Addendum for Eggtimer Assembly Manual

Board Version RevD

Acting upon customer feedback, we have made some changes to the Eggtimer board. Note that the hardware and operation is basically unchanged; all Eggtimer firmware versions that were designed for the RevC board work with the RevD board without any changes.

First, we have changed the spacing and alignment of all solder pads so that they are all in groups of four on .1" (2.54mm) centers. We have added a little spacing around them, so that locking headers on .1" centers can now be used to terminate the pads. The advantage of having the locking headers is that it makes it easier to move the Eggtimer from one rocket to another, or to redo the wiring. The disadvantage is that it adds about ¼" to the width of the board, and makes the profile about ½" taller. It also adds a little weight, although you are unlikely to ever see any difference. We recommend that you do not use locking headers for the battery and switch terminals, on the (slim) chance that they might go intermittent under a high-G load or vibration. The locking header/socket kit is an extra-cost option; they do not come with the standard Eggtimer RevD kit.

Secondly, we have added a voltage regulator option, so that in addition to the "classic" option of 3V-4V you can now use just about any battery up to 30VDC. You will need to set some voltage selection jumpers regardless of which way you build it, depending on whether or not you use the voltage regulator. Using the regulator gives you more battery flexibility, and if you are using a battery that produces significantly more power than is required by your igniter for deployment (i.e. a 350 mAH, 20C 7.4V-2S LiPo pack firing a Quest Q2G2 igniter) then it is safe to use that battery for both deployment and the Eggtimer power, as long as you SOLDER the battery and switch leads to the board. The voltage regulator is included with the Eggtimer RevD kit.

Finally, we have replaced the Bosch BMP085 sensor with the BMP180, its newer replacement. The BMP180 is electrically and functionally identical, the main difference is that it is smaller and is in a metal can instead of ceramic.

The mounting hole locations remain the same as the RevC board, see the Knowledge Base section under Support on the web site (www.eggtimerrocketry.com) for a drawing.

Board Version RevC

The Eggtimer board has been revised to clean up some issues that arose with the original hardware and to add a few new features. The assembly instructions have been revised to incorporate the new board.

The Eggtimer RevC board incorporates headers that have all of the external indicators on it that are not essential for the operation of the flight computer functions. Specifically, they are the external Ready LED, the external Buzzer pizo output, and two new outputs for Channel A and Channel B igniter continuity LEDs. The LED outputs are current-limited with an 820 ohm resistor, so a 9v battery will source approximately 9 mA of current. This should be more than enough to light up a T-1 sized high-brightness LED so that it will be visible outdoors from a reasonable distance. These LEDs are in parallel with the driver transistor collector-emitters, so they will be on as long as there is power to that channel and the igniter has continuity. The intent of these LEDs is to give you a visual indicator that you have power to the channel and igniter continuity; if the LED doesn't light then there's a pretty good chance you're going to fail self-test too.

In addition there are three new deployment outputs labeled AUX1, AUX2, and AUX3. These are logic-level outputs and are not buffered. In the 1.44 version of the software, they have the following functions:

AUX1 – Turns ON (+V) for two seconds starting at nose-over detect
AUX2 – Shadows the CHA (MAIN) output, for redundancy
AUX3 – Turns ON at landing detect and stays on until the Eggtimer is reset

Since these outputs are unbuffered, it is most likely that you will need some kind of driver circuit if you want to use them to trigger an ematch, igniter, or relay (recommended only for AUX3… don't use a relay in flight).

Please check the Eggtimer web site (www.EggtimerRocketry.com) for suggested buffer circuits suitable for triggering higher current loads.

Board RevB

It was found that the two 2.2K pull-down resistors between the base of the output driver transistors and deployment power ground was causing the output current to be limited, since the TIP120 transistors internally have similar resistors. They should not be installed on the board, any RevB boards shipped will have a piece of masking tape covering these pads so you know which ones should be omitted. The pads were removed from the RevC board.

