

**CETECOM™****CETECOM ICT Services**
consulting - testing - certification >>>

TEST REPORT

Test report no.: 1-8297/14-04-02-A

Deutsche
Akkreditierungsstelle
D-PL-12076-01-00

Testing laboratory

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The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-00

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Manufacturer

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Test standard/s

47 CFR Part 22

Title 47 of the Code of Federal Regulations; Chapter I; Part 22 - Public mobile services

47 CFR Part 24

Title 47 of the Code of Federal Regulations; Chapter I; Part 24 - Personal communications services

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item: Advanced Telecommunication module (ATM) Roof Version**Model name:** ATM-01 R1-RoW-4G**FCC ID:** QWY-ATM-R-132Frequency: GSM: 824.2 – 848.8 MHz, 1850.2 – 1909.8 MHz
UMTS: 826.4 – 846.6 MHz

Technology tested: GSM / EDGE, UMTS

Antenna: External and internal antenna

Power supply: 14.0 V DC by external power supply

Temperature range: -30°C to +60°C



This test report is electronically signed and valid without handwriting signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorised:

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Test performed:

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1 Table of contents

| | | |
|---------|--|----|
| 1 | Table of contents | 2 |
| 2 | General information | 3 |
| 2.1 | Notes and disclaimer | 3 |
| 2.2 | Application details | 3 |
| 3 | Test standard/s | 3 |
| 3.1 | Measurement guidance | 3 |
| 4 | Test environment | 4 |
| 5 | Test item | 4 |
| 5.1 | Additional information | 4 |
| 6 | Test laboratories sub-contracted | 4 |
| 7 | Summary of measurement results | 5 |
| 7.1 | GSM 850 | 5 |
| 7.2 | PCS 1900 | 5 |
| 7.3 | UMTS band V | 6 |
| 8 | Description of test setup | 7 |
| 8.1 | Shielded fully anechoic chamber | 8 |
| 8.2 | Conducted measurements normal and extreme conditions | 9 |
| 9 | Test Results | 10 |
| 9.1 | Results GSM 850 | 10 |
| 9.1.1 | RF output power | 10 |
| 9.1.2 | Frequency stability | 12 |
| 9.1.3 | Spurious emissions conducted | 14 |
| 9.1.4 | Spurious emissions radiated | 18 |
| 9.1.5 | Block edge compliance | 24 |
| 9.1.6 | Occupied bandwidth | 27 |
| 9.2 | Results PCS 1900 | 35 |
| 9.2.1 | RF output power | 35 |
| 9.2.2 | Frequency stability | 37 |
| 9.2.3 | Spurious emissions radiated | 39 |
| 9.2.4 | Spurious emissions conducted | 47 |
| 9.2.5 | Block edge compliance | 51 |
| 9.2.6 | Occupied bandwidth | 54 |
| 9.3 | Results UMTS band V | 62 |
| 9.3.1 | RF output power | 62 |
| 9.3.2 | Frequency stability | 64 |
| 9.3.3 | Spurious emissions radiated | 66 |
| 9.3.4 | Spurious emissions conducted | 71 |
| 9.3.5 | Block edge compliance | 75 |
| 9.3.6 | Occupied bandwidth | 77 |
| 10 | Observations | 82 |
| Annex A | Document history | 83 |
| Annex B | Further information | 83 |
| Annex C | Accreditation Certificate | 84 |

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CETECOM ICT Services GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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This test report replaces the test report with the number 1-8297/14-04-02 and dated 2015-04-22

2.2 Application details

| | |
|------------------------------------|------------|
| Date of receipt of order: | 2014-12-19 |
| Date of receipt of test item: | 2015-02-17 |
| Start of test: | 2015-03-19 |
| End of test: | 2015-07-22 |
| Person(s) present during the test: | -/- |

3 Test standard/s

| Test standard | Date | Test standard description |
|----------------|------|--|
| 47 CFR Part 22 | -/- | Title 47 of the Code of Federal Regulations; Chapter I; Part 22 - Public mobile services |
| 47 CFR Part 24 | -/- | Title 47 of the Code of Federal Regulations; Chapter I; Part 24 - Personal communications services |

3.1 Measurement guidance

| Guidance | Version | Description |
|------------------|---------|---|
| ANSI C63.4-2014 | -/- | American national standard for methods of measurement of radio-noise emissions from low-voltage electrical and electronic equipment in the range of 9 kHz to 40 GHz |
| ANSI C63.10-2013 | -/- | American national standard of procedures for compliance testing of unlicensed wireless devices |

4 Test environment

| | | |
|----------------------------|-----------|---------------------------------------|
| Temperature: | T_{nom} | +22 °C during room temperature tests |
| | T_{max} | +60 °C during high temperature tests |
| | T_{min} | -30 °C during low temperature tests |
| Relative humidity content: | | 42 % |
| Barometric pressure: | | not relevant for this kind of testing |
| Power supply: | V_{nom} | 14.0 V DC by external power supply |
| | V_{max} | 18.0 V |
| | V_{min} | 4.5 V |

5 Test item

| | | |
|---------------------|---|--|
| Kind of test item | : | Advanced Telecommunication module (ATM) Roof Version |
| Type identification | : | ATM-01 R1-RoW-4G |
| | | |
| S/N serial number | : | Radiated unit: 0000503806 Conducted unit: 0000503803 |
| HW hardware status | : | 112.010.010 |
| SW software status | : | 001.017.047 |
| Frequency band | : | GSM: 824.2 – 848.8 MHz, 1850.2 – 1909.8 MHz UMTS: 826.4 – 846.6 MHz |
| Type of modulation | : | GMSK, 8-PSK, QPSK |
| Antenna | : | External and internal antenna |
| Power supply | : | 14.0 V DC by external power supply |
| Temperature range | : | -30°C to +60°C |

5.1 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup- and EUT-photos are included in test report: 1-8297/14-04-01_AnnexA
1-8297/14-04-01_AnnexB
1-8297/14-04-01_AnnexC

6 Test laboratories sub-contracted

None

7 Summary of measurement results

| | |
|-------------------------------------|--|
| <input checked="" type="checkbox"/> | No deviations from the technical specifications were ascertained |
| <input type="checkbox"/> | There were deviations from the technical specifications ascertained |
| <input type="checkbox"/> | This test report is only a partial test report. The content and verdict of the performed test cases are listed below. |

| TC identifier | Description | verdict | date | Remark |
|---------------|-----------------|------------|------------|--------|
| RF-Testing | CFR Part 22, 24 | See table! | 2015-07-22 | -/- |

7.1 GSM 850

| Test Case | temperature conditions | power source voltages | Pass | Fail | NA | NP | Remark |
|------------------------------|------------------------|-----------------------|-------------------------------------|--------------------------|--------------------------|--------------------------|----------|
| RF Output Power | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Frequency Stability | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Spurious Emissions Radiated | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Spurious Emissions Conducted | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Block Edge Compliance | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Occupied Bandwidth | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |

Note: NA = Not applicable; NP = Not performed

7.2 PCS 1900

| Test Case | temperature conditions | power source voltages | Pass | Fail | NA | NP | Remark |
|------------------------------|------------------------|-----------------------|-------------------------------------|--------------------------|--------------------------|--------------------------|----------|
| RF Output Power | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Frequency Stability | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Spurious Emissions Radiated | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Spurious Emissions Conducted | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Block Edge Compliance | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Occupied Bandwidth | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |

Note: NA = Not applicable; NP = Not performed

7.3 UMTS band V

| Test Case | temperature conditions | power source voltages | Pass | Fail | NA | NP | Remark |
|------------------------------|------------------------|-----------------------|-------------------------------------|--------------------------|--------------------------|--------------------------|----------|
| RF Output Power | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Frequency Stability | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Spurious Emissions Radiated | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Spurious Emissions Conducted | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Block Edge Compliance | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |
| Occupied Bandwidth | Nominal | Nominal | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | complies |

Note: NA = Not applicable; NP = Not performed

8 Description of test setup

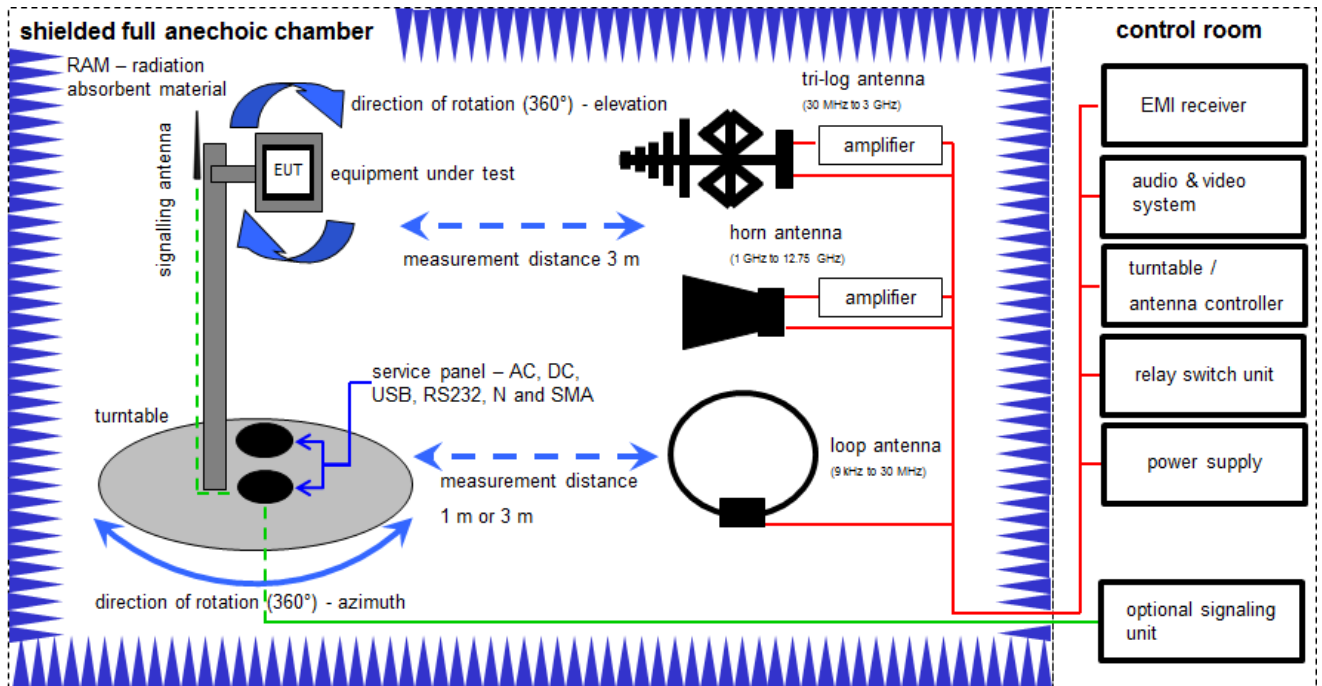
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signalling equipment as well as measuring receivers and analysers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

| | | | |
|------|--|-----|--|
| k | calibration / calibrated | EK | limited calibration |
| ne | not required (k, ev, izw, zw not required) | zw | cyclical maintenance (external cyclical maintenance) |
| ev | periodic self verification | izw | internal cyclical maintenance |
| Ve | long-term stability recognized | g | blocked for accredited testing |
| vkl! | Attention: extended calibration interval | | |
| NK! | Attention: not calibrated | *) | next calibration ordered / currently in progress |

8.1 Shielded fully anechoic chamber

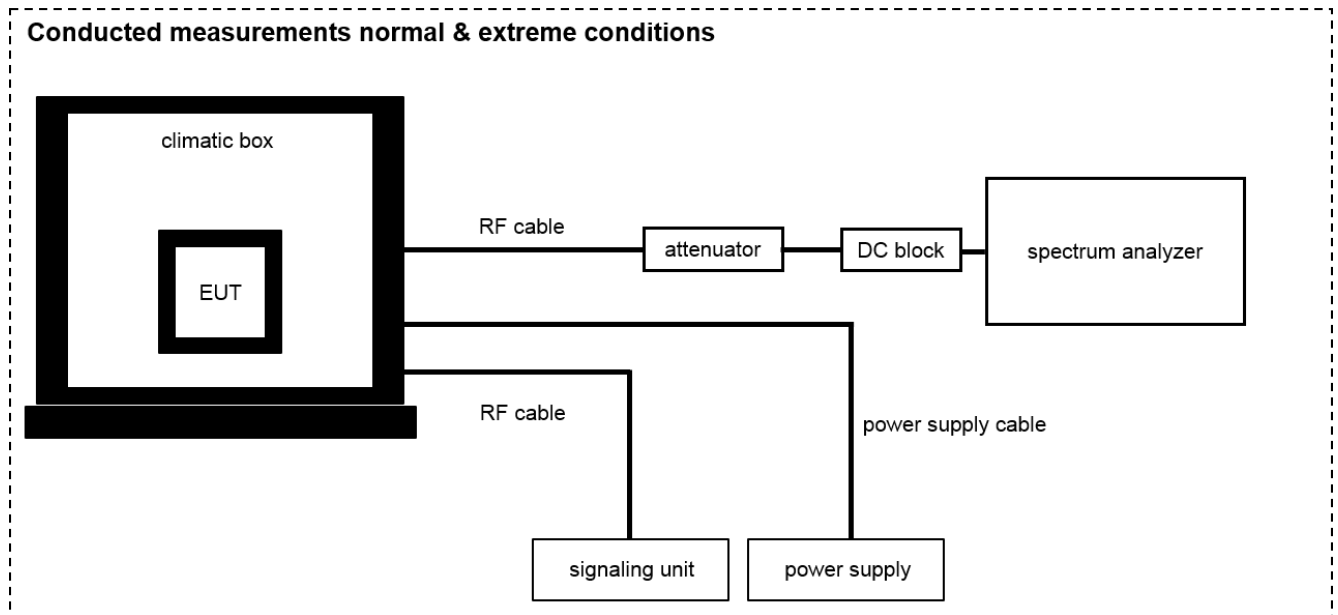


Equipment table:

| No. | Lab / Item | Equipment | Type | Manufact. | Serial No. | INV. No Cetecom | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|--|--------------------------------|----------------------|------------|-----------------|---------------------|------------------|------------------|
| 1 | n. a. | DC power supply, 60Vdc, 50A, 1200 W | 6032A | HP | 2818A03450 | 300001040 | Ve | 20.01.2015 | 20.01.2018 |
| 2 | n. a. | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115 | EMCO | 8812-3088 | 300001032 | vIKI! | 08.05.2013 | 08.05.2015 |
| 3 | n. a. | Anechoic chamber | FAC 3/5m | MWB / TDK | 87400/02 | 300000996 | ev | | |
| 4 | n. a. | Switch / Control Unit | 3488A | HP | * | 300000199 | ne | | |
| 5 | 9 | Artificial Mains 9 kHz to 30 MHz | ESH3-Z5 | R&S | 828576/020 | 300001210 | Ve | 30.01.2014 | 30.01.2016 |
| 6 | 9 | Isolating Transformer | MPL IEC625 Bus Regeltrenntravo | Erli | 91350 | 300001155 | ne | | |
| 7 | 90 | Active Loop Antenna 10 kHz to 30 MHz | 6502 | Kontron Psychotech | 8905-2342 | 300000256 | k | 13.06.2013 | 13.06.2015 |
| 8 | 90 | Amplifier | js42-00502650-28-5a | Parzich GMBH | 928979 | 300003143 | ne | | |
| 9 | 90 | Band Reject filter | WRCG1855/1910-1835/1925-40/8SS | Wainwright | 7 | 300003350 | ev | | |
| 10 | 90 | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck | 371 | 300003854 | vIKI! | 29.10.2014 | 29.10.2017 |
| 11 | 90 | MXE EMI Receiver 20 Hz to 26.5 GHz | N9038A | Agilent Technologies | MY51210197 | 300004405 | k | 13.03.2014 | 13.03.2015 |
| 12 | 11b | Microwave System Amplifier, 0.5-26.5 GHz | 83017A | HP | 00419 | 300002268 | ev | | |
| 13 | A026 | Std. Gain Horn Antenna 12.4 to 18.0 GHz | 639 | Narda | 8402 | 300000787 | k | 22.07.2013 | 22.07.2015 |
| 14 | A029 | Std. Gain Horn Antenna 18.0 to 26.5 GHz | 638 | Narda | 8205 | 300002442 | k | 19.07.2013 | 19.07.2015 |
| 15 | A029 | Signal Analyzer 40 GHz | FSV40 | R&S | 101042 | 300004517 | k | 22.01.2015 | 22.01.2016 |

8.2 Conducted measurements normal and extreme conditions

Conducted measurements normal & extreme conditions



$$OP = AV + CA$$

(OP-output power; AV-analyzer value; CA-loss signal path)

Example calculation:

$$OP \text{ [dBm]} = 6.0 \text{ [dBm]} + (11.7) \text{ [dB]} = 17.7 \text{ [dBm]} (58.88 \text{ mW})$$

Equipment table:

| No. | Lab / Item | Equipment | Type | Manufact. | Serial No. | INV. No Cetecom | Kind of Calibration | Last Calibration | Next Calibration |
|-----|------------|--|---------|-----------------|-------------|-----------------|---------------------|------------------|------------------|
| 1 | n. a. | Switch / Control Unit | 3488A | HP | 2605e08770 | 300001443 | ne | | |
| 2 | n. a. | Signal Analyzer 20Hz-26,5GHz-150 to + 30 DBM | FSiQ26 | R&S | 835111/0004 | 300002678 | Ve | 22.01.2015 | 22.01.2017 |
| 3 | n. a. | Power Supply 0-20V; 0-5A | 6632B | HP | US37478366 | 400000117 | vIKI! | 20.01.2015 | 20.01.2017 |
| 4 | n. a. | Universal Communication Tester | CMU200 | R&S | 106240 | 300003321 | vIKI! | 12.06.2013 | 12.06.2015 |
| 5 | n. a. | Temperature Test Chamber | VT 4002 | Heraeus Voetsch | 521/83761 | 300002326 | Ve | 26.09.2013 | 26.09.2015 |

9 Test Results

9.1 Results GSM 850

All GSM-band measurements are done in GSM mode only (circuit switched).

All relevant tests have been repeated using 8-PSK modulation if EDGE mode is supported. All tests were performed with one timeslot in uplink activated and one timeslot in downlink activated. For each mode the highest output power was determined and used.

9.1.1 RF output power

Description:

This paragraph contains average power, peak output power and ERP measurements for the mobile station. In all cases, the peak output power is within the required mask (this mask is specified in the JTC standards, TIA PN3389 Vol. 1 Chap 7, and is no FCC requirement).

Measurement:

The mobile was set up for the maximum output power with pseudo random data modulation.

| Measurement parameters | |
|------------------------|-------------------------------|
| Detector: | Peak and RMS (Power in Burst) |
| Sweep time: | Auto |
| Video bandwidth: | 1 MHz |
| Resolution bandwidth: | 1 MHz |
| Span: | Zero Span |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

Limits:

| FCC |
|---|
| CFR Part 22.913 CFR Part 2.1046 |
| Nominal Peak Output Power |
| +38.45 dBm In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB. |

Results:

| Output Power (conducted) GMSK mode | | |
|------------------------------------|----------------------------|----------------------------|
| Frequency (MHz) | Average Output Power (dBm) | Peak to Average Ratio (dB) |
| 824.2 | 32.0 | 0.07 |
| 836.4 | 31.5 | 0.03 |
| 848.8 | 31.2 | 0.03 |
| Measurement uncertainty | ± 0.5 dB | |

| Output Power (conducted) 8-PSK mode | | |
|-------------------------------------|----------------------------|----------------------------|
| Frequency. (MHz) | Average Output Power (dBm) | Peak to Average Ratio (dB) |
| 824.2 | 26.3 | 3.12 |
| 836.4 | 26.1 | 3.13 |
| 848.8 | 26.0 | 3.12 |
| Measurement uncertainty | ± 0.5 dB | |

| Output Power (radiated) GMSK mode | |
|-----------------------------------|----------------------------------|
| Frequency (MHz) | Average Output Power (dBm) - ERP |
| 824.2 (internal antenna) | 26.2 |
| 824.2 (external antenna) | 28.3 |
| 836.4 (external antenna) | 29.2 |
| 848.8 (external antenna) | 27.9 |
| Measurement uncertainty | ± 2.0 dB |

| Output Power (radiated) 8-PSK mode | |
|------------------------------------|----------------------------------|
| Frequency (MHz) | Average Output Power (dBm) - ERP |
| 824.2 (internal antenna) | 20.5 |
| 824.2 (external antenna) | 22.5 |
| 836.4 (external antenna) | 23.8 |
| 848.8 (external antenna) | 22.7 |
| Measurement uncertainty | ± 2.0 dB |

Verdict: [complies](#)

9.1.2 Frequency stability

Description:

In order to measure the carrier frequency under the condition of AFC lock, it is necessary to make measurements with the mobile station in a "call mode". This is accomplished with the use of a R&S CMU200 DIGITAL RADIOCOMMUNICATION TESTER.

1. Measure the carrier frequency at room temperature.
2. Subject the mobile station to overnight soak at -30 °C.
3. With the mobile station, powered with V_{nom} , connected to the CMU200 and in a simulated call on channel 189 (centre channel), measure the carrier frequency. These measurements should be made within two minutes of powering up the mobile station, to prevent significant self warming.
4. Repeat the above measurements at 10°C increments from -30°C to +60°C. Allow at least 1.5 hours at each temperature, unpowered, before making measurements.
5. Remeasure carrier frequency at room temperature with V_{nom} . Vary supply voltage from V_{min} to V_{max} . Pause at V_{nom} for 1.5 hours unpowered, to allow any self heating to stabilize, before continuing.
6. At all temperature levels hold the temperature to $\pm 0.5^{\circ}\text{C}$ during the measurement procedure.

Measurement:

| Measurement parameters | |
|------------------------|----------------------|
| Detector: | Measured with CMU200 |
| Sweep time: | |
| Video bandwidth: | |
| Resolution bandwidth: | |
| Span: | |
| Trace-Mode: | see chapter 8.2 |
| Used test setup: | |

Limits:

| FCC |
|------------------------------------|
| CFR Part 22.355 CFR Part 2.1055 |
| Frequency Stability |
| ± 2.5 ppm |

Results:**AFC FREQ ERROR versus VOLTAGE**

| Voltage (V) | Frequency Error (Hz) | Frequency Error (%) | Frequency Error (ppm) |
|-------------|----------------------|---------------------|-----------------------|
| 4.5 | -16 | -0.00000191 | -0.0191 |
| 4.8 | -16 | -0.00000191 | -0.0191 |
| 8.0 | -11 | -0.00000132 | -0.0132 |
| 14.0 | -9 | -0.00000108 | -0.0108 |
| 18.0 | -5 | -0.00000060 | -0.0060 |

AFC FREQ ERROR versus TEMPERATURE

| Temperature (°C) | Frequency Error (Hz) | Frequency Error (%) | Frequency Error (ppm) |
|------------------|----------------------|---------------------|-----------------------|
| -30 | -21 | -0.00000251 | -0.0251 |
| -20 | -8 | -0.00000096 | -0.0096 |
| -10 | -11 | -0.00000132 | -0.0132 |
| ± 0 | -6 | -0.00000072 | -0.0072 |
| 10 | -8 | -0.00000096 | -0.0096 |
| 20 | 5 | 0.00000060 | 0.0060 |
| 30 | -5 | -0.00000060 | -0.0060 |
| 40 | -10 | -0.00000120 | -0.0120 |
| 50 | -7 | -0.00000084 | -0.0084 |
| 60 | -11 | -0.00000132 | -0.0132 |

Verdict: [complies](#)

9.1.3 Spurious emissions conducted

Description:

The following steps outline the procedure used to measure the conducted emissions from the mobile station.

1. Determine frequency range for measurements: From CFR 2.1057 the spectrum should be investigated from the lowest radio frequency generated in the equipment up to at least the 10th harmonic of the carrier frequency. For the mobile station equipment tested, this equates to a frequency range of 13 MHz to 9 GHz, data taken from 10 MHz to 25 GHz.
2. Determine mobile station transmits frequencies: below outlines the band edge frequencies pertinent to conducted emissions testing.

