



2009 at RS



## This Issue's Feature

### Unique Waveguide Bandpass Filters with Wide Stopbands

Low insertion loss bandpass filters with wide spurious free stopband are usually realized by cascading a bandpass inductive iris-coupled  $TE_{101}$  mode cavity filter (BPF) and a broadband quasi-lowpass filter (LPF), such as waffle iron, corrugated, or ridged waveguide evanescent mode filter. While the BPF provides the filter selectivity on a relatively narrowband basis, by employing high Q-factor resonators, the quasi-LPF is used to reject the BPF's harmonics. Such a LPF employs relatively low Q-factor resonators and has a wide passband. In this way, the overall loss is the sum of the losses of the two cascaded filters. For receiving application, this could be not good enough to guarantee the required radio-link performance.

RS Microwave developed new non-conventional designs for high Q-factor waveguide BPFs that provide a wide spurious free stopband without needing a cascaded quasi-LPF, thus reducing the insertion loss performance with respect to the conventional approaches. The designs take into account also the rejection of the higher order modes.

Different concepts are implemented in the filter design:

- Capacitive irises instead of inductive irises: a capacitive iris is itself as a lowpass element and provides better spurious performance at high frequency;
- Wider cavities: the width of the cavities is dimensioned for suppression of low frequencies spurious (generated by the capacitive irises), and for moving most of the high frequency harmonics within prescribed frequency ranges. The width of the cavities can also change along the filter (inhomogenous approach).
- Input/output semi-lumped resonators: short sections of corrugated waveguide with associated input notch elements are used as first and last resonators of the filters. The input/output corrugated resonators provide significant harmonic suppression while do not affecting dramatically the filter insertion loss; the associated notch elements provide further suppression on prescribed frequency ranges.

- Reduced size waveguide sections: reduced size rectangular or ridged waveguide sections are used at the filter sides to reject higher order modes propagation and for further suppression of the dominant mode in the lower stopband.

Fig.1 shows the design of a bandpass filter assembly, including a 90 degree H-plane bend, at 20.7 GHz. The interfaces are standard WR-42. The filter order is six: the first and last cavities are semi-lumped corrugated resonators, while the other four cavities are  $TE_{101}$  mode resonators coupled through capacitive irises. Two E-plane stubs (notch elements) are associated with the first and last resonator. The H-plane 90 degree bend is interfaced with two reduced width waveguide sections that avoid the transmission of the  $TE_{20}$  mode within the required stopband.

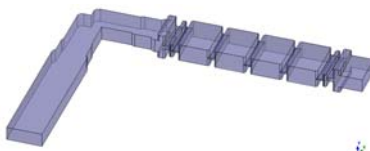


Fig. 1: Wide spurious free waveguide bandpass filter assembly (20.7 GHz)  
(cont'd p.2)

## Our Latest Technical Developments

A report from Yaroslav Krishtal tells of RS Microwave's current work on a new prototype high frequency switch using the latest MMIC technology. One of the goals is to be able to manufacture high frequency, low cost switches using off the shelf surface mount components. Parallel to that effort, we are investigating the possibility of expanding the manufacture of extremely small size components such as beam lead diodes using wire bonding techniques. Resultant success will open a wide array of possibilities for in-house manufacture of these microwave components, expanding product offerings while keeping manufacturing costs low.

In addition, work is progressing on adding to our high power test capability. The high power amplifier presently under construction will be capable of providing CW signal in excess of 300 Watts in VHF/UHF band. The amplifier is scheduled for use this Fall.

## Company News

### Microwave Doctoral Student Visits

Simone the Perugia paid summer as doctoral



Bastioli from University of us a visit this part of his research. His

dissertation advisor, Professor Roberto Sorrentino, a colleague of Dr. Snyder, recommended him for the visit. Simone's doctoral thesis area is in innovative waveguide filters using ridge resonators, which are the subject of many of his previous publications.

Dr. Snyder has been pleased to assist Simone in practical aspects of his technical studies while here. Simone has gained valuable insight for his work and the microwave field from consultation with Dr. S. and the engineering staff here. He has seen how RS Microwave and all its employees participate in a complex process that solves a customer problem, each making a unique and specific contribution resulting in an "ideal", not just "working", filter for a myriad of important applications.

Besides his research experience, Simone has thoroughly enjoyed his stay in the U.S. including our American hospitality, barbecues, Duncan Donuts, 4<sup>th</sup> of July, New York and the Yankees! In his own words: "I would like to thank everybody at RS Microwave who made me feel like I was at home. I will not forget them and their kindness."

