GSM 1900

NORTEL NETWORKS

S2000L BTS GSM 1900 : FCC Part 24 Class II Permissive Change Application

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Abstract / Comments :

The document presents the FCC regulatory assessment achieved in order to introduce the following items into the S2000L BTS System :

- new design DRX
- new source of Duplexer
- modifications of the LPA
- Enhanced packaging

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DOCUMENT AMENDMENTS

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1. INTRODUCTION

1.1. OBJECT

The document presents the FCC regulatory assessment achieved in order to introduce the following items into the S2000L BTS System :

- new design DRX
- new source of Duplexer (ATG Forem)
- modifications of the LPA
- Enhanced packaging

These modifications have been evaluated to be a class II permissive change to the original FCC Part 24 Type Accepted equipment, as described in FCC Part 2 rules :

2.1001 Changes in type accepted equipment.

(a) Equipment of the same type is defined for purposes of type acceptance as being equipment which is electrically and mechanically interchangeable and in addition will have the same basic tube or semiconductor lineup, frequency multiplication, basic frequency determining and stabilizing circuitry, basic modulator circuit and maximum power rating. Variations in electrical and mechanical construction, other than the items indicated above are permitted, provided the variation or change is made in compliance with the requirements of paragraphs (b), (c) and (d) of this section.

(b) Two classes of permissive changes may be made in type accepted equipment without requiring a new application for and grant of type acceptance.

(1) A Class I permissive change includes those modifications in the equipment which do not change the equipment characteristics beyond the rated limits established by the manufacturer and accepted by the Commission when type acceptance is granted, and which do not change the type of equipment as defined in paragraph (a) of this section. No filing with the Commission is required for a Class I permissive change.

(2) *A Class II permissive change includes those modifications which bring the performance of the equipment outside the manufacturer's rated limits as originally filed but not below the minimum requirements of the applicable rules, and do not change the type of equipment as defined in paragraph (a) of this section. When a Class II permissive change is made by the grantee, he shall supply the Commission with complete information and results of tests of the characteristics affected by such change. The modified equipment shall not be marketed under the existing grant of type acceptance prior to acknowledgment by the Commission that the change is acceptable.*

1.2. SCOPE

The document applies to the S2000L BTS GSM 1900.

2. RELATED DOCUMENTS

2.1. APPLICABLE DOCUMENTS

[A1]	CFR 47 Part 2	Frequency allocations and radio treaty matters; general rules and regulations
[A2]	CFR 47 Part 24	Personal Computer Services

2.2. REFERENCE DOCUMENTS

[R1]	PCS/BTS/DJD/0330	S2000L 1900 program 98 step 3 FCC part 24 test report.
[R2]	888-215-04/e	Bull test report : EMI measurements according to CFR 47 Part 15 Class B and Part 24.

3. ABBREVIATIONS & DEFINITIONS

3.1. ABBREVIATIONS

DRX	Driver Receiver Unit
BTS	Base Transceiver Station
EP	Enhanced Packaging
GSM	Global System for Mobile Communications
LNA	Low Noise Amplifier
OMC	Operation and Maintenance Center
LPA	Low Power Amplifier
TCU	Trans-Coding Unit
MSC	Mobile Switching Center
RF	Radio Frequency
SBCF	Small Base Common Function

3.2. DEFINITIONS

None

4. ONGOING COMPLIANCE

As part of the Nortel Engineering Change Process, the Product Integrity group reviews all product changes to the S2000L BTS System. These reviews include an assessment of the impact that the changes or additions will have to the ongoing EMC/Radio Compliance of the System. When required, Analysis and Testing are performed to ensure continued compliance of the System.

Below is a list of the type of changes which are flagged during the reviews of product changes :

- Device changes which impact the clock speed or rise time
- Routing changes which could affect the emission and/or immunity profile for a circuit pack
- Changes to Power Supplies (input/output filtering, switching frequency, etc.)
- Addition of new circuit pack (electronic sub-assembly) to the S2000L BTS system (potential change in emission and/or immunity profile)
- Re-configuration of existing S2000L BTS hardware (variants) which change the emission profile (additional units, new combinations of units, etc.)
- Changes to the physical design which could impact Radio and/or EMC performances
- Addition of new sub-systems (variants) to the S2000L BTS system

Where analysis of changes to the S2000L BTS system indicates that verification testing is required to confirm continued compliance, the details of the changes to the system, test configuration and rationale, test results, and conclusions are included in this document for review and approval by the FCC, when required.

The BTS software is released in a controlled batch release format. For each of these releases, there may or may not be hardware content. New features are introduced at these structured release dates.

New features can be both hardware and software, or just one of the two. For all releases with hardware content, the ongoing compliance process outlined in this section is applied. For releases with only software content, no radio, engineering, or testing is required.

The architecture of the BTS Family of Products is such that the communication links are defined by the hardware (e.g. the ABIS link remains at the same data bit rate regardless of the actual data being transported). As such, the changes to software features which are not accompanied by hardware upgrades do not have any impact on the radio performances of the BTS Family of Products.

During testing, care is taken to ensure “worst case” system operational states are addressed. This ensures that all applications available on the BTS Family Hardware have been evaluated. Until there are updates to the hardware, no further system testing is required.

5. DESCRIPTION OF APPARATUS

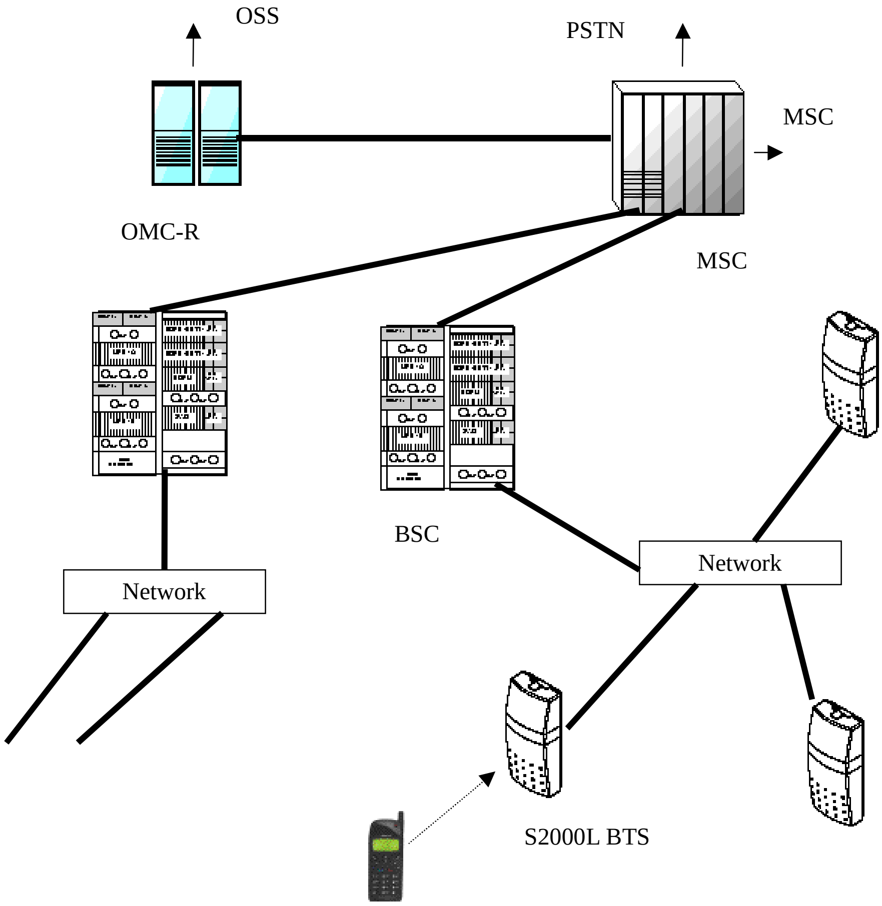
5.1. THE BTS SYSTEM

The Base Transceiver Station (BTS) provides the interface between the fixed network and the mobile stations which is a radio interface.

The radio interface carries signaling and speech/data channels using digitized and encoded signals modulated in GMSK in GSM 1900 MHz band for North American products.

Communication with the fixed network are enabled across a wire interface called the Abis interface. It connects the BTS to its Base Station Controller (BSC). The transmission of signaling, speech, and data channels is carried out on PCM link (also called ABIS interface).

The BTS configures its equipment, establishes, maintains and clears calls to and from mobile stations as directed by the Base Station Controller (BSC). The BTS organizes and manages radio-electric resources, supervises its own equipment and conducts stand-alone defense actions as and when required.



5.2. RF MANAGEMENT

Two frequency bands are allocated to the system as follows :

- downlink or “base to mobile” (TX part),
- uplink or “mobile to base” (RX part).

Both RX and TX bands are frequency divided into 200 kHz channels. Each channel is identified by an Absolute Radio Frequency Channel Number (ARFCN).

The first and the last channel on the edge of the bandwidth are not used for actual RF transmissions, and may be used for testing purposes.

All RF channels are time multiplexed according to the system fundamental TDMA frame, composed of up to eight time slots.

