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File: cpu.sch

TABLE 1
 Summary of the 1000 Genomes Project

File: ted.sch

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File: ram.sch

SHEET: ROMS

File: rom.sch

File: keyboard.sch

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File: datasette.sch

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File: exp_port.sch

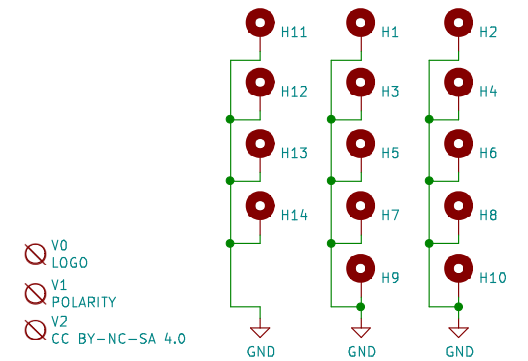
File: misc.sch

File: joysticks.sch

File: pla.sch

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File: avout.sch



SukkoPera

Sheet: /

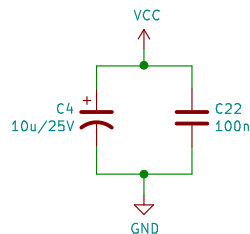
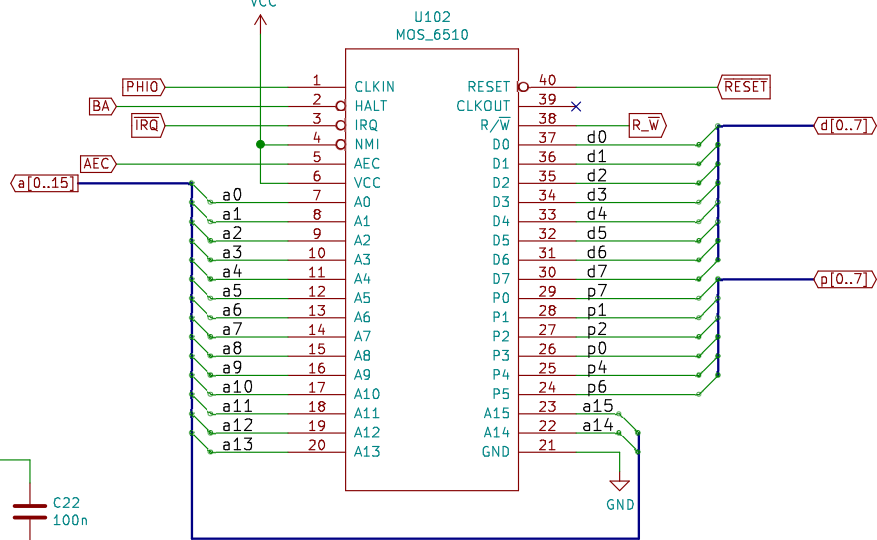
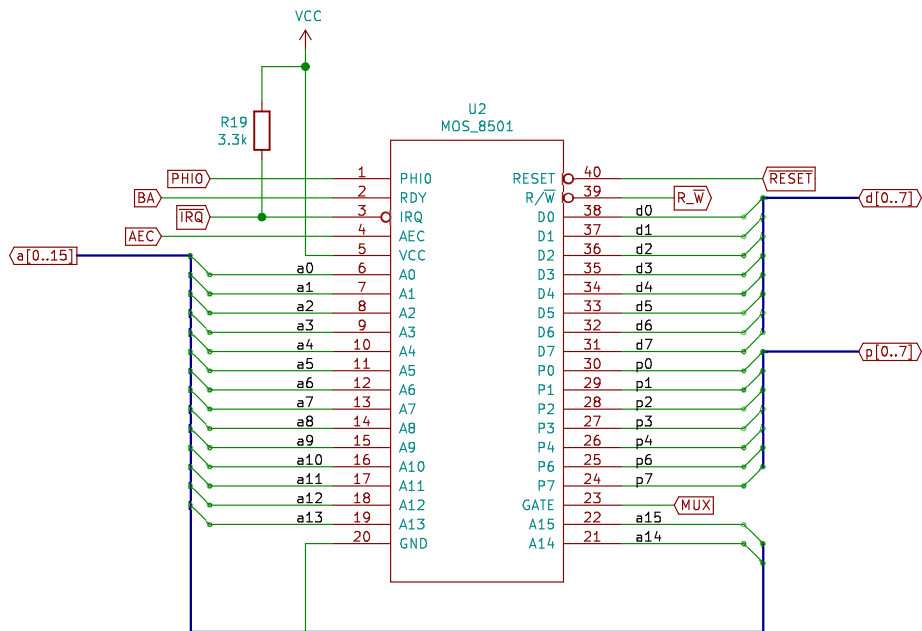
File: LittleSixteen.sch

Title: LittleSixteen

Size: A4	Date: 2021-11-17	Rev: 3git
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KiCad E.D.A. kicad 5.1.10	Id: 1/12
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Id: 1/12



The 7501/8501 CPU used in the x264 series is not much different from the 6510 that was used in the C64. Mapping of most pins is straightforward. Some signals change names but they are obviously the same.

6510s were working at 1MHz in the C64, while the x264 design is able to push them to nearly 2 MHz during video blanking. Since most 6510s seem to be pretty forgiving in this regard, we are left with two issues:

– GATE_IN: There is a lot of myth and inaccuracy about the purpose of this pin that is not available on the 6510. Here's a quote from the TED System Hardware Manual that should clarify things:

"GATE IN: TTL level input, used to gate the R/W line to prevent the R/W line from going low during a read cycle, before RAS and CAS go high (resulting in a Read/Write cycle). Normally connected to the MUX line in a system configuration to synchronize the DRAM memory cycle to the processor clock cycle.

If AEC is low when Gate In makes a low to high transition, the R/W line will go to a high impedance until the next transition of the Gate In line and AEC is high prior to the transition."

This is confirmed by some guys who recently decapped an 8501 and analyzed its die, please see <http://forum.6502.org/viewtopic.php?f=4&t=6617>.

A forum thread (<http://www.softwoles.com/arkiv/cbm-hackers/16/16855.html>) seems to suggest that when using DRAMs the signal is pretty useless, but it would be needed if SRAMs were used. I'm not sure this is correct and I really can't judge by myself, but since experience shows that leaving GATE_IN unconnected doesn't "seem" to hurt, we'll go with that for the moment, but for the future we might do something along the lines of this quote from Bil Herd himself:

"[During the development of the x264 family, where we were using 6510 CPUs] I think I did the Gated Read/Write with a 74LS73 only I drove the R/W line high, not HiZ."

