

# CETECOM



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## **CETECOM ICT Services GmbH**

Radio Satellite Communication  
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Issued test report consist of 60 Pages

Page 1 (60)

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## **Accredited Testing Laboratory**

**DAR-Registration number:  
TTL-P-G 166/98-00**

**Test report no.: 125/2001  
FCC Part 24 / 15.209**

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**1 General information**

**1.1 Notes**

**The test results of this test report relate exclusively to the test item specified in 1.5. The CETECOM Inc. does not assume responsibility for any conclusions and generalisations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of the CETECOM Inc.**

**1.2 Testing laboratory**

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### 1.3 Details of applicant

**Name** : Novatel Wireless Technologies Ltd.  
**Street Add.:** Suite 200, 6715-8<sup>th</sup> Street N.E  
**City/State** : Calgary, Alberta T2E 7H7  
**Country** : Canada  
**Contact** : Kevin Goodfellow  
**Telephone** : 403 295 4800  
**Telefax** : 403 295 4801  
**e-mail** : [kgoodfellow@novatelwireless.com](mailto:kgoodfellow@novatelwireless.com)

### 1.4 Application details

Date of receipt of application : 2001-01-20  
Date of receipt of test item : 2001-02-26  
Date of test : 2001-02-26/27/28

### 1.5 Test item

Manufacturer : applicant  
Type of equipment : GPRS Wireless Modem  
Model No. : PCS-1900  
Serial number : C-87  
**Additional informations: :**  
Frequency : PCS-1900  
Type of modulation : GSM/PCS  
Number of channels : 298  
Antenna : Dipole  
Power supply : PC Host Power Supply  
Output power : 29.60dBm Peak / ERP : 27.66dBm (Burst); EIRP: 29.76dBm (Burst)

EUT Temp. Tolerance : Temperature range : -30°C - +50°C

### 1.6 Test standards: FCC Part 24 / 15.209



**2.2 Test report**

**TEST REPORT**

**Test report no.: 125/2001**

**TEST REPORT REFERENCE**

**LIST OF MEASUREMENTS**

<b>PARAMETER TO BE MEASURED Paragraph</b>	<b>PAGE</b>
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**POWER OUTPUT**

**SUBCLAUSE § 24.232**

**Summary:**

This paragraph contains both average , peak output powers and EIRP measurements for the EUT. 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).

**Method of Measurements:**

The EUT was set up for the max. output power with pseudo random data modulation. The power was measured with R&S Spectrum Analyzer FSEM 30 ( peak and average) This measurements were done at 3 frequencies, 1850.2 MHz, 1880.0 MHz and 1909.8 MHz (bottom, middle and top of operational frequency range)

**Limits:**

Power Step	Nominal Peak Output Power (dBm)	Tolerance (dB)
0	+30	± 2

**Power Measurements:**

**Conducted:**

Frequency (MHz)	Power Step	Peak Output Power (dBm)	Average Output Power (dBm)
1850.2	0	29.60	27.5
1880.0	0	29.55	27.45
1909.8	0	29.41	27.31
Measurement uncertainty		±0.5 dB	

**EIRP Measurements**

Description: This is the test for the maximum radiated power from the EUT.

Rule Part 24.232(b) specifies that "Mobile/portable stations are limited to 2 watts e.i.r.p. peak power..." and 24.232(c) specifies that "Peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage."

Method of Measurement:

1. In an anechoic antenna test chamber, a half-wave dipole antenna for the frequency band of interest is placed at the reference center of the chamber. An RF Signal source for the frequency band of interest is connected to the dipole with a cable that has been constructed to not interfere with the radiation pattern of the antenna. A known (measured) power (Pin) is applied to the input of the dipole, and the power received (Pr) at the chamber's probe antenna is recorded.
2. A "reference path loss" is established as  $Pin + 2.1 - Pr$ .
3. The EUT is substituted for the dipole at the reference center of the chamber. The EUT is put into CW test mode and a scan is performed to obtain the radiation pattern.
4. From the radiation pattern, the co-ordinates where the maximum antenna gain occurs is identified.
5. The EUT is then put into pulse mode at its maximum power level (Power Step 0).
6. "Gated mode" power measurements are performed with the receiving antenna placed at the coordinates determined in Step 3 to determine the output power as defined in FCC Rule 24.232 (b) and (c). The "reference path loss" from Step 1 is added to this result.
7. This value is EIRP since the measurement is calibrated using a half-wave dipole antenna of known gain (2.1 dBi) and known input power (Pin).
8. ERP can be calculated from EIRP by subtracting the gain of the dipole,  $ERP = EIRP - 2.1 \text{ dBi}$ .

**Limits:**

Power Step	Burst Average EIRP (dBm)
0	<33

**Power Measurements:**

Plots are shown on next pages.

**Radiated:**

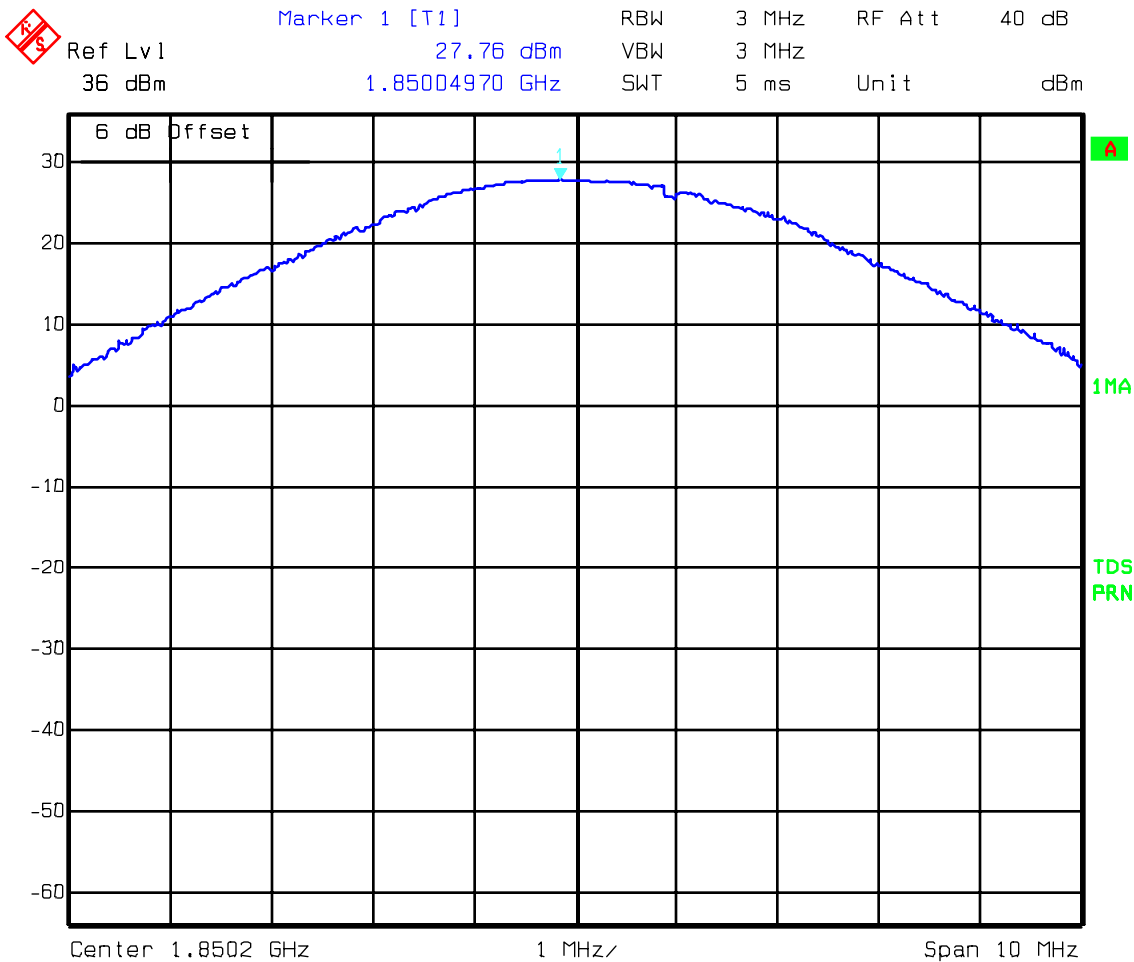
Frequency (MHz)	Power Step	BURST AVERAGE (dBm)		MODULATION AVERAGE (dBm)	
		EIRP	ERP	EIRP	ERP
1850.2	0	27.76	25.66	18.18	16.08
1880.0	0	28.65	26.55	19.07	16.97
1909.8	0	29.76	27.66	20.18	18.08
Measurement uncertainty		±0.5 dB			



CHANNEL 512:

Peak Power

Measurements were made using 6db Attenuator

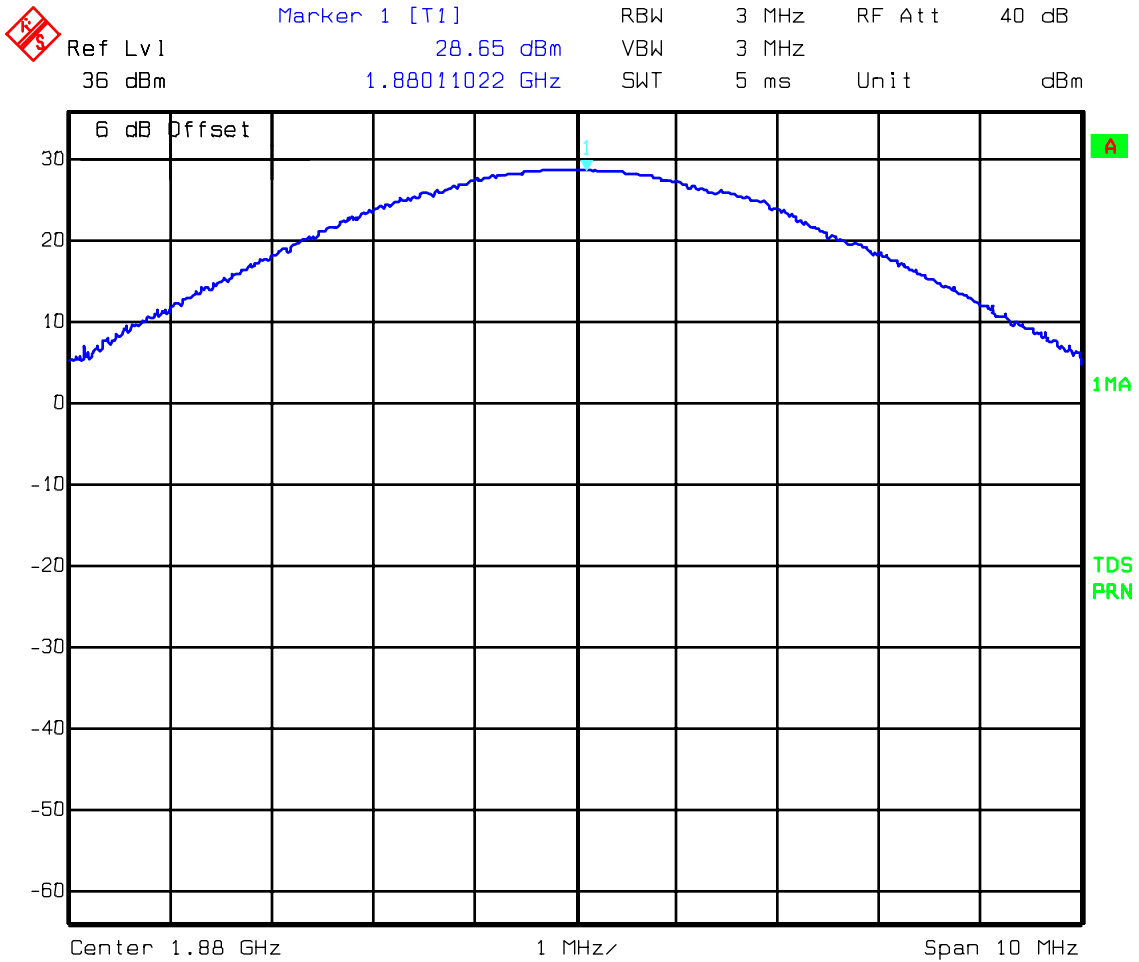


Date: 26.FEB.01 13:23:18

CHANNEL 661:

Peak Power

Measurements were made using 6db Attenuator

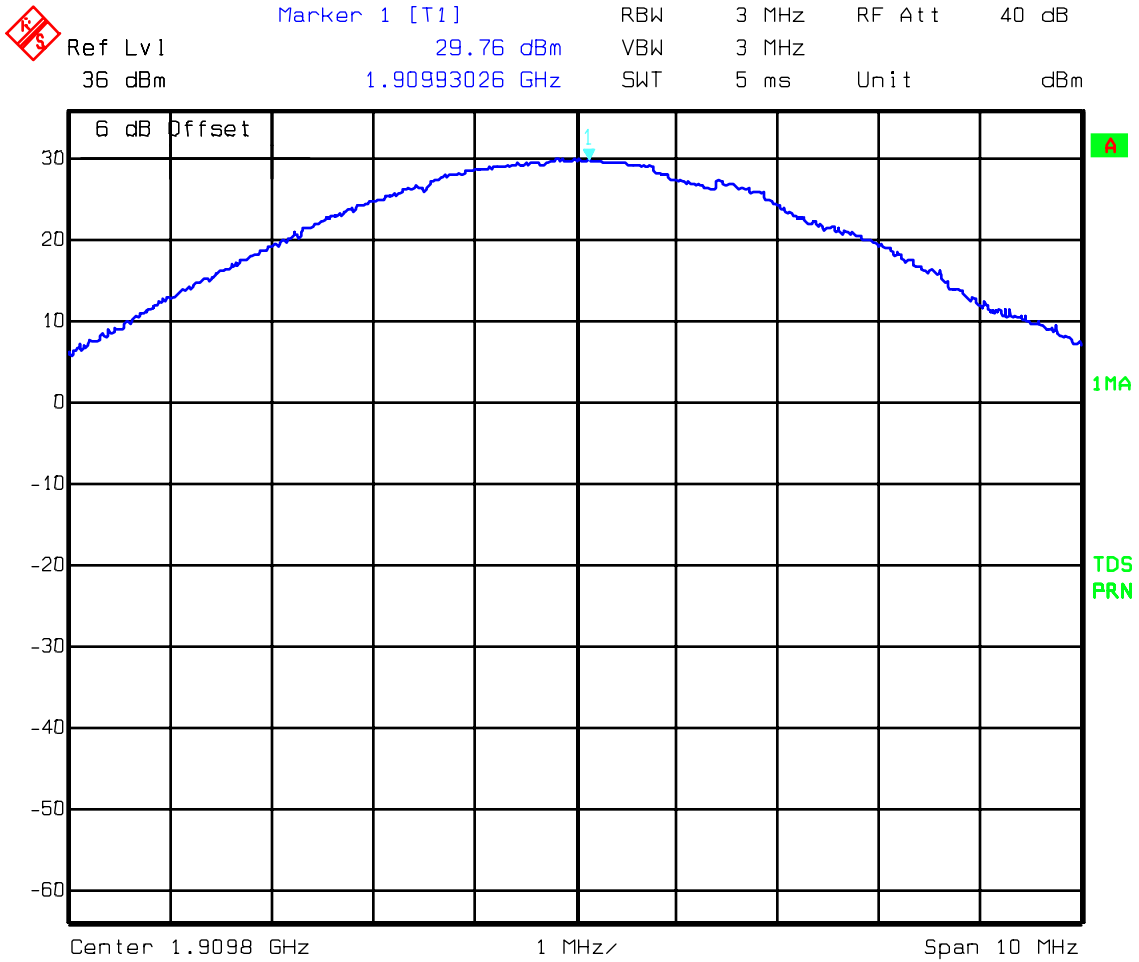


Date: 26.FEB.01 13:26:40

**CHANNEL 810:**

**Peak Power**

Measurements were made using 6db Attenuator



Date: 26.FEB.01 13:29:41

**FREQUENCY STABILITY****SUBCLAUSE § 24.235**

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**Method of Measurement:**

In order to measure the carrier frequency under the condition of AFC lock, it is necessary to make measurements with the EUT in a "call mode". This is accomplished with the use of a R&S CMD 55 DIGITAL RADIO COMMUNICATION TESTER.

