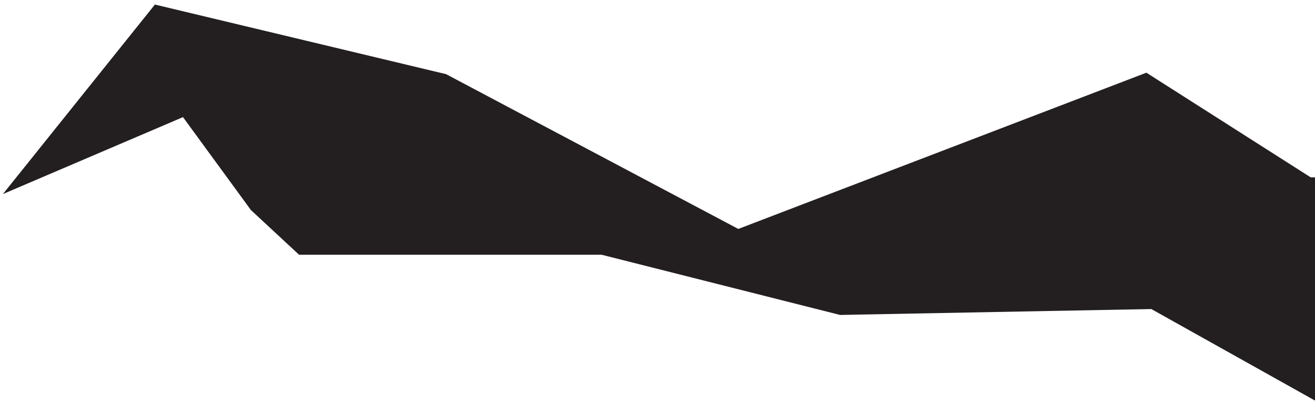
# MAKING OSCILLATIONS THAT WILL BE HEARD

*“Take a sound from whatever source, a note on a violin, a scream, a moan, a creaking door, and there is always this symmetry between the sound basis, which is complex and has numerous characteristics which emerge through a process of comparison within our perception.“*

Pierre Schaeffer, Perception, Door, Process

*“This example illustrates a frequent designer’s quandary, namely a choice between a complicated circuit that meets the strict worst-case design criterion, and is therefore guaranteed to work, and a simple circuit that doesn’t meet worst-case specifications, but is overwhelmingly likely to function without problems. There are times when you will find yourself choosing the latter, ignoring the little voice whispering into your ear.”*

Paul Horowitz and Winfield Hill, The Arts of Electronics



## ELECTRONICS AS MATERIALS:

# OSCILLATIONS / AMPLIFICATIONS / TRANSDUCTIONS / COMPOSITIONS

How might we imagine and build circuitry differently, if instead of thinking about electronics in terms of discrete components, we learn to control the flow of electricity through different materials?

In this introductory course, electronics are presented as materials or, rather, materials are presented as electronics. Students will learn how to probe existing materials to investigate what these are made of, understand their electro/magnetic properties and question how these can be turned into sensing and actuating contraptions.

## hannah

My work combines conductive materials and craft techniques to develop new styles of building electronics that emphasize materiality and process. I create working prototypes to demonstrate the kinds of electronic artifacts we might build for ourselves in a world of electronic diversity. A significant part of my work goes into documenting and disseminating my techniques so that they can be applied by others.

>> *plusea.at*
>> *kobakant.at*
>> *howtogetwhatyouwant.at*

## david

David is a scientist. His work and teachings explore creative use of technologies as a mean to probe and develop future scenarios involving humans and machines. He has scientific and artistic research expertise in domains ranging from actuated textiles to viral communications.

>> *gauthiier.info*

## ciid

Copenhagen Institute of Interaction Design (CIID) is an international hub of creative minds. Our integrated structure creates a unique environment that encompasses world-renowned education, a cutting edge research group, an award-winning consultancy and a startup incubator. We create impact through the design of innovative products, services and environments.

>> *ciid.dk*

**thank you**

*Ankkit and Moises, thank you for all the help organzing this workshop!*

*Some passages of text are taken from Forrest Mims Introduction to Electronics.*

*Some passage of text are taken from Wikipedia.*

## CONTENT

The focus of this year's module is on **sound**. How to produce oscillators, how to amplify electric signals so they become listenable and how to turn materials into both speakers and microphones. Inspired by the work of John Cage, Karlheinz Stockhausen, and Pierre Shaeffer, we will approach questions of how to produce sound compositions with objects that are not musical instruments per se but, rather, have been prepared to emit sonic tonalities.

Four areas will be presented for exploration during this course:

**1) Oscillators and their modulation**

**2) Handmade/crafted electronics**

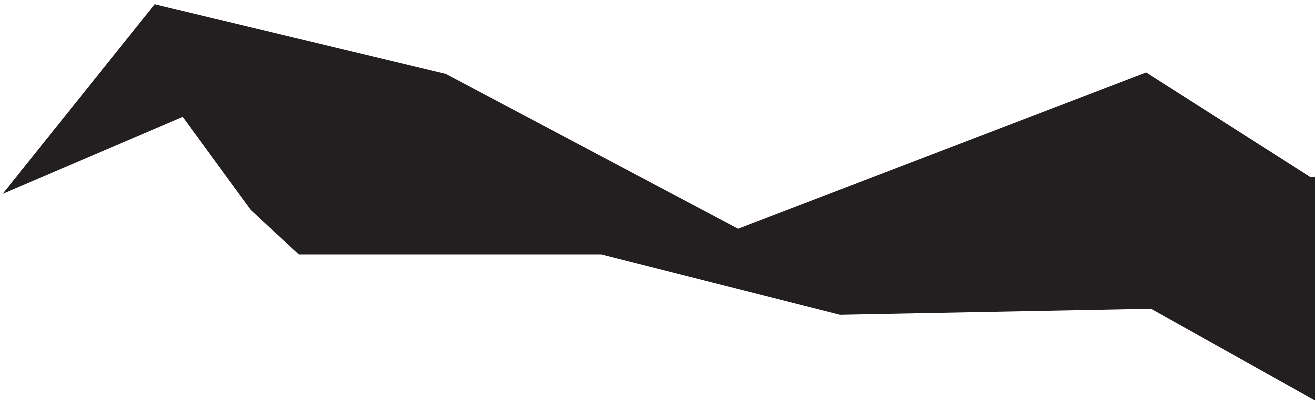
**3) Amplification of electronic signals**

**4) Electromagnetism, speakers and transduction**

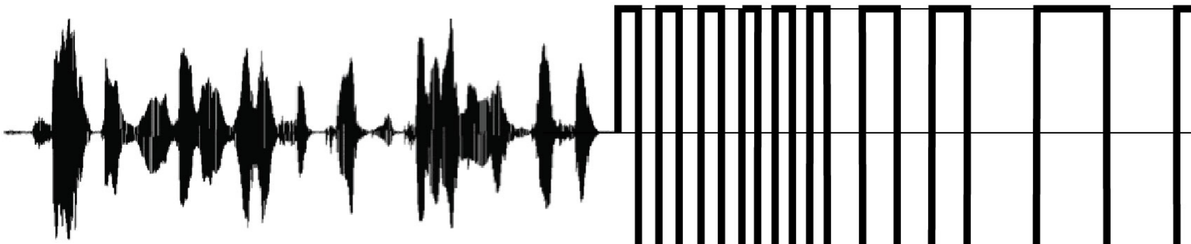
Each aforementioned area of exploration will be composed of multiple small exercises in which participants create electronic artefacts reflecting their learning as they go along. Our intention is to focuses not only on tools and materials, but on how these can become a part of the way students work, think, and design, enabling them to prototype and explore emerging ideas more quickly and more effectively using electronics.

## SCHEDULE

| *MONDAY* | *TUESDAY* | *WEDNESDAY* | *THURSDAY* | *FRIDAY* |
|---|---|---|---|---|
| *Kick-off Breakfast<br><br>Introduction:<br>Workshop content<br>David and Hannah<br><br>Build the Atari Punk Console circuit* | *Theory:<br>Electromagnetism / What is a speaker?<br><br>Build & Experiment:<br>Make a speaker* | *Build & Experiment:<br>Piezo elements as transducers / Make a microphone<br><br>Theory:<br>Voltages, Potentials & Analogue Waveforms* | *Explorations* | *Explorations* |
| *LUNCH* | *LUNCH* | *LUNCH* | *LUNCH* | *LUNCH* |
| *Theory:<br>Oscillators / What is a waveform?<br><br>Build & Experiment:<br>Material properties & sound modulation* | *Theory:<br>Signals & Amplification / What is an amplifier?<br><br>Build & Experiment:<br>Hooking up an amplifier (connecting signals)* | *Hand-out briefs for small project / compositions and discussions<br><br>Explorations* | *Show and tell to see what everybody is working on<br><br>Explorations* | *Presentations / Round table discussion / documentation / clean-up* |



# MAKING OSCILLATIONS…



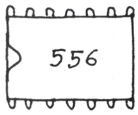
# ATARI PUNK CONSOLE

An Atari Punk Console is an electronic musical instrument that produces “low-fi” sounds that resemble classic Atari console games from the 1980s, with a square wave output similar to the Atari 2600. The Atari Punk Console (commonly shortened to APC) is a popular circuit that utilizes two 555 timer ICs or a single 556 dual timer IC.

