ISSN 1726-5479

SENSORS & TRANSDUCERS

7 vol. 106 /09

Sensor Networks and Wireless Sensor Networks

International Frequency Sensor Association Publishing

IFSA

Sensors & Transducers

Volume 106, Issue 7
July 2009

www.sensorsportal.com

ISSN 1726-5479

Sensors & Transducers Journal (ISSN 1726-5479) is a peer review international journal published monthly online by International Frequency Sensor Association (IFSA).
Available in electronic and on CD.

Sensors & Transducers Journal

Contents

Volume 106
Issue 7
July 2009

www.sensorsportal.com

ISSN 1726-5479

Research Articles

Authors are encouraged to submit article in MS Word (doc) and Acrobat (pdf) formats by e-mail: editor@sensorsportal.com
Please visit journal's webpage with preparation instructions: http://www.sensorsportal.com/HTML/DIGEST/Submition.htm

Sensors & Transducers Journal, Vol. 106, Issue 7, July 2009, pp. 107-113

www.sensorsportal.com

Sensors & Transducers

ISSN 1726-5479

http://www.sensorsportal.com

Channel Estimation of WCDMA with OFDM Signal

[1]N. R. Raajan, [2]Y. Venkataramani, [1]T. R. Sivaramakrishnan

[1]Department of Electronics & Communication Engineering, SASTRA University
Thanjavur – 613402, Tamilnadu, India
Tel.: +91(4362)264101, extn.: 147, fax: +91(4362)264120
[2]Department of Electronics and Communication Engineering,
Saranathan College of Engineering And Technology,
Trichy, Tamilnadu, India
E-mail: nrraajan@ece.sastra.edu, deantrs@sastra.edu

Received: 16 March 2009 /Accepted: 15 July 2009 /Published: 20 July 2009

Abstract: This paper concentrate on channel estimation to improve the coverage and capacity in a wideband code division multiple access (WCDMA) with OFDM. The impact of various parameters in AWGN and Rayleigh channels is observed and BER (Bit error rate) is calculated for each channels.

Keywords: WCDMA, OFDM, AWGN, Rayleigh, BER

1. Introduction

The third generation of mobile phone technology (3G) is arguably the most complex multinational collaborative project that the world has ever seen. Throughout virtually all developed nations, cellular equipment manufacturers, mobile network operators, silicon suppliers and software developers have been working together to bring about the successful deployment and commercial introduction of 3G. Although there have been some delays from the initial target schedules, the historical precedents in the development of the wireless industry suggest that the current problems associated with 3G roll out will be overcome and its long term commercial success is assured. The move from Global System for Mobile GSM to WCDMA is nothing short of a global technological revolution. However, this is not the first time the industry has gone through such major change; the introduction of 2G standards such as GSM also posed technical challenges and involved substantial multinational collaboration. The transition from GSM to WCDMA represents another development challenge that is much more

complex even than GSM. It represents a huge technological undertaking, which few in the press community have fully recognized. The lessons to be drawn from TACS and GSM are that evolutionary development can run to plan, but the revolutionary equivalent usually doesn't. 3G is clearly revolutionary and its development has not run to plan. A number of 3G network launches have been scheduled, only to be quietly postponed whilst ongoing technical issues are ironed out. But history would suggest that perhaps there is nothing wrong with 3G development; it is just that the predictions were wrong.

2. WCDMA

The spreading codes used in WCDMA are a concatenation of long pseudo-random scrambling sequences and short orthogonal channelization sequences. Multipath dispersion leads to a loss in orthogonality between the spreading codes. This is measured in WCDMA downlink capacity analyses and simulations by the orthogonality factor (OF) [1] & [8] and hence QPSK is been introduced along with OFDM (Orthogonal frequency division multiplexing.

The block diagram consists of the three major processing.