### 2009 MTT International Symposium Followup

While no real winner was declared in the debate of the century on the technology known as "metamaterials", it appears that the filter and network experts won the day over readiness of "Harry Potter type" invisibility. The jury is out on the next steps the erudite colleagues will take.

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## This Issue's Feature

(cont'd from p.1)

Fig. 2 shows the HFSS simulation of the assembly. The pass band is 20.2 – 21.2 GHz. Concerning the stopband, not less than 60 dB rejection are simulated up to 47 GHz, that is 2.3 times the filter center frequency (1.6 is usually accomplished with ordinary waveguide bandpass filters). No lower stopband spurious are present above -50 dB transmission. The simulated pass band insertion loss considering ideal copper surfaces is about **0.2 dB**: an equivalent design employing a cascade of a conventional BPF and a quasi-LPF would lead to roughly 0.4 dB simulated insertion loss.

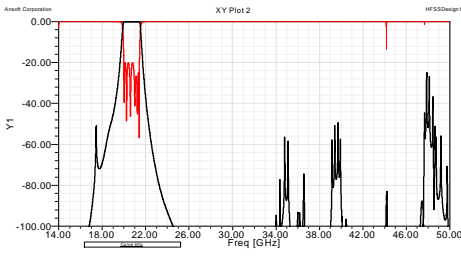


Fig. 2: HFSS simulation of the filter assembly of Fig. 1.

Fig. 3 shows a multimode HFSS simulation ( $TE_{01}$ ,  $TE_{20}$ , and  $TE_{30}$  are considered) demonstrating that the higher order modes are suppressed as well below -50 dB transmission up to 47 GHz: this is of crucial importance when the filter is implemented within a complex waveguide assembly in which higher order modes can be excited and feed the filter.

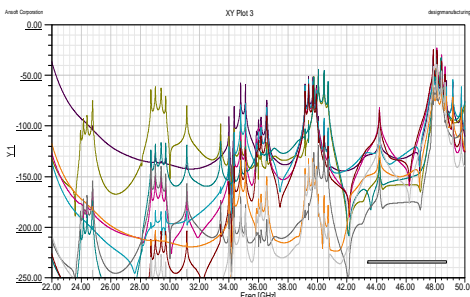


Fig. 3: Multimode HFSS simulation ( $TE_{01}$ ,  $TE_{20}$ , and  $TE_{30}$  are considered) of the stopband of the filter assembly of Fig. 1.

This article continues to describe four more figures and can be read in its entirety on our website at <https://www.rsmicro.com>.

## Employee Milestones



In recognition and appreciation of our longtime employees and their years of dedicated loyal service, RS has held a ceremony publicly awarding Certificates of Appreciation and Service Award Plaques to the following with thanks and congratulations.

### 10 Years+ Appreciation

*Jovo Palavestra  
Liljana Rajcinoska  
Pavel Sirka  
Valerie Snyder*

### 15 Years+ Appreciation

*Ginny Van Ess  
Howard Booth  
Richard Mann  
Sveto Jojic*

### 20 Years+ Service Awards

*Larry Jobes  
Pero Jojic  
Kevin Keck  
Helen Rupp  
Charlie Rupp  
Eugene Clegg\*  
Ralph Wiertz\**

\*Previously in 2007 and 2008, Ralph Wiertz and Eugene Clegg were also each shown the Company's appreciation and feted in honor of their **Quarter Century** of Dedicated Service to RS Microwave. A few employees above are coming up on a quarter century of service and we plan to show them our appreciation in a special way very soon!

## Personnel News

*Look who joined us in 2009!*



Terry Pearson joined us after a long term temp assignment with us. A formal welcome to her.

*In other news*, Rosa Kotevska is a grandmother for the second time. Congratulations!

And, many of employees are taking advantage of home buying opportunities. We wish Yaroslav, Alam, Juana and Dennis best wishes in their new homes.

## RS Products In Brief

### Filters - 1 MHz to 40 GHz

High Power - Low Loss  
Blind-Mate - Drop In  
Dielectric Resonator  
Notch Filters  
Coax or Waveguide

Tunable, Higher Order Mode

### Multiplexers - 1 MHz to 40 GHz

Contiguous  
Non - Contiguous  
Switched

### Subsystems - 1 MHz to 20 GHz

Combinations, including:  
Filters  
Circulators  
Amplifiers and Switches

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