Tomi Engdahl's ePanorama blog

All about electronics

Archive for the 'Circuits by Tomi' Category

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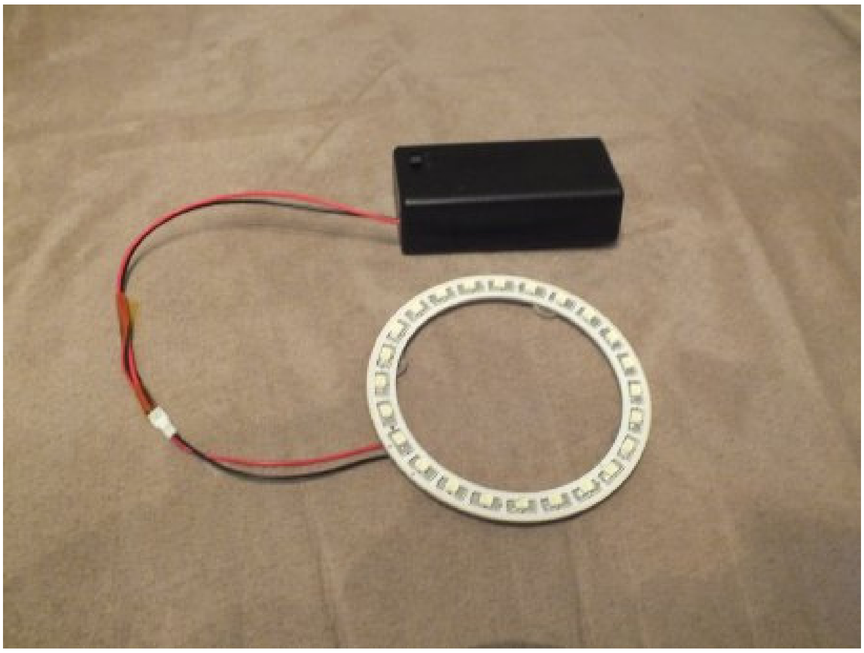
New LED ring macro light

Sunday, June 24th, 2012

I bought Fuji HS20 camera few months ago (just some months before the model was discontinued). HS20 is a pretty good superzoom digital camera. It has a very long zoom lens and good macro properties. I have taken many of the photos posted recently to this blog using this camera.

To take good macro photographs a good lighting is needed. In many cases a ring light around the lens is a good light to use for macro photography. My old DIY macro LED light did not fit it it. So I needed to make a new one.

To build it I bought T10 24-LED White Light Car Angel Eye (80mm Diameter) for the project. I selected it because in previous macro light project I used similar 12V LED light ring (just a smaller side) successfully with 9V battery with some simple modifications (replacing current limiting resistors). This time (like eariler) before doing any electrical modifications I tried connecting T10 24-LED White Light Car Angel Eye (80mm Diameter) directly to 9V battery to see how much light I get.



I got quite good amount of light. I measured that I get around 200-250 lux measured on the center at 5-10 cm distance from the LED ring. This was well enough to take good picture with my new camera. So all I needed was to add a suitable [9V battery holder](#) (a small box with on/off switch) and three small subber pads (to keep the right tightly around the camera lens) to make the project ready. Final touch was a small piece of plastic glued on the bottom of the battery holder box that allows to secure the battery box to camera flash shoe.

Update: An example picture taken with the new LED ring macro light and Fuji HS20 camera

Posted in Audio and Video, Circuits by Tomi, Products, diy | 4 Comments »

DIY magnetic field measurement adapter

Wednesday, May 16th, 2012

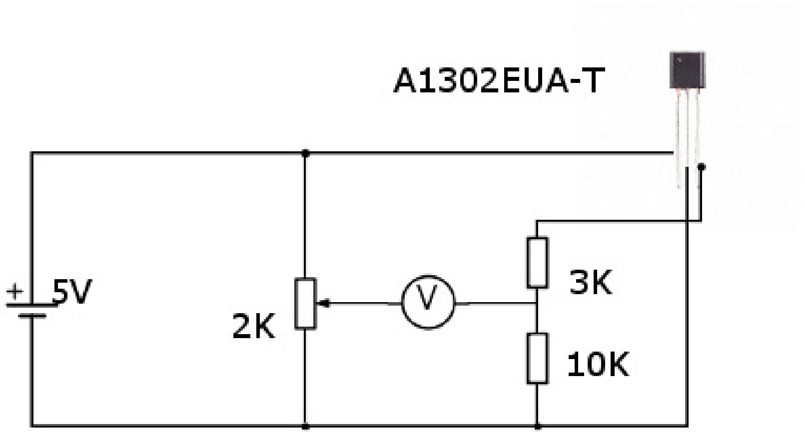
Have you ever wanted to find out how strong a magnet really was, or how the strength of the magnetic field varied as you changed the distance from the magnet. Devices used to measure the local magnetic field are called magnetometers or gaussmeters. There are commercially available meters for this, but they are usually a bit expensive for some experimenting.

The availability of inexpensive hall effect sensors have made is possible to build your own magnetic field meters cheaply. Measure Your Magnetism and Build your own Gaussmeter articles have a nice example circuit using hall effect sensor.

I decided to make my own circuit to do the same using a little bit different sensor component. I used Allegro A1302EUA-T hall sensor that I bought from Elfa (Hall-anturit SIL-3, A1302EUA-T). That IC is powered from 5V power source (needs 10 mA) and has output of 1.3 mV/G (= 13 mV/mT). The sensor hall sensor A1302EUA-T costs around three Euros. High precision in output levels is obtained by internal gain and offset trim adjustments made at end-of-line during the manufacturing process.

