# Wideband Switched Attenuator

## Background

It is often required that a known degree of attenuation be available to intersect between a source and load. The commonest example is a signal generator output and the input of a receiver when making measurements of sensitivity.

The attenuator offered by Electro-Resales provides accurate 1db steps of attenuation from 0db to 20db and has been designed to match a 50Ω system. Frequency response exceeds 100 MHz and has shown to be accurate to 150 MHz

## Attenuation Math

While it is not necessary to understand this section (Or even read it) knowing the how's and why's of attenuation is very useful. Attenuation is usually expressed on the decibel scale. This scale allows for both power and voltage ratios to be expressed in db. This is determined mathematically from:

$$db_N = 20\ x\ \log_{10}\frac{Vout}{Vin}$$

So, if the signal voltage in is 1.90 V, and the measured voltage at the load is 0.63, using the equation above gives;

$$db_N = 20\ x\ \log_{10}\frac{0.63}{1.90}$$

$20\ x(-0.4794)$ = -9.6 or approx. -10db

The calculation works in either direction as the equation can be used to determine gain or attenuation in a circuit.

## Circuit Details

The design of the attenuator has been made using 50Ω as the circuit impedance as this is common impedance often met in radio work. For audio 600Ω is typically used.
The design was determined using a Thevenin* equivalent circuit to reduce design complexity, and a mixture of π & T networks were combined to achieve the most accurate attenuation levels and also to allow common value resistance to be used where possible and maintain impedance across the network. This insures the attenuator is balanced and can be inserted either way into the circuit without damage or loss of capability.

Please also refer to the schematic included at the end of this document to get a better view of this design.

## How to use

The attenuator has 5 double pole toggle switch that allow a number of different attenuation combinations to be attained. The BNC jacks allow the attenuator to be inserted into circuit with minimal disruption, and as previously mentioned there is no in or out as such, so the device has no polarity.

The switches bring in 1, 2, 2, 5 & 10db attenuation levels, meaning that when all switches are in the up position a total attenuation of 20db is achieved.

Typically in use the switches are initially set so that only a 10db level is being applied, this allows the reduction or increase in attenuation to be achieved.

Please also note that the attenuator is not intended to be used to reduce transmitter outputs, use in such applications will cause irreparable damage to the device, and its intended use is with low power signals such as those coming from test instruments.

## Measured attenuation levels

The attenuator was measured against a commercial unit of similar specifications from RLC. This is typically the best way to determine the accuracy of an attenuator. A known frequency of known voltage peak was used as shown below.

Frequency = 10MHz

V peak = 1.90 Volts

| | 1db setting | 2db setting | 5db setting | 10db setting |
|---|---|---|---|---|
| **ER Attenuator** | **1.1db** | **2.05db** | **4.98db** | **9.6db** |
| **RLC Attenuator** | **1.1db** | **2.05db** | **4.98db** | **9.6db** |

Values were obtained using the calculations given earlier, as can be seen no variation was seen between the unit from Electro-Resales and one from RLC.

# The small Print

## DISCLAIMER

**Any person who constructs or works on electronic equipment may be exposed to hazards, including physical injury, the risk of electric shock or electrocution.. These hazards can result in health problems, injury, or death. Only qualified persons who understand and are willing to bear these risks themselves should attempt the construction of electronic equipment. By purchasing this item, the buyer acknowledges these risks.**

**There is a risk of electric shock, electrocution, burns, or fires that is inherent in the construction and use of electronic equipment. By purchasing this item, the buyer acknowledges these risks.**

**IN NO EVENT SHALL THE SELLER BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY NATURE including, but not limited to, property damage, personal injury, death or legal expenses. Buyer's recovery from Seller for any claim shall not exceed the purchase price paid by Buyer for the goods, irrespective of the nature of the claim, whether in warrant, contract or otherwise. By purchasing this item, BUYER AGREES TO INDEMNIFY, DEFEND AND HOLD SELLER HARMLESS FROM ANY CLAIMS BROUGHT BY ANY PARTY REGARDING ITEMS SUPPLIED BY SELLER AND INCORPORATED INTO THE BUYER'S PRODUCT.**

# Electro-Resales

## Schematic