

**4060**

**Instruction manual v. 0.1**



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olegtron@gmail.com

## SAFETY DISCLAIMER

- Olegtron\* will take no responsibility if you destroy your unit or something connected to it.
- The 4060 is a device designed for experimenting, and in experiments there's always a risk of failure.
- However, the unit does not output a lot of power: it will supply only 10mA of current per DIVIDER output, according to datasheets.
- Since the 4060 operates with a 9 volt battery and there's nothing that will upscale it, the unit should do no harm to people. If you have epilepsy or some other related condition, please consult your doctor before using the 4060.
- WARNING! The 4060 can drive headphones with a really loud volume! So if you want to directly use headphones as an output, use suitable resistors to patch the sound or keep the starvation at so low that the volume will not be too loud!
- The 9 volt battery will supply full current from PWR + and PWR -. Don't connect there anything you wouldn't connect to a 9 volt battery.
- If you want to take audio output from STARVED +, its best to patch it with a capacitor or a resistor.
- Always start experimenting with the amplifiers volume and gain in the minimum, and take care while experimenting, and your amplifier should be safe. No connected machine (amplifiers, mixers, effect boxes etc.) has been destroyed during countless tests made at Olegtron\*.
- If you're still not sure, get computer speakers from flee market. They can also be used as a preamp, just connect their headphones out to your good amp.

## GETTING STARTED

Initial preparations before you can start to use Olegtron\* 4060 are these:

- Open the box by unscrewing the one black screw on top of the box.
- Carefully open the box and insert a 9v battery or an accu to the battery connector.
- Place the battery to the bottom of the box and close the box so that the battery wires fit in nicely.

How to start patching:

- NOTE! If your amplifier is sensitive, use large resistors (like 715k or 133k) instead of patch wires
- Turn your amplifier's volume to minimum
- Connect the amplifier to the 3,5mm stereo connector
- Connect SLEEVE to PWR – with a patch wire or some component
- Connect two of the signals from the DIVIDER to TIP and RING with patch wires or some components
- Switch 4060's power on
- Carefully start to raise the volume in your amplifier
- Stick components in between some of the DIVIDER outputs
- Experiment with STARVATION and FREQUENCY pots
- Experiment by patching TIP, RING and SLEEVE to different DIVIDER outputs
- Experiment by repositioning and changing components
- Try connecting TIP or RING to COM, CAP or RES with some component to get the base frequency
- Try different connections, and if the sound dies, undo the connection and try again.
- Print out an Olegtron 4060\* patch card, write down your favorite patches and share them
- Save your favorite patches by soldering them into a header connector

# INTRODUCTION TO 4060



Olegtron\* 4060 is a compact oscillator/divider box capable of creating unique signals and sequences through a revolutionary programming method of sticking components to it's patchboard!

The device can be used as a standalone sound generator that connects with a 3.5mm stereo jack output or to control a wide variety of machines, such as toys or synths with control voltage, clock or gate input. You can also use it as a test signal generator in your electronics lab, blink leds, drive small motors etc.

Using the 4060 doesn't require any previous electronics skills, but experimenting with different components helps you get the idea of how they work, and your programming can become more systematic.

Name of the device comes from CD4060, which is an integrated circuit, or chip if you may. It belongs to the famous easy to utilize logic building blocks called 4000B-series. This series of logic chips dates back to the sixties but is still relevant in DIY. Olegtron\* 4060 interfaces directly with 4000B-series.

Olegtron\* 4060 is based on the RC-oscillator example from [CD4060 datasheet](#), with the addition of a starve potentiometer known from the world of [circuit bending](#). The rest is just user interface design, highlighting of course the innovative patchboard that makes a good platform for experimenting.

Being as simple as that, the Olegtron\* 4060 pays homage to a somewhat forgotten but really versatile chip, CD4060!

## PART I: PWR



In the upper part of the device is located PWR – power. PWR – and + give you straight the output of the machine’s battery, so you can power up external devices. The PWR – is always connected to the minus of the battery, but the PWR + comes after the ON/OFF switch, meaning that you can simultaneously turn off the 4060 and the machine you are giving power to.

STARVED + is a parallel output of the CD4060 chip’s operating voltage. It is also switched from the ON/OFF switch, but goes also through a current limiting potentiometer STARVATION. When STARVATION is set to maximum, the chip gets maximum current input, and the chip is operating properly. When you limit the current by turning STARVATION counterclockwise, the chip becomes more vulnerable to interference. This means that loading the chip will drop it’s operating voltage (STARVED +). As the voltage drops, the base frequency drops too, and other things happen depending on the patch.

