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Society for e-Business Studies

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춘계학술대회

SPRING CONFERENCE OF KISM & SEBS 2019

PROCEEDINGS

일시 : 2019년 04월 26일(금) ~ 27일(토)
장소 : 한국교통대학교 충주캠퍼스

Oral Session 2 : Smart Information
4월 27일 (토) 09:00-10:30
발표장 : 한국교통대학교 충주캠퍼스 중앙도서관 605호 / 좌장 : 한복동(한국교통대)

O07 (p22)	제목 :	리뷰 속성 분류를 통한 감성 판별 방법
	저자 :	임명진(조선대학교), 신주현(조선대학교)
O08 (p25)	제목 :	High-Isolation Branch-Line Balun with Wideband Characteristics
	저자 :	Qi Wang(전북대학교), Phirun Kim(전북대학교), Junhyung Jeong(전북대학교), Yongchae Jeong(전북대학교)
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	저자 :	박정훈(삼성전자 AI센터), 임강빈(순천향대학교)
O11 (p33)	제목 :	지능형 영상, 음성 패턴 알고리즘 기반 Home Security 시스템
	저자 :	김시원(한국교통대학교), 정주호(한국교통대학교), 오염덕(한국교통대학교), 안준호(한국교통대학교), 이광(한국교통대학교)
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	저자 :	Phanam Pech(전북대학교), 정준형(전북대학교), Girdhari Chaudhary(전북대학교), 정용채(전북대학교)

High-Isolation Branch-Line Balun with Wideband Characteristics

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Abstract

This paper presents a design of high-isolation branch-line balun with wideband characteristics. The high isolation can be obtained by adding a shunt coupled-line open-stub and a resistor between the output ports. The branch line balun was designed at center frequency (f_0) of 3.5 GHz. The simulated bandwidth of 20 dB return loss is 0.91 GHz (3.05–3.96 GHz). The power divisions of 3.05 dB at f_0 are obtained. The isolation better than 20 dB is obtained over a bandwidth of 1.318 GHz (2.887– 4.205 GHz). The simulated phase imbalance is better than 180 ± 8^o over the bandwidth of 0.91 GHz.

1. Introduction

High-isolation branch-line balun have been researched and applied in many applications such as push-pull amplifier [1], antennas [2], and mixers [3]. In [4], a three-layer wideband Marchand balun was presented using slot-coupled microstrip lines. This work did not consider isolation characteristics between the output ports. Marchand baluns with high isolation characteristics were introduced in [5], [6]. These works were considered only at the center frequency (f_0), which can provide a narrow bandwidth characteristic. Three-ports baluns composed of symmetrical four-ports branch-line structures by a terminating an open-circuited port were reported in [7], [8]. In [8], a branch-line balun with stubs on vertical branches, which can eliminate unwanted even-mode capacitance and reduce overall circuit size, was presented. However, the circuit performances had relatively narrow bandwidths and did not consider the isolation characteristic between output ports.

In this paper, wideband high isolation branch-line balun is proposed. The general designed equations are derived. The high isolation can be obtained by using open-circuit parallel coupled line and a shunt resistor at the output ports.

2. Design Equations

Fig. 1 shows the proposed structure of high-isolation wideband branch-line balun. The proposed circuit consists of a pair of horizontal quarter-wavelength ($\lambda/4$) transmission lines (TLs) with characteristic impedance Z_2 and a pair of vertical half wavelength ($\lambda/2$) TLs with characteristic impedances Z_1. The parallel coupled lines connected back-to-back with a shunt resistor at the center of the

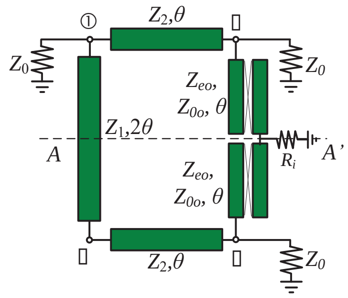
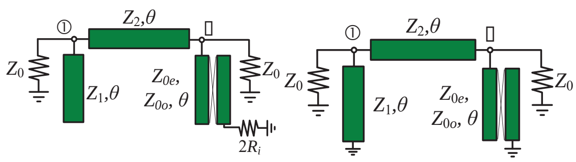


Fig. 1. Proposed high isolation wideband balun structure.



