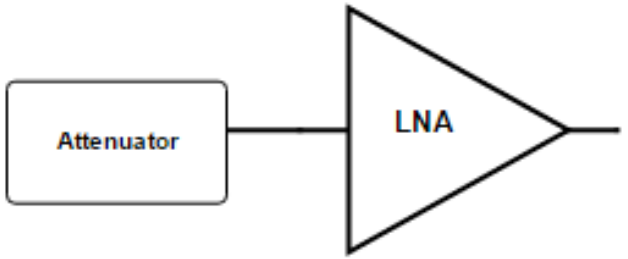
RF Components and Basic Concepts

1.17 - RF Attenuator

What is an attenuator?

- As the name implies RF attenuators reduce the level of the signal.
- This attenuation may be required to **protect** a circuit stage from receiving a signal level that is too high.
- An attenuator may be used to provide an **accurate impedance** match.
- Most fixed attenuators offer a well-defined impedance, or attenuators may be used in a variety of areas where signal levels need to be controlled.



Types of RF attenuator

- ***Fixed RF attenuator:*** Fixed attenuators have a specific value and this cannot be changed.

- ***Switched RF attenuators:*** Switched RF attenuators are widely used in test systems where **levels may need to be changed**. They are often seen as small boxes with a number of switches, typically with switches for 1, 2, 4, 8, etc dB changes.
- ***Variable RF attenuators:*** variable RF attenuators are normally used in applications where it is necessary to **continuously** vary the level of a signal. Typically they provide a continuous level change by varying an analogue voltage on the input control line. They are normally used where accuracy is not a prime requirement.

Types of RF attenuator

- There are a number of ways in which attenuators can be designed and made

- ***Resistor RF attenuators:*** Resistor attenuators are used to provide fixed levels of attenuation. Levels may be varied by switching in different attenuator sections to provide the levels that are required.
- ***PIN diode RF attenuators:*** PIN diode attenuators are normally used in attenuator designs where a continuously variable level is required.
- ***FET RF attenuators:*** FLike a PIN diode attenuator, FET attenuators use an analogue control voltage to control the level of attenuation.

Resistor RF attenuator

dB = attenuation in decibels

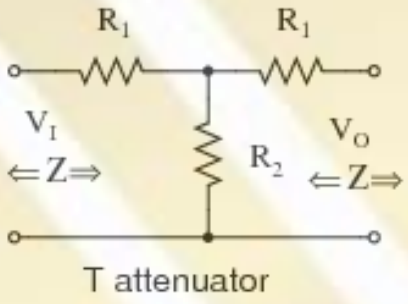
Z = source/load impedance (resistive)

