Fixed-Wing Foamboard Trainer Project (4-Channel: Ailerons + Elevator + Rudder + Throttle)

A comprehensive, step-by-step build guide using your current parts as a stepping stone toward custom drone design.

Date: February 16, 2026
Build level: Beginner-to-intermediate
Goal: A reliable 4-channel foamboard airplane you can tune and later expand (flaperons, stabilization, FPV, autonomy).

Safety first: Treat the prop like a blender and the LiPo like a power tool battery. Always remove the prop when configuring radio/ESC on the bench. Use a throttle-cut switch. Charge LiPos on a non-flammable surface and never unattended.

What you'll end up with: a high-wing trainer-style airframe with ailerons, elevator, rudder, and a front-mounted (tractor) prop. It will be hand-launched and belly-landed by default (optional landing gear later).

Inventory you have

This guide is written around the parts you already collected. Items marked as “Optional add-ons” later are recommended but not required to fly.

Radio control	• RadioMaster Pocket (2.4 GHz ExpressLRS) transmitter (EdgeTX) • RadioMaster ER5A 5CH 2.4 GHz ExpressLRS PWM receiver (pins for direct servo/ESC connection)
Propulsion & power	• OVONIC 3S LiPo 1000 mAh 11.1 V (XT60) 35C • 40A brushless ESC with 5V/3A UBEC/BEC, XT60 input, 3.5 mm bullet outputs • A2212 1000KV brushless outrunner motors x4 (shaft diameter 3.17 mm) • 9x4.7 propellers (2 CW + 2 CCW) with hole adapter rings • Prop adapter set: 3.17 mm motor shaft aperture to 6 mm output axle (6-pack)
Servos & linkages	• MG90S metal-gear micro servos x4 (2 original + 2 added) • Pushrod/connector/control horn kit (pushrods, linkage stoppers, nylon control horns)
Airframe materials & tools	• Foam board pack (11x14 in, 1/8 in thick) • Servo tester (6-channel) for centering and quick checks • 3-pin servo extension cable set (10/15/20/30/50 cm; 20 pcs total)
Charging	• B3 2S/3S LiPo balance charger (XH plugs) • 4-slot Li-ion charger kit • 18650 Li-ion cells 3.7 V, 2500 mAh button-top x4 (for transmitter)

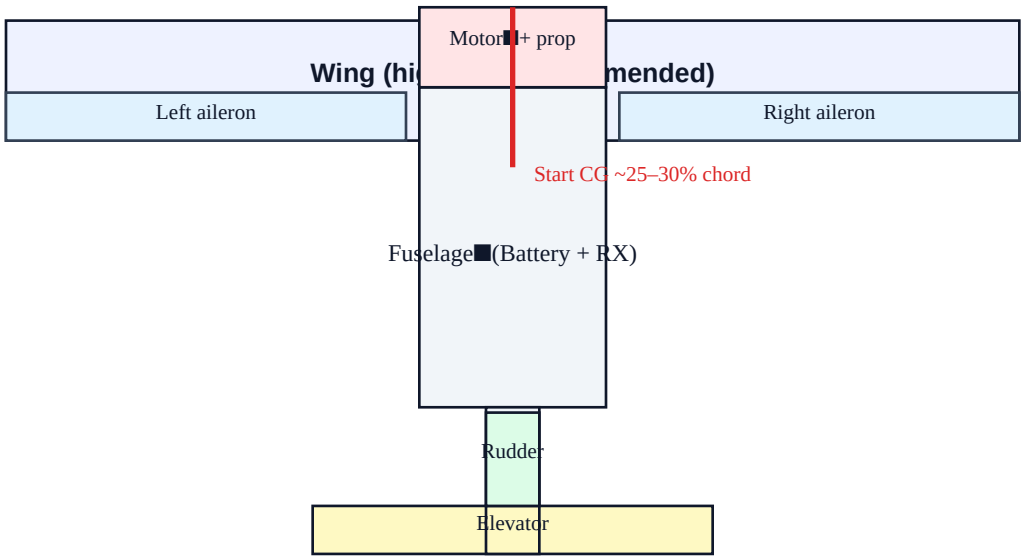
Project overview and learning path

You’re building a fixed-wing airplane as a stepping stone toward designing your own drones. Fixed-wing teaches the same fundamentals you’ll reuse later: power systems, RF link reliability, control authority, stability, trim, failsafes, and iterative tuning. Ailerons from day one also sets you up for flaperons and other control-surface experiments.

