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### AUTHORITY
- AFATL ltr, 24 Jun 1974
CLOSE AIR SUPPORT MISSILE
GUIDANCE AND CONTROL STUDY
VOLUME I SIX-DEGREE-OF-FREEDOM SIMULATION

DEPARTMENT OF MECHANICAL ENGINEERING
THE UNIVERSITY OF FLORIDA

TECHNICAL REPORT AFATL-TR-71-169, VOLUME I

DECEMBER 1971

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this report documents the close air support missile guid-
ance and control study, distribution limitation applied
December 1971. Other requests for this document must be
referred to the Air Force Armament Laboratory (DLWG),
Eglin Air Force Base, Florida 32542.

AIR FORCE ARMAMENT LABORATORY
AIR FORCE SYSTEMS COMMAND - UNITED STATES AIR FORCE

EGLIN AIR FORCE BASE, FLORIDA
Close Air Support Missile
Guidance And Control Study

Volume I. Six-Degree-Of-Freedom Simulation

J. Mahiy

Distribution limited to U.S. Government agencies only; this report documents the close air support missile guidance and control study. Distribution limitation applied December 1971. Other requests for this document must be referred to the Air Force Armament Laboratory (DLNG), Eglin Air Force Base, Florida 32542.
FOREWORD

This report was prepared by the Industrial and Experiment Station, Department of Mechanical Engineering, University of Florida, Gainesville, Florida, under Contract No. F08635-71-C-0073 with the Air Force Armament Laboratory, Eglin Air Force Base, Florida, during the period from 9 December 1970 to 9 December 1971. Lieutenant Robert J. Karner (DLWG) monitored the project for the Armament Laboratory.

The principal investigator for the contractor was Dr. J. Mahig.

This report consists of two volumes. Volume I is devoted to the Six-Degree-of-Freedom Simulation while Volume II is concerned with the Three-Degree-of-Freedom Simulation. This is Volume I.

This technical report has been reviewed and is approved.

[Signature]

HEYM AND H. STRONG
Acting Chief, Air-to-Surface Guided Weapons Div.
This report describes a six-degree-of-freedom program which can be used to determine the trajectory and miss distance of a missile system. The options for the program are such as to permit variation of the aerodynamics, seeker, autopilot, actuator, and missile motor performance for the purpose of accurately simulating a given missile design and evaluating the effects of any changes in system parameters. Sufficient detail has been included in the text in order to minimize the users' effort needed to know how to update or modify the program for his purposes.
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SECTION I
INTRODUCTION

The purpose of this report is to provide a reference which will enable ready access to the use of a six-degree-of-freedom program which is capable of accurately determining the trajectory and miss distance of a semi-active or passive guided missile. The program is divided into convenient blocks, called modules or subroutines, which do specific tasks: e.g., determine aerodynamic forces, seeker output, state of autopilot, current value of thrust, etc. As a result, the user will be able to easily locate the section of the program where specific calculations are performed and modify them or, if necessary, to add modules to achieve other purposes.

This program has been derived from a program in the library of the North American Rockwell Company, Columbus Division, and is described in NR 70H-232-1 and -2. The purpose of the program was to determine trajectory and miss distance of an air-to-air or air-to-surface missile. This manual goes into somewhat greater detail in identifying the variables and defining coordinate systems than heretofore. This has been possible because of the extensive work carried out with the program by the author in satisfying the requirements of this contract and information supplied by Mr. A. J. Ehrich and P. D. Capcara of the North American Rockwell (NAR) Corporation. The program described below has been modified from the original version supplied to USAF by North American Rockwell Corporation by personnel at the Air Force Armament Laboratory to permit the consideration of the effect of a random spot motion on the miss distance of a laser guided missile. Incorporated into the version presented in this report are additional capabilities which provide an accurate simulation of the quadrant detector, range closure, proportional lead guidance, simplified program reset mechanism for multiple runs, greater target maneuverability in air-to-air simulations, and a more general high frequency actuator routine which will accept either experimental or theoretically derived transfer functions.
SECTION II
PROGRAM DESCRIPTION

2.1 Subroutines, Modules, and Tables

A complete listing of this program appears in Section V. The program consists of three types of subprograms:

(a) Tables of aerodynamic coefficients in block data form.
(b) Modules describing missile subsystems.
(c) Executive subroutines and the main program.

The block data subroutines must be physically located at the front of the program deck after the main program for proper operation. Data is extracted from these tables in the module A1 which makes use of the table look-up subroutines TABLI, TABL2, and TABL3 which form a part of the executive routines.

For each module (e.g., A1, C4) the programmer has the option of using an associated initialization module (e.g., C41). These initialization modules may be used to compute initial conditions from input data or add to the list of state variables to be integrated. The initialization modules are executed only once at the start of each simulated mission. It is in the modules themselves (e.g., C4) that the derivatives of the state variables are computed. Time is incremented by a fixed amount (Δt) after every other pass since a predictor-corrector integration algorithm is used.

A large block common array, called C, allows the communication of certain variables between modules and subroutines for input/output, integration, and control purposes.

The mathematical relationship of various modules and subroutines are shown in Figure 1, and a corresponding list of the modules is given in Table I.
Figure 1. Flow Chart for State Variable Calculations
# TABLE I. SUBROUTINE AND MODULE LIST SIX-DEGREE-OF-FREEDOM DIGITAL PROGRAM

## I. GEOPHYSICAL AND EXTERNAL ENVIRONMENT

<table>
<thead>
<tr>
<th>Subroutine/Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>G2</td>
<td>Steady winds</td>
</tr>
<tr>
<td>G3</td>
<td>Air data - including dynamic pressure, density, speed of sound</td>
</tr>
<tr>
<td>G4</td>
<td>Terminal geometry - computes miss distance</td>
</tr>
<tr>
<td>G5</td>
<td>Transformations of position and velocity between various coordinate systems</td>
</tr>
</tbody>
</table>

## II. SENSORS

<table>
<thead>
<tr>
<th>Subroutine/Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10</td>
<td>Spot motion - including boresight error, aiming error, hotspot motion, etc.</td>
</tr>
<tr>
<td>S1</td>
<td>Seeker - Seeker performance and platform motion</td>
</tr>
<tr>
<td>QUADET</td>
<td>Quadrant detector simulator</td>
</tr>
</tbody>
</table>

## III. COMPUTERS

<table>
<thead>
<tr>
<th>Subroutine/Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Autopilot - computes steering commands from seeker output</td>
</tr>
<tr>
<td>C4</td>
<td>Actuators - includes flap motion and limits</td>
</tr>
</tbody>
</table>

## IV. AIRFRAME

<table>
<thead>
<tr>
<th>Subroutine/Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Aerodynamics coefficients - table look-up</td>
</tr>
<tr>
<td>A2</td>
<td>Aerodynamic forces and moments - in wind axis, includes forces and moments on lugs while missile is on rail</td>
</tr>
<tr>
<td>A3</td>
<td>Engine - computes thrust forces as well as c.g. shifts and mass changes</td>
</tr>
</tbody>
</table>

## V. DYNAMICS

<table>
<thead>
<tr>
<th>Subroutine/Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Translation dynamics of missile - accelerations in body axes are transformed into earth coordinates and integrated into velocities and positions</td>
</tr>
<tr>
<td>D2</td>
<td>Rotational dynamics of missile - computes rotational accelerations and velocities referred to missile body axes</td>
</tr>
</tbody>
</table>
2.2 A2 - Aero Forces and Moments

Figure 2 shows the relationship between the body axis and wind axis coordinate system. In addition, the coordinate directions are shown for the positive direction of the dimensionless aerodynamics' coefficients in both the body axis system and the wind or primed axis system. The body axis system and the wind axis system are related by the following system of equations:

\[
\begin{bmatrix}
X_B \\
Y_B \\
Z_B
\end{bmatrix} = \phi'
\begin{bmatrix}
X'_B \\
Y'_B \\
Z'_B
\end{bmatrix}
\]

The aerodynamic coefficients are functions of the aerodynamic roll angle (\(\phi'\)) and angle of attack \(\alpha'\). It can be seen that the angles \(\phi'\) and \(\alpha'\) locate the wind vector in much the same way that a magnitude \(r\) and angle \(\theta\) locate a vector in polar coordinates. With reference to Figure 2, it is apparent that the plane containing the wind vector is obtained by rotating the \(X_BZ_B\) plane through \(\phi'\) about the missile centerline (\(X_B\) axis). The wind vector is located in this plane by the angle \(\alpha'\) measured from the \(X_B\) axis. The angles \(\phi'\) and \(\alpha'\) are related to the angle of attack \(\alpha\) and sideslip \(\beta\) by the following equations:

\[
\begin{align*}
\cos \alpha' &= \cos \alpha \cos \beta \\
\sin \phi' &= \sin \beta / \sqrt{1 - \cos^2 \alpha \cos^2 \beta}
\end{align*}
\]

where if \(\alpha\) and \(\beta\) are small, one finds

\[
\alpha'^2 = \alpha^2 + \beta^2.
\]

Since if \(\alpha\) and \(\beta\) are small, \(\alpha'\) will similarly be small and it will be found that

\[
\begin{align*}
\beta &= \alpha' \sin \phi' \\
\phi' &= \alpha' \cos \phi' \\
\tan \phi' &= \beta / \alpha \\
\alpha' &= \sqrt{\alpha^2 + \beta^2}.
\end{align*}
\]
Figure 2. Wind Axis System
'A is the aerodynamic roll angle referenced to zero with the missile flying in the + configuration. If the missile is intended to fly in the X configuration, \( \phi' \) equals 45° with \( \beta = 0 \). Thus, \( \phi' = \phi' - 45^\circ \).

It will be found that the following relationships hold with respect to \( \phi \) and \( \phi' \):

\[
\begin{align*}
\cos 4\phi' &= -\cos 4\phi \\
\sin 4\phi' &= -\sin 4\phi \\
\cos (\phi' - 45^\circ) &= \cos \phi' \\
\sin (\phi' - 45^\circ) &= \sin \phi'.
\end{align*}
\]

Some of the above relations can be experienced in terms of the angle \( \phi' \).

In order to facilitate application to the program, Table II lists the correspondence between variable names, commonly used aero symbols, and their COMMON location in the program.
<table>
<thead>
<tr>
<th>Name</th>
<th>Symbol</th>
<th>Common Location</th>
<th>Name</th>
<th>Symbol</th>
<th>Common Location</th>
</tr>
</thead>
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<tr>
<td>CX</td>
<td>$C_A$</td>
<td>1203</td>
<td>CLDRP</td>
<td>$C_n'/\delta r$</td>
<td>1225</td>
</tr>
<tr>
<td>CY</td>
<td>$C_Y$</td>
<td>1204</td>
<td>CNQ</td>
<td>$C_n'/\delta q$</td>
<td>1226</td>
</tr>
<tr>
<td>C2</td>
<td>$C_2$</td>
<td>1205</td>
<td>CLD</td>
<td>$C_\ell'/\delta p$</td>
<td>1227</td>
</tr>
<tr>
<td>CLP</td>
<td>$C_{LP}$</td>
<td>1206</td>
<td>CLMP</td>
<td>$C_m'$</td>
<td>1228</td>
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<tr>
<td>CMQ</td>
<td>$C_{mq}$</td>
<td>1207</td>
<td>CLNP</td>
<td>$C_n'$</td>
<td>1229</td>
</tr>
<tr>
<td>CNR</td>
<td>$C_{nr}$</td>
<td>1208</td>
<td>BDEFL</td>
<td>$</td>
<td>\delta</td>
</tr>
<tr>
<td>CL</td>
<td>$C_{\ell'}$</td>
<td>1209</td>
<td>CDCM</td>
<td>$C_m'(\phi')$</td>
<td>1231</td>
</tr>
<tr>
<td>C1</td>
<td>$C_1$</td>
<td>1210</td>
<td>DDL</td>
<td>$\delta_p$</td>
<td>1232</td>
</tr>
<tr>
<td>CN</td>
<td>$C_N$</td>
<td>1211</td>
<td>BDM</td>
<td>$\delta_q$</td>
<td>1233</td>
</tr>
<tr>
<td>CXO</td>
<td>$C_A$</td>
<td>1212</td>
<td>BDN</td>
<td>$\delta_r$</td>
<td>1234</td>
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<tr>
<td>CXC</td>
<td>$C_A'(trim)$</td>
<td>1213</td>
<td>CDCN</td>
<td>$C_N'(\phi')$</td>
<td>1235</td>
</tr>
<tr>
<td>CNPT</td>
<td>$C_N'(\alpha')$</td>
<td>1214</td>
<td>CL2</td>
<td>$C_\ell'(\phi)$</td>
<td>1240</td>
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<tr>
<td>CY2</td>
<td>$C_Y'(\phi')$</td>
<td>1215</td>
<td>CL3</td>
<td>$C_\ell'(\phi)_{1ug}$</td>
<td>1241</td>
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<tr>
<td>CMO</td>
<td>$C_m'(\alpha')$</td>
<td>1217</td>
<td>CNPU</td>
<td>$C_N'(\phi',\alpha')$</td>
<td>1244</td>
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<tr>
<td>CN2</td>
<td>$C_N'(\phi')$</td>
<td>1218</td>
<td>CYPU</td>
<td>$C_Y'(\phi)$</td>
<td>1245</td>
</tr>
<tr>
<td>CZQ</td>
<td>$C_N'/\delta q$</td>
<td>1219</td>
<td>CMP</td>
<td>$C_m'(\alpha',\phi')$</td>
<td>1247</td>
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<tr>
<td>CZR</td>
<td>$C_N'/\delta r$</td>
<td>1220</td>
<td>CNP</td>
<td>$C_n'(\phi')$</td>
<td>1248</td>
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<td>C:IDQP</td>
<td>$C_N'/\delta q$</td>
<td>1221</td>
<td>CLR</td>
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<td>1249</td>
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<tr>
<td>CMR</td>
<td>$C_m'/\delta r$</td>
<td>1222</td>
<td>C2P</td>
<td>$C_N'$</td>
<td>1250</td>
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<tr>
<td>CYR</td>
<td>$C_Y'/\delta r$</td>
<td>1223</td>
<td>CYP</td>
<td>$C_Y'$</td>
<td>1251</td>
</tr>
<tr>
<td>CYQ</td>
<td>$C_Y'/\delta q$</td>
<td>1224</td>
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</tbody>
</table>
2.3.1 **D1, D2 - Translational and Rotational Dynamics Module**

The following list of symbols applies to the equations of motion which are developed in paragraph 2.3.3 for modules D1 and D2.

### 2.3.2 **List of Symbols**

- **m** - $F(t)$ instantaneous mass (slugs)
- **p** - Rolling velocity = angular velocity along X axis (rad/sec)
- **q** - Pitching velocity = angular velocity along Y axis (rad/sec)
- **r** - Yawing velocity = angular velocity along Z axis (rad/sec)
- **$I_X$** - Moment of inertia about X axis (slug-ft)
- **$I_Y$** - Moment of inertia about Y axis (slug-ft)
- **$I_Z$** - Moment of inertia about Z axis (slug-ft)
  \[(I_z = I_y \text{ for a perfectly symmetrical missile})\]
- **U** - Linear velocity along the X body ($X_E$) axis (ft/sec)
- **V = U_\alpha** - Linear velocity along the Y body ($Y_E$) axis (ft/sec)
- **W = U_\beta** - Linear velocity along the Z body ($Z_B$) axis (ft/sec)
- **$X_B, Y_B, Z_B$** - Airframe axis system that moves with airframes
- **$X_e, Y_e, Z_e$** - Earth coordinates
- **\(\alpha\)** - Angle of attack = angle between a fuselage reference line and the relative wind in the $X_B, Z_B$ plane (rad)
  \[\tan \alpha = \frac{W}{U}; \alpha = \frac{W}{U}\]
- **\(\beta\)** - Angle of sideslip (rad)
  \[\tan \beta = \frac{V}{U^2 + W^2}; \beta = \frac{V}{U}\]
Euler angles
ψ, θ, and φ - ψ is the rotation about Z_B, θ is the rotation about Y_B, and φ is the rotation about X_B in that order (rad)

g - Acceleration due to gravity (ft/sec²)

T - Thrust along X_B

C_N, C_Y, C_C, C_R, C_m, C_n - Dimensionless aerodynamics coefficients (body axes)

C'_N, C'_Y, C'_C, C'_R, C'_m, C'_n - Dimensionless aerodynamics coefficients (primed axes system - Figure 2)

- Density (slug/ft³)

q₀ - Dynamic pressure = ½ρU² (lb/ft²)

S - Body reference cross sectional area (ft²)

ι - Reference body length (ft)

ΔX - Shift of center of gravity from a reference point along the X_B axis (ft) - negative aft

δ - Control surface deflection (rad)

δq - Control surface deflection to give pitching motion (rad)

δp - Control surface deflection to give rolling motion (rad)

δr - Control surface deflection to give yawing motion (rad)

C_ij - Dimensionless aerodynamic derivatives

d' - Aerodynamic or wind angles of attack (rad) - Figure 2

ϕ' - Aerodynamic roll angle (rad) - Figure 2

ϕ''_A - Aerodynamic roll angle (rad) referenced to zero when flying in the + configuration.
ϕ''_A = ϕ' + 45°
2.3.3 Equations of Motion

The six-degree-of-freedom equations of motion implemented in the computer program in terms of the body axes are given below*. (See Figure 3 for coordinate system orientation.)

**Longitudinal Force**

\[ \Sigma F_x = m[U + U_d q - U_b r] = q \rho S_n C_x - mg \sin \theta + T \]

**Lateral Force**

\[ \Sigma F_y = m[d/dt(U_d) + Ur - U_d P] = q \rho S_n [C_y \Phi' - \sin \Phi']_n + mg \cos \theta \sin \phi \]

**Vertical Force**

\[ \Sigma F_z = m[d/dt(U_a) + U_b p - U_q] = -q \rho S_n [C_z \Phi' + \sin \Phi']_n + mg \cos \theta \cos \phi \]

**Rolling Moment**

\[ \Sigma M_x = I_x p = q \rho S_n \ell [C_l + \ell/2U_c \rho P] \]

**Pitching Moment**

\[ \Sigma M_y = I_y q + (I_x - I_z)p r = q \rho S_n \ell [C_m \Phi' + \sin \Phi']_n + \ell/2U_c m q - \Delta X/2U_c (\sin \Phi' + \cos \Phi')_n \]

**Yawing Moment**

\[ \Sigma M_z = I_z r + (I_y - I_x)p q = q \rho S_n \ell [C_n \Phi' - \sin \Phi']_n + \ell/2U_c m r - \Delta X/2U_c (\cos \Phi' - \sin \Phi')_n \]

* U\_X velocity in X direction
  V\_Y velocity in Y direction
  W\_Z velocity in Z direction
Figure 3. Definitions of Angles and Coordinate Systems
The Euler transformations of

\[ \dot{\phi} = p = r\cos\phi / \cos \theta + q\sin\phi / \cos \theta \]
\[ \dot{\theta} = q = q\cos\phi - r\sin\phi \]
\[ \dot{\psi} = r = p + (r\cos\phi + q\sin\phi) \tan \theta \]

The velocity, in terms of the earth axes, can be obtained as:

\[ X = U\cos\theta \cos\psi + U_\beta (\sin\psi \sin\theta \cos\psi - \cos\psi \sin\psi) \]
\[ + U_\alpha (\cos\psi \sin\theta \cos\psi + \sin\psi \sin\psi) \]
\[ Y = U\cos\theta \sin\psi + U_\beta (\cos\psi \cos\psi + \sin\psi \sin\psi \sin\phi) \]
\[ + U_\alpha (\cos\psi \sin\psi \sin\psi - \sin\psi \cos\psi) \]
\[ Z = - U\sin\theta + U_\beta \sin\psi \cos\theta + U_\alpha \cos\theta \cos\phi \]

The Euler angles, shown in Figure 4, and the position of the missile in earth coordinates can be obtained through an integration of the above equations.

