EMC Evaluation of an ACT-enabled Camera Development under the Bosch Series Framework

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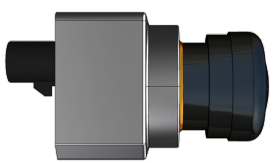
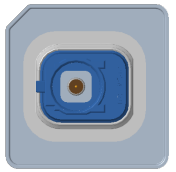
802.3dm - ACT Camera
Stats

- Camera based on Bosch's **F**uture **C**amera **H**ead (FCH) Platform design
  - Single PCB design
    - Utilizing Revision-A of Infineon's ACT Bridge Chip
    - 10 Gbps Asymmetrical Ethernet with 100 Mbps Backchannel
    - Video (CSI-2) and I2C encapsulation in IEEE 1722
  - 120° optics
- Electrical
  - Supply range 6 – 18 V

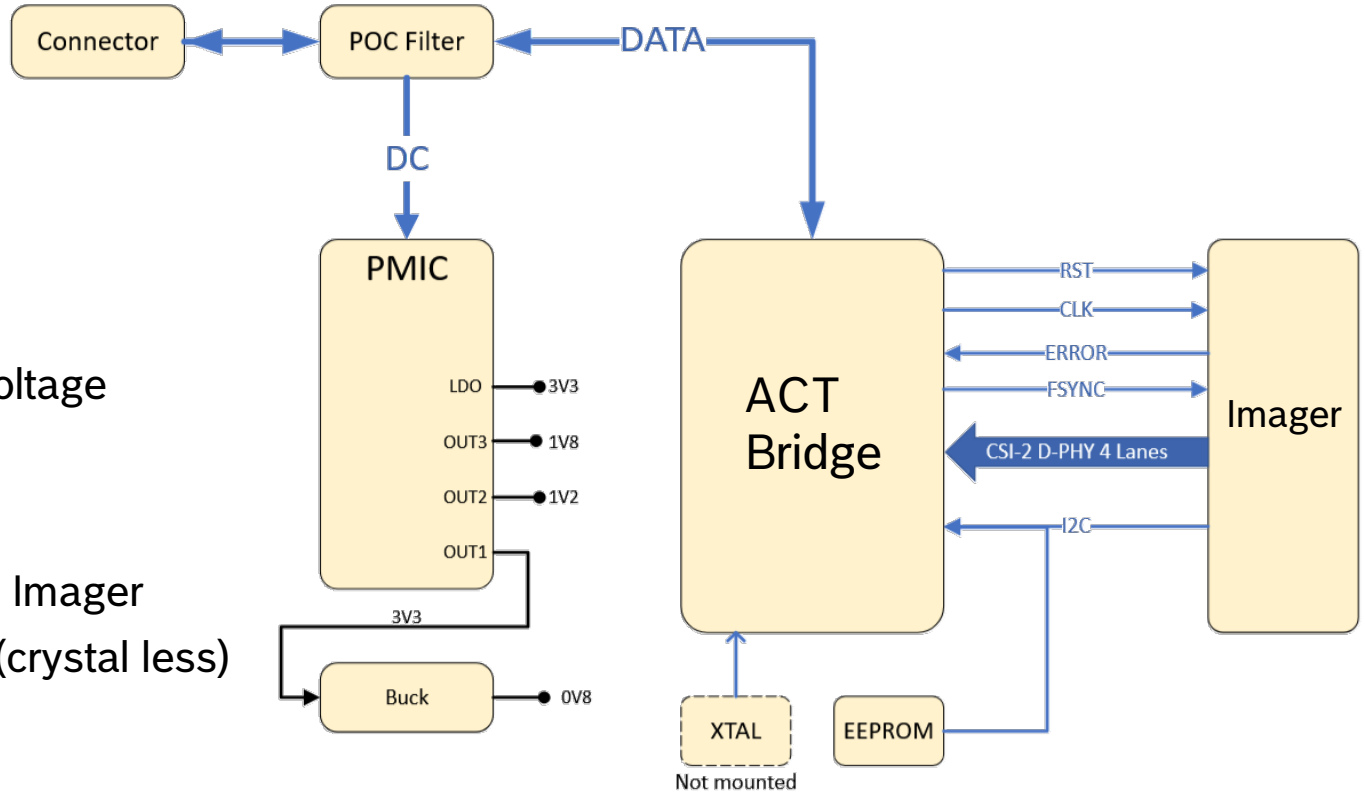




Note: At time of measurement the camera was not finally assembled with optics

802.3dm - ACT Camera
Design

- PoC-Filter
  - Small form factor 2 inductors
- Power Supply
  - PMIC with intermediate voltage and three supply rails
  - External Buck for ACT Bridge Core voltage
- 802.3dm ACT PHY Bridge
  - Controlling imager via I2C
  - Providing 25 MHz reference clock for Imager
  - External oscillator was **not** mounted (crystal less)
- Imager
  - CSI-2 Interface with 4 Lanes
  - No external oscillator



802.3dm – ACT PHY
Specifications of Device under Test (DUT)

- The ACT PHY was based on the original ACT proposal in https://www.ieee802.org/3/dm/public/0924/jonsson_3dm_01_09_15_24.pdf

- Two main differences between the PHY used in the test and the current 802.3dm proposal are
- Different RS-FEC for LX_TX was used
  - RS(30, 26, 5) instead of proposed RS(50, 46, 6)
  - See Slide 9 of https://www.ieee802.org/3/dm/public/0924/jonsson_3dm_01_09_15_24.pdf
- Initial proposed transmit power for 802.3dm ACT is used for LS_TX and HS_TX
  - See Slide 10 of https://www.ieee802.org/3/dm/public/0924/jonsson_3dm_01_09_15_24.pdf