GSM-850 Transmitter Channel Frequency

128 824.2 MHz

189 836.4 MHz

251 848.8 MHz

Measurement:

| Measurement parameters | |
|------------------------|--|
| Detector: | Peak |
| Sweep time: | Auto |
| Video bandwidth: | Pre-measurement with 1 MHz On spurious detection re-measurement below 1 GHz with 100 kHz Above 1 GHz with 1 MHz |
| Resolution bandwidth: | Pre-measurement with 1 MHz On spurious detection re-measurement below 1 GHz with 100 kHz Above 1 GHz with 1 MHz |
| Span: | 30 MHz – 25 GHz |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

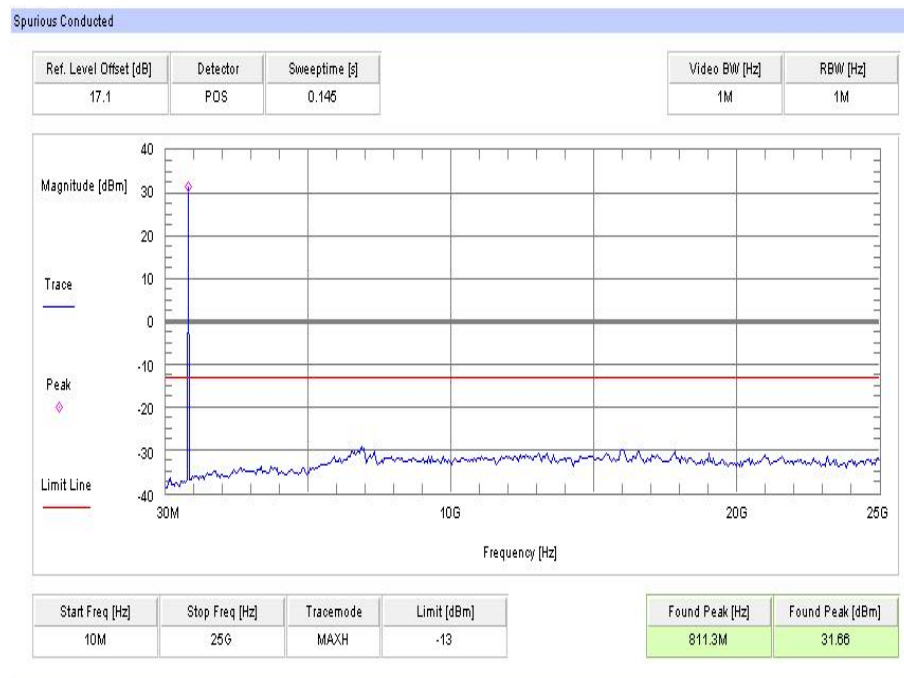
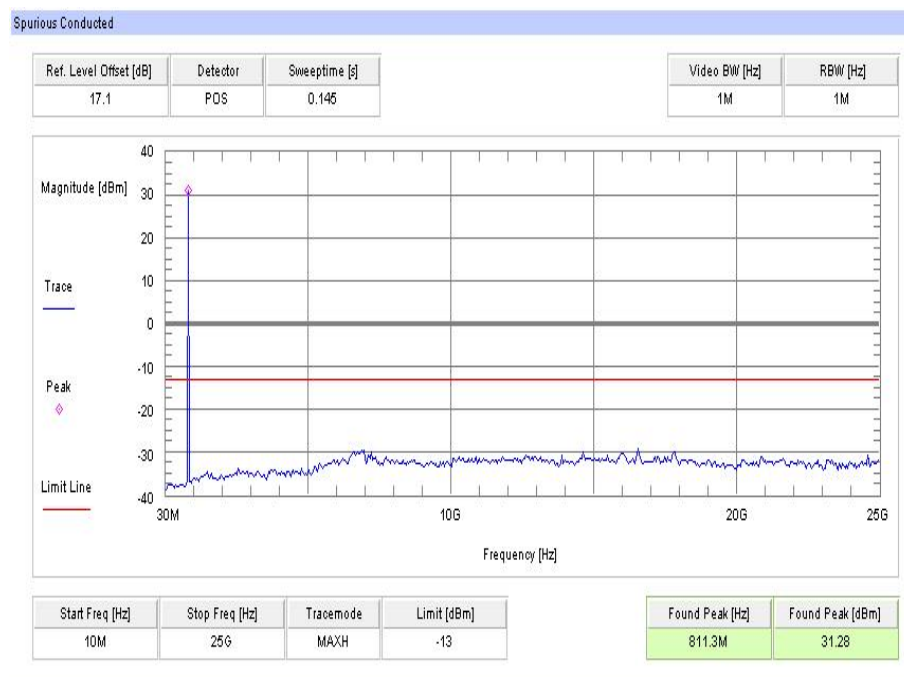
Limits:

| FCC |
|--|
| CFR Part 22.917 CFR Part 2.1051 |
| Spurious Emissions Conducted |
| Attenuation $\geq 43 + 10\log(P)$ (P, Power in Watts) |
| -13 dBm |

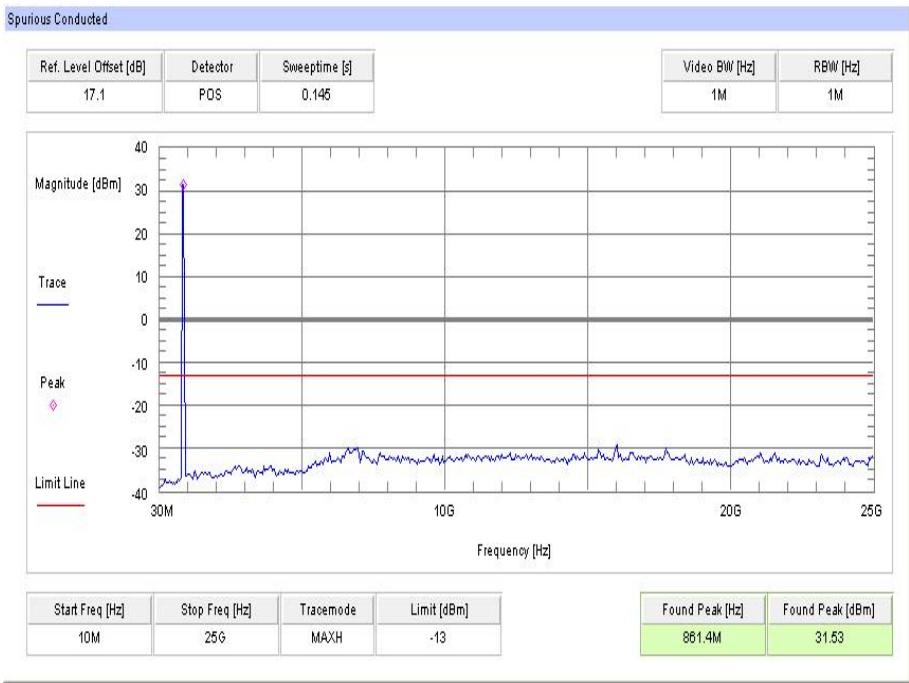
Results:

| Spurious Emission Level (dBm) | | | | | | | | |
|-------------------------------|------------------------|----------------|----------|------------------------|----------------|----------|------------------------|----------------|
| Harmonic | Ch. 128 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 189 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 251 Freq. (MHz) | Level [dBm] |
| 2 | 1648.4 | - | 2 | 1672.8 | - | 2 | 1697.6 | - |
| 3 | 2472.6 | - | 3 | 2509.2 | - | 3 | 2546.4 | - |
| 4 | 3296.8 | - | 4 | 3345.6 | - | 4 | 3395.2 | - |
| 5 | 4121.0 | - | 5 | 4182.0 | - | 5 | 4244.0 | - |
| 6 | 4945.2 | - | 6 | 5018.4 | - | 6 | 5092.8 | - |
| 7 | 5769.4 | - | 7 | 5854.8 | - | 7 | 5941.6 | - |
| 8 | 6593.6 | - | 8 | 6691.2 | - | 8 | 6790.4 | - |
| 9 | 7417.8 | - | 9 | 7527.6 | - | 9 | 7639.2 | - |
| 10 | 8242.0 | - | 10 | 8364.0 | - | 10 | 8488.0 | - |
| Measurement uncertainty | | | | | ± 3dB | | | |

Verdict: [complies](#)

Plots:**Plot 1: Channel 128 (10 MHz - 25 GHz)****Plot 2: Channel 189 (10 MHz - 25 GHz)**

Plot 3: Channel 251 (10 MHz - 25 GHz)



9.1.4 Spurious emissions radiated

Description:

The following steps outline the procedure used to measure the radiated emissions from the mobile station. The site is constructed in accordance with ANSI C63.4-2014 requirements and is recognized by the FCC to be in compliance for a 3 and a 10 meter site. The spectrum was scanned from 30 MHz to the 10th harmonic of the highest frequency generated within the equipment, which is the transmitted carrier that can be as high as 848.8 MHz. Measurement made up to 12.75 GHz. The resolution bandwidth is set as outlined in Part 22.917. The spectrum was scanned with the mobile station transmitting at carrier frequencies that pertain to low, mid and high channels of the GSM-850 band.

- The test item was placed on a 0.8 meter high non-conductive stand at a 3 meter test distance from the receive antenna. For measurements above 1 GHz the EUT is placed on a 1.5 meter high stand.
- The antenna output was terminated in a 50 ohm load (if possible).
- A double ridged wave guide antenna was placed on an adjustable height antenna mast 3 meters from the test item for emission measurements.
- Detected emissions were maximized at each frequency by rotating the test item and adjusting the receive antenna height and polarization. The maximum meter reading was recorded. The radiated emission measurements of the harmonics of the transmit frequency through the 10th harmonic were measured with peak detector and 1 MHz bandwidth. If the harmonic could not be detected above the noise floor, the ambient level was recorded. The equivalent power into a dipole antenna was calculated from the field intensity levels measured at 3 meters.
- Now each detected emissions were substituted by the substitution method, in accordance with the TIA/EIA 603.

Measurement:

| Measurement parameters | |
|------------------------|--|
| Detector: | Peak |
| Sweep time: | 2 sec. |
| Video bandwidth: | Below 1 GHz: 100 kHz Above 1 GHz: 1 MHz |
| Resolution bandwidth: | Below 1 GHz: 100 kHz Above 1 GHz: 1 MHz |
| Span: | 100 MHz Steps |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.1 |

Limits:

| FCC |
|--|
| CFR Part 22.917 CFR Part 2.1053 |
| Spurious Emissions Radiated |
| Attenuation $\geq 43 + 10\log(P)$ (P, Power in Watts) |
| -13 dBm |

Results:

Radiated emissions measurements were made only at the upper, center, and lower carrier frequencies of the GSM-850 band (824.2 MHz, 836.4 MHz and 848.8 MHz). It was decided that measurements at these three carrier frequencies would be sufficient to demonstrate compliance with emissions limits because it was seen that all the significant spurs occur well outside the band and no radiation was seen from a carrier in one block of the GSM-850 band into any of the other blocks. The equipment must still, however, meet emissions requirements with the carrier at all frequencies over which it is capable of operating and it is the manufacturer's responsibility to verify this.

The final open field radiated levels are presented on the next pages.

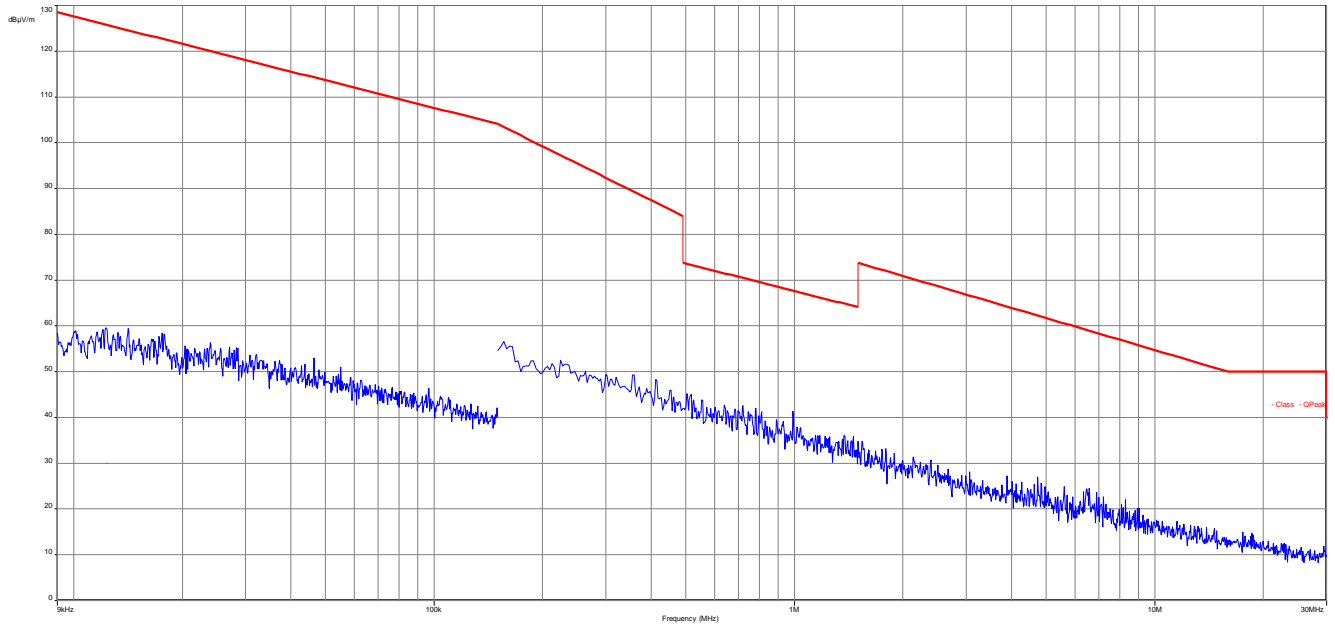
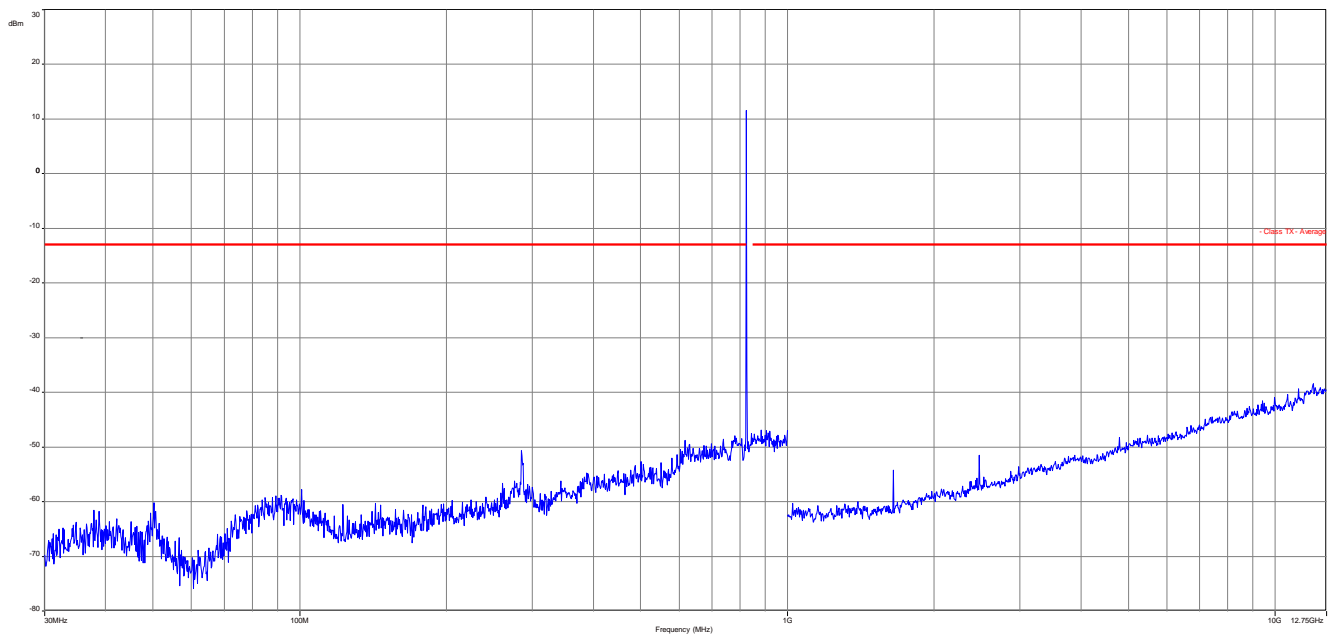
All measurements were done in horizontal and vertical polarization; the plots show the worst case.

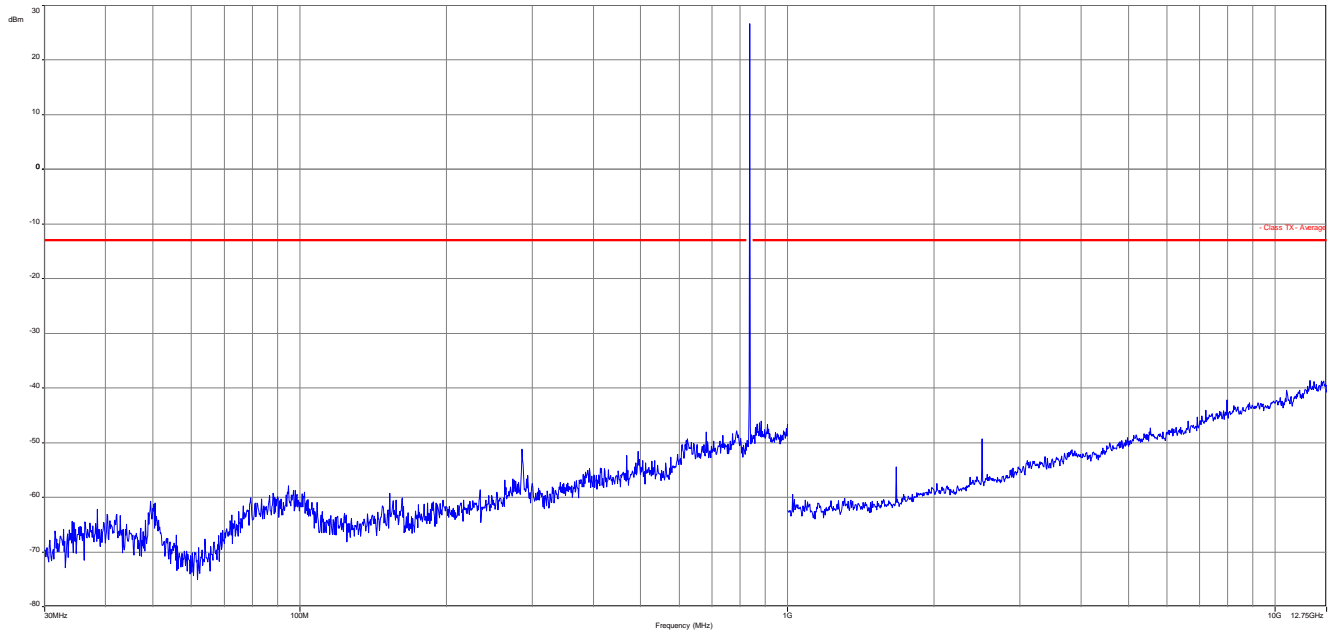
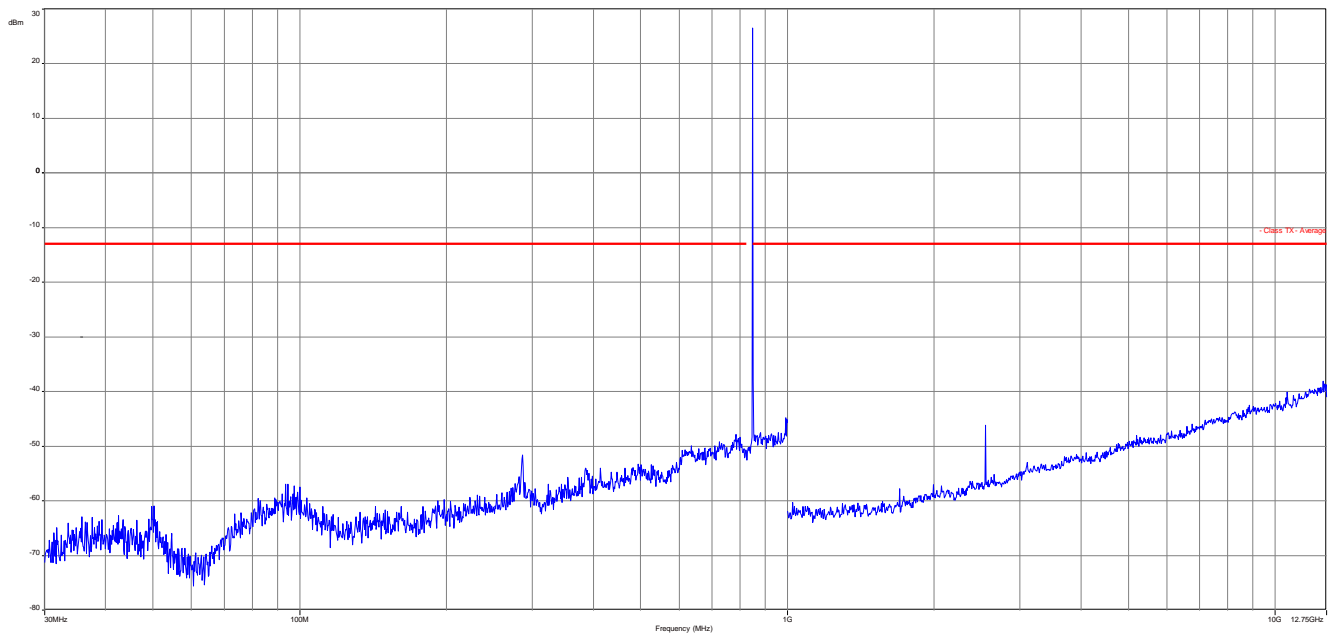
The plots show only the middle channel. If spurious were detected, the lowest and highest channel were checked too. The found values are stated in the table below.

As can be seen from this data, the emissions from the test item were within the specification limit.

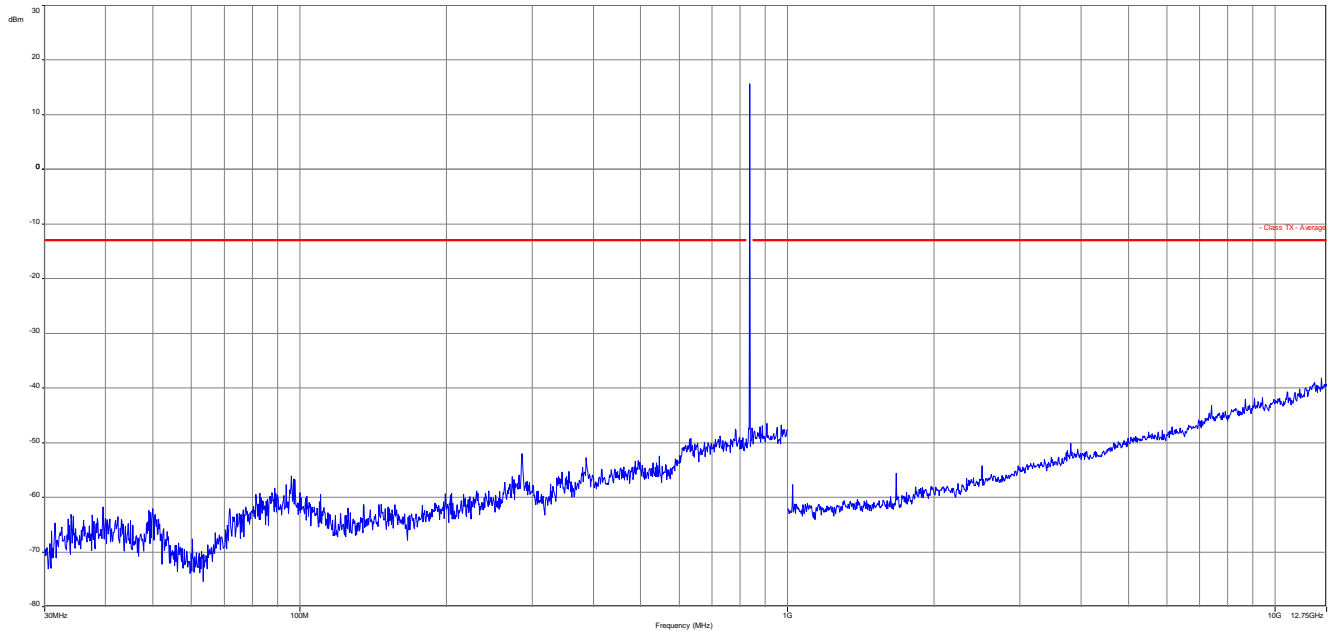
| Spurious Emission Level GMSK (dBm) | | | | | | | | |
|------------------------------------|------------------------|----------------|----------|------------------------|----------------|----------|------------------------|----------------|
| Harmonic | Ch. 128 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 189 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 251 Freq. (MHz) | Level [dBm] |
| 2 | 1648.4 | - | 2 | 1672.8 | - | 2 | 1697.6 | - |
| 3 | 2472.6 | - | 3 | 2509.2 | - | 3 | 2546.4 | - |
| 4 | 3296.8 | - | 4 | 3345.6 | - | 4 | 3395.2 | - |
| 5 | 4121.0 | - | 5 | 4182.0 | - | 5 | 4244.0 | - |
| 6 | 4945.2 | - | 6 | 5018.4 | - | 6 | 5092.8 | - |
| 7 | 5769.4 | - | 7 | 5854.8 | - | 7 | 5941.6 | - |
| 8 | 6593.6 | - | 8 | 6691.2 | - | 8 | 6790.4 | - |
| 9 | 7417.8 | - | 9 | 7527.6 | - | 9 | 7639.2 | - |
| 10 | 8242.0 | - | 10 | 8364.0 | - | 10 | 8488.0 | - |
| Measurement uncertainty | | | | | ± 3dB | | | |

Verdict: [complies](#)

Plots: (external antenna)**Plot 1:** Channel 189 (Traffic mode up to 30 MHz), GSM**Plot 2:** Channel 128 (30 MHz – 12.75 GHz), GSM

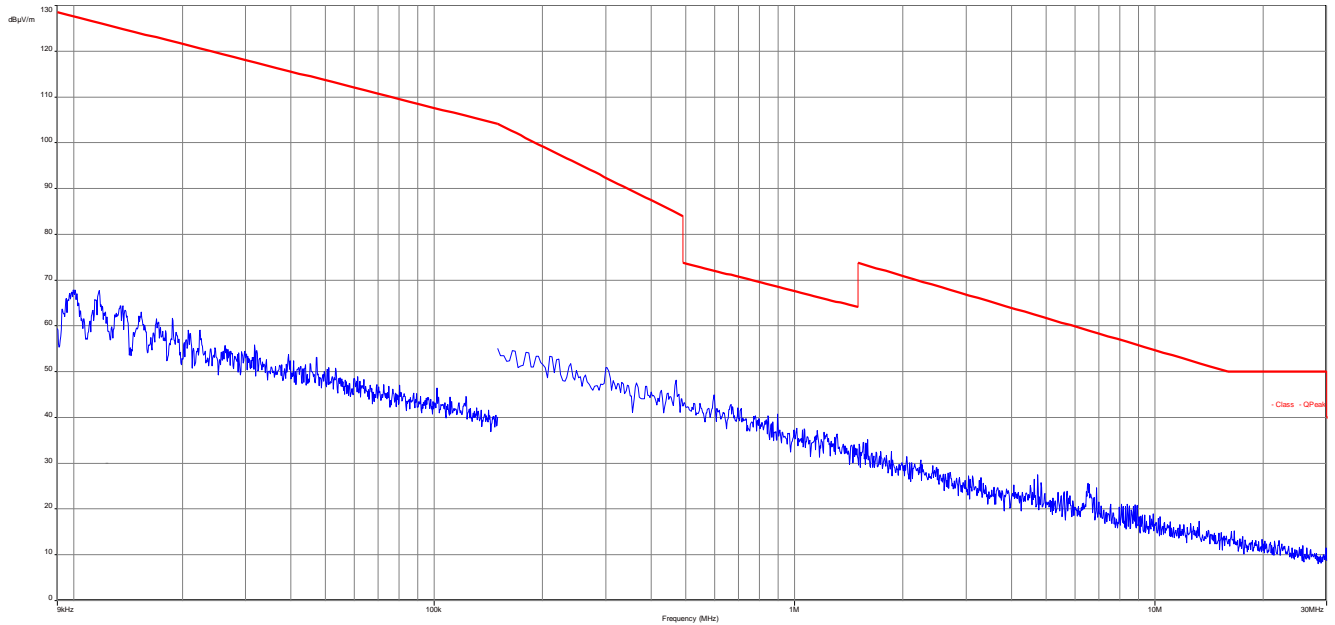
Plot 3: Channel 189 (30 MHz – 12.75 GHz), GSM**Plot 4:** Channel 251 (30 MHz – 12.75 GHz), GSM

Plot 5: Channel 189 (30 MHz – 12.75 GHz), EDGE

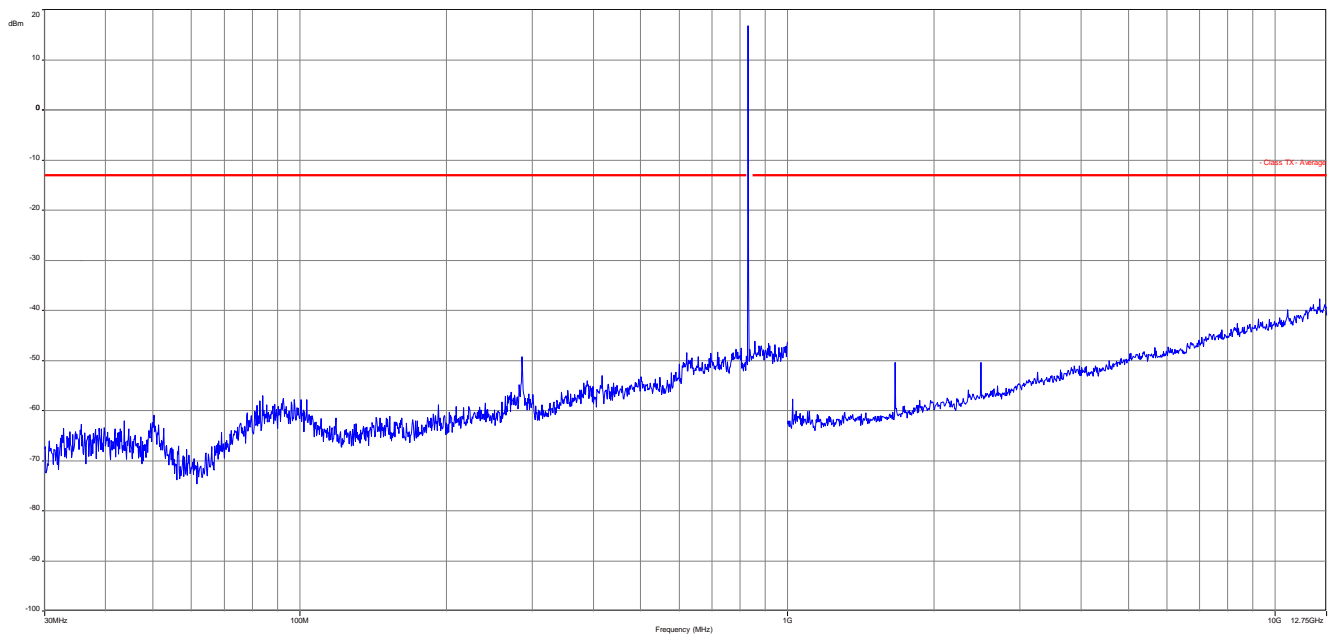


Plots: (internal antenna)

