TU4B-1

Intrinsically Switched Multiplexer Based Reconfigurable Filter MMIC

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qorvo
all around you

Presentation Outline

- Introduction and Motivation
- Approach
- Design
- Experimental Results
- Conclusions

Introduction and Motivation

- Prevent saturation in high sensitivity wideband digital receivers
  - Not for damage protection
  - Reduction of the strength of potentially saturating external signals
  - Not for the reduction of self interference
- The reduced signal must still be receivable
  - Process must not add significant additional distortion
  - Attempt to maintain a constant dynamic range
- Operate with as much low loss bandwidth as possible
  - Programable notch filter ⟹ Frequency Selective Limiter (FSL)

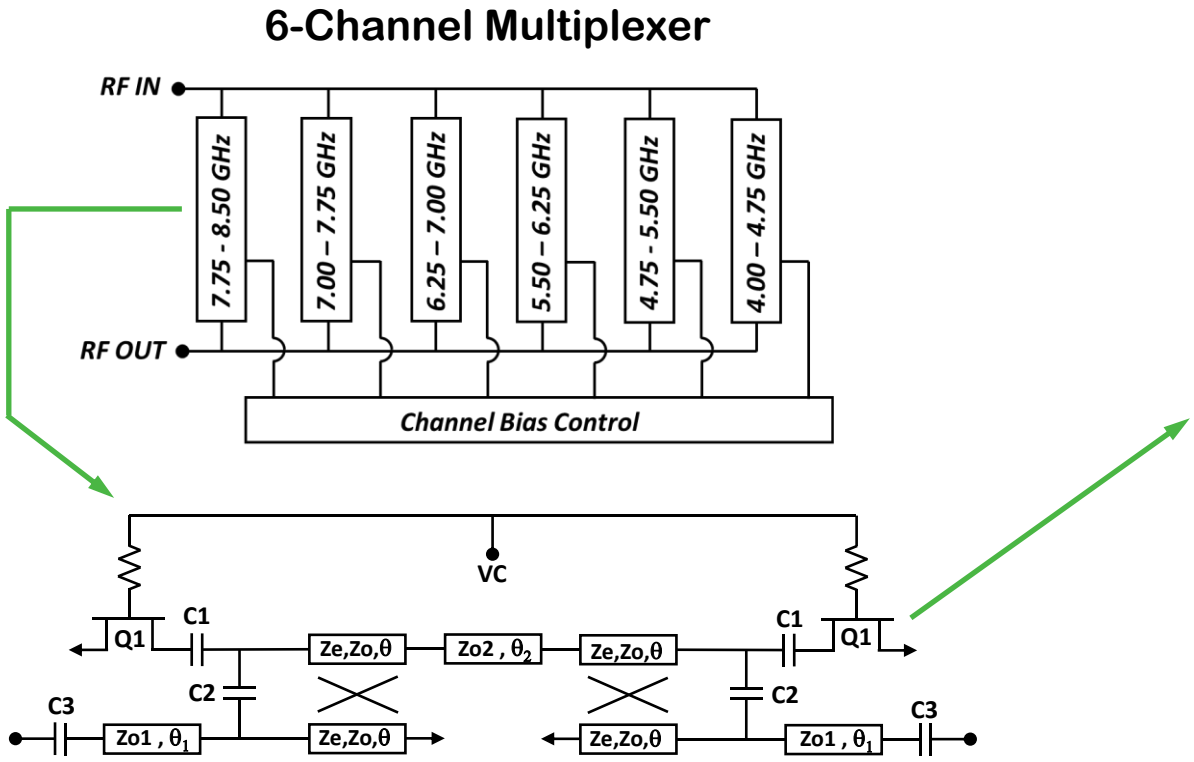
Introduction and Motivation

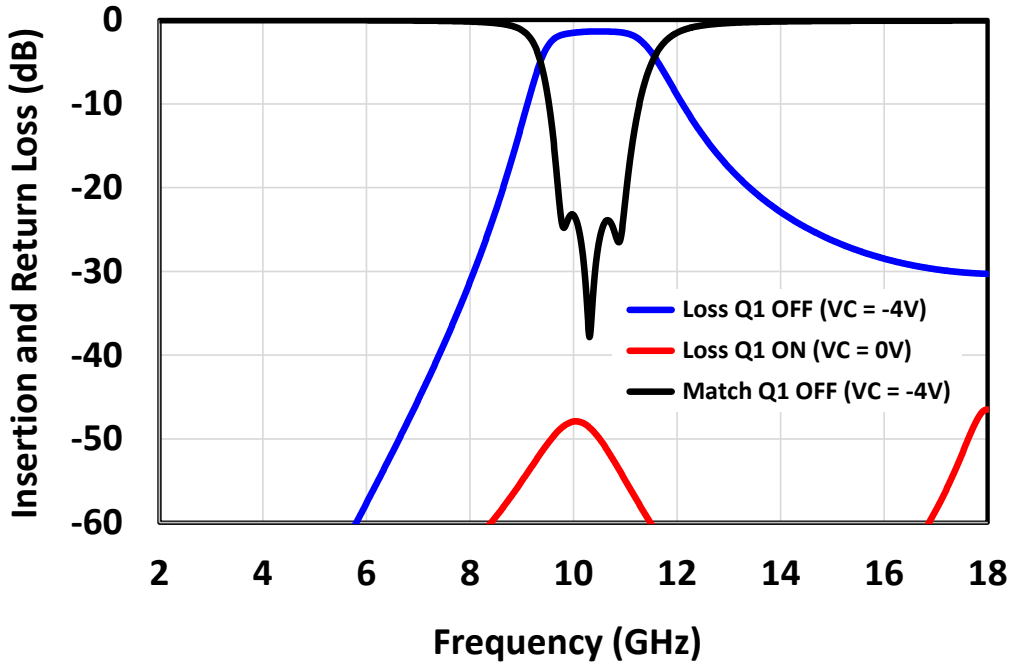
- **Performance Goals**

Metric	Goal	Notes
Operating Band	4.0 – 8.5 GHz	
Average IN-Band Loss	< 5dB	No Signal Reduction
Input Signal Level	< 10 dBm	< 2.0 Vpp
Output Signal Level	< -20 dBm	< 63.2 mVpp
Selectivity	> 3:1	Requires 6 Filter Channels
IN-Band IIP3	> 15 dBm	No Signal Reduction
OUT-of-Band IIP3	> 50 dBm	With Signal Reduction
Signal Detection	Integrated	Peak Detection
Automated Control	Closed Loop	Use Microcontroller
DC Power Consumption	< 250 mW	Can’t use test equipment

