Power Measurements for Wireless Communications

J Ascroft & J Beaumont
Centre for Electromagnetic Metrology
National Physical Laboratory
Teddington, TW11 0LW, UK

Abstract

With the next-generation wireless standards development underway and the invitation from the International Telecommunications Union (ITU) calling for proposals detailing third-generation standards for the mobile communications industry, NPL has become involved with investigating the problems associated with providing traceable power measurements for the wireless communications industry.

Introduction

The European market for cellular service was first introduced in the early 1980s by the Scandinavian Nordic Mobile Telephone (NMT) system[1]. The introduction of Global System for Mobile communications (GSM) in 1992 has seen the development of more than 25 separate networks in the EU alone. The global head count of GSM subscribers is currently in excess of 100 million with the expectation of doubling by the year 2000. GSM presently makes up approximately 50% of the current wireless communications market and for this reason the GSM specifications have become the recognised standard within the industry. The current standard employed is the European Telecommunications Standard (ETSI) GSM series of specifications which were introduced in 1994 and now require updating to accommodate the changes within the industry in recent years.

In 1997 the European Union set up a regulatory framework for the Universal Mobile Telecommunications System (UMTS) with the aim of integrating current systems leading to a standardised third-generation telecommunications network. Following this a recent report[2] has stated that five major European GSM manufacturers are to develop a next generation wireless standard that will combine all aspects of current cellular technologies.

As a result of rapid growth in the wireless communications market the allocated frequency bands quickly become saturated and this has led to operators expanding into new higher frequency bands. This trend has become apparent with the rapid take-up of the 38 GHz transmission band which is used for point-to-point, line of sight communications which over the past five years has increased from a few 10s to around 5000 fixed link installations. Frequency allocation bands for wireless communications in the UK extend as high as 60 GHz with total usage currently more than 15,000 fixed link installations in the UK operating above 7 GHz. It is anticipated that frequency bands within this region will become further utilised over the next few years. This will lead to the development of new or improved standards which, with the introduction of test and measurement equipment, will require traceability to National Standards.

Research Activity

The pulse power system to be developed by NPL must be capable of measuring current digital modulation waveforms at frequencies up to 30 GHz. Modulation techniques currently being employed such as Code Division Multiple Access (CDMA), Time Division Multiple Access (TDMA) and various configurations of Quadrature Phase Shift Keying (QPSK) will require the development of new systems to measure the power amplitude sequences involved in these varied digital communication techniques.

The proposal set forward by NPL is to provide traceable power measurement for the wireless communications industry covering the major RF communications systems as well as higher frequency line of sight transmission for point to point communications.

A specification for the development of the system will largely depend on the outcome of discussions planned at an open forum, where members of all sectors of the wireless communications industry will be invited to attend and contribute.

A proposed specification for the system will be capable of carrying out measurements between 0.1mW and 100mW at the relevant transmission power levels with modulation techniques such as QPSK, π/4DQPSK and Gaussian Minimum Shift Keying (GMSK) with channel spacing of 25 kHz - 1250 kHz and channel bit rates of 42 kb/s - 1.2288 Mb/s. The system will be capable of monitoring both the average power for a transmission burst and the peak power of individual pulses within that burst with particular attention given to resolving peak power levels of adjacent pulses. It is anticipated that the system will be capable of resolving adjacent pulses with a minimum pulse width of 20 μs. This is a proposed specification and may vary given the advice from the forum.

Measurement Techniques

A number of techniques will be considered in order to develop a system with the lowest measurement uncertainty. NPL has recently developed a pulse power measurement capability[3] with technology that may be extended to provide a measurement service traceable to National Standards for complex modulation waveforms. The current system conforms to the relevant GSM 05.05 specification and provides traceable measurements for both GSM and DCS-1800 type pulses. The system measures GSM pulses (0.3GMSK) with one active timeslot in the TDMA frame, traceable to National Standards through the calibration of the transfer standard in the Continuous Wave (CW) mode. The calibration of the measurement system is carried out by referring it to a traceable thermistor mount in the CW mode at the power levels which will be used for measuring the Device Under Test (DUT), thus reducing the effects of the non-linearity of the reference sensor. The measurement on a DUT is then carried out in the pulsed modulation mode and the efficiency of the standard is transferred to that of the DUT taking account of any mismatch correction at the measurement plane.

Conclusions

Accurate measurement of peak power must take into account the cumulative contribution from several sources, such as multiple symbol power levels, compound amplitude ringing (a result of necessary filtering) and multiple carrier power addition (more active time slots in the TDMA frame). The current system developed at NPL for pulse power measurement is capable of traceable measurements performed on GSM type pulses with one active time slot in the TDMA frame. This system will be further developed so it can cope with the inevitable problems which occur with increasing complexity of the modulating signal used. The system currently being used at NPL will be developed to handle, for example, more active time slots in the TDMA frame and peak power phase changes which accompany the QPSK modulation techniques.

References

[1] "Boundless Europe : The Wireless Revolution", B Shankar, Microwave journal, September 1997.

[2] "Next Generation TDMA/CDMA Wireless Standard Development", Microwave Journal, December 1997.

[3] "Pulse Power System for Measuring the Efficiency of Mounts for GSM and DCS-1800 Traceable to National Standards", S Swarnowski, RF & Microwave Research Note No.123, August 1997.