ANALOG DEVICES

AHEAD OF WHAT'S POSSIBLE™

PoDL for NGAUTO- Technical and Economic Feasibility

GITESH BHAGWAT

SANTA BARBARA DESIGN CENTER

Supporters

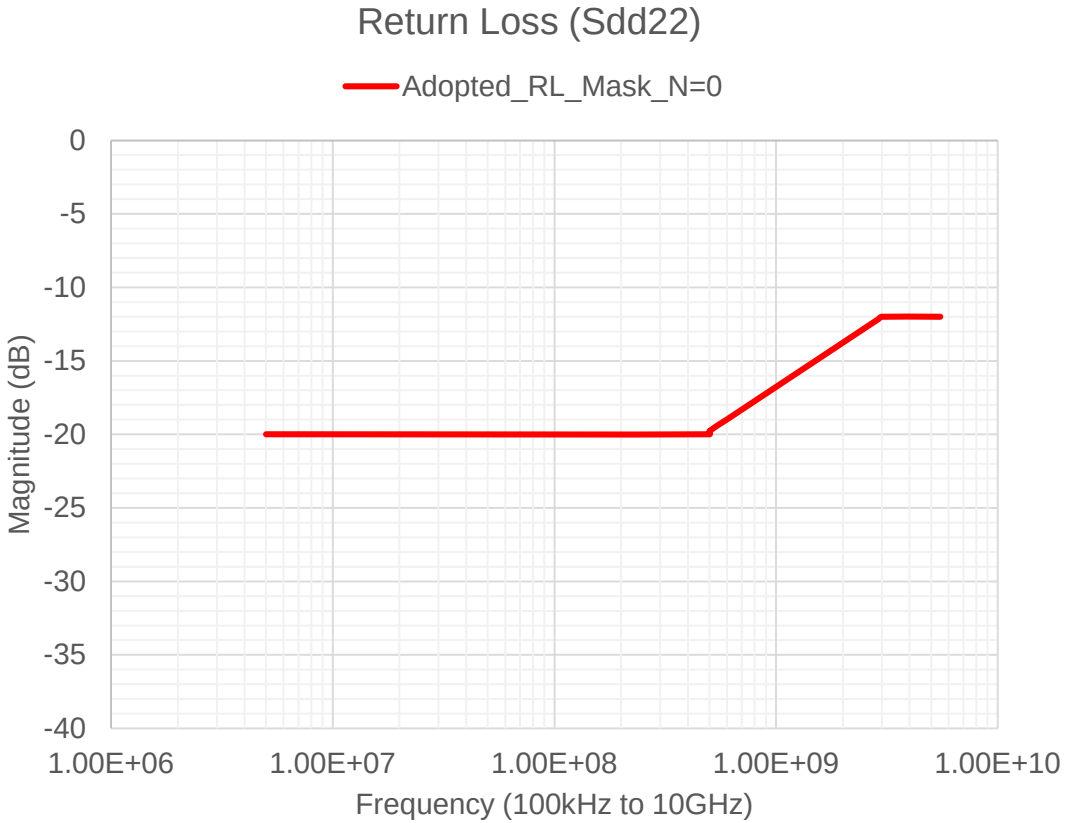
Kurt Smith (Coilcraft)

Presentation Outline

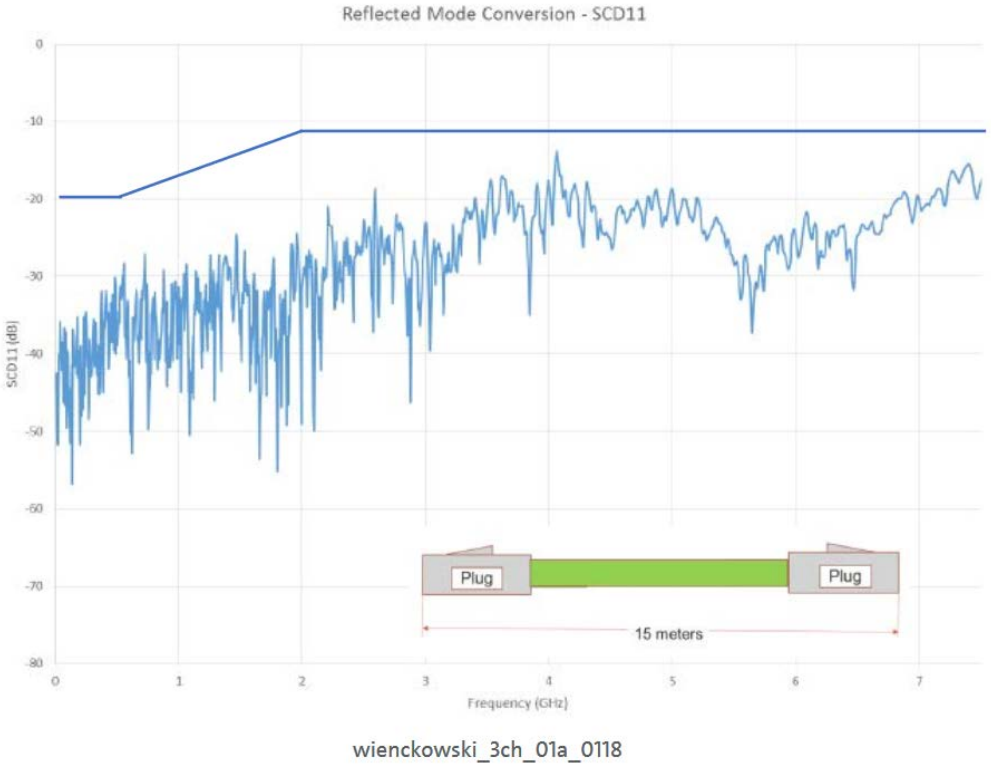
- Review NGAUTO Adopted and Proposed Link Electrical Specifications
  - Return and Mode Conversion Loss
- MDI vs Link Segment Electrical Characteristics for 100BASE-T1 and 1000BASE-T1
- Proposal for MDI Electrical Characteristics for NGAUTO
- Feasibility of PoDL with Proposed MDI Limits
  - Measurement Setup
  - Measured Data
- Conclusion

NGAUTO Link Electrical Specifications

- Reference: http://www.ieee802.org/3/ch/public/jan18/wienckowski_3ch_01a_0118.pdf
  - Adopted Return Loss
    - Mask defined from 5Mhz to 5.5GHz



