Signal Generator SMIQ

# Simulating channel models for 3GPP fading tests

**Thanks to its versatile architecture, SMIQ can generate signals for 3GPP (third-generation partnership project) to test mobile radios and base stations on both the uplink and downlink with channel coding [*]. Option SMIQ B49 now also allows you to simulate the new channel models defined in the associated standards (3GPP TS 25.104 annex B and identical in 3GPP TS 25.141 annex D).**

## Classic channel models

The channel models defined in TS 25.104 annex B2 are very similar to the scenarios used to date for mobile radio. Multipath reception of up to four paths is simulated, five different cases being looked at (FIG 1).

Cases 1, 2 and 4 simulate a pedestrian moving in the field of base stations of different power (case 1) and two or three stations of the same power (cases 2 and 4). The classic doppler spectrum, i. e. Rayleigh distribution, is used here as the fading profile.

Cases 3 and 5 correspond to reception in a vehicle (50 km/h and 120 km/h) where two or four radio signals of different delay and power are received. Here too, a Rayleigh distribution is used.

Simulating these channel models is possible with the previous option SMIQ B14, but setting channel delay is only possible with time resolution of 50 ns. Options SMIQ B14/B15 together with SMIQ B49 achieve 1 ns resolution, which provides exact representation of the above channel models.

## New channel models

In addition to these familiar channel models, two new scenarios have been introduced in 3GPP that allow assessment of the rake receiver in a mobile phone and in a base station. These are a slow change of the path with regard to time (moving propagation condition) and an erratic delay change (birth-death propagation condition).

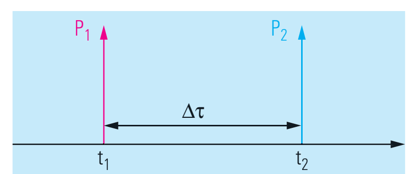



FIG 2 Two paths for moving propagation

### Moving propagation

The moving propagation model tests a receiver's ability to adjust to changing delay conditions in the radio channel. This is done by using two equally powerful paths that shift relative to each other in time. Their levels remain constant. The first path ($P_1$) serves as a

FIG 1 Channel models of TS 25.104 annex B2

| | Case 1 (3 km/h) | | Case 2 (3 km/h) | | Case 3 (120 km/h) | | Case 4 (3 km/h) | | Case 5 (50 km/h) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Relative delay | Average power | Relative delay | Average power | Relative delay | Average power | Relative delay | Average power | Relative delay | Average power |
| Path 1 | 0 ns | 0 dB | 0 ns | 0 dB | 0 ns | 0 dB | 0 ns | 0 dB | 0 ns | 0 dB |
| Path 2 | 976 ns | –10 dB | 976 ns | 0 dB | 260 ns | –3 dB | 976 ns | 0 dB | 976 ns | –10 dB |
| Path 3 | | | 20 000 ns | 0 dB | 521 ns | –6 dB | | | | |
| Path 4 | | | | | 781 ns | –9 dB | | | | |

reference, the second path ($P_2$) moves slowly back and forth during its delay as a sinusoidal function (FIG 2).

The delay of the reference path remains constant, the delay $\Delta\tau$ of the moving path is given by the equation in FIG 3. The variable path moves sinusoidally around a (settable) mean basic delay ($DELAY_{MEAN}$) with selectable amplitude and frequency. Usually a very low frequency and thus very low speed of delay variation are selected, because in reality the delay changes are only produced by the movement of a receiver of course. This channel model allows you to test a receiver's ability to adjust the delay of its "fingers" to the changing radio traffic field.

3GPP TS 25.104 annex B3 recommends the following values for the parameters in the equation:

| | |
|---|---|
| $DELAY_{MEAN}$ | = delay (path 1) |
| $DELAY_{VARIATION}$ | 5 ms |
| VARIATION PERIOD | 157 s |

For further tests, the SMIQ fading option allows you to change both the basic delay ($DELAY_{MEAN}$) and the parameters of variation. In addition, both paths may exhibit different levels (FIGs 4 and 5).

