A Comparison of Ladder, Series, and Shunt Type Stepped Attenuators.

For the discerning audiophile, stepped attenuators offer distinct advantages over common potentiometers. This is due to their use of precision discrete resistors and the purest method of signal attenuation: fixed-resistor voltage dividers. Precision resistors have better low noise characteristics than the typical carbon or cermet resistor elements used in pots.

With stepped attenuators, each switch position is for a precisely calculated voltage divider, so front panel calibration markings represent actual signal levels.

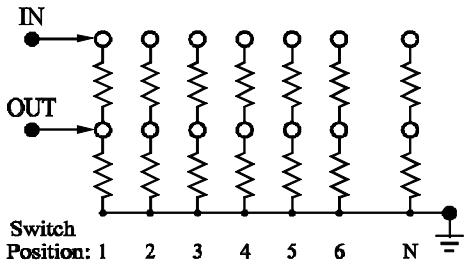
The wearing (rubbing) parts in stepped attenuators are switch contacts, not resistive elements with wipers sliding on them as in potentiometers. Pots used as volume controls can become "scratchy" sounding due to wear.

The channel-to-channel tracking specification for stereo pots, even very expensive ones, is typically 5% to 20%. By using stepped attenuators, you can easily achieve levels matched to within 1% or 2%.

The three types of stepped attenuators commonly used by audiophiles are Ladder, Series, and Shunt.

Ladder Type Stepped Attenuators

In a ladder type stepped attenuator, the rotary switch is used to select an input-to-output resistor and an output-to-ground resistor, forming a set voltage divider for each switch position. Having only two resistors active at any one time results in low resistor noise and makes it is easy to achieve very good channel-to-channel signal level matching.



The total series resistance of each set of resistors is equal, so the signal source connected to the input of the attenuator always sees the same load impedance. Ladder attenuators are an excellent choice for high end audio applications.

advantages:

+ low resistor noise.
+ easy to match signal levels in multiple channels.
+ source equipment always sees same impedance.

disadvantages:

– two switch contacts in signal path.
– twice as many resistors required (compared to series and shunt types).
– requires more expensive multi-wafer switches.

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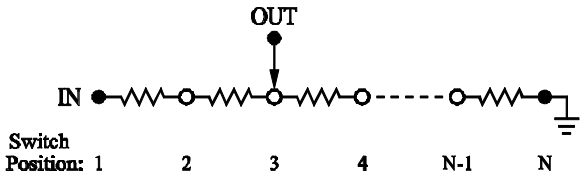
Series Type Stepped Attenuators

As its name implies, the series type stepped attenuator is simply a *series* of resistors forming one "long" voltage divider. The rotary switch is used to select where, in this voltage divider, the output will be. Electrically, it is just like a potentiometer with built-in mechanical detents.



Like a potentiometer, the input impedance of a series type stepped attenuator is fixed, so the signal source sees a constant, non-varying impedance.

advantages:

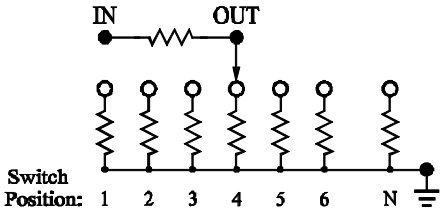
+ only one switch contact in the signal path.
+ fewer parts than ladder or shunt types.
+ lowest cost of all three types.

disadvantages:

– the resistor noise generated from each series resistor is additive.
– the individual resistor tolerances are additive.

Shunt Type Stepped Attenuators

In a shunt type stepped attenuator, a voltage divider is formed with one “constant value” input-to-output resistor, and one other resistor selected by the rotary switch position.



Shunt attenuators vary the load on the signal source. To minimize this, one wants to choose a large value input-to-output resistor. This can conflict with the need to have a small input-to-output resistor so that the attenuator will pass the maximum signal level at high volume settings (and have less effect on high frequency signals).

This type of attenuator is best used with low impedance signal sources, thereby minimizing the effects of the attenuator’s own varying input impedance and allowing a smaller value for the input-to-output resistor.

advantages:

+ only one switch contact in signal path.
+ fewer parts (lower cost) compared to ladder type attenuators.

disadvantages:

– varying input impedance requires consideration of the actual circuit and/or equipment it will be used with so as to avoid overloading the input signal source equipment.

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