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Foreword

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1 Scope

The present document is the Technical Report for the Work Item on Multi-band and Multi-standard radio BS requirements.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 25.104: "Base Station (BS) radio transmission and reception (FDD)".

[3] 3GPP TS 25.105: "Base Station (BS) radio transmission and reception (TDD)".

[4] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception".

[5] 3GPP TS 45.005: "Radio transmission and reception".

[6] 3GPP TS 37.104: "E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) radio transmission and reception".

[7] 3GPP TR 37.900: "Radio Frequency (RF) requirements for Multicarrier and Multiple Radio Access Technology (Multi-RAT) Base Station (BS)".

[8] 3GPP TR 37.802: "Multi-standard radio Base Station (BS) Radio Frequency (RF) requirements for non-contiguous spectrum deployments".

[9] 3GPP TR 25.942: "Radio Frequency (RF) system scenarios".

[10] 3GPP TR 25.951: "FDD Base Station (BS) classification".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [x].

Band category: A group of operating bands for which the same MSR scenarios apply

Base Station RF bandwidth: The bandwidth in which a Base Station transmits and receives multiple carriers and/or RATs simultaneously within each supported operating band

Base Station RF bandwidth edge: The frequency of one of the edges of the Base Station RF bandwidth

Carrier: The modulated waveform conveying the E-UTRA, UTRA or GSM/EDGE physical channels

Carrier aggregation: aggregation of two or more E-UTRA component carriers in order to support wider transmission bandwidths

Carrier aggregation band: a set of one or more operating bands across which multiple E-UTRA carriers are aggregated with a specific set of technical requirements.

NOTE: Carrier aggregation band(s) for an E-UTRA BS is declared by the manufacturer according to the designations in Tables 5.5-2 to 5.5-3 of TS 36.104 [4]

Channel bandwidth: The bandwidth supporting a single E-UTRA, UTRA or GSM/EDGE RF carrier with the transmission bandwidth configured in the uplink or downlink of a cell. The channel bandwidth is measured in MHz and is used as a reference for transmitter and receiver RF requirements.

Contiguous carriers: a set of two or more carriers configured in a spectrum block where there are no RF requirements based on co-existence for un-coordinated operation within the spectrum block.

Carrier power: The power at the antenna connector in the channel bandwidth of the carrier averaged over at least one subframe for E-UTRA, at least one slot for UTRA and the useful part of the burst for GSM/EDGE.

Configured carrier power: Target maximum power for a specific carrier for the operating mode set in the BS

Contiguous spectrum: Spectrum consisting of a contiguous block of spectrum with no sub-block gaps.

Downlink operating band: The part of the operating band designated for downlink.

Inter RF bandwidth gap: The frequency gap between two consecutive RF bandwidths that respectively correspond to two supported operating bands.

Inter-band carrier aggregation: carrier aggregation of E-UTRA component carriers in different operating bands**.**

NOTE: Carriers aggregated in each band can be contiguous or non-contiguous.

Intra-band contiguous carrier aggregation: contiguous E-UTRA carriers aggregated in the same operating band.

Intra-band non-contiguous carrier aggregation: non-contiguous E-UTRA carriers aggregated in the same operating band.

Lower RF bandwidth edge: The frequency of the lower edge of the Base Station RF bandwidth, used as a frequency reference point for transmitter and receiver requirements**.**

Lower sub-block edge: The frequency at the lower edge of one sub-block. It is used as a frequency reference point for both transmitter and receiver requirements.

Maximum Base Station RF bandwidth: The maximum RF bandwidth supported by a BS within each supported operating band.

NOTE: The Maximum Base Station RF bandwidth for BS configured for contiguous and non-contiguous operation within each supported operating band is declared separately.

Maximum carrier output power: Carrier power available at the antenna connector for a specified reference condition.

Maximum RAT output power: The sum of the power of all carriers of the same RAT available at the antenna connector for a specified reference condition.

Maximum throughput: The maximum achievable throughput for a reference measurement channel.

Maximum total output power: The sum of the power of all carriers available at the antenna connector for a specified reference condition.

MB-MSR Base Station: MSR Base Station characterized by the ability of its transmitter and/or receiver to process two or more carriers in common active RF components simultaneously, where at least one carrier is configured at a different operating band than the other carrier(s).

Measurement bandwidth: The bandwidth in which an emission level is specified.

MSR Base station: Base Station characterized by the ability of its receiver and transmitter to process two or more carriers in common active RF components simultaneously in a declared RF bandwidth, where at least one carrier is of a different RAT than the other carrier(s).

Multi-band transmitter: Transmitter characterized by the ability to process two or more carriers in common active RF components simultaneously, where at least one carrier is configured at a different operating band than the other carrier(s).

Multi-band receiver: Receiver characterized by the ability to process two or more carriers in common active RF components simultaneously, where at least one carrier is configured at a different operating band than the other carrier(s).

Non-contiguous spectrum: Spectrum consisting of two or more sub-blocks separated by sub-block gap(s).

Occupied bandwidth: The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage $\beta/2$ of the total mean power of a given emission.

Operating band: A frequency range in which E-UTRA, UTRA or GSM/EDGE operates (paired or unpaired), that is defined with a specific set of technical requirements**.**

NOTE: The operating band(s) for a BS is declared by the manufacturer.

Sub-block: This is one contiguous allocated block of spectrum for use by the same Base Station. There may be multiple instances of sub-blocks within an RF bandwidth.

Sub-block bandwidth: The bandwidth of one sub-block.

Sub-block gap: A frequency gap between two consecutive sub-blocks within an RF bandwidth, where the RF requirements in the gap are based on co-existence for un-coordinated operation.

Synchronized operation: Operation of TDD in two different systems, where no simultaneous uplink and downlink occur.

Throughput: The number of payload bits successfully received per second for a reference measurement channel in a specified reference condition.

Transmission bandwidth: Bandwidth of an instantaneous E-UTRA transmission from a UE or BS, measured in Resource Block units.

Transmitter ON period: The time period during which the BS transmitter is transmitting data and/or reference symbols

Transmitter OFF period: The time period during which the BS transmitter is not allowed to transmit

Transmitter transient period: The time period during which the transmitter is changing from the OFF period to the ON period or vice versa

Unsynchronized operation: Operation of TDD in two different systems, where the conditions for synchronized operation are not met.

Uplink operating band: The part of the operating band designated for uplink.

Upper RF bandwidth edge: The frequency of the upper edge of the Base Station RF bandwidth, used as a frequency reference point for transmitter and receiver requirements

Upper sub-block edge: The frequency at the upper edge of one sub-block. It is used as a frequency reference point for both transmitter and receiver requirements.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

β	Percentage of the mean transmitted power emitted outside the occupied bandwidth on the assigned channel
$BW_{Channel}$	Channel bandwidth (for E-UTRA)

BW_{RF}	Base Station RF bandwidth, where $BW_{RF} = F_{BW\ RF,high} – F_{BW\ RF,low}$
$BW_{RF,max}$	Maximum Base Station RF bandwidth
DwPTS	Downlink part of the special subframe (for E-UTRA TDD operation)
f	Frequency
Δf	Separation between the Base Station RF bandwidth edge frequency and the nominal -3dB point of the measuring filter closest to the carrier frequency
Δf_{max}	The largest value of Δf used for defining the requirement
F_C	Carrier centre frequency
F_{filter}	Filter centre frequency
f_offset	Separation between the Base Station RF bandwidth edge frequency and the centre of the measuring filter
f_offset_{max}	The maximum value of f_offset used for defining the requirement
$F_{block,high}$	Upper sub-block edge, where $F_{block,high} = F_{C,block,high} + F_{offset,\ RAT}$
$F_{block,low}$	Lower sub-block edge, where $F_{block,low} = F_{C,block,low} - F_{offset,\ RAT}$
$F_{BW\ RF,high}$	Upper RF bandwidth edge, where $F_{BW\ RF,high} = F_{C,high} + F_{offset,\ RAT}$
$F_{BW\ RF,low}$	Lower RF bandwidth edge, where $F_{BW\ RF,low} = F_{C,low} - F_{offset,\ RAT}$
$F_{C,block,high}$	Center frequency of the highest transmitted/received carrier in a sub-block.
$F_{C,block,low}$	Center frequency of the lowest transmitted/received carrier in a sub-block.
$F_{C,high}$	Center frequency of the highest transmitted/received carrier.
$F_{C,low}$	Center frequency of the lowest transmitted/received carrier.
$F_{offset,\ RAT}$	Frequency offset from the centre frequency of the *highest* transmitted/received carrier to the *upper* RF bandwidth edge or sub-block edge, or from the centre frequency of the *lowest* transmitted/received to the *lower* RF bandwidth edge or sub-block edge for a specific RAT.
F_{DL_low}	The lowest frequency of the downlink operating band
F_{DL_high}	The highest frequency of the downlink operating band
F_{UL_low}	The lowest frequency of the uplink operating band
F_{UL_high}	The highest frequency of the uplink operating band
$P_{EM,N}$	Declared emission level for channel N
P_{max}	Maximum total output power
$P_{max,RAT}$	Maximum RAT output power
$P_{max,c}$	Maximum carrier output power
$P_{REFSENS}$	Reference Sensitivity power level
W_{gap}	Sub-block gap or inter RF bandwidth gap size

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [x] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
ARFCN	Absolute Radio Frequency Channel Number
AWGN	Additive White Gaussian Noise
BC	Band Category
BER	Bit Error Ratio
BS	Base Station
BTS	Base Transceiver Station
CA	Carrier Aggregation
CACLR	Cumulative Adjacent Channel Leakage Ratio
CP	Cyclic prefix
CW	Continuous Wave
DB-DC-HSDPA	Dual Band Dual Cell HSDPA
DC-HSDPA	Dual Cell HSDPA
DC-HSUPA	Dual Cell HSUPA
DTT	Digital Terrestrial Television
EARFCN	E-UTRA Absolute Radio Frequency Channel Number
EDGE	Enhanced Data rates for GSM Evolution
EIRP	Effective Isotropic Radiated Power
EVM	Error Vector Magnitude
FCC	Federal Communications Commission
FDD	Frequency Division Duplex

FRC	Fixed Reference Channel
GP	Guard Period (for E-UTRA TDD operation)
GSM	Global System for Mobile Communications
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
ICS	In-Channel Selectivity
ITU-R	Radiocommunication Sector of the ITU
LNA	Low Noise Amplifier
MIMO	Multiple Input Multiple Output
MB-MSR	Multi-Band Multi-Standard Radio
MS	Mobile Station
MSR	Multi-Standard Radio
PA	Power Amplifier
PHS	Personal Handyphone System
QPSK	Quadrature Phase-Shift Keying
RAT	Radio Access Technology
RB	Resource Block (for E-UTRA)
RF	Radio Frequency
RMS	Root Mean Square (value)
RS	Reference Symbol
RX	Receiver
SNR	Signal-to-Noise Ratio
TDD	Time Division Duplex
TX	Transmitter
UARFCN	UTRA Absolute Radio Frequency Channel Number
UE	User Equipment
UEM	operating band Unwanted Emissions Mask

4 General

Currently, MSR requirements (including contiguous and non-contiguous MSR) only apply for single band BS. For some adjacent bands, say band 8 and band 20, RF technologies is mature enough to allow a MSR base station (BS) to support simultaneous multiple band and multiple RATs transmission and/or reception through a common radio. Such a BS supporting both multi-band (MB) and MSR (including contiguous and non-contiguous) can be called MB-MSR base station. The most important feature of an MB-MSR BS is to support dynamic power sharing between different bands and hence allow operators more flexibility in the network deployment. From the site engineering point of view, an MB-MSR BS can reduce installation complexity for different bands at the same site. Furthermore, MB-MSR BS can reduce insertion loss for the antenna sharing dual-band scenario since no combiner is needed.

