Some General Aspects of Interconnects and Packaging

Wolfgang Menzel

Microwave Techniques, University of Ulm, PO Box, D-89069 Ulm, Germany
Phone: +49-731-5026350, Fax: +49-731-5026359, E-mail: wolfgang.menzel@ieee.org

Outline

- Introduction
- Substrates and transmission lines
- Interconnects
- Environmental protection
- Moding, resonances
- Outlook

Frequency ranges for commercial mm-wave application

Application/Band	Frequency	Bandwidth
ISM bands	24.0 – 24.25 GHz 61.0 – 61.5 GHz	0.25 GHz 0.5 GHz
Point-to-point communication	24.5 – 26.5 GHz, 27.5 – 29.5 GHz 37.0 – 39.5 GHz 55.78 – 58.2 GHz 64 - 65 GHz	2 GHz 2.5 GHz 2.42 GHz 1 GHz
LMDS	22.0 – 23.6 GHz, 40.5 - 43.5 GHz	1.6 GHz 3 GHz
VSAT	17.7 – 20.2 GHz/27.5 – 30.0 GHz	2.5 GHz
Automotive sensors	24.0 – 24.25 GHz 76.0 – 77.0 GHz 92 - 95 GHz (USA)	0.25 GHz 1 GHz 3 GHz

For a long time, conventional micro- and mm-wave circuit and "packaging" technologies were based on "chip and wire", mostly realized as individual solutions.

(Special substrates, custom designed housings, specialized machines…)

Parallel to this, the high pin count of signal processing circuits led to the development of new substrate techniques (e. g. ceramic multilayer), surface mounting of devices and ICs, flip-chip, ball grid arrays, …

In the last year, these techniques were more and more refined, became more accurate, and therefore have found increasing interest for micro- and mm-wave circuit.

First applications of such technologies are found mobile phones, GPS, bluetooth, WLAN using well established production techniques

- PCBs based on FR4 multilayer substrates, low-cost LTCC, mixed substrates
- Thick film techniques
- Bonding, SMD device mounting (flip chip), …

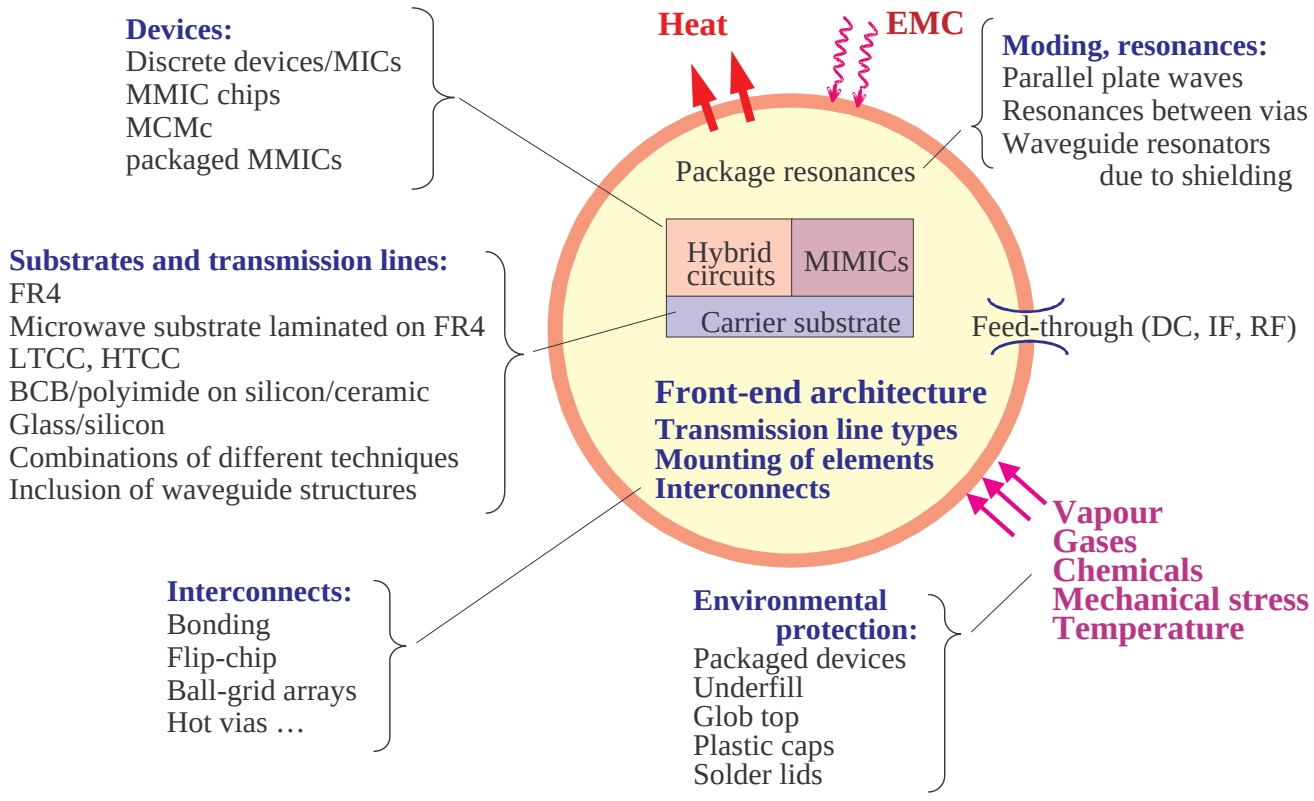
Although mm-wave frequencies require improved accuracy, tolerances, finer structures etc., approved techniques should be applied for a cost-effective mass production.