Plot 1: Channel 251 (Traffic mode up to 30 MHz), GSM



Plot 2: Channel 251 (30 MHz – 12.75 GHz), GSM



9.1.5 Block edge compliance

Description:

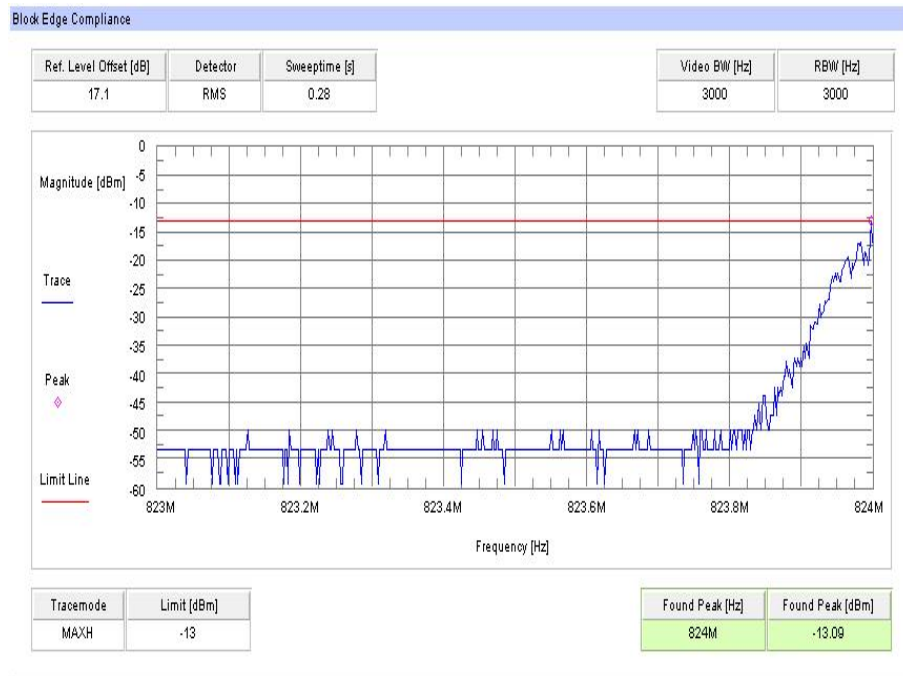
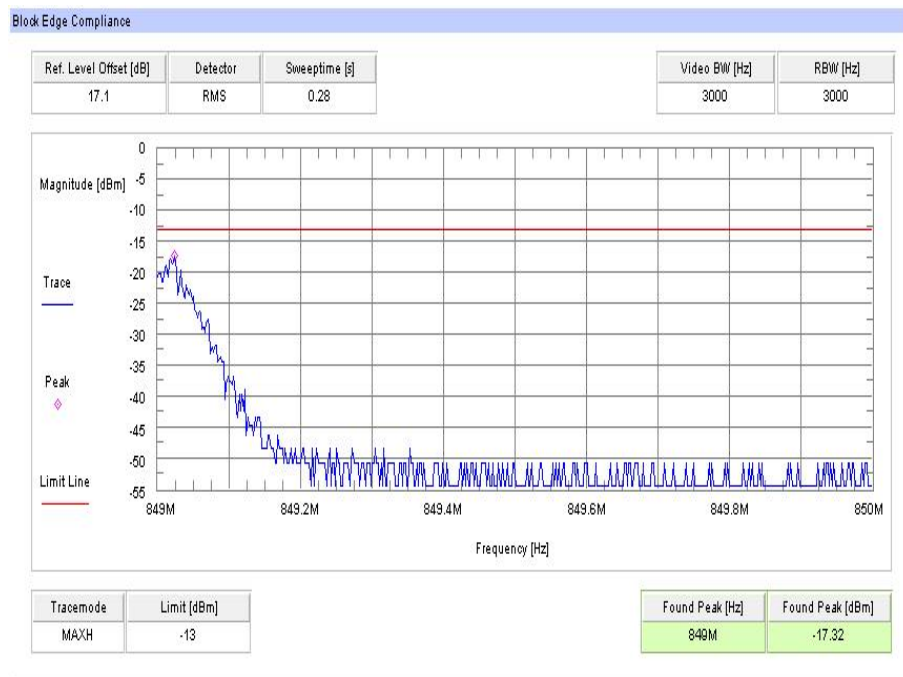
The spectrum at the band edges must comply with the spurious emissions limits.

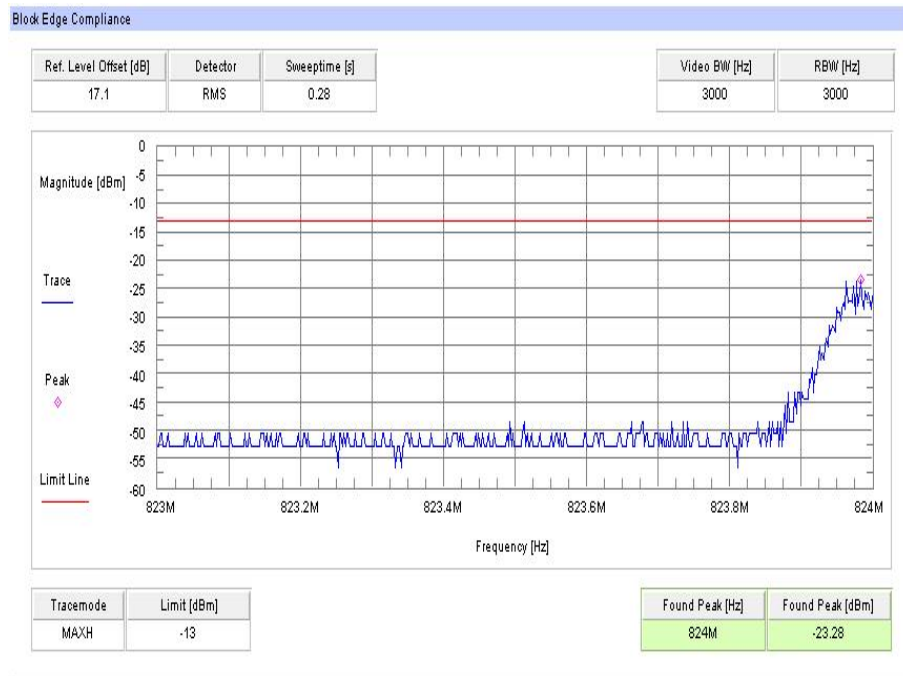
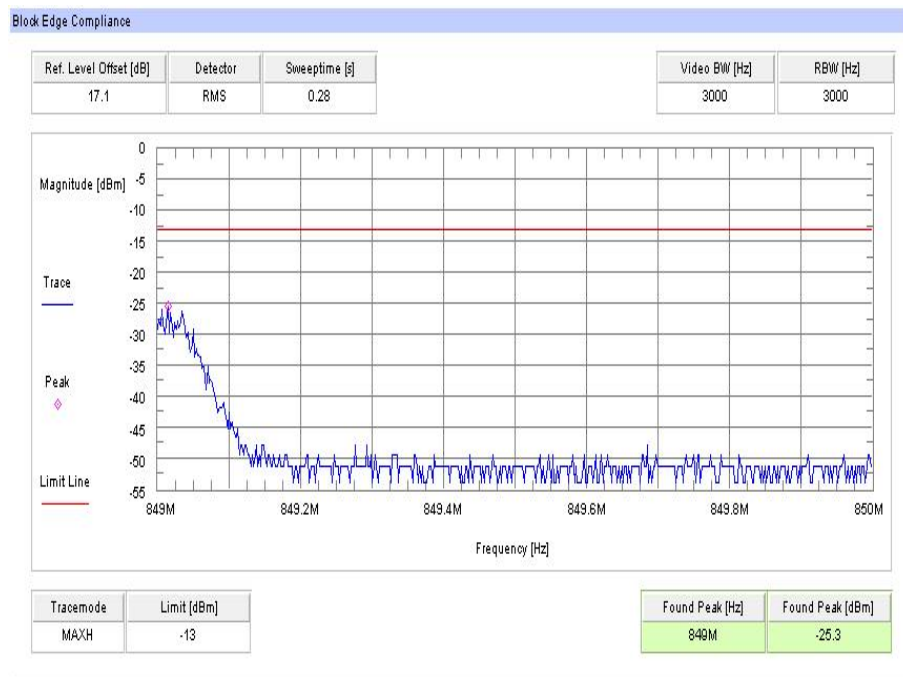
Measurement:

| Measurement parameters | |
|------------------------|-----------------|
| Detector: | RMS |
| Sweep time: | Auto |
| Video bandwidth: | 3 kHz |
| Resolution bandwidth: | 3 kHz |
| Span: | 1 MHz |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

Limits:

| FCC |
|--|
| CFR Part 22.917 CFR Part 2.1051 |
| Block Edge Compliance |
| Attenuation $\geq 43 + 10\log(P)$ (P, Power in Watts) |
| -13 dBm |

Plots:**Plot 1: Channel 128 (GSM-mode)****Plot 2: Channel 251 (GSM-mode)**

Plot 3: Channel 128 (EDGE-mode)**Plot 4: Channel 251 (EDGE-mode)****Verdict:** **complies**

9.1.6 Occupied bandwidth

Description:

Measurement of the occupied bandwidth of the transmitted signal.

Measurement:

Similar to conducted emissions, occupied bandwidth measurements are only provided for selected frequencies in order to reduce the amount of submitted data. Data were taken at the extreme and mid frequencies of the GSM-850 frequency band. The table below lists the measured 99% power and -26dBc occupied bandwidths. Spectrum analyzer plots are included on the following pages.

Part 22.917 requires a measurement bandwidth of at least 1% of the occupied bandwidth. For ca. 300 kHz, this equates to a resolution bandwidth of at least 3 kHz. For this testing, a resolution bandwidth 3.0 kHz was used.

| Measurement parameters | |
|------------------------|-----------------|
| Detector: | Peak |
| Sweep time: | Auto |
| Video bandwidth: | 30 kHz |
| Resolution bandwidth: | 10 kHz |
| Span: | 1 MHz |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

Limits:

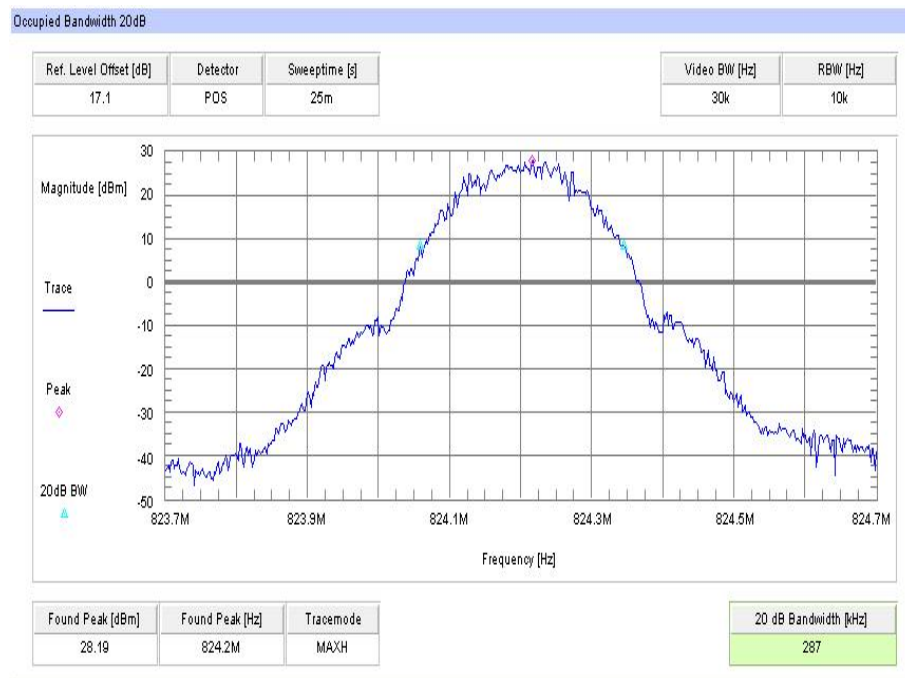
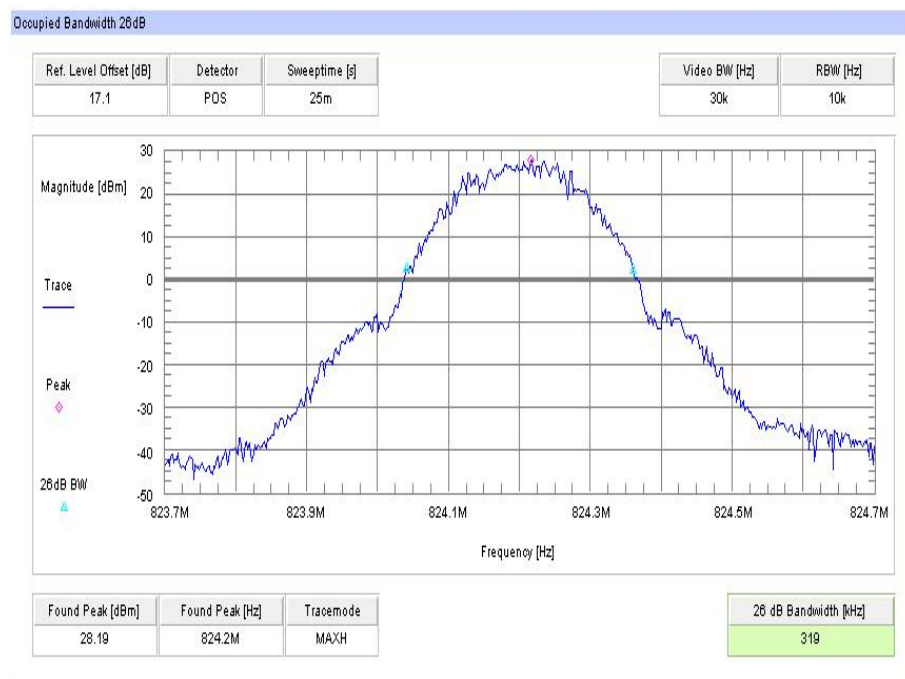
| FCC |
|---|
| CFR Part 22.917 CFR Part 2.1049 |
| Occupied Bandwidth |
| Spectrum must fall completely in the specified band |

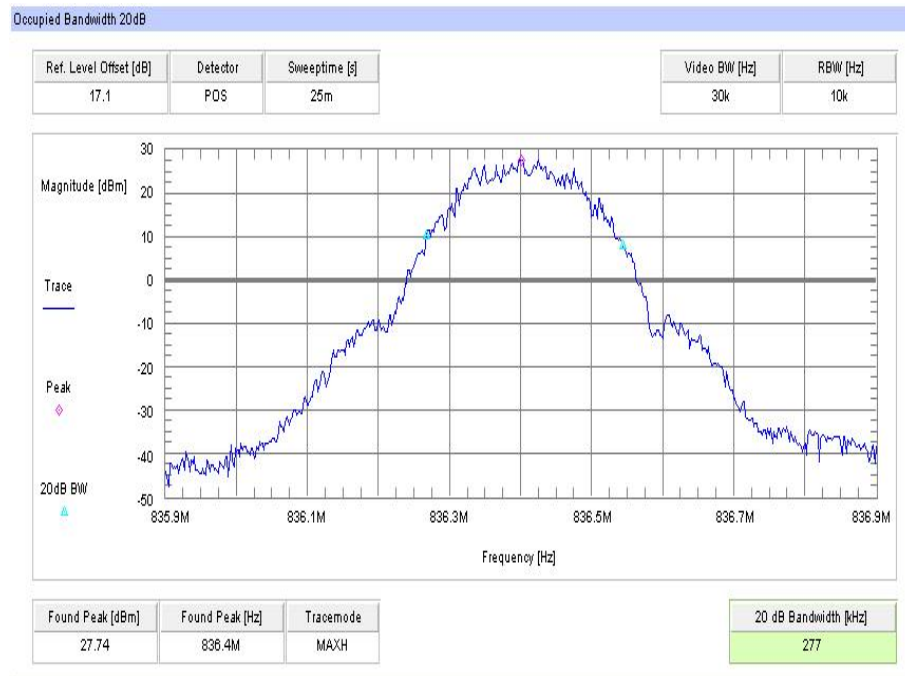
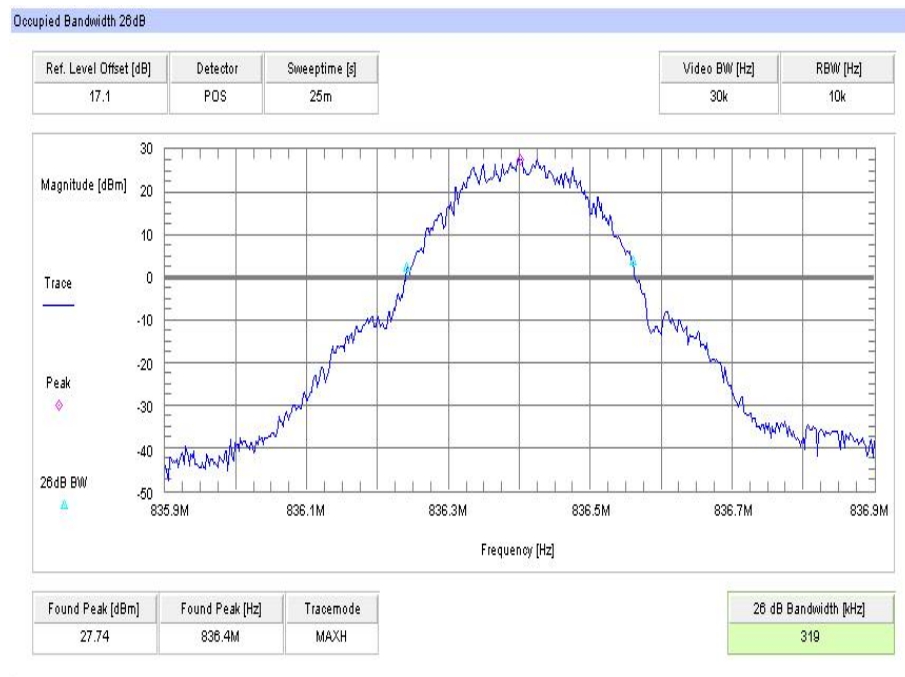
Results:

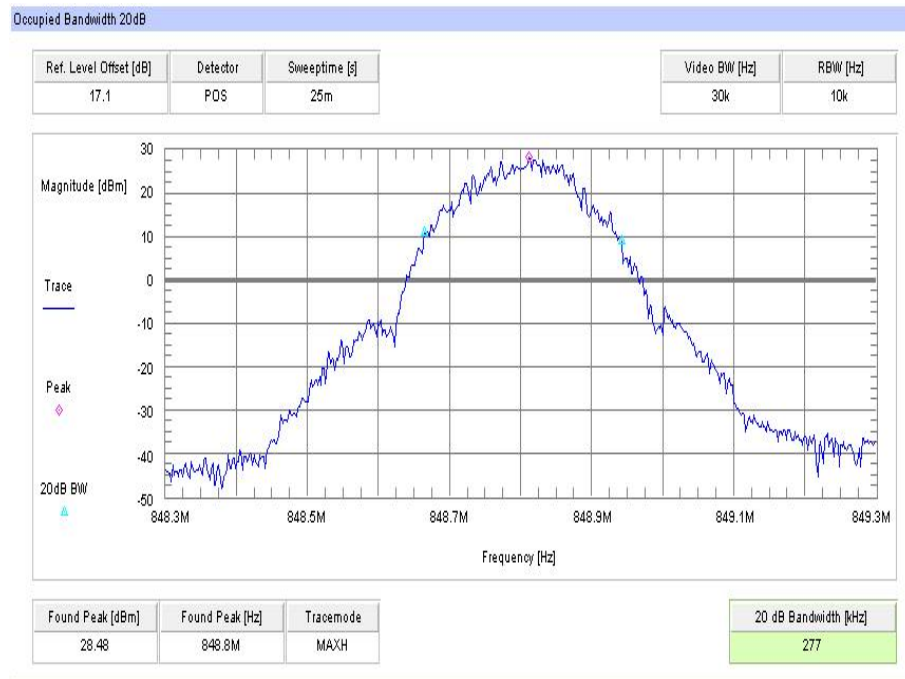
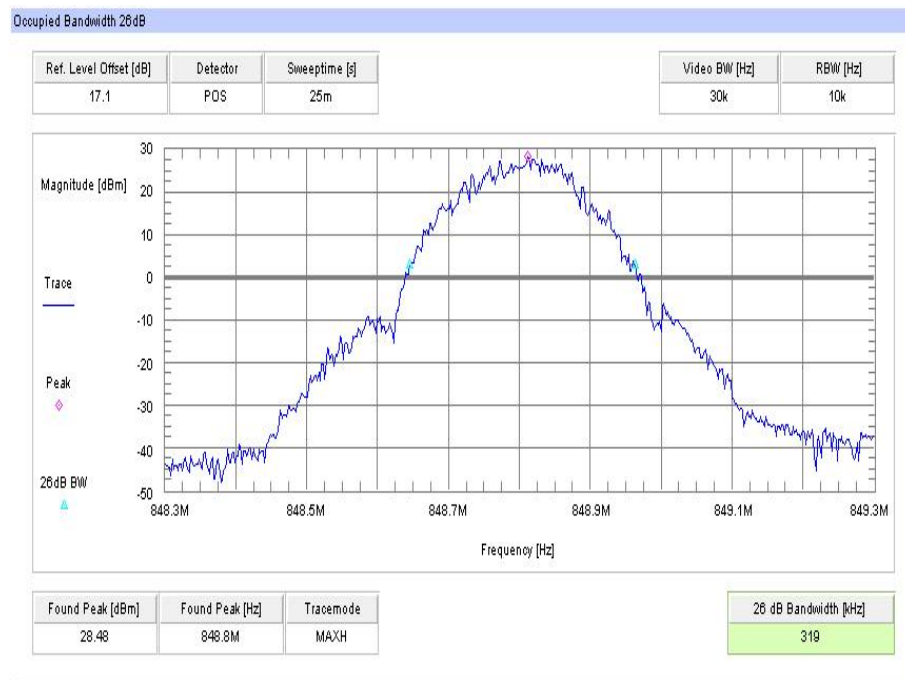
| Occupied Bandwidth - GMSK mode | | |
|--------------------------------|---------------|------------------|
| Frequency (MHz) | 99% OBW (kHz) | -26 dBc BW (kHz) |
| 824.2 | 287 | 319 |
| 836.4 | 277 | 319 |
| 848.8 | 277 | 319 |
| Measurement uncertainty | ± 3 kHz | |

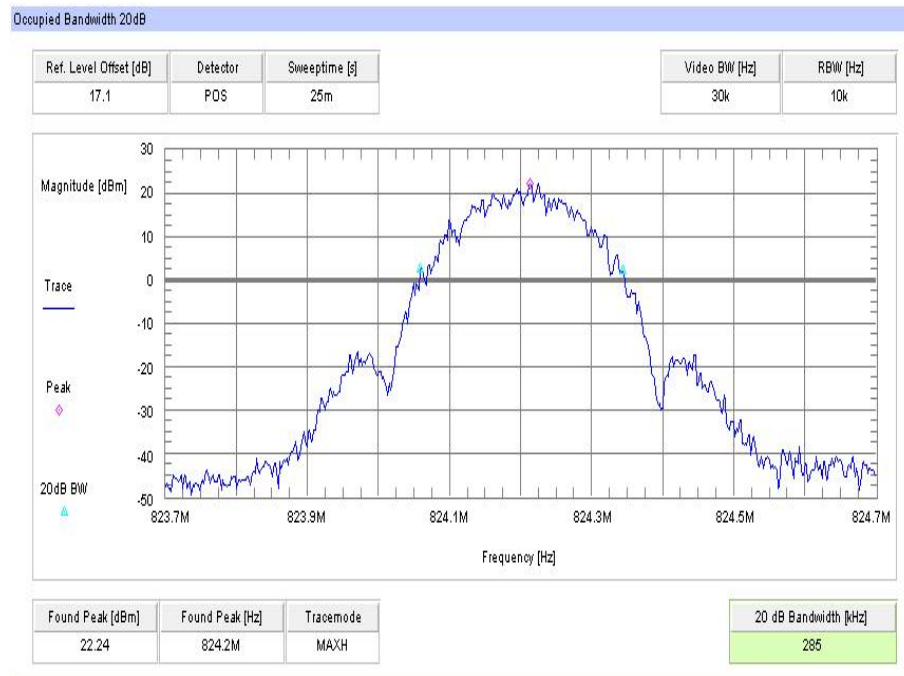
| Occupied Bandwidth – 8-PSK mode | | |
|---------------------------------|---------------|------------------|
| Frequency (MHz) | 99% OBW (kHz) | -26 dBc BW (kHz) |
| 824.2 | 285 | 313 |
| 836.4 | 275 | 307 |
| 848.8 | 279 | 315 |
| Measurement uncertainty | ± 3 kHz | |

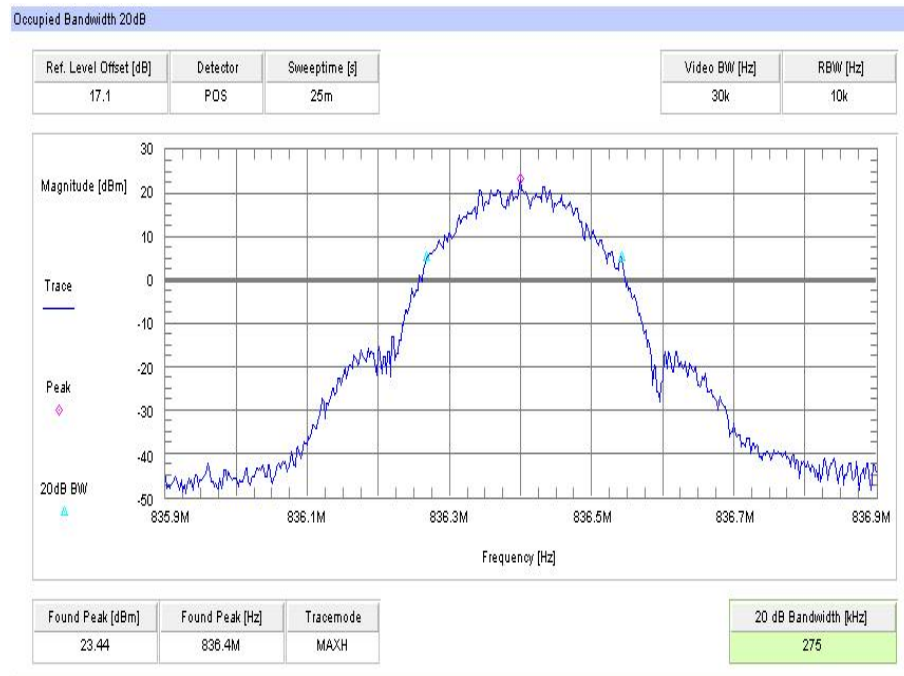
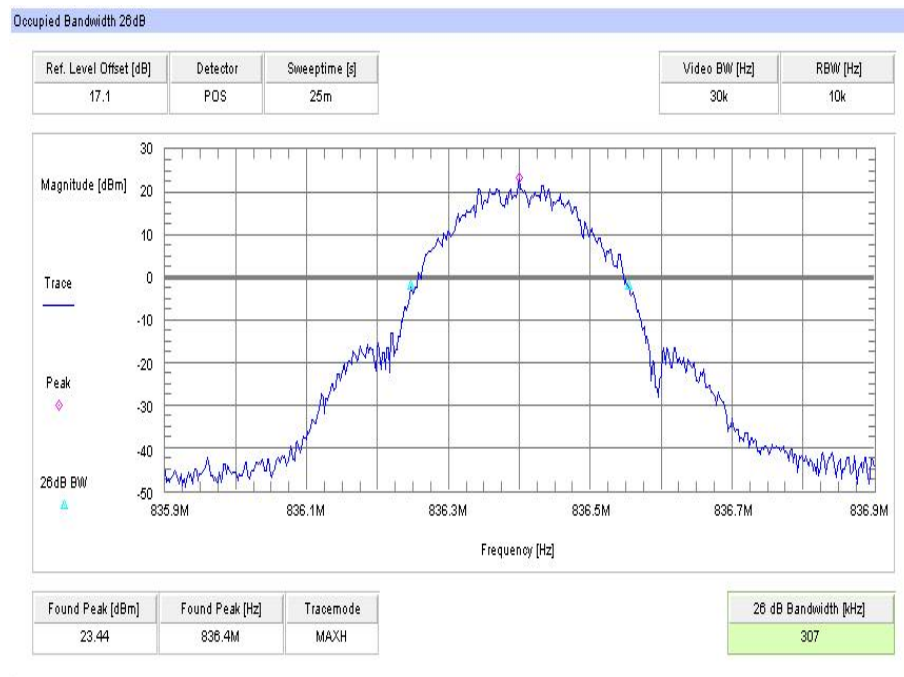
Verdict: [complies](#)