Atari Punk console is an astable square wave oscillator driving a monostable oscillator that creates a single (square) pulse. There are two controls, one for the frequency of the oscillator [R1] and one to control the width of the pulse [R3]. The controls are usually potentiometers but the circuit can also be controlled by light, temperature, pressure etc. by replacing a potentiometer with a suitable sensor (e.g., photo resistor for light sensitivity). Most of the time there is also a power switch (often a toggle switch) and a volume knob.

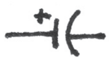
*>> http://www.ataripunkconsole.com*

## parts




*556 Timer IC*

*0.01uF Ceramic Capacitor [C1]*
*0.1uF Ceramic Capacitor [C2]*

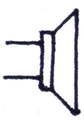


*10 uF Electrolytic Capacitor [C3]*

*1k Ω Resistor [R2]*

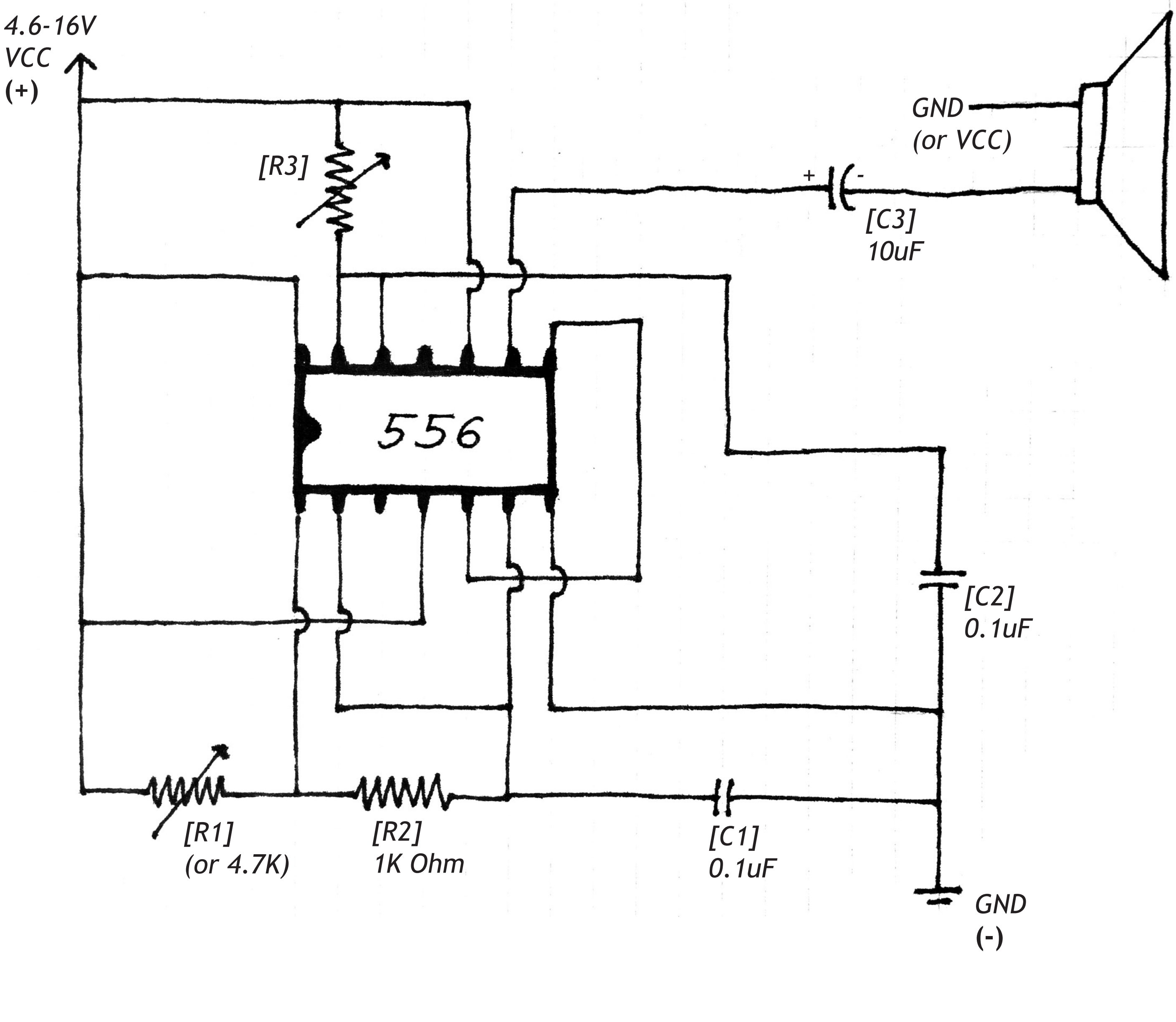
*Variable Resistor [R1] - frequency*
*Variable Resistor [R3] - duration*

*9V Battery*



*Speaker*

## CIRCUIT DIAGRAM/ SCEMATIC




**Capacitor Value Chart** *(just incase you're interested:-)*

| uF | nF | pF | # |
|---|---|---|---|
| 0.01 | 10 | 10000 | 103 |
| .1 | 100 | 100000 | 104 |
| 1 | 1000 | 1000000 | 105 |
| 10 | 10000 | 10000000 | 10uF |

# LM556 DUAL TIMER DATASHEET

Here are some excerpts from the LM556 datasheet, just to give an idea of what kinds of information you will find there.

>> *ti.com/lit/ds/symlink/lm556.pdf*

## LM556 Dual Timer

### 1 Features

- Direct Replacement for SE556/NE556
- Timing From Microseconds Through Hours
- Operates in Both Astable and Monostable Modes
- Replaces Two 555 Timers
- Adjustable Duty Cycle
- Output Can Source or Sink 200 mA
- Output and Supply TTL-Compatible
- Temperature Stability Better Than 0.005% per °C
- Normally On and Normally Off Output

### 2 Applications

- Precision Timing
- Pulse Generation
- Sequential Timing
- Time Delay Generation
- Pulse Width Modulation
- Pulse Position Modulation
- Linear Ramp Generator

### 3 Description

The LM556 dual-timing circuit is a highly-stable controller capable of producing accurate time delays or oscillation. The LM556 device is a dual-timing version of the LM555 device. Timing is provided by an external resistor and capacitor for each timing function. The two timers operate independently of each other, sharing only $V_{CC}$ and ground. The circuits may be triggered and reset on falling waveforms. The output structures may sink or source 200 mA.

**Device Information(1)**

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|---|---|---|
| LM556 | SOIC (14) | 3.91 mm × 8.65 mm |
| | PDIP (14) | 6.35 mm × 19.177 mm |

(1) For all available packages, see the orderable addendum at the end of the data sheet.

### 6.1 Absolute Maximum Ratings

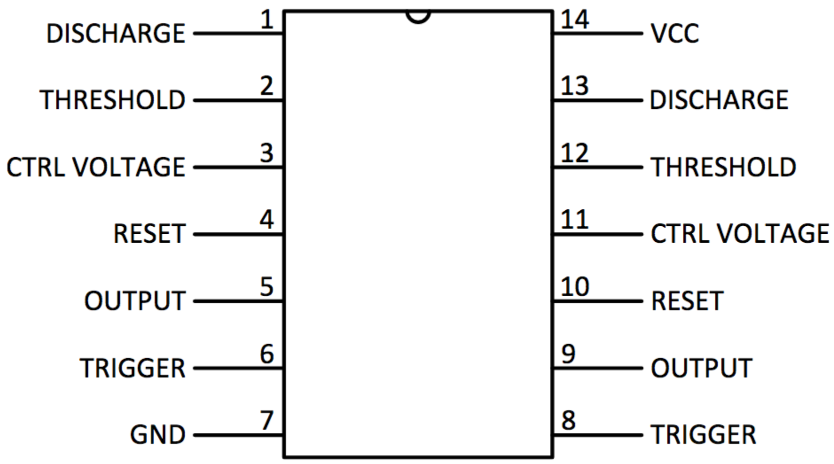
over operating free-air temperature range (unless otherwise noted)(1)(2)

