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IEEE Standard for Minimum Performance Characteristics of IEEE 802.20 Terminals and Base Stations/Access Nodes

IEEE Computer Society

Sponsored by the
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IEEE Standard for Minimum Performance Characteristics of IEEE 802.20 Terminals and Base Stations/Access Nodes

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Abstract: This standard specifies minimum performance parameters and the associated test methodologies for implementation of IEEE 802.20 compliant systems.
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IEEE Standard for Minimum Performance Characteristics of IEEE 802.20 Terminals and Base Stations/Access Nodes

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1. Overview

1.1 Scope

This standard details definitions, method of measurements and minimum performance characteristics for IEEE 802.20™ MBWA terminals and base stations (BSs)/access nodes (ANs). The test methods are specified in this document; however, methods other than those specified may suffice for the same purpose.

1.2 Purpose

The purpose of this standard is to specify minimum performance characteristics for IEEE 802.20 implementations. Service providers deploying equipment meeting this specification can expect to meet a particular service level with user terminals that also comply with this specification.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ITU Radio Regulations: "International Telecommunications Union Radio Regulations," Edition 2004, Volume 1—Articles, ITU, December 2004.[1]

ITU-R SM.328-10, Spectra and Bandwidth of Emissions.

3. Definitions, acronyms, and abbreviations

For the purposes of this document, the following terms and definitions apply. *The IEEE Standards Dictionary: Glossary of Terms & Definitions* should be referenced for terms not defined in this clause.[2]

3.1 Definitions

emission bandwidth (BW): The x dB bandwidth (MHz): is defined in ITU-R SM.328-10; x = 26 dB is used in FCC definitions; EBW26dB > OBW99%. It is commonly used in regulations when specifying the emission requirement in the first 1 MHz to the channel edge. For instance, FCC requires –13 dBm for 1% of the 26 dB-EBW in that region.

occupied bandwidth (BW): Provides a verification of channel bandwidth. Occupied bandwidth is less than channel bandwidth. It is defined as 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 β/2 of the total mean power of a given emission. Unless otherwise specified by the Radiocommunication Assembly for the appropriate class of emission, the value of β/2 should be taken as 0.5%. (ITU Radio Regulations, ITU-R SM.328-10.)

3.2 Acronyms and abbreviations

ACLR	Adjacent Channel Leakage Ratio
ACP	adjacent carrier power
ACPR	Adjacent Carrier Power Ratio
ACS	adjacent channel selectivity
AN	access node
AT	access terminal
AWGN	Additive White Gaussian Noise
BCH	broadcast channel

[1] ITU publications are available from Publication Sales, International Telecommunication Union, Place des Nations, 1211 Geneva 20, Switzerland (http://www.itu.int/).

[2] *The IEEE Standards Dictionary: Glossary of Terms & Definitions* is available at http://shop.ieee.org/.

BS	base station
BW	bandwidth
CBW	channel bandwidth
CRC	Cyclic Redundancy Check
CW	continuous waveform
DSSI	Desired Signal Strength Indicator
EBW	emission bandwidth
EVM	error vector magnitude
FER	frame error rate
FFT	Fast Fourier Transform
FL	forward link
HARQ	Hybrid Automatic Repeat Request
ITU	International Telecommunication Union
MA	modulation accuracy
MAC	Media Access Control
MBWA	Mobile Broadband Wireless Access
MC	multicarrier
MCIP	multicarrier intermodulation product
MPS	Minimum Performance Specification
OBW	occupied bandwidth
PHS	Personal Handy-phone System
PSD	power spectral density
QAM	Quadrature Amplitude Modulation
QPSK	quadrature phase shift keying
RBW	resolution bandwidth
REFSENS	reference sensitivity
RF	radio frequency
RL	reverse link
SINR	Signal Interference Noise Ratio
SNR	signal-to-noise ratio
SRRC	Square Root Raised Cosine
UT	user terminal
TBW	transmission bandwidth
TX	transmit

4. Minimum performance requirements for the Wideband Mode

4.1 General

This subclause details definitions, methods of measurement, and minimum performance requirements for access nodes and access terminals. This standard shares the purpose of IEEE Std 802.20 (and subsequent revisions thereof) by ensuring that an access terminal can obtain service in any system that meets the compatibility requirements of IEEE Std 802.20.

