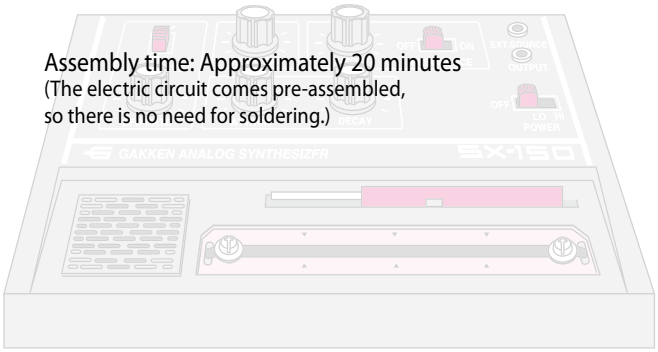


Assembly time: Approximately 20 minutes
(The electric circuit comes pre-assembled,
so there is no need for soldering.)

Analog Synthesizer SX-150

GAKKEN ANALOG SYNTHESIZER

How to Assemble and Use the Supplement

Things you will need

☒ Phillips screwdriver (No. 1)
☒ AA alkaline batteries
(4 new)

* Please note that rechargeable NiCd batteries and non-rechargeable Oxyride and nickel-based batteries should not be used due to a high risk of components melting or fire breaking out with these batteries because of accidental short-circuiting or the like. Additionally, because this supplement was designed based on operation at 6 V, it may not operate in the desired way due to an excess of or a deficiency in voltage with the above batteries. Incidentally, most rechargeable batteries provide 1.2 V and Oxyride batteries, 1.7 V.

☒ Cellophane tape

Notes for tightening screws

The types of screws used for the supplement are those that carve grooves into the plastic as they are inserted (self-threading). The screwdriver most suited to tightening the screws is the #1 JIS screwdriver. When tightening screws, firmly press the provided screwdriver straight against the screws and turn. It is said that 70 percent of the force applied is used for pushing against the screw and 30 percent for turning it. Precision screwdrivers are hard to turn, so use a small screwdriver with a grip diameter of about 2 cm.

Full-scale image of a #1 screwdriver

☒ Plastic materials used in this kit
Main unit/knobs: HIPS
Electrode handles: PE
Printed circuit boards/slider panel: Phenolic resin
☒ Metallic materials used in this kit
Electrodes: Iron (nickel plating)
Screws: Iron

Parts in the Kit

CAUTION Please be sure to read the following instructions before assembling this kit.

- Take necessary caution when handling parts with pointed edges. There is a risk of injury.

☒ There are many parts with pointed edges on the back side of the circuit board, so please take care that you do not get injured by getting a finger or other body part caught on one of the sharp edges.

☒ This kit includes screws and other small parts. Be careful not to swallow them. There is a risk of suffocation.

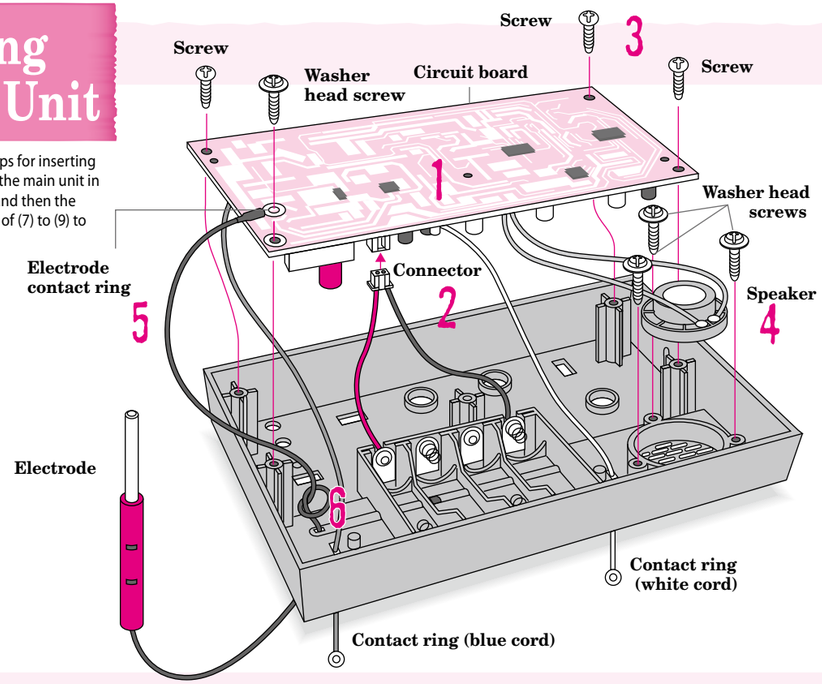
This supplement uses AA alkaline batteries. Incorrect use of the batteries may cause the generation of heat, explosions or liquid leakage.
The following precautions should be taken.

