High Energy Solar Spectroscopic Imager (HESSI)

Hot Bench Simulation Training

May 4, 2001

Stan Fernandes
Jeff Jackson
Diane Li
E-mails:  stan.fernandes@specastro.com
        jeff.jackson@specastro.com
        diane.li@specastro.com
Content

ACS Hot Bench Test Description and Configuration

Power On Procedure for Hardware

Run Simulations and Collect Data

Change Spacecraft Initial Attitude Conditions and Orbit Parameters
  • Change Parameters in Real Time

Simulate Failure Scenarios
  • Setup Failure Cases in Real Time

Back-up Charts
Hot Bench Test Description
High Energy Solar Spectroscopic Imager (HES)}

Hot Bench Simulation Setup

**AC1000**
- **40 Hz**
  - **CPU**
  - **MAG**
    - **D/A**
  - **CSS**
    - **D/A**
  - **SAS**
    - **D/A**
  - **FSS**
    - **D/A**
  - **VME Write**
  - **VME Read**
  - **VME Write**
  - **TQR**
    - **A/D**

**Simulating SC Dynamics, Sensors**
- **TM = Transition Module**
  - 4 Analogs
    - -5 to +5 volts
  - 8 Analogs
    - -10 to 0 volts
  - 2 Analogs
    - -2.5 to +2.5 volts
  - FSS SPI Bit
    - low, high
  - 10-Bit Coarse Data
    - Gray Code
  - 2000 Hz
  - 2 Analog
    - -5 to +5 volts
  - 2 Analog
    - -2.5 to +2.5 volts
  - 4 Analog
    - -5 to +5 volts
  - 8 Analog
    - -5 to +5 volts
  - 8 Analog
    - 0 to 1300 amps

**EM CPU Electronics Boards**
- **IDPU SAS Simulator**
- **Serial Data**
- **Enable Gate**
  - low, high
- **Enable & Clock**
  - low, high
- **10-Bit Coarse Data**
  - Gray Code
- **2 Analogs**
  - -5 to +5 volts
- **3 Analog**
  - -5 to +5 volts
- **3 Analog**
  - -0.25 to +0.25 amps

**CDHS**
- **8 Hz**
  - **RAD6000 CPU**
  - **PACI**
  - **CIB**
  - **ADB**
Description - AC1000 Unit

**AC1000 Unit**

- VME Backplane
- Processor Board at 40 Hz, Housing Autocoded C Code Simulating:
  - SC Dynamics
  - ACS Sensor Models - MAG, FSS, CSS, SAS
  - Ephemeris - Orbit Dynamics, Earth’s Magnetic Field, Sun Position
  - Disturbance Models - Gravity Gradient, Aerodynamics
- Three 6-Channel D/A Boards for Outputs:
  - 4 MAG Signals
  - 8 CSS Signals
  - 2 SAS Signals - X and Y counts of Sun Vector
  - 2 FSS Signals - sine and cosine
- VME Write/Read, 2000 Hz, Communicating with FSS Simulator for:
  - FSS SPI
  - FSE Signal Output Enable Gate
  - FSE 10-Bit Gray-coded Coarse Data
- One 16-Channel A/D Board for Inputs:
  - 3 Analog Signals from ADB Board - Three Torque Rod Coil Currents
Description - FSS, IDPU

FSS Simulator
• Processor Board within AC1000 VME Cage
• Inputs
  • An Enable Gate 100 Hz - Switch Between X and Y Axes, Enable Output of Coarse Data
  • Clock 9600Hz for Reading 10-bit Coarse FSS Data
  • FSS SPI and 10-Bit Coarse Data
• Outputs
  • Enable Gate
  • FSS SPI
  • 10-bit Coarse Data

IDPU Simulator
• Provides Emulation of IDPU Data Packet Outputs at 1Hz
• Inputs - 2 Analog Signals of X and Y Data from AC1000 & TM
• Outputs - Serial Data to PACI
• Delays
  • 2 Seconds Sampling Delay
  • 0.5 seconds Serial Interface Delay to PACI
• Others
CDHS Unit
• VME Backplane
• Engineering Model of RAD6000 CPU
  • Runs Flight Software (FSW) at 8Hz
• PACI, CIB, ADB
• Inputs
  • 4 MAG Voltage
  • 8 CSS Current
  • 2 FSS Voltage
  • FSS SPI and Coarse Data
  • Serial Data from IDPU
• Outputs
  • Enable Gate and Clock to FSS Simulator
  • 3 Torque Rod Current From ADB

