PC SOUND-CARD SCOPE INTERFACE FACILITATES DC RESTORATION

by **ajoyraman** on January 15, 2012

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I am a retired Electronic Systems Engineer now pursuing my hobbies full time.

Intro: PC SOUND-CARD SCOPE INTERFACE FACILITATES DC RESTORATION

To start with I must appreciate acknowledge and thank ‘Christian Zeitnitz’ for the fantastic Sound-card Oscilloscope & signal generator software available at his website on which this Instructable is based.

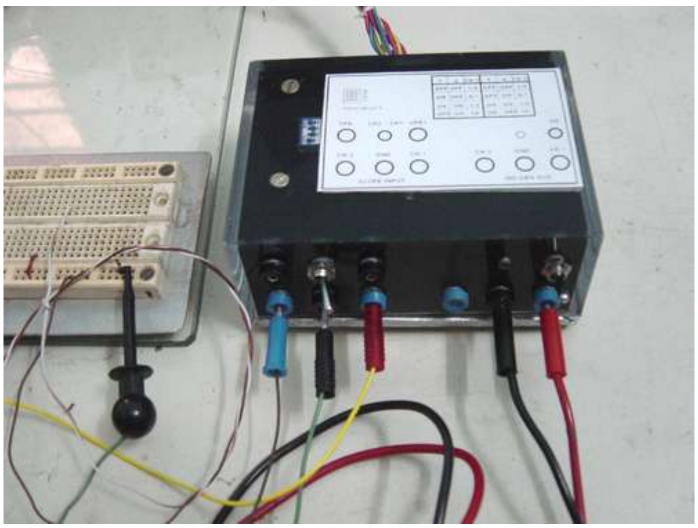
While working with the PC sound-card oscilloscope and signal generator I found the following limitations:

1. A low Input Impedance of the order 10 Kilo Ohms
2. Input voltage range limited to 2.8 V p-p
3. AC coupling of the I/O signals
4. Output voltage limited to 2V p-p
5. Sampling rate limited to 44kbps

Not much can be done about the sampling rate as it is a limitation of the sound card but the scope interface presented here attempts to improve the other factors.

Most significant is the addition of circuitry to estimate the positive and negative peak DC values of the signal and use this to offset the waveforms providing a realistic DC-coupled scope display.

Let me illustrate this with an two **Examples**



Step 1: 555 Timer Example

Waveform before correction

The 555 Timer IC when operated as an astable oscillator from 5V provides a square wave of 0-5V and the waveform at the timing capacitor varies from 1/3 to 2/3 of 5V.

The first screen shot shows the timer IC 555 AC coupled waveforms as captured by the PC sound-card. It can be seen that the zero settles at the average value. (The input has been scaled by 1:10 to remain within the input voltage limits.)

The square wave shows a peak value of 171mV instead of 5V and the capacitor waveform appears to be centered at 0V with a peak value of 66.59mV.

The interface circuit provides two peak-hold circuits which provide the positive and negative peak DC value of the input waveforms. Using a multimeter to measure these values gave 468mV and 283mV as the positive peak values for the square and capacitor waveforms respectively.

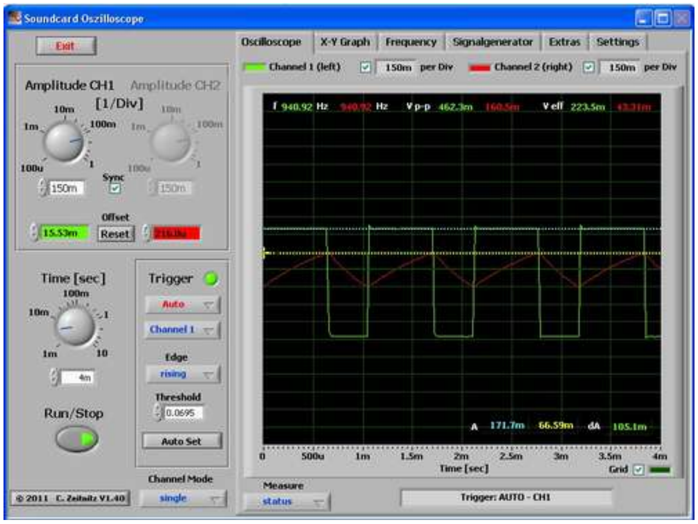
We can compute that the square wave needs to be offset by 468mV -171mV = 297mV and the capacitor waveform by 283mV - 66mV = 217mV.

