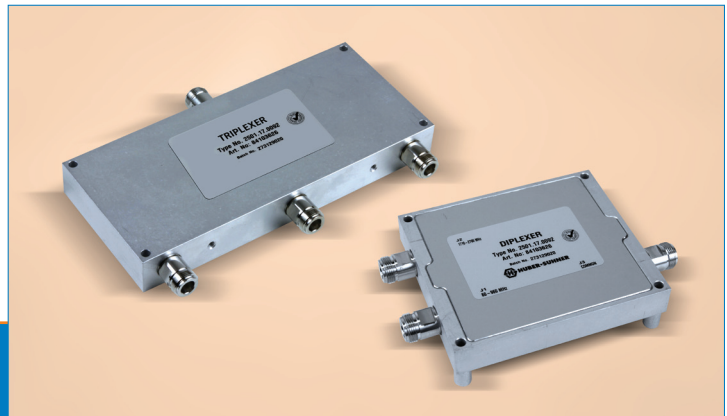


## **Microlab Diplexer and Triplexer Filters for Wireless System Design**

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### **Abstract**

An RF diplexer or antenna diplexer is used for a RF application which can be used to enable more than one transmitter to operate on a single RF antenna. Typically antenna diplexers enable transmitters operating of different frequencies to use the same antenna. A diplexer is a set of filters with a common feed point that is used to combine or split signals travelling to or from an antenna while providing isolation between the two independent paths. Multiplexers require more than two independent paths. This application note discusses the details of the performance characteristics of the diplexer and triplexer filters and their applications.

## Difference between Diplexer and Duplexer

In order to avoid some confusion between diplexer and duplexer, diplexers separate or combine different bands such as cellular, PCS, LTE or UMTS and typically use suspended substrate type of filters. On the other hand duplexers separate transmit and receive within the same band as those channels are very close to each other and hence require cavity type of filters. This type of filter is comparatively bigger in size and very expensive. Duplexers are more challenging to meet the low PIM which is required for the system integrity.

## Diplexer and Triplexer Filters for in-building and DAS System Design

Diplexers are a combination of filters which are used to separate and combine different wireless cellular bands. In this way, the paths for the different transmitters and receivers can be separated according to the frequency they use. Cavity filters are tuned to provide in excess of 50 dB of isolation between bands which are sufficient for most indoor diplexer applications, such as sharing a common antenna or Distributed Antenna System (DAS). Any new signal like LTE or WiFi can be injected into the existing DAS system by using diplexers without affecting the existing system performance. The modest size of the diplexer also makes it suitable for use in neutral host combiner boxes.

RF diplexers type consists of regular or suspended strip line techniques. Suspended Substrate (SSS) filter technology enables high frequency broadband filters to be realized utilizing elliptical responses for excellent close-in rejection. The diplexers also sometimes call as “cross-band” coupler as it uses signals from several signal bands. The most important performance specifications that need to be considered when selecting RF diplexers or triplexers are: signal rejection or isolation over transmission signal, insertion loss, and Voltage Standing Wave Ratio (VSWR).

In the case of an in-building Distributed Antenna System (DAS), which could easily be configured to use three or even four feeds to different sections of a building, a passive combiner system can be designed to take the advantages of Diplexers or Triplexers in a ‘Lossless’ configuration. The above Figure shows how nine inputs can be combined onto three feeds with practically minimal loss. In practice, of course the number of inputs is rarely such a convenient number, but with careful selection of hybrid matrices and the use of diplexers and triplexers, can minimize the loss and provide adequate input isolation at a reasonable price.

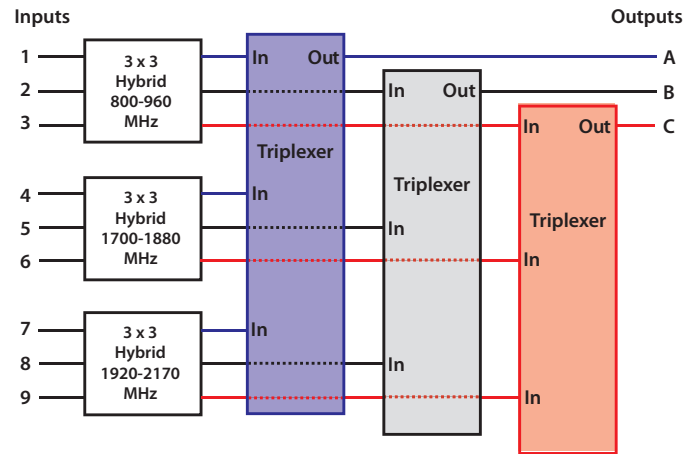


Fig 1: ‘Lossless’ combining of 9 inputs to 3 distributed antenna feeds, as might be used in an in-building DAS system.

