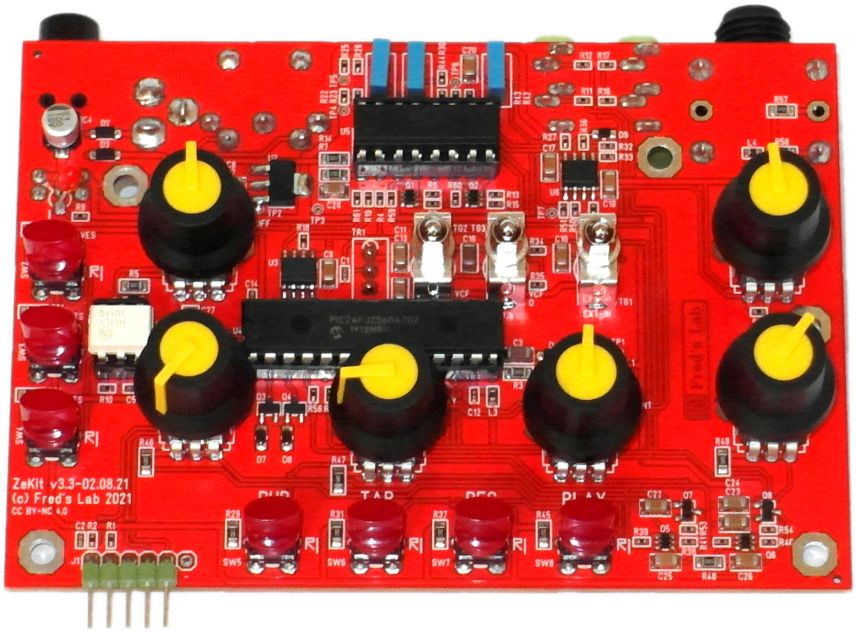
ZEKIT
Assembling Instructions

Revision 1.3 EN - 23/02/2022



Fred's Lab

February 23, 2022

Contents

1 Special Thanks

I would like to thank the following persons for their contributions:

- Design consulting: René Schmitz, Oliver Rockstedt
- Panel graphics: Serge "erewhon" Beauchamp
- Instruction guide: Oliver Rockstedt
- Beta-testing: Benoit Ruelle, Will Zégal, Mathieu Meslin

2 Introduction

Welcome to ZeKit assembly guide!

The **ZeKit** is a fully functional 4-voice paraphonic synth kit with **digital oscillators** and **an analog filter and amplifier.** It also features **two analog envelopes** as well as **a simple pattern sequencer**. The instrument can be controlled via **MIDI,** handles **external clocks** and has **an audio input.**

Hopefully, *you'll learn a lot* while building this kit and you'll end up with **an inexpensive and fun instrument** that will quickly integrate your studio setup.

2.1 Required skills

- **Basic knowledge of analog synthesis**
- Some soldering experience with through-hole components
- Some knowledge on how to read a placement diagram

2.2 Required tools

In order to fully assemble the kit, you'll need the following tools:

- A soldering iron with a 3mm flat tip
- 1mm solder wire
- A wire cutter
- A flat head screwdriver

2.3 Required accessories

- A power supply, DC 5 to 9V, 0.5A with a 2.1mm x 5.5mm center positive barrel connector (*)
- A 6.35mm jack audio cable
- Optional / computer, sequencer or MIDI controller
- Optional / MIDI cable

(*) A compatible power adapter can be purchased from **Fred's Lab**, but we recommend you **to reuse** any adapter you already own.

3 Box Content

In addition to **the pre-assembled PCB,** the **ZeKit** package contains the following:

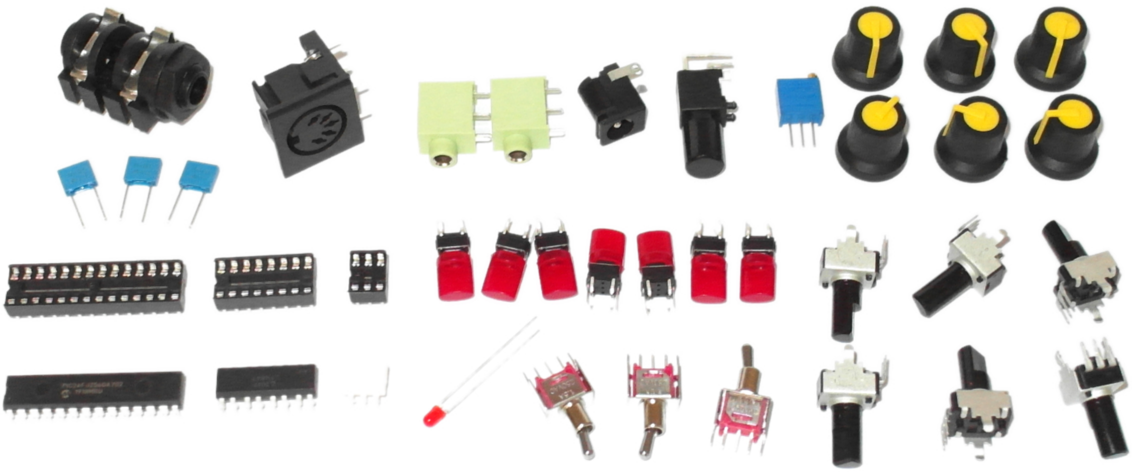


Figure 1: Components included in the kit

Amount	Description	Value
1	Pre-assembled PCB	
1	TRS jack socket	6.35mm TRS
1	DIN5 socket	
2	TRS jacks socket	3.5mm TRS
1	Power jack socket	
1	Power switch	
1	Trim potentiometer	10k Ohm
6	Potentiometer knobs	
3	Film capacitors	47nF / 63v
1	DIL28 IC socket	
1	DIL16 IC socket	
1	DIL6 IC socket	
7	Tactile switches	
2	Potentiometers	10k Ohm
4	Potentiometers	100k Ohm
1	Microcontroller IC	PIC24FJ256GA702
1	Optocoupler IC	LTV-847
1	Optocoupler IC	H11L1
1	LED	3mm red color
3	Toggle switches	

Before firing up your soldering iron, **make sure your kit is complete** and take the time **to get to know** the different components.

Also, no need to print out every page of this manual. Only **pages 15 to 22** describe the assembly process.

3.1 Pre-assembled PCB

The **ZeKit** makes use of **SMD** (Surface Mounted Devices) and **THT** (Through Hole Technology) components. SMD components allow the design to **remain compact and simple to manufacture** and also more cost effective.

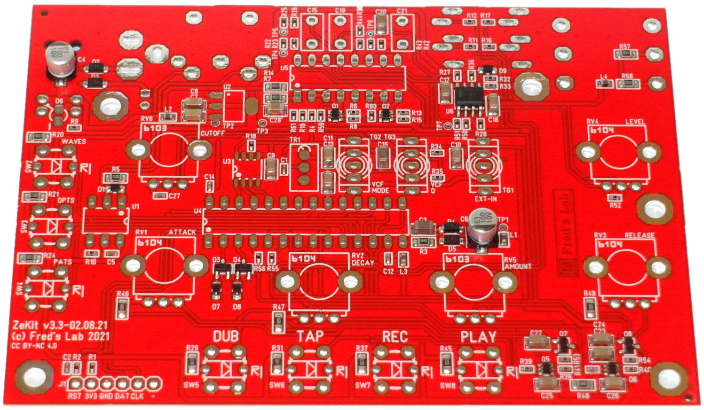


Figure 2: Pre-assembled ZeKit PCB

All **SMD components** come already assembled on the **PCB** (Printed Circuit Board). The **THT components** are left to be hand soldered, **and this is your mission!**

3.2 Learn the Components

3.2.1 Power LED

Figure 3: 3mm red LED

The **LED** (Light Emitting Diode) is an indicator that lights up when a current is running through it. Here, it shows that the instrument is powered on.

3.2.2 Tactile Switches

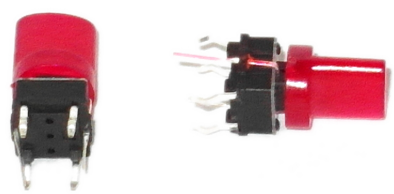


Figure 4: Tactile switches

The **tactile switches** are **momentary switches** used as interface buttons.

Their contact is normally open and gets closed when the switch is pressed. These switches have **a LED built-in** that illuminates the cap to show some status information.

They are connected to the microcontroller directly and are used to select the oscillator waveform, choose the sequencer pattern and toggle various options.

3.2.3 Toggle Switches

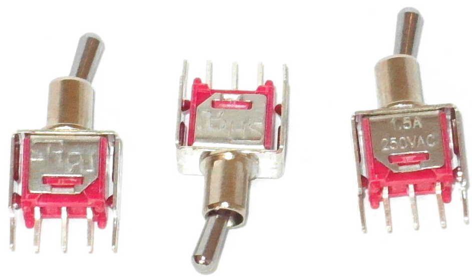


Figure 5: SPDT toggle switches

In contrast to the tactile switches, the **toggle switches** have **two stable positions.** They are also called **SPDT** (single pole, dual throw) switches. Depending on the lever position, one contact is closed while the other is open and vice versa.

In the **ZeKit**, these switches select the filter mode (low-pass or band-pass), the filter resonance amount (low or high) and the routing of the external audio input.

3.2.4 Potentiometers

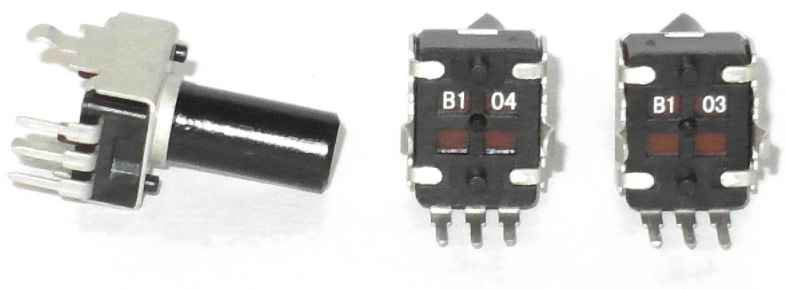


Figure 6: Linear mono potentiometers

The **potentiometers** (or "pots") are **variable resistors** meant to control sound parameters in the analog domain. They consist of **a conductive wiper** that slides over a circular **resistive track** to form a voltage-divider.

The **ZeKit** uses potentiometers of two different values: **10k & 100k Ohm.**

The pots must not be interchanged or the circuit won't work correctly.
They can be easily identified by the label found at their bottom:

- **B103** = 10k Ohm
- **B104** = 100k Ohm

3.2.5 Trimmer

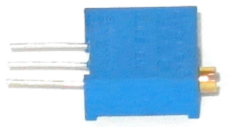


Figure 7: Multiturn trimmer

Trimmers are specific potentiometers **intended for calibration** to compensate for the effects of tolerances in other components manufacturing.

These are smaller than regular potentiometers and need to be adjusted with a flathead screwdriver. They offer a **great setting precision** since their screw can be turned multiple times. They are also called **multiturn trimmers**.

The **ZeKit** uses a single trimmer to define the filter **cutoff frequency** range.