1. Measure the carrier frequency at room temperature.
2. Subject the EUT to overnight soak at -30 C.
3. With the EUT, powered via 5.0 Volts, connected to the CMD 55 and in a simulated call on channel 661 (center channel), measure the carrier frequency. These measurements should be made within 2 minutes of powering up the EUT, to prevent significant self warming.
4. Repeat the above measurements at 10 C increments from -30 C to +50 C. Allow at least 1 1/2 hours at each temperature, unpowered, before making measurements.
5. Remeasure carrier frequency at room temperature with nominal 5.0 Volts. Vary supply voltage from minimum 4.0 Volts to maximum 5.75 Volts, in 0.2 Volt increments remeasuring carrier frequency at each voltage. Pause at 5.0 Volts for 1 1/2 hours unpowered, to allow any self heating to stabilize, before continuing.
6. Subject the EUT to overnight soak at +50 C.
7. With the EUT, powered via 5.0 Volts, connected to the CMD 55 and in a simulated call on channel 661 (center channel), measure the carrier frequency. These measurements should be made within 2 minutes of powering up the mobile station, to prevent significant self warming.
8. Repeat the above measurements at 10 C increments from +50 C to -30 C. Allow at least 1 1/2 hours at each temperature, unpowered, before making measurements.
9. At all temperature levels hold the temperature to +/- 0.5 C during the measurement procedure.

**Measurement Limit:**

According to the JTC standard the frequency stability of the carrier shall be accurate to within 0.1 ppm of the received frequency from the base station. This accuracy is sufficient to meet Sec. 24.235, Frequency Stability. The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block. As this transceiver is considered "Hand carried, battery powered equipment...", Section 2.1055(d)(2) applies. This requires that the lower voltage for frequency stability testing be specified by the manufacturer. This transceiver is specified to operate with an input voltage of between 4.0 VDC and 5.75 VDC, with a nominal voltage of 5.0 VDC (HP-E3610A). Operation above or below these voltage limits is prohibited by transceiver software in order to prevent improper operation as well as to protect components from overstress. These voltages represent a tolerance of + 15 % and -20 %. For the purposes of measuring frequency stability these voltage limits are to be used.

**AFC FREQ ERROR vs. VOLTAGE**

<b>Voltage (V)</b>	<b>Frequency Error (Hz)</b>	<b>Frequency Error (ppm)</b>
4.0	-10	-0.005
4.20	19	0.010
4.40	25	0.013
4.60	36	0.019
4.80	49	0.026
5.00	57	0.030
5.20	47	0.025
5.40	58	0.030
5.60	50	0.026
5.75	32	0.017

**AFC FREQ ERROR vs. TEMPERATURE**

<b>TEMPERATURE (°C)</b>	<b>Frequency Error (Hz)</b>	<b>Frequency Error (ppm)</b>
-30	62	0.032
-20	53	0.028
-10	30	0.015
0	50	0.026
+10	59	0.031
+20	63	0.033
+30	67	0.035
+40	73	0.038
+50	78	0.041

**EMISSIONS LIMITS****§24.238****Measurement Procedure:**

The following steps outline the procedure used to measure the radiated emissions from the EUT. The site is constructed in accordance with ANSI C63.4 – 1992 requirements and is recognised 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. This was rounded up to 20 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 USPCS band.

**The final open field emission test procedure is as follows:**

- a) The test item was placed on a 0.8 meter high non-conductive stand at a 3 meter test distance from the receive antenna.
- b) The antenna output was terminated in a 50 ohm load.
- c) A double ridged waveguide antenna was placed on an adjustable height antenna mast 3 meters from the test item for emission measurements.
- d) 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 using the equation shown below:

$$P_g = E^2 4\pi d^2 / 120\pi = E^2 d^2 / 30$$

where :  
 P = power in watts  
 g = arithmetic gain of transmitting antenna over isotropic radiator.  
 E = maximum field strength in volts/meter  
 d = measurement distance in meter

Using a dipole gain of 1.67 or 2.2 dB and a test distance of 3 meters, this equation reduces to:

$$P(\text{dBm}) = E(\text{dBuV/m}) - 97.2\text{dB}$$

**Measurement Limit:**

Sec. 24.238 Emission Limits.

(a) On any frequency outside a licensee's frequency block (e.g. A, D, B, etc.) within the USPCS spectrum, the power of any emission shall be attenuated below the transmitter power (P, in Watts) by at least  $43 + 10\log(P)$  dB.

The specification that emissions shall be attenuated below the transmitter power (P) by at least  $43 + 10\log(P)$  dB, translates in the relevant power range (1 to 0.001 W) to -13 dBm. At 1 W the specified minimum attenuation becomes 43 dB and relative to a 30 dBm (1 W) carrier becomes a limit of -13 dBm. At 0.001 W (0 dBm) the minimum attenuation is 13 dB which again yields a limit of -13 dBm. In this way a translation of the specification from relative to absolute terms is carried out.

**Measurement Results:**

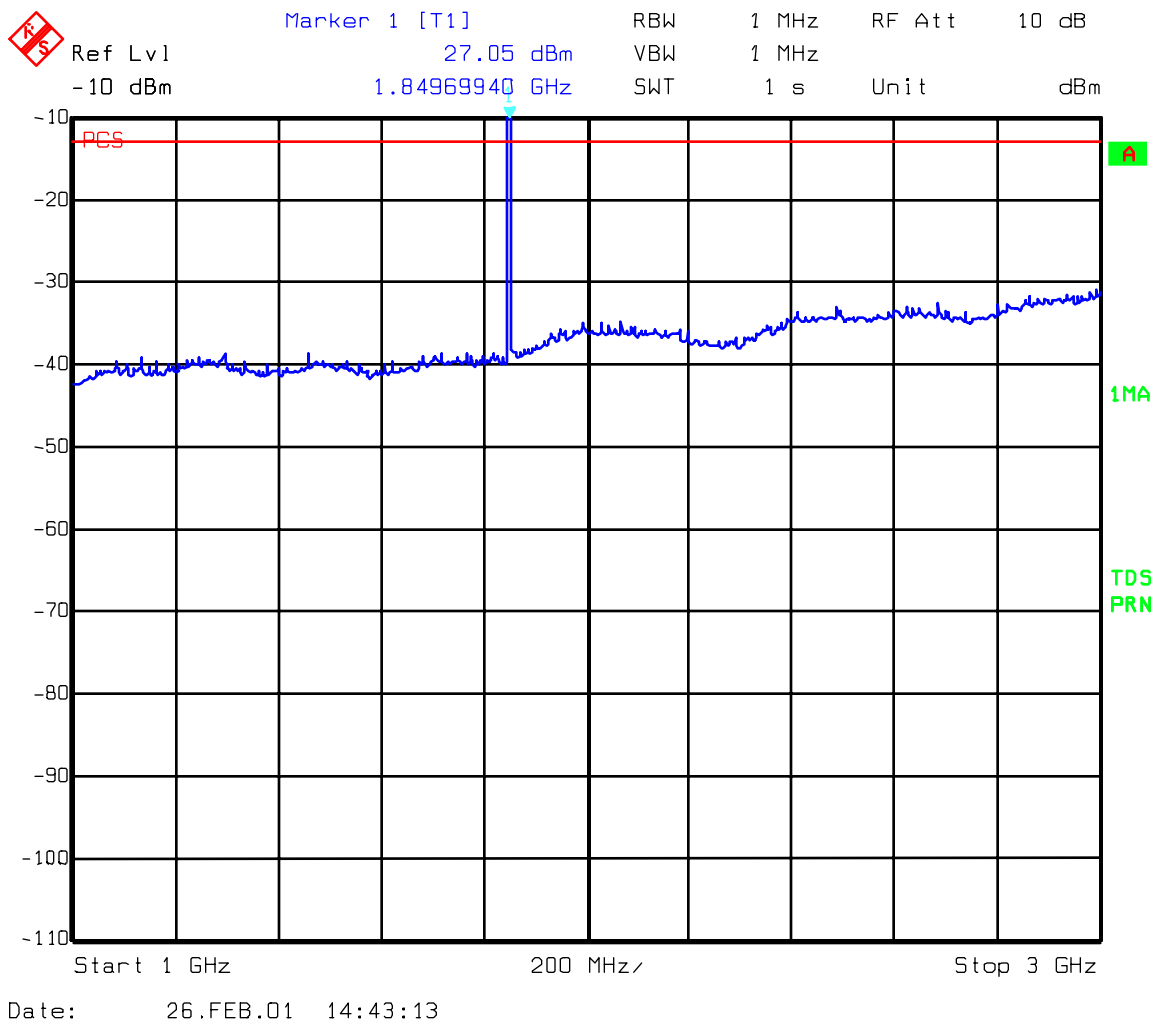
Radiated emissions measurements were made only at the upper, center, and lower carrier frequencies of the USPCS band (1850.2 MHz, 1879.8 MHz and 1909.8 MHz). It was decided that measurements at these three carrier frequencies would be sufficient to demonstrate compliance with emissions limits because it was seen that all the significant spurs occur well



**Channel 512 :**  
**Radiated Spurious Emissions**

Spurious emission limit -13dBm

Note: Marker indicates the carrier signal frequency.







