Instructions for modifying a Sony Discman ESP2, model D-E445

The circuitry of the various models of portable Sony CD players differs slightly, the information in this manual can also be applied to other models. It is important that the CD player should be equipped with an ESP (Electronic Skip Protection) function in order to achieve the desired effects. ESP enables a CD player to play music without interruption despite mechanical shocks. Playback devices with ESP have an electronic memory; when the buffer circuit is in operation, the compact disc is read at a fixed reading speed (CAV) and the content is buffered and fed into the player‘s RAM memory. The audio content is read from the RAM, optionally decompressed and then sent to the digital-to-analog converter. If the reading of the disc is interrupted, the player briefly reads the data stored in RAM while the tracking circuit finds the passage on the CD before the interruption.1

The circuit is to be manipulated before the digital-to-analog converter. The aim is to send random data stored in the buffer to the input of the DA converter at the touch of a button, which then converts it into acoustic signals and makes them audible.

Fig.1, Sony Discman ESP2, Model D-E445

1 Circuit Bending

Before opening the device, I thought it would be useful to download the circuit diagram.[1] I don‘t think it‘s important to understand and explain every single process in the circuit, but it does make sense to be able to more easily trace the connections between the components. Above all, portable CD players are very tightly built and the circuit diagram makes it easier to find alternative soldering points that are not the sensitive ICs.

1.2 Opening the case.

After removing the screws on the bottom of the case, it is possible to remove the top half of the housing. To operate the player, it is necessary to bypass the lid switch (“Door-switch” see Fig. 2)
After inserting a CD and connecting the audio output to my mixing desk, I was able to start the most exciting part of circuit bending: making contacts between different points on the circuit board and listening to the resulting sounds. From previous projects, I know that connections in the area of the components IC601 (RAM controller), IC602 (DRAM) and IC301 (D/A converter) can lead to exciting results.
Absolutely to be avoided is the connection to the supply voltage (VCC), this can destroy the circuit immediately and makes the device unusable. Connections to GND, on the other hand, often cause the playback to stop, but pressing the play button restarts the CD and you can continue working.

1.3 Determining contacts

I have gotten into the habit of carefully documenting the points of the circuit that I connect, describing the effect caused with a word and/or giving an evaluation. This clearly serves to provide an overview and to select the preferred effects to continue working with.

1 601/24/XLT	->	601/16/DATA	crackling leise	poti!!
2 601/24/XLT	->	GND	Loops, div. Pitch	
3 601/24/XLT	->	601/11/DataIn	short pitches	(short impulse!)
4 601/24/XLT	->	601/12/LRCK1	jumps+glitches	(short impulse!)
5 601/24/XLT	->	601/15/LRCK	Bitcrush	
6 601/11/DataIn	->	601/16/DATA	quietsch Noise	
7 601/16/ DATA	->	601/12/LRCK1	aliens talking	
8 601/11/DataIn	->	601/12/LRCK1	clicks and panorama	

1 https://elektrotanya.com/sony_d-e440,e441,e443,e445,e446,e449.pdf/download.html#dl

