

# DESIGN OF A 2.4 GHz WILKINSON POWER DIVIDER WITH A DISTRIBUTED-ELEMENT BANDPASS FILTER

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Power dividers are fundamental components in modern radio frequency (RF) and microwave systems. They are mostly used for even distribution of signal power among multiple ports. Of the various power divider architectures, the Wilkinson power divider has garnered significant attention due to its desirable characteristics, including high isolation between output ports and equal power division [1]. Despite the fact that this type of topology provides high isolation between output ports, a distributed-element bandpass filter is installed before the input of the Wilkinson power divider in order to improve signal quality and control the bandwidth more accurately.

The power divider with a bandpass filter is designed using microstrip lines. When low-loss dielectric materials are used, microstrips can provide excellent performance with minimal signal attenuation and good impedance control at RF and microwave frequencies. For circuit design, the low-loss dielectric material Rogers 4350B/C is used, which has a dielectric constant of  $\epsilon_r = 3.66$ . Keysight Advanced Design System (ADS) software is used for circuit design and simulation [2]. The simulations examine S-parameters, which are commonly used to describe the input-output behavior of RF and microwave devices [3]. The following parameters are simulated: reflection coefficient  $S_{11}$ , forward transmission coefficients  $S_{21}$  and  $S_{31}$ , and isolation between terminals  $S_{23}$  and  $S_{32}$ . During simulation, the input reflection coefficient  $S_{11}$  shows that at 2.4 GHz only a small part of the signal is reflected back towards the source, meaning that the circuit is properly matched to the design frequency and most of the power is transmitted to the load. The forward transmission coefficients  $S_{21}$  and  $S_{31}$  indicate a nearly equal distribution of power between the two output ports, while the isolation parameters show that only a very small part of the signal leaks from one output to the other.

Integrating a distributed-element bandpass filter with a Wilkinson power divider is an effective way to achieve simultaneous power division and signal filtering in the 2.4 GHz band while maintaining good matching and high isolation between output ports. The proposed design can serve as a basis for further development of filtering power dividers for use in compact RF circuits which operate in the 2.4 GHz band, such as Wi-Fi and Bluetooth transceivers, multi-antenna access points, or measurement and testing setups where a single RF signal must be split into two or more band-limited paths. Integration and optimization of a filtering component directly into the power divider's architecture helps to address common signal quality issues in compact RF systems.

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[1] "Hybrid power divider and combiner for passive RFID tag wireless energy harvesting," IEEE Journals & Magazine | IEEE Xplore, 2022. <https://ieeexplore.ieee.org/document/9663231>

[2] Keysight, "Advanced Design System (ADS) Circuit Design Cookbook 2.0," Keysight, Apr. 25, 2024. <https://www.keysight.com/us/en/assets/7018-04800/application-notes/5992-0707.pdf>

[3] J. Zhu, Y. Wang, K. Zhao, Y. Wang, C. Fu, and K. Man, "Assessment of measurement uncertainty for S-Parameter measurement based on covariance matrix," Sensors, vol. 24, no. 11, p. 3668, Jun. 2024, doi: 10.3390/s24113668.