Making Music With Programmable Logic

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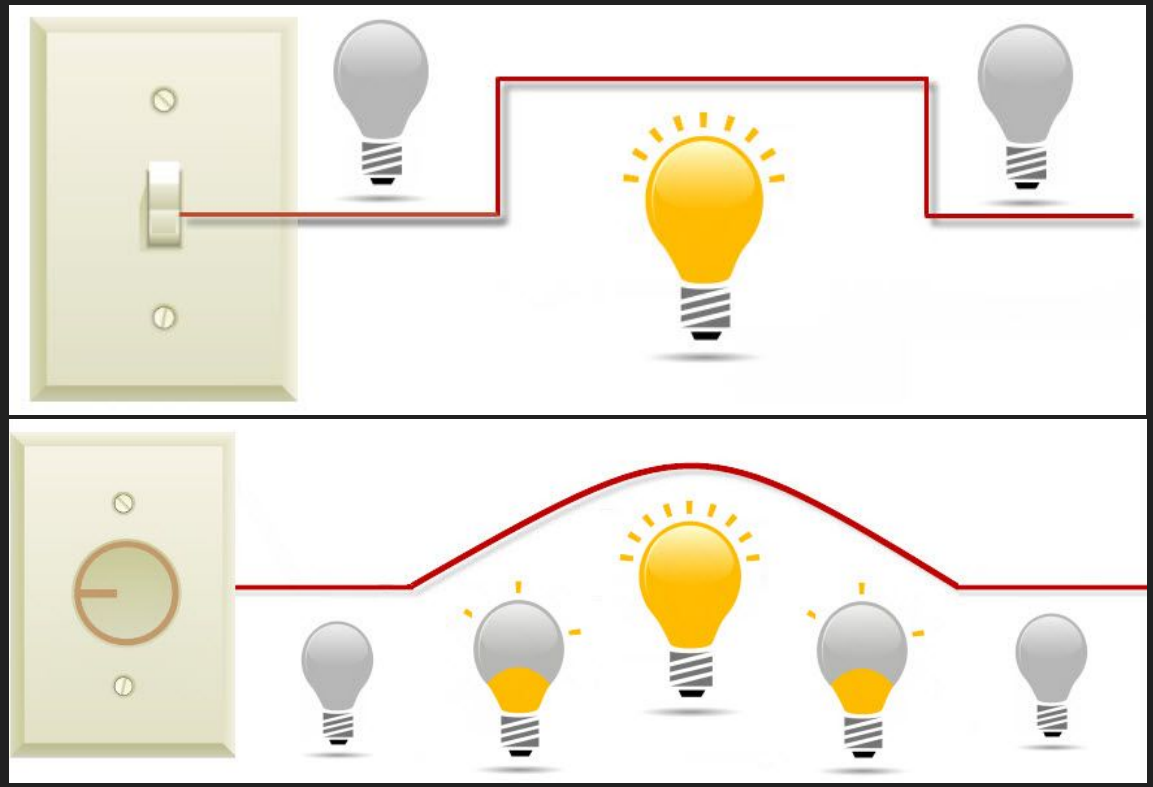
Field Programmable Gate Arrays

- Semiconducting device consisting of reprogrammable logic cells
- Versatile applications
- Peripheral modules
- Embedded processing/System on Chip
- Prototyping Application Specific Integrated Circuits

The Physics of Music

- Sine waves
- Discrete(sampled) vs. Analogue(continuous)

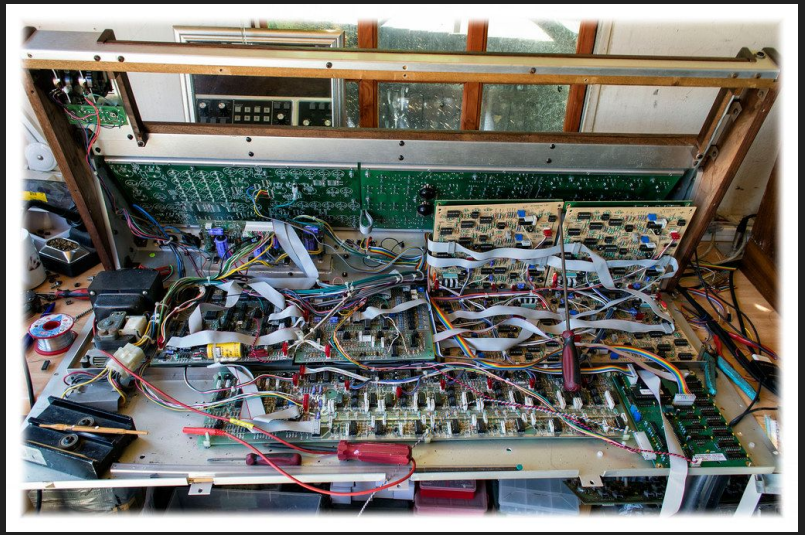


https://library.automationdirect.com/wp-content/uploads/2014/08/Lighton_off-ligit.jpg

