Blue Jay User's Guide

Version 1.2 for the Blue Jay, May 2026.

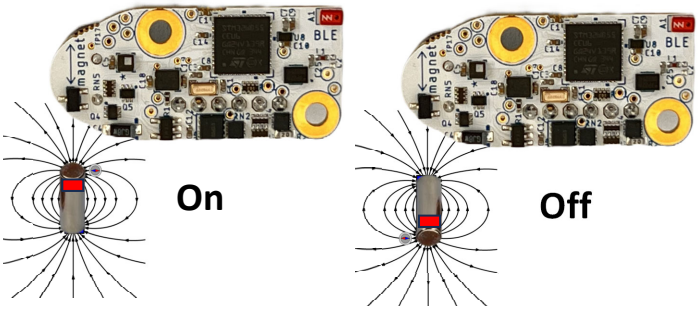
Introduction

The Blue Jay is amateur rocketry's easiest altimeter to install and operate, using a mobile app interface is designed to be intuitive and easy enough to use to make a user's manual optional. For those who would prefer to skip or skim the manual, the Quick Start Highlights Section gives key pieces of information that you will want to know. Please read it. The rest of the manual provides in-depth information.

Quick Start Highlights

Pre-launch:

- Mount the Blue Jay in any orientation. For the apogee charge to be on time, vent the av-bay, rigidly mount the Blue Jay inside the airframe, or preferably both. Mounting hole spacing is shown later in the manual, and there is a .step file for 3D CAD on the website.
- If a battery with reversed polarity is connected to the Blue Jay, it will fire any connected charges.
- The sensor for the Blue Jay's magnetic switch is located on the low-profile side of the board, and the field alignment for turning the Blue Jay on and off is shown with the arrow labeled "magnet". For the best magnetic range, the axis of magnet provided with the Blue Jay should be oriented parallel to this arrow to turn it on and off. One orientation turns it on, and the opposite orientation turns it off. Bypassing the magnetic switch is described later in the manual.



- **1S (3V-4.2V) lipo are recommended**. The Blue Jay is designed to tolerate 9V, but use of a **battery over 4.2V is not recommended** because of the risk of permanent damage in the event of accidental contact of higher voltage on the exposed parts of the board. If the output current goes over 4 Amps, the Blue Jay will now reduce the average current to 1 Amp, so large capacity lipos are now o.k.
- The App is released in the Apple App Store and Google Play under "Featherweight UI" and released versions can be installed with this method.
- If an over-the-air firmware update is interrupted, the Blue Jay will complete the firmware update after a power cycle using a built-in application that does not show any outward signs that the Blue

Jay is powered on, (no LEDs for example) and is shown under the Devices screen as "STM_OTA".

- The Blue Jay only connects to one phone at a time, so if it's not connecting to your phone, check that your Bluetooth is enabled, and it's not already paired to another phone in the vicinity. For security at the pad, the Blue Jay only accepts commands from the first phone it connects to after being powered on. If another phone connects it will show "unauthorized" in the devices page. If this happens accidentally, power cycle the Blue Jay with the desired interface phone in the vicinity.
- If the Blue Jay is powered off and then powered back on a short time later, the barometric sensor may not get properly reset, and as a result it can output nonsensical values. The Blue Jay will provide a long, low beep as a warning if this happens, rather than the usual continuity beeps. This can be fixed by powering off the Blue Jay for about 1 minute to fully reset the barometric chip before powering on again.
- Resetting to default settings is recommended for most rockets. With the default settings, the Blue Jay fires the Apo channel at apogee, even if there is a sensor failure. The channel fires the main chute at 700 feet by default. The Main channel will also fire early in the event of excessive descent rate due to a failed apogee deployment.
- If you modify the deployment output settings using the custom screen, be sure to review both the primary and secondary settings. Whichever set of conditions is true first will fire the output.
- Run a simulated flight to get familiar with the features and capabilities of the phone. But do not run a simulation while you have charges connected to the outputs, unless you want them to fire, because the simulated flights fire charges just like real flights.
- Re-calibration of the accelerometers isn't needed for a safe, successful flight. But if you want the best quality inertial navigation and recorded data performance, I recommend re-calibrating within a week of the flight.

<u>At the pad:</u>

- When the Blue Jay is using default settings, all you need to do to make it ready for launch is power it up and wait at least 20 seconds. If both memory banks are full of flight data, the oldest one will be erased automatically to make room for the new flight. This can take up to a few minutes if a long flight is being erased.
- The live data screen shows the readiness for launch of all the measurements. Before launch, read each measurement on the screen and think about if it is valid. Green means go. Red means not ready for launch. Unused channels show up as red, but that's o.k. if it's a channel you're intentionally not using. It's also o.k. if the accelerometer or the gyro briefly show red from noise, especially if there is gusty wind at the pad.
- The beeps are optional and can be turned off in the upper right corner of the live data screen. The startup sequence of beeps gives examples of high and low tones, then it beeps out the battery voltage rounded down to the nearest Volt. Then if the barometric and accelerometer sensors are healthy, the continuity status of the 2 output channels is beeped out, in order of Apo, Main. Low beep indicates less than 3.80V. A high beep indicates greater than 3.80V. The continuity beeps

