Measuring Multistandard Radio Base Stations

according to TS 37.141

Application Note

Products:

- R&S®SMU200A
- R&S®SMBV100A
- R&S®FSQ
- R&S®FSV
- R&S®FSW

3GPP Release 9 Technical Specification (TS) 37.141 covers multistandard radio base station conformance testing. Multistandard radio includes four standards of mobile communications: GSM, WCDMA, TD-SCDMA, and LTE. This application note introduces the concept of multistandard radio base stations as well as solutions for transmitter and receiver tests based on R&S® signal generators and R&S® signal and spectrum analyzers.

ROHDE&SCHWARZ

Application Note

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1 Introduction

1.1 Multistandard Radio

The technological advances made in the field of mobile radio have given rise to a wide variety of standards over the past several decades. These standards, which include those produced by the global cooperative for standardization – the 3rd Generation Partnership Project (3GPP) – are based on various transmission technologies. Network operators can deploy GSM/EDGE, WCDMA, TD-SCDMA and LTE or combinations of these four standards.

To handle these complex scenarios, the Multistandard Radio Base Station (MSR-BS) was developed. These can transmit and receive multiple standards simultaneously on various carriers. An MSR-BS combines at least two different radio access technologies (RAT). Thus, less space is required for an MSR-BS, and installation effort is reduced. An MSR-BS does not have to use two or more technologies simultaneously, which is why a distinction is made between single RAT and multi-RAT operation. This provides the operator with additional configuration options.

3GPP has published the specifications TS 37.141 and TS 37.104 for multistandard base stations. The latter describes the minimum requirements for multistandard base stations in terms of RF requirements for the downlink and uplink. TS 37.141 defines the tests and test requirements for the MSR-BS based on these RF requirements.

This application note discusses MSR-BS testing according to TS 37.141. It begins with a more detailed explanation of 3GPP Standard TS 37.141 for MSR-BS, and then introduces test configurations for the requirements from this standard. Differences in the test requirements between TS 37.141 and the existing specifications for the different standards are highlighted and described in some detail. The matching T&M solutions offered by Rohde & Schwarz for MSR-BS transmitter and receiver tests are also presented.

The following abbreviations are used in this application note for Rohde & Schwarz test equipment:

The R&S®SMU200A is referred to as the SMU.
The R&S®SMBV100A is referred to as the SMBV.
The R&S®FSQ is referred to as the FSQ.
The R&S®FSV is referred to as the FSV.
The R&S®FSW is referred to as the FSW.
The R&S®WinIQSIM2™ Simulation Software is referred to as WinIQSIM2.

The following naming conventions for the different RATs are used in this application note:

Table 1: Naming for 3GPP standards	
Naming in TS 37.141	**Naming in this Application Note**
E-UTRA FDD or TDD	LTE FDD or TDD
UTRA-FDD	WCDMA
UTRA-TDD	TD-SCDMA
GSM, GSM/EDGE	GSM, GSM/EDGE

1.2 Remarks on TS 37.141

This application note covers Release 10 of TS 37.141 [1]. The main difference to Release 9 [2] is that Release 10 defines some further requirements in order to support frequency bands 41-43 for LTE TDD. In addition, the spurious emission mask in Release 10 has been extended from 12.75 GHz to 19 GHz.

1.2.1 Single- and multi-RAT-capable MSR-BS

The specification TS 37.141 makes a distinction between multi- and single radio access technology (RAT) operation. This is dependent on the MSR-BS configuration chosen by the network operator. An MSR-BS is capable of using multiple different standards at the same time. Multi-RAT operation is defined as when different technologies are used on different carriers in an MSR-BS; for example, LTE paired with WCDMA. Single-RAT operation means that only one RAT is used in an MSR-BS, possibly in multicarrier mode. Accordingly, TS 37.141 provides a separate description for each possible application. The decision to configure a BS as single-RAT or multi-RAT is left to the manufacturer, who does this using "capability sets". The capability sets are described in more detail in section 1.2.5 of this application note. However, the TS 37.141 specification does not provide for single-RAT GSM operation, as this is covered by existing GSM specifications.

1.2.2 Band categories in MSR

As a result of regulatory decisions, not every frequency band can be used for all standards. It is therefore possible that not all RATs will be available in a specific band. This is why the various bands are subdivided into three band categories (BC). In summary, it can be said that only the four bands of BC2 allow multistandard operation of LTE, WCDMA and GSM. These are LTE bands 2, 3, 5, and 8. The other two band categories define simultaneous operation of LTE FDD and WCDMA, as well as LTE TDD and TD-SCDMA. Exceptions are bands 17 and 18, which allow only LTE operation, and band 6, which allows only WCDMA operation.

Table 2 defines the three band categories.

Table 2: Band categories as defined in TS 37.141, subclause 4.4	
Band category	**Comment**
Band Category 1 (BC1)	Bands for LTE FDD and WCDMA operation
Band Category 2 (BC2)	Bands for LTE, WCDMA, and GSM/EDGE operation
Band Category 3 (BC3)	Bands for LTE TDD and TD-SCDMA operation
Note:	The UTRA-TDD requirements in TS 37.141 are defined only for a chip rate of 1.28 Mcps.

As an additional requirement, each band category has a minimum offset between the carriers and the upper and lower band edges, as described in the following section.

1.2.3 Bandwidth of an MSR-BS

Figure 1 shows the bandwidth of an MSR-capable base station (BW_{RF}), which is calculated as follows:

$$BW_{RF} = F_{BWRF,high} - F_{BWRF,low},$$

where $F_{BW\ RF,high}$ is the upper edge and $F_{BW\ RF,low}$ the lower edge of the frequency range supported by the MSR-BS.
The band can be used for multiple carrier signals, where a defined offset ($F_{offset,\ RAT,\ low}$ and $F_{offset,RAT,high}$ in Figure 1) must be maintained between the center frequency of the first carrier $F_{C,low}$ or the last carrier $F_{C,high}$ to the lower or upper band edge.

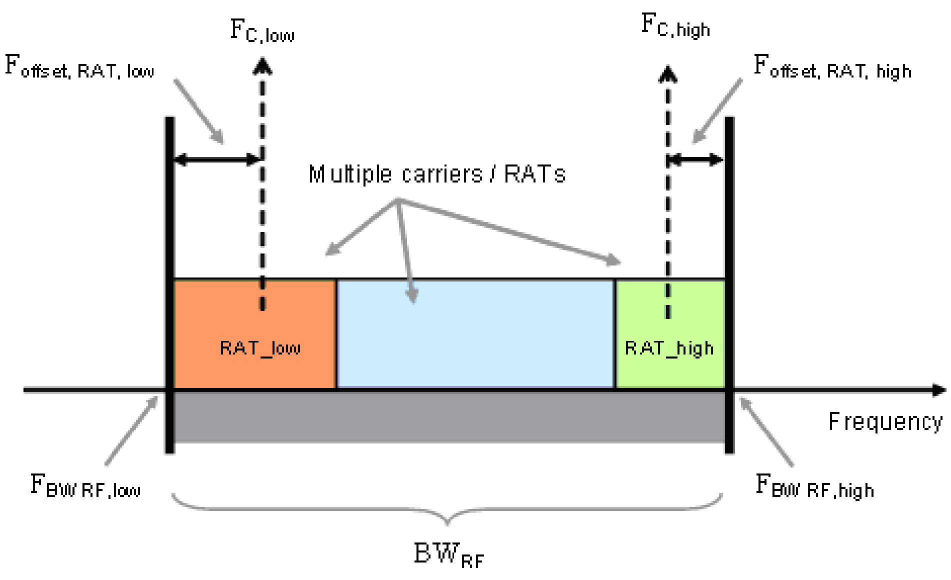


Figure 1: Definition of BW_{RF} and other symbols for MSR-BS according to TS 37.141, Figure 3.2-1

This offset is dependent on the band category, the RAT being used, and in the case of LTE, also on the channel bandwidth. The required offsets to the upper and lower edges of BW_{RF} for each of the band categories are defined as shown in Table 3:

Table 3: Frequency offsets at the upper and lower edge of BW_{RF}

Definition of the offset between center frequencies of the lowest and highest carrier and the band edges of BW_{RF} according to TS 37.141, subclause 4.4

Band category	RAT	$F_{offset,RAT}$
BC1	1.4, 3 MHz E-UTRA FDD	$BW_{Channel}/2$ + 200 kHz
	5, 10, 15, 20 MHz E-UTRA FDD	$BW_{Channel}/2$
	UTRA FDD	2.5 MHz
BC2	E-UTRA	$BW_{Channel}/2$
	UTRA FDD	2.5 MHz
	GSM/EDGE	200 kHz
BC3	1.4, 3 MHz E-UTRA TDD	$BW_{Channel}/2$ + 200 kHz
	5, 10, 15, 20 MHz E-UTRA TDD	$BW_{Channel}/2$
	UTRA TDD	1 MHz

Many of the tests described in TS 37.141 use the maximum supported bandwidth BW_{RF} of an MSR-BS. The bandwidth BW_{RF} of an MSR-BS can be at the top edge, the middle, or the bottom edge of the operating band. These three ranges B_{RFBW} (Bottom), M_{RFBW} (Middle), and T_{RFBW} (Top) are positioned as follows in the operating band:

- B_{RFBW} : Maximum RF bandwidth at the bottom edge of the frequency range in the operating band
- M_{RFBW}: Maximum RF bandwidth in the middle of the frequency range in the operating band
- T_{RFBW} : Maximum RF bandwidth at the top edge of the frequency range in the operating band

If not defined otherwise in the specific test requirements, the tests are performed for all three ranges.

The MSR-BS channels being tested are also defined for the single-RAT tests:

B: Bottom-most channel located at the lower edge of B_{RFBW}

M: Center-most channel in M_{RFBW}

T: Upper-most channel located at the upper edge of T_{RFBW}

When testing M, the channel N/2 is tested when there is an even number of channels, and the channel (N+1)/2 is tested when there is an odd number of channels.

1.2.4 Channel arrangement and frequency assignment

1.2.4.1 Channel spacing

The channel spacing for GSM is 200 kHz.

The nominal channel spacing for WCDMA is 5 MHz, while for TD-SCDMA it is 1.6 MHz.

For LTE, the channel spacing depends on the channel bandwidth. The nominal channel spacing for two adjacent E-UTRA carriers is defined as follows:

$$\text{Nominal channel spacing} = \frac{BW_{Channel(1)} + BW_{Channel(2)}}{2}$$

Bandwidths of various sizes may be used for LTE carriers.

1.2.4.2 Channel raster

The raster for GSM is 200 kHz for all bands.

WCDMA and TD-SCDMA also use a channel raster of 200 kHz for all bands. The selected center frequency must therefore be a whole number multiple of 200 kHz. However, there are exceptions.

The channel raster for LTE is 100 kHz for all bands and the center frequency must therefore be a whole number multiple of 100 kHz.

In this respect, the new specification does not differ from the previous 3GPP Release 9 specifications TS 45.005, TS 25.104, TS 25.105, and TS 36.104. Also carrier frequencies and their numbering are defined according to these specifications.

1.2.5 Capability sets supported by the BS

To limit the number of RAT combinations in an MSR-BS, six different capability sets are classified in TS 37.141. Manufacturers must classify their products accordingly. The capability sets differ in which RAT they support, whether single-RAT or multi-RAT is used, and whether a single-carrier or multicarrier mode can be used. Each capability set specifies the test configurations to be used (as defined in the next section of this application note). And finally, each capability set defines the available band categories. See Table 4 for the six capability sets.

Table 4: Capability sets defined in TS 37.141, Table 4.7.1-1						
Capability set supported by a BS	**CS 1**	**CS2**	**CS3**	**CS4**	**CS5**	**CS6**
Supported RATs	**UTRA (MC)**	**E-UTRA (MC)**	**UTRA, E-UTRA**	**GSM, UTRA**	**GSM, E-UTRA**	**GSM, UTRA, E-UTRA**
Supported configurations	SR UTRA (SC, MC)	SR E-UTRA (SC, MC, CA)	MR (UTRA + E-UTRA) SR UTRA (SC, MC) SR E-UTRA (SC, MC, CA)	MR GSM + UTRA SR GSM (MCBTS) SR UTRA (SC, MC)	MR GSM + E-UTRA SR GSM SR E-UTRA (SC, MC, CA)	MR GSM + UTRA + E-UTRA MR GSM + UTRA MR GSM + E-UTRA MR UTRA + E-UTRA SR GSM (MCBTS) SR UTRA (SC, MC) SR E-UTRA (SC, MC, CA)
Applicable BC	BC1, BC2 or BC3	BC1, BC2 or BC3	BC1, BC2 or BC3	BC2	BC2	BC2
NOTE: MC denotes multicarrier in single RAT; SC denotes single carrier; MR denotes multi-RAT; SR denotes single-RAT						

1.3 MSR-BS test configurations

MSR-BS offers an enormous amount of flexibility in how various RATs are used. However, this also serves to increase the complexity of test cases. Considering that an MSR-BS of type CS6 supports three different RATs in its BW_{RF}, it quickly becomes obvious how many options there are with respect to carrier configurations.

To allow efficient MSR-BS testing, TS 37.141 includes test configurations (TCx). The goal of these test configurations is to significantly reduce the complexity of the many possible test scenarios. They are limited to the worst-case scenarios with the strictest criteria.

Thus, for example, a test configuration is provided for receiver tests in which two signals–a GSM carrier and an LTE carrier with a $BW_{Channel}$ = 5 MHz–are positioned at the lower and upper edge of BW_{RF} while maintaining $F_{offset\text{-}RAT}$. This allows receiver tests to be performed with a configuration that fully utilizes the maximum bandwidth BW_{RF} of the MSR-BS.

Transmitter tests are performed using configurations in which the remaining available bandwidth is filled with additional carriers. The maximum rated power of an MSR-BS is distributed equally to all carriers. Adherence to the requirements with respect to operating band unwanted emissions and spurious emissions for an MSR-BS in multi-RAT operation can be tested using this configuration, as an example.

For many measurements, the LTE, WCDMA, TS-SCDMA, or GSM/EDGE specifications previously published for single-RAT operation still apply. The requirements have not changed. As a result, the following requirements from sections 6 and 7 of the TS 37.141 specification are simply references to requirements in existing specifications:

- Base station output power (6.2)
- Output power dynamics (6.3)
- Transmitted signal quality (6.5)
- Occupied bandwidth (6.6.3)
- Adjacent channel leakage power ratio (6.6.4)
- Reference sensitivity level (7.2)
- Dynamic range (7.3)
- In-channel selectivity (7.8)

No new requirements were defined for these measurements, nor were the existing requirements changed. However, what did change were the test signals for the measurements. These correspond to the receiver and transmitter test configurations defined in TS 37.141.

TS 37.141 uses the following downlink test models or test signals from the existing single-RAT specifications for configuring the signals from the various standards in the transmitter test configurations:

- WCDMA test model TM1 from TS 25.141, subclause 6.1.1.1, 6.1.1.4/A
- TD-SCDMA test signal per Table 6.1A in TS 25.142, subclause 6.2.4.1.2,
- LTE test model E-TM1 from TS 36.141, subclause 6.1.1.1,
- GSM carriers should use a GMSK modulation as defined in TS 51.021, clause 6.2.2.

There are exceptions with respect to the modulation quality and frequency error measurements because different test models are used for these. See section 4.9.2 Test Models in the TS 37.141 specification for more information.

The UL signals for receiver tests are defined in more detail as part of the test configuration in section 1.3.2 of this application note as well as the test setup in chapter 3.

1.3.1 Test configurations for the transmitter

1.3.1.1 TC1: UTRA multicarrier operation

TC1 tests the transmitter characteristics for UTRA multicarrier operation on an MSR-BS from capability set CS1. The following measurements are performed with this configuration:

- Base station output power,
- Transmit ON/OFF power (TC1b only),
- Modulation quality,
- Frequency error,
- Transmitter spurious emissions,
- Operating band unwanted emissions,
- Transmitter intermodulation.

A distinction is made here between the two cases TC1a and TC1b, where TC1b is possible only within band category BC3. TC1a is defined for band categories BC1 and BC2. TC1a specifies that a WCDMA carrier should be placed at the lower and upper edges of BW_{RF}, at an offset of $f_{offset, RAT}$ = 2.5 MHz. This same carrier configuration applies in TC1b, but with TD-SCDMA carriers. In this case, the offset is $f_{offset, RAT}$ = 1.6 MHz.

Additional WCDMA or TD-SCDMA carriers are then placed alternately next to the upper and the lower carrier, working toward the center until the entire bandwidth is utilized completely. Of course, the nominal carrier offset must be maintained at all times.

Figure 2 illustrates TC1a schematically (note that this figure is not true to scale).

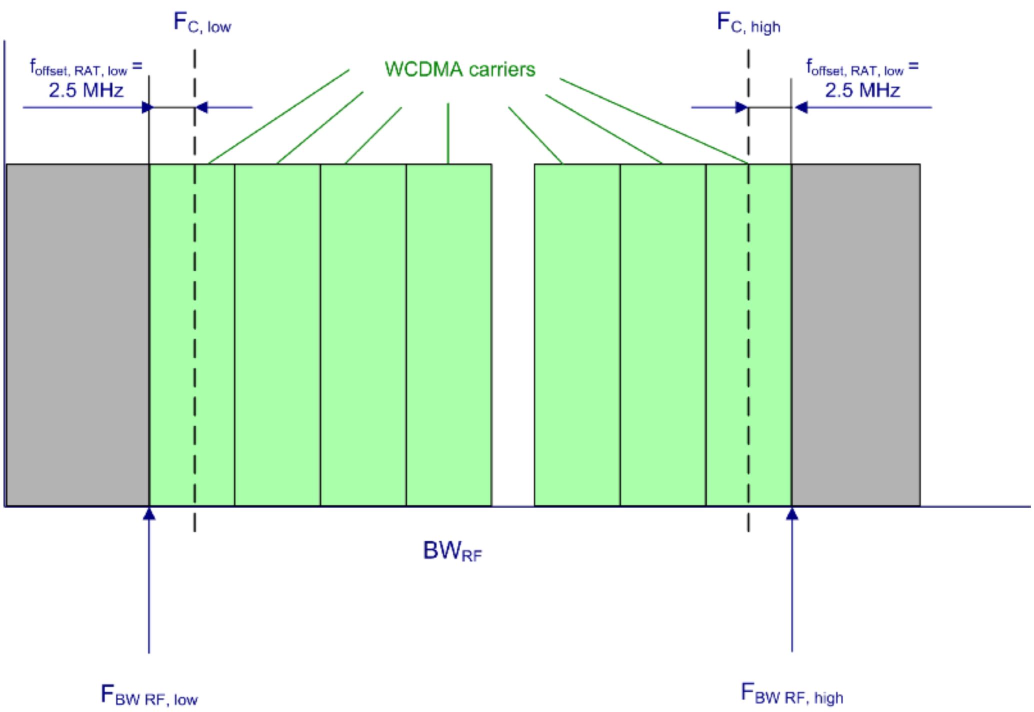


Figure 2: Transmitter configuration TC1a: WCDMA multicarrier operation

1.3.1.2 TC2: E-UTRA multicarrier operation

This configuration provides a closer study of single-RAT, LTE multicarrier operation for the transmitter of an MSR-BS from capability set CS2. The configuration can be used for either LTE FDD or LTE TDD. The following measurements are performed with this configuration:

- Base station output power,
- Transmit ON/OFF power (for LTE TDD only),
- Modulation quality,
- Frequency error,
- Transmitter spurious emissions,
- Operating band unwanted emissions,
- Transmitter intermodulation

TC2 places an LTE carrier at both the lower and upper band edge of BW_{RF}. In these tests, the carrier at the lower edge should use the lowest available LTE bandwidth supported by the base station (e.g., 1.4 MHz). The offset of the LTE carrier to the edge of BW_{RF} is selected based on Table 3 (e.g., $f_{offset, RAT, low} = BW_{Channel}/2 + 200$ kHz= 0.9 MHz for 1.4 MHz LTE bandwidth). TC2 can be used for capability set CS2.

The carrier at the upper edge should be set with a fixed bandwidth of 5 MHz and should be offset by $f_{offset, RAT, high} = BW_{Channel}/2 = 2.5$ MHz to the upper edge of BW_{RF}. Starting at the upper-most carrier, the remaining band is filled with additional 5-MHz LTE carriers. Figure 3 illustrates TC2 schematically.

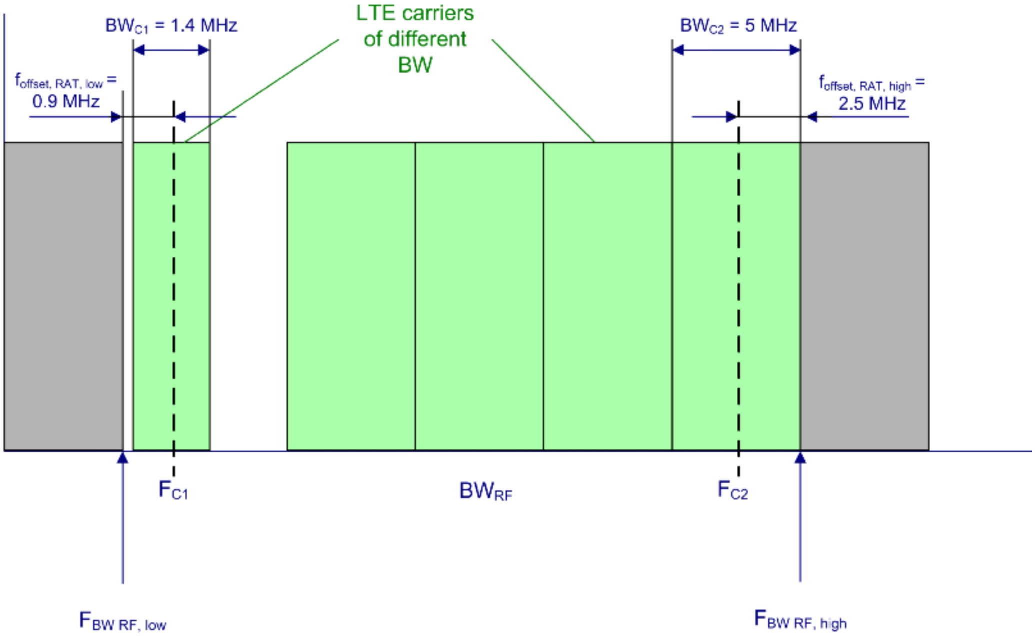


Figure 3: Transmitter configuration TC2: LTE multicarrier operation

1.3.1.3 TC3: UTRA and E-UTRA multi-RAT operation

This configuration provides a closer study of LTE and WCDMA multi-RAT operation on an MSR-BS from capability set CS3. The following transmitter measurements are performed with this configuration:

- Base station output power,
- Modulation quality,
- Frequency error,
- Transmitter spurious emissions,
- Operating band unwanted emissions,
- Transmitter intermodulation

In these tests, the BS should transmit the maximum number of carriers in multi-RAT operation using the maximum transmit power. If the BS cannot do these simultaneously, TC3 is split into two test cases so that the transmitter tests are performed separately:

- One test with the maximum number of carriers at reduced power,
- A second test at maximum power with a reduced number of carriers.