Approach

- **Architecture – Intrinsically Switched Multiplexer (ISM) [1,2]**

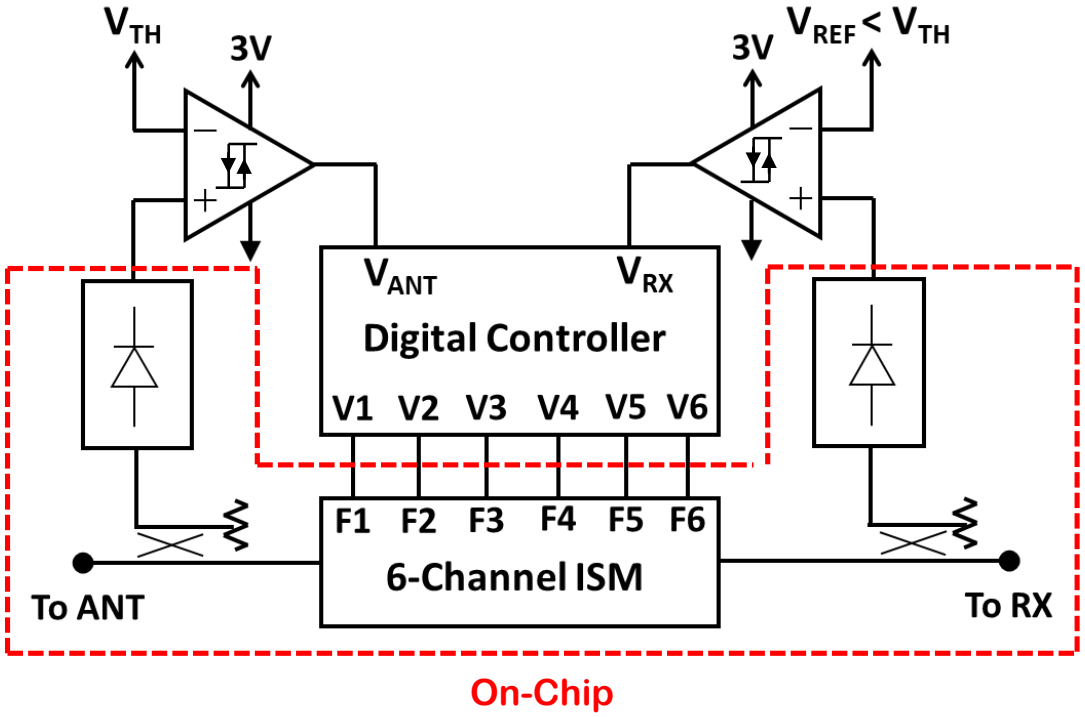




[1] A. C. Guyette, "Theory and design of intrinsically switched multiplexers with optimum phase linearity," IEEE Trans. Microw. Theory Techn.
[2] E. J. Naglich and A. C. Guyette, "Frequency Selective Limiters Utilizing Contiguous-Channel Double Multiplexer Topology," IEEE Trans. Microw. Theory Techn.

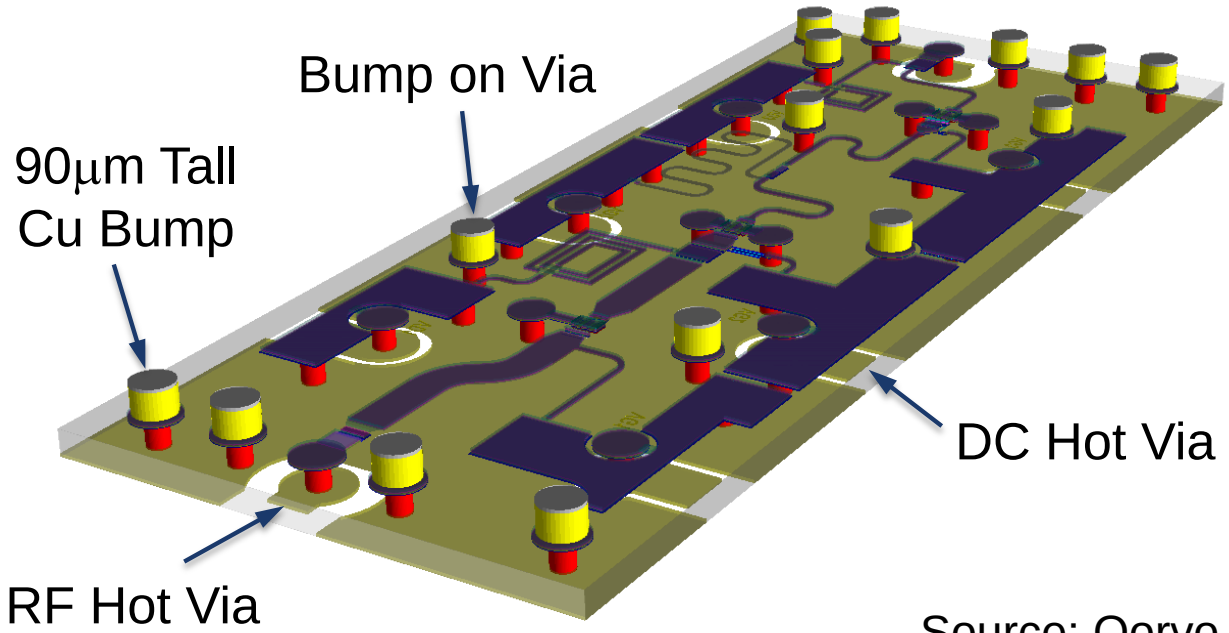
Approach

- The ISM works for ALL $2^6 = 64$ control states
- System Detect and Control Architecture
- ANT Detector – Interferer Present?
- RX Detector – Interferer Reduced?
- Flat Detector Frequency Response
- High Directivity Sampling
  - IN-Band: ISM is well matched
  - OUT-of-Band: ISM is Reflective
- Future Work – Closed Loop Control



Design

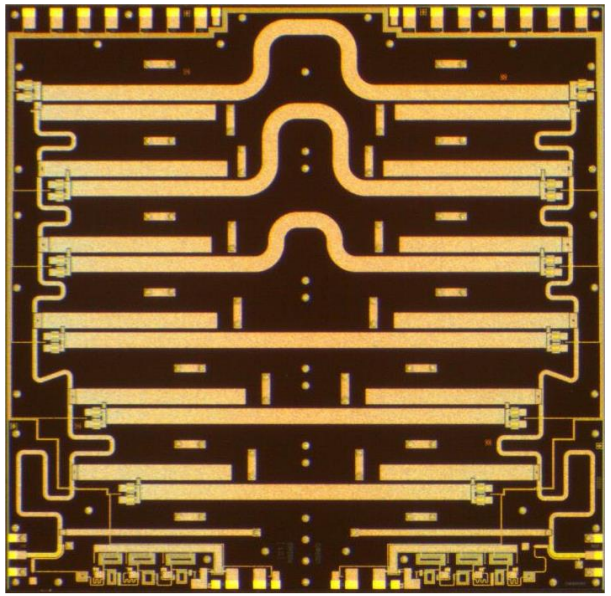
- **Qorvo's production released PHT09 GaAs PHEMT process utilized**
  - **90 nm gate length**
  - **Switch FET FOM ≈ 700 GHz**
  - **Vp = -0.6V**
  - **VBD = 14V**
  - **F_T / Fmax = 65 GHz / 125GHz**
- **3D interconnect Features**
  - **Under Development**