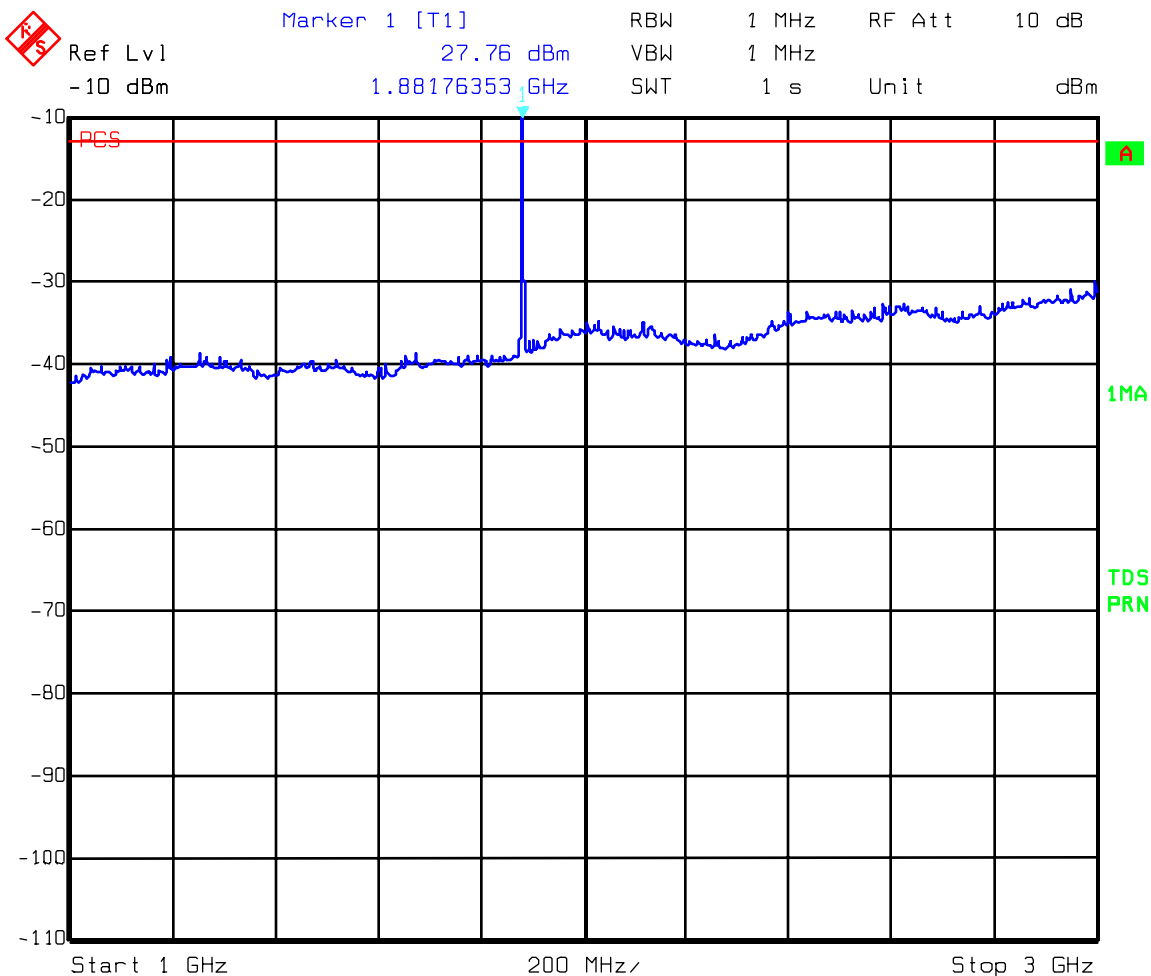




**Channel 661 :**  
**Radiated Spurious Emissions**

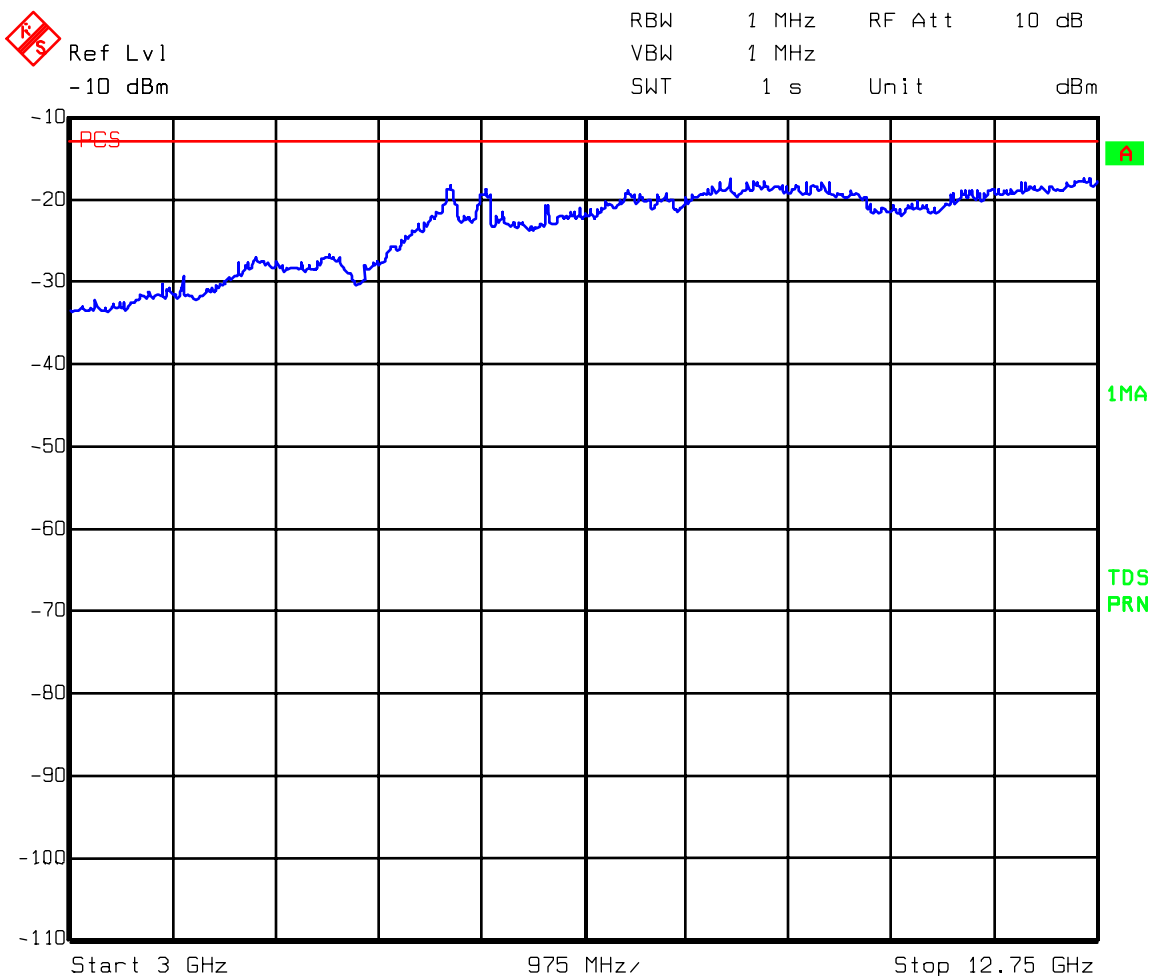
Spurious emission limit -13dBm

Note: Marker indicates the carrier signal frequency



Date: 26.FEB.01 14:45:17

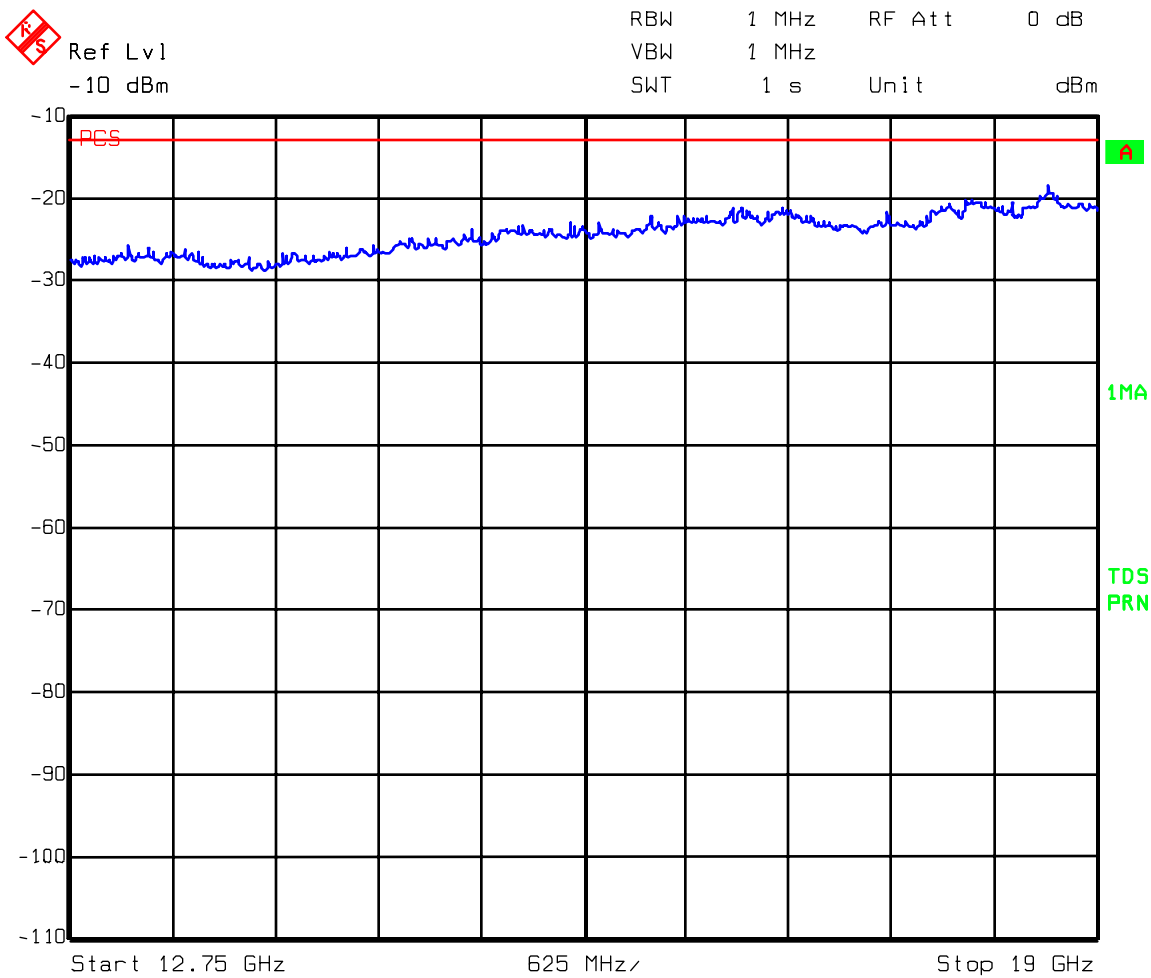
**Channel 661 :**  
**Radiated Spurious Emissions**  
Spurious emission limit -13dBm