TC3 further provides TC3a for LTE FDD paired with WCDMA and TC3b for LTE TDD paired with TD-SCDMA.

TC3a divides the maximum specified BW_{RF} for the MSR-BS as follows: A WCDMA carrier is placed at the lower band edge at an offset of $f_{offset, RAT, low} = BW_{Channel}/2 = 2.5$ MHz. An LTE carrier of 5 MHz bandwidth is set at the upper band edge at an offset of $f_{offset, RAT, high} = BW_{Channel}/2 = 2.5$ MHz to the upper band edge.

If the BS does not support 5-MHz LTE carriers, the next smaller channel bandwidth is selected. Additional LTE or WCDMA carriers are then placed in turn next to these two carriers to form an alternating pattern. This pattern is continued until no more carriers fit in the band. Many bands can end up with gaps of less than 5 MHz.
Figure 4 illustrates the spectrum in the downlink of an MSR-BS for TC3a schematically, but with the requirement that the BS be capable of transmitting the maximum number of carriers while simultaneously maintaining maximum power.

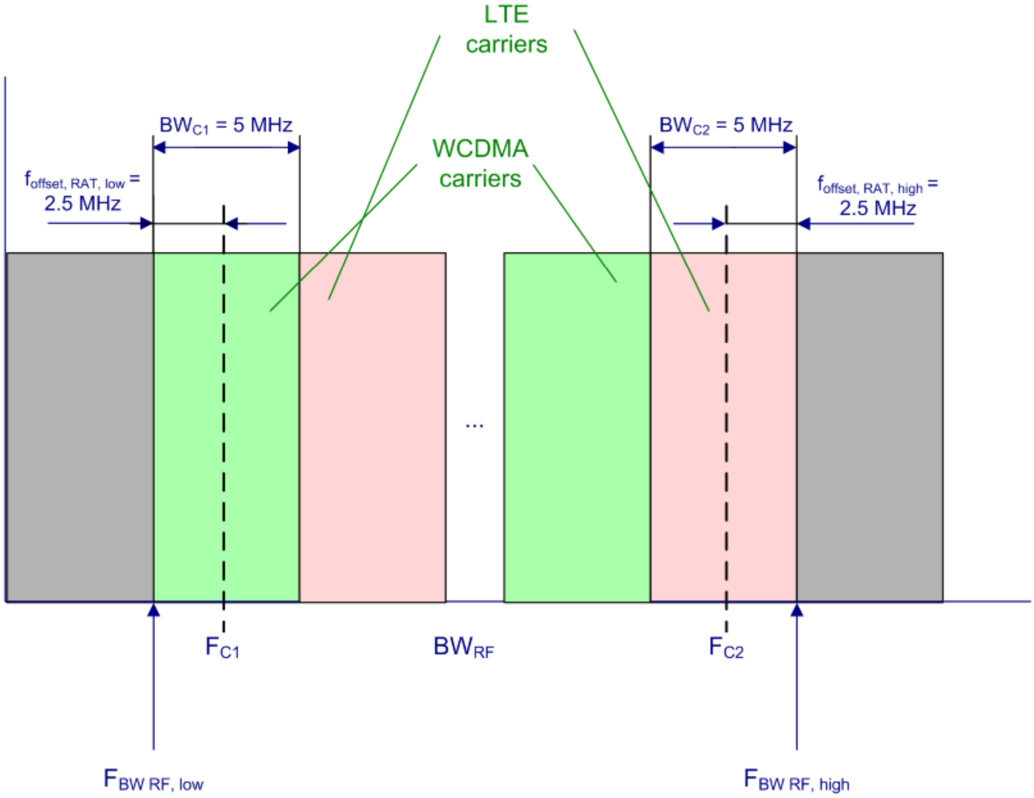


Figure 4: Transmitter configuration TC3a: LTE and WCDMA multi-RAT operation

1.3.1.4 TC4: BC2 transmitter operation

This configuration performs transmitter tests from capability sets CS4, CS5, and CS6 for multi-RAT operation with GSM. The following transmitter measurements for an MSR-BS from BC2 are performed with this configuration:

- Base station output power,
- Modulation quality,
- Frequency error,
- Transmitter spurious emissions,
- Operating band unwanted emissions,
- Transmitter intermodulation.

In these tests, the BS should transmit the maximum number of carriers in multi-RAT operation using the maximum transmit power. If the BS cannot do this simultaneously, TC4 is split into two test cases so that the transmitter tests are performed separately:

- One test with the maximum number of carriers at reduced power,
- A second test at maximum power with a reduced number of carriers.

TC4 provides five different configurations for an MSR-BS from BC2. For example, TC4c tests the parallel operation of LTE, WCDMA, and GSM in a single frequency band (e.g. in LTE band 8). A GSM carrier is placed at both the lower edge and the upper edge of BW_{RF} . These two GSM carriers must remain 200 kHz from their respective band edges.

An LTE and a WCDMA carrier with a bandwidth of 5 MHz are then placed in the center of the band. If the MSR-BS does not support 5-MHz LTE carriers, the next smaller channel bandwidth is selected.

Starting from the two outer carriers and working toward the center, GSM carriers are added to the band at 600 kHz intervals either until no more carriers fit or until the maximum supported number of GSM carriers is reached. If bandwidth is still free, more LTE or WCDMA carriers may be placed in the center of the band. The LTE carriers must have the same channel bandwidth as the first one placed. Figure 5 illustrates TC4c schematically.

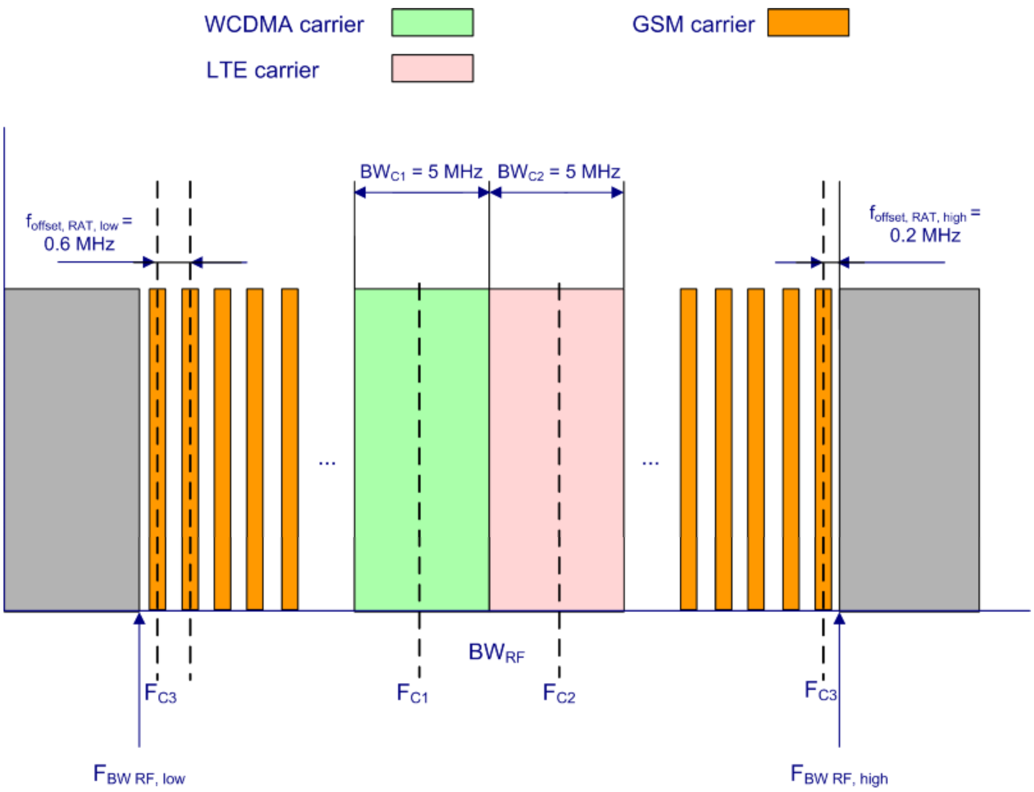


Figure 5: Transmitter configuration TC4c: LTE, WCDMA, and GSM multi-RAT operation

1.3.2 Test configurations for the receiver

1.3.2.1 TC1: UTRA multicarrier operation

Receiver configuration TC1 tests the receiver characteristics for UTRA multicarrier operation on an MSR-BS from capability set CS1. The following measurements are performed with this configuration:

- In-band selectivity and blocking,
- Out-of-band blocking,
- Receiver spurious emissions, and
- Receiver intermodulation.

Receiver configuration TC1a specifies that a WCDMA carrier should be placed at the lower and upper band edge of BW_{RF}, at an offset of $f_{offset, RAT}$ = 2.5 MHz. TC1b places two TD-SCDMA carriers while maintaining the offset defined for TD-SCDMA. The remaining band is not used. TC1 tests receiver characteristics in multicarrier operation.

Figure 6 shows the configuration of TC1 in more detail.

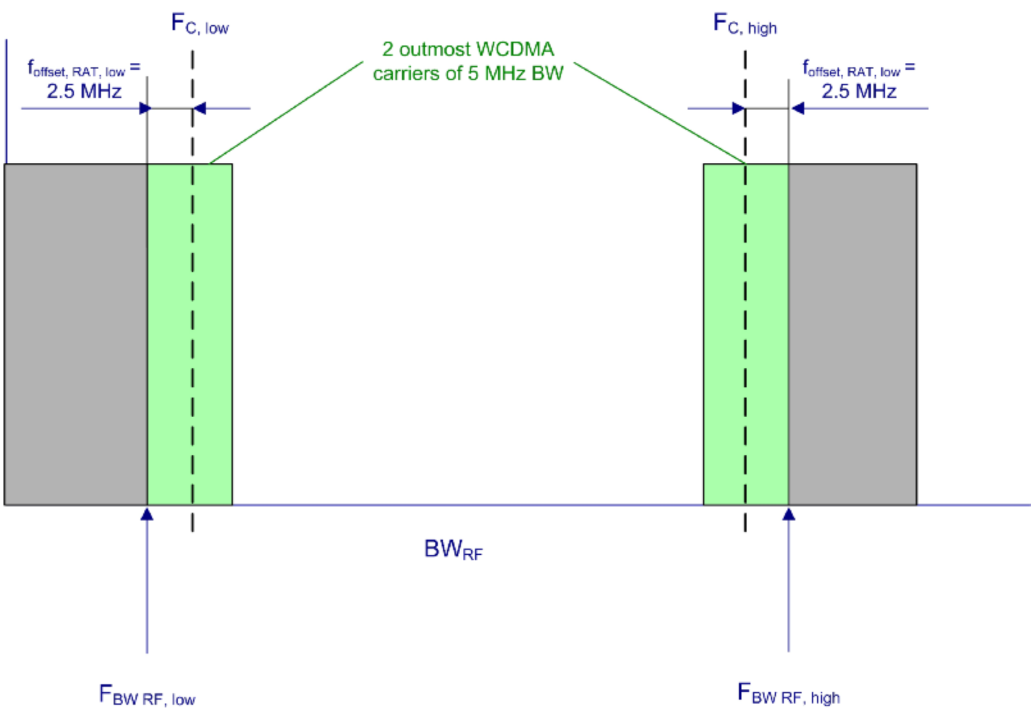


Figure 6: Receiver configuration TC1a: WCDMA multicarrier operation

1.3.2.2 TC2: E-UTRA multicarrier operation

This configuration provides a closer study of single-RAT, LTE multicarrier operation for the receiver of an MSR-BS from capability set CS2. The configuration can be used for either LTE FDD or LTE TDD. The following measurements are performed with this configuration:

- In-band selectivity and blocking,
- Out-of-band blocking,
- Receiver spurious emissions, and
- Receiver intermodulation.

TC2 places an LTE carrier at both the lower and upper band edge of BW_{RF}. The carrier at the lower edge should be set with the lowest available carrier bandwidth for the MSR-BS (e.g., 1.4 MHz) and should be offset as defined in Table 3 ($f_{offset, RAT, low}$ = $BW_{Channel}/2$ + 200 kHz for 1.4 MHz LTE bandwidth). The carrier at the upper edge should be set at 5 MHz bandwidth and should be offset by $f_{offset,RAT,high} = BW_{Channel}/2$ = 2.5 MHz to the upper edge of BW_{RF}. Figure 7 illustrates TC2 schematically.

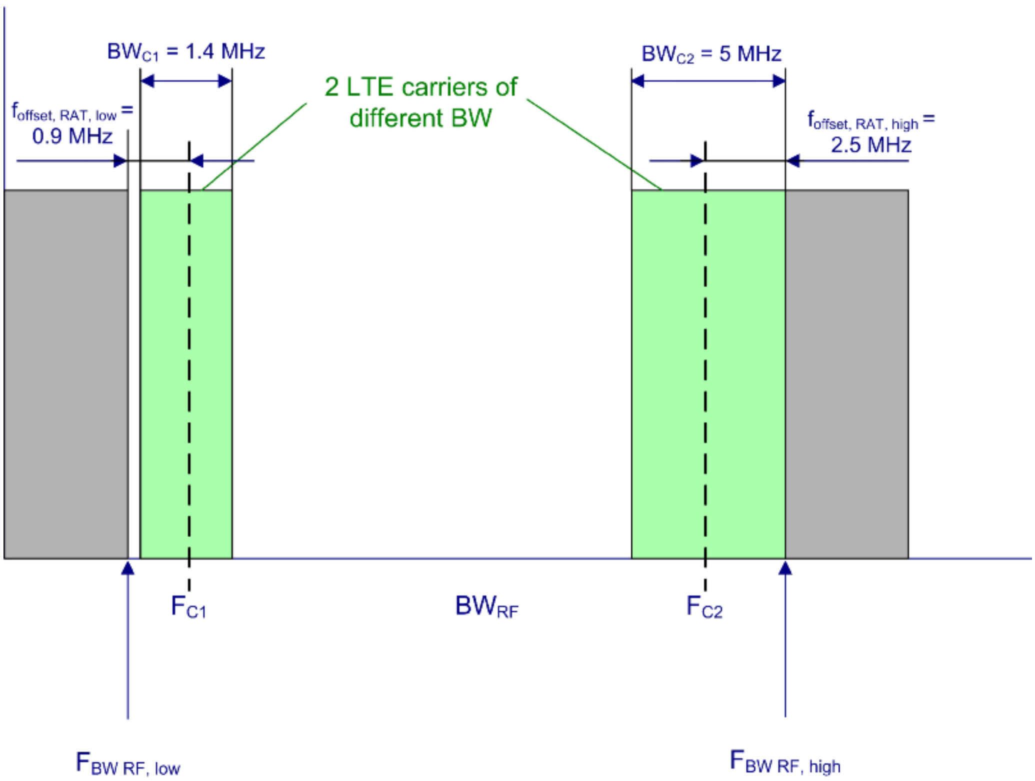


Figure 7: Receiver configuration TC2: LTE multicarrier operation

1.3.2.3 TC3: UTRA and E-UTRA multi-RAT operation

The following receiver tests in LTE and WCDMA multi-RAT operation on an MSR-BS from capability set CS3 are performed with this configuration:

- In-band selectivity and blocking,
- Out-of-band blocking,
- Receiver spurious emissions, and
- Receiver intermodulation.

TC3 further provides TC3a in FDD mode and TC3b in TDD mode. Figure 8 illustrates TC3a schematically.

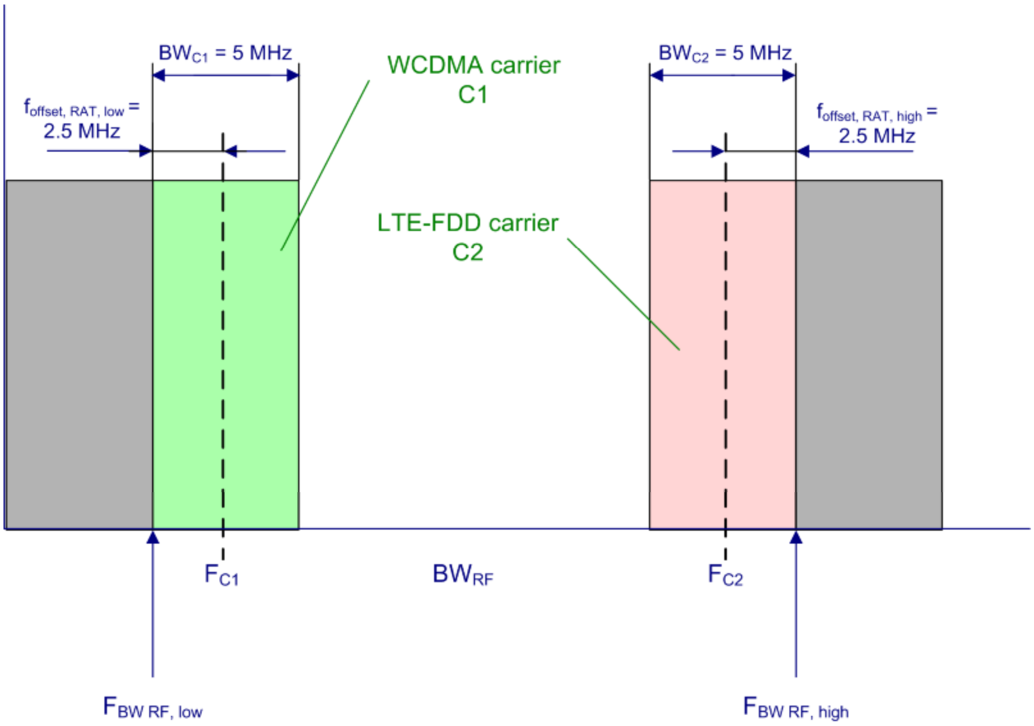


Figure 8: Receiver configuration TC3a: WCDMA and LTE multicarrier operation

A WCDMA carrier is placed at the lower band edge at an offset of $f_{offset, RAT, low}$ = $BW_{Channel}/2$ = 2.5 MHz. A 5-MHz LTE carrier should be set at the upper band edge, offset by $f_{offset, RAT, high}$ = $BW_{Channel}/2$ = 2.5 MHz to the upper edge of BW_{RF}. If the BS cannot provide a 5-MHz LTE carrier, the next smaller channel bandwidth should be selected.

1.3.2.4 TC5: BC2 receiver operation

The goal of this configuration is to measure the receiver characteristics of an MSR-BS in multi-RAT mode from capability sets CS4, CS5, and CS6. Two test cases TC5a and TC5b are provided here as well. TC5a operates a GSM carrier in parallel with a WCDMA carrier, while TC5b replaces the WCDMA carrier with a 5-MHz LTE carrier. The following receiver tests are performed using the configurations TC5a and TC5b:

- In-band selectivity and blocking,
- Out-of-band blocking, and
- Receiver intermodulation.

The GSM carrier is placed at an offset of 0.2 MHz to the lower band edge and the WCDMA or LTE carrier at an offset of $BW_{C2}/2$ = 2.5 MHz to the upper band edge. Figure 9 illustrates TC5 schematically.

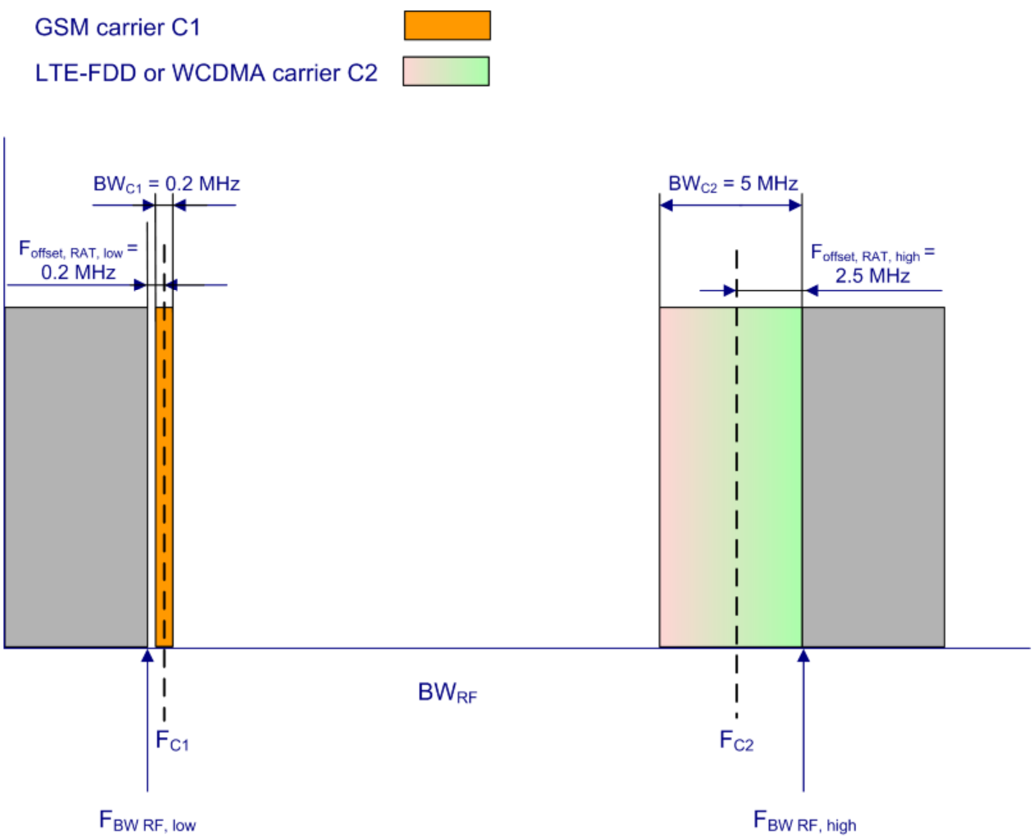


Figure 9: Receiver configuration TC5: BC2 receiver operation

1.3.2.5 TC6: Single carrier for receiver tests

TC6 provides an interferer for the two receiver tests, in-band selectivity / blocking and receiver intermodulation; see Tables 5.1-1 and 5.2-1 in TS 37.141.

