# Same-Band Combining for Cell Size Optimization


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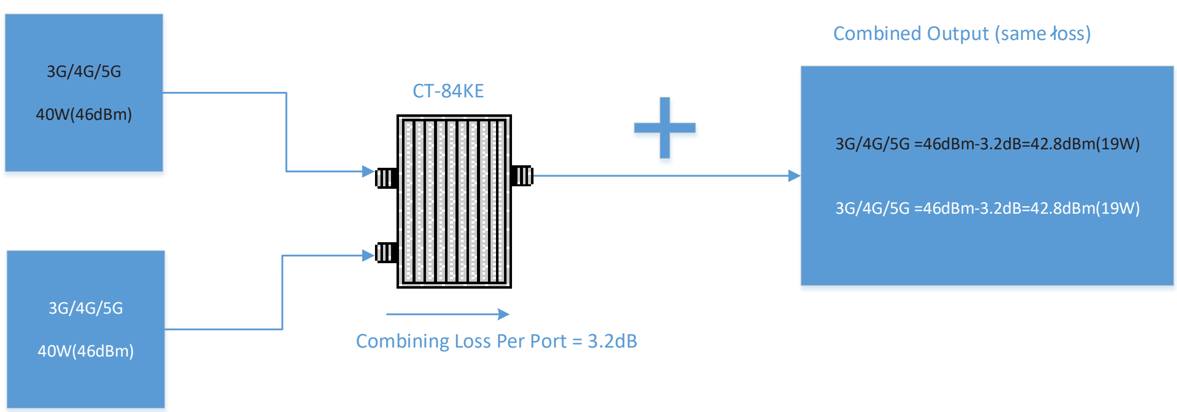
The increase in demand for mobile capacity will continue into the foreseeable future driven by many use cases. This trend is requiring mobile network operators (MNOs), Neutral Hosts (NH), and 3rd Party Network Owners (3PO) to find novel ways to efficiently combine the 4G/5G NR technologies to overlay 3G systems currently in operation. There is an uptrend for RF components that allow these technologies to co-inhabit without costly upgrades of existing hardware and real-estate. Adding 4G or new 5G NR services to existing infrastructure using the combiner options discussed below allow for sharing infrastructure, ultimately reducing the cost to upgrade and buildout. The next two sections describe two combining schemes: the common symmetrical approach and the second being a novel asymmetrical method to allow for more coverage flexibility between the combined services. Both these options facilitate a quick deployment of the new technologies to existing sites.

### Symmetrical Same-band Combining

The symmetrical approach is agnostic to the signals combined. It allows for same-band combining or multiple-bands as long as the chosen component covers the frequency range. In this case, both signals are equally combined, but in a more cost-effective manner and within a smaller form factor. When two RF signals close to each other in frequency are combined, it becomes cost-prohibitive to design an extremely sharp cut-off filter between the two ports to provide adequate isolation. To realize a filter with such sharp roll-off would require more sections, become larger, have more loss at the port cross-over points, and most importantly be cost detrimental. The symmetrical same band combining method shown below uses an internally terminated hybrid 2x2 coupler. It provides sufficient isolation across a wideband (617-2700MHz) to protect radios. The 3dB loss is an acceptable trade-off to gain the benefits of cost and size in most deployments.