– I/O Port: The 8501 has a 7-bit I/O port while the 6510 only has a 6-bit, plus the exposed bits are numbered differently, so some remapping is needed, which implies that some modding to the KERNAL is required as well. I decided to follow what Andrew Challis did at <http://hackjunk.com/2017/06/23/commodore-16-plus-4-8501-to-6510-cpu-conversion/>. So, the 6510 socket is basically Andy's adapter built into the mainboard. If you go with a 6510 you will need to use his modified KERNAL and to solder the diode and resistor at D/R93. This comes at a compromise though:

- Disk fastloaders will not work (unless they are modified themselves to match our pin shuffling).
- The Datasette motor will spin whenever one of its keys is pressed, the computer will no longer be able to control it.

I think these drawbacks are acceptable, as most fastloaders won't work anyway when using an SD2IEC, which is what most people do these days, I guess, while the loss of tape control isn't much of an issue in itself. Make sure to send a small donation to Andy if you go this way.

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Sheet: /CPU/

File: cpu.sch

Title: LittleSixteen

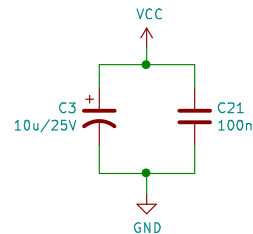
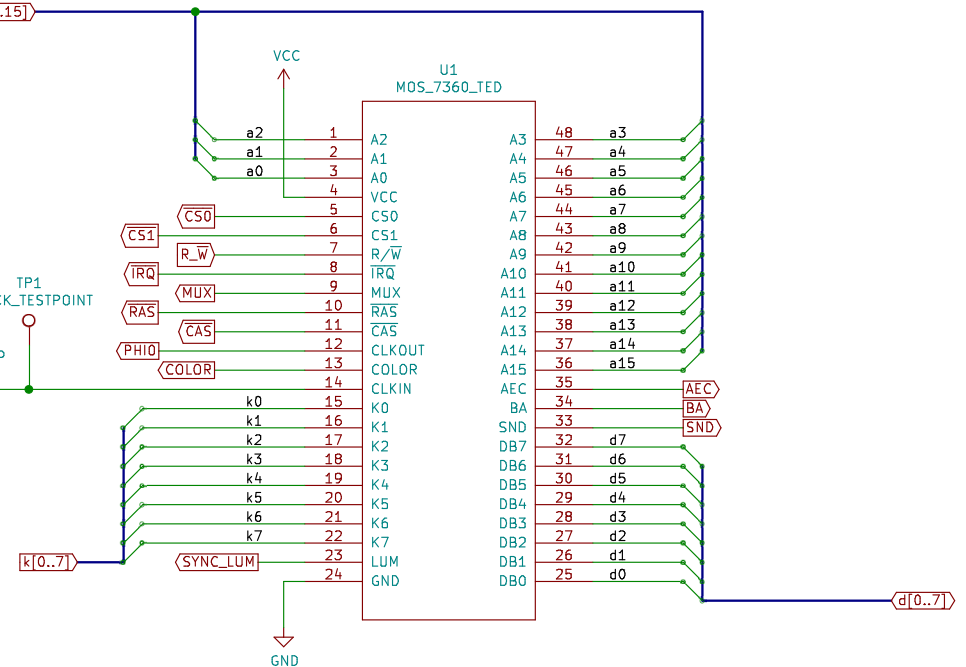
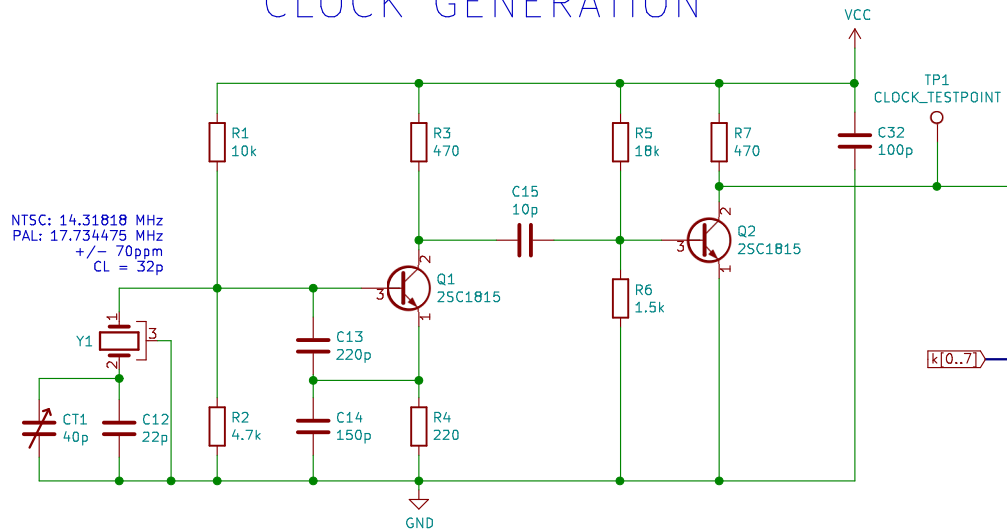
Size: A4 Date: 2021-11-17

