BladeRunner ™

Precision Propeller Controller

Installation & Operation Manual

Manufactured by
Aerolink Precision Instruments LLC
Exclusively for
Eggenfellner Aircraft Inc.

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Product Description

BladeRunner is a precision, microprocessor-based, electronic propeller controller offering both in-flight-adjustable and constant-speed modes of operation and a propeller tachometer with digital display.

Pilots use a single knob to select the desired mode of operation and propeller RPM. The controller will maintain the desired RPM by varying the pitch of the propeller blades. It will also enforce a 'red-line' RPM limit for the powerplant.

WARNING - PLEASE READ CAREFULLY

This product was designed to work exclusively with powerplants from Eggenfellner Aircraft Inc. equipped with Quinti/Sensenich or MT electric constant-speed propellers in Experimental Category aircraft. It is NOT intended to be used in production certified aircraft or in any other application. Use of this product with any other powerplant or propeller is strictly forbidden and very likely to result in damage to the controller, the propeller or the powerplant and create an unnecessary risk to the aircraft and its occupants.

Customers must review, sign and return the End User License Agreement before purchasing, installing and using this product.

Specifications

- Working Input Voltage Range: +10.0 VDC to +16.5 VDC
- Nominal Servo Drive Range: 1.0 to 9.5 Amps
- Limited Servo Drive Current: 9.5 Amps (Internal, self-resetting fuse)
- Temperature Range: -35C (-31F) to +85C (185F)
- Required External Circuit Breaker: 15A push-pull type (not provided).
- Maximum Controlled Prop RPM: 2900 (Programmable)
- Connector: Single DSUB DB-9 (Male end on wiring harness)
- Mounting: In-Panel or Under-Panel

Installation

Installation should be performed by a competent aviation electrician. Familiarity with aviation electrical tools, practices, and procedures is required.

Mounting Location

The controller may be mounted in or under the instrument panel. The controller can be oriented vertically or horizontally. The location is a matter of pilot preference, but some thought should be given to the following points:

1. **For best daytime visibility, mount the controller in a shaded location within a reasonably direct line-of-sight. The display uses advanced polarized optical materials to minimize reflected light, but a little shade from your glare panel or an overhanging instrument panel will greatly improve daytime visibility.**
2. Is the control knob within reach of both pilot and co-pilot? Keep in mind that this knob controls your speed and is used more often than your throttle.
3. Is the external circuit-breaker mounted near the controller and clearly labeled?
4. Is the controller mounted away from direct heat sources?
5. Is there enough room behind the controller to install the DB-9 connector and wiring harness and to allow some cooling airflow?

Mounting Method

Your controller is packaged with a pair of mounting brackets and set-screws.

Through-Panel Method: Make a cutout in your instrument panel **1.2" high by 4.3" wide**. Be sure to leave room for the front bezel overhang which is approximately 3/16" larger on all sides. Also be sure to provide at least 5" of depth behind the panel for the controller and connector. Insert the controller through the cutout. Slide the mounting brackets from the rear of the controller into the dove-tailed slots on the sides. For best results, insert the brackets upside-down so that the horizontal flange of the bracket is located roughly in the center of the sides of the controller. Slide the brackets against the back-side of the panel and secure with the set-screws (3/32" hex key).

Under-Panel Method: Slide the mounting brackets from the rear of the controller into the dove-tailed slots on the sides and tighten the bracket set-screws (3/32 hex key). Position the controller and mark the position of the bracket slots. Drill two holes in the panel for mounting screws. Secure the controller with two screws and washers (#10-32 recommended, not supplied).

NEVER DRILL HOLES INTO THE CONTROLLER CASE!

Electrical Connections

The controller wiring harness has five wires marked with colored tape.

1. RED: +13.8V (nominal) Power. Switched via Master Switch or similar.
2. BLACK: Airframe Ground
3. WHITE: Propeller Hub Servo Motor Lead A
4. GREEN: Propeller Hub Servo Motor Lead B
5. BLUE: Tachometer Input from Fuel Injector Pulse

The provided wiring harness should be long enough for the typical installation. If it is necessary to extend the wires, consider using a terminal strip at the point where extensions are required.

NOTE: If you decide to create your own harness using a new DB-9 connector, dismantle the provided connector and note the pin assignments and the four pin-to-pin jumper wires. This pairing of pins is essential for the connector to carry the required amperage and provides a degree of redundancy.

Harness Power Wire (RED Tape. Internal Connector Pins 1 & 9)

Hook this wire to ships power through an external 15 Amp circuit-breaker. The circuit breaker must be a good quality aircraft type breaker such as a “Klixon” brand. Either push-pull or switch type is fine. The breaker must be clearly marked and accessible to the pilot.

The source of power must be a switched bus, so that the controller turns on and off with the Master Switch. Some electrical systems have multiple buses. In this case, be sure to install the controller on a bus that will continue to supply current during a primary bus failure. There are a variety of methods used to control multiple-bus systems, so we can only assume that proper bus switching and isolation techniques have been employed. Consult an avionics expert if you are uncertain about your system.

