

Node	Description	Location in body coordinates (meter)
B2N1	C.M. of Body #2	(0.5989,-0.2901,1.0272)
B2N2	Origin of Body #2 coordinate	(0,0,0)
B2N3	Pivot point of Actuator #1	(0.0593,-0.5085,0.1630)
B2N4	Pivot point of Actuator #2	(0.0380,-0.1458,0.1966)
B2N5	Pivot point of Actuator #3	(0.9616,-0.5116,0.1630)
B2N6	Pivot point of Actuator #4	(0.9829,-0.1458,0.1966)
B2N7	Pivot point of Actuator #5	(0.8122,0.0737,-0.1844)
B2N8	Pivot point of Actuator #6	(0.2087,0.0737,-0.1844)
B2N9	Pivot point of Actuator #7	(0.6781,-0.4902,1.8821)
B2N10	Pivot point of Actuator #8	(0.3398,-0.5512,1.8821)
B2N11	Accelerometer #1 & #2	(0.0207,0.1331,1.6560)
B2N12	Accelerometer #3 & #5	(-0.0301,-0.0455,0.1320)
B2N13	Accelerometer #4	(-0.0301,-0.0447,0.1320)
B2N14	Accelerometer #6, #7 & #8	(1.0139,-0.0447,0.1320)
B2N15	C.M. of Body #3	(0.0593,-0.5485,0.1560)
B2N16	C.M. of Body #5	(0.038,-0.1058,0.1896)
B2N17	C.M. of Body #7	(0.9616,-0.5516,0.1560)
B2N18	C.M. of Body #9	(0.9829,-0.1058,0.1896)
B2N19	C.M. of Body #11	(0.8522,0.0667,-0.1844)
B2N20	C.M. of Body #13	(0.1687,0.0667,-0.1844)
B2N21	C.M. of Body #15	(0.6449,-0.5135,1.8821)
B2N22	C.M. of Body #17	(0.3730,-0.5745,1.8821)
B2N23	Umbilical connection	(0.2595,0,0.0914)

Each moving motor of eight actuator assemblies (Bodies #3, #5, #7, #9, #11, #13, #15 and #17) has same configuration and three nodal points are defined with respect to local body coordinate system to represent the center of mass, pivot point that is the origin of local coordinate system, and a connecting point to the one end of push rod of actuator assembly. Table 3.2.1.1-3 summarized the nodes of each moving motor of actuator assemblies (Body #3, 5, 7, 9, 11, 13, 15, 17) (for example, B3 denotes Body #3 and N2 denotes node #2).

Table 3.2.1.1-3: Nodes Definition of TREETOPS ARIS Actuator Moving Motors

Body	Node	Description	Location in body coordinates (meter)
B3,9,13,17	N1	Center of Mass	(-0.007,0.004,0)
B5,7,11,15	N1	Center of Mass	(0.007,0.004,0)
B3,5,9,11,13,15,17	N2	Origin of each body coordinate	(0,0,0)
B3,9,13,17	N3	Attaching point to push rod	(-0.088,0.025,0)
B5,7,11,15	N3	Attaching point to push rod	(0.088,0.025,0)

For each push rod of eight actuator assemblies (Body #4, 6, 8, 10, 12, 14, 16, 18), three nodal points are defined with respect to each body's local body coordinate system to represent the center of mass, the origin of local coordinate system, and a connecting point to the space shuttle's connection point. Table 3.2.1.1-4 summarized the nodes of each moving motor of actuator assemblies (Body #4, 6, 8, 10, 12, 14, 16, 18) (for example, B4 denotes Body #4 and N2 denotes node #2).

Table 3.2.1.1-4: Nodes Definition of TREETOPS ARIS Actuator Pushrods

Body	Node	Description	Location in body coordinates (meter)
B4,8	N1	Center of Mass	(0.2959,0,0)
B6,10	N1	Center of Mass	(0.2566,0,0)
B12,14	N1	Center of Mass	(0.1956,0,0)
B16,18	N1	Center of Mass	(0.3226,0,0)
B4,6,8,10,12,14,16,18	N2	Origin of each body coordinate	(0,0,0)
B4,8	N3	Attaching point to Body #1	(0.59180,0)
B6,10	N3	Attaching point to Body #1	(0.5131,0,0)
B12,14	N3	Attaching point to Body #1	(0.3912,0,0)
B16,18	N3	Attaching point to Body #1	(0.6452,0,0)

3.2.1.2 ARIS Hinge models

According to tree topology of TREETOPS modeling, the number of hinges that connects neighboring bodies must be equal to total number of bodies. Therefore, ARIS TREETOPS model has eighteen hinges and each hinge defines nodal points of two connecting bodies, the relationship of each body's coordinate system and DOFs of relative motion between two bodies. The definitions of all hinges of ARIS TREETOPS model are summarized in Table 3.2.1.2-1.

Table 3.2.1.2-1: Hinges Definition of ARIS TREETOPS Model

Hinge	Connecting nodes	No. of DOF	L1_in - L1_out	L3_in - L3_out
1	B0N0 - B1N1	3RDOF, 3TDOF	(1,0,0) - (1,0,0)	(0,0,1) - (0,0,1)
2	B1N11 - B2N1	3RDOF, 3TDOF	(1,0,0) - (1,0,0)	(0,0,1) - (0,0,1)
3	B2N3 - B3N2	1RDOF	(1,0,0) - (0,0,1)	(0,0,1) - (1,0,0)
4	B3N3 -B4N2	3RDOF	(0,0,1) - (0,0,1)	(0,1,0) - (-0.874,-0.486,0)
5	B2N4 - B5N2	1RDOF	(1,0,0) - (0,0,1)	(0,0,1) - (-1,0,0)
6	B5N3 - B6N2	3RDOF	(0,0,1) - (0,0,1)	(0,1,0) - (-0.779,0.626,0)
7	B2N5 - B7N2	1RDOF	(1,0,0) - (0,0,-1)	(0,0,1) - (-1,0,0)
8	B7N3 - B8N2	3RDOF	(0,0,1) - (0,0,1)	(0,1,0) - (-0.874,0.486,0)
9	B2N6 - B9N2	1RDOF	(1,0,0) - (0,0,-1)	(0,0,1) - (1,0,0)
10	B9N3 - B10N2	3RDOF	(0,0,1) - (0,0,1)	(0,1,0) - (-0.779,-0.626,0)
11	B2N7 - B11N2	1RDOF	(1,0,0) - (0,0,1)	(0,0,1) - (-1,0,0)
12	B11N3 - B12N2	3RDOF	(0,0,1) - (0.1301,0,0.9915)	(0,1,0) - (-0.8004,0.5903,0.1050)
13	B2N8 - B13N2	1RDOF	(0,0,1) - (0,0,1)	(0,1,0) - (1,0,0)
14	B13N3 - B14N2	3RDOF	(0,0,1) - (0.1301,0,0.9915)	(0,1,0) - (-0.8004,-0.5903,0.1050)
15	B2N9 - B15N2	1RDOF	(0,0,1) - (0,0,1)	(0,1,0) - (0.707,-0.707,0)
16	B15N3 - B16N2	3RDOF	(0,0,1) - (0,0,1)	(0,1,0) - (-0.8702,0.4927,0)
17	B2N10 - B17N2	1RDOF	(0,0,1) - (0,0,1)	(0,1,0) - (-0.707,-0.707,0)
18	B17N3 - B18N2	3RDOF	(0,0,1) - (0,0,1)	(0,1,0) - (-0.8702,-0.4927,0)

The Hinge #1 and #2 have zero rotational and translational stiffness, but other hinges have rotational stiffness corresponding to pivot or string stiffness.

3.2.1.3 ARIS Pushrod Constraint Models

Eight pushrods are connected between the ARIS rack and the space shuttle. The connection between the ARIS rack and one side of push rod is modeled as TREETOPS' Hinge as described in section 3.2.1.2. The other connection of push rod and the Spacelab can be modeled using the TREETOPS' Closed-Loop Constrain Device (CL) that causes two nodes on two adjacent bodies to be co-located. The constraints of the ARIS system are summarized in Table 3.2.1.3-1.

Table 3.2.1.3-1: Constraints Definition of TREETOPS ARIS System

Constraint	Type	Connecting nodes
1	CL	B4N3 - B1N3
2	CL	B6N3 - B1N4
3	CL	B8N3 - B1N5
4	CL	B10N3 - B1N6
5	CL	B12N3 - B1N7
6	CL	B14N3 - B1N8
7	CL	B16N3 - B1N9
8	CL	B18N3 - B1N10

The torque due to the stiffness of the connecting string may be calculated by measuring the relative rotational angles between each push rod and the Spacelab from TREETOPS and multiplying them by the stiffness of the connecting string. This computation is done in user-supplied subroutine DIST. The equal and opposite torque are applied to each push rod and the space shuttle.

3.2.2 ARIS Actuator Models

The ARIS actuator assembly consists of a moving motor that is pivoted on a mounting point of the ARIS rack and a push rod that connects the moving motor and the Spacelab. When the motor is moving through the electronic coils attached on ARIS rack, acting force and reacting force are generated on the moving motor and the ARIS rack, respectively. The force diagram of actuator system is shown in Figure 3.2-2. The control forces f_i (i=1 through 8) acting through the push rods are calculated from the Control Law in Section 3.2.4.4 and then the actuator forces are determined from the control forces and geometric relationship shown in Figure 3.2.2-1.

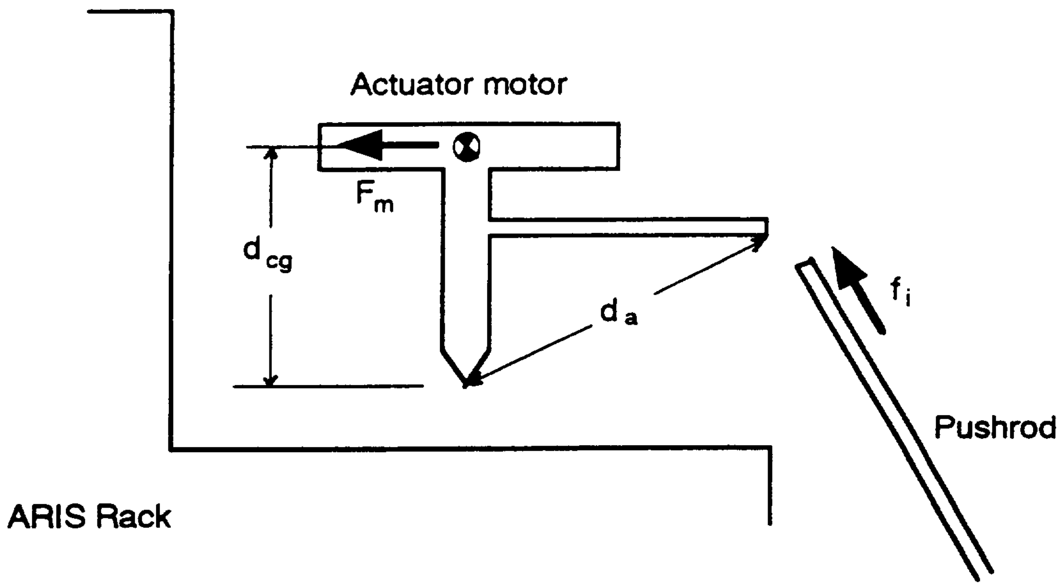

Figure 3.2.2-1: Force Diagram of Actuator System

The acting actuator force is applied to the center of mass of the each moving motor to the moving direction in body coordinates using TREETOPS JET (J) actuator. The counteracting actuator force is applied to the Rack's nodal point corresponding to the center of mass of the each moving motor. This force is decomposed to the two orthogonal components parallel to motor's moving plane in Body #2 coordinate system and modeled as two TREETOPS JET (J) actuators.

The acting actuator forces of the each actuator, F_m $(m = 3,5,7,9,11,13,15,17)$ are determined by following equations.

$$F_3 = f_1 \frac{d_a}{d_{cg}}; \quad F_5 = -f_2 \frac{d_a}{d_{cg}}; \quad F_7 = -f_3 \frac{d_a}{d_{cg}}; \quad F_9 = f_4 \frac{d_a}{d_{cg}}$$
$$F_{11} = -f_5 \frac{d_a}{d_{cg}}; \quad F_{13} = f_6 \frac{d_a}{d_{cg}}; \quad F_{15} = -f_7 \frac{d_a}{d_{cg}}; \quad F_{17} = f_8 \frac{d_a}{d_{cg}} \qquad (3.2..2\text{-}1)$$

where d_{cg} is distance from pivot to center of mass of each actuator and d_a is distance from pivot to connecting node to push rod.

In order to determine the counteracting actuator forces, the transformation matrix between rack body coordinate system and each actuator body coordinate system may be obtained by following equations.

$$\left[\vec{i}_m \;\; \vec{j}_m \;\; \vec{k}_m\right] = \left[\vec{I} \; \vec{J} \; \vec{K}\right] C_m$$

$$\left[\vec{i}_2 \;\; \vec{j}_2 \; \vec{k}_2\right] = \left[\vec{I} \; \vec{J} \; \vec{K}\right] C_2$$

Therefore,

$$\left[\vec{i}_m \;\; \vec{j}_m \; \vec{k}_m\right] = \left[\vec{i}_2 \;\; \vec{j}_2 \; \vec{k}_2\right](C_2^T \; C_m)$$

The transformation matrix between inertial coordinate and rack coordinate, C_2 and transformation matrices between inertial coordinate and eight moving motors of actuator assemblies, C_m ($m = 3,5,7,9,11,13,15,17$) are calculated by TREETOPS. Therefore, the counteracting actuator force being applied to the Rack's nodal point corresponding to the center of mass of the each moving motor are determined from the following equations and coded in user supplied subroutine, DIST. The DIST subroutine is attached in Appendix C.

$$\vec{F}_m = \left[\vec{i}_m \;\; \vec{j}_m \; \vec{k}_m\right]\begin{bmatrix} F_m \\ 0 \\ 0 \end{bmatrix} = \left[\vec{i}_2 \;\; \vec{j}_2 \; \vec{k}_2\right](C_2^T \; C_m)\begin{bmatrix} F_m \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} F_x \\ F_y \\ F_z \end{bmatrix}_m = -(C_2^T \; C_m)\begin{bmatrix} F_m \\ 0 \\ 0 \end{bmatrix} \qquad (3.2.2\text{-}2)$$

The TREETOPS actuators for the ARIS actuator assemblies are summarized in Table 3.2.2-1.

Table 3.2.2-1: Definition of TREETOPS ARIS Actuators Model

Actuator ID	Type	Acting node	Direction	Description
101	Jet	B3N1	(1,0,0)	F_3
102	Jet	B2N15	(0,1,0)	F_{y_3}
103	Jet	B2N15	(0,0,1)	F_{z_3}
201	Jet	B5N1	(1,0,0)	F_5
202	Jet	B2N16	(0,1,0)	F_{y_5}
203	Jet	B2N16	(0,0,1)	F_{z_5}
301	Jet	B7N1	(1,0,0)	F_7
302	Jet	B2N17	(0,1,0)	F_{y_7}
303	Jet	B2N17	(0,0,1)	F_{z_7}
401	Jet	B9N1	(1,0,0)	F_9
402	Jet	B2N18	(0,1,0)	F_{y_9}
403	Jet	B2N18	(0,0,1)	F_{z_9}
501	Jet	B11N1	(1,0,0)	F_{11}
502	Jet	B2N19	(1,0,0)	$F_{x_{11}}$
503	Jet	B2N19	(0,1,0)	$F_{y_{11}}$
601	Jet	B13N1	(1,0,0)	F_{13}
602	Jet	B2N20	(1,0,0)	$F_{x_{13}}$
603	Jet	B2N20	(0,1,0)	$F_{y_{13}}$
701	Jet	B15N1	(1,0,0)	F_{15}
702	Jet	B2N21	(1,0,0)	$F_{x_{15}}$
703	Jet	B2N21	(0,1,0)	$F_{y_{15}}$
801	Jet	B17N1	(1,0,0)	F_{17}
802	Jet	B2N22	(1,0,0)	$F_{x_{17}}$
803	Jet	B2N22	(0,1,0)	$F_{y_{17}}$

3.2.3 ARIS Sensor Models

The ARIS system has eight accelerometers on the ARIS Rack to measure acceleration at the attached nodes to the aligned direction. Each accelerometer was modeled as a TREETOPS' ACCELEROMETER (AC) sensor that measures the acceleration of the body at the specified node to the specified direction. Therefore, eight AC sensors are attached on the nodes #11, 12, 13, 14 of Body #2 defined in Table 3.2.1.1-2 with specified measuring directions. In order to determine attenuation performance of ARIS system, the accelerations at the center of mass of the Body #1, 2 are needed to be measured. Three AC sensors are attached at the center of mass of Body #1 and #2 and aligned to the three orthogonal directions. These AC sensors are summarized in Table 3.2.3-1.

Table 3.2.3-1: Definition of TREETOPS ARIS Sensors Model

Sensor ID	Type	Attached node	Direction	Description
101	AC	B1N1	(1,0,0)	a_{x_1}
102	AC	B1N1	(0,1,0)	a_{y_1}
103	AC	B1N1	(0,0,1)	a_{z_1}
201	AC	B2N1	(1,0,0)	a_{x_2}
202	AC	B2N1	(0,1,0)	a_{y_2}
203	AC	B2N1	(0,0,1)	a_{z_2}
211	AC	B2N11	(0.707,0.707,0)	Acceleration #1
212	AC	B2N11	(-0.707,0.707,0)	Acceleration #2
221	AC	B2N12	(0.146,0.853,0.5)	Acceleration #3
222	AC	B2N13	(-0.853,-0.146,0.5)	Acceleration #4
223	AC	B2N12	(0.5,-0.5,0.707)	Acceleration #5
231	AC	B2N14	(0.853,-0.146,0.5)	Acceleration #6
232	AC	B2N14	(-0.146,0.853,0.5)	Acceleration #7
233	AC	B2N14	(-0.5,-0.5,0.707)	Acceleration #8

The ARIS system has eight position sensors. A position sensor consists of one detector fixed on the actuator assembly case and one laser mounted on the moving shaft about pivot point of the actuator assembly. In the ARIS flight hardware each position sensor measures the projection of a laser on a detector, that is the position movement at each actuator attaching node to the direction of pushrod. Therefore, eight position movements at eight actuator attaching nodes are used to determine the transitional and rotational displacements of the center of mass of the ARIS rack that is input for the position control loop. There is no built-in TREETOPS sensor corresponding to the ARIS position sensor assembly. However, since the rotational angles of eight actuators about pivot points available from TREETOPS simulation are proportional to the ARIS position sensor's outputs, eight rotational angles of eight actuators about pivot points are used to determine the transitional and rotational displacements of the center of mass of ARIS rack.

3.2.4 ARIS Control Law Models

The ARIS control system consists of one fast inner acceleration control loop, one slow outer position control loop, and one feedforward compensator to remove adverse effect of the coupling rack dynamics. The ARIS control law and control gains were provided by the Boeing's ARIS Team. In order to implement this ARIS controller in the TREETOPS dynamic model, two TREETOPS control modules (CBDC, USCC) were used. Since the units used for Boeing's control law are English units and Metric units are used for the ARIS TREETOPS dynamic model, the proper conversion factors are required to implement Boeing's control law into the ARIS TREETOPS dynamic model.

The inner acceleration control loop has six independent channels for three translational and three rotational motion. Each inner acceleration control loop was modeled as the same continuous transfer function with the control gain corresponding to each directional mass property using CBDC (Continuos Block Diagram Controller). The outer PID position control loop was also modeled as a continuous transfer function and added to CBDC Control module.

Each control loop was designed and normalized for six uncoupled motion, in order to implement this control law into the coupled nonlinear ARIS dynamic system successfully, a feedforward control loop was added to the inner acceleration control loop to remove the coupled dynamic motion of the ARIS system. This feedforward control force is calculated by multiplying the position error by the pre-determined off-diagonal stiffness matrix of the ARIS dynamic system.

The computation of actuator forces and feedforward control forces are being done in USCC (User Defined Continuous Controller). The USCC was also used to define the transformation matrix from the measured acceleration to the acceleration at the rack C.M., the transformation matrix from the control forces at the rack C.M. to the actuator forces at the actuator's pivot point to the direction of the push rod, the transformation matrix from the rotational angles of actuator to the movement of rack C.M. The USCC subroutine is attached in Appendix D. The overall ARIS TREETOPS dynamics and control model is shown in Figure 3.2.4-1.

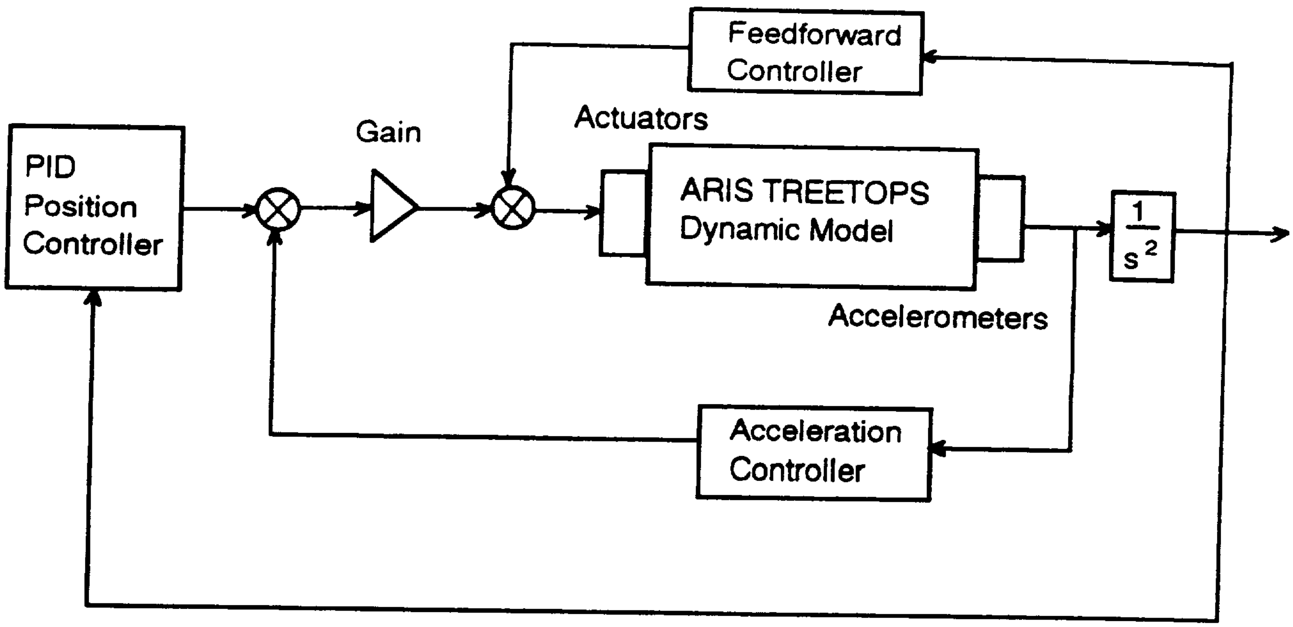

Figure 3.2.4-1: ARIS TREETOPS Dynamics and Control Model Layout

3.2.4.1 Position Control Loop

The ARIS position controller has six independent channels for three translational and three rotational motion. The ARIS position PID controller with a low-pass filter of each channel was modeled as a continuous transfer function and implemented in the TREETOPS ARIS model using CBDC. Inputs to this position PID controller are six displacements of the center of mass of the ARIS rack and the position controller generates acceleration commands based on the position error. The position error of the center of mass of the ARIS rack may be determined using the rotational angles of eight actuators about pivot points obtained from the ARIS dynamic simulation and the transformation matrix between these angles and the position error of the center of mass of the ARIS rack. This computation is done in USCC.

The above transformation matrix, whose elements are the rotational angles of eight actuators about pivot points due to each unit displacement of the center of mass of the ARIS rack to the direction of three translational and three rotational motion, is determined from off-line computation by measuring the rotational angles of eight actuators and the displacement of the center of mass of the ARIS rack from TREETOPS simulation when an arbitrary force is applied at the center of mass of the ARIS rack in each direction of three translational and three rotational motion without controllers. This transformation matrix, T_p^x was defined in USCC.

3.2.4.2 Acceleration Control Loop

The inner acceleration control loop was modeled as two serially connected transfer functions for each channel of six rigid body motion of ARIS rack and implemented in CBDC. Inputs to this acceleration control loop are three linear accelerations and three angular accelerations at the center of mass of the ARIS rack. These accelerations at center of mass of the ARIS rack may be determined as follows using the measured acceleration and the transformation matrix from the measured acceleration to the acceleration at the rack C.M..

Let position vectors from the origin of ARIS body coordinate to the accelerometers #1, #2 and #3, #4, #5 and #6, #7, #8 be $\vec{r}_i$ or $\left[r_i(1)\; r_i(2)\; r_i(3)\right]^T$, $(i = 1,\cdots,3)$, respectively, and the skew matrices of $\vec{r}_i$, $\tilde{r}_i$ $(i = 1,2,3)$ be defined as

$$\tilde{r}_i = \begin{bmatrix} 0 & -r_i(3) & r_i(2) \\ r_i(3) & 0 & -r_i(1) \\ -r_i(2) & r_i(1) & 0 \end{bmatrix},$$

then,

$$\begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix}_i = \begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix}_{C.M.} + \vec{\alpha} \times \vec{r}_i = \begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix}_{C.M.} - \tilde{r}_i \begin{bmatrix} \alpha_x \\ \alpha_y \\ \alpha_z \end{bmatrix}_{C.M.} \qquad (3.2.4.2\text{-}1)$$

where $\vec{\alpha}$ is rotational angular acceleration of ARIS rock.

Defining

$$A_i = \begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix}_i, \quad \ddot{\varepsilon} = \begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix}_{C.M.}, \text{ and } \ddot{\psi} = \begin{bmatrix} \alpha_x \\ \alpha_y \\ \alpha_z \end{bmatrix}_{C.M.},$$

the acceleration components at three locations of accelerometer may determined as follows.

$$\begin{bmatrix} A_1 \\ A_2 \\ A_3 \end{bmatrix} = \begin{bmatrix} I & -\tilde{r}_1 \\ I & -\tilde{r}_2 \\ I & -\tilde{r}_3 \end{bmatrix} \begin{bmatrix} \ddot{\varepsilon} \\ \ddot{\psi} \end{bmatrix} \equiv T_x^w \begin{bmatrix} \ddot{\varepsilon} \\ \ddot{\psi} \end{bmatrix} \qquad (3.2.4.2\text{-}2)$$

Simultaneously, the acceleration components at three locations of accelerometer may be determined from the eight measured accelerations, $a_i, (i = 1,\cdots,8)$ with measuring directional unit vectors, $\hat{u}_i$ as follows.

$$
\begin{bmatrix} A_1 \\ A_2 \\ A_3 \end{bmatrix} = \begin{bmatrix} \hat{u}_1 & \hat{u}_2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \hat{u}_3 & \hat{u}_4 & \hat{u}_5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \hat{u}_6 & \hat{u}_7 & \hat{u}_8 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \\ a_6 \\ a_7 \\ a_8 \end{bmatrix} \equiv T_m^w \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \\ a_6 \\ a_7 \\ a_8 \end{bmatrix} \qquad (3.2.4.2\text{-}3)
$$

Equating Equation (3.2.4.2-2) to (3.2.4.2-3) and taking pseudo-inverse yield the acceleration at center of mass of the ARIS rack as the follows.

$$
\begin{bmatrix} \ddot{\varepsilon} \\ \ddot{\psi} \end{bmatrix} = (T_m^{w\,T} T_x^w)^{-1} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \\ a_6 \\ a_7 \\ a_8 \end{bmatrix} \equiv T_m^x \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \\ a_6 \\ a_7 \\ a_8 \end{bmatrix} \qquad (3.2.4.2\text{-}4)
$$

This computation and the above transformation matrix, T_m^x are described in USCC. The above computed accelerations at the center of mass of the ARIS rack are read into CBDC module and processed by acceleration control law to generate compensated accelerations. These compensated accelerations and the acceleration commands generated by the position control loop are summed to form the error signals. CBDC generates control forces and moments by multiplying these error signals by gains that are corresponding mass property to each DOF motion.

3.2.4.3 Feedforward Control Loop

A feedforward compensating force is added to the control force calculated from the acceleration and position control loops to cancel out the adverse effect of the coupling motion on stability of the ARIS system. This force is determined by multiplying the compensating stiffness matrix of the ARIS system by the position error at the center of mass of the ARIS rack that is calculated in USCC. The compensating stiffness matrix of the ARIS system may be calculated off-line by canceling out off-diagonal elements of the total stiffness matrix and adjusting the diagonal elements corresponding to the specified frequency of each DOF motion (for example, 1.4 rad/sec frequency was chosen for simulation in this report). Since the total stiffness of the ARIS system is a combination of the stiffness of umbilicals and the stiffness of the pivots and pushrods connection of eight actuators, it has to be determined from test. For the operation in the orbit, the stiffness of the total ARIS system is calculated from the measured forces due to unit displacement at the center of mass of rack to each direction of six DOF motions by commanding position controller without the acceleration controller.

In order to determine the stiffness of the total ARIS TREETOPS model, with only position controller loops, a position command was given to the position controller in each direction of three translational and rotational motion one at a time, and the required forces and moments are calculated from CBDC. These forces and moments per unit displacement fill each row of stiffness matrix of the total ARIS system. There were two sets of gains for the position control loops provided by the Boeing's ARIS Team: one for normal operational mode and another one for the standby mode that is larger. The gain set for the standby mode is used for the position control gain to determine the above mentioned stiffness matrix of the total ARIS system.

3.2.4.4 Control Force Distribution

The control forces at the center of mass of the ARIS rack that were determined through position control loop, acceleration control loop, and feedforward control loop may be distributed to each actuator assembly using a transformation matrix between forces at the C.M. of ARIS rack and the actuator forces at the actuator's pivot point to the longitudinal direction of pushrod.

Let position vectors from the origin of ARIS body coordinate to the pivot points of eight actuators be $\vec{R}_i, (i = 1,\cdots,8)$, the control forces at the center of mass of ARIS rack be $\left[\vec{F}\ \vec{T}\right]^T_{C.M.}$, and the actuator forces at the actuator's pivot point to the longitudinal direction of pushrod be $\vec{f}_i = f_i \vec{u}_i,\ (i = 1,\cdots 8)$, then

$$\begin{bmatrix} \vec{F} \\ \vec{T} \end{bmatrix}_{C.M.} = \begin{bmatrix} \sum_{i=1}^{8} \vec{f}_i \\ \sum_{i=1}^{8} \vec{R}_i \times \vec{f}_i \end{bmatrix} \qquad (3.2.4.4\text{-}1)$$

Defining $\hat{U}_i, (i = 1,\cdots,8)$ be column matrix for unit directional vector along ith pushrod, $\vec{u}_i$ and the skew matrix of $\vec{R}_i$, $\tilde{R}_i$ be as

$$\tilde{R}_i = \begin{bmatrix} 0 & -R_i(3) & R_i(2) \\ R_i(3) & 0 & -R_i(1) \\ -R_i(2) & R_i(1) & 0 \end{bmatrix},$$

the above vector form of equation can be rewritten in matrix form in the ARIS rack coordinate system as follows.

$$\begin{bmatrix} F_x \\ F_y \\ F_z \\ T_x \\ T_y \\ T_z \end{bmatrix}_{C.M.} = \begin{bmatrix} \hat{U}_1 & \hat{U}_2 & \cdots & \hat{U}_8 \\ \tilde{R}_1 \hat{U}_1 & \tilde{R}_2 \hat{U}_2 & \cdots & \tilde{R}_8 \hat{U}_8 \end{bmatrix} \begin{bmatrix} f_1 \\ f_2 \\ f_3 \\ f_4 \\ f_5 \\ f_6 \\ f_7 \\ f_8 \end{bmatrix} = T_u^x \begin{bmatrix} f_1 \\ \vdots \\ f_8 \end{bmatrix} \qquad (3.2.4.4\text{-}2)$$

where $\begin{bmatrix} F_x & F_y & F_z & T_x & T_y & T_z \end{bmatrix}_{C.M.}^T$ is the column matrix whose components are X, Y, and Z axis components of control force and moment at the C.M. of the ARIS rack. Once these control force and moment are calculated from the ARIS control law, the magnitude of the actuator forces at the actuator's pivot point to the longitudinal direction of pushrod may be determined from the following equation.

$$\begin{bmatrix} f_1 \\ f_2 \\ f_3 \\ f_4 \\ f_5 \\ f_6 \\ f_7 \\ f_8 \end{bmatrix} = T_x^u \begin{bmatrix} F_x \\ F_y \\ F_z \\ T_x \\ T_y \\ T_z \end{bmatrix}_{C.M.} \qquad (3.2.4.4\text{-}3)$$

where T_x^u is a transformation matrix from the forces and moments at the C.M. of ARIS rack to the actuator forces at the actuator's pivot point to the longitudinal direction of pushrod, and is calculated by taking the pseudo-inverse of T_u^x given in Equation (3.2.4.4-2).

3.3 ARIS Simulation Results

In the Section 3.2, the details of the TREETOPS modeling of the standard nominal ARIS system was described. However, geometric configuration and mass properties of the ARIS system may vary slightly depending on payloads that will be accommodated in ARIS system. This section describes numerical results about the attenuation performance analysis of the ARIS system for the Space Station Furnace Facility (SSFF) Integrated Configuration One (IC1) obtained from TREETOPS simulation. The Input file of ARIS TREETOPS simulation is attached in Appendix E.

Although the standard ARIS system has eight actuator assemblies, the ARIS for SSFF IC1 may have seven actuator assemblies due to restricted accessibility of the actuator #1 assembly. In order to minimize efforts to modify standard ARIS TREETOPS model described in Section 4 for the ARIS system of SSFF IC1, the masses of Body #3 and #4 (actuator assembly #1) are set to be negligibly small with zero DOF of Hinge #3 and #4 and deleting the geometric constraint between push rod of actuator assembly #1 and base Body #1.

For numerical simulation, the mass properties and location of C.M. of ARIS rack for SSFF IC1 are given in Table 3.3-1. And the stiffness of umbilical cords used for this simulation is described in Table 3.3-2.

Table 3.3-1: Mass Properties and Location of C.M. of ARIS Rack for SSFF IC1

Mass (Kg)	840
$I_{xx}, I_{yy}, I_{zz}, I_{xy}, I_{xz}, I_{yz}$ $(Kg-m^2)$	208.7974, 227.7789, 96.2637, 2.7117, 8.1350, 10.8466
B1N1, B1N11, B2N1 ($meter$)	0.5989, -0.2901, 1.0272

Table 3.3-2: Stiffness of Umbilical Cords Used for ARIS TREETOPS Simulation

K_x (N/m)	1225.88
K_y (N/m)	2189.07
K_x (N/m)	1926.39

The pivot of the actuator assembly has one rotational DOF with stiffness of 0.0565 $N-m/rad$. The pushrod string of actuator assembly could have three rotational DOFs, however, since Renbrandt flexures restricts twisting motion, a torsional DOF about neutral axis of the string was deleted. The stiffness of two rotational DOFs of the pushrod connecting string of an actuator assembly is given as 0.0565 $N-m/rad$.

3.3.1 Determination of Transformation Matrices T_u^x, T_x^u, T_m^x, T_p^x

The transformation matrix from the actuator forces at the actuator's pivot point to the longitudinal direction of the pushrod to the forces and moments at the C.M. of the ARIS rack, T_u^x may be calculated from Equation (3.2-6) with the position vectors of pivot points from the C.M. of the ARIS rack and directional vector of pushrods of ARIS actuator assemblies of SSFF IC1.

The position vectors of pivot points from the C.M. of the ARIS rack are obtained from subtracting the location vector of the C.M. of the ARIS rack from the location vectors of the pivot points of actuators and given in Table 3.3.1-1.

Table 3.3.1-1: Position Vectors of Pivot Points from the C.M. of the ARIS Rack

Description	Location vectors from the C.M. of ARIS rack in Body #2 coordinates (meter)
Pivot point of Actuator #1 $[R_1(1), R_1(2), R_1(3)]$	[-0.5396, -0.2184,-0.8642]
Pivot point of Actuator #2 $[R_2(1), R_2(2), R_2(3)]$	[-0.5609, 0.1443, -0.8306]
Pivot point of Actuator #3 $[R_3(1), R_3(2), R_3(3)]$	[0.3627, -0.2215, -0.8642]
Pivot point of Actuator #4 $[R_4(1), R_4(2), R_4(3)]$	[0.3840, 0.1443, -0.8306]
Pivot point of Actuator #5 $[R_5(1), R_5(2), R_5(3)]$	[0.2133, 0.3638, -1.2116]
Pivot point of Actuator #6 $[R_6(1), R_6(2), R_6(3)]$	[-0.3902, 0.3638, -1.2116]
Pivot point of Actuator #7 $[R_7(1), R_7(2), R_7(3)]$	[0.0792, -0.2001, 0.8549]
Pivot point of Actuator #8 $[R_8(1), R_8(2), R_8(3)]$	[-0.2591, -0.2611, 0.8549]

Table 3.3.1-2: Unit Directional Vectors along the Pushrod of ARIS Eight Actuator Assemblies

Description	Row matrix for unit directional vector in Body #2 coordinates
Pushrod #1, $\hat{U}_1^T$	[0, 0.874, -0.486]
Pushrod #2, $\hat{U}_2^T$	[0, -0.779, -0.626]
Pushrod #3, $\hat{U}_3^T$	[0, 0.874, -0.486]
Pushrod #4, $\hat{U}_4^T$	[0, -0.779, -0.626]
Pushrod #5, $\hat{U}_5^T$	[-0.800, -0.585, 0.130]
Pushrod #6, $\hat{U}_6^T$	[0.800, -0.585, 0.130]
Pushrod #7, $\hat{U}_7^T$	[0.267, 0.964, 0]
Pushrod #8, $\hat{U}_8^T$	[-0.267, 0.964, 0]

The row matrices for unit directional vector along the pushrod of ARIS ith actuator assembly of SSFF IC1, $\hat{U}_i^T, (i = 1,\cdots,8)$ are given Table 3.3.1-2.

Therefore, a transformation matrix from the forces and moments at the C.M. of ARIS rack to the actuator forces at the actuator's pivot point to the longitudinal direction of pushrod, T_x^u was calculated by taking pseudo-inverse of T_u^x and coded as *tdelxtou* in subroutine USCC attached in Appendix D.

The transformation matrix from the measured acceleration to the acceleration at the rack C.M., T_m^x may be calculated using the procedures described in Section 3.2.4.2 with three position vectors of accelerometers location from the C.M. of the ARIS rack for SSFF IC1 and measuring the directional unit vectors of eight accelerometers.

The three position vectors of accelerometers location from the C.M. of the ARIS rack are obtained from subtracting location vector of the C.M. of ARIS rack from the location vectors of accelerometers and given in Table 3.3.1-3.

Table 3.3.1-3: Position Vectors of Accelerometers Location
from the C.M. of the ARIS Rack

Description	Location vectors from the C.M. of ARIS rack in Body #2 coordinates (meter)
Accelerometers #1, #2 $[r_1(1), r_1(2), r_1(3)]$	[-0.5782, 0.4232, 0.6288]
Accelerometers #3, #4, #5 $[r_2(1), r_2(2), r_2(3)]$	[-0.6290, 0.2446, -0.8952]
Accelerometers #6, #7, #8 $[r_3(1), r_3(2), r_3(3)]$	[0.4150, 0.2454, -0.8952]

The row matrices for unit measuring directional vector the ith accelerometer of SSFF IC1, $\hat{u}_i^T$, $(i = 1,\cdots,8)$ are given Table 3.3.1-4.

Table 3.3.1-4: Unit Measuring Directional Vectors the ARIS accelerometers

Description	Row matrix for unit directional vector in Body #2 coordinates
Accelerometer #1, $\hat{u}_1^T$	[0.707, 0.707, 0]
Accelerometer #2, $\hat{u}_2^T$	[-0.707, 0.707, 0]
Accelerometer #3, $\hat{u}_3^T$	[0.146, 0.853, 0.5]
Accelerometer #4, $\hat{u}_4^T$	[-0.853, -0.146, 0.5]
Accelerometer #5, $\hat{u}_5^T$	[0.5, -0.5, 0.707]
Accelerometer #6, $\hat{u}_6^T$	[0.853, -0.146, 0.5]
Accelerometer #7, $\hat{u}_7^T$	[-0.146, 0.853, 0.5]
Accelerometer #8, $\hat{u}_8^T$	[-0.5, -0.5, 0.707]

Therefore, a transformation matrix from the measured acceleration to the acceleration at the rack C.M., T_m^x was calculated as described as the above and coded as *tmtox* in subroutine USCC attached in Appendix D.

The transformation matrix from rotational angles of actuators' moving motor about pivot to the position error of the C.M. of ARIS rack, T_p^x was determined as described in Section 4.4.1 by applying 1600 N on C.M. of ARIS rack to the X, Y and Z direction, and 400 N-m about X and Y axis, 200 N-m about Z axis on C.M. of ARIS rack, respectively.

The calculated T_p^x was coded as *tptox1* in subroutine USCC attached in Appendix D.

3.3.2 Determination of Feedforward Compensating Stiffness Matrix

Total stiffness of ARIS system for SSFF IC1 was calculated using the procedures described in Section 4.4.3 with the standby mode gains of the ARIS PID position controller ($K_P = 5, K_D = 4, K_I = 5$) and second order low pass filter of 0.6 damping ratio and 2 Hz band width. The compensating stiffness matrix was determined by canceling out off-diagonal elements of the calculated total stiffness of ARIS system and adjusting the diagonal elements corresponding to 1.4 rad/sec frequency. This compensating stiffness matrix was coded as *pk* in subroutine USCC attached in Appendix D.

3.3.3 Transient Response Analysis with Initial Excitation

In order to demonstrate how well the ARIS system can overcome sudden disturbance, a 100 μg disturbance was given on the C.M. of base Body #1 to the X-, Y-, Z-directions for 1 second, and the transient response was calculated. For this transient response analysis condition the ARIS PID position controller had nominal gains ($K_P = 0.036, K_D = 6, K_I = 0.018$) and second order low pass filter of damping ratio 1 and 0.01 Hz band width.

The numerical results of this transient response analysis are shown in Figures 3.3.3-1 through 3.3.3-5. Figure 3.3.3-1 shows the measured accelerations at C.M. of the base Body #1 and the ARIS rack. It is clearly noticed that ARIS controller quickly sense the initial acceleration disturbance and remove it.

In Figure 3.3.3-2 and 3.3.3-3 the position errors at the C.M. of the ARIS rack calculated from the rotational angles of seven actuators about pivot points using T_p^x, that are input for PID position controller in actual flight condition, are compared with the measured position errors using the TREETOPS built-in sensors for the checking purpose. Initial translational position errors at the C.M. of the ARIS rack due to 100 N of 1 second pulse type disturbance are less than 4 mm and reduced to zero mm in 500 seconds. It is noticed that there are discrepancies between the rotational angle errors at the C.M. of the ARIS rack calculated from the rotational angles of seven actuators about pivot points using T_p^x and the rotational angle errors measured from the TREETOPS built-in sensors attached at the C.M. of ARIS rack, however the magnitudes are negligibly small under the small deflection assumption for linearization when these rotational angles are due to coupling effects due to translational motion.

The control forces along pushrods of the ARIS actuators that the ARIS controller requires to remove the acceleration disturbance given to the ARIS rack through umbilicals due to the 100 N 1 second pulse type disturbance given on the C.M. of the base Body #1 are shown in Figure 3.3.3-4. It is noticed that since actuator #1 was deleted, actuator #2 on the same side as actuator #1 takes most control force. Figure 3.3.3-5 shows actuator forces acting on the C.M. of moving motors of each actuators that are d_a/d_{cg} (=2.2871) times control forces shown in Figure 3.3.3-4.

3.3.4 Attenuation Performance Analysis

In order to estimate the attenuation performance of the ARIS system for SSFF IC1, the acceleration attenuation curve was determined by measuring the acceleration at the platform C.M. due to the frequency range of 0.001 Hz through 100 Hz of sinusoidal disturbances given to the base with position and acceleration controller active. For normal operating condition the ARIS PID position controller has gains ($K_P = 0.036, K_D = 6, K_I = 0.018$) and second order filter with damping ratio 1 and 0.01 Hz band width. Figure 3.3.4-1 shows the acceleration attenuation curve of the ARIS system obtained from TREETOPS simulation. It is noticed that below 0.03 Hz, the ARIS system slightly amplified the disturbance given to the ARIS rack as expected, however the ARIS system gives about 13 dB of attenuation at 0.1 Hz and about 33 dB of attenuation at 1 Hz for this disturbance.