The block diagram of the implementation of the equations of motion and the Euler transformations are shown in Figure 5.

2.4 Subroutine G2

This subroutine is called the wind and gust module. This module determines the velocity and direction of the wind. The module assumes that there is no wind above an altitude RHW. Below that altitude the wind direction and magnitude are assumed to be constant throughout a layer RWINC in depth. (It should be noted that RWINC is measured along the line of sight. Since most missiles fly with only small deviation from the original line of sight, the altitude increments, if needed, may be readily estimated.) Two random variables are associated with the wind in each layer: the magnitude and angular orientation which are considered constant in each layer. The mean value of the wind magnitude is VWTE, and its standard deviation is given as SW. The mean value of the angular orientation of the wind in a layer is BPSIW, and the standard deviation of the angular variation is SW1. The current value of the wind magnitude and direction is given by VWTEV and BPSIYV, respectively. The relationship between these mean values and the inertial coordinate system is shown in Figure 6.
Figure 4. Euler Angles Between Body Axis and Inertial Axis
FIGURE 5. SIX-DEGREE-OF-FREEDOM EQUATIONS OF MOTION
Figure 6. Coordinate System Associated with Wind and Gust Module
2.5 **Subroutine C10**

This subroutine determines the ground plane coordinates of that point in the area illuminated by the laser beam which the missile seeker physics causes the autopilot to consider the designated target. This distinction is necessary since some seekers are hotspot trackers while others are centroidal trackers. The procedure used to develop this apparent target is accomplished first through the designation of the coordinates of the illuminator (XIL, HILL) which may either be on the forward air controller or on the launch aircraft. The maximum errors generated on the ground are considered to be made up of three parts: the maximum boresight error (BORE), the maximum pointing error (WAND), and the maximum deviation of the hotspot from the resulting beam centroid, which is designated as (RADIUS). Each of these variables is considered a random variable with a uniform distribution. The resulting random variables generated are, respectively, BOREF, WANDF, and SPWID. The variables are considered to vary independently in the XE and YE direction and are then appropriately summed in order to determine the apparent target location. The coordinates of this point are designated as the variables ZLASR and YLASR. The location in earth coordinates may be found by equating ZLASR to XE and YLASR to YE and setting ZE equal to zero.

2.6 **Subroutine QUADET**

Subroutine QUADET is called by Sl for the determination of the signal generated to the autopilot by the quadrant detector (Figure 7). The quadrant detector is oriented such that the dead zone is in the same direction as the fins, assuming the missile flies in the X configuration. The subroutine determines the current size of the circular image through the assumption that the image size increases inversely proportional to the range of the missile from the laser spot. RT1 is the variable designating the ratio of the size of the current spot to its size at infinity. The laser image on the detector is assumed to be circular. In order to determine the portion of the area of each quadrant covered by the laser image, the area of the detector is subdivided into LT segments. (In the current program LT is set equal to 16.) In order to effect a dead zone, an area around the axis of the coordinate system equal to half the segment width is not included in the area of the image which cover these segments. If a portion of the laser image falls off the assumed circular detector's surface, it is not considered. The variable DETRID is half the instantaneous field of view of the detector in degrees. DEFICS is half the
Missile fin orientation

Vertical

AA, BB, CC, DD - Area of laser spot in respective quadrant (sq. in.) (less dead zone) shaded area represents defocused spot on quadrant detector

Figure 7. Quadrant Detector Geometry
instantaneous field of view intercepted by the image of
the laser spot on the detector. The subroutine will de-
termine if the following blind range and breaklock cri-
teria are met and print this information on the line
printer. The breaklock criteria is met if there is no
portion of the laser image on any of the four quadrants.
The blind range criteria is met if the image of the laser
spot on the detector exceeds 90 percent of the total area
of the detector.

2.7 Subroutine S1 (Module)

The purpose of the S1 Module is to simulate the re-
sponse of several types of seeker models and to generate
the commands which are transmitted to the autopilot.

The subroutine will simulate the seeker response to
either a continuous information source or a sampled data
source. This is accomplished by setting the variable
OPTKR either to zero or one, respectively. If operating
from a continuous information source, the seeker is as-
sumed by the module to be a proportional seeker. In the
sampled data mode the seeker can be programmed as either
a proportional or a bang-bang seeker by the choice of the
magnitude of the variable DEFOCS. If this variable is
chosen so that it is equivalent to DELF (detector radius/LT
(in current program), the seeker will simulate a bang-bang
laser seeker; whereas, if this variable is chosen so that
it is larger than DELF, it will produce a proportional
laser processor.

In the sample data mode the seeker will simulate
either a pursuit or a proportional navigation system by
setting the variable CAGE equal to zero or one, respective-
ly. In the continuous information mode, corresponding
changes in the guidance law will occur. In either mode
of operation the PLG option may be implemented. This is
done by removing the C from the two cards following the
PLG OPTION card.

The mode of operation of the subroutine in either
mode is to initially determine the true location of the
target in the gimbal axis coordinate system (RXG, RYG, and
RZG) and then determine the angles the lines of sight make
with the RYG, RXG plane and the RZG, RXG planes (BEPSY and
BEPSZ, respectively, shown in Figure 8 and Figure 9).
Figure 8. Coordinate Relations Between Body and Gimbal Axis System and the Line of Sight
Gyroscope Platform Gimbal Angles

$\theta_g$ outer gimbal - pitch

$\psi_g$ inner gimbal - yaw

Figure 9. Schematic Diagram of Platform Gimbal Angles
The rate of pulse loss is determined by the value, between zero and one, initially given the variable VLAZRP. This is done by comparing a uniformly distributed random variable [C(103)] whose range is also between zero and one with VLAZRP. If it is greater, it is assumed that the information in the pulse is lost. If pulse loss has not occurred, then the apparent location of the target is determined in the gimbal axis coordinate system which has resulted from boresight errors, wander, etc. Subroutine QUADDET is then called to determine the output of the quadrant detector. This output is used to generate the required gimbal rate and autopilot commands. If pulse loss has occurred, previously generated commands (e.g., gimbal rate, autopilot signals) are maintained.

In addition, Appendix I shows the mechanics of the coordinate transformation from the body axis to the gimbal axis system for easy reference.

2.8 C1 Autopilot Module

The following high and low frequency autopilot block diagrams are suitable representations for an autopilot that would prove to be consistent with either a proportional or bang-bang seeker. The block diagrams for each of those autopilots are given in Figures 10, 11, 12, and 13. These systems correspond to those mechanized in the program listing found in Section V for the low frequency autopilot and in Appendix III for the high frequency autopilot.

2.9 C4 - Actuator Module

The actuator module simulates the action of the actuator up to a third order system, as shown in Figure 14, which corresponds to a high frequency actuator. Under these conditions it is capable of simulating the dynamics of either a torque balance system whose block diagram is shown in Figure 15, or that of the position loop-controlled actuator shown in Figure 16. It will also simulate the dynamics of an actuator whose transfer function has been determined from hardware test data up to the third order.

The transfer function, given in general form as expressed in this module, is shown below:

\[
\frac{\delta}{\delta_c} = \frac{K}{\lambda_1 \cdot s^3 + \lambda_2 \cdot s^2 + \lambda_3 \cdot s + \lambda_4}
\]
FIGURE 10. AUTOPILOT
HIGH FREQUENCY MODEL
Figure 11. Pitch Rate Gyro
Figure 12. Yaw Rate Gyro
\[
\frac{\delta}{\delta_c} = \frac{1}{(16.3 + 1)(\frac{S^2}{180^2} + \frac{96}{180} S + 1)}
\]
[worst case model from hardware test data]

\[\delta \sim BDFLTRC(1) \frac{K_W}{K_L} \frac{1}{TS+1}\]

Figure 15. Actuator Torque Balance System
Figure 16. Actuator Position Loop Block Diagram
The transfer function for either the position feedback system or the torque balance system can be brought into the following form:

\[
\frac{\delta}{\delta_C} = \frac{K_yA^*\delta_57.3}{K_L[S(K_LJS(\tau S+1) + K_R(\tau S+1) + (A \tau)^2/K_L] + K_SK_57.3(\tau S+1)}
\]

and similarly for the position loop block diagram.

If either the torque balance system or the position loop control system is to be activated, then CKACT should be either set equal to one or zero, depending on whether the aerodynamic tables for FMH1, FMH2, FMH3, and FMH4 are included in the data tables. The variable BDMAX limits the maximum amplitude of the fin motion. The low frequency actuator equations are developed below.

**Low Frequency Actuator**

\[
\begin{align*}
BDELT(1) & = BDELT(1) - \delta p + \delta q - \delta r \\
BDELT(2) & = BDELT(2) - \delta p + \delta q + \delta r \\
BDELT(3) & = BDELT(3) + \delta p + \delta q - \delta r \\
BDELT(4) & = BDELT(4) + \delta p + \delta q + \delta r \\
\delta_1 & = BDELT(1) \\
\delta_2 & = BDELT(2) \\
\delta_3 & = BDELT(3) \\
\delta_4 & = BDELT(4)
\end{align*}
\]

where

\[
\begin{align*}
\delta p & = DELTPB \\
\delta q & = DELTQB \\
\delta r & = DELTRB
\end{align*}
\]

The mechanization of these equations may be found in the Program Listing (Section V) for the low frequency actuator. The high frequency actuator program listing may be found in Appendix II.
2.9.1 Fin Deflection

A positive pitch rate (motion up) is obtained with a negative $\delta q$, where

$$\delta q = \frac{\delta_1 + \delta_2 + \delta_3 + \delta_4}{4}.$$

A positive roll rate (motion clockwise about the X body axis) is obtained with a positive $\delta p$, where

$$\delta p = \frac{(\delta_3 - \delta_2 + \delta_4 - \delta_1)}{4}.$$

A positive yaw rate (motion clockwise about the Z body axis) is obtained with a negative $\delta r$.

A positive surface deflection is defined as a trailing edge down. The surfaces are labeled by looking at the missile tail-on, with $\delta_1$ being the upper right surface, $\delta_2$ the lower right surface, $\delta_3$ the lower left surface, and $\delta_4$ the upper left surface, as shown in Figure 17.

It is assumed that the surface effectiveness will be given in terms of $\delta q$, $\delta p$, and $\delta r$ as a function of $\alpha'$ and $\phi'$. These terms will be considered as a part of the aerodynamic coefficients given in the primed axis system.

2.10 A3 - Engine Module

As a result of various sources of error occurring in the manufacture and assembly of a solid propellant motor, the thrust alignment is not perfect. The coordinate system used in determining the misalignment the user wishes to simulate is shown in Figure 18.
Figure 17. Fin Sign Conventions
RFXCG - X Component of thrust vector with respect to body axis in the X direction

RFYCG - Y Component of thrust vector with respect to body axis in the Y direction

RFZCG - Z Component of thrust vector with respect to body axis in the Z direction

FTHRST - Missile Thrust

Figure 18. Offset Thrust Vector Coordinate System
SECTION III

VARIABLE LOCATIONS

3.1 Variable Names, Block Locations, and Definitions

Since the proper use of this program requires that the definition of upwards of five hundred singly dimensioned variables as well as many multidimensioned be made, it is clear that some order must be maintained in the allocation of storage or serious programming difficulties could arise. Therefore, blocks of common location have been allocated to specific subroutines as shown in Table III. This procedure should be continued in the event it is necessary to add variables as a result of program modifications.

Of the large number of variables actually listed by the program, only two hundred and fifty appear to be significant in the preparation of the input or of an aid in understanding the output. Therefore, it was felt that they should be separately defined. This is done in Table IV. It should be noted that the units of the variables listed in that table should be considered to be in feet, seconds, pounds, or degrees unless otherwise specified.
<table>
<thead>
<tr>
<th>Array Index</th>
<th>Module Name</th>
<th>Module Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 50</td>
<td>C10</td>
<td>Unsteady Illuminator</td>
</tr>
<tr>
<td>50 - 102</td>
<td>G2</td>
<td>Steady Winds, Variable Winds</td>
</tr>
<tr>
<td>200 - 299</td>
<td>G3</td>
<td>Air Data</td>
</tr>
<tr>
<td>350 - 399</td>
<td>G5</td>
<td>Coordinate Conversion</td>
</tr>
<tr>
<td>400 - 499</td>
<td>S1, S1I</td>
<td>Seeker - Platform</td>
</tr>
<tr>
<td>800 - 899</td>
<td>C1, C1I</td>
<td>Autopilot</td>
</tr>
<tr>
<td>1100 - 1149</td>
<td>C4, C4I</td>
<td>Actuators</td>
</tr>
<tr>
<td>1200 - 1299</td>
<td>A1</td>
<td>Aero Table Look-Up</td>
</tr>
<tr>
<td>1300 - 1399</td>
<td>A2</td>
<td>Forces and Moments</td>
</tr>
<tr>
<td>1400 - 1499</td>
<td>A3, A3I</td>
<td>Engine</td>
</tr>
<tr>
<td>1600 - 1699</td>
<td>D1, D1I</td>
<td>Translational Dynamics</td>
</tr>
<tr>
<td>1700 - 1799</td>
<td>D2, D2I</td>
<td>Rotational Dynamics</td>
</tr>
</tbody>
</table>

Note: Locations 1950 - 4310 are reserved for Executive Subroutines, Initial Conditions, and Input-Output Instructions.
<table>
<thead>
<tr>
<th>Common Location</th>
<th>Variable Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(1)</td>
<td>BORE</td>
<td>Maximum boresight error</td>
</tr>
<tr>
<td>C(2)</td>
<td>WAND</td>
<td>Maximum pointing error</td>
</tr>
<tr>
<td>C(3)</td>
<td>RADIUS</td>
<td>Maximum deviation of hotspot from beam centroid</td>
</tr>
<tr>
<td>C(4)</td>
<td>HILL</td>
<td>Height of illuminator</td>
</tr>
<tr>
<td>C(5)</td>
<td>RILL</td>
<td>Ground range of illuminator</td>
</tr>
</tbody>
</table>
| C(6)            | AIS PTT       | { 0. - Centroid tracker  
|                |               | 1. - Hotspot tracker } |
| C(7)            | AILL          | { 0. - Stationary illuminator*  
|                |               | 1. - Moving illuminator } |
| C(8)            | SPOTMO        | { 0. - No spot motion  
|                |               | 1. - Spot motion } |
| C(9)            | XSPOT         | X - Coordinate of centroid or hotspot |
| C(10)           | YSPOT         | Y - Coordinate of centroid or hotspot |
| C(11)           | AIFAC         | { 0. - Tracker on ground or on launch aircraft  
|                |               | 1. - Tracker on separate aircraft } |
| C(12)           | VILM          | Velocity of illuminator, Mach number |
| C(18)           | XILL          | Ground range in X direction of illuminator |