Phases:

- **Phase 1 – Bench bring-up:** radio bind, servo centering, ESC throttle range calibration, motor direction, throttle cut.
- **Phase 2 – Airframe build:** foamboard cut/fold, hinge surfaces, servo installation, pushrod geometry, reinforcement, CG provisions.
- **Phase 3 – Integration:** wiring, strain relief, extensions, receiver mounting, range check, preflight.
- **Phase 4 – Maiden + trim:** safe throws, hand launch, trim, CG adjustment, rudder-aileron coordination.
- **Phase 5 – Tuning + upgrades:** dual rates/expo, differential aileron, flaperons, later: stabilization/INAV/ArduPilot.

Airframe concept (schematic)



Design choice: High-wing + some dihedral (wing tips slightly higher than center) makes trainers self-correcting. If you’re unsure, build in dihedral rather than a perfectly flat wing.

Airframe design: a practical foamboard trainer

Because you're using 11x14 foamboard panels, this guide targets a compact but stable trainer. You can scale up later. The numbers below are a proven starting point; they are not the only way to build it, but they produce a flyable airplane with your power system.

Parameter	Recommended starting value (adjustable)
Wingspan	850–950 mm (33–37 in)
Wing chord	180–220 mm (7–8.5 in)
Wing area	≈ 0.16–0.21 m²
Dihedral	10–20 mm tip rise per side (mild)
Airfoil	Simple undercamber or folded "KFm-style"/flat-bottom; keep it consistent
Tailplane span	320–380 mm
Tailplane chord	90–120 mm
Elevator	30–40% of tailplane chord
Rudder	35–45% of fin area; generous is OK for trainers
All-up weight target	450–750 g (lighter is easier)
CG starting point	25–30% of wing chord back from leading edge at root

Foamboard note: "Foam core" boards vary in weight. If yours is heavy, keep the build smaller, minimize glue, and avoid over-reinforcing. Weight is the enemy of slow, forgiving flight.

Build steps: structure

Below is a detailed, no-magic process. You can build without a full-size printed plan by using measurements and straight cuts.

1. Cut a wing blank: chord ~200 mm, span ~900 mm. If your foamboard is 11x14, splice panels with a butt joint and tape on both sides. Stagger seams so they are not all on the same line.
2. Add a spar: glue in a foam/wood/carbon strip near 30–35% chord (even a doubled foam strip works). This is the main stiffness member.
3. Create dihedral (recommended): cut the wing at centerline, bevel the joining edges, prop each wing half up 10–20 mm, and tape/glue the joint. Add a top tape "bandage".
4. Hinge the ailerons: cut ailerons ~35–45 mm wide along the trailing edge, leaving at least 25–30% of the wing uncut near the center for strength. Use tape hinges (top and optionally bottom).
5. Build a box fuselage: inside width ~55–65 mm; height ~70–85 mm; length ~600–700 mm. Reinforce the nose where the motor mounts.

6 Add the tail boom/section: ensure tail is straight and aligned with wing. Misalignment causes constant trim issues.

7 Cut tailplane and fin. Hinge elevator and rudder with tape hinges. Keep hinge lines straight; sloppy hinges feel ‘mushy’ in the air.