WARNING: In the event of total loss of power or internal component failure, the controller is designed to freeze in its current prop pitch position. Assuming that you were flying to being with, you should still be able to fly the plane to a safe landing. Learning to fly with a variety of sub-optimal pitch settings is yet another piloting skill that you should practice often. Your propeller hub must also have its mechanical pitch-stops adjusted to match the proper flight envelope of your aircraft. This prevents any situation where the pitch is so far out of range (excessively fine or coarse) that the aircraft is un-flyable. Consult your propeller documentation for adjustment guidelines.

Harness Ground Wire (BLACK Tape. Internal Connector Pins 3 & 7)

Hook this wire to your main airframe ground.

Harness Servo Motor A (WHITE Tape. Internal Connector Pins 2 & 6)

See below.

Harness Servo Motor B (GREEN Tape. Internal Connector Pins 4 & 8)

The two longest wires in the harness are to be routed to your propeller brush assembly. Connections to the brush assembly can be made through a small terminal strip, properly crimped aviation quality connectors, or soldered connections. Protect these connections from moisture, heat and vibration.

Your propeller servo motor turns in both directions, thus there is no *positive* or *negative* wire because the controller reverses the polarity to reverse the direction of the motor. Instead, servo motor wires are typically referred to as Servo "A" and "B".

So which servo motor wire is 'A' and which is 'B'? Good question! We won't actually know until we power up the controller and test it. Just hook them up either way for now. There is a 50% chance that we'll get them backwards. If we need to swap them, we can easily do so at the prop hub brush block.

Harness Tachometer Wire (BLUE Tape. Internal Connector Pin 5)

A unique feature of the BladeRunner controller is that it does not use a traditional magnetic tachometer pickup on the prop hub. If your prop has one of these, you can remove it, use it for another purpose such as an EFIS-based tachometer, or just tie it off.

Because the BladeRunner was designed exclusively for Eggenfellner Aircraft Inc. powerplants, and all of these powerplants have Electronic Fuel Injection, and all come factory pre-wired with a "Fuel Injector Pulse" wire, we will use that wire as the source of our tachometer signal.

Do not confuse the Engine Control Module's (ECM) "Tachometer" wire with the Fuel Injector Pulse wire! The type of signal found on each of these wires is dramatically different. We want only the <u>*Fuel Injector Pulse*</u> wire.

Identify your Fuel Injector Pulse wire in your engine wiring harness. It should have been labeled at the factory. If you cannot identify it or your wiring harness does not appear to have it, do the following:

1. Look at the fuel injectors. Each one will have two wires.

2. One of these two wires will be the same color on all fuel injectors, while the other wire will be a unique color on each fuel injector.

3. Use any one of the UNIQUELY colored wires as the tachometer source.
4. Splice into one of these wires with a run of 22 gauge wire back to the controller. Protect the splice well with tape or sealant or shrink-tubing.

Proceed with the next two sections: Basic Controller Concepts, then Initial Controller checkout.

Basic Controller Concepts

Let's review some terminology and gain a basic understanding of how the controller works.

Pitch = The angle-of-attack of the prop blades. Pitch is typically limited to a safe range by mechanical pitch stops inside the hub.

Fine Pitch = A pitch angle very nearly flat. A fine pitch takes a small 'bite' of air. This is useful for starting, taxiing, accelerating during takeoff, climb and using the propeller as an air-brake. The act of selecting a finer pitch is referred to as ***DECREASING PITCH***.

Coarse Pitch = A pitch angle which is NOT nearly flat. A coarse pitch takes a sizeable 'bite' of air. This is useful for cruising at high speed, for fast descents and for best fuel economy. The act of selecting a coarser pitch is referred to as ***INCREASING PITCH***.

When the pilot selects a RPM value using the prop controller, the controller adjusts the propeller pitch as necessary to obtain and then maintain the selected RPM. A fine pitch allows the engine to run at a higher RPM by taking very small bites of air (small angle-of-attack). Conversely, a coarse pitch slows the engine down by taking a bigger bite of air (high angle-of-attack), placing a higher load on the engine.

For any aircraft with a properly matched propeller and powerplant, there will be a point where the engine cannot develop enough horsepower and torque to accept a coarser pitch setting, or the prop blades may stall if the prop is too small for the available power. This is the classic trade-off for people using fixed-pitch props. Do I want climb performance (fine), or cruise performance (coarse)? The compromise is usually somewhere in between. This compromise is not required with a variable pitch prop.

If engine power were unlimited, a coarse pitch would also provide best climb performance, but these engines develop their best power at high RPM, thus we use a finer pitch during climb to achieve a high RPM and best use of the engines power curve.

When we level out after climb, the load on the propeller and engine are reduced because we are no longer fighting gravity. At this point, a fine pitch might allow the engine to over-speed if we didn't do something to change the load. So in cruise flight, we can use a coarser pitch to take a larger bite out of the air and provide enough additional load to prevent the engine from over-speeding. In essence, we have traded the load associated with climb (gravity) for the load associated with speed (drag).

