CH Robotics
AN-1003 Getting Started with the UM6 Orientation Sensor
Document rev. 1.0, updated 8/17/2012

1. Introduction

This application note provides instructions for communicating with, configuring, and calibrating the UM6 and the UM6-LT Orientation Sensors from CH Robotics.

The UM6 Orientation Sensor combines sensor measurements from rate gyros, accelerometers, and magnetic sensors to measure orientation at 500 Hz. The UM6 also has the capability to interface with external GPS modules to provide position, velocity, course, and speed information. Communication with the UM6 is performed over either a TTL (3.3V) UART or a SPI bus.

While the UM6 and the UM6-LT were designed to be easy to use, we recognize that diving into the datasheet immediately can be a time-consuming task. This document provides a concise overview of what is required to get up and running as quickly as possible.

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2. ESD Precautions

The UM6 and the UM6-LT Orientation Sensors are sensitive to electrostatic discharge (ESD) and can easily be damaged by the buildup of static on your body and in your work area. To minimize the chances of damaging your sensor, please observe the following precautions:

1. If possible, only handle the sensors at an ESD-safe workstation, with grounding mats, wrist-straps, and other protective equipment.
2. Avoid handling your sensor in carpeted areas where static charge might build up
3. When working with OEM boards (like the UM6-LT), handle the board by its edges and avoid touching parts or conductive surfaces on the board itself. When you do have to touch the board, ensure that you touch a grounded surface beforehand. Good grounds might include the metal case on your soldering iron, or the screw holding the faceplate on an electrical outlet.

3. Using the UM6 Serial Breakout Board

If you purchased the UM6 with the Serial Breakout Board, connecting the sensor to your computer is as easy as plugging it in and turning it on. The Serial Breakout Board comes with a DB9 Serial Cable for connecting the sensor to a PC and a 5V power supply. With the Serial Breakout Board, the UM6, and a free serial port on your computer, you have everything you need to plot and log data in real-time, calibrate the magnetometer, and set other configuration settings on the UM6.

Step 1 - Unpack. The UM6 Serial Breakout Board should come with everything shown below except for the UM6 itself (that is sold separately).

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Figure 1 - Serial Breakout Board Kit

Step 2 - Plug the power supply into a wall outlet. Plug one end of the serial cable into your computer and the other end into the Serial Breakout Board as shown. If your computer does not have a free serial port, you can optionally use a USB-serial converter. However, note that some USB-serial converters don't do a great job of keeping up with the data being transmitted by the UM6 - they can cause the data to look "jumpy." We've found that Keyspan USB-Serial converters work well.
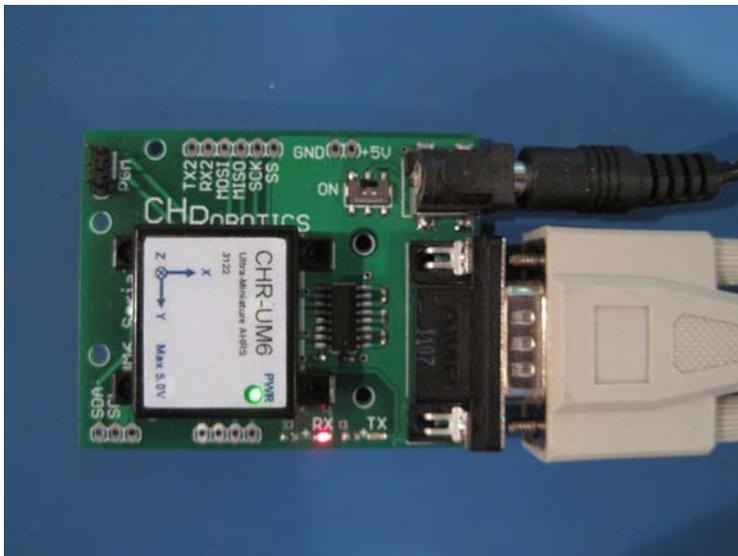
Figure 2 - Serial Breakout Board Operating

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As shown above, the PWR light on the UM6 should turn on and the RX light should start flashing, indicating that the UM6 is transmitting data. By default, the UM6 transmits processed sensor data from the accelerometers, gyros, and magnetometers. It also transmits Euler Angle estimates (yaw, pitch, and roll angles).