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| Supply voltage | | | 18 | V |
| Power dissipation(3) | LM556CM | | 410 | mW |
| | LM556CN | | 1620 | mW |
| Operating temperature, LM556C | | 0 | 70 | °C |
| Soldering information | PDIP package soldering (10 seconds) | | 260 | °C |
| | SOIC package vapor phase (60 seconds) | | 215 | °C |
| | SOIC package infrared (15 seconds) | | 220 | °C |
| Storage temperature, $T_{stg}$ | | –65 | 150 | °C |

### 6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

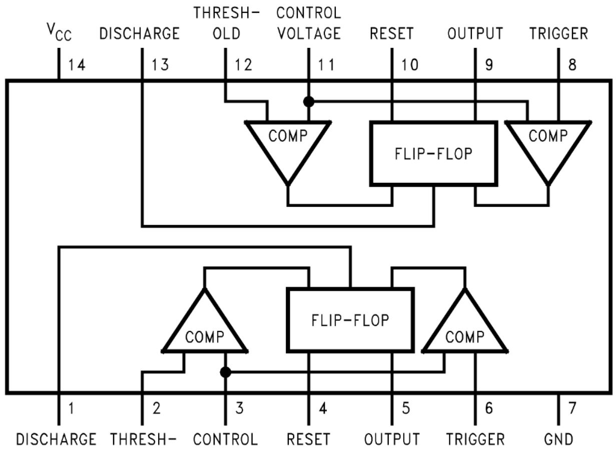
| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | 4.5 | 16 | V |
| $T_A$ | Operating temperature | 0 | 70 | °C |

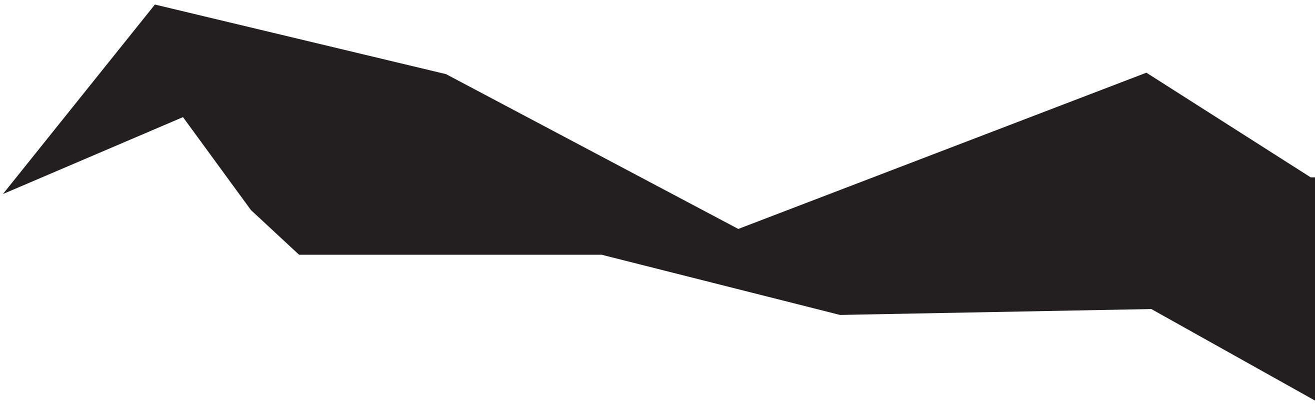



**Pin Functions**

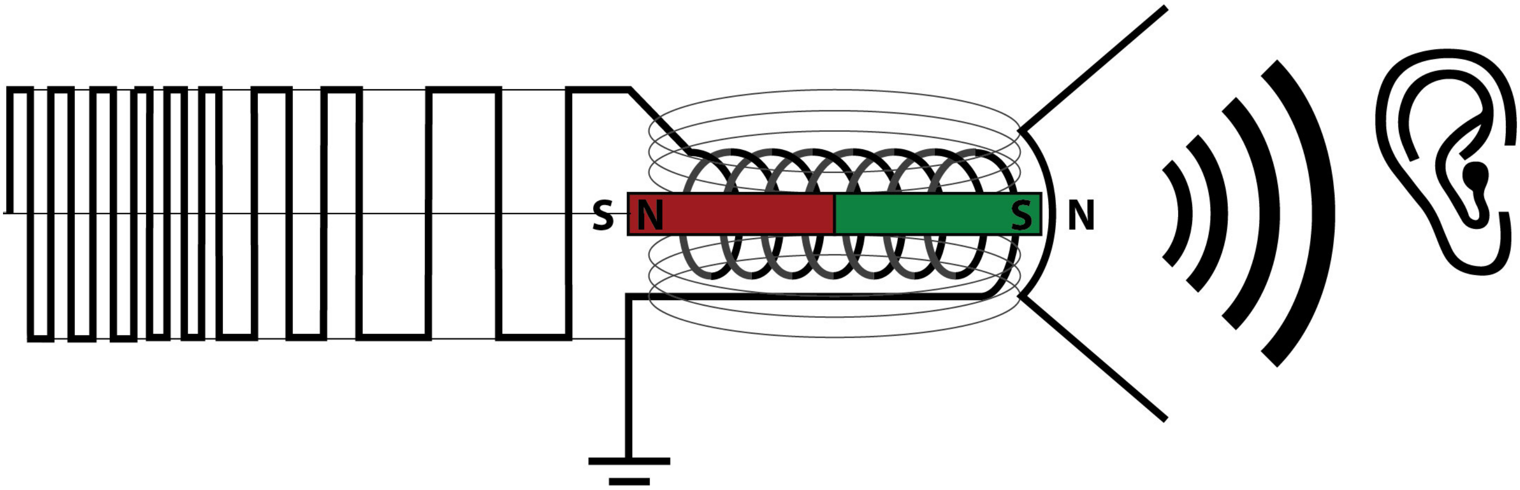
| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| NAME | NO. | | |
| CONTROL VOLTAGE (Timer 0) | 3 | I | Controls the threshold and trigger levels. It determines the pulse width of the output waveform. An external voltage applied to this pin can also be used to modulate the output waveform. |
| CONTROL VOLTAGE (Timer 1) | 11 | I | Controls the threshold and trigger levels. It determines the pulse width of the output waveform. An external voltage applied to this pin can also be used to modulate the output waveform. |
| DISCHARGE (Timer 0) | 1 | I | Open collector output which discharges a capacitor between intervals (in phase with output). It toggles the output from high to low when voltage reaches 2/3 of supply voltage. |
| DISCHARGE (Timer 1) | 13 | I | Open collector output which discharges a capacitor between intervals (in phase with output). It toggles the output from high to low when voltage reaches 2/3 of supply voltage. |
| GND | 7 | O | Ground reference voltage |
| OUTPUT (Timer 0) | 5 | O | Output driven waveform |
| OUTPUT (Timer 1) | 9 | O | Output driven waveform |
| RESET (Timer 0) | 4 | I | Negative pulse applied to this pin to disable or reset the timer. When not used for reset purposes, it should be connected to Vcc to avoid false triggering. |
| RESET (Timer 1) | 10 | I | Negative pulse applied to this pin to disable or reset the timer. When not used for reset purposes, it should be connected to Vcc to avoid false triggering. |
| THRESHOLD (Timer 0) | 2 | I | Compares the voltage applied to the terminal with a reference voltage of 2/3 $V_{CC}$. The amplitude of voltage applied to this terminal is responsible for the set state of the flip-flop. |
| TRIGGER (Timer 0) | 6 | I | Responsible for transition of the flip-flop from set to reset. The output of the timer depends on the amplitude of the external trigger pulse applied to this pin. |
| THRESHOLD (Timer 1) | 12 | I | Compares the voltage applied to the terminal with a reference voltage of 2/3 $V_{CC}$. The amplitude of voltage applied to this terminal is responsible for the set state of the flip-flop. |
| TRIGGER (Timer 1) | 8 | I | Responsible for transition of the flip-flop from set to reset. The output of the timer depends on the amplitude of the external trigger pulse applied to this pin. |
| VCC | 14 | I | Supply voltage with respect to GND |

