

Products: SMIQ, WinIQSIM™

Generating 3GPP Multi Carrier Signals for Amplifier Tests with R&S SMIQ03HD and WinIQSIM™

Application Note

Power amplifiers for WCDMA/3GPP base stations should have the best possible spectral purity and smallest intermodulation distortion, in order to prevent disturbance of the neighbouring channels. To test such amplifiers, signal generators are required that can generate WCDMA signals with low noise and intermodulation over a very wide dynamic range. The R&S SMIQ03HD signal generator with its outstanding Adjacent Channel Leakage Ratio (ACLR) performance is especially designed for these applications. This application note describes how to use SMIQ03HD to get the best performance with 3GPP single and multi carrier signals.



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1 Introduction

Base station power amplifiers for WCDMA/3GPP must have the best possible dynamic range not to disturb neighbouring transmission channels. The measured quantity to describe the dynamic range of a 3GPP base station (BS) is the Adjacent Channel Leakage Ratio (ACLR)¹. 3GPP specifies a minimum value of 45 dB for the ACLR in 5 MHz offset. Most base station manufacturers target an ACLR of 50 dB for the entire BS. To achieve this value, the BS components such as power amplifiers need typically 10 dB better ACLR than the BS overall.

To test such amplifiers, the measurement equipment needs yet another 10 dB margin. This requires signal generators that can generate 3GPP signals with 70 dB ACLR. Furthermore, a signal generator should be able to generate multi carrier signals in a one-box solution. This is particularly an important issue if production is targeted.

The R&S SMIQ03HD signal generator is the ideal tool for these high dynamic applications. It can be used for single carrier signals as well as for multi carrier scenarios. Equipped with four different I/Q filters SMIQ03HD shows excellent ACLR for 3GPP signals with one to four carriers. For highest demands, option R&S SMIQB57 – High ACLR for WCDMA 2110 MHz to 2170 MHz – provides signals with typically ACLR of 77 dB in 5 MHz offset (3GPP Test Model 1, 64 channels). Combining four SMIQ03HD with SMIQB57 gives typically 74 dB ACLR in 5 MHz offset for a four carrier 3GPP signal.

¹ ACLR = (power in the wanted channel) / (power in the adjacent channel). Note that the reciprocal value of this quantity, called Adjacent Channel Power Ratio (ACPR), has been used previously.

This application note has two major issues: to show the excellent dynamics of the R&S SMIQ03HD and to give some advice how to set up the instrument to obtain maximum performance. Sections 2 and 3 provide an introduction to multi carrier signals and ACLR measurements. Sections 4 and 5 focus on the features of SMIQ03HD, while section 6 shows how to set up the generator to achieve best possible performance, including measurement results. Step-by-step setting guides are given in the appendix.

In this application note, the focus is on signal generator issues related to multi carrier signals and amplifier testing. For a comprehensive treatment of amplifier tests, including analyzer issues, we refer also to application note 1MA48 [2], which complements the present paper.

2 Properties of Multi Carrier Signals

Baseband representation

In this section we will describe all signals in the baseband or I/Q representation.

Every RF signal $z(t)$ can be written as

$$\begin{aligned} z(t) &= A(t) \cdot \cos[\omega t + \phi(t)] \\ &= I(t) \cdot \cos \omega t - Q(t) \cdot \sin \omega t \\ &= \frac{1}{2} [s(t) \cdot e^{i\omega t} + s^*(t) \cdot e^{-i\omega t}] \end{aligned}$$

with

$$\begin{aligned} I(t) &= A(t) \cdot \cos \phi(t) \\ Q(t) &= A(t) \cdot \sin \phi(t) \end{aligned}$$

and

$$s(t) = I(t) + iQ(t) = A(t) \cdot e^{i\phi(t)}$$

The complex baseband signal $s(t)$ contains all the signal information. Therefore it is sufficient for describing the statistical behaviour of the signal.

This can be generalized to multi carrier signals by treating the entire multi carrier scenario as one modulated signal. The center frequency of the scenario is taken as "the RF frequency", the positions of the other carriers are treated as frequency offsets from this RF frequency. Then the entire scenario is converted to the baseband, i.e. the RF frequency becomes $f = 0$. Carrier offsets lead to additional oscillating terms in $I(t)$ and $Q(t)$.

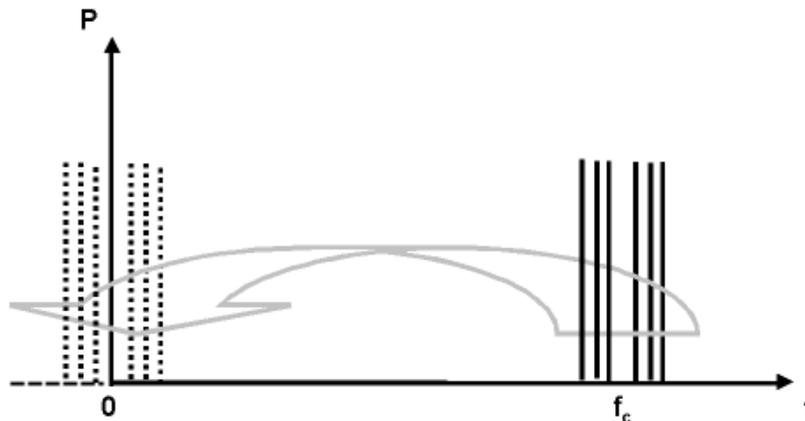


Fig. 2.1: Baseband representation of multi carrier signals

Average power and peak envelope power

The power characteristics of a signal can be described by two quantities: the average power and the peak envelope power (PEP). The average power P_{avg} is obtained by averaging the instantaneous power over the modulation period. The power averaged over the period of a carrier is called envelope power $P_e(t)$. The envelope power is proportional to the instantaneous power of the baseband signal. The maximum of $P_e(t)$ is the peak envelope power. The ratio between PEP and average power is called peak to average ratio or crest factor.

If nothing else is stated, we will deal with multi carrier signals with equal spacing between the carriers and where the carriers have equal average power.

Complementary Cumulative Distribution Function

Peak envelope power and average power are key parameters for any amplifier design. If the amplifier compresses when transmitting with PEP, the related data will be disturbed. Ideally, an amplifier should have linear characteristics in the entire power range. However, compression in the PEP range is less severe if the PEP is reached very rarely. In this case, bit errors due to compression can be compensated by forward error correction methods. For a given signal not only the power range is important, but also the power statistics.

The quantity to describe power statistics is the complementary cumulative distribution function (CCDF). It indicates how often a particular power level is exceeded. The measurement procedure is in principle:

- i. Divide the entire power level range of the signal into small intervals.
- ii. Measure the signal power in the time domain with good time resolution often enough to get a statistically relevant result (for example 1 million values).
- iii. Check how many values fall into or above the first power interval – which will be all, so for zero power the CCDF is always equal to 100%.
- iv. Go on with the next higher power interval - and so on...

Plot the probability of being *above* a certain interval as a function of the power level. This gives the CCDF function. Usually the CCDF is represented in units of the average power and given in the region between the average and the peak envelope power.

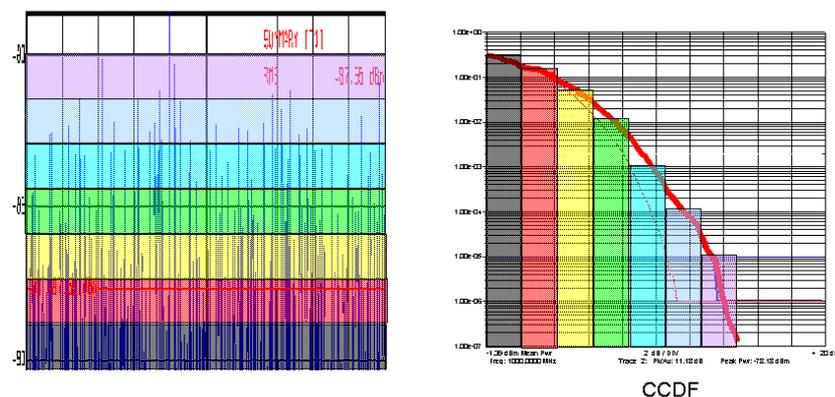


Fig. 2.2: Calculation of the CCDF.

Even if two signals have the same peak to average ratio, they can significantly differ in statistical properties.

Fig. 2.3 shows two different CCDF curves with roughly the same crest factor, but different shape. A steep CCDF means that near-peak values are reached often. For a given crest factor, a signal with a steep CCDF leads to more stress on an amplifier.

With rare peaks the signal can in principle be clipped without significantly increasing the bit error rate of the communication line. With clipping, the bits related to the peak values might be corrupted. But if the probability of such peak values is small, only a few bits are affected, and this can easily be compensated with intelligent error protection algorithms. Clipping is used in base stations to reduce stress on amplifiers.

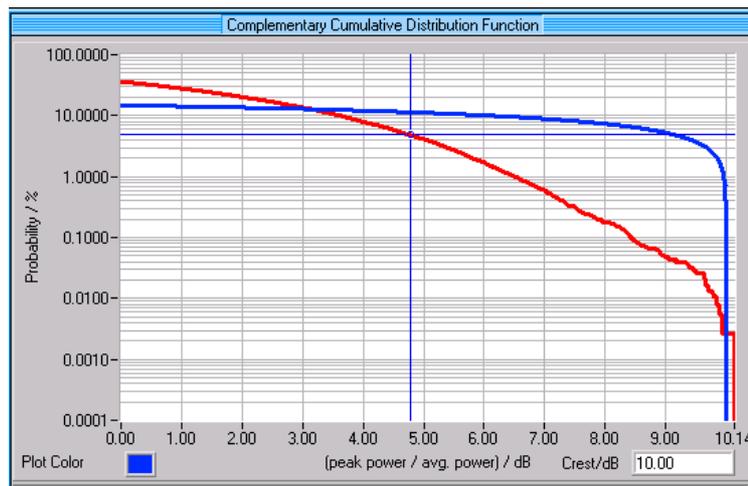


Fig. 2.3: Two signals with the same crest factor can have different CCDF functions and therefore stress an amplifier in different ways.

What affects the CCDF of a signal?

Unmodulated multi carrier signals

A multi carrier signal containing only unmodulated carriers is just a superposition of sinewaves with amplitudes A_i and start phases φ_i .

$$s(t) = \sum_i A_i \cdot \cos(\omega_i t + \varphi_i)$$

The frequencies ω_i give the carriers' positions in the frequency domain. Note that this is a baseband representation, that means the ω_i can be negative.

The key parameter most affecting the CCDF is the phase relation of the carriers. If the carriers are in phase (for example all phases are zero), the crest factor will be high. In most cases the carriers have equal spacing. Then their frequencies have a common factor and the sum signal is strictly periodic, leading to a steep CCDF.

If the carrier phases are randomized, the crest factor is significantly reduced, as shown in the five carriers example in Fig. 2.4.

Generating Multi Carrier Signals

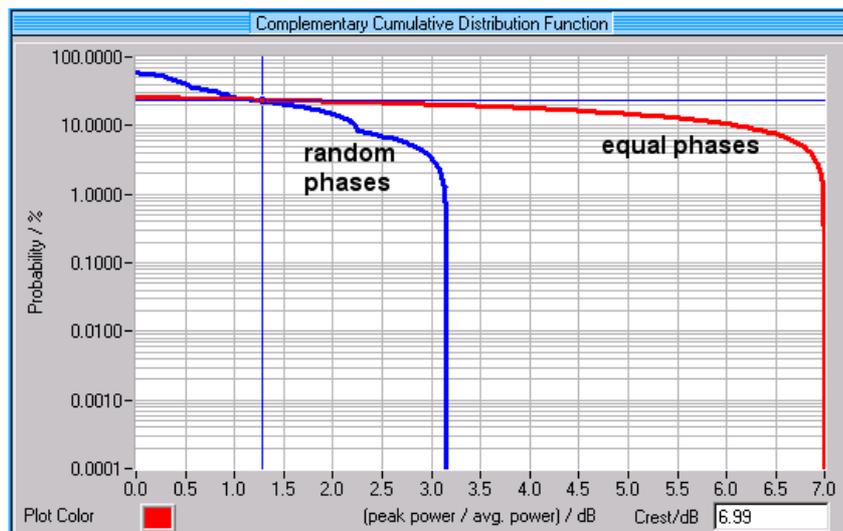


Fig. 2.4: CCDF for a signal with five unmodulated carriers. Carrier phase randomization significantly decreases the crest factor.

For this example, the CCDF of the signal with random phases is still rather steep. However, for large numbers of carriers with random phases, the CCDF will approximately equal the CCDF of Gaussian noise (Central Limit Theorem). Therefore, CW² multi carrier generators are sometimes used to simulate noise signals.

TDMA multi carrier signals

Modulated multi carrier signals have an additional parameter to be taken into account; the nature of the data that is transmitted. If all carriers have the same data - and there is no other difference due to coding or filtering - all carriers, regarded as single carriers, are equal. This resembles the CW carrier case². Actually, this is not a realistic situation. In real life, data on different carriers will be uncorrelated.

The CCDF of a modulated multi carrier signal depends significantly on the fact if the data are correlated or not. Therefore, test signals with uncorrelated data should be used. Fig. 2.5 shows an example with five IS-136 (NADC) carriers (symbol rate 24.3 kHz), carrier spacing is 30 kHz. Correlated data increases the crest factor roughly by 2 dB in this case.

Additional variation of the start phases is a second order effect for decorrelated carriers and has not much influence. The reason is that the five carriers differ already because of the decorrelated data - which in turn leads to partial destructive interference of the carriers. With the start phase variation one tries to reach a similar result. As this is already done by the decorrelated data there is not much additional effect of the phase variation. However, random start phases should be used if a system without coherent RF carriers is simulated.

The fourth curve shows a set of equal carriers with phase randomization. This gives a severely reduced crest factor. The reason is that it is easy to minimize the crest factor of equal signals by forcing destructive interference. Therefore the phase randomizer is very effective in this case.

But it is also obvious that the resulting CCDF differs from a realistic one with different data on different carriers. So phase randomization cannot replace using realistic data scenarios on the different carriers.

² CW = continuous wave, synonym for unmodulated

³ CW could be treated as a special case where the „equal data“ is just a DC voltage.

Generating Multi Carrier Signals

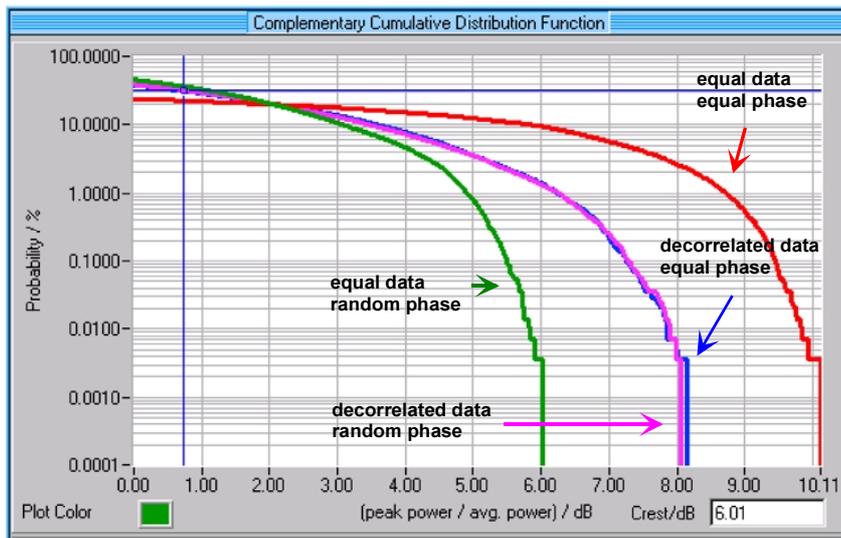


Fig. 2.5: CCDF for a signal with five NADC carriers. Equal data leads to a extremely high crest factor, being 3 dB above the realistic scenario with decorrelated data. Phase randomization does not affect signals with decorrelated data, but leads to a CCDF that differs from the realistic one when applied to signals with equal data.

