OWNER'S

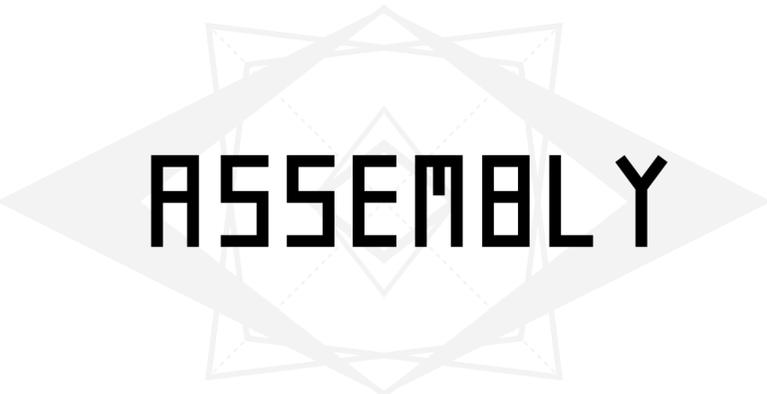# INTER CONTINENTAL CAPACITIVE BALLISTIC SYNTH

MANUAL

Thank you for purchasing the new Inter Continental Capacitive Ballistic Synth, IC^{2}BS, from Freedom Enterprise. This small portable synth was designed to be a new tool in your inventory of sound equipment to help you get started in the world of sound synthesis. By reading this manual you'll become familiar with the IC^{2}BS, how to use it and how to make the most of it. Good luck, and have a great experience with your brand-new synth from Freedom Enterprise.

CONTENTS

ASSEMBLY

Putting together the IC²BS is a simple task if you're familiar with soldering electronic kits. You'll need a #2.5 hex wrench, soldering iron, tin solder, flux and wire clipper.

A WARNING ABOUT ELECTROSTATIC DISCHARGES

These instructions will guide you through the whole process.
Electrostatic discharges, or ESD, can occur when two electrically charged objects, such as the human body and an electronic device, come in contact with each other. This phenomenon can be of the order of several thousand volts and can destroy integrated circuits, like the LM386, PT2399 and ATMEGA328P. To prevent this from happening, touch a metal surface, like a door knob, before handling any IC.

BOM

Comment	Description	Designator
18650 Battery Holder		
Battery Charger		BC1
0.1uF	Ceramic Capacitor	C1, C2, C6, C8, C9, C11,C23
220uF	USW0J221MDD1TP	C3, C5
0.047uF	Film Capacitors .047uF 63V 10%	C4
10uF	USW1C100MDD	C7, C20, C21, C22
47uF	USW0J470MDD1TE	C10, C17
3300pf	Film Capacitors 3300 pF 100 VDC 5%	C12
0.1uF	Film Capacitors 0.1uF 63V 5%	C13, C14
680pF	Film Capacitors 680pF 100V 2.5%	C15, C16
10uF	Electrolytic Capacitor 6.3X7mm	C18
0.01uF	Film Capacitors 0.01uF 250 Volts 20%	C19
Header 1X8 M	2.54mm	CN5, CN6
PJ-327U-SMT	3.5mm SMD Headphone Gold Plated	CN?, CN1, CN3, CN4
Led Red 5mm		D1
DC-DC Booster		DC1
Ferrite Bead		FB1
LM386		IC1
PT2399		IC2
ATMEGA328		IC3
10 Ω	Resistor 1/4	R1
5K Ω	Resistor 1/4	R2, R3

Comment	Description	Designator
10K Ω	Resistor 1/4	R4, R5, R8, R9, R16
15K Ω	Resistor 1/4	R6, R10
5.6K Ω	Resistor 1/4	R7
1K Ω	Resistor 1/4	R11, R14, R15
470 Ω	Resistor 1/4	R12
3.9K Ω	Resistor 1/4	R13
SPST Switch_Vertical		SW1, SW2
Header 1X8 M	2.54mm	CN1, CN2
100K Ω	Attack, Release, Modulation, Filter, Pitch, Double, Repeat, Speed	RV1, RV2, RV3, RV4, RV5, RV6, RV8, RV9
10K Ω	Volume	RV7
SPDT Switch		SW1

Table 1

USER INTERFACE

Start by snaping in the nine potentiometers in place. Follow the BOM to ensure the correct values.

