A wideband balun of tapered structure using planar microstrip

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Abstract - In this paper, a wideband balun of tapered structure using planar microstrip is desigde ad analyzed. The balun structure was fabricated on a Teflon substrate with a thickness of 0.8mm and relative dielectric constant ε_r of 2.5. Two back-to back CPW-to-CPS transitions were simulated and optimized using HFSS. A movel plaar balun using tapered structure of microstip to CPW is suggested and designed. The measurement result, the bandwidth for a reflection coefficient better than -10dB of the balun is 2GHz to 8GHz. The planar balun can improved the performance of wideband spiral antenna.

Keywords: Balun, planar microstrip, CPW, CPS

1 Introduction

Balun can get can get the signal that is the size the half of an input signal and has each other 180° phase differences in the output port.

To be used for feed of balanced element, The structure to be composed of coaxal cable must become a plane structure that March-and presents in 1944. Due to a plane structure, this has general advantages of the circuit of a plane form and this can make the circuit as well simple. We make the Balun with a remainder part of a feeding circuit easily conbine.[1]

Balun can divide by passive balun that use active balun and coaxial cable, CPW (coplanar waveguide), microstip line etc. that use active component. In the case of active balun, because there is shortcoming that power consumption and high-pitched noise happen, passive balun is used much present. In the case of passive balun, we use microstrip to slot line combined structure, CPW to slot line combined structure, CPW to CPW combined structure in microstrip form of most plane structure. [2][3]

We must use balun that is designed by transformer when connect feed line from wideband planar waveguide of unbalanced structure to plane strip line of balance structure.

2 Structure and analysis method

2.1 Designs of proposed Balun

For this study Used several chebyshev multistage impedance matching transformer to be conformed to characteristic impedance 80Ω of spiral antenna in SMA connector 50Ω. [4]

This depends on ratio in each impedance, and reflection coefficient designed by 0.05 chebyshev multistage impedance matching at conversion by 80Ω impedance in 50Ω impedance. Balun characteristic of figure 1 appears. Figure 1 is explaining each balun's parts.

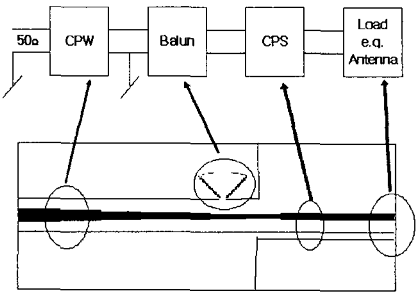

Fig 1. balun's basis structure

Chebyshev converter designs chebyshev polynom ial expression and $\Gamma(\theta)$ that have special quality of most suitable as is same.

When speak that N are number of stage of chebyshev converter, we put $\Gamma(\theta)$ commensurately with $T_N(\sec\theta_m \cos\theta)$ and compose chebyshev uniformity ripple pass-band filter converter that design.

$$\begin{aligned}\Gamma(\theta) &= 2e^{-jN\theta}[\Gamma_0 \cos N\theta + \Gamma_1 \cos(N-2)\theta + \cdots \\ &\quad + \Gamma_n \cos(N-2n)\theta + \cdots] \\ &= Ae^{-jN\theta}T_n(\sec\theta_m \cos\theta)\end{aligned} \tag{1}$$

It is $(1/2)\Gamma_{N/2}$ if N are odd from last term of series of formula (1), and it is $\Gamma_{N/2}(\cos\theta)$ if is even.

As case of binomial converter, can yield constant A indeed deciding frequency by 0.(in other words, $\theta = 0$)

Therefore,

$$\Gamma(0) = \frac{Z_L - Z_0}{Z_L + Z_0} = AT_N(\sec\theta_m) \tag{2}$$

$$A = \frac{Z_L - Z_0}{Z_L + Z_0}\frac{1}{T_N(\sec\theta_m)} \tag{3}$$

Now, in passband filter, $\Gamma_m = A$ become because maximum value of in passband filter by formula (1) is 1 if speak Γ_m size of maximum permission reflection coefficient.

that is, θ_m is

$$T_N(\sec\theta_m) = \frac{1}{\Gamma_m}\left|\frac{Z_L - Z_0}{Z_L + Z_0}\right| \tag{4}$$

or,

$$\sec\theta_m = \cosh\left[\frac{1}{N}\cos^{-1}\left(\frac{1}{\Gamma_m}\left|\frac{Z_L - Z_0}{Z_L + Z_0}\right|\right)\right] \tag{5}$$

If know θ_m, we can calculate fractional bandwidth.

$$\frac{\Delta f}{f_0} = 2 - \frac{4\theta_m}{\pi}$$

If unfold $T_N(\sec\theta_m \cos\theta)$ and put to have resemblant terms that have relationship $\cos(N-2n)\theta$ form, can yield Γ_n from formula (1), can yield characteristic impedance Z_n.[4]

2.2 Structures of proposed Balun

First, CPW of Taper structure and CPS feed in Patch form on dielectric substance upside. And in chebyshev multistage transformer's beginning point Coaxial of(+), to(-) Ground connect. We connect planar CPS structure on balun's end part after change characteristic impedance 50Ω to change impedance 80Ω through chebyshev multistage transformer. Balun is consisted of transformer of 7 stage, and each transformer has $4/\lambda$ length.

At lower part figure 2, to measures balun's return loss (S_{11}) and insertion loss (S_{21}) value, we connected 2 balun each other. Substrate is teflon board($\varepsilon_r = 2.5$), and size did by 25mm×25mm×0.8mm.

