TECHNISCHE UNIVERSITÄT WIEN

Project Update TU Wien

Interreg AMOR ATCZ-203

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Contents

Motivation

- **Survey of industry partners**
  - Mostly small companies
  - Almost all struggle with EMC
  - Central problem: radiated emission and immunity testing
  - Others: filter design, PCB layout
  - Low/No-budget available for measurement instruments

- **General research question**
  - How to estimate radiated emission and immunity test performance

Circumstances
  - Low capabilities in terms of: premises
  - Financial liquidity
  - (Know-How)

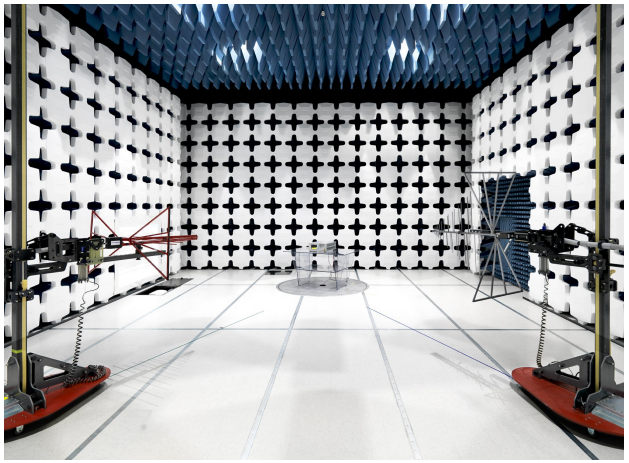
Contents

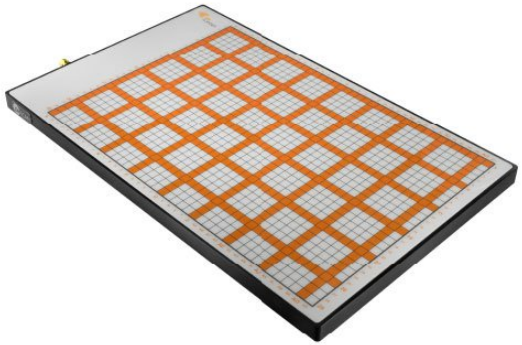
State-of-the-Art

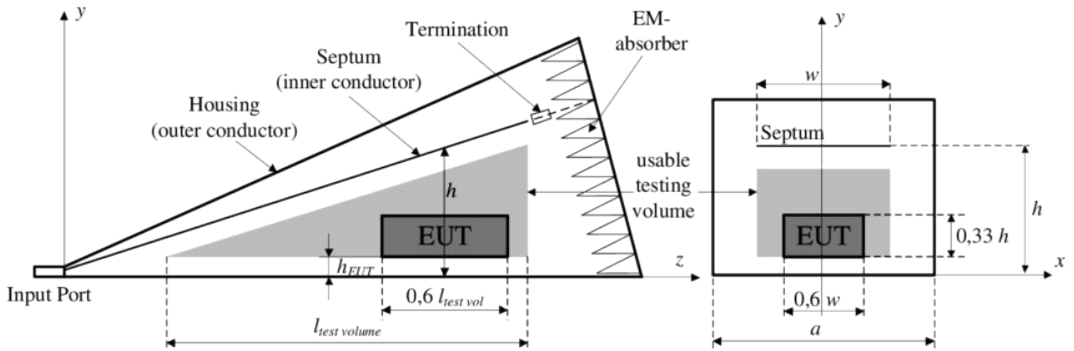
- **Optimum test site:**
  - Semi Anaechoic Chamber
  - Very large
  - Very expensive
  - Long measurement times

- **Near-field sites:**
  - YIC EMScanner
  - Pendulum Detectus
  - Visualize EMI spots
  - Fast and repeatable
  - No statement about absolute values
  - Not compliant!
  - Currently, no immunity testing
  - > 20000€