Follow this by placing the power switch and solder all the components.
The eight pin male headers will be assembled later.

MAIN PCB

Start by soldering the Li-Ion Charger and DC Booster modules first. To do this, apply flux to the pads on the Main PCB and place the modules in their correct orientation on the Main PCB. Secure them if needed and apply heat with your soldering iron on the pads of the modules. Apply solder to the pads of the modules and let the solder flow into the pads on the Main PCB, securing them together.

Do the same procedure to solder the 3.5mm jacks as well as the 18650-cell socket on the underside of the Main PCB. Ensure the correct polarity on the socket.

Follow this by placing the remaining components on the Main PCB. Start with the smaller ones such as resistors and ceramic capacitors.

Notice that the electrolytic capacitors and the LED have polarities and must be installed in the correct orientation according to the silkscreen on the Main PCB.
Solder these components and trim the leads.
Insert the IC sockets in their correct orientation.
Solder the sockets and only then install the provided ICs.

Insert the eight pin female header on the Main PCB and the eight pin male headers on the User Interface. Secure the two PCBs with the provided brass standoff and screws and solder the headers.
Finish off by cleaning the flux left behind and perform a visual inspection.

SIDE PANELS

The side wood panels can be installed by sliding them into the two tabs on the Main PCB, with the mounting holes facing upward. Insert the aluminium standoff and then the brass hex screws. Secure them tightly.
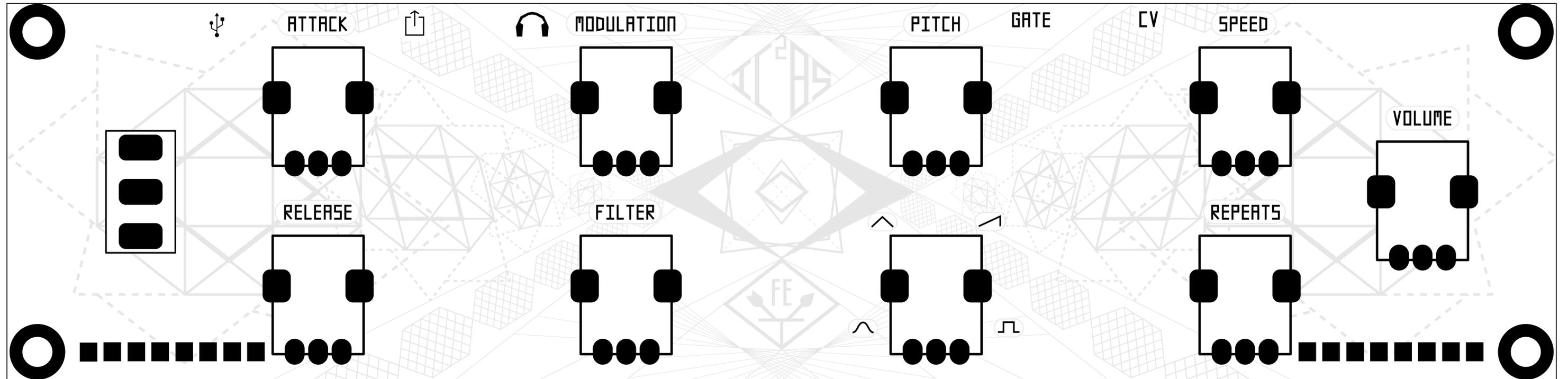
INTERFACE

