Automatic Measurement and Monitoring of RF Field Strength Characteristics from GSM Systems

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Abstract: **- Mobile communication was well known from the period of 1980's. For the past three decades, it attains more growth and getrid of the burden of wired communication. Nowadays, it is one of the essential devices for our day to day life activities to deliver the voice and data from one point to other point in fast way. Generally, the mobile communication uses two types of communications namely, GSM and CDMA. Each type has different spectrum allocation and all are microwave waves. Due to more demand in mobile communication, spectrum sharing and mode of communication also increased. Hence measurement and monitoring of the electromagnetic fields for GSM and CDMA systems are imperative. The main objective of this paper is to introduce a virtual instrumentation system and real time system for automated characterization of the electromagnetic fields generated by GSM and CDMA systems. This system consists of calibrated antennas, and controlled spectrum analyzer with USB connectivity and Lab VIEW software for monitoring and data transfer, processing and analysis. At first, RF fields are define for GSM and CDMA base stations, it can be used for examining the RF exposure from other communication technologies.**

Keywords: VIS, GSM, UMTS,CDMA,Spectrum analyzer.

1. INTRODUCTION:

During the past decade, the increased use of mobile phones has led to the installation of an extremely large number of mobile phone base stations, especially in densely populated areas. As a consequence, public concern about possible adverse health effects of the exposure to RF electromagnetic fields generated by GSM systems has often emerged. Therefore, there is a need not only for computing the RF fields from base station antennas [2]-[4], but also for performing systematic measurements of the RF exposure levels in their vicinity [4], to ensure that these levels are within the reference limits specified in applicable guidelines. Because, in most cases, the assessment of RF exposure from GSM systems require carrying out and processing a large volume of measurements, our efforts have been directed towards the development of an automated solution for RF field strength characterization. By adopting a virtual instrumentation approach focused on Lab*VIEW* graphical programming, it was possible to combine traditional equipment with "measurement"algorithms into a more flexible PC-based system, which can compute, analyze and monitor various parameters, such as electric field strength (E), magnetic field strength (H), power density (S), mean and standard deviation of these quantities, etc. The main aspects regarding the system operation andsoftware functionality, as well as a few short-term monitoring results, are presented in the subsequent sections

2. LITERATURE SURVEY

For this work existing measuring and monitoring techniques in base station extensive study on different measuring software available now. We use NI Lab*view.* For this proposed work, the various ideas are collected from the various literatures.The literature survey is done by 10papers; they are characterized by different topics as shown below.

A: VIRTUAL INSTRUMENTATION SYSTEM

the virtual instrumentationapproaches have potential to enhance the content of a widerange of courses, complementing the theoretical lessonsand promoting the experimental learning. Representativeapplication fields include, but are not limited to: sensorsand instrumentation [1, 2], electrical machines [3, 4],electric circuit analysis [3, 5], digital circuits [6, 7], digitalsignal processing [8–10], power electronics [3, 11] andautomatic control systems [12]. Additionally, this paperdemonstrates that, using a virtual instrumentationapproach, it is also possible to enhance theElectromagnetic Compatibility education through thedevelopment of new teaching resources. Working withLab*VIEW* for many years and looking for new ways tomake the EMC course in our faculty more engaging andenjoyable, we have introduced a set of computer-basedinstructional modules (VIs) concerning EMC concepts

The virtual instrumentation system (VIS) is built on a PC program and an R&S FS300 programmable spectrum analyzer, which operates in the frequency range from 9 kHz to 3 GHz. With 16 digitally implemented resolution bandwidths from 200 Hz to 1 MHz, the R&S FS300 can be optimally configured to perform narrowband measurements of the RF-fields generated by both GSM 900 and GSM 1800 base station antennas. Unfortunately, this instrument has no RMS detector (it has only positive peak detector), which is usually preferred when assessing the RF exposure originating on UMTS systems [1]Because the R&S FS300

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has low power requirements andprovides full remote control via USB, the VIS can be used for performing both indoor and outdoor measurements. In the last case, a notebook computer and a common uninterruptible power supply (UPS) for home or office could provide a simple solution for ensuring portability. Such a setup is shown in Fig. 1, where the R&S FS300 is operated in conjunction with an AT4002A, 800 MHz – 5 GHz horn antenna (Amplifier Research) for measuring E-field emissions in the vicinity of a multi-system base station from n urban environment.

