Synbal

by Kenneth McAlpine

★ **Metallic and Noise Voicings**
★ **Dynamic Response**
★ **State Variable Filter**
★ **Modular Construction**
★ **Optional Stereo Output**

PARTS COST GUIDE with Pre sets **£12.50**

Synbal is the first of two modules intended to provide a complete range of electronic percussion. This unit can provide the 'metallic' sounds such as Cymbal, Hi-Hat, Cowbell or Gongs while the next module, the Syntom II, will provide Bass, Snare and Tom-Toms.

The modules can be built up in any combination to provide a custom percussion system, sounds being continuously variable or pre-set.

Background

Synthesising electronic percussion, such as Cymbals, Gongs or Bells, is a fairly difficult task due to the extremely complex nature of their sounds.

Designers have used various methods of synthesis over the past few years including filtered noise, ring modulation and now digital sampling.

Early rhythm machines used white noise passed through filters then gated, to produce Hi-Hat and Cymbal simulations. The sound, however, did not have the 'metallic' edge required, which was later provided by using several oscillators through ring modulator type circuitry.

Currently, there are two ways of producing a realistic Cymbal or Hi-Hat sound using digital sampling. The first, as used in the Linn Drum, is to sample the complete envelope of a real Cymbal and store this in an EPROM (Eraseable Programmed Read Only Memory) via an Analogue to Digital Converter (ADC). The sound can then be reproduced when required by reading out the digital data at the same rate through a Digital to Analogue Converter (DAC). Unfortunately, since the Cymbal has such a large high frequency content and a long decay, a lot of memory is required. The LinnDrum, in fact, uses 262,144 bits of information to store each Cymbal! (see review in this issue).

The second method, used by several manufacturers including Simmons, is to sample a short section of the Cymbal sound and store this in memory. To reproduce the sound the data is read out and converted, in the same way as method 1, but in a continuous loop. Thus a waveform with the required 'metallic' content is produced which can be shaped using conventional analogue circuitry.

The first method is undoubtedly more authentic, but only the clocking rate can be adjusted to change the quality of the sound. With the second method harmonic content, decay and dynamics can be controlled using analogue circuitry. However, both do have the disadvantage of being costly, mainly due to the memory and the DAC's.

Synbal Voicing

The Synbal provides a compromise between sound and cost. Sounds are generated by analogue circuitry to keep the price down but which is versatile enough to allow a large range of convincing imitations to be produced.

The block diagram of the system is shown in Figure 1. Metallic voicing and noise generator outputs are mixed and processed by a state variable Voltage Controlled Filter (VCF), the cut-off frequency of which can be varied manually by a control pot or automatically by the Envelope Generator.

Highpass, Bandpass or Lowpass output is connected to a Voltage Controlled Amplifier (VCA) which varies the level of the output according to the height of the envelope. Controls for Sensitivity and Decay are provided on the Envelope Generator.

An optional panning network also allows the output to be set anywhere in the stereo field.

The trigger input is level sensitive, that is, the higher the trigger voltage, the higher the output level. Triggers can be provided by piezo pickups, crystal mic inserts or by synthesiser/computer type gate signals.
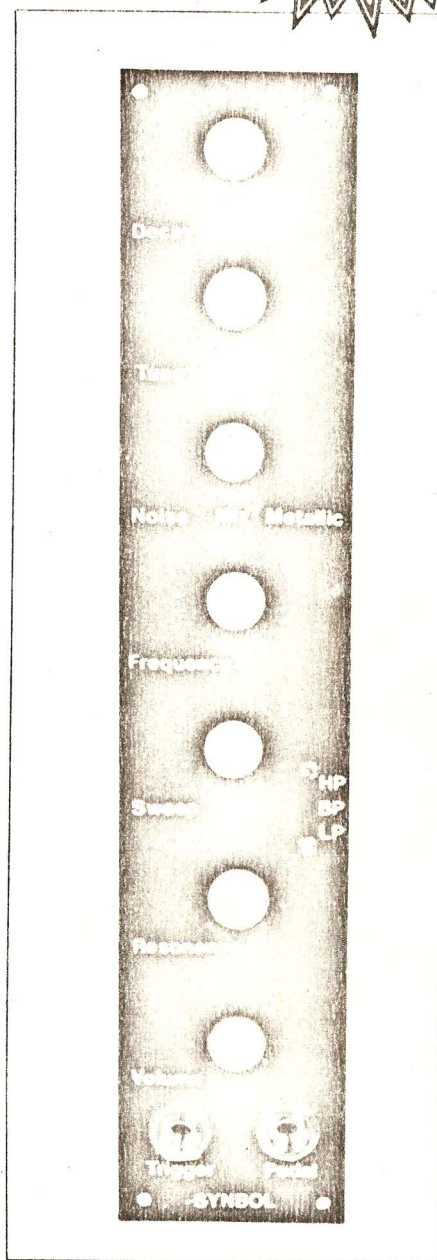
Circuitry