2.1. Transmitter

Transmitter consists of source data along with IQ mapper and OFDM modulator in which WCDMA signal is taken into modulation section for the processing of signals QPSK is Phase modulation is a version of frequency modulation where the phase of the carrier wave is modulated to encode bits of digital information in each phase change. The "PSK" in QPSK refers to the use of Phased Shift Keying. Phased Shift Keying is a form of phase modulation which is accomplished by the use of a discrete number of states. QPSK refers to PSK with 4 states. With half that number of states, you will have BPSK (Binary Phased Shift Keying). With twice the number of states as QPSK, you will have 8PSK.The "Quad" in QPSK refers to four phases in which a carrier is sent in QPSK: 45, 135, 225, and 315 degrees then the signal is treated for security over interleave and CRC and feed into channel for propagation.

2.2. Channel

AWGN channel model is one in which the information is given a single impairment: a linear addition of wideband or white noise with a constant spectral density (expressed as watts/hertz of bandwidth) and a Gaussian distribution of noise samples. The model does not account for the phenomena of fading, frequency selectivity, interference, nonlinearity or dispersion. However, it produces simple and tractable mathematical models which are useful for gaining insight into the underlying behavior of a system before these other phenomena are considered. Wideband Gaussian noise comes from many natural sources, such as the thermal vibrations of atoms in antenna (referred to as thermal noise or Johnson Nyquist noise), short noise, black body radiation from the earth and other objects. The AWGN channel is a good model for many satellites and deep space communication link.

Rayleigh distribution is a continuous probability distribution. It can arise when a two-dimensional vector (e.g. wind velocity, which consists of a speed value and a direction) has elements that are normally distributed, are uncorrelated, and have equal variance. The vector's magnitude (e.g. wind speed) will then have a Rayleigh distribution.

2.3. Receiver

A constellation diagram (Fig. 7) is a representation of a signal modulated by a digital modulation scheme such as quadrature amplitude modulation or phase shift keying. It displays the signal as a two dimensional scatter diagram in the complex plane at symbol sampling instants. In a more abstract sense, it represents the possible symbols that may be selected by a given modulation scheme as points in the complex plane. Measured constellation diagram can be used to recognize the type of interference and distortion in a signal.

For the sake of simplicity the concepts of WCDMA capacity will be described and assuming that there are multiple users using the same service in uplink and downlink without any interference. Assuming the number of users is N, the required E_b/I_0 to achieve the required quality at the receiving side is $(E_b/I_0)_{req}$, the transmission speed of the user information is R(bps), chip rate B(cps) to R is pg and the thermal noise power density is N_0 (W/Hz).

$$\frac{E_b * R * pg}{E_b * R * (N-1) + N_0 * B} = (Eb / I_0)_{req} \tag{1}$$

$$C_0 = \lim_{E_b \to \infty} N = \lim_{E_b \to \infty} \left(\frac{pg}{(E_b / I_0)_{req}} + 1 - \frac{N_0 * pg}{E_b}\right) = \frac{pg}{(E_b / I_0)_{req}} + 1 \tag{2}$$

As the equation (1) shows the required received power E_b rapidly increasing and eventually diffuses in line with the increase in the number of users N the marginal capacity referred to in equation (2) is sometimes called pole capacity. In practical however it is impossible to infinity increase received power.

$$\eta = \frac{E_b * R * N + N_0 * B}{N_0 * B} \tag{3}$$

In order to limit interference margin η is introduced, which indicates how large the total amount of interference is in comparison to the thermal noise. Assuming that the amount of interference is limited, the capacity can be worked out on the basis of the equation below, after solving equation (3) with respect to E_b and using equation (1):

$$C = N|_\eta = \left(\frac{pg}{(E_b / I_0)_{req}} + 1\right) * (1 - \eta^{-1}) = C_0 * (1 - \eta^{-1}) \tag{4}$$

The relationship in equation (4) shows that a large η leads to a large capacity C.

The above stated C, E_b, I_0 are some basic parameters that has to be in the WCDMA signal processing core in order to achieve the required signal in the particular state and efficiency is also increased by that the binary signal is generated from the source and it has been divided into I and Q bit for processing, and again it has been converted into analog I and Q signal for modulation see Fig. 1 for the IQ mapper and both the signals are multiplexed for the transmission in the channel after the channel the signal is observed with various parameters as shown below (Fig. 2).

