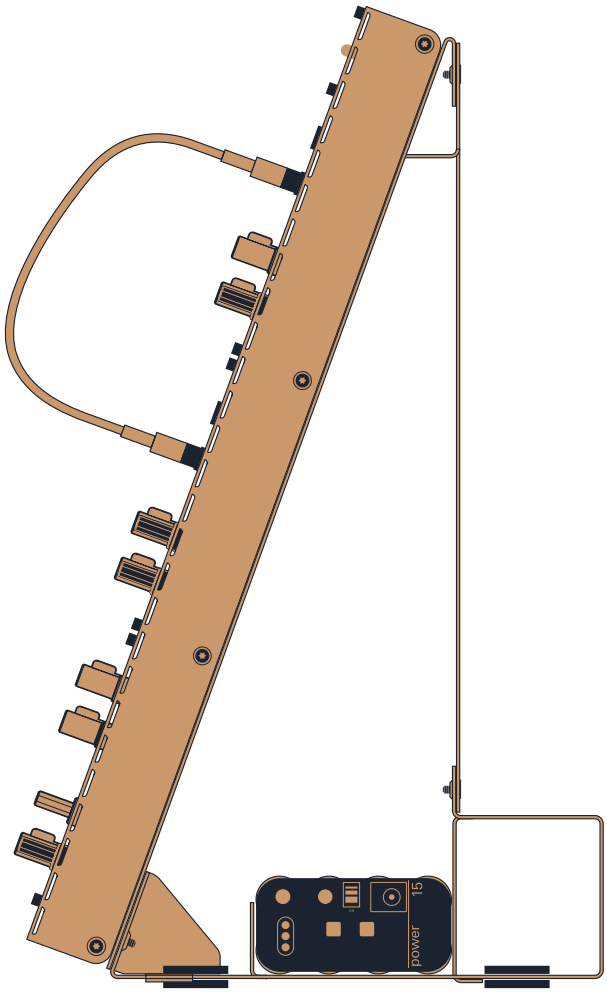
400

pocket
operator
modular

user guide

ガイド

V.2.0



notice. read this first.

the product is esd sensitive and is sold without casing.

battery information:

1. install only new batteries of the same type.
2. failure to insert batteries in the correct polarity, as indicated in the battery compartment, may shorten the life of the batteries or cause batteries to leak.
3. do not mix old and new batteries.
4. do not mix alkaline, standard (carbon-zink) or rechargeable (nickel cadmium) or (nickel metal hybride) batteries.
5. do not dispose of batteries in fire.
6. batteries should be recycled or disposed of as per state and local guidelines.

fcc statement:
note: this equipment has been tested and found to comply with the limits for a class b digital device, pursuant to part 15 of the fcc rules. these limits are designed to provide reasonable protection against harmful interference in a residential installation. this equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. however, there is no guarantee that interference will not occur in a particular installation.;

if this equipment does cause harmful interference to radio or television reception, which can be determined but turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures;

- reorient or relocate the receiving antenna
- increase the separation between the equipment and receiver
- connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- consult the dealer or an experienced radio/tv technician for help.

this device complies with part 15 of the fcc rules. operation is subject to the following conditions;
1. this device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

caution: changes or modifications not expressly approved by the party responsible for compliance could void user' s authority to operate the equipment.

teenage engineering warrants that this product will be free from defects in material or workmanship for a period of 12 months from the date of teenage engineering' s shipment of the product to you, the customer. in the event of a defect covered by this limited warranty, teenage engineering will, at its option and free of charge to customer, repair, replace or refund the purchase price paid.

TEENAGE ENGINEERING MAKES NO OTHER EXPRESS WARRANTIES EXCEPT AS PROVIDED HEREIN, AND ANY AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE SHALL ONLY BE IN EFFECT DURING THE 12 MONTH WARRANTY PERIOD PROVIDED HEREUNDER. TEENAGE ENGINEERING'S LIABILITY ON ANY WARRANTY CLAIM SHALL BE LIMITED TO THE ACTUAL PURCHASE PRICE PAID. TEENAGE ENGINEERING SHALL NOT BE RESPONSIBLE TO CUSTOMER OR ANY THIRD PARTY FOR ANY CONSEQUENTIAL, INCIDENTAL OR INDIRECT DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF PROFITS, LOSS OF DATA, REVENUES, SALES, BUSINESS, GOODWILL OR USE.

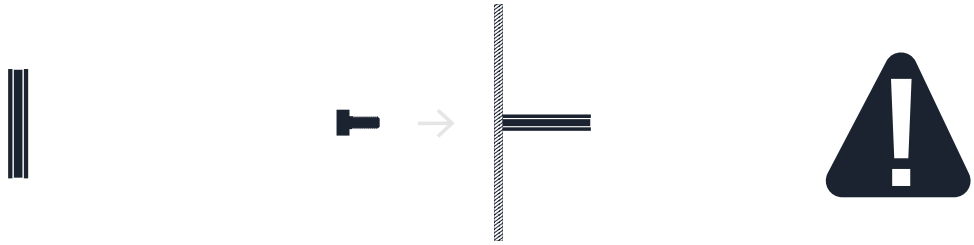
what does this limited warranty not cover?

teenage engineering has no obligation to repair, replace, or provide refunds in the following instances:

- if the alleged defect arises because customer has altered or repaired the product without the prior written consent or authorization of teenage engineering;
- if customer did not follow any applicable instructions for proper storage, usage, or maintenance of this product;
- if customer has failed to notify teenage engineering of any defect where the defect should have been reasonably apparent on inspection; or
- if customer fails to notify teenage engineering of the defect within 12 months of teenage engineering's shipment of this product to customer. this limited warranty does not cover the cost of shipping the defective product to teenage engineering for repair, or the cost of shipping the repaired or replacement product to you. how do customers receive warranty service? please call your teenage engineering customer service representative for details on how to raise an issue in relation to your product.

