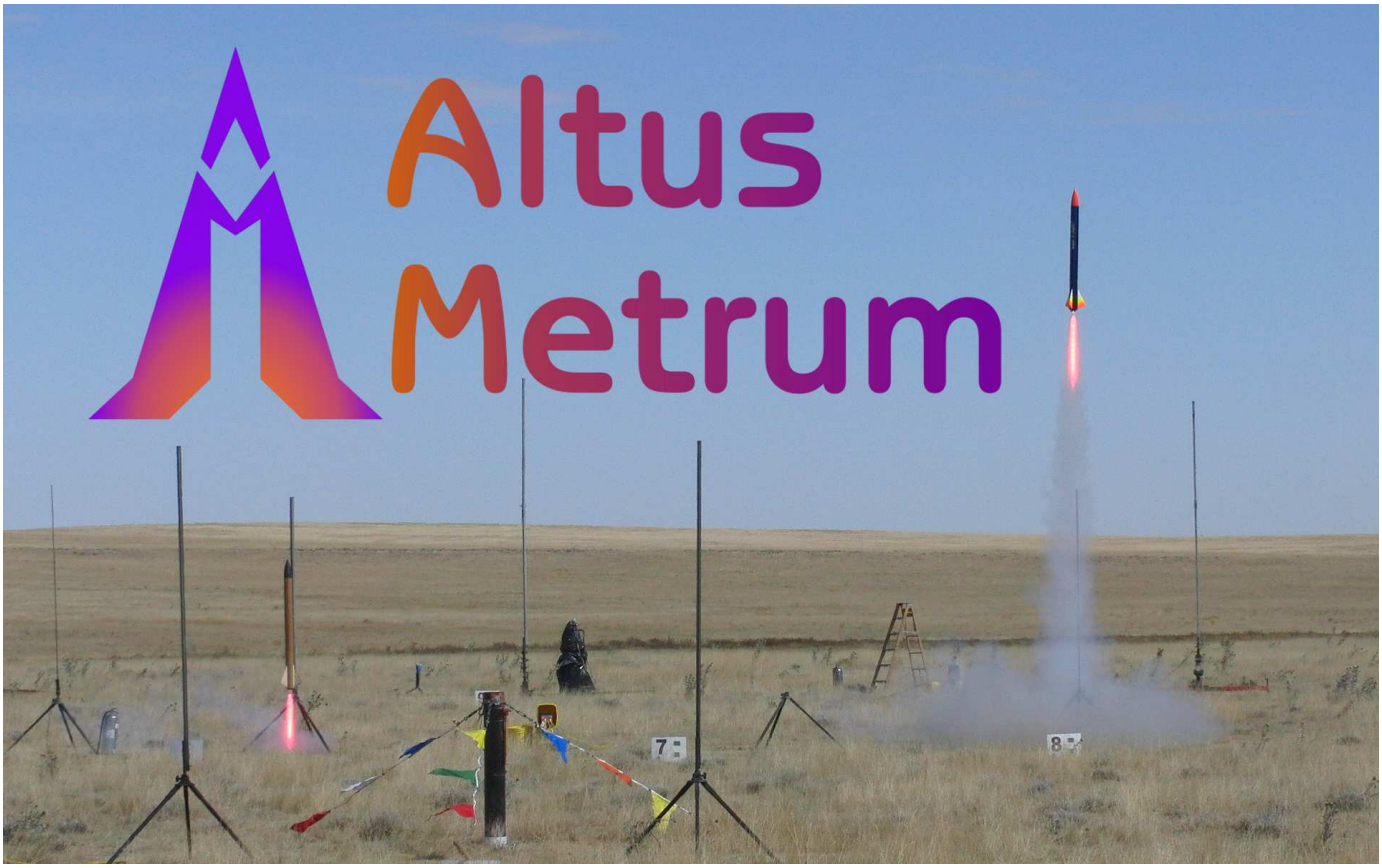

Motor Testing

Static and In-Flight Motor Performance Testing

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Chapter 1. Introduction and Overview

Welcome to the Altus Metrum community! Our circuits and software reflect our passion for both hobby rocketry and Free Software. We hope their capabilities and performance will delight you in every way, but by releasing all of our hardware and software designs under open licenses, we also hope to empower you to take as active a role in our collective future as you wish!

Thank you for your interest in motor testing products from Altus Metrum. Our first such product is EasyMotor, an in-flight motor data collection board for hobby rockets. EasyMotor is a small circuit board that is meant to log motor chamber pressure and rocket acceleration during flight. With this data it's possible to determine whether a research motor is performing as expected. With additional information about masses and airframe drag, it is even possible to closely estimate complete motor performance.