Compatibility, as used in connection with this standard and IEEE Std 802.20 is understood to mean that any access terminal is able to open data connections in any suitably implemented Mobile Broadband Wireless Access (MBWA) system supporting the same mode of operation. Conversely, all suitably implemented MBWA systems are able to open connections with any access terminal.

Test methods are recommended in this standard; however, methods other than those recommended may suffice for the same purpose.

The performance metrics in this clause require an access terminal to provide a single antenna connector for testing. Access terminals having multiple antennas, such as for receive diversity, shall provide a single antenna connector for testing. If an access terminal has more than one antenna connector, only one connector shall be used for testing.

4.2 Bandwidth

Table 1 presents the different channel bandwidths to be used for MBWA signal transmission measurements.

Table 1—MBWA channel bandwidths

N_{FFT}	512	1024	2048
CBW[a]	5	10	20
N_T, tiles	32	64	128
N_{guard}, tiles	1	2	4
TBW, tiles[b]	30	60	120

[a]CBW: Channel bandwidth in MHz.

[b]TBW: Transmission bandwidth that varies from one tile to the maximum transmission BW as defined in Figure 1 Note 4. If the TBW is not associated with a number of tiles, then what is meant is the maximum TBW.

5 MHz and larger channel bandwidths include guard-bands of 1 tile for 5 MHz, 2 tiles for 10 MHz, and 4 tiles for 20 MHz channels.

Figure 1 illustrates the spectral arrangement of a 10 MHz bandwidth IEEE 802.20 Wideband Mode signal. [3]