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CLOCK GENERATION



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Sheet: /TED/

File: ted.sch

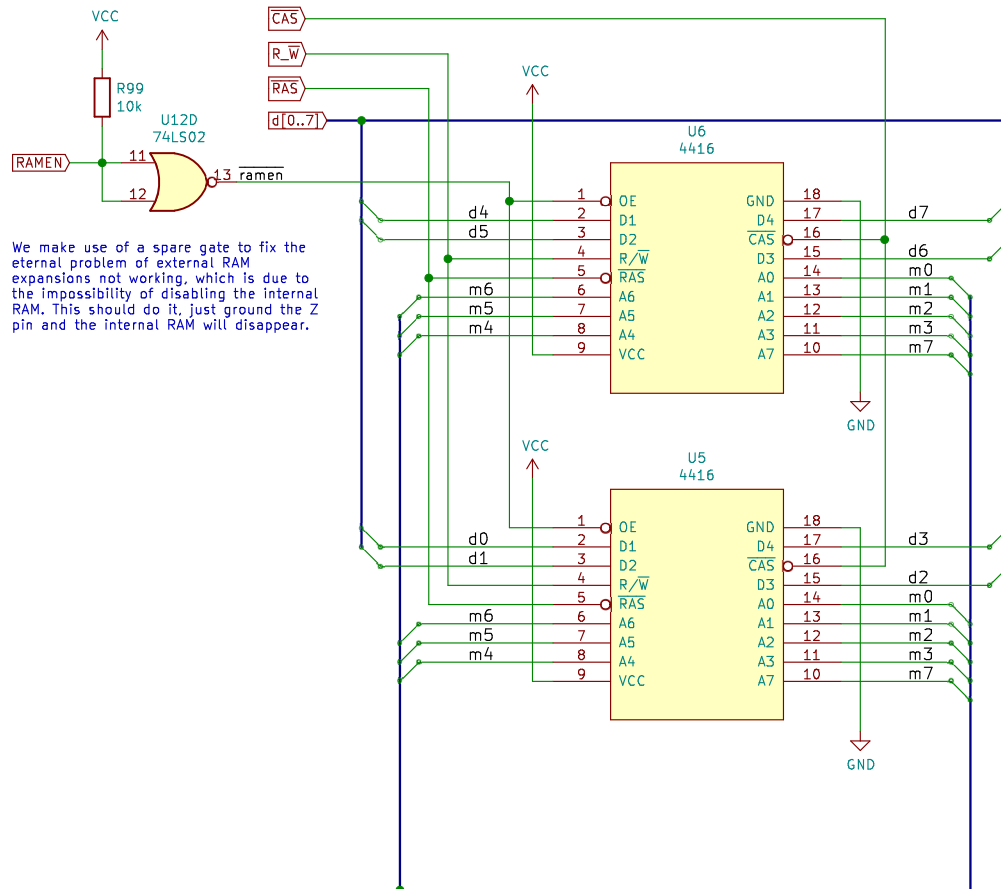
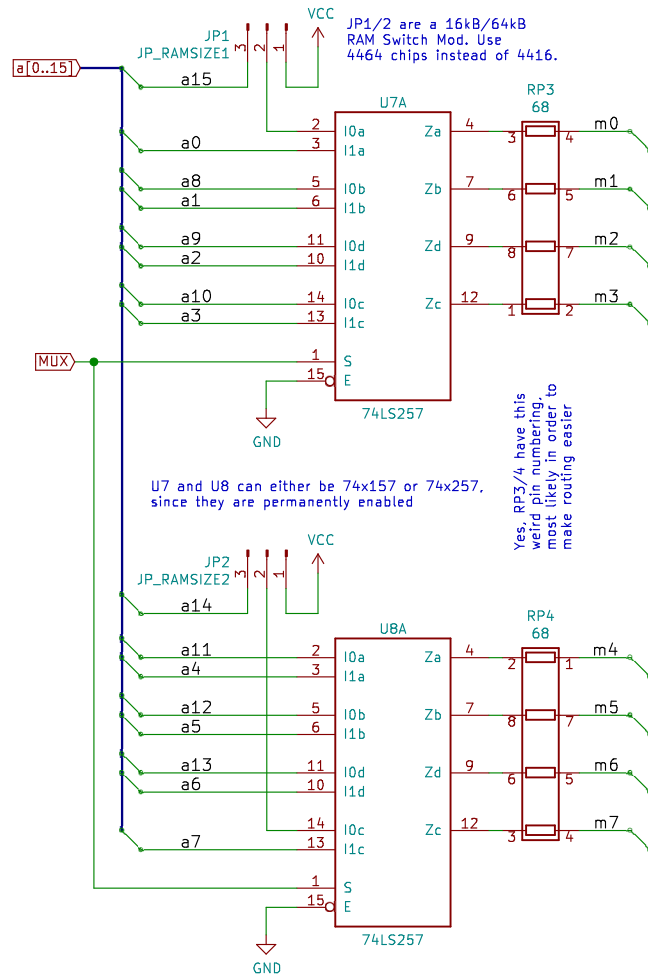
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Size: A4 Date: 2020-01-03

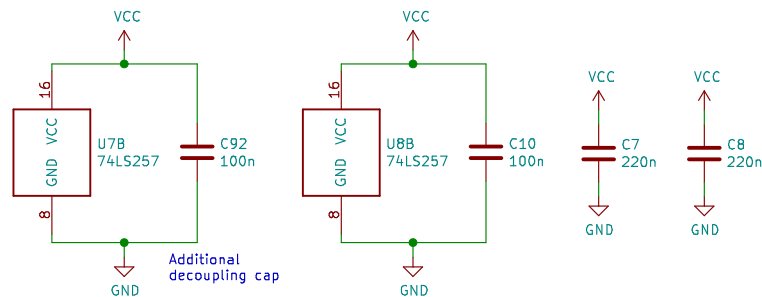
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Rev: 3git

Id: 3/12



We make use of a spare gate to fix the eternal problem of external RAM expansions not working, which is due to the impossibility of disabling the internal RAM. This should do it, just ground the Z pin and the internal RAM will disappear.



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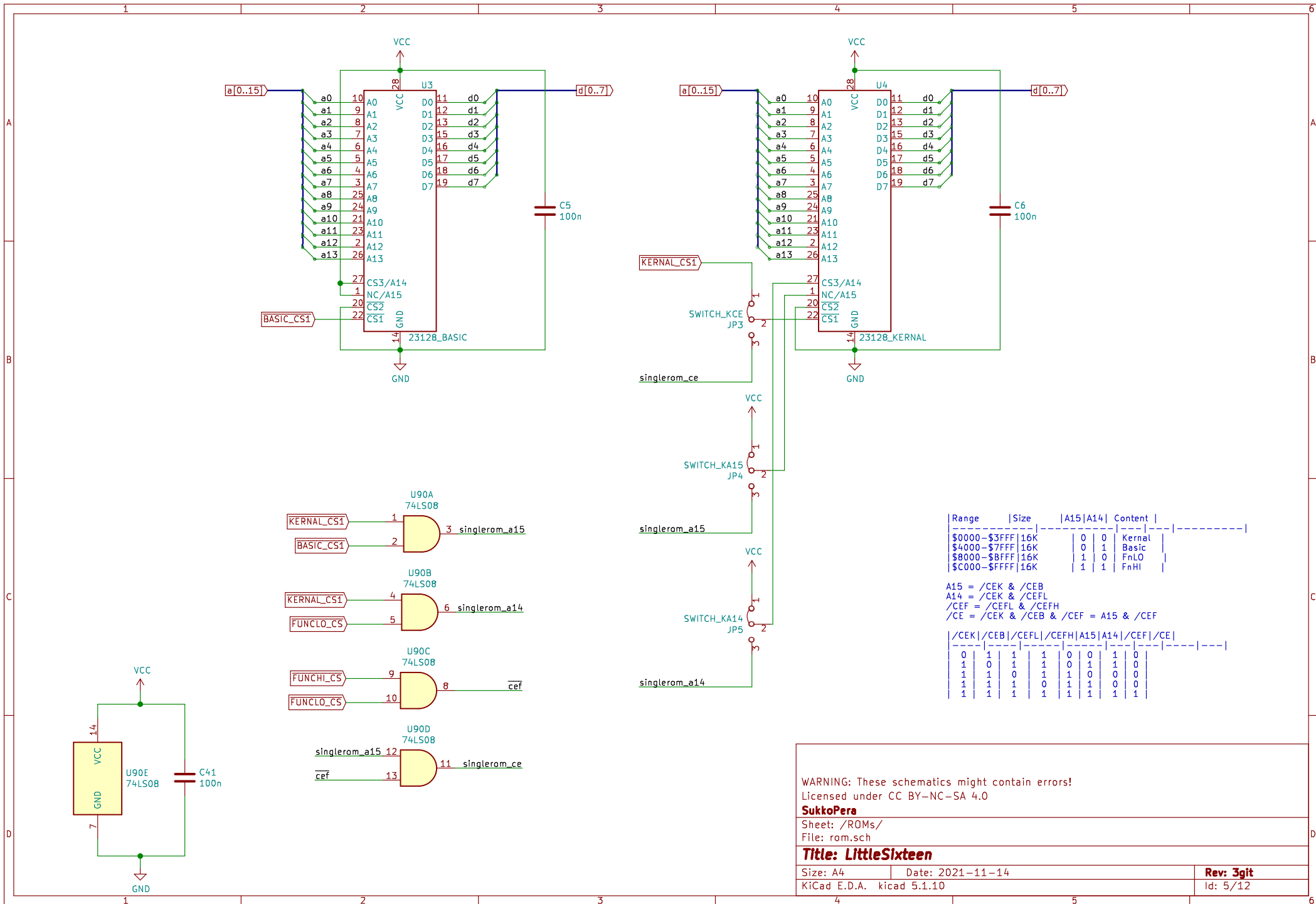
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Sheet: /RAM/
File: ram.sch

