February 17, 2024

An Introduction to Radio Controlled Flying and Student Flight Instruction

This student flight-training manual was adapted from the Tuscarora Radio Controlled Aircraft Flying Club manual written by Ed Pollack, a similar document from the Holly Springs Skyhawks Club by Doug Leroy, and several other sources from the web as sited.

Introduction to Radio Controlled Flying

Purpose: Radio Controlled (RC) aircraft modeling is one of today's most exciting hobbies. It involves many interests, disciplines, and skills. Some of these include aerodynamics, electronics, mechanics, drafting and design, composite material, construction, and woodworking. These are in the model aircraft alone. To reduce the chance of frustration, and before purchasing any equipment, the beginner should become involved with other modelers, visit a flying site, become acquainted with experienced modelers, or join a local RC model flying club.

Any new modeler begins with an investment, and care must be taken in equipment purchase whether new or quality used. This instruction manual is written with the assumption that the student is utilizing an E-flite Apprentice® S 15e or STS with Sensor Assisted Flight Envelope (SAFE) as their training model. Knowledge comes with time and practice. You will always be learning. Welcome to an exciting hobby.

Student Flight Instruction Manual

The purpose of this instruction is not only for you to "solo," but to become proficient in RC model flying for your safety, and enjoyment to other fliers as well as spectators, family, and neighbors. The intent is to get your proficiency level to where you can safely and consistently launch and recover your model with reduced chance of an unfavorable outcome. As a wise pilot once said, ***"Take-offs are optional, but landings are mandatory."***

General Safety Guidelines

SAFETY is the #1 rule while flying a remotely piloted model. RESPOSIBILITY and ACCOUNTABLILITY are equally important.

Membership in the Academy of Model Aeronautics (AMA) at https://www.modelaircraft.org. is highly encouraged. AMA membership is normally required to join a local RC flying club and to fly at any AMA chartered flying field. Please label your RC models with your AMA membership number on the outside of the model, and you can optionally place identification on the inside of the model to include your name, address, and/or phone number. Membership in the AMA ensures you have a minimum level of personal liability insurance available should an unfortunate mishap occur.

Additionally, you should register with the Federal Aviation Administration (FAA) at the FAA Drone Zone https://faadronezone-access.faa.gov, label your RC models with your FAA registration number on the outside of your models, then take The Recreational UAS Safety Test (TRUST) at https://www.modelaircraft.org/trust/, and carry proof of test passage.

All RC model operations should be conducted in accordance with the AMA National Safety Code https://www.modelaircraft.org/system/files/documents/105.pdf) and any other RC flying field posted guidelines.

STEP ONE: Ground School

Recommend that you select an Almost-Ready-to-Fly (ARF) or a Ready-to-Fly (RTF) RC trainer model as your first model. A good example is the E-flite Apprentice® S 15e with SAFE or Eflite Mini-Apprentice® with SAFE (or equivalent) as your training model. Many RC flying club members primarily fly using Spektrum® brand radio equipment. Purchasing equipment within this brand will ensure your system is compatible with the type flown by many designated instructor pilots. If you purchased a Ready-to-Fly package, you are all set!

Before purchasing any equipment, the beginner should ask himself, *"Is this a hobby I want to try to see if I like it, or is it a hobby I am going remain involved in for years to come?"* If the beginner is going to remain in the hobby for years, they might consider buying more expensive equipment such as a ball bearing engine and a six (6) channel radio system. Otherwise, they should try to keep their initial outlay as low as possible. A beginner can limit their spending to as little as $300 by buying good used equipment but care must be taken to ensure that the equipment is reliable. At the other end of the scale, a beginner could easily invest $1000 on new equipment if they are not prudent with their purchases. As you get to know some of the club members and share opinions, it will be easier and less stressful to understand what is "must" have and what is "nice" to have.

Every RC pilot should gain a basic understanding of aerodynamics. With this knowledge you will better understand why the model does what it does. After you solo and gain more flight experience, this knowledge will come in handy as you explore and master more advanced models.

The Basics of Flight…The Model Aircraft

One significant component(s) of any model aircraft are the wings. Their design and location determine flight characteristics, and each has specific flight attitudes.

Wing: The horizontal surfaces which provide the lifting force. There are three basic wing profiles.
Flat Bottom: Creates the most lift and is the most stable. Most trainers are flat bottom. This wing cross section should have a virtually flat bottom. This type of cross section has more gentle flight characteristics that are necessary for a beginner.
Semi-Symmetrical: Still stable yet allows more maneuverability and extends aerobatic capability.
Great for "second" models.
Fully Symmetrical: Least stable and most aerobatic. For more experienced flyers only.

Wing position/location: There are three basic wing locations.

High-Wing. A high wing model is inherently more stable than a low wing model due to pendulum effect. Since the weight of the model is below the wing, the fuselage tends to swing downward like a pendulum to equalize forces.
Mid-Wing,/ Low-Wing. The weight of the model divided by the area of the wing should not exceed 19 oz. /sq. This reduces the speed required to maintain an acceptable rate that the model descends when the power is reduced resulting in a lower landing speed.

Stability diminishes as the wing comes down; the high wing being the most stable. Here too, most trainers are high wing. A fully symmetrical, mid-wing with no dihedral is the most aerobatic.

The Basic Trainer

A beginning pilot must realize the dedication that is required to gain the ability to fly the type of model that perhaps initially spawned their interest in this hobby. He or she must begin the hobby with a basic trainer and progress through different levels of models until your goal is reached to be successful. Too often new pilots get discouraged from the onset by not making prudent choices with the introductory model. These are called a trainer. The model is called a trainer because of that reason, it trains. As your first RC model, if you have selected the Apprentice® then you have EXACTLY the model you should have as a beginner.

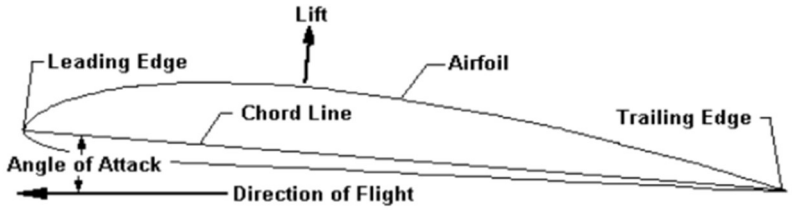
There are certain criteria that a trainer model should have to be satisfactory for a beginner.
High-Wing: A high wing model is inherently more stable than a low wing model due to pendulum effect. Since the weight of the model is below the wing, the fuselage tends to swing downward like a pendulum to equalize forces.
Flat Bottom: Creates the most lift and is the most stable. Most trainers are flat bottom. This wing cross section should have a virtually flat bottom. This type of cross section has more gentle flight characteristics that are necessary for a beginner.

Dihedral: The wing should have some dihedral. This means that the tips of the wings are higher than the center. The effect of the dihedral is to try to equalize forces and keep the wings level or to return the wings to a level orientation.
High Aspect Ratio: The ratio of the wing length or span should be at least 5 ½ times the width or chord. This will reduce the rate at which the model responds to command input allowing more time for a beginner to react.
Constant Chord: The width of the wing should be the same from the center or root to the end or tip. This distributes the weight of the model evenly over the entire surface of the wing.
Moderate Size: Most trainers are for engine sizes between .15 and .60. The smaller ones are more susceptible to the effects of wind and normally the wing loading is higher simply because of the weight of the radio equipment. The larger sizes are easier to fly and easier to see but are more difficult to transport. Most trainers are for .40 size engines. These trainers have been widely accepted as the optimum size.
Structurally Sound: A trainer must be able to take the abuses imposed by a beginner. This is especially true for hard landings. It must be able to withstand minor crashes with minimal damage. It should be relatively easy to repair.

The Basics of Flight

Note: Right, left, up, and down refer to the model from a pilot's perspective as if you are seated IN the model.

A beginner should understand the concepts of flight. The theories behind the physics of flight are covered in many volumes of books. A model aircraft flies because lift is generated as a result of air pressure on the bottom of the wing being higher than the air pressure on the top of the wing.