The difference in CCDF between correlated and uncorrelated data affects the intermodulation performance of an amplifier significantly. This is shown in Fig. 2.6. For the signal with correlated data the intermodulation performance is 12 dB worse.

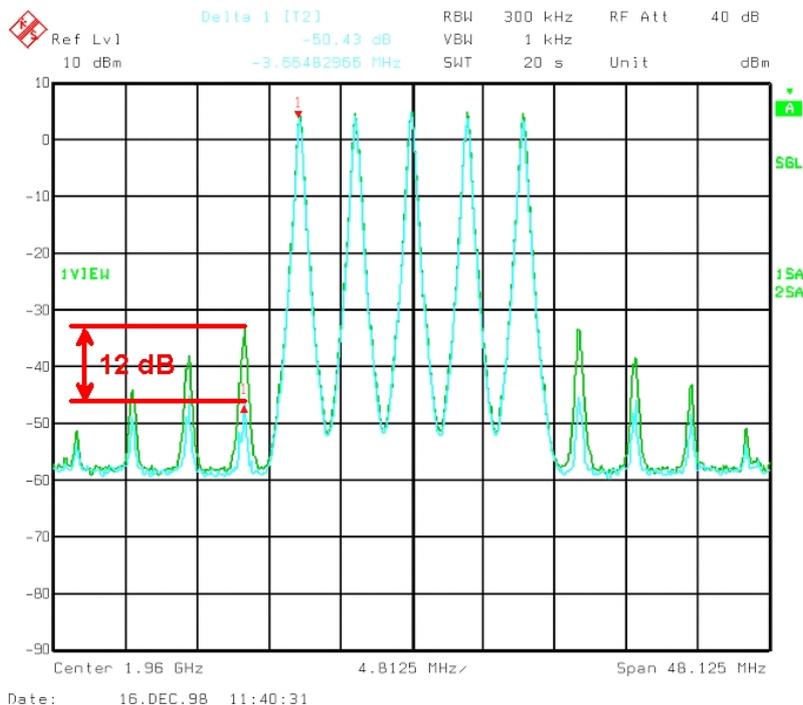


Fig. 2.6: With TDMA multi carrier signals, the intermodulation performance of an amplifier strongly depends on the carrier data. In this example with five NADC carriers, correlated data lead to 12 dB worse intermodulation performance.

CCDF of 3GPP FDD multi carrier signals

Statistics of 3GPP FDD signals

The CCDF and crest factor of a WCDMA signal depend on the number of active code channels as well as the spreading code configuration and data contents of the channels.

The statistical behaviour of a 3GPP signal mostly depends on three parameters (beside the number of code channels):

- the selection of channelization codes
- the correlation of the user data
- the timing offsets between code channels

Selection of channelization codes

Channelization codes of the same order are orthogonal to each other. However, there are code combinations which are more likely to produce constructive interference than others. So code selection affects the statistical properties of the sum signal.

Data correlation

Sending the same data on all channels may increase the probability of constructive interference, especially for code selections with high crest factor. As described in the previous subsection, correlated data is not a realistic situation, therefore we assume uncorrelated data on different code channels.

Timing offset

For a given selection of channelization codes, the crest factor can be reduced by assigning different timing offsets to different channels.

As the pilot symbol part of DPCHs is not coded, all DPCH contain the same pilot bits. This leads to constructive interference if the pilot parts are transmitted at the same time. Therefore, it is possible in 3GPP to use timing offsets for the channels. Taking the best case code selection from above, a timing offset of 3 times 256 chips from channel to channel leads to a further crest factor decrease of 1.4 dB (see Fig. 2.7). Again the effect increases with increasing number of channels.

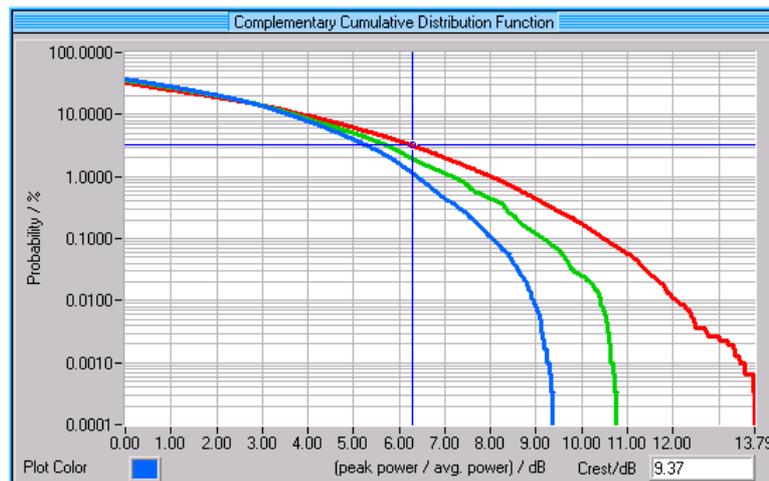


Fig. 2.7 Channelization code selection and timing offsets between code channels reduce the crest factor of a 3GPP signal. Here the CCDF curves of the worst case code selection without offsets (right curve), the best case code selection without offsets (middle curve) and the best case code selection with timing offsets (left curve) are compared.

Generating Multi Carrier Signals

As a conclusion, 3GPP has specified all these parameters in the 3GPP test models to enable comparable measurements of 3GPP signals⁴

3GPP FDD multi carrier signals

3GPP multi carrier signals need realistic signal configurations, too. As different carriers will transmit independently, the carriers must be decorrelated, but not by using different channelization codes. This would restrict the system's degrees of freedom too much. It must be possible to use the same channelization codes on different carriers.

A straightforward and effective method is to generate a 3GPP test model on each carrier and introduce a timing delay of 1/5 slot (= 133 μ s) between the carriers, as suggested in 3GPP TS 25.141 [1]. In addition, different scrambling codes for the carriers are used, similar to a real base station. A four carrier signal with Test Model 1, 64 DPCH on each carrier gives the following results.

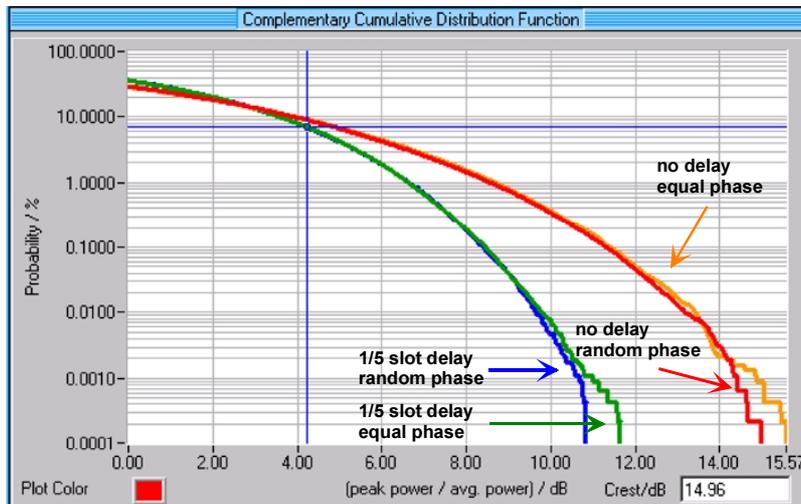


Fig. 2.8: CCDF of four neighbouring 3GPP carriers (each with Test Model 1, 64 channels).

The signal without any delay or phase randomization has the largest crest factor, as this contains four carriers with nearly the same modulation signal, leading to a high PEP of the sum signal. Phase randomization affects the carrier phases, but not the envelope due to the modulation. With decorrelation by relative carrier delays, the crest factor is significantly reduced; and in this case additional phase randomization has nearly no effect. However, this is the most realistic scenario if the carriers are generated by separate RF units (and their phases are not locked). To compare signals entirely generated with an arbitrary waveform generator (ARB) and a single RF upconverter, and signals generated by separate generators, phase randomization is applied to the ARB multi carrier signal.

In addition, if different data on different carriers is used, there is no data correlation between different code channels on the same carrier and no data correlation between different carriers. However, this has no significant effect, as can be seen in Fig. 2.9. Due to the relative delay, the carriers are already effectively decorrelated.

⁴ In cdmaOne, the test model defines a Walsh code scenario with the number of code channels and relative power. However, the Walsh codes to be used are not specified. This has led to ambiguous measurement results for the "IS-97 test model" because the model is not clearly defined. The same problem appears in cdma2000.

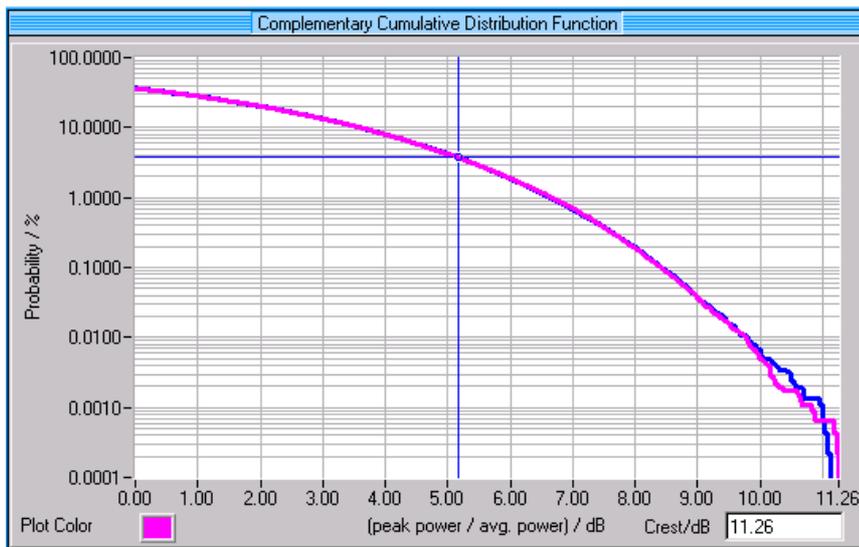


Fig. 2.9: CCDF for a signal with four 3GPP carriers, relative carrier delays and random start phases; once with different data on every carrier, once with the same data on all carriers.

3 ACLR Measurements with Multi Carrier Signals

The origins of ACLR

Any signal sent through an amplifier is disturbed for two reasons: generation of additional noise and a nonlinear transfer function of the amplifier which leads to 3rd and 5th order intermodulation products.

For a WCDMA signal, these effects lead to spectral regrowth in the adjacent and alternate channels, as can be seen in Fig. 3.1.

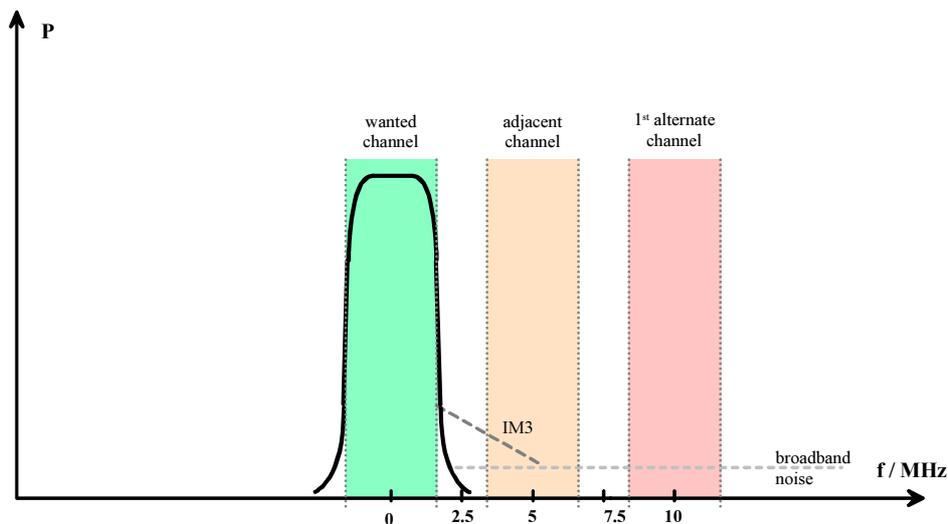


Fig. 3.1 Schematic of spectral regrowth for a 3GPP single carrier signal

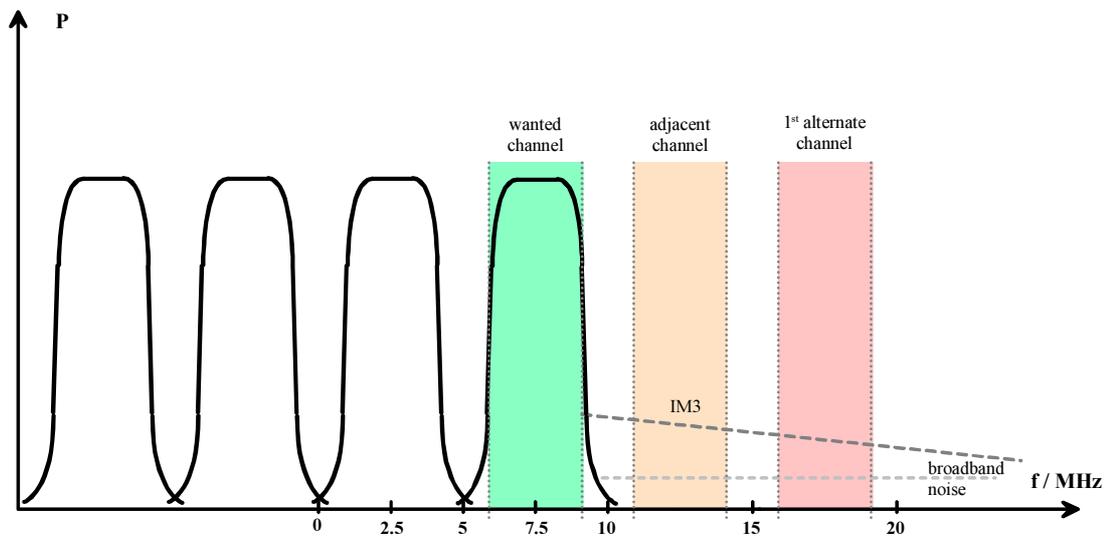


Fig. 3.2: Schematic of spectral regrowth for a 3GPP four carrier signal.

In 3GPP the bandwidth of a carrier is 3.84 MHz, the carrier spacing 5 MHz. The 3rd order intermodulation (IM 3) products are located next to the carrier and have the same bandwidth, i.e. IM 3 products appear from 1.92 MHz to 5.76 MHz (all frequencies relative to the carrier center). Therefore, IM 3 and broadband noise are present in the upper and lower adjacent channels, where IM 3 is the main contribution in most cases. The alternate channels (≥ 10 MHz offset) are mainly affected by broadband noise as IM 5 is an order of magnitude smaller than IM 3.

This applies for a single WCDMA carrier, for a multi carrier signal the situation is different. For example, a signal with four neighbouring 3GPP signals (see Fig. 3.2) is nearly 20 MHz wide (actually 18.84 MHz). This means that IM 3 products will appear in the frequency range [9.42 MHz; 28.26 MHz], again relative to the carrier center. Therefore IM 3 will dominate the spectral regrowth in the adjacent and alternate channels.

Note that this behaviour of an amplifier does not depend on the way the multi carrier signal is generated. Even if four separate signal generators are combined, the amplifier “sees” and reacts to the sum signal.

Typical measurement setups

Multiple signal generators

Each carrier is generated by a separate SMIQ Vector Signal Generator. The signal generator outputs are combined with hybrid couplers, for example.