B: Network used

GSM900

The term GSM900 is used for a GSM system which operates in any 900MHz. The 900 MHz band defined in the ETSI standard includes the primary GSM band (GSM-P), the extension (see E-GSM) and the part of the 900 MHz band that is reserved for railways (R-GSM). The total GSM900 band defined in the standard ranges from 876 - 915 MHz paired with 921 - 960MHz. Mobiles transmit in the lower band and base stations transmit in the upper band. In daily life, the term GSM900 band is used for the parts of the band that are used by the GSM operators to offer public services, which excludes the R-GSM band. This part of the band that remains ranges from 880 - 915 MHz paired with 925 - 960 MHz band.

System	P-GSM 900	E-GSM 900	GSM 1800
Frequencies:			
• Uplink	890-915 MHz	880-915 MHz	1710-1785 MHz
• Downlink	935-960 MHz	925-960 MHz	1805-1880 MHz
Wavelength	~ 33 cm	~ 33 cm	~ 17 cm
Bandwidth	25 MHz	35 MHz	75 MHz
Duplex Distance	45 MHz	45 MHz	95 MHz
Carrier Separation	200 kHz	200 kHz	200 kHz
Radio Channels[1]	125	175	375
Transmission Rate	270 kbits/s	270 kbits/s	270 kbits/s

GSM1800

GSM1800 is the term used to denote GSM Operating in the 1800 MHz band. The 1800 MHz band ranges from 1710 - 1785 MHz and from 1805 - 1880MHz. Mobiles transmit in the lower band and base stations transmit in the upper band. GSM1800 is also known under the old name *Digital Communications System* 1800 (DCS1800).

UMTS

UMTS uses a multiple access technique, where several users as well as the signalization is separated by different spreading codes (WCDMA - Wideband Code Division Multiple Access). By multiplication with the spreading code, the data signal is spread in the spectrum. Spectrum of a UMTS signal Fig. 3 shows a real measured UMTS signal in frequency domain. The 10 dB bandwidth is about 4.3MHz, in the literature 4.6 MHz is often stated. In time domain UMTS signals are also noise like with typical crest factors in the region of 8 to10 db. In contrast to DVB-T and DAB, the crest factor at UMTS is not constant in time, but varies with the traffic of the station. The downlink frequency range for UMTS is 2110-2170 MHz Due to the power control of UMTS, the radiated power of a station is dependent on the transmitted data volume and the connection quality to the UMTS terminal.in accordance to the measured signal.

CDMA

CDMA for this method as it can be implemented very easily and effectively. According to the latest report by researcher Gartner India's mobile subscriber base should grow to 993 million by 2014, which expects the world's fastest-growing mobile market to close 2010 with more than 660 million subscribers. India is the second-largest wireless market in the world after China with its 618 million mobile subscribers at end-May, according to data from the country's telecoms regulator. Mobile connections were at 525 million at end of 2009. Latest data by the Cellular Operators Association of India (COAI) showed GSM operators had added 6.68 million in November 2012 and the GSM subscriber base was at 632.08 million. GSM operators added 7.55 million new subscribers inDecember, taking the total GSM user base to 639.64 million in the country, according to the COAI’s data released. In this scenario the utilization of existing GSM network for metering in India will be a cost effective method for all class of people.

C:HORN ANTENNA

Pyramidal microwave horn antenna, with a bandwidth of 0.8 to 18 GHz. A coaxial cable feed line attaches to the connector visible at top. This type is called a ridged horn; the curving fins visible inside the mouth of the horn increase the antenna's bandwidth.Pyramidal horn antennas for a variety of frequencies. They have flanges at the top to attach to standard waveguides.