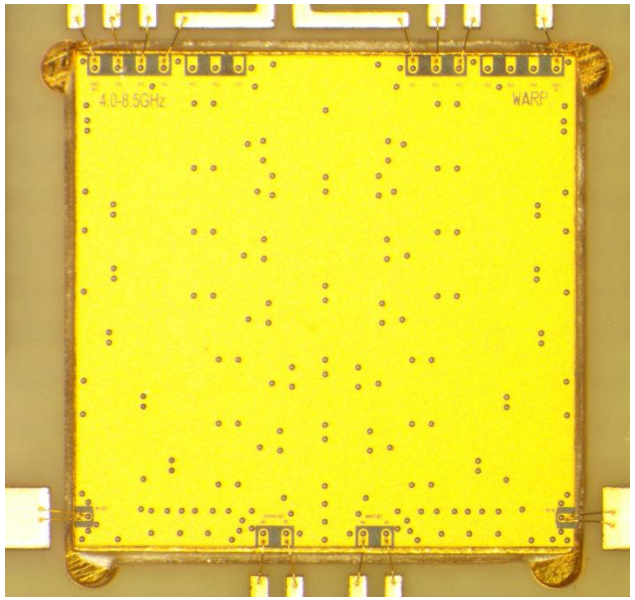


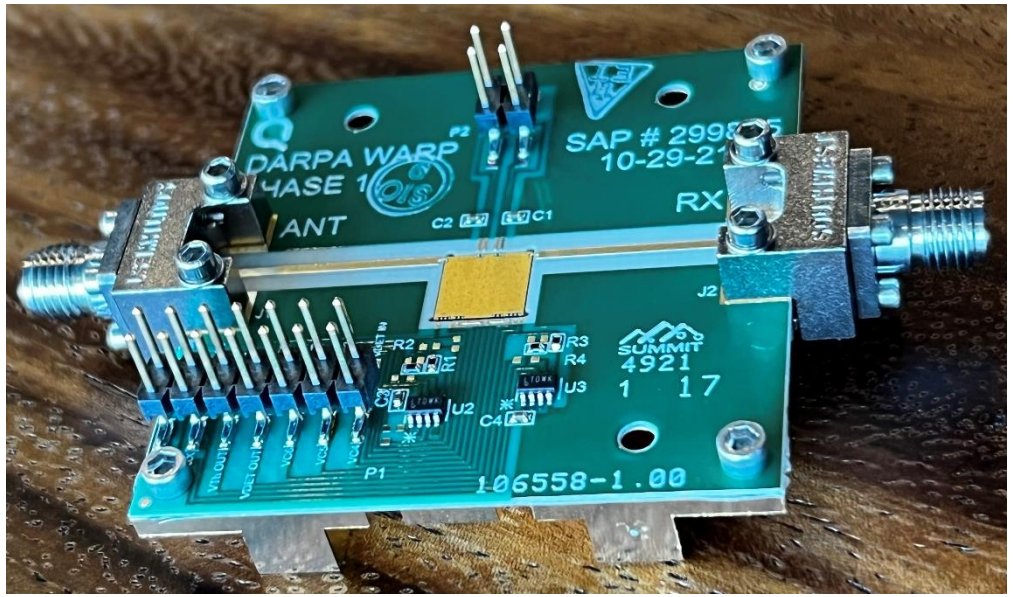
Source: Qorvo

Design

- **ISM MMIC is designed to be flipped over a ground plane**
  - **Grounds are connected with Cu Bumps over Substrate Vias**
  - **Bond wire RF / DC Interconnects using the backside Hot Vias**