Date: 26.FEB.01 15:02:12

**Channel 661 :**  
**Radiated Spurious Emissions**

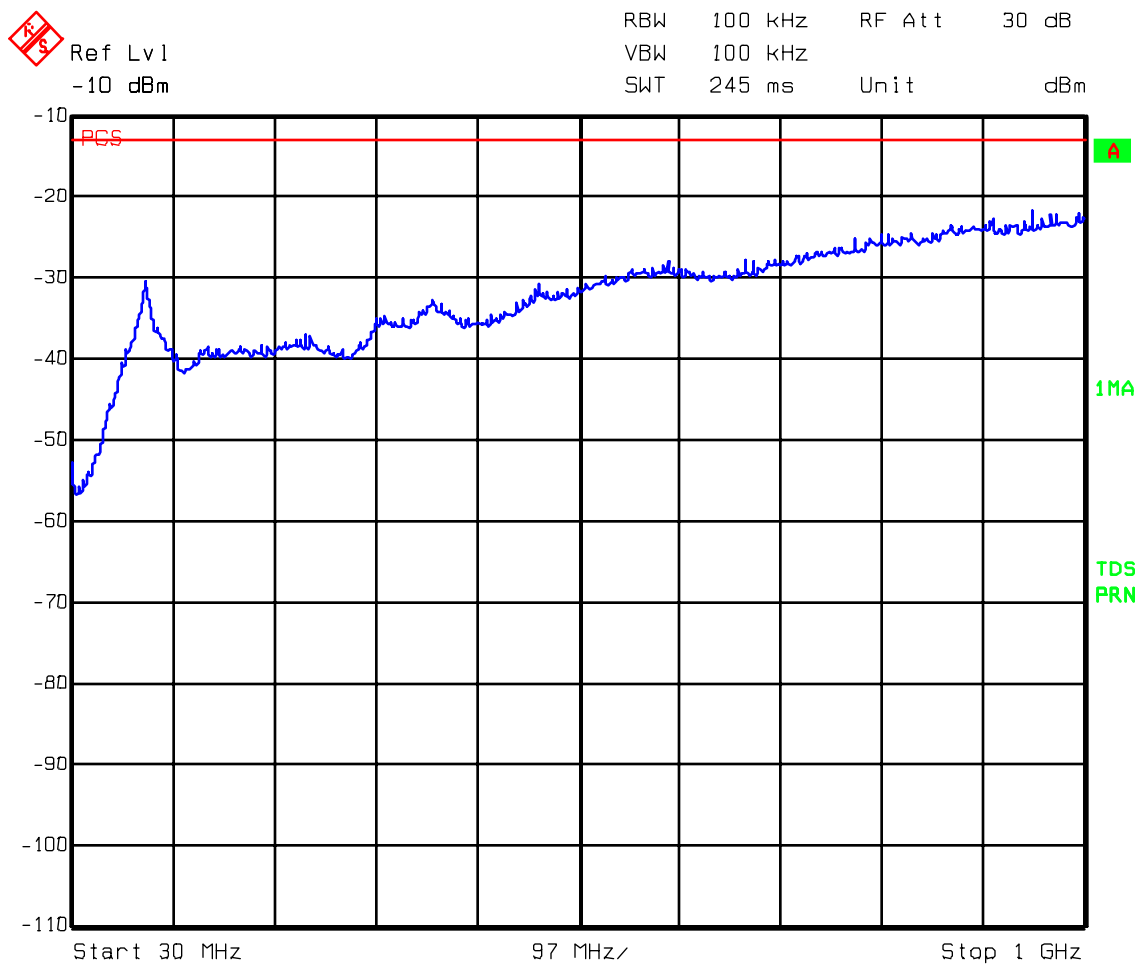
Spurious emission limit -13dBm



Date: 26.FEB.01 15:14:31

**Channel 810 :**  
**Radiated Spurious Emissions**

Spurious emission limit -13dBm



Date: 26.FEB.01 15:32:41



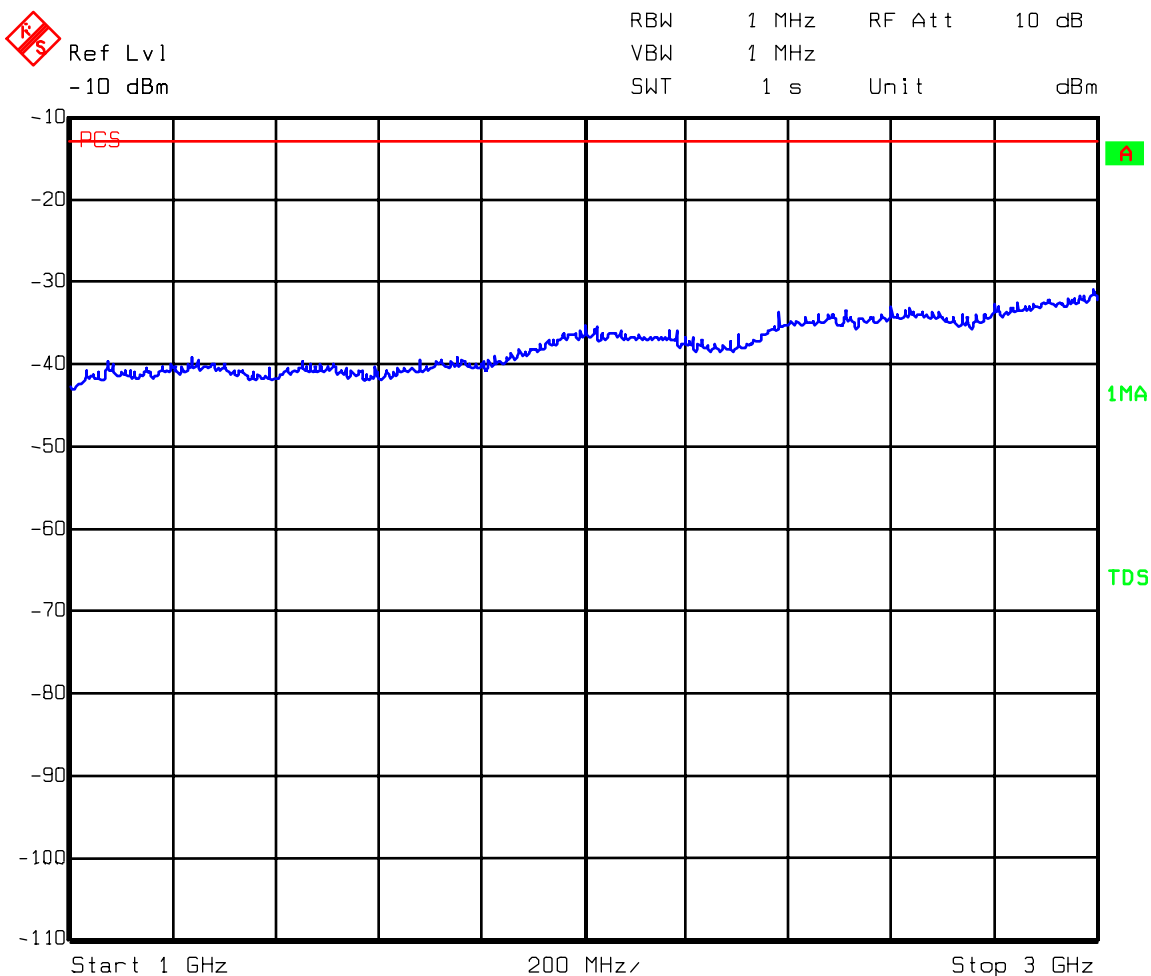








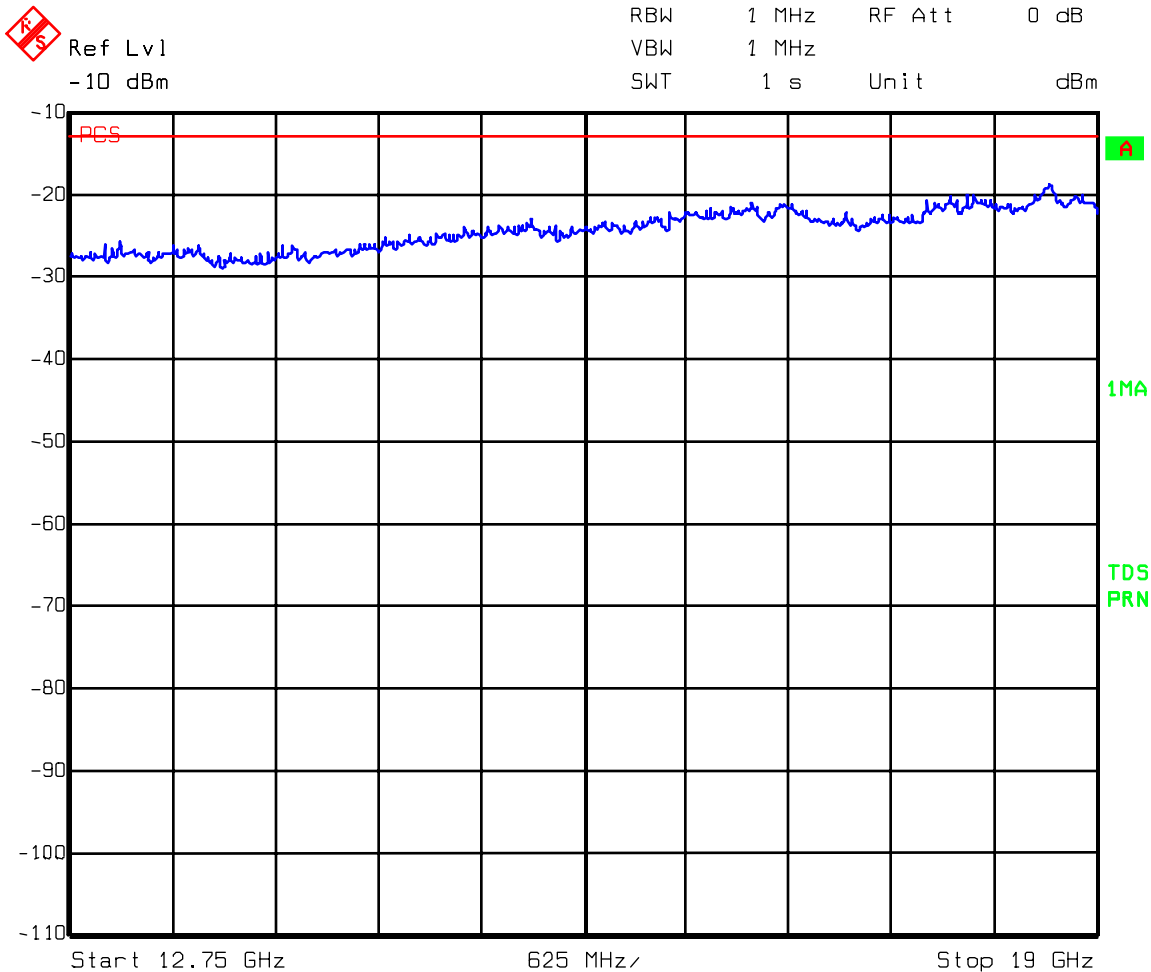
EUT in Idle Mode  
Radiated Spurious Emissions



Date: 26.FEB.01 14:52:44



**EUT in Idle Mode**  
**Radiated Spurious Emissions**



Date: 26.FEB.01 15:22:04

**Conducted Spurious Emissions****Measurement Procedure:**

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

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 equipment under test, this equates to a frequency range of 13 MHz to 19.1 GHz, data taken from 10 MHz to 20 GHz.

2. Determine EUT transmit frequencies: below outlines the band edge frequencies pertinent to conducted emissions testing.

**USPCS Transmitter****Channel Frequency**

512 1850.2 MHz

661 1880.0 MHz

810 1909.8 MHz

**Measurement Limit:**

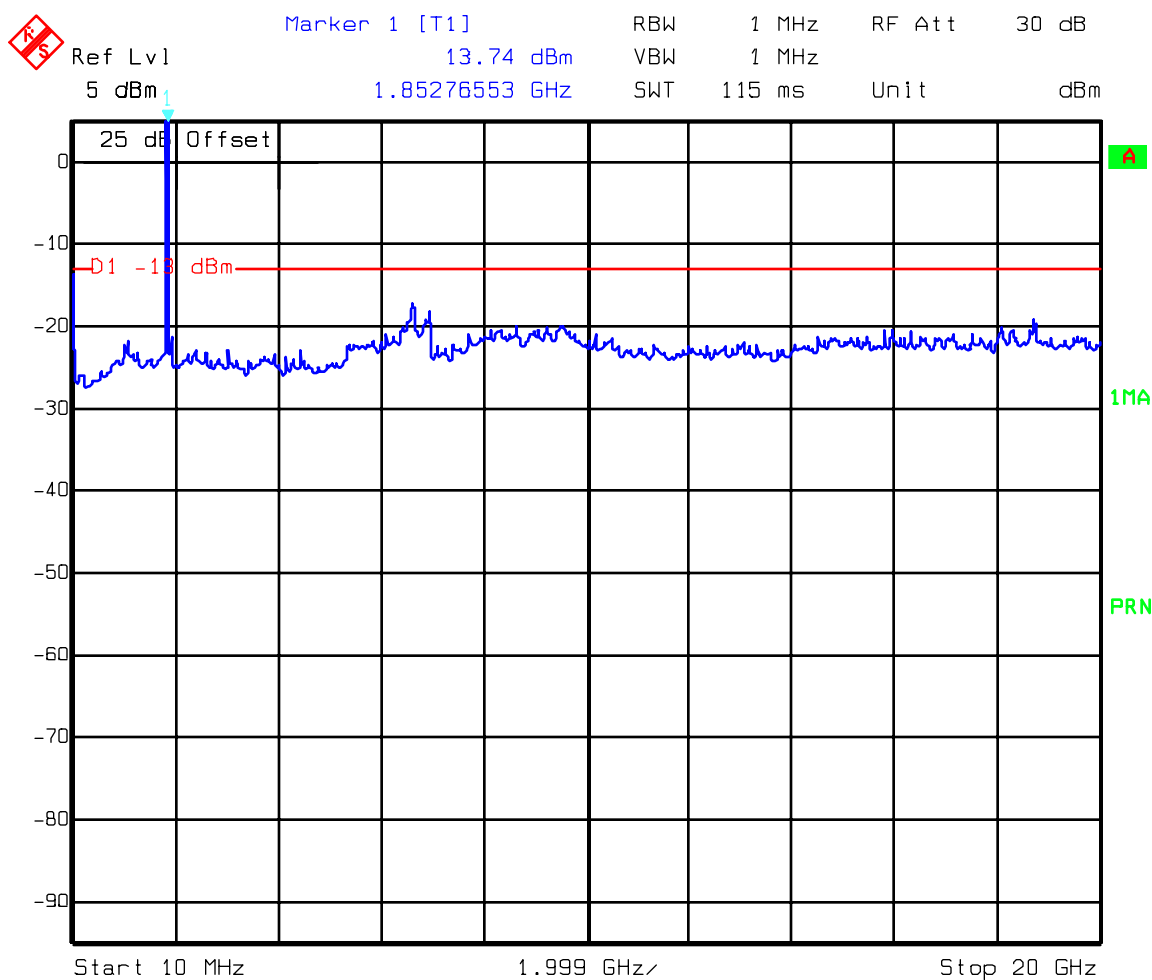
Sec. 24.238 Emission Limits.

(a) On any frequency outside frequency band of the USPCS spectrum, the power of any emission shall be attenuated below the transmitter power (P, in Watts) by at least  $43+10\text{Log}(P)$  dB. For all power levels +30 dBm to 0dBm, this becomes a constant specification limit of -13 dBm.

Measurements:

Channel: 512  
Conducted Spurious Emissions

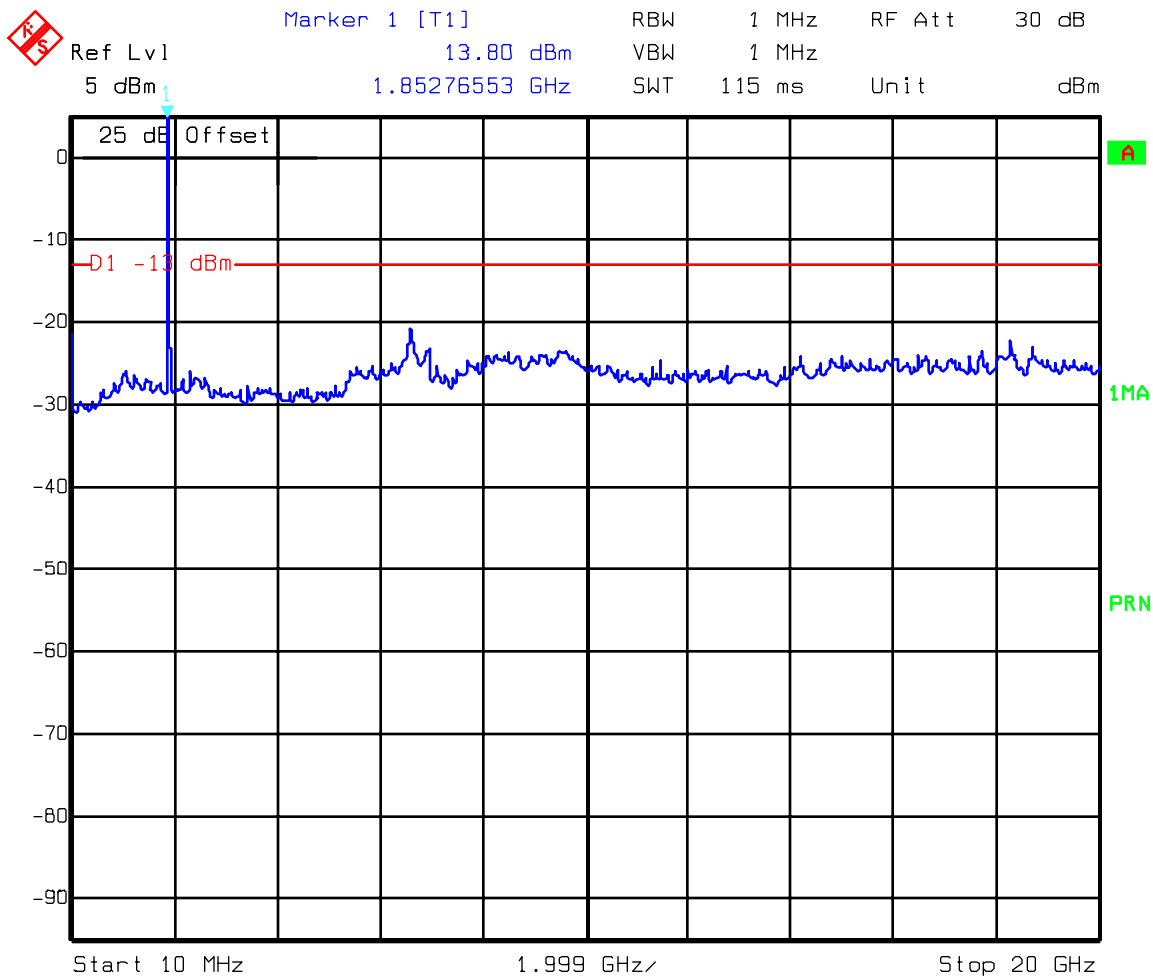
Note: Marker indicates the carrier signal frequency





Channel 661  
Conducted Spurious Emissions

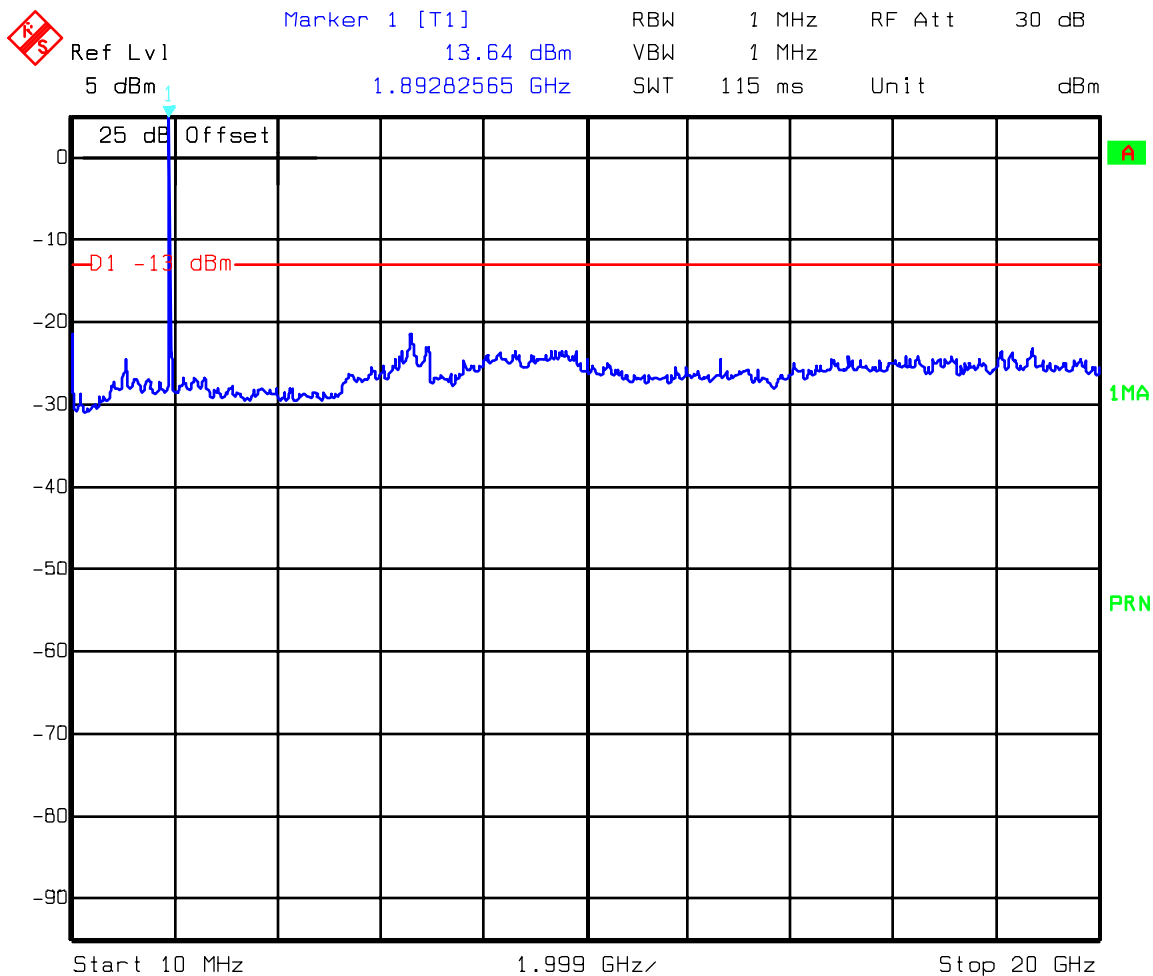
Note: Marker indicates the carrier signal frequency



