Signal Generator SMIQ + SMIQ-B42

Multichannel signal source for CDMA

SMIQ is an extremely versatile instrument for the generation of digital modulation. Fitted with the optional modulation coder and data generator, it is capable of generating both TDMA and CDMA signals. Now a new, cost-effective software option is available that turns SMIQ into a powerful IS-95 CDMA signal generator. With this option, SMIQ can simulate the transmit signals of base and mobile stations.

Simulation of signals

With the IS-95 CDMA software option (SMIQ-B42), Signal Generator SMIQ (FIG 1) [1] supplies signals conforming to standard for testing IS-95 CDMA transceivers. In forward link operation, where SMIQ simulates the transmit signal of a base station, two modes are available. Mode 18 provides up to 18 code channels. Walsh code and data source can be set separately for each channel. The powers of the pilot channel and two further code channels (e.g., sync channel and paging channel) are freely selectable in this mode. The other code channels (usually traffic channels) have uniform power. This exactly conforms to IS-97 specifications for the “Base Station Test Model”. FIG 2 shows the corresponding setting menu of SMIQ, in this case with nine active channels.

The second forward link mode provides as many as 64 code channels. The power of the pilot channel is freely selectable; the powers in the other channels are uniform. This mode is used to simulate maximum channel usage of a base station, since the forward link contains a maximum of 64 code channels. Modulation data are supplied by a PRBS generator; in addition, simple data patterns (00..., 11..., 01...) are available. PRBS data are ideal for component testing, for example of amplifiers. Data patterns are used for basic tests on demodulators of mobile station receivers. With a chip rate of 1.2288 Mchip/s, the modulation data rate is 19,200 bit/s. Channel coding or interleaving is not performed by SMIQ.

In reverse link operation, SMIQ simulates the transmit signal of a mobile station. This signal comprises only one code channel. SMIQ performs orthogonal modulation stipulated by IS-95 as well as spreading of modulation data. In full-rate mode, an offset-QPSK-modulated signal with constant output power is generated. For measurements on the output stages of a mobile station, half-rate mode with power gating can be simulated. A switchable burst randomizer is integrated, which is of advantage in burst measurements. Like with forward link, PRBS data or simple data patterns can be selected as a data source. The modulation data rate is 28,800 bit/s, the long code is set to zero.
High-quality reference source

Signal generators are often used as a reference source, so the accuracy of the generated modulation signal is an important quality criterion. SMIQ meets these requirements with an extremely low error vector of typically 1%. This corresponds to a \( p \) factor of 0.9999 for the CDMA signal. In the case of a forward link signal with several code channels, this small error vector makes for very low crosstalk between the code channels. The purely digital generation and addition of the code channels in conjunction with the small error vector results in highly accurate setting of the channel powers. FIG 3 shows that the setting error for the code channel powers is less than 0.1 dB. The time offset or phase difference between signals of different code channels is extremely small. Typical measured values are 1 ns or 0.3°.

High spectral purity for amplifier measurements

Two characteristics of a signal source are of particular importance for measurements on the power amplifier of a CDMA base station: a large and selectable number of code channels and a frequency spectrum with low adjacent-channel noise power. Here, SMIQ sets unique standards. FIGs 4 and 5 show the measured spectra of a pilot signal and of a signal with nine code channels. The ratio of peak power to average power, ie the crest factor, which is critical for measurements on power amplifiers, is greater than 10 dB for the nine-channel signal [2]. Measured at a bandwidth of 30 kHz, the noise power of the adjacent-channel spectrum is 70 dB below total channel power. Adjacent-channel power is thus more than 20 dB below IS-97 limit values for base stations.

Ideal signal source for component testing

Excellent signal quality of SMIQ and versatile setting facilities of CDMA option make the unit an ideal source for measurements on CDMA components of any type. Passive components, eg filters, cause deterioration of modulation quality through linear distortion. The good \( p \) factor of SMIQ is therefore required to evaluate frequency-response errors and group-delay distortion of such components. In the case of active components such as transistors or amplifiers as well as mixers, the effect of nonlinear distortion is predominant. Third-order nonlinearities result in intermodulation products in the adjacent CDMA frequency channel (spectral regrowth). High spectral purity as offered by SMIQ is a must for spectral regrowth measurements. A particular asset is the possibility of crest factor variation by modifying the number of active code channels (forward link).