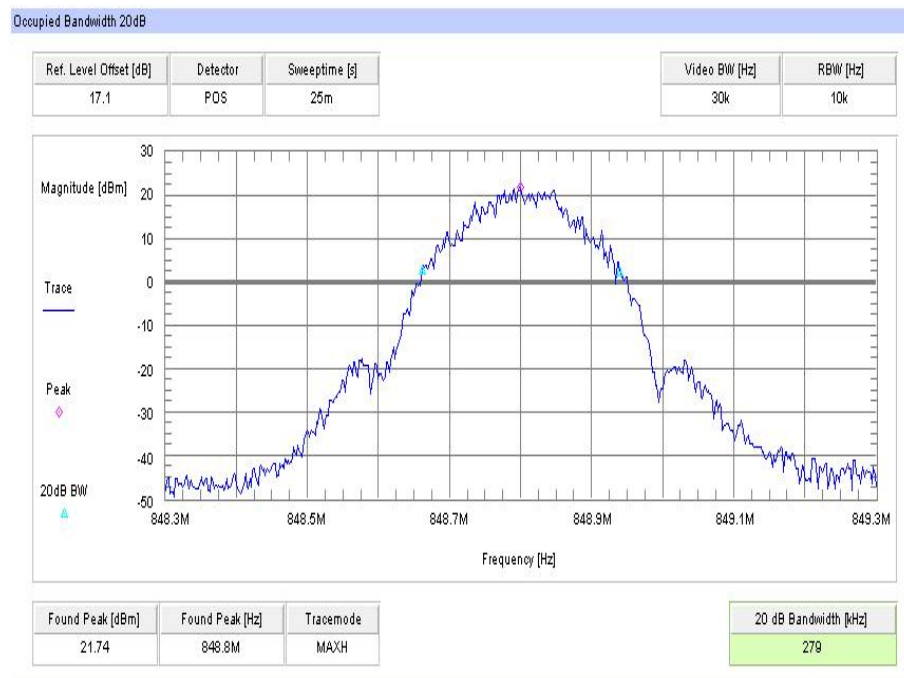
Plots:**Plot 1: Channel 128 (99% - OBW)****Plot 2: Channel 128 (-26 dBc BW)**

Plot 3: Channel 189 (99% - OBW)**Plot 4: Channel 189 (-26 dBc BW)**

Plot 5: Channel 251 (99% - OBW)**Plot 6: Channel 251 (-26 dBc BW)**

Plot 7: Channel 128 (99% - OBW) – 8-PSK**Plot 8: Channel 128 (-26 dBc BW) - 8-PSK**

Plot 9: Channel 189 (99% - OBW) - 8-PSK**Plot 10: Channel 189 (-26 dBc BW) - 8-PSK**

Plot 11: Channel 251 (99% - OBW) - 8-PSK**Plot 12: Channel 251 (-26 dBc BW) - 8-PSK**

9.2 Results PCS 1900

All GSM-band measurements are done in GSM mode only (circuit switched).

All relevant tests have been repeated using 8-PSK modulation if EDGE mode is supported. All tests were performed with one timeslot in uplink activated and one timeslot in downlink activated. For each mode the highest output power was determined and used.

9.2.1 RF output power

Description:

This paragraph contains average power, peak output power and EIRP measurements for the mobile station. In all cases, the peak output power is within the required mask (this mask is specified in the JTC standards, TIA PN3389 Vol. 1 Chap 7, and is no FCC requirement).

Measurement:

The mobile was set up for the maximum output power with pseudo random data modulation.

| Measurement parameters | |
|------------------------|-------------------------------|
| Detector: | Peak and RMS (Power in Burst) |
| Sweep time: | Auto |
| Video bandwidth: | 1 MHz |
| Resolution bandwidth: | 1 MHz |
| Span: | Zero Span |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

Limits:

| FCC |
|---|
| CFR Part 24.232 CFR Part 2.1046 |
| Nominal Peak Output Power |
| +33.00 dBm In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB. |

Results:

| Output Power (conducted) GMSK mode | | |
|------------------------------------|----------------------------|----------------------------|
| Frequency (MHz) | Average Output Power (dBm) | Peak to Average Ratio (dB) |
| 1850.2 | 29.2 | 0.05 |
| 1880.0 | 29.3 | 0.04 |
| 1909.8 | 30.2 | 0.03 |
| Measurement uncertainty | ± 0.5 dB | |

| Output Power (conducted) 8-PSK mode | | |
|-------------------------------------|----------------------------|----------------------------|
| Frequency (MHz) | Average Output Power (dBm) | Peak to Average Ratio (dB) |
| 1850.2 | 25.3 | 3.07 |
| 1880.0 | 25.3 | 3.17 |
| 1909.8 | 25.7 | 3.27 |
| Measurement uncertainty | ± 0.5 dB | |

| Output Power (radiated) GMSK mode | |
|-----------------------------------|-----------------------------------|
| Frequency (MHz) | Average Output Power (dBm) - EIRP |
| 1850.2 (external antenna) | 30.0 |
| 1880.0 (external antenna) | 28.5 |
| 1909.8 (external antenna) | 28.7 |
| 1909.8 (internal antenna) | 31.9 |
| Measurement uncertainty | ± 2.0 dB |

| Output Power (radiated) 8-PSK mode | |
|------------------------------------|-----------------------------------|
| Frequency (MHz) | Average Output Power (dBm) - EIRP |
| 1850.2 (external antenna) | 26.1 |
| 1880.0 (external antenna) | 24.6 |
| 1909.8 (external antenna) | 24.2 |
| 1909.8 (internal antenna) | 27.4 |
| Measurement uncertainty | ± 2.0 dB |

Verdict: [complies](#)

9.2.2 Frequency stability

Description:

In order to measure the carrier frequency under the condition of AFC lock, it is necessary to make measurements with the mobile station in a "call mode". This is accomplished with the use of a R&S CMU200 DIGITAL RADIOCOMMUNICATION TESTER.

1. Measure the carrier frequency at room temperature.
2. Subject the mobile station to overnight soak at -30 °C.
3. With the mobile station, powered with V_{nom} , connected to the CMU200 and in a simulated call on channel 661 (centre channel), measure the carrier frequency. These measurements should be made within two minutes of powering up the mobile station, to prevent significant self warming.
4. Repeat the above measurements at 10°C increments from -30°C to +60°C. Allow at least 1.5 hours at each temperature, unpowered, before making measurements.
5. Remeasure carrier frequency at room temperature with V_{nom} . Vary supply voltage from V_{min} to V_{max} . Pause at V_{nom} for 1.5 hours unpowered, to allow any self heating to stabilize, before continuing.
6. At all temperature levels hold the temperature to +/- 0.5°C during the measurement procedure.

Measurement:

| Measurement parameters | |
|------------------------|----------------------|
| Detector: | Measured with CMU200 |
| Sweep time: | |
| Video bandwidth: | |
| Resolution bandwidth: | |
| Span: | |
| Trace-Mode: | see chapter 8.2 |
| Used test setup: | |

Limits:

| FCC |
|--|
| CFR Part 24.235 CFR Part 2.1055 |
| Frequency Stability |
| The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block. |

Results:**AFC FREQ ERROR versus VOLTAGE**

| Voltage (V) | Frequency Error (Hz) | Frequency Error (%) | Frequency Error (ppm) |
|-------------|----------------------|---------------------|-----------------------|
| 4.5 | 11 | 0.00000059 | 0.0059 |
| 4.8 | 23 | 0.00000122 | 0.0122 |
| 8.0 | 11 | 0.00000059 | 0.0059 |
| 14.0 | -7 | -0.00000037 | -0.0037 |
| 18.0 | 15 | 0.00000080 | 0.0080 |

AFC FREQ ERROR versus TEMPERATURE

| Temperature (°C) | Frequency Error (Hz) | Frequency Error (%) | Frequency Error (ppm) |
|------------------|----------------------|---------------------|-----------------------|
| -30 | -8 | -0.00000043 | -0.0043 |
| -20 | -11 | -0.00000059 | -0.0059 |
| -10 | -20 | -0.00000106 | -0.0106 |
| ± 0 | -17 | -0.00000090 | -0.0090 |
| 10 | -12 | -0.00000064 | -0.0064 |
| 20 | -21 | -0.00000112 | -0.0112 |
| 30 | -7 | -0.00000037 | -0.0037 |
| 40 | -1 | -0.00000005 | -0.0005 |
| 50 | 6 | 0.00000032 | 0.0032 |
| 60 | 10 | 0.00000053 | 0.0053 |

Verdict: [complies](#)

9.2.3 Spurious emissions radiated

Description:

The following steps outline the procedure used to measure the radiated emissions from the mobile station. The site is constructed in accordance with ANSI C63.4-2014 requirements and is recognized by the FCC to be in compliance for a 3 and a 10 meter site. The spectrum was scanned from 30 MHz to the 10th harmonic of the highest frequency generated within the equipment, which is the transmitted carrier that can be as high as 1910 MHz. Measurement made up to 26 GHz. The resolution bandwidth is set as outlined in Part 24.238. The spectrum was scanned with the mobile station transmitting at carrier frequencies that pertain to low, mid and high channels of the PCS1900 band.

The final open field emission (here 10m semi-anechoic chamber listed by FCC) test procedure is as follows:

- The test item was placed on a 0.8 meter high non-conductive stand at a 3 meter test distance from the receive antenna.
- The antenna output was terminated in a 50 ohm load (if possible).
- A double ridged wave guide antenna was placed on an adjustable height antenna mast 3 meters from the test item for emission measurements.
- Detected emissions were maximized at each frequency by rotating the test item and adjusting the receive antenna height and polarization. The maximum meter reading was recorded. The radiated emission measurements of the harmonics of the transmit frequency through the 10th harmonic were measured with peak detector and 1 MHz bandwidth. If the harmonic could not be detected above the noise floor, the ambient level was recorded. The equivalent power into a dipole antenna was calculated from the field intensity levels measured at 3 meters.
- Now each detected emissions were substituted by the substitution method, in accordance with the TIA/EIA 603.

Measurement:

| Measurement parameters | |
|------------------------|--|
| Detector: | Peak |
| Sweep time: | 2 sec. |
| Video bandwidth: | Below 1 GHz: 100 kHz Above 1 GHz: 1 MHz |
| Resolution bandwidth: | Below 1 GHz: 100 kHz Above 1 GHz: 1 MHz |
| Span: | 100 MHz Steps |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.1 |

Limits:

| FCC |
|--|
| CFR Part 24.238 CFR Part 2.1053 |
| Spurious Emissions Radiated |
| Attenuation $\geq 43 + 10\log(P)$ (P, Power in Watts) |
| -13 dBm |

Results:

Radiated emissions measurements were made only at the upper, center, and lower carrier frequencies of the PCS1900 band (1850.2 MHz, 1880.0 MHz and 1909.8 MHz). It was decided that measurements at these three carrier frequencies would be sufficient to demonstrate compliance with emissions limits because it was seen that all the significant spurs occur well outside the band and no radiation was seen from a carrier in one block of the PCS1900 band into any of the other blocks. The equipment must still, however, meet emissions requirements with the carrier at all frequencies over which it is capable of operating and it is the manufacturer's responsibility to verify this.

The final open field radiated levels are presented on the next pages.

All measurements were done in horizontal and vertical polarization; the plots show the worst case.

The plots show only the middle channel. If spurious were detected, the lowest and highest channel were checked too. The found values are stated in the table below.

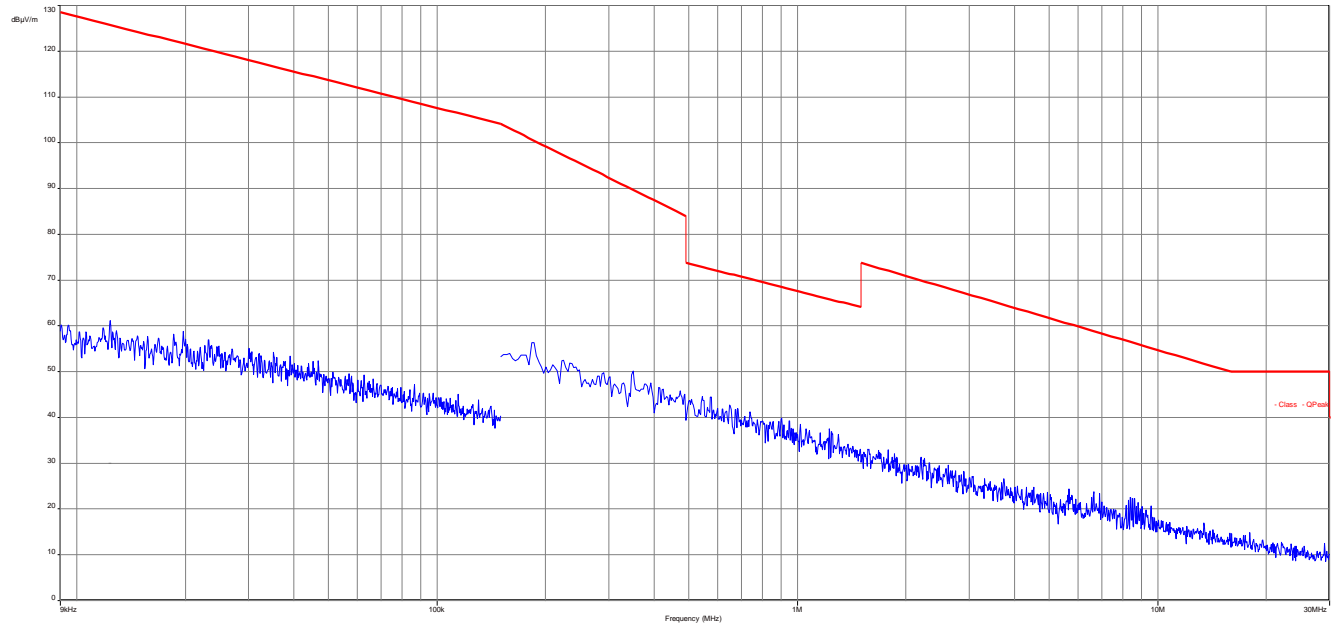
As can be seen from this data, the emissions from the test item were within the specification limit.

| Spurious Emission Level GMSK (dBm) | | | | | | | | |
|------------------------------------|------------------------|----------------|----------|------------------------|----------------|----------|------------------------|----------------|
| Harmonic | Ch. 512 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 661 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 810 Freq. (MHz) | Level [dBm] |
| 2 | 3700.4 | - | 2 | 3760.0 | - | 2 | 3819.6 | - |
| 3 | 5550.6 | - | 3 | 5640.0 | - | 3 | 5729.4 | - |
| 4 | 7400.8 | - | 4 | 7520.0 | - | 4 | 7639.2 | - |
| 5 | 9251.0 | - | 5 | 9400.0 | - | 5 | 9549.0 | - |
| 6 | 11101.2 | - | 6 | 11280.0 | - | 6 | 11458.8 | - |
| 7 | 12951.4 | - | 7 | 13160.0 | - | 7 | 13368.6 | - |
| 8 | 14801.6 | - | 8 | 15040.0 | - | 8 | 15278.4 | - |
| 9 | 16651.8 | - | 9 | 16920.0 | - | 9 | 17188.2 | - |
| 10 | 18502.0 | - | 10 | 18800.0 | - | 10 | 19098.0 | - |
| Measurement uncertainty | | | | | ± 3dB | | | |

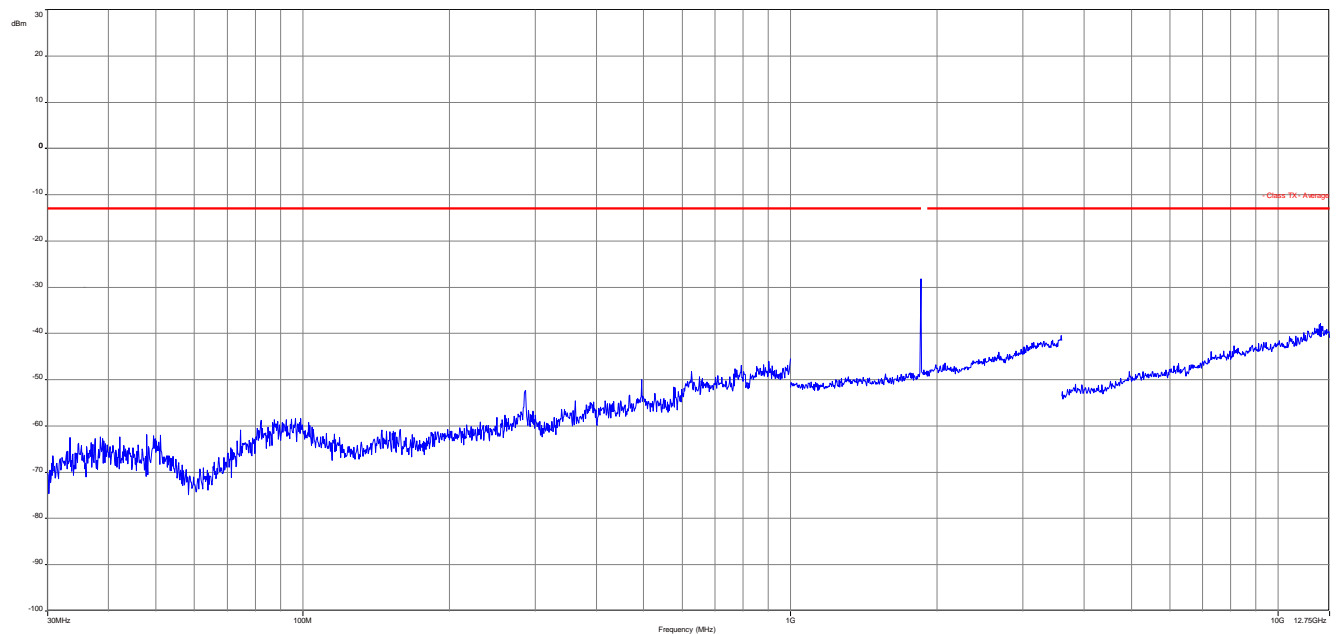
Verdict: [complies](#)

Plots: (external antenna)

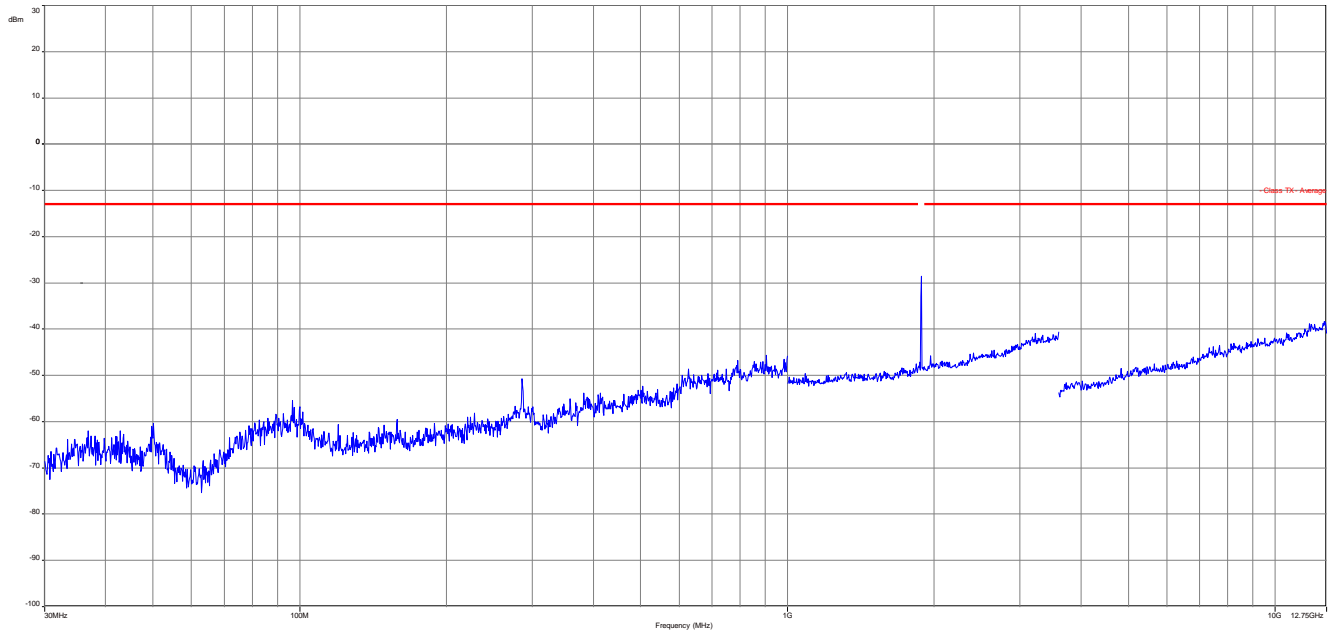
Plot 1: Channel 661 (Traffic mode up to 30 MHz), GSM



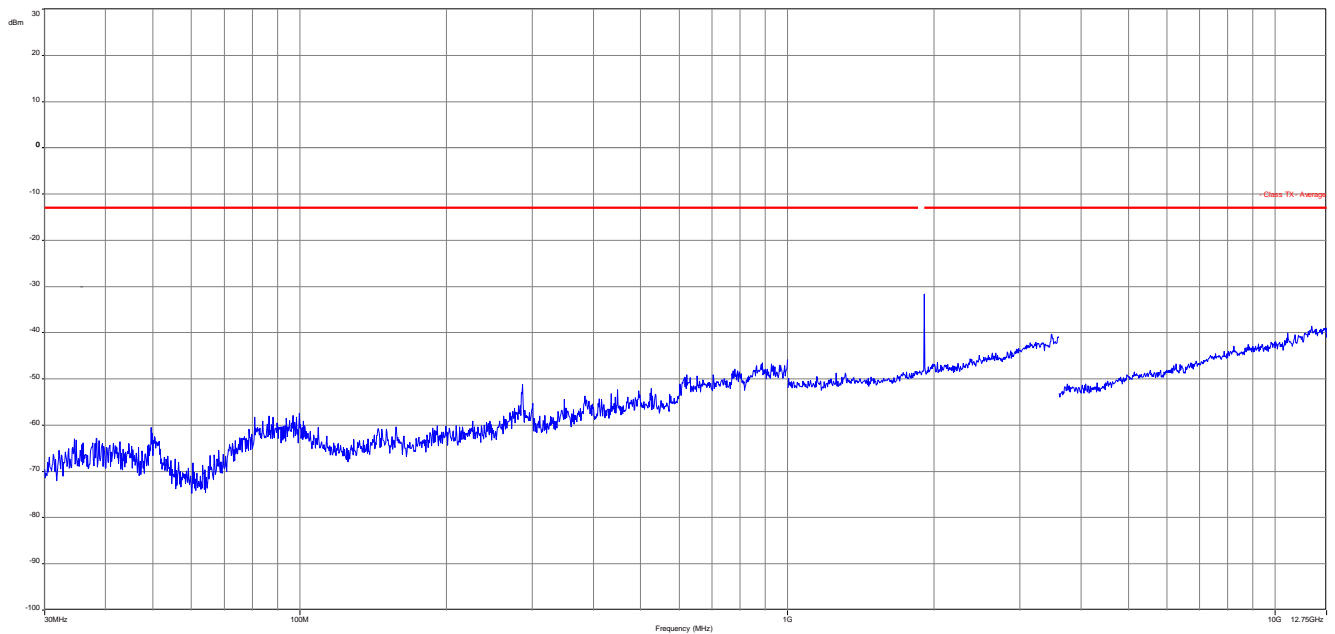
Plot 2: Channel 512 (30 MHz – 12.75 GHz), GSM



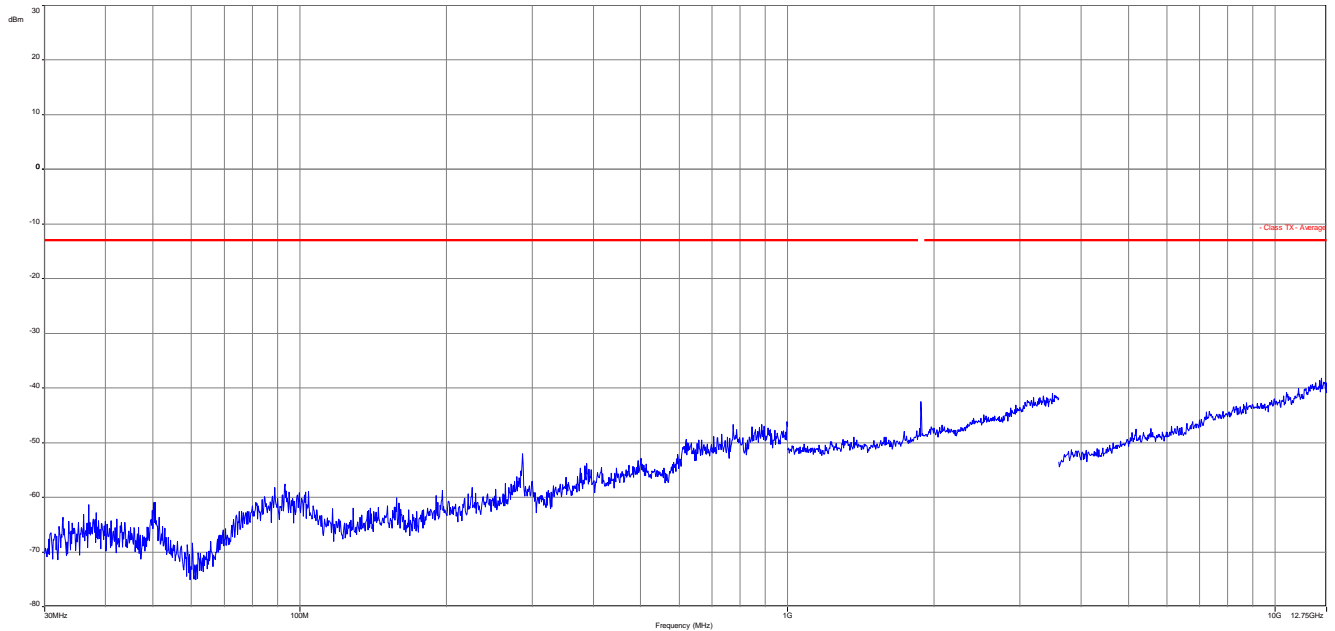
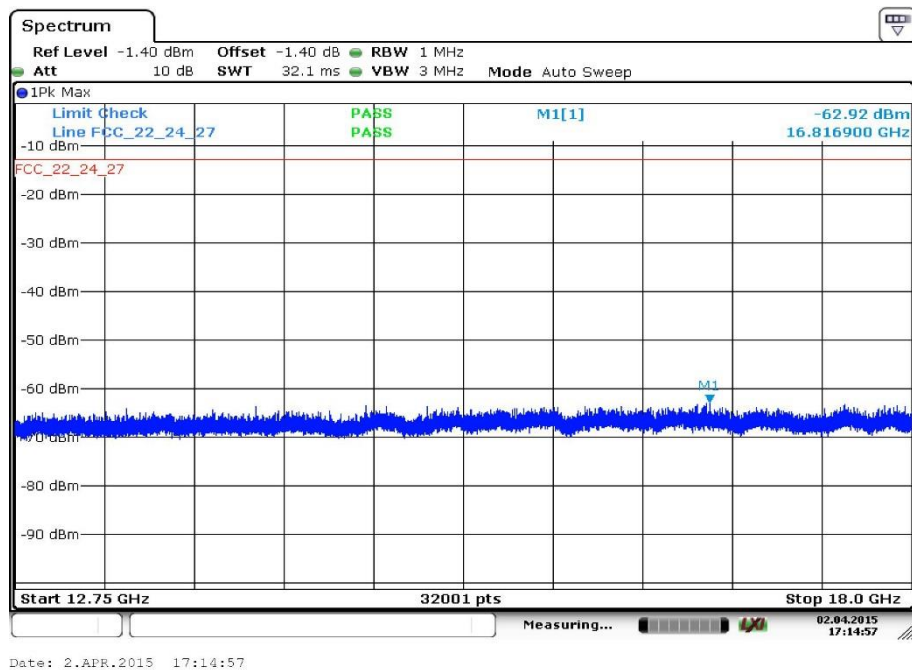
Carrier notched with 1.9 GHz rejection filter

