# Wiring a Solar Power System for LoRa Repeaters

Proper wiring is the difference between a reliable 5-year solar node and a fire hazard or intermittent failure. This page covers the complete wiring path from solar panel to LoRa load, including fusing strategy, wire gauge selection, connector types, weatherproofing, and cable management inside enclosures.

## System Wiring Overview

A correctly wired solar system follows this signal path:

```
Solar Panel(s)
  │
  ├──── [Fuse #1: Panel → Controller] ── MC4 cable to controller PV input
  │
Charge Controller (MPPT/PWM)
  │
  ├──── [Fuse #2: Controller → Battery] ── to battery positive terminal
  │
Battery Pack (LiFePO4/LiPo + BMS)
  │
  └──── [Fuse #3: Battery → Load] ── to load (LoRa node, 5V regulator, etc.)
```

Three independent fuses are required. Never combine them. Each fuse protects the wire segment between it and the next power source, limiting fault current to what the wire can safely carry.

## Fusing Requirements

| Segment | Fuse Type | Rating (for 10 W panel, 7 Ah battery) | Placement |
|---|---|---|---|
| Panel → Charge controller (PV in) | Blade fuse or ANL | 10 A (next standard above Isc × 1.56) | Within 12 inches of panel junction box positive terminal |
| Charge controller → Battery | Blade fuse or ANL | 15 A (next standard above charge controller rated output × 1.25) | Within 12 inches of battery positive terminal |

| Segment | Fuse Type | Rating (for 10 W panel, 7 Ah battery) | Placement |
|---|---|---|---|
| Battery → Load | Blade fuse or resettable PPTC | 3 - 5 A (sized to wire gauge, not load) | Within 7 inches of battery positive terminal |

Fuse ratings are sized to protect the *wire*, not the load. Use the next standard blade fuse size above 125% of the wire's ampacity at the installation temperature. ANL (bolt-down) fuses are preferred for currents above 30 A. For small LoRa systems (under 10 A total), automotive blade fuses in a waterproof inline holder (Littelfuse SPTP series, ~$2) are adequate.

# Wire Gauge Selection

| AWG | Conductor Area (mm²) | Max Ampacity (60 °C insulation, bundled) | Typical LoRa System Use |
|---|---|---|---|
| AWG 22 | 0.33 mm² | 3 A | Sensor wiring, signal lines |
| AWG 20 | 0.52 mm² | 5 A | Load output for single ESP32 node |
| AWG 18 | 0.82 mm² | 7 A | Load output for small system (5 A load) |
| AWG 16 | 1.31 mm² | 10 A | Battery-to-controller runs under 3 m |
| AWG 14 | 2.08 mm² | 15 A | Battery-to-controller runs 3 - 10 m; 10 W panel to controller |
| AWG 12 | 3.31 mm² | 20 A | 20 - 40 W panel runs; Pi gateway battery cables |
| AWG 10 | 5.26 mm² | 30 A | 40 - 100 W panel runs over 5 m |
| AWG 8 | 8.37 mm² | 40 A | 100 W+ systems; long battery cable runs |

Always use **stranded copper wire** with UV-resistant and temperature-rated insulation (XLPE or THWN-2 for outdoor; silicone for inside enclosures near heat). Solid wire is not suitable for mobile or vibrating installations. Use tinned copper wire in marine environments.

For voltage drop calculation in long cable runs:

```
Voltage_drop (V) = 2 × I (A) × R_per_meter (Ω/m) × Length (m)

Target: keep drop to less than 3% of system voltage.
For 12 V system, 3% = 0.36 V maximum drop.
```

```
Example: 5 A load, 5 m one-way run, AWG 14 (0.0083 Ω/m):
 Drop = 2 × 5 × 0.0083 × 5 = 0.415 V (3.5% - marginal, upgrade to AWG 12)
```

# Weatherproof Connectors

## MC4 Connectors (Panel Wiring)

MC4 (Multi-Contact 4 mm) connectors are the industry standard for solar panel connections. They are IP67-rated, UV-resistant, and rated to 1000 V DC and 30 A. Never use non-MC4 connectors on the panel-side wiring - the exposed conductors in DIY terminal connections will corrode and introduce resistance. Crimp MC4 connectors with the correct MC4 crimper (not pliers) to ensure proper contact retention. MC4 pairs from different manufacturers (e.g., Stäubli vs Amphenol) are nominally cross-compatible but may have reduced IP rating when mixed - use matched pairs.

## Anderson Powerpole Connectors (Load Connections)

Anderson Powerpole connectors (SB series 15 A, 30 A, 45 A) are the amateur radio and telecom standard for DC power distribution. They are genderless, stackable, and accept 12 - 20 AWG wire. The Powerpole 15/30 A connector accepts 14 - 18 AWG; crimp with an RENNSTEIG RE 2-30 or similar ratchet crimper. ARES (Amateur Radio Emergency Service) has standardized on red (+) and black (−) 30 A Powerpoles for all portable power connections.

## Other Connectors

| Connector | Rating | Use Case |
|---|---|---|
| XT60 | 60 A continuous, 12 V | High-current battery connections in drone/RC-derived builds |
| JST PH 2.0 mm | 2 A | LiPo cell to embedded board (standard on most Adafruit/SparkFun boards) |
| JST XH 2.54 mm | 3 A | Sensor connections inside enclosure |
| Dean's Ultra T-plug | 30 A | Legacy RC packs; avoid for new designs |

# Polarity Protection

A reverse-polarity connection will damage or destroy the charge controller, LoRa board, and BMS in milliseconds. Implement at least one of the following:

1. **Asymmetric connectors:** MC4 (panel), Powerpole (load), JST (board) are all polarised - they cannot be connected backwards if crimped correctly.
2. **Schottky diode on the input:** A 3 A / 40 V Schottky diode (e.g., 1N5822) in series with the positive line wastes 0.3 - 0.4 V but prevents reverse connection. Only practical for low-current loads.
3. **P-channel MOSFET reverse protection:** A P-channel MOSFET (e.g., AO3401, IRF9540) provides near-zero-drop reverse polarity protection. Standard in commercial MPPT charge controller input stages.

# Cable Routing and Strain Relief in Enclosures

Inside IP65/IP67 enclosures (Polycase WQ series, Bud Industries NBF, PolyBox), cables enter through compression cable glands. Rules:

- Use **double-sealed cable glands** (IP68 rated) for any cable entering an outdoor enclosure - single-seal glands allow moisture wicking along the cable jacket.
- All cable entries should be **on the side or bottom** of the enclosure, never on the top, to prevent water pooling at the seal.
- Leave a **drip loop** on the outside of each cable entry - a short downward curve below the gland that water follows away from the entry point before the cable turns upward.
- Inside the enclosure, route cables along the walls and use **cable ties on standoffs**, not across the PCB or battery. Keep power cables away from antenna cables to prevent RF interference.
- Add a **silica gel desiccant pack** (4 g minimum per 0.5 L enclosure volume) and replace annually.
- Secure the battery with **hook-and-loop strap or foam padding** to prevent it from shifting and chafing cables during thermal expansion/contraction.

Revision #2
Created 2026-05-03 05:39:21 UTC by Mesh America Admin
Updated 2026-05-03 13:01:19 UTC by Mesh America Admin