## Diplexer and Triplexer Filters

Microlab offers several models of diplexer filters for wireless communication markets. For example, the BK-26N 3 GHz Diplexer is one of the available models which allow efficient combining of WiMAX and 5 GHz W-LAN designed to 802.11(a) and similar systems, with a coaxial distributed in-building cellular network or DAS. The unit has a very broad frequency range with minimal loss for maximum flexibility. This can provide the benefit of the same controlled coverage of the higher frequency services with the DAS. The Diplexer has been designed to be small and lightweight, using passive, proprietary techniques to ensure minimal loss and very high reliability. A simple bracket and tapped holes are provided for simple mounting to a surface or cable tray. The unit is available with both N connectors and SMA connectors. The most important performance specifications that need to be considered when selecting RF diplexers or triplexers are: signal rejection or isolation over transmission signal, insertion loss, and Voltage Standing Wave Ratio (VSWR).

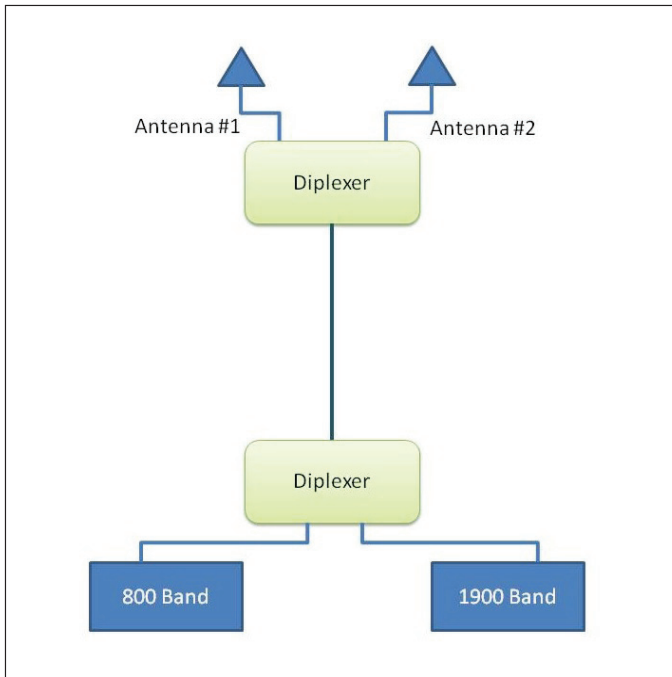


Fig 2: Example of a macro-site co-location in an in-building DAS or out-building antenna system

Fig. 2 shows an example of a macro-site co-location in an in- or out-building antenna system. The both input signals of two bands are properly isolated by using a diplexer and then transmitted through the common coax cable to the top where another diplexer can be used to split the signal to the low and high bands so that it can be broadcasted out of the antennas. This speeds up the deployment and reduces costs for additional carrier or frequencies. Fig. 3 shows insertion loss characteristics for both low and high bands. And fig 4 shows a return loss characteristics of a diplexer filter.