Step 3 - Now that you are connected, you need to run the CHR Serial Interface software so that you can see the data. Download the most recent version of the software from http://www.chrobotics.com/downloads. Note that the software used for the UM6 is different from the software used by the 6d and the 6dm. Be sure to download the right software. Once it is downloaded and installed, run it. You should see something like the picture below:
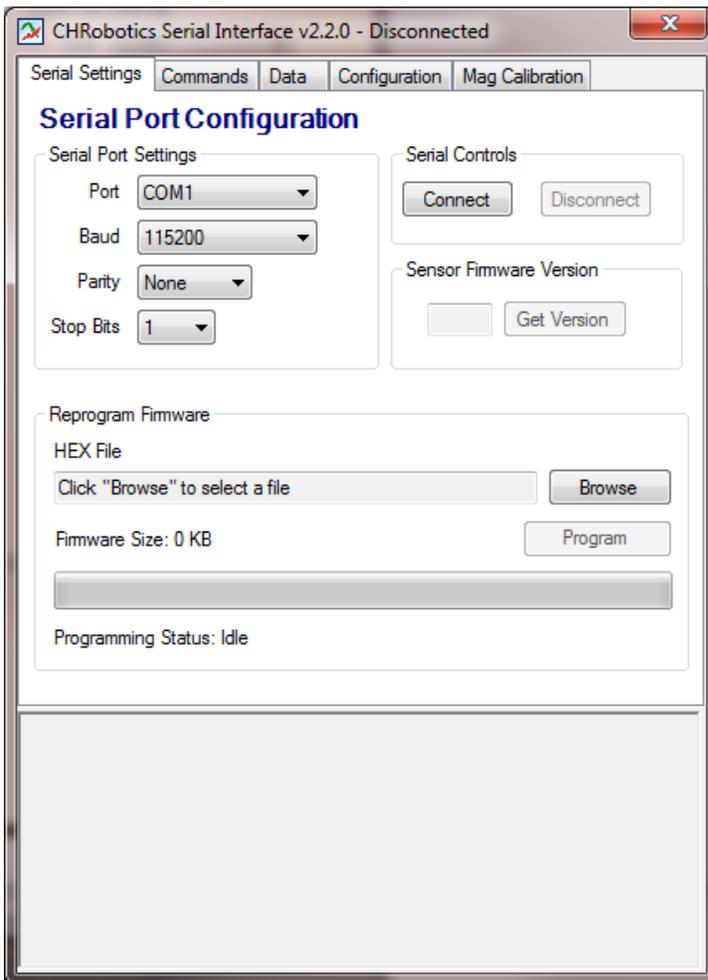
Figure 3 - CHR Serial Interface on Startup

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Step 4 - Make sure that you've selected the correct serial port and click "Connect." The software will open the serial port and send a message to the UM6 to determine what version of the firmware it is running. If all goes well, you should see the sensor version appear in the "Sensor Firmware Version" box as shown below.
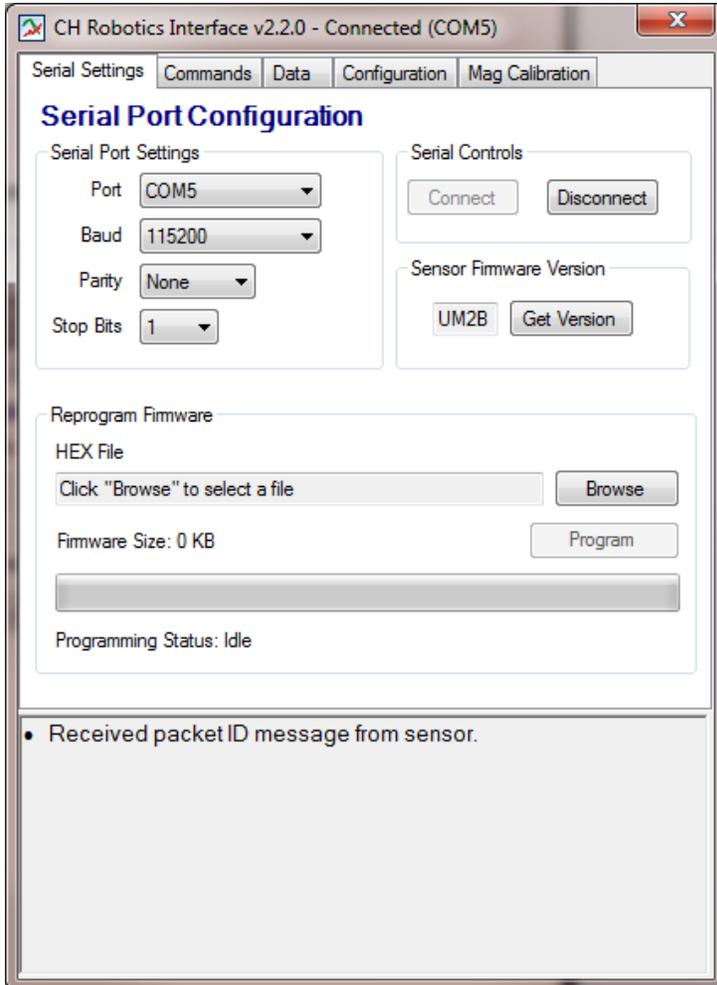
Figure 4 - CHR Serial Interface after Connecting

