WAH | FUZZ | SWITCHING | SUSTAIN | ATTACK/DECAY | VIBRATO/TREMOLO

Download the Wah/Fuzz and Switching project in PDF

Introduction

NOTE ; Circuits using the LDR/LED modules will not work with the new "Superbright" LEDs .

These two projects , Wah and Fuzz, are the results of a modification to a Morley dual channel volume control pedal that one of my sons suggested I undertake as He had no use for the volume unit but thought I could modify the pedal into a Wah unit. I decided later to add a Fuzz circuit and combine the two into a single switchable unit as described further on.

The WAH Module

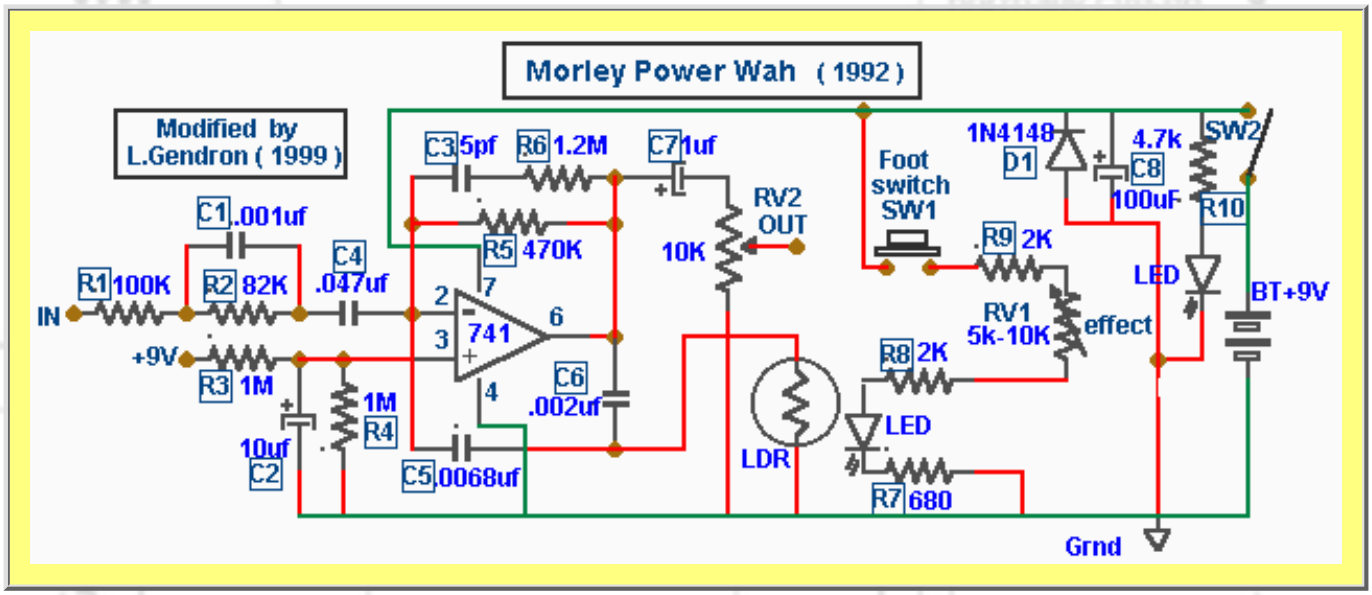
Not being one to re-invent the wheel, I downloaded several circuits from the Internet and after breadboarding severals I chose the original Morley circuit as it had the best sound and was using an LDR/LED control which simplified its construction.
I then proceeded to modify the circuit by adding RV2 to control the output level , RV1 to provide a range adjustment to the wah and R8,R9 to provide limits for the LED current range . I dug into my junk box for all the parts but the LDR (CDS Photocell) which I bought from RadioShack Cat # 276-116 .

Circuit description

The input signal is filtered and fed to pin 2 of the 741 op-amp and amplified by the feed back combination of R5,R6,C3,C5 and C6.The output is taken from C7 to the volume control RV2.
The circuit being used in an AC configuration needs a common ground level which is supplied to pin 3 by the voltage divider made up of R3,R4 and C2.

The Wah action is controlled by the activation of the LED shining on the LDR whose resistance varies depending on the LDR brightness which is controlled by RV1 . When the LED is off the LDR resistance one side of which is connected to the junction of C5-C6 has little effect on the feedback gain circuit but as soon as the LED is turned on with the foot switch SW1, the LDR resistance drops and shunt C5,C6 to ground through the LDR resistance boosting the gain and shifting the sound frequencies, thus the Wah effect.

The foot switch , SW1 , is a heavy duty push button or mcroswitch momentarely SPST switch mounted on top of the case .

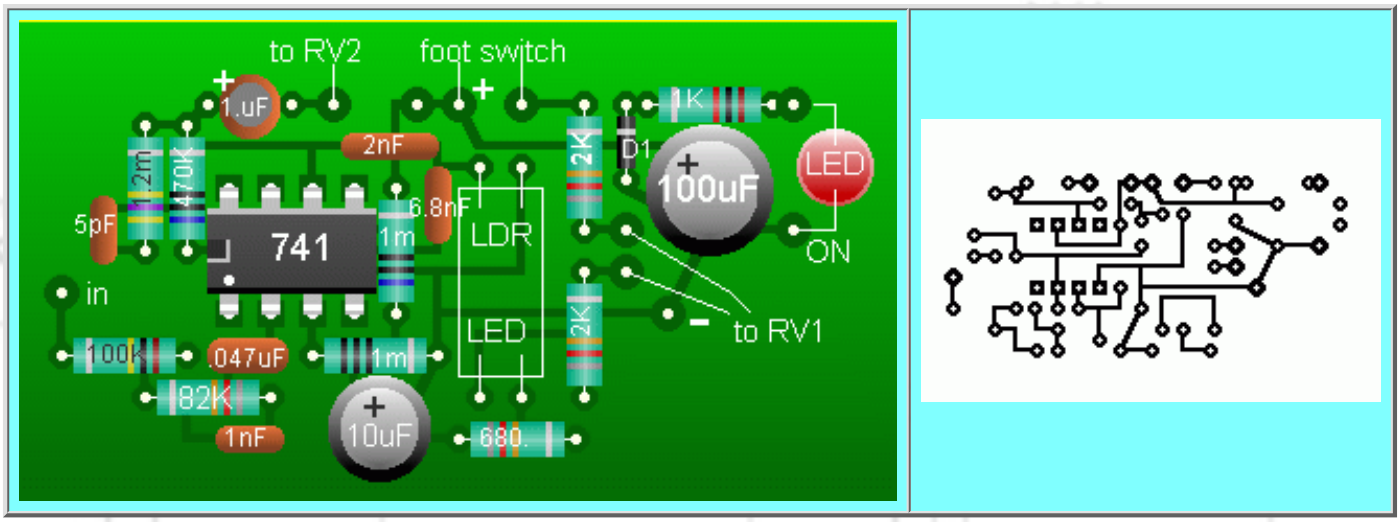


Construction

Resistors R8 and R9 may be soldered directly to the center and right tab of RV1 and one side of SW1 is connected directly to the other end of R9 , the other side of the SW1 is connected to the positive supply .
I would like to mention that I always use a socket , nobody is perfect and sometime a screw-up need not be a nightmare of desoldering and reinstalling a suspicious IC.

I avoid making printed circuit for most of my projects, instead I have becomed skilled in using #26 or smaller bare wire in making connections as laid out on a piece of perforated board to the proper size. It looks good , it is rugged and can be repaired easily . Below is a suggested layout and tracing is also shown for those who whish to make Printed circuit board

All resistors are 1/4 W , capacitors miniature ,voltge rating @10 volts min. except for C8 which is rated 20volts.



Wah Update (May 2002)

After using the wah that I originally published above for a while and hearing so much rave about the smooth performance of the inductor type , I decided to look into a way to to enable more flexibility in producing a Wah sound similar to the variable pedal and came up with the design shown below .

Using the phase shifting design with an op-amp sounds very close to the inductor type Wah circuit but with no up and down variation like the pedal allows .

I concentrated on the triggering aspect of the LED/LCD to try and produce a varying attack and decay that can closely resemble the pedal action . While retaining the Wah circuit but discarded the output volume control , I redesigned the triggering portion with another op-amp with a ramping function adjustable with RV2 .

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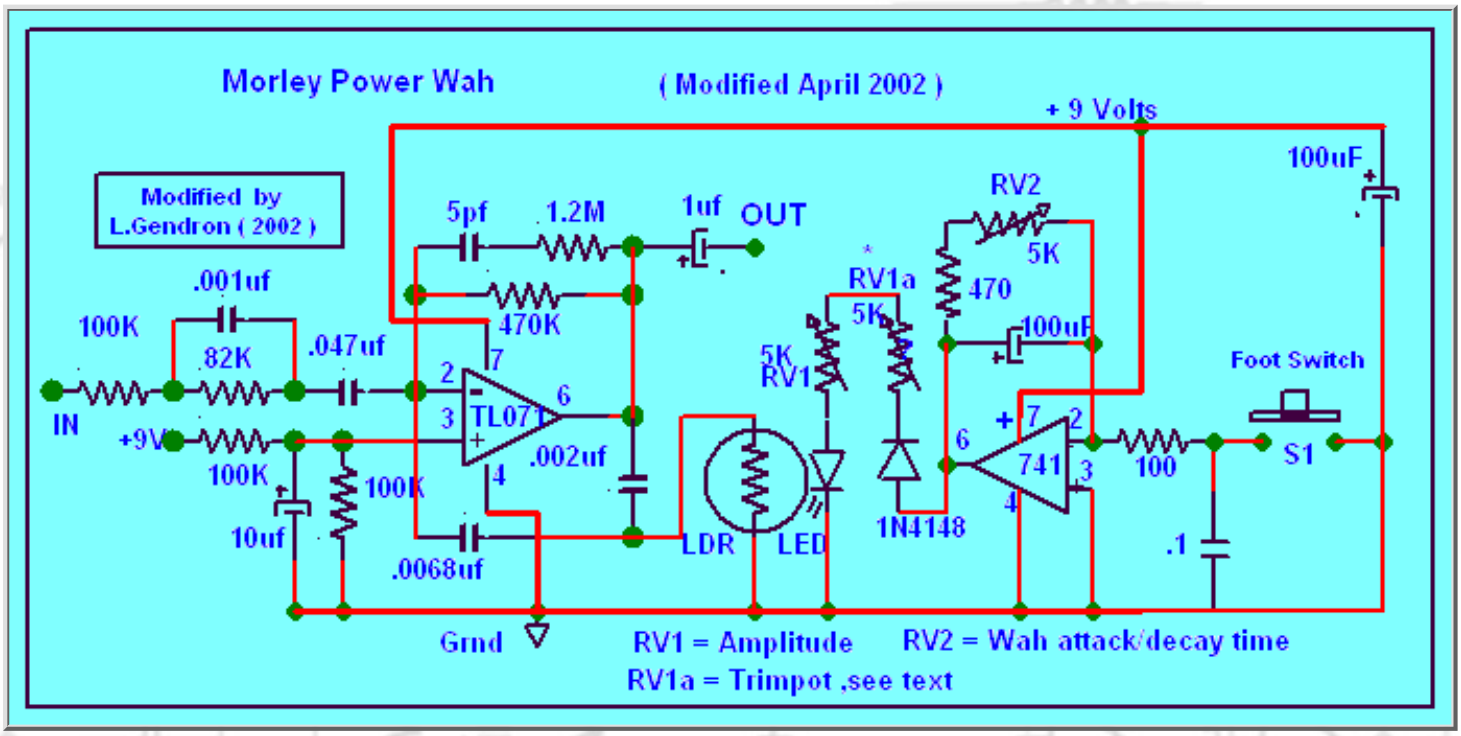
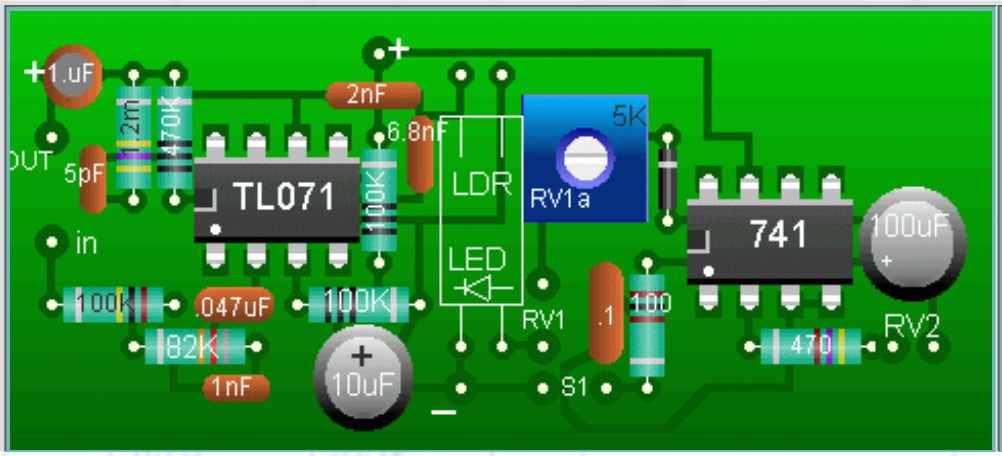
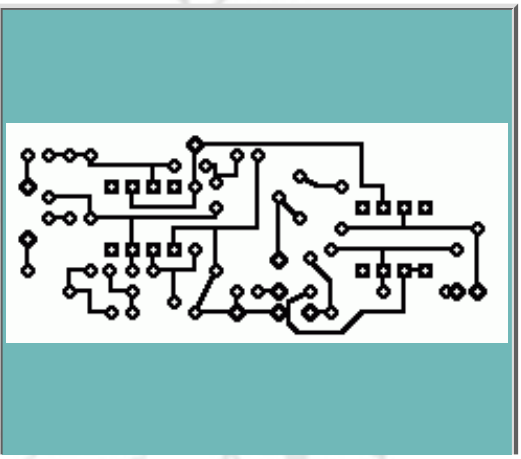


