AMPLITUDE BALANCE: The maximum amplitude difference between the output ports of a power divider. It is measured in dB.

ATTENUATION: Loss measured in dB, incurred when the signal passes through a dissipative network. Usually refers to amplitude loss.

BANDWIDTH: The width of the pass band of a bandpass filter, which is the difference between the upper and the lower 3dB frequencies.

CENTER FREQUENCY (f_0): This is defined as the arithmetic or the geometric mean between the upper and lower 3dB frequencies defined as,

Arithmetically: $f_0 = \frac{f_l + f_u}{2}$

Geometrically: $f_0 = \sqrt{f_l \times f_u}$

f_0 does not have to be the peak transmission point in of the bandpass filter.

CHARACTERISTIC IMPEDANCE: Measured in Ohms (Ω), the characteristic impedance of a filter is usually equal to L/C, where L is the total series impedance in *henries (H)* and C is the total shunt capacitance in *farads (F)*.

CUT-OFF FREQUENCY (f_c): The upper pass band edge in a Lowpass Filter or a the lower pass band edge of a Highpass Filter, usually this is the frequency where the attenuation is 3dB from the reference level.

DECIBEL (dB): Unit of gain or attenuation, expressed as a ratio of two voltages or power. It is also described as power gain, power loss or performance factor.

$$dB = 10Log_{10}\frac{P_1}{P_2}$$

DIRECTIONAL COUPLERS: Passive four-port RF device that samples an input and/or reflected RF power accurately without any disruption to the transmission line. It can also couple a small portion of the signal on a transmission line so that the incoming power can be continuously examined without excessive loss.

DIRECTIVITY: Measure of the desired signal strength to the undesired signal strength. It is defined as the ratio of coupled output power to the leaked power from the isolated port, and can be calculated as shown in the expression below,

$$Directivity(dB) = Isolation - (P_{Coupled} + InsertionLoss)$$

DISSIPATION LOSS: Energy loss caused by the I^2R loss in the conductors and components of a device. Generally, this loss is inversely proportional to the Q of the structure.

DISTORTION: Modification of the signal, which produce undesirable end effects. These can be attributed to phase, amplitude or delay distortion.

GROUP DELAY: It is the propagation time delay with in the pass band of a filter. Sometimes also called as time delay or envelope delay, it is the derivative of the phase response with respect to frequency in radians (rad). Typically the group delay deviation is specified as the peak-to-peak maximally allowable in the pass band. Group delay is of interest in many digital applications as it can limit the minimum symbol width of a signal for a given BER (Bit Error Rate).

HYBRID COUPLER: A passive four-port RF device that is used to split an input signal into two equal output signals that are 90° out of phase with respect to each other.

INSERTION LOSS (IL): Insertion loss of a device (filter/combiner/coupler) is the loss between the source and the load caused by inserting the device, compared to its absence. It is measured in dB and is the sum of the dissipation loss and the reflection loss.

ISOLATION: Isolation refers to the ability to prevent signal appearing at a port where it is unwanted. In Power Dividers, isolation can be defined as the measure to keep signal at the output ports separate from each other, to prevent cross talk between the ports. In Power Combiner, isolation is the measure to prevent signal at an input port from appearing at any other input ports. The greater the isolation value, lesser is the interference between the signals at one port with reference to another.

LOAD IMPEDANCE: The impedance that is normally connected to the output of the filter, in order to meet the filter specifications. The filter will drive this load.

MISMATCH LOSS: Measure of power loss due to reflections within a device, usually of very small magnitude. This is caused by design and manufacturing limitations.

PASSBAND RIPPLE: This refers to the variation in attenuation in the pass band of a bandpass filter that occurs due to load mismatch. Chebyshev and Elliptical filters are characterized by equal ripple in the pass band where as Butterworth, Guassian and Bessel filters have no ripple. Ripple is measured in dB.

PHASE SHIFT: This refers to the changing of phase of a signal as it passes through a filter. A delay in time of the signal is referred to as phase lag. In normal networks, phase lag increases with frequency, producing a positive envelope delay.

PHASE BALANCE: The maximum phase difference (in degrees) between the output ports of a power divider.

Q or QUALITY FACTOR: A figure of merit of a capacitor or inductor. Defined as the ratio of its reactance to its equivalent series resistance. This is an important parameter in a bandpass and band reject filter. Q for bandpass or band reject filter is given as

$$Q = \frac{f_0}{3dBBandwidth}$$

RELATIVE ATTENUATION: Attenuation measured taking the point of minimum attenuation as the zero dB reference. Relative Attenuation = Attenuation – Insertion Loss.

RESPONSE: This is the term used to describe how a filter reacts to a given input signal.

RETURN LOSS (VSWR): Voltage Standing Wave Ratio (VSWR) is the maximum to minimum value of the standing wave ratio in a circuit due to the mismatch of the source and the load. An ideal conjugate match will produce VSWR of 1. This ratio is related to the Return Loss of the filter, which is nothing but the amount of signal that reflects back to the source due to the mismatch.

$$RL = -20Log_{10}\frac{(VSWR+1)}{(VSWR-1)}$$

Return Loss of 14 dB corresponds to 1.5:1 VSWR.

RISE TIME: The time it takes for a step-function at the output of the filter to move from 10% to 90% of its steady state value on the initial rise.

ROLL OFF: A term used to describe the stop band characteristics of a filter and is also referred to as Slope of the filter. A filter may be specified to have a roll off of 40 dB/octave, which implies that at the second octave, it should be down 80 dB and at the third octave, 120 dB. However, in reality, spurious noise kicks in at around 85 to 90 dB.

SHAPE FACTOR: This is an important factor defined for filters as stated below,

Bandpass & Band Reject Filters: $S = \frac{AttenuationBandwidth}{3dBBandwidth}$

Lowpass & Highpass Filters: $S = \frac{AttenuationBandwidth}{3dBCutoff}$

TIME DELAY: The amount of time it takes for signal to pass through a filter.

WILKINSON POWER DIVIDER: Passive RF device that splits an input signal into equal phase, equal amplitude output signals, or summing like signals to a common port. An exclusive feature of the Wilkinson Power Divider/Combiner is the high port-to-port isolation, so the signal entering in one of the ports will not interfere with signal on the other ports. However, the limiting factors for Wilkinson Power Dividers is that they are not used for very wide bandwidth applications when compared to the reactive splitters and the power dissipation for the Wilkinson Power Combiners is very high.