Date: 26.FEB.01 16:14:19

**Channel 810**  
**Conducted Spurious Emissions**

Note: Marker indicates the carrier signal frequency



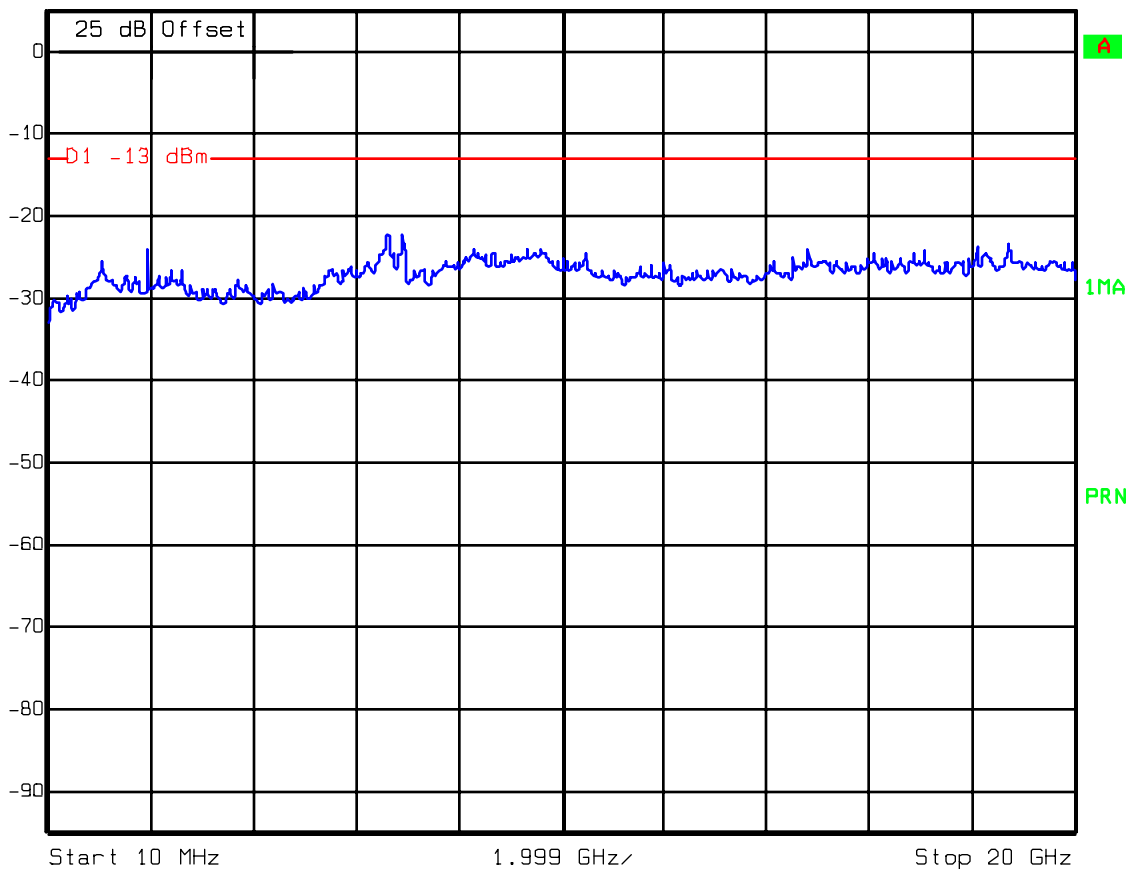
Date: 26.FEB.01 16:16:28

**EUT in Idle Mode**  
**Conducted Spurious Emissions**



Ref Lvl  
5 dBm

RBW 1 MHz RF Att 30 dB  
VBW 1 MHz  
SWT 115 ms Unit dBm



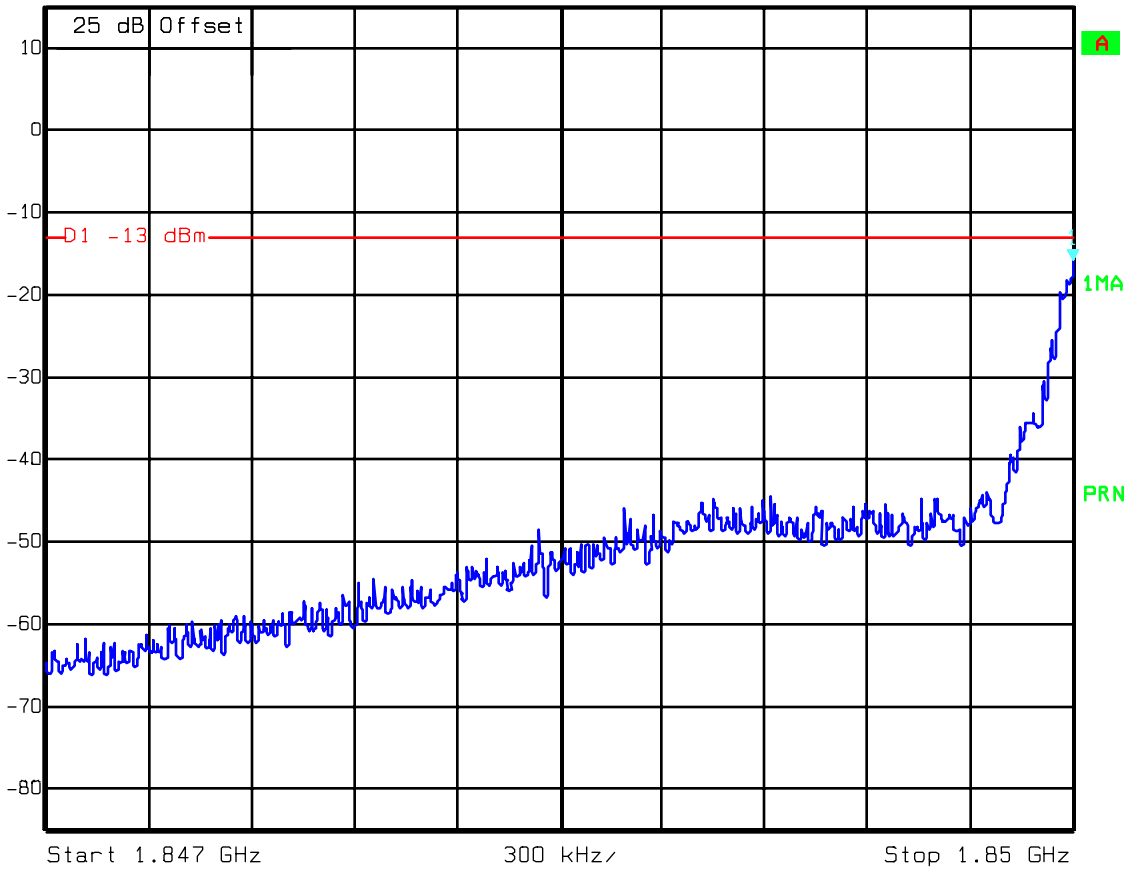
Start 10 MHz 1.999 GHz/ Stop 20 GHz

Date: 26.FEB.01 16:18:11

Lower Band Edge:



Marker 1 [T1] RBW 3 kHz RF Att 10 dB  
Ref Lvl -15.92 dBm VBW 3 kHz  
15 dBm 1.85000000 GHz SWT 840 ms Unit dBm



Date: 26.FEB.01 16:22:09



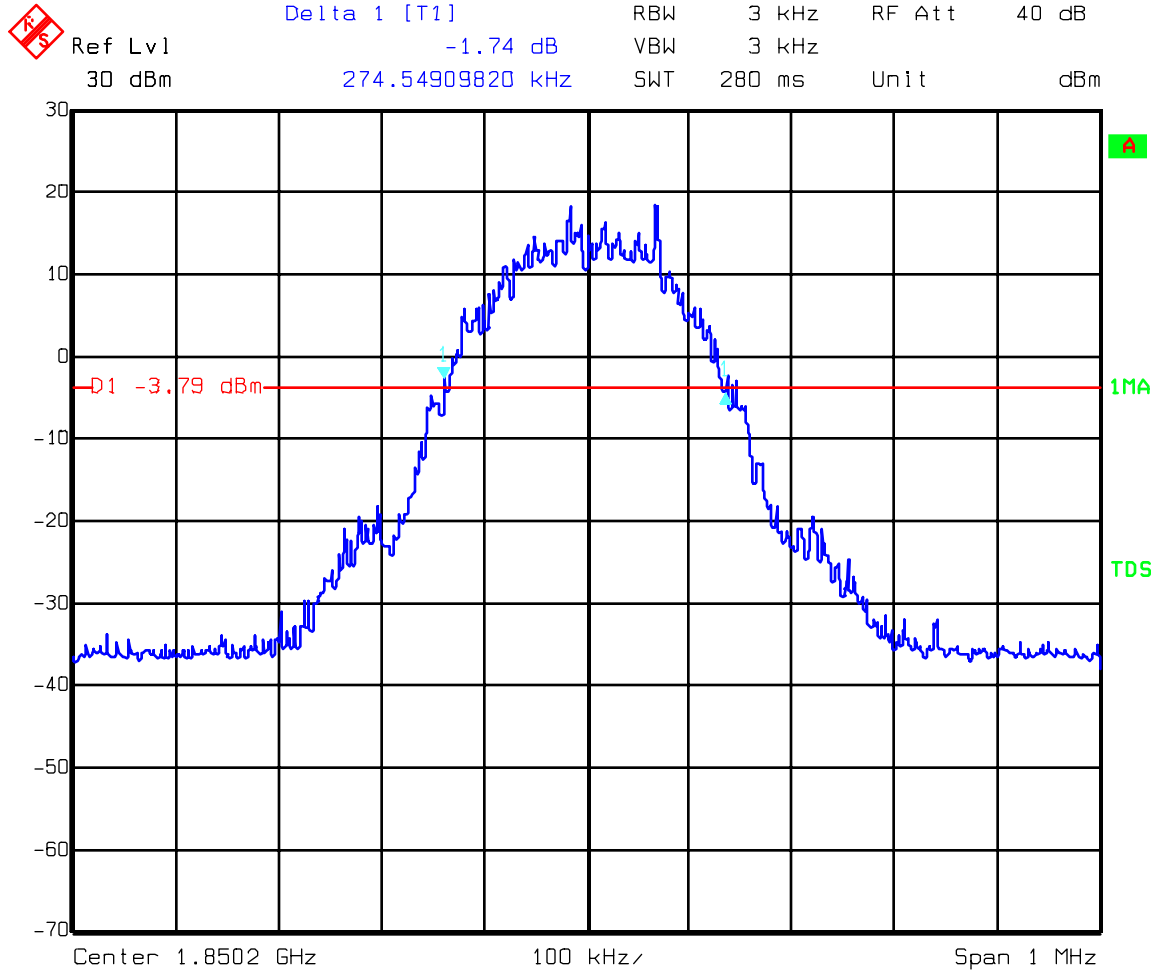
**OCCUPIED BANDWIDTH****\$2.989****Occupied Bandwidth Results**

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 USPCS frequency band. Table 8.2 below lists the measured 99% power and -26dBC occupied bandwidths. Spectrum analyzer plots are included on the following pages.

<b>Frequency</b>	<b>99% Occupied Bandwidth</b>	<b>-26 dBc Bandwidth</b>
<b>1850.2 MHz</b>	<b>274.5 kHz</b>	<b>316.6 KHz</b>
<b>1880.0 MHz</b>	<b>278.5 kHz</b>	<b>318.6 KHz</b>
<b>1909.2 MHz</b>	<b>278.5 kHz</b>	<b>318.6 KHz</b>

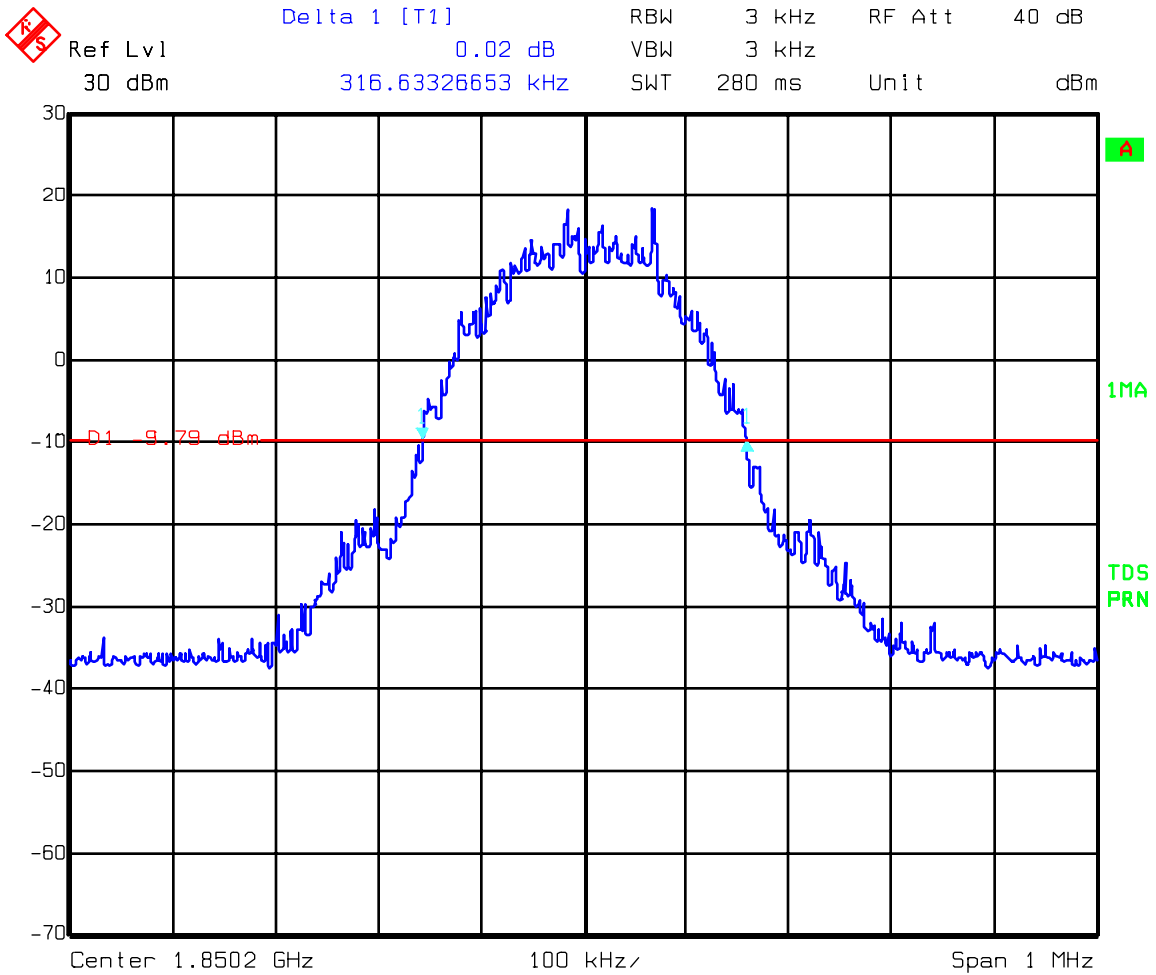
Part 24.238 (a) requires a measurement bandwidth of at least 1% of the occupied bandwidth. For ca. 290 kHz, this equates to a resolution bandwidth of at least 2.96 kHz. For this testing, a resolution bandwidth 3.0 kHz was used.

