Enclosures

- Choosing an Enclosure
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Choosing an Enclosure

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The enclosure protects your electronics from weather, UV, and physical damage. Choose based on IP rating requirements, available mounting options, and your willingness to do custom drilling and fitting. As a rule, target **IP65 as the practical minimum for a sheltered outdoor enclosure, and IP66/67 for direct weather exposure**.

IP Rating Guide

Rating	Protection	Suitable For
IP54	Dust-protected (limited ingress), splash-resistant	Under eaves, protected outdoor locations
IP65	Dust-tight, low-pressure water jets	Standard outdoor exposed deployment (practical minimum)
IP67	Dust-tight, immersion 1m/30min	Ground-level, flood-risk, or harsh weather sites
IP68	Dust-tight, continuous immersion	Underwater or buried applications

Common Enclosure Options

Zulkit IP65 Junction Box - ~$12 (price as of 2026-06-08, varies)

Typically 150 × 100 × 70mm. Hinged lid with a foam gasket; many listings include two cable glands pre-installed (confirm against the specific listing, as price, size, and included glands vary). Good balance of cost, size, and weatherproofing for a single-node solar repeater. A box this size will accommodate a Heltec V3/V4, a charge controller module, and an 18650 battery holder - confirm internal usable depth leaves clearance once mounted.

Generic IP65 - IP68 Junction Boxes - ~$10 - $15 (approximate, volatile)

Available in many sizes from AliExpress and Amazon. Quality varies; check reviews for gasket quality. At this price point, IP65 is reliable; IP68 ratings on cheap boxes should be treated skeptically.

Pelican 1300 - ~$45 - $60 for a genuine case (price as of 2026-06-08)

Durable, crushproof, watertight. Note that a genuine Pelican 1300 typically runs around $45-60 - figures well below $20 usually indicate a clone or used unit, so budget accordingly and check current pricing. Overkill for most deployments but excellent for portability or high-risk mounting locations. Foam insert must be cut to fit your components.

Ammo Can

Military surplus ammo cans are cheap, widely available, and extremely durable. **In plain terms: a metal box blocks radio signals, so the antenna MUST be outside the can** on a bulkhead/feed-through connector - the steel construction provides RF shielding and good weather sealing, but it will detune or block a radio mounted inside it. Mount the board on stand-offs so it cannot short against the metal walls. Be aware that drilling and sealing a watertight antenna feed-through in steel is more work than in a plastic box. Replace the original gasket with EPDM for cold-climate use (EPDM stays flexible to roughly -40°C and resists ozone/weathering).

PVC Pipe Cap Enclosure - ~$3 - $5 (hardware-store pricing)

A 3 - 4 inch PVC end cap can house a minimal node (Heltec V3 + small LiPo + charge controller) and can be made water-resistant - not certified weatherproof, and with no IP rating - when the seams are sealed with PVC cement and silicone. This is an unrated, ad-hoc DIY solution. **Caution:** do not permanently glue or cement a lithium-cell node into a non-openable enclosure. You must be able to inspect and replace a swollen cell, and a sealed, cemented box gives a venting cell nowhere to relieve pressure - a fire-containment concern. For any lithium-powered build, prefer a gasketed, openable enclosure.

Muzi Works 3D-Printed Cases (PLA-CF)

Custom-designed for the Heltec V3 and available from Muzi Works directly. These are 3D-printed cases (carbon-fiber PLA per the product listing), not injection-molded. More form-fitting than generic boxes and easier to assemble, but more expensive. A good option if you want a clean-looking install without custom fabrication. Note that PLA-based filament UV-embrittles outdoors over time; treat it as a sheltered/semi-permanent solution rather than a long-term direct-weather enclosure.

3D Printed Enclosures

Community-designed enclosures are available on Printables, Thingiverse, Thangs, and Cults3D. Search for your specific device model. Print in PETG or ASA for outdoor use - ASA is the strongest

UV/outdoor performer (Tg ~100°C), PETG is good (~80°C), and PLA degrades in UV and heat (Tg ~60°C, embrittles outdoors) so avoid PLA for direct-weather parts. Seal seams and lid interfaces with neutral-cure (non-acetic) silicone RTV - not acetic-cure aquarium-type sealant, whose acetic vapor corrodes copper. Add UV-resistant coating or paint to PETG prints for long-term outdoor durability.

Size Selection

Measure your components before ordering an enclosure. As a rough guideline, a typical single-node solar repeater (Heltec V3 or V4 + 18650 + CN3791) fits comfortably in a 150 × 100 × 70mm box. For a RAK WisBlock with larger battery packs, consider 200 × 120 × 75mm or larger. These figures are configuration-dependent - verify against your actual parts.