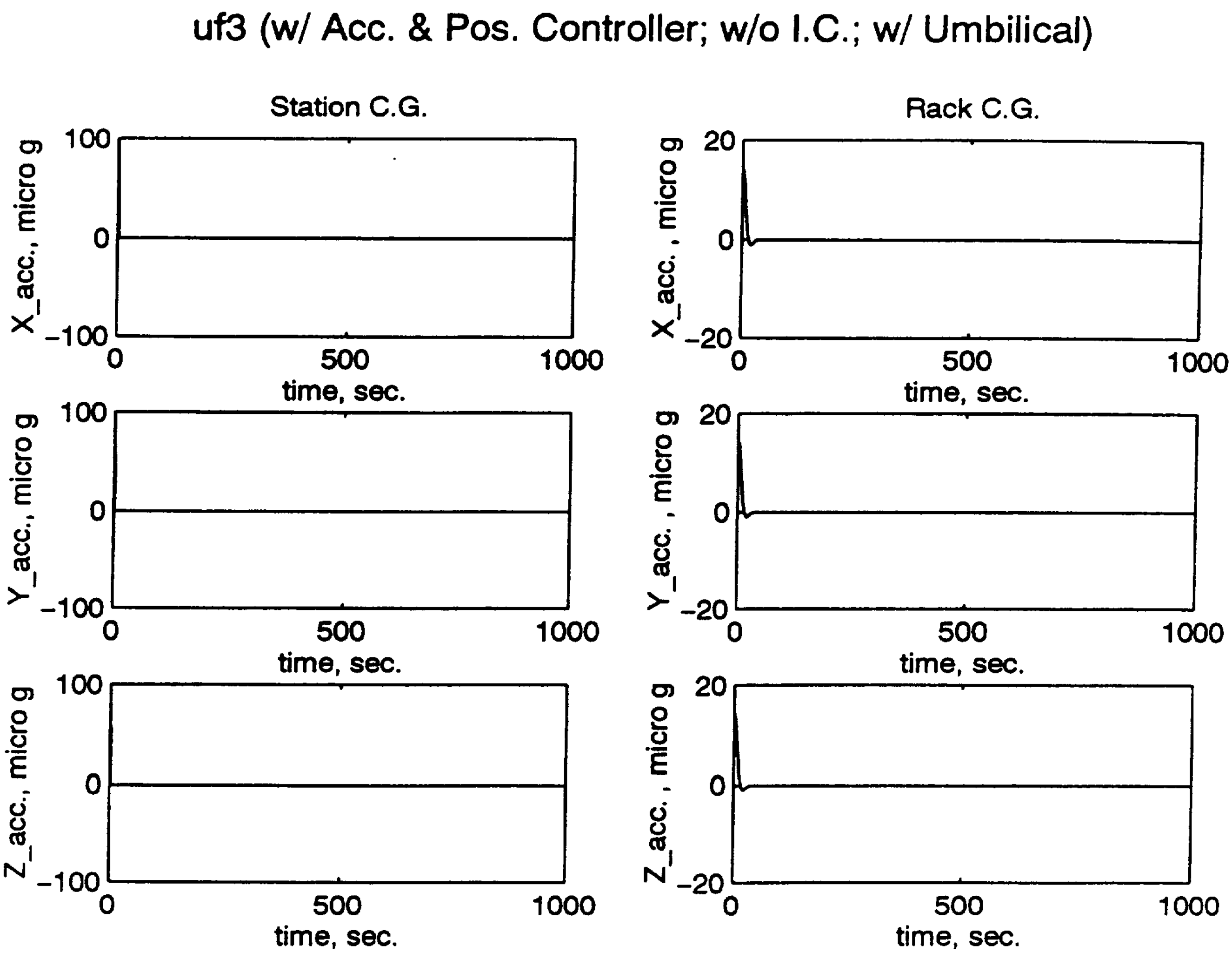

Figure 3.3.3-1: Measured Accelerations at C.M. of Body #1 and the ARIS Rack

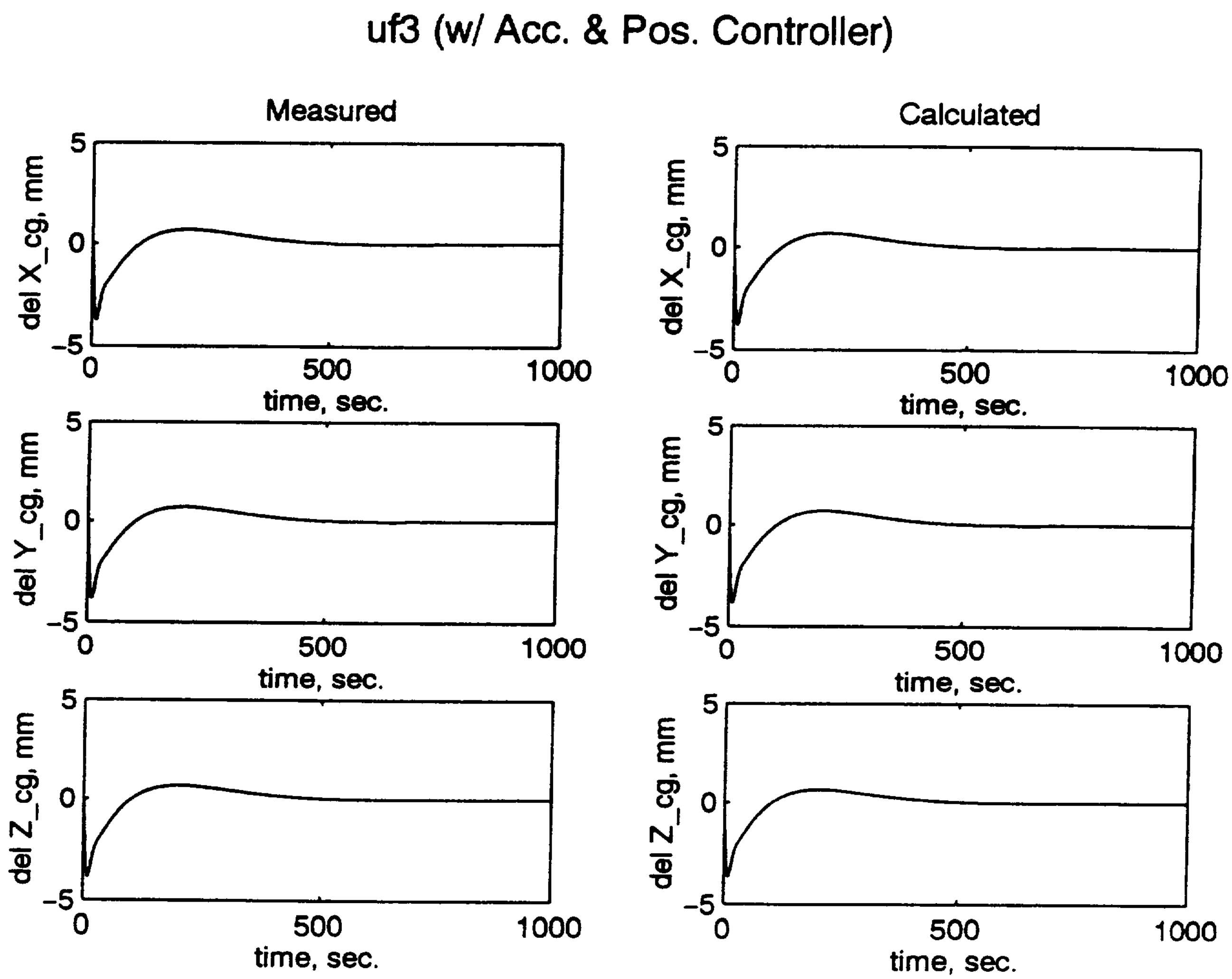

Figure 3.3.3-2: Translational Position Errors at the C.M. of the ARIS Rack

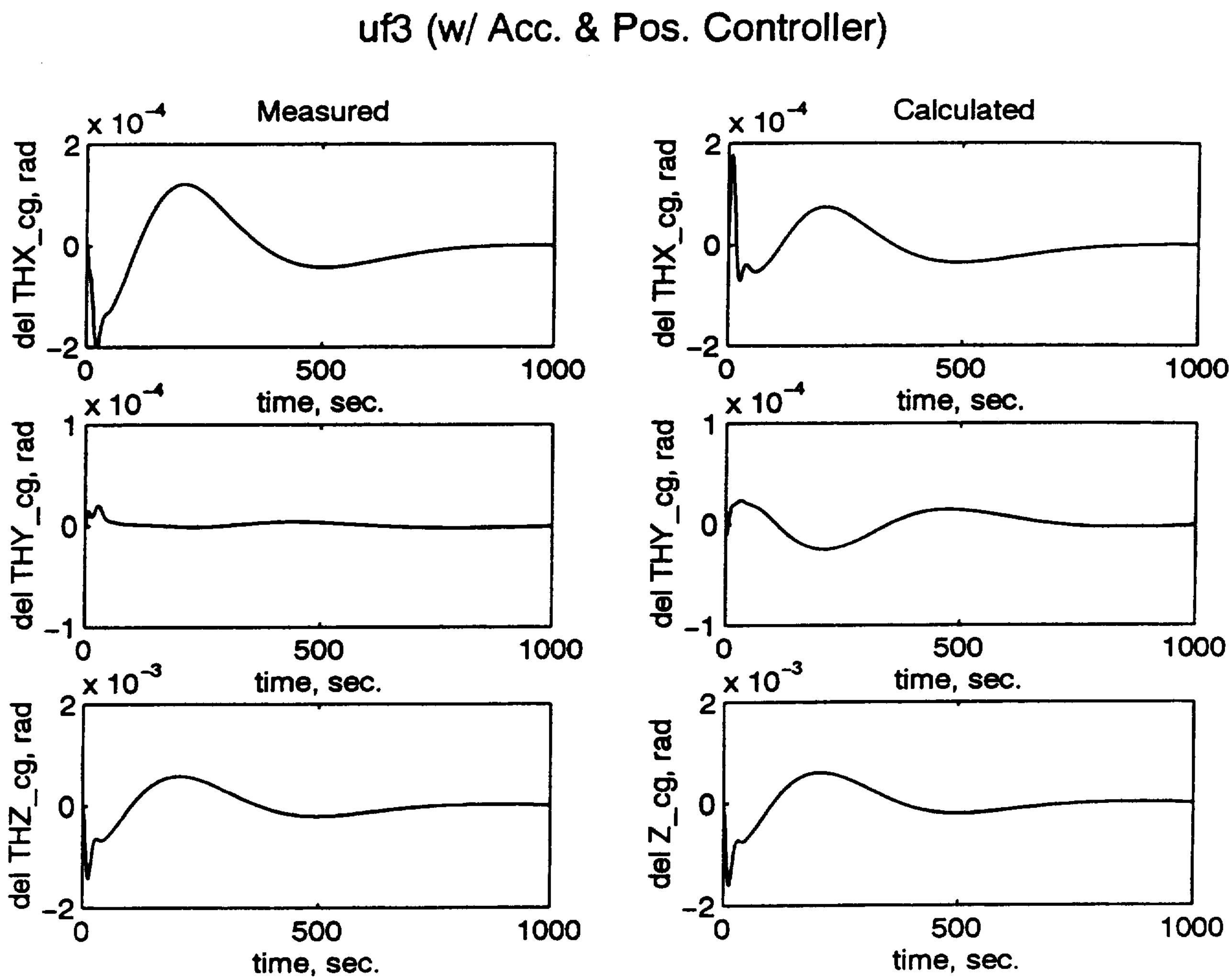

Figure 3.3.3-3: Rotational Position Errors at the C.M. of the ARIS Rack

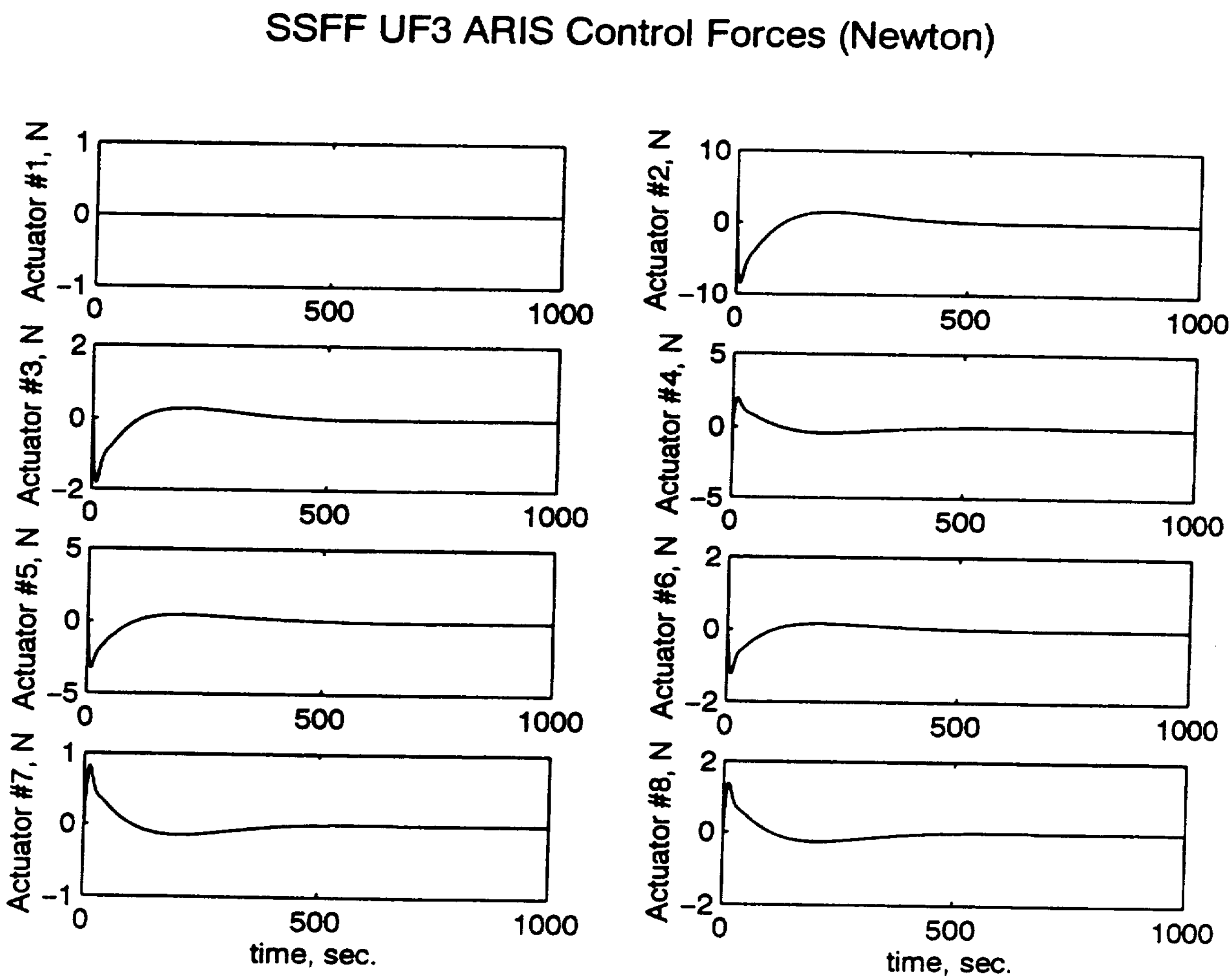

Figure 3.3.3-4: Control Forces along Pushrods of the ARIS Actuators

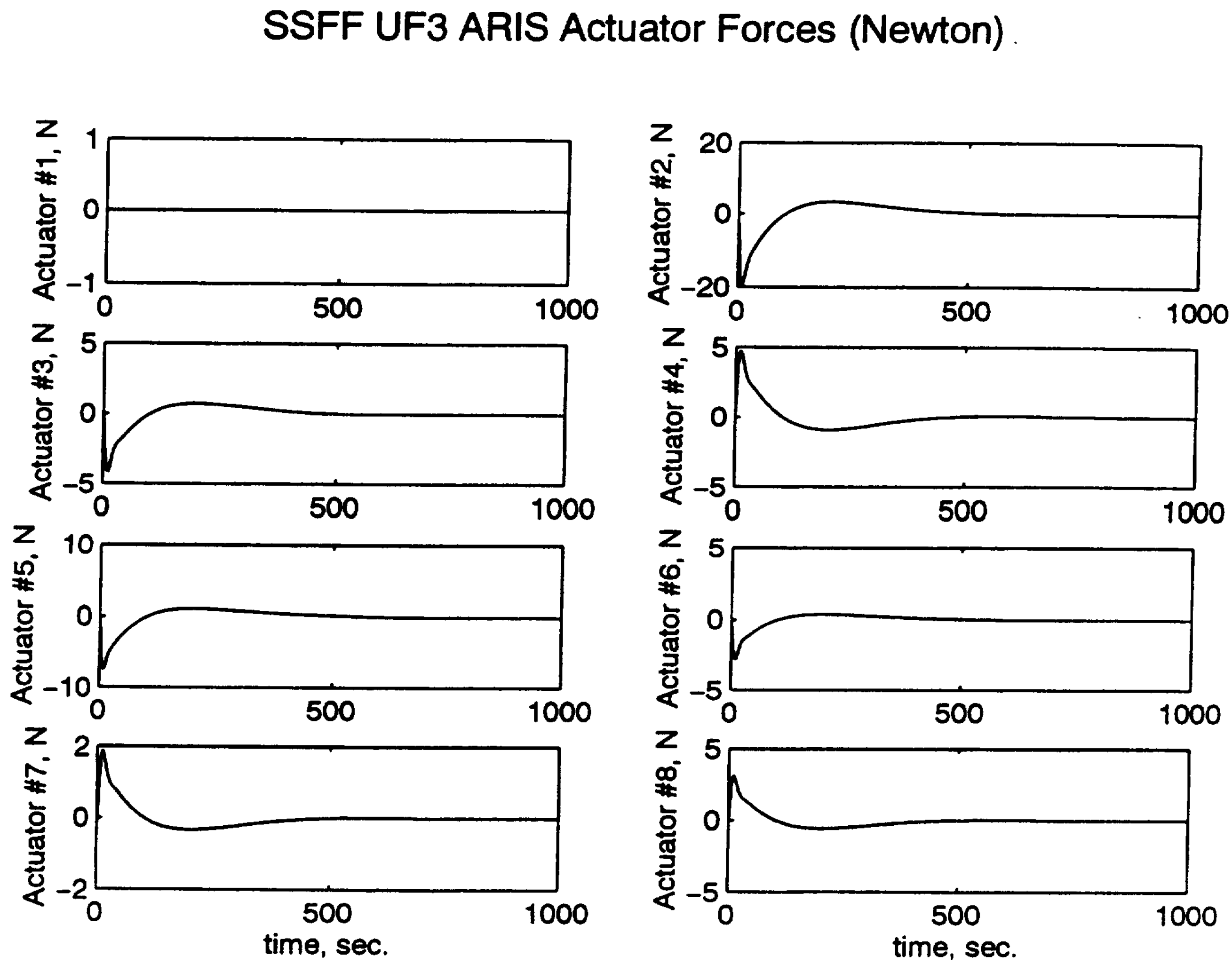

Figure 3.3.3-5: Actuator Forces on the C.M. of Moving Motors of Actuators

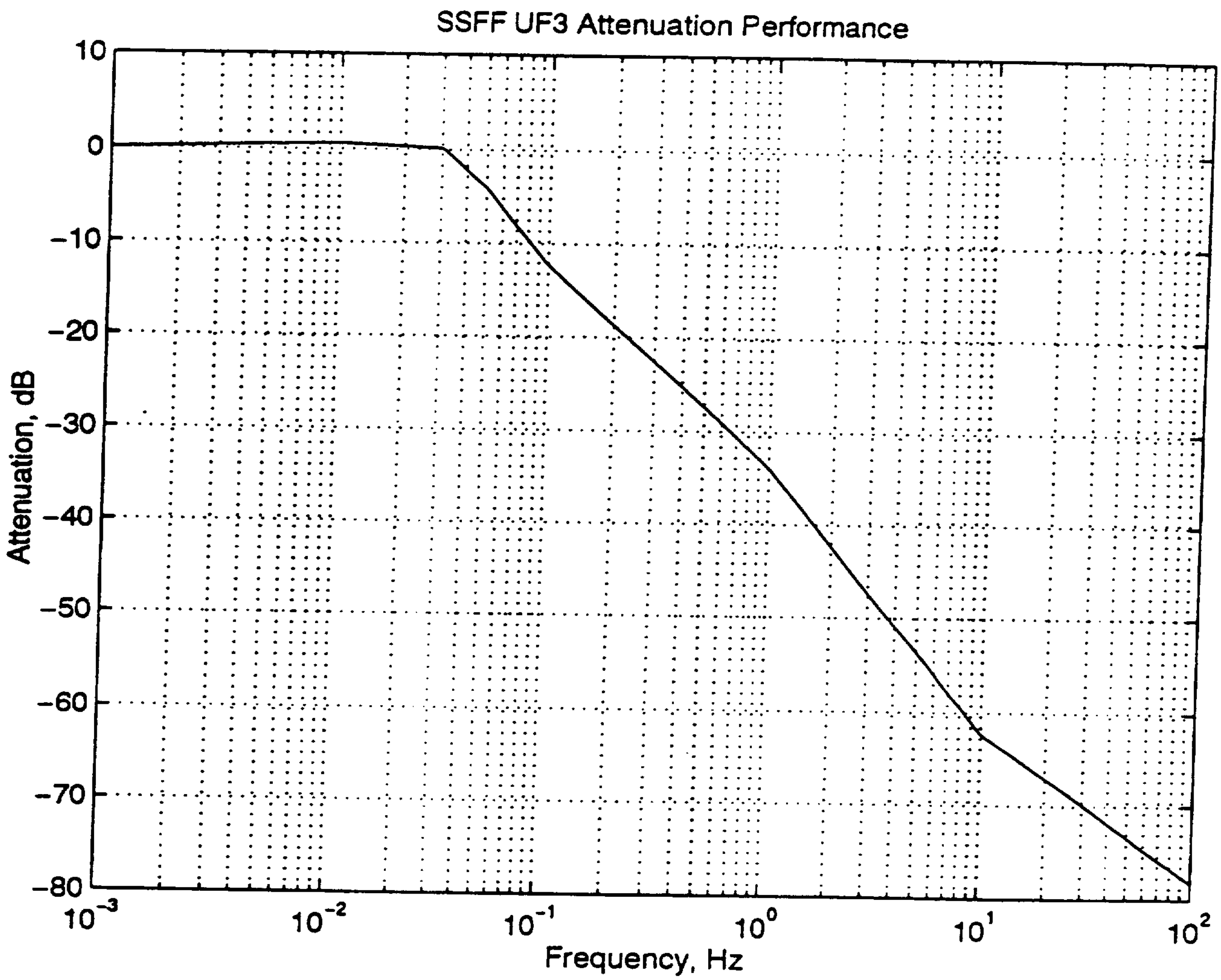

Figure 3.3.4-1: Acceleration Attenuation Curve of ARIS System for SSFF IC1

3.4 Conclusion

In Section 3 the details of high fidelity mathematical model of the ARIS dynamics/control system and its numerical simulation results for SSFF IC1 were documented. The multi-body simulation tool, TREETOPS was used to implemented the six DOF dynamics of the ARIS rack as well as the dynamic models of all sensors, actuators, and the control algorithm in the software. The standard TREETOPS simulation model developed for nominal ARIS configuration in this report could be easily modified and used to estimate the performance of the ARIS in the orbital environment for various ISSA μ-gravity experiments.

3.5 References

[1] Nurre, G., Whorton, S., Perkins, B., Eldridge, J., Patterson, A., Alhorn, D., Tyler, T., Matienzo, J., Kim, Y., "ARIS Independent Review Team Final Report," Marshall Space Flight Center, NASA, November 1995.

[2] Boeing Co. ARIS Team, Working Notes & Telecommunication

[2] "User's Manual for TREETOPS, A Control System Simulation for Structures With a Tree Topology," NASA Contract NAS-36287, Marshall Space Flight Center, April 1990.

Appendix A

STABLE User Defined Controller Subroutine

```
c     For STABLE.int
c     updated on 6/08/95
c
c     User Defined Continuous Controller for STABLE micro-gravity
c     vibratiion isolation system.
c--------------------------------------------------------
      SUBROUTINE USCC(T,U,X,R,XDOT)
      IMPLICIT DOUBLE PRECISION(A-H,O-Z)
      DIMENSION U(18),X(1),R(12),XDOT(1)
ccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
c Controller #3 input:
c     u(1)=  output #2  of controller #1
c     u(2)=  output #16 of controller #2
c     u(3)=  output #28 of controller #2
c     u(4)=  output #4  of controller #1
c     u(5)=  output #17 of controller #2
c     u(6)=  output #29 of controller #2
c     u(7)=  output #6  of controller #1
c     u(8)=  output #18 of controller #2
c     u(9)=  output #30 of controller #2
c     u(10)= output #8  of controller #1
c     u(11)= output #19 of controller #2
c     u(12)= output #31 of controller #2
c     u(13)= output #10 of controller #1
c     u(14)= output #20 of controller #2
c     u(15)= output #32 of controller #2
c     u(16)= output #12 of controller #1
c     u(17)= output #21 of controller #2
c     u(18)= output #33 of controller #2
c
c Controller #3 output:
c     r(1) = input #4  of controller #1
c     r(2) = input #5  of controller #1
c     r(3) = input #9  of controller #1
c     r(4) = input #10 of controller #1
c     r(5) = input #14 of controller #1
c     r(6) = input #15 of controller #1
c     r(7) = input #19 of controller #1
c     r(8) = input #20 of controller #1
c     r(9) = input #24 of controller #1
c     r(10)= input #25 of controller #1
c     r(11)= input #29 of controller #1
c     r(12)= input #30 of controller #1
ccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
      do 10 k=1,6
         r(2*k-1) = u(3*k-2)*u(k*3)
         r(2*k) = u(3*k-1)*u(k*3)
 10   continue
      RETURN
      END
c
c--------------------------------------------------------
c
      SUBROUTINE USDC(T,U,R)
      IMPLICIT DOUBLE PRECISION(A-H,O-Z)
      INCLUDE 'DBP.F'
      INCLUDE 'DBC.F'
      DOUBLE PRECISION KD,KP,KI
      DOUBLE PRECISION KDLOW,KDHIGH,KPLOW,KPHIGH,KILOW,KIHIGH
      double precision KLLOW,KLHIGH,kalow, kahigh
      DIMENSION U(27),R(82),Ctrl(3,3),rvec(9)
      DIMENSION D(6),TM(6,6),D1(6),D0(6),RATE(6),CR0(6),CR1(6),CR(6)
      DIMENSION CP(6),XI(6),XI0(6),CILOW(6),CIHIGH(6)
      DIMENSION XIDELTAL(6),XIDELTAH(6),cobias1(6),cobias2(6)
      dimension PF(6),PC(6),IGAIN(6),XILCHECK(6),NCOUNT(6)
C
C     User Defined Discrete Controller
C
ccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
c Controller #2 Input:
c     u(1):  SE401 (Star Sensor #1 at B2N3), beta_1 (y component)
c     u(2):  SE401 (Star Sensor #1 at B2N3), beta_2 (z component)
c     u(3):  SE501 (Star Sensor #2 at B2N5), beta_1 (y component)
c     u(4):  SE501 (Star Sensor #2 at B2N5), beta_2 (z component)
c     u(5):  SE601 (Star Sensor #3 at B2N7), beta_1 (y component)
```

```
c      u(6):  SE601 (Star Sensor #3 at B2N7), beta_2 (z component)
c      u(7):  SE701 (Position vector sensor #1 at B2N3), dx (x component)
c      u(8):  SE701 (Position vector sensor #1 at B2N3), dy (y component)
c      u(9):  SE701 (Position vector sensor #1 at B2N3), dz (z component)
c      u(10)  SE801 (Position vector sensor #2 at B2N5), dx (x component)
c      u(11): SE801 (Position vector sensor #2 at B2N5), dy (y component)
c      u(12): SE801 (Position vector sensor #2 at B2N5), dz (z component)
c      u(13): SE901 (Position vector sensor #3 at B2N7), dx (x component)
c      u(14): SE901 (Position vector sensor #3 at B2N7), dy (y component)
c      u(15): SE901 (Position vector sensor #3 at B2N7), dz (z component)
c      u(16): SE402 (Star Sensor #4 at B1N3), beta_1 (y component)
c      u(17): SE402 (Star Sensor #4 at B1N3), beta_2 (z component)
c      u(18): SE502 (Star Sensor #5 at B1N5), beta_1 (y component)
c      u(19): SE502 (Star Sensor #5 at B1N5), beta_2 (z component)
c      u(20): SE602 (Star Sensor #6 at B1N7), beta_1 (y component)
c      u(21): SE602 (Star Sensor #6 at B1N7), beta_2 (z component)
c      u(22): SE911 (Position vector sensor #4 at B2N1), dx (x component)
c      u(23): SE911 (Position vector sensor #4 at B2N1), dy (y component)
c      u(24): SE911 (Position vector sensor #4 at B2N1), dz (z component)
c      u(25): SE922 (IMU sensor #2 at B1N1), Theta_x
c      u(26): SE922 (IMU sensor #2 at B1N1), Theta_y
c      u(27): SE922 (IMU sensor #2 at B1N1), Theta_z
c
c Controller #2 Output:
c The followings are calculated from analytic equation.
c      r(1):  #1 position sensor error y component
c      r(2):  #1 position sensor error z component
c      r(3):  #2 position sensor error y component
c      r(4):  #2 position sensor error z component
c      r(5):  #3 position sensor error y component
c      r(6):  #3 position sensor error z component
c      r(7):  payload (body 2) C.M x displacement w.r.t body 1 frame
c      r(8):  payload (body 2) C.M y displacement w.r.t body 1 frame
c      r(9):  payload (body 2) C.M z displacement w.r.t body 1 frame
c      r(10): payload (body 2) C.M Theta_x w.r.t body 1 frame
c      r(11): payload (body 2) C.M Theta_y w.r.t body 1 frame
c      r(12): payload (body 2) C.M Theta_z w.r.t body 1 frame
c The follwoings are obtained from TREETOPS.
c      r(13):  payload (body 2) C.M x displacement w.r.t body 1 frame
c      r(14):  payload (body 2) C.M y displacement w.r.t body 1 frame
c      r(15):  payload (body 2) C.M z displacement w.r.t body 1 frame
c      r(16)-r(21): PID controller ouput
c      r(22)-r(27): Displacement of actuator gap
c      r(28)-r(33): High/Low continuous integral controller gain
c      r(34):  High/Low gain loop flag (1.=high, 0.=low)
c      r(35)-r(40): PID fine control loop output
c      r(41)-r(46): PID coarse control loop output
c      r(47)-r(52): PID proportional channel signal (before quantization )
c      r(53)-r(58): PID rate channel signal (before quantization)
c      r(59)-r(64): PID low integral channel signal (before quantization)
c      r(65)-r(70): PID high integral channel signal (before quantization)
c      r(71)-r(76): PID rate signal
c      r(77)-r(82): PID integral signal
c
c Nominal values of control parameters:
c
C      Continous integral controller gain
c          kalow=  cntdta(1)=[3.d4]
c          kahigh= cntdta(2)=[3.d2]
C      PID low gains
c          KDLOW=  cntdta(3)=[8.8d-2]
c          KPLOW=  cntdta(4)=[4.d-3]
c          KILOW=  cntdta(5)=[20.d-5]
C      PID high gains
c          KDHIGH= cntdta(6)=[2.d0]
c          KPHIGH= cntdta(7)=[4.d-1]
c          KIHIGH= cntdta(8)=[4.d-2]
C      Rate low pass filter
c          CA=     cntdta(9)=[6.28d0]
C
C      Integral loop limiters
c          CILMAX= XILCHECK*KILOW
c                = cntdta(10)*(1 micro g)=[2.D1]*(9.8D0)*(1.D-6)
c          CILIM1= cntdta(11)*(1 micro g)=[1.D2]*(9.8D0)*(1.D-6)
c          CILIM2= cntdta(12)*(1 micro g)=[1.D4]*(9.8D0)*(1.D-6)
```

```
c      Displacements boundary for low/high gain loop
c           DLOW=   cntdta(13)=[1.d-3]
c           DHIGH=  cntdta(14)=[9.d-3]
c      PID compensation adjustment
c           CILDEL= UXIDEL*KIHIGH
c                 = cntdta(15)*RLSB2=[1.d0]*(1.D1)*(9.8D0)*(1.D-6)
c      Least Significant Beats of low/hign gain loop
c           RLSB1=  cntdta(16)*(1 micro g)=[1.d-1]*(9.8D0)*(1.D-6)
c           RLSB2=  cntdta(17)*(1 micro g)=[1.d1]*(9.8D0)*(1.D-6)
c      PID controller total loop gains
c           KLLOW=  cntdta(18)=[5.d0]
c           KLHIGH= cntdta(19)=[1.d0]
c      PID controller sampling time.
c           TS=cntdta(20)=[0.1d0]
c      Number of H/L gain pass tests
c           NSTEP=cntdta(21)=[100]
c      Initial high/low gain mode setting(1=low, 2=high gain mode)
c           INITMODE=cntdta(22)=[2]
c      Selected No. of PID controller channel
c           NCH=cntdta(23)=[6]
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
c Initialization
      if (t .eq. 0.D0) then        !beginning of initialization
c
c      Define location of C.M., Laser and Position sensor
c
      r1=0.004d0
      r2=-0.02d0
      r3=0.067d0
      s=0.139d0
      sd3=0.139d0
      dgap=0.0147d0
c
c      Acutaor Gap Position w.r.t Body 1 coordinate system
c
      R11=0.d0
      R12=0.1433D0
      R13=0.0423d0
      R21=-0.1218D0
      R22=-0.1735D0
      R23=0.0423d0
      R31=0.1218D0
      R32=-0.1735D0
      R33=0.0423d0
c
      A=DSQRT(2.D0)/2
c
c      DEFINE TRANSFORMATION MATRIX BETWEEN DISPLACEMENTS AT C.M AND
c      ACTUATOR GAP POSITION.
c
      DO 10 I=1,6
      DO 10 J=1,6
         TM(I,J)=0.D0
 10   CONTINUE
      TM(1,1)=1.D0
      TM(1,5)=(R13-r3)
      TM(1,6)=-(R12-r2)
      TM(2,3)=1.D0
      TM(2,4)=+(R12-r2)
      TM(2,5)=-(R11-r1)
      TM(3,1)=-A
      TM(3,2)=A
      TM(3,4)=-A*(R23-r3)
      TM(3,5)=-A*(R23-r3)
      TM(3,6)=A*(R21-r1+R22-r2)
      TM(4,3)=1.D0
      TM(4,4)=(R22-r2)
      TM(4,5)=-(R21-r1)
      TM(5,1)=-A
      TM(5,2)=-A
      TM(5,4)=A*(R33-r3)
      TM(5,5)=-A*(R33-r3)
      TM(5,6)=A*(R32-r2-R31+r1)
      TM(6,3)=1.D0
      TM(6,4)=(R32-r2)
```

```
      TM(6,5)=-(R31-r1)
C
C     DEFINE CONTROLLER PARAMETERS
C
      kalow=cntdta(1)
      kahigh=cntdta(2)
      KLLOW=CNTDTA(18)
      KLHIGH=CNTDTA(19)
C      THIGH=CNTDTA(20)
C
C     PID Controller Initialization
C
      INITMODE=cntdta(22)
      DO 1 I=1,6
          DO(I)=0.D0
          CR0(I)=0.D0
          XI0(I)=0.D0
          XIDELTAL(I)=0.d0
          XIDELTAH(I)=0.d0
cyk           IGAIN(I)=1          ! low gain loop setting
cyk           IGAIN(I)=2          ! high gain loop setting
          IGAIN(I)=INITMODE
          NCOUNT(I)=0
          cobias1(i)=0.d0
          cobias2(i)=0.d0
    1 CONTINUE
C
C     PID low gains
C
      KDLOW=cntdta(3)
      KPLOW=cntdta(4)
      KILOW=cntdta(5)
C
C     PID high gains
C
      KDHIGH=cntdta(6)
      KPHIGH=cntdta(7)
      KIHIGH=cntdta(8)
C
      TS=cntdta(20)
      CA=cntdta(9)
C
      CILMAX=cntdta(10)
      CILIM1=cntdta(11)
      CILIM2=cntdta(12)
      DO 2 I=1,6
           XILCHECK(I)=(CILMAX)*(9.8)*(1.E-6)/KILOW
    2 CONTINUE
C
      DLOW=cntdta(13)
      DHIGH=cntdta(14)
      NSTEP=cntdta(21)
C
      RLSB1=cntdta(16)*(9.8D0)*(1.D-6)
      RLSB2=cntdta(17)*(9.8D0)*(1.D-6)
cyk      UXIDEL=cntdta(15)*RLSB2/KIHIGH
      UXIDEL=cntdta(15)*RLSB2/KILOW
      NCH=cntdta(23)
      nlow=1
c
      endif     !end of initialization
c
c Determine a transpose of transformation matrix Ctr1 from inertial
c frame to body 1 frame using three Euler angles (theta_x, theta_y, theta_z)
c obtained from IMU sensor fixed on C.M. of body 1.
c
          s1 = DSIN(u(25))
          c1 = DCOS(u(25))
          s2 = DSIN(u(26))
          c2 = DCOS(u(26))
          s3 = DSIN(u(27))
          c3 = DCOS(u(27))
c
c Transpose of C matrix from inertial frame to body 1 frame
c
```

```
      Ctrl(1,1)=c2*c3
      Ctrl(2,1)=-c2*s3
      Ctrl(3,1)=s2
      Ctrl(1,2)=s1*s2*c3+s3*c1
      Ctrl(2,2)=-s1*s2*s3+c3*c1
      Ctrl(3,2)=-s1*c2
      Ctrl(1,3)=-c1*s2*c3+s3*s1
      Ctrl(2,3)=c1*s2*s3+c3*s1
      Ctrl(3,3)=c1*c2
c
c Transform relative position vector from inertial frame to body 1 frame
c
      CALL MDM(Ctrl,u(7),rvec(1),3,3,3,1)
      CALL MDM(Ctrl,u(10),rvec(4),3,3,3,1)
      CALL MDM(Ctrl,u(13),rvec(7),3,3,3,1)
c
c Determine projection angle from laser position sensor.
c
      th13 = u(1) - u(16)
      th12 = u(2) - u(17)
      th23 = u(3) - u(18)
      th22 = u(4) - u(19)
      th33 = u(5) - u(20)
      th31 = u(6) - u(21)
c
c Determine position sensor errors.
c
      r(1)=-rvec(2) + dabs(rvec(1)) * dtan(th13)
      r(2)= rvec(3) - dabs(rvec(1)) * dtan(th12)
      r(3)= rvec(5) - dabs(rvec(4)) * dtan(th23)
      r(4)= rvec(6) - dabs(rvec(4)) * dtan(th22)
      r(5)=-rvec(7) + dabs(rvec(8)) * dtan(th33)
      r(6)= rvec(9) - dabs(rvec(8)) * dtan(th31)

c     Determine C.M. movement of payload (body 2) w.r.t.
c     body 1 frame using analytic equation.
c
      r(12)=-(r(1)+r(3))/(2*(s+dgap))
      r(11)=-(r(2)-r(4))/(2*(s+dgap))
      A1=-r(6)+(r(2)+r(4))/2+r(5)*r(11)-r3*r(11)*r(11)
     &  +(sd3+dgap+r2)*r(11)*r(12)
      B1=(r(3)-r(1))/2+r1*r(12)+r(12)*(-r(5)+r3*r(11)
     &   -(sd3+dgap+r2)*r(12))
      a2=1+r(12)*r(12)
      b2=(sd3+dgap)*a2+r3*r(11)*r(12)-B1
      c=r3*A1-B1*(sd3+dgap)
      r(8)=(-b2+dsqrt((b2*b2-4*a2*c)))/(2*a2)
      r(7)=-r(5)+r3*r(11)-(sd3+dgap+r2)*r(12)-r(8)*r(12)
      r(10)=(A1+r(11)*r(12)*r(8))/(sd3+dgap+r(8))
      r(9)=(r(2)+r(4))/2+r2*r(10)-r1*r(11)-r(7)*r(11)
c
c     Determine C.M. movement of payload (body 2) w.r.t.
c     body 1 frame from TREETOPS sensor output.
c
      CALL MDM(Ctrl,u(22),r(13),3,3,3,1)
C
C     DETERMINE DISPLACEMENTS OF ACTUATOR GAP POSITION FROM C.M MOVEMENTS
C
      CALL MDM(TM,r(7),D,6,6,6,1)
C
      NSET=1
      ILOOP=1
      DO 100 K=1,6
C
C     DETERMINE LOW OR HIGH GAIN LOOP BASED ON ACTUATOR GAP POSITION
C
      IF (IGAIN(K) .EQ. 1 .AND. DABS(D(K)) .LE. DHIGH) THEN
          IGAIN(K)=1
      ELSEIF (IGAIN(K) .EQ. 1 .AND. DABS(D(K)) .GT. DHIGH) THEN
          IGAIN(K)=2
      ELSEIF (IGAIN(K) .EQ. 2 .AND. DABS(D(K)) .GE. DLOW) THEN
          NSET=0
          IGAIN(K)=2
      ELSEIF (IGAIN(K) .EQ. 2 .AND. DABS(D(K)) .LT. DLOW) THEN
          NCOUNT(K)=NCOUNT(K)+1
```

```
          IF (NCOUNT(K) .GE. NSTEP) THEN
              IGAIN(K)=1
          ELSE
              IGAIN(K)=2
          ENDIF
      ENDIF
      ILOOP=ILOOP*IGAIN(K)
 100  CONTINUE
C
      IF (ILOOP .EQ. 1) THEN
          KD=KDLOW
          KP=KPLOW
cyk          KI=KILOW
      ELSE
          KD=KDHIGH
          KP=KPHIGH
cyk          KI=KIHIGH
          do 110 i=1,6
              igain(i)=2      !resetting for high gain loop
              NCOUNT(I)=NCOUNT(I)*NSET
 110      continue
      ENDIF
C
      DO 200 K=1,6
C
C     RATE COTROLLER COMPONENT
C
      D1(K)=D(K)
          if (t .eq. 0.D0 ) then
              RATE(k)=0.d0
          else
              RATE(K)=(D1(K)-D0(K))/TS
          endif
      D0(K)=D1(K)
      cr1(K)=(RATE(K)*CA*TS+CR0(K))/(1+CA*TS)       !with filter
      CR0(K)=cr1(K)
      cr(k)=kd*cr1(k)
C
C     POSITION CONTROLLER COMPONENT
C
      CP(K)=KP*D(K)
C
      IF(ILOOP .EQ. 1) THEN
C
C     LOW GAIN PID INTEGRAL LOOP
C
      XI(K)=(D(K)*TS+XI0(K))*nlow
      XI0(K)=XI(K)
          XILEXCES= DABS(XI(K)-XIDELTAL(K)) - XILCHECK(K)
          IF(XILEXCES .GT. 0) THEN
              XILDUMP=INT(XILEXCES/UXIDEL)*UXIDEL
              XIDELTAL(K)=XIDELTAL(K)+XILDUMP*SGN(XI(K))
              XIDELTAH(K)=XIDELTAH(K)+XILDUMP*(KILOW/KIHIGH)*SGN(XI(K))
          ENDIF
          CILOW(K)=(XI(K)-XIDELTAL(K))*KILOW
cyk             IF(DABS(CILOW(K)) .GE. CILIM1) THEN
cyk                  CILOW(K)=SGN(CILOW(K))*CILIM1
cyk              ENDIF
          CIHIGH(K)=XIDELTAH(K)*KIHIGH
C
          PF(K)=INT(DABS(((CR(K)+CP(K)+CILOW(K))*KLLOW)+RLSB1/2)/RLSB1)
     &           *RLSB1*SGN((CR(K)+CP(K)+CILOW(K)))
          PC(K)=INT(DABS((CIHIGH(K)*KLHIGH+cobias2(k))+RLSB2/2)/RLSB2)
     &           *RLSB2*SGN(CIHIGH(K)*KLHIGH+cobias2(k))  ! quantization
cyk        cobias1(k)=CIHIGH(K)*KLHIGH+cobias2(k)
      ELSE
C
C     HIGH GAIN PID INTEGRAL LOOP
C
      XI(K)=(D(K)*TS+XI0(K))
      XI0(K)=XI(K)
          XIDELTAH(K)=0.d0
          XIDELTAL(K)=0.d0
          CILOW(K)=0.D0
          CIHIGH(K)=XI(K)*KIHIGH
```

```
cyk             IF(DABS(CIHIGH(K)) .GE. CILIM2) THEN
cyk                 CIHIGH(K)=SGN(CIHIGH(K))*CILIM2
cyk             ENDIF
       PF(K)=0.D0
cyk        PC(K)=INT(DABS(((CR(K)+CP(K)+CIHIGH(K))*KLHIGH+cobias1(k))
cyk       &        +RLSB2/2)/RLSB2)
cyk       &        *RLSB2*SGN((CR(K)+CP(K)+CIHIGH(K))*KLHIGH+cobias1(k))
cyk        cobias2(k)=(CR(K)+CP(K)+CIHIGH(K))*KLHIGH+cobias1(k)
       PC(K)=INT(DABS(((CR(K)+CP(K)+CIHIGH(K))*KLHIGH)
     &        +RLSB2/2)/RLSB2)
     &        *RLSB2*SGN((CR(K)+CP(K)+CIHIGH(K))*KLHIGH)
       cobias2(k)=(CR(K)+CP(K)+CIHIGH(K))*KLHIGH
       ENDIF
C
       R(K+15)=PF(K)+PC(K)
       R(K+21)=D(K)
       R(K+34)=PF(K)
       R(K+40)=PC(K)
c
       r(k+46)=cp(k)
       r(k+52)=cr(k)
       r(k+58)=cilow(k)
       r(k+64)=cihigh(k)
       r(k+70)=rate(k)
       r(k+76)=XI(k)
c
 200   CONTINUE
C
       if (ILOOP .EQ. 1) then
           do 21 i1=1,6
  21           r(i1+27)=kalow
               r(34)=0.d0
               nlow=1
       else
           do 22 i2=1,6
  22           r(i2+27)=kahigh
               r(34)=1.d0
               nlow=0
       endif
c
cyk        r(47)=cr(NCH)
cyk        r(48)=cp(NCH)
cyk        r(49)=cilow(NCH)
cyk        r(50)=cihigh(NCH)
cyk        r(51)=rate(NCH)
cyk        r(52)=XI(NCH)
      RETURN
      END
```

Appendix B

STABLE TREETOPS Input File

TREETOPS REV 10 06/05/95

SIM CONTROL

1	SI	0	Title	IC ONLY
2	SI	0	Simulation stop time	100.
3	SI	0	Plot data interval	0.2
4	SI	0	Integration type (R,S or U)	R
5	SI	0	Step size (sec)	5E-4
6	SI	0	Sandia integration absolute and relative error	
7	SI	0	Linearization option (L,Z or N)	L
8	SI	0	Restart option (Y/N)	N
9	SI	0	Contact force computation option (Y/N)	N
10	SI	0	Constraint force computation option (Y/N)	N
11	SI	0	Small angle speedup option (All,Bypass,First,Nth)	A
12	SI	0	Mass matrix speedup option (All,Bypass,First,Nth)	A
13	SI	0	Non-Linear speedup option (All,Bypass,First,Nth)	A
14	SI	0	Constraint speedup option (All,Bypass,First,Nth)	A
15	SI	0	Constraint stabilization option (Y/N)	N
16	SI	0	Stabilization epsilon	

BODY

17	BO	1	Body ID number	1
18	BO	1	Type (Rigid,Flexible,NASTRAN)	R
19	BO	1	Number of modes	
20	BO	1	Modal calculation option (0, 1 or 2)	
21	BO	1	Foreshortening option (Y/N)	
22	BO	1	Model reduction method (NO,MS,MC,CC,QM,CV)	
23	BO	1	NASTRAN data file FORTRAN unit number (40 - 60)	
24	BO	1	Number of augmented nodes (0 if none)	
25	BO	1	Damping matrix option (NS,CD,HL,SD)	
26	BO	1	Constant damping ratio	
27	BO	1	Low frequency, High frequency ratios	
28	BO	1	Mode ID number, damping ratio	
29	BO	1	Conversion factors: Length,Mass,Force	
30	BO	1	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
31	BO	1	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.E7,1.E7,1.E7
32	BO	1	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0,0,0
33	BO	1	Mass (kg)	1.E5
34	BO	1	Number of Nodes	12
35	BO	1	Node ID, Node coord. (meters) x,y,z	1,0,0,0.02
36	BO	1	Node ID, Node coord. (meters) x,y,z	2,0,0,0
37	BO	1	Node ID, Node coord. (meters) x,y,z	3,0.1537,0,0
38	BO	1	Node ID, Node coord. (meters) x,y,z	4,-0.1537,0,0
39	BO	1	Node ID, Node coord. (meters) x,y,z	5,0,-0.1537,0
40	BO	1	Node ID, Node coord. (meters) x,y,z	6,0.004,-0.02,0.067
41	BO	1	Node ID, Node coord. (meters) x,y,z	7,10.0686,-0.0787,-0.0205
42	BO	1	Node ID, Node coord. (meters) x,y,z	8,0.0686,9.9213,-0.0205
43	BO	1	Node ID, Node coord. (meters) x,y,z	9,0.0686,-0.0787,9.9795
44	BO	1	Node ID, Node coord. (meters) x,y,z	10,9.9314,-0.0787,-0.0205
45	BO	1	Node ID, Node coord. (meters) x,y,z	11,-0.0686,9.9213,-0.0205
46	BO	1	Node ID, Node coord. (meters) x,y,z	12,-0.0686,-0.0787,9.9795
47	BO	1	Node ID, Node structual joint ID	
48	BO	2	Body ID number	2
49	BO	2	Type (Rigid,Flexible,NASTRAN)	R
50	BO	2	Number of modes	
51	BO	2	Modal calculation option (0, 1 or 2)	
52	BO	2	Foreshortening option (Y/N)	
53	BO	2	Model reduction method (NO,MS,MC,CC,QM,CV)	
54	BO	2	NASTRAN data file FORTRAN unit number (40 - 60)	
55	BO	2	Number of augmented nodes (0 if none)	
56	BO	2	Damping matrix option (NS,CD,HL,SD)	
57	BO	2	Constant damping ratio	
58	BO	2	Low frequency, High frequency ratios	
59	BO	2	Mode ID number, damping ratio	
60	BO	2	Conversion factors: Length,Mass,Force	
61	BO	2	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
62	BO	2	Moments of inertia (kg-m2) Ixx,Iyy,Izz	0.167,0.108,0.179

63	BO	2	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0,0,0
64	BO	2	Mass (kg)	12.646
65	BO	2	Number of Nodes	16
66	BO	2	Node ID, Node coord. (meters) x,y,z	1,0.004,-0.020,0.067
67	BO	2	Node ID, Node coord. (meters) x,y,z	2,0,0,0
68	BO	2	Node ID, Node coord. (meters) x,y,z	3,0.139,0,0
69	BO	2	Node ID, Node coord. (meters) x,y,z	4,0.0411,0.0942,0.0754
70	BO	2	Node ID, Node coord. (meters) x,y,z	5,0,0.1433,0.0423
71	BO	2	Node ID, Node coord. (meters) x,y,z	6,-0.139,0,0
72	BO	2	Node ID, Node coord. (meters) x,y,z	7,-0.1218,-0.1735,0.0423
73	BO	2	Node ID, Node coord. (meters) x,y,z	8,-0.0582,-0.1696,0.0754
74	BO	2	Node ID, Node coord. (meters) x,y,z	9,0,-0.139,0
75	BO	2	Node ID, Node coord. (meters) x,y,z	10,0.0582,-0.1696,0.0754
76	BO	2	Node ID, Node coord. (meters) x,y,z	11,0.1218,-0.1735,0.0423
77	BO	2	Node ID, Node coord. (meters) x,y,z	12,0.0686,-0.0787,-0.0205
78	BO	2	Node ID, Node coord. (meters) x,y,z	13,-0.0686,-0.0787,-0.0205
79	BO	2	Node ID, Node coord. (meters) x,y,z	14,0,0.0942,-0.0206
80	BO	2	Node ID, Node coord. (meters) x,y,z	15,-0.0918,-0.1388,-0.0206
81	BO	2	Node ID, Node coord. (meters) x,y,z	16,0.0918,-0.1388,-0.0206
82	BO	2	Node ID, Node structual joint ID	

HINGE

83	HI	1	Hinge ID number	1
84	HI	1	Inboard body ID, Outboard body ID	0,1
85	HI	1	"p" node ID, "q" node ID	0,2
86	HI	1	Number of rotation DOFs, Rotation option (F or G)	3,F
87	HI	1	L1 unit vector in inboard body coord. x,y,z	1,0,0
88	HI	1	L1 unit vector in outboard body coord. x,y,z	1,0,0
89	HI	1	L2 unit vector in inboard body coord. x,y,z	
90	HI	1	L2 unit vector in outboard body coord. x,y,z	
91	HI	1	L3 unit vector in inboard body coord. x,y,z	0,0,1
92	HI	1	L3 unit vector in outboard body coord. x,y,z	0,0,1
93	HI	1	Initial rotation angles (deg)	0 0 0
94	HI	1	Initial rotation rates (deg/sec)	0 0 0
95	HI	1	Rotation stiffness (newton-meters/rad)	0 0 0
96	HI	1	Rotation damping (newton-meters/rad/sec)	0 0 0
97	HI	1	Null torque angles (deg)	0 0 0
98	HI	1	Number of translation DOFs	3
99	HI	1	First translation unit vector g1	1 0 0
100	HI	1	Second translation unit vector g2	0 1 0
101	HI	1	Third translation unit vector g3	0 0 1
102	HI	1	Initial translation (meters)	0,0,0
103	HI	1	Initial translation velocity (meters/sec)	0 0 0
104	HI	1	Translation stiffness (newtons/meters)	0 0 0
105	HI	1	Translation damping (newtons/meter/sec)	0 0 0
106	HI	1	Null force translations	0 0 0
107	HI	2	Hinge ID number	2
108	HI	2	Inboard body ID, Outboard body ID	1,2
109	HI	2	"p" node ID, "q" node ID	6,1
110	HI	2	Number of rotation DOFs, Rotation option (F or G)	3
111	HI	2	L1 unit vector in inboard body coord. x,y,z	1,0,0
112	HI	2	L1 unit vector in outboard body coord. x,y,z	1,0,0
113	HI	2	L2 unit vector in inboard body coord. x,y,z	
114	HI	2	L2 unit vector in outboard body coord. x,y,z	
115	HI	2	L3 unit vector in inboard body coord. x,y,z	0,0,1
116	HI	2	L3 unit vector in outboard body coord. x,y,z	0,0,1
117	HI	2	Initial rotation angles (deg)	0 0 0
118	HI	2	Initial rotation rates (deg/sec)	0 0 0
119	HI	2	Rotation stiffness (newton-meters/rad)	0 0 0
120	HI	2	Rotation damping (newton-meters/rad/sec)	0 0 0
121	HI	2	Null torque angles (deg)	0 0 0
122	HI	2	Number of translation DOFs	3
123	HI	2	First translation unit vector g1	1 0 0
124	HI	2	Second translation unit vector g2	0 1 0
125	HI	2	Third translation unit vector g3	0 0 1
126	HI	2	Initial translation (meters)	0.01,0.01,0.01
127	HI	2	Initial translation velocity (meters/sec)	0 0 0
128	HI	2	Translation stiffness (newtons/meters)	0 0 0
129	HI	2	Translation damping (newtons/meter/sec)	0 0 0
130	HI	2	Null force translations	0 0 0

SENSOR

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131 SE 101 Sensor ID number                                       101
132 SE 101 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)          AC
133 SE 101 Mounting point body ID, Mounting point node ID         2,4
134 SE 101 Second mounting point body ID, Second node ID
135 SE 101 Input axis unit vector (IA) x,y,z                      1,0,0
136 SE 101 Mounting point Hinge index, Axis index
137 SE 101 First focal plane unit vector  (Fp1) x,y,z
138 SE 101 Second focal plane unit vector (Fp2) x,y,z
139 SE 101 Sun/Star unit vector (Us) x,y,z
140 SE 101 Euler Angle Sequence (1-6)
141 SE 101 CMG ID number and Gimbal number

142 SE 102 Sensor ID number                                       102
143 SE 102 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)          AC
144 SE 102 Mounting point body ID, Mounting point node ID         2,14
145 SE 102 Second mounting point body ID, Second node ID
146 SE 102 Input axis unit vector (IA) x,y,z                      0,0,1
147 SE 102 Mounting point Hinge index, Axis index
148 SE 102 First focal plane unit vector  (Fp1) x,y,z
149 SE 102 Second focal plane unit vector (Fp2) x,y,z
150 SE 102 Sun/Star unit vector (Us) x,y,z
151 SE 102 Euler Angle Sequence (1-6)
152 SE 102 CMG ID number and Gimbal number

153 SE 201 Sensor ID number                                       201
154 SE 201 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)          AC
155 SE 201 Mounting point body ID, Mounting point node ID         2,8
156 SE 201 Second mounting point body ID, Second node ID
157 SE 201 Input axis unit vector (IA) x,y,z                      -0.707,0.707,0
158 SE 201 Mounting point Hinge index, Axis index
159 SE 201 First focal plane unit vector  (Fp1) x,y,z
160 SE 201 Second focal plane unit vector (Fp2) x,y,z
161 SE 201 Sun/Star unit vector (Us) x,y,z
162 SE 201 Euler Angle Sequence (1-6)
163 SE 201 CMG ID number and Gimbal number

164 SE 202 Sensor ID number                                       202
165 SE 202 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)          AC
166 SE 202 Mounting point body ID, Mounting point node ID         2,15
167 SE 202 Second mounting point body ID, Second node ID
168 SE 202 Input axis unit vector (IA) x,y,z                      0,0,1
169 SE 202 Mounting point Hinge index, Axis index
170 SE 202 First focal plane unit vector  (Fp1) x,y,z
171 SE 202 Second focal plane unit vector (Fp2) x,y,z
172 SE 202 Sun/Star unit vector (Us) x,y,z
173 SE 202 Euler Angle Sequence (1-6)
174 SE 202 CMG ID number and Gimbal number

175 SE 301 Sensor ID number                                       301
176 SE 301 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)          AC
177 SE 301 Mounting point body ID, Mounting point node ID         2,10
178 SE 301 Second mounting point body ID, Second node ID
179 SE 301 Input axis unit vector (IA) x,y,z                      -0.707,-0.707,0
180 SE 301 Mounting point Hinge index, Axis index
181 SE 301 First focal plane unit vector  (Fp1) x,y,z
182 SE 301 Second focal plane unit vector (Fp2) x,y,z
183 SE 301 Sun/Star unit vector (Us) x,y,z
184 SE 301 Euler Angle Sequence (1-6)
185 SE 301 CMG ID number and Gimbal number

186 SE 302 Sensor ID number                                       302
187 SE 302 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)          AC
188 SE 302 Mounting point body ID, Mounting point node ID         2,16
189 SE 302 Second mounting point body ID, Second node ID
190 SE 302 Input axis unit vector (IA) x,y,z                      0,0,1
191 SE 302 Mounting point Hinge index, Axis index
192 SE 302 First focal plane unit vector  (Fp1) x,y,z
193 SE 302 Second focal plane unit vector (Fp2) x,y,z
194 SE 302 Sun/Star unit vector (Us) x,y,z
195 SE 302 Euler Angle Sequence (1-6)
196 SE 302 CMG ID number and Gimbal number

197 SE 401 Sensor ID number                                       401
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198 SE 401 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      ST
199 SE 401 Mounting point body ID, Mounting point node ID     2,3
200 SE 401 Second mounting point body ID, Second node ID
201 SE 401 Input axis unit vector (IA) x,y,z
202 SE 401 Mounting point Hinge index, Axis index
203 SE 401 First focal plane unit vector  (Fp1) x,y,z         0,1,0
204 SE 401 Second focal plane unit vector (Fp2) x,y,z         0,0,1
205 SE 401 Sun/Star unit vector (Us) x,y,z                    1,0,0
206 SE 401 Euler Angle Sequence (1-6)
207 SE 401 CMG ID number and Gimbal number

208 SE 402 Sensor ID number                                   402
209 SE 402 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      ST
210 SE 402 Mounting point body ID, Mounting point node ID     1,3
211 SE 402 Second mounting point body ID, Second node ID
212 SE 402 Input axis unit vector (IA) x,y,z
213 SE 402 Mounting point Hinge index, Axis index
214 SE 402 First focal plane unit vector  (Fp1) x,y,z         0,1,0
215 SE 402 Second focal plane unit vector (Fp2) x,y,z         0,0,1
216 SE 402 Sun/Star unit vector (Us) x,y,z                    1,0,0
217 SE 402 Euler Angle Sequence (1-6)
218 SE 402 CMG ID number and Gimbal number

219 SE 501 Sensor ID number                                   501
220 SE 501 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      ST
221 SE 501 Mounting point body ID, Mounting point node ID     2,6
222 SE 501 Second mounting point body ID, Second node ID
223 SE 501 Input axis unit vector (IA) x,y,z
224 SE 501 Mounting point Hinge index, Axis index
225 SE 501 First focal plane unit vector  (Fp1) x,y,z         0,1,0
226 SE 501 Second focal plane unit vector (Fp2) x,y,z         0,0,1
227 SE 501 Sun/Star unit vector (Us) x,y,z                    -1,0,0
228 SE 501 Euler Angle Sequence (1-6)
229 SE 501 CMG ID number and Gimbal number

230 SE 502 Sensor ID number                                   502
231 SE 502 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      ST
232 SE 502 Mounting point body ID, Mounting point node ID     1,4
233 SE 502 Second mounting point body ID, Second node ID
234 SE 502 Input axis unit vector (IA) x,y,z
235 SE 502 Mounting point Hinge index, Axis index
236 SE 502 First focal plane unit vector  (Fp1) x,y,z         0,1,0
237 SE 502 Second focal plane unit vector (Fp2) x,y,z         0,0,1
238 SE 502 Sun/Star unit vector (Us) x,y,z                    -1,0,0
239 SE 502 Euler Angle Sequence (1-6)
240 SE 502 CMG ID number and Gimbal number