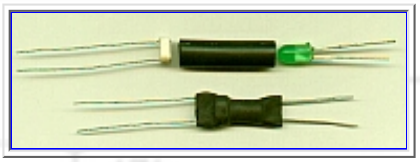
The 741 op-amp is used in the inverted mode as a simple DC amplifier with a 100uF capacitor in parrallel with the 470 ohms resistor in series with RV2 (5K) feed back resistors connected between pin 2 and 6 . By varying RV2 we can select the attack and decay time constant of the Wah from fast to slow (or vice-versa). With the 100 ohms resistor connected to the inverting input (pin 2) and left floating (not connected) the ouput at pin 6 of the op-amp is about 2 volts , this voltage may be high enough in most cases to induce current through RV1 and RV1a resistors to illuminate the LED . I therefore inserted a diode (1N4148 or 1N914) in series to drop the voltage by half a volt to insure the LED is off when S1 is not closed.
RV1 is the main control to adjust the LED sensitivity from a hard to a soft wah and to compensate for different LEDs sensitivity , I added a miniature trimpot (RV1a) to be adjusted as required when testing the wah function . It can be replaced by a fixed resistor once the preferred value is found .

As soon as S1 is closed connecting the 100 ohms resistor to ground , the op-amp swings into its inverting mode and produces a positive voltage of 8 volts charging the feed back capacitor (100uF) and depending on the setting of RV2 setting the delay time , turn on the LED gradually depending on RV1 setting which is used to control the current to the LED.
It will be noted that a fast repeated action of S1 on/off will reduce the delay time set by RV2 for an interesting effect depending on RV1 setting .





The LDR/LED capsule



NOTE: New superbright LEDs will not work

As mentionned I got the LDR in a package of five from RadioShack . No data is supplied . I needed to select the widest resistance range available of the five LDRs and used the schematic set-up to test each one. To prevent ambient light to reflect on the LDR I used a 1 1/2" length of black shrink tubing to accomodade the LDR in one end and the LED facing the LDR from the other end and connected the make-shift module as per the circuit details and proceeded to test for minimum and maximum resistance measured with my ohmmeter by varying RV1 and with power on/off. I then inserted the chosen one into the shrink tubing along with the LED. Make note which is the positive lead of the LED and rotate the LED so that the positive lead is situated in the tube as to match the future physical connection to R7 as shown on the PC module.

With the heat of a lighter or match slowly heat the shrink tubing to a tight fit making sure to pinch each end while still warm .

Assembly

This section applies to all circuits altough some terms and descriptions may vary .
If you are going to use only the Wah system you are ready to insert the module into a strong enclosure either metal or plastic about 3" by 5" , large enought and deep enought (about 1 1/2 " dept) to accomodate the foot switches, SW1/S1 and the by - pass switch , the Wah module and a 9V battery (use a battery clip) and one of each input and output jacks on opposite sides . The small SPST power switch if used and controls could mounted oneach sides of the enclosure and the LED on top but well away from and protected from the foot action.

Use shielded wire for all input and output connections to prevent hum noise and make sure the shield is connected to the negative or ground side of the battery as well as the case (if metal) .

For more guitar effect two fuzz circuits are described on the next page followed by a complete description of the Wah and Fuzz system assembly on the switching page.

More Wah Continued

WAH	FUZZ	SWITCHING	SUSTAIN	ATTACK/DECAY	VIBRATO/TREMOLO

HOME

Introduction

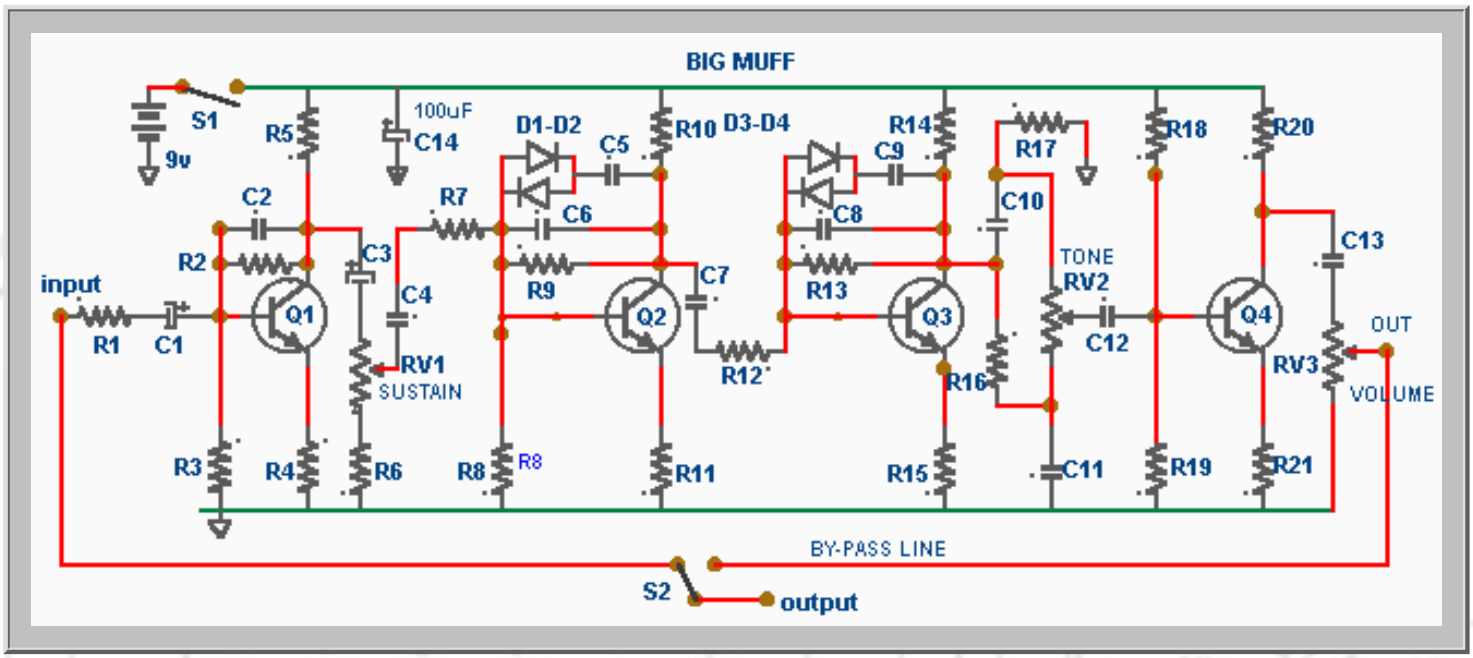
Building a Fuzz module

As with the Wah circuit, I downloaded several circuits from the Internet and after breadboarding and testing severals with the guitar I settled on building the " Big Muff " and the " Fuzz Face " which I describe in the following .

The Big Muff

Construction is straight forward except for the choice of transistors , notice the diodes polarities . The signal is first applied to throught R1 , C1, and pre-amplified by Q1 then fed to RV1 which is adjusted for the amount of sustain to the next two very high gain amplifier circuits Q2 and Q3 which combined with the diodes in the feed back circuitry distort the signal . The resulting fuzzed signal is then fed to the tone circuit control then on to the final stage of amplification Q4 , volume output is adjusted with RV3.
A simple by-pass circuit is shown but a true by-pass can be added as previously described.

You may apply the power is several ways , S1 can be a small SPST switch or a switch attached to the Volume control RV3 or as part of the input jacks switching on the NEGATIVE side of the supply line.
An LED indicator can be used connected in series with 1K to 4.7K seristor across the circuit power supply or incorporated in the by-pass as shown in Switching circuit C .



