# Nemko TEST REPORT

| Number:<br>No. 1 / 1 | **1032312** | Date of handing in: | 11.06.2004 |
| | | Tested by: | |

_Timo Hietala, Test Engineer_

Reviewed by:

_Jyrki Leino, Market Access Manager_

SORT OF EQUIPMENT: **Triple band (900/1800/1900) E-GPRS GSM mobile phone**

MARKETING NAME:

TYPE: **RM-17**

MANUFACTURER: **Nokia Corporation**

CLIENT: **Nokia Germany**

ADDRESS: **Lise Meitner Strasse 10, 89081 ULM Germany**

TELEPHONE: **+49 1735 459 941, Jukka Pekkala**

TEST LABORATORY: **Nemko Oy**

FCC REG. NO. **91087    August 27, 2001**

IC FILE NO. **IC 4627    July 2, 2003**

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SUMMARY:

In regard to the performed tests the equipment under test fulfils the requirements defined in the test specifications, see page 2 for details

Version f1.00

## Summary of performed tests and test results

| Section in CFR 47 | Section in RSS-133 | | Result |
|---|---|---|---|
| 24.232, (b) | 6.2 | Radiated RF output | **PASS** |
| 2.1049, (h) | 5.6 | 99% occupied bandwidth | **X** |
| 24.238 (a) | 6.3 | Band-edge compliance | **PASS** |
| 24.238 (a), 2.1053 | 6.3 | Spurious radiated emissions | **PASS** |
| 24.235, 2.1055 (a)(1)(b) | 7 | Frequency stability, temperature variation | **PASS** |
| 24.235, 2.1055 (d)(1)(2) | 7 | Frequency stability, voltage variation | **PASS** |

Explanations:

PASS     The EUT passed that particular test.
FAIL     The EUT failed that particular test.
X          The measurement was done, but there is no applicable performance criteria.

# Contents

# 1. EUT and Accessory Information

## 1.1 EUT description

The EUT is a Triple band (900/1800/1900) E-GPRS GSM mobile phone.

## 1.2 EUT and accessories

|  | unit | type | S/N |
|---|---|---|---|
| EUT1 | **Mobile phone** | **RM-17** | **004400/41/165223/1**<br>**HW:5701,  SW: 3.06.1** |
| EUT2 | **Mobile phone** | **RM-17** | **004400/41/165103/5**<br>**HW:5701,  SW: 3.06.1** |
| EUT3 | **Mobile phone** | **RM-17** | **004400/41/165239/7**<br>**HW:5701,  SW: 3.06.1** |
| Accessories | **Battery, EUT 1**<br>**Battery, EUT 2**<br>**Battery, EUT 3**<br>**Dummy Battery**<br>**Antenna adapter** | **BL-5B**<br>**BL-5B**<br>**BL-5B**<br>**SF-17D**<br>**Special fixed, EUT2** | **L103C20101746**<br>**L103C20101731**<br>**L103C20101811** |

## 2.    Standards and measurement methods

The test were performed in guidance of the CFR 47 part 24, part 2, ANSI/TIA/EIA-603-A and RSS-133
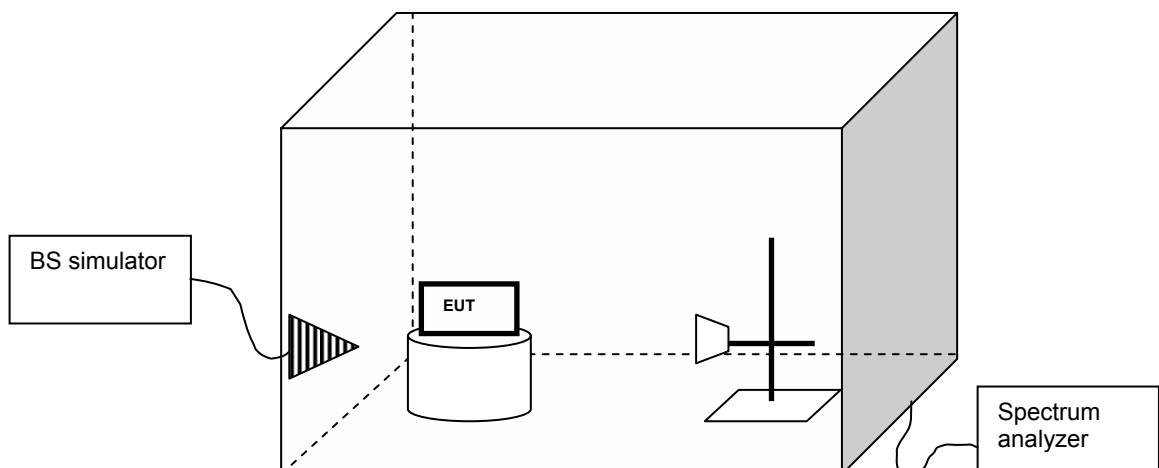
## 3.    Test results

### 3.1    Radiated RF output power

The test was performed as a compliance test. The test parameters concerned were as follows:

| *EUT* | EUT1 |
|---|---|
| *Site name* | Nemko Oy / Perkkaa |
| *Section in CRF 47* | § 24.232 (b) |
| *Section in RSS-133* | 6.2 |
| *Date of testing* | 21.06.2004 |
| *Test equipment* | 42, 351, 319, 350, 184, 545, X3 |
| *Test conditions* | 22 °C, 40 % RH |
| *Test result* | **PASS** |

#### 3.1.1  Test method and limit

The test was performed inside a semi anechoic shielded room. For the duration of the test the EUT was placed on a non-conductive support 0.8 m high standing on the turntable. In the corner of the chamber there was a communication antenna, which was connected to the BS simulator located outside the room. The radiated power from the EUT was measured with an antenna fixed to a antenna tower. The tower and turn table were remotely controlled to turn the EUT and change the antenna polarization. The measured signal was routed from the measuring antenna to the spectrum analyzer. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.

a) The maximum power level was searched at each frequency by rotating the turntable and adjusting the measuring antenna polarization and height (from 1- 4 m). This level (PEUT) was recorded. The measurements were performed the EUT at all three orthogonal planes

b) The EUT was replaced with a substituting antenna.

c) The substituting antenna was fed with the power ($P_{Gen}$) giving a convenient reading on the spectrum analyzer and the measuring antenna height was adjusted to obtain a maximum reading at spectrum analyzer. That reading ($P_{Subst}$) on spectrum analyzer was recorded.