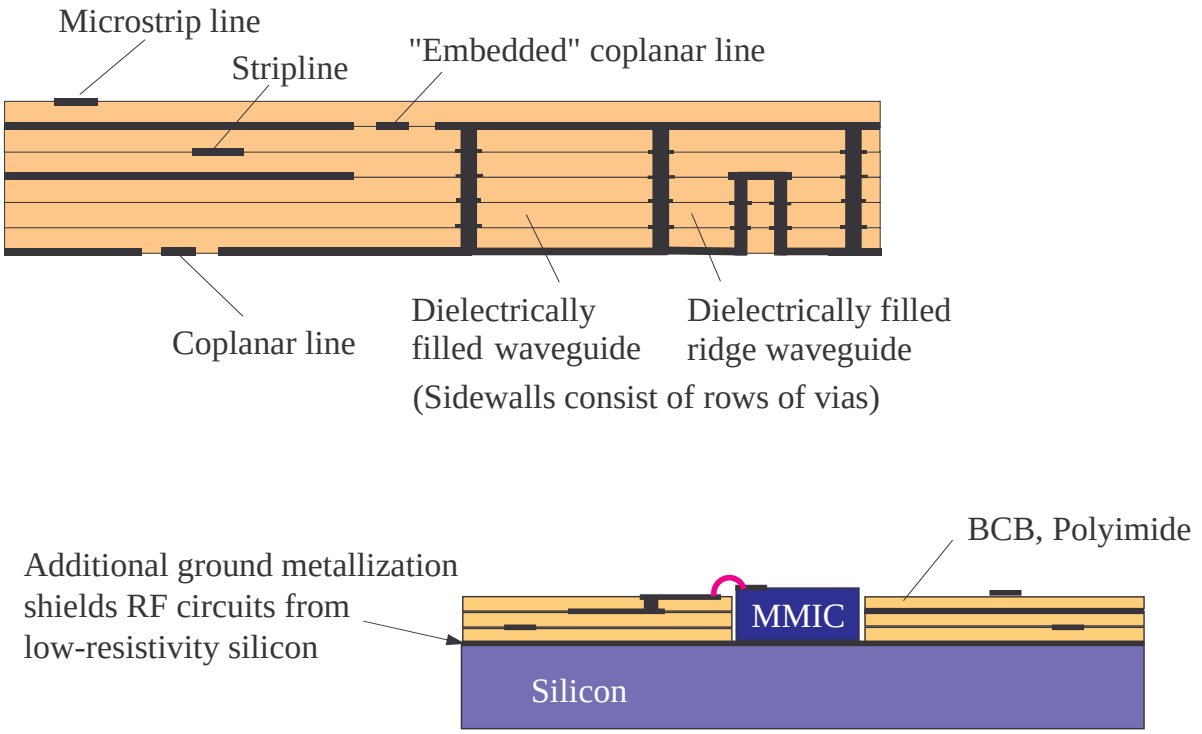
If this is not completely possible, only critical circuit parts should be produced using specific microwave techniques and the combined with low-cost technologies.

Requirements

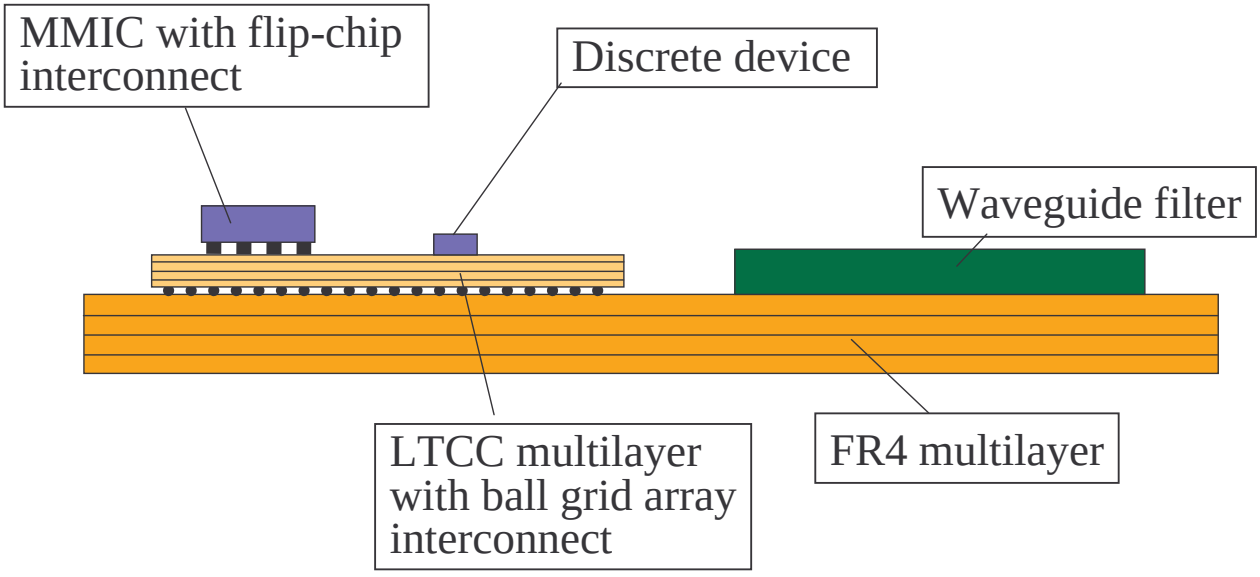
- Optimized front-end architecture
  - Best performance
  - Easy manufacturability
- Improved simulation, tolerance-centered design
- Improved manufacturing technology based on established facilities
- Appropriate interconnect techniques
- Process control