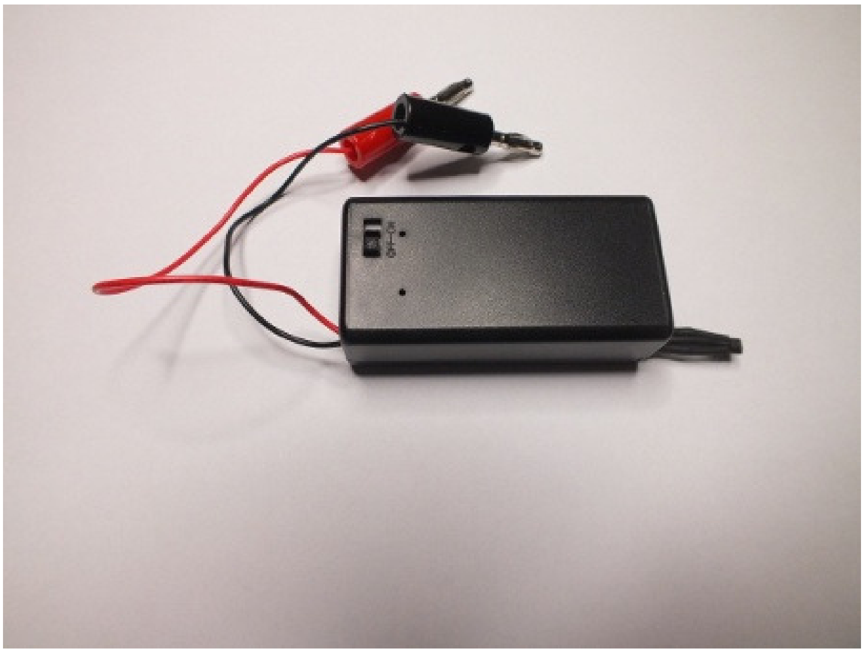
hall_7333925-01

The circuit below is my version of magnetic field measurement. The V letter inside the circle means voltage meter. I connected my digital multimeter there. The hall effect sensor is on the right. The resistor on it's output convert the 13 mV/mT voltage output to 10 mV/mT that is more practical reading on multimeter screen (you can easily figure out the mT value from multimeter reading without doing calculations).

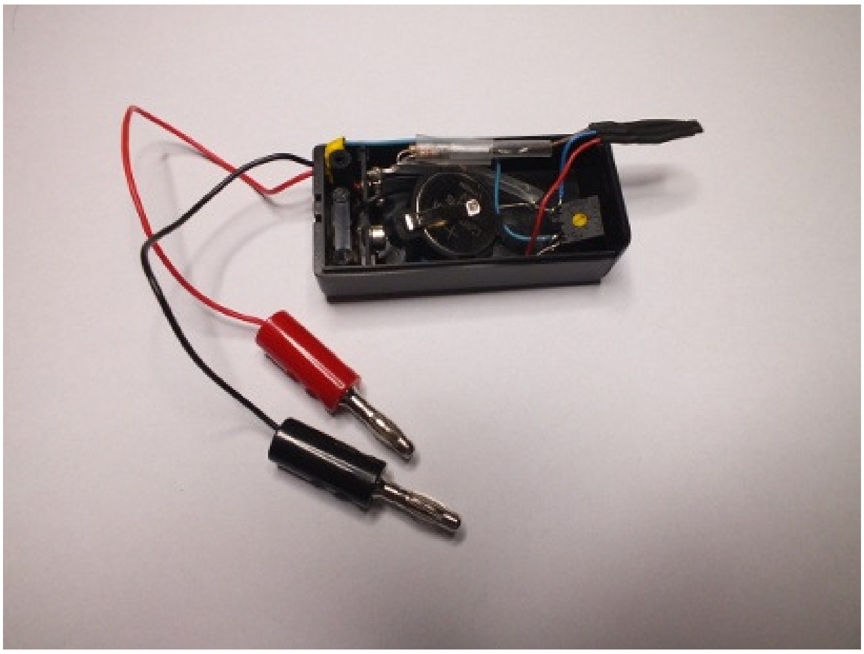


On the left side that 2 kohm trimmer is for zero adjust. The hall sensor output is at around half of the operating voltage when there is no external magnetic field. By setting the trimmer to the same voltage allows you to get exactly 0V reading on the multimeter when there is no magnetic field. Now it is easy to read the magnetic field strength and the polarity from multimeter. When you set the multimeter to millivolts DC range, the reading directly shows you Gauss reading. Just leave out the last digit (millivolt), and you get the the reading in milli-Teslas. Simple and easy. The measurement range is according to datasheet at least +-140 milli-Teslas (1400 Gauss). The adapter can be also used to measure varying magnetic fields by connecting the output to oscilloscope (hall sensor has 20 kHz bandwidth).

I decided to power the circuit with stable 5V power supply because the quiescent voltage output and the magnetic sensitivity, Sens, are proportional to the supply voltage. To get the stable 5V power for the circuit I used a modified version of my Simple 5V power supply. I used LM2936Z-5.0 regulator IC. It is a low-dropout (LDO) 5V regulator in TO-92 case (pretty similar to 78L05 but works with lower input-output voltage difference). I first though of using 9V battery for the power, and I even had a nice case for that battery. But after some thinking I decided to use two 3V lithium batteries as the power source and build the entire circuit inside that 9V battery case. Here is how my project turned out. The banana connectors are designed to be connected to the multimeter.



Here is the view to the dirty details inside the project case.



Posted in Circuits by Tomi, Electronics Design, diy | 4 Comments »

USB soundcard to digital storage oscilloscope

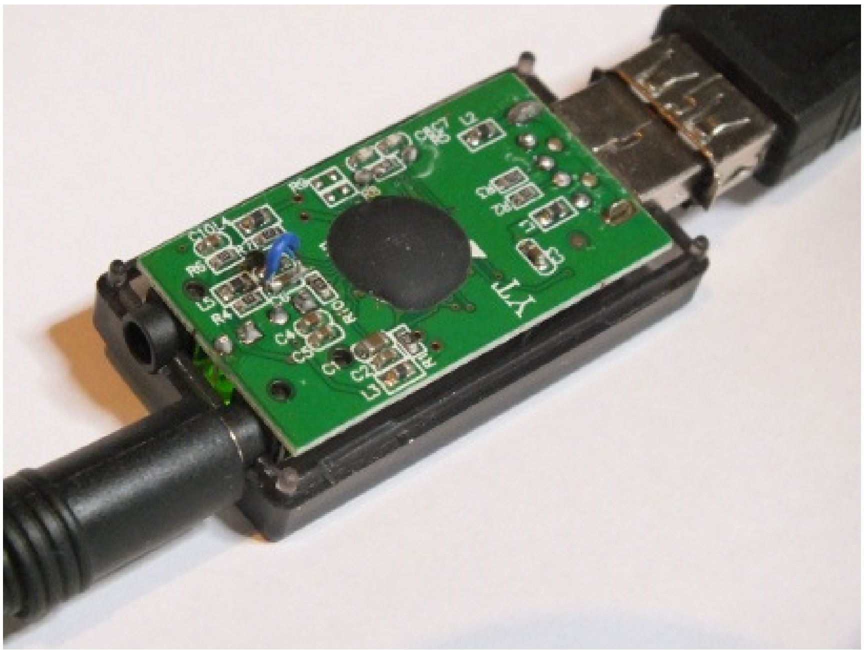
Tuesday, May 8th, 2012

I bought USB Virtual 7.1 Channel External Sound Card Adapter to build a cheap PC based digital storage oscilloscope. Sound card based oscilloscope is not new to me, I have used it sometimes. There are many free oscilloscope software that you can use. For example "zeitnitz" is a very fine program!

