Dorking with RF

How to add a radio to your project without losing your mind

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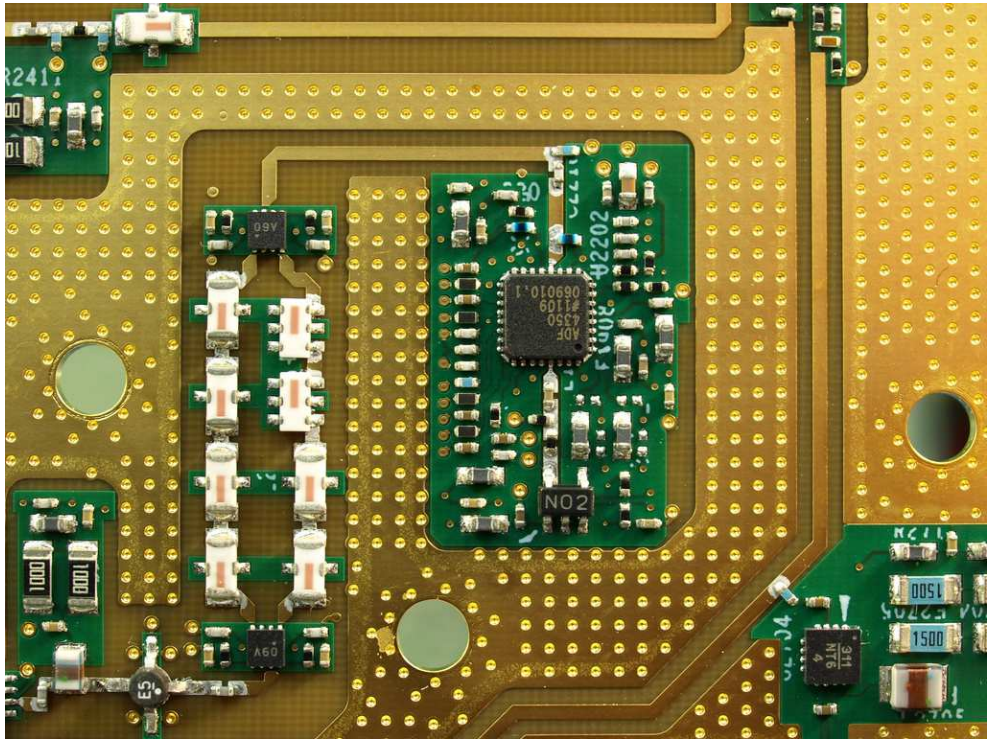
DorkbotPDX 0x07

Intro

- Adding a radio to your project can make it
  - Cooler
  - Work better
  - Easier to use
- Adding a radio to your project can also lead to
  - Stress
  - Anxiety
  - Depression
- But it doesn’t have to!

RF is hard. Don't do it.

- Complicated
  - Lots of additional components
  - More PCB layers
  - Will cause your project to fail in new and interesting ways
- Unpredictable
  - Interference
  - Antenna performance
  - Range
- Expensive
  - Components
  - Test gear
  - Simulation software
  - Compliance testing

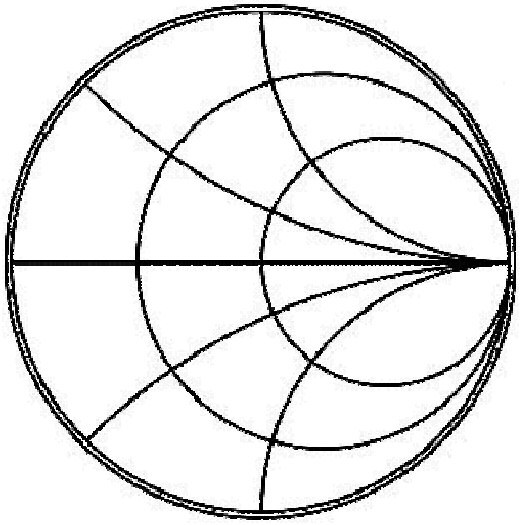


RF is hard. Don't do it. Really.

- Technically challenging
  - Math, math, math
  - Antennas
  - Layout sensitivities
  - Instability
  - Power supply issues
  - Temperature drift
  - Component parasitics
  - Compliance

$$\nabla x\ B = \frac{4\pi k}{c^2} J + \frac{1}{c^2}\frac{\partial E}{\partial t}$$

$$= \frac{J}{\varepsilon_0 c^2} + \frac{1}{c^2}\frac{\partial E}{\partial t}$$



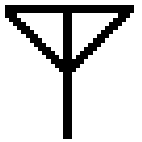
- Wouldn't you rather be doing something else?