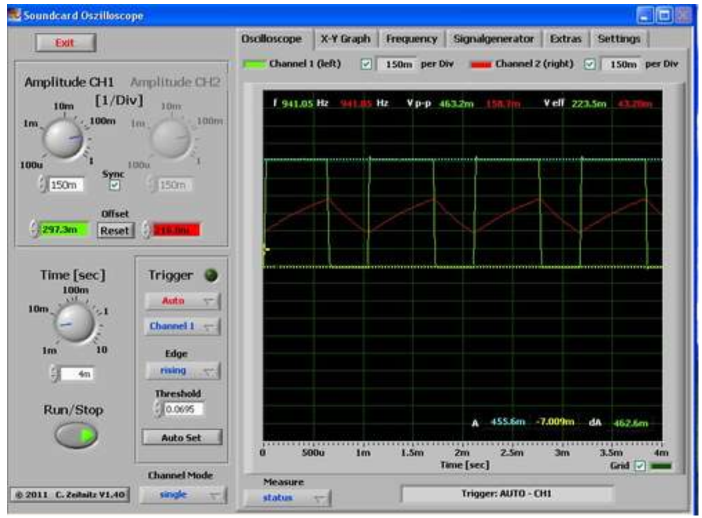
Waveform after DC restoration

The second figure shows the waveforms after entering the offset values 297mV and 217mV into the offset boxes for CH1 and Ch2.

After DC restoration the square wave varies from 0 to 455mV and the capacitor waveform from 1/3 to 2/3 of 5V.

This would be the display we would see on a scope with DC coupling.





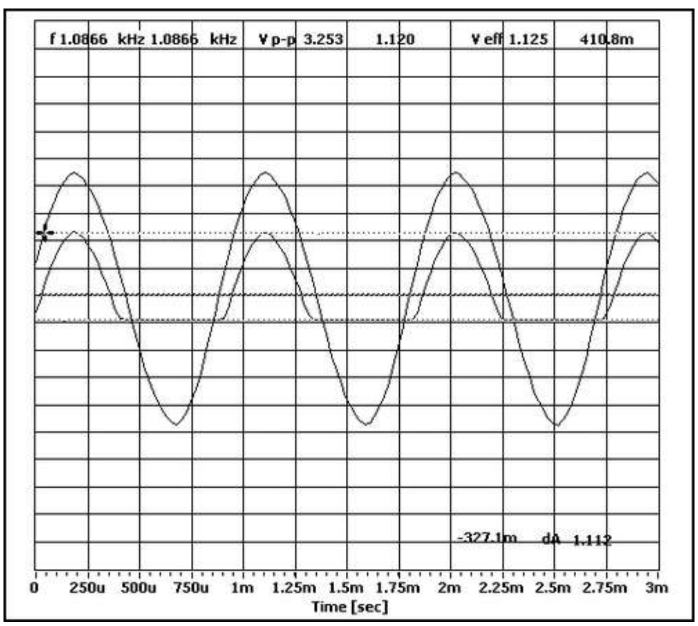
Step 2: BEFORE AND AFTER FOR A RECTIFIED SINE WAVE

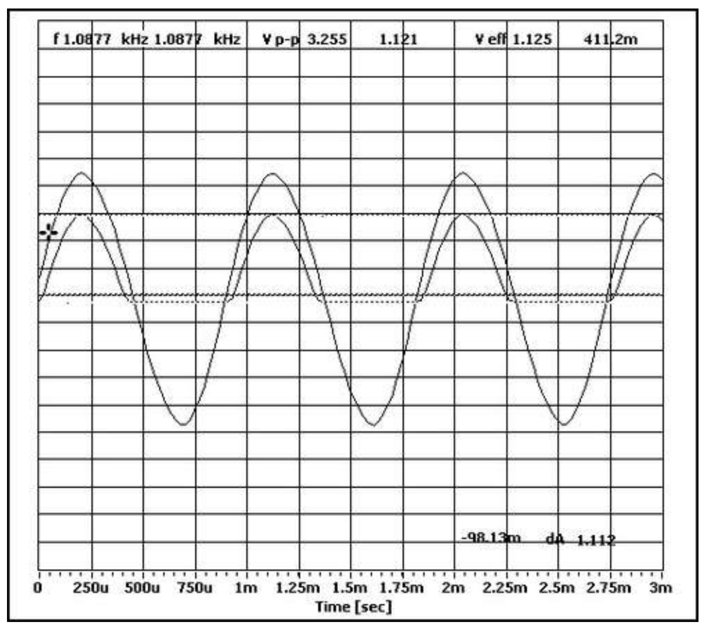
A 3V p-p 1kHz sine wave is fed through a silicon diode to a resistive load.