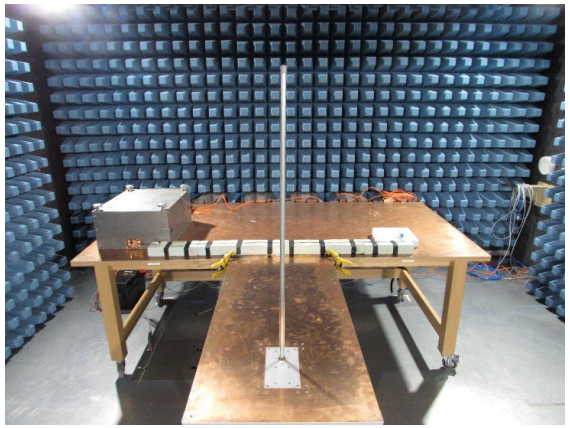
EMC Measurements
EMC Lab & Standards

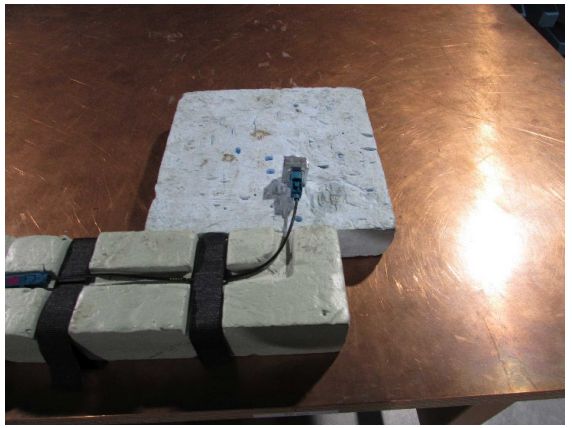
- Measurements took place in our in-house EMC Lab (part of automotive test center in Schwieberdingen (Germany)
  - The EMC laboratory is accredited according to DAkkS (DIN EN ISO/IEC 17025)
  - Used for serial product testing

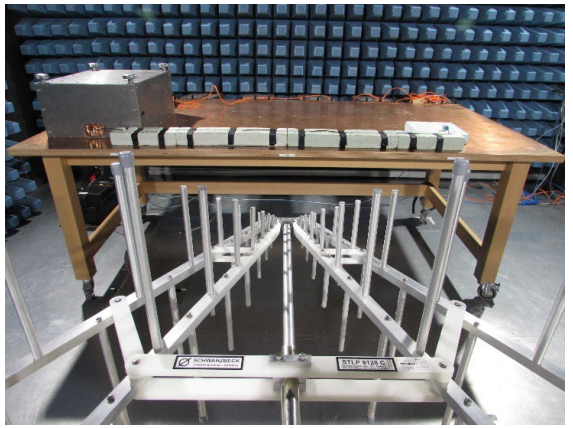
- Following measurements were performed:
  - Radiated Emission Antenna (REA) according CISPR 25 (2021)
  - Radiated Immunity Antenna(RIA) according ISO 1145-2 (2023)

EMC Measurements
Measurement Setup

- Wiring harness 200 cm with one in-line connector
- The DUT, wiring harness and optical transceiver(s) were placed on 50 mm insulation above the ground plane
- DUT Supply Voltage 13.5 V from buffered automotive battery
- Receiver Board placed in grounded metal housing
- Reception of MIPI data was continuously checked **(CRC errors)** via the receiver board







Results Camera - REA

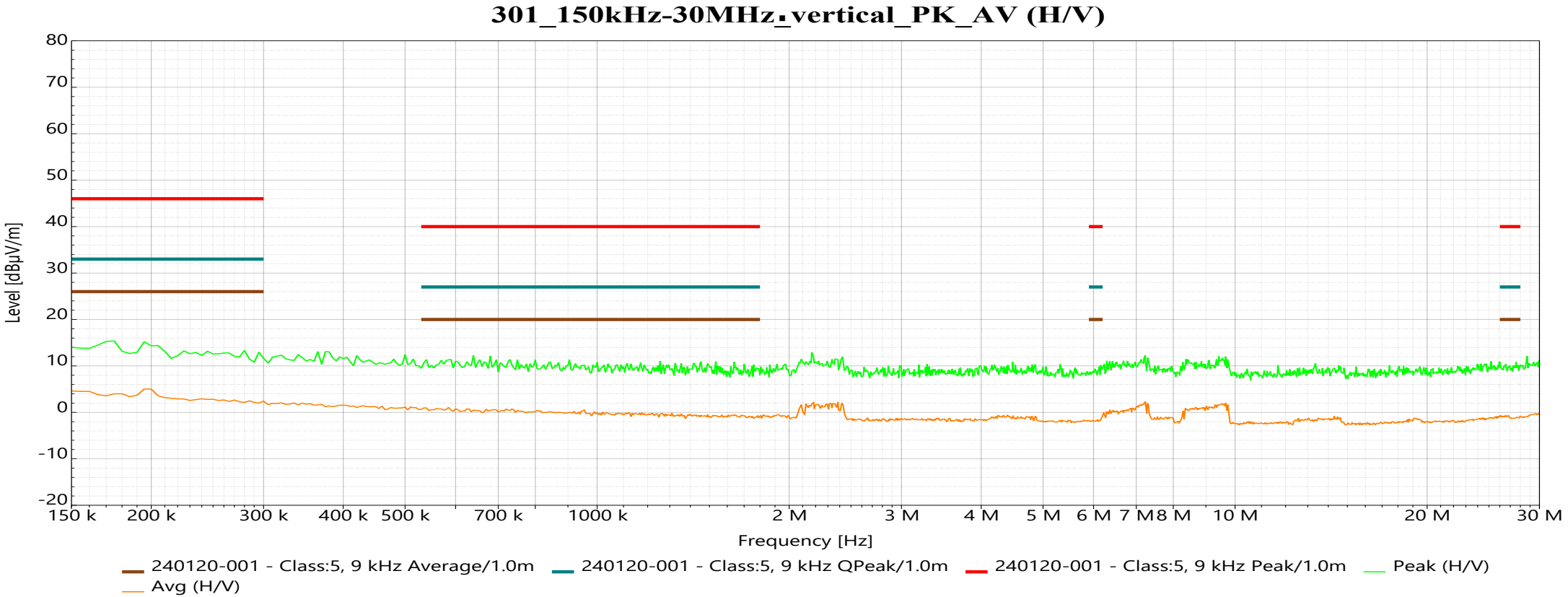
Results Summary - Radiated Emission Antenna

- All conducted tests were passed:

Test carried out	Result
150 kHz – 30 MHz, 9 kHz BW	PASSED
30 MHz – 200 MHz, 120 kHz BW	PASSED
200 MHz – 1000 MHz, 120/1000 kHz BW	PASSED
1 GHz – 6 GHz, 1000 kHz BW	PASSED
1800 MHz – 2 GHz, 120 kHz BW	PASSED
1.15 GHz – 1.62 GHz, 9 kHz BW	PASSED