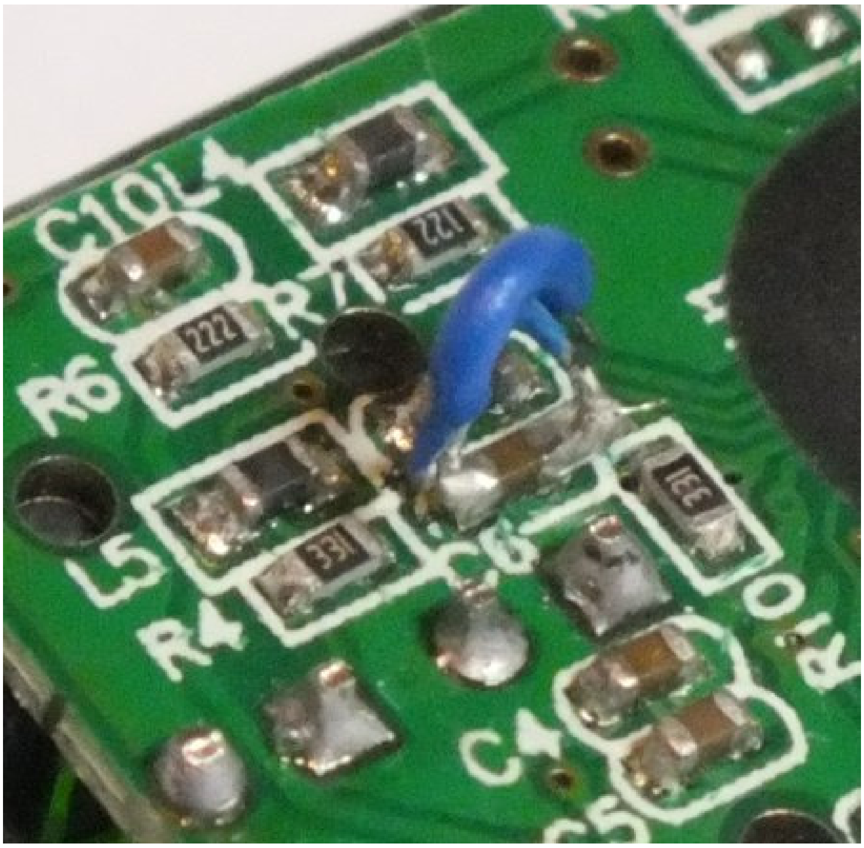
Using an external USB sound card instead of one built onto computer has several benefits: you don't have to disturb normal PC sound operations with your measurements and mistakes do not break your mains sound card. USB based sound cards are cheap, and some can even be modified a DC measurements capable measuring instrument.

The product I selected for my project is USB Virtual 7.1 Channel External Sound Card Adapter. It is based CM119 USB soundcard IC according to product comments. It seems to be good device, cheap ($3.70) and plug-and-play – easy to use. No extra drivers needed in Windows (should work well on Linux according to comments but I have not tried that myself).

The CM119 IC has, unlike most other sound card controller ICs, no digital highpass inside, which means that it can measure also DC, if the input capacitor is removed. So after modification the device should works on your computer with a bandwidth of DC to 15kHz, which is enough for many purposes of DIY electronics. The capacitor can be pretty easily found on circuit board when you know what you are looking for. On my device that capacitor is market with symbol C6 and one end of the capacitor measures low resistance to the mic input 3.5 mm connector tip.



A closer look at my modification. I just soldered a wire that short circuits C6. The SMD components on the circuit board are quite small, so the wire looks quite thick on the picture and it is hard to make a nice looking solder joint. Even if this does not look very good it works well.



I measured that the mic input is by default designed to take around 100 mV AC signal for full output. That's OK for many uses (use attenuator if you want higher range).

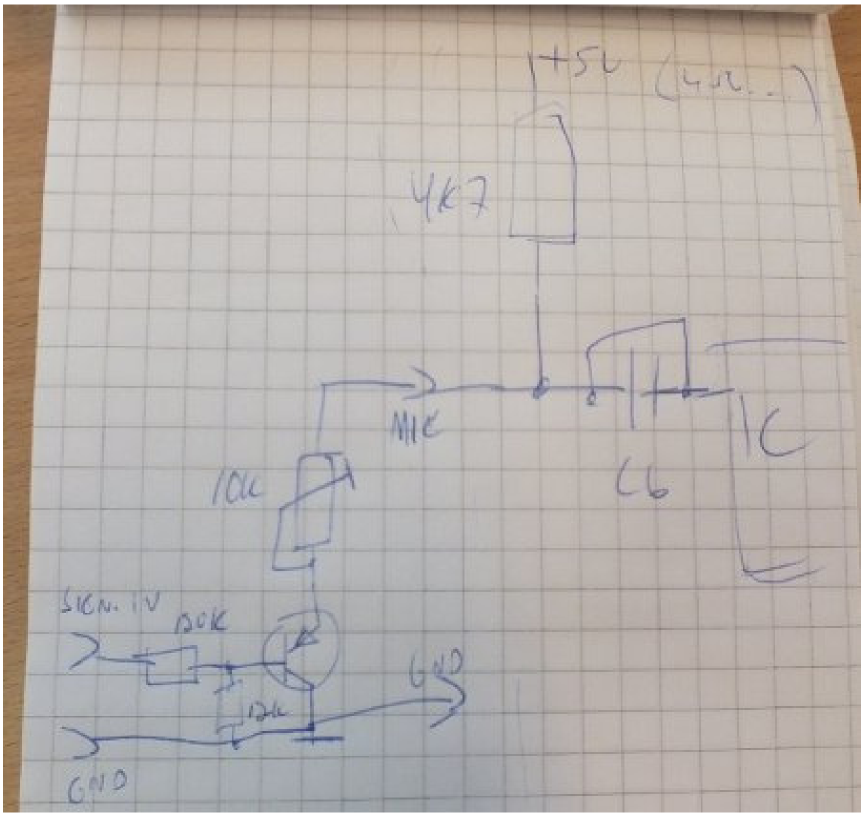
Some modifications and additions needs to be done besides short circuiting C6 to make this USB sound card to be useful DC capable measuring instrument. First the sound card mic input has bias current feed (designed for electret mic powering) that is approximately 4.3V fed through around 4.7 kohm resistor.

The DC potential on the CM119 mic in should be around 2-2.2V DC range for everything to work well. So if I just short circuit capacitor C6, when there is nothing connected to input the voltage CM119 mic in is over the top of the operating range, and when 0V is connected to input it is below lower range.