3.2.6 Power Switch

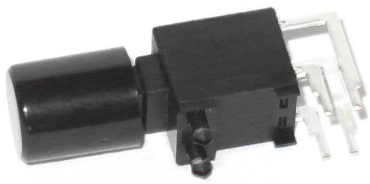


Figure 8: Power switch

The **power switch** is a **latching push button** with a toggle behavior.
Pressed once, the contact closes and remains in this state until it is pressed again.

This switch turns the **ZeKit** power on or off.

3.2.7 Power Jack Socket

Figure 9: Power jack socket

The **power jack** is a standard 2.1mm barrel or coaxial connector that has a widespread use with low voltage power supplies.

The **ZeKit** can be powered from any DC (direct current) adapter with a voltage ranging from 5V to 9V. The center connection must be positive.

3.2.8 DIN5 Socket

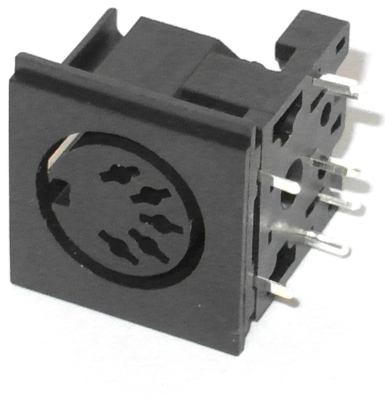


Figure 10: DIN5 socket

The **DIN5 socket** is a 5-pin connector used for **MIDI input**. **MIDI** stands for **Music Instrument Digital Interface** and allows the **ZeKit** to play notes and be synchronized rhythmically with other compatible gear, like controllers or sequencers.

3.2.9 6.35mm TS Jack Socket

Figure 11: 6.35mm Jack Socket

The **TS jack** stands for "tip and sleeve". This connector is common in **audio systems** to transmit the sound. The sleeve connection is always grounded whereas the tip carries the mono or "left" audio signal. An optional "ring" connection will carry the "right" signal.

This connector is used as the **ZeKit** line and, optionally, headphones output.

3.2.10 3.5mm TRS Jack Sockets

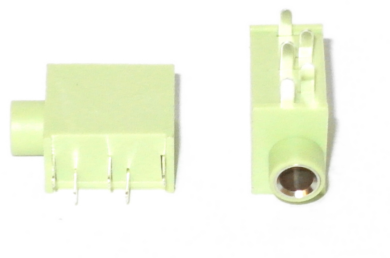


Figure 12: 3.5mm Jack Sockets

These sockets are smaller and stereo versions of the 6.35mm ones. In the **ZeKit**, they are used for the **external audio** and the **clock or "sync"** inputs.

The **clock signal** is expected on the jack tip and the sequencer running state (start or stop) on the ring connection. The sleeve connection is grounded.

3.2.11 Film Capacitors

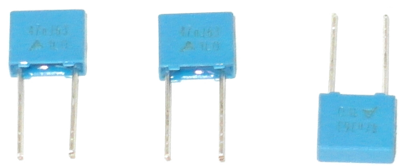


Figure 13: 47nF Film Capacitors

The **film capacitors** are capacitors or "caps", they can **store and release energy.** These types are superior to standard ceramic ones, in terms of **distortion and noise immunity.** They also have tighter capacity tolerances.

In the **ZeKit**, they are used in the voltage controlled filter and amplifier circuits to process the audio signal.

3.2.12 PIC Microcontroller IC

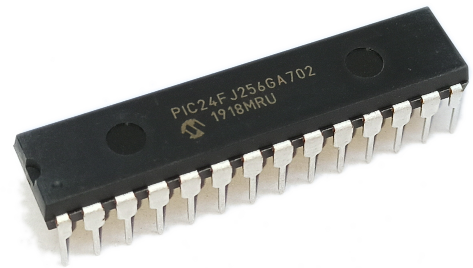


Figure 14: PIC24F 16bit MCU

The **microcontroller** or "MCU" (Micro-Controller Unit) is an IC (integrated circuit) that contains a **complete computer.** It features flash memory to store the firmware, RAM to hold data and a processing core with a number of integrated peripherals to communicate with external components.

The **ZeKit** MCU has a **16-bit architecture** running at 16Mhz. Its job is to process incoming MIDI messages, handle clock signals, generate the waveforms, run the sequencer, control the envelopes and manage the user interface (buttons and LEDs).

The firmware handling these tasks comes pre-programmed by **Fred's Lab,** but it can be modified and replaced by the user, using special tools.

3.2.13 Optocoupler ICs

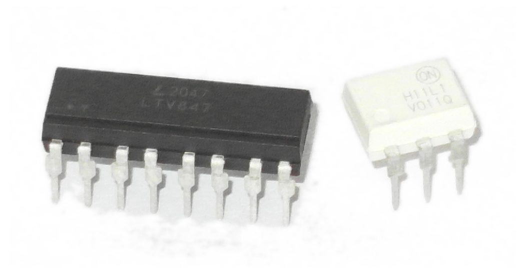


Figure 15: Single and quad optocouplers

An **optocoupler** is a combination of a **photo transistor** and an **LED** inside a light sealed package. It is used to keep circuits **electrically isolated** while transferring signals.

The conductance of the photo transistor is related to the brightness of the LED.

The **ZeKit** uses optocouplers for the **MIDI input** and as **current controlled resistors** in the VCF (voltage controlled filter) and VCA (voltage controlled amplifier) sections.

3.2.14 DIP Sockets

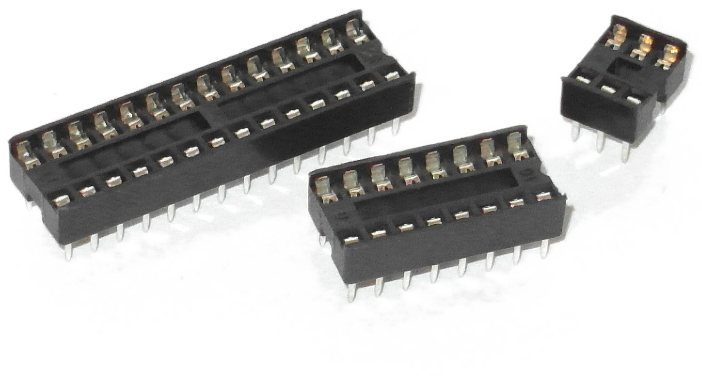


Figure 16: DIP Sockets

Instead of directly soldering the ICs onto the PCB, **DIP Sockets** (Dual In-line Package) are preferably installed first.

They will **protect the ICs** from soldering heat and keep them exchangeable.

Lastly, that way ICs won't be soldered in the wrong direction ... but don't worry, this happens to all of us!

3.2.15 Knobs

Figure 17: Potentiometer Knobs

The knobs are fitted onto the pots, after the kit is **fully assembled**, and only then!.

They contribute to the **final look-and-feel** and allow precise control of the potentiometers and the associated sound settings.

4 Assembling the Kit

4.1 General Advice

To maximize your chance of success assembling the **ZeKit,** work preferably on a **tidy & properly lit** surface. Don't hesitate to **use magnification** to control your solder joints, reheat with *no-clean flux*, when necessary. Keep unused parts in their original packaging, so you won't loose them.

Soldering is easier with **a clean & non oxidized** iron tip. Always **switch off your iron** when not soldering to extend your tip lifespan!

4.2 Setting up the soldering gig

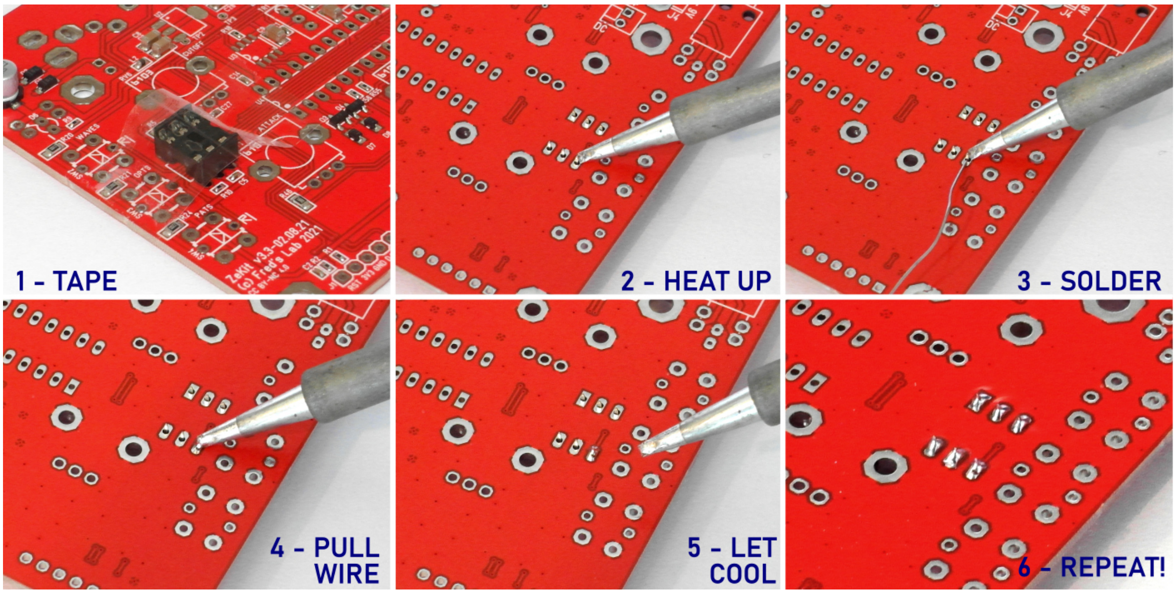
- Only work in a well-ventilated room
- Use SnCuNiGe (SN100C), SN96.5Ag3Cu0.5 (SAC305) or Sn60Pb40 solder wire
- Regularly clean the tip with a wet sponge
- Have some duct tape or blu tack at hand

4.3 How to solder like a Pro

Great solder joints can be achieved *even with basic equipment* and little practice,
by following these steps:

1. Position (and secure) the component properly
2. Apply heat to the PCB pad first with the iron tip
3. Bring in the solder wire until there is enough material
4. Pull back the solder wire still heating the joint
5. Pull back the tip from the joint
6. Let the solder joint cool down naturally - don't blow on it

Illustrated soldering process:



Additional Tips:

- Tape or tack the components before soldering
- Double-check the components orientation
- Verify sockets notch match with footprint
- Ensure the board is clean before soldering
- Optional - use isopropyl alcohol (propan-2-ol) to clean the board
- Optional - apply *no-clean flux* on pads and legs

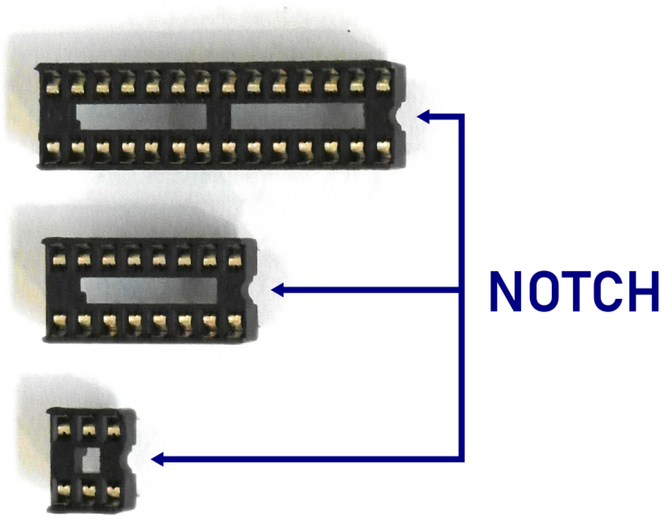


Figure 18: IC sockets notch

4.4 Soldering the Components

Let's heat-up that iron!