Results Camera - REA

150 kHz – 30 MHz, 9 kHz, PK + AV



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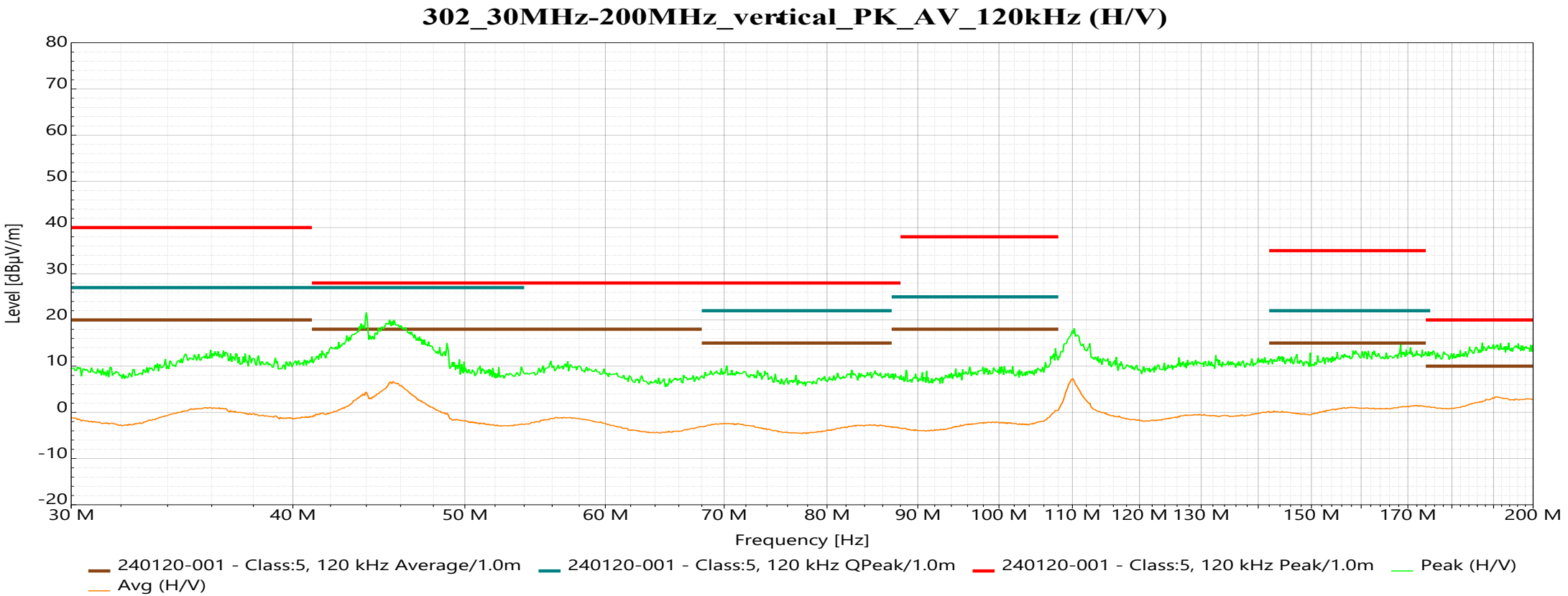
Results Camera - REA

30 – 200 MHz, 120 kHz BW, PK + AV



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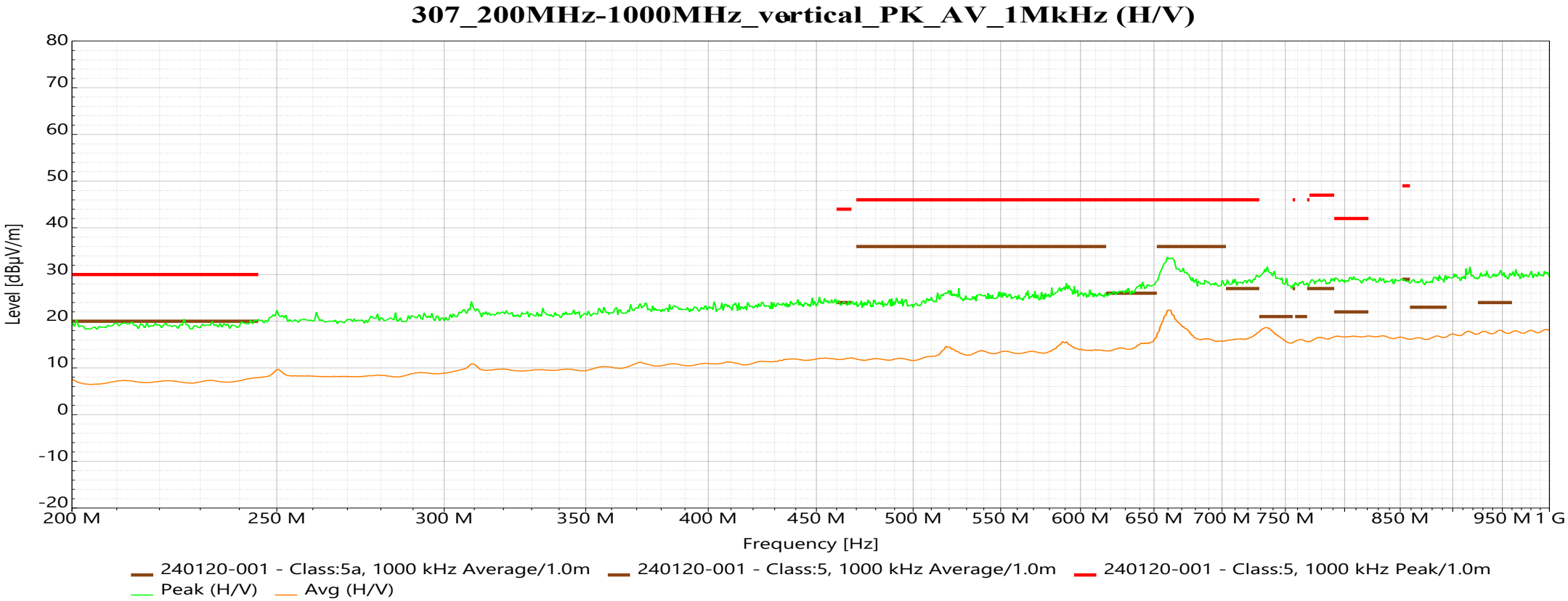
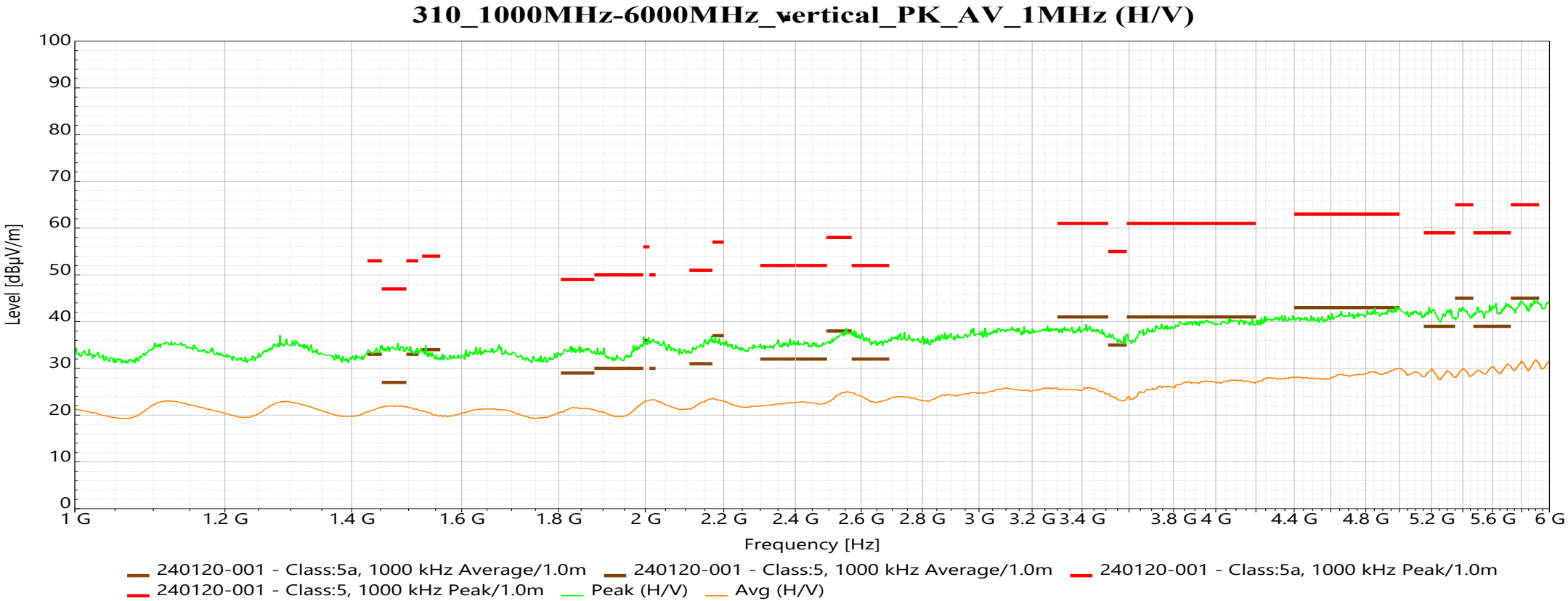
Results Camera - REA

