Audio Analyzer R&S UPL

Measuring the acoustic characteristics of 3G mobile phones

Good acoustic reproduction quality is the most important characteristic for troublefree communication with mobile phones. The trend towards ever smaller and lighter phones does not exactly make life easier for the designer. With the new UPL-B9 option, all the tests for handset measurements defined in 3GPP TS26.132 are now available on the Audio Analyzer R&S UPL together with the Radio Communication Tester R&S CMU 200 (FIG 1).

Acoustic measurements are indispensable

Measuring the acoustic characteristics of mobile phones is very important, since users themselves do not immediately recognize the deficiencies. Considerably deviating transmit frequency response, distortion and noise do not become noticeable until callers complain of difficulty understanding each other – and they usually tend to suspect a poor connection via the base station before exposing their own mobile as the culprit.

Rohde & Schwarz already developed methods several years ago that also enabled the acoustic quality of GSM mobile telephones to be measured on the air interface [1]. Using speech-like multitone signals and sophisticated measurement methods, the same results, with only minor deviations, were achieved as when measuring via the digital audio interface (DAI). Implemented in the R&S UPL [2] with the Radio Communication Tester R&S CMD or the more recent R&S CMU 200 [3], a test setup was produced that was soon adopted by manufacturers, test houses, and service providers throughout the world. The great advantage of this method is that any commercially available telephone can be measured without special modifications. However, the method is not standardized worldwide, so it cannot be used for type-approval tests.


Photo 43845

FIG 1 Acoustic measurement of 3G mobile phone with Audio Analyzer R&S UPL and Radio Communication Tester R&S CMU 200

Perfecting a proven concept

During the development of third-generation mobile radio, it was suggested that methods enabling measurement of acoustic characteristics via the normal air interface (similar to that devised by Rohde & Schwarz) should be specified in international standards, and that a special DAI interface should not be used. Thus, it should be possible to measure all characteristics in the mode in which the telephone is normally used. All the signal processing algorithms in the mobile phone should remain active during measurement. Specific measuring problems arose from the voice activity detector, which uses the signal's mod-

Test	Section of 3GPP TS 26.132	Section of 3GPP TS 51.010
Sending frequency response and loudness rating	7.4.1 and 7.2.2.1	30.12 and 30.13
Receiving frequency response and loudness rating	7.4.2 and 7.2.2.2	30.14 and 30.15
Sidetone masking rating STMR	7.5.1	30.16
Echo loss (terminal coupling loss)	7.7.3	30.17.1
Stability margin	7.6	30.17.2
Sending distortion	7.8.1	30.18
Receiving distortion	7.8.2	–
Idle channel noise sending	7.3.1	–
Idle channel noise receiving	7.3.2	–
Ambient noise rejection	7.9	30.19

FIG 2 The Audio Analyzer R&S UPL can handle these tests in conjunction with the Radio Communication Tester R&S CMU 200.

ulation to determine whether the signal involved is unwanted interference or the useful voice signal. So, in order to be recognized as the useful signal, the test signal must be modulated in time like speech. Consequently, the first draft of the test standard 3GPP TS26.132 suggested artificial voice to ITU-T P.50 as the test signal. However, the unfavourable ratio between peak value and rms value creates problems for some measurements. A test signal to ITU-T P.501, which can be generated as an amplitude-modulated multitone signal for example, was consequently approved. It provides much better signal/noise ratio and increases dynamic range by more than 10 dB compared to artificial voice. This is essential for measuring echo suppression in mobile phones (box next page).

Well equipped with the new option

All acoustic measurements for 3G mobile telephones are described in 3GPP TS 26.132 and the required values defined in 3GPP TS26.131. When the test specifications were updated, far-reaching harmonization of GSM and 3GPP specifications was also implemented. The previous GSM 11.10 was revised and is now available as 3GPP TS 51.010. It describes all acoustic tests on GSM mobile phones. Up to Release 1999 the previous instructions still apply, and as of Release 4 the new specifications 3GPP TS 26.132 and 3GPP TS 26.131 apply to both GSM and 3GPP telephones. Consequently, there are now uniform test specifications for both standards for measurements via the air interface.

With the new UPL-B9 option, all the tests for handset measurements defined in 3GPP TS 26.132 are now available on the Audio Analyzer UPL together with the Radio Communication Tester CMU 200 (FIG 2). The option comprises a cable for connecting the UPL to the CMU and a matching transformer for driving the artificial mouth. The necessary acoustic interfaces, such as test rack, artificial mouth, artificial ears with preamplifier and, if necessary, an anechoic test chamber, are not supplied with the option and must be purchased separately (FIG 4).