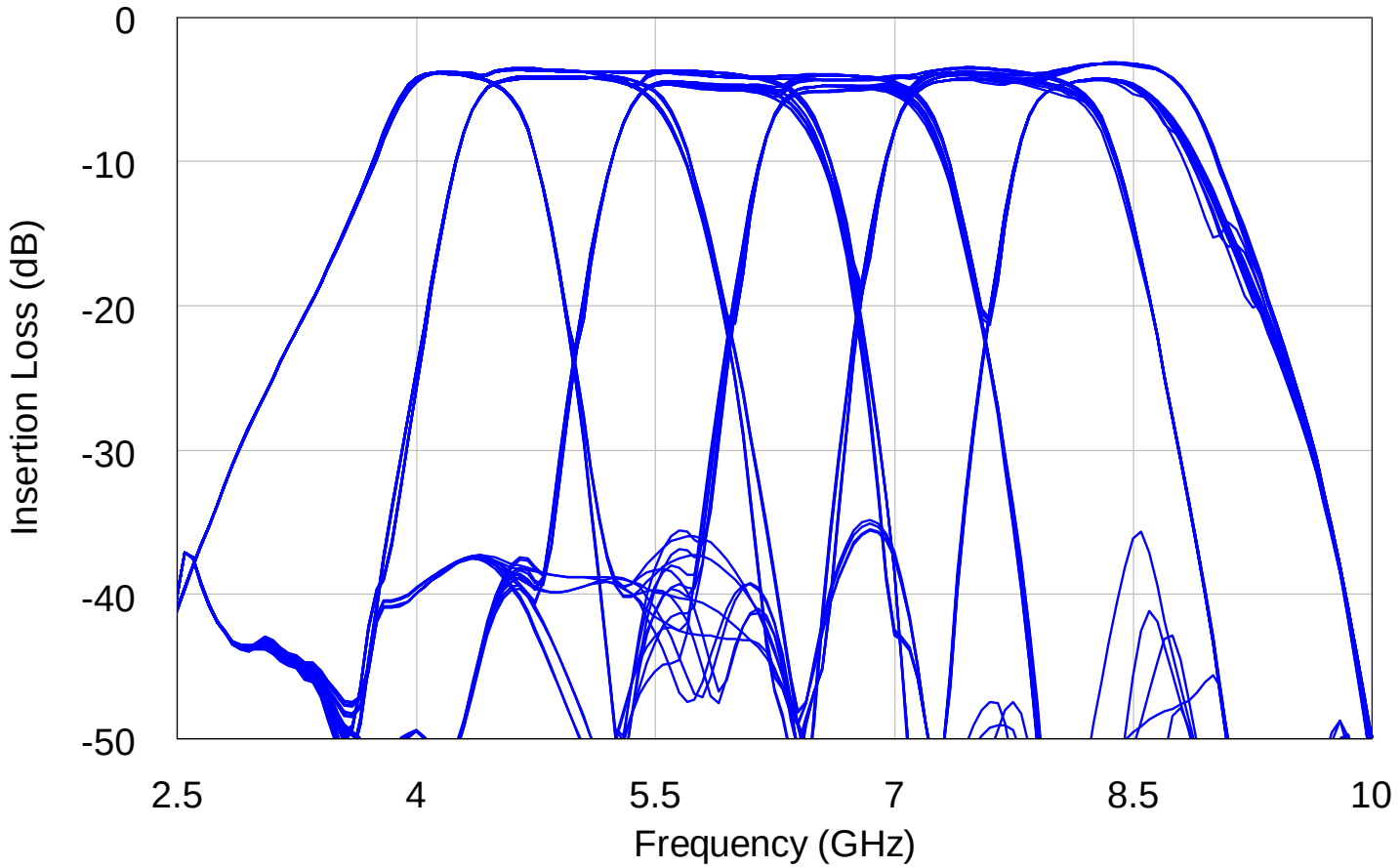






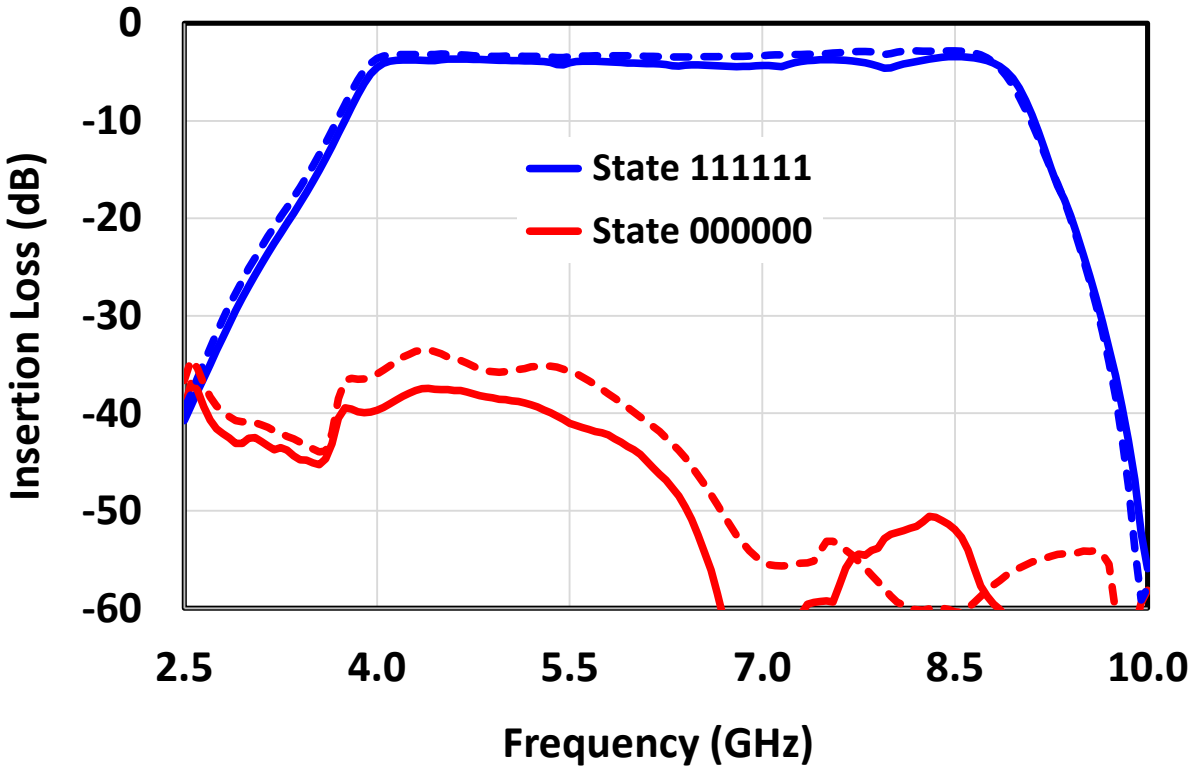
Experimental Results

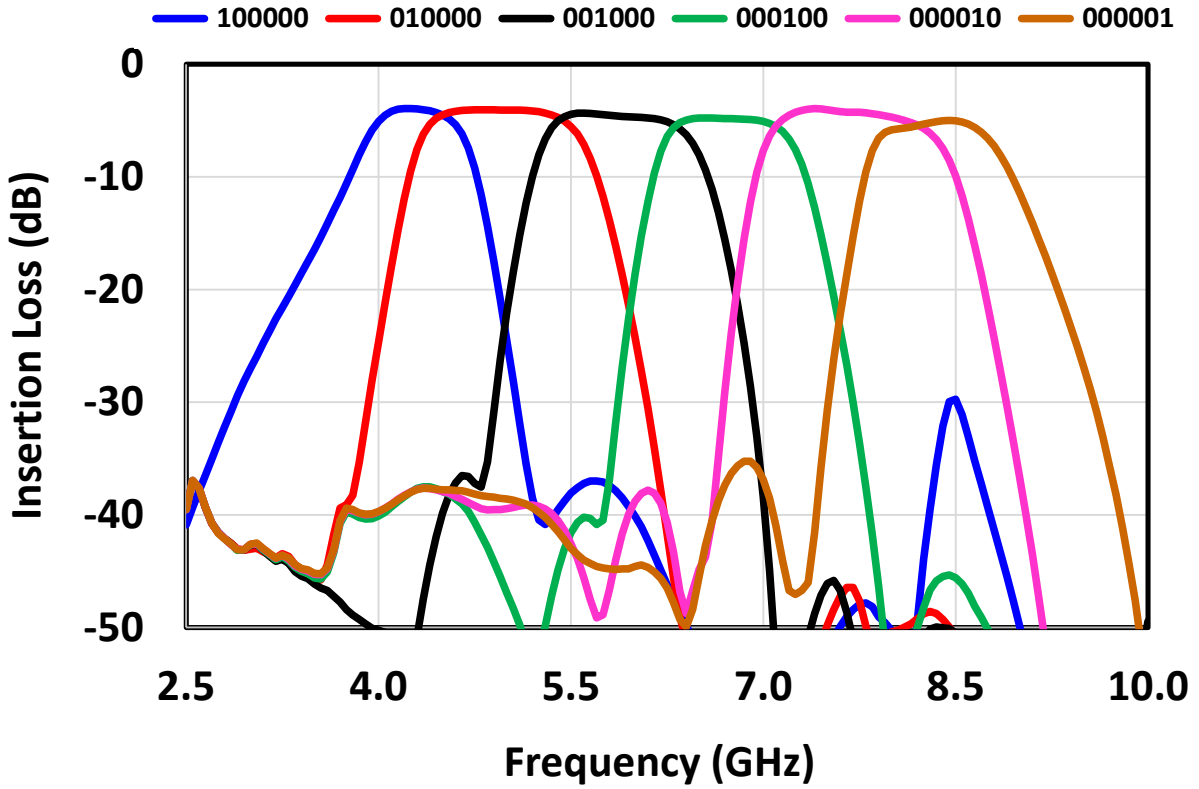
- **Measured Frequency Response of All 64 Filter States**



Experimental Results

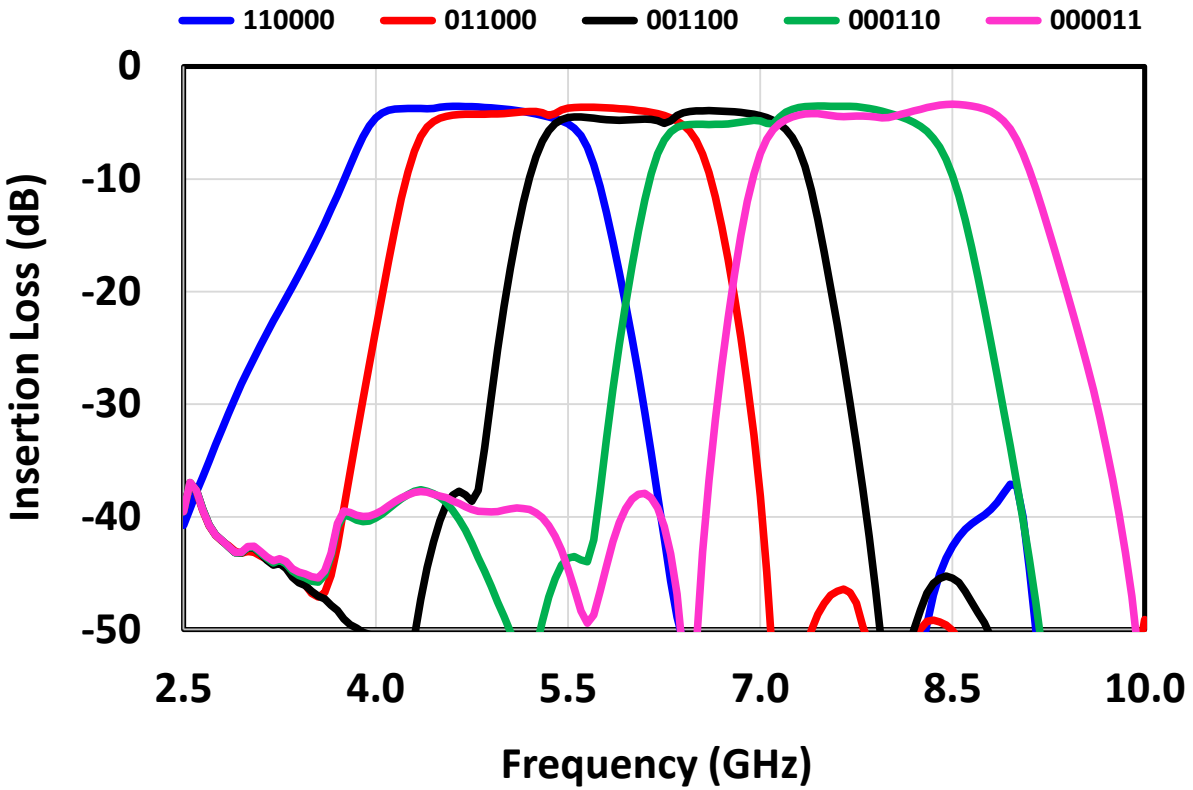
- **IN / OUT-of-Band and Individual States – Dashed Traces Simulated**