The first figure shows that the sin wave is centered around zero as it has an average value of zero, but the rectified wave settles with flattened portion of the waveform corresponding to the negative cycle below the zero line at -327mV.

By applying the same technique, that is measuring the peak value of the rectified wave and applying the corresponding offset we get the waveform in the next figure.

After DC restoration the negative cycles show a value closer to zero volts.





Step 3: CONSTRUCTION OF THE SCOPE INTERFACE

Circuit Diagram, Description, Front panel & BOM

IC 747 U1 forms the input interface to the PC sound-card. The operational amplifiers are in the non-inverting configuration to provide high impedance and the gain can be set to 0.1, 1 or 10 using the DIP switch.

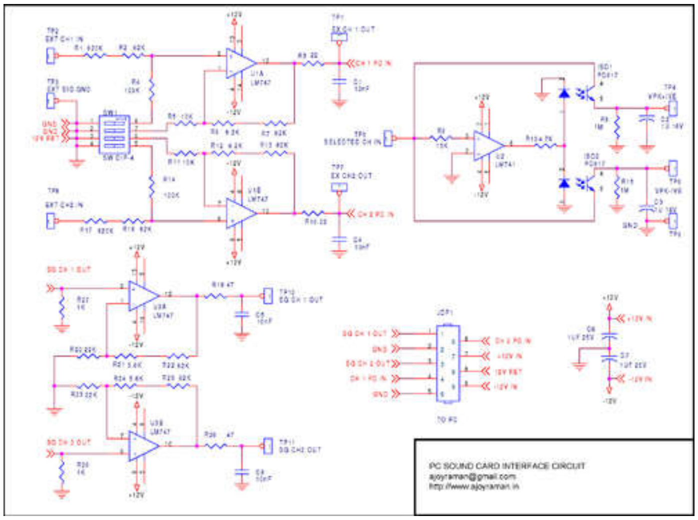
The peak detector circuits using U2 as a comparator and Optical isolators ISO1 and ISO2 form the **"novel feature"** of this circuit. When the input signal is high U2 output is positive driving ISO1 ON, the signal charges capacitor C2 to the peak value of the input signal as seen at the sound card input. The capacitor cannot discharge if the input goes below the peak value as the output transistor is reverse biased. Slow decay of the stored peak value is permitted through R8.

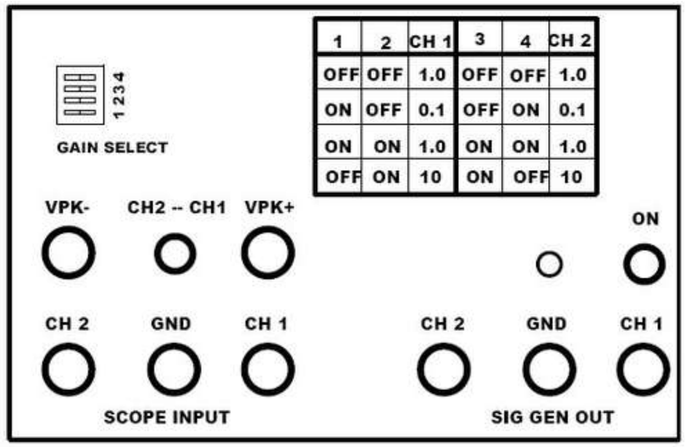
The negative peak is captured in a similar manner by ISO2.

IC U3 forms a gain X 5 stage for the sound card output

The second figure gives the front panel layout and gain selection table.

The Bill of Materials is provided.