The electronic parts are best soldered in **a specific order** that is determined by their placement and their size.

You can **tape or tack the parts** to prevent them from falling off when turning over the PCB for soldering. All potentiometers, switches and connectors **must be soldered as straight as possible.**

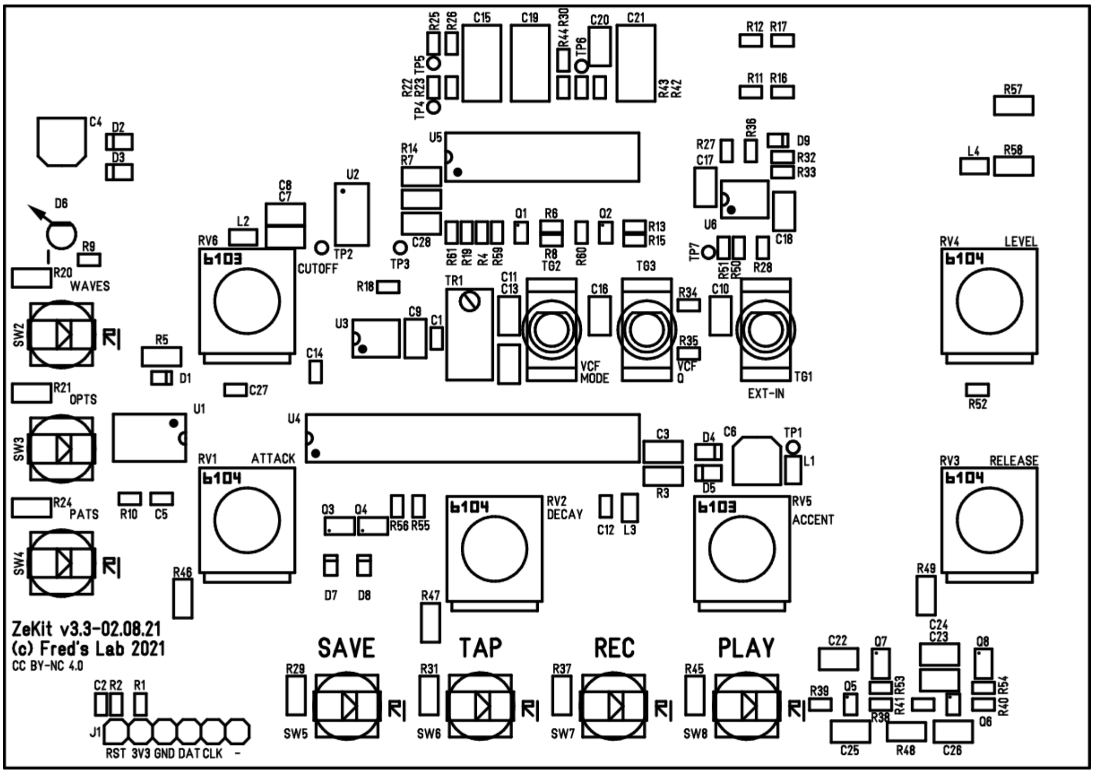


Figure 19: Top placement diagram

IMPORTANT

> Some parts have a polarity and **must be soldered in the right orientation.** These components may fit in more than one way but using a wrong orientation will result in erroneous operation or can destroy them.

> All connectors and the power switch are located **on the bottom side** of the PCB and must be soldered **from the top.**

> **De-soldering a part** which has been incorrectly mounted **is tedious** and requires good soldering experience and specific tools. To avoid this, better check the part placement twice **before soldering.**

4.4.1 Step 1: IC Sockets

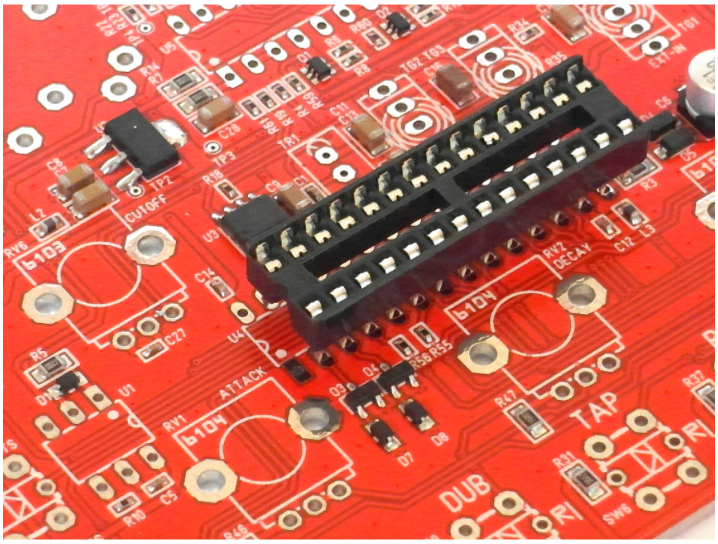


Figure 20: Inserting sockets

The **IC sockets** have a **notch** on one side. This marking must match the **footprint** drawn on the PCB **silk screen print**. The notch is represented by a semi-circle. The white point located next to it indicates the component pin number 1.

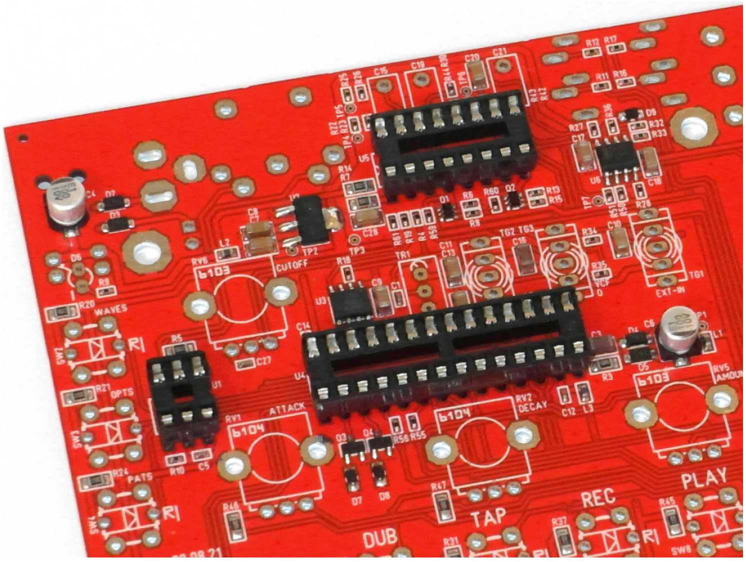


Figure 21: All sockets placed

Take the necessary time to solder each socket pin and ensure there are **no solder bridges nor cold solder joints**. Once done, the board should ressemble the following picture.

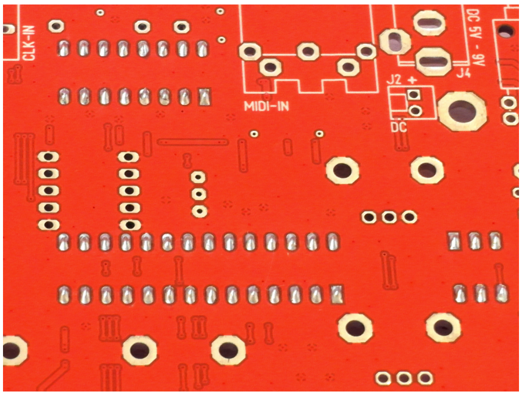


Figure 22: All sockets soldered

4.4.2 Step 2: Film Capacitors

The **film capacitors** are more **heat sensitive** than other parts. Do not heat the pins for a period longer than 5s. These parts **are not polarized** and can be soldered in any orientation.

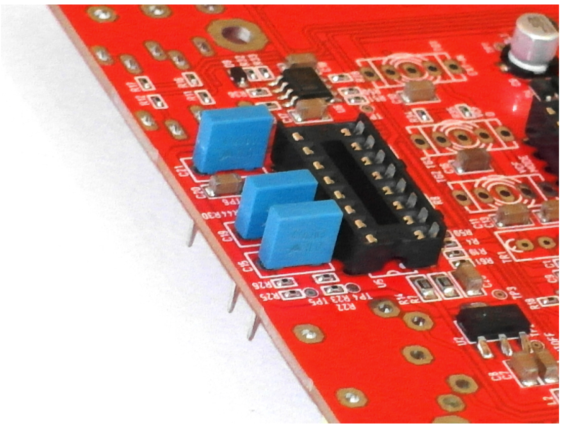


Figure 23: Film capacitors

After soldering, **trim off** the capacitors legs with a wire cutter, as shown on the picture.

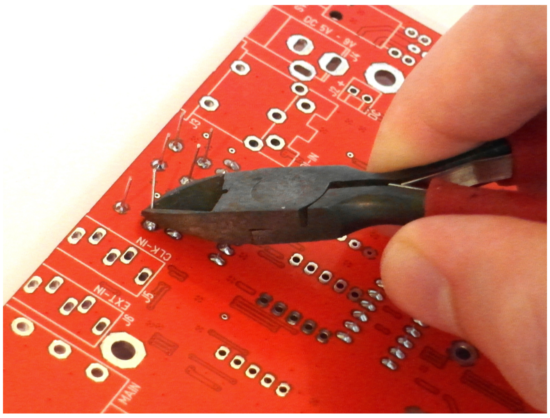


Figure 24: Trimming legs

4.4.3 Step 3: Trimmer

The **trimmer** is the blue part labeled **W103**. This component is not polarized and can be soldered in any orientation.

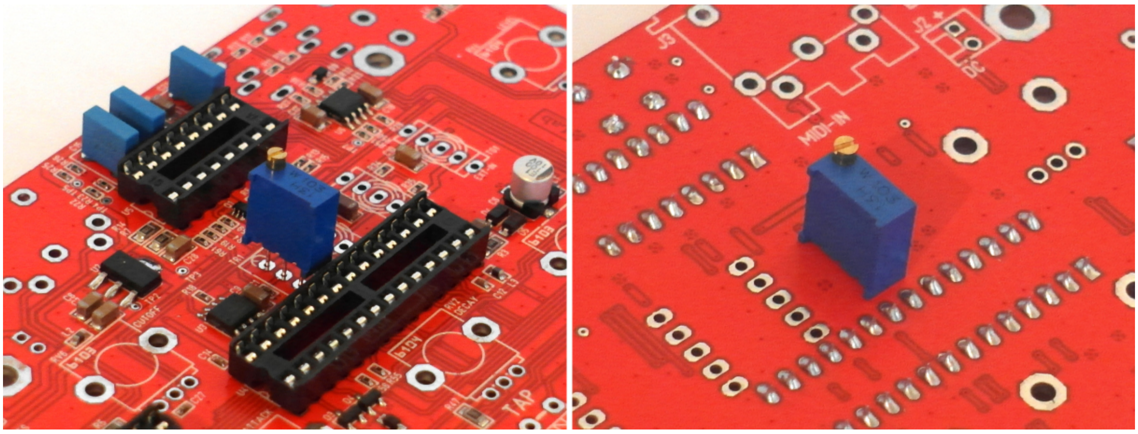


Figure 25: Top or bottom configuration

The trimmer can be installed at the **top or at the bottom** of the PCB. If you plan to give the **ZeKit** an enclosure, install the trimmer at the bottom and solder it later, at the connectors soldering step (see step 8).