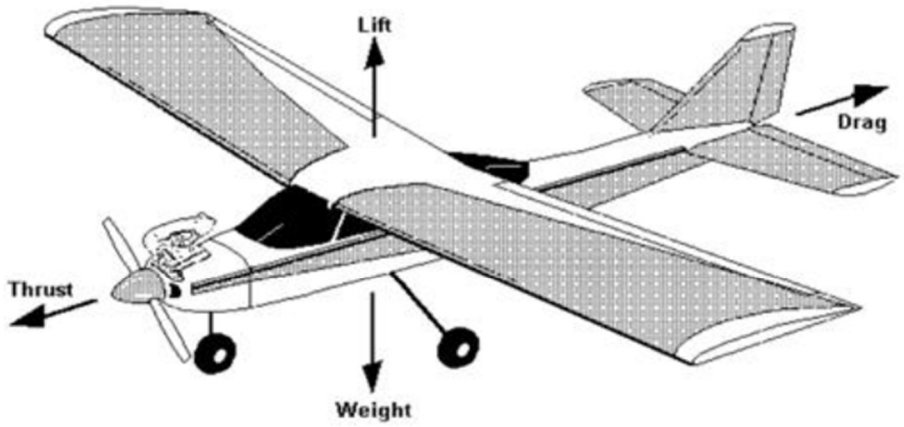
The above diagram shows some of the basic terms relating to a wing section. These terms are common to RC flight.

Airfoil: The cross section of the wing.
Angle of Attack: The angle between the chord line and the relative direction of flight.
Chord Line: The line between the leading edge and the trailing edge of the airfoil.
Direction of Flight: The relative direction of the wing in relation to still air.
Leading Edge: The most forward edge of the wing.

Trailing Edge: The most rearward edge of the wing.

Lift increases as the velocity of the air passing over the wing increases, or as the angle of attack increases, as long as the flow of air over the wing remains smooth. Actual flight is attained when the force of the lift equal to or greater than the weight of the model.

There are four (4) primary forces that act on a model in flight; thrust, lift, drag, and weight. Thrust is the force applied by the combination of engine/motor and propeller acting to pull or push the model forward. Drag is the resistance against the model by the force of the air against the forward-facing surfaces. Weight is caused by gravity. For a constant speed to be maintained, thrust and drag must be equal. For a constant altitude to be maintained, lift and weight must be equal.

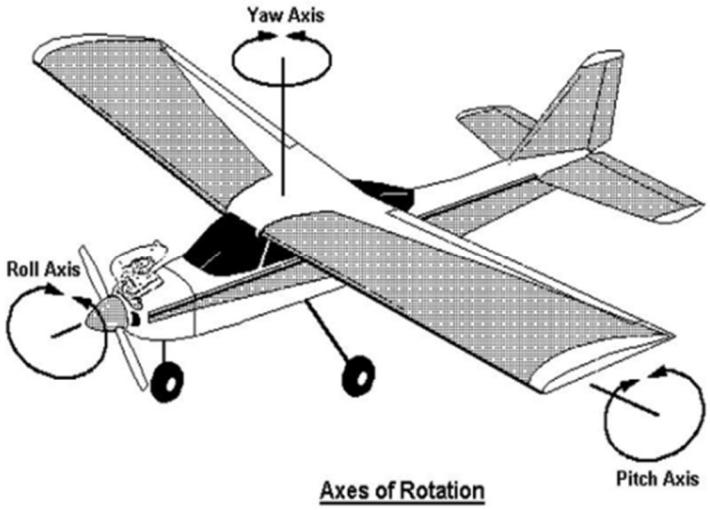


Flight Forces

A model pivots about three (3) axes: the yaw or vertical axis controlled by the rudder; the pitch or lateral axis controlled by the elevator; and the roll of longitudinal axis controlled by the ailerons. It can pivot about any one of these axes individually or in combination based on the control surfaces that are moved and the direction of their movement.

The Basic Trainer and Flight Physics

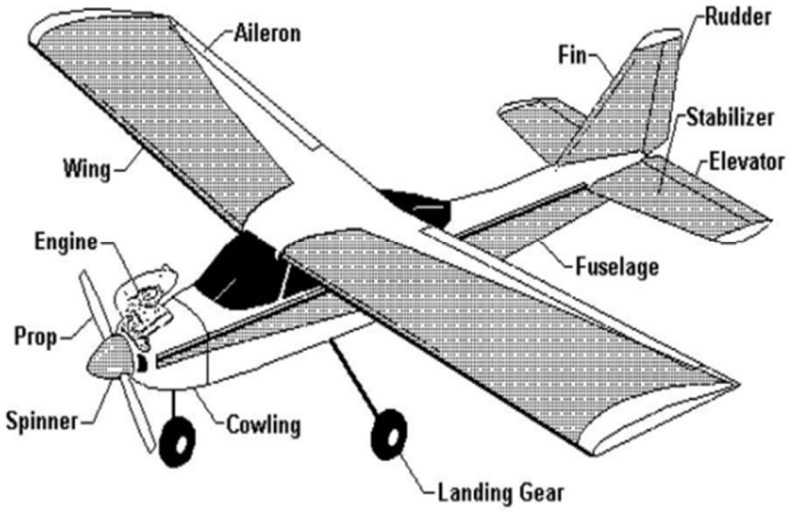
A beginning pilot must realize the dedication that is required to gain the ability to fly the type of model that perhaps initially spawned their interest in this hobby. As your first model, if you have selected the Apprentice® then you have EXACTLY the model you should have as a beginner.



Axes of Rotation

When the rudder is moved to the right, the model will rotate to the right about the yaw axis and vice versa. When the elevator is moved up, the model will pitch the nose upward. The ailerons move in opposite directions. When the left aileron is moved up and right one down, the model will rotate to the left and vice versa. This will be covered in greater detail below in the "Effect of Control Surfaces" section.

Model Aircraft Nomenclature



Aileron: The moveable portion of the wing which causes a change about the roll axis.
Cowling: The part of the fuselage which covers the engine.

Engine: A two-cycle reciprocating machine which provides the motivational power.
Elevator: The moveable portion of the horizontal stabilizer which causes a change about the pitch axis.
Fin: Properly know as vertical stabilizer, which provides stabilization about the yaw axis.
Fuselage: The main body of a model.
Landing Gear: The supporting structure of a model, including landing gear struts and wheels.
Propeller: The combination of blades that provide thrust.
Rudder: The moveable portion of the vertical stabilizer that causes change about the yaw axis.
Spinner: Covering over the propeller hub used in starting.
Stabilizer: Properly known as horizontal stabilizer, which provides stabilization about the pitch axis.
Wing(s): The horizontal surface(s) which provide the lifting forces.

The Basic Power Plant

There are two types of engines/motor's that are used today: fueled (glow or gas) and electric.

Electric

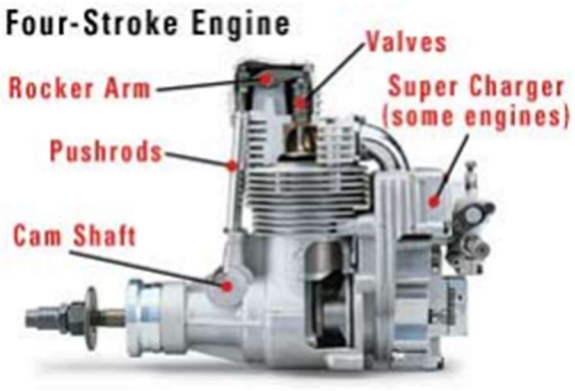
Electric motors are adequate for most beginning- to intermediate-level models. They require an onboard battery pack that must be recharged after each flight. An electric motor can be started remotely and does not require a separate starter. This is considerably safer for fliers, whose fingers don't have to get near a spinning propeller during start-up.
Electric Pros: Can be made infinitely faster, easier to maintain, quiet, lower operating costs.
Electric Cons: Expensive startup costs, down time between charges, unless you have multiple batteries.

Fueled (Glow or Gas)

All fueled engines use what are called glow/spark plugs to ignite the fuel inside the combustion chamber. These engines come in both two-stroke and more powerful four-stroke varieties. The glow engine requires a battery-operated glow starter to heat the plug, in addition to a propeller starter or hand starting.

