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Analog 2.0 documentation

Vol. 6

VCO production

Version: 2.2

Created : December **21 , 2009**

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table of contents

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1. About this document

This document describes **the** VCO **module of the analog synthesizer system Analog** 2.0 .

I will explain the production method.

This document should be produced by the user with reference to the following documents.

It is written on the premise of.

--Analog 2.0 **Starter Kit**

--vol.4 **Manufacture of noise generator and mixer**

--vol.5 **Production of** VCA

Change log

Version date		**Changes**
2.0 2.0	2009/11/19	Analog2.0 **Document version** 2.0 -Review **the circuit design.** -Revised **the document accordingly.**
2.1 2.1	2009/12/05	-Description **of polypropylene capacitor-** Corrected C1 **to** C3 . -Added **processing example around temperature compensation resistor.**
2.2	2009/12/21	-Fixed **parts list.** TRIM1, 3, 4 **(wrong) Semi-fixed resistance (positive) Potentiometer** SW1 **(wrong) toggle switch (correct) rotary switch**

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2. VCO module manufacturing 2.1.

Manufacturing flow The module manufacturing flow is the same every time as follows. -- Obtaining parts --Installing parts on the board --Installing panel parts --Checking the wiring on the board --Checking the operation --Adjustment

In the sections after 2.3 , **we will explain the flow of this production step by step.**

2.2. Outline of the module to be manufactured 2.2.1. Functions In this article, the VCO module is manufactured.

VCO (Voltage Controlled Oscillator) **is translated as a voltage controlled oscillator.** As shown in **Figure 2-1 it has three sound signal outputs and two control voltage** (CV, Control Voltage) **inputs. Each waveform is always output. The frequency (pitch) of the waveform is controlled by the pitch control voltage.** The relationship between **frequency and** CV **is designed to be an exponential function rather than a proportional relationship. Specifically, every time the CV goes** up by 1V , **the pitch goes** up by one **octave (double). The pulse width (duty cycle) of a square wave or pulse wave can be changed by** the PWM (Pulse Width Modulation) control voltage.

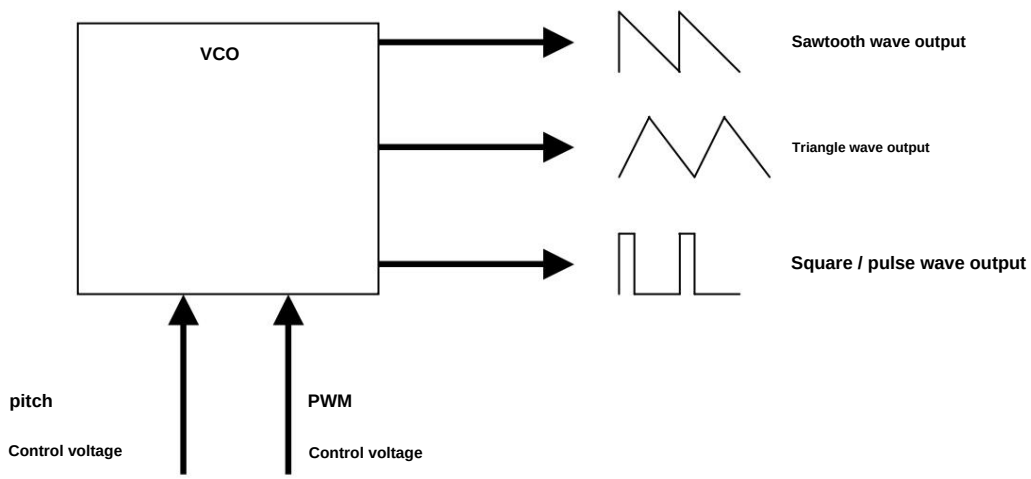

Figure 2-1 Conceptual diagram of VCO

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2.2.2. Positioning in the system

Figure 2-2 shows the position of the VCO in the configuration of the Analog 2.0 **production system . VCO is** It is a sound module placed at the first stage of Analog2.0 , **and is responsible for outputting the waveform that is the source of the sound signal. It does not have an input terminal and puts the output in the mixer. It accepts outputs from** Pitch CVs **and** LFOs **as control voltages .** The modulation signal from the **LFO is used for pulse width modulation in addition to pitch modulation.**

The LFO module **that connects to the** VCO **has not been manufactured yet, so it is not connected in this production article. Also, since the VCF to which the sound signal is supplied has not been manufactured, until the VCF is manufacture Will connect the mixer output directly** to the VCA **when checking the operation .**