*Must give HILL, XILL for input
<table>
<thead>
<tr>
<th>Common Location</th>
<th>Variable Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(51)</td>
<td>BPSIW</td>
<td>Mean angle of wind velocity vector</td>
</tr>
<tr>
<td>C(52)</td>
<td>VWTE</td>
<td>Mean wind velocity</td>
</tr>
<tr>
<td>C(53)</td>
<td>RHW</td>
<td>Altitude above which all the winds are zero</td>
</tr>
<tr>
<td>C(55)</td>
<td>SW</td>
<td>Standard deviation from mean angle of wind velocity vector BPSIW</td>
</tr>
<tr>
<td>C(56)</td>
<td>RWINC</td>
<td>Shear layer of wind. Depth of wind layers at which wind velocity and angle remain constant.</td>
</tr>
<tr>
<td>C(58)</td>
<td>SWl</td>
<td>Standard deviation from mean wind velocity VWTE</td>
</tr>
<tr>
<td>C(100)</td>
<td>VWXE</td>
<td>Wind velocity (X component with reference to the earth-fixed coordinate system)</td>
</tr>
<tr>
<td>C(101)</td>
<td>VWYE</td>
<td>Wind velocity (Y component with reference to the earth-fixed coordinate system)</td>
</tr>
<tr>
<td>C(102)</td>
<td>VWZE</td>
<td>Wind velocity (Z component with reference to the earth-fixed coordinate system)</td>
</tr>
<tr>
<td>C(203)</td>
<td>PDYNMC</td>
<td>Dynamic pressure</td>
</tr>
<tr>
<td>C(204)</td>
<td>VMACH</td>
<td>Mach number</td>
</tr>
<tr>
<td>C(205)</td>
<td>DRHO</td>
<td>Air density</td>
</tr>
<tr>
<td>C(206)</td>
<td>VSOUND</td>
<td>Speed of sound</td>
</tr>
<tr>
<td>C(207)</td>
<td>VAIRSP</td>
<td>Missile velocity with respect to air mass in earth axes</td>
</tr>
<tr>
<td>Common Location</td>
<td>Variable Name</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------</td>
<td>------------</td>
</tr>
<tr>
<td>C(208)</td>
<td>RH2RO</td>
<td>Initial altitude of the missile</td>
</tr>
<tr>
<td>C(209)</td>
<td>RI</td>
<td>Present altitude of the missile</td>
</tr>
<tr>
<td>C(350)</td>
<td>BTHT</td>
<td>Pitch angle in degrees - $\theta$</td>
</tr>
<tr>
<td>C(351)</td>
<td>BPSI</td>
<td>Roll angle in degrees - $\phi$</td>
</tr>
<tr>
<td>C(352)</td>
<td>BPHI</td>
<td>Yaw angle in degrees - $\psi$</td>
</tr>
<tr>
<td>C(356)</td>
<td>VTOTE</td>
<td>Total missile velocity</td>
</tr>
<tr>
<td>C(357)</td>
<td>LGAMH</td>
<td>Horizontal proportional navigation angle (degrees)</td>
</tr>
<tr>
<td>C(358)</td>
<td>LGAMV</td>
<td>Vertical proportional navigation angle (degrees)</td>
</tr>
<tr>
<td>C(367)</td>
<td>B(ALPHA)</td>
<td>Vertical component of angle of attack</td>
</tr>
<tr>
<td>C(368)</td>
<td>BALPHY</td>
<td>Horizontal component of angle of attack</td>
</tr>
<tr>
<td>C(369)</td>
<td>BALPHI</td>
<td>$\alpha' = \sqrt{B(ALPHA)^2 + BALPHY^2}$ total angle of attack</td>
</tr>
<tr>
<td>C(370)</td>
<td>BPHIF</td>
<td>$\gamma'$ orientation of wind vector in roll axis</td>
</tr>
<tr>
<td>C(371)</td>
<td>RANGE</td>
<td>Range</td>
</tr>
<tr>
<td>C(372)</td>
<td>RXBA</td>
<td>Range (X component in body coordinate system)</td>
</tr>
<tr>
<td>C(373)</td>
<td>RYBA</td>
<td>Range (Y component in body coordinate system)</td>
</tr>
<tr>
<td>C(374)</td>
<td>RZBA</td>
<td>Range (Z component in body coordinate system)</td>
</tr>
<tr>
<td>Common Location</td>
<td>Variable Name</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------</td>
<td>------------</td>
</tr>
<tr>
<td>C(377)</td>
<td>BALPD</td>
<td>(d(BALPHA)/dt)</td>
</tr>
<tr>
<td>C(378)</td>
<td>BALYD</td>
<td>(d(BALPHY)/dt)</td>
</tr>
<tr>
<td>C(379)</td>
<td>BALPPD</td>
<td>(d(BALPHP)/dt)</td>
</tr>
<tr>
<td>C(380)</td>
<td>RANGO</td>
<td>The distance of missile from the launch point</td>
</tr>
<tr>
<td>C(403)</td>
<td>E2</td>
<td>Seeker output to autopilot (pitch)</td>
</tr>
<tr>
<td>C(407)</td>
<td>EY</td>
<td>Seeker output to autopilot (yaw)</td>
</tr>
<tr>
<td>C(427)</td>
<td>BTHTG</td>
<td>Platform position (\theta_g)</td>
</tr>
<tr>
<td>C(431)</td>
<td>DPSIG</td>
<td>Platform position yaw gimbal angle (\psi_g)</td>
</tr>
<tr>
<td>C(432)</td>
<td>RXG</td>
<td>Range X in gimbal axes</td>
</tr>
<tr>
<td>C(433)</td>
<td>RYG</td>
<td>Range Y in gimbal axes</td>
</tr>
<tr>
<td>C(434)</td>
<td>RZG</td>
<td>Range Z in gimbal axes</td>
</tr>
<tr>
<td>C(435)</td>
<td>BEPSZ</td>
<td>Angular position of the line of sight in gimbal axes (see Figure 2)</td>
</tr>
<tr>
<td>C(435)</td>
<td>BEPSY</td>
<td></td>
</tr>
<tr>
<td>C(437)</td>
<td>WZ</td>
<td>Missile body rate (W_z)</td>
</tr>
<tr>
<td>C(438)</td>
<td>WY</td>
<td>Missile body rate (W_y)</td>
</tr>
<tr>
<td>C(441)</td>
<td>SZGBLS</td>
<td>Pitch gimbal torque bias (deg/sec)</td>
</tr>
<tr>
<td>C(442)</td>
<td>SYGBLS</td>
<td>Yaw gimbal torque bias (deg/sec)</td>
</tr>
<tr>
<td>C(443)</td>
<td>OPTKR</td>
<td>Optics routine</td>
</tr>
<tr>
<td>C(444)</td>
<td>OPTBKLC</td>
<td>Optical breaklock</td>
</tr>
<tr>
<td>C(445)</td>
<td>UT</td>
<td>Time at which next pulse expected</td>
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<tr>
<td>C(446)</td>
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<tr>
<td>Common Location</td>
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<tr>
<td>C(450) NSW</td>
<td>Acquisition gain seeker constant</td>
<td></td>
</tr>
<tr>
<td>C(451) CAGE</td>
<td>[&gt;&lt;0 uncaged gimbals] [(&gt;&lt;0 remain in caged position]</td>
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<tr>
<td>C(452) QBREAK</td>
<td>(Breaklock has occurred due to loss of signal) (automatically parameterized)</td>
<td></td>
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<tr>
<td>C(453) RBLK</td>
<td>Range at breaklock (maximum range at which lock-on can take place)</td>
<td></td>
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<tr>
<td>C(454) BLEG</td>
<td>Half the field of view</td>
<td></td>
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<tr>
<td>C(455) WEPSMX</td>
<td>Breaklock drift rate</td>
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<td>C(456) CKDDR</td>
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<td></td>
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<td>C(457) CROSSTP</td>
<td>Pitch to yaw friction coupling</td>
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</tr>
<tr>
<td>C(458) CROSPT</td>
<td>Yaw to pitch friction coupling</td>
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<tr>
<td>C(460) GUIDE</td>
<td>(=1 missile guidance system in effect) (=0 missile guidance system not in effect)</td>
<td></td>
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<tr>
<td>C(461) SAMP</td>
<td>Preprogrammed guidance trajectory (cutoff check automatically parameterized) (0 - missile uses preprogrammed flight path) (1 - missile uses preprogrammed flight path until seeker acquires target)</td>
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<tr>
<td>C(464) CGADES</td>
<td>Vertical trajectory programming constant</td>
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<td>C(465) CGADES</td>
<td>Horizontal trajectory programming constant</td>
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<tr>
<td>C(466) ZLASE</td>
<td>Location of laser spot on target in X direction due to ground or airborne FAC</td>
<td></td>
</tr>
<tr>
<td>Common Location</td>
<td>Variable Name</td>
<td>Definition</td>
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<tr>
<td>C(467)</td>
<td>YLAZR</td>
<td>Location of laser spot on target in Y direction due to ground or airborne FAC</td>
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<tr>
<td>C(468)</td>
<td>DEFOCS</td>
<td>Half angle in degrees of angle intercepted by image of laser spot on detector surface</td>
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<tr>
<td>C(469)</td>
<td>DETRAD</td>
<td>Half angle in degrees of angle intercepted by quadrant detector</td>
</tr>
<tr>
<td>C(472)</td>
<td>CKSK1</td>
<td>Seeker driver constant</td>
</tr>
<tr>
<td>C(473)</td>
<td>VLAZRP</td>
<td>Used in pulse loss calculation</td>
</tr>
<tr>
<td>C(850)</td>
<td>HLIMO</td>
<td>Limit on $\delta_c$ from pitch and yaw plane (deg) (fins 1 and 3)</td>
</tr>
<tr>
<td>C(851)</td>
<td>HLIME</td>
<td>Limit on $\delta_c$ from pitch and yaw plane (deg) (fins 2 and 4)</td>
</tr>
<tr>
<td>C(852)</td>
<td>QBIAS</td>
<td>Pitch body rate bias (deg/sec) (used as &quot;g&quot; bias)</td>
</tr>
<tr>
<td>C(853)</td>
<td>RBIAS</td>
<td>Yaw body rate bias (deg/sec)</td>
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<tr>
<td>C(855)</td>
<td>GZ</td>
<td>Navigation ratio for pitch plane</td>
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<tr>
<td>C(856)</td>
<td>GY</td>
<td>Navigation ratio for yaw plane</td>
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<tr>
<td>C(863)</td>
<td>TAUZ</td>
<td>Pitch guidance lag filter (rad/sec)</td>
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<tr>
<td>C(864)</td>
<td>TAUY</td>
<td>Yaw guidance lag filter (rad/sec)</td>
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<td>C(865)</td>
<td>TDY1</td>
<td>Rate loop gain switch 1 (sec)</td>
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<tr>
<td>C(866)</td>
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<td>Rate loop gain switch 2 (sec)</td>
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<tr>
<td>C(877)</td>
<td>TAUL</td>
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<td>C(888)</td>
<td>CKSK2</td>
<td>Seeker gain constant</td>
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<tr>
<td>C(1117)</td>
<td>BSURF 1</td>
<td>$\delta_1$</td>
</tr>
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<td>C(1118)</td>
<td>BSURF 2</td>
<td>$\delta_2$</td>
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<tr>
<td>C(1119)</td>
<td>BSURF 3</td>
<td>$\delta_3$</td>
</tr>
<tr>
<td>C(1120)</td>
<td>BSURF 4</td>
<td>$\delta_4$</td>
</tr>
<tr>
<td>C(1160)</td>
<td>DELTPB</td>
<td>$\delta_p = (-\delta_1 - \delta_2 + \delta_3 + \delta_4)/4$</td>
</tr>
<tr>
<td>C(1161)</td>
<td>DELTQB</td>
<td>$\delta_q = (\delta_1 + \delta_2 + \delta_3 + \delta_4)/4$</td>
</tr>
<tr>
<td>C(1162)</td>
<td>DELTRB</td>
<td>$\delta_r = (-\delta_1 - \delta_2 + \delta_3 + \delta_4)/4$</td>
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<tr>
<td>C(1260)</td>
<td>CXERR</td>
<td>Drag coefficient error</td>
</tr>
<tr>
<td>C(1261)</td>
<td>CZERR</td>
<td>Normal force ($C'z$) coefficient error</td>
</tr>
<tr>
<td>C(1262)</td>
<td>CYERR</td>
<td>Side force ($C'y$) coefficient error</td>
</tr>
<tr>
<td>C(1263)</td>
<td>CLERR</td>
<td>Roll moment ($C'L$) coefficient error</td>
</tr>
<tr>
<td>C(1264)</td>
<td>CMERR</td>
<td>Pitch moment ($C'M$) coefficient error</td>
</tr>
<tr>
<td>C(1265)</td>
<td>CNERR</td>
<td>Yaw moment ($C'N$) coefficient error</td>
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<tr>
<td>C(1300)</td>
<td>FXBA</td>
<td>The X component of aero force in body coordinate system</td>
</tr>
<tr>
<td>C(1301)</td>
<td>FYBA</td>
<td>The Y component of aero force in body coordinate system</td>
</tr>
<tr>
<td>C(1302)</td>
<td>FZBA</td>
<td>The Z component of aero force in body coordinate system</td>
</tr>
<tr>
<td>C(1303)</td>
<td>FMXBA</td>
<td>The X component of aero moment in body coordinate system</td>
</tr>
<tr>
<td>C(1304)</td>
<td>FYBA</td>
<td>The Y component of aero moment in body coordinate system</td>
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<th>Common Location</th>
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<td>C(1305)</td>
<td>FMZBA</td>
<td>The Z component of aero moment in body coordinate system</td>
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<tr>
<td>C(1306)</td>
<td>RFAREA</td>
<td>Missile reference area (ft²)</td>
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<tr>
<td>C(1307)</td>
<td>RFLGTH</td>
<td>Missile reference length (ft)</td>
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<tr>
<td>C(1308)</td>
<td>RDELCG</td>
<td>Center of gravity shift (ft)</td>
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<tr>
<td>C(1309)</td>
<td>FMH1</td>
<td>Hinge moments</td>
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<tr>
<td>C(1310)</td>
<td>FMH2</td>
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</tr>
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<td>FMH3</td>
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</tr>
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<td>C(1312)</td>
<td>FMH4</td>
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<tr>
<td>C(1313)</td>
<td>RFXCG</td>
<td>Thrust vector displacements (ft)</td>
</tr>
<tr>
<td>C(1314)</td>
<td>RFYCG</td>
<td></td>
</tr>
<tr>
<td>C(1315)</td>
<td>RFZCG</td>
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<tr>
<td>C(1316)</td>
<td>RLUG</td>
<td>Distance between lugs (ft)</td>
</tr>
<tr>
<td>C(1317)</td>
<td>RAIL</td>
<td>Rail length (ft) (between rear of front lug and end of rail)</td>
</tr>
<tr>
<td>C(1320)</td>
<td>FMXTH</td>
<td>X component of moment caused by thrust misalignments</td>
</tr>
<tr>
<td>C(1321)</td>
<td>FMYTH</td>
<td>Y component of moment caused by thrust misalignments</td>
</tr>
<tr>
<td>C(1322)</td>
<td>FMZTH</td>
<td>Z component of moment caused by thrust misalignments</td>
</tr>
<tr>
<td>C(1323)</td>
<td>FMXLUG</td>
<td>X component of moment due to lugs</td>
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<tr>
<td>C(1324)</td>
<td>FMYLUG</td>
<td>Y component of moment due to lugs</td>
</tr>
<tr>
<td>C(1325)</td>
<td>FMZLUG</td>
<td>Z component of moment due to lugs</td>
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<th>Common Location</th>
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<tr>
<td>C(1401)</td>
<td>BALPHT</td>
<td>The angles as indicated in Figure 18</td>
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<td>C(1402)</td>
<td>LPHIT</td>
<td>(&gt; 0; include thrust misalignment angles)</td>
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<tr>
<td>C(1403)</td>
<td>QNALGN</td>
<td>Fractional increase in total thrust</td>
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<tr>
<td>C(1404)</td>
<td>FCFTX</td>
<td>Parameterized by program</td>
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<td>C(1405)</td>
<td>QBURN</td>
<td>Missile thrust</td>
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<td>FTHRST</td>
<td>X component of missile thrust</td>
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<tr>
<td>C(1411)</td>
<td>FTHX</td>
<td>Y component of missile thrust</td>
</tr>
<tr>
<td>C(1412)</td>
<td>FTHY</td>
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<tr>
<td>C(1413)</td>
<td>FTHZ</td>
<td>Specific impulse (lb/sec)</td>
</tr>
<tr>
<td>C(1414)</td>
<td>CISP</td>
<td>Total missile plus propellant wt (lb) initial</td>
</tr>
<tr>
<td>C(1415)</td>
<td>DWI</td>
<td>Propellant weight (lb)</td>
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<tr>
<td>C(1416)</td>
<td>DWP</td>
<td>Initial value of c.g. shift (ft)</td>
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<tr>
<td>C(1417)</td>
<td>RDCGO</td>
<td>Burnout value of c.g. shift (ft)</td>
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<tr>
<td>C(1418)</td>
<td>RDCGP</td>
<td>Initial value of moment of inertia about the roll axis (slugs ft)</td>
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<tr>
<td>C(1419)</td>
<td>FMIKO</td>
<td>Initial value of moment of inertia about the pitch axis (slugs ft)</td>
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<td>FMIYO</td>
<td>Distance between launch c.g. and rear lug (ft)</td>
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<tr>
<td>C(1421)</td>
<td>FLCGA</td>
<td>Present position of c.g. of missile</td>
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<td>C(1496)</td>
<td>UIMP</td>
<td>Thrust of the motor</td>
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<tr>
<td>C(1499)</td>
<td>UIMP</td>
<td>Impulse of the motor</td>
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<tr>
<td>C(1603)</td>
<td>VXE</td>
<td>(X,Y,Z) coordinates of missile velocity with respect to the earth fixed coordinate system</td>
</tr>
<tr>
<td>C(1607)</td>
<td>VYE</td>
<td>(X,Y,Z) coordinates of missile c.g. with respect to the earth fixed coordinate system</td>
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<tr>
<td>C(1611)</td>
<td>VZE</td>
<td>(X,Y,Z) coordinates of missile c.g. with respect to the earth fixed coordinate system</td>
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<td>C(1615)</td>
<td>RXE</td>
<td>(X,Y,Z) coordinates of missile c.g. with respect to the earth fixed coordinate system</td>
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<td>C(1619)</td>
<td>RYE</td>
<td>(X,Y,Z) coordinates of missile c.g. with respect to the earth fixed coordinate system</td>
</tr>
<tr>
<td>C(1623)</td>
<td>RZE</td>
<td>(X,Y,Z) coordinates of missile c.g. with respect to the earth fixed coordinate system</td>
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<tr>
<td>C(1624)</td>
<td>AXBA</td>
<td>(X) component of acceleration in body coordinate axis</td>
</tr>
<tr>
<td>C(1625)</td>
<td>AYBA</td>
<td>(Y) component of acceleration in body coordinate axis</td>
</tr>
<tr>
<td>C(1626)</td>
<td>AZBA</td>
<td>(Z) component of acceleration in body coordinate axis</td>
</tr>
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<td>C(1627)</td>
<td>AGRAV</td>
<td>Gravitational constant</td>
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<tr>
<td>C(1628)</td>
<td>DMASS</td>
<td>Current mass</td>
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<tr>
<td>C(1629)</td>
<td>ATHRST</td>
<td>Target thrust</td>
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<tr>
<td>C(1630)</td>
<td>ATURNT</td>
<td>Maximum transverse acceleration of target in terms of (g)</td>
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<tr>
<td>C(1632)</td>
<td>VDELX</td>
<td>Relative velocity of missile to target in (X) direction</td>
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<tr>
<td>C(1633)</td>
<td>VDELY</td>
<td>Relative velocity of missile to target in (Y) direction</td>
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<tr>
<td>C(1634)</td>
<td>VDELZ</td>
<td>Relative velocity of missile to target in (Z) direction</td>
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<tr>
<td>C(1635)</td>
<td>RDELX</td>
<td>Range difference between target and missile in the X direction of the earth fixed coordinate system</td>
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<tr>
<td>C(1636)</td>
<td>RDELY</td>
<td>Range difference between target and missile in the Y direction of the earth fixed coordinate system</td>
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<td>C(1637)</td>
<td>RDELZ</td>
<td>Range difference between target and missile in the Z direction of the earth fixed coordinate system</td>
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<td>C(1644)</td>
<td>ATARG</td>
<td>Acceleration of the target</td>
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<td>C(1647)</td>
<td>VTARG</td>
<td>Velocity of the target</td>
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<td>C(1648)</td>
<td>RTXED</td>
<td>The X component of the velocity of the target in the earth fixed coordinate system</td>
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<tr>
<td>C(1651)</td>
<td>RTXE</td>
<td>The X coordinate of the position of the target in the earth fixed coordinate system</td>
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<td>C(1652)</td>
<td>RTYED</td>
<td>The Y component of the velocity of the target in the earth fixed coordinate system</td>
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<td>RTYE</td>
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<td>Definition</td>
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<td>The Y component of the velocity of the target in the earth fixed coordinate system</td>
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<td>C(1662)</td>
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<td>The Z component of the velocity of the target in the earth fixed coordinate system</td>
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<td>C(1663)</td>
<td>VDXB</td>
<td>The X component of the acceleration of missile in the body coordinate axes</td>
</tr>
<tr>
<td>C(1664)</td>
<td>VDYB</td>
<td>The Y component of the acceleration of missile in the body coordinate axes</td>
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<tr>
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<td>VDZB</td>
<td>The Z component of the acceleration of missile in the body coordinate axes</td>
</tr>
<tr>
<td>C(1666)</td>
<td>BDIVE</td>
<td>Initial pitch orientation of the aircraft (missile assumed oriented parallel to aircraft)</td>
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<tr>
<td>C(1667)</td>
<td>RSLANT</td>
<td>Initial slant range</td>
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<td>C(1668)</td>
<td>RXO</td>
<td>The X component of the original launch point of the missile in the earth fixed coordinate system</td>
</tr>
<tr>
<td>C(1669)</td>
<td>RYO</td>
<td>The Y component of the original launch point of the missile in the earth fixed coordinate system</td>
</tr>
<tr>
<td>C(1670)</td>
<td>RZO</td>
<td>The Z component of the original launch point of the missile in the earth fixed coordinate system</td>
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<td>C(1672)</td>
<td>BPSITD</td>
<td>The angular rate of turn of target</td>
</tr>
<tr>
<td>C(1675)</td>
<td>BPSIT</td>
<td>The total angle through which the target has turned in degrees</td>
</tr>
<tr>
<td>Common Location</td>
<td>Variable Name</td>
<td>Definition</td>
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<tr>
<td>-----------------</td>
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<tr>
<td>C(1676)</td>
<td>ANGX</td>
<td>The X component of the acceleration of the missile in terms of g with respect to body axes</td>
</tr>
<tr>
<td>C(1677)</td>
<td>ANGY</td>
<td>The Y component of the acceleration of the missile in terms of g with respect to body axes</td>
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<td>Derivative of CFA11</td>
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<td>C(1703)</td>
<td>CFA11</td>
<td>Cos(\psi) Cos(\theta)</td>
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<td>CFA12D</td>
<td>Derivative of CFA12</td>
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<td>CFA12</td>
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<td>CFA13D</td>
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<td>CFA13</td>
<td>-Sin(\theta)</td>
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<td>CFA21D</td>
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<td>CFA21</td>
<td>Sin(\psi) Cos(\theta) + Cos(\psi) Sin(\theta) Sin(\phi)</td>
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<td>CFA22D</td>
<td>Derivative of CFA22</td>
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<td>CFA22</td>
<td>Cos(\psi) Cos(\phi) + Sin(\psi) Sin(\theta) Sin(\phi)</td>
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<td>Cos(\theta) Sin(\phi)</td>
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<td>CFA31</td>
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<td>d(WQ)/dt</td>
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3.2 Subroutine Call Sequence