  - Proposed Mode Conversion
    - Relaxed due to shielded cables

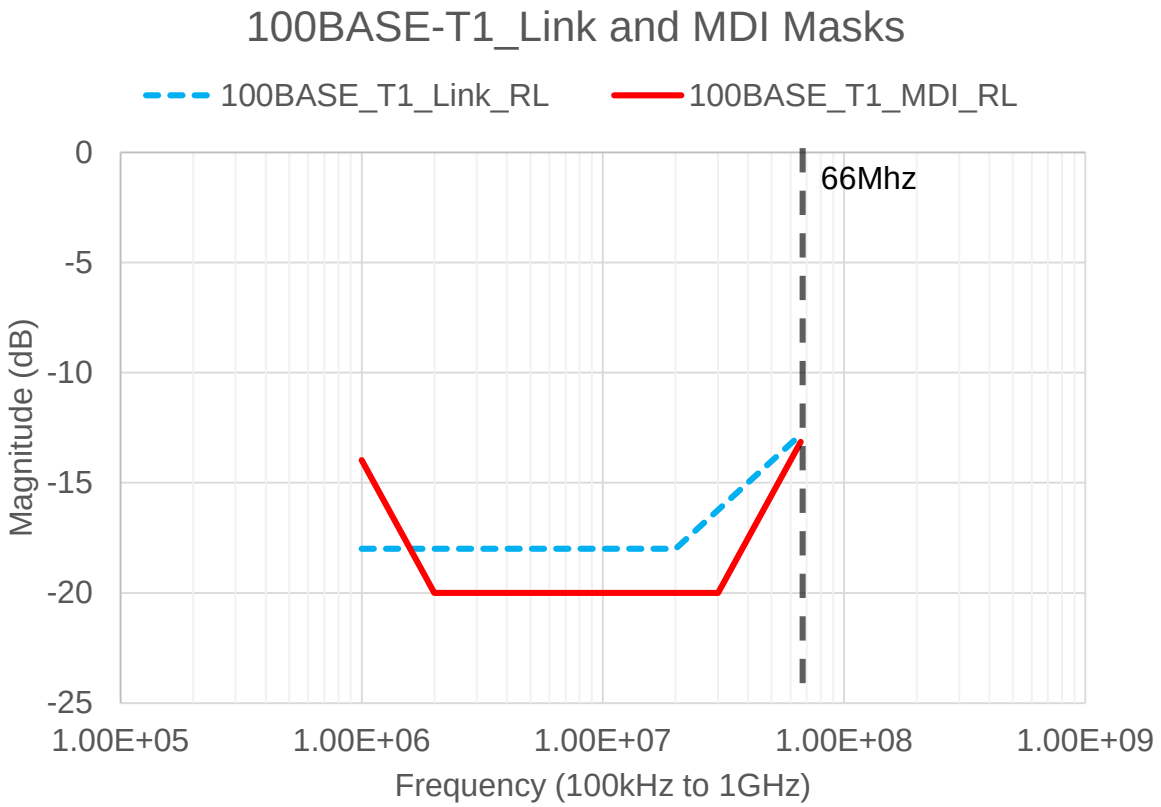


wienckowski_3ch_01a_0118

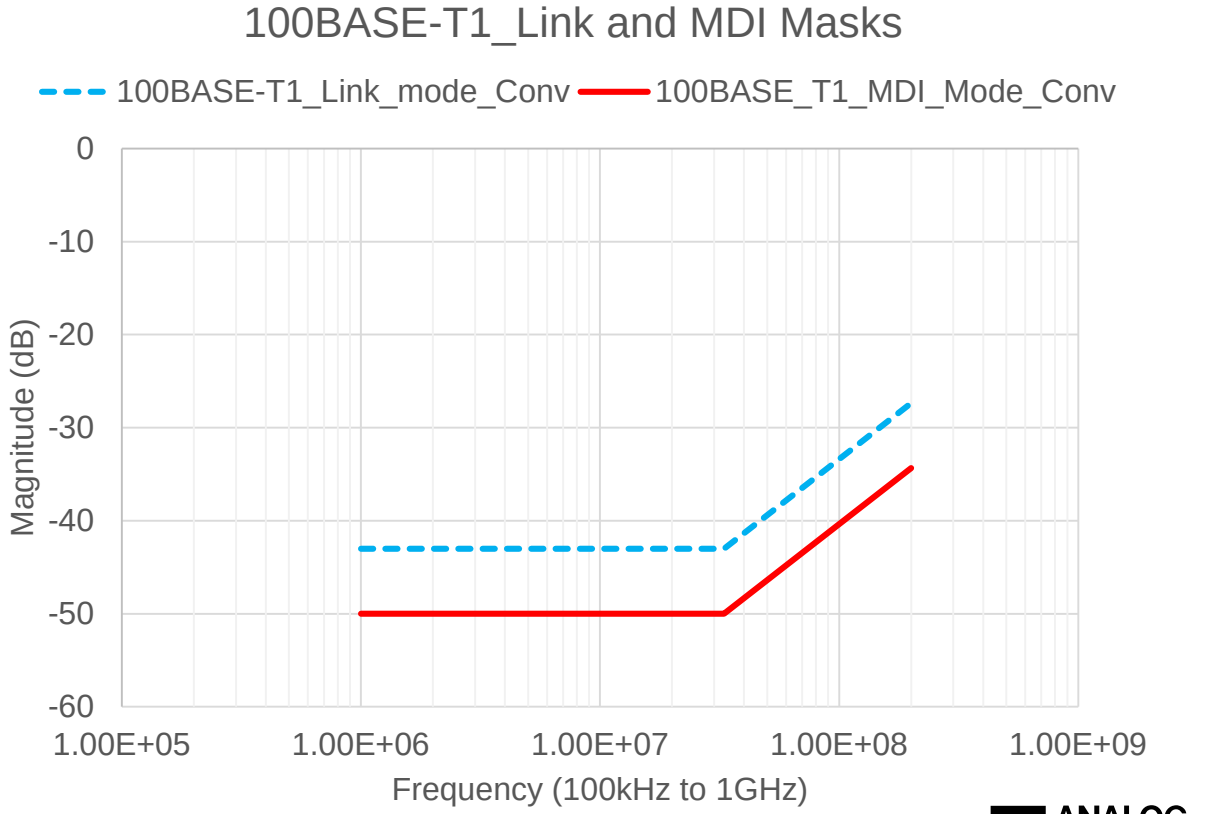
ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

