AVENUE SHIFTERS™

Sensor Configuration

Automatic Bicycle Gear Shifting — where the sensors live, and why

Avenue Cruisers Co. LLC · Des Moines, Iowa · October 29, 2026

The question: where do the sensors of the Avenue predictive automatic-shift system live so that they are **protected** — out of the strike zone, out of the spray, out of reach — and **extremely functional** — reading exactly the signal the shift logic needs?

The answer, in one line: every pickup moves *inside* something — inside the dropout pocket, inside the bottom-bracket shell zone, inside the servo housing, inside a frame radome — and the one channel that would need an exposed sensor (load) has no sensor at all: it is inferred inside the controller. The placements below keep the proven signal paths — wheel counts, cadence counts, back-of-servo Hall gear position — and change only where the hardware sits, so protection is added without touching what the test record already established.



Figure 1 — Servo upright bicycle, sensor placement map. Illustration is a rendering; proportions are indicative, placement positions are the configuration.

1 **Wheel-speed pickup** — inside the rear dropout / chainstay pocket, reading the hub tone ring.

2 **Cadence pickup** — sealed at the bottom bracket / crank-spindle interface.

3 **Gear-position Hall array** — inside the servo module housing, at the back of the servo.

4 **Servo shift module** — derailleur-zone mount under a heavy-duty bolt-on protective guard.

© 2026 Avenue Cruisers Co. LLC · Avenue Shifters™ is a trademark of Avenue Cruisers Co. LLC.

5 **GPS antenna** — seat-cluster radome, highest practical point with clear sky view.

6 **Load sensing** — no external sensor; inferred in the controller (marker sits on the controller housing).

7 **Controller + incline (IMU)** — sealed housing at the down-tube / bottom-bracket junction, rigid to the frame. *Proposal addition* — see table.

Sensor table — placement, protection, function, wiring, service

1 — Wheel-speed pickup PROVEN CHANNEL	
Measures	Rear-wheel speed — pulse counts per revolution, read by the shift controller.
Placement	Pickup seated in a machined pocket **inside the rear dropout / chainstay**, facing a tone ring (or magnet set) carried on the rear hub shell. Nothing protrudes past the dropout face.
Protection	The dropout and chainstay form a metal pocket around the pickup: no spoke strike can reach it, no pannier strap or heel can knock it, wash spray and road debris hit the frame first, and there is no exposed bracket to bend or pull.
Function	The pickup-to-ring gap is set by the **dropout machining**, not by a zip-tied fork mount that creeps. The gap is identical after every wheel removal — the wheel self-locates in the dropout, so count quality is preserved ride after ride.
Wiring	Lead runs **inside the chainstay** to the bottom-bracket junction, then inside the down tube to the controller. No external cable along the stay.
Service	The wheel removes normally — the pickup never moves. A failed pickup swaps as a pocket module from inside the dropout; the tone ring is part of the hub and is not a service item.

2 — Cadence pickup PROVEN CHANNEL	
Measures	Crank cadence — rider input counts, read by the shift controller.
Placement	Sealed pickup at the **bottom bracket / crank interface**: a sealed ring on the crank spindle inside the BB shell zone, read through the shell-side sensor face.
Protection	The shell and the crankarm guard the pickup on both sides. There is **no external arm-mounted magnet** to knock off, no spoke-style magnet to misalign, and the sealed ring is out of the chain's fling path and out of wash spray.
Function	The spindle ring turns at exact crank speed with a fixed, factory-set sensor gap — cadence counts stay clean at low rpm, which is where the shift logic leans on cadence most (starts and climbs).
Wiring	Short internal lead from the BB shell zone straight into the frame junction — the shortest run on the bike, entirely inside the frame.
Service	Swaps with the bottom-bracket service unit. Crank removal is the only access step, and it is a standard shop operation; the pickup itself never needs alignment after install.

3 — Gear-position Hall array PROVEN CHANNEL	
Measures	Actual gear position — Hall-effect readings at the **back of the servo**, read against the gear-angle table.

© 2026 Avenue Cruisers Co. LLC · Avenue Shifters™ is a trademark of Avenue Cruisers Co. LLC.