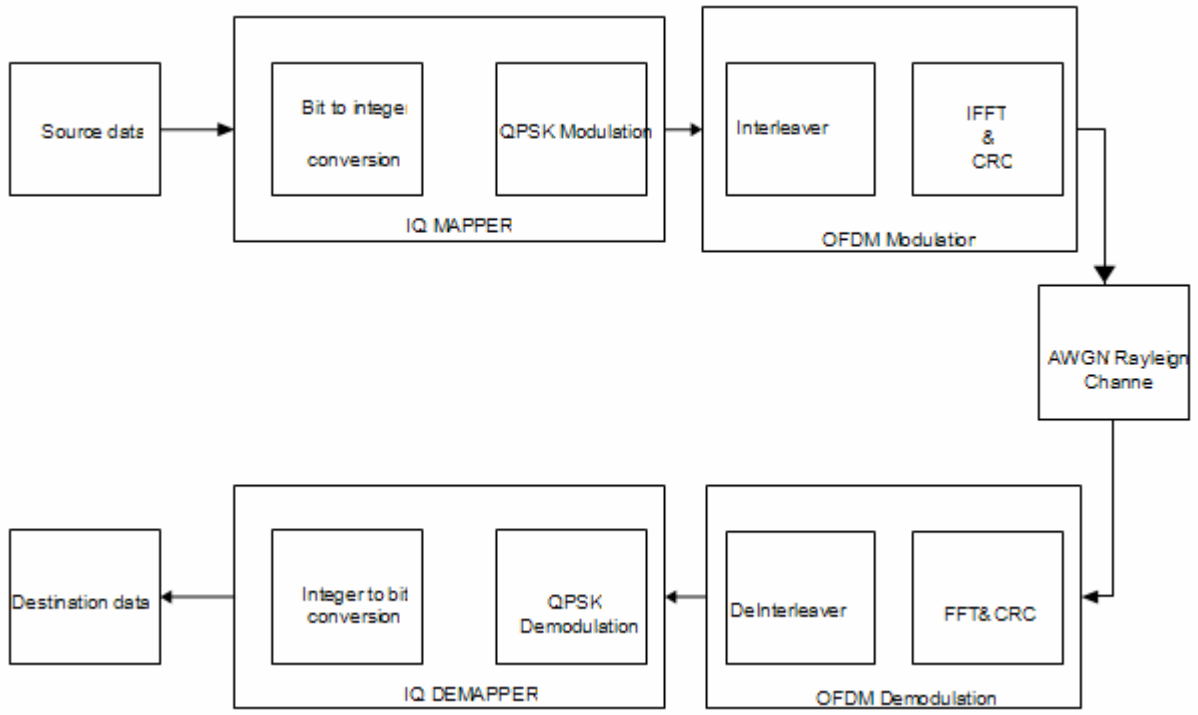

Fig. 1. Block diagram of WCDMA with OFDM in QPSK signal.