Fueled Pros: Faster out of the box. Lower initial cost.

Fueled Cons: Higher operating costs (Glow fuel (nitro) is approx. $32 per gallon and is not renewable. Batteries can be used over and over).



Comparison

Both types of engines have their supporters. A fueled engine provides a lot of power in a small package, plus a realistic engine sound that some modelers like. An electric motor is usually less powerful, but it is quiet and can be started with the push of a button. Fueled engines require constant refueling. They also often have a cylinder or carburetor that sticks out of the model's fuselage to the possible detriment of the model's aerodynamics and appearance. Fans of electric motors enjoy the devices' low maintenance, as opposed to the difficulty of tuning a fuel engine. Either type of engine is usually suitable for aerobatics.

Costs

The glow engine requires a specialized fuel, which can get expensive. Electric motors just need a recharge from any standard power source. The flight time of a fueled powered model depends on the size of the fuel tank, whereas an electric model’s flight time is established by the battery type and size (charge capacity).

Radio Systems

Many RC flying club members primarily fly using Spektrum® brand radio systems and 2.4 GHz frequencies only. They are affordable, widely used, and will greatly enhance your enjoyment of this hobby. The buyer is limited only by their budget, recommend you select at least the Spektrum® brand DX6 Gen 3 as a starter system. A beginner should discuss their choice of systems with the intended instructor. There are several reasons for doing this. The primary reason is that the student's systems must be compatible with that instructor's system, especially if a buddy box is being used.

All basic radio systems consist of four (4) basic components.

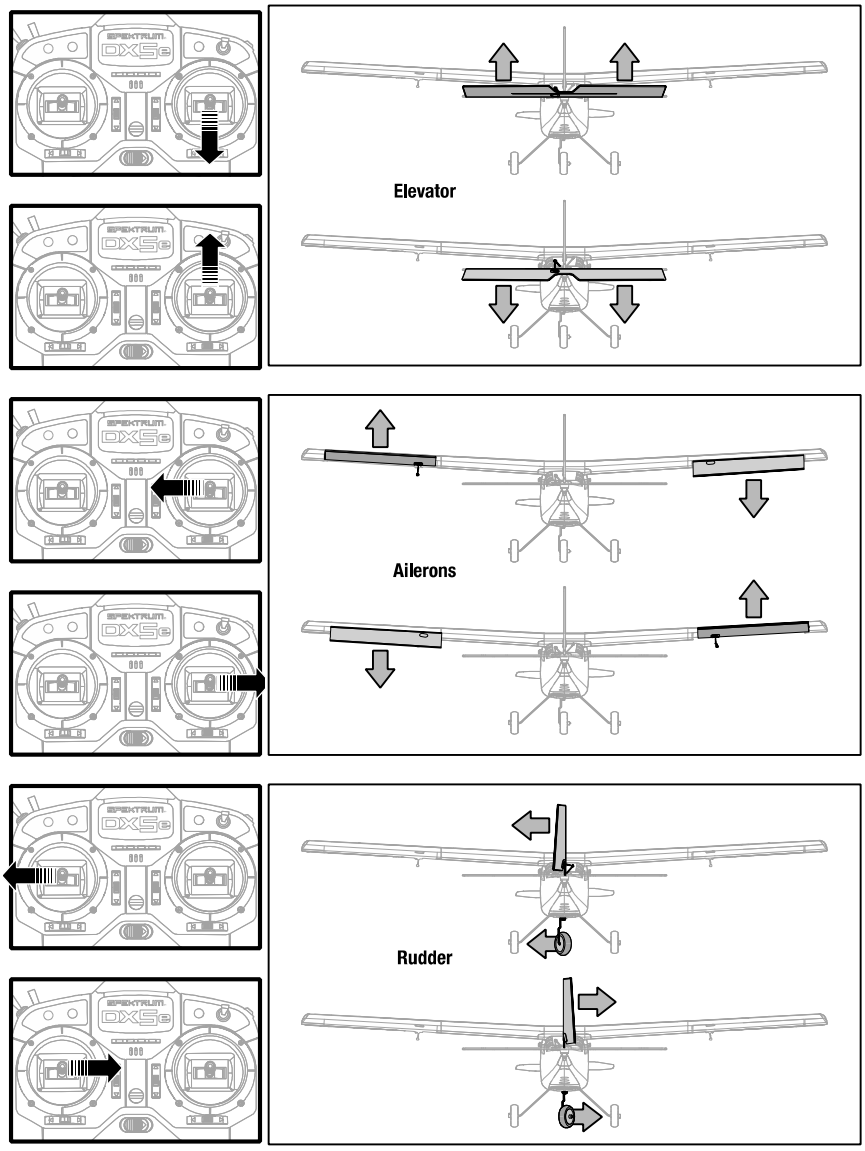
Transmitter: The unit, which takes the input from the user through the gimbals or sticks, encodes it, and sends it to the RC model.

Receiver: The unit that receives the signal, decodes it, and routes it to the appropriate servo.

Servo: The device that converts the decoded signal to mechanical force to operate a control surface.

Battery: The device that provides power for the other devices to operate. Typically, for electric powered models, the same battery used to fly your model will also power your receiver and servos via an Electronic Speed Control (ESC).

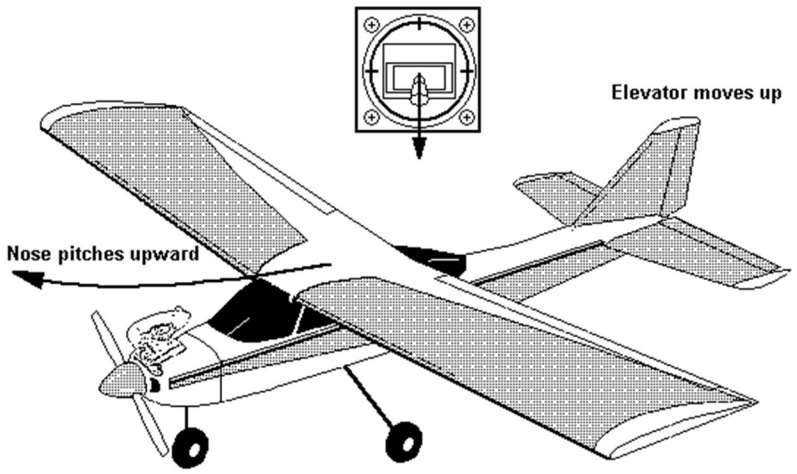
This is a typical layout of the transmitter and its basic functions. Recommend the DX6 as the minimum radio system.



Transmitter Control Stick to RC Model Control Surface Relationships

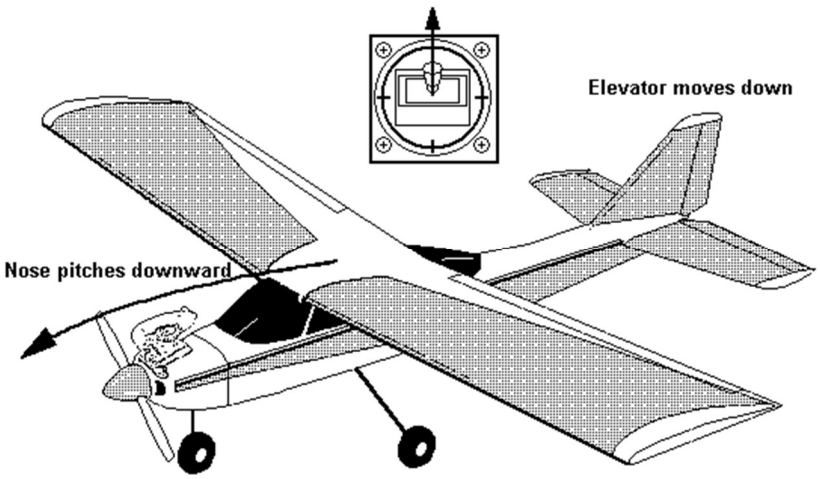
Effects of RC Model Control Surfaces[1]

The new radio systems are proportional control meaning that the control surfaces move in proportion to the amount of movement of the stick. If the stick is moved half of its total travel in one direction, the corresponding control surface will move half of its total travel in the corresponding direction. A beginner must first know the effect that a stick movement has on the model. During normal flight, the throttle is set so that a constant speed is maintained. This means that thrust is equal to drag, and lift is equal to weight. From this stable condition, the effects that the stick movements have on the trainer are described below.