PC SOUND CARD SCOPE INTERFACE CIRCUIT
Revised: Sunday, January 15, 2012

Bill Of Materials January 15,2012 11:31:43 Page1

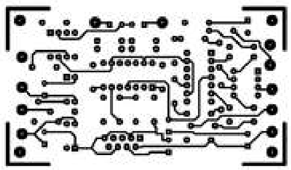
Item	Quantity	Reference	Part
1	4	C1,C4,C5,C8	10nF
2	2	C2,C3	1U 16V
3	2	C7,C6	1UF 25V
4	2	ISO1,ISO2	PC817
6	2	R1,R17	820K
6	6	R2,R7,R13,R18,R22,R25	82K
7	2	R3,R16	22
8	2	R4,R14	100K
9	2	R5,R11	10K
10	2	R6,R12	8.2K
11	2	R15,R8	1M
12	1	R9	15K
13	1	R10	4.7K
14	2	R19,R26	47
15	2	R23,R20	22K
16	2	R21,R24	5.6K
17	2	R27,R28	1K
18	1	SW1	SW DIP-4
19	2	U1,U3	LM747
20	1	U2	LM741

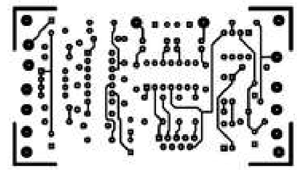
Step 4: PCB AND COMPONENT PLACEMENT

The .jpg images give the 1:1 PCB layout in A4 size suitable for fabrication using the toner transfer method.

The TOP layer is given mirrored and the BOTTOM is normal.

The component placement is shown.



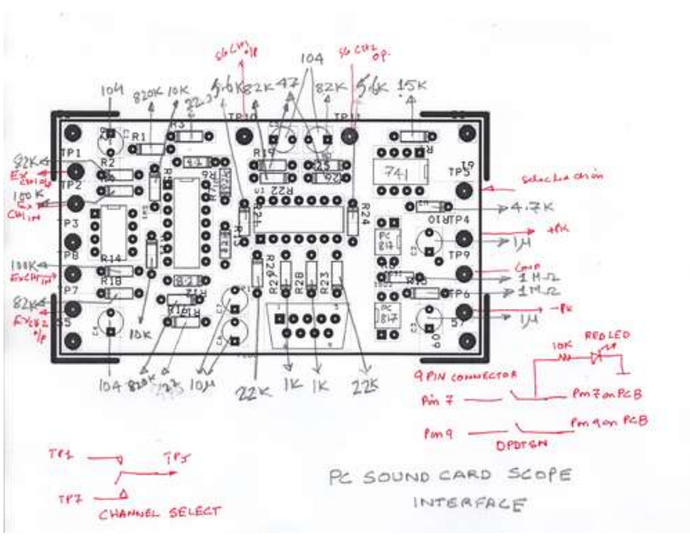


PCB TOP

MIRRORED SO THAT IT CAN BE DIRECTLY PRINTED ON PHOTO PAPER FOR TONER TRANSFER METHOD OF PCB FABRICATION

PCB BOTTOM

TO BE DIRECTLY PRINTED ON PHOTO PAPER FOR TONER TRANSFER METHOD OF PCB FABRICATION



Step 5: POPULATING THE PCB

The images give in sequence:

1. The Bare PCB TOP

2. Bare PCB Bottom

3. PCB with IC bases and resistors

4. PCB with all components populated.

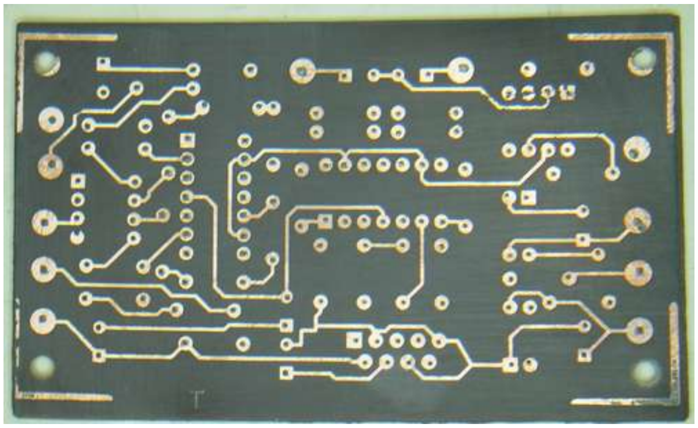
Note:

