Preface

In the design of electronic equipments, additional frequency components outside the frequency band of interest are generated for various reasons such as interference and nonlinearity. The additional frequency components are unwanted band of frequencies as they affect the satisfactory functioning of the equipments. Filter circuits are inserted between appropriate electronic modules in the equipments to pass the required band of frequencies with minimum attenuation and to reject the unwanted band of frequencies with maximum attenuation. The frequency band of filters varies with the design requirements of equipments. Considering size, frequency band and other electrical characteristics of filters, a host of technologies is available for designing the filters.

Commercial electromagnetic field simulator is popular for designing RF (Radio Frequency) filters. Vast microwave literature on filter design technologies is available and they are also used for designing RF filters. The application of microwave literature for designing lumped/semi-lumped filters and combline/iris-coupled microwave cavity filters is presented. The design of the filters is based on the established design procedures from the Microwave Filter Design Book [1] and practical industrial experience. The design equations and graphs available in the various chapters of the Microwave Filter Design Book are organised in the form of tutorials and the design of the filters is illustrated with examples to enthuse confidence among students and young entrepreneurs to become RF filter designers. The tutorial presentations could be computerised to save design time of RF filters. Physical understanding of the terms and characteristics of RF filters is emphasised in the book. Mathematical treatment is limited to the level that supports physical understanding. The book complements engineering textbooks on RF components and provides valuable support for the project assignments of students.

Chapter 1 explains the need for RF filters and discusses the performance characteristics of the four basic types of filters, namely, low pass, high pass, band pass and band stop filters. Industrial applications of the most commonly used filters are indicated. The RF filter terms, Characteristic impedance, Transmission lines and VSWR are fundamental for all RF engineers and they are explained in detail in Chap. 2. The concept of impedance is derived from resistance using a simple example. The commonly used transmission line structures, coaxial, microstrip and stripline lines, are described. VSWR is explained graphically for open circuit, short circuit, matched and partially matched load conditions with numerical examples for better understanding.

RF filters are characterised by electrical specifications. The electrical specifications are explained in detail with random limiting values for low pass, high pass, band pass and band stop filters in Chap. 3. Typical performance graphs are provided for the four basic types of filters. Mechanical specifications and environmental requirements are industrial needs in designing RF filters. Mechanical specifications cover dimensions (outline), weight, input/output connectors and finish. Environmental specifications pertain to operating temperature, humidity and sealing requirements. The industrial needs are briefly presented.

Lumped/Semi-lumped, Microwave cavity and Microstrip/Stripline technologies for designing RF filters are presented in Chap. 4. Electrical circuit configurations are indicated for the lumped low pass, high pass, band pass and band stop filters explaining the functioning of the filters. The concept of semi-lumped filter is explained indicating the method of developing distributed capacitance. Structure, applications, advantages and the equivalent circuits of combline and iris-coupled microwave cavity filters are discussed. The construction and applications of basic microstrip/stripline circuits and computer aids for the design of the filters are briefly presented.

RF filter designs that just satisfy the specified requirements of customers are termed as functional designs. Functional design is definitely the core design task but it alone is not adequate. RF filters should also be designed for repeatability, reproducibility, produceability and reliability in addition to functional design requirements. Simple definitions for the four abilities, the benefits of value added design and the practical method of integrating the abilities with functional design are explained in Chap. 5.

The design of lumped and semi-lumped tubular low pass filters is illustrated with examples in Chap. 6. Guidance is provided for the selection of inductors and capacitors of lumped RF filters. The method of realising distributed capacitors and the interconnection of the reactive elements are explained for tubular filters. End coupling to input/output connectors and the tuning of filters are also explained.

The design of combline and iris-coupled cavity band pass filters is illustrated with examples in Chap. 7. Guidance is provided for the design of the piece parts of the cavity filters. The design graphs presented in the Microwave filter design book [1] need to be referred for designing cavity filters. Polynomials are fitted to the design graphs using computer-oriented numerical techniques [2], eliminating the need to refer the graphs. The methods of coupling end resonators to input/output connectors and the tuning of filters are explained.

Practical expertise is shared for the design and manufacturing of lumped low pass RF filter, semi-lumped tubular low pass filter, combline band pass filter and iris-coupled band pass filter in Chap. 8. Preventing the degradation of the reliability of piece parts of filters, tuning, ‘cut and try’ method, cross coupling for steep roll down filters and developing filter design software are some of the important topics covered in the chapter.

Additional information regarding the modes of transmission, RF coaxial connectors and statistical analysis of filter characteristics for six sigma design are provided in the Appendices.

References

1. Matthei GL, Leo Y, Jones EMT (1980) Microwave filters, impedance-matching networks, and coupling structures. Artech House, Norwood
2. Rajaraman V (1985) Computer oriented numerical techniques. Prentice Hall International, New Delhi

http://www.springer.com/978-3-642-32860-2

A Practical Design of Lumped, Semi-lumped &
Microwave Cavity Filters
Natarajan, D.
2013, XII, 148 p., Hardcover
ISBN: 978-3-642-32860-2