1. module assembly

1.1 installing the standoffs



before connecting the modules first add the standoffs to the back of the faceplate to make installation easier. start from the bottom and continue up leaving the power distribution until last.

to attach the standoffs, place the screws through the holes from the outside, and using a pair of needle nose pliers, hold the standoffs firmly at the back while screwing.

now repeat this procedure for all modules leaving only the power distro without standoffs.

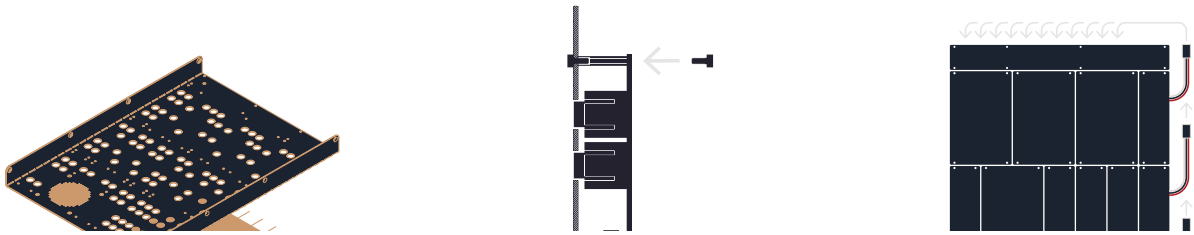
note: be careful not to over tighten.

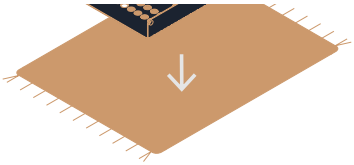
1.2 power distro

the power distro attaches to the frame differently than the other modules. first cut the standoffs from the psu in half using a pair of pliers or wire cutters. then place the screws through the holes and place the power distro on the back, on top of the pre-attached protective sticker cover.

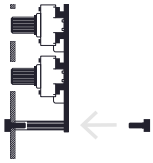
finally attach the shorter standoffs to the top of the frame to fasten the power distro. make sure it is seated flush to the back of the faceplate.

1.3 installing the modules



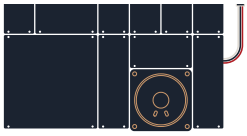


place the front plate face down. tip: put a soft surface such as towel beneath.



place the modules on top of the standoffs and ensure the jacks are correctly aligned with the holes. screw the modules to the standoffs.

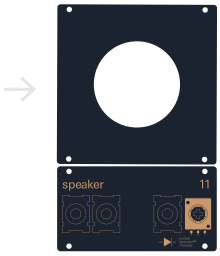
ensure the screws on the faceplate are not rotating. be careful not to over tighten.



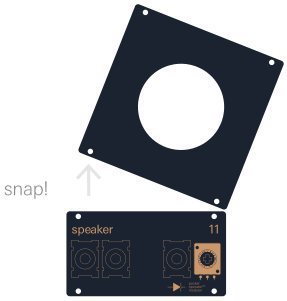
once screwed in place, plug in the cables to the power sockets.

it is advised to go from right to left and top to bottom. start with mixer and end with the speaker module, to avoid crossing power cables and too much tangle.

1.4 speaker assembly

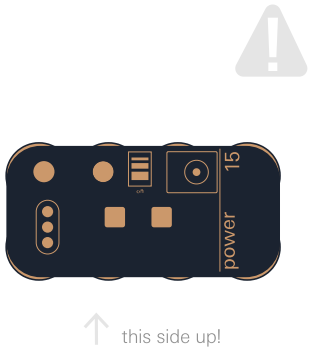


the speaker module pcb comes with a part that is not needed.



firmly and carefully break off the square part. take care when installing the speaker as the cable connecting the speaker unit to the pcb needs to fit nicely.

1.5 psu



the psu holds 8 x aa batteries. with high quality rechargeable batteries you can expect up to about 5 hour battery life. it is recommended to use a power adapter whenever possible.

2. basics

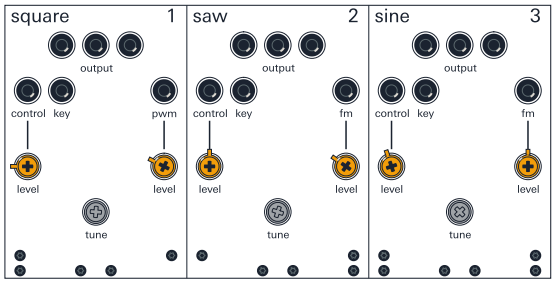
2.1 types of signals

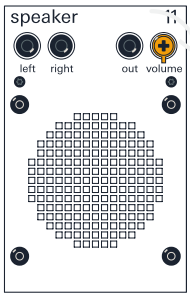
in modular synthesis there are two types of signal. audio signals and control voltages (cv). audio signals are for sounds and cv is for controlling things. these two different signals will be used to connect the different modules together.

this is how sounds and patterns are created in a modular system. the beauty of modular is that you can pretty much connect anything to anything, creating all kinds of relationships and interesting sounds, that all dynamically interact with each other.

that said you should generally avoid connecting outputs to outputs or inputs to inputs.

