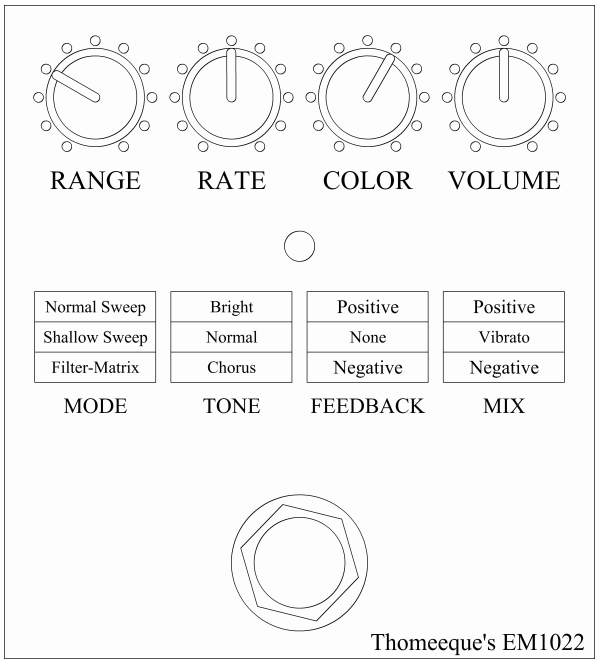

EM1022 Build Instructions (v1.0) *DRAFT*

Thomeeque, 2009/07/05

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1. Intro

EM1022 is a clone of original EHX Electric Mistress 9V flanger using TDA1022 BBD chip. It introduces few new features (overall volume drop fix, feedback and dry/wet mix polarity switches etc.) making it more versatile pedal, on the other hand it still should be capable to get very close to original EM character. Well, definitely check the demo first ;)

2. References

http://thmq.mysteria.cz/em1022/	My EM1022 project "homepage" (photo-gallery, some info, demo)
http://www.diystompboxes.com/smfforum/index.php?topic=74867.0	"TDA1022 Flanger" Topic on diystompboxes.com forum – here I have reported progress from the beginning to this point, you may find useful info there and ask for more as well.
http://www.tonepad.com/project.asp?id=54	Tonepad.com "9v Electric Mistress" project page, EM1022 is based on schematics from this page mainly.
http://thmq.mysteria.cz/em1022/TDA1022.pdf	TDA1022 datasheet.
http://thmq.mysteria.cz/em1022/SAD1024.pdf	SAD1024 datasheet, original EM was based on this BBD.
http://thmq.mysteria.cz/em1022/RD5107.pdf	RD5106A(5107A) datasheet, actual EM models are based on this BBD.

3. Build Hints

1. When ordering/buying parts, besides electrical characteristics take care about part dimensions, layouts are tight - use 1:1 layouts to do (virtual) fit-tests. E.g. C16 and C17 may give you some trouble.
2. Use sockets for all ICs, layouts expect it, precise type.
3. Solder all direct on-board jumpers first, some of them start/end under IC sockets, it would be problematic to install them if sockets were already there. For those leading between IC socket pins use isolated wire.
4. Long jumpers (Feedback jumper and Clock jumpers at Main Board) solder when all parts are placed on PCB.
5. Lead Feedback jumper shortest possible way at bottom (solder) side of PCB.
6. Twist Clock jumpers together and lead them shortest possible way at top side of PCB (you can switch them, it does not matter).
7. If you would like to use clock signals buffer[1], use interrupted Clock jumpers to get in and out.
8. If you don't plan to use clock signals buffer, you don't have to install R23, C11 and IC2 socket at Buffers Board.
9. Main Board and Buffers Board are connected by nine wires, leading from [BBx] to [MBx] wirepads. Use solid core wires, twist following groups: (1+2+3), (4+5+6+7) and (8+9).
10. It can be problematic to get 1M/EXP (reverse-audio) potentiometer for POT2_SPEED, I usually

1 May give you better BBD transition at highest clock speeds.

use 1M/LOG (audio) pot with reversed function[2] in these situations instead. PCB therefor leaves middle lug of POT2_SPEED unconnected to be ready for both scenarios. Jumper must be soldered to connect pot's middle lug with one of outer lugs, depending on your POT2_SPEED type (as indicated on Picture 7: Main Board Layout (Names)).

11. Keep leads to the potentiometers shortest as possible, especially those leading to speed pot generate lot of electromagnetic hum. For same reason try to lead audio signal wires and place IN/OUT jacks as far from LFO&Clock circuitry as possible. If you still get ticking into the signal, you can try to introduce some shielding there.
12. Between power pins of each of ICs are at the bottom (solder) side[3] of PCB soldered 100nF ceramic filtering capacitors (not drawn on schematics, as it's sort of default thing).
13. LED1 on Main Board is not intended to be visible once the effect is boxed, just solder it at PCB as any other part.
14. Photo-gallery may give you some useful hints, definitely check it but beware – used layouts slightly differ here and there little bit, circuitry has changed since original PCBs were etched and there's lot of patches, so don't get confused by this.
15. Do as many partial checks as possible (both layouts are very tight and circuitry has already some level of complexity, so try to avoid potential future debugging until it's easy yet):
    - Check shiny new etched PCB traces for cuts and bleeds,
    - Check that all on-board jumpers are there before proceeding with soldering of components,
    - Check all resistor values by DMM before soldering,
    - Double-check orientation of IC sockets before soldering (and of ICs themselves later before putting them in of course :)),
    - Double-check polarity of all polarized caps before soldering,
    - Double-check right pinout of transistors before soldering,
    - Basically double-check every component and every wire (right position, right value, right orientation) before soldering ;),
    - When all parts and jumpers are soldered and you are about to start putting the real ICs there for the first time, check yet before, that expected voltages (especially GND and V_{CC}) are at expected pins of all IC sockets (and vice versa),
    - Don't put all ICs there at once, fill them by functional blocks (LFO, clock, input buffer, output buffers, BBD..) and check that given block works before filling another one.
    - etc.