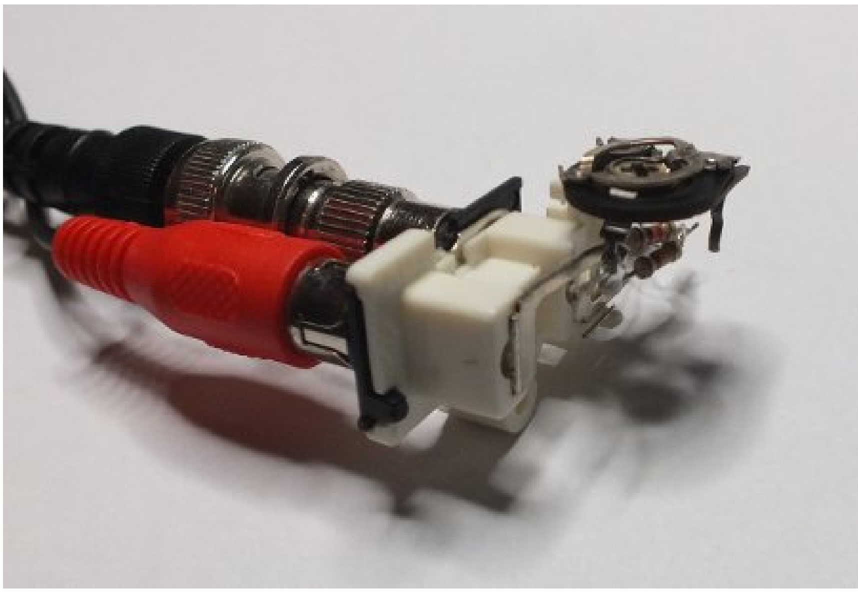
So what we need is a circuit that would scale the around +-100 mV DC input at around 0V to voltage in around 2-2.2V DC range on soundcard microphone input, preferably with some form of DC bias adjustment.

There are many design for such DC shifting circuits, but many of them need somewhat complicated external powering (dual polarity DC supply usually needed for this kind of opamp circuits). So I decided to make my own.

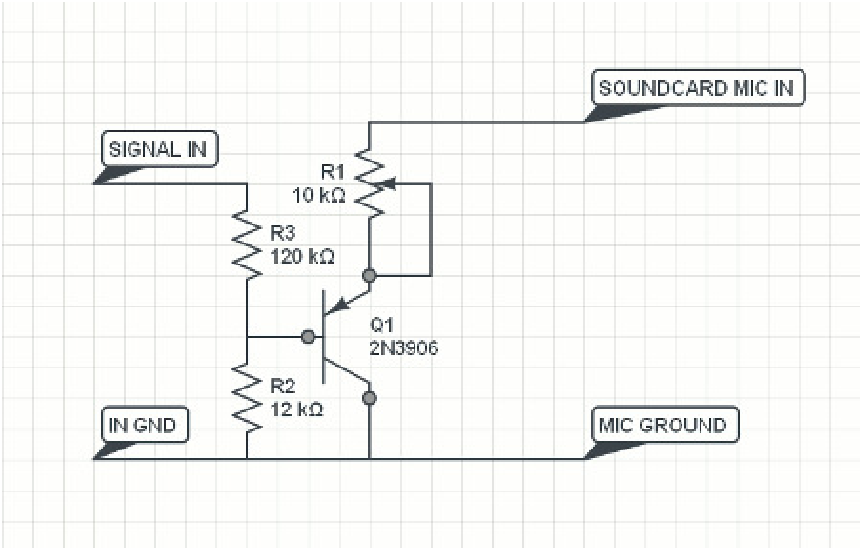
My design consists of one PNP transistor (BC559), one resistor and one potentiometer (10 kohms). Here is my initial design drawing:



Here is what my initial test prototype looked like. This was designed to be connected between RCA-3.5mm plug cable (red plug) that goes to USB sound card and normal oscilloscope probe (1:1 probe with black BNC connector connected to BNC-RCA adapter).



Here is a clearer schematic of my DC in adapter drawn with [Circuitlab](http://www.circuitlab.com) (NOTE: I used BC557 transistor but this editor did not know that so I had to substitute it with something that exist on it, closest to that I could find on the included library was 2N3906).



The benefit of this design is that the circuit is very simple and still works well. The downside of this design is that R1 controls both the DC polarity and circuit gain/attenuation. So if you adjust DC with R1 at the same time you change the sensitivity (if you are at normal operation range the change to gain is not very much). Anyways the circuit is simple, cheap, works OK and does not need any external power to operate. The input impedance is around 120 kohms. The circuit accepts signal levels to around two volts as it is. If you want higher input voltage range, you need to add your own external attenuators for that.

Now you have one channel analogue computer interface with a bandwidth from DC to around 15kHz at 16 bit input ADC resolution. This is enough for many purposes of DIY electronics. The "Zeitnitz" tool also adds a two channel signal generator and FFT function!

Great for DIY purposes.

Posted in Circuits by Tomi, Computers, Electronics Design, diy | 3 Comments »

Replacing flashlight bulbs with LEDs

Sunday, October 2nd, 2011

One day I had an old flashlight that had burned light bulb on it. It was a small cheap model powered with two AA batteries. I could fix it with new light bulb, but going through the trouble of trying to find exactly suitable replacement light bulb felt like more than the value of the flashlight.

If I need to replace the bulb with new one, why not convert the lamp to use LED instead.The lamp runs on two AA batteries in series. They give out around 3V voltage. That's about the same voltage drop many white LEDs have (typically 2.8-3.5V or so). I had earlier found out that some white LEDs can be directly powered with 3V battery without any current limiting electronics. You just need to find out suitable LED. Some small LED lamps are driving white LED with 3V lithium button cells without a resistor! There are LEDs out there with internal resistors. And there are some LED that just work.

The general advice is that DO NOT use LEDS without a current limiting resistor in series with the LED. The forward voltage rating is TYPICAL and can vary from part to part, so while some LEDs may work fine just connected to a battery of the proper voltage, others will be easily over-driven and be destroyed.

Driving an LED with or without a resistor article on the other hand says that if you are able to run your complete circuit with the same voltage as forward voltage of the LED, perfect. No resistor needed. If you try to run run a 3.2 /3.4 volt warm white of a 3 volt power supply, you will get light but not the maximum amount. But usually enough for small flashlight application anyways. I had even used this idea on my LED light ring for macro photography project, so I was pretty comfortable with this idea.

Now all I need was to find suitable LED from my electronics junk box. I could check the datasheet or do measurements to verify suitability of the LED. It seemed that quite many white LEDs can be run from 3V battery without limiting resistor. But it is best to verify with measurement that things work well. I took a random white LED and put it to Kemo M087 LED testing box. I tested the voltage drop of the LED and different currents from 5 mA to 20 mA (and very quicly with 50 mA). The LED seemed to take somewhat less than 3V at 5 mA and 10 mA. At 20 mA the voltage drop was around 3.2V. At 50 mA the voltage drop was around 3.4V. With this data I could expect that with two new AA batteries in series (gives around 1.6V each) the LED would take around 20 mA current and the current would drop from that when batteries wear out. With this data it seems that this LED would work here.

