Thrusters

Legacy

Previous iterations of the sub have used Seabotix thrusters, which are DC motors. We've controlled them using Sabertooth 2×12 motor drivers made by Dimension Engineering. These controllers communicated via a serial interface, and thus were directly controlled by the computer.

Current

The new submarine is using AC T200 thrusters by Blue Robotics, which are controlled via the BlueESC, which is integrated directly within the thruster. These controllers communicate via an I^{2}C interface, therefore an intermediate microcontroller is used to translate serial commands from the computer to I^{2}C.

T200 + BlueESC Information

Official documentation can be found on the BlueRobotics website. The most pertinent information is copied here for quick reference. There are two cables coming off of them. The thicker cable is power, and the smaller cable is signalling.

Wiring information:

Power Cable:

- Red - positive power
- Black - ground

Signalling:

- Yellow - PWM control (tie to ground if using I^{2}C)
- Green - I^{2}C clock
- White - I^{2}C data
- Black - ground

I2C Interface

The thrusters are controlled by sending a throttle command between -32767 and +32767, with 0 is stopped. There is no deadband on these thrusters, however the relationship between throttle and thrust is believed to be quadratic (need to verify). The controllers have a built-in safety timeout, if no throttle command is received for 1-2 seconds (need to verify), the motors will automatically stop. If further commands are sent, they will be ignored. To activate the thrusters again, a throttle value of 0 must be sent.

The BlueESC also can provide us with information concerning motor RPM, voltage, current, and temperature.

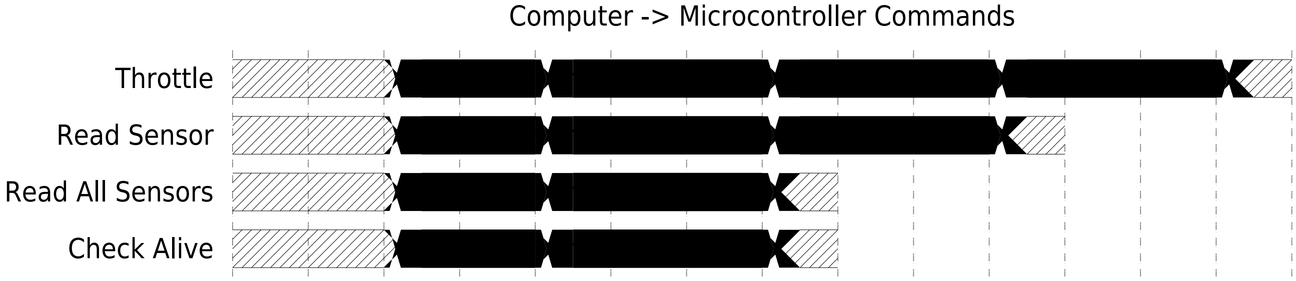
When shipped from the factory, the thrusters all use the I^{2}C address of 0x29. To change the address, the firmware must be re-flashed. We have programmed our thrusters with the addresses 0x30-0x37.

Computer-Thruster Interface

The microcontroller code receives incoming commands from the computer and dispatches them. Some commands result in the microcontroller sending a response back to the computer. Commands and responses are wrapped up via our Packetizer class, so all diagrams are simply describing what should be in the "data" section of a packet.

Computer to Microcontroller

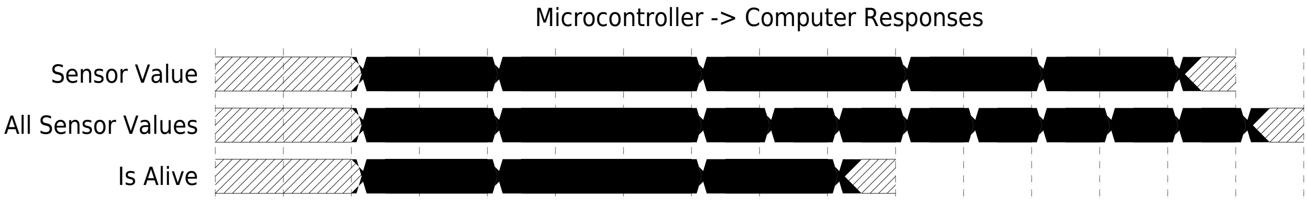
The following types of commands should be accepted by the microcontroller:



The first two commands are the basic interface for controlling the thrusters and getting information. There is the third macro command for reading all the registers of a thruster. There is no macro command for talking to all thrusters because this would require the microcontroller to know what thrusters exist/are active on the sub, which would complicate the code. The final command is a method for checking if a thruster is alive and responding, it will return a bool true/false value.

Microcontroller to Computer

The computer should expect to receive the following packets from the microcontroller:



The IDs for responses correspond to the IDs for the commands as described in the previous section. The "Read all Sensors" response contains 8 bytes of data (B0-B7), which are described below:

- Byte 0: pulse_count_h
- Byte 1: pulse_count_l
- Byte 2: voltage_h
- Byte 3: voltage_l
- Byte 4: temperature_h
- Byte 5: temperature_l
- Byte 6: current_h
- Byte 7: current_l

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