RAK3172 Power-Supply and Brownout Design Guidelines

Purpose

The RAK3172 can transmit LoRa packets and update non-volatile LoRaWAN parameters within the same operating period. A weak supply, a current-limited supply, or bouncing battery contacts can interrupt a flash erase or program operation.

These guidelines reduce that risk without assuming a particular battery chemistry or battery-discharge curve. They are system-design recommendations, not a replacement for firmware-side flash recovery.

Power-supply requirements

- Keep the voltage measured at the RAK3172 supply pins within the module's specified operating range during startup, LoRa transmission, receive windows, and flash erase/program operations.
- Size the regulator and battery path for the LoRa transmit peak current, not only the average application current.
- Include voltage drop from the battery, protection circuit, regulator, switches, connectors, PCB traces, and battery contacts in the power budget.
- Place local bulk capacitance and high-frequency decoupling close to the module supply pins. Select the values from measurements on the final product, including capacitor tolerance, DC-bias derating, temperature, and aging.
- Avoid supply configurations that repeatedly cross the module

operating threshold when a battery is nearly empty.

Battery insertion and startup

- Battery holders and removable contacts can produce several short power pulses before making a stable connection. Do not rely on firmware timing alone to filter these pulses.
- Where contact bounce or a slow supply ramp is possible, use a suitable voltage supervisor, reset supervisor, load switch, or power-path circuit to hold the module in reset or keep it disconnected until the supply is stable.
- Start automatic LoRaWAN join only after the supply has remained stable for a product-defined qualification interval.
- Do not use the automatic-join delay as the only protection. A voltage drop can also occur during later transmissions.

Operation and controlled shutdown

- Do not intentionally disconnect power during LoRaWAN join, uplink completion, configuration updates, factory-configuration backup, or other operations that can update flash.
- If the application exposes a flash-operation indication or callback, wait for the operation-complete indication before a host-controlled power-off.
- A host-controlled shutdown should first stop new LoRa operations, wait for pending non-volatile updates to finish, and then remove power.
- `AT+FACTORY` should be executed only with a stable external supply. The command updates the saved baseline configuration and must not be treated as safe during an uncontrolled power loss.

Low-battery policy

The correct low-battery threshold depends on the battery chemistry, regulator, load path, temperature, source impedance, and the selected LoRa transmit power. Therefore, firmware should not use one universal battery-voltage threshold for every product.

For a finished product, determine the threshold by measuring the minimum voltage at the module pins during the worst-case LoRa transmission. Include:

- a nearly discharged and aged battery;
- the lowest supported operating temperature;
- the highest configured transmit power;
- the worst supported region and packet airtime;
- battery-contact and cable resistance;
- regulator transient response and current limiting.

The product may stop new joins and transmissions when its validated safe-power condition is not met. This is an application policy and does not guarantee that an unexpected battery removal cannot occur.

Recommended validation

Validate the final power design using the actual enclosure, battery holder, regulator, PCB, antenna configuration, and firmware:

1. Monitor voltage directly at the module supply pins with sufficient oscilloscope bandwidth.
2. Trigger on the minimum voltage during startup, join, uplink, receive windows, and flash updates.
3. Repeat the test with a current-limited bench supply and with batteries at different discharge levels and temperatures.
4. Introduce battery-contact bounce and random power interruption during join and uplink completion.
5. Verify that the module either completes the operation or restarts and remains responsive to AT commands.
6. Verify that LoRaWAN nonces and frame counters never move backward or reuse a previously transmitted value.

Firmware responsibility

Even when these hardware recommendations are followed, firmware should assume that power can fail at any point. Persistent configuration and LoRaWAN counter storage should use recoverable update methods, and flash ECC errors should not leave the module in a permanent reset or fault loop.