4. Setup Hints

- Set all trimmers as indicated on Picture 1: Main Board Schematic
- ***TODO***

5. Part Lists

- All capacitors: 12V or more

2 Fastest at minimum, slowest at maximum.
3 These capacitors should be generally placed as close to IC pins as possible, so I do it this way.

- All resistors: Metallic, 0207 package
- Pads are listed only for wire checks or something

5.1 Main Board

Part	Value	Package (pin distance)	Check
C1	10nF	Foil (5mm)	
C2	47nF	Foil (5mm)	
C3	1nF	Foil (5mm)	
C4	2.2nF	Foil (5mm)	
C5	100nF	Foil (5mm)	
C6	680pF	Foil (5mm)	
C7	47nF	Foil (5mm)	
C8	220nF	Foil (5mm)	
C9	10µF	Elyt (2.5mm)	
C10	33µF	Tantal (2.5mm)	
C11	33µF	Tantal (2.5mm)	
C12	1µF	Tantal (2.5mm)	
C13	1µF	Tantal (2.5mm)	
C14	47pF	Ceramic (5mm)	
C15	220µF	Elyt (2.5mm)	
C16	470µF	Elyt (2.5mm)	
C17	470µF	Elyt (2.5mm)	
Filtering Caps[4]	5x 100nF	Ceramic (5mm)	
D1	1N4001	D-7.5	
D2	1N4001	D-7.5	
D3	Zener Diode 12V	D-2.5	
IC1	TDA1022	DIL16	
IC2	LM324	DIL14	
IC3	LM4558	DIL08	
IC4	LM311N	DIL08	
IC5	4013BE	DIL14	
LED1	RED	LED3MM	
POT1_FB	10k/LIN	POT_16_MONO	
POT2_SPEED	1M/EXP	POT_16_MONO	
POT3_RANGE	100k/LIN	POT_16_MONO	
Q1	2N5087	TO92D	
Q2	2N5087	TO92D	
R1	10k	0207/7	
R2	1M2	0207/7	
R3	470R	0207/7	
R4	4k7	0207/7	
R5	5k6	0207/2V	
R6	100k	0207/7	
R7	1k	0207/7	
R8	10k	0207/7	
R9	8k2	0207/7	
R10	39k	0207/7	
R11	13k	0207/7	

4 See 3.Build Hints

R12	470R	0207/7	
R13	100k	0207/2V	
R14	100k	0207/5V	
R15	1k	0207/2V	
R16	100k	0207/10	
R17	8k2	0207/7	
R18	24k	0207/7	
R19	39k	0207/7	
R20	30k	0207/7	
R21	10k	0207/10	
R22	3k9	0207/10	
R23	47k	0207/10	
R24	27k	0207/7	
R25	33k	0207/10	
R26	1M2	0207/7	
R27	62k	0207/7	
R28	3k9	0207/7	
R29	10k	0207/7	
R30	10R	0207/2V	
R31	2M2	0207/7	
RT1	1k	Cermet Trimmer	
RT2	10k	Cermet Trimmer	
RT3	100k	Cermet Precise Trimmer	
RT4	10k	Cermet Trimmer	
PAD1	In	wirepad	
PAD2	In-gnd	wirepad	
PAD3	[BB1]	wirepad	
PAD4	[BB2]	wirepad	
PAD5	[BB3]	wirepad	
PAD6	[BB5]	wirepad	
PAD7	[BB4]	wirepad	
PAD8	[BB7]	wirepad	
PAD9	[BB6]	wirepad	
PAD10	[BB9]	wirepad	
PAD11	[BB8]	wirepad	
PAD12	gnd	wirepad	
PAD13	+9V	wirepad	

5.2 Buffers Board

Part	Value	Package	Check
C1	220nF	Foil (5mm)	
C2A	3.3nF	Foil (5mm)	
C2B	10nF	Foil (5mm)	
C3A	47nF	Foil (5mm)	
C3B	33nF	Foil (5mm)	
C4A	47nF	Foil (5mm)	
C4B	33nF	Foil (5mm)	
C5	47nF	Foil (5mm)	
C6	1µF	Foil (5mm)	