Depending on the type of carrier, TC6 provides three test cases. TC6a uses a WCDMA carrier, TC6b uses an LTE carrier with the minimum supported bandwidth, and TC6c uses a TD-SCDMA carrier.

One of these carriers is placed exactly in the center of the maximum available bandwidth of the MSR-BS. This carrier is then shifted by a defined offset for the two receiver tests above. Refer to chapter 3 of this application note for more information about the two receiver tests and the associated interferer configuration.

Figure 10 shows the basic configuration of TC6.

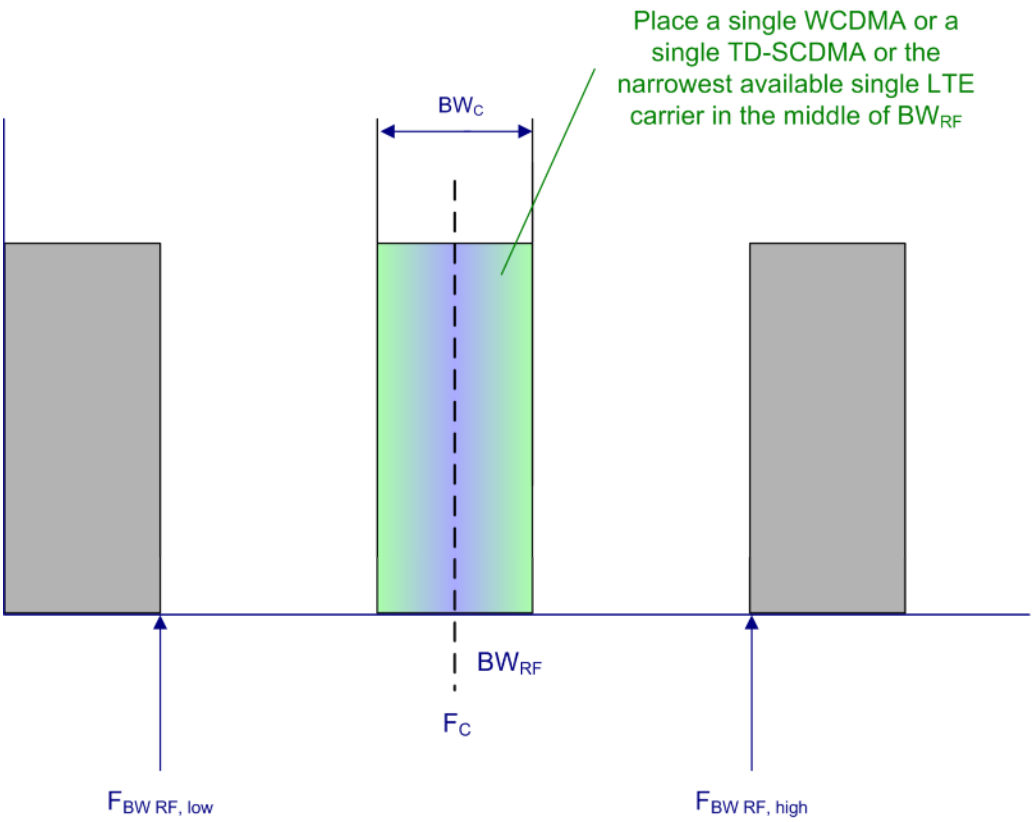


Figure 10: Receiver configuration TC6: Single carrier for receiver tests

2 Transmitter test solutions

At a minimum, the MSR-BS must meet the transmitter characteristics requirements from chapter 6 of TS 37.141.

The FSW, FSQ and FSV spectrum and signal analyzers can be used to perform TX tests on MSR-BS. See Figure 11 for an illustration of the FSW.

Figure 11: FSW spectrum & signal analyzer

The FSW, FSQ and FSV base units can be used for spectrum measurements as well as for measurements of spurious emissions, out-of-band emissions, and adjacent channel leakage ratio.

More extensive tests are possible with powerful options that are capable of analyzing and demodulating standard signals. Software options in the FSW, FSQ and FSV are available to support the standards GSM, WCDMA, LTE FDD/TDD, and TD-SCDMA. In addition a special Multi-Standard Radio Analyzer Mode to measure different standards in parallel is available for the FSW (see section 2.2).

LTE single-RAT tests and the remote control commands for these tests are described in detail in the application note „1MA154: LTE Base Station Tests”.

Figure 12 shows the ACLR measurement of four adjacent LTE carriers, each with 20-MHz bandwidth, in single-RAT multicarrier operation.

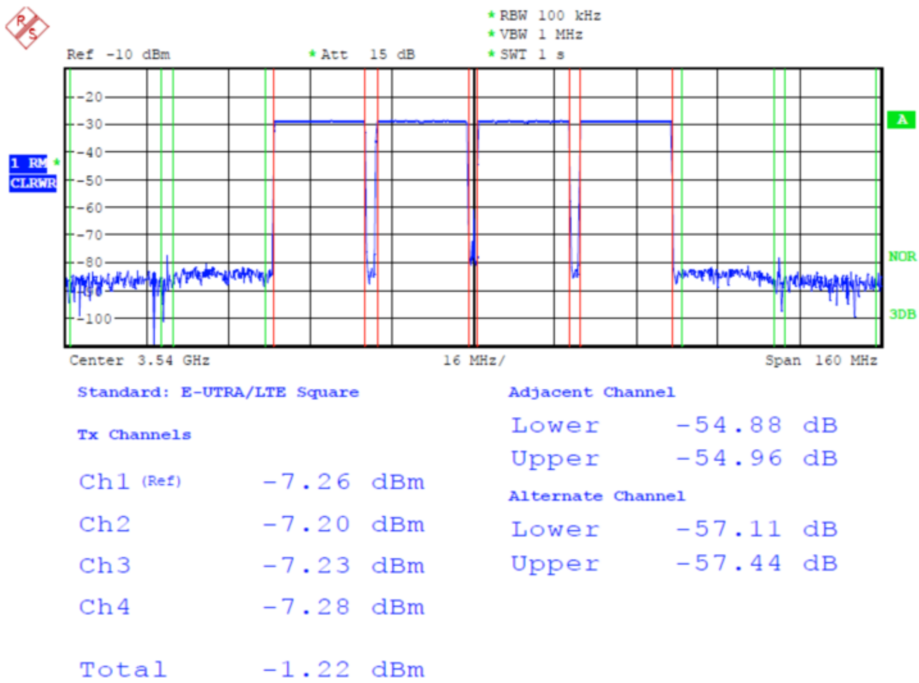


Figure 12: ACLR measurement of four contiguous single-RAT LTE DL carriers with 20-MHz BW each

The FSW base unit supports up to 160 MHz analysis bandwidth. The FSQ base unit has a demodulation bandwidth of 28 MHz, and this is increased to 120 MHz with option B-72. This provides maximum flexibility when measuring MSR-BS; for example, it also supports band 40 which is 100 MHz wide. The demodulation bandwidth of the FSV base unit is 40 MHz.

2.1 Setup for transmitter test configuration measurements

Very high power occurs on base stations! Be sure to use suitable attenuators in order to prevent damage to the test equipment.

See Figure 13 for a generic test setup for the transmitter test configurations from section 1.3.

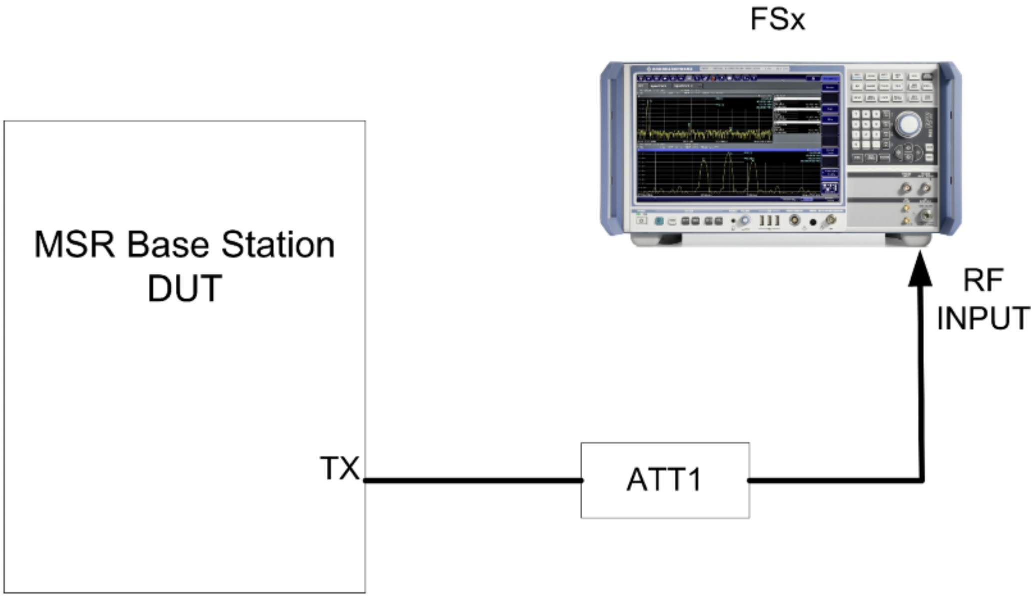


Figure 13: General setup for TX measurements

The **transmitter intermodulation** test requires an expanded setup. This setup is explained in more detail in section 2.6.

2.2 Multi-Standard Radio Analyzer with FSW

Handling tests of Multi-Standard Transmitters is made significantly easier with the Multi-Standard Radio Analyzer (MSRA) operating mode which is part of the basic software functions of the FSW analyzer.

In this mode, IQ-Data are captured over the full bandwidth (up to 160 MHz, depending on options) over a long time (up to 200 Msamples) and may be analyzed for various mobile radio standards. With this mode e.g. interactions between the different carriers can be found and the reasons for possible performance degradation can be traced..

MSRA supports following mobile standards (depending on installed options):

- 3GPP FDD (W-CDMA)
- CDMA2000
- 1xEV-DO
- GSM
- LTE

When testing MSR-base stations, the quality of all individual signals have to be checked. In addition co-existence / interactions between the different signals have to be investigated, especially interferences like crosstalk. Independent from the MSR mode, analyzing of the different radio standards is also possible with the dedicated applications (options) for the standard signal and spectrum analyzer. Measurements are done one after the other in that case – the analyzed data have no time correlation and interactions may not be shown.

The MSRA mode of the FSW overcomes this restriction: All transmitted signals within available bandwidth are captured at once and saved as IQ data in the **MSRA Master** channel. The standard-specific measurement applications (options) analyze the individual signals. Each application works on the same data set, so the analysis is done in parallel.

All global parameters are set in the **MSRA Master channel** tab. This channel is the only one capturing data, so here global settings like bandwidth, sample rate, record length, trigger settings etc. are handled. The measurement applications for the different mobile radio standards can be added and are shown in separate tabs.

Each measurement application can handle separate parameter sets. As all applications use the same IQ data, no parameter collisions are allowed (e.g. concerning bandwidth) between any involved mobile radio application and the **MSRA Master**.

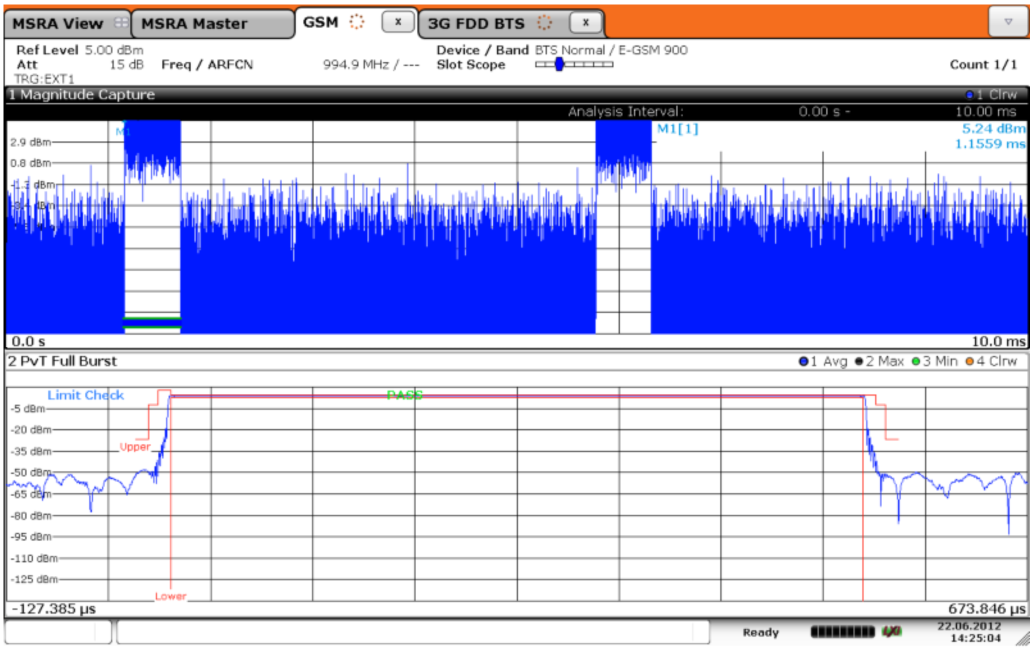
The data for each channel (application) are filtered and newly sampled. Each application can handle measurement and decoding of the signal and the display of the results on its own.

The MSRA mode also provides an overview **MSRA View** tab which shows the whole signal as well as the results for the different measurement applications. Here again the display setting can be adjusted to own needs. In the display of the whole signal the different measurement ranges used by the different applications are marked in the frequency and/or time domain.

Figure 14 shows the MSRA-View for an MSR-Signal example which consists of a GSM and a W-CDMA-Carrier. The top shows the entire spectrum of the signal with the marked frequency ranges used by the applications. In the bottom the results for the GSM part is shown on the left and the W-CDMA part on the right.

Figure 14: MSRA View with overview of the GSM and WCDMA signal

Figure 15 and Figure 16 show detailed views of both signals in the different applications. The W-CDMA signal shows a high EVM at chip 1878 (marker 1) in slot 0. Analyzing the GSM signal in the same time area it shows a rising edge of the burst. The GSM signal may interfere with the W-CDMA signal and cause higher EVM.



Date: 22.JUN.2012 14:25:04

Figure 15: Detailed overview of the GSM measurement

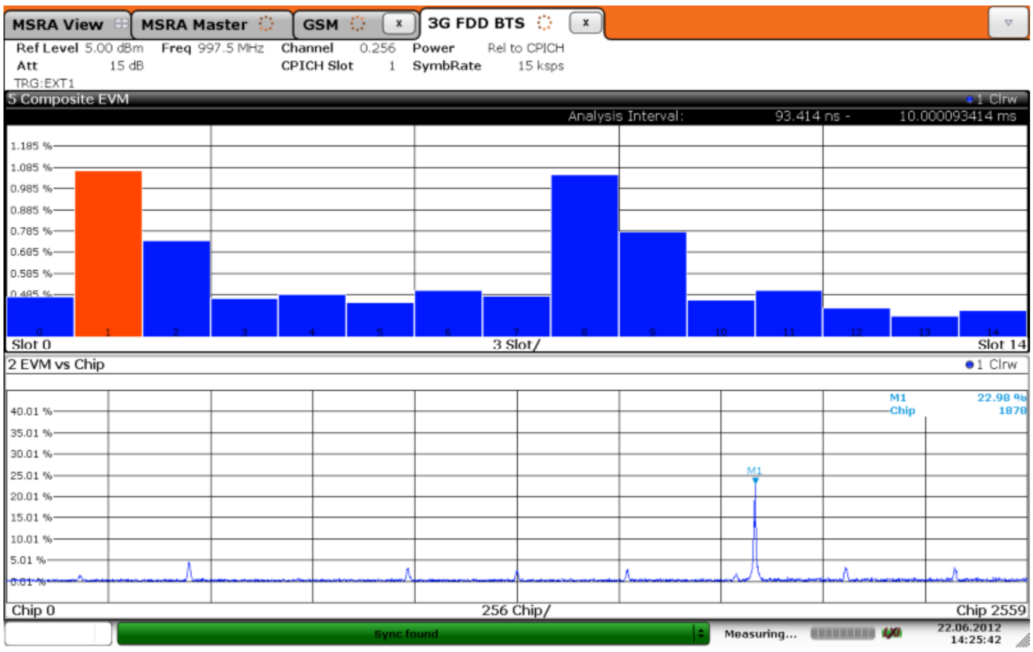


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Figure 16: Detailed overview of the W-CDMA measurement

More detailed information about measurements with the MSRA mode of the FSW and several more examples can be found in the MSRA user manual [19] and in the Application Note: Using R&S FSW for efficient Measurements on Multi-Standard Radio Base Stations [20].

2.3 Revisions in TS 37.141

The new standard TS 37.141 has retained some of the existing transmitter characteristics requirements from the 3GPP specifications for LTE, WCDMA, TD-SCDMA, and GSM for use in the MSR-BS tests in downlink operation. However, some of the requirements were adapted or newly defined specifically for MSR-BS. Table 5 provides an overview of the updated requirements.

Table 5: Overview of the MSR-BS DL requirements

Updated or new TX requirements defined in TS 37.141

TX characteristics	Requirements updated or new
BS maximum output power (6.2.1)	-
E-UTRA DL RS power (6.2.2)	-
UTRA FDD primary CPICH power (6.2.3)	-
UTRA TDD primary CCPCH power (6.2.4)	-
Output power dynamics (6.3)	-
Transmit ON/OFF power (6.4)	√
Modulation quality (6.5.1)	-
Frequency error (6.5.2)	-
Time alignment error (6.5.3)	-
Transmitter spurious emissions (6.6.1)	√
Operating band unwanted emissions (6.6.2)	√
Occupied bandwidth (6.6.3)	-
Adjacent channel leakage power ratio (ACLR) (6.6.4)	-
Transmitter intermodulation (6.7)	√

Sections 2.3 through 2.6 describe the updated requirements for the tests from Table 5 in more detail.

2.4 Transmit ON/OFF power (6.4)

This measurement is relevant only for bands in category BC3–that is, for TD-SCDMA and LTE TDD–and is carried out for M_{RFBW}. The transmitter OFF power is defined as the mean power measured over 70 µs and filtered with a square filter of bandwidth that is equal to the RF bandwidth of the BS centered on the central frequency of the RF bandwidth during the transmitter OFF period.

The brief transition times from power ON to OFF and back are called the transmitter transient period. Figure 17 illustrates the scenario from section 6.4 of TS 37.141. Table 6 clarifies the changes in the transmitter transient period requirements.

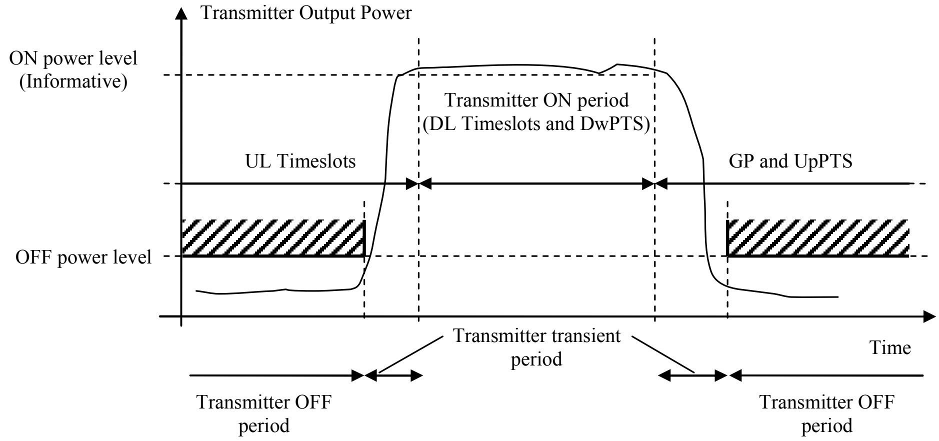


Figure 17: Illustration of the relationship between transmitter ON period, transmitter OFF period, and transmitter transient period in TS 37.141

Table 6: Transmitter transient period length for transmitter ON/OFF power measurement, minimum requirements			
For BC3 BS			
Switching direction	**Existing specifications**		**MSR (TS 37.104)**
	TD-SCDMA (TS 25.105)	**LTE TDD (TS 36.104)**	**For both LTE TDD and TD-SCDMA**
OFF to ON	8 chips	17 µs	6.25 µs
ON to OFF	85 + 3 chips*	17 µs	17 µs
Note *: The transmit power during these last 3 chips must be below -42 dBm in TD-SCDMA.			

The transmitter OFF power is measured before the start or after the end of the transmitter transient period. For an MSR-BS, the result should be a power spectral density of under **-85 dBm/MHz** (see Table 7).

Table 7: Transmitter OFF power spectral density limits, minimum requirements		
For BC3 BS		
TD-SCDMA (TS 25.105)	**LTE TDD (TS 36.104)**	**MSR (TS 37.104)**
–82 dBm *	–85 dBm/MHz	–85 dBm/MHz
Note *: TS 25.105 defines limits for absolute transmit OFF power, not for transmit OFF power spectral density.		

On the FSQ and FSV, this measurement is called "Power vs Time". Further information regarding the measurement of LTE TDD signals are available in the application card ”TD-LTE - Test the ON-OFF power of your TD-LTE base station according to 3GPP TS 36.141”.

2.5 Transmitter spurious emissions (6.6.1)

During the modulation of the wanted signal on the carrier, spurious emissions are generated as a result of undesirable effects in the transmitter, such as harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products that can occur outside of the frequency range being used. TS 37.141 sets the limits for spurious emissions at 9 kHz – 12.75 GHz, which does not include the range extending from 10 MHz under the lowest frequency to 10 MHz above the highest frequency of an operating band. The test is carried out for B_{RFBW}, M_{RFBW}, and T_{RFBW} . These requirements apply to both single-carrier and multicarrier operation.