So, the bottom line is, that when you turn the STARVATION counterclockwise, all things that happen inside the box start to fluctuate the STARVED +. This makes the STARVED + a good overall signal source. Since STARVED + can supply direct current from the battery, it is advisable to patch it to the amp with a capacitor. Try also loading the STARVED + with an internal or external signal.

NOTE: When the power switch is off you can use an external power source to power up the unit. Power source can be from 3v to 15v DC or something experimental, but never reverse polarity! One thing you could do is power up the unit with a signal from another 4060 or probably even a positive CV-, CLOCK- or GATE-signal from a synth. When you power the 4060 from an external source you can connect the source to PWR + and be able to starve it, or connect it straight to STARVED +. When you give power out from the 4060 you can use the STARVED + output to simultaneously starve the powered device.

## PART II: OSC



Below the divider is OSC – oscillator control. It gives you the ability to control the base frequency of the box. You can do this by patching components between the rows: patch a capacitor between CAP (capacitor) and COM (common) and the frequency will shift down. Patch a resistor between RES (resistor) and COM and the frequency will shift up.

You can achieve swinging rhythms by patching signals to OSC from DIVIDER. You might want to try small capacitors in here. The OSC-part is quite sensitive, though, and the oscillation might stop. In such case just undo the last patch and try with other components and combinations.

NOTE: If you want to use an external clock signal to drive the divider, you may connect it directly to CAP terminal (try the others in OSC too). Using this method you can also cascade many 4060's to create mega-long cycles: use the slowest frequency of a 4060 as the clock for another 4060, and so on. If there's some unwanted oscillation present, patch a pulldown resistor (133k for example) from CAP to PWR -. Note also, that when you feed signals to the 4060's inputs, you must have the ground of control signal connected too. Input signal should not exceed 15 volts, since too high voltages might cause damage to the chip.

## PART III: I/O



The I/O, Input/Output, consists of three rows of patchboard that represent the the [3,5mm stereo connector](#) located in the rear of the box. The connector is also called a TRS-connector, since it is divided to three contacts: TIP, RING and SLEEVE. If nothing is patched to I/O, the TRS-connector is not connected at all, and if you want to use the connector, you have to patch something to it.

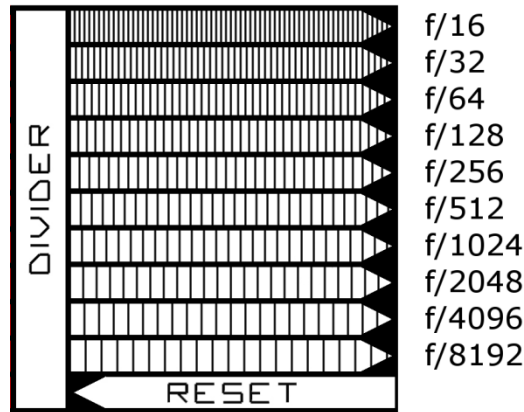
A signal always needs two cables to travel: the other is for the signal itself and the other for ground. Ground means in here a voltage level to which the signal is in relation to. This means that you have to patch at least two of the connectors to get sound output. You could start with SLEEVE, which is the ground of the stereo connector, and TIP, which is the left channel. If you want two channels output, patch something to RING too.

You may use the I/O part to connect two inputs, such as a clock suggested in the previous chapter, or some other signal you want to inject somewhere in the circuit. Having two channels in the I/O connector makes it also possible to use the other channel for input and the other for output, full duplex!

NOTE: A signal can go below (minus-voltage) or above (plus-voltage) the ground. If it does both, we talk about AC or alternating current, if its only on one side, it's DC, direct current. Since the 4060 is battery operated, it's floating, i.e. the ground voltage of the circuit is not necessarily tied to other machines. This

means you can patch any of the signals to the controlled machine's ground and the 4060 will be above or below that, depending on the signal.

#### PART IV: DIVIDER



The divider is internally a ripple counter, which is fed by the base frequency  $f$ . Ripple counter means, that the input frequency is divided to half, the result of that is divided to half and so on, stage by stage. In musical terms every stage slows down tempo to half or transposes the pitch one octave down. The highest frequency you get from the DIVIDER is  $f/16$  and the lowest  $f/8192$ .