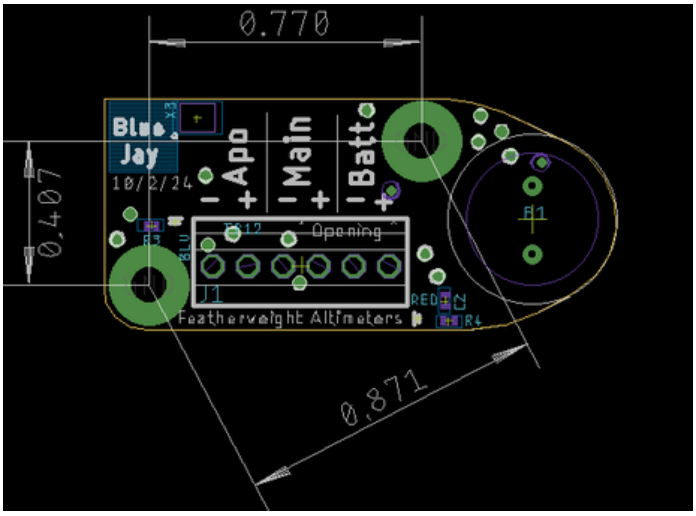
are repeated every few seconds. The Blue Jay will still operate and do its best to fire the charge if the continuity voltage is below 3.8V at launch.

- If a channel is set up to perform an airstart motor ignition, it will start out in a disarmed state when the Blue Jay is powered up. Don't forget to arm it at the pad when the rocket is ready to fly. The other output function options (chute deployments, in particular) are armed at power-up.

After the flight:

- If you keep the app up and running on your phone during the launch, it will automatically download the flight summary data as you walk up to your rocket, and start downloading the low rate and high rate data. There is so much recorded data to download that it can take a long time, but it's o.k. to review the flight summary data or change to the live data screen as long as you go back to the flight screen to let the downloading complete. Don't start a new flight, a simulated flight, or a ground test before the downloading is complete, if you want to preserve that flight data.

Blue Jay mounting and electrical connections

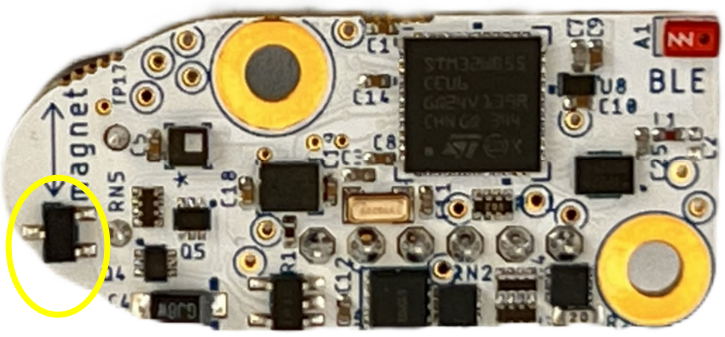


The mounting holes are compatible with 4-40 screws, and two screws and nylon standoffs are provided. The Blue Jay's mounting holes are electrically connected to ground. Be sure to use the correct polarity when applying power. Note that each deployment output channel fires by connecting the "-" output terminal to the ground (Gnd) terminal. The "+" terminal for each ematch is connected to the + side of the battery through an onboard switch on the + side when the Blue Jay is turned on via the magnetic switch (or when power is applied if the magnetic switch is bypassed)

Commented [GP1]: If damage can occur to the Blue Raven from connecting the battery with reverse polarity, this warrants a warning.

The Blue Jay can be installed in any orientation, including horizontal, or skewed by any amount, and the operation will be unaffected.

The sensor for the magnetic switch is highlighted with the yellow oval in the photo below.

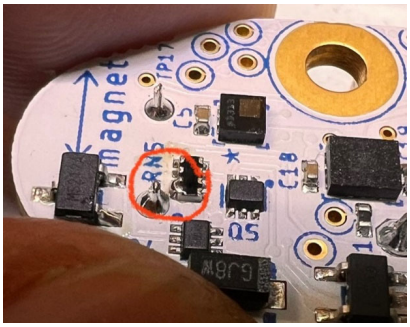


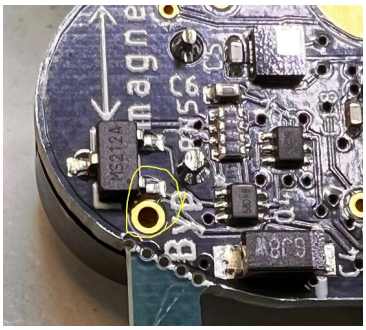
The range of the magnetic sensor is about 2 inches using the provided magnet. For maximum range, the magnet should be aligned with its long axis parallel with the arrow above the "magnet" label. One end of the magnet turns the Blue Jay on, and the other turns it off.