Channel 512  
99% Occupied Bandwidth



Date: 26.FEB.01 13:51:46

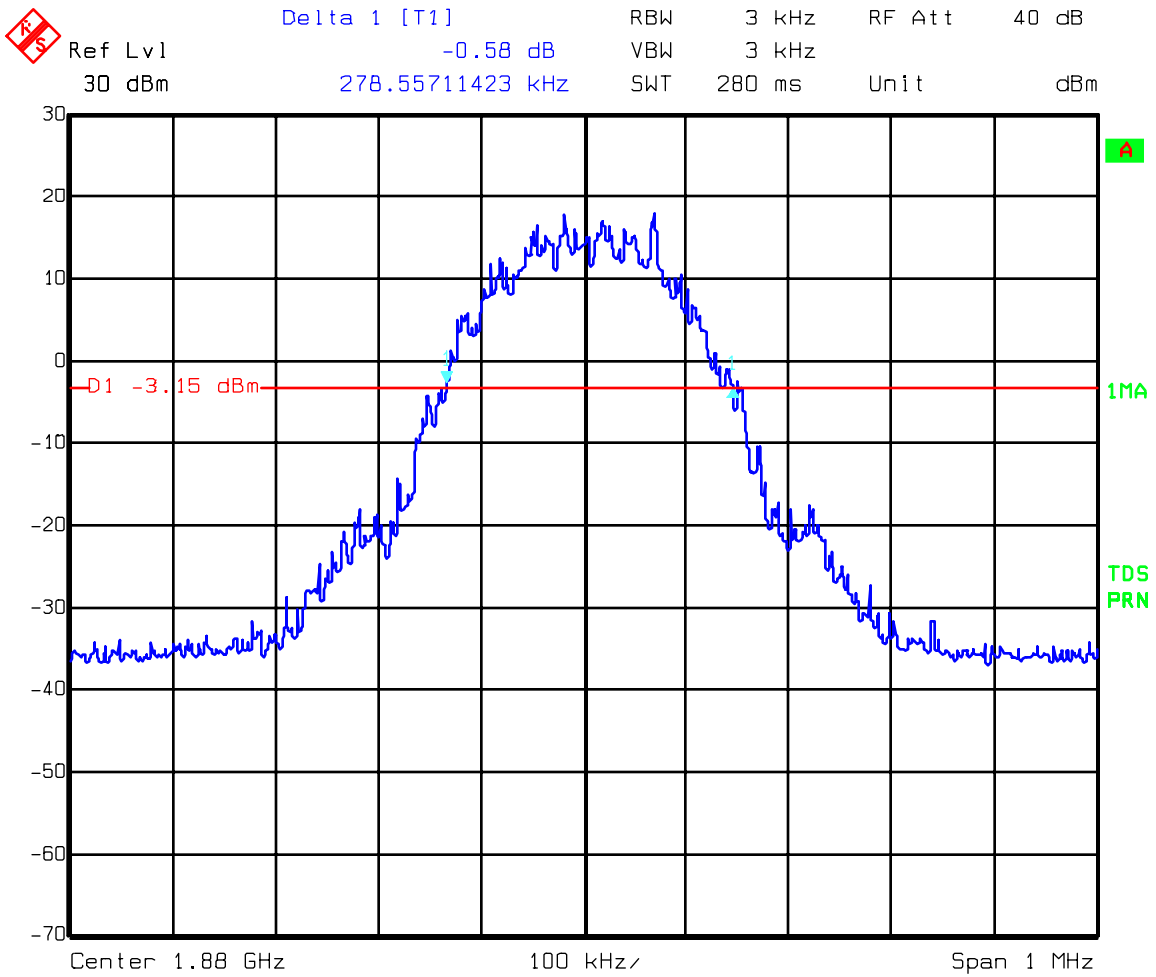
Channel 512  
-26 dBc Bandwidth



Date: 26.FEB.01 13:48:11

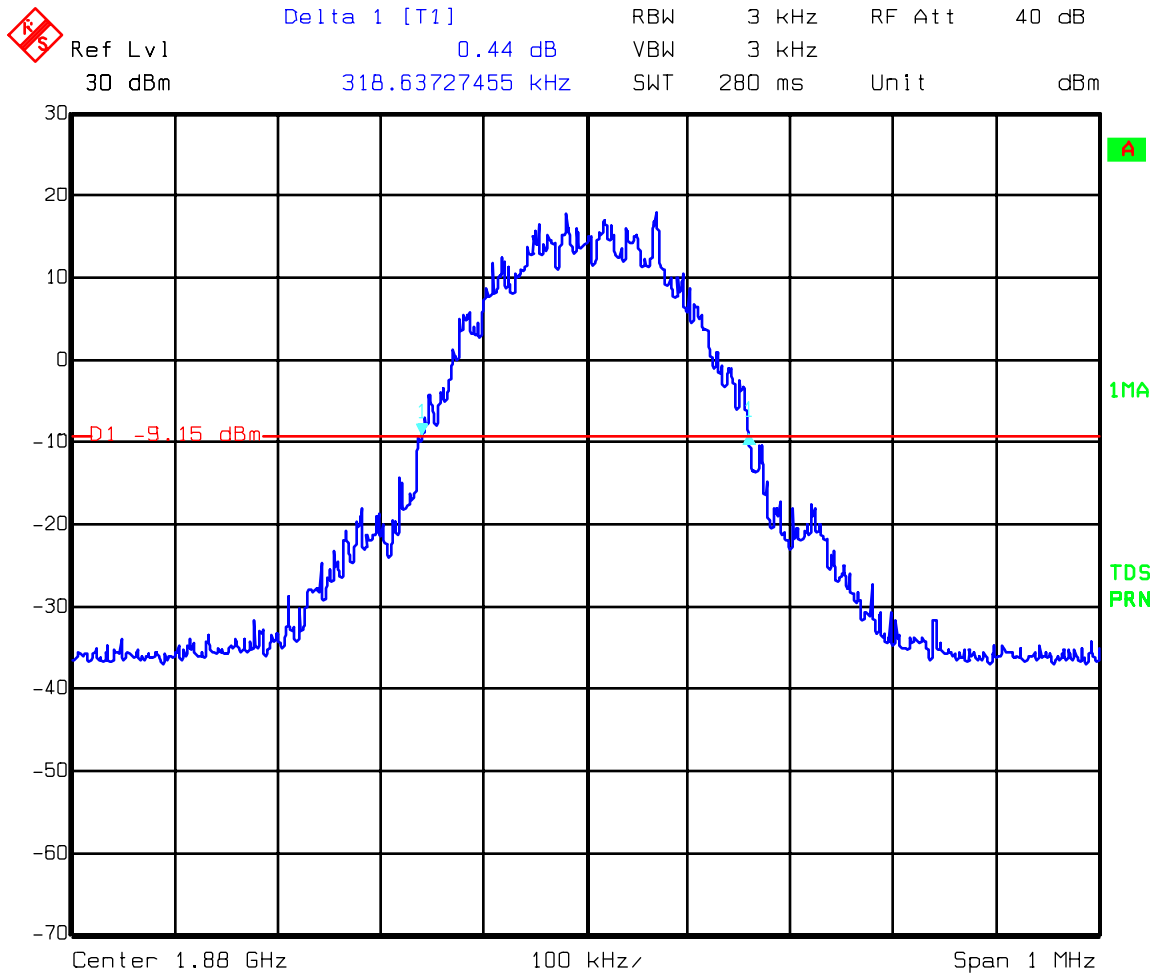


Channel 661  
99% Occupied Bandwidth



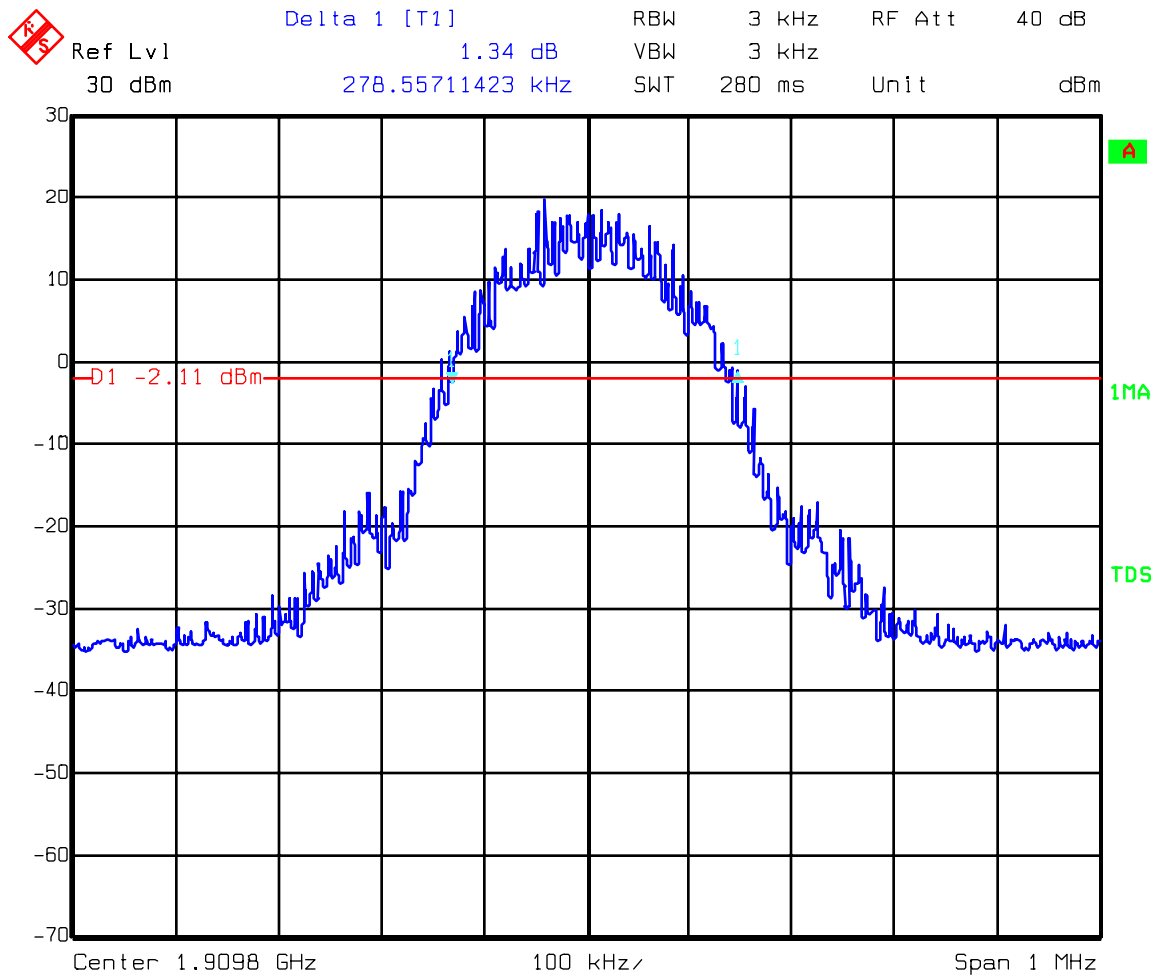
Date: 26.FEB.01 13:58:12

Channel 661  
-26 dBc Bandwidth



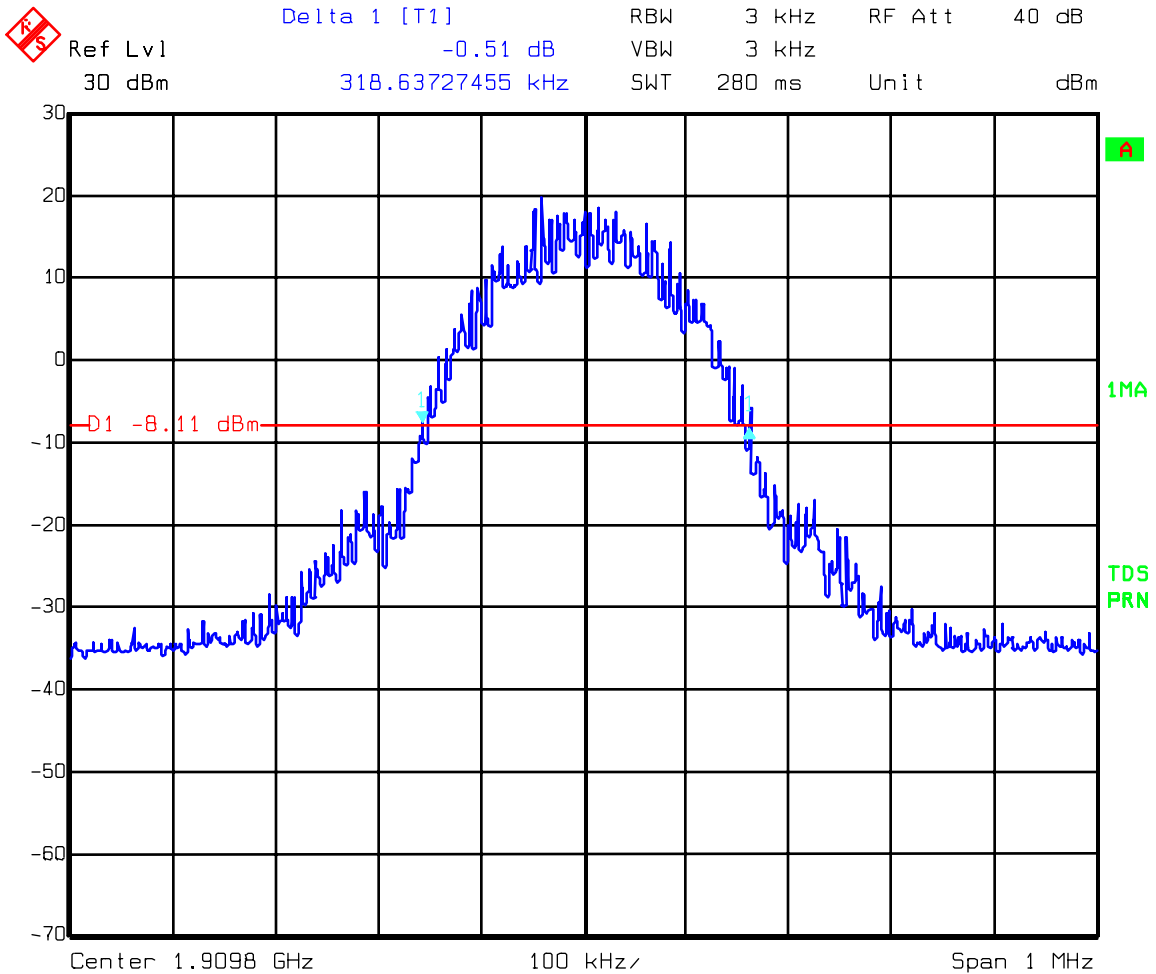
Date: 26.FEB.01 13:56:16

Channel 810  
99% Occupied Bandwidth



Date: 26.FEB.01 14:08:53

Channel 810  
-26 dBc Bandwidth



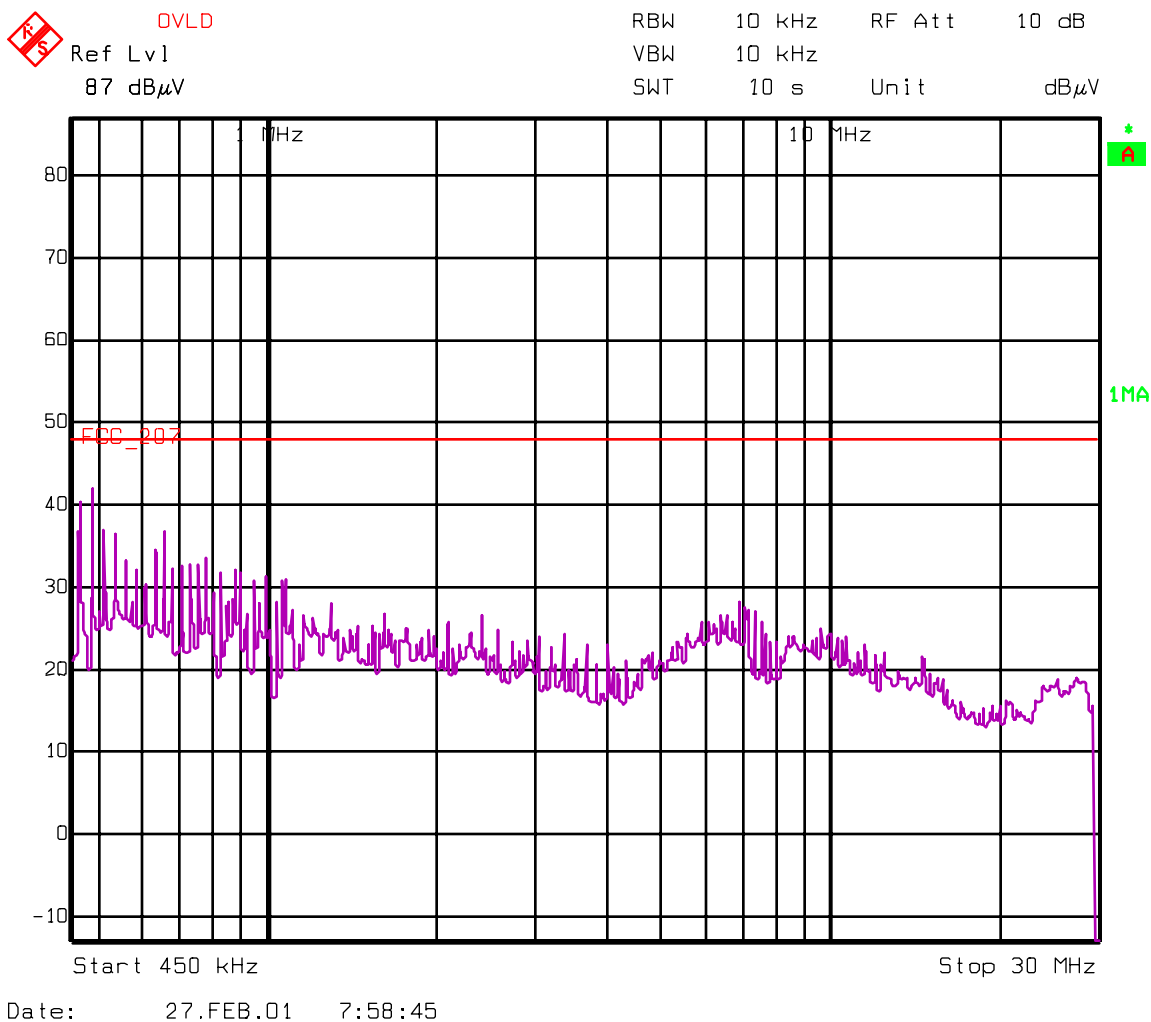
Date: 26.FEB.01 14:02:36

**CONDUCTED EMISSIONS**

§ 15.107/207

Measured with AC/DC power adapter plugged in LISN

Phase: Line

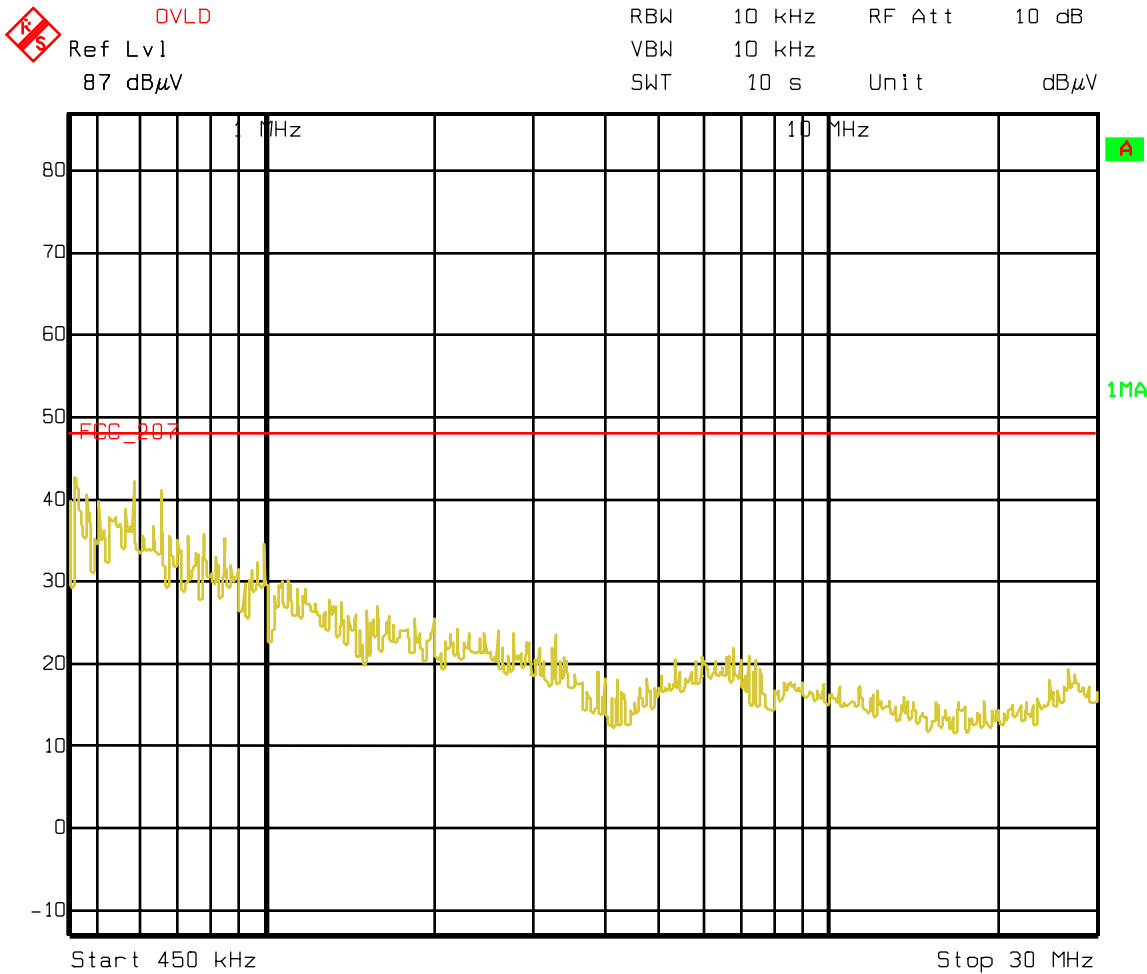


**Technical specification : 15.107 / 15.207 (Revised as of October 1, 1991 )**

**Limit**

0.45 to 30 MHz	250 μV / 47.96 dBμV