The subroutine call sequence is determined by the order in which these subroutines are identified in the data card assembly. A data card is identified by the program as a subroutine call by the number 2 located in column 2. The identification number of the subroutine may be called as either [MODNO(NOMOD)] or [XMODNO(NOMOD)] by the program. This integer must be right adjusted to column 25 on the card. Table V shows the identification number and the subroutines called in the example problem. If other routines are required, they will be found listed with their identification numbers in subroutine AUXSUB.

3.3 State Variables

The state variables within this six-degree-of-freedom simulation program are defined in the initialization subroutines (modules). These variables are identified through the IPL table which also defines the location of the state variables. Only these variables are integrated by the integration routine AMRK. Other variables found in the program which are derivatives are not state variables by this definition. A listing of the sequence number, IPL numbers, and variable names are found in Table VI. The listing is for the program when it contains the high frequency autopilot and actuator.

In the event a location is defined as a state variable, the following convention must be observed:

\[ C(J + 3) \text{ State variable} \]

then

\[ C(J) \text{ is the derivative of that state variable.} \]
### TABLE V. INITIALIZATION SUBROUTINE CALL SEQUENCE

(By Subroutine AUXI) (As defined by current program listing)

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<thead>
<tr>
<th>NOMOD</th>
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SECTION IV
INPUT REQUIREMENTS

4.1 Initial Conditions

In order to simplify the input data, the options which had existed in the original program have been eliminated. It is assumed by the program that all variables not initialized are automatically set equal to zero. Input data and initial conditions are entered into the program by entering a number 3 in column 2 of the data card which identifies the type of information. The name of the variable may be entered in column 3 to 20. Common location of the variable must be entered right adjusted in columns 21 to 25 and the numerical data in columns 31 to 45. Figure 19 shows the position of the data card in the completed program deck which is ready for submission, as well as the actual data card format.

In addition, since the seeker is generally assumed to lock on before launch, the gimbal angles are automatically initialized to this position. However, in the cases where gimbal angles must be chosen in any other position, the transformations and angular displacements between gimbal axes and body axes coordinate systems are given in Appendix I and Figure T-1, respectively.

Initial position and velocity can only be specified in one manner for simplicity. They are specified in terms of the following variables:

- BDIVL (in degrees, negative when orientation below horizontal)
- RSLPH (in ft)
- LALPHA (in degrees)
- DALPHY (in degrees)
- VMACH (Mach number)

It should be noted that the program when used to simulate many missions requires only that subsequent changes in data be added since the program will only update the last data set for the next run. (See "Program Description.")
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<tr>
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SECTION V
PROGRAM LISTING

5.1 Complete Six-Degree-of-Freedom Program Listing with Example
C

**********IPCGES TO BE USED WITH PORTRAM ANARK INTEGRATION ROUTINE

C

CCPGON C14310),GRAPP

EQUIVALENCE (CI2662),HMIN 1, (CI2663),NMAX 1, (CI2664),DER 1
C
C
C(I2900),N 3, (CI2902),IPL 1, (CI2904),ER 1
C
C(I22001),T 1, (CI22003),TSTEP 1, (CI22010),STEP 1
C
C(I22031),LSTEP 1, (CI22008),PLDIST 1, (CI22001),NCPLOT 1
C
C(I22021),OPQINT 1, (CI22023),TIME 1, (CI22203),VARIABLE 1
C
C(I3167),NODUT 1, (CI22023),OPTINT 1, (CI22001),REPLPT 1
C
C(I22005),EU 1, (CI22008),EL 1, (CI22001),PIELESS 1
C
EQUIVALENCE (CI1973),XASE 1, (CI1974),WX 1, (CI1975),API 1
C
DIMENSION VPAR[12],P 2
DIMENSION VLVAR[12,153] ; IPL[100], DER[100]
C
DIMENSION VAR[1001] + EL[100] + EU[100]
C
EQUIVALENCE (CI1981),NXT 3
EQUIVALENCE (CI1982),PLOTNA 3
EQUIVALENCE (CI1983),PLOT2 3
EQUIVALENCE (CI1984),PLOT 3
INTEGER CPQT
INTEGER CPFT
INTEGER CPFT
EXTERNAL AUSUB
CC 22=1,4910
22 C1130

C
CALL COUNT
C
CALL ZER0
1000 CONTINUE
1001 IF(F(PCLT<60),L600)GOTOF
C
IF(REPPLT=0. USE NEW NO. 4,7 (DISCARD OLD)
C
C
C
C
IF (REPPLT.GT.10) NODUT = U
C
T CALL C1APFL
C
IN หากแต่ไม่ได้ไว้ซึ่ง NPTH = 1
C
STEP = STEP
C
NPCLT4=PCLN
C
NPCLT2=PLOTN2
C
AUSUB=CPU
1002 CALL SUB1
1003 CALL AUX1
C
1004 CALL SUB2
1005 CC = 0.1 * 2N
C
C
J = 1
C
C
C
E = (J+1) * (J+1)
C
VAP = C (J+3)
C
DER = C (J)
C
VARI = 1
C
1006 CALL AUSUB
C
1007 AUS=1
C
CALL APPR1AUSUB
1008 DC 50 = 1 * 2N
C
J = IPL1 = 11
C
50 C(J+3) + VARI

59
| DATA AX/0.0.:7 | 9 | 0.1.05, 1.1, 1.5, 1.7, 2.0, 2.3/ |
| CATA CP/ |
| - 0.0, -0.05, 1.58, 2.25, 3.12, 4.1, 7.08, 10.71/ |
| - 0.0, -0.04, 1.41, 2.25, 3.17, 4.10, 7.18, 10.84/ |
| - 0.0, -0.03, 1.40, 2.32, 3.27, 4.31, 7.30, 11.14/ |
| - 0.0, -0.77, 1.62, 2.55, 3.54, 4.72, 7.98, 12.02/ |
| - 0.0, -0.77, 1.62, 2.57, 3.56, 4.74, 8.02, 12.11/ |
| - 0.0, -0.81, 1.65, 2.35, 3.36, 4.43, 7.6, 11.60/ |
| - 0.0, -0.7, 1.66, 2.37, 3.34, 4.40, 7.59, 11.61/ |
| - 0.0, -0.69, 1.67, 2.34, 3.30, 4.38, 7.59, 11.61/ |
| - 0.0, -0.67, 1.65, 2.37, 3.29, 4.20, 7.42, 11.47/ |
| DATA NCP/0.0,0/ |
| DATA ALF/0.0.:4 | 6 | 0.0, 12, 16, 20/ |
| DATA CP/ |
| - 0.0, -0.11, 2.46, -3.97, -5.62, -7.51, -12.03, -19.28/ |
| - 0.0, -0.11, 2.54, -4.06, -5.16, -7.68, -13.10, -19.04/ |
| - 0.0, -0.12, 2.60, -4.23, -5.59, -7.97, -13.54, -20.24/ |
| - 0.0, -0.16, 3.35, -5.28, -7.40, -9.75, -16.26, -23.67/ |
| - 0.0, -0.68, -3.48, -5.66, -7.68, -10.09, -16.75, -23.94/ |
| - 0.0, -1.07, -2.31, -3.34, -5.25, -7.12, -12.48, -19.91/ |
| - 0.0, -1.11, -2.34, -3.65, -5.50, -7.40, -12.70, -19.12/ |
| - 0.0, -1.15, -2.67, -3.97, -5.85, -7.57, -12.90, -19.70/ |
| - 0.0, -1.14, -2.46, -3.96, -5.63, -7.54, -12.81, -19.09/ |
| CATA NCP/6,6:6,0/ |
| CATA ALF/0.0.:4 | 6 | 0.0, 12, 16, 20/ |
| CATA CP/ |
| - 0.0, -0.13, -2.84, -5.62, -7.51, -12.03, -19.28/ |
| - 0.0, -0.13, -2.84, -5.62, -7.51, -12.03, -19.28/ |
| - 0.0, -0.13, -2.84, -5.62, -7.51, -12.03, -19.28/ |
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| - 0.0, -0.13, -2.84, -5.62, -7.51, -12.03, -19.28/ |
| - 0.0, -0.13, -2.84, -5.62, -7.51, -12.03, -19.28/ |
| ENC |
| BLOCK DATA |
| CCPP/CC/NC/NCOD23 |
| / CXARC/PAP10 |
| / CXF/NC/NCOD23/ |
| DATA NCP/4/ |
| CATA ALF/0.0.:4 | 6 | 0.0, 12, 16, 20/ |
| CATA CP/ |
| - 0.0, -0.13, -2.84, -5.62, -7.51, -12.03, -19.28/ |
| - 0.0, -0.13, -2.84, -5.62, -7.51, -12.03, -19.28/ |
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| - 0.0, -0.13, -2.84, -5.62, -7.51, -12.03, -19.28/ |
| ENC |
| BLOCK DATA |
| CCPP/CC/NC/NCOD24/ |
| / CXARC/ALP101. AM191 |
| / C/N2FUN/NCOD24/ |
| DATA NCP/26,3,0.0/ |
| CATA ALF/0.0.:4 | 6 | 0.0, 12, 16, 20/ |
| CATA CP/ |
| - 0.0, -0.13, -2.84, -5.62, -7.51, -12.03, -19.28/ |

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EQUIVALENCE (E11, AIFAC)  
EQUIVALENCE (E123, CIL)  
EQUIVALENCE (E420X, VAC)  
EQUIVALENCE (E532, XIL)  
EQUIVALENCE (E1456, AXR)  
EQUIVALENCE (E17, SCH)  
EQUIVALENCE (E1823, RHE)  
EQUIVALENCE (E19, BIL)  
EQUIVALENCE (E201, VIL)  
EQUIVALENCE (E2131, VIL)  
EQUIVALENCE (E2010, 11)  
EQUIVALENCE (E1466, VCI)  
EQUIVALENCE (E1587, ASLANT)  
EQUIVALENCE (E189, SP2/MOS)  
IF (SP2/MOS) .GT. 0.01 RETURN  
UT = 0.0  
IF (UJ.EQ.0.01 GO TO 10  
WRITE(6,1234) VILM, VNAF, XIL, T, MILL, RZE; VIL, VSOUND, VILF  
RETURN  
ENC  
SUBROUTINE C10  
C=PSY(4,1310)  
EQUIVALENCE (C490, TLG591, 14471, TL583)  
EQUIVALENCE (C571, RIL)  
EQUIVALENCE (C153, VIL)  
EQUIVALENCE (C124, VIL, MIN)  
EQUIVALENCE (C159, RIL)  
EQUIVALENCE (C10, HIL)  
EQUIVALENCE (C11, BREL)  
EQUIVALENCE (C22, WONE)  
EQUIVALENCE (C31, BACTUS)  
EQUIVALENCE (C66, RIL)  
EQUIVALENCE (C91, KSOFT)  
EQUIVALENCE (C102, KSOFT)  
EQUIVALENCE (C143, UT)  
EQUIVALENCE (C209, G, T)  
EQUIVALENCE (C246, ET)  
EQUIVALENCE (C185, RXT)  
EQUIVALENCE (C185, RXT)  
EQUIVALENCE (C185, RXT)  
EQUIVALENCE (C185, RXT)  
IF (SP2/MOS) .GT. 0.01 RETURN  
IF (E1.EQ.0.01 GO TO 1  
IF (UJ.EQ.0.01 GO TO 3  
IF (UT.EQ.0.01) GO TO 2  
IF (E1.EQ.0.01) GO TO 4  
CONTINUE  
140  
UT = UT + C40T  
67
CONTINUE
ANGILL = ASIN(0.0)
BCREF = BCREF*1.0
WANG = WANG*ANGILL
SPHID = SPHID*1.0
SPLEN = SPLEN*1.0
OUTC = OUTC*1.0

4 CONTINUE
XSCRT = 0.0
YSCRT = 0.0
I = 1
RETURN
END
FUNCTION ASINDIX
ASINDIX = 5.0
RETURN
END
FUNCTION RONDIX
RONDIX = 5.0
RETURN
END
68
SUBROUTINE CLINE(IX,IA,IB,IC)
  COMMON (X*X,IC) 
  DIMENSION A(I),B(I)
  IF(JA) 100,101,101
101 DO 102 J = 2, M 
  K = J 
102 CONTINUE 
  IF (EA(J) > E(J)) 103, 102, 103
103 Y = E(J) - (E(J) - E(A(J))/A(A(J)-A(J-1)) 
  RETURN
  Y = 0.0 
  RETURN
  END
FUNCTION BMON(B)
  COMMON (X*X,IC) 
  DIMENSION A(I),B(I)
  IF(JA) 100,101,101
101 DO 102 J = 2, M
  K = J
102 CONTINUE 
  IF (EA(J) > E(J)) 103, 102, 103
103 Y = E(J) - (E(J) - E(A(J))/A(A(J)-A(J-1)) 
  RETURN
  Y = 0.0 
  RETURN
  END

**End-Of-Run Calculations Subroutine GA**

**This is a Subroutine, Not a Module.**
C++ IT IS CALLED BY STAGE 3 TO COMPUTE MISS DISTANCE AND STOP THE
C++ PROCEDURE IF RANGE IS ZERO.

C** STATE VARIABLE INPUTS, DATA, TIME
C** OTHER VARIABLES ARE INVOLVED IN COMMON

C++ STATE VARIABLE OUTPUTS
C** OTHER OUTPUTS INVOLVED IN COMMON

C++ MISS DISTANCE PARAMETERS ARE OUTPUT DIRECTLY AND ARE NOT IN COMMON
C++ TEST FOR INCREASING RANGE AND SOLVE FOR TIME AT WHICH RANGE IS ZERO
C++ FORMAT (1/F) 16H MISS DISTANCE*#1017.8/1018 TIME FINAL*#1017.8
C++ TEST FOR INCREASING RANGE AND SOLVE FOR TIME AT WHICH RANGE IS ZERO
C++ IF RANGE>0.0 GO TO 20
C++ IF RANGE<1.0-D.T.0.0 GO TO 10

C++ FORMAT (1/F) 16H MISS DISTANCE*#1017.8/1018 TIME FINAL*#1017.8
C++ TEST FOR INCREASING RANGE AND SOLVE FOR TIME AT WHICH RANGE IS ZERO
C++ IF RANGE>0.0 GO TO 20
C++ IF RANGE<1.0-D.T.0.0 GO TO 10

C++ FORMAT (1/F) 16H MISS DISTANCE*#1017.8/1018 TIME FINAL*#1017.8
C++ TEST FOR INCREASING RANGE AND SOLVE FOR TIME AT WHICH RANGE IS ZERO
C++ IF RANGE>0.0 GO TO 20
C++ IF RANGE<1.0-D.T.0.0 GO TO 10

C++ FORMAT (1/F) 16H MISS DISTANCE*#1017.8/1018 TIME FINAL*#1017.8
C++ TEST FOR INCREASING RANGE AND SOLVE FOR TIME AT WHICH RANGE IS ZERO
C++ IF RANGE>0.0 GO TO 20
C++ IF RANGE<1.0-D.T.0.0 GO TO 10

C++ FORMAT (1/F) 16H MISS DISTANCE*#1017.8/1018 TIME FINAL*#1017.8
C++ TEST FOR INCREASING RANGE AND SOLVE FOR TIME AT WHICH RANGE IS ZERO
C++ IF RANGE>0.0 GO TO 20
C++ IF RANGE<1.0-D.T.0.0 GO TO 10

C++ FORMAT (1/F) 16H MISS DISTANCE*#1017.8/1018 TIME FINAL*#1017.8
C++ TEST FOR INCREASING RANGE AND SOLVE FOR TIME AT WHICH RANGE IS ZERO
C++ IF RANGE>0.0 GO TO 20
C++ IF RANGE<1.0-D.T.0.0 GO TO 10

C++ FORMAT (1/F) 16H MISS DISTANCE*#1017.8/1018 TIME FINAL*#1017.8
C++ TEST FOR INCREASING RANGE AND SOLVE FOR TIME AT WHICH RANGE IS ZERO
C++ IF RANGE>0.0 GO TO 20
C++ IF RANGE<1.0-D.T.0.0 GO TO 10