Transition Modules
• For Signal Conditioning
• Signal Conversions
Power On Hardware

**Turn On EGSE VME Power**

Run RESMAN From the **SEM Test PC**

Run UCB FSW-ACS Hot Bench **Diagnostic.Vi**

Turn on the 28V Transition Module Power Supply

Turn on the COTS Power Switch on the Transition Module Chassis

Setup PTP on the **CMD/TLM PC**

Start ITOS on the SUN Workstation

Set the Battery Supply Enable to off (Battery Simulator)

Turn on the 28V Power Supply for the Battery Simulator.

Set the Battery Supply Enable to on (Battery Simulator)

Set the DUT Power Switch to on at the Transition Module Chassis

Turn on the CPU by Simulating Separation or by Sending the Appropriate HCD Command
Power On Torque Rods

Turn On Torque Rods

At the **SEM Test PC**, Enable the Following Loads: TRX, TRY, TRZP, TRZR.

Turn on NEB1 by Sending the “*/Pcbsetswitch Neb1,on*” Command

Turn on Torque Rod X and Z Primary Power by Sending the “*/Pcbsetswitch Tbd,on*” Command

Turn on Torque Rod Y and Z Redundant Power by Sending the “*/Pcbsetswitch Tbd,on*” Command
Run Simulations
Key Simulation Components

### Run Third Party SW:
- **Realsim**
- **Xmath/SystemBuild**
  - Develop SC Truth Model
  - Generate Autocoded C Code
  - Compile and Link to AC1000
  - Monitor Truth Model Data
  - Setup Hardware Connections
  - Setup Data Acquisition
  - Download and Run On AC1000
  - Start/Stop AC1000 Controller
  - Upload, Convert, Process Data

### Run Autocoded Truth Model C code:
- SC Dynamics
- ACS Sensor Models
- Torque Coil Dipoles
- GG and Aero Torque
- Earth’s Magnetic Field
- Sun Position
- Orbit Dynamics

### Run FSW with Autocoded C code:
- Sensor Processing
- Mode Selection Logic
- Control Logic

### Ground Control:
- Collect Telemetry Data
- Send Commands to SC

### HESSI Real Time Simulation:
- Change Initial Conditions
- Simulating Failure Scenarios
Procedure for Running Simulations At Host Computer

1. Establish Connection Between Host Computer and AC1000 Real Time Controller
2. Bring Up Realsim GUI, Download Program to AC1000 and Run Simulation
3. At Host Computer
   • Setup Data Acquisition
   • Start AC1000 Controller
   • Start Data Acquisition
4. At Animation Screens While in Simulation:
   • Change Initial Attitude, Select Mass Configuration, Setup Orbit Parameters
   • Simulate Various ACS Component Failure Scenarios
5. At ITOS Computer:
   • Command SC to Appropriate Mission Mode
   • Log Data
   • Stop Data Logging
6. At Host Computer
   • Stop Data Acquisition
   • Stop Simulation on AC1000 Controller
   • Upload Raw Data from AC1000 to Host Computer
   • Reset AC1000 and Exit Animation Screen
7. At Realsim GUI:
   • Convert Raw Data into Xmath Format - file.dat
8. At Xmath
   • Load and Plot Data
   • Or Save it to Other Form for Off-Line Processing
Establish Connection Between Host Computer and AC1000 Controller

From Host Computer:
1. Click Icon **Chameleon UNIX(R) Link 97** on Windows Screen to Bring up a Small Window:

   ![Chameleon UNIX(R) Link 97](image1)

2. Click on **NetManage Additions** to Bring up Another Small Window:

   ![NetManage Additions](image2)

3. Click on **Tftp** Icon to Bring up TFTP Window Showing Connection Information

On AC1000 Controller:
1. Physically Press the Reset Button on AC1000
   2. Verify at **Tftp** Window that the Connection is Established - Target Server Running

![Tftp Window](image3)
Bring Up Realsim Work Bench
At Host Computer

Click Realsim 61.3 on Windows Screen to Bring Up **Realsim** Command Window (DOS Window)