One of the most important things a propeller controller must do is to prevent the engine from over-speeding. This is done by increasing the pitch (coarser) as the engine reaches its red-line RPM. In a long descent, the controller will also need to increase pitch (coarser) to maintain the selected RPM because the load is dramatically reduced during a descent. As you might imagine, the controller is very busy, 'constantly' changing pitch to maintain the selected RPM, hence the term "*CONSTANT-SPEED*".

Notice that I have yet to mention the throttle. For pilots who have never flown with a constant-speed prop, this is a strange concept, but here goes… *The throttle does not control the vehicle speed.* In fact, it never has, even in a low-end Cessna or your family car.

The throttle controls the amount of *power* generated by the engine. It is the *load* on the engine and vehicle that ultimately controls its speed at any RPM significantly above idle. Consider what would happen in a car if you stomped on the brakes while applying full throttle? Your speed would remain zero, even at full throttle, because of the high brake load you are placing on the engine. So is it the throttle or the load that controls vehicle speed?

In an aircraft with a fixed-pitch propeller, the illusion that the throttle controls engine speed is a result of that compromise in prop selection we talked about. Since you can't change the pitch of the prop, you have little means of altering the load on the engine, other than to climb or descend, so your only option when landing is to reduce the power being generated by the engine by restricting its air intake via throttle, letting the forces of drag and gravity take over.

When flying an aircraft equipped with a constant-speed prop, you should learn to think of the throttle as a 'power' lever. The controller will do the best it can to maintain the selected RPM using the amount of power you have made available to it.

For takeoffs, we need all the power we can get, but in cruise, we have an option of reducing power and saving fuel, or maintaining high power and trading it for speed. Many pilots will simply leave the throttle wide open and fly the entire flight using propeller pitch to control speed, right up to the final landing. There is nothing wrong with this approach. The engine is most efficient when it is not being artificially starved for air (i.e. the throttle is wide-open). However, our happy engine is also going to be a thirsty engine.

Each aircraft has a 'sweet-spot' in cruise flight where it achieves best overall efficiency. Once you discover this about your own aircraft by experimenting with various pitch/RPM and throttle combinations, you'll find that you can save considerable fuel without losing much speed, by reducing the throttle slightly. So in this regard, you can treat the throttle almost as you would a mixture control. Trim the plane for hands-off flying, then trim the prop pitch for best cruise, then trim the throttle for best economy.

There is another variation of propeller and controller which is known as "in-flight adjustable". For some light aircraft applications, all that is desired is a way to let the pilot adjust the prop pitch directly. This type of controller can be as simple as a DPDT toggle switch with some sort of pitch limiting mechanism. The advantage of an in-flight-adjustable prop is lower cost and simplicity. However, it places higher burden on the pilot to know and maintain the right pitch and it is very difficult to maintain a steady RPM in the very fluid world of flight. On the other hand, many pilots were trained using aircraft with fixed-pitch props and are thus more comfortable with thinking of their throttle as the primary means of controlling speed.

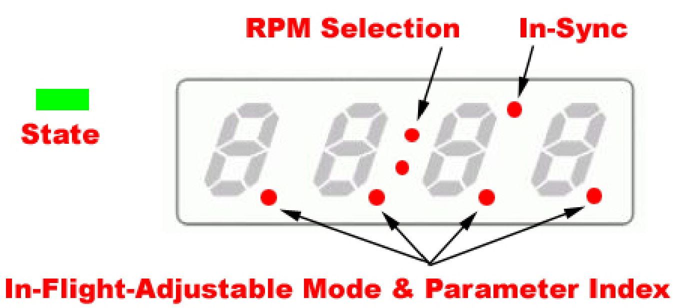
The BladeRunner controller offers both constant-speed and in-flight-adjustable modes of operation. When a pilot selects the in-flight-adjustable mode of operation, the BladeRunner controller will seek the RPM selected by the pilot, but once achieving this RPM, it will suspend further pitch changes until the pilot selects a different RPM or returns to constant-speed mode. This will be explained in greater detail later in this manual.

The advantage of supporting both modes is primarily for landing the aircraft. By landing the aircraft with a fixed propeller pitch, the engine can be run at a lower RPM, reducing noise around our airports and allowing the pilot to *fly-by-throttle* as they would in a typical Cessna. It's a matter of personal preference. Some pilots like this, others don't. You have a choice!

The pilot can switch freely between modes at any time. In-flight-adjustable mode can also be useful in very turbulent air where a constant-speed prop has to work extremely hard to maintain a stable RPM.

Indicators

This illustration highlights the various indicators. The function of each is described below.



- **STATE** – Green when servo motion is being controlled. Red when servo motion is suspended for any reason, such as when blades have reached their mechanical pitch-stops.

- **RPM Selection** – This colon is displayed whenever the pilot is in the process of selecting an RPM using the knob. A few seconds after the selection is made, this indicator turns off and the display returns to its tachometer function.

- **InSync** – Whenever the propeller RPM has synchronized with the selected RPM, this indicator will appear.

- **InFlightAdjustable Mode –** When the In-Flight-Adjustable mode is selected, these four dots will appear. Think of them as indicating "land" or the "runway" because this mode is most often used when landing the aircraft. When calibrating parameters, these dots are used as decimal points in some cases.