200 MHz – 1000 MHz, 1 MHz BW, PK + AV



Results Camera - REA

1000 MHz – 6000 MHz, 1 MHz BW, PK + AV



Results Camera - RIA
Results Summary - Radiated Immunity Antenna

- All conducted tests were passed:

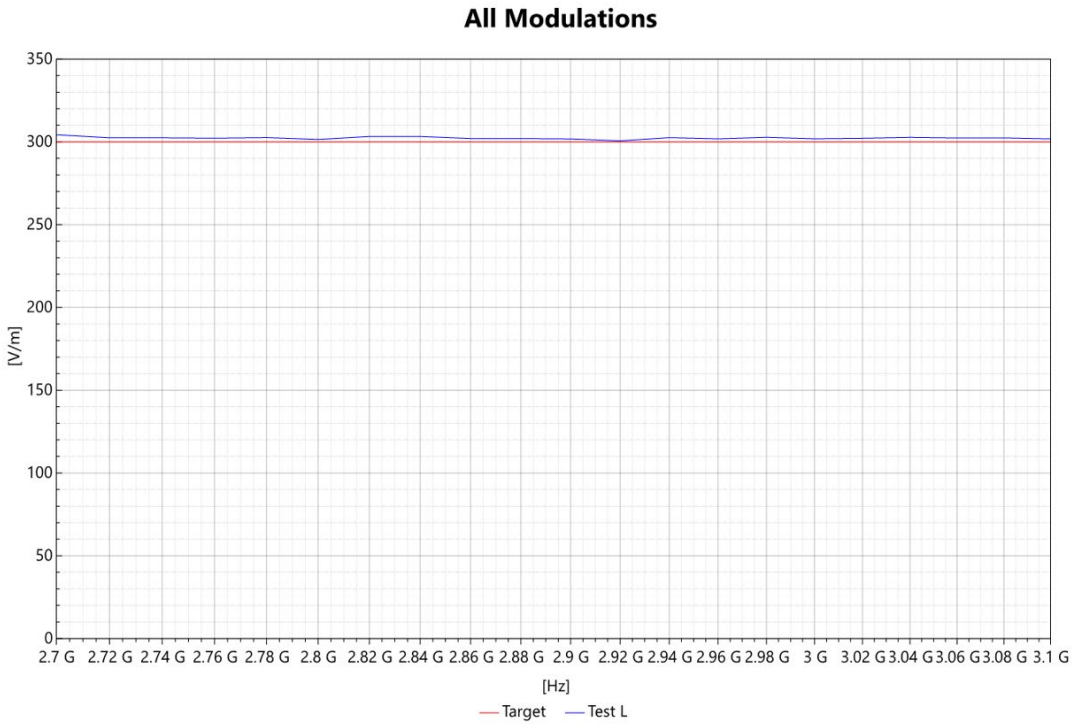
Test carried out	Result
200 MHz – 1 GHz CW 200V/m	PASSED
1 GHz – 4 GHz CW 200V/m	PASSED
2.7 GHz – 3.1 GHz PM 300V/m	PASSED

Results Camera - RIA

2700 MHz – 3100 MHz, horizontal, PM, 300V/m

Comment: (204_2700MHz-3100MHz_PM2_horizontal_300 V/m_DUT_Orientation_Z)