Change to the Directory D:\HESSI\hotbench_UCB as Shown

Type in the Command **realsim** as Shown:

```
Welcome to Integrated System's RealSim Development Environment
RealSim setting up for Windows NT system
MAISTRx Product Family Version 61.3 Build 61mx1411 (win32)
RealSim Host Tools Version 61.3 Build 61rs1411
RealSim AC-1000 Target Support Tools Version 61.3 Build 61rs1411
** To select an AC-1000 RealSim target, use the C_PPC604 Compiler Option.

Directory set to RealSim AC-1000 project root.
Then, type realsim to invoke the RealSim GUI.
[RealSim 61.3] G:\Users\dli\ac1000prj> d:
[RealSim 61.3] D:\HESSI\hotbench_UCB> realsim
```

Hit Enter Key to Bring up the Realsim GUI Shown in Next Page
Click on Button

**Download and Run**

to Download the Truth Model to AC1000 Controller and Run it.

**Note:** The Program Has Been Autocoded, Compiled and Linked, the Animation Screens Built and Hardware Connection Established

The Animation Screen will Appear as Shown on Next Page

The Default Project Name
Main Animation Screen

HESSI Hot Bench Simulation - Main Page

Elapsed Time (sec): 0

Torqrod Commands (amps)

<table>
<thead>
<tr>
<th>Torqrod</th>
<th>Ix</th>
<th>Iy</th>
<th>Iz</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Y</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Z</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
</tbody>
</table>

CSS Output Current

<table>
<thead>
<tr>
<th>CX11</th>
<th>CX12</th>
<th>CX13</th>
<th>CX14</th>
<th>CX15</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

X-Axis (deg)

Sun Vector

<table>
<thead>
<tr>
<th>Sun X</th>
<th>Sun Y</th>
<th>Sun Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Body Rates (rad/sec)

<table>
<thead>
<tr>
<th>Rate X</th>
<th>Rate Y</th>
<th>Spin Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Magnetometer Output (Volt)

<table>
<thead>
<tr>
<th>MAG X</th>
<th>MAG Y</th>
<th>MAG Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Setup Orbit | Setup Init Attitude | Go To TQR Failures | Go To CSS Failures | Go To FSS Failures | Go To MAG Failures
An **AC1000 Controller** Button Should Appear on the Bottom of the Windows Screen. Click on the Button **ac1000**:

![AC1000 Controller Window](image)

The **ac1000-1000 iaclient Control Window** Should Appear:

![ac1000-1000 iaclient Control Window](image)

Click On the Button **Set Data Acquisition Parameters** to Bring Up the Window **RealSim Data Acquisition Parameters**

Shown on the Next Page
### Setup Data Acquisition Properties:

- **Enter Data Save File Name** as Desired - Example: hessi_uclb
- **Set time Span** - Enter (hh:mm:ss) for the Desired Time Period of Data Collection. Example: 10 hours
  - If Using Default Value 00:00:00, Data Acquisition Will Go On Until **Stop Data Acquisition** Button is Clicked
- **Toggle Type of Save** from CDisk to Memory
- **Click Done** to Close this Window

#### RealSim Data Acquisition Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Save File Name</td>
<td>hessi_uclb</td>
</tr>
<tr>
<td>Time Span</td>
<td>10:00:00</td>
</tr>
<tr>
<td>Auto Start Delay</td>
<td>00:00:00</td>
</tr>
<tr>
<td>Pre-Trigger Span</td>
<td>00:00:00</td>
</tr>
<tr>
<td>Configuration Set Number</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Type of Save

- **Memory**
- **Time**
- **Off**
- **Off**

#### Triggering

- **Off**

#### Trigger re-enable

- **Off**

#### Done
Start Simulation

At `ac1000-1000 iaclient Control Window`:
- Click on the Button **Start Controller**
- Click on the Button **Start Data Acquisition**
  - A Raw Data File will be Created Automatically. Example: `hessi_uclb_18.raw`

The Animation Screens Should be Active Now
Log Telemetry Data At ITOS Computer

At ITOS Command Window
• Type `seqprt acs, 10 > data1.log` (Log File Name) - Log Data at 10 Seconds of Sampling Interval
• Change ACS to Appropriate Mode: Example - `/acssetmode acquisition`
• Change to Auto Mode - `/acssetmode auto`
  • Verify that the Mode is Correct
• After the Test is Done, type `seqprt clear` to Stop Data Logging