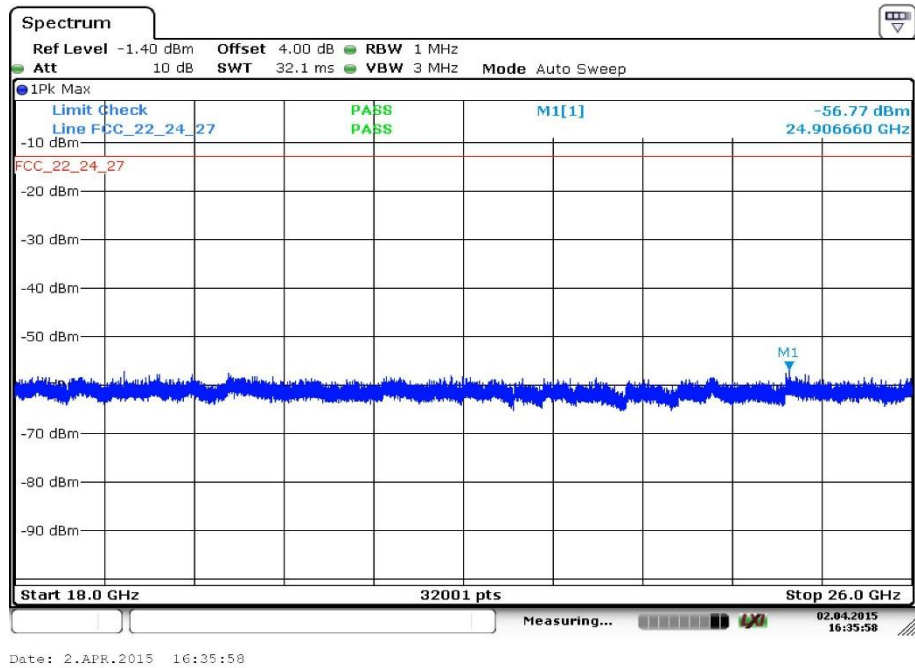
Plot 3: Channel 661 (30 MHz – 12.75 GHz), GSM

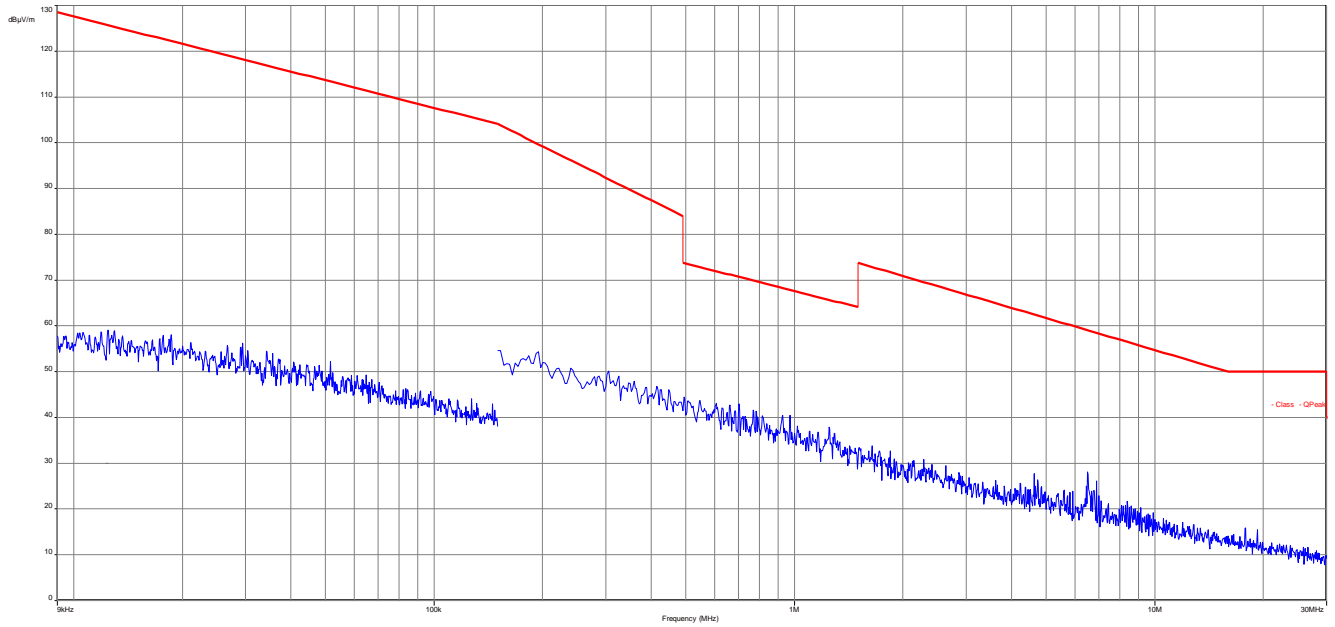
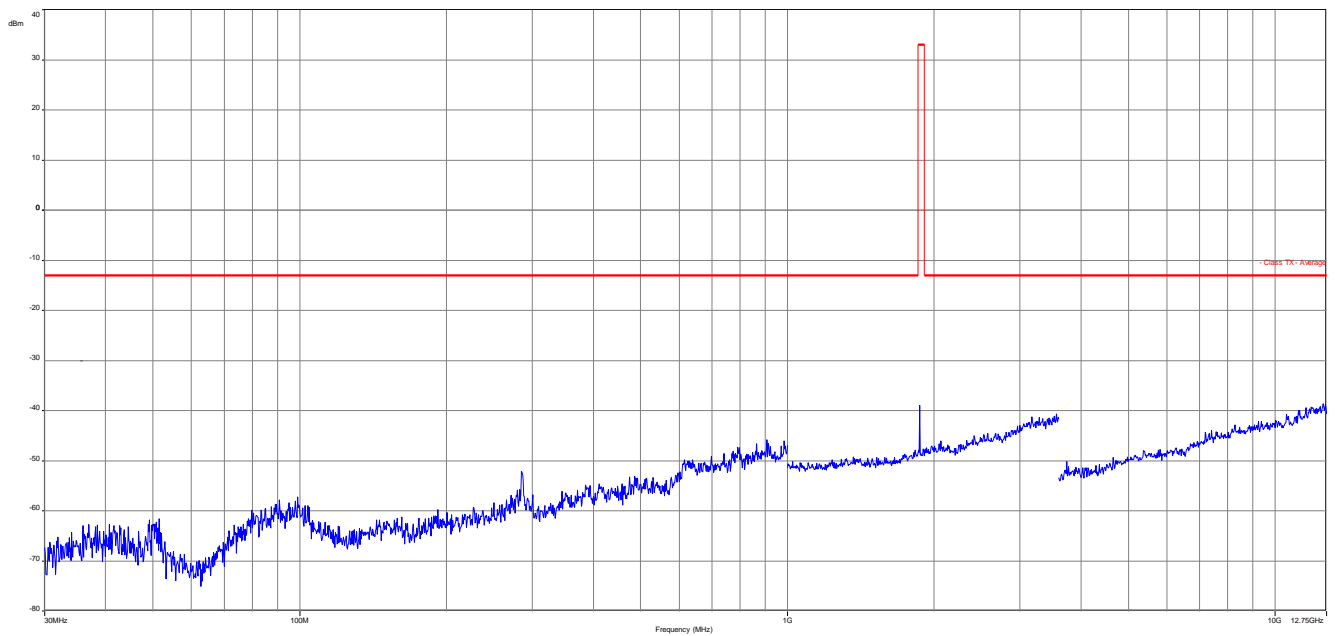
Carrier notched with 1.9 GHz rejection filter

Plot 4: Channel 810 (30 MHz – 12.75 GHz), GSM

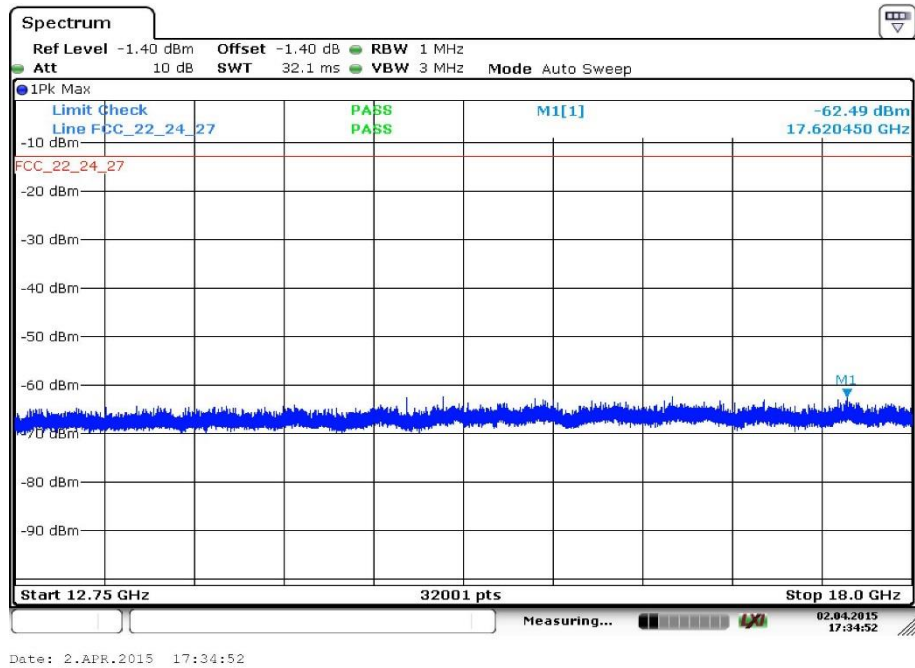
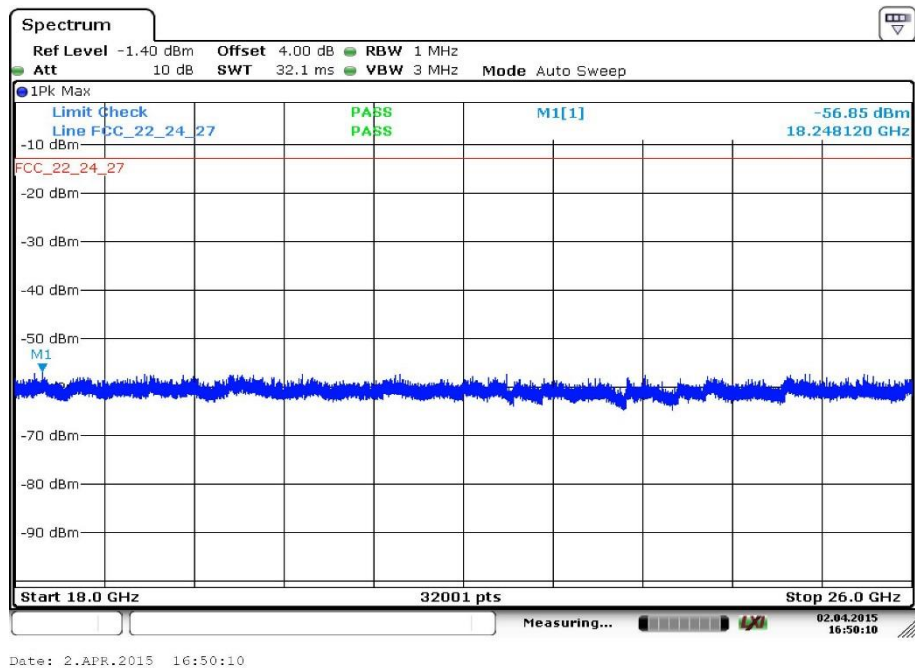
Carrier notched with 1.9 GHz rejection filter

Plot 5: Channel 661 (30 MHz – 12.75 GHz), EDGE**Plot 6:** Channel 661 (12.75 GHz - 18 GHz), GSM

Plot 7: Channel 661 (18 GHz - 26 GHz), GSM

Plots: (internal antenna)**Plot 1:** Channel 661 (Traffic mode up to 30 MHz), GSM**Plot 2:** Channel 810 (30 MHz – 12.75 GHz), GSM

Carrier notched with 1.9 GHz rejection filter

Plot 3: Channel 661 (12.75 GHz - 18 GHz), GSM**Plot 4: Channel 661 (18 GHz - 26 GHz), GSM**

9.2.4 Spurious emissions conducted

Description:

The following steps outline the procedure used to measure the conducted emissions from the mobile station.

1. Determine frequency range for measurements: From CFR 2.1057 the spectrum should be investigated from the lowest radio frequency generated in the equipment up to at least the 10th harmonic of the carrier frequency. For the mobile station equipment tested, this equates to a frequency range of 13 MHz to 19.1 GHz, data taken from 10 MHz to 25 GHz.
2. Determine mobile station transmits frequencies: below outlines the band edge frequencies pertinent to conducted emissions testing.

PCS1900 Transmitter Channel Frequency

512 1850.2 MHz

661 1880.0 MHz

810 1909.8 MHz

Measurement:

| Measurement parameters | |
|------------------------|--|
| Detector: | Peak |
| Sweep time: | Auto |
| Video bandwidth: | Pre-measurement with 1 MHz On spurious detection re-measurement below 1 GHz with 100 kHz Above 1 GHz with 1 MHz |
| Resolution bandwidth: | Pre-measurement with 1 MHz On spurious detection re-measurement below 1 GHz with 100 kHz Above 1 GHz with 1 MHz |
| Span: | 30 MHz – 25 GHz |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

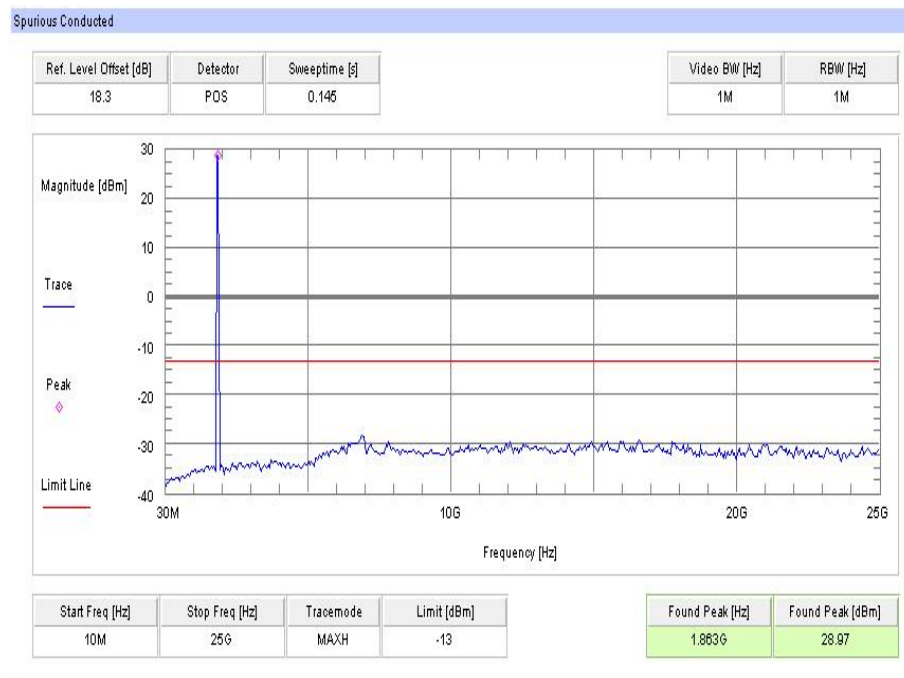
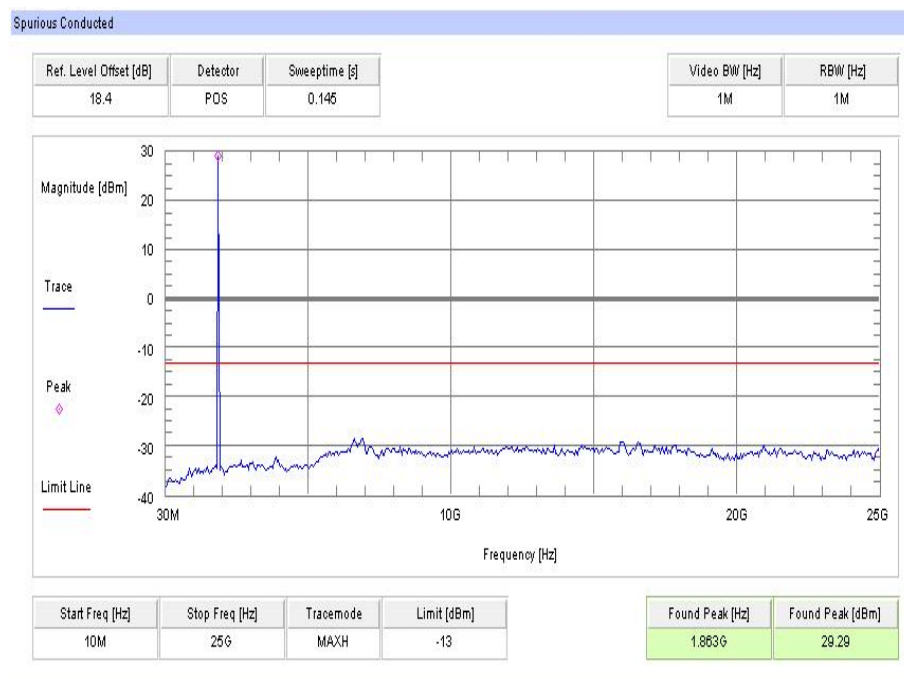
Limits:

| FCC |
|--|
| CFR Part 24.238 CFR Part 2.1051 |
| Spurious Emissions Conducted |
| Attenuation $\geq 43 + 10\log(P)$ (P, Power in Watts) |
| -13 dBm |

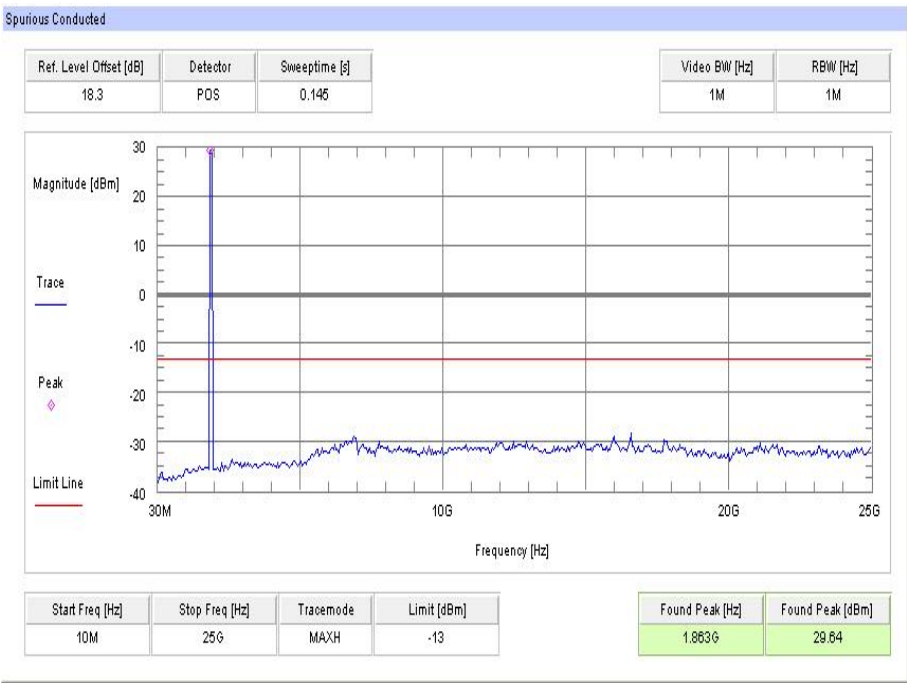
Results:

| Spurious Emission Level (dBm) | | | | | | | | |
|-------------------------------|------------------------|----------------|----------|------------------------|----------------|----------|------------------------|----------------|
| Harmonic | Ch. 512 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 661 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 810 Freq. (MHz) | Level [dBm] |
| 2 | 3700.4 | - | 2 | 3760.0 | - | 2 | 3819.6 | - |
| 3 | 5550.6 | - | 3 | 5640.0 | - | 3 | 5729.4 | - |
| 4 | 7400.8 | - | 4 | 7520.0 | - | 4 | 7639.2 | - |
| 5 | 9251.0 | - | 5 | 9400.0 | - | 5 | 9549.0 | - |
| 6 | 11101.2 | - | 6 | 11280.0 | - | 6 | 11458.8 | - |
| 7 | 12951.4 | - | 7 | 13160.0 | - | 7 | 13368.6 | - |
| 8 | 14801.6 | - | 8 | 15040.0 | - | 8 | 15278.4 | - |
| 9 | 16651.8 | - | 9 | 16920.0 | - | 9 | 17188.2 | - |
| 10 | 18502.0 | - | 10 | 18800.0 | - | 10 | 19098.0 | - |
| Measurement uncertainty | | | | | ± 3dB | | | |

Verdict: [complies](#)

Plots:**Plot 1: Channel 512 (10 MHz - 25 GHz)****Plot 2: Channel 661 (10 MHz - 25 GHz)**

Plot 3: Channel 810 (10 MHz - 25 GHz)



9.2.5 Block edge compliance**Description:**

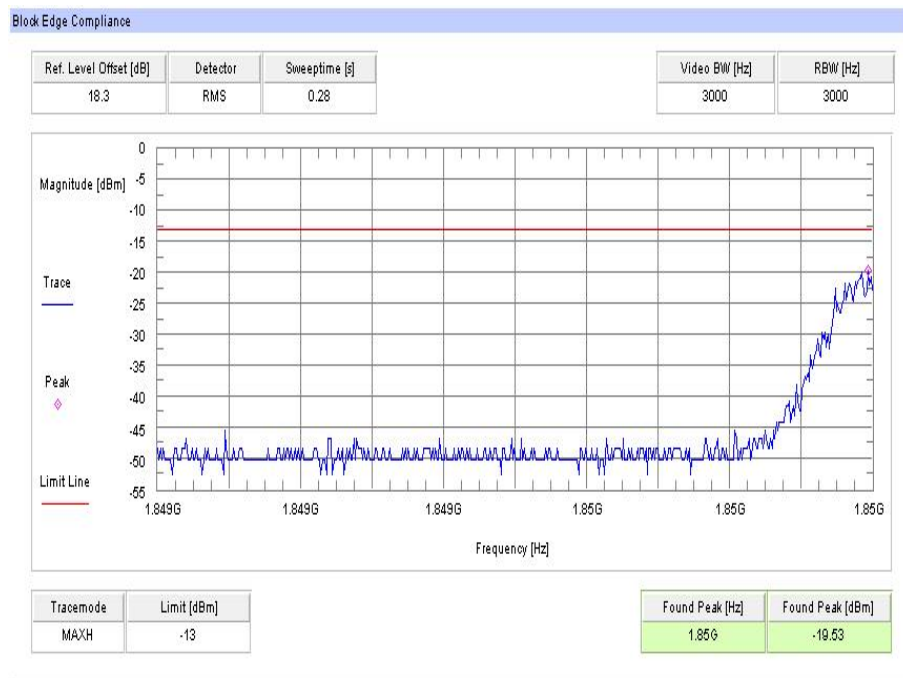
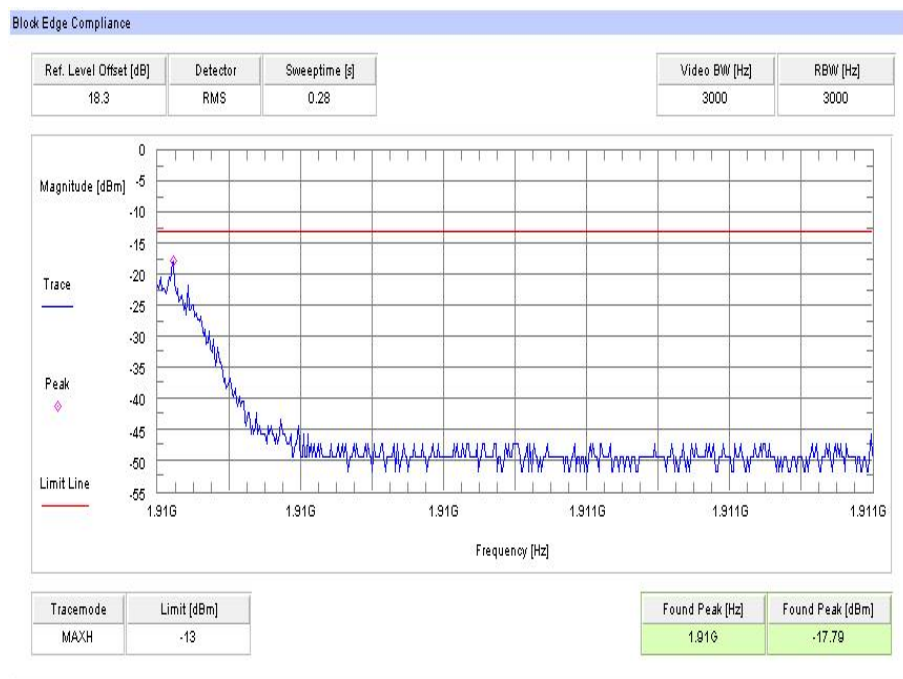
The spectrum at the band edges must comply with the spurious emissions limits.