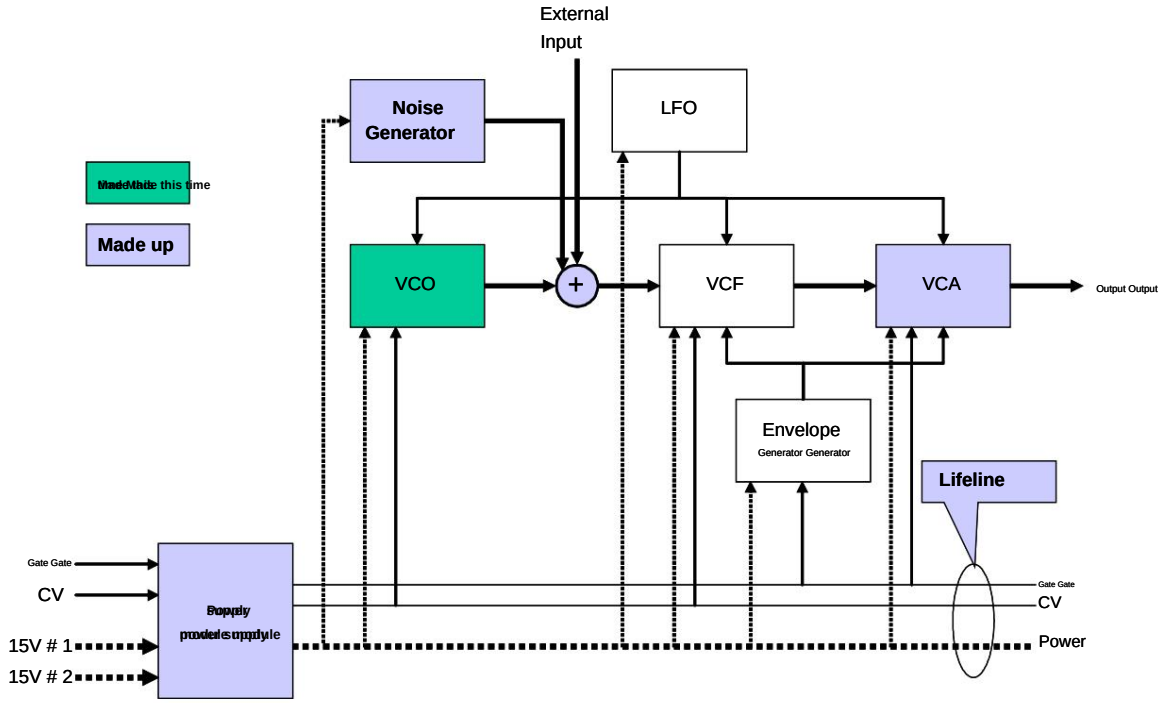

Figure 2-2 Positioning of VCO

Within the panel, the VCO is **positioned as shown in Figure** 2-3 .

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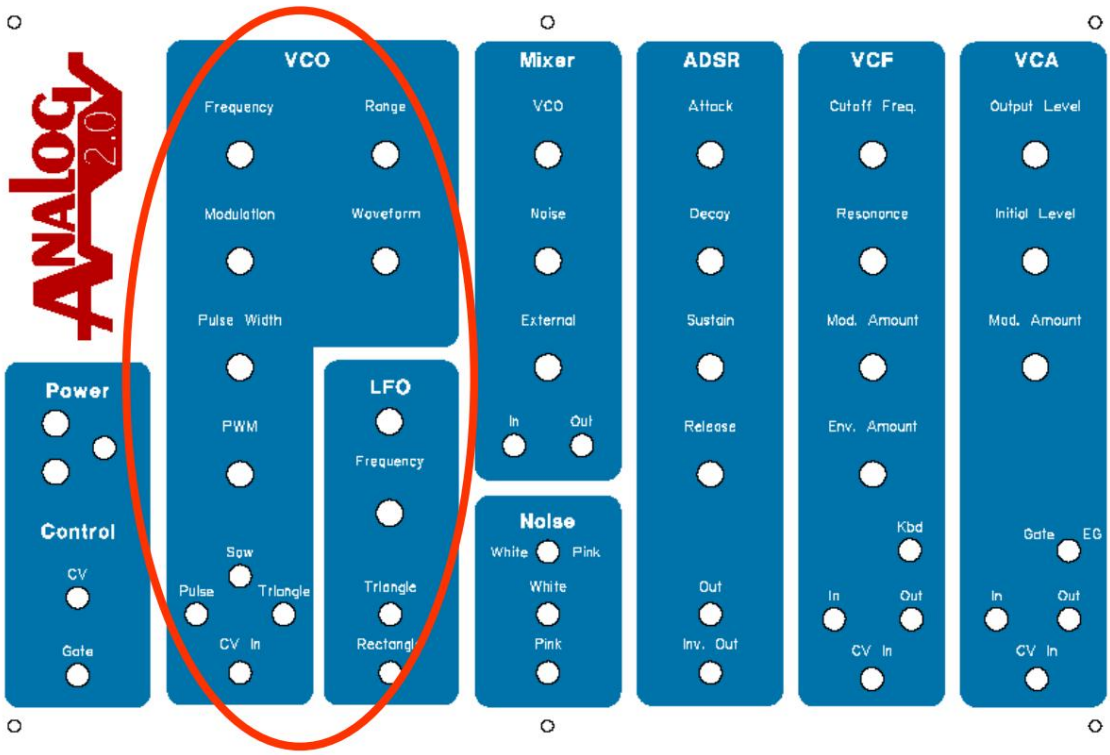

Figure 2-3 **Positioning in the panel**

2.2.3. Specifications

The VCO **specifications are as follows.**

- **Output signal level: ± 5V**
- **Output waveform: sawtooth wave, triangle wave, square / pulse wave**
- **Pitch CV level: 0-10V 0V corresponds to C0.**
- **Pitch / CV: Oct / CV exponential function**
- **Pitch CV input system:**
  - o **LFO / external input**
  - o **Initials (fixed)**
- **PWM CV level: 0-5V**
- **PWM CV input system:**
  - o **LFO / external input**
  - o **Initials (fixed)**

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2.2.4. Circuit

The circuit diagram of the VCO to **be manufactured** is shown in Figure 2-4.