Advantages:

- + no restrictions in carrier spacing or bandwidth of the sum signal
- + in most cases large dynamic range possible

Disadvantages:

- space-consuming
- extensive hardware requirements
- complex setup due to combiners, etc. Reverse intermodulation possible.

Generating Multi Carrier Signals

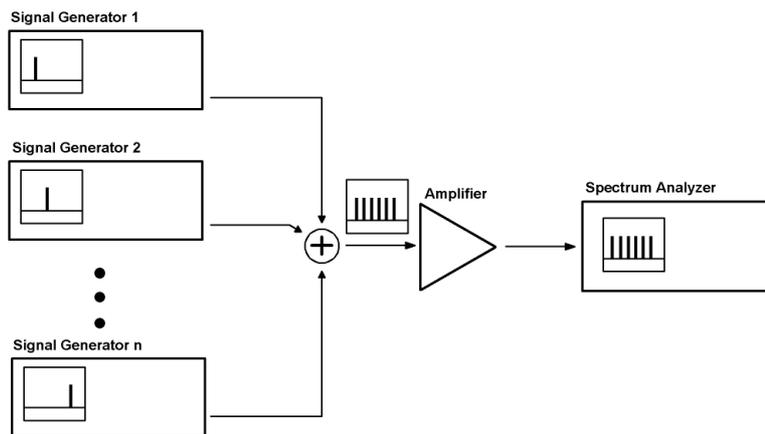


Fig. 3.3: Setup for multi carrier power amplifier tests, where each carrier is generated by a separate SMIQ vector signal generator.

Multi carrier signal generator

The entire multi carrier signal is generated as an I/Q signal by an arbitrary waveform generator (ARB) and converted to RF by a single vector signal generator. ARB and vector signal generator can be in the same box (SMIQ with option SMIQB60) or separate devices (AMIQ and SMIQ).

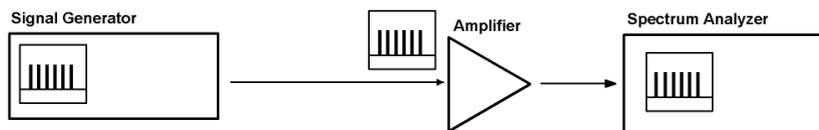


Fig. 3.4: Setup for multi carrier power amplifier tests, where the entire multi carrier signal is generated by a single signal generator.

Advantages:

- + cost-efficient
- + smaller setup
- + easy to set up

Disadvantages:

- limited bandwidth
- limited dynamic range due to the ARB D/A converters and wideband noise of the ARB and I/Q modulator

(c) “Hybrid” setup

Reduce the number of required signal generators by using ARBs to generate parts of the multi carrier setup. Compromise between the two settings described above.

Influence of measurement equipment

The physical performance requirements on measurement equipment are derived from the requirements on the devices under test. There is a general rule that the measurement equipment shall have 10 dB better performance than the device to be tested.

Regard a typical setup consisting of signal generator, device under test (DUT) and signal analyzer. All three devices are non-ideal, i.e. they give rise to signal disturbances and noise. If, for example, the phase noise of the DUT is measured, and signal source and DUT have the same performance, the analyzer measures the combined phase noise of both devices. Neglecting the noise contribution of the analyzer, we get a result that is 3 dB higher than the “true” value.

In reality, the analyzer’s own noise contribution adds to the displayed measurement result. For narrowband signals, phase noise of the local oscillator is the analyzer’s main contribution. With WCDMA signals, broadband, i.e. thermal noise has to be taken into account.

The R&S FSU spectrum analyzer can automatically subtract its thermal noise contribution from the measurement result (NOISE CORRECTION function). This is done by disconnecting the input signal for a short period of time. The inherent noise floor is subtracted from the displayed sum signal (= analyzer noise floor + input signal), which gives the input signal. Note that the input signal is again a sum, namely the sum of the signal generator and DUT contributions. Therefore the signal generator contribution has to be subtracted in a second step.

A quantitative description will lead to a correction curve as shown in Fig. 3.5. If, for example, the displayed sum signal (= analyzer noise floor + input signal) is 3 dB higher than the analyzer noise alone, the corrected result (input signal alone) is also 3 dB below the sum signal, i.e. analyzer noise and input signal are equal in power⁵.

In principle, you can measure signals that are well below the analyzer’s noise floor with this procedure. However, the uncertainty of the final result will increase if the difference between sum signal and analyzer noise becomes smaller. For example, Fig. 3.5 suggests that for (sum signal – analyzer noise floor = 1 dB), the input signal will be about 6 dB below the sum signal. However, both the sum signal and the analyzer noise are measured quantities and therefore are erroneous. If both values have an uncertainty of 2 %, the calculated input signal for this example will have an uncertainty of 14 %.

This example shows that the measurement devices do not only affect the measurement result, but also give rise to additional uncertainty. These problems can be avoided if all measurement instruments have significantly better performance than the DUT, so that their contributions to signal disturbances can be neglected. Fig. 3.5 shows that 10 dB is a practical margin.

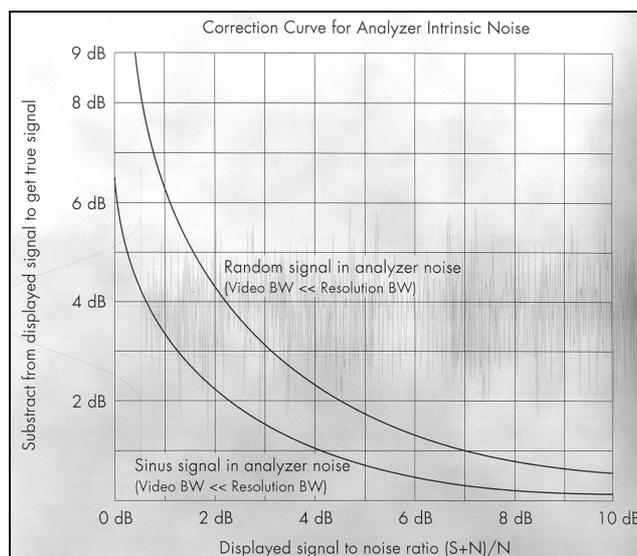


Fig. 3.5: Correction curve for analyzer intrinsic noise.

⁵ Note that simple power subtractions are only valid for sums of statistically independent terms. This is true for broadband noise from different devices, but not for contributions arising from intermodulation.

4 SMIQ Functions to optimize ACLR Performance

There are four positions in the SMIQ signal chain, where settings can be optimized for the ACLR performance of the generator (see Fig. 4.1):

1. Adjustable baseband filtering
2. I/Q filter
3. High ACLR filter for WCDMA
4. Output mode

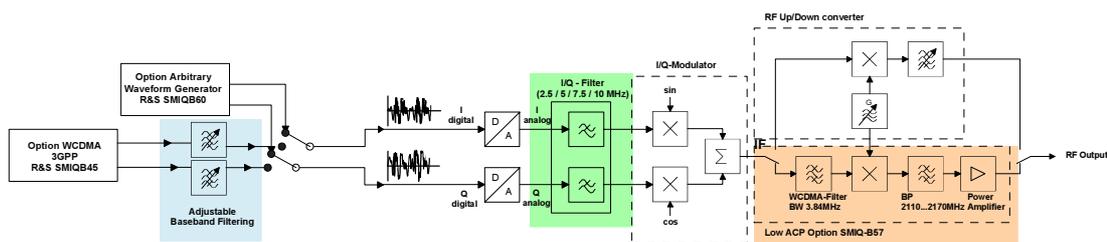


Fig. 4.1: Schematic block diagram of SMIQ with functions that affect the ACLR performance.

Low ACP mode for baseband filter

With SMIQB45, set the baseband filters implemented in SMIQ to LOW ACP as opposed to LOW EVM mode. LOW ACP mode is the default setting. The baseband filter can be set in the FILTER... menu of the digital standard to be used.

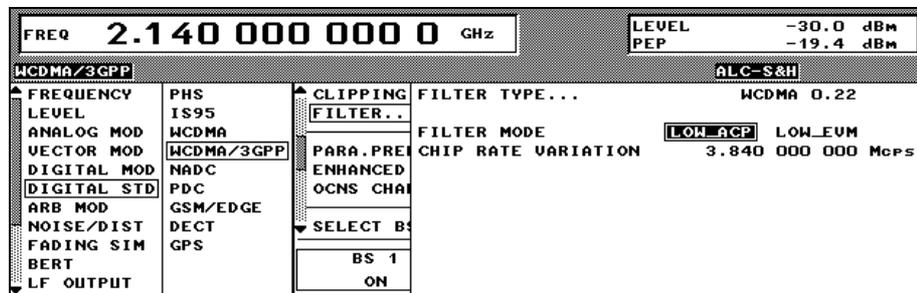


Fig. 4.2: The low ACP and low EVM modes of the baseband filter in WCDMA/3GPP (SMIQB45).

If the internal arbitrary waveform generator SMIQB60 is used to generate the signal, the baseband filtering is already included in the WiniQSIM™ calculation.

I/Q filter

(Option SMIQB47 for SMIQB, built-in for SMIQ03HD)

This function suppresses broadband noise arising from the baseband modules. It includes several filters with different I/Q bandwidths designed for different carrier setups:

- 850 kHz (SMIQB only) for one IS-95 carrier
- 2.5 MHz for one 3GPP carrier
- 5 MHz for a two carrier 3GPP signal, e.g. generated with SMIQB60 or AMIQ.
- 7.5 MHz (SMIQ03HD only) for three neighbouring 3GPP carriers.
- 10 MHz (SMIQ03HD only) for four neighbouring 3GPP carriers.

Generating Multi Carrier Signals

Activate and set the I/Q filter in the menu VECTOR MOD → I/Q FILTER. An SMIQ03HD with activated 2.5 MHz filter shows a typical ACLR of 70 dB for a 3GPP test model 1, 64 DPCH.

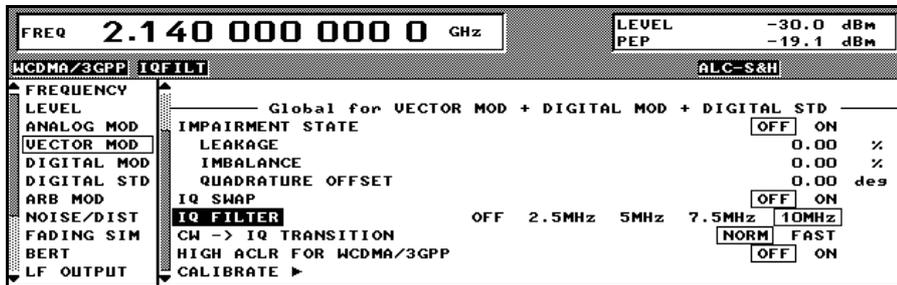


Fig. 4.3: The SMIQ's I/Q filters can be set in the VECTOR MOD menu. This screenshot shows the SMIQ03HD version with four filters (2.5 MHz, 5 MHz, 7.5 MHz and 10 MHz).

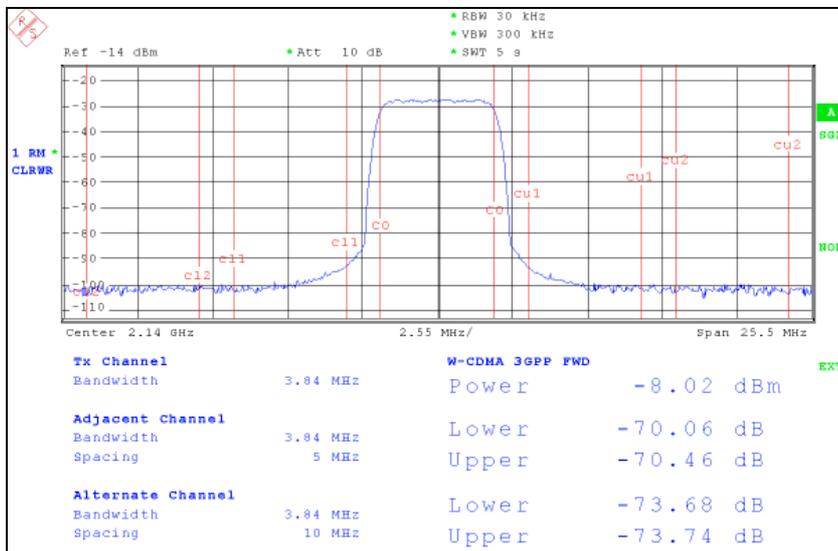


Fig. 4.4: For a WCDMA/3GPP Test Model 1 with 64 active DPCH, an ACLR performance of typically 70 dB is achieved using the 2.5 MHz I/Q filter of SMIQ03HD.

High ACLR for WCDMA, 2110 MHz - 2170 MHz (Option SMIQB57, for SMIQ03HD only)

This option is based on a narrow band SAW filter operating at a local frequency of 380 MHz IF band with a passband width of 4.9 MHz. The filter lets the carrier pass without degradation of the carrier slope and filters the side bands with an effectiveness of typically 31 dB at a carrier offset of 4.2 MHz. The insertion loss of the filter is around 8 dB. After filtering, a mixer converts the signal to the 3GPP downlink band. A power amplifier circuit at the end of the signal path can generate signals with a high power output of up to 30 dBm PEP (see the SMIQ03HD data sheet for details).

Generating Multi Carrier Signals

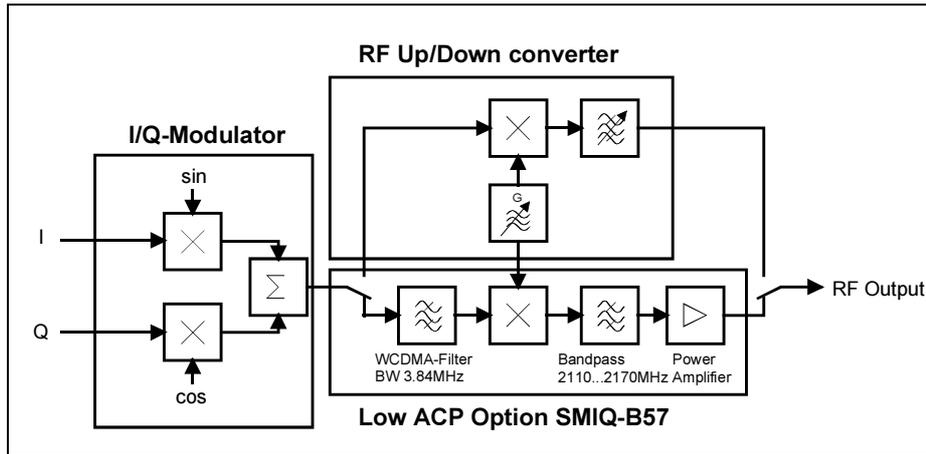


Fig. 4.5: The schematic block diagram of SMIQB57 located after the I/Q modulator in the SMIQ03HD.

SMIQB57 enhances the spectral quality of a single WCDMA carrier (3GPP test model 1, 64 DPCH) significantly to an ACLR value of typically 77 dB in the adjacent channel and typically 82 dB ACLR in the alternate channel, as shown in Fig. 4.6.