The next step was just building the LED bulb replacement. Here is a small DIY flashlight bulb LED replacement. It consists of the lamp base (small edison base from old broken bulb), 5mm white LED, solder tin and hot glue. The LED anode goes to the center of the light bulb base.

Here is picture of my LED bulb in the flashlight in use.

Now I have a nice working flashlight that is not very bright, but that has a very long battery life.

If this modification looks interesting, then you might wonder how to convert lamps with different number of batteries to LED lamps. With flashlights that use three batteries or mode, the standard method to use would a white LED + suitable current limiting electronics does job. A resistor will work nut switch mode current source is better. For 20 mA LED and 4.5V operation voltage a 75 ohms or 82 ohms resistor will do. For other operating voltages and LED currents, do your own LED resistor calculations.

If your flashlight uses just one 1.5V battery, you will need a switch mode power supply that boosts the battery voltage to over 3V and limits the current. Joule Thief is a nickname for a minimalist self-oscillating voltage booster that is small, low-cost, and easy-to-build. It can use nearly all of the energy in an electric battery, even far below the voltage where other circuits consider the battery fully discharged (or "dead"). The energy is converter to current and voltage suitable for driving white LED. Make a joule thief if you want to drive white LED from one 1.5V battery.

Posted in Circuits by Tomi, LEDs, diy | 3 Comments »

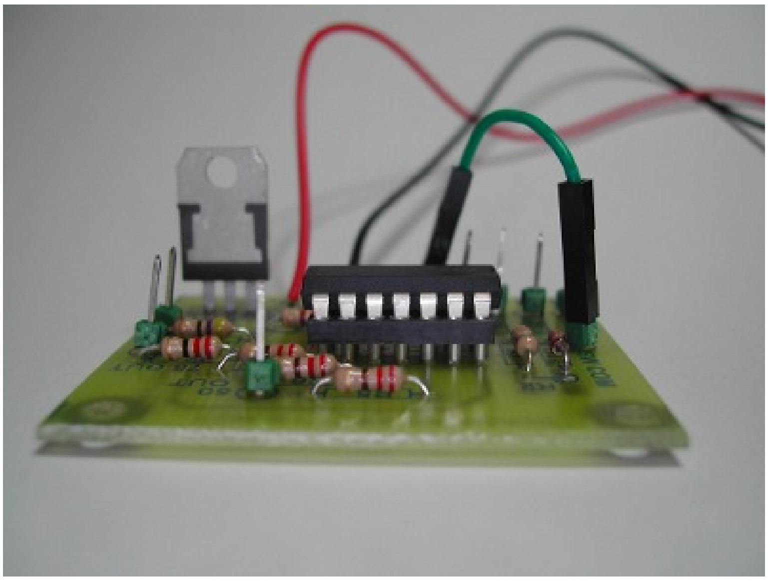
TDR kit built

Wednesday, September 29th, 2010

My Time Domain Reflectometer (TDR) circuit has been available as kit made by Far Circuits. The kit consists only of circuit board and components needed to build the circuit in a small plastic bag (you need to download the building instructions).

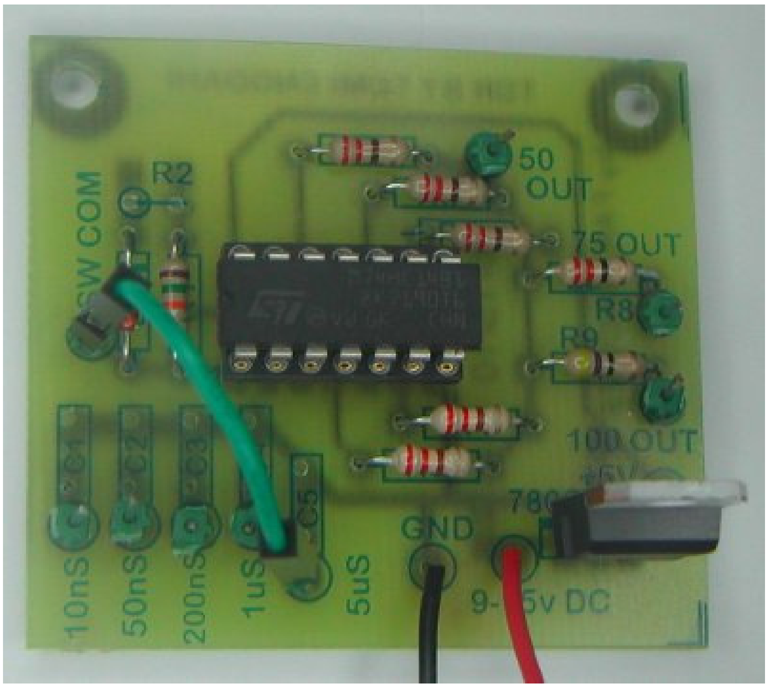
The original circuit design is from my web page and Far Circuits added 5V regulator and designed the circuit board.

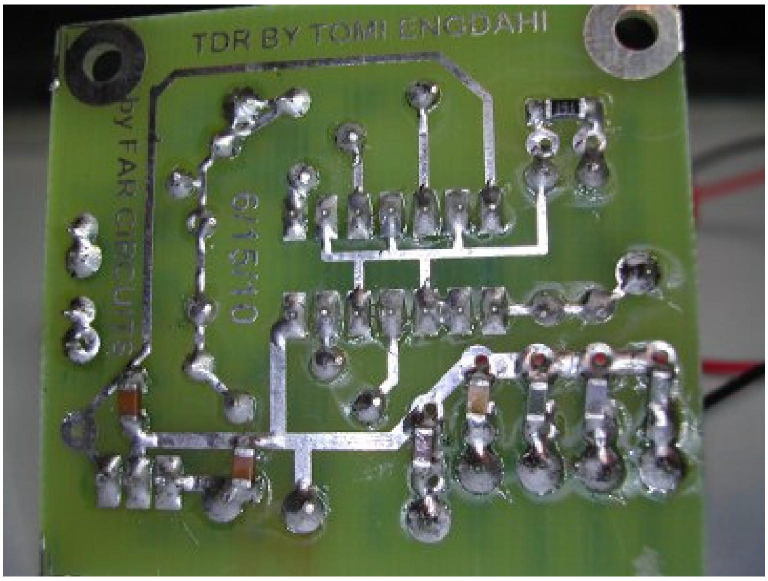
I have written some information about the TDR kit earlier, but now you have more. I just finished building my own kit sample some days ago.



Around half of the components on the kit are SMD components and half of the components are traditional through-hole soldered components. I was pretty easy to build, no problems there. I used lead free solder to build the circuit even though [it might not be optimal solder if some components contains lead](#).

