VARMS Aerotow Guide

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Contents

Purpose

To assist and advise glider and tug pilots on how to have a safe and enjoyable glider towing experience. To this end, this document covers: -

- Gilder and Tug pilot tips on
  - Preflight checks
  - Flying during the aero tow phase
  - Flying after tow release
  - Landing phase
- For the Glider Pilot
  - Important glider setup considerations during build prior to the maiden flight

Glider and Tug Pilot Aero-tow guide

Preflight Check list

- The glider pilot must connect the tow loop to their glider before moving the glider onto the strip to hook up to the tow line.
- The glider pilot will stand next to the tug pilot in the designated pilot area so that they can clearly communicate with each other during the towing phase of the flight without distraction from other people.
- After hooking up but prior to each take off the tug pilot will remind the glider pilot to check all glider controls while the tug pilot also checks the tow plane controls.
- All flight controls on the tug and glider must be working in the correct directions with the correct amount of travel for the corresponding stick movements.
- Tug pilot must also check the tow line is sitting above the tail plane.
- Tug pilot must ensure the tug is restrained before engine start and that no one is standing near the propeller other than the person who is starting the prop. It is recommended this is done using an electric prop starter or spring starter on the engine.
- Tug pilot will gently move the tow plane forward to take up any slack in tow line.
- Once glider and tug pilot are ready and the safety officer has given clearance for take-off, the tug pilot will call take-off and proceed to power up and take off.

During tow phase

- Good clear regular communication between the glider and tug pilots is essential with no unnecessary distractions from other pilots or bystanders.
- The glider pilot: -
    - Will endeavour to keep their wings roughly level using aileron control during the tow.
    - Will drift the glider to the outside of turns instigated by the tow pilot so that the tow line is kept tight.
    - Should quickly advise the tug pilot to climb more steeply if the glider is getting too fast, for lighter gliders the tow pilot may also need to reduce the engine power to prevent over speeding the glider.
    - Should quickly advise the tug pilot to climb less steeply if the glider speed is to slow and the glider is in danger of stalling. Also tug engine power can be increased if not already at full power.
    - Can release at any stage during the tow if they wish to do so.
    - Must release from the tow immediately if the tug pilot requests this.
    - Only advised the tug pilot they have released once they are certain that they have released OK.
- Before the tug pilot intends to turn, they must advise the glider pilot the direction they intend to turn so that the glider pilot can ensure the glider is positioned correctly for the turn.
- Tug pilots may need to shallow the climb a little during turns if they are towing a heavy glider to prevent a stall.
- Tug pilots should monitor height using telemetry on the tug and advise glider pilots to release if the nominal release height has been reached.

Flying after tow release

Finding Lift and Thermalling

- It is recommended that you install variometer/altimeter telemetry in your glider to provide audible feedback on your transmitter of when you are flying though lift or sink and advise of height above ground level. This will assist in prolonging your gliders flight time and teaching you how to read the signs for lift and sink.
- Sudden changes in wind direction can often be an indicator of a thermal drifting past the windsock. In this case fly the glider to the down wind direction to find the lift.
- A strong thermal will suck air from all directions towards the centre of lift and the air will funnel anticlockwise around the low-pressure lift area.
- Grass or dust blowing up in a willy-willy indicates lift.
- Observing where other glider pilots are circling.
- Sometimes larger birds circling high up indicate where the centre of lift is, in this case fly the glider to this area and start circling with the birds.
- Small birds circling and chasing insects blowing up from the ground can indicate an area of lift.

Once you have found lift, to stay in it, start thermal turns while following the lift as it drifts in the direction of the wind. When drifting with the thermal do not go too far down wind so that you have enough height to fly back upwind and land. If you are joining other gliders in the thermal, do your thermal turns in the same direction as the other gliders.

When flying high it is recommended to have a spotter as per our rules and procedures, especially if your glider is small.