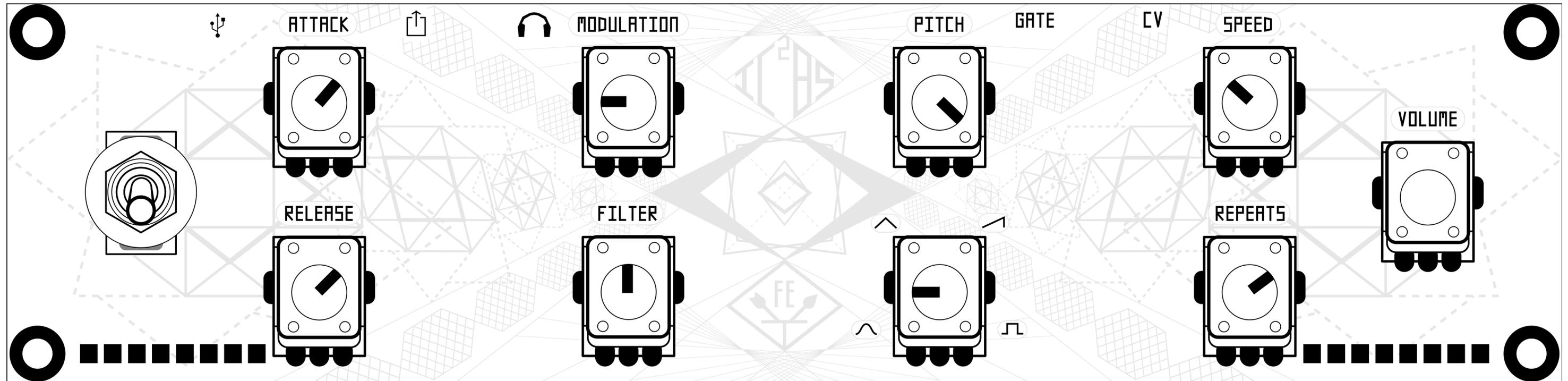*Figure 1. User Interface.*

BOOTING UP

Figure 2. Preset example.

Insert a Li-Ion 18650 cell in the battery holder with the correct polarity.
Connect a micro-USB cable and a red led should light up on the Li-ion charger
indicating the battery is charging.
Flip the power switch and the LED in the middle of the Main PCB should light up, as
well as a red LED on the DC Booster.

MODES OF OPERATION

Monophony and Polyphony

This synth contains two different modes that can be switched by the user during boot up. In Monophony mode, only one note can be played at the time, however the two built in DCOs are used to create a ring modulator. This is the default boot up mode.
In Polyphony mode, two notes can be played at the same time. There's a DCO, DCF and DCA for each voice. However, in this mode the ring modulator is not present.
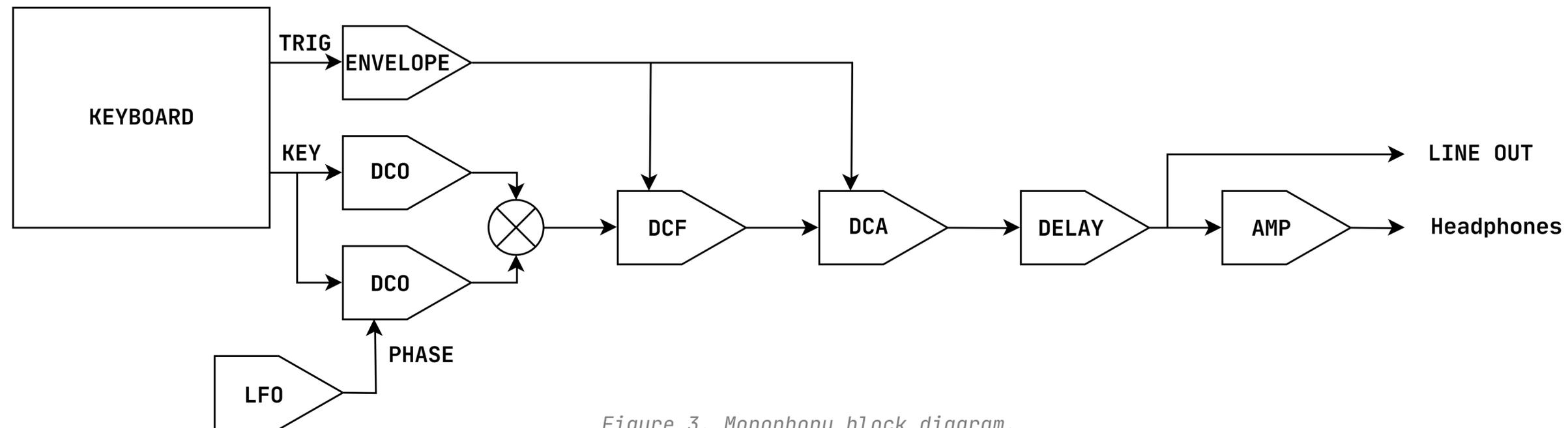To access this mode, press and hold SW1 during power up.