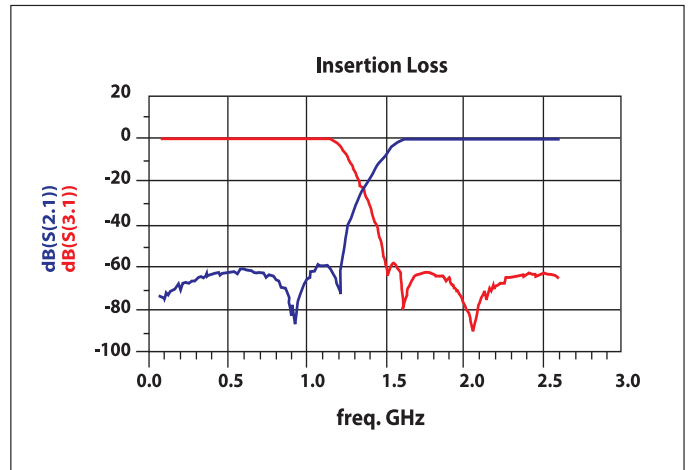


Fig 3: Insertion loss characteristics of a Microlab diplexer

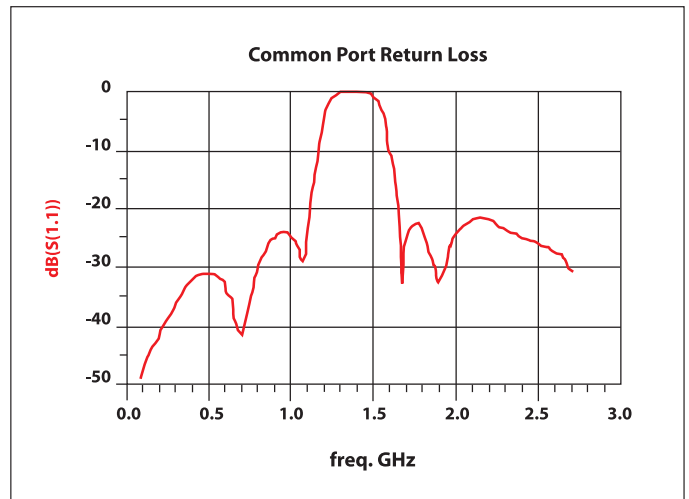


Fig 4: Return loss characteristics of a diplexer filter

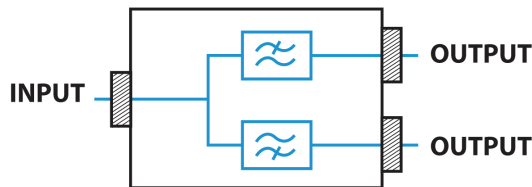
Microlab also offers triplexer filters for wireless communication systems. The Model BK-30 series is a three input Triplexer which allows combination and separation of the signals in each wireless band. To minimize band inter-reaction, the inputs are well isolated and have minimal insertion loss over their respective frequency bands. The Triplexer has been designed using passive, proprietary techniques which minimize cost and size. Through holes are provided for simple mounting to a surface or cable tray using SMA, N or QMA connectors.

## Highlighted Features of Diplexer and Triplexer Filters



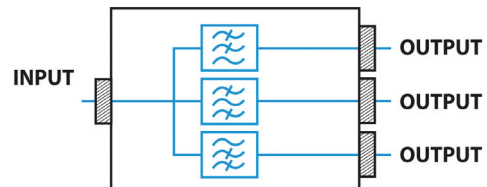
### Diplexer

Wireless frequency coverage from 80 to 6000 MHz  
 Lowest PIM (< -150 dBc, test with 2 x +43 dBm tones)  
 High average power ratings as per different  
 input frequency range  
 Available with N & 7-16 mm DIN female connectors  
 50 dB input isolation  
 Minimal RF insertion loss over the frequency bands  
 (0.2 dB typical, 0.8 dB maximum)  
 Excellent input and output VSWR (1.25:1 max.)



### Triplexer

Wireless frequency coverage from 820 to 2170 MHz  
 Lowest PIM (< -150 dBc, test with 2 x +43 dBm tones)  
 10 Watt/port, average power rating  
 Available with SMA, N and QMA female connecto  
 30 dB input isolation  
 Lower insertion loss over the frequency bands  
 (<1.3 dB, typically <1 dB)  
 Lower input VSWR



## Conclusion

Microlab offers a wide range of broadband and narrowband diplexers and triplexers to meet the rigorous demands of the wireless market. The focus is to provide very broad bandwidths, with minimum loss and low PIM. The most suitable design technique for such requirements is often the suspended substrate which has low loss and has also the cost benefit of being tuned by design. Such units have become a very important building block in the combining of multiple signals being distributed in Distributed Antenna Systems, or DAS.

### References:

- [1] Microlab Diplexers and Triplexers filters  
[\[ http://fxr.com/products/filters/filtersdiplexers \]](http://fxr.com/products/filters/filtersdiplexers)
- [2] Video clip on Diplexer and triplexer filters for wireless applications  
[\[ http://www.youtube.com/WTGinnovation#p/a/u/1/y8bnKv43STA \]](http://www.youtube.com/WTGinnovation#p/a/u/1/y8bnKv43STA)

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