Receiver measurements

SMIQ offers a variety of trigger modes for receiver measurements. Frame and superframe clock as well as 2-s clock are available as trigger output signals. Conversely, CDMA signal generation in SMIQ can be started by means of an external trigger. For use as an OCNS (orthogonal channel noise simulator), output frequency and chip clock can be externally synchronized, too. These setting facilities provided for the data source already allow a number of basic tests to be performed on the receiver. With an extension of the CDMA option (currently under development) it will also be possible to measure the frame error rate (FER) on base station receivers. This requires generation of a reverse link signal with a length of several hundred frames.

An add-on to SMIQ which is of particular importance for FER measurements should not be left out: Fading Simulator SMIQ-B14. This option turns SMIQ into a fully-fledged radio channel simulator with six propagation paths [3]. In terms of accuracy, the fading option clearly exceeds the stipulations of IS-97, while offering an enormous price advantage compared to conventional RF fading simulators.
The next step: broadband CDMA

SMIQ provides an extremely powerful hardware platform for baseband generation. CDMA signal generation is effected in a chip rate range between 1 kchip/s and 7 Mchip/s (0.1 Hz resolution). For baseband filtering, a Nyquist filter with adjustable roll-off factor can be used instead of IS-95 filters. Further developments towards broadband CDMA are therefore to be expected. SMIQ offers the great advantage that any extensions required to this effect come as software options and can thus be retrofitted very easily. For chip rates above 7 Mchip/s, too, SMIQ is a good choice. With an RF bandwidth larger than 50 MHz, the vector modulator offers ample reserves for externally applied I/Q signals.

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REFERENCES

Condensed data of Signal Generator SMIQ with CDMA IS-95 Option SMIQ-B42
Frequency range 300 kHz to 3300 MHz
Chip rate 1.2288 Mchip/s
IS-95 standard
SMIQ range 1 kchip/s to 7 Mchip/s
Forward link to IS-95 and J-STD-008
Number of code channels 1 to 64
Fraction of power of each code channel 0 to –30 dB, selectable for up to 4 channels
Modulation data (19,200 bit/s) PRBS, simple data patterns
Reverse link to IS-95 and J-STD-008
Modes full rate, half rate
Modulation data (28,800 bit/s) PRBS, simple data patterns
Modulation accuracy (pilot) ρ > 0.9995
Adjacent-channel power (pilot) typ. –75 dBc (at 30 kHz bandwidth)

Test hint

Simple bandwidth measurement in radiomonitoring

In radiomonitoring it is sometimes necessary to determine the bandwidth of a signal. This is usually performed with a test receiver, but now Radiomonitoring Receiver ESMC with Software Package ESMC-RAMON can also be used for this task.

ITU Recommendation 443 defines signal bandwidth at the 6 dB or 26 dB point. Section 3.4 of the ITU manual describes a method of bandwidth measurement using a spectrum analyzer with maximum hold function. ESMC provides an equivalent measurement in frequency scan mode. The signal of interest is scanned with a narrowband filter at small stepwidths. The signal levels are displayed in the overview window of ESMC-RAMON software. This window also contains the maximum hold function, so that only results with maximum level are displayed. The signal bandwidth can easily be determined by means of lines and markers.

In addition to this level-based bandwidth measurement, an example of power-related measurement is given in Annex 1 to Section 3.4 of the ITU manual. This example defines the bandwidth limit at 0.5% of the signal power. Type of bandwidth measurement, too, can be performed by means of Receiver ESMC, Software ESMC-RAMON, the Evaluate option and a spreadsheet routine. The signal is scanned in the same way as in level-based bandwidth measurement, but data are stored not only for display but also in the processor. The analyzer program of the Evaluate option transfers the stored data to the spreadsheet routine, where they are processed as described in the ITU manual.

Radiomonitoring Receiver ESMC provides very good results for simple, manual bandwidth determination as described above. For fast, automatic bandwidth measurements, a test receiver, eg ESVN40 from Rohde & Schwarz, is the obvious choice.

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Reader service card 156/04 for further information on ESMC

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