Requirements for Powering the Go2 Robot Using External Power

Based on the detailed discussion in the provided content (from the Unitree Go2 Discord channels), powering the Go2 robot (Air, Pro, or EDU models) externally is possible and has been tested by multiple users. However, there are specific requirements, safety considerations, and limitations to ensure it works reliably without damaging the robot, battery, or causing unexpected behavior (e.g., the robot collapsing or app errors). I'll break this down step-by-step, drawing directly from user experiences, tests, and shared solutions.

1. Key Concepts and Options

- **External Power Sources**: You can use a bench power supply (PSU), external battery pack (e.g., 8S LiPo), or even a custom setup. The goal is to provide stable DC power mimicking the internal battery's output.
- **Primary Connection Point**: The XT30 connector on the back (under the strap cover) is the main external power input/output port. It's directly tied to the battery rail, so it can power the robot or charge the internal battery.
    - **Polarity**: Positive (+) on the top pin, Negative (-) on the bottom pin (standard XT30 orientation). Always confirm with a multimeter to avoid shorts.
    - **Connector Type**: Use an XT30 male plug to connect to the dog's female XT30. These are widely available (e.g., on Amazon for ~$5-10 per pack).
- **Two Main Scenarios**:
    - **Powering Without Internal Battery**: Run the robot solely on external power (e.g., for testing or extended stationary use).
    - **Powering/Charging With Internal Battery Installed**: Extend runtime or charge in-place (e.g., via a docking station).
- **Charging Pads (Bottom Nipples/Washers)**: These are for docking/charging stations. They connect internally to the battery charging circuit. Front pads are typically positive (+), back are negative (-). You can use them for charging, but they require careful polarity and may cause the robot to power on unexpectedly.

2. Voltage and Current Requirements

- **Voltage Range** (Based on Battery Specs and User Tests):
    - **Nominal/Operating Voltage**: 28V (safe minimum for running the robot).
    - **Maximum Safe Voltage**: 31.5V-32V for running without charging the battery. Up to 33.6V if charging the internal battery (matches full 8S LiPo charge).
    - **For Charging the Internal Battery**: 33.5V-34V (matches the stock charger's output). Lower voltages (e.g., 28V) won't charge effectively.
    - **Why This Range?** The Go2 uses an 8S (8-cell) LiPo/Li-Ion battery equivalent (nominal 29.6V, full 33.6V). Users report:
        - 28V works for basic operation but may cause instability or low-power warnings.
        - 31V-32V is "solid and safe" for extended use without over-stressing components.
        - Below 28V (e.g., 24V from a 6S pack) may not boot or causes errors.
- **Current (Amps)**:
    - **Idle/Standby**: 1-2A.
    - **Walking/Moving**: 3-5A average, with peaks up to 10A+ during jumps or high-torque actions.
    - **Recommended PSU Rating**: At least 5A continuous, 10A+ peak capability. Use a regulated DC PSU (e.g., 30V/10A bench supply) to handle spikes without voltage drops.
    - **Safety Note**: Overcurrent can damage motors or the board. Use a PSU with current limiting. For battery packs, ensure they can handle 10C+ discharge (e.g., a 15000mAh pack at 10C = 150A peak, overkill but safe).
- **Power Draw Examples from Users**:
    - Idle: ~30-50W (1-2A at 28V).
    - Active Use: 100-200W+ (4-7A at 28V).
    - Max: Up to 300W peaks.

3. Setup Instructions

- **Basic External Power (No Internal Battery)**:

    1. Remove the internal battery (or ensure it's disconnected/off).
    2. Plug your external PSU or battery pack into the back XT30 (positive top, negative bottom).
    3. Set voltage to 28-32V.
    4. Power on the robot via the battery bay button (it will detect power from XT30).
    - **Behavior**: Robot boots, but app shows 0% battery. Basic movement works, but AI/Companion modes may fail (error: "Battery too low").
    - **Limitations**: No battery monitoring; app errors; potential instability if voltage sags.

- **External Power + Charging Internal Battery**:

    1. Leave the internal battery installed and off.
    2. Connect external power to back XT30.
    3. (Optional for Charging Dock): To charge without the robot standing up, jumper the positive from your source to the front charging pads (nipples) and negative to the XT30 ground. This bypasses the main board slightly, reducing power-on risk.
    4. Set voltage to 33.5-34V for charging.
    - **Behavior**: Charges battery in-place. Robot may power on (fans/lights activate), but jumper trick prevents full boot/standing.
    - **Limitations**: App may show errors; avoid if robot is moving.

- **Dual Power (External + Internal Battery)**: **Not Recommended**. Risks voltage mismatch, overcurrent, or damage. Users report instability or shorts. Use one or the other.

- **Building a Charging Dock**:

    - Use stainless steel plates (conductive, non-oxidizing) for contacts.
    - Polarity: Front plates positive (+), back negative (-).
    - Connect your PSU to plates (33.5V, 5A+).
    - Add fuse/short protection (e.g., resettable PTC fuse).
    - QR code/aruco marker helps robot align (use Unitree's app for docking).
    - Users built simple docks from wood/metal; robot charges but may try to stand (use jumper to prevent).

4. Safety and Best Practices

- **Voltage/Current Protection**: Use a PSU with overvoltage/overcurrent protection. Add a 10-15A fuse inline.
- **Polarity Check**: Always multimeter-test before connecting, reverse polarity can fry the board.
- **Battery Emulation**: Without internal battery, app shows 0%, bypass via WebRTC API for commands (ignores low-battery lock).
- **Heat/Monitoring**: External power skips BMS, monitor voltage manually to avoid over-discharge.
- **Low-Voltage Cutoff**: For LiPo packs, add a buzzer/alarm (e.g., balance port buzzer) to prevent deep discharge.
- **Risks**:

    - Shorts: Metal surfaces can cause issues, insulate if needed.
    - Collapse: Sudden power loss = robot falls.
    - Warranty: Modding voids it.
- **Tested Setups**:
    - Bench PSU at 30V/5A: Works for testing.
    - 8S LiPo (29.6V nominal): Extends runtime; use XT30 adapter.
    - Avoid 7S (25.2V nominal), too low for stable operation.

5. Limitations and Caveats

- **App/Features**: No battery = 0% shown; AI/Companion modes disabled. Use WebRTC/Python SDK for full control.
- **Charging Time**: ~2-3 hours for full charge at 33.6V/5A.
- **Secure Boot Models**: Newer Go2s may have restrictions, ensure your firmware supports mods.
- **If Issues**: Check logs via SSH (if jailbroken) or Unitree support.

If you provide more details (e.g., model, PSU type, or exact setup), I can refine this. Users like @legion1581 and @w_t_f_007 shared most tests, search the Discord for "external power" or "XT30" for photos/videos. Always start low-voltage and test safely!