- **TEM wave guides**:
  - Fully compliant site
  - No cables allowed
  - TEM size scales with EUT size
  - Cheap manufacturing process
  - Frequency limitations
  - < 1000€

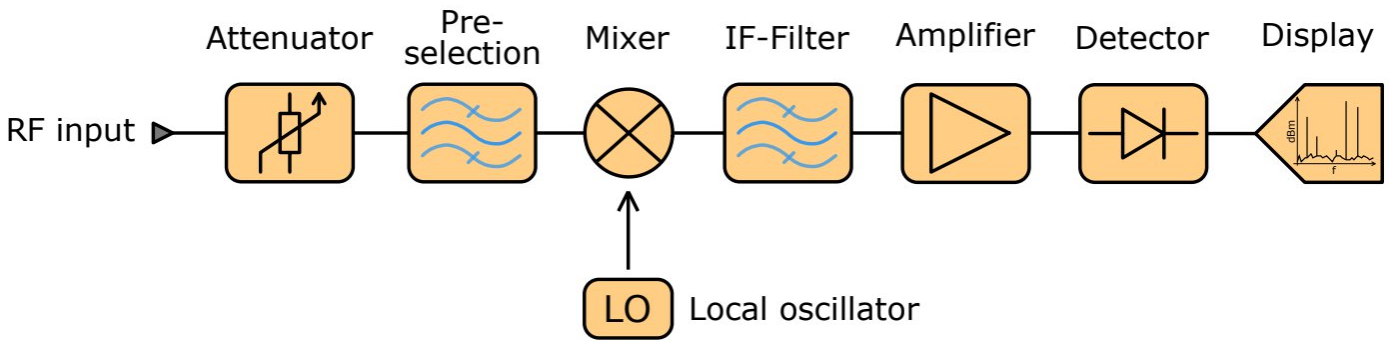




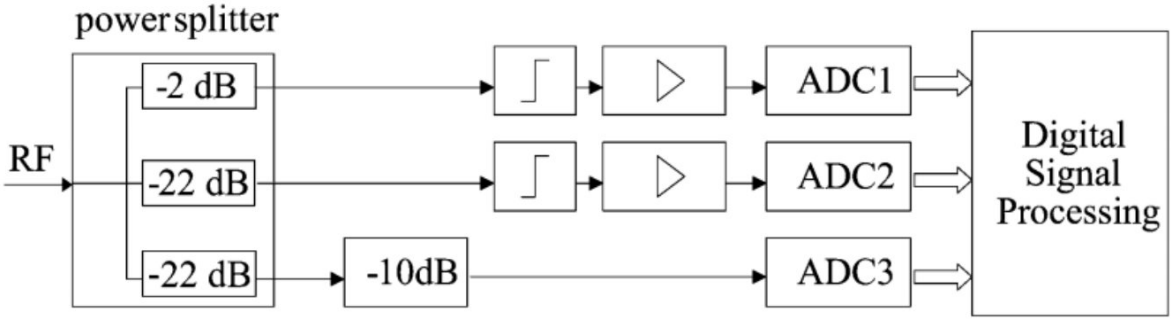


State-of-the-Art

- **Heterodyne EMI Receivers**
  - Massive pre-selection filter bank
  - Limited analysis bandwidth
  - Real-time operation available



- **Floating**
  - In\
  - Very large real-time analysis bandwidth > 1GHz
  - Outperforms heterodyne principle in terms of measurement speed
  - Problems with DR and echoes!