The formula below was used to calculate the EIRP of the EUT.

$$P_{EIRP[dbm]} = P_{Measured[dB]} – P_{Subst[dB]} - L_{Cable[dB]} + G_{Antenna[dBi]} + P_{Gen[dBm]}$$

Where

$P_{Measured[dBm]}$      measured power level from the EUT

$P_{Subst[dBm]}$      measured emission level from substitutive antenna

$L_{Cable[dB]}$      loss of the cable between substitutive antenna and signal generator

$G_{Antenna[dBi]}$      gain of the substitutive antenna

$P_{Gen[dBm]}$      signal generator power fed to the substitutive antenna

### 3.1.2 Limit

| Power level | EIRP power (dBm) | EIRP power (W) |
|:---:|:---:|:---:|
| 0 | ≤ 33 | ≤ 2 |

### 3.1.3 EUT operation mode

| EUT operation mode | GSM 1900, TX ON, 1 time slot transmission, audio PRBS 2E9-1 modulation, GMSK modulation |
|---|---|
| EUT channel | 512, 661, 810 |
| EUT power level | 0  (+ 30 dBm) |

### 3.1.4 Test results

| EUT Channel | $P_{Measured}$ [dBm] | $P_{Gen}$ [dBm] | $P_{Subst}$ [dBm] | $L_{Cable}$ [dBm] | $G_{Antenna}$ [dBd] | EIRP [dBm] | EIRP [W] |
|:---:|:---:|:---:|:---:|:---:|:---:|:---:|:---:|
| 512 | -18.2 | 10 | -40.7 | 1.8 | -0.7 | 30.0 | 1.000 |
| 661 | -17.8 | 10 | -40.3 | 1.8 | -1.0 | 29.7 | 0.933 |
| 810 | -17.7 | 10 | -40.1 | 1.8 | -1.4 | 29.2 | 0.832 |

### 3.1.5 EUT operation mode

| EUT operation mode | GSM 1900, TX ON, 1 time slot transmission, audio PRBS 2E9-1 modulation, 8PSK (edge) modulation |
|---|---|
| EUT channel | 512, 661, 810 |
| EUT power level | 0  (+ 30 dBm) |

### 3.1.6 Test results

| EUT Channel | $P_{Measured}$ [dBm] | $P_{Gen}$ [dBm] | $P_{Subst}$ [dBm] | $L_{Cable}$ [dBm] | $G_{Antenna}$ [dBd] | EIRP [dBm] | EIRP [W] |
|---|---|---|---|---|---|---|---|
| 512 | -19.9 | 10 | -36.2 | 2.9 | -0.7 | 28.4 | 0.684 |
| 661 | -19.5 | 10 | -36.7 | 3 | -1.0 | 28.1 | 0.638 |
| 810 | -19.4 | 10 | -39.2 | 3 | -1.4 | 27.6 | 0.569 |

### 3.1.7 EUT operation mode

| EUT operation mode | GSM 1900, TX ON, 2 time slot GPRS transmission, audio PRBS 2E9-1 modulation, GMSK modulation |
|---|---|
| EUT channel | 512, 661, 810 |
| EUT power level | 0  (+ 30 dBm) |

### 3.1.8 Test results

| EUT Channel | $P_{Measured}$ [dBm] | $P_{Gen}$ [dBm] | $P_{Subst}$ [dBm] | $L_{Cable}$ [dBm] | $G_{Antenna}$ [dBd] | EIRP [dBm] | EIRP [W] |
|---|---|---|---|---|---|---|---|
| 512 | -18.8 | 10 | -40.7 | 1.8 | -0.7 | 29.4 | 0.871 |
| 661 | -18.9 | 10 | -40.3 | 1.8 | -1.0 | 28.6 | 0.724 |
| 810 | -18.7 | 10 | -40.1 | 1.8 | -1.4 | 28.2 | 0.661 |

### 3.2 99% occupied bandwidth

The test was performed as a compliance test. The test parameters concerned were as follows:

| | |
|---|---|
| *EUT* | EUT3 |
| *Site name* | Nemko Oy / Perkkaa |
| *Section in CRF 47* | § 2.1049, (h) |
| *Section in RSS-133* | 5.6 |
| *Date of testing* | 22.06.2004 |
| *Test equipment* | 42, 519, 545, X2 |
| *Test conditions* | 22 °C, 40 % RH |
| *Test result* | **PASS** |

#### 3.2.1 Test method and limit

The test was performed inside a shielded room. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.
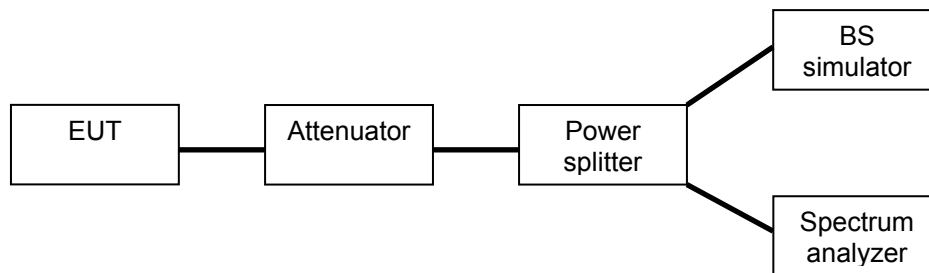


