Application Note
Cross-band Combiner

An increasing demand for additional services and new technologies has led to an increased need for antenna line equipment on radio sites. Operators are also facing increasing restrictions on tower infrastructure deployment by local planning authorities and increased demands from site owners that make the deployment of additional equipment and services a time consuming and expensive challenge.
Cross-band combiners enable signals from multiple base stations of different bands to be combined onto a single pair of feeders which speeds up deployment, saves the cost of additional feeders and when used with ultra-wideband antennas and multi-band TMAs, reduced site clutter.
This application note explores the use of different types of cross-band combiners and their application in mobile networks.

Cross-band Combiners

Cross-band combiners are used to combine multiple frequency bands and are technology independent. They consist of wideband filters for each required band combined with a common junction to enable each band to be presented to a common antenna connection. Depending on the number of bands involved, the cross band combiner can be referred to as diplexer (Two frequency bands), triplexer (three frequency bands), quad-plexers (four frequency bands), etc.

Figure 1, shows how using a cross-band combiner can help reducing the number of required equipment on a cell site compared to when each base station has its own dedicated equipment i.e feeders, antennas, etc.

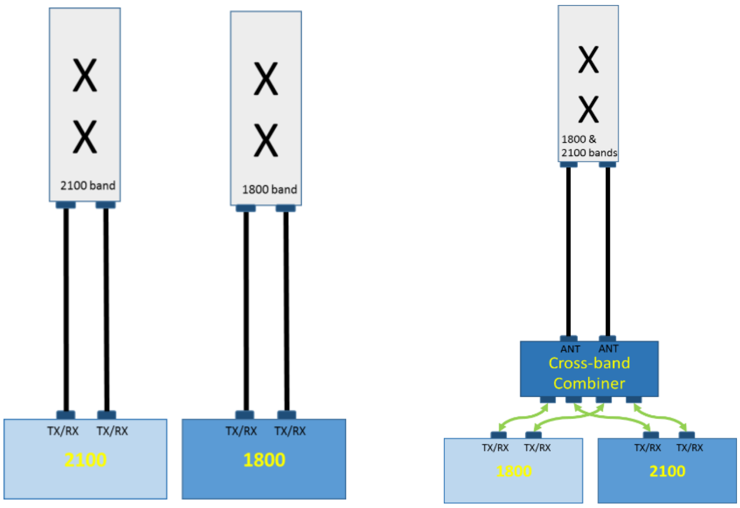

Figure 1. (a) Dedicated equipment for each base stations at a cell site, (b) the cross band combiner used to combine two frequency bands in order to reduce the number of required equipment

Cross-band Combiners Arrangement

Cross-band combiners can be used in scenarios where multiple base stations are sharing the feeder cables while using separate antennas for each frequency bands or they can be used where wideband antenna is being used to support multiple bands.
In the first scenario, two cross band combiners are required in order to combine the signals out of the radios and split them before feeding to the antenna. This is shown in Figure.2 (a).

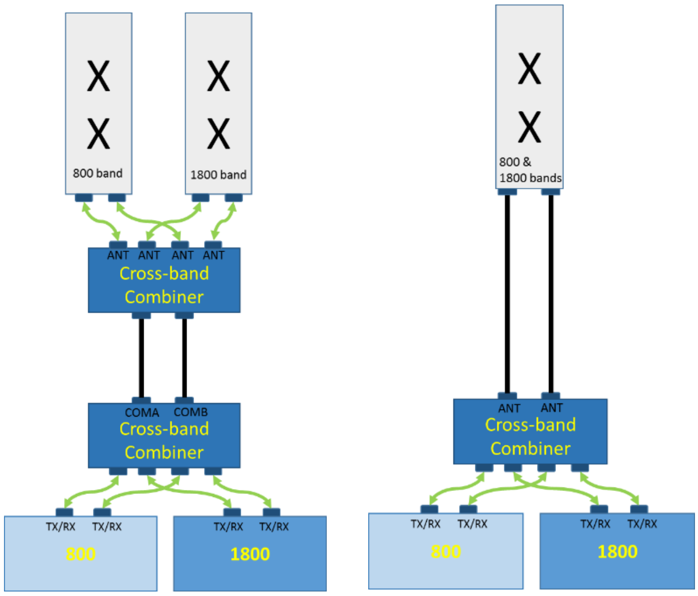

Figure 2. Cross-band Combiner used with (a) single band antenna (b) multiband antenna

Alternatively, where a multiband antenna is been used, only one combiner is required to feed the combined signal to the antenna, Figure.2 (b).