Step 5 - You are ready to go! Click on the "Data" tab. You will see a tree view with a list of a bunch of items. Go ahead and expand the "Accel Data" item and select the three processed accelerometer channels as shown below:
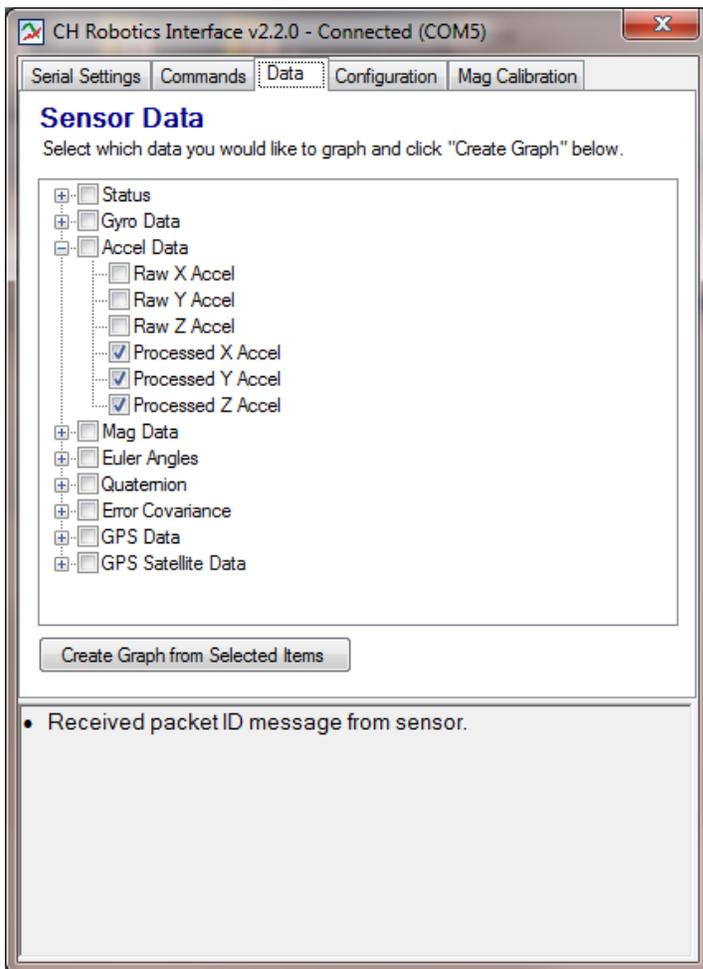
Figure 5 - Data Tab in Serial Interface

Now click "Create Graph from Selected Items." This will open a new resizable window with the processed accelerometer data. If the UM6 is laying flat on a table-top, it should look like the graph shown below. (Acceleration is measured in gravities, so you are seeing gravity in the plot).

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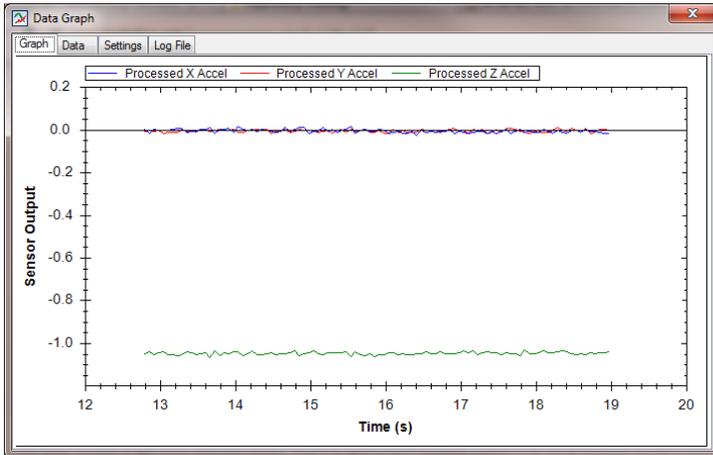
Figure 6 - Processed Accelerometer Output

There are many other features of the CHR Serial Interface software. For more details, see App Note AN-1004 - Using the CHR Serial Interface, available from http://www.chrobotics.com.