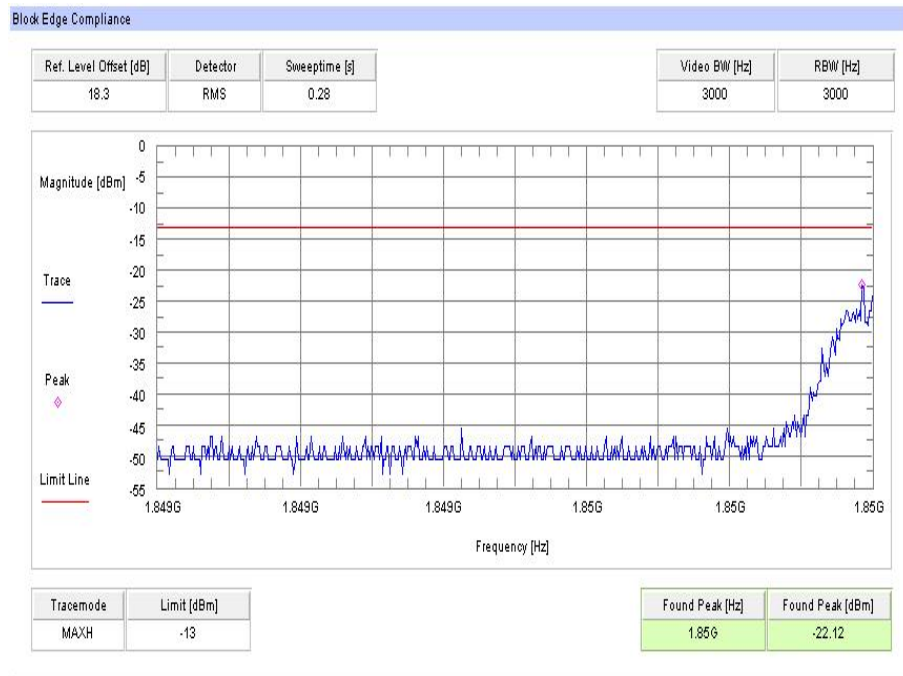
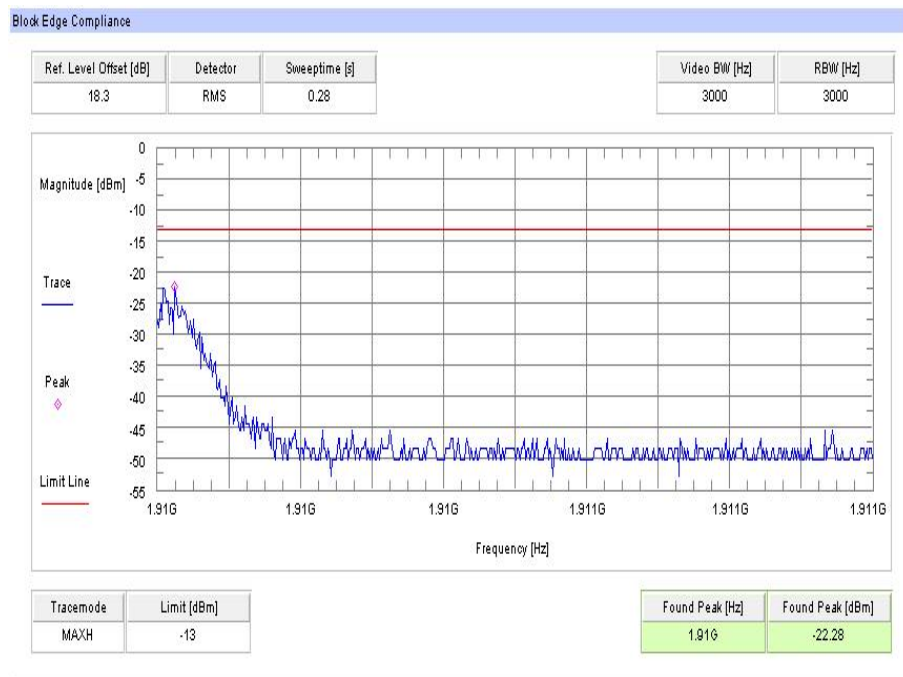
Measurement:

| Measurement parameters | |
|------------------------|-----------------|
| Detector: | RMS |
| Sweep time: | Auto |
| Video bandwidth: | 3 kHz |
| Resolution bandwidth: | 3 kHz |
| Span: | 1 MHz |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

Limits:

| FCC |
|--|
| CFR Part 24.238 CFR Part 2.1051 |
| Block Edge Compliance |
| Attenuation $\geq 43 + 10\log(P)$ (P, Power in Watts) |
| -13 dBm |

Plots:**Plot 1: Channel 512 (GSM-mode)****Plot 2: Channel 810 (GSM-mode)**

Plot 3: Channel 512 (EDGE-mode)**Plot 4: Channel 810 (EDGE-mode)****Verdict:** **complies**

9.2.6 Occupied bandwidth

Description:

Measurement of the occupied bandwidth of the transmitted signal.

Measurement:

Similar to conducted emissions, occupied bandwidth measurements are only provided for selected frequencies in order to reduce the amount of submitted data. Data were taken at the extreme and mid frequencies of the PCS1900 frequency band. The table below lists the measured 99% power and -26dBc occupied bandwidths. Spectrum analyzer plots are included on the following pages.

Part 24.238 requires a measurement bandwidth of at least 1% of the occupied bandwidth. For ca. 300 kHz, this equates to a resolution bandwidth of at least 3.0 kHz. For this testing, a resolution bandwidth 3.0 kHz was used.

| Measurement parameters | |
|------------------------|-----------------|
| Detector: | Peak |
| Sweep time: | Auto |
| Video bandwidth: | 30 kHz |
| Resolution bandwidth: | 10 kHz |
| Span: | 1 MHz |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

Limits:

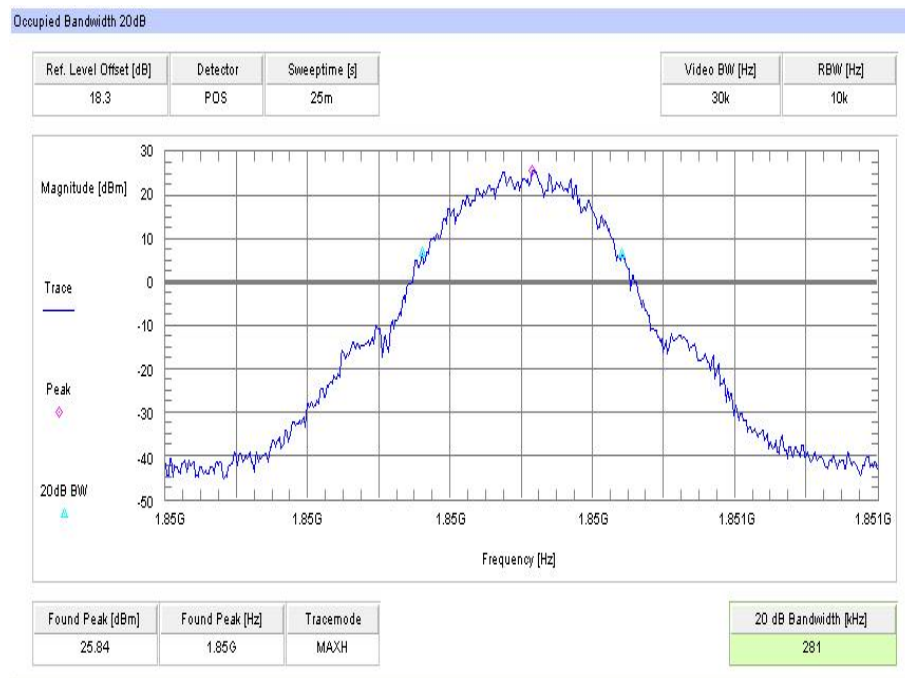
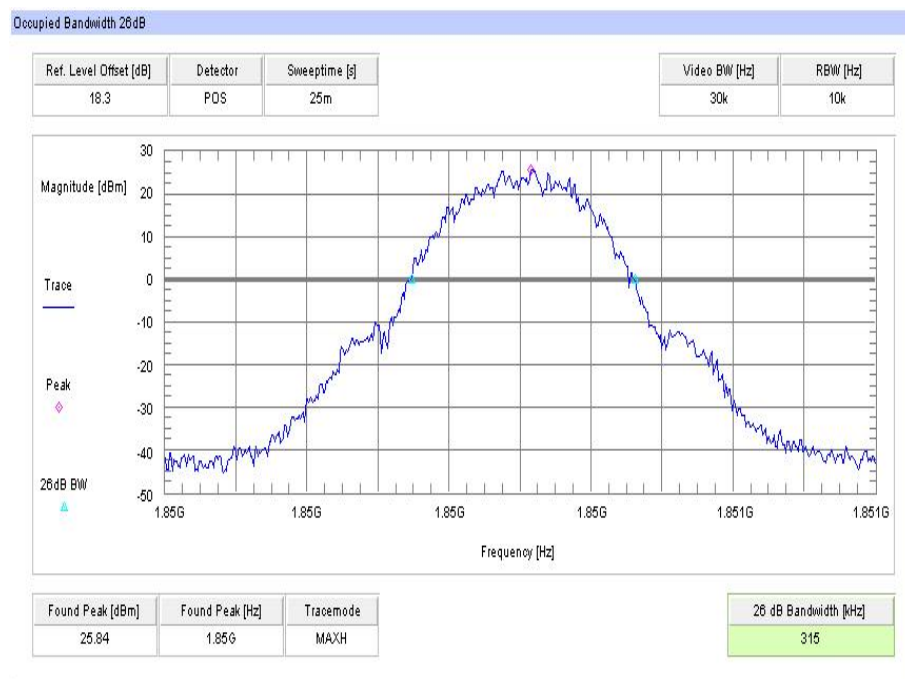
| FCC |
|---|
| CFR Part 24.238 CFR Part 2.1049 |
| Occupied Bandwidth |
| Spectrum must fall completely in the specified band |

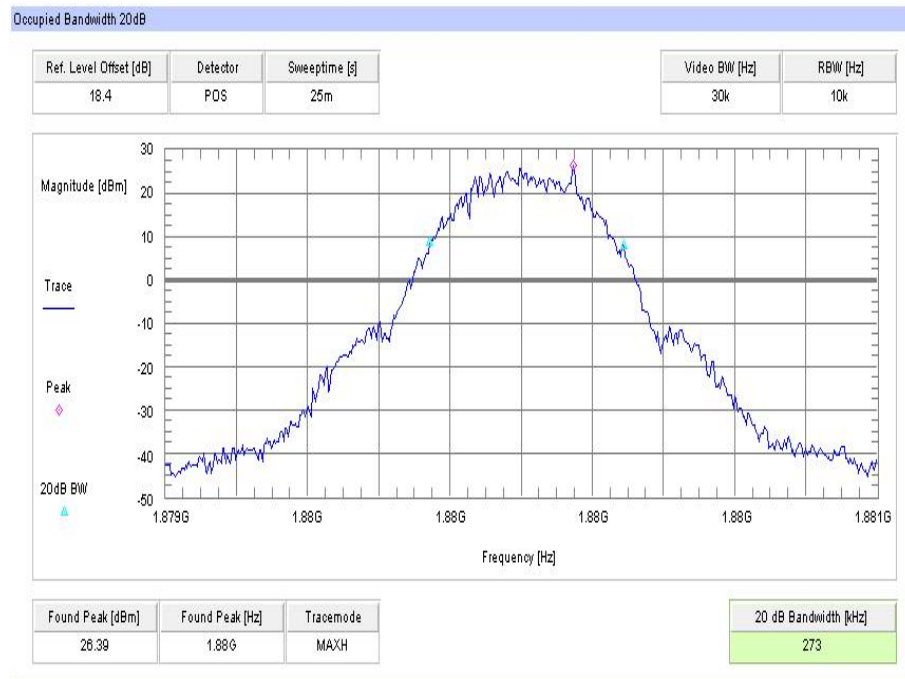
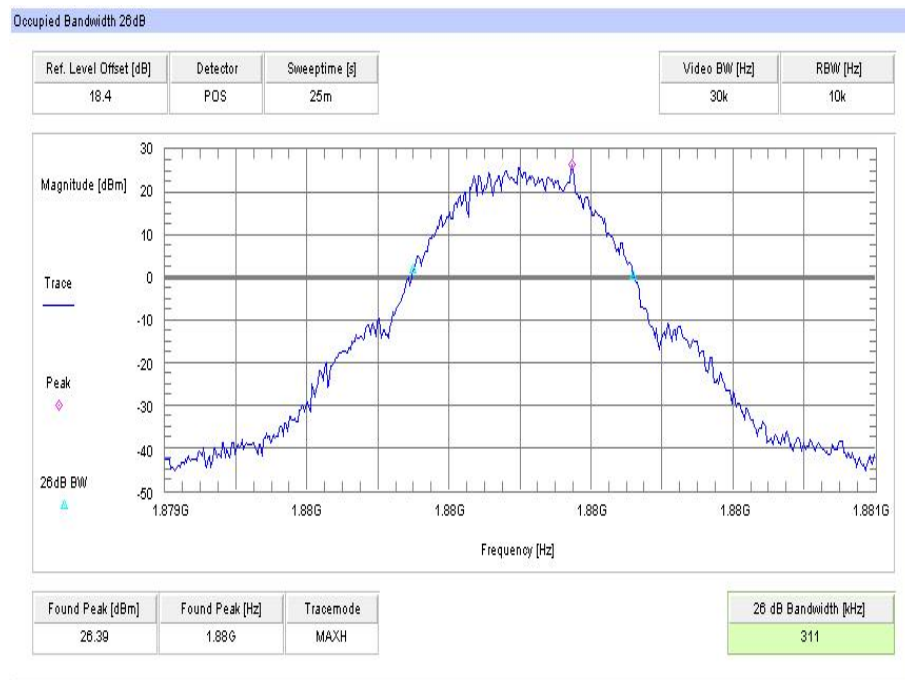
Results:

| Occupied Bandwidth - GMSK mode | | |
|--------------------------------|---------------|------------------|
| Frequency (MHz) | 99% OBW (kHz) | -26 dBc BW (kHz) |
| 1850.2 | 281 | 315 |
| 1880.0 | 273 | 311 |
| 1909.8 | 261 | 315 |
| Measurement uncertainty | ± 3 kHz | |

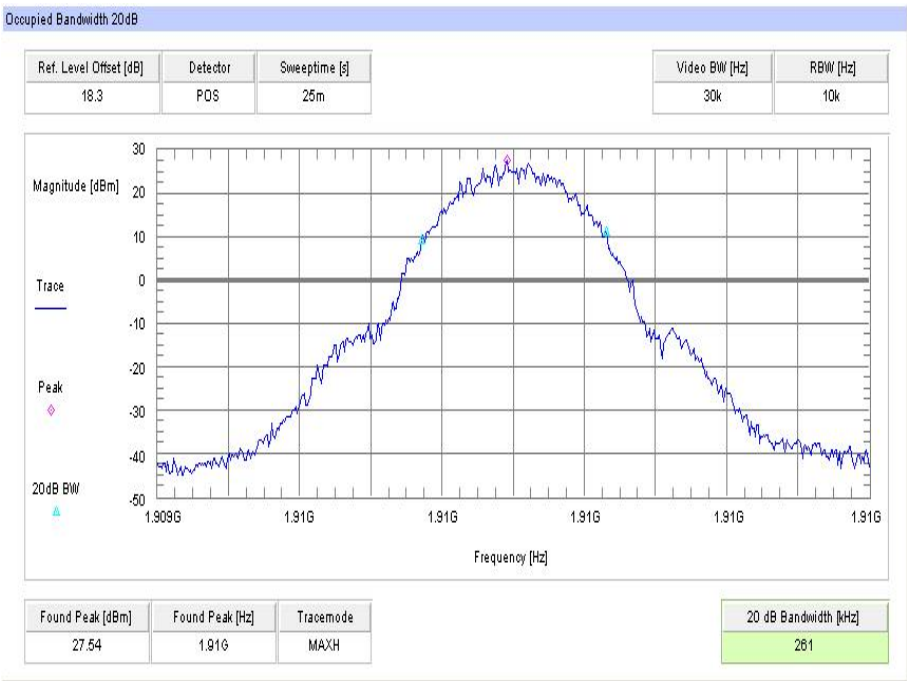
| Occupied Bandwidth - EDGE mode | | |
|--------------------------------|---------------|------------------|
| Frequency (MHz) | 99% OBW (kHz) | -26 dBc BW (kHz) |
| 1850.2 | 275 | 303 |
| 1880.0 | 261 | 299 |
| 1909.8 | 255 | 291 |
| Measurement uncertainty | ± 3 kHz | |

Verdict: [complies](#)

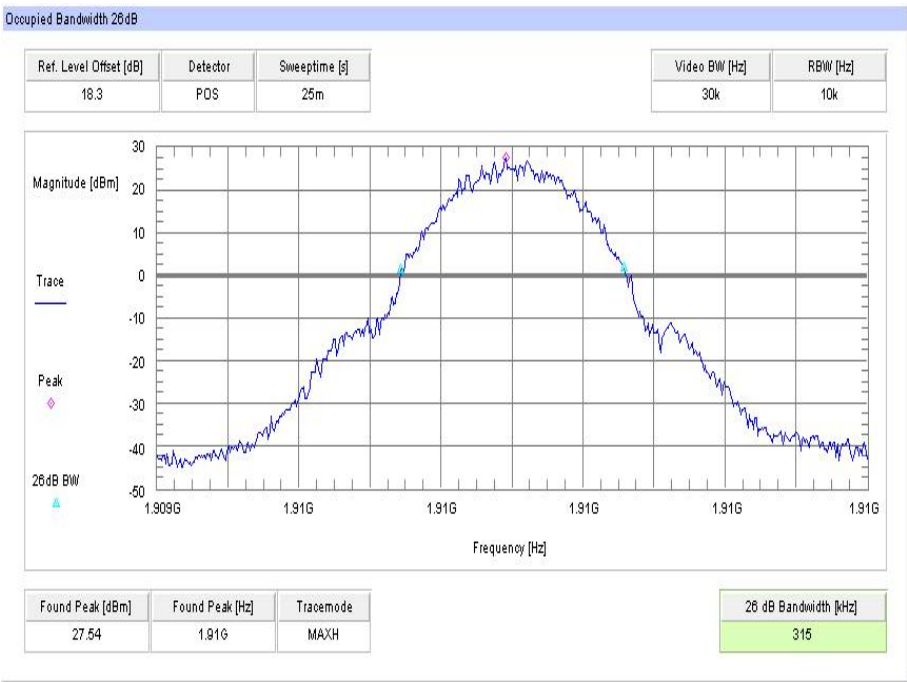
Plots:**Plot 1: Channel 512 (99% - OBW)****Plot 2: Channel 512 (-26 dBc BW)**

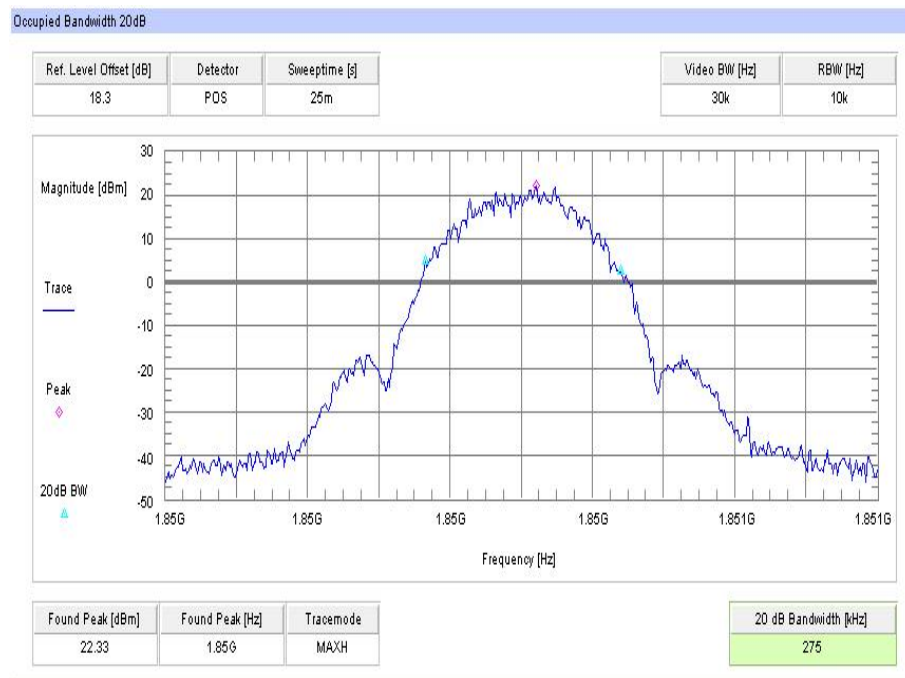
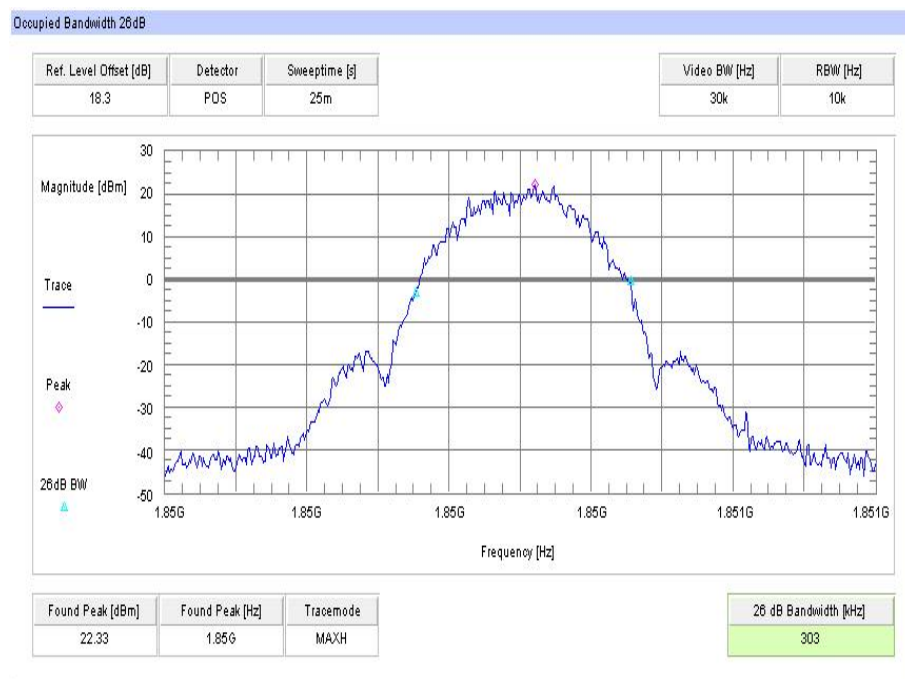
Plot 3: Channel 661 (99% - OBW)**Plot 4: Channel 661 (-26 dBc BW)**

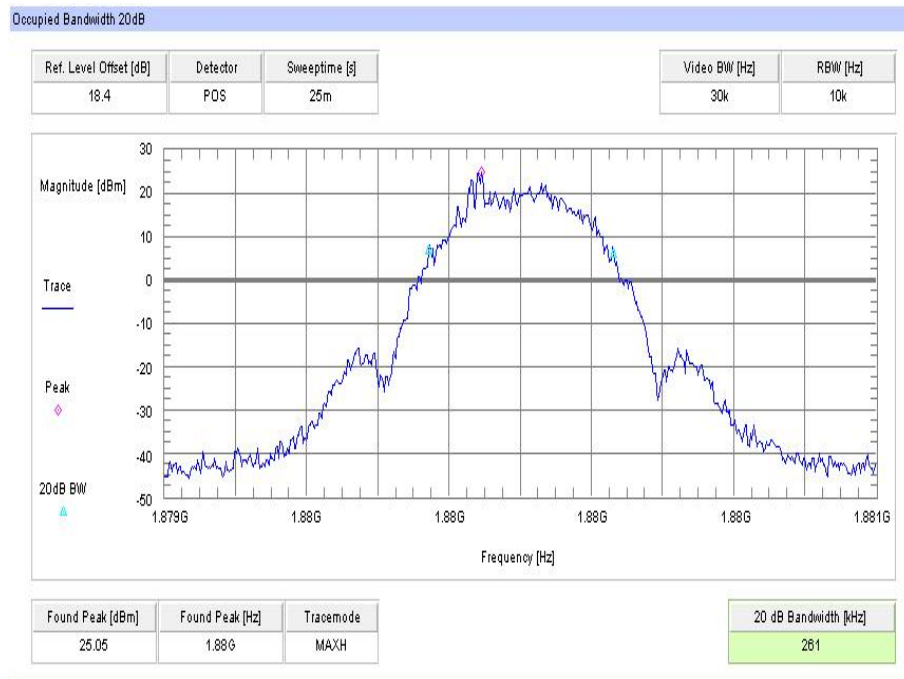
Plot 5: Channel 810 (99% - OBW)

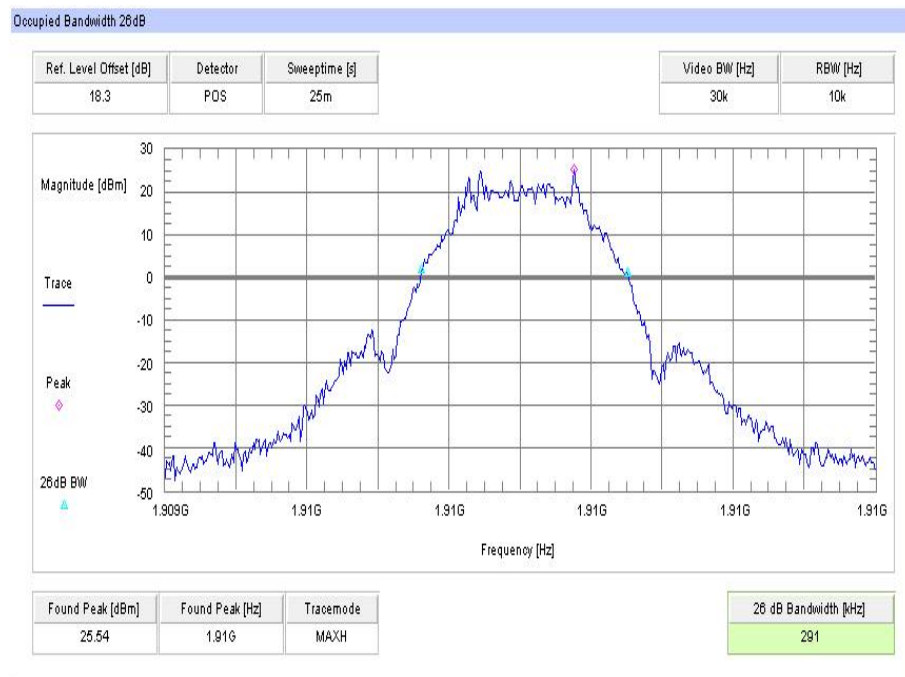


Plot 6: Channel 810 (-26 dBc BW)



Plot 7: Channel 512 (99% - OBW) - EDGE**Plot 8: Channel 512 (-26 dBc BW) - EDGE**

Plot 9: Channel 661 (99% - OBW) - EDGE**Plot 10: Channel 661 (-26 dBc BW) - EDGE**

Plot 11: Channel 810 (99% - OBW) - EDGE**Plot 12: Channel 810 (-26 dBc BW) - EDGE**

9.3 Results UMTS band V

All UMTS-band measurements are done in WCDMA mode only.

The connection was established with the following setup: WCDMA CS-RMC, Max Power (All Bit up)

9.3.1 RF output power

Description:

This paragraph contains average power, peak output power and ERP measurements for the mobile station. In all cases, the peak output power is within the required mask (this mask is specified in the JTC standards, TIA PN3389 Vol. 1 Chap 7, and is no FCC requirement).

Measurement:

The mobile was set up for the maximum output power with pseudo random data modulation.