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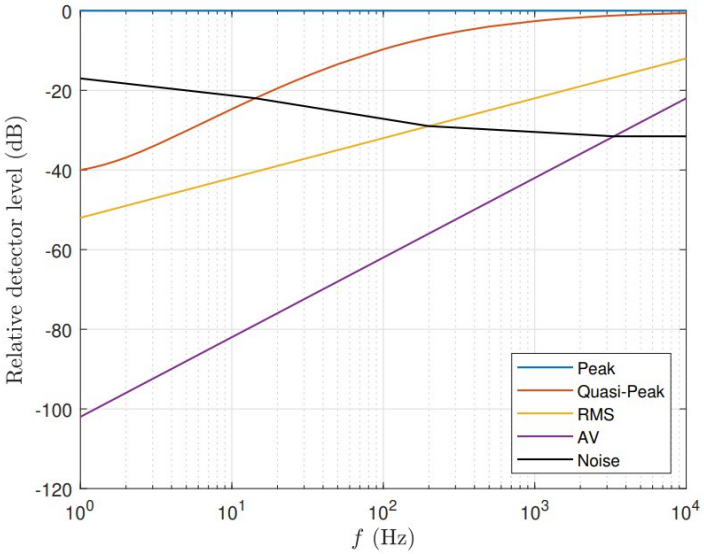
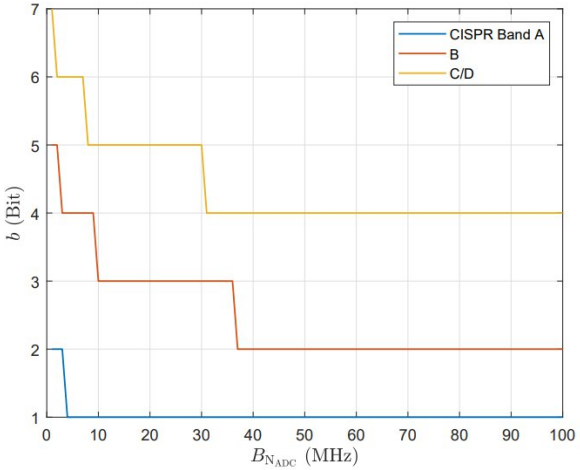
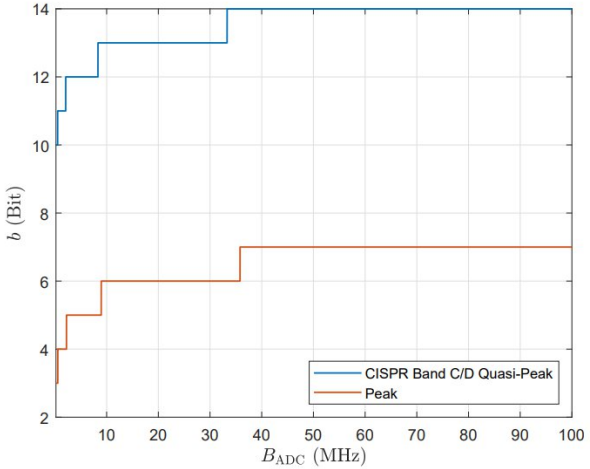
General Requirements

- **CISPR 16-1-1**
  - Identifies the receiver as black box
  - Performance is verified by applying signals
  - Broadband impulses (BW > 1GHz) and CW
  - Constraints are hard to meet for fully compliant receivers (Quasi-Peak detector)
  - For instance: an impulse with ~75V and a CW with 1mV has to be measured in the same config
  - Analyzing the utilized scenarios leads to typical parameters: ENOB, DR, etc.





