Eggtimer Quantum
User's Guide

Software Rev. 1.09G
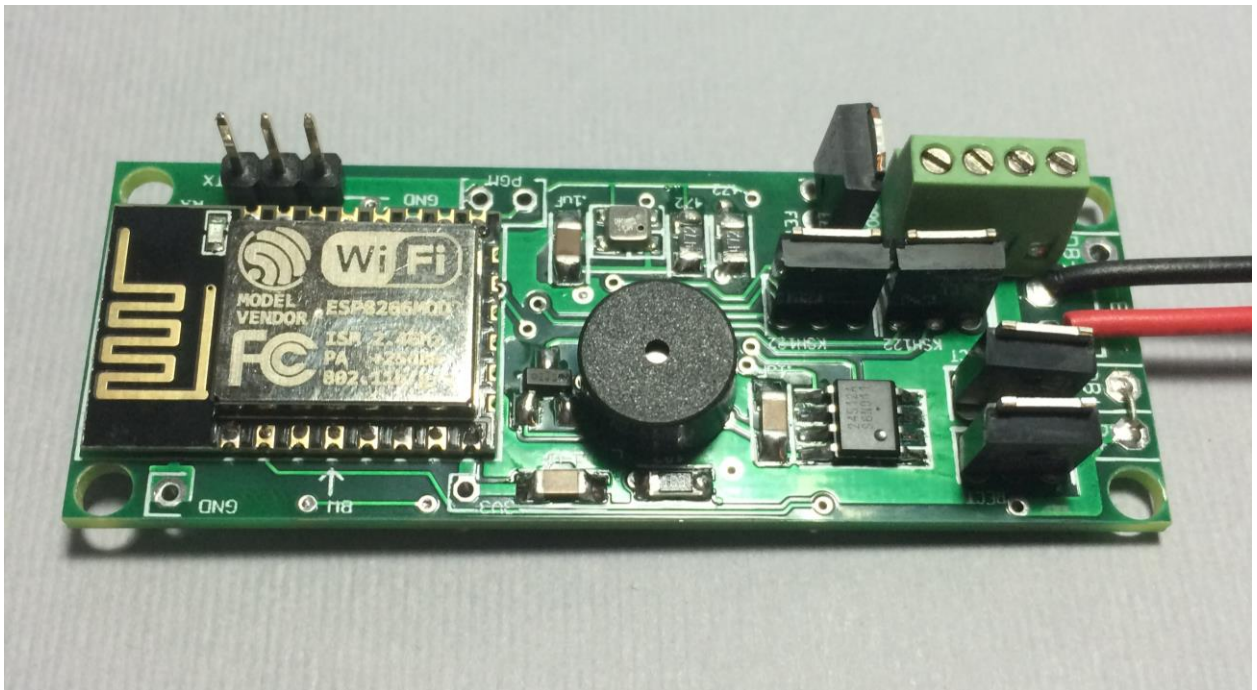
Eggtimer Quantum Features

WiFi-Enabled, Dual-Output logging flight computer

Programming, arming, and downloading can all be done with any WiFi/browser-enabled device

No apps required on your device, just a browser

Small size: Only 2.5" x .9", fits easily in a 24mm body tube, weighs only 15 grams

Altimeter records data up to 60,000'

Detailed flight data for 15 flights is saved, and can be downloaded using your browser

Summary data can be downloaded or viewed on your browser, immediately after the flight

Main deployment channel can be set to fire from 100' to 2000'

Drogue deployment channel delay configurable from nose-over +0 to +9 secs

Deployment channels' on-time can be set from 1-9 secs… great for hot-wire non-pyro deployments

Deployment channels can be set for standard servos, travel from 23-90 degrees CW or CCW

Real-time telemetry is streamed out the serial port during flight for use with the Eggtimer Telemetry Module and Eggfinder LCD Receiver

Fully "mach immune", deployments are inhibited until the rocket is moving slowly near apogee

Battery input is fully polarity immune… it works either way

Works with a 2S/7.4V LiPo battery, 300 mAH or more recommended

Optional separate battery input for deployment channels protects against "brownouts"

Works with almost all common deployment ematches, will even light an Estes® igniter with a 2S LiPo

Test mode so you can do an actual pyro test remotely up to 200' away from your rocket

Dual-ended deployment outputs, igniters are essentially "dead" until well into the flight

No switch needed, since it's disarmed and the igniters are dead until YOU arm it

"Fail-Safe" mode can fire main chute if a drogue failure is detected, preventing a potential high-speed chute deployment or crash

Disclaimers, Legal Stuff, Etc.

The Eggtimer Quantum is meant to be used for hobby and experimental rocketry purposes. Although hobby rocketry has an admirable safety record, largely due to the efforts of the good people at the National Association of Rocketry (NAR) and the Tripoli Rocketry Association (TRA), rocketry can be dangerous if proper safety precautions are not observed. This is particularly true with some of the advanced techniques like pyrotechnic parachute deployment. People can and have been seriously injured by not following recognized and accepted safety practices. We cannot be responsible for your actions.

We *strongly* recommend that if you are not a member of either the NAR or the TRA, you join one of them, join a local rocketry club, and pick the brains of experienced members before you try any kind of multiple deployment or airstart flight. The safety information included in these instructions is by no means comprehensive or complete, and is no substitute for the supervision and advice of experienced rocketeers.

Limited Warranty

Eggtimer Rocketry warrants that all of the parts on the packing list of this Eggtimer Rocketry kit have been included, and that they are all in working condition. If you are missing something, contact us immediately at support@EggtimerRocketry.com and we will send you whatever it is that you are missing. If you are missing something really egregious (like the PC board or the processor, for example), we may ask you to return the entire kit unbuilt, we will send you a prepaid shipping label for this purpose. We'd especially like to see the packing list so we can figure out what went wrong so it doesn't happen again…

If your Eggtimer Quantum does not work properly after assembly, take a deep breath, get out the magnifying glass and a good light, and see if you have inadvertently created a solder bridge somewhere. Chances are pretty good that you have, or that you have installed a part incorrectly. We are a very small company and we just don't have the resources to repair your board, but we will be more than happy to give you advice and we might be able to help you find your error if you send us some high resolution pictures, to support@EggtimerRocketry.com . We cannot take responsibility for your assembly techniques; if you do not have experience building kits of this nature, we recommend that you enlist some help. (Another reason for joining a rocketry club, there is usually at least one electronically-inclined member who can be bribed with a beverage or two to give you a hand. Engineering types love a challenge, especially it it's easy for them but hard for you.)

Eggtimer Rocketry warrants that when properly assembled this Eggtimer Rocketry product will perform substantially according to the published documentation. This means that we spent a lot of time trying to ensure that it's going to work the way that we say it does, and we try to fix things that don't quite work right in a reasonable time. Nevertheless, we can not and do not warrant that this product is perfect and will meet every rocketry purpose, for the simple reason that we can't test every possible rocket/motor/environmental combination. It is the buyer's responsibility to determine the suitability of the Eggtimer Quantum for their particular purpose. If you have a problem with this, please contact us and we will be happy to send you a prepaid return label for your unbuilt kit and we will refund your purchase price.

Meet the Eggtimer Quantum

The Eggtimer Quantum is a barometric altimeter-based flight computer, its job is to properly deploy your parachutes and bring your high-powered rocket safely to the ground, and to record flight information for later analysis. It has two channels: a drogue channel, which is typically fired near the apogee of the flight, and a main channel which fires at a somewhat lower altitude that you can choose. The idea is that the drogue parachute is much smaller, so your rocket comes down at a controlled but relatively fast rate, typically between 50-100 ft/sec. This relatively high rate of descent helps minimize the rocket's drift due to wind, and for you impatient types it also helps it come down faster too. The main parachute is typically opened somewhere between 500'-1000', slowing the rocket down so that it lands gently but preventing it from drifting excessively.

It's nice to get your rocket down in one piece, but it's also nice to know how the flight went. The Quantum can record your last 15 flights, and you can easily view and/or download both summary statistical information and detailed time vs. event information.

What makes the Quantum different from other flight computers is that it has a WiFi interface. Instead of using switches, jumpers, or a data cable to your laptop to program it, you simply connect to it with your phone, tablet, or computer using WiFi and a browser like Safari, Firefox, Internet Explorer, or Chrome. You remotely arm it at the pad using your handheld device too, so for many applications you do not need a mechanical switch… it won't turn on until you tell it to. Optionally, you can override remote arming, so it will arm like "other" altimeters when you power it on.   Flight data is downloaded to your handheld device using WiFi, and with the installation of an appropriate spreadsheet or other data analysis program you can actually get a flight graph within seconds of recovering your rocket.

In addition, there is a serial output port that streams live data during your flight. Along with an Eggtimer Telemetry Module, it will send out live altitude data to an Eggfinder LCD receiver. If you have an Eggtimer Voice Module in your Eggfinder LCD receiver, it will literally "call out" your real-time altitude, apogee, deployments events, and ready/not-ready status.

Since one of the tenants of successful electronic deployment is ground testing, the Quantum incorporates a ground-test feature so that you can check YOUR battery with YOUR igniters to make sure that they are compatible and will work in flight. This is done remotely over WiFi, so you can even test with "live" pyro charges, standing up to 100' away from your rocket.

The deployment channels are capable of triggering just about any ematch that you're likely to encounter, we've even fired a medium-current Estes igniter with it using a 2S/7.4V LiPo. You can set the output on-time from 1-9 seconds, so it's ideal for use with a hot-wire non-pyro deployment. There's a separate battery input for the deployment circuitry, so you can optionally use a second battery on the deployment outputs that 100% guarantees that a deployment glitch will not cause your Quantum to "brownout" due to low voltage.   You can also use standard PWM hobby servos with the Quantum, for non-pyro deployments. This makes it ideal for use by TARC teams that want to experiment with electronic deployment but can't use pyrotechnics, or for flights over 30,000' in which pyro charges may not be effective.

In addition to deployment functions, the Quantum can also be used to "airstart" additional motors in flight, either for "strap on" boosters or for starting a second stage motor. It works as a timer that starts at launch, and is qualified by breakwire support, velocity-at-time, and/or altitude at time. This helps ensure that your second stage won't light unless your rocket is going "up". Since those functions are highly specialized, there's an additional manual for airstart functions… you can find it in the Eggtimer Rocketry web site under Eggtimer Quantum Support/Documentation.

Getting to know your Quantum

Although the Quantum seems relatively simple, you will want to familiarize yourself with it BEFORE you install it in a rocket, and certainly before you try flying it.

Battery (BATT) – Two solder pads for connecting the Quantum's battery.   It's not polarized… you can't hook the battery up the "wrong" way.   We recommend a 2S/7.4V LiPo battery, 300 mAH or higher… more on that later.

Buzzer - "Beeps" out status, warnings, apogee at landing, and other important notifications.

Main Deployment (MAIN) - Two solder pads for connecting an electric match or other deployment device such as a hot-wire or a servo. Deployment altitude can be set from 100' up to 3,000', or it can be turned off if you don't need to use it.

Drogue Deployment (DROG) - Two solder pads for connecting an electric match or other deployment device such as a hot-wire or a servo. This normally triggers right after nose-over, but you can delay it from 100 ms to 30 seconds for backup use, or deploying some other device. You can also turn it off if you're not going to use it.

Battery Output (B+) – Used for the single-battery option when jumpered to the DB+ pad.

Deployment Battery (DB+/DB-) – Two solder pads for connecting a separate deployment battery. If you choose to use the Quantum with a single battery for both the computer and the deployment side, you simply jumper the DB+ pad to the B+ pad, which provides the power for the deployment channels. Note that there is a 5V minimum requirement for the drivers to operate… a 1S/3.7V LiPo isn't going to work.

Programming Cable Header – 3-pin header that's used with an Eggtimer USB-Serial cable for updating the software or for viewing the WiFi passkey (in case you lose it).   It can also be used to connect to the Eggtimer Telemetry Module for live-streaming flight data to an Eggfinder LCD receiver.

Programming Jumper Pads (PGM) – Two pads used to put the Quantum into programming mode at boot-up, for uploading software updates. Normally you won't do anything with these pads.

3.3V Output (3V3) – Header for connecting power to optional Eggtimer Telemetry Module (B1 version and up).

Breakwire Connection (BW) – Optional connection for using breakwire with airstarts.

Servo Drogue (SD) – Optional digital-level output for using Drogue channel with standard PWM servos (B3 version and up).

Main Drogue (MD) – Optional digital-level output for using Main channel with standard PWM servos (B3 version and up).

Mounting the Quantum in Your AV Bay

The Quantum has four #4 holes for mounting in a AV bay sled. It's about 2.5" x .9" x 3/8", so you'll need to make sure that you have enough room on your sled for it. It doesn't matter which way you mount it, as long as it's mounted so the WiFi module is facing outwards. There's a drilling template on the Eggtimer Rocketry web site, we recommend that you download it, print it, and cut it out with scissors so you can drill the mounting holes accurately.

Our first choice for mounting hardware is to use #4 Nylon screws and nuts.   They're non-conductive so you don't have to worry about shorts, and in the event of a crash they will actually shear, taking the load off the PC board.   With metal hardware, the PC board is going to take the full brunt of the impact and damage is more likely.