RF requirements for MB-MSR are not defined yet. And some of the existing MSR RF requirements based on the single band scenario cannot be directly reused for an MB-MSR base station. Therefore, both core and test requirements need to be updated for MB-MSR base station based on identified multi-band application scenarios.

One typical application scenario for MB-MSR BS is band 20 + band 8 but other band combinations in different regions (e.g. band 12/13/14/17 + band 5, band 3 + band 1, band 2 + band 4) may also be feasible.

4.1 Work item objective

The objective of MB-MSR Work Item is to specify the RF requirements for multi-band MSR (MB-MSR) BS. The requirements for MB-MSR BS are based on macro-cell deployment scenarios. The requirements based on Micro and Pico deployment scenarios will be developed in a second step.

All single- and multi-RAT configurations (excluding only GSM+GSM) in the different bands shall be considered.

UTRA MC-HSPA as well as EUTRA Carrier Aggregation, and transmit power imbalance between bands / carriers shall be considered. The RF requirements of the existing Base Station types will remain and be applicable within their current scope. For a MB-MSR Base Station, the new RF requirements will be applicable for that equipment.

The work will focus on the following steps:

1. Develop the framework of the RF requirements for MB-MSR BS, using band 20 + band 8 as an initial scenario for FDD and band 34 + band 39 as an initial scenario for TDD.
2. Identify additional deployment scenarios and band combinations for MB-MSR BS.
3. Define the MB-MSR BS based on common transmitter and/or receiver RF chain for the multiple bands.
4. Creation of core requirements for MB-MSR BS for all the identified deployment scenarios and band combinations with an initial focus on the completion of requirements for band 20 + band 8 and band 34 + band 39.
5. The existing per band requirement should be maintained wherever possible.
6. Development of test configurations and specification of the test requirements corresponding to the modified core requirements.

The following specification work is required:

a. Core RF requirements for RAN4 MSR specifications.

b. Test requirements for RAN4 MSR specifications, derived from the core RF requirements.

4.2 Relation to other RAN and GERAN specifications

Requirements for an MSR BS can be divided into three types, depending on their relation to the single-RAT specifications, i.e., Generic MSR requirement, Generic MSR requirement, with additional single-RAT requirements and Single-RAT only requirements.

Table 4.2-1 lists the corresponding types for all TX and RX requirements.

Table 4.2-1 MSR requirements and corresponding types

RF requirement	Requirements type
Base station output power	Generic MSR requirement
Output power dynamics	Single-RAT only requirements
Transmitted signal quality	Single-RAT only requirements
Modulation quality	Single-RAT only requirements
Frequency error	Single-RAT only requirements
Time alignment error	Single-RAT only requirements
Unwanted emissions	
Transmitter spurious emissions	Generic MSR requirement
Operating band unwanted emissions	Generic MSR requirement, with additional single-RAT requirements
Occupied bandwidth	Generic MSR requirement
ACLR	Single-RAT only requirements
Transmitter intermodulation	Generic MSR requirement
Reference sensitivity level	Single-RAT only requirements
Dynamic range	Single-RAT only requirements
In-band selectivity and blocking	
Blocking	Generic MSR requirement
Narrowband blocking	Generic MSR requirement, with additional single-RAT requirements
Out-of-band blocking	Generic MSR requirement
Receiver spurious emissions	Generic MSR requirement
Receiver intermodulation	
Intermodulation	Generic MSR requirement
Narrowband intermodulation	Generic MSR requirement, with additional single-RAT requirements
In-channel selectivity	Single-RAT only requirements

Single-RAT only requirements are those requirements specified through references to the respective single-RAT specifications. As listed in above table, all these requirements are in-band requirements which shall not be affected due to introduction of MB-MSR.

Another type of requirements which have relationship with other single-RAT specifications is generic MSR requirement, with additional single-RAT requirements. Additional single-RAT requirements are specified for GSM/EDGE only for operating band unwanted emissions, narrowband blocking and narrowband intermodulation.

Requirements for MB-MSR BS are mainly developed based on generic MSR requirements.

The relation to the single-RAT specification can be kept unchanged for MB-MSR BS. No changes will be needed for TS 37.104 in the general subclause 4.1 for "Relation to other RAN and GERAN specifications".

4.3 Regional requirements

Some requirements specified for MB-MSR BS may only apply in certain regions either as optional requirements, or set by local and regional regulation as mandatory requirements.

Since all the regional requirements listed in Table 4.4-1 of specification TS37.104 are independent of BS capability, no changes are needed for MB-MSR.

4.4 Manufacturer's declaration

For BS capable of multi-band operation, the existing set of parameters in sub-clause 4.7.2 in TS 37.141 can be applied for each operating band. In addition, manufacturer's declaration shall reflect the capability of total resources for all supported operating bands such as the rated total output power, total number of supported carriers and total bandwidth of transmitter and receiver.

The following additional declarations need to be considered for BS capable of multi-band operation:

- Supported operating band combinations of the BS
- Supported operating band(s) of each antenna connector
- Total number of supported carriers for the declared band combinations of the BS
- Total bandwidth of transmitter and receiver (sum of RF bandwidths in all supported operating bands) for the declared band combinations of the BS
- Total output power as a sum over all supported operating bands in the declared band combinations of the BS

Note that other parameters are for further studies.

4.5 Applicability of MB-MSR requirements

Most core requirements in TS 37.104 remain unchanged for BS capable of multi-band operation and apply as they are stated for each of the operating bands. There will be a few exceptions where there are specific additions or exclusions. In order to make this fact clear to a reader of the specification, it should be made visible by having a separate subclause for BS capable of multi-band operation in the general clause 4 of the specification.

The clause can be quite short and should explain that for BS capable of multi-band operation, the RF requirements in clause 6 and 7 apply for each operating band unless otherwise stated and that for some requirements it is explicitly stated that specific additions or exclusions to the requirement apply for multi-band BS operation.

There is also a need to update the tables in clause 5.1 (Applicability of requirements) to reflect that requirements apply for each band.

For MB-MSR base station, various possible structures based on combination of different transmitter and receiver implementations (multi-band or single band) as well as mapping of transceivers to antenna ports in different ways are captured in subclause 5.3. Independent of the BS structure, the core requirements shall be developed in a BS implementation agnostic way.

5 MB-MSR deployment scenarios

5.1 Definitions and terminology

The definitions of operating bands, band numbering, channel arrangements, channel spacing, channel raster and channel numbering remain from what is defined for MSR in TR 37.900.

The definitions of the RF bandwidth and related parameters remain from what is defined for MSR in TR 37. 900 for each operating band. Therefore, RF bandwidth definition needs a minor modification to specify that it is defined within each operating band that is supported by an MSR or MB-MSR BS. This modification should have consistent meaning for MSR-NC as well and no impact on the current MSR-NC requirements is expected.

Base Station RF bandwidth: The bandwidth in which a Base Station transmits and receives multiple carriers and/or RATs simultaneously within each supported operating band.

Maximum Base Station RF bandwidth: The maximum RF bandwidth supported by a BS within each supported operating band.

For MB-MSR, an additional definition "inter RF bandwidth gap" needs to be defined for the following reason. For a multi-band scenario, the spectrum occupied can cross multiple bands that are supported by an MB-MSR BS and it can also be contiguous or non-contiguous in each supported band. The requirements outside the edges of the RF bandwidth in each operating band are defined as for any MSR BS. For small RF bandwidth gaps however, considering that a common radio is shared between these different bands, the requirements inside the inter RF bandwidth gap will need similar consideration as requirements inside a sub-block gap for the single band MSR-NC case.

Inter RF bandwidth gap: The frequency gap between two consecutive RF bandwidths that respectively correspond to two supported operating bands.

Figure 5.1-1 and Figure 5.1-2 illustrate that the terminology and symbols that apply for MB-MSR inter RF bandwidth gap between multiple bands.

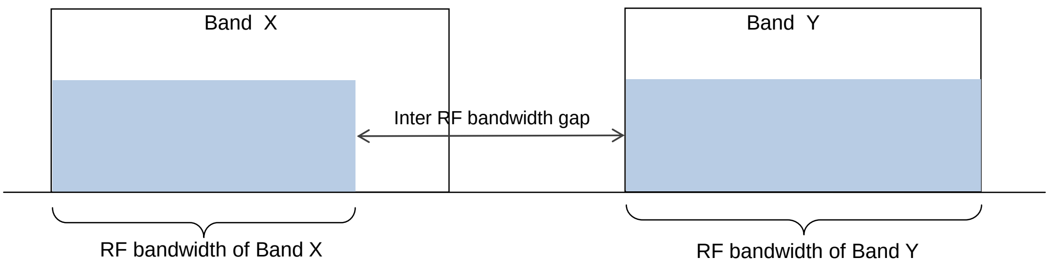

Figure 5.1-1: Graphical description of suggested terminology

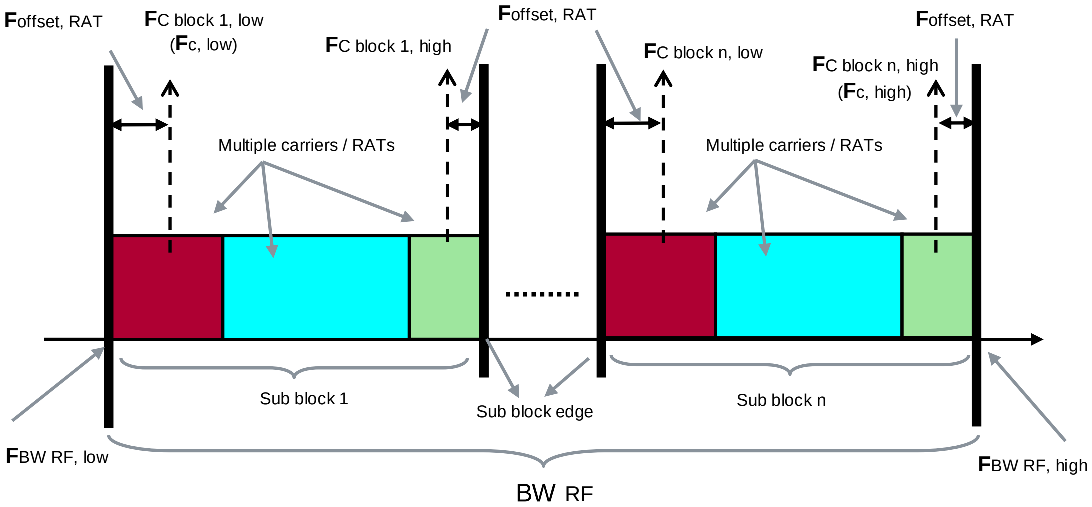

Figure 5.1-2: Illustration of RF bandwidth and related parameters in one supported operating band

5.2 Relation to legacy deployment

MB-MSR base station is a new type of MSR base station which can support multiple bands and multiple RATs transmission and/or reception through a common radio. Compared to the legacy multiple bands deployment, it can reduce site space, installation complexity as well as the insertion loss of cables at the same time for the multiple bands antenna sharing scenario.