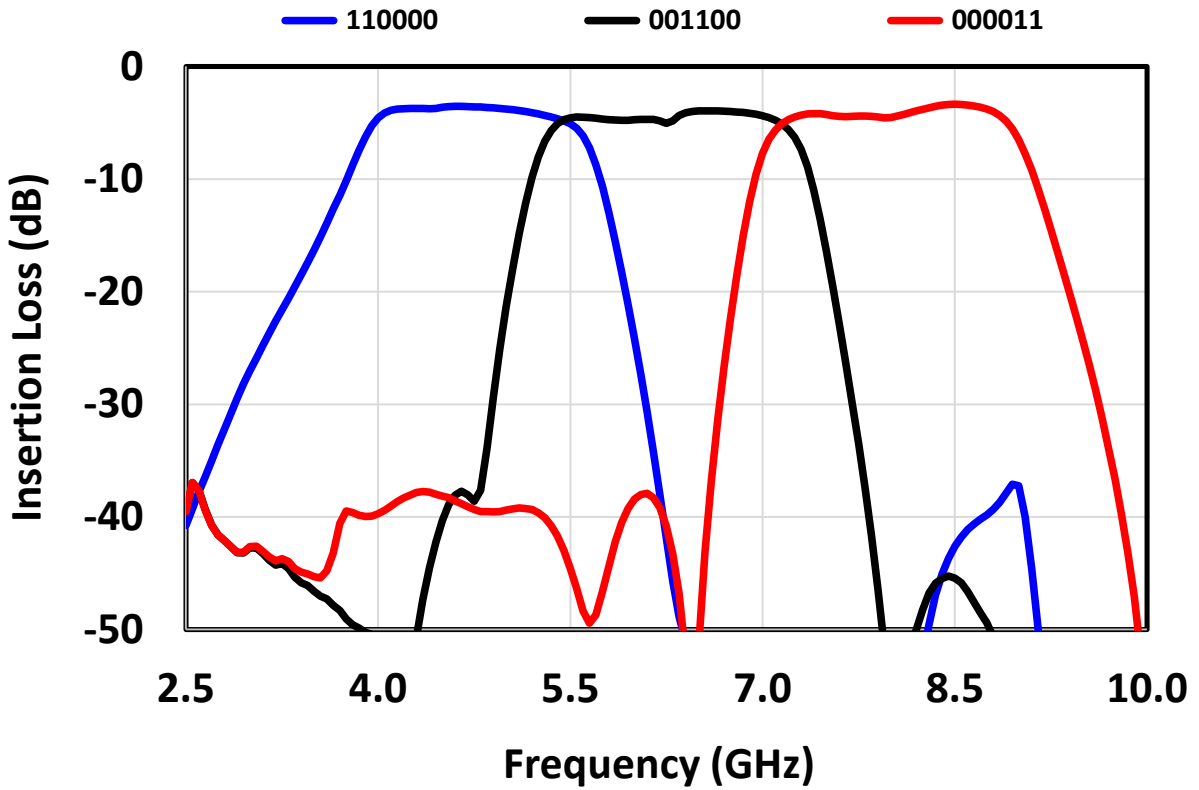




Experimental Results

- **Two Channel Bandpass Filter States**





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