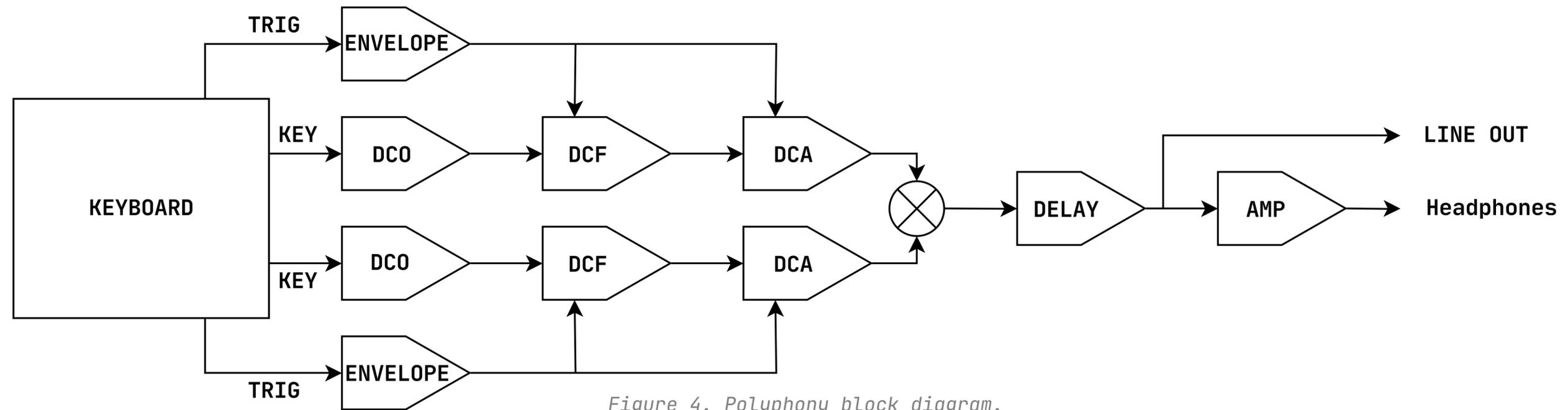
Figure 3. Monophony block diagram.

Figure 4. Polyphony block diagram.

CV and Gate

The keyboard generates a CV and Gate signals that can be used to control other equipment. The CV follows the 1V/Octave standard. This is the default boot up mode. To use the CV and Gate as inputs, thereby allowing other equipment to control the IC^{2}BS, press and hold the SW2 switch during power up.

Both input and output modes, the CV and Gate can only control one note at a time.

FEATURES AND CONTROLS

DCO [DIGITALLY CONTROLLED OSCILLATOR]

The oscillator is the primary component that generates the sound. Its frequency is controlled through the keyboard, while the pitch knob controls the octave. The wave selector knob switches between various waves being generated such as Sine, Triangle, Sawtooth and Square.

DCF [DIGITALLY CONTROLLED FILTER]

This digital filter simulates the filters found in conventional analog synths. Turn it CCW for a mellow sound and CW for a brighter sound filled with harmonics.
The filter is internally connected to the Envelope Generator, ramping up and down when a key is pressed and depressed.

DCA [DIGITALLY CONTROLLED AMPLIFIER]

The output amplitude of the audio signal is controlled through the DCA, following the envelope generator.

MODULATION

When in Monophony mode, the two internal DCO are used to create a ring modulator. The speed rate of the Ring modulator is controlled through the Modulation knob.

ENVELOPE GENERATOR

The envelope generator creates an envelope to control the previous circuits. This envelope is controlled with two parameters, the attack and release.