The existing site infrastructures such as any external filters, feeder cables and antennas are expected to be foreword compatible and reused in an upgrade of MB-MSR base station. The performance of the whole system with legacy site equipments and upgraded base station should not degrade. However, benefit from support of multiple bands in a single base station, some legacy external devices like combiner between multiple bands and feeders/jumpers connected to the combiner could be saved. From this aspect, deployment based on MB-MSR base station can potential improves the site performance and efficiency compared to the legacy deployment. Same as the deployment with legacy base station, passive intermodulation (PIM) product also can be generated in the site devices for MB-MSR BS deployment. This part will be studied further in PIM SI and not involved in this section.

Exclusion bands shall be considered in all supported operating bands in EMC testing for MB-MSR base station.

5.3 Application scenarios

MB-MSR is applied for operators who have two or more close spectrum blocks belong to different bands. The spectrum blocks in each band could be contiguous or non-contiguous spectrum. With the state-of-the-art RF technology, the BS could support RF bandwidth of several hundred MHz at the same time. For some adjacent bands, for example band 8 and band 20, RF technology is mature enough to allow a MSR base station (BS) to support simultaneous multiple bands and multiple RATs through a common radio.

Considering the hardware capability and global spectrum allocation, the following example scenarios are possible band combinations covering different regions, which do not exclude other combinations with further study.

- 800MHz (Band 20)+900MHz (Band 8)
- 1.8GHz (Band 3)+2.1GHz (Band 1)
- Group of Region 2 Bands in 700MHz (Bands 12, 13, 14, 17) + 850MHz (Band 5)
- PCS band (Band 2) + AWS band (Band 4)
- Band 34 + Band 39

With the development of the technology, more scenarios would be supported for MB-MSR. If no requirement is identified that must be specific to a certain band combination or that excludes certain combinations, generic requirements applying to any band combination should be developed. For this reason, the MB-MSR specification should not have to be limited to any specific set of band combinations. If band combinations are identified that will need specific requirements, they will be covered if time permits.

MB-MSR base station should support evolution from single band to two or more bands application. Operators who have two close bands could deploy a MB-MSR base station at one band initially, and upgrade it to two bands sharing a common radio without further hardware investment.

MB-MSR application scenarios are quite generic and cover the band combinations where there is possibility to have multi-band implementation of receiver and transmitter. Given the generic approach of defining MB-MSR requirements, there is no restriction posed on specific scenarios, but the band combinations supported by MB-MSR should be declared.

The MB-MSR application scenarios also cover both FDD and TDD, but are limited to MB-MSR for FDD only scenarios and TDD only scenarios respectively.

Possible MB-MSR structures and configurations based on combining different receiver/transmitter implementations (multi-band or single band), as well as mapping receive and transmit signals on antenna ports in different ways are also relevant scenarios which are accommodated by the MB-MSR WI. The MB-MSR structure and configurations is further discussed in sub-clause 5.3.1

5.3.1 Structure, scope and configurations

5.3.1.1 FDD aspects

There are various possible implementations for receiver and transmitter as shown in figure 5.3.1.1-1. One possible approach is to use multi-band receive/transmitter implementation for MB-MSR which can cover multiple band. Other implementation approaches could be to have receiver/transmitter implementation covering a single band.

Based on the definition for MB-MSR BS, the following definitions can be set for the multi-band transmitter and receiver:

Multi-band transmitter: Transmitter characterized by the ability to process two or more carriers in common active RF components simultaneously, where at least one carrier is configured at a different operating band than the other carrier(s).

Multi-band receiver: Receiver characterized by the ability to process two or more carriers in common active RF components simultaneously, where at least one carrier is configured at a different operating band than the other carrier(s).

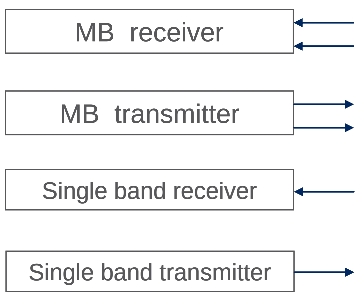

Figure 5.3.1.1-1: Possible logical implementation of receivers and transmitters

Considering the intention with MB-MSR, several possible MB-MSR structures assuming any of the above implementation approaches shall be possible. As an example for MB-MSR structure, Figure 5.3.1.1-2 shows a combination of a multi-band receiver and transmitter which can map the concerned bands on one antenna port, or alternatively map each band on separate ports. It is also possible to map the concerned transmitters on one port while the receivers are connected to the other port. The separation of transmit and receive can be deployed to combat and mitigate possible PIM issues which is the topic of a parallel study item.

Note that the box for filters in Figure 5.3.1.1-2 would represent different possible combination of band pass and diplexer filters, depending on the chosen implementation structure.

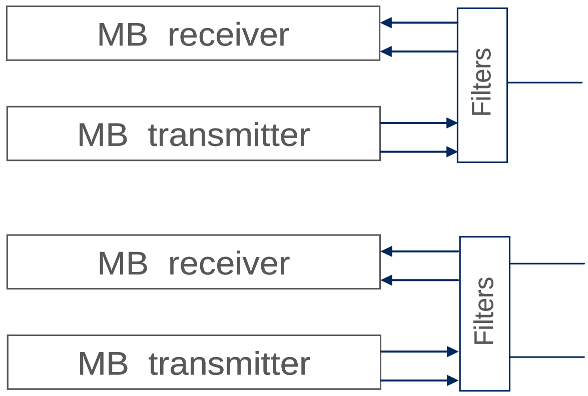

Figure 5.3.1.1-2: MB-MSR example structure using multi-band receiver and transmitter combining the bands in one port or two ports

Another example structure (see figure 5.3.1.1-3) would be to combine a multi-band transmitter with single band receivers where every individual receiver would have a maximum RFBW equal to or lower than the concerned UL band, where the mapping of transmitter and receivers towards one or two ports can be similar to what is described above.

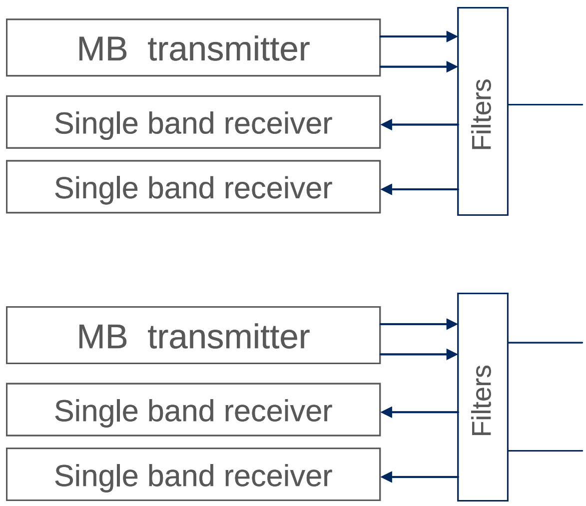

Figure 5.3.1.1-3: MB-MSR example structure using multi-band transmitter and single band receiver combining the bands in one port or two ports

Looking into the discussed band combinations, the combination of band 8 and band 20 would be a typical example to combine a multi-band receiver with single band transmitters with maximum RFBW equal to or less than the concerned bands as shown in figure 5.3.1.1-4.

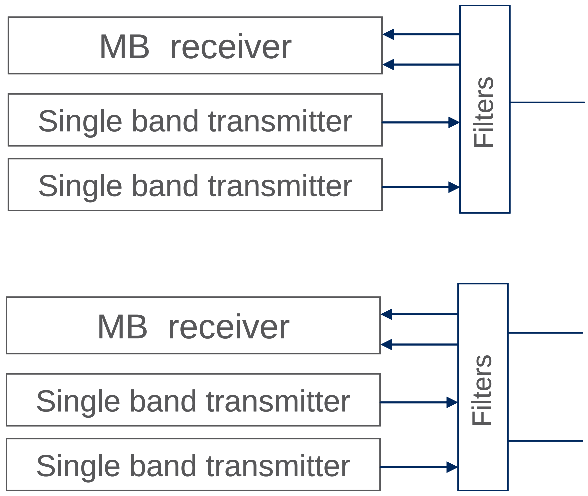

Figure 5.3.1.1-4: MB-MSR example structure using multi-band receiver and single band transmitter combining the bands in one port or two ports

The MB-MSR specification should not pose any restriction on the chosen combination of transmitter/receiver or the structure, as long as generic requirements handle the specific characteristics of the MB-MSR BS. It should be noted that the chosen structure should be parameterized, which would require an extension of the MSR declaration.

This also means that the MB-MSR scope of work should not restrict any structure or configuration. There should be proper requirement coverage (generic requirements) to allow for all possible combinations of multi-band transmitters/receivers with single band transmitters/receivers as well as mapping of transmitters and receivers to antenna ports in different ways, as visualized in the generic illustrations of Figure 5.3.1.1-5.

