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Discrimination TR-IB Metal Detector Circuit

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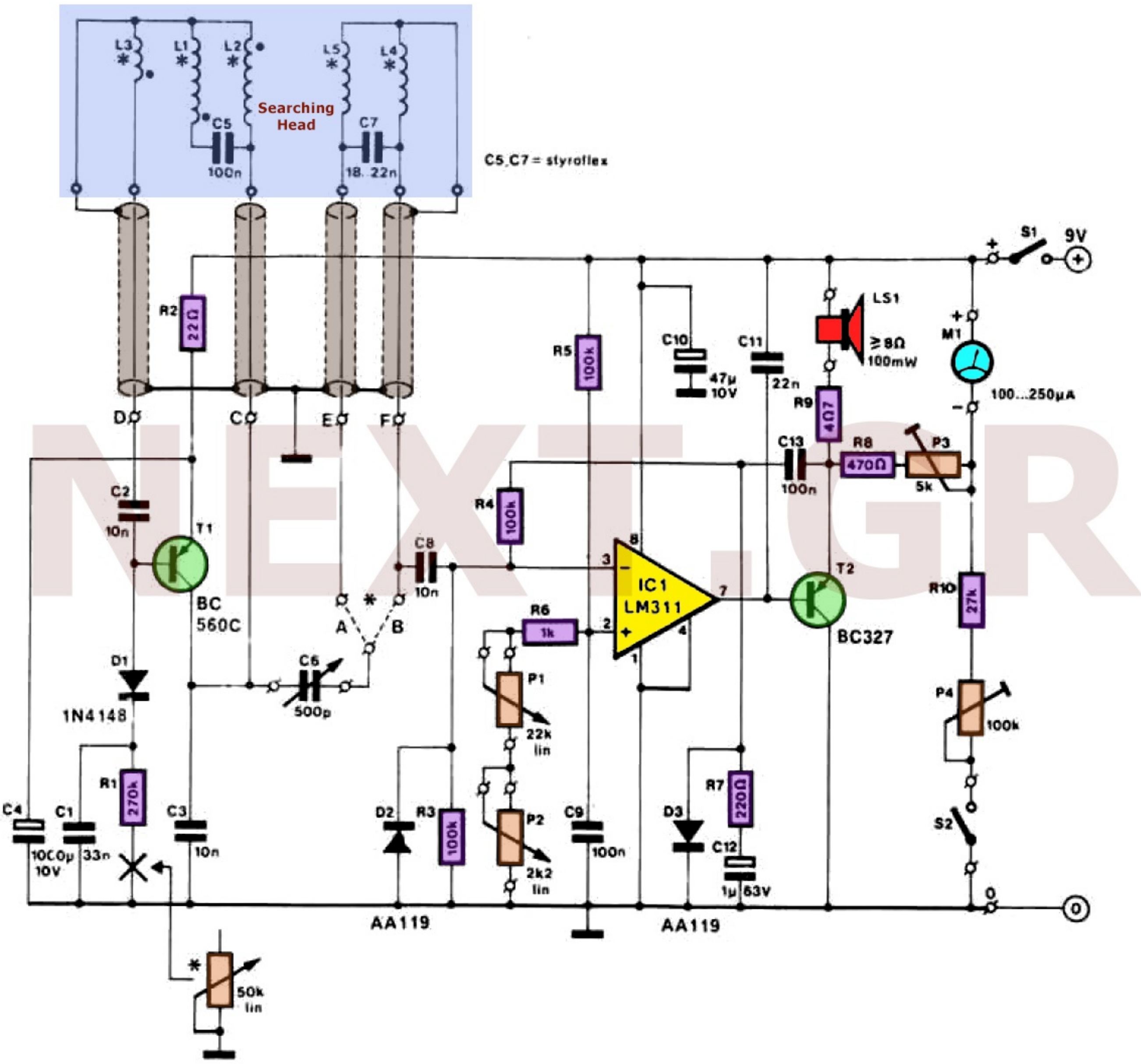
The metal detectors can be classified according to their principle of operation in those three categories: BFO, TR/IB and PI. Each of these methods has advantages as well as disadvantages. The ideal metal detector (do not look for it because it does not exist). It should take advantage of all the advantages of all methods while eliminating their disadvantages. Still, the detector should be sensitive enough and give some indication of the type of metal detected. The detector shown here belongs to the class of TR/IB detectors, for this reason, its head consists of two inductions. As will be seen below, the whole construction is based on the combination of a variable L oscillator and a detector.



