



Elliott Sound Products

Project 38

## Signal Detecting Auto Power-On Unit

© December 1999, Rod Elliott (ESP)

### Introduction

How many times have you wished that there was a simple way to turn on that sub-woofer or some other piece of audio equipment, simply by sending it a signal? This ability is fairly common in commercial subs and some other gear, but there seems to be a complete absence of circuits on the net, and they are unavailable as an add-on device.

'New Japan Radio' makes an IC that is specifically intended for the purpose (NJM2072), but you may not be able to get them where you are and there seem to be relatively few suppliers. The sensitivity of the IC is fixed at -36dBV (about 16mV) and the supply voltage is only 7V (maximum recommended). You have to use a low voltage relay coil and an external transistor, because the internal transistor current rating is not high enough to power a relay. The maximum time is also rather limited, with the maximum shown as 10 seconds - way too short for this application.

The circuit presented here will operate with a signal of 10mV (RMS), which will be adequate for all but the quietest listening. 10mV represents a typical power of about 6mW into an 8 Ohm speaker with a typical amplifier. That means a sound level of around 62dB SPL with typical speakers. It is possible to make it more sensitive - I tested it to 1mV, but at this level even tiny amounts of mains hum or other noise will trigger the circuit.

Using cheap and readily available parts, the unit will switch the most powerful amplifier as long as you select the correct relay. You can even use a small relay to operate a larger one, so you could switch anything you wanted to - so there are few limits.



**WARNING: This circuit requires experience with mains wiring. Do not attempt construction unless experienced and capable. Death or serious injury may result from incorrect wiring.**

The circuit shown is designed so that it will operate when power is applied. This isn't a design flaw - it's deliberate. If it didn't do it by itself, I would have added the circuitry needed to make sure that it turns on! When you connect a piece of equipment that doesn't have a mains switch (or when you first turn it on), you expect it to work, not just sit idly doing nothing. If there's no audio signal the circuit will switch off again after the time-out period. This provides a level of confidence that everything is functional without having to connect an audio lead.

**Please Note:** This circuit is designed for use with conventional electromechanical relays. It *MUST NOT* be used with a solid state relay (SSR) because the MOSFET

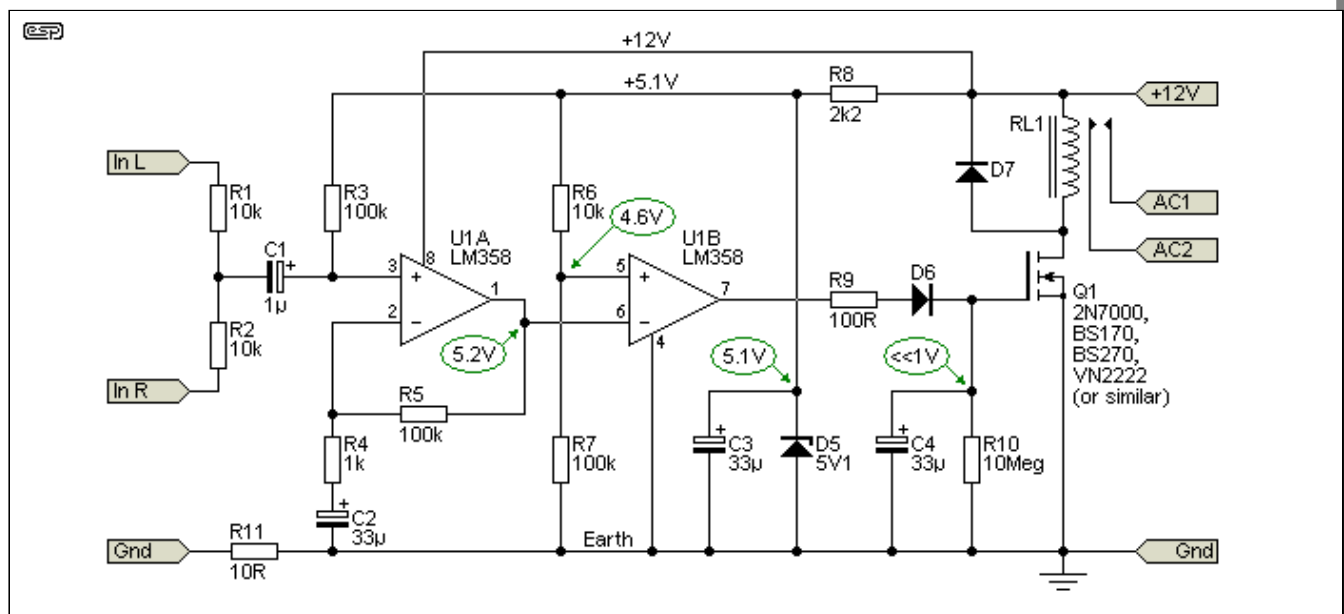
switching time is slow, and this will cause problems and possible damage to the SSR and/or the following circuitry. An electromechanical relay will hold in until the current falls to a low value, and will release at close to normal speed once the release threshold has been reached. Since the circuit (subwoofer amp for example) will be idle because there is no signal, the relay will easily break the small residual current and power down the controlled circuit.