4. Using the UM6 Without the Serial Breakout Board

Even without the Serial Breakout Board, it is still fairly straightforward to connect to the UM6. You can connect to the UM6 using either the 4-pin side connector or the 12-pin bottom connectors shown below.

Figure 7 - 4-Pin Side Connector
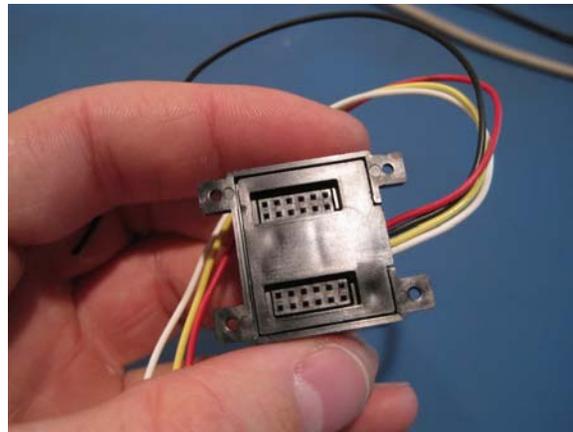
Figure 8 - 12-Pin Bottom Connectors

The 4-pin side connector provides access to the voltage input, ground, and the UART TX and RX lines needed to communicate with the sensor. The 12-pin bottom connectors provide access to the

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same pins, but also adds additional connections needed for SPI bus communication, reprogramming the firmware, and other general purpose pins for custom applications.

In order to connect the UM6 or the UM6-LT to a computer, the TX and RX lines from the UM6 UART must be converted to either RS-232 or USB. Connecting the UM6 or the UM6-LT directly to your computer will damage the sensor. The Serial Breakout Board performs the conversion for the UM6. If you did not purchase the serial breakout board, or if you are using the LT, a different converter must be used.
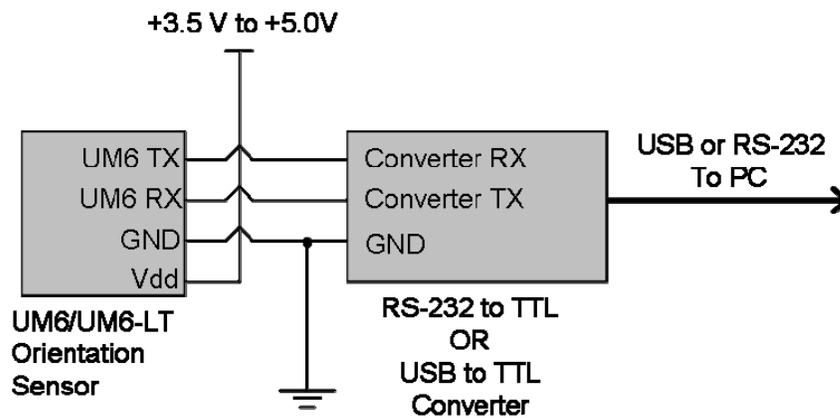
Figure 9 - Wiring Diagram for UM6

Once the UM6 or the LT is connected as shown above, you should be able to communicate with it as described in Section 3 - Using the UM6 Serial Breakout Board.

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5. Configuring the UM6 and the UM6-LT