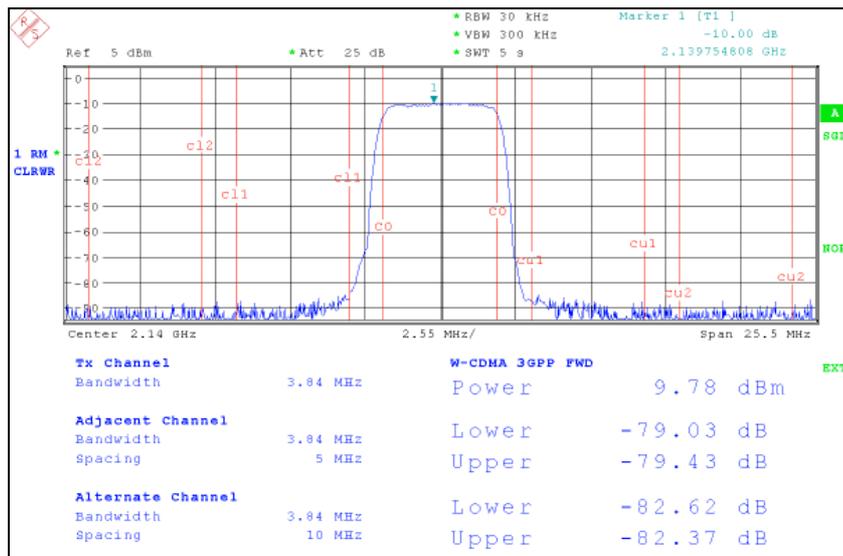


Fig. 4.6: If the SMIQ03HD is furnished with the high ACLR option SMIQB57 the ACLR performance improves significantly.

These values have not yet been achieved by any other signal generator, without using either external bandpass filters or cancellation methods. Such set-ups are more complex to handle and lead to a limited usability of the system.

A solution with external bandpass filters requires a wide range of filters for different frequency bands with steep filter slopes. Normally, such filters have significant insertion losses, sometimes several tens of dB. Therefore a driver amplifier has to be included into the signal path after the filter. The amplifier will contribute with its inherent noise to the ACLR and will reduce the dynamic. In general, such set-ups are complicated and difficult to handle, apart from the extra costs for the filters and the amplifier.

The cancellation method works as follows. The incoming signal provided by the signal source is immediately split into two paths, the reference path and the DUT path. A precise step down attenuator is necessary in the DUT path to match the level in the reference path. The reference signal path is designed as variable delay line to compensate the group delay of the DUT. Both signal paths are

Generating Multi Carrier Signals

combined and fed to a spectrum analyzer for further examination. A combiner must shift the phase of one of the input signals by 180° if the DUT is non inverting and 0° if the DUT is inverting.

The purpose of this circuit is to eliminate the original signal as far as possible (cancellation) and let only spectral power caused by the DUT's non linear characteristic pass to the analyzer. This allows to decrease the analyzer's reference level which increases the dynamic range.

The main problem is the exact adjustment of the delay line timing in order to compensate the group delay of the DUT signal. This is especially problematic if the DUT characteristics between devices is changing. Such considerations are not practicable in production, where a high throughput of devices is necessary and measurement time is the crucial factor.

All those problems are avoided with SMIQB57, as this option is fully integrated in the signal generator. SMIQB57 is available for the SMIQ03HD model only, and is activated in the VECTOR MOD menu.

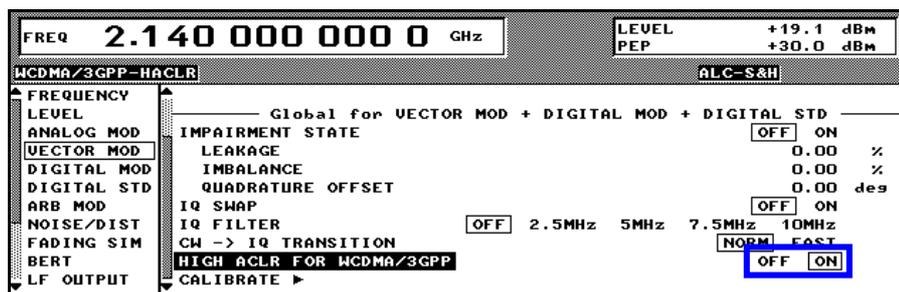


Fig. 4.7: The SMIQB57 is activated in the SMIQ03HD by just activating HIGH ACLR FOR WCDMA/3GPP in the VECTOR MOD menu.

Note that the I/Q filters and SMIQB57 cannot be activated at the same time.

LEVEL modes LOW NOISE and LOW DIST

As described in section 3, ACLR is mostly determined by IM 3 and broadband noise. Although that discussion was about amplifiers, the same arguments hold for the signal generator itself. While the SMIQ standard output mode (NORMAL) is a compromise between IM 3 and broadband noise, the output mode LOW DIST uses lower internal driving levels and therefore decreases IM 3. For a 3GPP single carrier signal, this mode leads to better ACLR performance in the adjacent channels (5 MHz offset). However, the noise floor relative to the carrier increases, leading to worse ACLR in the alternate channels. Therefore, use LOW DIST for measurements of the adjacent channels with 3GPP single carrier signals..

On the other hand, the LOW NOISE output mode uses higher internal driving levels and improves SMIQ's ACLR performance in the alternate channels for 3GPP single carrier signals. However, spectral regrowth in the adjacent channels is increased due to the enhanced IM 3. LOW NOISE is the right mode for measurements of the alternate channels with 3GPP single carrier signals.

If a single SMIQ generates a 3GPP multi carrier signal, IM 3 is the dominant contribution to ACLR in the adjacent and alternate channels. Therefore LOW DIST should be used.

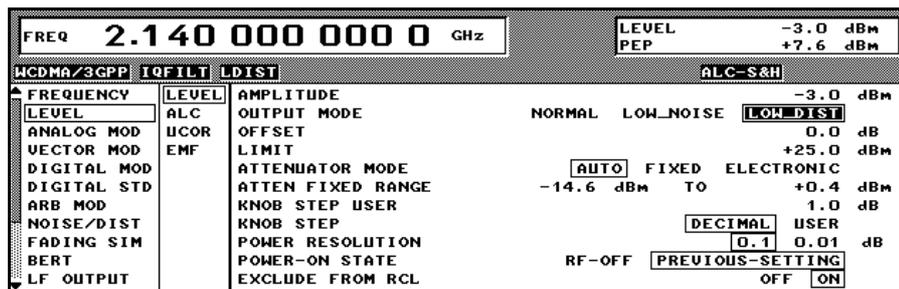


Fig. 4.8: The output modes LOW DIST and LOW NOISE can be found in the LEVEL-LEVEL menu.

Generating Multi Carrier Signals

Fig. 4.9 shows the two output level modes in comparison for a 3GPP single carrier signal. With the correct level mode selection the performance is significantly improved in either the adjacent channels or the alternate channels.

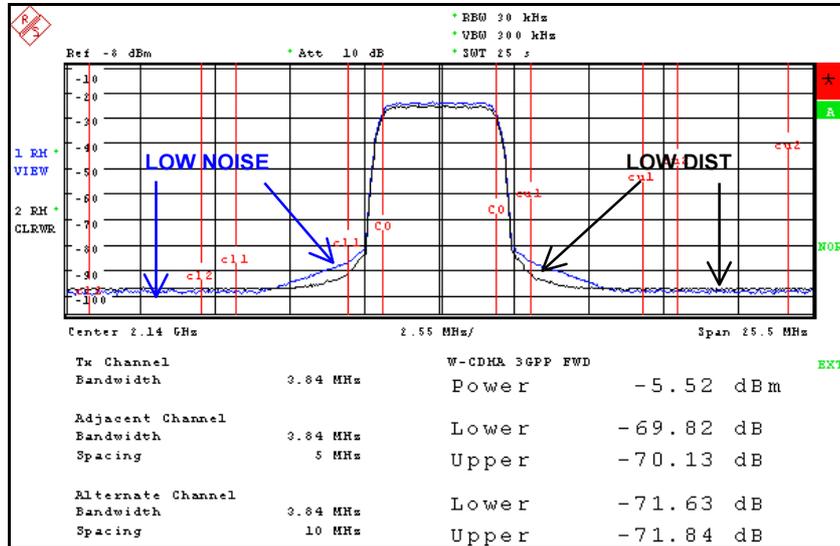


Fig. 4.9: Comparison of the two output level modes LOW DIST and LOW NOISE for a 3GPP single carrier signal. The LOW NOISE mode decreases the noise floor in the alternate channels whereas the LOW DIST mode shows better intermodulation performance in the adjacent channels.

5 SMIQ: Best Level Setting Modes for WCDMA Amplifier Tests

Another important issue in amplifier testing is level accuracy and repeatability of the signal generator. In many cases, modern amplifiers use predistortion techniques to compensate nonlinearities. With these methods the effective amplifier characteristic will be linear in an extended power range. However, if this range is exceeded, intermodulation products rise with the power of more than two. Therefore, such amplifiers are very sensitive to input level variations and require test equipment with very accurate and repeatable level setting.

SMIQ03HD with SMIQB57 active

To achieve best level accuracy with SMIQ03HD and SMIQB57 for WCDMA signals, select Attenuator Mode Fixed to allow uninterrupted level setting. The level setting range in this mode is >30 dB, according to the data sheet. The settable level resolution is 0.01 dB over the entire range. The total level uncertainty is typically 0.1 dB.

The improved level setting capabilities are available with SMIQ firmware 5.80 HX.

Generating Multi Carrier Signals

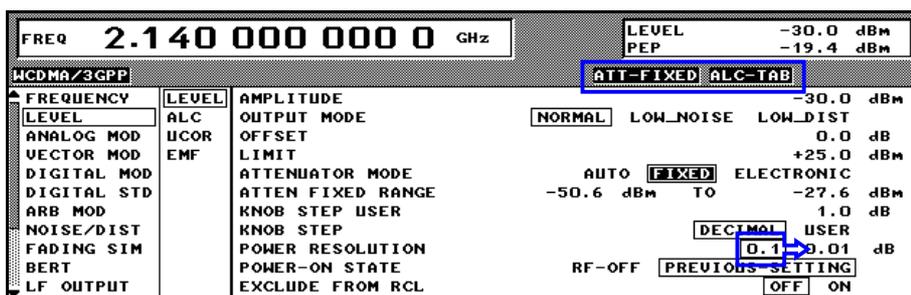


Fig. 5.1: Recommended attenuator and ALC modes to achieve best level accuracy for WCDMA signals with SMIQ03HD and SMIQB57 active.

SMIQ03HD without SMIQB57 active or SMIQ0xB

If the generator outputs a 3GPP signal, the default ALC mode is SAMPLE & HOLD. This gives good absolute accuracy over a wide level range. However, the level setting repeatability can be improved by selecting ALC mode TABLE [4]. Furthermore we recommend attenuator mode ELECTRONIC for uninterrupted level setting over a setting range of 90 dB. In this mode the level can be set in 0.01 dB steps.

If the generator is switched from attenuator mode AUTO (mechanical attenuator) to attenuator mode ELECTRONIC, the mechanical attenuator is kept fixed, and the level is attenuated electronically in a range of 90 dB. The level setting range depends on the level at the time of the mode switch, and is displayed in the field ATTENUATOR FIXED RANGE. Example: Level has been set to $L_{start} = -30$ dBm in attenuator mode AUTO. After switching to ELECTRONIC, the settable range will be from $L_{max} = -27.6$ dBm to $L_{min} = -120.6$ dBm⁶. The settable resolution will be 0.01 dB in a range $[L_{max} - x; L_{max}]$, where x is about 5 dB to 7 dB, and 0.02 dB below that range.

Note that a single calibration with a power meter might be required to get accurate absolute power values.

For a detailed discussion of SMIQ level accuracy and level setting, see application note 1GP42 [4].

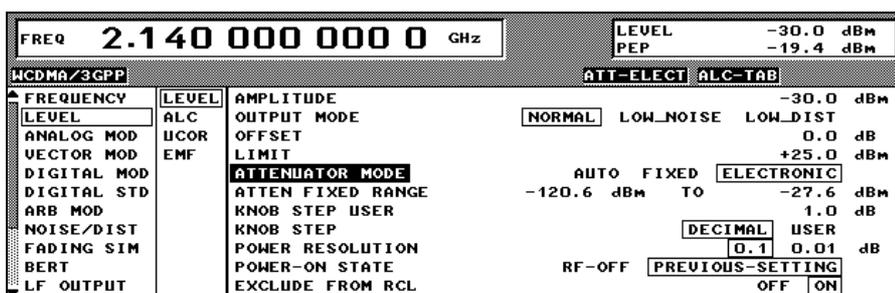


Fig. 5.2: Recommended attenuator and ALC modes to achieve best level accuracy for WCDMA signals with SMIQ03HD (without SMIQB57) and SMIQ0xB. Set the attenuator mode to ELECTRONIC. Then ALC mode is automatically set to TABLE, if WCDMA/3GPP or SMIQB60 is active.

⁶ The actual min and max values depend on where P_{start} lies relatively to the switching points of the mechanical attenuator – see application note 1GP42 [4] for a detailed explanation.

6 SMIQ ACLR Performance for 3GPP FDD Multi Carrier Signals

In this section we show the impact of the three possible signal generation setups described in section 3 on the SMIQ ACLR performance for 3GPP FDD multi carrier signals. As an example, we set a signal with four neighbouring 3GPP carriers (carrier spacing 5 MHz), each carrier transmitting a signal according to 3GPP Test Model 1, 64 code channels [1]. As suggested in [1], section 6.5.5.3.6, the four signals have different scrambling codes. To minimize correlation between the carriers, successive delays of 1/5 slot are applied. The carrier with lowest center frequency has scrambling code 0, the next one scrambling code 1 and 1/5 slot delay, the third one scrambling code 2 and 2/5 slot delay, and the fourth carrier has scrambling code 3 and 3/5 slot delay.

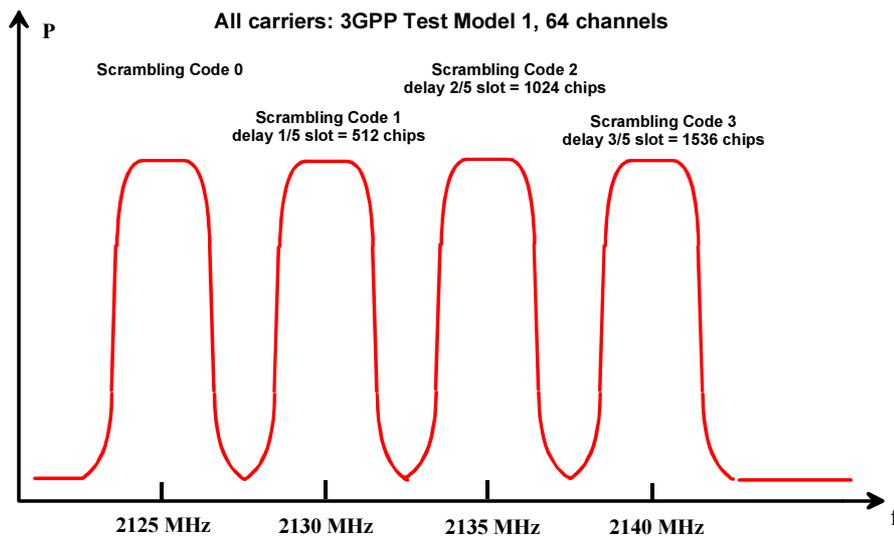


Fig. 6.1: Schematic of the 3GPP multi carrier signal to be measured.

This signal has a crest factor of 11.8 dB, as calculated in WinIQSIM™.

The signal is generated with three different setups:

1. Four SMIQs: each carrier is generated by a single SMIQ.
2. One SMIQ with Arbitrary Waveform Generator SMIQB60 generates the entire signal.
3. Hybrid setup: 2 SMIQs with SMIQB60, each generates 2 carriers.

We compare the ACLR performance of these signal generator setups and show how to set the instruments to get optimum performance. For a detailed settings instruction, see also the settings guides in the Appendix.

Setup with four SMIQs

Each SMIQ generates one 3GPP carrier.