Software Release Notes for Eggtimer Builds 1.28 – 1.52

Release Notes Build 1.52

Fixed Servo Bug

There was a problem with the servo deployment routine that would sometimes cause the servo to move only slightly, if at all. The servo routine has been rewritten to fix that problem, and to make it work with a wider variety of servos.

Release Notes Build 1.51

Added Backup Drogue Function

By popular request, an additional selection ("7") was added to the CHB deployment channel, causing the channel to turn on at TWO seconds past apogee rather than ONE second (i.e. at nose-over). This allows two Eggtimers to be installed for redundancy purposes, and the backup Eggtimer's drogue channel to be configured to fire later than the primary Eggtimer's drogue channel. This function is only for the igniter mode, and cannot be used for servo deployment.

Release Notes Build 1.50

Fixed Channel Test Bug

A bug was found in the channel test routine ("M" or "B" from the MON> prompt) that prevented deployment channels from firing ONLY if the Eggtimer had never been run through a simulated or actual flight cycle (i.e. to the "Ready" chirping). This bug did NOT affect an actual flight, since by definition the Ready cycle had to be reached prior to a flight.

Release Notes Build 1.49

Added MCU EEPROM Dump

To facilitate specific troubleshooting issues, we have added a MCU EEPROM dump function to the Monitor, accessed by typing "E" at the MON> prompt. It dumps the MCU EEPROM in .CSV format, identical to the "A" and "0" functions.

Release Notes Build 1.48b

Added Delay Mode to CHB

By request, we have added a new deployment option, "6-Delay" to the CHB modes. Delay mode works just like the motor-eject delay grain on a motor… it counts the time from Burn Time (emulating motor burnout) and fires at that time. The range is from zero to 60 seconds. Note that unlike the Airstart Timer, the Delay timer WILL fire during mach lockout, prior to nose-over, or as early or late as you have it set. We recommend that if you choose to use this timer for deployment, you model the flight with RocSim or OpenRocket, and set it accordingly to prevent a high-speed parachute deployment.

Added Airstart Minimum Velocity to CHB

By request, we have added a feature that allows you to specify the minimum velocity that must be attained by the rocket in order for an airstart to occur. This is a threshold trigger velocity, i.e. CHB will not trigger unless this velocity has been reached. The intent of this function is that if the velocity is too slow, chances are that the rocket may be going horizontally, and you don't want the airstart to trigger. The other thing that may cause this to happen would be if the baro velocity appears to be slow because of a mach transition; in this case, when the rocket comes out of mach transition, the velocity will appear to increase, and the airstart ignition will occur once the threshold is reached.

Change to Burn Timer Start

The Burn Timer now starts as close to the actual start of the flight as is possible to determine. Once LDA has been reached, the timer is back-timed to the last pre-LDA reading less than 5 feet AGL. In most cases, this will make the Burn Timer accurate to within 100-200 ms, which is close enough for almost all purposes.

Change to Burn Timer Range

Previously, the Burn Timer's range was 1-20 seconds, in 1-second intervals. Since it was only used for airstarts, and it was started at LDA, there was a built-in inaccuracy. With the new Burn Timer start logic, it is now possible to make this value more accurate. Therefore, the range for the Burn Timer is now 200-20000 milliseconds, in 100 ms increments. Hitting the ">" key will add 10 increments, or 1000 milliseconds (1 second) to this value; likewise, "<" will subtract 1000 milliseconds.

Minor Wording Changes in Screens

The “Main Enable” and “CHB Enable” prompts have been changed to “Main Mode” and “CHB Mode”. This is to reflect the expanded use of these fields from simple toggles to a mode-select field.

The “1-IGN” mode name has been changed to “1-Igniter”, based on feedback that the “IGN” term was ambiguous.

Filter Changes

The filter code has been simplified to save memory and cycles. It was pointed out that the code is actually an exponential weighted average filter and not a true Kalman filter, so a second-pass filter has been added for an additional level of smoothing/filtering. It is displayed with the detail download, but is not used for in-flight logic due to the additional lag that is accrued. The second pass is noticeably smoother than the first pass, but you will see that there is an additional 2-3 sample lag over the first-order filter.