4.4.4 Step 4: Tactile Switches

While the **tactile switches** themself will work in all orientations, the built-in LEDs **have a polarity** which must be respected.

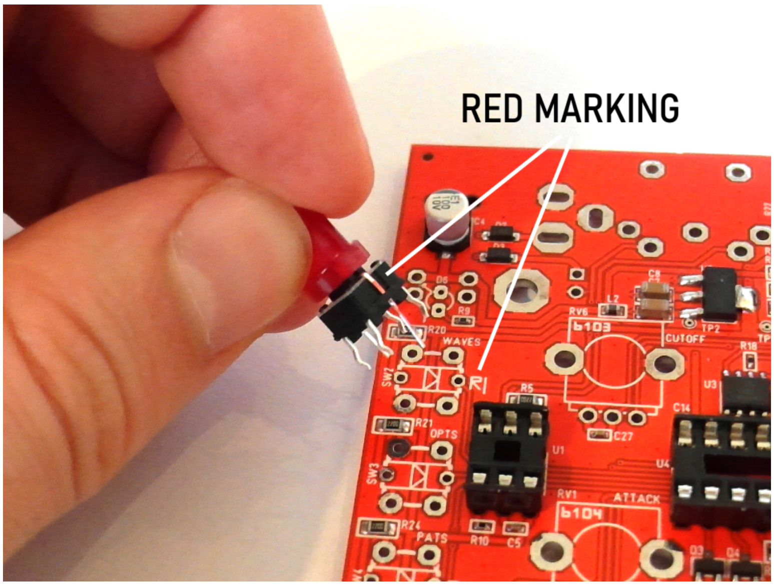


Figure 26: Mind the red leg!

LED pins have different lengths. The longer pin also has a **red marking** and must be located on the **right side** of the switch. Keep your attention **on soldering them straight.**

4.4.5 Step 5: Toggle Switches

The **toggle switches** are not polarized and can be soldered in any orientation.

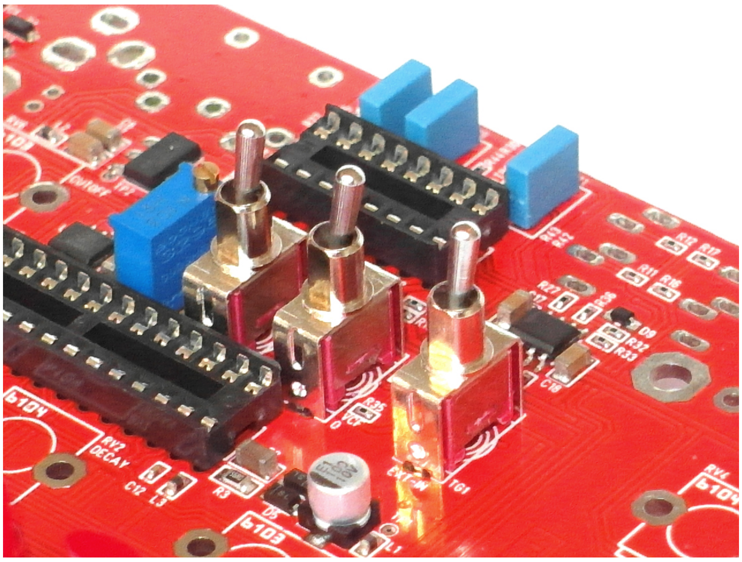


Figure 27: Mounted toggle switches

4.4.6 Step 6: Potentiometers

There are **two potentiometer values** provided: *10k and 100k Ohm.*
The **10k pots** are labeled **B103** at the bottom whereas the **100k** are labeled **B104**.

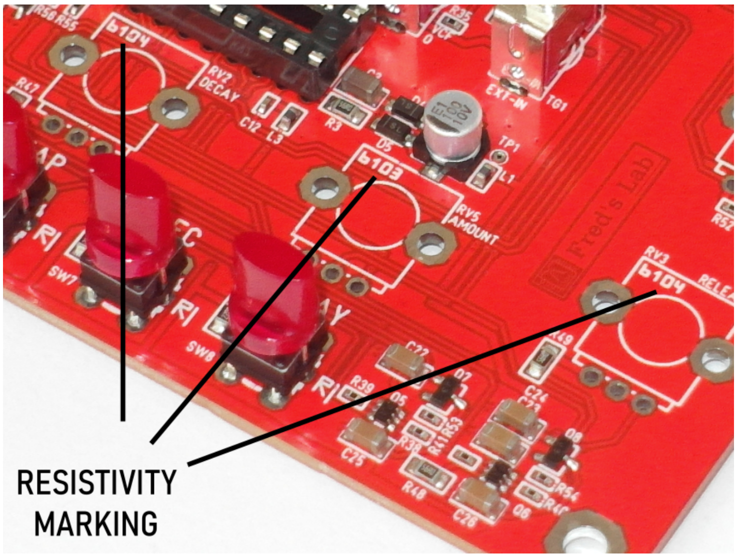


Figure 28: Pots resistivity marking

To install the right pot at the right spot, **follow the markings** drawn on the PCB.
Also, keep your attention **on soldering the pots straight.**

4.4.7 Step 7: Power LED

The **power LED** is a polarized component and must be installed **so its longer leg is the closest** to the *SW2 tactile switch* (see picture). The LED should be **mounted straight** on top at approximately **1cm** distance from the PCB surface.

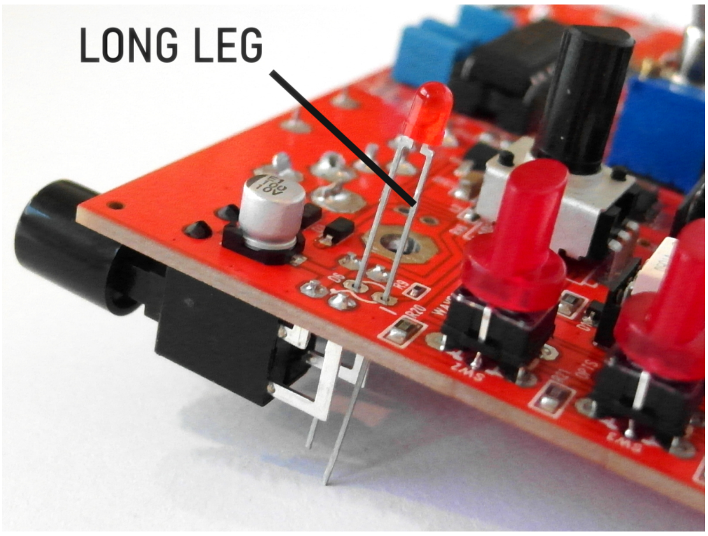


Figure 29: Power LED orientation

Solder the long leg first and then adjust the LED height and alignment by reheating the solder joint. Once you're satisfied with the LED position, solder the second leg and then trim them off with the cutter.

4.4.8 Step 8: Connectors & Power Switch

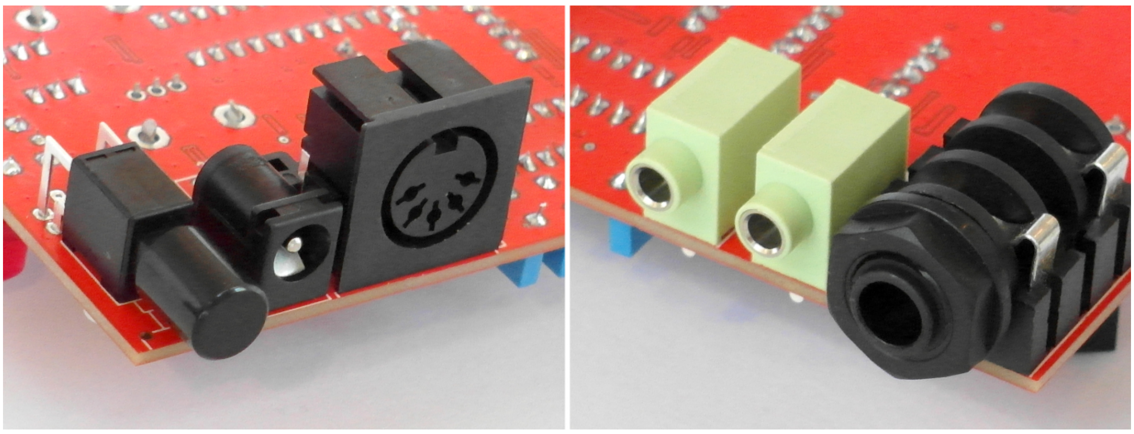


Figure 30: Bottom side connectors

The **connectors & power switch** are soldered last because they are located at the **bottom side** of the PCB.

If the **trimmer** wasn't installed at *step 3,* you should solder it now.

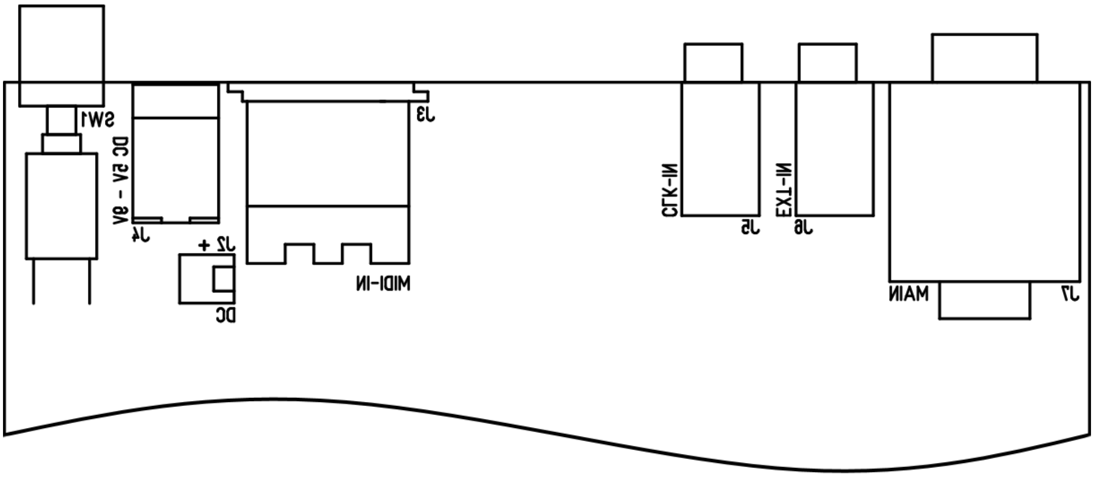


Figure 31: Bottom placement diagram

4.4.9 Step 9: Inserting the ICs

Now that the **ZeKit** is completely soldered, all ICs need to be inserted in their sockets, respecting the given orientation.