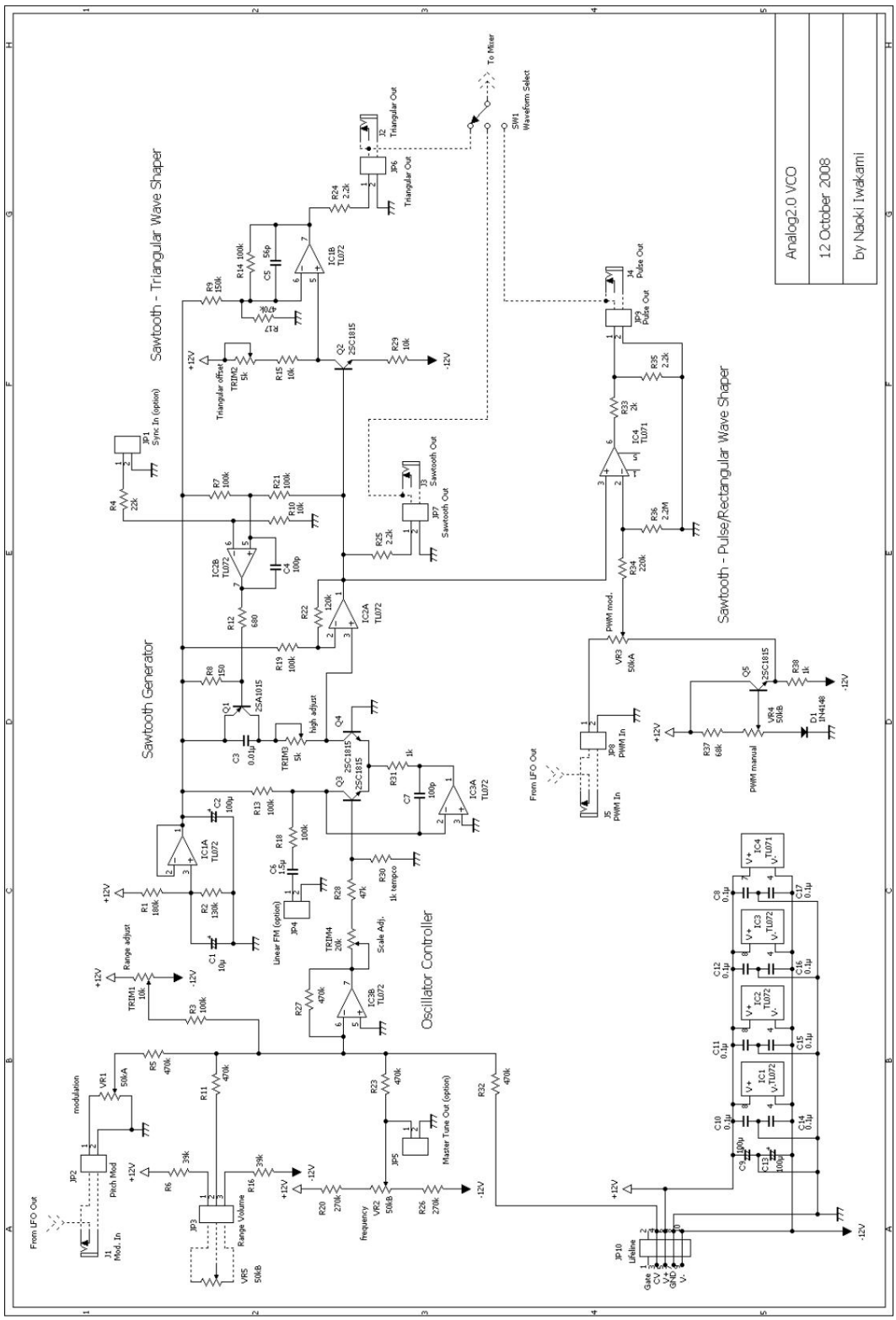

Figure 2-4 Schematic of the VCO module

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2.3. Obtaining parts

Well then, it's finally time to start production. The parts required for production are as follows. For production
So, get these parts first. Modules in this parts list
Not only the parts to be mounted on the circuit board, but also the switches and jacks to be mounted on the panel are included.
vinegar. The parts list does not include the knob. The knob is suitable for your taste
Please get it.

Table 2-1: **Parts required for** VCO production (inside the board)

parts number	Device name	Value / model number	remarks
C1	Electrolytic Capacitor	10 ÿF	Withstand voltage 25V or more
C2	Electrolytic Capacitor	100 ÿF	Withstand voltage 25V or more
C3	Polypropylene Capacitor	0.01ÿF	
C4	Ceramic Capacitor	100pF	
C5	Ceramic Capacitor	56pF	
C6	Multilayer Ceramic Capacitor	1.5ÿF	
C7	ceramic capacitor	100pF	
C8	Multilayer Ceramic Capacitor	0.1ÿF	
C9	Electrolytic Capacitor	100 ÿF	Withstand voltage 25V or more
C10	Multilayer Ceramic Capacitor	0.1ÿF	
C11	Multilayer Ceramic Capacitor	0.1ÿF	
C12	Multilayer Ceramic Capacitor	0.1ÿF	
C13	Electrolytic Capacitor	100 ÿF	Withstand voltage 25V or more
C14	Multilayer Ceramic Capacitor	0.1ÿF	
C15	Multilayer Ceramic Capacitor	0.1ÿF	
C16	Multilayer Ceramic Capacitor	0.1ÿF	
C17	Multilayer Ceramic Capacitor	0.1ÿF	
D1	Diode	1N4148	
IC1	op amp	TL072	
IC2	operational amplifier	TL072	
IC3	op amp	TL072	
IC4	op amp	TL071	
JP1	pin header 2.5mm pitch 1x2		Sync In
JP2	pin header 2.5mm pitch 1x2		Pitch Mod,