Change to Maximum Velocity in Summary Download

The Maximum Velocity and the derived Average Acceleration value that is reported in the Summary Download has been changed to be the first-order filtered value rather than the “raw” value. It is more accurate, and filters out any transient velocity peaks that would skew this value higher than it really should be.

Release Notes Build 1.47

Miscelleaneous Bug Fixes

• Fixed bug that caused pre-LDA settings to sometimes repeat
• Fixed bug that caused low-speed detect (Mach Unlock) to be inaccurate if velocity never reached 500 ft/sec
• Changed Flight Summary display for Main deployment to show altitude/time to be consistent with other flight events
• Fixed miscellaneous other display anomalies
• Miscellaneous internal memory-saving changes

Release Notes Build 1.46a

Added Non-Breakwire airstart option

Due to popular demand, an airstart option has been added to CHB that does not require the use of a breakwire. It is triggered by reaching the Launch Detect Altitude, the expiration of the Burn Timer, and the expiration of the optional Airstart Timer. Since it is theoretically possible (although highly unlikely) that a very strong gust of wind at an angle normal to the pressure ports could cause a pressure reduction that could be construed as reaching LDA, we strongly recommend that if you use this option you have a switch on the deployment battery, and only turn on the deployment power and the Eggtimer power immediately prior to launch. We also recommend that you use a higher than normal LDA, 300'-400' (assuming that your booster motor will burn out at a higher altitude than that). You don't need to worry about running out of memory, at 20 samples/sec you have 2.5 secs of pre-LDA memory available, so there is no way that you're going to run out of memory before LDA is reached.

Added Event Marking to flight detail display

Some columns have been added to the .CSV flight detail display to act as "markers" for major flight events. Specifically, they will indicate Burn Timer expiration, Low-Velocity indication (when mach-lockout is cleared), apogee, nose-over, CHA (Main) trigger, and CHB (drogue or airstart ignition) trigger. When imported into most spreadsheet/graphing programs there will be a short "spike" marking these events.

Removed Burnout reporting

As has been previously mentioned, burnout detection using barometric pressure readings is a touchy proposition at best. After conducting several dozen tests from LPR through HPR, it has been deemed to be unreliable, so we have removed it in favor of the Event Marking for the flight detail display. We needed the flash memory space, and it didn't make a lot of sense to use it on something that we knew wasn't right and would probably be difficult to fix at best.

Release Notes Build 1.45b

Fixed a bug in the deployment channel turn-off logic

Due to a change in a previous version, it was found that the timers that turn off the deployment channels were not working properly. In most cases, this might not even be noticed, since most ematches will typically blow open on firing, thus disconnecting the circuit. The Eggtimer also turns off the deployment channels at landing detect (unless they are set to continuous), so the effect would have been relatively minor, resulting in a minute or so of extra current drain on the deployment battery.

Telemetry output display change

The telemetry output reported elapsed time from the Eggtimer's power-on in milliseconds, along with altitude in feet. That has been changed so that the time is the elapsed time from the last near-zero AGL reading. This means that your in-flight transmissions' elapsed time and altitude reports will match the data stored in the EEPROM for that flight.

Flight Detail Dump Display Issue

Fixed an issue in which, in some rare cases, the Flight Detail Display could hang instead of dumping the .CSV-formatted data to the serial port.

Comments Editing Issue

Fixed an issue in which editing the Comments field after selecting a pre-programmed flight profile did not start at the end of the string.

Release Notes Build 1.44a1

Minor Pre-Programmed Flight Profile Changes

Due to changes since the original implementation of the pre-programmed flight profiles, the profiles did not match the documentation. Cleaned up both the flight profiles and the documentation.

