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Balanced Differential Coplanar Waveguide Directional Coupler

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The research on balanced/differential printed microwave planar devices has experienced a considerable growth during the last two decades, specially in those aspects related with passive circuitry (mostly focused on the implementation of common-mode filters and balanced differential filters, but also, more recently, directional couplers, power dividers and combiners, and other passive devices). The main reasons for such a growing interest are the well-known advantages of differential circuits in terms of immunity to environmental noise, crosstalk reduction, and electromagnetic interference minimization. Since, by far, the most studied balanced/differential planar passive microwave device is the filter, the reader can find a comprehensive review of the literature on the topic in [1] and references therein, for instance. However, obviously, in addition to microwave filters, modern communication systems based on balanced / differential signals need for other passive balanced/differential devices such as diplexers, power dividers, rat-race couplers, hybrid couplers or directional couplers (see [2] and references therein). In this work, a differential coupled-line directional coupler (DCLDC) implemented in double-side coplanar-waveguide (CPW) technology is presented (see Figure 1)[2]. The structure is totally symmetric, which simplifies the obtaining of the coupling level and characteristic impedances of in a straightforward and efficient way. Furthermore, thanks to the use of broadside coupling, it is possible to implement a wide range of coupling levels. A step-by-step synthesis procedure can be provided for this kind of directional coupler, facilitating the implementation of different couplers with different specifications in terms of center frequency, bandwidth and coupling level. The design procedure is based on a set of curves relating the most important geometrical parameters of the physical structure to the relevant electrical parameters of the DCLDC. This is exemplified by means of a 3-dB coupler with an impedance of 50 Ω at the terminal ports, which is designed, fabricated, and measured. In order to reduce common-mode (CM) transmission, which is the main drawback of any balanced/differential circuit, a compact CM rejection filter has been added at one of the input ports. Good agreement between simulated and measured results are obtained, thus proving the benefits of the proposed structure and the usefulness of the design procedure.

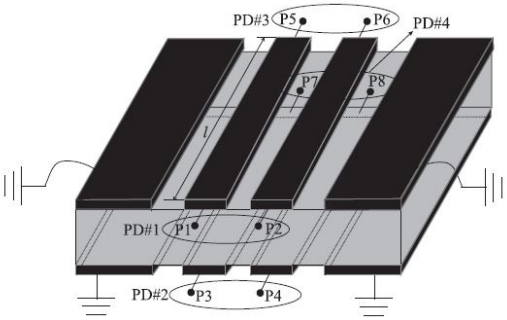

Figure 1. 3-D layout of the proposed DCLDC in a double-side CPW substrate. The eight physical single-ended ports (P1–P8) and the four corresponding differential ports (PD#1–PD#4) are shown.

References

[1] F. Martín, L. Zhu, J. S. Hong, and F. Medina, *Balanced Microwave Filters,* Hoboken, NJ, USA: Wiley, 2018. doi:10.1002/9781119238386.

[2] J. Martel, A. Fernández-Prieto, J. L. Medrán del Río, F. Martín and F. Medina, "Design of a Differential Coupled-Line Directional Coupler Using a Double-Side Coplanar Waveguide Structure With Common-Signal Suppression," *IEEE Trans. Microw. Theory Techn.*, **69**, 2, pp. 1273-1281, Feb. 2021, doi: 10.1109/TMTT.2020.3041226.2018.