C7	1µF	Foil (5mm)	
C8	100pF	Ceramic (5mm)	
C9	100µF	Elyt (2.5mm)	
C10	10µF	Elyt (2.5mm)	
C11[5]	100µF	Elyt (2.5mm)	
Filtering Caps[6]	2x 100nF	Ceramic (5mm)	
IC1	LM324	DIL14	
IC2[5]	4049	DIL16	
LED1	RED	LED3MM	
POT_VOLUME	100k/LOG	POT_16_MONO	
R1	3k3	0207/2V	
R2	120k	0207/10	
R3	5k1	0207/2V	
R4	10k	0207/10	
R5	22k	0207/2V	
R6	22k	0207/7	
R7	22k	0207/2V	
R8	1M	0207/2V	
R9	1M	0207/2V	
R10	8k2	0207/10	
R11	510R	0207/10	
R12	100k	0207/10	
R13	18k	0207/2V	
R14	470R	0207/7	
R15	100k	0207/5V	
R16	10R	0207/10	
R17	100k	0207/5V	
R18	100k	0207/5V	
R19	100R	0207/7	
R20	100k	0207/2V	
R21	39k	0207/2V	
R22	18k	0207/2V	
R23[5]	10R	0207/10	
R24	100k	0207/2V	
R25	100k	0207/2V	
R26	10k	0207/10	
SW1_MODE	P-GS373[7] or similar	MS-034 See Picture 15: MS-034 Slide Switch Specs	
SW2_TONE			
SW3_FB			
SW4_MIX			
PAD1	[MB2]	wirepad	
PAD2	[MB8]	wirepad	
PAD3	[MB9]	wirepad	
PAD4	[MB1]	wirepad	
PAD5	VOLUME-pot-[1]	wirepad	
PAD6	VOLUME-pot-[2+3]	wirepad	
PAD7	Out	wirepad	
PAD8	Out-gnd	wirepad	

5 Part of clock signals buffer (see 3.Build Hints).
6 See 3.Build Hints.
7 http://www.gme.cz/cz/index.php?product=631-096

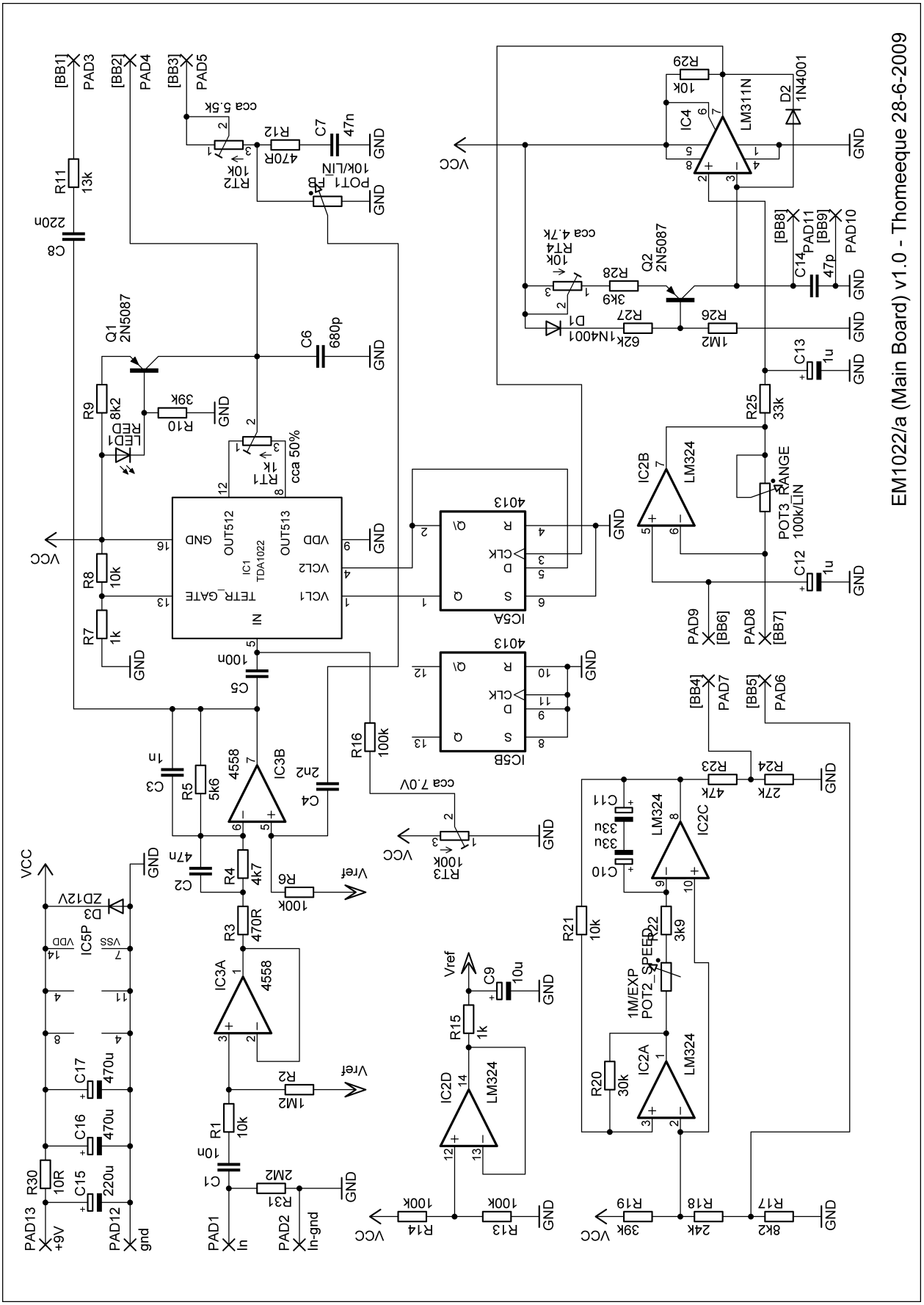
PAD9	[MB3]	wirepad	
PAD10	+9V	wirepad	
PAD11	gnd	wirepad	
PAD12	[MB4]	wirepad	
PAD13	[MB5]	wirepad	
PAD14	[MB6]	wirepad	
PAD15	[MB7]	wirepad	
PAD16	LED-sw-gnd	wirepad	
PAD17	LED-sw	wirepad	
PAD18[5]	+Q-in	wirepad	
PAD19[5]	-Q-in	wirepad	
PAD20[5]	+Q-out	wirepad	
PAD21[5]	-Q-out	wirepad	