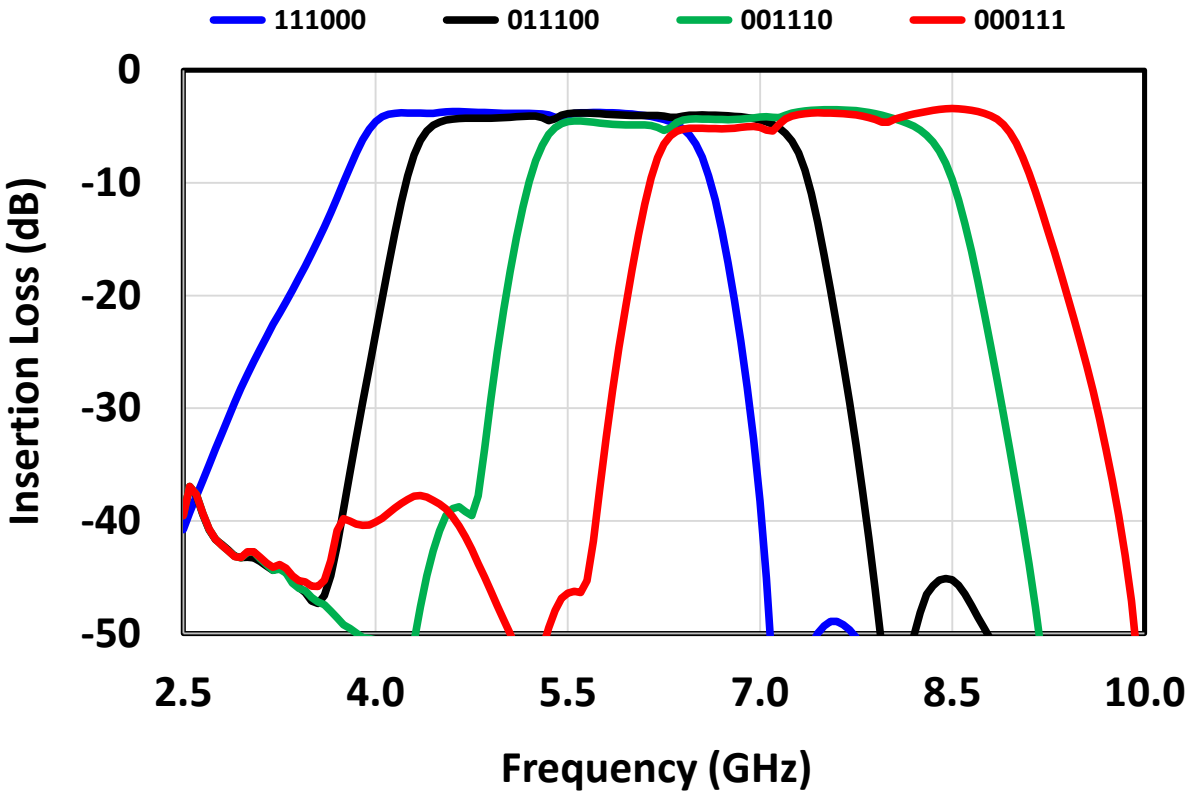
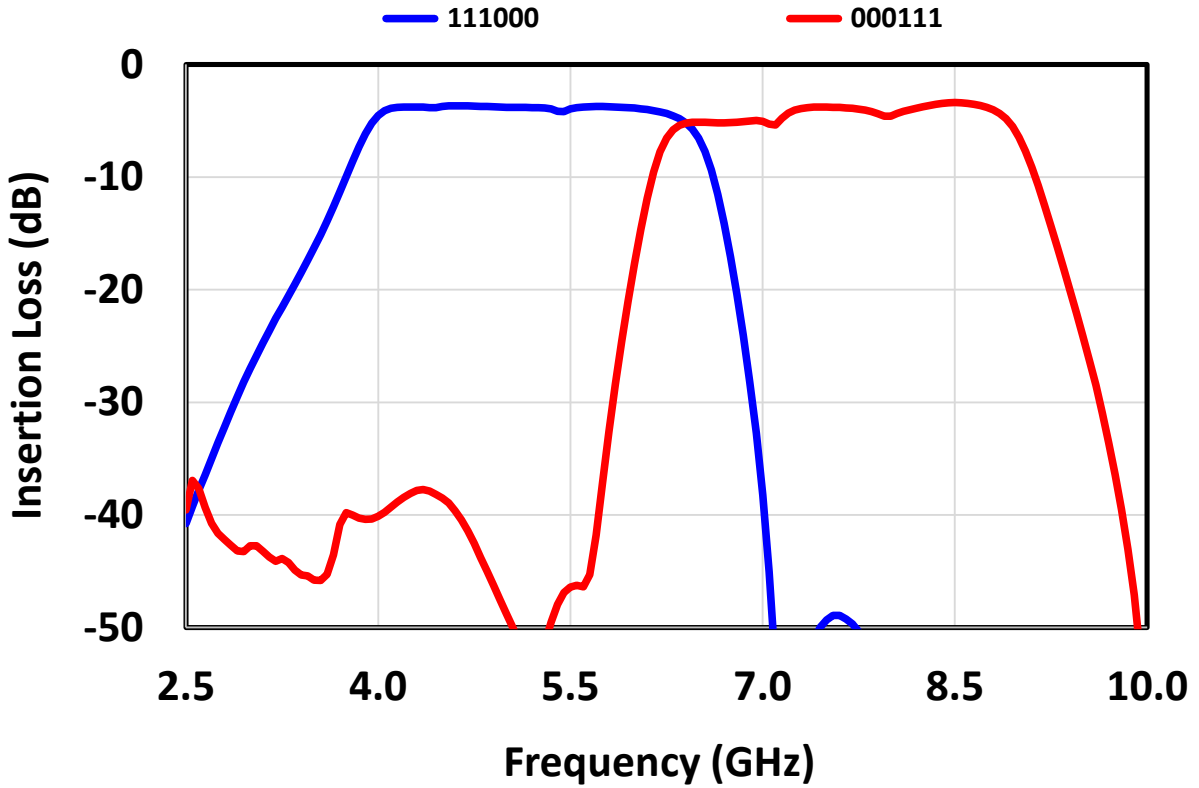
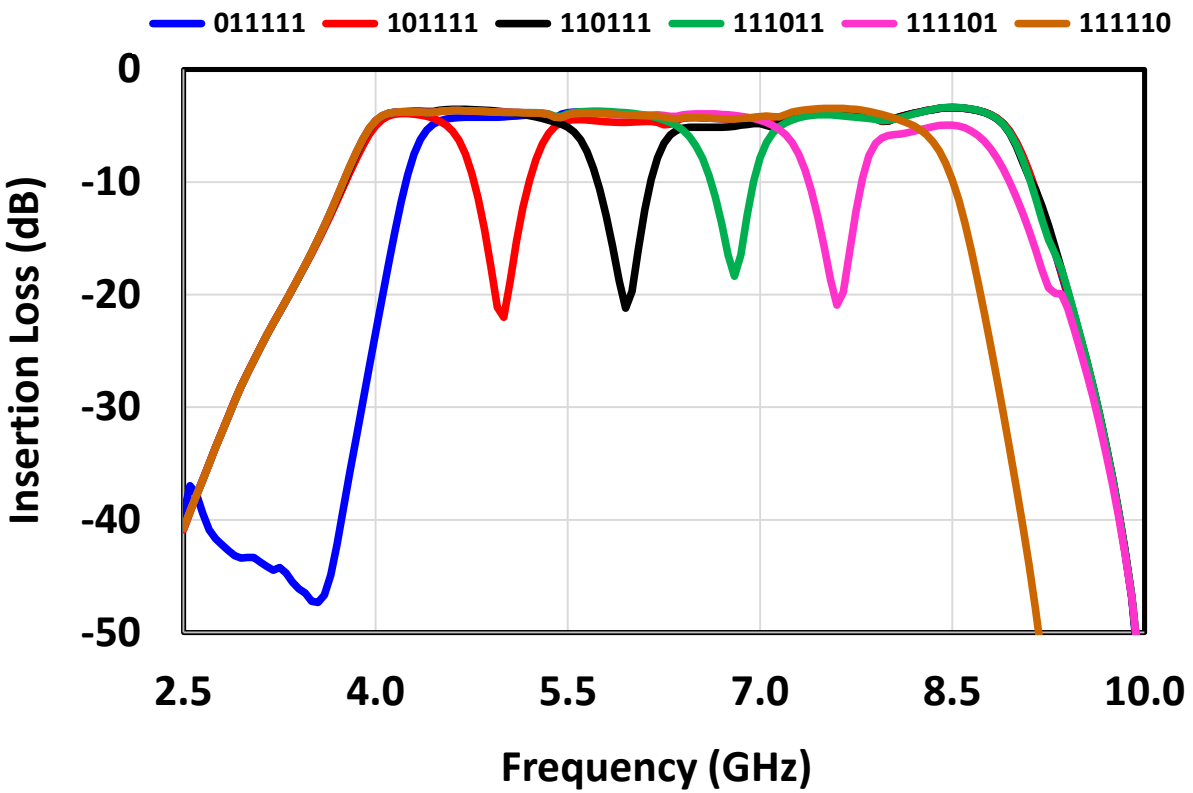
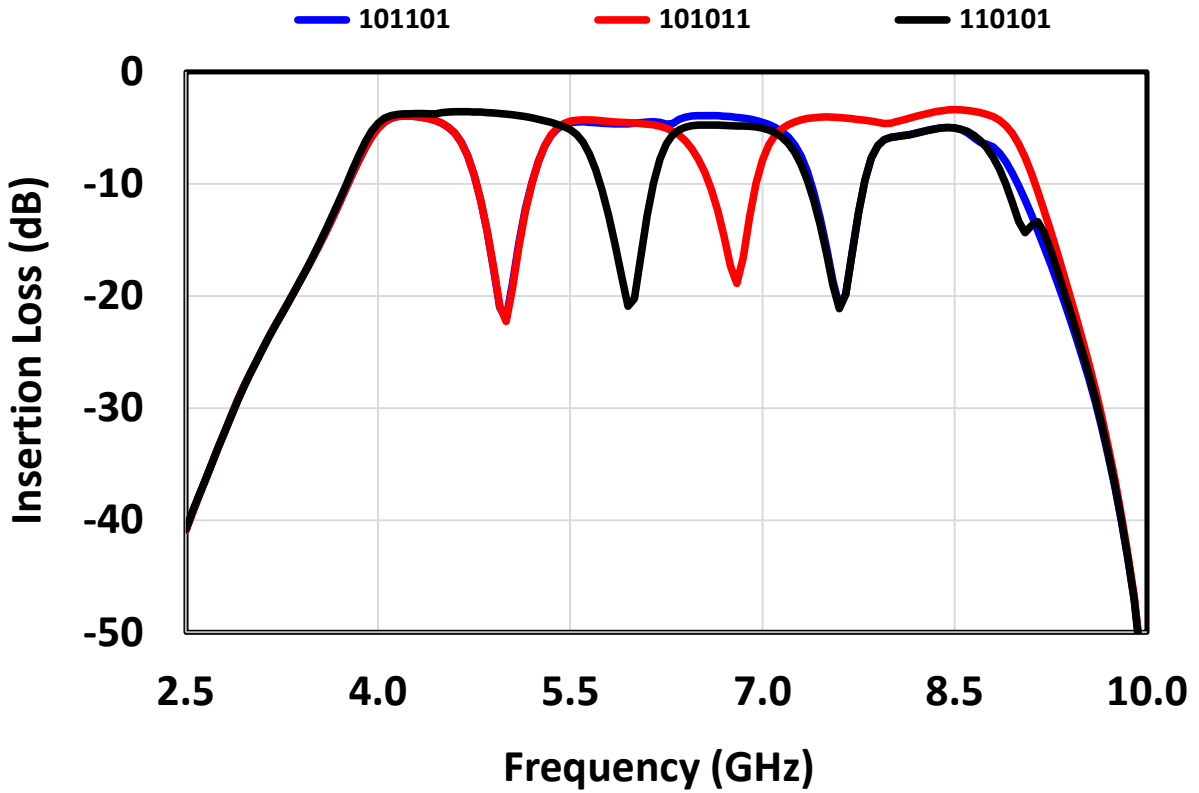