71
GO31 = UC314USPSI
GO32 = US324USPSI
GO33 = UCPSI
RXFF = UC314RCX <UC32> + ROT <UC33> RDZ
RYFF = UC314RCX <UC32> RDY
RXFF = UC314RCX <UC32> KCX <UC33> RDZ
WRITE (6,9) PM55, ZERO
WRITE (6,9) RCX, RCY, RDZ
WRITE (6,33) RXFF, RYFF
LCEAV = 2
RETURN
10 UT = 1
UKE = RKE
LXE = RYE
UX = XE
UX = XE
UXE = RYE
LXE = XE
UVX = RYE
UVT = VTX
UYT = VTY
UVT = VTX
20 URANGE = RANGE
IF INVE <GT 100,1 CC1 = 2
RETURN
END
CC35 UCC35 UCC35 CONVERSION MODULE
CC36 UCC36 CONVERSION CC36 (C3530)
CC37 UCC37 UCC37 EQU CC35(UCLCC 35)
 CC38 UCC38 UCC38 EQU CC37(UCLCN 35)
CC39 UCC39 UCC39 EQU CC36(UCLCN 35)
CC3A UCC3A UCC3A EQU CC35(UCLCC 35)
CC3B UCC3B UCC3B EQU CC36(UCLCC 35)
CC3C UCC3C UCC3C EQU CC37(UCLCC 35)
CC3D UCC3D UCC3D EQU CC38(UCLCN 35)
CC3E UCC3E UCC3E EQU CC39(UCLCN 35)
CC3F UCC3F UCC3F EQU CC3A(UCLCC 35)
C \texttt{BLANV = \text{ATANCE-ROELY,ROELY}}
C
C \texttt{**VERTICAL ARC HORIZONTAL LINE OF SIGHT ANGLES (EARTH AXES)}
C
C \texttt{BLANK = \text{ATANCE-ROELY,ROEL}}
C
C \texttt{**VERTICAL ARC HORIZONTAL PROPORTIONAL NAVIGATION ANGLES}
C \texttt{INIT=LY,GERICOGR30}
C \texttt{FP=\text{ANG.EQ}0.01 \text{ GO TO 2}}
C \texttt{VY=VX*ECO3+VXE*VYE*VYE/RANGE}
C \texttt{GONCINUE}
C \texttt{FP=\text{ANG.EQ}0.01 \text{ GO TO 3}}
C \texttt{VY=VX*ECO3+VXE*VYE*VYE/RANGE}
C \texttt{GONCINUE}
C \texttt{BLAM = \text{ATANCE-ROELY,ROELY}}
C
C \texttt{**VELOCITY AT AIR IN EARTH AXES}
C \texttt{UWPH = CFAS24*VX*VXE*VYE+CFAS24*VY+VYE*VYE}
C \texttt{VWPH = CFAS24*VX*VXE*VYE+CFAS24*VY+VYE*VYE}
C
C \texttt{**VERTICAL ARC HORIZONTAL ANGLES OF ATTACK}
C \texttt{BALPHA = \text{ATANCE-ROELY,ROELY}}
C \texttt{BALPHY = \text{ATANCE-ROELY,ROELY}}
C
C \texttt{USE = \text{VPH}}
C \texttt{IF\text{\texttt{SSS.EQ}0.01 \text{ AND \texttt{VPH.EQ}0.01 \text{ GO TO 3}}}
C \texttt{IF\text{\texttt{SSS.EQ}0.01 \text{ AND \texttt{VPH.EQ}0.01 \text{ GO TO 4}}}
C \texttt{IF\text{\texttt{SSS.EQ}0.01 \text{ AND \texttt{VPH.EQ}0.01 \text{ GO TO 5}}}
C \texttt{IF\text{\texttt{SSS.EQ}0.01 \text{ AND \texttt{VPH.EQ}0.01 \text{ GO TO 6}}}
C \texttt{IF\text{\texttt{SSS.EQ}0.01 \text{ AND \texttt{VPH.EQ}0.01 \text{ GO TO 7}}}
C
C \texttt{**ALPHA PRIME ARC PRIME \text{ WIND FLANGE AXES}}
C \texttt{IF\text{\texttt{SSS.EQ}0.01 \text{ AND \texttt{VPH.EQ}0.01 \text{ GO TO 9}}}
C \texttt{RETURN}
C \texttt{END}
C
C ** SEEKER AND PLATFORM INIT MODULE
C
C \texttt{SUBROUTINE 311}
C \texttt{ENDCNCH (C1=311301}
C \texttt{ENDCNCH (C1=311302}
C \texttt{ENDCNCH (C1=311303}
C \texttt{ENDCNCH (C1=311304}
C \texttt{ENDCNCH (C1=311305}
C \texttt{ENDCNCH (C1=311306}
C \texttt{ENDCNCH (C1=311307}
C \texttt{ENDCNCH (C1=311308}
C \texttt{ENDCNCH (C1=311309}
C \texttt{ENDCNCH (C1=311310}
C \texttt{ENDCNCH (C1=311311}
C \texttt{ENDCNCH (C1=311312}
C \texttt{ENDCNCH (C1=311313}
C \texttt{ENDCNCH (C1=311314}
C
C \texttt{74}
SUBROUTINE 91
CPFPEN C(43D)

C INPUT DATA

EQUIVALENCE IC(2502),IPL
52=0.
57=0.
UT = 0.
GUIDE+1.
CASE+0.
SAPP = 0.
C(452) = 0.
IPLINT = 428
IPLINT+1 = 428
RETURN
ENC

C TIGER PLATFORM INC TRACER MODULE

C SUBROUTINE 91
C CPFPEN C(43D)
C
C INPUT DATA

EQUIVALENCE IC(10443),SEGRRISI
EQUIVALENCE IC(10443),SYGRISI
EQUIVALENCE IC(443),OPTER
EQUIVALENCE IC(443),OPTERNL
EQUIVALENCE IC(443),UT
EQUIVALENCE IC(443),CDT
EQUIVALENCE IC(4473),CODB
EQUIVALENCE IC(4483),CFVDE
EQUIVALENCE IC(4493),CFVDE
EQUIVALENCE IC(14233),JMSLI
EQUIVALENCE IC(5001),GSW
EQUIVALENCE IC(553),CASE
EQUIVALENCE IC(10472),DREAM
EQUIVALENCE IC(10472),REXLOC
EQUIVALENCE IC(14072),REC
EQUIVALENCE IC(14072),SFP
EQUIVALENCE IC(6051),WEPSHI
EQUIVALENCE IC(14703),XICAL
EQUIVALENCE IC(14055),XLSAR
EQUIVALENCE IC(14072),RECOCS
EQUIVALENCE IC(14051),SFP
EQUIVALENCE IC(6051),CASE
EQUIVALENCE IC(6051),SFP
EQUIVALENCE IC(14233),JMSLI
EQUIVALENCE IC(14233),JMSLI
EQUIVALENCE IC(14072),CASE
EQUIVALENCE IC(14072),SFP
EQUIVALENCE IC(14072),SFP
EQUIVALENCE IC(14072),SFP
EQUIVALENCE IC(14072),SFP
EQUIVALENCE IC(14072),SFP
EQUIVALENCE IC(14072),SFP
EQUIVALENCE IC(14072),SFP
EQUIVALENCE IC(14072),SFP
EQUIVALENCE IC(14072),SFP
EQUIVALENCE IC(14072),SFP

C INPUTS FROM OTHER MODULES

EQUIVALENCE IC(43731),RANGE
EQUIVALENCE IC(43731),RXBA
EQUIVALENCE IC(43731),RXBA
EQUIVALENCE IC(43731),RXBA
EQUIVALENCE IC(43731),RXBA
EQUIVALENCE IC(43731),RXBA
EQUIVALENCE IC(43731),RXBA
EQUIVALENCE IC(43731),RXBA
EQUIVALENCE IC(43731),RXBA

75
EQUIVALENCE (EC179901, WM)
EQUIVALENCE (EC179901, WD)
EQUIVALENCE (EC179901, WG)
EQUIVALENCE (EC17941, WM)
EQUIVALENCE (EC17941, WD)
EQUIVALENCE (EC17941, WG)
EQUIVALENCE (IC120001, T)

**C**

**C** STATE VARIABLE CUTFITS
EQUIVALENCE (IC0241, BTHTG)
EQUIVALENCE (IC0241, BTFT)
EQUIVALENCE (IC0241, BP51)
EQUIVALENCE (IC0433, BP51)

**C**

**C** OTHER CUTFITS
EQUIVALENCE (EC10433, LE)
EQUIVALENCE (EC10371, EY)
EQUIVALENCE (EC10371, EY)
EQUIVALENCE (EC10371, BX)
EQUIVALENCE (EC10371, BX)
EQUIVALENCE (IC04351, IC04351)
EQUIVALENCE (IC04351, IC04351)
EQUIVALENCE (IC04351, IC04351)
EQUIVALENCE (IC04351, IC04351)
EQUIVALENCE (IC04331, IC04331)
EQUIVALENCE (IC04331, IC04331)

**C**

**C** DIRECTION COSINES FOR BODY TO PLATFORM TRANSFORMATION
EFC, G, D1, IC0T030
SLT= 0.
S2 = 0.
S3 = 0.
30 CONTINUE
U31 = SIN(D1)*HTG)
U33 = COS(D1)*HTG)
U012 = SIN(D1)*PS161
U022 = COS(D1)*PS161
U013 = -U23*U33
U023 = -U23*U33
U032 = 0.

**C**

**C** CALCULATE TOTAL REFLECTION OF GIMBALS
BGEFL *SGN(BHTG)*4*IC0PS51*23

**C**

**C** TRANSFORM LCS FROM BODY TO GIMBAL AXES
RG = U01+RDA+U12+RBA+U13+RBA
RG = U01+RDA+U12+RBA+U13+RBA
RG = U01+RDA+U12+RBA+U13+RBA
RG = U01+RDA+U12+RBA+U13+RBA

**C**

**C** CHECK FOR MISSILE AT SEEKER BREAK-LOCK RANGE
IF (RANGE, GT, 80) GO TO 30
IF (IC0PS51, LE, 0.1) GO TO 30
IF (IC0PS51, GE, 0.1) GO TO 30

**C**

**C** LINE OF SIGHT RATES AFTER BREAK-LOCK
LEPS = (IC0PS51 - 1.)*EPSMK
IF (IC0PS51, GT, .00) UEPS = EDEGE
IF (IC0PS51, LE, .00) BESY = UEPS
BESY = UEPS

76
OICHECK = 1.
GO TO 50
C
INITIALIZATION OF BREAK LOCK VARIABLES
35 VTYPE = T
UPST = DEPSZ
UPSY = DEPSY
VIVER = L
WRITE (10,200) T,KAMPF
200 KAMPF = (JuniorLockAs Occurred, TIME=,FC,-,BM, RANGE=,F12,*)
C
NO ERRORS IN PLATFORM COORDINATES
NO DEPSZ = ATANCF-RG,DEPSZ
DEPSY = ATANCF-DEPSY,DEPSY
GO TO 50
49 CICHECK = -1.
50 CONTINUE
C
IF (CFTKR .GT. 0.) GO TO 80
ST = CTPHR*DEPSZ
SY = CTPHR*DEPSY
GUICE = 1.
GO TO 52
80 IF (IT .LT. UEZ) GO TO 92
UT = UT + CFT
SUMP = 1.
CALL(CAUS,SET,A012,A120)
FRIC(S031),G12,G12V,DEPSZ(010)
SUMP = SUMP + 1.
CALL(SLGT,SEND,PE11,DEPSZ)
SUMP = SUMP/DEPSZ RANGE
60 PE1 = CC*ST*RANGE
PLOC=EX
DEPSZ = ATANCF-PLOC,DEPSZ
DEPSY = ATANCF-PLOC,DEPSY
CALL(GAKE,ICECF,CFECF,AE,BC,CC,DO,DEPSZ,DEPSY)
LT = 2 + 4*E10
IF(CFTKR.LE.1.E6) IF(10.
ST = ((CE-12)+CHR)E10
S2 = (ICE+91+CHR)/10
CALL(11)
GCF(E2)
91 S2 = 0.
ST = 0.
92 UT = UT + SX
LY = LT
IF(CFTKR.GT.0.)GICHECK = 1.
C
PITCH PROGRAMMING AND SEEKER GAIN SWITCHING
IF (GUICE.GT.0.)GO TO 20
IF (SAPP .GT. 0.1) GO TO 19
IF (EAGE .LE. 0.1) GO TO 21
UEZ = UEZ
SAPP = 1.
19 IF (SIGNAL .GE. 1.E-6) UEZ = 1.
UEZ = 2
GO TO 21
GUCE = 1.
20 DAFOC5 = 57.43*OFRF/CEFED
EF = UE/CHR+DAF0C5
EF = UF/CHR+DAF0C5
77
UZ = 0
UY = 0
GO TO 22
21 EE = CGAMYS/GZ
EV = CGANFS/GY
UZ = GSN/UE
UY = GSN/UU
22 CONTINUE
C
C == COUPLED FREQUENCY COUPLING OF GIMBALS
UZK = SIGNS(CEP1, BPS1C0)
ACY = SIGNS(CEP2, BPS2C0)
C
C == MISSILE ECCY RATES IN GIMBAL AXES
W = U31*X + U022*Y + U23*Z
W = U31*X + U022*Y + U23*Z
C
C == GIMBAL ANGLE DERIVATIVES
TF = EACH -- 5.1 TO 99
BP1GC = I1ALPD - K1/UB22
BPS1C0 = I1ETAO - K1
C
C == PLG OPTION
C
C == MISSILE -- 6X53+BTHIC
C
C == BPS1C0 -- 6X53+BPSIG
C
C == TIGER AUTOPILOT INITIALIZATION MODULE
C
C == FREQUENCY MODEL
C
SUBROUTINE CII
C
C = CII (1 + 310)
DIMENSION EPI(100)
EQUIVALENCE (EI, 8301, EES )
EQUIVALENCE (EI, 8302, EES )
EQUIVALENCE (EI, 8303, EES )
EQUIVALENCE (EI, 8304, EES )
EQUIVALENCE (EI, 8305, EES )
EQUIVALENCE (EI, 8306, EES )
EQUIVALENCE (EI, 8307, EES )
EQUIVALENCE (EI, 8308, EES )
RETURN
FFC
C
C == TIGER AUTOPILOT INITIALIZATION MODULE
C
C == FREQUENCY MODEL
C
SUBROUTINE CII
C
C = CII (1 + 310)
DIMENSION EPI(100)
EQUIVALENCE (EI, 8301, EES )
EQUIVALENCE (EI, 8302, EES )
EQUIVALENCE (EI, 8303, EES )
EQUIVALENCE (EI, 8304, EES )
EQUIVALENCE (EI, 8305, EES )
EQUIVALENCE (EI, 8306, EES )
EQUIVALENCE (EI, 8307, EES )
EQUIVALENCE (EI, 8308, EES )
RETURN
FFC
EYS = CGAF8
22 EISS = EES
EISS = EYS
C1 8037 = 0.
C1 8231 = 0.
C1 8273 = 0.
C1 8733 = 0.
C1 8593 = 0.
RETURN
END

C++ TIGER AUTOPILOT MODE
C++ New Frequency Model

SUBROUTINE C1
COMMON CLASID1
CIPRISTC=true,VAR(101)

C++ INPUT DATA
EQUIVALENCE ECI00850),MLHOL)
EQUIVALENCE ECI00851),MLMIN)
EQUIVALENCE ECI00852)],OB1AS)
EQUIVALENCE ECI00853)],GB1AS)
EQUIVALENCE ECI00854)],GL
EQUIVALENCE ECI00855),GT
C
C CE 0573 TO CE 0573 ARE USED BY ECNTAL(E)
EQUIVALENCE ECI00861],TAP2)
EQUIVALENCE ECI00862],TAU3)
EQUIVALENCE ECI00863],TAP2)
EQUIVALENCE ECI00864],TAP3)

C++ INPUTS FROM OTHER MODULES
EQUIVALENCE ECI10521],MP
EQUIVALENCE ECI103053),BB110
C
EQUIVALENCE ECI105031],CZ
EQUIVALENCE ECI105041],ET
EQUIVALENCE ECI10881],NP-SUM
EQUIVALENCE ECI10739],NP
EQUIVALENCE ECI10740],NP
EQUIVALENCE ECI10741],NP
EQUIVALENCE ECI10742],NP
EQUIVALENCE ECI10743],NP
EQUIVALENCE ECI10744],NP

C++ INPUTS FROM PARA PROGRAM
EQUIVALENCE ECI1220041],T
EQUIVALENCE ECI1220653],VAR
EQUIVALENCE ECI1226441],DER
C
C++ STATE VARIABLE OUTPUTS
EQUIVALENCE ECI001],BPHSME
EQUIVALENCE ECI002],BPHSME
EQUIVALENCE ECI003],BPHSME
EQUIVALENCE ECI004],BPHSME
EQUIVALENCE ECI005],BPHSME
EQUIVALENCE ECI006],BPHSME
EQUIVALENCE ECI007],BPHSME
EQUIVALENCE ECI008],BPHSME
EQUIVALENCE ECI009],BPHSME
EQUIVALENCE ECI010],BPHSME
EQUIVALENCE ECI011],BPHSME
EQUIVALENCE ECI012],BPHSME
EQUIVALENCE ECI013],BPHSME
EQUIVALENCE ECI014],BPHSME
EQUIVALENCE ECI015],BPHSME
EQUIVALENCE ECI016],BPHSME
EQUIVALENCE ECI017],BPHSME
EQUIVALENCE ECI018],BPHSME
EQUIVALENCE ECI019],BPHSME
EQUIVALENCE ECI020],BPHSME
EQUIVALENCE ECI021],BPHSME
EQUIVALENCE ECI022],BPHSME
EQUIVALENCE ECI023],BPHSME
EQUIVALENCE ECI024],BPHSME
EQUIVALENCE ECI025],BPHSME
EQUIVALENCE ECI026],BPHSME
EQUIVALENCE ECI027],BPHSME
EQUIVALENCE ECI028],BPHSME
EQUIVALENCE ECI029],BPHSME
EQUIVALENCE ECI030],BPHSME
EQUIVALENCE ECI031],BPHSME
EQUIVALENCE ECI032],BPHSME
EQUIVALENCE ECI033],BPHSME
EQUIVALENCE ECI034],BPHSME
EQUIVALENCE ECI035],BPHSME
EQUIVALENCE ECI036],BPHSME
EQUIVALENCE ECI037],BPHSME
EQUIVALENCE ECI038],BPHSME
EQUIVALENCE ECI039],BPHSME
EQUIVALENCE ECI040],BPHSME

