Power Consumption Measurement Methods

Accurate power consumption measurements help you design realistic solar power systems and understand why your battery life differs from specifications. This page covers practical measurement techniques for mesh node operators.

Measurement Tools

- **USB power meter (basic):** Plugs between USB charger and device. Shows voltage, current, and power in real time. Cost: $5-15. Limitation: only measures USB-powered devices; can't measure 3.3V or 3.7V native power.
- **USB power meter (logging):** Same as above but logs data over time. Shows how consumption varies between sleep/wake/transmit cycles. Cost: $15-30. Good for average consumption calculations.
- **Multimeter in current mode:** In-series measurement with any power supply. More flexible; requires breaking the power path to insert the meter in series. **Safety:** measuring current requires the meter's dedicated current jack and current mode, in series with the circuit - **NEVER place a current-mode meter across a battery or supply** (it is a near short-circuit and can blow the meter's internal fuse or damage the meter). Most multimeter current jacks are limited to 10 A; a LoRa node's average draw is milliamps, so use the mA jack, not the 10 A jack, and never the voltage jacks in series. When breaking a lithium battery lead, ensure the battery is fused, avoid momentarily shorting the terminals (a lithium cell can deliver tens of amps), and start on the highest current range.
- **Current probe/clamp meter:** Non-invasive; clamps around a wire to measure current. AC current only in basic versions; specialized DC clamp meters cost $40-100 but don't require circuit modification.
- **Nordic PPK2 (Power Profiler Kit 2):** ~$80 tool from Nordic Semiconductor (as of 2026-06-08). It is not nRF52-specific - it can source or pass through power to any low-power DUT and measure its current from roughly 200 nA up to ~1 A, with high time resolution. Ideal for profiling sleep vs. active states and showing the detailed consumption waveform, including brief TX peaks that a basic meter averages out.

Measuring Average vs. Peak Current

A critical distinction:

- **Peak current (transmit):** the brief current spike during a LoRa transmission, lasting roughly 100-300 ms. The magnitude depends entirely on the TX power setting and the radio module's power amplifier: a module with an internal PA at ~22 dBm draws on the order of 80-120 mA, while a 1 W external-PA module at high power draws far more (~120-280 mA - see the platform page). Important for battery internal-resistance sizing but not for the energy budget. State the TX power and module your own figures assume.
- **Average current:** What actually matters for battery sizing. Example - a node that transmits 10 times per hour for 200 ms at 100 mA peak and sits at a 4 mA low-active/idle draw the rest of the time (note: deep sleep is lower, ~0.2 mA; this 4 mA is the listening/idle state):

```
transmit time = 10 × 0.2 s = 2 s/hr
idle time     = 3600 s - 2 s = 3598 s/hr
average = (2 s × 100 mA + 3598 s × 4 mA) / 3600 s
        = (200 + 14392) / 3600
        ≈ 4.05 mA average
```

USB power loggers typically measure average current; this is what you want for battery sizing. Nordic PPK2 shows both.

Measuring nRF52840 Nodes (RAK4631, T-Echo)

```
# Using a small sense resistor in series with the battery:
# 1. Insert a SMALL shunt (e.g. 1 ohm or 0.1 ohm) in series with the
#    battery positive terminal. Size it so the voltage drop at MAX
#    current stays under ~50-100 mV, or the drop will brown out the
#    node mid-transmit and corrupt the reading.
#    WARNING: do NOT use a 10-ohm shunt for TX-peak measurement - at
#    80-120 mA TX it drops 0.8-1.2 V, which can reset the node. A large
```

```
#    (10-ohm) shunt is only acceptable for tiny uA-mA sleep currents.
# 2. Measure voltage across the resistor with an oscilloscope or fast
#    multimeter.
# 3. I = V / R. For a 1-ohm shunt: 5mV = 5mA, 10mV = 10mA, 100mV = 100mA.
#    For a 0.1-ohm shunt: multiply the implied current by 10.

# Using Nordic PPK2 (recommended - no brownout, handles TX peaks):
# Connect PPK2 between battery and node
# Run nRF Connect Power Profiler software
# Record average current over 10-minute period for steady-state measurement
# Record peak current during LoRa transmission
```

Real-World Measurements (Community Data)

These are community-reported measurements - actual values depend on firmware version, traffic, and config, so **measure your own node**. They are consistent with the ~10-15 mA representative nRF52840 repeater figure on the platform page.

Node	Mode	Avg Current	Battery Life (2500mAh)
RAK4631 MeshCore REPEATER	Active repeating, 1 hop/min	12-15 mA	7-8 days
RAK4631 Meshtastic ROUTER	Active, LongFast	10-14 mA	7-10 days
T-Beam ESP32 Meshtastic CLIENT	Active, WiFi off	35-50 mA	2-3 days
T-Echo nRF52840 Meshtastic	Power saving on	3-6 mA	17-35 days
Heltec V3 ESP32-S3	Active, WiFi off	25-40 mA	2.6-4 days

Note: Actual power consumption varies significantly with traffic load, transmit power setting, and environmental conditions (cold weather increases current draw).

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