5.3 Prototype Substitutions

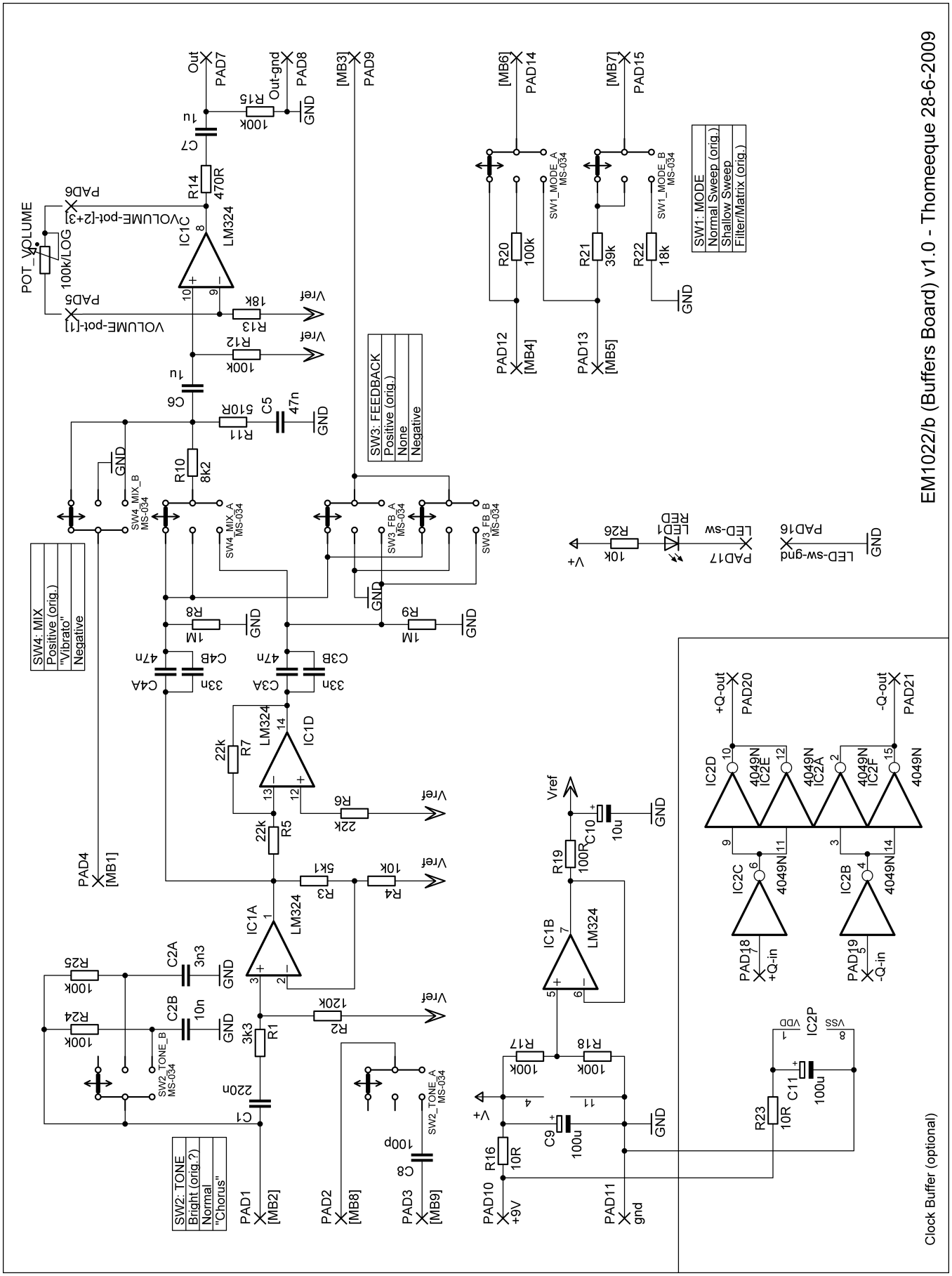
Since I did not get all proper parts up to now and therefor I had to do substitutions which may have altered effect somehow, I will list exact parts which are used in my EM1022 now and which were used for the demo:

- Main Board:
  - **C16 – 100µF**
  - **C17 – 1000µF**
  - **D1 – 1N4007** (here I'm definitely planing to get original part in the future, since it can alter sweep characteristic, which I want to have as close to original as possible)
  - **D2 – 1N4148** (Deluxe EM uses this type so it is probably close, but I will try to switch it as well once I'll get to 1N4001's)
  - **IC3 – Motorola T4558CP1**
  - **IC5 – CD4013BE**
  - **Q1 – BC560C** (well, this is not substitution actually - it's new part of circuit and I have used BC560C from the beginning, but here should any common small signal PNP do the job, so I list same type as for Q2 to make buying parts easier)
  - **Q2 – BC560C** (same as for D1 above applies here)
  - **C4 – 2.2nF + 15nF** (gives fatter feedback, closer to the "standard" flangers, use 2.2nF to be closer to original EM.. or experiment as I did :))
- Buffers Board
  - **IC1 - MC3403N**
  - Clock Buffer is not used
- PSU
  - **10V power-source** (I use 10 Volts PSU to feed all of my "9V" stomp-boxes)

