

Xinger. III DOHERTY COMBINER



Introduction

Anaren Doherty combiners are designed for symmetrical two-way Doherty power amplifier architectures that have even power splitting ratio between main and peak power amplifiers. A typical Doherty combining circuit consisting of two quarter-wave-length transmission lines of 50 Ohm and 35 Ohm are packaged in the combiner as shown in Figure 1.

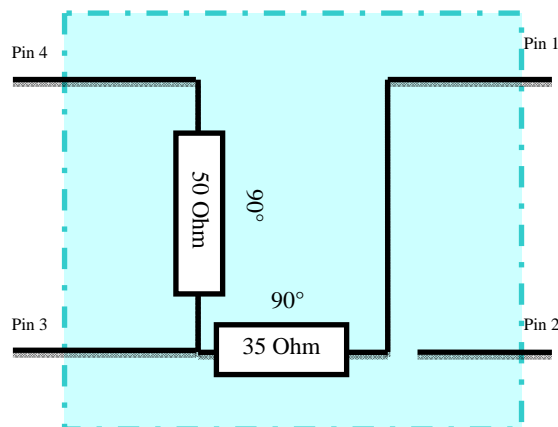


Figure 1: Doherty combiner transmission line impedances

A transmission line of fixed physical length is of quarter-wave length only at a single frequency, this type of Doherty combiners are considered narrow band. Typically +/- 5% of bandwidth are achieved in this type of Doherty amplifiers. With several models, the Anaren Doherty combiner product line covers major communication bands ranging from 700 MHz to 2700 MHz. Each model is optimized for the center frequency of targeted frequency band. However, as new spectrum is being released worldwide to meet urgent capacity demands, the pre-designed standard models can be tuned in customer applications to meet performance in these nearby frequency bands.

This document provides guidelines to tune these standard models for off-band applications.

Analysis

Figure 1 schematic serves two functions for required Doherty operation.

At maximum mode when the main and peak amplifiers deliver equal amount of output power, the combining circuit functions as a 1:1 combiner. The 50 Ohm quarter-wave-length transmission line provides required phase delay and amplitude division. The 35 Ohm quarter-wave-length transmission line serves as an impedance transformer transforming 25 Ohm to 50 Ohm.

At backoff mode or low power condition where the peak amplifier is turned off and presents high output impedance, the combining circuit functions as a 1:2 impedance transformer, providing the required load pulling-up for the main amplifier. The 35 Ohm quarter-wave-length transmission line still serves as a 1:2 impedance transformer transforming 25 Ohm to 50 Ohm. The 50 Ohm quarter-wave-length transmission line serves as a 1:4 impedance transformer transforming 25 Ohm to 100 Ohm.

The bandwidth of the Doherty combiner is limited to +/- 5% by this 1:4 impedance transforming function of the 50 Ohm line, while as a 1:2 impedance transformer, the 35 Ohm line provides much wider bandwidth and it typically can cover more than +/- 15% bandwidth.

Ideally if a pre-designed standard model is to be tuned outside its designated frequency band, both the 50 Ohm line and 35 Ohm line need to be adjusted to the center of the new band. However, if the application band is not too far away from the original targeted band center, it is possible that the 35 Ohm line without length adjustment can still cover the new band and provide good enough impedance transforming. In this case, only the 50 Ohm line needs its length adjusted. And even more conveniently, the increase or reduction of the 50 Ohm line can be easily absorbed in the offset phasing line of Doherty amplifier design. Once it is tuned to new center frequency, the impedance transforming function as well as the phase delay requirement can be re-satisfied in the new band. Amplifier designers are encouraged to take the s-parameter of Anaren Doherty combiner into the amplifier simulation to verify the performance.

Example

This example demonstrates how X3DC08E2 can be used outside its designated frequency.

X3DC08E2S is originally optimized at the 878 MHz targeting LTE band 5 of 862 – 894 MHz. By increasing the offset line on the main amplifier path, as shown in Figure 2, X3DC08E2S can support several new bands at lower frequencies. The required line length adjustment and corresponding electrical specifications are shown in table 1. And typical RF performances with tuning are also shown in the plots below. Similarly, using the same principle, the X3DC08E2S can be tuned for higher frequencies by subtracting the offset line on the main amplifier path.

Frequency	Phase Adjustment at main amplifier path	Return Loss (Max Power Condition)	Insertion Loss (Max Power Condition)
<i>MHz</i>	<i>Degrees @ 878MHz</i>	<i>dB Min</i>	<i>dB Max</i>
862 – 894	0	20	0.15
793 – 803	+9.5	20	0.15
783 – 793	+11	20	0.15
773 – 783	+12	20	0.15
Amplitude Imbalance (Max Power Condition)	Phase Imbalance (Max Power Condition)	Return Loss (Low Power Condition)	Insertion Loss (Low Power Condition)
<i>dB Max</i>	<i>Degrees</i>	<i>dB Min</i>	<i>dB Max</i>
±0.12	90 ± 3.0	20	0.25
±0.12	90 ± 3.0	20	0.25
±0.12	90 ± 3.0	20	0.25
±0.12	90 ± 3.0	20	0.25

Table 1: Electrical Specification of X3DC08E2 with Offset Line Tuning

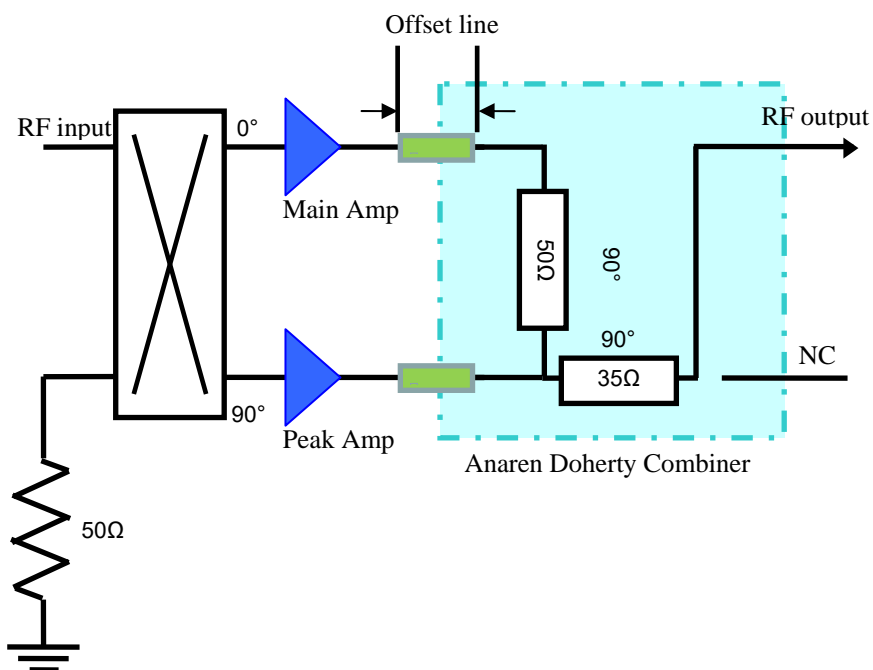


Figure 2: Adjusting Offset Line to Tune the Doherty Combiner

Conclusion

Anaren Doherty Combiners are versatile for today's amplifier architectures. For more information on tuning Anaren Doherty Combiners, please contact Anaren Microwave Inc or Richardson RFPD.

Typical Performance : 750-950 MHz