Each time slot is occupied by an RF burst. During the RF burst, the RF carrier may be modulated at a bit rate of 270 kb/s, using GMSK (Gaussian Minimum Shift Keying, with BT = 0.3) modulation.

In order to overcome propagation problems, the system uses slow frequency hopping techniques. The carrier frequency of each transmitter remains constant during each burst, and jumps randomly to any RF channel (over the full RF bandwidth) before transmitting the next burst.

The RF power generated by the transmitters is not constant: the peak power (defined as the r.m.s. power during the burst, excluding the leading and trailing edges) may be adjusted by the network operator for cell dimensioning and frequency reuse purpose.

In addition, the peak power may vary from one burst to the next one by 30 dB depending of the distance between the Base Transceiver Station and the mobiles.

The system may use voice activity detection (V.A.D.) and discontinuous transmission techniques (D.T.X.).

It is consequently impossible to predict, at each transmitter output, if a time slot will be actually used to transmit an RF burst, at which level, and how many carrier.

5.3. THE S2000L BTS

The S2000 Low Power BTS System is subdivided into six major areas :

- SBCF : this block is made of digital packs and provides management of the system as well as connection to the network
- DRX : it includes the whole set of functions necessary to handle a full TDMA frame including RF reception with diversity and RF transmission at low level
- LPA : the necessary amplification for transmission is achieved by a PA
- Duplexer and LNA : the duplexer provides separation between transmit and receive paths
- PSU : the core PSU provides power for all modules of the BTS
- Miscellaneous optional devices

SBCF

The SBCF module is the heart of the S2000L&L BTS. As described, this printed circuit pack (PCP) is composed of two boards: the small main common functions (SMCF) or board and the small PCM interface (SPCMI) board. In the S2000L&L system, to ensure that the package size would be minimized, all SBCF Interconnect (ICO) functions have been integrated onto the SMCF board. Each of these boards is described below :

- the SMCF board contains the functions of concentration, synchronization and switching. The SMCF includes the MC68MH360 QUICC32 control processor , a high stability clock synchronization block, a digital 8 x 8 PCM cross-point switch matrix, and all interfacing functions with the DRX, T1/E1, alarms, debug and maintenance. Additionally, all digital interconnect within the S2000L&L BTS have been integrated into the SMCF board

- the SPCMI board provides two PCM backhaul interfaces for the S2000L&L BTS . Two different hardware versions of this board support the following backhauls: dual T1 (100 Ohm); and dual E1 (120 Ohm)

DRX

The DRX includes the whole set of functions necessary to handle a full TDMA frame including RF reception with MRC diversity and RF transmission at low level.

The necessary amplification for transmission is achieved by a separate Power Amplifier (PA).

The main functionalities supported by the DRX are the following :

- support of the Abis interface
- (Discontinuous) Transmission of GMSK modulation
- diversity reception
- RF Power control
- Equalization
- channel (de)coding, for full and half rate speech channels, and for data channels
- frequency hopping (RF and Baseband)
- ciphering (A5/1 and/or A5/2, according to authorized ciphering algorithms)
- local alarms management

The following functionalities are NOT SUPPORTED by the DRX :

- collocated speech transcoders
- statistical transmit diversity
- transmit diversity

The DRX is composed of four boards :

- a DRX logic board including a frame processor, TX logic (GMSK modulation) and a local time base
- a DRX radio board including a low power driver and a dual receiver
- two power supplies conversion boards

LPA

The PA subassembly is designed as a stand alone unit, which may be used either inside the BTS, or remotely located outside the BTS. It is mounted in a closed metal housing fitted with a suitable heat sink and provided with RF coaxial and DC multiway connectors.

Furthermore the internal conception is done in such a way all the PA electronic circuits can be usable with no modification for MEU or SMART facet purposes if higher EIRP is required. The PA includes its own DC/DC converter.

The PA basic function consists in boosting the level of the GMSK modulated RF pulse, generated by the Tx driver (located in the DRx subassembly), up to the RF power level of the whole transmitter chain before the coupling stages.

The PA RF output power is measured with a built-in calibrated detector. The DRX receives this information from the PA (local or remote), and closes an ALC loop by acting on the driver, so that the RF power is levelled at the detector location.

As it can be used inside the BTS rack or remotely, the PA must include a micro controller in order to digitise some control signals.

The DRX and the PA amplifier are designed to take into account up to a maximum of 15 dB of cable losses for interconnection.

6. DESCRIPTION OF APPLICATION

6.1. NEW DESIGN DRX

In order to achieve some cost reduction, the S2000L BTS DRX has been redesigned. The general architecture remains unchanged but modifications have been achieved on the RF boards, leading thus to RF performances improvements.

In order to demonstrate ongoing compliance, the following tests are needed :

- Frequency Stability with power supply and temperature variations
- Conducted Spurious Emissions
- Occupied bandwidth
- RF Output Power

6.2. NEW SOURCE OF DUPLEXER

A new source of duplexer has been introduced in the S2000 L BTS. It allows to propose a multi supplier source. This duplexer is also cost reduced.

In order to demonstrate ongoing compliance, the following tests are needed :

- Conducted Spurious Emissions
- RF Output Power

6.3. MODIFICATIONS OF THE LPA

Four modifications are achieved on the LPA 1900 :

- a tolerance is changed so that the RF PA board could easier fit into the mother board
- the drilling diameter for components is reduced to avoid chips weakening
- a power transistor track is modified for its soldering being “fuji” done
- the material used for making the PCB (printed circuit board) was GETEK (American brand). It will be replaced by FR4 (found in Europe). GETEK is in fact an improved FR4. Consequence is a slight loss in the PA gain (around 0.1 to 0.2 dB) and thus in the PA output

The codes of the modules do not change. No additional testing is required. Indeed, the three first modifications have no impact. For the fourth one, as the PA output slightly decreases, levels for spurious measurements tests are better (besides, this test is passed for the PA module with a threshold of -38dBm).

6.4. ENHANCED PACKAGING

In order to achieve some cost reduction and provide improved electromagnetic and environmental enclosure, the mechanical structure of the BTS changes to an "*enhanced packaging*".
All radio or functional modules are strictly the same between this new packaging and the today approved one.

In order to demonstrate ongoing compliance, the following tests are needed :

- Frequency Stability with power supply and temperature variations
- Field strength of spurious radiation

7. CONCLUSION

As demonstrated in Exhibit 1, the S2000L BTS including all the above listed modifications still complies with FCC Part 24 requirements.

8. EXHIBIT 1 : TESTS REPORT

8.1. INTRODUCTION

The following information is submitted for update of the type acceptance of a Broadband PCS Base Station for Northern Telecom Inc. in accordance with FCC Part 24, Subpart E and Part 2, Subpart J of the FCC Rules and Regulations. The measurement procedures were in accordance with the requirements of Part 2.999.

8.2. MEASUREMENT RESULTS SUMMARY

Table 1 is a summary of the measurement results for this update.

Table 1 : Measurement Results Summary

FCC Measurement Specification	IC Limit Specification	Description	Result
2.985	24.232	RF Power Output	Complies
2.987		Modulation characteristics	Complies
2.989		Occupied Bandwidth	Complies
2.991, 2.997	24.328	Spurious Emissions at Antenna Terminals	Complies
2.993, 2.997	24.328	Field Strength of Spurious Radiation	Complies
2.995	24.235	Frequency Stability	Complies
24.51 (d)	24.51 (d)	RF Hazards	Not tested

8.3. MEASUREMENT RESULTS

The following sections contain the measurement results.

8.4. 2.985 RF OUPUT POWER

8.4.1. FCC REQUIREMENTS : PART 24.232

(a) Base stations are limited to 1640 watts peak equivalent isotropically radiated power (e.i.r.p.) with an antenna height up to 300 meters HAAT. See 24.53 for HAAT calculation method. Base station antenna heights may exceed 300 meters with a corresponding reduction in power. In no case may the peak output power of a base station transmitter exceed 100 watts

(b) Peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

8.4.2. TEST RESULTS

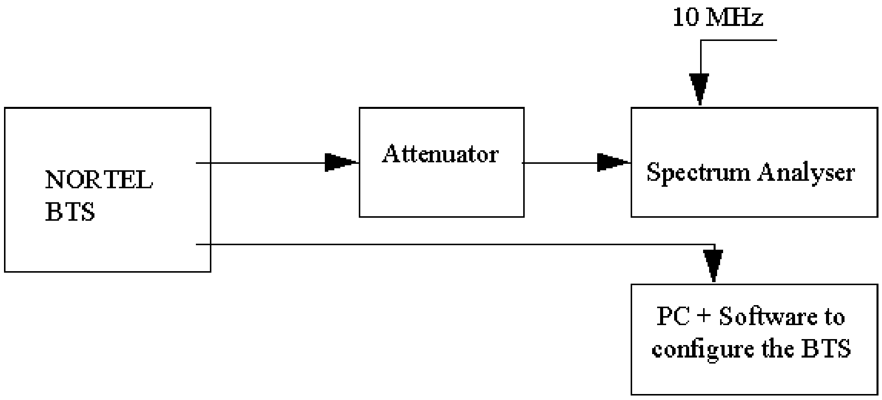
Table 2 shows the test results for RF Output Power.