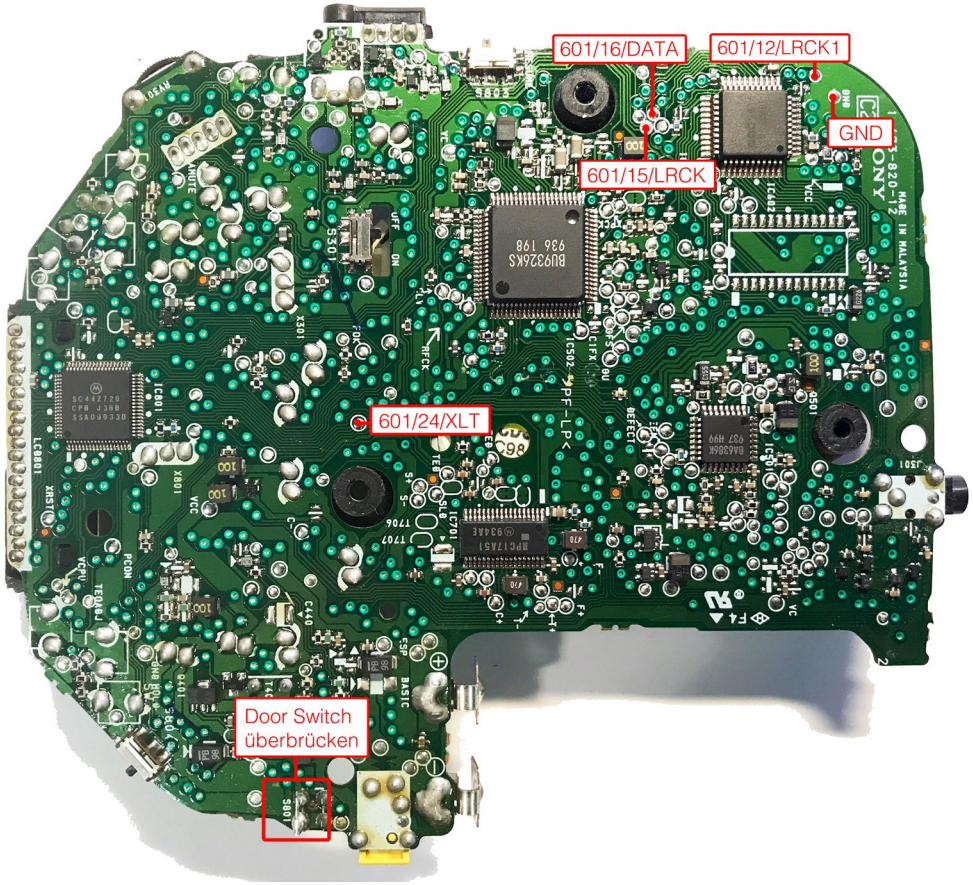

Fig. 2, Mainboard A

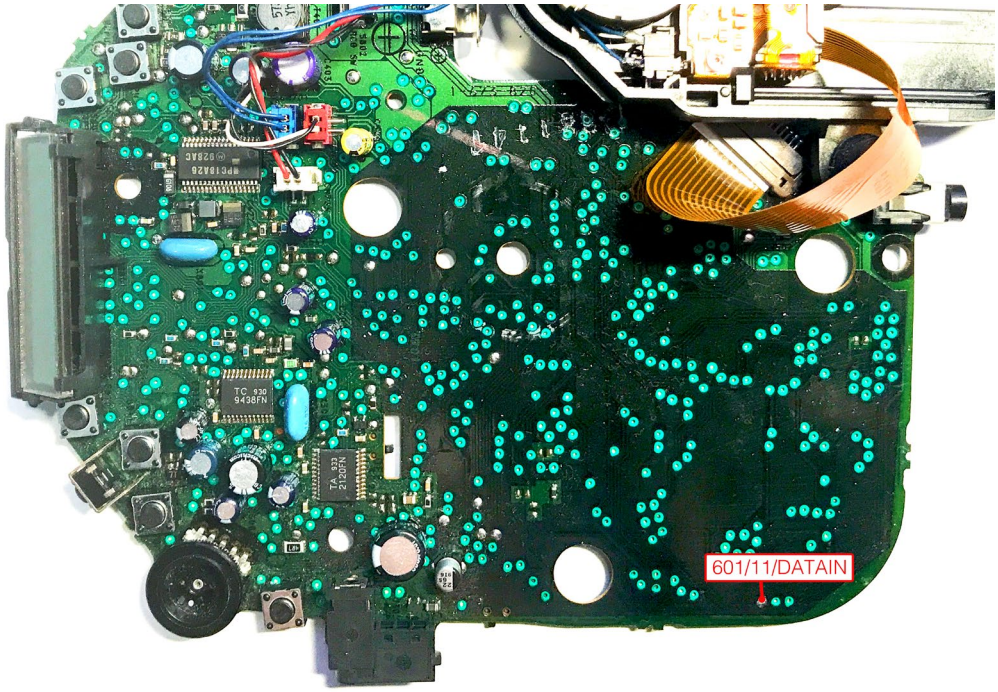

Fig. 3, Mainboard B

1.4 Soldering wires and test setup

Solder the wires to the points on the board and build a prototype of the planned circuit on the breadboard. I use conventional push buttons (6x6mm) to trigger a short circuit manually. When setting up the test, you can optionally try using a potentiometer for each contact.[2]

