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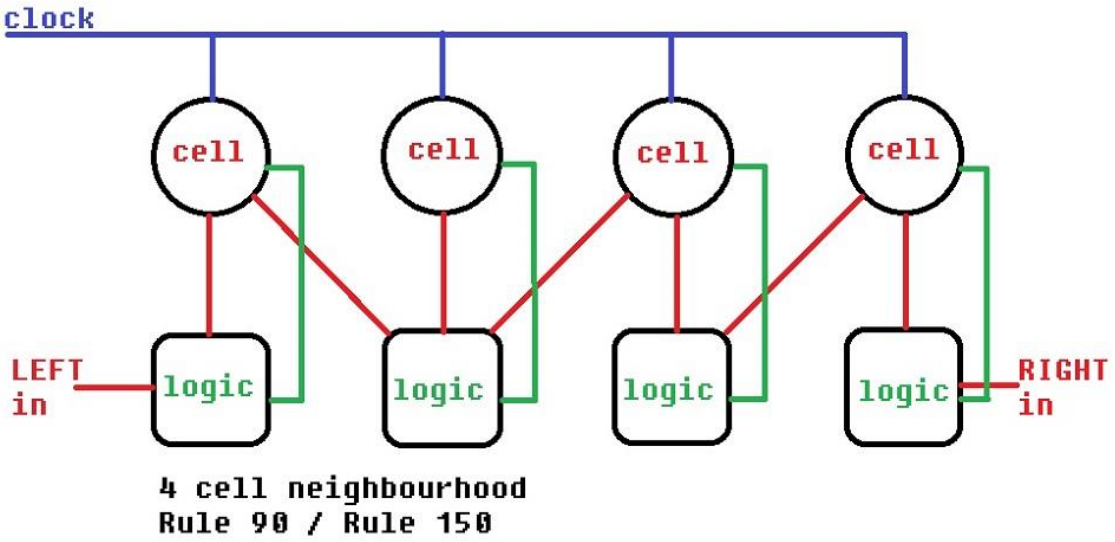
CELLULAR AUTOMATA SEQUENCER

Build notes vers.1.1 18 July 2013

This circuit was inspired by a paper on using cellular automata as a method of fault detection in analogue circuits (Theory and application of multiple attractor cellular automata for fault diagnosis – P. Kolin, et al). The paper does not supply a circuit but gives block diagrams of sample layouts. Although based on CA rules 90 & 150, the circuit kind of sits between the two.

The block diagram shows the basic function.



blue lines – clock signal for all four cells

red lines – input paths for the logic gates

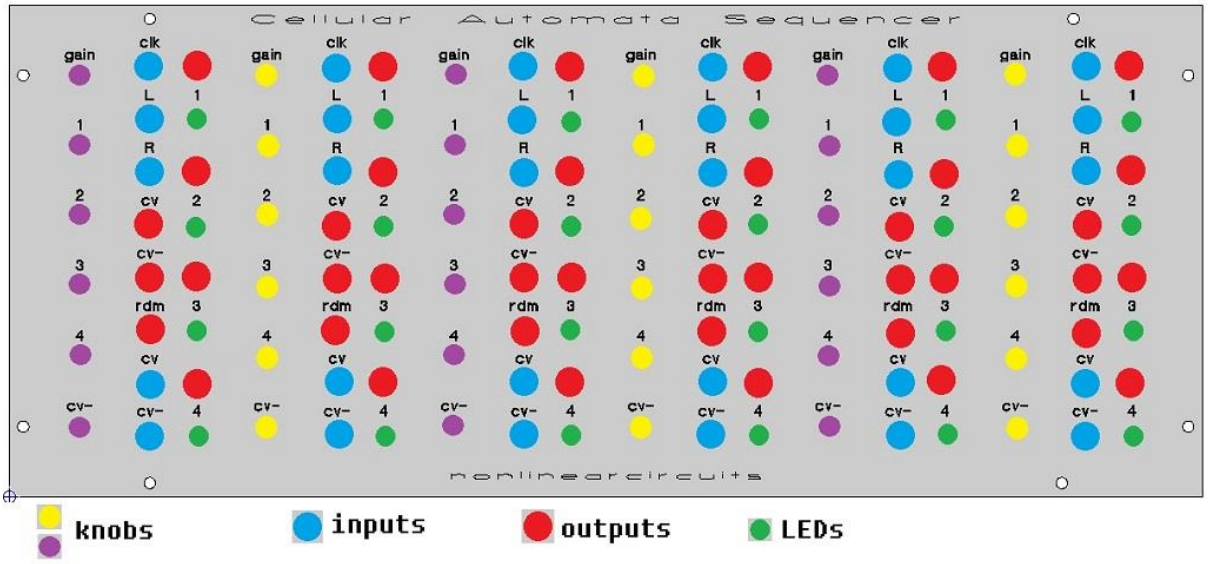
green lines – logic outputs

As each cell lives it puts out a gate for the length of its lifetime and a voltage to a pot that can be attenuated and then summed to get a CV signal (and its inverse….and there is a staircase divider off the 4 cells to give a semi-random CV as well). Of course more than one cell may be alive at the same time so the resulting CV is far more complex than a standard 4 stage CV.