Initial Controller Checkout

The BladeRunner controller is very simple to operate, but a few things need to be set up and verified after installation.

WARNING - Be sure to complete these tasks prior to first flight with your controller!

Servo Motor Polarity

The first thing we will need to verify is the polarity of the servo motor 'A' and 'B' wiring. This is an easy test. Just turn electrical power on, **without starting the engine**, and the controller should run the propeller to ***FULL FINE*** pitch.

When the blades are at full fine position, the controller display should appear as shown below (assuming that you have not disabled the tachometer and your engine is stopped).

Note the red color of the State LED. The State LED will turn red whenever the controller suspends servo motion for any reason. In this case, it has suspended servo motion because the blades have reached their mechanical pitch stops.

Observe your propeller blade pitch. The blades should be nearly flat, with only a small amount of pitch. Don't make a mistake here! The blades must be in their FULL FINE position.

If instead, your propeller blades moved to a FULL COARSE position, then the polarity of your servo motor A and B wires are backwards. This can be corrected by swapping the electrical connections of the two servo motor wires at your propeller hub brush block or terminal strip if that is more convenient.

DO NOT ATTEMPT TO FLY UNTIL THIS IS RIGHT!!!

WARNING - It is critically important that your propeller hub's mechanical pitch stops are set so that the propeller pitch is always adequate for safe operation. If set incorrectly, the aircraft could be difficult to fly with excessively fine or coarse pitch. There should be no possible pitch position that would render the aircraft incapable of safe flight in the event of an electrical failure. Adjust your pitch stops as needed, referring to your propeller vendor's documentation. This is YOUR responsibility. Take this repeated warning very seriously.

Tachometer Verification

The BladeRunner controller uses a *fuel injector pulse* as its tachometer source. Because four-stroke engines fire their injectors during their intake strokes and these strokes occur on every second revolution, this pulse will occur at one-half the engine RPM and will be no different for 4 or 6 cylinder engines, thus, this mechanical relationship does not change. However, Eggenfellner Aircraft Inc. utilizes a variety of Propeller Speed Reduction Units (PSRU or Gearbox). Because the BladeRunner uses and displays PROP RPM, it must internally perform the calculations required to compensate for the gear ratio of the PSRU.

If you ordered your BladeRunner along with your engine, then the factory will have already calibrated the controller for the PSRU on your engine (refer to the factory calibration label on top of the controller). If your BladeRunner controller was not factory-calibrated, or you have changed to a different PSRU, then you may need to re-calibrate the tachometer display. Refer to the section titled "Calibrating the Controller" for details.

The tachometer display (if not disabled) should read "0000" when the engine is stopped. During operation, you will notice that the least significant digit of the tachometer display always reads zero, thus the indicated RPM is rounded to the nearest 10. This was done to reduce the cockpit distraction of a continually changing display. The remaining digits will change as needed to display the current RPM, but during level cruise in constant-speed mode operation, the BladeRunner controller is capable of maintaining engine speed within this 10 RPM window. In actual operation, pilots quickly become accustomed to the sound of their engine and will rarely need to look at the tachometer.

Start the engine now and verify that the tachometer display reads correctly. Keep in mind that the BladeRunner always displays PROP RPM, not engine RPM.

Note: The tachometer feature can be disabled to reduce cockpit distraction if so desired. When disabled, the controller displays the selected RPM rather than the actual RPM. Keep this in mind during the following checkout procedures as the descriptions assume that the tachometer is enabled.

Synchronizer Checkout

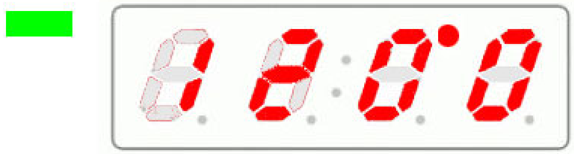
Taxi or tow your aircraft to a proper location where you can do a run-up.

Insert wheel chocks, climb in, set the brake and start your engine.

Turn the BladeRunner knob to select 1200 RPM. Note that a few seconds after rotating the knob, the display resumes indicating propeller RPM. Note also, that while turning the knob, the State LED turns red as a means of indicating that the controller has temporarily suspended servo motion. When the controller resumes normal operation, the State LED again turns green, unless servo motion was also suspended due to reaching a mechanical pitch stop.

Very gradually apply throttle, watching the BladeRunner display. As the current RPM nears the target RPM the controller should start adjusting the pitch to intercept and hold 1200 RPM

+/- 10. Whenever synchronization has been achieved, the small red “In-Sync Dot” should appear as shown below (between the least significant two digits).



Now, if you continue to add throttle, your engine should develop enough power to overcome the current pitch setting and the controller should respond by increasing the blade pitch to further reduce the RPM back to 1200 +/- 10 RPM. The response may require a few seconds due to mechanical factors in your hub, NOT the controller.