- Please note that rechargeable NiCd batteries and non-rechargeable Oxyride and nickel-based batteries should not be used.
- Ensure that the positive and negative terminals of the batteries are aligned correctly.
- If liquid that leaked from the batteries gets into your eyes, rinse them well with plenty of water and consult a doctor immediately.
If liquid leaks onto your skin or clothes, wash it off immediately.
- Always remove the batteries after use.

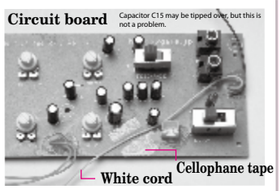
- Please read the instructions and cautions thoroughly before trying it out.
- For your safety, be sure to follow the instructions in this manual. In addition, do not use any parts that have become damaged or deformed during use.
- Always remove the batteries after use and place them in a location out of the reach of small children.

Assembling the Main Unit

First, carry out the steps for inserting the circuit board into the main unit in the order of (1) to (6) and then the last steps in the order of (7) to (9) to complete.



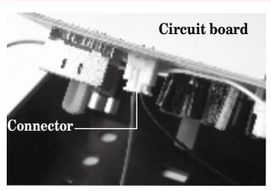
1



Attach the cord to the circuit board

Affix the white cord to the circuit board with cellophane tape so that it is out of the way when inserting the circuit board into the main unit.

2



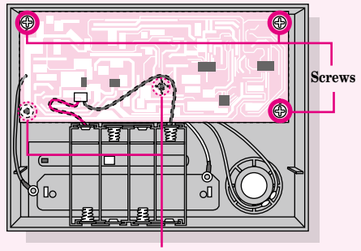
Connect the battery connector

Insert the connector for the battery box into the plug on the circuit board.

3

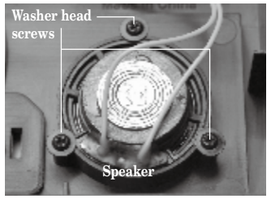
Screw the circuit board onto the main unit

Being careful not to let the cords get caught in any parts, affix the circuit board to the main body with screws.



*** Pass the blue and black cords around the protrusions as shown in the above picture.**

4

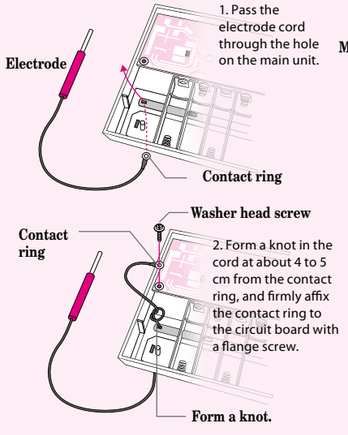


Attach the speaker

Attach the speaker to the hole on the main unit, and secure with washer head screws. Be careful not to let any parts of the cords on the speaker get caught in the screws.