Measurement setup and generator settings

SMIQ 1 plays the role of the master in the setup. All four SMIQs are using the reference oscillator and the chip clock of SMIQ 1. The signal output of SMIQ 2 to 4 is triggered by SMIQ 1. The trigger delays are set as described in Fig. 6.2. The trigger signal is at the TRIG OUT 3 output sent of the PAR DATA interface and fed back to the TRIG IN input of the next SMIQ as shown in Fig. 6.2. The external trigger delay is set to 512 chips for each SLAVE SMIQ.

The four signals are combined using a zero phase 4-way coaxial power combiner ZB4PD1-2000 from Mini-Circuits®. Its minimum isolation is 18 dB. With a typical isolation of 25 dB per port, a good decoupling between the four carriers results.

Generating Multi Carrier Signals

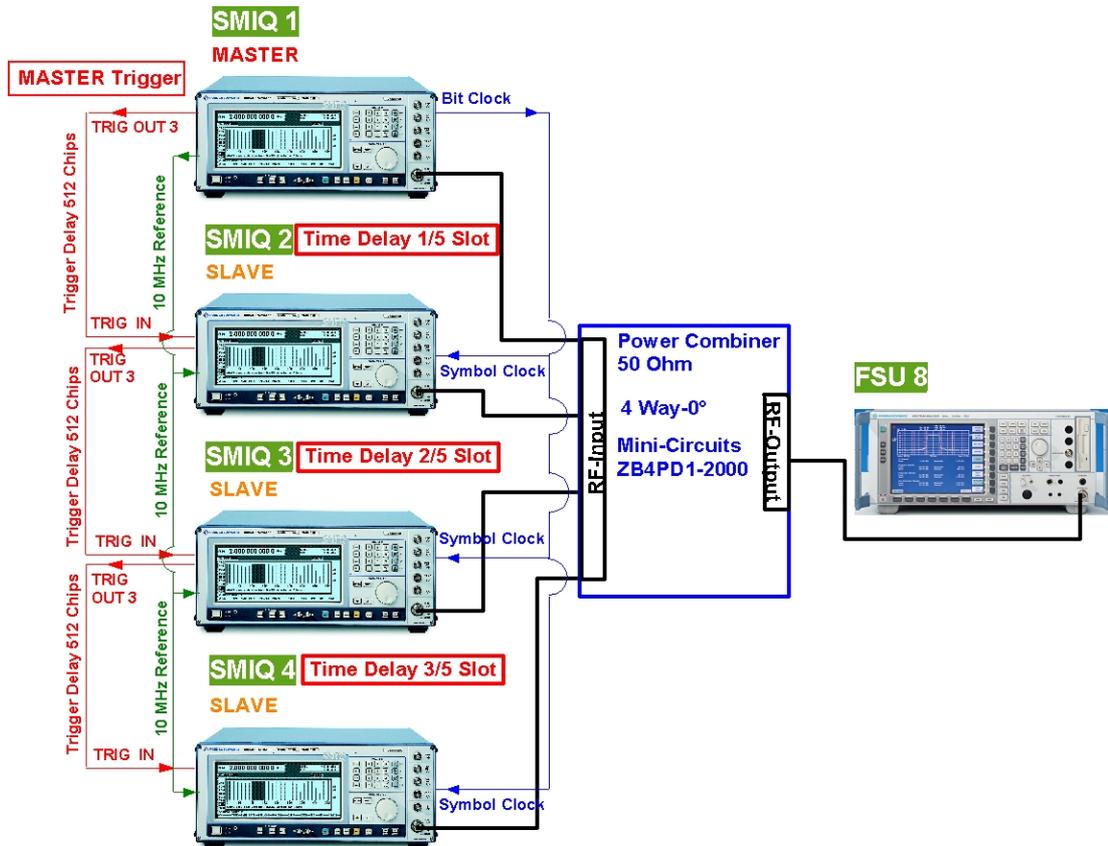


Fig. 6.2: Setup for four SMIQ Signal Generators for a four carrier 3GPP signal.

To optimize the ACLR performance of the setup, the following settings were made:

- All baseband filters are in the mode LOW ACP (default).
- High ACLR for WCDMA (Option SMIQB57) is active on all four units.
- SMIQs 1 and 4 (lowest and highest frequency band in this set-up) are using the LOW DIST mode in the LEVEL menu, SMIQs 2 and 3 the LOW NOISE mode.

(For detailed settings, see the guide in the appendix.)

Measurement Results

Parameters set in the FSU8:

	FSU8
RF-Attenuation	5 dB
RBW	30 kHz
VBW	300 kHz
Sweep Time	5 s
Detector	RMS Detector

RBW: Resolution Bandwidth

VBW: Video Bandwidth

Note, the analyzer indicates ACPR, not ACLR, thus showing negative values.

Generating Multi Carrier Signals

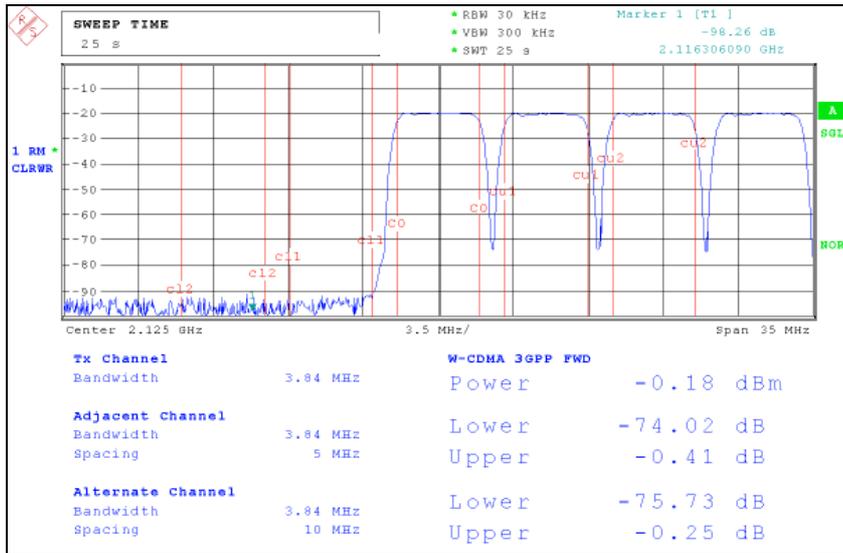


Fig. 6.3: A 4 carrier WCDMA/3GPP signal, generated by 4 SMIQ03HD with SMIQB57 active. This figure shows the ACLR for the lower adjacent and alternate channels.



Fig. 6.4: The upper adjacent channel and the upper alternate channel ACLR performance of 4 SMIQ03HD generating a 4 carrier WCDMA/3GPP using the SMIQB57 for each carrier separately.

Measurement results without SMIQB57

The next two figures show the results for the same setup, this time without SMIQB57. Instead, all four SMIQs have the 2.5 MHz I/Q filter activated.

Comparing these results with the previous measurements, SMIQB57 improves the performance for this kind of signal by approximately 8 dB.

Generating Multi Carrier Signals

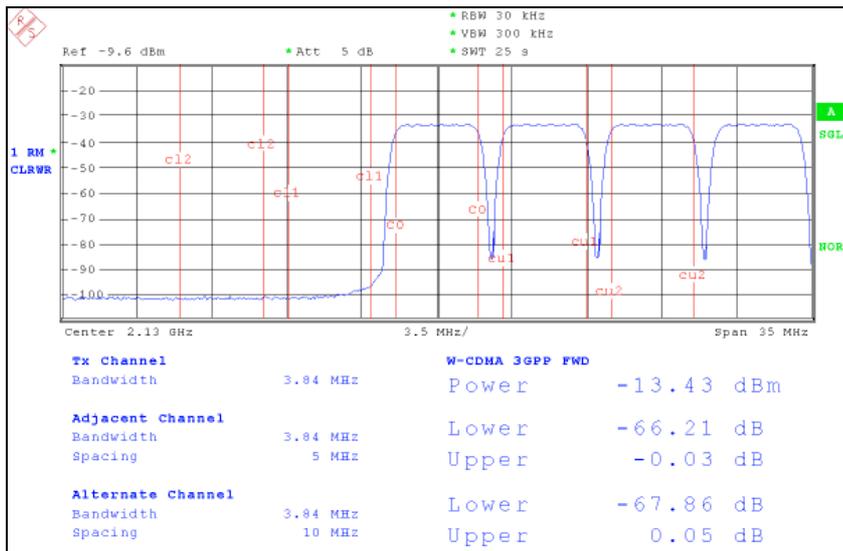


Fig. 6.5: A 4 carrier WCDMA/3GPP signal generated with 4 SMIQ03HD each using the 2.5 MHz I/Q filter. This screenshot shows the ACLR performance in the lower adjacent and 1st alternate channels.



Fig. 6.6: The upper adjacent and 1st alternate channel ACLR performance for the same setup and signal as in Fig. 6.5.

“Hybrid” setup with two SMIQ using SMIQB60

Each SMIQ generates two 3GPP carriers using the internal arbitrary waveform generator SMIQB60.

Measurement setup and generator settings

The configuration uses 2 SMIQ equipped with option SMIQB60⁷. A trigger from the master SMIQ is established to synchronize the slave SMIQ to the master.

⁷ You can also use AMIQs instead of SMIQB60 ARBs.

Generating Multi Carrier Signals

Each SMIQB60 generates a 2-carrier signal (carrier 1+2, carrier 3+4), precalculated in WinIQSIM™. The timing offset between the carriers is included in the WinIQSIM™ calculations. Then the two SMIQB60 can be started simultaneously using the trigger. The trigger signal is sent at the TRIG OUT 3 output of the PAR DATA interface and fed back to the TRIG IN input of the SLAVE SMIQ as shown in Fig. 6.7. The external trigger delay is set to 512 chips for the SLAVE SMIQ.

The 2 signals are combined using a power combiner from Mini-Circuits®. The zero phase 2 way coaxial power combiner ZFSC-2-11 has an isolation of typically 20 dB per port. Its minimum isolation is 15 dB. With a typical isolation of 20 dB per port, a good de-coupling between the four carriers results.

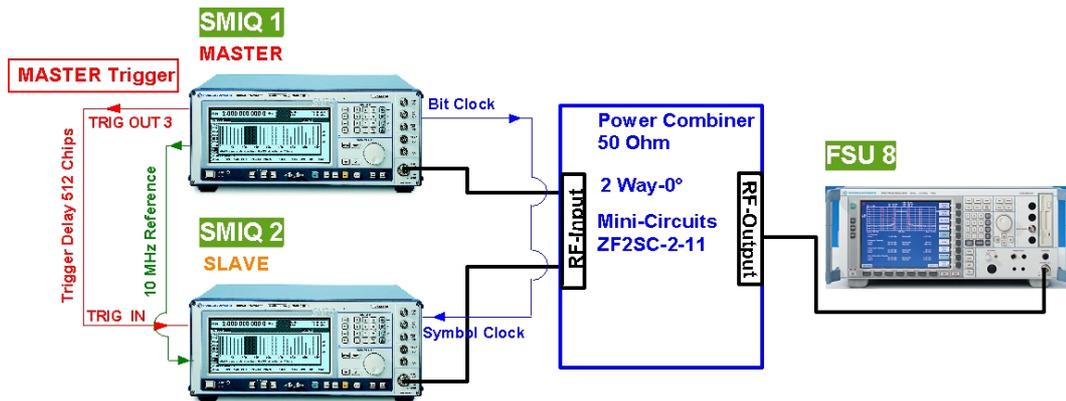


Fig. 6.7: Setup of 2 SMIQ03HD Signal Generators for a four carrier 3GPP signal. Each of the SMIQs generates 2 WCDMA/3GPP carriers using the internal ARB SMIQB60.

To optimize the ACLR performance of the setup, the following settings were made:

- Both SMIQs use the 5 MHz I/Q filter.
- For measurements on the lower adjacent and alternate channels, SMIQ 1 is set to output mode LOW DIST, SMIQ 2 to LOW NOISE. (Vice versa for measurements on the upper adjacent and alternate channels)

Note:

When SMIQB60 is active, SMIQ shows both the average power and the PEP in its level indicator. The crest factor is just the difference between these two values. In some cases SMIQ will show a slightly different crest factor than WinIQSIM™ has calculated. This is because SMIQB60 resamples the signal to a higher sample rate. In any case with SMIQB60 signals the SMIQ indication is the correct one. For more details on SMIQB60, see application note 1GP45 [5].

Measurement Results

Parameters set in the FSU8:

FSU8	
RF-Attenuation	5 dB
RBW	30 kHz
VBW	300 kHz
Sweep Time	5 s
Detector	RMS Detector

Fig. 6.8 and Fig. 6.9 show the ACLR result of the lower adjacent channel respectively upper adjacent channel of a 4 carrier signal as a combination of a 2 x 2 carrier WCDMA signal. Approximately 64 dB ACLR in the adjacent channel and 66 dB ACLR in the alternate channel are achieved using SMIQ's 5 MHz I/Q filter for each set of 2 carriers.

Generating Multi Carrier Signals

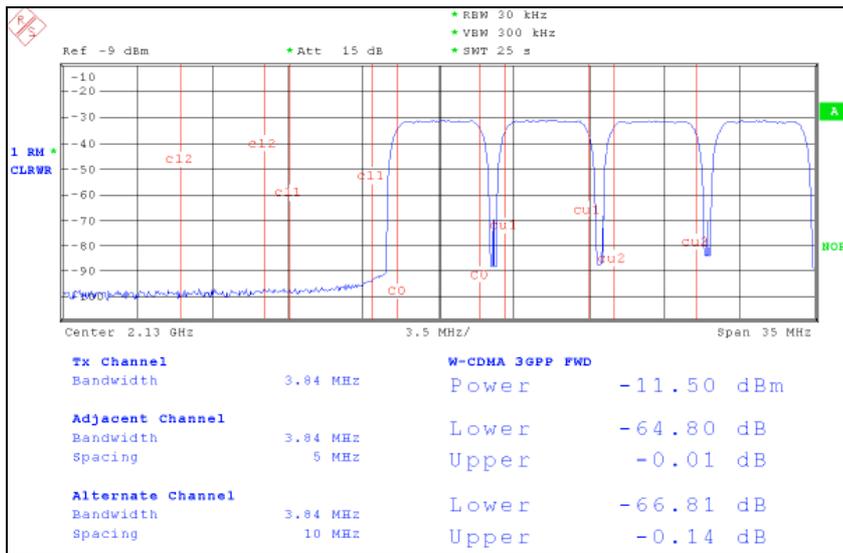


Fig. 6.8: A 4 carrier WCDMA/3GPP signal generated with the internal ARB SMIQB60. Each SMIQ03HD generates a two-carrier signal that is combined via a power combiner. The SMIQ, which neighboring channels are measured is set to LOW DIST mode. The other SMIQ is set to LOW NOISE mode.

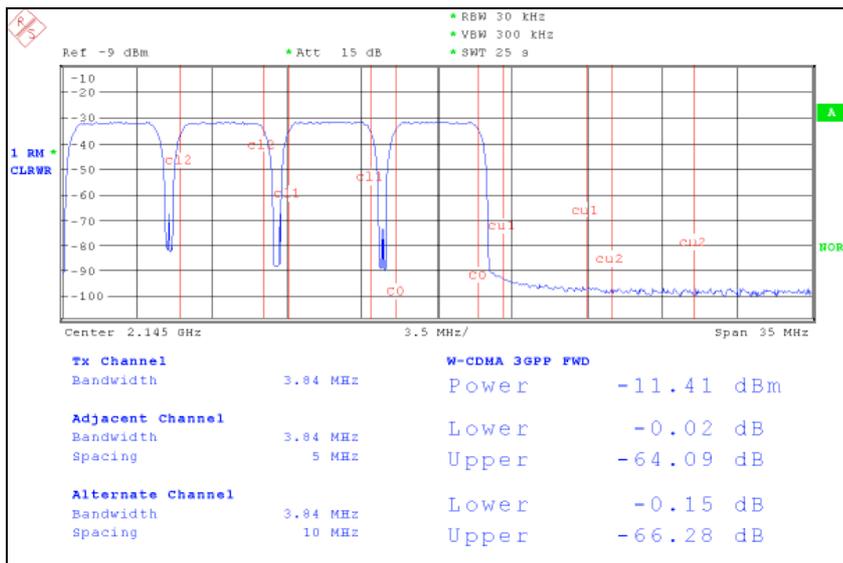


Fig. 6.9: The upper adjacent + alternate channel ACLR performance of a 2 x 2 SMIQ03HD set-up using the 5 MHz I/Q filter for 2 carriers of each SMIQ.