There is also an option to use the circuit as a sound activated switch. By using an electret microphone capsule at the input, the circuit will detect noise above a preset threshold and turn on the relay. This can be used to turn on a light, activate a video recorder, or anything else you wish.

## Description

The switch detector unit is shown in Figure 1, and uses an LM358 dual opamp, and a handful of other parts. The relay switching device is a MOSFET, selected because of the almost infinite input resistance. The 2N7000 shown is recommended because it has a threshold voltage of less than 3V and is fairly cheap, but virtually any MOSFET will work just as well, even if the gate threshold is a little higher. Alternatives are BS170, BS270, VN2222, etc. An MTP3055 can also be used, as shown originally in this circuit. Note that if the MOSFET's gate threshold voltage is too low, it may remain on permanently. Use two diodes in series in place of D6 to add an additional 0.65V. The opamp should be an LM358 (or similar) as shown. While you can use various others, the outputs of most common opamps cannot reach zero volts - the worst case minimum is about 2V. The LM358 is recommended because its output voltage goes to zero volts.

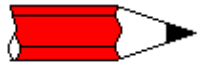
The circuit uses a reference voltage line (R8, D5 and C3, nominally +5.1V) to bias the opamp inputs and provide a comparator reference voltage. Since the same supply is used for both, regulation is not required as any variation will be applied both to opamp input and comparator, so the two will track properly over a wide voltage range. Voltages shown are typical - they could vary depending on the actual supply voltage. 12V and 5.1V as shown are nominal, and may be slightly different.



**Figure 1 - Audio Detector And Switching Circuit**

A signal feed is taken from both Left and Right channels via R1 and R2 (leave out one input resistor for a mono source such as a sub-woofer). This is amplified by 100 by U1A, and the output is supplied to the comparator U1B. When the amplified signal exceeds the comparator threshold of about 0.5V below the reference level ( $\sim 4.6V$ ), the output of U1B goes high momentarily, and starts charging C4. After a few cycles, Q1 turns on and energises the relay. Verify that the voltage at the output of U1A (pin 1) is more positive than the voltage at the non-inverting input of U1B (pin 5).

Should it be found that the circuit is too sensitive, increase the value of R6 - this makes the comparator less sensitive, so more signal will be needed. Likewise, to increase sensitivity reduce the value of R6 - use a 20k trimpot for a useful sensitivity range. The comparator is triggered by negative transitions from U1A, so the output of U1A has to fall *below* 5.2V for the comparator to produce a high output. Make sure that the voltage at the MOSFET gate is no more than perhaps 100-200mV or so when the output is supposed to be off. If the MOSFET turns on even very slightly, the relay may not release after the timeout.



Note that the above circuit is intended for signal levels, *NOT* speaker level. If the signal to be switched is speaker level, it must first be attenuated so that even at full power, no more than about 2 Volts is applied to the circuit inputs. High signal levels may destroy the input circuit of the opamp. See Figure 4 for a modified version of the input stage for speaker level signals.

After the audio signal is removed, it will take some time for C4 to discharge through R10, and after about 5½ minutes Q1 will switch off again, and disconnect power from the amplifier. The time can be varied by changing either C4 or R10 - increase either to make the time longer or vice versa. Note that even small amounts of leakage on a circuit board may reduce the time delay, so the junction of the gate of Q1, anode of D6, C4 and R10 can be 'skyhooked', or suspended in mid-air. Because C4 will most likely be an electrolytic type, make sure that you use a low leakage part or the delay time might be much shorter than expected. Don't use a tantalum caps in the circuit, as they are the most unreliable caps ever produced, and I never recommend them for anything.