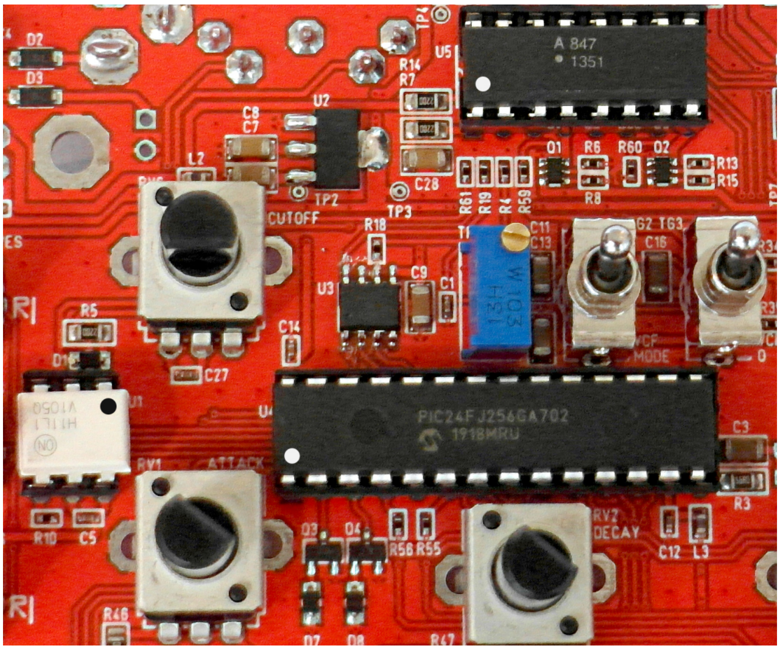


Figure 32: Correct ICs orientation

There are 3 different ICs:

- **H11L1** (*) - ”MIDI” optocoupler
- **LTV847** - VCF / VCA optocoupler
- **PIC24FJ256GA702** - 16bit microcontroller

(*) H11L1 can be shipped in black or white DIP (dual in-line package).

Before positioning the ICs, it is recommended to **carefully bend** their legs, so they are orientated more **parallel.** It will be easier to insert them in the sockets that way.

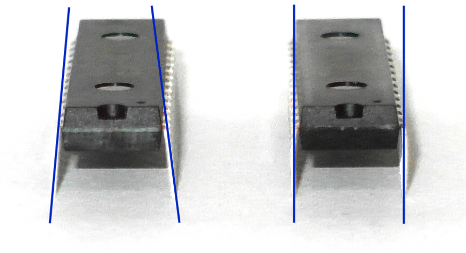


Figure 33: ICs parallel legs

Verify the **ICs alignment** with their socket, make sure **no leg is pointing out**, and firmly press the ICs into their sockets.

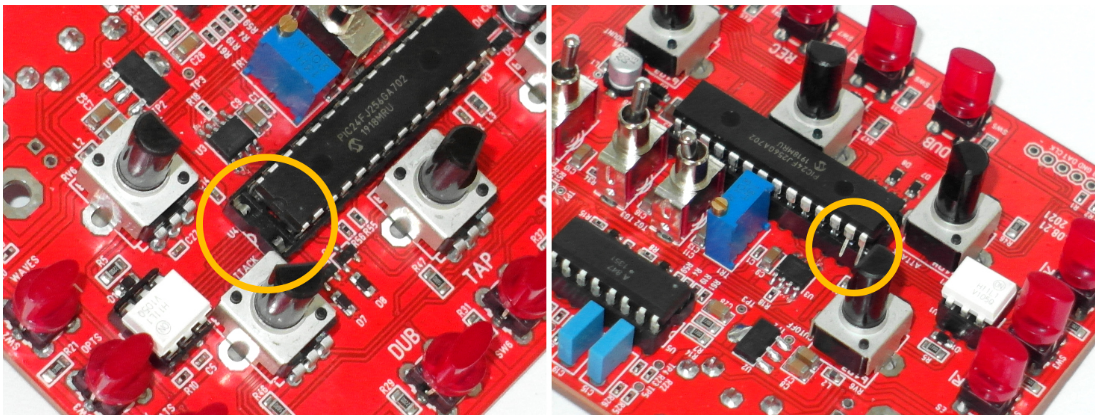


Figure 34: ICs mounted incorrectly

5 Finishing the Kit

5.1 First Power Up

Exciting moment ahead!

Before powering up the **ZeKit** for the first time, **a last visual control** of the soldering job and a full check of the ICs orientation won't hurt. For this, refer to the **component placement diagram.**

If this is your first build, try powering it up using **a lab power supply** or at least an adapter with some form of **current limiting.** You don't want all your hard work going up in smoke!

Once turned on, the **power LED** should light up and **all tact switches** should blink when pushed. The **linear regulator** *U2* must stay cool. If you press **the play switch** *SW8*, its function should latch, and **the tap switch** *SW6* should blink regularly, indicating that the MCU is **correctly running the firmware.**

Congratulations!

Now, you can attach your **ZeKit** to a *speaker system*, a *MIDI controller* and **have a lot of fun** discovering your new instrument!

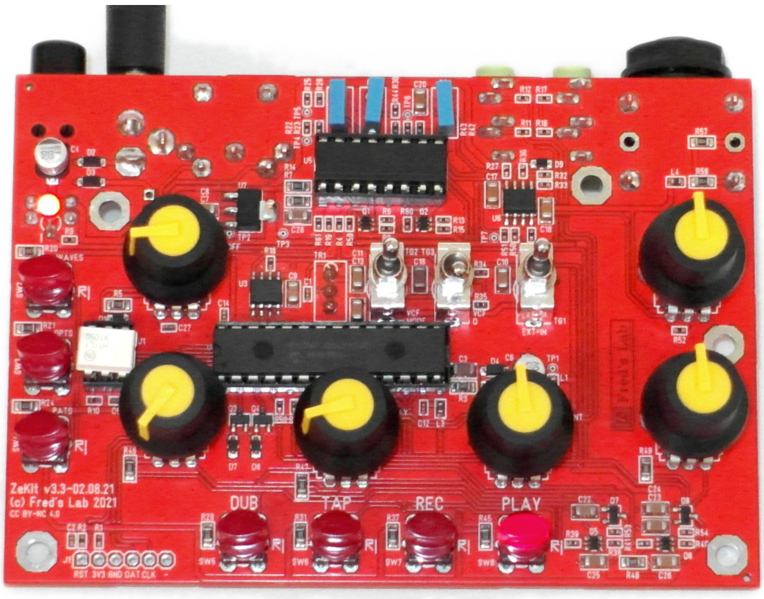


Figure 35: An happy ZeKit!

IMPORTANT

> If what described isn't what you're getting... **immediately switch the power off** and read the *Identifying Common Issues* section of this manual.

5.2 VCF Calibration

Let's tweak this VCF!

The **ZeKit** sound generation relies partly on **analog electronics** with their intrinsic manufacturing tolerances. Therefore, the filter will need some manual calibration.

The goal is to set the **VCF Cutoff Range** so the filter *opens and closes* completely.

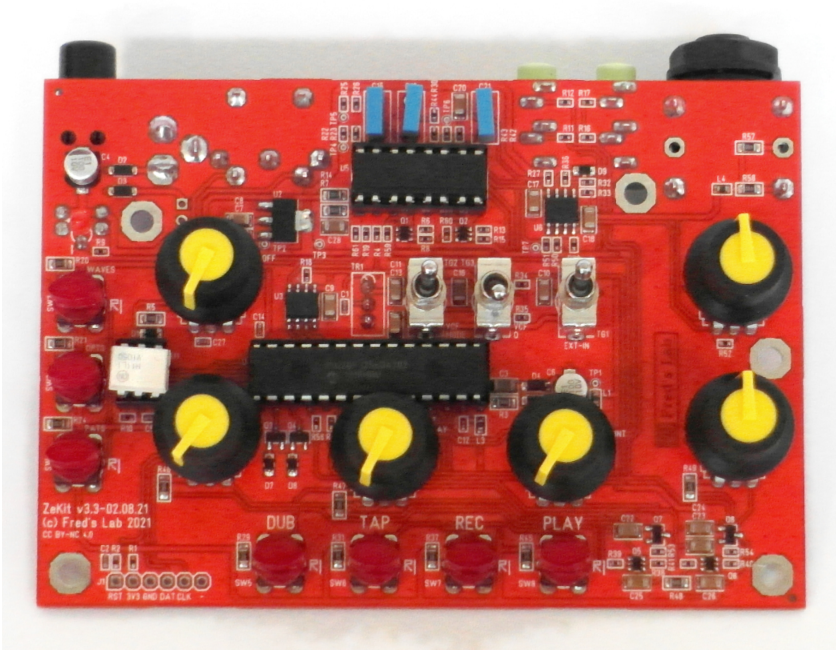


Figure 36: Calibrating configuration

To begin the calibration procedure, set the:

- **Cutoff** pot *RV6* to minimum
- **Attack** pot *RV1* to minimum
- **Decay** pot *RV2* to minimum
- **Accent** pot *RV5* to minimum
- **Release** pot *RV3* to center
- **Level** pot *RV4* to center
- **VCF Mode** switch *TG2* to top
- **VCF Q** switch *TG3* to bottom
- **EXT IN** switch *TG1* to top

Play some **very low notes** (the default MIDI channel is 1) such as G1 (49Hz) or C1 (32Hz) using a *MIDI keyboard* and **adjust the trimmer** *TR1 screw* with a screw driver **until these notes are dampened.**

Finally, check the overall *cutoff range* by sweeping the **Cutoff** pot *RV6* and ensure that the filter **is opened completely** when the **cutoff** is at maximum. Adjust the trimmer *TR1* accordingly.

5.3 What's Next?

ZeKit has been designed to be more than a *quickly assembled and affordable synth kit.*

The design material is provided under **Creative Commons (Schematics / PCB) and GNU GPL (Firmware) licenses** that allows you **to modify, extend and build upon** this project, as long as it **isn't for commercial purposes** (or contact us).

So let your imagination free, here are areas to explore:

- **Software modification**
  Firmware code is on GitHub
- **Hardware modding**
  Various test points are provided
- **Front panel design**
  Templates are on GitHub
- **Completely new housings**
- **Derivative work**

5.4 Identifying Common Issues

Here is a list of **the common troubles** you may be facing with:

- Missing solder joints
- Cold solder joints - see picture
- Solder bridges - see picture
- Wrong component polarity
- Bad IC insertion
- Dead IC (overheated or shorted)

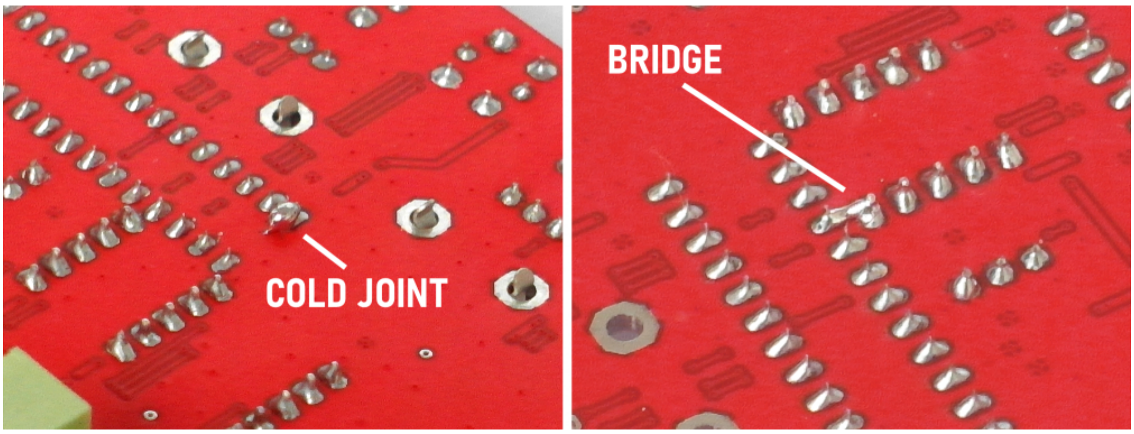


Figure 37: Soldering issues

If you cannot figure out your build problems, please **write us an email** (with pictures) or *kindly ask other users* who successfully assembled their **ZeKit**.