(a) (b)

Fig. 2. Equivalent circuits: (a) even- and (b) odd-modes.

coupled line are used for the wideband high isolation characteristic. From [7], the even- and odd-mode excitations are applied to derive design equations. The even- and odd-mode equivalent circuits of proposed circuits are shown in Figs. 2(a) and 2(b), respectively. Under the even-mode excitation, the symmetrical plane of AA' can be considered as a perfect magnetic wall (open-circuited). Under the odd-mode excitation, the symmetrical plane of AA' can be considered as a perfect electric wall (short-circuited). From Fig. 2(b), the S_{11} at f_0 of the odd-mode equivalent circuit can be derived as (1).

$$S_{11}\big|_{f=f_0} = \frac{Z_2^2 - 2Z_0^2}{Z_2^2 + 2Z_0^2} \quad (1)$$

From (1), the characteristic impedance of Z_2 with the specific S_{11} at f_0 can be found as (2).

$$Z_2 = Z_0 \frac{2\left(1 - S_{11}\big|_{f=f_0}\right)}{1 + S_{11}\big|_{f=f_0}} \tag{2}$$

The even-mode impedance (Z_{0e}) of the coupled line can be found as (3) by setting $S_{11} = 0$.

$$Z_{0e} = \frac{(2Z_{0o} + p) + \sqrt{p(8Z_{0o} + p)}}{2}, \tag{3a}$$

where

$$p = \frac{2Z_1 Z_2}{2(Z_1 + Z_2) - Z_1}. \tag{3b}$$

Z_1 and Z_{0o} can be chosen arbitrarily and Z_2 can be found from (2).

From Fig. 2(a), the isolation resistor R_i is split in half along the axis-*AA*'. The resistance R_i can be found as (4) with the specific isolation $S_{23}|_{f0}$.

$$R_i = \frac{(Z_{0e} - Z_{0o})^2 \left[2Z_0^2 - S_{23}\big|_{f_0}\left(Z_2^2 + 2Z_0^2\right)\right]}{Z_L 8\left[S_{23}\big|_{f_0}\left(Z_2^2 + 2Z_0^2\right) + Z_2^2\right]}, \tag{4}$$

where $S_{23}|_{f0}$ is the magnitude of the isolation at f_0.

The design procedure of proposed balun is summarized as follow. Firstly, specify Z_{0o}, Z_1, f_0, $S_{11}|_{f0}$, and $S_{23}|_{f0}$. Then Z_2, Z_{0e}, and R_i can be calculated from (2), (3), and (4), respectively.

3. Design Example

To validate the proposed circuit and designed equations, a wideband high isolation branch-line balun was designed at f_0 = 3.5 GHz with 20 dB return loss and isolation at f_0. The characteristic impedances of Z_1 = 70 Ω, Z_{0o} = 55 Ω, and $S_{11}|_{f0}$, = $S_{23}|_{f0}$ =20 dB were chosen. From (2), (3), and (4), Z_2 = 63.9602 Ω, Z_{0e} = 151.7051 Ω, and R_i = 19.1288 Ω are calculated, respectively. The simulation is performed using ADS tool. Fig. 4 shows the *S*-parameter characteristics of the proposed wideband branch-line balun. From the simulation, the return loss of 20 dB is obtained at f_0. The bandwidth of 20 dB return loss is 0.91 GHz (3.05 – 3.96 GHz). S_{21} = S_{31} = 3.05 dB is obtained at f_0, respectively. The amplitude imbalance better than ± 0.3 dB is obtained within the bandwidth of 0.91 GHz. The isolation between the output ports is obtained as 20 dB at f_0. Isolation better than 20 dB is obtained over a bandwidth of 1.318 GHz (2.887– 4.205 GHz). The simulated phase imbalance between two output ports is better than 180 ± 8° over the bandwidth of 0.91 GHz.

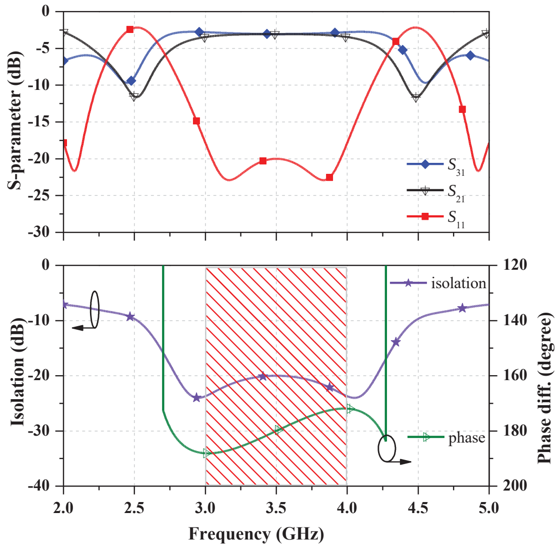


Fig. 3. Frequency response of proposed wideband balun high isolation (@Z_0=50 Ω).

4. Conclusion

In this paper, a wideband branch line balun is proposed. The high isolation can be obtained within a wideband characteristic using shunt coupled lines and a shunt resistor between the output ports. The magnitude of return loss and isolation at center frequency can be chosen arbitrarily. The low phase imbalance can be obtained over the wideband. The proposed circuit is simple to design and can be applicable for wideband RF systems.

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