Placement	**Inside the servo module housing**, fixed on the servo shaft axis at the back of the servo — the proven arrangement, kept as-is. The housing is sealed; the array never sees the outside.
Protection	The array lives inside a sealed housing: no water, grit, chain lube, or wash spray reaches it; nothing can strike it; and because it reads the servo itself, tampering with the external linkage cannot spoof the reported gear.
Function	Hall elements sit on the shaft axis at the servo's back face, so every reading is a true clock position of the servo output — the geometry behind the proven gear-position record. Fixed at assembly; no field alignment exists to drift.
Wiring	Internal to the module; the module's single harness carries power, command, and the position return to the controller along the chainstay route.
Service	Part of the servo module — service is a **module swap**, never an array repair. The swapped module arrives with its array fitted and aligned.

4 — Servo shift module PROVEN ACTUATOR

Measures	The actuator itself — executes the shift; carries the gear-position array (item 3).
Placement	Mounted in the derailleur zone on the module bracket, wrapped by a heavy-duty protective guard that stands proud of the housing on the strike side, with the shift linkage/cable path left open on the working side.
Protection	The derailleur zone is the most struck real estate on a bicycle — lean-overs, racks, curbs, trailside rocks. The guard stands between that world and the housing, and sheds spray and chain fling; the module sits inboard of the guard line, so a fall lands on the guard, not the servo.
Function	The guard protects the housing, not the motion: the output arm and linkage sweep stay unobstructed, and the module's mounting face is unchanged, so shift geometry — and the back-of-servo Hall readings — are exactly as proven.
Wiring	Module harness runs with the wheel-speed lead inside the chainstay to the frame junction. All joints **soldered and glued**, per the proven build — no field connectors in the spray zone.
Service	The guard unbolts as one piece for service; the module swaps as one unit.

5 — GPS antenna SYSTEM FEATURE

Measures	Position and elevation look-ahead — the controller reads the grade of the road ahead, so the shift is made *before* the hill loads the drive (GPS grade anticipation).
Placement	Inside a **radome housing at the seat cluster** — the top of the seat tube, under the saddle: the highest practical point on the upright frame, in a non-metallic housing cap.
Protection	The radome is the protection: a sealed, impact-tolerant cap over the antenna. At the seat cluster the antenna is behind the rider's leg line and above the spray arc of both wheels — the driest, least-struck high point on the bike.
Function	GPS needs sky, not exposure: the antenna sits high with an unobstructed upward view, clear of metal shielding (the housing cap is RF-transparent), so fix quality and elevation data stay at full strength while the antenna itself never sees weather.
Wiring	Lead runs **inside the seat tube** down to the frame junction and controller. Nothing external on the seat stays.

© 2026 Avenue Cruisers Co. LLC · Avenue Shifters™ is a trademark of Avenue Cruisers Co. LLC.

Service	The radome cap is a swap part; the antenna module lifts out with the seat-cluster service panel. No alignment or calibration step after swap.

6 — Load sensing INFERRED — NO SENSOR	
Measures	Drivetrain load — the input that rises with a climb's resistance and with a headwind (a headwind manifests as load), feeding the shift decision alongside speed, cadence, and grade.
Placement	**There is no load sensor to place.** Load is computed inside the controller from drivetrain behaviour — servo/motor current draw against the speed-and-cadence delta. The “placement” is the controller housing itself (marker 6 sits on it).
Protection	The strongest protection answer on the bike: a channel with no external hardware cannot be struck, soaked, misaligned, or torn off. Nothing on the frame's exterior corresponds to it.
Function	Inference reads the signals the system already measures at full rate — current, wheel counts, cadence — so load response is as fast as the proven channels it is derived from, with no added sensor lag or failure mode.
Wiring	None. The channel exists only as controller inputs already on the internal harness.
Service	Nothing to service. If load behaviour ever needs revision it is a configuration/firmware matter through the designed update provision — no hardware visit.

7 — Controller + incline (IMU) PROPOSAL ADDITION	
Measures	The shift controller — plus, as an **addition proposed here**, an incline/IMU element inside the same housing, giving the frame's own pitch as a direct grade input alongside GPS look-ahead.
Placement	Controller in a **sealed housing at the down-tube / bottom-bracket junction** — low, central, inside the frame's strongest triangle, behind the battery mass. The IMU is board-mounted inside that housing, rigid to the frame.
Protection	Low and central is the protected seat on a bicycle: the housing is shielded by the frame tubes and battery on every side, sits above the worst of the spray arc, and is the last place a fall or a rack strike reaches. The IMU inside it inherits all of that protection.
Function	An incline reading is only honest if the sensor is **rigid to the frame** — board-mounted in the frame-fixed controller housing, its pitch *is* the frame's pitch, with no bracket flex to filter out. The controller's inputs — wheel, cadence, gear position, GPS — all terminate at this one housing, keeping runs short.
Wiring	The junction is the frame's wiring hub: chainstay leads (items 1, 3, 4), BB lead (item 2), and seat-tube lead (item 5) all arrive here inside the frame. Joints soldered and glued per the proven build.
Service	The controller is the system's designed swap unit: the housing opens at the service panel, the board/module exchanges as one piece, and configuration loads through the update provision — no sealed assembly is cut open.

