

Certification Application

FCC ID:NE3PCS003

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Certification Application

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I. Introduction

This application is submitted on behalf of

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This application is submitted for type acceptance of the radio transmitter system

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to be used in base station model numbers BS-240U and BS-241U under part 24 and part 2 subpart J of the Federal Communications Commissions Rules and Regulations.

The equipment under test (EUT) is a PCS transceiver 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 43.8 dBm and operates in the frequency region from 1930.4 to 1989.6 MHz.

The EUT consists of 2 modules: carrier unit (CU) and duplexer amplifier multi coupler (DUAMCO). The EUT is typically installed in two different configurations of the BTS, the indoor version (model BS-240U) and the outdoor version (BS-241U). Due to cell configuration requirements two types of duplexer amplifier multicouplers are used (DUAMCO2:2, DUAMCO4:2).

After careful investigation, all testing was performed by selecting the worst case configuration of models BS-240U/BS-241U and DUAMCO2:2/DUAMCO4:2.

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. The transmitter path 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 BTSE functional blocks are indicated in Figure II-1

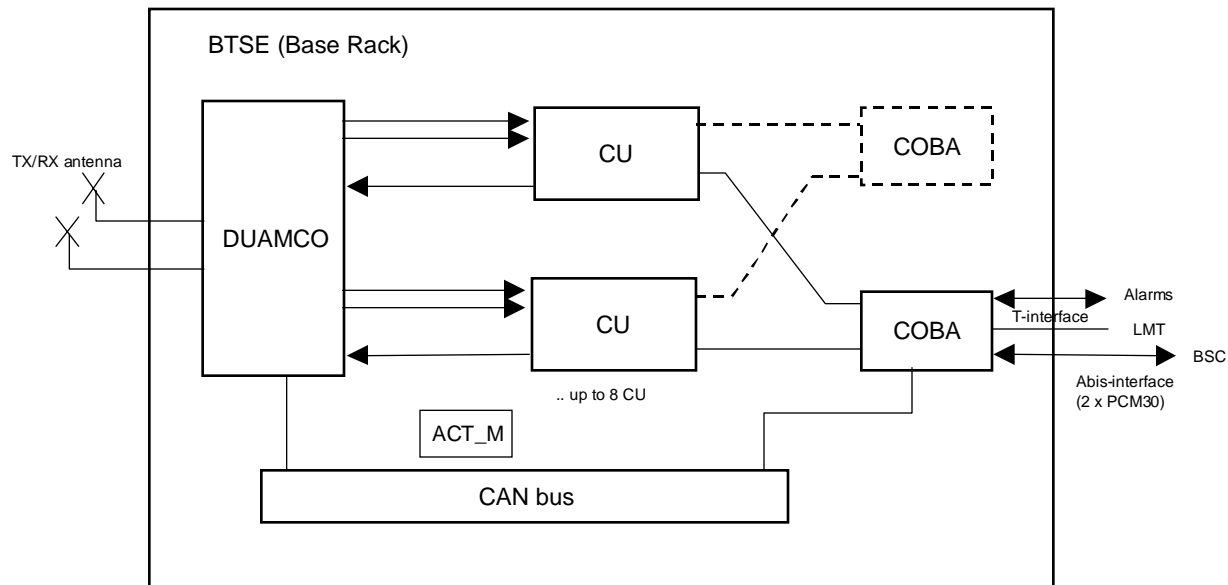


Figure II-1: Functional blocks of BTSE

Abbreviations for modules:

EUT:..... Equipment Under Test
 CU:..... Carrier Unit
 DUAMCO: Duplexer Amplifier Multi Coupler
 COBA: Core Basis
 TX:..... Transmitter
 RX:..... Receiver
 BSC:..... Base Station Controller
 LMT: Local Maintenance Terminal

Abbreviations for signals:

A-bis: PCM 30 Interfaces

B. EUT

. Overview

The transmitter path of the BTSE is the equipment under test. It consists of carrier unit (CU) and duplexer amplifier multi coupler (DUAMCO).

. CU

The carrier unit (CU) takes care for all carrier oriented tasks of the BS-240U/241U. In uplink direction two radio frequency signals (diversity) are received and finally converted into TRAU frames and signaling data. In downlink direction TRAU frames and signaling data are received and converted into a GMSK modulated radio frequency signal, which is amplified to the desired power level.

The carrier unit consists of the power amplifier and transceiver unit (PATRX) which provides the main analog functions of the CU and the signal processing unit (SIPRO) which provides all digital functions of the CU.