The minimum requirements for spurious emissions defined in the existing LTE specification TS 36.104 were also used in TS 37.104. However, effective immediately, these apply to MSR-BS im both multi-RAT and single-RAT operation for the four standards LTE, WCDMA, TD-SCDMA, and GSM.

These limits for spurious emissions are defined in dBm for various frequency ranges. Each frequency range is measured using a different filter bandwidth. Table 8 and Table 9 list the spurious emission limits for the transmitters on an MSR-BS from category A or category B.

Table 8: Spurious emissions limits for Category A, minimum requirement

For BC1, BC2, BC3, according to Table 6.6.1.1.1-1 in TS 37.104

Frequency range	Maximum level	Measurement bandwidth	Note
9 kHz – 150 kHz	-13 dBm	1 kHz	Note 1
150 kHz – 30 MHz		10 kHz	Note 1
30 MHz – 1 GHz		100 kHz	Note 1
1 GHz – 12.75 GHz		1 MHz	Note 2
12.75 GHz – 5th harmonic of the upper frequency edge of the DL operating band in GHz		1 MHz	Note 2, Note 3

Note 1: Bandwidth as in ITU-R SM.329, s4.1

Note 2: Bandwidth as in ITU-R SM.329, s4.1. Upper frequency as in ITU-R SM.329, s2.5 table 1

Note 3: Applies only for Bands 22, 42 and 43.

Table 9: Spurious emissions limits for Category B, minimum requirement			
For BC1, BC2, BC3, according to table 6.6.1.1.2-1 in TS 37.104			
Frequency range	**Maximum level**	**Measurement bandwidth**	**Note**
9 kHz – 150 kHz	- 36 dBm	1 kHz	Note 1
150 kHz – 30 MHz	- 36 dBm	10 kHz	Note 1
30 MHz – 1 GHz	- 36 dBm	100 kHz	Note 1
1 GHz – 12.75 GHz	- 30 dBm	1 MHz	Note 2
12.75 GHz ↔ 5th harmonic of the upper frequency edge of the DL operating band in GHz	-30 dBm	1 MHz	Note 2, Note 3
Note 1: Bandwidth as in ITU-R SM.329, s4.1 Note 2: Bandwidth as in ITU-R SM.329, s4.1. Upper frequency as in ITU-R SM.329, s2.5 table 1 Note 3: Applies only for Bands 22, 42 and 43.			

Additional limits were defined for MSR-BS from band category BC2. Table 10 lists these additions.

Table 10: Additional minimum requirement for BC2 (category B) in TS 37.104 for transmitter spurious emissions			
For BC2 BS when GSM/EDGE operation is configured			
Frequency range	**Frequency offset from transmitter operating band edge**	**Maximum level**	**Measurement bandwidth**
30 MHz ↔ 1 GHz	10 MHz to 20 MHz	-36 dBm	300 kHz
	20 MHz to 30 MHz	-36 dBm	1 MHz
	≥30 MHz	-36 dBm	3 MHz
1 GHz ↔ 12.75 GHz	≥30 MHz	-30 dBm	3 MHz

This is applicable only in those instances when GSM is used in multi-RAT operation in an MSR-BS. If GSM is not used, the minimum requirements for spurious emissions listed in Table 8 and Table 9 apply.

TS 37.141 does not distinguish among Home, Local, and Wide Area BS (compare to TS 36.141), but rather only among band categories (BC1, BC2, and BC3).

An additional requirement has been defined for the protection of the BS receiver. This requirement is applied to FDD operation to prevent BS receivers from being desensitized by emissions from the BS transmitter. It is measured at the transmit antenna port for any type of BS with common or separate TX/RX antenna ports. The power of any spurious emissions must not exceed the limits in Table 11.

Table 11: BS Spurious emissions limits for protection of the BS receiver			
For BC1 and BC2 BS only, minimum requirement according to Table 6.6.1.2.1-1 of TS 37.104			
Band category	**Frequency range**	**Maximum level**	**Measurement bandwidth**
BC1	F_{UL_low} to F_{UL_high}	-96 dBm	100 kHz
BC2	F_{UL_low} to F_{UL_high}	-98 dBm	100 kHz

Analogously to specifications TS 36.104, TS 25.104, and TS 25.105, the specification TS 37.104 defines additional minimum spurious emissions requirements for operation in conjunction with other transmission systems and for the protection of geographically adjacent base stations.

To measure spurious emissions on the FSQ or the FSV, press *SPECTRUM* and select *Spurious Emissions* from the menu. Then use the *SWEEP LIST* to set the spurious emissions limits. Finally, start the measurement with *START MEAS*.

2.6 Operating band unwanted emissions (6.6.2)

Operating band unwanted emissions are generated during modulation and as a result of nonlinearities in the transmitter. The limits for operating band unwanted emissions are defined at 10 MHz under the lowest to 10 MHz over the highest frequency in a downlink operating band. The requirements apply to all MSR-BS, regardless of whether multicarrier or single-carrier mode or whether single-RAT or multi-RAT operation is used. The only exception is GSM single-RAT operation in band category BC2, because the existing requirements from specification TS 45.005 apply in this case.

The test is performed at the maximum output power for the BS. The requirements were completely redefined from the existing LTE, WCDMA, TD-SCDMA, and GSM specifications, and are now organized into band categories.

During this test, the range under test is divided into subranges and each is then measured with a different filter bandwidth. The test is carried out for $B_{RFBW,}$ M_{RFBW}, and T_{RFBW} . Table 12 lists the minimum requirements for BC1 and BC3. The following applies:

- Δf is the separation between the RF bandwidth edge frequency and the nominal -3 dB point of the measuring filter closest to the carrier frequency.
- f_{offset} is the separation between the RF bandwidth edge frequency and the center of the measuring filter.
- $f\_{offset,max}$ is the offset to the frequency 10 MHz outside the downlink operating band.
- Δf_{max} is equal to $f\_{offset,max}$ minus half of the bandwidth of the measuring filter.

Table 12: Operating band unwanted emission mask (UEM) for BC1 and BC3, general minimum requirement			
According to table 6.6.2.1-1 of TS 37.104			
Frequency offset of measurement filter -3dB point, Δf	**Frequency offset of measurement filter center frequency, f_{offset}**	**Minimum requirement**	**Measurement bandwidth**
0 MHz ≤ Δf < 0.2 MHz	0.015 MHz ≤ f_{offset} < 0.215 MHz	-14dBm	30 kHz
0.2 MHz ≤ Δf < 1 MHz	0.215 MHz ≤ f_{offset} < 1.015 MHz	$-14dBm - 15 \cdot \left(\frac{f_{offset}}{MHz} - 0.215 \right) dB$	30 kHz
(Note 1)	1.015 MHz ≤ f_{offset} ≤ 1.5 MHz	-26 dBm	30 kHz
1 MHz ≤ Δf ≤ min($Δf_{max}$, 10 MHz)	1.5 MHz ≤ f_{offset} ≤ min($f_{offset,max}$, 10.5 MHz)	-13 dBm	1 MHz
10 MHz ≤ Δf ≤ $Δf_{max}$	10.5 MHz ≤ f_{offset} ≤ $f_{offset,max}$	-15 dBm (Note 2)	1 MHz
Note 1: This frequency range ensures that the range of values of f_{offset} is continuous. Note 2: The requirement is not applicable when $Δf_{max}$ < 10 MHz.			

These minimum requirements were already defined in TS 36.141 for operation with 20-MHz LTE channels, and TS 37.141 now applies them to all LTE channel bandwidths. Table 13 and Table 14 list the new minimum requirements for BC2 MSR-BS.

Table 13: Operating band unwanted emission mask (UEM) for BC2, general minimum requirement			
According to table 6.6.2.2-1 of TS 37.104			
Frequency offset of measurement filter -3dB point, Δf	**Frequency offset of measurement filter center frequency, f_{offset}**	**Minimum requirement**	**Measurement bandwidth**
0 MHz ≤ Δf < 0.2 MHz (Note 1)	0.015 MHz ≤ f_{offset} < 0.215 MHz	-14dBm	30 kHz
0.2 MHz ≤ Δf < 1 MHz	0.215 MHz ≤ f_{offset} < 1.015 MHz	$-14dBm - 15 \cdot \left(\frac{f_{offset}}{MHz} - 0.215 \right) dB$	30 kHz
(Note 2)	1.015 MHz ≤ f_{offset} < 1.5 MHz	-26 dBm	30 kHz
1 MHz ≤ Δf ≤ min($Δf_{max}$, 10 MHz)	1.5 MHz ≤ f_{offset} < min($f_{offset,max}$, 10.5 MHz)	-13 dBm	1 MHz
10 MHz ≤ Δf ≤ $Δf_{max}$	10.5 MHz ≤ f_{offset} < $f_{offset,max}$	-15 dBm (Note 3)	1 MHz
Note 1: For operation with a GSM/EDGE or an E-UTRA 1.4 or 3 MHz carrier adjacent to the RF bandwidth edge, the limits in Table 6.6.2.2-2 in TS 37.104 apply for 0 MHz ≤ Δf ≤ 0.15 MHz. Note 2: This frequency range ensures that the range of values for f_{offset} is continuous. Note 3: The requirement is not applicable when $Δf_{max}$ < 10 MHz.			

Table 14: Operating band unwanted emission limits for operation in BC2 with GSM/EDGE or E-UTRA 1.4 or 3 MHz carriers adjacent to the RF bandwidth edge			
According to Table 6.6.2.2-2 in TS 37.104			
Frequency offset of measurement filter -3dB point, Δf	**Frequency offset of measurement filter center frequency, f_{offset}**	**Minimum requirement**	**Measurement bandwidth**
0 MHz ≤ Δf < 0.05 MHz	0.015 MHz ≤ f_{offset} < 0.065 MHz	$5dBm - 60 \cdot \left(\frac{f_{offset}}{MHz} - 0.015 \right) dB$	30 kHz
0.05 MHz ≤ Δf < 0.15 MHz	0.065 MHz ≤ f_{offset} < 0.165 MHz	$2dBm - 160 \cdot \left(\frac{f_{offset}}{MHz} - 0.065 \right) dB$	30 kHz
Note: The limits in this table only apply for operation with a GSM/EDGE or an E-UTRA 1.4 or 3 MHz carrier adjacent to the RF bandwidth edge.			

In addition to these minimum requirements, additional regional requirements are defined for those situations where an MSR-BS from BC3 is operating in the same geographical area as another BS in TDD mode (unsynchronized). In this case, the emissions in the downlink operating band (outside of the range from ± 10 MHz to the RF bandwidth edges) may not exceed a power spectral density of -52 dBm/MHz.

To measure operating band unwanted emissions on the FSQ or FSV, press *SPECTRUM* and then select *Spectrum Emissions*. Then use the *SWEEP LIST* to set the spurious emissions limits. Finally, start the measurement with *START MEAS*. On the FSW press *MEAS* and press in the window *Select Measurement* the button *Spectrum Emission*. Then use the *SWEEP LIST* to set the spurious emissions limits.

2.7 Transmitter intermodulation (6.7)

This transmitter characteristic is a measurement of intermodulation products in a separate band that can be the result of unwanted signals received via the same antenna. The test measures the maximum permitted power of intermodulation products that result between useful and unwanted signals. These intermodulation products of the third and fifth order must adhere to the minimum limits defined in TS 37.141, section 6.7.2. The test setup for the transmitter intermodulation measurement is shown in Figure 18.

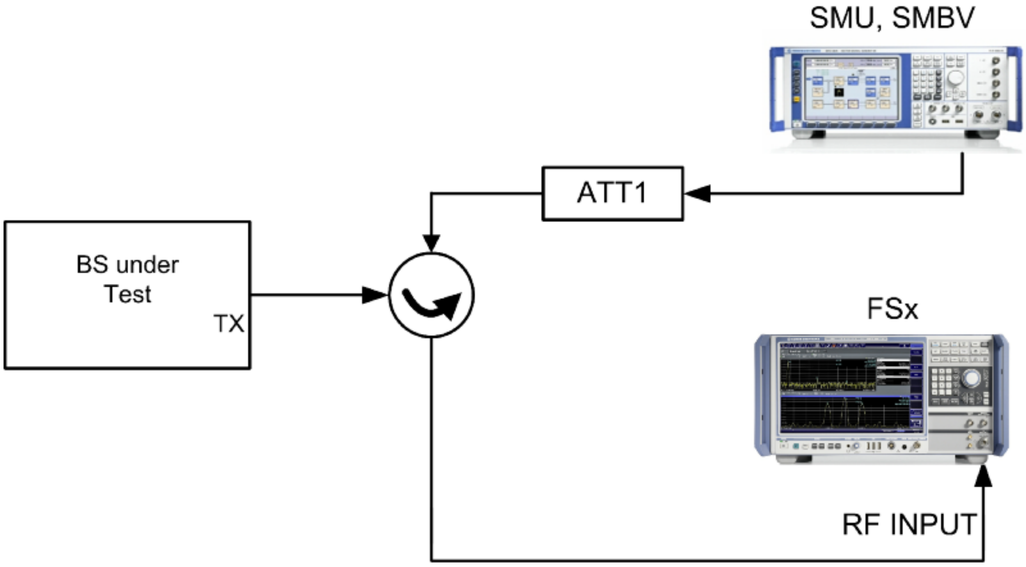


Figure 18: Test setup for transmitter intermodulation from TS 37.141, Annex D.1.2

The specification requires that the useful signal be configured in accordance with test configuration TC3 or TC4 depending on the application, and that it be transmitted at the maximum MSR-BS output power.

The requirements defined in TS 37.141 are based on those from LTE specification TS 36.141 and were expanded to include additional test procedure requirements for each of the three band categories BC1, BC2, and BC3.

The interfering signal should generally be configured at 5 MHz channel bandwidth in accordance with E-TM1.1. During the test, the interfering signal is placed one after one at various offsets (2.5 MHz, 7.5 MHz, and 12.5 MHz) to the band edges. MSR-BS of band category BC2 has an additional test requirement with a CW interferer and different offsets. For BC3 MSR-BS, there is an additional test requirement with a TD-SCDMA interfering signal as defined in Table 6.38A, TS 25.142.
Interfering signals that no longer lie in the downlink operating band because of the offset to the band edges do not generally have to be taken into consideration (see TS 37.104 for details).

Every configuration of the interfering signal is checked for compliance with the requirements for ACLR, operating band unwanted emissions, and spurious emissions at the frequencies of the 3rd and 5th order intermodulation products (depending on applicability based on the frequency range).

TS 37.104 offsets the interferer from the edges of BW_{RF} for the MSR-BS, and not from the center frequency of the wanted signal.

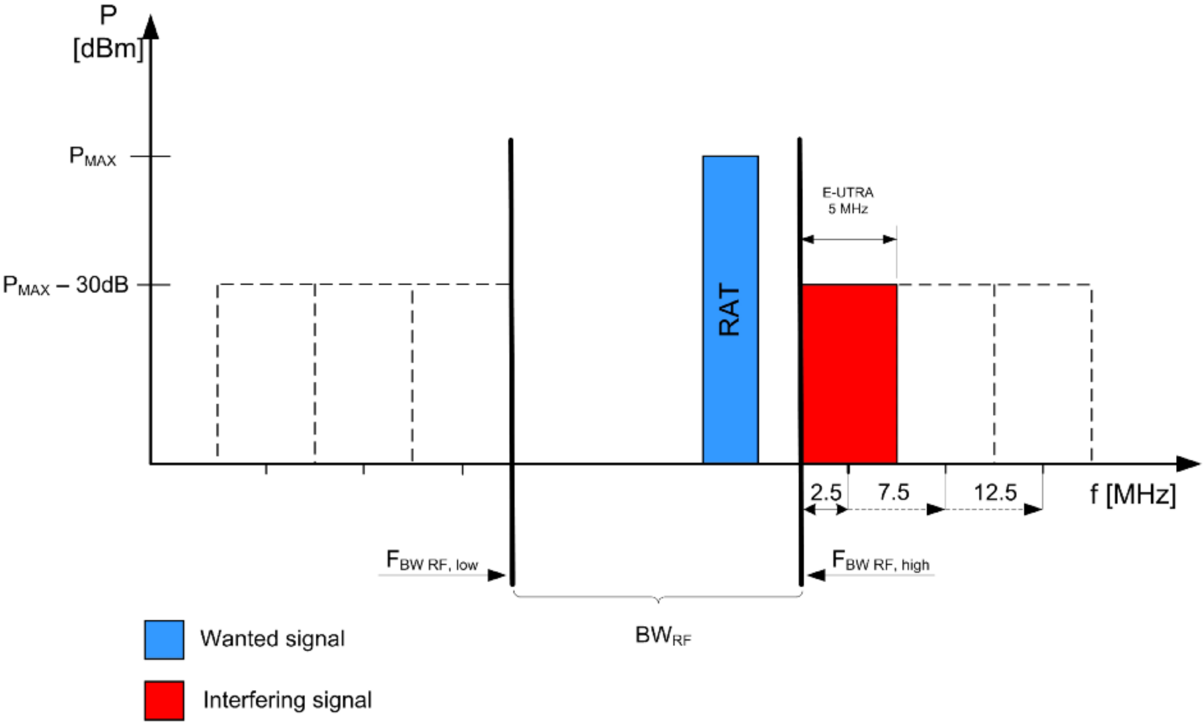
Table 15 lists the differences from existing specifications, using the interfering signal for LTE as an example.

Table 15: Interfering signals according to TS 36.104 and TS 37.104

For transmitter intermodulation, minimum requirements

Specification	Interfering signal mean power level	Interfering signal center frequency	Comment
TS37.104	30 dB below mean power of the wanted signal	2.5 MHz for modulated interferer 7.5 MHz for modulated interferer 12.5 MHz for modulated interferer	Interfering signal center frequency offset **from the edge of BW_{RF}** *
TS36.104	30 dB below mean power of the wanted signal	-BWChannel /2 - 12.5 MHz -BWChannel /2 - 7.5 MHz -BWChannel /2 - 2.5 MHz BWChannel /2 + 2.5 MHz BWChannel /2 + 7.5 MHz BWChannel /2 + 12.5 MHz	Interfering signal center frequency offset **from wanted signal carrier center frequency**

Note *: Interfering frequencies outside the operating band can be excluded according to TS 37.104 and TS 37.141.



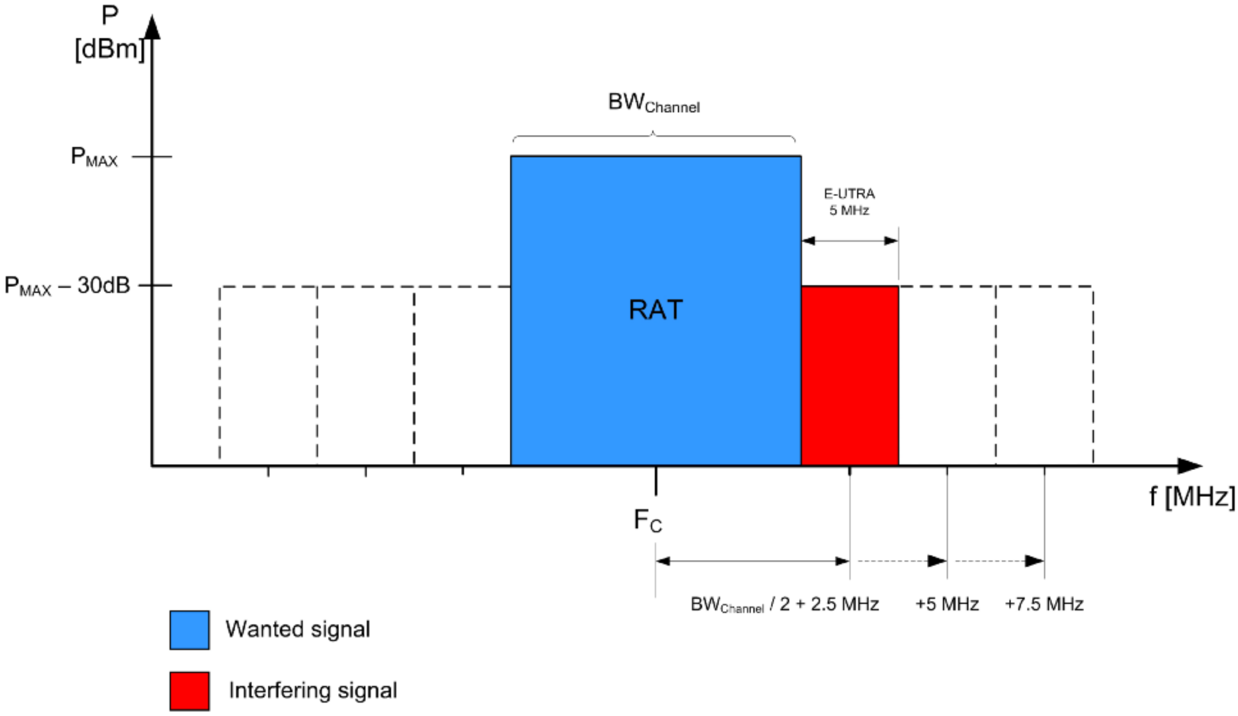


Figure 19: Overview: Transmitter Intermodulation

3 Receiver test solutions

At a minimum, the MSR-BS must meet the receiver characteristics requirements from chapter 7 of TS 37.141.

The R&S® signal generators, in particular the SMU and the SMBV, are available for receiver measurements on BS and MSR-BS. These instruments allow various test and reference signals to be generated for the required measurements.
Software options allow generation of test signals for all of the standards required for the MSR-BS measurements, i.e. GSM/EDGE, WCDMA, TD-SCDMA, and LTE FDD/TDD. Note, however, that channel coding for GSM is not supported by the GSM/EDGE option of the SMU or SMBV and needs to be done via a properly coded data list.

Figure 20 shows the SMU with the necessary options for two RF paths and two base bands. This configuration allows more complex test scenarios with only one instrument. This means, for example, that both interfering and useful signals can be generated on a single instrument. Other options also make it possible to add fading and noise to the signals.

