

# Design method for carrier to die transition for UWB System in Package

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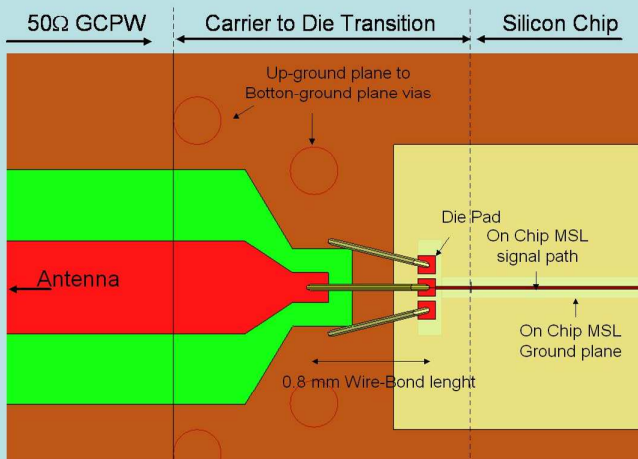
## Goals

- Design a broadband carrier to die transition useful for UWB applications
- High return loss and low insertion loss in the 3-10GHz UWB frequency band
- Use of Bond Wires attaches for low cost SIP technology

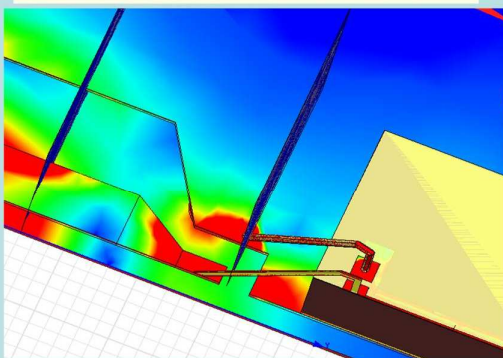
## Design of the high frequency carrier to die transition in a SiP technology

- **Design objectives:** Minimize the return loss of the incoming RF signal
  - > minimize WB lengths
  - > Minimize the ground return path of the RF port
  - > MSL to GCPW transition compatible with carrier design rules
  - > Via holes localization

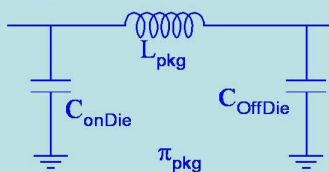
Technology : Carrier : Rogers 4003, Die: Standard CMOS, bond wire attaches



HFSS model of the carrier to die transition



Current density distribution in the carrier to die transition

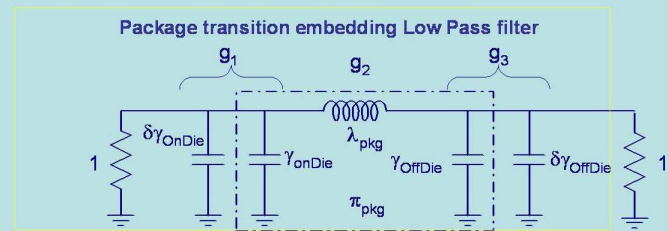


π lumped model of the carrier to die transition

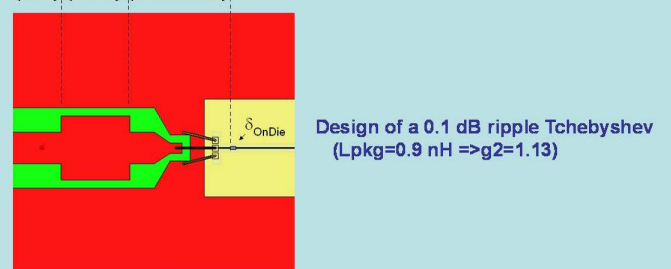
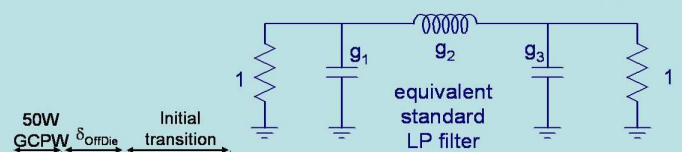
## Carrier to die transition optimization

• **Methodology:** The carrier to die transition is embedded in a low pass filter architecture that achieve a standard Tchebyshev response

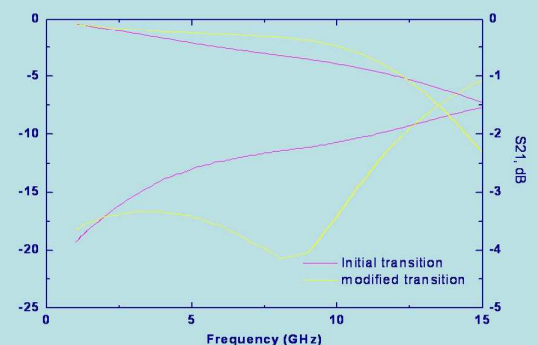
- > The modified transition perform like a standard 3<sup>rd</sup> order low pass filter with  $\epsilon_{dB}$  ripple of normalized values  $g_1, g_2, g_3$ ,
- > The ripple  $\epsilon_{dB}$  set the maximum return loss value in the bandwidth (here we target  $RL > 15dB$ )
- > The bonding wire inductor and the coefficient  $g_2$  set the cutoff frequency  $f_{CUTOFF}$
- > A capacitor  $\delta C_{onDie}$  is added into the die and a capacitor  $\delta C_{offDie}$  is added on the carrier to synthesize the equivalent filter



$$f_{cutoff} = Z_0 \frac{g_2}{2\pi L_{pkg}}$$



## Results



Transition	F15dB (GHz)	IL (at 10.6 GHz)
Bond Wire WB	3.2	-0.84 dB
3rd order filter	10.2	-0.57 dB