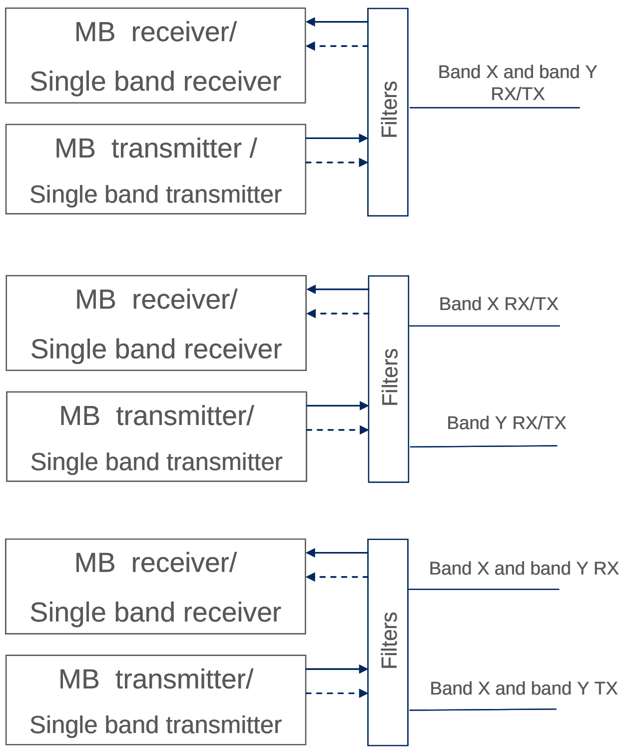

Figure 5.3.1.1-5: MB-MSR proposed structures included in the scope. Note that for each structure, at least the transmitter or the receiver has to be multi-band.

If possible, the generic requirements developed should handle WA applications as well as low power MR and LA BS applications, assuming that no additional conditions are identified for MR and LA BS. It is noted that once the principles of defining generic MB-MSR requirements is settled, there should be little or no additional work to accommodate all BS classes.

The declaration part of MB-MSR will require additional parameters, such as the supported MB-MSR bands, total maximum RFBW for transmitter and receiver, and maximum transmitter and receiver RFBW if a single band implementation is included in the structure.

5.3.1.2 TDD aspects

MB-MSR should be handled with generic requirements and thus should accommodate any combination of multi-band or single-band receivers and transmitters. Depending on the scenario and need, the MB-MSR WI should cover different possible mappings of transmit and receive signals through one or two antennas.

Given the MB-MSR generic approach, the principles above should be valid also for TDD MB-MSR. Possible structures for TDD MB-MSR are summarized below in Figures 5.3.1.2-1 to 5.3.1.2-4. These structures are examples among possible different implementations.

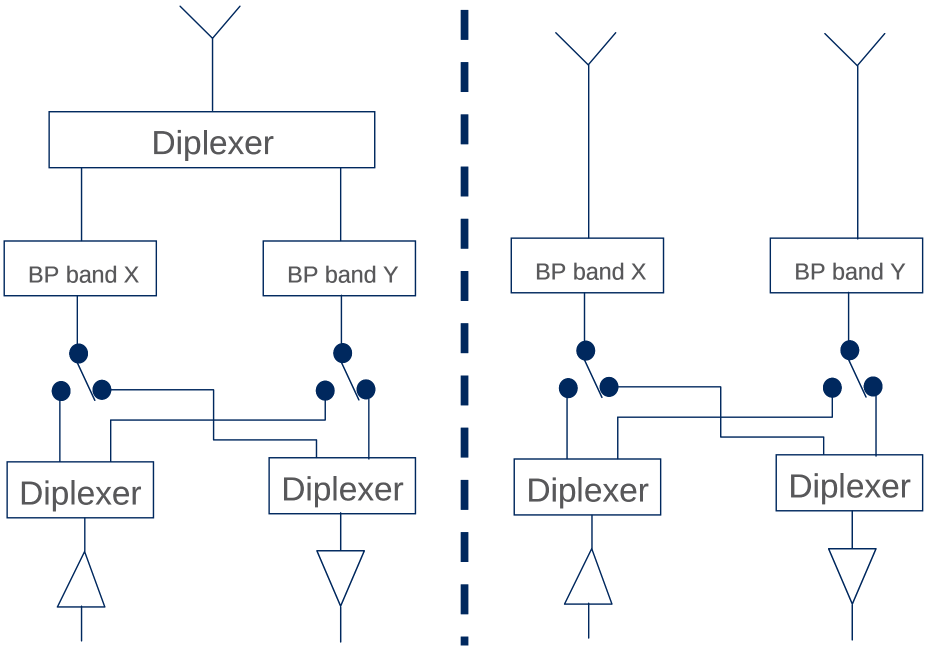

Figure 5.3.1.2-1: Example of Multi-band receiver and transmitter mapped into one and two antennas respectively

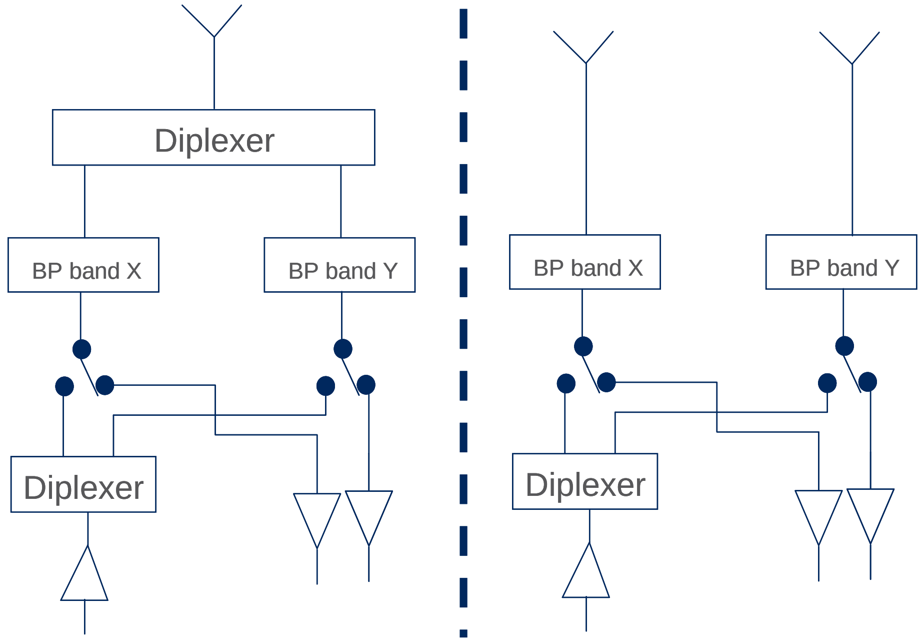

Figure 5.3.1.2-2: Example of Multi-band transmitter combined with single-band receivers mapped into one and two antennas respectively

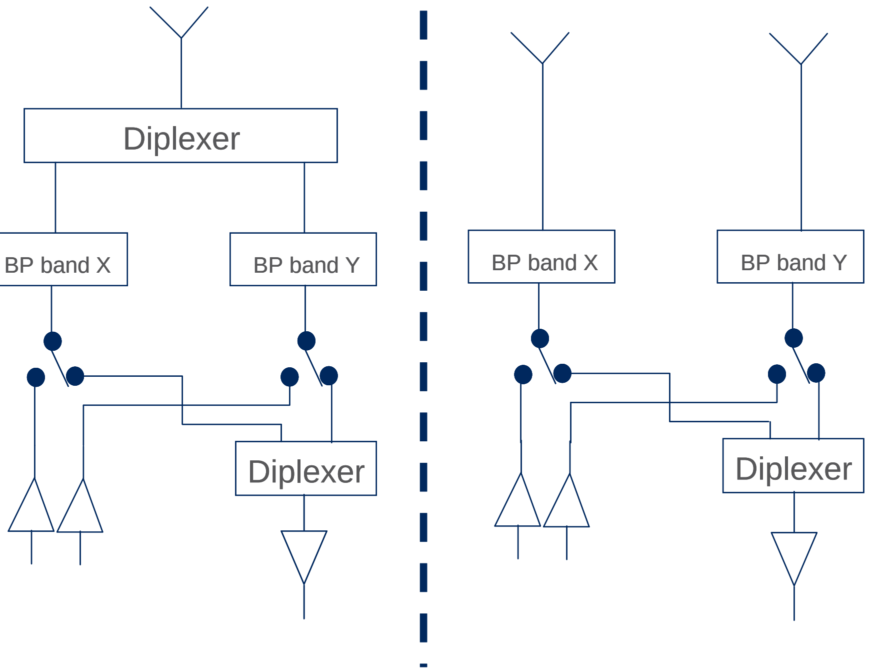

Figure 5.3.1.2-3: Example of Multi-band receivers combined with single-band transmitter mapped into one and two antennas respectively

As indicated above, TDD MB-MSR has slightly different structures compared to FDD, but the same principles can be made applicable.

For TDD MB-MSR, there is a need to address the inter-band synchronization aspect, since in the case where the operation is unsynchronized between the bands, the receiver and transmitter would operate simultaneously, which would require isolation between RX and TX on the order of 100 dB. Note that inter-band synchronization would require synchronization in time and the same UL/DL sub-frame allocation.

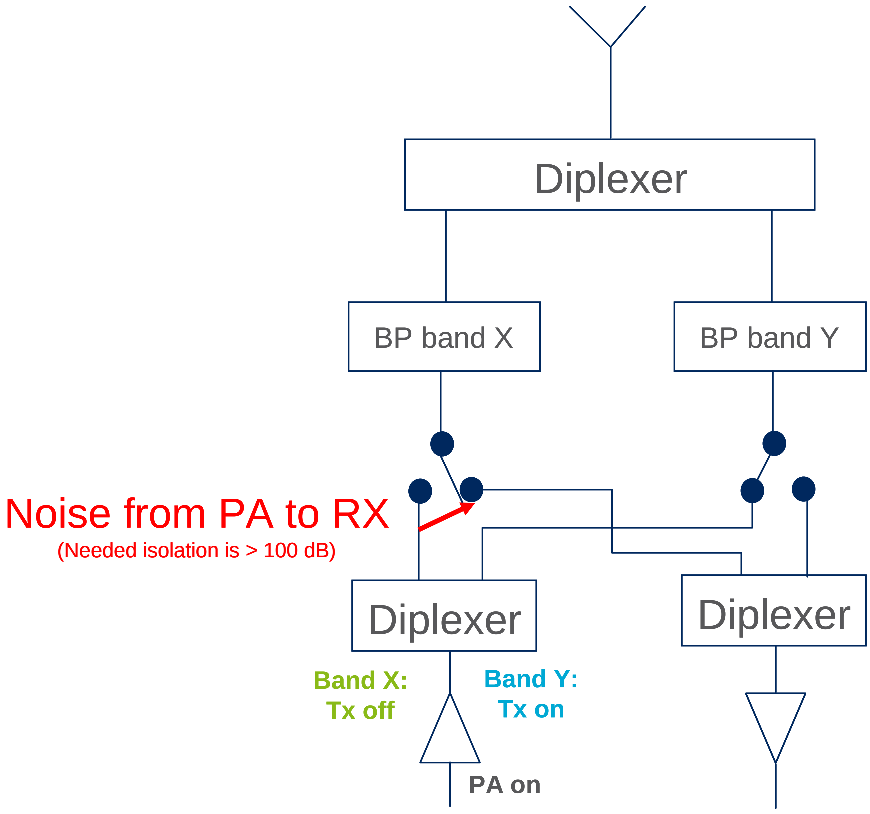

Figure 5.3.1.2-4: TX/RX isolation for inter-band unsynchronized operation in an example structure

For current single-band operation, the isolation is achieved by turning the transmitter off in conjunction with high quality switches as well other schemes. For MB-MSR unsynchronized operation, the transmitter can not be turned off.