Attack: When a key is pressed, the attack knob dictates the speed at which the envelope rises from 0 to 100. At full CCW, the rise time is instantaneous. At full CW, the envelope rises slowly from 0 to 100.
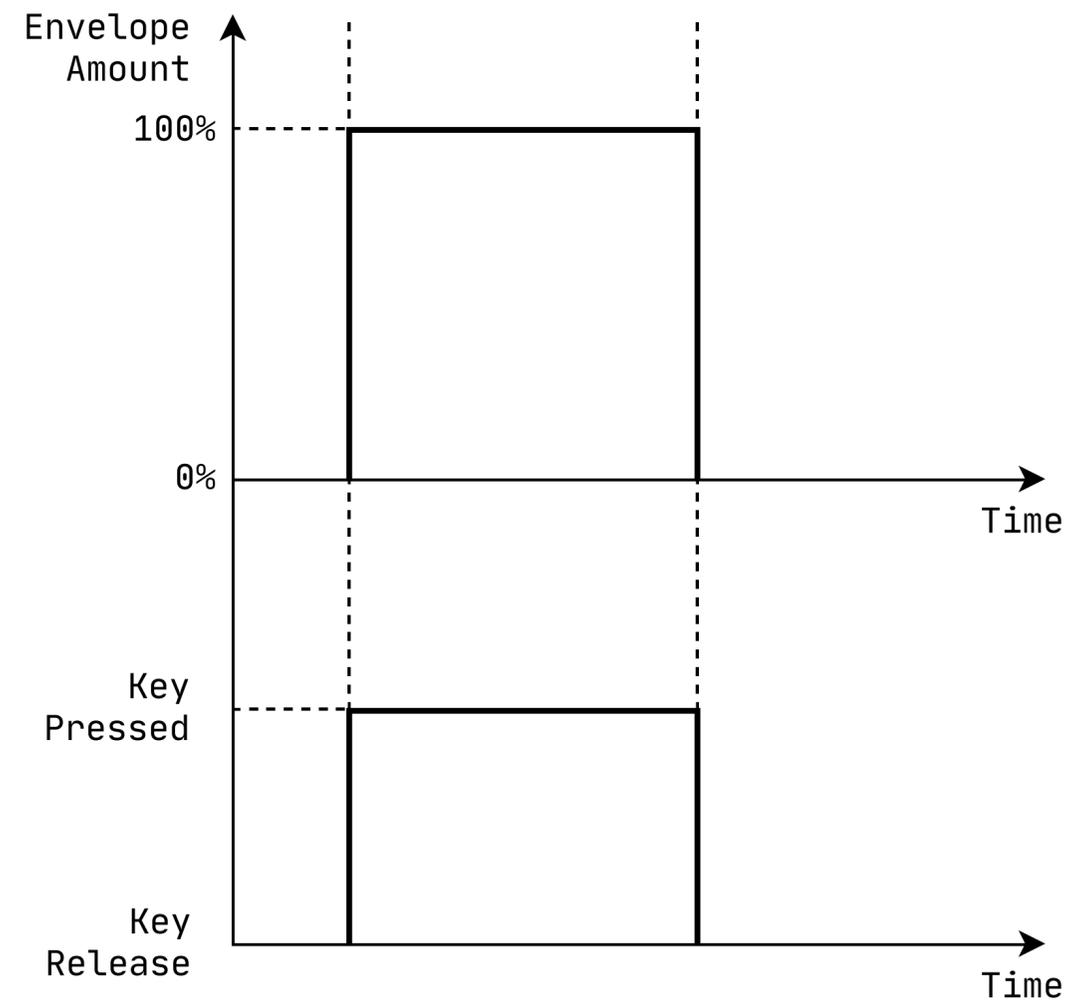

Figure 5. Attack and Release at full CCW.