Big Muff Parts List

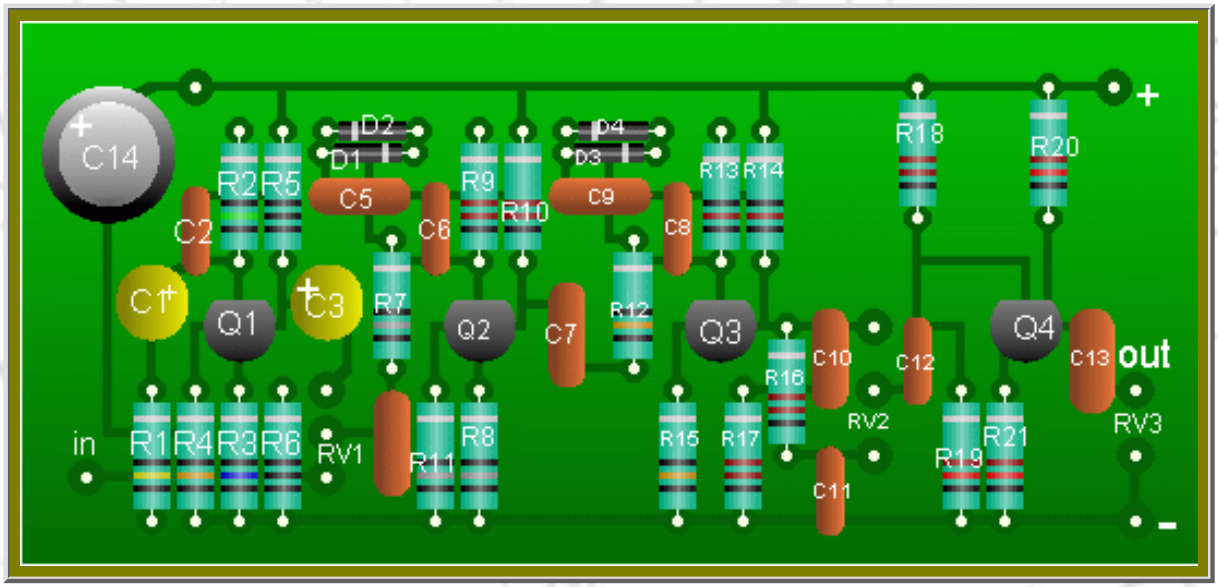
R1,R16..... 39K	C1,C3 .....1.0uF/16v PC mount
R2,R9,R13.....470K	C2,C6,C8 ..... 500pF
R3,R8,R19.....100K	C4,C5,C7,C9,C12,C13 .....0.1uF Polyester
R4,R11,R15.....150.0	C11.....0.01uF Poly.
R5,R10,R14.....15K	D1- D4 .....1N914 or 1N4148
R6..... 1K	Q1 - Q4.....NPN 2N5088,2N2222,2N3904 or similar
R7,R12.....8.2K	S1.....SPST miniature
R17.....22K	S2.....SPDT Heavy duty push button
R18..... 390K	
R20.....10K	
R21..... 2.2K	

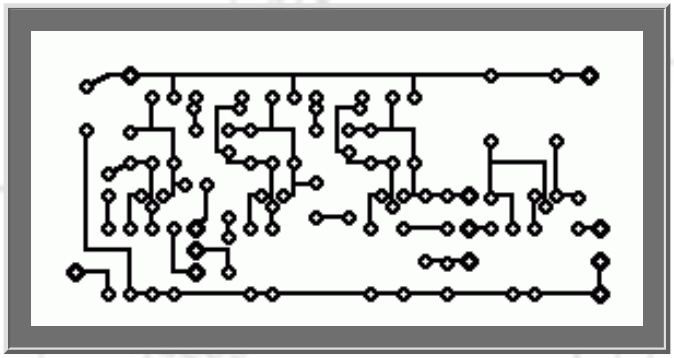
Note - The following parts are missing on the list
C10 = .1uf and C14 = 100uF/ 20v
RV1,RV2,RV3 = 100K

Again if you are going to use only the fuzz system on its own you may want to install the true by-pass circuit as described in the WAH module .

Transistors

All transistors are NPN types,all the transistors suggested that I have tested for used gaves the same peformance without the need to adjust the bias resistances . The transistor cases are TO92 plastic types .

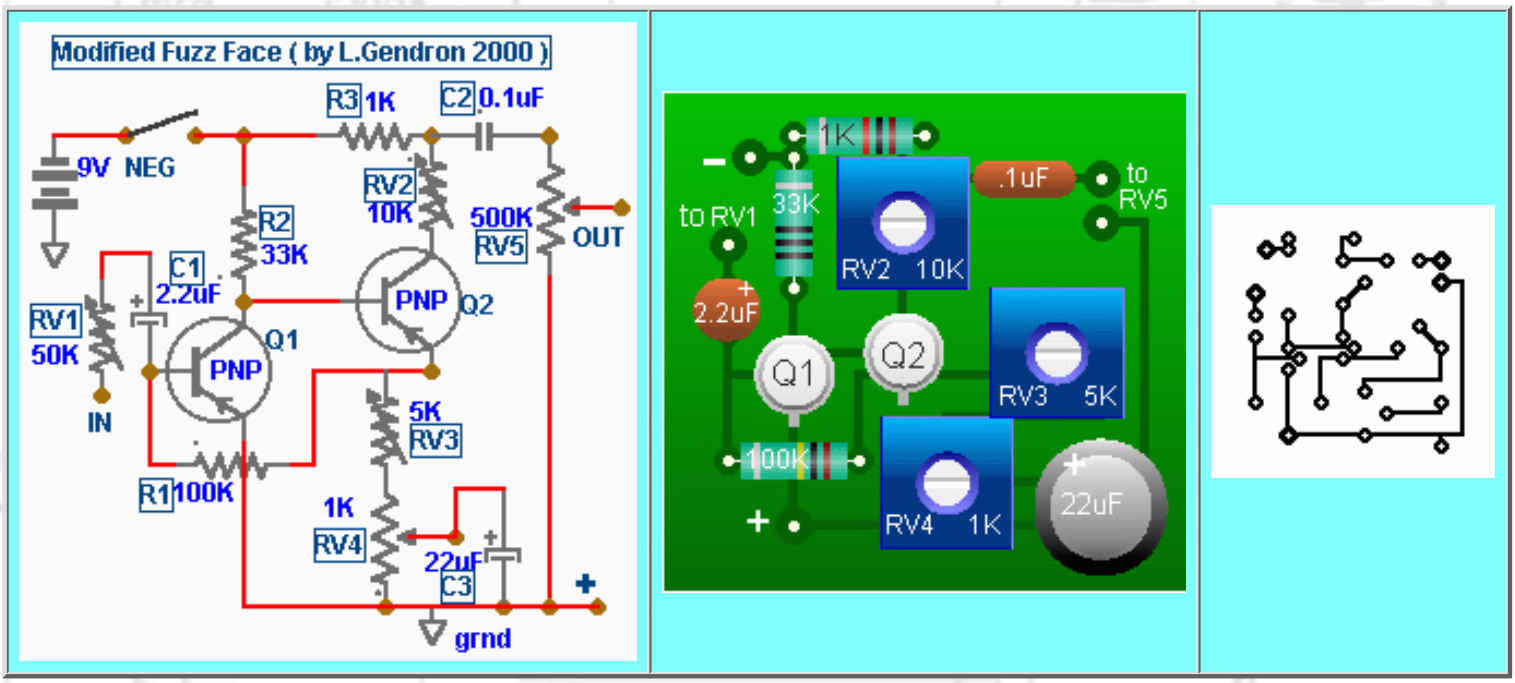




The Fuzz Face

The Fuzz Face circuit shown is a highly modified circuit of the original to provide exact tailoring to the taste of the user with the use of on board miniature potentiometers .
Adjustment of the on board potentiometers is not critical to the circuit and provides for a wide range of

tonal output and once adjustments has been made it is suggested that they be sealed to maintain the desired configuation.



Construction

You will notice that **PNP** transistors are used , as with the original Fuzz Face germanium type transistors are used for the apparent soft fuzz these transistors produced. I still had in my junk box many old germanium type from old portable radio vintage early 1970s and I used two 2SB175 which I assume are no longer available but any similar small signal germanium will do as well as silicon PNP.

You may want to use **NPN** types and that is allright but ensure that supply and capacitors polarity is reversed ,actually all of the same NPN transistors used for the Big Muff can be used for the Fuzz Face , you may also have to adjust R2 (33K) bias for best result.

RV2 , RV3 and RV4 are PC type miniature potentiometers while RV1 and RV5 are your external controls. Choice of by-pass switching is yours as described .

For a combined Wah and Fuzz guitar effect unit , the switching layout described on the next page shows how it is done .

WAH	FUZZ	SWITCHING	SUSTAIN	ATTACK/DECAY	VIBRATO/TREMOLO

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Guitar Sounds

WAH | FUZZ | SWITCHING | SUSTAIN | ATTACK/DECAY | VIBRATO/TREMOLO

Introduction

The two modules may be used in series with the input to the Fuzz module followed by the Wah otherwise the wah would be ineffective.The wiring arrangement provide for four mode of operation as follows:

1	Wah
2	Fuzz
3	Fuzz-- Wah
Foot	By-Pass

The Wah-Fuzz System

Figure **A** shows the external wiring for each modules (for identification chose your own wiring colours)
Figure **B** details the basic power supply wiring. (See "E" for option)

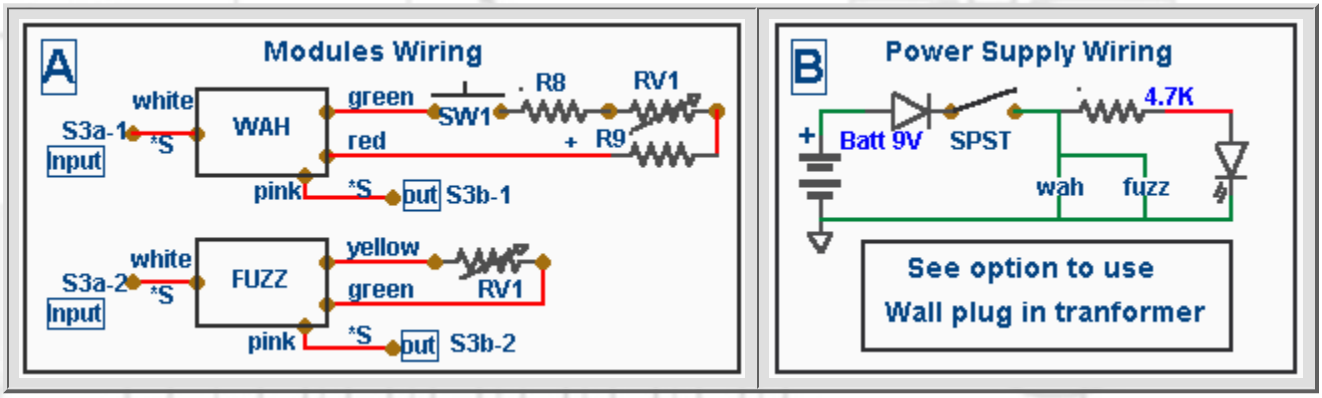


Figure **C** Shows the combined wiring of the by-pass switch S4 with the rotary switch mode selection S3. In order to indicate that the by-pass is active a small optional circuit is added , a green LED is indicated ,Q1 can be any high gain PNP small signal transistor , S4 as wired is said to be a true by-pass circuit. Two 100K resistors can be connected to the input and output of S4 to ground to help eliminate the POP from the amplifier when S4 is activated.