2.1.1 audio signals



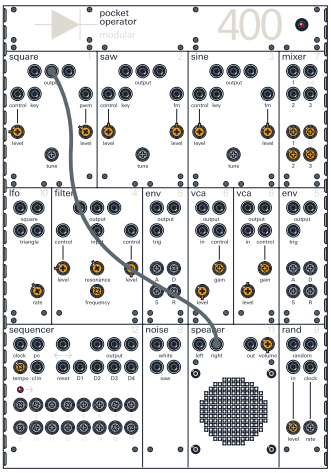


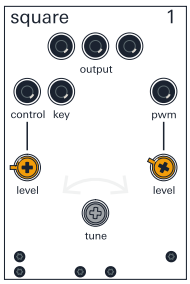
in a modular synthesizer it is usually the job of the oscillators to make the sounds that are processed by the rest of the system. the 400 includes three oscillator types: a square, a saw and a sine.

lets hear each of them through the 400's built-in speaker. first let's make sure the volume of the speaker module is turned down. locate the volume knob on the speaker module and turn it about mid way.

pro-tip: you can use audio signals as cv for some very interesting results and some cv modules such as the lfo can run at audio rates.

warning: never connect headphones directly to the outputs of the 400. you can damage your ears and your headphones if you do this, so be very careful.





to hear the sound of the oscillator we need to connect it to the speaker. to do this take a yellow cable and connect it to any of the three jacks labeled output on the top of the square oscillator. any of these jacks is fine as all three will output the same signal. take the other end of the cable and plug it into the jack on the speaker called right.

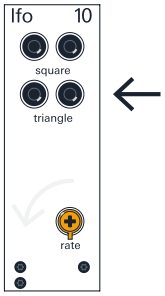
now we can change the volume of the speaker by turning the volume knob.

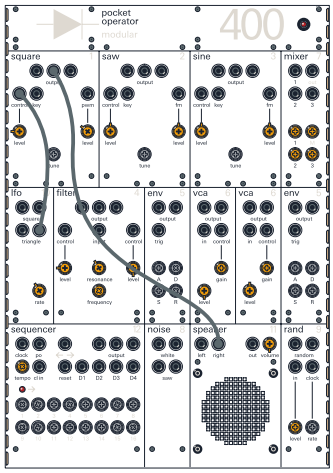
if you do not hear a sound it may be that your oscillator tuning is too high or too low. turn the tune knob to alter the pitch of the oscillator so that it is in the audible range. also turn the pwm level all the way to the left.

2.1.2 control voltages

control voltages are used to control different parts of the modular system. for example in the last example we manually altered the pitch of the oscillator but in this example we will use a control voltage to alter the pitch for us.

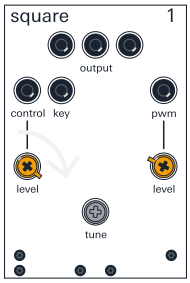
continuing from the last patch: set up a control voltage to control the pitch of our oscillator.

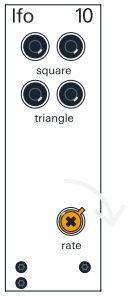




use the triangle wave from the lfo. locate the lfo module and plug a cable into either of the triangle outputs.
tip: set the rate to its slowest setting by turning the rate knob all the way to the left.

plug the other end of the cable into the input labeled control on the square oscillator.





turn the knob underneath that is labeled level all the way to the right. you should hear the pitch slowly rising and falling.

now lets change the 'rate' (speed of the control voltage). very slowly turn the knob labeled rate on the lfo to the right. the change in pitch should become faster until eventually we reach what is called audio rate modulation.

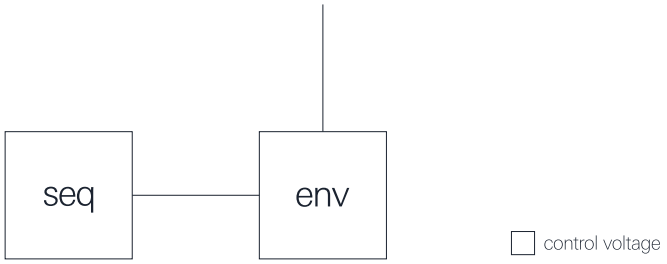
pro-tip: audio rate is a term used to describe cycling control signals that move so fast they actually become

the lfo is actually just an oscillator that can reach very slow speeds. by modulating parameters at

audible and enter the audible frequency range.

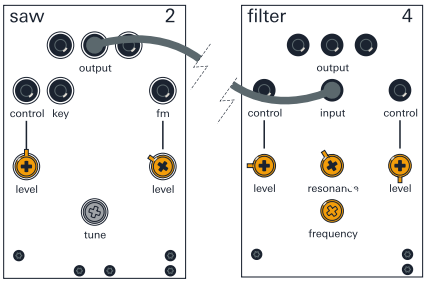
audio rates we can get all kinds of interesting effects.