----------------	---------------------

Phase: Neutral



Date: 27.FEB.01 7:56:31

Technical specification : 15.107 / 15.207 (Revised as of October 1, 1991 )

Limit

0.45 to 30 MHz	250 μV / 47.96 dBμV
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**RECEIVER SPURIOUS RADIATION**

§ 15.209

<b>Frequency (MHz)</b>	<b>Field strength (<math>\mu\text{V/m}</math>)</b>	<b>Field strength (dB <math>\mu\text{V/m}</math>)</b>
<b>30 - 88</b>	<b>100</b>	<b>40</b>
<b>88 - 216</b>	<b>150</b>	<b>43.3</b>
<b>216 - 960</b>	<b>200</b>	<b>46</b>
<b>above 960</b>	<b>500</b>	<b>54</b>

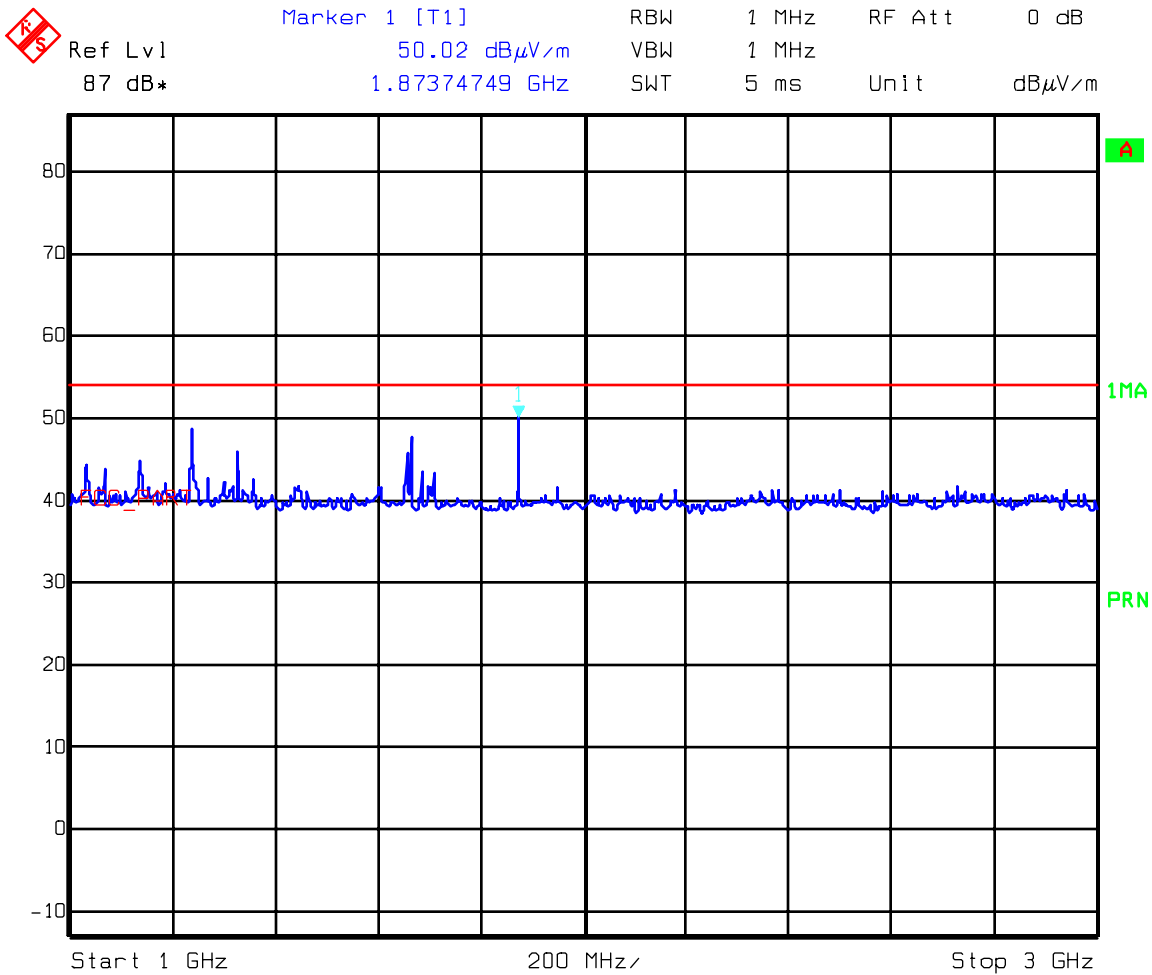
 $f < 1 \text{ GHz} : \text{RBW/VBW: } 100 \text{ kHz}$  $f \geq 1 \text{ GHz} : \text{RBW/VBW: } 1 \text{ MHz}$





