ADCS I2C Interface

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This file outlines the I2C interface used to communicate with the Pathfinder for Autonomous Navigation's attitude control system. The related code can be found on the pathfinder-for-autonomous-navigation/ADCSSoftware github under src/state_controller.cpp file.

Write Operations:

An i2c write operation consists of two parts. The first will be a byte specifying the register address being written to as specified in the table above. What follows will be the data written to the register/registers depending on the specified address and data packet length. See the following write operations below for more specifics.

Endianness	
Register Address	0x01
Minimum Packet Length	1 byte(s)
Valid Packets	0x00 - Little endianness (default)
	0x01 - Big endianness
Rollover	*ADCS Mode*

ADCS Mode	
Register Address	0x02
Minimum Packet Length	1 byte(s)
Valid Packets	0x00–ADCS passive mode (default)
	0x01–ADCS active mode
Rollover	*Read Pointer*

Read Pointer	
Register Address	0x03
Minimum Packet Length	1 byte(s)
Valid Packets	0xXX – Sets the next read address (see *Request Operations*; defaults to 0x00)
Rollover	NA

RWA Mode	
Register Address	0x04
Minimum Packet Length	1 byte(s)
Valid Packets	0x00 – Reaction wheels disabled (default)

	0x01 – Speed control
	0x02 – Acceleration control
Rollover	*RWA Command*

RWA Command	
Register Address	0x05
Minimum Packet Length	6 byte(s)
Valid Packets	Array of three 16-bit unsigned integers mapping to the x axis, y axis, and z axis in the body frame respectively. When in speed control, the number maps [-680.678, 680.678] radiances per second. When in acceleration control, the number maps [-0.0041875, 0.0041875] N m. Defaults to 0x0000 0x0000 0x0000
Rollover	NA

RWA Momentum Read Filter	
Register Address	0x0C
Minimum Packet Length	1 byte(s)
Valid Packets	Set the reaction wheel momentum read exponential filter constant with an eight-bit unsigned integer mapping from [0.0, 1.0]. Defaults to 0xFF.
Rollover	*RWA Ramp Read Filter*

RWA Ramp Read Filter	
Register Address	0x0D
Minimum Packet Length	1 byte(s)
Valid Packets	Set the reaction wheel ramp read exponential filter constant with an eight-bit unsigned integer mapping from [0.0, 1.0]. Defaults to 0xFF.
Rollover	NA

MTR Mode	
Register Address	0x1A
Minimum Packet Length	1 byte(s)
Valid Packets	0x00 – Disabled (default)
	0x01 – Enabled

Rollover	*MTR Command*

MTR Command	
Register Address	0x1B
Minimum Packet Length	6 byte(s)
Valid Packets	Array of three 16-bit unsigned integers mapping to the x axis, y axis, and z axis in the body frame respectively. Each value maps to a magnetic moment command in the range [-0.05667, 0.05667] A m^2
Rollover	*MTR Limit*

MTR Limit	
Register Address	0x21
Minimum Packet Length	2 byte(s)
Valid Packets	Sets the maximum magnetic moment the magnetic torque rods can produce with a 16-bit unsigned integer mapping to [-0.05667, 0.05667] A m^2.
Rollover	*MTR Limit*

SSA Mode	
Register Address	0x24
Minimum Packet Length	1 byte(s)
Valid Packets	0x00 – Indicates failure of a sun vector calculation (default)
	0x01 – Starts a sun vector calculation
	0x02 – Indicates success of a sun vector calculation
Rollover	NA

SSA Voltage Filter	
Register Address	0x2B
Minimum Packet Length	1 byte(s)
Valid Packets	Set the sun sensor voltage exponential filter constant with an eight-bit unsigned integer mapping from [0.0, 1.0]. Defaults to 0xFF.
Rollover	NA

IMU Mode	
Register Address	0x40

Minimum Packet Length	1 byte(s)
Valid Packets	0x00 – Use magnetometer one (default)
	0x01 – Use magnetometer two
	0b1X – Calibrate the magnetometer in use (specified by the free bit)
Rollover	NA

