Random Sequencer Expanders 1+2

PCB Rev 3 (Backpack)
Rev 2 (Pulses)
Rev 1 (Voltages)
April 2013
by Tom Whitwell

Block Diagrams

1: Backpack

2: Pulse Expander

3. Voltages Expander

Two expanders for the Random Looping Sequencer / Turing Machine.

There are three parts:
- A **backpack** for the RLS board. This adds expander headers, buffering and reverse polarity protection for the main module.
- **Pulses**: a random, looping clock divider, with seven pulse outputs, controlled by the main module.
- **Voltages**: an eight stage random looping step sequencer with illuminated faders, controlled by the main module. Unusually, any number of stages can be active at once, creating unpredictable results.

How many expanders can I use at once?

Each Random Looping Sequencer module can power TWO expanders. Pulses attaches to the Pulses header, and the Voltages and Mix expanders connect to the Gates header.

RLS only (60ma)
RLS + Backpack + Pulses (85ma)
RLS + Backpack + Voltages (100ma)
RLS + Backpack + Pulses + Voltages (124ma)

How to connect the expander modules.

Remove your RLS module from your case, and remove the power.
NB: Do not connect expander modules to your case power.

The Backpack attaches to the rear of the RLS module between the expansion port at the top and the power header at the bottom.
The Pulse Expander attaches using a standard 16 pin ribbon cable to the 'Pulses' header. Ensure the red stripe on your cable matches the stripes at the bottom of each header.
The Voltages expander attaches to the 'Gates' header in the same way.
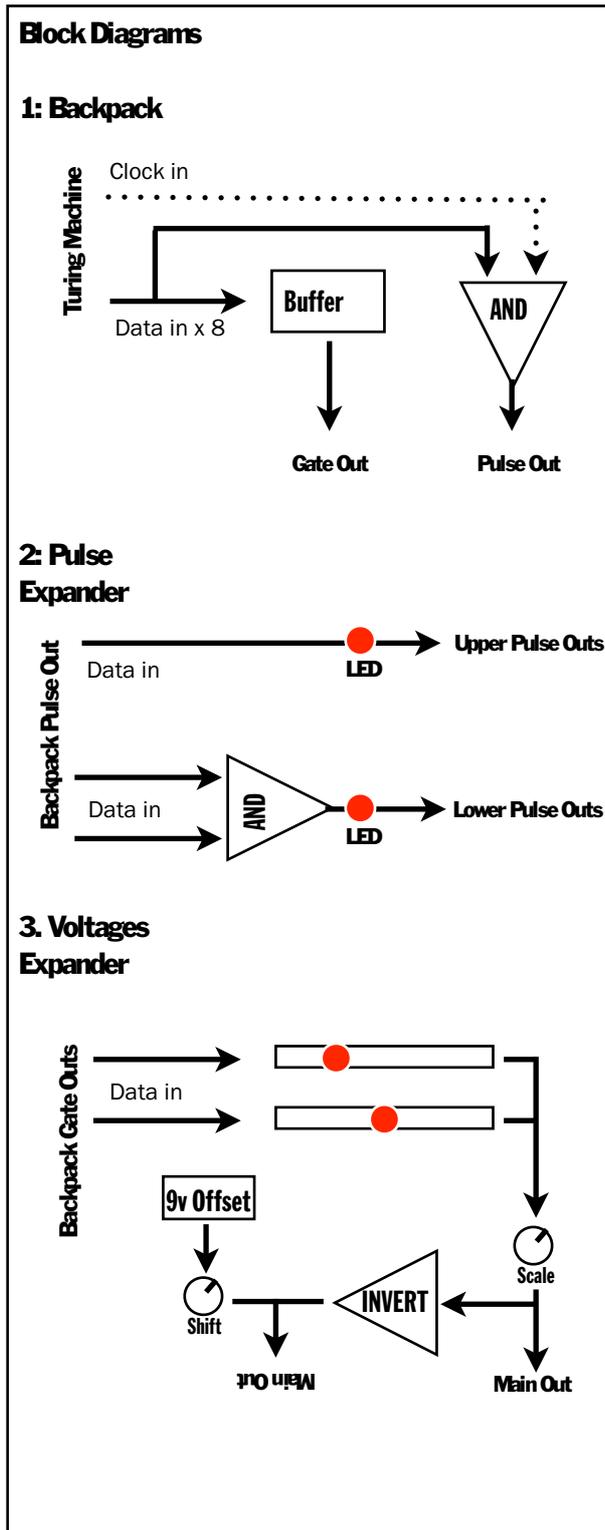
How to build the circuits