[3] Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

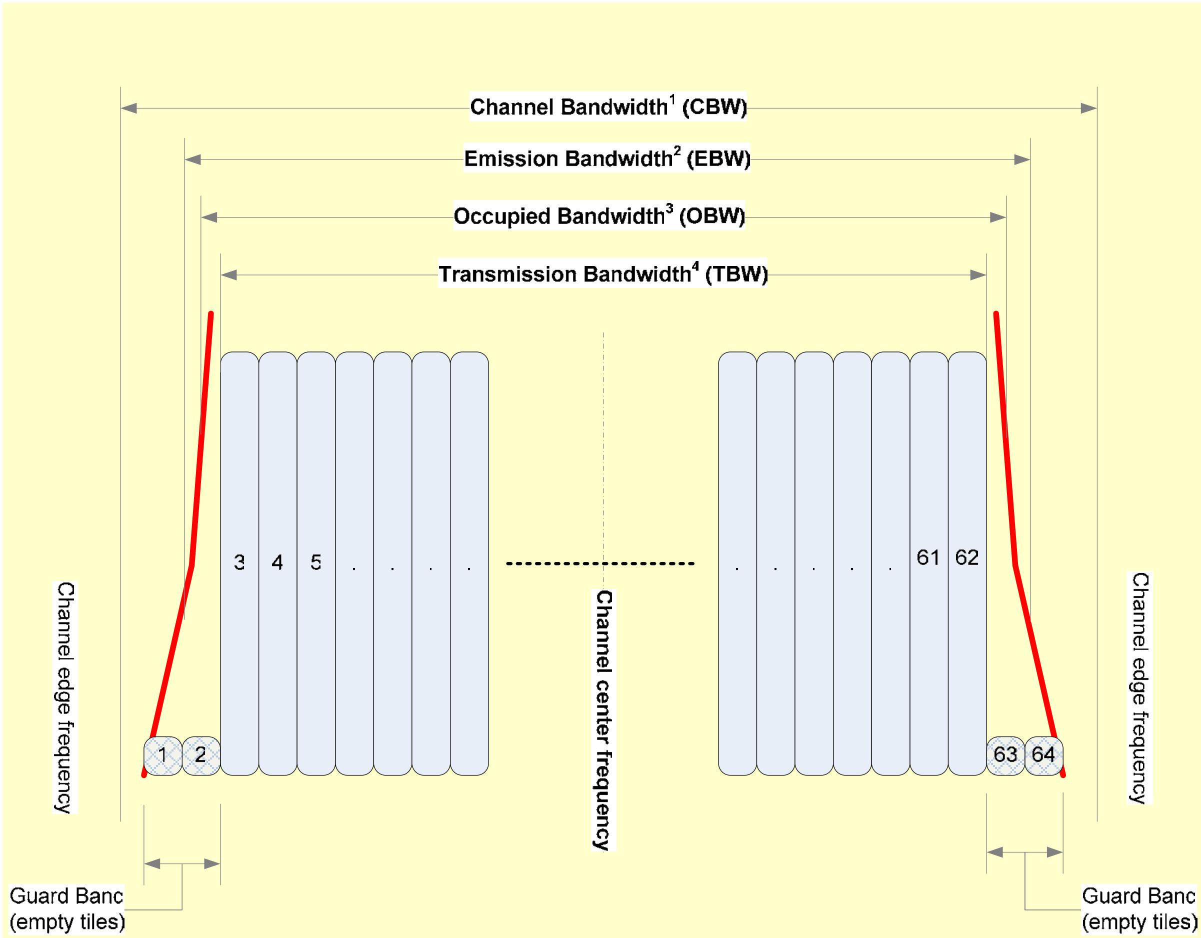

Figure 1—10 MHz signal example

NOTE 1—**Channel bandwidth (CBW) = (1.25; 2.5; 5; 10; 20),** ***MHz***; *CBW > EBW*.
NOTE 2—**Emission bandwidth (EBW) = x dB Bandwidth,** ***MHz:*** *is defined in ITU-R SM.328-10; x=26 dB is used in FCC definitions;* $EBW_{26dB} > OBW_{99\%}$.
NOTE 3—**Occupied bandwidth (OBW) = x% Bandwidth,** ***MHz***; *defined in ITU-R SM.328-10; x=99% is typical value;* $OBW \geq TBW$.
NOTE 4—**Transmission bandwidth (TBW) =** $(N_{FFT} - N_{guard} \times 2) \times 0.0096 / 16$, ***tiles***; N_{guard} *is number of guard subcarriers on each side of the carrier.*

4.2.1 Requirements

The occupied bandwidth for MBWA shall be based on β/2 = 0.5%. The occupied bandwidth shall be less than the channel bandwidth.

The measurement shall employ a resolution BW (RBW) of ≥ 1% of the CBW, except where it is explicitly set otherwise.

4.3 Band classes

This subclause specifies the different band classes and subclasses and their respective duplexer gaps. In Table 2, for each band class/subclass, the band for forward link channels and reverse link channels are listed. The duplexer gap is the gap between the forward link (FL) band and reverse link (RL) band.