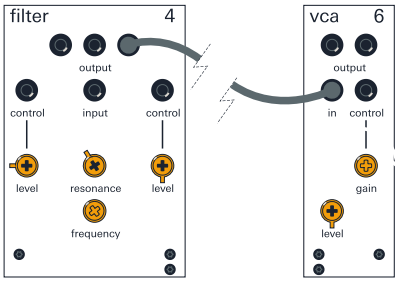
2.2 a simple mono synth



let's patch a simple mono synth including the following modules: [saw], [filter], [vca], [env], [speaker], [sequencer].

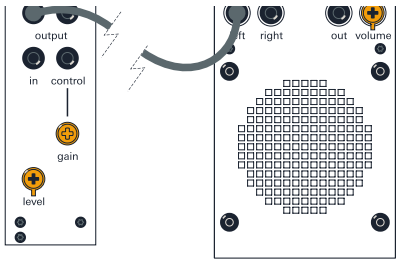
the diagram shows the flow of audio signals and control voltages when patching this mono synth.

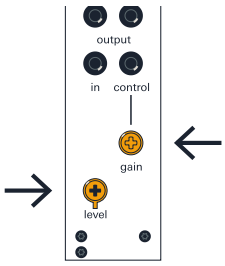




first step is to connect the sound source [saw] to the filter. connect a patch cable to any of the [saw] outputs. connect the other end to the jack labeled input on the [filter]. this will pass the audio generated from the oscillator to the filter. now open the filter all the way by turning the frequency knob all the way to the right.

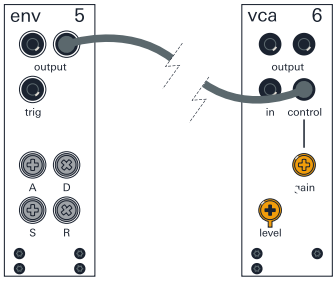
next: take the filter output and connect to the input on the vca. turn up both the level and the gain on the vca.

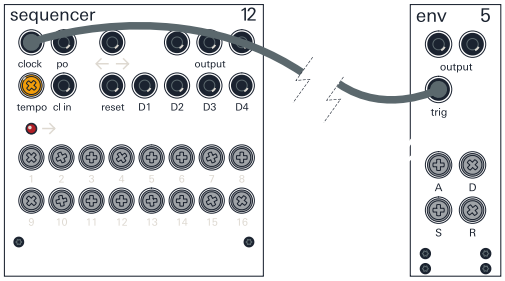




then connect the output of the vca to the left speaker input. you should hear a constant note. if you don't adjust the tuning of the saw oscillator or check that you opened the filter by moving frequency all the way to the right.

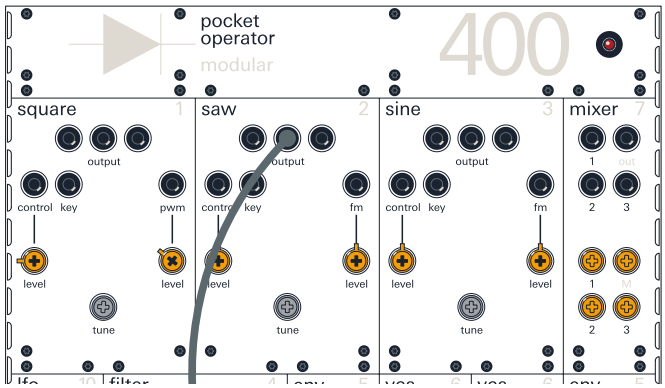
note: the vca or voltage controlled amplifier will control the volume of the signal. it is possible to do that manually using the level and gain knobs. this patch uses the envelope for this.

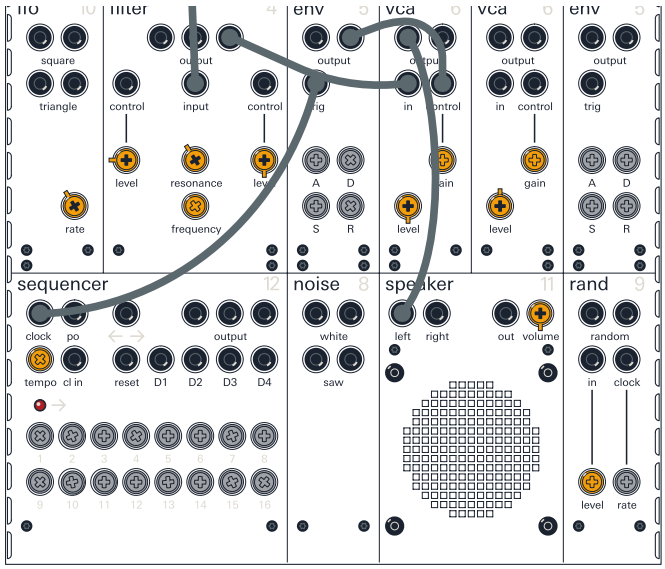




now connect the envelope output to the control input on the vca. this will let the envelope signal control the volume of the sound. the envelope has to be triggered to know when a note is sounded. we can do this from the sequencer which we will also use to set the notes of the sequence.

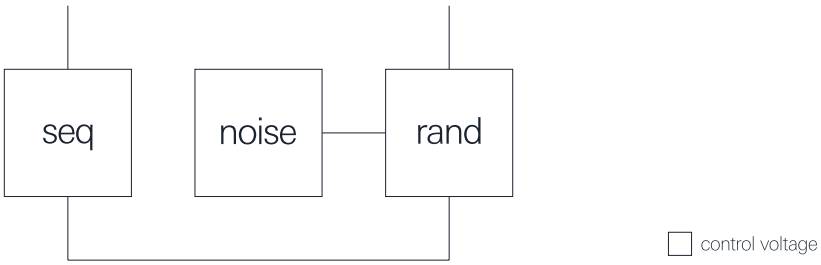
connect either clock out or po out of the sequencer to the trigger input of the envelope. the clock pulses will trigger the envelope every step of the sequence, where po out triggers every other step. adjust the adsr (attack, decay, sustain and release) on the envelope to get different changes in the volume. try setting attack all the way to the left.