241 SE 601 Sensor ID number                                   601
242 SE 601 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      ST
243 SE 601 Mounting point body ID, Mounting point node ID     2,9
244 SE 601 Second mounting point body ID, Second node ID
245 SE 601 Input axis unit vector (IA) x,y,z
246 SE 601 Mounting point Hinge index, Axis index
247 SE 601 First focal plane unit vector  (Fp1) x,y,z         1,0,0
248 SE 601 Second focal plane unit vector (Fp2) x,y,z         0,0,1
249 SE 601 Sun/Star unit vector (Us) x,y,z                    0,-1,0
250 SE 601 Euler Angle Sequence (1-6)
251 SE 601 CMG ID number and Gimbal number

252 SE 602 Sensor ID number                                   602
253 SE 602 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      ST
254 SE 602 Mounting point body ID, Mounting point node ID     1,5
255 SE 602 Second mounting point body ID, Second node ID
256 SE 602 Input axis unit vector (IA) x,y,z
257 SE 602 Mounting point Hinge index, Axis index
258 SE 602 First focal plane unit vector  (Fp1) x,y,z         1,0,0
259 SE 602 Second focal plane unit vector (Fp2) x,y,z         0,0,1
260 SE 602 Sun/Star unit vector (Us) x,y,z                    0,-1,0
261 SE 602 Euler Angle Sequence (1-6)
262 SE 602 CMG ID number and Gimbal number

263 SE 701 Sensor ID number                                   701
264 SE 701 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      P3
265 SE 701 Mounting point body ID, Mounting point node ID     1,3
266 SE 701 Second mounting point body ID, Second node ID      2,3
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267 SE 701 Input axis unit vector (IA) x,y,z
268 SE 701 Mounting point Hinge index, Axis index
269 SE 701 First focal plane unit vector (Fp1) x,y,z
270 SE 701 Second focal plane unit vector (Fp2) x,y,z
271 SE 701 Sun/Star unit vector (Us) x,y,z
272 SE 701 Euler Angle Sequence (1-6)
273 SE 701 CMG ID number and Gimbal number

274 SE 801 Sensor ID number 801
275 SE 801 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) P3
276 SE 801 Mounting point body ID, Mounting point node ID 1,4
277 SE 801 Second mounting point body ID, Second node ID 2,6
278 SE 801 Input axis unit vector (IA) x,y,z
279 SE 801 Mounting point Hinge index, Axis index
280 SE 801 First focal plane unit vector (Fp1) x,y,z
281 SE 801 Second focal plane unit vector (Fp2) x,y,z
282 SE 801 Sun/Star unit vector (Us) x,y,z
283 SE 801 Euler Angle Sequence (1-6)
284 SE 801 CMG ID number and Gimbal number

285 SE 901 Sensor ID number 901
286 SE 901 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) P3
287 SE 901 Mounting point body ID, Mounting point node ID 1,5
288 SE 901 Second mounting point body ID, Second node ID 2,9
289 SE 901 Input axis unit vector (IA) x,y,z
290 SE 901 Mounting point Hinge index, Axis index
291 SE 901 First focal plane unit vector (Fp1) x,y,z
292 SE 901 Second focal plane unit vector (Fp2) x,y,z
293 SE 901 Sun/Star unit vector (Us) x,y,z
294 SE 901 Euler Angle Sequence (1-6)
295 SE 901 CMG ID number and Gimbal number

296 SE 911 Sensor ID number 911
297 SE 911 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) P3
298 SE 911 Mounting point body ID, Mounting point node ID 1,6
299 SE 911 Second mounting point body ID, Second node ID 2,1
300 SE 911 Input axis unit vector (IA) x,y,z
301 SE 911 Mounting point Hinge index, Axis index
302 SE 911 First focal plane unit vector (Fp1) x,y,z
303 SE 911 Second focal plane unit vector (Fp2) x,y,z
304 SE 911 Sun/Star unit vector (Us) x,y,z
305 SE 911 Euler Angle Sequence (1-6)
306 SE 911 CMG ID number and Gimbal number

307 SE 912 Sensor ID number 912
308 SE 912 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) IM
309 SE 912 Mounting point body ID, Mounting point node ID 2,1
310 SE 912 Second mounting point body ID, Second node ID
311 SE 912 Input axis unit vector (IA) x,y,z
312 SE 912 Mounting point Hinge index, Axis index
313 SE 912 First focal plane unit vector (Fp1) x,y,z
314 SE 912 Second focal plane unit vector (Fp2) x,y,z
315 SE 912 Sun/Star unit vector (Us) x,y,z
316 SE 912 Euler Angle Sequence (1-6) 1
317 SE 912 CMG ID number and Gimbal number

318 SE 921 Sensor ID number 921
319 SE 921 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) P3
320 SE 921 Mounting point body ID, Mounting point node ID 0,0
321 SE 921 Second mounting point body ID, Second node ID 1,1
322 SE 921 Input axis unit vector (IA) x,y,z
323 SE 921 Mounting point Hinge index, Axis index
324 SE 921 First focal plane unit vector (Fp1) x,y,z
325 SE 921 Second focal plane unit vector (Fp2) x,y,z
326 SE 921 Sun/Star unit vector (Us) x,y,z
327 SE 921 Euler Angle Sequence (1-6)
328 SE 921 CMG ID number and Gimbal number

329 SE 922 Sensor ID number 922
330 SE 922 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) IM
331 SE 922 Mounting point body ID, Mounting point node ID 1,2
332 SE 922 Second mounting point body ID, Second node ID
333 SE 922 Input axis unit vector (IA) x,y,z
334 SE 922 Mounting point Hinge index, Axis index
335 SE 922 First focal plane unit vector (Fp1) x,y,z

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336 SE 922 Second focal plane unit vector (Fp2) x,y,z
337 SE 922 Sun/Star unit vector (Us) x,y,z
338 SE 922 Euler Angle Sequence (1-6)                         1
339 SE 922 CMG ID number and Gimbal number

           ACTR

340 AC   1 Actuator ID number                                 1
341 AC   1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                J
342 AC   1 Actuator location; Node or Hinge (N or H)
343 AC   1 Mounting point body ID number, node ID number      1,2
344 AC   1 Second mounting point body ID, second node ID
345 AC   1 Output axis unit vector x,y,z                      0,0,1
346 AC   1 Mounting point Hinge index, Axis index
347 AC   1 Rotor spin axis unit vector x,y,z
348 AC   1 Initial rotor momentum, H
349 AC   1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
350 AC   1 Outer gimbal axis unit vector x,y,z
351 AC   1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
352 AC   1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
353 AC   1 Inner gimbal axis unit vector x,y,z
354 AC   1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
355 AC   1 Initial length and rate, y(to) and ydot(to)
356 AC   1 Constants; K1 or wo, n or zeta, Kg, Jm
357 AC   1 Non-linearities; TLim, Tco, Dz

358 AC   2 Actuator ID number                                 2
359 AC   2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                J
360 AC   2 Actuator location; Node or Hinge (N or H)
361 AC   2 Mounting point body ID number, node ID number      1,2
362 AC   2 Second mounting point body ID, second node ID
363 AC   2 Output axis unit vector x,y,z                      0,0,1
364 AC   2 Mounting point Hinge index, Axis index
365 AC   2 Rotor spin axis unit vector x,y,z
366 AC   2 Initial rotor momentum, H
367 AC   2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
368 AC   2 Outer gimbal axis unit vector x,y,z
369 AC   2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
370 AC   2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
371 AC   2 Inner gimbal axis unit vector x,y,z
372 AC   2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
373 AC   2 Initial length and rate, y(to) and ydot(to)
374 AC   2 Constants; K1 or wo, n or zeta, Kg, Jm
375 AC   2 Non-linearities; TLim, Tco, Dz

376 AC 101 Actuator ID number                                 101
377 AC 101 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                J
378 AC 101 Actuator location; Node or Hinge (N or H)
379 AC 101 Mounting point body ID number, node ID number      2,5
380 AC 101 Second mounting point body ID, second node ID
381 AC 101 Output axis unit vector x,y,z                      1,0,0
382 AC 101 Mounting point Hinge index, Axis index
383 AC 101 Rotor spin axis unit vector x,y,z
384 AC 101 Initial rotor momentum, H
385 AC 101 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
386 AC 101 Outer gimbal axis unit vector x,y,z
387 AC 101 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
388 AC 101 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
389 AC 101 Inner gimbal axis unit vector x,y,z
390 AC 101 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
391 AC 101 Initial length and rate, y(to) and ydot(to)
392 AC 101 Constants; K1 or wo, n or zeta, Kg, Jm
393 AC 101 Non-linearities; TLim, Tco, Dz

394 AC 102 Actuator ID number                                 102
395 AC 102 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                J
396 AC 102 Actuator location; Node or Hinge (N or H)
397 AC 102 Mounting point body ID number, node ID number      2,5
398 AC 102 Second mounting point body ID, second node ID
399 AC 102 Output axis unit vector x,y,z                      0,0,1
400 AC 102 Mounting point Hinge index, Axis index
401 AC 102 Rotor spin axis unit vector x,y,z
402 AC 102 Initial rotor momentum, H
403 AC 102 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
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404 AC 102 Outer gimbal axis unit vector x,y,z
405 AC 102 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
406 AC 102 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
407 AC 102 Inner gimbal axis unit vector x,y,z
408 AC 102 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
409 AC 102 Initial length and rate, y(to) and ydot(to)
410 AC 102 Constants; K1 or wo, n or zeta, Kg, Jm
411 AC 102 Non-linearities; TLim, Tco, Dz

412 AC 201 Actuator ID number                                201
413 AC 201 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               J
414 AC 201 Actuator location; Node or Hinge (N or H)
415 AC 201 Mounting point body ID number, node ID number     2,7
416 AC 201 Second mounting point body ID, second node ID
417 AC 201 Output axis unit vector x,y,z                     -0.707,0.707,0
418 AC 201 Mounting point Hinge index, Axis index
419 AC 201 Rotor spin axis unit vector x,y,z
420 AC 201 Initial rotor momentum, H
421 AC 201 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
422 AC 201 Outer gimbal axis unit vector x,y,z
423 AC 201 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
424 AC 201 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
425 AC 201 Inner gimbal axis unit vector x,y,z
426 AC 201 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
427 AC 201 Initial length and rate, y(to) and ydot(to)
428 AC 201 Constants; K1 or wo, n or zeta, Kg, Jm
429 AC 201 Non-linearities; TLim, Tco, Dz

430 AC 202 Actuator ID number                                202
431 AC 202 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               J
432 AC 202 Actuator location; Node or Hinge (N or H)
433 AC 202 Mounting point body ID number, node ID number     2,7
434 AC 202 Second mounting point body ID, second node ID
435 AC 202 Output axis unit vector x,y,z                     0,0,1
436 AC 202 Mounting point Hinge index, Axis index
437 AC 202 Rotor spin axis unit vector x,y,z
438 AC 202 Initial rotor momentum, H
439 AC 202 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
440 AC 202 Outer gimbal axis unit vector x,y,z
441 AC 202 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
442 AC 202 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
443 AC 202 Inner gimbal axis unit vector x,y,z
444 AC 202 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
445 AC 202 Initial length and rate, y(to) and ydot(to)
446 AC 202 Constants; K1 or wo, n or zeta, Kg, Jm
447 AC 202 Non-linearities; TLim, Tco, Dz

448 AC 301 Actuator ID number                                301
449 AC 301 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               J
450 AC 301 Actuator location; Node or Hinge (N or H)
451 AC 301 Mounting point body ID number, node ID number     2,11
452 AC 301 Second mounting point body ID, second node ID
453 AC 301 Output axis unit vector x,y,z                     -0.707,-0.707,0
454 AC 301 Mounting point Hinge index, Axis index
455 AC 301 Rotor spin axis unit vector x,y,z
456 AC 301 Initial rotor momentum, H
457 AC 301 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
458 AC 301 Outer gimbal axis unit vector x,y,z
459 AC 301 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
460 AC 301 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
461 AC 301 Inner gimbal axis unit vector x,y,z
462 AC 301 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
463 AC 301 Initial length and rate, y(to) and ydot(to)
464 AC 301 Constants; K1 or wo, n or zeta, Kg, Jm
465 AC 301 Non-linearities; TLim, Tco, Dz

466 AC 302 Actuator ID number                                302
467 AC 302 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               J
468 AC 302 Actuator location; Node or Hinge (N or H)
469 AC 302 Mounting point body ID number, node ID number     2,11
470 AC 302 Second mounting point body ID, second node ID
471 AC 302 Output axis unit vector x,y,z                     0,0,1
472 AC 302 Mounting point Hinge index, Axis index
473 AC 302 Rotor spin axis unit vector x,y,z
474 AC 302 Initial rotor momentum, H
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475 AC 302 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
476 AC 302 Outer gimbal axis unit vector x,y,z
477 AC 302 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
478 AC 302 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
479 AC 302 Inner gimbal axis unit vector x,y,z
480 AC 302 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
481 AC 302 Initial length and rate, y(to) and ydot(to)
482 AC 302 Constants; K1 or wo, n or zeta, Kg, Jm
483 AC 302 Non-linearities; TLim, Tco, Dz

           CONTROLLER

484 CO   1 Controller ID number                                 1
485 CO   1 Controller type (CB,CM,DB,DM,UC,UD)                  CB
486 CO   1 Sample time (sec)
487 CO   1 Number of inputs, Number of outputs                  30,12
488 CO   1 Number of states
489 CO   1 Output No., Input type (I,S,T), Input ID, Gain       1,T,112,1
490 CO   1 Output No., Input type (I,S,T), Input ID, Gain       2,S,112,1
491 CO   1 Output No., Input type (I,S,T), Input ID, Gain       3,T,122,1
492 CO   1 Output No., Input type (I,S,T), Input ID, Gain       4,S,122,1
493 CO   1 Output No., Input type (I,S,T), Input ID, Gain       5,T,132,1
494 CO   1 Output No., Input type (I,S,T), Input ID, Gain       6,S,132,1
495 CO   1 Output No., Input type (I,S,T), Input ID, Gain       7,T,142,1
496 CO   1 Output No., Input type (I,S,T), Input ID, Gain       8,S,142,1
497 CO   1 Output No., Input type (I,S,T), Input ID, Gain       9,T,152,1
498 CO   1 Output No., Input type (I,S,T), Input ID, Gain       10,S,152,1
499 CO   1 Output No., Input type (I,S,T), Input ID, Gain       11,T,162,1
500 CO   1 Output No., Input type (I,S,T), Input ID, Gain       12,S,162,1

501 CO   2 Controller ID number                                 2
502 CO   2 Controller type (CB,CM,DB,DM,UC,UD)                  UD
503 CO   2 Sample time (sec)                                    0.1
504 CO   2 Number of inputs, Number of outputs                  27,82
505 CO   2 Number of states
506 CO   2 Output No., Input type (I,S,T), Input ID, Gain

507 CO   3 Controller ID number                                 3
508 CO   3 Controller type (CB,CM,DB,DM,UC,UD)                  UC
509 CO   3 Sample time (sec)
510 CO   3 Number of inputs, Number of outputs                  18,12
511 CO   3 Number of states                                     0
512 CO   3 Output No., Input type (I,S,T), Input ID, Gain

           SUMM JUNC

513 SU 112 Summing junction ID number                           112
514 SU 112 Controller ID number                                 1
515 SU 112 Number of inputs to summing junction                 3
516 SU 112 Input number,Input type(I,S,T),Input ID no,Gain      1,T,111,1
517 SU 112 Input number,Input type(I,S,T),Input ID no,Gain      2,I,2,1
518 SU 112 Input number,Input type(I,S,T),Input ID no,Gain      3,T,113,2.E-5

519 SU 113 Summing junction ID number                           113
520 SU 113 Controller ID number                                 1
521 SU 113 Number of inputs to summing junction                 2
522 SU 113 Input number,Input type(I,S,T),Input ID no,Gain      1,I,4,-1
523 SU 113 Input number,Input type(I,S,T),Input ID no,Gain      2,I,5,-1

524 SU 122 Summing junction ID number                           122
525 SU 122 Controller ID number                                 1
526 SU 122 Number of inputs to summing junction                 3
527 SU 122 Input number,Input type(I,S,T),Input ID no,Gain      1,T,121,1
528 SU 122 Input number,Input type(I,S,T),Input ID no,Gain      2,I,7,1
529 SU 122 Input number,Input type(I,S,T),Input ID no,Gain      3,T,123,2.E-5

530 SU 123 Summing junction ID number                           123
531 SU 123 Controller ID number                                 1
532 SU 123 Number of inputs to summing junction                 2
533 SU 123 Input number,Input type(I,S,T),Input ID no,Gain      1,I,9,-1
534 SU 123 Input number,Input type(I,S,T),Input ID no,Gain      2,I,10,-1

535 SU 132 Summing junction ID number                           132
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536 SU 132 Controller ID number                                1
537 SU 132 Number of inputs to summing junction                3
538 SU 132 Input number,Input type(I,S,T),Input ID no,Gain     1,T,131,1
539 SU 132 Input number,Input type(I,S,T),Input ID no,Gain     2,I,12,1
540 SU 132 Input number,Input type(I,S,T),Input ID no,Gain     3,T,133,2.E-5

541 SU 133 Summing junction ID number                          133
542 SU 133 Controller ID number                                1
543 SU 133 Number of inputs to summing junction                2
544 SU 133 Input number,Input type(I,S,T),Input ID no,Gain     1,I,14,-1
545 SU 133 Input number,Input type(I,S,T),Input ID no,Gain     2,I,15,-1

546 SU 142 Summing junction ID number                          142
547 SU 142 Controller ID number                                1
548 SU 142 Number of inputs to summing junction                3
549 SU 142 Input number,Input type(I,S,T),Input ID no,Gain     1,T,141,1
550 SU 142 Input number,Input type(I,S,T),Input ID no,Gain     2,I,17,1
551 SU 142 Input number,Input type(I,S,T),Input ID no,Gain     3,T,143,2.E-5

552 SU 143 Summing junction ID number                          143
553 SU 143 Controller ID number                                1
554 SU 143 Number of inputs to summing junction                2
555 SU 143 Input number,Input type(I,S,T),Input ID no,Gain     1,I,19,-1
556 SU 143 Input number,Input type(I,S,T),Input ID no,Gain     2,I,20,-1

557 SU 152 Summing junction ID number                          152
558 SU 152 Controller ID number                                1
559 SU 152 Number of inputs to summing junction                3
560 SU 152 Input number,Input type(I,S,T),Input ID no,Gain     1,T,151,1
561 SU 152 Input number,Input type(I,S,T),Input ID no,Gain     2,I,22,1
562 SU 152 Input number,Input type(I,S,T),Input ID no,Gain     3,T,153,2.E-5

563 SU 153 Summing junction ID number                          153
564 SU 153 Controller ID number                                1
565 SU 153 Number of inputs to summing junction                2
566 SU 153 Input number,Input type(I,S,T),Input ID no,Gain     1,I,24,-1
567 SU 153 Input number,Input type(I,S,T),Input ID no,Gain     2,I,25,-1

568 SU 162 Summing junction ID number                          162
569 SU 162 Controller ID number                                1
570 SU 162 Number of inputs to summing junction                3
571 SU 162 Input number,Input type(I,S,T),Input ID no,Gain     1,T,161,1
572 SU 162 Input number,Input type(I,S,T),Input ID no,Gain     2,I,27,1
573 SU 162 Input number,Input type(I,S,T),Input ID no,Gain     3,T,163,2.E-5

574 SU 163 Summing junction ID number                          163
575 SU 163 Controller ID number                                1
576 SU 163 Number of inputs to summing junction                2
577 SU 163 Input number,Input type(I,S,T),Input ID no,Gain     1,I,29,-1
578 SU 163 Input number,Input type(I,S,T),Input ID no,Gain     2,I,30,-1

           TRANSFER FUN


579 TR 111 Transfer function ID number                         111
580 TR 111 Controller ID number                                1
581 TR 111 Input type (I,S or T), Input ID number              I,3
582 TR 111 Order of numerator                                  0
583 TR 111 Numerator coefficients (4 per line max)             1
584 TR 111 Order of denominator                                0
585 TR 111 Denominator coefficients (4 per line max)           1
586 TR 111 Transfer function gain                              1

587 TR 112 Transfer function ID number                         112
588 TR 112 Controller ID number                                1
589 TR 112 Input type (I,S or T), Input ID number              S,113
590 TR 112 Order of numerator                                  1
591 TR 112 Numerator coefficients (4 per line max)             62.8, 1
592 TR 112 Order of denominator                                2
593 TR 112 Denominator coefficients (4 per line max)           0, 6.28, 1
594 TR 112 Transfer function gain                              0.1

595 TR 113 Transfer function ID number                         113
596 TR 113 Controller ID number                                1
597 TR 113 Input type (I,S or T), Input ID number              I,1
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598 TR 113 Order of numerator	1
599 TR 113 Numerator coefficients (4 per line max)	125.66, 1
600 TR 113 Order of denominator	2
601 TR 113 Denominator coefficients (4 per line max)	394784.18, 1068.14, 1
602 TR 113 Transfer function gain	3141.59
603 TR 121 Transfer function ID number	121
604 TR 121 Controller ID number	1
605 TR 121 Input type (I,S or T), Input ID number	I,8
606 TR 121 Order of numerator	0
607 TR 121 Numerator coefficients (4 per line max)	1
608 TR 121 Order of denominator	0
609 TR 121 Denominator coefficients (4 per line max)	1
610 TR 121 Transfer function gain	1
611 TR 122 Transfer function ID number	122
612 TR 122 Controller ID number	1
613 TR 122 Input type (I,S or T), Input ID number	S,123
614 TR 122 Order of numerator	1
615 TR 122 Numerator coefficients (4 per line max)	62.8, 1
616 TR 122 Order of denominator	2
617 TR 122 Denominator coefficients (4 per line max)	0, 6.28, 1
618 TR 122 Transfer function gain	0.1
619 TR 123 Transfer function ID number	123
620 TR 123 Controller ID number	1
621 TR 123 Input type (I,S or T), Input ID number	I,6
622 TR 123 Order of numerator	1
623 TR 123 Numerator coefficients (4 per line max)	125.66, 1
624 TR 123 Order of denominator	2
625 TR 123 Denominator coefficients (4 per line max)	394784.18, 1068.14, 1
626 TR 123 Transfer function gain	3141.59
627 TR 131 Transfer function ID number	131
628 TR 131 Controller ID number	1
629 TR 131 Input type (I,S or T), Input ID number	I,13
630 TR 131 Order of numerator	0
631 TR 131 Numerator coefficients (4 per line max)	1
632 TR 131 Order of denominator	0
633 TR 131 Denominator coefficients (4 per line max)	1
634 TR 131 Transfer function gain	1
635 TR 132 Transfer function ID number	132
636 TR 132 Controller ID number	1
637 TR 132 Input type (I,S or T), Input ID number	S,133
638 TR 132 Order of numerator	1
639 TR 132 Numerator coefficients (4 per line max)	62.8, 1
640 TR 132 Order of denominator	2
641 TR 132 Denominator coefficients (4 per line max)	0, 6.28, 1
642 TR 132 Transfer function gain	0.1
643 TR 133 Transfer function ID number	133
644 TR 133 Controller ID number	1
645 TR 133 Input type (I,S or T), Input ID number	I,11
646 TR 133 Order of numerator	1
647 TR 133 Numerator coefficients (4 per line max)	125.66, 1
648 TR 133 Order of denominator	2
649 TR 133 Denominator coefficients (4 per line max)	394784.18, 1068.14, 1
650 TR 133 Transfer function gain	3141.59
651 TR 141 Transfer function ID number	141
652 TR 141 Controller ID number	1
653 TR 141 Input type (I,S or T), Input ID number	I,18
654 TR 141 Order of numerator	0
655 TR 141 Numerator coefficients (4 per line max)	1
656 TR 141 Order of denominator	0
657 TR 141 Denominator coefficients (4 per line max)	1
658 TR 141 Transfer function gain	1
659 TR 142 Transfer function ID number	142
660 TR 142 Controller ID number	1
661 TR 142 Input type (I,S or T), Input ID number	S,143
662 TR 142 Order of numerator	1
663 TR 142 Numerator coefficients (4 per line max)	62.8, 1
664 TR 142 Order of denominator	2

665	TR	142	Denominator coefficients (4 per line max)	0, 6.28, 1
666	TR	142	Transfer function gain	0.1
667	TR	143	Transfer function ID number	143
668	TR	143	Controller ID number	1
669	TR	143	Input type (I,S or T), Input ID number	I,16
670	TR	143	Order of numerator	1
671	TR	143	Numerator coefficients (4 per line max)	125.66, 1
672	TR	143	Order of denominator	2
673	TR	143	Denominator coefficients (4 per line max)	394784.18, 1068.14, 1
674	TR	143	Transfer function gain	3141.59
675	TR	151	Transfer function ID number	151
676	TR	151	Controller ID number	1
677	TR	151	Input type (I,S or T), Input ID number	I,23
678	TR	151	Order of numerator	0
679	TR	151	Numerator coefficients (4 per line max)	1
680	TR	151	Order of denominator	0
681	TR	151	Denominator coefficients (4 per line max)	1
682	TR	151	Transfer function gain	1
683	TR	152	Transfer function ID number	152
684	TR	152	Controller ID number	1
685	TR	152	Input type (I,S or T), Input ID number	S,153
686	TR	152	Order of numerator	1
687	TR	152	Numerator coefficients (4 per line max)	62.8, 1
688	TR	152	Order of denominator	2
689	TR	152	Denominator coefficients (4 per line max)	0, 6.28, 1
690	TR	152	Transfer function gain	0.1
691	TR	153	Transfer function ID number	153
692	TR	153	Controller ID number	1
693	TR	153	Input type (I,S or T), Input ID number	I,21
694	TR	153	Order of numerator	1
695	TR	153	Numerator coefficients (4 per line max)	125.66, 1
696	TR	153	Order of denominator	2
697	TR	153	Denominator coefficients (4 per line max)	394784.18, 1068.14, 1
698	TR	153	Transfer function gain	3141.59
699	TR	161	Transfer function ID number	161
700	TR	161	Controller ID number	1
701	TR	161	Input type (I,S or T), Input ID number	I,28
702	TR	161	Order of numerator	0
703	TR	161	Numerator coefficients (4 per line max)	1
704	TR	161	Order of denominator	0
705	TR	161	Denominator coefficients (4 per line max)	1
706	TR	161	Transfer function gain	1
707	TR	162	Transfer function ID number	162
708	TR	162	Controller ID number	1
709	TR	162	Input type (I,S or T), Input ID number	S,163
710	TR	162	Order of numerator	1
711	TR	162	Numerator coefficients (4 per line max)	62.8, 1
712	TR	162	Order of denominator	2
713	TR	162	Denominator coefficients (4 per line max)	0, 6.28, 1
714	TR	162	Transfer function gain	0.1
715	TR	163	Transfer function ID number	163
716	TR	163	Controller ID number	1
717	TR	163	Input type (I,S or T), Input ID number	I,26
718	TR	163	Order of numerator	1
719	TR	163	Numerator coefficients (4 per line max)	125.66, 1
720	TR	163	Order of denominator	2
721	TR	163	Denominator coefficients (4 per line max)	394784.18, 1068.14, 1
722	TR	163	Transfer function gain	3141.59

FUNCTION GEN

723	FU	1	Function generator ID number	1
724	FU	1	Type (ST,RA,PU,SA,SI,US,NO,DO)	SI
725	FU	1	Amplitude	98
726	FU	1	Slope	
727	FU	1	Start time (sec)	0
728	FU	1	Stop time (sec)	5000

729	FU	1	Frequency (rad/sec)	0.628
730	FU	1	Phase shift (deg)	0
731	FU	1	Array location	
732	FU	1	Mean,Seed	
733	FU	1	Variance	
734	FU	1	Pulse width (sec)	
735	FU	1	Second pulse start time (sec)	
736	FU	2	Function generator ID number	2
737	FU	2	Type (ST,RA,PU,SA,SI,US,NO,DO)	PU
738	FU	2	Amplitude	1960
739	FU	2	Slope	
740	FU	2	Start time (sec)	0.
741	FU	2	Stop time (sec)	20.
742	FU	2	Frequency (rad/sec)	
743	FU	2	Phase shift (deg)	
744	FU	2	Array location	
745	FU	2	Mean,Seed	
746	FU	2	Variance	
747	FU	2	Pulse width (sec)	
748	FU	2	Second pulse start time (sec)	
749	FU	111	Function generator ID number	111
750	FU	111	Type (ST,RA,PU,SA,SI,US,NO,DO)	NO
751	FU	111	Amplitude	
752	FU	111	Slope	
753	FU	111	Start time (sec)	
754	FU	111	Stop time (sec)	
755	FU	111	Frequency (rad/sec)	
756	FU	111	Phase shift (deg)	
757	FU	111	Array location	
758	FU	111	Mean,Seed	0,1
759	FU	111	Variance	1
760	FU	111	Pulse width (sec)	
761	FU	111	Second pulse start time (sec)	
762	FU	112	Function generator ID number	112
763	FU	112	Type (ST,RA,PU,SA,SI,US,NO,DO)	ST
764	FU	112	Amplitude	1.023E-3
765	FU	112	Slope	
766	FU	112	Start time (sec)	0
767	FU	112	Stop time (sec)	
768	FU	112	Frequency (rad/sec)	
769	FU	112	Phase shift (deg)	
770	FU	112	Array location	
771	FU	112	Mean,Seed	
772	FU	112	Variance	
773	FU	112	Pulse width (sec)	
774	FU	112	Second pulse start time (sec)	
775	FU	121	Function generator ID number	121
776	FU	121	Type (ST,RA,PU,SA,SI,US,NO,DO)	NO
777	FU	121	Amplitude	
778	FU	121	Slope	
779	FU	121	Start time (sec)	
780	FU	121	Stop time (sec)	
781	FU	121	Frequency (rad/sec)	
782	FU	121	Phase shift (deg)	
783	FU	121	Array location	
784	FU	121	Mean,Seed	0,2
785	FU	121	Variance	1
786	FU	121	Pulse width (sec)	
787	FU	121	Second pulse start time (sec)	
788	FU	122	Function generator ID number	122
789	FU	122	Type (ST,RA,PU,SA,SI,US,NO,DO)	ST
790	FU	122	Amplitude	-1.519E-3
791	FU	122	Slope	
792	FU	122	Start time (sec)	0
793	FU	122	Stop time (sec)	
794	FU	122	Frequency (rad/sec)	
795	FU	122	Phase shift (deg)	
796	FU	122	Array location	
797	FU	122	Mean,Seed	
798	FU	122	Variance	

799 FU 122 Pulse width (sec)	
800 FU 122 Second pulse start time (sec)	
801 FU 131 Function generator ID number	131
802 FU 131 Type (ST,RA,PU,SA,SI,US,NO,DO)	NO
803 FU 131 Amplitude	
804 FU 131 Slope	
805 FU 131 Start time (sec)	
806 FU 131 Stop time (sec)	
807 FU 131 Frequency (rad/sec)	
808 FU 131 Phase shift (deg)	
809 FU 131 Array location	
810 FU 131 Mean,Seed	0,3
811 FU 131 Variance	1
812 FU 131 Pulse width (sec)	
813 FU 131 Second pulse start time (sec)	
814 FU 132 Function generator ID number	132
815 FU 132 Type (ST,RA,PU,SA,SI,US,NO,DO)	ST
816 FU 132 Amplitude	8.33E-4
817 FU 132 Slope	
818 FU 132 Start time (sec)	0
819 FU 132 Stop time (sec)	
820 FU 132 Frequency (rad/sec)	
821 FU 132 Phase shift (deg)	
822 FU 132 Array location	
823 FU 132 Mean,Seed	
824 FU 132 Variance	
825 FU 132 Pulse width (sec)	
826 FU 132 Second pulse start time (sec)	
827 FU 141 Function generator ID number	141
828 FU 141 Type (ST,RA,PU,SA,SI,US,NO,DO)	NO
829 FU 141 Amplitude	
830 FU 141 Slope	
831 FU 141 Start time (sec)	
832 FU 141 Stop time (sec)	
833 FU 141 Frequency (rad/sec)	
834 FU 141 Phase shift (deg)	
835 FU 141 Array location	
836 FU 141 Mean,Seed	0,4
837 FU 141 Variance	1
838 FU 141 Pulse width (sec)	
839 FU 141 Second pulse start time (sec)	
840 FU 142 Function generator ID number	142
841 FU 142 Type (ST,RA,PU,SA,SI,US,NO,DO)	ST
842 FU 142 Amplitude	-1.225E-3
843 FU 142 Slope	
844 FU 142 Start time (sec)	0
845 FU 142 Stop time (sec)	
846 FU 142 Frequency (rad/sec)	
847 FU 142 Phase shift (deg)	
848 FU 142 Array location	
849 FU 142 Mean,Seed	
850 FU 142 Variance	
851 FU 142 Pulse width (sec)	
852 FU 142 Second pulse start time (sec)	
853 FU 151 Function generator ID number	151
854 FU 151 Type (ST,RA,PU,SA,SI,US,NO,DO)	NO
855 FU 151 Amplitude	
856 FU 151 Slope	
857 FU 151 Start time (sec)	
858 FU 151 Stop time (sec)	
859 FU 151 Frequency (rad/sec)	
860 FU 151 Phase shift (deg)	
861 FU 151 Array location	
862 FU 151 Mean,Seed	0,5
863 FU 151 Variance	1
864 FU 151 Pulse width (sec)	
865 FU 151 Second pulse start time (sec)	
866 FU 152 Function generator ID number	152
867 FU 152 Type (ST,RA,PU,SA,SI,US,NO,DO)	ST

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868 FU 152 Amplitude                                             2.45E-4
869 FU 152 Slope
870 FU 152 Start time (sec)                                      0
871 FU 152 Stop time (sec)
872 FU 152 Frequency (rad/sec)
873 FU 152 Phase shift (deg)
874 FU 152 Array location
875 FU 152 Mean,Seed
876 FU 152 Variance
877 FU 152 Pulse width (sec)
878 FU 152 Second pulse start time (sec)

879 FU 161 Function generator ID number                          161
880 FU 161 Type (ST,RA,PU,SA,SI,US,NO,DO)                        NO
881 FU 161 Amplitude
882 FU 161 Slope
883 FU 161 Start time (sec)
884 FU 161 Stop time (sec)
885 FU 161 Frequency (rad/sec)
886 FU 161 Phase shift (deg)
887 FU 161 Array location
888 FU 161 Mean,Seed                                             0,6
889 FU 161 Variance                                              1
890 FU 161 Pulse width (sec)
891 FU 161 Second pulse start time (sec)

892 FU 162 Function generator ID number                          162
893 FU 162 Type (ST,RA,PU,SA,SI,US,NO,DO)                        ST
894 FU 162 Amplitude                                             1.127E-3
895 FU 162 Slope
896 FU 162 Start time (sec)                                      0
897 FU 162 Stop time (sec)
898 FU 162 Frequency (rad/sec)
899 FU 162 Phase shift (deg)
900 FU 162 Array location
901 FU 162 Mean,Seed
902 FU 162 Variance
903 FU 162 Pulse width (sec)
904 FU 162 Second pulse start time (sec)

           INTERCONNECT

905 IN   1 Interconnect ID number                                1
906 IN   1 Source type(S,C, or F),Source ID,Source row #         F,1,1
907 IN   1 Destination type(A or C),Dest ID,Dest row #           A,1,1
908 IN   1 Gain                                                  0

909 IN   2 Interconnect ID number                                2
910 IN   2 Source type(S,C, or F),Source ID,Source row #         F,2,1
911 IN   2 Destination type(A or C),Dest ID,Dest row #           A,2,1
912 IN   2 Gain                                                  0

913 IN 111 Interconnect ID number                                111
914 IN 111 Source type(S,C, or F),Source ID,Source row #         F,111,1
915 IN 111 Destination type(A or C),Dest ID,Dest row #           C,1,1
916 IN 111 Gain                                                  1

917 IN 112 Interconnect ID number                                112
918 IN 112 Source type(S,C, or F),Source ID,Source row #         F,112,1
919 IN 112 Destination type(A or C),Dest ID,Dest row #           C,1,2
920 IN 112 Gain                                                  1

921 IN 113 Interconnect ID number                                113
922 IN 113 Source type(S,C, or F),Source ID,Source row #         S,101,1
923 IN 113 Destination type(A or C),Dest ID,Dest row #           C,1,3
924 IN 113 Gain                                                  1

925 IN 114 Interconnect ID number                                114
926 IN 114 Source type(S,C, or F),Source ID,Source row #         C,3,1
927 IN 114 Destination type(A or C),Dest ID,Dest row #           C,1,4
928 IN 114 Gain                                                  1

929 IN 115 Interconnect ID number                                115
930 IN 115 Source type(S,C, or F),Source ID,Source row #         C,3,2
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931 IN 115 Destination type(A or C),Dest ID,Dest row #        C,1,5
932 IN 115 Gain                                                1

933 IN 116 Interconnect ID number                              116
934 IN 116 Source type(S,C, or F),Source ID,Source row #       C,1,1
935 IN 116 Destination type(A or C),Dest ID,Dest row #         A,101,1
936 IN 116 Gain                                                1

937 IN 117 Interconnect ID number                              117
938 IN 117 Source type(S,C, or F),Source ID,Source row #       C,1,2
939 IN 117 Destination type(A or C),Dest ID,Dest row #         C,3,1
940 IN 117 Gain                                                1

941 IN 121 Interconnect ID number                              121
942 IN 121 Source type(S,C, or F),Source ID,Source row #       F,121,1
943 IN 121 Destination type(A or C),Dest ID,Dest row #         C,1,6
944 IN 121 Gain                                                1

945 IN 122 Interconnect ID number                              122
946 IN 122 Source type(S,C, or F),Source ID,Source row #       F,122,1
947 IN 122 Destination type(A or C),Dest ID,Dest row #         C,1,7
948 IN 122 Gain                                                1

949 IN 123 Interconnect ID number                              123
950 IN 123 Source type(S,C, or F),Source ID,Source row #       S,102,1
951 IN 123 Destination type(A or C),Dest ID,Dest row #         C,1,8
952 IN 123 Gain                                                1

953 IN 124 Interconnect ID number                              124
954 IN 124 Source type(S,C, or F),Source ID,Source row #       C,3,3
955 IN 124 Destination type(A or C),Dest ID,Dest row #         C,1,9
956 IN 124 Gain                                                1

957 IN 125 Interconnect ID number                              125
958 IN 125 Source type(S,C, or F),Source ID,Source row #       C,3,4
959 IN 125 Destination type(A or C),Dest ID,Dest row #         C,1,10
960 IN 125 Gain                                                1

961 IN 126 Interconnect ID number                              126
962 IN 126 Source type(S,C, or F),Source ID,Source row #       C,1,3
963 IN 126 Destination type(A or C),Dest ID,Dest row #         A,102,1
964 IN 126 Gain                                                1

965 IN 127 Interconnect ID number                              127
966 IN 127 Source type(S,C, or F),Source ID,Source row #       C,1,4
967 IN 127 Destination type(A or C),Dest ID,Dest row #         C,3,4
968 IN 127 Gain                                                1

969 IN 131 Interconnect ID number                              131
970 IN 131 Source type(S,C, or F),Source ID,Source row #       F,131,1
971 IN 131 Destination type(A or C),Dest ID,Dest row #         C,1,11
972 IN 131 Gain                                                1

973 IN 132 Interconnect ID number                              132
974 IN 132 Source type(S,C, or F),Source ID,Source row #       F,132,1
975 IN 132 Destination type(A or C),Dest ID,Dest row #         C,1,12
976 IN 132 Gain                                                1

977 IN 133 Interconnect ID number                              133
978 IN 133 Source type(S,C, or F),Source ID,Source row #       S,201,1
979 IN 133 Destination type(A or C),Dest ID,Dest row #         C,1,13
980 IN 133 Gain                                                1

981 IN 134 Interconnect ID number                              134
982 IN 134 Source type(S,C, or F),Source ID,Source row #       C,3,5
983 IN 134 Destination type(A or C),Dest ID,Dest row #         C,1,14
984 IN 134 Gain                                                1

985 IN 135 Interconnect ID number                              135
986 IN 135 Source type(S,C, or F),Source ID,Source row #       C,3,6
987 IN 135 Destination type(A or C),Dest ID,Dest row #         C,1,15
988 IN 135 Gain                                                1

989 IN 136 Interconnect ID number                              136
990 IN 136 Source type(S,C, or F),Source ID,Source row #       C,1,5
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 991 IN 136 Destination type(A or C),Dest ID,Dest row #       A,201,1
 992 IN 136 Gain                                              1

 993 IN 137 Interconnect ID number                            137
 994 IN 137 Source type(S,C, or F),Source ID,Source row #     C,1,6
 995 IN 137 Destination type(A or C),Dest ID,Dest row #       C,3,7
 996 IN 137 Gain                                              1

 997 IN 141 Interconnect ID number                            141
 998 IN 141 Source type(S,C, or F),Source ID,Source row #     F,141,1
 999 IN 141 Destination type(A or C),Dest ID,Dest row #       C,1,16
1000 IN 141 Gain                                              1

1001 IN 142 Interconnect ID number                            142
1002 IN 142 Source type(S,C, or F),Source ID,Source row #     F,142,1
1003 IN 142 Destination type(A or C),Dest ID,Dest row #       C,1,17
1004 IN 142 Gain                                              1

1005 IN 143 Interconnect ID number                            143
1006 IN 143 Source type(S,C, or F),Source ID,Source row #     S,202,1
1007 IN 143 Destination type(A or C),Dest ID,Dest row #       C,1,18
1008 IN 143 Gain                                              1

1009 IN 144 Interconnect ID number                            144
1010 IN 144 Source type(S,C, or F),Source ID,Source row #     C,3,7
1011 IN 144 Destination type(A or C),Dest ID,Dest row #       C,1,19
1012 IN 144 Gain                                              1

1013 IN 145 Interconnect ID number                            145
1014 IN 145 Source type(S,C, or F),Source ID,Source row #     C,3,8
1015 IN 145 Destination type(A or C),Dest ID,Dest row #       C,1,20
1016 IN 145 Gain                                              1

1017 IN 146 Interconnect ID number                            146
1018 IN 146 Source type(S,C, or F),Source ID,Source row #     C,1,7
1019 IN 146 Destination type(A or C),Dest ID,Dest row #       A,202,1
1020 IN 146 Gain                                              1

1021 IN 147 Interconnect ID number                            147
1022 IN 147 Source type(S,C, or F),Source ID,Source row #     C,1,8
1023 IN 147 Destination type(A or C),Dest ID,Dest row #       C,3,10
1024 IN 147 Gain                                              1

1025 IN 151 Interconnect ID number                            151
1026 IN 151 Source type(S,C, or F),Source ID,Source row #     F,151,1
1027 IN 151 Destination type(A or C),Dest ID,Dest row #       C,1,21
1028 IN 151 Gain                                              1

1029 IN 152 Interconnect ID number                            152
1030 IN 152 Source type(S,C, or F),Source ID,Source row #     F,152,1
1031 IN 152 Destination type(A or C),Dest ID,Dest row #       C,1,22
1032 IN 152 Gain                                              1

1033 IN 153 Interconnect ID number                            153
1034 IN 153 Source type(S,C, or F),Source ID,Source row #     S,301,1
1035 IN 153 Destination type(A or C),Dest ID,Dest row #       C,1,23
1036 IN 153 Gain                                              1

1037 IN 154 Interconnect ID number                            154
1038 IN 154 Source type(S,C, or F),Source ID,Source row #     C,3,9
1039 IN 154 Destination type(A or C),Dest ID,Dest row #       C,1,24
1040 IN 154 Gain                                              1

1041 IN 155 Interconnect ID number                            155
1042 IN 155 Source type(S,C, or F),Source ID,Source row #     C,3,10
1043 IN 155 Destination type(A or C),Dest ID,Dest row #       C,1,25
1044 IN 155 Gain                                              1

1045 IN 156 Interconnect ID number                            156
1046 IN 156 Source type(S,C, or F),Source ID,Source row #     C,1,9
1047 IN 156 Destination type(A or C),Dest ID,Dest row #       A,301,1
1048 IN 156 Gain                                              1

1049 IN 157 Interconnect ID number                            157
1050 IN 157 Source type(S,C, or F),Source ID,Source row #     C,1,10
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1051 IN 157 Destination type(A or C),Dest ID,Dest row #        C,3,13
1052 IN 157 Gain                                               1

1053 IN 161 Interconnect ID number                             161
1054 IN 161 Source type(S,C, or F),Source ID,Source row #      F,161,1
1055 IN 161 Destination type(A or C),Dest ID,Dest row #        C,1,26
1056 IN 161 Gain                                               1

1057 IN 162 Interconnect ID number                             162
1058 IN 162 Source type(S,C, or F),Source ID,Source row #      F,162,1
1059 IN 162 Destination type(A or C),Dest ID,Dest row #        C,1,27
1060 IN 162 Gain                                               1

1061 IN 163 Interconnect ID number                             163
1062 IN 163 Source type(S,C, or F),Source ID,Source row #      S,302,1
1063 IN 163 Destination type(A or C),Dest ID,Dest row #        C,1,28
1064 IN 163 Gain                                               1

1065 IN 164 Interconnect ID number                             164
1066 IN 164 Source type(S,C, or F),Source ID,Source row #      C,3,11
1067 IN 164 Destination type(A or C),Dest ID,Dest row #        C,1,29
1068 IN 164 Gain                                               1

1069 IN 165 Interconnect ID number                             165
1070 IN 165 Source type(S,C, or F),Source ID,Source row #      C,3,12
1071 IN 165 Destination type(A or C),Dest ID,Dest row #        C,1,30
1072 IN 165 Gain                                               1

1073 IN 166 Interconnect ID number                             166
1074 IN 166 Source type(S,C, or F),Source ID,Source row #      C,1,11
1075 IN 166 Destination type(A or C),Dest ID,Dest row #        A,302,1
1076 IN 166 Gain                                               1

1077 IN 167 Interconnect ID number                             167
1078 IN 167 Source type(S,C, or F),Source ID,Source row #      C,1,12
1079 IN 167 Destination type(A or C),Dest ID,Dest row #        C,3,16
1080 IN 167 Gain                                               1

1081 IN 211 Interconnect ID number                             211
1082 IN 211 Source type(S,C, or F),Source ID,Source row #      S,401,1
1083 IN 211 Destination type(A or C),Dest ID,Dest row #        C,2,1
1084 IN 211 Gain                                               1

1085 IN 212 Interconnect ID number                             212
1086 IN 212 Source type(S,C, or F),Source ID,Source row #      S,401,2
1087 IN 212 Destination type(A or C),Dest ID,Dest row #        C,2,2
1088 IN 212 Gain                                               1

1089 IN 213 Interconnect ID number                             213
1090 IN 213 Source type(S,C, or F),Source ID,Source row #      S,501,1
1091 IN 213 Destination type(A or C),Dest ID,Dest row #        C,2,3
1092 IN 213 Gain                                               1

1093 IN 214 Interconnect ID number                             214
1094 IN 214 Source type(S,C, or F),Source ID,Source row #      S,501,2
1095 IN 214 Destination type(A or C),Dest ID,Dest row #        C,2,4
1096 IN 214 Gain                                               1

1097 IN 215 Interconnect ID number                             215
1098 IN 215 Source type(S,C, or F),Source ID,Source row #      S,601,1
1099 IN 215 Destination type(A or C),Dest ID,Dest row #        C,2,5
1100 IN 215 Gain                                               1

1101 IN 216 Interconnect ID number                             216
1102 IN 216 Source type(S,C, or F),Source ID,Source row #      S,601,2
1103 IN 216 Destination type(A or C),Dest ID,Dest row #        C,2,6
1104 IN 216 Gain                                               1

1105 IN 217 Interconnect ID number                             217
1106 IN 217 Source type(S,C, or F),Source ID,Source row #      S,701,1
1107 IN 217 Destination type(A or C),Dest ID,Dest row #        C,2,7
1108 IN 217 Gain                                               1

1109 IN 218 Interconnect ID number                             218
1110 IN 218 Source type(S,C, or F),Source ID,Source row #      S,701,2
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1111 IN 218 Destination type(A or C),Dest ID,Dest row #        C,2,8
1112 IN 218 Gain                                               1

1113 IN 219 Interconnect ID number                             219
1114 IN 219 Source type(S,C, or F),Source ID,Source row #      S,701,3
1115 IN 219 Destination type(A or C),Dest ID,Dest row #        C,2,9
1116 IN 219 Gain                                               1

1117 IN 220 Interconnect ID number                             220
1118 IN 220 Source type(S,C, or F),Source ID,Source row #      S,801,1
1119 IN 220 Destination type(A or C),Dest ID,Dest row #        C,2,10
1120 IN 220 Gain                                               1

1121 IN 221 Interconnect ID number                             221
1122 IN 221 Source type(S,C, or F),Source ID,Source row #      S,801,2
1123 IN 221 Destination type(A or C),Dest ID,Dest row #        C,2,11
1124 IN 221 Gain                                               1

1125 IN 222 Interconnect ID number                             222
1126 IN 222 Source type(S,C, or F),Source ID,Source row #      S,801,3
1127 IN 222 Destination type(A or C),Dest ID,Dest row #        C,2,12
1128 IN 222 Gain                                               1

1129 IN 223 Interconnect ID number                             223
1130 IN 223 Source type(S,C, or F),Source ID,Source row #      S,901,1
1131 IN 223 Destination type(A or C),Dest ID,Dest row #        C,2,13
1132 IN 223 Gain                                               1

1133 IN 224 Interconnect ID number                             224
1134 IN 224 Source type(S,C, or F),Source ID,Source row #      S,901,2
1135 IN 224 Destination type(A or C),Dest ID,Dest row #        C,2,14
1136 IN 224 Gain                                               1

1137 IN 225 Interconnect ID number                             225
1138 IN 225 Source type(S,C, or F),Source ID,Source row #      S,901,3
1139 IN 225 Destination type(A or C),Dest ID,Dest row #        C,2,15
1140 IN 225 Gain                                               1

1141 IN 226 Interconnect ID number                             226
1142 IN 226 Source type(S,C, or F),Source ID,Source row #      S,402,1
1143 IN 226 Destination type(A or C),Dest ID,Dest row #        C,2,16
1144 IN 226 Gain                                               1

1145 IN 227 Interconnect ID number                             227
1146 IN 227 Source type(S,C, or F),Source ID,Source row #      S,402,2
1147 IN 227 Destination type(A or C),Dest ID,Dest row #        C,2,17
1148 IN 227 Gain                                               1

1149 IN 228 Interconnect ID number                             228
1150 IN 228 Source type(S,C, or F),Source ID,Source row #      S,502,1
1151 IN 228 Destination type(A or C),Dest ID,Dest row #        C,2,18
1152 IN 228 Gain                                               1

1153 IN 229 Interconnect ID number                             229
1154 IN 229 Source type(S,C, or F),Source ID,Source row #      S,502,2
1155 IN 229 Destination type(A or C),Dest ID,Dest row #        C,2,19
1156 IN 229 Gain                                               1

1157 IN 230 Interconnect ID number                             230
1158 IN 230 Source type(S,C, or F),Source ID,Source row #      S,602,1
1159 IN 230 Destination type(A or C),Dest ID,Dest row #        C,2,20
1160 IN 230 Gain                                               1

1161 IN 231 Interconnect ID number                             231
1162 IN 231 Source type(S,C, or F),Source ID,Source row #      S,602,2
1163 IN 231 Destination type(A or C),Dest ID,Dest row #        C,2,21
1164 IN 231 Gain                                               1

1165 IN 232 Interconnect ID number                             232
1166 IN 232 Source type(S,C, or F),Source ID,Source row #      S,911,1
1167 IN 232 Destination type(A or C),Dest ID,Dest row #        C,2,22
1168 IN 232 Gain                                               1

1169 IN 233 Interconnect ID number                             233
1170 IN 233 Source type(S,C, or F),Source ID,Source row #      S,911,2
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1171 IN 233 Destination type(A or C),Dest ID,Dest row #        C,2,23
1172 IN 233 Gain                                               1

1173 IN 234 Interconnect ID number                             234
1174 IN 234 Source type(S,C, or F),Source ID,Source row #      S,911,3
1175 IN 234 Destination type(A or C),Dest ID,Dest row #        C,2,24
1176 IN 234 Gain                                               1

1177 IN 235 Interconnect ID number                             235
1178 IN 235 Source type(S,C, or F),Source ID,Source row #      S,922,1
1179 IN 235 Destination type(A or C),Dest ID,Dest row #        C,2,25
1180 IN 235 Gain                                               1

1181 IN 236 Interconnect ID number                             236
1182 IN 236 Source type(S,C, or F),Source ID,Source row #      S,922,2
1183 IN 236 Destination type(A or C),Dest ID,Dest row #        C,2,26
1184 IN 236 Gain                                               1

1185 IN 237 Interconnect ID number                             237
1186 IN 237 Source type(S,C, or F),Source ID,Source row #      S,922,3
1187 IN 237 Destination type(A or C),Dest ID,Dest row #        C,2,27
1188 IN 237 Gain                                               1

1189 IN 311 Interconnect ID number                             311
1190 IN 311 Source type(S,C, or F),Source ID,Source row #      C,2,16
1191 IN 311 Destination type(A or C),Dest ID,Dest row #        C,3,2
1192 IN 311 Gain                                               1