Let the RPM stabilize for a few seconds at 1200 PROP RPM. Now turn the knob to select 1400 RPM. Within a second or two of releasing the knob, you should hear the engine speed up to indicate 1400 RPM. Now turn the knob to select 1200 RPM again. You should hear the engine slow down again to 1200 RPM.

Your controller is working properly. You can experiment with various RPM values if you like, but be respectful of the noise and debris hazards you may be creating.

Some engines are powerful enough and accelerate quickly enough to get ahead of the selected pitch. For example, on takeoff, if you abruptly slam the throttle wide open, it may take the propeller hub a few seconds to move the blades coarse enough to catch the engine and prevent over-speeding. This is not typically the fault of the controller! The controller cannot make the gear-driven servo motor move any faster than it is designed to move. Of course if the controller is never telling the hub to move, then it may be the controllers fault. This should be easy to figure out using the test method just described and a practice takeoff run if necessary. It is generally a good practice to *roll-on* the throttle smoothly during takeoff to allow the propeller hub to remain in sync.

At this point, your propeller and controller appear to be working as expected.

Operation

Flying with the BladeRunner Controller

The beauty of a variable-pitch propeller and constant-speed controller is that there is no need for compromise, between climb and cruise performance. You will be able to achieve maximum climb and cruise performance under all conditions of flight. During a typical flight, the controller will quietly make thousands of small pitch adjustments to maintain the best performance for the level of power you have made available.

From the pilot's perspective, your throttle determines the overall amount of power being developed by your engine and the RPM selected by the knob on the controller determines how this power is to be allocated; to climb or cruise speed.

We will now discuss operation through a typical flight sequence from engine start, through the various phases of flight, to engine shutdown.

Engine Start

When you first apply electrical power to the BladeRunner, it will move the propeller pitch to FULL FINE position. The State LED will turn RED, indicating that servo motion has been suspended once the pitch has reached its mechanical limit. The full fine position allows the engine to be started with minimum propeller loading. Once started, the propeller RPM will be indicated.

Taxiing & Run-up

As you apply throttle, the full fine pitch allows the aircraft to begin rolling with very little effort. This is perfect for taxiing.

The BladeRunner provides a default "Initial RPM" selection (typically 2500) which is suitable for takeoff or go-around power if no further pilot input is provided. This value can be altered if a different initial RPM is desired. Refer to the section "Calibrating the Controller" for more details.

It is unlikely that you would exceed this Initial RPM value during taxiing, but you might while doing a normal run-up. In which case, you would notice that the State LED turns green as the controller initiates servo motion to maintain the selected RPM. This is a good thing to look for during a run-up as an indication of proper controller operation. If your aircraft cannot achieve this static RPM during run-up, you may want to consider specifying a lower Initial RPM, or just dialing in a slightly lower RPM to determine proper controller operation as part of your routine run-up checklist.

When your run-up is complete, select the desired RPM for takeoff before taxiing into position.

Takeoff

Takeoff typically benefits from maximum climb power, so select a suitable RPM for the current runway length and conditions.

For a max-effort, short-field, takeoff, you will probably want to select the highest RPM value. By default, this is factory-set at 2700 RPM. This can be altered if your particular aircraft requirements are different. Refer to the section "Calibrating the Controller" for details.

If you have plenty of runway and suitable weather conditions, you may want to use a slightly lower RPM (coarser pitch). The tradeoff will be slower acceleration and shallower climb rate, but faster speed and lower engine RPM and temperatures. Most takeoffs will occur between 2500 and 2700 RPM.

Be aware that you can calibrate your controller to allow even higher RPM, but if your prop turns too fast, the tips can go super-sonic, setting up a lot of noise and dangerous vibration with significant loss of efficiency. 2700 is the generally accepted limit for most sport aircraft propellers. The BladeRunner prohibits calibrating for greater than 2900 RPM.

Climb

The fine pitch used for takeoff is suitable for climb, but most pilots prefer to select a slightly coarser pitch (lower RPM) during the climb. Get familiar with your climb performance at a variety of RPM values. Often, you will not want maximum climb angle for the entire duration of the climb. Selecting a lower RPM, possibly through a series of adjustments, will result in a shallower climb rate with higher airspeed and better engine cooling.

Cruise

Cruise flight is where you can really experiment with the wide variety of pitch and throttle settings. If you are in a hurry to get somewhere, you will find a ‘sweet-spot’ pitch for a wide-open throttle.

Slowly adjust your RPM value, allowing several seconds for the aircraft to respond, while observing your TAS or GPS speeds. If your RPM is set too high (fine pitch) the speed will fall off, similar to a car being left in first gear. If your RPM is set too low (coarse pitch) you will reach a point where you run out of power to turn the prop and your speed will fall off again, like a car going up-hill in a high gear. Once you identify your aircrafts’ sweet-spot, record or take mental note of this optimal cruise RPM.

If you are not in a hurry, you will probably prefer a much lower cruise RPM and reduced throttle position. Most props, no matter how well balanced, will have certain RPM ranges that deliver a smoother ride. For pure economical and smooth travel, try to identify a cruise RPM that feels smoothest and quietest. Once you locate this RPM, now slowly back off the throttle, watching your TAS or GPS speeds and fuel-flow, if so equipped. You will discover that you can save a lot of fuel without sacrificing much speed. For long trips, this might be just the ticket to reduce pilot and credit-card fatigue!