→ Low cost
→ Reliability

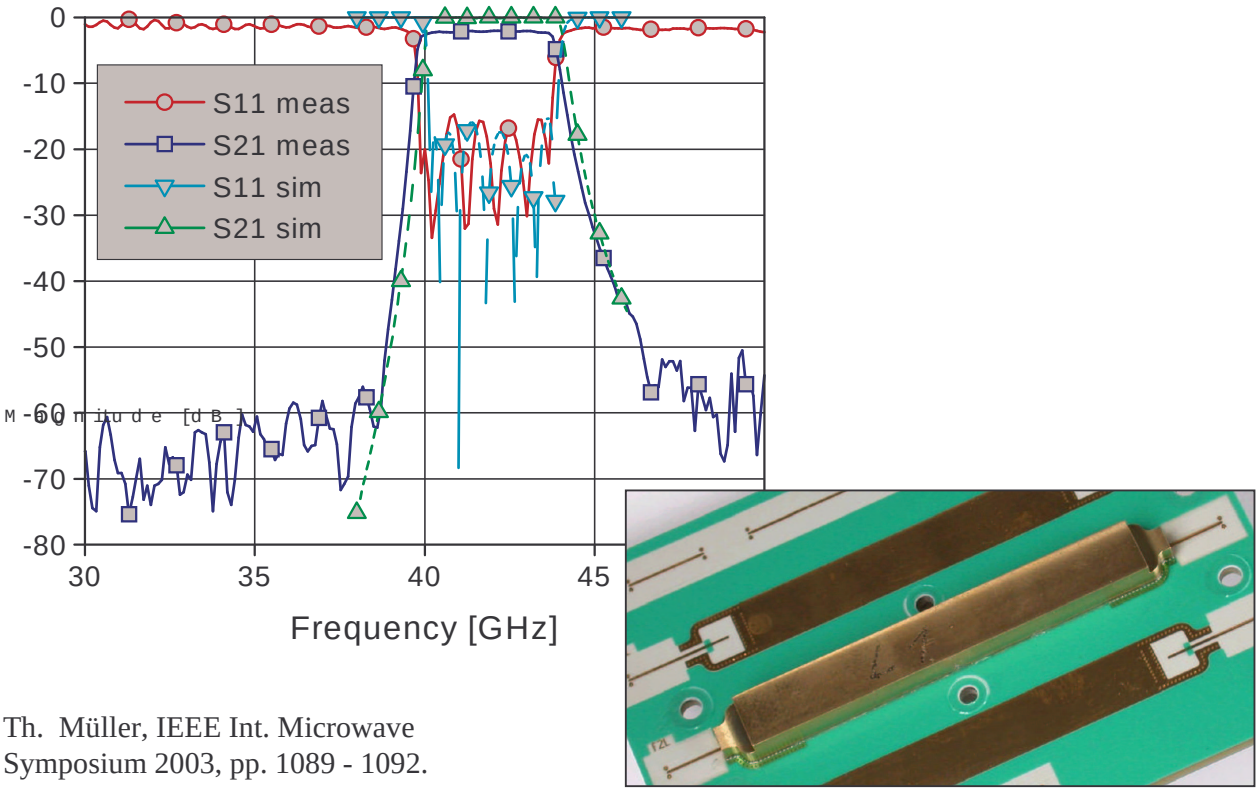




Cross section of a multilayer substrates with different types of transmission lines.