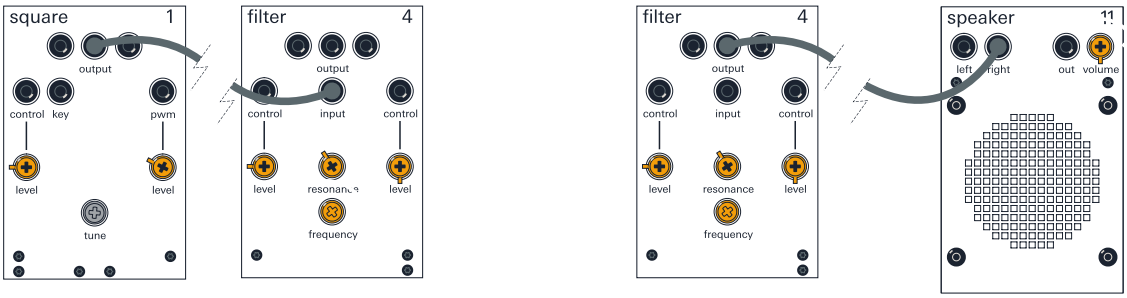
THIS IS WHAT THE FINISHED PATCH SHOULD LOOK LIKE.

2.3 a talking filter patch



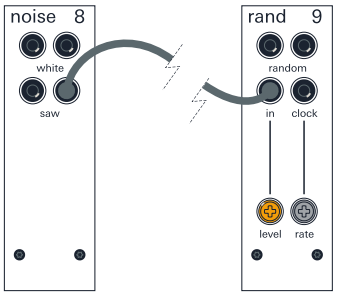
now lets make the classic talking filter patch. for this patch we will use the following modules: [square], [filter], [noise], [rand], [sequencer] and [speaker].

the diagram shows the flow of audio signals and control voltages when patching this talking filter. remove all cables to get ready for patching.



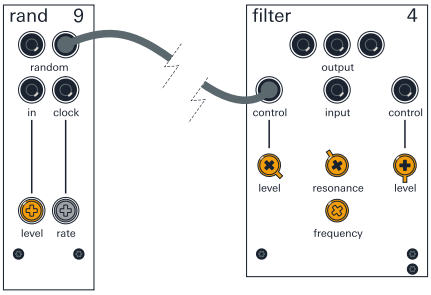
first connect the audio source to the filter. patch one of the square outputs to the audio input of the filter.

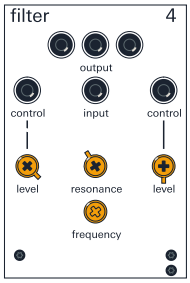
connect the filter output to the speaker. turn up the volume and open up the filter frequency to get a long droning sound.



use the noise and rand to create a stepped filter. the noise and rand modules work as a pair to create sources of randomness in our modular system. take the saw output of the noise module and connect it to the in of the rand module.

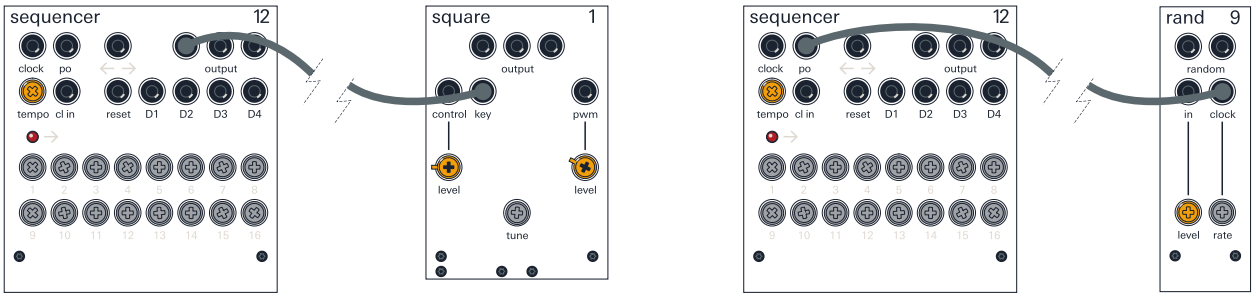
the rand acts as a sample and hold. meaning the rand will sample the voltage level of the incoming signal at a rate determined by either the rate knob or clock input. for example: to send a sine wave through the rand will give a stair stepping output. the saw noise output will be used for this patch. the saw noise creates a random pattern making it possible to create unpredictable results. this can be useful for adding an element of surprise to your patch.