#### 3.2.2 Limit

| *Power level* | *99% occupied bandwidth* |
|---|---|
| **0** | **--** |

### 3.2.3 EUT operation mode

| EUT operation mode | *GSM 1900, TX ON, 1 time slot transmission, audio PRBS 2E9-1 modulation, GMSK modulation* |
|---|---|
| *EUT channel* | **661** |
| *EUT power level* | **0  (+ 30 dBm)** |

### 3.2.4 Test results

| *Channel* | *99% occupied bandwidth  kHz* |
|---|---|
| **661** | **243.45** |

The 99% occupied bandwidth was calculated from the trace data of the spectrum analyzer.
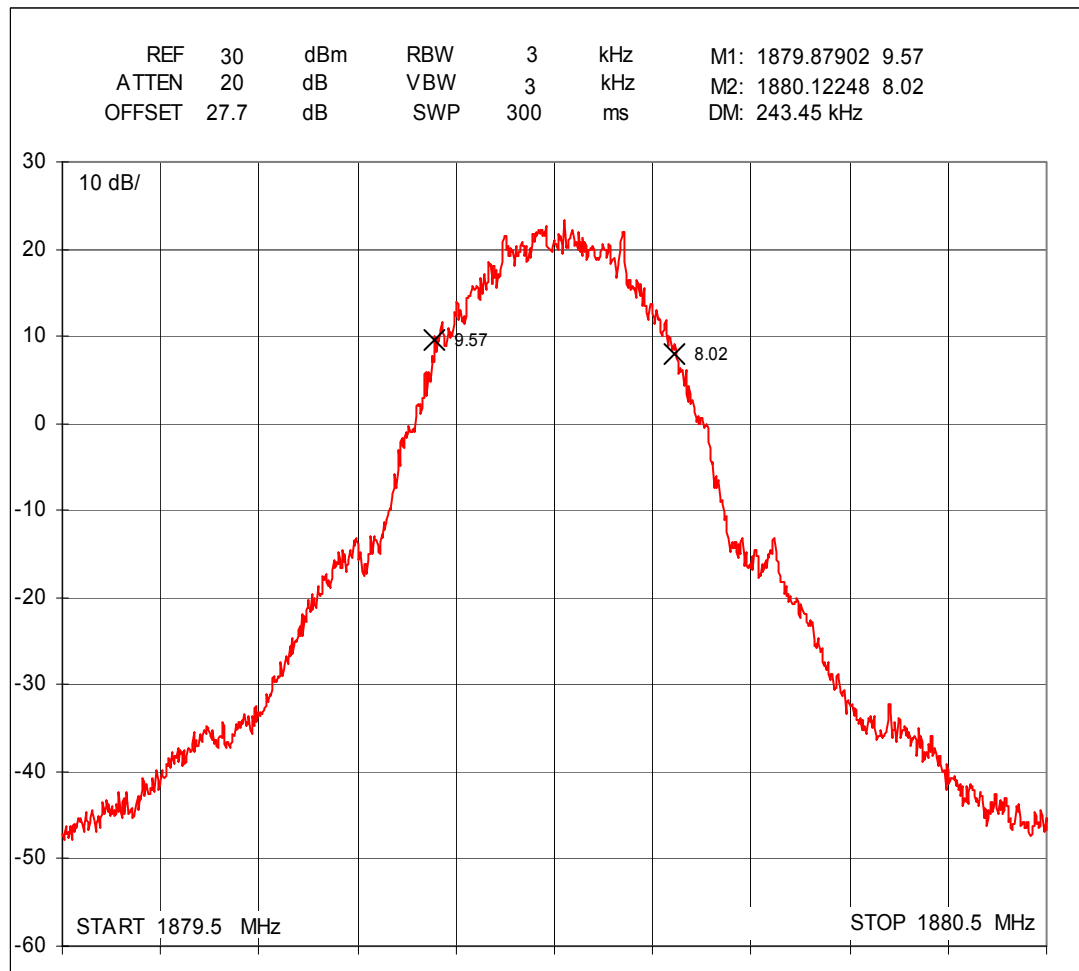


Spectrum analyzer plot channel 661, GMSK modulation

### 3.2.5 EUT operation mode

| | |
|---|---|
| *EUT operation mode* | **GSM 1900, TX ON, 1 time slot transmission, audio PRBS 2E9-1 modulation, 8PSK modulation (edge)** |
| *EUT channel* | **661** |
| *EUT power level* | **0  (+ 30 dBm)** |