Title: LittleSixteen

Size: A4 Date: 2021-11-28
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Sheet: /ROMs/
File: rom.sch

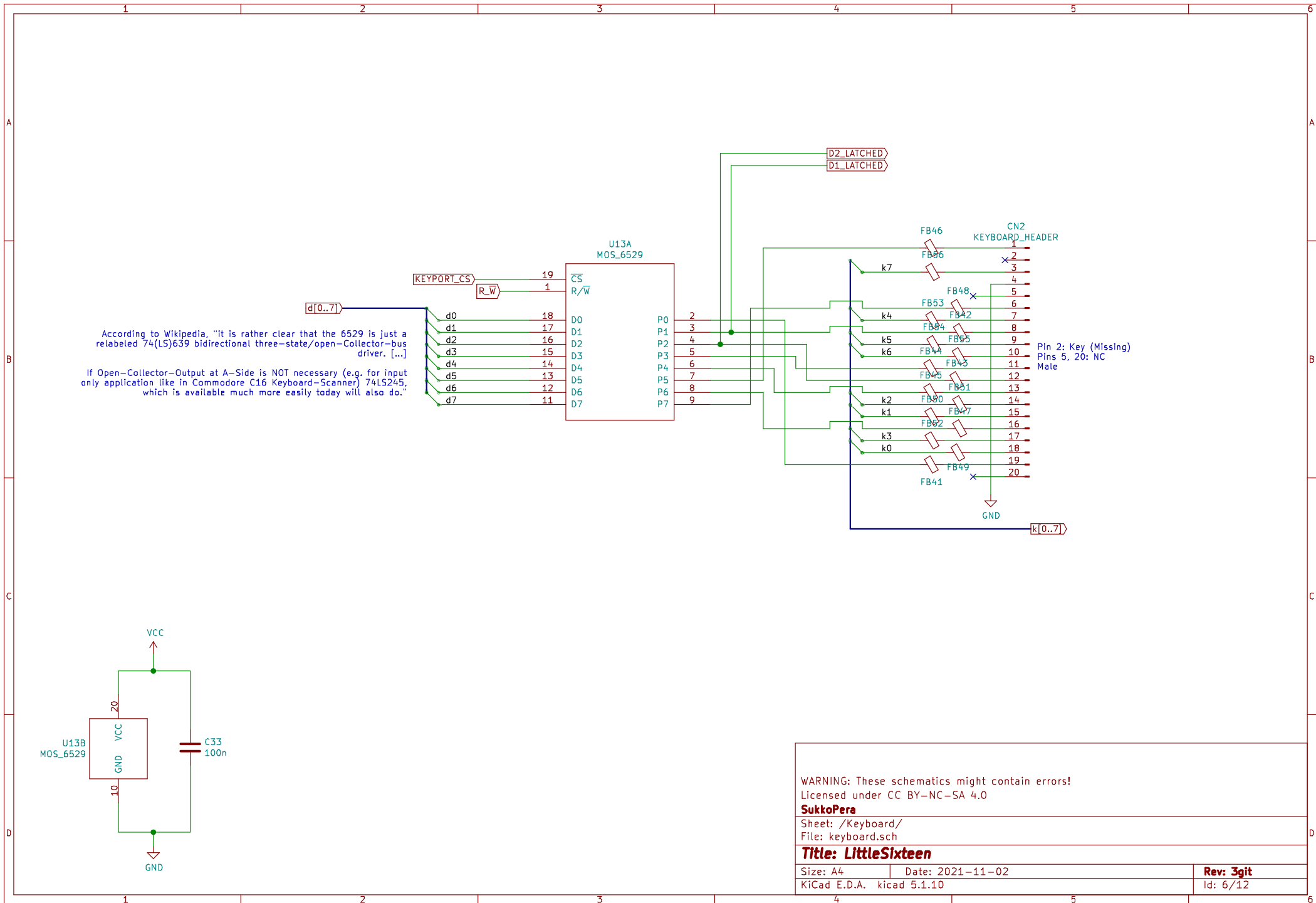
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Size: A4 Date: 2021-11-14