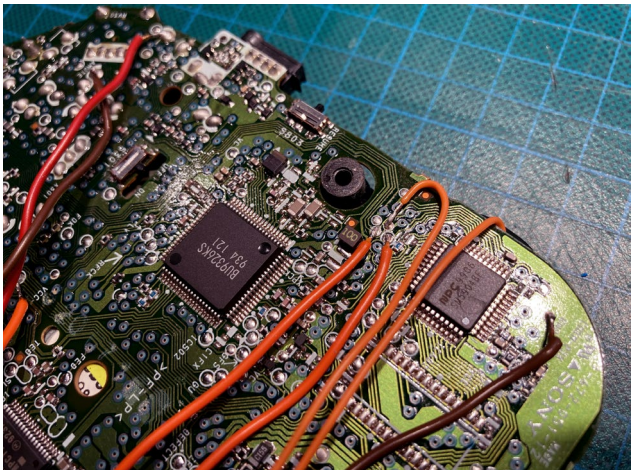

Fig. 4, soldered wires

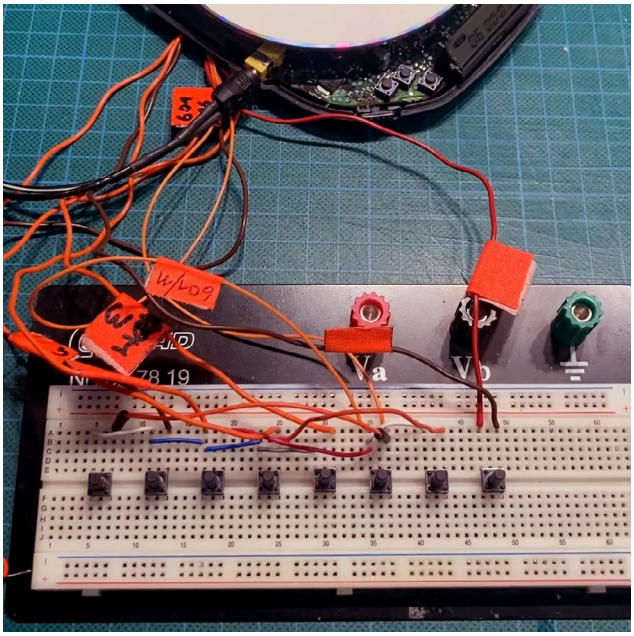

Fig. 5, prototyping on breadboard

2 https://vimeo.com/1048457632

1.5 The additional circuit

To activate the short circuits electrically (e.g. by signals from the modular synthesizer), the circuit must be extended. Optocouplers (CNY17-4) and operational amplifiers (LM324) are used for this purpose. The following sections provide only a superficial explanation of how these components work, without going into the specific properties of the makes used.

Fig. 6, CNY17-4 package

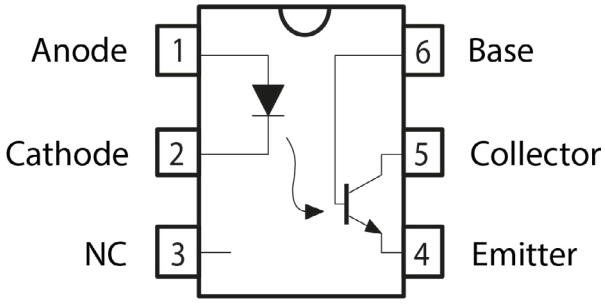

Fig.7, CNY17-4 pin assignment

An optocoupler consists of a light-emitting diode and a photosensor. The input signal is converted by an LED into a light pulse. The light pulse is directed onto a photosensor, whose internal resistance decreases depending on the level of the applied voltage: a connection is created between the two poles.

I also use an operational amplifier, which is used as a DC amplifier with a gain factor of 1.
It provides the current at the output for the further circuit (in this case the LED in the optocoupler) from the operating voltage without loading the source at the input.