If you do use metal hardware, we recommend using #4 machine screws about 3/4" long, with two #4 nylon washers to act as a spacer between the bottom of the PC board and the sled, and one nylon washer between the screw head and the top of the Quantum PC board.   That keeps metal from touching the board directly.   We recommend using nylon-insert nuts… they don't work loose. If you mount it like this, you can pretty much use whatever monster motor you may have on-hand (like the infamous O5800, for example) without fear of anything coming loose.

You MUST use non-metallic spacers between the bottom of the board and your sled. Since some parts are mounted on the bottom of the board, it's possible to damage your Quantum if you screw it down directly to the sled, doing that may break solder joints or even a lead on the IC if it's forced against the sled.

We generally recommend that you try to mount the Quantum as close to the battery as possible, and keep the wiring as short as possible. Small zip ties work really well for tidying up the wires. Also, we **strongly** recommend that you zip tie the wires connected to the Quantum to your sled, to provide strain relief for them. In general, if a wire can't move, it won't come loose. Enough said…

Note that large bits of metal in your AV bay will reduce the WiFi range of your Quantum, as will metallic paint or carbon fiber body tubes. In most cases, the range will be good enough for you to be able to operate the Quantum from a reasonable distance close to the rocket, maybe 10'-20', but you need to be aware of this in case you're thinking that you can arm your 75mm minimum-diameter carbon fiber machbuster sitting on the away pad from the LCO's table… it ain't gonna happen. In a typical dual-deploy rocket, you can expect 50'-100' of range from the WiFi signal.

Since the Quantum uses a barometric pressure sensor to determine altitude, you'll need to drill a few holes in your AV bay to vent it to the outside air. There's a lot of debate about what the right size for the holes is, how many, etc., but the most accepted rule of thumb is: One ¼" diameter hole for every 100 square inches of AV bay volume.

Now the tricky part is that you don't want ONE vent hole… the optimum number is THREE, equally spaced along the AV bay perimeter. This works out to about three 5/32" holes for every 100 square inches of volume. That's just about the size of a 4" diameter AV bay that's 8" long, so you can work up or down based on that.

Wiring Your Eggtimer Quantum

The Quantum is designed to have the power connector directly soldered to the board. You can either solder the output wires directly to the board, or you can use the optional screw terminal blocks. This allows you to choose whatever method of terminating the connections you want: barrier strips, solder directly to pigtails, through-bulkhead terminals, etc. It also prevents the connections from coming loose in flight due to vibrations and G-forces.

We've found that simply wire-wrapping the igniters to a "pigtail" wire soldered to the board works very well for smaller rockets. By soldering the pigtails to the board rather than having screw terminal blocks, you eliminate the possibility that the wire may work loose from the terminal in flight. We also like the wiring kits made by Doghouse Rocketry, the wire they supply is Teflon-jacketed and lends itself well to solder-type wiring. Their charge wells with integral through-bulkhead terminals work great for 39mm-54mm rockets.

We recommend using #22-#26 gauge wire for wiring to the Quantum board, we like to use the #24 gauge stranded wire that's found in Cat-5 network cables. It's cheap, easy to find, and just the right size. It's also twisted together in nice solid-striped pairs, so it's easy to tell the "+" from the "-" wire. If you can, get the "plenum" cable, since it has a Teflon jacket and doesn't melt as easily when you solder to it as the standard "riser" cable. You can also use solid wire, but solid wire is harder to work with and has a tendency to break after being bent a few times. These breaks can be a pain to find, because they are typically inside the insulator jacket where you can't see them.

 If you use stranded wire, you **MUST** TIN THE WIRES BEFORE SOLDERING TO THE BOARD. This is to prevent stray "whiskers" of wire strands from coming loose and bridging pads, or breaking off and landing on the board in some random place. We've seen the results of this happening, it's not pretty, and they can be very hard to find if the lodge underneath the processor chip or in some other hidden spot on the board.

If you build the board with the terminal block option, be sure to tin whatever wires you are using for your igniters before you insert them into the terminal block. Loose strands here can prevent deployments, if a strand comes loose and lodges in the wrong place it could cause an immediate deployment when you connect the battery. That would be bad…

Alternatively, you can use crimp ferrules to connect the wires to the terminal blocks. These work really well, but you must be sure to get the proper crimp tool for your ferrules. Don't just try to use pliers… your connection WILL come loose if you do.

We strongly recommend that you zip-tie any and all connections to the sled next to the pads/terminals. This prevents wires from pulling out of the screw terminals due to G forces. Similarly, you should tape closed any connectors, and zip-tie any loose wires to the sled. If it can't move, it can't come loose…

The Single-Battery Option

For a single battery, you only need to solder a jumper (or switch, see below) between the B+ and DB+ pads that are located next to the two BATT pads. This will provide power to the deployment circuitry directly from the battery. Nothing else is necessary.

The Dual-Battery Option

Using separate batteries for the Quantum's computer and deployment side has some advantages, and one disadvantage. The disadvantage is that it's going to take more stuff… one more battery, one more connector, and possibly, one more switch. The advantages that: 1) You can use a different voltage battery than the computer side, which you may want to do for a hot wire or solenoid; and (the big one) 2) No matter what happens on the deployment side, including a complete loss of battery power, it's not going to affect the computer side. This is the same philosophy behind the dual-battery architecture on other Eggtimer Rocketry flight computers such as the Eggtimer Classic.

Many other flight computers use a big capacitor on the power output, with a single battery to prevent brownouts. This protects against momentary disconnects such as a glitch due to G-forces when your drogue deploys, but it won't protect against a longer-term brownout such as a shorted ematch after firing. Once that capacitor drains, your altimeter is done. With the dual-battery setup, if you have a short on the drogue it's going to cause a high current drain for a few seconds until either the processor shuts the output transistor off, or until the transistor blows (not likely, by the way). Either way, that high current draw is going to stop. Unless your battery gets totally fried during these few seconds (also not very likely…), when the command is sent to the main to fire it's going to work.

To wire up your Quantum for dual-batteries, wire the +/positive side of the battery connector to the DB+ pad (next to the BATT pads), and the -/negative side of the battery to the DB- pad (located between the deployment output pads). Leave the B+ pad unconnected. If you are going to be using a separate disconnect switch for the deployment battery you will generally wire it in series with the +/positive side, so that it goes between the DB+ pad and the +/positive lead of your battery connector.

If you use a separate deployment battery, there are a few things you need to know. First, you need to turn on the deployment power BEFORE you power on the Quantum, or it will not start up. Once it starts, you can turn off the deployment battery if you wish. Also, while the deployment power is off, you will "see" continuity on the outputs, even though the power is off; that's because the drivers are "active-low", which means that they can't detect lack of continuity without power. If you use a switch, we recommend that you turn it on when you power on your Quantum to test igniter continuity at your work table BEFORE you add the pyro powder to your charge wells, then shut it off until you're safely on the pad. Turning on the deployment power does NOT power on the deployment FET; it only allows the trickle current to go through the optoisolators to test continuity, and with the dual-switched architecture of the Quantum it's virtually impossible to accidentally fire an output on the ground.

About Switches…

The Quantum is designed so that it will not self-arm itself. If you power it up, it will sit there on the Status page forever, changing the validation code every 60 seconds… you have to actually arm it using the validation code in order to start a flight. In addition, the unique dual-ended deployment output prevents any significant current from getting to the igniter until it's armed and actually in-flight.

Because of this, for most flights using electronic deployments up through NAR/TRA Level 2 you do not necessarily need a separate power switch if you're using the single-battery option. You can simply connect the battery to a locking connector such as a JST connector and you're ready to go until you arm it on the pad. This makes your AV bay build easier and smaller, and of course it makes your pre-flight procedure a lot simpler.

NAR and Tripoli rules require that the deployment charges on a Level 3 rocket are electrically disconnected until you're on the pad. The Quantum is different than most other altimeters because it has dual-ended switching on the deployment outputs: BOTH the "+" and the "-" side are switched off, leaving the igniter essentially dead until near deployment (except for a tiny trickle current that's used to test continuity). For the igniter to fire, both sides have to be activated independently, and this can't happen until you're in the air and the low-speed deployment enabling logic has been triggered. This may or may not meet the NAR/TRA L3 switch requirement (we're working on getting a ruling…) but regardless it's a nice safety feature because it virtually guarantees that you cannot have a deployment charge fire on the ground.

In the event that you do decide to add a switch, you have a few options, since the Quantum can use a separate power supply for the deployment devices.

If you are using a single battery for both the computer and the deployment side and you need to use a deployment disconnect switch, you can simply put a switch between the B+ and DB+ pads instead of a jumper. Turn on the switch when you're on the pad to power up the igniters, confirm that everything is OK, then arm your Quantum and go.

If you are using a separate battery for the deployment side, you can put the switch in series with the deployment power that goes on the DB+ pad. This is our recommended configuration for Level 3 rockets because having the separate deployment battery 100% prevents any kind of deployment glitch from affecting the flight computer side. Doing it this way allows you to make whatever changes you may need to make (for example, lowering the Main deployment altitude if the wind picks up a bit) while leaving the deployment side powered off.

Whatever switch you use, make sure that it can handle the expected G forces that you expect the rocket to experience during flight. In general, we recommend that if you use a slide switch that it is mounted so that it slides sideways, not up and down. This will prevent G forces from possibly causing the switch to "bounce", interrupting the power to the Quantum, which is not a good thing. Any slide switch that you use must be rated to at least twice the G forces that you are likely to see… a $1 Radio Shack special isn't going to cut it, spend a few bucks and get a high-quality switch.

You can also use a "push-on, push-off" type switch. Many users have had good success with them, also mounted laterally. You can put the switch just behind one of the air ports, and actuate it by pushing a small pin/wire through the hole. Just like with slide switches, spend the money to get a good quality switch.

A better option would be a more positive switch, such as a rotary switch or a screw-type switch that locks down positively. Since the major forces on rockets are almost entirely along the longitudinal axis of the rocket, the contacts on a rotary switch are unlikely to be interrupted by G forces. A good choice is the Schurter 033.4501 rotary switch, they cost about $5. This is a special-purpose rotary switch originally designed to be a 120v/220v power supply selector switch, but it works very well for our purposes. You can get them from a number of online

rocketry suppliers, or you can order one directly from Allied Electronics, a direct distributor for Schurter products. They're actually about a buck cheaper from Allied, but you'll have to pay shipping, so chances are pretty good that you're gonna come out ahead if you buy it from one of the rocketry suppliers because you're probably buying a bunch of stuff from them anyway.

Featherweight Rocketry and Missile Works also make good small screw-type switches, they use a screw to positively lock down the contacts and completely eliminate any possibility of the switch being jarred open. You can also make your own screw switch, Google around and you can probably find some good examples.

Finally, if you want to avoid moving contacts altogether, check out our Eggtimer WiFi Switch (www.EggtimerRocketry.com/page55.php) You can turn it on or off using your mobile device too, independently of your Quantum. It's about the same size and weight as the Quantum, so it may be a bit larger than other switch options but the convenience of not having to fumble around looking for the switch inside the AV bay more than makes up for the minor weight and size penalty, and you can safely arm your deployment electronics from up to 200' away from your rocket. And yes, the WiFi Switch will not interfere with the WiFi signal from your Quantum.

Quantum Battery Options

For most installations, we recommend using a 2S 7.4V LiPo battery. You'll need one that's at least 300 mAH, since the Quantum draws 85 mA (it's WiFi… that's the nature of the beast). You CAN get away with smaller batteries, IF (and ONLY IF) you connect the fully-charged battery up right before flying. We've used batteries as small as 180 mAH in testing, but we have several fully-charged batteries on-hand and we change them with a fresh one after each flight. With a larger battery, you can take your time… an 800 mAH 2S LiPo is about the same size and weight as a 9V alkaline battery, and will last all day. That's what we use for all but the skinniest of rockets. For smaller diameter rockets, we like the skinny packs used for Airsoft guns… they're about 100m x 18mm x 12mm, so it's easy to fit them on the back of the sled, and they have a lot of capacity… over 1000 mAH.

While we're on the subject of 9V alkaline batteries, DO NOT, repeat, DO NOT use a 9V battery to power the Quantum. At all. They don't source much current, especially compared to a 2S LiPo. While it will appear to work fine once it's new, it will quickly drain, and you will find that the range starts to rapidly decrease, and the Quantum will appear to become unresponsive. If you're using the single-battery option, the chance of a low-voltage "brownout" is much higher that it would be with a 2S LiPo. WiFi takes a lot of power, so make sure you feed it well.

In addition, if you are using a single battery we recommend that the current-sourcing capacity of the battery should be at least 5x the all-fire current of the igniter, to prevent any chance of the voltage dipping. To get that number, multiply the capacity in mAH by the "C" number of the battery. For example, a 300 mAH battery rated at 20C will easily put out 6,000 mA, or 6A. If you igniter is rated for 750 mA all-fire, 5 x 750 = 3750 mA, so that 300 mAH/20C battery would be just fine.