Setup with one SMIQ using SMIQB60

One SMIQ with SMIQB60 generates all four 3GPP carriers.

Measurement setup and generator settings

The configuration uses 1 SMIQ with SMIQB60. The crest factor of the 4 carrier signal is calculated using the WinIQSIM™ CCDF function, called from the WinIQSIM™ task bar.

All 4 carriers are generated using the same PRBS sequence when the Test Model 1 64 DPCH is used as the WCDMA signal. The PRBS 9 sequence is used as the data sequence for each WCDMA/3GPP carrier. For further de-correlation of carriers WinIQSIM™ offers in its Multi Carrier Mixed Signal mode a timing offset to be incorporated, similar to that discussed as trigger delay in Fig. 6.1. The timing offset is a 1/5 of a WCDMA/3GPP slot for each carrier and is entered into WinIQSIM™ as a time constant representing the chip delay in microseconds.

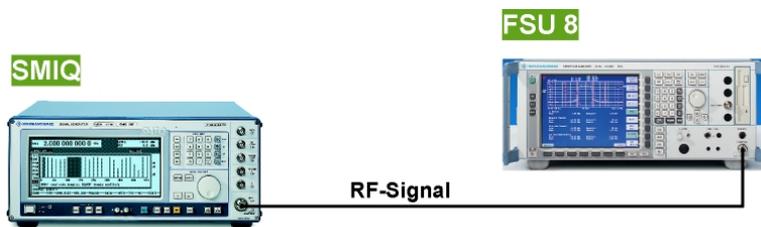


Fig. 6.10: It is also possible to generate an entire 4 carrier WCDMA/3GPP signal with only one SMIQ03HD. In order to obtain optimum ACLR performance the SMIQ03HD has the 10 MHz I/Q filter already included.

To optimize the ACLR performance of the setup, the following settings were made:

- The baseband filter is operating in the mode LOW ACP (default).
- The SMIQ uses the 10 MHz low ACP I/Q filter.
- The output mode is set to LOW DIST

Measurement Results

Parameters set in the FSU8:

	FSU8
RF-Attenuation	5 dB
RBW	30 kHz
VBW	300 kHz
Sweep Time	5 s
Detector	RMS Detector

The 4 carrier signal generated in the ARB of SMIQ03HD has respectable 62 dB ACLR in the adjacent channel and approximately 64.5 dB ACLR in the alternate channel when the 10 MHz I/Q filter is used for the measurement (see Fig. 6.11 and Fig. 6.12).

Generating Multi Carrier Signals

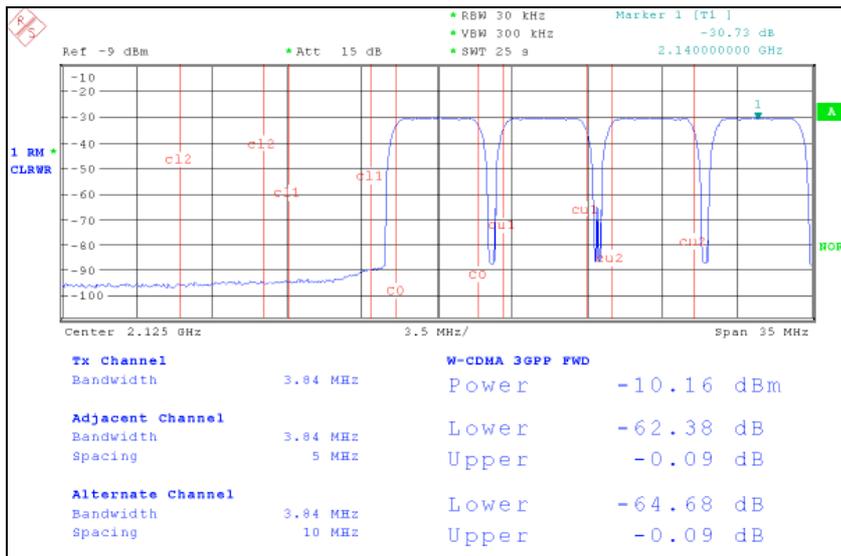


Fig. 6.11: A 4 carrier WCDMA/3GPP signal generated in the internal ARB of the SMIQ03HD, the SMIQB60.

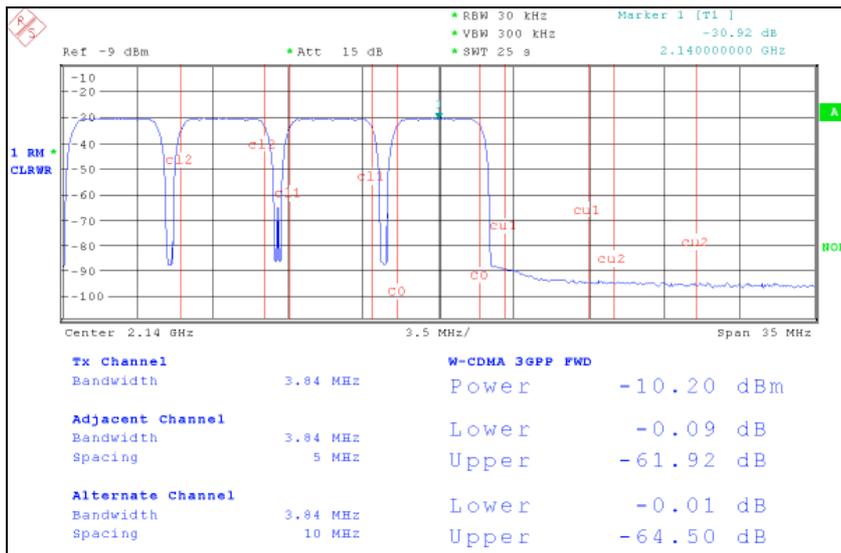


Fig. 6.12: The upper adjacent + alternate channel ACLR performance of a 4 carrier generated in one SMIQ03HD using the 10 MHz I/Q filter.

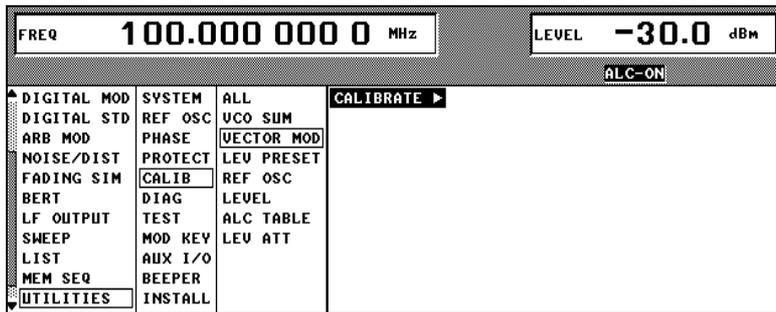
7 Appendix: Setting Guides

Calibrating the I/Q modulator

Before you start preparing the SMIQs for measurement calibrate the I/Q modulators.

Caution: *Execute calibration routines only once the instrument has warmed up!*

CALIB VECTOR MOD triggers the internal calibration routine for the I/Q modulator, which does not require any external measuring equipment.



Scroll down with the rotary knob to *UTILITIES* and select in the submenu path *CALIB*

Scroll to *VECTOR MOD*, and execute the calibration routines in the *VECTOR MOD* menu.

The calibration routines are executed at once. The state of the calibration process is shown by the calibration progress bar.

Alternatively, the I/Q modulator can be calibrated in the VECTOR MOD menu:

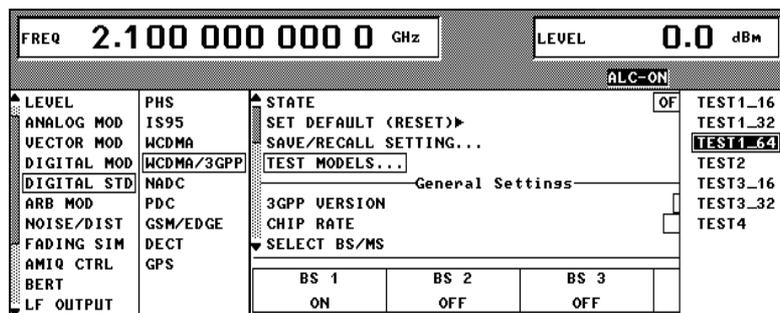


In the *VECTOR MOD* menu, scroll to *CALIBRATE* and execute the calibration.

The calibration routines are executed at once. The state of the calibration process is shown by the calibration progress bar.

Setting a 3GPP single carrier signal (Test Model 1, 64 code channels) with SMIQB45

The following guide will help you to set up a WCDMA/3GPP Test Model in SMIQ in order to perform the measurements for a 4 carrier signal scenario with 4 SMIQ as presented in chapter 6.

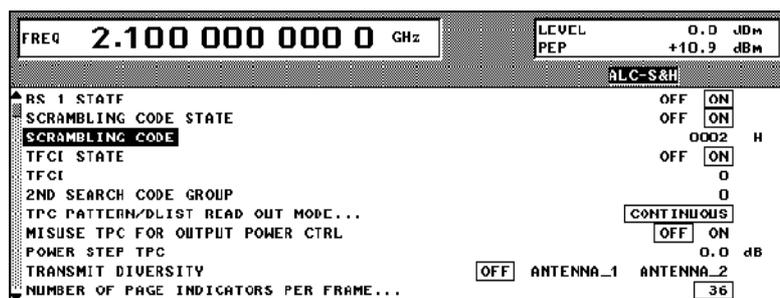


Select the appropriate Test Model:

Select in main menu *DIGITAL STANDARD* → *WCDMA/3GPP*. Now scroll back with the rotary knob to position *TEST MODELS...*

Select with rotary knob *TEST1_64*

Note: SMIQ does all the required settings automatically.



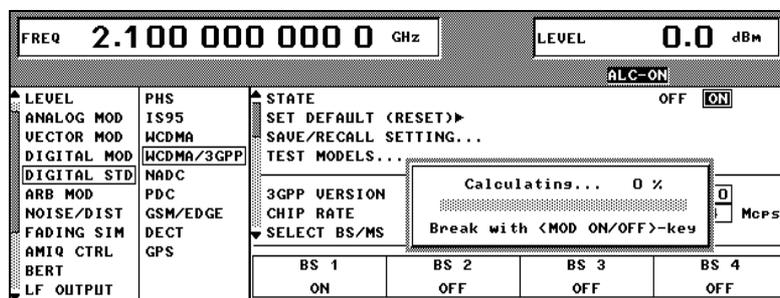
Set the appropriate scrambling code:

The scrambling code is set in ascending order similar to the ascending order of the four different frequency bands.

Scroll in the WCDMA menu to *SELECT BS/MS* and open the *BS 1* submenu.

Scroll to *SCRAMBLING CODE* and set scrambling code accordingly:

SMIQ 1: scrambling code 0
 SMIQ 2: scrambling code 1
 SMIQ 3: scrambling code 2
 SMIQ 4: scrambling code 3



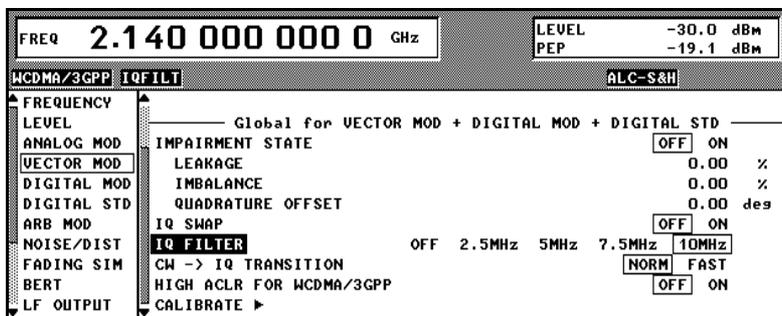
Switch the *WCDMA/3GPP* state to *ON*.

Scroll with the rotary knob to the top of the display until you hit *STATE*

Select *STATE ON*

The signal is then pre-calculated and output when the calculation is ready.

Setting the appropriate I/Q filter, or activating SMIQB57



To activate the appropriate I/Q filter:

From the main menu, select **VECTOR MOD**.

Scroll down to **IQ FILTER** and select the desired filter.

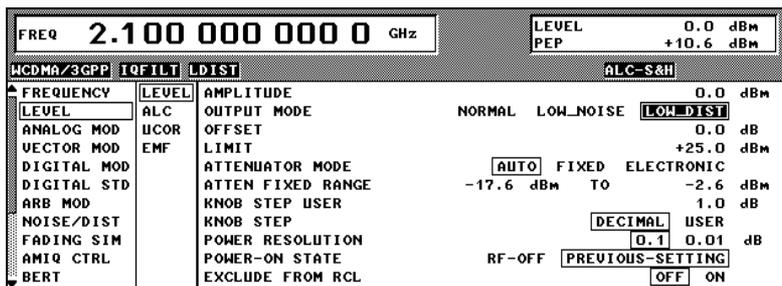
To activate SMIQ B57:

From the main menu, select **VECTOR MOD**.

Scroll down to menu **HIGH ACLR FOR WCDMA/3GPP** and select state **ON**.

Note: Do not switch in this menu STATE to ON. Otherwise you will activate vector modulation and you will force the SMIQ to automatically switch the 3GPP signal in the WCDMA/3GPP digital standard OFF.

Setting the appropriate output mode



Set the appropriate output mode:

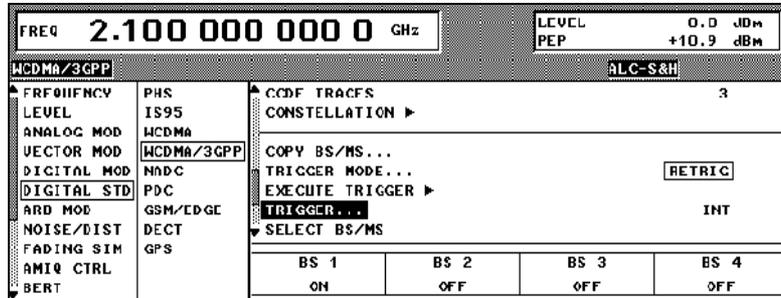
From the main menu select **LEVEL**.

In the **LEVEL-LEVEL** menu scroll down to **OUTPUT MODE** and select the **LOW_DIST** or **LOW_NOISE** function.

In one of the examples in chapter 6, set-up with four SMIQs. SMIQs 1 and 4 (lowest and highest frequency band in that particular set-up) are set to **LOW DIST** mode whereas SMIQs 2 and 3 are set to **LOW NOISE** mode.