Release Notes Build 1.44

Support for New AUX Channels in RevC Board

The Eggtimer RevC board includes three new unbuffered hardware channels labeled AUX1, AUX2, and AUX3. Build 1.44 assigns the following functions to these channels:

AUX1 – Turns ON (+V) for two seconds starting at nose-over detect

AUX2 – Turns ON (+V) for two seconds at main deployment altitude if the CHA (MAIN) output is igniter mode
AUX3 – Turns ON (+V) at landing detect and stays on until the Eggtimer is reset

This provides for redundancy for the two deployment channels (CHA/CHB) in typical multiple deployment mode (CHB at nose-over, CHA at a specified deployment altitude), and also allows the Eggtimer to provide multiple deployment capabilities when CHB is used in Airstart mode. For the latter, AUX1 would require a small buffer circuit to source enough current to fire an ematch; see the Eggtimer web site (www.EggtimerRocketry.com) for details. The purpose of the AUX3 channel is to allow some kind of tracking or sounding device to be turned on when the rocket lands; some consumer-oriented handheld tracking devices have FCC restrictions that may prevent their use during a flight, by turning them on only after landing this allows their legal use in rocketry applications.

Release Notes Build 1.43

Changes superceded in Build 1.44

Release Notes Build 1.42

Kalman Filtering for Altitude/Velocity

The weighted averaging filter that had been used to smooth out velocity for post-flight display has been replaced by a Kalman filter. Kalman filters work by building a statistical prediction of the "next" value to be read by the sensor, and dynamically changing the filter parameters as more data is read. Although the Kalman filter takes more processing time and is more complex than the weighted average filter, it produces a filtered altitude/velocity vs time graph that is more consistent over a larger range of flight parameters than the weighted average filter.

The Kalman filter is used in-flight for velocity analysis, and both raw and Kalman-filtered altitude and velocity are reported in the Flight Detail download.

Discontinuation of Mach Timer

To prevent the accidental firing of deployment charges due to the pressure buildup during mach transition, previous versions of the Eggtimer software used a timer what was set so

that deployments would be inhibited until the timer expired. It required some modeling work on the users' part, and would not be effective if it was set too low. In addition, setting it too high could possibly lead to late post-apogee deployments.

With the addition of the Kalman filter for velocity, it is now possible to predict the possibility of a mach transition and to automatically inhibit deployments accordingly. The Eggtimer now will inhibit deployments (either drogue or main) until the Kalman-filtered velocity is between 100 ft/sec and -100 ft/sec, for at least one second. This check is not performed until after LDA has been reached. Since a mach transition typically is perceived as a rapid drop in altitude followed by a rapid rise in altitude (due to the pressure increase/decrease), the combination of relatively low velocity and extended time will ensure that the rocket must have passed through the coasting phase of its flight before apogee/nose-over will be detected.

Internal Changes

Internal changes have been made to support additional deployment channels in future hardware models.

Release Notes Build 1.41

Changes superceded in Build 1.42

Release Notes Build 1.40

Consolidated Burn/Coast Samples

To conserve space, the separate setting for Coast Samples/Sec was removed. It rarely saves a significant amount of extra memory by reducing the sample rate for coasting, and there were other issues as detailed below.

Removed Dynamic Burnout Detection

After several dozen flight tests, it was determined that the Burnout detection was not reliable. The mechanism was to use a velocity trending routine to determine when the

velocity was beginning to drop after having steadily risen for several samples. The problem was that it was too susceptible to noise from aerodynamic and other influences to be reliable; it worked only about 50% of the time and was highly dependent on selecting the proper Burn Sample rate.

If this was only a reported parameter then it would not have been a big problem, however the Burnout detection was used to change the sample rate to the Coast Sample/Sec setting. Since the Burnout detection was not reliable, neither was the rate change. Therefore, we have removed both of them, and Burnout is now being reported in the Flight Summary data as the sample immediately following the Maximum Velocity sample. Since Maximum Velocity must occur under boost, the next sample would by inference be the first sample in which there is no boost, i.e. Burnout.

Removing the separate Coast Sample/Sec setting should have very little effect on the flight profile, since most of the time it was set to the Burn Sample/Sec rate anyway. Although this may theoretically reduce the total flight recording time, the number of samples that it would be reduced by is probably a few dozen at most.