Result (48): PASSED

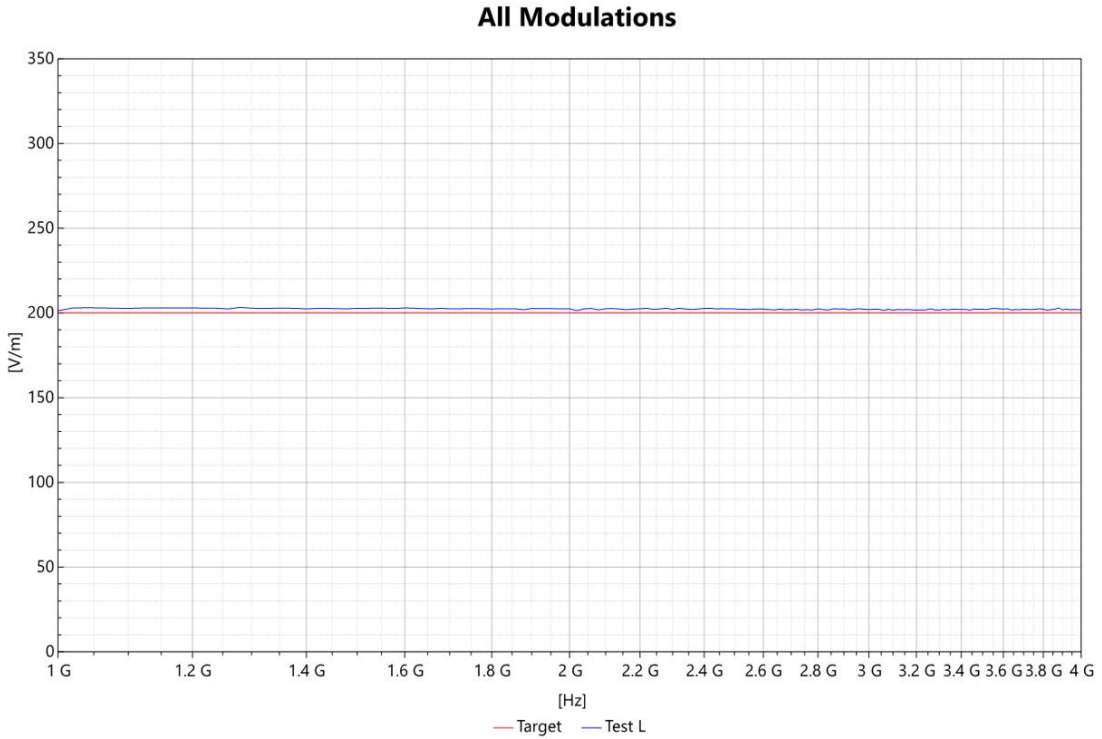


Results Camera - RIA

1000 MHz – 4000 MHz, CW, vertical, 200V/m

Comment: (201_1000MHz-4000MHz_CW_vertical_DUT_Orientation_Z)

Result (44): PASSED



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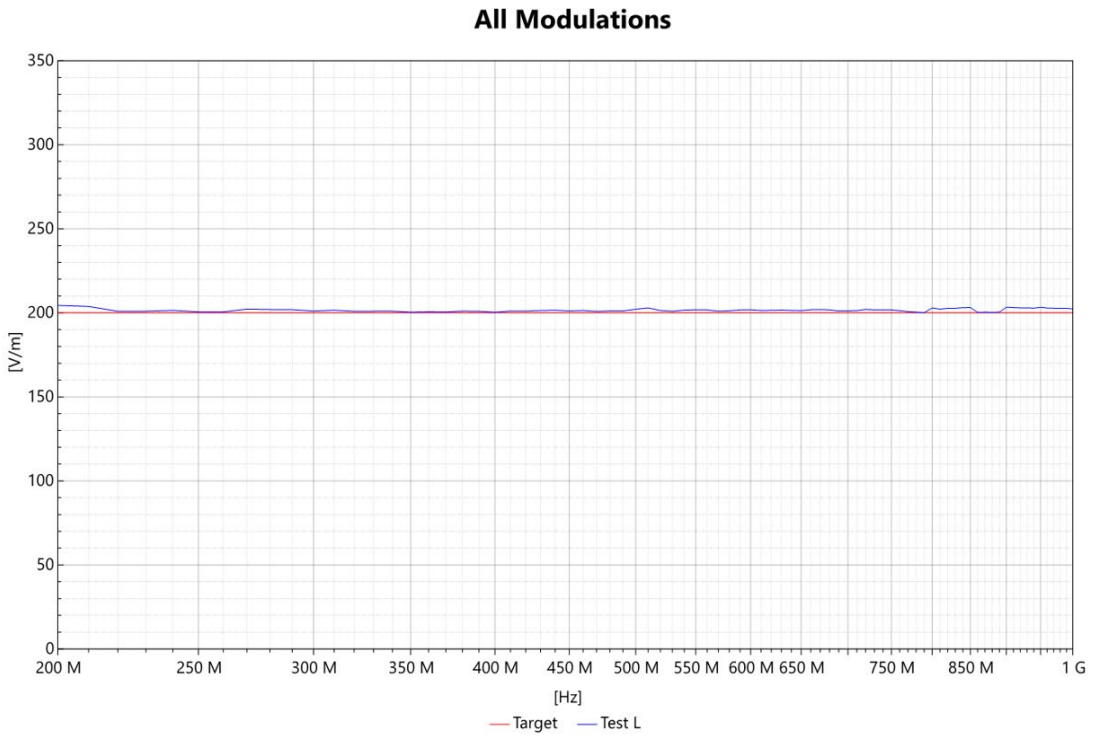
Results Camera - RIA

200 MHz – 1000 MHz, CW, vertical, 200V/m

Comment: (205_200MHz-1000MHz_CW_vertical_W/H)

Result (45): PASSED



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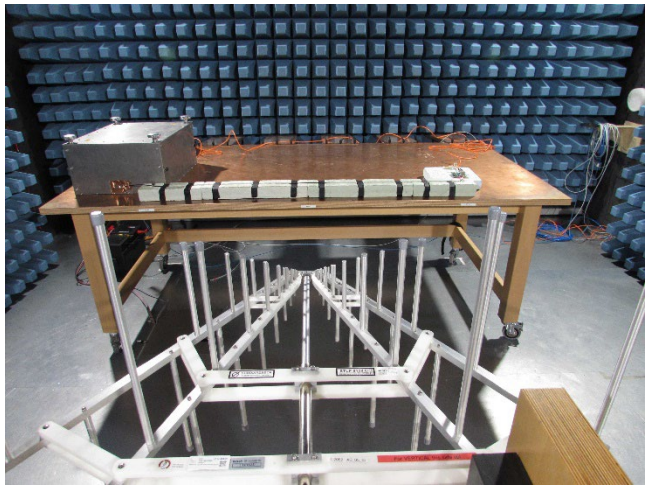
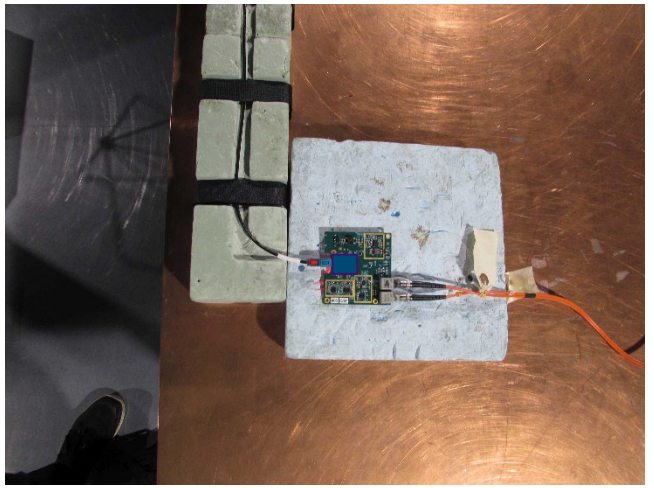
802.3dm ACT PHY – EMC Test Board Measurements

