

# THE IMPORTANCE OF ABSOLUTE PHASE IN AUDIO GEAR

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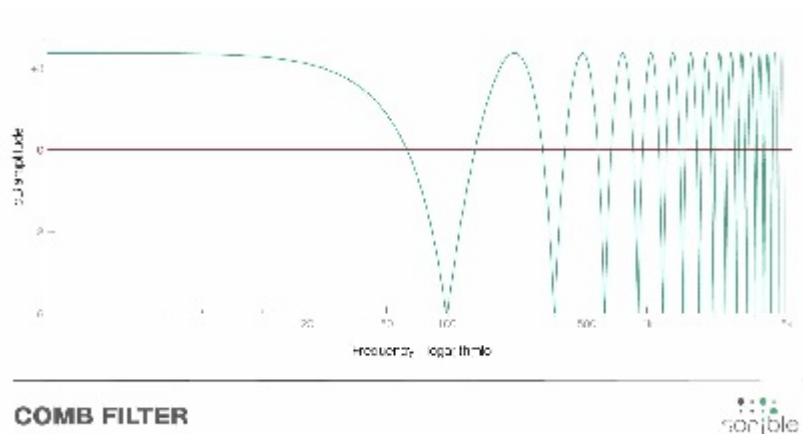
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In audio gear, whether for professional or consumer use, that does not have variable phase shift it is important that all inputs and outputs be in phase. This includes intermediate send and return loops. This is important because some signals reaching the speakers are unintentionally out of phase with other parts of the signal, cancellations and reinforcements may occur.

Sometimes one gets a comb filter effect in the frequency response such as shown to the right.

This is critical even in intermediate loops. Because the loop output is sometimes used as a tap for some intermediate use. While the loop return may be used as an input when a user only wants to use part of the product. It cannot be assumed that loops<sup>1</sup> will only be used as intended.



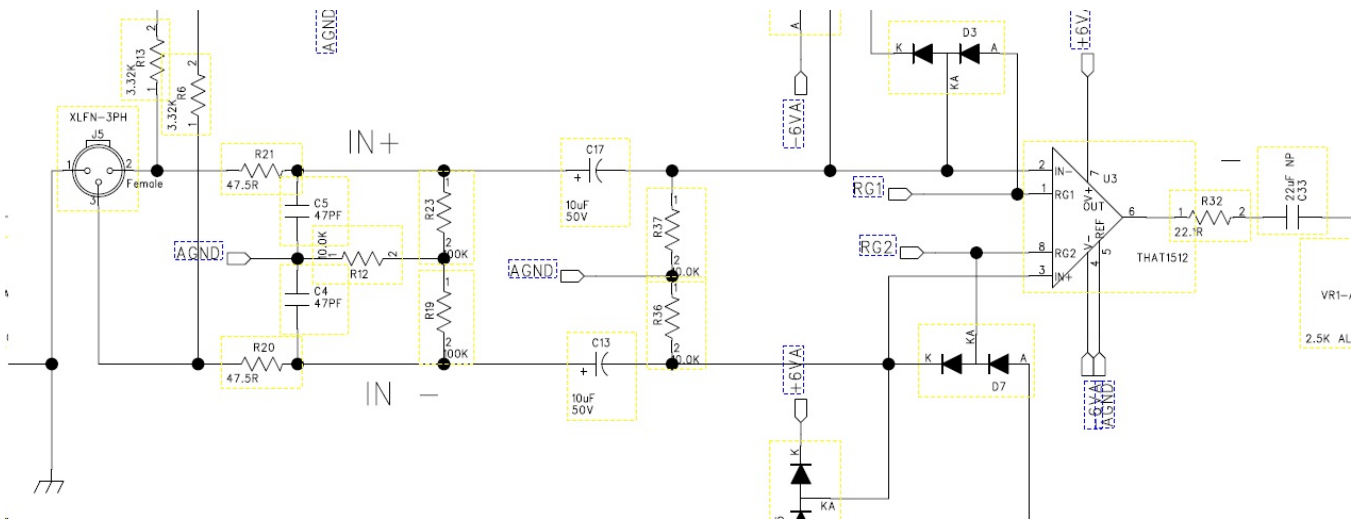
To keep track of the phase through a product, the writer puts “+” and “-“ signs along connections in the schematic.