Descending Safely

Most of the time pilots are hunting for lift, but sometimes in strong lift gliders can struggle to lose height safely. Attempting to dive to lose height in strong lift is a very bad idea. This can result in glider over-speeding, resulting in control surface flutter, excessive low dynamic pressure on the wings leading to structural failure of the wings. In this situation use the variometer to fly to an area of sink or at least low lift and circle in this area to lose height and deploy spoilers to increase sink rate while maintaining a normal airspeed.

Landing Phase

- Gliders have landing priority over tow planes except during a dead stick event on the tow plane.
- Tug and glider pilots must clearly call their landing when they join the circuit on the downwind approach leg to give the safety officer plenty of time to advise of other traffic in the landing pattern and coordinate landings.
- The safety officer can ask the tug pilot to go around and climb out if there are too may gliders in the circuit lining up for landing.
- When there are many gilders in the landing phase, the safety officer needs to direct glider pilots to land long, short, or wide as needed to minimise risk of landing collisions.
- During the final approach leg, the glider should be flown at a constant air speed all the way down to flare height just above the runway threshold while using spoilers to adjust sink rate as needed.

Glider set up before maiden flight

This section is intended to advise glider pilots how to set up and check their glider before a maiden flight. It is also recommended they let the tow pilot and safety officer know if they are doing a maiden flight.

Glider Power Supply

The Glider power supply comprises of the

- Batteries
- Battery connectors
- Wiring from battery to servos
- Wiring from battery to the radio receiver

Items to consider: -

1. Your power supply must supply a voltage close to the maximum voltage that both your servos and receiver are specified to handle. This provides the greatest voltage margin to prevent a receiver restart due to a low voltage dropout.
2. Consider using two batteries in parallel to provide redundancy in case of a battery failure. I use 2 x 2 cell LiFe batteries with diode bridging in my larger gliders as this provides 6 Volts to the load and battery redundancy.
3. Ensure the batteries, connectors and the wiring can handle the maximum expected load current with minimal voltage drop. Calculate the peak expected load current by adding the stall currents of all servos used in your glider. At this peak current the voltage should hold well above the minimum voltage needed for the receiver to operate. You can also use a multi meter set as an amp meter to measure current on you work bench while stalling a servo as well as checking the voltage under this load.
4. Ensure wiring is secured and can't flop around in the glider.
5. Ensure batteries are secured so that can't move about and are position optimally for glider centre of gravity.
6. I do not use on/off switches in the direct high current power supply feed as they are another point of failure that could lead to low voltage under load if they have a high resistance. I think it's better to unplug the batteries instead.
7. Ensure the battery(s) have enough capacity to power your glider for at least 1.5 x the expected maximum daily flying time. I usually aim for 6 to 8 hours of continuous usage before the battery goes flat. This can be calculated by multiplying the estimated average current draw by the maximum desired hours flying time and by 1.5 safety factor. For example: -

   Average measured current draw = 0.2Amps
   Maximum desired flying time = 6 Hours
   Safety margin factor = 1.5
   Required Battery Capacity = 0.2Amps x 6Hours X 1.5 = 1.8 Amp Hours

Receiver and Antenna Setup

1. The two exposed ends of the two 2.4GHz Antennas typically about 25mm in length must:
    a. Never run parallel to servo or battery wiring unless more that 75mm away from this wiring.
    b. Should be mounted at right angles to each other and at least 50mm apart but also in accordance with the manufacturer's guidelines on optimal antenna placement.
    c. Should be mounted inside plastic tubing to prevent the antennas getting bent or damaged.
2. The receiver should be mounted on soft foam or Velcro to dampen high frequency mechanical vibration that could damage components in the receiver over time.
3. A lot of transmitters these days can report telemetry on the receiver signal strength. If you have this, you can try different antenna mounting orientations and measure the results from different angles and distances to determine the optimal antenna placement for your glider.