### 3.2.6 Test results

| *Channel* | *99% occupied bandwidth  kHz* |
|---|---|
| **661** | **243.93** |

The 99% occupied bandwidth was calculated from the trace data of the spectrum analyzer.
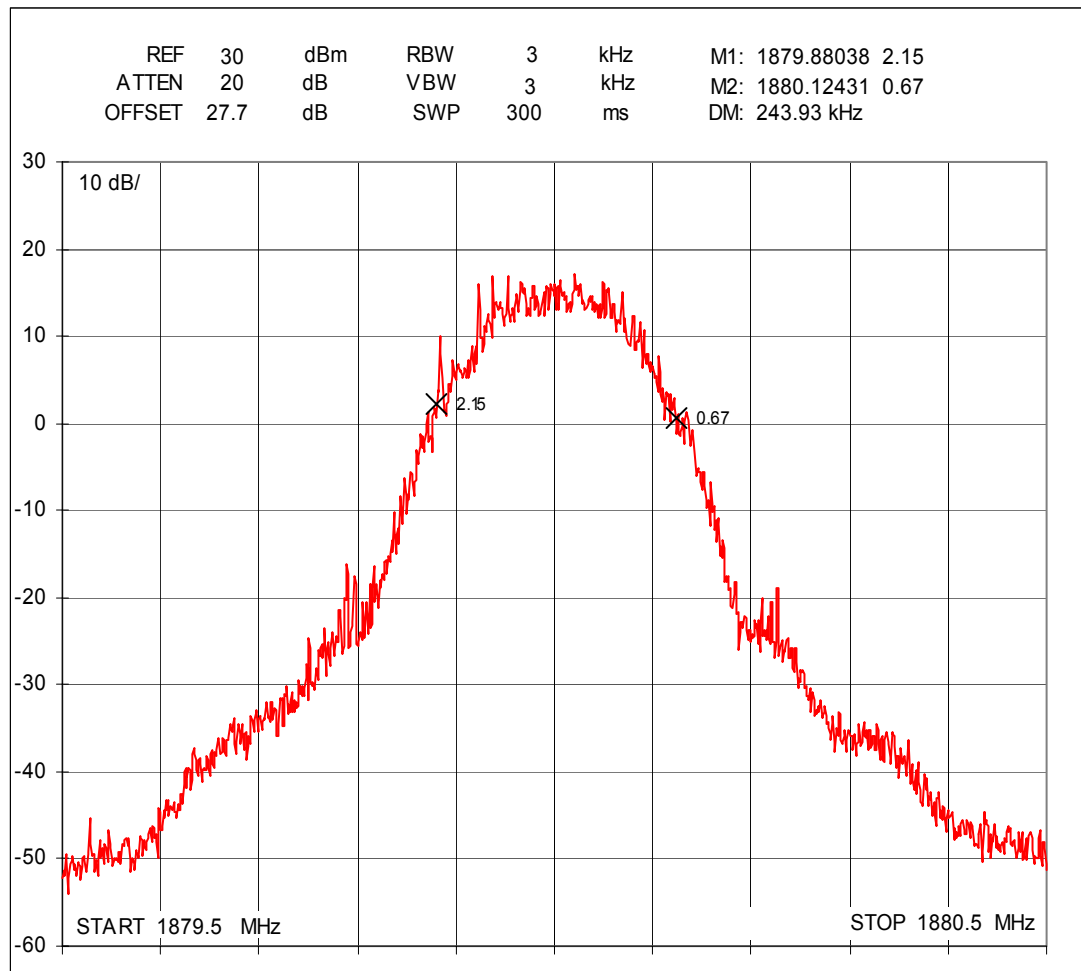


Spectrum analyzer plot channel 661, 8PSK modulation (edge)

### 3.3 Band-edge compliance

The test was performed as a compliance test. The test parameters concerned were as follows:

| | |
|---|---|
| *EUT* | EUT3 |
| *Site name* | Nemko Oy / Perkkaa |
| *Section in CRF 47* | § 24.238 (a) |
| *Section in RSS-133* | 6.3 |
| *Date of testing* | 22.06.2004 |
| *Test equipment* | 42, 519, 545, X2 |
| *Test conditions* | 22 °C, 40 % RH |
| *Test result* | **PASS** |

### 3.3.1 Test method and limit

The test was performed inside a shielded room. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.
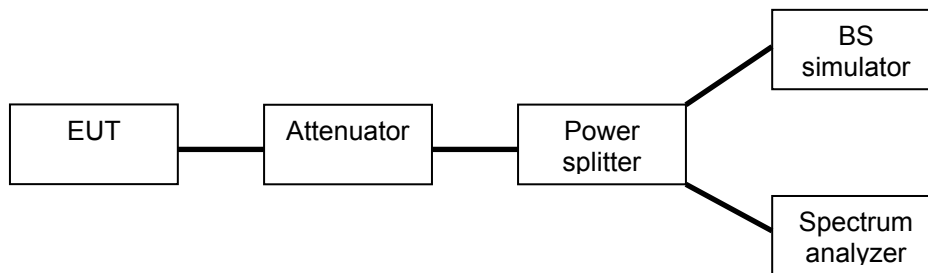


### 3.3.2 Limit

| *Frequency  MHz* | *Band-edge compliance  dBm* |
|---|---|
| **< 1850 or 1910 <** | **≤ -13** |

### 3.3.3 EUT operation mode

| EUT operation mode | *GSM 1900, TX ON, 1 time slot transmission, audio PRBS 2E9-1 modulation, GMSK modulation* |
|---|---|
| *EUT channel* | **512, 810** |
| *EUT power level* | **0 (+ 30 dBm)** |

### 3.3.4 Test results

The line in the spectrum analyzer plot is the -13dBm limit line. The band edge is at the middle of the screen. The results were corrected with combined attenuation of the cables, attenuator and power divider set as "offset" in the spectrum analyzer.

| | | *Limit* |
|---|---|---|
| *Channel* | *Band-edge compliance  MHz / dBm* | *Frequency  MHz / dBm* |
| **512** | **1849.998 / -13.5** | **< 1850 or 1910 < / ≤ -13** |