79
EQUVALENCE ICE 8571, UDELTC
C
C**OUTPUTS
EQUVALENCE ICE 8571, UDELTC
C
C**OTHER OUTPUTS
EQUVALENCE ICE 8571, UDELTC
C
C**PLATFORM RATES IN INERTIAL SPACE
EQUVALENCE ICE 8571, UDELTC
C
C**GRAVITY AND RATE DIAVS
EQUVALENCE ICE 8571, UDELTC
C
C**BODY RATE SHAPING AND CYRO DYNAMICS
EQUVALENCE ICE 8571, UDELTC
C
C**SUMMARY OF RATE CAMPING AND GUIANCE SIGNALS AND THEIR DERIVATIVES
EQUVALENCE ICE 8571, UDELTC
C
C**NCL SIGNAL SHAPING
EQUVALENCE ICE 8571, UDELTC
C
**CO*AUTOPIL** OUTPUT CURRENTS TO EACH ACTUATOR (FROM SUMMATION AMPS)

BDELT(1) = EDEL1 - RDELPC
BDELT(2) = EDEL2 - RDELPC
BDELT(3) = EDEL3 - RDELPC
BDELT(4) = EDEL4 - RDELPC
RETURN

**CC** TECER SIMPLIFIED ACTUATOR MODEL

****LCW : FREQUENCY MODEL****

**C** SUBROUTINE CA

C COPPEN (43310)

C DIMENSION BUDEL(4),BUDEL(4),BUDEL(4),VAR(10)

C DIMENSION ROCET(4),ROCET(4)

C **INPUT DATA**

EQUAICNCE IC(1121),ROMAX
EQUAICNCE IC(1140),DELTPB
EQUAICNCE IC(1141),DELTPB
EQUAICNCE IC(1142),DELTD

C **INPUTS FROM OTHER MODULES**

EQUAICNCE IC(1151),RODLT
EQUAICNCE IC(1152),RODLT
EQUAICNCE IC(1153),RODLT
EQUAICNCE IC(1154),RODLT

C **FLAP DEFORMATION X: Y: Z**

BDELT(1) = BDELT(1) - DELTPB - DELTPB - DELTPB - DELTPB
BDELT(2) = BDELT(2) - DELTPB - DELTPB - DELTPB - DELTPB
BDELT(3) = BDELT(3) - DELTPB - DELTPB - DELTPB - DELTPB
BDELT(4) = BDELT(4) - DELTPB - DELTPB - DELTPB - DELTPB

C **ACTUATOR DYNAMICS**

DC 30 NC 1.4
BDELT(4) - BDELT(4)

C **SURFACE POSITION LIMITER**

IF(ABS(BDELT(3)) > 1.5MAX)GOTO30
BDELT(4) = SIGMA7(3);BDELT(4)
30 CONTINUE

C BSURFF = BDELT(1)
BSURF2 = BDELT(2)
BSURF3 = BDELT(3)
BSURF4 = BDELT(4)

C (1103) = BDELT(1)
(1107) = BDELT(2)
(1111) = BDELT(3)
(1115) = BDELT(4)
RETURN

**CC** SUBROUTINE #1

C COPPEN (43310)

C **TABLE LOOKUP FOR BCY FORCE COEFFICIENTS**

81
EQUIVALENCE IC11213,CH
EQUIVALENCE IC11217,CPR
EQUIVALENCE IC11218,CH2
EQUIVALENCE IC11219,CLCM
EQUIVALENCE IC11220,CL2
EQUIVALENCE IC11223,CL0
EQUIVALENCE IC11224,CM
EQUIVALENCE IC11227,CM0
EQUIVALENCE IC11231,CL2
EQUIVALENCE IC11233,CM0
EQUIVALENCE IC11234,CM
EQUIVALENCE IC11237,CL0
EQUIVALENCE IC11238,CL2
EQUIVALENCE IC11239,CM
EQUIVALENCE IC11240,CM0
EQUIVALENCE IC11241,CM
EQUIVALENCE IC11247,CM0
EQUIVALENCE IC11250,CL2
EQUIVALENCE IC11251,CM0
EQUIVALENCE IC11252,CM

C **OUTPUTS - COEFFICIENTS FOR SURFACE EFFECTS, AND TOTAL EFFECTS**

EQUIVALENCE IC12001,CL2
EQUIVALENCE IC12002,CL2
EQUIVALENCE IC12003,CL0
EQUIVALENCE IC12004,CL2
EQUIVALENCE IC12005,CL0
EQUIVALENCE IC12006,CL2
EQUIVALENCE IC12009,CLCM
EQUIVALENCE IC12010,CL2
EQUIVALENCE IC12013,CH2
EQUIVALENCE IC12014,CHCM
EQUIVALENCE IC12020,CH2
EQUIVALENCE IC12021,CHCM
EQUIVALENCE IC12022,CH2
EQUIVALENCE IC12023,CHCM
EQUIVALENCE IC12024,CH2
EQUIVALENCE IC12025,CHCM
EQUIVALENCE IC12026,CH2
EQUIVALENCE IC12027,CHCM
EQUIVALENCE IC12028,CH2
EQUIVALENCE IC12029,CHCM
EQUIVALENCE IC12030,CH2
EQUIVALENCE IC12031,CHCM
EQUIVALENCE IC12032,CH2
EQUIVALENCE IC12033,CHCM
EQUIVALENCE IC12034,CH2
EQUIVALENCE IC12035,CHCM
EQUIVALENCE IC12036,CH2
EQUIVALENCE IC12037,CHCM
EQUIVALENCE IC12038,CH2
EQUIVALENCE IC12039,CHCM
EQUIVALENCE IC12040,CH2
EQUIVALENCE IC12041,CHCM

C INPUT VARIABLE XINTER IS THE INTERPOLATION CONTROL
C 0.0 - STRAIGHT LINE INTERPOLATION
C 1.0 - STRAIGHT LINE INTERPOLATION WITH END INTERVAL
C 0.0 - PARABOLIC INTERPOLATION
C POSITIVE = PARABOLIC INTERPOLATION WITH END INTERVAL
C IF XINTER .LE. 0.0, UINTER = 0.
C IF XINTER .GT. 0.0, UINTER = XINTER

C MULTIPLE ANGLE FORMULAE AND ABSOLUTE VALUES OF ANGLE OF ATTACK

C USPF1 = SIN(C1P+P2)
C USPH1 = COS(C1P+P2)
C USPH2 = SIN(C1P+P2)
C USPF2 = COS(C1P+P2)
C USPF3 = SIN(C1P+P2)
C USPH3 = COS(C1P+P2)

C **CALCULATION OF FORCE COEFFICIENTS**

C BOEFL = RADS(USPF1)*RADS(|USPH2|)*ABS(|USPF3|)*ABS(|USPH4|)
C FCDC = COS(C1P2)*COS(C1P3)*COS(C1P4)*COS(C1P5)
C CALL TABLE 151247P, 1520X, 15210, 15211, 15212, 15213, 15214
C CALL CGCV, 15220, 15221, 15222, 15223, 15224
C CALL C220, 15225, 15226, 15227
C CALL C228, 15229, 15230, 15231
C CALL C224, 15225, 15226, 15227
C CALL C228, 15229, 15230, 15231
C = CYTHPCRP= =CYTHPCRP
C = -CYPHPCRP=CYTHPCRP
C = CLHPCRP=CLHPCRP
C = CLHPCRP=CLHPCRP
RETURN

CNC

C...AEROFORCE AND MOMENT MODULE

COORDINATE AXES

SHEARindle #2

COPERA C (14310)

C

C...INPUT DATA

EQUIVALENCE (C(1100),AFAREA)
EQUIVALENCE (C(1101),RFLCENT)
EQUIVALENCE (C(1102),REJLCY)
EQUIVALENCE (C(1103),RFLCGR)
EQUIVALENCE (C(1104),RFLCG)
EQUIVALENCE (C(1105),RFLCG)
EQUIVALENCE (C(1106),RPLCG)
EQUIVALENCE (C(1107),RPLAL)
EQUIVALENCE (C(1108),RPLAG)
EQUIVALENCE (C(1109),RPLPH)
EQUIVALENCE (C(1110),RPLPH)

C

C...INPUTS FROM OTHER MODULES

EQUIVALENCE (C(1101),FRANK3)
EQUIVALENCE (C(1102),W VINP)
EQUIVALENCE (C(1103),SINT3)
EQUIVALENCE (C(1104),STP)
EQUIVALENCE (C(1105),STP)
EQUIVALENCE (C(1106),STP)
EQUIVALENCE (C(1107),STP)
EQUIVALENCE (C(1108),STP)
EQUIVALENCE (C(1109),STP)
EQUIVALENCE (C(1110),STP)

C

C...OTHER INPUTS

EQUIVALENCE (C(1101),FFBA)
EQUIVALENCE (C(1102),FFBA)
EQUIVALENCE (C(1103),FFBA)
EQUIVALENCE (C(1104),FFBA)
EQUIVALENCE (C(1105),FFBA)
EQUIVALENCE (C(1106),FFBA)
EQUIVALENCE (C(1107),FFBA)
EQUIVALENCE (C(1108),FFBA)
EQUIVALENCE (C(1109),FFBA)
EQUIVALENCE (C(1110),FFBA)

85
C  FORCED VECTOR COMPONENTS
UCS = ALIGNED AREA
UCS = UCS*PFLGM
C
FX = UCSUCS*(CX) + SPX
FY = UCSUCS*SPY
FZ = UCSUCS*SPZ
IF VARS - LEC = 0) GO TO 71
C  AERO MOMENTS
FXEA = (CL1*CLP*VAERS*PFLGC + WMP)*UOSL
FFEA = (CM1*CMU*VAERS*PFLGC + WMP)*UOSL + FIBA*RDELCG
FFEA = (CM1*CMU*VAERS*PFLGC + WMP)*UOSL + FIBA*RDELCG
C  MOMENTS CAUSED BY THRUST MISALIGNMENTS
FPITH = -FTPA*FACC # FTPI*FACC
FVTH = -FTPA*FACC # FTPI*FACC
FVTH = -FTPA*FACC # FTPI*FACC
C  MOMENTS ARE FORCES DUE TO LUGS
FPBH = -FTPA*FACC # FTPI*FACC
FPBH = -FTPA*FACC # FTPI*FACC
FPBH = -FTPA*FACC # FTPI*FACC
FPBH = -FTPA*FACC # FTPI*FACC
FPBH = -FTPA*FACC # FTPI*FACC
GO TO 74
70 IF (RACE = 'L.R. RAIL') GO TO 72
FXLUG = -(FIBA + MASA*GRAV) = (FM2B + FM2TH) + A
FM2B = (FM2B + MASA*GRAV) + A
FM2B = (FM2B + MASA*GRAV) + A
FM2B = (FM2B + MASA*GRAV) + A
FM2B = (FM2B + MASA*GRAV) + A
GO TO 74
72 CONTINUE
FXLUG = - (FIBA + MASA*GRAV) + A
FM2B = (FM2B + MASA*GRAV) + A
FM2B = (FM2B + MASA*GRAV) + A
FM2B = (FM2B + MASA*GRAV) + A
FM2B = (FM2B + MASA*GRAV) + A
74 CONTINUE
C  TOTAL FORC AND MOMENTS
FIBA = FIBA + FXLUG
FIBA = FIBA + FXLUG
FIBA = FIBA + FXLUG
FIBA = FIBA + FXLUG
FIBA = FIBA + FXLUG
C  CALCULATE MOMENTS
FPITH = C*UMP71
FPZ = C3+UCSL
FPHS = C3+UCSL
FPM = C3+UCSL
RETURN

END

C*INITIALIZATION FOR ENGINE MODULE
SUBROUTINE X3E
COPRCH (C4310)
CPASCH (C4310)
EQUIVALENCE (C125811, N)
EQUIVALENCE (C125811, IPL)
C1493 = 0.
IPL1M = 1.
N = 141
RETURN

END

C**ENGINE MODUUE
SUBROUTINE X3E
COPRCH (C4310)
C
C*CORP UP TABLE FOR TPHUS
COPRCH (C4310)
C
C* INPUT DATA
EQUIVALENCE (C114013, BALPM)
EQUIVALENCE (C114021, PHSF)
EQUIVALENCE (C114023, OHSF)
EQUIVALENCE (C114043, PCTH)
EQUIVALENCE (C114053, GPHN)
EQUIVALENCE (C114101, CHP)
EQUIVALENCE (C114151, CHP)
EQUIVALENCE (C114171, MCCG)
EQUIVALENCE (C114181, MCCG)
EQUIVALENCE (C114201, PHMO)
EQUIVALENCE (C114211, ACGG)
EQUIVALENCE (C114213, ACGG)
EQUIVALENCE (C114221, ACRAV)
EQUIVALENCE (C114223, ACRAV)

C* INPUTS FROM OTHER MODULES
EQUIVALENCE (C112521, XINTER)
EQUIVALENCE (C120001, T)

C* OUTPUTS
EQUIVALENCE (C113021, RDLCCG)
EQUIVALENCE (C114023, OCMP)
EQUIVALENCE (C114031, ORMST)
EQUIVALENCE (C114031, FTKH)
EQUIVALENCE (C114121, PTHY)
EQUIVALENCE (C114123, PTHY)
EQUIVALENCE (C114125, RTH)
EQUIVALENCE (C114127, PTHY)
EQUIVALENCE (C114129, RTHY)
EQUIVALENCE (C114121, RTH)
EQUIVALENCE (C114123, RTH)
EQUIVALENCE (C114125, RTH)
EQUIVALENCE (C114127, RTH)
EQUIVALENCE (C114129, RTH)

C* STATE VARIABLES AND THEIR DERIVATIVES
EQUIVALENCE (C114991, URMO)
EQUIVALENCE (C114991, UMPO)

C IF (IQUAN.GTABLE) RETURN
PFLM = CCEPH2(TPH, THM, THFR, XINTER, ENTHR)

87
C FTNST = FTNST+1.0, PCFTO

10 USINF = SINC(4BCLPHT)
FTNST = FTNST + COSC(4BCLPHT)
FTNY = FTNST*SIN(4BPHIT)
FTNM = FTNST + S(NACOSC10PHIT)
GO TO 30

20 IF(FTNST .LT. 0.1) RETURN

30 CONTINUE

C UMDP = FTNST
UDMP = UMDP/CISP

C CPASS = (CWT - UMDP/AGRAY
RDELCG = DCCGO - DCCGO - DCCGO - DCCGO + UMDP/DWP

C FPIX = FMIXC*HCWT - AGWIN/AGRP
FPIY = FMIXC*HWT - AGWIN/AGRP
FPIZ = FMIXC
RLEC = RCLCG + RDELCG
IF (FTNST .LT. 0.1) RETURN

C WRITE (4,1000) T
100 FORMAT (5/34H DURCAT TIME+FB,4.5H SEC.)
COUR = 3.0
FTNST = 0.0
FTNY = 0.0
FTNM = 0.0
RETURN

END

C** TRANSLATIONAL DYNAMICS INITIALIZATION MODULE FOR DI

C** INPUT DATA

C EQUIVALENCE (CI,1001) VVKE
EQUIVALENCE (CI,1002) VVWE
EQUIVALENCE (CI,1003) VVW2
EQUIVALENCE (CI,2041) VMACH
EQUIVALENCE (CI,2081) REN
EQUIVALENCE (CI,367) DLPMA
EQUIVALENCE (CI,371) RANCE
EQUIVALENCE (CI,1752) RNPH(UO)
EQUIVALENCE (CI,1751) RNPH(UO)
EQUIVALENCE (CI,3681) BLPH
EQUIVALENCE (CI,427) BTHG
EQUIVALENCE (CI,431) BPSEG1
EQUIVALENCE (CI,4405) DERN
EQUIVALENCE (CI,3513) DFPARG
EQUIVALENCE (CI,4866) DCEVE
EQUIVALENCE (CI,1161) ASSLNF
EQUIVALENCE (CI,1793) WM
EQUIVALENCE (CI,1743) MO
EQUIVALENCE (CI,1774) MR
EQUIVALENCE (CI,3502) DOPNA

88
C

C*** OUTPUT TO MODULES
EQUIVALENCE (IC13703, BPPIP)
EQUIVALENCE (IC14155, RPI)
EQUIVALENCE (IC16174, RPI)
EQUIVALENCE (IC16223, RPI)
EQUIVALENCE (IC16431, VPI)
EQUIVALENCE (IC19077, VRI)
EQUIVALENCE (IC21511, VPI)
EQUIVALENCE (IC25279, RPI)
EQUIVALENCE (IC16395, RPI)
EQUIVALENCE (IC16361, RPI)
EQUIVALENCE (IC16391, RPI)
EQUIVALENCE (IC16443, RPI)
EQUIVALENCE (IC16447, RPI)
EQUIVALENCE (IC16533, RTPE)
EQUIVALENCE (IC16553, RTPE)
EQUIVALENCE (IC16591, RPI)
EQUIVALENCE (IC16651, RPI)
EQUIVALENCE (IC17553, RTPE)
EQUIVALENCE (IC17554, RTPE)

C

C (16471)C (1648)

IPLIN = 1000
IPLIN+1 = 1004
IPLIN+2 = 1260
IPLIN+3 = 1612
IPLIN+4 = 1216
IPLIN+5 = 1620
IPLIN+6 = 1240
IPLIN+7 = 1244
IPLIN+8 = 1648
IPLIN+9 = 1652
IPLIN+10 = 1656
IPLIN+11 = 1672

CALL
IF (EMT#1G10.9, 10)
ATP1 = ATP1 + 838
GCTG11
9 ATARGD.
10 CONTINUE
SP-IC=9.