6. Schematics

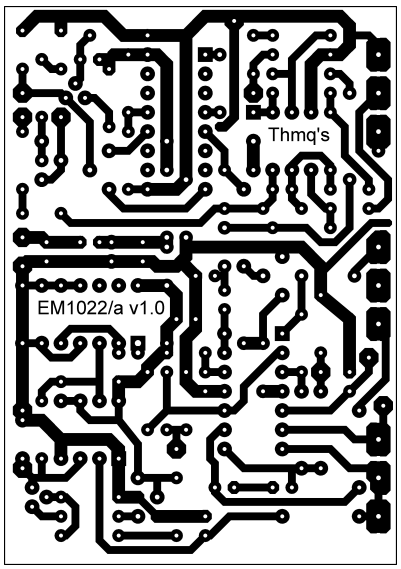


Picture 1: Main Board Schematic

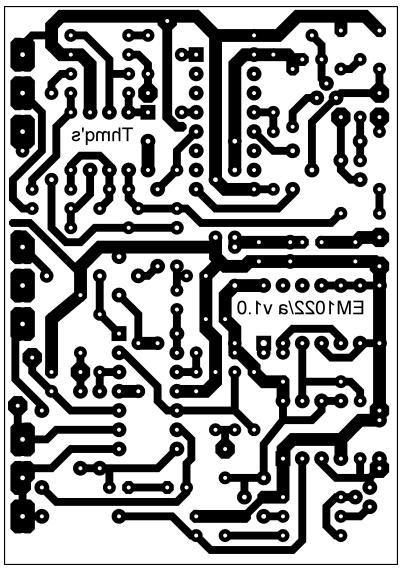


Picture 2: Buffers Board Schematic

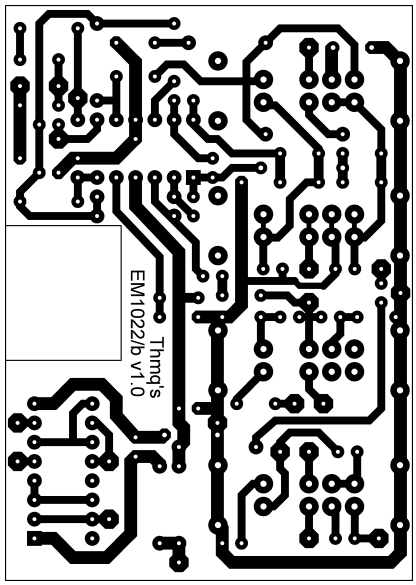
7. PCBs



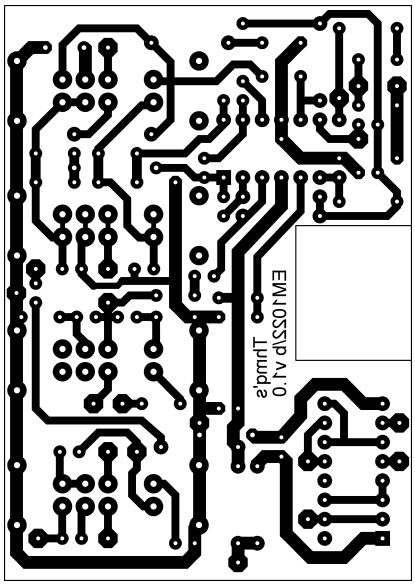
Picture 3: Main Board PCB



Picture 4: Main Board PCB (Mirror)