Release Notes Build 1.39

Changes Superceded in Build 1.40

Release Notes Build 1.38

Saved Breakwire Alt

The AGL altitude is now saved when the Breakwire is tripped during Airstarts. This is a forensic value, it is not reported in the Flight Summary Download, but it will show up in a memory page dump as location 40. If the breakwire is not tripped, this value will be -1. Note that the breakwire is tested after the altitude is read, so the reported values are the current altitude/index; the assumption is that it happened somewhere between the last altitude and the current altitude. In the case of most rockets, this difference should only be a few feet because it's going to be just leaving the pad.

Release Notes Build 1.37

Change Superceded in Build 1.38

Release Notes Build 1.36

Added Airstart Delay

The Burn Timer as a mechanism for arming airstart ignition did not allow for a delay from the Burn Timer expiration to the ignition of the second stage motor. The Airstart Delay timer was added so that it is now possible to delay the firing of the CHB deployment channel in airstart mode, the possible values are 0-9 seconds. Airstarts are now dependent on Nose-Over not having occurred; if Nose-Over occurs before the expiration of the Airstart Delay timer, the CHB channel will not fire. This is to prevent an airstart when the rocket is pointing downward, which is bad.

Added Mach Timer for Mach Transition Deployment Holdoff

The previous method of delaying deployments based on a derived-velocity prediction of mach transition was found to be inaccurate and prone to errors due to aerodynamically-induced noice. After thorough analysis of the problem, it was decided to forego the "automatic" mach detection in favor of a timer mechanism, controlled by the setting Mach Timer. The allowable values are 1-20 seconds, the same as the Burn Timer.

The Mach Timer value defaults to the same value as the Burn Timer, and if the Burn Timer is changed it will automatically be set to the same value. This value is appropriate for most "average" motors, with a burn time of 2-4 seconds. In the case of either fast-burning or long-burn motors that may cause the rocket to near or exceed Mach speeds, this value may be too short. This value should never exceed the time between the expiration of the Burn Timer and the time that the rocket is expected to hit apogee, preferably it should be 2-3 shorter, but should be long enough so that the rocket will be moving less than 700 ft/sec. at the expiration of the Mach Timer.

Since it is not possible to reliably predict if the rocket is going to go to near-Mach speeds or not, this timer is mandatory. For subsonic flights, this value can be left at the default since the coast phase is usually much longer than the boost phase. In the case of very draggy rockets such as saucers, this value can be reduced to 1 with no ill effect.

Release Notes Build 1.35

Added Velocity Smoothing Routine to Flight Detail Download

A velocity curve-smoothing routine has been added to the flight detail portion of the download. Basically, it's a weighted-averaging routine that weights the most recent value highest, and the least recent lowest. The current and previous four raw velocity values are processed, on the theory that recent values should be relatively linear, the error

in the samples is random, and therefore the error can be averaged out for a short number of samples. This is similar to the assumptions made using linear regression.

We have found that the difference using a weighed average routine for curve smoothing vs. linear regression is negligible, therefore we save flash memory space by going with the weighted average routine. If you look at the smoothed data vs the raw velocity data, the effect is pretty obvious…

Release Notes Build 1.34

Changes to Burn Timer support superseded in Build 1.36

Release Notes Build 1.33

Added support for larger EEPROM memory size in 0.4b board (512 Kb vs 256 Kb)

This allows us to save longer flights. Prior to 1.33, flight data was limited to 1 KB, and was organized as 50 pre-LDA samples, 400 post-LDA samples, with the remaining 124 bytes in each page being uses for flight settings and flight summary data. Starting with 1.33, this limit has been increased to 50 pre-LDA samples, 910 post-LDA samples, and 128 bytes of flight settings/summary data.

This allows for the case in which an HPR rocket using 25 or 33 samples/second uses 400-500 samples before nose-over. Prior to 1.33, it was possible for such a flight to exhaust the flight memory before apogee, resulting in an incomplete flight graph. Note that this would NOT affect deployment, because deployment events are strictly time/altitude related and are not dependent on flight memory.