## 7.2 Functional Block Diagram





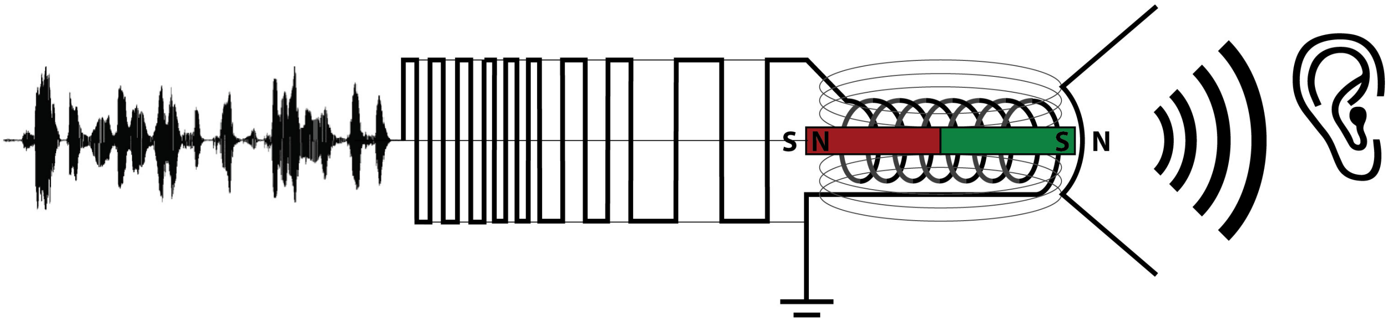
...THAT WILL BE HEARD



# TRANSDUCTION

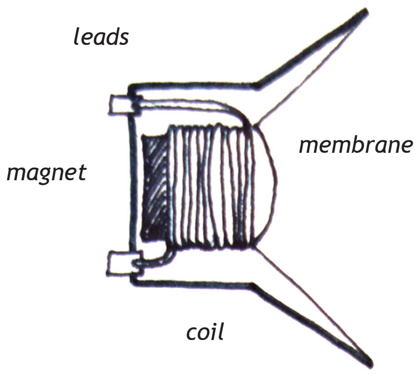
*The process of converting one form of energy to another is known as transduction.*
*A transducer is a device that converts a signal in one form of energy to a signal in another. Transducers are often employed where electrical signals are converted to and from other physical quantities (energy, force, torque, light, motion, position, etc.).*

*A speaker is a transducer, it converts variations in a current or voltage into sound waves. First the electrical sound signal is used to move a membrane back and forth, which in turn moves the air which is what we hear.*




## DYNAMIC SPEAKER

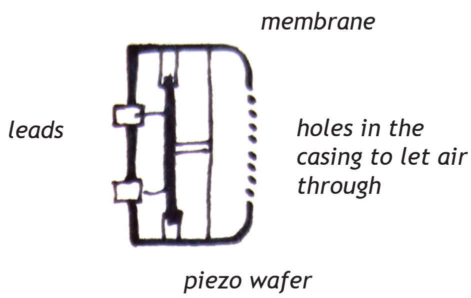
*A coil of wire is attached to a membrane and wrapped around a permanent magnet, with space for the coil to move in relation to the magnet.When pulses of electrical current (a sound signal) is fed into the coil it becomes an electromagnet and attracts or repells itself from the permanent magnet causing the membrane to move and move the air around it, sending soundwaves through the air which we will hear.*




## PIEZO CRYSTAL SPEAKER

*A wafer of piezoelectric material forms the membrane or is linked to the membrane. The piezoelectric material will bend when voltage is applied to it, causing the membrane to move, which in turn will move the air around it.*

*Piezoelectric materials also produces voltage when bent, meaning they can also be used to create microphones.*



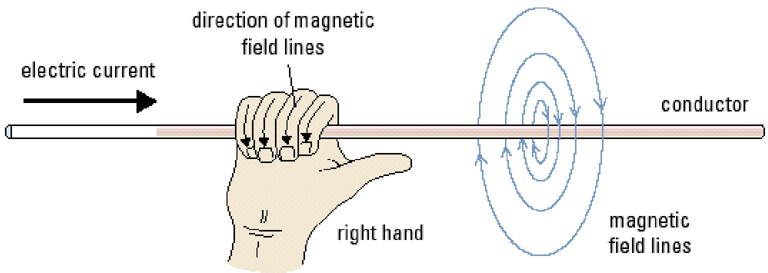

## MICROPHONES

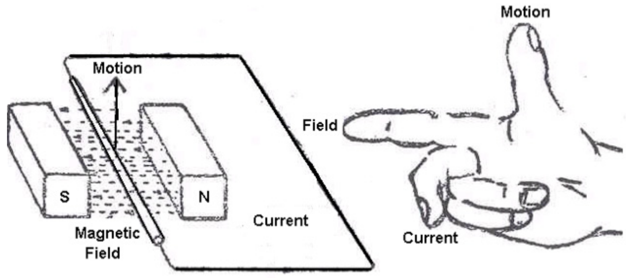
*A microphone works the opposite way of a speaker. Movement of the air causes a membrane (or diaphragme) to move which is translated into an electrical signal.*

*dynamic microphone = magnetic speaker*
*crystal microphone = piezo speaker / buzzer*

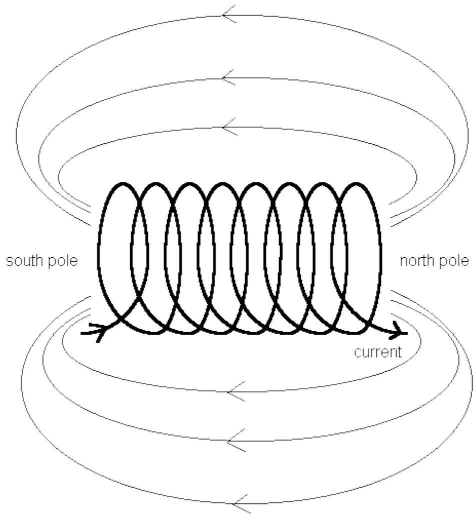
## ELECTROMAGNETISM

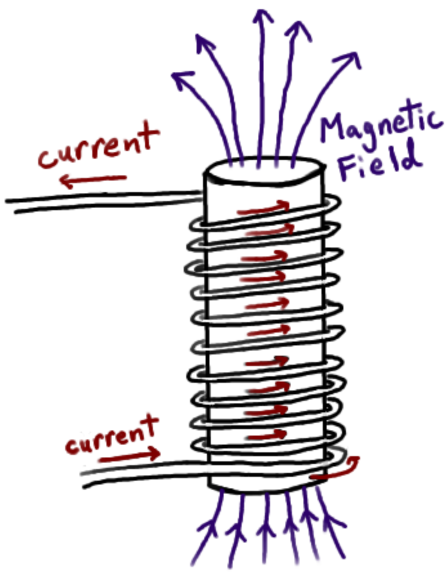
*A current flowing through a wire creates a magnetic field around the wire, this is called electromagnetism. The magnetic field disappears when the current is turned off.*
*You cannot see the field, but you can observe its effect.*

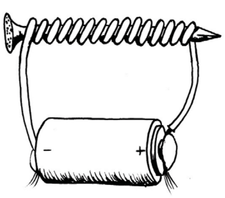



*Electromagnets usually consist of insulated wire wound into a coil because this allows you to increase the strength of the magnetic field. The more turns in your coil, the stronger the electromagnetic field. The electromagnetic field is concentrated in the hole in the center of the coil.*



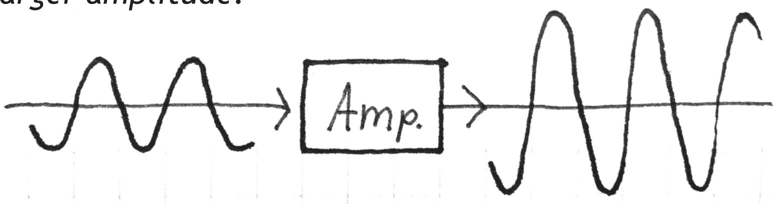



*The wire turns are often wound around a magnetic core made from a ferromagnetic or ferrimagnetic material such as an iron nail. The magnetic core concentrates the magnetic flux and makes a more powerful magnet.*

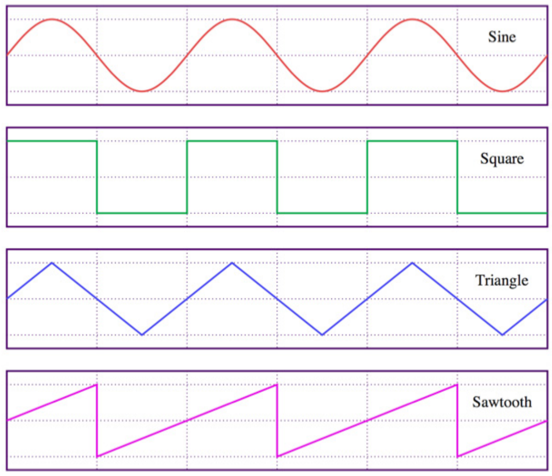
# AMPLIFICATION

*An electronic amplifier (amp) is a device that can increase the power of a signal (a time-varying voltage or current). It takes power from a power supply and controlls the output signal to match the input signal shape but with a larger amplitude.*