Table 2 : Test results for RF Output Power

ARFCN	Frequency (MHz)	Measured RF Output Power (dBm)		Maximum Rated Power (dBm)	Limit (dBm)
		Ant 1	Ant 2		
513	1930.4	34.4	34.4	37	50
548	1937.4	34.7	34.3	37	50
585	1944.8	35.0	34.6	37	50
587	1945.2	35.0	34.6	37	50
598	1947.4	35.0	34.4	37	50
610	1949.8	35.0	34.4	37	50
612	1950.2	34.9	34.3	37	50
648	1957.4	35.2	34.5	37	50
685	1964.8	34.9	34.4	37	50
687	1965.2	34.9	34.4	37	50
698	1967.4	34.9	34.4	37	50
710	1969.8	35.0	34.2	37	50
712	1970.2	35.0	34.4	37	50
723	1972.4	35.0	34.2	37	50
735	1974.8	35.2	34.3	37	50
737	1975.2	35.1	34.3	37	50
773	1982.4	34.9	34.5	37	50
809	1989.6	34.8	34.5	37	50

8.4.3. TEST PROCEDURE

The following test bench is re-used for the other tests.



The BTS was configured to transmit at maximum power (static level 0). Measurements were made at frequencies which are the bottom, middle and top of each of the licensed blocks.

The peak output power was measured using the spectrum analyzer which had the following settings :

Resolution Bandwidth	300 kHz
Video Bandwidth	1 MHz
Span	0 Hz
Reference Level	45 dBm
Reference Level Offset	corrected to account for cables and attenuator losses
Level Range	10 dB
Sweep Time	5 ms

8.5. 2.989 OCCUPIED BANDWIDTH

8.5.1. FCC REQUIREMENTS : PART 24.289

The occupied bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

8.5.2. TEST RESULTS

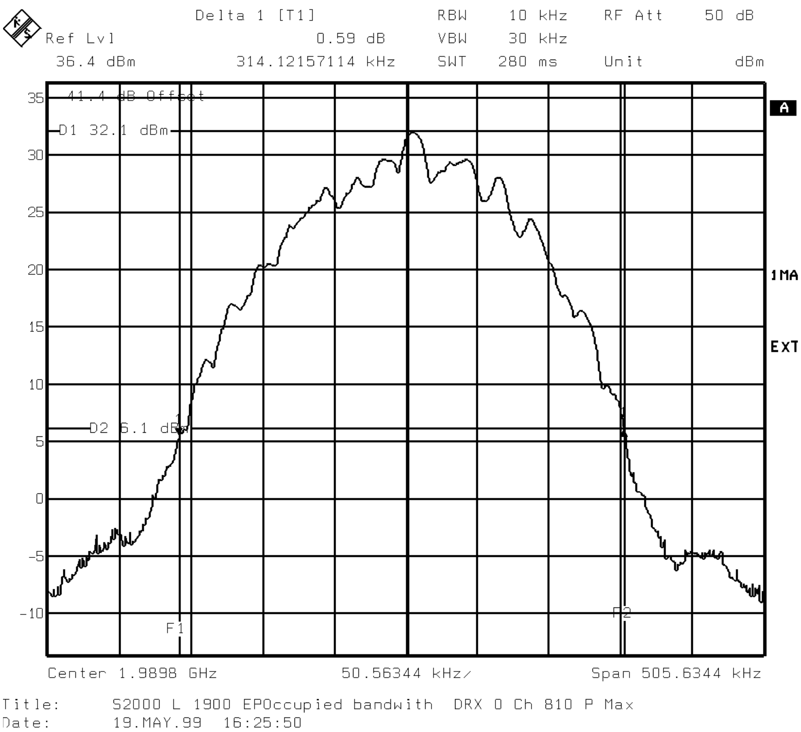
Table 3 shows the results for Occupied bandwidth.

Table 3: Test Results for Occupied bandwidth

ARFCN	Frequency (MHz)	Measured Occupied Bandwidth (kHz)	
		Ant 1	Ant 2
512	1930.2	309.1	309.1
661	1960.0	309.1	309.1
810	1989.8	314.1	312.2

Figure 1 shows a sample plot for the measurement of the occupied bandwidth. The maximum occupied bandwith was found to be 314.1 kHz.

Figure 1 : Sample plot for occupied bandwidth



8.5.3. TEST PROCEDURE

The BTS was configured to transmit at maximum power (static level 0). Measurements were made at frequencies which are the bottom, middle and top of each of the licensed blocks.

The occupied bandwidth was measured by determining the bandwidth out of which all emissions are attenuated at least 26 dB below the transmitter power.

The spectrum analyzer had the following settings :

Resolution Bandwidth	10 kHz
Video Bandwidth	30 kHz
Span	1 MHz
Reference Level	45 dBm
Reference Level Offset	corrected to account for cables and attenuator losses
Level Range	100 dB
Sweep Time	25 ms

8.6. 2.991 SPURIOUS EMISSIONS AT ANTENNA TERMINALS

8.6.1. FCC REQUIREMENTS : PART 24.238

(a) On any frequency outside a licensee's frequency block, the power of any emission shall be attenuated below the transmitter power (P) by at least 43 + 10 log (P) dB.

(b) Compliance with these provisions is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(b) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges, both upper and lower, as the design permits.

(d) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

8.6.2. TEST RESULTS

The emission bandwidth was found to be 314.1 kHz. This value was used to determine the resolution bandwidth required for measurements in the first adjacent MHz outside the licensee's frequency block.

The reference level for spurious emissions at the antenna terminals was taken from the measured output power (35.2 dBm = 3.3 Watts). Therefore the spurious emissions must be attenuated by at least 43 + 10*Log(3.3) = 48.2 dB. The measured output power was 35.8 dBm ; therefore the limit is 48.2 - 35.2 = -13 dBm.

Table 4 shows the results for Spurious Emissions at Antenna Terminals.

Table 4 : Test results for Spurious Emissions at Antenna Terminals

PCS Block	TCH Channel	Power configuration	Minimum margin in dBm (Limit = -13 dBm)	
			DRX 0	**DRX 1**
A	512	Pmax - 6 dB	4.5	7.0
A	513	Pmax	29.7	31.5
A	584	Pmax	29.1	30.2
A	585	Pmax - 6 dB	1.2	1.6
D	587	Pmax - 6 dB	2.2	3.6
D	588	Pmax	30.1	30.2
D	609	Pmax	28.1	30.3
D	610	Pmax - 6 dB	1.4	2.0
B	612	Pmax - 6 dB	2.9	3.6
B	613	Pmax	30.0	30.9
B	684	Pmax	29.3	30.5
B	685	Pmax - 6 dB	1.3	1.8
E	687	Pmax - 6 dB	3.9	3.7
E	688	Pmax	29.3	30.9
E	709	Pmax	29.4	30.7
E	710	Pmax - 6 dB	1.0	2.2
F	712	Pmax - 6 dB	2.3	3.0
F	713	Pmax	30.0	29.6
F	734	Pmax	28.3	30.4
F	735	Pmax - 6 dB	0.9	2.0
C	737	Pmax - 6 dB	2.3	4.0
C	738	Pmax	29.6	30.4
C	809	Pmax	28.4	29.2
C	810	Pmax - 6 dB	0.7	1.8

Notes :

- Measurements were made for both Antenna 1 and Antenna 2 connectors. The worst case emission was presented for each frequency range measured.
- Figure 2 shows sample plot for the case when the transmitter was tuned to Channel 735 with the power reduced by 6 dB.
- Figure 3 to Figure 16 show sample plots for frequency spans from 0 to 20 GHz (the transmitter was tuned to channel 810).