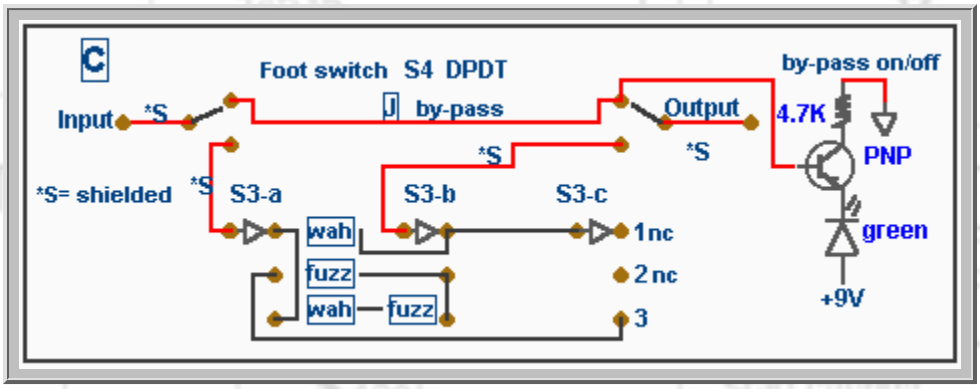
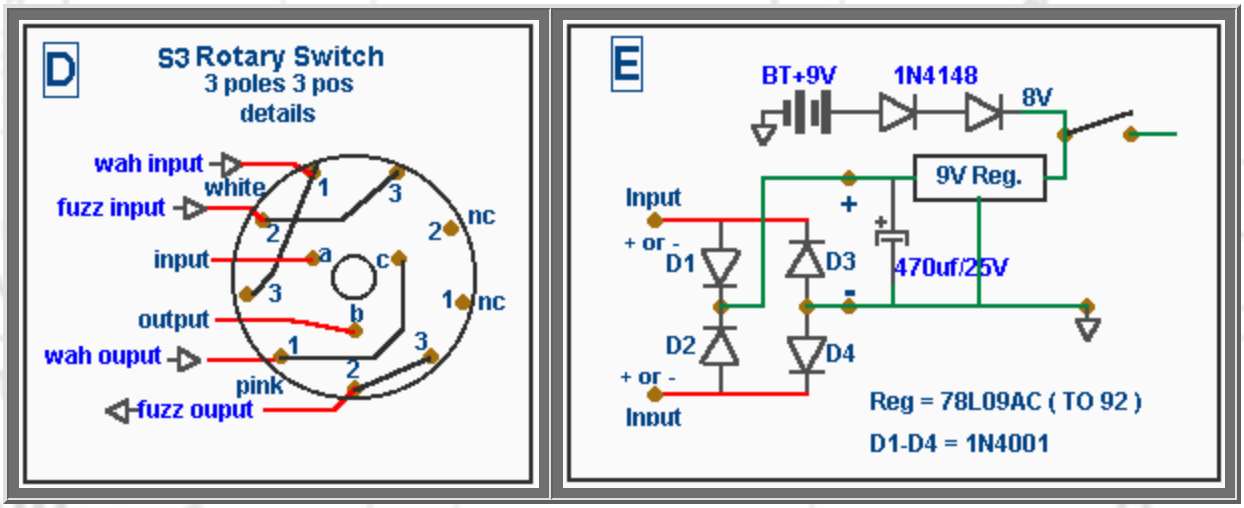


Figure **D** show the wiring details of Rotary switch S3 , position # 1 =Wah , #2 = Fuzz, #3 = Fuzz-Wah. S4 can be activated at anytime to override any of the selected mode.

Figure **E** Shows an optional circuit to use a wall plug transformer input . Wall plug units have the center pin positive

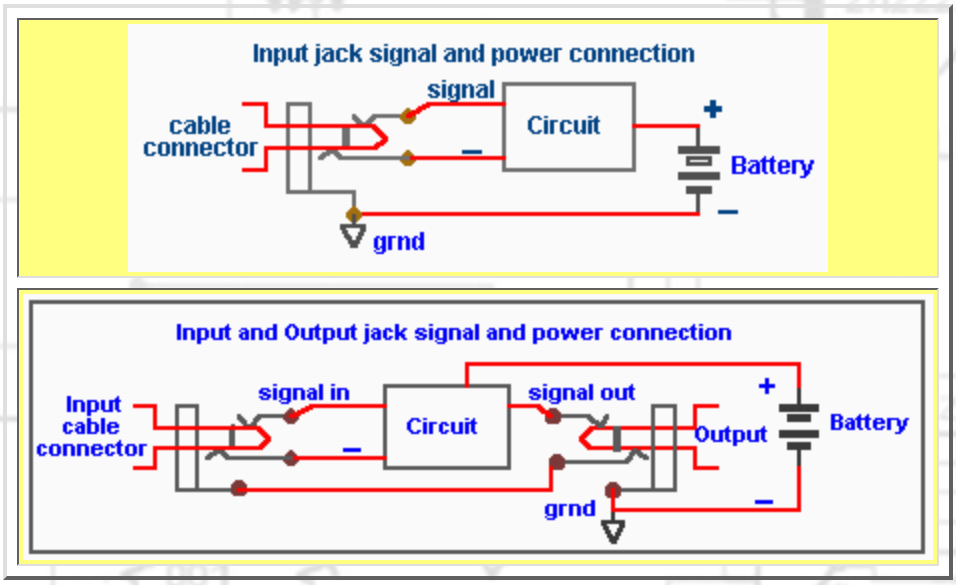
or negative , the circuit uses a protective steering diode bridge , regardless of the polarity input the output of the bridge will always be positive. A 9V regulator is used with a 470uf filter capacitor . The output of the regulator is connected as shown to a SPST switch. A 9V battery can also be used at the same time two diode in series are used to block the higher voltage potential of the regulator to the battery incase the regulator may be lower than 9V otherwise one diode would be sufficient to maintain a half volt lower potential.
In order for the voltage regulator to be effective a wall supply unit rated at 12 volts minimum and 100 mA is required since the total current consumption of the unit including the LEDs should not exceed 20mA and a small regulator in the TO92 package is sufficient. More information can be found here on regulators .

An alternative to the diodes in the battry circuit is to connect the battery to a 2 wires closed contact input jack of the type required by the wall unit output connector. In this case eliminate the diodes and connect the jack battery output directly to the switch.



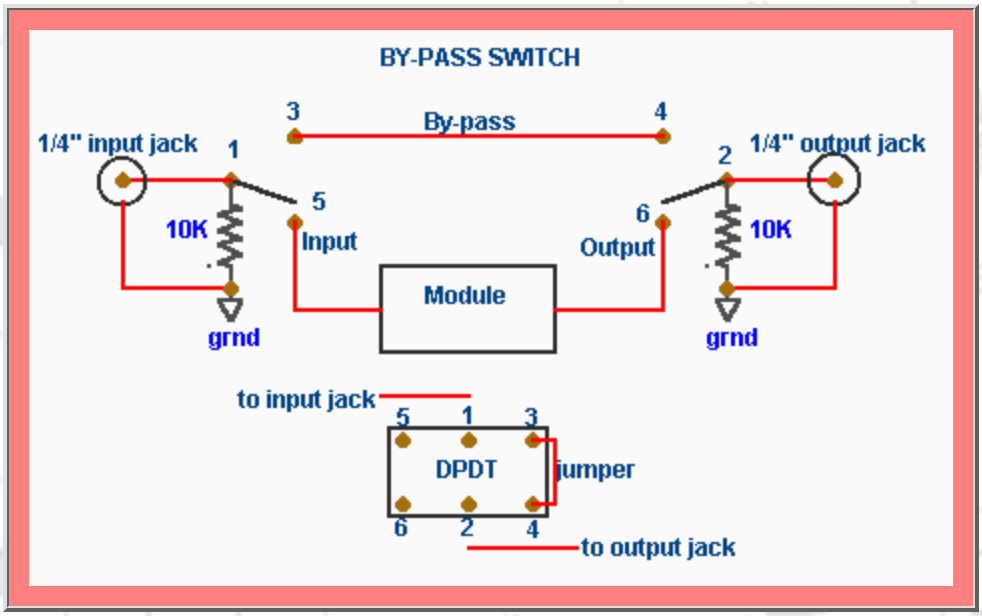
Input or Input and Output Jack connections

Below is the wiring to illustrate how an input or the output jack can be used for both the signal input and power supply connection instead of using a seperate power on/off switch . As the plug is inserted the negative side of the power supply connection is made with the plug body and the open connector contact while the signal is made with the insulated connector tip of the plug with its own lug .
The second illustration shows the input and output jacks connected in series make or break the negative supply connection . This is the safest way to protect the battery supply .



By-pass switch

When using the Wah module without the wah action the signal is passed through but with a small loss of the higher frequencies which might not be objectionable to you. In that case to simplify construction and saving you may well decide not to install a by-pass switch. If you desire to install the by-pass switch , connection layout is shown below.

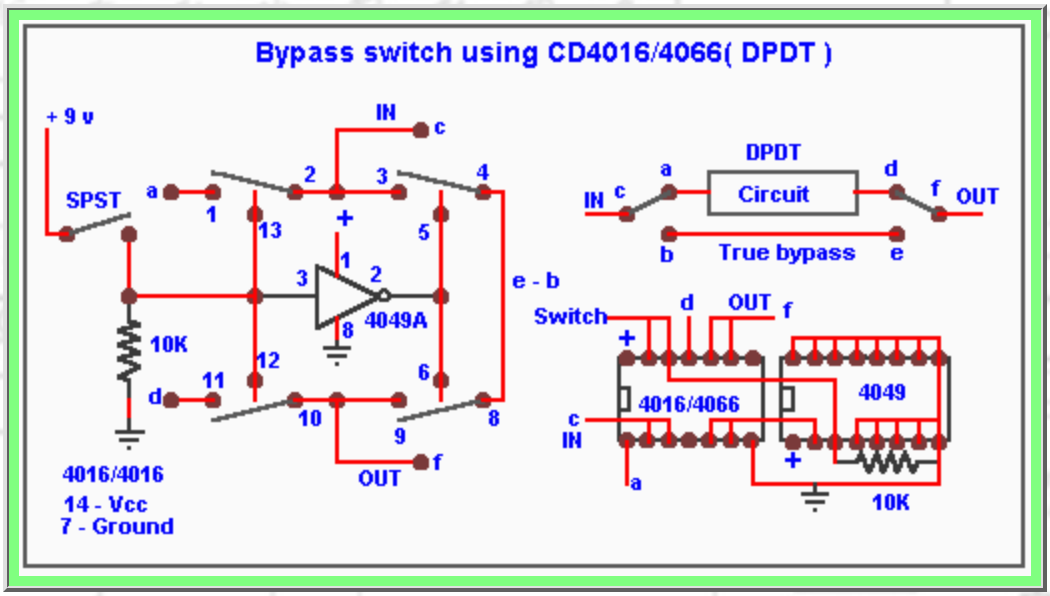


Electronic by-pass switch

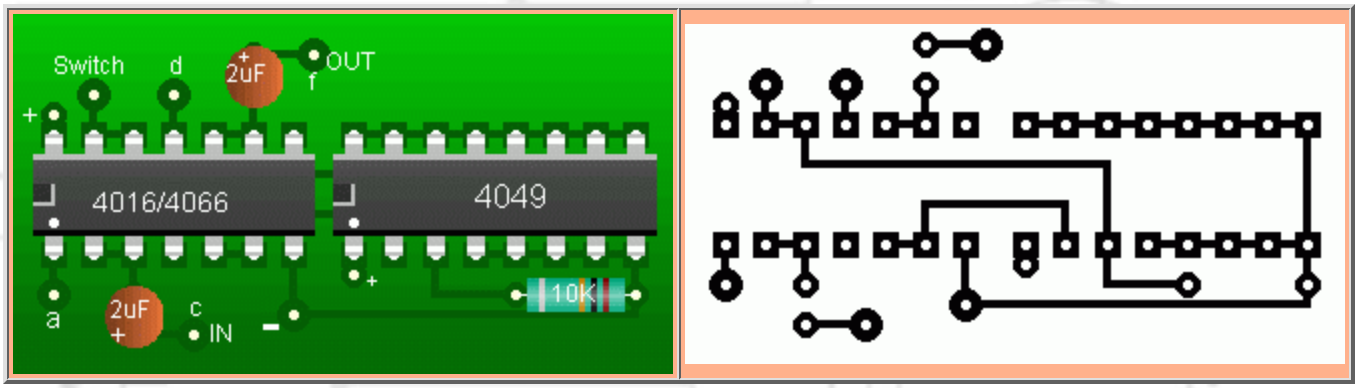
The last drawings show how you can use IC's to make and electronic true by-pass switch . A DPDT (Double poles double throw) foot switch cost anywhere from $ 12.00 to $ 17.00 (canadian $) and the price is still going up . You can save up to 2/3 the cost by making your own with simple IC's using a CD4016 or CD4066 and one gate of a CD4049 for one design or CD4053 and a few resistors for the other design switch .
The only draw back is that the power supply must on to activate the switch. A simple SPST push button switch can be used , a heavy duty one can be had from most electrical supply stores.