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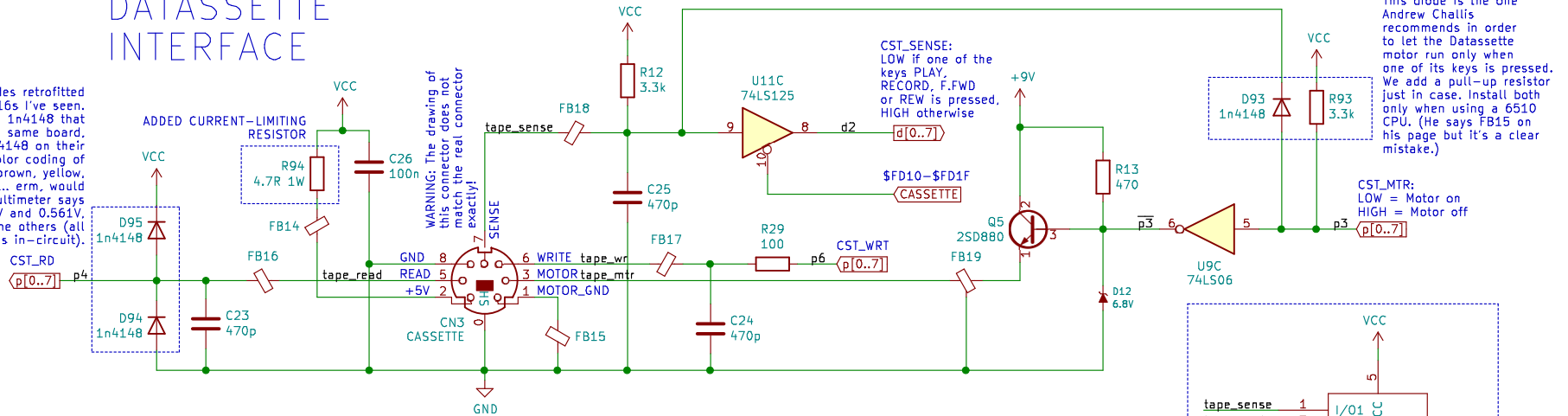
Rev: 3git

Id: 5/12



DATASSETTE INTERFACE

These are protection diodes retrofitted after production on "some" C16s I've seen. These seem different from the 1n4148 that are retrofitted on p6/p7 on the same board, since those clearly say 1n4148 on their bodies, while these have a color coding of yellow (thick/cathode), brown, yellow, grey (or light blue?), which... erm, would make them 1n4148. Multimeter says their Voltage drops are 0.555V and 0.561V while it says 0.323 for the others (all measures in-circuit).

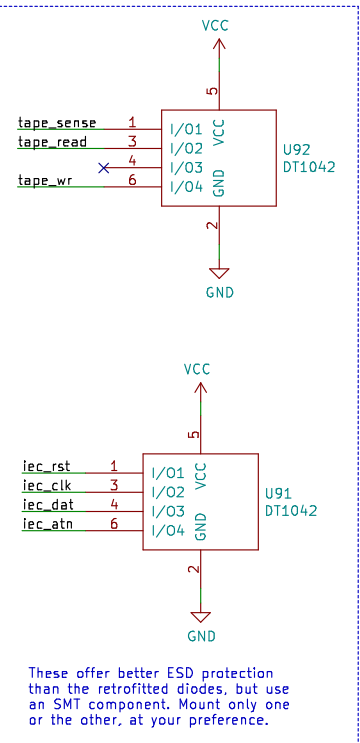
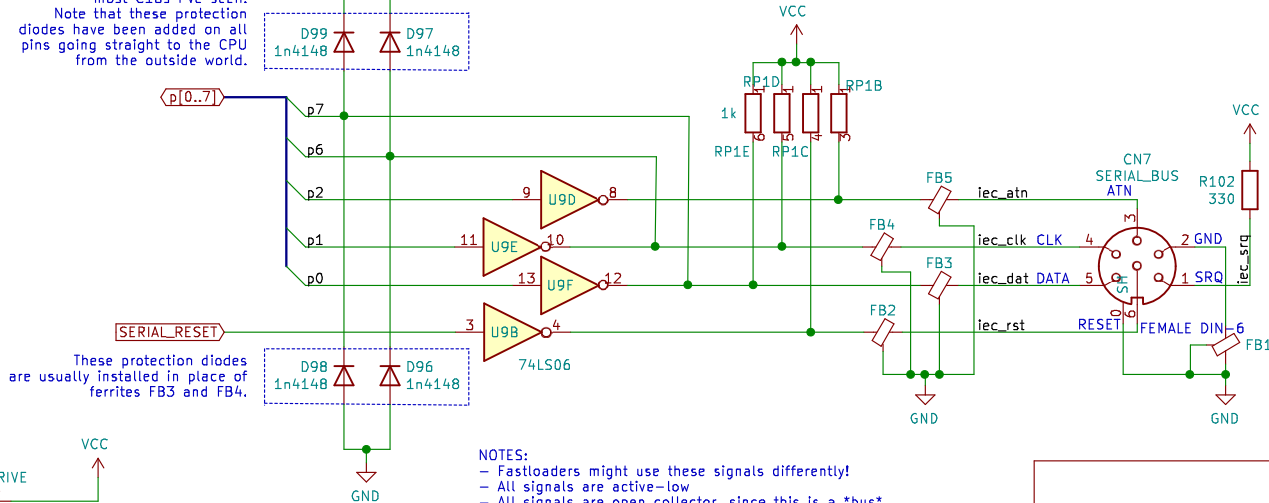


This diode is the one Andrew Challis recommends in order to let the Datasette motor run only when one of its keys is pressed. We add a pull-up resistor just in case. Install both only when using a 6510 CPU. (He says FB15 on his page but it's a clear mistake.)

CST_MTR:
LOW = Motor on
HIGH = Motor off

SERIAL BUS (OR 1541 DISK DRIVE)

These (and the ones below) are more retrofitted protection diodes, these are present on most C16s I've seen. Note that these protection diodes have been added on all pins going straight to the CPU from the outside world.



These offer better ESD protection than the retrofitted diodes, but use an SMT component. Mount only one or the other, at your preference.

NOTES:
- Fastloaders might use these signals differently!
- All signals are active-low
- All signals are open collector, since this is a *bus*

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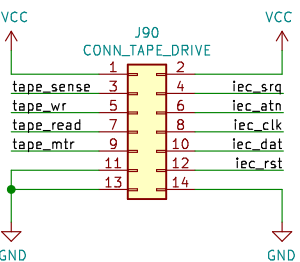
Sheet: /Datassette & Serial Bus/
File: datasette.sch