If FSW Hangs Up, Reboot FSW at ITOS Command Window
• Type `page_cib_hcd_cmds` to Bring Up a Page
• Press OFF button on CRC_BITS bit 1 (Reboot will Take about 30 seconds)
• Type `resync` to Re-Synchronize the System
Stop Simulation At Host Computer

After Data is Collected, Select ac1000 - 1000 iaclient Control Window:

- Click on the Button **Stop Controller**

- Click on the Button **Upload Raw Data**

- Click on the Button **Hardware Reset to Exit (Caution)** to Exit the Animation Screen and Go Back to Realsim GUI
Data Conversion and Processing

At Realsim GUI, Click on the Button **Convert DA Data** to Convert the Raw Data into Xmath Format

- A DOS Window Will Appear. Accept the Default Data File Name, or Enter a New One
- Converted Data Should Have Extension of .dat

At Realsim GUI, Bring Up Xmath by Clicking on the Button

At Xmath, Select **File/Load** to Load the Data File into Xmath Work Space:
Type **who** and Hit Enter to Show A List of Data Collected:

![Math commands window](image)

<table>
<thead>
<tr>
<th>Name</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>acs_time</td>
<td>4258x1</td>
</tr>
<tr>
<td>mag1</td>
<td>4258x1</td>
</tr>
<tr>
<td>mag2</td>
<td>4258x1</td>
</tr>
<tr>
<td>mag3</td>
<td>4258x1</td>
</tr>
<tr>
<td>m switched</td>
<td>1x1</td>
</tr>
<tr>
<td>nm</td>
<td>4258x1</td>
</tr>
<tr>
<td>spin_rate</td>
<td>4258x1</td>
</tr>
<tr>
<td>lat</td>
<td>4258x1</td>
</tr>
<tr>
<td>lon</td>
<td>4258x1</td>
</tr>
<tr>
<td>tf_clock</td>
<td>1x1</td>
</tr>
<tr>
<td>dt_time</td>
<td>1x24</td>
</tr>
<tr>
<td>a sacrificing</td>
<td>1x1</td>
</tr>
<tr>
<td>cycleoff</td>
<td>1x1</td>
</tr>
</tbody>
</table>

Other Useful Plotting Commands:

- **plot(acs_time, mag1, {xlab="Time", ylab="mag1", title="mag vs. Time"})** - Display Labels and Titles
- **plot(acs_time, [mag1, mag2], {ylab=["mag1","mag2"], strip})** - Plot Two Parameters Separately

Plot Variables Using:

**plot(acs_time, mag1)**

It Plots the Magnetometer X Output in Volts vs. the Time in Seconds.
Interactive Simulation

Change Parameters in Real Time:

- Six Command Buttons on Main Animation Screen Lead to Six Additional Screens:
  - Setup Orbit Parameters - Allow for Changing to Different Epoch Time and Orbit Parameters
  - S/C Initial Attitude Setup - Allow for Changing to Desired S/C Attitude and Solar Array Configuration
  - Torque Rod Failure Scenarios - Allow for Simulating Torque Rod Failures
  - CSS Failure Scenarios - Allow for Simulating CSS Failures
  - FSS Failure Scenarios - Allow for Simulating FSS Failures
  - Magnetometer Failure Scenarios - Allow for Simulating MAG Failures
Screen for Changing Orbit Parameters

**Setup Orbit Parameters**

**Monitors**
- Year: 2001
- Month: 6
- Day: 4
- Inclination: 30.00
- Eccentricity: 0.0002270
- Semimajor Axis: 6980.825
- Mean Angular Motion: 14.8935
- Mean Anomaly: 157.5119
- Ascending Node: 203.9900
- Argument of Perigee: 270.4271
- Eccentric Anomaly: 157.5119
- True Anomaly: 157.5119
- Distance: 6980.825
Change Orbit Parameters

Setup Orbit Parameters:
• **Enable/Disable** Switch: Controls All Parameters Setups in This Screen
• Setup Time (in Seconds) Should be Selected for Each Individual Parameter
• Epoch Time Selection:
  • Year - Default = 2001
  • Month - Default = 6
  • Day - Default = 4
• Orbit Parameters:
  • Inclination: Default $38 = \text{deg}$
  • Eccentricity: Default $= 0.0002278$
  • Semimajor Axis: Default $= 6980.825 \text{ km}$
  • Argument of Perigee: Default $= 270.4271 \text{ deg}$
  • Mean Angular Motion: Default $= 14.8934 \text{ rev/day}$
  • Mean Anomaly: Default $= 157.5119 \text{ deg}$
  • Ascending Node: Default $= 283.99 \text{ deg}$