There is also a CV input and inverted CV input with attenuator for each neighbourhood. This means neighbourhoods can be summed together for more complex signals or even the random output can be fed back in to be mixed with the CV.

Each neighbourhood needs a clock and a signal on the left or right input to get started, the cell gate outputs can then be used to activate cells in other neighbourhoods or even act as clocks for other neighbourhoods.

It is best to have at least four neighbourhoods to be able to patch-program a great deal of complex patterns. That said, even one neighbourhood is capable of producing some simply amazing patterns. This video was made using a single neighbourhood - http://www.youtube.com/watch?v=SlNc4ElJL-Y



BUILDING INFO

Error – On the PCB, near the power connector there is a capacitor marked "103". This should be 101 (100pF)

The engine and breakout boards need to be split apart and the edges rubbed to remove any splinters, please see this video to see how it is done - http://youtu.be/R3Dh0cbpXVQ

Close to pin 8 of the 4042 is a 3 hole box with "select" printed underneath it. Install a link between the hole marked "+" and the centre hole. Do connect anything to the other hole.

This was a leftover from the proto-type when I considered adding a switch to select between rising and falling edge for the clock signal. It turned out, the 4042 doesn't really care about edges, it likes high or low and requires a very narrow pulse otherwise the circuit gets into a 'race' condition and has a freakout. So **do not** install a switch, just connect the centre hole to the "+" hole ☺

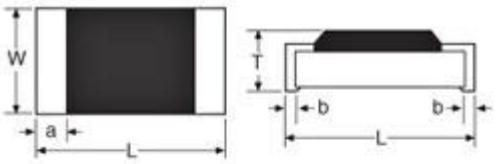
Resistors

10Ω - 2 (thru-hole), these are the only thru-hole resistors

All other resistors ***are SMD 1206*** *You should install these first*

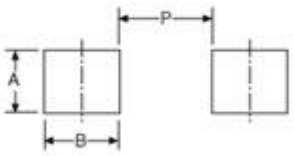
If you have no experience soldering SMD, check out some how-to vids on youtube.

1206 size is very easy, although a set of tweezers is required. Unless you are right hard and just use your finger to hold the component in place whilst soldering it.



Package Size (mm)

Type	L	W	a	b	T
1206	3.10	1.60	0.50	0.50	0.55



PCB Pad Layout(mm)

Type	A	B	P
1206	1.6	1.5	2.0

10R	thru-hole	2
1k (1k or unmarked on PCB)	1206 smd	15
10k (“d” on PCB)	1206 smd	11
100k (“c” on PCB)	1206 smd	22
200k (“2” on PCB)	1206 smd	6
1n4148 diode	thru-hole	3
unmarked caps (47nF-100nF)	thru-hole 2.5mm spacing	10
474 (470nF cap)	thru-hole 5mm spacing	1
100nF	1206 smd	1
10uF 25V (or more) electro	thru-hole 2.5mm spacing	2
100pF (marked 103 on PCB)*	thru-hole 2.5mm spacing	1
TL074	thru-hole	1
TL072	thru-hole	1
4071 quad OR gate	thru-hole	1
4070 quad XOR gate (4030 ok)	thru-hole	1
4042 quad latch	thru-hole	1
BC547 NPN transistors	thru-hole	5
100k pots	9mm vertical – see notes	6
LEDs (not superbright)		4
jacks		12
Connector IDC 20 pin		2
ribbon cable 20 core		15cm or so
20 Pin .100" Right Angle Male Headers - Double Row		1
20 Pin .100" Straight Male Headers - Double Row		1
Connector - Molex, .156 up, 3 pin	power connector	1

Pots

100kΩ Linear – 6

I use 100k pots from Song Huei - R0903N-B100k, L-25KC (the 25 is the length L).

It seems a pretty common footprint. Another pot that fits is this Alpha from Altronics - http://www.altronics.com.au/index.asp?area=item&id=R1948

If mounting the pots on the PCB, the spacing is 1 inch apart.

The PCB manufacturer made the pot holes too small. It means the pots have to be soldered on as 'surface mount'. The best way is to straighten the side mounting tabs with pliers and position the pot on the PCB so the 3 pins are in (on) their holes and the side tabs are slightly inserted in their larger holes.

Solder the three pins, but **not** the side tabs.

Do this for all 6 pots.

Attach the PCB to the panel and align the pots so they are correctly positioned.