For the reasons above, the general clause explaining "Applicability of MB-MSR requirements" also clarifies that for multi-band capable BS, operation in the multiple bands must be synchronized.

5.4 Operating bands and Band categories

In 37.104, Band Category is defined as a group of operating bands for which the same MSR scenarios apply. For the purpose of defining MSR requirements, the operating bands are divided into three band categories, where BC1 and BC2 are FDD bands and BC3 are TDD bands. It's clear that Band category is a property of the band(s) supported by the BS. Thus no changes are needed for the definition and the classification of the Band category. However the applicability of the RF requirements defined for each Band category need to be clarified where it is necessary.

Currently different RF requirements are defined for each Band category. The requirements for each BC can generally apply for MB-MSR BS on a per-band basis depending on which Band category the supported operating bands belong to. However for FDD MB-MSR BS, the multiple operating bands may belong to different Band categories. E.g. a MSR may support Band X and Band Y which belong to BC1 and BC2 respectively.

As stated in subclause 4.5, the RF requirements remain unchanged in general for multi-band BS operation and apply as they are stated for each of the operating bands forming the multi-band set.

There are however a few exceptions where the fact that one of the bands is a BC2 band, where there may be GSM/EDGE operation, has an impact on the other band for multi-band operation, even if the other band is a BC1 band. The situation for all BC2 specific RF requirements in TS 37.104 is summarized in Table 5.4-1 below.

Table 5.4-1: Overview of BC2 impact for MB-MSR

Clause in TS 37.104	RF requirement	BC2 impact
6.6.1.1.3	Transmitter spurious emissions; Additional minimum requirement for BC2 (Category B)	This is a transmitter emissions limit outside of the two operating bands, which is stricter in the case of BC2 operation. Since the emissions from multiple bands in this case will come from the same transmitter, it will be limited by the highest emission limit which is the general limit. Thus for the case where all supported operating bands belong to BC2 and GSM/EDGE is configured in all bands, then the additional BS Spurious emissions limits for BC2 would apply. For all other cases, only the general requirement would apply.
6.6.1.2	Protection of the BS receiver of own or different BS	The emission limit for protecting the own receive band in Table 6.6.1.2.1-1 is stricter for BC2 operation. This limit can be applied per band and it would still be sufficient to protect the other receiver operating band with the less strict limit if it is a BC1 band.
6.6.2.2	Operating band unwanted emissions; General minimum requirement for Band Category 2	This is a transmitter emissions limit inside of the two operating bands, which is different in the case of BC2 operation for the first 150 kHz from the RF bandwidth edge. This limit applies per band and the 150 kHz range with different limits close to the RF bandwidth edge in BC2 would only apply for the BC2 band.
6.6.2.3	Operating band unwanted emissions; GSM/EDGE single-RAT requirements	These requirements are single-RAT limits that are GSM-EDGE specific and only apply to GSM/EDGE carriers in BC2. They would not apply for a BC1 band in multi-band operation with a BC2 band.
7.4.3	In-band selectivity and blocking; Additional Narrowband blocking minimum requirement for GSM/EDGE	These single-RAT in-band requirements are GSM-EDGE specific and only apply in-band to GSM/EDGE carriers in BC2. They would not apply for a BC1 band in multi-band operation with a BC2 band.
7.4.4	In-band selectivity and blocking; GSM/EDGE requirements for AM suppression	These single-RAT in-band requirements are GSM-EDGE specific and only apply in-band to GSM/EDGE carriers in BC2. They would not apply for a BC1 band in multi-band operation with a BC2 band.
7.6.2	Receiver spurious emissions: Additional minimum requirement for BC2 (Category B)	This is a receiver emissions limit outside of the two operating bands, which is stricter in the case of BC2 operation. Since the emissions from multiple bands in this case will come from the same receiver, it will be limited by the highest emission limit which is the general limit. Thus for the case where all supported operating bands belong to BC2 and GSM/EDGE is configured in all bands, then the additional BS Spurious emissions limits for BC2 would apply. For all other cases, only the general requirement would apply.

From the overview above, it is seen that if one of the bands in multi-band operation is a BC2 band, only the spurious emission requirements in 6.6.1.1.3 and 7.6 will need a clarification in TS 37.104 of how the requirement applies in case an operating band is in BC2.

6 Transmitter characteristics

6.1 General

The current MSR transmitter requirements are classified to in-band requirements and out-of-band requirements, where UEM, ACLR/CACLR, EVM and transmit IM are examples for in-band requirements and spurious emission requirement represents out-of-band requirement. As pointed out in subclause 5.4, these transmitter requirements can generally be kept unchanged and applied for MB-MSR on a per-band basis depending on which Band Category the supported operating bands belong to. Exceptions are transmitter requirements for band combinations with minimum inter RF bandwidth gap <20MHz and the spurious emission requirement. Specific additions/exclusions are needed for the mentioned exception cases. The detailed analysis for each requirement can be found in the respective subclasses of clause 6.

The transmitter requirements in clauses 6 are applicable for both multi-RAT operation and single-RAT operation, where single RAT operation means the same RAT is configured in all supported operating bands.

It is FFS on how the requirements for MB-MSR are applied to the antenna connector (s).

6.2 Base station output power

The BS output power requirement is specified in subclause 6.2 of TS 37.104 and defines the tolerance for the maximum carrier output power relative to the declared power. There is in addition a regional requirement for what powers that can be declared and three single-RAT requirements.

For a multiband capable BS, RF carriers will be transmitted with power specified at an antenna connector, regardless of the transmitter structure and number of antenna connectors. The requirement for the BS power tolerance therefore remains the same as for a single-band BS.

NOTE: The text above assumes that the BS power parameters to be declared for a multiband capable BS will not lead to any additional minimum requirement for the BS. This topic should therefore to be revisited when the BS power declarations for MB-MSR are concluded.

6.3 Output power dynamics

Output power dynamics is defined by the BS transmitter's ability to operate at varying output power levels.

In existing MSR specification, output power dynamics requirements are specified as single-RAT only requirements for each concerned carrier. To guarantee existing RF performance, this requirement shall be kept unchanged for MB-MSR BS for each supported operating band.

6.4 Transmit ON/OFF power

Transmitter OFF power is defined as the mean power measured over 70 μs filtered with a square filter of bandwidth equal to the RF bandwidth of the BS centred on the central frequency of the RF bandwidth during the transmitter OFF period.

For TDD MB-MSR, there might be various implementations for the Tx chain, e.g. ultra-wide band Tx chain for multiple operating bands or separate Tx chain for each operating band supported. For BS supporting multi-band operation, the Tx OFF power is only applicable during the transmitter off period in all supported operating bands. The transmitter transient period requirement is applicable for both single band MSR and multi-band MSR for TDD. No further changes are needed for the transient period requirement.

6.5 Transmitted signal quality

6.5.1 Modulation quality

Modulation quality is defined by the difference between the measured carrier signal and a reference signal. Modulation quality can e.g. be expressed as Error Vector Magnitude (EVM), Peak Code domain Error (PCDE) or Relative Code domain Error (RCDE).

Modulation quality requirement in existing MSR specification is specified as single-RAT only requirement for each concerned carrier. To guarantee existing RF performance, this requirement shall be kept unchanged for MB-MSR BS for each supported operating band.

6.5.2 Frequency error

Frequency error is a measure of the difference between the actual BS transmits frequency and the assigned frequency. The same source shall be used for RF frequency and data clock generation.

Frequency error requirement in existing MSR specification is specified as single-RAT only requirement for each concerned carrier. To guarantee existing RF performance, this requirement shall be kept unchanged for MB-MSR BS for each supported operating band.

6.5.3 Time alignment error

Time Alignment Error (TAE) is defined as the largest timing difference between any two signals.

Time alignment error requirement in existing MSR specification is specified as single-RAT only requirement for each concerned carrier. To guarantee existing RF performance, this requirement shall be kept unchanged for MB-MSR BS for each supported operating band.

6.6 Unwanted emissions

The unwanted emissions requirements consist of Spurious emissions, which mainly covers frequency ranges outside an operating band, and ACLR/CACLR plus Operating band unwanted emissions (UEM) inside an operating band. There is in addition a requirement for Occupied bandwidth. In the MB-MSR context, all requirements in the band should in principle be kept per band as they are while for requirements outside the band, there is a need to introduce exclusion areas. The exclusion areas are illustrated for the unwanted emissions requirements in the following discussion.

Assuming a BS transmitting in Band X, the emission requirements in the band are specified as ACLR and an Unwanted Emissions Mask (UEM). These requirements should remain as they are in principle for multiband capable BS. The emission requirements outside the band are specified as spurious emissions, which are defined as a general limit with additional co-existence and co-location limits. Figure 6.6-1 is a visualization of the Band X and Band Y unwanted emission requirements, assuming single-band transmitters.

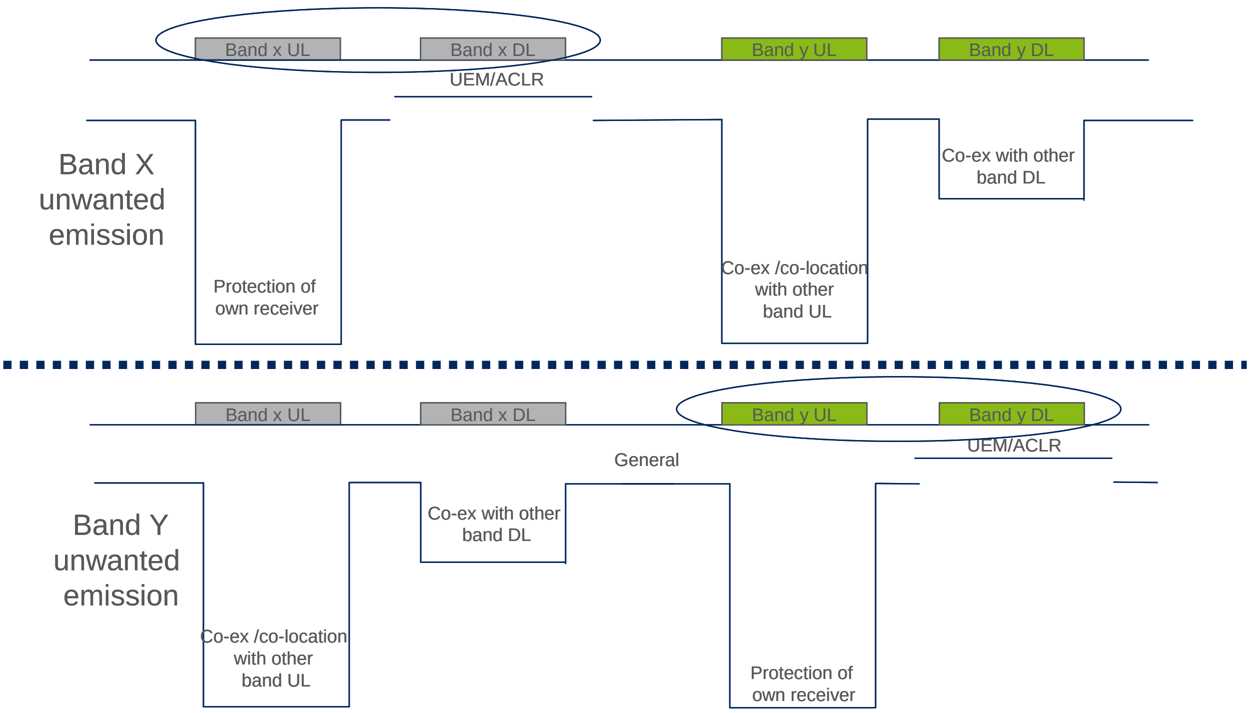

Figure 6.6-1: Single band emission requirements for Band X transmission (top) and Band Y transmission (bottom)

With simultaneous transmission in both Band X and Y for MB-MSR, it is clear that exclusion areas are needed since it would be physically impossible to measure spurious emission in a frequency where the BS at the same time transmit own carriers. Unwanted emissions from transmissions in one band into the other operating band would instead be seen as emissions inside the band and be covered by UEM (and ACLR) limits.