MDI Electrical Characteristics and Baud Rate – 100BASE-T1

- Reference: 802.3bw with PoDL
- Return Loss
  - Return Loss Mask Limited at 66Mhz
  - Max. Baud Rate of 66MBd



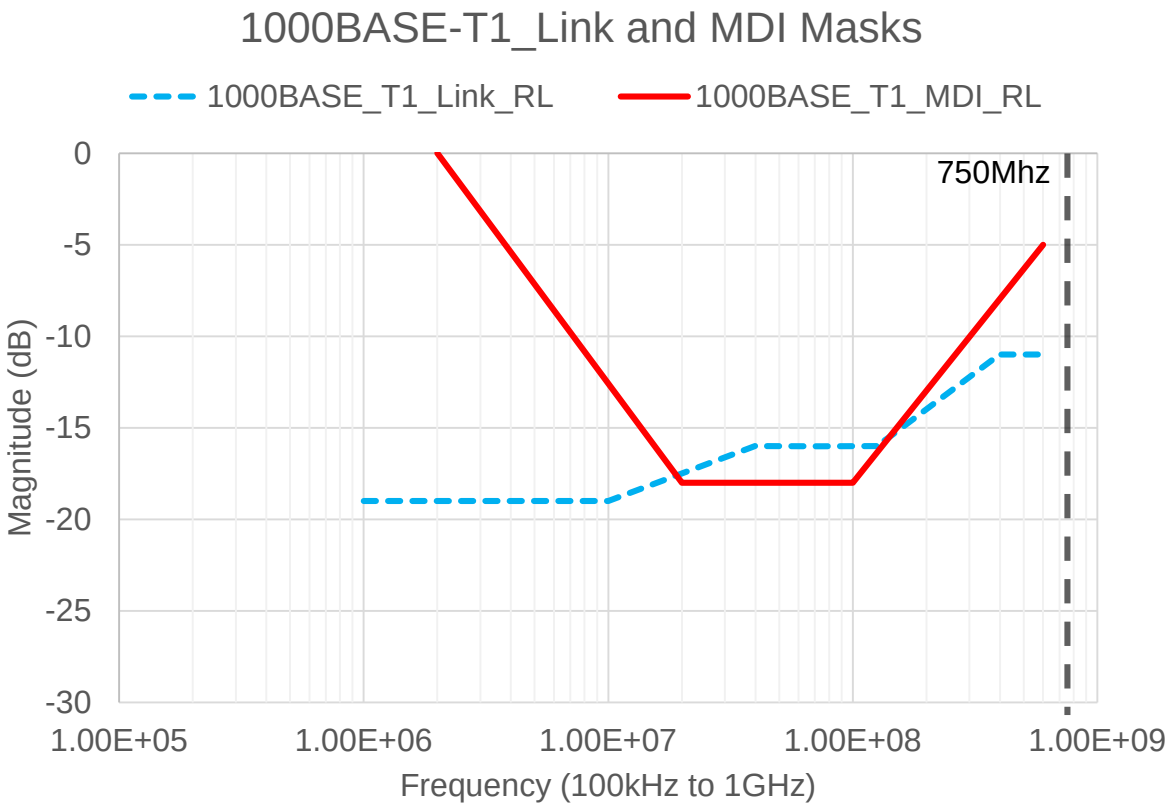
- Mode Conversion
  - MDI Mode Conversion Limit more stringent than Link Limit by 7dB



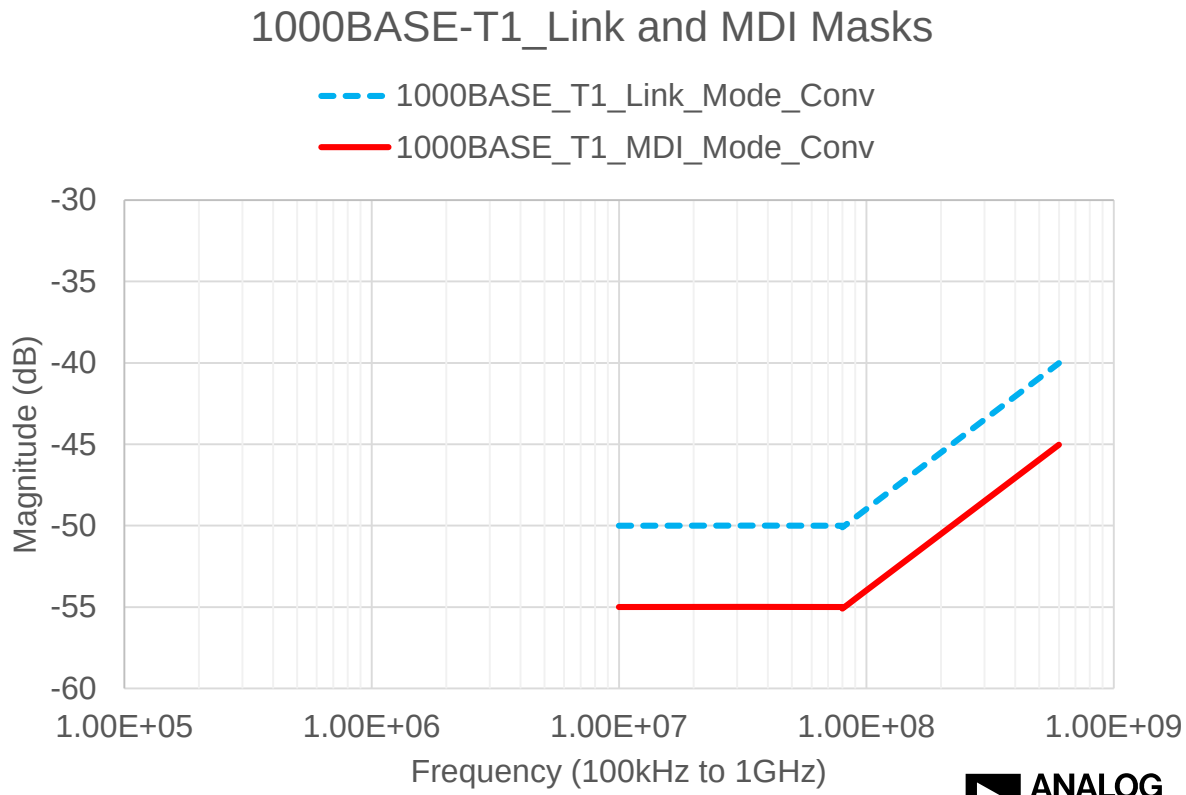
ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