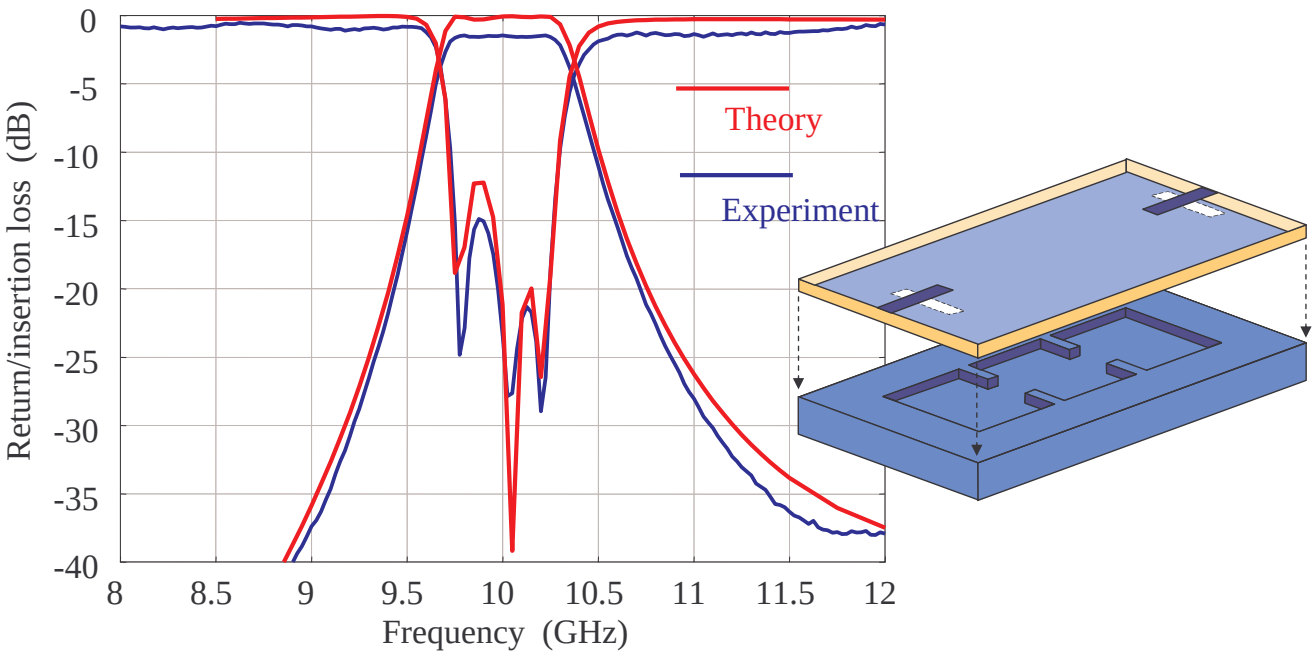


Substrate and transmission line mixture



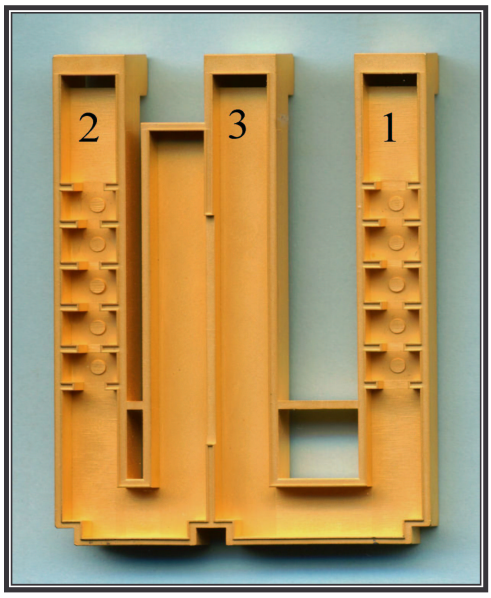
Th. Müller, IEEE Int. Microwave Symposium 2003, pp. 1089 - 1092.

Waveguide filter integrated on top of a substrate (courtesy of EADS, Ulm)

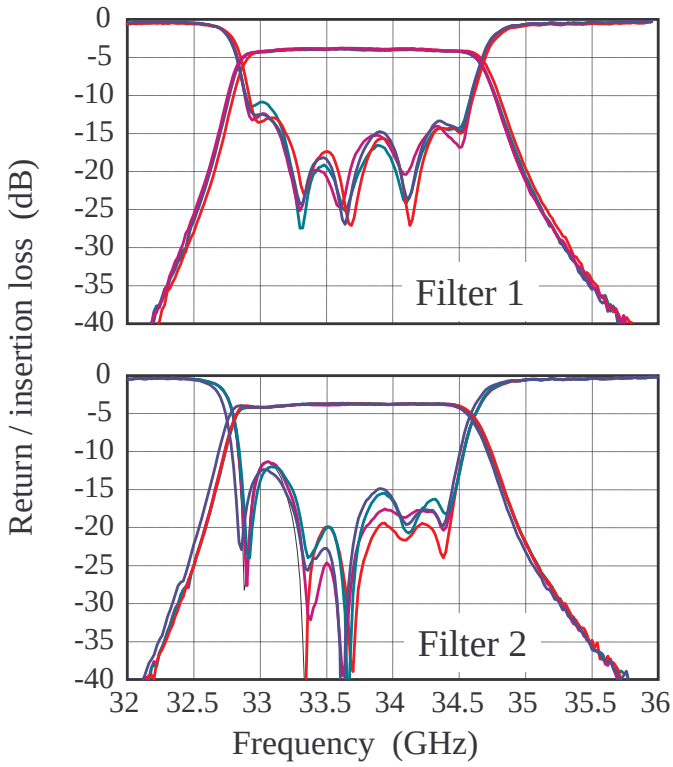


W. Menzel, M. Wetzel, European Microw. Conf. 2002, pp. 957 - 960 (Vol. III).

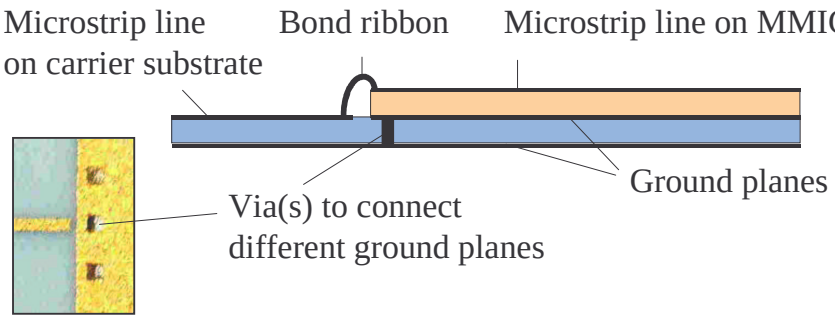
Waveguide filter integrated in the carrier plate of a planar circuit

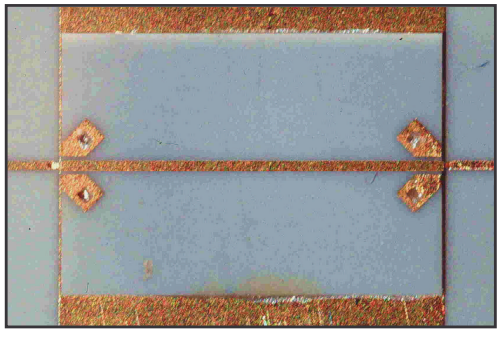


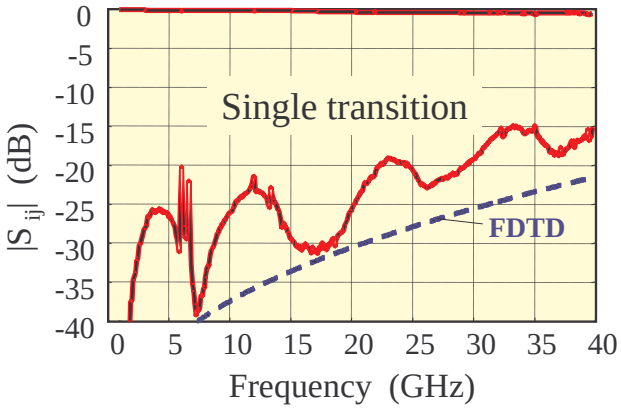
W. Menzel , J. Kassner, U. Goebel, IEICE Transactions on Electronics – C, Japan, pp. 2021 – 2028.