A horn antenna or microwave horn is an antenna that consists of a flaring metal waveguide shaped like a horn to direct radio waves in a beam. Horns are widely used as antennas at UHF and MICROWAVE frequencies, above

300MHz.They are used as feeders (called feed horn) for larger antenna structures such as paraboliantennas, as standard calibration antennas to measure the gain of other antennas, and as directive antennas for such devices as radar guns, automatic door openers, and microwave radiometers. Their advantages are moderate directivity (gain), low standing wave ratio (SWR), broad bandwidth, and simple construction and adjustment.[3]

One of the first horn antennas was constructed in 1897 by Indian radio researcher Jag dish Chandra Bose in his pioneering experiments with microwaves. In the 1930s the first experimental research (South worth and Barrow, 1936) and theoretical analysis (Barrow and Chu, 1939) of horns as antennas was done The development of radar in World War 2 stimulated horn research to design feed horns for radar antennas. The corrugated horn invented by Kay in 1962 has become widely used as a feed horn for microwave antennas such as satellite dishes and radio telescopes.

An advantage of horn antennas is that since they have no resonant elements, they can operate over a wide range of frequencies, a wide bandwidth. The usable bandwidth of horn antennas is typically of the order of 10:1, and can be up to 20:1 (for example allowing it to operate from 1 GHz to 20 GHz).The input impedance is slowly varying over this wide frequency range, allowing low voltage standing wave ratio (VSWR) over the bandwidth.[1] The gain of horn antennas ranges up to 25 dBs, with 10 - 20dBs being typical.

D: spectrum analyzer

The main PCB from a 20 GHzspectrum analyzer. Showing the strapline PCB filters, and modular block construction. A **spectrum analyzer** measures the magnitude of an input signal versus frequency within the full frequency range of the instrument. The primary use is to measure the power of the spectrum of known and unknown signals. The input signal that a spectrum analyzer measures is electrical, however, spectral compositions of other signals, such as acoustic pressure waves and optical light waves, can

be considered through the use of an appropriate transducer. Optical spectrum analyzers also exist, which use direct optical techniques such as a monochromatic to make measurements.By analyzing the spectra of electrical signals, dominant frequency, power, distortion, harmonics, bandwidth, and other spectral components of a signal can be observed that are not easily detectable in time domainwaveforms. These parameters are useful in the characterization of electronic devices, such as wireless transmitters.The display of a spectrum analyzer has frequency on the horizontal axis and the amplitude displayed on the vertical axis. To the casual observer, a spectrum analyzer looks like an oscilloscope and, in fact, some lab instruments can function either as an oscilloscope or a spectrum analyzer.

III. SOFTWARE

The associated software is designed to work under Windows XP and – as already stated – has been created as a Lab*VIEW* virtual instrument (VI). Therefore, it takes advantage of numerous benefits provided by this environment, including interactive graphical user interfaces, advanced data visualization, intuitive operation and possibility of further expansion. When running the software,the operation of the spectrum analyzer through its front panel is disabled and only a “blue screen” will be displayed by the instrument. Among others, the program – called RF-Field*VIEW* – is responsible for configuring the main parameters of the spectrum analyzer, retrieving the power data from the instrument, computing and displaying the field strength, time-averaged exposure and a number of statistic parameters,as well as recording data for subsequent analysis. The stored data can be analyzed by using another Lab*VIEW* program, which also allows for computing the resultant RMS field bytaking into account readings recorded on three orthogonal directions for a sufficiently long measurement time, as suggested in A. Algorithm Summary Basically, the RF-FieldVIEW software is based on the Lab*VIEW* instrument driver library for the FS300, provided by Rohde & Schwarz on its website. All these functions have been critically studied and a part of them have been incorporated as subVIs in the main program for ensuring proper control of the spectrum analyzer and receiving the trace data from the instrument, as presented in Fig. 2. Starting from the “live” trace data, further *LabVIEW* processing is devoted to compute relevant field quantities and statisticparameters. In order to provide simple system reconfiguration, the RF-FieldVIEW uses a modular approach. For instance, a number of subroutines (subVIs) are specifically designed for adding the antenna factors to the measurement results and compensating for the transmission line losses over the frequency range explored by the spectrum analyzer. If a particular antenna or transmission line must be used, the correspondent subVI will be called by the main program when it starts and no code modifications have to be made.

