# 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 cutting a wire in the power path. Risk: damage from wrong meter range selection.
- **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 professional-grade tool from Nordic Semiconductor. Measures nRF52 current with microsecond resolution. Perfect for profiling sleep vs. active states. Shows detailed consumption waveform.

## Measuring Average vs. Peak Current

A critical distinction:

- **Peak current (transmit):** 80-120 mA for 100-300 ms during transmission. Important for battery internal resistance sizing but not for energy budget.
- **Average current:** What actually matters for battery sizing. For a node that transmits 10 times per hour for 200ms at 100mA and sleeps (4mA) otherwise: average = (10 * 0.2s * 100mA + 3590s * 4mA) / 3600s = 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 10-ohm sense resistor in series with the battery:
# 1. Insert 10-ohm resistor in series with battery positive terminal
# 2. Measure voltage across resistor with oscilloscope or slow multimeter
# 3. V = I * R: 50mV = 5mA, 100mV = 10mA, 800mV = 80mA

# Using Nordic PPK2:
# 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)

| 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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