Using CMOS 4016 or 4066

Both chips are pins compatible and contain four SPST switches . We use all four switches in a flip-flop fashion using one gate of the 4049 to invert the switch signal to two of the switches to obtain a DPDT action as shown .
When the power is on and the foot switch is open the CD4016/66 switches c-b and e-f are held closed by the 10K resistance connected to ground allowing for the by-pass position . As soon as the foot switch is closed + 9 volts is applied to pins 12 and 13 of the CD4016/66 and pin 3 of the CD4049 and overcome the grounded gates and allows a-c and d-f to close and insert the circuit between a and d .
A suggested IC layout is shown and a representation of a similar DPDT switch action is shown with the pin connections . Gates resistance is very low on both designs and does not affect the signal level , I have tested them after assembly and was very satified with the operation .

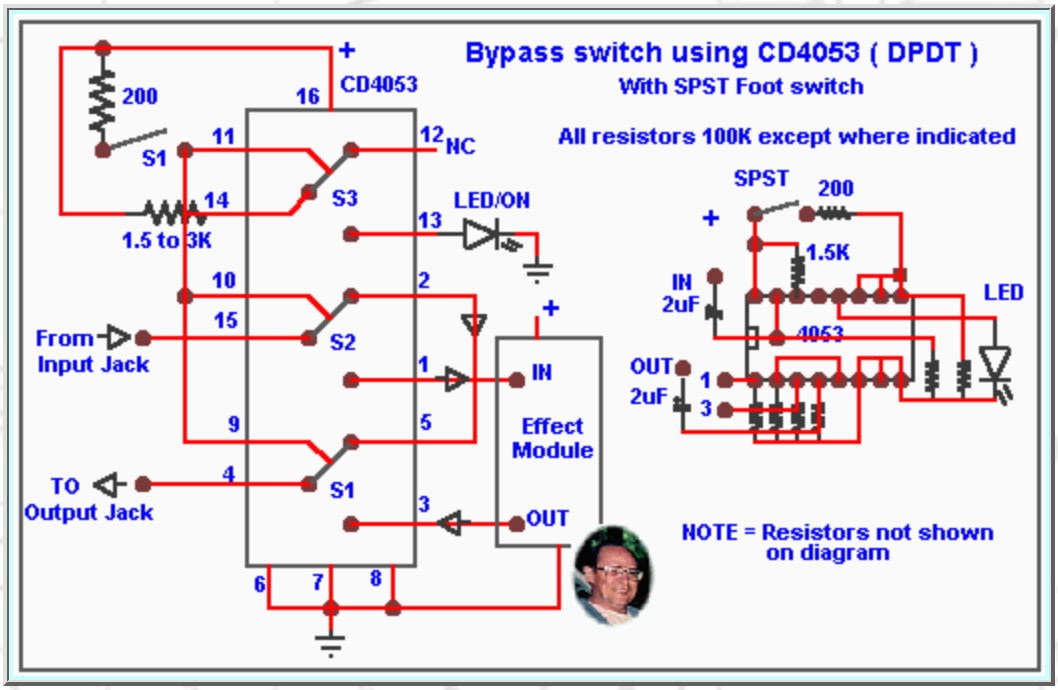


4016/4066 IC Layout and PCB shown twice the actual size

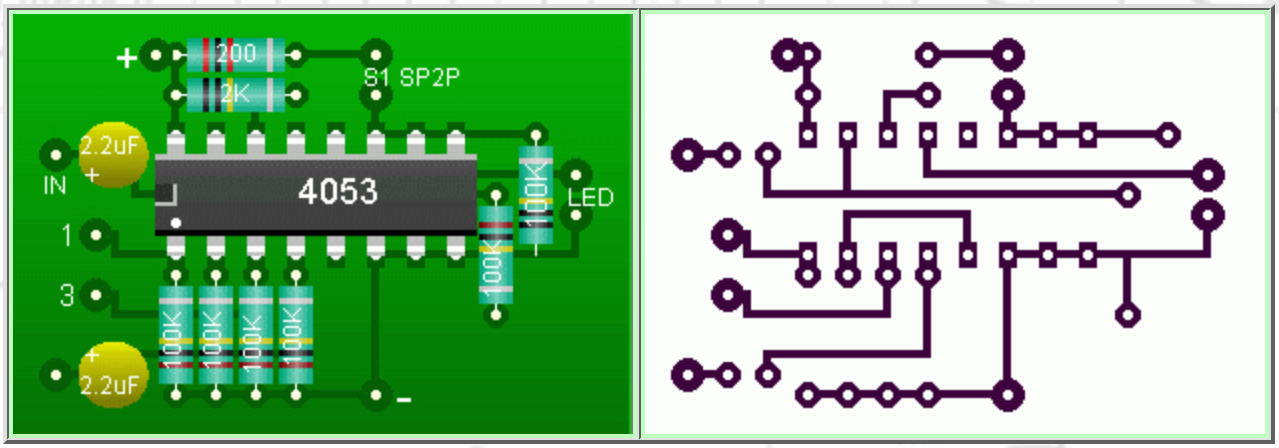


Using the CMOS 4053

Below is a DPDT switch using a 4053 IC , the on board chip contains three SP2P (Single pole two positions) and we use two for the circuit switching and the third one to activate an LED/ON indicator.The trigger level requires a positive high of about 4.5 V and will respond well with + 9 v from the switch through the 200 ohms resistance used as a safety current limit to the gates of pins 9 , 10 and 11 connected together which are held to ground with one 100K resistance when the switch is open .
As the CMOS are highly sensitive to noise , we must ensure that any outputs are not left floating and we use 100K ohms load resistances from all outputs to ground when the switches are off . A small 2uF capacitor should be used as shown at the input and output from the jacks .
To minimize the current flow throught the switch to the LED , a resistance from 1K to 3K used as a current limit for the LED and is connected from pin 14 to the + 9v and allows adequate brigthness .