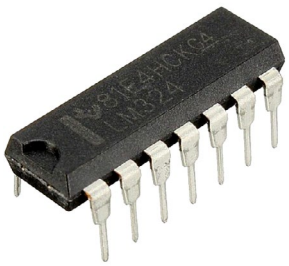

Fig. 8, LM324 housing

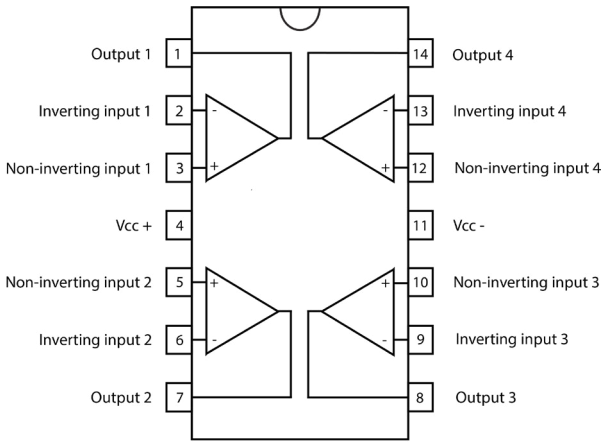

Fig. 9, LM324 pin assignment

I used a 9V battery to supply the additional circuit with power. From earlier attempts, it has been shown that a Discman is very sensitive to the power supply. The Discman should only be operated with the recommended batteries or from the 4.5V DC transformer.

1.6 Creating schematics and PCBs

There are several ways to implement the circuit. As in almost all of my projects, I decided to use the paper PCB variant.[3]

The circuit is designed for use with a conventional stripboard with a grid spacing of 2.54 mm (= 1/10 inch). The layout of the components and connections can be designed using 2D graphics software (e.g. Adobe Illustrator). Print out the graphic and stick it on the back of the stripboard.

