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Excitation networks for ultra-wideband antennas

***Abstract**. This paper attempts to give an overview of the excitation network of ultra-wideband (UWB) technology by covering aspects such as theory, challenges, designing steps, characteristics and performance. Proposed novel ultra-wideband hybrid based on stripline technology cover frequency range 3–6 GHz due to ETSI standards. Provided analysis considers EMD problems related to transmission of short duration impulses.*

***Streszczenie.** Artykuł prezentuje układy wzbudzenia ultraszerokopasmowych anten: podstawy teoretyczne, wymagania, procedury projektowania, charakterystyki oraz właściwości. Zaproponowano nowy układ hybrydowy oparty o technologię paskową do pracy w paśmie ETSI UWB 6-8,5GHz. Analiza uwzględnia aspekty EMD dotyczące transmisji krótkich sygnałów. (**Układy wzbudzenia ultraszerokopasmowych anten**).*

Keywords: ultra-wideband technology, EMD analysis, UWB excitation network of antennas, computer-aided design
Słowa kluczowe: technologia ultraszerokopasmowa, analiza EMD, układy wzbudzenia anten UWB, projektowanie komputerowe

Introduction

Today's wireless technologies cannot meet increasing requirements of users that explore bandwidth for wireless connectivity. Currently implementation of UWB technology requires solving some technical challenges and opens issues [1-3]. Nowadays common portable devices include small antennas that can be integrated into the equipment with excitation network. In this work the novel planar ultra-wideband hybrid is proposed as excitation network for such structures in Europe ETSI UWB bandwidth 6.0-8.5GHz. The spectral properties of UWB signals cannot allow for direct implementation of hybrid theory [5]. The reported model of the hybrid includes coupled striplines that can be integrated on the same substrate with UWB radiators.

Concept of UWB stripline hybrid

Nowadays wireless devices require small size structures basing on transmission medium having good performance in wide frequency range. The simplest solution can be realized in *stripline technology* that allows to design excitation network on the same substrate as dedicated for printed ultra-wideband antennas.

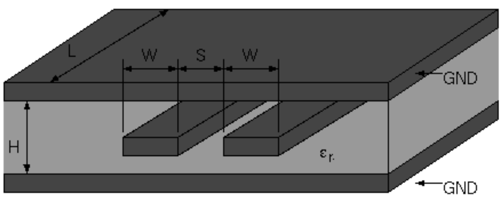

Fig.1. View of coupled striplines

Stripline can be treated as conductor sandwich with dielectric between a pair of ground planes. It has *similar properties to coax cable* usually used for narrowband baluns [4]. Due to analysis UWB hybrid can be made by two running transmission lines parallel to each other on the one surface. Example of coupled striplines is shown in Figure 1.

Design of UWB stripline hybrid

There are few steps in design procedure of stripline broadband hybrid. At first it is necessary to select convenient substrate characterized by relative permittivity. The structure will be integrated on the same substrate with common radiating planar monopoles. After analysis various structures of planar antennas it can be easily noticed that laminated provided by Rogers Corporation have good performance and can be adopt for this solution. In this work it was used high frequency laminate *Duroid 5880*. Thickness of plate is 1.575mm with relative permittivity $\varepsilon_r = 2.2$.

The major issue was to find *equivalent circuit of coaxial cables* (used in ideal hybrid). During research it was found that similar performance could be achieved using coupled striplines. All analysis and further design proceedings were carrying out by circuit-level simulator offered by Ansoft Corporation. Firstly, the dimensions of coupled lines creating ideal hybrid (Fig. 2a) were found. Calculated characteristics shown good power division between considered ports in frequency range between 6-8,5GHz (Fig. 2b). In this model it is not assumed the length of connection between each components ("zero").

Then, using the achieved width (w=7mm) and distance between coupled lines (s=5mm) the model the *stripline hybrid UWB* containing sectional matching lines was implemented in Serenade Design Environment. Analyzed circuit has two input ports having 50Ohm impedance description. The load of the network is 2-element antenna array having impedance 100 Ohm. It was tested different structures being modification of presented circuit; one of these is shown in Fig.4.

During research it was assumed the distance (around 4mm) between coupled lines and other parts that will reduce interferences (which may change performance of the system). It must be underlined that length of the connections between couple lines on each side must be the same.

One matching line has 3 section of stripline – the total length is 8mm. Second part includes 2 sectional lines –the total length is 16mm (concerning 8mm for coupled lines). The structure of UWB stripline hybrid was optimized using available in the software algorithms.