The magnetic switch consumes only about 0.072 mA when the battery is installed and the Blue Jay is off. With a 180 mAhr battery, you would discharge only about 6% of the battery capacity per week.

Bypassing the magnetic switch

If for some reason you need to bypass the operation of the magnetic switch, that can be accomplished by soldering a connection that forces the switch into an always-on configuration, and then controlling the power externally by adding a switch or disconnection between the battery and the Batt terminals of the Blue Jay. To bypass the switch in any of the versions of the Blue Jay, solder a bridge between the two terminals of the resistor net circled in red. Later designs provide an easier alternative shown circled in yellow on the right, where one lead of the magnetic switch could be soldered to the plated through-hole labeled "Byp."





Avoiding common installation problems

Provide vent holes from the avionics bay where the Blue Jay is installed, to the ambient atmosphere. Ideally these should be located on a cylindrical part of the airframe so that the air flows past the hole parallel to the hole opening. Adding several small holes is preferred to one or two larger holes so that the pressure measurement is less affected by wind at the pad or rocket orientation after the first deployment. Although there is no hard and fast rule for vent hole sizing, several online resources provide a reasonable starting point, such as https://rocketrycalculator.com/rocketry-calculator/test-vent-port/. If the vent holes are relatively large or the av-bay volume is relatively small, the recorded barometric pressure will be noisier than necessary. If the vent holes are relatively small and the av-bay is large, the measurements will be smoother but will lag the external pressure and may not fully catch up to the external pressure at apogee. The default deployment settings of the Blue Jay will work based on gyro and accelerometer measurements for apogee deployments even if the av-bay is sealed, but the main chute deployment won't work without the Blue Jay being exposed to the ambient air pressure.

The measurements of the barometric sensor in the Blue Jay are sensitive to light. Mount it in an av-bay that does not permit direct sunlight to hit the barometric sensor, by locating vent holes away from the sensor. Otherwise, the barometric sensor can have spurious readings during the rocket's motion if a shaft of sunlight passes across the sensor. This effect could provide misleading recorded data, though the Blue Jay's deployment logic has filters and persistence checks that are designed to prevent impact of this potential effect on deployment outputs.

Mount the Blue Jay rigidly to the airframe. If the Blue Jay's mounting orientation relative to the rocket can change under boost due to flexing of av-bay components, the accuracy of the inertial navigation will be degraded.

Keep the av-bay sealed against deployment charge pressure. Although the Blue Jay's deployment logic incorporates filters and persistence checks to prevent transient pressure changes from affecting the deployments, the recorded data will have misleading results if pressurized gas from a deployment charge is allowed to enter the av-bay and temporarily raise its pressure. Deployment charge gas also contains corrosive residue that should be cleaned off if the electronics are exposed to it.

Beeper and LEDs

The Blue Jay has a red and blue LED, and a beeper to communicate status in addition to the Bluetooth and USB interfaces. At power up, the Blue Jay beeps with a startup sequence that gives examples of high and low beeps, pauses and then beeps the input battery voltage rounded down to the nearest volt, one beep per volt. Each low beep has a red flash of the LED. After the battery voltage is beeped out, the Blue Jay periodically beeps the status of the voltage input to each channel with a series of 2 beeps, one beep per channel starting with the Apo channel followed by the Main channel. A high beep indicates that an ematch or igniter is electrically connected and not broken open. A low beep indicates that an ematch or igniter is disconnected or failed open. The threshold for continuity detection is 3.8V, which means that the battery supplying the pyro charges needs to have a voltage at least that high for the continuity indications to work. If the continuity voltage is lower than 3.8V, the Blue Jay will still attempt to fire the charge according to its settings.

Commented [GP2]: Making this something the non-engineer will understand - assuming this engineer understands the intent correctly. :)

The blue LED indicates Bluetooth radio activity. The LED flash is initially less frequent to indicate the Bluetooth radio is advertising but not yet connected. After the Bluetooth connection is established, the blue LED flashes more frequently.

The red LED flashes along with the low beeps to indicate low/no deployment output continuity voltage. It also turns on when the on-board flash memory is active, for example right after power-up when a previous flight's data is being erased to make room for a new flight, and during the flight when flight data is being written to flash memory.

The Devices Screen

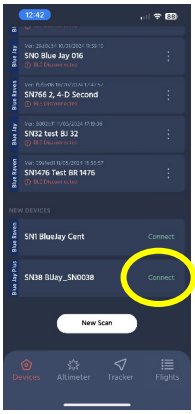
The devices screen displays the names and serial numbers of two lists of Featherweight devices. The devices in the New Devices list are ones that the app has discovered which you can connect to. For your devices, click on the device and select "connect" when the dialog box pops up. If you see someone else's device in the New Devices list, do not connect to it without their permission.