Okay, it's not really *that* hard

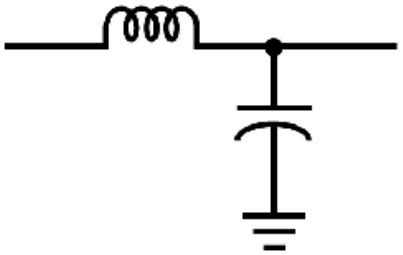
- Modules make life better
  - Isolate complexity
  - Contain cost
  - Guaranteed, verified design
  - Pre-tested, pre-certified
  - Integrated processors and software stacks
  - Physically larger, easier to solder
  - Integrated antennas
- Add a lot of functionality without a lot of effort
  - It's okay to "cheat"
  - It's worth it

Care and feeding

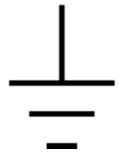
- Antennas
  - Keep integrated antennas clear of obstructions
  - Careful with case materials



- Power Supply
  - Bypassing/Decoupling
    Rejecting power supply noise and preventing the radio from leaking RF onto the power supply
  - Filtering – more aggressive noise rejection



- Layout
  - Groundplane
  - Antenna trace routing



- Power dissipation

The $15 wireless serial port

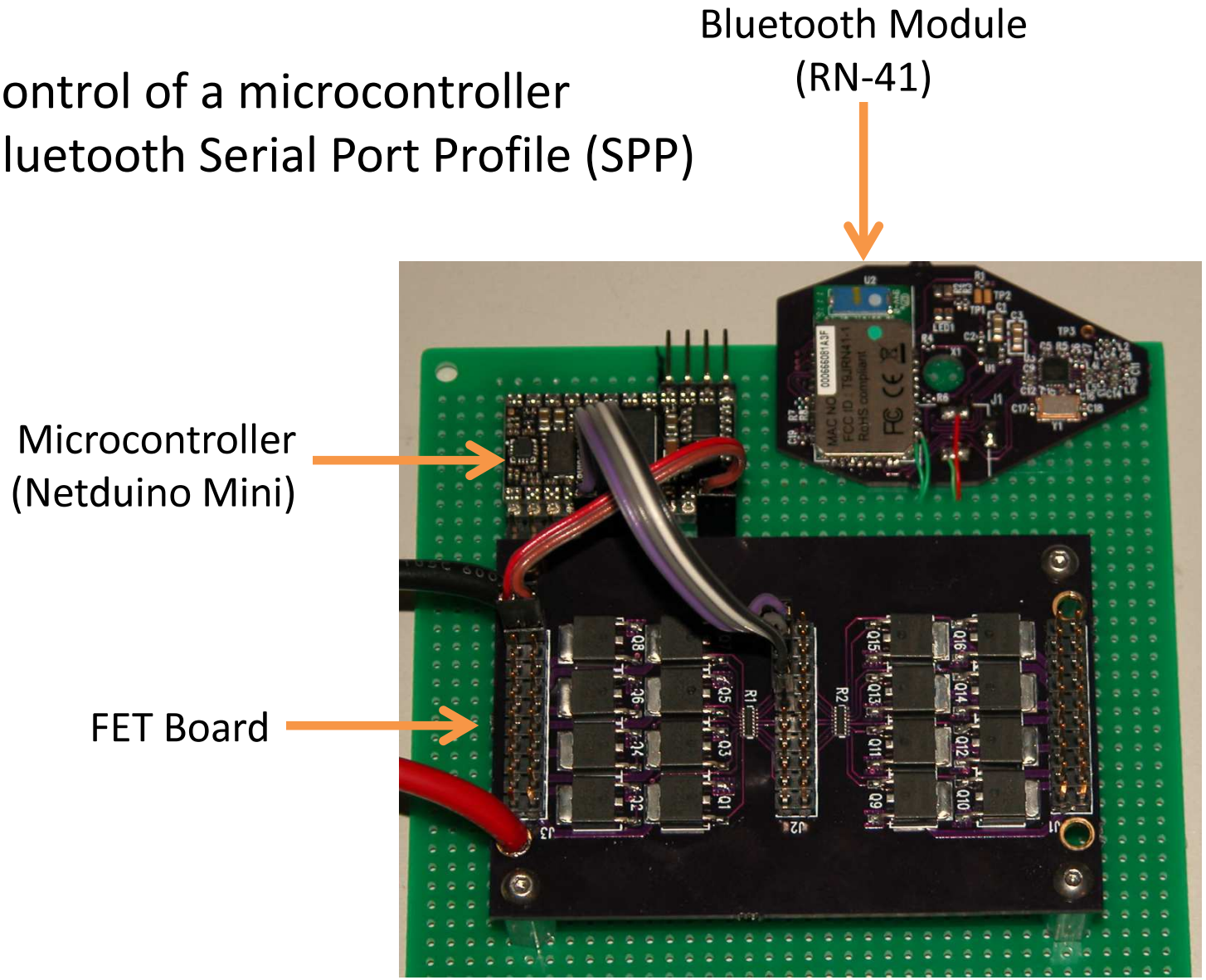
- Roving Networks RN-42
  - Class-2 Bluetooth (50-60 foot range)
  - Integrated antenna
  - Also available in Class 1: longer range