• **DUAMCO**

The duplexer amplifier multi coupler (DUAMCO) contains filters in order to combine the transmit path (TX) and the receiving path (RX) to one antenna connector. The receive path (RX) consists of a low noise amplifier (LNA) and a power splitter. The transmit path (TX) consists of isolators, a hybrid coupler and an antenna supervision unit (ASU).

There are two DUAMCO variants, DUAMCO2:2 and DUAMCO4:2. Both offer connectors for two antennas. DUAMCO2:2 offers two inputs for the transmit signals, whereas DUAMCO4:2 offers 4 inputs.

C. Digital control boards

The core board (COBA) has the following tasks inside the BTSE:

- local controlling of the entire BTSE
- generation of system clocks
- providing up to 8 Abis-interfaces to BSC or other BTSEs
- routing of Abis-data to up to 24 CUs
- providing an interface to the LMT/open test platform (OTP)
- handling and processing of O&M messages

D. Special references

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

III. Type of Emission

The emission designator is: **245KGXW**.

The bandwidth of 245 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	Block D	Block B	Block E	Block F	Block C
--	---------	---------	---------	---------	---------	---------

	[MHz]	[MHz]	[MHz]	[MHz]	[MHz]	[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 Frequency	1850.4 - 1864.6	1865.4 - 1869.6	1870.4 - 1884.6	1885.4 - 1889.6	1890.4 - 1894.6	1895.4 - 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 BTSE 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.

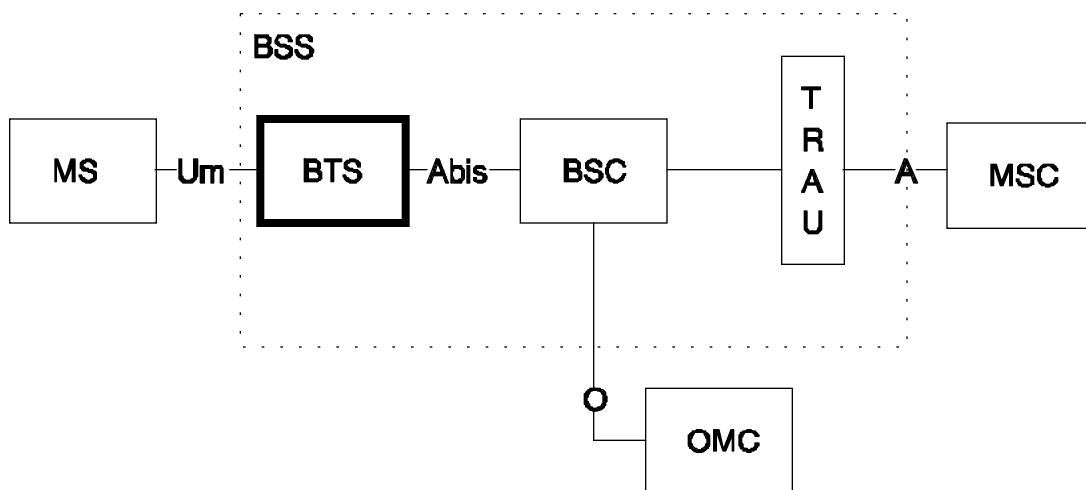


Figure IV-1: General GSM (PCS) Network Layout

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 Output Power Level: 43.8 dBm

Minimum Output Power Level: 1.8 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) for each time slot separately. In both cases the power is attenuated in 2 dB steps.

The output power is controlled by means of a fast action control loop located in the CUP module. For more details please refer to the circuit diagrams of the CUP in the “schematics” exhibit section.

VI. Maximum Power Rating

The maximum power rating is 43.8 dBm (23.99 Watts), as per paragraph 24.232 (a), as measured at the antenna connector of the DUAMCO2:2.

VII. DC Voltage and DC Current

Each CUP which performs the amplification and power leveling of one TX-signal is supplied by one Power Supply Unit (PSU), which converts the internal DC voltage of -48V to +26V, +5V, -5V and -12V used on the CUP-Board. The PSU is part of the CUP Unit. The final stages of the amplifier are powered by the 26V supply. In case of a detected error concerning the TX-Path, the 26V supply of this carrier is switched off.

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

Output power at the antenna connector	Total current of the Final stage 26 V supply
[dBm]	[A]
43	3.4
41	2.5
39	1.9
37	1.5
35	1.2
33	1.0
31	0.8

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 BTSE is initially powered up and during the operational mode.

This ensures that the BTSE operates with specified frequencies and power levels.

A. Board level tests

These tests/adjustments are carried out for each transmitter path of carrier unit.