1193 IN 312 Interconnect ID number                             312
1194 IN 312 Source type(S,C, or F),Source ID,Source row #      C,2,28
1195 IN 312 Destination type(A or C),Dest ID,Dest row #        C,3,3
1196 IN 312 Gain                                               1

1197 IN 321 Interconnect ID number                             321
1198 IN 321 Source type(S,C, or F),Source ID,Source row #      C,2,17
1199 IN 321 Destination type(A or C),Dest ID,Dest row #        C,3,5
1200 IN 321 Gain                                               1

1201 IN 322 Interconnect ID number                             322
1202 IN 322 Source type(S,C, or F),Source ID,Source row #      C,2,29
1203 IN 322 Destination type(A or C),Dest ID,Dest row #        C,3,6
1204 IN 322 Gain                                               1

1205 IN 331 Interconnect ID number                             331
1206 IN 331 Source type(S,C, or F),Source ID,Source row #      C,2,18
1207 IN 331 Destination type(A or C),Dest ID,Dest row #        C,3,8
1208 IN 331 Gain                                               1

1209 IN 332 Interconnect ID number                             332
1210 IN 332 Source type(S,C, or F),Source ID,Source row #      C,2,30
1211 IN 332 Destination type(A or C),Dest ID,Dest row #        C,3,9
1212 IN 332 Gain                                               1

1213 IN 341 Interconnect ID number                             341
1214 IN 341 Source type(S,C, or F),Source ID,Source row #      C,2,19
1215 IN 341 Destination type(A or C),Dest ID,Dest row #        C,3,11
1216 IN 341 Gain                                               1

1217 IN 342 Interconnect ID number                             342
1218 IN 342 Source type(S,C, or F),Source ID,Source row #      C,2,31
1219 IN 342 Destination type(A or C),Dest ID,Dest row #        C,3,12
1220 IN 342 Gain                                               1

1221 IN 351 Interconnect ID number                             351
1222 IN 351 Source type(S,C, or F),Source ID,Source row #      C,2,20
1223 IN 351 Destination type(A or C),Dest ID,Dest row #        C,3,14
1224 IN 351 Gain                                               1

1225 IN 352 Interconnect ID number                             352
1226 IN 352 Source type(S,C, or F),Source ID,Source row #      C,2,32
1227 IN 352 Destination type(A or C),Dest ID,Dest row #        C,3,15
1228 IN 352 Gain                                               1

1229 IN 361 Interconnect ID number                             361
1230 IN 361 Source type(S,C, or F),Source ID,Source row #      C,2,21
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1231	IN	361	Destination type(A or C),Dest ID,Dest row #	C,3,17
1232	IN	361	Gain	1
1233	IN	362	Interconnect ID number	362
1234	IN	362	Source type(S,C, or F),Source ID,Source row #	C,2,33
1235	IN	362	Destination type(A or C),Dest ID,Dest row #	C,3,18
1236	IN	362	Gain	1

DEVICE

1237	DE	1	Device ID number	1
1238	DE	1	Device Type (LI,QU,SD,CO,UH,LH)	LI
1239	DE	1	Device location (Node or Hinge)	N
1240	DE	1	Hinge ID no., Hinge axis no.(1-6)	
1241	DE	1	Node 1 Body ID no., Node 1 Node ID no.	1,7
1242	DE	1	Node 2 Body ID no., Node 2 Node ID no.	2,12
1243	DE	1	Hardstop Location, Initial force	
1244	DE	1	Stiffness Coefficient (Kqe)	0
1245	DE	1	Damping Coefficient (Bqe)	0
1246	DE	1	Unstreched spring/cable length	10
1247	DE	2	Device ID number	2
1248	DE	2	Device Type (LI,QU,SD,CO,UH,LH)	LI
1249	DE	2	Device location (Node or Hinge)	N
1250	DE	2	Hinge ID no., Hinge axis no.(1-6)	
1251	DE	2	Node 1 Body ID no., Node 1 Node ID no.	1,8
1252	DE	2	Node 2 Body ID no., Node 2 Node ID no.	2,12
1253	DE	2	Hardstop Location, Initial force	
1254	DE	2	Stiffness Coefficient (Kqe)	0.
1255	DE	2	Damping Coefficient (Bqe)	0
1256	DE	2	Unstreched spring/cable length	10
1257	DE	3	Device ID number	3
1258	DE	3	Device Type (LI,QU,SD,CO,UH,LH)	LI
1259	DE	3	Device location (Node or Hinge)	N
1260	DE	3	Hinge ID no., Hinge axis no.(1-6)	
1261	DE	3	Node 1 Body ID no., Node 1 Node ID no.	1,9
1262	DE	3	Node 2 Body ID no., Node 2 Node ID no.	2,12
1263	DE	3	Hardstop Location, Initial force	
1264	DE	3	Stiffness Coefficient (Kqe)	0
1265	DE	3	Damping Coefficient (Bqe)	0
1266	DE	3	Unstreched spring/cable length	10
1267	DE	4	Device ID number	4
1268	DE	4	Device Type (LI,QU,SD,CO,UH,LH)	LI
1269	DE	4	Device location (Node or Hinge)	N
1270	DE	4	Hinge ID no., Hinge axis no.(1-6)	
1271	DE	4	Node 1 Body ID no., Node 1 Node ID no.	1,10
1272	DE	4	Node 2 Body ID no., Node 2 Node ID no.	2,13
1273	DE	4	Hardstop Location, Initial force	
1274	DE	4	Stiffness Coefficient (Kqe)	18
1275	DE	4	Damping Coefficient (Bqe)	0
1276	DE	4	Unstreched spring/cable length	10
1277	DE	5	Device ID number	5
1278	DE	5	Device Type (LI,QU,SD,CO,UH,LH)	LI
1279	DE	5	Device location (Node or Hinge)	N
1280	DE	5	Hinge ID no., Hinge axis no.(1-6)	
1281	DE	5	Node 1 Body ID no., Node 1 Node ID no.	1,11
1282	DE	5	Node 2 Body ID no., Node 2 Node ID no.	2,13
1283	DE	5	Hardstop Location, Initial force	
1284	DE	5	Stiffness Coefficient (Kqe)	13.5
1285	DE	5	Damping Coefficient (Bqe)	0
1286	DE	5	Unstreched spring/cable length	10
1287	DE	6	Device ID number	6
1288	DE	6	Device Type (LI,QU,SD,CO,UH,LH)	LI
1289	DE	6	Device location (Node or Hinge)	N
1290	DE	6	Hinge ID no., Hinge axis no.(1-6)	
1291	DE	6	Node 1 Body ID no., Node 1 Node ID no.	1,12
1292	DE	6	Node 2 Body ID no., Node 2 Node ID no.	2,13
1293	DE	6	Hardstop Location, Initial force	
1294	DE	6	Stiffness Coefficient (Kqe)	20
1295	DE	6	Damping Coefficient (Bqe)	0

1296	DE	6 Unstreched spring/cable length	10
1297	DE	7 Device ID number	7
1298	DE	7 Device Type (LI,QU,SD,CO,UH,LH)	QU
1299	DE	7 Device location (Node or Hinge)	N
1300	DE	7 Hinge ID no., Hinge axis no.(1-6)	
1301	DE	7 Node 1 Body ID no., Node 1 Node ID no.	1,9
1302	DE	7 Node 2 Body ID no., Node 2 Node ID no.	2,12
1303	DE	7 Hardstop Location, Initial force	
1304	DE	7 Stiffness Coefficient (Kqe)	0.
1305	DE	7 Damping Coefficient (Bqe)	0
1306	DE	7 Unstreched spring/cable length	10
1307	DE	8 Device ID number	8
1308	DE	8 Device Type (LI,QU,SD,CO,UH,LH)	QU
1309	DE	8 Device location (Node or Hinge)	N
1310	DE	8 Hinge ID no., Hinge axis no.(1-6)	
1311	DE	8 Node 1 Body ID no., Node 1 Node ID no.	1,12
1312	DE	8 Node 2 Body ID no., Node 2 Node ID no.	2,13
1313	DE	8 Hardstop Location, Initial force	
1314	DE	8 Stiffness Coefficient (Kqe)	-672
1315	DE	8 Damping Coefficient (Bqe)	0
1316	DE	8 Unstreched spring/cable length	10

CNTDTA

1317	CN	1 CNTDTA : ID Number	1
1318	CN	1 CNTDTA : Number of data values (max = 150)	23
1319	CN	1 CNTDTA : Array value	5.5E4
1320	CN	1 CNTDTA : Array value	5.5E4
1321	CN	1 CNTDTA : Array value	8.8E-2
1322	CN	1 CNTDTA : Array value	4.E-3
1323	CN	1 CNTDTA : Array value	4.E-5
1324	CN	1 CNTDTA : Array value	2.
1325	CN	1 CNTDTA : Array value	0.4
1326	CN	1 CNTDTA : Array value	0.04
1327	CN	1 CNTDTA : Array value	6.28
1328	CN	1 CNTDTA : Array value	20.
1329	CN	1 CNTDTA : Array value	1E2
1330	CN	1 CNTDTA : Array value	1E4
1331	CN	1 CNTDTA : Array value	0.002
1332	CN	1 CNTDTA : Array value	0.008
1333	CN	1 CNTDTA : Array value	1.
1334	CN	1 CNTDTA : Array value	0.2
1335	CN	1 CNTDTA : Array value	10.
1336	CN	1 CNTDTA : Array value	2.00
1337	CN	1 CNTDTA : Array value	1.
1338	CN	1 CNTDTA : Array value	0.100
1339	CN	1 CNTDTA : Array value	100
1340	CN	1 CNTDTA : Array value	2
1341	CN	1 CNTDTA : Array value	6

Appendix C

ARIS User Defined Signal Generator Subroutine

```
cccccccccccccccccccccccccccccccccccccccccccccccccccccc
      SUBROUTINE DIST(TIME,FDIST,FDDIST)
*
*     THIS IS A SIGNAL GENERATOR FOR SSFF UF31 DEFINED BY YK
*     Actuator #1 deleted.
*
      IMPLICIT DOUBLE PRECISION(A-H,O-Z)
      include 'DBP.F'
      include 'DBB.F'
      include 'DBC.F'
      include 'DBSV.F'
      DIMENSION FDIST(1)
      dimension c1(3,3),c1t(3,3),c4(3,3),c4t(3,3),c6(3,3),
     1        c6t(3,3),c8(3,3),c8t(3,3),c10(3,3),c10t(3,3),c12(3,3),
     2        c12t(3,3),c14(3,3),c14t(3,3),c16(3,3),c16t(3,3),
     3        c18(3,3),c18t(3,3)
      dimension th4(3),th6(3),th8(3),th10(3),th12(3),th14(3),th16(3),
     1        th18(3),delth1(3),temp(3,3)
      dimension th4i(3),th6i(3),th8i(3),th10i(3),th12i(3),th14i(3),
     2        th16i(3),th18i(3)
ccccc INITIALIZATION cccccccccccccccccccccccccccccccccccccccccccccc
c          d2r=(4.d0*datan(1.d0))/180.d0
           tork=0.0565d0
c     Initial rotational angles at the connection node of push rod to SS (radian)
c     that can be determined from IG sensor output of geom4.int with zero I.C. .
           do 111 i=1,3
                th4i(i)=0.d0
                th6i(i)=0.d0
                th8i(i)=0.d0
                th10i(i)=0.d0
                th12i(i)=0.d0
                th14i(i)=0.d0
                th16i(i)=0.d0
                th18i(i)=0.d0
 111       continue
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
          nrpxx=0         ! Number of sensors upto IG sensor
          do 1 i=1,3
          do 1 j=1,3
                    c1(i,j)=ctrans(i,j,1)
                    c4(i,j)=ctrans(i,j,4)
                    c6(i,j)=ctrans(i,j,6)
                    c8(i,j)=ctrans(i,j,8)
                    c10(i,j)=ctrans(i,j,10)
                    c12(i,j)=ctrans(i,j,12)
                    c14(i,j)=ctrans(i,j,14)
                    c16(i,j)=ctrans(i,j,16)
                    c18(i,j)=ctrans(i,j,18)
1     continue
          do 2 i=1,3
          do 2 j=1,3
                    c1t(i,j)=c1(j,i)
                    c4t(i,j)=c4(j,i)
                    c6t(i,j)=c6(j,i)
                    c8t(i,j)=c8(j,i)
                    c10t(i,j)=c10(j,i)
                    c12t(i,j)=c12(j,i)
                    c14t(i,j)=c14(j,i)
                    c16t(i,j)=c16(j,i)
                    c18t(i,j)=c18(j,i)
```

```
  2       continue
c************************** Push rod #1 (Body #4) !!!! DELETED !!!!
        th4(1)=th4i(1)+rp(nrpxx+1)  !rotation about x4
        th4(2)=th4i(2)+rp(nrpxx+2)  !rotation about y4
        th4(3)=th4i(3)+rp(nrpxx+3)  !rotation about z4
c
        call m3x3(c4t,c1,temp)
        call mxv(temp,theta(1,1),delth1)
        do 4 i=1,3
                th4(i)=th4(i)-delth1(i)
cccccccccccc    4  fdist(i)=-tork*th4(i)
4               fdist(i)=0.d0
c
        call m3x3(c1t,c4,temp)
        call mxv(temp,fdist(1),fdist(4))
        do 41 j=1,3
cccccccccccc  41            fdist(j+3)=-fdist(j+3)
  41            fdist(j+3)=0.d0
c
c************************** Push rod #2 (Body #6)
        th6(1)=th6i(1)+rp(nrpxx+4)  !rotation about x6
        th6(2)=th6i(2)+rp(nrpxx+5)  !rotation about y6
        th6(3)=th6i(3)+rp(nrpxx+6)  !rotation about z6
c
        call m3x3(c6t,c1,temp)
        call mxv(temp,theta(1,1),delth1)
        do 6 i=1,3
                th6(i)=th6(i)-delth1(i)
  6             fdist(i+6*1)=-tork*th6(i)
c
        call m3x3(c1t,c6,temp)
        call mxv(temp,fdist(1+6*1),fdist(4+6*1))
        do 61 j=1,3
  61            fdist(6*1+j+3)=-fdist(6*1+j+3)
c
c************************** Push rod #3 (Body #8)
        th8(1)=th8i(1)+rp(nrpxx+7)  !rotation about x8
        th8(2)=th8i(2)+rp(nrpxx+8)  !rotation about y8
        th8(3)=th8i(3)+rp(nrpxx+9)  !rotation about z8
c
        call m3x3(c8t,c1,temp)
        call mxv(temp,theta(1,1),delth1)
        do 8 i=1,3
                th8(i)=th8(i)-delth1(i)
  8             fdist(i+6*2)=-tork*th8(i)
c
        call m3x3(c1t,c8,temp)
        call mxv(temp,fdist(1+6*2),fdist(4+6*2))
        do 81 j=1,3
  81            fdist(6*2+j+3)=-fdist(6*2+j+3)
c
c************************** Push rod #4 (Body #10)
        th10(1)=th10i(1)+rp(nrpxx+10)       !rotation about x10
        th10(2)=th10i(2)+rp(nrpxx+11)       !rotation about y10
        th10(3)=th10i(3)+rp(nrpxx+12)       !rotation about z10
c
        call m3x3(c10t,c1,temp)
        call mxv(temp,theta(1,1),delth1)
        do 10 i=1,3
                th10(i)=th10(i)-delth1(i)
```

```
 10              fdist(i+6*3)=-tork*th10(i)
c
         call m3x3(c1t,c10,temp)
         call mxv(temp,fdist(1+6*3),fdist(4+6*3))
         do 101 j=1,3
 101             fdist(6*3+j+3)=-fdist(6*3+j+3)
c
c************************** Push rod #5 (Body #12)
         th12(1)=th12i(1)+rp(nrpxx+13)       !rotation about x12
         th12(2)=th12i(2)+rp(nrpxx+14)       !rotation about y12
         th12(3)=th12i(3)+rp(nrpxx+15)       !rotation about z12
c
         call m3x3(c12t,c1,temp)
         call mxv(temp,theta(1,1),delth1)
         do 12 i=1,3
                 th12(i)=th12(i)-delth1(i)
 12              fdist(i+6*4)=-tork*th12(i)
c
         call m3x3(c1t,c12,temp)
         call mxv(temp,fdist(1+6*4),fdist(4+6*4))
         do 121 j=1,3
 121             fdist(6*4+j+3)=-fdist(6*4+j+3)
c
c************************** Push rod #6 (Body #14)
         th14(1)=th14i(1)+rp(nrpxx+16)       !rotation about x14
         th14(2)=th14i(2)+rp(nrpxx+17)       !rotation about y14
         th14(3)=th14i(3)+rp(nrpxx+18)       !rotation about z14
c
         call m3x3(c14t,c1,temp)
         call mxv(temp,theta(1,1),delth1)
         do 14 i=1,3
                 th14(i)=th14(i)-delth1(i)
 14              fdist(i+6*5)=-tork*th14(i)
c
         call m3x3(c1t,c14,temp)
         call mxv(temp,fdist(1+6*5),fdist(4+6*5))
         do 141 j=1,3
 141             fdist(6*5+j+3)=-fdist(6*5+j+3)
c
c************************** Push rod #7 (Body #16)
         th16(1)=th16i(1)+rp(nrpxx+19)       !rotation about x16
         th16(2)=th16i(2)+rp(nrpxx+20)       !rotation about y16
         th16(3)=th16i(3)+rp(nrpxx+21)       !rotation about z16
c
         call m3x3(c16t,c1,temp)
         call mxv(temp,theta(1,1),delth1)
         do 16 i=1,3
                 th16(i)=th16(i)-delth1(i)
 16              fdist(i+6*6)=-tork*th16(i)
c
         call m3x3(c1t,c16,temp)
         call mxv(temp,fdist(1+6*6),fdist(4+6*6))
         do 161 j=1,3
 161             fdist(6*6+j+3)=-fdist(6*6+j+3)
c
c************************** Push rod #8 (Body #18)
         th18(1)=th18i(1)+rp(nrpxx+22)       !rotation about x18
         th18(2)=th18i(2)+rp(nrpxx+23)       !rotation about y18
         th18(3)=th18i(3)+rp(nrpxx+24)       !rotation about z18
c
```

```
        call m3x3(c18t,c1,temp)
        call mxv(temp,theta(1,1),delth1)
        do 18 i=1,3
                th18(i)=th18(i)-delth1(i)
 18             fdist(i+6*7)=-tork*th18(i)
c
        call m3x3(c1t,c18,temp)
        call mxv(temp,fdist(1+6*7),fdist(4+6*7))
        do 181 j=1,3
 181            fdist(6*7+j+3)=-fdist(6*7+j+3)
c**********************************************************
cc    write(6,*) 'For time = ',time
cc    do 99 i=1,48
cc    write(6,*) 'fdist ',i,' = ',fdist(i)
cc 99 continue
cc    write(6,*) 'ctrans(18)= ',((ctrans(i,j,18),j=1,3),i=1,3)
   RETURN
   END
```

Appendix D

ARIS User Defined Controller Subroutine

```
C     SUBROUTINE USCC(T,U,X,R,XDOT)
C     DIMENSION U(1),X(1),R(1),XDOT(1)
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
c     Acc. & Position control loop for uf3.int
c     (Based on Boeing working notes)
c     Actuator #1 was deleted for SSFF UF3.
c     Written by Young Kim  on 5/14/96.
c
C*ST  User Defined Continuous Controller for SSFF_UF3 ARIS controller.
c---------------------------------------------------------
      SUBROUTINE USCC(T,U,X,R,XDOT)
      IMPLICIT DOUBLE PRECISION(A-H,O-Z)
      include 'DBP.F'
      include 'DBB.F'
      include 'DBC.F'
      include 'DBSV.F'
      DIMENSION U(14),X(1),R(42),XDOT(1)
      dimension tmtox(6,8),tdelxtou(8,6),tptox1(6,8),thpivot(8)
      dimension fa(8),fac(8),tempc(3,3),tempf(3),tempr(3)
      dimension c2(3,3),c2t(3,3),c3(3,3),c3t(3,3),c5(3,3),c5t(3,3),
     1       c7(3,3),c7t(3,3),c9(3,3),c9t(3,3),c11(3,3),
     2       c11t(3,3),c13(3,3),c13t(3,3),c15(3,3),c15t(3,3),
     3       c17(3,3),c17t(3,3),pk(6,6)
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
c Controller #2 input:
c    u(1)=  Acc. measurement of Sensor #211 (m/sec^2)
c    u(2)=  Acc. measurement of Sensor #212 (m/sec^2)
c    u(3)=  Acc. measurement of Sensor #221 (m/sec^2)
c    u(4)=  Acc. measurement of Sensor #222 (m/sec^2)
c    u(5)=  Acc. measurement of Sensor #223 (m/sec^2)
c    u(6)=  Acc. measurement of Sensor #231 (m/sec^2)
c    u(7)=  Acc. measurement of Sensor #232 (m/sec^2)
c    u(8)=  Acc. measurement of Sensor #233 (m/sec^2)
c    u(9)=   Control Force F_x at the Rack C.G. (Output #1 of Controller #1) (N)
c    u(10)=  Control Force F_y at the Rack C.G. (Output #2 of Controller #1) (N)
c    u(11)=  Control Force F_z at the Rack C.G. (Output #3 of Controller #1) (N)
c    u(12)=  Control Moment T_x at the Rack C.G. (Output #4 of Controller #1) (N-m)
c    u(13)=  Control Moment T_y at the Rack C.G. (Output #5 of Controller #1) (N-m)
c    u(14)=  Control Moment T_z at the Rack C.G. (Output #6 of Controller #1) (N-m)
c
c Controller #2 output:
c    r(1) =  X_acc at Rack C.G. (Input #1 of Controller #1) (m/sec^2)
c    r(2) =  Y_acc at Rack C.G. (Input #2 of Controller #1) (m/sec^2)
c    r(3) =  Z_acc at Rack C.G. (Input #3 of Controller #1) (m/sec^2)
c    r(4) =  ThX_acc at Rack C.G. (Input #4 of Controller #1) (rad/sec^2)
c    r(5) =  ThY_acc at Rack C.G. (Input #5 of Controller #1) (rad/sec^2)
c    r(6) =  ThZ_acc at Rack C.G. (Input #6 of Controller #1) (rad/sec^2)
c
c    r(7) =  Control force at Rotor #1 C.G. (Input of Act. #101) (Newton)
c    r(8) =  Control force at Rotor #2 C.G. (Input of Act. #201) (Newton)
c    r(9) =  Control force at Rotor #3 C.G. (Input of Act. #301) (Newton)
c    r(10)=  Control force at Rotor #4 C.G. (Input of Act. #401) (Newton)
c    r(11)=  Control force at Rotor #5 C.G. (Input of Act. #501) (Newton)
c    r(12)=  Control force at Rotor #6 C.G. (Input of Act. #601) (Newton)
```

```
c    r(13)= Control force at Rotor #7 C.G. (Input of Act. #701) (Newton)
c    r(14)= Control force at Rotor #8 C.G. (Input of Act. #801) (Newton)
c
c    r(15)= F_y3 at B2N15 counteracted to Act. #101 on B3N1(Input of Act. #102) (N)
c    r(16)= F_z3 at B2N15 counteracted to Act. #101 on B3N1(Input of Act. #103) (N)
c    r(17)= F_y5 at B2N16 counteracted to Act. #201 on B5N1(Input of Act. #202) (N)
c    r(18)= F_z5 at B2N16 counteracted to Act. #201 on B5N1(Input of Act. #203) (N)
c    r(19)= F_y7 at B2N17 counteracted to Act. #301 on B7N1(Input of Act. #302) (N)
c    r(20)= F_z7 at B2N17 counteracted to Act. #301 on B7N1(Input of Act. #303) (N)
c    r(21)= F_y9 at B2N18 counteracted to Act. #401 on B9N1(Input of Act. #402) (N)
c    r(22)= F_z9 at B2N18 counteracted to Act. #401 on B9N1(Input of Act. #403) (N)
c
c    r(23)= F_x11 at B2N19 counteracted to Act. #501 on B11N1(Input of Act. #502) (N)
c    r(24)= F_y11 at B2N19 counteracted to Act. #501 on B11N1(Input of Act. #503) (N)
c    r(25)= F_x13 at B2N20 counteracted to Act. #601 on B13N1(Input of Act. #602) (N)
c    r(26)= F_y13 at B2N20 counteracted to Act. #601 on B13N1(Input of Act. #603) (N)
c    r(27)= F_x15 at B2N21 counteracted to Act. #701 on B15N1(Input of Act. #702) (N)
c    r(28)= F_y15 at B2N21 counteracted to Act. #701 on B15N1(Input of Act. #703) (N)
c    r(29)= F_x17 at B2N22 counteracted to Act. #801 on B17N1(Input of Act. #802) (N)
c    r(30)= F_y17 at B2N22 counteracted to Act. #801 on B17N1(Input of Act. #803) (N)
c
c    r(31)= calculated del x of Rack C.G. (Input #7 of controller #1)
c    r(32)= calculated del y of Rack C.G. (Input #8 of controller #1)
c    r(33)= calculated del z of Rack C.G. (Input #9 of controller #1)
c    r(34)= calculated del th_x of Rack C.G. (Input #10 of controller #1)
c    r(35)= calculated del th_y of Rack C.G. (Input #11 of controller #1)
c    r(36)= calculated del th_z of Rack C.G. (Input #12 of controller #1)
c
c    r(37)= Feedforward Control Force F_x at the Rack C.G. (N)
c    r(38)= Feedforward Control Force F_y at the Rack C.G. (N)
c    r(39)= Feedforward Control Force F_z at the Rack C.G. (N)
c    r(40)= Feedforward Control Moment T_x at the Rack C.G. (N-m)
c    r(41)= Feedforward Control Moment T_y at the Rack C.G. (N-m)
c    r(42)= Feedforward Control Moment T_z at the Rack C.G. (N-m)
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
c Length unit=meter
c**** tmtox (6x8 Transformation matrix from Acc. sensor to Rack C.G.)
c
      tmtox(1,1)= 3.5512d-01
      tmtox(1,2)= -3.5522d-01
      tmtox(1,3)= -1.7478d-01
      tmtox(1,4)= -1.0352d-01
      tmtox(1,5)= 3.7271d-01
      tmtox(1,6)= 1.0309d-01
      tmtox(1,7)= 1.7491d-01
      tmtox(1,8)= -3.7250d-01
c
         tmtox(2,1)= 4.0004d-01
         tmtox(2,2)= 4.3077d-01
         tmtox(2,3)= -1.1711d-01
         tmtox(2,4)= 2.9665d-02
         tmtox(2,5)= 1.0671d-01
         tmtox(2,6)= -9.0448d-02
         tmtox(2,7)= 4.6953d-01
```

```
          tmtox(2,8)= -3.1296d-01
c
          tmtox(3,1)= 7.4299d-02
          tmtox(3,2)= 1.5310d-01
          tmtox(3,3)= 1.2106d-01
          tmtox(3,4)= 2.3664d-01
          tmtox(3,5)= 4.2431d-01
          tmtox(3,6)= 2.8685d-01
          tmtox(3,7)= 2.4174d-01
          tmtox(3,8)= 3.6332d-01
c
          tmtox(4,1)= -4.5160d-01
          tmtox(4,2)= -4.7649d-01
          tmtox(4,3)= 5.1634d-01
          tmtox(4,4)= -9.6167d-02
          tmtox(4,5)= -3.3348d-01
          tmtox(4,6)= 6.4876d-04
          tmtox(4,7)= 4.3893d-02
          tmtox(4,8)= 4.8291d-03
c
          tmtox(5,1)= 3.3965d-01
          tmtox(5,2)= -3.3984d-01
          tmtox(5,3)= 2.3101d-02
          tmtox(5,4)= 3.4543d-01
          tmtox(5,5)= 1.0229d-01
          tmtox(5,6)= -3.4556d-01
          tmtox(5,7)= -2.2967d-02
          tmtox(5,8)= -1.0229d-01
c
          tmtox(6,1)= -3.9981d-02
          tmtox(6,2)= 3.9919d-02
          tmtox(6,3)= -7.6429d-01
          tmtox(6,4)= 1.5582d-01
          tmtox(6,5)= 5.4695d-01
          tmtox(6,6)= -1.5707d-01
          tmtox(6,7)= 7.6455d-01
          tmtox(6,8)= -5.4625d-01
c
c**** tdelxtou (8x6 Transformation matrix from Rack C.G. control forces
c****        to Actuator control forces using position vectore from Rack C.G.
c          to Actuator pivot)
c
          tdelxtou(1,1)= 0.d0
          tdelxtou(1,2)= 0.d0
          tdelxtou(1,3)= 0.d0
          tdelxtou(1,4)= 0.d0
          tdelxtou(1,5)= 0.d0
          tdelxtou(1,6)= 0.d0
c
          tdelxtou(2,1)= -4.5727d-01
          tdelxtou(2,2)= -6.3467d-02
          tdelxtou(2,3)= -3.4637d-01
          tdelxtou(2,4)= -1.6167d-01
          tdelxtou(2,5)= -5.1471d-01
```

```
          tdelxtou(2,6)= 8.3287d-01
c
          tdelxtou(3,1)= 9.0962d-02
          tdelxtou(3,2)= 1.9754d-01
          tdelxtou(3,3)= -5.2658d-01
          tdelxtou(3,4)= 1.7884d-01
          tdelxtou(3,5)= 8.0816d-02
          tdelxtou(3,6)= 3.0012d-01
c
          tdelxtou(4,1)= 4.2174d-01
          tdelxtou(4,2)= -1.3586d-01
          tdelxtou(4,3)= -7.2504d-01
          tdelxtou(4,4)= -5.1089d-02
          tdelxtou(4,5)= 4.8315d-01
          tdelxtou(4,6)= -9.5007d-01
c
          tdelxtou(5,1)= -2.6706d-01
          tdelxtou(5,2)= -1.1745d-01
          tdelxtou(5,3)= 3.2529d-01
          tdelxtou(5,4)= -2.0025d-01
          tdelxtou(5,5)= 2.8795d-01
          tdelxtou(5,6)= 4.2177d-01
c
          tdelxtou(6,1)= 4.3606d-01
          tdelxtou(6,2)= -1.0388d-01
          tdelxtou(6,3)= 2.3917d-01
          tdelxtou(6,4)= -1.5569d-01
          tdelxtou(6,5)= -1.3780d-01
          tdelxtou(6,6)= 1.3582d-01
c
          tdelxtou(7,1)= 8.1499d-01
          tdelxtou(7,2)= 2.6110d-01
          tdelxtou(7,3)= 1.0610d-01
          tdelxtou(7,4)= -3.4179d-01
          tdelxtou(7,5)= 6.3401d-01
          tdelxtou(7,6)= 4.1416d-01
c
          tdelxtou(8,1)= -8.2361d-01
          tdelxtou(8,2)= 3.0176d-01
          tdelxtou(8,3)= -1.5194d-01
          tdelxtou(8,4)= -2.0828d-01
          tdelxtou(8,5)= -6.4167d-01
          tdelxtou(8,6)= -4.4260d-01
c
c**** Transformation matrix from pivot angles to Rack C.G. movement
c
          tptox1(1,1)= 0.d0
          tptox1(1,2)= -3.1385e-02
          tptox1(1,3)= -9.1657e-03
          tptox1(1,4)= 2.7721e-02
          tptox1(1,5)= -2.0287e-02
          tptox1(1,6)= -3.6934e-02
          tptox1(1,7)= 7.7021e-02
          tptox1(1,8)= 7.7478e-02
```

```
c
      tptox1(2,1)= 0.d0
      tptox1(2,2)= -4.8530e-03
      tptox1(2,3)= -1.6361e-02
      tptox1(2,4)= -1.1006e-02
      tptox1(2,5)= -1.0062e-02
      tptox1(2,6)= 8.9464e-03
      tptox1(2,7)= 2.4285e-02
      tptox1(2,8)= -2.7596e-02
c
      tptox1(3,1)= 0.d0
      tptox1(3,2)= -2.6564e-02
      tptox1(3,3)= 4.4069e-02
      tptox1(3,4)= -6.1912e-02
      tptox1(3,5)= 3.0380e-02
      tptox1(3,6)= -2.2803e-02
      tptox1(3,7)= 9.7298e-03
      tptox1(3,8)= 1.2415e-02
c
      tptox1(4,1)= 0.d0
      tptox1(4,2)= -1.5292e-02
      tptox1(4,3)= -1.2815e-02
      tptox1(4,4)= 4.2109e-04
      tptox1(4,5)= -1.9535e-02
      tptox1(4,6)= 1.4169e-02
      tptox1(4,7)= -3.3555e-02
      tptox1(4,8)= 1.3457e-02
c
      tptox1(5,1)= 0.d0
      tptox1(5,2)= -3.4974e-02
      tptox1(5,3)= -8.7257e-03
      tptox1(5,4)= 3.1582e-02
      tptox1(5,5)= 2.8050e-02
      tptox1(5,6)= 1.1537e-02
      tptox1(5,7)= 6.2379e-02
      tptox1(5,8)= 6.2294e-02
c
      tptox1(6,1)= 0.d0
      tptox1(6,2)= 7.9464e-02
      tptox1(6,3)= -3.2265e-02
      tptox1(6,4)= -9.1522e-02
      tptox1(6,5)= 4.2845e-02
      tptox1(6,6)= -2.0802e-02
      tptox1(6,7)= 3.7810e-02
      tptox1(6,8)= 3.5320e-02
c
c**** PK matrix (6x6) to compensate the uncoupling due to umblical and
c**** actuators stiffness.
c
      pk(1,1)= 0.4806d+03
   pk(1,2)= 0.d+03
   pk(1,3)= 0.d+03
   pk(1,4)= 0.d+03
   pk(1,5)= 1.1200d+03
```

```
      pk(1,6)= 0.3783d+03
c
      pk(2,2)= -0.4945d+03
      pk(2,3)= 0.d+03
      pk(2,4)= -1.8628d+03
      pk(2,5)= 0.d+03
      pk(2,6)= 0.6242d+03
c
      pk(3,3)= -0.1622d+03
      pk(3,4)= -0.5202d+03
      pk(3,5)= -0.6339d+03
      pk(3,6)= 0.d+03
c
      pk(4,4)= -1.3928d+03
      pk(4,5)= -0.1206d+03
      pk(4,6)= 0.5284d+03
c
      pk(5,5)=  -0.8404d+03
      pk(5,6)= -0.3821d+03
c
      pk(6,6)= -0.2133d+03
          do 99 i=1,6
          do 99 j=1,6
                  pk(j,i)=pk(i,j)
 99       continue
c
c**** Transformation matrix between Rack and each actuator rotor
c
          do 1 i=1,3
          do 1 j=1,3
                  c2(i,j)=ctrans(i,j,2)
                  c3(i,j)=ctrans(i,j,3)
                  c5(i,j)=ctrans(i,j,5)
                  c7(i,j)=ctrans(i,j,7)
                  c9(i,j)=ctrans(i,j,9)
                  c11(i,j)=ctrans(i,j,11)
                  c13(i,j)=ctrans(i,j,13)
                  c15(i,j)=ctrans(i,j,15)
                  c17(i,j)=ctrans(i,j,17)
 1    continue
          do 2 i=1,3
          do 2 j=1,3
                  c2t(i,j)=c2(j,i)
                  c3t(i,j)=c3(j,i)
                  c5t(i,j)=c5(j,i)
                  c7t(i,j)=c7(j,i)
                  c9t(i,j)=c9(j,i)
                  c11t(i,j)=c11(j,i)
                  c13t(i,j)=c13(j,i)
                  c15t(i,j)=c15(j,i)
                  c17t(i,j)=c17(j,i)
 2        continue
c
c**** Obtain 8 pivot angles from common storage
```

```
c
        do 9 i= 1,8
                thpivot(i) = theta(1,i*2+1)
 9      continue
ccc             write(6,*)'theta(1,3)= ',theta(1,3)  !TEST ONLY
c
c**** Calculate Acceleration at Rack C.G. [r(1) - r(6)]
c
        call mult(tmtox,u(1),r(1),6,8,1,6,8,6)
c
c**** Calculate control forces along Push Rod direction at actuators
c**** attached points on the Rack. (force unit = N)
c
        call mult(tdelxtou,u(9),fa,8,6,1,8,6,8)
c
c**** Calculate control forces at Rotor C.G. [r(7) - r(14)] (force unit = N)
c
        do 20 i=1,8
       fac(i)=cntdta(1)
cyk      fac(i)=dsqrt(0.088d0**2+0.025d0**2)/0.04d0
cyk      fac(i)=1.d0    !temporarily
 20     continue
     signchg=1.d0
        r(7)= fac(1)*fa(1)*signchg
        r(8)= -fac(2)*fa(2)*signchg
        r(9)= -fac(3)*fa(3)*signchg
        r(10)= fac(4)*fa(4)*signchg
        r(11)= -fac(5)*fa(5)*signchg
        r(12)= fac(6)*fa(6)*signchg
        r(13)= -fac(7)*fa(7)*signchg
        r(14)= fac(8)*fa(8)*signchg
ccc             write(6,*) 'force of act #1 = ', r(7)  !TEST ONLY
c
c**** Calculate counteracted control forces at Rack due to the electromagnetic
c**** forces at Rotor C.G. [r(15) - r(30)]
c
c r(15)=  F_y3 at B2N15 counteracted to Act. #101 on B3N1(Input of Act. #102)
c r(16)=  F_z3 at B2N15 counteracted to Act. #101 on B3N1(Input of Act. #103)
c
        tempf(1)=r(7)
        tempf(2)=0.0d0
        tempf(3)=0.0d0
        call m3x3(c2t,c3,tempc)
        call mxv(tempc,tempf,tempr)
        r(15)= -tempr(2)
        r(16)= -tempr(3)
c
c r(17)=  F_y5 at B2N16 counteracted to Act. #201 on B5N1(Input of Act. #202)
c r(18)=  F_z5 at B2N16 counteracted to Act. #201 on B5N1(Input of Act. #203)
c
        tempf(1)=r(8)
        call m3x3(c2t,c5,tempc)
        call mxv(tempc,tempf,tempr)
        r(17)= -tempr(2)
```

```
        r(18)= -tempr(3)
c
c r(19)=  F_y7 at B2N17 counteracted to Act. #301 on B7N1(Input of Act. #302)
c r(20)=  F_z7 at B2N17 counteracted to Act. #301 on B7N1(Input of Act. #303)
c
        tempf(1)=r(9)
        call m3x3(c2t,c7,tempc)
        call mxv(tempc,tempf,tempr)
        r(19)= -tempr(2)
        r(20)= -tempr(3)
c
c r(21)=  F_y9 at B2N18 counteracted to Act. #401 on B9N1(Input of Act. #402)
c r(22)=  F_z9 at B2N18 counteracted to Act. #401 on B9N1(Input of Act. #403)
c
        tempf(1)=r(10)
        call m3x3(c2t,c9,tempc)
        call mxv(tempc,tempf,tempr)
        r(21)= -tempr(2)
        r(22)= -tempr(3)
c
c r(23)=  F_x11 at B2N19 counteracted to Act. #501 on B11N1(Input of Act. #502)
c r(24)=  F_y11 at B2N19 counteracted to Act. #501 on B11N1(Input of Act. #503)
c
        tempf(1)=r(11)
        call m3x3(c2t,c11,tempc)
        call mxv(tempc,tempf,tempr)
        r(23)= -tempr(1)
        r(24)= -tempr(2)
c
c r(25)=  F_x13 at B2N20 counteracted to Act. #601 on B13N1(Input of Act. #602)
c r(26)=  F_y13 at B2N20 counteracted to Act. #601 on B13N1(Input of Act. #603)
c
        tempf(1)=r(12)
        call m3x3(c2t,c13,tempc)
        call mxv(tempc,tempf,tempr)
        r(25)= -tempr(1)
        r(26)= -tempr(2)
c
c r(27)=  F_x15 at B2N21 counteracted to Act. #701 on B15N1(Input of Act. #702)
c r(28)=  F_y15 at B2N21 counteracted to Act. #701 on B15N1(Input of Act. #703)
c
        tempf(1)=r(13)
        call m3x3(c2t,c15,tempc)
        call mxv(tempc,tempf,tempr)
        r(27)= -tempr(1)
        r(28)= -tempr(2)
c
c r(29)=  F_x17 at B2N22 counteracted to Act. #801 on B17N1(Input of Act. #802)
c r(30)=  F_y17 at B2N22 counteracted to Act. #801 on B17N1(Input of Act. #803)
c
        tempf(1)=r(14)
        call m3x3(c2t,c17,tempc)
        call mxv(tempc,tempf,tempr)
        r(29)= -tempr(1)
```

```
         r(30)= -tempr(2)
c
c    r(31)=  calculated del x of Rack C.G. (Input #7 of controller #1)
c    r(32)=  calculated del y of Rack C.G. (Input #8 of controller #1)
c    r(33)=  calculated del z of Rack C.G. (Input #9 of controller #1)
c    r(34)=  calculated del th_x of Rack C.G. (Input #10 of controller #1)
c    r(35)=  calculated del th_y of Rack C.G. (Input #11 of controller #1)
c    r(36)=  calculated del th_z of Rack C.G. (Input #12 of controller #1)
c
         call mult(tptox1,thpivot(1),r(31),6,8,1,6,8,6)
ccccccccccccccc Position control command
      do 88 i=1,6
        r(30+i)=r(30+i)-cntdta(1+i)
 88    continue
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
c          Feed forward control force to compensate coupling due umbilical
c     and act. spring stiffness.
c
c    r(37)=  Feedforward Control Force F_x at the Rack C.G. (N)
c    r(38)=  Feedforward Control Force F_y at the Rack C.G. (N)
c    r(39)=  Feedforward Control Force F_z at the Rack C.G. (N)
c    r(40)=  Feedforward Control Moment T_x at the Rack C.G. (N-m)
c    r(41)=  Feedforward Control Moment T_y at the Rack C.G. (N-m)
c    r(42)=  Feedforward Control Moment T_z at the Rack C.G. (N-m)
c
         call mult(pk,r(31),r(37),6,6,1,6,6,6)
c
    RETURN
    END
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
    SUBROUTINE USDC(T,U,R)
    IMPLICIT DOUBLE PRECISION (A-H,O-Z)
    DIMENSION U(1),R(1)
C
    RETURN
    END
```