- 4 wires
  - +3.3V, Ground, TX, RX
- Hardware configured
  - Pins on the device select hardware handshaking, port mode
- Easy pairing

Blinkenlights

Blinkenlights

- Simple project to demonstrate Bluetooth control
- Cell phone control of a microcontroller system via Bluetooth Serial Port Profile (SPP)



Peer-Peer Radios

- Digi XBee
  - Zigbee/802.15.4 module
  - Many different flavors
    - Integrated/external antenna
    - Different power levels
    - 900 MHz/2.4 GHz

- Extensive Arduino support
  - Big experimenter community
- Potential for mesh networking with some variants
- More complex from a software standpoint

Low-Power

- TI CC1101
  - Low-power, low-mid datarate radio (<=250 kBaud)
  - SPI interface
  - 16 µJ/byte, 80 MBytes on a 100mAH battery
  - Good candidate for solar/energy harvesting
  - 4 kBytes/hr on an SMT solar cell

- Proprietary wireless protocol
- Good support software from TI
  - You'll need it!
- Some knowledge of communications theory helpful
  - Modulation rate/sensitivity tradeoff
  - Range vs. data rate vs. power

Cellular

- Telit GE865
  - Quad-band GSM module
  - Lots of peripherals
  - UART interface
  - Python scripting, AT command set

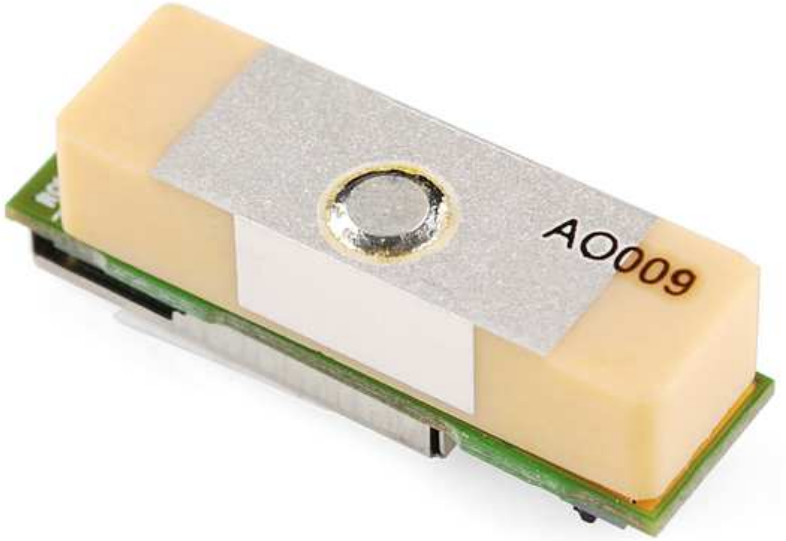
- More external components
  - Antenna
  - SIM Card

- More technically demanding
  - GSM has stringent power supply requirements
  - BGA package

- Have to deal with cellular companies

GPS

- ADH Technology GP-2106
  - SiRF Star IV chipset
  - UART interface
  - 1.8V supply



- Highly sensitive receiver
  - Care required in power supply
  - Other system radios may interfere

- Keep antenna clear for best performance

Why should I add a radio?

- Connectivity
- Control
- Functionality
- Interactivity
- Simplicity
- Easier installation
- Cleaner look

- AND

- It’s not as hard as it seems. Really!