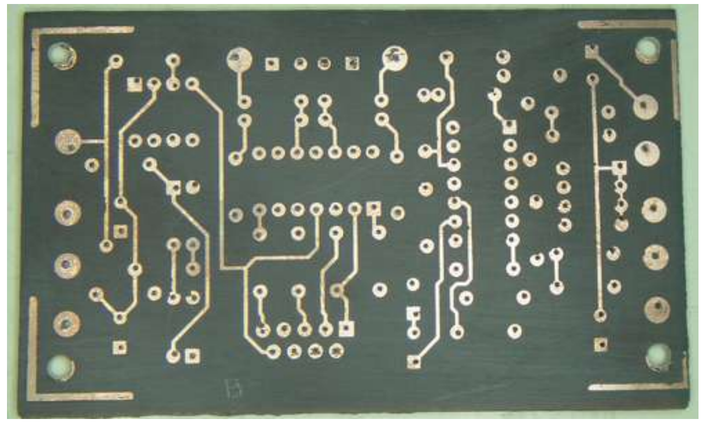
The DIP switch is planned for the bottom side and will be placed later.

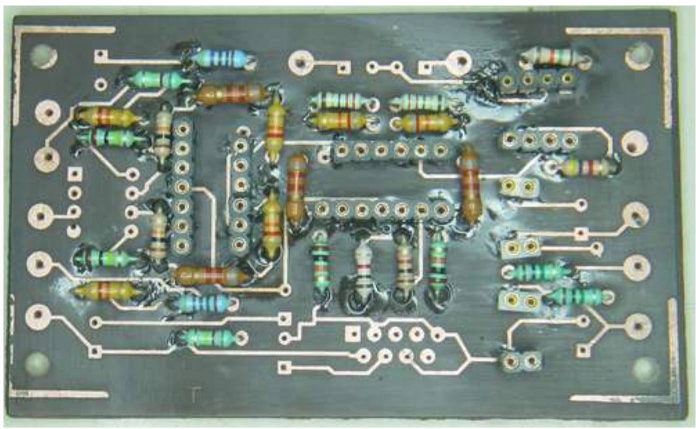
As the holes are not plated through the components need to be soldered on both sides wherever required.

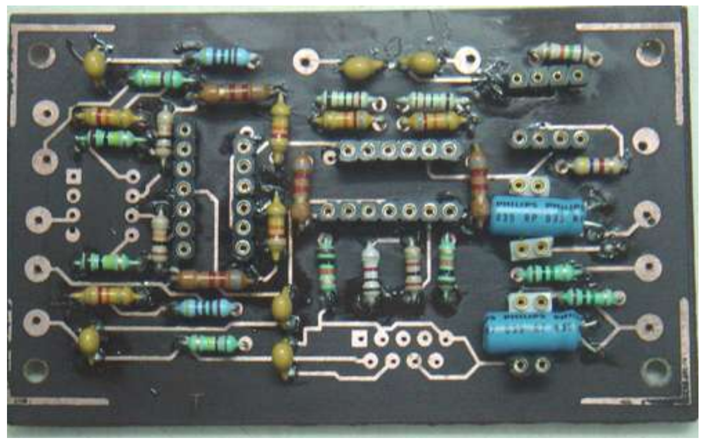
There is one via, do not miss this.

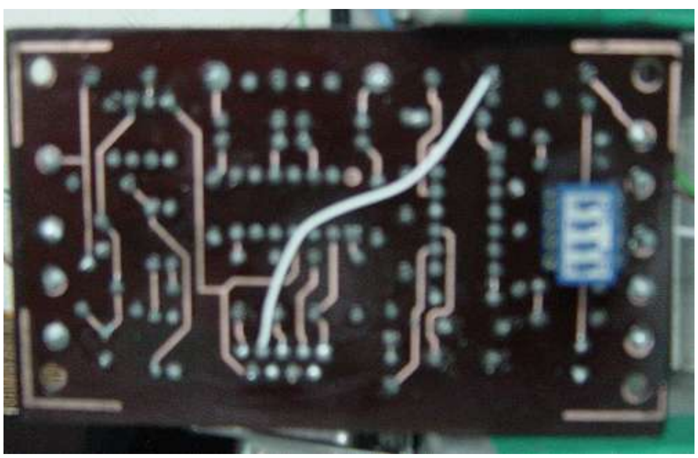
One connection has been missed in the routing this needs to be connected using a jumper. (Sorry for the bad image)