IMU Magnetometer Filter	
Register Address	0x4F
Minimum Packet Length	1 byte(s)
Valid Packets	Set the magnetometer exponential filter constant with an eight-bit unsigned integer mapping from [0.0, 1.0]. Defaults to 0xFF.
Rollover	*IMU Gyroscope Filter*

IMU Gyroscope Filter	
Register Address	0x4F
Minimum Packet Length	1 byte(s)
Valid Packets	Set the gyroscope exponential filter constant with an eight-bit unsigned integer mapping from [0.0, 1.0]. Defaults to 0xFF.
Rollover	*IMU Gyroscope Temperature Filter*

IMU Gyroscope Temperature Filter	
Register Address	0x4F
Minimum Packet Length	1 byte(s)
Valid Packets	Set the gyroscope temperature exponential filter constant with an eight-bit unsigned integer mapping from [0.0, 1.0]. Defaults to 0xFF.
Rollover	NA

IMU Gyroscope Temperature Kp	
Register Address	0x52
Minimum Packet Length	4 byte(s)
Valid Packets	Sets the proportional gain on the gyroscope temperature controller. For the format is a standard *float* value.
Rollover	*IMU Gyroscope Temperature Ki*

IMU Gyroscope Temperature Ki	
Register Address	0x56
Minimum Packet Length	4 byte(s)
Valid Packets	Sets the integral gain on the gyroscope temperature controller. For the format is a standard *float* value.
Rollover	*IMU Gyroscope Temperature Kd*

IMU Gyroscope Temperature Kd	
Register Address	0x5A
Minimum Packet Length	4 byte(s)
Valid Packets	Sets the derivative gain on the gyroscope temperature controller. For the format is a standard *float* value.
Rollover	*IMU Gyroscope Desired Temperature*

IMU Gyroscope Desired Temperature	
Register Address	0x5E
Minimum Packet Length	1 byte(s)
Valid Packets	Sets the desired gyroscope equilibrium temperature. This is an eight-bit unsigned integer mapping from [-40.0, 85.0] degrees Celsius.
Rollover	NA

HAVT OPERATIONS STILL NEED TO BE CREATED

Request Operations:

An I2C request places a buffer of predetermined length in the ADCS's outgoing buffer. The format of this buffer is determined by the current value of the *Read Pointer* register. The buffer formats are outlined below.

Who Am I	
Register Pointer Value	0x00
Buffer Size	1 byte(s)
Buffer Value	0x0F
Rollover	NA

RWA Read	
Register Pointer Value	0x0E

Buffer Size	12 byte(s)
Buffer Value	Consists of six 16-bit unsigned integers. The first three map wheel angular momentums from [-0.009189, 0.009189] kg m^2 s^-1 in the x, y, and z direction in the body frame. The last three map wheel torque commands from [-0.0041875, 0.0041875] N m in the x, y, and z direction in the body frame.
Rollover	NA

SSA Mode Read	
Register Pointer Value	0x24
Buffer Size	1 byte(s)
Buffer Value	Current *SSA Mode* value.
Rollover	NA

SSA Vector Read	
Register Pointer Value	0x25
Buffer Size	6 byte(s)
Buffer Value	Three 16-bit unsigned integers that encode the unit vector to the sun in the body frame of the spacecraft. The 16-bit unsigned integers map [-1.0, 1.0].
Rollover	NA

SSA Voltage Read	
Register Pointer Value	0x2C
Buffer Size	20 byte(s)
Buffer Value	Consists of 20 eight-bit unsigned integers specifying the voltage measurements at each photodiode on the range [0.0, 3.3] V.
Rollover	NA

IMU Read	
Register Pointer Value	0x41
Buffer Size	14 byte(s)
Buffer Value	Consists of seven 16-bit unsigned integers. First three encode the magnetic field measurement in the body frame of the spacecraft on the range [-16e-4, 16e-4] T. Second three encode the angular rate measurement in the body frame of the spacecraft on the range [-4.363, 4.363] radians s^-1.

	The last unsigned integer encodes the gyroscope temperature on the range [-103, 153] degrees Celsius.
Rollover	NA

HAVT READ STILL NEEDS TO BE CREATED