Console Handbook

**ADCO**
Attitude Determination and Control Officer

The ADCO (pronounced *add-co*) flight controller works together with a Russian flight controller counterpart to calculate and manage the attitude (or orientation) of the International Space Station (ISS). The ADCO flight controller also plans upcoming orientations and attitude maneuvers, and visiting vehicle dockings to the ISS. This person monitors the ISS position, velocity (speed and direction) and attitude to make sure that they do not change unless commanded to do so by the computers aboard the ISS.
ADCO
Attitude Determination and Control Officer

System Managed: Guidance, Navigation and Control (GNC) System

Guidance
*Where do I want to go? How do I want to be oriented?*

The ADCO flight controller manages the guidance of the ISS. To guide the ISS properly, the flight controller works to keep it in a stable, nearly circular, orbit around the Earth. The orbit is defined by how high the ISS is above the surface of the Earth and the angle of its orbital path with respect to the equator.

The flight controller also guides the ISS by planning changes to the attitude (orientation) for various activities, such as the docking and undocking of visiting vehicles.

Navigation
*Where am I? How am I currently oriented? Where is everything else?*

The ADCO flight controller manages the navigation of the ISS; which means maintaining a current estimate of the ISS position, velocity and attitude.

State Determination
*Where am I?*

The ISS state determination uses a Global Positioning System (GPS) receiver similar to the GPS system in a car or mobile phone. This GPS receiver keeps track of the ISS position and velocity at all points in the orbit.

To learn more about how a GPS works, view the NASA Launchpad: How GPS Works video at http://www.youtube.com/watch?v=DsmvTzw3GP4&feature=youtu.be.

Position = How high and where the ISS is located above the Earth, which averages between 340 and 420 kilometers (210 and 260 miles).

Velocity = How fast and in which direction the ISS is traveling in its orbit around Earth, which averages 27,700 kilometers per hour (17,225 miles per hour).
Attitude Determination
*How am I currently oriented?*

The ISS also uses GPS to determine how the ISS is oriented, or facing, as it orbits the Earth. This orientation, or attitude, can be determined by measuring the difference in time that the GPS signals are received by four antennas. These antennas receive the same GPS signal at slightly different times, with the signal traveling at a constant speed (the speed of light).

To calculate attitude, at least four of the nearly 24 GPS satellites in orbit must be in view of these antennas. The GPS receiver calculates the ISS attitude about once a minute, providing information on where the ISS is pointed at that point in time.

Pointing Data
*Where is everything else?*

The Guidance, Navigation and Control (GNC) system uses the current position, velocity and attitude of the ISS to calculate the angles formed between the ISS and the Sun, Earth and communication satellites. This information (called pointing data) is sent to other ISS systems, and is used to help properly point the antennas, solar arrays, cameras and other instruments.

Control
*How do I get to the preferred orbit? How do I get to the preferred attitude?*

While guidance means deciding on a path the ISS needs to take in order to stay in or reach a position or attitude in orbit, controlling the ISS means determining what is needed to move it along this path.

**Translational Control**
*How do I get to the preferred orbit?*

Over time, any spacecraft orbiting the Earth will slow down. Even though the ISS is in space, it is not in a complete vacuum, so there is still a tiny amount of air molecules to slow it down. As the ISS slows down, it begins orbiting closer to Earth. About once a month, the ISS must
reboost to keep it from falling to Earth. A reboost uses large engines on the ISS to increase the speed and put it into a higher orbit.

To learn more about what happens to crewmembers and equipment during an ISS reboost, view the NASA demonstrational video, *ISS Reboost*, at http://www.youtube.com/watch?v=ZkdfkRC4DbA&feature=player_embedded.

**Attitude Control**

*How do I get to the preferred attitude?*

The attitude is how the ISS faces in three-dimensional space. This orientation is defined by the Yaw, Pitch, and Roll angles with respect to a reference frame.

![Attitude](image)

Attitude control keeps the ISS pointing in the proper direction and maintains the microgravity environment needed for scientific research. Main control of the ISS attitude is provided by four Control Moment Gyrosopes (CMGs).

The CMGs are used more often than the rocket engines to control the ISS attitude because the gyroscopes do not require propellant, which is expensive to launch to the ISS. Instead, the CMGs use power generated by the solar panels. Similar to a toy gyroscope, each CMG contains a wheel which spins very fast. By pointing the wheels in different directions, the CMGs can either rotate the ISS, or prevent it from rotating.

To learn more about how CMG’s work:

- or view this video, *Cool New Space Station Parts*, at [http://www.youtube.com/watch?v=PBhupmu7Ekl&feature=youtube_gdata](http://www.youtube.com/watch?v=PBhupmu7Ekl&feature=youtube_gdata).

To learn more about guidance, navigation and control systems on the ISS, return to the ISSLive! website at www.isslive.com. Select “Interact”, and then select “Visit Space Station”.
ADCO Console Display

A wireless signal sends data from the ISS to the Mission Control Center. This data is updated on the ADCO console display. The ADCO flight controller checks the data on the console display to make sure the GNC system and CMGs are working as expected. The current ISS attitude is displayed in degrees.

Pictured above is a simplified version of the ADCO console display. To view this display, return to the ISSLive! website at www.isslive.com. Select “Interact”, and then select “Explore Mission Control”.

Space Station Live Data

Would you like to know more about the live data streaming from the ISS to the ADCO console display? Return to the ISSLive! website at www.isslive.com. Select “Resources”, and then select “Space Station Data”. There you will find a table which includes the names and brief descriptions of all the data values used to update the interactive Mission Control Center console displays.

Acronyms and Abbreviations

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