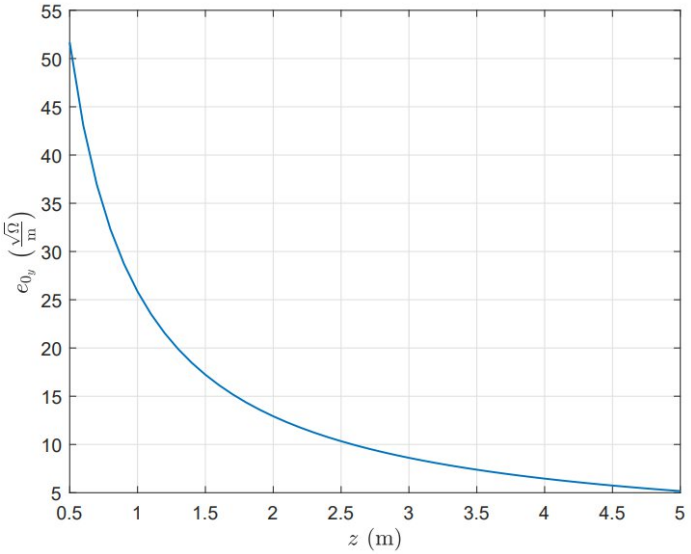
(a) CW signals

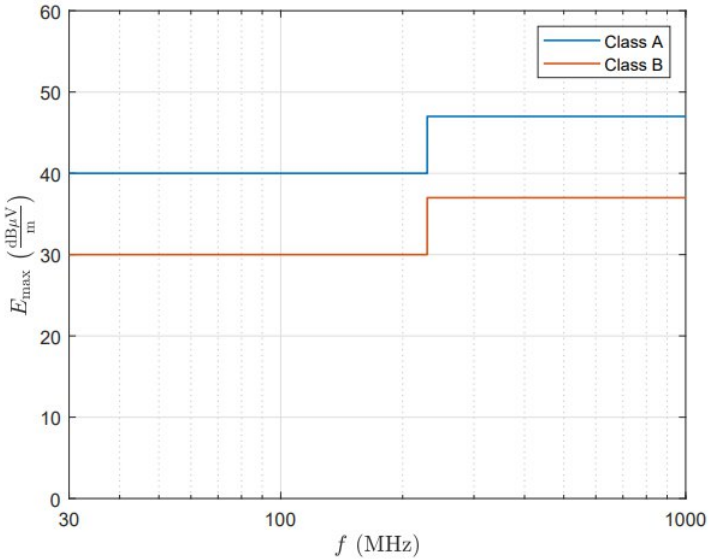


(b) Impulses in *CISPR band C/D* for peak and quasi-peak detection

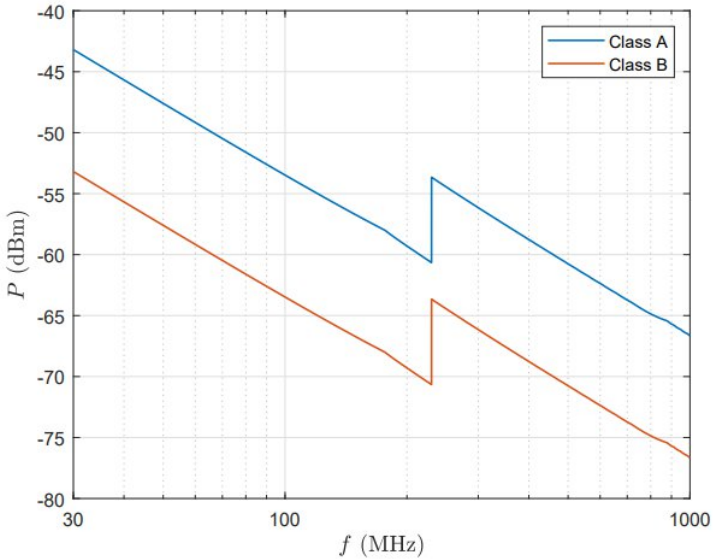
General Requirements

- **TEM cell**
  - Field factor increases with decreasing cell volume
  - The receiver sensitivity gets higher
  - Suffering less from frequency birdies
  - Noise figure can be relaxed
  - No LNA needed





(a) Maximum field strength *DIN EN 55032*



(b) Calculated power levels

Contents

- Motivation
- State-of-the-Art
- General requirements
  - CISPR 16-1-1
  - TEM cell
- **SDR platforms**
  - HackRF One
  - LimeSDR
  - USRP X310 (UBX daughterboard)
  - Limits
- RF extension board
  - Structure
  - Measurement results
- Further steps