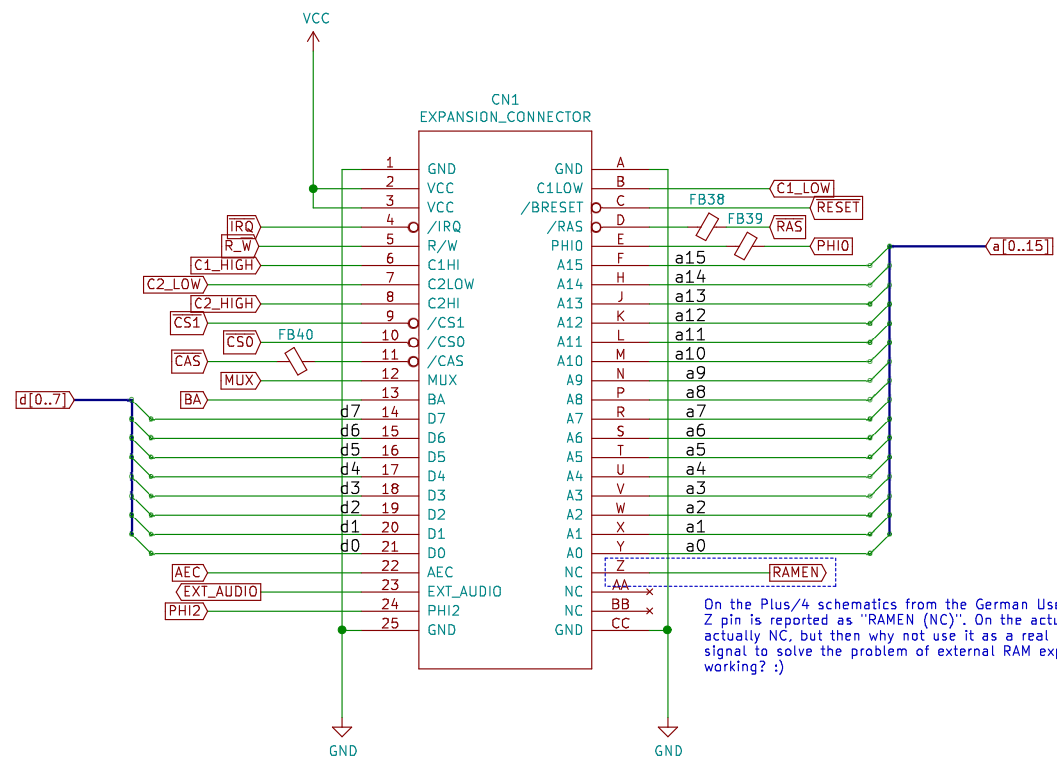
Title: LittleSixteen

Size: A4 Date: 2021-11-23
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This connector has all the Tape and IEC signals and can be used to implement an internal SD2IEC or Tapuino.





On the Plus/4 schematics from the German User's guide, the Z pin is reported as "RAMEN (NC)". On the actual boards it is actually NC, but then why not use it as a real "RAM Enable" signal to solve the problem of external RAM expansions not working? :)

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Sheet: /Expansion Port/
File: exp_port.sch

Title: LittleSixteen

Size: A4 Date: 2020-01-03
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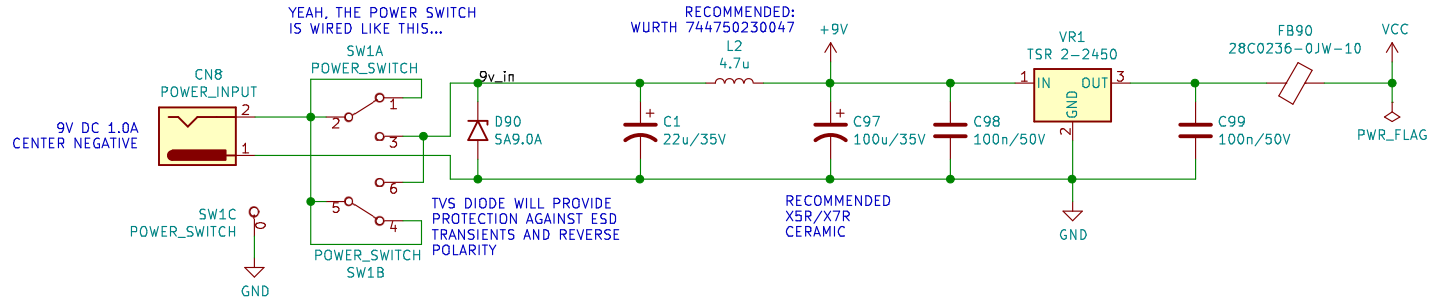
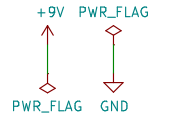
Rev: 3git
Id: 8/12

POWER REGULATION

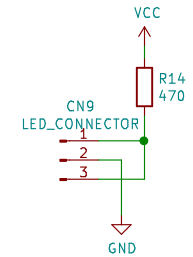
The TSR 2-2450 has a wide input range (6.5 – 36 VDC, 12 VDC nom.) and is able to output up to 2A.

The 1A model, TSR 1-2450 would probably be sufficient for most uses.

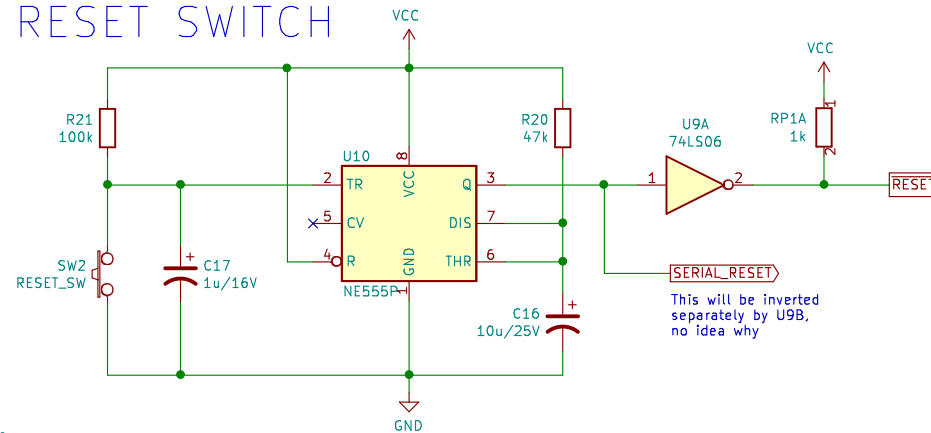
Thanks to Kinmami for helping design the input filter.