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JP3 pin header 2.5mm pitch 1x3		**Range Volume**
JP4 pin header 2.5mm pitch 1x2 JP5 pin header		**Linear FM (option)**
2.5mm pitch 1x2		**Master Tune Out (option)**
JP6 pin header 2.5mm pitch 1x2 JP7 pin header		**Triangular Out**
2.5mm pitch 1x2		**Sawtooth Out**
JP8 pin header 2.5mm pitch 1x2 JP9 pin header		**PWM In**
2.5mm pitch 1x2		**Pulse Out**
JP10 pin header 2.5mm pitch 2x5 L-shaped		**Lifeline**
Q1 transistor	**2SA1015**	
Q2 transistor	**2SC1815**	
Q3 transistor	**2SC1815**	
Q4 transistor	**2SC1815**	
Q5 transistor	**2SC1815**	
R1 carbon resistance	**180kÿ**	**1 / 4W 5%**
R2 carbon resistance	**130kÿ**	**1 / 4W 5%**
R3 carbon resistance	**100kÿ**	**1 / 4W 5%**
R4 carbon resistance	**22kÿ**	**1 / 4W 5%**
R5 carbon resistance	**470kÿ**	**1 / 4W 5%**
R6 carbon resistance	**39kÿ**	**1 / 4W 5%**
R7 carbon resistance	**100kÿ**	**1 / 4W 5%**
R8 carbon resistance	**150ÿ**	**1 / 4W 5%**
R9 carbon resistance	**150kÿ**	**1 / 4W 5%**
R10 carbon resistance	**10kÿ**	**1 / 4W 5%**
R11 carbon resistance	**470kÿ**	**1 / 4W 5%**
R12 carbon resistance	**680ÿ**	**1 / 4W 5%**
R13 carbon resistance	**100kÿ**	**1 / 4W 5%**
R14 carbon resistance	**100kÿ**	**1 / 4W 5%**
R15 carbon resistance	**10kÿ**	**1 / 4W 5%**
R16 carbon resistance	**39kÿ**	**1 / 4W 5%**
R17 carbon resistance	**470kÿ**	**1 / 4W 5%**
R18 carbon resistance	**100kÿ**	**1 / 4W 5%**
R19 carbon resistance	**100kÿ**	**1 / 4W 5%**
R20 carbon resistance	**270kÿ**	**1 / 4W 5%**
R21 carbon resistance	**100kÿ**	**1 / 4W 5%**
R22 carbon resistance	**120kÿ**	**1 / 4W 5%**

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R23 carbon resistance	**470kÿ**	**1 / 4W 5%**
R24 carbon resistance	**2.2kÿ**	**1 / 4W 5%**
R25 carbon resistance	**2.2kÿ**	**1 / 4W 5%**
R26 carbon resistance	**270kÿ**	**1 / 4W 5%**
R27 carbon resistance	**470kÿ**	**1 / 4W 5%**
R28 carbon resistance	**47kÿ**	**1 / 4W 5%**
R29 carbon resistance	**10kÿ**	**1 / 4W 5%**
R30 temperature compensation resistor	**1kÿ**	**3300ppm / ÿ**
R31 carbon resistance	**1kÿ**	**1 / 4W 5%**
R32 carbon resistance	**470kÿ**	**1 / 4W 5%**
R33 carbon resistance	**2kÿ**	**1 / 4W 5%**
R34 carbon resistance	**220kÿ**	**1 / 4W 5%**
R35 carbon resistance	**2.2kÿ**	**1 / 4W 5%**
R36 carbon resistance	**2.2Mÿ**	**1 / 4W 5%**
R37 carbon resistance	**68kÿ**	**1 / 4W 5%**
R38 carbon resistance	**1kÿ**	**1 / 4W 5%**
TRIM1 potentiometer	**10kÿ**	
TRIM2 semi-fixed resistance	**5kÿ**	
TRIM3 potentiometer	**5kÿ**	
TRIM4 potentiometer	**20kÿ**	
VR1 variable resistor	**50kÿA**	
VR2 variable resistor	**50kÿB**	
VR3 variable resistor	**50kÿA**	
VR4 variable resistor	**50kÿB**	

Table 2-2: **Parts required for** VCO production (outside the board)

parts number	**Device name**	**Value / model number**	**remarks**
VR5 variable resistor		**50kÿB**	
J1	**3.5mm mini jack**		**Mod. In**
J2	**3.5mm mini jack**		**Triangular Out**
J3	**3.5mm mini jack 3.5mm**		**Sawtooth Out**
J4	**mini jack**		**Pulse Out**
J5	**3.5mm mini jack**		**PWM In**
SW1 rotary switch		**1 circuit 3 contacts**	**Waveform Select**

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2.3.1. Precautions when obtaining

parts Parts are composed of those that can be obtained from Akihabara Sengoku Densho as much as possible.
If there are restrictions on the shape of the parts, the product number of Sengoku Densho is listed in the parts list. please refer.
Please be careful when obtaining the following parts.

