POWER DIVIDERS AND COMBINERS

There are several classes of devices that can be used to divide or combine RF/Microwave power. Generally, they are classitied according to the number of output ports and the relative phase difference between the output signals. The appropriate device must be carefully selected based on the device type and specifications. Particular care must be taken in specifying devices where the application calls for power combining.

The following is a description of the key characteristics normally used in specifying Power Divider performance, and the various types of Power Dividers available.

PARAMETER DEFINITIONS

Insertion Loss

Insertion loss is, simply, the difference in excess of the theoretical splitting loss (in dB) between the amplitude of any output signal and the amplitude of the input signal. The theoretical splitting loss is 3 dB for 2-way dividers, 6 dB for 4-way dividers, 9 dB for 8-way, etc.

Amplitude Balance

Amplitude Balance (in dB) refers to the maximum amplitude difference between any two output signals.

Phase Balance

Phase Balance (in degrees) refers to the maximum phase deviation from theoretical, measured betweenany two output signals (i.e., net phase difference in an in-phase device, net phase difference less 90 degrees in a quadrature device, etc.)

Isolation

Isolation (in dB), in a Power Divider, is defined as the attenuation between a signal present at any Output port and its level as measured at any other Output port, with the input port terminated in 50 ohms. This is a critical parameter that allows the design engineer to estimate "crosstalk" between the various outputs.

Internal Power Dissipation

Internal Power Dissipation is simply the power rating of the internal terminations. When the Power Divider is utilized in the recommended manner, these ratings would not be exceeded. However, some system configurations may allow, for example, the possibility of various outputs being disconnected. In this case, high power levels are "dumped" across the internal terminations. Obviously, in this case, care should be taken with respect to the Internal Power Dissipation rating.

DEVICE TYPES

In Phase: N-way Dividers

These devices deliver output signals in-phase with each other. The most common types are 2-, 4-, 8-, and 16-way dividers. Odd-numbered power division circuits, by design, have a narrower bandwidth. The following table contains number of output and corresponding coupling loss.

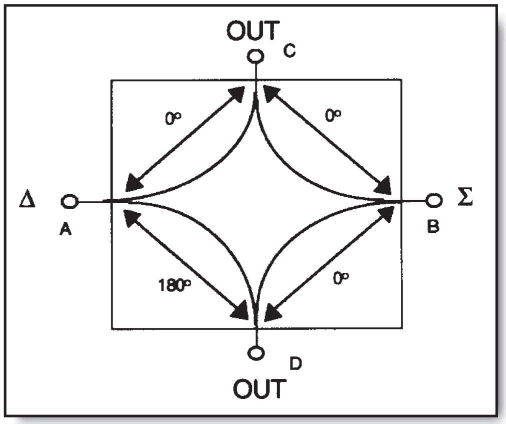
No. of output (N)	Coupling Loss (dB)
2	3.01
3	4.77
4	6.02
5	7.00
6	7.78
8	9.03
10	10.0
12	10.8

Extreme caution must be used when combining signals. Proper combining requires that all signals have the same frequency phase, and amplitude. If dissimilar signals are combined, make sure that the resistors used are capable of handling the required power.

180 Degree Hybrids

A 180 degree hybrid is a 4 port device which provides two (C&D) equal amplitude in phase signals when fed from its sum port (Σ), and two (C&D) equal amplitude 180 degrees out of phase signals when fed from its difference port (Δ).

If port B is terminated, then the 180 degree hybrid becomes a 3 port device.



90 Degree (Quadrature) Hybrids

These devices split or combine in quadrature (one output signal being 90 degrees out of phase with theother), and have many uses in signal processing. Even though they are reciprocal devices, the same care must be taken in combiner applications as with in-phase combiners. Bandwidth is the most important limitation of the quadrature ("quad") hybrid. "Crossover" quads have a bandwidth of 10% and can be manufactured to have excellent amplitude and phase balance as well as low loss, high isolation, and good VSWR. They are very useful for processing signal frequencies and their applications are numerous.

Synergy's Quadrature Hybrids are available in bandwidths of 10%, octave, 3:1, 5:1, and 10:1 in various package styles.