Power Divider/Power Combiner

Glossary of Terms

Amplitude Balance: The attribute of the output signals of an equal power divider having the same magnitude.

Characteristic Impedance: For a microwave signal in a transmission line, the ratio of the electric field to the magnetic field. Characteristic impedance is related to free-space impedance (377 ohms) and can be calculated based on the physical dimensions and dielectric properties of the transmission line. Most RF and microwave systems are designed to operate with a characteristic impedance of 50 ohms. An advantage of coaxial cable and microstrip is that its characteristic impedance is not frequency dependent.

Coherent Signals: RF or microwave signals exhibiting attributes such that, when input to a power combiner, their wave forms add constructively or subtract destructively. For RF and microwave signals, the attributes of frequency, shape and transmitted information (if present) must be identical for signal coherence to exist.

Combining Loss: Loss of signal due to the vector summing, in a power combiner, of coherent input signals that differ in phase and/or amplitude. The combining loss of coherent signals is proportional to the phase and amplitude unbalance of the signals. Identical coherent signals summed through a power combiner exhibit no combining loss. Coherent signals 180° out-of-phase exhibit total combining loss (zero sum or transmitted power). Non-Coherent signals exhibit a loss equal to 10 log (1/n), where n = number of combined signals. All combining loss is dissipated through the isolation resistors.

Frequency Range: The span of frequency over which the power divider, power combiner maintains all specified performance values.

In-Line Housing: A power divider, power combiner housing having input and output connectors parallel or "in-line" with each other.

Input VSWR: Voltage standing wave ratio measured at the power divider input port with all output ports terminated in 50 ohm loads.

Insertion Loss: In a power divider or power combiner, the total signal reduction within the device from input to output including such factors as theoretical power split, combining loss, mismatch loss and dissipation loss (including conductor and dielectric losses). Insertion loss (in dB) is expressed by the formula:

Insertion Loss = 10 log (P_T/P_I), where:

P_T = Transmitted Power,
P_I = Incident Power

Isolation: In a power divider, the ability to keep signals at the output ports separate from one another; to prevent cross-talk between ports. In a power combiner, the ability to prevent signals at any input from appearing at any other. Achieved through the placement of resistors of precisely calculated values at the ends of transformer sections between port pairs.

Microstrip Circuit: A circuit constructed of thin strip-like transmission lines separated from a ground plane by a dielectric substrate. Commonly used for constructing RF and microwave devices utilizing discrete components attached to the top of the circuit board.

Mismatch Loss: A measure of power loss due to reflections within a device, usually of very small magnitude, and caused by design and manufacturing limitations.

N Connector: A threaded coaxial connector with an air interface suitable for carrying medium power RF & microwave signals. Original design attributed to Paul Neill of Bell Labs in the 1940's. Available in mating jack and plug configurations. Connect finger tight or to 12 in-lb (136 N-cm) if a torque wrench is used.

Non-Coherent Signals: RF or microwave signals differing in frequency, shape or transmitted information such that, when input to a power combiner, their wave forms do not add constructively or subtract destructively but exhibit a loss equal to 10 log (1/n), where n = number of combined signals.

Output VSWR: Voltage standing wave ratio measured at the power divider output port with all other ports terminated in 50 ohm loads.

Phase Balance: The attribute of the output signals of a zero degree power divider being in phase (having no phase difference).

PIM (Passive Intermodulation): The production of unwanted signals in a wireless receive path from the non-linear mixing of two or more high power transmit signals in a passive component. PIM problems may be minimized by careful contact and current path junction design (including connector mating interfaces), use of linear materials such as brass and copper alloys, avoidance of or shielding from ferromagnetic materials, and cleanliness in the manufacturing process.

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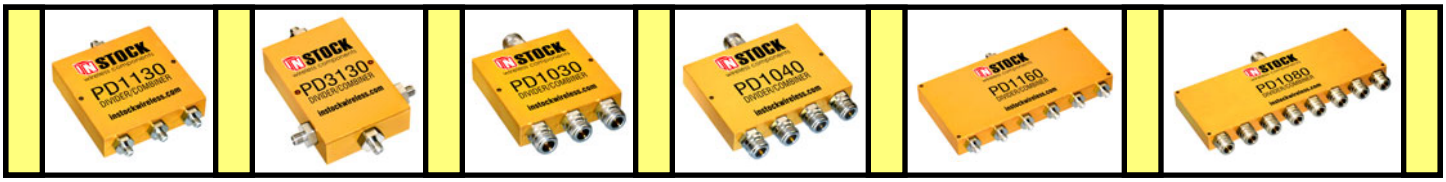

Power Combiner: A device that combines or sums "N" number of input signals to a common output.