If you're using a separate battery for the deployment side, whatever battery will fire your igniter or operate your other deployment device (hot wire, servo, etc.) is fine. Note that the drivers require a minimum of 5V, so you can NOT use a 1S/3.7V LiPo to power the deployments. You

can use a 9V alkaline battery for the deployment power if that's what you like, just be aware that they're pretty big and heavy by contemporary standards. If you do use a 9V battery, one more thing you need to be careful about is that some brands of 9V batteries simply have cells pressed together in a metal case, so high G forces can cause the battery to fail. If you absolutely HAVE to use a 9V battery, we recommend Duracell 9V batteries, because they use welded cells internally and are less likely to come apart than some other brands. If you do decide to use an alkaline 9V battery, we recommend that you replace it after EVERY flight. Yes, that can get expensive. And yes, you don't have to worry about your battery having been drained too much by a previous flight… enough said.

Regardless of what kind of batteries you choose, **charge or swap out your batteries before every session, and check the voltage with a digital voltmeter before every flight**. The voltage check on the Quantum is only on the processor battery, it does not test the deployment battery (assuming it's separate). You don't want to spend all the time to find the "perfect" battery combination for your 54mm minimum-diameter mach-buster only to realize after you dig it out of the ground after lawn-staking it that you forgot to charge the battery.

Unlike deployment controllers that use FET's on the output, the special automotive drivers in the Quantum provide current-limiting to the output igniters, generally around 10A. Especially with a LiPo, this helps prevent dead-shorts from damaging the battery and/or the output drivers. The drivers in the Quantum are also short-circuit and over-temperature protected… if there's a short, the driver will automatically shut off the load to protect the drivers. We've intentionally dead-shorted the Quantum's outputs in testing, with no harm to the Quantum at all.

The drivers also provide under-voltage protection, so in the event of a dead-short that causes the battery voltage to drop the driver will shut off so your battery voltage won't go so low that the Quantum resets. That's why the Quantum doesn't have a large "battery glitch" capacitor… it doesn't need one.

If you're using an ematch, you only need to set the deployment on-time to ONE second… if they don't fire in a few dozen milliseconds they probably won't fire at all. If you're using a hot-wire (for example, to cut a cable tie or nylon fishing line) you'll need to experiment with the on-time. You're going to want to do this on the ground, of course… flight-time is NOT for experimenting with your deployment parameters!

Using your Quantum

IMPORTANT NOTE: You MUST have deployment power to the Quantum BEFORE you power it on. **IF YOU DO NOT HAVE DEPLOYMENT POWER, YOUR QUANTUM WILL NOT BOOT!** If you are using a single battery, you must jumper the B+ and DP+ pads. If you are using a separate battery for deployments (on the DP+ and DP- pads), connect that battery before you connect the primary battery on the Quantum.

What sets the Quantum apart from other hobby rocketry flight computers is that it doesn't use any switches, jumpers, or cables to configure or download flight data. It's all done over a WiFi connection to your handheld device, using a common Internet browser. The pages have been written very simply so that they do not require Java, Javascript, .NET, or any other scripting language to operate… they're all just simple HTML 1.1. The pages are simple text with minimal formatting, and while they may not be particularly pretty they are very easy to read, and they render virtually the same on every browser and platform we've tested.

About Browsers and OS's…

All of the Quantum's functions will work almost identically with just about any browser that you use. Because of the differences in the way that browsers display things and handle downloaded files, however, you may find that one browser works better than another with your particular platform. Interestingly enough, some browsers are much faster than others… generally the ones that are provided by the vendor. Go figure…

In general, our recommendations are as follows, in order of preference:

Apple iOS: Safari, Firefox
Android: Firefox, Safari (yes, it's an old version…), Chrome
Windows: Internet Explorer, Edge, Firefox, Safari, Chrome

Note that Chrome comes out last on all of these lists. The reason is that Chrome does not handle the flight detail download function very well. In particular on an Android it can't tell what to do with the .CSV file that's generated from the flight detail download, so it either hangs for awhile or comes right back and does nothing. It's a shame, because we really like Chrome, but for this application it doesn't work very well. If you have an Android, use Firefox instead, it will display the .CSV file and launch your viewer if you have one installed.

Additional notes regarding browser compatibility and issues are in Appendix D.

Connecting to Your Quantum

Each Quantum has its own WiFi SSID network name, which is going to looks something like

Quantum_1a2b3c

The last 5 or 6 characters are derived from the unique MAC address of the Quantum's WiFi module, so they're pretty much unique. The Quantum uses the WPA2-PSK WiFi connection

protocol, so you need to enter an 8-digit passkey to connect. The passkey for your Quantum is on a label on the WiFi module that you got when you built it. It's also on a label on the package. If you accidentally lose it, you can also get it by connecting an Eggtimer USB-TTL data cable to the programming header. See the Appendix for instructions on how to do this. We recommend that you put a label on top of the WiFi module with the passkey… you'll be glad you did at some point.

To connect to your Quantum, hook up the battery and wait about 10 seconds for it to initialize. You'll hear some beeping as it goes through its self-test, and at the end of the long 3-second beep it should be discoverable over WiFi. Go to the WiFi Settings on your handheld device, and browse the wireless networks. You should see your Quantum listed as something like "Quantum_1a2b3c". Choose that network, and enter the passkey when prompted. Hint: When asked, be sure to check "save the password" and/or "connect automatically when in range". This will keep you from having to do this every time. Note that if you have multiple Quantum's you might NOT want to save the passkey… keep it handy by using a memo pad app on your device.

Open up your browser. If your home page is something on the Internet, you're gonna get a "Page can not be displayed" message because you're connected to your Quantum, not the Internet. That's OK and normal. Set your browser to the Quantum's home page:

192.168.4.1

 and you should see the Status Page. At this point, you should Bookmark this page so you don't have to re-enter the address every time… you're going to be going here a lot.

The Status Page

The first thing you will see is the Status Page. It tells you what your Quantum is doing, and gives you some other important information:

◦ Device Name (important if you have more than one of them in your rocket!)
◦ Flight Status: Armed or Disarmed
◦ Deployment channel status, settings, and link to change the settings (see below)
◦ Computer-side battery voltage
◦ Above-Sea-Level (ASL) altitude
◦ Temperature (it may read low for awhile… it takes 10-15 minutes to stabilize)

For arming:

◦ The current validation code (it changes every 60 seconds that you're idle)
◦ A text box to enter the validation code into for arming
◦ An "ARM" button for arming (once you type in the validation code)

Links:

◦ Deployment channel "Change" links – for changing deployment channel in-flight settings
◦ Settings – takes you to the Global Settings page
◦ Flights – takes you to the Flight Select page, for displaying saved flight info
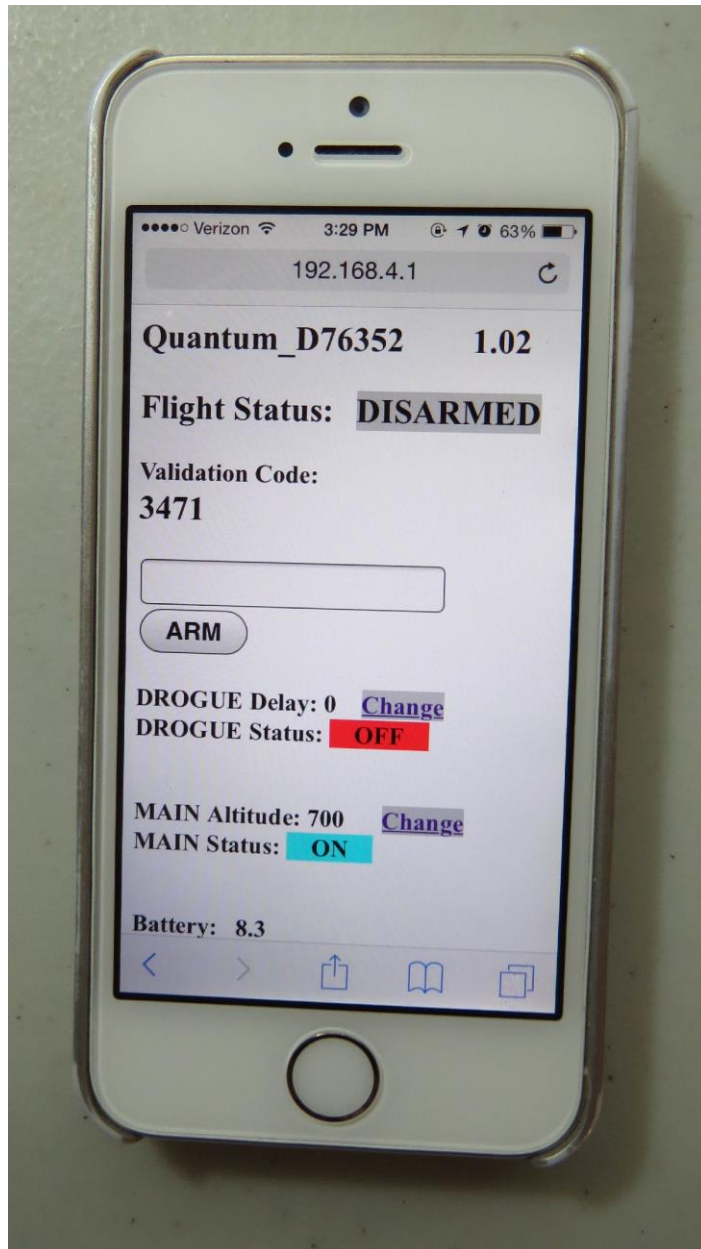
Depending on what you have hooked up to the deployment channels and how it's powered, you may see the deployment channel status displayed in different colors. The colors are:

◦ Silver – Status does not affect arming (channel turned off, for example)
◦ Aqua - Good deployment status, i.e. channel is enabled and you have continuity
◦ Red – No continuity on enabled channel, arming not possible

The Quantum updates the deployment status every time that the page refreshes. If you leave the page alone, it will refresh every 60 seconds. When it refreshes, you'll hear a little beep from the

speaker... this also lets you know that you've got power and are connected to your Quantum. In addition, every time the page refreshes a new validation code is created.   You can force a page refresh by hitting the refresh icon on your browser, or by clicking on the ARM button without entering a validation code or entering an invalid validation code.

Arming Your Quantum

In order to start a flight, you need to arm the Quantum. For safety reasons, the Quantum will not self-arm; that is, you must go to the Status page and arm it for the flight sequence to begin.   This is different than most other flight computers, which will go into an arming sequence a short time after powering up, assuming that the continuity is OK. The Quantum is a little bit different because it's assumed that you're not using a power switch so you are basically using the arming sequence as a remote switch.   This is the reason why we have the dual-ended switching architecture; it ensures that your igniter is essentially "dead" until the Quantum has been armed AND you have a flight in progress.

Before you can arm the Quantum, any enabled deployment channels must be in a flyable status. This means that if a channel is enabled there must be continuity; if a channel fails the continuity test then you will not be able to arm your Quantum. You can tell very easily from the Status page if it's ready to fly, because either or both of the failed channels with have the continuity status highlighted in RED. Note that this applies to both igniters and servos; see the Appendix for a discussion of how to connect servos properly so they will pass a continuity test.

To arm the Quantum, enter the 4-digit validation code into the text box then click on the ARM button. After about 5-10 seconds you should see an arming confirmation page:
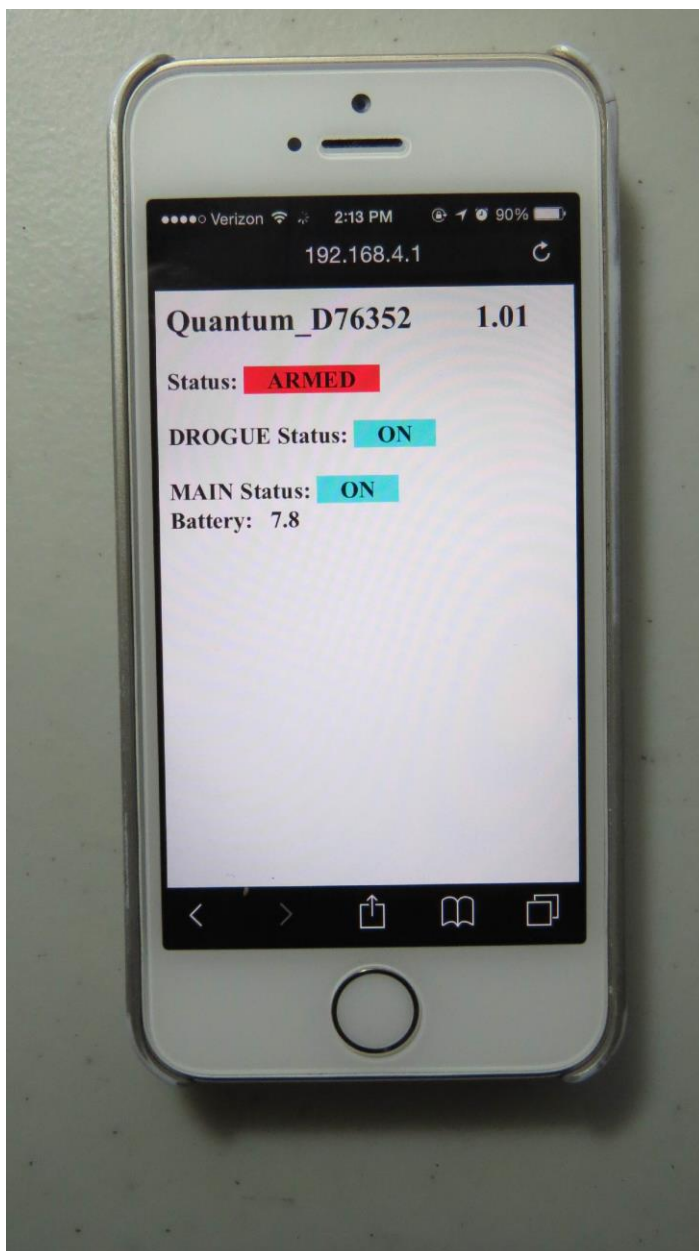
This page looks a lot like the status page, but the status is changed to "ARMED", it doesn't initially have the validation code/box, and only the channel continuity status and the battery voltage are displayed. A few seconds later you should start hearing the buzzer make a rapid "chirping" sound… kind of like a high-pitched warble. This is an audible confirmation that the Quantum is now in flight sequence mode, and you're ready for launch.