Metal Detector types

1) **BFO** (Beal Freqency Oscillalor) In this category of detectors, the induction of the probe is part of an oscillator whose variable output frequency contributes to a constant frequency generated in turn by a second oscillator. The result of this contribution is a frequency in the acoustic region. As soon as the detecting head approaches a metal object, the variable oscillator causes a change in the interference frequency, which can be perceived either by sound or in any other way. BFO metal detectors are relatively inexpensive and simple to use.

2) **TR/IB** (Transmit-Induction/Balance) The principle of operation of these sensors is based on the mutual induction between the transmit and receive coils. Once a metal object is found near the two coils, the coupling coefficient changes, resulting in a change in the oscillator output level.

3) **PI** (Pulsed Induction) Here a continuous pulse train is emitted which produces reverberation signals which are examined for their shape and amplitude. This can reveal the presence of metals within the area covered by the transmitter.

Magnetic properties

Each metallic object can cause changes in inductance of a coil as well as in the coefficient of coupling of two coils. This kind of effect, which may be positive or negative, depends on the relative permeability (μ) of the metal concerned. Here we have to mention that the materials are classified (Table 1) into paramagnetic, diamagnetic and ferromagnetic.

Diamagnetic [μ < 1]	**Paramagnetic [μ = 1]**	**Ferromagnetic [μ > 1]**
Gold	Magnesium	Iron
Glass	Aluminum	Cobalt
Silver	Oxygen	Nickel
Water	Ruthenium	Steel
Bismuth	Rhodium	Ferrocube
Lead	Palladium	
Mercury	Tin	
Copper	Titanium	
Zinc	Barium	
Germanium	Manganese	
Cadmium	Calcium	
Indium	Platinum	

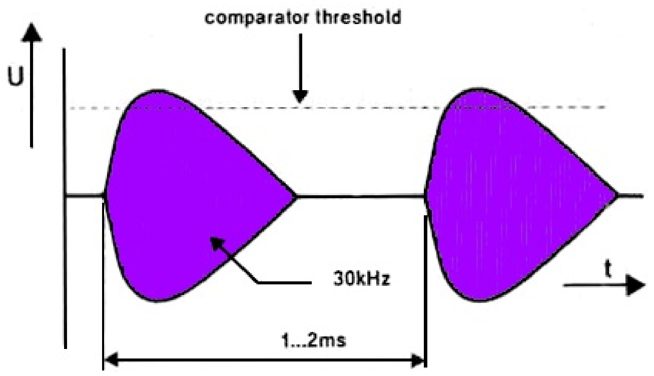
Determining the composition of an object based on the (μ) measurement is very difficult. However, due to the significant differences in the (μ) measure, a distinction can be made between paramagnetic and diamagnetic materials. On the one hand and ferromagnetic on the other.

By placing a conductive material inside a changing magnetic field, several currents are induced therein. The intensity of these currents depends on the shape and size of the metal object as well as on the resistivity of the material or materials from which it is composed. On a level and with a sufficiently large metal plate, the intensity of the currents can get great values. However, if we create slots on the same plate, the current intensity will decrease. Other factors that determine the intensity of the currents are the location of the material within the magnetic field (ie the number of dynamic lines that intersect it) and the surface composition of the earth.

Of all this, one can understand the difficulty of determining the composition of buried material. Using a single metering method.

Circuit description

In the detector circuit the transistor T1 acts as a self-modulating oscillator. This means that a low signal and a high frequency signal that is very similar to the AM waveform of the next image are produced.



