Certification Application

BS11 μBTS PCS Base Station

FCC ID:NE3PCS002

Name of Applicant

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Certification Application

Contents

I. Introduction

This application is submitted on behalf of

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This application is submitted for certification of the radio transmitter system

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to be used in base station model number BS11 under part 24 and part 2 subpart J of the Federal Communications Commissions Rules and Regulations.

The equipment under test (EUT) is a PCS micro base transceiver station (μBTS) operating in blocks A, B, C, D, E, and F of the authorized PCS frequency blocks. The EUT is rated at a maximum output power of 37.2 dBm and operates in the frequency region from 1930.4 to 1989.6 MHz.

The EUT consists of 16 modules: 1 CCU, 1 SMU, 2 MBBCU, 2 PSU, 2 RFTX, 2 RFRX, 2 PA, 2 LNA & BP and 2 DUPLEXER . The EUT can be installed either indoor or outdoor.

All available configurations of the BS11 (see Table I-1) were investigated and the worst case configuration was selected for testing (number 8). This configuration employs 2 RF transceivers (TRX) with direct AC power input (instead of optional DC power with battery backup system) and internal duplexers for connection to two external antennas for diversity receive (instead of optional integrated internal antennas).

Configuration Nr.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Number of TRX	one	two	one	two	one	two	one	two
Type of antennas	internal	internal	external	external	internal	internal	external	external
Type of power supply	DC	DC	DC	DC	AC	AC	AC	AC

Table I-1: BS11 configurations

Mass production is planned.

II. Base Station functional Overview

A. Block diagram

A Base Transceiver Station Equipment (BTSE) is used to receive signals from mobile phones, to transfer it to a public switching system and vice versa. The BTSE consists of digital control boards, the receive paths and the transmitter paths. In this application the entire BTSE, or μBTS, is considered as the equipment under test (EUT). The digital control boards provide the data from the switching system and deliver them to the transmitters. The signal of a mobile phone is received via the antennas and receive paths and sent to the switching system by the digital control boards. More details are listed in the next sections.

The μBTS functional blocks are illustrated in Figure II-1as follows:

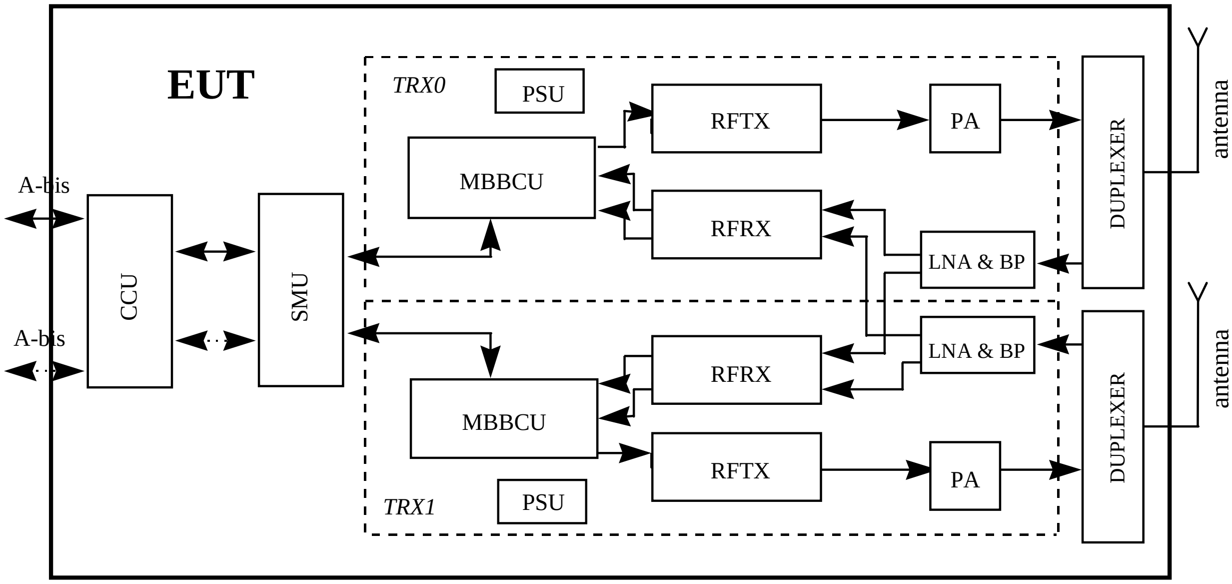

Figure II-1: Functional blocks of the μBTS

Abbreviations for modules:

