IEEE 802.3 RTPGE PHY Study Group

Zwickau University of Applied Sciences EMC Lab Testing for Automotive Ethernet Physical Layer Qualification

Michael Jones
Micrel Semiconductor

September, 2012 - Geneva

Introduction

- Overview of the work Zwickau University of Applied Sciences (FTZ) have performed to aid the qualification of Ethernet Physical Layer for Automotive applications
- We feel that these test methods will be useful information for the RTPGE Study Group

Introduction to FTZ

- Expert knowledge of EMC test methodology
- Vast experience in Automotive EMC qualifications
- Commissioned by the German OEM car makers to develop lab bench EMC test methods
  - Reduces the high cost & limited availability of stripline testing facilities
- Through extensive testing (since 2008), excellent correlation has been shown between FTZ test setup and classic stripline tests
- The FTZ testing is now the preferred 1st step before strip line testing is performed in Europe
  - Similar to UNH IOL

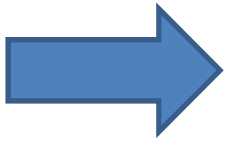
Note – Any test results in this presentation have been performed by FTZ

FTZ lab vs Classic Stripline Testing

FTZ Lab based

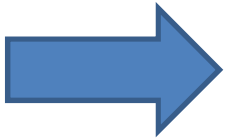
Stripline (chamber) based

RF Emissions
Based on IEC 61967-1/4
FTZ RF Board



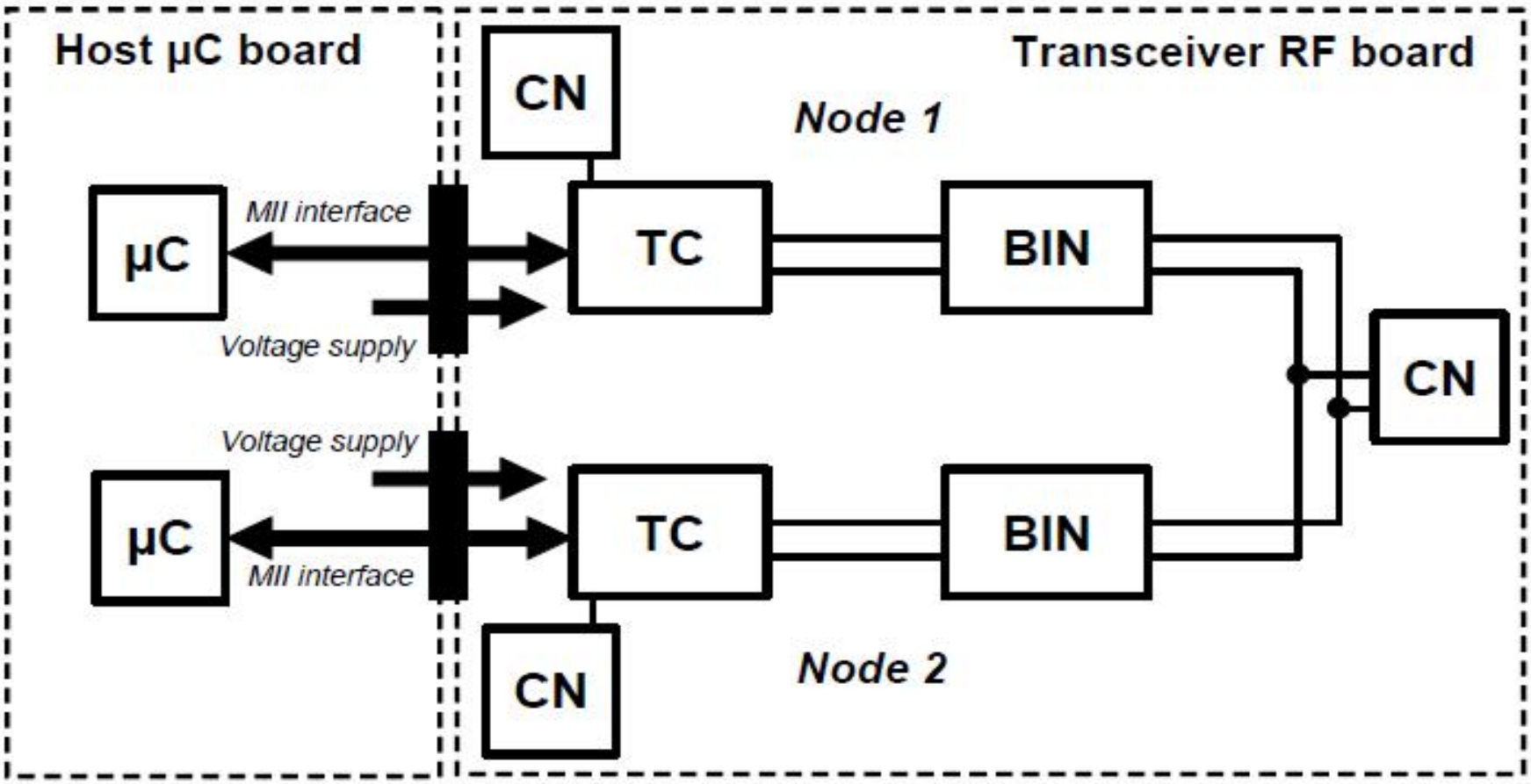
Stripline Emissions
Based on CISPR25
FTZ Dummy ECU Board