What to Avoid

- Generic "waterproof" boxes without an IP rating - these often fail in sustained rain
- Enclosures with screw-on lids that require tools to open - maintenance becomes annoying quickly
- Permanently sealing a lithium cell into a non-openable enclosure - keep lithium builds serviceable
- Non-UV-stabilized clear plastics in direct sun - clear lids are genuinely useful for status/OLED visibility on hard-to-reach nodes, so use them where that helps; just choose a UV-stabilized clear material and avoid clear lids where direct-sun thermal gain inside the box would overheat the electronics

Weatherproofing Tips

Weatherproofing Tips

Even a good IP65-rated enclosure can leak if improperly assembled. (IP65 is the practical minimum for a sheltered outdoor enclosure; choose IP66/IP67 for direct weather exposure — see the canonical IP-selection guidance on *Choosing an Outdoor Enclosure*.) These tips cover the details that matter in practice.

Cable Gland Selection and Installation

Cable glands are the most common failure point. The gland must match the cable diameter - a PG7 gland seals cables 3 - 6.5mm in diameter; a PG9 gland seals 4 - 8mm. If you are buying metric M-series glands instead, note that an M-gland threads into a hole of its *nominal* diameter (an M12 gland needs a ~12mm hole, not 16mm); pick one sizing convention site-wide and stick to it (see *Cable Glands and Penetrations* for the metric-to-cable-OD table). Using a gland that is too large for the cable leaves a gap that water will find.

1. Choose the correct gland size for each cable.
2. Thread the gland body into the hole from the outside. Wrap the threads with PTFE (plumber's) tape — use PTFE tape rather than a thread-sealant compound or liquid thread locker on gland threads.
3. Tighten to firm hand-tight + a quarter turn. Over-tightening cracks plastic enclosures.
4. Route the cable and tighten the gland compression nut until the rubber seal grips the cable firmly. You should not be able to pull the cable through the gland by hand.
5. Apply a small bead of silicone sealant around the outside of the gland where it meets the enclosure wall.

Drip Loops

Water can wick along cables by capillary action and enter glands even when properly tightened. A drip loop prevents this: route the cable so it makes a downward U-shape before rising back up to the gland. Gravity pulls water off the bottom of the loop rather than letting it travel into the enclosure.

Lid Gaskets

Inspect the lid gasket every time you open the enclosure. Gaskets compress and deform over time, especially with temperature cycling. Signs of gasket failure: visible cracks, flat spots, or moisture inside a previously dry enclosure. Replace gaskets with EPDM foam tape (available at hardware stores) cut to size.

Desiccant

Even a perfectly sealed enclosure will have moisture inside from assembly in humid air. Desiccant absorbs this residual moisture and any that enters during maintenance. Use silica gel packs or indicating silica gel (blue when dry, pink when saturated). Replace annually or when the indicating colour changes.

Two ways to avoid ongoing desiccant costs. **Loose indicating silica gel beads** (not sealed inside a plug-in unit) can be oven-regenerated at about 120°C (250°F) for 2 - 3 hours — do not exceed ~125°C. **Plug-in rechargeable units** such as the Eva-Dry E-333 have a built-in heating element and are regenerated by plugging the unit into a wall outlet for 10 - 12 hours when the indicator beads change colour — never bake an Eva-Dry (or any plug-in unit with a plastic housing and electronics) in an oven.

UV Protection

Most plastics degrade in UV light. Standard ABS and polycarbonate enclosures rated for outdoor use include UV stabilisers. Generic cheap enclosures often do not. A coat of UV-resistant paint or clear coat extends the life of any outdoor plastic enclosure significantly.

Antenna Feedline Entry

The antenna coax is the most challenging cable to seal because the connector end is large. Options:

- **PG9 cable gland:** Fits most small coax (RG174, RG316). The connector must be attached after routing the cable through the gland, or the gland must be large enough to pass the assembled connector.
- **N-connector bulkhead:** Mount an N-Female bulkhead connector in the enclosure wall. Run coax from the antenna to the bulkhead outside, and a short pigtail from the bulkhead to the node inside. The bulkhead connector provides a weatherproof sealed interface. This is the cleanest approach for permanent installations.
- **SMA bulkhead:** Same concept for SMA connector systems. Inexpensive — typically a few dollars from RF parts suppliers.

Condensation Prevention

Rapid temperature changes cause moisture to condense on cold surfaces inside the enclosure. Techniques to reduce condensation:

- Mount the enclosure in a shaded location or paint it white/light grey to reduce solar heating and temperature swings. This is the right choice for hot/sunny deployments (a black box can hit 70 - 80°C internally in full sun — see *Thermal Management*). The opposite advice applies only to extreme-cold, unheated deployments, where a darker enclosure adds a few degrees of solar warmth (see *Cold Weather Operation*); do not use a dark/black enclosure anywhere that sees direct summer sun.
- Use a breathable IP-rated vent plug (available from Roxtec and others) - these allow pressure equalisation without moisture ingress, eliminating the pressure differential that drives condensation
- Maintain desiccant in good condition

Annual Maintenance Checklist

- Inspect and replace desiccant
- Check lid gasket for cracking or deformation
- Inspect cable glands for cracking and retighten if loose
- Check all wire connections for corrosion
- Inspect antenna connector and coax for water intrusion or green corrosion
- Verify solar panel surface is clean (dirt reduces output)
- Check mounting hardware for rust or loosening