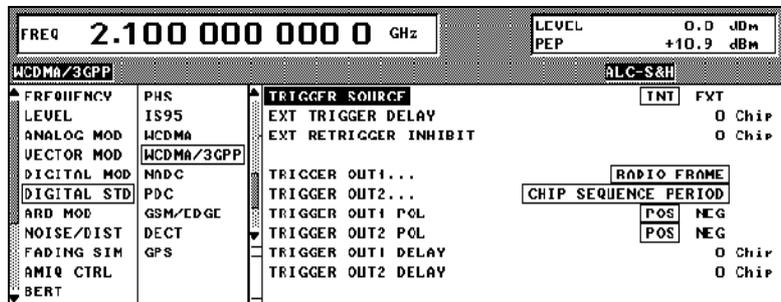
Setting the trigger delay in SMIQ

In order to achieve a further de-correlation between carriers, as stated in the WCDMA specification [3], and to obtain a better crest factor of the overall signal, it is possible to set a trigger delay for the three slave SMIQs when all SMIQs are synchronized.



Set the trigger delay in SMIQ:

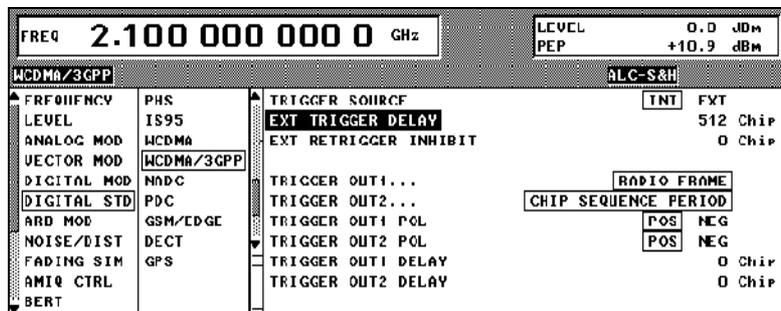
In the main WCDMA/3GPP menu scroll to TRIGGER...



Set the TRIGGER SOURCE:

In the TRIGGER SOURCE menu set TRIGGER SOURCE to EXT trigger for SMIQ 2 to 4 (slave SMIQs).

Leave the master SMIQ (SMIQ 1) at position INT.



Enter the trigger delay for each SMIQ:

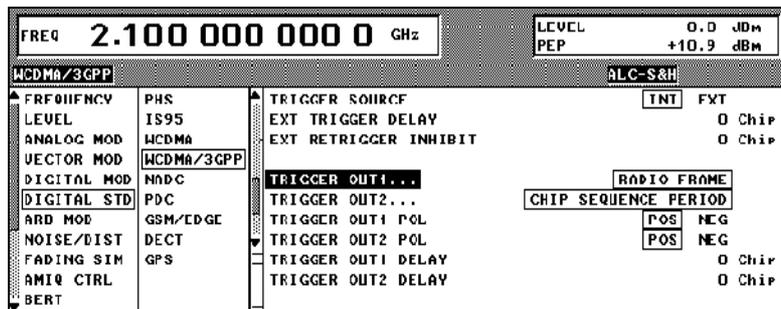
Scroll with the rotary knob to EXT TRIGGER DELAY

Set the trigger delay for SMIQ 2 to 4, representing a 1/5 Slot delay between each SMIQ.

1/5 of a WCDMA slot corresponds to 512 chips

Set the following trigger delay for the 3 slaves SMIQs

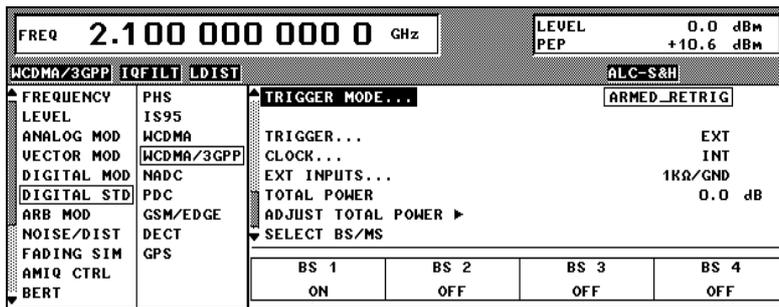
SMIQ 2: 512 Chip
SMIQ 3: 512 Chip
SMIQ 4: 512 Chip



Define TRIGGER OUT1 mode:

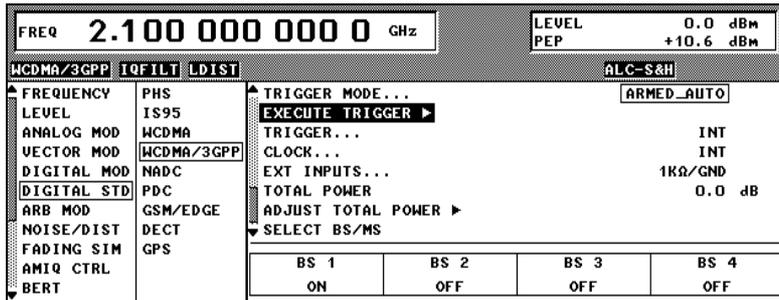
Check that TRIGGER OUT1 ... mode for SMIQ 1 is set to RADIO FRAME, since you trigger on the start of the frame.

Generating Multi Carrier Signals



Set TRIGGER MODE...:

In the *TRIGGER MODE...* menu of the slave SMIQs (SMIQ 2 to 4,) set the trigger mode to *ARMED_RETRIG*.



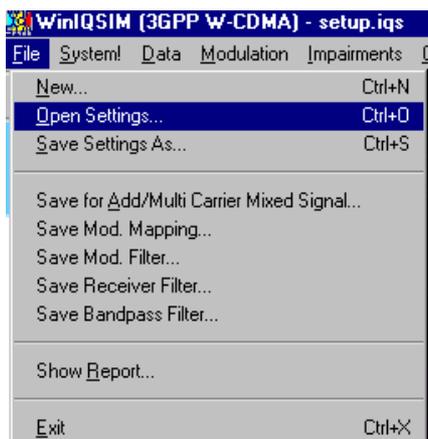
In the *TRIGGER MODE...* menu of SMIQ 1 (MASTER SMIQ) set the trigger mode to *ARMED_AUTO*.

To execute the trigger scroll down to *EXECUTE TRIGGER* and press the *SELECT* button.

Instead of using SMIQB45, you can also generate 3GPP single carriers with WinIQSIM™ and SMIQB60. This is explained below.

Setting a 3GPP Test Model in WinIQSIM™

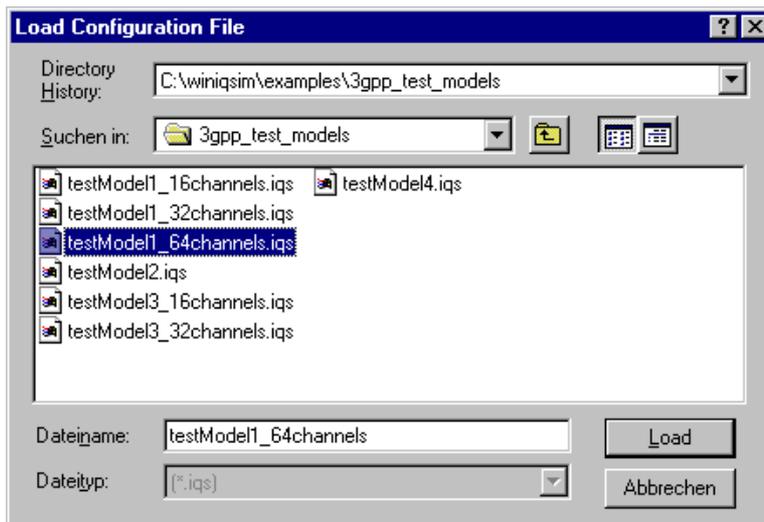
This section shows how to generate a 3GPP single carrier signal in WinIQSIM™. To obtain a multi carrier signal the single carrier signals are saved in a special format (.IBN file) and later composed to a multi carrier signal with the WinIQSIM™ Multi Carrier Mixed Signal function (see also next subsection).



WinIQSIM™ offers a set of pre-configured set-up files for different signal scenarios, including the 3GPP test models.

In the **File** menu select **Open Settings...**

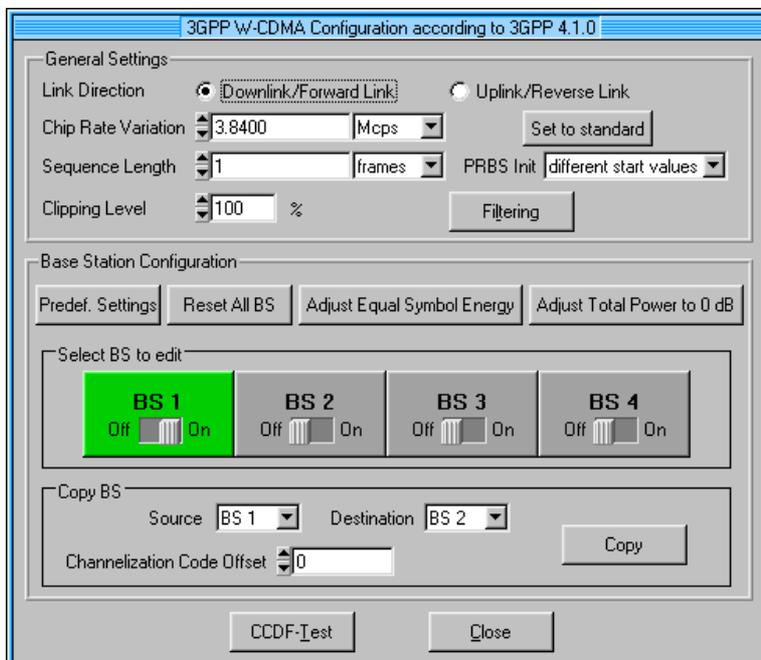
Generating Multi Carrier Signals



Load the configuration file by clicking through the directories until you find the directory path ...\\winiqsim\\examples\\3gpp_test_models.

Select the setup file **testModel1_64channels.iqs**

Press **Load** to load the configuration file into WinIQSIM™.

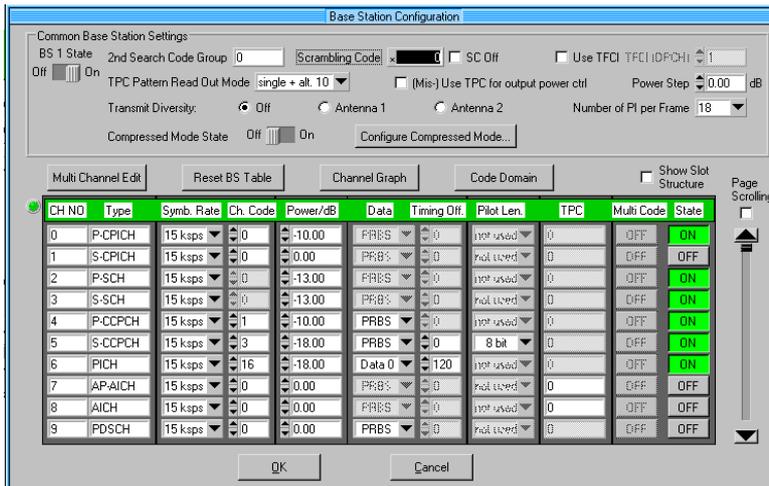


The 3GPP WCDMA Configuration panel pops up, and the program's parameters are set according to the test model.

To open up the Base Station Configuration panel to adjust the scrambling code for each carrier, press the green button labelled as **BS1**.

Note: The BS1 button has two functions. Pressing the green area on the button opens the Base Station Configuration panel. If the toggle switch is pressed you can toggle between state on or off, without the need to enter the BS1 panel. Switching into state off, the button color changes from green to grey.

Generating Multi Carrier Signals



Set the appropriate scrambling code:

The scrambling code is set in ascending order similar to the ascending order of the four different frequency bands.

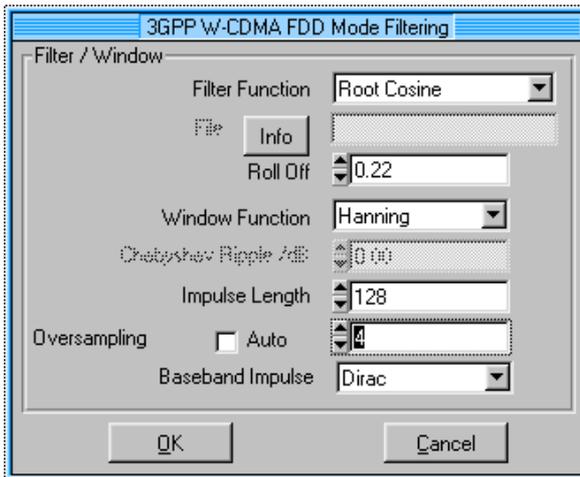
Choose the Scrambling Code for each individual carrier:

First carrier: scrambling code 0

Second carrier: scrambling code 1

Third carrier: scrambling code 2

Fourth carrier: scrambling code 3



Adjust the oversampling factor:

Set the oversampling factor:

From the 3GPP WCDMA Configuration panel press the Filtering button to open the 3GPP WCDMA FDD Mode Filtering panel

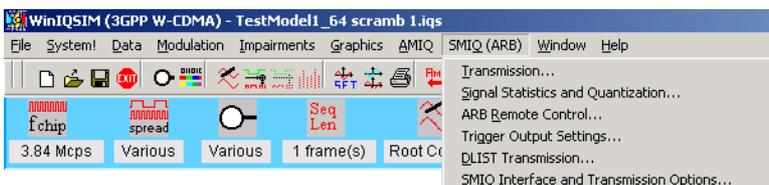
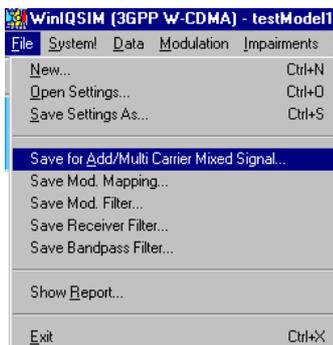
Un-checkmark the **Auto** box, and set **Oversampling** to **4**.

Press **OK** button.

Note: The oversampling has to be reduced to 4 to match the RAM capacity of SMIQB60. This does not affect the signal quality.

If you want to use this signal for a multi carrier composition:

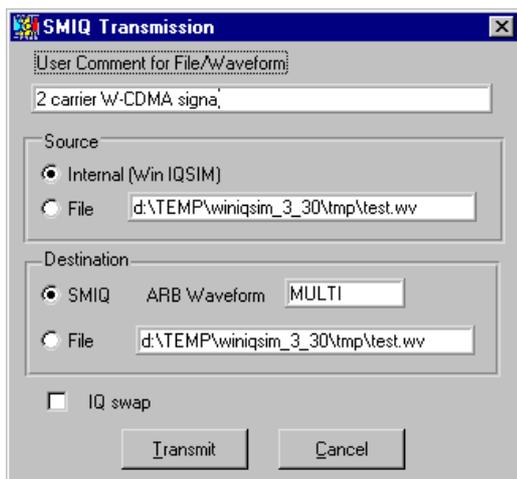
Save your configuration with **Save for Add/Multi Carrier Mixed Signal...**



Transmit the signal directly to SMIQB60:

From the **SMIQ(ARB)** task bar open the **SMIQ Transmission** panel.

Generating Multi Carrier Signals



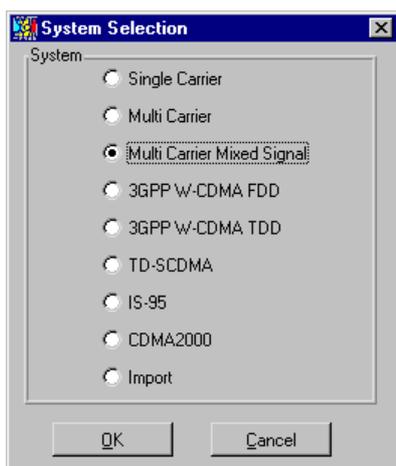
Enter a User File Information in the **User Comment for File/Waveform** text box and a **ARB Waveform** file name in the **Destination** section of the transmission panel.