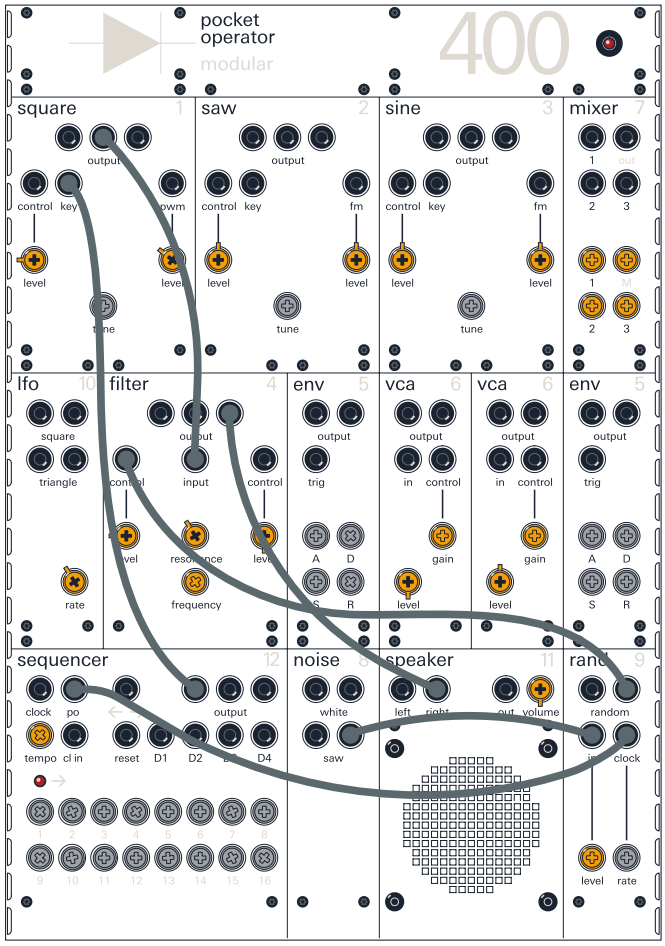


for this patch, take the rand output and patch it to the filter frequency input labeled control on the left of the filter module.

set the filter control level input to max and adjust the rate and level on the rand to create a talking filter patch.



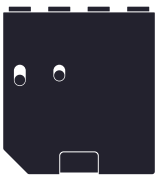
it is also possible to patch the sequencer output to the square oscillator key input and at the same time patch the sequencer clock out or po out to the rand clock input to get a different filter frequency for each note.



THIS IS WHAT THE FINISHED PATCH SHOULD LOOK LIKE.

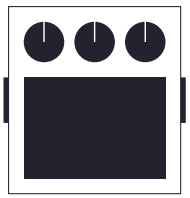
3. connections

3.1 oplab module



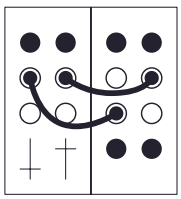
using the oplab module it is possible to control the 400 from the OP-Z. to fully use the oplab module you will need two splitters cables (y cables). the stereo cables provided with the 400 also work but will only give access to the basic features of the ZM-1 module.

3.2 effect pedals



when connecting to effects pedals it is very important to be careful with signal levels. it is possible to damage your pedal by running the audio through at full volume. always start with the volume at minimum and slowly raise it to the correct level.

3.3 modular



it is possible to integrate 400 with other modular systems and semi modular synths.

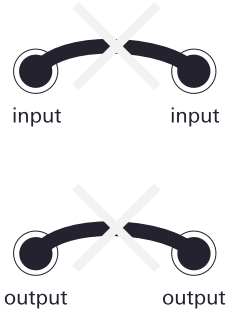
why not try connecting in some extra envelopes from your external system?

4. notes of caution

unlike most other audio equipment, modular synthesizers output audio and control voltage at much higher level (voltage) than other studio equipment. for this reason we recommend the following precautions and practices.

do not connect headphones directly to the 400. you can damage your headphones or much worse, your ears. always protect your hearing.

do not plug outputs of the 400 directly into equipment that is not designed to handle the larger voltage. for example, pocket operators, effects pedals etc. please consult the manufacturer of the product in question if you are not sure.



it is generally advised that you avoid connecting inputs to inputs or outputs to outputs. doing so can put unnecessary strain on the system and over time may eventually lead to damage.

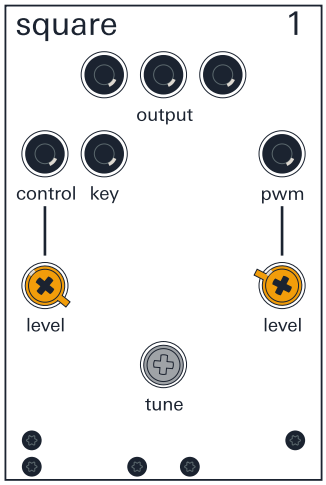
5. module specs

5.1 square

square is a square wave oscillator that can be used both as an audio signal and as an lfo, to control, trigger and modulate other sources.

pro-tip: with pwn set to above 50% no sound is heard. this can be great when modulated to create interesting rhythmic effects.

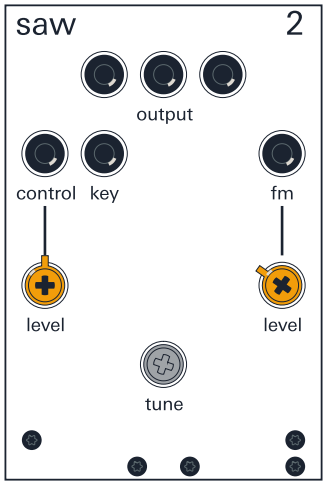
note: if you do not hear a sound it may be that your oscillator tuning is too high or too low. turn the tune knob to alter the pitch of the oscillator so that it is in the audible range. also turn the pwm level all the way to the left.



output	these three identical outputs can be used simultaneously.
control + key	these are inputs for controlling the pitch of the square waveform. key is set to 1v/oct, and control can be scaled by level.
level (left)	turn level to adjust how much any incoming control signal should modulate the waveform.
pwn	pulse width modulation or pwm input can be used to shape the waveform by offsetting the ratio between maximum and minimum voltage. try patching any signal through the pwm input to hear what this sounds like.
level (right)	adjust the pwm level with this knob. if nothing is connected to the input this knob acts as manual pwm control. if you can't hear anything make sure to turn this all the way down.
tune	tune sets the main frequency of the waveform. if you can't hear anything try setting this to somewhere in the middle.