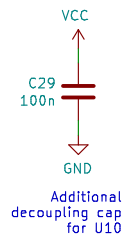
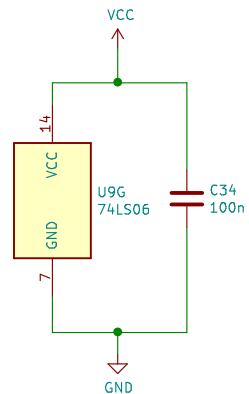
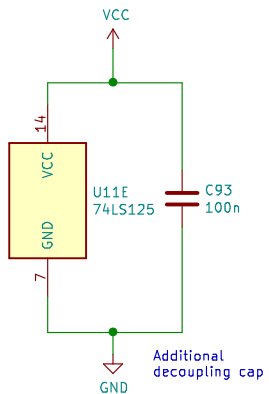
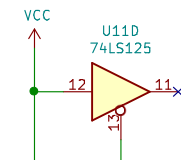
POWER LED



POWER-ON RESET + RESET SWITCH



SPARES



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Sheet: /Power & Misc/
File: misc.sch

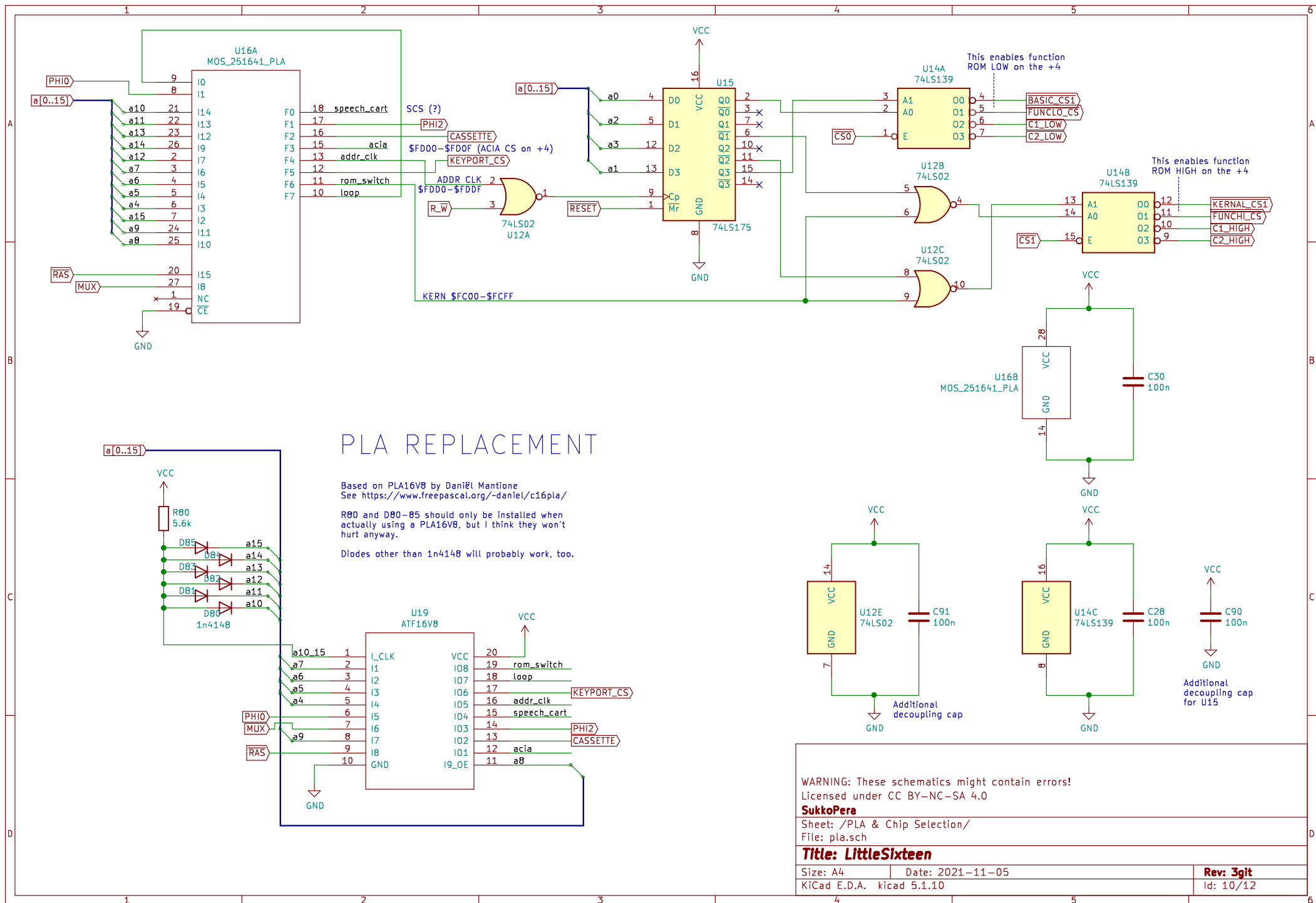
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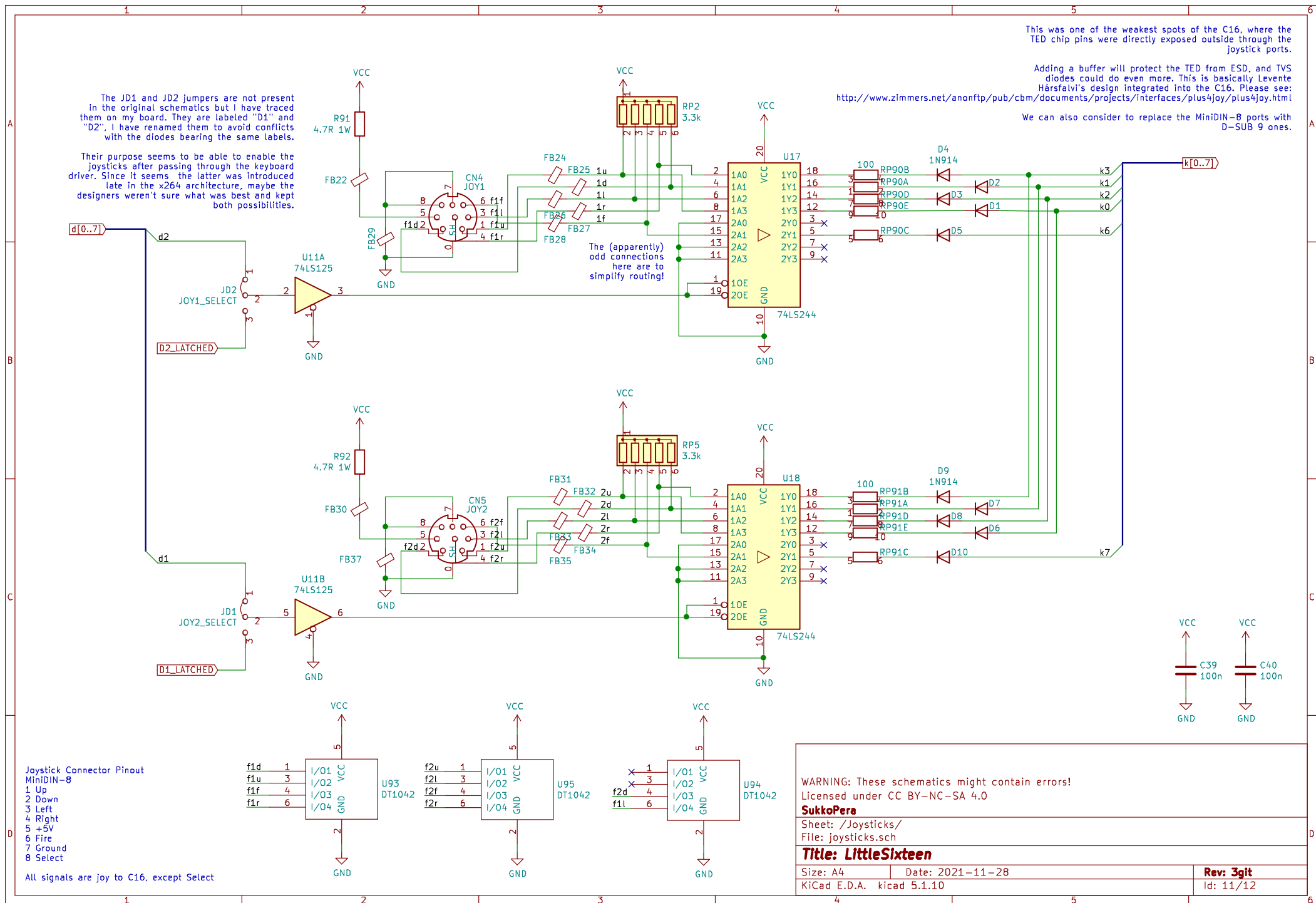
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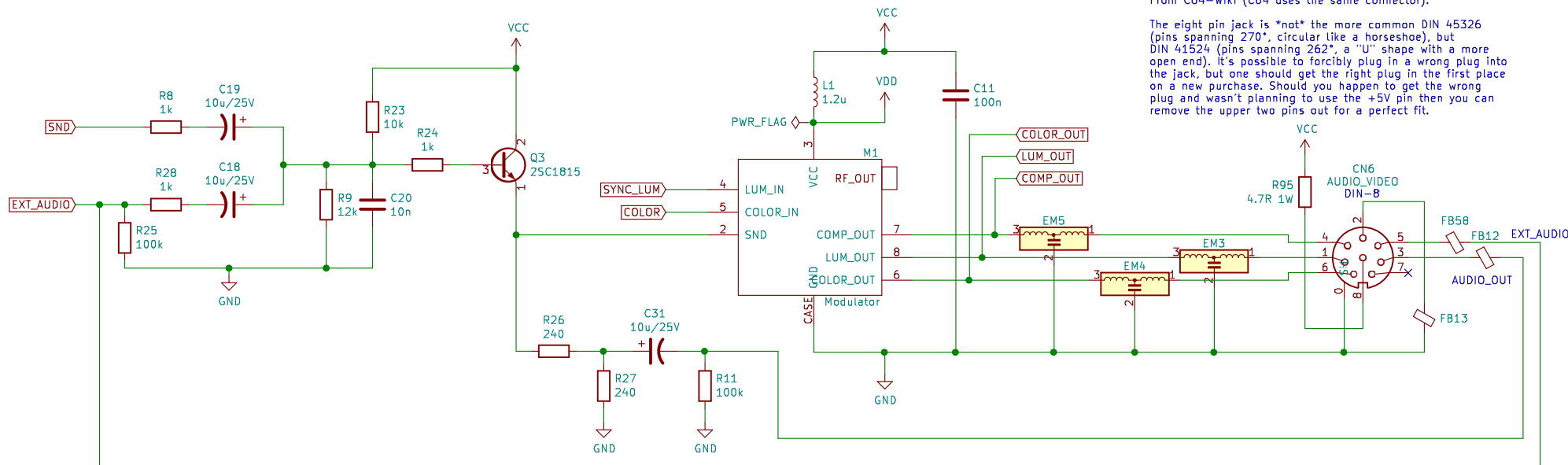
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Rev: 3git