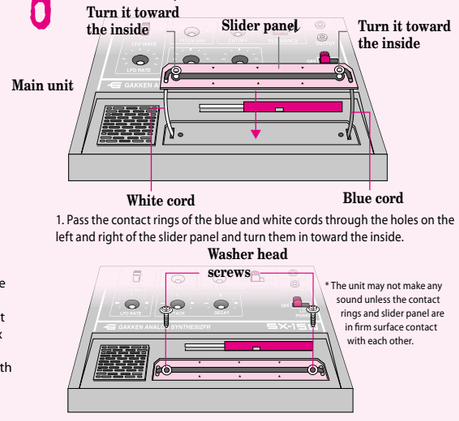
5

Attach the electrode



6

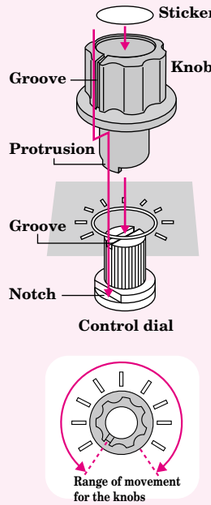
Install the slider panel



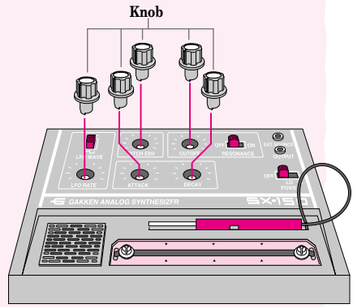
7

Attach the knobs

Attach the labels included in the magazine to the knobs, and then fit each knob onto a control dial.



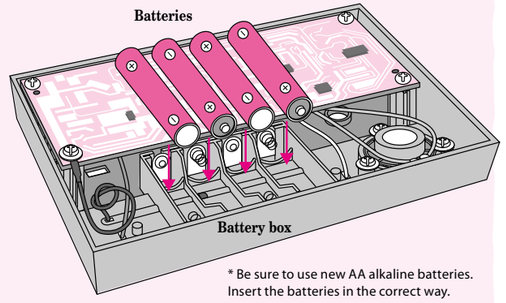
Lightly place each knob onto a control dial, and turn each one all the way to the left. Next, remove each knob, and then place each back onto a control dial using the grooves on the knob and the grooves on the control dials as a guide and push each knob onto its control dial all the way. If they are lined up correctly, you will be able to turn the knobs within the range shown in the picture on the bottom left.



8

Insert the batteries

Insert the batteries into the battery box on the main unit.

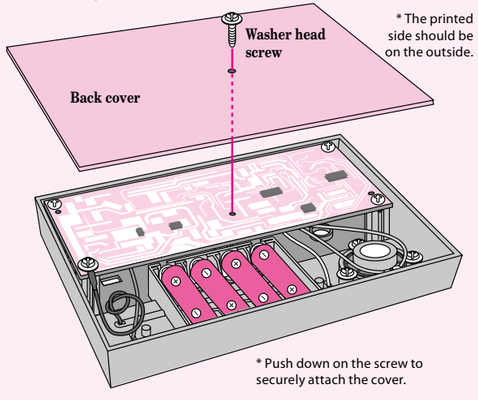


*** Be sure to use new AA alkaline batteries. Insert the batteries in the correct way.**

9

Attach the back cover

Cut the back cover out and remove it from the cardboard case, and then secure it with washer head screws onto the back of the main unit as shown in the picture.



* The printed side should be on the outside.

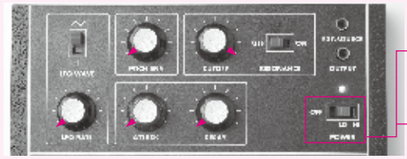
*** Push down on the screw to securely attach the cover.**

Analog Synthesizer
SX-150
GAKKEN ANALOG SYNTHESIZER

Try Making Some Sounds.