The required modification in the spurious emission requirements would be as follows: For MB-MSR with multi-band transmitter in band X and Y, the definition of spurious emission would exclude the frequency range for both the Band X operating band and the band Y operating band as shown in figure 6.6-2. Note that the unwanted emission requirements (UEM and ACLR) will still be applicable in both Band X and Y.

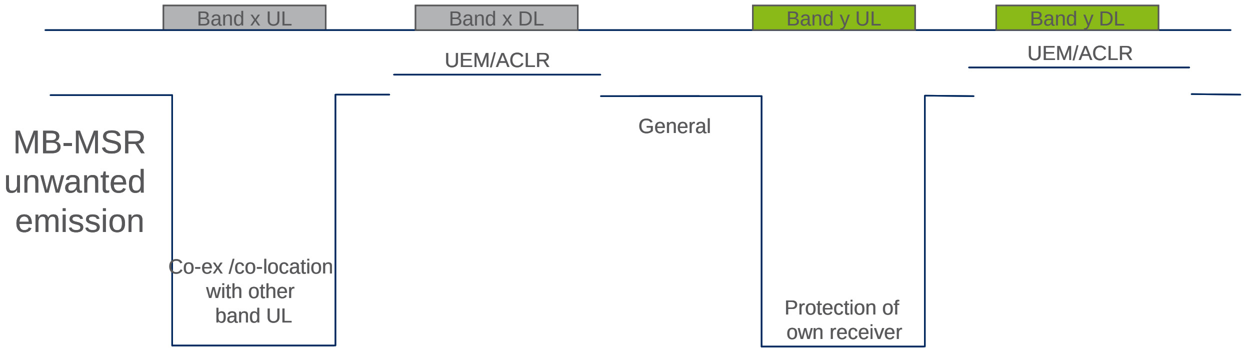

Figure 6.6-2: MB-MSR spurious emission requirements based on joint exclusion areas

Due to the regulatory nature of spurious emission limits, the general spurious emission limits are kept as they are without allowing for any cumulative approach or other relaxation.

This approach for MB-MSR would not pose any degradation since the requirements would still be compatible with operating two Base Stations with single band transmitters. The exclusion areas would also ensure that there are no dependencies between transmitters.

For multi-band combinations where the bands are close to each other, the inter RF bandwidth gap may be so small that the frequency ranges for the requirements in the band overlaps, which means that the joint exclusion area is actually a contiguous frequency range.

6.6.1 Transmitter spurious emissions

Spurious emissions as part of unwanted emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out of band emissions. The sources of spurious emissions have close relationship with application scenarios and the implementation capabilities of the BS.

For MB-MSR BS, the spurious emission limits shall apply to the common out of band frequency ranges of all operating bands. The application region of spurious emission limits for MB-MSR BS is illustrated in Figure 6.6.1-1. The limits shall be kept unchanged in the common spurious emission region.

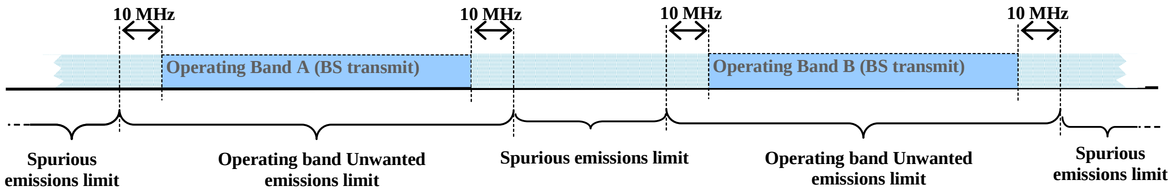

Figure 6.6.1-1 Defined frequency ranges for spurious emissions and operating band unwanted emissions for MB-MSR

In addition, for MSR BS supporting multi-band operation, the co-existence requirements do not apply for the frequency range of each supported downlink operating band. This is in the table for the requirement explained through notes for each protected band, stating that the limit does not apply for the operation in that band itself. It should be clarified for multi-band BS operation that the exclusions stated in the notes apply for each supported operating band. The same applies for the co-location requirement.

The spurious emission limits for protection of the BS receiver of own or different BS and co-location with other base stations shall be kept unchanged. If multiple bands belong to different band categories, the table should be interpreted per operating band, which means that each receive band will have the same protection limit as if it were a single -band implementation. This means that no change to the requirement is needed for multiband capable BS.

As explained in subclause 5.4, the stricter spurious emissions limit in subclause 6.6.1.1.3 of TS 37.104 applies in case of BC2 operation for a single-band BS. For a BS capable of multiband operation, the additional BC2 requirement will only apply when all supported operating bands belong to BC2 and GSM/EDGE is configured in all bands. A paragraph is added to subclause 6.6.1.1.3 to make this condition clear.

6.6.2 Operating band unwanted emissions

For multi-band capable BS with band combinations whose minimum downlink inter RF bandwidth gap >= 20MHz, the operating band unwanted emissions requirement is not affected by MB-MSR and existing requirements per band should apply.

For multi-band capable BS with band combinations whose minimum downlink inter RF bandwidth gap < 20MHz. The situation is similar to the sub-block gaps in case of non-contiguous spectrum.The minimum requirement within the inter RF band gaps is calculated as a cumulative sum from the RF bandwidth edges on each side of the inter RF bandwidth gap.

6.6.3 Occupied bandwidth

Occupied bandwidth requirement in existing MSR specification is specified per carrier. In addition, for E-UTRA CA operation, the requirement in corresponding subclause of TS 36.104 applies. The occupied bandwidth requirement is an in-band requirement that is not affected by MB-MSR and existing requirements per band should apply unchanged.

6.6.4 Adjacent Channel Leakage power Ratio (ACLR)

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency.

The ACLR requirement applies to frequency ranges outside the Base Station RF bandwidth. For MSR base station operating in non-contiguous spectrum, either ACLR or CACLR requirements are also applied inside sub-block gap dependent on the sub-block gap size.

For multiband capable BS with band combinations whose minimum downlink inter RF bandwidth gap >= 20MHz, the ACLR requirement is not affected by MB-MSR and existing requirements per band should apply. This case is already covered by the existing ACLR specification text, where it is stated that "The requirement applies to frequency ranges outside the Base Station RF bandwidth" and the inter RF bandwidth gap is fully outside the RF bandwidth of both bands.

For multiband capable BS with band combinations whose minimum downlink inter RF bandwidth gap < 20MHz, the situation is similar to the sub-block gaps in case of non-contiguous spectrum. Here, the CACLR requirement will apply and a reference to the CACLR clause will be needed for E-UTRA and UTRA FDD. The references for how the ACLR requirement applies inside gaps will not be needed for the inter RF bandwidth gap, since it is already stated that ACLR applies outside the RF bandwidth edges of the operating bands.

The CACLR requirement will now apply for both sub-block gaps and inter RF bandwidth gaps. The specification text needs to be updated accordingly and the symbol W_{gap} is re-defined to mean the width of either a sub-block gap or inter RF bandwidth gap.

6.7 Transmitter intermodulation

The transmitter intermodulation requirement is a measure of the capability of the transmitter to inhibit the generation of signals in its non linear elements caused by presence of the own transmit signal and an interfering signal reaching the transmitter via the antenna.

The transmitter intermodulation requirement is specified in subclause 6.7 of TS 37.104. It is basically a generic MSR requirement, with additional BC requirements. Thus for BS capable of multi-band operation, in order to guarantee existing RF performance, the existing Tx IM requirement applies for each supported operating band.

In addition, for band combinations with small inter RF bandwidth gap, the requirements applied inside the inter RF bandwidth gap shall follow the method used inside the sub-block gap for MSR-NC in which the additional BC2 requirement should be also applicable. For BS capable of multiband operation, the requirement applies relative to the RF bandwidth edges of each operating band. In case the inter RF bandwidth gap is less than 15 MHz, the requirement in the gap applies only for interfering signal offsets where the interfering signal falls completely within the inter RF bandwidth gap. If the inter RF bandwidth gap size is less than 5 MHz, the general intermodulation interfering signal can not fall completely inside the inter RF bandwidth gap, in this case, only the additional BC2 requirement can apply.

For band combinations with small inter RF bandwidth gap, the interferer types and interferer offsets which would fit the inter RF bandwidth gap size should apply for general and additional transmit intermodulation requirements.

7 Receiver characteristics

7.1 General

The receiver requirements can be classified into in-band requirements and out-of-band requirements. Receiver sensitivity, in-band blocking, RX intermodulation etc are examples of in-band requirements while out-of-band blocking and receiver spurious emission represent out-of-band requirements. For MB-MSR, in principle all in-band requirements should be applied on a per band basis while for the out-of-band requirement, there is a need to introduce exclusion areas. The detailed analysis for each requirement can be found in the respective subclasses of clause 7.

The receiver requirements in clause 7 are applicable for both multi-RAT operation and single-RAT operation, where single RAT operation means the same RAT is configured in all supported operating bands.

It is FFS on how the requirements for MB-MSR are applied to the antenna connector (s) since there is still no conclusion on the issue of multiple antenna connectors combined with single/multiple transmitter.

7.2 Reference sensitivity level

The reference sensitivity power level $P_{REFSENS}$ is the minimum mean power received at the antenna connector at which a reference performance requirement shall be met for a specified reference measurement channel.

