This document explains how the ADCS and the IHU are communicating down to the byte by byte level.

ADCS Interface

Detailed Description of the ADCS and IHU Interface

Revision: 1.0.5

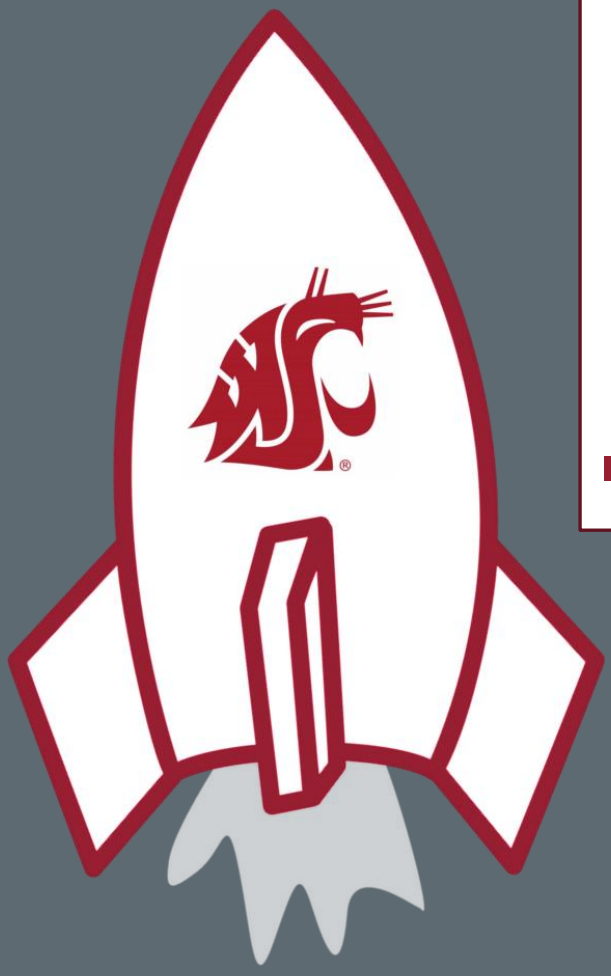

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Table of Contents

1 Hardware Layer

The hardware interface between the ADCS and the IHU is I^2C. It is a standard implementation of I^2C with a clock wire and a data wire. See Wikipedia's I^2C article for details on how it works.

2 Software Layer

The Attitude Determination Control System, located at 8b address 0xAC, is a slave board to the IHU. The ADCS oversees maintaining and manipulating the satellites orientation when in orbit. The IHU will periodically request data from the ADCS to populate a telemetry packet. The ADCS data will be read at Upon receiving multiple commands, the reading done by ADCS will reflect the most recent command. In all cases, the first byte represents the command ID (CID).

2.1 Location Data Request

The latitude and longitude are geographic coordinates, represented by 32b signed integers with 100μmin/LSB. For latitude, -90° S is represented by 0, and 90° N is represented by 2^{32}. Similarly, longitude is represented by -180° E being 0, and 180° W is 2^{32}. For more information on latitude and longitude, please read Wikipedia's page on the Geographic Coordinate System.

2.1.1 IHU to ADCS

The first byte represents the command ID.

Byte Offset	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07
0x00	0x00: Location Request							

2.1.2 ADCS to IHU

The ADCS replies with an array of two geographic coordinates.

Array Indices:	
0	Latitude Coordinate
1	Longitude Coordinate

2.2 Orientation Data Request

Roll, Pitch, and Yaw are all angles, represented by 16b unsigned integers where zero indicates 0, and 2^{16} indicates 2π.

2.2.1 IHU to ADCS

The first byte represents the command ID.

Byte Offset	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07
0x00	0x01: Request Orientation							

2.2.2 ADCS to IHU

ADCS replies with an array of three angles.

Array Indices:	
0	Roll Angle
1	Pitch Angle
2	Coil Z Temperature

2.3 Temperature Data Request

The temperatures are represented with an 8b signed integer with 1°C/LSB.

2.3.1 IHU to ADCS

The first byte represents the command ID.

Byte Offset	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07
0x00	0x02: Request Temperatures							

2.3.2 ADCS to IHU

The ADCS replies with an array of five temperatures.