The complete circuit diagram for the Synbal is shown in Figure 2.

Trigger inputs are connected to RV1, which adjusts the sensitivity. The input is differentiated by C1/R1 resulting in a short spike which is amplified by IC1b, and used to charge C2. The Decay pot RV2 and R4 provide a discharge path for the current from C2. The discharge rate or Decay being set by the pot. A foot-operated switch can be connected across RV2 which sets the discharge time to a minimum when the switch is closed. This allows open/close Hi-Hat effects to be played. The resulting Envelope is buffered by IC2a, which drives the LED and provides signals for the VCF and VCA.

The Metallic Voicing section is built around IC5, which contains 6 Schmitt triggers configured as oscillators, and IC6, a quad Exclusive OR package which is used to provide Ring Modulation type effects. A waveform with a very 'metallic' sound quality can be produced with the configuration of oscillators and gates shown. Tuning is accomplished by varying the supply voltage to IC's 5 and 6. This alters the time taken for the oscillators to reach their respective thresholds and therefore changes their running frequencies.

The metallic voicing is mixed, via RV5, with white noise, produced by making TR1 (any standard NPN) Zener and amplifying the resultant noise with IC4.

Filtering is provided by IC1d and dual transconductance amplifier, IC2, which combine to make a state variable -12dB/ octave voltage controlled filter. The three
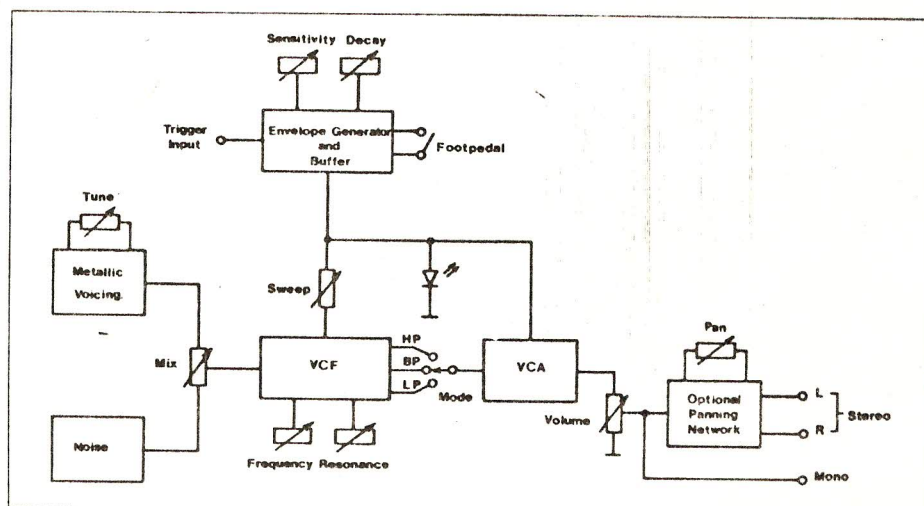

Suggested modular panel layout.