Backpack

1. Start with your Turing Machine Random Looping Sequencer module. Unplug the power cable from the module.
2. Cut the female pin sockets to length, from the long strip. You need 2 x 5 pins, and 1 x 10 pins. When cutting the sockets, you may need to sacrifice one pin, so start by cutting a 6 pin strip, and go from there!
3. Place the pin sockets onto the back of the RLS module over the power and expander pins.
4. Put the backpack PCB into place, ensuring the pins line up. "Careful Now" should be facing the RLS board, away from you. Solder the pins into place, then remove the RLS module.
5. Populate the rest of the board. Ensure the IC sockets and voltage regulators match the silkscreen outlines.
6. Take special care over the reverse polarity protection section. Ensure the diodes are the right way around. The fuses can go in either direction.
7. There is a lot of boring repetitive soldering of pins on this board - double check your work to ensure you haven't missed any pins or created any short circuits. Open a window!

Swapping Logic ICs

Several CMOS logic chips have the same pinout as the 4081 AND gate, so can be swapped into these circuits, either on the backpack or the pulse expander. I haven't tested these, but they may give interesting results. These chips should be compatible:
4001 NOR, 4011 NAND, 4030 XOR, 4071 OR, 4077 XNOR, 4081 AND, 4093 NAND. For details of how these chips work: http://www.kpsec.freeuk.com/gates.htm

---

Expansion Ports

Gate and Pulse outputs have identical pinout and are interchangeable. Feel free to experiment with putting Voltages onto the Pulse outputs, and Pulses onto the Gate outputs
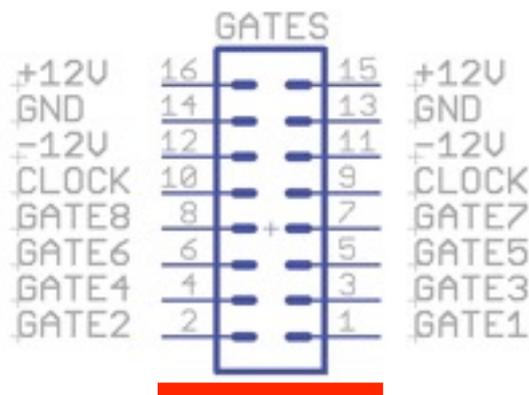
Pulse expander

1. This is a slightly fiddly build, but not difficult or time consuming.
2. Start with the components on the back; the IC socket and the pin header.
3. Then solder in the resistors. These are vertical. Be careful not to cause short circuits from resistors next to each other.
4. Attaching the LEDs can be slightly tricky. Make sure they are the right way around - the long leg in the + hole. If you're using an acrylic panel, you can put the LED wherever you like - either flush with the board, or standing up behind the panel - but make sure the LED isn't taller than the socket, or you won't be able to get the panel on
5. Sockets: It may be easier to mount the sockets if you attach them to the panel before soldering them to the PCB. Loosely mount the sockets on the panel - swivel them around to match the holes on the PCB, then solder them in.
6. If you're using an aluminium panel with holes for LEDs, you may need to assemble the whole 'sandwich' before you start to solder LEDs or sockets.

Voltages expander

1. This is a very quick, straightforward build, so long as you do everything in the right order!
2. Start on the back of the board, the side with the large 'Music Thing Modular' logo. Mount the IC socket, power header and R1.
3. **Two important notes about resistor networks:**
   a. Unlike normal resistors, they have a polarity. They have a mark at one end, usually a spot. Ensure the mark lines up with the cross on the silkscreen.
   b. The two networks in this module look the same but are NOT interchangeable.
   103LF = 10k = back of board, close to the power header
   202LF = 2k = front of board, next to 'Inspiration'
4. One the back of the board is populated, carefully trim the leads as neatly as you can. If they stick up too far, they'll make it hard to get the faders in straight.
5. Attach the other components on the front of the board, around the faders; resistors, capacitors, the 78l09 voltage reference, sockets, and the 2k resistor network.
6. Be careful with the potentiometers. Again, they look similar, but are different. Scale, on the left as you look at the faders, is 10k. Offset, on the right, is 50k.
7. Finally, install the faders. They will slot neatly into place. Push them in firmly, ensure all the pins are through the holes and that the plastic 'feet' of the fader are flush against the PCB, then solder.