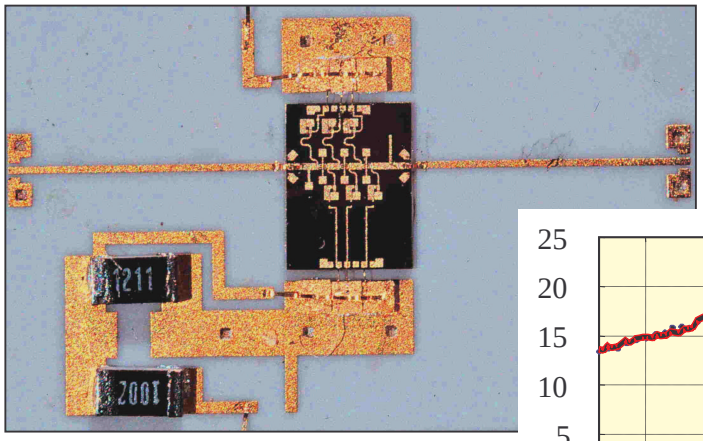
Filter/coupler assemblies realized with plastic injection molding and electroplating

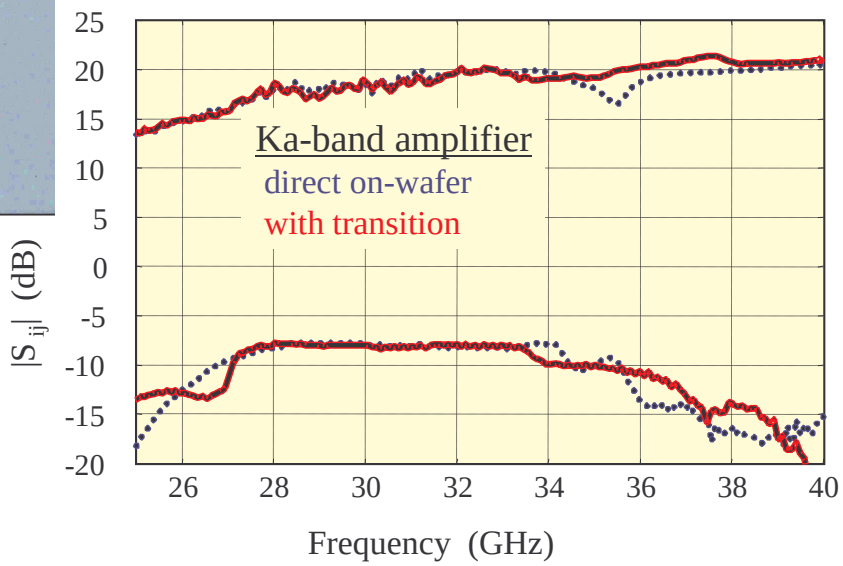




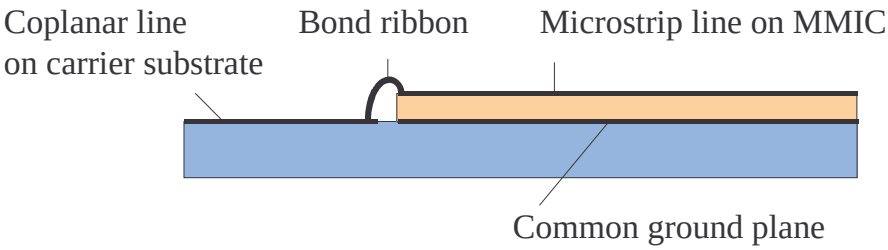


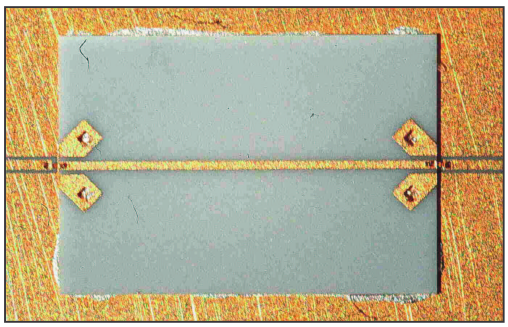
Microstrip on microstrip connected by bond ribbons (homogeneous line)

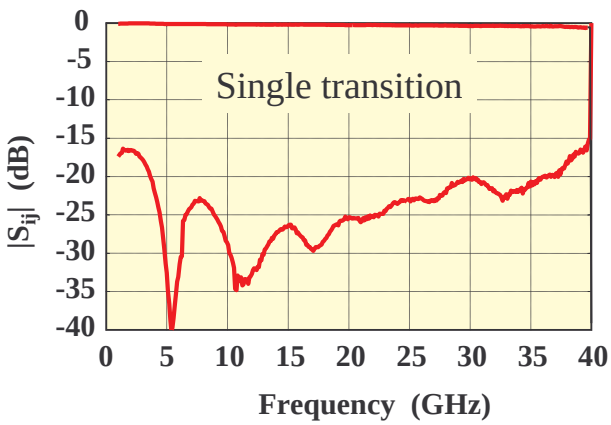




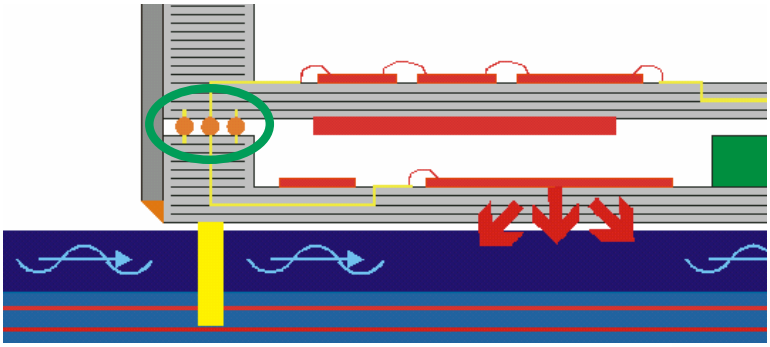
Microstrip on microstrip connected by bond ribbon (MMIC amplifier)