5.2 saw

saw is a sawtooth wave oscillator generating sounds rich in overtones. it can be used both as an lfo and as an audio signal.



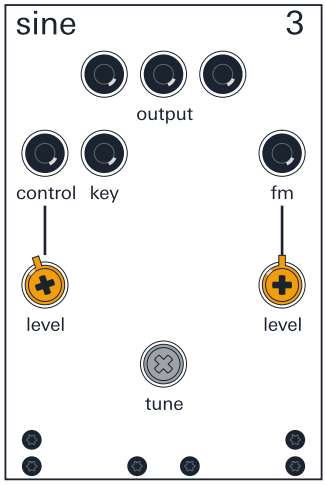
output	these three identical outputs can be used simultaneously.
control + key	these are inputs for controlling the pitch of the saw waveform. key is set to 1v/oct, and control can be scaled by level.

level (left)	turn level to adjust how much any incoming control signal should modulate the waveform.
fm	this is an input for linear fm or frequency modulation of the saw waveform. use this to modulate the original waveform into more complex shapes. try running any signal through the fm input to hear what this sounds like.
level	when something is connected into fm you can use this knob to adjust the amount of fm.
tune	tune sets the main frequency of the waveform. if you can't hear anything try setting this to somewhere in the middle.

5.3 sine

sine is a sine wave oscillator generating a fundamental frequency without many overtones. use it as an audio signal or as an lfo.

pro-tip: sine waves are great for fm modulation. use it as a control voltage source for your filter with an increased resonance for some cool vocal sounding filter fm effects..

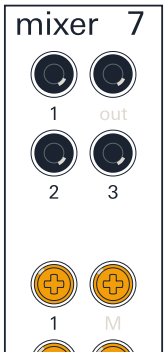


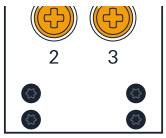
output	these three identical outputs can be used simultaneously.
control + key	these are inputs for controlling the pitch of the sine waveform. key is set to 1v/oct, and control can be scaled by level.
fm	this is an input for fm or frequency modulation of the sine waveform. use this to modulate the original waveform into more complex shapes. try running any signal through the fm input to hear what this sounds like.
level (right)	when something is connected into fm you can use this knob to adjust the amount of fm.
tune	tune sets the main frequency of the waveform. if you can't hear anything try setting this to somewhere in the middle.

5.4 mixer

the mixer can be used to sum three signals into one.

pro-tip: the mixer can be used to mix audio signals but it can also be used to mix control voltages. for example both lfo and one envelope can be mixed into one control signal. for best results do not mix audio signals with control voltage signals.

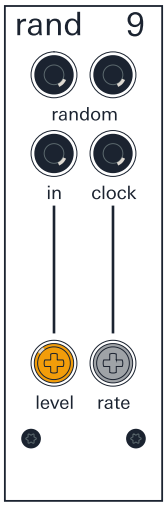




1	first input.
out	mixed output for any incoming signals.
2	second input.
3	third input.
knob 1	level control for first input.
knob M	level control for mixed output.
knob 2	level control for second input.
knob 3	level control for third input.

5.5 rand

rand is short for random and is a sample-and-hold module. patch anything into the input and it will sample it and generate a random output signal based on that. a good source for the input is the saw noise.

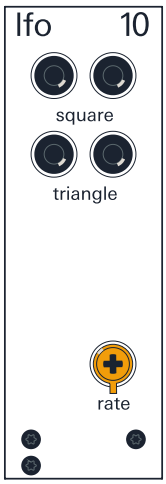


random	these are the two outputs for the random signal. they are identical and can be used simultaneously.
in	this is the input for the signal being sampled. make sure you have something patched into here to get an output from this module.
clock	if you want rand to be tempo-synced then patch a gate signal into here. this will override the manual rate knob.
level	turn this knob to adjust the level of the incoming control signal.
rate	this knob sets the rate of which the input signal is sampled, unless something is patched into clock.

5.6 lfo

lfo is short for low frequency oscillator. this one has four outputs, two square and two triangle

waveforms. it can be used to modulate any control input.



square	these square wave outputs can for example be used as gates to trigger the sequencer clock, or the env and rand modules.
triangle	try patching these triangle wave outputs to any control input, for example to modulate the filter cutoff frequency, the pitch of the oscillators or the amplitude of the vca's.
rate	use this knob to control the rate of the lfo. at high rates the frequency goes into audio range.

