

# ES 4: Making noise / exam review

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# Goals for today

- Give you a general sense of how to use sound in your project, plus some specific examples.
- Walk through a bunch of examples that are likely to appear on an exam.

# Memory

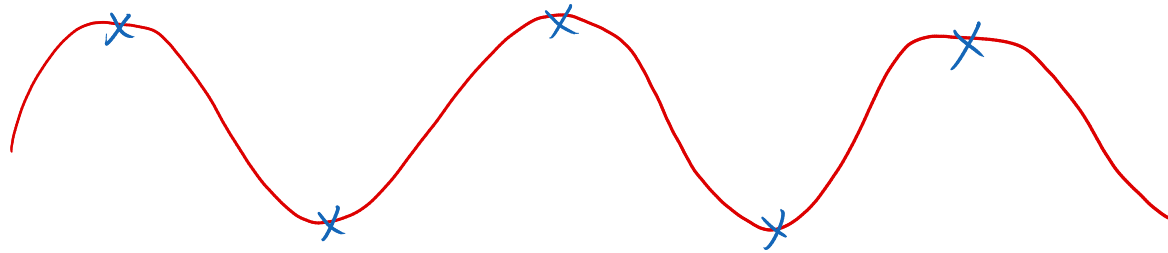
"Embedded block RAMs"  
(aka initializable memory)

Your FPGA has 30 EBRs with an 10-bit address and 4-bit data.

- 1) How many bits does one EBR store?
- 2) How many bits can your FPGA store in total?
- 3) How many seconds of audio can you store with that?

# Audio sampling

We have to sample at 2x the maximum frequency we want to record  
(Take EE 23 to understand why!)



Young humans can hear up to about 20kHz

Standard sampling is 44100 Hz (44.1kHz)  
*x 32 bits*

Telephone sampling is ~ 7kHz

# So what are my options?

- 1) Drive a speaker directly from the FPGA
- 2) Generate sound with logic, use I2S to play it on an amplifier
- 3) Load sound from SD card, use I2S to play it on an amplifier

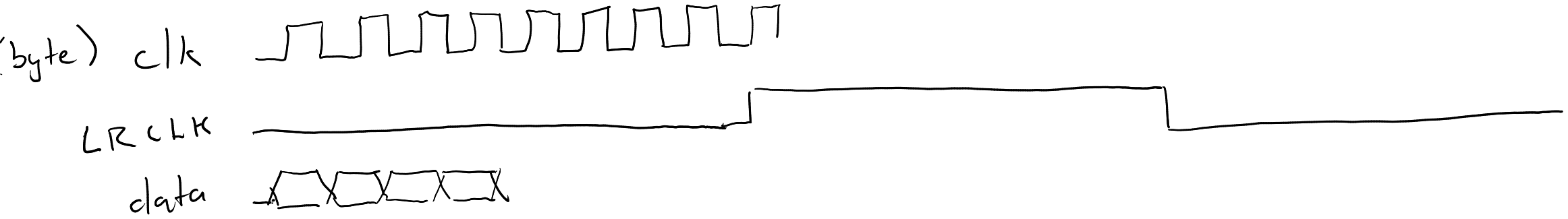


# Building a tone generator

<https://vhdlweb.com/problem/tone440>

If your tone generator were a state machine,  
how many states would it have?

# Using I2S





# Exam logistics