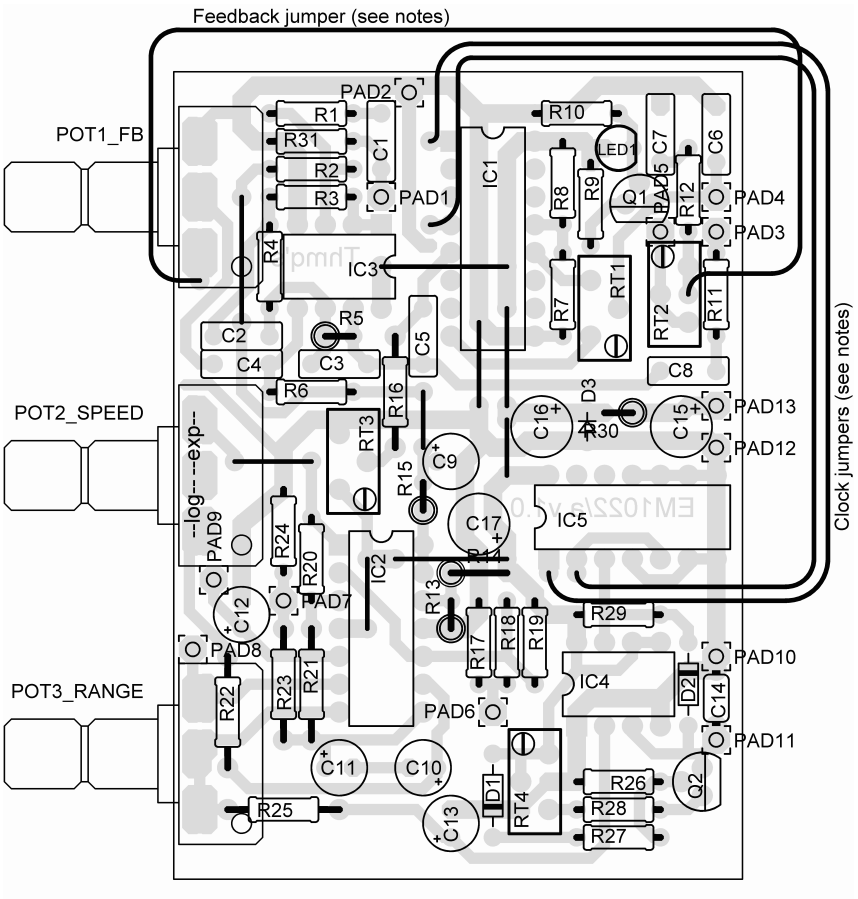


Picture 5: Buffers Board PCB

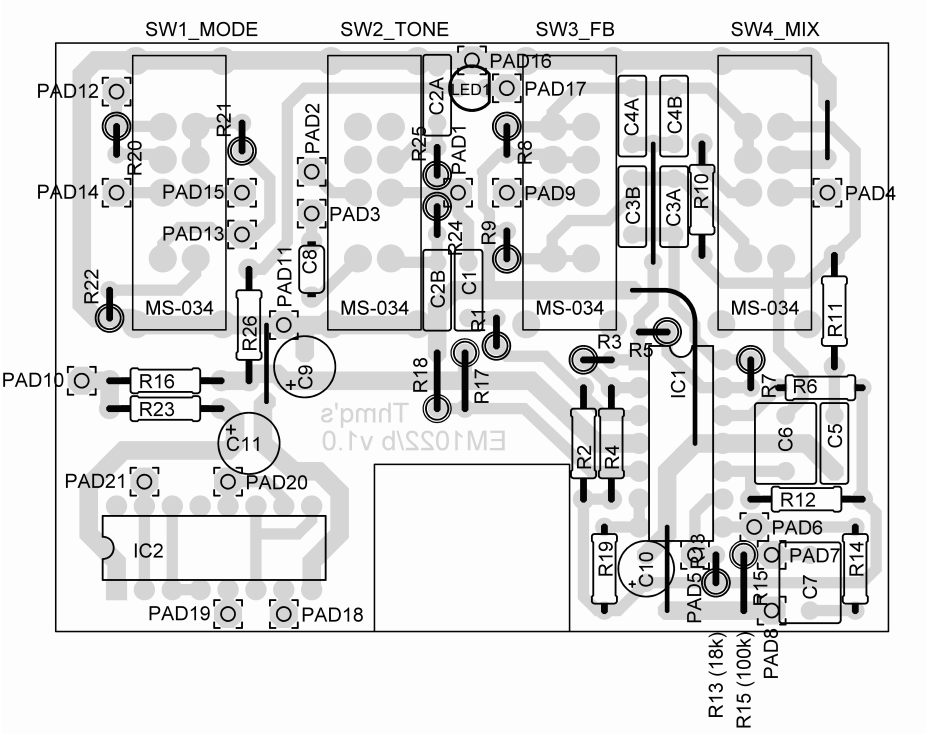


Picture 6: Buffers Board PCB (Mirror)

8. Layouts (Names)

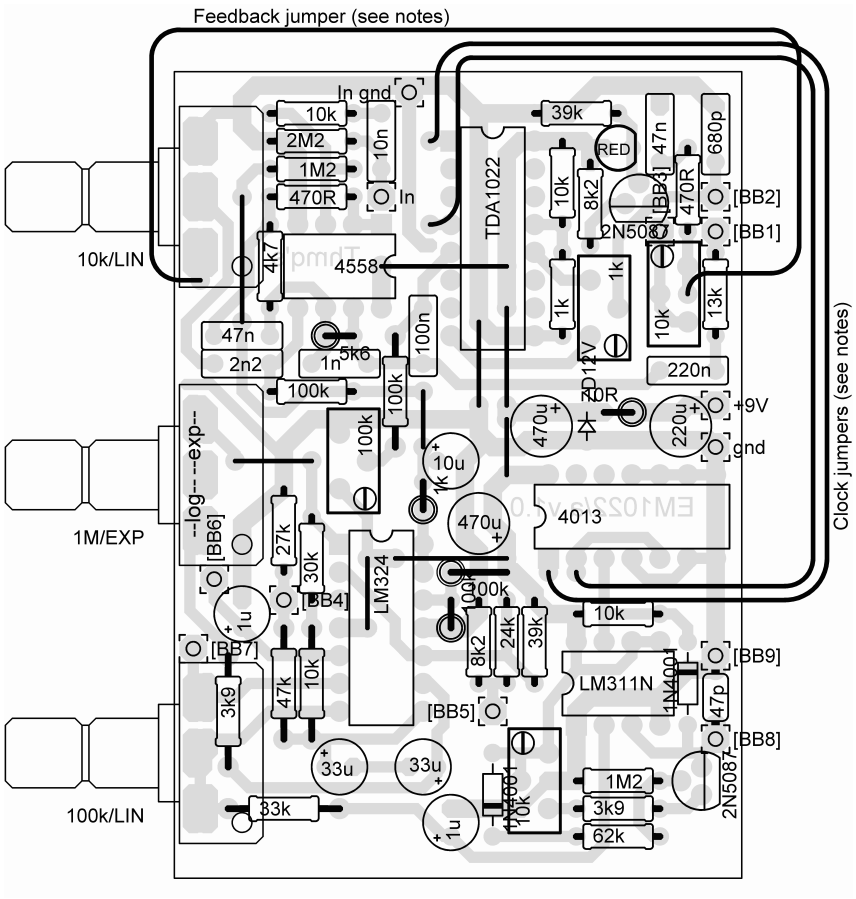


Picture 7: Main Board Layout (Names)