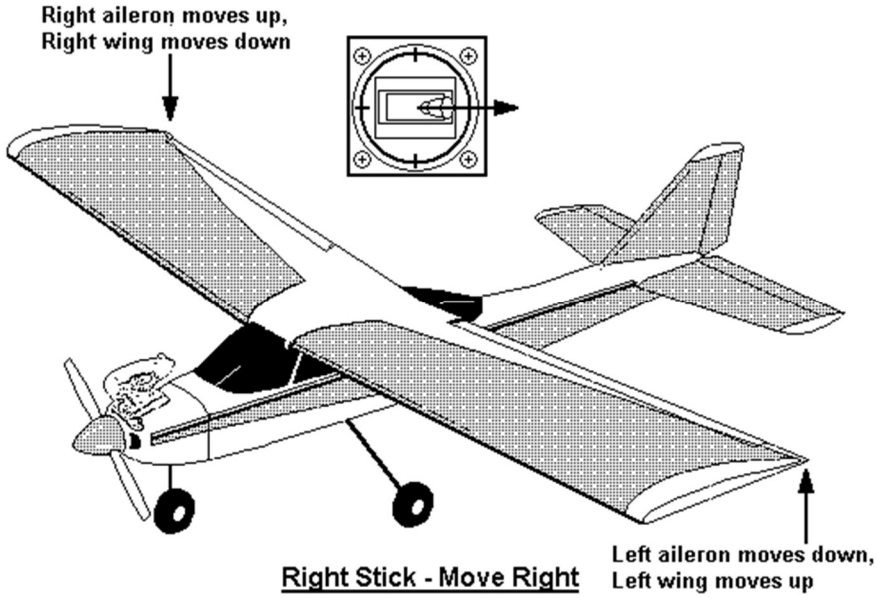
Right Stick - Pull Back

When the **right stick is pulled back**, the elevator moves up. This causes the nose to pitch upward increasing the angle of attack of the wing and increasing drag. If power is not applied, the model will slow down and eventually stall. This means that the air passing over the wing becomes turbulent and lift decreases until weight exceeds lift and the model will begin to drop.

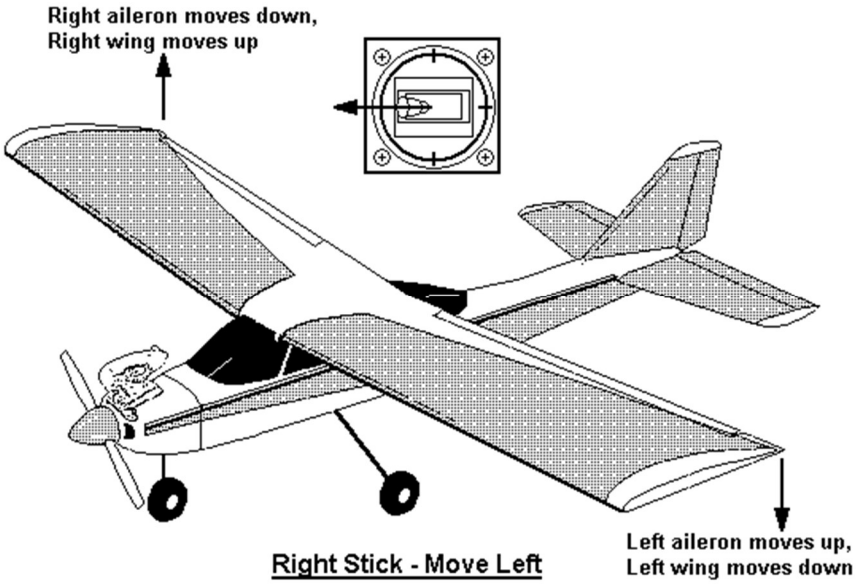


Right Stick - Push Forward

When the **right stick is pushed forward**, the elevator moves down. This causes the nose to pitch downward reducing the angle of attack of the wing and reducing drag. As the model descends its speed increases until drag and thrust are again in balance.

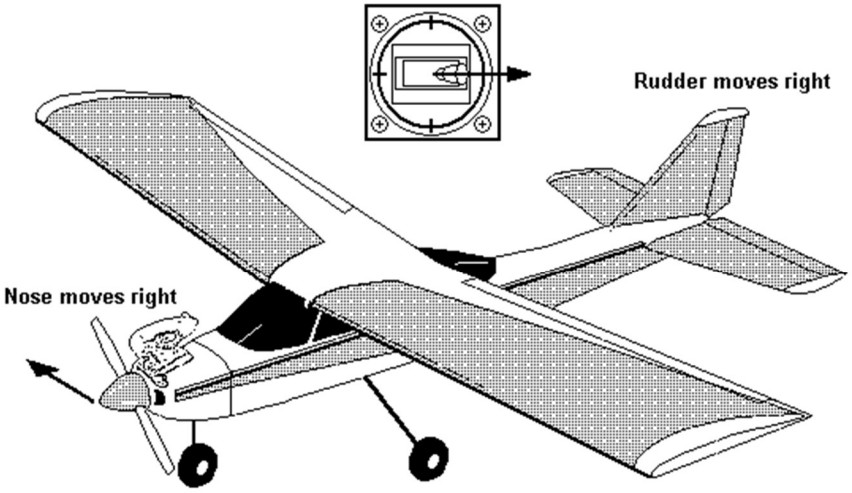


When the **right stick is moved right**, the left aileron moves down, and the right aileron moves up. This causes the model to roll to the right meaning that the left wing moves up and the right wing moves down. It will continue to roll if the stick is held in the same position. When the roll takes place, lift is no longer oriented vertically so the effective lift decreases. As the angle of the roll increases, effective lift continues to decrease, and the model will begin to drop.



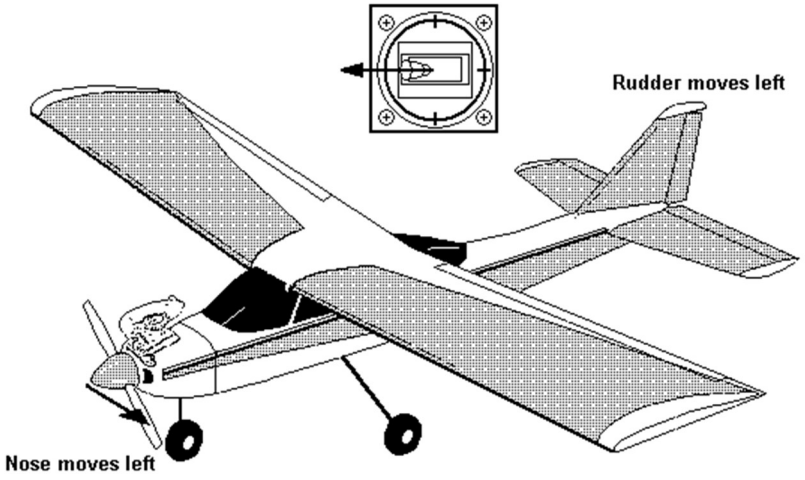
When the **right stick is moved left**, the left aileron moves up and the right aileron moves down. This causes the model to roll to the left meaning that the right wing moves up and the left wing moves down. It will continue to roll if the stick is held in the same position. When the roll takes place, lift is no longer oriented vertically so the effective lift decreases. As the

angle of the roll increases, effective lift continues to decrease, and the model will begin to drop.



Left Stick - Move Right

When the **left stick is moved right**, the rudder moves to the right. This causes the model to swing or yaw to the right. This causes the left wing to move slightly faster through the air causing an increase in lift. The combination of the yaw and the lift increase on the left wing results in a gentle turn to the right as long as the stick is held in position.



Left Stick - Move Left

When the **left stick is moved left**, the rudder moves to the left. This causes the model to swing or yaw to the left. This causes the right wing to move slightly faster through the air causing an increase in lift. The combination of the yaw and the lift increase on the right wing results in a gentle turn to the left as long as the stick is held in position.