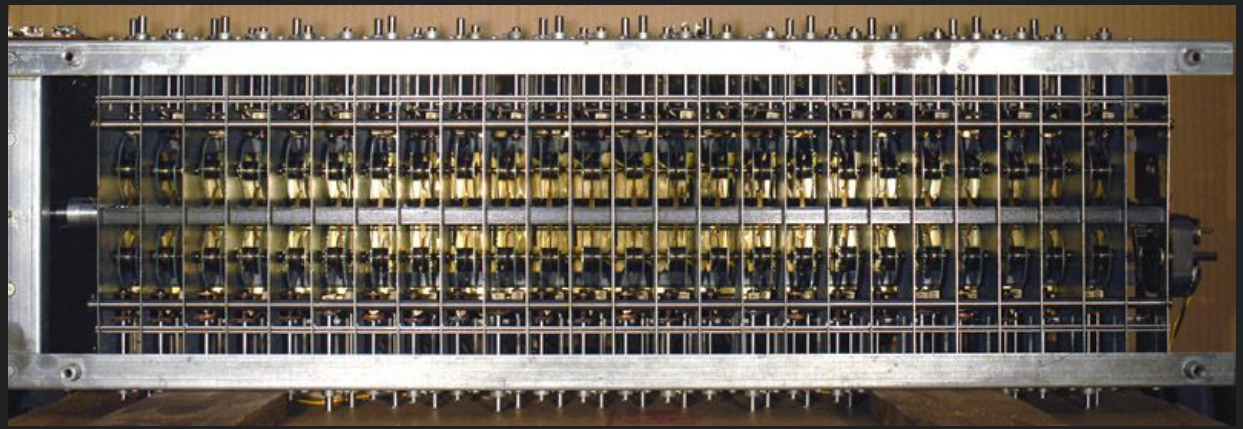
Classic Analogue Instruments

- Fender Rhodes
  - Piano style action
  - Hammers hit tines
  - Tines reverberate in tone bars
  - Magnetic pickup sends frequency to preamp
- Hammond Drawbar Organ
  - Tone wheels driven by a motor
  - Frequency determined by motor speed, number of teeth on wheel, and the ratio of the number of teeth on the driving and driven wheel
  - Keys and drawbars activate magnetic pickups to amplify sound
- Oscillator synths (Moog)
  - Divide oscillator speeds to get frequency

http://chicagoelectricpiano.com/wp-content/uploads/2015/09/IMG_1565.jpg



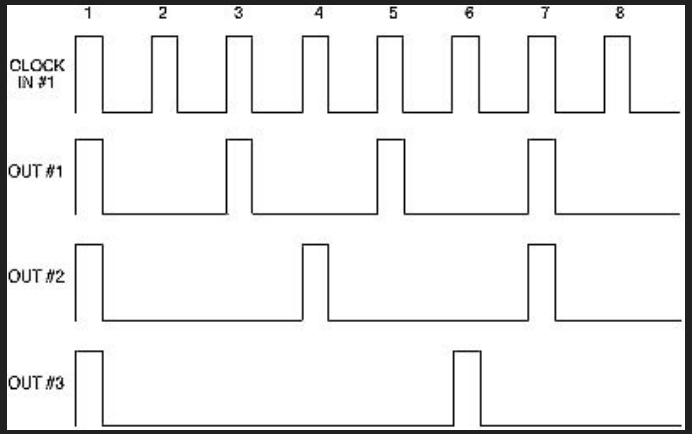
https://hiveminer.com/Tags/memorymoog



https://modularsynthesis.com/hammond/m3/m3.htm

FPGA Analogue Synthesis

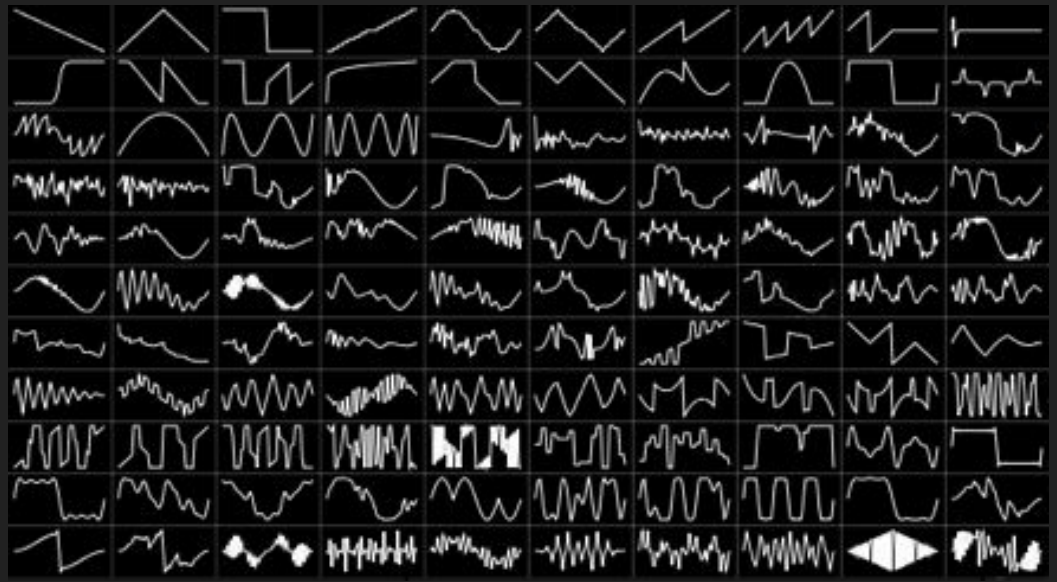
- Clock signal similar to Hammond motor, exactly like Moog Oscillator
- Divide clock to get frequencies
- Determine output based on input signals
- Output will be discrete without Digital to Analogue converter
- With enough clock divisions, complex waves can be created



http://www.yusynth.net/Modular/EN/DIVIDER/index.html

Other Methods of Making Music

- Lookup table
- Pre-recorded sounds



http://synthesizeracademy.com/wavetable-synthesis/

Digital Signal Processing

- FPGAs are often used to process various electric signals
- Filters
- Mixing
- Effects