Now solder the side tabs on the pots, ensure the solder flows thru to the other side of the PCB.

You will find the pots are firmly mounted on the PCB and will be fine for regular usage.

Caps

Except for the 470nF, all caps are for decoupling, the spacing is 2.5mm. An example is here - http://futurlec.com/Capacitors/C100UC.shtml

Connectors

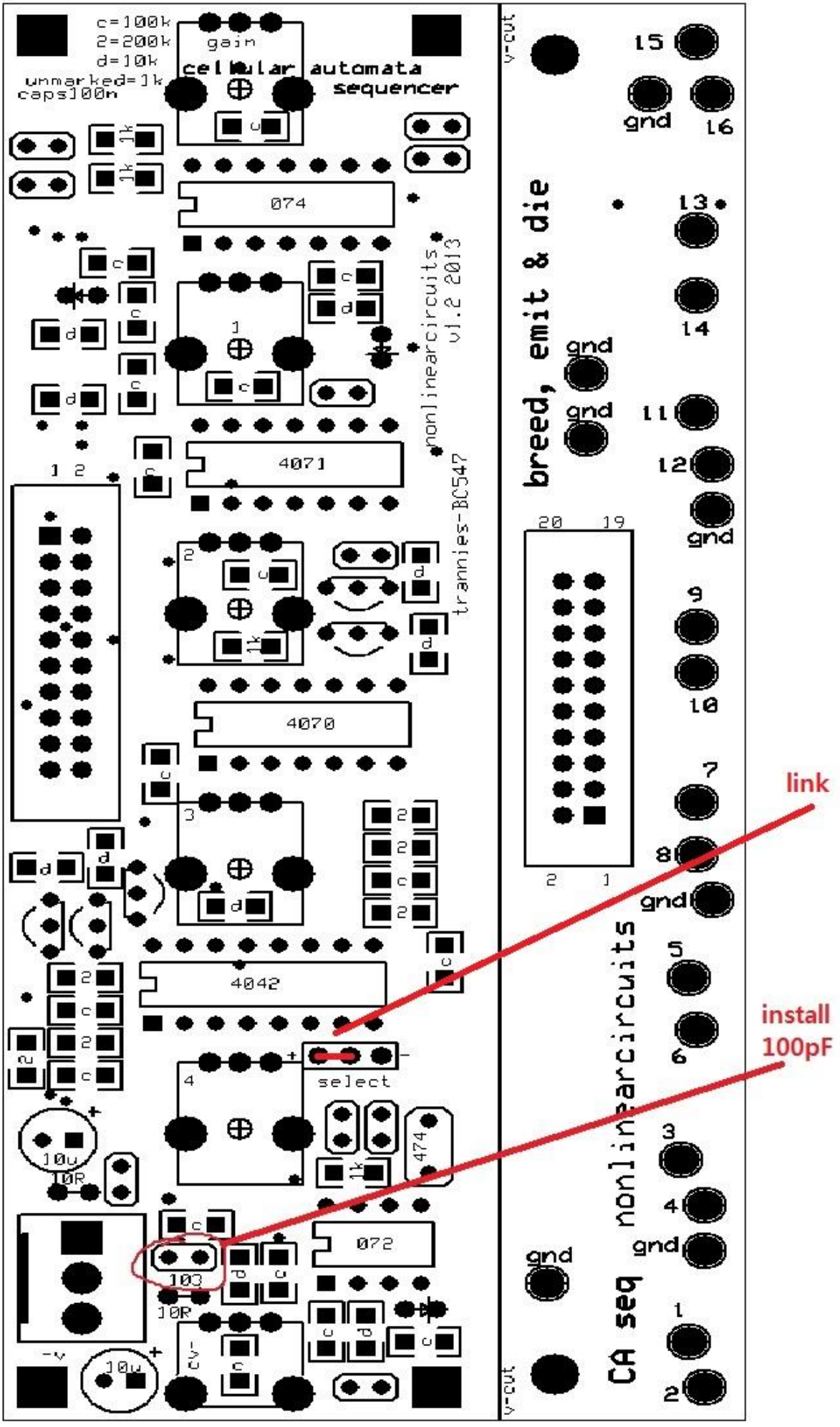
To go on main PCB

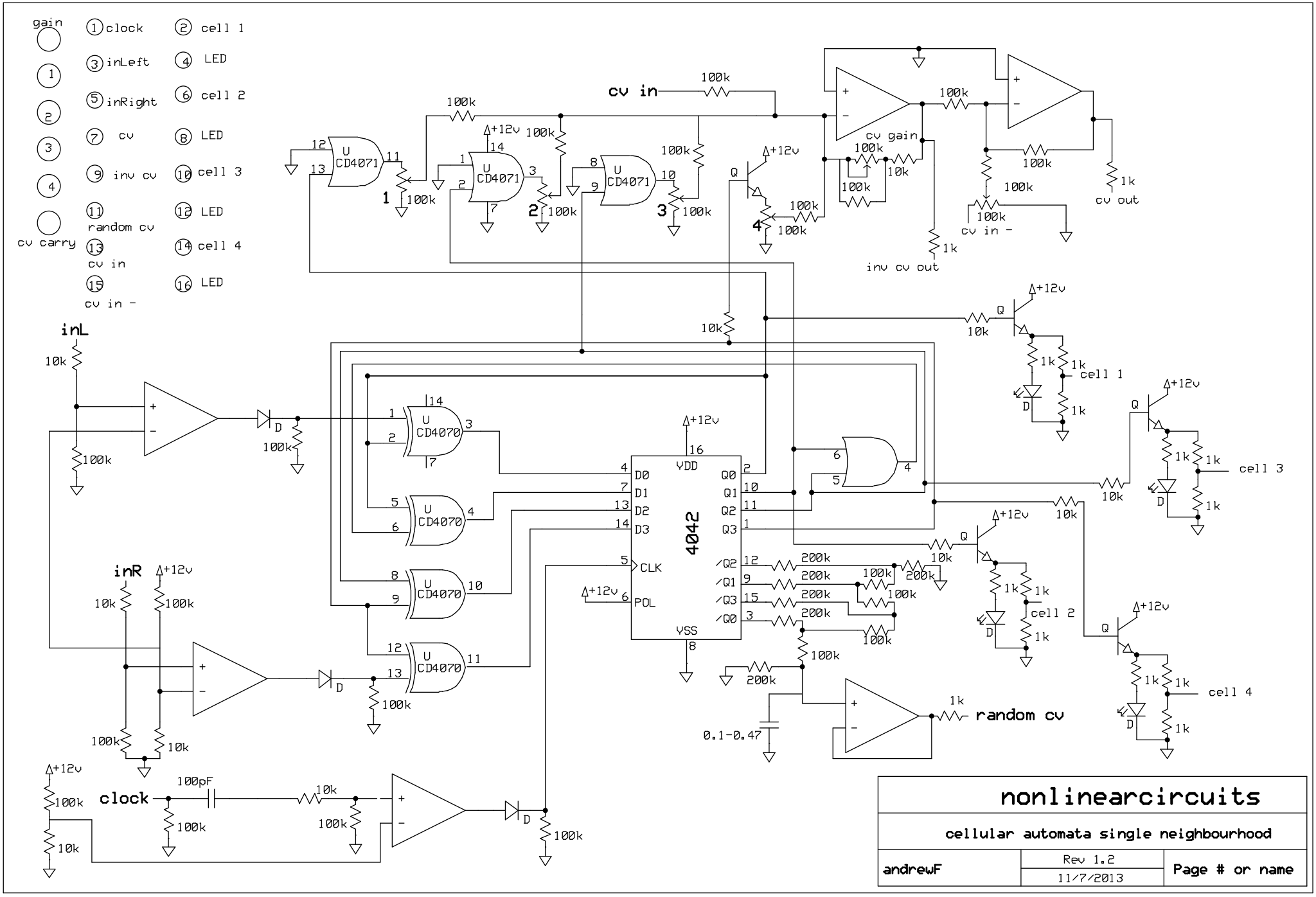
To go on breakout PCB

Breakout PCB connections

*Chain the LED cathodes together and solder to a ground pad on the breakout board

1	clock in	2	cell 1 gate out
3	in Left (any signal crossing 1V)	4	cell 1 LED anode
5	in Right (any signal crossing 1V)	6	cell 2 gate out
7	CV out	8	cell 2 LED anode
9	inverted CV out	10	cell 3 gate out
11	random CV out	12	cell 3 LED anode
13	CV input (mixes with CV out)	14	cell 4 gate out
15	inverted CV input	16	cell 4 LED anode


c=100k
2=200k
d=10k
unmarked=1k
caps100n
gain
cellular automata sequencer
074
4071
4070
4042
072
select
100
10R
10u
-v
cv-
nonlinearcircuits
v1.2 2013
trannies-BC547
v-cut
breed, emit & die
gnd
CA seq nonlinearcircuits
link
install
100pF



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cellular automata single neighbourhood

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MODS

I have not tried this yet but will eventually and update this section. You can obtain different types of cellular automata rules by substituting other quad CMOS logic ICs for the **4070**. Others that can go straight in are

4011 NAND

4071 OR

4077 XNOR

4081 AND

4001 NOR

Probably the 4081 will be a waste of time. The 4077 may be interesting, if you have a bank of 6 CAs, install a 4077 in one and 4070 in the other 5. The one with the 4077 will be like a seed module that can animate all the others. Just an idea, probably best to build it stock for now and use sockets for the ICs.