8 Dry-fit everything. Confirm you have room to move the battery forward/back to hit CG.

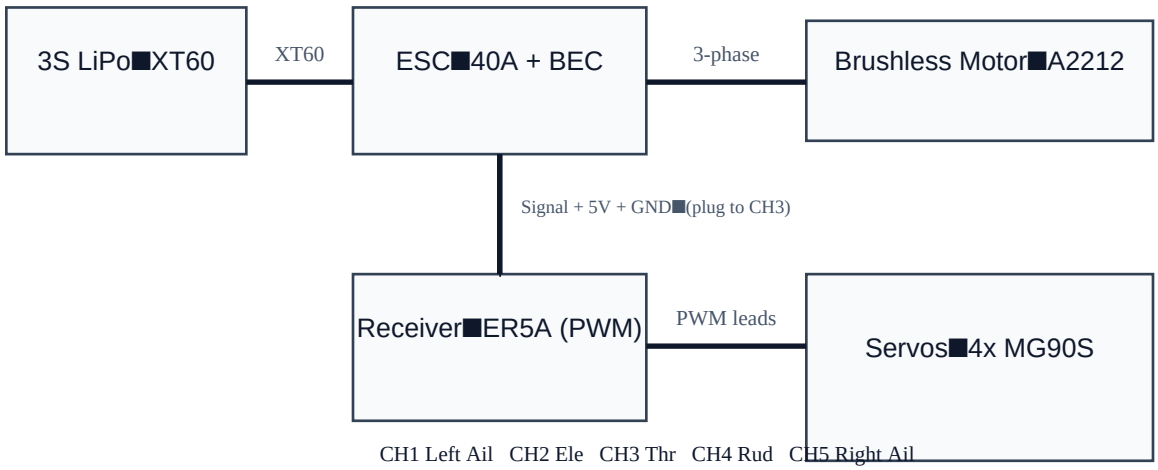
Reinforcement ideas (choose lightly)

- Filament tape along leading edge and across the wing center joint.
- Popsicle sticks / thin plywood for motor mount plate.
- A single carbon rod or wooden dowel as a wing spar if you have it.
- Packing tape on the belly for durable landings.

Electronics: wiring and installation

This section assumes **no flight controller** yet. The ER5A outputs PWM directly to servos and the ESC. Your ESC’s 5V/3A BEC powers the receiver and servos.

Wiring diagram



Channel map (recommended)

Receiver channel	Device	Notes
CH1	Left aileron servo	Use extension lead; reverse in radio if needed
CH2	Elevator servo	Keep pushrod straight; avoid flex
CH3	ESC signal lead	BEC power enters receiver here (5V + GND)
CH4	Rudder servo	Rudder authority is helpful for takeoff/launch correction
CH5	Right aileron servo	Independent ailerons enable flaperons/differential later

Prop rule: remove the prop for all bench setup (binding, servo reversing, ESC calibration). Install the prop only when you are ready for outdoor run-up.

Receiver placement and wiring hygiene

- Mount the receiver with foam tape. Avoid hard mounting directly to vibrating surfaces.
- Route servo wires away from battery leads and motor wires when possible. Cross at 90 degrees if they must cross.

- Use your servo extension set to keep runs tidy. Secure all connectors with a small piece of tape or heat-shrink so they cannot vibrate loose.
- Place the antenna(s) away from carbon/metal and away from the motor/ESC. A simple ‘V’ or ‘T’ orientation is fine.

Radio setup: EdgeTX + ELRS basics

This section is a practical setup checklist. Exact menu names can vary slightly by EdgeTX version, but the concepts stay the same.

1) Bind receiver to transmitter

1. Power the ER5A from the ESC BEC (plug ESC lead into CH3) or from a 5V source.
2. Put receiver into bind mode per ER5A instructions (often a button press or power-cycle pattern).
3. On the Pocket, open the ExpressLRS LUA script and bind (or use ‘Bind’ via model setup if applicable).
4. Confirm RSSI/LQ telemetry appears and that stick movements change channel outputs (use the receiver’s channel monitor if present, or servo movement after setup).

2) Create a new model: recommended switches

- **Throttle cut:** assign a dedicated switch that forces throttle to -100% (or 0) regardless of stick position.
- **Dual rates:** low/high rates switch for aileron and elevator (start on low).
- **Optional:** a ‘panic’ mode later if you add stabilization. For now, keep it simple.

3) Channel mapping and reversing

With the recommended wiring (CH1 left aileron, CH5 right aileron), you’ll typically reverse one aileron channel so they oppose correctly. Use the servo tester to center mechanically first; then reverse in the radio, not by flipping the servo horn geometry.