I first soldered the SMD components to clean circuit board using [pinbypin](#) method. Then I assembled the through hole components to their places and solder them.





The kit worked well but with some reduced performance compared to my [original design](#). The original circuit design used pretty high speed 74AC14 IC, but this kit I received used a slower speed 74HC14 IC. That was the actual IC that was in component bag instead of 74AC14 as listed on the component list.

Things seen on the pictures not included on the original kit: IC socket, pins to connect wire to, jumper wire connected between two pins to select the pulse length and the wired feeding power to the circuit.

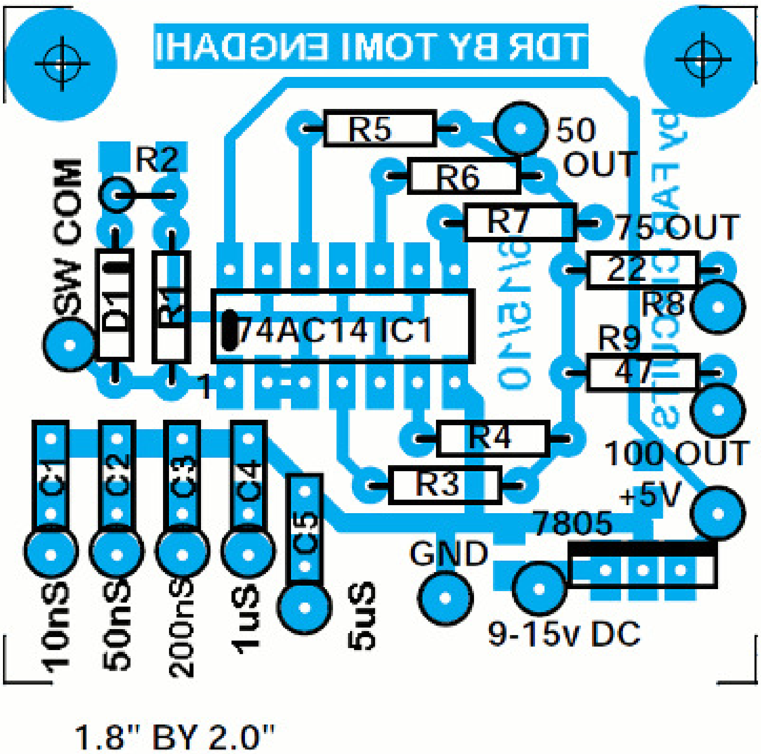
NOTE: The first kit versions were shipped with 74HC14 IC. According to [Farcircuits](#) the newer kit versions are shipped with 74AC14 IC.

Posted in [Circuits by Tomi](#), [Electronics Design](#), [Products](#), [diy](#) | [3 Comments »](#)

TDR circuit kit available

Saturday, July 17th, 2010

My Time Domain Reflectometer (TDR) circuit is now available in kit form. Far Circuits has made a TDR kit that consists of circuit board and components. The Far Circuits version is a slightly modified circuits, the modification is that the circuit board has a 5V regulator IC in it. With that regulator the circuit power supply can be in 8-15V DC range (maybe eve higher). I have received a sample kit but I have not yet built my kit.

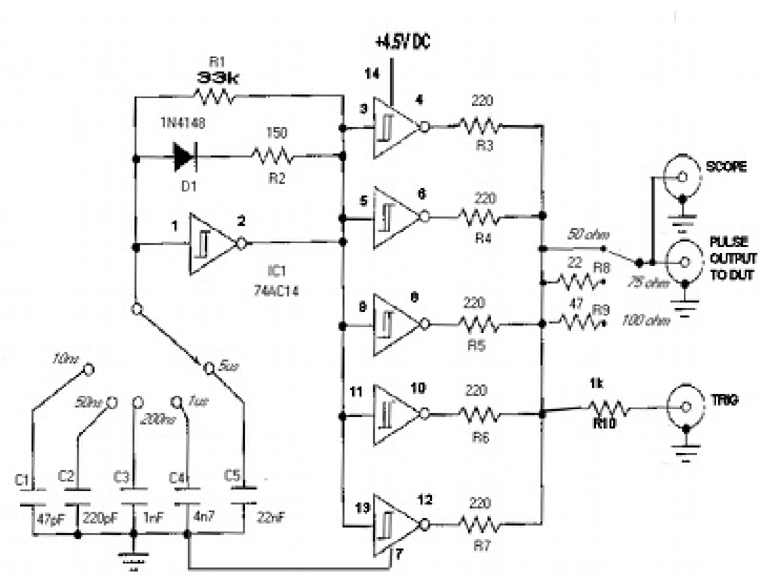


Posted in Circuits by Tomi, Electronics Design, Products, diy | 10 Comments »

TDR circuit modification idea

Tuesday, April 27th, 2010

You might know my Time Domain Reflectometer (TDR) signal source circuit published on ePanorama.net many years ago. It has worked well for me many times.



Some years ago I made a modification to my own TDR unit. This simple modification allows me to use the same box also as a signal source with a wide frequency range (kHz to almost 30 MHz) and controllable output impedance. This kind of square wave signal source is useful for all kinds of testing.

The TDR circuit shown above can be modified to a square wave signal source by modifying the oscillator part of the circuit (R1, R2, D1, one gate of IC1 and capacitor C1..C5). This oscillator is pretty normal square wave oscillator circuit with just D1 and R2 as extra. So if you leave out D1 from the circuit you get square wave signals. If the D1 is just removed the oscillator outputs square wave at frequency range from few kHz to few hundred kHz (frequency controlled by R1 and capacitor). If you replace the D1 with a short circuit you get higher frequency from hundred kHz to almost 30 MHz (frequency controlled by R1+R2 in parallel and the capacitor). If you leave the D1 as it is, the circuit works as TDR signal source.

The modification needed to add all this new functionality and still keep old things working is to add one three position changeover switch (onA-off-onB) to the circuit. Just wire it in such way that you get all the D1 as it is (=TDR), D1 open circuit (=low frequency) and D1 short circuit (=high frequency) settings.

Posted in Circuits by Tomi, Electronics Design, diy | 35 Comments »

LED light ring for macro photography

Monday, April 12th, 2010

For good macro photography you need to have good light. Getting nice light nicely to location near camera lens can be sometimes hard. Some photographers use special Macro Photo Studio. Some macro photographers use two flashes mounted on opposite sides of the lens. Some prefer to use ring lights. After some experimenting I thought that light ring would be an useful addition for my digital camera.

There are ready made right lights and also plans to build one. After some thinking I decided that I would get good results most easily by taking some inexpensive ring type LED lamp and modify it for my needs. After some searching I found T10 15-LED White Light Car Angle Eye (60mm Diameter) sold by Dealextreme ($4.03). It looked light pretty suitable. So I ordered it. This product is designed with 12V DC car power source (typically in 12-13.5V range). I connected 12V transformer to this light and it worked well.