1

Set the switches and knobs as shown below

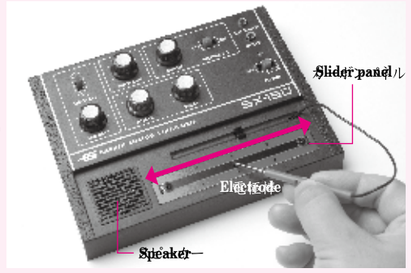


LFO WAVE	Set to either
LFO RATE	Turn all the way to the left
PITCH ENV	Turn all the way to the left
CUTOFF	Turn all the way to tthe right
RESONANCE	Set to OFF
ATTACK	Turn all the way to the left
DECAY	Turn all the way to the left
POWER	Set to LO (low volume) or HI

2

Touch the slider panel with the tip of the electrode to produce a sound from the speaker

Sliding the tip to the left will produce a lower pitch sound and to the right, a higher pitch sound. By sliding the tip across the panel from one end to the other, you can produce notes in four octaves.



Q&A

For demo performances, visit:
http://otonanokagaku.net/

No sound is produced.

- Ensure that you are using new batteries.
  Be sure to always use new alkaline batteries to replace any that have run out of power.
- Check all connections.
  Check to ensure that the connector for the battery box is fully engaged with the plug on the circuit board. Securely reconnect the connector if it is loose.
- Check the contact ring and screw on each side of the slider panel.
  No sound will be produced if either contact ring is not making good contact with the slider panel. No sound will be produced if it appears that each contact ring is just touching the slider panel, so reattach the contact rings so that they are as flat against the surface of the slider panel as possible.

Pitch increases towards the left of the slider panel and decreases towards the right.

- Check the colors of the cords connected to the slider panel.
  If the blue and while cords are connected in reverse, the relationship between pitch and position on the slider panel will be inverted.

The pitch of the sound does not change even if the electrode is moved along the slider panel.

- Check the contact ring and screw on the left side of the slider panel.
  The pitch will not change if the contact ring on the left is not making good contact with the slider panel. Electricity will not conduct if it appears that the contact ring is just touching the slider panel, so reattach the contact ring so that it is as flat against the surface of the slider panel as possible.

Descriptions of Each Part and Their Functions

By learning about the functions of each switch and knob, you can learn how to combine those functions together to produce sounds.

PITCH ENV
Amount of change in the rise/fall in pitch of the sound.

CUTOFF
Depth of the filter.

RESONANCE
Amount of resonance in the sound.

ATTACK/DECAY
Amount of change in the sound volume.

LFO WAVE
音の高さの変動波形。

LFO RATE
Varying waveform of pitch of the sound.

LFO RATE
Speed of variation of pitch.

Speaker
Outputs sound. (Used when no device is connected to OUTPUT)

EXT. SOURCE
External input terminal

OUTPUT
Terminal for connecting to a speaker or the like.

POWER LED
Lights up red when the power is ON.

POWER
OFF (Volume at 0)
LO (Volume low)
HI (Volume high)

Electrode

Slider panel/Electrode
Play sounds by touching the slider panel with the electrode.

Slider panel

LFO

LFO is the abbreviation of Low Frequency Oscillator and refers to an oscillator that operates at low frequency. It changes slowly over a constant cycle. It changes pitch of the original tone.

LFO WAVE

Changes the shape of the wave produced by LFO

Triangle wave:
A wave traveling along in a linear manner that repeatedly seesaws up and down.

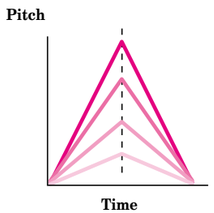
Square wave:
A wave with 50% of the width of a pulse wave that repeats at regular intervals.

LFO RATE

Adjusts the speed of the repetition of the wave produced by LFO.

PITCH ENV

Short for PITCH ENVELOPE.
Changes the pitch in accordance with the curve of the envelope (time variations of the sounds).

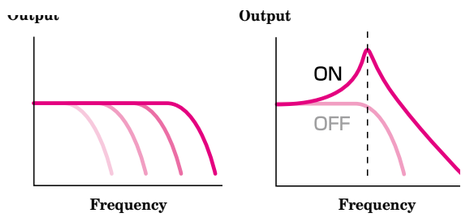


CUTOFF

CUTOFF
CUTOFF produces sounds of frequencies lower than the frequency set and cuts out sounds of higher frequencies.