At this point you should CLOSE THE BROWSER window on your handheld.

IMPORTANT:

NEVER "SWIPE" YOUR QUANTUM PAGES TO "CLOSE" THEM… YOUR DEVICE LEAVES THEM OPEN.   GO TO THE "x" AND ACTUALLY CLOSE THE PAGE. SIMILARLY, DO NOT REFRESH A PAGE USING THE BROWSER'S REFRESH BUTTON, IT WILL RESUBMIT THE PAGE AND IT IS POSSIBLE FOR UNINTENDED CONSEQUENCES TO OCCUR.

Until the flight actually starts, the Quantum will be listening for activity from your handheld. If you refresh this page or re-connect you will see the same page, but with a validation code, text box, and "DISARM" button, as shown below:
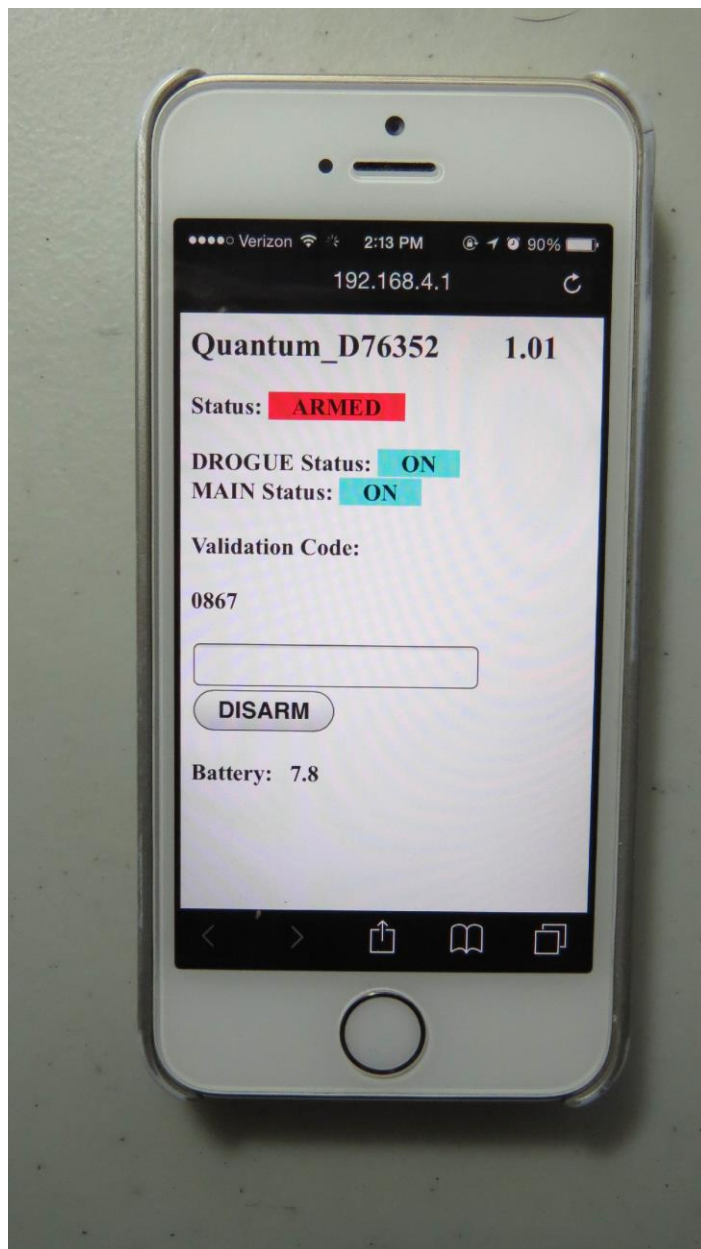
This allows you to end the flight sequence in case you have an issue, i.e. you burn an igniter and the rocket doesn't launch. In that case, you'd perform a disarm prior to inserting a new igniter, then re-arm it afterwards. Note that refreshing this page will halt the flight sequence for about 5 seconds while it performs processing and updates the statuses, which is why you should close the browser on your handheld after arming. Closing the browser window after arming helps to prevent potential interruptions to the flight sequence. Note that if you refresh the Disarm page without entering a validation code it will force a deployment status and battery check; this is OK if you intentionally want to do this, but remember that it also halts the flight sequence for about 5 seconds, so don't do it right before launching, and close the browser when you're done.

See the section titled "Flying With Your Quantum" for a further discussion of flight events.

Auto-Arming

The Quantum was designed so that by default it won't arm automatically when you power it up, however there may be some cases in which you DO want to have it arm after powering it on. For example, you may have multiple electronic devices in your rocket, and you want to simplify the pre-launch procedure by having all of them arm by powering on switches.   To accommodate this, the Quantum can optionally auto-arm. To turn this feature on or off, simply go into the Settings page and select the desired value of the Auto-Arm parameter.   "ON" will cause the Quantum to auto-arm after power-on, "OFF" will return it to the default remote-arming behavior.

When Auto-Arm is enabled, you will hear a short "blip" beep from the buzzer every 5 seconds, lasting for 60 seconds.   This is your "getting ready" notification.   After the 60 seconds is up, the Quantum will go into the normal arming sequence, i.e if all enabled outputs pass the continuity check you'll hear the "Ready to Fly" chirping, if it's not ready then you'll get a continuous beep that lets you know in no uncertain terms that you should not fly.

At any time during the 60 second waiting period, or if you get the "not ready" tone, you can override the sequence by simply connecting to the WiFi page.   That will give you the normal Status Page, and will allow you to change any flight parameters, or to see what may have been preventing it from arming.   Afterwards, you can either arm manually, or you can power-cycle your Quantum and it will begin the auto-arming cycle again.
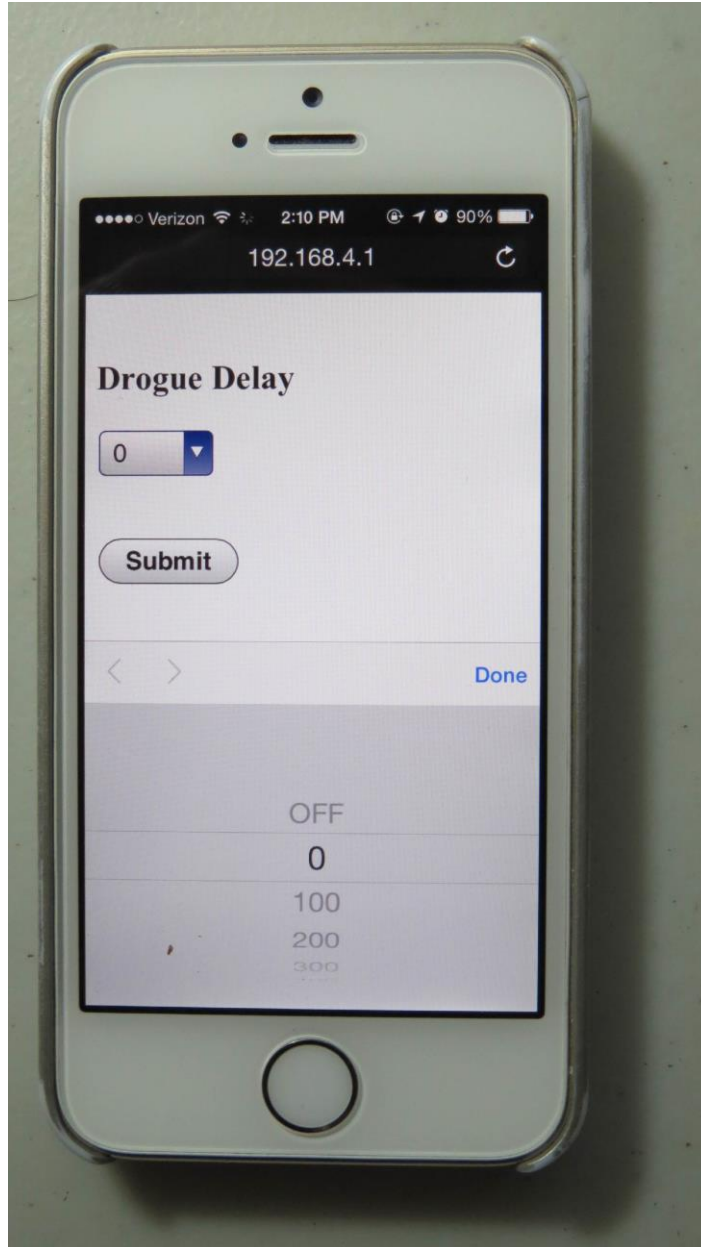
The Deployment Flight Settings Pages

Each of the two deployment channels has a specific purpose:

◦ Drogue – Deploys a recovery device near the apogee of flight

◦ Main – Deploys a recovery device at a specified altitude during descent
       OR
       Deploys a recovery device if the FailSafe conditions are met

Drogue Settings

The Drogue Settings page is accessed by clicking on the "Change" link next to the Drogue status on the Status page. When you click on the link, you'll see this page:

The purpose of this page is to set the delay from nose-over for firing the drogue, or to turn it off completely. For most dual-deployment flights, you'll probably want the drogue to fire as close to apogee as possible, in the Quantum this would be approximately one second after apogee. That's what we call "nose-over", since it's pretty much guaranteed that your rocket is pointing downward. There's also a low-velocity check, your rocket has to be going relatively slowly before the deployment channels are enabled.   For most flights that will be a second or two before apogee.

In general, if you're using dual-deployment then you should set this to ZERO.   If you aren't using the drogue channel (for example, you're using motor-deploy for the drogue) then set it to OFF. The other settings are designed for delaying the drogue using the Quantum as a backup deployment controller in a dual-controller redundant setup, or for special-purpose uses (i.e. the 5-second setting is designed for ejecting ARLISS CanSats).   Typically, the backup controller will have the drogue setting delayed slightly from the primary controller, so that if the primary controller fails the backup will fire and deploy the drogue. You should model your flight with a program such as OpenRocket or Rocsim in order to determine the best delay setting, you want to make sure that the rocket won't be going too fast before the backup controller deploys the drogue. Typically, 1.0 to 1.5 seconds is adequate.

To change this setting, click on the drop-down list and scroll to the setting that you wish to set. Depending on your browser/OS, you will either click on it or click a "Done" button to select it. Click on the Submit button to save it, and you will be returned to the Status page.

Main Settings

This page allows you to set the descent altitude at which the Main chute deploys, or to turn it off if you're not going to be using it. You can set it from 100' to 500' in 50' increments, and 600' to 3,000' in 100' increments. You can also set it to deploy at Nose-Over, just like the Drogue with a delay of zero seconds. This is for the ARLISS folks… you set the Main to fire at Nose-Over, and the Drogue to fire at Nose-Over + 5.0 seconds, deploying your CanSats. If you don't know what that's about, check it out at arliss.org … it's very cool stuff.

The Main altitude that you use depends on a lot of things: the size and layout of your flying field, how much wind is present, how many trees there are around you, the size of your rocket, and not the least, how far you're willing to walk to retrieve your rocket. 500' is the default setting when you first power up your Quantum, it's adequate for probably 80% of all flights. If you field is smaller, you're going to want to take that down a bit, so your rocket doesn't drift as far when the Main is deployed. If you have a big project, you may want to turn that up a bit, since you may not want a larger rocket deploying that close to the ground. If you're not sure what setting to use, ask your buddies at the field… it's guaranteed that they will have an opinion on the subject!