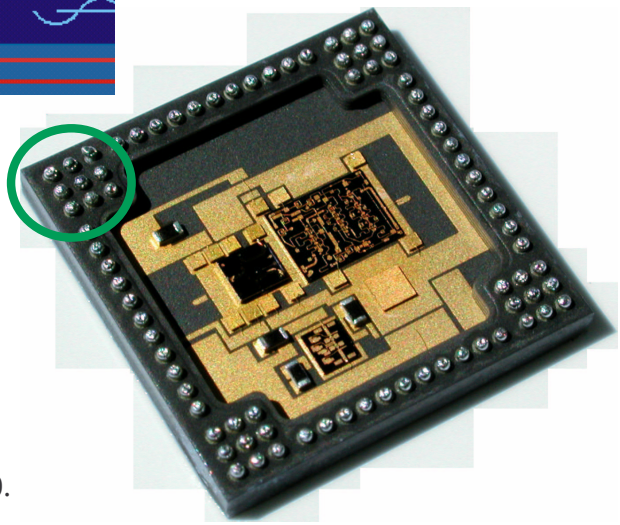






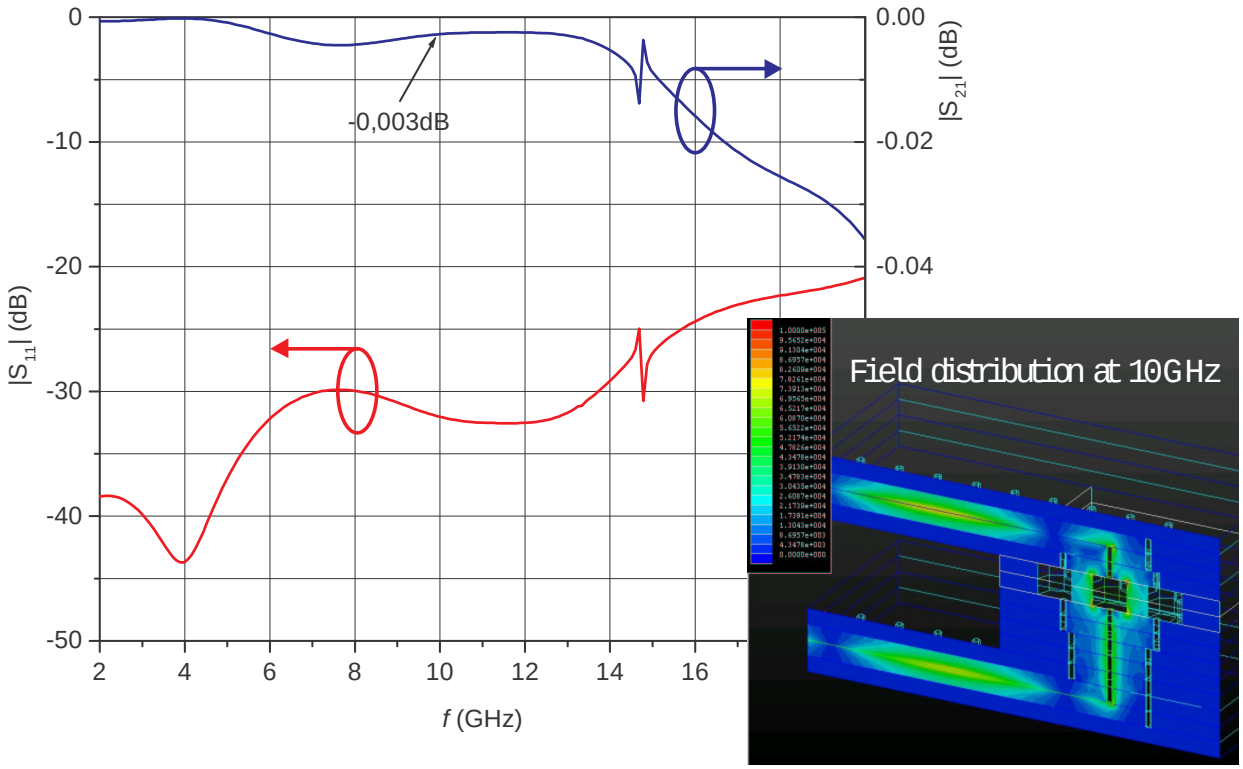
Microstrip on coplanar line connected by bond ribbons (homogeneous line)