Once the app has connected to a Featherweight device, it will shows up in the "My Devices" list and stay there even after it has been disconnected. To remove a device from the "My devices" list, click the three dots to the right of the device and select "forget device." This also resets the Bluetooth connection to the device, which can be useful if there is a problem with the Bluetooth connection with the phone. Forgetting a device does not delete any downloaded flight data.

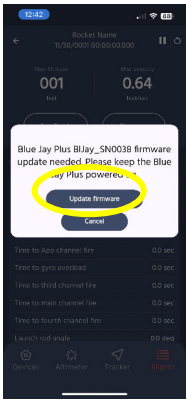
Any Featherweight device can be renamed by clicking on the three dots to the right of the device and selecting "Edit name." This does not affect the serial number, which is permanently assigned during manufacturing.

Updating the Blue Jay to the latest version of embedded software

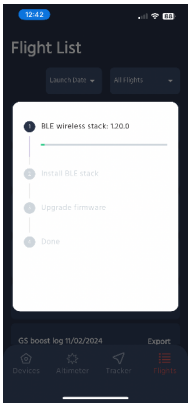
The Blue Jay uses a custom phone application on iOS and Android which provides the primary user interface to the Blue Jay, and updates the Blue Jay's embedded software over the air via its Bluetooth connection. When a new version of the firmware is available, it starts updating automatically:



Click the "Connect" button.



Click the "Update Firmware" button



The new firmware will now start loading.

The update process will update the Bluetooth stack then the application software. After the new embedded software has finished downloading, the Blue Jay will restart.

Command Authorization

The Blue Jay has a security feature to prevent unauthorized commanding of your device when your phone is not connected to it, for example when the Blue Jay is powered on at the pad and you have walked back to the flight line and out of Bluetooth range. The Blue Jay will only respond to commands from the first phone that has been connected to it since it has been turned on. When the Blue Jay is turned on, it goes through a handshaking procedure with the phone to authorize that phone for commanding. If there is a problem with that process, or if the phone is not the first to connect to it since it has been powered on, a red "Unauthorized" next to the device name. If you are the owner of the device, and get an "Unauthorized" status after turning it on, power cycle the Blue Jay to re-attempt command authorization. Most interactions with the Blue Jay won't work if commanding is not authorized.

Deployment setting introduction and background

Three levels of customization and flexibility are available for the Blue Jay's deployment settings. 1. The Blue Jay's default deployment settings provide reliable, fault-tolerant settings right out of the box for most rockets with apogee deployments or apogee/main chute dual deployments. 2. The Blue Jay phone app makes it easy to assign common functions like apogee or main deployments, airstarts or stage separations, with customization options tailored to those functions, such as main chute deployment altitude or airstart maximum tilt angle. 3. Finally, the deployment logic and settings for both of the Blue Jay channels are very customizable with 22 flight options and events to choose from, primary and secondary settings, and thresholds for event detection that are user-selected independently for each channel. The Blue Jay base model allows output settings to fire after apogee, while the Blue Jay Plus model also enables outputs to fire before apogee, such as would be used for stage separation or airstarts in a multi-stage flight

Factory Default settings

Apogee Channel

The Blue Jay default settings assigns the channel labeld "Apo" the job of firing a charge at the highest point of the rocket's flight (apogee). Firing a charge at apogee can be used for deploying a parachute for a single-deployment rocket, for separating rocket sections, and/or deploying a smaller drogue chute for a rocket that has dual deployments. With the default settings for the "Apo" channel, the Blue Jay first checks for motor burnout and then detects apogee based on fault-tolerant apogee detection logic that fires when 2 of 3 independent sensor methods detect apogee. The three sensor votes are barometric pressure increasing (altitude decreasing), gyro-based flight tilt exceeding 90 degrees, and accel-only velocity estimate of less than 0 feet/second.

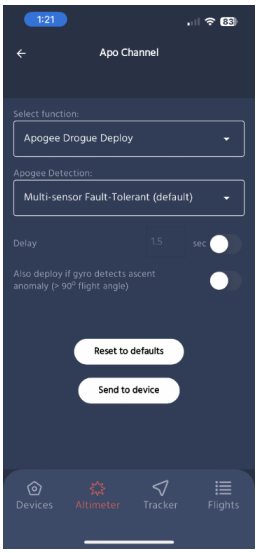
Commented [IJ3]: move explanation to first mention

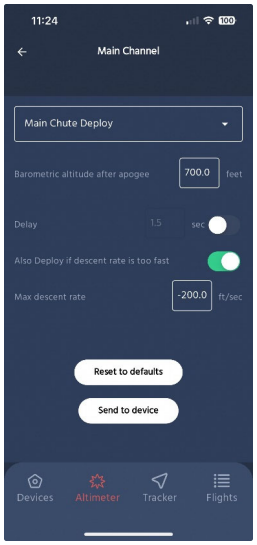
By default, the apogee channel also uses a secondary set of logic to fire immediately if it detects that the rocket flight is unstable while the rocket is close to the ground. This is to reduce risk to people and property in the launch vicinity. The specific conditions for firing are when the rocket tilt exceeds 90 degrees within 2 seconds of liftoff.