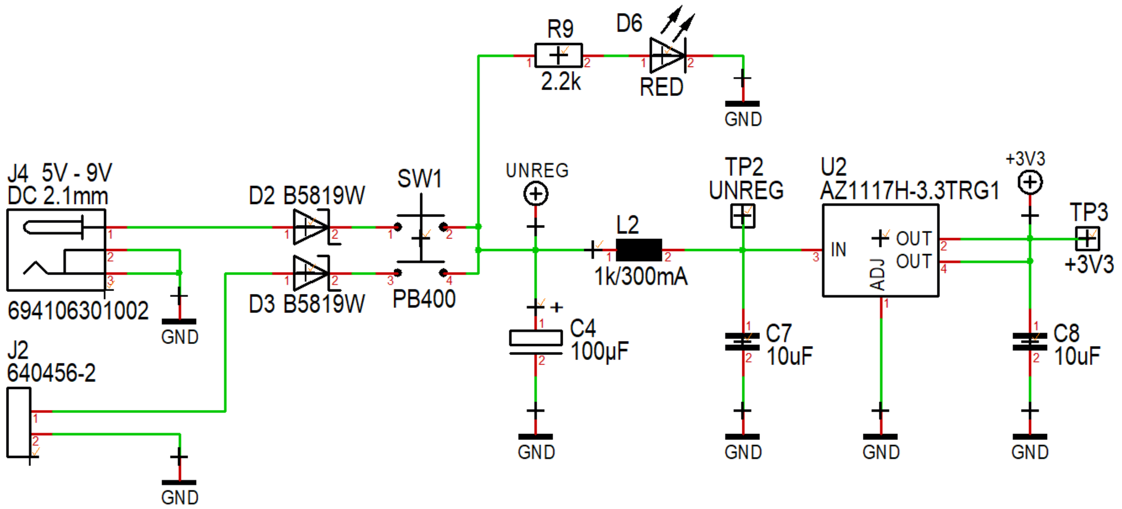
6 Functional Description

6.1 Power Supply

The **ZeKit** needs energy delivered by the power supply. This block provides 3 voltages:

- UNREG (what comes as input voltage)
- +3.3V using a **linear regulator**
- -2.0V using a **charge pump**

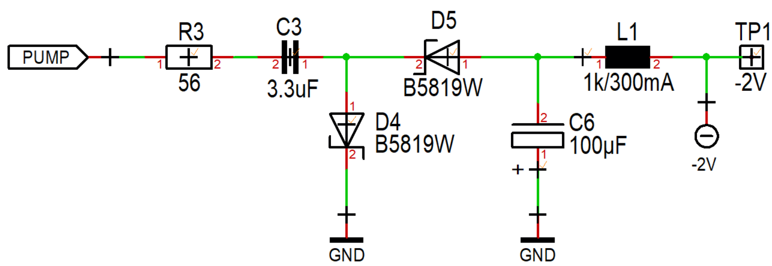
6.1.1 Linear Regulator



SW1 is the **power switch.** The diodes *D2* & *D3* ensure a **correct voltage polarity,** by letting the current flows only in the right direction. The diodes also select which source - power adapter or battery - powers the **ZeKit**.

C4, *L2* & *C7* filter the input voltage, **reducing supply noise.** *U2* regulates down the input, assuring a stable +3.3V in all circumstances. *C8* secures *U2* against possible oscillation of its output voltage.

6.1.2 Charge Pump

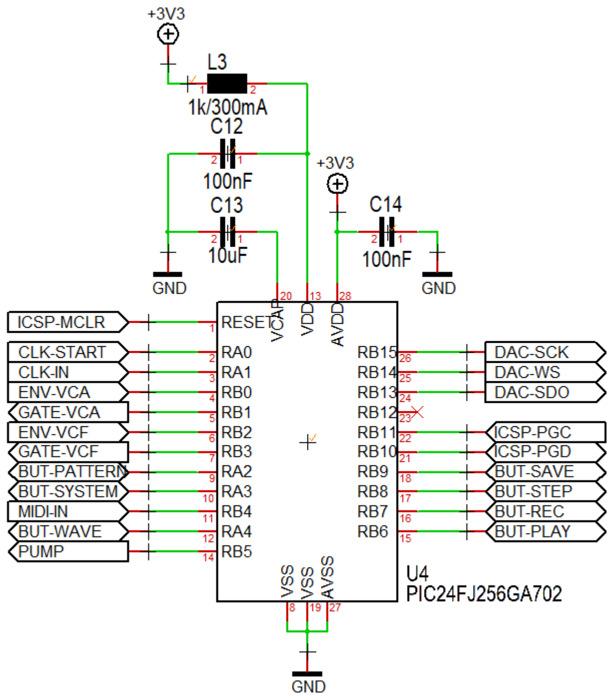


The *PUMP* signal is generated by the MCU and alternates between GND and +3.3V at a high frequency. When *PUMP* is at +3.3V, *C3* is charged via *R3* and *D4*, while *D5* is non-conductive. When *PUMP* is at GND, *D4* is blocking and the charge of *C3* is dumped through *R3*, literally pumping charges from *C6* via the now conducting *D5*.

The inductor *L1* filters the charge pump output voltage for better noise immunity.

Ideally, the output voltage at *TP1* would be -3.3V, but because of the losses inside the diodes, it will be around -2V, which is sufficient for proper operation.

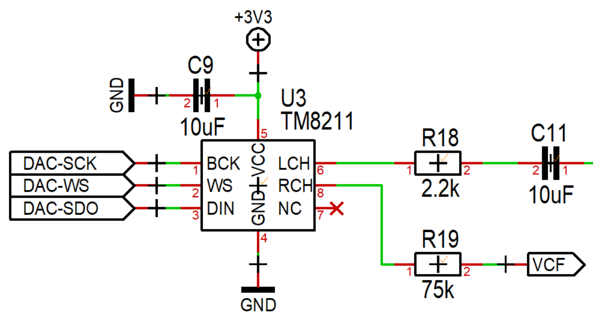
6.2 PIC Microcontroller



The **microcontroller** (MCU) *U4* is the brain of the **ZeKit**. It processes all signals from the switches and the inputs and generates the audio waveforms as well as control signals for the analog circuitry. This is done by running a firmware that is stored in the internal flash of the chip.

The capacitors *C12*, *C13* and *C14* are used together with the inductor *L3* to improve the stability of the power supply and reduce noise propagation.

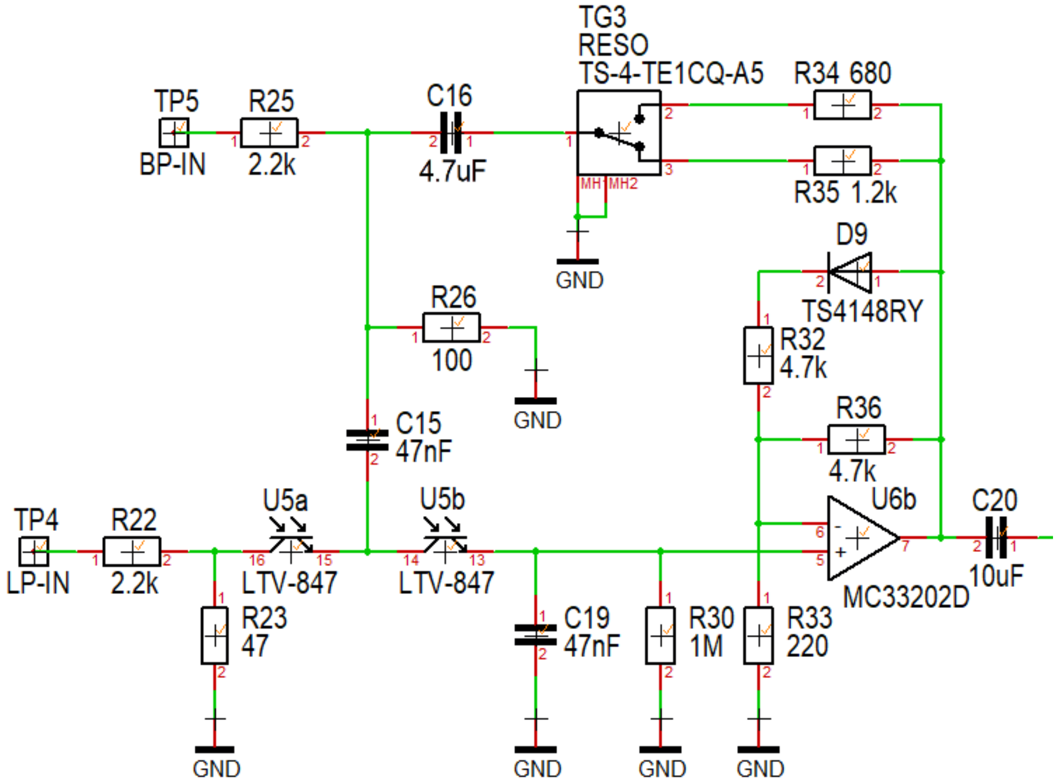
6.3 DAC



The **digital-to-analog converter** (DAC) *U3* is connected to the MCU via a standard signal bus, called *I2S*. It converts the generated digital waveforms into a signal in the analog domain. Capacitor *C11* removes the DC offset of the signal, resistor *R18* & *R19* condition the levels to suit the VCF block inputs.

This DAC chip provides two independent output channels which are used as oscillators output and filter cutoff control.

6.4 VCF

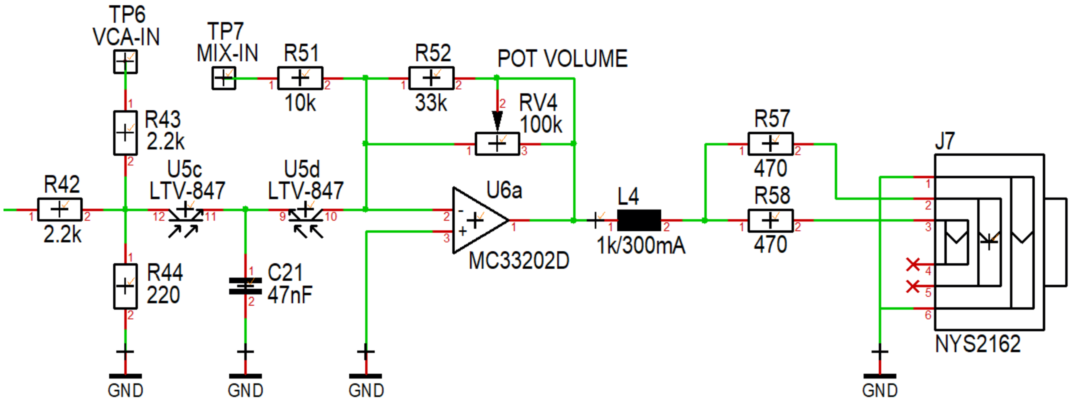


The **VCF** (voltage controlled filter) is a **2nd order design** with a 12dB/octave slope. The first stage consists of the optocouplers *U5a & U5b* and the capacitor *C15*, the second stage of the optocoupler *U5b* and the capacitor *C19*. Here, the optocouplers play the role of the resistive elements to control the cutoff frequency.