Spectrum analyzer plot channel 512, GMSK modulation

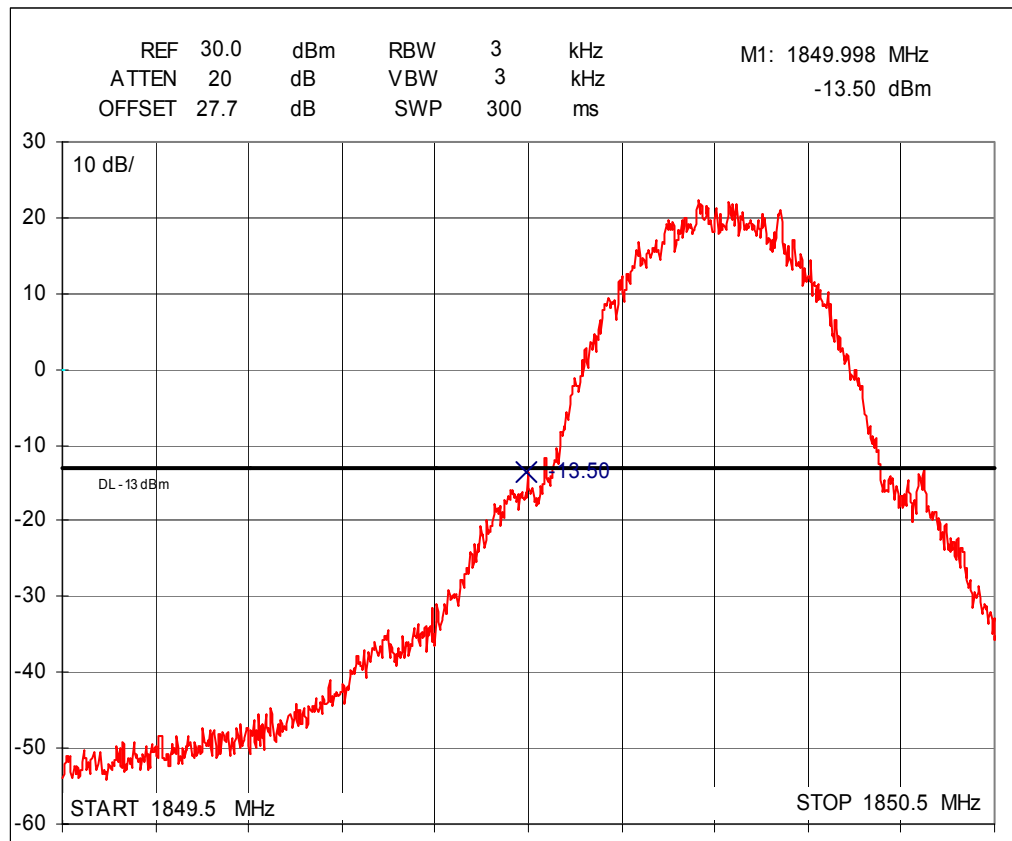| Channel | Band-edge compliance  MHz / dBm | *Limit* Frequency  MHz / dBm |
|---|---|---|
| **810** | **1910.003 / -13.9** | **< 1850 or 1910 < / ≤ -13** |



Spectrum analyzer plot channel 810, GMSK modulation

### 3.3.1 EUT operation mode

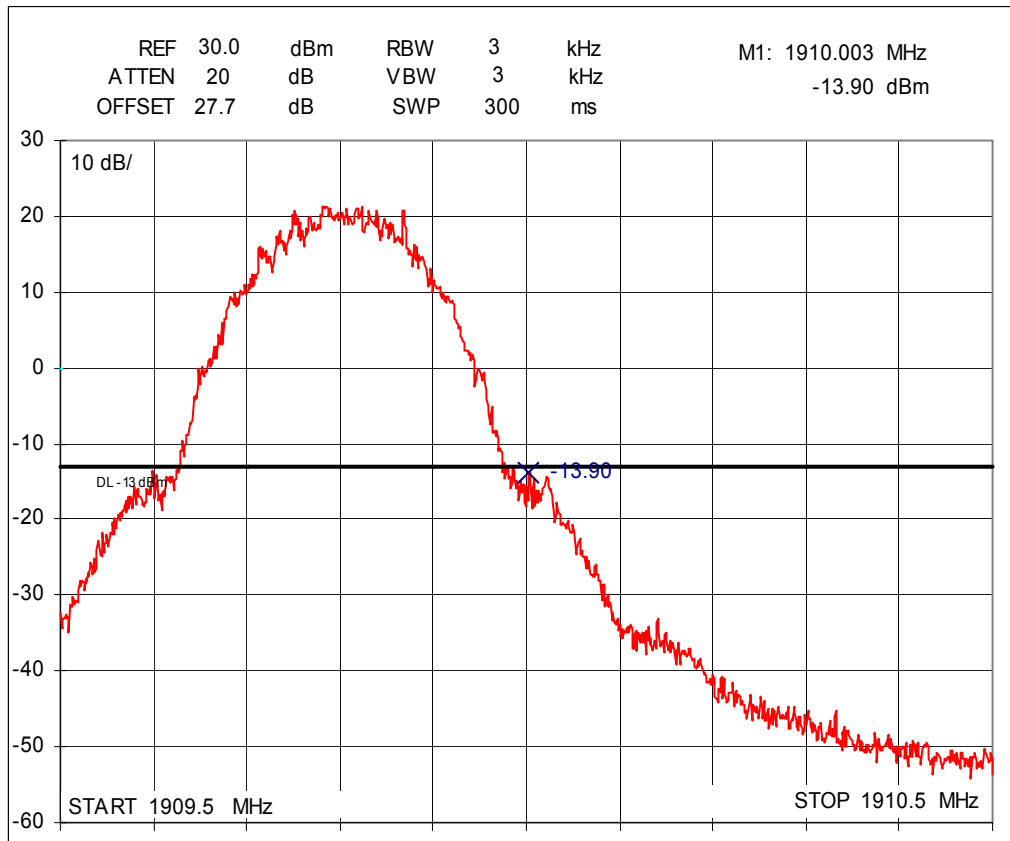| EUT operation mode | *GSM 1900, TX ON, 1 time slot transmission, audio PRBS 2E9-1 modulation, 8PSK modulation (edge)* |
|---|---|
| *EUT channel* | **512, 810** |
| *EUT power level* | **0  (+ 30 dBm)** |

### 3.3.2 Test results

The line in the spectrum analyzer plot is the -13dBm limit line. The band edge is at the middle of the screen. The results were corrected with combined attenuation of the cables, attenuator and power divider set as "offset" in the spectrum analyzer.