MDI Electrical Characteristics and Baud Rate – 1000BASE-T1

- Reference: 802.3bp
  - Return Loss
    - Return Loss Mask Limited at 600Mhz
    - Max. Baud Rate of 750MBd



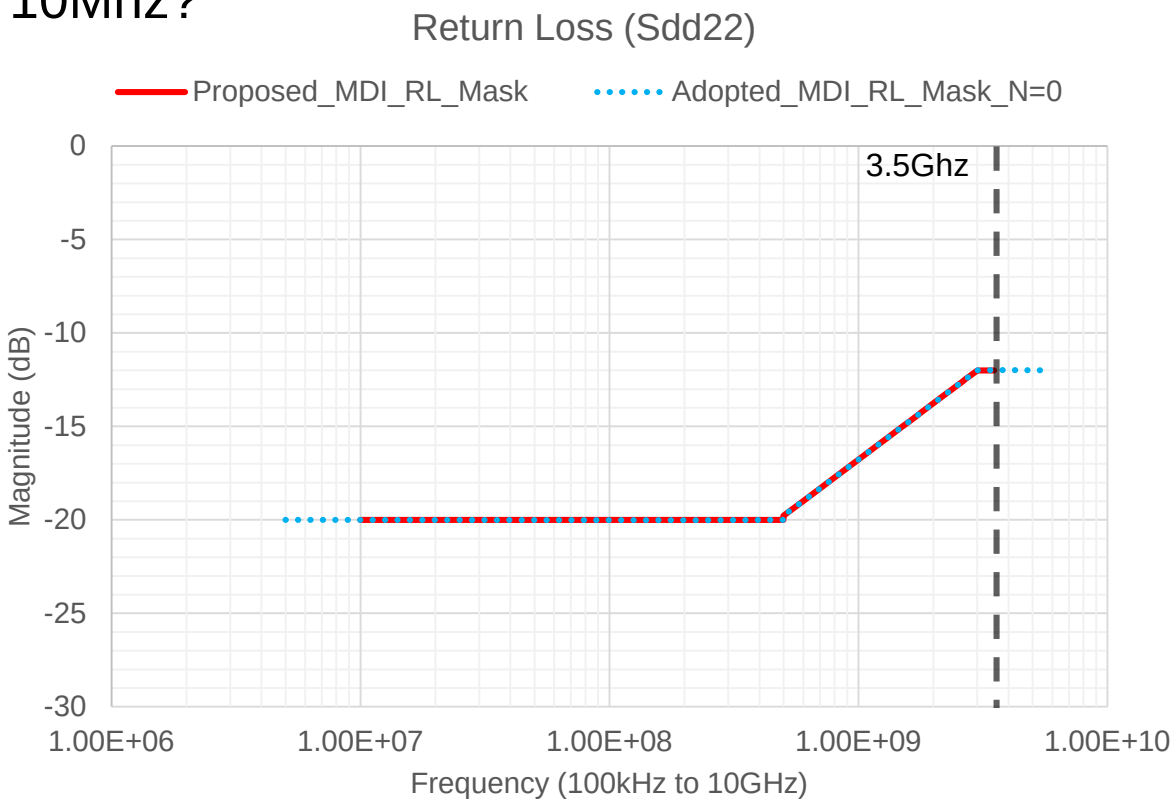
  - Mode Conversion
    - MDI Mode Conversion Limit more stringent than Link Limit by 5dB



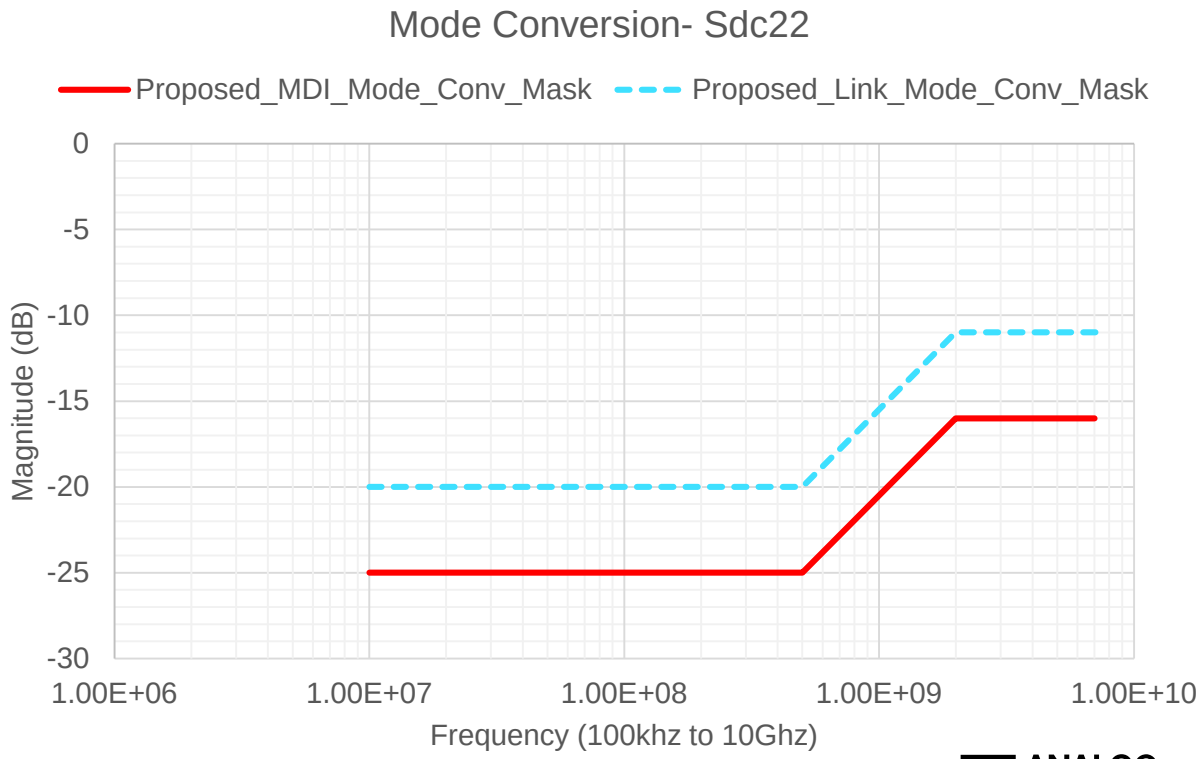
ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

NGAUTO Proposed MDI Electrical Specifications

- Can the **MDI Return Loss Mask** be considered up to (or less than) the proposed baud rate of 3.5GHz?
- Can the mask start frequency be considered 10Mhz?