Direct Power Injection (DPI)
Based on IEC 62132-1/4
FTZ RF Board



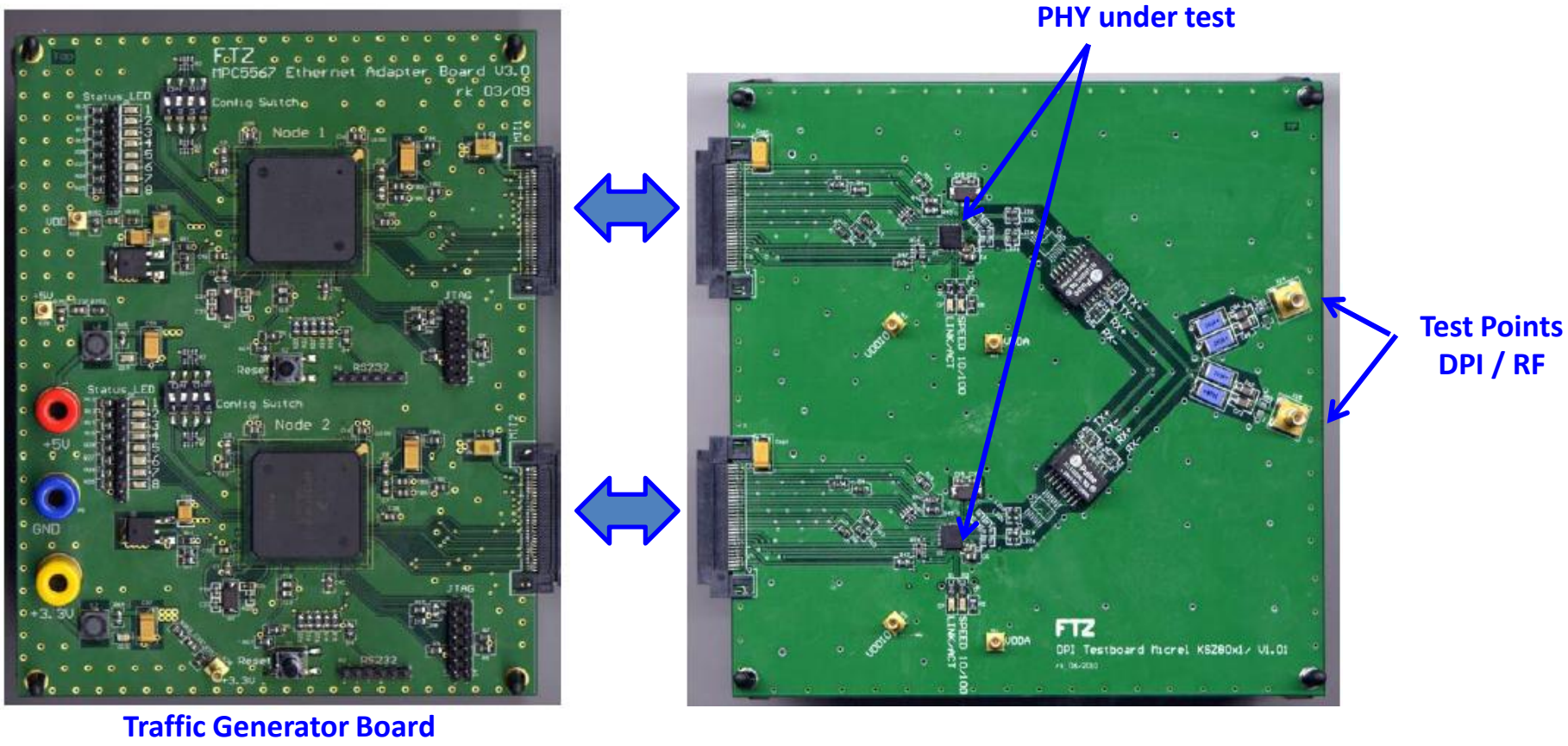
Bulk Current Immunity (BCI)
Based on ISO 11452-4
FTZ Dummy ECU Board

RF Test Board Functional Diagram



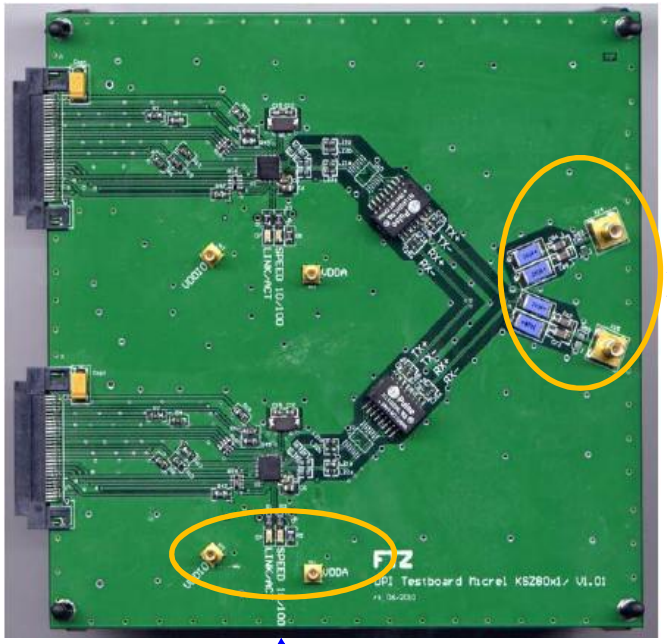
µC	Used to generate traffic if the PHY cannot	BIN	Filter network, including transformer, termination, ESD protection
TC	Ethernet transceiver under test (DUT)	CN	EMC Coupling network

RF Board

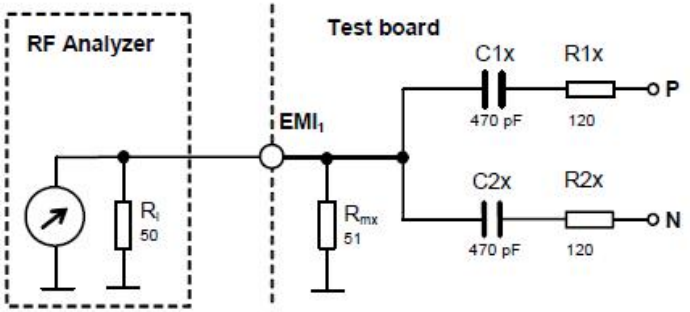


- Same board design / setup / test method
  - Consistent comparable results

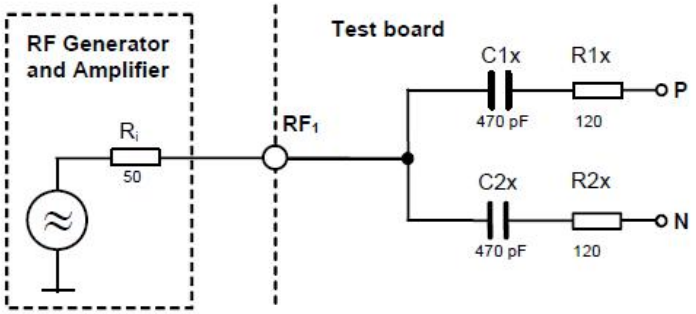
Coupling Networks

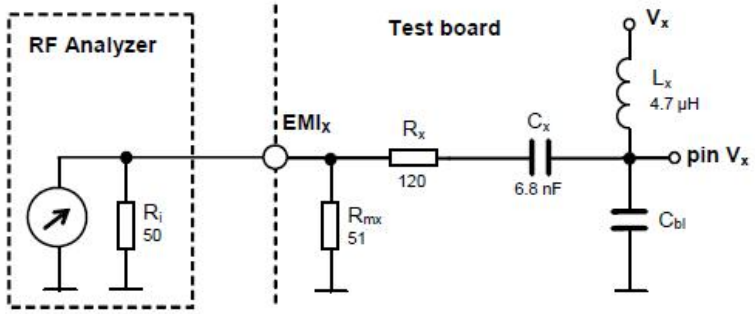


Line Emissions coupling network



Line Immunity coupling network





Voltage Supply Emissions coupling network

***NOTE**: For worse case testing coupling network is modified to +/-2.5% unbalanced*

Emission of RF Disturbances (RF Test Board)