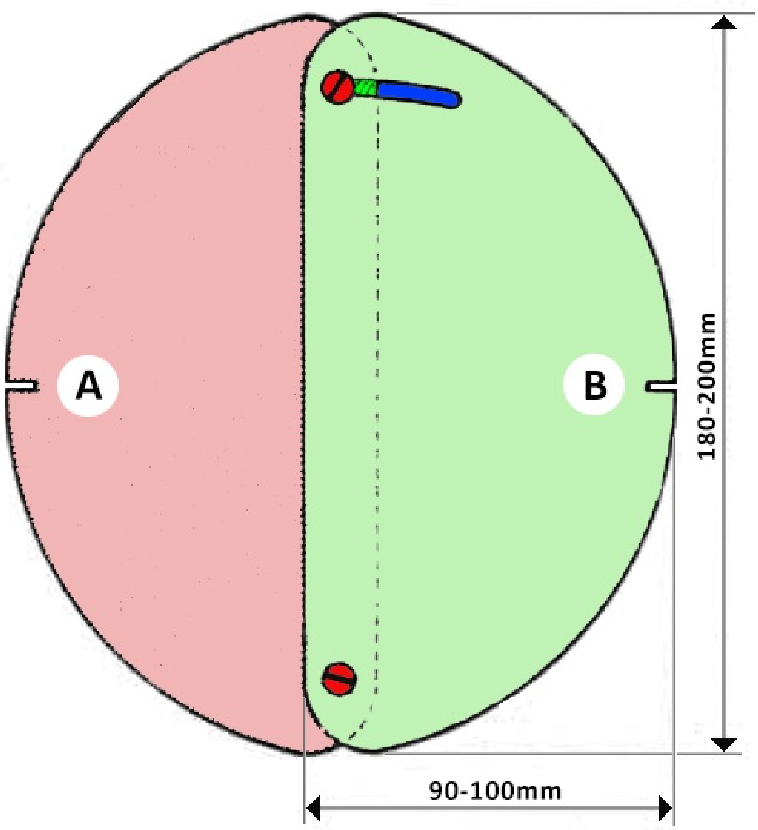
The slope of the positive front of this composite signal is greater than that of the negative face. The oscillator switching between the two states (open / closed) is done with the aid of D1, C1 and R1. The capacitor C1 during the oscillation is charged through diode D1 until its voltage cuts off T1. At this point the oscillation stops and Cl starts to discharge through R1, until its tendency allows T1 to reopen.

The coils of transmitters L1, L2 and L3 are connected between the base and the collector of T1. In practice, these inductions are arranged in such a way that they neutralize parasitic capacities that can affect oscillator stability.

Capacitor C5 is placed on the head to avoid the influence of parasitic wiring capacity between the head and the detector on the stability of the oscillator.

L4 and L5 coils form the coupling loop and are also located on the detector head. The depth signal of the L4-L5 can be compensated by means of the capacitor C6 which also cancels the detector output when aligning the coils And reception.

With the P2 you do the main sensitivity selection and with P1 you do the very fine sensitivity adjustment of the detector. Diode D2 is used to suppress any negative stresses that may occur in the inverting input of IC1. The detector operation is very simple. As soon as the rectified input signal (diode D2) exceeds the threshold voltage of the non-inverting input of the comparator, the IC will change state. Thus, the output, which is an open collector, takes the logic value (0) and activates the transistor T2 that drives the loudspeaker. The height of the note that sounds depends on the signal level obtained from the L4 - L5 receiver coils (the dotted horizontal line of the next drawing).



By varying the intensity of the received signal, the length of time the signal exceeds the threshold, changes. This results in a change in the height of the sound (which is perceived), with each detection of a metal object.

Through the D3, R7 and C12, the output voltage of T2 is converted to a negative feedback voltage for the comparator. This creates an AGC circuit (Automatic Gain Adjustment) that compensates for the strong changes in the input level. The mobile coil M1 gives a visual indication of the signal strength. With the S2 push-button, you can check the batteries.

