Cheatography

Saving Power in Low-Power Wireless Radio Systems Cheat Sheet

by [deleted] via cheatography.com/2754/cs/16725/

Introduction

When developing IoT solutions, these 11 considerations are always taken into account by the embedded design consultants at ByteSnap

Source: https://www.eeweb.com/profile/paulm-bytesnap17/articles/top-11-tips-for-saving-power-in-low-power-wireless-radio-systems

#1 System choice

The type of radio to use depends on several factors — principally, data rate, communication range, and operating costs. The range of options is considerable, from short-range ZigBee, Thread, Bluetooth, and Wi-Fi to long-range low-power radio like LoRa and SigFox or cellular solutions.

#2 Wavelength

Some radio wavelengths propagate much better than others, and this propagation may be correlated with increased power efficiency. Typically, lower frequencies propagate better than higher frequencies, but the compromise is that the possible data rate is lower. For example, the 2.4-/5-GHz bands have distances measured in tens of meters but can transmit hundreds of kilobits of data per second, whereas sub-GHz bands have distances measured in hundreds of meters, or even kilometers, but may only transmit a few kilobits of data per second. Wireless mesh networks manage to stretch the transmission distance by hopping the data between nodes..

#3 Microcontroller sleep power

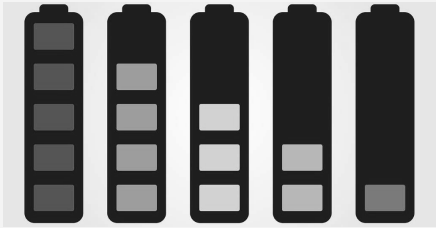
There is a wealth of microcontrollers claiming to be low-power. Some, however, have very low-power sleep states only, whilst others are low-power when running also. How often a device is asleep affects which is the key parameter. If your device is normally asleep, look to the deep-sleep power consumption; if, however, it is always awake — for instance, to listen to a network — then it is the operating power consumption that is key.

#4 Power source

Power is a key consideration in restricted devices. Once you've decided if user-replaceable (AA, AAA, etc.) or rechargeable cells such as Li-Po are appropriate for the product, there's plenty of optimization to do. Environmental factors (intense cold or heat) will have a big impact on life, as will the battery discharge curve. Low-power radios tend to use very little power whilst sleeping and then use large pulses of current for receiving and transmitting when awake — some types of battery may not handle this use model well..

#5 Pull-ups and other design tips

Battery Power



#6 Spreadsheets

Using a spreadsheet can be incredibly useful to determine which compromises should be made to make the design workable.
A spreadsheet can be used to see how compromises in transmit or receiver timing can affect the battery lifetime and how long the transmission should last as well as determine efficiencies of regulators over the voltage range and current requirements.

#7 Power measurement

Standard multimeters have low sample rates that will miss the short RF bursts associated with transmission. Either use an oscilloscope with a math function or a high-frequency multimeter for power measurement. Alternatively, sum the power over a long period with a watt-hour meter.

#8 Antenna tuning

If range is important, remember to tune your antenna. This maximizes what you've got without adding to the power budget of your system.

#9 TX power

Don't unnecessarily boost your output power beyond what you need. If your radio link has to span only 10 meters, for instance, then 5-dB output power is unlikely to be required and will just waste power, thereby reducing battery life.

#10 Batch testing

With battery-powered low-power devices, you can be operating close to the limits of component performance. In the case of FETs and other active devices in which you rely on a low voltage drop, for example, there will always be a variation in the characteristics between devices that may affect the performance. This means that it's worthwhile to perform batch testing with a good-sized batch to ensure that any variation will not compromise operation of the final systems.

Simulation of some simpler aspects of the design using a SPICE simulator — running tests across temperature and voltage extremes — can similarly save pain in mass production.

#11 Transmitter pulses

Low-power wireless radio system design requires attention to detail outside of just the radio circuit, such as pull-up resistors. These need to be optimized to maximize your battery life; for example, by adding active components such as FETs to turn devices and pull-up resistors on and off.

If you decide to use FETs in your design, then choose them carefully. Even though you may only be consuming a few milliamps, you'll find that a higher-power device rated for a few amps will have a lower Vf (forward voltage), meaning less power is wasted in the FET when it is on.

When the transmitter is on, a low-power radio is at its maximum power state. It makes sense to minimize that 'on' time by minimizing the amount of data that has to be transmitted, possibly by using binary or by compressing larger files using .zip format

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