RF electromagnetic measurements in a rural environment

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Abstract

Radioelectrical power measurements taken in the 20 MHz - 3 GHz frequency band in a typical rural environment are presented. They show that the spectrum is very clean outside frequency band allocated to land, aeronautical and maritime radiocommunication and more particularly in frequency bands allocated to radio-astronomy, spatial research, remote sensing, radio navigation. They show that the site environment does not suffer from strong electromagnetic fields able to create non linearity in the relevant frequency band. Calculated to the antenna level, electric fields are weak compared to standard limit values legal in France and in the European Union.

1. Introduction

The electromagnetic power measurements presented hereafter are typical examples of radioelectrical power observed in a rural environment. Located at 48° 47' 07 '' North latitude and 3° 31' 05'' West longitude, the measurements site where were operated the measurements is close to the radome of Pleumeur Bodou which shelters the first antenna of telecommunication by satellite and about one kilometer from the small town of Pleumeur Bodou (3800 habitants) and from the emitter. At the place where the measurements are performed, there is in the vicinity neither trains traffic, neither motorway, neither broadcast or television transmitters, nor airport. One can consider this place, at least with the electromagnetic direction as a very ordinary place such as one can find in all over the rural sites of the world.

The used method is the frequency bands analysis method. It consists to perform a frequency scan through the electromagnetic spectrum using a spectral analyzer. It allows to examine and to display the signal spectral composition. The frequency band is shared between numerous applications such as land mobile and terrestrial broadcasting, land, air and maritime mobile telecommunications, television, radio amateur, radio astronomy, spatial research, remote sensing, mobile telephony, radars systems, WI-FI and Bluetooth links, etc.

2. Measurement set-up

An HP 85462A spectrum analyzer is used. The measured band ranges from 20 MHz to 3 GHz covering the high part of HF band, VHF and UHF band. To cover these frequency bands, three different antennae were used: biconical, conical log spiral and double-ridged waveguide horn antenna. The aim here is to determine occupied bandwidth in the electromagnetic spectrum on Pleumeur Bodou site.

The biconical antenna (figure 1) is a broadband dipole antenna which consists of an arrangement of two conical conductors. The conductor has a common axis and vertex. It may be used in vertical or in horizontal polarization. Its bandwidth ranges from 20 to 220 MHz [1]. In the 100 MHz band, typically used by FM and broadcasting, the antenna factor is equal to 13 dB.

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Figure 1: Biconical antenna

The conical log-spiral antenna is constituted by two coaxial feeders, always wrapped around in the same sense (figure 2). On the top of the cone the central core and the wire brainding are reversed. One of the ends of the cable acts as a connector, the other one stays in the air. So the wire brainding of the coaxial cables acts as an illuminator. Polarization is circular in the same sense as the turns winding. Weaker is the "α" angle; more attenuated is the antenna back lobe. The progress of "e" distance is identical to that of a log periodical antenna; an antenna which impedance and radiation pattern are repetitive and following a frequency logarithmic law. For α = 30°, the antenna power gain is close to 6 dBi. The bandwidth of the used antenna ranges from 200 MHz to 1 GHz [2]. In the 900 MHz band, typically used by the Global System for Mobile communications (GSM), the antenna factor is equal to 28 dB.

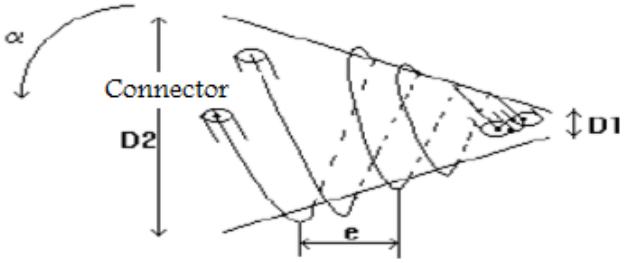

Figure 2: Conical log-spiral antenna

The double-ridged waveguide horn antenna (figure 3) is a linear polarized broadband directional antenna covering the band of frequency 1-18 GHz. According to its fixation, it can be used in vertical or horizontal polarization [3]. In the 2200 MHz band, typically used by the Universal Mobile Telecommunications System (UMTS), the antenna factor is equal to 27 dB.

Figure 3: Double- ridged waveguide horn antenna

The different antennae are connected to the spectrum analyzer through a 10 m length RG 213 cable. Its attenuation is evaluated to 1 dB. A printer linked to the spectrum analyzer allows displaying on a graphic the measurement results.

3. Measurements results

On each record showing radioelectrical power in function of the frequency different measurement characteristics are mentioned: date, hour, bandwidth, etc. We have also showed the detected services: broadcasting, television, radioamator communications, aeronautical navigation, radar, etc. The radioelectrical power ranges from -40 to -120 dBm. The noise threshold is equal to -108 dBm. The following graphics show examples of recording and analysis of observed typical services in HF, VHF and UHF frequency bands (figures 4, 5 and 6).