RF Emissions Functional Diagram

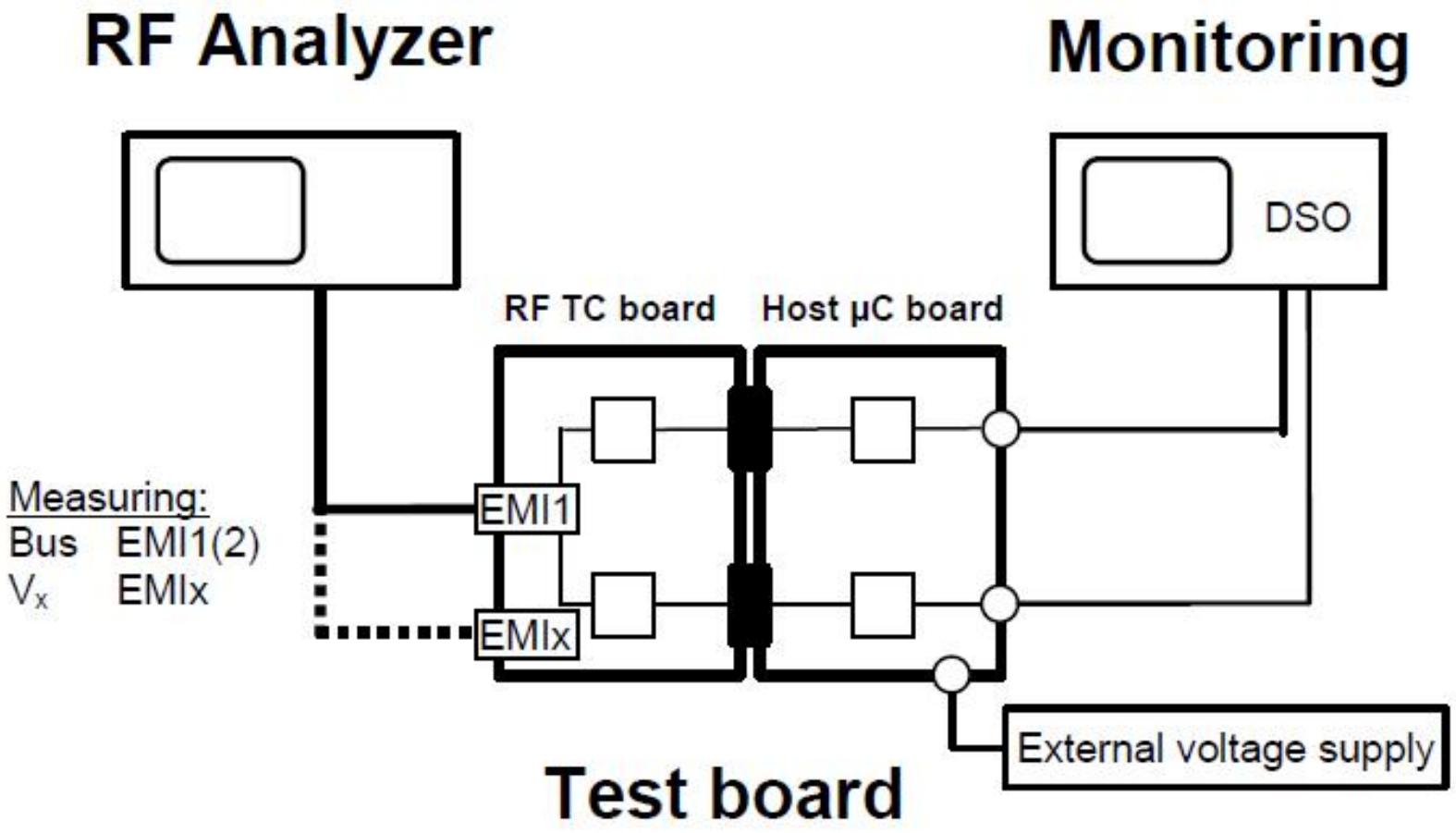