When the **left stick is moved forward**, the throttle is opened resulting in an increase in speed of the model. This causes an increase in lift and results in a tendency for the model to

climb. When the **left stick is moved back**, the throttle is closed resulting in a decrease in speed. This causes a decrease in lift and results in a tendency for the model to descend.

It is obvious from the descriptions of the effects of stick movement, that any movement can adversely affect the flight of a model. These effects can be overcome by using a combination of control surfaces to achieve the desired results. For instance, the right stick can be moved back when it is moved left. The result of this action would be that the nose of the model would be raised to overcome the loss of lift resulting in a banked turn without a loss of altitude.

To understand how to properly use the controls, a change in thinking may be required of a beginner who has some basic knowledge of control surfaces. A beginner must remember the forces acting on a model in flight and how they affect the model.

[1] Adapted from information at https://www.scritub.com/limba/engleza/education/Beginners-Guide-to-RC-Flight213144224.php/

Field Equipment

The equipment required to get a trainer off the ground can be very inexpensive. There are a few basic items that will suffice to get a beginner into the air and learning to fly but there are other items that can be added to make the job a lot easier.

Minimum Equipment

NAME	DESCRIPTION
Glow Plug Driver	Clip on battery for supplying power to glow plug
Chicken Stick	Stick used for flipping the prop to start the engine
Fuel	Fuel mixture recommended by engine manufacturer
Fuel Bulb	Rubber bulb used to transfer fuel to model tank
4 - Way Wrench	Combination wrench with sizes to fit glow plug, prop nut, etc.
Toolbox	Any box suitable for carrying the other equipment

These items should cost under $100. This can vary depending on the brand of the items and the place from which the items are purchased. An assortment of screwdrivers, pliers, and allen wrenches may also be needed to perform general at-field model maintenance.

Optimum Equipment

NAME	DESCRIPTION
Starter	Battery powered motor for starting model engine
Glow Plug Connector	Clip on battery connector for supplying power to glow plug
Power Panel	Power distribution panel for distributing power from a field battery to starter, glow plug connector, etc.
Field Battery	Small 12 volt wet or gel cell battery

Fuel	Fuel mixture recommended by engine manufacturer
Fuel Pump	Special pump used to transfer fuel to model tank
4 - Way Wrench	Combination wrench with sizes to fit glow plug, prop nut, etc.
Field Box	Toolbox specifically designed for carrying model field equipment

These items could cost more than $250. Again, the cost will vary depending on the brand of the items and the place from which the items are purchased. Field box kits are available for a wide range of prices but can be built from readily available materials. Plans are available for a simple field box that will fill the needs of a beginner or for a basic necessities field box for a beginner who wants something a little more sophisticated. An assortment of screwdrivers, pliers, nut drivers, and allen wrenches may also be needed to perform general at-field model maintenance.

LiPo Battery Use, Charging, Storage, Safety[2]

Lithium-ion Polymer (LiPo) batteries required special attention and care. Improper handling, charging, or storage of LiPo batteries could result in fire and property damage.

- Never charge, discharge, use, or store a damaged or puffy LiPo battery. Immediately follow proper disposal protocols.
- Avoid purchasing used LiPo batteries.
- Always use a proper LiPo battery balance charger/discharger when charging and discharging your LiPos. It is crucial that all cells in a LiPo battery always maintain the same voltage across all cells. If the voltages across the cells deviate too much from each other (5mV ~ 10Mv), the battery can become unstable and dangerous. (Unless it's a single cell LiPo, in which case you do not need to worry about cell balance).
- Always use a fireproof LiPo safety bag, metal ammo box, or other fireproof container when you are charging, discharging, or storing your LiPo batteries. While LiPo fires are rare, they can happen incredibly quickly and can do a lot of damage. All it takes is an internal short circuit to set the battery off. There is no way to predict when it will happen.
- Do not use your flight case/travel case for long term LiPo storage. The foam and plastic in these cases can help spread a LiPo fire. Always use a fireproof container such as a metal ammo box or fireproof safe for storage.
- Never leave your LiPo batteries charging while unattended. If a battery starts to become puffy, smoke, or catches fire you need to be able to immediately handle the situation.
- A LiPo fire is a chemical fire. Always keep a Carbon Dioxide (Co2) Class C fire extinguisher nearby your battery charging/discharging and storage area. The battery charging/discharging and storage area should be free from any materials which can

catch fire such as wood tables, carpet, or gasoline containers. The ideal surface for charging and storing LiPo batteries is concrete or ceramic.

- Never overcharge a LiPo battery.
- Never discharge a LiPo battery below 3.0v per cell. Ideally you never want to go below 3.2v per cell to maintain a healthy battery. 2.9v per cell and lower is causing permanent damage.
- Never leave your LiPo batteries sitting around on a full charge for more than 2-3 days. If by the 3rd day you realize you are not going to use your battery today, you need to discharge your battery down to 3.6v-3.8v per cell for safe storage until you are ready to use the battery again.
- Always store your LiPo batteries at room temperature. Do not store them in a hot garage, or in a cold refrigerator. Even though a cold battery has less chemical reaction taking place which can prolong its lifespan, taking a battery out from a cold fridge can cause condensation to occur on the inside of the battery, which can be very dangerous.
- Always remember that heat is the number one enemy of LiPo batteries. The hotter your batteries get, the shorter their lifespan will be. Never charge a battery that is still warm from usage, and never use a battery that is still warm from charging.
- Depending on how they are used, most LiPo batteries typically do not last longer than 300 charge/discharge cycles.

[2] Adapted from information at http://thedronegirl.com/2015/02/07/lipo-battery/

Model Aircraft Pre-Flight Checks[3]

The purpose of pre-flight checks is to ensure that your model is in a fit condition to fly, and that everything is working, as it should be. The exact pre-flight checks might differ from model to model, but there are some fundamental checks that all RC models need to have done, immediately before flight.

> **Warning:** If you neglect to carry out the pre-flight checks before you fly your model, and something is badly amiss, then an avoidable crash is very likely. Many pilots have lost their beloved model seconds after take-off, simply because they didn't do the checks!

Your first and foremost point of reference for the exact pre-flight checks needed for your model should be the instruction manual (DVD or CD ROM) that came with the model. But, failing that, listed below (in no order) are the minimum checks that you need to carry out before you attempt to take off...

- ✓ The model selected matches the model you intend to fly (**VERY IMPORTANT**)
- ✓ All servos are secure, and linkages to servo and control surfaces are secure.
- ✓ Servo horns and control horns are secure and not loose.
- ✓ Servo linkages can move freely and are not binding.

- ✓ All servo connections to the receiver, battery pack and ESC are secure and correct.
- ✓ The receiver and/or motor battery pack are securely fixed and cannot move during flight.
- ✓ Receiver antenna (aerial) is correctly positioned and not damaged.
- ✓ The propeller nut is tight / spinner is secure.
- ✓ The wing and tailplane (and fin) are secured properly, as per the instructions (i.e. with the correct method of fixing; rubber bands or wing bolts etc.)
- ✓ All control surfaces move in the correct sense i.e. moving the rudder stick left moves the rudder to the left.
- ✓ All control surface hinges are secure i.e. you can't pull the control surface away from its respective flying surface.
- ✓ The motor power works and spins in the correct direction.
- ✓ The radio failsafe is set and working correctly.
- ✓ A range check is completed satisfactorily. Perform a range check per the procedure for your radio system.

Always, always, always, take a few minutes to perform the above pre-flight checks before you commence your flying session. Get in to the habit of pre-flighting your model every time; the checks take just a couple of minutes to do and will save you the grief of a crashed model if something is amiss.

[3] Adapted from information contained here: https://www.rc-airplane-world.com/rc-airplane-pre-flight-checks.html

Learning to Fly[4]

The single most important aspect of learning to fly is getting an instructor. An instructor does not have to be certified to any standard but must be a competent experienced RC pilot who can give instructions with patience. Many people think that flying RC models is easy enough that it can be learned without an instructor, and many have succeeded but at great expense. Many have become frustrated and disillusioned because of a crash on the first flight and never tried again. This point cannot be stressed enough that RC flying is much more difficult that it might seem and that without an instructor to correct mistakes, a crash is inevitable.