| *Channel* | *Band-edge compliance  MHz / dBm* | *Limit*<br>*Frequency  MHz / dBm* |
|---|---|---|
| **512** | **1849.994 / -20.9** | **< 1850 or 1910 < / ≤ -13** |
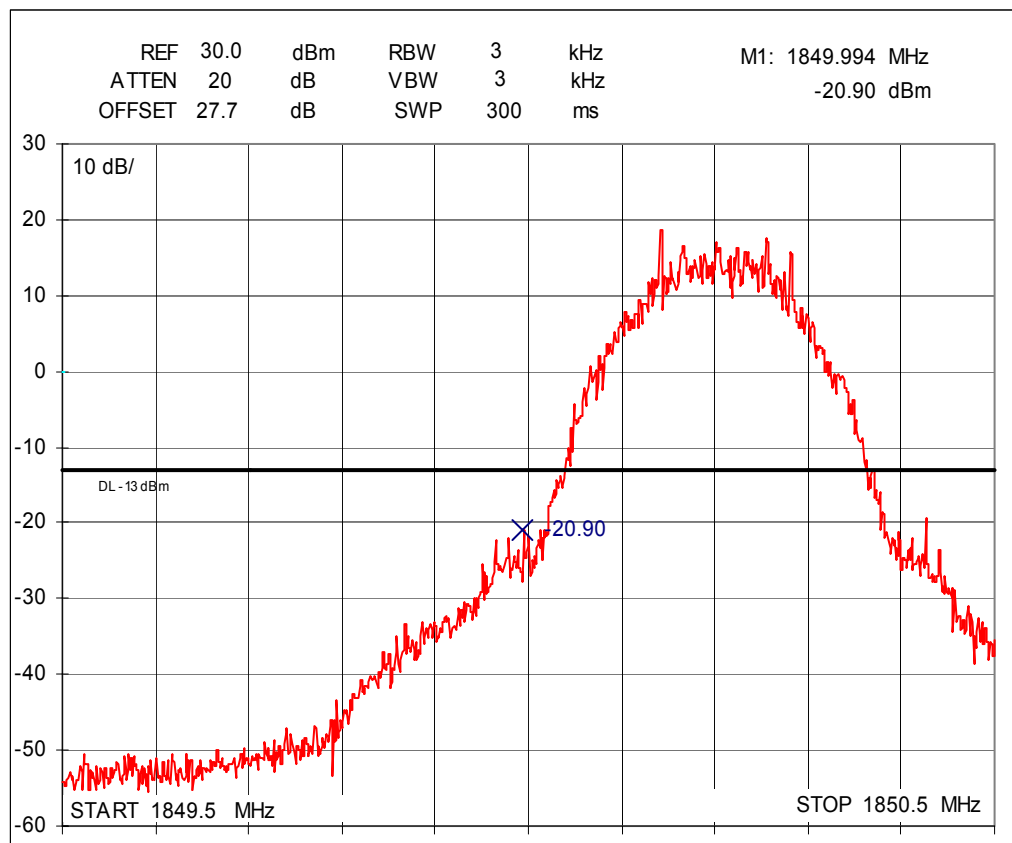


Spectrum analyzer plot channel 512, 8PSK modulation (edge)

**Nemko**

| Channel | Band-edge compliance  MHz / dBm | Limit<br>Frequency  MHz / dBm |
|---------|---------------------------------|-------------------------------|
| 810 | 1910.023 / -18.8 | < 1850 or 1910 < / ≤ -13 |
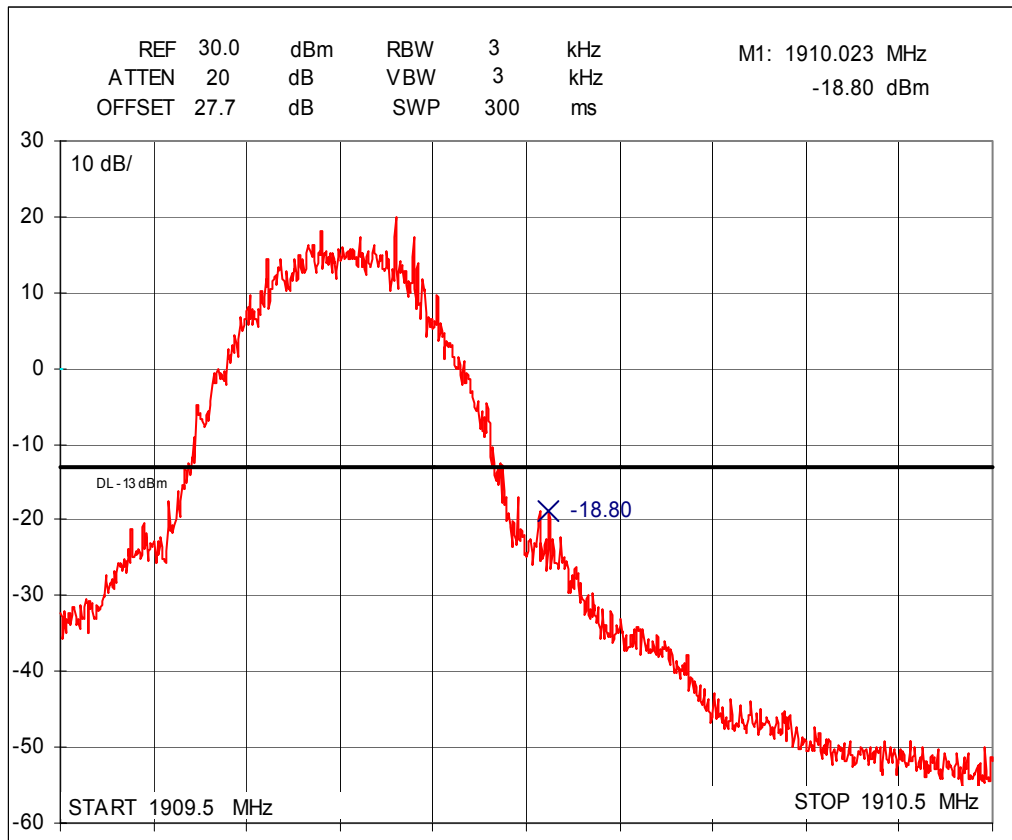