Experimental Results

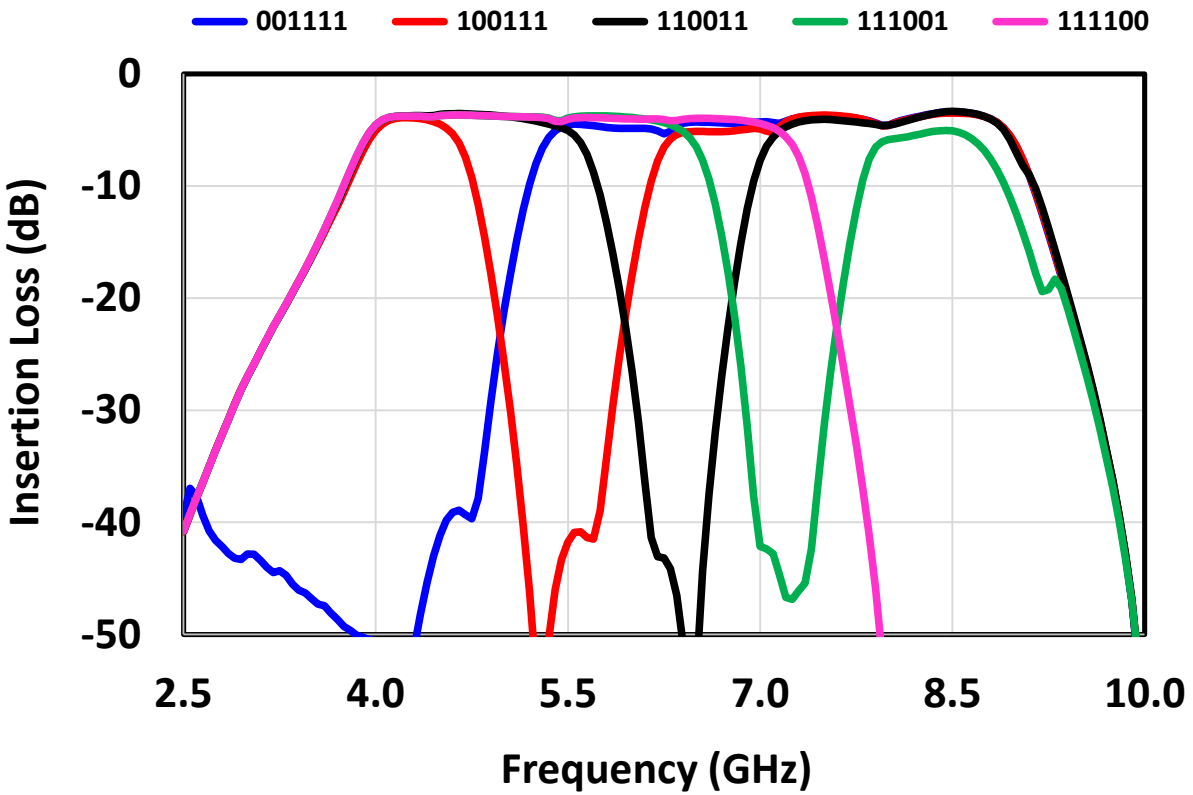
- **Single and Multiple Channel Notch Filter States**