The peak to average value is calculated by the difference between peak value and avg value.

| Measurement parameters | |
|------------------------|-------------------------------|
| Detector: | Peak and RMS (Power in Burst) |
| Sweep time: | Auto |
| Video bandwidth: | 10 MHz |
| Resolution bandwidth: | 10 MHz |
| Span: | Zero Span |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

Limits:

| FCC |
|---|
| CFR Part 22.913 CFR Part 2.1046 |
| Nominal Peak Output Power |
| +38.45 dBm In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB. |

Results:

| Output Power (conducted) WCDMA mode | | |
|-------------------------------------|----------------------------|----------------------------|
| Frequency (MHz) | Average Output Power (dBm) | Peak to Average Ratio (dB) |
| 826.4 | 22.7 | 3.41 |
| 836.0 | 22.7 | 3.54 |
| 846.6 | 22.8 | 3.48 |
| Measurement uncertainty | ± 0.5 dB | |

| Output Power (radiated) WCDMA mode | |
|------------------------------------|----------------------------------|
| Frequency (MHz) | Average Output Power (dBm) - ERP |
| 826.4 (external antenna) | 19.0 |
| 836.0 (external antenna) | 20.4 |
| 846.6 (external antenna) | 19.5 |
| 846.6 (internal antenna) | 17.0 |
| Measurement uncertainty | ± 2.0 dB |

Verdict: [complies](#)

9.3.2 Frequency stability

Description:

In order to measure the carrier frequency under the condition of AFC lock, it is necessary to make measurements with the mobile station in a "call mode". This is accomplished with the use of a R&S CMU200 DIGITAL RADIOCOMMUNICATION TESTER.

1. Measure the carrier frequency at room temperature.
2. Subject the mobile station to overnight soak at -30 °C.
3. With the mobile station, powered with V_{nom} , connected to the CMU200 and in a simulated call on channel 4180 (centre channel), measure the carrier frequency. These measurements should be made within two minutes of powering up the mobile station, to prevent significant self warming.
4. Repeat the above measurements at 10°C increments from -30°C to +60°C. Allow at least 1.5 hours at each temperature, unpowered, before making measurements.
5. Remeasure carrier frequency at room temperature with V_{nom} . Vary supply voltage from V_{min} to V_{max} . Pause at V_{nom} for 1.5 hours unpowered, to allow any self heating to stabilize, before continuing.
6. At all temperature levels hold the temperature to $\pm 0.5^\circ\text{C}$ during the measurement procedure.

Measurement:

| Measurement parameters | |
|------------------------|----------------------|
| Detector: | Measured with CMU200 |
| Sweep time: | |
| Video bandwidth: | |
| Resolution bandwidth: | |
| Span: | |
| Trace-Mode: | see chapter 8.2 |
| Used test setup: | |

Limits:

| FCC |
|------------------------------------|
| CFR Part 22.355 CFR Part 2.1055 |
| Frequency Stability |
| $\pm 0.1 \text{ ppm}$ |

Results:**AFC FREQ ERROR versus VOLTAGE**

| Voltage (V) | Frequency Error (Hz) | Frequency Error (%) | Frequency Error (ppm) |
|-------------|----------------------|---------------------|-----------------------|
| 4.5 | -6 | -0.00000072 | -0.0072 |
| 4.8 | -4 | -0.00000048 | -0.0048 |
| 8.0 | 7 | 0.00000084 | 0.0084 |
| 14.0 | 3 | 0.00000036 | 0.0036 |
| 18.0 | 1 | 0.00000012 | 0.0012 |

AFC FREQ ERROR versus TEMPERATURE

| Temperature (°C) | Frequency Error (Hz) | Frequency Error (%) | Frequency Error (ppm) |
|------------------|----------------------|---------------------|-----------------------|
| -30 | 1 | 0.00000012 | 0.0012 |
| -20 | -4 | -0.00000048 | -0.0048 |
| -10 | 3 | 0.00000036 | 0.0036 |
| ± 0 | -3 | -0.00000036 | -0.0036 |
| 10 | -3 | -0.00000036 | -0.0036 |
| 20 | 4 | 0.00000048 | 0.0048 |
| 30 | 3 | 0.00000036 | 0.0036 |
| 40 | -2 | -0.00000024 | -0.0024 |
| 50 | -4 | -0.00000048 | -0.0048 |
| 60 | 3 | 0.00000036 | 0.0036 |

Verdict: [complies](#)

9.3.3 Spurious emissions radiated

Description:

The following steps outline the procedure used to measure the radiated emissions from the mobile station. The site is constructed in accordance with ANSI C63.4-2014 requirements and is recognized by the FCC to be in compliance for a 3 and a 10 meter site. The spectrum was scanned from 30 MHz to the 10th harmonic of the highest frequency generated within the equipment, which is the transmitted carrier that can be as high as 846.6 MHz. Measurement made up to 12.75 GHz. The resolution bandwidth is set as outlined in Part 22.917. The spectrum was scanned with the mobile station transmitting at carrier frequencies that pertain to low, mid and high channels of the UMTS band V.

The final open field emission (here 10m semi-anechoic chamber listed by FCC) test procedure is as follows:

- The test item was placed on a 0.8 meter high non-conductive stand at a 3 meter test distance from the receive antenna.
- The antenna output was terminated in a 50 ohm load (if possible).
- A double ridged wave guide antenna was placed on an adjustable height antenna mast 3 meters from the test item for emission measurements.
- Detected emissions were maximized at each frequency by rotating the test item and adjusting the receive antenna height and polarization. The maximum meter reading was recorded. The radiated emission measurements of the harmonics of the transmit frequency through the 10th harmonic were measured with peak detector and 1 MHz bandwidth. If the harmonic could not be detected above the noise floor, the ambient level was recorded. The equivalent power into a dipole antenna was calculated from the field intensity levels measured at 3 meters.
- Now each detected emissions were substituted by the substitution method, in accordance with the TIA/EIA 603.

Measurement:

| Measurement parameters | |
|------------------------|--|
| Detector: | Peak |
| Sweep time: | 2 sec. |
| Video bandwidth: | Below 1 GHz: 100 kHz Above 1 GHz: 1 MHz |
| Resolution bandwidth: | Below 1 GHz: 100 kHz Above 1 GHz: 1 MHz |
| Span: | 100 MHz Steps |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.1 |

Limits:

| FCC |
|--|
| CFR Part 22.917 CFR Part 2.1053 |
| Spurious Emissions Radiated |
| Attenuation $\geq 43 + 10\log(P)$ (P, Power in Watts) |
| -13 dBm |

Results:

Radiated emissions measurements were made only at the upper, center, and lower carrier frequencies of the UMTS band V (826.4 MHz, 836.0 MHz and 846.6 MHz). It was decided that measurements at these three carrier frequencies would be sufficient to demonstrate compliance with emissions limits because it was seen that all the significant spurs occur well outside the band and no radiation was seen from a carrier in one block of the UMTS band V into any of the other blocks. The equipment must still, however, meet emissions requirements with the carrier at all frequencies over which it is capable of operating and it is the manufacturer's responsibility to verify this.

The final open field radiated levels are presented on the next pages.

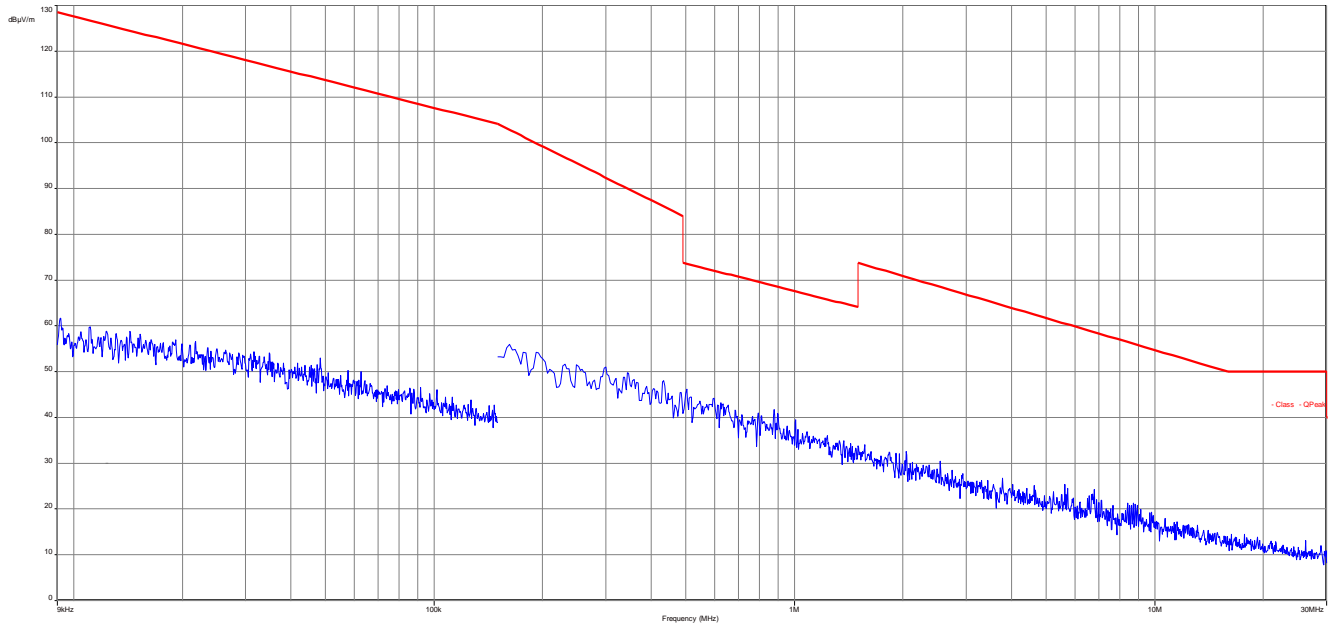
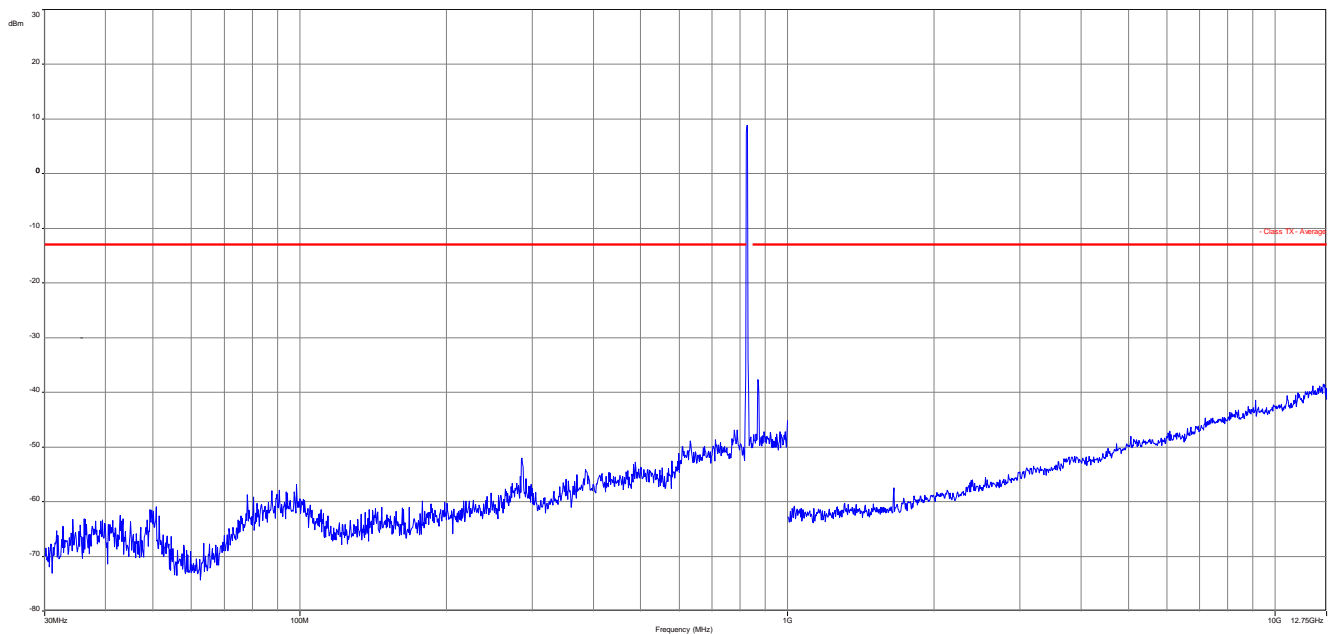
All measurements were done in horizontal and vertical polarization; the plots show the worst case.

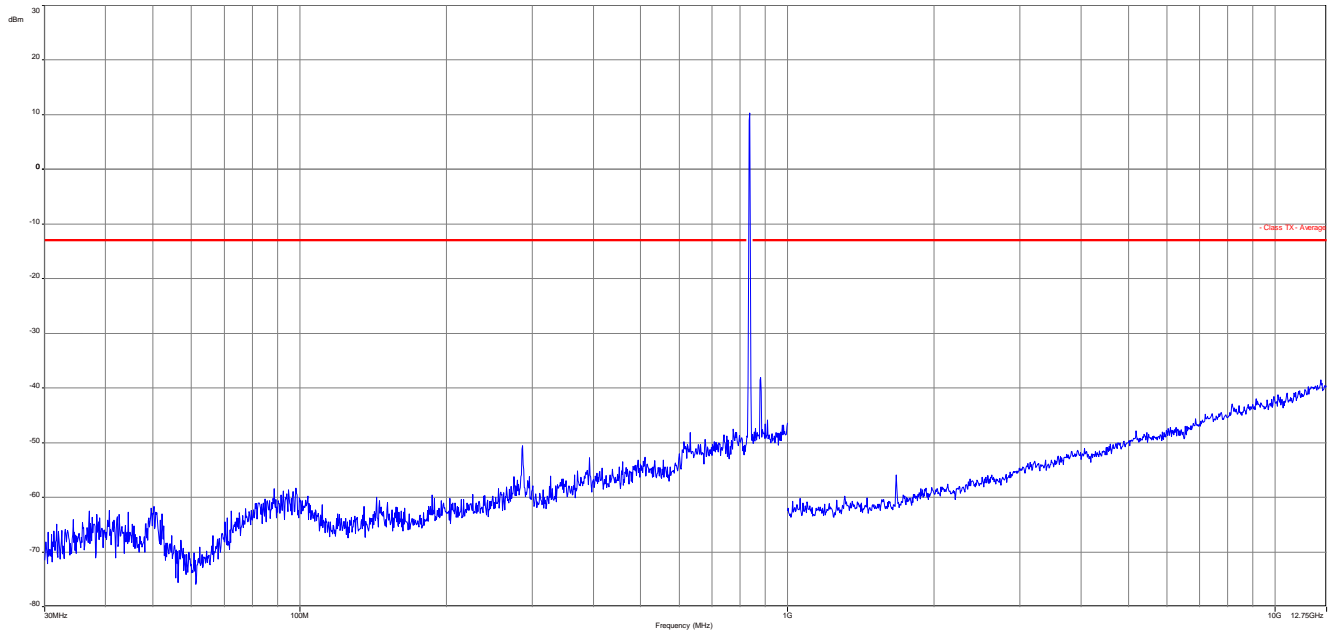
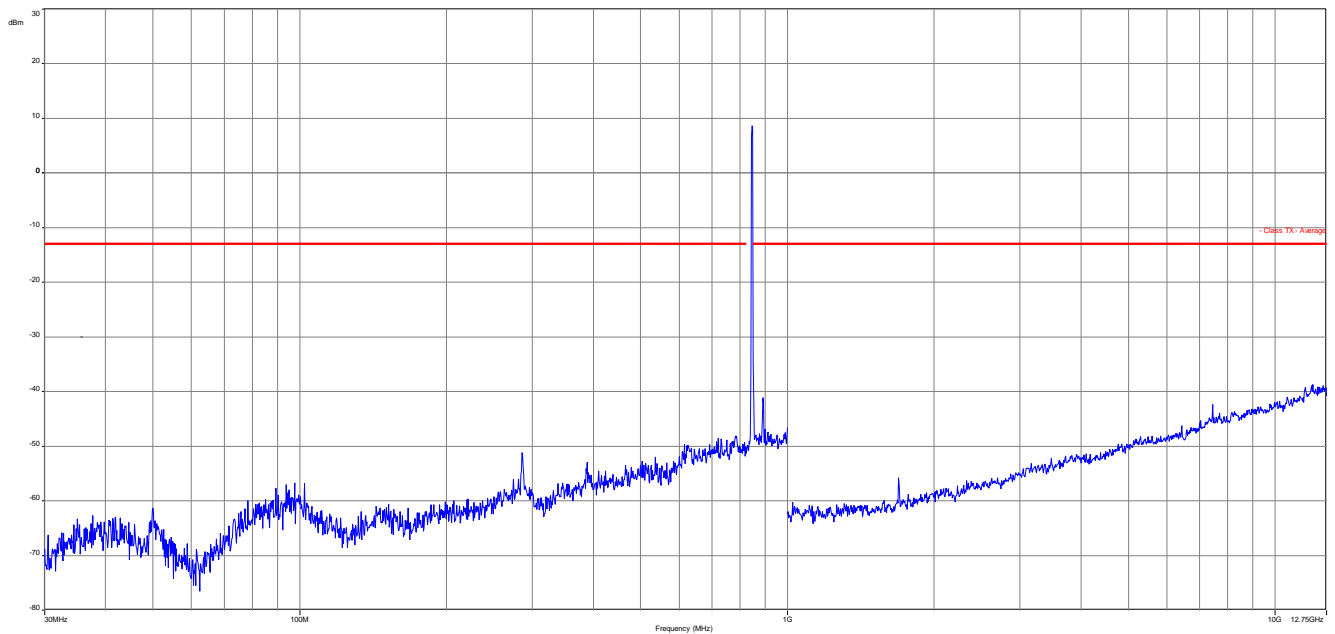
The plots show only the middle channel. If spurious were detected, the lowest and highest channel were checked too. The found values are stated in the table below.

As can be seen from this data, the emissions from the test item were within the specification limit.

| Spurious Emission Level (dBm) | | | | | | | | |
|-------------------------------|-------------------------|----------------|----------|-------------------------|----------------|----------|-------------------------|----------------|
| Harmonic | Ch. 4132 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 4180 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 4233 Freq. (MHz) | Level [dBm] |
| 2 | 1652.8 | - | 2 | 1672.0 | - | 2 | 1693.2 | - |
| 3 | 2479.2 | - | 3 | 2508.0 | - | 3 | 2539.8 | - |
| 4 | 3305.6 | - | 4 | 3344.0 | - | 4 | 3386.4 | - |
| 5 | 4132.0 | - | 5 | 4180.0 | - | 5 | 4233.0 | - |
| 6 | 4958.4 | - | 6 | 5016.0 | - | 6 | 5079.6 | - |
| 7 | 5784.8 | - | 7 | 5852.0 | - | 7 | 5926.2 | - |
| 8 | 6611.2 | - | 8 | 6688.0 | - | 8 | 6772.8 | - |
| 9 | 7437.6 | - | 9 | 7524.0 | - | 9 | 7619.4 | - |
| 10 | 8264.0 | - | 10 | 8360.0 | - | 10 | 8466.0 | - |
| Measurement uncertainty | | | | | ± 3dB | | | |

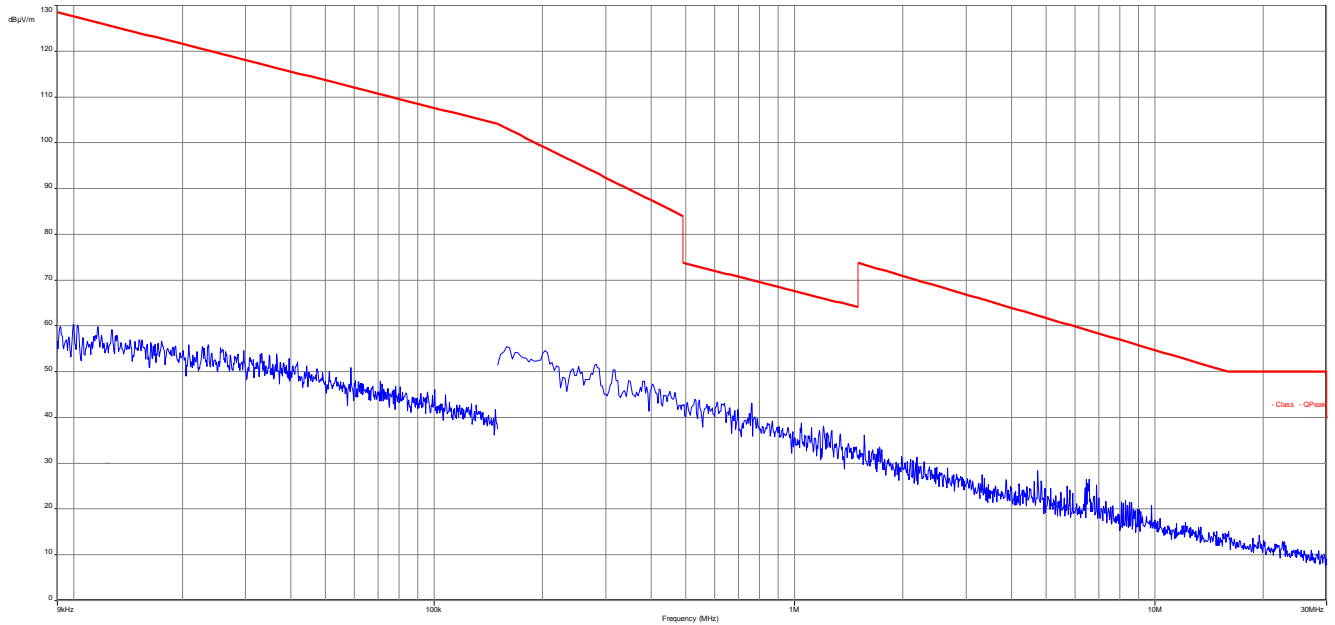
Verdict: **complies**

Plots: (external antenna)**Plot 1:** Channel 4180 (Traffic mode up to 30 MHz)**Plot 2:** Channel 4132 (30 MHz – 12.75 GHz)

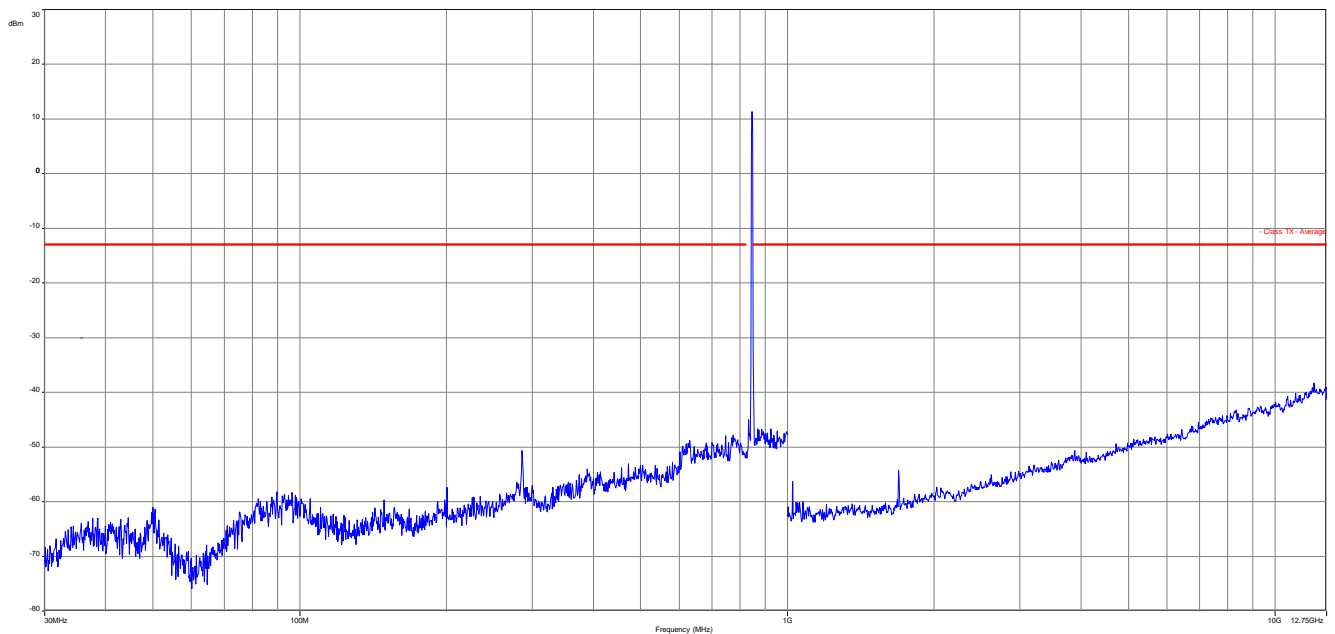
Plot 3: Channel 4180 (30 MHz – 12.75 GHz)**Plot 4:** Channel 4233 (30 MHz – 12.75 GHz)

Plots: (internal antenna)

Plot 1: Channel 4233 (Traffic mode up to 30 MHz)



Plot 2: Channel 4233 (30 MHz – 12.75 GHz)



9.3.4 Spurious emissions conducted

Description:

The following steps outline the procedure used to measure the conducted emissions from the mobile station.

1. Determine frequency range for measurements: From CFR 2.1057 the spectrum should be investigated from the lowest radio frequency generated in the equipment up to at least the 10th harmonic of the carrier frequency. For the mobile station equipment tested, this equates to a frequency range of 13 MHz to 9 GHz, data taken from 10 MHz to 12 GHz.
2. Determine mobile station transmits frequencies: below outlines the band edge frequencies pertinent to conducted emissions testing.