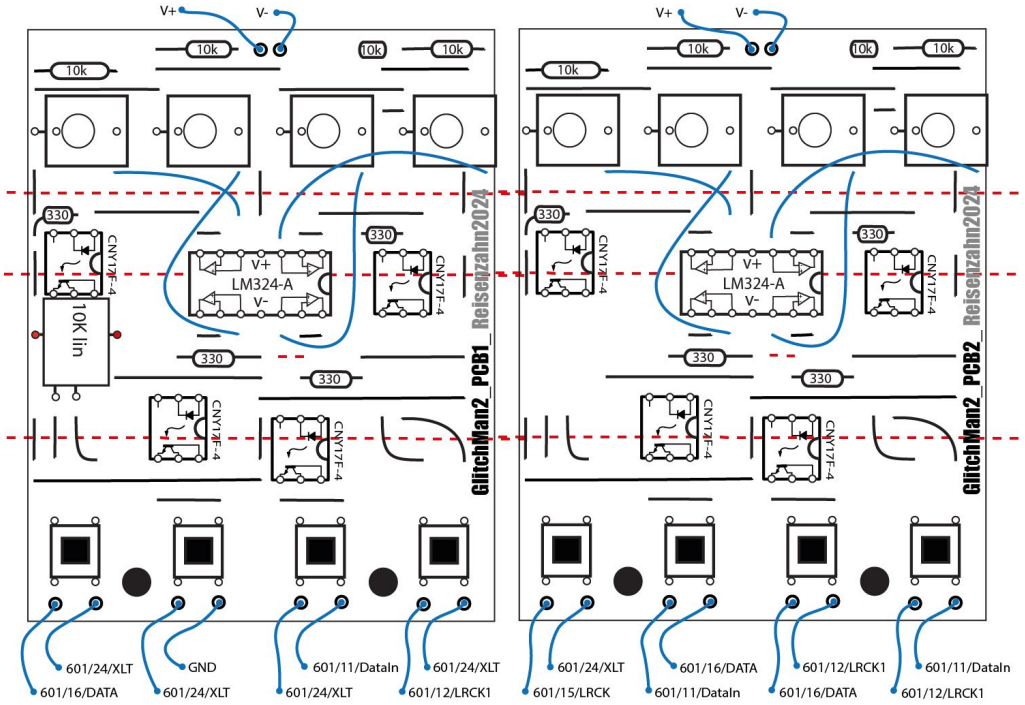

Fig. 10, Paper PCB for Glitchman

3 http://paperpcb.dernulleffekt.de/doku.php

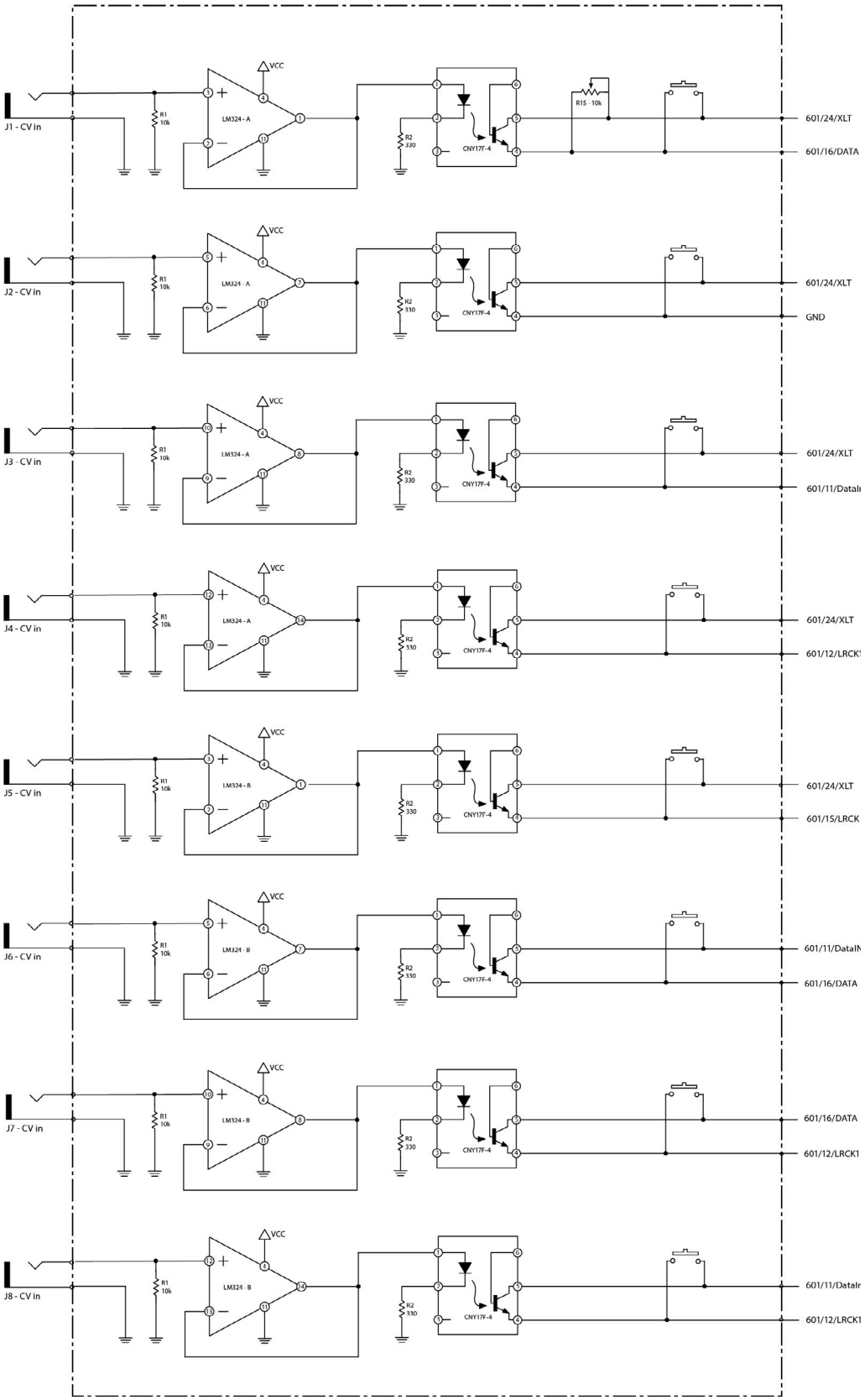

Fig. 11, final schematic, Glitchman

1.7 Housing

The compact design of portable CD players makes it impossible to integrate all the necessary technology into the existing housing. As an extension, the lower part of the housing can be attached to a box in which the additional electronics can be installed. A drilling template can also be created based on the PaperPCB graphic.