Main channel

The default settings for the channel labeled "Main" is for main chute deployments. For rockets configured for dual deployments, the main chute is deployed at lower altitudes to reduce the drift of the

rocket in the wind. The default settings for the “Main” channel will fire after apogee at 700 feet above ground level (AGL).

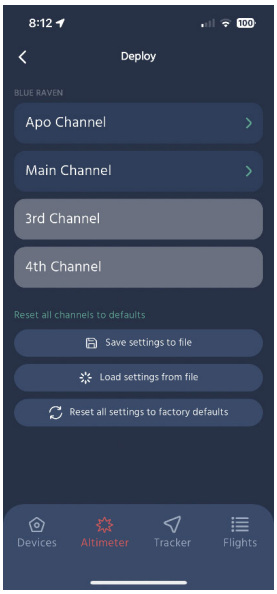




The main channel default settings also enable a backup safety feature in which the main will deploy early if the descent rate after apogee is too fast, as could happen if the apogee deployment did not work as expected. This descent rate threshold is automatically adjusted based on the air pressure during the flight, so that the threshold is crossed for a consistent dynamic pressure. For example, with a threshold velocity of 200 feet/second at sea level, the threshold at 32,000 feet (1/4 sea level pressure) would be 400 feet/second. Due to pressure sensor inaccuracy at very high altitudes, this option should be disabled for flights over 100,000 feet.

Deployment top level view

Clicking on “Set up deploy” in the altimeter screen brings up the deployment top level screen. This view provides access to each channel’s deployment settings, but also some additional options that are not available by just clicking on a channel while in the altimeter screen.



Save settings to file will create a .csv of all the deployment settings and bring up options to share the file through the share options available on your phone, such as email or cloud storage.

Reset all settings to factory defaults will set the deployment settings for each channel to the default values that originally came with your altimeter.

Function-based guided deployment settings with tailored customization

The Blue Jay phone app makes it easy to customize the output channels for your application. Standard output functions like apogee and main chute deployments, stage separation, and motor airstarts can be assigned to either of the hardware channels on the board. Each function has a setup screen with commonly-adjusted settings that are relevant for that function, for example deployment altitude for the main chute function, or tilt limits for the airstart function.

Full customization of deployment logic

With the custom settings option, all of the possible logic settings and thresholds are available for each channel. Each channel has a primary set and a secondary set of events that can be checked. When all the selected events of either the primary or the secondary set are true, then the channel turns on. The "<" (less than) or ">" (greater than) symbols in the table below show the condition that makes an event true. For example, the AGL1 event becomes true when the altitude is less than 700 feet, and it is false otherwise. All thresholds are checked 50 times per second. Except for the NOMANG and apogee checks, each of the following checks can become true or false every time the Blue Jay watches that condition, regardless of the previous state. The "nominal ascent" check controlled by the NOMANG threshold is latched for the remainder of the flight after the first time it goes false, and the apogee event is latched true after apogee is detected.

The following events have thresholds that are individually adjustable for each channel:

Description in the app		Default Value	Units and typical use case
Barometric altitude above the pad	<	700	Feet. Barometric altitude for main chute deployment
Barometric altitude above the pad	>	1000	Feet. Barometric altitude for altitude-based staging ignition
Tilt angle	<	7.0	Degrees. Max allowable current tilt angle
Tilt angle	>	90	Degrees. Detect the end of ascent
Future (+3 sec) Tilt Angle	>	15.0	Degrees. Future (+3 sec) expected tilt trigger
Time since liftoff	<	2.5	Seconds. Inhibit output after time delay
Time since liftoff	>	5.0	Seconds. Enable output after time delay
Accel-based total velocity	<	400	Feet/sec. Transonic inhibit to avoid barometric glitches
Accel-based total velocity	>	300	Feet/sec. Inhibit stage ignition if going too slowly
Barometric downward velocity	<	-200	Feet/sec. Negative is downward velocity. Early main deployment if apogee charge fails and rocket is falling too fast. Threshold is automatically adjusted proportional to barometric pressure to account for lower density at high altitudes
Max Angle for Nominal Ascent	<	60.0	Degrees. Maximum tilt angle for nominal ascent. Once it is false during the flight it will stay false for the rest of the flight.
Motor Burnout Counter	>	1	The burnout count increments each time a positive change in velocity of at least 40 feet/second has occurred followed by a deceleration of at least 5 feet per second. This can be used to gate events after a configurable number of stage burns are complete. This is necessary for a 3rd stage staging/ignition logic to be distinct from 2nd stage staging logic

In addition to the channel-specific events shown above, there are rocket-level flight events that can also be part of any channel's deployment logic.