To change this setting, click on the drop-down list and scroll to the setting that you wish to set. Depending on your browser/OS, you will either click on it or click a "Done" button to select it. Click on the Submit button to save it, and you will be returned to the Status page. An example of the page is shown below.
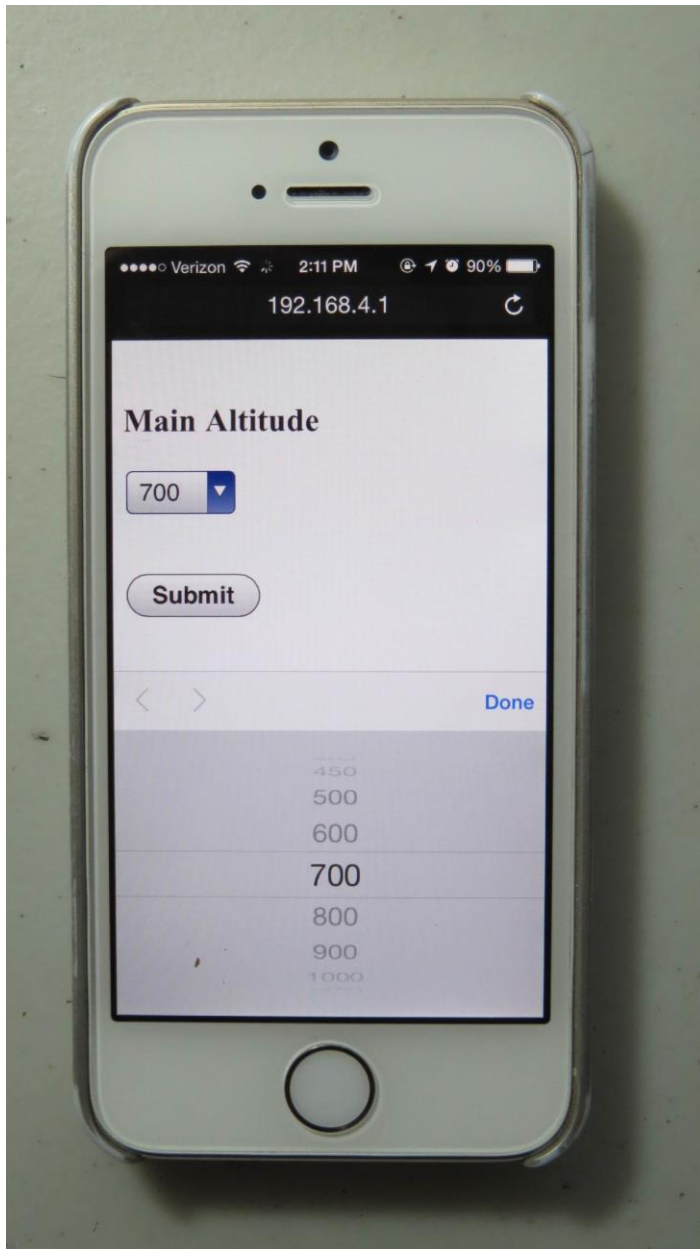
The Global Settings Page

The Global Settings page is used to change settings that are either hardware-specific or are not generally changed from flight to flight. You get into this page by clicking on the "Settings" link on the Status Page:

Launch Detect Altitude (LDA)

  Range: 50'-500' by 50' (default 200')

This setting allows you to select at what altitude the Quantum decides that a valid flight has started.   The 200' default is good for most flights. However, there may be some cases in which you may want to turn it up, and some very special cases in which you may want to turn it down.

If your flying site is subject to wind gusts, you may want to turn it up a bit so that when the wind gust subsides the decrease in pressure isn't viewed as the rocket ascending. That's not likely to happen, however, because we filter the readings to prevent this (and other similar occurrances). You may also want to turn it up if you increase the Launch Samples per Second.

If you have a very low flight you may want to turn it down, although generally we don't recommend it.

Launch Samples per Second

Range: 10,15, 20, 25, 30, 33 samples/sec. (default 20 samples/sec.)

This setting allows you to select the number of samples per second that are taken from the time that you arm the Quantum until it detects nose-over. The default setting (20 samples per second) is adequate for most flights. However, there may be reasons why you want to turn it up or down. For example, if you have a very short-burn motor (like a CTI V-Max) you may want to turn it up to 33 samples per second to make the velocity and acceleration figures more accurate. If you have a very long-burn motor you may want to turn it down to 15 samples per second, although 20 should be fine.   Note that increasing the sample rate decreases the amount of memory… more on that later.

Descent Samples per Second

Range: 1, 2, 4, 5, 8, 10 samples/sec. (default 2 samples/sec.)

The setting allows you to select the number of samples per second that are taken after nose-over is detected. When you're coming down, you're generally not going to be going very fast relative to your velocity going up, even if you freefall for a few seconds and the FailSafe kicks in. Consequently, there's really no reason to have the same high rate of sampling that you use for the ascent part of the flight. Reducing the sampling rate after nose-over saves a lot of memory, and allows you to record longer flights. For most flights, the default 2 samples/sec. rate is fine.

About Sampling Rates and Memory Usage

At this point you may be wondering about how long a flight the Quantum can record before running out of memory, and what happens if that occurs. The Quantum saves about 2,000 samples for each flight. When you're sitting on the pad or launched and have not yet reached LDA, the sampling rotates through those memory locations, saving the last reading < 3' AGL as the "start of flight". Once you hit LDA, the recording continues until either 1) the End of Flight benchmark (your rocket hasn't moved for at least 5 seconds) is reached, or 2) the memory wraps around to the start of flight location. In either case, recording stops there (it won't overwrite valid ascent data), but this does NOT affect any pending deployment events… if you run out of memory before the main chute is deployed, it will still be deployed, but you won't see it in the data downloads because it can't be recorded.

Now, you may be wondering how long a flight you can have with "only" 2,000 memory locations. Quite a long one, actually. Let's say that you want to fly to 30,000' and your motor will get you there in 30 seconds. At 20 samples per second, that's 600 samples. That leaves about 1,400 samples left for the "down" part of the flight. At 2 samples per second, that's 700 seconds, or over 11 minutes. You'd have to be coming down at a rate of about 40 ft/sec under drogue to exhaust the memory, there's no way you're gonna be coming down that slow from 30,000' (unless you really like walking a lot). More likely, it's going to be 50-70 feet/sec. Let's say that we come down at 60 ft/sec from 30,000', that's about 500 seconds, or 1,000 memory

locations at 2 samples/sec. You'd still have over 400 samples left when you land, nearly 20% of your memory.

If you have an extreme flight, say 50,000', it may take a bit longer to get up there, let's say 45 seconds. That's 900 samples, leaving 1100. If you take the rate down to 1 sample per second (reasonable since the events are happening relatively slowly and the air is pretty thin at 50K), you still have 1100 seconds, or over 18 minutes. No way it's gonna take that long to come down, unless for some reason the main comes out near apogee. At a conservative 50 ft/sec average speed under drogue, it's going to take 1,000 seconds, leaving you with at least 100 samples. Remember that at that altitude the air is very thin, so you're going to be coming down faster near apogee than you will be when the air thickens as you descend. It's very likely that you're going to be using a lot less memory than that.

So, as you see, there's plenty of memory for just about any flight scenario if you manage it wisely. For just about any flight under 30,000', just leave it at 20 samples per second for the Launch rate and 2 samples per second for the Descent rate, and you'll be fine.

Drogue Mode

Mode: Igniter or Servo
Igniter On-Time: 0.1-3.0 secs by 0.1 secs, 3-9 secs by 1 sec.
Servo Skew: See discussion below

You can change the Drogue so that it turns on for a specified amount of time when triggered (as it would be with an igniter) or so that it's pulse-width modulated (for hobby servo use). For Igniter mode, you can change the on-time from 1 to 30 seconds.   For Servo mode, you can select any of 8 different rotation and skew (amount of rotation) modes.

When you're using igniter mode, you only need to set the on-time and you're good. For most ematches, 1 second is fine… they typically fire in a few dozen milliseconds. The longer times are appropriate for hot-wire deployments or other special purposes… you'll probably know if you need to use them. Note that all deployments are disabled on landing detection.

About Servo Mode

Servo mode assumes that the servo is going rotate to the selected position relative to the zero-degree center position when actuated, and it's going to rotate in the opposite position by the same amount when reset. Typically, you're going to use some kind of trap-door or pull-pin mechanism, and there needs to be some way to close the door or reset the pin before you fly. That's done with the Test Menu… more on that in the Appendixes.

The servo pulses are sent for 2 seconds, which is plenty fast enough for any servo. Once the two seconds are up, no more servo pulses are sent, so the servo basically stays where it is, at the end of its selected travel.

Direction/Skews are in relation to the center point of the servo's travel. Ideally, a servo would have 180 degrees of travel, so full counter-clockwise (CCW) would go 90 degrees to the left, and full clockwise (CW) would go 90 degrees to the right. The reality is that many servos do not

have 180 degrees of travel, so we label them by percent of travel which is ALWAYS related directly to the standard pulse-width of the servos.

This label is the "Set" direction of the servo, i.e. the direction/skew that it will rotate when triggered during deployment. The opposite direction/skew is the "Reset" direction, that's what you will normally use in the Test Menu.

Values are:
> 100% counter clockwise (CCW)
> 75% CCW
> 50% CCW
> 25% CCW
> 25% (CW)
> 50% CW
> 75% CW
> 100% CW

Important Note: If you change a channel from Igniter to Servo mode (or back), the servo direction/skew or igniter on-time settings will NOT be changed. These settings are dependent on the mode that you choose. You **MUST** click on the Submit button to change the mode, **THEN** you need to go back into the Settings menu and select the proper on-time or direction/skew. This is because web pages are written when the page is first loaded, so any change you make to that page that's dependent on another setting requires the page to be reloaded.

Main Mode

> **Mode: Igniter or Servo**
> **Igniter On-Time: 0.1-3.0 secs by 0.1 sec, 3-9 secs by 1 sec.**
> **Servo Skew: See previous discussion**

You can change the Main so that it turns on for a specified amount of time when triggered (as it would be with an igniter) or so that it's pulse-width modulated (for hobby servo use). For Igniter mode, you can change the on-time from 1 to 9 seconds. For Servo mode, you can select any of 8 different rotation and skew (amount of rotation) modes.

The operation is identical to the Drogue Mode, except of course it applies to the Main channel. Also like the Drogue channel, the Main channel is shut off at landing detection. If you select a very low Main altitude (say, 100') and a very long Main on-time (say, 9 secs.), it may be shut off before that on-time threshold is reached. There's no point triggering the chute if you're already on the ground…

The FailSafe Option

Almost everyone who's had enough electronic-deployment flights has had a flight end badly because of a drogue deployment failure. Some common failures are:

- Motor eject charge fires late, or doesn't fire at all
- Drogue gets stuck in the body tube
- Shorted or bad ematch doesn't fire
- Just plain bad luck or you're cursed by the rocket gods

All of these have the same effect… your rocket starts free-falling from apogee and ends up picking up a lot of speed. Sometimes your Main chute will fire at the preset altitude, but this can be a double-edged sword: the high-speed chute deployment can tear up the chute, possibly zipper the body tube as the force of the deploying chute jerks against the shock cord, or it can tear the shock cord right out of the mount if it's glued in. All of these result in damage to your rocket, ranging from serious to catastrophic.

FailSafe helps prevent this from happening by firing the Main chute if you exceed a specified velocity for a specified amount of time. For example, if you expect your drogue chute to slow the rocket to 50 ft/sec you might set FailSafe to detect a fall of 100 ft/sec for over one second. In the event that your Drogue fails, the Main will fire at some point much closer to apogee, at a velocity that is much less likely to cause catastrophic damage to your rocket. Yes, your rocket is going to drift a lot more than it would with a successful dual-deploy, and it may even sustain some damage, but at least you'll get it back to figure out what happened, instead of having to get out the shovel and dig it out of the dirt, or spend an hour looking for the parts that scattered about when the Main deployed at 400 ft/sec. at 500' AGL.

Velocity settings are: OFF, 50,75,100,125,150,175, & 200 ft/sec.

Time threshold settings are: 500, 750, 1000,1250, 1500,1750, 2000,2250, 2500, 2750, & 3000 ms.

We recommend 100 ft/sec for 1000 ms (one second) as a good starting point. Most rockets will hit this threshold 4-5 seconds after apogee, unless it's a very light rocket. If you're flying drogueless you can expect the rocket to fall somewhat faster, so you may want to turn up the velocity threshold a bit, because you don't want FailSafe to fire the Main if you're intentionally coming down "hot".   You can estimate how fast a drogueless rocket is going to fall by using RocSim or OpenRocket and simulating a drogue chute with the same area as the cross-sectional area of the rocket. In fact, we recommend that you sim ALL HPR flights… it's easy and fun too.

The Flights Page

Clicking on the Flights link takes you to a page that allows you to select a flight for flight milestone display, and download a detailed .csv file that you can use with Excel or other data analysis programs to extract graphs and do other fun things. We'll go into that a bit later…

Flying with Your Quantum

The Quantum is very simple to operate. In general, a dual-deployment flight with the Quantum will look something like this:

At your Work Table

• Charge or swap out your battery/batteries and check it with a DVM to check the voltage
    DON'T SKIP THIS STEP!
• Install the battery(s) with the power switch OFF (if used), then secure everything in the AV bay
• Check the jumpers to make sure they're set the way you want them to be
• Close up the AV bay
• Install your igniters with the deployment power switch off (if used), with NO powder
· Turn on your deployment power switch (if used)
• Connect to the Quantum and confirm that you have continuity. If you don't, open up your AV bay and figure out why.
· Turn off the deployment power switch (if used)
• Add powder to the charge wells, and finish prepping your rocket

At the RSO Table

• Get your rocket safety-checked, get your pad assignment, and swagger out to the pad. Note that your Quantum will beep once every 60 seconds that it's powered on, as the web page refreshes. You may need to show your RSO the Status Page on your phone to show him that it's disarmed if he's not familiar with the Quantum, since most Altimeters only beep when they're armed.

