

AC Mains Power for Permanent Node Installations

For fixed infrastructure nodes at permanent sites with grid power access, AC mains power is the lowest-maintenance power solution for routine uptime, eliminating battery replacement cycles and enabling higher-power configurations. It is **not** the most reliable option in an emergency, however — the grid is commonly the first thing to fail in a disaster. Pair any mission-critical mains node with battery (and ideally solar) backup sized for the outage length you must survive.

Safety warning — AC mains can be lethal. Working on 120/240 V AC mains and breaker panels can kill you, and mistakes are unforgiving. AC mains and branch-circuit work should almost always be done by, or under the supervision of, a licensed electrician. Ensure proper equipment grounding/bonding of the enclosure and mast (NEC 250.x). This page describes the hardware involved, but it is not a substitute for a qualified electrician.

Power Supply Selection

Most ESP32/nRF52 LoRa mesh nodes regulate to 3.3V internally and accept 5V via USB or 3.7V from a single lithium cell. For AC-powered installations, you need a reliable AC/DC converter:

USB Wall Adapters

The simplest option for indoor nodes:

- **5V/3A USB-C adapter** - A basic 5V/3A USB-C adapter (full PD negotiation is not required) powers any USB-C node (Heltec V3, T-Beam Supreme). Roughly \$10-20 for quality Anker or Baseus adapters (prices as of 2026-06-08).
- **Quality matters** - Cheap switching adapters can emit RF noise. Use a reputable brand with proper EMI filtering. Choose adapters that comply with FCC Part 15 Subpart B (Class B) emission limits (see 47 CFR 15.107/15.109).
- **UPS integration** - A small USB UPS (Anker PowerCore Fusion, Cyberpower CP685AVR with USB output) adds battery backup to any USB-powered node.

DIN Rail Power Supplies

For professional installations in electrical enclosures or server racks:

- **Meanwell HDR-15-5** - 5V/2.4A (12W) DIN rail supply, ~\$15-20 (as of 2026-06-08). Widely used in industrial automation, proven reliable.
- **Meanwell HDR-30-12** - 12V/2A DIN rail supply for nodes that accept 12V input (most PoE-powered nodes, some T-Beams with barrel jack).
- DIN rail supplies mount in standard electrical enclosures alongside circuit breakers and terminal blocks.

PoE (Power over Ethernet)

For nodes at locations with Ethernet infrastructure (commercial buildings, outdoor fixtures with Cat5e runs):

- A PoE splitter converts standardized PoE (nominal 48V, range 44-57V) to 5V/12V for powering a node. Note that passive PoE may run at 24V or other voltages — match standard 802.3af/at gear to standard gear to avoid mismatch or damage.
- Enables remote power cycling via managed PoE switch (reboot a node from the office)
- Single cable for both data (if using an Ethernet-capable node or Pi-based room server) and power
- Requires Ethernet infrastructure - not practical for standalone outdoor nodes without network connectivity

UPS Integration for Grid-Powered Nodes

Even grid-powered nodes benefit from battery backup:

- **Mini UPS modules** - IP UPS boards (Waveshare UPS HAT, PiJuice) that sit between the power supply and the Pi or node. Runtime depends on load and battery capacity (commonly 1-4 h for low-power loads).
- **Standard UPS** - A small APC BE425M (~\$40, as of 2026-06-08) protects against power line surges and provides battery backup for a low-power node; runtime is load-dependent (commonly 30+ minutes for a sub-watt node). Verify the specific model's USB output before relying on it.
- **Lead-acid battery bank** - For extended outage protection (24+ hours), a 12V 7Ah SLA battery (84Wh) on a float charger provides long runtime — roughly 24-40 h at a 1-2W

node load. SLA tolerates continuous float charging well (unlike lithium), though chronic overvoltage causes gassing/drying and shortens life. Self-discharge (~5%/month at room temperature) is comparable to or slightly higher than LiPo.

Outdoor AC Power Runs

Running power to an outdoor enclosure requires weatherproof wiring:

- **Wire gauge:** AC branch-circuit conductors must be 14 AWG (15A) / 12 AWG (20A) per NEC 240.4(D), regardless of how little the node draws — a downstream fault must be cleared by the breaker before the wire overheats. **Do not run 18 AWG on a 15/20A AC circuit** — it cannot survive a 15A fault and is a fire hazard. 18 AWG belongs only on the low-voltage DC side, never as AC branch-circuit wiring.
- **Weatherproof conduit:** Schedule 40 PVC conduit is a common method for outdoor AC runs (NEC Article 352); other approved raceways include RMC and LFNC. Seal entry points with weatherproof conduit fittings.
- **GFCI protection:** The NEC requires GFCI protection for all outdoor outlets (NEC 210.8). Use a GFCI breaker or GFCI outlet at the first outlet in the outdoor circuit.
- **Permit requirements:** New AC circuit runs usually require an electrical permit, depending on your local jurisdiction (AHJ). Check local code — this is especially important for community networks working on public property — and have a licensed electrician perform the work.

Related Pages

This topic overlaps with the "Mains Power for Permanent Installations" page, which focuses more on mains-install practices and USB failover via JST battery. Treat this page as the AC supply-hardware reference; consult that page for installation practices, and follow whichever gives the more conservative safety guidance.

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