### Birth-death propagation

In contrast to moving propagation, birth-death propagation looks at a receiver's ability to react to the disappearance and reappearance of radio signals.

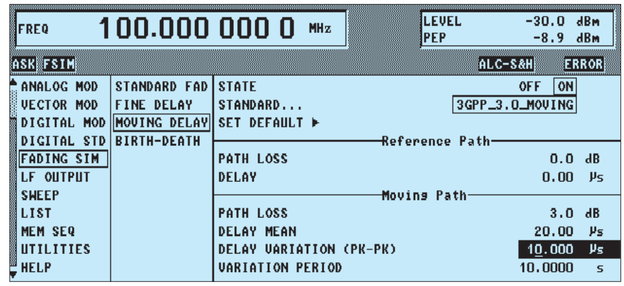
Again you have a scenario with two paths: one, the delay reference, remains constant, the second (which had a different delay) is now cut out (death) and immediately cut in again with a different delay (birth). In this way you can test a receiver's ability to ignore lost paths and simultaneously make quick use of new reception possibilities.

In the channel model recommended in 3GPP TS 25.104 annex B4, the two paths swap roles after birth and death, what was the reference path now adopting the role of the variable path. The period between two birth-death operations can be varied with option SMIQ B49, 3GPP TS 25.104 recommends a period of 191 ms.

**FIG 3 Delay $\Delta\tau$ of moving path**

$$\Delta\tau = DELAY_{MEAN} + \frac{DELAY_{VARIATION}}{2}\left(1+\sin\left(\frac{2\pi\cdot t}{VARIATION\ PERIOD}\right)\right)$$

**FIG 4 SMIQ menu for moving propagation**




## Simple installation

Simulating channel models according to 3GPP only requires installation of software option SMIQ B49. No modifications of SMIQ hardware are necessary.

Wolfgang Kufer


REFERENCES

[*] SMIQ: Fit for 3G with new options. News from Rohde & Schwarz (2000) No. 166, pp 10–12


Reader service card 169/04

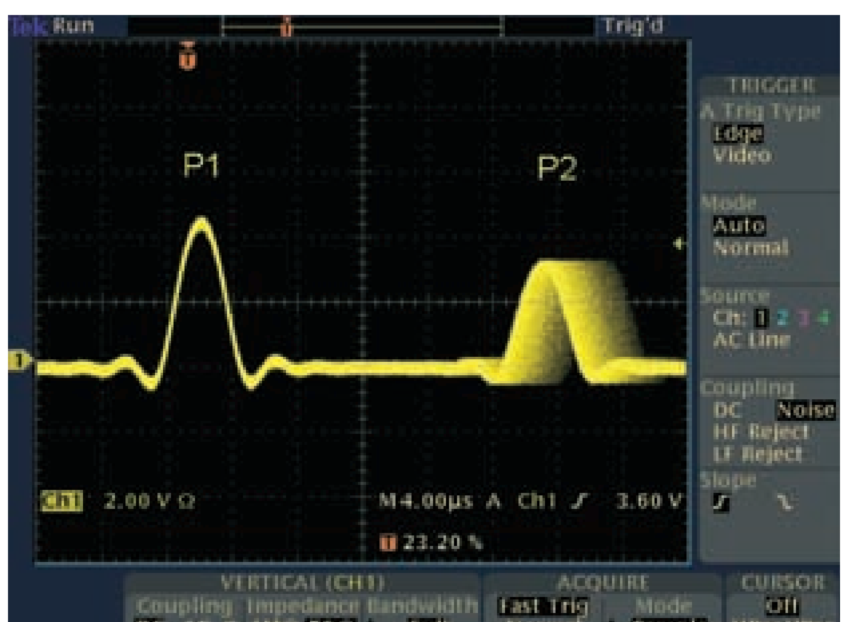



**FIG 5 Picture of two paths with the persistence of the oscilloscope set to 2 s. The moving path (P2) is easily recognized**