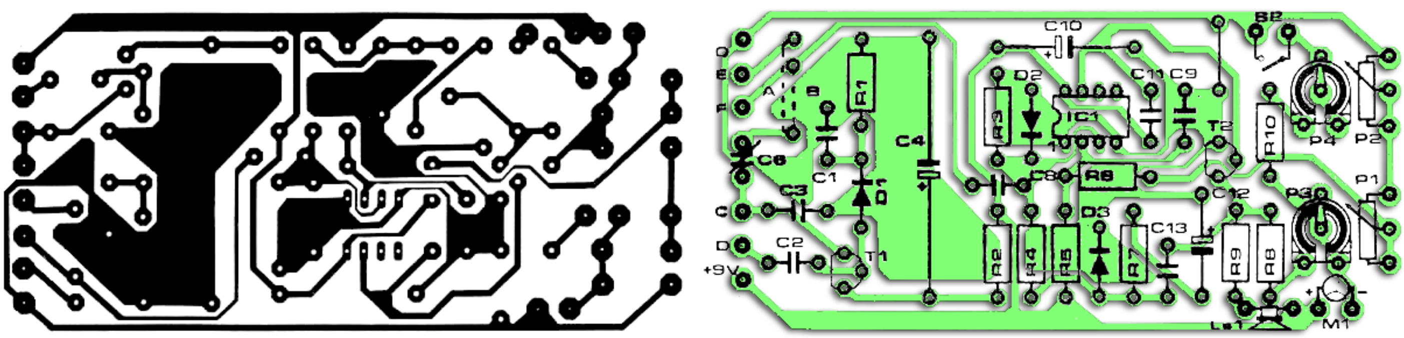
Construction

The ultimate performance of the detector depends to a large extent on the good construction of the detector head. The coils will be mechanically supported, on a plastic sheet, in dimensions and shape as the drawing above.

If you use wood as a support material (better do not try it), the head will be sensitive to ambient humidity changes and you will not be able to reset the detector. Using a cutting tool, make one notch on each sheet with a width of 5mm and a depth of 10mm.

The coils will be made with 0.3 mm (30 SWB) varnished copper wire by following the procedure: Seal the beginning of the first wrapping at point A of sheet 1. Passing through the notch around the side of the sheet, measure 22 clockwise turns (for coil L1). Stop at point A and take a shot by twisting the wire up to the length of 10cm, which you will stick to the surface of the sheet. The remaining edge, for now, just forget about it. The start of the coil L3, which will be constructed by winding 4 left-handed coils around the L1 coil, will connect to the shot we made.

To wrap L3 you will start from point A. ending again at the same point. The free end of L3 will stick to the sheet. Continue by constructing the L2 winding starting from the wire we left free after winding L1. L2 will consist of 22 clockwise turns that will pass through the notch, starting from point A and ending at the same point. Glue the edge that will get over the sheet.



The construction of the receiver coils will be made on sheet 2 following the fnext procedure. Starting from point B and ending at the same point, measure 36 clockwise turns for the L4 coil. Take a shot in the same way as with L1 and stick it together with the beginning of the winding on the surface of the sheet 2 Proceed with the same wire by wrapping the L5 coil consisting of 36 clockwise turns. Stop at point B and stick the edge of the last wire onto the sheet. Carefully recognize all wire ends as well as coil contacts Secure capacitors C5 and C7 onto the sheets and connect them with the corresponding cables.

Using a cutter and file, open a slot on sheet 2 and drill holes on both sheets to fit them together. The screws and nuts to be used for the support should be of plastic material.

The construction of the remaining mechanical pieces is left to your personal taste. The scanning head and the electronics box can be attached to a piece of wood or a PVC pipe. Prefer the PVC because you can hide the wires between the head and the detector.

Assembling the parts with the help of the board is a routine case. On the front of the box that will include electronics. Five sets of S1, S2, C6, P1 and P2 are displayed. However, a sixth may be added as shown below. The connections between the resonant circuits of the head and the detector must be made with a shielded cable.

The detector head itself can be placed in a suitably selected plastic case. The various empty spaces between the plastic case and the head can be filled with polyurethane or Epoxy Resin, while creating a compact construction.

Settings and Adjusting

First, the plastic sheets are adjusted to the largest distance allowed by the regulating plastic screw. Bridges A and B must not be placed on the board while all the sliders must be in the middle of the path. Give voltage to the detector circuit and find out with the help of the P1 and P2 regulators if some sound can be generated. When this work is about to be done, there should be no any metal around the detector head.