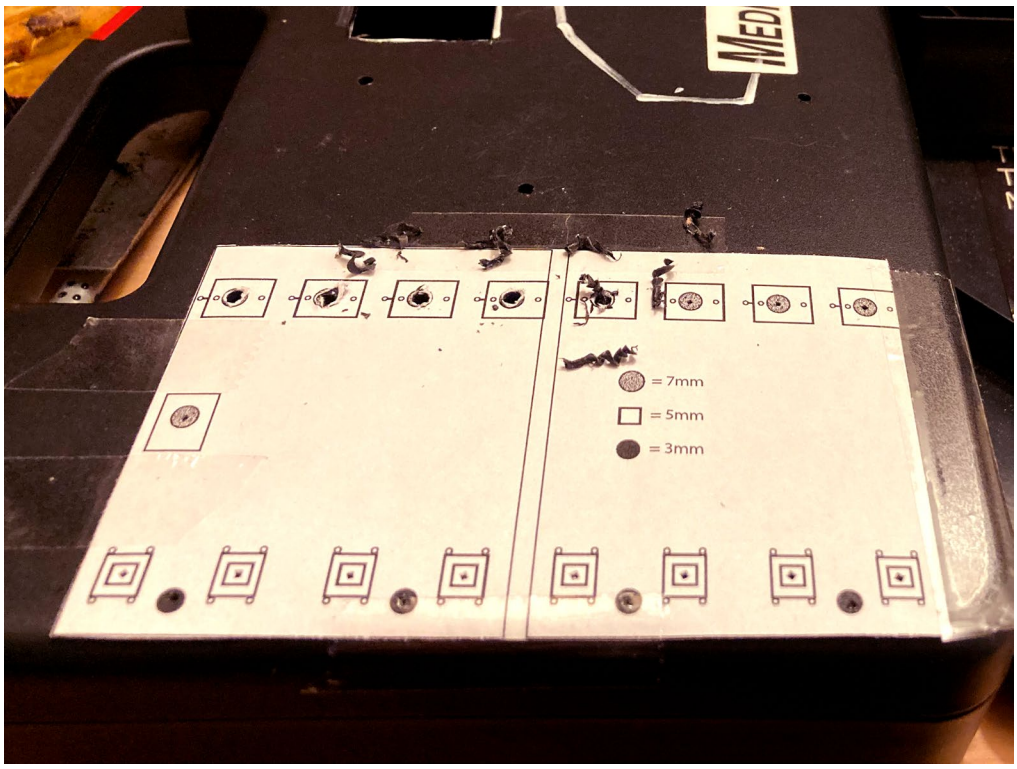

Fig. 12, Housing with drilling template

1.8 Final steps to completion

Finally, the electronic components are soldered onto the board and connected to the cables from the discman and installed in the housing.
To be able to use the battery for the extended circuit longer, I spontaneously decided to install a toggle switch. The LED next to the switch indicates whether the circuit is in operation or whether there is still voltage.