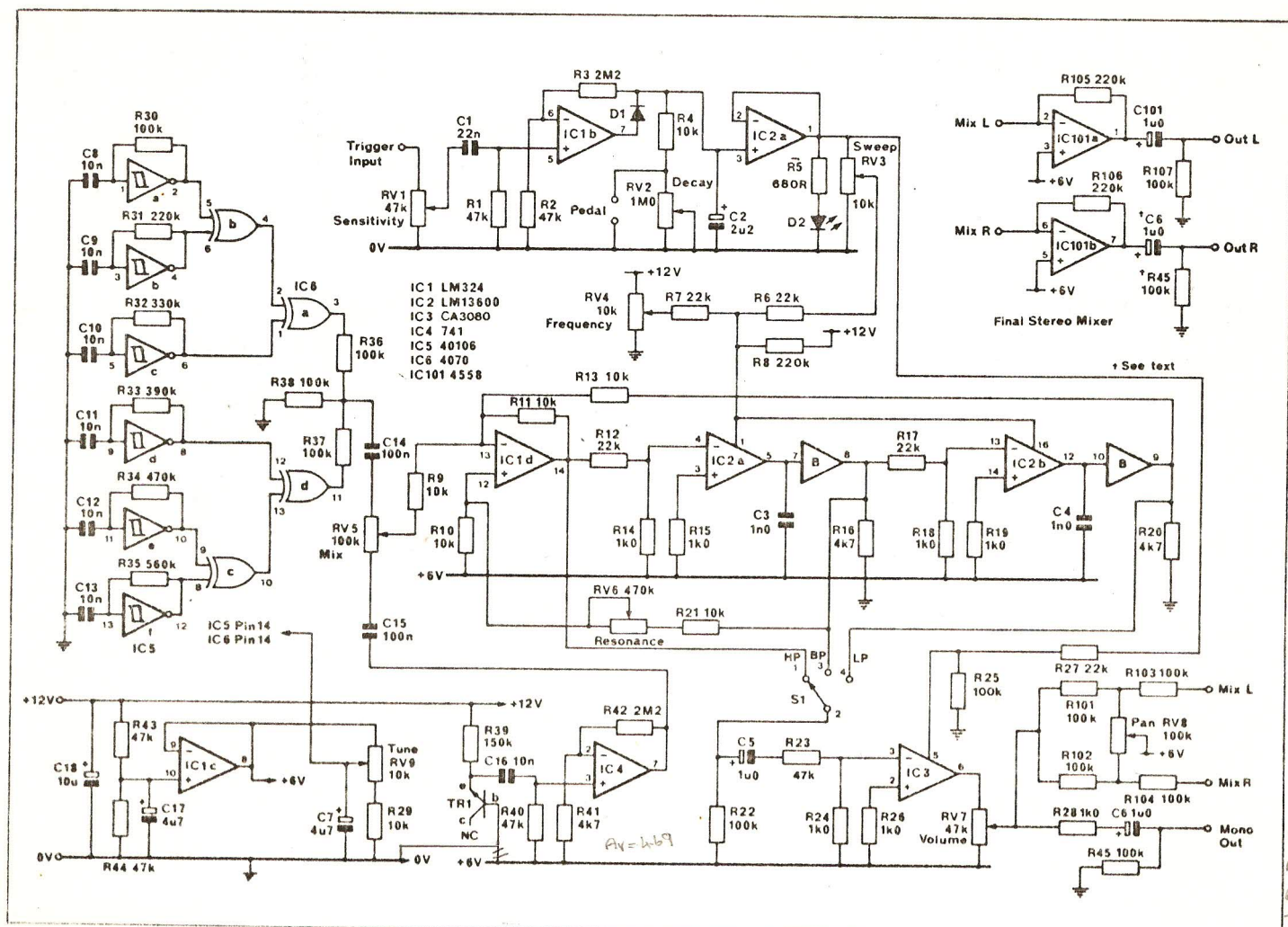**Figure 1. Block diagram of the Synbal.**

Figure 2. Circuit diagram of the Synbal.

Handwritten notes (right margin):
R41 - 5.6K
Av = 393
6.8K = Av = 325
7.5K = Av = 294
8.2K = Av = 269

IC component list (centre of schematic):
IC1 LM324
IC2 LM13600
IC3 CA3080
IC4 741
IC5 40106
IC6 4070
IC101 4558

Final Stereo Mixer

+ See text

states Highpass (HP), Bandpass (BP) and Lowpass (LP) are selected by S1 and feedback or resonance is varied with RV6. Cut-off frequency is controlled by the amount of current flowing into pins 1 and 16 of IC2. Manual frequency is set by RV4 and sweep frequency by RV3. A slight 'hold-on' bias is provided by R8.