Spectrum analyzer plot channel 810, 8PSK modulation (edge)

### 3.4 Spurious radiated emission

| EUT | EUT2 |
|---|---|
| Site name | Nemko Oy / Perkkaa |
| Section in CRF 47 | § 24.238 (a), § 2.1053 |
| Section in RSS-133 | 6.3 |
| Date of testing | 23.06.2004 |
| Test equipment | 350, 42, 525, 319, 544, 184, 542, 543, 545, 550, 552, X1 |
| Test conditions | 22 °C, 40 % RH |
| Test Result | **PASS** |

#### 3.4.1 Test method and limit

The test was performed inside a semi anechoic shielded room. For the duration of the test the EUT was placed on a non-conductive support 0.8 m high standing on the turntable. In the corner of the chamber there was a communication antenna, which was connected to the BS simulator located outside the room. The radiated power from the EUT was measured with an antenna fixed to a antenna tower. The tower and turn table were remotely controlled to turn the EUT and change the antenna polarization. The measured signal was routed from the measuring antenna to the spectrum analyzer. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.
a) The maximum power level was searched at each frequency by rotating the turntable and adjusting the measuring antenna polarization and height (from 1- 4 m). This level (PEUT) was recorded. The measurements were performed the EUT at all three orthogonal planes
b) The EUT was replaced with a substituting antenna.
c) The substituting antenna was fed with the power ($P_{Gen}$) giving a convenient reading on the spectrum analyzer and the measuring antenna height was adjusted to obtain a maximum reading at spectrum analyzer. That reading ($P_{Subst}$) on spectrum analyzer was recorded.

#### 3.4.2 Limit

| Frequency MHz | Level dBm |
|---|---|
| **30 - 19100** | **- 13** |

### 3.4.3 EUT operation mode

| EUT operation mode | GSM 1900, TX ON, 1 time slot transmission, audio PRBS 2E9-1 modulation, GMSK modulation |
|---|---|
| EUT channel | 661 |
| EUT power level | 0  (+ 30 dBm) |

### 3.4.4 Test results

The formula below was used to calculate the EIRP of the spurious emissions. If there were no emissions closer than 20 dB below the limit line, then the emission levels were measured at the transmitter's harmonics.

$$P_{Emission[dbm]} = P_{Measured[dB]} – P_{Subst[dB]} - L_{Cable[dB]} + G_{Antenna[dBi]} + P_{Gen[dBm]}$$

Where

$P_{Measured[dBm]}$      measured emission level

$P_{Subst[dBm]}$      measured emission level from substitutive antenna

$L_{Cable[dB]}$      loss of the cable between substitutive antenna and signal generator

$G_{Antenna[dBi]}$      gain of the substitutive antenna

$P_{Gen[dBm]}$      signal generator power fed to the substitutive antenna

Calculation example:

$$P_{3760[dbm]} = - 39.2_{Measured[dB]} - ( -20.9)_{Subst[dB]} – 2.6_{Cable[dB]} + 9.1_{Antenna[dBi]} + (- 30)_{Gen[dBm]}$$

$$= - 41.8_{dBm]}$$

**TX GSM 1900 (ch 661)**

| Frequency MHz | Result dBm | Limit dBm | Margin dB |
|---|---|---|---|
| 3760.0 | -41.8 | -13.0 | 28.8 |
| 5640.0 | -40.8 | -13.0 | 27.8 |
| 7520.0 | -44 | -13.0 | 31.0 |
| 9400.0 | -37.4 | -13.0 | 24.4 |
| 11280.0 | -33.1 | -13.0 | 20.1 |

### 3.4.5 EUT operation mode

| EUT operation mode | **GSM 1900, TX ON, 1 time slot transmission, audio PRBS 2E9-1 modulation, 8PSK modulation (edge)** |
|---|---|
| EUT channel | **661** |
| EUT power level | **0 (+ 30 dBm)** |

### 3.4.6 Test results

The formula below was used to calculate the EIRP of the spurious emissions. If there were no emissions closer than 20 dB below the limit line, then the emission levels were measured at the transmitter's harmonics.

$$P_{Emission[dbm]} = P_{Measured[dB]} – P_{Subst[dB]} - L_{Cable[dB]} + G_{Antenna[dBi]} + P_{Gen[dBm]}$$

Where

$P_{Measured[dBm]}$     measured emission level

$P_{Subst[dBm]}$     measured emission level from substitutive antenna

$L_{Cable[dB]}$     loss of the cable between substitutive antenna and signal generator

$G_{Antenna[dBi]}$     gain of the substitutive antenna

$P_{Gen[dBm]}$     signal generator power fed to the substitutive antenna

Calculation example:

$$P_{3760[dbm]} = - 41.9_{Measured[dB]} - ( -20.9)_{Subst[dB]} – 2.6_{Cable[dB]} + 9.1_{Antenna[dBi]} + (- 30)_{Gen[dBm]}$$

$$= - 44.5_{dBm]}$$

***TX GSM 1900 (ch 661), 8PSK modulation***

| Frequency MHz | Result dBm | Limit dBm | Margin dB |
|---|---|---|---|
| **3760.0** | **-44.5** | **-13.0** | **31.5** |
| **5640.0** | **-42.3** | **-13.0** | **29.3** |
| **7520.0** | **-45.5** | **-13.0** | **32.5** |
| **9400.0** | **-38.4** | **-13.0** | **25.4** |
| **11280.0** | **-35.1** | **-13.0** | **22.1** |