Example: The base frequency is set at 3,2kHz, which means that the highest output of the divider is  $3200\text{Hz}/16=200\text{Hz}$  and the slowest  $3200\text{Hz}/8129=0.39\text{Hz}$ , e.g. a duty cycle of about three seconds.

The DIVIDER gives out square wave with 9 volts amplitude. In other words the outputs switch between 0 volts and 9 volts, you could also think of them switching between off and on.

There is also an input called RESET. It is normally pulled down to 0 volt, which means the reset is off. When you bring 9 volts to reset input, it will reset all divider outputs to 0 and stop the oscillator. You can shorten the cycle by patching one of the signals from DIVIDER to RESET.

NOTE: If you need some other time signature, you can use an AND-gate to combine two or more signals from DIVIDER. The most simple AND-gate is a NPN-transistor: when you connect signal inputs to collector and base, you get the "anded" output from emitter.

## PATCHING WITH COMPONENTS

Patching components between different outputs combines the signals into a pattern that becomes more evident when the STARVATION is increased. Adjusting STARVATION will alter the amount of cross talk and fluctuation in both voltage and frequency, and adding components will result in a more complex pattern.

This chapter includes some simplified information of different components and how they work with the 4060. There might be some misinterpretations, since STARVATION makes things unpredictable. You can also skip this whole chapter and start by just experimenting. If you at some later point feel like finding out some information on the components, this could be the place to start.

### Wire (conductor)

Patching can be done with wires, especially when you need as clean and absolute signal as possible. One this kind of situation could be when using the 4060 as a test or clock generator. If you patch two DIVIDER outputs together with a wire they will form a short circuit and the sound will most likely die. Keeping a short circuit like that for a longer period of time might harm the chip. However, if you add STARVATION (turn the pot counterclockwise), the chip will most likely start to oscillate and should not be overloaded.

### Resistor

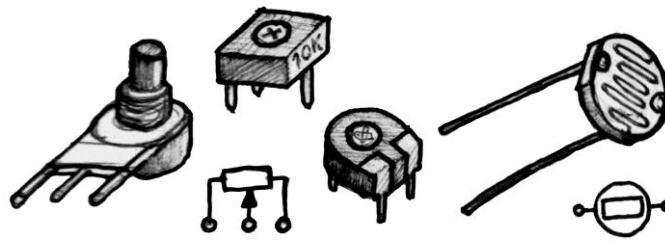


[Resistors](#) work often same way as wires, except that they don't conduct as much current, i.e. they have a resistance. A bigger resistance means less current and vice versa. Resistance is marked to the body of a resistor with color codes commonly found online. Typical resistances range from hundreds of ohms ( $\Omega$ ) to millions of ohms (megaohm,  $M\Omega$ ), most used being kilo-ohms ( $k\Omega$ ).

Since resistors don't conduct so much current they are not so absolute. Using different resistors can add "shades of gray" to your sound: a smaller resistor will have a stronger effect, while bigger resistors are more subtle. Different resistors regulate volume when patching to outputs, modulation depth when patching between DIVIDER outputs etc.

NOTE: You can also combine resistors to achieve different resistances. If you connect two or more resistors in *series*, the values simply add together ( $R = R_1 + R_2 + R_3...$ ). If you connect them in *parallel*, you add the reciprocals ( $1/R = 1/R_1 + 1/R_2 + 1/R_3...$ ). To say it more simply: resistance gets bigger when resistors are in series, and smaller when they are in parallel.

## Variable resistors

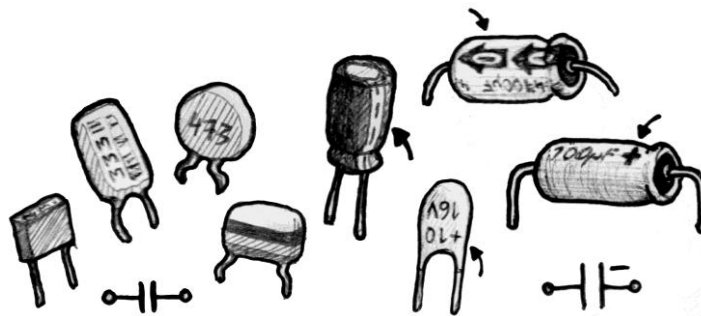


A [potentiometer](#), often visible as a knob, offers a convenient way of changing resistance by turning its shaft. With a potentiometer that's in the correct range you can precisely create any resistance, and be able to change it. Potentiometers normally have three contacts: two at the ends of a resistor, and a third one connected to a brush moving along the resistor. So, the whole resistance keeps the same, and the brush splits it into two complementary resistances on both sides of it. When you turn the shaft, the other gets smaller, and the other gets bigger. In 4060 a potentiometer can work as a variable resistor, a kind of patching cross fader etc.