5.1. Communication Settings

The UM6 and the UM6-LT can be configured to transmit any combination of raw and processed sensor data and orientation estimates. Specific details about the available communication settings is available in the product datasheet. However, the most simple way to configure the sensor is to use the CHR Serial Interface. Once the sensor has been connected to your computer as described in Section 3 - Using the UM6 Serial Breakout Board, you can change the sensor configuration by clicking the "Configuration" tab and then clicking the "Read" button. This will cause the Serial Interface to upload all current configuration settings from the device and display them as shown below:
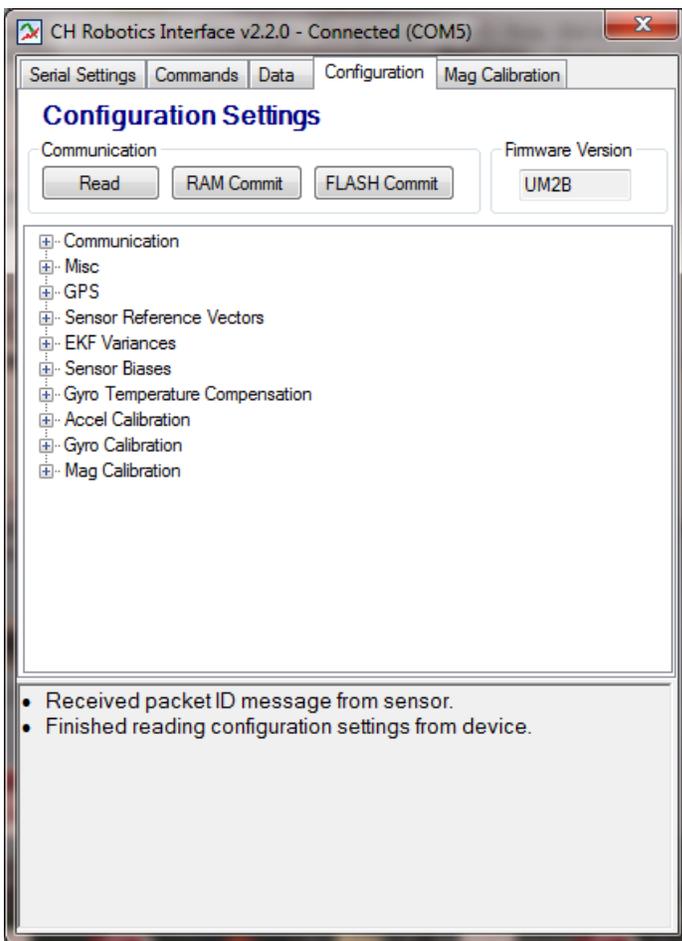
Figure 10 - Configuration Tab in the Serial Interface

There are a lot of settings that can be changed here, but don't worry! You won't need to do anything with most of them.

Go ahead and click the + symbol next to "Communication." The list will expand with all available communication options as shown:
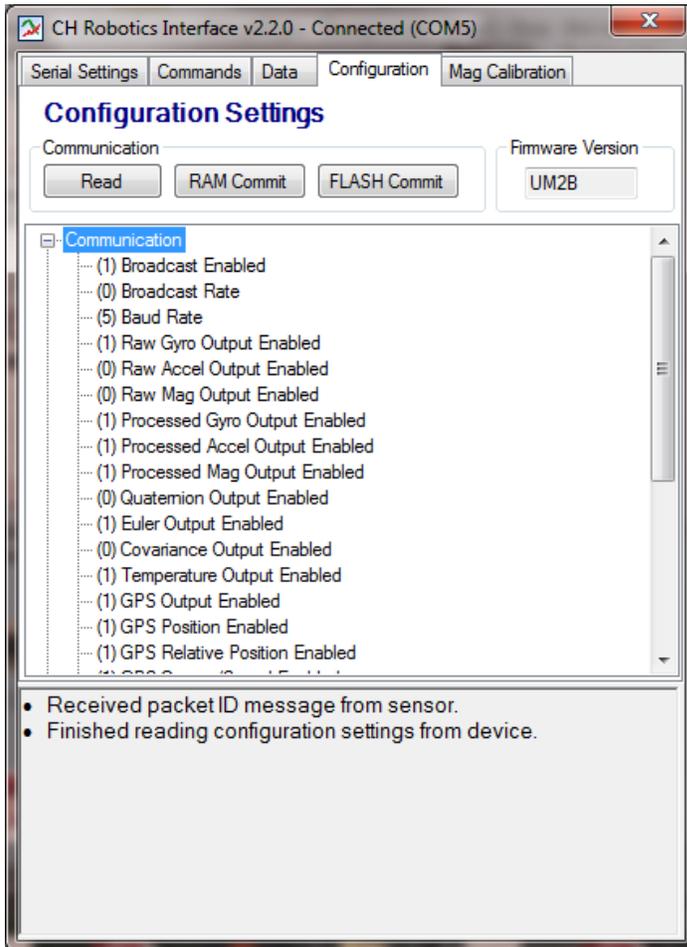
Figure 11 - Communication Settings

The "Broadcast Enabled" setting specifies whether the sensor will automatically transmit packets without waiting for requests. You should leave this enabled while using the Serial Interface.

The "Broadcast Rate" specifies how often data should be transmitted by the UM6. When this is set to 0 (default), it transmits data from all enabled channels 20 times per second. When set to 255 (max) it transmits data from all enabled channels 300 times per second.

The "Baud Rate" option specifies the baud rate of the serial output of the sensor. This is set to 115200 by default, but if you click on the option a drop-down list will appear allowing you to select

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different rates. We recommend that you don't decrease the baud-rate unless you have to. When you change the baud rate, you'll have to go back to the "Serial Settings" tab and reconnect with the new baud settings to communicate with the sensor again.