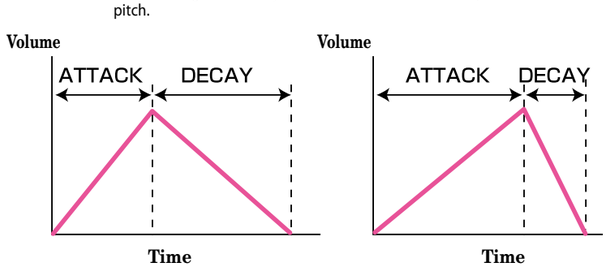
RESONANCE

Resonance refers to "resonating" and accentuates sounds at frequencies near those set by the CUTOFF.



ATTACK/DECAY

Determines the shape of the envelope. ATTACK changes the rising time for the sound. DECAY changes the decay time of the sound. This envelope affects CUTOFF and the pitch.

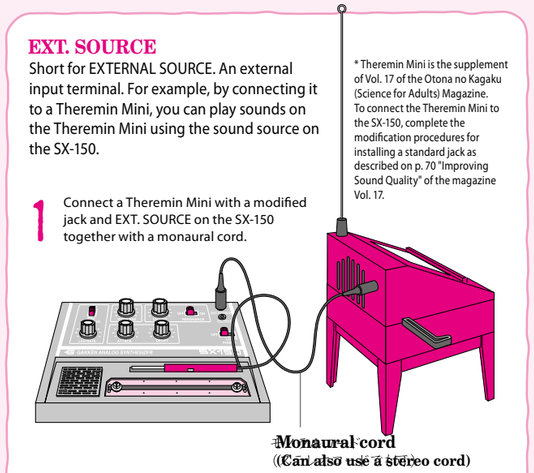


EXT. SOURCE

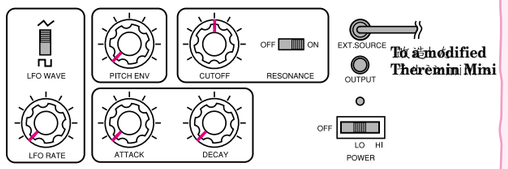
Short for EXTERNAL SOURCE. An external input terminal. For example, by connecting it to a Theremin Mini, you can play sounds on the Theremin Mini using the sound source on the SX-150.

* Theremin Mini is the supplement of Vol. 17 of the Otona no Kagaku (Science for Adults) Magazine. To connect the Theremin Mini to the SX-150, complete the modification procedures for installing a standard jack as described on p. 70 "Improving Sound Quality" of the magazine Vol. 17.

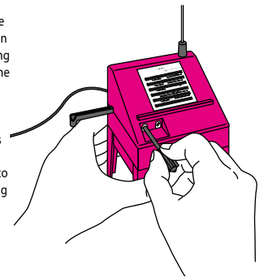
1 Connect a Theremin Mini with a modified jack and EXT. SOURCE on the SX-150 together with a monaural cord.



2 Set the knobs and switches on the SX-150 as shown below, and turn on the switch for the Theremin Mini. You can control LFO, CUTOFF, and RESONANCE, but PITCH ENV and ATTACK/DECAY cannot be changed.



3 Tune the Theremin Mini. The method for tuning it is basically the same as that for when the Theremin Mini is used on its own. After turning the left control dial all the way to the right, start turning it slowly to the left, a little bit at a time. Difference between this and when the Theremin Mini is used on its own is that the pitch not only goes lower but also goes higher, but the step to stop right before sound stops being produced is the same.



As with a regular theremin, if you create a zero point, the range within which you can play sounds by moving your hand will get narrower. If this occurs, play sounds with tuning having been completed while sounds were still being produced. Try switching LFO WAVE and changing LFO RATE and further changing CUTOFF and RESONANCE. You can also use CUTOFF for the volume control as well.