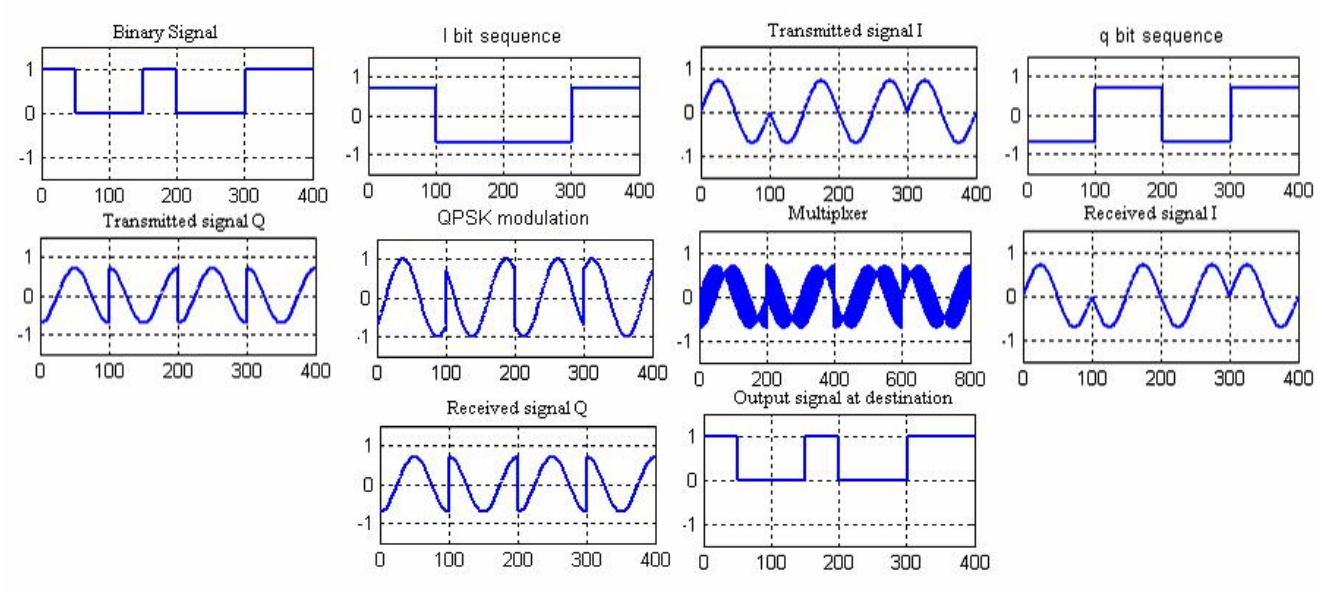

Fig. 2. Output waveform obtained from various levels of blocks in Fig. 1.

3. Obtained Results

Output signal observed along with various parameters in accordance with same input (Figures 3-7).

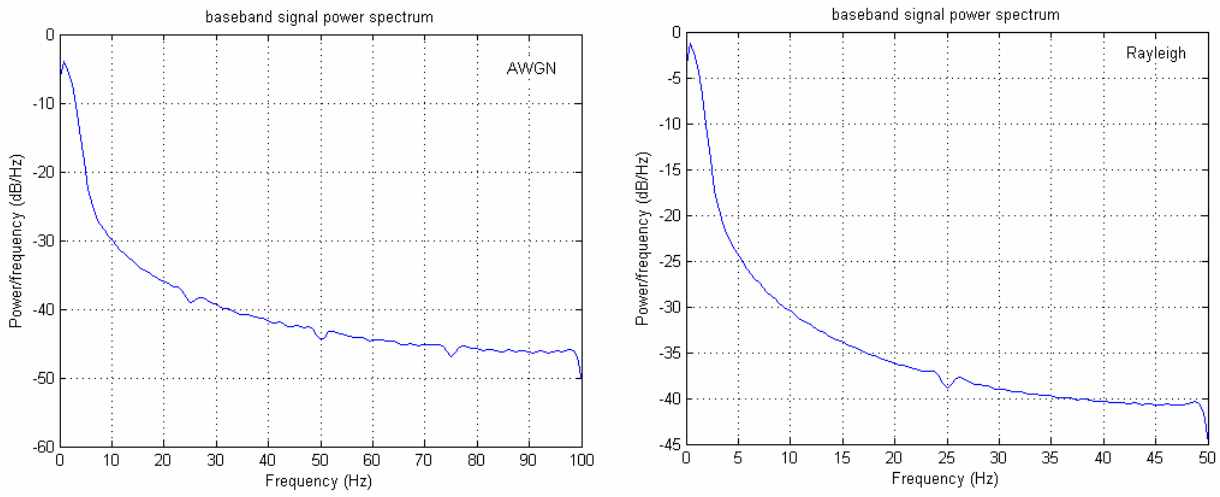

Fig. 3. Baseband signal power spectrum for AWGN (Left) and Rayleigh (Right).

