

Elliott Sound Products

The Audio Pages

Project 107

Phase / Polarity Inversion Switch

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Introduction

There are a few applications where it is useful to be able to reverse the polarity of a signal, and while a simple opamp inverter can be used to provide the inverted output, this method requires a double throw switch and 3 wires. It is possible to accomplish the same thing using a single pole switch, and since one connection goes to signal earth (ground), effectively only one wire is needed for each reversal circuit.

This method also maintains the same number of opamps in the circuit at all times, and although the likelihood of hearing the difference is minimal, there is something to be said for keeping the circuitry as straightforward as possible, whilst not changing the number of active components in the circuit.

This project is useful if you wish to experiment with absolute phase, or are just interested in the possibilities of a polarity reversal circuit. In the case of absolute phase, many studies have shown that there can be an audible difference between polarities, but be aware that there is no way to really know for certain what the original phase was. Typical microphone methods mean that in some cases the polarity may be reversed compared to the way you may hear the same sound live. As a result, there is not necessarily a 'correct' polarity, since there are so many different ways that a signal may be processed before you hear it. Just because you hear a difference, this does not mean that one signal polarity is 'right' and the other 'wrong' - it is more likely that both are wrong in different ways.

Description

The more conventional method is shown in Figure 1, and is simply an inverting buffer with a switch. Simple, and does exactly what is needed, but as noted above requires a double pole switch and 3 wires for each channel. While there is no requirement to have an especially low source impedance, it is highly recommended that it be as close as possible to that used for the inverter (typically 100 Ohms).