Figure 20: SMU vector signal generator with two RF paths and baseband generators

When using the internal baseband generator, the SMU can generate RF signals with a bandwidth of up to 80 MHz, the SMBV up to 120 MHz.

The following chapters explain the SMU or SMBV signal generator configurations required for RX measurements in multi-RAT and multicarrier applications in more detail.

LTE single-RAT tests and the remote control commands for these tests are described in detail in the application note "1MA154: LTE Base Station Tests".

3.1 Test signal generation with R&S® signal generators

The receiver test configurations as described in section 1.3.2 in particular require the generation of multicarrier or multi-RAT signals. The SMU and SMBV offer three different ways of generating these types of signals:

- Addition of the various signals (realtime) via both basebands of a two-path SMU,
- Generation of a multicarrier ARB waveform file,
- Coupling of multiple RF paths in one or more SMUs or SMBVs (if necessary, also in combination with the two options above).

These three methods are described in more detail below.

3.1.1 Addition of carriers in baseband with the SMU signal generator

The TCs for RX tests require the presence of two test signals. This is possible with one SMU without any further limitations.

At the signal generator, the uplink signals for the respective baseband can be configured based on the standard being used. To combine the two basebands, simply route baseband B to path A. This can be done by clicking "Route to Path A" in baseband block B. The frequency offset for both basebands can also be defined. The basebands can be shifted around the center frequency of the RF path with a maximum frequency offset of -40 MHz to +40 MHz, whereby the maximum total bandwidth of the RF signal cannot exceed 80 MHz. In addition a path gain can be set. Figure 21 shows the setup to divert the baseband .

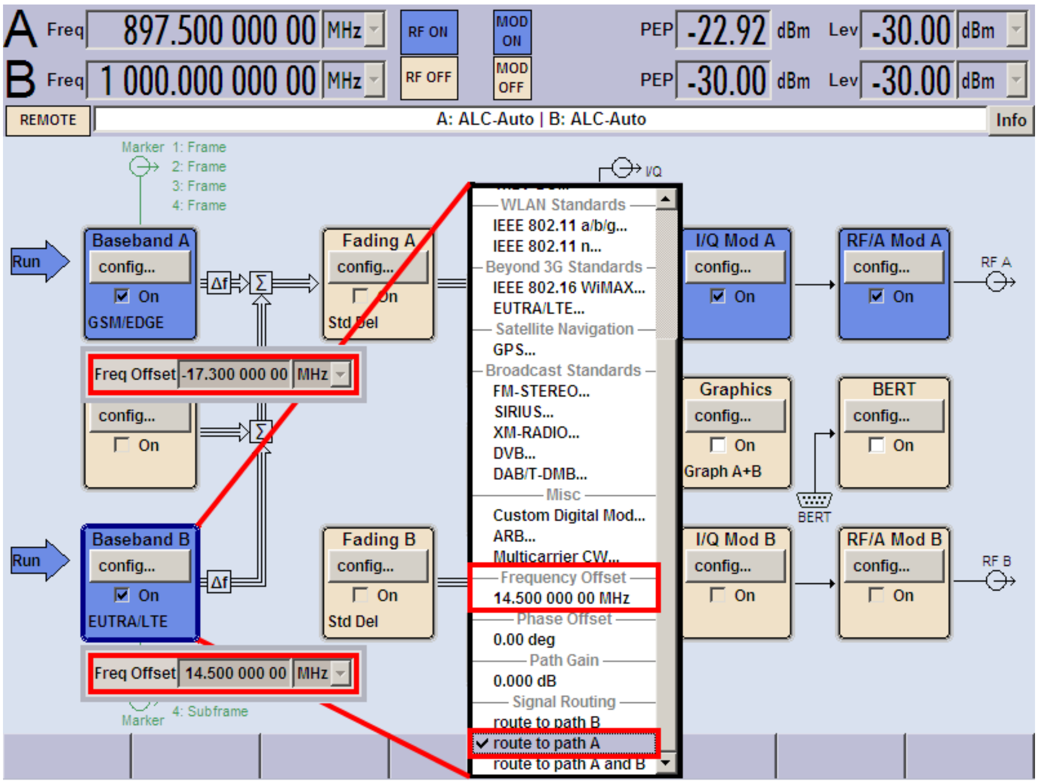


Figure 21: Addition of two signals in baseband in the SMU and settings for frequency offsets

The advantage of this configuration is that each baseband can be configured as needed and real-time signals can be generated. Each of the standards defined for MSR-BS is available as a software option for the SMU and the SMBV.

All test configurations defined in TS 37.141 for receiver tests can be generated using the default test setup, as shown in Figure 22. An exception is band 40, because its spectrum is 100 MHz wide and thus exceeds the 80 MHz bandwidth limit for the SMU when the internal baseband generators are used.

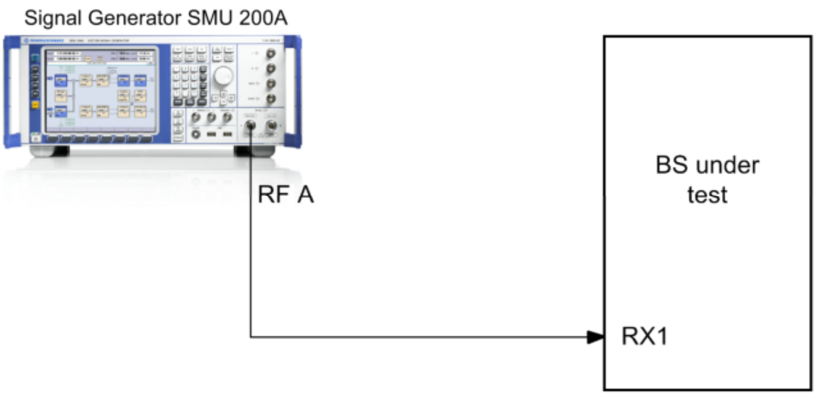


Figure 22: General setup for RX testing with the SMU and baseband addition on RF path A

To generate signals with a bandwidth greater than 80 MHz, the signals are added to the RF. See section 3.1.3 for details.

3.1.2 Test signal generation with ARB waveform files

The test signals can also be configured and played back as multicarrier ARB waveform files.

ARB stands for arbitrary waveform memory. On the SMU or the SMBV, the ARB can be used to play back configurable signals as ARB waveforms. The ARB waveforms now need only be "reproduced" by the instrument, and no longer have to be calculated in realtime. To generate a multicarrier signal, the single-carrier signals are first generated as separate ARB waveforms. The single-carrier signals are then combined into a multicarrier signal in a separate ARB waveform file. This has the advantage that multiple carriers can be generated on one baseband, so that even a single-path signal generator can be used to generate the multicarrier signal.

These special multicarrier ARB waveforms can be generated in three different ways:

- using directly the "Multi-Carrier ARB" dialog on the SMU or SMBV signal generator
- using the "Rohde & Schwarz WinIQSIM2 Simulation Software" tool on a PC.
- using the composer function of the ARB Toolbox Plus [18].

It is important to take the maximum waveform size into consideration based on the ARB memory of the instrument.

This section presents an example of test configuration TC5 “BC2 receiver operation” and describes how to set up this scenario with WinIQSIM2 as an ARB waveform file. A BC2 receiver uses GSM and the standards WCDMA or LTE simultaneously. This measurement assumes an MSR-capable BS supporting band 8 with an uplink frequency range from 880 to 915 MHz. The carrier on the lower RF bandwidth edge is a GSM carrier, and the other one on the upper edge is a LTE carrier. The LTE channel was configured according to TS 37.141 with test model E-TM1.1 and 5 MHz. Figure 23 shows test configuration TC5b with the chosen frequencies.

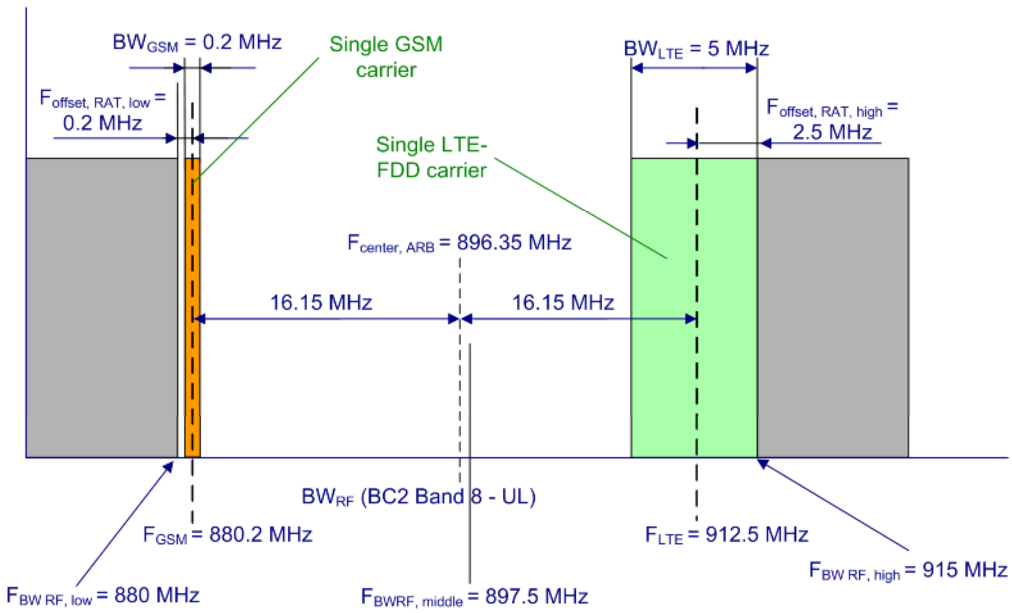


Figure 23: Schematic setup of the receiver test configuration TC5b for BC2, band 8

The offsets to the edges of BW_{RF} are according to TC5b. The distance between the two carrier is 32.3 MHz and the center between the two carriers, which is needed to set the frequency on the SMU or SMBV, lies at frequency 896.35 MHz. The actual multicarrier ARB waveform files are then generated:

After WinIQSIM2 is started, the main screen is displayed as shown in Figure 24.

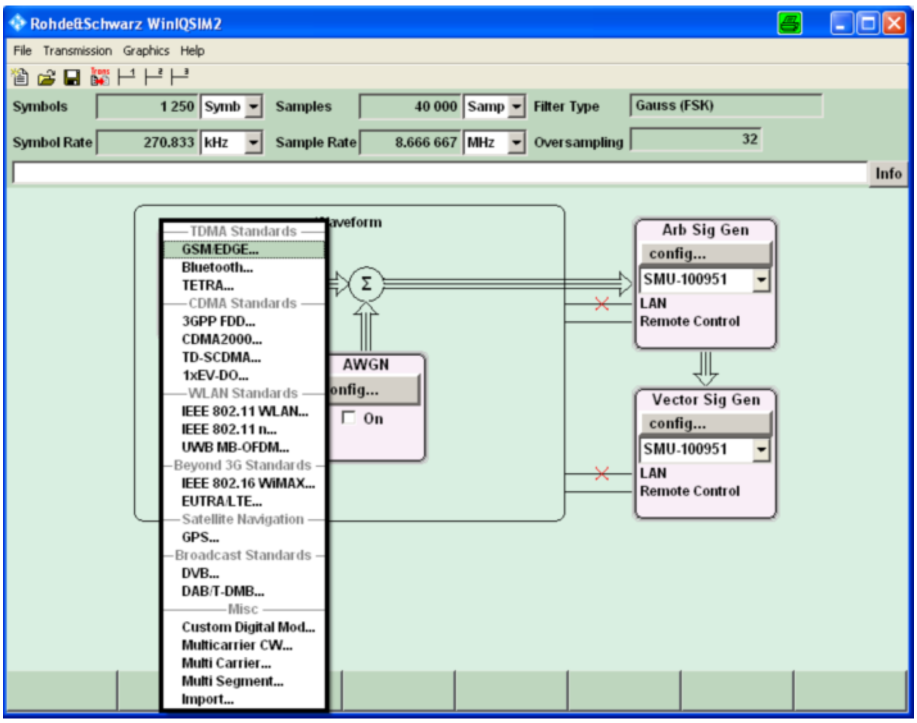


Figure 24: Selection of baseband standards in WinIQSIM2

The ARB waveform is generated in 3 steps:

1. Generation of the GSM waveform file,
2. Generation of the LTE waveform file,
3. Addition of both files into a multicarrier ARB waveform file.

To generate the GSM waveform file, click *config* in the Baseband field and select *GSM/EDGE* from the menu. The basic settings for the GSM carrier are displayed; see Figure 25.

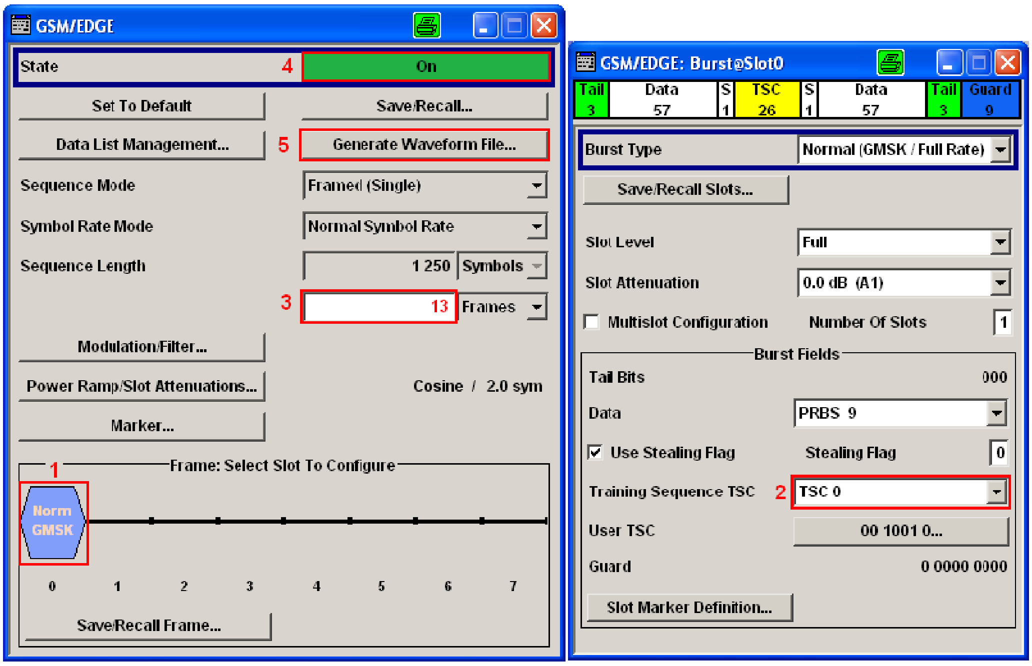


Figure 25: GSM/EDGE settings and burst settings for Slot 0

Click the first slot to open the *Burst@Slot0* menu (1).

Select a predefined training sequence from the *Burst Fields* field under *Training Sequence TSC* (2).

When combining GSM with other standards, it is important to understand the influence of the signal duration. The single waveforms of a multicarrier ARB waveform all have their own periodicity, caused by the different frame lengths used by the different RATs. Therefore, the length of a multicarrier ARB waveform has to be the least common multiple of the frame lengths of the single carrier waveforms that make up the multicarrier ARB waveform. Only when this requirement is fulfilled will the sequence of the multicarrier ARB waveform run smoothly. If it is not fulfilled, it is possible that the PN sequence used as the data source for BER tests will be truncated. This bears the risk that the test will run with statistically unreliable signals that could deliver false results, especially for BER measurements.

One GSM frame has a length of 4.61538 ms. LTE and WCDMA both have a frame length of 10 ms. As you can see in Figure 25 (3) we use 13 GSM frames and, as shown in Figure 26 (3), we use 6 LTE frames in this example, which results in a total sequence length of approx. 60 ms for GSM and 60 ms for either LTE or WCDMA. When generating a multi-carrier ARB waveform in WinIQSIM2, it is important to ensure that the separate waveform files that are used as the basis for the multicarrier ARB waveform are not truncated in the SMU or in the SMBV. This is done by setting the *Signal Period Mode* parameter in the *Multicarrier ARB* menu to *Longest File Wins(*see Figure 29).

After closing the window for configuring the GSM burst settings in slot 0, click (4) to start the generator (see Figure 25). As soon as the generator is loaded, click "*Generate Waveform File.*" (5) to generate the GSM ARB waveform file. In the new window, specify where to save the GSM-ARB waveform file.

The next step is to generate the LTE-UL signal:

In the baseband box under *config*, select the *E-UTRA/LTE* option.

In the next window (seeFigure 26), first set *Duplex mode* FDD (1), the link direction (2), and a sequence length of 6 frames (3).

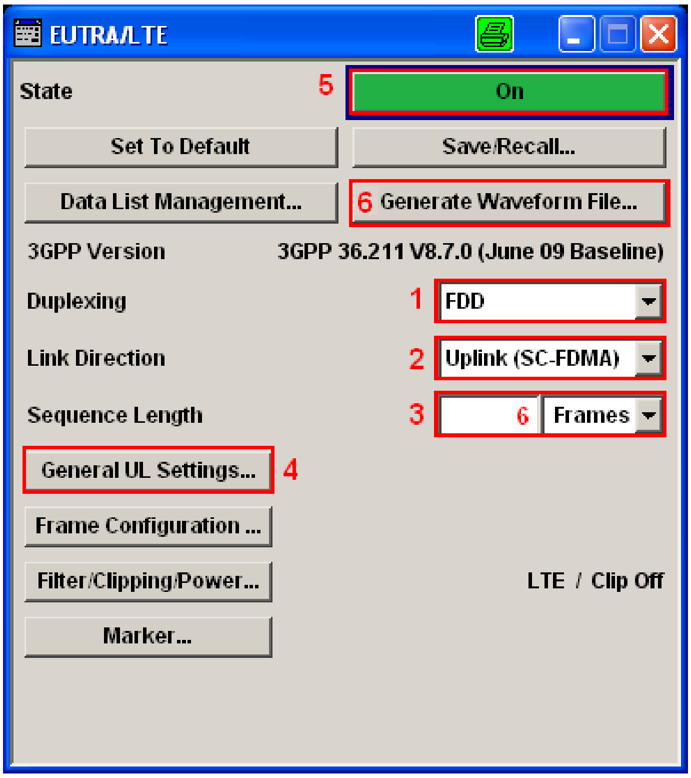


Figure 26: LTE settings

Click *General UL Settings* (4), then set the channel bandwidth to 5 MHz; see Figure 27.

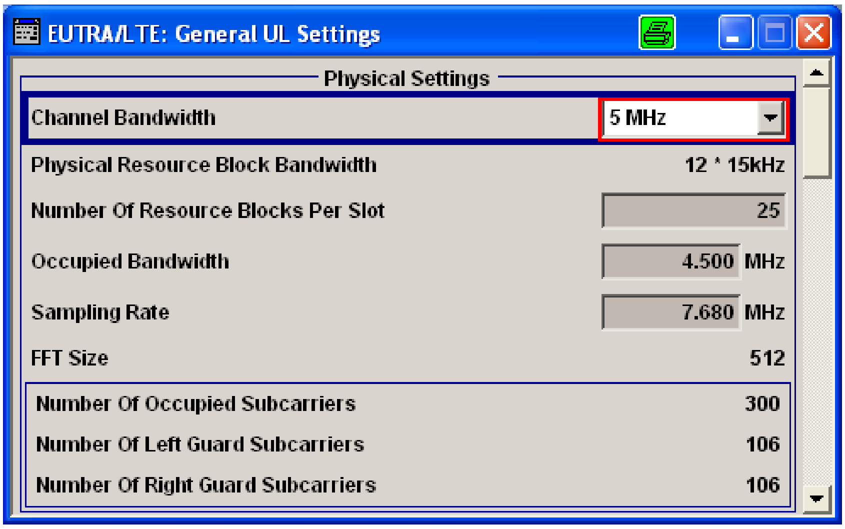


Figure 27: General UL settings for LTE

Click under *Frame Configuration* (see Figure 26) to configure UE1 in more detail; see Figure 28.

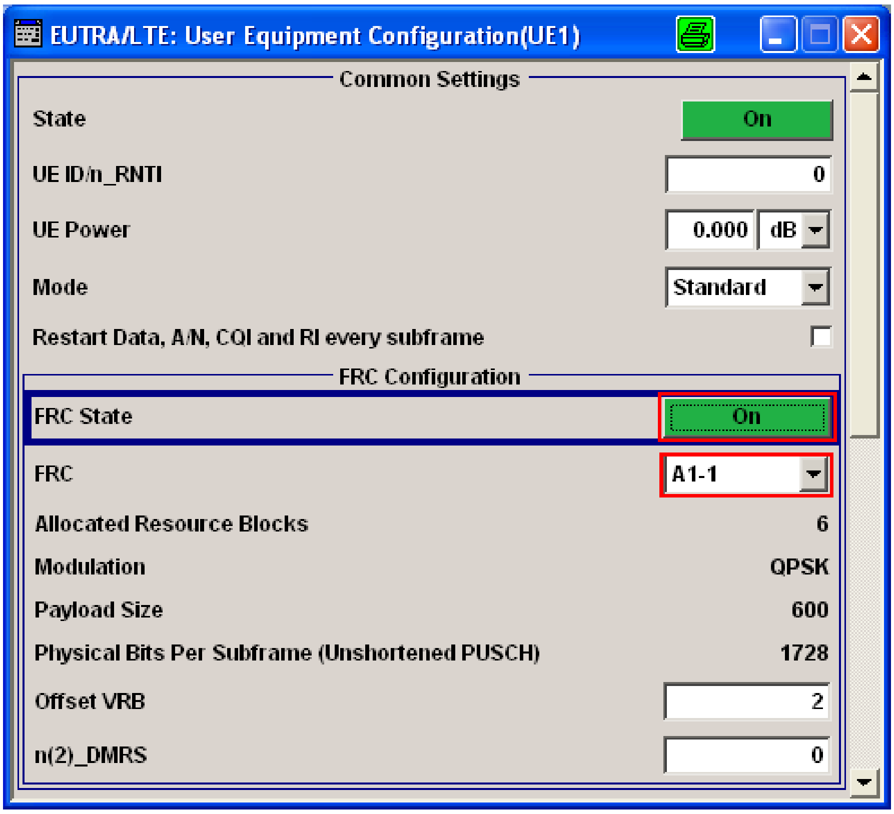


Figure 28: UE configuration for BS UL testing

First activate a *Fixed Reference Channel* (FRC) and then select the appropriate types in accordance with specification TS 36.141. Close the two windows and then click (5) in Figure 26 to switch the baseband on. Generate the waveform file by clicking (6) and selecting a location to save the file; see also Figure 26.