Aileron direction test:
Move stick right. The right aileron should go up and the left aileron should go down. If not, reverse the appropriate channel.

4) Starting rates and expo

Surface	Low rate throw (start)	High rate throw	Expo (start)
Aileron	8–10 mm up / 6–8 mm down	12–15 mm up / 10–12 mm down	20–30%
Elevator	8–10 mm up/down	12–15 mm up/down	25–35%
Rudder	12–18 mm each way	20–30 mm each way	10–20%

These are conservative trainer settings. Reduce throws if the plane feels twitchy; increase once trimmed and comfortable.

Propulsion setup: ESC, motor, prop

Your A2212 motor (1000KV) on 3S with a 9x4.7 prop is a common trainer setup. The goal is reliable thrust at modest current, not maximum speed.

Prop mounting (3.17 mm to 6 mm adapter)

- Install the 3.17 mm adapter onto the motor shaft and tighten set screws firmly (use blue threadlocker if available).
- Select the correct prop hole adapter ring so the prop fits snugly on the 6 mm output axle.
- Tighten the prop nut so it will not slip. Re-check after the first run-up.
- Balance props if possible. Even small imbalance increases vibration and can loosen hardware.

ESC calibration (throttle range)

Most ESCs need one-time calibration so ‘stick low’ equals idle and ‘stick high’ equals full throttle. Follow your ESC’s manual if it differs, but the common process is:

1. Remove prop. Turn on transmitter. Disable throttle cut temporarily so the throttle channel can reach full.
2. Set throttle stick to full. Power the ESC (connect battery).
3. Wait for the calibration beeps/tones, then move throttle to minimum. ESC confirms with beeps.
4. Re-enable throttle cut and confirm minimum throttle is safe.

Motor direction: If the prop blows air forward (wrong), swap any two of the three motor wires. (Never change direction by swapping receiver channels.)

Battery and runtime expectations

A 3S 1000 mAh pack is fine for a small foamboard trainer. Expect shorter flights than larger packs; aim for **4–7 minutes** initially and land early. You can scale to larger capacity later once CG and structure are proven.

LiPo handling checklist

- Inspect pack before each flight. Do not fly if swollen or damaged.
- After flight, let the pack cool before charging.
- Avoid deep discharge. If the plane feels weak, land. (ESC LVC is a last resort.)
- Store packs at storage voltage when possible (a more advanced charger helps).

Mechanics: servos, linkages, and control geometry

Good geometry makes the airplane feel predictable. Sloppy linkages make it feel ‘drifty’ and hard to trim.

Servo centering and horn setup

- Use your servo tester to center each servo (neutral).
- Install horns as close to 90 degrees as possible; then use radio subtrim only for small corrections.
- For initial setup, choose a mid-range hole on the servo horn and a mid-range hole on the control horn.

Pushrod routing

- Keep pushrods straight. If you must bend, make smooth bends and support long runs with a straw/guide tube.
- Avoid flex: elevator pushrod flex causes pitch oscillations.
- Use the adjustable pushrod connectors to fine-tune neutral without re-bending Z-bends.

Aileron specifics: differential and flaperon-ready setup

Because you’re using CH1 and CH5 separately, you can add two useful refinements later:

- **Differential:** more up than down aileron reduces adverse yaw. Start with ~60–70% down compared to up.
- **Flaperons:** both ailerons droop together for slower landing. Start with small amounts (5–10 degrees).

Adverse yaw tip: Many trainers need a touch of rudder with aileron turns. This is normal and teaches coordinated flight.

Preflight, maiden flight, and trimming

Treat the maiden as a data-gathering flight. The goal is not aerobatics; it’s confirming CG, trims, and control authority.

Preflight checklist (do not skip)

- Prop tight; spinner/adapter set screws tight; motor mount tight.
- Receiver antenna secure and away from motor/ESC; wires secured.
- All surfaces move the correct direction.
- Failsafe set: on signal loss, throttle goes to cut/off (verify with prop removed).
- Battery secured with Velcro/strap; cannot slide.
- CG check at 25–30% chord; slightly nose heavy is OK.
- Range check: walk 20–30+ meters; confirm control remains solid.