UMTS band V Transmitter Channel Frequency

4132 826.4 MHz

4180 836.0 MHz

4233 846.6 MHz

Measurement:

| Measurement parameters | |
|------------------------|--|
| Detector: | Peak |
| Sweep time: | Auto |
| Video bandwidth: | Pre-measurement with 1 MHz On spurious detection re-measurement below 1 GHz with 100 kHz Above 1 GHz with 1 MHz |
| Resolution bandwidth: | Pre-measurement with 1 MHz On spurious detection re-measurement below 1 GHz with 100 kHz Above 1 GHz with 1 MHz |
| Span: | 30 MHz – 25 GHz |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

Limits:

| FCC |
|--|
| CFR Part 22.917 CFR Part 2.1051 |
| Spurious Emissions Conducted |
| Attenuation $\geq 43 + 10\log(P)$ (P, Power in Watts) |
| -13 dBm |

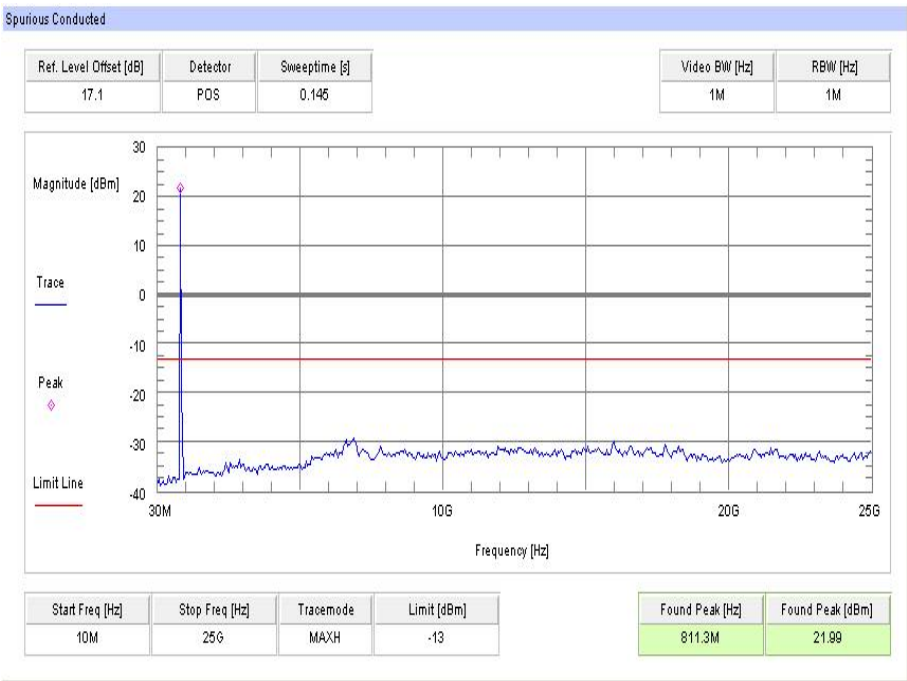
Results:

| Spurious Emission Level (dBm) | | | | | | | | |
|-------------------------------|-------------------------|----------------|----------|-------------------------|----------------|----------|-------------------------|----------------|
| Harmonic | Ch. 4132 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 4180 Freq. (MHz) | Level [dBm] | Harmonic | Ch. 4233 Freq. (MHz) | Level [dBm] |
| 2 | 1652.8 | - | 2 | 1672.0 | - | 2 | 1693.2 | - |
| 3 | 2479.2 | - | 3 | 2508.0 | - | 3 | 2539.8 | - |
| 4 | 3305.6 | - | 4 | 3344.0 | - | 4 | 3386.4 | - |
| 5 | 4132.0 | - | 5 | 4180.0 | - | 5 | 4233.0 | - |
| 6 | 4958.4 | - | 6 | 5016.0 | - | 6 | 5079.6 | - |
| 7 | 5784.8 | - | 7 | 5852.0 | - | 7 | 5926.2 | - |
| 8 | 6611.2 | - | 8 | 6688.0 | - | 8 | 6772.8 | - |
| 9 | 7437.6 | - | 9 | 7524.0 | - | 9 | 7619.4 | - |
| 10 | 8264.0 | - | 10 | 8360.0 | - | 10 | 8466.0 | - |
| Measurement uncertainty | | | | | ± 3dB | | | |

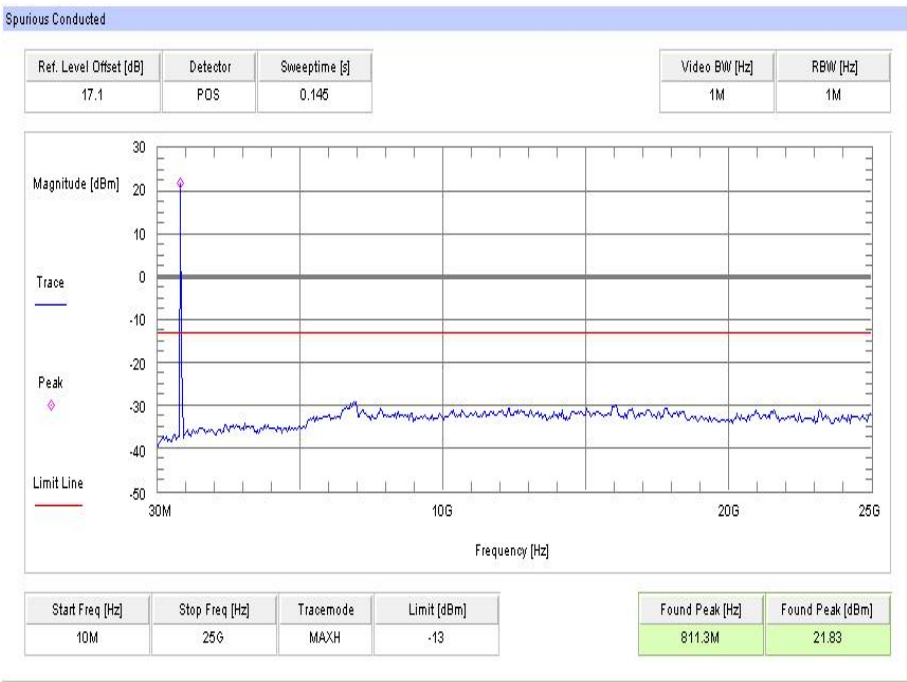
Verdict: [complies](#)

Plots:

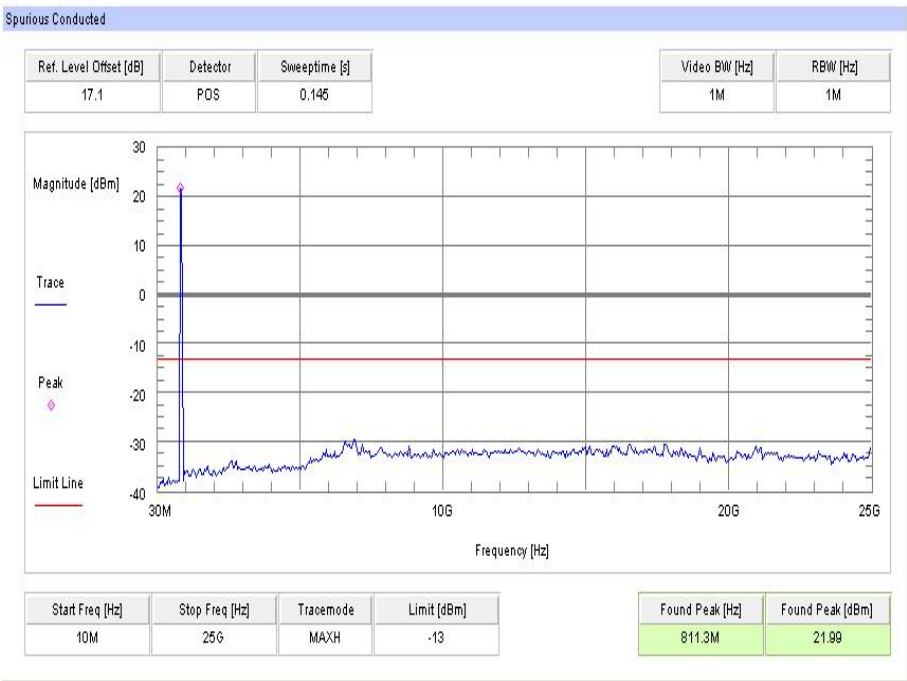
Plot 1: Channel 4132 (10 MHz - 25 GHz)



Plot 2: Channel 4180 (10 MHz - 25 GHz)



Plot 3: Channel 4233 (10 MHz - 25 GHz)



9.3.5 Block edge compliance

Description:

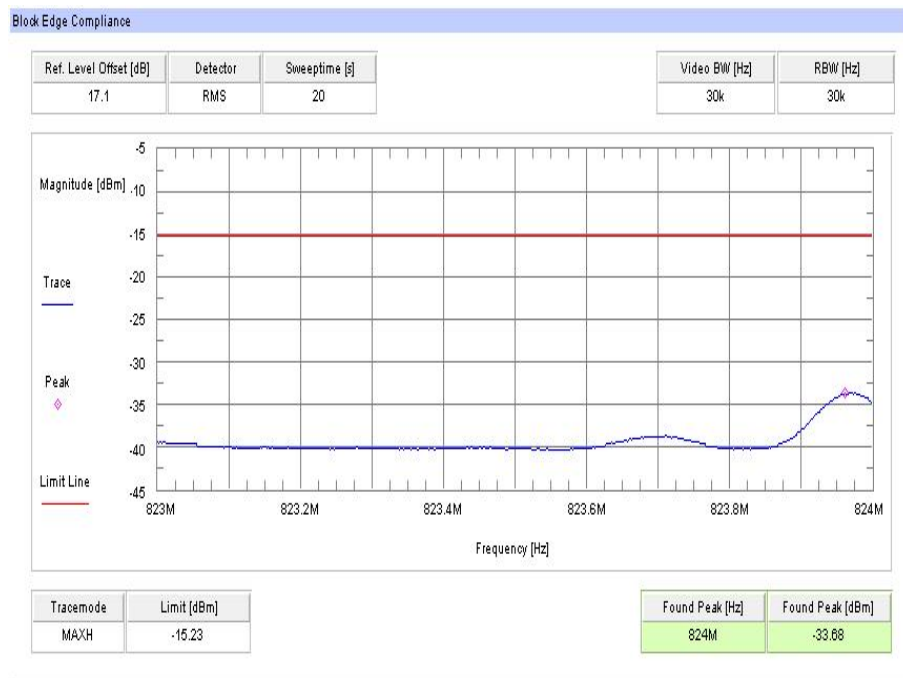
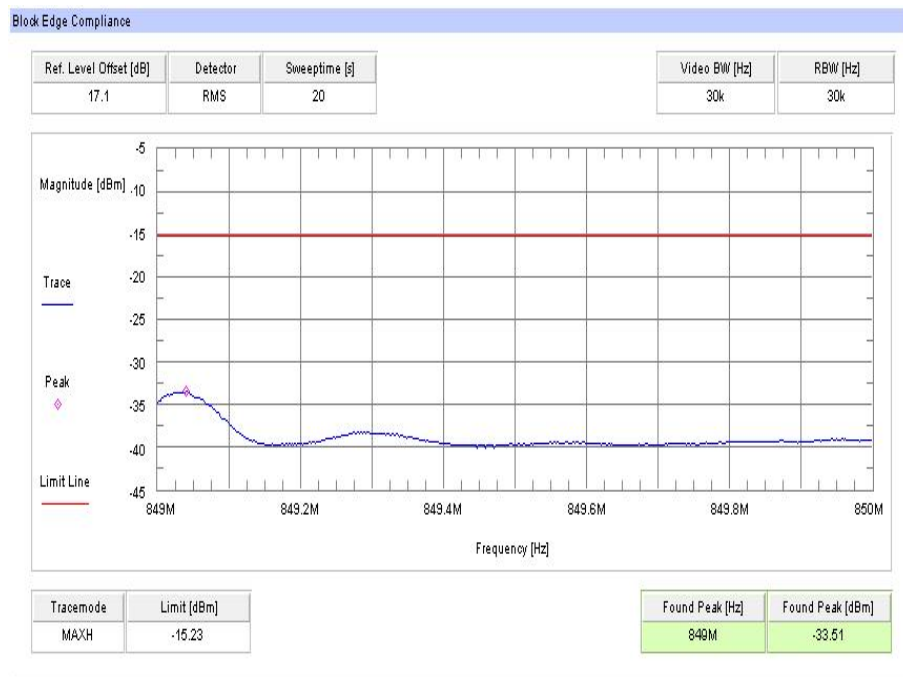
The spectrum at the band edges must comply with the spurious emissions limits.

Measurement:

| Measurement parameters | |
|------------------------|-----------------|
| Detector: | RMS |
| Sweep time: | 20 sec. |
| Video bandwidth: | 30 kHz |
| Resolution bandwidth: | 30 kHz |
| Span: | 1 MHz |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

Limits:

| FCC |
|---|
| CFR Part 22.917 CFR Part 2.1051 |
| Block Edge Compliance |
| <p>Part 22.917 specifies that "the power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB."</p> <p>However, in publication number 890810, The FCC Office of Engineering and Technology specified the following correction to the limits when a resolution bandwidth smaller than 1% of the emission bandwidth is used:</p> <p>"An alternative is to add an additional correction factor of $10 \log(RBW1/RBW2)$ to the $43 + 10 \log(P)$ limit. RBW1 is the narrower measurement resolution bandwidth and RBW2 is either the 1% emissions bandwidth or 1 MHz."</p> <p>When using a 30 kHz bandwidth, this yields a -2.2185 adjustment to the limit [$10 \log(30\text{kHz}/50\text{kHz}) = -2.2185$]. When this adjustment is applied to the limit, the limit becomes -15.2185.</p> |
| -15.22 dBm |

Plots:**Plot 1: Channel 4132****Plot 2: Channel 4233****Verdict:** **complies**

9.3.6 Occupied bandwidth

Description:

Measurement of the occupied bandwidth of the transmitted signal.

Measurement:

Similar to conducted emissions, occupied bandwidth measurements are only provided for selected frequencies in order to reduce the amount of submitted data. Data were taken at the extreme and mid frequencies of the UMTS band V. The table below lists the measured 99% power and -26dBc occupied bandwidths. Spectrum analyzer plots are included on the following pages.

Part 22.917 requires a measurement bandwidth of at least 1% of the occupied bandwidth. For ca. 4700 kHz, this equates to a resolution bandwidth of at least 50 kHz. For this testing, a resolution bandwidth 100 kHz was used.

| Measurement parameters | |
|------------------------|-----------------|
| Detector: | Peak |
| Sweep time: | Auto |
| Video bandwidth: | 300 kHz |
| Resolution bandwidth: | 100 kHz |
| Span: | 6 MHz |
| Trace-Mode: | Max Hold |
| Used test setup: | see chapter 8.2 |

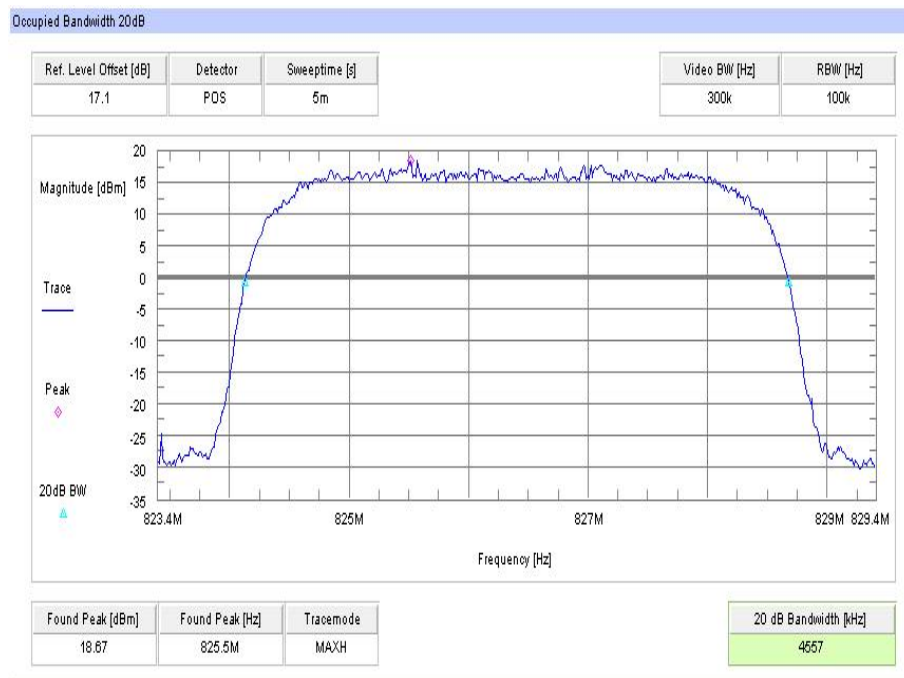
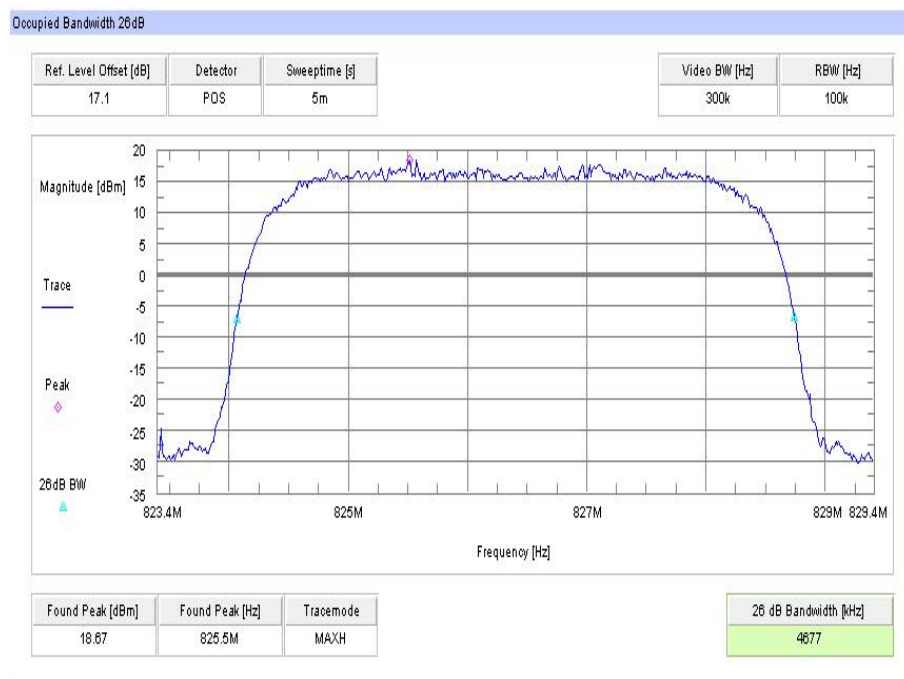
Limits:

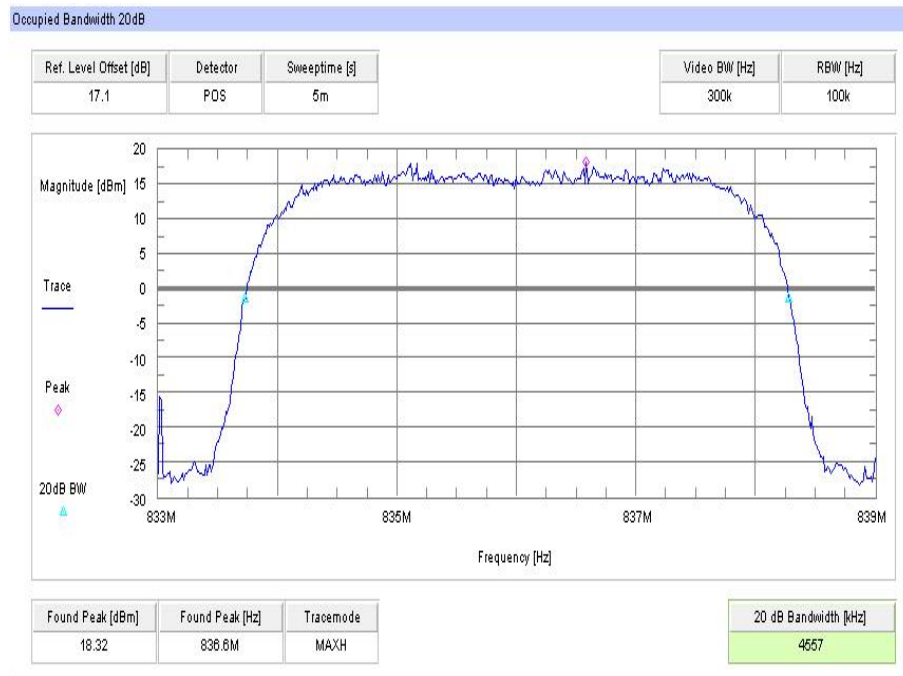
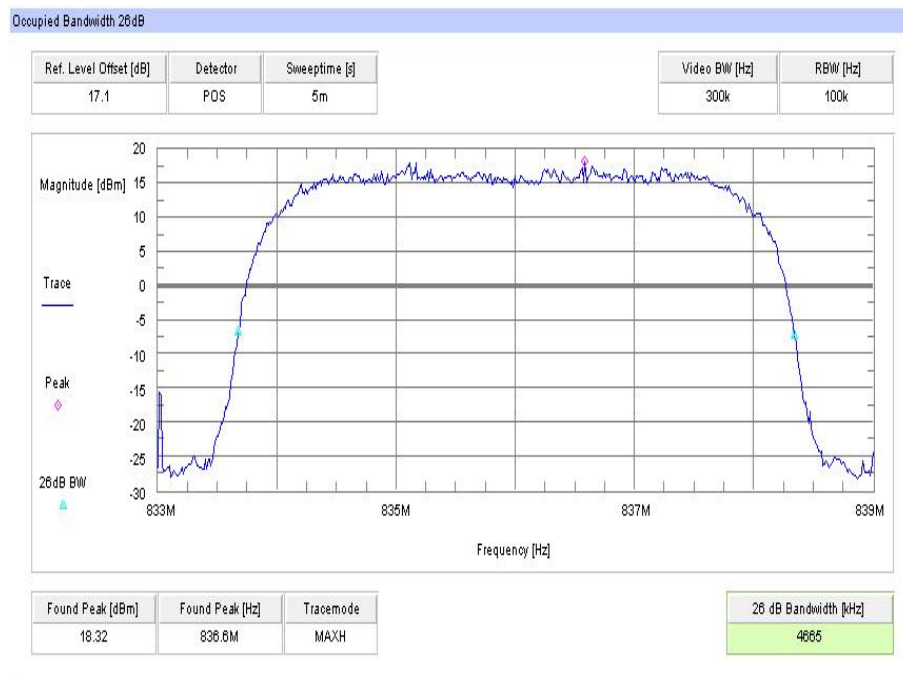
| FCC |
|---|
| CFR Part 22.917 CFR Part 2.1049 |
| Occupied Bandwidth |
| Spectrum must fall completely in the specified band |

Results:

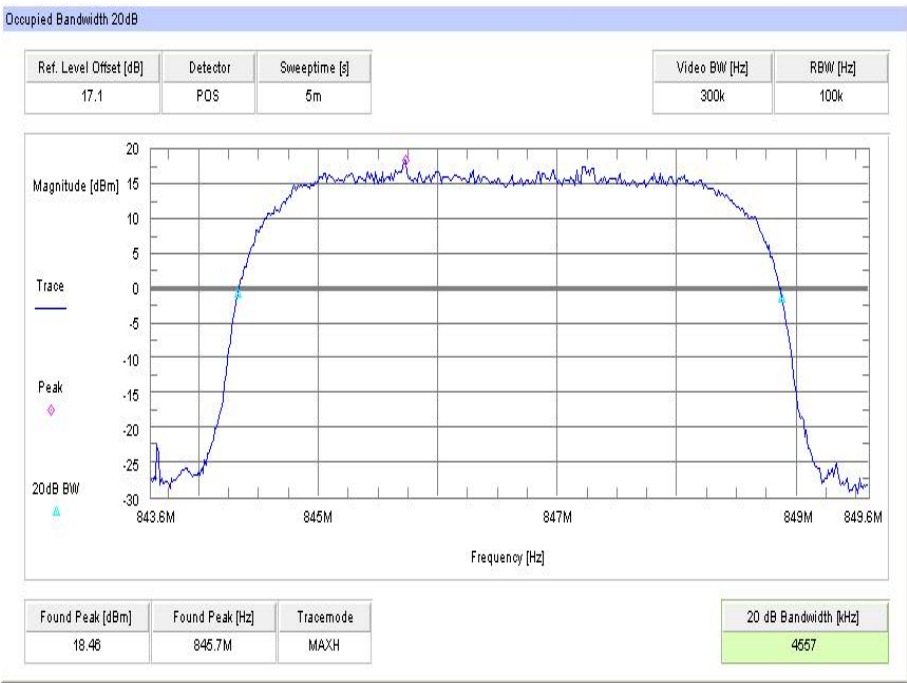
| Occupied Bandwidth | | |
|-------------------------|---------------|------------------|
| Frequency (MHz) | 99% OBW (kHz) | -26 dBc BW (kHz) |
| 826.4 | 4557 | 4677 |
| 836.0 | 4557 | 4665 |
| 846.6 | 4557 | 4665 |
| Measurement uncertainty | ± 100 kHz | |

Verdict: [complies](#)

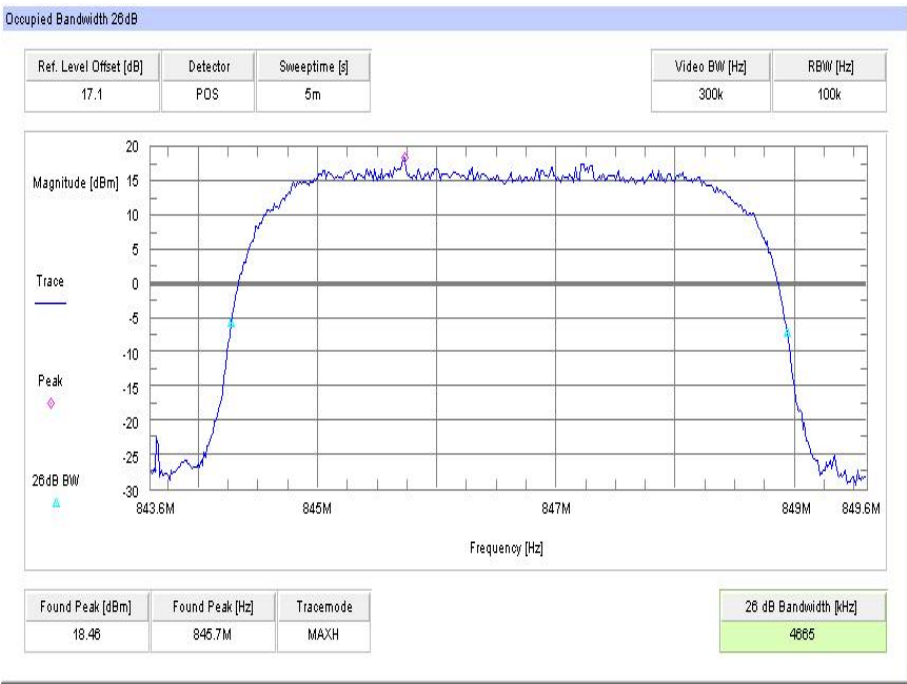
Plots:**Plot 1: Channel 4132 (99% - OBW)****Plot 2: Channel 4132 (-26 dBc BW)**

Plot 3: Channel 4180 (99% - OBW)**Plot 4: Channel 4180 (-26 dBc BW)**

Plot 5: Channel 4233 (99% - OBW)



Plot 6: Channel 4233 (-26 dBc BW)



10 Observations

No observations except those reported with the single test cases have been made.

Annex A Document history

| Version | Applied changes | Date of release |
|---------|---|-----------------|
| | Initial release | 2015-04-22 |
| A | Editorial changes – references to IC removed Measurement results for frequency stability 4.5 V added | 2015-07-22 |

Annex B Further information**Glossary**

| | | |
|----------|---|--|
| AVG | - | Average |
| DUT | - | Device under test |
| EMC | - | Electromagnetic Compatibility |
| EN | - | European Standard |
| EUT | - | Equipment under test |
| ETSI | - | European Telecommunications Standard Institute |
| FCC | - | Federal Communication Commission |
| FCC ID | - | Company Identifier at FCC |
| HW | - | Hardware |
| IC | - | Industry Canada |
| Inv. No. | - | Inventory number |
| N/A | - | Not applicable |
| PP | - | Positive peak |
| QP | - | Quasi peak |
| S/N | - | Serial number |
| SW | - | Software |

Annex C Accreditation Certificate

Front side of certificate

Back side of certificate



Deutsche Akkreditierungsstelle GmbH

Bellehene gemäß § 8 Absatz 1 AkkStelleG i.V.m. § 1 Absatz 1 AkkStelleGBV
Unterzeichnerin der Multilateralen Abkommen
von EA, ILAC und IAF zur gegenseitigen Anerkennung

Akkreditierung



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CETECOM ICT Services GmbH
Untertürkheimer Straße 6-10, 66117 Saarbrücken

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VoIP und DECT
Akustik
Funk einschließlich WLAN
Short Range Devices (SRD)
RFID
WiMax und Richtfunk
Mobilfunk (GSM / DCs, Over the Air (OTA) Performance)
Elektromagnetische Verträglichkeit (EMV) einschließlich Automotive
Produktsicherheit
SAR und Hearing Aid Compatibility (HAC)
Umweltsimulation
Smart Card Terminals
Bluetooth
Wi-Fi Services

Die Akkreditierungsurkunde gilt nur in Verbindung mit dem Beschluss vom 07.02.2014 mit der Akkreditierungsnummer D-PL-12076-01 und ist gültig 17.01.2018. Sie besteht aus diesem Deckblatt, der Rückseite des Deckblatts und der folgenden Anlage mit insgesamt 77 Seiten.

Registrierungsnummer der Urkunde: D-PL-12076-01-00

Frankfurt am Main, 07.02.2014

Date of issue of the certificate

Dr. Ingrid Dill-Weber, Stellvertreterin
Mitglied des Präsidiums

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The current certificate including annex is published on our website (see link below) or may be received from CETECOM ICT Services on request.

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