Begin aligning the two sheets carefully until they reach a position where the loudness of the loudspeaker will be reduced. Increase the distance between the two sheets to about 0.5mm and tighten the adjusting screw. At this point you can place the coil system in the detector head and seal it with some suitable material (referred to above). Install bridging A and check if you can set a draft at the detector output with the C6 setting. If setup fails, place bridging B. If setup fails again, place a 470pf capacitor parallel to C6. If the problem is not solved definitively, your only solution is to build a new scanning head.

Feed the circuit with a stabilized voltage 9V and adjust the sensitivity slider so that no sound is produced by the detector. Press S2 and adjust P4 to fully deflect the M1 needle. Reduce the supply voltage to 7V and mark the new needle position in red. With the P3 trimmer you can adjust the sensitivity as you want.

A final observation regarding the oscillator. The output may sound a beep (frequency 100-150 Hz). You can eliminate it by placing a 50K potentiometer (the sixth slider) in line with R1.

Using the detector

For those who will use the detector for the first time, it is best to test the effect of the C6 settings. The sensitivity of the detector is greater when the sound produced by the loudspeaker is too low. Turning C6 left or right from the zero point, you can determine whether the detected material is ferromagnetic or paramagnetic or diamagnetic. However, experience is also the biggest factor in the proper exploitation of the detector, who in the right circumstances can discriminate from a metal-dirt soil a small coin at a depth of 20 cm. Happy gold hunting ;)

List of Components

Resistances (5% tolerance): R1 = 270K | R2 = 22R | R3, R4, R5 = 100K | R6 = 1K | R7 = 220R | R8 = 470R | R9 = 4R7 | R10 = 27K | P1 = 22K linear potentiometer | P2 = 2K2 linear potentiometer | P3 = 5K trimer | P4 = 100K trimer

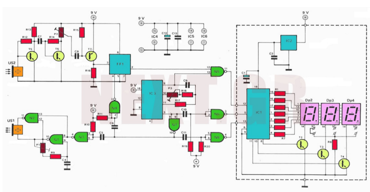
Capacitors: C1 = 33p | C2, C3, C8 = 10nF | C4 = 1000μF / 10V axial | C5 = 100nF styroflex | C6 = 500pF variable | C7 = 18-22nF styroflex | C9, C13 = 100nF | C10 = 47μF / 10V axial | C11 = 22nF | C12 = 1μF / 63V axial electrolytic

Semiconductors: | D1 = 1N4148 | D2, D3 = AA119 | T1 = BC560C | T2 = BC327 | IC1 = LM311

Miscellaneous: | L1-L5 = see text | S1 = simple on-off switch | S2 = push button | LS1 = 100mW / 8R | M1 = 100-250μA {mobile coil instrument) | PCB

New Circuits

Ultrasonic distance finder circuit



The circuit described here uses ultrasonic oscillations and operates based on the propagation velocity of these oscillations in the air. Thus, we can easily determine the distance of two points if the time within which the wave travels this distance is measured. There are three main categories of distance measurement methods in use: a) By...

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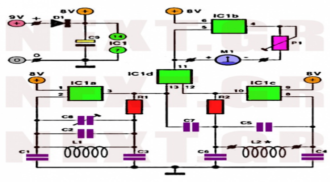
Simple Metal detector circuit with CD4030



Sometimes the precious metals are hidden too deep and are not detected except with complicated devices. In many cases, however, small pieces of precious metal buried near the surface can be detected by relatively simple means. Everyone is very attractive to find something potentially valuable, hidden a few centimeters below the soil. So many...

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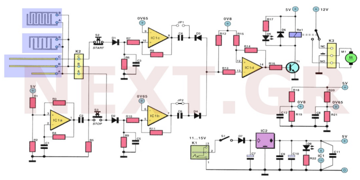
Fully automatic watering circuit for flower pots



Many times for various reasons we forget or can not water the plants that we have in our homes. And many humidity sensors units just notify us with a beeping sound or with a flashing light, that the pot needs watering. But what if we are away from home? This circuit comes as a solution to this problem. Depending on humidity of the pot at...