Table 2—Duplexer gaps for all band classes and subclasses

Band class	Sub class	Reverse link band (MHz)	Forward link band (MHz)	Duplexer gap (MHz)	Recommended bandwidth (MHz)
0	0	824.000 – 849.000	869.000 – 894.000	20.000	4.608 (See NOTE 1), 9.216 (See NOTE 2)
	1	824.000 – 849.000	869.000 – 894.000	20.000	4.608, 9.216
	2	824.000 – 830.000	869.000 – 875.000	39.000	4.608, 9.216
	3	815.000 – 830.000	860.000 – 875.000	30.000	4.608, 9.216
1		1850.000 – 1910.000	1930.000 – 1990.000	20.000	4.608, 9.216
2	0	890.000 – 905.000	935.000 – 950.000	30.000	4.608, 9.216
	1	890.000 – 915.000	935.000 – 960.000	20.000	4.608, 9.216
	2	872.000 – 905.000	917.000 – 950.000	12.000	4.608, 9.216
3		887.000 – 889.000 893.000 – 901.000 915.000 – 925.000	832.000 – 834.000 838.000 – 846.000 860.000 – 870.000	17.000	4.608, 9.216
4		1750.000 – 1780.000	1840.000 – 1870.000	60.000	4.608, 9.216
5	0	452.500 – 457.475	462.500 – 467.475	5.025	4.608
	1	452.000 – 456.475	462.000 – 466.475	5.525	4.608
	2	450.000 – 454.800	460.000 – 464.800	5.200	4.608
	3	411.675 – 415.850	421.675 – 425.850	5.825	4.608
	4	415.500 – 419.975	425.500 – 429.975	5.525	4.608
	5	479.000 – 483.480	489.000 – 493.480	5.520	4.608
	6	455.230 – 459.990	465.230 – 469.990	5.240	4.608
	7	451.310 – 455.730	461.310 – 465.730	5.580	4.608
	8	451.325 – 455.725	461.325 – 465.725	5.600	4.608
	9	455.250 – 459.975	465.250 – 469.975	5.275	4.608
	10	479.000 – 483.475	489.000 – 493.475	5.525	4.608
	11	410.000 – 414.975	420.000 – 424.975	5.025	4.608
6		1920.000 – 1980.000	2110.000 – 2170.000	130.000	4.608, 9.216

Band class	Sub class	Reverse link band (MHz)	Forward link band (MHz)	Duplexer gap (MHz)	Recommended bandwidth (MHz)
7		776.000 – 788.000	746.000 – 758.000	18.000	4.608, 9.216
8		1710.000 – 1785.000	1805.000 – 1880.000	20.000	4.608, 9.216
9		880.000 – 915.000	925.000 – 960.000	10.000	4.608, 9.216
10	0	806.000 – 811.000	851.000 – 856.000	40.000	4.608, 9.216
	1	811.000 – 816.000	856.000 – 861.000	40.000	4.608, 9.216
	2	816.000 – 821.000	861.000 – 866.000	40.000	4.608, 9.216
	3	821.000 – 824.000	866.000 – 869.000	42.000	4.608, 9.216
	4	896.000 – 901.000	935.000 – 940.000	34.000	4.608, 9.216
11	0	452.500 – 457.475	462.500 – 467.475	5.025	4.608
	1	452.000 – 456.475	462.000 – 466.475	5.525	4.608
	2	450.000 – 454.800	460.000 – 464.800	5.200	4.608
	3	411.675 – 415.850	421.675 – 425.850	5.825	4.608
	4	415.500 – 419.975	425.500 – 429.975	5.525	4.608
	5	Not specified	Not specified	Not specified	Not specified
	6	Not specified	Not specified	Not specified	Not specified
	7	Not specified	Not specified	Not specified	Not specified
	8	451.325 – 455.725	461.325 – 465.725	5.600	4.608
	9	455.250 – 459.975	465.250 – 469.975	5.275	4.608
	10	479.000 – 483.475	489.000 – 493.475	5.525	4.608
	11	410.000 – 414.975	420.000 – 424.975	5.025	4.608
12	0	870.000 – 876.000	915.000 – 921.000	39.000	4.608, 9.216
	1	871.500 – 874.500	916.500 – 919.500	42.000	4.608, 9.216
	2	870.000 – 876.000	915.000 – 921.000	39.000	4.608, 9.216
13		2500.000 – 2570.000	2620.000 – 2690.000	50.000	4.608, 9.216
14		1850.000 – 1915.000	1930.000 – 1995.000	15.000	4.608, 9.216
15		1710.000 – 1755.000	2110.000 – 2155.000	355.000	4.608, 9.216
16		2502.000 – 2568.000	2624.000 – 2690.000	56.000	4.608, 9.216
17		Not specified	Not specified	Not specified	Not specified
18		787.000 – 799.000	757.000 – 769.000	18.000	4.608, 9.216
19		698.000 – 716.000	728.000 – 746.000	12.000	4.608, 9.216

NOTE 1— The recommend bandwidth of 4.608 MHz corresponds to a system with 480 non-guard subcarriers.

NOTE 2— The recommend bandwidth of 9.216 MHz corresponds to a system with 960 non-guard subcarriers.