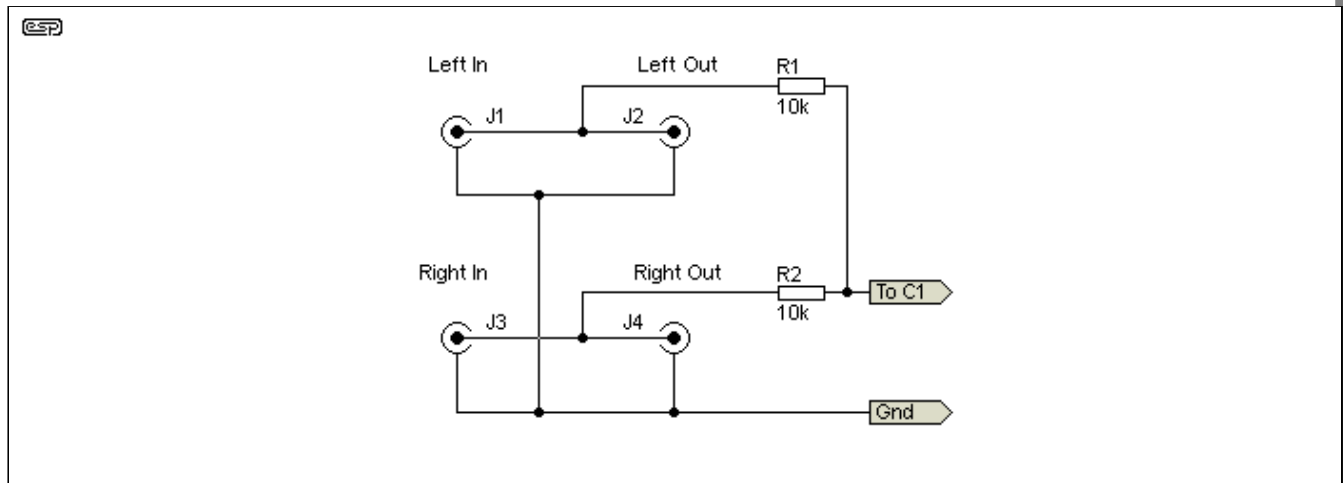
The diodes can be 1N4148 or 1N4004 types, whichever is the easiest to find (or is already at hand). They are not critical, so other types will be just as suitable (I shall leave this to the reader).

When I tested the circuit, I tried a 100nF cap to the gate (instead of 33μF), and no discharge resistor. I got tired of waiting for the relay to release, so it is possible to get very long (but unpredictable) times even with small capacitance values. As noted above, the gate voltage *must* fall to less than 1V - ideally zero. Be careful, because even a tiny leakage current from the supply to the gate circuit may prevent the circuit from turning off the relay. The impedance is very high, and that's why I suggested using the 'skyhook' approach above. Fortunately, most electrolytic capacitors have some leakage, so C4 will discharge itself ... eventually.

If this unit is to be used to power existing equipment and will be in its own case, use the input circuit shown in Figure 2 to allow the signal to pass through the switching unit. There are no electronics in the signal path, so the signal will not be impaired. The 10k input resistors may introduce some crosstalk if the drive amp has high output impedance, but this is unlikely to cause a problem with the majority of preamps. If you have a valve preamp with an output impedance of

more than 1k Ohm, you might want to use only one input and leave the other disconnected.

An alternative is to increase the value of the resistors (R1 and R2), but bear in mind that this will reduce the system's sensitivity. It might be necessary to increase the gain of U1A (reduce R4) to compensate, as well as install a 20k trimpot in place of R6 (Figure 1) to allow you to set the sensitivity.