To transmit the waveform press the **Transmit** button.

The Destination section offers two choices, either to save the waveform to a file directly on the PC or to transmit the waveform straight to the SMIQ ARB. The radio button indicates the current selection.

The file path where the waveform file is stored on the PC are selected in the text box next to the file radio button. A windows box opens if you click into the text box.

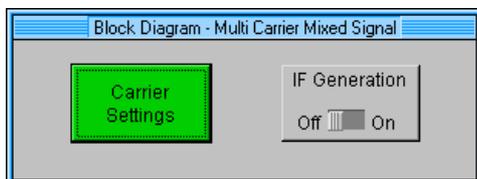
Setting a multi carrier WCDMA/3GPP signal in WinIQSIM™



Compose a multi carrier mixed signal:

Switch to **Multi Carrier Mixed Signal** in the System Selection panel.

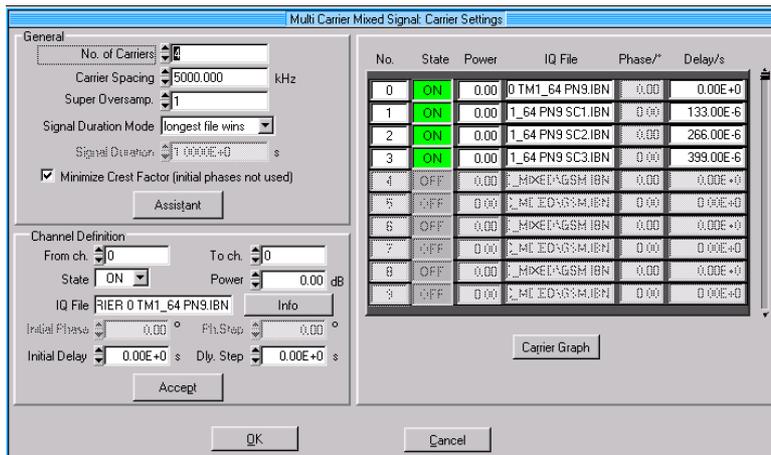
Press the **OK** button



The WinIQSIM™ Block Diagram for Multi Carrier Mixed Signal appears.

Click on the **Carrier Settings** block

Generating Multi Carrier Signals



The **Multi Carrier Mixed Signal Carrier Settings** panel appears.

The panel is divided into three functional blocks and sets a wide range of different multi carrier mixed signal scenarios. Everything is set and controlled only from this single panel.

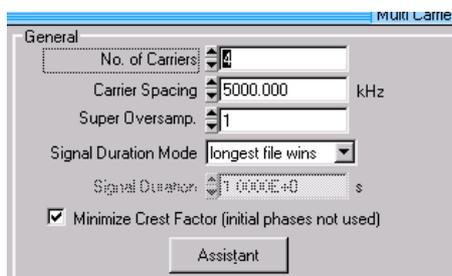
The three functional blocks in the panel are:

- The General Settings Block
- The Channel Definition Block
- The Carrier Table Block

In the General Settings Block the number of carriers and the carrier spacing within the baseband etc. are defined.

The Channel Definition Block sets the carriers physical conditions such as activation state, initial delay, etc., and what type of *.IBN file will be up-loaded into the Carrier Table.

The Carrier Table Block shows the status of each carrier loaded into the table. The order of carriers is in ascending order to their frequency position in the baseband.



Set the carrier spacing and the oversampling:

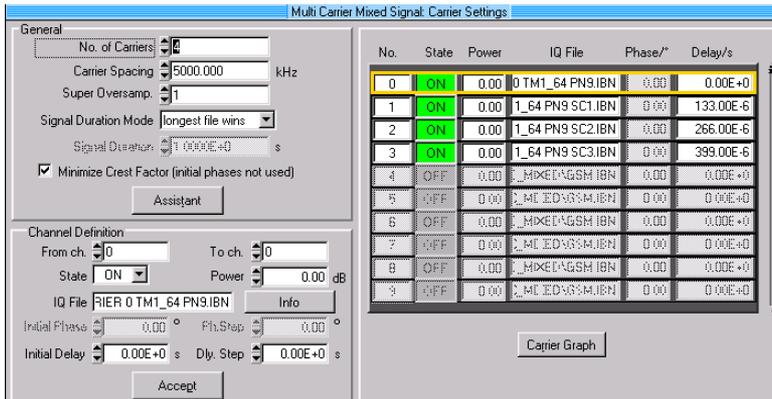
Set the number of carriers in the General section to 4 carriers.

Continue in the General section, with setting the **Carrier Spacing** to 5000 kHz in order to comply with the WCDMA/3GPP standard.

Set **Super Oversampling** to 1.

Keep the **Minimize Crest Factor (initial phases not used)** checkbox check marked

Generating Multi Carrier Signals



In the Channel Definition block, click on the first table entry of the carrier table. The table entry is highlighted with a yellow box. Now all your changes in the Channel Definition section will affect the entry field as soon as you press the **Accept** button in the Channel Definition section.

Load the first file that you have created in **Save for Add/Multi Carrier Mixed Signal** into the table, by clicking in the IQ File selection field.

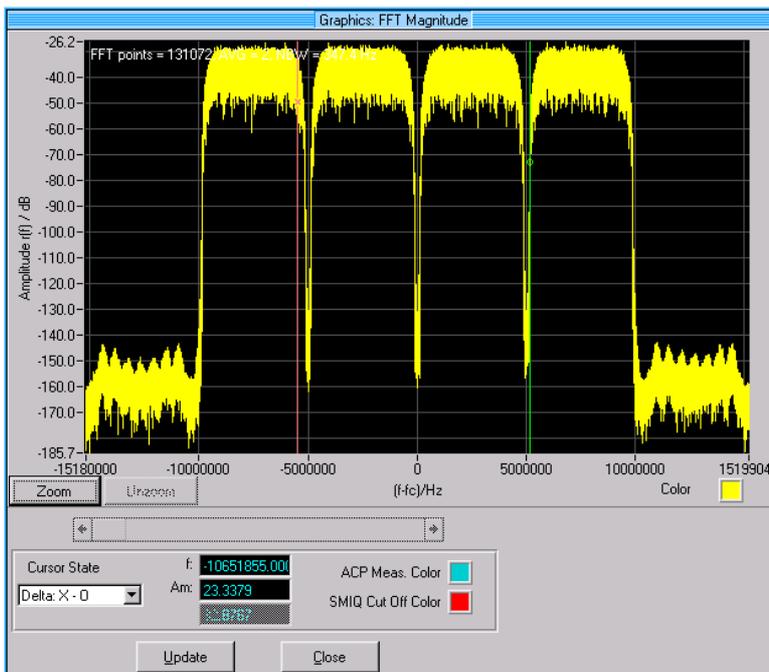
Check if the carrier **State** is set to ON.

No.	State	Power	IQ File	Phase/*	Delay/s
0	ON	0.00	0 TM1_64 PN9.IBN	0.00	0.00E+0
1	ON	0.00	1_64 PN9 SC1.IBN	0.00	133.00E-6
2	ON	0.00	1_64 PN9 SC2.IBN	0.00	266.00E-6
3	ON	0.00	1_64 PN9 SC3.IBN	0.00	399.00E-6
4	OFF	0.00	1_MIXED_QSSM.IBN	0.00	0.00E+0
5	OFF	0.00	1_MIXED_QSSM.IBN	0.00	0.00E+0
6	OFF	0.00	1_MIXED_QSSM.IBN	0.00	0.00E+0
7	OFF	0.00	1_MIXED_QSSM.IBN	0.00	0.00E+0
8	OFF	0.00	1_MIXED_QSSM.IBN	0.00	0.00E+0
9	OFF	0.00	1_MIXED_QSSM.IBN	0.00	0.00E+0

One WCDMA/3GPP slot is 10/15 ms long, representing a time period of 0.6667 ms for each slot. 1/5 of a WCDMA/3GPP slot represents an initial time delay of 133 μ s. Therefore the initial delay distribution is as follows:

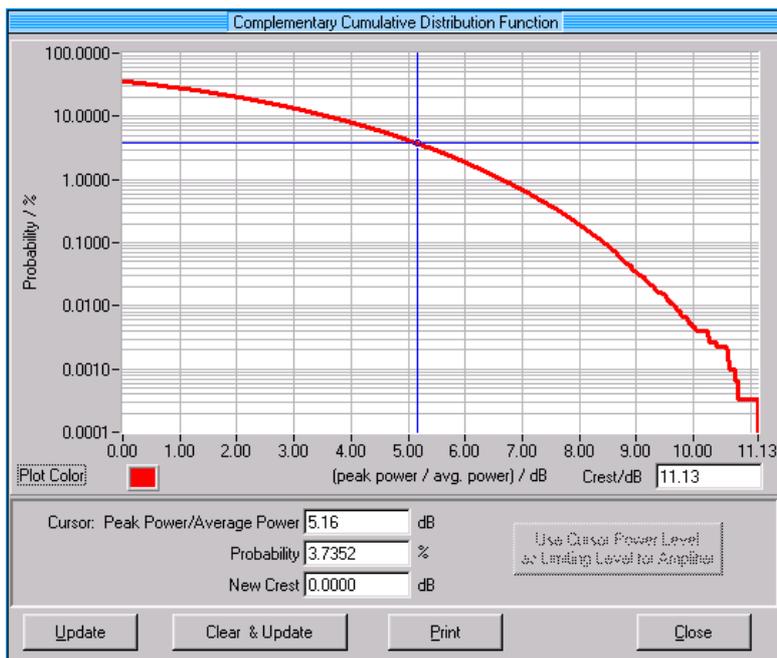
- Carrier 0: 0 s
- Carrier 1: 133 μ s
- Carrier 2: 266 μ s
- Carrier 3: 399 μ s

Press **Accept** button to activate your settings in the highlighted box.

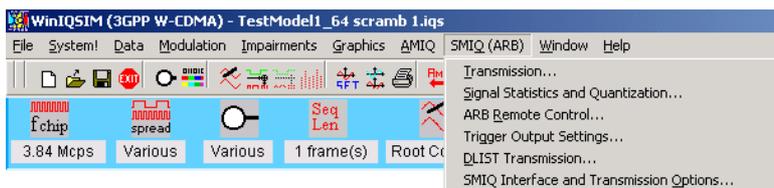


With the **Graphics** → **Settings...** functionality in the task bar you can verify your settings and to see a simulation of the generated signal before downloading the signal configuration to the AMIQ. Please refer for further information on graphics features and functions to the WinIQSIM™ Application Manual or the WinIQSIM™ online help.

Generating Multi Carrier Signals



WinIQSIM™ can also calculate the CCDF and the crest factor of the signal.



In the **SMIQ(ARB)** task bar open the **SMIQ Transmission** panel.



Enter a User File Information in the **User Comment for File/Waveform** text box and a **ARB Waveform** file name in the **Destination** section of the transmission panel.

Press the **Transmit** button to transmit the waveform.

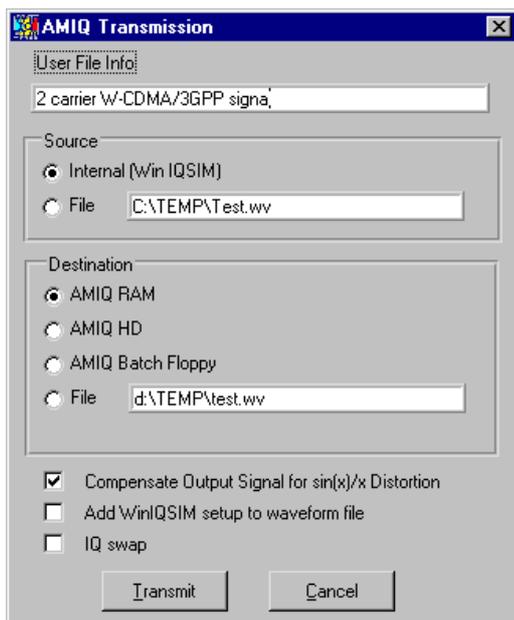
The Destination section offers two choices, either to save the waveform to a file directly on the PC or to transmit the waveform straight to the SMIQ ARB. The radio button indicates the current selection.

The file path where the waveform file is stored on the PC are selected in the text box next to the file radio button. A windows box opens if you click into the text box.

Note for AMIQ users:

WinIQSIM™ can set the crest factor parameter in the VECTOR MOD menu of SMIQ. No extra manual settings in the SMIQ are necessary. Since WinIQSIM™ does not include this in its default settings you need to activate the function prior of downloading the signal to AMIQ (see below).

Generating Multi Carrier Signals



Transfer your multi carrier mixed signal to AMIQ using the **AMIQ Transmission** option.

In the **AMIQ** task bar open the AMIQ Transmission panel.

Enter the **User File Information**

Transmit the settings pressing the **Transmit** button.



Once the waveform is transmitted to AMIQ the **VECTOR MOD STATE** in the SMIQ is set to **ON**, and the **CREST FACTOR** is automatically set to the correct value.

8 References

- [1] 3GPP specifications: TS 25.104 v4.2.0, TS 25.141 v4.2.0, 2002
- [2] Generating and Analyzing 3 GPP Multicarrier Signals with High Dynamic Range, Application Note 1MA48, Rohde & Schwarz (2002)
- [3] WCDMA Signal Generator Solutions by Rohde & Schwarz, Application Note 1GP39, Rohde & Schwarz (2000)
- [4] Level Accuracy and Electronic Level Settings of SMIQ, Application Note 1GP42, Rohde & Schwarz (2001)
- [5] SMIQB60 Arbitrary Waveform Generator for SMIQ, Application Note 1GP45, Rohde & Schwarz (2001)
- [6] Software WinIQSIM™ for Calculating I/Q Signals for I/Q Modulation Generator AMIQ, Application Manual, PD 1007.9245.42, Rohde & Schwarz (2000)
- [7] Software WinIQSIM™ for Calculating I/Q Signals for I/Q Modulation Generator AMIQ, Software Manual, PD 1110.3645.42, Rohde & Schwarz (2000)
- [8] Vector Signal Generator SMIQ, Operating Manual, PD 1125.5610.12, Rohde & Schwarz (2002)

9 Ordering information

Vector Signal Generator: SMIQ03HD	300 kHz to 3.3 GHz	1125.5555.33
Options: SMIQB57	High ACLR for WCDMA/3GPP 2110 MHz to 2170 MHz	1105.1831.02
(other options see SMIQ 0xB)		
Vector Signal Generator: SMIQ02B	300 kHz to 2.2 GHz	1125.5555.02
SMIQ03B	300 kHz to 3.3 GHz	1125.5555.03
SMIQ04B	300 kHz to 4.4 GHz	1125.5555.04
SMIQ06B	300 kHz to 6.4 GHz	1125.5555.06
Options: SMIQB11	Data Generator	1085.4502.04
SMIQB12	Memory Extension	1085.2800.04
SMIQB14	Fading Simulator	1085.4002.02
SMIQB20	Modulation Coder	1125.5190.02
SMIQB45	Digital Standard WCDMA (3GPP)	1104.8232.02
SMIQB47	Low ACP for CDMA and WCDMA (SMIQ0xB only)	1125.5090.02
SMIQB60	Arbitrary Waveform Generator incl. WinIQSIM™	1136.4390.02
I/Q Modulation Generator AMIQ03 incl. WinIQSIM™	4 Msamples Memory	1110.2003.03
AMIQ04 incl. WinIQSIM™	16 Msamples Memory	1110.2003.04
Spectrum Analyzer FSU3	20 Hz to 3.6 GHz	1129.9003.03
FSU8	20 Hz to 8 GHz	1129.2003.04



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