C+++CALCULATE MISSILE PARAMETER INITIAL CONDITIONS
BYTC=BETEY+ALPHA
BPS1E=PS1E+ALPHA
RAXEL=SLANT+COS(RECEIVE)
RAYC=SLANT
RVE=SLANT+SEC(BALPHA)
RVE=SLANT+COS(RECEIVE)

20 HH = HRIT - RZE
C(+47)+ALPHA
C(+49)+ALPHA
C(+43)+ALPHA
C(+41)+ALPHA

C

C USHT = SIND1(TD1)
USHT = COST(TD1)
UCPSI = COSD1(FPS1D)
USP1 = SIND1(FPS1D)
UCPSI = COSD1(FPS1D)
SXA = -UPSI1*UCMTREE * USTMTREE
RBA = USPS1*UCMTREE
RBU = -UPSI1*UCMTREE - USTMTREE

24 VSCLUD = 1.17.3 = .0039288
VNYTE = VNYC + VSCUD
VNYR = VNYC + CSUD(ALPHA = BFEND)
VNYVRK = VNYT + COS(166PHY)
VNYVRE = VNYT + SIN(166PHY)
VNE = VNYT - WHITE + SIN(1806)

C 30 PCEL = RTG-RE
PCEL = RTG-RE
PECL = RE-RE
PCL = RE
PCL = RE
PCL = RE
RETURN
END

C*TRANSFORMATION CYKAPICS MODULE

SUPROUTAE C1
COPPEN C143301
C
C*INPUT DATA
EQUIVALEN E(16421),RAIL 1
EQUIVALEN E(16271),AGRA 1
EQUIVALEN E(16221),CHAD 1
EQUIVALEN E(16221),CHAD 1
EQUIVALEN E(16271),ATUR 1
EQUIVALEN E(16331),CCAT 1
EQUIVALEN E(16801),DPMD 1
EQUIVALEN E(18031),CIV 1
EQUIVALEN E(18531),CRAV 1
EQUIVALEN E(19301),Optr 4 1

C*CINPUTS PMP OTHER MODULES
EQUIVALEN E(17711),RANGE 1
EQUIVALEN E(17001),RANGE 1
EQUIVALEN E(17001),PBA 1
EQUIVALEN E(17001),PBA 1
EQUIVALEN E(17001),PBA 1
EQUIVALEN E(17001),PBA 1
EQUIVALEN E(17001),PBA 1
EQUIVALEN E(17001),PBA 1
EQUIVALEN E(17001),PBA 1
EQUIVALEN E(17001),PBA 1
EQUIVALEN E(17001),PBA 1
EQUIVALEN E(17001),PBA 1
EQUIVALEN E(17001),PBA 1

C*STATE VARIABLE OUTPUTS
EQUIVALEN E(18001),VRE 1
EQUIVALEN E(18001),VRE 1
EQUIVALEN E(18041),VRE 1
EQUIVALEN E(18041),VRE 1
EQUIVALEN E(18071),VRE 1
EQUIVALEN E(18071),VRE 1
EQUIVALEN E(18081),VRE 1
EQUIVALEN E(18081),VRE 1
EQUIVALEN E(18111),VRE 1
EQUIVALEN E(18111),VRE 1
EQUIVALEN E(18141),VRE 1
EQUIVALEN E(18141),VRE 1

90
C**ADD AERO AND THRUST FORCES TO GET TOTAL ACCELERATION IN BODY AXES
\nAEX = FEX/MASS
AAYE = FYE/MASS
ABE = FEY/MASS
\nC**RESOLVE FCHE ABCY TO EARTH AXES
AEX = CFA1*VXED+CFA2*AYE+CFA3*ZED
AAYE = CFA2*VXED+CFA22*AYE+CFA23*ZED
ABE = CFA3*VXED+CFA23*AYE+CFA33*ZED
\nC**INTEGRATE ACCELERATIONS
VXED = VX
VY = AY
VZED = AZ + AGRAV
\nC* CALCULATE TOTAL MISSILE ACCELERATION IN BODY AXES
VXBE = CFAL1*VXED+CFA12*VY+VZED+CFA13*ZED
VYBE = CFAL2*VXED+CFA22*VY+VZED+CFA23*ZED
VZEBE = CFAL3*VXED+CFA32*VY+VZED+CFA33*ZED
\nIF (AGRAV-LE100)=0, GO TO 10
\nANGX = VXBE/AGRAX
ANGY = VYBE/AGRAX
ANGZ = VZEBE/AGRAX
C*INTEGRATE VELOCITIES TO EARTH AXES POSITION
AXEC=AXE
AYEC = YVE
AZEC = ZVE
INERTIAP(10:4)+10
ATARG=ATST/INERTA
CGETC1
9 ATARG=0.
11 CONTINUE
IF (VTARG.0.1) BPSICTH ATURN+AGRAV+GRAD/VTARG
C
ATARG = XIJE
AYEC = YJE
AZEC = ZJE
C
VCELX = VTXE-VXE
VCELY = VYJE-YJE
VCELZ = VZJE-ZJE
C
REEXL = RAXE-ARE
REELY = RYJE-REJ
REELZ = RZJE-ZJE
VCLNG = RCELX*VCELX+RCELY*VCELY+RCELZ*VCELZ/RANGE
RETURN
END
C**ROTATIONAL DYNAMICS INITIALIZATION MODULE OZIELU
SUBROUTINE OZIELU
C
C**INPUTS FROM MAIN PROGRAM
C
C**STATE VARIABLES INPUTS
C
C**STATE VARIABLES OUTPUTS
C
C**OTHER INPUTS
C
C**OTHER OUTPUTS
C
C**INITIAL CALCULATION OF EULER ANGLE MATRIX OF DIRECTION COSINES (CFA)

USPHI = COSDEP+PI0
USEP = COSDEP+PI0
UCSP = COSDEP+PI0
USPS1 = SIND1PHS1
USPS2 = SIND1PHS2
USPS3 = SIND1PHS3
CFA11 = USPHI*USPHI+USPS1*USPS1+USPS2*USPS2
CFA12 = USPHI*USPS2+USPS1*USPS3
CFA13 = USPS1*USPS3
CFA21 = USPS1*USPHI+USPS2*USPHI+USPS3*USPHI
CFA22 = USPS2*USPHI+USPS3*USPHI
CFA23 = USPS3*USPHI
CFA31 = USPS1*USPHI+USPS2*USPHI+USPS3*USPHI
CFA32 = USPS2*USPHI
CFA33 = USPS3*USPHI

C
92
C** INTEGRATED PARAMETER LIST I IPL FOR WPD, WDG, WAD, AND CFAAD

C IPL = 11703
  IPL(1) = 11704
  IPL(2) = 11708
  IPL(3) = 11712
  IPL(4) = 11716
  IPL(5) = 11720
  IPL(6) = 11724
  IPL(7) = 11728
  IPL(8) = 11732
  IPL(9) = 11736
  IPL(10) = 11740
  IPL(11) = 11744
  h = 0.12

C** RESET ANGULAR RATE DERIVATIVES TO ZERO.

C CE1001 = 0.
  CE1002 = 0.
  CE1003 = 0.
  CE1004 = 0.
  CE1005 = 0.
  CE1006 = 0.
  CE1007 = 0.
  CE1008 = 0.
  CE1009 = 0.
  CE1010 = 0.

C RETURN

C** ROTATIONAL DYNAMICS MODULE

SUBROUTINE F7

C C DATA I NPUTS

C EQUIVALENCE (CE11401,RAIL)
  EQUIVALENCE (CE117481,FM81)
  EQUIVALENCE (CE117493,FM82)
  EQUIVALENCE (CE117563,CRAD)
  EQUIVALENCE (CE119031,OPTRI)
  EQUIVALENCE (CE125064,UPTRI)

C C INPUTS FOR OTHER MODULES

C EQUIVALENCE (CE139301,RAND)
  EQUIVALENCE (CE139321,WMDA)
  EQUIVALENCE (CE119341,FMDA)
  EQUIVALENCE (CE119351,FMDA)
  EQUIVALENCE (CE119361,FMCG)

C C INPUTS FOR THE PROGRAM

C EQUIVALENCE (CE115001,CFALL)
  EQUIVALENCE (CE115011,CFALL)
  EQUIVALENCE (CE115031,CAFIA3)
  EQUIVALENCE (CE115041,CAFIA2)
  EQUIVALENCE (CE115061,CAFIA4)
  EQUIVALENCE (CE115071,CAFIA1)
  EQUIVALENCE (CE115131,CF2C)
  EQUIVALENCE (CE115151,CF2C)
  EQUIVALENCE (CE115161,CEF2C)
  EQUIVALENCE (CE115171,CEF2C)

93
INTEGER STATUS
CPI(NX(N1))<59,59
95  KK=0
96  CONTINUE
JAR = 0
WRITE(*,51)
51  FLP(H1,H2,IJU,TPT)
    1 READ(C,2) T1(1),ALPHA(1),ALPHA(2),ALPHA(3),I(2), RED(1), VR(2)
    2 WRITE(6,30) T1(1),ALPHA(1),ALPHA(2),ALPHA(3),I(2), RED(1), VR(2)
    30 FORMAT(2,3X,5.1,3X,5.1,3X,5.1,2X,5.1)
7 IF (I(JAR), NE. 1) GO TO 3
    ACSUB = ACSUB + 1
    SLT(C,ACSUB,1)
    R1=KK+3510
    C(I(1)+1)=R1
    KK=KK+2
    CC FC L
3 IF (I(1), NE. 2) GO TO 4
    NCED = NUMCE + 1
    NCED(1,NCED) = I(12)
    R1=KK+3510
    C(I(1)+1)=R1
    KK=KK+3510
    NCED = NUMCE + 1
    NCED = NUMCE + 1
    R1=KK+3510
    C(I(1)+1)=R1
    KK=KK+2
    CC FC L
4 IF (I(1), NE. 3) GO TO 5
    L = I(12)
    C(EJ) = VR(1)
    R1=KK+3510
    C(I(1)+1)=R1
    KK=KK+2
    IF (VR(12), EQ. 0), 2 GO TO 1
    NCLIST = NOLIST + 1
    NLIST(NLIST) = L
    NLIST(NLIST) = VR(12)
    R1=KK+3510
    C(I(1)+1)=R1
    KK=KK+4
    CC FC L
5 IF (I(1), NE. 4), GO TO 6
    NCUT = A(CUT) + 1
    IF (ACUT(T), EQ. 0), GO TO 1
    C(A(1), NCLIST) = L
    C(A(1), NCLIST) = A(CUT)
    NLIST(NLIST) = I(12)
    R1=KK+3510
    C(I(1)+1)=ALPHA(2)
    KK=KK+3
    IF (L(1), EQ. 1), GO TO 7
    C(I(1)+1)=L(1)+L(2)
    KK=KK+6
    CC FC L
6 IF (I(1), NE. 5) GO TO 16
    IF (VR(12), EQ. 0), GO TO 17
WRITE (6, 134)
13 FORMAT (1(15D10)) " WARNING- PLOTTING ARRAY FILLED- ONLY FIRST 309 P
COUNTS Plotted: ****, ****
14 COUNTO = POINT
15 CONTINUE
16 COUNTO = POINT
17 CONTINUE
18 COUNTO = POINT
19 CONTINUE
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260 COUNTO = POINT
261 CONTINUE
262 COUNTO = POINT
C ADAP=GOUCLS INTEGRATION
200 KCUT=CLS
DELTA=0.5
CC 250 1=1.1
R1=J2=J
R2=J3=1

C COMPUTE Y-PREDICIEED

C C[1]:NP=P(1)
N=NP+1=C(NP+1)+E1(T1-E1+P2+T(K3)-P3+T(K2))
210 V=V1+11(NP)
V=V+11(E1)
V=V+11(NP)
CALL AUX
CC 250 1=1.1
R2=J2=1

C COMPUTE Y-CL-PREDICED

N=NP+1=C(NP+1)+E3(E1-E1+P4+T(K4)+P3+T(K3))
220 IF=(K4<K4) GO TO 250
STEP=STEP+STEP(1)
CC TO 240
C IF=STEP(1) < STEP TO 230
STEP=STEP(1)
STEP=STEP(1)
WHITE=2,291
SPT(IP[E1+TEMP)
230 IF=(K5<K5) GO TO 270
STEP=STEP(1)
CC TO 280
C IF=STEP(1) < STEP TO 230
STEP=STEP(1)
STEP=STEP(1)
WHITE=2,291
SPT(IP[E1+TEMP)
250 IF=(K3<K3) GO TO 290
STEP=STEP(1)
CC TO 270
C IF=STEP(1) < STEP TO 250
STEP=STEP(1)
STEP=STEP(1)
WHITE=2,291
SPT(IP[E1+TEMP)
270 IF=(K3<K3) GO TO 290
STEP=STEP(1)
CC TO 270
C IF=STEP(1) < STEP TO 250
STEP=STEP(1)
STEP=STEP(1)
WHITE=2,291
SPT(IP[E1+TEMP)
290 IF=(K3<K3) GO TO 290
STEP=STEP(1)
CC TO 270
C IF=STEP(1) < STEP TO 250
STEP=STEP(1)
STEP=STEP(1)
WHITE=2,291
SPT(IP[E1+TEMP)
C SET-UP FOR CCULDING STEP SIZE

C CC=COUNT+1 TO 290
CC CC=COUNT+1 TO 290
R2=J2=1
R2=J3=1
R5=J5=1
T(E1+T(K1))
T(K1)+T(K2)
200 IF=(K2<K2) GO TO 290
DELTA=0.5
HCAL=7
290 IF=(K2<K2) GO TO 290
DELTA=0.5
HCAL=7
CC TO 290
C SET-UP FOR SAVING STEP SIZE
270 IF MOUNT=5L, A100 TO 310
   TPE=1PE-CALL
   V11=1PE
   DL1=DECL
cell=0.5(d11)
   CC ~20 = 1.d11
   A1 = 3.1.
   A2 = 2.1.
   A3 = 3.1.
   A8+1(1)=DOLI
   V12(A)=1 CL1(A)
   V(T31(A))=V(T21(A))=0.5(T21(A))=T21(A)
   V(T21)=T22
280 T21(T31(1)(1)((10.5N1(1)+T11)
   CC TO 400
   C INTEGRATION IS, FINISH, SET UP DERIVATIVES AND EXIT.
290 CC NO 14L,H3
   NPEP=1(N1=1)
   300 V(11)=N1CC11
   CC TO 400
   C RETURN TO THE PRECEDING POINT AND RESTART
310 DO 320 1=1,41
   A1=V11
   NPEP1=1(N1)
320 V11=1PE
   TPE=1PE+G(C1)
   V11=1PE
   DL1=DECL
   CALL AUSUB
   CC TO 30
   T1=
   SUBROUTINE AUSUB
   CC=CN CN3010
   EQUALS: P (CE238), WUOOG T, CECE23821, WUOOG1, CECE23811
   CREATION AUSOGE1199
   A =
   CC 1 = 1
   WUOOG11
   1 AUSOGE11
   GC TC 015, 016, 017, 018, 019, 020, 021, 022, 023
   1 .24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38
   2 CALL A11
   CC TO 1
   3 CALL A21
   GC TO 1
   4 CALL A31
   GC TO 1
   5 CALL A41
   GC TO 1
   6 CALL A51
   CC TO 1
   7 CALL A61
   CC TO 1
   8 CALL A71
   CC TO 1
   9 CALL A81
   CC TO 1
   10 CALL A91
   CC TO 1
   11 CALL A11
   CC TO 1
   12 CALL A12
   103
GO TO 1
13 CALL C7E
GO TO 1
14 CALL C6E
GO TO 1
15 CALL C4E
GO TO 1
16 CALL C1E01
GO TO 1
17 CALL C1E
GO TO 1
18 CALL C2E
GO TO 1
19 CALL C3E
GO TO 1
20 CALL C4E
GO TO 1
21 CALL C5E
GO TO 1
22 CALL C6E
GO TO 1
23 CALL C7E
GO TO 1
24 CALL C8E
GO TO 1
25 CALL C9E
GO TO 1
26 CALL C0E
GO TO 1
27 CALL C1E
GO TO 1
28 CALL C2E
GO TO 1
29 CALL C3E
GO TO 1
30 CALL C4E
GO TO 1
31 CALL C5E
GO TO 1
32 CALL C6E
GO TO 1
33 CALL C7E
GO TO 1
34 CALL C8E
GO TO 1
35 CALL C9E
GO TO 1
36 CALL SL1E
GO TO 1
37 CALL SL0E
GO TO 1
1 CONTINUE
RETURN
END
SUBROUTINE AUXSUB
COPCH (C(459))
EQUIVALENCE (C(2000),T ) + (C(2561),XMOD ) + (C(2562),XCOND )
EQUIVALENCE (C(2563),T ) + (C(2562),IPL ) + (C(2564),DER )
EQUIVALENCE (C(2565),VAR )
DIMENSION (ER1(101) ) + WAR(101 ) + P(100)
DECK C354(XMOD2N999)
DO 50 1 = 2, N
104
29 CALL S2
30 CALL S3
GO TO 1
31 CALL S4
GO TO 1
32 CALL S5
CC TC 1
33 CALL S6
GO TO 1
34 CALL S7
CC TO 1
35 CALL S8
GO TO 1
36 CALL S9
CC TO 1
37 CALL S10
CONTINUE
DO AS 1 * 2, N
J = 1 (PLF = 1)
60 DOPIAS + (EJ)
RETURN
END
SUBROUTINE RESQ
CUPCLX X (4,10)
EQUVALENCE (IC(4,10),K,EC,ER)
EQUVALENCE (C(13041),MOLESTK, ICE(3007),LISTIN11, (C(13171),VALUE 1)
EQUVALENCE (C(13001),NORMIS, (C(13411),RADMNO)
EQUVALENCE KE(1300), B)
DIPNEN (K(4,10))
DIPNEN (LISTIG(59))
DIPNEN (PLF(50))
DIPNEN (RADIUS(50))
C3332=1.x3599
33 C3332=0.
C30=3.494
D3=1.33500+4C2
63 K(I) = K(I)+1
K (2561) = K (2500)
K (2361) = K (2300)
K (1301) = K (1000)
K (1361) = K (1300)
K (13301) = K (1305)
K (33101) = K (3200)
K (3101) = K (3000)
K (3120) = K (3050)
K (2120) = K (2010)
K (110) = 2
RELIAB
END
C DUMMY SUBROUTINE
C SUBROUTINE DUMMY
C ENTRY A1
C ENTRY A11
C ENTRY A2
C ENTRY A21
C ENTRY A3
C ENTRY A31
C ENTRY A4
C ENTRY A41
C ENTRY A5
C ENTRY A51

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ENTRY A741
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Functeb ATAC (X,Y)

ATAC 7.120578+51322 (X,Y)

CONTINUE

RETURN

END

SUBROUTINE TABLE (X,Y)

DIMENSION AXELE (3)

Y = CC1B2 (X,XY,XE,XY,AXELE)

RETURN

END

SUBROUTINE TABLE1 (X,Y)

DIMENSION AXELE (2)

Y = CC1B2 (X,XY,XE,XY,AXELE)

RETURN

END

SUBROUTINE TABLE2 (X,Y)

DIMENSION AXELE (2)

Y = CC1B2 (X,XY,XE,XY,AXELE)

RETURN

END

SUBROUTINE TEPICICLET)

RETURN

END

SUBROUTINE WRITE1 (P, N)

RETURN

END

SUBROUTINE PLOTGRAPH (VARIABLE, TIME, X, Y)

RETURN

END

SUBROUTINE PLOT1(X, Y)

RETURN

END

SUBROUTINE PLOT2 (X, Y)

RETURN

END

SUBROUTINE PLOT3 (X, Y)

RETURN

END

SUBROUTINE CODEN

DITCE

TO FI A OF POINTS WITH A CONTINUOUS FUNCTION THAT
SIMULATES A LINEAR CURV OR CURVE FIT.