The Tow Release Mechanism

Using a test tow loop:

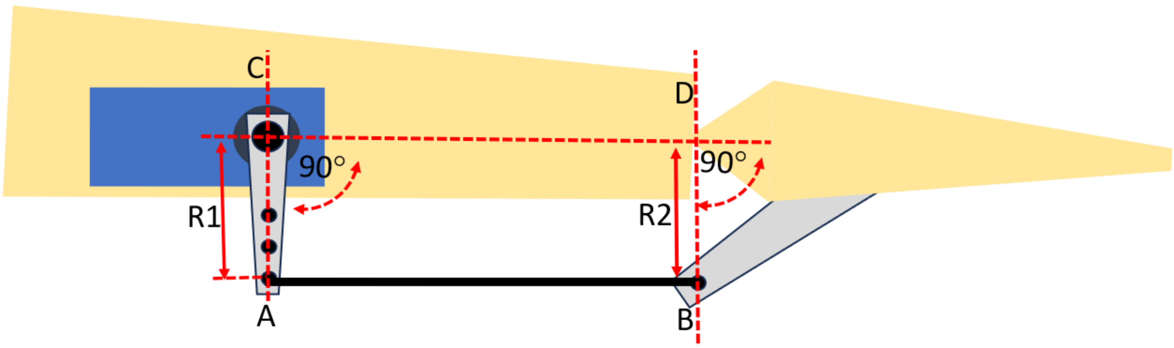
1. Ensure the tow release switch on your transmitter releases the tow loop on your glider reliably while the tow loop has a pulling force on it of at least 1.5 times the weight of your glider.
2. Ensure the tow loop connected to your glider is the weakest link and will break with a force no greater than 6 times the weight of your glider.
3. Typically, the tow release servo doesn't need a lot of distance travel so better mechanical advantage can be obtained by placing the tow release push rod on an inner radius hole on the servo arm side.
4. The tow connection point on the glider should be no further back than half the distance between the nose of the glider and the leading edge of the wing. The position is not very critical. It can be on the nose, underneath or on the side of the fuselage. The side or nose is generally easier to get at when connecting.

Servo setup

Mechanically setting up servos, associated push rods and flight control arm geometry correctly should be done before any trim adjustment is done with the transmitter.

The diagram below shows a typical servo to flight control setup:

1. Pivot point radii R1 and R2 can be made the same for best 1:1 mechanical torque transfer and servo resolution.
2. When push rod alignment line AB is parallel to line CD and 90 degrees to line BD the control will have equal travel in both directions. If Mechanical differential is required distance AB can be a little greater than distance CD while keeping line BD at right angles to CD.
3. For cases where more flight control torque is required, radius R1 can be made less than radius R2. This can be useful to: -
    a. Reduce the likelihood of flutter at higher air speeds.
    b. Mechanically reduce flight control rate.
    c. Allows full servo travel with desired flight control travel.



- It's important to check and optimise control linkage geometry to prevent the servo or flight control from hitting a mechanical stop that could stall or damage the servo, control arms or flight control.
- Push rods should be strong enough to handle the expected forces without bending and have a threaded clevis at least one end so their length can be easily adjusted.
- Ensure that control linkage does not flex when it is under compression to operate the control surface.
- For high load control surfaces, high toque metal gear servos with metal servo arms are recommended as plastic gears can break and plastic arms can split at the servo spline.
- Controls should be mechanically centred, and rate adjusted with the servo at the mid point (1500 micro second PPM pulse width centre radio trim) before any radio fine tuning of travel rate or trim centre are made.
- Ensure the servo and flight control arm hole diameter matches the diameter of the clevis pin and or push rod so that there is no slop. This will ensue crisp flight control and prevent flutter.

In my workshop during servo installation, I use a lab power supply with a built-in amp meter to power the aircraft during control testing. This allows me to monitor current draw while operating the transmitter controls to their endpoint to look for unexpected current spikes. Sudden high current draw means the servo is mechanically hitting an endpoint and stalling or is encountering a high degree of mechanical resistance due to poor setup. I can then rectify this to minimise servo current draw which prevents excessive battery consumption during flight and prolongs the life of the servos.