The last thing that is required of a beginner before they set out to conquer the world of flight is to join the Academy of Model Aeronautics (AMA) or the Sport Flyers Association (SFA). Each of these organizations provides insurance to cover the cost of a catastrophic incident resulting from a model aircraft accident. Very few RC flying clubs will allow a beginner to fly at their fields unless they are covered by this type of insurance. Some clubs will only accept one type of insurance, either AMA or SFA. Joining a club is strictly optional but is recommended since this can be a large resource of information. If the beginner can find a suitable place to fly that does not have an ordinance against this type of activity, then a club is not necessary for success. Insurance should not be looked at as an option but as a

necessary evil. There are many other benefits offered by the organizations. These benefits are covered by each organization when a contact to the organization is made. The easiest way to find a local club is to ask the owner of a local hobby shop for information. If there is not a hobby shop in the area, the AMA or SFA has information about the clubs.

When the beginner has acquired their equipment, an instructor, and insurance, and they understand the basics of flight and the use of the controls, they are then ready to start the steps toward becoming a qualified RC pilot. Each piece of equipment should be checked out by the instructor to ensure that it works properly. The model must be checked for proper center of gravity (CG) balance then test flown and adjusted for proper flight. If the test pilot feels that there is a serious problem with the model, it must be corrected before the student attempts their first flight. Only after all the equipment and the model have been approved by the test pilot should the training begin.

There are a few things that a student pilot should keep in mind when preparing for each flight. These will help in getting the feel for the model in flight.

> Be very gentle with the controls. It takes very little movement to get the model to execute a maneuver. Remember that the farther the stick is moved, the more the control surface moves and the more the model will respond.
>
> As long as the stick is held in a control position, the maneuver will continue. This is most important when using the ailerons. When the stick is moved to roll the model, it will continue to roll as long as the stick is held in that position.
>
> Fly it in...fly it out. When a maneuver is executed, it takes equal and opposite controls to overcome it and return to normal flight. A turn requires the movement of the ailerons in the desired direction of the turn. To recover from the turn, opposite aileron input is required.
>
> Keep the model high. A Certified Flight Instructor once said, "The two most useless things to a pilot are air above you and runway behind you." By this he meant that if a pilot gets into trouble, they must have plenty of air below them to recover. When landing, the runway that is behind the model after touchdown is wasted because there is a reduction in length of runway to take off again in case of trouble.
>
> Keep the model in sight. Do not fly too high nor too far away. Although the trainer may seem large, it is easy to get it far enough away so that it is difficult to see its orientation. Do not fly into the sun. A moment of blindness caused by the sun can be long enough to lose a model.
>
> Do not become discouraged. There will be times when nothing seems to go right. Each maneuver results in a near catastrophe. Everyone who flies RC models today has been through this in learning to fly. Do not give up. The next session will be better.

DO NOT PANIC. When a maneuver goes wrong, take all the time necessary to recover from the mistake. Panic will cause a student to over-control in an attempt to recover and cause

the condition to worsen in the opposite direction. Although the instructor may seem to be a casual observer standing at the side of the student, they will be watching in case the student gets their model in a dangerous situation.

[4] Adapted from information at https://www.scritub.com/limba/engleza/education/Beginners-Guide-to-RC-Flight213144224.php/

AS3X and SAFE

These two terms are used by Spektrum® and found on many E-flite manufactured model aircraft sold by Horizon Hobby. Both do different things and are sometimes confused with each other.

AS3X stands for Artificial Stabilization – 3 axis and uses a gyro system built into the Spektrum® receiver. It allows automatic micro-corrections of the flight control surfaces for smoother, more stable flight during windy conditions. AS3X does not get activated until the throttle is advanced past 25%. AS3X is not an "auto-pilot" system!

SAFE stands for Sensor Assisted Flight Envelope. SAFE allows for progressive performance modes (Beginner, Intermediate (some) and Experienced). In Beginner mode, SAFE will not allow you to over-correct. It limits how far the model will bank left/right or climb/descend, no matter how much transmitter stick movement you give. In the Intermediate Mode, it has less limitation on banking and climbing/descending which allows you to be more maneuverable in the air, but there still are some limits. In the Experienced mode, all limits are removed for advanced flying and aerobatics.

On most trainer models with SAFE technology, there is a "Panic Recovery" mode that can be instantly activated by a simple push of a button (or release of the sticks to neutral on some) in case you lose control of your model. This will instantly bring your model back to straight and level flight.

There are other receivers available by other manufacturers that have a gyro/stabilization system built into them, or even a "Panic Recovery" mode, but SAFE and AS3X are registered names of Spektrum and allow for the progressive performance modes (beginner, intermediate, (some) and experience.

SAFE® Introduction (Horizon Hobby documentation)

Sensor Assisted Flight Envelope (SAFE) Technology

Sensor Assisted Flight Envelope (SAFE) Technology

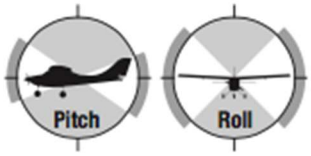
SAFE technology is a revolutionary flight training system designed to give you a stable platform for safely developing your flying skills. This is not an autopilot or self-guiding robot. The sensors and software in this system help you fly the aircraft where you want to go while decreasing the risk of an out-of-control crash. You can progress through the Beginner, Intermediate and Experienced flight modes as your skills increase, all with the confidence of an optional Panic recovery mode. At any time during a flight you can switch between the 3 flight modes or use Panic recovery to get your aircraft to a safe flying attitude.

SAFE Flight Modes

Beginner Mode

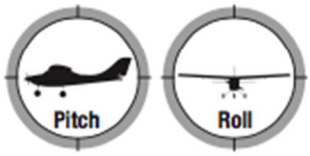
- Envelope limit: Pitch (nose up and down) and Roll (wing tips up and down) angles are limited to help you keep the aircraft airborne
- Self-leveling: when the pitch and roll controls are returned to neutral, the aircraft returns to level flight
- Stability assisted takeoff and landing
- Throttle based climb and descent

Intermediate Mode



- Natural Flight Experience: In normal training flight conditions, the pilot experiences natural AS3X® flight for smooth handling and outstanding precision
- Large Flight Envelope: The pilot is only prevented from entering extreme flight conditions outside the training flight envelope

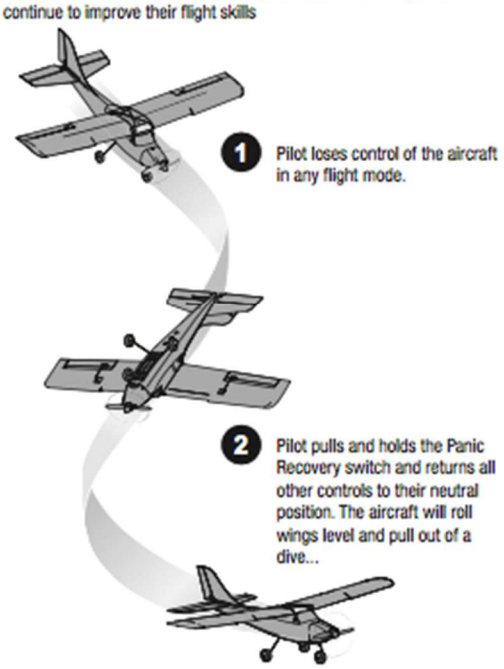
Experienced Mode



- Natural Flight Experience: The pilot experiences natural AS3X flight for smooth handling and outstanding precision
- Unlimited Flight Envelope: No limit on Pitch and Roll angles (airframe limited)

Panic Recovery

- Immediate recovery to a safe flying attitude
- Return all transmitter controls to neutral for the quickest recovery
- This mode is intended to provide the pilot with the confidence to continue to improve their flight skills



1. Pilot loses control of the aircraft in any flight mode.
2. Pilot pulls and holds the Panic Recovery switch and returns all other controls to their neutral position. The aircraft will roll wings level and pull out of a dive...
3. ...once the aircraft is flying straight and level, the pilot releases the Panic Recovery switch and continues a gentle climb to a safe altitude.