Rocket Event	Event description and use cases
Liftoff Detected	Always required before any deployment.
Apogee Detected	This fault-tolerant event detection is latched true when 2 of 3 sensor evaluations detect apogee: Baro pressure increasing, total velocity is < 0, Gyro-based tilt angle > 90. This event is checked for the default apogee and main deployment logic, and is latched true for the rest of the flight. This condition can only be ignored for the Blue Jay+ and Blue Raven altimeters.
Barometric Pressure Increasing	A version of the barometric pressure with a strong low-pass filter (slow changing) is used to detect when the rocket is encountering increasing atmospheric pressure (i.e. descending).
Apo channel fired	This event turns true 1 second after the apogee deployment channel first turns on. The delay is there to ensure that any transient events associated with the apogee deployment are complete. This check is used for the default main deployment primary set of checks.
Main channel fired	Similar to the Apo channel fired, but for the Main channel.
ECI Vertical Velocity <= 0	This event is the inertial navigation's estimate for apogee. It uses the gyros and the accelerometer to add up all the accelerations in any direction, while accounting for the rocket's orientation. This is the recommended apogee detection for exo-atmospheric flights where tumbling can happen in a nominal flight.
Accel-only velocity <=0	This event adds up the accelerations in the rocket's liftoff direction, and assumes that the rocket is vertical during the flight. This accel-only apogee detection is one of the 3 independent votes for apogee used in the fault-tolerant apogee detection.

Three other options apply for each channel:

Option	Option type	Description with default values and use cases
Delay after conditions met	[number of seconds]	(Default is 1.5) The output countdown delay timer starts after the checked events are true. When the timer expires the output will fire regardless of whether the checked events are still true. This should not be used as a delay for airstarts, because unsafe conditions such as excessive tilt could occur during the delay and the output will still fire.
Armed at Power-Up	True/False	When true (default for deployments), the channel is enabled at power up. When false, the channel will not fire in flight unless a manual software arming step has taken place pre-launch (default for airstarts)
Keep output on until landing	True/False	Default false. When true, if the output is turned on, it will stay on until landing is detected. When false, the output will be on for 1.0 seconds.

Commented [IJ4]: not entirely sure how this differs from other thresholds

Flight Simulation

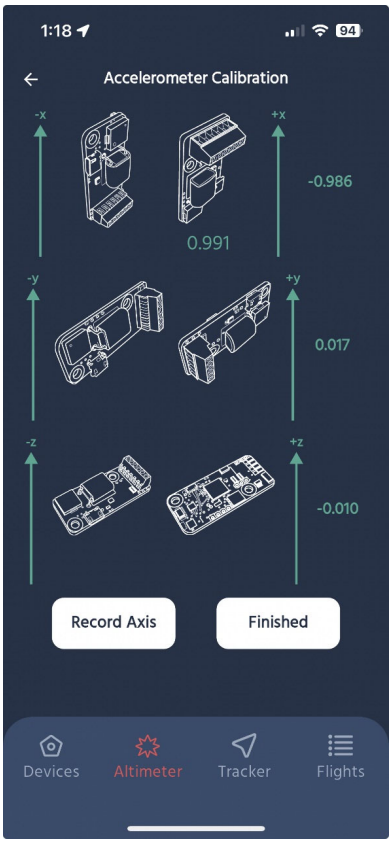
The Blue Jay flight simulation capability verifies that deployment settings work as expected before a real flight, and familiarizes the user with the Blue Jay's flight data recording and analysis features. While the Blue Jay is sitting on the ground, a simulated flight will make the Blue Jay behave just as if it is flying

through all the flight dynamics it would experience in a real flight. The Blue Jay will react by turning on the real output channels under the conditions it would during the flight, and the flight data is recorded just as it would be in a real flight to let the user review the deployment events and the conditions that triggered them. Events that are driven by Blue Jay outputs that affect a real flight's dynamics, including apogee deployment, main chute deployment, and 2nd and 3rd stage motor airstarts can also be simulated and triggered by the real output deployment settings of any of the output channels. Physical effects such as launch angle, atmospheric density changing with altitude, aerodynamic drag, and rocket configuration changes are included in the simulation so that the deployment logic can be fully tested.

Other Simulation Notes

The simulated flight dynamics are added onto the actual measurements made by the accelerometers and gyros during the flight, so be sure to keep the Blue Jay still during the simulation to prevent changes in tilt orientation which would cause unexpected behavior in the simulation.

Accelerometer Calibration



The Blue Jay has 3-axis accelerometers that can be re-calibrated by the user to compensate for sensor calibration drift that can occur over time. Re-calibrating within a few days prior to launch is recommended for best inertial navigation performance but is not necessary for general purpose deployment control.

To calibrate the accelerometers, click the "Start calibration" button in the altimeter screen. Although the diagrams were originally drawn for the Blue Raven, the operation is the same for the Blue Jay.