Telemetry Setup

These day's a lot of radio control systems support variometer and altimeter telemetry. If your system support this, it is recommended that you make full use of this to monitor the following: -

- Height above ground with audible alerts for reaching tow release height which is about 1000 feet at the VARMS site.
- Variometer tones associated with lift and sink. Refer to the *Flying after tow release* section above for how and why this is worth doing.
- Monitoring receiver battery voltage with audible alarms for low voltage
- Monitoring receiver signal strength indication with audible alarms for low RSSI

Centre of Gravity Setup

Centre of gravity (CG) is specified longitudinal (forward and aft) and/or lateral (left and right). Usually, it's only longitudinal CG that needs adjustment by adding or removing weight from as close to the nose or tail of the aircraft as possible. Its better, but not always possible to remove weight or move batteries forward or backward to correct the GC rather than adding more ballast weight. If additional ballast weight is needed, it should be placed as close to the front or rear of the aircraft as possible so that the least amount of additional weight is needed to correct the longitudinal balance.

Longitudinal (pitch) stability is maintained by ensuring the CG is slightly ahead of the centre of lift. This produces a fixed nose-down force independent of the airspeed and ensures your aircraft will:

- Fly with minimum drag with neutral centre elevator trim.
- Have good elevator authority at lower airspeeds such as take-off roll.
- Have pitch stability at a wide range of air speeds without need for large elevator corrections or trimming adjustments and will not oscillate about the pitch axis in flight.
- Perform thermal turns well without need for a lot of elevator correction.
- Not stall prematurely during landing flares.
- Fly inverted with minimal down elevator compensation.
- Penetrate into strong winds more easily without excessive elevator trim changes.

Before initial test flights, measure and adjust the longitudinal CG using one of the following methods:

1. As specified in the model build manual provided.
2. Using an online CG calculator such as https://rcplanes.online/cg_calc.htm
3. Seeking advice from knowledgeable club members
4. Or a combination of methods above

Most model aircraft typically require the longitudinal CG to be close to or on the main wing spar/joiner location. This is usually between quarter and a third of the distance of the mean wing cord behind its leading edge.

Initial balance should be done by placing the aircraft in a balancing jig to balance it at the desired location by adjusting the ballast weight until it balances.

CG Test flights

During initial flights after trimming the elevator for normal flying speed, perform one or more of the following tests to check longitudinal CG making small changes to GC between test flights:

Flight Test	Observed behaviour	Result	Adjustments required
Moderate Dive Test	Pulls out very quickly with without elevator input	Nose heavy	Add tail weight, re-trim the elevator during the next test flight for normal flight speed and retest.
	Pulls out of a dive slowly with no elevator correction	Good	No CG or elevator trim adjustment is needed.
	Fails to pull out of dive without additional up elevator	Tail heavy	Add nose weight, re-trim the elevator during the next test flight for normal flight speed and retest.
Shallow angle 360 Turn	Nose drops and a lot of up elevator compensation is needed to maintain level flight during the turn	Nose heavy	Add tail weight and re-trim the elevator during the next test flight for normal flight speed and retest.
	Completes the turn with minimal elevator input to keep the nose level and air speed remains consistent during the turn	Good	No CG or elevator trim adjustment is needed.
	Glider slows and stalls or progresses to an incipient spin	Tail heavy	Add nose weight, re-trim the elevator during the next test flight for normal flight speed and retest.
Loop	At the top of the loop while the glider is inverted at minimum airspeed it drops the nose	Nose heavy	Add tail weight and re-trim the elevator during the next test flight for normal flight speed and retest.
	Completes a nice consistent radius loop without stalling at the top of the loop	Good	No CG or elevator trim adjustment is needed.
	At the top of the loop, it tends to stall and or spin	Tail heavy	Add nose weight, re-trim the elevator during the next test flight for normal flight speed and retest.