In the next step, configure the multicarrier waveform file. In the main screen, click *config* then select the option "*Multicarrier ...*" under *Misc*.

The main menu then opens as shown in the window to the right in Figure 29.

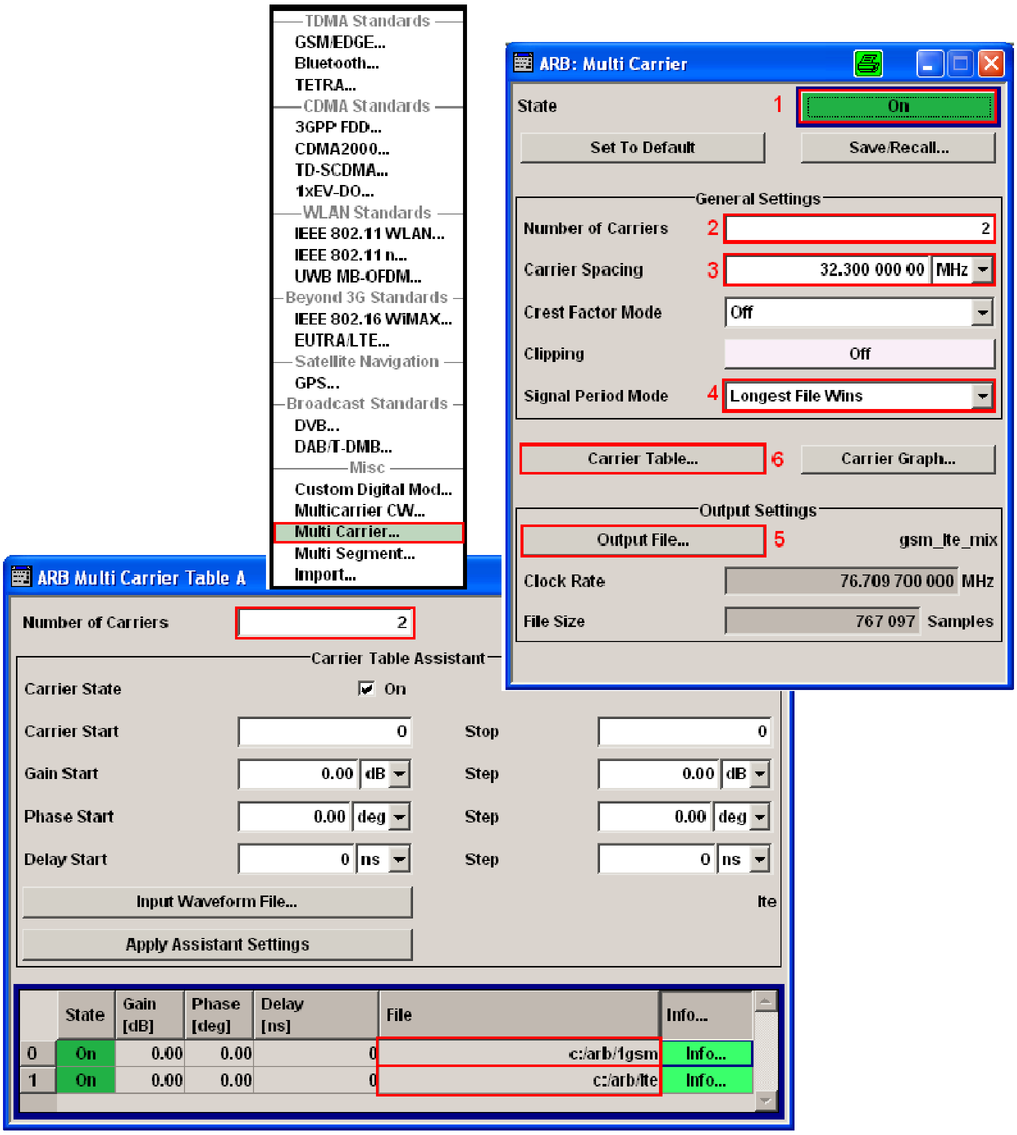


Figure 29: Multicarrier configurations for the final ARB waveform file

Under *Number of Carriers* (2), set the number of carriers (2 in this example). *Carrier Spacing* (3) represents the distance between the carrier signals. This value is 32.3 MHz in this example. Set *Signal Period Mode* (4) to *Longest File Wins*, as previously mentioned. Under *"Output File…"* (5), define the local storage location for the multicarrier ARB waveform file. Finally, click *"Carrier Table…"* (6) to display the parameters for the individual carriers in table form. Now enable multicarrier mode (1).

For this example, set 2 carriers. In the lower section, the paths to the two previously generated ARB waveform files for the GSM and LTE carriers must be selected. The *Carrier Table Assistant* is in the middle. This is used to facilitate generation of a multicarrier signal based on a single ARB waveform file. It also has fields to define characteristics such as attenuation, phase shift, and latency for individual carriers.

To check the multicarrier settings, click *Carrier Graph* to view them schematically as a spectrum; see Figure 30.

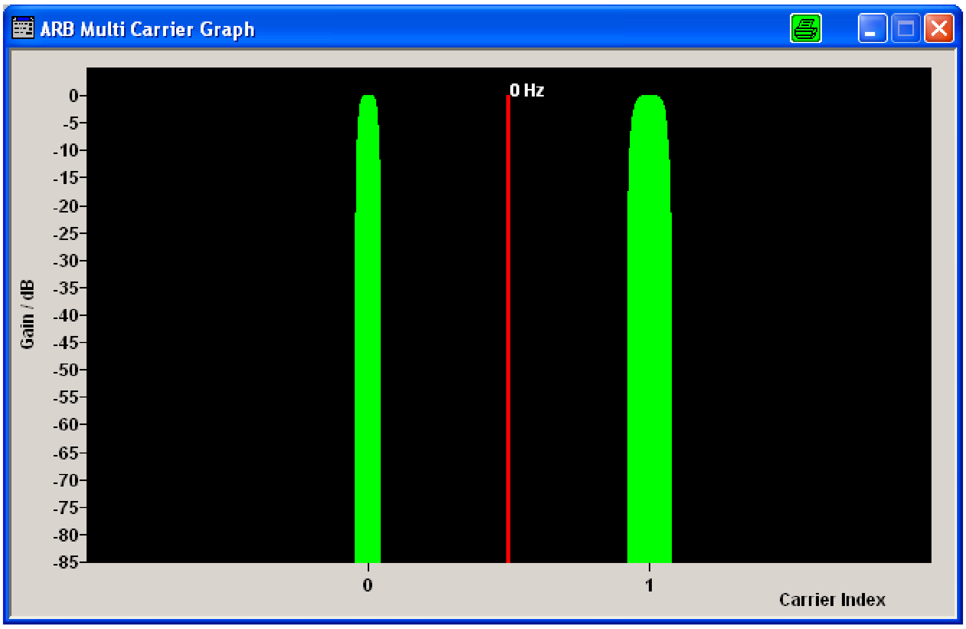


Figure 30: Multicarrier graph shows the example spectrum of TC5b

The ARB file can now be transferred to the signal generator. However, the signal generator must first be added to the settings under *Transmission->Instruments*. Click *Transmission->Transmit* to open a window as shown in Figure 31.

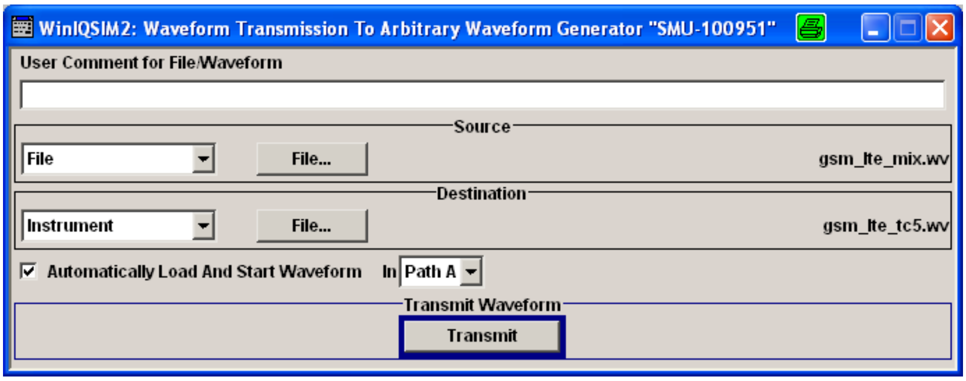


Figure 31: Transmitting the multicarrier ARB file to the signal generator

Under *Source*, click *"File…"* to select the local path to the multicarrier ARB waveform file, and under *Destination*, click *"File…"* to select the location to save the file on the signal generator. Click *Transmit* to send the ARB file. The level and center frequency for the ARB file–896.35 MHz in this example– have to be set on the signal generator.

The test signals required in TC5b are then generated by the SMU and can be used for RX measurements on a BC2 receiver.
A variety of scenarios can be created and simulated by using WinIQSIM2 in conjunction with signal generators like the SMU or the SMBV. See the WinIQSIM2 manual for more information. This manual is available in the general download section of the software.

3.1.3 Coupling the two RF paths of one SMU or two SMBVs

The following test setup must be used to generate test signals for receiver measurements on an MSR-BS that require a bandwidth of more than 80 MHz for the SMU or more than 120 MHz for the SMBV; see Figure 32. This setup includes one SMU and 2 RF paths.

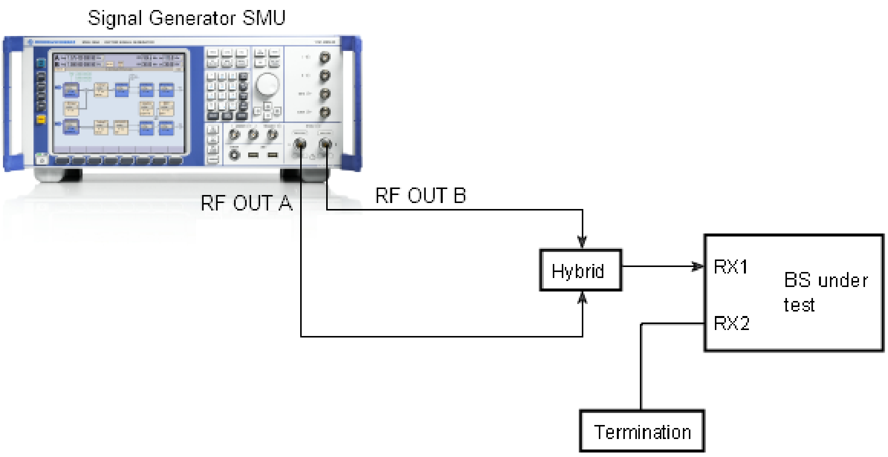


Figure 32: General test setup for receiver tests on frequency bands with more than 80 MHz BW (SMU) or 120 MHz (SMBV)

Instead of an SMU, it is also possible to couple the two paths from two SMBVs.

This setup must be used, for example, for MSR-BS whose BW_{RF} covers the entire band 40, because this band has an effective uplink bandwidth of 100 MHz.

One carrier signal is generated per RF path and added using a coupler in order to generate the two carriers at the edges of BW_{RF}. One advantage of this setup is flexibility. When configuring the signals in both RF paths, the complete level and frequency range of the SMU (or the SMBV) can be utilized.
If the objective is to use this setup to measure the receiver intermodulation, an additional SMU is needed to generate the interfering signals.

3.2 Revisions in TS 37.141

For MSR-BS measurements in the uplink, standard TS 37.141 refers to existing receiver characteristic requirements from the 3GPP specifications for LTE, WCDMA, TD-SCDMA, and GSM. However, some of the requirements were adapted or redefined specifically for MSR-BS operation. Table 16 provides an overview of the updated requirements.

Table 16: Overview of requirements for the UL of MSR-BS	
Updated or new RX requirements defined in TS 37.141	
RX characteristics	**Requirements updated or new**
Reference sensitivity level (7.2)	-
Dynamic range (7.3)	-
In-band selectivity and blocking (7.4)	√
Narrowband blocking (7.4.5)	√
Out-of-band blocking (7.5)	√
Receiver spurious emissions (7.6)	√
Receiver intermodulation (7.7)	√
In-channel selectivity (7.8)	-

This section provides a more detailed explanation of all measurements that have new requirements.

3.3 In-band selectivity and blocking (7.4)

The receiver characteristic that defines how a specific signal is received in the presence of an unwanted interferer within the same operating band is described by the inband selectivity and blocking characteristics. A distinction is made between wideband and narrowband blocking. The test is intended to determine how sensitive a BS receiver is to interference from an unwanted interferer with a fixed frequency offset. Figure 34 shows the test setup with the SMU. This measurement is taken in the range M_{RFBW}.

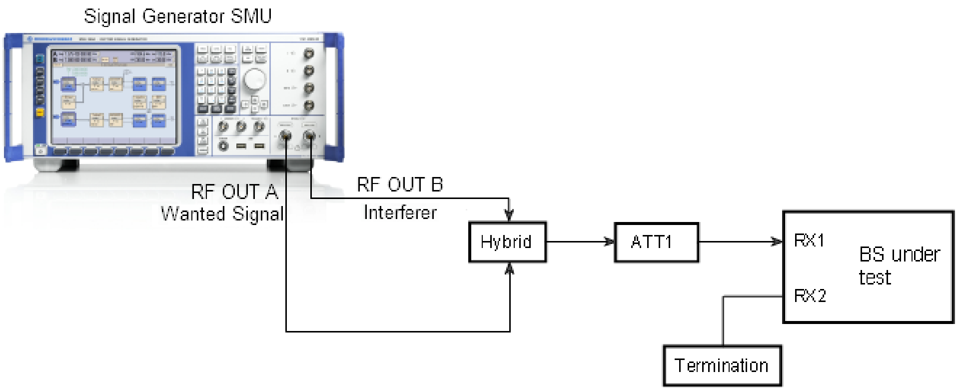


Figure 33: Test setup for receiver blocking characteristics from TS 37.141, Annex D.2.1

In Figure 34, the useful signal is generated in path A of the SMU with the desired test configuration (as a multicarrier ARB waveform). Path B generates the interfering signal. If the test configuration being used exceeds an RF bandwidth of 80 MHz (e.g., for band 40), the test setup will require a second signal generator.
In TS 37.141, section 7.4 defines test procedures and requirements for general blocking and narrowband blocking. Additional requirements are also provided for band category BC3.

General blocking

The minimum requirements for the general blocking test were completely redefined in TS 37.104. The interferer should be a WCDMA signal and configured according to Table 17 in TS 37.104, Annex A.1.

Table 17: Characteristics of UTRA FDD interfering signal, minimum requirement				
According to Table A.1-1 from TS 37.104				
Channel	**Bit Rate**	**Spreading Factor**	**Channelization Code**	**Relative Power**
DPDCH	240 kbps	16	4	0 dB
DPCCH	15 kbps	256	0	-5.46 dB
NOTE: The DPDCH and DPCCH settings are chosen to simulate a signal with realistic peak-to-average ratio.				

The measurement procedure in TS 37.141 is defined as follows, and the positioning of the interferer signal in particular is redefined from the existing specifications:

1. Adjust the signal generators to the type of interfering signal, levels, and the frequency offsets as specified in Table 18.

2. The interfering signal is then swept with a step size of 1 MHz, starting from the minimum offset to the channel edges of the wanted signal as specified in Table 18.

3. Measure the performance of the wanted signal at the BS receiver, as shown in Table 19, for the relevant carriers specified by the test configuration in chapter 1.3.2 of this application note.

The wanted signal has to be configured with the relevant reference measurement channels according to the following specifications:

- For LTE, see Annex A.1 in TS 36.141.
- For WCDMA, see Annex A.2 in TS 25.141.
- For TD-SCDMA, see Annex A.2.1 in TS 25.142.
- For GSM, see subclause 7.6.2 in TS 51.021 and Annex P in TS 45.005 for reference channels to test.

<table>
<tr><th colspan="7">Table 18: General blocking minimum requirement</th></tr>
<tr><th colspan="7">Configuration of the interferer according to TS 37.104, Table 7.4.1-1</th></tr>
<tr><th>Operating band number</th><th colspan="3">Center frequency of interfering signal [MHz]</th><th>Interfering signal mean power [dBm]</th><th>Wanted signal mean power [dBm]</th><th>Interfering signal center frequency minimum frequency offset from the RF bandwidth edge [MHz]</th></tr>
<tr><td>1-7, 9-11, 13, 14, 18, 19, 21-23, 24, 33-43</td><td>$(F_{UL\_low}-20)$</td><td>to</td><td>$(F_{UL\_high}+20)$</td><td rowspan="6">-40</td><td rowspan="6">$P_{REFSENS}$ + x dB*</td><td rowspan="6">±7.5</td></tr>
<tr><td>8</td><td>$(F_{UL\_low}-20)$</td><td>to</td><td>$(F_{UL\_high}+10)$</td></tr>
<tr><td>12</td><td>$(F_{UL\_low}-20)$</td><td>to</td><td>$(F_{UL\_high}+13)$</td></tr>
<tr><td>17</td><td>$(F_{UL\_low}-20)$</td><td>to</td><td>$(F_{UL\_high}+18)$</td></tr>
<tr><td>20</td><td>$(F_{UL\_low}-11)$</td><td>to</td><td>$(F_{UL\_high}+20)$</td></tr>
<tr><td>25</td><td>$(F_{UL\_low}-20)$</td><td>to</td><td>$(F_{UL\_high}+15)$</td></tr>
<tr><td colspan="7">NOTE*: $P_{REFSENS}$ depends on the RAT and on the channel bandwidth; see subclause 7.2 in TS 37.104.
NOTE**: "x" is equal to 6 for E-UTRA or UTRA wanted signals and equal to 3 for GSM/EDGE wanted signals.</td></tr>
</table>

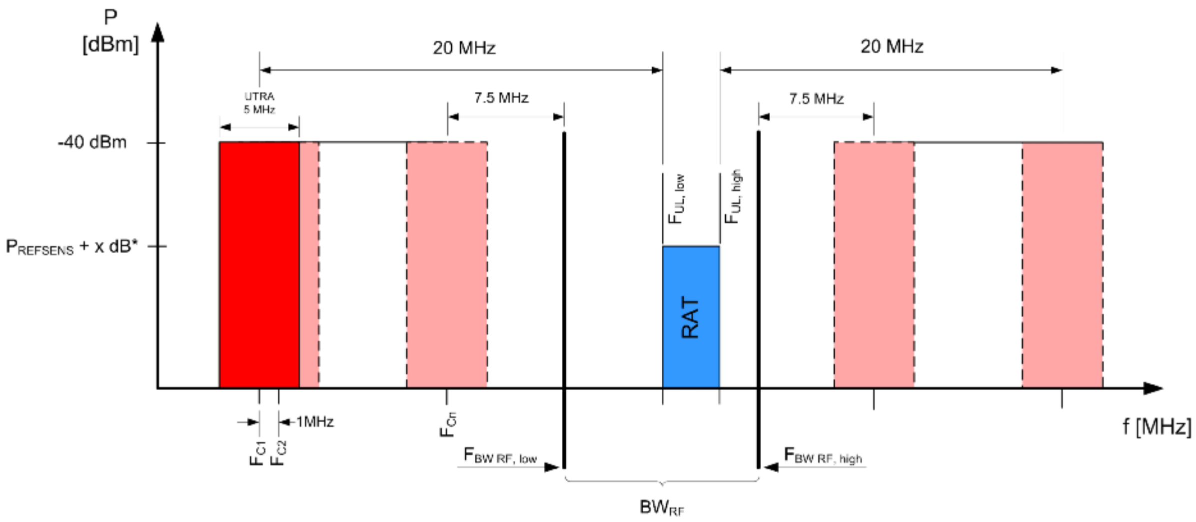


Figure 34: Overview: General Blocking

Table 19: Overview of minimum performance requirements for LTE, W-CDMA, TD-SCDMA, and GSM/EDGE as defined in subclause 7.4.5.1 of TS 37.141

RAT	Requirement	Reference
LTE	Throughput of the measured carrier must be ≥95% of the reference measurement channel maximum throughput	TS 36.104, subclause 7.2
W-CDMA	BER must not exceed 0.001 for the reference measurement channel	TS 25.104, subclause 7.2
TD-SCDMA	BER must not exceed 0.001 for the reference measurement channel	TS 25.105, subclause 7.2
GSM/EDGE	Reference receiver performance for GMSK modulated speech channels, 8-PSK modulated circuit-switched data channels, 8-PSK modulated packet-switched channels (EGPRS) with lowest supported coding scheme (MCS) using basic transmit-time-interval (BTTI) and no piggy-backed ACK/NACK reporting (PAN)	TS 45.005, Annex P.2.1

Narrowband blocking

The minimum requirements for the narrowband blocking test have also changed. The interferer is a 3-MHz LTE uplink signal, configured with a resource block as defined in TS 37.141, Annex A.3. QPSK is selected as the modulation type. The signal should be configured with the resource bock (RB) offset and the corresponding disturbance power; see Table 20.
The test procedure is as follows:

1. Adjust the signal generators to the type of interfering signal, levels, and the frequency offsets as specified in Table 20.

2. Set up and sweep the interfering RB center frequency offset to the channel edge of the wanted signal according to Table 20.

3. Measure the performance of the wanted signal at the BS receiver, as shown in Table 19, for the relevant carriers specified by the test configuration in chapter 1.3.2 of this application note.

Table 20: Narrow band blocking minimum requirements			
According to Table 7.4.2-1, TS 37.104			
RAT of the carrier	**Wanted signal mean power [dBm]**	**Interfering signal mean power [dBm]**	**Interfering RB*** center frequency offset from the RF bandwidth edge [kHz]**
E-UTRA, UTRA and GSM/EDGE	$P_{REFSENS}$ + x dB*	-49	±(240 +m*180), m=0, 1, 2, 3, 4, 9, 14
NOTE*: $P_{REFSENS}$ depends on the RAT and on the channel bandwidth; see subclause 7.2 in TS 37.104. NOTE**: "x" is equal to 6 for E-UTRA or UTRA wanted signals and equal to 3 for GSM/EDGE wanted signals. NOTE***: Interfering signal (E-UTRA 3 MHz), consisting of one resource block positioned at the stated offset; the channel bandwidth of the interfering signal is located adjacent to the RF bandwidth edge.			