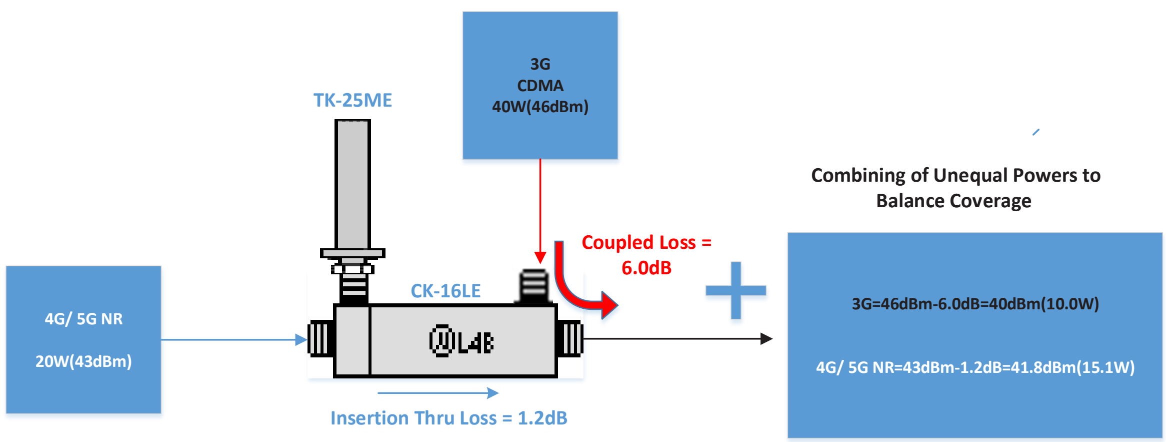



Method for Same-Band Combining Using Microlab CT-84KE

The CT-84KE is a broadband 2x-1 hybrid combiner which can combine any two signals from 617-2700MHz. It is a cost-effective and straightforward method for same-band combining applications. Though both radios will have a 3dB impact to link-budget, this would be the tradeoff in instances where a low-loss, high-isolation diplexer cannot be realized due to adjacent frequency blocks and lack of guard-bands.

## Assymetrical Same-band Combining

The second approach to unequal or asymmetrical combining helps balance radios with different max powers to ensure the overlays can be independently controlled. Since 4G/5G radios will be lower power than 3G radios, it may not be ideal to take a 3dB equal loss from both signals to balance RF coverage for both services. The 4G/5G radios will need the most physical coverage determined by SNR. The high SNR (signal to noise) requirement comes from the new modulation schemes enabling higher throughputs, which correlates to a smaller maximum cell coverage radius than 3G. Given that 4G/5G radios are already lower in power than 3G, it is imperative to adjust each service's losses independently. This can quickly be addressed using an asymmetrical combining approach. For high SNR and maximum cell radius, the 4G/5G signal would be injected into the lower loss path. In contrast, the 3G signal overlay can be adjusted as required based on the respective coupler value chosen.




Asymmetrical Same-band Combining using Microlab CK-16LE

NOTE: The low-PIM termination is sized to dissipate 75% of 3G + 25% of 4G/5G. The termination can be modified based on the actual radio implementation.

Suppose 3G is combined with 4G/5G service; the asymmetrical combining method provides MAXIMUM 4G/5G coverage by optimizing link budget with minimal impact to 3G fallback coverage. 3G radios tend to have higher power ratings than 4G/5G radios and can handle higher distribution loss. If we used a 3dB hybrid combiner in this example, the 4G/5G LTE signal would be reduced by 3.2dB, not 1.2dB, as noted. Thus, if the 4G/5G radio were capable of 20W, the loss would be 10W of the power after combing with 3G. This novel approach helps balance radio powers, where it is critical to preserve as much 4G/5G combined power. This combining example provides a net gain of 50% more 4G/5G power delivered than using a conventional 3dB hybrid.

Choosing the correct 4-port coupler value provides the adjustment needed to create a proper imbalance for optimizing coverage. A low-PIM termination of the forward couple path should be chosen to dissipate the "uncoupled" 3G + 4G/5G power as heat. For this example, the TK-25ME would be able to handle the total dissipated loss. The coupled port radio is attenuated accordingly to balance the radiated power of two services by choosing the appropriate coupling value.

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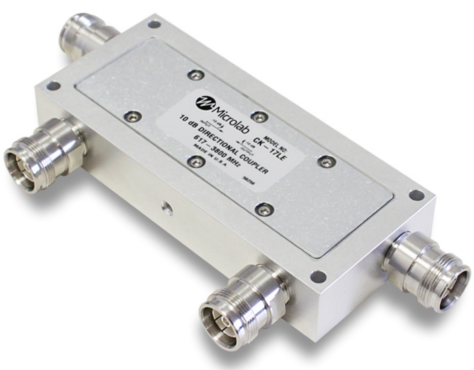
In summary, the two combining options shown above does not limit what services can be combined. All permutations of 3G+4G+5G can be achieved using the components listed below. The critical point to take away from this is that combiner loss of two signals can be controlled when the application requires.

## Microlab Symmetrical Same-Band Combining Solution:

1. CT-84N - 2-1 Low PIM Combiner 617-2700 MHz 160W Type N -161dBc IP67
2. CT-84KE - 2-1 Low PIM Combiner 617-2700 MHz 160W 4.3-10 -161dBc IP68 Salt-Fog
3. CT-84KD - 2-1 Low PIM Combiner 617-2700 MHz 160W 7-16 -161dBc IP68 Salt-Fog



## Microlab Asymmetrical Same-Band Combining Solution:

1. CK-16LE - 6dB 4-Port Coupler 617-3800MHz 200W 4.3-10 -161dBc PIM
2. CK-17LE - 10dB 4-Port Coupler 617-3800MHz 200W 4.3-10 -161dBc PIM

*Ensure that the properly sized low-PIM termination is chosen for the unused port