Form 2

Dissertation Abstract

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Dissertation title	Novel Compact Ultra-Wideband Microstrip Power Dividers（新しい小型超広帯域マイクロストリップ電力分配器に関する研究）		

Abstract

※ *The abstract should be in keeping with the structure of the dissertation (objective, statement of problem, investigation, conclusion) and should convey the substance of the dissertation.*

In Japan, the current cable television (CATV) systems are designed working over 10 MHz ~ 770 MHz. On the other hand, in order to accommodate the 4K and 8K broadcasting services, the intermediate frequency (IF) for satellite-television receivers is now extended to 3.224 GHz from the present 1.032GHz ~ 2.071GHz. In other countries, like the United States of America and China, similar frequency bands are also used in the CATV and satellite-television systems. As a result, the next generation of a common transmission platform on which both the CATV and satellite-television systems can be accommodated is required to be capable of operating over a few megahertz to a few gigahertz. In order to build such a transmission platform, it is strongly demanded to develop novel, compact, and ultra-wideband power dividers (PDs).

Conventional power dividers, like the most commonly used Wilkinson power dividers (WPDs) are designed with different techniques corresponding to the frequencies. At frequencies of a few gigahertz or higher, distributed transmission lines like microstrip lines are usually used. The performance of this kind of WPDs, particularly the isolation between the outputs, becomes poor at low frequencies. The circuit size of the WPD becomes also too large to be acceptable when designed at a few megahertz.

At frequencies of tens of megahertz or lower, miniaturized PDs can be designed by using lumped element circuits. However, the parasitic effects and losses associated with the lumped elements increase rapidly with frequency, and the performance of this type of PDs deteriorates drastically at frequencies up to gigahertz.

Other works reported PDs working at frequencies over a few megahertz to a few hundreds of megahertz. However, ferrite cores and hand-made copper inductor coils are used, which are time-consuming, costly, unstable in performance, weak to vibration, and cannot work at frequencies up to gigahertz.

In this wok, we try to research and develop novel and compact microstrip PDs with ultra-wideband property for possible applications in future CATV and satellite-television systems. First, a novel and general design method of wideband transmission line impedance transformers is proposed which will be used later for the design of PDs. Next, a novel compact microstrip PD is proposed and designed

which will be used as the basic structure of our finally developed compact ultra-wideband PD. Finally, two types of novel ultra-wideband PDs are proposed, designed, and both their measured frequency responses satisfy well the design specifications.

The dissertation consists of six chapters described below.

Chapter 1 introduces first the motivation and objective of the research of this dissertation. Then, a comprehensive review of previous publications on wide band impedance transformers and PDs is provided, which makes clear the challenging problems associated with the research target of our work.

Chapter 2 describes a design method of wideband bandpass filters using shunt short-circuited stubs, which will be extend to the design of wideband impedance transformers in Chapter 3. The design method of conventional WPDs is then explained briefly for design of wideband and ultra-wideband PDs in the following Chapters.

Chapter 3 presents a novel and general design method of wideband impedance transformers consisting of transmission lines and shunt short-circuited stubs. Based on the derived formulas, all the circuit parameters are determined with the assistance of a self-coded optimization program. The design method is general and can be applied to impedance transformers with an arbitrary number and arbitrary mounting positions of the short-circuited stubs. The design method is also accurate, efficient, and are verified well by multiple designed examples with excellent measured results.

Chapter 4 introduces first the design method of conventional WPDs through the design example of a five-section WPD. Next, a novel compact wideband PD is proposed, and its design method is developed. The proposed and designed microstrip PD at 3.0 GHz occupies an area of only $0.20\lambda_g \times 0.13\lambda_g$, which is much smaller compared with the conventional five-section WPD having the same level of performance. The structure of the proposed PD is simple without using coupled- lines, via-holes, and defected ground structures (DGS).

Chapter 5 describes our proposed two types of novel ultra-wideband PDs aiming at applications in future CATV and satellite-television systems. By loading shunt lumped compensation elements at appropriate positions to the five-section WPD or to the compact wideband PD designed in Chapter 4, the operation frequency band of the PD is significantly extended from tens of megahertz to a few gigahertz. Both the simulated and measured performances of the proposed two types of microstrip ultra-wideband PDs meet the design specifications well. At most frequencies ranging from 10 MHz to 4 GHz, the VSWRs at all three ports are less than 2.0, the insertion loss at the two outputs is within 3.3 ~ 5.0 dB, and the isolation between the two output ports is larger than 10.0 dB. It is concluded that both the proposed ultra-wideband PDs are good candidates for future CATV and satellite-television systems.

In Chapter 6, the main research works and obtained results of this dissertation are summarized, and a brief discussion on prospective future works is also given.