4.4 Access node (AN) Minimum Performance Specification (MPS)

4.4.1 AN receiver minimum standards

The sector receiving equipment shall include two diversity radio frequency (RF) input ports. Receiver tests employ both inputs, unless otherwise specified. The equipment setups referenced in this subclause are functional. Other configurations may be necessary for actual testing due to equipment limitations and tolerances.

4.4.1.1 Receiver sensitivity

4.4.1.1.1 Definition

The reference sensitivity (REFSENS) level is defined for one receive antenna as the minimum mean power received at the antenna connector to attain 1% frame error rate (FER) for the configurations specified in Table 3.

4.4.1.1.2 Method of measurement

The test shall be carried out for every band class and CBW supported by the sector using the relevant configuration as specified in Table 3.

a) Configure the sector under test and an access terminal simulator as shown in Figure 2.

b) Disable the Additive White Gaussian Noise (AWGN) generators (set their output powers to zero).

c) Configure the access node to use reference channel parameters specified in the first column of Table 3 for the channel bandwidth being used for the test.

d) Fix the access node transmit power to the maximum supported for the configuration.

e) The power level should be fixed such that the access node REFSENS level is at the value specified in Table 4 for the channel bandwidth being used.

f) Measure the FER.

Table 3—Encoder parameters for receiver sensitivity

Reference channel parameter	Value
Allocated tiles	30
Guard Band (tiles per side)	1
Symbols per tile	8
Modulation	QPSK
Packet format	0
Number of Hybrid Automatic Repeat Request (HARQ) transmissions	1
Payload size (bits)	1666
Tones per tile	16
Data channel Cyclic Redundancy Check (CRC) (bits)	24
Cyclic prefix (µs)	13.02
Symbol duration (µs)	120.44
Frame duration (µs)	963.52
PHY layer throughput (kbps)	1729

Table 4—Access node REFSENS level

Channel bandwidth (MHz)	Access node REFSENS level (dBm)
5	–102.2 + x + y
10	–102.2 + x + y
20	–102.2 + x + y
NOTE—x is the reference signal C/I requirement. x = –0.5 dB for 1% FER and y = 2.5 dB is the implementation loss	

4.4.1.1.3 Minimum standard

The FER in all the tests shall not exceed 1% with 95% confidence.

4.4.1.2 Receiver dynamic range

4.4.1.2.1 Definition

The dynamic range requirement of the MBWA system is specified as a measure of the capability of the receiver to receive a desired MBWA signal in the presence of an AWGN interfering signal of the same bandwidth as that of the desired signal in the reception frequency channel. The requirement is to attain a FER less than or equal to 1% for transmission configurations in Table 5.

4.4.1.2.2 Method of measurement

The test shall be carried out for every band class and CBW supported by the sector using the relevant configuration as specified in Table 5.

a) Configure the sector under test and an access terminal simulator as shown in Figure 2.
b) Configure the access node to use reference channel parameters specified Table 5 for the channel bandwidth being used for the test.
c) Fix the access node transmit power to the maximum supported for the configuration.
d) Adjust the interfering signal’s mean power to the level specified in Table 6.
e) Measure the FER.

Table 5—Encoding parameters for receiver dynamic range test[a]

Reference channel parameter	Value
Allocated tiles	30
Guard Band (tiles per side)	1
Symbols per tile	8
Modulation	64-QAM
Packet format	7
Number of HARQ transmissions	1
Payload size (bits)	9576
Subcarriers per tile	16
Data channel CRC (bits)	24
Cyclic prefix (µsec)	13.02
Symbol duration (µs)	120.44
Frame duration (µs)	963.52
Phy layer throughput (kbps)	9939

[a]The channel code is Turbo code R1/5.