Array Indices:	
0	Coil X Temperature
1	Coil Y Temperature
2	Coil Z Temperature
3	ADCS Temperature
4	GPS Temperature

2.4 Coil Control Data Request

The PWM is represented by a 16b unsigned integer.

2.4.1 IHU to ADCS

The first byte represents the command ID.

Byte Offset	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07
0x00	0x03: Request PWM							

2.4.2 ADCS to IHU

The ADCS replies with an array of three 16b integers.

Array Indices:	
0	Coil X PWM Out
1	Coil Y PWM Out
2	Coil Z PWM Out

2.5 Coil Current Data Request

The current is represented by a 16b signed integer with 150μA/LSB.

2.5.1 IHU to ADCS

The first byte represents the command ID.

Byte Offset	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07
0x00	0x04: Request Coil Currents							

2.5.2 ADCS to IHU

The ADCS replies with an array of three 16b currents.

Array Indices:	
0	Coil X PWM Out
1	Coil Y PWM Out
2	Coil Z PWM Out

2.6 Orientation Commands

These are the general rotation commands the satellite will use to orient itself when aiming towards a location on Earth, a point in space, to position solar panels, or to protect the satellite from temperature related damage.

2.6.1 IHU to ADCS

The first byte is the CID, and all three parameters are angles, as defined in Section 2.2.

Byte Offset	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07
0x00	0x05: Adjust Orientation	Roll		Pitch		Yaw		

2.6.1 ADCS to IHU

The ADCS replies with a Boolean indicating the command was successfully enqueued.

2.7 Satellite Maneuvers for Earth

This command passes in a latitude and a longitude as two 32b signed integers to find and maintain a fixed direction towards a location on Earth. This will point the selected piece of the satellite towards the given parameters around the Earth.

2.7.1 IHU to ADCS

The first byte is the CID, and both remaining parameters are the respective geographic coordinates, as defined in Section 2.1.

Byte Offset	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07
0x00	0x06: Point Camera 0x07: Point Antenna	Latitude				Longitude		
0x08	Longitude							

2.7.2 ADCS to IHU

The ADCS replies with a Boolean indicating the command was successfully enqueued.

2.8 Satellite Maneuvers for Space

This command will pass in an 8b integer representing the face, a 32b integer. For more information about the Equatorial Coordinate System, please go to Wikipedia's page on the subject.

2.8.1 IHU to ADCS

The first byte is the CID, the parameters are the respective equatorial coordinates.

Byte Offset	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07
0x00	0x07: Point Camera CID 0x08: Point Solar Panels CID	Right Ascension				Declination		
0x08	Declination							

2.8.2 ADCS to IHU

The ADCS replies with a Boolean indicating the command was successfully enqueued.

2.9 Roast the Chicken

These functions are primarily for maintaining the health of the satellite. The function "Roast the Chicken" behaves similarly to a rotisserie, evenly distributing the received power from the sun, aiding to normalize temperatures. As it is used to remedy a temperature related issue, it will take precedence, and does not need to be enqueued. It will, instead, become the immediate action until temperature levels are normalized or a new command is sent.

2.9.1 IHU to ADCS

The first byte is the CID, the parameters are the respective equatorial coordinates.

Byte Offset	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07
0x00	0x09: Roast the Chicken							

2.9.2 ADCS to IHU

The ADCS replied with a Boolean indicating the satellite is now executing the maneuver "Roast the Chicken".

2.10 Drift

The drifting command halts the work of the ADCS's X, Y, and Z coils, and lets it tumble freely.

2.10.1 IHU to ADCS

The first byte is the CID, the parameters are the respective equatorial coordinates.

Byte Offset	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07
0x00	0x10: Drift							

2.10.2 ADCS to IHU

The ADCS replies with a Boolean indicating the maneuver has been enqueued.

3 Example Communication

3.1 Simple Data Request for Location

IHU: [0xAC]0x00 [ADCS write] location request
ADCS collects location data and stores array in its buffer
IHU: [0xAD] [ADCS read]
ADCS: 0xBFEC 0.0000, 0.000

3.2 Simple Repeated Data Request

IHU: [0xAC]0x02 [ADCS write] temperature request
IHU: [0xAC]0x00 [ADCS write] location request
ADCS collects location data and stores array in its buffer
IHU: [0xAD] [ADCS read]
ADCS: 0xBFEC 0.000, 0.100