EUT:...................Equipment Under Test
TRX:...................Transceiver Unit
SMU:..................Site Manager Unit
CCU: ....Combo Card Unit
MBBCU: ....Multi-channel Base Band Control Unit
PSU: ....Power Supply Unit
RFTX: ....Radio Frequency Transmitter Unit
RFRX: ....Radio Frequency Receiver Unit
PA: ....Power Amplifier
LNA & BP:.........Low Noise Amplifier & Band Pass filtering
DUPLEXER:......Duplex Combiner

Abbreviations for signals:

A-bis:..................PCM 24 Interfaces

B. B. EUT

. Overview

The entire μBTS is the equipment under test. It consists of two transmitter/receiver units (TRX0 and TRX1), two duplex combiners (DUPLEXER), one Site Manager Unit (SMU) and one Combo Card Unit (CCU). A brief description of these units, together with the main blocks composing the transceivers, will be given in the followings.

- **SMU**

This unit is composed of a Site Manager processor, whose main functions are to process signalling connections to/from BSC (Base Station Controller), to collect, manage and report (to BSC) all internal µBTS alarms, to handle up to eight external alarms (e.g. of the external battery back-up system and additional external modules), to store all of the µBTS codes into a 4 Mbytes flash memory, and finally to handle an LMT terminal.

- **CCU**

This unit is the interconnection element between the µBTS and the BSC. It consists of an FPGA and PLL circuits whose function is to generate all clock timings, which can work in locked (network clock based) or stand-alone (local oscillator based) mode; and of the line interfaces, which can be two T1 interfaces or two ISDN BRA interfaces.

- **MBBCU**

The MBBCU unit is the one dedicated to the base-band management of the speech/data channels; it is composed of the following main blocks: a LAPD-O&M processor which manages one 16/64 kbit/s LAPD link to/from BSC both for radio and O&M signalling; a LEVEL 3 processor which is dedicated to level 3 radio signalling; a LAPDm processor which manages level 1 and level 2 radio signalling; a channel coder which forms bursts and sends them to the modulator or receives and decodes demodulated bursts from the demodulator; a TRAU controller which is dedicated to the transfer of frames to and from the remote Transcoder / Rate Adaptor unit; a demodulator based on the Viterbi algorithm; and finally an encryptor.

- **RFTX**

This is the transmitter unit of the µBTS. The main RFTX functions are the reception from MBCCU of the base-band 270 kbit/s modulating signal and the direct GMSK modulation in the defined frequency band; the RF frequency hopping, following instructions given by RFRX; the static and dynamic power control in downlink direction, according to the configured class; a first pass-band filtering of the RF signal and, finally, system timings generation and RF carriers reference clock generation.

- **PA**

This is the power amplifier unit; it controls the maximum output power according to configured parameters; it switches off automatically at high temperature (it can be put again into operation by an O&M command). The PA gain is fixed at about +32 dB; the total gain is therefore the sum of this fixed gain and of an adaptive gain due to the power control (static + dynamic) performed by RFTX according to the µBTS class.

- **Duplexer**

The duplexer is a passive duplex filter. Thus, receive and transmit signals are connected to the same antenna. The loss due to the duplexer is ≤ 2 dB. The purpose of the duplex filter is to filter in the proper RX/TX band the incoming/outgoing signal; at the TX input of the duplexer the VSWR measurement is performed to detect antenna mismatch.

- **LNA & BP**

For each receive antenna the LNA&BP unit has a chain composed of two low noise amplifiers and a pass-band filter, applied to the input signal received by the duplexer; the nominal gain of this chain is ≥ 12 dB. Each LNA&BP chain has a splitter with two outputs (one for each RFRX unit) for diversity receive. The splitter loss is balanced by the low noise amplifiers themselves.