Release: The time it takes for the envelope to go from 100 to 0 when a key is released is controlled with the release knob. At full CCW, the envelope will decay to 0 instantly when a key is released. At near full CW, the envelope will slowly decay once the key is released. At full CW, the envelope will maintain its position, sustaining the last note played.
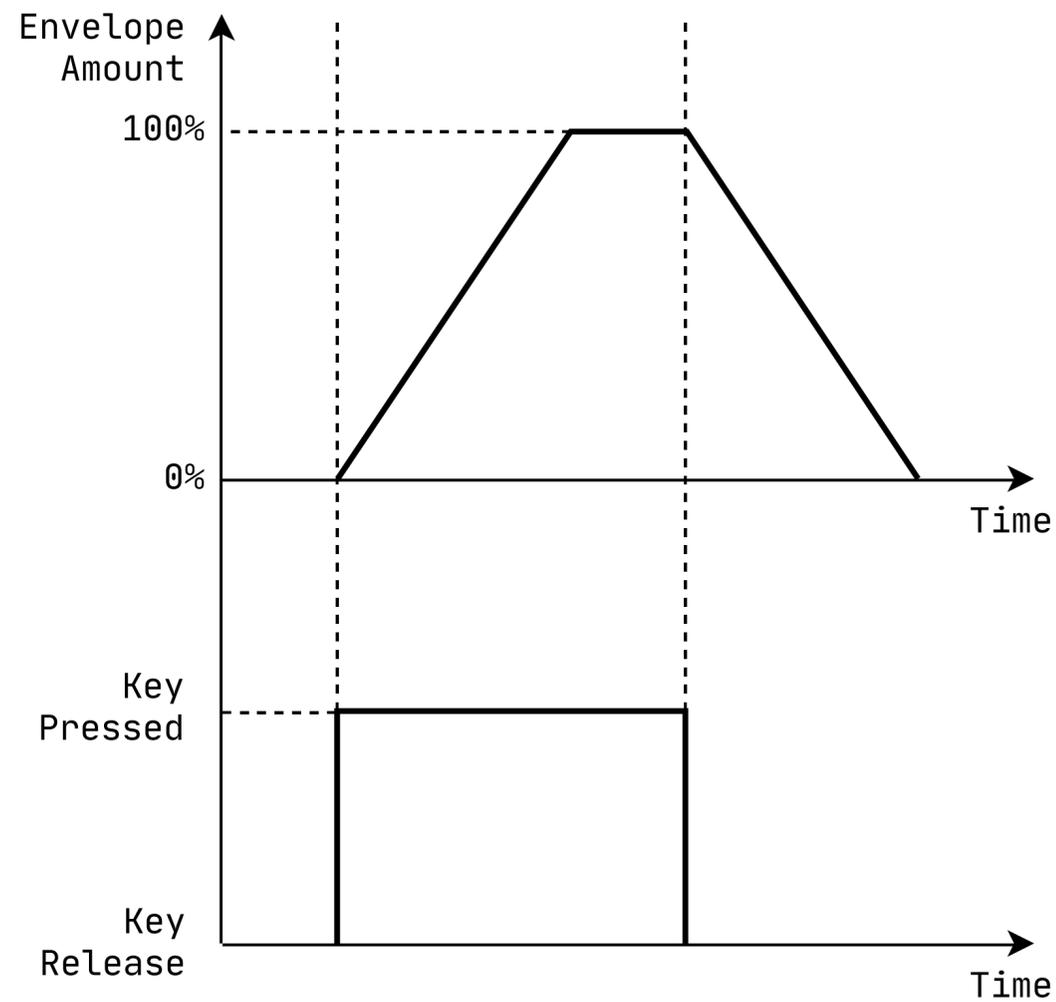