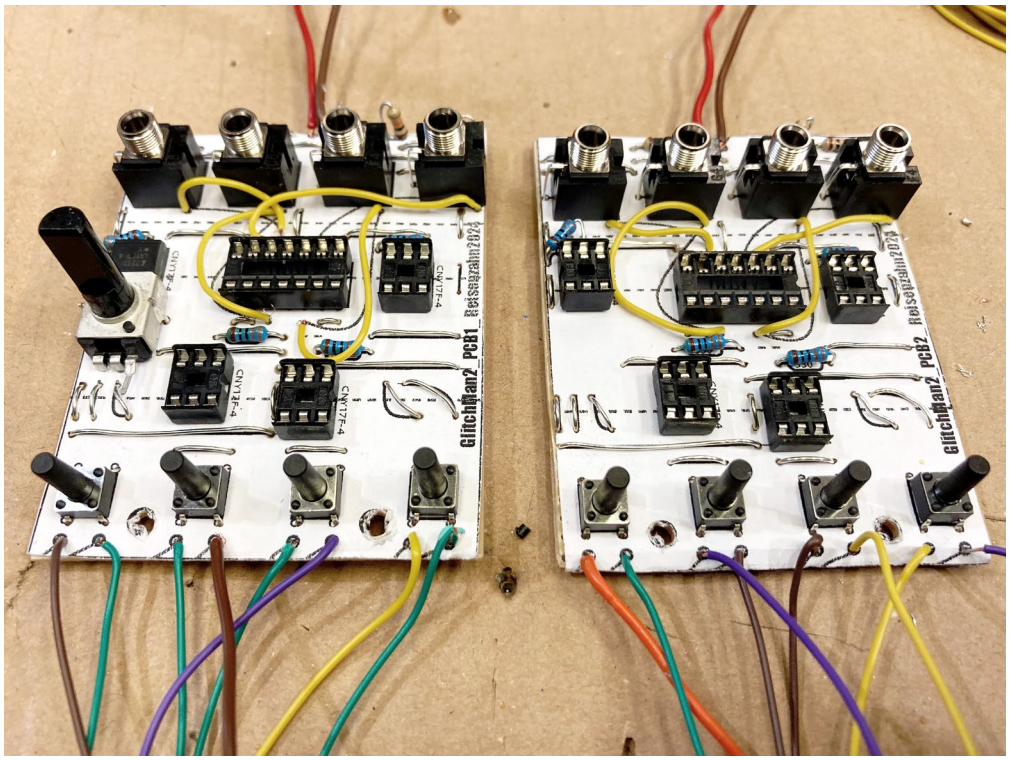

Fig. 13, soldering Paper PCB

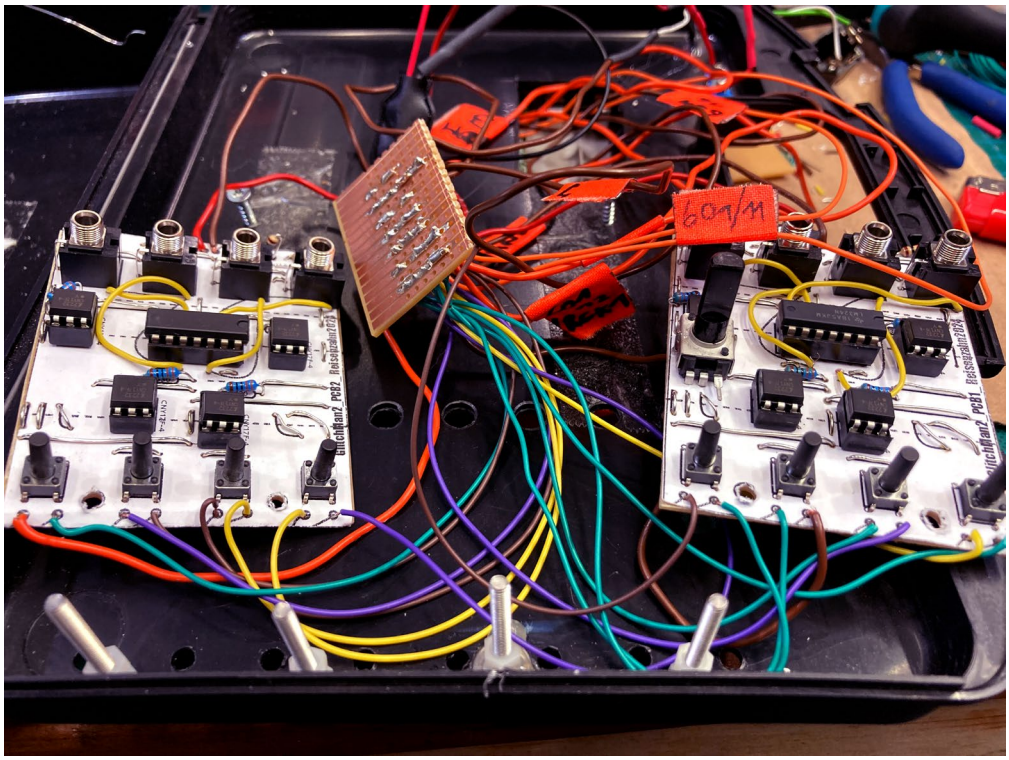

Fig. 14, last steps

Fig.15, finished device incl. Housing and marks

1.9 Experience report

Fortunately, we managed to preserve the original functionality of the device. Still a CD player. Even after activating the additional circuit, nothing changes at first. Pressing the buttons makes sounds. Some buttons always produce the same sound, others change the sounds played by the CD, comparable to an effects unit.

If several buttons are pressed at the same time or a button is held down for a longer period of time, this can lead to a failure after a few seconds: no sound is output and the time display stops, although the CD is still turning. I can only explain this by the fact that the digital-to-analog converter is “overloaded” and can no longer process the data. Pressing the STOP button and then the PLAY button resets the device to its usual functionality.
The D-E445 model starts playback with the title that was last played.
If you change the CD and continue to generate interference with the buttons or via CV inputs, it is possible that sounds from the previous CD that are still in the buffer will be called up, and this can continue for several minutes. This is probably due to the maximum storage capacity of the ESP buffer.

Have fun experimenting!

Reinhard Reisenzahn
www.reinhardreisenzahn.com
info@reinhardreisenzahn.com