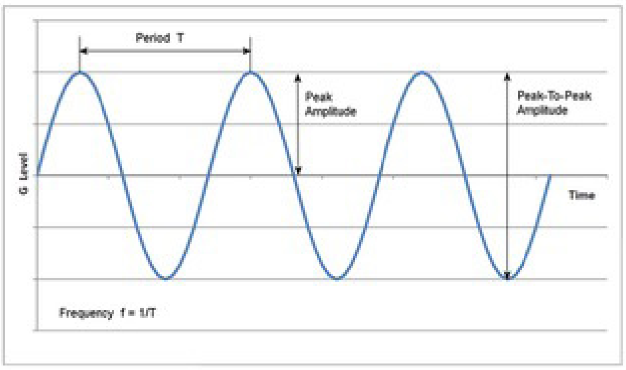


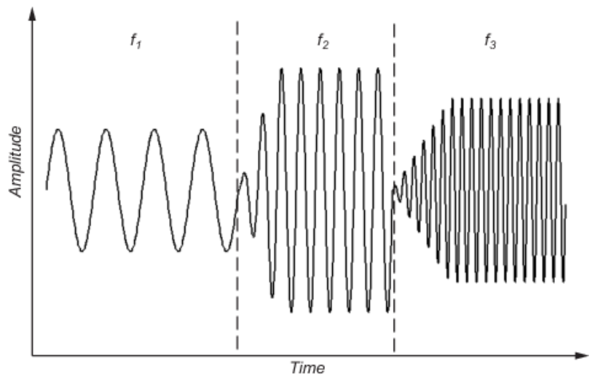

## WAVEFORMS

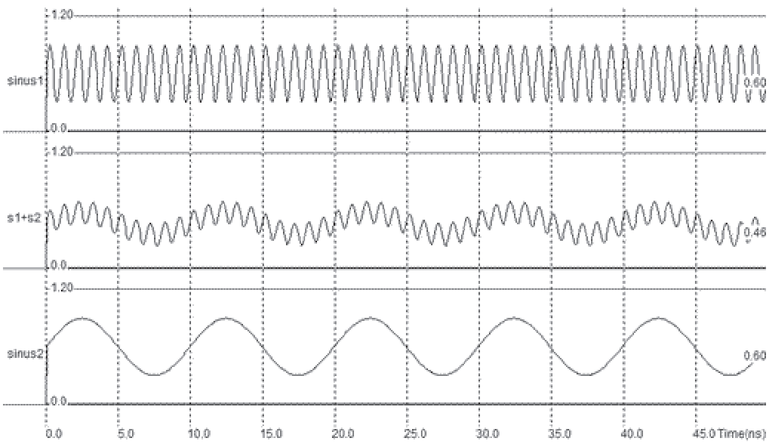
**Analog vs. Digital**
*We live in an analog world. There are an **infinite** amount of tones we can hear, smells we can smell, colours we can see. Digital signals and objects deal in the realm of the **discrete or finite**, meaning there is a limited set of values they can be.*




**Signals**
*The signals we're talking about are time-varying "quantities" which convey some sort of information. In electrical engineering the quantity that's time-varying is usually voltage (if not that, then usually current). So when we talk about signals, just think of them as a voltage that's changing over time.*



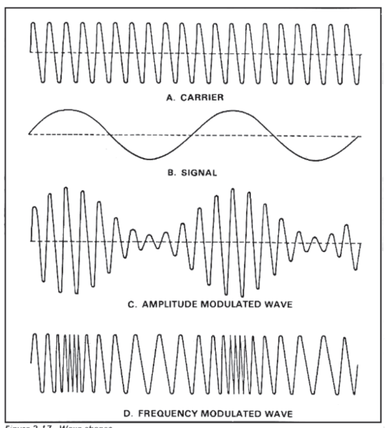



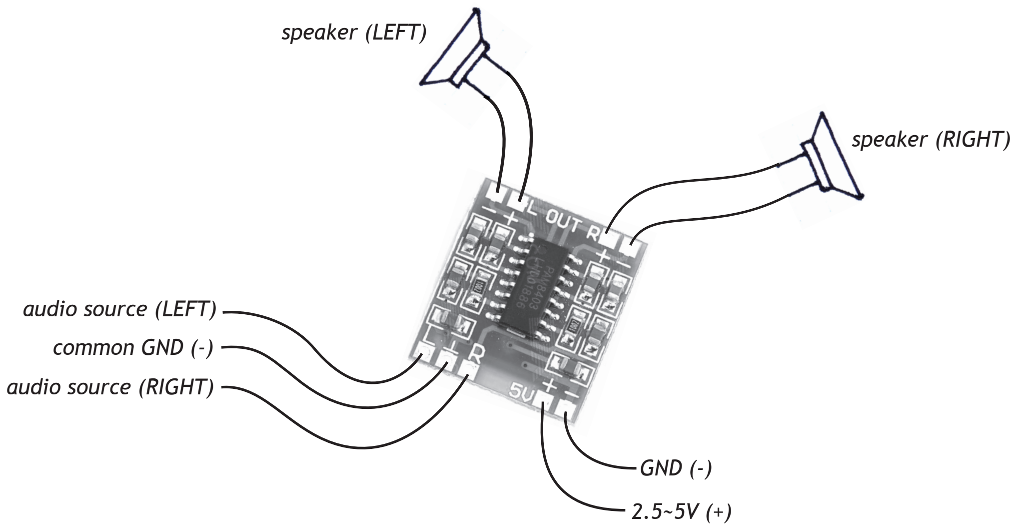

*Figure 2-17. Wave shapes*

## Mini Digital Audio Amplifier Board (GF-007)

*Two channel stereo, 5V power supply, it can output 3W+3W power and can drive 4 ohm, 8 ohm small speakers directly. Input voltage: 2.5~5V, can be powered by USB.*

**Warning:** *the negative of the left and right channel's output can not be connected together, otherwise it will burn the IC!!!*

**Note:** *connect the speaker before power is switched.*




## Tip122 Darlington Transistor

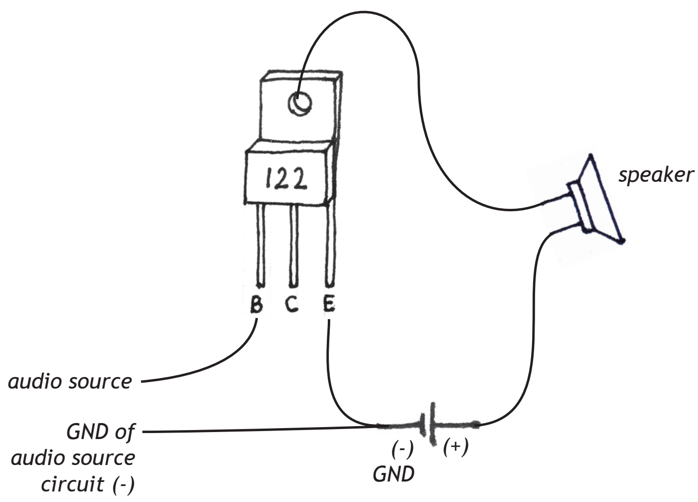
*The Darlington transistor consists of two bipolar transistors connected in such a way that the current amplified by the first transistor is amplified further by the second one. This configuration gives a much higher common/emitter current gain than each transistor taken separately.*

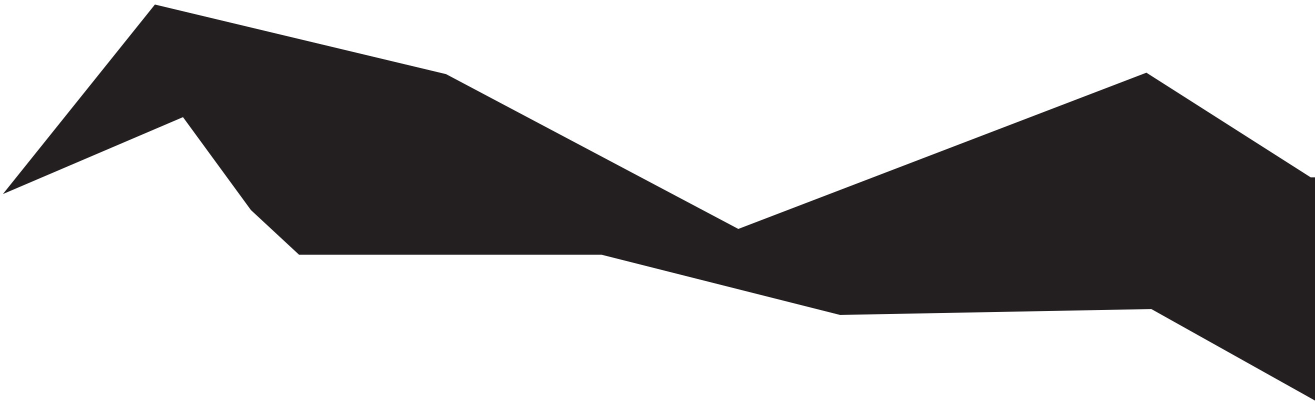
the three pins of the transistor are called Base (B), Collector (C) and Emiter (E).