Since the Radio Communication Tester CMU 200 is currently only equipped with a GSM speech coder, all the tests can be carried out only in GSM mode. At present, 3GPP TS 51.010 stipulates that the full rate coder be used for testing GSM telephones. However, the enhanced full rate coder corresponds exactly to the 12.2 kbit/s mode of the adaptive multi-rate (AMR) coder prescribed for 3GPP. As a result, there are currently moves to have this mode permitted for future testing on GSM telephones. Since all 3GPP mobile phones launched on the market

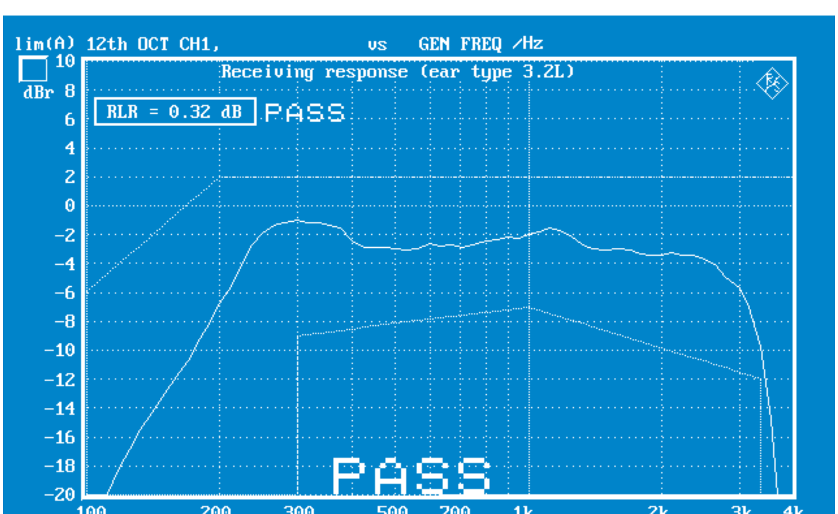

FIG 3 Typical result of frequency response and loudness rating measurement in the receive direction of a GSM mobile phone

Multitone signals for measuring echo suppression

Most mobile phone users are familiar with the irritating echo that sometimes makes normal conversation practically impossible. In many cases this is due to poor echo suppression in the mobile phone.

GSM 11.10 required echo attenuation of 46 dB and stipulated artificial voice to ITU-T P.50 as the test signal, because sinusoidal signals could not be used. Since artificial voice has a crest factor of approx. 20 dB and the peak value must not overdrive the coder, only an rms value of at least 20 dB below the full-scale value can be attained. The theoretical maximum S/N ratio of the GSM system is about 66 dB, so a pure interfering signal of at least 46 dB is still measured even if no echo is present. Echo signals of >46 dB are normally masked by the noise. As a result of the measuring problems detected early on, this important test was practically no longer carried out and excluded from the obligatory measurements, which had a negative impact on the features of many mobile phones.

When the tests were defined for 3GPP mobile phones, emphasis was placed on finding a method with sufficient dynamic range for echo suppression measurement. Rohde & Schwarz prepared several suggestions and presented them for discussion. It was ultimately decided to use an optimized, amplitude-modulated multitone signal that contains a signal for each third-octave band at the center frequency of the band and thus optimally uses the signal energy. Echo suppression is measured and calculated in the same way as defined in the earlier GSM 11.10. Concentrating the signal energy on the third-octave center frequencies results in a considerably higher signal/noise ratio, which allows the required 46 dB echo suppression to be measured with a sufficiently large margin. FIG 5 shows a typical result of the measurement on a modern GSM mobile phone.

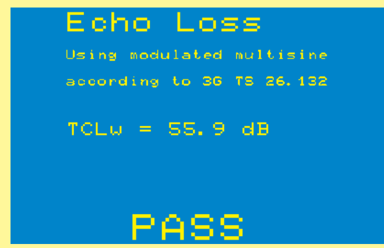

FIG 5 Such values for echo suppression are obtained with modern mobile phones.

in the near future will presumably be dual-mode, supporting both GSM and WCDMA, it is quite sufficient to test their acoustic characteristics in GSM mode (FIG 3).

FIG 4 Recommended equipment for acoustic measurements on 3G mobile phones (B&K: Brüel & Kjaer)

Telephone test head	B&K 4602 B
Ear simulator	B&K 4185 type 1 B&K 4195 type 3.2 low leakage and high leakage
Artificial mouth	B&K 4227
Head and torso simulator	B&K 4128 D
Acoustic calibrator	B&K 4231
Microphone power supply	B&K 2690 A0 S2
Acoustic test chamber	e.g. Studio Box type S

The tests that can be performed with the UPL-B9 option comply exactly with the test specification 3GPP TS 26.132 for narrowband telephony and have been validated by an independent test house for type-approval tests. This means that, for the first time, a complete, favourably priced system solution is available for the development, quality assurance and type-approval testing of 3GPP and GSM mobile phones without a DAI interface.

Tilman Betz

More information and data sheet for UPL at www.rohde-schwarz.com (search term: UPL)

REFERENCES
[1] New for GSM mobile phones: multitone analysis via air interface. News from Rohde & Schwarz (1999) No. 162, pp 18–19
[2] Audio Analyzer UPL16: Speech quality of GSM mobile phones improved by precise audio measurement. News from Rohde & Schwarz (1998) No. 159, pp 16–17
[3] This issue contains several articles on the R&S CMU 200.