The rest of the communication settings indicate whether the specified data will be transmitted during a broadcast. For example, in the above image, the sensor is configured to transmit all processed sensor data, raw gyro data, Euler Angles, and GPS data (whenever new GPS data is available, which is never if you haven't connected a GPS module to the UM6).

After you've made changes to the sensor, click "RAM Commit" to send them to the sensor. After you've committed the changes to RAM, you can click "FLASH Commit" to make the changes persist after you turn off the sensor.

5.2.   Calibration

There are a lot of ways to calibrate the UM6 and the UM6-LT, but most of them aren't necessary to get reasonable performance from the sensor. The most important requirements are to calibrate the magnetometer and zero the rate gyros.

5.2.1. Magnetometer Calibration

Magnetometer calibration typically only needs to be performed once after the sensor has been integrated into its assembly (say, in an airplane or a ground robot). The magnetometer on the UM6 comes pre-calibrated, so no additional calibration is required unless it is mounted somewhere near objects that distort the Earth's magnetic field. The UM6-LT does NOT come with a pre-calibrated magnetometer, so calibration is required to obtain good performance from the sensor.

Magnetometer calibration can be performed via the CHR Serial Interface by clicking the "Mag Calibration" tab as shown in Figure 12. **Before beginning calibration, visit the "Configuration" tab and make sure that raw magnetometer data is being automatically transmitted by the sensor.** Once you have verified that raw magnetometer data is being transmitted, click the "Start Data Collection" button.

The software will increment the "Collected Data Points" indicator as raw data arrives. While the software collects data, rotate the sensor through a wide variety of yaw, pitch, and roll angles so that

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the software gets a good picture of the shape of the magnetic field. You should ensure that the sensor is far from any magnetic field distortions that won't be around when it is operating (for example, being too close to you computer monitor, moving the sensor past dangling cables, or being too close to metal supports on your desk will all cause problems).

After 300 data points have been collected, the "Compute Calibration" button becomes active. Click it and the software will compute a calibration matrix and a set of biases. Click "Write to RAM." To make the calibration persist after restarting the sensor, visit the "Configuration" tab and click "FLASH Commit." A result of the calibration operation is shown in Figure 13
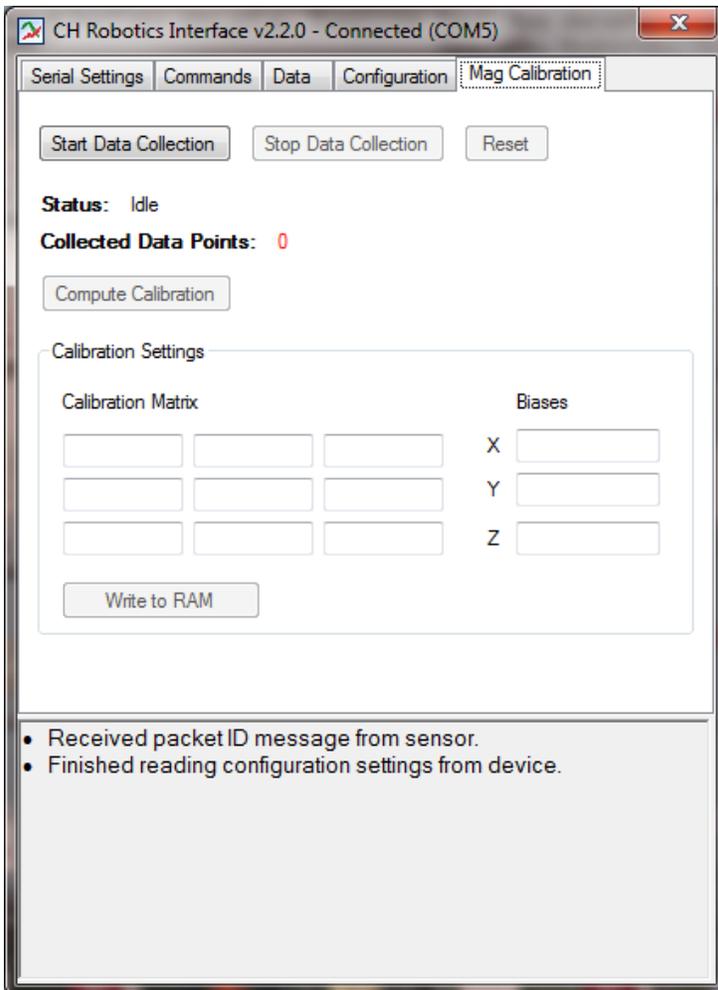
Figure 12 - Magnetometer Calibration Tab

