EE 14: Analog to digital converters

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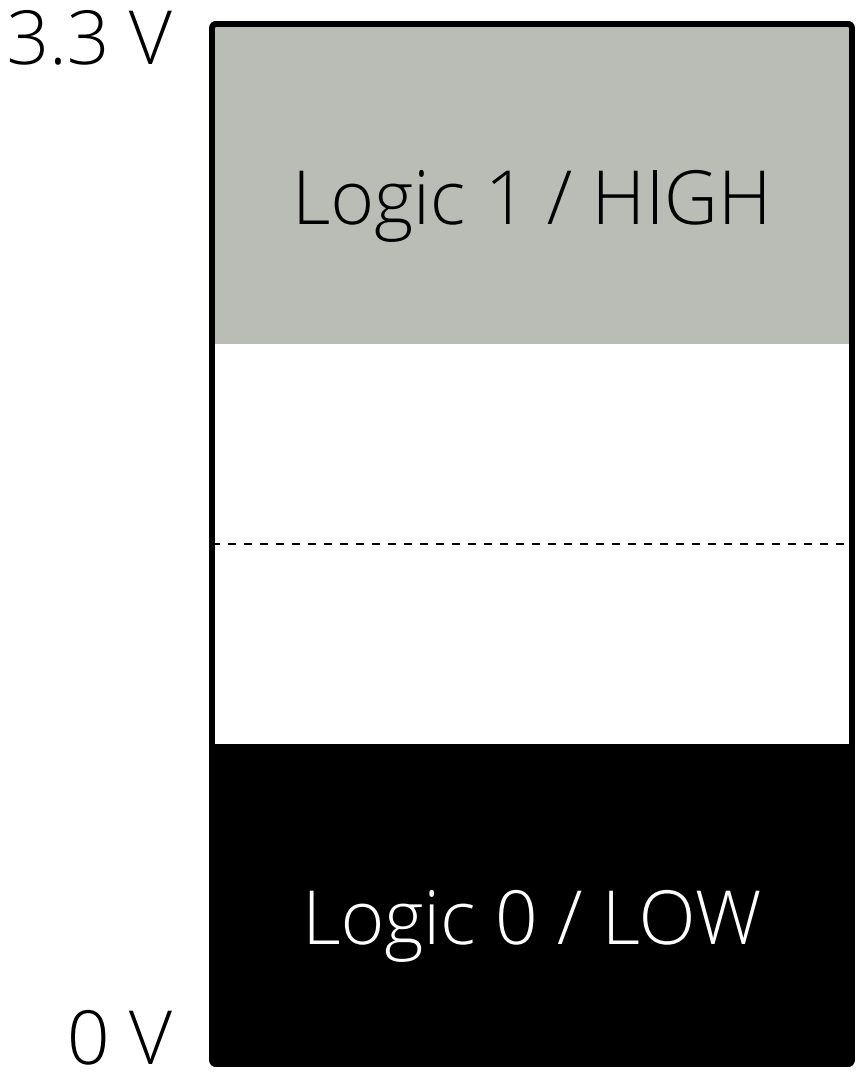
By the end of class today, you should be able to:

- Explain what ADC resolution and sampling time are
- Describe at least two ways the STM32 ADC hardware is optimized for signal processing applications.
- Given an ADC reading, calculate the voltage at the pin

GPIO pins read digital voltages



GPIO pins have a circuit called a "Schmitt trigger" which takes an indeterminate input and forces it to be low or high.

Digital inputs are great

We just have ones and zeros that go straight into the logic of the CPU

We can read them at the native speed of the processor

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But lots of things aren't digital!

Potentiometers, photoresistors, phototransistors

Sensors with an analog voltage readout (less common but still plentiful)