Temperature compensation resistor

The most special part in this production is the temperature compensation resistor. The resistance value of a normal resistor is almost constant even when the temperature rises, but the temperature compensation resistance increases by 0.3% each time the temperature rises by 1 ° C. vinegar. The temperature compensation resistance is used to compensate the temperature of the antilog circuit and contributes to the stability of the pitch against temperature. Obtaining this part is a bit difficult. This part is distributed on the **Analog2.0 site and can also be obtained from here.**
http://gaje.jp/analog20/

The **polypropylene capacitor** C3 is the heart of the VCO **and requires high stability.**
It will be. Therefore, polypropylene capacitors are used only here.
Polypropylene capacitors are a companion to the same plastic film capacitors as Myra capacitors, but Myra Conde
It has better temperature characteristics and accuracy than the sensor. This capacitor is Not available at Sengoku Densho. However, it is not a hard-to-find part. In Akihabara, you can get it at stores such as Radio Department Store, Marutsu Part Kan, and Suzusho.

Potentiometer

The VCO **uses a multi-turn semi-fixed resistor called a potentiometer because the adjustment requires precision. With normal semi-fixed resistance Does not make one revolution from the minimum to the maximum resistance, but with a potentiometer, it can only be reached from the minimum to the maximum by turning the knob multiple times. Therefore, it is possible to adjust with higher accuracy than the normal semi-fixed resistance. In this production, we will use the type with the knob facing sideways, as shown in Fig. 2-5.**

There are three output waveforms for the **rotary switch** VCO , **but it is the one that can be put into the mixer. Only one of them. Use the rotary switch to select the waveform .** The blue type of Alps **is recommended, but any non-shot type with three contacts will do. With non-short**
Is the distinction between whether or not to short-circuit with the adjacent terminal when the contact is switched. Of course, non-short is not short. Shi Please do not use the shot type.

3.5mm **mini jack** The 3.5mm **mini jack is attached to the panel, so the "neck" part**

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The minute must be long to some extent. All 3.5mm mini jacks **available from Sengoku Densho have short necks** and are **not suitable for panel mounting with Analog 2.0. The Analog 2.0 production machine uses the product number** J109 **from the Marzparts Building. In Akihabara, there are several other types of mini jacks sold at Suzusho stores that have long necks .** (As **of April 2008) TL072 is specified for the operational amplifier. In other articles,**

Operational amplifier TL072

I mentioned the replacement with an operational amplifier such as NJM4558 . **Here, about** IC1 that needs to have high input impedance **Is not recommended.** However, if **it is a FET input type such as NJM2082 , it can be replaced.**

Pin header

A pin header is used at the connection point with external parts. 2P _ There are ones and 3P **ones. 2P and** 3P **pin headers are difficult to obtain and uneconomical, so cut down the pin headers with a large number of pins (for example,** 20P) **(Fig.** 2-7).

2x5 box pin header Use L **-shaped lead wires as much as possible .**

Knob

When using the straight type, pay attention to the orientation of the notch when installing. Since the knob is a part with different tastes, the model number is not specified in this document. Please select according to your taste. The shaft diameter of the volume used for production is 6 mm , **and any knob that matches this can be used. For reference, the prototype**

So, I am using the one with the product number MAV B-15 .

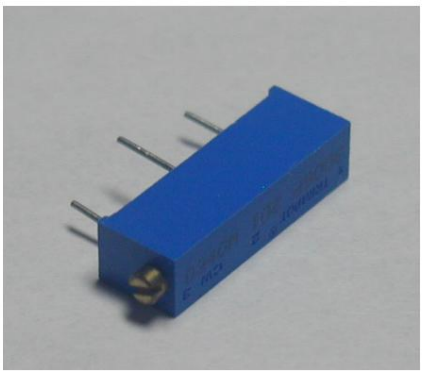

Figure 2-5 Potentiometer

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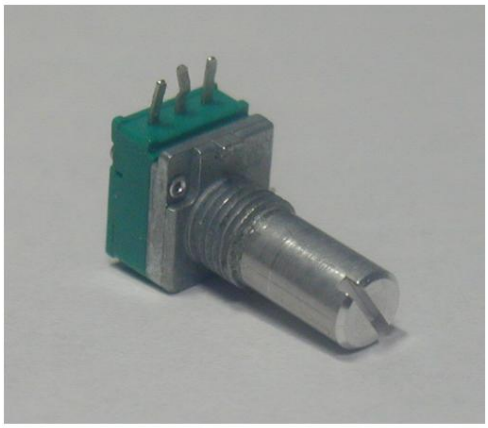

Figure 2-6 Volume used for production

Figure 2-7 2P 3P pin header

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2.4. Attaching parts to the board

Figure 2-8 **is the wiring diagram of the printed circuit board to be manufactured this time.**