In existing MSR/MSR-NC specification, reference sensitivity requirements are specified per single-RAT only. This requirement can be kept unchanged for MB-MSR BS for each supported operating band.

7.3 Dynamic range

The receiver dynamic range is a measure of the capability of the receiver to receive a wanted signal in the presence of an interfering signal inside the received channel bandwidth or the capability of receiving high level of wanted signal.

The requirements are specified as single-RAT in-band requirements and are not affected by multiband operation. Existing dynamic range requirements will thus apply unchanged in each supported operating band.

7.4 In-band selectivity and blocking

The in-band selectivity and blocking characteristics are measures of the receiver ability to receive a wanted signal at its assigned channel in the presence of an unwanted interferer inside the operating band and are defined by a wideband and a narrowband blocking requirement.

As explained in subclause 7.1 and 7.5, for a multi-band receiver capable of operating in band X and Y, the band Y in-band blocking range should be excluded from the band X out-of-band blocking requirement and vice versa. For this joint exclusion area, the in-band blocking requirement would apply instead.

In order to minimize the impact of blocking between the bands, the in-band blocking is modified for multi-band capable BS to ensure that the blocking probability for each band is kept to a reasonably low level and does not increase proportionally with the added frequency range with multiple bands. In order to achieve this, the interfering signal in one band should degrade the wanted signal level for the other band by much less than the 6 dB applied for in-band blocking within one band. The allowed degradation can be determined through analysis of blocking probabilities.

The in-band blocking requirements are normally derived through system simulations giving a distribution of potential interfering signal levels. The maximum in-band blocking interferer level is then picked so that it is not exceeded in 99.99% of the cases for macro scenarios [9] or 99.98% of the cases for micro scenarios [9, 10]. This gives 0.01% and 0.02% blocking probability respectively for macro and micro scenarios.

If the frequency range with potential blockers is extended with another band of equal size and we allow the same 6 dB level of degradation, the probability of not being blocked (in the macro scenario) will be 99.99% from each of the bands. The total blocking probability will then be

$$P[\text{blocked}] = 1 - P\,[\text{Not blocked}] = 1 - 0.9999 \times 0.9999 \approx 0.02\%$$

In order to avoid this doubling of the blocking probability, it is agreed to allow for less degradation in case of a blocker in the "other" band. If we want interferers in the "other" band to have a considerably reduced impact on blocking, we need a probability of not being blocked much closer to 1 from that band, rather than 0.9999.

The blocking probability has a very strong dependence on the assumed blocking limit, which has been showed in numerous simulations documented in 3GPP TRs [9, 10]. The results show that the probability of not being blocked is much closer to 1 if the blocking limit is increased 4-5 dB. The same effect would occur if the system can be more resistant to the same blocking limit, i.e. the degradation for the same blocking level in the "other" band will be less than the usual 6 dB in order to reduce the blocking impact. Such a decreased degradation can be translated into an *equivalent* reduction in blocking interferer level.

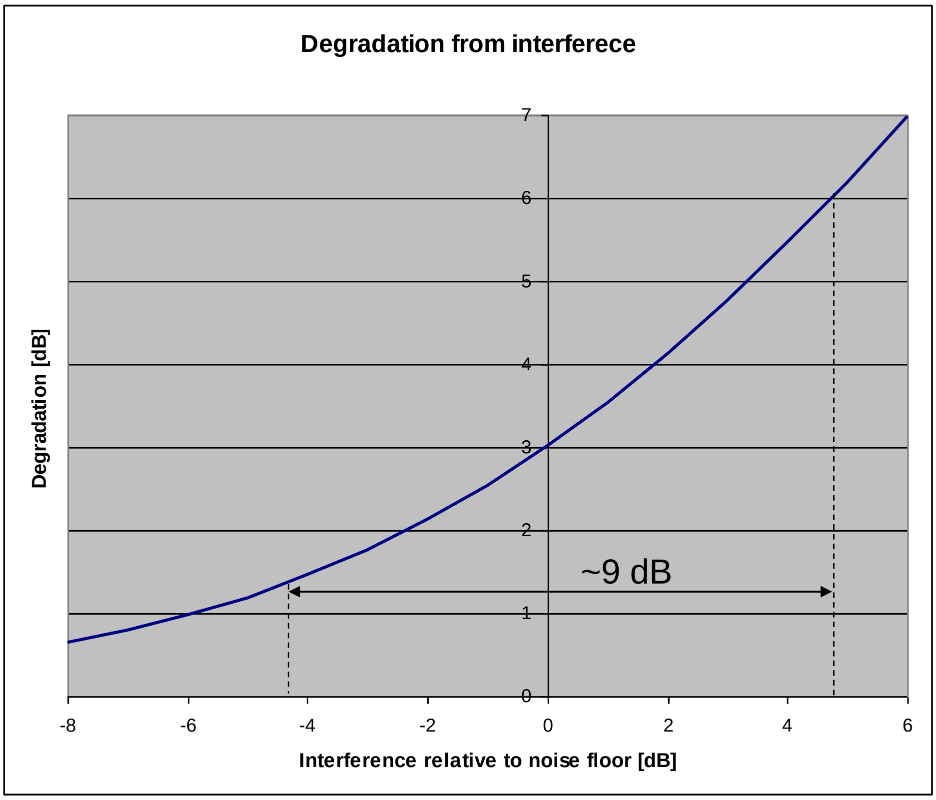

Figure 7.4-1: Relation between the equivalent interferer level and degradation

Figure 7.4-1 shows the relation between interferer level and the resulting degradation, assuming that the interferer adds linearly to noise as power. The relation shows that a reduced degradation from 6 to 1.4 dB corresponds to an equivalent 9 dB decrease in the interferer level. When translating this 9 dB reduced interferer level into a reduced blocking probability, it can be seen that it results in a considerably reduced impact on the blocking probability. It is therefore sufficient to reduce the degradation for in-band blocking from the "other" band from 6 to 1.4 dB. This would ensure that the blocking probability for each band is kept to a reasonably low level and does not increase proportionally to the added frequency range with multiple bands. The note in the blocking tables is modified accordingly.

For multi-band combination where the bands are close to each other, the inter RF bandwidth gap may be so small that the frequency range for the in-band blocking requirement overlaps, which means that the joint exclusion area is actually a contiguous frequency range. In this case the usual in-band blocking requirement (with 6 dB sensitivity degradation for UTRA/E-UTRA) should apply for the full in-band blocking frequency range listed for the operating band, while the lower sensitivity degradation would apply outside that frequency range in the joint exclusion area.

7.5 Out-of-band blocking

The out-of-band blocking characteristics are measures of the receiver ability to receive a wanted signal at its assigned channel in the presence of an unwanted interferer outside the operating band. The out-of-band blocking requirements in TS37.104 include a general requirement and co-location requirements.

In the MB-MSR context, all in-band requirements per band should be kept as they are while for out-of band requirements, there is a need to introduce exclusion areas for some requirements. To exemplify the exclusion areas, the blocking requirement are further discussed below.

Assuming a BS receiving in Band X, the in-band requirements are described as in-band blocking and receiver intermodulation. These requirements should remain in principle for multiband capable BS. Out-of-band blocking (general and co-location) and receiver spurious emission requirement being out-of-band requirements would require some modification. Figure 7.5-1 is a visualization of band X and band Y (example bands for MB-MSR) blocking requirements for single band receivers.

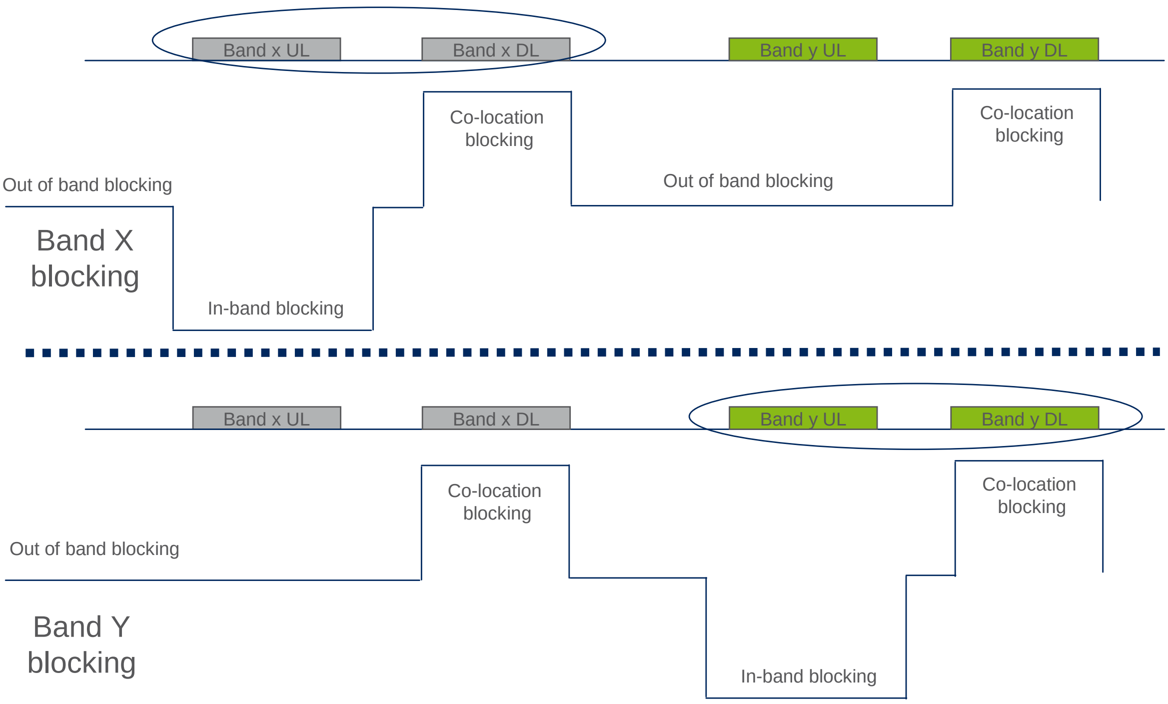

Figure 7.5-1: Single band receiver requirements for Band X (top) and Band Y (bottom)

With simultaneous reception in both Band X and Y for MB-MSR, it is clear that exclusion areas are needed since in-band levels for band Y would be out-of-band levels for band X and vice versa. An MB-MSR receiver covering both bands can not be expected to have out-of-band blocking levels as in-band requirements. There is consequently a need for "joint exclusion areas".

The required modification in blocking requirements based on joint exclusion areas would be as follows: For MB-MSR with a multi-band capable receiver in band X and Y, the in-band blocking range of band Y should be excluded from the band X out-of-band blocking requirement and vice versa. This is as in figure 7.5-2. Note that the in-band requirements would still be applicable for both band X and Y.