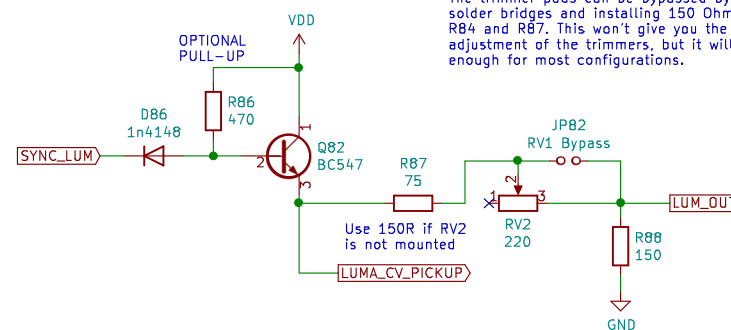
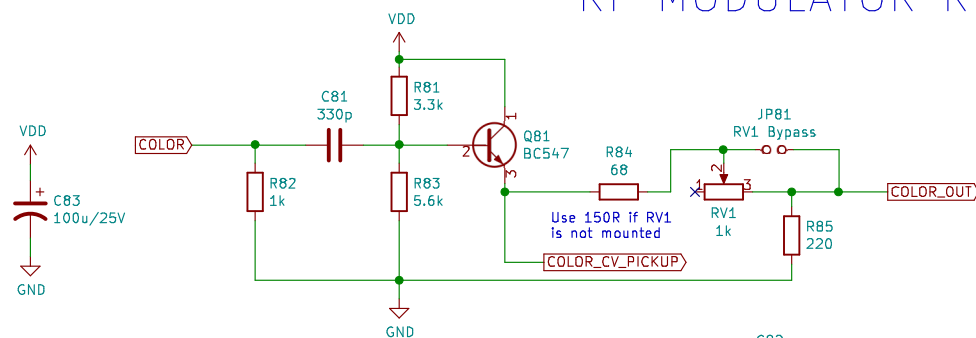
Id: 9/12





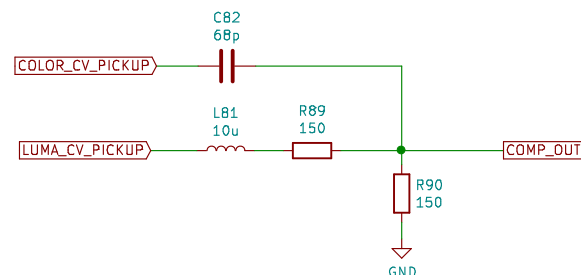


RF MODULATOR REPLACEMENT



These circuits can replace the composite/luma/chroma output functionality of the original modulator.

It's basically the same as mbarszcz-pcb's c64-rf-modulator-replacement project for the C64, please see: <https://github.com/mbarszcz-pcb/c64-rf-modulator-replacement>



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Sheet: /Audio/Video Output/
File: avout.sch

Title: LittleSixteen

Size: A4 Date: 2021-11-09

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Rev: 3git

Id: 12/12