Setup

- Same measurements were performed with the 802.3dm ACT PHY EMC Test Board from Infineon using the same measurement setup
- The Camera was replaced with an EMC Test Board which also features a Revision-A of Infineon's 802.3dm ACT PHY Bridge Chip and an optical interface
- On receiver side, the same board was placed inside the grounded metal box





Results EMC Test Board - REA

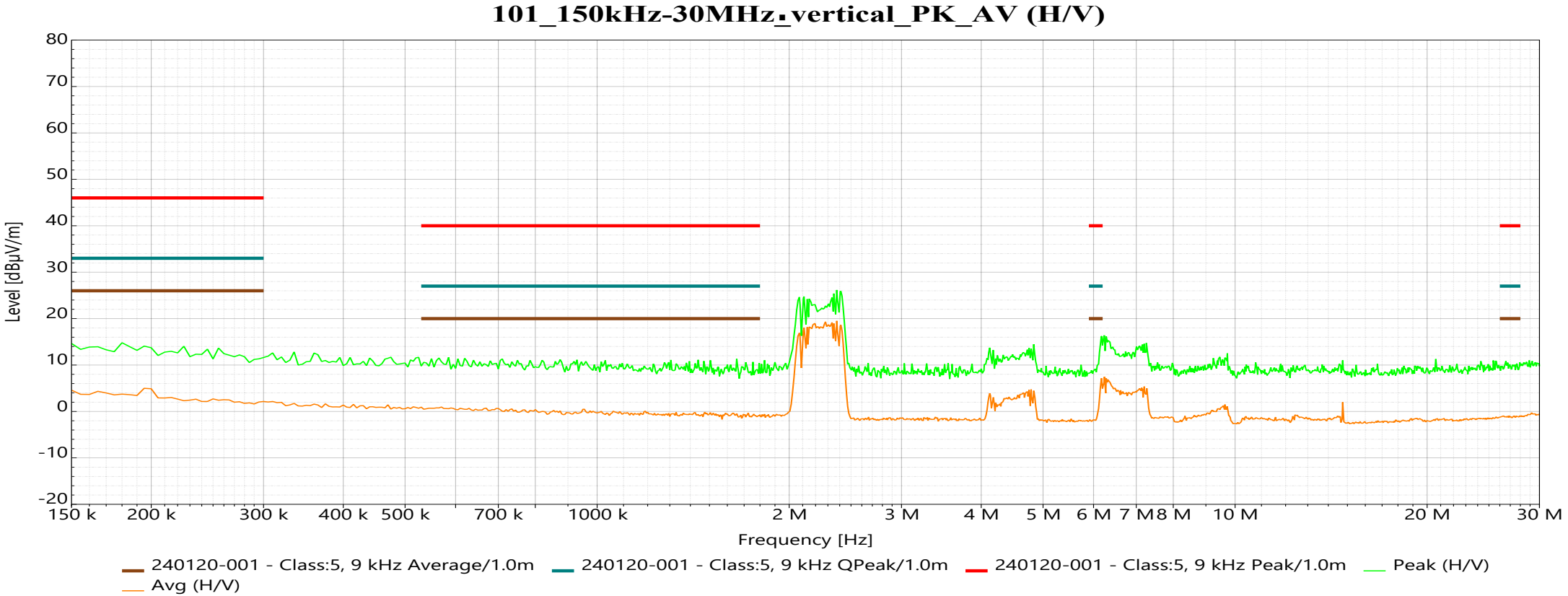
Results Summary - Radiated Emission Antenna

- All conducted tests were passed:

Test carried out	Result
150 kHz – 30 MHz, 9 kHz BW	PASSED
30 MHz – 200 MHz, 120 kHz BW	PASSED
200 MHz – 1000 MHz, 120/1000 kHz BW	PASSED
1 GHz – 6 GHz, 1000 kHz BW	PASSED
1800 MHz – 2 GHz, 120 kHz BW	PASSED
1.15 GHz – 1.62 GHz, 9 kHz BW	PASSED