Another interesting and intuitive way of controlling is patching with [LDRs](#) (Light Dependent Resistor). LDRs conduct more the more light lands on them, and when they're in darkness, the resistance can be many megaohms. LDRs respond quite slowly, which might be heard as sweeps or delayed gesture response.

Skin is not a good conductor, but it does conduct. This can be used in experiments as body contact, where your skin is used as a resistor. A common practice would be to wet your finger a bit to make it more conductive and touch different places on the patchboard. You can construct different body contact modules or just use the provided male header as a body contact for your patch.

## Capacitor



[Capacitors](#) are constructed of two conducting metal plates, that are as close as possible, but don't touch. This means, that capacitors don't conduct at all. Still, an alternating signal can get through them. This is explained by the electric field that forms between the plates – when you push or pull electrons to the other leg, the electric field pushes or pulls the electrons from the other.

Capacitors have an ability to store energy into the electric field. This ability is called capacitance and the unit is Farad (F). Most used values are nano- (nF) and microfarads ( $\mu\text{F}$  or uF). The bigger the value, the more it can store. You can simply charge a capacitor by touching its legs to a battery, and then discharge it by touching the legs to a conductor, or rather use the energy into something useful - and control the charging too.



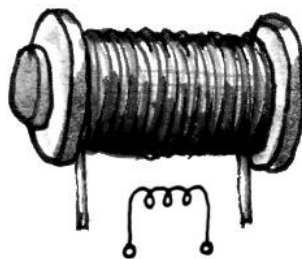
Capacitors can charge and discharge really quickly, but when you limit the charging/discharging current with a resistor, the voltage in a capacitor rises and falls slowly. This phenomena does a lot in 4060. You don't even need an extra current limiting resistor, since the STARVATION pot does it to the whole circuit. Because capacitors have timing properties, capacitors can also make a patch in 4060 frequency selective: the resulting loop is different depending on the setting of FREQUENCY.

The slow rising and falling of a RC (resistor-capacitor) pair forms the basis of many time based circuits, such as oscillators, envelope generators etc. The controlling of such circuits happens often by changing the resistance, but there are variable capacitors too. At least some household scales have them as weight sensors and some old radio receivers have them as the tuning component. You might get interesting result by using a capacitance diode, that changes the capacitance according to voltage. Constructing your own capacitors from two metal foils and some isolator in between is also possible.

NOTE: Capacitors have a maximum voltage rating often written to the body. Make sure that your supply voltage won't exceed this rating, since it might damage the capacitor. This mean that with a standard 4060 you must use capacitors that have a rating of 9 volts or more.

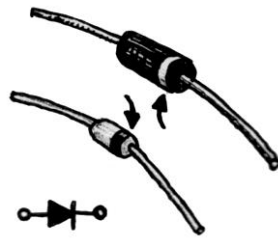
You can combine capacitors to achieve different capacitances. Calculations go similar to resistors, but opposite. So, if you connect two or more capacitors in *parallel*, the values simply add together ( $C = C_1 + C_2 + C_3...$ ). If you connect them in *series*, you add the reciprocals ( $1/C = 1/C_1 + 1/C_2 + 1/C_3...$ ). To say it more simply: capacitance gets bigger when capacitors are in parallel, and smaller when they are in series.

### Coil (inductor)

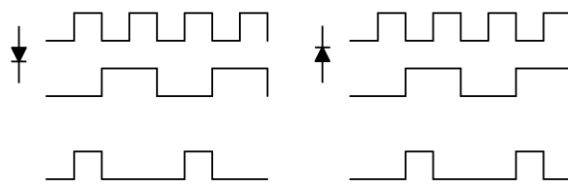


[Coil](#) is basically just a conductor wound around a core. Coils are related to capacitors: they can store energy and they are used in timing circuits. Coil's operation is somewhat opposite to capacitor, though. Coils conduct direct current, but will not let alternating current through. They obstruct alternating signals at a certain resonance frequency, depending on the coils characteristics. The other thing is, that instead of electric field, coils store energy in magnetic field. One use for them is electromagnets, and they can either transform electricity to magnetic field, or catch an alternating magnetic field and turn it into electric current. You can experiment with coils in 4060 and make the patch frequency-selective. The loop will have different characteristics depending on the setting of FREQUENCY.