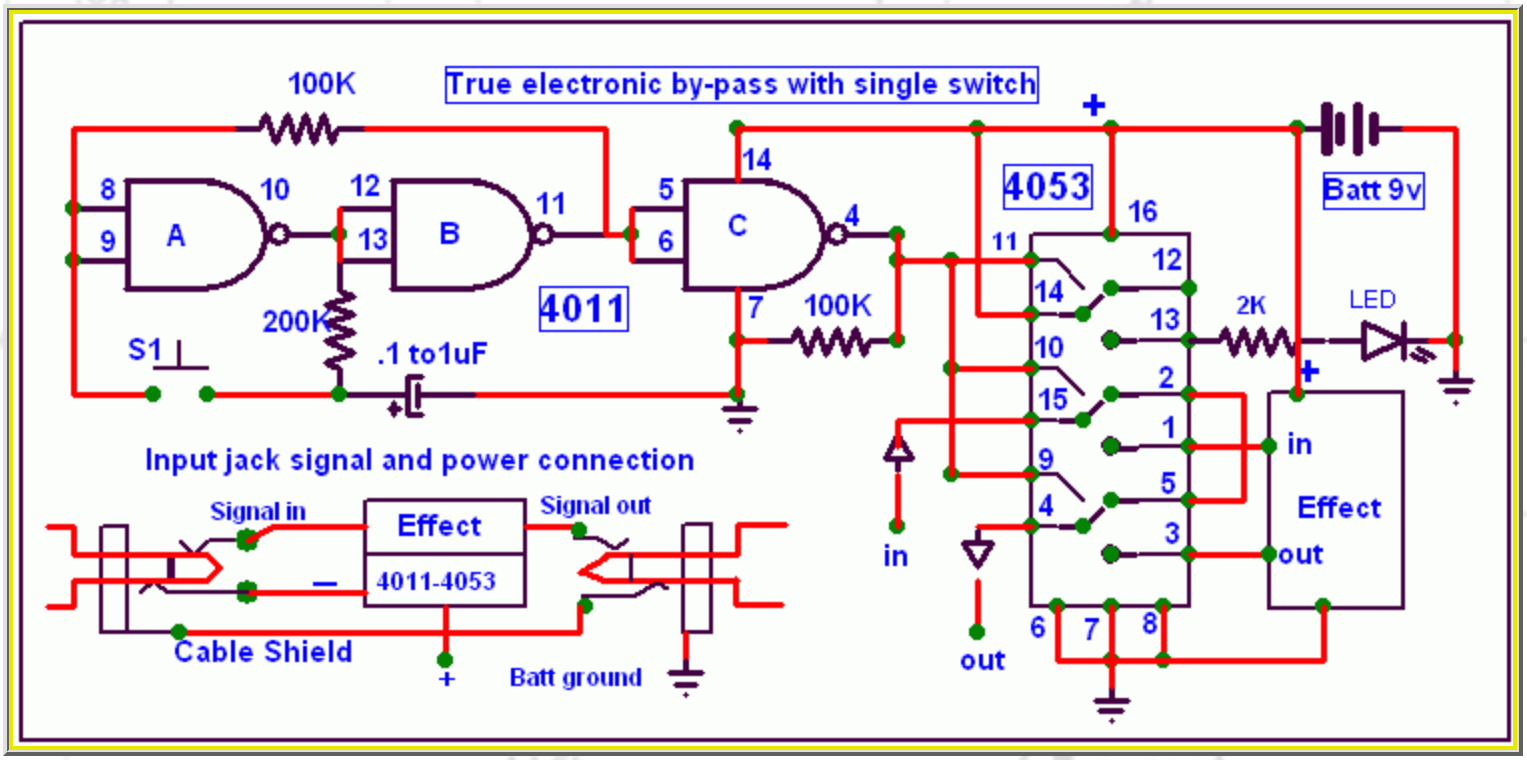


4053 IC Layout and PCB shown twice the actual size

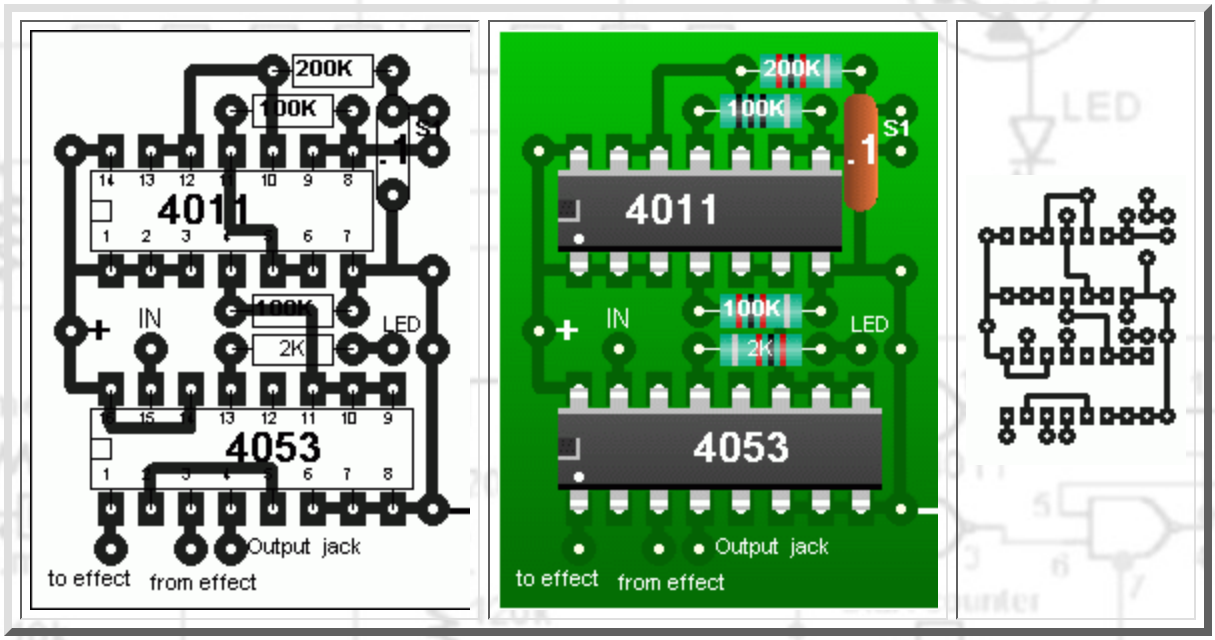


Using a Push Button

Its is possible to use a push button or a microswitch with normally open position to activate a flip/flop which will change the ON/OFF state of the 4053 . A Flip/Flop is made with a CMOS 4011 as shown below .
When the switch is closed the positive voltage charges the .1uF capacitor from the 100k resistor and produces a positive output at gate C pin 4 which triggers ON the inputs pins 9,10 and 11 of the 4053 . The capacitor remains charged and maintains that state until the next closure of the switch allows the capacitor to discharge throught the 100K resistance allowing gate C pin4 to change state and trigger OFF the 4053 .

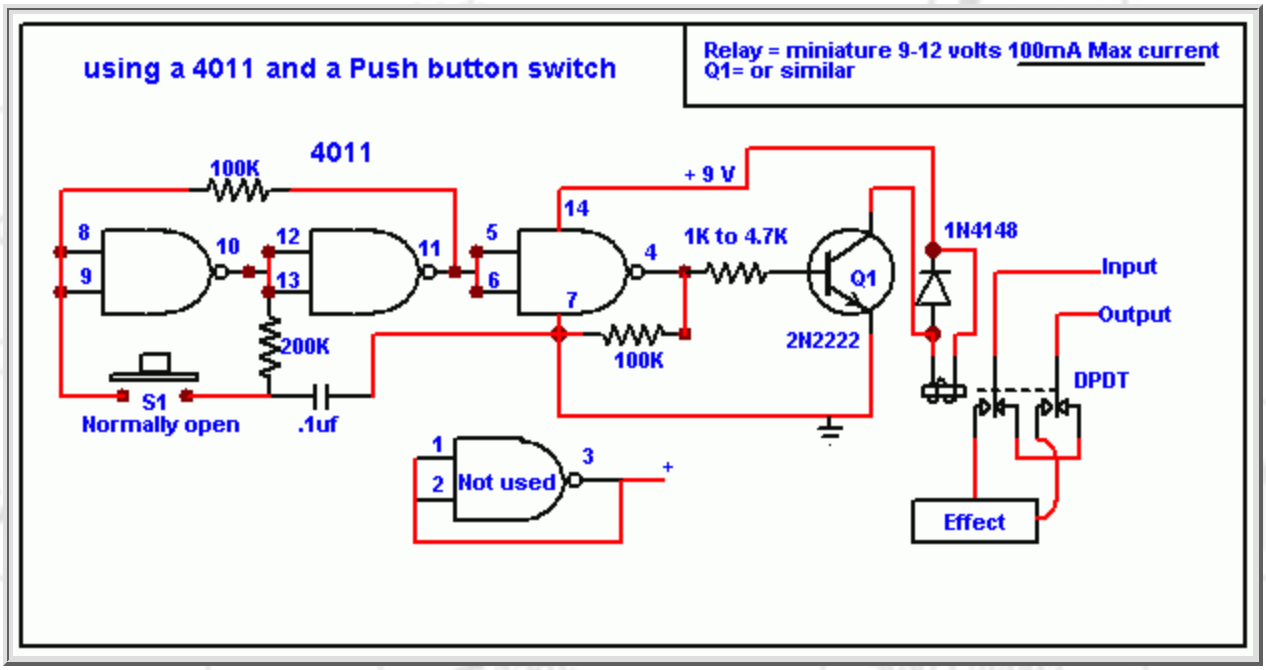


4011/4053 Layout and PCB shown actual size



Using a push button with a relay for a true by-pass switch

You can use voltage up to 14 Volts **BUT** the current must never exceed 100Ma with the transistor shown , but a larger transistor can be used .



The PCB of your choice can be included on your main circuit board and connections made with either tracing or wired from point to point .

Next page ***Sequential Electronic Switching***

I hope you have enjoyed studying this project , if you have any questions please feel free to contact me .

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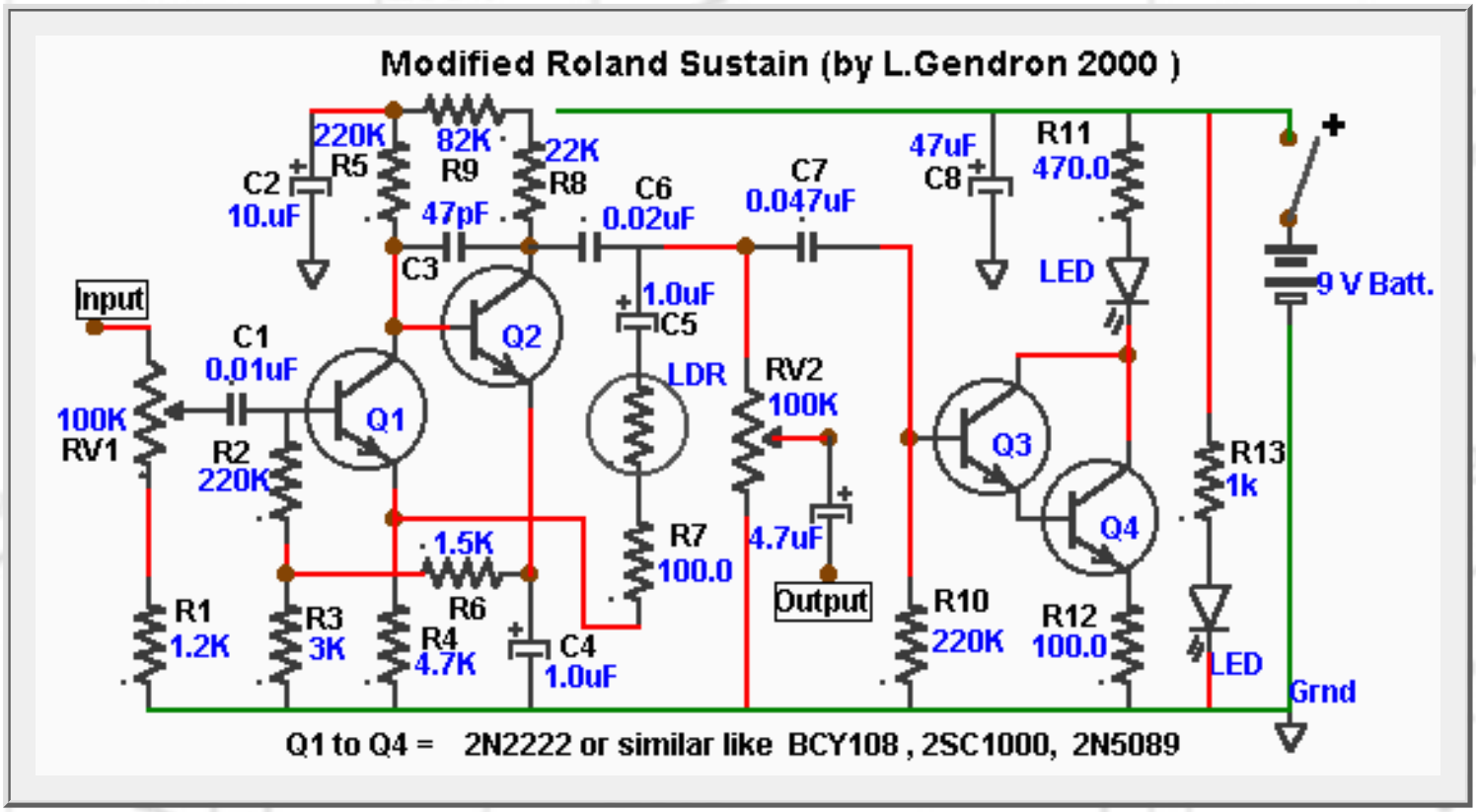
Download the Sustain project in PDF

Introduction

Infinite Sustain Module

There are not many sustain circuits available on which to base some kind of experimention, of the few I have come across the newer system are build using op-amp ICs and are very difficult to tame into a pure sustain that will not go wild into a distorted signal .

I have come across the Roland Sustain circuit and found it be a predictable and easy to control system without distortion until you really crank the Sustain control RV1 to its maximum and increase the guitar signal output . I have found that the sustain could be maintained with a guitar signal output as low as 10mV or less depending on the transistor gain in use .



How does it work

The signal is introduced to the very high gain amplifiers of Q1 and Q2 the amplified signal is taken from Q2 output collector through C7 and fed to the base of Q3 which turns on and allows current to flow through the LED which turns on and illuminate the LDR . As the LED increases in brightness the LDR lowers its resistance shunting its feed back to Q1 emitter decreasing its gain . As the signal is reduced the LED respond in kind allowing the LDR to increase its resistance allowing Q1 and Q2 to increase their gain thus maintaining a sustained amplification as the signal decreases .

NOTE (2 Sept/02)
Some of the readers who have build the unit have experienced radio interference . This due to the very high gain of the amplifier and the capacitance associated with certain type of connecting cables used . The interference can be eliminated by adding a .01uF capacitor between the center tap of the 100K (RV1) control and ground .
Not clearly labeled on the shematic , the LED encapsuled with the LDR is the one connected between R11 and the collectors of Q3 and 4 .