Signals from the filter, via S1, are decoupled with C5 and attenuated to a suitable level for the transconductance amplifier, IC3. The output level is again controlled by a current, this time into pin 5. The voltage from the Envelope Generator is converted to a current via R27, with R25 provided to prevent breakthrough.

One of two output paths can now be followed: the first, for mono output, is through R28 whereas the second, used for stereo output is via the panning network.

Panning works by creating two outputs with R101 and 102, either output being reduced by shifting the wiper of RV8 towards it. This creates a shift between Right and Left channels when amplified by IC101. Note that C6 and R45 are used in both configurations (see Options).

A centre rail of 6V is provided by IC1c to allow the circuit to function from a single 12-15V power supply.

Options

The Synbal PCB has been designed to make the circuit as flexible as possible by allowing for a number of user options.
Controls: 1) *Rotary* — The PCB can be mounted on a panel such as the one shown in the photo. All the pots, switch, LED and sockets are hard-wired to the board. This allows the sound to be continuously variable.
2) *Vertical Pre-sets* — The pre-sets can be mounted vertically and the switch horizontally on the PCB, as shown in the photo. An extra 5 links must be inserted if this is the

case, shown dotted in Figure 3. Boards can then be slotted into a case with the left hand edges at the front allowing occasional adjustments to be made.
3) *Horizontal Pre-sets* — The pre-sets can be mounted horizontally and the switch vertically, as shown in the component overlay. This allows adjustments to be made to a board mounted horizontally in an enclosure.
4) *Combinations* — Obviously any combination of controls could be used. The most

commonly used, such as the Decay and Filter Frequency could be rotary and the rest pre-set. The switch could also be omitted and a link inserted for the required filter state.

Outputs: 1) *Mono* — If mono outputs are required then RV8 and components numbered 100 upwards are omitted. Resistor R28 should be inserted and Out R/Mono used as signal output.
2) *Stereo* — For stereo use R28 should be
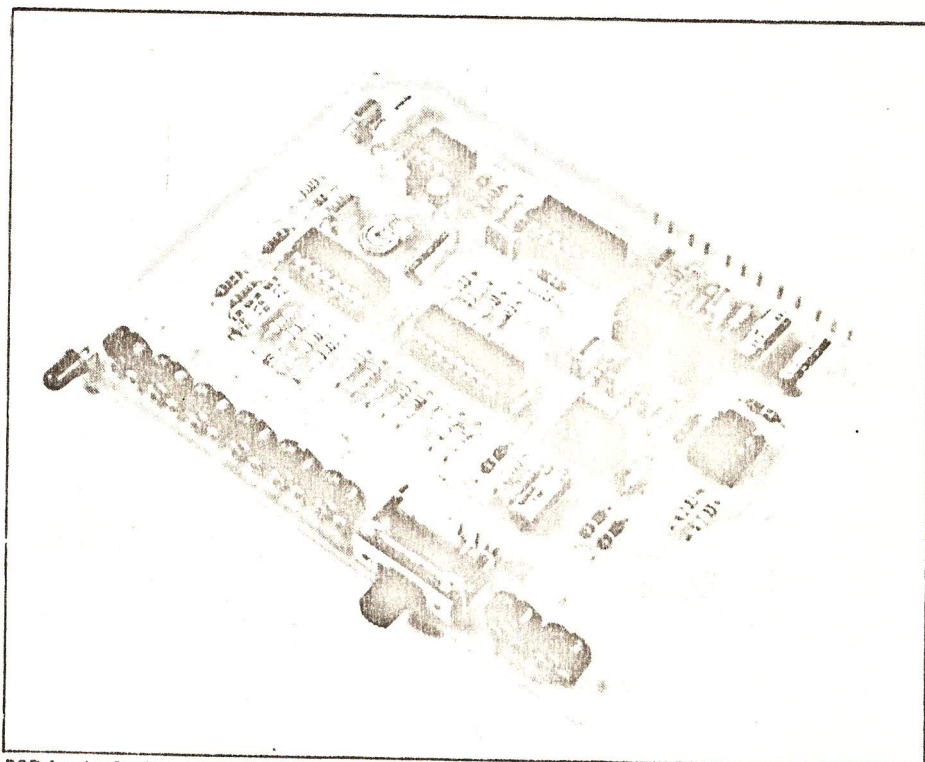
PCB for the Synbal.