Table 6—Access node receive power level for dynamic range test

MBWA channel bandwidth (MHz)	Desired signal mean power (dBm)	Interfering signal mean power (dBm) /transmission BW	Type of interfering signal
5	–86.2 + x + y	–86.2	AWGN
10	–86.2 + x + y	–83.2	AWGN
20	–86.2 + x + y	–80.2	AWGN
NOTE 1—requirement shall be met in consecutive application of the configuration in Table 1 to groups of 30 tiles. NOTE 2—x = 14.5 for 1% FER assuming 1 receive antenna and y = 2.5 dB.			

4.4.1.2.3 Minimum standard

The FER in all the tests shall not exceed 1% with 95% confidence.

4.4.1.3 Intermodulation spurious response attenuation

4.4.1.3.1 Definition

The intermodulation spurious response attenuation requirement of the MBWA system is specified as a measure of the capability of the receiver to receive a desired MBWA signal in the presence of interfering signals. It is measured by specifying signals at a carefully chosen frequency offset, such that their third order intermodulation product falls in the desired signal channel, increasing the noise floor. The desired signal is allowed to desense the receiver by at most 6 dB.

4.4.1.3.2 Method of measurement

The test shall be carried out for every band class and CBW supported by the sector using the relevant configuration as specified in Table 7 and Table 8.

a) Configure the sector under test and an access terminal simulator as shown in Figure 4.

b) Configure the access node to use the reference channel configuration in Table 3 (receiver sensitivity).

c) Fix the access node transmit power to the maximum supported for the configuration.

d) Adjust the mean power of the interfering signals to the level specified in Table 7 and Table 8.

e) For broadband intermodulation test, the power level should be fixed such that the access node receiver power is at the level specified in Table 7. For narrowband intermodulation test, the power level should be fixed such that the access node receiver power is at the level specified in Table 8.

f) Measure the FER.

Table 7—Access node broadband intermodulation performance requirement

MBWA channel bandwidth (MHz)	Configuration	Desired signal mean power (dBm) (The value of REFSENS is as specified in Table 4)	Interfering signal mean power (dBm)	Interfering signal center frequency offset to the channel edge of the desired carrier (MHz)	Type of interfering signal
5	See Table 3	REFSENS + 6 dB	–52	7.5	CW
			–52	17.5	5 MHz MBWA signal
10	See Table 3	REFSENS + 6 dB	–52	7.5	CW
			–52	17.7	5 MHz MBWA signal
20	See Table 3	REFSENS + 6 dB	–52	7.5	CW
			–52	17.95	5 MHz MBWA signal

Table 8—Access node narrowband intermodulation performance requirement

MBWA channel bandwidth (MHz)	Configuration	Wanted signal mean power (dBm) (The value of REFSENS is as specified in Table 4)	Interfering signal mean power (dBm)	Interfering signal offset to the channel edge of the desired carrier (kHz)	Type of interfering signal
5	See Table 3	REFSENS + 6 dB	–52	384	CW
			–52	1040.8	5 MHz MBWA signal, 1 tile[a] (10th tile from center)
10	See Table 3	REFSENS + 6 dB	–52	439.6	CW
			–52	1348	5 MHz MBWA signal, 1 tile[a] (8th tile from center)
20	See Table 3	REFSENS + 6 dB	–52	474	CW
			–52	1655.2	5 MHz MBWA signal, 1 tile[a] (6th tile from center)

[a]Interfering signal consisting of one tile positioned at the stated offset.

4.4.1.3.3 Minimum standard

The FER in all the tests shall not exceed 1% with 95% confidence.

4.4.1.4 Adjacent channel selectivity

4.4.1.4.1 Definition

Adjacent channel selectivity (ACS) is defined by specifying a certain receiver performance (FER = 0.01) at a specified data rate, desired signal mean power and interfering signal mean power, where the interferer is a MBWA signal located on the adjacent channel. The following two signals specify the MBWA ACS requirement:

— A single tile signal from an adjacent MBWA system with minimum center frequency offset of the interfering signal to the channel edge of a victim system equal to 272.8 kHz as shown in Table 9.

— A wideband signal in an adjacent channel position. The wideband signal is a 5 MHz MBWA carrier, independent of the MBWA channel bandwidth with minimum center frequency offset of the interfering signal to the band edge of a victim system equal to 2.5 MHz as shown in Table 10.

