Interfacing and controlling your bends

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Interfacing

• More than just switches and knobs
• Modulation of bends
• Automated switching
  – Rhythm
  – New sounds
  – Talking between devices (syncing)
What is a bend?

• Change in resistance
  – Variable
  – Fixed resistance
  – Switched resistance (0 ohms)
• Change in capacitance
• Change in inductance
• Change in voltage
• We will be focusing on the first and last.
• “Other”
Resistive ≈ Voltage Controlled

• Digital vs analog circuits
  – Analog = variable
  – Digital = switched

• Controlling analog
  – Control voltages
  – Voltage >> resistance

• Controlling digital
  – Multiplexers
  – Digital sequencing & switching
What is a control voltage?

• Variable voltage
• Changes some parameter
• Traditionally used in synthesizers
• Typical ranges
  – $\pm 15V$ or $\pm 12V$ $>>$ $\pm 5V$ or $\pm 10V$
  – $+9V$ $>>$ $+5V$
  – $+5V$ $>>$ $+5V$ (digital)
  – Arbitrary
Voltage to resistance

• Vactrols
  – Homebrew
  – Vactec/ParkinElmer
• H11F3
• Other methods
  – No resistance (just CV)
  – Fast switching
  – LM13700
Vactrol - Quick & Dirty

- Simply an LED coupled with an LDR
- Cheap, easy to make in a pinch
- Resistance range depends on LDR
- Doesn’t work well for 0 - >5k
- Doesn’t work well with fast resistance changes
- May require extra circuitry to work like you want it to
H11F3 - Clean & Precise

- LED coupled with OptoFET
- Roughly $1 each, no DIY option
- Consistent resistance range unit to unit
- Very large range: 100 ohm - 100M
- Can work with pretty much any range
- Very fast
- Sometimes picky in audio circuits
- May require extra circuitry to work like you want it to
CCR not VCR

• LEDs aren’t really voltage controlled
• Resistance depends on current
• Current $\approx$ voltage… sometimes
• In many (simple) cases, no problem
• For precision, and in many other cases, we need extra circuitry
Buffers

- Varying voltage >> buffer >> voltage source
- No (very little) output resistance
- When do you need them?
- Play it safe
- Remember clipping
- Transistor vs. op amp vs. CMOS
Some CV circuits

- Voltage dividers
- Simple LFOs (555, square waves)
- Complex LFOs (VC, triangle, saw, etc)
- Envelope controls
- Sequencers
- Other
Side note - Expression pedals

- Non-standardization
- Converting one resistance range to another
- Expression pedals: Just voltage dividers
- With buffers, a voltage source
- With VCRs, a varying resistance
- With an H11F3, any range
When a bend is digital…

- Digital is two states: on/off
- Much simpler and easier to deal with
- Many switches & keypads are really digital inputs
- On/off bends (switched) can be digitally controlled
- Sequencers and square waves are inherently digital
Multiplexers

• Automatic switches
• Normally can switch analog or digital signals
• In a digital circuit, logic can be used instead
• Some common types:
  – CD4051
  – CD4052
  – CD4053
  – CD4066/4016
  – Relays
  – Other/”Special Function”
Synced switching

• Squarewaves: Digital on/off
  – 555
  – CMOS-type
• Flip-flops: Divide by two (by two… by two…)
• Sequencers: Clock signal >> stepped outputs
• Microcontrollers: All of this at once
• Not limited to a single device - fanout
Combining analog & digital

• Digital signals can also control vactrols and H11F3
• Square >> triangle (or anything else) is very hard
• Analog multiplexers can take analog inputs >> analog sequencer
• The ultimate circuit