Synbal

omitted with RV8 and the 100-up components inserted. Outputs are taken from Out L and Out R.

3) *Modular Stereo* — To allow a modulator stereo system to be built up the virtual earth busses of the final mixer are available. Only one of the system boards need contain the final mixer IC101. The rest only have R101 to 104 and RV8 inserted. All of the Mix R and Mix L outputs are connected together and the final output taken from the board with IC101 inserted.

Once the configuration of your system has been decided the parts can be assembled on the board using the component overlay in Figure 3.

Components should be assembled in the following order: Veropins, links, resistors, capacitors, diode, transistor and IC sockets (if required). Controls and LED can then be mounted and IC's inserted last.

Using the Synbal

Triggering can be provided by a piezo pickup or crystal mic connected to the trigger input, the sensitivity control being used to adjust the dynamic response. Pickups can then be mounted in existing drums or practice pads. The trigger will accept signals up to about 5V which can be from a sequencer, rhythm machine or computer. Higher voltages can be accommodated by raising the value of R2.

A footswitch, with momentary action, can be connected across the Pedal input and 0V. Closing the switch gives minimum decay, opening retains the set decay.

Six sample settings are provided in Figure 4 to give an idea of some of the possible sounds available from the Synbal.

Details of a power supply and modular construction will be given in the next article, the Syntom II.
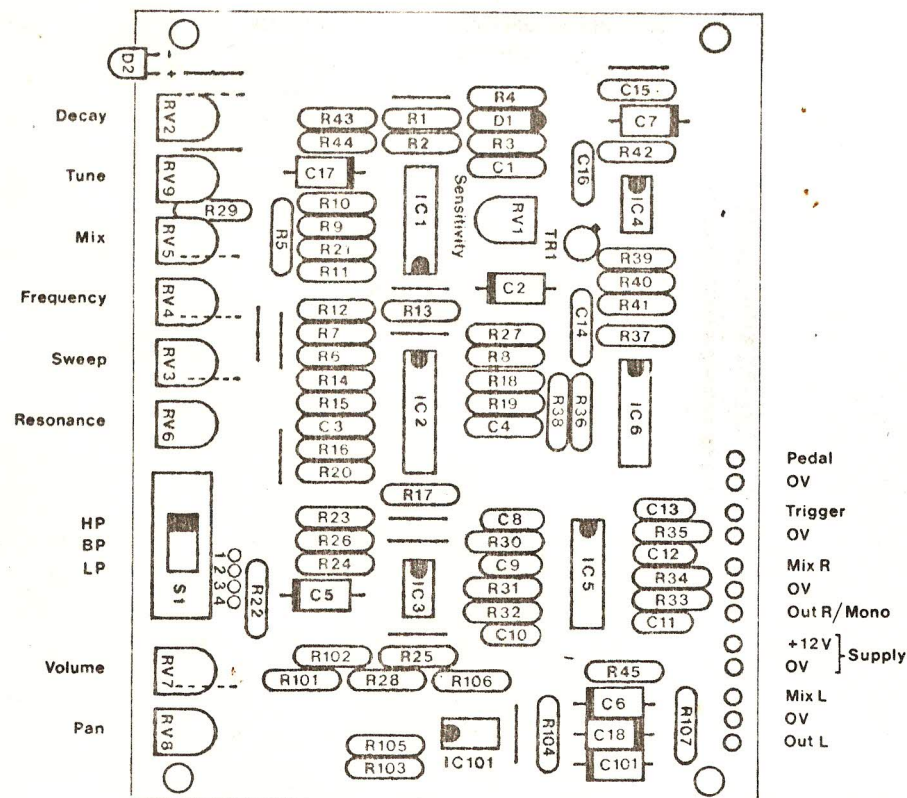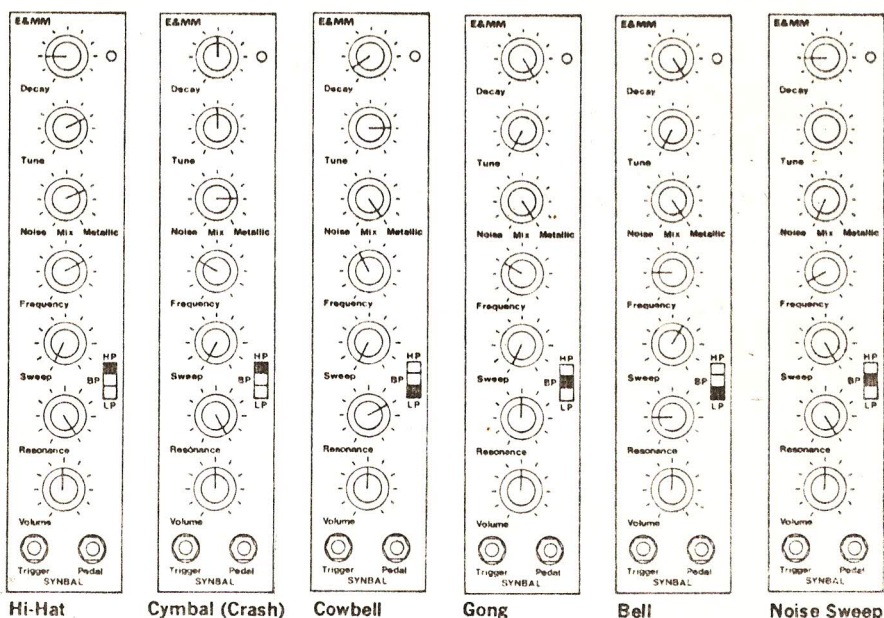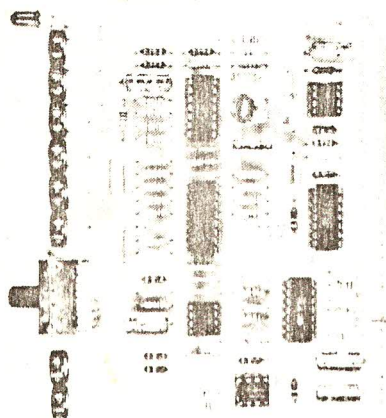
E&MM