Figure 2 : 1 MHz adjacent band (Channel 735, Pmax -6 dB)

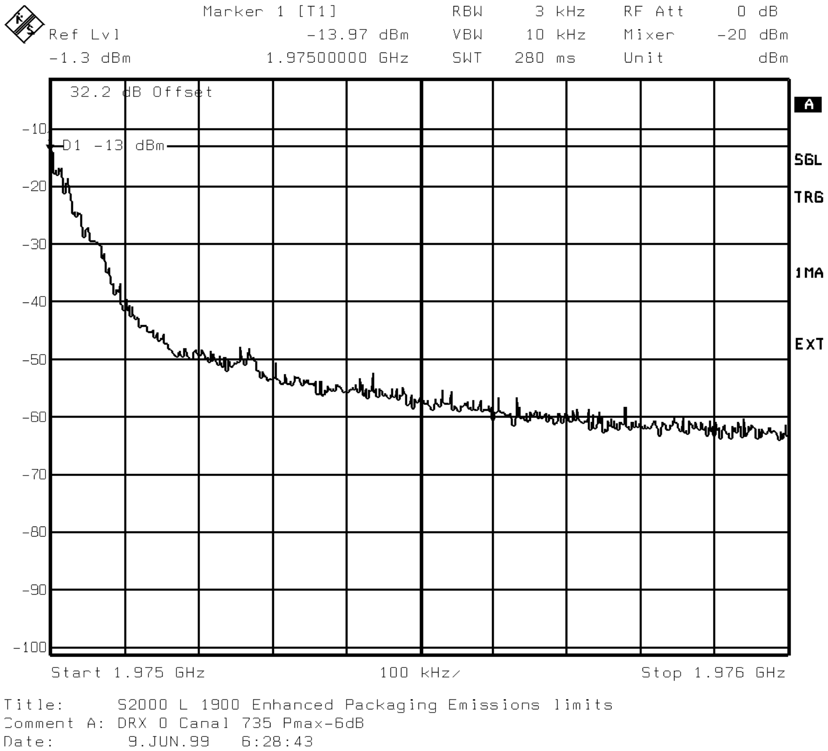


Figure 3 : 200 MHz to 1974 MHz band (Channel 810, Pmax -6 dB)

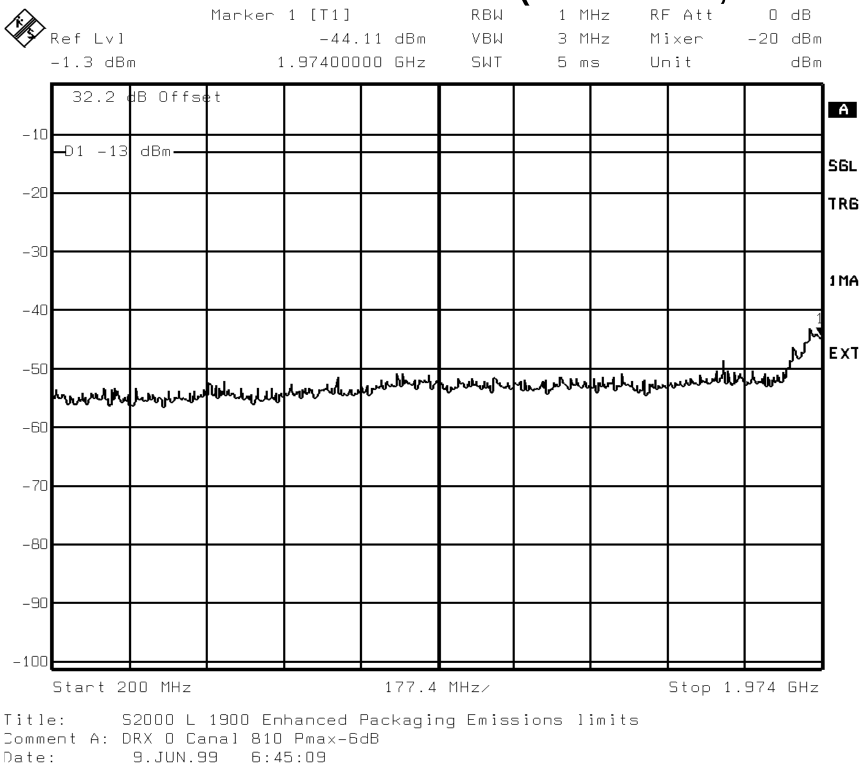


Figure 4 : 1974 MHz to 1975 MHz band (Channel 810, Pmax -6 dB)

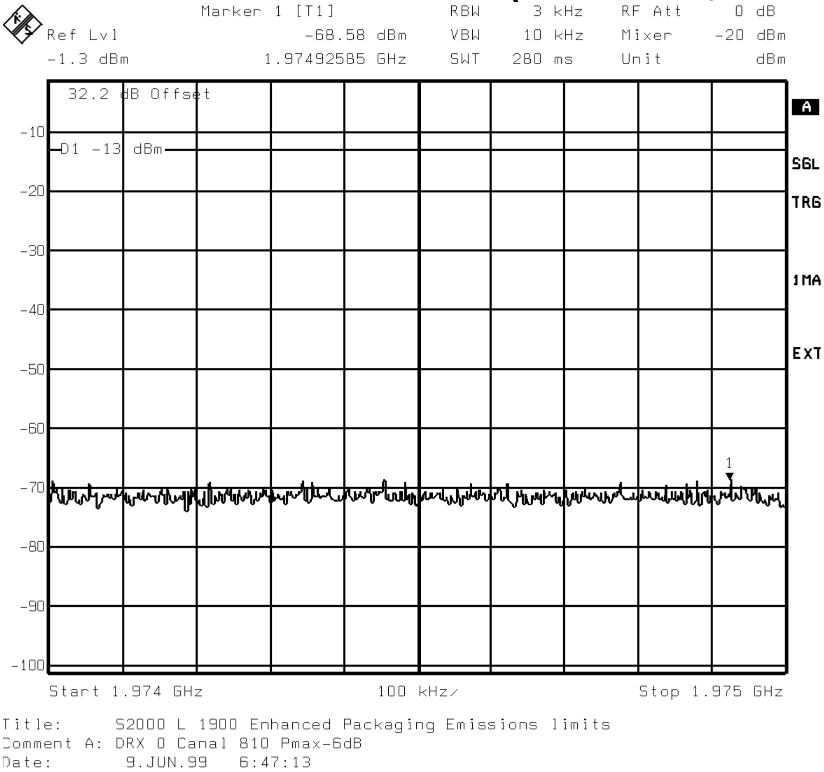


Figure 5 : 1990 MHz to 1991 MHz band (Channel 810, Pmax -6 dB)

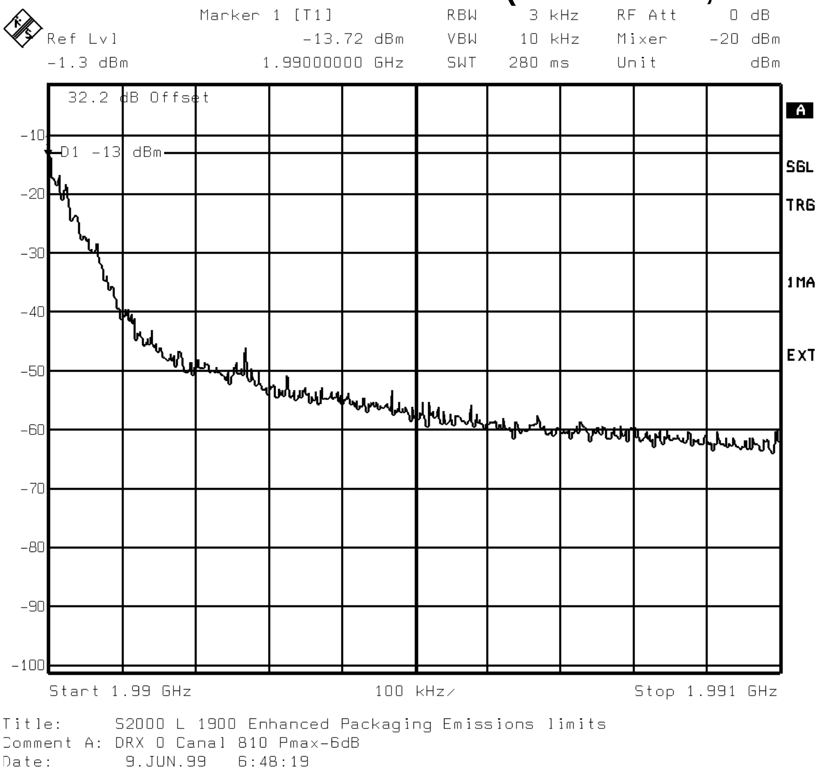


Figure 6 : 1991 MHz to 1993 MHz band (Channel 810, Pmax -6 dB)

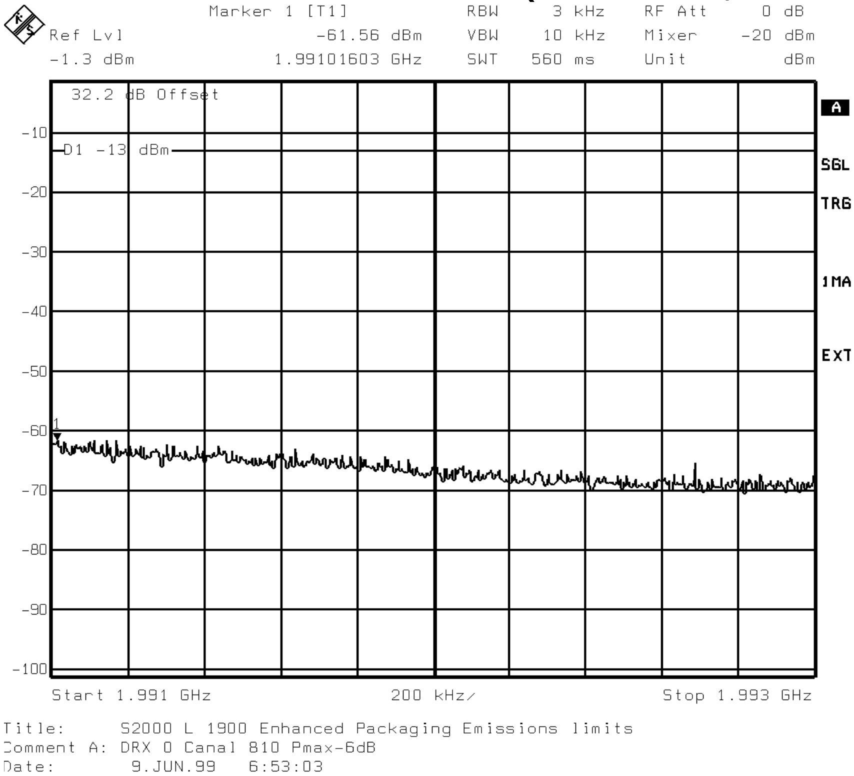


Figure 7 : 1993 MHz to 2000 MHz band (Channel 810, Pmax -6 dB)