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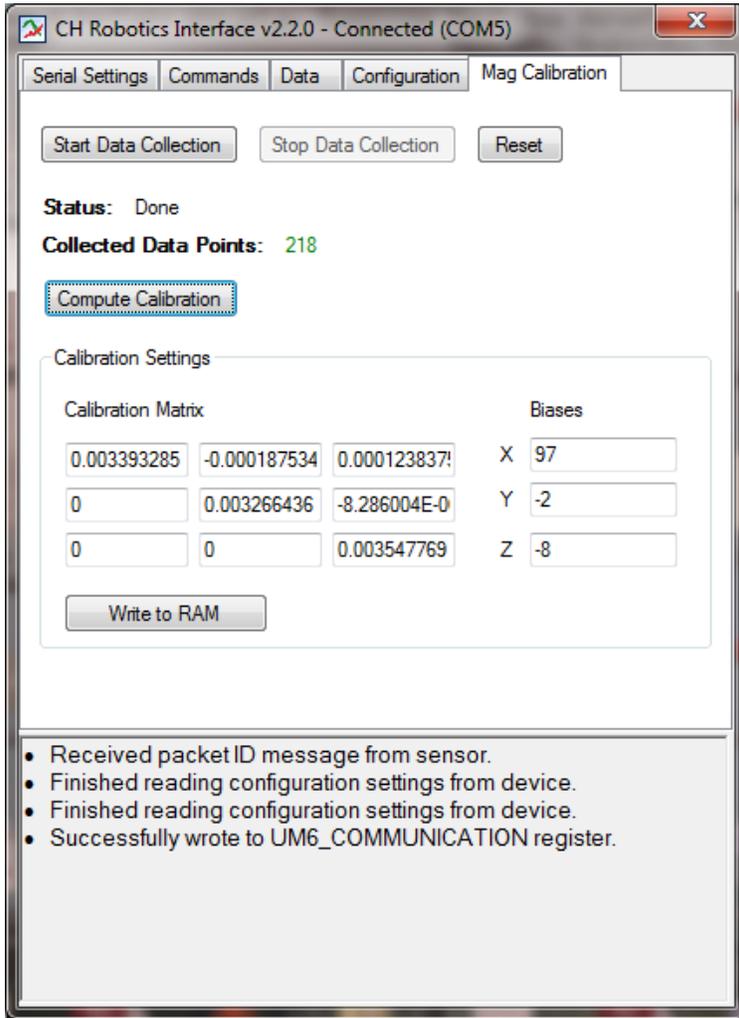
Figure 13 - Magnetometer Calibration Performed

And that's it! After you've calibrated the magnetometer correctly once, you shouldn't have to do it again.

5.2.2. Rate Gyro Bias Calibration

Unlike magnetometer calibration, rate gyro biases should be zeroed every time the sensor starts up and periodically while running. The rate gyros are very sensitive to temperature variation, and to keep costs low they are not calibrated in the factory. This means that for best results, they should be zeroed periodically.