Descent

There are two decent ways to handle descent, although there may be dissenting opinions on the subject.

First, a long slow descent places very little load on the engine, so you may want to select a lower RPM (coarser pitch) and reduce throttle to prevent wind-milling the engine during descent. This will result in a faster airspeed, so pay attention to your VNE.

Second, for you Top-Gunners out there, you can achieve astonishing descent rates by selecting a high RPM (finer pitch) and greatly reducing the throttle. In this configuration, the propeller is acting as a speed brake and the plane will literally ‘drop like a rock’. You need to pull the throttle back quite far to prevent wind-milling and over-speeding the engine, but descent rates of nearly 8000 fpm have been achieved (by well known Norwegians) in this manner! Be prepared to increase the pitch as you pull out of this maneuver or you’ll over-speed for sure.

Aerobatics

Since we’ve got our adrenaline pumping, let’s talk about aerobatics.

Electrically operated props are not ideal for aerobatic flight because they change pitch much slower than hydraulically operated props. For mild aerobatics, you may be able to leave the controller in constant-speed mode and simply watch out for over-speed conditions. Or you may prefer to put the controller into its in-flight-adjustable mode and handle pitch changes yourself. In-flight adjustable mode is described in more detail under “Landing”.

Give it a try and let us know what works best.

Landing

As with most things in aviation, there is more than one way to land an airplane and walk away smiling. Here are two methods.

Constant-Speed Mode Landings

Consider what RPM would be best for doing a go-around if necessary. Typically, 2300 to 2500 is sufficient for go-around power. Higher RPM if you have terrain concerns. Select this RPM during entry into the traffic pattern. If you have been descending, then your engine is likely to speed up when you select this RPM. That’s OK. Landing in constant-speed mode involves higher RPM.

Continue flying the pattern. Slowly reduce your throttle. As you do, the controller will continue to move the prop blades to a finer pitch, attempting to maintain the high RPM. The net effect is that the prop starts acting as a speed brake, so make your throttle adjustments very slowly, paying attention to any faster-than-expected loss of speed and altitude. Generally it is wise to carry a little extra throttle into the base leg and make final throttle adjustments during final approach.

On final approach, very slowly reduce throttle, paying attention to speed and altitude loss. When you are over the numbers and have the landing assured, continue reducing throttle to touchdown. Upon touchdown, if you pull the throttle all the way off, the prop will go to full fine pitch, if not there already, and the plane should slow down very rapidly.

If a go-around is needed, you will already be in a perfect pitch for power application and fast response, so just apply throttle and proceed with your go-around.

In-Flight-Adjustable Mode Landings

Some pilots are more comfortable *flying by throttle*, similar to how you would fly an aircraft with a fixed-pitch prop. The BladeRunner controller allows you to select in-flight-adjustable mode at any time. This can be particularly useful for landings. I personally prefer this method because of noise concerns around my home airport. Screaming over the fence at high RPM is not a neighborly thing to do where I live. Here's a more lawyer-friendly approach.

Consider what RPM would be best for doing a go-around if necessary. Typically, 2300 to 2500 is sufficient for go-around power. Higher RPM if you have terrain concerns. Select this RPM during entry into the traffic pattern. If you have been descending, then your engine is likely to speed up when you select this RPM. That's OK for now.

PRESS THE CONTROLLER KNOB ONE TIME. This is how you toggle between constant-speed and in-flight-adjustable modes. In-flight-adjustable mode is indicated by a row of dots (decimal points) between each digit of the display as shown in the following illustration. Think of this as indicating "land" (preferably a runway).

In this mode, the controller will attempt to achieve the selected RPM <u>one time only</u>.

Once it is in synchronization, indicated by the "In-Sync" dot, the controller will make no further attempt to adjust pitch.

In essence, you are now flying a fixed pitch prop that has been optimized for the RPM you selected.

The controller will resume making adjustments to pitch only if you select a new RPM, return to constant-speed mode (by pressing the knob again) or start to exceed red-line RPM.

Make sure you have achieved "sync-lock". That is, make sure the "In-Sync" dot is on. If not, give it a short burst of throttle to allow the controller to synchronize with your selected RPM.

From this point on, you can land the plane using throttle alone to control prop speed. This makes for nice quiet landings. If you need to go-around, simply reapply throttle. Your prop is already optimized for the selected go-around RPM.

At any point, you can select a different in-flight-adjustable RPM/pitch. Just be aware that the pitch will not be "sync-locked" until the engine actually reaches the selected RPM.

To return to constant-speed mode, simply press the controller knob ONCE. The row of dots will turn off and you are back to constant-speed operation.

Experiment with both modes of operation at any time during flight. Each mode has its benefits. In extremely turbulent air, in-fight-adjustable mode can offer a smoother ride because the controller will not be constantly tweaking RPM every time you hit a ‘bump in the road’.