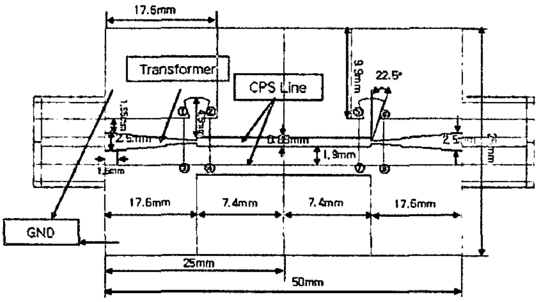

Fig. 2 Back-to-back coupled balun structure.

3 Measurement and Simulation result

To distinguish whether balun express flat transfer characteristic in frequency band that want, connecting 2 balun directly like figure 2, we measured and compared with simulation. Radial slot's angle 45° is properest as Simulation result, and radius could get the best result when is 4.5mm. Figure 3 appears returnloss and insertion loss when reduced balun's size by 1mm in 0.8mm to 25mm×25mm(25~22mm)×0.8mm. Size is decrescent, characteristic curve by high frequency shift did and insertion loss shows that improve .

Figure 4 appears parameter characteristic curve to shift by high frequency when reduced size by 1mm in 0.8mm to 35mm × 25mm(25~22mm) × 0.8mm. In 5~6GHz, returnloss rises about 0.7 dB but improved about 1 dB in 3~4GHz.

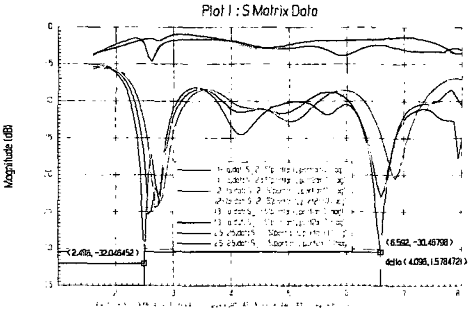

Fig. 3. balun's simulation result.

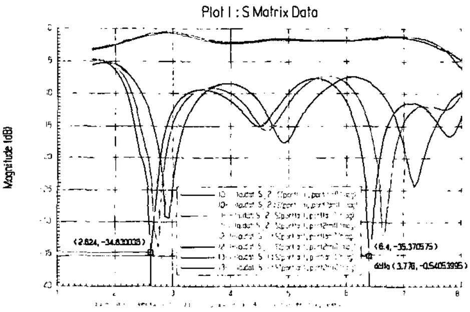

Fig. 4. balun's simulation result.

Figure 5 appears parameter characteristic curve to shift about 200MHz by low frequency when increased size by 1mm in 0.8mm to 25mm×25mm (25~7mm)×0.8mm, returnloss is improved in high frequency and insertion loss worsened about 2dB in low frequency.

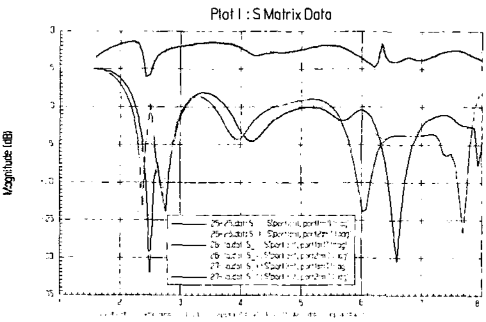

Fig. 5. balun's simulation result.

Returnloss improved about 1.3dB high frequency (5~6GHz) as result that figure 6 measures in network analyzer equipment Version 8510C. And, insertion loss appears about within -2dB ~ -3dB. That shows characteristic curve such as Simulation result. Figure 7 is picture that manufacture actually of Coupled balun structure. To connect both ground plane by jump line, we could reduce Return loss.

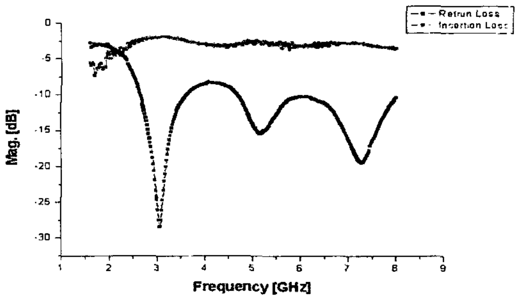

Fig. 6. balun's results of measurements.

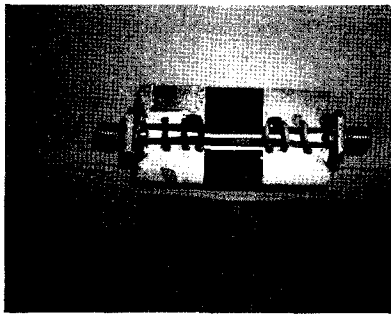

Fig. 7. Back-to-back balun's manufacture picture.

4 Conclusions

This study proposed implementable balun in Teflon substrate using CPW structure of microstrip of Taper structure.

Proposed balun's numerical analysis used FEM, and return loss improved as whole size grows at simulation result, but insertion loss worsened. And, whole size is more decrescent, return loss grew worse, but insertion loss is improved. As a result to measure in network analyzer equipment Version 8510C, return loss appeared by maximum (-28 dB) in 3GHz, returnloss is within -10 dB in permissable frequency extent 2GHz~8.0GHz and insertion loss was -2dB ~ -3dB interior and exteriors

Therefore, proposed balun can prove whole performance when used in antenna. Balun that is proposed in this study is advantage that can get broadband property, and realize by small volume and area relatively. Also, planar balun is apt to design and manufacture, and can get broadband property by a low-cost

Therefore, broadband balun that propose in study can be improved whole performance in balanced Mixer, amplifier, antenna to get broadband property in an input and output,

References

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