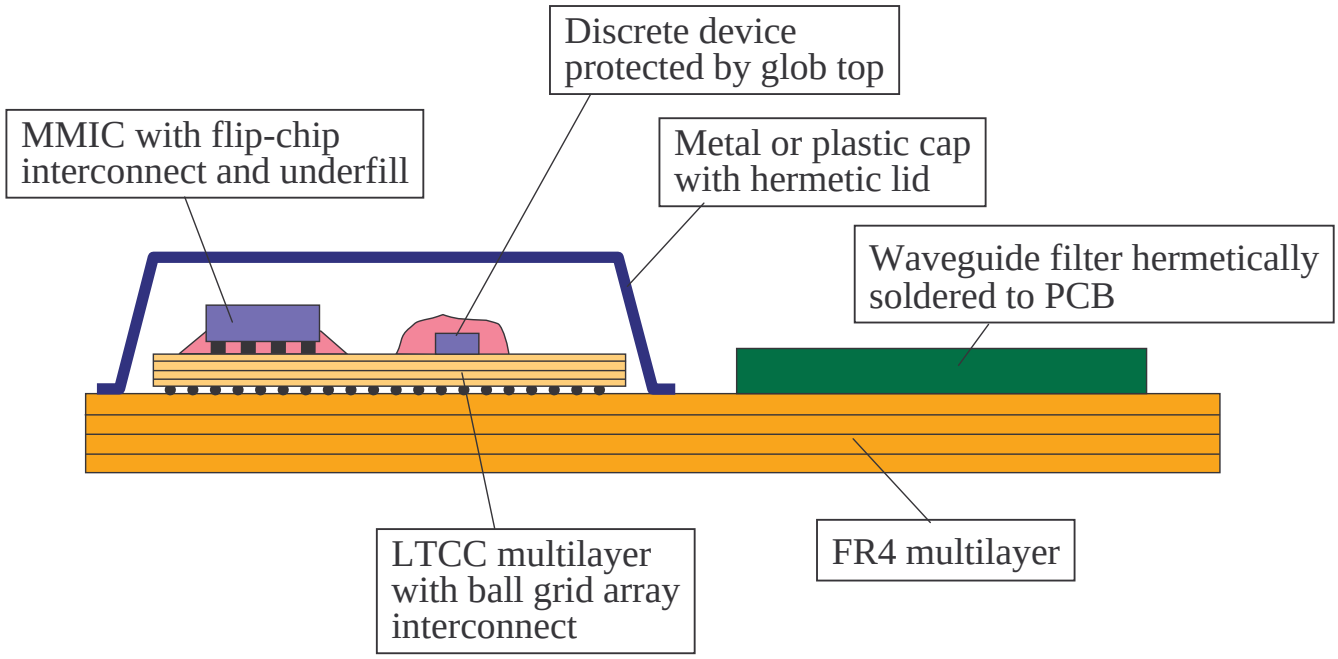


M. Schreiner, H. Leier, H.-P. Feldle, W. Menzel,
IEEE Int. Microwave Symposium 2003, pp. 567 - 570.

Cross section and photograph of an active phased array module for conformal array applications



Return and insertion loss of a transition via solder balls

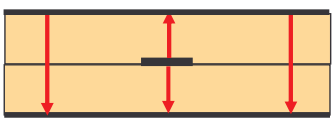


Some possibilities of hermetic sealing

Coplanar line with desired field distribution

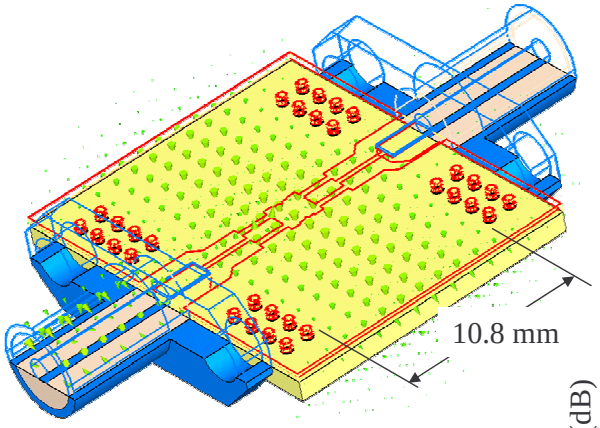
Coplanar line with slot mode

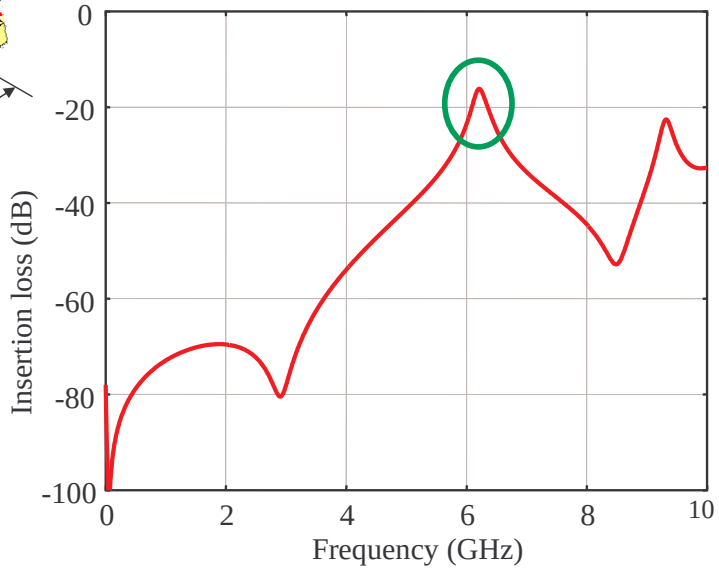
Conductor-backed coplanar line with cpw/microstrip mode and parallel-plate waves