Parking

After landing, if you are in constant-speed mode, the controller will automatically seek full fine pitch simply because you have reduced throttle to the point where even full fine pitch cannot achieve the selected RPM. Thus you will be all set for ideal taxiing. *Taxi to parking, contact ground, g’day!*

If you are in in-flight-adjustable mode, your prop is probably in sync-lock with whatever pitch you last selected. Chances are this is fine enough for taxiing, but if you prefer full fine pitch, either press the knob once to return to constant-speed mode or select the highest RPM. Either way, you will return to full fine position. *Taxi to parking, contact ground, g’day!*

Dimming the Display

During night operation, the display can be dimmed approximately 30% by pressing the controller knob TWO TIMES in rapid succession. Repeat this procedure to return the display to full intensity.

The BladeRunner uses a type of LED (Light-Emitting-Diode) display. This was selected over a LCD (Liquid-Crystal-Display) because it has better environmental and lifecycle specifications. LCD displays are a problem in cold climates and have notoriously short lifespan. More exotic types of displays were available but at prohibitively high cost.

Unfortunately, LED displays are not ideal in direct sunlight. For this reason, we strongly suggest that the controller be located in a position where some shade is offered by a glare panel or by suspending the controller underneath (and slightly behind if possible) the instrument panel. For best readability, you may occasionally need to use your hand to shield the display from direct sunlight.

Calibrating the Controller

The BladeRunner controller is factory calibrated and should never require further adjustment. However, there are a few user-programmable features that are worth discussing, so we may as well run through the whole process.

The following parameters can be user-specified in the following order.

1. Initial “Go-Around” Prop RPM
2. Maximum “Red-Line” Prop RPM
3. Pitch Stop Feedback Amperage
4. Tachometer Calibration Factor
5. Tachometer Display Enable/Disable

These parameters are pre-set at the factory to match your particular propeller and powerplant combination. We prefer that users avoid changing these parameters, but in some circumstances it makes sense to allow changes. Be advised however, that you can do great damage by ‘arbitrarily’ changing these parameters and we have methods of tracking user changes, so don’t expect a lot of mercy if you return a burnt out controller or damaged servo motor to us! Consider yourself duly warned.

Entering Calibration Mode

The five parameters are specified in sequence. When entering calibration mode you will step through each of the parameters. Change only those that require new values.

When the sequence completes, the full set of parameters will be saved. Yes, if you totally screw up, there is an easy way to return to the factory defaults.

Calibration can be done in-flight, but be aware that controller operation will be suspended during calibration and the new values will take effect the moment calibration is completed. This could create surprises and most pilots don’t like surprises.

To enter calibration mode, press the controller knob FOUR TIMES in rapid succession. The first parameter will be displayed. Turning the knob changes the parameter value. Pressing the knob ONCE, steps to the next parameter. When there are no more parameters, the next press will exit and save any changes made and the state LED will turn green again. If no changes to a parameter are required, just step to the next one.

In sequence, here are the descriptions of each parameter.

Initial RPM & Go-Around Prop RPM

- 2500 (default)

This is the RPM that will be in effect whenever power is applied to the controller. The value should represent an RPM which is appropriate for go-around operations and for safety reasons, should also be high enough to allow the plane to be flown by a pilot who is unfamiliar with the controller operation. The controller will not allow this value to be greater than the Maximum Red-Line Prop RPM, although it can be equal to that value.

Maximum Red-Line Prop RPM

- 2700 (default)

Maximum enforced Prop RPM. Set this too high and your blades can self-destruct. For this reason, the controller will not allow this value to be higher than 2900. Set this value too low and the aircraft becomes a taxi-cab. For this reason, the controller will not allow this value to be less than 2000.

Pitch Stop Feedback Amperage

- 9.0 for the Quinti/Sensenich 4-blade Hub (default)
- 8.0 for the Quinti/Sensenich 3-blade Hub
- 4.5 for the MT 3-blade Hub

This value is used in an equation that determines the maximum instantaneous amperage allowed to be drawn by the servo motor before declaring that the blades have reached their mechanical pitch stops.

Incorrectly specifying this value can result in serious damage to the propeller hub and controller and can result in unsafe condition for flight. Changes must be made with full understanding of the process and mechanical workings of the hub.

The factory calibration procedure is to start with a very low value and observe the behavior of the hub while cycling through the full range of motion in a controlled test environment. If false-pitch-stop triggering occurs, the value is incremented and the test is repeated. When no further false triggering occurs, the resulting amperage is measured with external test equipment and compared with the manufacturer's specification. If the measured current is less than the specification, the difference is split and included in the final parameter. The BladeRunner software uses an algorithm which will compensate for environmental changes, so it is possible for this value to have mysteriously changed from the last time you saw it.

Tachometer Calibration Factor

Default:

- 500 for 2.02:1 gearboxes (default)
- 1524 for 1.86:1 gearboxes

This parameter indirectly represents the gear reduction ratio in the tachometer equation. When turning the knob, each click will increment or decrement this value by 5. Incrementing the parameter has the net effect of increasing the displayed RPM, while decrementing decreases the displayed RPM.