- Can the **MDI Mode Conversion Mask** be made 5dB more stringent than the Link Mode Conversion Mask with frequency from 10Mhz to 7Ghz?



ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

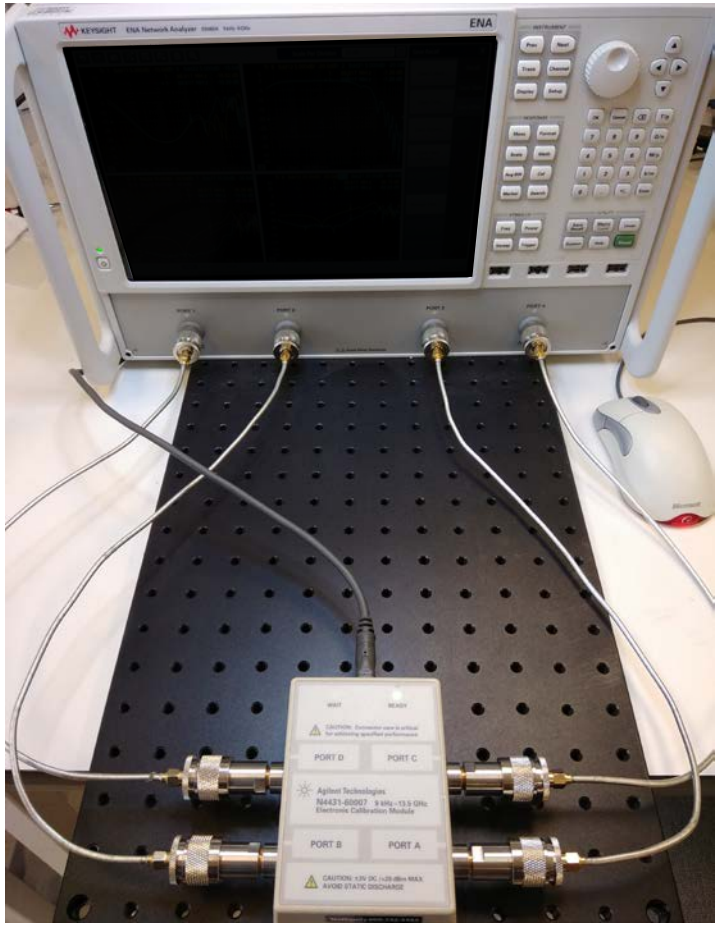
Feasibility of PoDL with Proposed MDI Limits

In continuation of previous work:

http://www.ieee802.org/3/NGAUTO/public/feb17/agardner_3NGAUTO_01a_0217.pdf

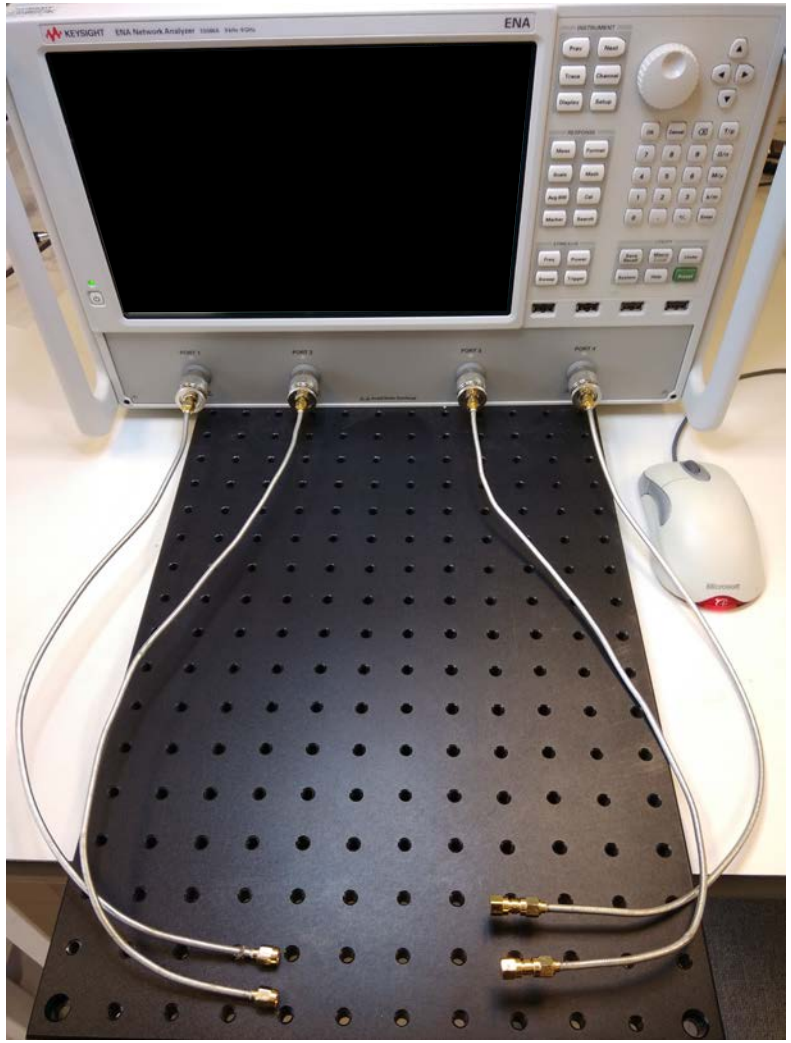
Measurement Setup

- Keysight Network Analyzer- E5080A (9Khz to 9GHz)
- Amphenol RF Rigid Cables
- Calibration using Ecal Module – N4431 60007
- Baseline measurement using Coax SMA stubs
- 2Port Configuration used with on board termination resistors

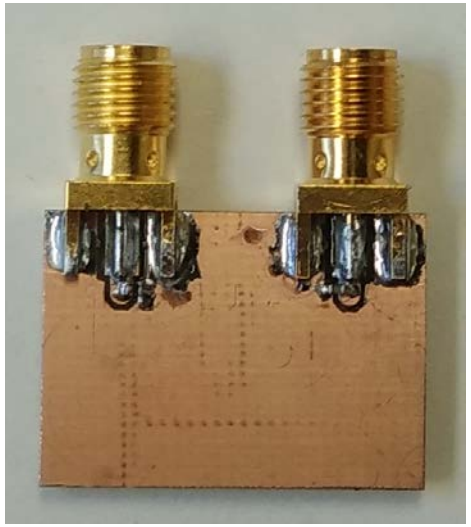


Test Fixtures and Baselines

- Copper Clad Boards using in-lab CNC:LPKF Protomat M 60
- 1oz Cu FR4 with 62 mil Board thickness
- Cable and Calibration baseline using SMA stubs
- Board Layout and Termination Resistor baseline using only termination resistors
- Two types of termination resistors:
  - 0402 1% 50ohm generic resistors from digikey
  - 0402 1% 50ohm HF thin film – ATC 504L Series UBR