At the Pad

Put the rocket up on the rail/rod, then go to the Quantum's status page. If you're using a deployment power switch, turn it on. Make sure that you have continuity on whatever channels you're using… if you do not, it's going to be easy to tell because the status will be highlighted in RED.   If it's OK, it will be either AQUA or GRAY. Assuming it's OK, enter the validation code into the box and click on the SUBMIT box, after a second or two you should see the armed page. Once that happens, CLOSE THE WEB PAGE. Closing the page prevents any data from interfering with the flight sequence.

After a few seconds, you'll hear a few beeps, then after about 10 seconds of silence (as it takes baseline measurements) you'll hear the "I'm ready" beeping. Connect your igniter, test the continuity, then go back to the safety zone to await your flight.

If you're new to dual-deployments, you can see that it's a lot more involved than just stuffing some wadding and the parachute into the tube, popping in the motor, and hooking up the igniter. Multiple deployments require discipline in order to make them work reliably; we've seen way more than our share of failed deployments, on everything from a small mid-power E-size rocket all the way up to an M-sized 200 pound beast. We've seen deployments fail with the top-end flight computers and with the low-cost units, even with redundancy. The reality is that most deployment failures are not the fault of the electronics; it's usually something mechanical like a bad connection, a nose cone

that's too tight, a chute that gets stuck in the tube, etc. Having your blood, sweat, and tears free-fall from 10,000' bury itself in six feet of dirt is going to ruin your whole day.

We STRONGLY recommend that you use a checklist every flight so that you don't forget anything. We also recommend that you get a copy of the book <u>Modern High Power Rocketry</u> , it's full of good information too, and subscribing to a forum like The Rocket Forum (www.rocketryforum.com) is a really good idea, too.

In the Air…

Once your rocket is launched, altitude samples are taken at whatever ascent rate you've selected, typically 20 samples per second. These samples are run through a filter to eliminate "noise" that may be caused by a number of different factors, primarily aerodynamic but also some external factors such as wind and temperature.

Velocity readings are computed based on the difference in altitude between successive samples and the elapsed time between the samples. In a perfect world, this would give you a precise and 100% accurate velocity reading. The reality is somewhat different, however. There are several things that can introduce errors into the velocity reading: angle of attack, wind, errors in the pressure readings due to aerodynamic influences, and time differences. If the pressure ports in your payload bay aren't sized properly, this can introduce an error, particularly if they're too big and you have two of them opposite each other (you'll get a crossflow through the payload bay which makes the pressure readings very noisy). Finally, differences in the processor's timing may introduce errors, although the readings are taking at relatively precise intervals so it's going to be very small.

The good news is that the magnitude of these errors tend to be proportionate to velocity as the rocket ascends, so they respond well to being filtered with mathematical noise filters. Velocity-related events are run through a digital filter to smooth out any sharp peaks or valleys that may develop due to pressure-induced noise.

Mach Transition…

As your motor continues to burn and the velocity increases, if the velocity exceeds 800 ft/sec aerodynamic shock wave buildup can fool the pressure sensor into thinking that the rocket is descending when in fact it is actually ascending at a rather rapid speed. If this were not taken into account, the flight computer might deploy the main parachute at near-mach speed, which would undoubtedly break something and ruin your day, not to mention what an object falling from the sky at these speeds could do.

To prevent this from happening, the Quantum uses a predictive mechanism to hold off deployments until it's safely out of the mach "danger zone". Deployments are initially disabled when the Quantum is armed. When the noise-filtered velocity drops below 100 ft/sec for at least 1 second after the Launch Detect Altitude has been reached, deployments are enabled. Typically, this will be a second or two before apogee, although it may be a little later in some cases (i.e. a very draggy rocket). In any case, it guarantees that your rocket isn't going very fast when the drogue deployment occurs, which is the ultimate goal. This is the same logic that we've used for several years with all Eggtimer Rocketry altimeters, and in several thousand flights we've never heard of a zipper due to an early/late deployment that wasn't due to the rocket going horizontal.

Apogee and Nose-Over

Assuming that your rocket is moving more or less straight up, it will continue to slow down during the coast phase until it gets as high as it's going to go. If the rocket was going absolutely straight up, the velocity at this point would be zero; it would simply start falling to the ground. In reality, this almost never happens, because for safety you usually angle the rod/rail at a slight angle so that the rocket takes off away from the flight line. This results in the velocity disparity that we've previously mentioned. The rocket usually has some forward velocity at apogee; hopefully it's relatively small so your parachute deployment happens at a low velocity and won't cause any mechanical problems like a broken shock cord or a zippered tube.   It also means that you really don't know that you've reached apogee until *after* you've been there.

Accordingly, the Quantum fires the drogue parachute at Nose-Over, which we define as one second past apogee (highest recorded altitude). If the rocket is still going up, chances are that its altitude is going to keep increasing before a one second interval elapses, so you're unlikely to get a false apogee detection. If the rocket hasn't gained any more altitude after one second then you must be starting on your way down, so the Quantum fires the drogue at that point, for one second.

When Nose-Over is detected, the Quantum begins using the Descent Samples value for altitude sampling. This setting is very low, typically 2 samples/sec.   As the rocket descends, when the altitude drops below the Main deployment altitude the Main channel is triggered, for one second. At this point your Main chute should pop out, to thundering applause and a hearty round of high-fives all around.

On the Ground

The Quantum detects that your rocket is on the ground when the AGL altitude is below 30 feet for over 5 seconds. Once on the ground, the Quantum will start beeping out the maximum altitude continuously for anyone within earshot to hear. The beeps work like this:

1 Beep = 1
2 Beeps = 2
…..
9 Beeps = 9
10 Beeps = 0

So, if you fly to 12, 360' you will hear:

Long Pause…
Long Beep… ("I'm going to give you're the apogee reading…")
Short Pause…

1 Beep   (10,000')

Short Pause

 2 Beeps (2 x 1000')
Short Pause

3 Beeps (3 x 100')
Short Pause

6 Beeps (6 x 10')
Short Pause

10 Beeps (zero 1' reading)

<sequence repeats>

The beeps continue until you turn off the power, and also act as a verification that you had a successful flight, but getting your rocket back in one piece pretty much told you that, didn't it?

In addition, the WiFi interface will start back up again, and will take you directly to the Flight Summary page for the flight that you just completed.   Note that it may take 10-15 seconds to bring up the Flight Summary page after you connect to the Quantum, because it sends out the page after it's done beeping out the altitude, so you have to wait until it goes quiet for a few seconds. You'll also be able to download/view the flight detail too, so if your handheld device has some kind of data analysis program then you can actually look at your flight right after it's on the ground. Pretty cool, huh?

Post-Flight Analysis

The Quantum saves your last 15 flights, both summary and detailed time/altitude data. Clicking on the 'Flights' link in the Quantum's Status page takes you to an index page that allows you to select the flight that you want to review. Note that each flight has an index number from 1-15, this is the memory location that it's in, and each flight has a Flight number that is sequential from 1 to however many flights you've had with your Quantum. If you fly it enough, you'll probably get to the point at which flights drop off, and the flight numbers won't start with 1 anymore, but the indexes will always be from 1 to 15.

Each entry in the Flight Select page shows the Flight Index, the Flight Number, the Apogee, and a 'More' link that takes you to the Flight Summary page. Note that after you land and while it's beeping out the altitude, it will take you directly to the Flight Summary page for that flight only.

The Flight Select Page

You can view the last 15 flights by selecting them from the Flight Select page, you get there by clicking on the "Flights" link from the Status Page. It shows you the Flight Index (the location in memory, 1-15, "Idx"), the Flight Number (which increments every time you start a flight, "Flt"), the Apogee of the flight ("60335" means that there was no flight), and a link to display the Flight Summary/Detail for that flight ("More").
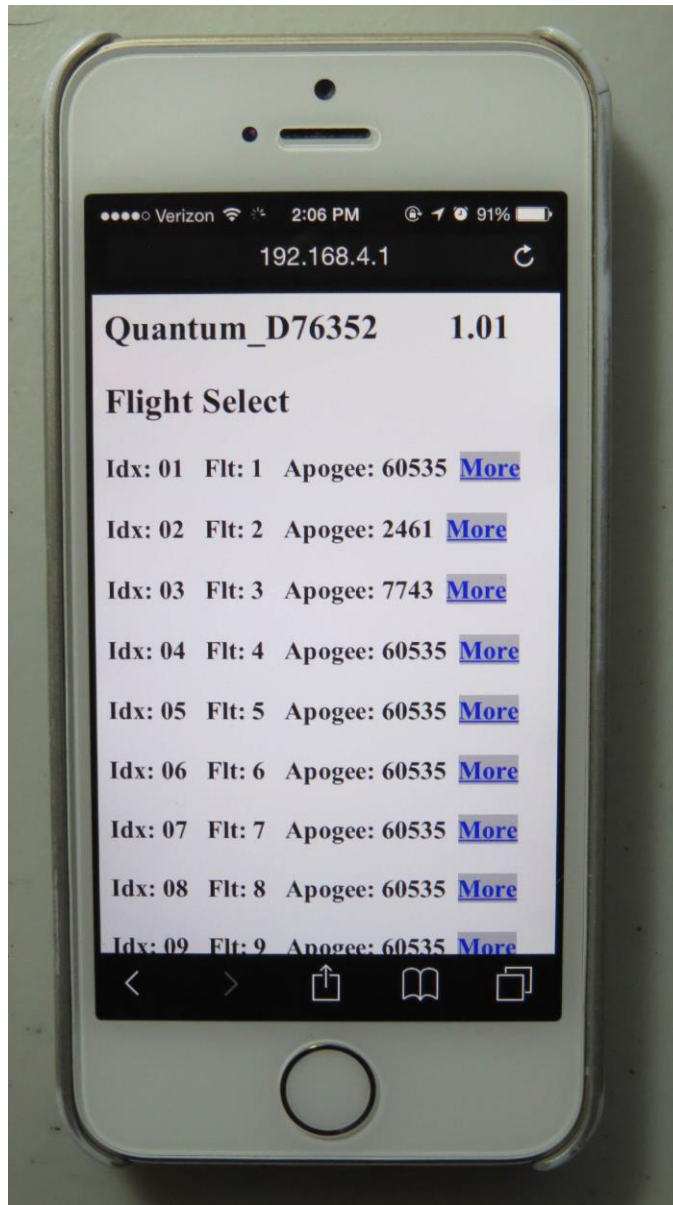
The Flight Summary Page