OUTPUT

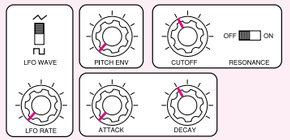
An external output terminal. Sound quality will increase if the kit is connected to an external speaker with amplifier for PC or a musical instrument amplifier. This is a monaural terminal, so you'll only get sound from one channel if you connect to a stereo device.

Try Producing Sounds

The knob positions are provided only as rough guides. Search for the closest equivalent sound as possible by adjusting the knobs to the left and right around what is shown in the pictures.

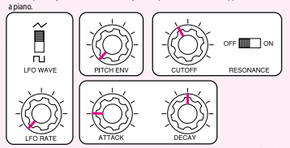
Musical instruments

Guitar



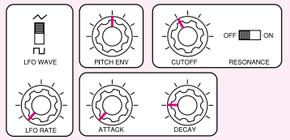
You will get a guitar sound if you play at a higher pitch and a bass guitar sound if you play at a lower pitch.If you increase the DECAY, you can produce sounds that approximate those of a piano.

Wind instrument



From the settings for the guitar sounds, you can change the sound to that of a wind instrument by raising ATTACK slightly and making the rise for the sound slower.

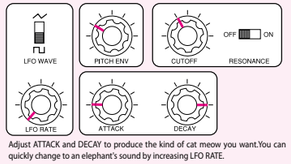
Synth drum



Try to create the sound of the synth drum used by YMO.
By varying the setting of PITCH ENV, you can also change it to create the sounds used in video games.

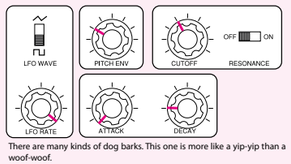
Sound effects

Cat meowing



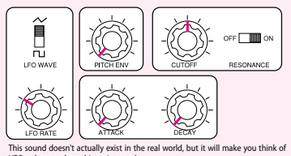
Adjust ATTACK and DECAY to produce the kind of cat meow you want.You can quickly change to an elephant's sound by increasing LFO RATE.

Dog barking



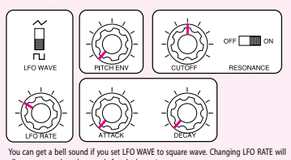
There are many kinds of dog barks. This one is more like a yip-yip than a woof-woof.

UFO



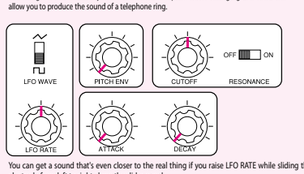
This sound doesn't actually exist in the real world, but it will make you think of UFOs when you hear this eerie sound.

Train departure bell



You can get a bell sound if you set LFO WAVE to square wave. Changing LFO RATE will allow you to produce the sound of a telephone ring.

Car engine



You can get a sound that's even closer to the real thing if you raise LFO RATE while sliding the electrode from left to right along the slider panel.