### 3.5 Frequency stability, temperature variation

The test was performed as a compliance test. The test parameters concerned were as follows:

| | |
|---|---|
| *EUT* | EUT3 |
| *Site name* | Nemko Oy / Perkkaa |
| *Section in CRF 47* | 24.235, 2.1055 (a)(1)(b) |
| *Section in RSS-133* | 7 |
| *Date of testing* | 28 and 29.06.2004 |
| *Test equipment* | 545, 157 |
| *Test conditions* | 24 °C, 52 % RH |
| *Test result* | **PASS** |

### 3.5.1 Test method and limit

The test was performed EUT placed inside a temperature chamber. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.

a) The climate chamber temperature was set to the minimum value and the temperature was allowed to stabilize.
b) The EUT was placed in the chamber
c) The EUT was set in idle mode for 60 minutes.
d) The EUT was set to transmit.
e) The transmit frequency error was measured immediately
f) The steps c - e were repeated for each temperature

```
 ┌─────────────┐
 │             │
 │             │────┌──────────┐
 │             │    │ BS       │
 │             │    │ simulator│
 │             │    └──────────┘
 └─────────────┘
```
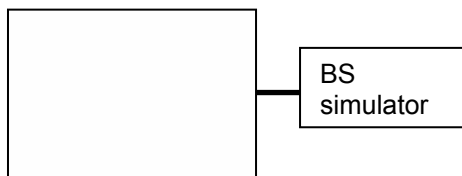
### 3.5.2 Limit

| *Frequency error    ppm* |
|---|
| **± 2.5** |

### 3.5.3 EUT operation mode

| | |
|---|---|
| *EUT operation mode* | **GSM 1900, TX ON, 1 time slot transmission, audio PRBS 2E9-1 modulation, GMSK modulation** |
| *EUT channel* | **661** |
| *EUT power level* | **0  (+ 30 dBm)** |

### 3.5.4 Test results

| Temperature [ºC] | Deviation [Hz] | Deviation [ppm] |
|---|---|---|
| *-30* | **100** | **0.053** |
| *-20* | **36** | **0.019** |
| *-10* | **32** | **0.017** |
| *0* | **36** | **0.019** |
| *10* | **39** | **0.021** |
| *20* | **43** | **0.023** |
| *30* | **-32** | **-0.017** |
| *40* | **-48** | **-0.026** |
| *50* | **-43** | **-0.023** |

Frequency deviation, temperature variation

### 3.6 Frequency stability, voltage variation

The test was performed as a compliance test. The test parameters concerned were as follows:

| | |
|---|---|
| *EUT* | EUT3 |
| *Site name* | Nemko Oy / Perkkaa |
| *Section in CRF 47* | 24.235, 2.1055 (d)(1)(2) |
| *Section in RSS-133* | 7 |
| *Date of testing* | 28.06.2004 |
| *Test equipment* | 545, 76 |
| *Test conditions* | 24 °C, 52 % RH |
| *Test result* | **PASS** |

### 3.6.1 Test method and limit

The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.

The EUT battery was replaced with an adjustable power supply. The frequency stability was measured at nominal voltage and in 0.1V increments the battery cut-off point.

```
┌──────────┐     ┌──────────┐     ┌──────────┐
│  Power   │     │   EUT    │     │   BS     │
│  supply  │─────│          │─────│ simulator│
└──────────┘     └──────────┘     └──────────┘
```

### 3.6.2 Limit

| *Frequency error    ppm* |
|---|
| **± 2.5** |

### 3.6.3 EUT operation mode

| EUT operation mode | GSM 1900, TX ON, 1 time slot transmission, audio PRBS 2E9-1 modulation, GMSK modulation |
|---|---|
| EUT channel | 661 |
| EUT power level | 0  (+ 30 dBm) |

### 3.6.4 Test results

| Battery level | Voltage [ V ] | Deviation [Hz] | Deviation [ppm] |
|---|---|---|---|
| Nominal | 3.7 | 46 | 0.025 |
| Cut off-point | 3.2 | 39 | 0.021 |

Frequency deviation, voltage variation

## 4. List of test equipment

Each active test equipment is calibrated once a year, antennas every 18 months and other passive equipment every 24 months.

| Nr. | Equipment | Type | Manufacturer | Serial number |
|---|---|---|---|---|
| 42 | Spectrum analyzer | 8566B | Hewlett Packard | 2637A04102 |
| 76 | Power supply | B32-30R | Oltronix | 537 |
| 157 | Temp. test chamber | VMT 04/240 | Vötch | 31884 |
| 184 | Temp. & humidity meter | H MI 32 | Vaisala | 63837 |
| 319 | Antenna | CBL6112 | Chase | 2018 |
| 348 | Shielded room | RFSD-100 | Euroshield Oy | 1320 |
| 350 | Semianechoic shielded room | RFD-F-100 | Euroshield Oy | 1327 |
| 351 | RF generator | SMT 06 | Rohde & Schwarz | 845715/001 |
| 519 | RF High-Power Attenuator | 765-20 | Narda | |
| 525 | Double-Ridged Horn | 3115 | Emco | 6691 |
| 542 | Double-Ridged Horn | 3115 | Emco | 00023905 |
| 543 | RF-amplifier | JCA018-501 | JCA Technologies | 103 |
| 544 | RF-amplifier | ZFL-2000VH2 | Mini-Circuits | D01080 |
| 545 | GSM MS Test System | CMU | Rohde & Schwarz | 836536/049 |
| 552 | Highpass Filter | WHK2.3/18G-10SS | Wainwright Instruments | 1 |
| 550 | Notch Filter | WRCD1800/2000-0.2/40-5SSSD | Wainwright Instruments | 1 |
| X1 | RF-Generator | 8341B | Hewlett Packard | 2802A01090 |
| X2 | Power splitter | 1870A | Weinschel | 1798 |
| X3 | Antenna | 3125-1880 | ETS | 00028029 |
| | | | | |
| | | | | |

## 5. Photographs

See "1032312_test_setup_photographs"