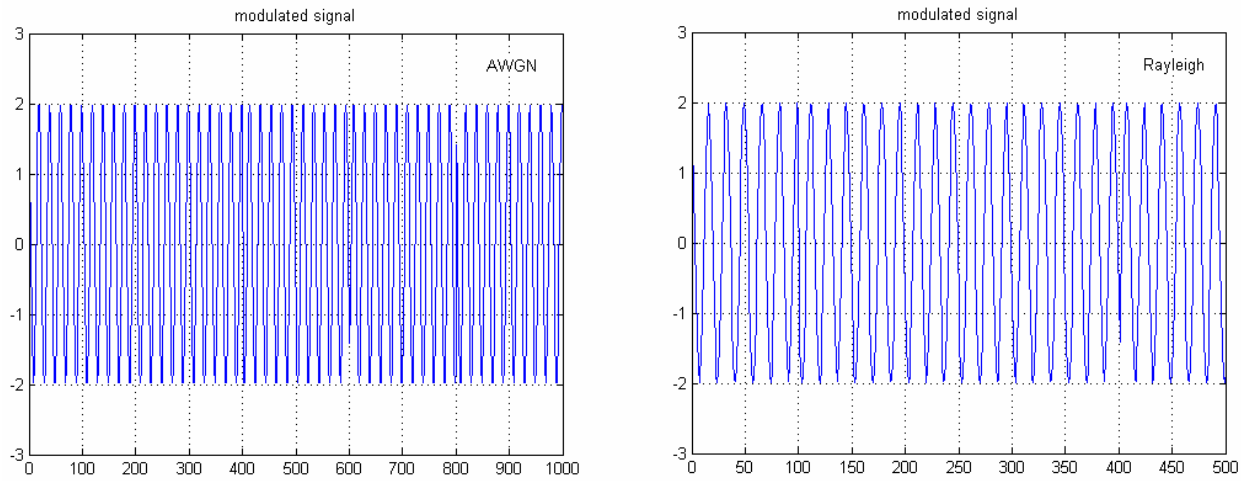

Fig. 4. Modulated signal at the channel for AWGN (Left) and Rayleigh (right).

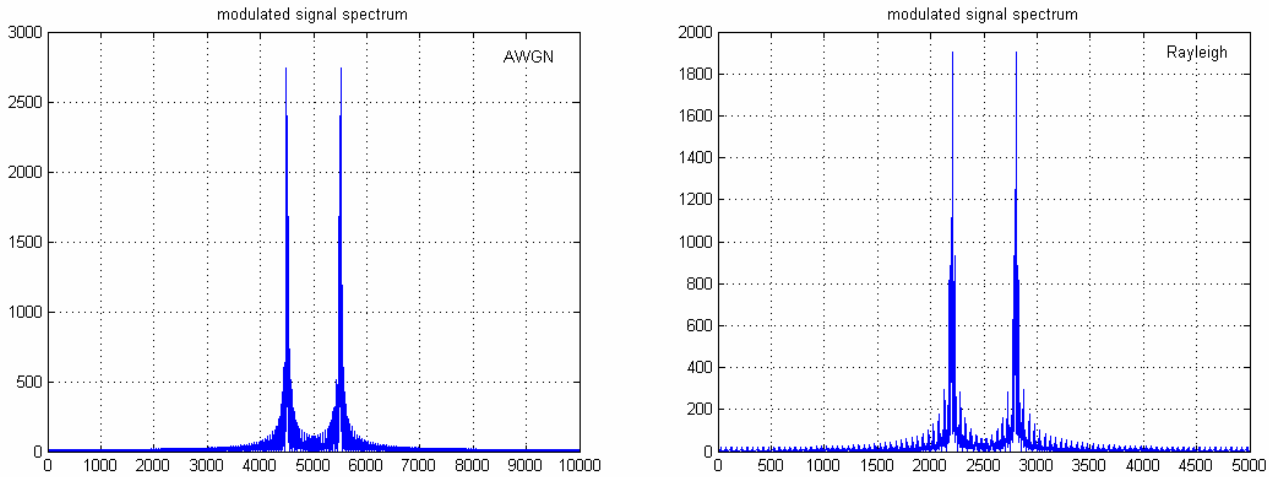

Fig. 5. Modulated signal spectrum for AWGN (Left) and Rayleigh (Right).