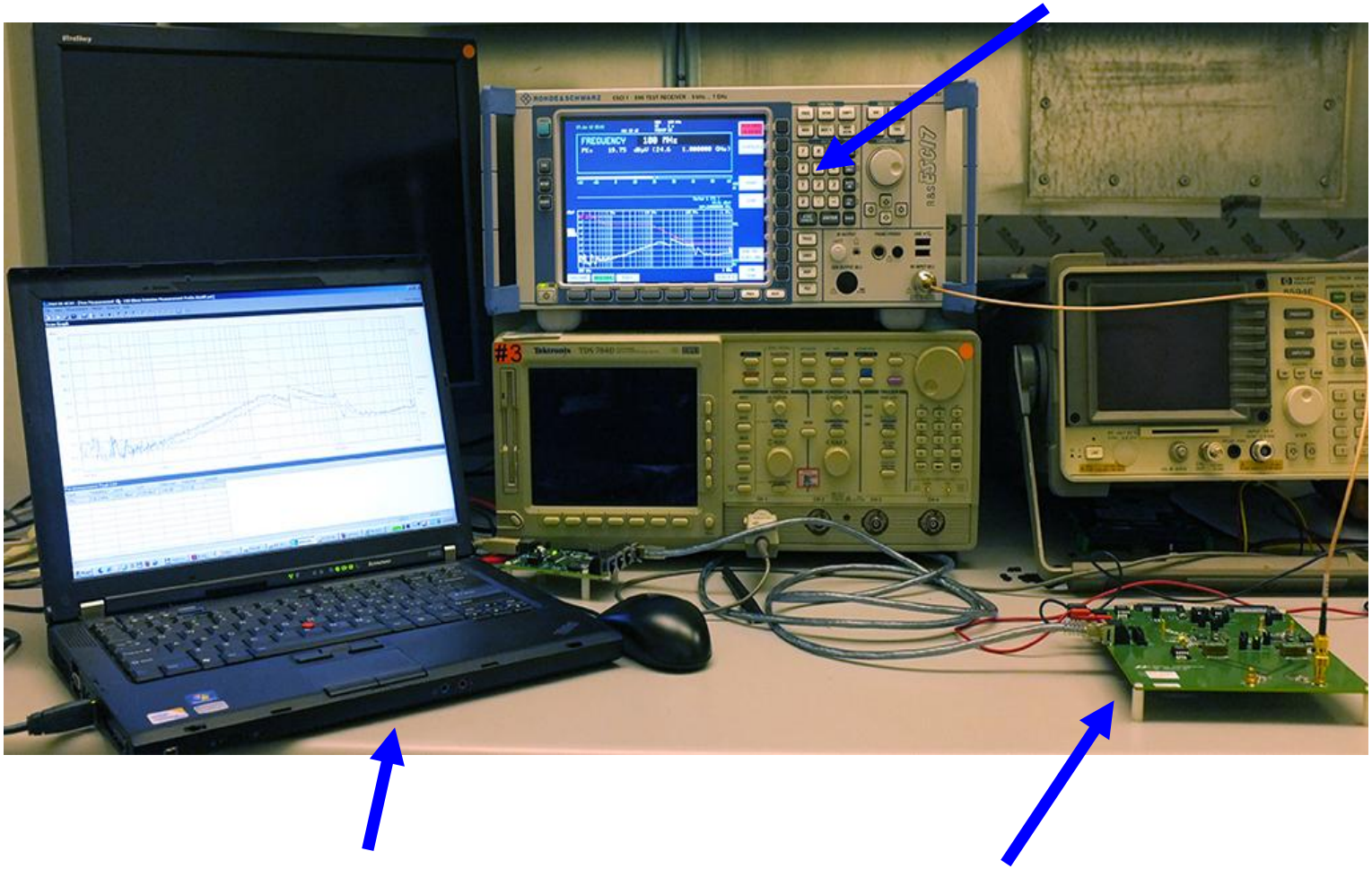
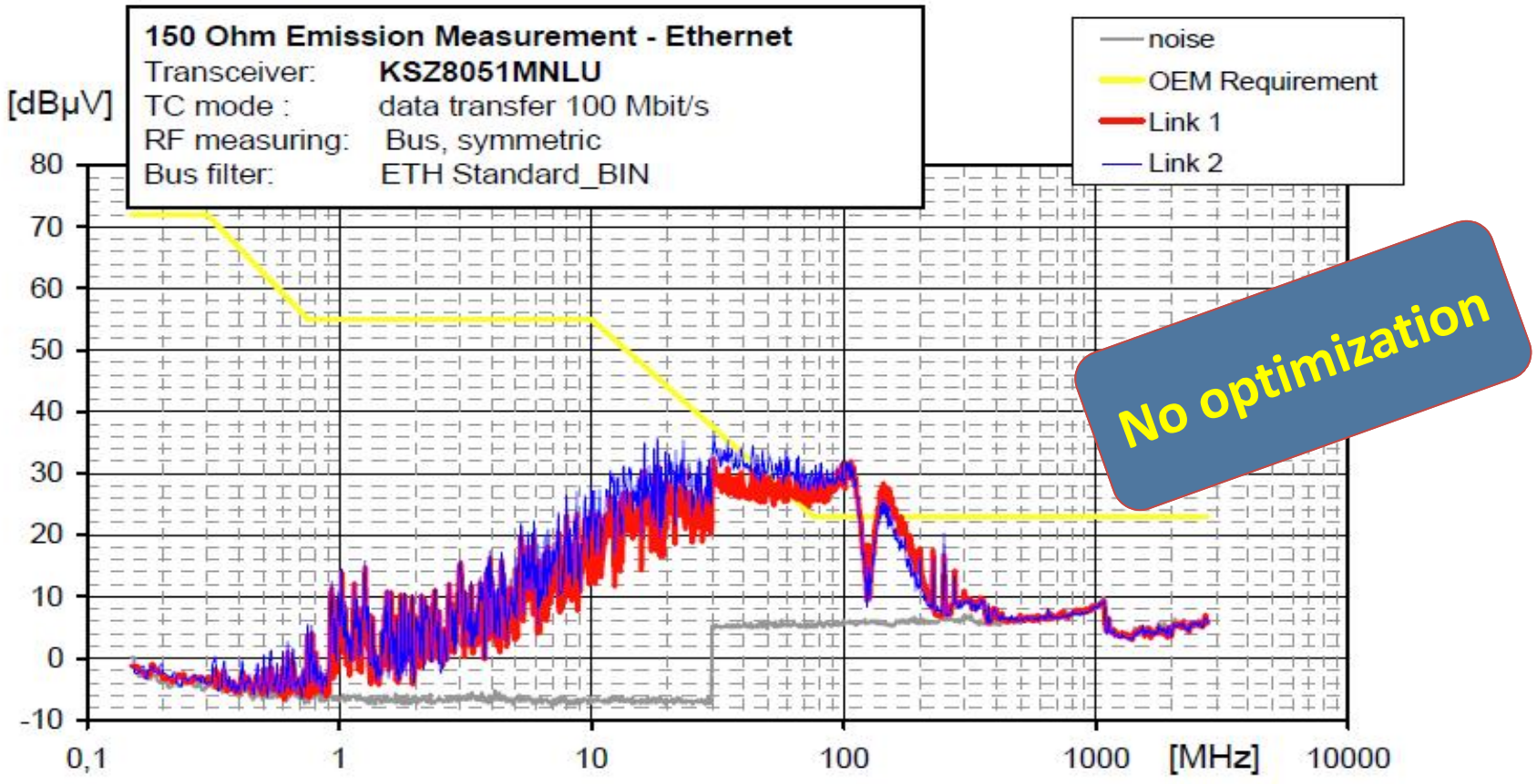