The Flight Summary page gives you a lot of information about what happened during your flight. You get there by clicking the Flights link from the Status Page. After you land, you can also connect to it… the Quantum will show you only the status for the current flight, plus the detail, until you power-cycle it.
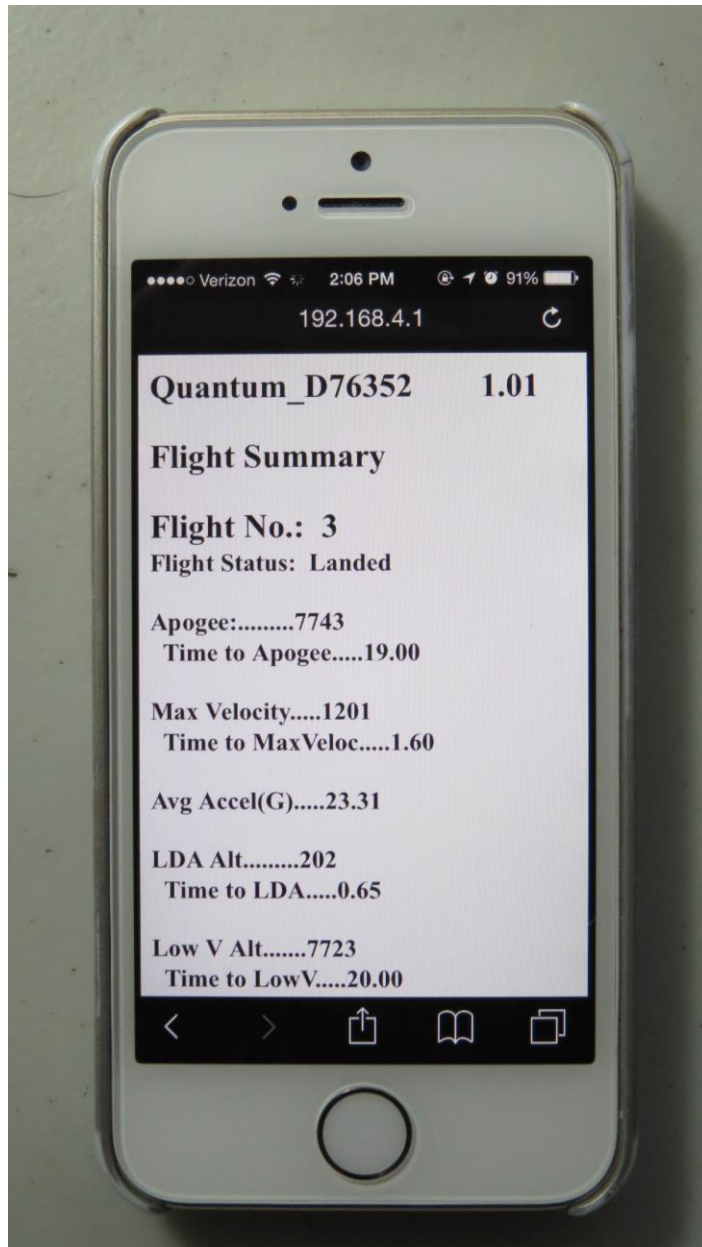
- 35 -
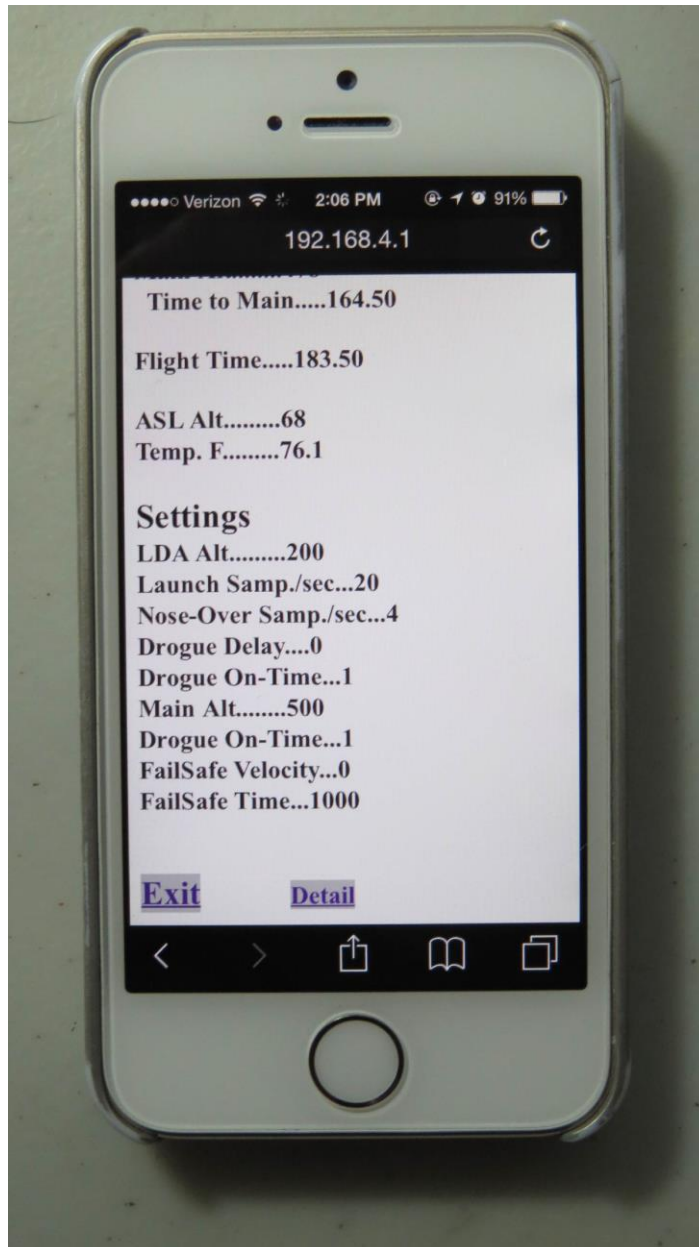
Flight Status – What the last major event was. Typically it will be "Landed", but it may be something else if there was an anomaly in your flight.

Apogee – What the apogee of your flight was, and the time-to-apogee from launch detect (LD).

(About Launch Detect: Because this is a barometric pressure altimeter, there's no definitive way to say "yeah, we just hit 5 G's so we must have launched". To detect launch, the Quantum uses the last reading below 3' AGL, after the LDA has been reached. While it's technically possible that this figure may be a little off, our experience has shown that it's only off by one or two samples at most… typically under 100 ms.)

Max Velocity – The maximum velocity that was reached, and the time from LD. Note that this figure works for "most" flights, but it may be fooled by very high-thrust or very low-thrust motors… again, that's the nature of baro-only altimeters.

Avg Acceleration in G's – The average acceleration taken at the point of Max Velocity. As with Max Velocity, it's relatively accurate for "most" but not all flights.

LDA Alt – The actual altitude that exceeded the programmed LDA setting, and the time from LD.

Low V Alt – The altitude at which deployments were enabled, i.e. the rocket slowed under 100 ft/sec for at least one second, and the time from LD.

Nose Over Alt – The altitude at which the rocket nosed over, typically one second past apogee, and the time from LD.

Drogue Alt – The altitude at which the Drogue was fired (if enabled), and the time from LD.

Main Alt – The altitude at which the Main was fired (if enabled), and the time from LD.

FailSafe Alt – The altitude at which the Main was fired in FailSafe mode, if it was enabled and reached, and the time from LD. Note that this supercedes the Main Alt.

Flight Time – The elapsed time from LD until landing detect, which is when the rocket drops below ½ of the apogee and hasn't moved more than 10' in 5 seconds.

ASL Alt – The Above-Sea-Level reading of your launch site.

Temp – The temperature in Farhenheit at the time of launch. This will be very accurate if the Quantum has been powered on for 10-15 minutes, but will tend to be on the low side if you fly shortly after powering up.

Settings – All the flight settings that were selected for this flight.

As you can see, that's a lot of stuff to look at. Particularly right after landing, it gives you a pretty good idea of what happened. For example, we did a test in which we intentionally didn't install a drogue charge and left out the motor eject, and turned on FailSafe as a test. (We don't recommend that YOU do this, though…) We expected the Main to pop 3-4 seconds after apogee, but that didn't happen, instead it came out at about 500' as if there was a drogue. When we looked at the Flight Summary data, it turns out that it never fell fast enough to trigger FailSafe… it was a light Estes rocket on an Aerotech F24, and the drag was enough to slow it down below the threshold.

We've had other flights in which we had FailSafe enabled as a safety measure, and it triggered when we though it should not have. Turns out the drogueless rocket fell faster than we expected… obviously we should have modeled it better! All of this data can tell you a lot.

Downloading the Flight Detail

In addition to the Flight Summary data, each altitude sample during flight is saved into memory, and the data can be retrieved and time/event correlated as a standard comma-separated-variable (.csv) file by clicking on the 'Detail' link at the bottom of the Flight Summary page.

A .csv file is basically just a text file, with commas separating each field. Depending on what apps you have on your device, it may do one of three things when you click on the Detail link:

1) It may display the data as if it were a text-only web page
2) It may open up some kind of application (i.e. Excel if you have a laptop)
3) It may just sit there and hang because it doesn't know what to do with it

We generally do NOT recommend that you download the data with a smartphone, it's just too danged hard to see. That being said, we HAVE done it with an iPhone after installing WPS Office (the default on an iPhone is to display it as a web page). The advantage is that you can literally get a graph of your flight within seconds after landing. The disadvantage is that the screen is too small to be really useful, even if you zoom in.

Note that it can take some time (over a minute or two in some cases) to download the detail data, because of the "on-the-fly" formatting. When you're downloading the data, the little blue LED on the WiFi module next to the antenna will blink… that's a sign that it's working.
We've had good luck with WPS Office for Android and iOS, it's free and works very well with the simple .csv data that the Quantum sends out, and it's very easy to get a flight/event graph. For a Windows laptop, we use Excel, but any data analysis program that can take a .csv file will work.

Each entry in the flight detail file looks like this, of course there's a comma between each field…

T (time) – Seconds from Launch Detect

Alt (altitude) – the RAW pressure-derived altitude value from the altimeter

Veloc (velocity) – the RAW velocity for that sample, derived from the difference in altitude between this sample and the previous sample and the time interval between them

FAlt (filtered altitude) – the FILTERED pressure-derived altitude value

FVeloc (filtered velocity) – the FILTERED velocity for that sample, derived from the difference in FILTERED altitude between this ample and the previous sample and the time interval between them

Following that data are the events. Event data is ZERO unless the sample triggers the event, in which case it's the RAW altitude data, since these events theoretically should occur at a relatively low velocity (sub-mach transition). This format causes a scatter graph of the data to show a little spike where the event occurs, which is a very easy and convenient way of viewing where the event occurred.

LDA – Non-zero at the sample when the LDA altitude is first exceeded

LowV – Non-zero at the sample when the low velocity threshold (< 100 ft/sec for 1 second) is reached

Apogee – Non-zero at the sample when apogee is reached

N-O – Non-zero at the sample when Nose-Over is reached, typically one second past apogee

Drogue – Non-zero at the sample when the Drogue is first triggered

Main – Non-zero at the sample when the Main is first triggered

Due to the many programs that can be used to view/manipulate this data, we're not going to go into what you should do to graph/view it… we recommend that you check the documentation for your data analysis program for that information.

Appendix A – Deployment Channel Testing

The Quantum has some special testing functions built in, in particular you can test the deployment channels with your battery and igniter combination to make sure that when it fires you aren't going to get any nasty surprises (such as the Quantum resetting in flight, or the igniter not firing because the battery can't source enough current).

Deployment Channel Testing

Whenever you try a new type of igniter and/or battery, you should test them together by doing a deployment channel test. This ensures that your battery and igniter combination will work during a flight… you don't want to find out that there's an issue afterwards!

Note: Do NOT perform tests with a live charge until you have become familiar with this procedure, and are at a safe distance away from the rocket! We recommend 30' to the side… the range of the Quantum's WiFi outdoors is well over 100', so you can step away from your rocket safely while performing a deployment test.

There is a special URL that is used to connect to the test page, which is not accessible from the normal pages. This has been done so that you cannot accidentally put it into test mode while your rocket is sitting on the pad or your workbench.

To get to the test page, set your browser to :

192.168.4.1/test

You will see the following page
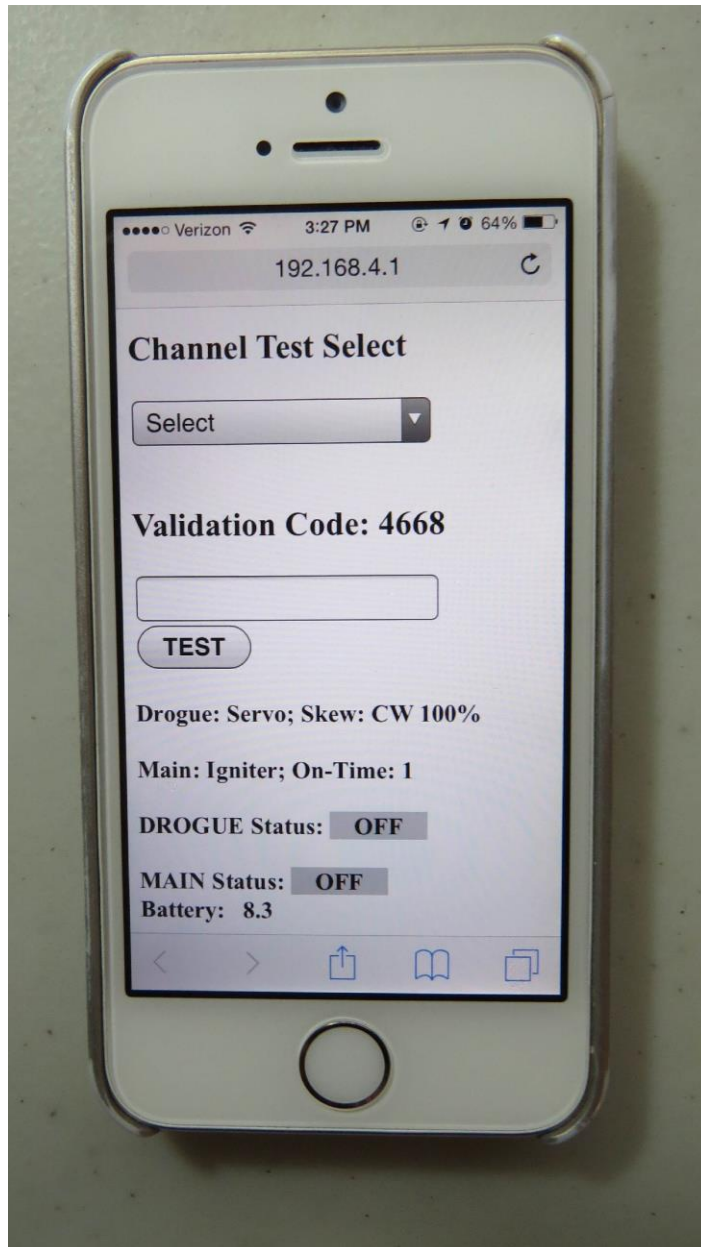
This is pretty explanatory… there's a pull-down to select the channel that you want to test, then you simply enter the 4-digit validation code and click on the TEST button. The channel settings are inherited from the Global Settings page… for example, if you have a channel set to be used in igniter mode with a 3-second firing time then that channel will fire for 3 seconds.

If you set a channel up for servo deployment, it will use the same servo direction and direction/skew that you programmed into Global Settings, but you have the option to SET the servo (rotate in the "on" direction) or RESET the servo (rotate the servo in the opposite direction). The RESET function can be used when you're at your worktable to close up the deployment bay… typically, servo deployments use some kind of trapdoor system so you'll generally need to rotate the servo in the opposite direction to close it up after you pack the parachute. You generally don't want to do this by manually moving the servo's output wheel, since that can strip the gears.