Operating Principles for the Supplement's Synthesizer

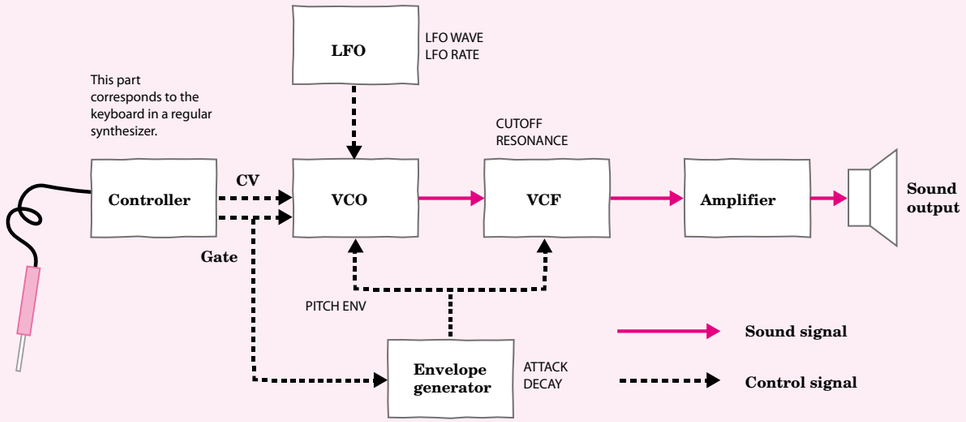
Written by: Gan

The electric circuit in the supplement's Synthesizer is made up of a combination of several circuits, each performing a simple operation. Breaking the circuit down at this level would yield a configuration like the one shown in the diagram below. Each of the blocks in the diagram is referred to as a function block. The function blocks send requests to each other to operate as a synthesizer. The requests that the function blocks send to each other are called "signals." The signals used in the supplement's Synthesizer can roughly be divided into two groups of "sound signals" and "control signals."

This may seem a little bit difficult to understand, but it might be easier if you think of it in terms of a piano. Roughly speaking, a piano is made up of the following:

☒ A mechanism for generating sound
(Strings wound with piano wire Sounding board)
☒ A mechanism for controlling how sound is released
(Keyboard/hammers/dampers)

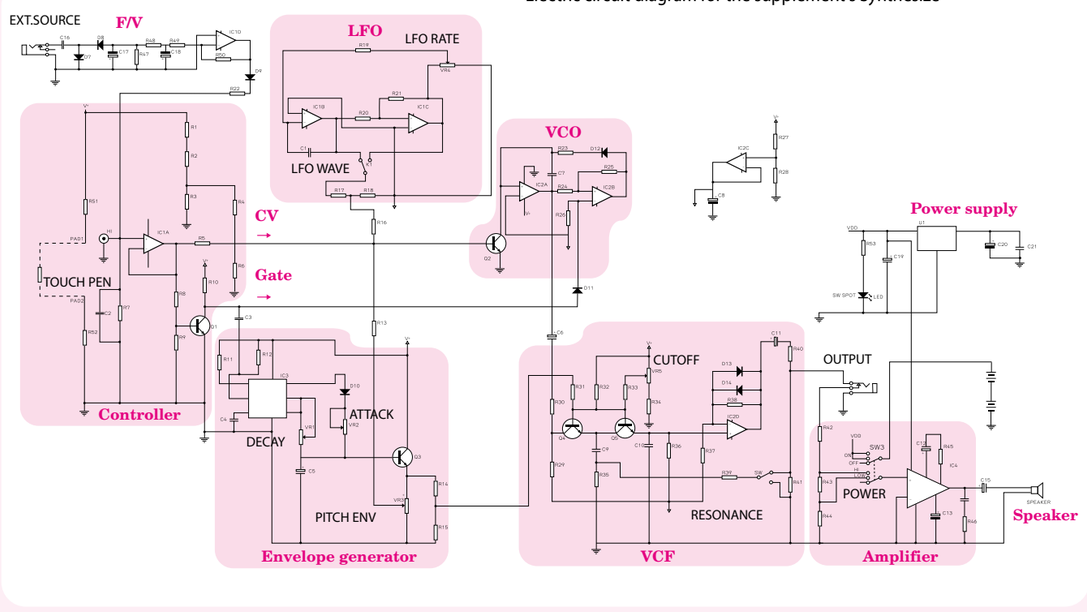
The supplement's Synthesizer is similar to this, where sound signals are the mechanism for generating sound and control signals are the mechanism for controlling how the sound is released.



* Here, this explains the electrical characteristics of the supplement's electric circuit. Please read from page 76 for a more general description of the Synthesizer.