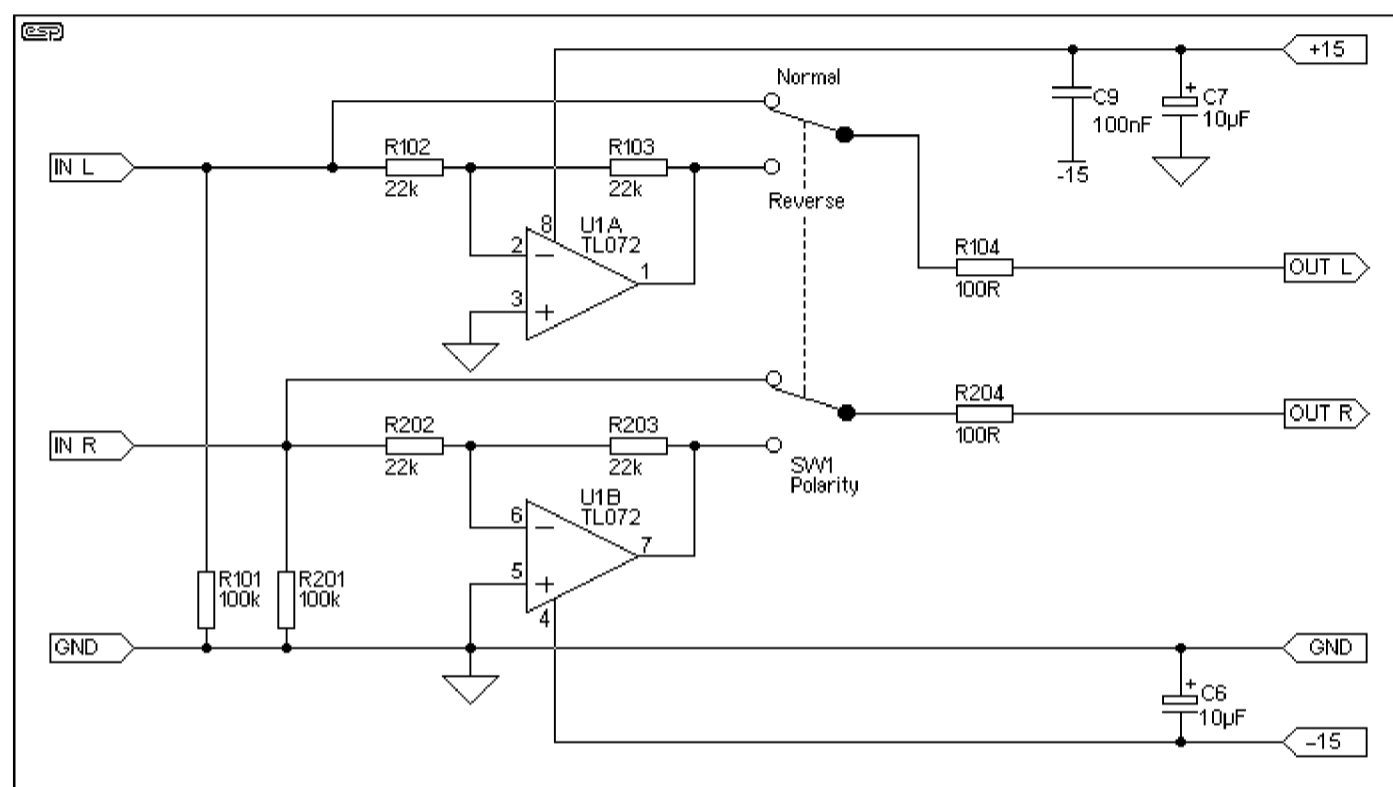


Figure 1 - Conventional Phase Inversion Circuit

By selecting the normal output or that from the inverter, the output polarity is inverted (or shifted by 180° if you prefer). The additional loading on the normal output is negligible, but it must be low impedance to prevent the normal and inverted signals from having different output impedance, and therefore possibly different levels.

The input resistors (R101, R201) are to ensure that the opamp is biased even with no input connected. Also, note that the circuit (and the one in Figure 2) is DC coupled, so if there is any risk of feeding DC into the following power amplifier, then a capacitor should be used at the outputs of each channel. To ensure flat response down to low frequencies, a 10uF bipolar electrolytic may be used in series with each output.