Photo of the RF Emissions Test Setup

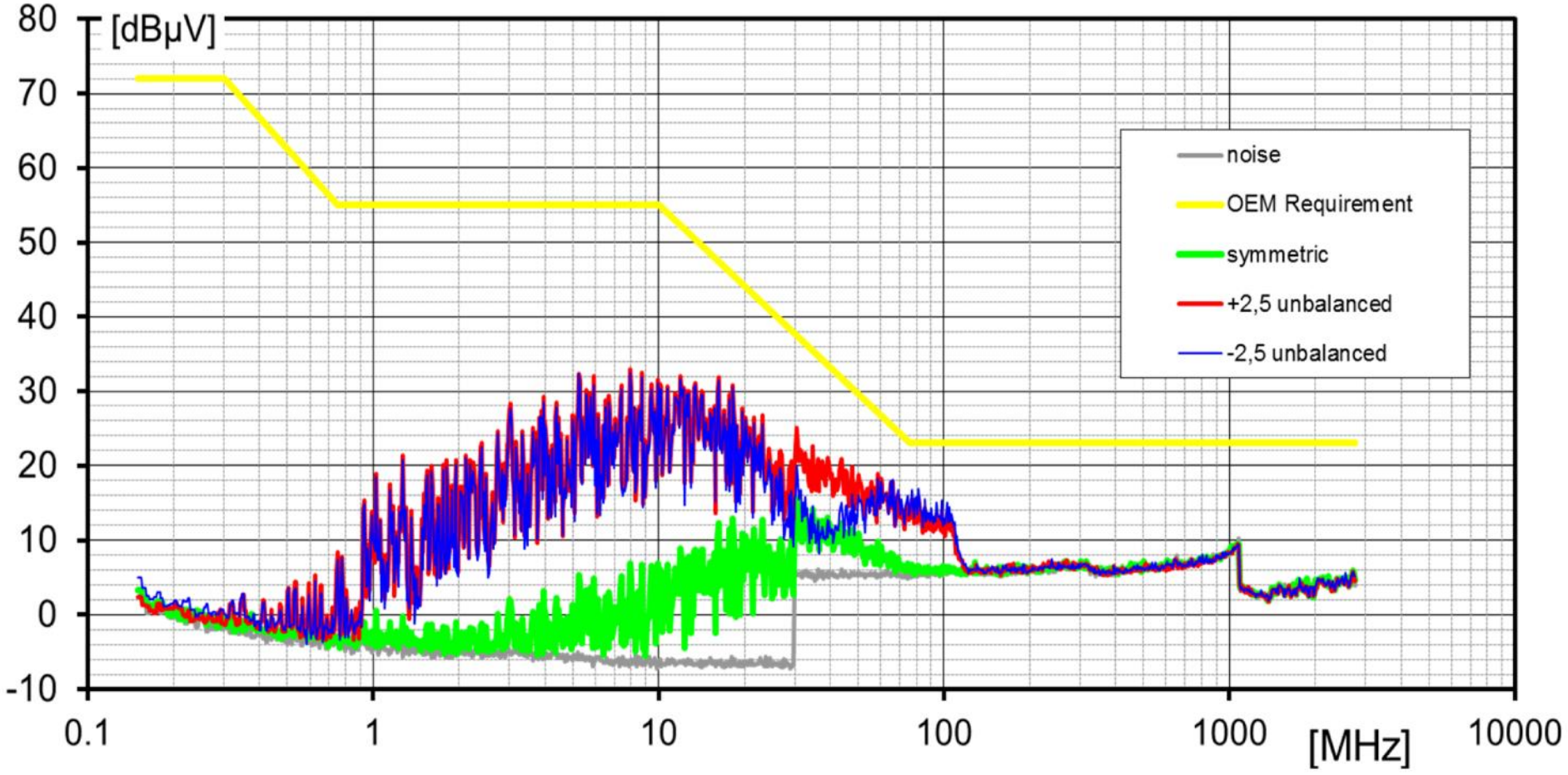


Typical 100BASE-TX PHY Emissions over UTP



- High Energy 50MHz to 100MHz due to line data
  - Sensitive to transformer, termination
- 25MHz /125MHz (line) harmonics

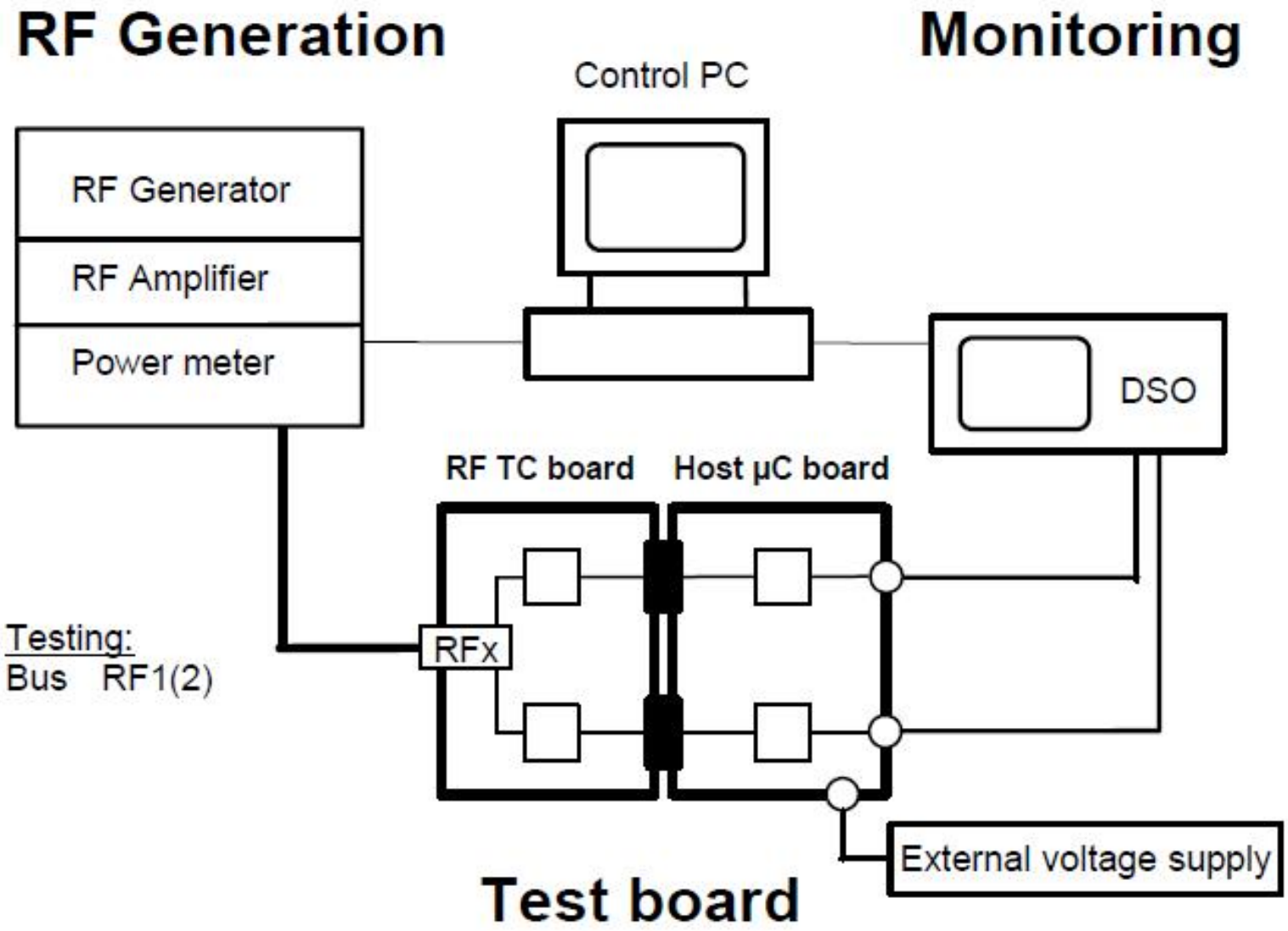
Simulating worse case - Unsymmetrical Testing