- . **TXLO Adjustment**
 - TX Even adjustment
 - TX Odd adjustment
- . **PA Adjustment**
 - Pmax and recording of ramp
 - Frequency response
 - Programming of ramp
- . **IQ Modulator Adjustment**
 - IQ modulator adjust
 - Carrier test
 - LSB test
 - USB test
- . **Output power control**
 - Nominal power (Bottom, Middle, Top)
- . **Power steps (Bottom, Middle, Top) Phase and Frequency Error**
 - RMS (Bottom and Top)
 - Peak (Bottom and Top)
 - Frequency error (Bottom and Top)
- . **Power vs Time**
 - Power vs. Time (Bottom, Top)
- . **Switching transients**
 - Switching transients (Bottom and Top) for &400kHz
 - Switching transients (Bottom and Top) for &600kHz
 - Switching transients (Bottom and Top) for &1200kHz
 - Switching transients (Bottom and Top) for &1800kHz
- . **Spectrum due to Modulation**
 - Spectrum due to modulation

- . **TX band spurious**
 - Inband Spurious

B. *Final factory test*

These tests are carried out with a completely equipped BTS 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 (out of band).

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 accuracy of the BTSE is compliant to the requirement of the J-STD-007 standard of $5 \cdot 10^{-6} \%$ for the air interface.

The frequency stability of the BTSE can be defined in short term and long term stability. The MCLK located on COBA supports the long term stability for the BTSE, and the consecutive synthesizers within the transceiver equipment, i.e. CUP determines the short term stability.

B. Long Term Stability

The MCLK uses the PCM line 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 $< 5 \cdot 10^{-6} \%$ on the air interface is maintained.

Principally there are two possibilities how the PCM lines (and hence the BTSE) are synchronized. This depends on the network synchronization structure of the provider.

- In case of clock transparent lines, the MCLK 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 $< 1 \cdot 10^{-6} \%$ /day to the BTSE.
- In case of non-clock transparent lines, the MCLK stays synchronized to the network. The PCM network uses a clock distribution hierarchy defined in ITU-T G.811 and G.812 standards. The BTSE is then synchronized to the local network node to which the PCM connections are established.

The MCLK permanently measures the frequency stability of the PCM reference against its own oven-controlled oscillator. If degraded frequency stability or short term interruptions of the PCM line occur, the MCLK will enter the holdover operation mode. This mode supports the last good frequency value (before failures occur) until the frequency stability of the PCM line is recovered. The holdover stability is $< 3 \cdot 10^{-6} \%$ /day.

C. Short term stability

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

- A local crystal oscillator at 52 MHz, which is synchronized to the MCLK reference frequency, is used as reference by the CUP module.
- A fixed TX IF is used within the CUP. For generation of the IF a synthesizer is used.
- A synthesizer is used for the up-conversion to the final TX frequency. The output frequency of the synthesizer is set according to the selected channel's requirement.
- Setting of all synthesizers is controlled by the software.
- All synthesizers on CUP are synchronized to a 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	26.0
TX-IF	238.0
TX-LO	1703.4 ... 1762.6
TX-RF	1930.4 ... 1989.6

Table XII-1: Synthesizer frequencies of the CUP module

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

A. *Suppression of spurious radiation*

Spurious radiation are 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 module CUP, 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 radiations within the TX-path to the antenna connector:

- Baseband (BB) - filter (CUP)
- IF - filter (CUP)
- RF-filter (CUP)
- RF-filter (DUAMCO)

. Block diagram: TX-path

Please refer to the “block diagram” exhibit section.

. Limiting of modulation

The spectrum due to modulation is determined by the GMSK-Modulator (ASIC), and the BB-Filter.

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

C. *Suppression of spurious radiation*

For rejection of IF-harmonics and noise, the IQ-Modulator is followed by a lowpass and a bandpass filter. The suppression of harmonics from TX-LO (transmit local oscillator), Power-Stage, and the image band is provided by a filter chain (RF-bandpass and DUAMCO).

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

D. *Limiting of output power*

The controlling of the power level of the CUP is done by a fast power-control loop. The output power of the CUP 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 power supply of the final stage amplifiers are switched off, causing the output power to be less than -60 dBm.

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 TX-path consists of the digital GMSK generator with a high accuracy DAC and reconstruction filters.

The GMSK-Modulation is generated on CUP with an ASIC to provide IQ signals.

An IQ-Modulator is used to set the GMSK signal into the IF frequency.

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 (Technical Basis for Regulation)** 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 BS-240U/BS-241U BTS 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.