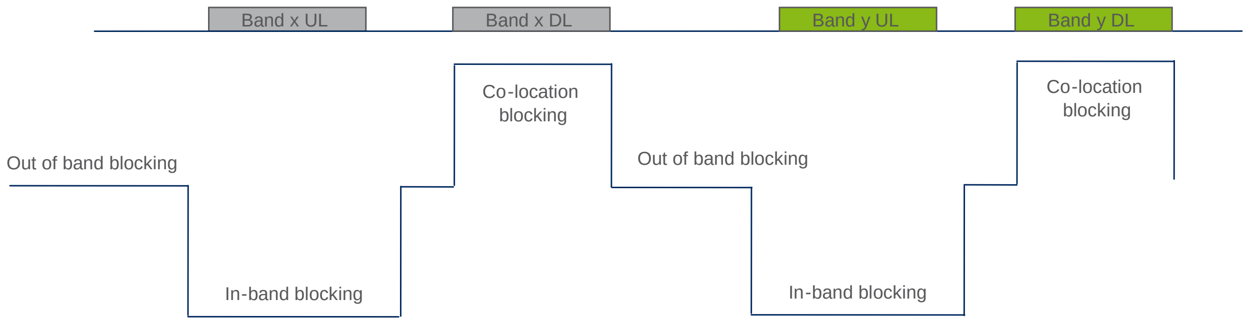

Figure 7.5-2: MB-MSR out-of-band blocking requirement based on joint exclusion areas

The approach for a multi-band capable BS should not pose any major degradation in terms of blocking between the bands and the requirements should be compatible with operating two single-band BS.

For multi-band combination where the bands are close to each other, the inter RF bandwidth gap may be so small that the frequency range for the in-band blocking requirement overlaps, which means that the joint exclusion area is actually a contiguous frequency range.

For BS capable of multi-band operation, it is concluded that from the perspectives of both the system co-existence and the reasonable implementation, a joint exclusion of all operating bands should apply for the out-of-band blocking requirement. The implication is that for BS capable of multi-band operation and a wanted signal received in one band, the interfering signal positions defined for all operating bands supported by the BS as listed in Table 7.4.1-1 of TS 37.104 should be excluded from the out-of-band blocking requirement.

7.6 Receiver spurious emissions

The receiver spurious emissions power is the power of 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 antenna ports. In this case for FDD BS the test shall be performed when both TX and RX are on, with the TX port terminated.

For base station capable of multi-band operation, the frequency range for receiver spurious emission is defined from 30MHz to the 5th harmonic of the upper frequency edge of all UL operating bands. The frequency range from $F_{BW\ RF,DL,low}$ -10 MHz to $F_{BW\ RF,,DLhigh}$ + 10 MHz of all supported operating bands should be excluded from the requirement.

This applicability of the exclusion can be explained in the existing note to the requirement in Table 7.6.1-1 of the core specification TS 37.104. The requirement in Table 7.6.2-1 is already outside the excluded frequency range.

For multi-band combination where the bands are close to each other, the inter RF bandwidth gap may be so small that the excluded frequency ranges overlaps. This does however not affect the way the requirement is stated.

As explained in subclause 5.4, the stricter spurious emissions limit in subclause 6.6.1.1.3 of TS 37.104 applies in case of BC2 operation for a single-band BS. For MB-MSR base station which can operate on two bands simultaneously, it is apparent that the actual emission perceived would be dominated by the higher emission level from either of the two bands from coexistence point of view. Therefore, for the case where the two supported operating bands belong to BC2 and GSM/EDGE is configured in both bands, then the additional BS Spurious emissions limits for BC2 would apply. For all other cases, only the general requirement would apply.

7.7 Receiver intermodulation

The receiver intermodulation requirement in TS37.104 includes general intermodulation, general narrowband intermodulation and additional narrowband intermodulation minimum requirement for GSM/EDGE.

The requirements are in-band requirements and are such in principle not affected by multi-band operation. The additional GSM/EDGE requirements are single-RAT. The only exception is for the general intermodulation requirement inside small inter RF bandwidth gap.

Considering the interferer type and offset of general intermodulation requirement, the gap size of at least twice as wide as the UTRA/E-UTRA interfering signal centre frequency offset from the RF bandwidth edge is required for two consecutive RF bandwidths for all types of carrier at the edge of RF bandwidth in the gap. This condition should apply for general intermodulation requirement inside a inter RF bandwidth gap.

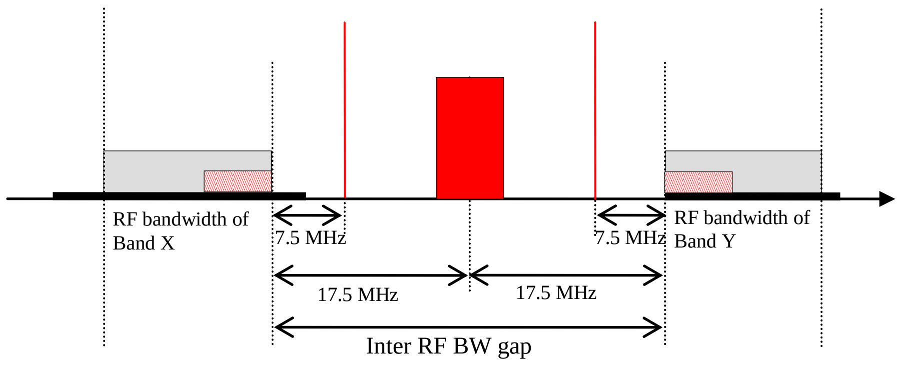

Figure 7.7-1: Applicability of the general intermodulation requirement inside a gap

7.8 In-channel selectivity

In-channel selectivity (ICS) is a measure of the receiver ability to receive a wanted signal at its assigned resource block locations in the presence of an interfering signal received at a larger power spectral density.

The in-channel selectivity requirement is only specified for E-UTRA and independent of the BS capabilities. Thus the existing requirements in each supported operating band should apply, no changes due to MB-MSR operation are needed.

8 Test specification

8.1 General

8.2.1 Test configurations for multi-band operation

<Text will be added.>

8.2.2 RF channels

For multi-band operation, RF bandwidth position in each band shall be able to verify the multi-band capability and the requirements inside inter RF bandwidth gap. For that reason, relative extreme farthest and nearest distances between the two RF bandwidth positions shall be adopted in the test.

For BS capable of multi-band operation, unless otherwise stated, the test shall be performed at B_{RFBW}_T_{RFBW}, M_{RFBW}_M_{RFBW} and T_{RFBW}_B_{RFBW} defined as following:

B_{RFBW}_T_{RFBW}: maximum RF bandwidth located at the bottom of the supported frequency range in the lower band and at the top of the supported frequency range in the upper band.

T_{RFBW}_B_{RFBW}: maximum RF bandwidth located at the top of the supported frequency range in the lower band and at the bottom of the supported frequency range in the upper band.

M_{RFBW}_M_{RFBW}: maximum RF bandwidth located at the middle of the supported frequency range in the lower band and at the middle of the supported frequency range in the upper band.

8.2 Test configurations

<Text will be added.>

Annex A: Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2012-03	R4#62bis	R4-121645			Report skeleton		0.0.1
2012-03	R4#62bis	R4-122095			Editorial revision of the scope in clause 1 and title of subclause 6.5.3 Add subclause 5.2 Relation to legacy deployment Add clause 8 Test specification	0.0.1	0.0.2
2012-05	R4#63	R4-123953			Agreed Text Proposal in RAN4 #63: **R4-122478**, "TP for MB-MSR WI objective" **R4-123525**, "TP for MB-MSR application scenarios"	0.0.2	0.1.0
2012-08	R4#64	R4-125332			Agreed Text Proposal in RAN4 #64: **R4-123955**, "TP on updated objective of MB-MSR WI" **R4-124858**, "TP on MB-MSR Occupied Bandwidth" **R4-124859**, "TP on UEM and ACLR requirements for MB-MSR BS" **R4-124861**, "Transmit on/off power for MB-MSR BS" **R4-124862**, "TP on Definitions, symbols and abbreviations for MB-MSR BS (Section 3)" **R4-124863**, "TP on Transmitted signal quality for MB-MSR BS" **R4-124868**, "TP on Output power dynamics (TR Clause 6.3)" **R4-124870**, "TP on Transmitter intermodulation (TR Clause 6.7)" **R4-124871**, "TP on Reference sensitivity level for MB-MSR BS" **R4-124872**, "TP on MB-MSR Receiver dynamic range" **R4-124873**, "TP on In-channel selectivity for MB-MSR" **R4-124875**, "TP on Receiver intermodulation for MB-MSR BS" **R4-124876**, "TP on Spurious emissions for MB-MSR BS" **R4-124878**, "TP on Receiver spurious emission for MB-MSR BS" **R4-124879**, "TP on Regional requirements for MB-MSR (TR Clause 4.3)" **R4-124880**, "TP on Relation to other RAN and GERAN specifications for MB-MSR BS" **R4-124881**, "TP on Scope, configurations and scenarios for MB-MSR" **R4-124882**, "TP on legacy deployment for MB-MSR BS" R4-124883, "Operating bands and Band categories CATT"	0.1.0	0.2.0
2012-10	R4#64bis	R4-126337			Agreed Text Proposal in RAN4 #64bis: **R4-125478**, "TP on MB-MSR BS output power" **R4-125628**, "introduction of TDD MB-MSR application scenarios for MB-MSR TR" **R4-125946**, "TP on MB-MSR TR general clause 6.1" **R4-125947**, "TP on MB-MSR general clause and applicability of requirements" **R4-125948**, "TP on MB-MSR ACLR for small inter RF BW gap" **R4-125949**, "TP on band category and requirements for MB-MSR" **R4-125955**, "TP on Definitions and terminology for MB-MSR BS" **R4-125957**, "TP on TX spurious emissions for MB-MSR BS" **R4-125958**, "TP on Transmitter intermodulation for MB-MSR BS" **R4-125963**, "TP on MB-MSR Unwanted emissions" **R4-125966**, "TP on Operating band unwanted emissions for MB-MSR BS" **R4-125968**, "TP on General part of receiver	0.2.0	0.3.0

					characteristics" **R4-125969**, "TP on In-band blocking" **R4-125970**, "TP on Out-of-band blocking for MB-MSR BS" **R4-125971**, "TP on MB-MSR Receiver spurious emissions" **R4-125972**, "TP on Receiver intermodulation for MB-MSR BS" **R4-125973**, "TP on Impact on TDD requirements"		
2012-11	R4#65	R4-127001			**R4-126877**, " TP on Manufacturer's declaration" **R4-126880**, " TP on RF channels for MB-MSR BS"	0.3.0	0.4.0
2012-12	RAN#58	RP-121760			Presentation of the report to TSG RAN for approval	0.4.0	1.0.0
2012-12	RAN#58				TR Approved by RAN	1.0.0	11.0.0
2013-03	RP-59	RP-130282	001	1	Background to in-band blocking requirement	11.0.0	11.1.0