Cross-band Combiner Architecture

The cross-band combiner is usually designed using multiple separate wideband filters supporting RX/TX at each frequency band. The DC/AISG path can be designed to be transparent to all ports. This gives the flexibility to the user to decide which port to be used for sending the AISG signalling.

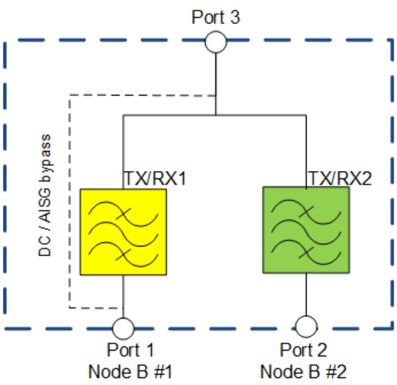

Figure 2. The cross-band combiner with TX/RX filters for combining two frequency bands

Cross-band Combiners with diversity feature

In the applications where the RF or baseband diversity is required, combiners can be used to provide the appropriate diversity signals. Figure.6 shows the triple cross-band combiner which allows three basestations to share the same antenna and preserve the recieve and transmit diversity with minimum loss. Port4A and Port4B are the main and diversity ports of the antenna and in both uplink and downlink directions the main and diversity signals of all three basestations are combined and connected to the relevant antenna port.

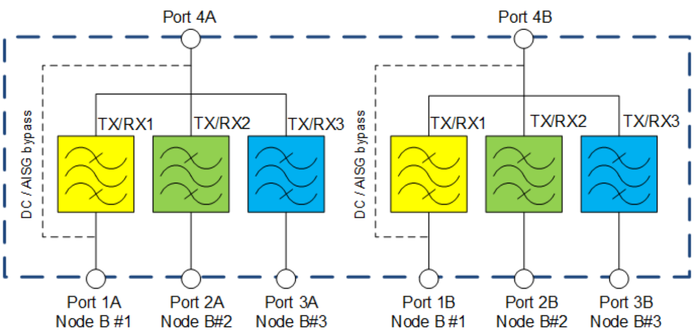

Figure 3. Triple MIMO cross-band combiner

Design Considerations

The most important parameters that need to be considered when choosing the cross-band combiner are the insertion loss, the isolation between ports and the power handling at each port, all of which can affect the performance of the networks to be combined.

In designing the filters there is always a trade-off between the selectivity, insertion loss, isolation, size and cost of the filter.
High isolation i.e 50dB between the input ports will require more resonators and hence bigger size, higher insertion loss and higher cost.
Lower insertion loss requires larger cavities and high Q resonators and again increased size and cost.
A typical cross-band combiner will have 50dB of isolation and 0.3dB of insertion loss.

Another factor in the design of cross-band combiners is the proximity of the frequency bands to be combined. The higher the seperation of the bands, the less demanding the filter design. For example, a cross-band combiner designed to combine 800 and 900 bands would be more complex, bulkier and more costly than the one designed for combining 800 and 1800 bands. Moreover, the number of frequency bands to be combined can also add to the complexity, size and cost of the cross-band combiner.

Figure.5 shows the performance for a combiner designed to combine LTE800-EGSM900 (790 to 960MHz) and EGSM1800-LTE2100 (1710-2170MHz) signals. The combiner consists of two very wideband filters with very low in-band insertion loss and high rejection over the opposite band.

