

A Faraday Cage Structure for Substrate Crosstalk Isolation

Personnel

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Sponsorship

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There is a great deal of concern these days about substrate crosstalk in mixed-signal integrated circuits. Substrate coupling noise from logic circuits can seriously affect the operation of sensitive on-chip analog circuits. Although many substrate crosstalk isolation schemes have been proposed, until now, no compact structure has been demonstrated that exhibits sufficient isolation effectiveness and consumes little valuable Si real state. At MIT, we have recently demonstrated a new Faraday cage isolation structure that is both compact and achieves exceptional crosstalk suppression.

The Faraday cage consists of a ring of high-aspect ratio substrate vias encircling noisy or sensitive circuits. A schematic is shown in figure 37. The substrate vias connect with the wafer ground plane and are shorted out at the top. The basic fabrication process involves DRIE to etch the vias, PECVD Si_3N_4 as a liner, and electrochemically grown Cu as a solid filling. We use Cu CMP to smooth the top surface.

To evaluate crosstalk isolation, we have fabricated a test structure that consists of transmitter and receiver pads in a coplanar configuration. S_{21} was used as isolation figure of merit. Figure 38 shows S_{21} for a typical structure with 10 mm in diameter on a 77 mm thick substrate (via aspect ratio of 8). For reference, an identical structure without the cage was measured. The Faraday cage exhibits a substrate crosstalk suppression of 32 dB at 10 GHz and 18 dB at 50 GHz.

The small footprint of the isolation structure and its high isolation effectiveness at short distances allows close packing of mixed-signal circuits. The footprint of the Faraday cage can be further improved since our substrate via technology is capable of nominal aspect ratios as high as 30.

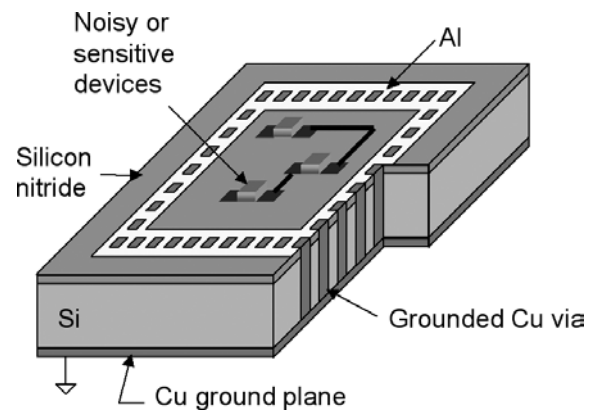


Fig. 37: Schematic diagram of Faraday cage structure for substrate crosstalk isolation.

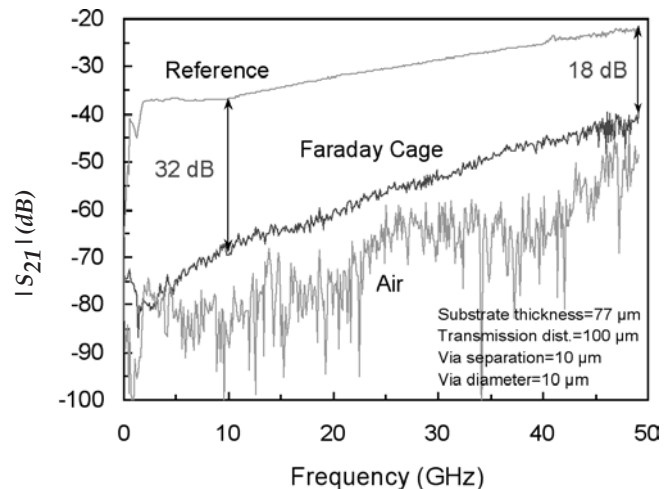


Fig. 38: $|S_{21}|$ as a function of frequency for Faraday cage and reference structure. Transmitter-receiver separation is 100 μm . Via diameter and via separation are 10 μm .