After some experimenting I found that the wire from 12V transformer is annoying. I would like to make this light mobile with some small power source. But 12V small portable power source is not too common. 12V made from AA or AAA is quite big and heavy. Smaller button batteries or tiny 12V batteries had too low capacity. I would prefer to use normal 9V battery. I tried using 9V battery, but there was very little light output compared to 12V power source. So something needs to be done.

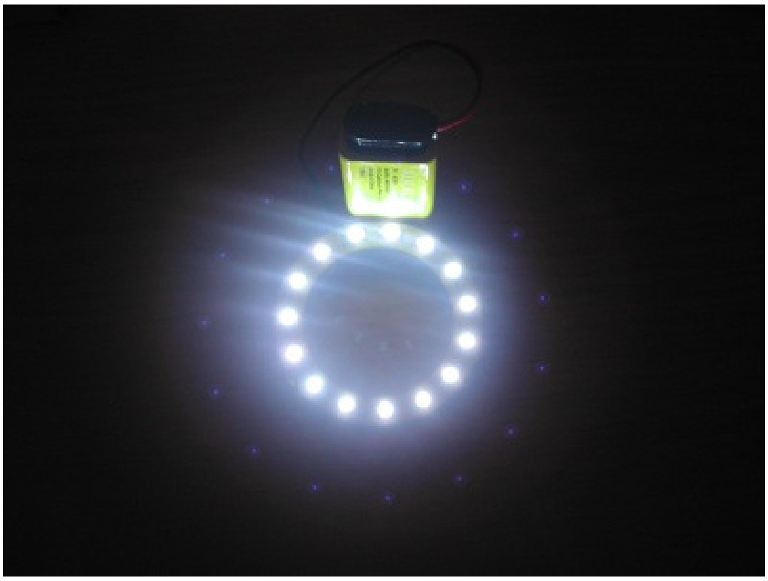
I did some measuring and found out that this device takes around 80 mA of current from 12V DC power source. The circuit inside this light consists of five LED sets. Each LED set consist of three while LEDs wires in series and in addition there is around 150 ohms resistor for current limiting (resistors did not have markings in them, the value was measured with multimeter). With 12V power the resistor has around 3V voltage drop and LEDs about 9V. For 9V operation there was no voltage drop left for any current limiting resistor or circuit.

Could the LEDs (three in series) could work directly from 9V battery without any current limiting resistors? Generally it is not a good idea to run LEDs without current current limiting series resistor, but some small LED lamps use white LEDs that are directly powered from 3V battery.

The LEDs used in this circuit I was modifying had fortunately such specifications that they worked nicely (three in series) from 9V battery power source without any current limiting resistor. It took some experiemting and measuring to be sure that this would be a safe way to go. The solution to operate the circuit from 9V battery was to short circuit all five resistors on the back side of the circuit board.

With this modification the circuit took around 30 mA current from 9V battery and gave about half of the light as unmodified circuit from 12V power source. I just added 9V battery connector and my macro ring light electronics was ready.The light output was enough for it to be an useful digital camera macro photography light.

Here is a picture what kind of light you get from this (note that there is some blue lens flare on the picture):



All I need to figure out now how to keep this nicely in place in front of camera around the lens. The small rubber like pads I glued to this light are not the most reliable way to attach it to camera objective. I am still trying out different options for that. Also a battery holder for that 9V battery would be nice to include to the holder.

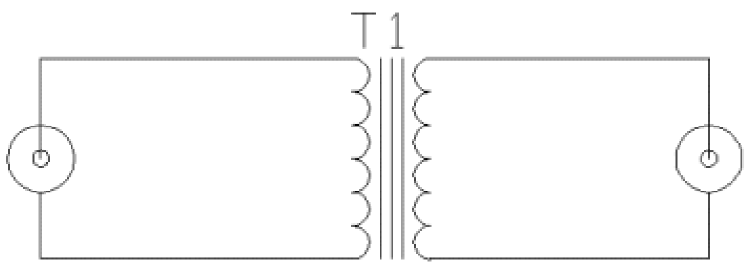
Other ideas and information related to macro photography can be found at the following pages: MACRO PHOTOGRAPHY, How To: DIY $10 Macro Photo Studio and Macro Photography: how to take close-up pictures of small things. It is also worth to read Shedding Light on Machine Vision.

Posted in Audio and Video, Circuits by Tomi, LEDs, diy | 290 Comments »

Digital audio isolation

Friday, October 2nd, 2009

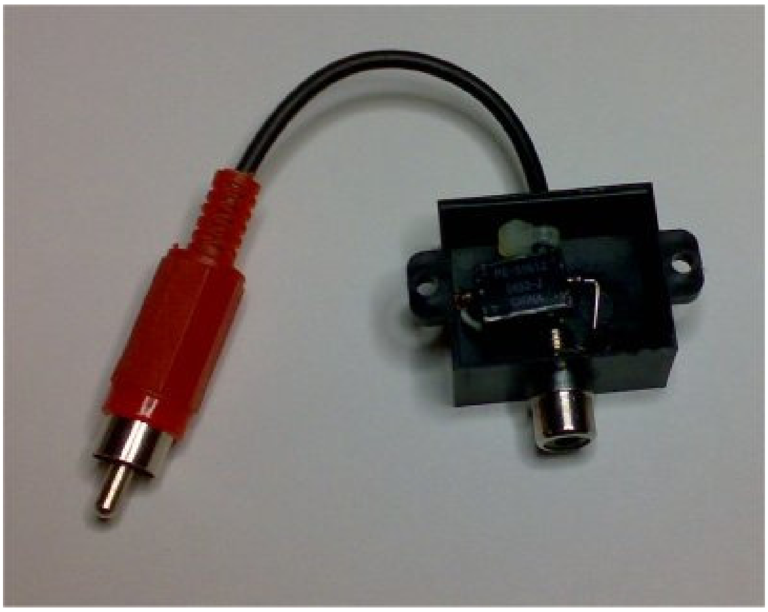
Isolator for digital audio is needed in cases where coaxial S/PDIF digital audio link forms a ground loop in your audio system. Typically in coaxial S/PDIF connections the coaxial cable shield is connected to equipment cases. This arrangement easily creates ground loops which can cause noise problems in various places in audio system. A suitable transformer can be used to isolate the coaxial S/PDIF signal and avoid ground loop problems (other option is to use optical connection instead of coax). Here is the circuit of the S/PDIF signal isolator I have used:

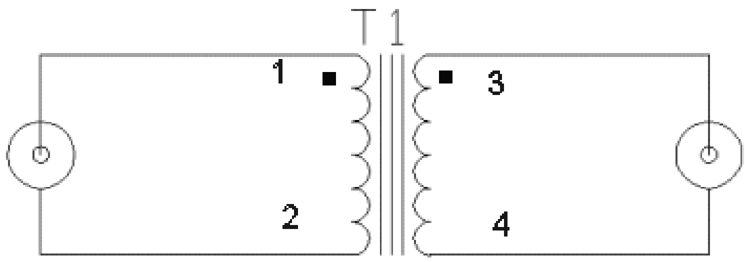


ELFA catalogue product **56-550-55** "PE65612 Trafo dig.siirt." is a tranformer suitable for isolating S/PDIF digital audio signal. The manufacturer for this product is Pulse Engineering and their product code is PE-65612.