## Diode



[Diode](#) is the most basic semiconductor device, and its function is to conduct current only to one direction, i.e. rectify. For it to conduct it must be placed so that the cathode (marked in the picture) is pointing towards a more negative voltage. When a diode doesn't conduct, it practically becomes an isolator.



Diodes are very useful in patching the 4060. Part of the time they work as conductors, part of the time they act as if they were not connected at all. At the bottom of the figure above is shown the conduction pattern of a diode connected between two DIVIDER outputs. It shows clearly that diodes conduct only  $\frac{1}{4}$  of the time. This makes it possible to create more variations.

Electrically there is one difference if you compare a diode to a conductor: diodes have a threshold voltage of normally 0.6 volts. This threshold must be exceeded for the 4060 to start to conduct. The threshold causes also a voltage drop: when a diode is conducting, 9 volts going through it will drop 0,6v into 8,4 volts.

NOTE: There are many different types of diodes available. One type worth mentioning is a [zener-diode](#). Zeners have different threshold voltages at which they start to conduct. This can be really useful with the 4060, since the voltage of the whole circuit fluctuates up and down. You could use zeners with different voltages, say 5.6v, 6.8v and 8.2v, to make the patch voltage sensitive.

## LED (Light Emitting Diode)

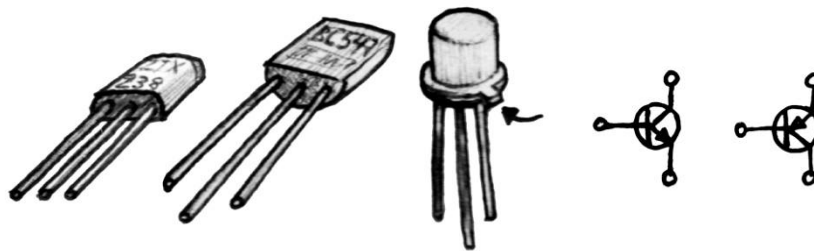


[LED](#) is a diode that starts to emit light when conducting. Since LEDs need only a little current, they are becoming more and more the standard in lighting, and they have been around for decades as indicators. LEDs, similar to diodes and zeners have got a threshold voltage that's different for different colors of leds. A red led typically lights at less than two volts, while green leds need something like 4 volts.

When you patch a LED in between two outputs, it will work somewhat similar to normal diodes or zeners, except that it will give visual output by blink in a pattern. The pattern forms in same way as with a normal diode (as shown before).

NOTE: Standard indicator LEDs draw something like 20mA current, but 4060 will light most of them. Since CD4060 by definition will supply much less current, you practically can not destroy leds with it – and you don't need a current limiting resistor! Super bright LEDs might not light, since they might need much more current, such as 350mA.

## Transistor



[Transistor](#) is an active component that can act as an electrically controlled switch or resistor. It does, however, let current flow to only one direction. The switching happens between legs called *collector* and *emitter*, and the control signal is fed to *base*. The leg order can vary depending on the transistor type.

Along with 4060 ships two different transistors, [BC457](#) and [BC557](#). They are both of bipolar type, and generic examples of their kind. The difference between these two models is that BC457 is aNPN transistor, that starts to conduct (switches on) with a positive signal, and BC557 is a PNP transistor, that switches on with a negative signal.

Patching transistors in between DIVIDER outputs combines the signals to a pattern and sometimes creates interesting and unexpected modulations. A transistor can also be used as a simple two input [AND-gate](#) to limit the length of the 4060's loop into a wanted time signature. This action will be shown in some future tutorials.

## Integrated circuits and other complex parts



Complex parts have their own characteristic sound patterns and can be directly used as song modules. Display units also often show cryptic visual patterns that go in sync with the sound, naturally. Integrated circuits can be patched into the patchboard. It doesn't matter if you can only fit other side of the chip there, because it might already have a lot of effect. If you want, you can park two 4060s against each other, so that the integrated circuit will fit between them. Adjusting the knobs now should create nice cross-modulations between the two units.

## **Controlling other machines with 4060**

Experimenting with 4060 as a self contained unit can be lots of fun, but when you expand the horizon to controlling other machines, it all escalates. This part will be written next.