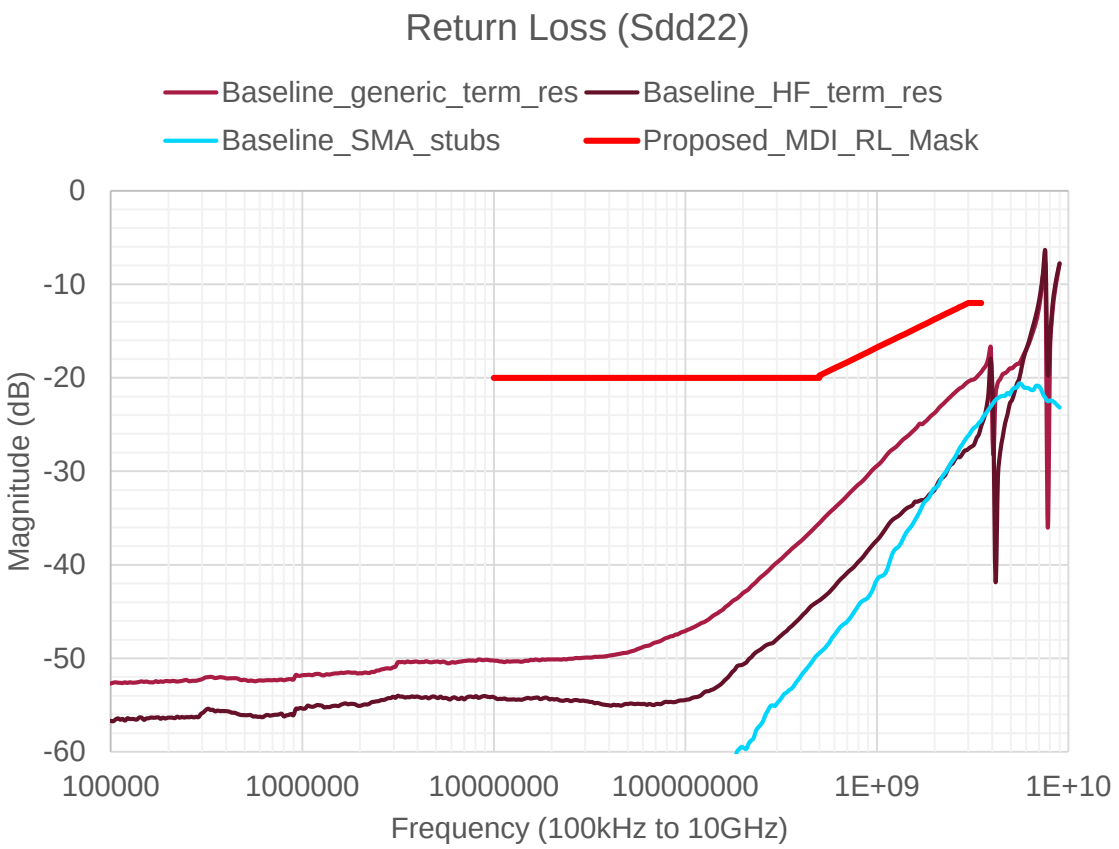


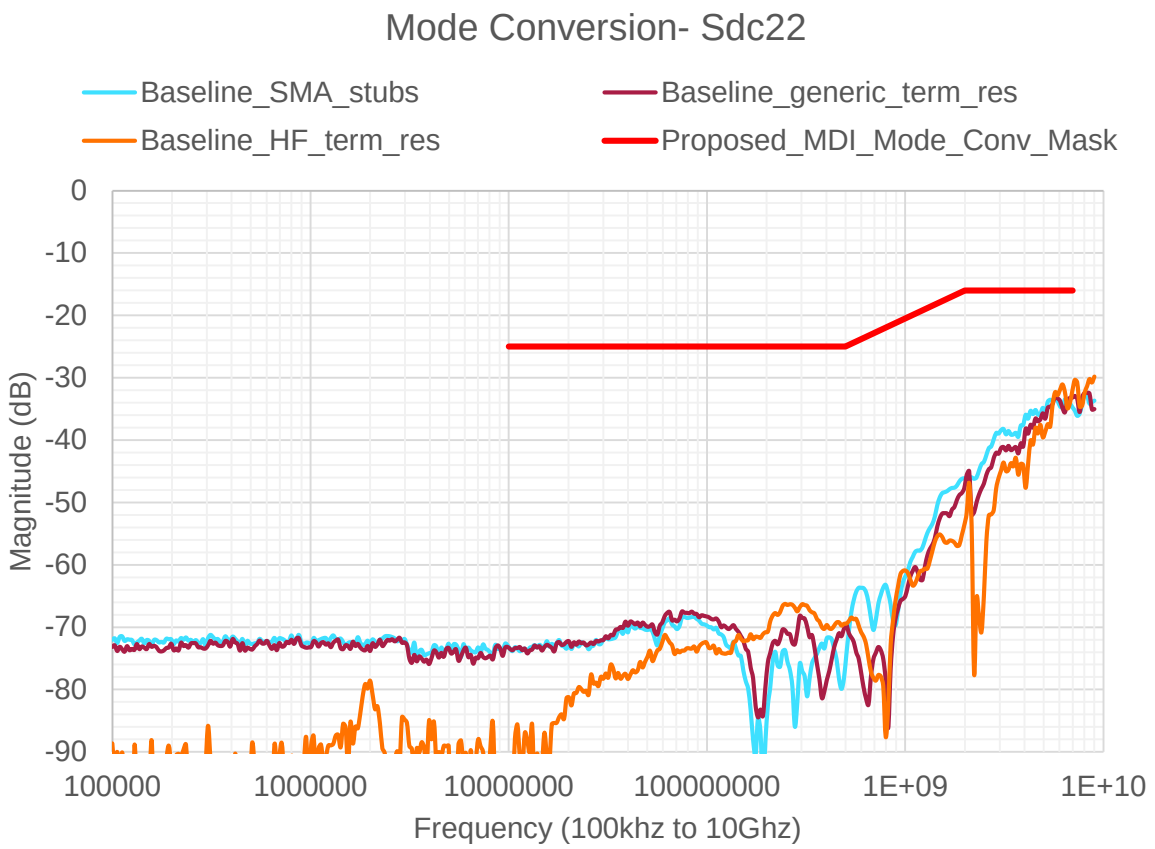
Baseline with SMA stubs



Baseline with termination resistors

Test Fixtures and Baselines- Results

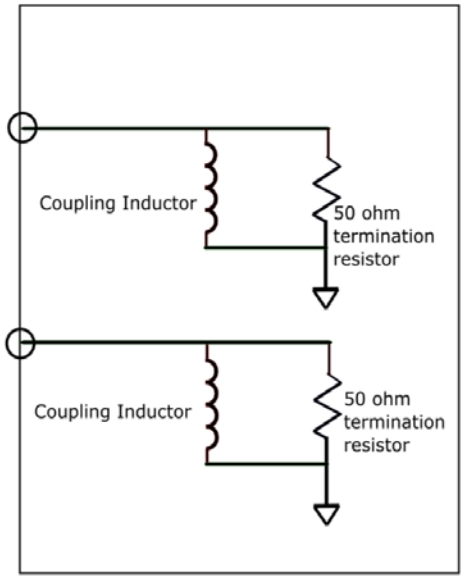




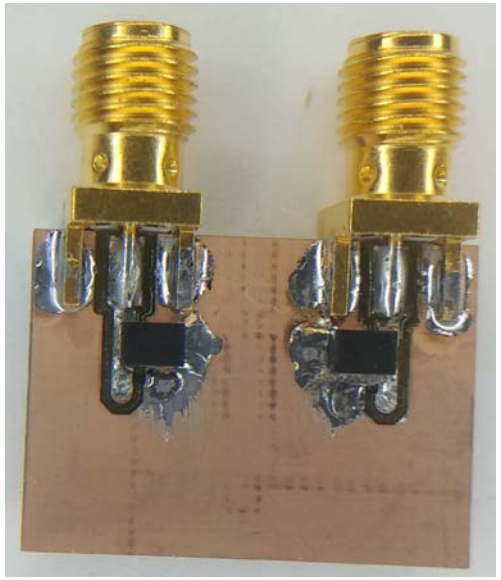
- Return Loss degradation at higher frequencies can be attributed to package inductance of term resistors
- Moved to 0402 package from 0603 to improve this
- 0201 package not tested since HF 0402 resistors match performance of SMA stubs above 2GHz

Power Coupling Inductors and Test Fixtures

Part Number	Inductance (uH)	Tolerance (%)	Dimensions (mm)	Current Rating (20℃ rise)
PFL3215-103	10	+/- 20%	3.2 X 2.3 X 1.5	300 mA

