An Assessment of Band Pass And Band Stop Combiners.

FM Combining Units

One of the most common forms of channel combining networks for FM radio utilises a number of constant impedance modules in series. Each module adds the power of yet one further transmitter to those previously combined.

Typically these modules consist of a pair of hybrid networks (invariably 3 dB couplers) connected in a 0dB arrangement. A pair of identical filters are connected between the internal arms of this configuration. This arrangement is shown opposite.

The filter may be of the band pass or band stop type. Similar module parameters are produced in either case. The difference in performance will be examined here.

In both cases the module has a wide band input, a narrow band input a combined output and the forth port is terminated in a matched resistive load.

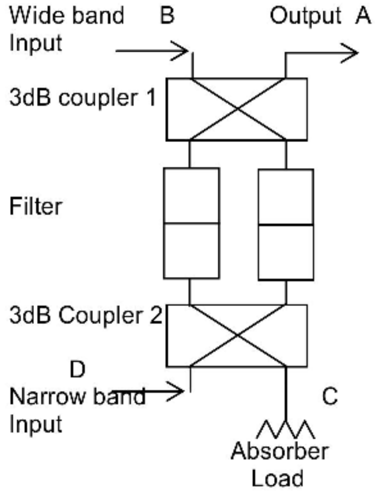

Fig 1

Referring to Fig 1 the module will be configured as follows:

	Band Pass	Band Stop
Output	A	A
Narrow Band Input	D	B
Wide Band Input	B	D
Load	C	C

Effectively the positions of the two inputs are reversed.

The mode of operation is such that power entering Port B will be equally divided by coupler 1. The power is then "bounced" off the filter at its stop band frequencies. The power is recombined in coupler 1 to emerge at port A.

Power entering port D will be equally divided by coupler 2. The power passes unobstructed by the filters at their pass frequencies to be recombined in coupler 1 and emerged at port A.

Any power that is misrouted by the filters due to imperfect pass or imperfect stop performance is routed to port C where it is dissipated in the balancing load.

It follows that power entering port D travels in a matched form throughout the network to the output at A. All VSWR will be low throughout the network. However, power entering at port B is "bounced" off the filters and returns to port A. The coupler 1, the adjacent input port of the filter and the interconnecting lines all are operating in a form with a VSWR approaching infinite. Double the matched voltages and currents occurs as standing waves in this part of the network.

From a coupler consideration this difference is irrelevant when equal power, single channels enter the narrow and wide band ports (i.e. a module furthest from the antenna output port).

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However, on the highest power module where there may be up to 10 combined frequencies at high power entering the wide band port, differences result. In a band stop module 90% of the power is transmitted in a matched configuration so coupler 1 and 2 will be similarly sized capable of handling the voltages and currents of the sum of the powers.

In a band pass module coupler 2 will pass the power of only one channel in a matched mode so can be of insignificant size, however, coupler 1 will have to handle twice the voltage and four times the copper loss heating of the equivalent coupler in a band stop module.

Considering again the wide band performance the transfer of power in a band stop module is along a matched path through a pair of 3dB couplers which (in theory at least) have perfect VSWR performance over the full FM bandwidth. Thus the theoretical wide band VSWR is unity.

In contrast a band pass system has the power "bounced" back into the input coupler to be transferred to the output. Any bounced power that is misrouted appears at the wide band input as VSWR. If the 3 dB coupler operates as a single quarter wave proximity coupled line then it follows that the best output balance achievable over the FM band is 3 dB +/- 0.03 dB which inherently results in a VSWR of 1.02:1. The phase of this reflection changes through a full circle over the band so the mismatch cannot be fully compensated. It is difficult to match the broad band port on a multi channel system to better than 1.3:1.

For the above reasons a band pass filter operates at its tuned frequency in a matched mode. Similar currents and voltages will occur in all sections of the filter. Conversely a band stop filter appears as a short circuit at the tuned frequency, so standing waves will result in double current and voltage in the first section which will run hot but subsequent sections will have low currents and be cool. A two section band stop filter has twice the loss of the equivalent band pass filter.

Isolation between inputs will be high at the filters stop frequencies but typically 35 dB at the filters pass frequency. It follows that in an assembly of several band pass modules isolation between any two narrow band inputs will be high giving rise to very good inter modulation product suppression in all cases. The isolation from every narrow band input to the wide band input will be poor making it not very suitable for standby operation use.

In an assembly of several band stop modules isolation to the wide band port is good so it may be utilised for combining an additional channel without adding a module.

Thus either type offers certain advantages. Band stop modules are more suited to providing standby operation through the wide band port or alternatively there may be an economic advantage since one less module than channels is needed. Band pass modules tend to provide better levels of inter modulation product suppression. Also they have the advantage of small filter sizes but need oversized couplers.