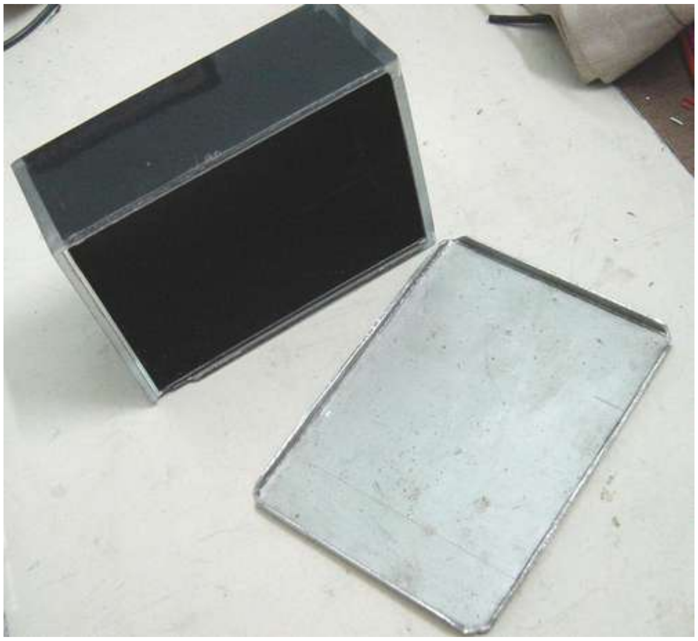


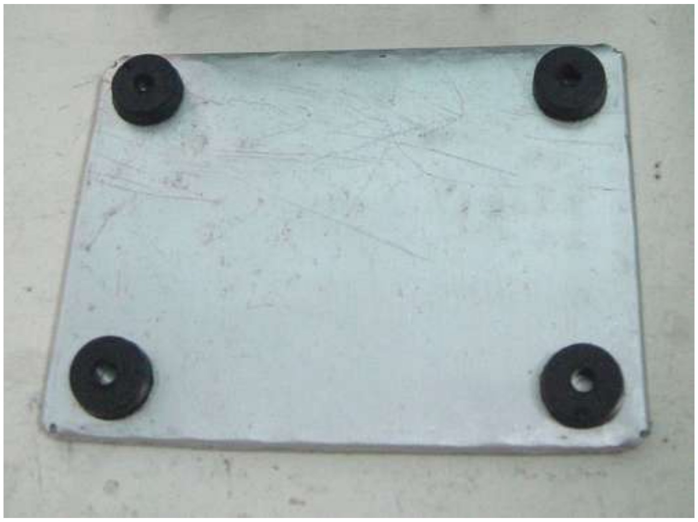
Step 6: THE ENCLOSURE

I had an old plastic container to which an aluminum bottom plate has been added.

I planned the positioning of the front panel connectors and switches a slot for the DIP switch on top and for the 9-Pin D connector at the rear.

The images show the enclosure fabrication in steps.