SDR Platforms

HackRF One

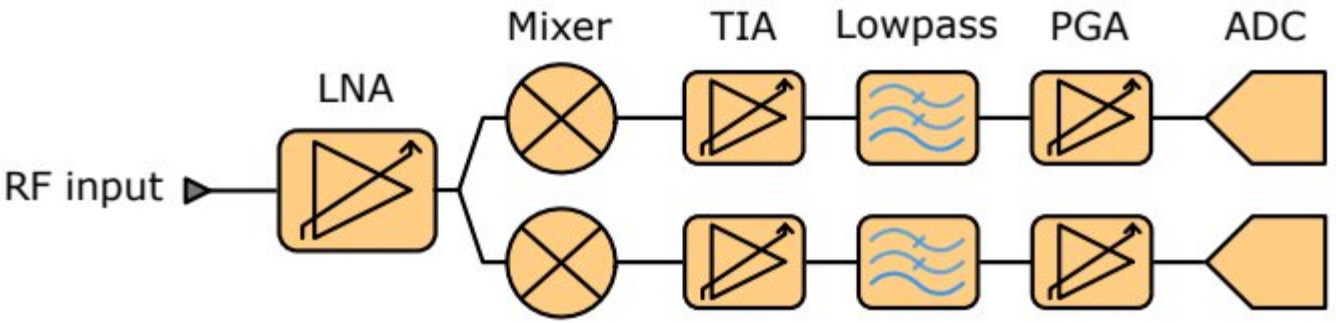
- 8 Bit
- DCR with second IF stage
- High DR mixer P1db ~ 10dBm

LimeSDR

- 12 Bit
- DCR
- 3 pole lowpass

USRP X310 (UBX)

- 14 Bit
- DCR with second IF stage
- > 10 pole Lowpass
- LNA cannot be bypassed
- Gain setting easy, only one programmable attenuator



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  - Structure
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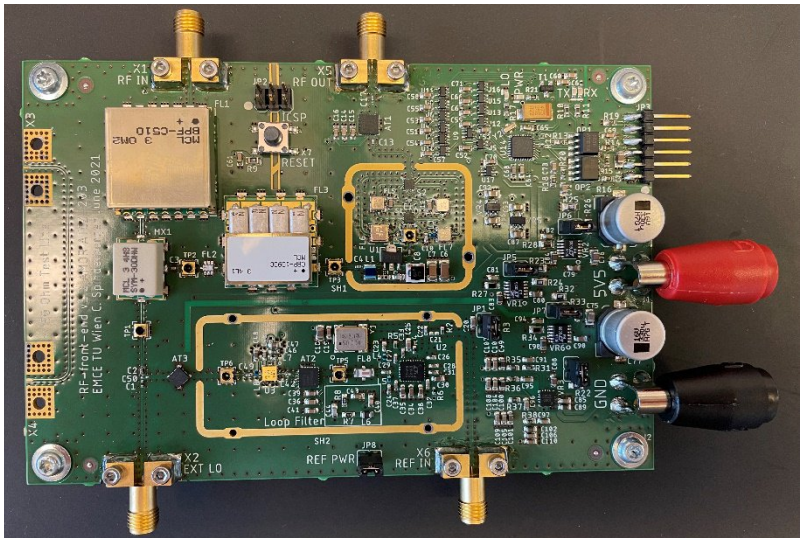
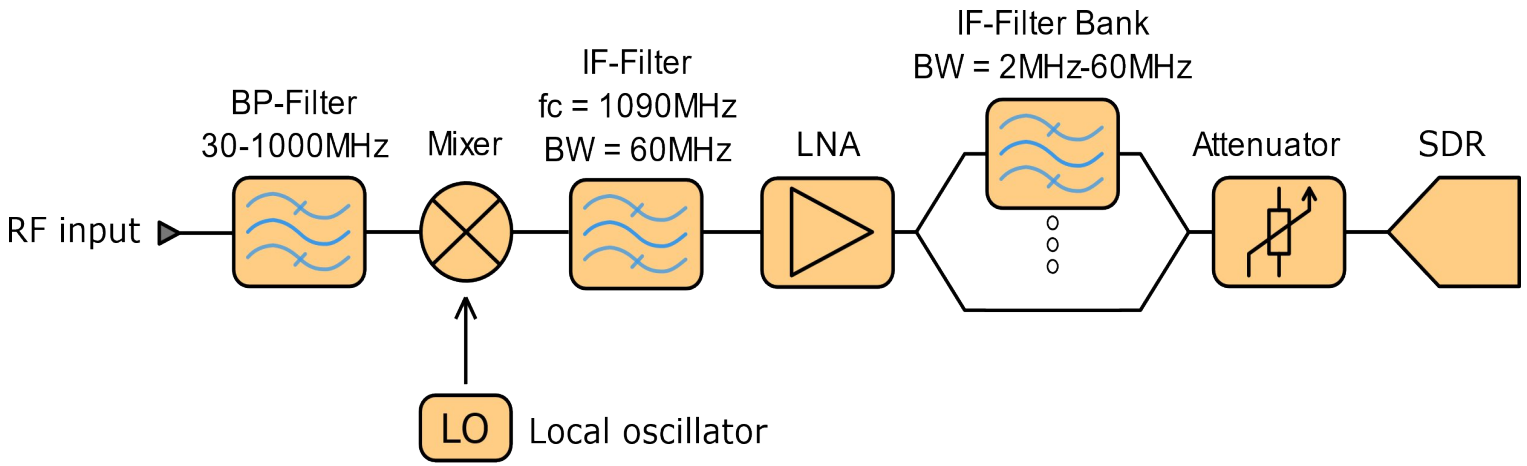
RF Extension Board