. **RFRX**

This is the receiver unit of the µBTS. The main functions of this unit are: the conversion of the radio signal to a first intermediate frequency; automatic gain control; radio signal strength measurement; the conversion of the radio signal to a second intermediate frequency, its sampling and multiplexing with other receive branch; the calculation of the list of frequencies to be used for both transmission and reception.

. **PSU**

Two types of power supply can be installed in the BS11 to allow the use of alternate or direct current power feed. An external battery back-up system can also be used. There is one PSU for each TRX and each of them feeds the SMU; each PSU contains a heater. In case of low temperature the heater is automatically switched on and kept in operation until an acceptable temperature is reached within the µBTS. In case of high temperature the PSU sends an alarm to the SMU, which is able to switch off the power supply for the relevant TRX. If the temperature exceeds a higher threshold, the PSU switches automatically off, until the temperature decreases to an acceptable level; it then switches on again automatically. In the alternate current case the input voltage can be in the range of 88 - 265 Vac (50/60 Hz); the AC/DC can hold over for ac mains failure up to 20 ms.

C. Digital control boards

Please see MBCCU unit in previous description at point B.

D. Special references

For further details, please refer to the product description in the “operational description” exhibit section. Please note that the product description document is based on a generic product description and therefore covers not only the equipment under test (EUT) but also equipment and operational aspects for frequency ranges other than the PCS 1900 system.

III. Type of Emission

The emission designator is: **315KGXW**
The bandwidth of 315 kHz of the modulated signal was measured in accordance with the FCC rules.
For details see the occupied bandwidth plots in the “test report w/data & plots” exhibit section..

IV. Frequency Range

A. Frequency range

Please note that the blocks are arranged according to ascending order of frequency.

	Block A [MHz]	**Block D [MHz]**	**Block B [MHz]**	**Block E [MHz]**	**Block F [MHz]**	**Block C [MHz]**
Down link Frequency	1930.4 - 1944.6	1945.4 - 1949.6	1950.4 - 1964.6	1965.4 - 1969.6	1970.4 - 1974.6	1975.4 - 1989.6
Up link	1850.4 -	1865.4 -	1870.4 -	1885.4 -	1890.4 -	1895.4 -

Frequency	1864.6	1869.6	1884.6	1889.6	1894.6	1909.6
Channel Number	513 - 584	588 - 609	613 - 684	688 - 709	713 - 734	738 - 809

Table IV-1: Applicable frequency channels

B. Disabled carrier frequencies at the band edges of each licensed frequency block

The activation of carrier frequencies at the block edges is prohibited under all circumstances through proprietary software modules included in the base station system (BSS).
This ensures that neither the operator nor the maintenance personnel may activate frequency channels other than given in the Table above.
The configuration for the µBTS is controlled by the operator via the OMC (Operational and Maintenance Center) and the BSC (Base Station Controller) as shown in Figure IV-1.
The activation / deactivation of the channel is done via the administration software in the BSC.
The proprietary software checks the channel number parameter of the activate/deactivate command to ensure that no unauthorized channels can be activated. The only channels that can be activated are the authorized channels listed in Table IV-1.