4.4.1.4.2 Method of measurement

The test shall be carried out for every band class and CBW supported by the sector using the relevant configuration as specified in Table 9 and Table 10.

a) Configure the sector under test and an access terminal simulator as shown in Figure 3.

b) Configure the access node to use the reference channel configuration in Table 3 (receiver sensitivity).

c) Fix the access node transmit power to the maximum supported for the configuration.

d) Adjust the mean power of the interfering signals to the level specified in Table 9 and Table 10.

e) For narrowband ACS test, the power level should be fixed such that the access node receiver power is at the level specified in Table 9. For wideband ACS test, the power level should be fixed such that the access node receiver power is at the level specified in Table 10.

f) Measure the FER.

Table 9—MBWA AN ACS (narrowband) requirement

MBWA channel bandwidth (MHz)	Reference measurement channel	Wanted signal mean power (dBm) (The value of REFSENS is as specified in Table 4)	Interfering signal mean power (dBm)	Interfering tile center frequency offset to the channel edge of the wanted carrier (kHz)	Type of interfering signal
5	See Table 3	REFSENS + 6 dB	–49	272.8 + m × 153.6, m = 0, 14, 30	5 MHz MBWA signal, 1 tile[a]
10	See Table 3	REFSENS + 6 dB	–49	272.8 + m × 153.6, m = 0, 14, 30	5 MHz MBWA signal, 1 tile[a]
20	See Table 3	REFSENS + 6 dB	–49	272.8 + m × 153.6, m = 0, 14, 30	5 MHz MBWA signal, 1 tile[a]

[a]Interfering signal consisting of one tile. The requirement applies to both upper and lower frequency edge of the MBWA channel. Add offset to the upper frequency edge and subtract offset from the lower frequency edge.

Table 10—MBWA AN ACS (wideband) requirement

MBWA channel bandwidth (MHz)	Reference measurement channel	Desired signal mean power (dBm)	Interfering signal mean power (dBm)	Interfering signal center frequency offset to the channel edge [a] of the wanted carrier (MHz)	Type of interfering signal
5	See Table 3	REFSENS + 6 dB	–52	2.5	5 MHz MBWA signal
10	See Table 3	REFSENS + 6 dB	–52	2.5	5 MHz MBWA signal
20	See Table 3	REFSENS + 6 dB	–52	2.5	5 MHz MBWA signal

[a] The requirement applies to both upper and lower frequency edge of the MBWA channel. Add offset to the upper frequency edge and subtract offset from the lower frequency edge

4.4.1.4.3 Minimum standard

The FER in all the tests shall not exceed 1% with 95% confidence.

4.4.1.5 In-channel selectivity

4.4.1.5.1 Definition

The in-channel selectivity (ICS) requirement of the MBWA system is specified as a measure of the capability of the receiver to receive a desired MBWA signal (denoted as the victim) at its assigned tile locations in the presence of another in-channel desired signal (denoted as the aggressor) received at adjacent tile allocations that are received at a higher power spectral density (PSD).

Table 11 and Table 12 specify the tile allocations for the victim and aggressor signal as well as the received energy level for both. The victim signal uses Quadrature Phase Shift Keying (QPSK) modulation and the aggressor resembles a 64-QAM received signal. The aggressor PSD is set at 25 dB above the noise floor. The requirement is to have a selectivity of 25 dB on the aggressor such that the noise it causes at the victim tiles is at the same level as its own noise floor, i.e., the total noise floor on the victim tiles increases by 3 dB or alternatively the aggressor causes 3 dB desense.

4.4.1.5.2 Method of measurement

The test shall be carried out for every band class and CBW supported by the sector using the relevant configuration as specified in Table 11.

a) Configure the sector under test and an access terminal simulator (victim) and another access terminal simulator (aggressor) as shown in Figure 3.

b) Configure the access node to use reference channel in Table 11.

c) Fix the access node transmit power to the maximum supported for the configuration.

d) Fix the transmit power on the access terminal (aggressor) simulator and start the data packet transmission on the reverse link. The power level should be fixed such that the access node receiver power is at the level specified in Table 12 for the channel bandwidth being used.

e) Set up a connection between the access terminal (victim) and the access node.

f) The power level should be fixed such that the access node receiver power is at the level specified in Table 12 for the channel bandwidth being used.

g) Measure the FER.