**Figure 2 - Pass Through Input Circuit**

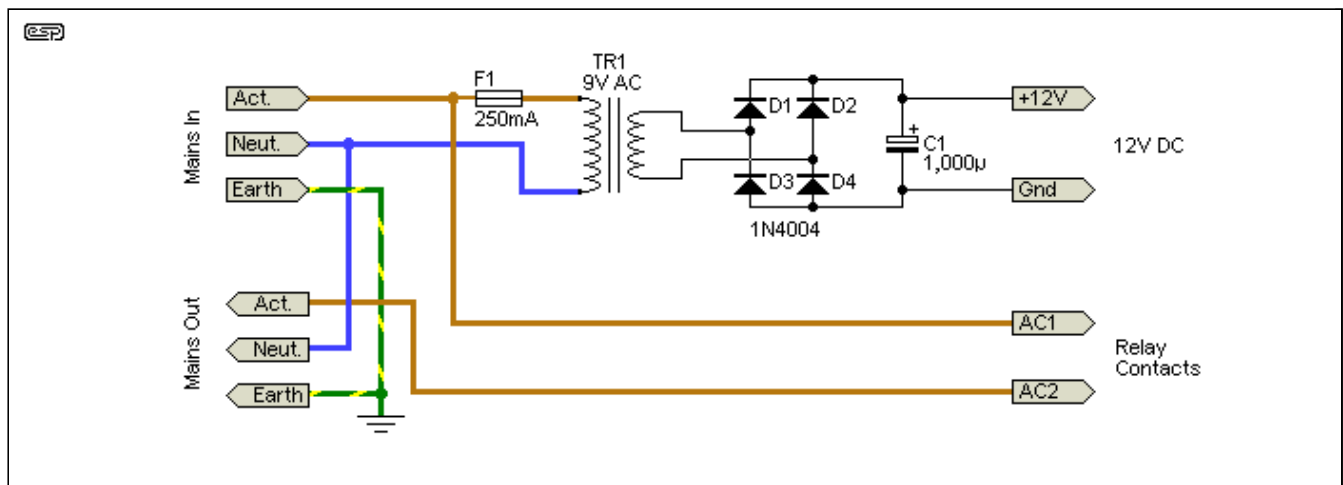
**Note:** The point marked 'C1' on this circuit connects to C1 in Figure 1. R1 and R2 in this diagram are the same as in Figure 1 and not an addition.

## Power Supply And Mains Switching

The power supply for this circuit must be on permanently (predictably), so I suggest that a quality transformer be used to prevent the possibility of fire or other failure. This point cannot be overlooked, as a cheap tranny may not have the build quality of a good one and may pose a genuine hazard. A transformer with an integral thermal fuse provides added peace of mind.

Having said this, the supply is very simple. It does not need to be regulated, and the detector will work quite happily from 9 to 15 Volts. A plug-pack ('wall-wart') supply is quite suitable (including switchmode types), and most of these are well protected against internal failure. Since it expected that a 12V relay (coil voltage) will be the most commonly available, I suggest a supply of 12V. The relay must have contacts rated at the full mains voltage (240 or 110 V AC, as appropriate), and with sufficient current rating to suit the amplifier being powered. Typically a 5 or 10A relay will be more than sufficient, but bear in mind that some large power amps draw a massive current when switched on, so make sure that the relay is capable of high surge current (most are, but if you are not sure, ask your parts dealer for advice).

The bridge rectifier shown can be made using 1N4004 diodes, as the current is low and standard diodes will be quite satisfactory. A 1A bridge rectifier will be more than sufficient to power the circuit.



**Figure 3 - Power Supply And Mains Switching**

All mains wiring must be done using approved mains cable (do *not* use normal hook-up wire), and any exposed terminals must be securely shrouded using heatshrink tubing or similar. Do not use insulation tape, as this has a tendency to come undone and leaves sticky stuff all over everything. Use an approved mains outlet if the unit is to be used as a peripheral device to existing equipment. In this case, see Figure 2 for pass through connector wiring.