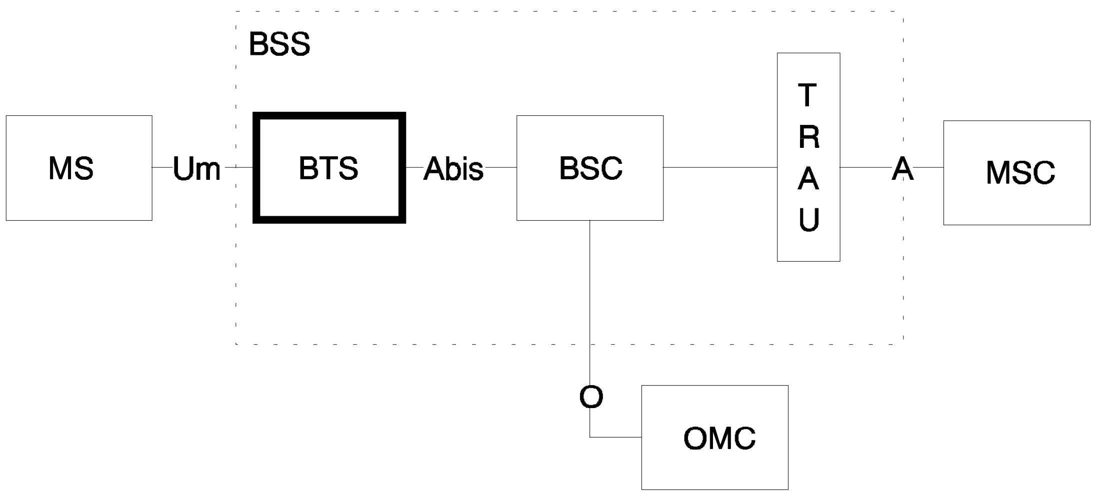

Figure IV-1: General GSM (PCS) Network Layout

Abbreviations:

BSS: ....Base Station System
BTS: ....Base Transceiver Station
BSC: ....Base Station Controller
OMC: ....Operation & Maintenance Center
MS:.....................Mobile station
TRAU:................Transcoding and rate adaptation unit
MSC: ....Mobile services switching center
Um:.....................Air interface
A, Abis: ....PCM interfaces

V. Range of Operating Power Values and Description of any Means provided for Variation of Operating Power

Maximum Rated Output Power Level: 37.2 dBm
Minimum Rated Output Power Level: 1.7 dBm

The variation of the output power is controlled by two methods: static and dynamic power control.
The reduction of the static output power is controlled by the operator. Using this command, the output power of all time slots can be reduced by a maximum of 6 steps of 2 dB each. A further reduction can be obtained through the dynamic power control (maximum of 15 steps of 2 dB each). In both cases the power is attenuated in 2 dB steps.
In addition, the output power can be reduced for each time slot separately.
The output power is controlled by means of a fast action control loop located in the PA and RFTX modules. For more details please refer to the circuit diagrams of the PA and RFTX in the “schematics” exhibit section..

VI. Maximum Power Rating

The maximum power rating is 37.2 dBm (5.2 Watts), as per paragraph 24.232 (a), as measured at the antenna connector of the equipment cabinet (duplexer is included).

VII. DC Voltage and DC Current

Each PA, which performs the amplification and power leveling of one TRX, is powered by DC converters which convert the AC coming from the mains through a primary AC/DC converter into +26 and +13 Vdc. The final stages of the amplifier are powered by the 16 V supply. In the case an error would be detected in the PA/antenna RF path the input RF driving power is removed.

Table VII-1 lists the DC-currents into one PA for normal operation over the static power levels.

Output power at the antenna connector [dBm]	**Total current of the final stage 26 V supply [A]**
35	1.35
33	1.10
31	0.88
29	0.73
27	0.60
25	0.52
23	0.45
5	0.31

Table VII-1 : DC supply currents of the final stage vs. power setting

VIII. Function of each Semiconductor

Please refer to the “operational description” exhibit section for more details.

IX. Circuit Diagrams

Please refer to the “schematics” exhibit section for details of the RF path circuit diagrams.

X. Users Manual

Please refer to the “user’s manuals” exhibit section..

XI. Description of the Tune Up Procedure

The tune-up procedure is comprised of three steps: The board level tests, the final factory tests and the third step, start-up and supervision, which is performed whenever the μBTS is initially powered up and during the operational mode. This ensures that the μBTS operates with the specified frequencies and power levels.

A. Board level tests

These tests/adjustments are carried out for each of the concerned boards in the transmitter path (RFTX and PA).