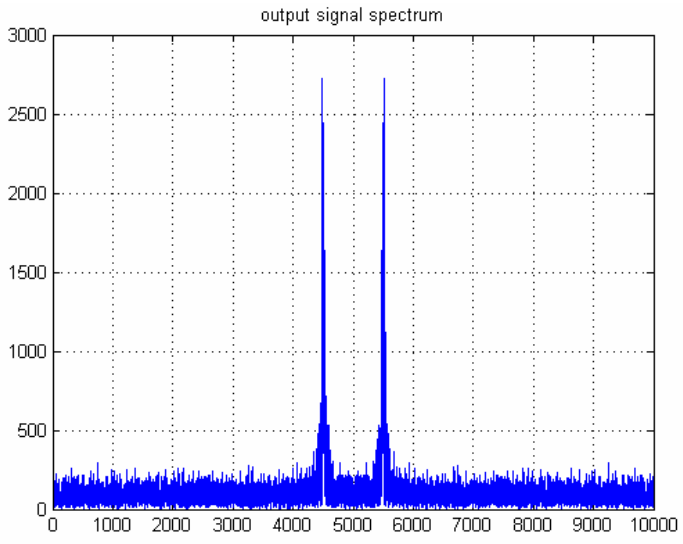

Fig. 6. Output signal spectrum for the received signal.

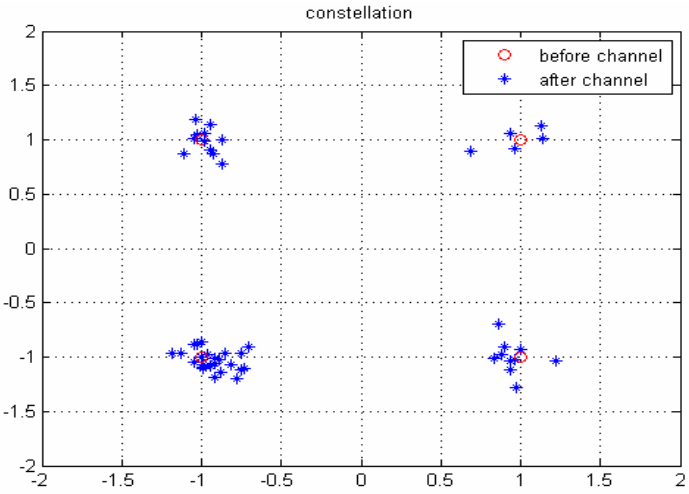

Fig. 7. Constellation output for the signal before and after the channel.

4. Conclusions

The results obtained are verified with the theoretical values specified in 3GPP [5] - [6]. The operation for the WCDMA on OFDM was performed (Fig. 8) by MATLAB®. Wireless Communication must cope with performance limiting challenges such as frequency selective fading and ISI for high data rate transmission. OFDM as a multicarrier modulation technique is effective for supporting high speed transmission as well as combating multipath fading and frequency selective fading in broad band wireless communication. This reduces the requirement for more efficient equalization technique. The results of this work strongly prove that OFDM schemes perform better in wireless platform and they can be used effectively for multimedia data transmission over AWGN channel.