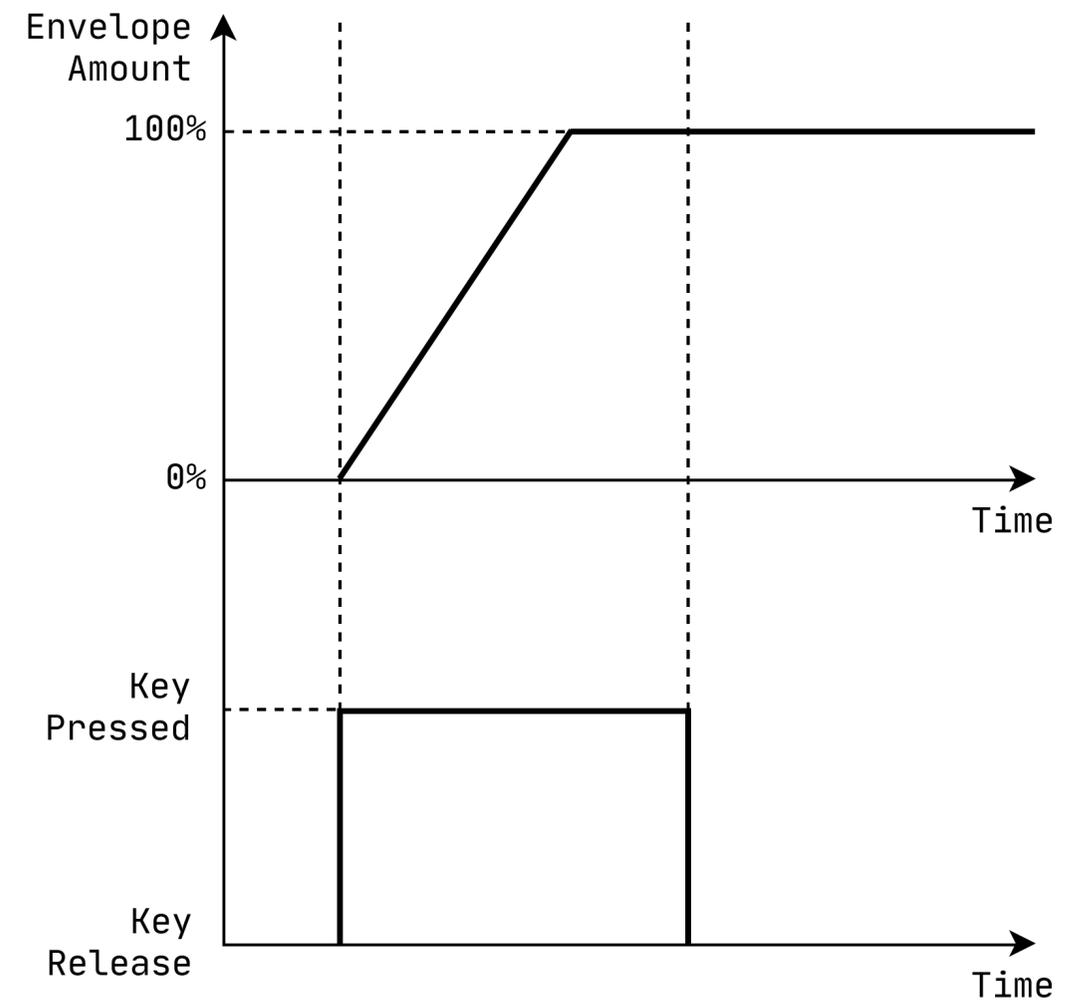*Figure 6. Attack at full CW, Release near full CW.*

Figure 7. Attack and Release at full CW.

SPECIFICATIONS

Dimensions in Milimeters (W/O Side Panels)	
Width	120
Height	35
Length	190

Power
3.7 V @ 25 mA
1860 Li-Ion Cell
Micro USB charge port

Sound	
PWM	35KHz

Connectivity
0-5V, 1V/Octave CV
0-5V Gate

CREATIVE COMMONS LICENSE

The circuit design and schematics present on the PCBs are licensed under a Creative Commons Attribution 4.0 International License. You may share and adapt this work for any purpose, even commercially, but only when appropriate credit is provided and if the material is shared under the same license as the original. The PCBs layout, artwork and names are the property of Freedom Enterprise and may not be cloned or replicated for commercial purposes. Read the full license at creativecommons.org/ licenses/by-sa/4.0.

WARRANTY

Fully assembled versions of this product are covered by warranty for one year following the date of purchase. This warranty covers any defect in the manufacturing of this product, such as assembly errors or faulty components. This warranty does not cover any damage or malfunction caused by incorrect use, such as, but not limited to, power cables connected backwards, excessive voltage levels, or exposure to extreme temperature or moisture levels. The cost of returning a product for repair or replacement is paid for by the customer. DIY kits and bare printed circuit boards are not covered under any warranty and come with no guarantee of assembly troubleshooting or customer support (although I'll try help you out).

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IC²BS

OWNER'S MANUAL

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Written by Pedro Silva

Art by Seni