. RFTX tests

- Modulation mask of the modulated output signal
- Phase and frequency accuracy of the modulated output signal
- Spurious of the synthesizers and of the output signal
- Function of PLL lock detect and alarms

. PA tests

- Gain and linearity
- Bandwidth
- DC outputs of direct and reflected power detectors
- DC input current from +26V at maximum output

B. Final factory test

These tests are carried out with a completely equipped μBTS assembly.
The following transmitter tests are performed and tested at the antenna connector:

- Phase and frequency error.
- Power level accuracy.
- Transmitted RF carrier power versus time.
- Spectrum due to modulation.
- Switching transients spectrum.
- Spurious emissions.

C. Start-up and supervision

Whenever the equipment is powered on, the following test procedure is performed automatically prior to the activation of the RF output power: the transmitter is set to its operational frequency, all PLL's are checked for lock. If one of these tests fails the transmitter remains disabled.
During operation, the PLL lock signals, the transmitted power, the power control loop, and the temperature are checked periodically. High temperature, unlocked synthesizers of the RFTX and also a wrong power control loop of the PA are treated as critical alarms.
The complete transmitter is switched off immediately in case of a critical alarm.
This means that uncontrolled RF transmission, violating the emission limits, is prevented.

XII. Description of the Frequency Stabilization

A. Overview

The frequency stabilization is obtained by use of synthesizers locked to a 13 MHz VTCXO; the 13 MHz is locked itself to a 2048 kHz coming from a high accuracy master 16.384 MHz, which can be locked to the BSC. The frequency accuracy of the µBTS is compliant to the requirement of the J-STD-007 standard of $5*10^{-6}$ % for the air interface.
The frequency stability of the µBTS can be defined in short term and long term stability. The CCU board supports the long term stability for the µBTS, and the consecutive synthesizers within the transceiver equipment, i.e. RFTX, determine the short term stability.

B. Long Term Stability

The CCU uses the PCM/ISDN lines of the Abis interface as the synchronization media. Synchronization is done with a digital microprocessor controlled PLL, with a cut-off frequency in the MHz range. The transmission technology of the network operator being compliant with ITU-T G.823, G.824, G.825, GR-1244 and ETSI TBR12, jitter and wander suppression according to ITU-T standards G.823 and G.824 will be guaranteed.

That means that even in case of jittered lines at the Abis interface within the limits of ITU-T G.823, the frequency stability of $< 5*10^{-6}$ % on the air interface is maintained.

Principally there are two possibilities according to which the PCM/ISDN lines (and hence the µBTS) are synchronized. This depends on the network synchronization structure of the provider.

- In case of clock transparent lines, the CCU stays synchronized to the BSC. The BSC itself stays synchronized to the MSC. The MSC guarantees the long term stability of the whole BSS network. ITU-T standards G.811 and G.812 define the frequency stability for the MSC. In case of network failures between MSC and BSC, the BSC supports a stability of < 1*10-6 %/day to the BTS.

- In case of non-clock transparent lines, the CCU stays synchronized to the network. The PCM network uses a clock distribution hierarchy defined in ITU-T G.811 and G.812 standards. Whereas, the ISDN network uses a clock distribution hierarchy defined in GR-1244 standard. The µBTS is then synchronized to the local network node to which the PCM or ISDN connections are established.

The CCU permanently measures the frequency stability of the PCM/ISDN reference against its own oven-controlled oscillator. If degraded frequency stability or short term interruptions of the PCM/ISDN line occur, the CCU will enter the holdover operation mode. This mode supports the last good frequency value (before failures occur) until the frequency stability of the PCM/ISDN line is recovered. The holdover stability is < $2.5*10^{-6}$ %/year.

C. Short term stability

The short term stability is basically provided by the RFTX module.

- A local crystal oscillator at 13 MHz, which is synchronized to the CCU reference frequency, is used as reference by the RFTX module.
- Setting of all synthesizers is controlled by the software.
- All synthesizers on RFTX are synchronized to the local crystal oscillator.
- The lock-state of all synthesizer is checked by software.
- The frequencies of the synthesizers are listed in the following Table:

Frequency Source	**Frequency [MHz]**
Reference	13.0
TX-RF	1930.4 ... 1989.6

Table XII-1: Synthesizer frequencies of the RFTX module

XIII. Description of Circuits for Suppression of Spurious Radiation, Limiting Modulation and Power

A. Suppression of spurious radiation

Spurious radiation is kept below the compliance level as set forth in the FCC rules.
Two kinds of measures are taken for limiting radiated emissions of the base station.
The first one is the shielding of the complete base station, which is housed in a metal cabinet.
Secondly, all elements on the modules RFTX and PA, which amplify or generate RF, are shielded by metal boxes.