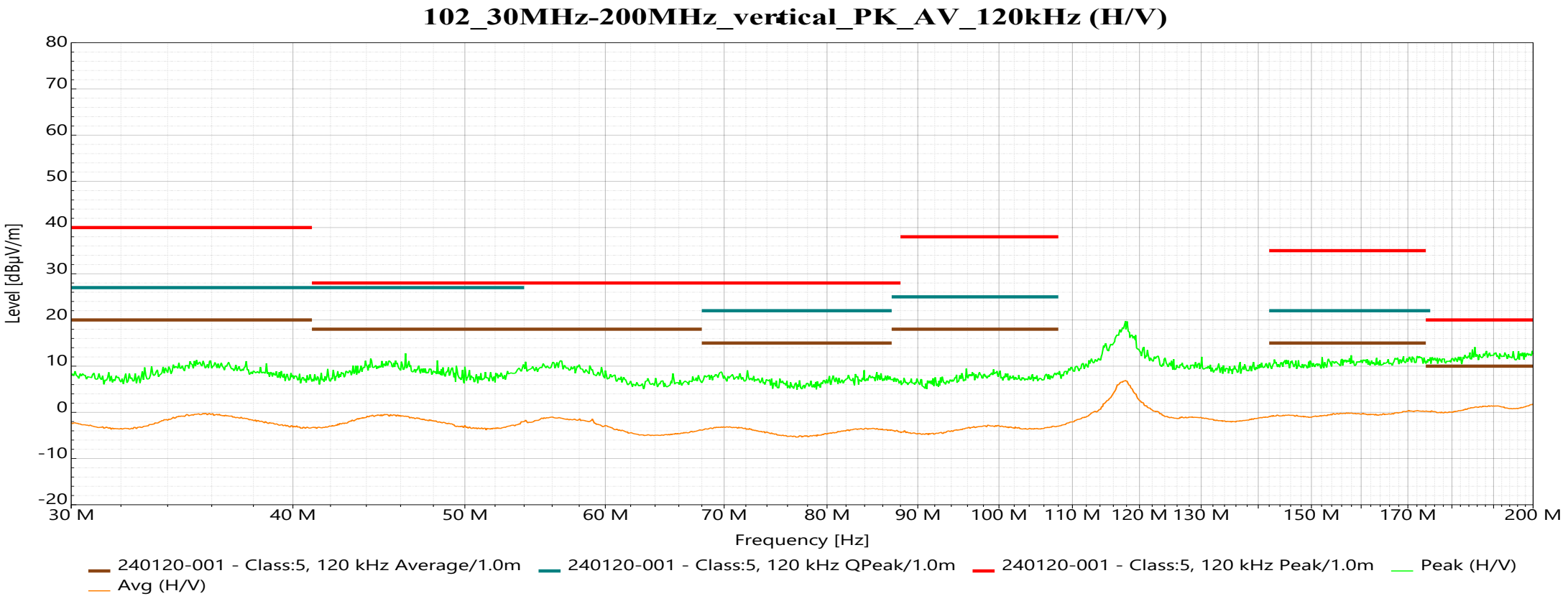
Results EMC Test Board - REA

150 kHz – 30 MHz, 9 kHz, PK + AV



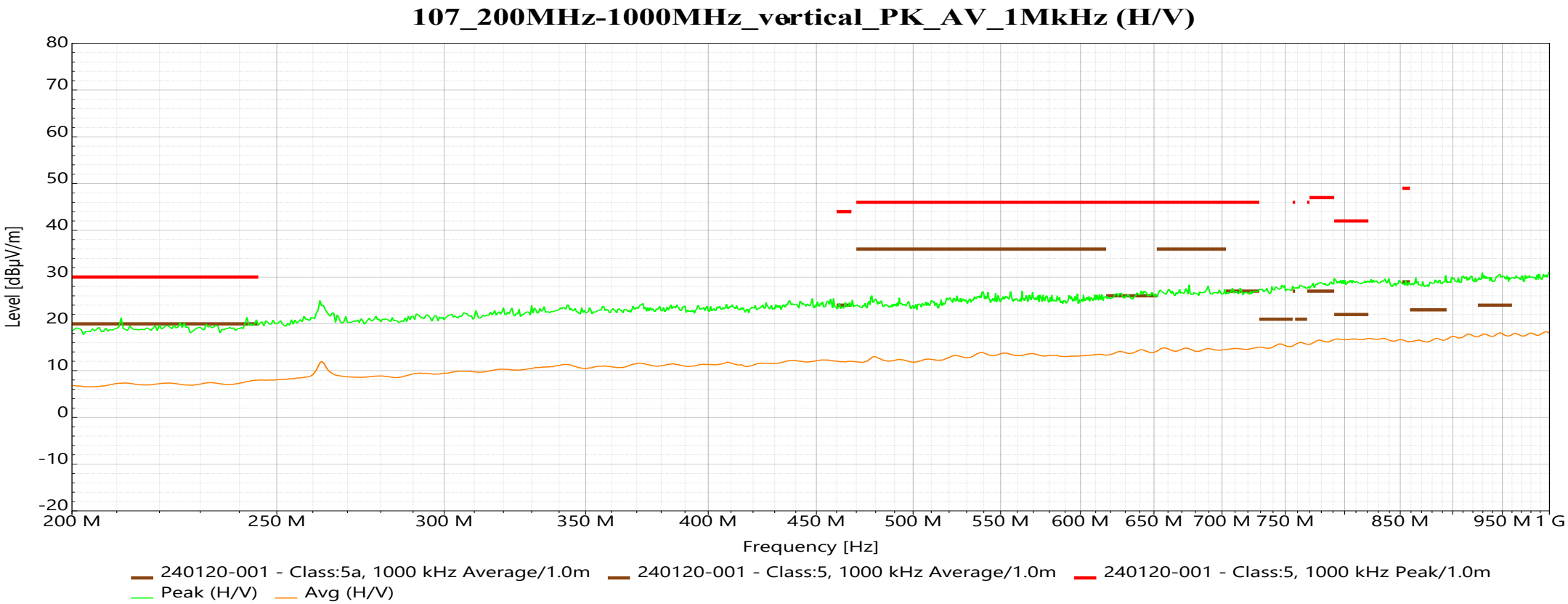
Results EMC Test Board - REA

30 – 200 MHz, 120 kHz BW, PK + AV



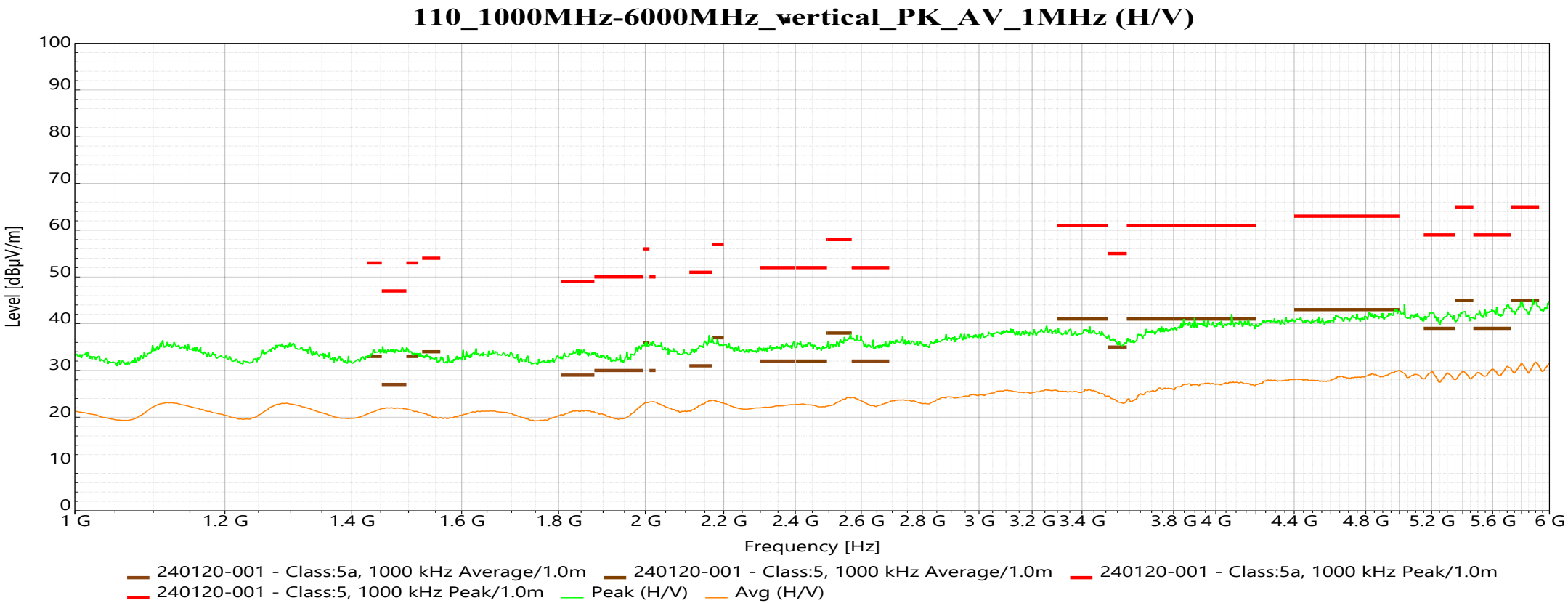
Results EMC Test Board - REA

200 MHz – 1000 MHz, 1 MHz BW, PK + AV



Results EMC Test Board - REA

1000 MHz – 6000 MHz, 1 MHz BW, PK + AV



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Results EMC Test Board - RIA