Structure of the supplement's Synthesizer

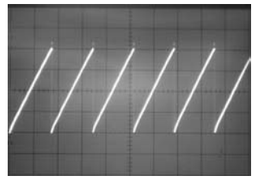
Electric circuit diagram for the supplement's Synthesize



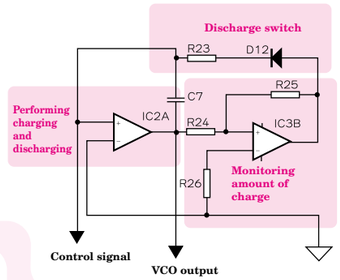
So, what happens inside the supplement's Synthesizer once you actually start playing sounds using the electrode?
Once you start playing sounds with the electrode, the controller generates two types of control signals. One signal is referred to as the control voltage (CV) and is a signal for controlling the pitch of the sound. The other signal is referred to as a gate and is a signal for controlling ON/OFF for the sound. The CV changes according to the position of the electrode on the slider panel. The gate turns ON when the electrode touches the slider panel. These two signals are sent to a voltage controlled oscillator (VCO). The VCO generates a sound signal while the gate signal is ON. The pitch of the sound is determined by the CV. If the output of the VCO is left as is, the only sound that will be produced is a monotone buzzer-like "bzzz" sound. To change this, this signal is passed through a voltage controlled filter (VCF). Of the frequency components of the sound signal, the VCF removes only those from the high pitch region and modifies the tone. At this time, the sound is not only merely processed, but application of the filter is changed in response to the amount of time that passes since the gate starts working, and the tone of the sound is changed. This variation in time is controlled by a signal from an envelope generator (EG). The EG generates a signal with a pattern that decays after it has risen once in response to the gate being turned ON. You can adjust the rising times and the decay times and use the results to produce different kinds of variant patterns. The supplement's Synthesizer has one more control signal generator, which is referred to as an LFO. The LFO will make the pitch of the sound of the VCO vibrate by generating a control signal with a repeating pattern. You can produce a variety of sounds using combinations of these functions.

How a VCO works

A VCO is made up of a part for charging and discharging capacitors, a part for monitoring the charging and discharging, and a discharge switch. Charging is done slowly at a speed that is based on the CV. Once a certain amount of electricity has built up in the capacitor, the monitoring part responds and turns on the discharge switch, and the electricity is discharged at high speed. The waveform output is a sawtooth wave.

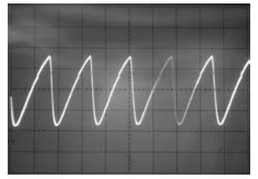


η Waveform output from the VCO.

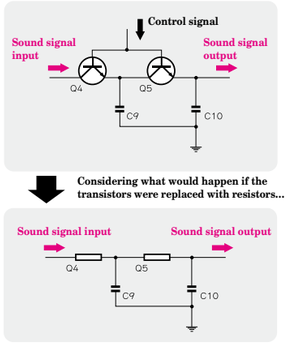


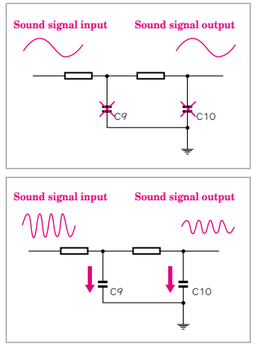
How a VCF works

The basic structure of a VCF is formed of transistors and capacitors. It may be easier to understand how a VCF works if the transistors are replaced with resistors. Capacitors have a property that allows them to pass signals with high frequencies more easily, so, only those components of high pitch are removed, out of all of the sound signals. If the control signals applied to the transistors are changed, the frequency at which the filter begins to be applied will change. Sounds passed through the VCF become softer and the waveforms become more rounded. This supplement employs a Korg MS-20-type filter.



η Waveform output from the VCO.





In the low pitch region, signals do not pass through the capacitors very easily
☒ Sound signals pass through unaffected

In the high pitch region, signals pass through the capacitors quite easily
☒ Sound signals decay

How an Envelope Generator (EG) works

An envelope generator (EG) obtains a control signal that varies with time through charging and discharging of a capacitor.