The full tachometer equation is rather complex, so the best way to calibrate the tachometer is to use an external reference such as an optical tachometer and simply dial-in the display. The only time this should be required is if you have upgraded to a different gearbox ratio. Calibrate for a value in mid-range, such as 2400 RPM. Minor variances are functionally insignificant so don't waste your time trying to reach perfection across the full range.

Tachometer Enable/Disable

- 1 = Enabled (default)
- 0 = Disabled.

Setting this parameter to 0 will disable the tachometer display and cause the controller to permanently display the selected RPM. Some pilots have requested this as a means of minimizing cockpit distractions. All other functions of the controller continue to work as specified.

Restoring Factory Default Parameter Values

So you've been poking around in things you don't fully understand and now nothing seems to be working right? Press the controller knob FIVE TIMES in rapid succession to return to factory defaults for all parameters. The State LED will flash briefly to indicate that the factory default parameters have been restored. You should then review the settings (and manual) before your next flight.

Care, Maintenance, Lifecycle and Safety Considerations

No routine maintenance or care is required. Avoid scratching the display surface.

Never introduce water, cleaners or lubricants into the controller.

The BladeRunner controller has been designed with the best available components having Industrial or Military quality ratings. Its internal software was developed by a well-seasoned software engineer and was run through rigorous bench and flight testing. Despite the effort that went into its design, all electronic devices are subject to certain failure modes and also exhibit a limited lifespan.

The knob turns the only mechanical component, an optical encoder, which is rated for a minimum lifecycle of 1 million rotations. The weakest link in the hardware chain is a single large capacitor which has an expected lifespan of approximately 10,000 hours at peak performance. A cumulative failure rate analysis would suggest an expected lifecycle of approximately 5000 hours. That's a long time for any electronic device to be in service. It is prudent to suggest that if you have achieved several thousand hours of operation, you should consider replacing your controller or having it refurbished by the factory or a qualified technician.

If your aircraft has been struck by lightning or other severe electrical or mechanical shock, run through the Initial Controller Checkout section again to be certain that nothing was damaged before flying next. The BladeRunner has built-in reverse-polarity protection so a 12 volt battery or jumper cable reversal should not destroy it. If you mess up the other wiring, or hit it with 28 volts, all bets are off!

For your own safety, we reiterate once again the importance of setting your propellers mechanical pitch stops to restrict blade pitch travel to only the flyable range. If the BladeRunner fails, or your aircraft suffers an electrical failure, the controller is designed to freeze at the current, presumably flying, pitch. You may not have the optimal pitch for landing, but if your prop has been correctly set up, a safe landing should always be possible. If your pitch is a little coarser than desired, make a long shallow approach. If it is finer than desired you should have no problem maintaining adequate speed, again, assuming that you set those pitch stops correctly!

In case of apparent controller misbehavior, you might try cycling the power to the controller via circuit breaker. Just beware that when you reapply power, the controller will select the "Initial Go-Around RPM" value. If the controllers internal circuit protection device has tripped, you must remove power via external circuit breaker for at least 5 seconds, in which time the internal device will reset itself, then you may reapply power. If the controller continues to misbehave, remove power via the external circuit breaker for the remainder of the flight and contact the factory for repair information.

If you are uneasy about your flying skills with non-optimal pitch settings and would like to be able to adjust your pitch even in the presence of a controller failure, it is possible to wire an external switch into your aircraft to override the controller. Contact the factory to discuss this method and its drawbacks.

Upgrade & Repair Policy

Occasionally we may introduce software enhancements for the BladeRunner. Our policy for upgrading your controller is as follows:

Software and Hardware Upgrades

1. Customers who **a)** brings their controller to one of the major experimental air shows that we attend each year (at least Oshkosh and Sun-N-Fun) or schedules a visit to our primary facility in Florida and **b)** has good things to say about our products, gets a free software upgrade.

2. Customers who do not comply with the above statement, can send their controller to our Factory address for a free software upgrade, provided they also include a check to cover return postage and use a suitable shipping container.

3. Customers desiring a **hardware** upgrade will be required to pay the cost of the hardware as specified in the associated upgrade announcement and postage if required. There is no labor charge for functional upgrades assuming that the controller is not damaged in any way and the serial number seal is intact.

Repairs

Repairs will be performed at reasonable labor and parts rates. A quote will be provided upon initial examination of the product including an estimate of the time required to make the repairs. We reserve the right to refuse to make repairs in the event that the product is obsolete or parts are no longer obtainable or the product has suffered apparent misuse or the serial number seal has been broken.

Limited Warranty

The BladeRunner Limited Warranty covers factory defects and failures that are unrelated to product misuse or physical damage for a period of 1 year from the date of purchase. Warranty coverage will result in replacement, repair, or refund at our sole discretion. The BladeRunner Limited Warranty covers only customers who have purchased the product directly from our factory, have signed and returned the End User License Agreement and have only used the product with an approved propeller and powerplant. The BladeRunner Limited Warranty is non-transferable, unless the new owner also contacts the factory and signs a new End User License Agreement. Any evidence of misuse or tampering with the serial number seal will void the warranty.

Contact

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