Monitors:
• Display True Parameters

Return Button:
• Click to Go Back to Main Animation Screen
Screen for Changing Initial S/C Attitude

**Mass Matrix**

- 1 - SA Fully Deployed
- 2 - \( +X \) SA Stowed
- 3 - \( +X \) & \( +Y \) Stowed
- 4 - \( +X \) & \( -X \) Stowed

**Init S/C Rates**

- Init Rate X Setup Time: 200000
- Init Rate X (rad/sec): 0.0450
- Init Rate Y Setup Time: 200000
- Init Rate Y (rad/sec): 0.0450
- Init Rate Z Setup Time: 200000
- Init Rate Z (rad/sec): 0.0637

**Init Quaternion**

- Init q1 Setup Time: 200000
- Initial q1: 0.000
- Init q2 Setup Time: 200000
- Initial q2: 0.000
- Init q3 Setup Time: 200000
- Initial q3: 0.000
- Init q4 Setup Time: 200000
- Initial q4: 1.000

**Monitors**

- Sun X
- MOI

### Sun X

<table>
<thead>
<tr>
<th>MOI</th>
<th>159.9</th>
<th>0.38</th>
<th>0.00</th>
</tr>
</thead>
</table>

### MOI

<table>
<thead>
<tr>
<th>MOI</th>
<th>159.3</th>
<th>0.00</th>
</tr>
</thead>
</table>

### RETURN
Setup Mass and Attitude:
- **Enable/Disable** Switch: Controls All Parameters Setups in This Screen
- Setup Time (in Seconds) Should be Selected for Each Individual Parameter
- **Mass Matrix** Selection from Four Configurations:
  - 1 = Four Solar Arrays Nominally Deployed
  - 2 = +X Solar Array Stowed
  - 3 = +X and +Y Solar Arrays Stowed
  - 4 = ±X Solar Arrays Stowed
- Initial S/C Body Rates (rad/sec):
  - Rates X, Y, Z
- Initial Quaternion:
  - q1, q2, q3, q4

Monitors:
- True Sun Vector on XY Plane
- Mass Matrix with Fully Deployed Solar Arrays
- True Body Rates
- True Quaternion

**Return** Button:
- Click to Go Back to Main Animation Screen
Examples of Initial Conditions

Nominal LV Tip-off - Rates (4,4,17) deg/sec:

\[
w_0 = \begin{bmatrix} 0.0458 \\ 0.0458 \\ 0.0637 \end{bmatrix} \text{ (rad/sec)}
\]

Normal Mission Mode - Spin Rate 15 rpm (90 deg/sec):

\[
w_0 = \begin{bmatrix} 0.0 \\ 0.0 \\ 1.5708 \end{bmatrix} \text{ (rad/sec)}
\]

The Quaternion Depends on the Sun Position. Assume Initial Sun is on the X-Axis (ECI Frame):

•For Nominal Tip-Off - 10 deg from the Sun:

\[
q_0 = \begin{bmatrix} -0.0695964 \\ 0.501638 \\ -0.2762 \\ 0.79953 \end{bmatrix}
\]

•Worst Anti-Sun LV Tip-off - 180 deg from Sun:

\[
q_0 = \begin{bmatrix} -4.71336e-5 \\ -0.657088 \\ 0.420087 \\ 0.464007 \end{bmatrix}
\]

•Other Case of LV Tip-off - 90 deg from Sun:

\[
q_0 = \begin{bmatrix} -0.413224 \\ 2.96304e-5 \\ 0.264086 \\ 0.830517 \end{bmatrix}
\]

•Normal Mission Mode with Perfect Sun Pointing:

\[
q_0 = \begin{bmatrix} 0.0 \\ 0.7071 \\ 0.0 \\ 0.7071 \end{bmatrix}
\]
Screen for Simulating TQR Failures

Torque Rod Failure Scenarios

Fails Torque Rods

Monitors

X Tqr Current (Amp): 0.0000
Y Tqr Current (Amp): 0.0000
Z Pri Tqr Current (Amp): 0.0000
Z Red Tqr Current (Amp): 0.0000

