In this Thesis the realization of low-loss microwave circuits in strip transmission line technique has been studied. Several novel design methodologies, circuit topologies and realization schemes have been proposed. The conducted theoretical studies have been supported with experimental results on an example of numerous manufactured circuits. Within the scope of the Thesis, various approaches have been considered and investigated focused on power loss reduction.

Alternative, to classic solutions, circuit topologies and realization schemes have been studied on an example of microwave filters to allow for obtaining a given functionality while featuring improved properties such as highly-selective frequency response, compact physical size or relatively low insertion loss. The periodic structures approach was considered and proven to be well suitable for the realization filters for which a cascade connection of *n* identical, electrically small unit cells of given properties is used.

Following, the influence of circuit topology and realization technique on the total power loss have been investigated on an example of broadband pseudo-highpass microwave filters. It was shown that by improving the filters topology by replacement of relatively lossy lumped components with distributed type ones as well as changing from stripline/microstrip to suspended stripline/microstrip allows for significant reduction of power loss.

Moreover, design methodologies and circuit topologies focused on performance improvement have been studied to allow for power loss reduction on an example of directional filters and directional couplers. It was show that a high-performance circuits can meet the design requirements while featuring shorter total electrical length or requiring less physical area.

A natural next step was to investigate the possibility of power loss reduction by integration of functionalities within one circuit and increasing level of integration of various circuits on an example of power division/summation networks for both amplitude and frequency, Circuits with simultaneous power division and impedance transformation have been show to for the application in compact multi-channel power amplifiers. Moreover, a directional filters based frequency multiplexers have been proposed where high selectivity is obtained by integration of both filter`s response and multiplexer`s topology properties.

Additionally, the application of novel materials and manufacturing technologies for low-loss circuits realization within microwave frequency range has been considered. It was shown that by enabling the 3rd degree of structure control allows for the design of compact high-performance circuits as it has been shown on an example of directional couplers. Moreover, aspects such as materials conductivity, dielectric properties and manufacturing technologies have been investigated in terms of requirements for low-loss circuits realization ;

Finally, it was shown that reduction of power loss allows to extend the circuit functionality on an example of broad-range impedance tuner for source and load pull transistor measurements. The proposed tuner has been proven to be useful for finding optimal terminating impedances for maximum power termination of high-power transistors allowing to design an exemplary 20 W output transceving front-end.

The original achievements of the Author presented in this Thesis can be summarized as follows:

- Development of compact unit cells composed of coupled and uncoupled transmission line sections allowing for bandpass filters realization, published in [1].

- Development of a compact unit cell composed of transmission line sections allowing for bandstop filters realization, published in [1].

- Development of pseudo-highpass filters composed of transmission line sections and lumped capacitor unit cells, published in [1].

- Development of loss-reduced pseudo-highpass filters composed of transmission line sections and lumped capacitor unit cells, published in [1].

- Development of loss-reduced pseudo-highpass filters composed of coupled and uncoupled transmission line sections unit cells, published in [1].

- Development of miniaturized travelling wave directional filters, published in [1].

- Development of traveling-wave directional filters with additional, easily controllable transmission zeroes created by appropriate cascading two identical filters, published in [1].

- Development of low-loss directional filters composed of two differential bandstop filters featuring improved isolation bandwidth, published in

- Development of traveling-wave directional filters with additional, easily controllable transmission zeroes created by introduction of loose cross coupling, published in [1].

- Development of a broadband directional coupler composed of loosely coupled single-section directional couplers in tandem configuration, published in []

- Development of impedance transforming directional coupler with high impedance transformation ration, published in []

- Development of impedance transforming balance-to-unbalance signal converting circuit, published in

- Development of design approach for frequency multiplexers where increased selectivity of each channel is obtained by appropriate design of asymmetric directional filters and taking advantage of multiplexer`s topology, published in

- Theoretical investigation, confirmed with experimental results on the application of FDM type 3D printing with conductive filaments for realization of low-loss microwave circuits in suspended microstrip technique, published in [] and []

- Development of realization technique of multilayers microstrip circuits using a combination of additive manufacturing technique, published in []

- Development of design methodology with enabled 3rd degree of structure control using 3D printing for realization of high-performance directional couplers in suspended stripline, published in []

- Development of low-cost impedance tuner with realizable ration of VWSR as high as 41:1 for load and source pull transistor measurement, published in

- Development of high-power RF front-end for ADS-B vehicle transponder and MODE-S interrogator with 20 W peak output power amplifier.

In the view of the above listed achievements it can be concluded, that the goals stated in \hyperref[intro:goal]{Introduction} have been achieved. Various design techniques, circuit topologies and retaliation schemes have been investigated proving that low-loss filters (goal I) and power division/summation circuits such as directional couplers and frequency multiplexers (goal II) can be realized in strip transmission line technique. Finally, an exemplary high-power RF frontend was developed (goal III).

~~The Author believes that the research results presented in the Thesis can be useful in further development of low-loss and highly integrated circuits and functional blocks of , particularly in the context of growing demand for transmitting and receiving capabilities of telecommunication systems.~~

The Author believes that the research results presented in the Thesis focused on power loss minimization of circuits realized in strip transmission line technique will contribute to the development of microwave theory and techniques and will be useful in further development of highly integrated functional blocks of telecommunication systems., particularly in the context of growing demand for transmitting and receiving capabilities. The replacement of currently used combination of metal waveguides and PCB technology with one uniform realization technique will allow much more efficient utilization of the system`s physical volume and higher integration of particular building blocks leading to fulfillment of the above stated demands.

~~Opracowane w ramach rozprawy doktorskiej nowe metody projektowania oraz rozwiązania układowe ukierunkowane na minimalizację strat wtrąceniowych wykonane w technice linii paskowych przyczynią się do rozwoju techniki mikrofalowej. Ponadto, w przyszłości pozwolą na lepszą integrację poszczególnych bloków torów nadawczych sprzętu telekomunikacyjnego dużej mocy oraz zmniejszenie całkowitych rozmiarów systemu poprzez zastąpienie obecnie wykorzystywanych układów wykonanych w technologii falowodów jednorodnym, zintegrowanym systemem zaprojektowanym z wykorzystaniem techniki linii paskowych.~~

Further research efforts will be focused on the application of 3D printing technology for the realization of strip transmission line circuits with enabled third dimension of circuit control opening new directions of circuits and systems development. The preliminary results presented in [x], [x], [x] have shown the potential of such approach, however there are challenges that needs to be solved in order for it to be applicable. Moreover, modeling and design of circuits in true three dimensional space requires new tool and methodologies to be developed.

Another promising direction of further research can be found in the design and manufacturing of very high frequency circuits where waveguide technique is replaced with strip transmission line technique. It has been shown in [tmtt\_aerosol] and [eumw\_aerosol] that the application of aerosol jet 3D printing technology in combination with conductive inks and very low loss dielectric inks has a potential for realization of mm-wave circuits. However, further development is required in terms of materials and manufacturing process optimization.