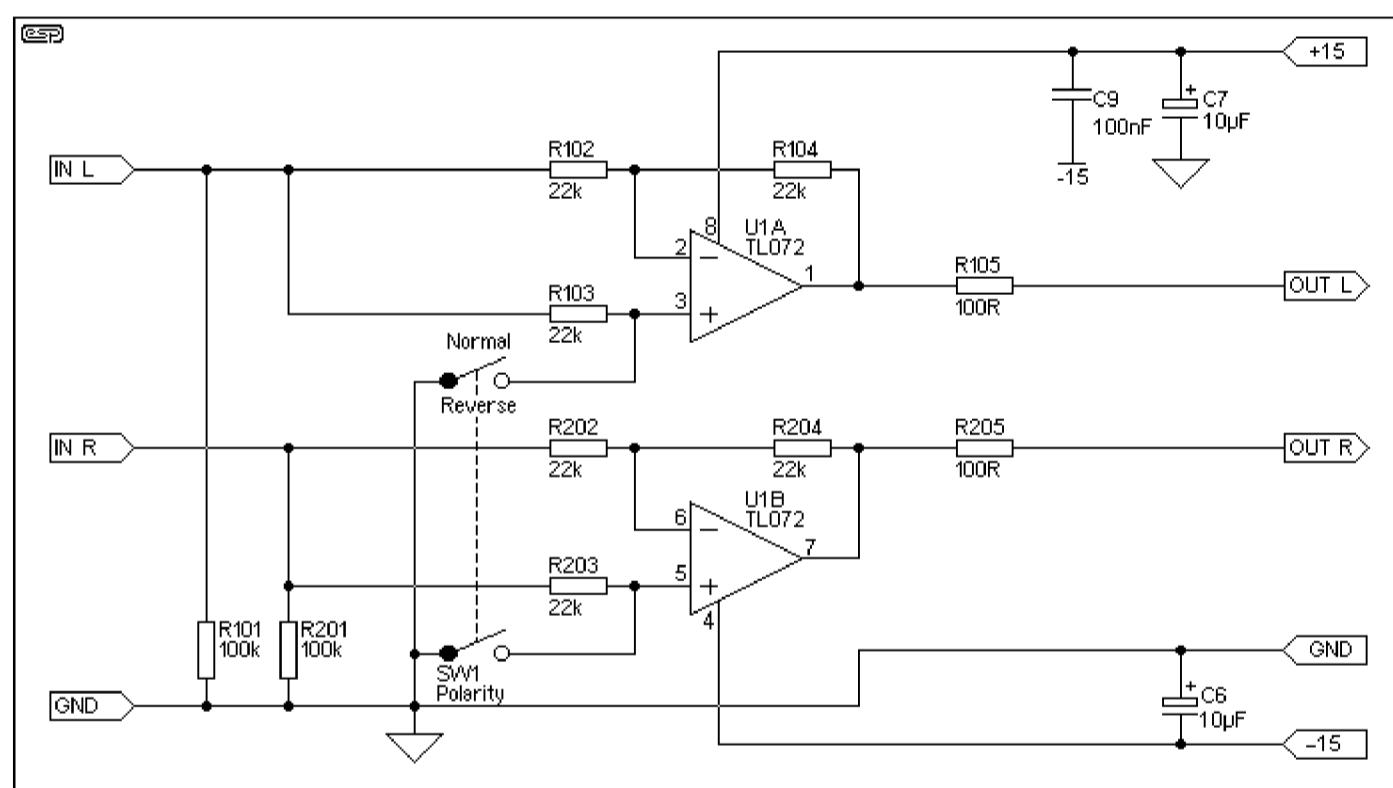


Figure 2 - 'Improved' Phase Inversion Circuit

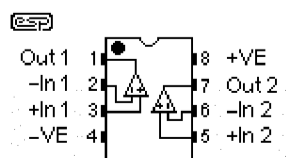
This circuit has similar constraints to the previous version - source impedance should be low, and in this circuit the impedance changes when the switch is opened or closed. With the values shown, Z_{in} will be very high (typically >1M Ω) with the switch open, and 11k with it closed. This can be increased if desired by increasing the value of all resistors. A maximum of 100k is suggested to keep noise to the minimum, and to ensure that stray capacitance does not cause a problem (see construction notes below for more detail). Source impedance should be no more than around 220 Ω if you use 22k resistors, or about 1k if you use 100k resistors. This gives an error of a little under 0.15dB. For less error between normal and inverted, use a lower source impedance.

The primary benefit of the second circuit is that the opamp remains in circuit all the time, and the switching is simplified. While this may not be important for some applications, it is useful nonetheless, and the circuit also shows the tremendous versatility of opamps.

Construction

Construction is not critical for either version of the circuit, but if you choose to use very fast opamps you may get instability if the supplies are not well bypassed, or if you have a layout that is not optimised for high speed devices. It is unlikely that boards will be made available for this project, because it has limited appeal, and is so easy to build on Veroboard or similar prototype board.

The version shown in Figure 2 has one additional constraint - the wiring to the switch should be as short as possible to minimise capacitance. Any appreciable capacitance will cause the circuit to act as a phase shift network at high frequencies, which although generally inaudible is considered by some to be unacceptable. As little as 10pF at the non-inverting inputs will cause a phase shift of a just under 4° at 20kHz (for 22k resistors), so keep wiring short and away from the chassis to minimise the capacitance and resulting phase shift. Use of higher resistance than the 22k shown will make the circuit's sensitivity to stray capacitance worse, while lower resistance will improve matters (at the expense of loading the source).




The standard pinout for a dual opamp is shown on the left. If the opamps are installed backwards, they will almost certainly fail, so be careful.

The suggested TL072 opamps will be quite satisfactory for most work, but if you prefer to use ultra low noise or wide bandwidth devices, that choice is yours.

Testing

Connect to a suitable power supply - remember that the supply earth (ground) must be connected! When powering up for the first time, use 100 ohm to 560 ohm "safety" resistors in series with each supply to limit the current if you have made a mistake in the wiring.

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