IMPORTANT: Aircraft will recover to a safer attitude even if sticks are held. Some control input is still used with panic activated.

AS3X® technology

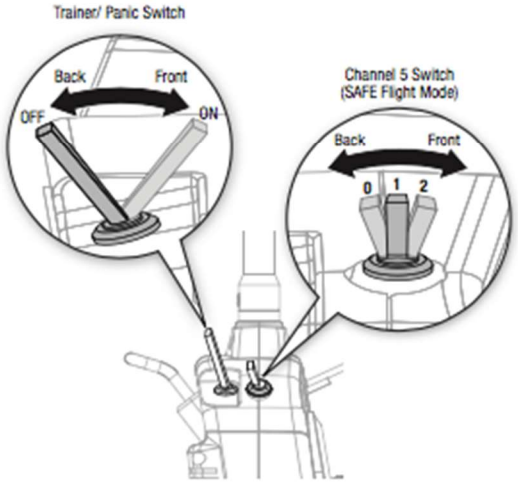
Horizon Hobby has always made RC sport, scale and unique aircraft with the kind of performance experts appreciate. Now the exclusive Artificial Stability 3 axis (AS3X) system helps take performance expectations in aircraft a quantum leap higher. Based on the successful use of MEMS sensor technology within the AS3X Stabilization System essential to Blade® ultra micro flybarless helicopters, the specifically tuned AS3X System for airplanes helps invisibly correct for turbulence, torque and tip stalls when encountered. Furthermore, the outstanding control agility delivers an ultra smooth, locked-in feel that obeys your every command with performance that's natural feeling. It's so gratifying, in fact, that it's as though you're the RC pilot of an expertly tuned, giant-scale aircraft. AS3X will change the way you'll want to fly now and in the future. To see what we mean, go to www.E-fliteRC.com/AS3X.

Sensor Assisted Flight Envelope (SAFE) Technology

You control the help SAFE™ technology provides while you learn to fly. As your flying skills grow, decrease SAFE technology assistance. Change aircraft response at any time by moving the Channel 5 (SAFE Flight mode) switch on your transmitter.

IMPORTANT: These instructions are for the included DX5e transmitter (or similar transmitters) with a 3-position switch for Channel 5. If you fly this aircraft with a Spektrum transmitter other than the included DX5e, refer to Optional Transmitter Setup and Receiver Setup.

SAFE Flight Modes	Channel 5 Switch Position
Beginner Mode	Position 0
Intermediate Mode	Position 1
Experienced Mode	Position 2



Panic Recovery Mode

If you get into distress while flying in any mode, pull and hold the Trainer (Panic) Switch and move the control sticks to their neutral position. The SAFE technology will return the aircraft to a stable attitude, if the aircraft is at a sufficient height with no obstacles in its path. Release the Panic Switch to turn off Panic mode and return the current SAFE flight mode. If you get into trouble and need to go back to Beginner mode for maximum stability, remember to fully move back the Channel 5 switch.

SAFE Technology makes this aircraft a better learning tool, but you must set yourself up for success in flying:

- SAFE technology is designed as flight assistance, not an autopilot. The pilot is always in control and required to fly the aircraft at all times
- Follow the instructions provided in this manual to maintain your aircraft in top flying condition
- Seek qualified model flying instruction through your local model flying club. A qualified flight instructor can propel your advancement in this hobby
- Wind and environment can affect SAFE technology flight performance
- Ensure you have no distractions so you benefit from every moment of flight time
- You must still fly the aircraft away from obstacles and at an altitude that will allow for a safe recovery

Activating SAFE Technology

SAFE technology is not active until you advance the throttle past 25%. Once the SAFE technology is active, the control surfaces may move on the aircraft. This is normal. The SAFE technology will remain active until the ESC is turned off.

Understanding Oscillation

In some flight conditions, you may see oscillation. If oscillation occurs, decrease the airspeed. If oscillation still persists, refer to the Troubleshooting Guide for more information.

⚠ **CAUTION:** Flying in level forward flight and calm wind conditions at full throttle in any mode or long high-speed dives may result in strong oscillation that can damage the aircraft.
If there is oscillation in any mode, decrease throttle immediately. If oscillation persists, refer to the Troubleshooting Guide.

⚠ **CAUTION:** Beginner, Intermediate, and Panic modes are intended for the training environment. Flying continuous high-G maneuvers (such as loops) in Experienced mode for an extended period of time may lead to inconsistent flight envelope and Panic mode behavior. If this occurs, land in Experienced mode and power cycle the receiver before flying again.

Launch and Landing Assistance

Take off and landings can be better managed by using the Beginner mode. If the model is launched incorrectly, or is landing at a less than perfect attitude, pull and hold the Panic Switch. The model can correct and help to prevent a crash.
See the Take Off and Landing sections in this manual.

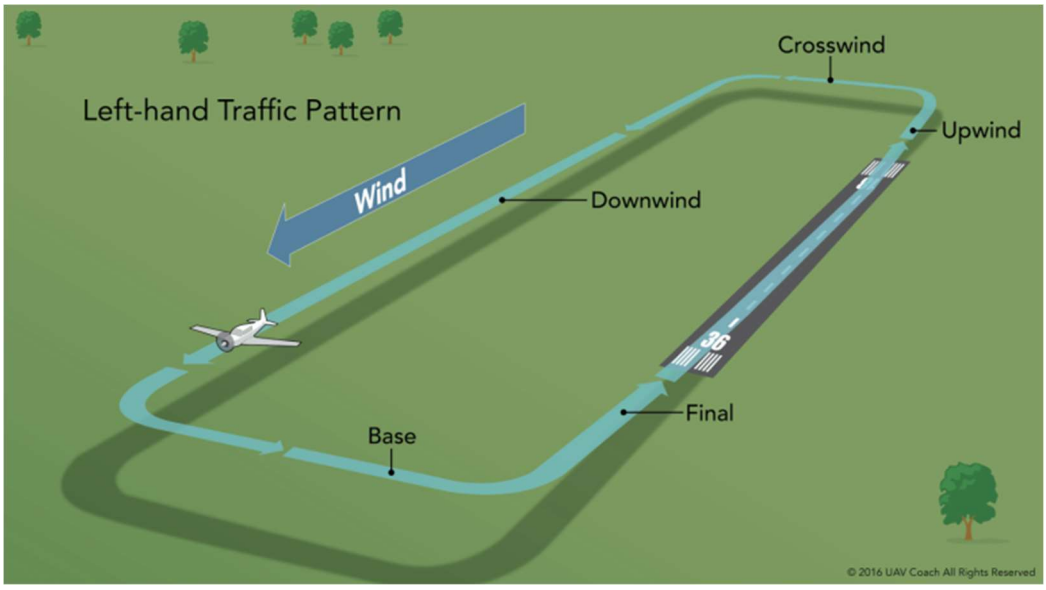
IMPORTANT: A level runway is required for takeoffs in Beginner mode due to throttle climb assistance.

Failsafe

In the unlikely loss of radio connection, failsafe will turn the aircraft in a descending circle to the ground, unless the radio connection is restored.

General RC Model Flying Field Operations Guidelines

- Just like real aircraft, RC model aircraft establish a flying field pattern for take-offs and landings. Prior to first flight of the day, the pilots present at a flying field should establish this pattern.
- Take-offs and landings should be made into the wind, when possible. If there is no discernible wind direction, the preferred take-off direction should be established, such as left-to-right take-off, to enter a left-hand traffic pattern. After rotating on take-off, turn and bank left away from the Pit Area, Parking Lot, and Spectator Area. If a change in wind direction dictates a change in the flight pattern, the pilot recognizing the change would call out to the other pilots on the flight line to reverse the pattern. Pilots would then take-off from and land on the Runway, parallel to the long dimension of the Runway.