Release Notes Build 1.32

Added Battery check to status display on Flight Settings screen

Added Battery check to self-test routine (Failure Code 1 if < 2.8v)

Note that as we have mentioned in the documentation many times, the on-board battery check should not be considered to be a substitute for checking the batteries pre-flight with

a DVM. The battery check circuitry may be off by 3%, high or low. A DVM is usually accurate to about 0.01v in the 0-20v DC scale.

Release Notes Build 1.31

Internal changes to save memory

Release Notes Build 1.30

Menu changes to save memory

Release Notes Build 1.29

Internal changes to save memory

Release Notes Build 1.28

Added pre-programmed flight settings

Prior to 1.28, there was no way to change any settings without connecting the terminal cable. Starting with 1.28, pressing the button during the Flight Settings screen allows the user to select one of up to eight pre-programmed flight settings. The pre-programmed flight settings are fixed and are not alterable.

Addendums to Documentation Version 1.28-1.48b

Adendum to Version 1.52 Documentation

No functionality changes were made, so only the version number was changed.

Addendum to Version 1.51 Documentation

Changed Screens/Docs to Match 1.49-1.51 Features

The manual has been changed where appropriate to reflect changes in functionality added in Versions 1.49-1.51.

Addendum to Version 1.48b Documentation

Board RevD References Added

The manual has been changed where appropriate to reflect the RevD version of the board.

CHB Mode 6 Added

The new 6-Delay option has been added to the documentation, and the screens have been changed accordingly

Airstart Min Velocity Added

The Airstart Min Velocity field has been added to the documentation.

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Addendum to Version 1.47 Documentation

Added Quick Reference Guide

Added short summary of Eggtimer operation and functions, tables, etc. This will make it easier to perform programming and troubleshooting in the field, since you don't need the entire manual.

Miscellaneous Corrections

Fixed various inconsistencies and issues with the documentation. In particular, some of the Monitor functions' sequences were not correct.

Addendum to Version 1.46a Documentation

Added screens and references to CHB airstart option 5.

Updated flight detail display to include Event Marking, and updated graph accordingly.

Removed references to Burnout detection.

Addendum to Version 1.45 Documentation

Due to popular request, a quick-reference subject index was added to the start of the documentation.

The self-test function of the Eggtimer executes once, and if the tests pass it goes into the "Ready for Flight" mode (chirp/flashing). If for some reason, the deployment power is disconnected after the self-test has completed, the Eggtimer will NOT abort the flight sequence, since it has already passed self-test. This is one reason for the external continuity LED outputs; to ensure before launch that BOTH the "Ready for Flight" sequence has completed AND the continuity is still good. The documentation has been updated to point this out.

Addendum to Version 1.44 Documentation

The documentation has been changed to add the two external deployment channel LED indicators and the three additional unbuffered output channels that are in the RevC board.

Addendum to Version 1.43 Documentation

No changes were made to the documentation for this version.

Addendum to Version 1.42 Documentation

All mention of the Mach Timer has been removed since this feature was obsoleted in 1.42. The menus have been changed accordingly.

Addendum to Version 1.40 Documentation

All mention of the separate Coast Samples/Sec has been removed since this feature was removed in 1.40. Instead, the Coast Sample setting has been consolidated into the Burn Sample setting.

Addendum to Version 1.36 Documentation

Page 30-33

The Flight Summary Download example in the documentation does not reflect the addition of the Airstart Delay and the Mach Timer settings.

This is because the flight that was used as a multiple-deployment example pre-dated the addition of these features. Rather than replace it with another example that did not have multiple deployment, we left it in because we felt that it was more important to show what a multiple deployment data download looks like.

Addendum to Version 1.35 Documentation

Page 30-33

The Flight Detail Download example in the documentation does not reflect the velocity smoothing that was added in Build 1.35. It is shown correctly in the document "Graphing Flight Data with Microsoft Excel" in the Knowledge Base section of the web site.

This is because the flight that was used as a multiple-deployment example pre-dated the addition of the velocity smoothing routine. Rather than replace it with another example that did not have multiple deployment, we left it in because we felt that it was more important to show what a multiple deployment data download looks like.