Force-sensitive resistors

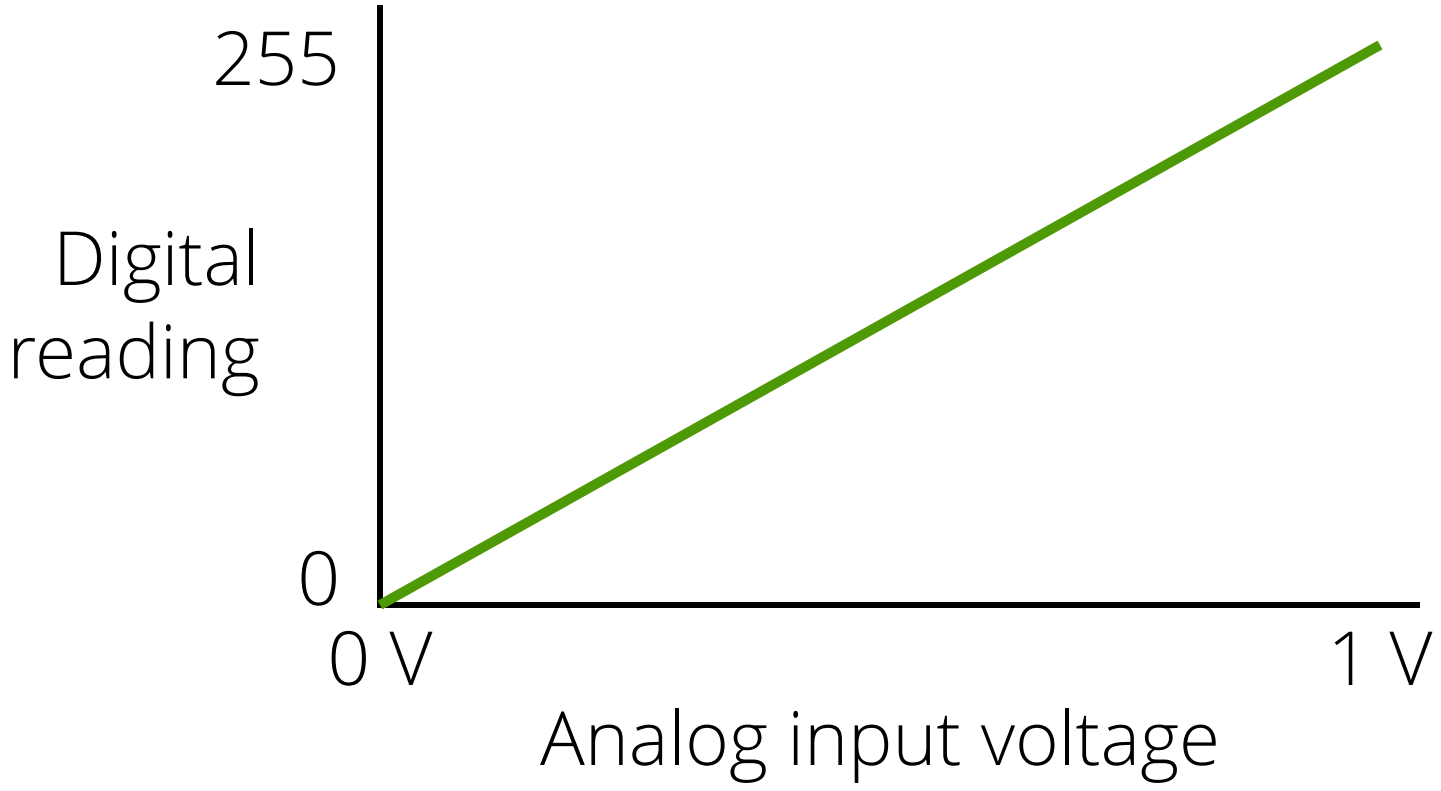
Audio or other signals (ECG?)

So we have analog-to-digital converters (ADCs)

Measures a voltage on a pin, and returns a number.

Suppose we have a measurement range of 0-1V, and 8-bit ADC result

ADC results will be 0-255



ADC resolution

10-14 bits is common on microcontrollers

16-20 bits is common on special-purpose ADCs

Beyond that you're just into noise...

12-bit ADC, 0-3.3V range. An input of 2.5 V will give a reading of:

Making good ADCs is hard!

We have a long wishlist:

- Low noise
- Fast sampling (conversions / second)
- High resolution
- And low power too, please.

An entire course could be devoted to designing ADCs…

ADCs are complex peripherals

The STM32L432KC has a total of **one** ADC.

So if you want to measure multiple pins, it has to be shared

Signal-processing applications require consistent sampling

So there are many timing configuration options

It needs to capture many samples with minimal intervention

So there are continuous capture modes, interrupts, and DMA

And sometimes it needs to sample in response to an event

So it can "inject" additional conversion requests on the fly