Return
Simulating TQRs Failures

Fails Torque Rods:
• **Enable/Disable** Switch: Controls All Parameters Setups in This Screen
• Fail Time (in Seconds) Should be Selected for Each Individual Parameter
• Select Torque Rod Current:
  • X Torque Rod: Default = 0 Amp
  • Y Torque Rod: Default = 0 Amp
  • Z Primary Torque Rod: Default = 0 Amp
  • Z Secondary Torque Rod: Default = 0 Amp
• Select Torque Rod Phase:
  • X Torque Rod: Default = 1
  • Y Torque Rod: Default = 1
  • Z Primary Torque Rod: Default = 1
  • Z Secondary Torque Rod: Default = 1

Monitors:
• Display Torque Rod Actual Currents

Return Button:
• Click to Go Back to **Main Animation Screen**
Screen for Simulating CSS Failures

Fails CSS Channels

<table>
<thead>
<tr>
<th>CSS1 Fail Time</th>
<th>CSS2 Fail Time</th>
<th>CSS3 Fail Time</th>
<th>CSS4 Fail Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>200000</td>
<td>200000</td>
<td>200000</td>
<td>200000</td>
</tr>
<tr>
<td>CSS1 Current Amp (0, 0.0013)</td>
<td>CSS2 Current Amp (0, 0.0013)</td>
<td>CSS3 Current Amp (0, 0.0013)</td>
<td>CSS4 Current Amp (0, 0.0013)</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Monitors

(Amp * -7593)

<table>
<thead>
<tr>
<th>CSS1 (Volt)</th>
<th>CSS2 (Volt)</th>
<th>CSS3 (Volt)</th>
<th>CSS4 (Volt)</th>
<th>CSS5 (Volt)</th>
<th>CSS6 (Volt)</th>
<th>CSS7 (Volt)</th>
<th>CSS8 (Volt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Simulating CSS Failures

Fails CSS:
• **Enable/Disable** Switch: Controls All Parameters Setups in This Screen
• Fail Time (in Seconds) Should be Selected for Each Individual Parameter
• Select CSS Channel Current Output:
  • CSS 1: Default = 0 Amp
  • CSS 2: Default = 0 Amp
  • CSS 3: Default = 0 Amp
  • CSS 4: Default = 0 Amp
  • CSS 5: Default = 0 Amp
  • CSS 6: Default = 0 Amp
  • CSS 7: Default = 0 Amp
  • CSS 8: Default = 0 Amp

Monitors:
• Display CSS Channel Outputs in Voltage

Return Button:
• Click to Go Back to **Main Animation Screen**
Simulating FSS Failures

Fails FSS:
- **Enable/Disable** Switch: Controls All Parameters Setups in This Screen
- Fail Time (in Seconds) Should be Selected for Each Individual Parameter
- Select FSS Sun Presence Indicator (SPI): Default = 1
- Select FSS State Of Health (SOH) Output: Default = 3.5 Volt
- Select X Axis Outputs:
  - Integer Part Output: Default = 31 (Equivalent of 0 deg Sun Error)
  - Analog Sine Output: Default = 0 Volt
  - Analog Cosine Output: Default = 0 Volt
- Select Y Axis Outputs:
  - Integer Part Output: Default = 31 (Equivalent of 0 deg Sun Error)
  - Analog Sine Output: Default = 0 Volt
  - Analog Cosine Output: Default = 0 Volt

Monitors:
- Display FSS SPI, SOH
- FSS Electronics Outputs: 10-bit Digital Output, analog sin and cos Voltages
- FSS Model Outputs: Integer Data, Analog Signals for X, Y Axes

Return Button:
- Click to Go Back to **Main Animation Screen**
Screen for Simulating MAG Failures

Magnetometer Failure Scenarios

Fails MAG

Monitors

- MAG X Output (Volt): 0.00
- MAG Y Output (Volt): 0.00
- MAG Z Output (Volt): 0.00
- MAG Temperature (Volt): 2.50

Return
Simulating MAG Failures

Fails MAG:
- **Enable/Disable** Switch: Controls All Parameters Setups in This Screen
- Fail Time (in Seconds) Should be Selected for Each Individual Parameter
- Select MAG Outputs:
  - X Axis Output: Default = 0 Volt
  - Y Axis Output: Default = 0 Volt
  - Z Axis Output: Default = 0 Volt
  - Temperature Output: Default = 2.5 Volt