USAGE

Y = CODEN (X, X, Y, X, N, F + LABEL)

OR

Y = CODEN (X, X, Y, N, F + LABEL)

DESCRIPTION OF PARAMETERS

E

ARGUMENT - INDEPENDENT VARIABLE

X

ARRAY OF INDEPENDENT VARIABLES - X

Y

ARRAY OF COEFFICIENT VARIABLES - Y

N

NUMBER OF POINTS REPRESENTED BY X AND Y ARRAYS

F

INTERPOLATION CONTROL

LESS THAN ZERO - STRAIGHT LINE INTERPOLATION

POSITIVE - END INTERVAL INTERPOLATION

0.0 STRAIGHT LINE

1.0 FULL PARABOLIC

109
C

FUNCTION GCCEP (X, XI, YE, N, F, XLABEL)

DIMENSION XE(N), YE(N), PI2(2), EI(2), XI(N), XLABEL(N)

C

REMARKS

EXTRAPOLATION IS DONE BY PASSING A STRAIGHT LINE THRU THE

THE ALCONS AT THE END INTERVAL.

THE ARRAY OF THE INDEPENDENT VARIABLE, XI, MAY BE IN

 EITHER INCREASING OR DECREASING ORDER.

C

PARAMETERS

FUNCTION GCCEP (X, XI, YE, N, F, XLABEL)

100 OUT = .FALSE.

XI = .FALSE.

K = .FALSE.

J = 1

IF (XI - XI(2)) 500 .GT. 200 .AND. 500

400 CC = 1000 XII = XI

900 CONTINUE

800 J = J + 1

CALL REMARK (XLABEL)

CC TO 1000

900 CUT = .FALSE.

IF (J .LT. 20) 1000, 1000, 1000

1000 KPL = 1

CC TO 1000

1100 IF (J .LT. 1500) 1000, 1400, 1300

1200 J = J + 1

1300 CONTINUE

1400 IF (XI(2) - XI(1)) 250 .GT. 1500 .AND. 1500

1500 AL = (XI(2) - XI(1)) / (XI(2) - XI(1))

CC = II .AND. XI(2) + XI(1) .AND. XI(1) .AND. XI(2) .AND. XI(1) .AND. XI(2)

IF (CUT = .TRUE.) RETURN

CC = 1000 MP = KPL .AND. KPU

CC = 0.0

CC = 0.0

CC = 1.0 .AND. J .EQ. K

1950 XI = 0.

1990 XI = XI(1)

110
PROCEDURE

1750 JL=JAPSIN,MP
1760 J2 = J * (SQR(J)+MP)
1800 J3 = P1J) + Y1) + (XK - XI(J3)) / (XO - XI(J3))
        * (XK - XI(J2)) / (XO - XI(J2))
        IF EKL+J2, MP=1 GO TO 1700
1800 CONTINUE
        IF (11) + (E2) = EQ G.O.1 RETURN
        ECCM2 = (E1 + AL) + P2) + (E1 + G.0. - AL) )
        IF (11) / (E1 + AL) + (E2) + (G.0. - AL) )
        RETURN
        END

C DIMENSION 2-DIMENSION INTERPOLATION SUBPROGRAM

C CALLING SEQUENCE =
C Z = FCOM2(X1,X2,Y1,Y2,NX,NY,XX,YY,IX,IX)
C
Z = ARGUMENT 1ST VARIABLE
X = ARGUMENT 2ND VARIABLE
X = ARRAY OF 1ST VARIABLE
Y = ARRAY OF 2ND VARIABLE
Z = ARRAY OF COEFFICIENT VARIABLE
N = COEFFICIENTS SIZE OF X ARRAY
M = NUMBER OF VALUES IN ARRAY Y
K = EU INTERVAL INTERPOLATION CONSTANT

LABEL = 5-CHARACTER FIELD OF UP TO 5 CHARACTERS

C THIS ROUTINE DIFFERS FROM FCOM2 IN THAT THE Z ARRAY DOES NOT
C HAVE TO BE SORTED - I.E., IT DOES NOT HAVE TO OCCUPY COORDINATE
C SECTIONS LOCATIONS IN CORE, AND IN THAT EITHER OR BOTH THE
C X AND Y ARRAYS MAY BE IN ASCENDING OR DESCENDING ORDER.

C FUNCTION FCOM2XYX1X2Y1Y2NXNYXXYMY LABEL
C DIMENSION X1(Y1, Y2), XXMNX, NY, XX, YY, IX, IX
C IF (NX+NY) GO TO 120
120 NX+NY = LABEL(2)
130 IF (Y1+Y2) = EQ 130, 150, 133
140 GO TO 150
150 IF (Y1+Y2) = EQ 130, 150, 133
160 GO TO 150
170 CONTINUE
180 CONTINUE
190 NW+NY = 3

111
GO TO 200
C
112
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**Note:** The table above contains various parameters such as time, roll, pitch, yaw, speed, heading, altitude, and heading. The units and values are to be interpreted based on the context of the document.
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APPENDIX I

COORDINATE TRANSFORMATION FROM BODY TO GIMBAL AXIS SYSTEM
Figure I-1. Angles Between Gimbal and Body Axes

Transformation for Gimbal Pitch Angle \( (\theta_g) \)

\[
\begin{bmatrix}
X_B' \\
X_B' \\
Z_B'
\end{bmatrix} = \begin{bmatrix}
\cos \theta_g & 0 & -\sin \theta_g \\
0 & 1 & 0 \\
\sin \theta_g & 0 & \cos \theta_g
\end{bmatrix} \begin{bmatrix}
X_B \\
Y_B \\
Z_B
\end{bmatrix}
\]

Transformation for Gimbal Yaw Angle \( (\psi_g) \)

\[
\begin{bmatrix}
X_G \\
Y_G \\
Z_G
\end{bmatrix} = \begin{bmatrix}
\cos \psi_g & \sin \psi_g & 0 \\
-\sin \psi_g & \cos \psi_g & 0 \\
0 & 0 & 1
\end{bmatrix} \begin{bmatrix}
X_B' \\
Y_B' \\
Z_B'
\end{bmatrix}
\]

Transformation from Body Axis to Gimbal Axes

\[
\begin{bmatrix}
X_G \\
Y_G \\
Z_G
\end{bmatrix} = \begin{bmatrix}
\cos \psi_g & \sin \psi_g & 0 \\
-\sin \psi_g & \cos \psi_g & 0 \\
0 & 0 & 1
\end{bmatrix} \begin{bmatrix}
\cos \theta_g & 0 & -\sin \theta_g \\
0 & 1 & 0 \\
\sin \theta_g & 0 & \cos \theta_g
\end{bmatrix} \begin{bmatrix}
X_B \\
Y_B \\
Z_B
\end{bmatrix}
\]
Transformation for both Gimbal Pitch angle and Gimbal Yaw angle for Range Determination is given as:

\[
\begin{bmatrix}
RXG \\
RYG \\
RZG
\end{bmatrix} =
\begin{bmatrix}
\cos\psi \cos\theta & \sin\psi & -\sin\theta \cos\psi \\
-\sin\psi \cos\theta & \cos\psi & -\sin\psi \sin\theta \\
\sin\theta & 0 & \cos\theta
\end{bmatrix}
\begin{bmatrix}
RXBA \\
RYBA \\
RZBA
\end{bmatrix}
\]
APPENDIX II
HIGH FREQUENCY ACTUATOR PROGRAM LISTING
**INITIALIZATION MODULE FOR TIGER**

**Simplified Actuator Model**

C

**Subroutine CAT**

C

**C**

**DELTIN**

C

**CALL**

END

C

**TIGER SIMPLIFIED ACTUATOR MODEL**

**HIGH FREQUENCY MODEL**

C

**Subroutine CA4**

C

**C**

**INPUT DATA**

C

**C**

**DELT** are MEASURES IN RADIANS
C
C**INPUTS FFP LIPER MOLECLES
EQUIVALENCE IC(11300)./WELT)
EQUIVALENCE IC(153)./WELT)
EQUIVALENCE IC(1111)./WELT)
EQUIVALENCE IC(1111)./WELT)
EQUIVALENCE IC(1111)./WELT)
EQUIVALENCE IC(1111)./WELT)
EQUIVALENCE IC(1111)./WELT)
EQUIVALENCE IC(1111)./WELT)
C
C**STATE VARIABLE OUTPUTS
BCELTF(1) = CE(11231)
BCELTF(2) = CE(11331)
BCELTF(3) = CE(11330)
BCELTF(4) = CE(11323)
BCELTF(5) = CE(11322)
BCELTF(6) = CE(11321)
BCELTF(7) = CE(11313)
BCELTF(8) = CE(11312)
BCELTF(9) = CE(11311)
BCELTF(10) = CE(11310)
BCELTF(11) = CE(11309)
BCELTF(12) = CE(11308)
BCELTF(13) = CE(11307)
BCELTF(14) = CE(11306)
BCELTF(15) = CE(11305)
BCELTF(16) = CE(11304)
BCELTF(17) = CE(11303)
BCELTF(18) = CE(11302)
BCELTF(19) = CE(11301)
BCELTF(20) = CE(11300)
C
C**INPUTS FFP* PAIN PROGRAM
EQUIVALENCE IC(27965).VAR
1
CE(1131).=CE(1132)
CE(1132)=CE(1133)
CE(1133)=CE(1134)
CE(1134)=CE(1135)
CE(1135)=CE(1136)
CE(1136)=CE(1137)
CE(1137)=CE(1138)
CE(1138)=CE(1139)
CE(1139)=CE(1140)
CE(1140)=CE(1141)
CE(1141)=CE(1142)
CE(1142)=CE(1143)
C
C**FLAP CELLITION BEAS
BCELTF(1) = BCELTF(1) - CELTF + DELTOR - DELTB
BCELTF(2) = BCELTF(2) - CELTF + DELTO - DELTB
BCELTF(3) = BCELTF(3) - CELTF + DELTB + DLTETB
BCELTF(4) = BCELTF(4) - CELTF + DELTB + DELTB
C
C**ACTUATOR DYNAMICS
IC 70 1+1
CECET(1) = +CECLF(11)+PT
H = 1-1.461
CECET(1) = CE(1121.1)
CECET(1) = BCELTF(1)
CECET(1) = BCELTF(1)-3/A1+DELTO+DELTO-A4/A1+DELTE+DELTE
**CECET(1)+A1+01+HY(+1)/A1
C
C**SURFACE POSITION LIMITER
IF (CECLET(1) = A1) GO TO 600
BCELTF(1) = SIGMOT +BCELTF(1)
J = CECLF(1)
VARJ = COFL(1)
IF (SIGMA = BCELTF(1) = CECLF(1) = COFL(1)) GO TO 60

126
BCEL(1) = 0.
BCEL(2) = 0.
J = J + 4

d = abs(BCEL(1))

10 CONTINUE
C

C SLF1 = CCEL 2; PT
B5L2 = CCEL 12; PT
B5L3 = CCEL 43; PT
B5L4 = CCEL 64; PT
C(1) = C(1) + C(1) + C(1) + C(1)
C(2) = C(2) + C(2) + C(2) + C(2)
C(3) = C(3) + C(3) + C(3) + C(3)
C(4) = C(4) + C(4) + C(4) + C(4)

C

C***OUTPUT DERIVATIVES OF STATE VARIABLES TO INTEGRATION
C
C(1100) = CCEL(11)
C(1101) = CCEL(12)
C(1102) = CCEL(13)
C(1103) = CCEL(14)
C(1104) = CCEL(15)
C(1105) = CCEL(16)
C(1106) = CCEL(17)
C(1107) = CCEL(18)
RETURN
END
APPENDIX III
HIGH FREQUENCY AUTOPilot PROGRAM LISTING
C*** TIGER AUTOPILOT INITIALIZATION MODULE
C**********HIGH FREQUENCY MODEL********
SL2CMULTIDE C1
CCEPA (4310)
COPPASL (FL1100)
EQUVALENCE (C1 373, E29)
EQUVALENCE (C1 473, E29)
EQUVALENCE (C1 573, E29)
EQUVALENCE (C1 673, E29)
EQUVALENCE (E1 4843, C345)
EQUVALENCE (C1 4843, C345)
EQUVALENCE (C1 5843, C345)
EQUVALENCE (C1 FL1843, E25)
EQUVALENCE (C1 6843, C345)
EQUVALENCE (C1 7843, C345)
EQUVALENCE (C1 8843, C345)

C
APSP = H
FLPLN = A30
FLPLN+1 = 004
FLPLN+2 = 000
FLPLN+3 = 012
FLPLN+4 = 016
FLPLN+5 = 020
FLPLN+6 = 024
FLPLN+7 = 028
FLPLN+8 = 032
FLPLN+9 = 036
FLPLN+10 = 040
FLPLN+11 = 044
FLPLN+12 = 048
FLPLN+13 = 052
FLPLN+14 = 056
FLPLN+15 = 060
FLPLN+16 = 064
FLPLN+17 = 068
FLPLN+18 = 072
FLPLN+19 = 076
FLPLN+20 = 080
FLPLN+21 = 084
FLPLN+22 = 088
FLPLN+23 = 092
FLPLN+24 = 096
FLPLN+25 = 100
FLPLN+26 = 104
FLPLN+27 = 108
FLPLN+28 = 112
FLPLN+29 = 116
FLPLN+30 = 120
FLPLN+31 = 124

21 E2S = C345
EVS = C345
EVS = C345

22 E2S = E2S
EYS = EYS
C1 803 = 0
C1 807 = 0
C1 813 = 0
C1 819 = 0
C1 823 = 0
C1 827 = 0
C1 833 = 0
C1 839 = 0
RETURN
EN0

C*** TIGER AUTOPILOT MODULE
C**********HIGH FREQUENCY MODEL********
SHIPMULTIDE C1
CCEPA (4310)
CIPERSICH BEELTCE (1, 4A93130)
C
C***INPUT DATA
EQUVALENCE (C1OR53) = PLIMD 1
EQUIVALENCE (IC(256), LE(1)
EQUIVALENCE (IC, 007, LE(2)
EQUIVALENCE (IC, 00, LE(2)
EQUIVALENCE (IC, 02, LE(2)
EQUIVALENCE (IC, 0X6, LE(2)
EQUIVALENCE (IC, 02, LE(2)
EQUIVALENCE (IC, 007, LE(2)
EQUIVALENCE (IC, 00, LE(2)
EQUIVALENCE (IC, 007, LE(2)
EQUIVALENCE (IC, 00, LE(2)

C (BIT) IN #CC ARE USED BY EQN(11)
EQUIVALENCE (IC, 003, LE(2)
EQUIVALENCE (IC, 004, LE(2)
EQUIVALENCE (IC, 005, LE(2)
EQUIVALENCE (IC, 006, LE(2)

C++ INPUT PACK ETHER POCKETS
EQUIVALENCE (IC, 0052, LE(2)
EQUIVALENCE (IC, 0051, LE(2)
EQUIVALENCE (IC, 0051, LE(2)
EQUIVALENCE (IC, 0051, LE(2)
EQUIVALENCE (IC, 0051, LE(2)
EQUIVALENCE (IC, 0051, LE(2)
EQUIVALENCE (IC, 0051, LE(2)
EQUIVALENCE (IC, 0051, LE(2)

C++ INPUT PACK WITH PROGRAM
EQUIVALENCE (IC, 0053, LE(2)
EQUIVALENCE (IC, 0054, LE(2)
EQUIVALENCE (IC, 0055, LE(2)

C++ STATE VARIABLE OUTPUTS
EQUIVALENCE (IC, 0056, LE(2)
EQUIVALENCE (IC, 0057, LE(2)
EQUIVALENCE (IC, 0058, LE(2)
EQUIVALENCE (IC, 0059, LE(2)
EQUIVALENCE (IC, 0060, LE(2)
EQUIVALENCE (IC, 0061, LE(2)
EQUIVALENCE (IC, 0062, LE(2)
EQUIVALENCE (IC, 0063, LE(2)

130
**C** **OUTPUTS**

EQUIVALENCE IC= RSP, BCELTC

**C** **OTHER CLIPUTS**

EQUIVALENCE IGORBETLC.ZRRA, 1
EQUIVALENCE IGORBETLC.EPS, 1
EQUIVALENCE IGORBETLC.WCC, 1
EQUIVALENCE IGORBETLC.RTLC.WCC, 1

**C** **EXTERNAL SIGNAL SHAPING**

ELEC = SELEC
CVRH = ECVW
E2SC = EDSP
E3SC = EVSP
E3SC = TALC1 (TALC1 = E31) = 2.2E30)
E3SL = TALC2 (TALC2 = E32) = 2.2E30)
E3SC = TALC1 (TALC1 = E31) + E32 = E33)
E3SS = TALC1 (TALC1 = E31) + E32 = E33)

**C** **GRAVITY FACE RATE RIS**

WCP = E35 + CT4AS
WCP = EYSS + HTAS

**C**

**C** **DECAY RATE SHAPING AND CYNO DYNAMICS**

WSEC = WSP:
WSEC = HASC
WSEC = HASC (WEC = WSEC - 2.2WSE30)
WSEC = HASC (WEC = WSEC - 2.2WSE30)

IF (ABS (E30) = 0.1) GO TO 30
WEC = SICH (E30) WEC: GO TO 30
WSEC = 0.
WSEC = 0.
WSEC = 0.
WSEC = 0.
WSEC = 0.
WSEC = 0.
WSEC = 0.

30 IF (E35(WBC) .LE. 30) GO TO 32
WEC = SICH (E35(WBC) .NE. WEC) WEC: GO TO 32
WSEC = 0.
WSEC = 0.
WSEC = 0.
WSEC = 0.
WSEC = 0.
WSEC = 0.
WSEC = 0.
WSEC = 0.
WSEC = 0.
WSEC = 0.

32 CONTINUE

**C** **SUPPRESSION OF RATE DAMPING AND QUICHCANCE SIGNALS AND THEIR DERIVATIVES**

E4AR = UCS - WUC
E4AR = UCS - WUC

**C**

UTC = -25
IF (UTC .LT. T6) UTR = 4.25
IF (UTC .LT. T6) UTR = 6.

**C**

ES = UCW + E3 AR + E4 AR
ES = UCW + E3 AR + E4 AR

131
C  END ALL SIGNAL SHAPING

C**OUTPIECE OUTPUT CURRENTS TO EACH ACTUATOR (FROM SUMMATION AMPS)

DCELFCL(1) = EVICR - BCELPC

DCELFCL(2) = EVICR - BCELPC

DCELFCL(3) = EVICR - BCELPC

DCELFCL(4) = EVICR - BCELPC

RETURN

END

132
Distribution List
Not Filmed

Fax 133-134
This report describes in detail a six-degree-of-freedom program which can be used to determine the trajectory and miss distance of a missile system. The options for the program are such as to permit variation of the aerodynamics, seeker, autopilot actuator, and missile motor performance for the purpose of accurately simulating a given missile design and evaluating the effects of changes in system parameters. Sufficient detail has been included in the text in order to minimize the users' effort needed to know how to update or modify the program for his purposes.
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