Construction

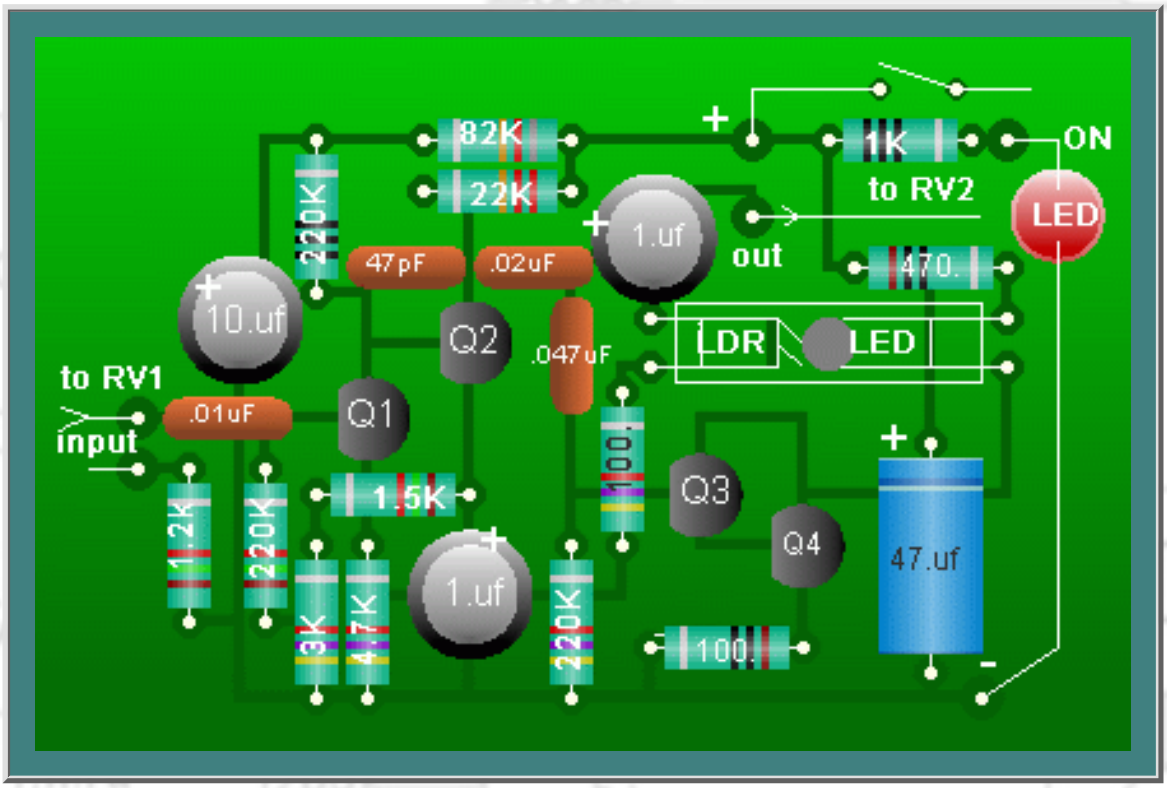
Below is the suggested PC board layout of the circuit which can be easily hand wired on a perforated board .

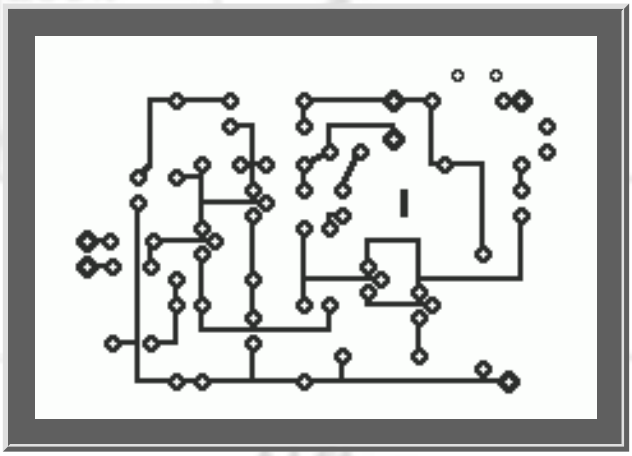
The construction of the LDR/LED capsule is the same as in use in the Wah circuit .

Sustain control flexibility would be better using a foot control for RV1, if an old or availble foot controlled resistance unit is available I would recommend using it otherwise RV1 Sustain control should be mounted on top of the box along with RV2 Volume Control as well as the switch which is a SPST miniature wired between the +9V battery and the positive bus of the circuit .

The LED power on indicator is mounted on top of the box and the series resistor can be reduced for more brightness but keep in mind that the lower the resistance used (minimum 1K) the more current is consumed from the battery .

Input and output jacks to accomodate your cable connector plugs are required . Female input/ouput jacks with an open circuit can be used to connect the negative side of the battery to the circuit instead of the power switch. See Input Jack connections





WAH	FUZZ	SWITCHING	SUSTAIN	ATTACK/DECAY	VIBRATO/TREMOLO

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Download the Vibrato/Tremolo project in PDF

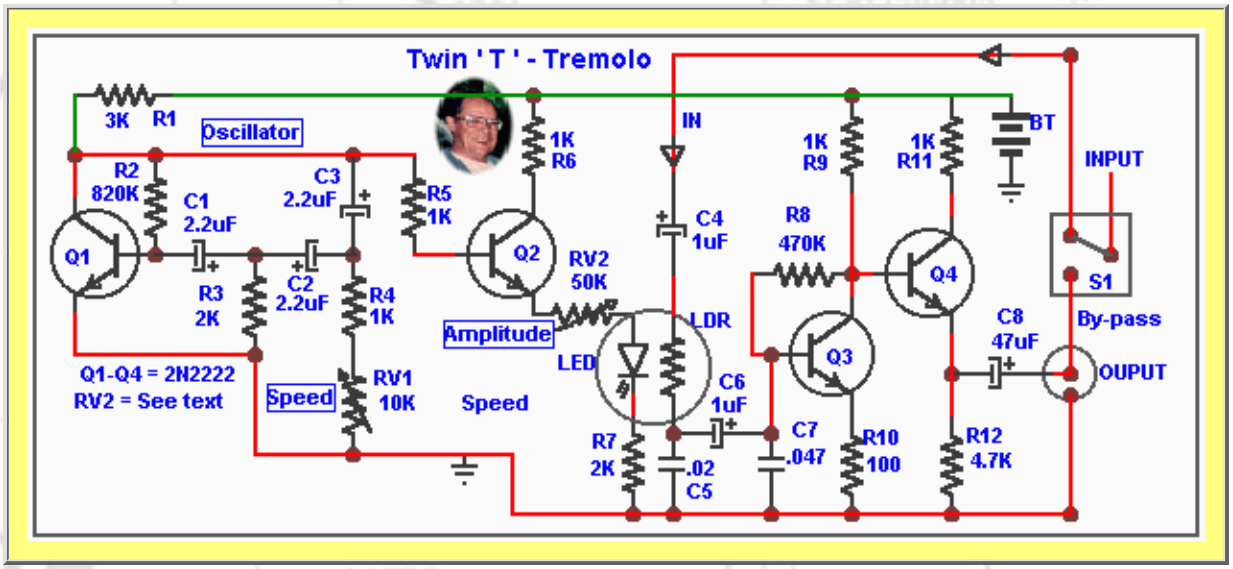
Introduction

Vibrato or Tremolo

This is the latest addition to the Guitar Effects projects . I , personally could never discern the difference but I found some definitions describing the effects. Tremolo was defined as the modulating of a note volume or amplitude while vibrato was said to be the effect produce by varying the pitch of a note like when moving the string on the fret of a guitar .
Below are two tremolos , the first one using a "Twin-T" oscillator and the second one using a 555 IC timer .

Twin-T Oscillator

When a signal is processed by this circuit it adds modulations called Tremolo depending on the rate set by the oscillator . For the guitarist , many amplifiers incorporate a tremolo effect but for those that do not , this little circuit will provide the missing elements such as choice of speed from about 3 to 10 Hz and amplitude setting .



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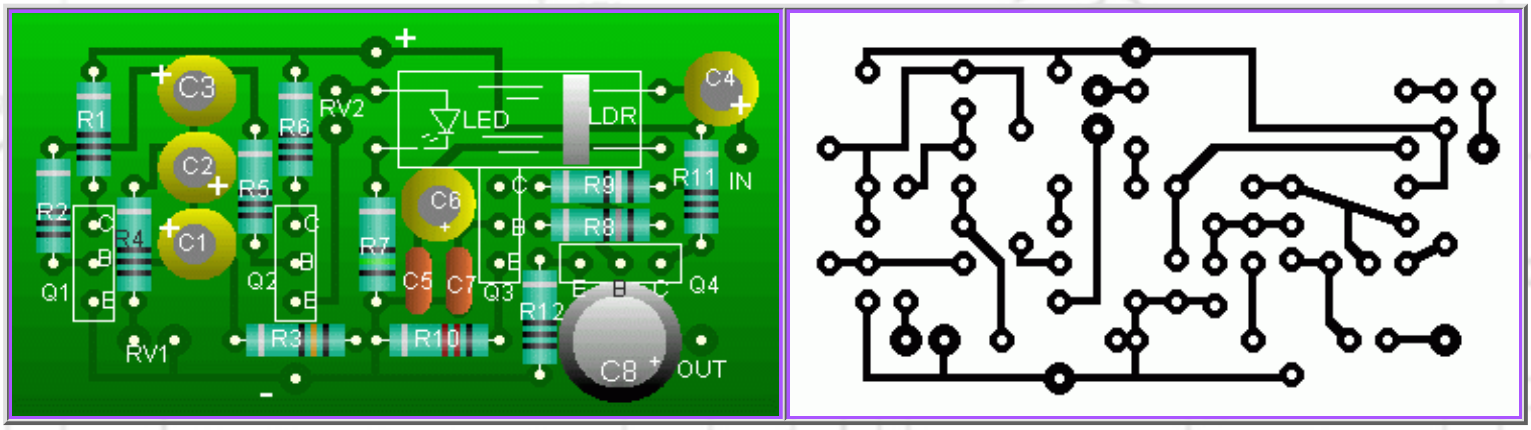
How does it work

This tremolo uses a transistor oscillator which is made of Q1, R1 to R4 , RV1, and three capacitors C1,C2,C3 . RV1 sets the oscillation rate . It produces a sine wave which is ideal for a smooth voltage signal which is applied to the base of Q2 used as a current amplifier the output of which is about 3 VAC . RV2 control the current to the LED's maximum brightness which in turn varies (modulates) the resistance of the LDR therefore the signal apllied through it .
The input signal is introduced to the LDR through C4 and the output is filtered by C5 and C7 . Q3 ampliflies the modulated signal and the ouput is taken from C8. Q4 main purpose is to provide a low impedance output .The battery should last a long time as the total current used is only 5mA . Too much amplification with Q3 will result only in amplifying the LDR noise caused by the varying resistance and this noise could be heard even when a signal is not present . .