Example Flying Field Flight Left-Hand Pattern Diagram

- Treat every model propeller as if it will fail structurally at any moment. Always keep all body parts clear of the propeller arc. When pilots are tuning their engine, they should stay clear of the propeller arc, and always perform glow driver removal, needle adjustments, and "run-ups" from behind the propeller arc.
- When a pilot is ready to come out onto the Runway for take-off, the pilot should notify other pilots of entry on the Runway by loudly yelling out - **"Entering the Runway for Take-Off."**
- When preparing to take-off, the pilot should notify other pilots of intentions by yelling out - **"Taking off Left to Right (or Right to Left)"**. Any landing models should have priority over models preparing to take-off.

- During take-off, the model should stay parallel to the Runway until such altitude is gained to allow you to safely turn away from the Pit Areas, Parking Lots, and Spectator Areas.
- When preparing to land or to perform touch-and-goes, the pilot or observer should notify the other pilots of their intentions. The landing model should have priority over models waiting to take-off.
- When landing please yell out - **"Landing Left to Right (or Right to Left)"** so that other pilots can give you a clear landing.
- Once a landing is completed, the model should clear the Runway immediately. In case of dead-stick landings, the model must be removed and taken off the Runway for restarting. In no case should restarting take place on the Runway.
- You should not taxi your model into the Pit Areas. After landing, stop the engine/motor at the edge of the Runway and carry/tow the model back to the Pit Areas.
- When walking to retrieve a landed aircraft on the Runway yell out - **"On the Runway"** so other pilots nearby are aware and can acknowledge your actions. Once clear of the Runway, yell out - **"Runway Clear"** so other pilots nearby are aware and can acknowledge your actions.
- Pilots should limit individual flights to a maximum of 15 minutes unless a longer duration is agreed to with other pilots waiting to fly.
- In case of engine/motor cutoff in flight, pilot must loudly call out - **"Dead-Stick"** immediately to other pilots to gain priority to the Runway for landing over other powered models.
- In the event a model goes out of control and becomes an immediate danger, ANYONE making such an observation must quickly and loudly call out - **"HEADS UP"** to warn others.
- In the event of an aircraft crash in the Runway area while models are in the air, you need to wait until all models are on the ground before you attempt to recover the crashed model.

STEP TWO: Flight Instruction and Solo

Student:_____

LEVEL ONE - Solo Flight (SAFE® Certified)

1. Demonstrate ability to switch safely between flight modes while maintaining safe control of the aircraft.
2. Demonstrate use of the "PANIC RECOVERY" function when aircraft is in unusual attitudes. Perform ten (10) panic recoveries with your instructor.
3. Perform five (5) unassisted ground taxi maneuvers to the TAKE-OFF position and from the LANDING location.
4. Demonstrate adequate and safe aircraft control in intermediate flight mode. Student should be able to perform an entire flight in this mode.
5. Demonstrate adequate and safe aircraft control in EXPERT flight mode. Student should be able to perform an entire flight in this mode.
6. Ten take-offs and landings with adequate control in INTERMEDIATE mode. Touch and go may be utilized to accomplish this.
7. Complete the SOLO Flight Certification Tasks.

SOLO Flight Certification Tasks

Task #1: Ground support equipment, engine starting, and taxi/ground handling.

- ❑ Perform aircraft preparation and inspection.
- ❑ Perform engine start and radio checks.
- ❑ Perform taxi course.

Task #1 Complete: _____ Date: _____

Task #2: Orientation flight. (Instructor led)

- ❑ Observe orientation flight.
- ❑ Note ground and flight safety restrictions.

Task #2 Complete: _____ Date: _____

Task #3: Basic flight skills development.

- ❑ Become familiar with speed, yaw, pitch, and roll commands.
- ❑ Become familiar with flight trim techniques.
- ❑ Execute straight-and-level flight.
- ❑ Execute left and right turns.

- ❑ Initiate stall or unusual attitude recovery.

Task #3 Complete: _____ Date: _____

Task #4: Take-off.

- ❑ Execute proper upwind take-off runway alignment.
- ❑ Initiate take-off throttle setting.
- ❑ Maintain runway centerline ground steering during take-off acceleration.
- ❑ Execute take-off rotation at proper speed.
- ❑ Execute proper climb speed, pitch, and bank angle.
- ❑ Perform a take-off abort if required.

Task #4 Proficiency: _____ Date: _____

Task # 5: Turns.

- ❑ Perform level shallow turns (left and right) at approximately a 20° bank angle.
- ❑ Perform level medium turns (left and right) at approximately a 40° bank angle.
- ❑ Perform level steep turns (left and right) at approximately a 60° bank angle.
- ❑ Execute shallow, medium, and steep turns (left and right), level flight at low, medium,
and full speeds.
- ❑ Execute figure-eight turns in a designated area while maintaining altitude.

Task #5 Proficiency: _____ Date: _____

Task #6: "On Command" maneuvers.

- ❑ Perform level rectangular patterns (left and right) as well as Figure Eights over specific ground location(s) on command from Instructor.
- ❑ Perform correct turning maneuvers while "nose-in" on command from the Instructor.

Task #6 Proficiency: _____ Date: _____

Task #7: Landing pattern and go-around.

- ❑ Execute upwind landing patterns.
- ❑ Execute crosswind-landing patterns.
- ❑ Execute downwind landing patterns.

- ❑ Perform go-arounds at a 2-meter height on final approach.

Task #7 Proficiency: _____ Date: _____

Task #8: Touch-and-go landing.

- ❑ Perform traffic pattern(s), final approach, and touchdown, followed by power application, take-off, and pattern reentry.
- ❑ Perform normal and crosswind traffic patterns with touch-and-go maneuvers.

Task #8 Proficiency: _____ Date: _____

Task #9: Full stop landing and supervised solo control.

- ❑ Execute full-stop landing followed by taxi back and take-off.
- ❑ Execute simulated engine-out landings.
- ❑ Perform a supervised solo flight.

Task #9 Proficiency: _____ Date: _____

Task #10: SAFE®

- ❑ Execute panic recovery function and re-establish normal, level flight.

Task #10 Proficiency: _____ Date: _____

SOLO Task #11: Supervised solo proficiency/mid-phase review (solo flight).

- ❑ Practice tasks 1 through 9 maneuvers.
- ❑ Demonstrate SAFE® proficiency and operation of recovery from instructor led scenarios.
- ❑ Place additional emphasis on instructor-recommended areas of needed improvement.

SOLO Task #11 Sign-Off: _____ Date: _____

SOLO Task #12: Mid-phase evaluation task (solo flight).

- ❑ Perform the sequence of maneuvers required during the mid-phase evaluation.
- ❑ Review mid-phase I flight evaluation results and discuss strengths and weaknesses with

instructors.

SOLO Task #12 Sign-Off: _____ Date: _____

SOLO Task #13: Airspeed control maneuvers (solo flight).

- ❑ Perform full-, medium-, and slow-speed rectangular patterns (left and right) as well as Figure Eights from level flight.
- ❑ Execute a constant-speed climbing rectangular pattern as well as Figure Eights.
- ❑ Execute a constant-glide rectangular pattern as well as Figure Eights.
- ❑ Perform all maneuvers over designated ground locations.

SOLO Task #13 Sign-Off: _____ Date: _____

SOLO Task #14: Power-on spot landing (solo flight).

- ❑ Perform near-stalled touchdowns on the runway with power on.
- ❑ Execute near-stalled touchdowns within 2 meters of the runway centerline.
- ❑ Perform touchdowns initially within a 30-meter-long touchdown zone, within 2 meters of runway centerline, graduating to a 15-meter-long touchdown zone.
- ❑ Execute a go-around whenever overshoot landing conditions exist.

SOLO Task #14 Sign-Off: _____ Date: _____

SOLO Task #15: Power-off (idle) spot landings (solo control).

- ❑ Perform a near-stalled touchdown on the runway with power off (idle).
- ❑ Adjust landing pattern to touch down within 2 meters of the runway centerline with power off (idle).
- ❑ Adjust landing pattern to touch down within 2 meters of runway centerline and within a 30-meter-long touchdown zone.

SOLO Task #15 Sign-Off: _____ Date: _____

CONGRATULATIONS YOU HAVE COMPLETED LEVEL ONE SOLO INSTRUCTION!

Instructor: _____ Date: _____

Please return the completed sign-off pages to a club officer.