Position the Blue Jay with any of the edges aligned vertically. The measurements for each axis of the accelerometer are shown along the right side of the screen. When an axis is near 1.0 or -1.0 Gs, and the other axes are or less than +/- 0.025 Gs, the measurement goes from white to green. When you have adjusted the alignment so that all 3 axes are green, click "Record Axis" and the readings for that position are recorded. In the example shown to the left, the +X orientation has been recorded and the -X orientation is ready to be recorded. The fact that the +X axis is done is shown with the +X recorded value of 0.991 Gs. The order of the orientations does not matter because the Blue Jay identifies which axis is up. Re-measuring an orientation is o.k. Once all 6 orientations have been recorded, click Finished. If all 6 orientations have valid recordings, the new calibrations will be stored in flash memory in the altimeter. If there are less than 6 orientations with valid measurements when Finished is clicked, then the altimeter will keep the original calbration on all axes.

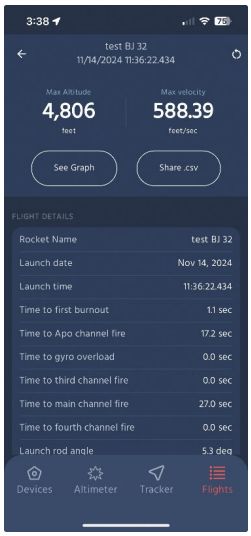
Flight Data Recording and Post-Flight Downloads

The Blue Jay records two sets of data for each flight:

1. Flight summary data such as maximum altitude and speed
2. Low rate data, which includes a large number of measurements recorded at 50 Hz

There is flash memory space in the Blue Jay for two flights. If there is no free space available when the unit is powered up, the oldest flight data is erased.

Both sets of data are downloaded automatically over Bluetooth once the flyer gets back in range of the rocket after the flight. The summary data is downloaded first so that the flight performance is immediately available for review while the other data sets are downloaded in the background. This can take several minutes.



It's possible for the downloaded data to have errors during the data transfer due to weak signal or radio interference. After the download is done, it's best to review the data immediately using the graphs to make sure that there aren't any obvious errors. If there are, the data can be re-downloaded by clicking on the repeat button at the top left of the data summary screen.

Summary value interpretation

Rocket Name

The first line is the user-defined name, up to 13 characters. Name is set in the devices page.

Launch date and time

The times in the summary file are the local time that comes from the phone. If the date and time is close to the build date and time, that indicates that the phone did not provide time information to the Blue Jay, possibly because of a command authorization issue

Time to first burnout

Burnout is detected when the rocket accelerates to at least 40 feet per second, and then the velocity drops by 5 feet per second from the maximum. The motor may still be putting out thrust when burnout is detected, if the rocket is slowing down at that time because the thrust is less than the rocket drag.

Time to Apo channel fire

Time since launch detection of the end of the apogee channel firing (Apo firing start + 1 second)

Time to Main channel fire

Time since launch detection of the end of the Main channel firing (Main firing start + 1 second)

Time to Gyro Overload

Time since launch detection when the gyro reading on any axis exceeds 2200 deg/second (max readout)

Launch rod angle
The angle between the gravity vector measured before launch, and the measured direction of the rocket motion 3 feet after liftoff

Roll rate at burnout
A snapshot of the tilt angle taken when burnout is detected.

Roll rate at burnout
A snapshot of the roll rate taken when burnout is detected.

Thrust tilt efficiency
The ratio of the upward velocity at burnout compared to the integrated axial velocity.

Number of ascent rolls
Total number of roll rotations based on the gyro.

Inertial navigation max altitude
Calculated from all 3 axes of the accelerometer, taking into account the gyro-based attitude during the flight.

Max motor burn acceleration
Maximum acceleration in the rocket axis between launch and burnout

Peak drag deceleration
Maximum acceleration measured between burnout detection and apogee

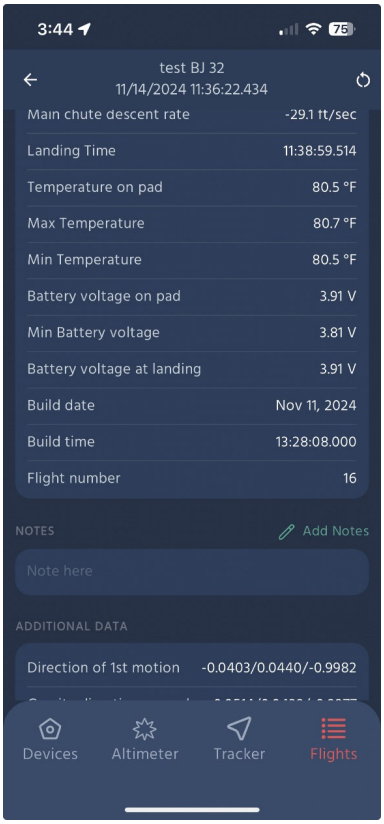
Apo channel max accel
Maximum acceleration measured during the time the apogee channel is active

Main channel max accel
Maximum acceleration measured during the time the Main channel is active

Max landing accel
Maximum acceleration measured during the 10 seconds leading up to landing detection

Drogue descent rate
Barometric-based descent velocity at the start of the main channel firing

Main chute deploy altitude
Barometric altitude at the start of the main chute deployment.



Main chute descent rate

Barometric-based velocity 6 seconds after the main deployment channel turns on.