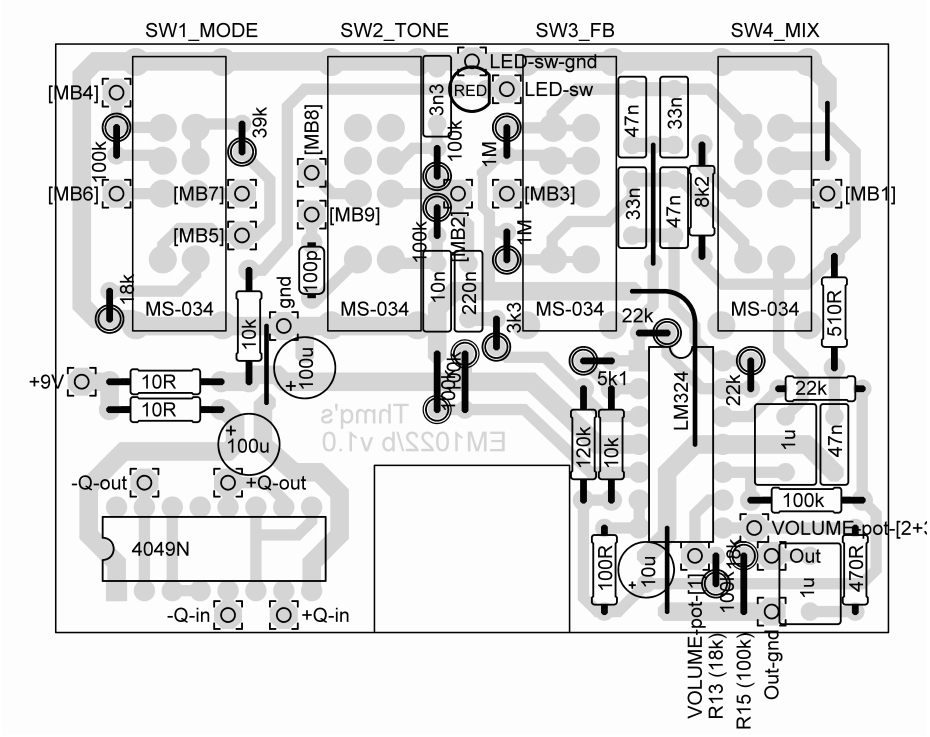


Picture 8: Buffers Board Layout (Names)

9. Layouts (Values)

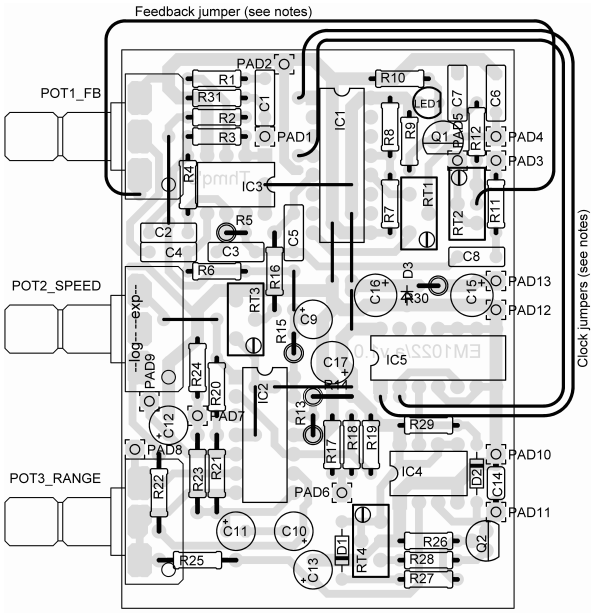


Picture 9: Main Board Layout (Values)

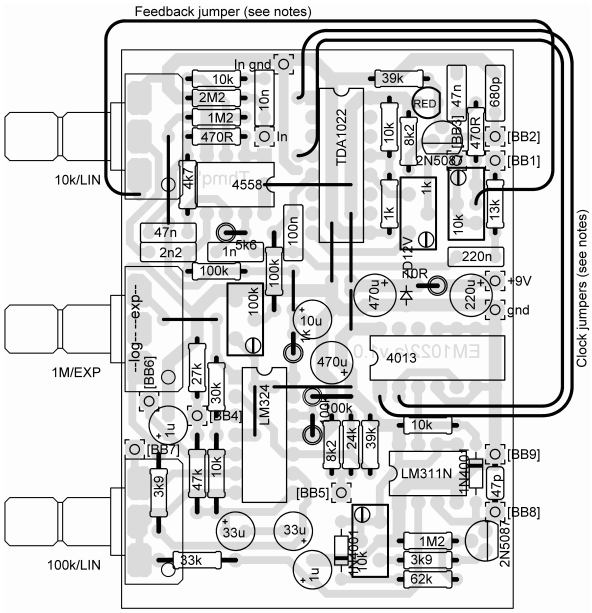


Picture 10: Buffers Board Layout (Values)

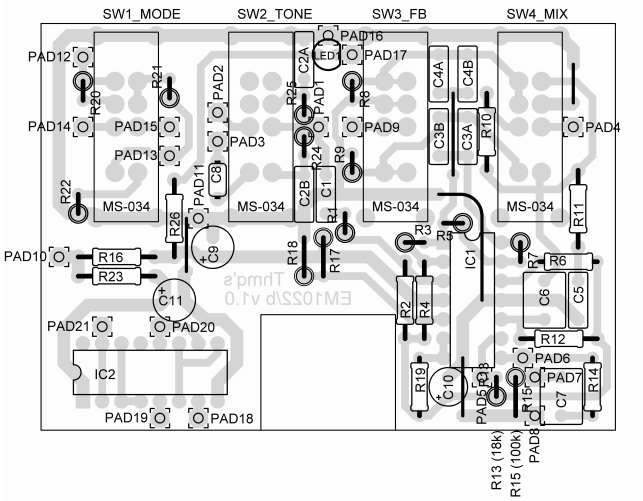
10. Layouts (1:1)