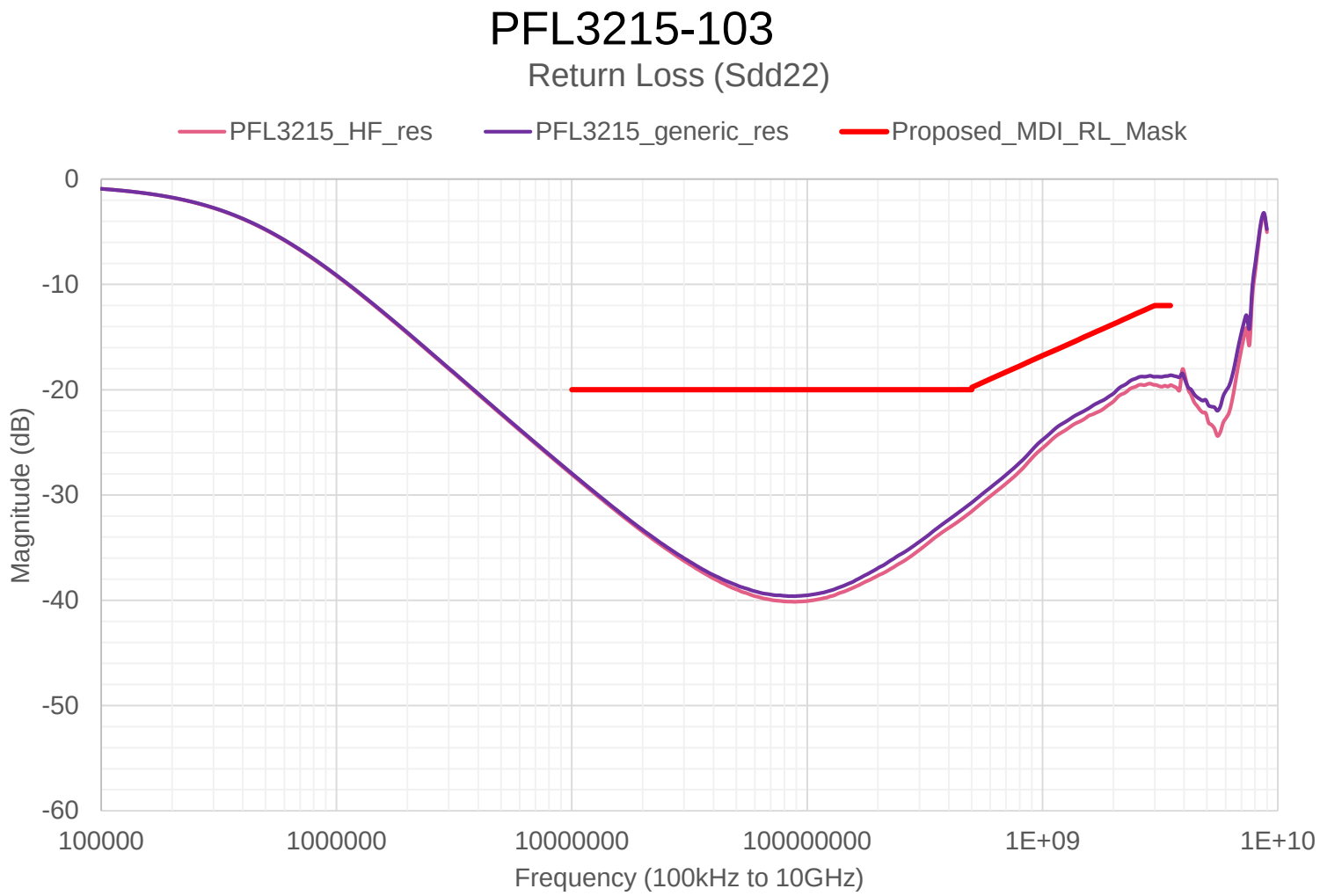


Schematic



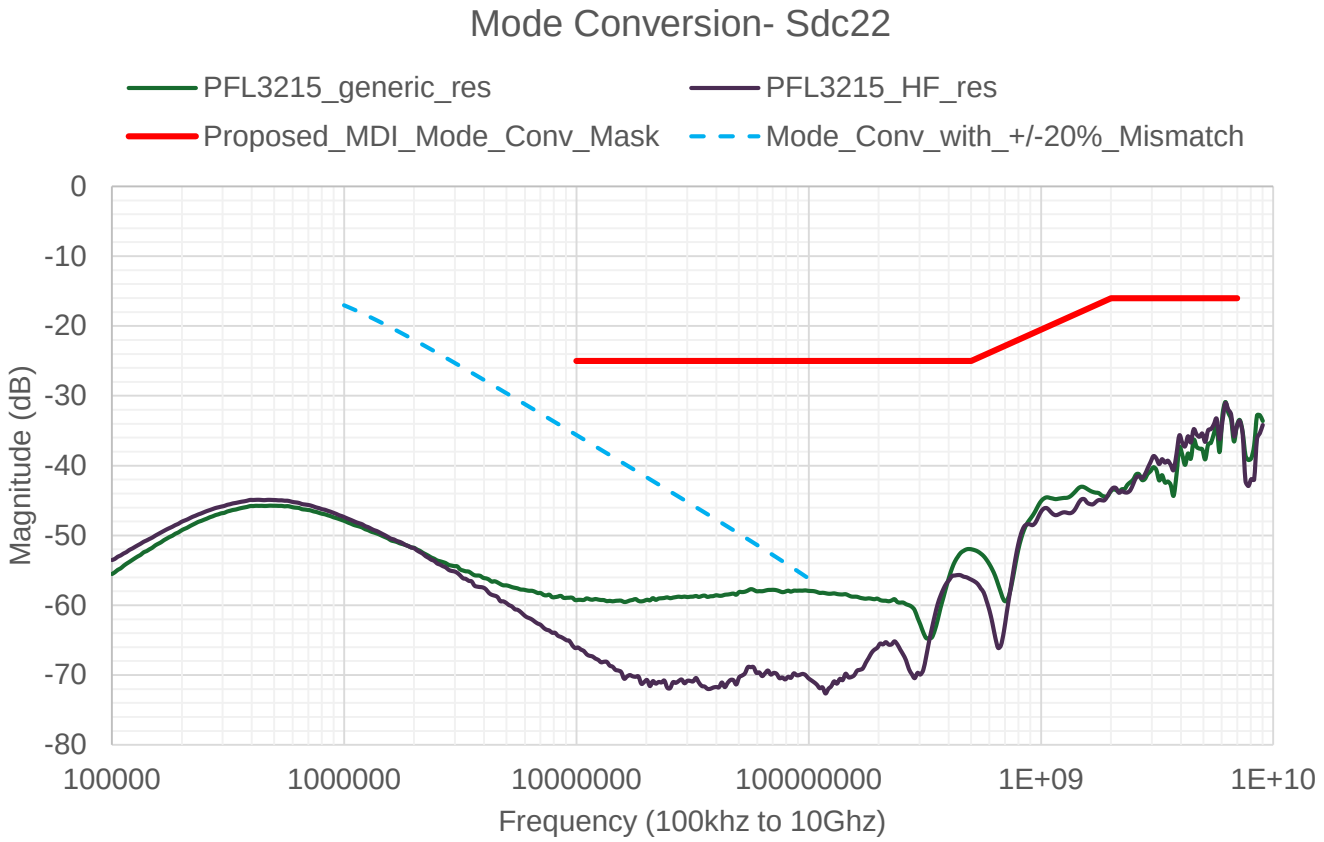
PFL3215- 103

Measured Data – Return Loss



Measured Data- Mode Conversion

- Measured mode conversion data indicates excellent matching (better than +/- 1%) of inductors
- Realistically, Low Frequency Mode Conversion will be dominated by Inductor Tolerance
- Possible to meet -20dB Mode Conversion @ 10MHz with +/- 20% tolerance



Conclusion

- Commercial Off the Shelf inductors can provide sufficient MDI performance
- Good Current capacity and Small Footprint achievable