Numerical results

Proposed hybrid was analyzed in terms of scattering parameters (showing power distribution between each ports). The voltage standing wave ratio is evaluated to help understanding the performance of the excitation network. Results of computations provided in Serenade Design Environment are presented in Fig.3. Calculated frequency characteristics of s13 and s14 parameters are in level of around -3dB over the entire frequency range confirming that transmitting signal will be almost equally divided between two outputs. Analyzing shown characteristic of voltage standing wave ratio in Fig. 3b it can be easily noticed that the level of SWR almost does not exceed 1.2 in whole UWB band. The transmitted signals, in the form of very short pulses, will not be distorted so sufficiently small structure can be easily integrated into various equipments working in ETSI UWB frequency band.

a) b)

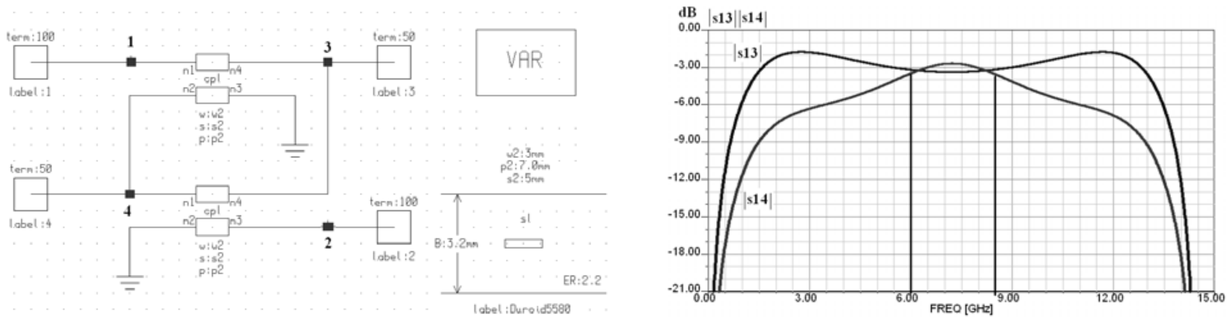

Fig.2. Structure (a) and characteristics (b) of equivalent ideal hybrid based on coupled striplines

a) b)

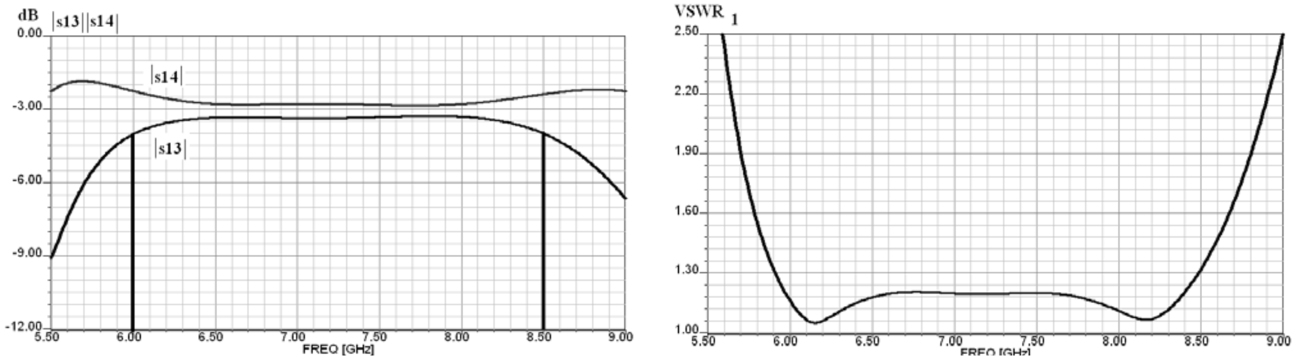

Fig.3. Characteristics of scattering matrix (a) and calculated voltage standing wave ratio for port 1 (b) of proposed hybrid

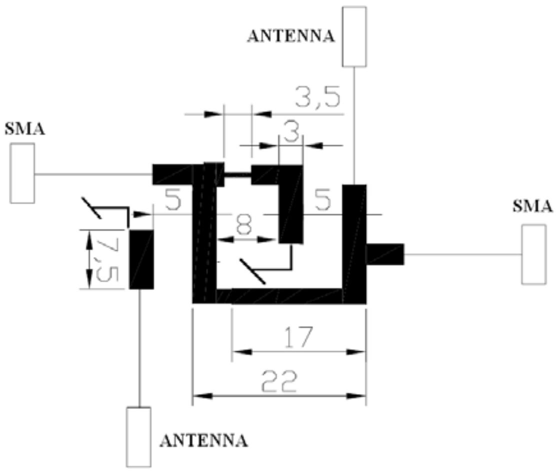

Fig.4. Layout of metal layer of striplines hybrid

Conclusions

Many microwave systems and measurement devices require hybrids as important components [1,3]. They perform the function commutating inputs in used frequency band due to ETSI regulation 6-8,5GHz. In addition to the required ultra-wide operation bandwidth, planar implementations are desired for an easy integration with radiating elements of antennas [2].

In the paper, the design procedure for stripline hybrid on UWB application is presented. Using the proposed algorithm, the structure of metallization layout (in terms of scattering parameters) was selected and examined. To aid the balun design and characterization was used circuit-level simulator - Serenade Design Environment offered by Ansoft Corporation. Results of a computer simulation of proposed hybrid confirm good performance due to ETSI UWB standard. Achieved results are promising and will be the base for next analysis and research in this field.

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