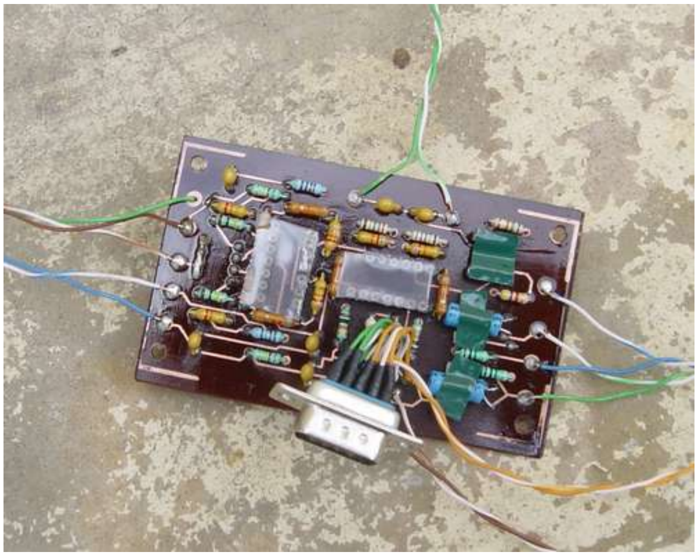


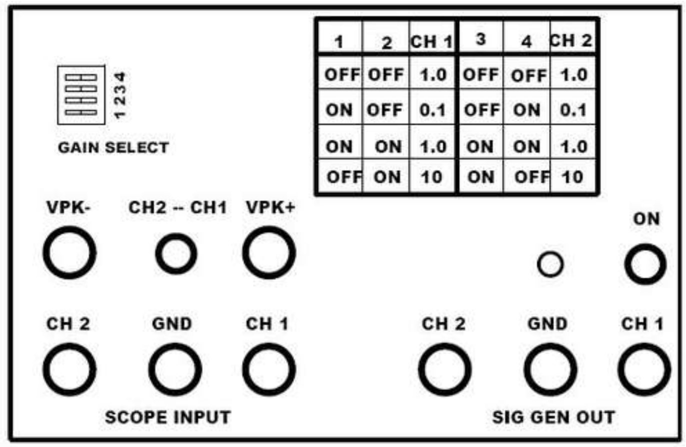
Step 7: CONFORMAL COATING AND ASSEMBLY

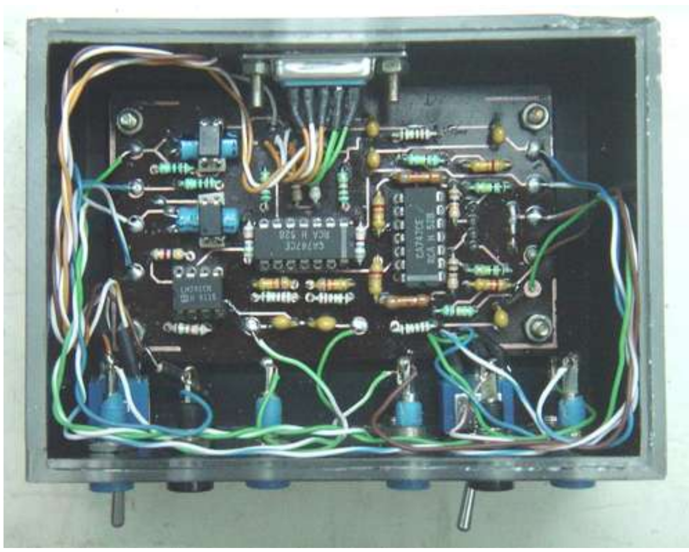
Interconnecting wire is soldered to the board with extra length so that the board can be coated with lacquer before assembly.

The front panel layout is provided again.

The wiring is carried out as per the circuit diagram and additional details given in the component placement diagram. The +/- 12V supply is routed through the Power ON switch and an LED indicator added to the +12V line.





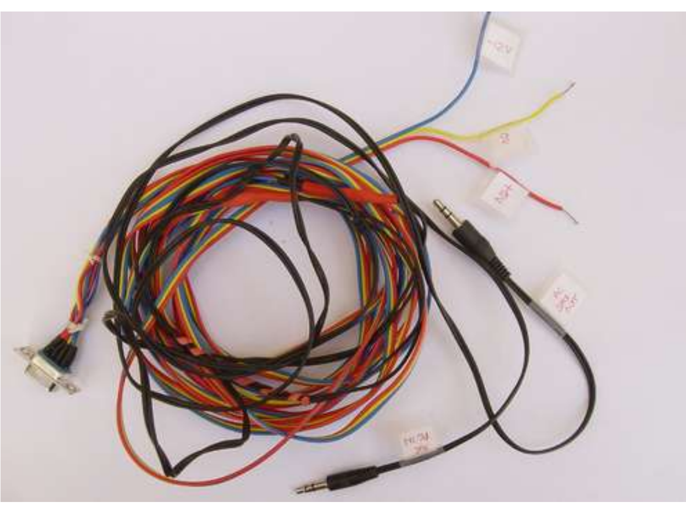


Step 8: PC INTERCONNECT CABLE

The sound card line input and speaker out are wired to the 9Pin D-Connector using 3-mm stereo jacks from old sets of earphones. Three wires are added for the External DC supply +/- 12V.

A length of 3meters is chosen for convenience. No shielding was carried out.