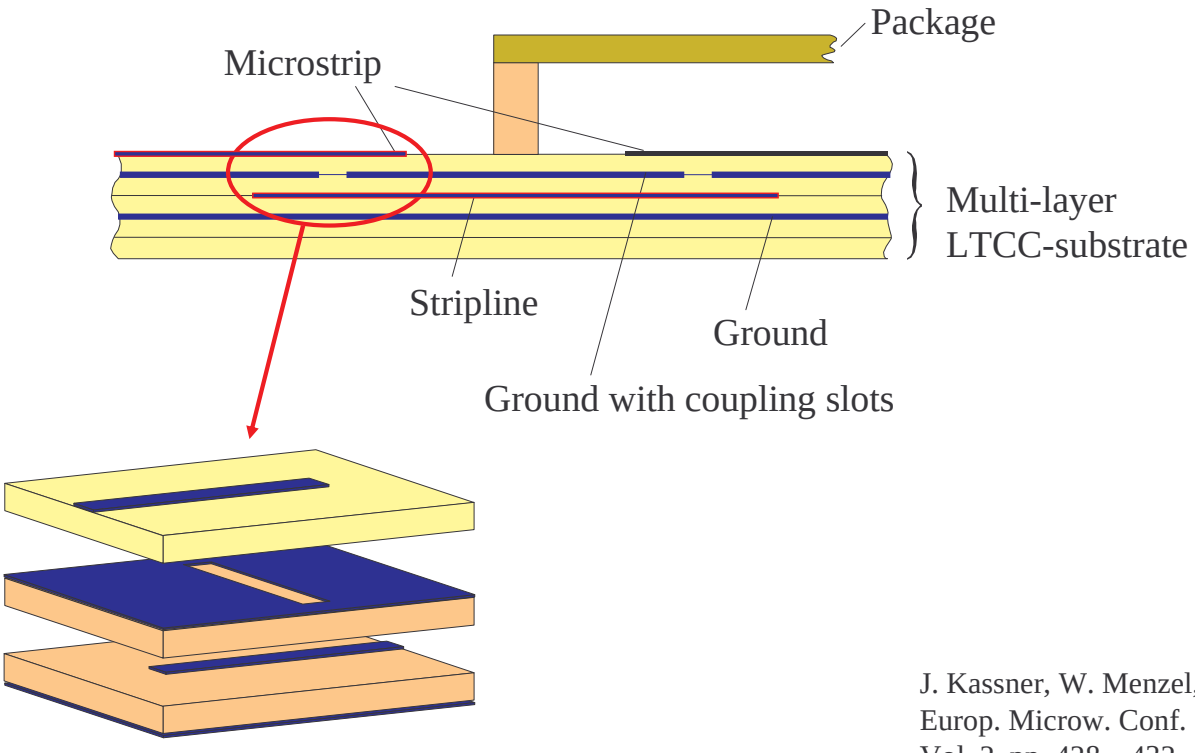
Stripline with desired mode and parallel-plate waves

Desired and undesired modes in planar waveguides



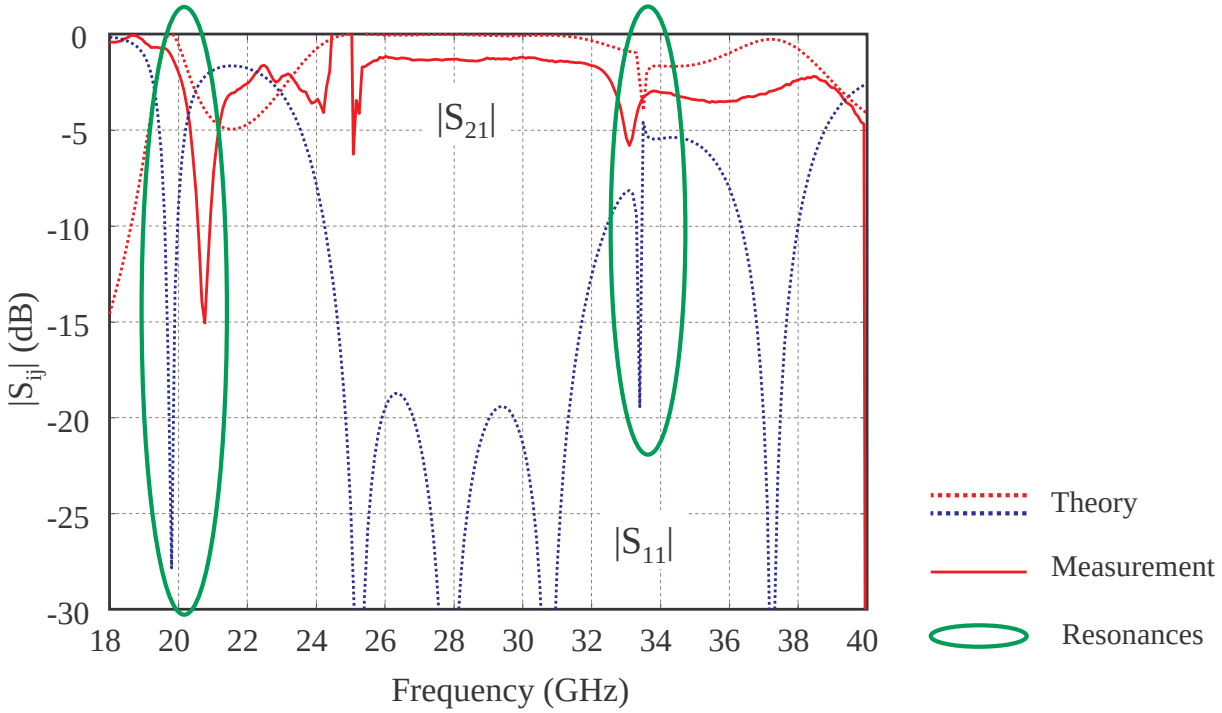


Resonances in a PCB test substrate



J. Kassner, W. Menzel,
Europ. Microw. Conf. 1998,
Vol. 2, pp. 428 – 432.

Slot coupled feed-through structure



Results of a slot coupled transition into a package on LTCC

Outlook

Near future

- Improved front-end architectures
- Improved interconnect technologies
- Improved package technologies
- State-of the art fabrication facilities

Further on

- Higher integration density
- Integration of analogue and digital functions (Si, SiGe)
- 3D circuits
- ….