Figure 4. Sample sound settings.

Hi-Hat   Cymbal (Crash)   Cowbell   Gong   Bell   Noise Sweep

PARTS LIST FOR SYNBAL

Resistors — all ¼W, 5%, carbon film

R1,2,23,40,43,44	47k
R3,42	2M2
R4,9,10,11,13,21,29	10k
R5	680Ω
R6,7,12,17,27	22k
R8,31,105,106	220k
R14,15,18,19,24,26,28	1k
R16,20,41	4k7
R22,25,30,36,37,45, 101,102,103, 104,107	100k
R32	330k
R33	390k
R34	470k
R35	560k
R38	33k
R39	150k

Capacitors

C1	22nF Polycarbonate
C2	2u2 63V Axial Electrolytic
C3,4	1nF Ceramic
C5,6,101	1uF 63V Axial Electrolytic
C7,17	4u7 63V Axial Electrolytic
C8,9,10,11,12,13,16	10nF Polycarbonate
C14,15	100nF Polycarbonate
C18	10uF 25V Axial Electrolytic

Potentiometers (see text)

RV1	47k horizontal pre-set
RV2	1M
RV3,4,5,8	100k
RV6	470k
RV7	47k
RV9	10k

Semiconductors

D1	1N4148
D2	LED
TR1	BC108B
IC1	LM324 or 3403
IC2	LM13600
IC3	CA3080
IC4	741
IC5	CD40106
IC6	CD4070
IC101	TL1458 or 4558

Miscellaneous

S1	3-way 4-pole slide switch (Maplin FH38R)
	Veropins
	16-pin DIL socket (1 off)
	14-pin DIL socket (3 off)
	8-pin DIL socket (3 off)
	PCB

Figure 3. Component overlay of the PCB.