

Shape your LTE signal Application

Filtering and how it impacts the performance of your LTE signal



Test setup with the R&S®SMBV100A and R&S®FSV.

Your task

In contrast to the third generation of mobile communications, 3GPP has not defined a transmission filter for LTE (release 8). WCDMA/HSPA, for example, specifies a root-raised cosine filter with a roll-off factor of $\alpha = 0.22$. Applying this filtering to a transmit signal enlarges the signal bandwidth of 3.84 MHz, resulting in a transmission bandwidth of 4.68 MHz.

This is the simple answer why a channel bandwidth of 5 MHz is defined for 3G systems. Up to WCDMA/HSPA, design engineers have to approximate the overall design of the transmitter chain as closely as possible to this ideal signal shape to ensure optimal performance. This makes it possible to meet in-channel requirements, including transmit quality criteria and a low error vector magnitude (EVM), as well as out-of-channel requirements, estimated by performing an adjacent channel power (ACP) and spectrum emission mask (SEM) measurement.

There is no filter definition with LTE. This creates possibilities and also presents challenges. The design engineer can optimize the transmitter chain either for in-channel performance (transmit quality, e.g. EVM) or for out-of-channel performance (ACP, SEM). The challenge is to find the right balance between both. With LTE, the receiver cannot rely on a defined signal shape like in 3G. Instead, the receiver has to use reference signals to correct phase and frequency offset, which might cause problems if the noise floor is high and equalization does not work properly.

T & M solution

Rohde & Schwarz addresses the non-availability of an LTE transmission filter definition on its leading signal generators, including the R&S®SMBV100A and the R&S®SMU200A, by providing three different types of filters: Best EVM, Best ACP, Balanced EVM and ACP. This is a trade-off between in-channel and out-of-channel performance. The selected filter is applied to the generated downlink or uplink signal. To meet special test demands, selected parameters can even be adjusted manually, for example the value of the cut-off frequency shift of the Best EVM filter.

The limits and tolerances requested for test purposes are very often tighter than specified by 3GPP. In case of EVM-optimized filtering, it is possible that additional requirements for ACLR are not met due to the frequency band used. 36 dB is defined as a general limit when a WCDMA signal is present in a distance of 12.5 MHz ($UTRA_{ACLR2} = 36$ dB). E-UTRA has higher requirements: Band I, for example, specifies $UTRA_{ACLR2bis} = 43$ dB. This tight limit might be violated if the filtering applied to the signal is too smooth.

75 Years of Driving Innovation

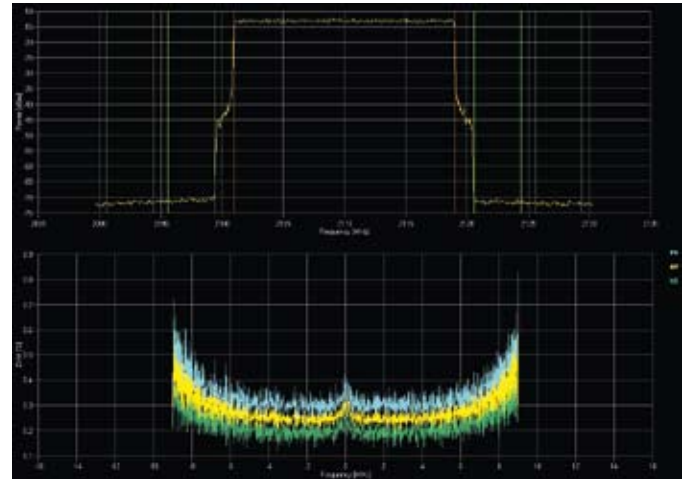
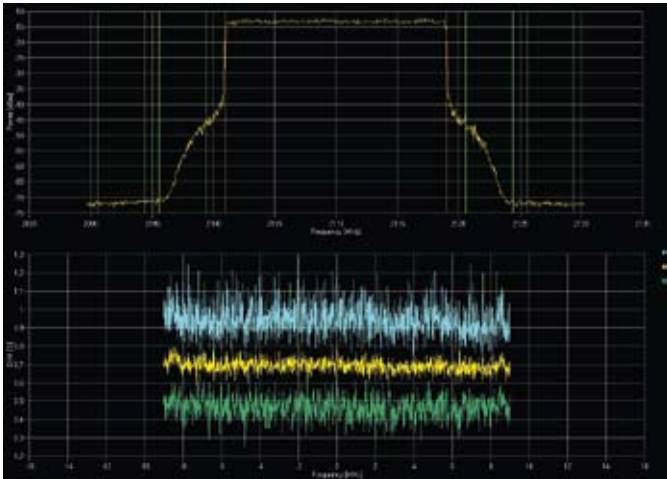