Build standard

Wiring throughout follows the proven bench build: joints are **soldered and glued** — they are not plugs to be pulled in the field, and no service step in this configuration asks anyone to unplug one. Service is by **module swap** (pickup module, BB unit, servo module, radome cap, controller) — the same maintainability

© 2026 Avenue Cruisers Co. LLC · Avenue Shifters™ is a trademark of Avenue Cruisers Co. LLC.

rule the Avenue Haulers line runs on: standard parts, swap the module, never open a sealed assembly to update or repair it.

Trans-Porter carryover — the same philosophy, inside the hubs

The Avenue Haulers Trans-Porter takes the same control technology — the Avenue predictive automatic-shift controller and its wheel/Hall, incline/GPS, and load-estimation suite — and applies the same rule, **every pickup lives inside a housing**, at vehicle scale:

- **Wheel speed / Hall sensing — inside the hub housings.** Each rear hub motor carries its speed and Hall sensing sealed inside the hub shell, reading the rotor it already surrounds. On the bike, the dropout pocket protects the pickup; in the hub, the shell *is* the pocket — no external pickup, no tone-ring gap to set, and nothing on the wheel to strike, soak, or align.
- **Range-position feedback — inside the servo actuators.** The gear-position lesson of the bike line — read position at the back of the servo, inside the housing — carries over directly: each hub's two-speed planetary range actuator reports its range position from inside its own sealed actuator housing, on the shaft axis, exactly as the bike's Hall array reads the servo's clock position. External linkage position is never trusted as the position signal.
- **Controller — in the sealed electrical bay.** The predictive controller sits in the vehicle's sealed electrical bay, not on an exposed bracket: one protected volume for the controller, its incline/GPS inputs, and the load/headwind estimation that — as on the bike — is inferred from drive behaviour rather than sensed by anything outside.
- **Diagnostics without exposure.** Controller and pack data surface at a single diagnostics service port, and updates run through the designed provision — servicing the sensor suite never means opening a hub or the electrical bay's sealed assemblies.
- **Nothing sensor-like on the exterior.** The Trans-Porter's outside carries lights, seals, and structure — no pickups, no external magnets, no antenna stubs. The full sensor suite is invisible from outside the vehicle, which is the point: a fleet vehicle that gets pressure-washed, bumped at docks, and parked anywhere keeps every sensor it has.

Protection vs. function — the summary

Sort the whole configuration by where each channel lives, and the design rule shows itself:

- **Inside a housing:** the gear-position Hall array (servo housing), the GPS antenna (seat-cluster radome), the controller and its proposed incline element (sealed junction housing), and — on the Trans-Porter — every hub and actuator sensor.
- **Inside the frame's structure:** the wheel-speed pickup (dropout pocket, gap held by machining) and the cadence pickup (BB shell zone), with every wire run inside the tubes and every joint soldered and glued.
- **Doesn't exist:** the load sensor. Headwind and grade load are inferred from current, wheel counts, and cadence inside the controller — the most protected channel on the vehicle is the one with no hardware at all.

Function is not traded away for any of it: the proven channels keep their proven signal paths, each fixed geometry — dropout machining, spindle ring, shaft-axis array — holds its sensor gap by construction rather than by adjustment, and the two look-ahead inputs (GPS grade anticipation, frame incline) sit exactly where their physics works best: high with a sky view, and rigid with the frame. **Protected because**

© 2026 Avenue Cruisers Co. LLC · Avenue Shifters™ is a trademark of Avenue Cruisers Co. LLC.

it is inside; functional because what is inside was placed where the signal is.

Contact: bill@aitoolsfortoday.com · avenuecruisers.com | Figure 1 is a rendering prepared for this document. Item 7's incline element is a proposal addition and is labelled as such.

© 2026 Avenue Cruisers Co. LLC · Avenue Shifters™ is a trademark of Avenue Cruisers Co. LLC.