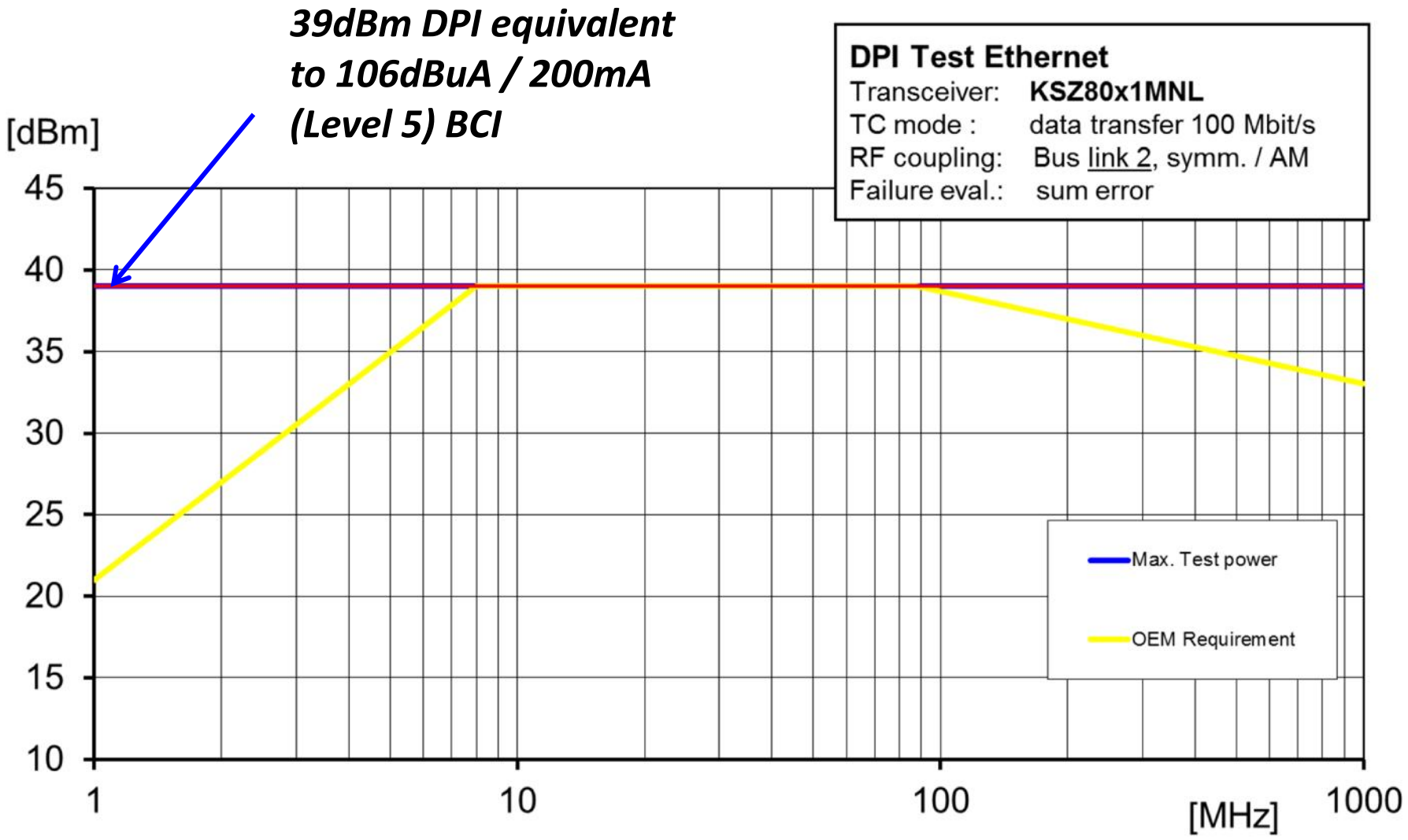
- Coupling network is modified to +/-2.5% unbalanced
- Simulates worse case conditions
  - Transformer, termination, connector….

Immunity to RF Disturbances (RF Test Board)

