What does STM32 need

- There is a **5V** (actually 4.56V) output pin
  - See user manual, page 17 for limit
  - You can also use it as an input.
- There is a **3V** (actually 2.95V) output pin
  - You can use that as an input.
- VDD?
  - Schematic separates 3V from VDD.
  - Connected to 3V through JP2 (user manual pg 38)
  - Remove JP2 to measure current flow to the STM32 alone.
What happens if current flow out of the 5V pin is too high?

- You will blow the diode (D1) between USB input and 5V output.
  - Our lab engineer can replace it with a better diode.
    - But not on a weekend or a holiday.
      - Or at 3am before your project demonstration.

- If you have project that needs more than 100mA, you need an external power supply.
Providing power for projects

- No computers for demos
  - No USB ports to power STM32 and extras
- You may use USB phone chargers
  - Plug-in or battery.
  - We have a dozen 5.2V 2A chargers. Plenty to loan.
- External power supply to power STM32 as well as other devices.
Projects that need lots of power

• Combine multiple power adapters.
  – If they’re the same type and rating.
Projects that need lots of power

- Combine multiple power adapters (of potentially different types) with shared grounds.
  - Segregate the power distribution to the things that need it.

Remember to connect grounds!
Projects that need audio power

• Op-amps work best with +/- voltage.
  – e.g. +12, -12 for a 24-volt range.
  – With a single-ended supply (0 – +V), you will produce a distorted output unless you have unity gain.
Audio example

• Make sure that grounds are connected.
High current example

- LED matrix draws 157mA from 5V output of STM32. ("How has this not failed?")
  - USB port power limits the current to 250mA unless the device negotiates for higher current.
    - When you plug STM32 into phone charger, you blow diode D1.
- Solution: Wire external ECE 270 supply to LED matrix and STM32 5V input.
- New problem: LED matrix now has strange streaks and bad picture.
The OLED display in your dev kit is supposed to run on 5V (4.56V).

- Logic "high" is $0.7 \times \text{Vdd} = 0.7 \times 4.56\text{V} = 3.192\text{V}$
- STM32 outputs 2.95V high. Close enough to work.

When LED display runs on 5.0V:

- Logic "high" is $0.7 \times \text{Vdd} = 3.5\text{V}$.
- STM32 is not going anywhere near that.
Pull-up resistors

- You can pull 2.95V up to 3.5V.
  - 330Ω between signal and 5V.
- When STM32 pulls line low:
  - 5V / .330 kΩ = 15.15mA (at most) flows into pin.
    - Not going to cause problems.
Another solution: level shifters

- Use a buffer (such as a 74HC541 octal buffer)
- Power it at 5V.
- Recognizes 2.95V high.
- Outputs a 5V high.
Another solution: Drop device $V_{DD}$

- Your OLED LCD is supposed to run at $\geq 4.5\text{V}$.
- Works fine at $2.95\text{V}$. (?!)
- How about other devices.
  - LED matrix displays supposedly require $5\text{V}$ (2A).
    - But they don’t reliably understand STM32 levels.
    - When they run at $4.3\text{V}$, they work fine with STM32.
Other power supplies

- Batteries are too variable to be directly connected since their voltage will change as they are depleted.
  - Use a "boost" converter to raise a low voltage to a higher voltage (with a lower current than battery).
  - Use a "buck" converter to lower a high voltage to a lower voltage.
- Either/both of these are very efficient.
- Either/both add noise.
Linear Regulators

- These take a moderately higher DC voltage and drop it to 5V. E.g. LM7805 regulator.
  - Max 1A.
  - Input must be >=7V.
  - Higher voltages mean larger voltage drop.
  - High current * voltage drop = power dissipation.
    - e.g. 1A through a 2V drop is 2W. Hot.
    - Inefficient (30% – 50%, typically)
  - Fine for STM32, and very low current peripherals, it's fine.
Low Drop-Out Regulators

- Like the LM7805, but can operate with lower input voltage margin.
  - There are still I*V power losses.
  - Still bad for high current / high input voltage.
Before you hook up a power supply

• Let’s say you have a 5V power supply you want to use.
• Test the power supply with no load.
  ‒ Use a DMM on voltage setting.
  ‒ Test the voltage with no load.
  ‒ If the voltage exceeds 5.5V, don’t use it.
• Test the power supply with a low-value resistor.
  ‒ If the voltage exceeds 5.5V, don’t use it.
Noise

• Any AC-to-DC converter will have residual 60-Hz noise.
• Switching power supplies will have higher frequency noise.
• Examine this on an oscilloscope.
• Capacitors help, serial inductors help.
“Pi” filter

- So named, because the legs of the capacitors on either side of the inductor look like the Greek letter Pi.