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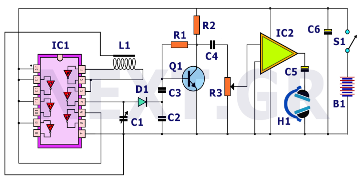
Simple deep searching metal detector circuit



The principle behind a metal detector is really very simple. Proof of this is the circuit that follows, in which it proves that the construction of a metal detector can be done in the minute, with few components that we find very easily everywhere. With the circuit of this metal detector, it is possible to detect a metal coin in depth of 90 to...

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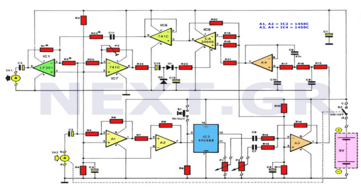
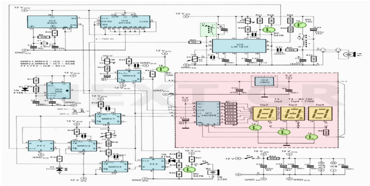
Sub-Harmonic Bass Converter for Electric Guitars



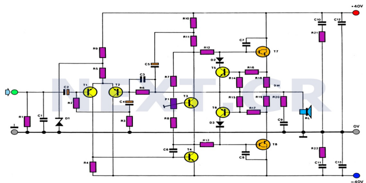
The sub-harmonic bass generator is a sound producing unit for guitars. The sound it produces looks very much like that of the bass guitar. The octave generator is sometimes quite unusual since it does not produce any of the usual ways of coloring the sound, such as filtering or distortion. Instead, a frequency division system produces outputs...

Echo Depth Sounding Sonar for Boats



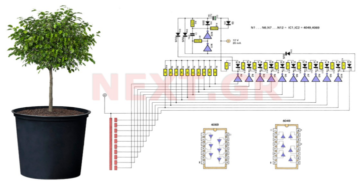
In the past the sounding (sea bottom measurement) was done with the "bullet", that is, with a heavy lead object that the seamen plucked into the sea hung from a calibrated rope. As soon as the "bullet" reached the bottom, the depth appeared directly from the calibration of the rope. This arrangement still exists in some yachts. The big...

100W HiFi Audio Amplifier Circuit



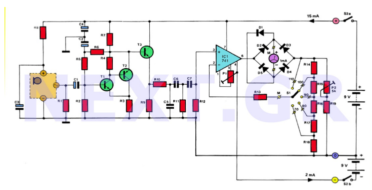
This Amplifier was designed to have the following specifications: Distortion less than 0.1% at full power of 100W even at 20KHz. Power has to be attributed to an extended bandwidth. The output transistors must be protected against short circuits. The power supply must be symmetrical so that no electrolytic capacitors are needed at the outlet....

Plant-Pot Water Level Indicator Circuit



A series of LEDs serve to alert the gardener when plants need water. Using two conventional digital integrated LEDs and a series of LEDs, we make a very useful device for gardening. The device detects the amount of water in the pot and alerts the grower. The circuit of the device is shown in Figure 2. The water detection is made from the bottom...

Analogue Sound Preasure dB-Meter Circuit



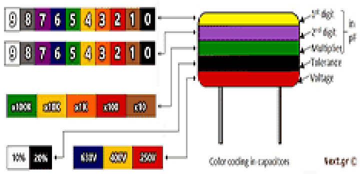
The best human ear can capture sounds from 20Hz to 20KHz. These limits are known to be the broadest that can exist. Normally the normal limits range from 100Hz to about 13KHz and depend on the age and health of the individual. We for our measurements and to have a good accuracy we will get the limits of 20Hz to 20KHz. A sound to be heard does...

New Tutorials

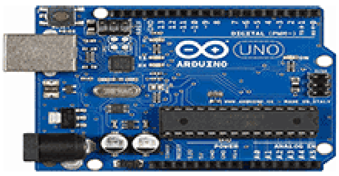
DIY HV Variable Capacitor

DIY PMA Alternator Plans

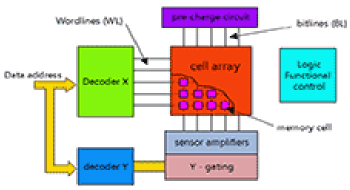
Capacitors Tutorial



Arduino Tutorial



Digital Memories



Digital Signal Integrity