To keep track of this in a design, referring to the following schematic, using the microphone input of the Radial Voco Loco as an example, the XLR input pin 2 is considered the “+” phase and pin 3 is the “-“ or inverted phase.

It can be seen the Pin 2 input is feeding the IN- pin on U3 which results in inverted phase on the IC output indicated by - sign. The reason for this inversion was that it was found that when the entire product was designed with the + input feeding IN+ the loop send was out of phase. Swapping the inputs of U3 was the easiest thing to do to bring the loop send into phase. It must be noted that U3 is a special microphone pre-amp chip, a THAT1512, and not a standard opamp. This use of the +/- symbols made it easy to predict the phase.

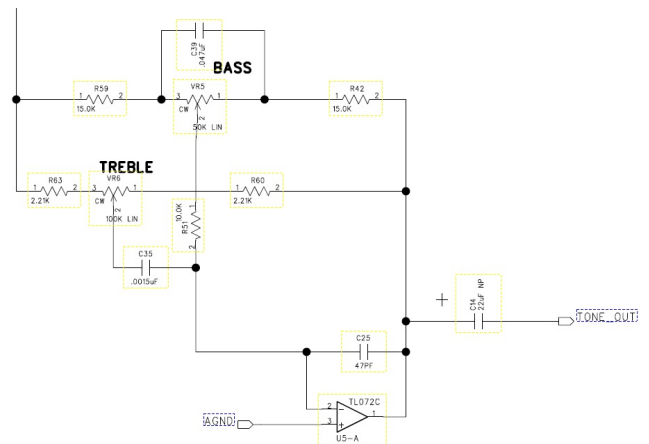
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<sup>1</sup>These could be tape monitor loops or effects send and return loops.

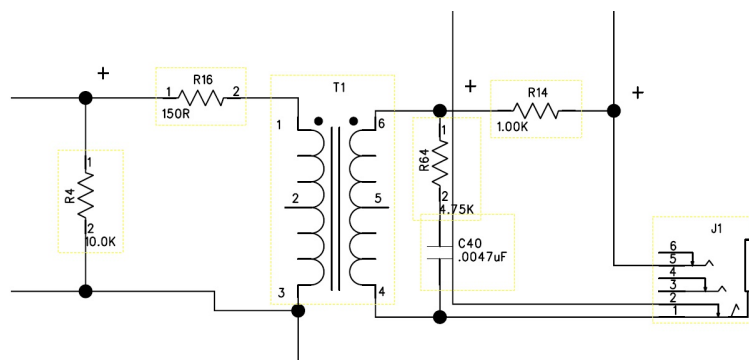


In doing this sort of thing we try not to say the - phase is 180 degrees out of phase. That is because this describes a time delay. In this case the peak of the - phase is occurring at exactly the same time as the + phase. Except that the signal is inverted. What we should say is that we have an in phase signal and an inverted signal.

The following stage is a standard Baxandall tone control with bass and treble controls. Though in pro audio we avoid such consumer grade terms and refer to these as LF and HF EQ. It is to be noted that the signal enters into the CW (clockwise) ends of the controls. The wipers connect to the - inputs of the opamp which means this is an inverting circuit. Because the signal entering from the previous circuit was inverted, this inverting circuit puts the signal back into phase as indicated with a + sign in the TONE\_OUT line.



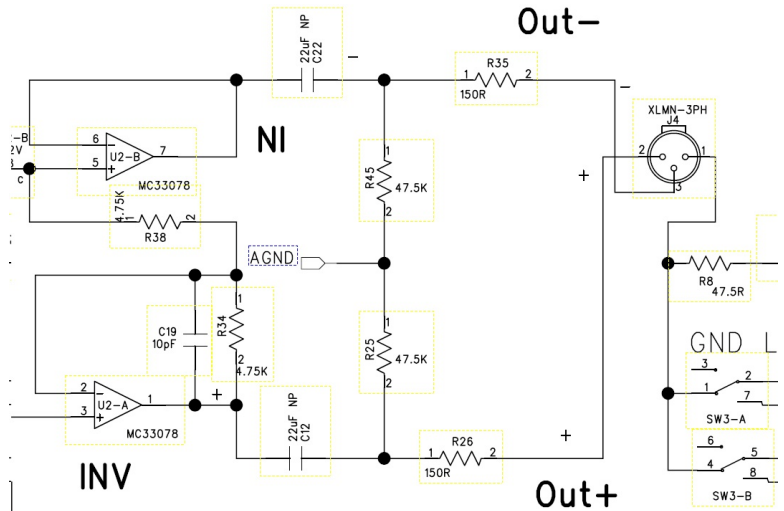
Here in the effects send circuit we always show the switches in the OUT position. In this case for a phase switch it is the position where the signal stays in phase. Thus there are + signs on both sides.