With EasyMotor, the dilemma of "do I burn this on a test stand to learn more about how it actually works, or do I go fly it" is no more! You can fly your motor and get real performance data about it too!

Because documentation is just as prone as software to contain "bugs", and can always be improved... If you have questions that aren't answered in this manual, or just need a little help figuring things out, we strongly suggest joining the Altus Metrum user email list, which you can do by visiting https://groups.io/g/altusmetrum.

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Chapter 2. Configuration

There is very little that must be configured to make EasyMotor work. In fact, the default configuration from the factory is typically sufficient without change.

2.1. Connecting to a Unit

To change any EasyMotor configuration, you need to attach a battery and a power switch, then use a micro USB cable to connect the board to a computer running AltosUI.

2.2. Changing the Configuration

All available configuration options can be set using the “Configure Altimeter” menu selection within the AltosUI program.

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Chapter 3. Installation

Firmware versions prior to 1.9.13 used acceleration to detect launch. Starting with 1.9.13, the firmware switched to using pressure to trigger recording. Altus Metrum strongly recommends upgrading all EasyMotor boards to current firmware, the behavior of which is described here.

EasyMotor needs to be rigidly attached in the airframe, in any convenient orientation.

3.1. Trigger to Start Recording

Starting with firmware version 1.9.13, a pressure sensor must be attached, and pressure change is used to initiate and conclude data recording. Pressure and 3 axes of acceleration are recorded for later analysis.

EasyMotor looks for a 50 psi rise in pressure from ambient to start recording. Recording stops when the pressure drops below 50 psi and shows variation of less than 30 psi for at least 10 seconds. These conditions are intended to capture all actual burn data including anomalies such as "chuffs".

3.2. Power Switch and Battery

In addition to the circuit board itself, EasyMotor needs a power switch and battery to operate. Like many Altus Metrum products, EasyMotor requires a single-cell LiPo battery, and has an on-board charging circuit. The 5V needed for inexpensive pressure sensors is generated onboard using a switching regulator to boost the voltage.

Because he often mounts EasyMotor to the motor’s forward bulkhead instead of to the airframe itself, Bdale often uses a length of “shooter wire” from an e-match or used motor igniter as a power switch, routing the wire out of the typical fin can vent hole and using “twist and tape” to power up the board. Whatever works!

3.3. Pressure Sensor

The primary motivation for designing EasyMotor was to have a reliable way of recording motor chamber pressure during flight. To that end, EasyMotor supports attachment of a low-cost analog pressure sensor. The board provides 5V to power the sensor, and an input for measuring and logging the output voltage from the sensor.

The kind of sensor EasyMotor is designed to work with takes 5V in and has a linear analog output that ranges from 0.5V at 0 to 4.5V at the maximum pressure supported by the sensor. Very inexpensive sensors that have a “1/8 NPT” threaded input, a “Buick-style” 3-pin connector, and typically ship with a short cable and mating connector, are readily available through various vendors including Amazon, eBay, and AliExpress.

These pressure sensors have three wires and sometimes a shield around those wires. The colors of the wires can vary, but typically are red for power, black for ground, and green for the analog output. Hook red to '+5', green to 'PRES', and black to one of the two 'GND' screws on the

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board. The other 'GND' screw is available for connecting the shield if one is present. This is mostly relevant if you're using the product for static testing on the ground with a longer than usual cable.

To log in-flight chamber pressure, a typical approach might be to drill a 1/8" sampling hole all the way through the center of the motor's forward closure, then drill and tap partially through the closure with a "1/8 NPT" pipe tap. Fill the touch hole with grease, screw in the pressure sensor, and attach the sensor leads to EasyMotor.

If you aren't up for machining closures yourself, Loki Research sells 54mm and 75mm "experimental bulkheads" with threaded sensor ports that can be used with snap ring cases, and other related mechanical bits and pieces.

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Chapter 4. Operation

Operating an EasyMotor board is pretty easy. Turn the power on before launch, typically during the usual pre-flight electronics checklist after the rocket is installed on a launch rail.

The board will beep out a Morse code “P” every few seconds indicating that it’s in pad mode and ready to detect the start of the motor burn. Recording starts when chamber pressure rises by at least 50psi, then the board logs pressure and acceleration data 100 times per second until chamber pressure goes low again and remains stable for at least 10 seconds.

After flight, attach a USB data cable to the board before powering it on so that it goes in to 'idle mode'. Then AltosUI can be used to download the flight data, view a quick graph of acceleration and pressure with pan and zoom capabilities, then export it to a comma separated values (CSV) file. Such a file can easily be loaded into a spreadsheet for analysis.

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