Appendix E

ARIS TREETOPS Input File

```
TREETOPS REV 10  06/05/95

SIM CONTROL

 1 SI   0 Title                                                  SSFF_UF3
 2 SI   0 Simulation stop time                                   0.1
 3 SI   0 Plot data interval                                     0.001
 4 SI   0 Integration type (R,S or U)                            R
 5 SI   0 Step size (sec)                                        0.001
 6 SI   0 Sandia integration absolute and relative error
 7 SI   0 Linearization option  (L,Z or N)                       N
 8 SI   0 Restart option          (Y/N)                          N
 9 SI   0 Contact force computation option      (Y/N)            N
10 SI   0 Constraint force computation option  (Y/N)             N
11 SI   0 Small angle speedup option (All,Bypass,First,Nth)      A
12 SI   0 Mass matrix speedup option (All,Bypass,First,Nth)      A
13 SI   0 Non-Linear  speedup option (All,Bypass,First,Nth)      A
14 SI   0 Constraint  speedup option (All,Bypass,First,Nth)      A
15 SI   0 Constraint stabilization option  (Y/N)                 N
16 SI   0 Stabilization epsilon



BODY


17 BO   1 Body ID number                                         1
18 BO   1 Type (Rigid,Flexible,NASTRAN)                          R
19 BO   1 Number of modes
20 BO   1 Modal calculation option (0, 1 or 2)
21 BO   1 Foreshortening option (Y/N)
22 BO   1 Model reduction method (NO,MS,MC,CC,QM,CV)
23 BO   1 NASTRAN data file FORTRAN unit number (40 - 60)
24 BO   1 Number of augmented nodes (0 if none)
25 BO   1 Damping matrix option (NS,CD,HL,SD)
26 BO   1 Constant damping ratio
27 BO   1 Low frequency, High frequency ratios
28 BO   1 Mode ID number, damping ratio
29 BO   1 Conversion factors: Length,Mass,Force
30 BO   1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
31 BO   1 Moments of inertia (kg-m2) Ixx,Iyy,Izz                 5E4,5E4,5E4
32 BO   1 Products of inertia (kg-m2) Ixy,Ixz,Iyz                0,0,0
33 BO   1 Mass (kg)                                              1E5
34 BO   1 Number of Nodes                                        14
35 BO   1 Node ID, Node coord. (meters) x,y,z                    1,0.5989,-0.2901,1.0272
36 BO   1 Node ID, Node coord. (meters) x,y,z                    2,0,0,0
37 BO   1 Node ID, Node coord. (meters) x,y,z                    3,0.0593,-0.016285419,-0.21260445
38 BO   1 Node ID, Node coord. (meters) x,y,z                    4,0.038,-0.52076156,-0.21280685
39 BO   1 Node ID, Node coord. (meters) x,y,z                    5,0.9616,-0.019385419,-0.21260445
40 BO   1 Node ID, Node coord. (meters) x,y,z                    6,0.9829,-0.52076156,-0.21280685
41 BO   1 Node ID, Node coord. (meters) x,y,z                    7,0.52410219,-0.24324904,-0.13350484
42 BO   1 Node ID, Node coord. (meters) x,y,z                    8,0.49679781,-0.24324904,-0.13350484
43 BO   1 Node ID, Node coord. (meters) x,y,z                    9,0.77042187,0.17613677,1.8821
44 BO   1 Node ID, Node coord. (meters) x,y,z                    10,0.24747813,0.11513677,1.8821
45 BO   1 Node ID, Node coord. (meters) x,y,z                    11,0.5989,-0.2901,1.0272
46 BO   1 Node ID, Node coord. (meters) x,y,z                    12,10.2595,0,0.0914
47 BO   1 Node ID, Node coord. (meters) x,y,z                    13,0.2595,10.,0.0914
48 BO   1 Node ID, Node coord. (meters) x,y,z                    14,0.2595,0.,10.0914
49 BO   1 Node ID, Node structual joint ID

50 BO   2 Body ID number                                         2
51 BO   2 Type (Rigid,Flexible,NASTRAN)                          R
52 BO   2 Number of modes
53 BO   2 Modal calculation option (0, 1 or 2)
54 BO   2 Foreshortening option (Y/N)
55 BO   2 Model reduction method (NO,MS,MC,CC,QM,CV)
56 BO   2 NASTRAN data file FORTRAN unit number (40 - 60)
57 BO   2 Number of augmented nodes (0 if none)
58 BO   2 Damping matrix option (NS,CD,HL,SD)
59 BO   2 Constant damping ratio
60 BO   2 Low frequency, High frequency ratios
61 BO   2 Mode ID number, damping ratio
62 BO   2 Conversion factors: Length,Mass,Force
```

```
 63 BO   2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 64 BO   2 Moments of inertia (kg-m2) Ixx,Iyy,Izz            208.7974,227.7789,96.2637
 65 BO   2 Products of inertia (kg-m2) Ixy,Ixz,Iyz           -2.7117,-8.1350,-10.8466
 66 BO   2 Mass (kg)                                         840.
 67 BO   2 Number of Nodes                                   23
 68 BO   2 Node ID, Node coord. (meters) x,y,z               1,0.5989,-0.2901,1.0272
 69 BO   2 Node ID, Node coord. (meters) x,y,z               2,0,0,0
 70 BO   2 Node ID, Node coord. (meters) x,y,z               3,0.0593,-0.5085,0.1630
 71 BO   2 Node ID, Node coord. (meters) x,y,z               4,0.0380,-0.1458,0.1966
 72 BO   2 Node ID, Node coord. (meters) x,y,z               5,0.9616,-0.5116,0.1630
 73 BO   2 Node ID, Node coord. (meters) x,y,z               6,0.9829,-0.1458,0.1966
 74 BO   2 Node ID, Node coord. (meters) x,y,z               7,0.8122,0.0737,-0.1844
 75 BO   2 Node ID, Node coord. (meters) x,y,z               8,0.2087,0.0737,-0.1844
 76 BO   2 Node ID, Node coord. (meters) x,y,z               9,0.6781,-0.4902,1.8821
 77 BO   2 Node ID, Node coord. (meters) x,y,z               10,0.3398,-0.5512,1.8821
 78 BO   2 Node ID, Node coord. (meters) x,y,z               11,0.0207,0.1331,1.6560
 79 BO   2 Node ID, Node coord. (meters) x,y,z               12,-0.0301,-0.0455,0.1320
 80 BO   2 Node ID, Node coord. (meters) x,y,z               13,-0.0301,-0.0447,0.1320
 81 BO   2 Node ID, Node coord. (meters) x,y,z               14,1.0139,-0.0447,0.1320
 82 BO   2 Node ID, Node coord. (meters) x,y,z               15,0.0593,-0.5485,0.1560
 83 BO   2 Node ID, Node coord. (meters) x,y,z               16,0.038,-0.1058,0.1896
 84 BO   2 Node ID, Node coord. (meters) x,y,z               17,0.9616,-0.5516,0.1560
 85 BO   2 Node ID, Node coord. (meters) x,y,z               18,0.9829,-0.1058,0.1896
 86 BO   2 Node ID, Node coord. (meters) x,y,z               19,0.8522,0.0667,-0.1844
 87 BO   2 Node ID, Node coord. (meters) x,y,z               20,0.1687,0.0667,-0.1844
 88 BO   2 Node ID, Node coord. (meters) x,y,z               21,0.6449,-0.5135,1.8821
 89 BO   2 Node ID, Node coord. (meters) x,y,z               22,0.3730,-0.5745,1.8821
 90 BO   2 Node ID, Node coord. (meters) x,y,z               23,0.2595,0.,0.0914
 91 BO   2 Node ID, Node structual joint ID

 92 BO   3 Body ID number                                    3
 93 BO   3 Type (Rigid,Flexible,NASTRAN)                     R
 94 BO   3 Number of modes
 95 BO   3 Modal calculation option (0, 1 or 2)
 96 BO   3 Foreshortening option (Y/N)
 97 BO   3 Model reduction method (NO,MS,MC,CC,QM,CV)
 98 BO   3 NASTRAN data file FORTRAN unit number (40 - 60)
 99 BO   3 Number of augmented nodes (0 if none)
100 BO   3 Damping matrix option (NS,CD,HL,SD)
101 BO   3 Constant damping ratio
102 BO   3 Low frequency, High frequency ratios
103 BO   3 Mode ID number, damping ratio
104 BO   3 Conversion factors: Length,Mass,Force
105 BO   3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
106 BO   3 Moments of inertia (kg-m2) Ixx,Iyy,Izz            1E-20,1E-20,1E-20
107 BO   3 Products of inertia (kg-m2) Ixy,Ixz,Iyz           0,0,0
108 BO   3 Mass (kg)                                         1E-20
109 BO   3 Number of Nodes                                   3
110 BO   3 Node ID, Node coord. (meters) x,y,z               1,-0.007,0.04,0
111 BO   3 Node ID, Node coord. (meters) x,y,z               2,0,0,0
112 BO   3 Node ID, Node coord. (meters) x,y,z               3,-0.088,0.025,0
113 BO   3 Node ID, Node structual joint ID

114 BO   4 Body ID number                                    4
115 BO   4 Type (Rigid,Flexible,NASTRAN)                     R
116 BO   4 Number of modes
117 BO   4 Modal calculation option (0, 1 or 2)
118 BO   4 Foreshortening option (Y/N)
119 BO   4 Model reduction method (NO,MS,MC,CC,QM,CV)
120 BO   4 NASTRAN data file FORTRAN unit number (40 - 60)
121 BO   4 Number of augmented nodes (0 if none)
122 BO   4 Damping matrix option (NS,CD,HL,SD)
123 BO   4 Constant damping ratio
124 BO   4 Low frequency, High frequency ratios
125 BO   4 Mode ID number, damping ratio
126 BO   4 Conversion factors: Length,Mass,Force
127 BO   4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
128 BO   4 Moments of inertia (kg-m2) Ixx,Iyy,Izz            1E-20,1E-20,1E-20
129 BO   4 Products of inertia (kg-m2) Ixy,Ixz,Iyz           0,0,0
130 BO   4 Mass (kg)                                         1E-20
131 BO   4 Number of Nodes                                   3
132 BO   4 Node ID, Node coord. (meters) x,y,z               1,0.2959,0,0
133 BO   4 Node ID, Node coord. (meters) x,y,z               2,0,0,0
134 BO   4 Node ID, Node coord. (meters) x,y,z               3,0.5918,0,0
135 BO   4 Node ID, Node structual joint ID
```

```
136 BO   5 Body ID number                                       5
137 BO   5 Type (Rigid,Flexible,NASTRAN)                        R
138 BO   5 Number of modes
139 BO   5 Modal calculation option (0, 1 or 2)
140 BO   5 Foreshortening option (Y/N)
141 BO   5 Model reduction method (NO,MS,MC,CC,QM,CV)
142 BO   5 NASTRAN data file FORTRAN unit number (40 - 60)
143 BO   5 Number of augmented nodes (0 if none)
144 BO   5 Damping matrix option (NS,CD,HL,SD)
145 BO   5 Constant damping ratio
146 BO   5 Low frequency, High frequency ratios
147 BO   5 Mode ID number, damping ratio
148 BO   5 Conversion factors: Length,Mass,Force
149 BO   5 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
150 BO   5 Moments of inertia (kg-m2) Ixx,Iyy,Izz               1E-4,1E-4,1E-4
151 BO   5 Products of inertia (kg-m2) Ixy,Ixz,Iyz              0,0,0
152 BO   5 Mass (kg)                                            0.122
153 BO   5 Number of Nodes                                      3
154 BO   5 Node ID, Node coord. (meters) x,y,z                  1,0.007,0.04,0
155 BO   5 Node ID, Node coord. (meters) x,y,z                  2,0,0,0
156 BO   5 Node ID, Node coord. (meters) x,y,z                  3,0.088,0.025,0
157 BO   5 Node ID, Node structual joint ID

158 BO   6 Body ID number                                       6
159 BO   6 Type (Rigid,Flexible,NASTRAN)                        R
160 BO   6 Number of modes
161 BO   6 Modal calculation option (0, 1 or 2)
162 BO   6 Foreshortening option (Y/N)
163 BO   6 Model reduction method (NO,MS,MC,CC,QM,CV)
164 BO   6 NASTRAN data file FORTRAN unit number (40 - 60)
165 BO   6 Number of augmented nodes (0 if none)
166 BO   6 Damping matrix option (NS,CD,HL,SD)
167 BO   6 Constant damping ratio
168 BO   6 Low frequency, High frequency ratios
169 BO   6 Mode ID number, damping ratio
170 BO   6 Conversion factors: Length,Mass,Force
171 BO   6 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
172 BO   6 Moments of inertia (kg-m2) Ixx,Iyy,Izz               1E-6,6.54E-4,6.54E-4
173 BO   6 Products of inertia (kg-m2) Ixy,Ixz,Iyz              0,0,0
174 BO   6 Mass (kg)                                            0.0312
175 BO   6 Number of Nodes                                      3
176 BO   6 Node ID, Node coord. (meters) x,y,z                  1,0.2566,0,0
177 BO   6 Node ID, Node coord. (meters) x,y,z                  2,0,0,0
178 BO   6 Node ID, Node coord. (meters) x,y,z                  3,0.5131,0,0
179 BO   6 Node ID, Node structual joint ID

180 BO   7 Body ID number                                       7
181 BO   7 Type (Rigid,Flexible,NASTRAN)                        R
182 BO   7 Number of modes
183 BO   7 Modal calculation option (0, 1 or 2)
184 BO   7 Foreshortening option (Y/N)
185 BO   7 Model reduction method (NO,MS,MC,CC,QM,CV)
186 BO   7 NASTRAN data file FORTRAN unit number (40 - 60)
187 BO   7 Number of augmented nodes (0 if none)
188 BO   7 Damping matrix option (NS,CD,HL,SD)
189 BO   7 Constant damping ratio
190 BO   7 Low frequency, High frequency ratios
191 BO   7 Mode ID number, damping ratio
192 BO   7 Conversion factors: Length,Mass,Force
193 BO   7 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
194 BO   7 Moments of inertia (kg-m2) Ixx,Iyy,Izz               1E-4,1E-4,1E-4
195 BO   7 Products of inertia (kg-m2) Ixy,Ixz,Iyz              0,0,0
196 BO   7 Mass (kg)                                            0.122
197 BO   7 Number of Nodes                                      3
198 BO   7 Node ID, Node coord. (meters) x,y,z                  1,0.007,0.04,0
199 BO   7 Node ID, Node coord. (meters) x,y,z                  2,0,0,0
200 BO   7 Node ID, Node coord. (meters) x,y,z                  3,0.088,0.025,0
201 BO   7 Node ID, Node structual joint ID

202 BO   8 Body ID number                                       8
203 BO   8 Type (Rigid,Flexible,NASTRAN)                        R
204 BO   8 Number of modes
205 BO   8 Modal calculation option (0, 1 or 2)
206 BO   8 Foreshortening option (Y/N)
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207 BO    8 Model reduction method (NO,MS,MC,CC,QM,CV)
208 BO    8 NASTRAN data file FORTRAN unit number (40 - 60)
209 BO    8 Number of augmented nodes (0 if none)
210 BO    8 Damping matrix option (NS,CD,HL,SD)
211 BO    8 Constant damping ratio
212 BO    8 Low frequency, High frequency ratios
213 BO    8 Mode ID number, damping ratio
214 BO    8 Conversion factors: Length,Mass,Force
215 BO    8 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
216 BO    8 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1E-6,6.54E-4,6.54E-4
217 BO    8 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0,0,0
218 BO    8 Mass (kg)                                           0.0312
219 BO    8 Number of Nodes                                     3
220 BO    8 Node ID, Node coord. (meters) x,y,z                 1,0.2959,0,0
221 BO    8 Node ID, Node coord. (meters) x,y,z                 2,0,0,0
222 BO    8 Node ID, Node coord. (meters) x,y,z                 3,0.5918,0,0
223 BO    8 Node ID, Node structual joint ID

224 BO    9 Body ID number                                      9
225 BO    9 Type (Rigid,Flexible,NASTRAN)                       R
226 BO    9 Number of modes
227 BO    9 Modal calculation option (0, 1 or 2)
228 BO    9 Foreshortening option (Y/N)
229 BO    9 Model reduction method (NO,MS,MC,CC,QM,CV)
230 BO    9 NASTRAN data file FORTRAN unit number (40 - 60)
231 BO    9 Number of augmented nodes (0 if none)
232 BO    9 Damping matrix option (NS,CD,HL,SD)
233 BO    9 Constant damping ratio
234 BO    9 Low frequency, High frequency ratios
235 BO    9 Mode ID number, damping ratio
236 BO    9 Conversion factors: Length,Mass,Force
237 BO    9 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
238 BO    9 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1E-4,1E-4,1E-4
239 BO    9 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0,0,0
240 BO    9 Mass (kg)                                           0.122
241 BO    9 Number of Nodes                                     3
242 BO    9 Node ID, Node coord. (meters) x,y,z                 1,-0.007,0.04,0
243 BO    9 Node ID, Node coord. (meters) x,y,z                 2,0,0,0
244 BO    9 Node ID, Node coord. (meters) x,y,z                 3,-0.088,0.025,0
245 BO    9 Node ID, Node structual joint ID

246 BO   10 Body ID number                                      10
247 BO   10 Type (Rigid,Flexible,NASTRAN)                       R
248 BO   10 Number of modes
249 BO   10 Modal calculation option (0, 1 or 2)
250 BO   10 Foreshortening option (Y/N)
251 BO   10 Model reduction method (NO,MS,MC,CC,QM,CV)
252 BO   10 NASTRAN data file FORTRAN unit number (40 - 60)
253 BO   10 Number of augmented nodes (0 if none)
254 BO   10 Damping matrix option (NS,CD,HL,SD)
255 BO   10 Constant damping ratio
256 BO   10 Low frequency, High frequency ratios
257 BO   10 Mode ID number, damping ratio
258 BO   10 Conversion factors: Length,Mass,Force
259 BO   10 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
260 BO   10 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1E-6,6.54E-4,6.54E-4
261 BO   10 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0,0,0
262 BO   10 Mass (kg)                                           0.0312
263 BO   10 Number of Nodes                                     3
264 BO   10 Node ID, Node coord. (meters) x,y,z                 1,0.2566,0,0
265 BO   10 Node ID, Node coord. (meters) x,y,z                 2,0,0,0
266 BO   10 Node ID, Node coord. (meters) x,y,z                 3,0.5131,0,0
267 BO   10 Node ID, Node structual joint ID

268 BO   11 Body ID number                                      11
269 BO   11 Type (Rigid,Flexible,NASTRAN)                       R
270 BO   11 Number of modes
271 BO   11 Modal calculation option (0, 1 or 2)
272 BO   11 Foreshortening option (Y/N)
273 BO   11 Model reduction method (NO,MS,MC,CC,QM,CV)
274 BO   11 NASTRAN data file FORTRAN unit number (40 - 60)
275 BO   11 Number of augmented nodes (0 if none)
276 BO   11 Damping matrix option (NS,CD,HL,SD)
277 BO   11 Constant damping ratio
278 BO   11 Low frequency, High frequency ratios
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279 BO  11 Mode ID number, damping ratio
280 BO  11 Conversion factors: Length,Mass,Force
281 BO  11 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
282 BO  11 Moments of inertia (kg-m2) Ixx,Iyy,Izz             1E-4,1E-4,1E-4
283 BO  11 Products of inertia (kg-m2) Ixy,Ixz,Iyz            0,0,0
284 BO  11 Mass (kg)                                           0.122
285 BO  11 Number of Nodes                                     3
286 BO  11 Node ID, Node coord. (meters) x,y,z                 1,0.007,0.04,0
287 BO  11 Node ID, Node coord. (meters) x,y,z                 2,0,0,0
288 BO  11 Node ID, Node coord. (meters) x,y,z                 3,0.088,0.025,0
289 BO  11 Node ID, Node structual joint ID

290 BO  12 Body ID number                                      12
291 BO  12 Type (Rigid,Flexible,NASTRAN)                       R
292 BO  12 Number of modes
293 BO  12 Modal calculation option (0, 1 or 2)
294 BO  12 Foreshortening option (Y/N)
295 BO  12 Model reduction method (NO,MS,MC,CC,QM,CV)
296 BO  12 NASTRAN data file FORTRAN unit number (40 - 60)
297 BO  12 Number of augmented nodes (0 if none)
298 BO  12 Damping matrix option (NS,CD,HL,SD)
299 BO  12 Constant damping ratio
300 BO  12 Low frequency, High frequency ratios
301 BO  12 Mode ID number, damping ratio
302 BO  12 Conversion factors: Length,Mass,Force
303 BO  12 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
304 BO  12 Moments of inertia (kg-m2) Ixx,Iyy,Izz             1E-6,6.54E-4,6.54E-4
305 BO  12 Products of inertia (kg-m2) Ixy,Ixz,Iyz            0,0,0
306 BO  12 Mass (kg)                                           0.0312
307 BO  12 Number of Nodes                                     3
308 BO  12 Node ID, Node coord. (meters) x,y,z                 1,0.1956,0,0
309 BO  12 Node ID, Node coord. (meters) x,y,z                 2,0,0,0
310 BO  12 Node ID, Node coord. (meters) x,y,z                 3,0.3912,0,0
311 BO  12 Node ID, Node structual joint ID

312 BO  13 Body ID number                                      13
313 BO  13 Type (Rigid,Flexible,NASTRAN)                       R
314 BO  13 Number of modes
315 BO  13 Modal calculation option (0, 1 or 2)
316 BO  13 Foreshortening option (Y/N)
317 BO  13 Model reduction method (NO,MS,MC,CC,QM,CV)
318 BO  13 NASTRAN data file FORTRAN unit number (40 - 60)
319 BO  13 Number of augmented nodes (0 if none)
320 BO  13 Damping matrix option (NS,CD,HL,SD)
321 BO  13 Constant damping ratio
322 BO  13 Low frequency, High frequency ratios
323 BO  13 Mode ID number, damping ratio
324 BO  13 Conversion factors: Length,Mass,Force
325 BO  13 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
326 BO  13 Moments of inertia (kg-m2) Ixx,Iyy,Izz             1E-4,1E-4,1E-4
327 BO  13 Products of inertia (kg-m2) Ixy,Ixz,Iyz            0,0,0
328 BO  13 Mass (kg)                                           0.122
329 BO  13 Number of Nodes                                     3
330 BO  13 Node ID, Node coord. (meters) x,y,z                 1,-0.007,0.04,0
331 BO  13 Node ID, Node coord. (meters) x,y,z                 2,0,0,0
332 BO  13 Node ID, Node coord. (meters) x,y,z                 3,-0.088,0.025,0
333 BO  13 Node ID, Node structual joint ID

334 BO  14 Body ID number                                      14
335 BO  14 Type (Rigid,Flexible,NASTRAN)                       R
336 BO  14 Number of modes
337 BO  14 Modal calculation option (0, 1 or 2)
338 BO  14 Foreshortening option (Y/N)
339 BO  14 Model reduction method (NO,MS,MC,CC,QM,CV)
340 BO  14 NASTRAN data file FORTRAN unit number (40 - 60)
341 BO  14 Number of augmented nodes (0 if none)
342 BO  14 Damping matrix option (NS,CD,HL,SD)
343 BO  14 Constant damping ratio
344 BO  14 Low frequency, High frequency ratios
345 BO  14 Mode ID number, damping ratio
346 BO  14 Conversion factors: Length,Mass,Force
347 BO  14 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
348 BO  14 Moments of inertia (kg-m2) Ixx,Iyy,Izz             1E-6,6.54E-4,6.54E-4
349 BO  14 Products of inertia (kg-m2) Ixy,Ixz,Iyz            0,0,0
350 BO  14 Mass (kg)                                           0.0312
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351 BO  14 Number of Nodes                                      3
352 BO  14 Node ID, Node coord. (meters) x,y,z                  1,0.1956,0,0
353 BO  14 Node ID, Node coord. (meters) x,y,z                  2,0,0,0
354 BO  14 Node ID, Node coord. (meters) x,y,z                  3,0.3912,0,0
355 BO  14 Node ID, Node structual joint ID

356 BO  15 Body ID number                                       15
357 BO  15 Type (Rigid,Flexible,NASTRAN)                        R
358 BO  15 Number of modes
359 BO  15 Modal calculation option (0, 1 or 2)
360 BO  15 Foreshortening option (Y/N)
361 BO  15 Model reduction method (NO,MS,MC,CC,QM,CV)
362 BO  15 NASTRAN data file FORTRAN unit number (40 - 60)
363 BO  15 Number of augmented nodes (0 if none)
364 BO  15 Damping matrix option (NS,CD,HL,SD)
365 BO  15 Constant damping ratio
366 BO  15 Low frequency, High frequency ratios
367 BO  15 Mode ID number, damping ratio
368 BO  15 Conversion factors: Length,Mass,Force
369 BO  15 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
370 BO  15 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1E-4,1E-4,1E-4
371 BO  15 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0,0,0
372 BO  15 Mass (kg)                                            0.122
373 BO  15 Number of Nodes                                      3
374 BO  15 Node ID, Node coord. (meters) x,y,z                  1,0.007,0.04,0
375 BO  15 Node ID, Node coord. (meters) x,y,z                  2,0,0,0
376 BO  15 Node ID, Node coord. (meters) x,y,z                  3,0.088,0.025,0
377 BO  15 Node ID, Node structual joint ID

378 BO  16 Body ID number                                       16
379 BO  16 Type (Rigid,Flexible,NASTRAN)                        R
380 BO  16 Number of modes
381 BO  16 Modal calculation option (0, 1 or 2)
382 BO  16 Foreshortening option (Y/N)
383 BO  16 Model reduction method (NO,MS,MC,CC,QM,CV)
384 BO  16 NASTRAN data file FORTRAN unit number (40 - 60)
385 BO  16 Number of augmented nodes (0 if none)
386 BO  16 Damping matrix option (NS,CD,HL,SD)
387 BO  16 Constant damping ratio
388 BO  16 Low frequency, High frequency ratios
389 BO  16 Mode ID number, damping ratio
390 BO  16 Conversion factors: Length,Mass,Force
391 BO  16 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
392 BO  16 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1E-6,6.54E-4,6.54E-4
393 BO  16 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0,0,0
394 BO  16 Mass (kg)                                            0.0312
395 BO  16 Number of Nodes                                      3
396 BO  16 Node ID, Node coord. (meters) x,y,z                  1,0.3226,0,0
397 BO  16 Node ID, Node coord. (meters) x,y,z                  2,0,0,0
398 BO  16 Node ID, Node coord. (meters) x,y,z                  3,0.6452,0,0
399 BO  16 Node ID, Node structual joint ID

400 BO  17 Body ID number                                       17
401 BO  17 Type (Rigid,Flexible,NASTRAN)                        R
402 BO  17 Number of modes
403 BO  17 Modal calculation option (0, 1 or 2)
404 BO  17 Foreshortening option (Y/N)
405 BO  17 Model reduction method (NO,MS,MC,CC,QM,CV)
406 BO  17 NASTRAN data file FORTRAN unit number (40 - 60)
407 BO  17 Number of augmented nodes (0 if none)
408 BO  17 Damping matrix option (NS,CD,HL,SD)
409 BO  17 Constant damping ratio
410 BO  17 Low frequency, High frequency ratios
411 BO  17 Mode ID number, damping ratio
412 BO  17 Conversion factors: Length,Mass,Force
413 BO  17 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
414 BO  17 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1E-4,1E-4,1E-4
415 BO  17 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0,0,0
416 BO  17 Mass (kg)                                            0.122
417 BO  17 Number of Nodes                                      3
418 BO  17 Node ID, Node coord. (meters) x,y,z                  1,-0.007,0.04,0
419 BO  17 Node ID, Node coord. (meters) x,y,z                  2,0,0,0
420 BO  17 Node ID, Node coord. (meters) x,y,z                  3,-0.088,0.025,0
421 BO  17 Node ID, Node structual joint ID
```

422	BO	18 Body ID number	18
423	BO	18 Type (Rigid,Flexible,NASTRAN)	R
424	BO	18 Number of modes	
425	BO	18 Modal calculation option (0, 1 or 2)	
426	BO	18 Foreshortening option (Y/N)	
427	BO	18 Model reduction method (NO,MS,MC,CC,QM,CV)	
428	BO	18 NASTRAN data file FORTRAN unit number (40 - 60)	
429	BO	18 Number of augmented nodes (0 if none)	
430	BO	18 Damping matrix option (NS,CD,HL,SD)	
431	BO	18 Constant damping ratio	
432	BO	18 Low frequency, High frequency ratios	
433	BO	18 Mode ID number, damping ratio	
434	BO	18 Conversion factors: Length,Mass,Force	
435	BO	18 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
436	BO	18 Moments of inertia (kg-m2) Ixx,Iyy,Izz	1E-6,6.54E-4,6.54E-4
437	BO	18 Products of inertia (kg-m2) Ixy,Ixz,Iyz	0,0,0
438	BO	18 Mass (kg)	0.0312
439	BO	18 Number of Nodes	3
440	BO	18 Node ID, Node coord. (meters) x,y,z	1,0.3226,0,0
441	BO	18 Node ID, Node coord. (meters) x,y,z	2,0,0,0
442	BO	18 Node ID, Node coord. (meters) x,y,z	3,0.6452,0,0
443	BO	18 Node ID, Node structual joint ID	

HINGE

444	HI	1 Hinge ID number	1
445	HI	1 Inboard body ID, Outboard body ID	0,1
446	HI	1 "p" node ID, "q" node ID	0,1
447	HI	1 Number of rotation DOFs, Rotation option (F or G)	3,F
448	HI	1 L1 unit vector in inboard body coord. x,y,z	1,0,0
449	HI	1 L1 unit vector in outboard body coord. x,y,z	1,0,0
450	HI	1 L2 unit vector in inboard body coord. x,y,z	
451	HI	1 L2 unit vector in outboard body coord. x,y,z	
452	HI	1 L3 unit vector in inboard body coord. x,y,z	0,0,1
453	HI	1 L3 unit vector in outboard body coord. x,y,z	0,0,1
454	HI	1 Initial rotation angles (deg)	0,0,0
455	HI	1 Initial rotation rates (deg/sec)	0 0 0
456	HI	1 Rotation stiffness (newton-meters/rad)	0 0 0
457	HI	1 Rotation damping (newton-meters/rad/sec)	0 0 0
458	HI	1 Null torque angles (deg)	0 0 0
459	HI	1 Number of translation DOFs	3
460	HI	1 First translation unit vector g1	1 0 0
461	HI	1 Second translation unit vector g2	0 1 0
462	HI	1 Third translation unit vector g3	0 0 1
463	HI	1 Initial translation (meters)	0,0,0
464	HI	1 Initial translation velocity (meters/sec)	0 0 0
465	HI	1 Translation stiffness (newtons/meters)	0 0 0
466	HI	1 Translation damping (newtons/meter/sec)	0 0 0
467	HI	1 Null force translations	0 0 0
468	HI	2 Hinge ID number	2
469	HI	2 Inboard body ID, Outboard body ID	1,2
470	HI	2 "p" node ID, "q" node ID	11,1
471	HI	2 No of rotation DOFs, Hinge 1 rotation option(F/G)	3
472	HI	2 L1 unit vector in inboard body coord. x,y,z	1 0 0
473	HI	2 L1 unit vector in outboard body coord. x,y,z	1 0 0
474	HI	2 L2 unit vector in inboard body coord. x,y,z	
475	HI	2 L2 unit vector in outboard body coord. x,y,z	
476	HI	2 L3 unit vector in inboard body coord. x,y,z	0 0 1
477	HI	2 L3 unit vector in outboard body coord. x,y,z	0 0 1
478	HI	2 Initial rotation angles (deg)	0,0,0
479	HI	2 Initial rotation rates (deg/sec)	0 0 0
480	HI	2 Rotation stiffness (newton-meters/rad)	0 0 0
481	HI	2 Rotation damping (newton-meters/rad/sec)	0 0 0
482	HI	2 Null torque angles (deg)	0 0 0
483	HI	2 Number of translation DOFs	3
484	HI	2 First translation unit vector g1	1 0 0
485	HI	2 Second translation unit vector g2	0 1 0
486	HI	2 Third translation unit vector g3	0 0 1
487	HI	2 Initial translation (meters)	0,0,0
488	HI	2 Initial translation velocity (meters/sec)	0 0 0
489	HI	2 Translation stiffness (newtons/meters)	0 0 0
490	HI	2 Translation damping (newtons/meter/sec)	0 0 0
491	HI	2 Null force translations	0 0 0

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492 HI   3 Hinge ID number                                    3
493 HI   3 Inboard body ID, Outboard body ID                  2,3
494 HI   3 "p" node ID, "q" node ID                           3,2
495 HI   3  Number of rotation DOFs                           0
496 HI   3 L1 unit vector in inboard body coord. x,y,z        1 0 0
497 HI   3 L1 unit vector in outboard body coord. x,y,z       0 0 1
498 HI   3 L2 unit vector in inboard body coord. x,y,z
499 HI   3 L2 unit vector in outboard body coord. x,y,z
500 HI   3 L3 unit vector in inboard body coord. x,y,z        0 0 1
501 HI   3 L3 unit vector in outboard body coord. x,y,z       1 0 0
502 HI   3 Initial rotation angles (deg)                      0,0,0
503 HI   3 Initial rotation rates (deg/sec)
504 HI   3 Rotation stiffness (newton-meters/rad)
505 HI   3 Rotation damping (newton-meters/rad/sec)
506 HI   3 Null torque angles (deg)
507 HI   3 Number of translation DOFs                         0
508 HI   3 First translation unit vector   g1                 1 0 0
509 HI   3 Second translation unit vector  g2                 0 1 0
510 HI   3 Third translation unit vector   g3                 0 0 1
511 HI   3 Initial translation (meters)                       0 0 0
512 HI   3 Initial translation velocity (meters/sec)
513 HI   3 Translation stiffness (newtons/meters)
514 HI   3 Translation damping (newtons/meter/sec)
515 HI   3 Null force translations

516 HI   4 Hinge ID number                                    4
517 HI   4 Inboard body ID, Outboard body ID                  3,4
518 HI   4 "p" node ID, "q" node ID                           3,2
519 HI   4  Number of rotation DOFs                           0
520 HI   4 L1 unit vector in inboard body coord. x,y,z        0 0 1
521 HI   4 L1 unit vector in outboard body coord. x,y,z       0 0 1
522 HI   4 L2 unit vector in inboard body coord. x,y,z
523 HI   4 L2 unit vector in outboard body coord. x,y,z
524 HI   4 L3 unit vector in inboard body coord. x,y,z        0 1 0
525 HI   4 L3 unit vector in outboard body coord. x,y,z       -0.874,-0.486,0
526 HI   4 Initial rotation angles (deg)                      0,0,0
527 HI   4 Initial rotation rates (deg/sec)
528 HI   4 Rotation stiffness (newton-meters/rad)
529 HI   4 Rotation damping (newton-meters/rad/sec)
530 HI   4 Null torque angles (deg)
531 HI   4 Number of translation DOFs                         0
532 HI   4 First translation unit vector   g1                 1 0 0
533 HI   4 Second translation unit vector  g2                 0 1 0
534 HI   4 Third translation unit vector   g3                 0 0 1
535 HI   4 Initial translation (meters)                       0 0 0
536 HI   4 Initial translation velocity (meters/sec)
537 HI   4 Translation stiffness (newtons/meters)
538 HI   4 Translation damping (newtons/meter/sec)
539 HI   4 Null force translations

540 HI   5 Hinge ID number                                    5
541 HI   5 Inboard body ID, Outboard body ID                  2,5
542 HI   5 "p" node ID, "q" node ID                           4,2
543 HI   5  Number of rotation DOFs                           1
544 HI   5 L1 unit vector in inboard body coord. x,y,z        1 0 0
545 HI   5 L1 unit vector in outboard body coord. x,y,z       0 0 1
546 HI   5 L2 unit vector in inboard body coord. x,y,z
547 HI   5 L2 unit vector in outboard body coord. x,y,z
548 HI   5 L3 unit vector in inboard body coord. x,y,z        0 0 1
549 HI   5 L3 unit vector in outboard body coord. x,y,z       -1 0 0
550 HI   5 Initial rotation angles (deg)                      0,0,0
551 HI   5 Initial rotation rates (deg/sec)                   0
552 HI   5 Rotation stiffness (newton-meters/rad)             0.0565
553 HI   5 Rotation damping (newton-meters/rad/sec)           0
554 HI   5 Null torque angles (deg)                           0
555 HI   5 Number of translation DOFs                         0
556 HI   5 First translation unit vector   g1                 1 0 0
557 HI   5 Second translation unit vector  g2                 0 1 0
558 HI   5 Third translation unit vector   g3                 0 0 1
559 HI   5 Initial translation (meters)                       0 0 0
560 HI   5 Initial translation velocity (meters/sec)
561 HI   5 Translation stiffness (newtons/meters)
562 HI   5 Translation damping (newtons/meter/sec)
563 HI   5 Null force translations
```

```
564 HI   6 Hinge ID number                                     6
565 HI   6 Inboard body ID, Outboard body ID                   5,6
566 HI   6 "p" node ID, "q" node ID                            3,2
567 HI   6  Number of rotation DOFs                            2
568 HI   6 L1 unit vector in inboard body coord. x,y,z         0 0 1
569 HI   6 L1 unit vector in outboard body coord. x,y,z        0 0 1
570 HI   6 L2 unit vector in inboard body coord. x,y,z         0 1 0
571 HI   6 L2 unit vector in outboard body coord. x,y,z        -0.779,0.626,0
572 HI   6 L3 unit vector in inboard body coord. x,y,z
573 HI   6 L3 unit vector in outboard body coord. x,y,z
574 HI   6 Initial rotation angles (deg)                       0,0,0
575 HI   6 Initial rotation rates (deg/sec)                    0 0
576 HI   6 Rotation stiffness (newton-meters/rad)              0.0565 0.0565
577 HI   6 Rotation damping (newton-meters/rad/sec)            0 0
578 HI   6 Null torque angles (deg)                            0 0
579 HI   6 Number of translation DOFs                          0
580 HI   6 First translation unit vector   g1                  1 0 0
581 HI   6 Second translation unit vector  g2                  0 1 0
582 HI   6 Third translation unit vector   g3                  0 0 1
583 HI   6 Initial translation (meters)                        0 0 0
584 HI   6 Initial translation velocity (meters/sec)
585 HI   6 Translation stiffness (newtons/meters)
586 HI   6 Translation damping (newtons/meter/sec)
587 HI   6 Null force translations

588 HI   7 Hinge ID number                                     7
589 HI   7 Inboard body ID, Outboard body ID                   2,7
590 HI   7 "p" node ID, "q" node ID                            5,2
591 HI   7  Number of rotation DOFs                            1
592 HI   7 L1 unit vector in inboard body coord. x,y,z         1 0 0
593 HI   7 L1 unit vector in outboard body coord. x,y,z        0 0 -1
594 HI   7 L2 unit vector in inboard body coord. x,y,z
595 HI   7 L2 unit vector in outboard body coord. x,y,z
596 HI   7 L3 unit vector in inboard body coord. x,y,z         0 0 1
597 HI   7 L3 unit vector in outboard body coord. x,y,z        -1 0 0
598 HI   7 Initial rotation angles (deg)                       0,0,0
599 HI   7 Initial rotation rates (deg/sec)                    0
600 HI   7 Rotation stiffness (newton-meters/rad)              0.0565
601 HI   7 Rotation damping (newton-meters/rad/sec)            0
602 HI   7 Null torque angles (deg)                            0
603 HI   7 Number of translation DOFs                          0
604 HI   7 First translation unit vector   g1                  1 0 0
605 HI   7 Second translation unit vector  g2                  0 1 0
606 HI   7 Third translation unit vector   g3                  0 0 1
607 HI   7 Initial translation (meters)                        0 0 0
608 HI   7 Initial translation velocity (meters/sec)
609 HI   7 Translation stiffness (newtons/meters)
610 HI   7 Translation damping (newtons/meter/sec)
611 HI   7 Null force translations

612 HI   8 Hinge ID number                                     8
613 HI   8 Inboard body ID, Outboard body ID                   7,8
614 HI   8 "p" node ID, "q" node ID                            3,2
615 HI   8  Number of rotation DOFs                            2
616 HI   8 L1 unit vector in inboard body coord. x,y,z         0 0 1
617 HI   8 L1 unit vector in outboard body coord. x,y,z        0 0 1
618 HI   8 L2 unit vector in inboard body coord. x,y,z         0 1 0
619 HI   8 L2 unit vector in outboard body coord. x,y,z        -0.874,0.486,0
620 HI   8 L3 unit vector in inboard body coord. x,y,z
621 HI   8 L3 unit vector in outboard body coord. x,y,z
622 HI   8 Initial rotation angles (deg)                       0,0,0
623 HI   8 Initial rotation rates (deg/sec)                    0 0
624 HI   8 Rotation stiffness (newton-meters/rad)              0.0565 0.0565
625 HI   8 Rotation damping (newton-meters/rad/sec)            0 0
626 HI   8 Null torque angles (deg)                            0 0
627 HI   8 Number of translation DOFs                          0
628 HI   8 First translation unit vector   g1                  1 0 0
629 HI   8 Second translation unit vector  g2                  0 1 0
630 HI   8 Third translation unit vector   g3                  0 0 1
631 HI   8 Initial translation (meters)                        0 0 0
632 HI   8 Initial translation velocity (meters/sec)
633 HI   8 Translation stiffness (newtons/meters)
634 HI   8 Translation damping (newtons/meter/sec)
635 HI   8 Null force translations
```

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636 HI   9 Hinge ID number                                       9
637 HI   9 Inboard body ID, Outboard body ID                     2,9
638 HI   9 "p" node ID, "q" node ID                              6,2
639 HI   9  Number of rotation DOFs                              1
640 HI   9 L1 unit vector in inboard body coord. x,y,z           1 0 0
641 HI   9 L1 unit vector in outboard body coord. x,y,z          0 0 -1
642 HI   9 L2 unit vector in inboard body coord. x,y,z
643 HI   9 L2 unit vector in outboard body coord. x,y,z
644 HI   9 L3 unit vector in inboard body coord. x,y,z           0 0 1
645 HI   9 L3 unit vector in outboard body coord. x,y,z          1 0 0
646 HI   9 Initial rotation angles (deg)                         0,0,0
647 HI   9 Initial rotation rates (deg/sec)                      0
648 HI   9 Rotation stiffness (newton-meters/rad)                0.0565
649 HI   9 Rotation damping (newton-meters/rad/sec)              0
650 HI   9 Null torque angles (deg)                              0
651 HI   9 Number of translation DOFs                            0
652 HI   9 First translation unit vector   g1                    1 0 0
653 HI   9 Second translation unit vector  g2                    0 1 0
654 HI   9 Third translation unit vector   g3                    0 0 1
655 HI   9 Initial translation (meters)                          0 0 0
656 HI   9 Initial translation velocity (meters/sec)
657 HI   9 Translation stiffness (newtons/meters)
658 HI   9 Translation damping (newtons/meter/sec)
659 HI   9 Null force translations

660 HI  10 Hinge ID number                                       10
661 HI  10 Inboard body ID, Outboard body ID                     9,10
662 HI  10 "p" node ID, "q" node ID                              3,2
663 HI  10  Number of rotation DOFs                              2
664 HI  10 L1 unit vector in inboard body coord. x,y,z           0 0 1
665 HI  10 L1 unit vector in outboard body coord. x,y,z          0 0 1
666 HI  10 L2 unit vector in inboard body coord. x,y,z           0 1 0
667 HI  10 L2 unit vector in outboard body coord. x,y,z          -0.779,-0.626,0
668 HI  10 L3 unit vector in inboard body coord. x,y,z
669 HI  10 L3 unit vector in outboard body coord. x,y,z
670 HI  10 Initial rotation angles (deg)                         0,0,0
671 HI  10 Initial rotation rates (deg/sec)                      0 0
672 HI  10 Rotation stiffness (newton-meters/rad)                0.0565 0.0565
673 HI  10 Rotation damping (newton-meters/rad/sec)              0 0
674 HI  10 Null torque angles (deg)                              0 0
675 HI  10 Number of translation DOFs                            0
676 HI  10 First translation unit vector   g1                    1 0 0
677 HI  10 Second translation unit vector  g2                    0 1 0
678 HI  10 Third translation unit vector   g3                    0 0 1
679 HI  10 Initial translation (meters)                          0 0 0
680 HI  10 Initial translation velocity (meters/sec)
681 HI  10 Translation stiffness (newtons/meters)
682 HI  10 Translation damping (newtons/meter/sec)
683 HI  10 Null force translations

684 HI  11 Hinge ID number                                       11
685 HI  11 Inboard body ID, Outboard body ID                     2,11
686 HI  11 "p" node ID, "q" node ID                              7,2
687 HI  11  Number of rotation DOFs                              1
688 HI  11 L1 unit vector in inboard body coord. x,y,z           0 0 1
689 HI  11 L1 unit vector in outboard body coord. x,y,z          0 0 1
690 HI  11 L2 unit vector in inboard body coord. x,y,z
691 HI  11 L2 unit vector in outboard body coord. x,y,z
692 HI  11 L3 unit vector in inboard body coord. x,y,z           0 1 0
693 HI  11 L3 unit vector in outboard body coord. x,y,z          -1 0 0
694 HI  11 Initial rotation angles (deg)                         0,0,0
695 HI  11 Initial rotation rates (deg/sec)                      0
696 HI  11 Rotation stiffness (newton-meters/rad)                0.0565
697 HI  11 Rotation damping (newton-meters/rad/sec)              0
698 HI  11 Null torque angles (deg)                              0
699 HI  11 Number of translation DOFs                            0
700 HI  11 First translation unit vector   g1                    1 0 0
701 HI  11 Second translation unit vector  g2                    0 1 0
702 HI  11 Third translation unit vector   g3                    0 0 1
703 HI  11 Initial translation (meters)                          0 0 0
704 HI  11 Initial translation velocity (meters/sec)
705 HI  11 Translation stiffness (newtons/meters)
706 HI  11 Translation damping (newtons/meter/sec)
707 HI  11 Null force translations
```

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708 HI  12 Hinge ID number                                   12
709 HI  12 Inboard body ID, Outboard body ID                 11,12
710 HI  12 "p" node ID, "q" node ID                          3,2
711 HI  12  Number of rotation DOFs                          2
712 HI  12 L1 unit vector in inboard body coord. x,y,z       0 0 1
713 HI  12 L1 unit vector in outboard body coord. x,y,z      0.1301,0,0.9915
714 HI  12 L2 unit vector in inboard body coord. x,y,z       0 1 0
715 HI  12 L2 unit vector in outboard body coord. x,y,z      -0.8004,0.5903,0.1050
716 HI  12 L3 unit vector in inboard body coord. x,y,z
717 HI  12 L3 unit vector in outboard body coord. x,y,z
718 HI  12 Initial rotation angles (deg)                     0,0,0
719 HI  12 Initial rotation rates (deg/sec)                  0 0
720 HI  12 Rotation stiffness (newton-meters/rad)            0.0565 0.0565
721 HI  12 Rotation damping (newton-meters/rad/sec)          0 0
722 HI  12 Null torque angles (deg)                          0 0
723 HI  12 Number of translation DOFs                        0
724 HI  12 First translation unit vector   g1               1 0 0
725 HI  12 Second translation unit vector  g2               0 1 0
726 HI  12 Third translation unit vector   g3               0 0 1
727 HI  12 Initial translation (meters)                      0 0 0
728 HI  12 Initial translation velocity (meters/sec)
729 HI  12 Translation stiffness (newtons/meters)
730 HI  12 Translation damping (newtons/meter/sec)
731 HI  12 Null force translations

732 HI  13 Hinge ID number                                   13
733 HI  13 Inboard body ID, Outboard body ID                 2,13
734 HI  13 "p" node ID, "q" node ID                          8,2
735 HI  13  Number of rotation DOFs                          1
736 HI  13 L1 unit vector in inboard body coord. x,y,z       0 0 1
737 HI  13 L1 unit vector in outboard body coord. x,y,z      0 0 1
738 HI  13 L2 unit vector in inboard body coord. x,y,z
739 HI  13 L2 unit vector in outboard body coord. x,y,z
740 HI  13 L3 unit vector in inboard body coord. x,y,z       0 1 0
741 HI  13 L3 unit vector in outboard body coord. x,y,z      1 0 0
742 HI  13 Initial rotation angles (deg)                     0,0,0
743 HI  13 Initial rotation rates (deg/sec)                  0
744 HI  13 Rotation stiffness (newton-meters/rad)            0.0565
745 HI  13 Rotation damping (newton-meters/rad/sec)          0
746 HI  13 Null torque angles (deg)                          0
747 HI  13 Number of translation DOFs                        0
748 HI  13 First translation unit vector   g1               1 0 0
749 HI  13 Second translation unit vector  g2               0 1 0
750 HI  13 Third translation unit vector   g3               0 0 1
751 HI  13 Initial translation (meters)                      0 0 0
752 HI  13 Initial translation velocity (meters/sec)
753 HI  13 Translation stiffness (newtons/meters)
754 HI  13 Translation damping (newtons/meter/sec)
755 HI  13 Null force translations