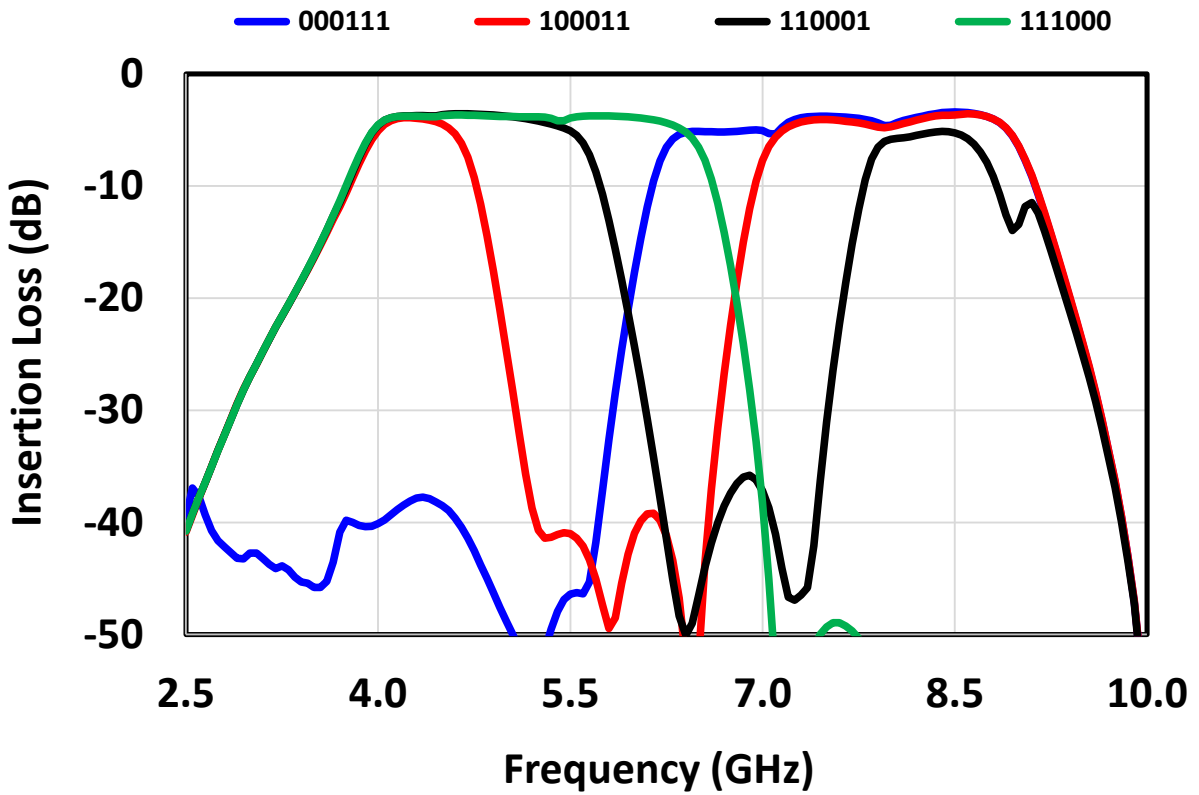




Experimental Results

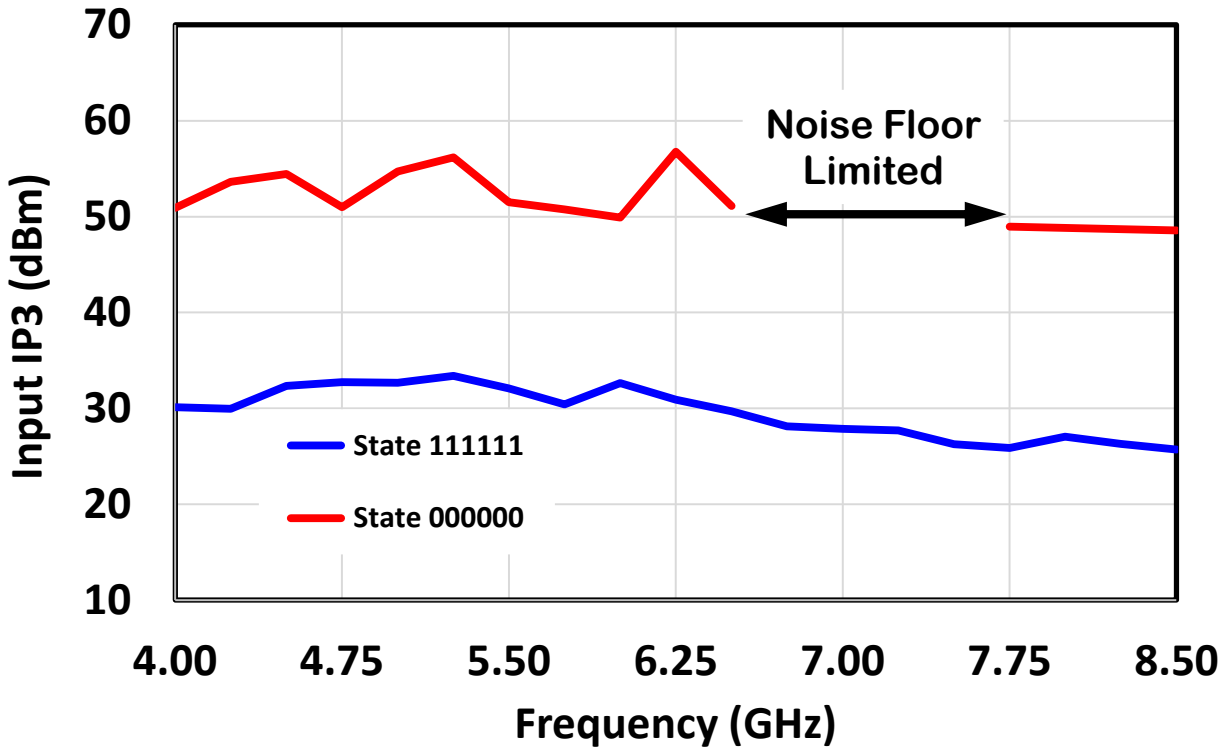
- Two and Three Channel Notch Filter States





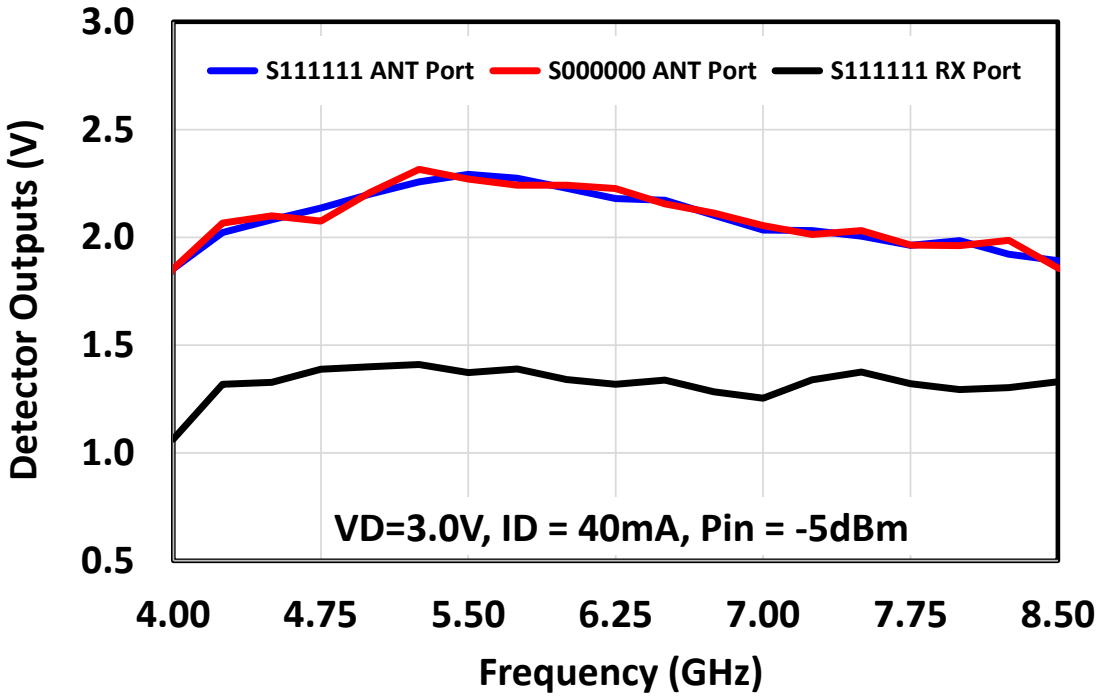
Experimental Results

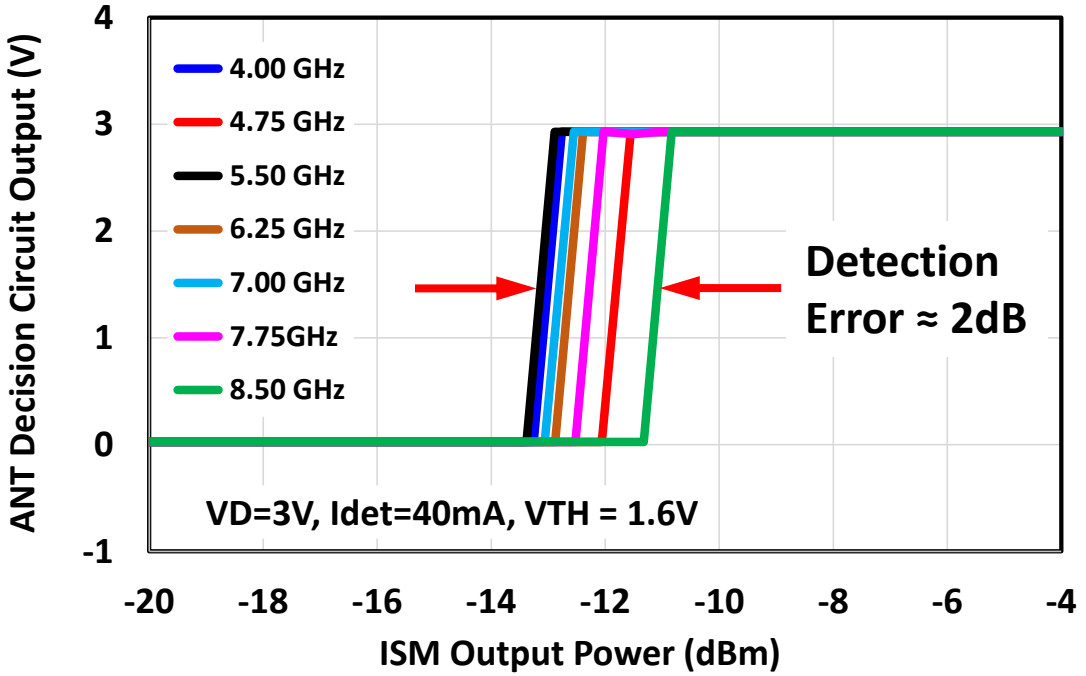
- Input 3rd Order Intercept Point for IN-Band and Out-of-Band



Experimental Results

- **Integrated Detection**





Conclusions

- The design and results for a 6-channel intrinsically switched multiplexer based filter bank MMIC has been presented
- The design features 64 operational states and integrated sensing
- Applications include closed loop frequency selective limiting and reconfigurable bandpass / notch filters
- This research was developed with funding from the Defense Advanced Research Projects Agency (DARPA). The views, opinions and/or findings expressed are those of the authors and should not be interpreted as representing the official views or policies of the Department of Defense or the U.S. Government.