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The predefined filter types of the signal generators enable the convenient and detailed evaluation of an LTE design. This allows design engineers to easily verify that the ACP criteria are still met, when EVM-optimized filtering is used within the transmitter.

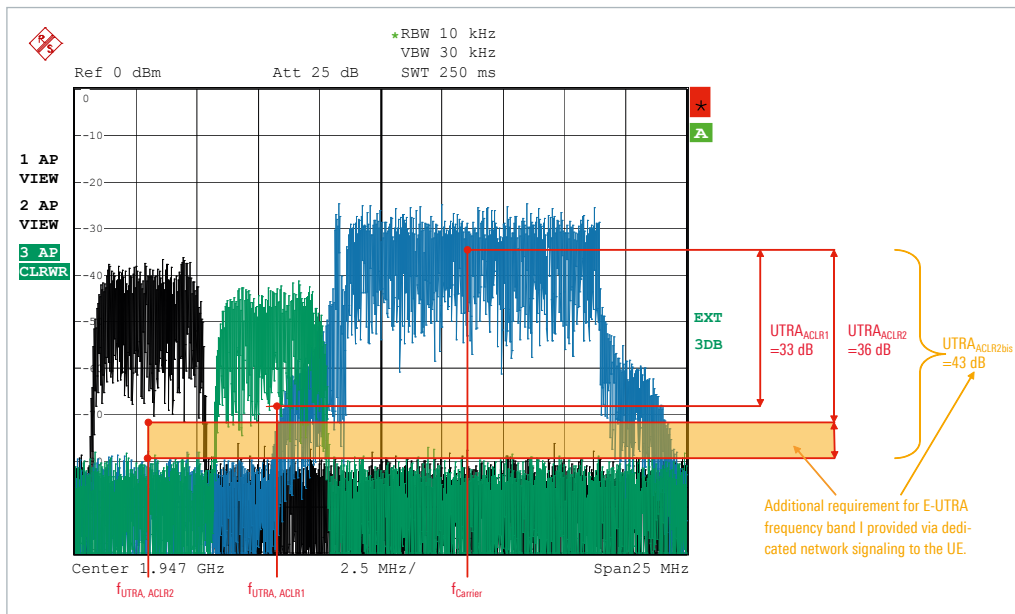
The different impact of an EVM- and ACP-optimized filter on a downlink signal is shown in the ACP and EVM versus subcarrier measurement below. The strong signal filtering of the ACP-optimized filter results in reduced EVM performance at the upper and lower edge of the spectrum.

In practical terms, it is difficult to allocate resource blocks using higher-order modulation schemes at both edges of the spectrum as the limits might be exceeded.

The extensive feature set, including preset and user-specific filter types available for Rohde&Schwarz signal generators enable test engineers to verify the behavior of their transmitter circuit against specified tolerances and to optimize their design to achieve the best performance.



ACP and EVM versus subcarrier measurement of a downlink signal applying EVM-optimized filtering (left-hand side) and ACP-optimized filtering (right-hand side).



E-UTRA specifies tighter limits than WCDMA, depending on the selected frequency band.

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