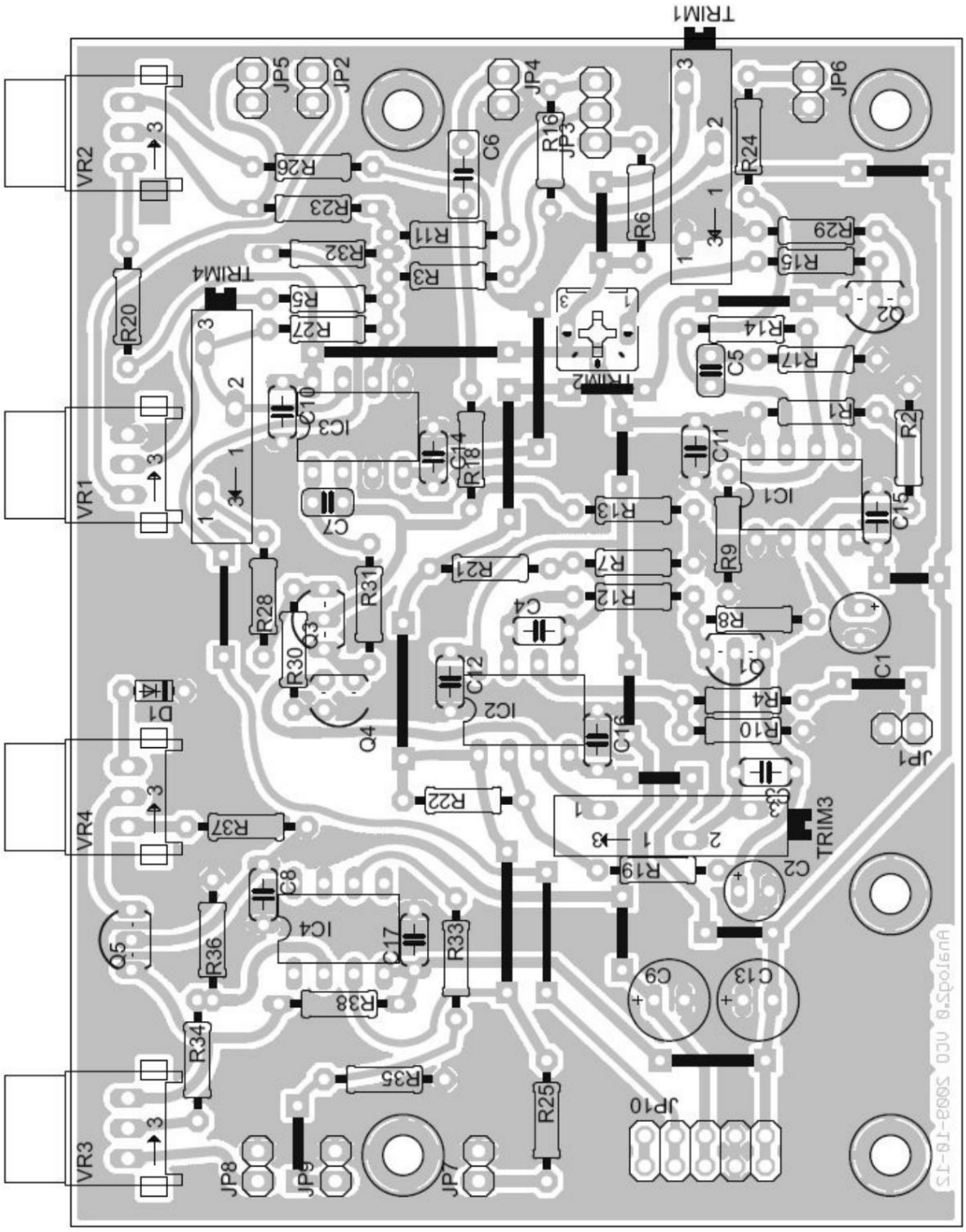

Figure 2-8 **Wiring diagram of VCO board**

R30 is **a special resistor that compensates for the temperature of the antilog circuit consisting** of Q3 **and** Q4 . **That cetera**

Therefore, it is better to keep these three **parts at the same temperature to obtain a stable pitch.**

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Figure 2-9 **is an example of processing. It is hardened with an epoxy adhesive. The parts should be as close together as possible.**

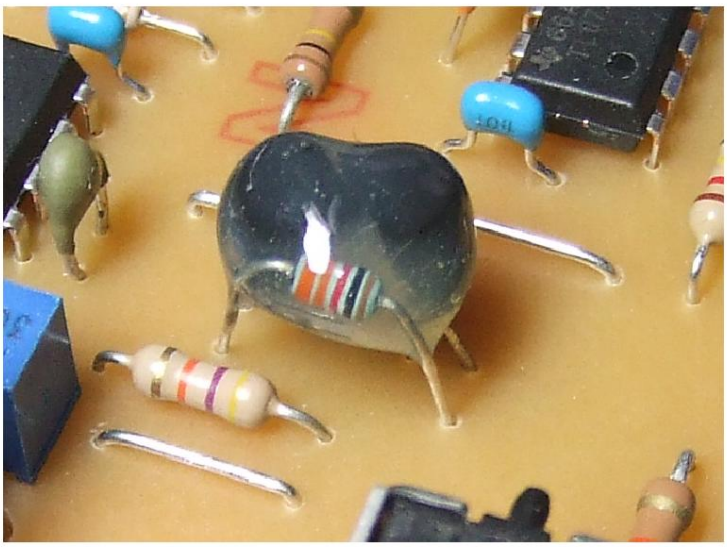

Figure 2-9 **Thermal coupling of antilog transistor, temperature compensation resistor and temperature compensation resistor**

2.5. Installing the panel parts

After installing the board parts, wire the parts to be attached to the panel (parts outside the board). Connect **the pin header and the switch / mini jack with lead wires as** shown in Fig. 2-10 . Connect the VCO input terminal **of the mixer to the place where the mixer input is written .** In the actual wiring diagram shown in **Fig.** 2-10 , **the lead wires are intentionally routed to make the connection easier to see. However, please try to make the lead wire as compact as possible in the actual wiring.** The photo in **Figure** 2-11 **is an example of mounting the board on a panel. Figure 2-12 shows the implementation on the panel from the front side. As you can see from the photo, the board has no volume axis. It is fixed by tightening it.**