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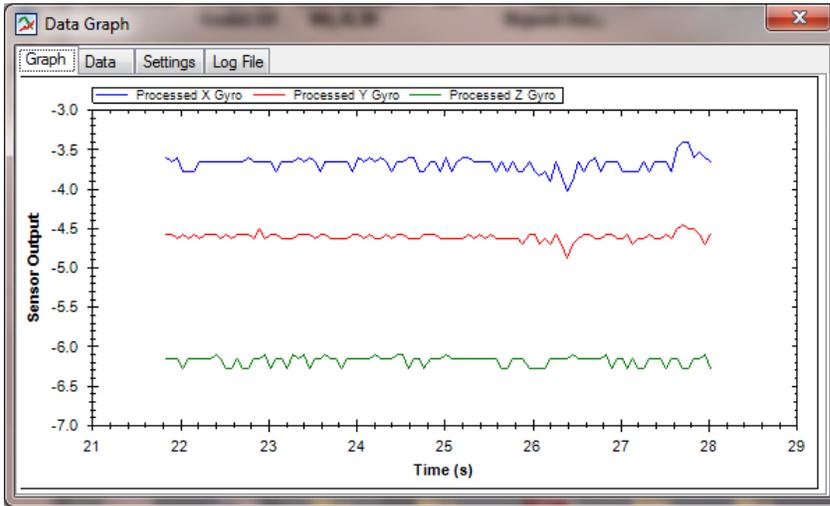
Figure 14 - Rate Gyro Output Before Zeroing
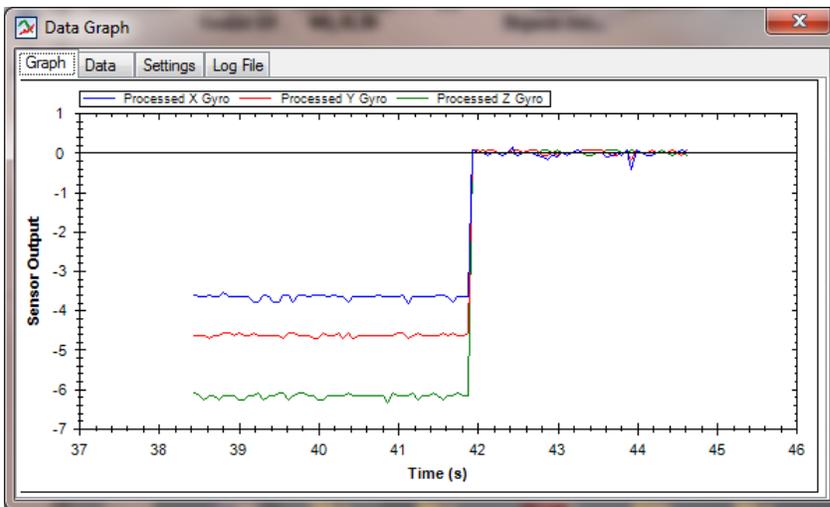
Figure 15 - Rate Gyro Output After Zeroing

To zero the rate gyros, visit the "Commands" tab in the Serial Interface as shown in Figure 16. Make sure that the sensor is stationary and double-click "Zero Rate Gyros." You should see a message in the bottom status window that says "Command Complete: Zero Rate Gyros." If you don't see it after a few seconds, double-click the command again to make sure the sensor received it.

Figure 14 and Figure 15 show the processed rate gyro output both before and after they have been zeroed.

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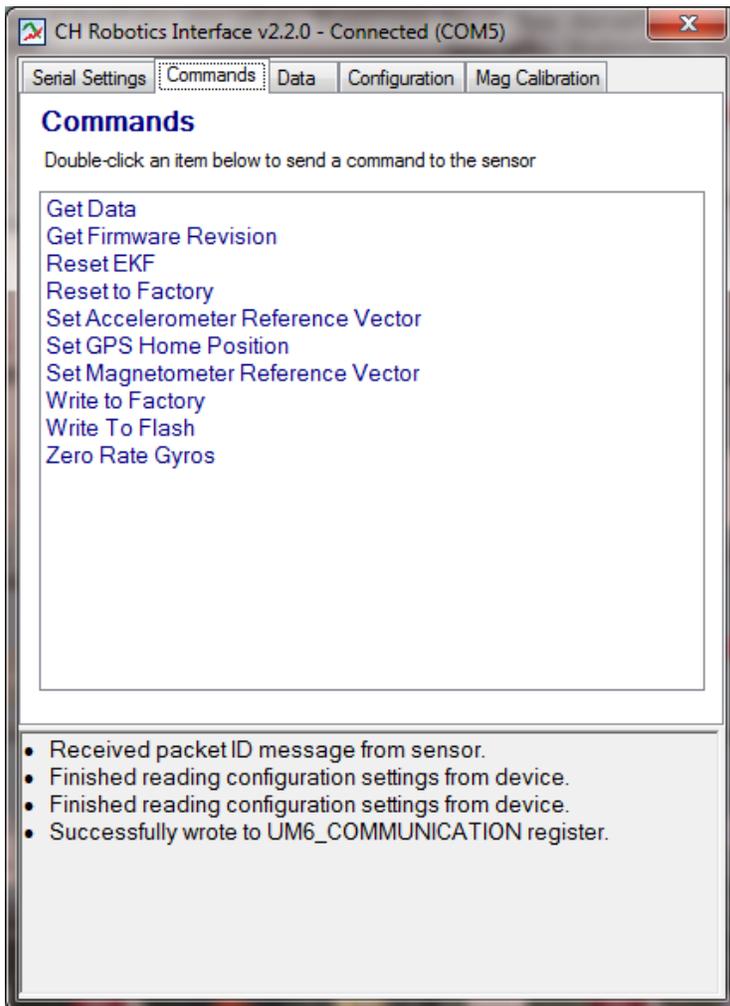
Figure 16 - Commands Tab in the CHR Serial Interface

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