B. Suppression of spurious radiation and limiting of modulation at the antenna interface

. Overview:

The following filter stages provide the overall suppression of spurious radiation within the TX-path to the antenna connector:

- Base band (BB) - filter (RFTX)
- RF-filter (RFTX)
- RF-filter (DUPLEXER)

. Block diagram: TX-path

Please refer to the “block diagram” exhibit section.

. Limiting of modulation

The spectrum due to modulation is limited by the GMSK-Modulator (1617 AT&T). A base band low pass filter suppresses noise and switching transients from the base band switch.

Please refer to the “operational description” exhibit section for specific details

C. Suppression of spurious radiation

For rejection of RF-harmonics and noise, the I/Q modulator is followed by a band pass filter, after power controller on RFTX, and finally by a RF band pass filter in the branching circuitry (duplexer TX branch).

Please refer to the “operational description” exhibit section for specific details

D. Limiting of output power

The power level control of the PA is done by a fast power control loop.
The output power of the PA is controlled according to the dynamic and static power level setting during the burst and the guard period with high precision.
In case of a detected error causing the power loop to reach the limits, the driving power of the final stage amplifiers is switched off.
A second supervisory function concerning the output power is implemented in the RFTX. The output power during each burst is measured and compared to the expected value according to the dynamic and static power control settings. In case of a non-conformity, an error message is sent to the controller, causing the output to be switched off.

XIV. Description of Modulation System

A. Theoretical description

For a theoretical description of the modulating system, please refer to J-STD-007.

B. Implementation

The GMSK modulation is generated on the RFTX with two DACs to provide a pair of I/Q signals. Digital to analog conversion uses data memorized into a lookup table located in the DSP internal memory. The I/Q analog signals are applied to a direct carrier I/Q modulator after proper reconstruction filters and offset/gain controllers.

XV. Reference Documents

References

- **J-STD-007**, Air Interface: Vol.1
- **CCITT 6.811 (11/88)**
  Timing requirements at the outputs of primary reference clocks suitable for plesiochronous operation of international digital links.
  Blue book facsimile III.5
- **CCITT 6.812 (11/88)**
  Timing requirements at the outputs of slave clocks suitable for plesiochronous operation of international digital links.
  Blue book facsimile III.5
- **ITU-T G.823 (03/93),**
  The Control of Jitter and Wander within Digital Networks which are based on the 2048 kbit/s Hierarchy
  ITU-T (Telecommunication Standardization Sector of International Telecommunication Union)
- **ITU-T G.824 (03/93),**
  The Control of Jitter and Wander within Digital Networks which are based on the 1544 kbit/s Hierarchy
  ITU-T (Telecommunication Standardization Sector of International Telecommunication Union)
- **ITU-T G.825 (03/93),**
  The Control of Jitter and Wander within Digital Networks which are based on the Synchronous Digital Hierarchy (SDH)
  ITU-T (Telecommunication Standardization Sector of International Telecommunication Union)
- **GR-1244-Core**,
  Clocks for the Synchronized Network: Common Generic Criteria, Issue 1 (Bellcore, June 1995)
- **TBR12** (**T**echnical **B**asis for **R**egulation) December 1993
  Business Telecommunications (BT);
  Open Network Provision (ONP) technical requirements;
  2 048 kbit/s digital unstructured leased line (D2048U)
  Attachment requirements for terminal equipment
  ETSI (European Telecommunications Standards Institute)

XVI. Human exposure to Radiation

The BS11 µBTS is not required to be tested for compliance with IEEE C95.1-1991 “IEEE Standards for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, as per the criteria for PCS (part 24) transmitters, facilities, and operations defined in Table 1 of CFR 47 §1.1307 .