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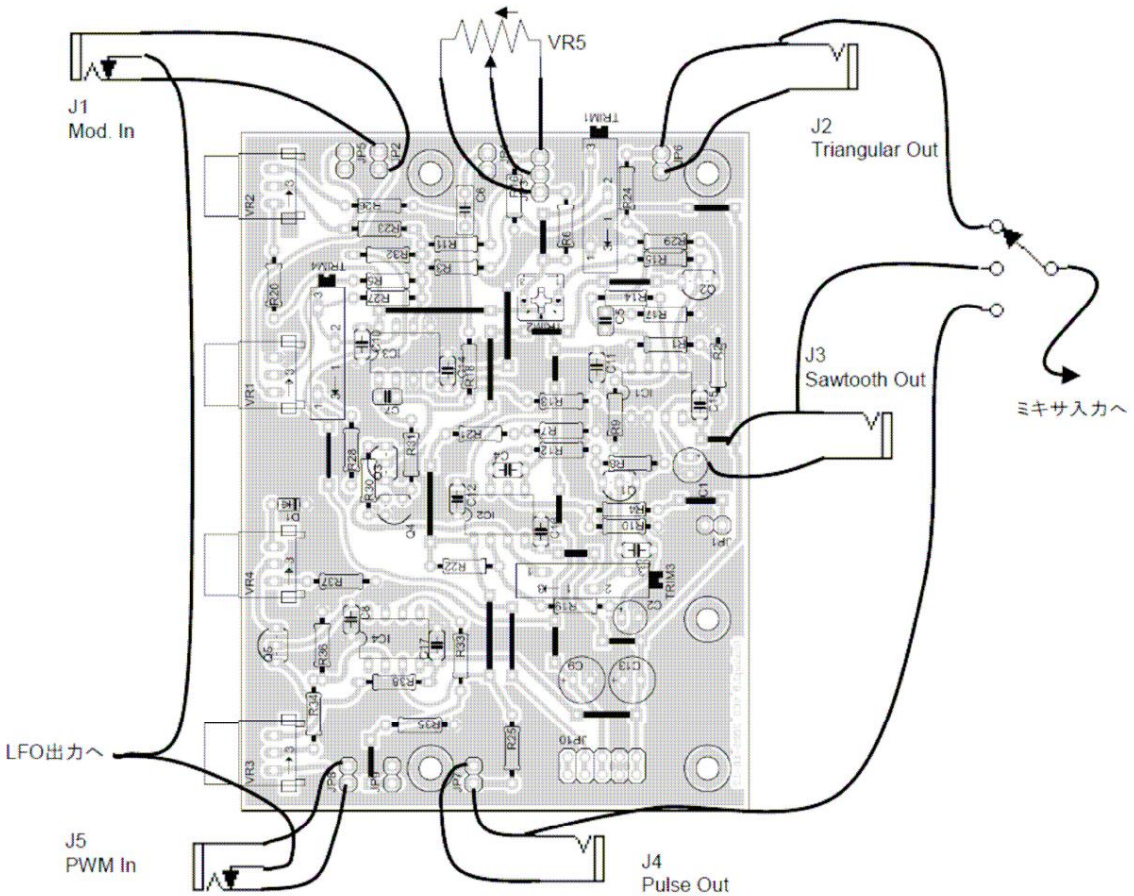

Figure 2-10 **Wiring of panel parts**

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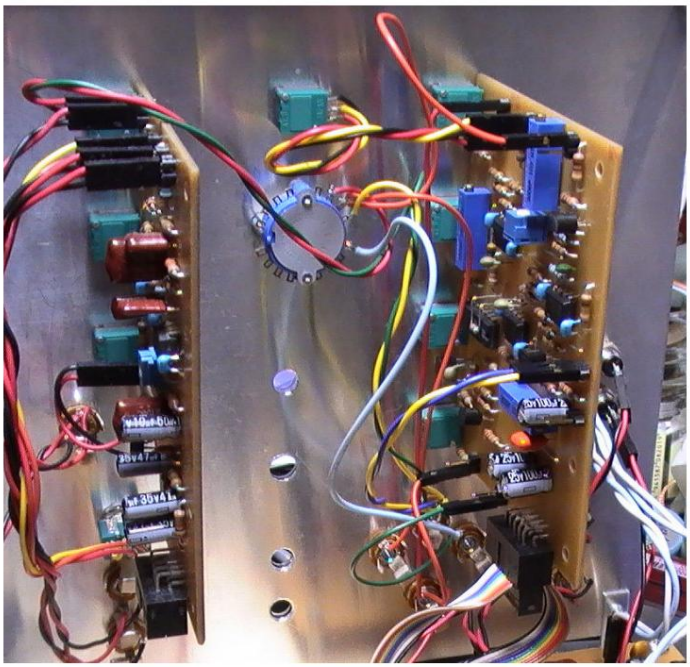

Figure 2-11 Mounting example on the panel (back side)

Figure 2-12 Implementation example on the panel (front side)

2.6. Checking the wiring on the board

At this point, the assembly of the VCO module is complete. I'd like to move it right away,
Do not turn on the power yet. Be sure to check the wiring before turning on the power. In the unlikely event that there is a wiring error, not only will it not operate normally, but in some cases parts will be damaged. vinegar. Check the checklist below to see if the wiring is correct.

[] Is the resistor installed in the correct place and with the correct value?
[] Is the capacitor installed in the correct place, with the correct type and with the correct value? [] Is the electrolytic capacitor installed in the correct orientation? [] Is the diode installed in the correct place and in the correct orientation? [] Is the transistor installed in the correct place and in the correct orientation?
[] Is the IC **installed in the correct place and in the correct orientation?**
[] Is the jack pin header installed in the correct place? [] Turn the board over and check the soldering points. The adjacent copper foil pattern is Han

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Is there a solder bridge that is short-circuited in the da?