Monitors:
- Display MAG Three Axis Outputs and Temperature

Return Button:
- Click to Go Back to **Main Animation Screen**
Back-Up Charts
Another Way To Change Initial Conditions of Spacecraft Truth Model:

- Bring Up RealSim GUI
- Load Software Package Xmath/SystemBuild
  - Change Parameters of Spacecraft Model
  - Generate Real Time Code for Truth Model
- Generate Autocoded C Code
- Compile and Link Truth Model
- Modify Animation Screen
- View Hardware Connection
- Configure Data Acquisition
- Download to AC1000 and Run

The Only Parameters to Modify:
- Initial Rate Vector \( \omega_0 \)
- Initial Attitude Quaternion \( q_0 \)

Combined into One Vector:

\[
\mathbf{wq}_0 = \begin{bmatrix}
\dot{\omega}_0 \ (\text{rad/sec}) \\
q_0
\end{bmatrix}
\]
Step 1. Work with Default Project

At Realsim GUI, Click on the Button

To Bring Up Xmath/SystemBuild Window

Xmath Display Window

Xmath Command Window:
Type in Commands Here
Step 2.1. Load Program:
Select **File -> Load** from
**Xmath Commands** Window to Bring Up
**Load File** Window on the Right:

Step 2.2. Load Existing Program:
Select **hessi_hbt_ucb.xmd** and Click on **Load**
Button to Load in the Program and Bring Up
**SystemBuild Catalog Browser** Window
Step 2.3. Modify Initial Conditions:
Two Ways:
1. At the Bottom of Xmath Commands Window, Type in $wq0 = [wx;wy;wz;q01;q02;q03;q04]$ as Desired
2. Put Initial Rate and Attitude Vectors in a File Named `init_attitude.ms`. Comment out Unused Ones.
   - Execute `init_attitude.ms` from Xmath File/Execute as Shown Below
   - Verify Parameters are Correctly Set: Type `wq0` at the Xmath Commands Window, `wq0` will be Shown in the Display Window

Recommendation - Use Method 2
- It Avoids Any Unwanted Changes at Xmath Command Window
- It Keeps the Record of What Have Been Used in Simulations
Example Parameter File

```
# init_attitude.ms
# This file contains initial attitude conditions

# Nominal LV tip-off - (4,4,17) deg/sec, 10 deg from the Sun:
wq0 = [0.0458;0.0458;0.0637;-0.0695964;0.501638;-0.2763;0.79953];

# Worst case LV tip-off - (4,4,17) deg/sec, 180 deg from the Sun:
wq0 = [0.0458;0.0458;0.0637;-4.71336e-5; -0.657088; 0.420087; 0.464007];

# Other case LV tip-off - (4,4,17) deg/sec, 90 deg from the Sun:
wq0 = [0.0458;0.0458;0.0637;-0.413224; 2.96304e-5; 0.264086; 0.830517];
```
Step 3.1. Select Model for Generating Real Time C Code:
1. At SystemBuild Catalog Browser, Highlight Main\SuperBlocks\HESSI_IA\HESSI
2. Select Tools\AutoCode to Bring Up Generate Real-Time Code Dialog Box Shown on Next Page:
Step 3.2. Generate Real Time Code:

at Generating Real Time Code Window:
1. Enter File Name at Prompt: hessi_ucb
2. Language Should be RTF only
3. Click OK When Done
4. Verify at Xmath Commands Window a File with Name hessi_ucb.rtf is Generated

Note: All the File Names have to be the Same as the Project Name

Go Back at Realsim GUI. Notice that Red Mark Appears on Some Buttons - Updating is Needed
STEP 4

Step 4. Generate Source C Code:

at Realsim GUI, Click on the Button **AutoCode** to Start Generating C-code.

Verify at a DOS Window that the Autocode Generation is Completed Successfully:
STEP 5

Step 5: Compile and Link
At Realsim GUI, Click on the Button to Compile and Link the Source C Code.