RECEIVER SPURIOUS RADIATION

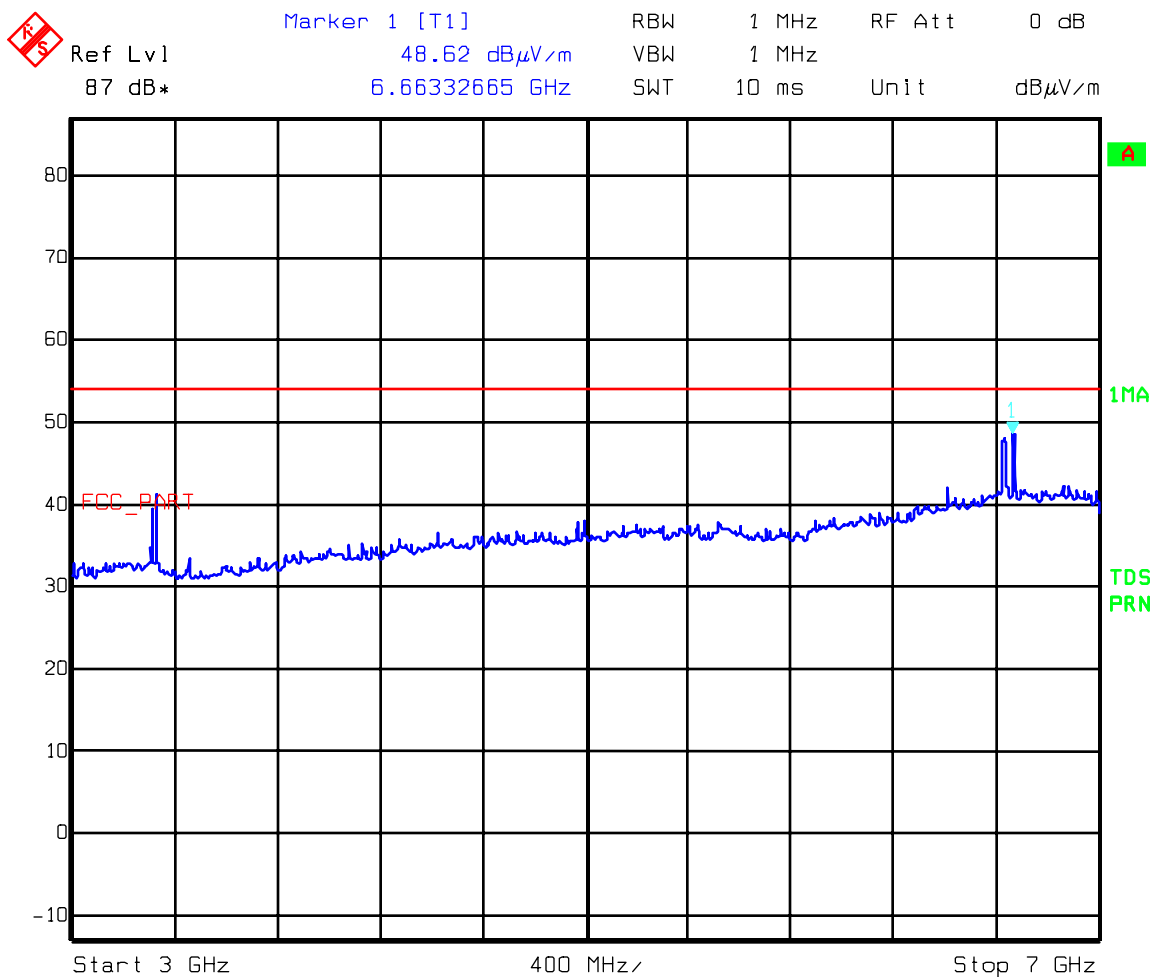
Plot No.2



Date: 4.JAN.80 10:17:30

RECEIVER SPURIOUS RADIATION

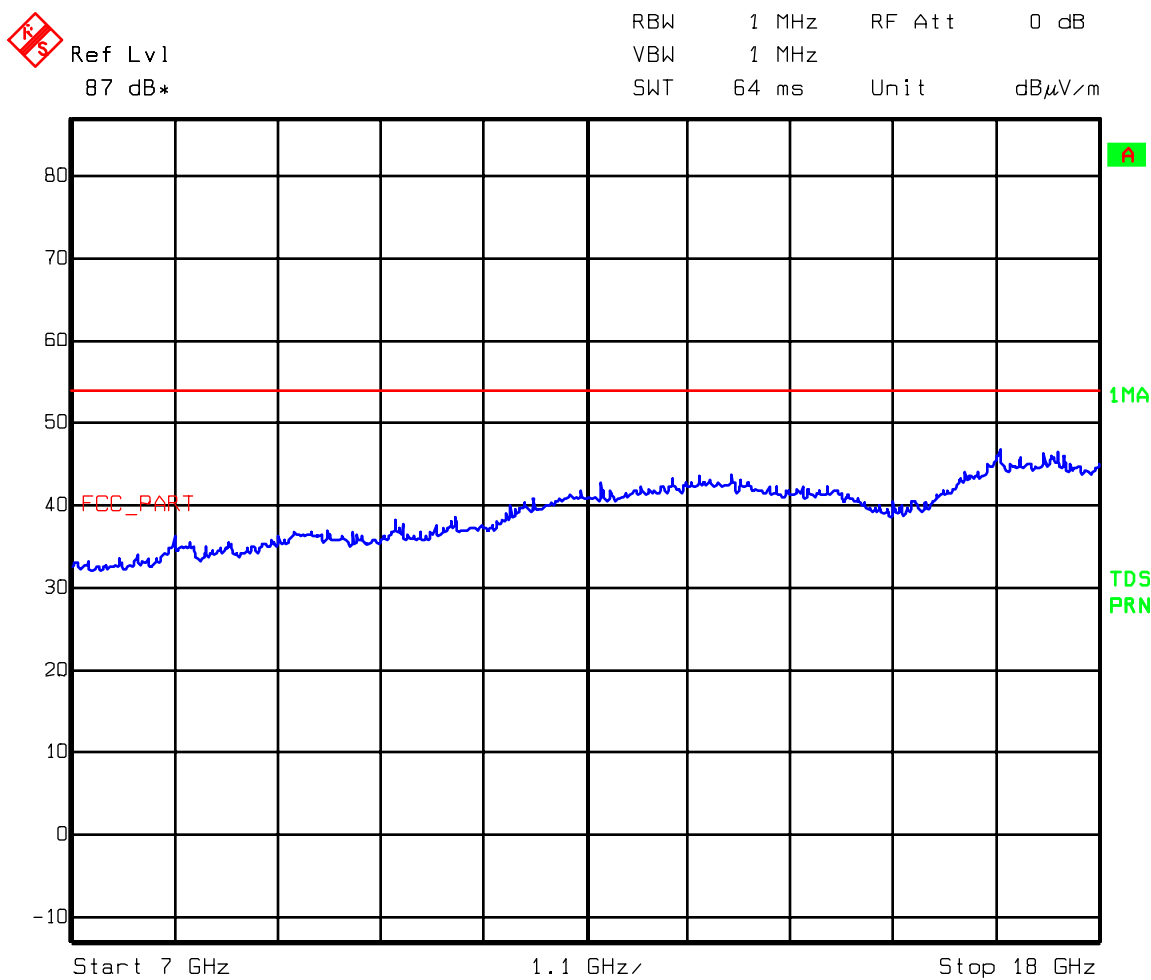
Plot No.3



Date: 4.JAN.80 10:10:39

RECEIVER SPURIOUS RADIATION

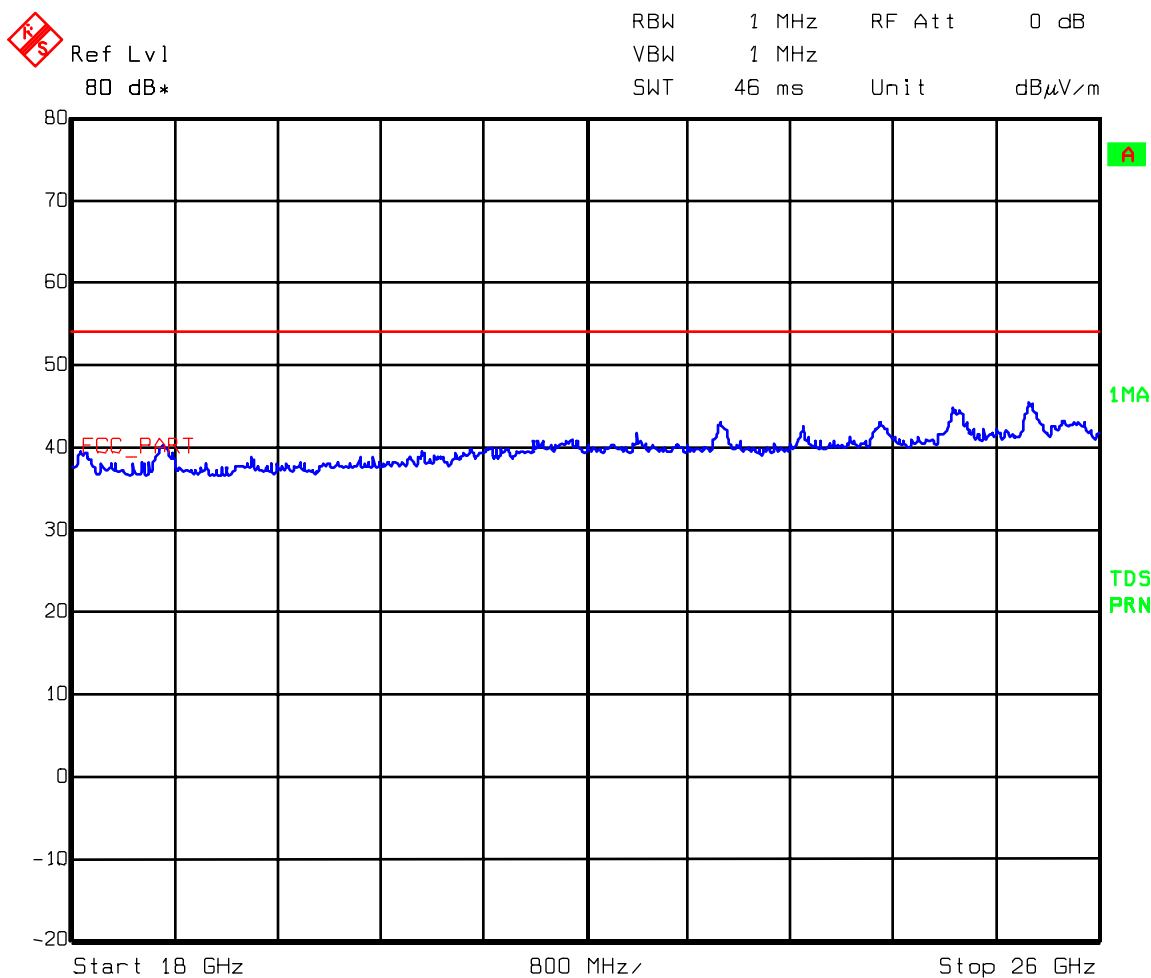
Plot No.4



Date: 4.JAN.80 10:37:30

RECEIVER SPURIOUS RADIATION

Plot No.5



Date: 4.JAN.80 10:40:20



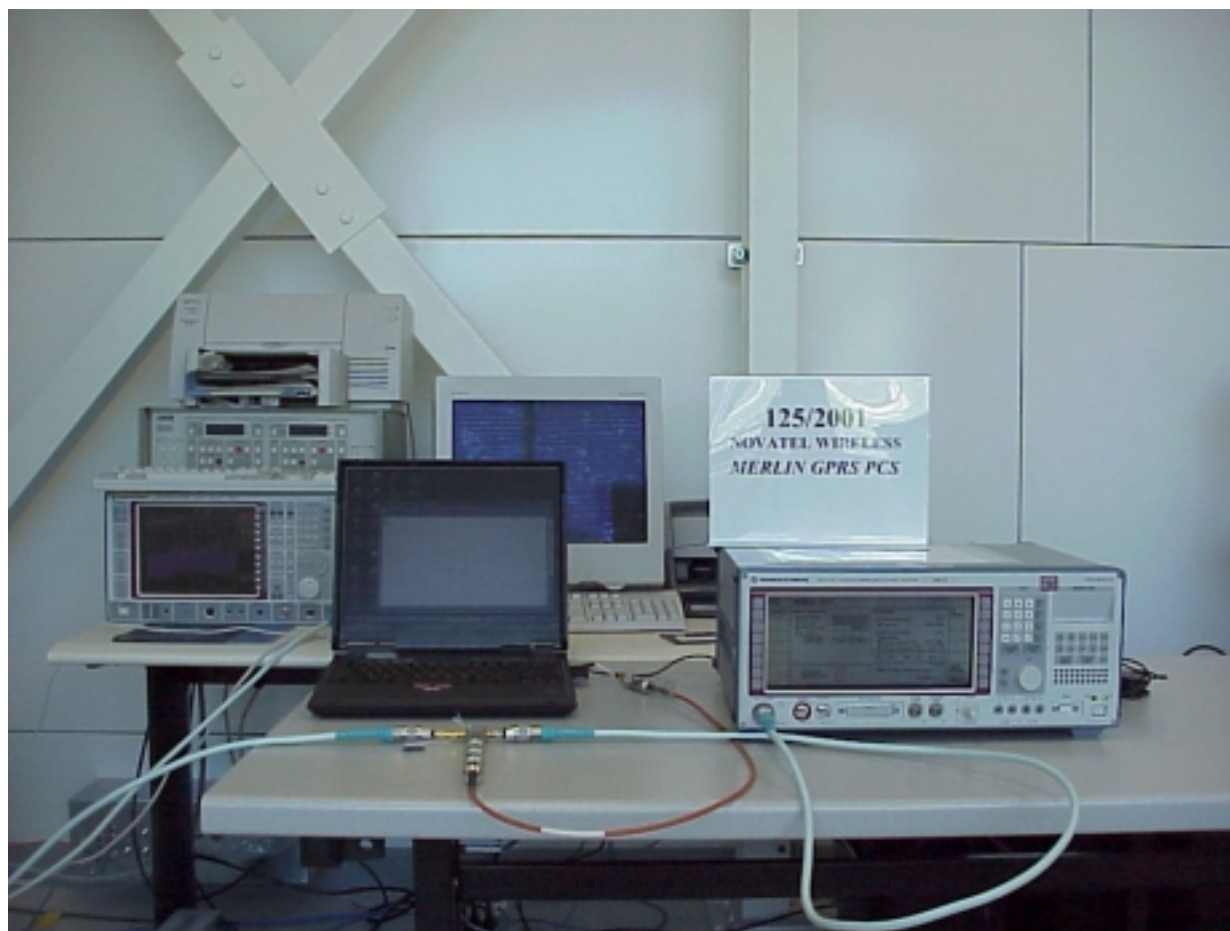
**Test site**

RADIATED EMISSIONS



**Test site:**

CONDUCTED EMISSIONS



**Test site:**

CONDUCTED EMISSIONS





Test site:  
EUT in Climatic Chamber



Photographs of the equipment

Photograph no.: 1



**Photographs of the equipment**

**Photograph no.: 2**





Photographs of the equipment

Photograph no.: 3