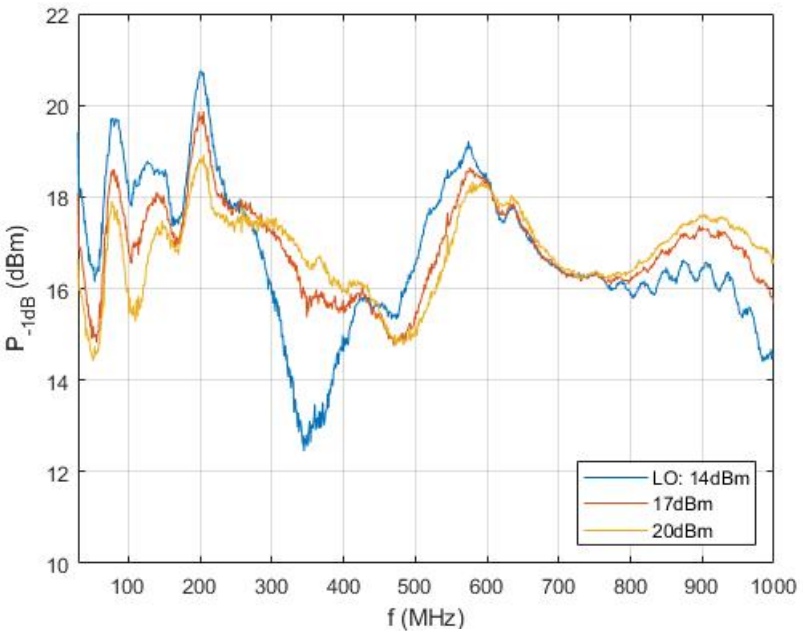
- **Consisting of:**
  - Pre-selection filter
  - High DR mixer
  - High DR LNA
  - SAW IF filter bank (2MHz to 60MHz)
  - Attenuator