They connect to the circuit as follows:

- ***Base*** *connects to sound signal*
- ***Emitter*** *connects to the GND*
- ***Collector*** *connects to one speaker lead (the other speaker lead connects directly to +9V)*

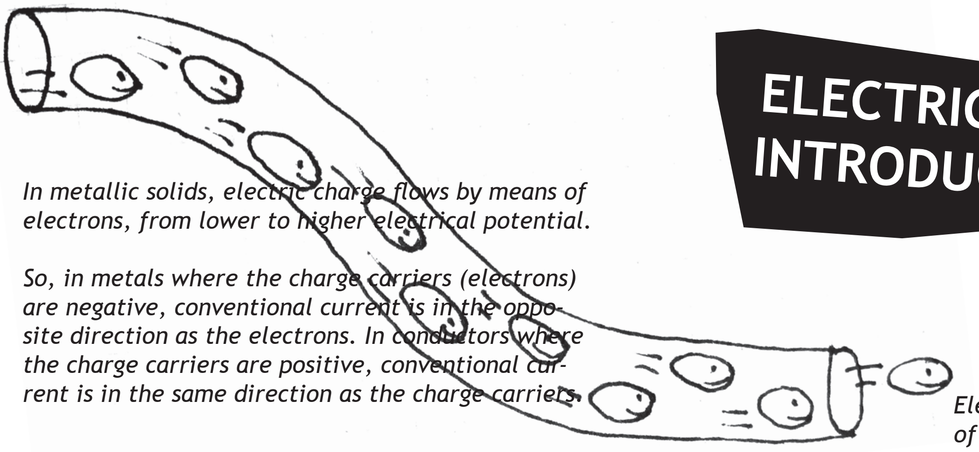
***Note:*** *the collector leg/lead 'C' is connected to the large piece of metal that acts as a heat-sync.*





# APENDIX

# ELECTRICITY INTRODUCED

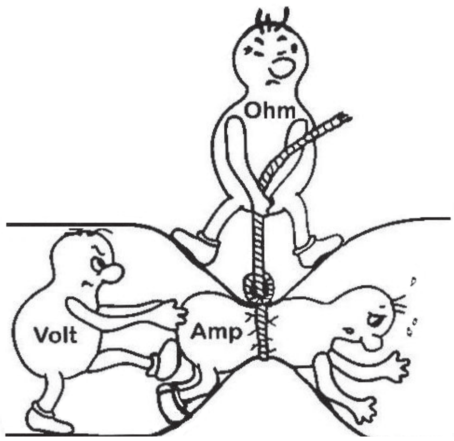


*In metallic solids, electric charge flows by means of electrons, from lower to higher electrical potential.*

*So, in metals where the charge carriers (electrons) are negative, conventional current is in the opposite direction as the electrons. In conductors where the charge carriers are positive, conventional current is in the same direction as the charge carriers.*

*Electrical current flows from a region of high charge or potential to a region of low potential.*

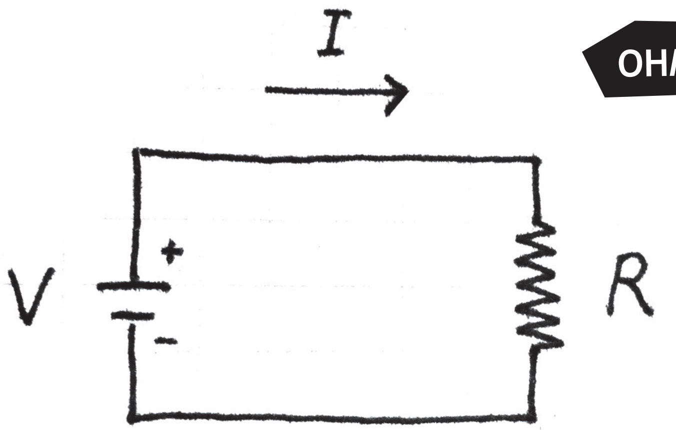
***Voltage (V) -** is electrical pressure or force. Sometimes referred to as potential. Voltage drop is the difference in voltage between the two ends of a conductor through which current is flowing.*




***Current (I) -** is the quantity of electronics passing a given point. The unit of current is Ampere.*
*1 Amp = 6,280,000,000,000,000,000 electronics passing a point in one second.*

***Resistance (R) -** conductors are not perfect, they resist the flow of current to some degree. the unit of resistance is the Ohm (Ω).*

## OHM'S LAW




$$V = I \times R$$

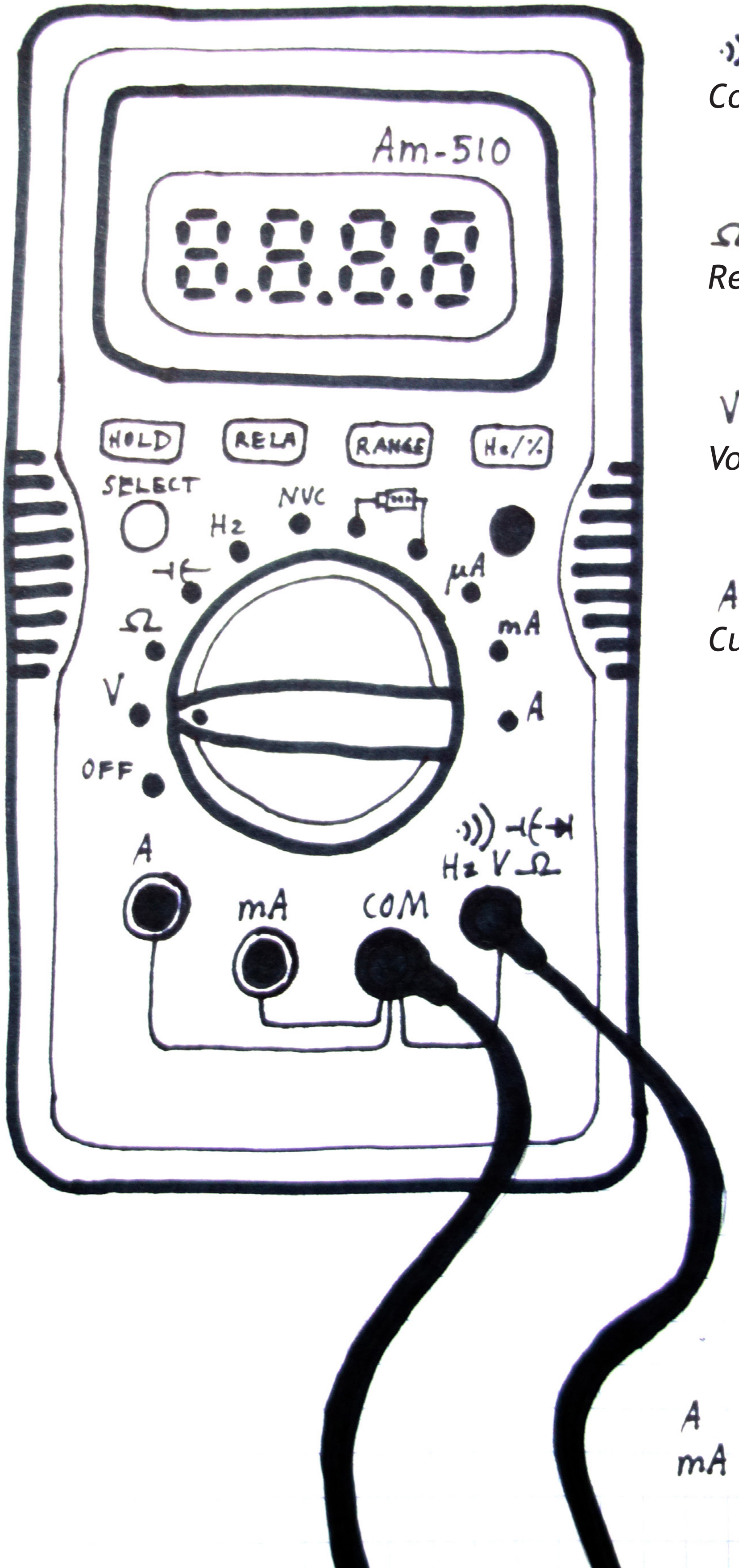
*A potential difference of **1V** will force a current of **1A** through a resistance of **1Ω***

## WATER ANALOGY

*If we compare electricity to water flowing through a pipe, then:*
*Voltage is the water pressure,*
*Current is the stream of flow of water,*
*Resistance is the valve.*

# MEET THE MULTIMETER

*The multimeter is the single most important electronic text instrument. In the context of this workshop we will use it it for measuring electrical voltage (V DC), continuity, resistance (Ω) and maybe sometimes current (Ampere).*




·)))
*Continuity*

Ω
*Resistance*

V
*Voltage*

A
*Current*

*The leads of the multimeter's probes plug into these sockets. The black lead can generally stay in the COM socket, while the red lead will plug into a different socket depending on what you are measuring.*