[] Is there any place where the soldering is immo soldering? If the body of the part is shaken and the lead at the soldering point moves, it is almost certainly immo solder. The potato solder will peel off over time, so if you find it, re-solder it.

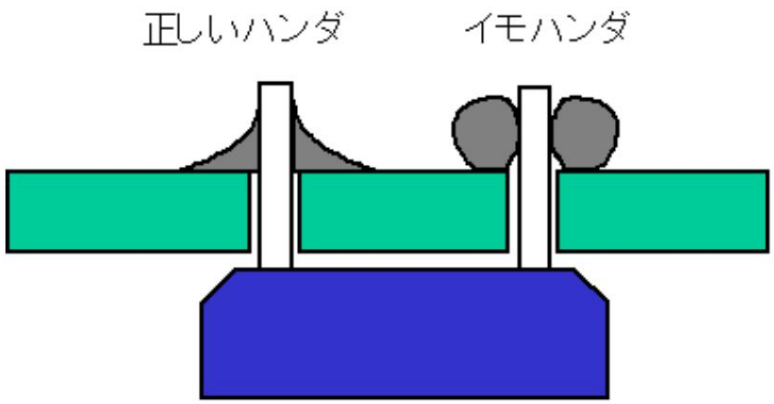

Figure 2-13 Correct solder and immo solder

2.7. Operation check and adjustment

Now, let's check the operation. Let's make some adjustments as well. The mountain of production of Analog2.0 will be the adjustment of VCO . With a **VCO , you need to balance and adjust multiple locations, which requires time and patience. However, once you get over this, production will be easier. Let's do it patiently.**

Before turning on the power, make the following preparations.

1. Please prepare the following tools necessary for this adjustment.

- o **CV Generator – This document uses MInI-Board.**
- o **440Hz reference tone generator – Use the 440Hz generator included with the CV generator. Also, electric You can also use the functions provided with the child metronome and tuner.**

  The tuning fork is not suitable because I want to produce a continuous sound.
- o **Monitor Speaker Amplifier-Pitch adjustment is done by listening to the actual sound. So you need a monitor tool.**
- o **Frequency meter – You can adjust it without it, but it may be psychologically reassuring. De Some digital testers have functions.**

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- **Oscilloscope – Dedicated machine or software is fine.**

2. **Make sure the board is secured to the panel.**

3. **Make sure that the power switch is off, and the lifeline extending from the power module**
   Connect the terminals of the cable to the VCO module.

4. **Connect the two AC adapters to the DC jack of the power supply, and it's time to turn on the power.**

Follow the procedure below to check the operation.

1. **Set both Frequency and Range volumes to the midpoint. Modulation, PWM, Pulse**
   Width is squeezed to the far left. Set the waveform selection to the center (sawtooth wave).

2. **Set TRIM1, TRIM2, TRIM4 in the middle position. The current position of the multi-turn trimmer is known**
   It's hard to do, but with the one I used this time, if you make 15 turns to the left and then 7 turns to the right, it's roughly
   I will come to the midpoint. TRIM3 should be turned all the way to the right by 15 turns.

3. **Connect the monitor speaker directly to the VCO output and check that the dial tone is output from the VCO.**
   To. There are three types of outputs: sawtooth wave, triangle wave, and pulse wave, so check all three.

4. **Maximum Output Volume, Maximum Initial Volume, Maximum Mixer VCO Volume,**
   Minimize the Noise volume.

5. **Connect a monitor speaker to the VCA output and check that the VCO is oscillating.**

If this check is okay, the module is working for now.

Next, make the adjustment according to the following procedure.

[Pitch Adjustment-Scale Range Adjustment and High Frequency Correction]

1. **Make sure TRIM1 and TRIM2 are set in the middle position. Turned 15 turns to the left**
   After that, if you turn it 7 times to the right, it will be set in the middle. Turn TRIM3 all the way to the right.

2. **Maximum Output Volume, Maximum Initial Volume, All VCO Volumes on Mixer**
   Maximum, minimize others.

3. **Select a square wave for the VCO waveform. Minimize the PWM / PWM manual knob.**

4. **Set the VCO Frequency and Range knobs to the midpoint.**

5. **Connect the CV generator to the lifeline. A voltage equivalent to A3 is generated from the CV generator.**
   Press the octave button to set it to 3, and then press the A button.

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6. Adjust the TRIM1 with reference to the reference oscillator 440Hz or using a frequency meter to VCO.

Set the oscillation frequency of to 220Hz. When using a reference oscillator, both the reference sound and the VCO sound

Play, listen to the growl, and look for exactly one octave lower.

7. Switch the CV generator to generate the voltage equivalent to A2. Press the octave button 2

Just press the A button.

8. Adjust the TRIM4 so that the VCO output is 110Hz.

9. Switch the CV generator to generate the voltage equivalent to A5.

10. Adjust the TRIM3 so that the VCO output is 880Hz.

11. Repeat steps 6-9 until A2 110Hz, A3 220Hz, A5 880Hz.

12. Generate a voltage equivalent to A6 from the CV generator.

13. Adjust TRIM3 so that the oscillator output is 1760Hz.

14. Repeat 6-12 until the frequency of A6 reaches 1760Hz.

[Triangle wave offset adjustment]

1. Connect the VCO's triangular wave output to the oscilloscope.

2. Output a voltage equivalent to A4 from the CV generator.

3. While observing the waveform, adjust TRIM2 so that the waveform becomes a triangular wave.

This completes the adjustment of the VCO module.

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