DPI Immunity Functional Diagram

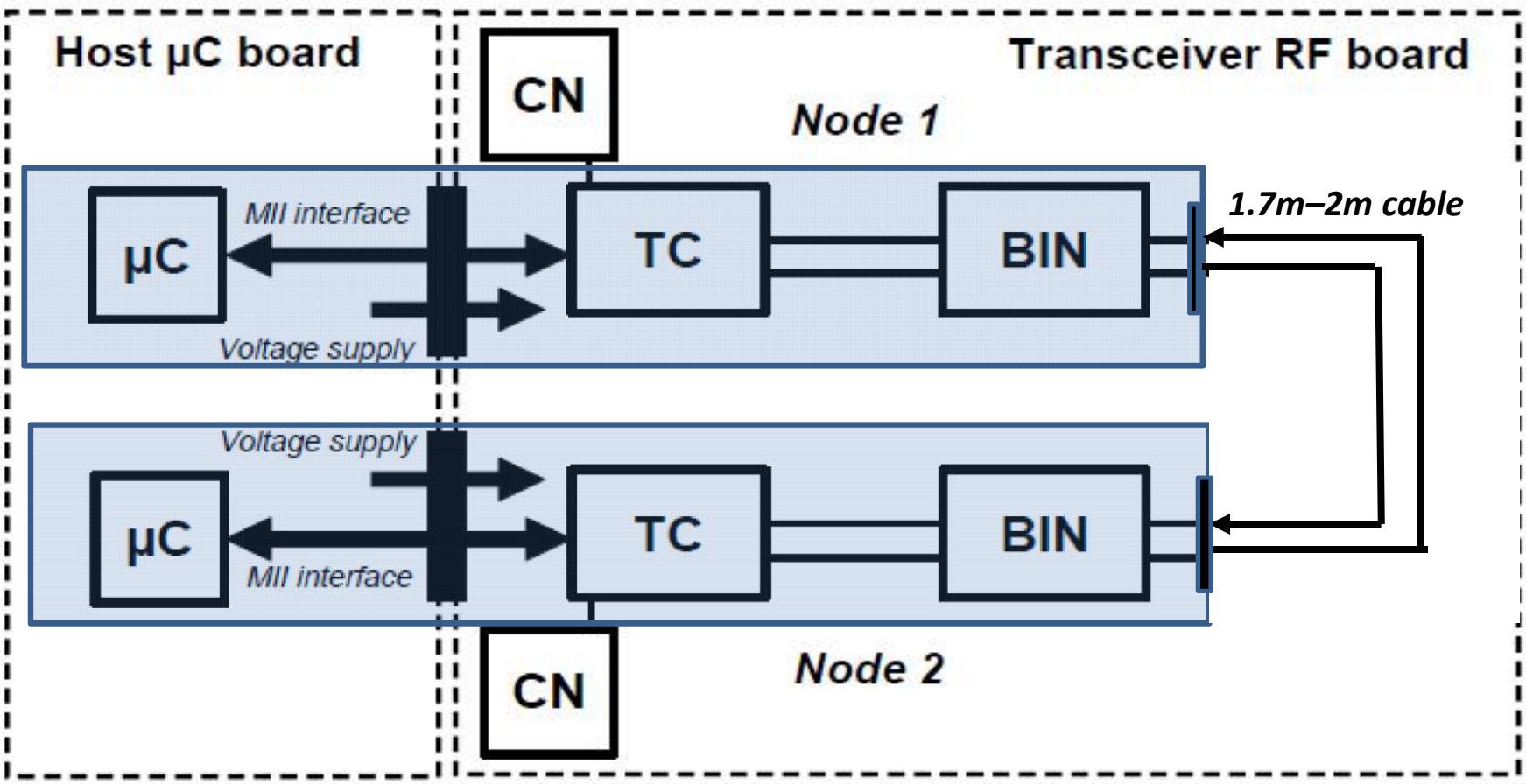


Example of PHY passing DPI Immunity



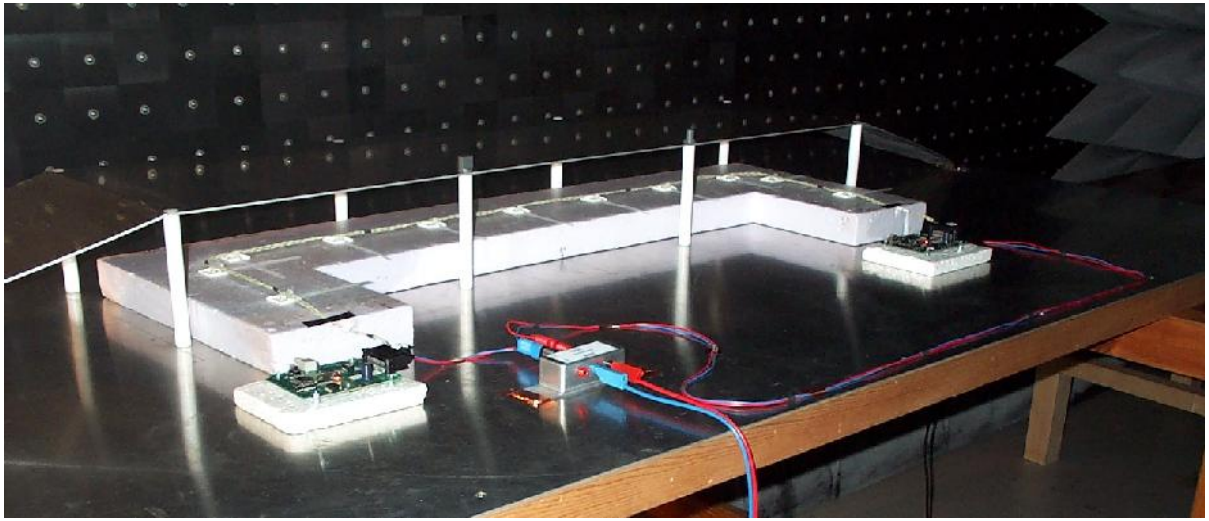
RF Emissions & Immunity using Stripline methods (Dummy ECU Test Board)