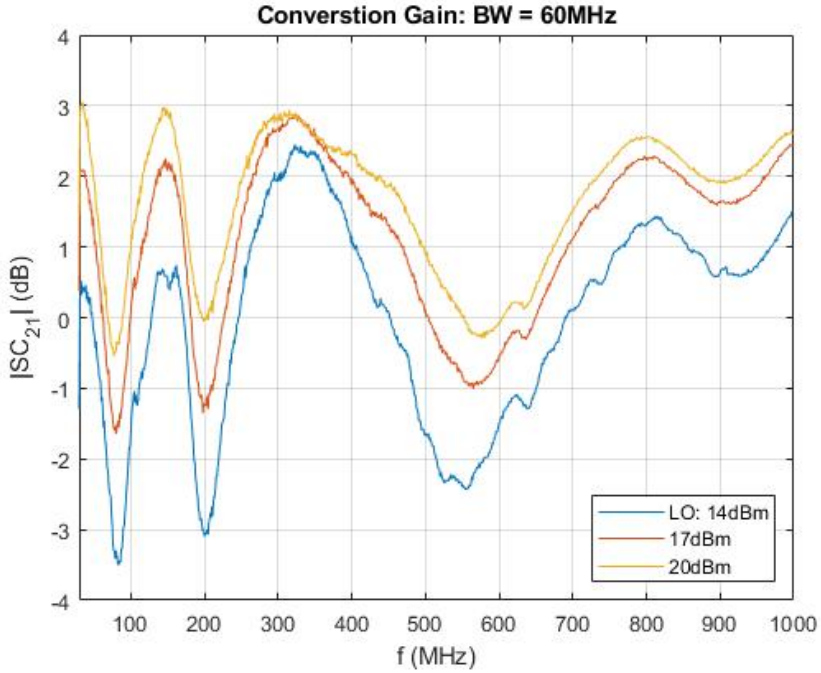
- **Replacing pre-selection filter bank**
- **Gain adaptation can be relaxed**

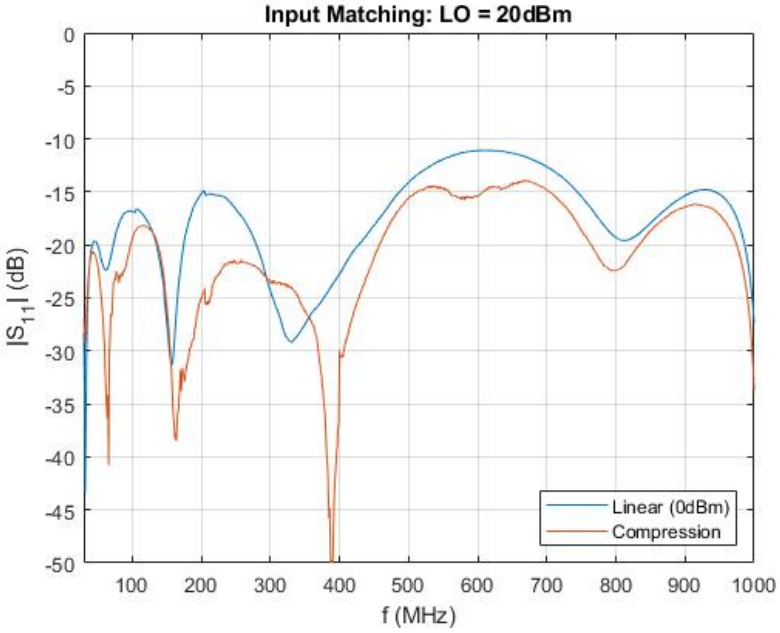




RF Extension Board







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Further steps

- Noise figure and IMD measurements of the RF extension board
- Measuring optimum gain settings of SDRs
- Characterizing SDR performance in terms of CISPR 16-1-1
  - QP dynamic range
  - Harmonic distortion
  - Spectral regrowth etc.
  - Comparing with RF extension

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Thank you for your attention!