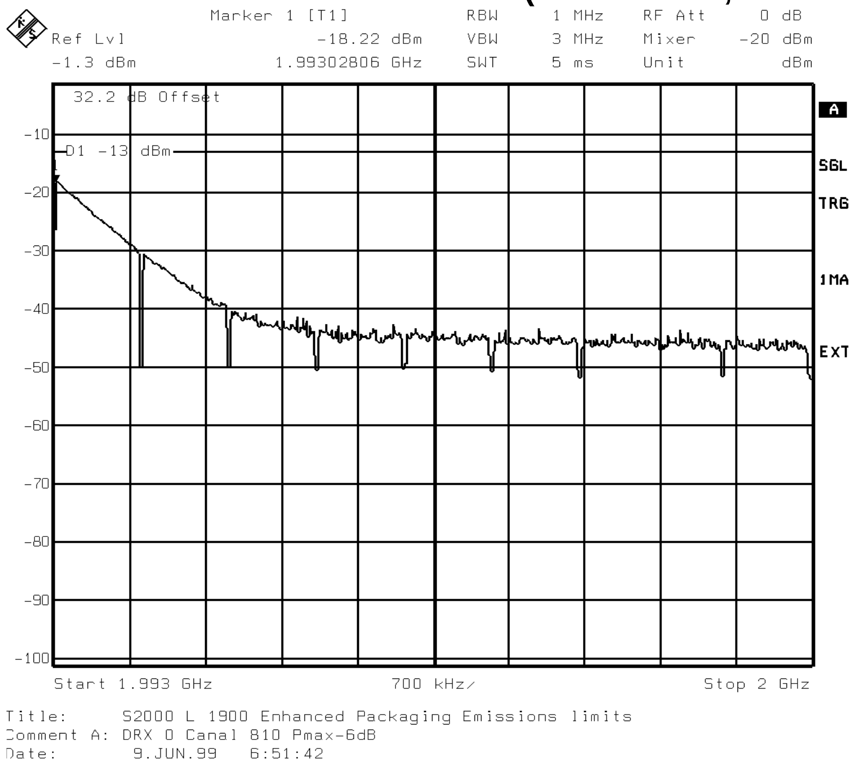


Figure 8 : 2000 MHz to 4000 MHz band (Channel 810, Pmax -6 dB)

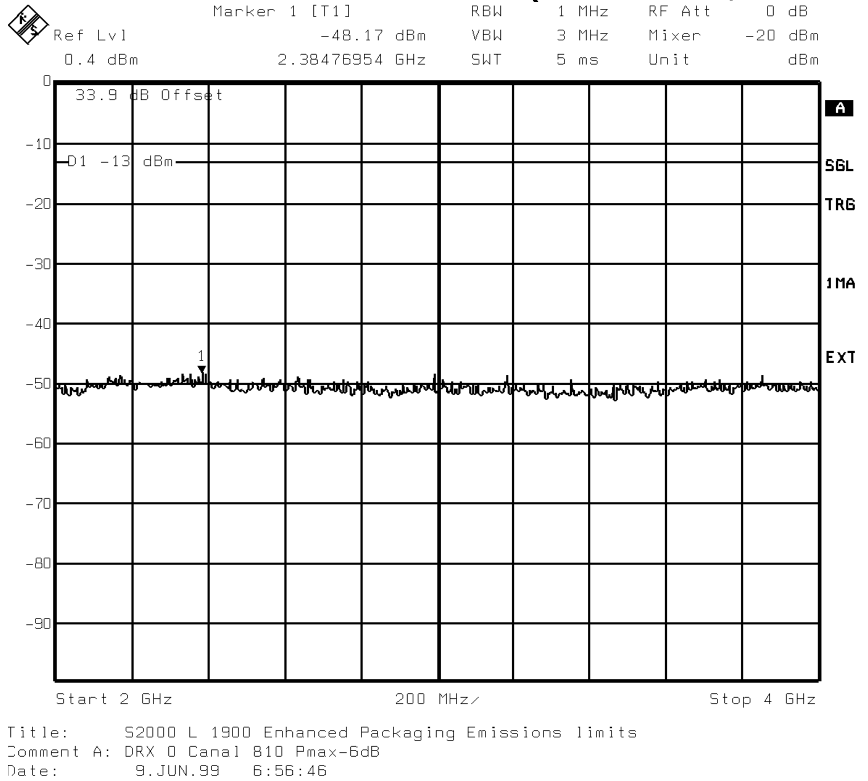


Figure 9 : 4000 MHz to 6000 MHz band (Channel 810, Pmax -6 dB)

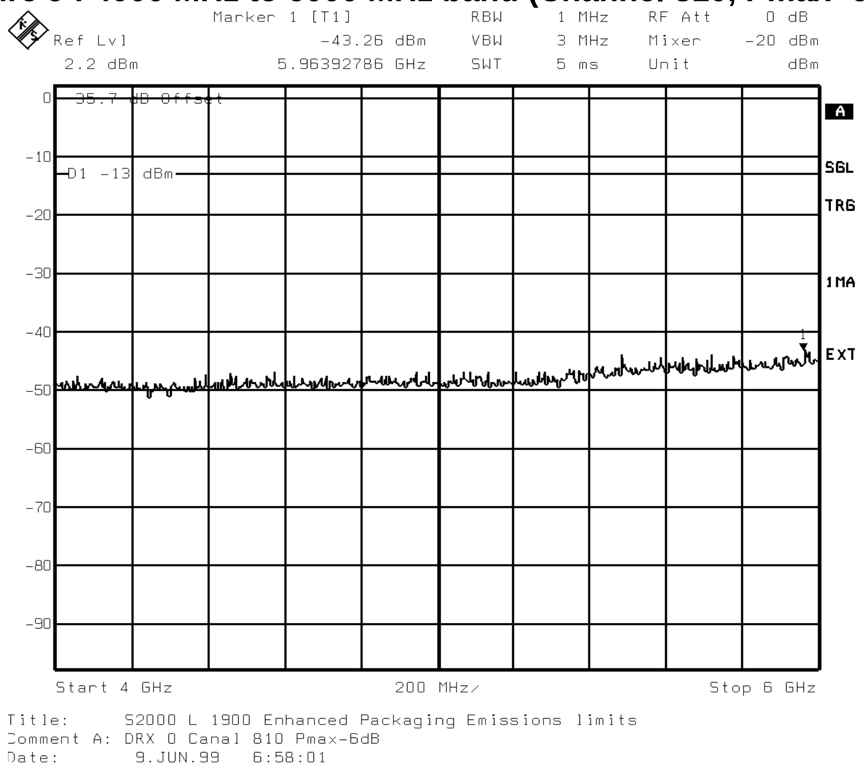


Figure 10 : 6000 MHz to 8000 MHz band (Channel 810, Pmax -6 dB)

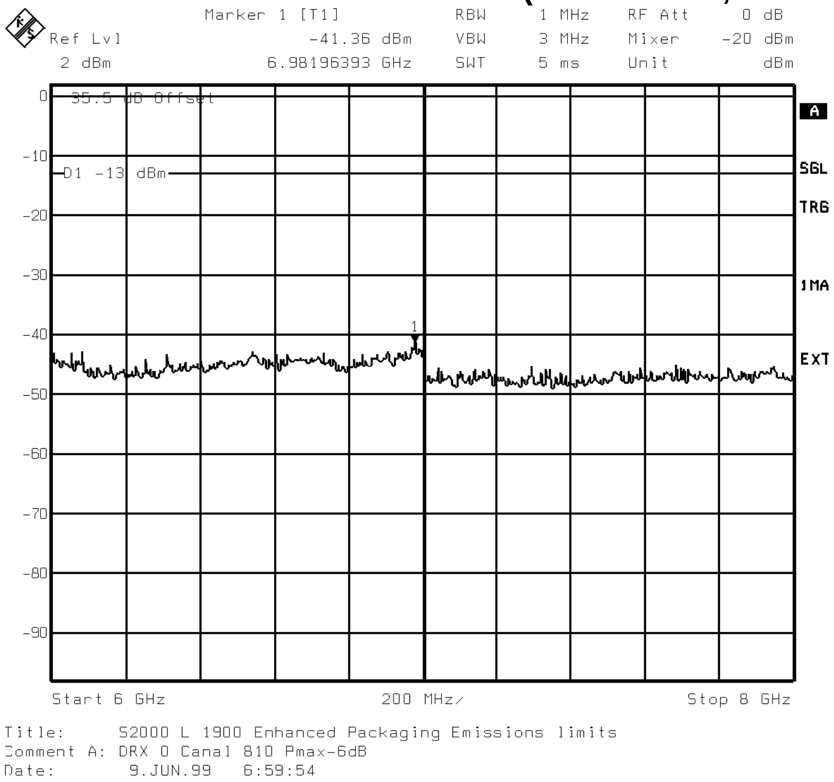


Figure 11 : 8000 MHz to 10000 MHz band (Channel 810, Pmax -6 dB)