756 HI  14 Hinge ID number                                   14
757 HI  14 Inboard body ID, Outboard body ID                 13,14
758 HI  14 "p" node ID, "q" node ID                          3,2
759 HI  14  Number of rotation DOFs                          2
760 HI  14 L1 unit vector in inboard body coord. x,y,z       0 0 1
761 HI  14 L1 unit vector in outboard body coord. x,y,z      0.1301,0,0.9915
762 HI  14 L2 unit vector in inboard body coord. x,y,z       0 1 0
763 HI  14 L2 unit vector in outboard body coord. x,y,z      -0.8004,-0.5903,0.1050
764 HI  14 L3 unit vector in inboard body coord. x,y,z
765 HI  14 L3 unit vector in outboard body coord. x,y,z
766 HI  14 Initial rotation angles (deg)                     0,0,0
767 HI  14 Initial rotation rates (deg/sec)                  0 0
768 HI  14 Rotation stiffness (newton-meters/rad)            0.0565 0.0565
769 HI  14 Rotation damping (newton-meters/rad/sec)          0 0
770 HI  14 Null torque angles (deg)                          0 0
771 HI  14 Number of translation DOFs                        0
772 HI  14 First translation unit vector   g1               1 0 0
773 HI  14 Second translation unit vector  g2               0 1 0
774 HI  14 Third translation unit vector   g3               0 0 1
775 HI  14 Initial translation (meters)                      0 0 0
776 HI  14 Initial translation velocity (meters/sec)
777 HI  14 Translation stiffness (newtons/meters)
778 HI  14 Translation damping (newtons/meter/sec)
779 HI  14 Null force translations
```

780	HI	15	Hinge ID number	15
781	HI	15	Inboard body ID, Outboard body ID	2,15
782	HI	15	"p" node ID, "q" node ID	9,2
783	HI	15	Number of rotation DOFs	1
784	HI	15	L1 unit vector in inboard body coord. x,y,z	0 0 1
785	HI	15	L1 unit vector in outboard body coord. x,y,z	0 0 1
786	HI	15	L2 unit vector in inboard body coord. x,y,z	
787	HI	15	L2 unit vector in outboard body coord. x,y,z	
788	HI	15	L3 unit vector in inboard body coord. x,y,z	0 1 0
789	HI	15	L3 unit vector in outboard body coord. x,y,z	0.707 -0.707 0
790	HI	15	Initial rotation angles (deg)	0,0,0
791	HI	15	Initial rotation rates (deg/sec)	0
792	HI	15	Rotation stiffness (newton-meters/rad)	0.0565
793	HI	15	Rotation damping (newton-meters/rad/sec)	0
794	HI	15	Null torque angles (deg)	0
795	HI	15	Number of translation DOFs	0
796	HI	15	First translation unit vector g1	1 0 0
797	HI	15	Second translation unit vector g2	0 1 0
798	HI	15	Third translation unit vector g3	0 0 1
799	HI	15	Initial translation (meters)	0 0 0
800	HI	15	Initial translation velocity (meters/sec)	
801	HI	15	Translation stiffness (newtons/meters)	
802	HI	15	Translation damping (newtons/meter/sec)	
803	HI	15	Null force translations	
804	HI	16	Hinge ID number	16
805	HI	16	Inboard body ID, Outboard body ID	15,16
806	HI	16	"p" node ID, "q" node ID	3,2
807	HI	16	Number of rotation DOFs	2
808	HI	16	L1 unit vector in inboard body coord. x,y,z	0 0 1
809	HI	16	L1 unit vector in outboard body coord. x,y,z	0 0 1
810	HI	16	L2 unit vector in inboard body coord. x,y,z	0 1 0
811	HI	16	L2 unit vector in outboard body coord. x,y,z	-0.8702,0.4927,0
812	HI	16	L3 unit vector in inboard body coord. x,y,z	
813	HI	16	L3 unit vector in outboard body coord. x,y,z	
814	HI	16	Initial rotation angles (deg)	0,0,0
815	HI	16	Initial rotation rates (deg/sec)	0 0
816	HI	16	Rotation stiffness (newton-meters/rad)	0.0565 0.0565
817	HI	16	Rotation damping (newton-meters/rad/sec)	0 0
818	HI	16	Null torque angles (deg)	0 0
819	HI	16	Number of translation DOFs	0
820	HI	16	First translation unit vector g1	1 0 0
821	HI	16	Second translation unit vector g2	0 1 0
822	HI	16	Third translation unit vector g3	0 0 1
823	HI	16	Initial translation (meters)	0 0 0
824	HI	16	Initial translation velocity (meters/sec)	
825	HI	16	Translation stiffness (newtons/meters)	
826	HI	16	Translation damping (newtons/meter/sec)	
827	HI	16	Null force translations	
828	HI	17	Hinge ID number	17
829	HI	17	Inboard body ID, Outboard body ID	2,17
830	HI	17	"p" node ID, "q" node ID	10,2
831	HI	17	Number of rotation DOFs	1
832	HI	17	L1 unit vector in inboard body coord. x,y,z	0 0 1
833	HI	17	L1 unit vector in outboard body coord. x,y,z	0 0 1
834	HI	17	L2 unit vector in inboard body coord. x,y,z	
835	HI	17	L2 unit vector in outboard body coord. x,y,z	
836	HI	17	L3 unit vector in inboard body coord. x,y,z	0 1 0
837	HI	17	L3 unit vector in outboard body coord. x,y,z	-0.707 -0.707 0
838	HI	17	Initial rotation angles (deg)	0,0,0
839	HI	17	Initial rotation rates (deg/sec)	0
840	HI	17	Rotation stiffness (newton-meters/rad)	0.0565
841	HI	17	Rotation damping (newton-meters/rad/sec)	0
842	HI	17	Null torque angles (deg)	0
843	HI	17	Number of translation DOFs	0
844	HI	17	First translation unit vector g1	1 0 0
845	HI	17	Second translation unit vector g2	0 1 0
846	HI	17	Third translation unit vector g3	0 0 1
847	HI	17	Initial translation (meters)	0 0 0
848	HI	17	Initial translation velocity (meters/sec)	
849	HI	17	Translation stiffness (newtons/meters)	
850	HI	17	Translation damping (newtons/meter/sec)	
851	HI	17	Null force translations	

852	HI	18	Hinge ID number	18
853	HI	18	Inboard body ID, Outboard body ID	17,18
854	HI	18	"p" node ID, "q" node ID	3,2
855	HI	18	Number of rotation DOFs	2
856	HI	18	L1 unit vector in inboard body coord. x,y,z	0 0 1
857	HI	18	L1 unit vector in outboard body coord. x,y,z	0 0 1
858	HI	18	L2 unit vector in inboard body coord. x,y,z	0 1 0
859	HI	18	L2 unit vector in outboard body coord. x,y,z	-0.8702,-0.4927,0
860	HI	18	L3 unit vector in inboard body coord. x,y,z	
861	HI	18	L3 unit vector in outboard body coord. x,y,z	
862	HI	18	Initial rotation angles (deg)	0,0,0
863	HI	18	Initial rotation rates (deg/sec)	0 0
864	HI	18	Rotation stiffness (newton-meters/rad)	0.0565 0.0565
865	HI	18	Rotation damping (newton-meters/rad/sec)	0 0
866	HI	18	Null torque angles (deg)	0 0
867	HI	18	Number of translation DOFs	0
868	HI	18	First translation unit vector g1	1 0 0
869	HI	18	Second translation unit vector g2	0 1 0
870	HI	18	Third translation unit vector g3	0 0 1
871	HI	18	Initial translation (meters)	0 0 0
872	HI	18	Initial translation velocity (meters/sec)	
873	HI	18	Translation stiffness (newtons/meters)	
874	HI	18	Translation damping (newtons/meter/sec)	
875	HI	18	Null force translations	

SENSOR

876	SE	11	Sensor ID number	11
877	SE	11	Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)	I
878	SE	11	Mounting point body ID, Mounting point node ID	4,3
879	SE	11	Second mounting point body ID, Second node ID	
880	SE	11	Input axis unit vector (IA) x,y,z	1,0,0
881	SE	11	Mounting point Hinge index, Axis index	
882	SE	11	First focal plane unit vector (Fp1) x,y,z	
883	SE	11	Second focal plane unit vector (Fp2) x,y,z	
884	SE	11	Sun/Star unit vector (Us) x,y,z	
885	SE	11	Euler Angle Sequence (1-6)	
886	SE	11	CMG ID number and Gimbal number	
887	SE	12	Sensor ID number	12
888	SE	12	Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)	I
889	SE	12	Mounting point body ID, Mounting point node ID	4,3
890	SE	12	Second mounting point body ID, Second node ID	
891	SE	12	Input axis unit vector (IA) x,y,z	0,1,0
892	SE	12	Mounting point Hinge index, Axis index	
893	SE	12	First focal plane unit vector (Fp1) x,y,z	
894	SE	12	Second focal plane unit vector (Fp2) x,y,z	
895	SE	12	Sun/Star unit vector (Us) x,y,z	
896	SE	12	Euler Angle Sequence (1-6)	
897	SE	12	CMG ID number and Gimbal number	
898	SE	13	Sensor ID number	13
899	SE	13	Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)	I
900	SE	13	Mounting point body ID, Mounting point node ID	4,3
901	SE	13	Second mounting point body ID, Second node ID	
902	SE	13	Input axis unit vector (IA) x,y,z	0,0,1
903	SE	13	Mounting point Hinge index, Axis index	
904	SE	13	First focal plane unit vector (Fp1) x,y,z	
905	SE	13	Second focal plane unit vector (Fp2) x,y,z	
906	SE	13	Sun/Star unit vector (Us) x,y,z	
907	SE	13	Euler Angle Sequence (1-6)	
908	SE	13	CMG ID number and Gimbal number	
909	SE	21	Sensor ID number	21
910	SE	21	Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)	I
911	SE	21	Mounting point body ID, Mounting point node ID	6,3
912	SE	21	Second mounting point body ID, Second node ID	
913	SE	21	Input axis unit vector (IA) x,y,z	1,0,0
914	SE	21	Mounting point Hinge index, Axis index	
915	SE	21	First focal plane unit vector (Fp1) x,y,z	
916	SE	21	Second focal plane unit vector (Fp2) x,y,z	
917	SE	21	Sun/Star unit vector (Us) x,y,z	
918	SE	21	Euler Angle Sequence (1-6)	

919	SE	21	CMG ID number and Gimbal number	
920	SE	22	Sensor ID number	22
921	SE	22	Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)	I
922	SE	22	Mounting point body ID, Mounting point node ID	6,3
923	SE	22	Second mounting point body ID, Second node ID	
924	SE	22	Input axis unit vector (IA) x,y,z	0,1,0
925	SE	22	Mounting point Hinge index, Axis index	
926	SE	22	First focal plane unit vector (Fp1) x,y,z	
927	SE	22	Second focal plane unit vector (Fp2) x,y,z	
928	SE	22	Sun/Star unit vector (Us) x,y,z	
929	SE	22	Euler Angle Sequence (1-6)	
930	SE	22	CMG ID number and Gimbal number	
931	SE	23	Sensor ID number	23
932	SE	23	Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)	I
933	SE	23	Mounting point body ID, Mounting point node ID	6,3
934	SE	23	Second mounting point body ID, Second node ID	
935	SE	23	Input axis unit vector (IA) x,y,z	0,0,1
936	SE	23	Mounting point Hinge index, Axis index	
937	SE	23	First focal plane unit vector (Fp1) x,y,z	
938	SE	23	Second focal plane unit vector (Fp2) x,y,z	
939	SE	23	Sun/Star unit vector (Us) x,y,z	
940	SE	23	Euler Angle Sequence (1-6)	
941	SE	23	CMG ID number and Gimbal number	
942	SE	31	Sensor ID number	31
943	SE	31	Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)	I
944	SE	31	Mounting point body ID, Mounting point node ID	8,3
945	SE	31	Second mounting point body ID, Second node ID	
946	SE	31	Input axis unit vector (IA) x,y,z	1,0,0
947	SE	31	Mounting point Hinge index, Axis index	
948	SE	31	First focal plane unit vector (Fp1) x,y,z	
949	SE	31	Second focal plane unit vector (Fp2) x,y,z	
950	SE	31	Sun/Star unit vector (Us) x,y,z	
951	SE	31	Euler Angle Sequence (1-6)	
952	SE	31	CMG ID number and Gimbal number	
953	SE	32	Sensor ID number	32
954	SE	32	Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)	I
955	SE	32	Mounting point body ID, Mounting point node ID	8,3
956	SE	32	Second mounting point body ID, Second node ID	
957	SE	32	Input axis unit vector (IA) x,y,z	0,1,0
958	SE	32	Mounting point Hinge index, Axis index	
959	SE	32	First focal plane unit vector (Fp1) x,y,z	
960	SE	32	Second focal plane unit vector (Fp2) x,y,z	
961	SE	32	Sun/Star unit vector (Us) x,y,z	
962	SE	32	Euler Angle Sequence (1-6)	
963	SE	32	CMG ID number and Gimbal number	
964	SE	33	Sensor ID number	33
965	SE	33	Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)	I
966	SE	33	Mounting point body ID, Mounting point node ID	8,3
967	SE	33	Second mounting point body ID, Second node ID	
968	SE	33	Input axis unit vector (IA) x,y,z	0,0,1
969	SE	33	Mounting point Hinge index, Axis index	
970	SE	33	First focal plane unit vector (Fp1) x,y,z	
971	SE	33	Second focal plane unit vector (Fp2) x,y,z	
972	SE	33	Sun/Star unit vector (Us) x,y,z	
973	SE	33	Euler Angle Sequence (1-6)	
974	SE	33	CMG ID number and Gimbal number	
975	SE	41	Sensor ID number	41
976	SE	41	Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)	I
977	SE	41	Mounting point body ID, Mounting point node ID	10,3
978	SE	41	Second mounting point body ID, Second node ID	
979	SE	41	Input axis unit vector (IA) x,y,z	1,0,0
980	SE	41	Mounting point Hinge index, Axis index	
981	SE	41	First focal plane unit vector (Fp1) x,y,z	
982	SE	41	Second focal plane unit vector (Fp2) x,y,z	
983	SE	41	Sun/Star unit vector (Us) x,y,z	
984	SE	41	Euler Angle Sequence (1-6)	
985	SE	41	CMG ID number and Gimbal number	
986	SE	42	Sensor ID number	42

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 987 SE  42 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      I
 988 SE  42 Mounting point body ID, Mounting point node ID     10,3
 989 SE  42 Second mounting point body ID, Second node ID
 990 SE  42 Input axis unit vector (IA) x,y,z                  0,1,0
 991 SE  42 Mounting point Hinge index, Axis index
 992 SE  42 First focal plane unit vector  (Fp1) x,y,z
 993 SE  42 Second focal plane unit vector (Fp2) x,y,z
 994 SE  42 Sun/Star unit vector (Us) x,y,z
 995 SE  42 Euler Angle Sequence (1-6)
 996 SE  42 CMG ID number and Gimbal number

 997 SE  43 Sensor ID number                                   43
 998 SE  43 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      I
 999 SE  43 Mounting point body ID, Mounting point node ID     10,3
1000 SE  43 Second mounting point body ID, Second node ID
1001 SE  43 Input axis unit vector (IA) x,y,z                  0,0,1
1002 SE  43 Mounting point Hinge index, Axis index
1003 SE  43 First focal plane unit vector  (Fp1) x,y,z
1004 SE  43 Second focal plane unit vector (Fp2) x,y,z
1005 SE  43 Sun/Star unit vector (Us) x,y,z
1006 SE  43 Euler Angle Sequence (1-6)
1007 SE  43 CMG ID number and Gimbal number

1008 SE  51 Sensor ID number                                   51
1009 SE  51 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      I
1010 SE  51 Mounting point body ID, Mounting point node ID     12,3
1011 SE  51 Second mounting point body ID, Second node ID
1012 SE  51 Input axis unit vector (IA) x,y,z                  1,0,0
1013 SE  51 Mounting point Hinge index, Axis index
1014 SE  51 First focal plane unit vector  (Fp1) x,y,z
1015 SE  51 Second focal plane unit vector (Fp2) x,y,z
1016 SE  51 Sun/Star unit vector (Us) x,y,z
1017 SE  51 Euler Angle Sequence (1-6)
1018 SE  51 CMG ID number and Gimbal number

1019 SE  52 Sensor ID number                                   52
1020 SE  52 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      I
1021 SE  52 Mounting point body ID, Mounting point node ID     12,3
1022 SE  52 Second mounting point body ID, Second node ID
1023 SE  52 Input axis unit vector (IA) x,y,z                  0,1,0
1024 SE  52 Mounting point Hinge index, Axis index
1025 SE  52 First focal plane unit vector  (Fp1) x,y,z
1026 SE  52 Second focal plane unit vector (Fp2) x,y,z
1027 SE  52 Sun/Star unit vector (Us) x,y,z
1028 SE  52 Euler Angle Sequence (1-6)
1029 SE  52 CMG ID number and Gimbal number

1030 SE  53 Sensor ID number                                   53
1031 SE  53 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      I
1032 SE  53 Mounting point body ID, Mounting point node ID     12,3
1033 SE  53 Second mounting point body ID, Second node ID
1034 SE  53 Input axis unit vector (IA) x,y,z                  0,0,1
1035 SE  53 Mounting point Hinge index, Axis index
1036 SE  53 First focal plane unit vector  (Fp1) x,y,z
1037 SE  53 Second focal plane unit vector (Fp2) x,y,z
1038 SE  53 Sun/Star unit vector (Us) x,y,z
1039 SE  53 Euler Angle Sequence (1-6)
1040 SE  53 CMG ID number and Gimbal number

1041 SE  61 Sensor ID number                                   61
1042 SE  61 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      I
1043 SE  61 Mounting point body ID, Mounting point node ID     14,3
1044 SE  61 Second mounting point body ID, Second node ID
1045 SE  61 Input axis unit vector (IA) x,y,z                  1,0,0
1046 SE  61 Mounting point Hinge index, Axis index
1047 SE  61 First focal plane unit vector  (Fp1) x,y,z
1048 SE  61 Second focal plane unit vector (Fp2) x,y,z
1049 SE  61 Sun/Star unit vector (Us) x,y,z
1050 SE  61 Euler Angle Sequence (1-6)
1051 SE  61 CMG ID number and Gimbal number

1052 SE  62 Sensor ID number                                   62
1053 SE  62 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      I
1054 SE  62 Mounting point body ID, Mounting point node ID     14,3
1055 SE  62 Second mounting point body ID, Second node ID
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1056 SE  62 Input axis unit vector (IA) x,y,z                    0,1,0
1057 SE  62 Mounting point Hinge index, Axis index
1058 SE  62 First focal plane unit vector  (Fp1) x,y,z
1059 SE  62 Second focal plane unit vector (Fp2) x,y,z
1060 SE  62 Sun/Star unit vector (Us) x,y,z
1061 SE  62 Euler Angle Sequence (1-6)
1062 SE  62 CMG ID number and Gimbal number

1063 SE  63 Sensor ID number                                     63
1064 SE  63 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)         I
1065 SE  63 Mounting point body ID, Mounting point node ID       14,3
1066 SE  63 Second mounting point body ID, Second node ID
1067 SE  63 Input axis unit vector (IA) x,y,z                    0,0,1
1068 SE  63 Mounting point Hinge index, Axis index
1069 SE  63 First focal plane unit vector  (Fp1) x,y,z
1070 SE  63 Second focal plane unit vector (Fp2) x,y,z
1071 SE  63 Sun/Star unit vector (Us) x,y,z
1072 SE  63 Euler Angle Sequence (1-6)
1073 SE  63 CMG ID number and Gimbal number

1074 SE  71 Sensor ID number                                     71
1075 SE  71 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)         I
1076 SE  71 Mounting point body ID, Mounting point node ID       16,3
1077 SE  71 Second mounting point body ID, Second node ID
1078 SE  71 Input axis unit vector (IA) x,y,z                    1,0,0
1079 SE  71 Mounting point Hinge index, Axis index
1080 SE  71 First focal plane unit vector  (Fp1) x,y,z
1081 SE  71 Second focal plane unit vector (Fp2) x,y,z
1082 SE  71 Sun/Star unit vector (Us) x,y,z
1083 SE  71 Euler Angle Sequence (1-6)
1084 SE  71 CMG ID number and Gimbal number

1085 SE  72 Sensor ID number                                     72
1086 SE  72 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)         I
1087 SE  72 Mounting point body ID, Mounting point node ID       16,3
1088 SE  72 Second mounting point body ID, Second node ID
1089 SE  72 Input axis unit vector (IA) x,y,z                    0,1,0
1090 SE  72 Mounting point Hinge index, Axis index
1091 SE  72 First focal plane unit vector  (Fp1) x,y,z
1092 SE  72 Second focal plane unit vector (Fp2) x,y,z
1093 SE  72 Sun/Star unit vector (Us) x,y,z
1094 SE  72 Euler Angle Sequence (1-6)
1095 SE  72 CMG ID number and Gimbal number

1096 SE  73 Sensor ID number                                     73
1097 SE  73 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)         I
1098 SE  73 Mounting point body ID, Mounting point node ID       16,3
1099 SE  73 Second mounting point body ID, Second node ID
1100 SE  73 Input axis unit vector (IA) x,y,z                    0,0,1
1101 SE  73 Mounting point Hinge index, Axis index
1102 SE  73 First focal plane unit vector  (Fp1) x,y,z
1103 SE  73 Second focal plane unit vector (Fp2) x,y,z
1104 SE  73 Sun/Star unit vector (Us) x,y,z
1105 SE  73 Euler Angle Sequence (1-6)
1106 SE  73 CMG ID number and Gimbal number

1107 SE  81 Sensor ID number                                     81
1108 SE  81 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)         I
1109 SE  81 Mounting point body ID, Mounting point node ID       18,3
1110 SE  81 Second mounting point body ID, Second node ID
1111 SE  81 Input axis unit vector (IA) x,y,z                    1,0,0
1112 SE  81 Mounting point Hinge index, Axis index
1113 SE  81 First focal plane unit vector  (Fp1) x,y,z
1114 SE  81 Second focal plane unit vector (Fp2) x,y,z
1115 SE  81 Sun/Star unit vector (Us) x,y,z
1116 SE  81 Euler Angle Sequence (1-6)
1117 SE  81 CMG ID number and Gimbal number

1118 SE  82 Sensor ID number                                     82
1119 SE  82 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)         I
1120 SE  82 Mounting point body ID, Mounting point node ID       18,3
1121 SE  82 Second mounting point body ID, Second node ID
1122 SE  82 Input axis unit vector (IA) x,y,z                    0,1,0
1123 SE  82 Mounting point Hinge index, Axis index
1124 SE  82 First focal plane unit vector  (Fp1) x,y,z
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1125 SE  82 Second focal plane unit vector (Fp2) x,y,z
1126 SE  82 Sun/Star unit vector (Us) x,y,z
1127 SE  82 Euler Angle Sequence (1-6)
1128 SE  82 CMG ID number and Gimbal number

1129 SE  83 Sensor ID number                                   83
1130 SE  83 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      I
1131 SE  83 Mounting point body ID, Mounting point node ID     18,3
1132 SE  83 Second mounting point body ID, Second node ID
1133 SE  83 Input axis unit vector (IA) x,y,z                  0,0,1
1134 SE  83 Mounting point Hinge index, Axis index
1135 SE  83 First focal plane unit vector  (Fp1) x,y,z
1136 SE  83 Second focal plane unit vector (Fp2) x,y,z
1137 SE  83 Sun/Star unit vector (Us) x,y,z
1138 SE  83 Euler Angle Sequence (1-6)
1139 SE  83 CMG ID number and Gimbal number

1140 SE 101 Sensor ID number                                   101
1141 SE 101 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      AC
1142 SE 101 Mounting point body ID, Mounting point node ID     1,1
1143 SE 101 Second mounting point body ID, Second node ID
1144 SE 101 Input axis unit vector (IA) x,y,z                  1 0 0
1145 SE 101 Mounting point Hinge index, Axis index
1146 SE 101 First focal plane unit vector  (Fp1) x,y,z
1147 SE 101 Second focal plane unit vector (Fp2) x,y,z
1148 SE 101 Sun/Star unit vector (Us) x,y,z
1149 SE 101 Euler Angle Sequence (1-6)
1150 SE 101 CMG ID number and Gimbal number

1151 SE 102 Sensor ID number                                   102
1152 SE 102 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      AC
1153 SE 102 Mounting point body ID, Mounting point node ID     1,1
1154 SE 102 Second mounting point body ID, Second node ID
1155 SE 102 Input axis unit vector (IA) x,y,z                  0 1 0
1156 SE 102 Mounting point Hinge index, Axis index
1157 SE 102 First focal plane unit vector  (Fp1) x,y,z
1158 SE 102 Second focal plane unit vector (Fp2) x,y,z
1159 SE 102 Sun/Star unit vector (Us) x,y,z
1160 SE 102 Euler Angle Sequence (1-6)
1161 SE 102 CMG ID number and Gimbal number

1162 SE 103 Sensor ID number                                   103
1163 SE 103 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      AC
1164 SE 103 Mounting point body ID, Mounting point node ID     1,1
1165 SE 103 Second mounting point body ID, Second node ID
1166 SE 103 Input axis unit vector (IA) x,y,z                  0 0 1
1167 SE 103 Mounting point Hinge index, Axis index
1168 SE 103 First focal plane unit vector  (Fp1) x,y,z
1169 SE 103 Second focal plane unit vector (Fp2) x,y,z
1170 SE 103 Sun/Star unit vector (Us) x,y,z
1171 SE 103 Euler Angle Sequence (1-6)
1172 SE 103 CMG ID number and Gimbal number

1173 SE 201 Sensor ID number                                   201
1174 SE 201 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      AC
1175 SE 201 Mounting point body ID, Mounting point node ID     2,1
1176 SE 201 Second mounting point body ID, Second node ID
1177 SE 201 Input axis unit vector (IA) x,y,z                  1 0 0
1178 SE 201 Mounting point Hinge index, Axis index
1179 SE 201 First focal plane unit vector  (Fp1) x,y,z
1180 SE 201 Second focal plane unit vector (Fp2) x,y,z
1181 SE 201 Sun/Star unit vector (Us) x,y,z
1182 SE 201 Euler Angle Sequence (1-6)
1183 SE 201 CMG ID number and Gimbal number

1184 SE 202 Sensor ID number                                   202
1185 SE 202 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      AC
1186 SE 202 Mounting point body ID, Mounting point node ID     2,1
1187 SE 202 Second mounting point body ID, Second node ID
1188 SE 202 Input axis unit vector (IA) x,y,z                  0 1 0
1189 SE 202 Mounting point Hinge index, Axis index
1190 SE 202 First focal plane unit vector  (Fp1) x,y,z
1191 SE 202 Second focal plane unit vector (Fp2) x,y,z
1192 SE 202 Sun/Star unit vector (Us) x,y,z
1193 SE 202 Euler Angle Sequence (1-6)
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1194 SE 202 CMG ID number and Gimbal number

1195 SE 203 Sensor ID number 203
1196 SE 203 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) AC
1197 SE 203 Mounting point body ID, Mounting point node ID 2,1
1198 SE 203 Second mounting point body ID, Second node ID
1199 SE 203 Input axis unit vector (IA) x,y,z 0 0 1
1200 SE 203 Mounting point Hinge index, Axis index
1201 SE 203 First focal plane unit vector (Fp1) x,y,z
1202 SE 203 Second focal plane unit vector (Fp2) x,y,z
1203 SE 203 Sun/Star unit vector (Us) x,y,z
1204 SE 203 Euler Angle Sequence (1-6)
1205 SE 203 CMG ID number and Gimbal number

1206 SE 211 Sensor ID number 211
1207 SE 211 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) AC
1208 SE 211 Mounting point body ID, Mounting point node ID 2,11
1209 SE 211 Second mounting point body ID, Second node ID
1210 SE 211 Input axis unit vector (IA) x,y,z 0.707,0.707,0
1211 SE 211 Mounting point Hinge index, Axis index
1212 SE 211 First focal plane unit vector (Fp1) x,y,z
1213 SE 211 Second focal plane unit vector (Fp2) x,y,z
1214 SE 211 Sun/Star unit vector (Us) x,y,z
1215 SE 211 Euler Angle Sequence (1-6)
1216 SE 211 CMG ID number and Gimbal number

1217 SE 212 Sensor ID number 212
1218 SE 212 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) AC
1219 SE 212 Mounting point body ID, Mounting point node ID 2,11
1220 SE 212 Second mounting point body ID, Second node ID
1221 SE 212 Input axis unit vector (IA) x,y,z -0.707,0.707,0
1222 SE 212 Mounting point Hinge index, Axis index
1223 SE 212 First focal plane unit vector (Fp1) x,y,z
1224 SE 212 Second focal plane unit vector (Fp2) x,y,z
1225 SE 212 Sun/Star unit vector (Us) x,y,z
1226 SE 212 Euler Angle Sequence (1-6)
1227 SE 212 CMG ID number and Gimbal number

1228 SE 221 Sensor ID number 221
1229 SE 221 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) AC
1230 SE 221 Mounting point body ID, Mounting point node ID 2,12
1231 SE 221 Second mounting point body ID, Second node ID
1232 SE 221 Input axis unit vector (IA) x,y,z 0.146,0.853,0.5
1233 SE 221 Mounting point Hinge index, Axis index
1234 SE 221 First focal plane unit vector (Fp1) x,y,z
1235 SE 221 Second focal plane unit vector (Fp2) x,y,z
1236 SE 221 Sun/Star unit vector (Us) x,y,z
1237 SE 221 Euler Angle Sequence (1-6)
1238 SE 221 CMG ID number and Gimbal number

1239 SE 222 Sensor ID number 222
1240 SE 222 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) AC
1241 SE 222 Mounting point body ID, Mounting point node ID 2,13
1242 SE 222 Second mounting point body ID, Second node ID
1243 SE 222 Input axis unit vector (IA) x,y,z -0.853,-0.146,0.5
1244 SE 222 Mounting point Hinge index, Axis index
1245 SE 222 First focal plane unit vector (Fp1) x,y,z
1246 SE 222 Second focal plane unit vector (Fp2) x,y,z
1247 SE 222 Sun/Star unit vector (Us) x,y,z
1248 SE 222 Euler Angle Sequence (1-6)
1249 SE 222 CMG ID number and Gimbal number

1250 SE 223 Sensor ID number 223
1251 SE 223 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT) AC
1252 SE 223 Mounting point body ID, Mounting point node ID 2,12
1253 SE 223 Second mounting point body ID, Second node ID
1254 SE 223 Input axis unit vector (IA) x,y,z 0.5,-0.5,0.707
1255 SE 223 Mounting point Hinge index, Axis index
1256 SE 223 First focal plane unit vector (Fp1) x,y,z
1257 SE 223 Second focal plane unit vector (Fp2) x,y,z
1258 SE 223 Sun/Star unit vector (Us) x,y,z
1259 SE 223 Euler Angle Sequence (1-6)
1260 SE 223 CMG ID number and Gimbal number

1261 SE 231 Sensor ID number 231

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1262 SE 231 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      AC
1263 SE 231 Mounting point body ID, Mounting point node ID     2,14
1264 SE 231 Second mounting point body ID, Second node ID
1265 SE 231 Input axis unit vector (IA) x,y,z                  0.853,-0.146,0.5
1266 SE 231 Mounting point Hinge index, Axis index
1267 SE 231 First focal plane unit vector  (Fp1) x,y,z
1268 SE 231 Second focal plane unit vector (Fp2) x,y,z
1269 SE 231 Sun/Star unit vector (Us) x,y,z
1270 SE 231 Euler Angle Sequence (1-6)
1271 SE 231 CMG ID number and Gimbal number

1272 SE 232 Sensor ID number                                   232
1273 SE 232 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      AC
1274 SE 232 Mounting point body ID, Mounting point node ID     2,14
1275 SE 232 Second mounting point body ID, Second node ID
1276 SE 232 Input axis unit vector (IA) x,y,z                  -0.146,0.853,0.5
1277 SE 232 Mounting point Hinge index, Axis index
1278 SE 232 First focal plane unit vector  (Fp1) x,y,z
1279 SE 232 Second focal plane unit vector (Fp2) x,y,z
1280 SE 232 Sun/Star unit vector (Us) x,y,z
1281 SE 232 Euler Angle Sequence (1-6)
1282 SE 232 CMG ID number and Gimbal number

1283 SE 233 Sensor ID number                                   233
1284 SE 233 Type (G,R,AN,V,P,AC,T,I,SU,ST,IM,P3,V3,CR,CT)      AC
1285 SE 233 Mounting point body ID, Mounting point node ID     2,14
1286 SE 233 Second mounting point body ID, Second node ID
1287 SE 233 Input axis unit vector (IA) x,y,z                  -0.5,-0.5,0.707
1288 SE 233 Mounting point Hinge index, Axis index
1289 SE 233 First focal plane unit vector  (Fp1) x,y,z
1290 SE 233 Second focal plane unit vector (Fp2) x,y,z
1291 SE 233 Sun/Star unit vector (Us) x,y,z
1292 SE 233 Euler Angle Sequence (1-6)
1293 SE 233 CMG ID number and Gimbal number

            ACTR

1294 AC  11 Actuator ID number                                 11
1295 AC  11 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
1296 AC  11 Actuator location; Node or Hinge (N or H)
1297 AC  11 Mounting point body ID number, node ID number      4,3
1298 AC  11 Second mounting point body ID, second node ID
1299 AC  11 Output axis unit vector x,y,z                      1,0,0
1300 AC  11 Mounting point Hinge index, Axis index
1301 AC  11 Rotor spin axis unit vector x,y,z
1302 AC  11 Initial rotor momentum, H
1303 AC  11 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1304 AC  11 Outer gimbal axis unit vector x,y,z
1305 AC  11 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1306 AC  11 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1307 AC  11 Inner gimbal axis unit vector x,y,z
1308 AC  11 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1309 AC  11 Initial length and rate, y(to) and ydot(to)
1310 AC  11 Constants; K1 or wo, n or zeta, Kg, Jm
1311 AC  11 Non-linearities; TLim, Tco, Dz

1312 AC  12 Actuator ID number                                 12
1313 AC  12 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
1314 AC  12 Actuator location; Node or Hinge (N or H)
1315 AC  12 Mounting point body ID number, node ID number      4,3
1316 AC  12 Second mounting point body ID, second node ID
1317 AC  12 Output axis unit vector x,y,z                      0,1,0
1318 AC  12 Mounting point Hinge index, Axis index
1319 AC  12 Rotor spin axis unit vector x,y,z
1320 AC  12 Initial rotor momentum, H
1321 AC  12 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1322 AC  12 Outer gimbal axis unit vector x,y,z
1323 AC  12 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1324 AC  12 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1325 AC  12 Inner gimbal axis unit vector x,y,z
1326 AC  12 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1327 AC  12 Initial length and rate, y(to) and ydot(to)
1328 AC  12 Constants; K1 or wo, n or zeta, Kg, Jm
1329 AC  12 Non-linearities; TLim, Tco, Dz
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1330 AC  13 Actuator ID number                                 13
1331 AC  13 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
1332 AC  13 Actuator location; Node or Hinge (N or H)
1333 AC  13 Mounting point body ID number, node ID number       4,3
1334 AC  13 Second mounting point body ID, second node ID
1335 AC  13 Output axis unit vector x,y,z                      0,0,1
1336 AC  13 Mounting point Hinge index, Axis index
1337 AC  13 Rotor spin axis unit vector x,y,z
1338 AC  13 Initial rotor momentum, H
1339 AC  13 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1340 AC  13 Outer gimbal axis unit vector x,y,z
1341 AC  13 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1342 AC  13 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1343 AC  13 Inner gimbal axis unit vector x,y,z
1344 AC  13 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1345 AC  13 Initial length and rate, y(to) and ydot(to)
1346 AC  13 Constants; K1 or wo, n or zeta, Kg, Jm
1347 AC  13 Non-linearities; TLim, Tco, Dz

1348 AC  14 Actuator ID number                                 14
1349 AC  14 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
1350 AC  14 Actuator location; Node or Hinge (N or H)
1351 AC  14 Mounting point body ID number, node ID number       1,3
1352 AC  14 Second mounting point body ID, second node ID
1353 AC  14 Output axis unit vector x,y,z                      1,0,0
1354 AC  14 Mounting point Hinge index, Axis index
1355 AC  14 Rotor spin axis unit vector x,y,z
1356 AC  14 Initial rotor momentum, H
1357 AC  14 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1358 AC  14 Outer gimbal axis unit vector x,y,z
1359 AC  14 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1360 AC  14 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1361 AC  14 Inner gimbal axis unit vector x,y,z
1362 AC  14 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1363 AC  14 Initial length and rate, y(to) and ydot(to)
1364 AC  14 Constants; K1 or wo, n or zeta, Kg, Jm
1365 AC  14 Non-linearities; TLim, Tco, Dz

1366 AC  15 Actuator ID number                                 15
1367 AC  15 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
1368 AC  15 Actuator location; Node or Hinge (N or H)
1369 AC  15 Mounting point body ID number, node ID number       1,3
1370 AC  15 Second mounting point body ID, second node ID
1371 AC  15 Output axis unit vector x,y,z                      0,1,0
1372 AC  15 Mounting point Hinge index, Axis index
1373 AC  15 Rotor spin axis unit vector x,y,z
1374 AC  15 Initial rotor momentum, H
1375 AC  15 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1376 AC  15 Outer gimbal axis unit vector x,y,z
1377 AC  15 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1378 AC  15 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1379 AC  15 Inner gimbal axis unit vector x,y,z
1380 AC  15 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1381 AC  15 Initial length and rate, y(to) and ydot(to)
1382 AC  15 Constants; K1 or wo, n or zeta, Kg, Jm
1383 AC  15 Non-linearities; TLim, Tco, Dz

1384 AC  16 Actuator ID number                                 16
1385 AC  16 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
1386 AC  16 Actuator location; Node or Hinge (N or H)
1387 AC  16 Mounting point body ID number, node ID number       1,3
1388 AC  16 Second mounting point body ID, second node ID
1389 AC  16 Output axis unit vector x,y,z                      0,0,1
1390 AC  16 Mounting point Hinge index, Axis index
1391 AC  16 Rotor spin axis unit vector x,y,z
1392 AC  16 Initial rotor momentum, H
1393 AC  16 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1394 AC  16 Outer gimbal axis unit vector x,y,z
1395 AC  16 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1396 AC  16 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1397 AC  16 Inner gimbal axis unit vector x,y,z
1398 AC  16 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1399 AC  16 Initial length and rate, y(to) and ydot(to)
1400 AC  16 Constants; K1 or wo, n or zeta, Kg, Jm
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1401 AC  16 Non-linearities; TLim, Tco, Dz

1402 AC  21 Actuator ID number                                  21
1403 AC  21 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1404 AC  21 Actuator location; Node or Hinge (N or H)
1405 AC  21 Mounting point body ID number, node ID number       6,3
1406 AC  21 Second mounting point body ID, second node ID
1407 AC  21 Output axis unit vector x,y,z                       1,0,0
1408 AC  21 Mounting point Hinge index, Axis index
1409 AC  21 Rotor spin axis unit vector x,y,z
1410 AC  21 Initial rotor momentum, H
1411 AC  21 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1412 AC  21 Outer gimbal axis unit vector x,y,z
1413 AC  21 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1414 AC  21 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1415 AC  21 Inner gimbal axis unit vector x,y,z
1416 AC  21 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1417 AC  21 Initial length and rate, y(to) and ydot(to)
1418 AC  21 Constants; K1 or wo, n or zeta, Kg, Jm
1419 AC  21 Non-linearities; TLim, Tco, Dz

1420 AC  22 Actuator ID number                                  22
1421 AC  22 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1422 AC  22 Actuator location; Node or Hinge (N or H)
1423 AC  22 Mounting point body ID number, node ID number       6,3
1424 AC  22 Second mounting point body ID, second node ID
1425 AC  22 Output axis unit vector x,y,z                       0,1,0
1426 AC  22 Mounting point Hinge index, Axis index
1427 AC  22 Rotor spin axis unit vector x,y,z
1428 AC  22 Initial rotor momentum, H
1429 AC  22 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1430 AC  22 Outer gimbal axis unit vector x,y,z
1431 AC  22 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1432 AC  22 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1433 AC  22 Inner gimbal axis unit vector x,y,z
1434 AC  22 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1435 AC  22 Initial length and rate, y(to) and ydot(to)
1436 AC  22 Constants; K1 or wo, n or zeta, Kg, Jm
1437 AC  22 Non-linearities; TLim, Tco, Dz

1438 AC  23 Actuator ID number                                  23
1439 AC  23 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1440 AC  23 Actuator location; Node or Hinge (N or H)
1441 AC  23 Mounting point body ID number, node ID number       6,3
1442 AC  23 Second mounting point body ID, second node ID
1443 AC  23 Output axis unit vector x,y,z                       0,0,1
1444 AC  23 Mounting point Hinge index, Axis index
1445 AC  23 Rotor spin axis unit vector x,y,z
1446 AC  23 Initial rotor momentum, H
1447 AC  23 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1448 AC  23 Outer gimbal axis unit vector x,y,z
1449 AC  23 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1450 AC  23 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1451 AC  23 Inner gimbal axis unit vector x,y,z
1452 AC  23 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1453 AC  23 Initial length and rate, y(to) and ydot(to)
1454 AC  23 Constants; K1 or wo, n or zeta, Kg, Jm
1455 AC  23 Non-linearities; TLim, Tco, Dz

1456 AC  24 Actuator ID number                                  24
1457 AC  24 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1458 AC  24 Actuator location; Node or Hinge (N or H)
1459 AC  24 Mounting point body ID number, node ID number       1,4
1460 AC  24 Second mounting point body ID, second node ID
1461 AC  24 Output axis unit vector x,y,z                       1,0,0
1462 AC  24 Mounting point Hinge index, Axis index
1463 AC  24 Rotor spin axis unit vector x,y,z
1464 AC  24 Initial rotor momentum, H
1465 AC  24 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1466 AC  24 Outer gimbal axis unit vector x,y,z
1467 AC  24 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1468 AC  24 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1469 AC  24 Inner gimbal axis unit vector x,y,z
1470 AC  24 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1471 AC  24 Initial length and rate, y(to) and ydot(to)
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1472 AC  24 Constants; K1 or wo, n or zeta, Kg, Jm
1473 AC  24 Non-linearities; TLim, Tco, Dz

1474 AC  25 Actuator ID number                                 25
1475 AC  25 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1476 AC  25 Actuator location; Node or Hinge (N or H)
1477 AC  25 Mounting point body ID number, node ID number      1,4
1478 AC  25 Second mounting point body ID, second node ID
1479 AC  25 Output axis unit vector x,y,z                      0,1,0
1480 AC  25 Mounting point Hinge index, Axis index
1481 AC  25 Rotor spin axis unit vector x,y,z
1482 AC  25 Initial rotor momentum, H
1483 AC  25 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1484 AC  25 Outer gimbal axis unit vector x,y,z
1485 AC  25 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1486 AC  25 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1487 AC  25 Inner gimbal axis unit vector x,y,z
1488 AC  25 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1489 AC  25 Initial length and rate, y(to) and ydot(to)
1490 AC  25 Constants; K1 or wo, n or zeta, Kg, Jm
1491 AC  25 Non-linearities; TLim, Tco, Dz

1492 AC  26 Actuator ID number                                 26
1493 AC  26 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1494 AC  26 Actuator location; Node or Hinge (N or H)
1495 AC  26 Mounting point body ID number, node ID number      1,4
1496 AC  26 Second mounting point body ID, second node ID
1497 AC  26 Output axis unit vector x,y,z                      0,0,1
1498 AC  26 Mounting point Hinge index, Axis index
1499 AC  26 Rotor spin axis unit vector x,y,z
1500 AC  26 Initial rotor momentum, H
1501 AC  26 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1502 AC  26 Outer gimbal axis unit vector x,y,z
1503 AC  26 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1504 AC  26 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1505 AC  26 Inner gimbal axis unit vector x,y,z
1506 AC  26 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1507 AC  26 Initial length and rate, y(to) and ydot(to)
1508 AC  26 Constants; K1 or wo, n or zeta, Kg, Jm
1509 AC  26 Non-linearities; TLim, Tco, Dz

1510 AC  31 Actuator ID number                                 31
1511 AC  31 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1512 AC  31 Actuator location; Node or Hinge (N or H)
1513 AC  31 Mounting point body ID number, node ID number      8,3
1514 AC  31 Second mounting point body ID, second node ID
1515 AC  31 Output axis unit vector x,y,z                      1,0,0
1516 AC  31 Mounting point Hinge index, Axis index
1517 AC  31 Rotor spin axis unit vector x,y,z
1518 AC  31 Initial rotor momentum, H
1519 AC  31 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1520 AC  31 Outer gimbal axis unit vector x,y,z
1521 AC  31 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1522 AC  31 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1523 AC  31 Inner gimbal axis unit vector x,y,z
1524 AC  31 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1525 AC  31 Initial length and rate, y(to) and ydot(to)
1526 AC  31 Constants; K1 or wo, n or zeta, Kg, Jm
1527 AC  31 Non-linearities; TLim, Tco, Dz

1528 AC  32 Actuator ID number                                 32
1529 AC  32 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1530 AC  32 Actuator location; Node or Hinge (N or H)
1531 AC  32 Mounting point body ID number, node ID number      8,3
1532 AC  32 Second mounting point body ID, second node ID
1533 AC  32 Output axis unit vector x,y,z                      0,1,0
1534 AC  32 Mounting point Hinge index, Axis index
1535 AC  32 Rotor spin axis unit vector x,y,z
1536 AC  32 Initial rotor momentum, H
1537 AC  32 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1538 AC  32 Outer gimbal axis unit vector x,y,z
1539 AC  32 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1540 AC  32 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1541 AC  32 Inner gimbal axis unit vector x,y,z
1542 AC  32 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
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1543 AC  32 Initial length and rate, y(to) and ydot(to)
1544 AC  32 Constants; K1 or wo, n or zeta, Kg, Jm
1545 AC  32 Non-linearities; TLim, Tco, Dz

1546 AC  33 Actuator ID number                                 33
1547 AC  33 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
1548 AC  33 Actuator location; Node or Hinge (N or H)
1549 AC  33 Mounting point body ID number, node ID number      8,3
1550 AC  33 Second mounting point body ID, second node ID
1551 AC  33 Output axis unit vector x,y,z                      0,0,1
1552 AC  33 Mounting point Hinge index, Axis index
1553 AC  33 Rotor spin axis unit vector x,y,z
1554 AC  33 Initial rotor momentum, H
1555 AC  33 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1556 AC  33 Outer gimbal axis unit vector x,y,z
1557 AC  33 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1558 AC  33 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1559 AC  33 Inner gimbal axis unit vector x,y,z
1560 AC  33 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1561 AC  33 Initial length and rate, y(to) and ydot(to)
1562 AC  33 Constants; K1 or wo, n or zeta, Kg, Jm
1563 AC  33 Non-linearities; TLim, Tco, Dz

1564 AC  34 Actuator ID number                                 34
1565 AC  34 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
1566 AC  34 Actuator location; Node or Hinge (N or H)
1567 AC  34 Mounting point body ID number, node ID number      1,5
1568 AC  34 Second mounting point body ID, second node ID
1569 AC  34 Output axis unit vector x,y,z                      1,0,0
1570 AC  34 Mounting point Hinge index, Axis index
1571 AC  34 Rotor spin axis unit vector x,y,z
1572 AC  34 Initial rotor momentum, H
1573 AC  34 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1574 AC  34 Outer gimbal axis unit vector x,y,z
1575 AC  34 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1576 AC  34 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1577 AC  34 Inner gimbal axis unit vector x,y,z
1578 AC  34 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1579 AC  34 Initial length and rate, y(to) and ydot(to)
1580 AC  34 Constants; K1 or wo, n or zeta, Kg, Jm
1581 AC  34 Non-linearities; TLim, Tco, Dz

1582 AC  35 Actuator ID number                                 35
1583 AC  35 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
1584 AC  35 Actuator location; Node or Hinge (N or H)
1585 AC  35 Mounting point body ID number, node ID number      1,5
1586 AC  35 Second mounting point body ID, second node ID
1587 AC  35 Output axis unit vector x,y,z                      0,1,0
1588 AC  35 Mounting point Hinge index, Axis index
1589 AC  35 Rotor spin axis unit vector x,y,z
1590 AC  35 Initial rotor momentum, H
1591 AC  35 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1592 AC  35 Outer gimbal axis unit vector x,y,z
1593 AC  35 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1594 AC  35 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1595 AC  35 Inner gimbal axis unit vector x,y,z
1596 AC  35 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1597 AC  35 Initial length and rate, y(to) and ydot(to)
1598 AC  35 Constants; K1 or wo, n or zeta, Kg, Jm
1599 AC  35 Non-linearities; TLim, Tco, Dz

1600 AC  36 Actuator ID number                                 36
1601 AC  36 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
1602 AC  36 Actuator location; Node or Hinge (N or H)
1603 AC  36 Mounting point body ID number, node ID number      1,5
1604 AC  36 Second mounting point body ID, second node ID
1605 AC  36 Output axis unit vector x,y,z                      0,0,1
1606 AC  36 Mounting point Hinge index, Axis index
1607 AC  36 Rotor spin axis unit vector x,y,z
1608 AC  36 Initial rotor momentum, H
1609 AC  36 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1610 AC  36 Outer gimbal axis unit vector x,y,z
1611 AC  36 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1612 AC  36 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1613 AC  36 Inner gimbal axis unit vector x,y,z
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1614 AC  36 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1615 AC  36 Initial length and rate, y(to) and ydot(to)
1616 AC  36 Constants; K1 or wo, n or zeta, Kg, Jm
1617 AC  36 Non-linearities; TLim, Tco, Dz

1618 AC  41 Actuator ID number                                41
1619 AC  41 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1620 AC  41 Actuator location; Node or Hinge (N or H)
1621 AC  41 Mounting point body ID number, node ID number     10,3
1622 AC  41 Second mounting point body ID, second node ID
1623 AC  41 Output axis unit vector x,y,z                     1,0,0
1624 AC  41 Mounting point Hinge index, Axis index
1625 AC  41 Rotor spin axis unit vector x,y,z
1626 AC  41 Initial rotor momentum, H
1627 AC  41 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1628 AC  41 Outer gimbal axis unit vector x,y,z
1629 AC  41 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1630 AC  41 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1631 AC  41 Inner gimbal axis unit vector x,y,z
1632 AC  41 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1633 AC  41 Initial length and rate, y(to) and ydot(to)
1634 AC  41 Constants; K1 or wo, n or zeta, Kg, Jm
1635 AC  41 Non-linearities; TLim, Tco, Dz

1636 AC  42 Actuator ID number                                42
1637 AC  42 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1638 AC  42 Actuator location; Node or Hinge (N or H)
1639 AC  42 Mounting point body ID number, node ID number     10,3
1640 AC  42 Second mounting point body ID, second node ID
1641 AC  42 Output axis unit vector x,y,z                     0,1,0
1642 AC  42 Mounting point Hinge index, Axis index
1643 AC  42 Rotor spin axis unit vector x,y,z
1644 AC  42 Initial rotor momentum, H
1645 AC  42 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1646 AC  42 Outer gimbal axis unit vector x,y,z
1647 AC  42 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1648 AC  42 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1649 AC  42 Inner gimbal axis unit vector x,y,z
1650 AC  42 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1651 AC  42 Initial length and rate, y(to) and ydot(to)
1652 AC  42 Constants; K1 or wo, n or zeta, Kg, Jm
1653 AC  42 Non-linearities; TLim, Tco, Dz

1654 AC  43 Actuator ID number                                43
1655 AC  43 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1656 AC  43 Actuator location; Node or Hinge (N or H)
1657 AC  43 Mounting point body ID number, node ID number     10,3
1658 AC  43 Second mounting point body ID, second node ID
1659 AC  43 Output axis unit vector x,y,z                     0,0,1
1660 AC  43 Mounting point Hinge index, Axis index
1661 AC  43 Rotor spin axis unit vector x,y,z
1662 AC  43 Initial rotor momentum, H
1663 AC  43 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1664 AC  43 Outer gimbal axis unit vector x,y,z
1665 AC  43 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1666 AC  43 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1667 AC  43 Inner gimbal axis unit vector x,y,z
1668 AC  43 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1669 AC  43 Initial length and rate, y(to) and ydot(to)
1670 AC  43 Constants; K1 or wo, n or zeta, Kg, Jm
1671 AC  43 Non-linearities; TLim, Tco, Dz

1672 AC  44 Actuator ID number                                44
1673 AC  44 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1674 AC  44 Actuator location; Node or Hinge (N or H)
1675 AC  44 Mounting point body ID number, node ID number     1,6
1676 AC  44 Second mounting point body ID, second node ID
1677 AC  44 Output axis unit vector x,y,z                     1,0,0
1678 AC  44 Mounting point Hinge index, Axis index
1679 AC  44 Rotor spin axis unit vector x,y,z
1680 AC  44 Initial rotor momentum, H
1681 AC  44 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1682 AC  44 Outer gimbal axis unit vector x,y,z
1683 AC  44 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1684 AC  44 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
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1685 AC  44 Inner gimbal axis unit vector x,y,z
1686 AC  44 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1687 AC  44 Initial length and rate, y(to) and ydot(to)
1688 AC  44 Constants; K1 or wo, n or zeta, Kg, Jm
1689 AC  44 Non-linearities; TLim, Tco, Dz

1690 AC  45 Actuator ID number                                   45
1691 AC  45 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
1692 AC  45 Actuator location; Node or Hinge (N or H)
1693 AC  45 Mounting point body ID number, node ID number        1,6
1694 AC  45 Second mounting point body ID, second node ID
1695 AC  45 Output axis unit vector x,y,z                        0,1,0
1696 AC  45 Mounting point Hinge index, Axis index
1697 AC  45 Rotor spin axis unit vector x,y,z
1698 AC  45 Initial rotor momentum, H
1699 AC  45 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1700 AC  45 Outer gimbal axis unit vector x,y,z
1701 AC  45 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1702 AC  45 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1703 AC  45 Inner gimbal axis unit vector x,y,z
1704 AC  45 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1705 AC  45 Initial length and rate, y(to) and ydot(to)
1706 AC  45 Constants; K1 or wo, n or zeta, Kg, Jm
1707 AC  45 Non-linearities; TLim, Tco, Dz

1708 AC  46 Actuator ID number                                   46
1709 AC  46 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
1710 AC  46 Actuator location; Node or Hinge (N or H)
1711 AC  46 Mounting point body ID number, node ID number        1,6
1712 AC  46 Second mounting point body ID, second node ID
1713 AC  46 Output axis unit vector x,y,z                        0,0,1
1714 AC  46 Mounting point Hinge index, Axis index
1715 AC  46 Rotor spin axis unit vector x,y,z
1716 AC  46 Initial rotor momentum, H
1717 AC  46 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1718 AC  46 Outer gimbal axis unit vector x,y,z
1719 AC  46 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1720 AC  46 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1721 AC  46 Inner gimbal axis unit vector x,y,z
1722 AC  46 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1723 AC  46 Initial length and rate, y(to) and ydot(to)
1724 AC  46 Constants; K1 or wo, n or zeta, Kg, Jm
1725 AC  46 Non-linearities; TLim, Tco, Dz

1726 AC  51 Actuator ID number                                   51
1727 AC  51 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
1728 AC  51 Actuator location; Node or Hinge (N or H)
1729 AC  51 Mounting point body ID number, node ID number        12,3
1730 AC  51 Second mounting point body ID, second node ID
1731 AC  51 Output axis unit vector x,y,z                        1,0,0
1732 AC  51 Mounting point Hinge index, Axis index
1733 AC  51 Rotor spin axis unit vector x,y,z
1734 AC  51 Initial rotor momentum, H
1735 AC  51 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1736 AC  51 Outer gimbal axis unit vector x,y,z
1737 AC  51 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1738 AC  51 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1739 AC  51 Inner gimbal axis unit vector x,y,z
1740 AC  51 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1741 AC  51 Initial length and rate, y(to) and ydot(to)
1742 AC  51 Constants; K1 or wo, n or zeta, Kg, Jm
1743 AC  51 Non-linearities; TLim, Tco, Dz

1744 AC  52 Actuator ID number                                   52
1745 AC  52 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
1746 AC  52 Actuator location; Node or Hinge (N or H)
1747 AC  52 Mounting point body ID number, node ID number        12,3
1748 AC  52 Second mounting point body ID, second node ID
1749 AC  52 Output axis unit vector x,y,z                        0,1,0
1750 AC  52 Mounting point Hinge index, Axis index
1751 AC  52 Rotor spin axis unit vector x,y,z
1752 AC  52 Initial rotor momentum, H
1753 AC  52 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1754 AC  52 Outer gimbal axis unit vector x,y,z
1755 AC  52 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
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1756 AC  52 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1757 AC  52 Inner gimbal axis unit vector x,y,z
1758 AC  52 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1759 AC  52 Initial length and rate, y(to) and ydot(to)
1760 AC  52 Constants; K1 or wo, n or zeta, Kg, Jm
1761 AC  52 Non-linearities; TLim, Tco, Dz

1762 AC  53 Actuator ID number                                53
1763 AC  53 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1764 AC  53 Actuator location; Node or Hinge (N or H)
1765 AC  53 Mounting point body ID number, node ID number     12,3
1766 AC  53 Second mounting point body ID, second node ID
1767 AC  53 Output axis unit vector x,y,z                     0,0,1
1768 AC  53 Mounting point Hinge index, Axis index
1769 AC  53 Rotor spin axis unit vector x,y,z
1770 AC  53 Initial rotor momentum, H
1771 AC  53 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1772 AC  53 Outer gimbal axis unit vector x,y,z
1773 AC  53 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1774 AC  53 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1775 AC  53 Inner gimbal axis unit vector x,y,z
1776 AC  53 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1777 AC  53 Initial length and rate, y(to) and ydot(to)
1778 AC  53 Constants; K1 or wo, n or zeta, Kg, Jm
1779 AC  53 Non-linearities; TLim, Tco, Dz

1780 AC  54 Actuator ID number                                54
1781 AC  54 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1782 AC  54 Actuator location; Node or Hinge (N or H)
1783 AC  54 Mounting point body ID number, node ID number     1,7
1784 AC  54 Second mounting point body ID, second node ID
1785 AC  54 Output axis unit vector x,y,z                     1,0,0
1786 AC  54 Mounting point Hinge index, Axis index
1787 AC  54 Rotor spin axis unit vector x,y,z
1788 AC  54 Initial rotor momentum, H
1789 AC  54 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1790 AC  54 Outer gimbal axis unit vector x,y,z
1791 AC  54 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1792 AC  54 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1793 AC  54 Inner gimbal axis unit vector x,y,z
1794 AC  54 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1795 AC  54 Initial length and rate, y(to) and ydot(to)
1796 AC  54 Constants; K1 or wo, n or zeta, Kg, Jm
1797 AC  54 Non-linearities; TLim, Tco, Dz

1798 AC  55 Actuator ID number                                55
1799 AC  55 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1800 AC  55 Actuator location; Node or Hinge (N or H)
1801 AC  55 Mounting point body ID number, node ID number     1,7
1802 AC  55 Second mounting point body ID, second node ID
1803 AC  55 Output axis unit vector x,y,z                     0,1,0
1804 AC  55 Mounting point Hinge index, Axis index
1805 AC  55 Rotor spin axis unit vector x,y,z
1806 AC  55 Initial rotor momentum, H
1807 AC  55 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1808 AC  55 Outer gimbal axis unit vector x,y,z
1809 AC  55 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1810 AC  55 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1811 AC  55 Inner gimbal axis unit vector x,y,z
1812 AC  55 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1813 AC  55 Initial length and rate, y(to) and ydot(to)
1814 AC  55 Constants; K1 or wo, n or zeta, Kg, Jm
1815 AC  55 Non-linearities; TLim, Tco, Dz

1816 AC  56 Actuator ID number                                56
1817 AC  56 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)               MO
1818 AC  56 Actuator location; Node or Hinge (N or H)
1819 AC  56 Mounting point body ID number, node ID number     1,7
1820 AC  56 Second mounting point body ID, second node ID
1821 AC  56 Output axis unit vector x,y,z                     0,0,1
1822 AC  56 Mounting point Hinge index, Axis index
1823 AC  56 Rotor spin axis unit vector x,y,z
1824 AC  56 Initial rotor momentum, H
1825 AC  56 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1826 AC  56 Outer gimbal axis unit vector x,y,z
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1827 AC  56 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1828 AC  56 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1829 AC  56 Inner gimbal axis unit vector x,y,z
1830 AC  56 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1831 AC  56 Initial length and rate, y(to) and ydot(to)
1832 AC  56 Constants; K1 or wo, n or zeta, Kg, Jm
1833 AC  56 Non-linearities; TLim, Tco, Dz

1834 AC  61 Actuator ID number                                  61
1835 AC  61 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1836 AC  61 Actuator location; Node or Hinge (N or H)
1837 AC  61 Mounting point body ID number, node ID number       14,3
1838 AC  61 Second mounting point body ID, second node ID
1839 AC  61 Output axis unit vector x,y,z                       1,0,0
1840 AC  61 Mounting point Hinge index, Axis index
1841 AC  61 Rotor spin axis unit vector x,y,z
1842 AC  61 Initial rotor momentum, H
1843 AC  61 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1844 AC  61 Outer gimbal axis unit vector x,y,z
1845 AC  61 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1846 AC  61 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1847 AC  61 Inner gimbal axis unit vector x,y,z
1848 AC  61 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1849 AC  61 Initial length and rate, y(to) and ydot(to)
1850 AC  61 Constants; K1 or wo, n or zeta, Kg, Jm
1851 AC  61 Non-linearities; TLim, Tco, Dz

1852 AC  62 Actuator ID number                                  62
1853 AC  62 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1854 AC  62 Actuator location; Node or Hinge (N or H)
1855 AC  62 Mounting point body ID number, node ID number       14,3
1856 AC  62 Second mounting point body ID, second node ID
1857 AC  62 Output axis unit vector x,y,z                       0,1,0
1858 AC  62 Mounting point Hinge index, Axis index
1859 AC  62 Rotor spin axis unit vector x,y,z
1860 AC  62 Initial rotor momentum, H
1861 AC  62 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1862 AC  62 Outer gimbal axis unit vector x,y,z
1863 AC  62 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1864 AC  62 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1865 AC  62 Inner gimbal axis unit vector x,y,z
1866 AC  62 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1867 AC  62 Initial length and rate, y(to) and ydot(to)
1868 AC  62 Constants; K1 or wo, n or zeta, Kg, Jm
1869 AC  62 Non-linearities; TLim, Tco, Dz

1870 AC  63 Actuator ID number                                  63
1871 AC  63 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1872 AC  63 Actuator location; Node or Hinge (N or H)
1873 AC  63 Mounting point body ID number, node ID number       14,3
1874 AC  63 Second mounting point body ID, second node ID
1875 AC  63 Output axis unit vector x,y,z                       0,0,1
1876 AC  63 Mounting point Hinge index, Axis index
1877 AC  63 Rotor spin axis unit vector x,y,z
1878 AC  63 Initial rotor momentum, H
1879 AC  63 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1880 AC  63 Outer gimbal axis unit vector x,y,z
1881 AC  63 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1882 AC  63 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1883 AC  63 Inner gimbal axis unit vector x,y,z
1884 AC  63 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1885 AC  63 Initial length and rate, y(to) and ydot(to)
1886 AC  63 Constants; K1 or wo, n or zeta, Kg, Jm
1887 AC  63 Non-linearities; TLim, Tco, Dz

1888 AC  64 Actuator ID number                                  64
1889 AC  64 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1890 AC  64 Actuator location; Node or Hinge (N or H)
1891 AC  64 Mounting point body ID number, node ID number       1,8
1892 AC  64 Second mounting point body ID, second node ID
1893 AC  64 Output axis unit vector x,y,z                       1,0,0
1894 AC  64 Mounting point Hinge index, Axis index
1895 AC  64 Rotor spin axis unit vector x,y,z
1896 AC  64 Initial rotor momentum, H
1897 AC  64 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
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1898 AC  64 Outer gimbal axis unit vector x,y,z
1899 AC  64 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1900 AC  64 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1901 AC  64 Inner gimbal axis unit vector x,y,z
1902 AC  64 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1903 AC  64 Initial length and rate, y(to) and ydot(to)
1904 AC  64 Constants; K1 or wo, n or zeta, Kg, Jm
1905 AC  64 Non-linearities; TLim, Tco, Dz

1906 AC  65 Actuator ID number                                  65
1907 AC  65 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1908 AC  65 Actuator location; Node or Hinge (N or H)
1909 AC  65 Mounting point body ID number, node ID number       1,8
1910 AC  65 Second mounting point body ID, second node ID
1911 AC  65 Output axis unit vector x,y,z                       0,1,0
1912 AC  65 Mounting point Hinge index, Axis index
1913 AC  65 Rotor spin axis unit vector x,y,z
1914 AC  65 Initial rotor momentum, H
1915 AC  65 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1916 AC  65 Outer gimbal axis unit vector x,y,z
1917 AC  65 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1918 AC  65 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1919 AC  65 Inner gimbal axis unit vector x,y,z
1920 AC  65 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1921 AC  65 Initial length and rate, y(to) and ydot(to)
1922 AC  65 Constants; K1 or wo, n or zeta, Kg, Jm
1923 AC  65 Non-linearities; TLim, Tco, Dz

1924 AC  66 Actuator ID number                                  66
1925 AC  66 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1926 AC  66 Actuator location; Node or Hinge (N or H)
1927 AC  66 Mounting point body ID number, node ID number       1,8
1928 AC  66 Second mounting point body ID, second node ID
1929 AC  66 Output axis unit vector x,y,z                       0,0,1
1930 AC  66 Mounting point Hinge index, Axis index
1931 AC  66 Rotor spin axis unit vector x,y,z
1932 AC  66 Initial rotor momentum, H
1933 AC  66 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1934 AC  66 Outer gimbal axis unit vector x,y,z
1935 AC  66 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1936 AC  66 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1937 AC  66 Inner gimbal axis unit vector x,y,z
1938 AC  66 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1939 AC  66 Initial length and rate, y(to) and ydot(to)
1940 AC  66 Constants; K1 or wo, n or zeta, Kg, Jm
1941 AC  66 Non-linearities; TLim, Tco, Dz

1942 AC  71 Actuator ID number                                  71
1943 AC  71 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1944 AC  71 Actuator location; Node or Hinge (N or H)
1945 AC  71 Mounting point body ID number, node ID number       16,3
1946 AC  71 Second mounting point body ID, second node ID
1947 AC  71 Output axis unit vector x,y,z                       1,0,0
1948 AC  71 Mounting point Hinge index, Axis index
1949 AC  71 Rotor spin axis unit vector x,y,z
1950 AC  71 Initial rotor momentum, H
1951 AC  71 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1952 AC  71 Outer gimbal axis unit vector x,y,z
1953 AC  71 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1954 AC  71 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1955 AC  71 Inner gimbal axis unit vector x,y,z
1956 AC  71 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1957 AC  71 Initial length and rate, y(to) and ydot(to)
1958 AC  71 Constants; K1 or wo, n or zeta, Kg, Jm
1959 AC  71 Non-linearities; TLim, Tco, Dz

1960 AC  72 Actuator ID number                                  72
1961 AC  72 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
1962 AC  72 Actuator location; Node or Hinge (N or H)
1963 AC  72 Mounting point body ID number, node ID number       16,3
1964 AC  72 Second mounting point body ID, second node ID
1965 AC  72 Output axis unit vector x,y,z                       0,1,0
1966 AC  72 Mounting point Hinge index, Axis index
1967 AC  72 Rotor spin axis unit vector x,y,z
1968 AC  72 Initial rotor momentum, H
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1969 AC  72 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1970 AC  72 Outer gimbal axis unit vector x,y,z
1971 AC  72 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1972 AC  72 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1973 AC  72 Inner gimbal axis unit vector x,y,z
1974 AC  72 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1975 AC  72 Initial length and rate, y(to) and ydot(to)
1976 AC  72 Constants; K1 or wo, n or zeta, Kg, Jm
1977 AC  72 Non-linearities; TLim, Tco, Dz

1978 AC  73 Actuator ID number                                   73
1979 AC  73 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
1980 AC  73 Actuator location; Node or Hinge (N or H)
1981 AC  73 Mounting point body ID number, node ID number        16,3
1982 AC  73 Second mounting point body ID, second node ID
1983 AC  73 Output axis unit vector x,y,z                        0,0,1
1984 AC  73 Mounting point Hinge index, Axis index
1985 AC  73 Rotor spin axis unit vector x,y,z
1986 AC  73 Initial rotor momentum, H
1987 AC  73 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
1988 AC  73 Outer gimbal axis unit vector x,y,z
1989 AC  73 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1990 AC  73 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
1991 AC  73 Inner gimbal axis unit vector x,y,z
1992 AC  73 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
1993 AC  73 Initial length and rate, y(to) and ydot(to)
1994 AC  73 Constants; K1 or wo, n or zeta, Kg, Jm
1995 AC  73 Non-linearities; TLim, Tco, Dz

1996 AC  74 Actuator ID number                                   74
1997 AC  74 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
1998 AC  74 Actuator location; Node or Hinge (N or H)
1999 AC  74 Mounting point body ID number, node ID number        1,9
2000 AC  74 Second mounting point body ID, second node ID
2001 AC  74 Output axis unit vector x,y,z                        1,0,0
2002 AC  74 Mounting point Hinge index, Axis index
2003 AC  74 Rotor spin axis unit vector x,y,z
2004 AC  74 Initial rotor momentum, H
2005 AC  74 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2006 AC  74 Outer gimbal axis unit vector x,y,z
2007 AC  74 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2008 AC  74 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2009 AC  74 Inner gimbal axis unit vector x,y,z
2010 AC  74 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2011 AC  74 Initial length and rate, y(to) and ydot(to)
2012 AC  74 Constants; K1 or wo, n or zeta, Kg, Jm
2013 AC  74 Non-linearities; TLim, Tco, Dz

2014 AC  75 Actuator ID number                                   75
2015 AC  75 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
2016 AC  75 Actuator location; Node or Hinge (N or H)
2017 AC  75 Mounting point body ID number, node ID number        1,9
2018 AC  75 Second mounting point body ID, second node ID
2019 AC  75 Output axis unit vector x,y,z                        0,1,0
2020 AC  75 Mounting point Hinge index, Axis index
2021 AC  75 Rotor spin axis unit vector x,y,z
2022 AC  75 Initial rotor momentum, H
2023 AC  75 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2024 AC  75 Outer gimbal axis unit vector x,y,z
2025 AC  75 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2026 AC  75 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2027 AC  75 Inner gimbal axis unit vector x,y,z
2028 AC  75 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2029 AC  75 Initial length and rate, y(to) and ydot(to)
2030 AC  75 Constants; K1 or wo, n or zeta, Kg, Jm
2031 AC  75 Non-linearities; TLim, Tco, Dz

2032 AC  76 Actuator ID number                                   76
2033 AC  76 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
2034 AC  76 Actuator location; Node or Hinge (N or H)
2035 AC  76 Mounting point body ID number, node ID number        1,9
2036 AC  76 Second mounting point body ID, second node ID
2037 AC  76 Output axis unit vector x,y,z                        0,0,1
2038 AC  76 Mounting point Hinge index, Axis index
2039 AC  76 Rotor spin axis unit vector x,y,z
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2040 AC  76 Initial rotor momentum, H
2041 AC  76 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2042 AC  76 Outer gimbal axis unit vector x,y,z
2043 AC  76 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2044 AC  76 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2045 AC  76 Inner gimbal axis unit vector x,y,z
2046 AC  76 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2047 AC  76 Initial length and rate, y(to) and ydot(to)
2048 AC  76 Constants; K1 or wo, n or zeta, Kg, Jm
2049 AC  76 Non-linearities; TLim, Tco, Dz

2050 AC  81 Actuator ID number                                 81
2051 AC  81 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
2052 AC  81 Actuator location; Node or Hinge (N or H)
2053 AC  81 Mounting point body ID number, node ID number      18,3
2054 AC  81 Second mounting point body ID, second node ID
2055 AC  81 Output axis unit vector x,y,z                      1,0,0
2056 AC  81 Mounting point Hinge index, Axis index
2057 AC  81 Rotor spin axis unit vector x,y,z
2058 AC  81 Initial rotor momentum, H
2059 AC  81 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2060 AC  81 Outer gimbal axis unit vector x,y,z
2061 AC  81 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2062 AC  81 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2063 AC  81 Inner gimbal axis unit vector x,y,z
2064 AC  81 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2065 AC  81 Initial length and rate, y(to) and ydot(to)
2066 AC  81 Constants; K1 or wo, n or zeta, Kg, Jm
2067 AC  81 Non-linearities; TLim, Tco, Dz

2068 AC  82 Actuator ID number                                 82
2069 AC  82 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
2070 AC  82 Actuator location; Node or Hinge (N or H)
2071 AC  82 Mounting point body ID number, node ID number      18,3
2072 AC  82 Second mounting point body ID, second node ID
2073 AC  82 Output axis unit vector x,y,z                      0,1,0
2074 AC  82 Mounting point Hinge index, Axis index
2075 AC  82 Rotor spin axis unit vector x,y,z
2076 AC  82 Initial rotor momentum, H
2077 AC  82 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2078 AC  82 Outer gimbal axis unit vector x,y,z
2079 AC  82 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2080 AC  82 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2081 AC  82 Inner gimbal axis unit vector x,y,z
2082 AC  82 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2083 AC  82 Initial length and rate, y(to) and ydot(to)
2084 AC  82 Constants; K1 or wo, n or zeta, Kg, Jm
2085 AC  82 Non-linearities; TLim, Tco, Dz

2086 AC  83 Actuator ID number                                 83
2087 AC  83 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
2088 AC  83 Actuator location; Node or Hinge (N or H)
2089 AC  83 Mounting point body ID number, node ID number      18,3
2090 AC  83 Second mounting point body ID, second node ID
2091 AC  83 Output axis unit vector x,y,z                      0,0,1
2092 AC  83 Mounting point Hinge index, Axis index
2093 AC  83 Rotor spin axis unit vector x,y,z
2094 AC  83 Initial rotor momentum, H
2095 AC  83 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2096 AC  83 Outer gimbal axis unit vector x,y,z
2097 AC  83 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2098 AC  83 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2099 AC  83 Inner gimbal axis unit vector x,y,z
2100 AC  83 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2101 AC  83 Initial length and rate, y(to) and ydot(to)
2102 AC  83 Constants; K1 or wo, n or zeta, Kg, Jm
2103 AC  83 Non-linearities; TLim, Tco, Dz

2104 AC  84 Actuator ID number                                 84
2105 AC  84 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
2106 AC  84 Actuator location; Node or Hinge (N or H)
2107 AC  84 Mounting point body ID number, node ID number      1,10
2108 AC  84 Second mounting point body ID, second node ID
2109 AC  84 Output axis unit vector x,y,z                      1,0,0
2110 AC  84 Mounting point Hinge index, Axis index
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2111 AC  84 Rotor spin axis unit vector x,y,z
2112 AC  84 Initial rotor momentum, H
2113 AC  84 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2114 AC  84 Outer gimbal axis unit vector x,y,z
2115 AC  84 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2116 AC  84 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2117 AC  84 Inner gimbal axis unit vector x,y,z
2118 AC  84 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2119 AC  84 Initial length and rate, y(to) and ydot(to)
2120 AC  84 Constants; K1 or wo, n or zeta, Kg, Jm
2121 AC  84 Non-linearities; TLim, Tco, Dz

2122 AC  85 Actuator ID number                                  85
2123 AC  85 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
2124 AC  85 Actuator location; Node or Hinge (N or H)
2125 AC  85 Mounting point body ID number, node ID number       1,10
2126 AC  85 Second mounting point body ID, second node ID
2127 AC  85 Output axis unit vector x,y,z                       0,1,0
2128 AC  85 Mounting point Hinge index, Axis index
2129 AC  85 Rotor spin axis unit vector x,y,z
2130 AC  85 Initial rotor momentum, H
2131 AC  85 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2132 AC  85 Outer gimbal axis unit vector x,y,z
2133 AC  85 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2134 AC  85 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2135 AC  85 Inner gimbal axis unit vector x,y,z
2136 AC  85 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2137 AC  85 Initial length and rate, y(to) and ydot(to)
2138 AC  85 Constants; K1 or wo, n or zeta, Kg, Jm
2139 AC  85 Non-linearities; TLim, Tco, Dz

2140 AC  86 Actuator ID number                                  86
2141 AC  86 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
2142 AC  86 Actuator location; Node or Hinge (N or H)
2143 AC  86 Mounting point body ID number, node ID number       1,10
2144 AC  86 Second mounting point body ID, second node ID
2145 AC  86 Output axis unit vector x,y,z                       0,0,1
2146 AC  86 Mounting point Hinge index, Axis index
2147 AC  86 Rotor spin axis unit vector x,y,z
2148 AC  86 Initial rotor momentum, H
2149 AC  86 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2150 AC  86 Outer gimbal axis unit vector x,y,z
2151 AC  86 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2152 AC  86 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2153 AC  86 Inner gimbal axis unit vector x,y,z
2154 AC  86 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2155 AC  86 Initial length and rate, y(to) and ydot(to)
2156 AC  86 Constants; K1 or wo, n or zeta, Kg, Jm
2157 AC  86 Non-linearities; TLim, Tco, Dz

2158 AC 101 Actuator ID number                                  101
2159 AC 101 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 J
2160 AC 101 Actuator location; Node or Hinge (N or H)
2161 AC 101 Mounting point body ID number, node ID number       3,1
2162 AC 101 Second mounting point body ID, second node ID
2163 AC 101 Output axis unit vector x,y,z                       1,0,0
2164 AC 101 Mounting point Hinge index, Axis index
2165 AC 101 Rotor spin axis unit vector x,y,z
2166 AC 101 Initial rotor momentum, H
2167 AC 101 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2168 AC 101 Outer gimbal axis unit vector x,y,z
2169 AC 101 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2170 AC 101 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2171 AC 101 Inner gimbal axis unit vector x,y,z
2172 AC 101 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2173 AC 101 Initial length and rate, y(to) and ydot(to)
2174 AC 101 Constants; K1 or wo, n or zeta, Kg, Jm
2175 AC 101 Non-linearities; TLim, Tco, Dz

2176 AC 102 Actuator ID number                                  102
2177 AC 102 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 J
2178 AC 102 Actuator location; Node or Hinge (N or H)
2179 AC 102 Mounting point body ID number, node ID number       2,15
2180 AC 102 Second mounting point body ID, second node ID
2181 AC 102 Output axis unit vector x,y,z                       0,1,0
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2182 AC 102 Mounting point Hinge index, Axis index
2183 AC 102 Rotor spin axis unit vector x,y,z
2184 AC 102 Initial rotor momentum, H
2185 AC 102 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2186 AC 102 Outer gimbal axis unit vector x,y,z
2187 AC 102 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2188 AC 102 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2189 AC 102 Inner gimbal axis unit vector x,y,z
2190 AC 102 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2191 AC 102 Initial length and rate, y(to) and ydot(to)
2192 AC 102 Constants; K1 or wo, n or zeta, Kg, Jm
2193 AC 102 Non-linearities; TLim, Tco, Dz

2194 AC 103 Actuator ID number                                103
2195 AC 103 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                J
2196 AC 103 Actuator location; Node or Hinge (N or H)
2197 AC 103 Mounting point body ID number, node ID number     2,15
2198 AC 103 Second mounting point body ID, second node ID
2199 AC 103 Output axis unit vector x,y,z                      0,0,1
2200 AC 103 Mounting point Hinge index, Axis index
2201 AC 103 Rotor spin axis unit vector x,y,z
2202 AC 103 Initial rotor momentum, H
2203 AC 103 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2204 AC 103 Outer gimbal axis unit vector x,y,z
2205 AC 103 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2206 AC 103 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2207 AC 103 Inner gimbal axis unit vector x,y,z
2208 AC 103 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2209 AC 103 Initial length and rate, y(to) and ydot(to)
2210 AC 103 Constants; K1 or wo, n or zeta, Kg, Jm
2211 AC 103 Non-linearities; TLim, Tco, Dz

2212 AC 111 Actuator ID number                                111
2213 AC 111 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                J
2214 AC 111 Actuator location; Node or Hinge (N or H)
2215 AC 111 Mounting point body ID number, node ID number     1,1
2216 AC 111 Second mounting point body ID, second node ID
2217 AC 111 Output axis unit vector x,y,z                      1,0,0
2218 AC 111 Mounting point Hinge index, Axis index
2219 AC 111 Rotor spin axis unit vector x,y,z
2220 AC 111 Initial rotor momentum, H
2221 AC 111 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2222 AC 111 Outer gimbal axis unit vector x,y,z
2223 AC 111 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2224 AC 111 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2225 AC 111 Inner gimbal axis unit vector x,y,z
2226 AC 111 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2227 AC 111 Initial length and rate, y(to) and ydot(to)
2228 AC 111 Constants; K1 or wo, n or zeta, Kg, Jm
2229 AC 111 Non-linearities; TLim, Tco, Dz

2230 AC 112 Actuator ID number                                112
2231 AC 112 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                J
2232 AC 112 Actuator location; Node or Hinge (N or H)
2233 AC 112 Mounting point body ID number, node ID number     1,1
2234 AC 112 Second mounting point body ID, second node ID
2235 AC 112 Output axis unit vector x,y,z                      0,1,0
2236 AC 112 Mounting point Hinge index, Axis index
2237 AC 112 Rotor spin axis unit vector x,y,z
2238 AC 112 Initial rotor momentum, H
2239 AC 112 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2240 AC 112 Outer gimbal axis unit vector x,y,z
2241 AC 112 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2242 AC 112 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2243 AC 112 Inner gimbal axis unit vector x,y,z
2244 AC 112 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2245 AC 112 Initial length and rate, y(to) and ydot(to)
2246 AC 112 Constants; K1 or wo, n or zeta, Kg, Jm
2247 AC 112 Non-linearities; TLim, Tco, Dz

2248 AC 113 Actuator ID number                                113
2249 AC 113 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                J
2250 AC 113 Actuator location; Node or Hinge (N or H)
2251 AC 113 Mounting point body ID number, node ID number     1,1
2252 AC 113 Second mounting point body ID, second node ID
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2253 AC 113 Output axis unit vector x,y,z                          0,0,1
2254 AC 113 Mounting point Hinge index, Axis index
2255 AC 113 Rotor spin axis unit vector x,y,z
2256 AC 113 Initial rotor momentum, H
2257 AC 113 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2258 AC 113 Outer gimbal axis unit vector x,y,z
2259 AC 113 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2260 AC 113 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2261 AC 113 Inner gimbal axis unit vector x,y,z
2262 AC 113 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2263 AC 113 Initial length and rate, y(to) and ydot(to)
2264 AC 113 Constants; K1 or wo, n or zeta, Kg, Jm
2265 AC 113 Non-linearities; TLim, Tco, Dz

2266 AC 201 Actuator ID number                                     201
2267 AC 201 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                    J
2268 AC 201 Actuator location; Node or Hinge (N or H)
2269 AC 201 Mounting point body ID number, node ID number          5,1
2270 AC 201 Second mounting point body ID, second node ID
2271 AC 201 Output axis unit vector x,y,z                          1,0,0
2272 AC 201 Mounting point Hinge index, Axis index
2273 AC 201 Rotor spin axis unit vector x,y,z
2274 AC 201 Initial rotor momentum, H
2275 AC 201 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2276 AC 201 Outer gimbal axis unit vector x,y,z
2277 AC 201 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2278 AC 201 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2279 AC 201 Inner gimbal axis unit vector x,y,z
2280 AC 201 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2281 AC 201 Initial length and rate, y(to) and ydot(to)
2282 AC 201 Constants; K1 or wo, n or zeta, Kg, Jm
2283 AC 201 Non-linearities; TLim, Tco, Dz

2284 AC 202 Actuator ID number                                     202
2285 AC 202 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                    J
2286 AC 202 Actuator location; Node or Hinge (N or H)
2287 AC 202 Mounting point body ID number, node ID number          2,16
2288 AC 202 Second mounting point body ID, second node ID
2289 AC 202 Output axis unit vector x,y,z                          0,1,0
2290 AC 202 Mounting point Hinge index, Axis index
2291 AC 202 Rotor spin axis unit vector x,y,z
2292 AC 202 Initial rotor momentum, H
2293 AC 202 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2294 AC 202 Outer gimbal axis unit vector x,y,z
2295 AC 202 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2296 AC 202 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2297 AC 202 Inner gimbal axis unit vector x,y,z
2298 AC 202 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2299 AC 202 Initial length and rate, y(to) and ydot(to)
2300 AC 202 Constants; K1 or wo, n or zeta, Kg, Jm
2301 AC 202 Non-linearities; TLim, Tco, Dz

2302 AC 203 Actuator ID number                                     203
2303 AC 203 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                    J
2304 AC 203 Actuator location; Node or Hinge (N or H)
2305 AC 203 Mounting point body ID number, node ID number          2,16
2306 AC 203 Second mounting point body ID, second node ID
2307 AC 203 Output axis unit vector x,y,z                          0,0,1
2308 AC 203 Mounting point Hinge index, Axis index
2309 AC 203 Rotor spin axis unit vector x,y,z
2310 AC 203 Initial rotor momentum, H
2311 AC 203 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2312 AC 203 Outer gimbal axis unit vector x,y,z
2313 AC 203 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2314 AC 203 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2315 AC 203 Inner gimbal axis unit vector x,y,z
2316 AC 203 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2317 AC 203 Initial length and rate, y(to) and ydot(to)
2318 AC 203 Constants; K1 or wo, n or zeta, Kg, Jm