If Successful, the DOS Window Should Show as Below and the Red Mark on the Button Should Disappear. Otherwise, Error Messages will be Displayed at DOS Window. Warning Messages can be Ignored.
STEP 6.1

Step 6.1. Create Animation Screen:

at Realsim GUI, Click on the Button to Load Interactive_Animation Screen and Control_Panel

Click on the button LOAD PIC to Bring Up an INQUIRY Box Shown on Next Page:
Step 6.2. Use Existing Animation File:
Accept the Default File Name hessi_ac1.pic
Click on Button Done
The Animation Screen Should Show Up

6.3. Save Animation File:
After Viewing the Screen, Click on Button SAVE PIC
from Control_Panel Window to Bring Up Another
INQUIRY Box
Accept the Default Name by Clicking DONE

Click on Button EXIT from Control_Panel Window

Now the Red Mark on the Button Animation Builder at RealSim GUI Should Disappear.
Step 7.1 View Hardware Connection
At RealSim GUI, Click on the Button

to Bring up Hardware Connection Editor (HCE)

AC1000 Truth Model Inputs:
- One ADC Module:
  - 4 Commanded Torque Rod currents: \( I_x, I_y, I_z1, I_z2 \)
- One Digital Module:
  - 1 FSS Enabling Gate
- Type **MONITOR_INPUT** are from Animation Screens, They Do Not Use Actual Hardware

Click on **Done** to Bring Up AC1000 Output List Shown on Next Page.
Step 7.2 View AC1000 Output Signals:
- It Lists All Outputs from SC Truth Model
- 3 DAC Modules
- One Digital Module (Shared with Inputs)
- NO_DEVICE - No Actual Hardware Connected

AC1000 Truth Model Outputs:
- MAG Outputs - 4 Signals
- CSS Outputs - 8 Signals
- FSS_SPI
- SAS X and Y Axis Counts
- Analog Sine and Cosine Signal of FSS
- Digital Bits of FSS
- Others

CAUTION:
Once Hardware Connection is Set, Please Do Not Change Them! They are Corresponding to the Physical Hardware Module Positions in the Rack.
### Step 8.1 Setup Data Acquisition for Inputs:

On Realsim GUI, Click On Button **Data Acq. Editor** to Bring up Data Acquisition Editor (DAE)

The First Screen is for Truth Model Input Signals

Note:
No Data Acquisition for Input Signal is Setup for HESSI Simulation

#### Data Acquisition Editor (DAE)

<table>
<thead>
<tr>
<th>chan</th>
<th>label(1:10)</th>
<th>type</th>
<th>mod ch#</th>
<th>DA dec</th>
<th>trig above</th>
<th>trig below</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IP_HIADC_5V</td>
<td>1</td>
<td>1</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>IP_HIADC_5V</td>
<td>1</td>
<td>2</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>IP_HIADC_5V</td>
<td>1</td>
<td>3</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>IP_DIG24b</td>
<td>5</td>
<td>12</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>IP_HIADC_5V</td>
<td>1</td>
<td>4</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>MONITOR_INPUT</td>
<td>0</td>
<td>0</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>MONITOR_INPUT</td>
<td>0</td>
<td>0</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>MONITOR_INPUT</td>
<td>0</td>
<td>0</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>MONITOR_INPUT</td>
<td>0</td>
<td>0</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>MONITOR_INPUT</td>
<td>0</td>
<td>0</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>MONITOR_INPUT</td>
<td>0</td>
<td>0</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>MONITOR_INPUT</td>
<td>0</td>
<td>0</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>MONITOR_INPUT</td>
<td>0</td>
<td>0</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>MONITOR_INPUT</td>
<td>0</td>
<td>0</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>MONITOR_INPUT</td>
<td>0</td>
<td>0</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>MONITOR_INPUT</td>
<td>0</td>
<td>0</td>
<td>OFF</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

**Toggle Display** to Show **SB_OUTPUTS**, Bringing Up Output List Shown on Next Page.
Step 8.2 Setup Data Acquisition for Outputs:

Data Acquisition:
• Collect Data from AC1000 Truth Model
• Data is Saved on AC1000 Controller
• Data can be Uploaded to Host Computer
• No Hardware Device is Needed

Data Acquisition Editor Allows for:
• Configure DA for Each Signal
• Click on One Variable to Highlight
  • Turn DA_Setting On/Off
  • Select DA_Decimation_Factor for Sampling Rate - DEC Shall be the Multiples of the Mim Cycle in the Truth Model (0.00025 sec)
  • 40000 Cycles = 10 seconds

Click on DONE when Finished
Step 9: Download and Run

At RealSim GUI, Click on the Button to Download Source Code and Run AC1000

The Main Animation Screen Should Appear.