The input signal *VCF-IN* is fed in either to the first stage or the filter feedback path, depending whether low-pass or band-pass configuration is selected by the toggle switch *TG2*. The resonance is determined by the feedback loop and can be chosen between two amounts via toggle switch *TG3*.

The operational amplifier *U6b* provides the necessary gain and low impedance to drive the next stage and the feedback loop. It uses the diode *D9* to tame the amplitude at higher levels and produce a nice-sounding distortion.

6.5 VCA



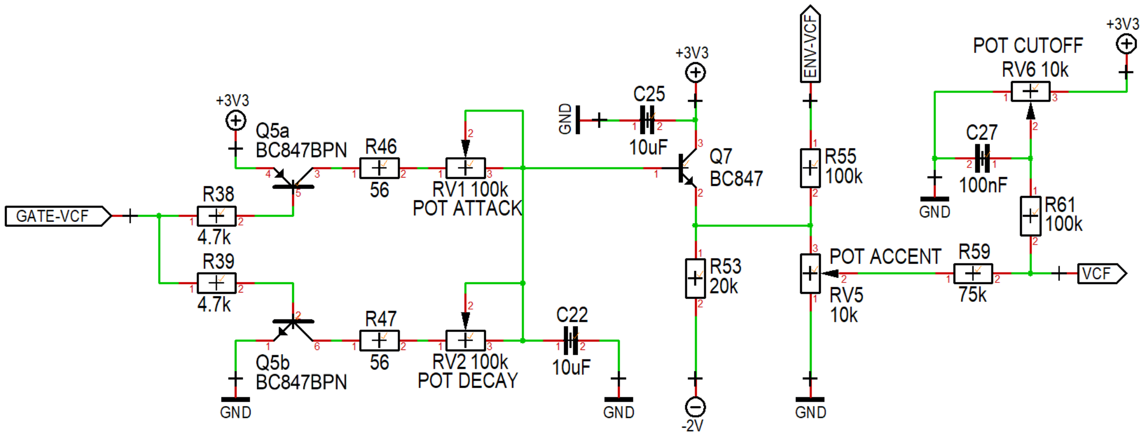
The **VCA** (voltage controlled amplifier) uses the optocoupler *U5c/U5d* to gain-control the operational amplifier *U6a*. The input signal *VCA-IN* is decoupled by capacitor *C20* and then divided down by resistors *R42* and *R44* to an appropriate level for the optocoupler.

To set the output level, the **Volume** potentiometer is part of the feedback path of the opamp. Resistor *52* in parallel to the pot provides a nicer control curve for the volume setting.

The output is RF filtered by inductor *L4*, followed by protection resistors *R57* and *R58* and then routed to the output jack *J7*.

6.6 Envelopes

6.6.1 VCF Envelope

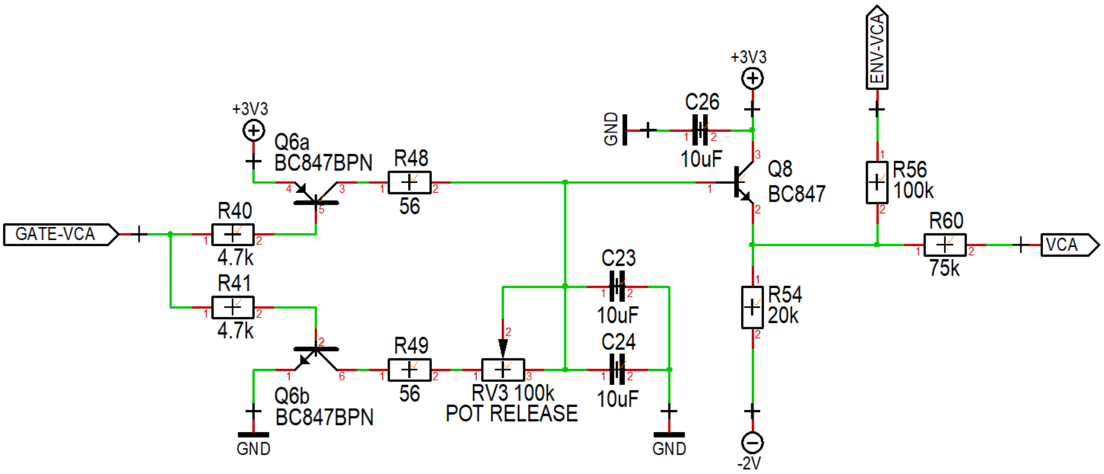


The **filter envelope** is generated by either charging capacitor *C22* to +3.3V or discharging it to GND. To trigger the envelope, the MCU sets the *GATE-VCF* signal to GND. The transistor *Q5a* then conducts and *C22* is charged via the resistor *R46* and the **Attack** potentiometer.

To release the envelope, the MCU sets the *GATE-VCF* signal to +3.3V. *Q5a* then cuts off and *Q5b* starts to conduct, resulting in *C22* being discharged via *R47* and the **Release** potentiometer.

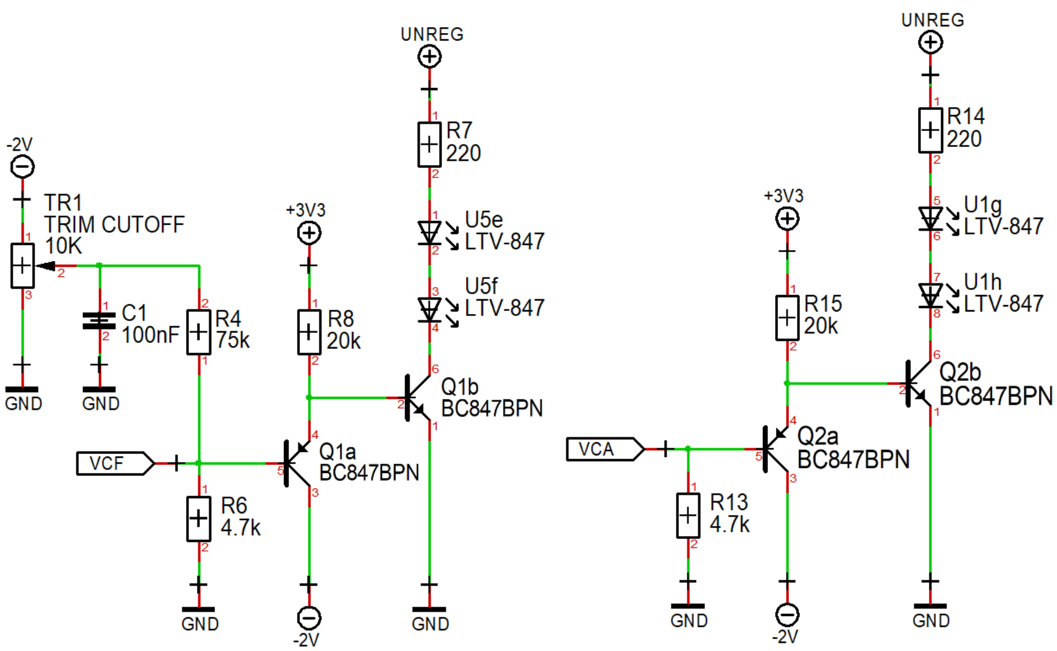
The transistor *Q7* acts as a buffer to decouple the envelope and prevent *C22* to loose its charge. The *ENV-VCF* signal is routed back to the MCU so it can detect when the *attack phase* is finished. Finally, the envelope amount is controlled by the **Accent** potentiometer and added to the constant level set by the **Cutoff** potentiometer.

6.6.2 VCA Envelope



The **amplifier envelope** is a simplified version of the filter envelope. It works the same but lacks the **Attack** and **Amount** controls.

6.7 Exponential Control Circuits



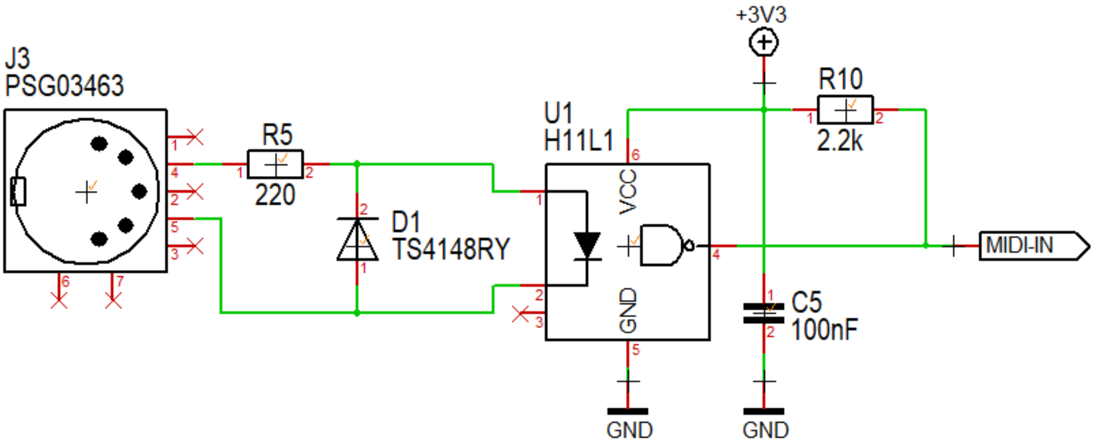
This **exponentiator circuit** converts the linear control voltage into **an exponential current** to drive the optocouplers LEDs. The requirement for this is the *nature of our human hearing* which recognizes pitches and volumes in an exponential way.

The signal *VCF* comes from the filter envelope and drives the buffer transistor *Q1a*.

The trim potentiometer *TR1* adds an offset to the input to calibrate the filter cutoff range. The emitter of *Q1a* drives the base of transistor *Q1b* which does the curve conversion. It exploits the exponential relationship between the base-emitter voltage and the collector current of a transistor. The collector current of *Q1b* drives the LEDs inside the optocoupler *U5*, controlling the filter cutoff.

The VCA uses a similar circuit that is driven by the *VCA* signal coming from the amplifier envelope.

6.8 MIDI Input

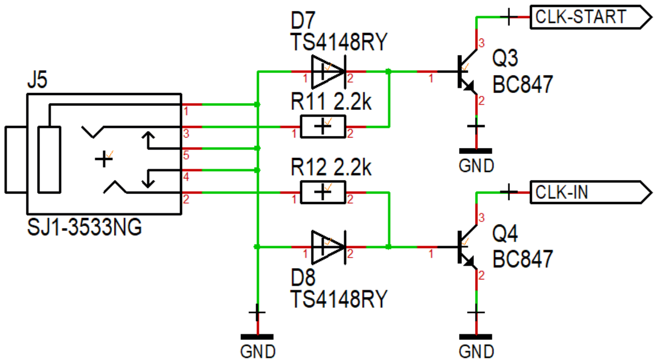


The **MIDI input** is electrically isolated from the attached MIDI gear by using an optocoupler (this time in their intended usage) to prevent ground loops and the commonly associated audio noises. This is required by the *official MIDI specification*.