2319 AC 203 Non-linearities; TLim, Tco, Dz

2320 AC 301 Actuator ID number                                     301
2321 AC 301 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                    J
2322 AC 301 Actuator location; Node or Hinge (N or H)
2323 AC 301 Mounting point body ID number, node ID number          7,1
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2324 AC 301 Second mounting point body ID, second node ID
2325 AC 301 Output axis unit vector x,y,z                         1,0,0
2326 AC 301 Mounting point Hinge index, Axis index
2327 AC 301 Rotor spin axis unit vector x,y,z
2328 AC 301 Initial rotor momentum, H
2329 AC 301 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2330 AC 301 Outer gimbal axis unit vector x,y,z
2331 AC 301 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2332 AC 301 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2333 AC 301 Inner gimbal axis unit vector x,y,z
2334 AC 301 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2335 AC 301 Initial length and rate, y(to) and ydot(to)
2336 AC 301 Constants; K1 or wo, n or zeta, Kg, Jm
2337 AC 301 Non-linearities; TLim, Tco, Dz

2338 AC 302 Actuator ID number                                    302
2339 AC 302 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                   J
2340 AC 302 Actuator location; Node or Hinge (N or H)
2341 AC 302 Mounting point body ID number, node ID number         2,17
2342 AC 302 Second mounting point body ID, second node ID
2343 AC 302 Output axis unit vector x,y,z                         0,1,0
2344 AC 302 Mounting point Hinge index, Axis index
2345 AC 302 Rotor spin axis unit vector x,y,z
2346 AC 302 Initial rotor momentum, H
2347 AC 302 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2348 AC 302 Outer gimbal axis unit vector x,y,z
2349 AC 302 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2350 AC 302 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2351 AC 302 Inner gimbal axis unit vector x,y,z
2352 AC 302 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2353 AC 302 Initial length and rate, y(to) and ydot(to)
2354 AC 302 Constants; K1 or wo, n or zeta, Kg, Jm
2355 AC 302 Non-linearities; TLim, Tco, Dz

2356 AC 303 Actuator ID number                                    303
2357 AC 303 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                   J
2358 AC 303 Actuator location; Node or Hinge (N or H)
2359 AC 303 Mounting point body ID number, node ID number         2,17
2360 AC 303 Second mounting point body ID, second node ID
2361 AC 303 Output axis unit vector x,y,z                         0,0,1
2362 AC 303 Mounting point Hinge index, Axis index
2363 AC 303 Rotor spin axis unit vector x,y,z
2364 AC 303 Initial rotor momentum, H
2365 AC 303 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2366 AC 303 Outer gimbal axis unit vector x,y,z
2367 AC 303 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2368 AC 303 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2369 AC 303 Inner gimbal axis unit vector x,y,z
2370 AC 303 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2371 AC 303 Initial length and rate, y(to) and ydot(to)
2372 AC 303 Constants; K1 or wo, n or zeta, Kg, Jm
2373 AC 303 Non-linearities; TLim, Tco, Dz

2374 AC 401 Actuator ID number                                    401
2375 AC 401 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                   J
2376 AC 401 Actuator location; Node or Hinge (N or H)
2377 AC 401 Mounting point body ID number, node ID number         9,1
2378 AC 401 Second mounting point body ID, second node ID
2379 AC 401 Output axis unit vector x,y,z                         1,0,0
2380 AC 401 Mounting point Hinge index, Axis index
2381 AC 401 Rotor spin axis unit vector x,y,z
2382 AC 401 Initial rotor momentum, H
2383 AC 401 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2384 AC 401 Outer gimbal axis unit vector x,y,z
2385 AC 401 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2386 AC 401 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2387 AC 401 Inner gimbal axis unit vector x,y,z
2388 AC 401 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2389 AC 401 Initial length and rate, y(to) and ydot(to)
2390 AC 401 Constants; K1 or wo, n or zeta, Kg, Jm
2391 AC 401 Non-linearities; TLim, Tco, Dz

2392 AC 402 Actuator ID number                                    402
2393 AC 402 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                   J
2394 AC 402 Actuator location; Node or Hinge (N or H)
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2395 AC 402 Mounting point body ID number, node ID number      2,18
2396 AC 402 Second mounting point body ID, second node ID
2397 AC 402 Output axis unit vector x,y,z                      0,1,0
2398 AC 402 Mounting point Hinge index, Axis index
2399 AC 402 Rotor spin axis unit vector x,y,z
2400 AC 402 Initial rotor momentum, H
2401 AC 402 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2402 AC 402 Outer gimbal axis unit vector x,y,z
2403 AC 402 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2404 AC 402 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2405 AC 402 Inner gimbal axis unit vector x,y,z
2406 AC 402 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2407 AC 402 Initial length and rate, y(to) and ydot(to)
2408 AC 402 Constants; K1 or wo, n or zeta, Kg, Jm
2409 AC 402 Non-linearities; TLim, Tco, Dz

2410 AC 403 Actuator ID number                                 403
2411 AC 403 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 J
2412 AC 403 Actuator location; Node or Hinge (N or H)
2413 AC 403 Mounting point body ID number, node ID number      2,18
2414 AC 403 Second mounting point body ID, second node ID
2415 AC 403 Output axis unit vector x,y,z                      0,0,1
2416 AC 403 Mounting point Hinge index, Axis index
2417 AC 403 Rotor spin axis unit vector x,y,z
2418 AC 403 Initial rotor momentum, H
2419 AC 403 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2420 AC 403 Outer gimbal axis unit vector x,y,z
2421 AC 403 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2422 AC 403 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2423 AC 403 Inner gimbal axis unit vector x,y,z
2424 AC 403 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2425 AC 403 Initial length and rate, y(to) and ydot(to)
2426 AC 403 Constants; K1 or wo, n or zeta, Kg, Jm
2427 AC 403 Non-linearities; TLim, Tco, Dz

2428 AC 501 Actuator ID number                                 501
2429 AC 501 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 J
2430 AC 501 Actuator location; Node or Hinge (N or H)
2431 AC 501 Mounting point body ID number, node ID number      11,1
2432 AC 501 Second mounting point body ID, second node ID
2433 AC 501 Output axis unit vector x,y,z                      1,0,0
2434 AC 501 Mounting point Hinge index, Axis index
2435 AC 501 Rotor spin axis unit vector x,y,z
2436 AC 501 Initial rotor momentum, H
2437 AC 501 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2438 AC 501 Outer gimbal axis unit vector x,y,z
2439 AC 501 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2440 AC 501 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2441 AC 501 Inner gimbal axis unit vector x,y,z
2442 AC 501 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2443 AC 501 Initial length and rate, y(to) and ydot(to)
2444 AC 501 Constants; K1 or wo, n or zeta, Kg, Jm
2445 AC 501 Non-linearities; TLim, Tco, Dz

2446 AC 502 Actuator ID number                                 502
2447 AC 502 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 J
2448 AC 502 Actuator location; Node or Hinge (N or H)
2449 AC 502 Mounting point body ID number, node ID number      2,19
2450 AC 502 Second mounting point body ID, second node ID
2451 AC 502 Output axis unit vector x,y,z                      1,0,0
2452 AC 502 Mounting point Hinge index, Axis index
2453 AC 502 Rotor spin axis unit vector x,y,z
2454 AC 502 Initial rotor momentum, H
2455 AC 502 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2456 AC 502 Outer gimbal axis unit vector x,y,z
2457 AC 502 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2458 AC 502 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2459 AC 502 Inner gimbal axis unit vector x,y,z
2460 AC 502 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2461 AC 502 Initial length and rate, y(to) and ydot(to)
2462 AC 502 Constants; K1 or wo, n or zeta, Kg, Jm
2463 AC 502 Non-linearities; TLim, Tco, Dz

2464 AC 503 Actuator ID number                                 503
2465 AC 503 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 J
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2466 AC 503 Actuator location; Node or Hinge (N or H)
2467 AC 503 Mounting point body ID number, node ID number      2,19
2468 AC 503 Second mounting point body ID, second node ID
2469 AC 503 Output axis unit vector x,y,z                      0,1,0
2470 AC 503 Mounting point Hinge index, Axis index
2471 AC 503 Rotor spin axis unit vector x,y,z
2472 AC 503 Initial rotor momentum, H
2473 AC 503 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2474 AC 503 Outer gimbal axis unit vector x,y,z
2475 AC 503 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2476 AC 503 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2477 AC 503 Inner gimbal axis unit vector x,y,z
2478 AC 503 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2479 AC 503 Initial length and rate, y(to) and ydot(to)
2480 AC 503 Constants; K1 or wo, n or zeta, Kg, Jm
2481 AC 503 Non-linearities; TLim, Tco, Dz

2482 AC 601 Actuator ID number                                 601
2483 AC 601 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                J
2484 AC 601 Actuator location; Node or Hinge (N or H)
2485 AC 601 Mounting point body ID number, node ID number      13,1
2486 AC 601 Second mounting point body ID, second node ID
2487 AC 601 Output axis unit vector x,y,z                      1,0,0
2488 AC 601 Mounting point Hinge index, Axis index
2489 AC 601 Rotor spin axis unit vector x,y,z
2490 AC 601 Initial rotor momentum, H
2491 AC 601 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2492 AC 601 Outer gimbal axis unit vector x,y,z
2493 AC 601 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2494 AC 601 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2495 AC 601 Inner gimbal axis unit vector x,y,z
2496 AC 601 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2497 AC 601 Initial length and rate, y(to) and ydot(to)
2498 AC 601 Constants; K1 or wo, n or zeta, Kg, Jm
2499 AC 601 Non-linearities; TLim, Tco, Dz

2500 AC 602 Actuator ID number                                 602
2501 AC 602 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                J
2502 AC 602 Actuator location; Node or Hinge (N or H)
2503 AC 602 Mounting point body ID number, node ID number      2,20
2504 AC 602 Second mounting point body ID, second node ID
2505 AC 602 Output axis unit vector x,y,z                      1,0,0
2506 AC 602 Mounting point Hinge index, Axis index
2507 AC 602 Rotor spin axis unit vector x,y,z
2508 AC 602 Initial rotor momentum, H
2509 AC 602 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2510 AC 602 Outer gimbal axis unit vector x,y,z
2511 AC 602 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2512 AC 602 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2513 AC 602 Inner gimbal axis unit vector x,y,z
2514 AC 602 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2515 AC 602 Initial length and rate, y(to) and ydot(to)
2516 AC 602 Constants; K1 or wo, n or zeta, Kg, Jm
2517 AC 602 Non-linearities; TLim, Tco, Dz

2518 AC 603 Actuator ID number                                 603
2519 AC 603 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                J
2520 AC 603 Actuator location; Node or Hinge (N or H)
2521 AC 603 Mounting point body ID number, node ID number      2,20
2522 AC 603 Second mounting point body ID, second node ID
2523 AC 603 Output axis unit vector x,y,z                      0,1,0
2524 AC 603 Mounting point Hinge index, Axis index
2525 AC 603 Rotor spin axis unit vector x,y,z
2526 AC 603 Initial rotor momentum, H
2527 AC 603 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2528 AC 603 Outer gimbal axis unit vector x,y,z
2529 AC 603 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2530 AC 603 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2531 AC 603 Inner gimbal axis unit vector x,y,z
2532 AC 603 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2533 AC 603 Initial length and rate, y(to) and ydot(to)
2534 AC 603 Constants; K1 or wo, n or zeta, Kg, Jm
2535 AC 603 Non-linearities; TLim, Tco, Dz

2536 AC 701 Actuator ID number                                 701
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2537 AC 701 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  J
2538 AC 701 Actuator location; Node or Hinge (N or H)
2539 AC 701 Mounting point body ID number, node ID number        15,1
2540 AC 701 Second mounting point body ID, second node ID
2541 AC 701 Output axis unit vector x,y,z                        1,0,0
2542 AC 701 Mounting point Hinge index, Axis index
2543 AC 701 Rotor spin axis unit vector x,y,z
2544 AC 701 Initial rotor momentum, H
2545 AC 701 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2546 AC 701 Outer gimbal axis unit vector x,y,z
2547 AC 701 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2548 AC 701 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2549 AC 701 Inner gimbal axis unit vector x,y,z
2550 AC 701 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2551 AC 701 Initial length and rate, y(to) and ydot(to)
2552 AC 701 Constants; K1 or wo, n or zeta, Kg, Jm
2553 AC 701 Non-linearities; TLim, Tco, Dz

2554 AC 702 Actuator ID number                                   702
2555 AC 702 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  J
2556 AC 702 Actuator location; Node or Hinge (N or H)
2557 AC 702 Mounting point body ID number, node ID number        2,21
2558 AC 702 Second mounting point body ID, second node ID
2559 AC 702 Output axis unit vector x,y,z                        1,0,0
2560 AC 702 Mounting point Hinge index, Axis index
2561 AC 702 Rotor spin axis unit vector x,y,z
2562 AC 702 Initial rotor momentum, H
2563 AC 702 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2564 AC 702 Outer gimbal axis unit vector x,y,z
2565 AC 702 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2566 AC 702 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2567 AC 702 Inner gimbal axis unit vector x,y,z
2568 AC 702 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2569 AC 702 Initial length and rate, y(to) and ydot(to)
2570 AC 702 Constants; K1 or wo, n or zeta, Kg, Jm
2571 AC 702 Non-linearities; TLim, Tco, Dz

2572 AC 703 Actuator ID number                                   703
2573 AC 703 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  J
2574 AC 703 Actuator location; Node or Hinge (N or H)
2575 AC 703 Mounting point body ID number, node ID number        2,21
2576 AC 703 Second mounting point body ID, second node ID
2577 AC 703 Output axis unit vector x,y,z                        0,1,0
2578 AC 703 Mounting point Hinge index, Axis index
2579 AC 703 Rotor spin axis unit vector x,y,z
2580 AC 703 Initial rotor momentum, H
2581 AC 703 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2582 AC 703 Outer gimbal axis unit vector x,y,z
2583 AC 703 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2584 AC 703 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2585 AC 703 Inner gimbal axis unit vector x,y,z
2586 AC 703 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2587 AC 703 Initial length and rate, y(to) and ydot(to)
2588 AC 703 Constants; K1 or wo, n or zeta, Kg, Jm
2589 AC 703 Non-linearities; TLim, Tco, Dz

2590 AC 801 Actuator ID number                                   801
2591 AC 801 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  J
2592 AC 801 Actuator location; Node or Hinge (N or H)
2593 AC 801 Mounting point body ID number, node ID number        17,1
2594 AC 801 Second mounting point body ID, second node ID
2595 AC 801 Output axis unit vector x,y,z                        1,0,0
2596 AC 801 Mounting point Hinge index, Axis index
2597 AC 801 Rotor spin axis unit vector x,y,z
2598 AC 801 Initial rotor momentum, H
2599 AC 801 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2600 AC 801 Outer gimbal axis unit vector x,y,z
2601 AC 801 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2602 AC 801 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2603 AC 801 Inner gimbal axis unit vector x,y,z
2604 AC 801 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2605 AC 801 Initial length and rate, y(to) and ydot(to)
2606 AC 801 Constants; K1 or wo, n or zeta, Kg, Jm
2607 AC 801 Non-linearities; TLim, Tco, Dz
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2608 AC 802 Actuator ID number                                  802
2609 AC 802 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 J
2610 AC 802 Actuator location; Node or Hinge (N or H)
2611 AC 802 Mounting point body ID number, node ID number       2,22
2612 AC 802 Second mounting point body ID, second node ID
2613 AC 802 Output axis unit vector x,y,z                       1,0,0
2614 AC 802 Mounting point Hinge index, Axis index
2615 AC 802 Rotor spin axis unit vector x,y,z
2616 AC 802 Initial rotor momentum, H
2617 AC 802 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2618 AC 802 Outer gimbal axis unit vector x,y,z
2619 AC 802 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2620 AC 802 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2621 AC 802 Inner gimbal axis unit vector x,y,z
2622 AC 802 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2623 AC 802 Initial length and rate, y(to) and ydot(to)
2624 AC 802 Constants; K1 or wo, n or zeta, Kg, Jm
2625 AC 802 Non-linearities; TLim, Tco, Dz

2626 AC 803 Actuator ID number                                  803
2627 AC 803 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 J
2628 AC 803 Actuator location; Node or Hinge (N or H)
2629 AC 803 Mounting point body ID number, node ID number       2,22
2630 AC 803 Second mounting point body ID, second node ID
2631 AC 803 Output axis unit vector x,y,z                       0,1,0
2632 AC 803 Mounting point Hinge index, Axis index
2633 AC 803 Rotor spin axis unit vector x,y,z
2634 AC 803 Initial rotor momentum, H
2635 AC 803 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
2636 AC 803 Outer gimbal axis unit vector x,y,z
2637 AC 803 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2638 AC 803 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
2639 AC 803 Inner gimbal axis unit vector x,y,z
2640 AC 803 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
2641 AC 803 Initial length and rate, y(to) and ydot(to)
2642 AC 803 Constants; K1 or wo, n or zeta, Kg, Jm
2643 AC 803 Non-linearities; TLim, Tco, Dz

            CONTROLLER

2644 CO   1 Controller ID number                                1
2645 CO   1 Controller type (CB,CM,DB,DM,UC,UD)                 CB
2646 CO   1 Sample time (sec)
2647 CO   1 Number of inputs, Number of outputs                 18,6
2648 CO   1 Number of states
2649 CO   1 Output No., Input type (I,S,T), Input ID, Gain      1,S,101,1
2650 CO   1 Output No., Input type (I,S,T), Input ID, Gain      2,S,102,1
2651 CO   1 Output No., Input type (I,S,T), Input ID, Gain      3,S,103,1
2652 CO   1 Output No., Input type (I,S,T), Input ID, Gain      4,S,104,1
2653 CO   1 Output No., Input type (I,S,T), Input ID, Gain      5,S,105,1
2654 CO   1 Output No., Input type (I,S,T), Input ID, Gain      6,S,106,1

2655 CO   2 Controller ID number                                2
2656 CO   2 Controller type (CB,CM,DB,DM,UC,UD)                 UC
2657 CO   2 Sample time (sec)
2658 CO   2 Number of inputs, Number of outputs                 14,42
2659 CO   2 Number of states                                    0
2660 CO   2 Output No., Input type (I,S,T), Input ID, Gain

            SUMM JUNC

2661 SU 101 Summing junction ID number                          101
2662 SU 101 Controller ID number                                1
2663 SU 101 Number of inputs to summing junction                3
2664 SU 101 Input number,Input type(I,S,T),Input ID no,Gain     1,T,102,840.
2665 SU 101 Input number,Input type(I,S,T),Input ID no,Gain     2,T,11,840.
2666 SU 101 Input number,Input type(I,S,T),Input ID no,Gain     3,I,13,1

2667 SU 102 Summing junction ID number                          102
2668 SU 102 Controller ID number                                1
2669 SU 102 Number of inputs to summing junction                3
2670 SU 102 Input number,Input type(I,S,T),Input ID no,Gain     1,T,202,840.
2671 SU 102 Input number,Input type(I,S,T),Input ID no,Gain     2,T,12,840.
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2672 SU 102 Input number,Input type(I,S,T),Input ID no,Gain    3,I,14,1

2673 SU 103 Summing junction ID number                         103
2674 SU 103 Controller ID number                               1
2675 SU 103 Number of inputs to summing junction               3
2676 SU 103 Input number,Input type(I,S,T),Input ID no,Gain    1,T,302,840.
2677 SU 103 Input number,Input type(I,S,T),Input ID no,Gain    2,T,13,840.
2678 SU 103 Input number,Input type(I,S,T),Input ID no,Gain    3,I,15,1

2679 SU 104 Summing junction ID number                         104
2680 SU 104 Controller ID number                               1
2681 SU 104 Number of inputs to summing junction               3
2682 SU 104 Input number,Input type(I,S,T),Input ID no,Gain    1,T,402,208.7974
2683 SU 104 Input number,Input type(I,S,T),Input ID no,Gain    2,T,14,208.7974
2684 SU 104 Input number,Input type(I,S,T),Input ID no,Gain    3,I,16,1

2685 SU 105 Summing junction ID number                         105
2686 SU 105 Controller ID number                               1
2687 SU 105 Number of inputs to summing junction               3
2688 SU 105 Input number,Input type(I,S,T),Input ID no,Gain    1,T,503,227.7789
2689 SU 105 Input number,Input type(I,S,T),Input ID no,Gain    2,T,15,227.7789
2690 SU 105 Input number,Input type(I,S,T),Input ID no,Gain    3,I,17,1

2691 SU 106 Summing junction ID number                         106
2692 SU 106 Controller ID number                               1
2693 SU 106 Number of inputs to summing junction               3
2694 SU 106 Input number,Input type(I,S,T),Input ID no,Gain    1,T,603,96.2637
2695 SU 106 Input number,Input type(I,S,T),Input ID no,Gain    2,T,16,96.2637
2696 SU 106 Input number,Input type(I,S,T),Input ID no,Gain    3,I,18,1

            TRANSFER FUN

2697 TR  11 Transfer function ID number                        11
2698 TR  11 Controller ID number                               1
2699 TR  11 Input type (I,S or T), Input ID number             I,7
2700 TR  11 Order of numerator                                 2
2701 TR  11 Numerator coefficients (4 per line max)            0.000071 0.002404 0.41688
2702 TR  11 Order of denominator                               3
2703 TR  11 Denominator coefficients (4 per line max)          0 0.003948 0.12566 1
2704 TR  11 Transfer function gain                             1

2705 TR  12 Transfer function ID number                        12
2706 TR  12 Controller ID number                               1
2707 TR  12 Input type (I,S or T), Input ID number             I,8
2708 TR  12 Order of numerator                                 2
2709 TR  12 Numerator coefficients (4 per line max)            0.000071 0.002404 0.41688
2710 TR  12 Order of denominator                               3
2711 TR  12 Denominator coefficients (4 per line max)          0 0.003948 0.12566 1
2712 TR  12 Transfer function gain                             1

2713 TR  13 Transfer function ID number                        13
2714 TR  13 Controller ID number                               1
2715 TR  13 Input type (I,S or T), Input ID number             I,9
2716 TR  13 Order of numerator                                 2
2717 TR  13 Numerator coefficients (4 per line max)            0.000071 0.002404 0.41688
2718 TR  13 Order of denominator                               3
2719 TR  13 Denominator coefficients (4 per line max)          0 0.003948 0.12566 1
2720 TR  13 Transfer function gain                             1

2721 TR  14 Transfer function ID number                        14
2722 TR  14 Controller ID number                               1
2723 TR  14 Input type (I,S or T), Input ID number             I,10
2724 TR  14 Order of numerator                                 2
2725 TR  14 Numerator coefficients (4 per line max)            0.000071 0.002404 0.41688
2726 TR  14 Order of denominator                               3
2727 TR  14 Denominator coefficients (4 per line max)          0 0.003948 0.12566 1
2728 TR  14 Transfer function gain                             1

2729 TR  15 Transfer function ID number                        15
2730 TR  15 Controller ID number                               1
2731 TR  15 Input type (I,S or T), Input ID number             I,11
2732 TR  15 Order of numerator                                 2
2733 TR  15 Numerator coefficients (4 per line max)            0.000071 0.002404 0.41688
2734 TR  15 Order of denominator                               3
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2735 TR  15 Denominator coefficients (4 per line max)      0 0.003948 0.12566 1
2736 TR  15 Transfer function gain                         1

2737 TR  16 Transfer function ID number                    16
2738 TR  16 Controller ID number                           1
2739 TR  16 Input type (I,S or T), Input ID number         I,12
2740 TR  16 Order of numerator                             2
2741 TR  16 Numerator coefficients (4 per line max)        0.000071 0.002404 0.41688
2742 TR  16 Order of denominator                           3
2743 TR  16 Denominator coefficients (4 per line max)      0 0.003948 0.12566 1
2744 TR  16 Transfer function gain                         1

2745 TR 101 Transfer function ID number                    101
2746 TR 101 Controller ID number                           1
2747 TR 101 Input type (I,S or T), Input ID number         I,1
2748 TR 101 Order of numerator                             2
2749 TR 101 Numerator coefficients (4 per line max)        0.0675 0.6 1
2750 TR 101 Order of denominator                           3
2751 TR 101 Denominator coefficients (4 per line max)      0.0019 0.0672 0.65 1
2752 TR 101 Transfer function gain                         16

2753 TR 102 Transfer function ID number                    102
2754 TR 102 Controller ID number                           1
2755 TR 102 Input type (I,S or T), Input ID number         T,101
2756 TR 102 Order of numerator                             0
2757 TR 102 Numerator coefficients (4 per line max)        2304
2758 TR 102 Order of denominator                           2
2759 TR 102 Denominator coefficients (4 per line max)      2304 57.6 1
2760 TR 102 Transfer function gain                         1.

2761 TR 201 Transfer function ID number                    201
2762 TR 201 Controller ID number                           1
2763 TR 201 Input type (I,S or T), Input ID number         I,2
2764 TR 201 Order of numerator                             2
2765 TR 201 Numerator coefficients (4 per line max)        0.0675 0.6 1
2766 TR 201 Order of denominator                           3
2767 TR 201 Denominator coefficients (4 per line max)      0.0019 0.0672 0.65 1
2768 TR 201 Transfer function gain                         16

2769 TR 202 Transfer function ID number                    202
2770 TR 202 Controller ID number                           1
2771 TR 202 Input type (I,S or T), Input ID number         T,201
2772 TR 202 Order of numerator                             0
2773 TR 202 Numerator coefficients (4 per line max)        2304
2774 TR 202 Order of denominator                           2
2775 TR 202 Denominator coefficients (4 per line max)      2304 57.6 1
2776 TR 202 Transfer function gain                         1.

2777 TR 301 Transfer function ID number                    301
2778 TR 301 Controller ID number                           1
2779 TR 301 Input type (I,S or T), Input ID number         I,3
2780 TR 301 Order of numerator                             2
2781 TR 301 Numerator coefficients (4 per line max)        0.0675 0.6 1
2782 TR 301 Order of denominator                           3
2783 TR 301 Denominator coefficients (4 per line max)      0.0019 0.0672 0.65 1
2784 TR 301 Transfer function gain                         16

2785 TR 302 Transfer function ID number                    302
2786 TR 302 Controller ID number                           1
2787 TR 302 Input type (I,S or T), Input ID number         T,301
2788 TR 302 Order of numerator                             0
2789 TR 302 Numerator coefficients (4 per line max)        2304
2790 TR 302 Order of denominator                           2
2791 TR 302 Denominator coefficients (4 per line max)      2304 57.6 1
2792 TR 302 Transfer function gain                         1.

2793 TR 401 Transfer function ID number                    401
2794 TR 401 Controller ID number                           1
2795 TR 401 Input type (I,S or T), Input ID number         I,4
2796 TR 401 Order of numerator                             2
2797 TR 401 Numerator coefficients (4 per line max)        0.0675 0.6 1
2798 TR 401 Order of denominator                           3
2799 TR 401 Denominator coefficients (4 per line max)      0.0019 0.0672 0.65 1
2800 TR 401 Transfer function gain                         16
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2801 TR 402 Transfer function ID number                      402
2802 TR 402 Controller ID number                             1
2803 TR 402 Input type (I,S or T), Input ID number           T,401
2804 TR 402 Order of numerator                               0
2805 TR 402 Numerator coefficients (4 per line max)          2304
2806 TR 402 Order of denominator                             2
2807 TR 402 Denominator coefficients (4 per line max)        2304 57.6 1
2808 TR 402 Transfer function gain                           1.

2809 TR 501 Transfer function ID number                      501
2810 TR 501 Controller ID number                             1
2811 TR 501 Input type (I,S or T), Input ID number           I,5
2812 TR 501 Order of numerator                               2
2813 TR 501 Numerator coefficients (4 per line max)          0.0675 0.6 1
2814 TR 501 Order of denominator                             3
2815 TR 501 Denominator coefficients (4 per line max)        0.0019 0.0672 0.65 1
2816 TR 501 Transfer function gain                           16

2817 TR 502 Transfer function ID number                      502
2818 TR 502 Controller ID number                             1
2819 TR 502 Input type (I,S or T), Input ID number           T,501
2820 TR 502 Order of numerator                               0
2821 TR 502 Numerator coefficients (4 per line max)          2304
2822 TR 502 Order of denominator                             2
2823 TR 502 Denominator coefficients (4 per line max)        2304 57.6 1
2824 TR 502 Transfer function gain                           1.

2825 TR 503 Transfer function ID number                      503
2826 TR 503 Controller ID number                             1
2827 TR 503 Input type (I,S or T), Input ID number           T,502
2828 TR 503 Order of numerator                               0
2829 TR 503 Numerator coefficients (4 per line max)          1
2830 TR 503 Order of denominator                             0
2831 TR 503 Denominator coefficients (4 per line max)        1
2832 TR 503 Transfer function gain                           1.

2833 TR 601 Transfer function ID number                      601
2834 TR 601 Controller ID number                             1
2835 TR 601 Input type (I,S or T), Input ID number           I,6
2836 TR 601 Order of numerator                               2
2837 TR 601 Numerator coefficients (4 per line max)          0.0675 0.6 1
2838 TR 601 Order of denominator                             3
2839 TR 601 Denominator coefficients (4 per line max)        0.0019 0.0672 0.65 1
2840 TR 601 Transfer function gain                           16

2841 TR 602 Transfer function ID number                      602
2842 TR 602 Controller ID number                             1
2843 TR 602 Input type (I,S or T), Input ID number           T,601
2844 TR 602 Order of numerator                               0
2845 TR 602 Numerator coefficients (4 per line max)          2304
2846 TR 602 Order of denominator                             2
2847 TR 602 Denominator coefficients (4 per line max)        2304 57.6 1
2848 TR 602 Transfer function gain                           1.

2849 TR 603 Transfer function ID number                      603
2850 TR 603 Controller ID number                             1
2851 TR 603 Input type (I,S or T), Input ID number           T,602
2852 TR 603 Order of numerator                               0
2853 TR 603 Numerator coefficients (4 per line max)          1
2854 TR 603 Order of denominator                             0
2855 TR 603 Denominator coefficients (4 per line max)        1
2856 TR 603 Transfer function gain                           1.

            FUNCTION GEN

2857 FU  11 Function generator ID number                     11
2858 FU  11 Type (ST,RA,PU,SA,SI,US,NO,DO)                   US
2859 FU  11 Amplitude
2860 FU  11 Slope
2861 FU  11 Start time (sec)
2862 FU  11 Stop time (sec)
2863 FU  11 Frequency (rad/sec)
2864 FU  11 Phase shift (deg)
2865 FU  11 Array location                                   1
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2866	FU	11	Mean,Seed	
2867	FU	11	Variance	
2868	FU	11	Pulse width (sec)	
2869	FU	11	Second pulse start time (sec)	
2870	FU	12	Function generator ID number	12
2871	FU	12	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
2872	FU	12	Amplitude	
2873	FU	12	Slope	
2874	FU	12	Start time (sec)	
2875	FU	12	Stop time (sec)	
2876	FU	12	Frequency (rad/sec)	
2877	FU	12	Phase shift (deg)	
2878	FU	12	Array location	2
2879	FU	12	Mean,Seed	
2880	FU	12	Variance	
2881	FU	12	Pulse width (sec)	
2882	FU	12	Second pulse start time (sec)	
2883	FU	13	Function generator ID number	13
2884	FU	13	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
2885	FU	13	Amplitude	
2886	FU	13	Slope	
2887	FU	13	Start time (sec)	
2888	FU	13	Stop time (sec)	
2889	FU	13	Frequency (rad/sec)	
2890	FU	13	Phase shift (deg)	
2891	FU	13	Array location	3
2892	FU	13	Mean,Seed	
2893	FU	13	Variance	
2894	FU	13	Pulse width (sec)	
2895	FU	13	Second pulse start time (sec)	
2896	FU	14	Function generator ID number	14
2897	FU	14	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
2898	FU	14	Amplitude	
2899	FU	14	Slope	
2900	FU	14	Start time (sec)	
2901	FU	14	Stop time (sec)	
2902	FU	14	Frequency (rad/sec)	
2903	FU	14	Phase shift (deg)	
2904	FU	14	Array location	4
2905	FU	14	Mean,Seed	
2906	FU	14	Variance	
2907	FU	14	Pulse width (sec)	
2908	FU	14	Second pulse start time (sec)	
2909	FU	15	Function generator ID number	15
2910	FU	15	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
2911	FU	15	Amplitude	
2912	FU	15	Slope	
2913	FU	15	Start time (sec)	
2914	FU	15	Stop time (sec)	
2915	FU	15	Frequency (rad/sec)	
2916	FU	15	Phase shift (deg)	
2917	FU	15	Array location	5
2918	FU	15	Mean,Seed	
2919	FU	15	Variance	
2920	FU	15	Pulse width (sec)	
2921	FU	15	Second pulse start time (sec)	
2922	FU	16	Function generator ID number	16
2923	FU	16	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
2924	FU	16	Amplitude	
2925	FU	16	Slope	
2926	FU	16	Start time (sec)	
2927	FU	16	Stop time (sec)	
2928	FU	16	Frequency (rad/sec)	
2929	FU	16	Phase shift (deg)	
2930	FU	16	Array location	6
2931	FU	16	Mean,Seed	
2932	FU	16	Variance	
2933	FU	16	Pulse width (sec)	
2934	FU	16	Second pulse start time (sec)	

2935	FU	21	Function generator ID number	21
2936	FU	21	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
2937	FU	21	Amplitude	
2938	FU	21	Slope	
2939	FU	21	Start time (sec)	
2940	FU	21	Stop time (sec)	
2941	FU	21	Frequency (rad/sec)	
2942	FU	21	Phase shift (deg)	
2943	FU	21	Array location	7
2944	FU	21	Mean,Seed	
2945	FU	21	Variance	
2946	FU	21	Pulse width (sec)	
2947	FU	21	Second pulse start time (sec)	
2948	FU	22	Function generator ID number	22
2949	FU	22	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
2950	FU	22	Amplitude	
2951	FU	22	Slope	
2952	FU	22	Start time (sec)	
2953	FU	22	Stop time (sec)	
2954	FU	22	Frequency (rad/sec)	
2955	FU	22	Phase shift (deg)	
2956	FU	22	Array location	8
2957	FU	22	Mean,Seed	
2958	FU	22	Variance	
2959	FU	22	Pulse width (sec)	
2960	FU	22	Second pulse start time (sec)	
2961	FU	23	Function generator ID number	23
2962	FU	23	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
2963	FU	23	Amplitude	
2964	FU	23	Slope	
2965	FU	23	Start time (sec)	
2966	FU	23	Stop time (sec)	
2967	FU	23	Frequency (rad/sec)	
2968	FU	23	Phase shift (deg)	
2969	FU	23	Array location	9
2970	FU	23	Mean,Seed	
2971	FU	23	Variance	
2972	FU	23	Pulse width (sec)	
2973	FU	23	Second pulse start time (sec)	
2974	FU	24	Function generator ID number	24
2975	FU	24	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
2976	FU	24	Amplitude	
2977	FU	24	Slope	
2978	FU	24	Start time (sec)	
2979	FU	24	Stop time (sec)	
2980	FU	24	Frequency (rad/sec)	
2981	FU	24	Phase shift (deg)	
2982	FU	24	Array location	10
2983	FU	24	Mean,Seed	
2984	FU	24	Variance	
2985	FU	24	Pulse width (sec)	
2986	FU	24	Second pulse start time (sec)	
2987	FU	25	Function generator ID number	25
2988	FU	25	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
2989	FU	25	Amplitude	
2990	FU	25	Slope	
2991	FU	25	Start time (sec)	
2992	FU	25	Stop time (sec)	
2993	FU	25	Frequency (rad/sec)	
2994	FU	25	Phase shift (deg)	
2995	FU	25	Array location	11
2996	FU	25	Mean,Seed	
2997	FU	25	Variance	
2998	FU	25	Pulse width (sec)	
2999	FU	25	Second pulse start time (sec)	
3000	FU	26	Function generator ID number	26
3001	FU	26	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3002	FU	26	Amplitude	
3003	FU	26	Slope	
3004	FU	26	Start time (sec)	

3005	FU	26	Stop time (sec)	
3006	FU	26	Frequency (rad/sec)	
3007	FU	26	Phase shift (deg)	
3008	FU	26	Array location	12
3009	FU	26	Mean,Seed	
3010	FU	26	Variance	
3011	FU	26	Pulse width (sec)	
3012	FU	26	Second pulse start time (sec)	
3013	FU	31	Function generator ID number	31
3014	FU	31	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3015	FU	31	Amplitude	
3016	FU	31	Slope	
3017	FU	31	Start time (sec)	
3018	FU	31	Stop time (sec)	
3019	FU	31	Frequency (rad/sec)	
3020	FU	31	Phase shift (deg)	
3021	FU	31	Array location	13
3022	FU	31	Mean,Seed	
3023	FU	31	Variance	
3024	FU	31	Pulse width (sec)	
3025	FU	31	Second pulse start time (sec)	
3026	FU	32	Function generator ID number	32
3027	FU	32	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3028	FU	32	Amplitude	
3029	FU	32	Slope	
3030	FU	32	Start time (sec)	
3031	FU	32	Stop time (sec)	
3032	FU	32	Frequency (rad/sec)	
3033	FU	32	Phase shift (deg)	
3034	FU	32	Array location	14
3035	FU	32	Mean,Seed	
3036	FU	32	Variance	
3037	FU	32	Pulse width (sec)	
3038	FU	32	Second pulse start time (sec)	
3039	FU	33	Function generator ID number	33
3040	FU	33	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3041	FU	33	Amplitude	
3042	FU	33	Slope	
3043	FU	33	Start time (sec)	
3044	FU	33	Stop time (sec)	
3045	FU	33	Frequency (rad/sec)	
3046	FU	33	Phase shift (deg)	
3047	FU	33	Array location	15
3048	FU	33	Mean,Seed	
3049	FU	33	Variance	
3050	FU	33	Pulse width (sec)	
3051	FU	33	Second pulse start time (sec)	
3052	FU	34	Function generator ID number	34
3053	FU	34	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3054	FU	34	Amplitude	
3055	FU	34	Slope	
3056	FU	34	Start time (sec)	
3057	FU	34	Stop time (sec)	
3058	FU	34	Frequency (rad/sec)	
3059	FU	34	Phase shift (deg)	
3060	FU	34	Array location	16
3061	FU	34	Mean,Seed	
3062	FU	34	Variance	
3063	FU	34	Pulse width (sec)	
3064	FU	34	Second pulse start time (sec)	
3065	FU	35	Function generator ID number	35
3066	FU	35	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3067	FU	35	Amplitude	
3068	FU	35	Slope	
3069	FU	35	Start time (sec)	
3070	FU	35	Stop time (sec)	
3071	FU	35	Frequency (rad/sec)	
3072	FU	35	Phase shift (deg)	
3073	FU	35	Array location	17
3074	FU	35	Mean,Seed	

3075	FU	35	Variance	
3076	FU	35	Pulse width (sec)	
3077	FU	35	Second pulse start time (sec)	
3078	FU	36	Function generator ID number	36
3079	FU	36	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3080	FU	36	Amplitude	
3081	FU	36	Slope	
3082	FU	36	Start time (sec)	
3083	FU	36	Stop time (sec)	
3084	FU	36	Frequency (rad/sec)	
3085	FU	36	Phase shift (deg)	
3086	FU	36	Array location	18
3087	FU	36	Mean,Seed	
3088	FU	36	Variance	
3089	FU	36	Pulse width (sec)	
3090	FU	36	Second pulse start time (sec)	
3091	FU	41	Function generator ID number	41
3092	FU	41	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3093	FU	41	Amplitude	
3094	FU	41	Slope	
3095	FU	41	Start time (sec)	
3096	FU	41	Stop time (sec)	
3097	FU	41	Frequency (rad/sec)	
3098	FU	41	Phase shift (deg)	
3099	FU	41	Array location	19
3100	FU	41	Mean,Seed	
3101	FU	41	Variance	
3102	FU	41	Pulse width (sec)	
3103	FU	41	Second pulse start time (sec)	
3104	FU	42	Function generator ID number	42
3105	FU	42	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3106	FU	42	Amplitude	
3107	FU	42	Slope	
3108	FU	42	Start time (sec)	
3109	FU	42	Stop time (sec)	
3110	FU	42	Frequency (rad/sec)	
3111	FU	42	Phase shift (deg)	
3112	FU	42	Array location	20
3113	FU	42	Mean,Seed	
3114	FU	42	Variance	
3115	FU	42	Pulse width (sec)	
3116	FU	42	Second pulse start time (sec)	
3117	FU	43	Function generator ID number	43
3118	FU	43	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3119	FU	43	Amplitude	
3120	FU	43	Slope	
3121	FU	43	Start time (sec)	
3122	FU	43	Stop time (sec)	
3123	FU	43	Frequency (rad/sec)	
3124	FU	43	Phase shift (deg)	
3125	FU	43	Array location	21
3126	FU	43	Mean,Seed	
3127	FU	43	Variance	
3128	FU	43	Pulse width (sec)	
3129	FU	43	Second pulse start time (sec)	
3130	FU	44	Function generator ID number	44
3131	FU	44	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3132	FU	44	Amplitude	
3133	FU	44	Slope	
3134	FU	44	Start time (sec)	
3135	FU	44	Stop time (sec)	
3136	FU	44	Frequency (rad/sec)	
3137	FU	44	Phase shift (deg)	
3138	FU	44	Array location	22
3139	FU	44	Mean,Seed	
3140	FU	44	Variance	
3141	FU	44	Pulse width (sec)	
3142	FU	44	Second pulse start time (sec)	
3143	FU	45	Function generator ID number	45

3144	FU	45	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3145	FU	45	Amplitude	
3146	FU	45	Slope	
3147	FU	45	Start time (sec)	
3148	FU	45	Stop time (sec)	
3149	FU	45	Frequency (rad/sec)	
3150	FU	45	Phase shift (deg)	
3151	FU	45	Array location	23
3152	FU	45	Mean,Seed	
3153	FU	45	Variance	
3154	FU	45	Pulse width (sec)	
3155	FU	45	Second pulse start time (sec)	
3156	FU	46	Function generator ID number	46
3157	FU	46	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3158	FU	46	Amplitude	
3159	FU	46	Slope	
3160	FU	46	Start time (sec)	
3161	FU	46	Stop time (sec)	
3162	FU	46	Frequency (rad/sec)	
3163	FU	46	Phase shift (deg)	
3164	FU	46	Array location	24
3165	FU	46	Mean,Seed	
3166	FU	46	Variance	
3167	FU	46	Pulse width (sec)	
3168	FU	46	Second pulse start time (sec)	
3169	FU	51	Function generator ID number	51
3170	FU	51	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3171	FU	51	Amplitude	
3172	FU	51	Slope	
3173	FU	51	Start time (sec)	
3174	FU	51	Stop time (sec)	
3175	FU	51	Frequency (rad/sec)	
3176	FU	51	Phase shift (deg)	
3177	FU	51	Array location	25
3178	FU	51	Mean,Seed	
3179	FU	51	Variance	
3180	FU	51	Pulse width (sec)	
3181	FU	51	Second pulse start time (sec)	
3182	FU	52	Function generator ID number	52
3183	FU	52	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3184	FU	52	Amplitude	
3185	FU	52	Slope	
3186	FU	52	Start time (sec)	
3187	FU	52	Stop time (sec)	
3188	FU	52	Frequency (rad/sec)	
3189	FU	52	Phase shift (deg)	
3190	FU	52	Array location	26
3191	FU	52	Mean,Seed	
3192	FU	52	Variance	
3193	FU	52	Pulse width (sec)	
3194	FU	52	Second pulse start time (sec)	
3195	FU	53	Function generator ID number	53
3196	FU	53	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3197	FU	53	Amplitude	
3198	FU	53	Slope	
3199	FU	53	Start time (sec)	
3200	FU	53	Stop time (sec)	
3201	FU	53	Frequency (rad/sec)	
3202	FU	53	Phase shift (deg)	
3203	FU	53	Array location	27
3204	FU	53	Mean,Seed	
3205	FU	53	Variance	
3206	FU	53	Pulse width (sec)	
3207	FU	53	Second pulse start time (sec)	
3208	FU	54	Function generator ID number	54
3209	FU	54	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3210	FU	54	Amplitude	
3211	FU	54	Slope	
3212	FU	54	Start time (sec)	
3213	FU	54	Stop time (sec)	

3214	FU	54	Frequency (rad/sec)	
3215	FU	54	Phase shift (deg)	
3216	FU	54	Array location	28
3217	FU	54	Mean,Seed	
3218	FU	54	Variance	
3219	FU	54	Pulse width (sec)	
3220	FU	54	Second pulse start time (sec)	
3221	FU	55	Function generator ID number	55
3222	FU	55	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3223	FU	55	Amplitude	
3224	FU	55	Slope	
3225	FU	55	Start time (sec)	
3226	FU	55	Stop time (sec)	
3227	FU	55	Frequency (rad/sec)	
3228	FU	55	Phase shift (deg)	
3229	FU	55	Array location	29
3230	FU	55	Mean,Seed	
3231	FU	55	Variance	
3232	FU	55	Pulse width (sec)	
3233	FU	55	Second pulse start time (sec)	
3234	FU	56	Function generator ID number	56
3235	FU	56	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3236	FU	56	Amplitude	
3237	FU	56	Slope	
3238	FU	56	Start time (sec)	
3239	FU	56	Stop time (sec)	
3240	FU	56	Frequency (rad/sec)	
3241	FU	56	Phase shift (deg)	
3242	FU	56	Array location	30
3243	FU	56	Mean,Seed	
3244	FU	56	Variance	
3245	FU	56	Pulse width (sec)	
3246	FU	56	Second pulse start time (sec)	
3247	FU	61	Function generator ID number	61
3248	FU	61	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3249	FU	61	Amplitude	
3250	FU	61	Slope	
3251	FU	61	Start time (sec)	
3252	FU	61	Stop time (sec)	
3253	FU	61	Frequency (rad/sec)	
3254	FU	61	Phase shift (deg)	
3255	FU	61	Array location	31
3256	FU	61	Mean,Seed	
3257	FU	61	Variance	
3258	FU	61	Pulse width (sec)	
3259	FU	61	Second pulse start time (sec)	
3260	FU	62	Function generator ID number	62
3261	FU	62	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3262	FU	62	Amplitude	
3263	FU	62	Slope	
3264	FU	62	Start time (sec)	
3265	FU	62	Stop time (sec)	
3266	FU	62	Frequency (rad/sec)	
3267	FU	62	Phase shift (deg)	
3268	FU	62	Array location	32
3269	FU	62	Mean,Seed	
3270	FU	62	Variance	
3271	FU	62	Pulse width (sec)	
3272	FU	62	Second pulse start time (sec)	
3273	FU	63	Function generator ID number	63
3274	FU	63	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3275	FU	63	Amplitude	
3276	FU	63	Slope	
3277	FU	63	Start time (sec)	
3278	FU	63	Stop time (sec)	
3279	FU	63	Frequency (rad/sec)	
3280	FU	63	Phase shift (deg)	
3281	FU	63	Array location	33
3282	FU	63	Mean,Seed	
3283	FU	63	Variance	

3284	FU	63	Pulse width (sec)	
3285	FU	63	Second pulse start time (sec)	
3286	FU	64	Function generator ID number	64
3287	FU	64	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3288	FU	64	Amplitude	
3289	FU	64	Slope	
3290	FU	64	Start time (sec)	
3291	FU	64	Stop time (sec)	
3292	FU	64	Frequency (rad/sec)	
3293	FU	64	Phase shift (deg)	
3294	FU	64	Array location	34
3295	FU	64	Mean,Seed	
3296	FU	64	Variance	
3297	FU	64	Pulse width (sec)	
3298	FU	64	Second pulse start time (sec)	
3299	FU	65	Function generator ID number	65
3300	FU	65	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3301	FU	65	Amplitude	
3302	FU	65	Slope	
3303	FU	65	Start time (sec)	
3304	FU	65	Stop time (sec)	
3305	FU	65	Frequency (rad/sec)	
3306	FU	65	Phase shift (deg)	
3307	FU	65	Array location	35
3308	FU	65	Mean,Seed	
3309	FU	65	Variance	
3310	FU	65	Pulse width (sec)	
3311	FU	65	Second pulse start time (sec)	
3312	FU	66	Function generator ID number	66
3313	FU	66	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3314	FU	66	Amplitude	
3315	FU	66	Slope	
3316	FU	66	Start time (sec)	
3317	FU	66	Stop time (sec)	
3318	FU	66	Frequency (rad/sec)	
3319	FU	66	Phase shift (deg)	
3320	FU	66	Array location	36
3321	FU	66	Mean,Seed	
3322	FU	66	Variance	
3323	FU	66	Pulse width (sec)	
3324	FU	66	Second pulse start time (sec)	
3325	FU	71	Function generator ID number	71
3326	FU	71	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3327	FU	71	Amplitude	
3328	FU	71	Slope	
3329	FU	71	Start time (sec)	
3330	FU	71	Stop time (sec)	
3331	FU	71	Frequency (rad/sec)	
3332	FU	71	Phase shift (deg)	
3333	FU	71	Array location	37
3334	FU	71	Mean,Seed	
3335	FU	71	Variance	
3336	FU	71	Pulse width (sec)	
3337	FU	71	Second pulse start time (sec)	
3338	FU	72	Function generator ID number	72
3339	FU	72	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3340	FU	72	Amplitude	
3341	FU	72	Slope	
3342	FU	72	Start time (sec)	
3343	FU	72	Stop time (sec)	
3344	FU	72	Frequency (rad/sec)	
3345	FU	72	Phase shift (deg)	
3346	FU	72	Array location	38
3347	FU	72	Mean,Seed	
3348	FU	72	Variance	
3349	FU	72	Pulse width (sec)	
3350	FU	72	Second pulse start time (sec)	
3351	FU	73	Function generator ID number	73
3352	FU	73	Type (ST,RA,PU,SA,SI,US,NO,DO)	US

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3353 FU  73 Amplitude
3354 FU  73 Slope
3355 FU  73 Start time (sec)
3356 FU  73 Stop time (sec)
3357 FU  73 Frequency (rad/sec)
3358 FU  73 Phase shift (deg)
3359 FU  73 Array location                                39
3360 FU  73 Mean,Seed
3361 FU  73 Variance
3362 FU  73 Pulse width (sec)
3363 FU  73 Second pulse start time (sec)

3364 FU  74 Function generator ID number                  74
3365 FU  74 Type (ST,RA,PU,SA,SI,US,NO,DO)                US
3366 FU  74 Amplitude
3367 FU  74 Slope
3368 FU  74 Start time (sec)
3369 FU  74 Stop time (sec)
3370 FU  74 Frequency (rad/sec)
3371 FU  74 Phase shift (deg)
3372 FU  74 Array location                                40
3373 FU  74 Mean,Seed
3374 FU  74 Variance
3375 FU  74 Pulse width (sec)
3376 FU  74 Second pulse start time (sec)

3377 FU  75 Function generator ID number                  75
3378 FU  75 Type (ST,RA,PU,SA,SI,US,NO,DO)                US
3379 FU  75 Amplitude
3380 FU  75 Slope
3381 FU  75 Start time (sec)
3382 FU  75 Stop time (sec)
3383 FU  75 Frequency (rad/sec)
3384 FU  75 Phase shift (deg)
3385 FU  75 Array location                                41
3386 FU  75 Mean,Seed
3387 FU  75 Variance
3388 FU  75 Pulse width (sec)
3389 FU  75 Second pulse start time (sec)

3390 FU  76 Function generator ID number                  76
3391 FU  76 Type (ST,RA,PU,SA,SI,US,NO,DO)                US
3392 FU  76 Amplitude
3393 FU  76 Slope
3394 FU  76 Start time (sec)
3395 FU  76 Stop time (sec)
3396 FU  76 Frequency (rad/sec)
3397 FU  76 Phase shift (deg)
3398 FU  76 Array location                                42
3399 FU  76 Mean,Seed
3400 FU  76 Variance
3401 FU  76 Pulse width (sec)
3402 FU  76 Second pulse start time (sec)

3403 FU  81 Function generator ID number                  81
3404 FU  81 Type (ST,RA,PU,SA,SI,US,NO,DO)                US
3405 FU  81 Amplitude
3406 FU  81 Slope
3407 FU  81 Start time (sec)
3408 FU  81 Stop time (sec)
3409 FU  81 Frequency (rad/sec)
3410 FU  81 Phase shift (deg)
3411 FU  81 Array location                                43
3412 FU  81 Mean,Seed
3413 FU  81 Variance
3414 FU  81 Pulse width (sec)
3415 FU  81 Second pulse start time (sec)

3416 FU  82 Function generator ID number                  82
3417 FU  82 Type (ST,RA,PU,SA,SI,US,NO,DO)                US
3418 FU  82 Amplitude
3419 FU  82 Slope
3420 FU  82 Start time (sec)
3421 FU  82 Stop time (sec)
3422 FU  82 Frequency (rad/sec)
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3423	FU	82	Phase shift (deg)	
3424	FU	82	Array location	44
3425	FU	82	Mean,Seed	
3426	FU	82	Variance	
3427	FU	82	Pulse width (sec)	
3428	FU	82	Second pulse start time (sec)	
3429	FU	83	Function generator ID number	83
3430	FU	83	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3431	FU	83	Amplitude	
3432	FU	83	Slope	
3433	FU	83	Start time (sec)	
3434	FU	83	Stop time (sec)	
3435	FU	83	Frequency (rad/sec)	
3436	FU	83	Phase shift (deg)	
3437	FU	83	Array location	45
3438	FU	83	Mean,Seed	
3439	FU	83	Variance	
3440	FU	83	Pulse width (sec)	
3441	FU	83	Second pulse start time (sec)	
3442	FU	84	Function generator ID number	84
3443	FU	84	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3444	FU	84	Amplitude	
3445	FU	84	Slope	
3446	FU	84	Start time (sec)	
3447	FU	84	Stop time (sec)	
3448	FU	84	Frequency (rad/sec)	
3449	FU	84	Phase shift (deg)	
3450	FU	84	Array location	46
3451	FU	84	Mean,Seed	
3452	FU	84	Variance	
3453	FU	84	Pulse width (sec)	
3454	FU	84	Second pulse start time (sec)	
3455	FU	85	Function generator ID number	85
3456	FU	85	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3457	FU	85	Amplitude	
3458	FU	85	Slope	
3459	FU	85	Start time (sec)	
3460	FU	85	Stop time (sec)	
3461	FU	85	Frequency (rad/sec)	
3462	FU	85	Phase shift (deg)	
3463	FU	85	Array location	47
3464	FU	85	Mean,Seed	
3465	FU	85	Variance	
3466	FU	85	Pulse width (sec)	
3467	FU	85	Second pulse start time (sec)	
3468	FU	86	Function generator ID number	86
3469	FU	86	Type (ST,RA,PU,SA,SI,US,NO,DO)	US
3470	FU	86	Amplitude	
3471	FU	86	Slope	
3472	FU	86	Start time (sec)	
3473	FU	86	Stop time (sec)	
3474	FU	86	Frequency (rad/sec)	
3475	FU	86	Phase shift (deg)	
3476	FU	86	Array location	48
3477	FU	86	Mean,Seed	
3478	FU	86	Variance	
3479	FU	86	Pulse width (sec)	
3480	FU	86	Second pulse start time (sec)	
3481	FU	111	Function generator ID number	111
3482	FU	111	Type (ST,RA,PU,SA,SI,US,NO,DO)	SI
3483	FU	111	Amplitude	9800
3484	FU	111	Slope	
3485	FU	111	Start time (sec)	0
3486	FU	111	Stop time (sec)	10000
3487	FU	111	Frequency (rad/sec)	628
3488	FU	111	Phase shift (deg)	0
3489	FU	111	Array location	
3490	FU	111	Mean,Seed	
3491	FU	111	Variance	
3492	FU	111	Pulse width (sec)	

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3493 FU 111 Second pulse start time (sec)

            INTERCONNECT

3494 IN  11 Interconnect ID number                           11
3495 IN  11 Source type(S,C, or F),Source ID,Source row #    F,11,1
3496 IN  11 Destination type(A or C),Dest ID,Dest row #      A,11,1
3497 IN  11 Gain                                             0

3498 IN  12 Interconnect ID number                           12
3499 IN  12 Source type(S,C, or F),Source ID,Source row #    F,12,1
3500 IN  12 Destination type(A or C),Dest ID,Dest row #      A,12,1
3501 IN  12 Gain                                             0

3502 IN  13 Interconnect ID number                           13
3503 IN  13 Source type(S,C, or F),Source ID,Source row #    F,13,1
3504 IN  13 Destination type(A or C),Dest ID,Dest row #      A,13,1
3505 IN  13 Gain                                             0

3506 IN  14 Interconnect ID number                           14
3507 IN  14 Source type(S,C, or F),Source ID,Source row #    F,14,1
3508 IN  14 Destination type(A or C),Dest ID,Dest row #      A,14,1
3509 IN  14 Gain                                             0

3510 IN  15 Interconnect ID number                           15
3511 IN  15 Source type(S,C, or F),Source ID,Source row #    F,15,1
3512 IN  15 Destination type(A or C),Dest ID,Dest row #      A,15,1
3513 IN  15 Gain                                             0

3514 IN  16 Interconnect ID number                           16
3515 IN  16 Source type(S,C, or F),Source ID,Source row #    F,16,1
3516 IN  16 Destination type(A or C),Dest ID,Dest row #      A,16,1
3517 IN  16 Gain                                             0

3518 IN  21 Interconnect ID number                           21
3519 IN  21 Source type(S,C, or F),Source ID,Source row #    F,21,1
3520 IN  21 Destination type(A or C),Dest ID,Dest row #      A,21,1
3521 IN  21 Gain                                             1

3522 IN  22 Interconnect ID number                           22
3523 IN  22 Source type(S,C, or F),Source ID,Source row #    F,22,1
3524 IN  22 Destination type(A or C),Dest ID,Dest row #      A,22,1
3525 IN  22 Gain                                             1

3526 IN  23 Interconnect ID number                           23
3527 IN  23 Source type(S,C, or F),Source ID,Source row #    F,23,1
3528 IN  23 Destination type(A or C),Dest ID,Dest row #      A,23,1
3529 IN  23 Gain                                             1

3530 IN  24 Interconnect ID number                           24
3531 IN  24 Source type(S,C, or F),Source ID,Source row #    F,24,1
3532 IN  24 Destination type(A or C),Dest ID,Dest row #      A,24,1
3533 IN  24 Gain                                             1

3534 IN  25 Interconnect ID number                           25
3535 IN  25 Source type(S,C, or F),Source ID,Source row #    F,25,1
3536 IN  25 Destination type(A or C),Dest ID,Dest row #      A,25,1
3537 IN  25 Gain                                             1

3538 IN  26 Interconnect ID number                           26
3539 IN  26 Source type(S,C, or F),Source ID,Source row #    F,26,1
3540 IN  26 Destination type(A or C),Dest ID,Dest row #      A,26,1
3541 IN  26 Gain                                             1

3542 IN  31 Interconnect ID number                           31
3543 IN  31 Source type(S,C, or F),Source ID,Source row #    F,31,1
3544 IN  31 Destination type(A or C),Dest ID,Dest row #      A,31,1
3545 IN  31 Gain                                             1

3546 IN  32 Interconnect ID number                           32
3547 IN  32 Source type(S,C, or F),Source ID,Source row #    F,32,1
3548 IN  32 Destination type(A or C),Dest ID,Dest row #      A,32,1
3549 IN  32 Gain                                             1
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3550 IN  33 Interconnect ID number                               33
3551 IN  33 Source type(S,C, or F),Source ID,Source row #        F,33,1
3552 IN  33 Destination type(A or C),Dest ID,Dest row #          A,33,1
3553 IN  33 Gain                                                 1

3554 IN  34 Interconnect ID number                               34
3555 IN  34 Source type(S,C, or F),Source ID,Source row #        F,34,1
3556 IN  34 Destination type(A or C),Dest ID,Dest row #          A,34,1
3557 IN  34 Gain                                                 1

3558 IN  35 Interconnect ID number                               35
3559 IN  35 Source type(S,C, or F),Source ID,Source row #        F,35,1
3560 IN  35 Destination type(A or C),Dest ID,Dest row #          A,35,1
3561 IN  35 Gain                                                 1

3562 IN  36 Interconnect ID number                               36
3563 IN  36 Source type(S,C, or F),Source ID,Source row #        F,36,1
3564 IN  36 Destination type(A or C),Dest ID,Dest row #          A,36,1
3565 IN  36 Gain                                                 1

3566 IN  41 Interconnect ID number                               41
3567 IN  41 Source type(S,C, or F),Source ID,Source row #        F,41,1
3568 IN  41 Destination type(A or C),Dest ID,Dest row #          A,41,1
3569 IN  41 Gain                                                 1

3570 IN  42 Interconnect ID number                               42
3571 IN  42 Source type(S,C, or F),Source ID,Source row #        F,42,1
3572 IN  42 Destination type(A or C),Dest ID,Dest row #          A,42,1
3573 IN  42 Gain                                                 1

3574 IN  43 Interconnect ID number                               43
3575 IN  43 Source type(S,C, or F),Source ID,Source row #        F,43,1
3576 IN  43 Destination type(A or C),Dest ID,Dest row #          A,43,1
3577 IN  43 Gain                                                 1

3578 IN  44 Interconnect ID number                               44
3579 IN  44 Source type(S,C, or F),Source ID,Source row #        F,44,1
3580 IN  44 Destination type(A or C),Dest ID,Dest row #          A,44,1
3581 IN  44 Gain                                                 1

3582 IN  45 Interconnect ID number                               45
3583 IN  45 Source type(S,C, or F),Source ID,Source row #        F,45,1
3584 IN  45 Destination type(A or C),Dest ID,Dest row #          A,45,1
3585 IN  45 Gain                                                 1

3586 IN  46 Interconnect ID number                               46
3587 IN  46 Source type(S,C, or F),Source ID,Source row #        F,46,1
3588 IN  46 Destination type(A or C),Dest ID,Dest row #          A,46,1
3589 IN  46 Gain                                                 1

3590 IN  51 Interconnect ID number                               51
3591 IN  51 Source type(S,C, or F),Source ID,Source row #        F,51,1
3592 IN  51 Destination type(A or C),Dest ID,Dest row #          A,51,1
3593 IN  51 Gain                                                 1

3594 IN  52 Interconnect ID number                               52
3595 IN  52 Source type(S,C, or F),Source ID,Source row #        F,52,1
3596 IN  52 Destination type(A or C),Dest ID,Dest row #          A,52,1
3597 IN  52 Gain                                                 1

3598 IN  53 Interconnect ID number                               53
3599 IN  53 Source type(S,C, or F),Source ID,Source row #        F,53,1
3600 IN  53 Destination type(A or C),Dest ID,Dest row #          A,53,1
3601 IN  53 Gain                                                 1

3602 IN  54 Interconnect ID number                               54
3603 IN  54 Source type(S,C, or F),Source ID,Source row #        F,54,1
3604 IN  54 Destination type(A or C),Dest ID,Dest row #          A,54,1
3605 IN  54 Gain                                                 1

3606 IN  55 Interconnect ID number                               55
3607 IN  55 Source type(S,C, or F),Source ID,Source row #        F,55,1
3608 IN  55 Destination type(A or C),Dest ID,Dest row #          A,55,1
3609 IN  55 Gain                                                 1
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3610 IN  56 Interconnect ID number                                  56
3611 IN  56 Source type(S,C, or F),Source ID,Source row #          F,56,1
3612 IN  56 Destination type(A or C),Dest ID,Dest row #            A,56,1
3613 IN  56 Gain                                                    1

3614 IN  61 Interconnect ID number                                  61
3615 IN  61 Source type(S,C, or F),Source ID,Source row #          F,61,1
3616 IN  61 Destination type(A or C),Dest ID,Dest row #            A,61,1
3617 IN  61 Gain                                                    1

3618 IN  62 Interconnect ID number                                  62
3619 IN  62 Source type(S,C, or F),Source ID,Source row #          F,62,1
3620 IN  62 Destination type(A or C),Dest ID,Dest row #            A,62,1
3621 IN  62 Gain                                                    1

3622 IN  63 Interconnect ID number                                  63
3623 IN  63 Source type(S,C, or F),Source ID,Source row #          F,63,1
3624 IN  63 Destination type(A or C),Dest ID,Dest row #            A,63,1
3625 IN  63 Gain                                                    1

3626 IN  64 Interconnect ID number                                  64
3627 IN  64 Source type(S,C, or F),Source ID,Source row #          F,64,1
3628 IN  64 Destination type(A or C),Dest ID,Dest row #            A,64,1
3629 IN  64 Gain                                                    1

3630 IN  65 Interconnect ID number                                  65
3631 IN  65 Source type(S,C, or F),Source ID,Source row #          F,65,1
3632 IN  65 Destination type(A or C),Dest ID,Dest row #            A,65,1
3633 IN  65 Gain                                                    1

3634 IN  66 Interconnect ID number                                  66
3635 IN  66 Source type(S,C, or F),Source ID,Source row #          F,66,1
3636 IN  66 Destination type(A or C),Dest ID,Dest row #            A,66,1
3637 IN  66 Gain                                                    1

3638 IN  71 Interconnect ID number                                  71
3639 IN  71 Source type(S,C, or F),Source ID,Source row #          F,71,1
3640 IN  71 Destination type(A or C),Dest ID,Dest row #            A,71,1
3641 IN  71 Gain                                                    1

3642 IN  72 Interconnect ID number                                  72
3643 IN  72 Source type(S,C, or F),Source ID,Source row #          F,72,1
3644 IN  72 Destination type(A or C),Dest ID,Dest row #            A,72,1
3645 IN  72 Gain                                                    1

3646 IN  73 Interconnect ID number                                  73
3647 IN  73 Source type(S,C, or F),Source ID,Source row #          F,73,1
3648 IN  73 Destination type(A or C),Dest ID,Dest row #            A,73,1
3649 IN  73 Gain                                                    1

3650 IN  74 Interconnect ID number                                  74
3651 IN  74 Source type(S,C, or F),Source ID,Source row #          F,74,1
3652 IN  74 Destination type(A or C),Dest ID,Dest row #            A,74,1
3653 IN  74 Gain                                                    1

3654 IN  75 Interconnect ID number                                  75
3655 IN  75 Source type(S,C, or F),Source ID,Source row #          F,75,1
3656 IN  75 Destination type(A or C),Dest ID,Dest row #            A,75,1
3657 IN  75 Gain                                                    1

3658 IN  76 Interconnect ID number                                  76
3659 IN  76 Source type(S,C, or F),Source ID,Source row #          F,76,1
3660 IN  76 Destination type(A or C),Dest ID,Dest row #            A,76,1
3661 IN  76 Gain                                                    1

3662 IN  81 Interconnect ID number                                  81
3663 IN  81 Source type(S,C, or F),Source ID,Source row #          F,81,1
3664 IN  81 Destination type(A or C),Dest ID,Dest row #            A,81,1
3665 IN  81 Gain                                                    1

3666 IN  82 Interconnect ID number                                  82
3667 IN  82 Source type(S,C, or F),Source ID,Source row #          F,82,1
3668 IN  82 Destination type(A or C),Dest ID,Dest row #            A,82,1
3669 IN  82 Gain                                                    1
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3670 IN  83 Interconnect ID number                              83
3671 IN  83 Source type(S,C, or F),Source ID,Source row #       F,83,1
3672 IN  83 Destination type(A or C),Dest ID,Dest row #         A,83,1
3673 IN  83 Gain                                                1

3674 IN  84 Interconnect ID number                              84
3675 IN  84 Source type(S,C, or F),Source ID,Source row #       F,84,1
3676 IN  84 Destination type(A or C),Dest ID,Dest row #         A,84,1
3677 IN  84 Gain                                                1

3678 IN  85 Interconnect ID number                              85
3679 IN  85 Source type(S,C, or F),Source ID,Source row #       F,85,1
3680 IN  85 Destination type(A or C),Dest ID,Dest row #         A,85,1
3681 IN  85 Gain                                                1

3682 IN  86 Interconnect ID number                              86
3683 IN  86 Source type(S,C, or F),Source ID,Source row #       F,86,1
3684 IN  86 Destination type(A or C),Dest ID,Dest row #         A,86,1
3685 IN  86 Gain                                                1

3686 IN 101 Interconnect ID number                              101
3687 IN 101 Source type(S,C, or F),Source ID,Source row #       C,2,1
3688 IN 101 Destination type(A or C),Dest ID,Dest row #         C,1,1
3689 IN 101 Gain                                                1.

3690 IN 102 Interconnect ID number                              102
3691 IN 102 Source type(S,C, or F),Source ID,Source row #       C,2,2
3692 IN 102 Destination type(A or C),Dest ID,Dest row #         C,1,2
3693 IN 102 Gain                                                1.

3694 IN 103 Interconnect ID number                              103
3695 IN 103 Source type(S,C, or F),Source ID,Source row #       C,2,3
3696 IN 103 Destination type(A or C),Dest ID,Dest row #         C,1,3
3697 IN 103 Gain                                                1.

3698 IN 104 Interconnect ID number                              104
3699 IN 104 Source type(S,C, or F),Source ID,Source row #       C,2,4
3700 IN 104 Destination type(A or C),Dest ID,Dest row #         C,1,4
3701 IN 104 Gain                                                1.

3702 IN 105 Interconnect ID number                              105
3703 IN 105 Source type(S,C, or F),Source ID,Source row #       C,2,5
3704 IN 105 Destination type(A or C),Dest ID,Dest row #         C,1,5
3705 IN 105 Gain                                                1.

3706 IN 106 Interconnect ID number                              106
3707 IN 106 Source type(S,C, or F),Source ID,Source row #       C,2,6
3708 IN 106 Destination type(A or C),Dest ID,Dest row #         C,1,6
3709 IN 106 Gain                                                1.

3710 IN 107 Interconnect ID number                              107
3711 IN 107 Source type(S,C, or F),Source ID,Source row #       C,2,31
3712 IN 107 Destination type(A or C),Dest ID,Dest row #         C,1,7
3713 IN 107 Gain                                                1.

3714 IN 108 Interconnect ID number                              108
3715 IN 108 Source type(S,C, or F),Source ID,Source row #       C,2,32
3716 IN 108 Destination type(A or C),Dest ID,Dest row #         C,1,8
3717 IN 108 Gain                                                1.

3718 IN 109 Interconnect ID number                              109
3719 IN 109 Source type(S,C, or F),Source ID,Source row #       C,2,33
3720 IN 109 Destination type(A or C),Dest ID,Dest row #         C,1,9
3721 IN 109 Gain                                                1.

3722 IN 110 Interconnect ID number                              110
3723 IN 110 Source type(S,C, or F),Source ID,Source row #       C,2,34
3724 IN 110 Destination type(A or C),Dest ID,Dest row #         C,1,10
3725 IN 110 Gain                                                1

3726 IN 111 Interconnect ID number                              111
3727 IN 111 Source type(S,C, or F),Source ID,Source row #       C,2,35
3728 IN 111 Destination type(A or C),Dest ID,Dest row #         C,1,11
3729 IN 111 Gain                                                1
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3730 IN 112 Interconnect ID number                                    112
3731 IN 112 Source type(S,C, or F),Source ID,Source row #             C,2,36
3732 IN 112 Destination type(A or C),Dest ID,Dest row #               C,1,12
3733 IN 112 Gain                                                      1

3734 IN 113 Interconnect ID number                                    113
3735 IN 113 Source type(S,C, or F),Source ID,Source row #             C,2,37
3736 IN 113 Destination type(A or C),Dest ID,Dest row #               C,1,13
3737 IN 113 Gain                                                      1

3738 IN 114 Interconnect ID number                                    114
3739 IN 114 Source type(S,C, or F),Source ID,Source row #             C,2,38
3740 IN 114 Destination type(A or C),Dest ID,Dest row #               C,1,14
3741 IN 114 Gain                                                      1

3742 IN 115 Interconnect ID number                                    115
3743 IN 115 Source type(S,C, or F),Source ID,Source row #             C,2,39
3744 IN 115 Destination type(A or C),Dest ID,Dest row #               C,1,15
3745 IN 115 Gain                                                      1

3746 IN 116 Interconnect ID number                                    116
3747 IN 116 Source type(S,C, or F),Source ID,Source row #             C,2,40
3748 IN 116 Destination type(A or C),Dest ID,Dest row #               C,1,16
3749 IN 116 Gain                                                      1

3750 IN 117 Interconnect ID number                                    117
3751 IN 117 Source type(S,C, or F),Source ID,Source row #             C,2,41
3752 IN 117 Destination type(A or C),Dest ID,Dest row #               C,1,17
3753 IN 117 Gain                                                      1

3754 IN 118 Interconnect ID number                                    118
3755 IN 118 Source type(S,C, or F),Source ID,Source row #             C,2,42
3756 IN 118 Destination type(A or C),Dest ID,Dest row #               C,1,18
3757 IN 118 Gain                                                      1

3758 IN 201 Interconnect ID number                                    201
3759 IN 201 Source type(S,C, or F),Source ID,Source row #             S,211,1
3760 IN 201 Destination type(A or C),Dest ID,Dest row #               C,2,1
3761 IN 201 Gain                                                      1

3762 IN 202 Interconnect ID number                                    202
3763 IN 202 Source type(S,C, or F),Source ID,Source row #             S,212,1
3764 IN 202 Destination type(A or C),Dest ID,Dest row #               C,2,2
3765 IN 202 Gain                                                      1

3766 IN 203 Interconnect ID number                                    203
3767 IN 203 Source type(S,C, or F),Source ID,Source row #             S,221,1
3768 IN 203 Destination type(A or C),Dest ID,Dest row #               C,2,3
3769 IN 203 Gain                                                      1

3770 IN 204 Interconnect ID number                                    204
3771 IN 204 Source type(S,C, or F),Source ID,Source row #             S,222,1
3772 IN 204 Destination type(A or C),Dest ID,Dest row #               C,2,4
3773 IN 204 Gain                                                      1

3774 IN 205 Interconnect ID number                                    205
3775 IN 205 Source type(S,C, or F),Source ID,Source row #             S,223,1
3776 IN 205 Destination type(A or C),Dest ID,Dest row #               C,2,5
3777 IN 205 Gain                                                      1

3778 IN 206 Interconnect ID number                                    206
3779 IN 206 Source type(S,C, or F),Source ID,Source row #             S,231,1
3780 IN 206 Destination type(A or C),Dest ID,Dest row #               C,2,6
3781 IN 206 Gain                                                      1

3782 IN 207 Interconnect ID number                                    207
3783 IN 207 Source type(S,C, or F),Source ID,Source row #             S,232,1
3784 IN 207 Destination type(A or C),Dest ID,Dest row #               C,2,7
3785 IN 207 Gain                                                      1

3786 IN 208 Interconnect ID number                                    208
3787 IN 208 Source type(S,C, or F),Source ID,Source row #             S,233,1
3788 IN 208 Destination type(A or C),Dest ID,Dest row #               C,2,8
3789 IN 208 Gain                                                      1
```

```
3790 IN 209 Interconnect ID number                                   209
3791 IN 209 Source type(S,C, or F),Source ID,Source row #            C,1,1
3792 IN 209 Destination type(A or C),Dest ID,Dest row #              C,2,9
3793 IN 209 Gain                                                     -1.

3794 IN 210 Interconnect ID number                                   210
3795 IN 210 Source type(S,C, or F),Source ID,Source row #            C,1,2
3796 IN 210 Destination type(A or C),Dest ID,Dest row #              C,2,10
3797 IN 210 Gain                                                     -1.

3798 IN 211 Interconnect ID number                                   211
3799 IN 211 Source type(S,C, or F),Source ID,Source row #            C,1,3
3800 IN 211 Destination type(A or C),Dest ID,Dest row #              C,2,11
3801 IN 211 Gain                                                     -1.

3802 IN 212 Interconnect ID number                                   212
3803 IN 212 Source type(S,C, or F),Source ID,Source row #            C,1,4
3804 IN 212 Destination type(A or C),Dest ID,Dest row #              C,2,12
3805 IN 212 Gain                                                     -1.

3806 IN 213 Interconnect ID number                                   213
3807 IN 213 Source type(S,C, or F),Source ID,Source row #            C,1,5
3808 IN 213 Destination type(A or C),Dest ID,Dest row #              C,2,13
3809 IN 213 Gain                                                     -1.

3810 IN 214 Interconnect ID number                                   214
3811 IN 214 Source type(S,C, or F),Source ID,Source row #            C,1,6
3812 IN 214 Destination type(A or C),Dest ID,Dest row #              C,2,14
3813 IN 214 Gain                                                     -1.

3814 IN 215 Interconnect ID number                                   215
3815 IN 215 Source type(S,C, or F),Source ID,Source row #            C,2,7
3816 IN 215 Destination type(A or C),Dest ID,Dest row #              A,101,1
3817 IN 215 Gain                                                     0

3818 IN 216 Interconnect ID number                                   216
3819 IN 216 Source type(S,C, or F),Source ID,Source row #            C,2,8
3820 IN 216 Destination type(A or C),Dest ID,Dest row #              A,201,1
3821 IN 216 Gain                                                     1

3822 IN 217 Interconnect ID number                                   217
3823 IN 217 Source type(S,C, or F),Source ID,Source row #            C,2,9
3824 IN 217 Destination type(A or C),Dest ID,Dest row #              A,301,1
3825 IN 217 Gain                                                     1

3826 IN 218 Interconnect ID number                                   218
3827 IN 218 Source type(S,C, or F),Source ID,Source row #            C,2,10
3828 IN 218 Destination type(A or C),Dest ID,Dest row #              A,401,1
3829 IN 218 Gain                                                     1

3830 IN 219 Interconnect ID number                                   219
3831 IN 219 Source type(S,C, or F),Source ID,Source row #            C,2,11
3832 IN 219 Destination type(A or C),Dest ID,Dest row #              A,501,1
3833 IN 219 Gain                                                     1

3834 IN 220 Interconnect ID number                                   220
3835 IN 220 Source type(S,C, or F),Source ID,Source row #            C,2,12
3836 IN 220 Destination type(A or C),Dest ID,Dest row #              A,601,1
3837 IN 220 Gain                                                     1

3838 IN 221 Interconnect ID number                                   221
3839 IN 221 Source type(S,C, or F),Source ID,Source row #            C,2,13
3840 IN 221 Destination type(A or C),Dest ID,Dest row #              A,701,1
3841 IN 221 Gain                                                     1

3842 IN 222 Interconnect ID number                                   222
3843 IN 222 Source type(S,C, or F),Source ID,Source row #            C,2,14
3844 IN 222 Destination type(A or C),Dest ID,Dest row #              A,801,1
3845 IN 222 Gain                                                     1

3846 IN 223 Interconnect ID number                                   223
3847 IN 223 Source type(S,C, or F),Source ID,Source row #            C,2,15
3848 IN 223 Destination type(A or C),Dest ID,Dest row #              A,102,1
3849 IN 223 Gain                                                     0
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3850 IN 224 Interconnect ID number                                    224
3851 IN 224 Source type(S,C, or F),Source ID,Source row #             C,2,17
3852 IN 224 Destination type(A or C),Dest ID,Dest row #               A,202,1
3853 IN 224 Gain                                                      1

3854 IN 225 Interconnect ID number                                    225
3855 IN 225 Source type(S,C, or F),Source ID,Source row #             C,2,19
3856 IN 225 Destination type(A or C),Dest ID,Dest row #               A,302,1
3857 IN 225 Gain                                                      1

3858 IN 226 Interconnect ID number                                    226
3859 IN 226 Source type(S,C, or F),Source ID,Source row #             C,2,21
3860 IN 226 Destination type(A or C),Dest ID,Dest row #               A,402,1
3861 IN 226 Gain                                                      1

3862 IN 227 Interconnect ID number                                    227
3863 IN 227 Source type(S,C, or F),Source ID,Source row #             C,2,23
3864 IN 227 Destination type(A or C),Dest ID,Dest row #               A,502,1
3865 IN 227 Gain                                                      1

3866 IN 228 Interconnect ID number                                    228
3867 IN 228 Source type(S,C, or F),Source ID,Source row #             C,2,25
3868 IN 228 Destination type(A or C),Dest ID,Dest row #               A,602,1
3869 IN 228 Gain                                                      1

3870 IN 229 Interconnect ID number                                    229
3871 IN 229 Source type(S,C, or F),Source ID,Source row #             C,2,27
3872 IN 229 Destination type(A or C),Dest ID,Dest row #               A,702,1
3873 IN 229 Gain                                                      1

3874 IN 230 Interconnect ID number                                    230
3875 IN 230 Source type(S,C, or F),Source ID,Source row #             C,2,29
3876 IN 230 Destination type(A or C),Dest ID,Dest row #               A,802,1
3877 IN 230 Gain                                                      1

3878 IN 231 Interconnect ID number                                    231
3879 IN 231 Source type(S,C, or F),Source ID,Source row #             C,2,16
3880 IN 231 Destination type(A or C),Dest ID,Dest row #               A,103,1
3881 IN 231 Gain                                                      0

3882 IN 232 Interconnect ID number                                    232
3883 IN 232 Source type(S,C, or F),Source ID,Source row #             C,2,18
3884 IN 232 Destination type(A or C),Dest ID,Dest row #               A,203,1
3885 IN 232 Gain                                                      1

3886 IN 233 Interconnect ID number                                    233
3887 IN 233 Source type(S,C, or F),Source ID,Source row #             C,2,20
3888 IN 233 Destination type(A or C),Dest ID,Dest row #               A,303,1
3889 IN 233 Gain                                                      1

3890 IN 234 Interconnect ID number                                    234
3891 IN 234 Source type(S,C, or F),Source ID,Source row #             C,2,22
3892 IN 234 Destination type(A or C),Dest ID,Dest row #               A,403,1
3893 IN 234 Gain                                                      1

3894 IN 235 Interconnect ID number                                    235
3895 IN 235 Source type(S,C, or F),Source ID,Source row #             C,2,24
3896 IN 235 Destination type(A or C),Dest ID,Dest row #               A,503,1
3897 IN 235 Gain                                                      1

3898 IN 236 Interconnect ID number                                    236
3899 IN 236 Source type(S,C, or F),Source ID,Source row #             C,2,26
3900 IN 236 Destination type(A or C),Dest ID,Dest row #               A,603,1
3901 IN 236 Gain                                                      1

3902 IN 237 Interconnect ID number                                    237
3903 IN 237 Source type(S,C, or F),Source ID,Source row #             C,2,28
3904 IN 237 Destination type(A or C),Dest ID,Dest row #               A,703,1
3905 IN 237 Gain                                                      1

3906 IN 238 Interconnect ID number                                    238
3907 IN 238 Source type(S,C, or F),Source ID,Source row #             C,2,30
3908 IN 238 Destination type(A or C),Dest ID,Dest row #               A,803,1
3909 IN 238 Gain                                                      1
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3910 IN 991 Interconnect ID number                                 991
3911 IN 991 Source type(S,C, or F),Source ID,Source row #          F,111,1
3912 IN 991 Destination type(A or C),Dest ID,Dest row #            A,111,1
3913 IN 991 Gain                                                   1

3914 IN 992 Interconnect ID number                                 992
3915 IN 992 Source type(S,C, or F),Source ID,Source row #          F,111,1
3916 IN 992 Destination type(A or C),Dest ID,Dest row #            A,112,1
3917 IN 992 Gain                                                   1

3918 IN 993 Interconnect ID number                                 993
3919 IN 993 Source type(S,C, or F),Source ID,Source row #          F,111,1
3920 IN 993 Destination type(A or C),Dest ID,Dest row #            A,113,1
3921 IN 993 Gain                                                   1

            DEVICE

3922 DE   1 Device ID number                                       1
3923 DE   1 Device Type (LI,QU,SD,CO,UH,LH)                        LI
3924 DE   1 Device location (Node or Hinge)                        N
3925 DE   1 Hinge ID no., Hinge axis no.(1-6)
3926 DE   1 Node 1 Body ID no., Node 1 Node ID no.                 1,12
3927 DE   1 Node 2 Body ID no., Node 2 Node ID no.                 2,23
3928 DE   1 Hardstop Location, Initial force
3929 DE   1 Stiffness Coefficient (Kqe)                            1225.88
3930 DE   1 Damping Coefficient (Bqe)                              0
3931 DE   1 Unstreched spring/cable length                         10

3932 DE   2 Device ID number                                       2
3933 DE   2 Device Type (LI,QU,SD,CO,UH,LH)                        LI
3934 DE   2 Device location (Node or Hinge)                        N
3935 DE   2 Hinge ID no., Hinge axis no.(1-6)
3936 DE   2 Node 1 Body ID no., Node 1 Node ID no.                 1,13
3937 DE   2 Node 2 Body ID no., Node 2 Node ID no.                 2,23
3938 DE   2 Hardstop Location, Initial force
3939 DE   2 Stiffness Coefficient (Kqe)                            2189.07
3940 DE   2 Damping Coefficient (Bqe)                              0
3941 DE   2 Unstreched spring/cable length                         10

3942 DE   3 Device ID number                                       3
3943 DE   3 Device Type (LI,QU,SD,CO,UH,LH)                        LI
3944 DE   3 Device location (Node or Hinge)                        N
3945 DE   3 Hinge ID no., Hinge axis no.(1-6)
3946 DE   3 Node 1 Body ID no., Node 1 Node ID no.                 1,14
3947 DE   3 Node 2 Body ID no., Node 2 Node ID no.                 2,23
3948 DE   3 Hardstop Location, Initial force
3949 DE   3 Stiffness Coefficient (Kqe)                            1926.39
3950 DE   3 Damping Coefficient (Bqe)                              0
3951 DE   3 Unstreched spring/cable length                         10

            CONSTRAINED

3952 CD   2 ID Number                                              2
3953 CD   2 Type (CL,VT,VD,RT,RD,PL,HI,CJ)                         CL
3954 CD   2 Node 1 body ID, Node 1 node ID                         6,3
3955 CD   2 Node 2 body ID, Node 2 node ID                         1,4
3956 CD   2 Constraint Unit Vector (x, y, z)
3957 CD   2 Hinge/Cut Joint ID, Axis
3958 CD   2 Function Generator ID

3959 CD   3 ID Number                                              3
3960 CD   3 Type (CL,VT,VD,RT,RD,PL,HI,CJ)                         CL
3961 CD   3 Node 1 body ID, Node 1 node ID                         8,3
3962 CD   3 Node 2 body ID, Node 2 node ID                         1,5
3963 CD   3 Constraint Unit Vector (x, y, z)
3964 CD   3 Hinge/Cut Joint ID, Axis
3965 CD   3 Function Generator ID

3966 CD   4 ID Number                                              4
3967 CD   4 Type (CL,VT,VD,RT,RD,PL,HI,CJ)                         CL
3968 CD   4 Node 1 body ID, Node 1 node ID                         10,3
3969 CD   4 Node 2 body ID, Node 2 node ID                         1,6
3970 CD   4 Constraint Unit Vector (x, y, z)
```