Ratio: 1:1
Bandwidth: 100 kHz-55 MHz ±3 dB

Here is a picture of the S/PDIF signal isoltor I built (box open):





More information on S/PDIF and related circuits can be found on my SPDIF document.

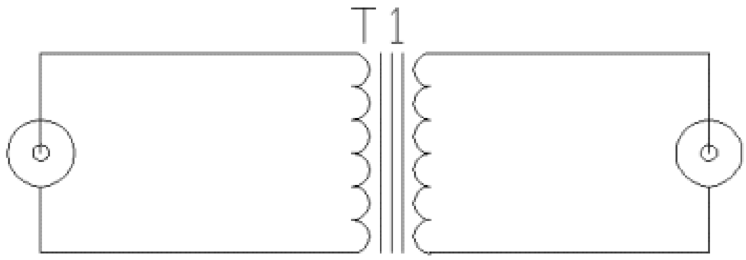
Posted in Audio and Video, Circuits by Tomi, Groundloop, Products, diy | 44 Comments »

Build video isolator

Tuesday, September 15th, 2009

Video isolation transformers are primarily used in CCTV application in fields of security, manufacturing, avionics and display. The video isolation transformer is an extremely broad bandpass 1:1 isolation transformer. Its hum isolation is very good and it can sustain very high noise voltages without degradation. Isolation decreases with increasing noise frequency.

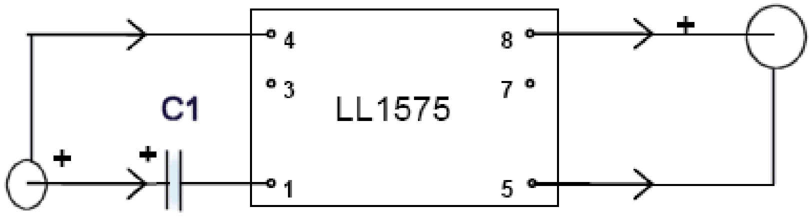
Video signals can transformer isolated in many applications. Most video signal transport paths are AC coupled, so this kind of signal can pass through a suitable transformer. Video isolation transformers are used CCTV applications where they solve ground loop problems or protect system against ground potential differences between different locations.



The design of a high bandwidth transformer which can go to very low and very frequencies is very hard. Video signal can have significant signal components from 50 Hz up to 6 MHz. Unfortunately in practical transformers you have to always make some compromises on low and high frequency responses (highest components of composite video can be attenuated even few dB). Signal amplitude at low frequencies is limited by core saturation and coil inductance. High frequency response is limited by leakage inductance and winding capacitance. Many video isolation transformers are only designed for CCTV other not so demanding applications application, where more signal distortion is accepted than in broadcast industry.

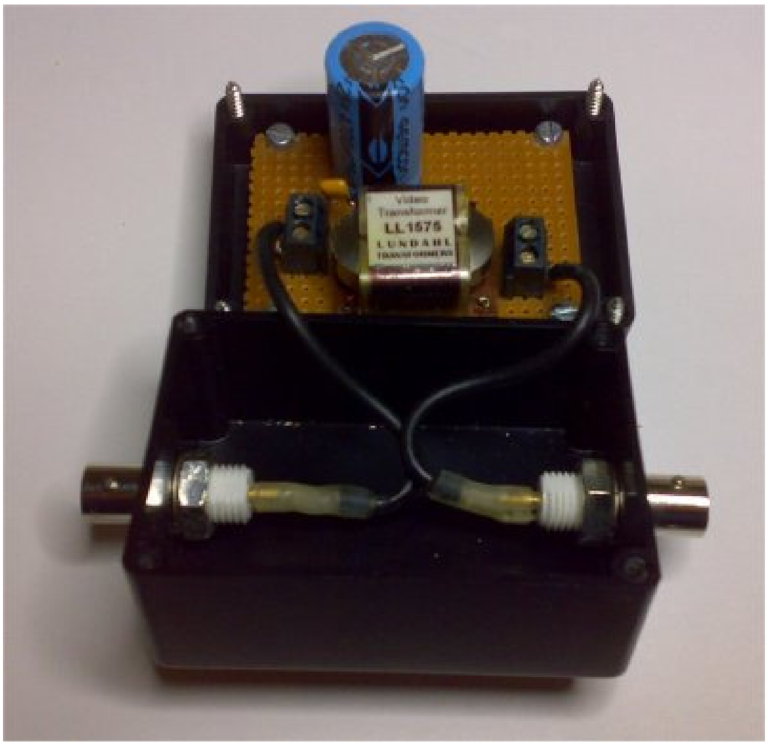
Lundahl LL1575 is a high bandwidth video isolation transformer designed for CCTV (closed circuit television) applications. I have used that transformer successfull to build video video isolators. That transformer has 20 Hz – 11 MHz +0 /- 3 dB frequency response (possible with special bifilar winding technique and special core construction). That transformer gives 2 kV rms isolation between primary and secondary windings.

The LL1575 datasheet recommends that if DC current is present, the transformer must be decoupled (with large capacitor). Because in many video circuits there can some DC present especially in video outputs, I thought that it would be a good idea to include suitable DC blocking capacitor to the circuit input side (on the left, connected to video signal source output). A suitable capacitor value should be 1000 uF or higher (practically demands using electrolytic capacitor) and have good high frequency characteristics (electrolytic capacitors are not good at this, ceramic etc.. would be much better here). The capacitor I used was built from 4700 uF electrolytic capacitor (gives capacitance) wired in parallel with 100 nF ceramic capacitor (handles the high frequencies where electrolytic capacitor is not good at). 25V or higher voltage rating is suitable for the application (you normally see 1Vpp video signal plus maybe few volts DC).



The circuit is best constructed to a small plastic box with suitable connectors. For professional applications I recommend to use BNC connectors. If all your equipment use RCA for video signal, then use those connectors if they are easier for you. Plastic box is easiest for the construction because in this way it is easy to guarantee good electrical isolation between input and output side connectors (in metal box needed isolation could be hard to do reliably).

Here ia picture of the video isolator I have built:



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