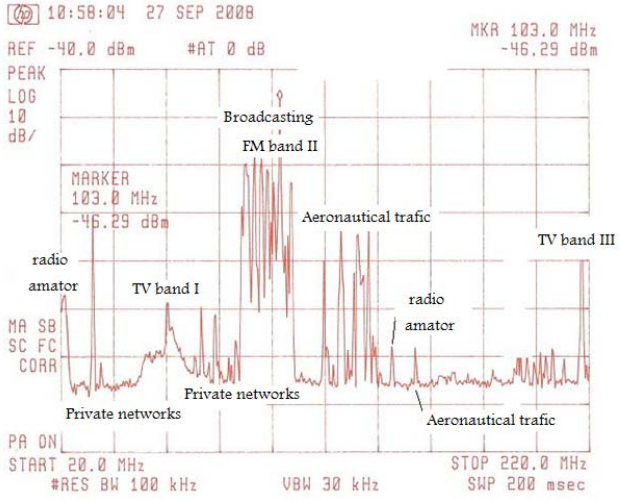

Figure 4: Radioelectrical power measurements in the following conditions: Frequency band: 20-220 MHz, biconical antenna, horizontal polarization, East-West direction.

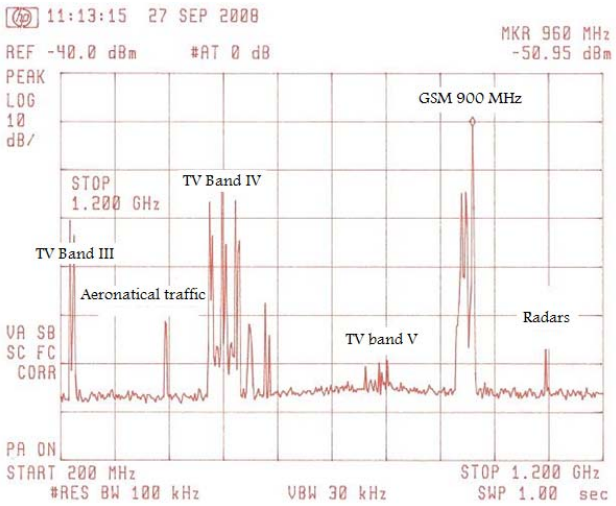

Figure 5: Radioelectrical power measurements in the following conditions: Frequency band: 200-1200 MHz, conical log spiral antenna, circular polarization, South direction.

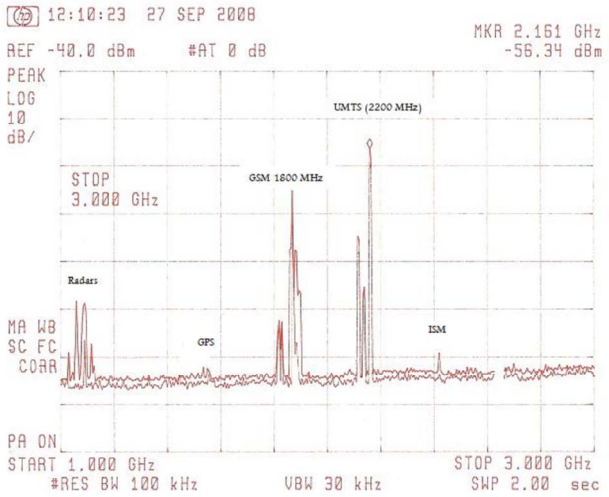

Figure 6: Radioelectrical power measurements in the following conditions: Frequency band: 1-3 GHz, double-ridged waveguide horn antenna, horizontal polarization, East direction.

5. Conclusion

Measurements realized in the 20 MHz – 3 GHz frequency band in an rural environment show that the spectrum is very clean outside frequency bands allocated to land, aeronautical and maritime radio communications and more particularly in frequency bands allocated to radio astronomy, spatial research, remote sensing, radio navigation, etc.
They show that the site did not suffer of strong electromagnetic fields able to create non linearity in ours interested frequency band.

To compare the measurement radioelectrical power to electrical field strength limit values at the antenna level, conversion are made for different services (FM and broadcasting (100 MHz), GSM(900 MHz) and UMTS services (2,2 GHz)). We find respectively 5.6, 17.8 and 8.9 mV/m. They show that electric fields close to the antenna are weak compared to limit standard values legal in France and in the European Union (41 V/m).

6. Acknowledgments

These measurements were carried out by Philippe Maliet, Lucien Macé, Michel Dontenwille, André Gilloire and Hervé Sizun from “Pleumeur Bodou radioelectrical observation” association and were realized on the site belonging to the “Communauté d’Agglomération” from Lannion.

7. References

1. Biconical antenna, model 3104c, EMCO manufacturers: www.ets-lindgren.com

2. Conical Log Spiral antenna, model 3101, EMCO manufacturers: www.ets-lindgren.com

3. Double-Ridged Waveguide Horn antenna, model 3115, EMCO manufacturers: www.ets-lindgren.com