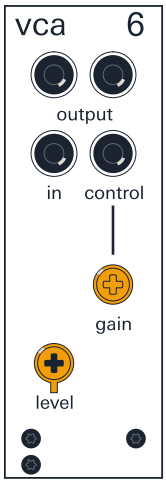
5.7 env

env is short for envelope. adsr stands for attack, decay, sustain and release, and when triggered it is a control source for shaping a sound over time.

output	this outputs the control signal used to shape the sound. try patching this to any control input. these two identical outputs can be used simultaneously.
trig	patch a control signal into this input to trigger the envelope. you can for instance use one of the sequencer outputs or any clock or gate signal.
A	attack time.
D	decay time.
S	sustain level. this is the level at which sustained notes will be held.
R	release time.

5.8 vca

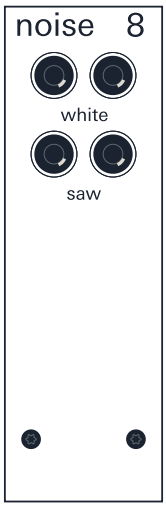
vca is short for voltage-controlled amplifier. patch any signal through this module to modulate its amplitude, such as changing the volume of a sound.



output	whatever is patched into in gets modulated by control, and then back out through here. these two identical outputs can be used simultaneously.
in	this is the main input for the vca. patch whatever audio signal you want to modulate into here.
control	this is the input for the modulating control signal. try patching the output of an env into here.
gain	this knob adjusts depth of the control signal.
level	this knob adjusts level of the input signal.

5.9 noise

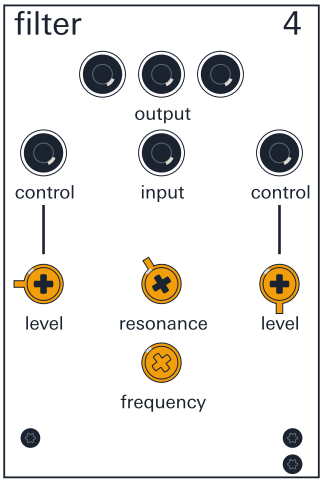
noise outputs two types of continuous noise, great for adding texture to any signal or for generating randomness in a patch.



white	white noise output.
saw	saw noise output. this is a unique noise source that uses a saw wave as its basis.

5.10 filter

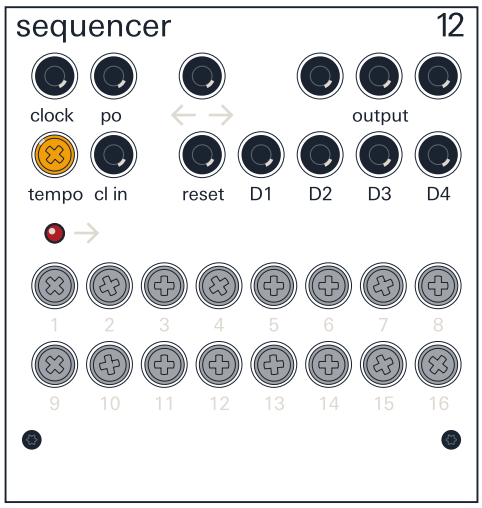
filter is a resonant low pass filter that allows you to shape a signal by filtering out high frequencies.



output	these three identical outputs can be used simultaneously.
control (left + right)	these are inputs for controlling the cutoff frequency of the filter.
input	this is the input for the filter. patch whatever audio signal you want to filter into here.
level (left + right)	turn level to adjust how much the incoming control signal should modulate the cutoff frequency.
resonance	this controls the resonance of the filter. turn this up to emphasize the frequencies around the cut off point to get a sharper thinner sound. keep turning it up and the filter will start to self-oscillate.
frequency	this controls the main cutoff frequency of the filter. turn it down to only let low frequencies pass through. if you don't hear anything try turning this all the way up.

5.11 sequencer

sequencer is a 16-step sequencer module used to control and modulate everything on the 400 or external devices. this can be used to create melodies or rhythmic patterns, by patching an output to a control input.

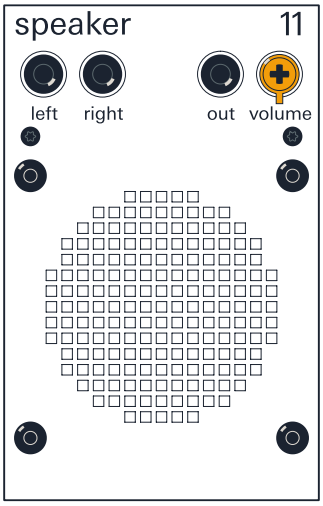


clock out	this output sends a clock trig based on the tempo used.

po out	this output sends a divided clock trig compatible with pocket operators.
left / right	patch a trig signal into here to reverse sequencer running direction.
output	these are the three main outputs of the sequencer and they can all be used simultaneously.
tempo	adjust this knob to set the internal tempo for the sequencer, if nothing is connected into clock in.
clock in	use an external clock and patch that into here to have the sequencer follow the external tempo.
reset	whenever this is triggered the sequencer resets to the first step.
D1 – D4	these are binary inputs for addressing individual steps of the sequencer.
led light	this lights up whenever the first step is triggered.
knobs 1–16	turn these knobs to set the level of control voltage sent to output, for each corresponding step. setting a knob to max will shorten the sequence and play only the preceding steps.

5.12 speaker

speaker is a dual input speaker module allowing you to to hear what your patch sounds like.



left	left input.
right	right input.
out	stereo output.
volume	this is the volume control for the speaker module and for the output. turn it clockwise to turn the volume up and counterclockwise to turn it down. the control is reversed on the first production units. in that case treat it the opposite way. note: when using the speaker or the output always be careful with your ears and equipment.