·))) Hz V Ω

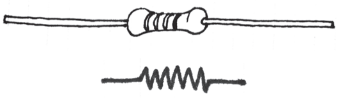
*For measuring **continuity, resistance and voltage**, the red lead needs to be in the **far right socket**.*

A
mA

*For measuring **current**, the red lead needs to be plugged into one of the **left sockets**.*

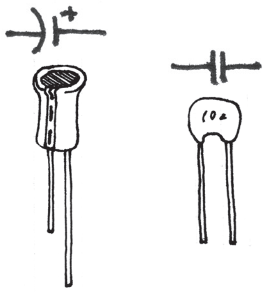
# DISCRETE COMPONENTS

*Electronic functionality tends to get packaged into discrete components, also called electronic parts. Leads or legs protoruding from their housings provide contact to their inner electrical function. Many of these parts can be taken apart to better understand how they work, and I recommend you do so. When you understand how these 'parts' work, you will find that you can also build many of them yourself from the materials available in this workshop!*



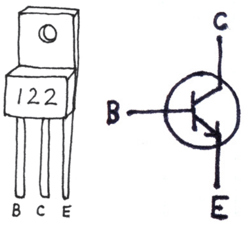
## Resistors

*Resistors limit the flow of current in an electrical circuit. For example a resistor can be used to reduce the brightness of an LED. Coloured bands indicate the value of each resistor.*



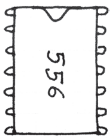
## Capacitors

*Capacitors store small amount of electrical charge and function like tiny batteries, each tuned to a specific value. They a often used in power supply and audio circuits.*




## TIP 122 - NPN Transistors

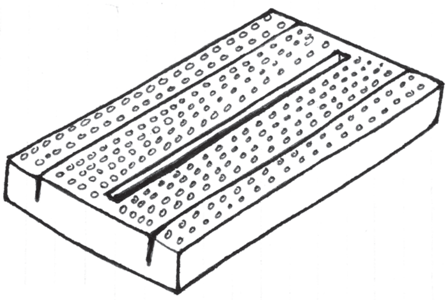
*Transistors are the most basic digital component. They have three legs: a "base", "emitter" and "collector". When a small current is applied to the base, the transistor will let a larger current flow from the collector to the emitter and so become a digital switch or amplifier.*




## LM556 Dual Timer - Integrated Circuits (ICs)

*An IC is a set of electronic circuits on one small chip of semiconductor material, normally silicon. This can be made much smaller than a discrete circuit made from independent electronic components. Imagine several billion transistors in an area the size of a fingernail*

*The LM556 dual-timing circuit is a highly-stable controller capable of producing accurate time delays or oscillation.*

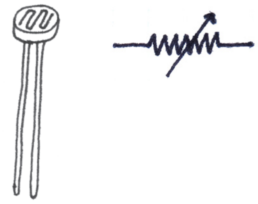


## Breadboards

*A breadboard is a construction base for prototyping electronics. The leads of components can be poked into the holes of the board where they will make electrical connections with other leads poked into holes along the same strip.*

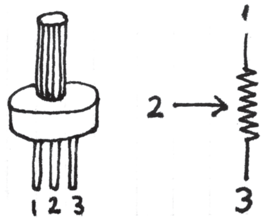
***Note**: the holes in the center are connected horizontally and split in the middle. The holes along the side are connected vertically and intended to be used as power rails.*

***Beware!** On some long breadboards the power rails do not connect from one half to the other. Use a multimeter to check before using.*



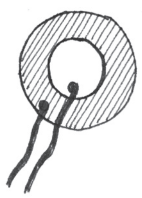
## Light Dependent Resistor (LDR) or Photocell

*A LDR is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity.*



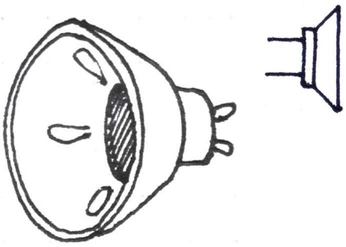

## Potentiometers (Pots)

A potentiometer, informally a pot, is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.



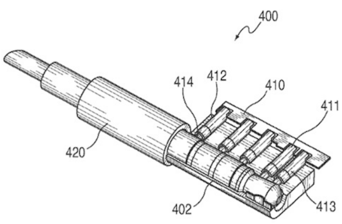
## Piezoelectric Element

A piezoelectric speaker or buzzer is a loudspeaker that uses the piezoelectric effect for generating sound. The initial mechanical motion is created by applying a voltage to a piezoelectric material, and this motion is typically converted into audible sound using diaphragms and resonators.



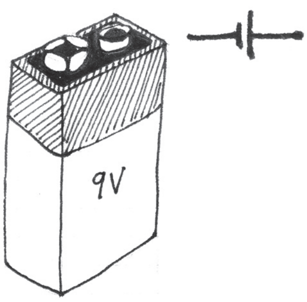
## Dynamic Speaker

*A speaker is an electroacoustic transducer which converts an electrical audio signal into a corresponding sound. When an alternating current electrical audio signal is applied to its voice coil, a coil of wire suspended in a circular gap between the poles of a permanent magnet, the coil is forced to move rapidly back and forth due to Faraday's law of induction, which causes a diaphragm (usually conically shaped) attached to the coil to move back and forth, pushing on the air to create sound waves.*




## Jack/Socket

*Is an electrical connector set typically used for analog signals, primarily audio. The jack is cylindrical, with typically 2, 3, 4 or 5 contacts. Three-contact versions are known as TRS connectors, where T stands for "tip", R stands for "ring" and S stands for "sleeve".*
*The sockets come in a variety of forms and make electrical contact with the contacts on the jack and pins protruding from the connector which are intended to be soldered to a circuit board.*




## 9V Battery

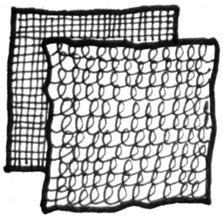
*An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode.*

*Did you know: inside an alkaline or carbon-zinc 9-volt battery there are six 1.5V cylindrical or flat cells connected in series.*

# MEET THE MATERIALS

## Conductive Fabrics

*There are a variety of conductive fabrics available.*

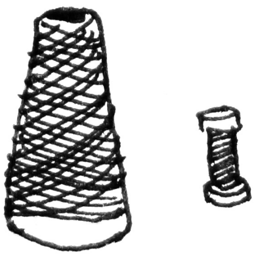


***Metallized conductive fabrics** are non-conductive fabrics that have been plated (coated) in a thin layer of metal. The fabric itself is almost always sythetic because the fibers are smoother and easier to coat uniformly. The metals used in the coating are most include copper, silver and nickel.*

***Constructed conductive fabrics** are fabrics that are made from a combination of conductive and non-conductive threads. This creates a fabric that is not necessairilly condutive all over, and may have rows/columns of conductors.*

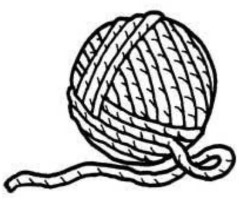
*Knit fabrics will be stretchy, while woven and non-woven fabrics will not stretch.*

## Conductive Threads



***Metal conductive threads** are made from thin filaments of solid metal, very much like a multi-stranded wire, except they are spun with a synthetic core (nylon, kevlar...) to give them the tensile strength they need to be sewn with. Metals used tend to be copper, silver coated copper and stainless steel. Copper and silver are solderable.*

***Metalilzed or metal plated threads** are non-conductive threads that have been plated (coated) in a thin layer of metal. The thread itself is almost always sythetic because the fibers are smoother and easier to coat uniformly. The metals used in the coating are most include copper, silver and nickel.*
*and may have rows/columns of conductors.*



## Conductive Yarns

*Thicker than thread, yarn is intended for knitting or crochet. Conductive yarns are spun from a blen of conductive and non-conductive fibers or metalized thread.*

## Copper Tape

*An adhesive-backed copper tape that comes in two forms: with conductive adhesive or with non-conductive adhesive (which is more common).*

## Wire

***Magnet wire** or enameled wire is a copper or aluminium wire coated with a very thin layer of insulation.*

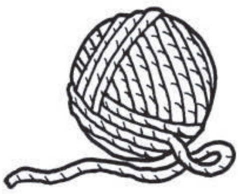
***Solid-core wire or hook-up wire** is a single-stranded wire that is stiff yet bendable and often used as jumper wire to make connections on a breadboard, or soldered connections on a through-hole PCB.*

***Multi-stranded wire** is made up of multiple strands of thin wire, which makes it flexible and good for applications where movement of the wire is required.*

## Graphite

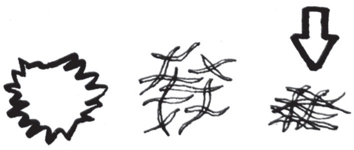
*Graphite is a form of carbon and is conductive. Most pencil cores are made of graphite mixed with a clay binder and can be used to draw conductive traces. Soft pencils will work better.*