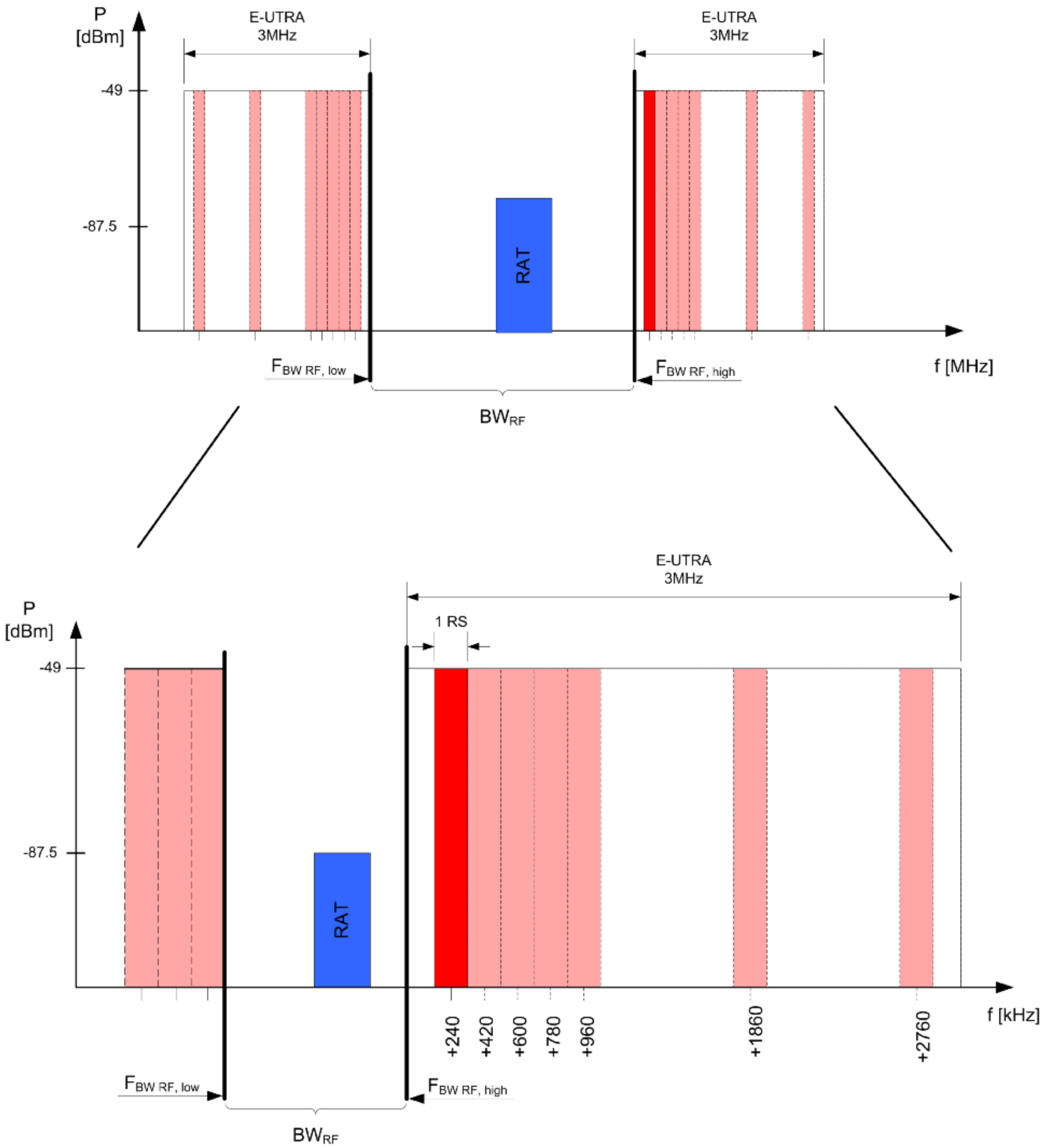


Figure 35: Overview: Narrowband Blocking

For GSM/EDGE, there is an additional narrowband blocking requirement as well as an AM suppression requirement. For both, TS 37.141 refers to the TS 51.021 and TS 45.005 specifications.

Additional requirements are defined for BC3 BS. These additional minimum requirements for bands 33-40 of a BC3 BS apply to performance measurements with a TD-SCDMA interfering signal. The interfering signal is configured as defined in Table 21.

Table 21: Additional blocking minimum requirement				
For BC3 BS according to Table 7.4.5-1 in TS 37.104				
Operating Band	**Center Frequency of Interfering Signal [MHz]**	**Interfering signal mean power [dBm]**	**Wanted signal mean power [dBm]**	**Interfering signal center frequency minimum frequency offset from the RF bandwidth edge [MHz]**
33-43	(F_{UL_low} -20) to (F_{UL_high}+20)	-40	$P_{REFSENS}$ + 6 dB*	±2.4
NOTE*: $P_{REFSENS}$ depends on the RAT and on the channel bandwidth; see section 7.2 in TS 37.104				

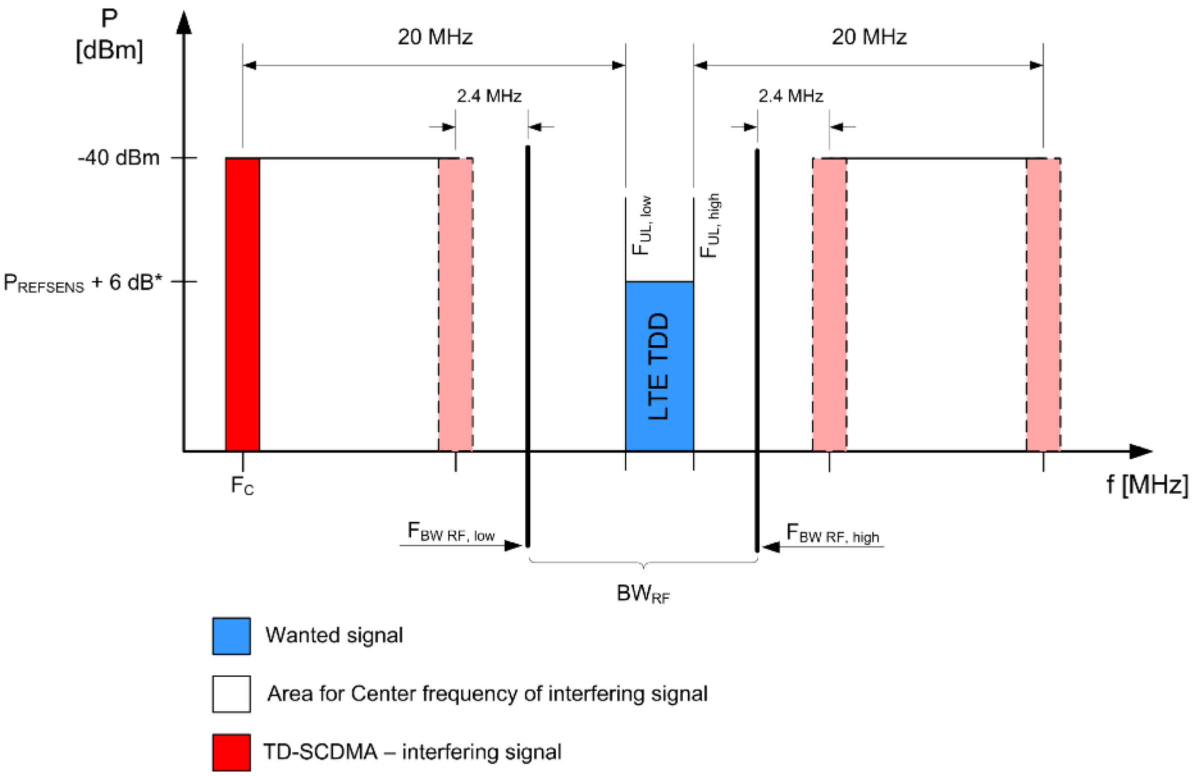


Figure 36: Overview: Additional blocking

The LTE TDD carrier and the TD-SCDMA carrier for the BC3 BS must not exceed the performance limits defined in Table 19.

3.4 Out-of-band blocking (7.5)

The out-of-band blocking characteristic is a measure of the receiver's ability to receive a wanted signal at its assigned channel in the presence of an unwanted interferer outside the uplink operating band.

Use the general test setup for blocking tests as shown in Figure 33, and then start transmitting the reference measurement channels to the BS under test as follows:

- For LTE, see Annex A.1 in TS 36.141.
- For WCDMA, see Annex A.2 in TS 25.141.
- For TD-SCDMA, see Annex A.2.1 in TS 25.142.
- For GSM, see subclause 7.6.2 in TS 51.021 and Annex P in TS 45.005 for reference channels to test.

The test procedure as defined in TS 37.141 is divided into the following three steps:

1. Adjust the signal generators to the type of interfering signal, levels, and the frequency offsets as specified in Table 22 and, when applicable, also for co-location test requirements in Table 7.5.5.2-1 of TS 37.141.

Table 22: Blocking performance requirement

For BC1, BC2 and BC3 BS, according to Table 7.5.1.-1 of TS 37.104

Operating band number	Center frequency of interfering signal [MHz]	Interfering signal mean power [dBm]	Wanted signal mean power [dBm]	Type of interfering signal
1-7, 9-11, 13, 14, 18, 19, 21-23, 33-43	1 to (F_{UL_low}-20) (F_{UL_low}+20) to 12750	-15	$P_{REFSENS}$ + x dB *	CW carrier
8	1 to (F_{UL_low}-20) (F_{UL_low}+10) to 12750	-15	$P_{REFSENS}$ + x dB *	CW carrier
12	1 to (F_{UL_low}-20) (F_{UL_low}+13) to 12750	-15	$P_{REFSENS}$ + x dB *	CW carrier
17	1 to (F_{UL_low}-20) (F_{UL_low}+18) to 12750	-15	$P_{REFSENS}$ + x dB *	CW carrier
20	1 to (F_{UL_low}-11) (F_{UL_low}+20) to 12750	-15	$P_{REFSENS}$ + x dB *	CW carrier
25	1 to (F_{UL_low} -20) (F_{UL_high} +15) to 12750	-15	$P_{REFSENS}$ + x dB *	CW carrier

NOTE *: $P_{REFSENS}$ depends on the RAT and the channel bandwidth; see subclause 7.2 of TS 37.104. "x" is equal to 6 for E-UTRA or UTRA wanted signals and equal to 3 for GSM/EDGE wanted signals.

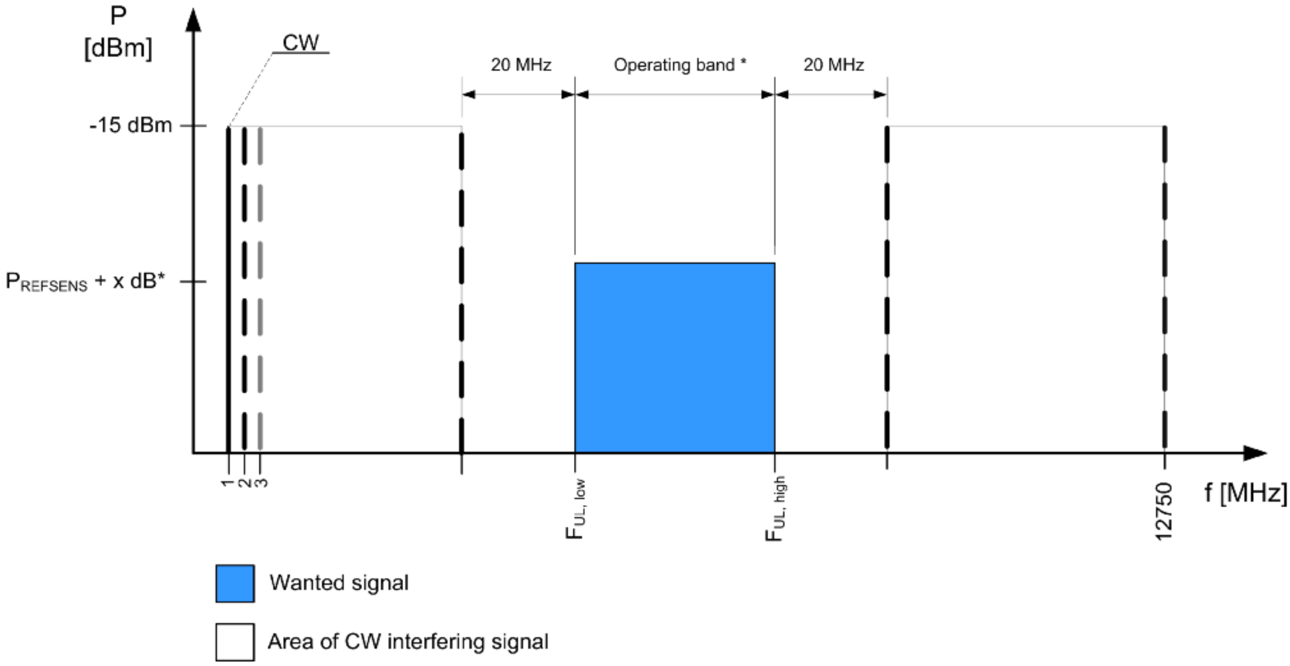


Figure 37: Overview: Out of band blocking

2. The CW interfering signal is then swept with a step size of 1 MHz within the specified range.

3. Measure the performance of the wanted signal at the BS receiver, as shown in Table 19, for the relevant carriers specified by the test configuration in chapter 1.3.2 of this application note.

Besides the general requirement, there is also a blocking requirement for co-location tests, as mentioned above in Step 1 of the test procedure. This additional blocking requirement may be applied for the protection of BS receivers when LTE, WCDMA, TD-SCDMA, or GSM/EDGE BS operating in a different frequency band are co-located with another BS. The interfering signal is again a CW carrier positioned according to table 7.5.5.2-1 of TS 37.141.

The requirement assumes a 30-dB coupling loss between the interfering transmitter and the BS receiver. For co-location with WCDMA or TD-SCDMA, the requirements are based on co-location with wide-area WCDMA or TD-SCDMA BS.

The performance requirements from Table 19 also apply for the co-location test.

3.5 Receiver spurious emissions (7.6)

The receiver spurious emissions power is the power of the emissions generated or amplified in a receiver that appear at the BS receiver antenna connector. The requirements apply to all BS with separate RX and TX ports. In this case of FDD BS, the test is performed when both TX and RX are active and with the TX port terminated.

For TDD BS with a common RX and TX antenna port, the requirement applies during the transmitter OFF period. For FDD BS with a common RX and TX antenna port, the transmitter spurious emission limits as specified in chapter 2.4 of this application note are valid.

The power of any spurious emissions must not exceed the levels in Table 23.

Table 23: General spurious emissions minimum requirement		
For BC1, BC2 and BC3 receivers, according to Table 7.6.1-1 of TS 37.104		
Frequency range	**Maximum level**	**Measurement bandwidth**
30 MHz – 1 GHz	- 57 dBm	100 kHz
1 GHz – 12.75 GHz	- 47 dBm	1 MHz
12.75 GHz - 5th harmonic of the upper frequency edge of the UL operating band in GHz (Note 2)	- 47 dBm	1 MHz
Note: The frequency range from $F_{BW\ RF,DL,low}$ – 10 MHz to $F_{BW\ RF,DL,high}$ + 10 MHz may be excluded from the requirement. Note 2: Applies only for Bands 22, 42 and 43.		

The test is performed at M_{RFBW} with the test setup shown in the following figure.

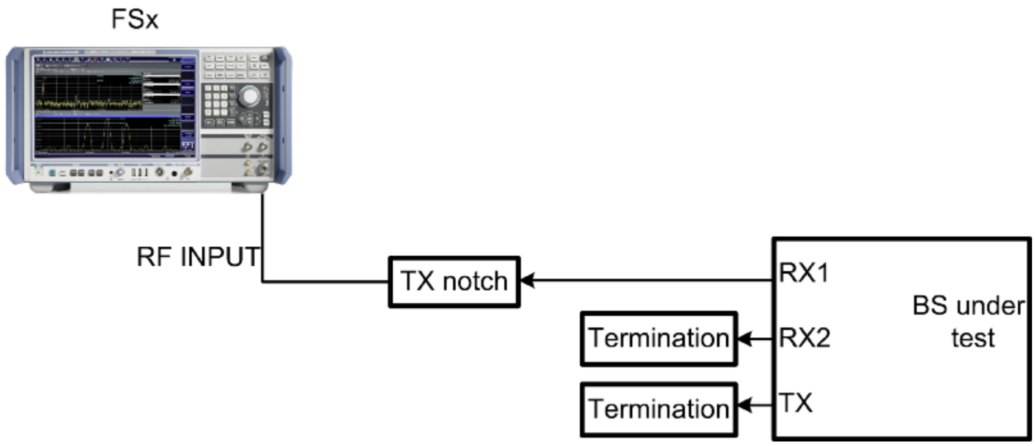


Figure 38: Test setup for receiver spurious emissions

There is an additional requirement for a BC2 BS of category B when GSM is configured. The power of any spurious emissions must not exceed the limits in Table 24.

Table 24: Receiver spurious emissions additional minimum requirements			
For BC2 BS (Category B) when GSM is configured, according to Table 7.6.2-1 from TS 37.104			
Frequency range	**Frequency offset from transmitter operating band edge**	**Maximum level**	**Measurement bandwidth**
30 MHz – 1 GHz	10 MHz to 20 MHz	-57 dBm	300 kHz
	20 MHz to 30 MHz	-57 dBm	1 MHz
	≥ 30 MHz	-57 dBm	3 MHz
1 GHz – 12.75 GHz	≥ 30 MHz	-47 dBm	3 MHz

In addition to the requirements in Table 23, the power of any spurious emission must not exceed the additional spurious emissions requirements in chapter 2.4 of this application note, and in case of FDD BS (for BC1 and BC2), emissions must not exceed the levels specified for protection of the BS receiver of the own or a different BS as in subclause 6.6.1.2 of TS 37.104. In addition, the requirements for co-location with other BS specified in subclause 6.6.1.4 of TS 37.104 may also be applied.

3.6 Receiver intermodulation (7.7)

The purpose of this measurement is to check how well the receiver of an MSR-BS can receive a reference channel while in the presence of two interferers that generate intermodulation products in the band of the reference channel.

The intermodulation measurement can be performed using two different test setups. One option is to use an SMU signal generator with two RF paths as shown in Figure 39. The useful signal is generated in the first path and overlaid with a CW interferer. This requires software option K62 (additive white Gaussian noise), which offers a mode for generating a CW interferer. The second path of the same SMU generates the modulated interferer signal.

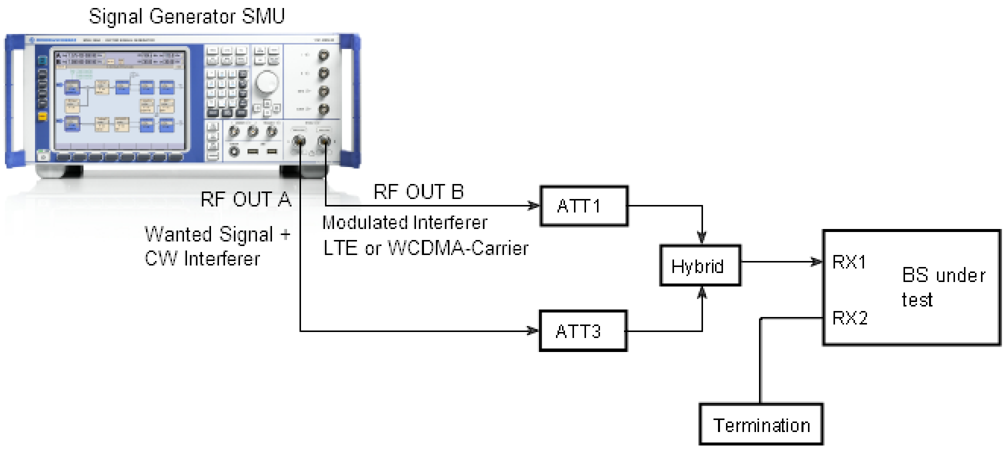


Figure 39: Setup for receiver intermodulation test with one SMU

This setup can be used when the CW interferer and the useful signal together do not exceed an RF bandwidth of 80 MHz. The CW interferer can be positioned in the range of ±40 MHz near the center frequency of RF path A set on the SMU.
As an alternative to the setup in Figure 39, it is possible to use two signal generators as shown in Figure 33, whereby the useful signal is generated in the first path of one SMU and the modulated interfering signal is generated in the other path of the same SMU. The second signal generator is responsible for generating the CW interfering signal. All RF paths are combined via hybrid combiners.

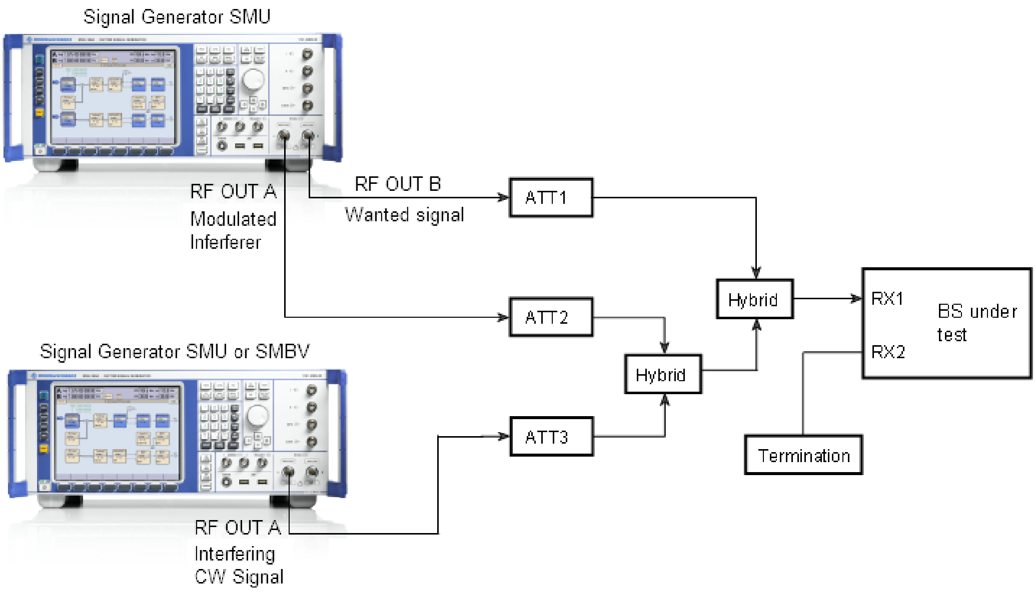


Figure 40: Alternative setup for receiver intermodulation test with two signal generators

If the test configuration of the useful signal already exceeds an RF bandwidth of 80 MHz (e.g., band 40), the first SMU in Figure 40 is used to generate the test configuration and the second SMU is used to generate the two interferers.