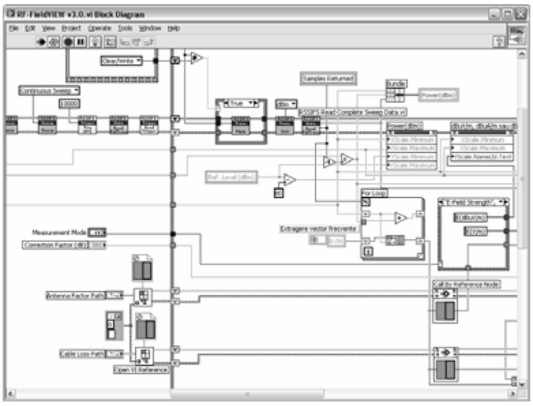


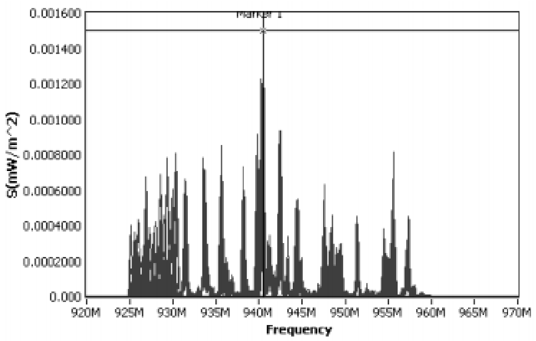
Fig. 2. Part of the block diagram.

The program runs continuously until the user aborts its execution, a specified execution time has elapsed or a communication error has been detected. In this case, an error message will be displayed for the user.

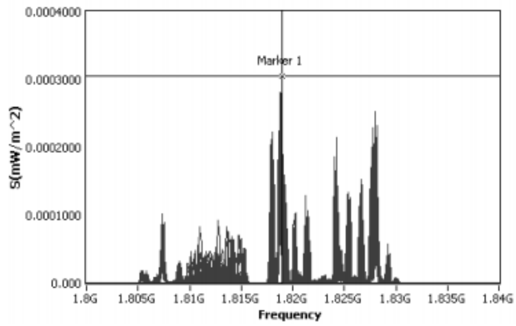
3. MONITORING RESULTS

According to the ICNIRP guidelines the reference levels for general public exposure from mobile Communications are: 4.5 W/m2for GSM networks operating in the 900 MHz frequency band, 9 W/m2 for GSM networks operating at 1800 MHz and 10 W/m2for 3G/UMTS. In order to get an idea of the actual RF exposure levels associated with these technologies, a short-term monitoring has been conducted in a typical indoor environment. First of all, to investigate the short-term evolution of the background electromagnetic field, wideband measurements from 800 MHz to 2.6 GHz have been taken at each 0.5 minutes during 24hours.Then narrowband measurements covering the downlink frequency bands.

The power density in the frequency range from 2110 MHz to 2170 MHz, which corresponds to the UMTS downlink, is shown in Fig. 8. This plot consists of 2030 readings taken over 17 hours, in the average mode, and has a maximum of 0.0391mW/m2at the frequency of 2161.4MHz. All measurements have been automatically corrected by a factor that accounts for the limited resolution bandwidth of the spectrum analyzer with respect to the UMTS signal bandwidth.



Emission of GSM 900



Emission of GSM 1800

4. CONCLUSION

According to the literature survey in this work is proposed to develop the full monitoring and measuringto analysis all above networks .which one is less EMF emitting that network will less human diseases affected. The associated software provides user-friendly operation and accommodates various features for fast field characterization, including spectrum view for all quantities, markers, zoom, limits, simultaneous display of a very large number of saved traces, etc.

5. REFERENCES

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