Hand launch technique

- Pick a calm day. Wind makes early flights harder.
- Hold the fuselage firmly under the wing. Use ~60–75% throttle (not full).
- Throw level, slightly nose-up (a few degrees). Do not ‘lob’ it upward.
- Use small corrections. Let it fly out and gain speed.

Trimming sequence

1. At safe altitude, reduce to a comfortable cruise throttle.
2. Trim for hands-off level flight: elevator first, then aileron, then rudder.
3. If you need lots of elevator trim, adjust CG (battery position). Nose-heavy needs up-elevator; tail-heavy feels twitchy and unstable.
4. Land early. Write down what you observed.

CG diagnosis:
• Nose-heavy: wants to dive, needs lots of up-trim, lands fast.
• Tail-heavy: feels twitchy, porpoises, stalls abruptly. If in doubt, move battery forward.

Troubleshooting guide

Symptom	Likely causes and fixes
Plane rolls left/right constantly	Re-check wing alignment and aileron neutrals. Verify one aileron isn’t slightly up/down at neutral. Check CG and that the wing isn’t warped.
Porpoising (up/down oscillation)	Usually CG too far back or elevator pushrod flex. Move battery forward and stiffen linkage.
Adverse yaw (nose yaws opposite turn)	Add rudder with aileron. Later add aileron differential (more up than down).
Servo jitter / random resets	Loose connectors, wire routing near power leads, or BEC overload. Secure connectors, reduce friction, check for binding control surfaces.
Short flights / weak power	Battery sag, prop too large, or poor airflow to ESC. Start conservative and land early; consider a larger capacity pack later.
Prop loosens	Wrong thread direction/self-tightening orientation or inadequate tightening. Re-check adapter and nut; use a proper prop washer.

Bench sanity checks (quick)

Use these anytime something feels off:

- Prop off, throttle cut on, confirm servos respond cleanly.
- Check aileron and elevator deflection doesn’t bind at full throw.
- Wiggle-test connectors while powered; no resets should occur.
- Verify failsafe: turn off transmitter, throttle must go to cut.

Upgrade path: from trainer to ‘drone plane’

Once you can reliably take off/launch, fly a circuit, and land, you’re ready to add ‘drone’ capabilities in a controlled way.

Safe upgrades (keep it fun)

- **Flaperons:** use CH1+CH5 to droop both ailerons for slower approaches.
- **Differential aileron:** reduces adverse yaw and makes turns cleaner.
- **FPV camera (later):** adds excitement but keep it after basic piloting is solid.
- **Stabilization:** add a fixed-wing flight controller and keep the ER5A as your PWM receiver or switch to a CRSF receiver. Stabilization makes experimentation easier.
- **Autonomy:** GPS + return-to-home + mission planning after stabilization is proven.

Suggestion: Keep this first airframe as your “test mule.” When you try new mixes or new gear, do it on the mule, not your ‘pretty’ build.

Optional add-ons (not required to fly)

- LiPo-safe bag and a basic cell checker/alarm.
- A charger with storage-charge mode (for long-term pack health).
- Spare props, spare pushrods, spare tape.
- Lightweight spar material (carbon rod) if you scale up wingspan.

Appendix: quick reference

Receiver channel quick map

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CH5	Right aileron servo	Independent ailerons enable flaperons/differential later

Bench setup order (fast)

1. Prop off. Throttle cut ON.
2. Center servos (servo tester). Install horns at 90 degrees.
3. Bind Pocket ↔ ER5A.
4. Verify channel directions. Reverse channels in radio if needed.
5. Calibrate ESC throttle range (per manual).
6. Install prop. Outdoor run-up only.

Field kit (what to bring)

- Spare props + prop nut tool/wrench
- Tape, small screwdriver, small pliers
- Battery(s), charger, LiPo bag
- Zip ties / rubber bands for quick fixes
- Notebook: record CG position and trims

End

Once you complete a few flights, tell me what the plane felt like (stable/twitchy, trim amounts, stall behavior), and I'll help you tune CG, throws, and mixes—and plan the next 'unique' control-surface experiment.