On the transformer there is a dot at one end of each winding's symbol. If the dots are aligned, the phase will stay the same. Thus by feeding a + phase signal into pin 1 with the dot and we use the pin with the dot on the secondary as the "hot" lead,

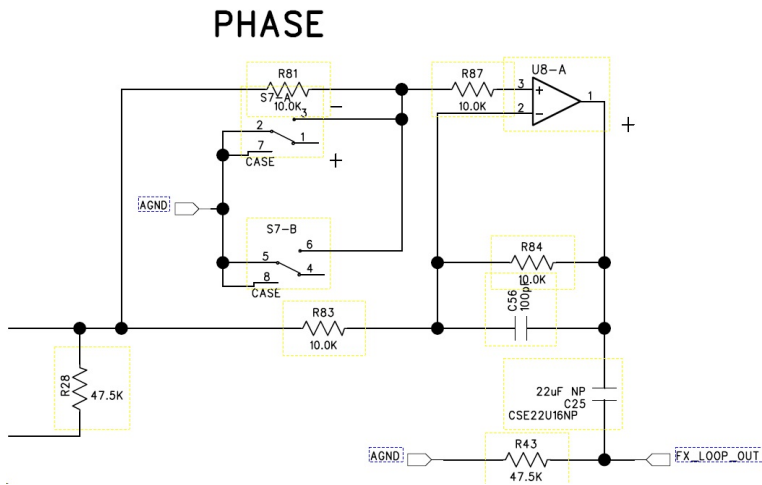
phase will be maintained through the transformer. Or if pins 4 and 5 were reversed then the output signal would be of inverted phase. But here we wanted phase to be maintained. These dots or some other indication may or may not be on the actual transformer. The spec sheet may have to be consulted to avoid accidentally reversing phase.

For the output stage you would normally expect the + phase to come out to the upper device and the - to the lower. However it did not turn out that way. While a phase inverting stage could have been placed ahead of the output, this adds extra cost, noise and distortion. So in this case pins 2 and 3 of the XLR output connector were merely swapped to bring things back in phase. Pin2 is always the + phase output on a balanced line. The criss crossing of the lines seems clumsy but it does not hurt anything. Each device does not care of it is in phase or of inverted phase.



Therefore, go through the schematic of the Voco Loco and other products to see how the phase was marked on lines and what sort of circuits invert and do not invert the signal.

Here is a handy circuit that is in the Bassbone OD.



Normally 2 op amps are used to produce in phase and out of phase signals to chose from in making a phase inversion switch. In this circuit when the phase switch is in the rest position, when open, the phase of the output is in phase with the input. This is indicated with the + sign on that pin of the switch. When the switch is closed, the opamp becomes a phase inverter as indicated on the activated position with a - symbol. The two gangs of the switch are in parallel merely

because we had a spare gang on the switch. With both in parallel the switch will last longer before it becomes noisy from corrosion. It is best if all 4 resistors are the same value and 1% tolerance. The 47.5K resistor on the input is there just to give a ground path for the bias currents of the op amp inputs and to set a ground reference. The output capacitor and resistor R43 are there to prevent a thump when the switch is pressed as with some op-amps there could be a DC

level shift. Pins 7 and 8 on the switch are the metal switch body and are grounded so that hum will not be picked up in the switch itself.

The point of this document is to give people an idea that absolute phase is important and to provide a means to assist a designer to put notation on a schematic to help them maintain phase on all the connections to the outside world. In the pro world, people will curse the designer that allowed any inputs or outputs to be of opposite phase. If they want something to be inverting phase they will use a phase invert switch when needed.