ANALOG DEVICES

AHEAD OF WHAT'S POSSIBLE™

Thank You!

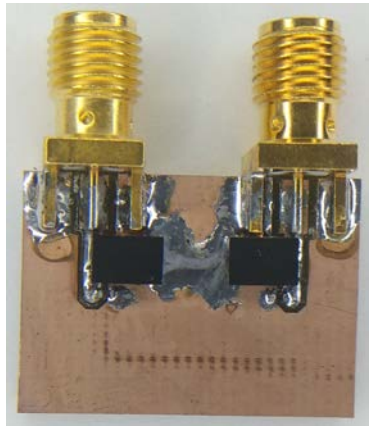
QUESTIONS? FEEDBACK?

ANALOG DEVICES

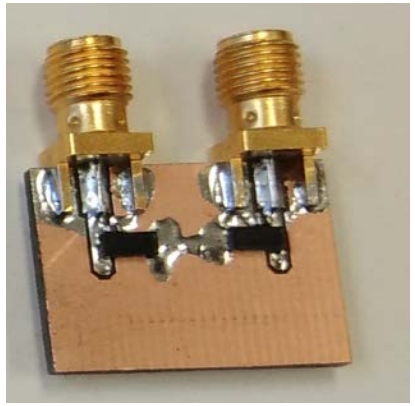
AHEAD OF WHAT'S POSSIBLE™

Back Up Slides

Other Coupling Inductors- to be tested



PFL4514- 682



WA8514

- Coupling Inductor : WA8514 https://www.coilcraft.com/wa8514.cfm#
- And PFL4514- 682

Part Number	Inductance (uH)	Tolerance (%)	Dimensions (mm)	Current Rating (20℃ rise)
WA8514	5.6	+/- 20%	4.34 X 1.98 X 1.02	600 mA
PFL4514-682	6.8	+/- 20%	4.9 X 3.4 X 1.4	860 mA