After you enter the validation code and click on the TEST button, you'll see a count down screen from 10 to zero seconds, after which time it will trigger the deployment device. When it's done, it goes back to the Deployment Test page. When you are done with your tests, CLOSE YOUR BROWSER PAGE.

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If for some reason you need to abort a test, all you need to do is to close your browser BEFORE it counts down to zero. After you close it, you should open the Status Page; re-opening the test page immediately after closing it may cause it to be resumed from that point, depending on how your browser caches pages.

Note: NEVER do a deployment test with just a piece of bare wire, you need to have some kind of resistive load such as an ematch, igniter, or small piece of fine nichrome wire (#36 or #40, for example). If you do, you may blow out the output transistors. We've designed the Quantum very conservatively, and the optoisolator/transistor combination automatically provides some current limiting to help protect the transistors and your battery. Nevertheless, it is still possible to blow up a transistor if you try hard enough.

Appendix B - Telemetry

The serial port on the Eggtimer Quantum sends out a variety of telemetry data during flight, it is easy to connect an Eggtimer Telemetry Module to the 3-pin connector and the 3V3 pin to view the data on the ground using an Eggfinder LCD receiver.

Data sent by the Quantum includes:

Altitude –   Real-time altitude, in 100' increments
Velocity - Real-time velocity
Flight Status – Flight phase (waiting, launch detected, descending, landed)
Channel Status – Status of each deployment channel (Enabled, Disabled, Fired)
Temperature – Temperature in F
Battery Voltage
Apogee – Apogee (reported after nose-over)
Maximum Velocity (reported after nose-over)
Device Name – For 70cm Ham version, sends out your FCC call sign

Instructions for connecting your Quantum to an Eggtimer Telemetry Module and using the Eggfinder LCD receiver for receiving telemetry data can be found in the Eggtimer Telemetry Module User's Guide.

Appendix C - Using Servos with the Quantum

The Quantum was designed to modulate standard PWM hobby servos, for use with non-pyrotechnic deployments. Typically, these will be some kind of "trap door" mechanism that's released by pulling out a pin. If you go very high, over 30,000', pyrotechnic charges lose much of their efficiency, because the reduced air pressure requires a larger amount of generated pressure to achieve the same force against the nose cone (or AV bay, for a drogue). With a trap door, it's altitude-independent; once you pop the door, the parachute is going to come out.

Also, some very large rockets do not lend themselves very well to pyrotechnic deployments, and minors cannot legally use pyrotechnic deployments. For example NAR TARC teams are allowed to use multiple deployments, but they cannot use pyrotechnics. The Quantum's servo support is ideal for these scenarios.

We strongly recommend that you power the servos with a separate battery than the one that you're using with the Quantum. This prevents any motor-startup current spike from affecting the computer side, and possibly resetting the Quantum. In general, you should use whatever battery you would if the servo was going into a R/C model; most of the time a 600 mAH 4.8V or 6V NiCad, NiMH, or LiFe pack will suffice. If you're not sure what battery to use, ask your local hobby shop; they probably know more about R/C servos then you'll want to hear.

To connect a servo, you need to first identify the 3 leads on the servo:

Power – Provides Positive battery power to the servo (usually red)
Ground – Provides Negative battery power to the servo (usually black)
Signal – PWM signal input to the servo (usually white)

If you're not sure which lead is which, check with your servo manufacturer's support web site. Not every servo has the leads in the same order, or using the same colors, but they all use the same three leads.

Once you've identified the servo leads, you will need to connect them to the Quantum as follows:

Power – Connect to the "+" side of your servo battery.

Ground – Connect to the DB- pad, regardless of whether you're using one or two batteries, AND connect to the "-" side of your servo battery

Signal – See below.

The "Signal" line for servos is a digital input, and should not be driven beyond the input voltage of the servo.   You can NOT simply connect it to the high-current output of the Quantum; the voltage will probably be too high.

On the B3 version of the Quantum, two digital pads are brought out specifically for connecting to servos.   If you are going to use the Drogue channel to drive a servo, you would connect the Signal line on the servo to the SD pad (Servo Drogue), located on the ESP8266 module. If you are going to use the Main channel to drive a servo, you would connect the Signal line on the

servo to the SM pad (Servo Main), which is located near the terminal block.   We recommend that you put a 330 ohm resistor in series with these signals and your servo Signal input, to protect against glitches.

On earlier versions, you can tap the digital outputs directly from the ESP8266 module.   The Drogue output will be Pin 5, the 5th pin from the left (as you view the module with the antenna to the left).   The Main output will be Pin 7, the 7th pin from the left.   We recommend that you put a 330 ohm resistor in series with these signals and your servo Signal input, to protect against glitches.

At this point, bring up your Quantum, go to Settings and set the channel you're using for servo deployment, then go back into the Settings page and select the direction and skew. You should now be able to go into the Deployment Test page and move the servo. If not, check your wiring.

Appendix D - Browser Notes

IMPORTANT:

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Here are some notes regarding browser compatibility. They may or may not apply to your platform… there are a LOT of different hardware/software combinations, particularly with Android. In general, the manufacturer's browser is usually the best choice, except with Android in which case we recommend Firefox.

Apple IOS
Newer versions of IOS (since 14.2) may generate a message "weak security" when you connect to the SSID.   This is because the WiFi connection uses TKIP encryption, an older version which is highly compatible with just about everything.   It won't keep you from connecting, it's just an advisory message.

Also, newer versions of IOS assume that if you have a WiFi connection that it must be to get onto the Internet.   This is not true of the Quantum, of course.   If you get a message that notifies you that you do not have an Internet connection and asks if you want to connect to your cellular data connection, you need to tell it to "Keep using WiFi".

Android
Newer versions of Android may assume that if you have a WiFi connection that it must be to get onto the Internet.   This is not true of the Quantum, of course.   If you get a message that notifies you that you do not have an Internet connection and asks if you want to connect to your cellular data connection, you need to tell it to "Keep using WiFi".

We recommend using Firefox with Android instead of Chrome, it seems to be faster.

Windows
If you're using Windows, we recommend that you use Internet Explorer if you can, or Edge. You may also have to change some hardware settings on your WiFi device so that it works with 802.11g connections with TKIP encryption; some updates may change you drivers so that they will only work with newer AES encryption.

Appendix E – Recovering the Passkey

Like any secured WiFi network, you need two things to connect… the SSID and the passkey. The default SSID of your Quantum will be "Quantum_nnnnnn" where nnnn is the last 6 hexadecimal digits of your device's MAC address (a unique address given to every Ethernet device). The SSID is broadcast, so you should be able to see it in your device's WiFi manager.

The passkey is an eight-digit number generated by a random number algorithm the first time that your Quantum is powered on, and is saved in EEPROM memory at that time. It's going to be unique for every Quantum. There should be a label on the little baggie that the WiFi module came in with the passkey (you kept it, right?), but it's easy to get it if you lose it…

To get the passkey, connect a USB-Serial cable (the same cable that's used with all Eggtimer Rocketry products) to the 3-pin header as follows:

BLACK wire – GND
WHITE wire – TX
GREEN wire – not used

Using an ASCII terminal program such as TeraTerm or HyperTerminal, connect to the serial port at 115,200 baud, 8 bits, no parity, 1 stop bit. Now connect the battery on your Quantum. You should see the following information:

```
        (a few lines of garbage… part of the boot process)

                 Quantum v1.08H
                 SSID: Quantum_F87C6E
                 PASSKEY:  3718 6501
```

Note that there is a space between the first four digits of the passkey and the second four digits, that's just to make it easier to read; when you actually enter the passkey don't type the space.

Disconnect the battery, and remove the serial cable. You won't need the cable again unless you forget the passkey, or you need to flash the software.

Now, fire up your device's WiFi manager. Connect the battery to your Quantum… you'll hear the buzzer beep 3 times then stay on for a second, and in about 10-15 seconds you should see your Quantum's SSID on your WiFi manager. Connect to the SSID using the passkey that you obtained earlier (but don't put the space between the digits!), and you should see the Quantum's status page. You're now connected to your Quantum, and ready to start using it.

Appendix F – The Hardware Setup Menu

Due to hardware differences between some of the different versions of the Quantum boards, beginning in Version 1.08H of the software there is a special menu that allows you to program global setup functions that do not change with flights and are not separately reported. Typically, these functions are accessed once and calibrated, at that point you don't need to go into them again.

To access the Hardware Setup menu, connect to the Quantum using its SSID/passkey, and browse to:

http://192.168.4.1/hsetup

The Hardware Setup screen looks like this:

Quantum_F87C6E   1.08H

Voltage Offset:

   0.2 v

SSID: _____

Submit

"Voltage Offset" is the difference between the reported and actual battery voltage. This setting allows you to adjust for difference between the two, due to the rectifiers the reported voltage may be higher than actual. To determine the correct value, use a DVM to measure the voltage across the battery, then set this value to Reported Value – Actual Value. For example, if your Quantum reports 8.5V and your DVM says the battery is 8.2V you would set it to 0.3V. The default value is 0.2V; if you have the older A12 board, it will probably be 1.2V or higher due to the higher voltage drop in the A12's rectifiers.

"SSID" allows you to set a custom SSID that will be broadcast to your WiFi device. This is very useful if you have multiple Quantums in a rocket such as a primary and a backup, because it easily allows you to tell which Quantum is which. For example, you may want to set one Quantum's SSID to "PunisherPri" and the other one to "PunisherBU". The SSID is displayed on every page so you know for sure which one you connected to. The SSID must be between 8-14 characters; allowable characters are a-z, A-Z, 0-9, and the underscore ("_"). If you have a custom SSID and wish to change it back to the default ("Quantum_" plus the shortened MAC address), you can do so by blanking out this field. Note that any changes to the SSID do not take effect until you power-cycle the Quantum.

There is no "exit" link on this menu, when you're done just close the page. We recommend that you power-cycle the Quantum after making any changes to this page, especially to the SSID.

Eggtimer Quantum Quick Start Guide

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Power: 7.4v/2S LiPo, 300 mAH or higher recommended. Bigger is Better…
Connect to the two BATT terminals, it's polarity-independent (no "+" or "-")

Deployment Power:

Any battery that will operate your deployment device is OK..

For SINGLE battery, jumper B+ and DP+
For DUAL batteries, connect: "+" of deployment battery to DP+
"-" of deployment battery to DP-
Do NOT use the B+ pad

Outputs:
Drogue: Connect to DROG terminals
Main: Connect to MAIN terminals
See Appendix C for use with servos

WiFi Connection

Select the "Quantum_xxxxx" SSID (or your custom SSID if you set one), and use the passkey that was on the WiFi module's envelope (you did save it, right?), or recover the passkey using the data cable (see Appendix E for instructions)

Set your browser to **192.168.4.1** to open the Status Page…bookmark it for later use!

Status Page
Displays:
SSID
Status (Disarmed, normally)
Validation Code (for arming)
Drogue Settings
Main Settings
Battery Voltage
ASL altitude
Temperature in F

Drogue Settings

Click on Change link next to Drogue settings to change
   0.1-9.0 secs by 0.1 secs, 3-30 secs by 1 sec.

Main Settings
Click on Change link next to Main settings to change
   OFF, Nose-Over, 50'-500' by 50', 500'-3,000' by 100'

Global Settings
Click on the Settings link on the Status Page to change:
   LDA – Launch Detect Altitude
   Launch samples/sec
   Descent Samples/sec
   Drogue mode (igniter/servo)
   Drogue on-time or servo direction/skew
   Main Mode (igniter/servo)
   Main on-time or servo direction/skew
   FailSafe:
      Velocity: OFF, 50-200 ft/sec by 25 ft/sec
       Time: 50-3000 ms by 25 ms
   Auto-Arm (OFF/ON)
   Name (sent out telemetry port with other data, we recommend using your Ham call sign
   if you're using the 70cm Ham version of the Eggtimer Telemetry Module)

Arming
Remote Arming:
   Select the proper flight settings
   Enter the 4-digit validation code, then click ARM
   When the "Armed" page displays, **CLOSE YOUR BROWSER**

Auto-Arm:
   Quantum will arm itself 60 seconds after power-on, if channels pass continuity check

Disarming (for aborted flight)
Connect to the Status page (192.168.4.1)
Enter the 4-digit validation code, then click DISARM
Wait for the normal Status Page… if it takes more than 10 seconds, refresh your browser

Downloading Flight Status Data
Click on the Flights link on the Status Page
Click on the 'More' link next to the flight
View the Flight Summary data…

For detail .csv download, click on the 'Detail' link at the bottom of the Flight Summary page

Deployment Channel Testing
Check your Settings first, set appropriately
Go to the test page… **192.168.4.1/test**
Select the channel to fire… it uses the settings from the Global Settings page
Enter the 4-digit validation code then click TEST
To abort a test, close the page before it counts down to zero
When you're done, **CLOSE YOUR BROWSER**

Hardware Setup Menu
Go to **192.168.4.1/hsetup**
Voltage Offset: Reported Voltage – Actual Battery Voltage
SSID: Custom WiFi SSID (A-Z,a-z,0-9, and underscore), 8-14 characters
Close the page to exit, we recommend power-cycling the Quantum as well