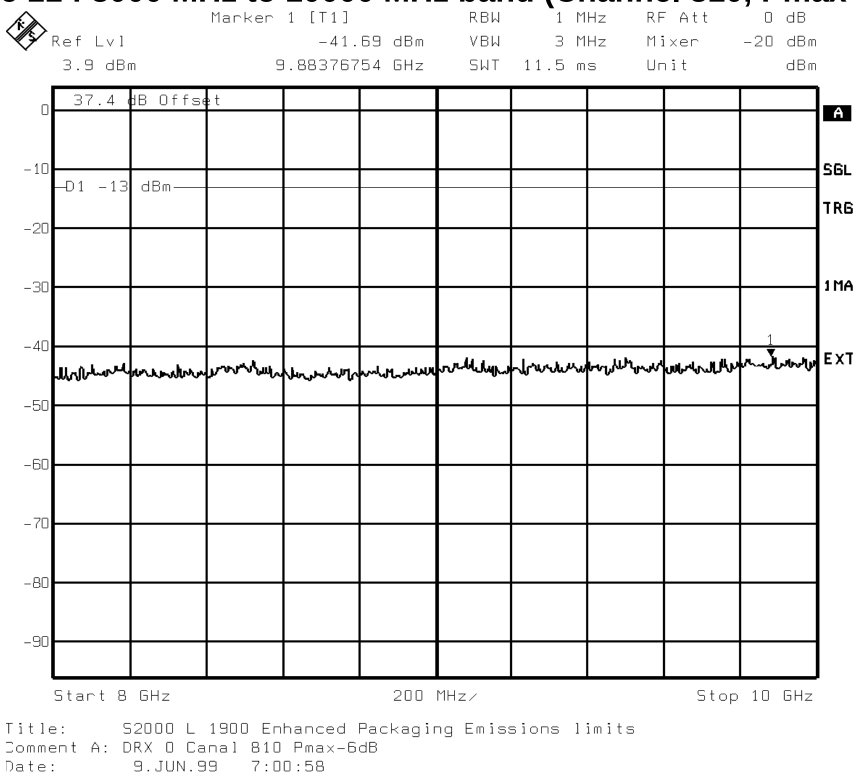


Figure 12 : 10000 MHz to 12000 MHz band (Channel 810, Pmax -6 dB)

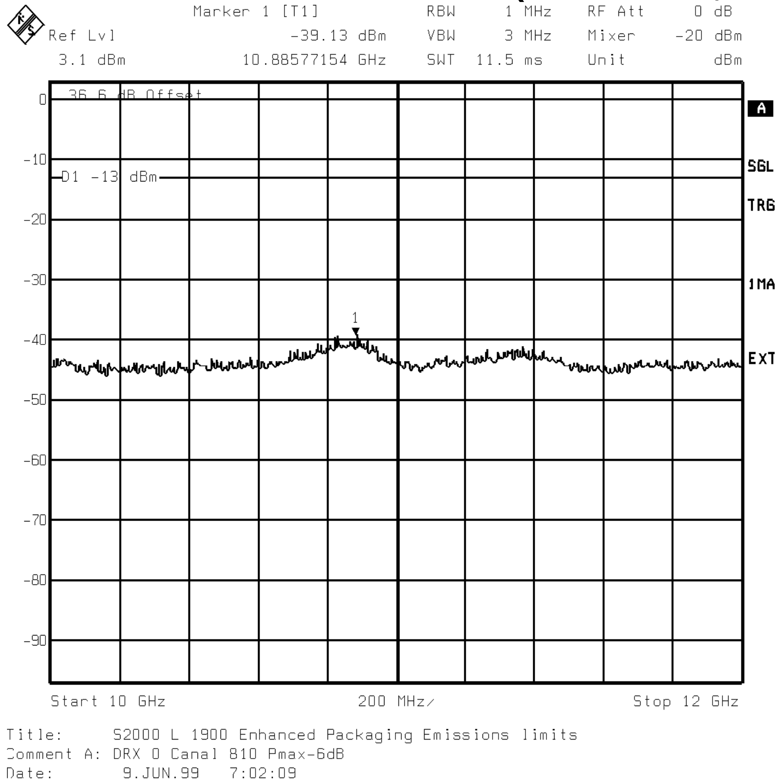


Figure 13 : 12000 MHz to 14000 MHz band (Channel 810, Pmax -6 dB)

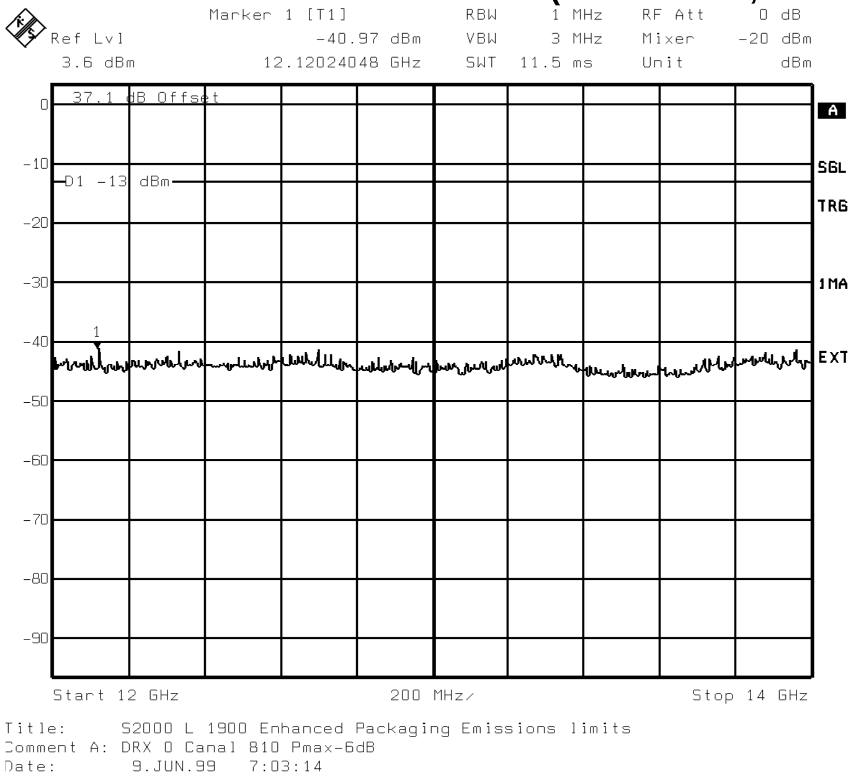


Figure 14 : 14000 MHz to 16000 MHz band (Channel 810, Pmax -6 dB)

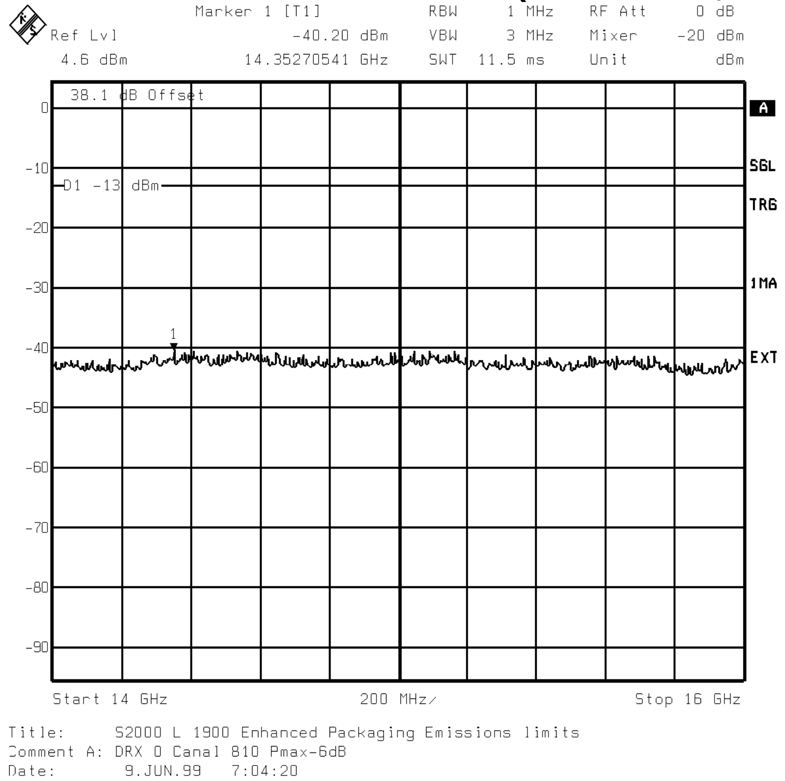


Figure 15 : 16000 MHz to 18000 MHz band (Channel 810, Pmax -6 dB)