Landing time

Landing time based on the phone time

Temperature on pad

Temperature at the time of liftoff detection

Max and Min Temperature

Max and min temperature of the baro sensor between liftoff and landing

Battery voltage on pad

Battery voltage at the time of liftoff detection

Min Battery voltage

Minimum battery voltage between liftoff and landing. (Could be lower than at landing due to high firing current)

Battery voltage at landing

Battery voltage snapshot at landing

Build date and time

Date and time of the last time the current firmware version was compiled

Flight number

Number of recorded flights including this one, and including ground tests and simulated flights.

Low-rate downloaded data interpretation

The Blue Jay records a large amount of data at 50 samples per second and exports it in a .csv format which you can open in Excel, Google sheets, Matlab, etc.

Tips for Excel

- Select the first row with the column headers and select wrap cells.
- Select column D (Time) and choose Time for the number format so that it shows the time of day including hours, rather than just the minutes and seconds portion of the time.
- Setting the column alignment to center can make reading the data easier, especially for the flight event register states.

Year, Month, Day and Time are based on your phone's time and time zone. The phone sets the clock of the Blue Jay when it first connects.

Flight time is the time in seconds since liftoff detection, which is somewhat after the first rocket motion. The Blue Raven stores about 2 seconds of pre-liftoff pad data.

The sync code is a millisecond counter recorded in both the low-rate and high-rate data (Blue Raven only) so that the two data sets can be aligned with each other. The sync code rolls over every 250 msec.

Temperature and Pressure come from the barometric sensor.

Baro altitude ASL is the pressure converted to altitude above sea level using the standard atmosphere model with no temperature correction. Baro AGL subtracts off a filtered average of the pad altitude.

Battery volts, apo volts, and main volts are the voltages of the input power, and the continuity voltages across the terminals of the apo and main channels, respectively.

The velocity and inertial position data are given in ground-relative inertial coordinates (rather than rocket axes), which is possible due to the rocket attitude propagation performed on-board using the gyro measurements. These measurements are only reasonably accurate as long as the rocket experiences rotation rates within the measurement range of the gyros (+/- 2000 deg/sec). If the rocket has rates beyond that (often the case for small rockets immediately after chute deployment), the rocket will lose track of which way is up, and the effect of gravity will generate large errors on the position and velocity estimates. Other normal gyro and accelerometer measurement errors can also contribute to significant errors in the velocity and position estimates, particularly in the horizontal directions.

The tilt angle is the angle between the rocket's axis and vertical. The Blue Jay can be mounted in any orientation, and so it measures which direction, relative to its sensors, is the rocket axis by measuring the direction of the initial motion while the rocket is on the rail. The Future tilt angle is a prediction of what the tilt angle will be 3 seconds into the future. This is useful as an airstart trigger on a two or three stage rocket because it allows the maximum coast time while staying within a tilt limit, accounting for a conservative ignition delay. It is calculated during the flight based on the inertial vertical and horizontal velocity assuming the rocket is pointed in the flight path direction.

The roll angle is a simple integration over time of the measured roll rate perpendicular to the rocket axis. It does not take into account how motion in other axes affects the rocket orientation.

There are five Flight event registers: One rocket-level Flight Event Register that records the flight events that affect all channels (such as apogee detection). Each of the 4 output channels has a separate channel flight event register, which is governed by a set of independent event thresholds for each channel. The values are hex-encoded binary values that use one bit for each event. The flight event registers are expanded into binary states in the subsequent columns. These states are all the criteria that can be used to trigger an output that were described earlier in this manual.

Commented [IJ5]: delete have or use

Commented [GU6]: Reword into 2-3 sentences

Specifications

- 1.45" long by 0.65" wide, fits into an 18mm Estes BT20 tube
- 4.7 grams
- Mount in any orientation
- Two screw terminals per e-match
- Mounting holes for 4-40 screws (included)
- Magnetic switch has approx. 2" range

- Compatible with any size battery up to 12V (1s lipo recommended)
- Power consumption: 15 mA
- Two output channels
- Automatic current limiting to 1 Amp
- Automatic brownout protection by turning off outputs if onboard voltage drops too low.
- Continues to operate after power interruption for approx. 15 msec
- Sensors:
    - 3-axis +/- 32G accelerometer (Blue Jay 1 and Blue Jay 2)
    - 3-axis +/- 400G accelerometer (Blue Jay 2)
    - 3-axis gyroscope (2200 deg/sec for Blue Jay 1, 4000 deg/sec for Blue Jay 2)
    - Barometric sensor (apogee detection possible at > 80,000 feet)
    - Apogee and Main channels continuity voltage
    - Battery voltage
- 50 samples per second data recording:
    - Barometric sensor altitude and temperature
    - Tilt angle, roll angle, and predicted tilt +3 seconds
    - Vertical velocity, down-range horizontal velocity and cross-range horizontal velocity
    - Battery voltage and continuity voltage on both outputs
    - All flight events used for deployment logic