Results Summary - Radiated Immunity Antenna

- All conducted tests were passed:

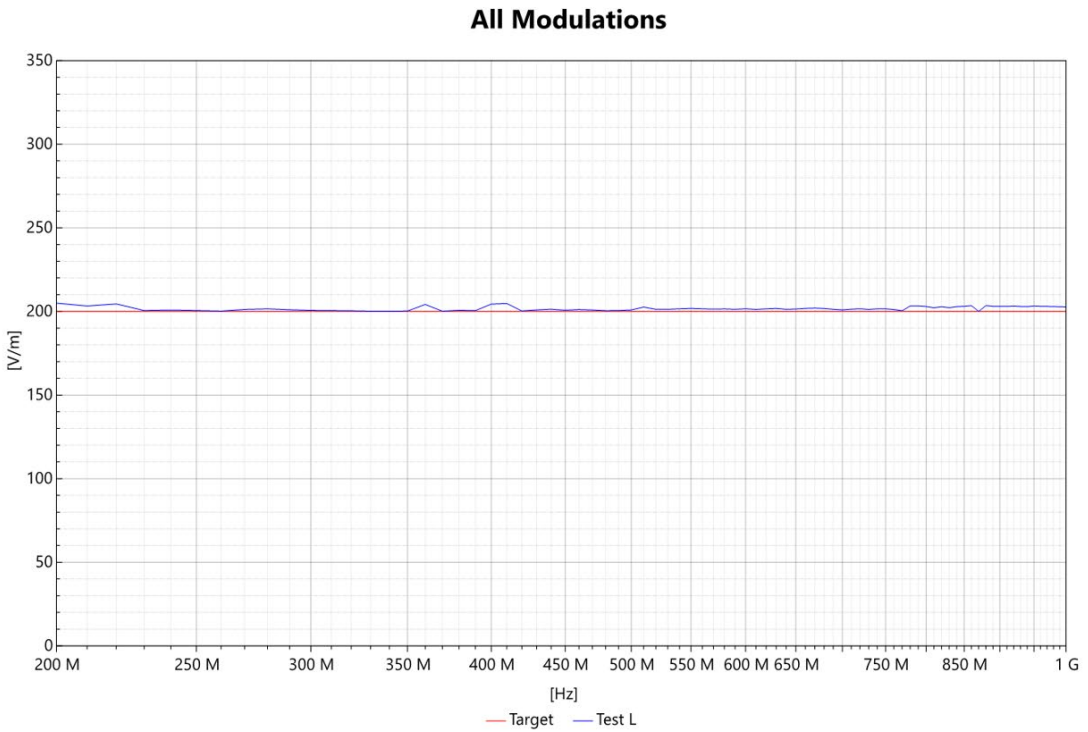
Test carried out	Result
200 MHz – 1 GHz CW 200V/m	PASSED
1 GHz – 4 GHz CW 200V/m	PASSED
2.7 GHz – 3.1 GHz PM 300V/m	PASSED

EMC Results - RIA

200 MHz – 1000 MHz, CW, vertical, 200V/m

Comment: (105_200MHz-1000MHz_CW_vertical_W/H)

Result (38): PASSED

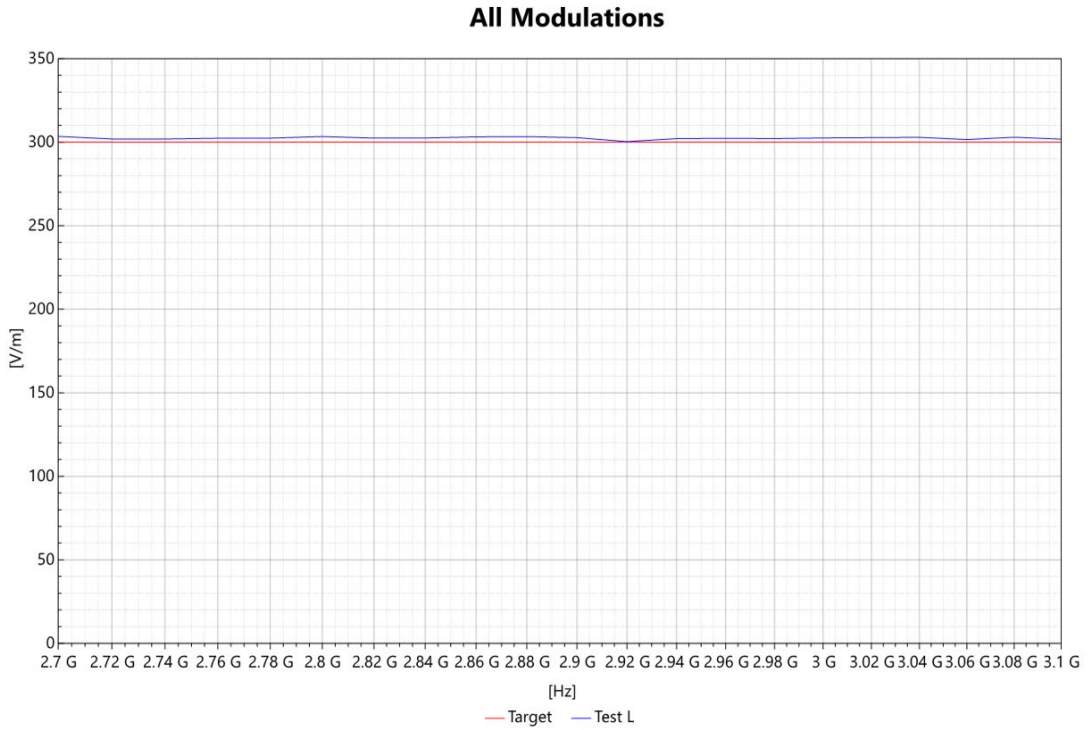


EMC Results - RIA

2700 MHz – 3100 MHz, horizontal, PM, 300V/m

Comment: (104_2700MHz-3100MHz_PM2_horizontal_300 V/m_DUT_Orientation_Z)

Result (40): PASSED



EMC Results - RIA

1000 MHz – 4000 MHz, CW, vertical, 200V/m

Comment: (101_1000MHz-4000MHz_CW_vertical_DUT_Orientation_Z)

Result (35): PASSED