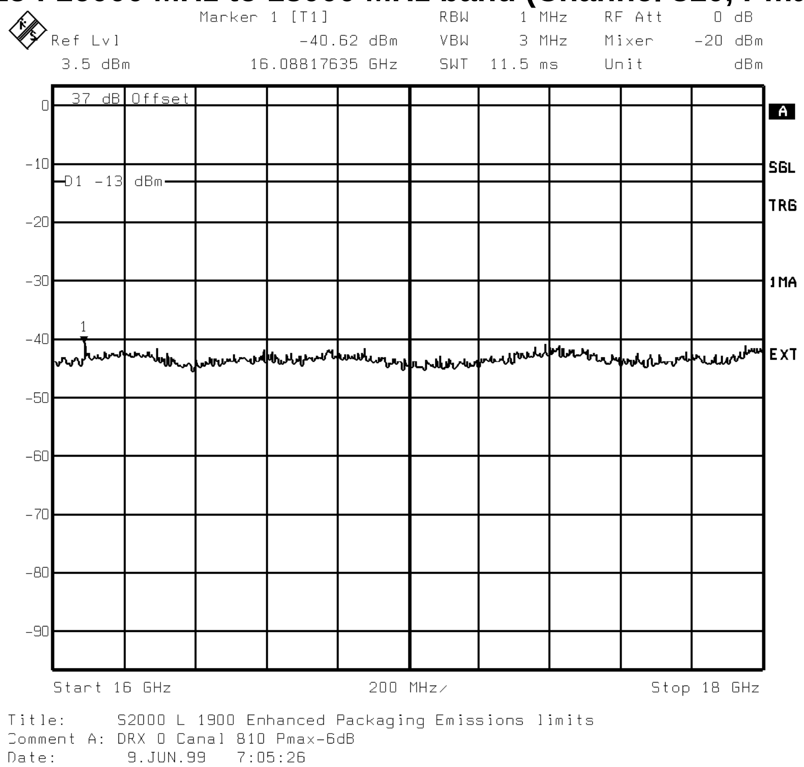
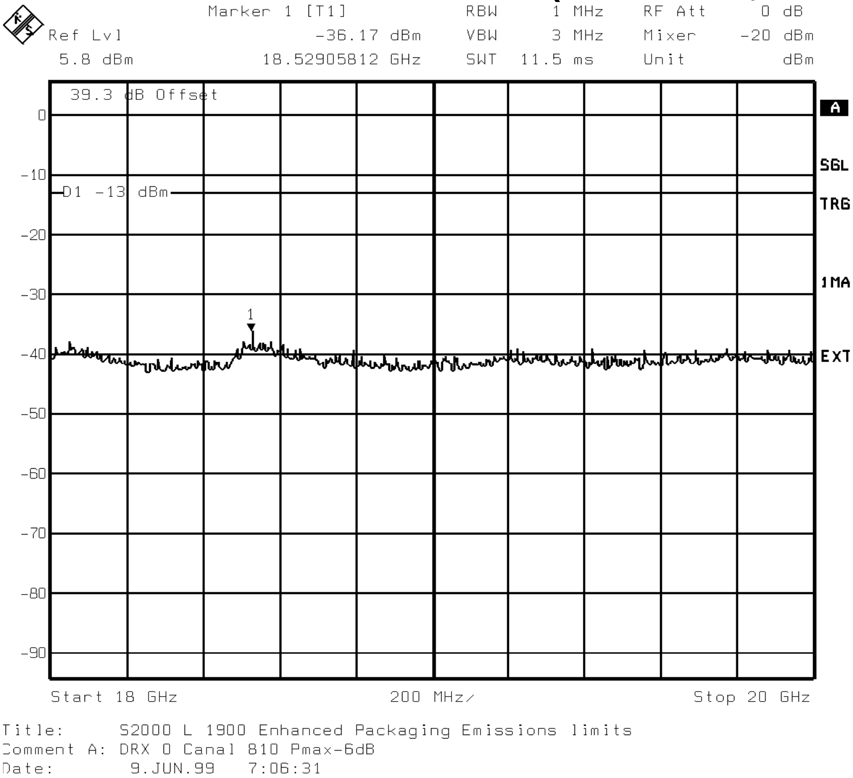


Figure 16 : 18000 MHz to 20000 MHz band (Channel 810, Pmax -6 dB)



8.6.3. TEST PROCEDURE

For adjacent channels emissions, the BTS nominal carrier frequency was adjusted to each block edge channel. Channels 512 and 810 are those channels which are at the lower and upper edges of the PCS band respectively. The transmitter was set to operate to maximum power minus 12 dB.

For these measurements, the resolution bandwidth was of the spectrum analyzer was set to at least 1% of the emission bandwidth. In this case the emission bandwidth measured was 314.1 kHz. Therefore, the resolution bandwidth was set to 3 kHz.

The spectrum analyzer had the following settings :

Resolution Bandwidth	3 kHz
Video Bandwidth	10 kHz
Span	1 MHz
Reference Level	10 dBm
Reference Level Offset	corrected to account for cables and attenuator losses
Level Range	100 dB
Sweep Time	coupled

For all measurements, the BTS carrier frequency was adjusted to channel 810. The emissions were investigated up to the tenth harmonic of the fundamental emission (20GHz). The measured level of emissions was recorded and compared to –13 dBm limit.

8.7. 2.993 FIELD STRENGHT OF SPURIOUS RADIATION

8.7.1. FCC REQUIREMENTS

8.7.1.1. FCC Part 24.238

(a) On any frequency outside a licensee's frequency block, the power of any emission shall be attenuated below the transmitter power (P) by at least 43 + 10 log (P) dB.

8.7.1.2. FCC Part 2.993

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission.

8.7.2. TEST RESULTS

Measurement is done with transmitters on 1930.2 MHz and 1989.8 MHz.

Table 5 shows the results for radiated spurious emissions measurements.

Table 5 : Test results for spurious emissions

Frequency (MHz)	Antenna Polarization	Measured Level (dBµV)	Correction Factor (dB)	Corrected Level (dBµv/m)	Limit (dBµV/m) @ 1 m
1930.2	Vertical	70	29.9	99.9	Fundamental frequency
1989.8	Vertical	72	29.9	101.9	Fundamental frequency

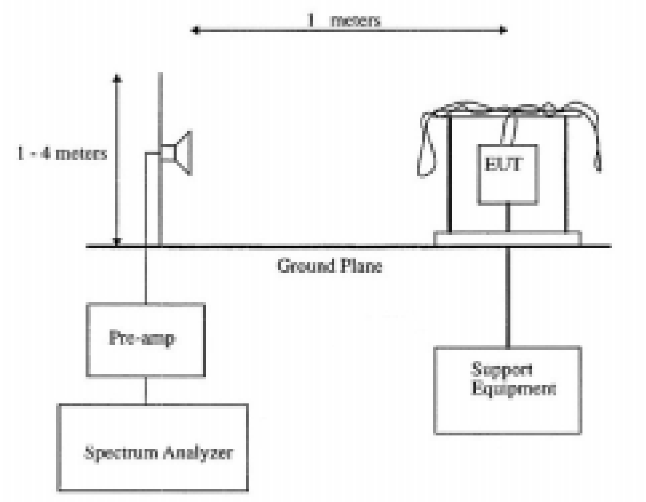
The field strength is calculate by adding the correction factor to the measured level to obtain the corrected level. A sample calculation is as follows :

Correction Factor$_{(dB)}$ = Cable Losses$_{(dB)}$ + Antenna Factor$_{(dB)}$ - pre-amplifier gain$_{(dB)}$
Corrected Level$_{(dB\mu V/m)}$ = Measured Level$_{(dB\mu V/m)}$ + Correction Factor$_{(dB)}$

No spurious emissions were found with a level upper to noise level in 100 kHz bandwidth (17 dBµV) from 1 GHz to 20 GHz.

8.7.3. TEST PROCEDURE

The equipment was configured as shown in figure below.