K > 1

$$K = \frac{V_I}{V_O} = 10^{dB/20}$$

$$R_1 = Z\left(\frac{K-1}{K+1}\right)$$

$$R_2 = Z\left(\frac{2K}{K^2-1}\right)$$

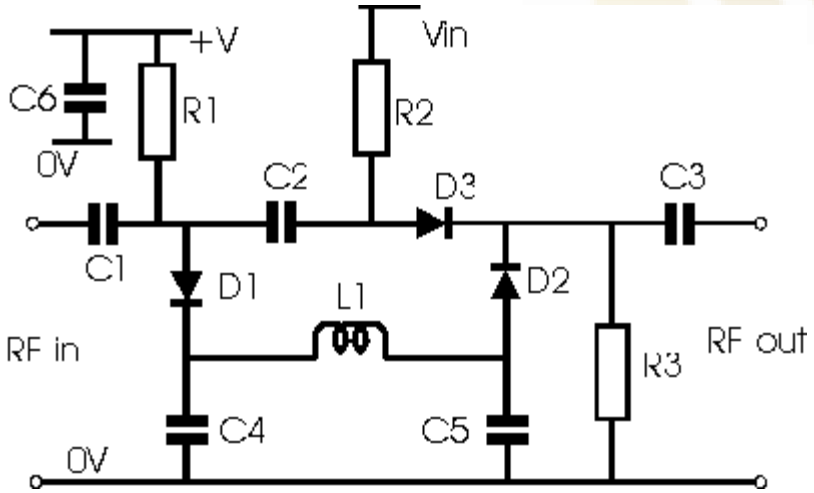


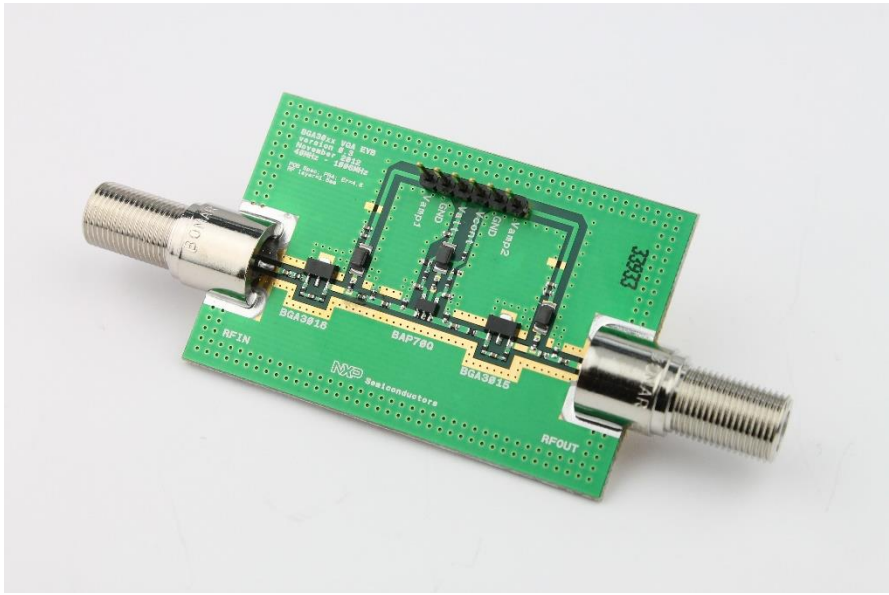
T attenuator

Resistors for T-section			
Z = 50			
Attenuation			
dB	K=Vi/Vo	R1	R2
1.0	1.12	2.88	433.34
2.0	1.26	5.73	215.24
3.0	1.41	8.55	141.93
4.0	1.58	11.31	104.83
6.0	2.00	16.61	66.93
10.0	3.16	25.97	35.14
20.0	10.00	40.91	10.10

PIN Diode RF attenuator

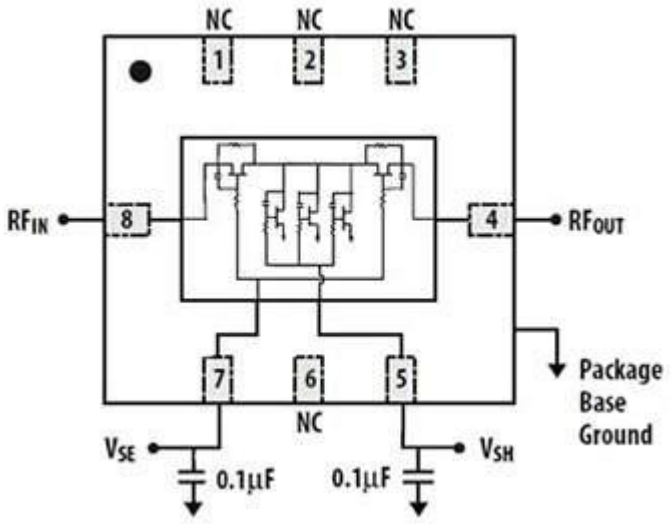
The maximum attenuation is achieved when Vin is at a minimum.

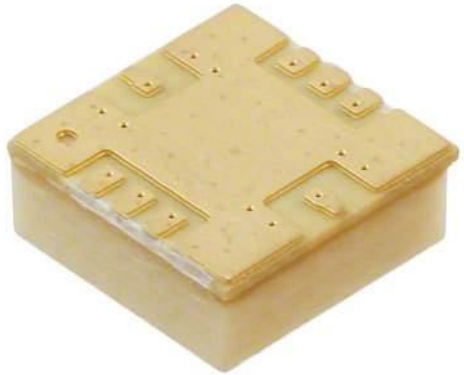




FET RF attenuator

The Avago AMMP-6640 DC to 40 GHz variable attenuator uses tandem pairing of a series FET and a shunt FET to manage signal strength.





RF attenuator specifications

- ***Attenuation***
- ***Attenuation accuracy***
- ***Frequency response***
- ***Impedance :*** RF attenuators will be designed for use in systems with a given characteristic impedance. 50 ohms is the most common, although 75 ohms is also used.
- ***Power dissipation:*** In order to reduce the signal level, RF attenuators dissipate or absorb the unwanted power. For many small signal applications, power dissipation is not an issue, but for other applications where signal levels are higher, it is necessary to ensure that the RF attenuator will satisfactorily be able to handle the power levels anticipated
- ***Mechanical details of the attenuator:*** Aspects such as the size and weight.
- ***Environmental details:*** Many applications for attenuators are for use within conditions such as a laboratory environment. Environmental conditions would not be an issue. However for some applications it is possible that an environmental is required to detail factors such as vibration, temperature, humidity and etc.