The external MIDI device drives the optocoupler *U1* internal LED via the resistor *R5*. When the LED is on, the phototransistor conducts and the *MIDI-IN* signal is pulled to GND. When the LED is off, the phototransistor cuts off and *MIDI-IN* is set to +3.3V, by the pull-up resistor *R10*.

The diode *D1* clamps potential reverse spikes due to static electricity and prevents optocoupler LED being damaged.

6.9 Clock Input

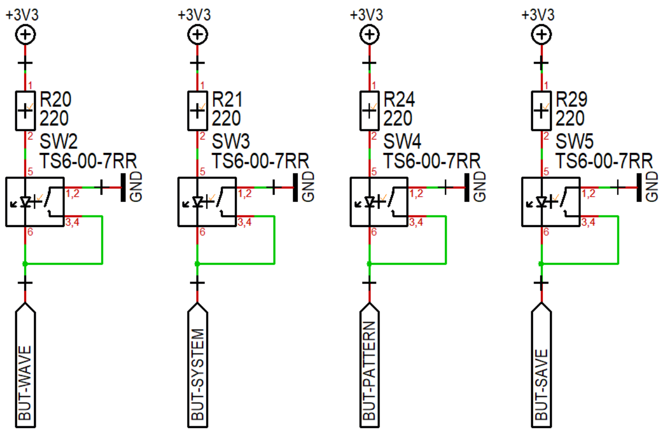


The **clock signal** is taken from the tip of the input jack *J5*. Depending on the input voltage, the transistor *Q4* is either conducting or not. Resistor *R12* and diode *D8* protect the transistor against over-voltage or wrong polarity at the input.

At the end, the signal *CLK-IN* is routed to the microcontroller. The MCU uses an internal pull-up resistor to detect the high level when the transistor *Q4* is off.

The **start signal** is taken from the ring of the input jack and processed in a similar fashion by driving the transistor *Q3* to generate the *CLK-START* signal for the MCU.

6.10 Tactile Switches



The **illuminated tactile switches** are directly connected to the microcontroller.

To reduce the number of required signals, the MCU firmware uses a neat trick:
It alternates the MCU pin mode connected to the switch signal between input and open-drain (like a switch to ground) modes.

When the MCU pin is **configured as an input,** the button state can be read. When the button is released, a high level is detected, because the pin is connected to +3.3V via the LED and the limiting resistor. When the button is pressed, the pin is directly connected to GND and a low level is detected.

When the MCU pin is **configured as an output,** the switch LED can be switched on by driving the control signal to GND and switched off by letting the signal ”floating” (or set to high-impedance).

7 Additional Resource

You will find plenty of **additional resource** (graphic files, firmwares, sources, template, manuals...), at the following addresses:

- **GitHub (source code, design files)**
  https://github.com/Marzac/zekit

- **Fred's Lab Website**
  https://fredslab.net/en/zekit-module.php

Community created material, videos, sounds and links will be added as the project grows!

8 Legal Notices

Fred's Lab cannot be liable for erroneous information contained in this manual. Its contents may be updated without prior notice. We have put our best effort to ensure the information provided here is **useful and accurate. Fred's Lab** extends no liabilities in regard to this manual other than those required by the local laws.

Frédéric Meslin Audiogeräte
Herwarthstraße, 20
53115 Bonn, Germany
info@fredslab.net
http://fredslab.net

Support requests
For support requests, you can reach us per e-mail at:

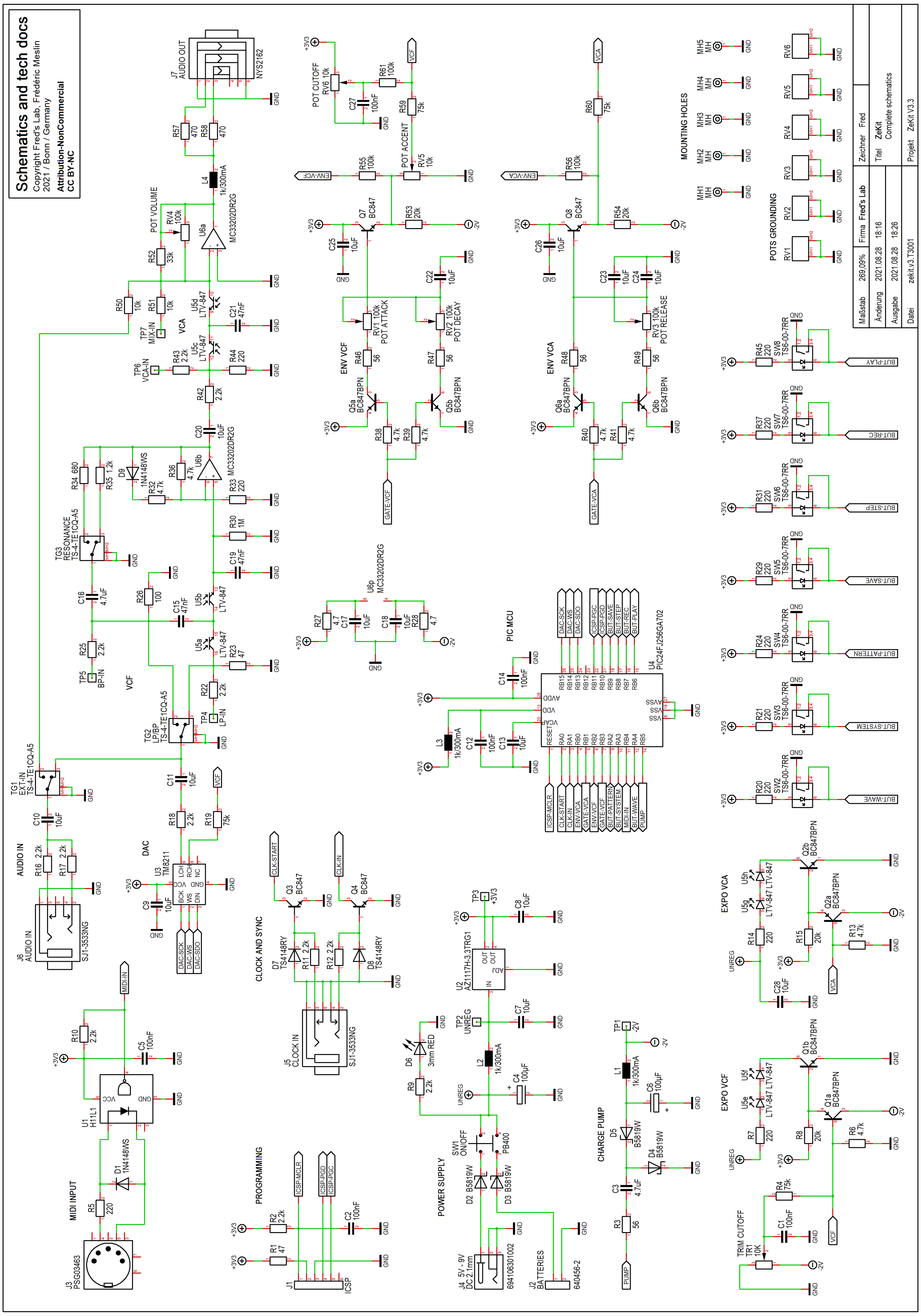
support@fredslab.net

or per post, using the company address.

For each support request, please include the **product model, serial number** and a **precise description** of the problem encountered with a maximum of details and supporting elements for a quick resolution.

Copyright information

9 Schematics



10 Bill Of Material

ZeKit V3.3
Bill Of Material – BOM
Fred's Lab 2021 – 25/08/21

Designator	Description	Qty	Value	Limits	Tolerance	Footprint
Resistors						
R27,R28	Thick film resistor	2	4.7R		1,00 %	0805
R1,R23	Thick film resistor	2	47R		1,00 %	0402
R3,R46,R47,R48,R49	Thick film resistor	5	56R		1,00 %	0805
R26	Thick film resistor	1	100R		1,00 %	0402
R5,R7,R14,R20,R21,R24,R29,R31,R37,R45	Thick film resistor	10	220R		1,00 %	0805
R33,R44	Thick film resistor	2	220R		1,00 %	0402
R57,R58	Thick film resistor	2	470R		1,00 %	0805
R34	Thick film resistor	1	680R		1,00 %	0402
R35	Thick film resistor	1	1.2k		1,00 %	0402
R2,R9,R10,R11,R12,R16,R17,R18,R22,R25 R42,R43	Thick film resistor	12	2.2k		1,00 %	0402
R6,R13,R32,R36,R38,R39,R40,R41	Thick film resistor	8	4.7k		1,00 %	0402
R50,R51	Thick film resistor	2	10k		1,00 %	0402
R8,R15,R53,R54	Thick film resistor	4	20k		1,00 %	0402
R52	Thick film resistor	1	33k		1,00 %	0402
R4,R19,R59,R60	Thick film resistor	4	75k		1,00 %	0402
R55,R56,R61	Thick film resistor	3	100k		1,00 %	0402
R30	Thick film resistor	1	1.0M		1,00 %	0402
TR1	Multiturn trimmer	1	10k			3296W
Capacitors						
C15,C19,C21	Film capacitor	3	47nF	63v	10,00 %	5.08mm
C1,C2,C5,C12,C14,C27	Ceramic capacitor	6	100nF	16v	10,00 %	0402
C3,C16	Ceramic capacitor	2	4.7uF	50v	10,00 %	1206
C7,C8,C9,C10,C11,C13,C17,C18,C20,C22 C23,C24,C25,C26,C28	Ceramic capacitor	15	10uF	50v	10,00 %	1206
C4,C6	Electrolytic capacitor	2	100uF	16v	20,00 %	5x5.3mm
Miscs						
L1,L2,L3,L4	Ferrite bead	4	600R @ 100MHz	300mA		0603
Semiconductors						
D1,D7,D8,D9	Signal diode	4	1N4148WS	150mA		SOD-323
D2,D3,D4,D5	Schottky diode	4	B5819W	1A		SOD-123
D6	3mm red LED	1				
Q1,Q2,Q5,Q6	NPN / PNP BJT	4	BC847BPN	100mA		SOT363
Q3,Q4,Q7,Q8	NPN BJT	4	BC847	100mA		SOT-23-3
ICs						
U1	Optocoupler logic	1	H11L1			DIL6
U2	+3v3 LDO regulator	1	AZ1117H-3.3			SOT223
U3	Stereo DAC	1	TM8211			SOIC8
U4	16bit MCU	1	PIC24FJ256GA702			DIL28
U5	Quad optocoupler	1	LTV-847			DIL16
U6	Rail-to-rail opamp	1	MC33202DR2G			SOIC8
Switches & pots						
RV5,RV6	10k linear pot	2	PTV09A-4020F-B103			
RV1,RV2,RV3,RV4	100k linear pot	4	PTV09A-4020F-B104			
SW1	Power switch	1	PB400EEQR1BLK			
SW2,SW3,SW4,SW5,SW6,SW7,SW8	Illuminated tactile switch	7	TS6-00-7RR			
TG1,TG2,TG3	Subminiature toggle switch	3	TS-4-TE1CQ-A5			
Connectors						
J2	DIN5 socket	1				
J4	2mm DC socket	1				
J5,J6	3.5mm jack socket	1				
J7	6.35mm jack socket	1				