Power Divider: A device that divides or splits an input signal into "N" number of output signals.

Power Rating: The maximum amount of continuous input power (in watts) a power divider or power combiner can safely handle without permanent performance degradation. For a power divider, max input power is dependent on the VSWR and phase of loads connected to the outputs. For a power combiner, max input power is dependent on the properties of the input signals and the magnitude of any combining loss they suffer. Ultimately, power rating is directly related to the power handling capability of the isolation resistors, as it is through these resistors that most power is dissipated.

Power Split: The theoretical power ratio from input to output of a power divider (in dB) expressed by the formula:

Power Split = 10 log (1/N), where:

N = number of outputs of an equal power divider.

Often referred to as insertion loss, although not a true loss as this power is recoverable.

PTFE (PolyTetraFluoroEthylene): A thermoplastic member of the fluoropolymer family of plastics. PTFE is commonly used as a support insulator in RF and microwave coaxial connectors because of its low & stable dielectric constant and loss factor over a wide temperature and frequency range. The original PTFE resin was invented by Dupont in 1938 and called Teflon®.

SMA Connector (SubMiniature version A): A threaded coaxial connector with a dielectric loaded interface providing excellent electrical performance from DC to 18 GHz. Precursor designs first appeared in 1958; current designation established in 1968. Available in mating jack and plug configurations. Recommended mating torque is 7-10 in-lb (80-110 N-cm).

T-Housing: A power divider, power combiner housing having input and output connectors perpendicular to one another in the configuration of a "T".

Tri-Alloy Plating: An alloy of copper, tin and zinc providing good electrical performance and tarnish resistance. Being non-magnetic, it provides passive intermodulation performance comparable to silver. Appearance resembles stainless steel. Similar in composition and characteristics to proprietary processes such as albaloy, white bronze, sucoplate, etc.

True Insertion Loss: For a power divider or power combiner, the non-recoverable power loss due to internal mismatch and dissipation losses. Does not include power split or combining losses. This is the value specified for insertion loss of INSTOCK Wireless Power Divider, Power Combiners.

True 3-Way: A non-binary, modified, Wilkinson power divider, power combiner constructed of three transformers joined at a common node. Differs from 3-Way divider/combiners constructed from a 4-Way with one terminated port. Theoretical insertion loss due to power split is 4.77 dB.

True 6-Way: A non-binary, modified, Wilkinson power divider, power combiner constructed by cascading 2-Way and true 3-Way power divider/combiners. Differs from 6-Way divider/combiners constructed from an 8-Way with two terminated ports. Theoretical insertion loss due to power split is 7.78 dB.

VSWR: Voltage Standing Wave Ratio. An expression of the voltage standing wave pattern in a device caused by the phase addition and subtraction of incident and reflected waves. VSWR is the ratio of maximum to minimum voltage of this standing wave pattern and is expressed by the formula:

$VSWR = E_{max}/E_{min} = (E_I + E_R)/(E_I - E_R)$, where:

E_I = incident voltage wave amplitude,
E_R = reflected voltage wave amplitude, and
the sign of voltage wave amplitudes is positive

Wilkinson Power Divider: A device capable of splitting an input signal into equal phase, equal amplitude output signals or combining like signals to a common port. A unique feature of the Wilkinson divider is output port isolation. Constructed of one or more quarter-wave length transformer sections matching input and output impedances with a resistor placed between the ends of each transformer section. First demonstrated by Ernest Wilkinson with the 1960 publication of his paper, "An N-Way Hybrid Power Divider."

Zero Degree (0°) Power Divider: A power divider whose output signals are in-phase (having no phase difference, subject to specified design and manufacturing limitations). All INSTOCK Wireless Power Divider, Power Combiners are zero degree (in-phase).

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