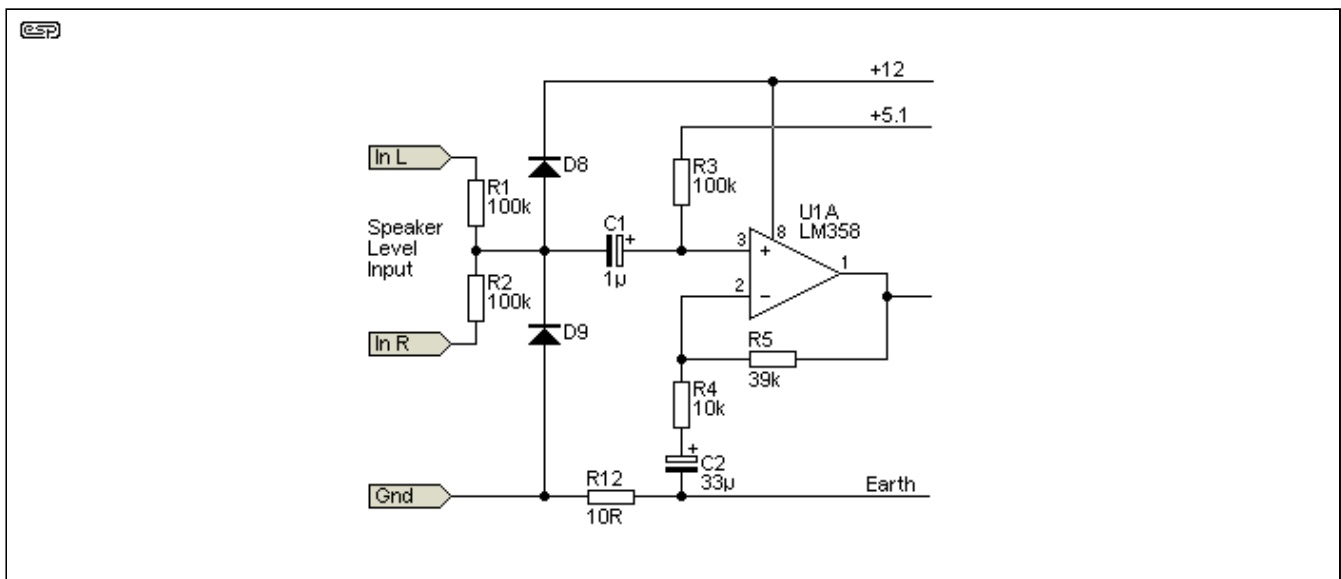
Make sure that mains wiring is properly separated from input wiring and other low voltage wiring. The relay must be mounted securely, and well away from the signal input wiring. The terminal marked 'A' is the active/ live/ hot mains lead, and as seen goes to the transformer (via the fuse) and to the normally open switching contacts on the relay. The neutral lead is connected to the transformer, and to the outlet (lower three connections on the left of the diagram). The earth (ground) must be connected to prevent electric shock, and is connected to the chassis (assuming a metal case). If a plastic case is used, the earth should be connected to the mounting bracket of the transformer (assuming a 'open frame' type).

The secondary circuitry (after the transformer) does not need to be connected to earth, however it is far safer to do so. The 10 Ohm resistor (R11 in Figure 1) is designed to prevent any earth loop hum, so connecting the secondary circuitry to mains earth will not cause a problem with hum or other noise.

The other alternative is to use a *good quality* switchmode supply, typically in the 'wall transformer' style. These are readily available from most electronics outlets, but steer clear of any that don't have *genuine* approvals from the appropriate regulatory agency where you live - e.g. CE, UL, FCC, CSA, Veda, AS (and C-Tick), etc. A certain auction site has plenty on offer, but many are not approved (despite the claims made) and some are positively dangerous. The output needs to be 12V DC, at a current of 100mA or more. Since it will be on permanently, choose one that has a very low idle power (less than 1W).

## Speaker Signal Powering

If the unit is to be operated by detecting speaker level signals, some changes are needed to the front-end circuitry. The level must be reduced, and protection is needed for the opamp input, otherwise the high signal level would damage the opamp. Figure 4 shows the needed changes.



**Figure 4 - Input Circuit For Speaker Input**

The diodes prevent high level signals from causing damage, and the signal is attenuated and current limited by using 100k input resistors. The opamp is run with a gain of five - increase the value of R5 to increase the gain if needed. Diodes are 1N4148 or 1N4004. With the circuit set up as shown, a speaker level of about 200mV on each speaker line (equivalent to 5mW into an 8 ohm speaker) will trigger the circuit.

The supply connections are as shown, and the opamp output goes directly to pin 6 of U1 as before.

### Sound Activated Switch

There are a few applications where a sound powered switch is required. This might be to turn on a light when sound is detected, which may be more convenient than using a passive IR (infra-red) or microwave motion detector. There have been 'gimmick' products over the years that turn lights on and off based on hand claps, but this is not feasible with the circuit shown. This is intended purely to turn on a light (or anything else) when noise is detected above the threshold.





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Page Created and Copyright © 05 Dec 1999./ Updated May 2014 - added typical voltages to schematic, changed recommended opamp to LM358./ Jul 2018 - added sound activated switch option./ Feb 2021 - included description of Fig.5 as 'auto-mute'.