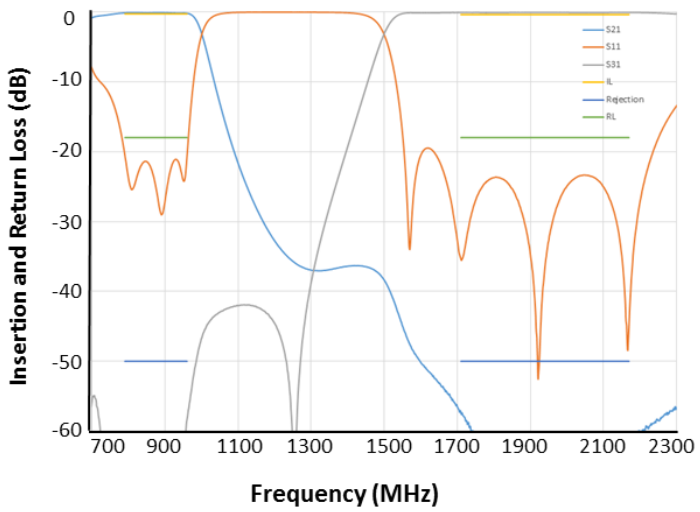

Figure 5. The LTE700-EGSM900 and EGSM1800-LTE2600 bands are combined with wideband cross-band combiner

As another example, Figure.6 shows the performance plot of a combiner designed to combine two very close LTE800 (790-862GHz) and EGSM900 (880-960MHz) bands.

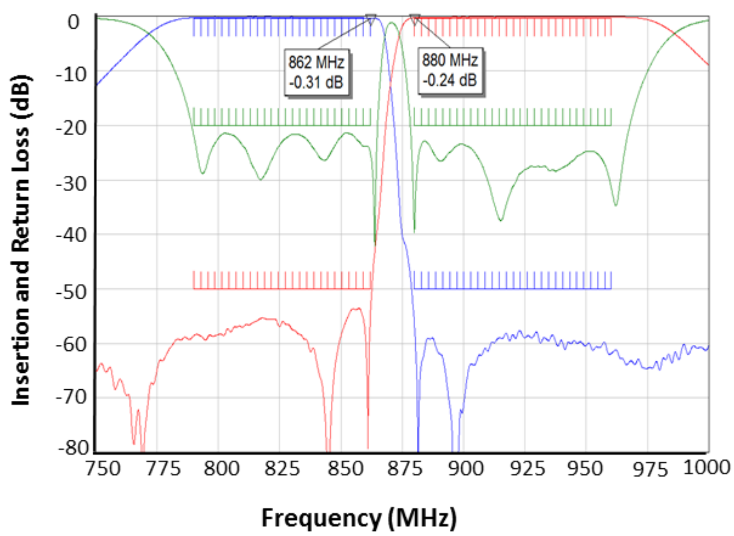

Figure 6. Two closely spaced LTE800 and EGSM900 bands are combines with a cross-band combiner

Cross-band Combiner Examples

Filtronic offers a wide range of cross-band combiners for different scenarios in the infrastructure sharing market. The filters are designed for various combination of 800, 900, 1200, 1800, 2100 and 2600MHz frequency bands.
As an example of Filtronic cross-band combiners, PCC043 offers combining of the LTE800 (790-862MHz) and EGSM900 (880-960MHz) bands. The filter has very low loss across both frequency bands and very high isolation. The filter is designed with Filtronic proprietary architecture to achieve significantly reduced overall size, weight and cost.
PCC044 is another product in the cross-band combiner range which combines LTE1800 (1710-1880MHz) band with LTE2100 (1920-2200MHz) band.
As another example we can name PCC046 which is designed to combine two very wide LTE800-EGSM900 and EGSM1800-LTE2600 bands. The combiner offers a very low loss at all ports across the whole frequency bands.
Similarly there are wide range of cross-band combiners for different frequency bands to fulfil the requirements for different scenarios. For more information please review our product portfolio.

General Features of Cross-band Combiners

- Covers wide range of wireless frequency bands; 800, 900, 1200, 1800, 2100 and 2600MHz
- Supports different technologies; GSM, UMTS, CDMA, WCDMA and LTE
- Minimal RF insertion loss over all frequency bands
- Very high isolation and return loss
- Lowest PIM (<-160dBc, 2 x +43dBm tones)
- Excellent power handling at all input ports
- AISG and DC pass-through
- N x 7/16 DIN female connectors

Conclusion

Filtronic has a long history in filter design and offers a wide range of cross-band combiners which covers different scenarios of equipment and technology sharing. The combiner can be designed with high power handling, very low insertion loss and high isolation between input ports.

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