The BTS was configured to transmit at maximum power (static level 0).
Measurements were made according to the procedures outline in ANSI C63.4.
The emissions were investigated up to the tenth harmonic of the fundamental emission (20 GHz). The measured level of the emissions was recorded and compared to the limit.
The reference level for spurious radiation was taken with reference to an ideal dipole antenna excited by the rated output power according to the following relationship :

$$E\left(\frac{V}{M}\right)=\frac{1}{R(m)}*\sqrt{30*Pt*G}$$

Where,

E = Field Strength in Volts/meter,
R = Measurement distance in meters,
Pt = Transmitter Rated Power in Watts (5 Watts),
G = Gain of Ideal Dipole (linear)

Therefore :

$$E\left(\frac{V}{M}\right)=\sqrt{30*5*1.64}$$

E = 15.7 V/m = 143.9 dBµV/m
The spurious emissions must be attenuated by at least 43 + 10*Log(5) = 50 dB.
Therefore the field strength limit at 1 meters is :
E = 143.9 dBµV/m - 50 dB = 93.9 dBµV/m

8.8. 2.995 FREQUENCY STABILITY

8.8.1. FCC REQUIREMENTS : PART 24.235

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

8.8.2. TEST RESULTS

Table 6, 7 and 8 show the results for Frequency Stability.

Table 6 : Test results for Frequency Stability (220 VAC mode)

Temperature (°C)	Maximum Carrier Frequency Deviation (Hz)		
	Supply Voltage (85% of Nominal) 176.8 V	Supply Voltage (Nominal) 220 V	Supply Voltage (115% of Nominal) 276 V
50	29,25	28,8	29,77
40	28,15	25,63	29,7
30	29,63	35,64	28,73
+ 20 (DRX 1 on)	37,19	34,48	28,67
+10(DRX 1 off)	33,32	36,68	37,39
0	28,54	29,19	37,06
-5 (without heater)	34,22	30,15	31,83
- 10 (with heater)	24,09	37,84	37,39
-20	36,42	24,54	40,81
-30	33,32	35,9	-23,96

Notes :

- From +50°C to +20°C, the measurements have been made on the DRX 1 (the warmest one) and from +10°C to –30°C the measurements have been made on the DRX 0 (the coldest one).
- The measurements have been made from +50°C to –5°C without heaters and from –10°c to –30°c with heaters. The heaters are off until –10°C.

Table 7 : Test results for Frequency Stability (110 VAC mode)

Temperature (°C)	Maximum Carrier Frequency Deviation (Hz)		
	Supply Voltage (85% of Nominal) 93 V	Supply Voltage (Nominal) 120 V	Supply Voltage (115% of Nominal) 138 V
50	36,68	16,72	32,67
40	33	26,8	32,87
30	34,68	36,22	33,25
+ 20 (DRX 1 on)	22,73	36,03	39,65
+10(DRX 1 off)	35,64	30,48	24,34
0	31,7	27,77	29,96
-5 (without heater)	30,74	33,25	34,29
- 10 (with heater)	24,92	25,05	27,89
-20	32,16	37,77	30,93
-30	-30,28	36,48	22,73

Notes :

- From +50°C to +20°C, the measurements have been made on the DRX 1 (the warmest one) and from +10°C to –30°C the measurements have been made on the DRX 0 (the coldest one).
- The measurements have been made from +50°C to –5°C without heaters and from –10°c to –30°c with heaters. The heaters are off until –10°C.

Table 8 : Test results for Frequency Stability (48 VDC mode)

Temperature (°C)	Maximum Carrier Frequency Deviation (Hz)		
	Supply Voltage (85% of Nominal) -43.4 V (Note 1)	Supply Voltage (Nominal) -48 V	Supply Voltage (115% of Nominal) 55.2 V
50	-44,1	33,71	36,35
40	31,38	30,8	31,7
30	32,93	25,44	28,82
+ 20 (DRX 1 on)	24,21	22,79	-23,31
+10(DRX 1 off)	37,77	20,4	23,57
0	38,1	35,06	39,91
- 10	28,67	29,57	28,15
- 20	*Note 2*	*Note 2*	*Note 2*
- 30	*Note 2*	*Note 2*	*Note 2*

Note 1 :

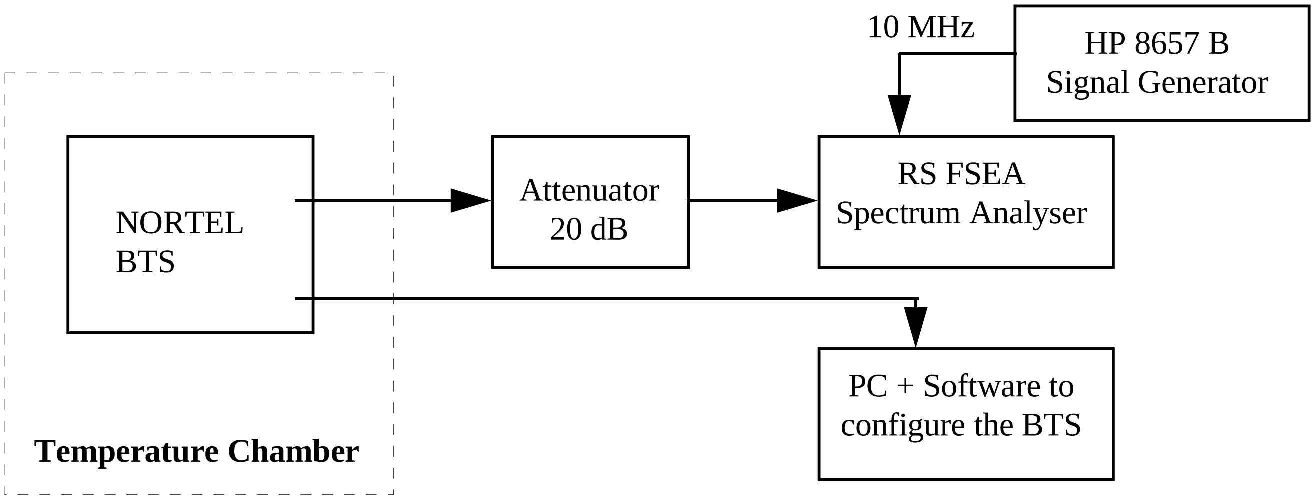
- There is an under voltage shutdown of the BTS at about 43 VDC.

Note 2 :

- When powered in DC mode, the BTS heaters are not supplied. Under these conditions, when subjected to low temperatures, the BTS shut downs. It should be noted that before the BTS shut down, the frequency deviation is still such that the fundamental emission stays within the authorized frequency block.

The maximum deviation is more than sufficient to ensure the above statement. Therefore the S2000L BTS still complies with the requirements.

8.8.3. TEST PROCEDURE



The BTS was configured to transmit at maximum power (static level 0). At each temperature, measurements were made with the primary supply voltage of the nominal value. At each of the above specified conditions, the maximum carrier frequency deviation was recorded from the time the transmitter was keyed-on for a period of ten minutes using a R&S FSEA spectrum analyzer.

8.9. MEASUREMENT EQUIPMENT LIST

Equipment Description	Manufacturer	Model No.	Serial No.
Spectrum analyzer	Rohde & Schwarz	FSEM	502 383
Network Analyzer	HP	8719P	521 768
Calibration Kit	HP	85054 D	521 769
30 dB attenuator	HP	8498 A	1801A06457
Power meter	Gigatronics	85 42 C	515 956
Power sensor	Gigatronics	80 401 A	500 344
Power generator	Rohde & Schwarz	SMP 02	522 314
Spectrum analyzer	Rohde & Schwarz	FSEA	502 584
Digital synchronization unit	Wander & Goltermann	DSA-15	511 584
Power Meter	Rohde & Schwarz	NRVS	502 586
Power Sensor	Rohde & Schwarz	NRVZ	507 764
Power generator	HP	33120 A	503 258
Power Generator	HP	8657 B	502 298
Variable Power supply Unit	REGAVO	-	7 304
Multimeter	LEM HEME	LH 240	20 374
Multimeter	WAVETEK	28XT	20 067
Climatic Chamber	Secasi	$30m^3$	521 308
DC Power Generator	XANTREX	XKW 8037	515 929

9. EXHIBIT 2 : EQUIPMENT LIST

Description	Hardware code	Comment
Main cabinet	NTQA28CA	
Base module	NTQA23CA NT0603BA NTQA23EA NT0603DA NT0603PA NT0603QA	Hardware code according to : • radio site configuration (O1, O2), • power supply (110 VAC, 220 VAC, -48 VDC), • Heaters or no heaters
SBCF	NTQA2785	
PSU	NTQA2612	
DRX	NTQA29FA	
I&C	NTQA2287	
P.A	NTQA2624	
DUPLEXER	NTQA2202 NTQA2698	Forem or Solitra
LNA 1900	NTQA2626	

10. EXHIBIT 3 : SCHEMATICS

10.1. NEW DESIGN DRX ASSEMBLY

ADQA29FA (5 pages)

10.2. DRX RADIO POWER SUPPLY

CSQA0108 (2 pages) and ADQA0108 (3 pages)

10.3. DRX LOGIC POWER SUPPLY

DQA0106 (3 pages)

10.4. LOGIC DRIVER / RECEIVER

ADQA0143 (6 pages)

10.5. LOGIC DRIVER / RECEIVER MODULE

CSQA0143 (20 pages)

10.6. RDRX-P-ND RADIO BOARD

ADQA0145 (3 pages) and CSQA0145 (38 pages)

END OF DOCUMENT