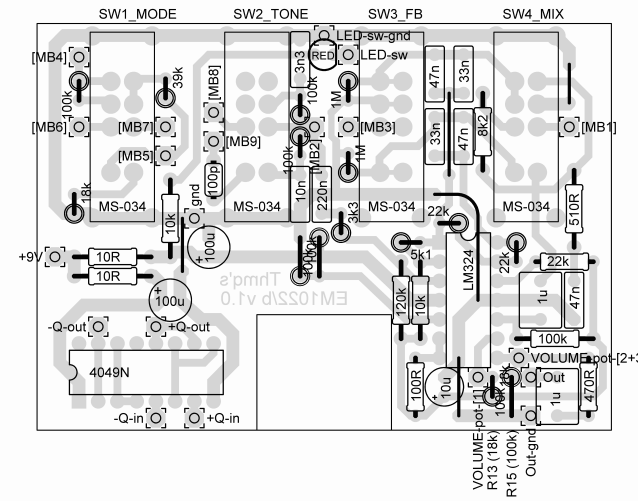
Picture 11: Main Board Layout 1:1 (Names)



Picture 12: Main Board Layout 1:1 (Values)

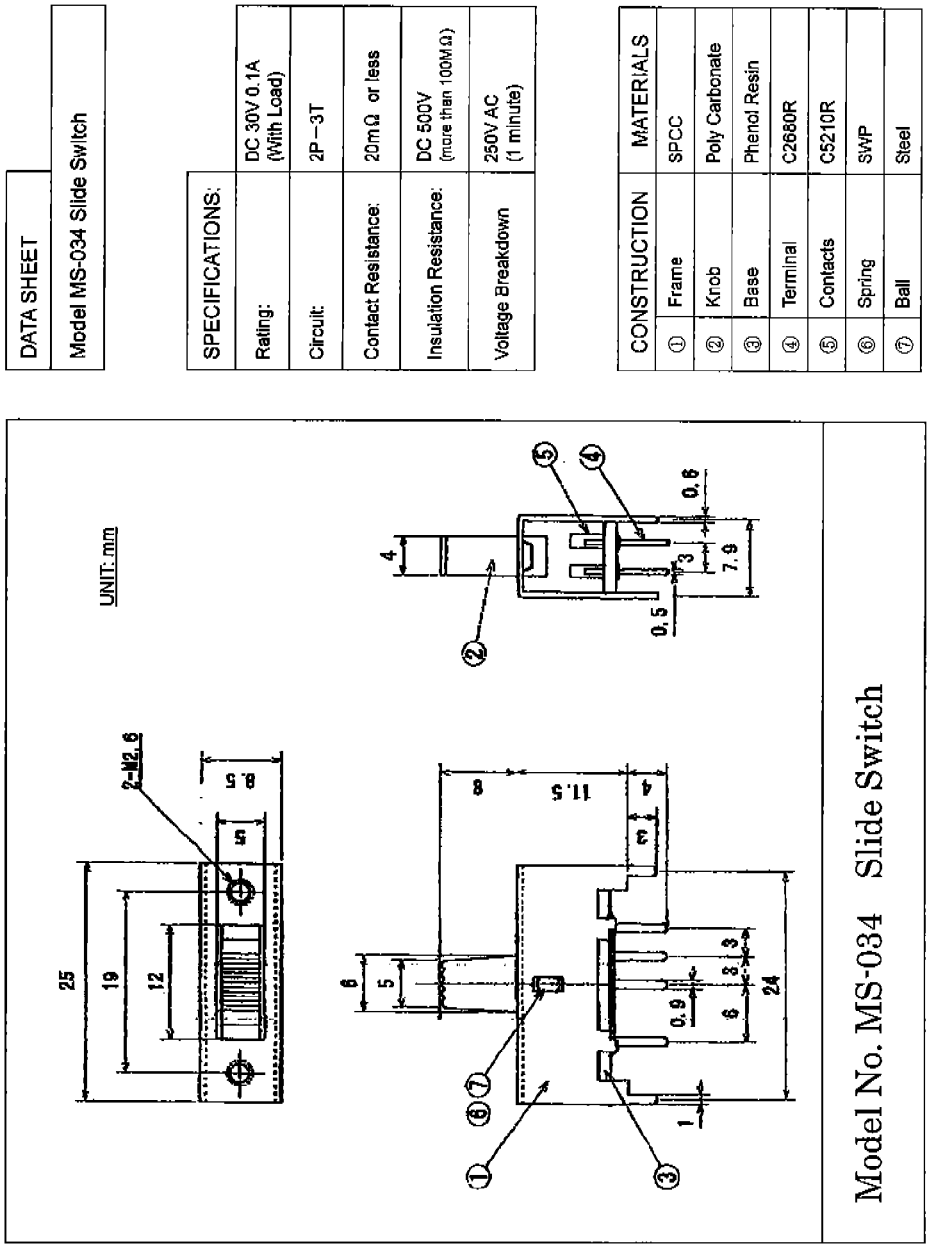


Picture 13: Buffers Board Layout 1:1 (Names)



Picture 14: Buffers Board Layout 1:1 (Values)

11. MS-034 DP3T Slide Switch



Picture 15: MS-034 Slide Switch Specs