## Resistive Yarn



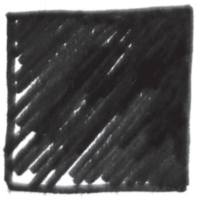
*Spun from a blend of stainless steel fiber and polyester or wool fibers. The conductive fibers are short and not continuous, so that the electrical resistance across them is high. When stretched or pressured, the contact between the fibers improves and the connection becomes more conductive.*

## Stainless Steel Fiber



*A blend of stainless steel and polyester or wool fibers that can be felted together using a felting needle or rubbing them together with or without soap and water.*
*The conductive fibers are short and not well connected, so that the electrical resistance across them is high. When squeezed together, the contact between the fibers improves and the connection becomes more conductive the more you squeeze.*

## Carbon Impregnated Plastic Sheet Material

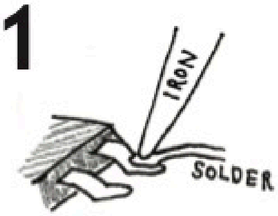


*This carbon impregnated polymeric foil is commonly known under the brand names Velostat or Linqstat. The resistance across the surface of the material increases, the larger the distance. The resistance through the material decreases when pressured, because the carbon particles are squeezed together and make better electrical contact, this property is called piezoresistive.*

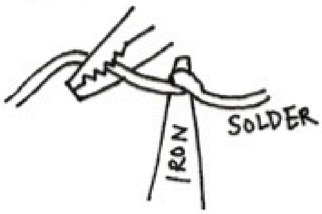
# How to solder...

Soldering is a technique of joining metal items by melting solder onto the joint.

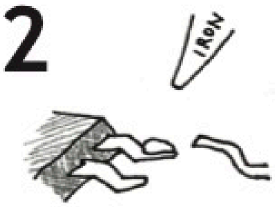
**1**



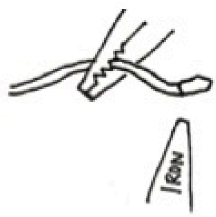

*First apply to solder seperately to the two parts that you want to join.*



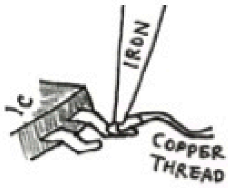

**2**




*Use the hot tip of a soldering iron to heat up the parts you want the solder to flow on to.*

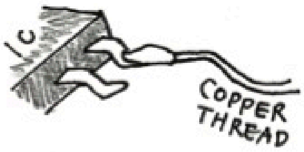



**3**




*Then hold the two parts together and use the soldering iron to re-flow the solder from both parts together.*

**4**

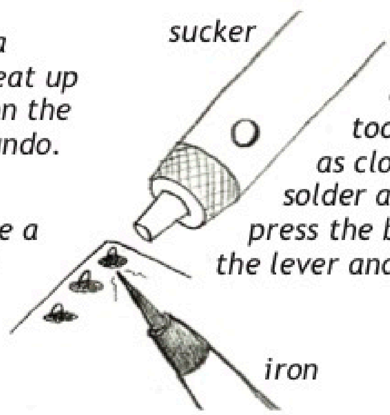



# How to desolder...

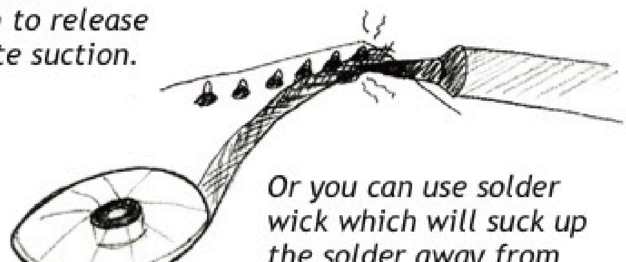
Desoldering is a technique of removing solder from a soldered joint to disconnect parts from one another.

*Use the hot tip of a soldering iron to heat up the solder that is on the joint you want to undo.*

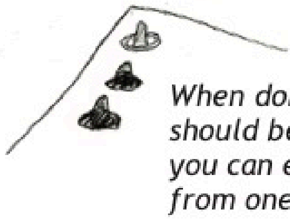
*You can either use a de-solder tool to create a suction that sucks away the hot solder.*




*Push in the lever of the de-solder tool, hold it's nossel as close to the hot solder as possible and press the button to release the lever and create suction.*



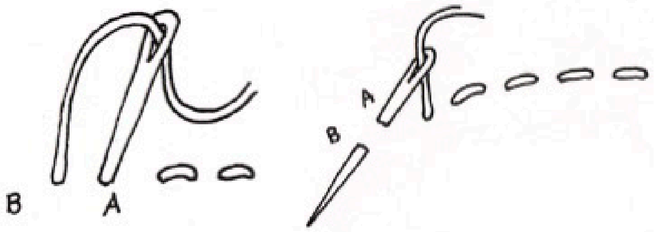
*Or you can use solder wick which will suck up the solder away from the joint as you heat it up with the soldering iron.*



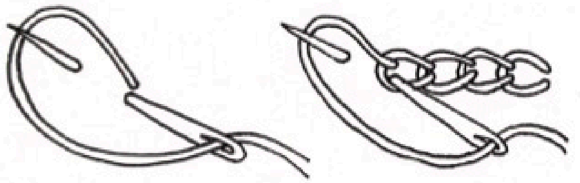
*When done your solder joint should be clean of solder so that you can easily seperate the parts from one another.*

# How to sew...

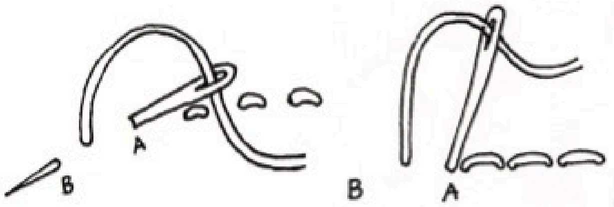
*Running stitch*



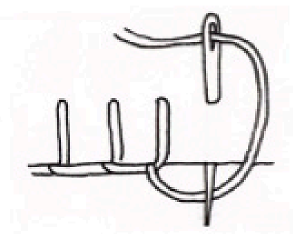

*Chain stitch*



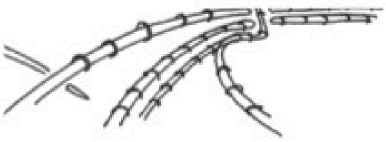
*Backstitch*



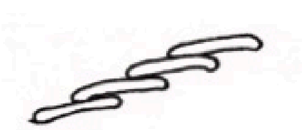

*Blanket stitch*



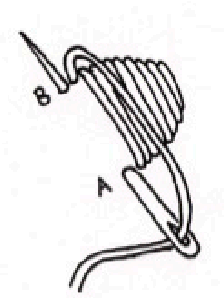
*Couching stitch*



*Tent stitch*

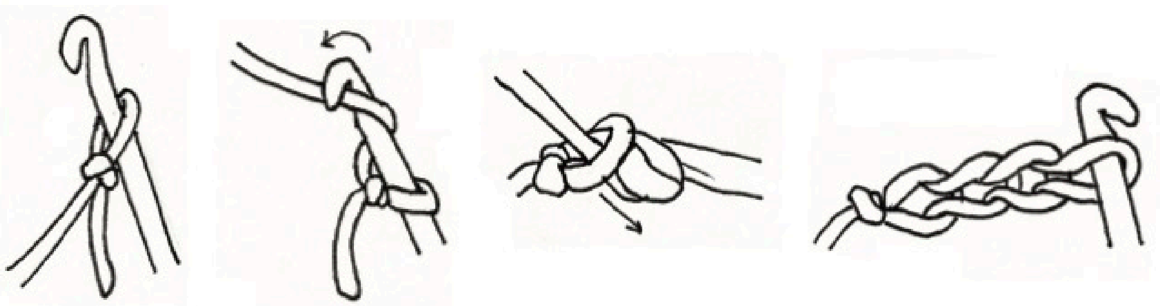


*Fill stitch*

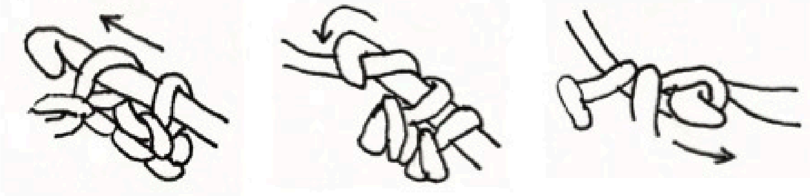



# How to crochet...

*First row*



*Second row*



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David Gauthier &
Hannah Perner-Wilson

CIID, February 2017