General intermodulation

The useful signal is configured with reference channels in accordance with the existing specifications for GSM, WCDMA, LTE, and TD-SCDMA. The two interferers include a CW signal and either a WCDMA or an LTE signal. The measurement is carried out in M_{RFBW}.

Table 25 shows the interfering signal parameters to be set.

Table 25: Interfering signals for intermodulation requirement

According to TS 37.141, Table 7.7.5.1-2

RAT of the carrier adjacent to the high (low) edge of the RF bandwidth	Interfering signal center frequency offset from the RF bandwidth edge [MHz]	Type of interfering signal
E-UTRA 1.4 MHz	±2.0 (BC1 and BC3) / ±2.1 (BC2)	CW
	±4.9	1.4 MHz E-UTRA signal
E-UTRA 3 MHz	±4.4 (BC1 and BC3) / ±4.5 (BC2)	CW
	±10.5	3 MHz E-UTRA signal
UTRA FDD and E-UTRA 5 MHz	±7.5	CW
	±17.5	5 MHz E-UTRA signal
E-UTRA 10 MHz	±7.375	CW
	±17.5	5 MHz E-UTRA signal
E-UTRA 15 MHz	±7.25	CW
	±17.5	5 MHz E-UTRA signal
E-UTRA 20 MHz	±7.125	CW
	±17.5	5 MHz E-UTRA signal
GSM/EDGE	±7.575	CW
	±17.5	5 MHz E-UTRA signal
1.28 Mcps UTRA TDD	±2.3 (BC3)	CW
	±5.6 (BC3)	1.28 Mcps UTRA TDD signal

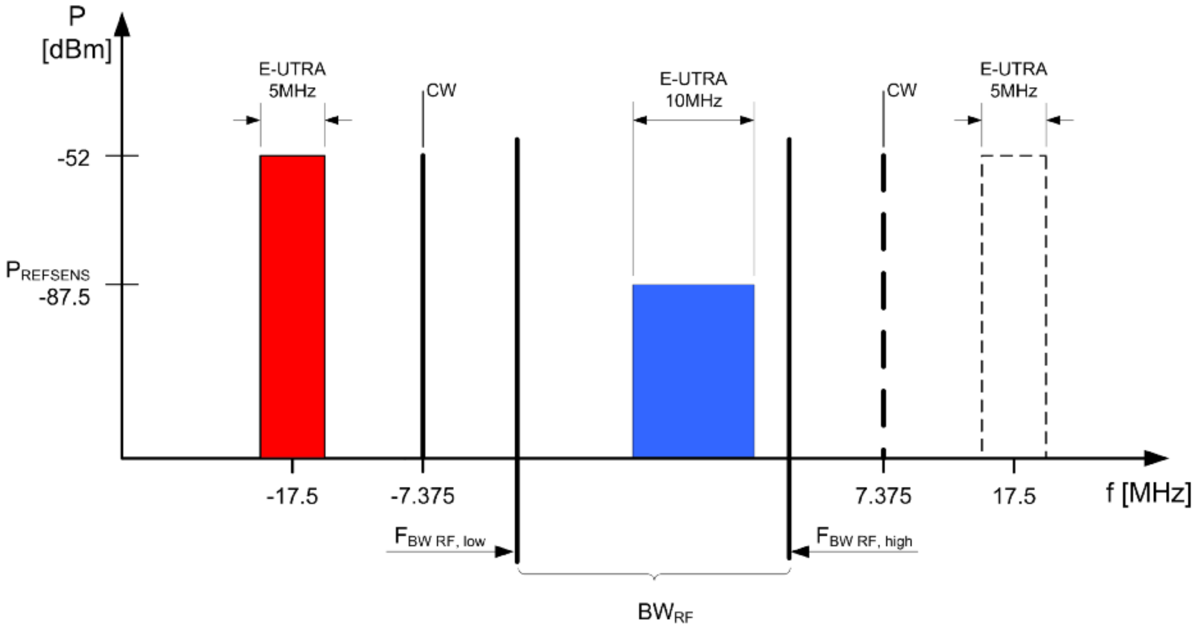


Figure 41: Overview: Intermodulation: Example for 10 MHz

Table 26 shows the minimum requirements for general intermodulation. The receiver sensitivity $P_{REFSENS}$ can be found in the existing specifications for GSM, TD-SCDMA, WCDMA, and LTE. The reference channels performance requirements are listed in Table 19.

Table 26: General intermodulation minimum requirements		
For the wanted signal according to TS 37.104, Table 7.7.1-1		
Mean power of interfering signals [dBm]	**Wanted signal mean power [dBm]**	**Type of interfering signal**
-48	$P_{REFSENS}$ + x dB*	See Table 7.7.1-2 in TS 37.104
NOTE*: $P_{REFSENS}$ depends on the RAT and on the channel bandwidth; see subclause 7.2 in TS 37.104. "x" is equal to 6 for E-UTRA or UTRA wanted signals and equal to 3 for GSM/EDGE wanted signals.		

Narrowband intermodulation

In addition to the general requirements for receiver intermodulation, new requirements were defined specifically for narrowband intermodulation. Two interfering signals are again used here, a CW and an LTE signal. The LTE signal uses only one resource block (RB); see Annex A.3 in TS 37.141. The general requirements for narrowband intermodulation are defined in Table 27.

Table 27: General narrowband intermodulation requirement		
For the wanted signal according to TS 37.104, Table 7.7.2-1		
Mean power of interfering signals [dBm]	**Wanted signal mean power [dBm]**	**Type of interfering signal**
-52	$P_{REFSENS}$ + x dB*	See 7.7.2-2 in TS 37.104
NOTE*: $P_{REFSENS}$ depends on the RAT and on the channel bandwidth; see subclause 7.2 in TS 37.104. "x" is equal to 6 for E-UTRA or UTRA wanted signals and equal to 3 for GSM/EDGE wanted signals.		

Table 28 defines the corresponding parameters for interfering signals.

Table 28: Interfering signals for narrowband intermodulation test requirement		
According to TS 37.141, Table 7.7.5.2-2		
RAT of the carrier adjacent to the high (low) edge of the RF bandwidth	**Interfering signal center frequency offset from the RF bandwidth edge [kHz]**	**Type of interfering signal**
E-UTRA 1.4 MHz	±260 (BC1 and BC3) / ±270 (BC2)	CW
	±970 (BC1 and BC3) / ±790 (BC2)	1.4 MHz E-UTRA signal, 1RB*
E-UTRA 3 MHz	±260 (BC1 and BC3) / ±270 (BC2)	CW
	±960 (BC1 and BC3) / ±780 (BC2)	3 MHz E-UTRA signal, 1 RB*
E-UTRA 5 MHz	±360	CW
	±1060	5 MHz E-UTRA signal, 1 RB*
E-UTRA 10 MHz (**)	±325	CW
	±1240	5 MHz E-UTRA signal, 1 RB*
E-UTRA 15 MHz (**)	±380	CW
	±1600	5 MHz E-UTRA signal, 1 RB*
E-UTRA 20 MHz (**)	±345	CW
	±1780	5 MHz E-UTRA signal, 1 RB*
UTRA FDD	±345 (BC1 and BC2)	CW
	±1780 (BC1 and BC2)	5 MHz E-UTRA signal, 1 RB*
GSM/EDGE	±340	CW
	±880	5 MHz E-UTRA signal, 1 RB*
1.28 Mcps UTRA TDD	±190 (BC3)	CW
	±970 (BC3)	1.4 E-UTRA signal, 1 RB*

Table 28: Interfering signals for narrowband intermodulation test requirement

According to TS 37.141, Table 7.7.5.2-2

RAT of the carrier adjacent to the high (low) edge of the RF bandwidth	Interfering signal center frequency offset from the RF bandwidth edge [kHz]	Type of interfering signal

NOTE *: Interfering signal consisting of one resource block positioned at the stated offset; the channel bandwidth of the interfering signal is located adjacent to the RF bandwidth edge.

NOTE **: This requirement applies only for an E-UTRA FRC A1-3 mapped to the frequency range at the channel edge adjacent to the interfering signals.

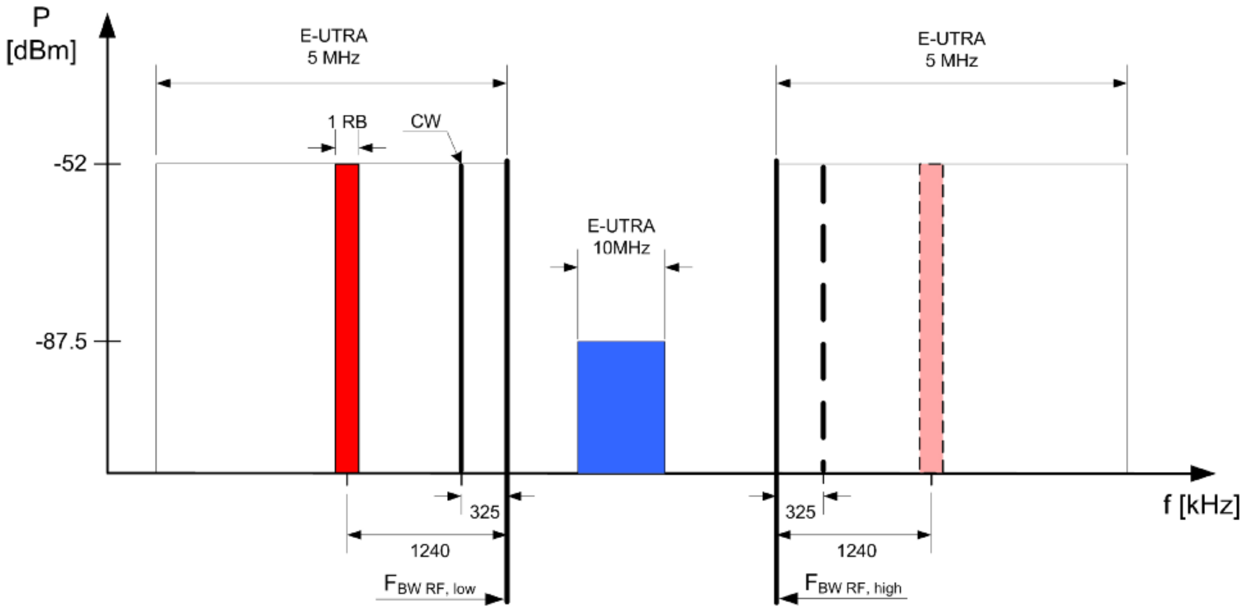


Figure 42: Overview: Narrowband Intermodulation, Example for 10 MHz

In all measurements using these interfering signals, the general performance requirements from Table 19 in section 3.3.1 apply for the useful signal reference channels.

A reference is made to TS 45.005 for an additional narrowband intermodulation requirement for GSM/EDGE.

4 Performance requirements

The performance requirements for MSR-BS have not changed. As a result, the minimum performance requirements defined in the existing specifications for GSM, WCDMA, TD-SCDMA, and LTE still apply in full. They can be found in chapter 8 of the specifications TS 36.104 for LTE, TS 25.104 for WCDMA, and TS 25.105 for TD-SCDMA, as well as sections 6.2 to 6.6 of TS 45.005 for GSM.

5 Appendix

5.1 Literature

1. **3GPP TS 37.141 V10.6.0** (2012-03) 3rd Generation Partnership Project- Technical Specification Group Radio Access Network; “E-UTRA, UTRA and GSM/EDGE, Multistandard Radio (MSR) Base Station (BS) conformance testing” (Release 9);
2. **3GPP TS 37.141 V9.4.0** (2011-06) 3rd Generation Partnership Project- Technical Specification Group Radio Access Network; “E-UTRA, UTRA and GSM/EDGE, Multistandard Radio (MSR) Base Station (BS) conformance testing” (Release 10);
3. **3GPP TS 37.104 V10.6.0** (2012-03) Technical Specification Group Radio Access Networks; “E-UTRA, UTRA and GSM/EDGE; Multistandard Radio (MSR) Base Station (BS) radio transmission and reception” (Release 9);
4. **3GPP TS 36.141 V9.8.0** (2011-06) Technical Specification Group Radio Access Network; “Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing” (Release 9);
5. **3GPP TS 36.104 V9.8.0** (2011-06) Technical Specification Group Radio Access Network; “Evolved Universal Terrestrial Radio Access (E-UTRA) Base Station (BS) radio transmission and reception”(Release 9);
6. **3GPP TS 25.141 V9.8.0** (2011-06) Technical Specification Group Radio Access Network; “Base Station (BS) conformance testing (FDD)” (Release 9);
7. **3GPP TS 25.142 V9.4.0** (2010-12) Technical Specification Group Radio Access Network; “Base Station (BS) conformance testing (TDD)” (Release 9);
8. **3GPP TS 25.104 V9.7.0** (2011-06) Technical Specification Group Radio Access Network; “Base Station (BS) radio transmission and reception (FDD)” (Release 9);
9. **3GPP TS 25.105 V9.2.0** (2010-09) Technical Specification Group Radio Access Network; “Base Station (BS) radio transmission and reception (TDD)” (Release 9);
10. **3GPP TS 45.005 V9.7.0** (2011-06) Technical Specification Group GSM/EDGE Radio Access Network; “Radio transmission and reception” (Release 9);
11. **3GPP TS 51.021 V9.6.0** (2011-06) Technical Specification Group GSM/EDGE Radio Access Network; “Base Station System (BSS) equipment specification; Radio aspects” (Release 9);
12. Rohde & Schwarz: Operating Manual: Vector Signal Generator R&S®SMU200A;
13. Rohde & Schwarz: Operating Manual: Vector Signal Analyzer R&S®FSQ;
14. Rohde & Schwarz: Operating Manual: Vector Signal Analyzer R&S®FSV;
15. Rohde & Schwarz: Operating Manual: R&S®FSQ/FSV-K100/-K102/-K104 EUTRA/LTE DL PC Software;
16. Rohde & Schwarz: 1MA169 "LTE-Advanced Technology Introduction" Application Note;
17. Rohde & Schwarz: R&S WinIQSIM2 Software Manual
18. Rohde & Schwarz: **ARB Toolbox Plus**, Application Note 1GP188
19. Rohde & Schwarz: Operating Manual: **Fehler! Hyperlink-Referenz ungültig.**
20. Rohde & Schwarz: Using R&S FSW for efficient Measurements on Multi-Standard Radio Base Stations, Application Note 1EF83.

5.2 Additional Information

This application note is subject to improvements and extensions. Please visit our website to download new versions. Please send any comments or suggestions about this application note to TM-Applications@rohde-schwarz.com.

5.3 Ordering Information

Ordering Information		
Vector Signal Generator		
SMU200A		**1141.2005.02**
SMU-B9	Baseband Generator with ARB (128 Msamples) and Digital Modulation (realtime)	1161.0766.02
SMU-B10	Baseband Generator with ARB (64 Msamples) and Digital Modulation (realtime)	1141.7007.02
SMU-B11	Baseband Generator with ARB (16 Msamples) and Digital Modulation (realtime)	1159.8411.02
SMU-B13	Baseband Main Module	1141.8003.04
SMU-B102 / B103 /B 104 / B106	1st RF Path	1141.8x03.02, x depending on frequency range
SMU-B202 / B203	2nd RF Path	1141.9x00.02, x depending on frequency range
SMU-K40	Digital Standard GSM/EDGE	1160.7609.02
SMU-K41	Digital Standard EDGE Evolution	1408.7810.02
SMU-K42	Digital Standard 3GPP FDD	1160.7909.02
SMU-K43	3GPP FDD Enhanced MS/BS Tests, incl. HSDPA	1160.9660.02
SMU-K45	Digital Standard 3GPP FDD HSUPA	1161.0666.02
SMU-K50	Digital Standard TD-SCDMA	1160.7909.02
SMU-K51	Digital Standard Enhanced TD-SCDMA	1161.1062.02
SMU-K55	Digital Standard LTE/EUTRA	1408.7310.02
SMU-K59	Digital Standard HSPA+	1415.0001.02
SMU-K69	LTE Closed-Loop BS Test	1408.8117.02
SMU-K62	Additive White Gaussian Noise (AWGN)	1159.8511.02
SMU-K84	LTE Release 9 + Enhanced Features	1408.8475.02
SMU-B14	Fading Simulator	1160.1800.02

Ordering Information		
SMU-B15	Fading Simulator Extension	1160.2288.02
SMU-K71	Dynamic fading and enhanced resolution	1160.9201.02
SMU-K74	MIMO fading	1408.7762.02
SMBV100A		**1407.6004.02**
SMBV-B106	RF 9 kHz – 6 GHz	1407.9703.02
SMBV-B10	Baseband Generator with Digital Modulation (realtime) and ARB (32 Msample), 120-MHz RF BW	407.8907.02
SMBV-B55	Memory Extension for ARB to 256 Msamples	1407.9203.02
SMBV-K40	Digital Standard GSM/EDGE	1415.8031.02
SMBV-K41	Digital Standard EDGE Evolution	1415.8460.02
SMBV-K42	Digital Standard 3GPP FDD	1415.8048.02
SMBV-K43	3GPP FDD Enhanced MS/BS Tests, incl. HSDPA	1415.8054.02
SMBV-K50	Digital Standard TD-SCDMA	1415.8125.02
SMBV-K51	TD-SCDMA Enhanced BS/MS Tests	1415.8160.02
SMBV-K55	Digital Standard EUTRA/LTE	1415.8177.02
SMBV-K62	Additive White Gaussian Noise (AWGN)	1415.8419.02
Signal generators		
SMF100A	Microwave Signal Generator	1167.0000.02
SMB100A	RF and Microwave Signal Generator	1406.6000.02
SGS100A	SGMA RF Source	1416.0505.02

Ordering Information		
Signal analyzers		
FSW	**Up to 8, 13, 26 GHz**	**1312.8000Kxx**
FSW-K72	3GPP (WCDMA) BS (DL) Analysis, incl. HSDPA and HSDPA+	1313.1422.02
FSW-K82	CDMA2000® BS Measurements	1313.1468.02
FSW-K84	1xEV-DO BS Measurements	1313.1480.02
FS-K100PC	LTE FDD DL Measurement Software	1309.9916.02
FS-K104PC	LTE TDD DL Measurement Software	1309.9951.02
FSW-B28	Analysis bandwidth extension to 28 MHz	1313.1645.02
FSW-B40	Analysis bandwidth extension to 40 MHz	1313.0861.02
FSW-B80	Analysis bandwidth extension to 80 MHz	1313.0878.02
FSW-B160	Analysis bandwidth extension to 160 MHz	1313.1668.02
FSQ	**Up to 3, 8, 26, 40 GHz**	**1313.9100.xx**
FS-K5	GSM/EDGE Application Firmware	1141.1496.02
FS-K10	GSM/EDGE/EDGE Evolution Measurements	1309.9700.02
FS-K72	3GPP BTS/Node B FDD Application Firmware	1154.7000.02
FS-K74	3GPP HSDPA BTS Application Firmware	1300.7156.02
FS-K74+	3GPP HSPA+ BTS Application Firmware	1309.9180.02
FS-K76	3GPP TD-SCDMA BTS Application Firmware	1300.7291.02
FS-K100	EUTRA/LTE Downlink	1308.9006.02
FS-K104	EUTRA/LTE Downlink, TDD	1309.9422.02
FSV	**Up to 3, 7, 13, 30, 40 GHz**	**1307.9002.xx**
FSV-K10	GSM/EDGE Analysis	1310.8055.02
FSV-K72	3GPP FDD BS Analysis	1310.8503.02
FSV-K76	TD-SCDMA BTS Measurements	1310.8603.02
FSV-K100	EUTRA/LTE Downlink	1310.9051.02
FSV-K104	EUTRA/LTE Downlink, TDD	1309.9774.02

If using the R&S® WinIQSIM2™ with SMBV or SMU to generate standard signals, you must include the appropriate K2x option, where x refers to the standard to be used as defined in this table. For example, to generate GSM/EDGE signals with WinIQSIM2, you need option K-240.

xx represents the various frequency ranges (e.g. 1155.5001.26 up to 26 GHz).

Note: Available options are not listed in detail. Please contact your local Rohde & Schwarz sales office for further assistance.

5.4 Abbreviations

3GPP	3rd Generation Partnership Project
BC	Band Category
BER	Bit Error Rate
BLER	Block Error Rate
BS	Base Station
BW	Bandwidth
CDMA	Code Division Multiple Access
CW	Continuous Wave
DL	Downlink
EDGE	Enhanced Data Rates for GSM Evolution
EVM	Error Vector Magnitude
E-UTRA	Evolved – UTRA
FDD	Frequency Division Duplexing
GSM	Global System for Mobile Communications
ITU-R	International Telecommunication Union – Radiocommunication Sector
MS	Mobile Station
MSR	Multistandard Radio
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
PHS	Personal Handyphone System
RAT	Radio Access Technology
RB	Resource Block (for E-UTRA)
RF	Radio Frequency
RMS	Root Mean Square
RS	Reference Symbol
RX	Receiver
TC	Test Configuration
TD-SCDMA	Time Division – Synchronous CDMA
TS	Technical Specification
TSG RAN	Technical Specification Group Radio Access Network
TX	Transmitter
TDD	Time Division Duplexing
UE	User Equipment
UL	Uplink
UTRA	Universal Terrestrial Radio Access
WCDMA	Wideband CDMA
WG	Working Group

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Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established more than 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

Environmental commitment

- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

Certified Quality System
ISO 9001

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