Cables with clips are also wired for the input and jacks for the output. (See this in the final figure)



Step 9: INTERFACE IN ACTION & SUMMARY

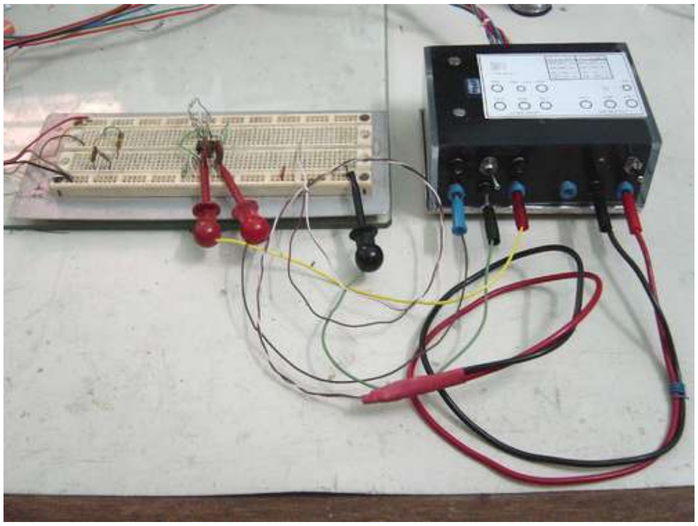
See the interface in action with the input clips connected to the IC 555 timer circuit which is on a breadboard.

The terminal layout and DIP switch gain setting table are pasted on the cover of the enclosure.

SUMMARY:

The PC Sound-card Interface presented improves the I/O characteristics and illustrates a method of DC restoration of the AC coupled waveforms using a novel peak-hold circuit. The resulting waveforms are a realistic representation of those obtained by a DC coupled oscilloscope.

This offset correction can also be carried out offline on the .csv format data provided by the software using MS EXCEL.



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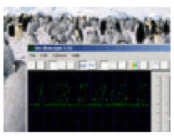

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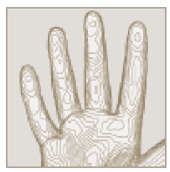


Idea Turn an obsolete PC into an Electronics Engineering Experimentation Environment by westfw

LCS-1M - A Full-Featured, Low-Cost Hobby Oscilloscope by womai

ajoyraman (author) 2 years ago

Yes you can use 2 LM741's instead of the LM747 but you will need to make the appropriate connections.

The 741/747 need +/- 9 V supply typically.

This scheme should comfortably work for signals down to 100mV.

Flag [d

opampboy ajoyraman 2 years ago

Best part of this scope is that it comes with internal variable gain system. I was plannin make a separate variable gain circuit with another scope instructable and I came acros this instructable. A big thank you for that :-)

opampboy 2 years ago

Hi,

1-Can I use 2 LM741 instead of single LM747 , I hope the function is same?

2- What is the min Vcc required for these amplifiers? I want to make a scope for low voltage signals(<2V).

stanfk54 3 years ago

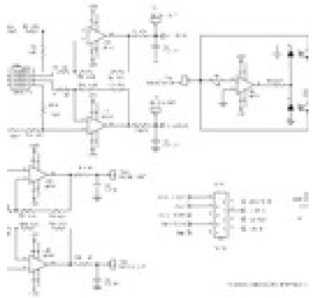
Great Job. Very clear and helpful instructable. You are my hero!!!
I wish you had data file for this PC board, do you?

deserticus 5 years ago

how can i get the schematic from here?

ajoyraman (author) deserticus 5 years ago

Thank You for your interest. I am providing a higher resolution version of the schematic here.



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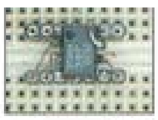
ajoyraman (author)

5 years ago

Thanks for the great response!

I find the DC offset in the X 10 gain is high and have changed the LM747, U1 to the LF353 u an 8Pin to 14Pin converter. The LF353 pins need to be bent upwards delicately and the converter leads soldered on. Plug this into the U1 socket. It works fine now.



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Brunomaster

5 years ago

Some video of the device working?
download links?
the project is good but needs some more work

You're doing great, keep it up ^^

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Bio: I am a retired Electronic Systems Engineer now pursuing my hobbies full time. I share what I do especially with the world wide student community.

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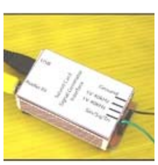

PC Sound-Card Signal-Generator-Interface
by ajoyraman