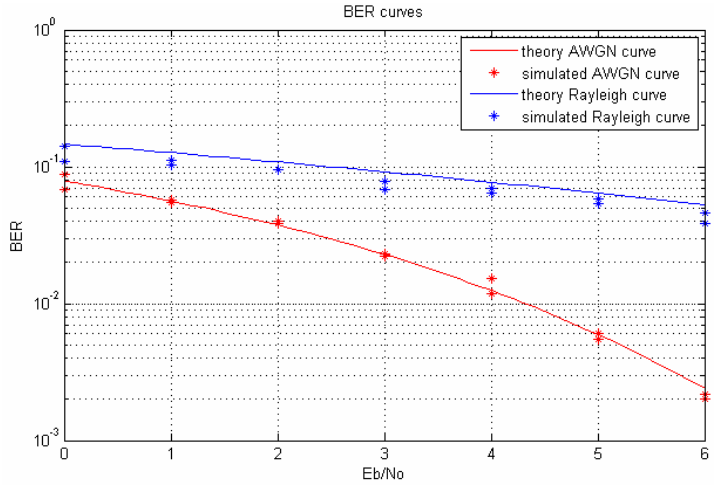

Fig. 8. BER (Bit Error Rate) calculation for both the channels.

References

[1]. Tero Ojanpera, Ramjee Prasad, Wideband Cdma for Third Generation Mobile Communication, Ed.; *Artech House*, 1998.
[2]. H. Holma and A. Toskala, WCDMA for UMTS, *John Wiley*, 2000.
[3]. M. Steinbauer and A. F. Molisch, Directional channel modelling, in Wireless Flexible Personalized Communications, European Co-operation in Mobile Radio Research, *John Wiley*, 2001.
[4]. C. Chevallier. et al, WCDMA Network Deployment, *John Wiley*, 2006.
[5]. 3GPP TS 25.104 Base Station (BS) Radio Transmission and Reception (FDD).
[6]. 3GPP TS 25.212 V3.6.0 (2001-06) Multiplexing and Channel Coding (FDD).
[7]. Harri Holma and Antti Toskala, HSDPA/HSUPA for UMTS, *John Wiley*, 2006.
[8]. K. Hiltunen and B. De Ricardo, WCDMA downlink capacity estimation, *in Proc. of the VTC*, 2000, pp. 992–996.
[9]. Keiji Tachikawa, W-CDMA mobile communication system, *John Wiley*, 2002.

Guide for Contributors

Aims and Scope

Sensors & Transducers Journal (ISSN 1726-5479) provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes state-of-the-art reviews, regular research and application specific papers, short notes, letters to Editor and sensors related books reviews as well as academic, practical and commercial information of interest to its readership. Because it is an open access, peer review international journal, papers rapidly published in *Sensors & Transducers Journal* will receive a very high publicity. The journal is published monthly as twelve issues per annual by International Frequency Association (IFSA). In additional, some special sponsored and conference issues published annually. *Sensors & Transducers Journal* is indexed and abstracted very quickly by Chemical Abstracts, IndexCopernicus Journals Master List, Open J-Gate, Google Scholar, etc.

Topics Covered

Contributions are invited on all aspects of research, development and application of the science and technology of sensors, transducers and sensor instrumentations. Topics include, but are not restricted to:

- Physical, chemical and biosensors;
- Digital, frequency, period, duty-cycle, time interval, PWM, pulse number output sensors and transducers;
- Theory, principles, effects, design, standardization and modeling;
- Smart sensors and systems;
- Sensor instrumentation;
- Virtual instruments;
- Sensors interfaces, buses and networks;
- Signal processing;
- Frequency (period, duty-cycle)-to-digital converters, ADC;
- Technologies and materials;
- Nanosensors;
- Microsystems;
- Applications.

Submission of papers

Articles should be written in English. Authors are invited to submit by e-mail editor@sensorsportal.com 8-14 pages article (including abstract, illustrations (color or grayscale), photos and references) in both: MS Word (doc) and Acrobat (pdf) formats. Detailed preparation instructions, paper example and template of manuscript are available from the journal's webpage: http://www.sensorsportal.com/HTML/DIGEST/Submition.htm Authors must follow the instructions strictly when submitting their manuscripts.

Advertising Information

Advertising orders and enquires may be sent to sales@sensorsportal.com Please download also our media kit: http://www.sensorsportal.com/DOWNLOADS/Media_Kit_2009.pdf