3971	CD	4 Hinge/Cut Joint ID, Axis	
3972	CD	4 Function Generator ID	
3973	CD	5 ID Number	5
3974	CD	5 Type (CL,VT,VD,RT,RD,PL,HI,CJ)	CL
3975	CD	5 Node 1 body ID, Node 1 node ID	12,3
3976	CD	5 Node 2 body ID, Node 2 node ID	1,7
3977	CD	5 Constraint Unit Vector (x, y, z)	
3978	CD	5 Hinge/Cut Joint ID, Axis	
3979	CD	5 Function Generator ID	
3980	CD	6 ID Number	6
3981	CD	6 Type (CL,VT,VD,RT,RD,PL,HI,CJ)	CL
3982	CD	6 Node 1 body ID, Node 1 node ID	14,3
3983	CD	6 Node 2 body ID, Node 2 node ID	1,8
3984	CD	6 Constraint Unit Vector (x, y, z)	
3985	CD	6 Hinge/Cut Joint ID, Axis	
3986	CD	6 Function Generator ID	
3987	CD	7 ID Number	7
3988	CD	7 Type (CL,VT,VD,RT,RD,PL,HI,CJ)	CL
3989	CD	7 Node 1 body ID, Node 1 node ID	16,3
3990	CD	7 Node 2 body ID, Node 2 node ID	1,9
3991	CD	7 Constraint Unit Vector (x, y, z)	
3992	CD	7 Hinge/Cut Joint ID, Axis	
3993	CD	7 Function Generator ID	
3994	CD	8 ID Number	8
3995	CD	8 Type (CL,VT,VD,RT,RD,PL,HI,CJ)	CL
3996	CD	8 Node 1 body ID, Node 1 node ID	18,3
3997	CD	8 Node 2 body ID, Node 2 node ID	1,10
3998	CD	8 Constraint Unit Vector (x, y, z)	
3999	CD	8 Hinge/Cut Joint ID, Axis	
4000	CD	8 Function Generator ID	

CNTDTA

4001	CN	1 CNTDTA : ID Number	1
4002	CN	1 CNTDTA : Number of data values (max = 150)	7
4003	CN	1 CNTDTA : Array value	2.2871
4004	CN	1 CNTDTA : Array value	0.000
4005	CN	1 CNTDTA : Array value	0.000
4006	CN	1 CNTDTA : Array value	0.000
4007	CN	1 CNTDTA : Array value	0.000
4008	CN	1 CNTDTA : Array value	0.000
4009	CN	1 CNTDTA : Array value	0.000

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16. Abstract

A successful design of a space-based or ground optical system requires an iterative procedure which includes the kinematics and dynamics of the system in operating environment, control synthesis and verification. To facilitate the task of designing optical wave front control systems being developed at NAS/MSFC, a multi-discipline dynamics and control tool has been developed by utilizing TREETOPS, a multi-body dynamics and control simulation, NASTRAN and MATLAB. Dynamics and control models of STABLE and ARIS were developed for TREETOPS simulation, and their simulation results are documented in this report.

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