A by-pass switch (S1) is used as shown , it can be a normally closed push button single pole double throw (SPDT) or a momentary type . The oscillator starts to operate as soon as the power is applied from a 9 volts battery . An On/Off switch can be used or the switching arrangement using the jack connections as described , see Input Jack connections

Layout and PCB shown twice the actual size



LDR Module

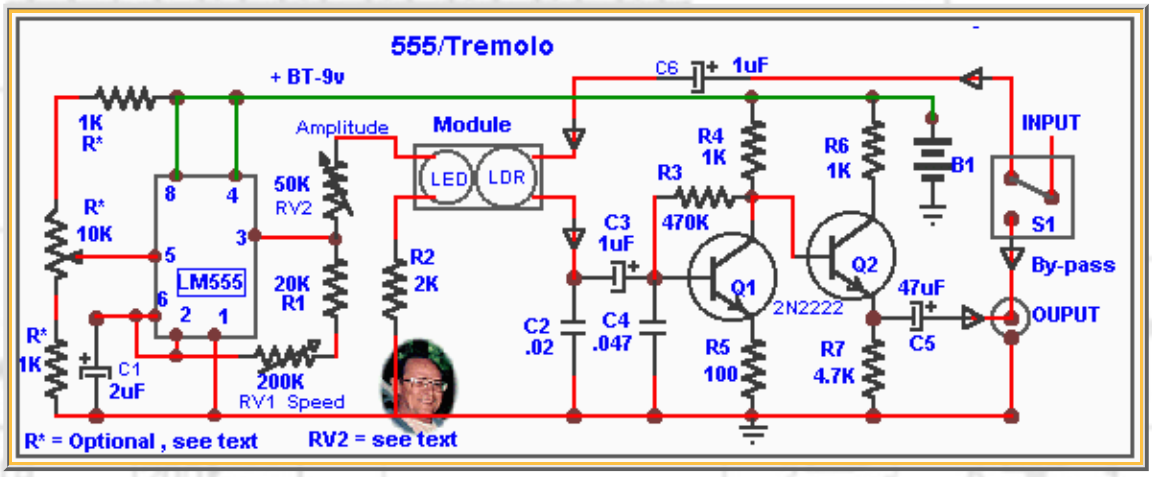
The construction of the LED/LDR capsule is the same as in use in the Wah circuit . Use a high brightness LED , red is OK . Choose an LDR which has a low top resistance value when in darkness , a 5 to 10 meg . resistance is about right .

Important Notes

The oscillator depends on the specified components values for stability and oscillation rate within the designed range , any substituted values will affect its function . C1 , C2 and C3 should be dipped tantalum types but non-polarized capacitor are still better for this application .
RV2 value of 50K was used on my protoype but to accomodate different LEDs and LDRs response , other resistance values may be required to obtain the best result .

Tremolo with the 555 Timer

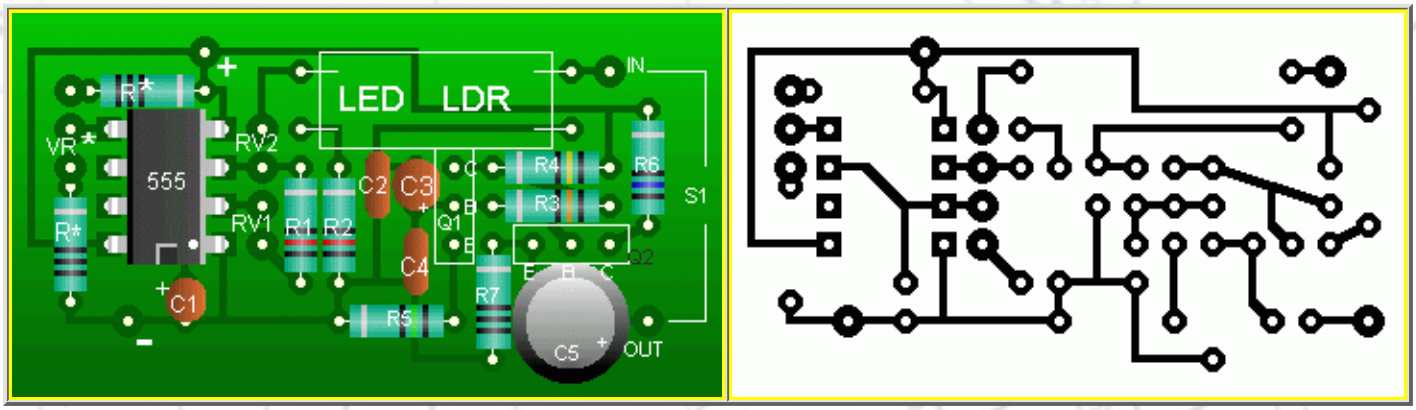
This circuit is not as smooth as the previous one . Because the 555 Timer oscillator produces a square wave it has a sharper attack tremolo effect but it allows for a wider range of frequency and with the addition of the optional circuit wich consist R* and RV* connected to pin 5 of the timer will enable varying the square wave from its normal 50% down to a sharp pulse or to its maximum pulse lenght .
This option combined with the speed and amplitude setting produces a multitude of effects like staccado , slow or sharp tremolo and more . Try it also with reverb for unusual results .



Construction

The oscillator set-up allows for a frequency of 1Hz to about 22Hz , changing the value of C1 will give other ranges , multiple ranges can be had by simply switching different values .
The same comments about using the amplitude setting RV2 applies for this circuit and the remaining part of the amplifier circuit is the same as the with the Twin-'T' Tremolo .

Layout and PCB shown twice the actual size

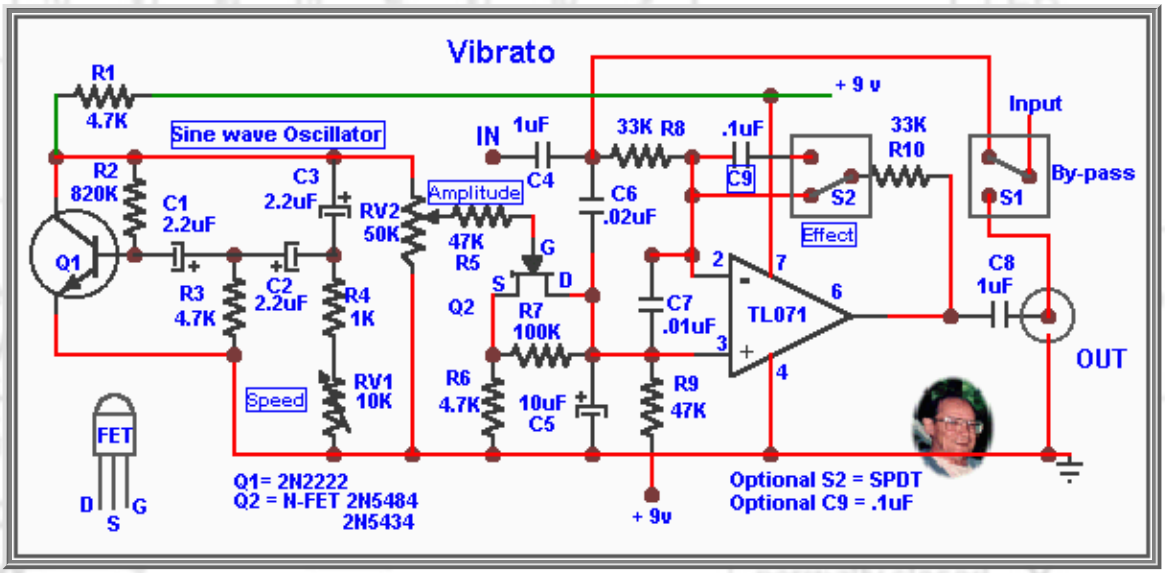


Using the Tremolo

I found the best way to use the tremolo is to first set the guitar volume control to 3/4 of maximum output , turn on the amplifier and raise volume control until a slight breathing sound is heard then just back down until the output is clear of any noise . Try some notes , adjust the tremolo amplitude to maximum then readjust the guitar volume control higher or lower as required .

Vibrato

Below is the circuit for theVibrato which is the result of pitch modulation and to accomplish this I chose a N-FET transistor as a variable resistor to modulate the bias of the op-amp at pin 3 . C6 and C7 are used as phase shifter thus modulating the pitch at the signal source .
The oscillator used is the Twin-T oscillator wich is similar to the tremolo with slight change in values to R1 and R3 the result is a slightly faster oscillating range and slight gain in voltage output and doing away with the buffer stage . The sine wave is taken from the Q1 collector and its amplituted is controlled by RV2 to modulated the gate (G) of the FET's resistance . This modulated resistance is applied between the negative bus (source)and the op-amp at pin 3 (drain) .
Normally the op-amp needs a voltage half the power supply at pin 3 to operate in the AC configuration and you will notice that R9 is used as the voltage divider resistance connected to positive bus providing a fixed positive bias to the op-amp while the FET modulates the negative side of the bias .



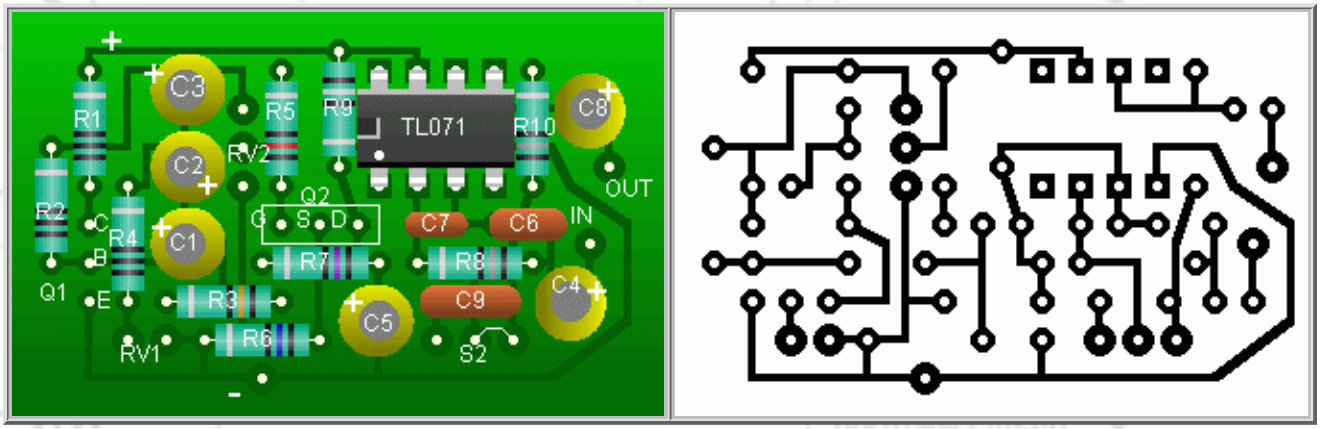
The components value used to calibrate the FET , RV2,R5,R6,R7 and R9 are critical and should not be changed . I used both the 2N5484 and the 2N5434 with good results and low noise , some other FETs I've tried produced excessive noise that could be easily detected by the amplifier . The TL071 , a FET input op-amp has been chosen for its low noise output but other op-amps can be used .
Use good shielding pratice , S1 is shown as simple by-pass switch , more info can be found about that on the switching page .

Effect Option

S2 , a SPDT miniature swtich and C9 (.1uF) have been added to produce a very pleasant effect when switched in series with R10 which is the gain feed back resistor . When switched in and depending of the setting of RV1 and RV2 will give a

tremulous to something like an echo modulation , I found it to be a very pleasant sound . The effect is optional and if not used S2 and C9 can be omitted and a jumper installed where shown on the layout at S2 connection points .

Layout and PCB shown twice the actual size



Let me have your comments on the performance results of these little circuits .
Laurier Gendron

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