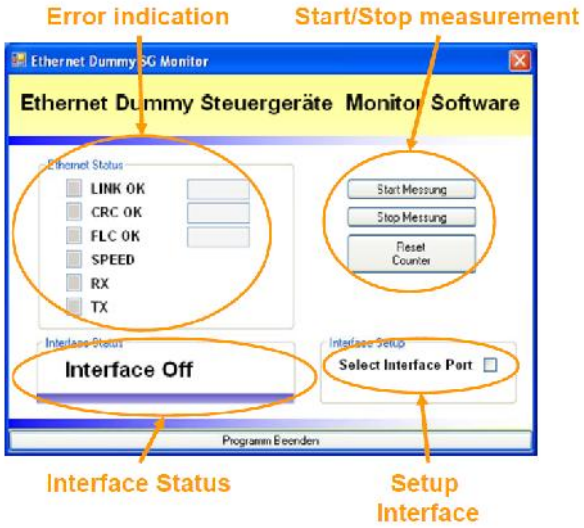
Dummy ECU Test Board Functional Diagram



- Same schematic / layout used as the RF Test Board

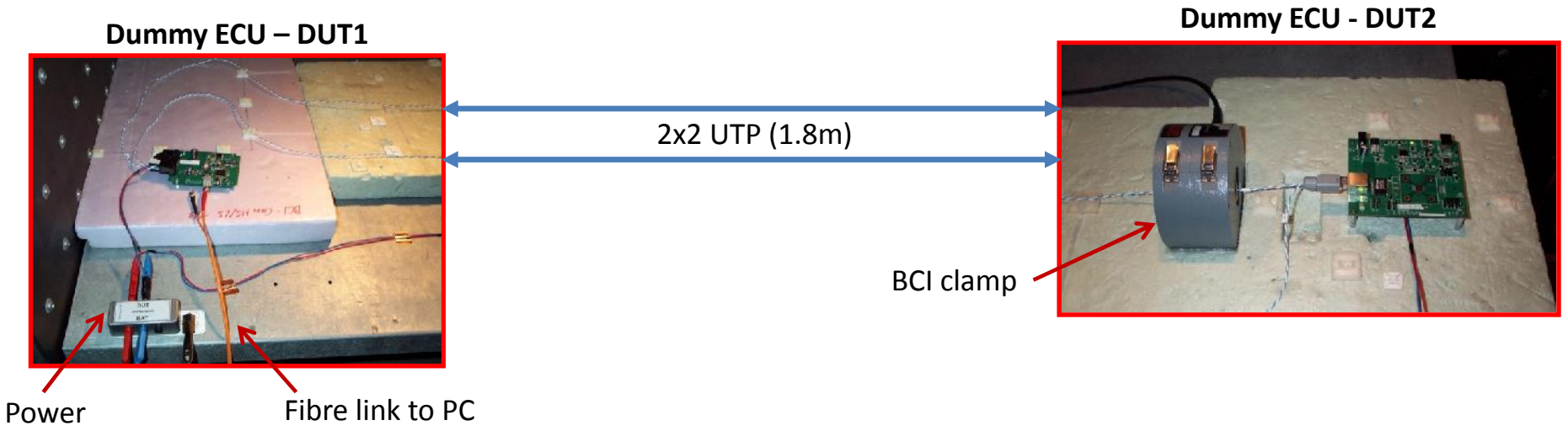
Strip line Emission test





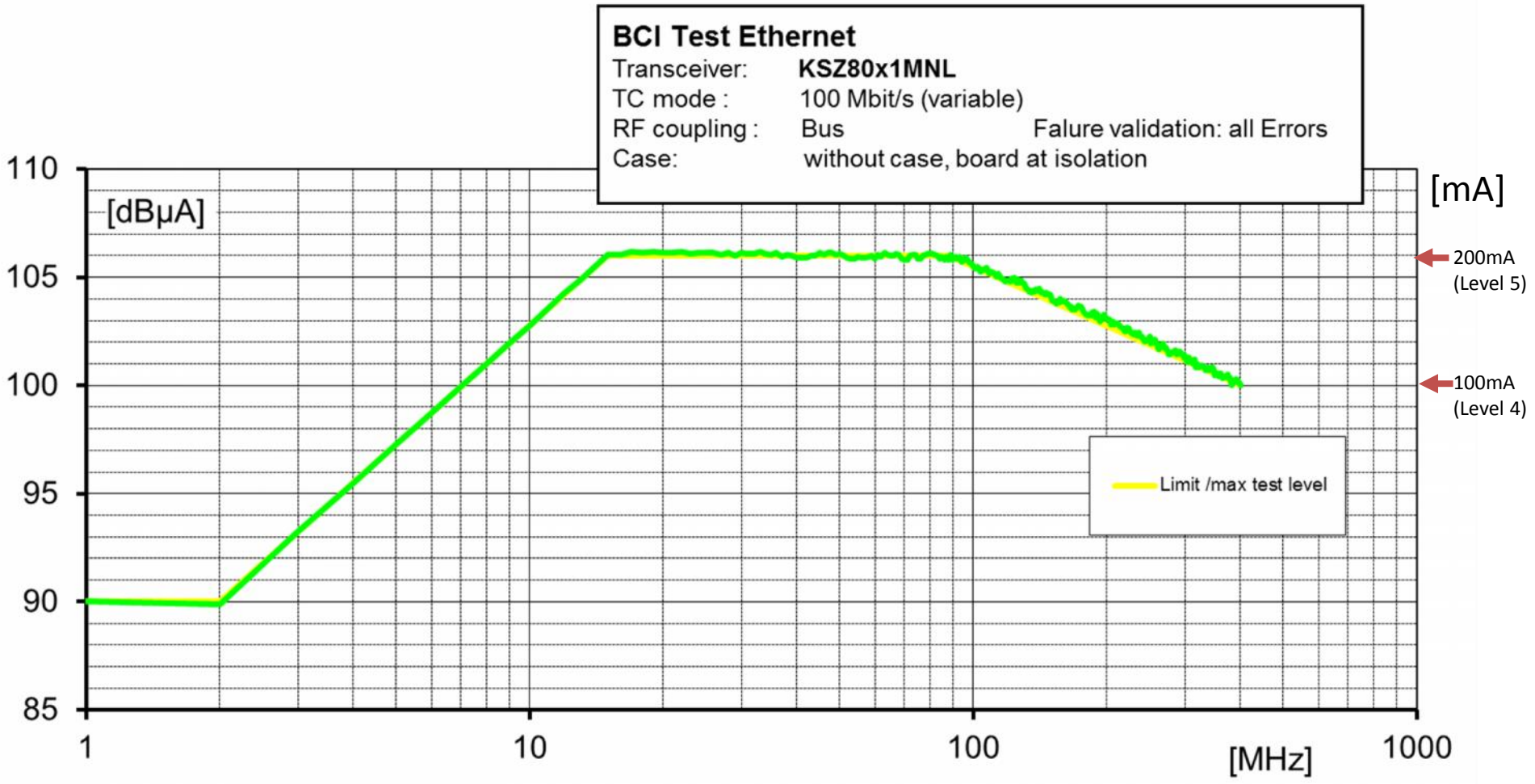
- Stripline emission measurement according to CISPR25 with 1.8m cable length
  - 2x2 unshielded twisted pair
- Dummy ECU used : Processor + PHY (DUT) board
  - Fibre link to PC running monitoring tool
  - Any errors monitored

Bulk Current Immunity test



- BCI test according to ISO 11452-4 (substitution method) with 1,8m cable length
  - 2x2 unshielded twisted pair
- Dummy ECU used : Processor + PHY (DUT) board
  - Fibre link to PC running monitoring tool
  - Link, CRC and Flow control errors monitored for both nodes

Example of OEM BCI Immunity limits



Summary

- Such test methodologies can provide a means to qualifying the Ethernet PHY Layer
  - PHY Transceiver and Network Interface (transformer, termination etc)
- Lowers the cost and time versus classic stripline methods
  - Testing performed on lab bench and not EMC Chamber
- Extremely useful during pre-qualification / selection of Ethernet PHY Layer components

Thank you