PCB Versions
Backpack:
Rev 1 Oct 2012, first prototype.
Rev 2 Jan 2013, fixed bit order
Rev 3 Mar 2013, added voltage references

Pulse expander:
Unlabelled: Beta pcb, limited distribution
Rev 2: Jan 2013, first published version (simplified layout)

Voltages Expander
Rev 1 March 2013

How the modules work, how to use them, and patch ideas:

Pulses

Demo video: http://youtu.be/8qCspHcMFfI

This module is hard to explain, but pretty clear when you're using it - it's a bunch of rhythmic pulses synchronised to the clock in.

Look at the LED bar on the main module.

Imagine the second LED from the left (the one after the clock indicator) is a pulse output.

Each time the LED is on, the output is active, and the clock pulse can pass through to the output. If the LED is off, nothing comes out.

You can hear it at the start of the demo video above - that kick drum pattern at the start is coming from the pulse output marked 7 - you can see the LED flashing in time.

The first four outputs come directly from the 1,2,4,7 bits. They will all output the same rhythm, but offset by the number of steps:

OUT1 = ■□□■■□●
OUT2 = □□■■□■●
OUT4 = ■■□■■□□

The lower outputs are ANDed versions of the top outputs, so:

OUT1+2 = □□□●□□■

In use: Lock the RLS into a loop. Patch the pulse outputs to trigger-ey inputs - sequencer clocks, 'Strike' inputs, Low Pass Gates, drum modules, FM indexes. If you don't like the rhythm, swap to another pulse output. Once you get something good, let the RLS 'slip' a bit, and the entire rhythm will shift, while remaining in time.

Voltages:

http://youtu.be/uNkGzJhYWbA

This module is even harder to explain.

One the curious things about the original RLS is that it has a rather distinctive sound.

The random voltages it produces can follow a familiar pattern, sometimes rising and falling in a recognisable way, as the binary bits flow into the fixed digital to analog converter.

In a normal DAC, a preset function determines how much each single bit contributes the the voltage output, according to the binary value:

Binary: 00000001 = Decimal 1 = .03v
Binary: 10000000 = Decimal 128 = 4.5v
Binary: 11111111 = Decimal 255 = 9v

The voltages module is (and I'm not sure this makes it any clearer) a non-standard digital to analog converter that you can play.

In this DAC, the positions of the faders determine how much each bit contributes to the final voltage output. 00000001 might be a few millivolts, it might be 8 volts - it depends where the fader is.

Each fader is controlled by one bit from the RLS. Step 1 controls the top fader etc.

If all the faders are to the left, the main output will be at zero volts (roughly)

If you slide one fader up, each time that bit is active, the ouput will go up by an amount proportional to the position of the fader.

If you have a loop in the RLS where only one bit is active (i.e. one bit zipping across the display), then Pulses acts exactly like a normal step sequencer, with the 'scale' knob acting like an attenuator on the output voltages.

However, if you have more than one bit in the loop, the voltages from each active fader are added together.

The positions of the faders set up the range of possible voltages that the module can produce. The binary stream from the main RLS module determines how those voltages actually emerge.

This is - I think - similar to the first prototype Klee sequencer by Scott Stites. On his site, he says:

"Setting it up to perform a 'sequence' is very different than a step sequencer - it's like molding clay more than anything, because each pot not only affects the level of its bit, it also influences the mixed output level of the other bits when it's high at the same time. It can, however, be a very creative process."

The inverted output comes with a 'shift' control, which simply adds up to +9v to the signal. I did this simply because I didn't want an output that could only produce negative signals - this inverted output can drive oscillators etc once 'shift' is turned up a bit.

As Scott says of his module, this is a very intuitive, suck-it-and-see module. You can't program it, but you can steer it.

In use: Lock a loop into the RLS (ideally one with a good mix of 'ons and offs'). Patch the Voltages main output to an oscillator, and listen to the output. As you move the faders and the scale control, you're producing big voltage changes - 0-9v, so the oscillator may spring in and out of audible range. Use the scale control to control the range of the sliders. Move one fader at a time, so see how the sequence changes. Small moves can make big changes, and vice versa. It's sometimes possible for one fader to cancel out another. THEN, unlock the RLS by moving the main knob to 12 o'clock. You'll hear random notes, but within the system of notes and intervals that you set up with the faders.