Table 11—Encoding parameters for in-channel selectivity

Reference channel	A1	A2
Allocated tiles for victim	16	32
Guard Band (tiles per side)	1	2 for channel bandwidth = 10 MHz; 4 for channel bandwidth = 20 MHz
Symbols per tile	8	8
Modulation	QPSK	QPSK
Packet format	0	0
Number of HARQ transmissions	1	1
Payload size (bits)	877	2860
Cyclic prefix (µsec)	13.02	13.02
Tones per tile	16	16
Data channel CRC (bits)	24	24
Symbol duration (µs)	120.44	120.44
Frame duration (µs)	963.52	963.52
PHY layer throughput (kbps)	910	1820

Table 12—Victim/aggressor tiles allocations and received energy levels

MBWA Channel Bandwidth (MHz)	Reference measurement channel	Tiles victim signal	Tiles aggressor signal	Desired signal mean power (dBm)	Interfering signal mean power (dBm)
5	A1 in Table 11	16	14	–105 + x + y +3	–80.6
10	A2 in Table 11	32	28	–102 + x + y +3	–77.6
20	A2 in Table 11	32	28	–102 + x + y +3	–77.6
NOTE—x = 0.5 dB and y = 2.5dB					

4.4.1.5.3 Minimum standard

The FER in all the tests shall not exceed 1% with 95% confidence.

4.4.1.6 Receiver blocking characteristics

4.4.1.6.1 Definition

The blocking performance requirement of the MBWA system is specified as a measure of the receiver ability to receive a desired signal at its assigned channel frequency in the presence of an unwanted interferer. The following two different cases are specified:

a) In-band blocking using a 5 MHz MBWA signal as interference signal.

b) Out-of-band blocking with CW signal as interference signal on frequencies other than those “close-in” to the desired channel.

4.4.1.6.2 Method of measurement

The test shall be carried out for each CBW supported by the sector using the configuration as specified in Table 3 (receiver sensitivity).

a) Configure the sector under test and an access terminal simulator as shown in Figure 3.

b) Configure the access node to use the reference channel configuration in Table 3 (receiver sensitivity).

c) Fix the access node transmit power to the maximum supported for the configuration.

d) Adjust the mean power of the interfering signals to the level specified in Table 13 and Table 14. Table 14 shall be used for the frequency range of 1MHz to f_3 and f_4 to 12.750 GHz. The frequency ranges f_3 and f_4 are defined in Table 15.

e) Set up a connection between the access terminal and the access node and ensure that the configuration specified in step b) is in use.

f) Fix the transmit power on the access terminal (aggressor) simulator and start the data packet transmission on the reverse link. The power level should be fixed such that the access node receiver power is at the level specified in Table 13 and Table 14 for the channel bandwidth being used.

g) Measure the FER.

Table 13—MBWA access node in-band blocking requirements

MBWA assigned bandwidth (MHz)	Wanted signal mean power (dBm)	Interfering signal mean power (dBm)	Interfering signal minimum offset to the channel edge of the wanted carrier (MHz)	Type of interfering signal
5	REFSENS + 3 dB	–43	7.5	5 MHz MBWA signal
10	REFSENS + 3 dB	–43	7.5	5 MHz MBWA signal
20	REFSENS + 3 dB	–43	7.5	5 MHz MBWA signal

Table 14—MBWA access node out-of-band blocking requirements

MBWA assigned bandwidth (MHz)	Wanted signal mean power (dBm)	Interfering signal mean power above access terminal mean power (dB)	Type of interfering signal
5	REFSENS + 3 dB	+75	CW carrier
10	REFSENS + 3 dB	+75	CW carrier
20	REFSENS + 3 dB	+75	CW carrier

Table 15—Frequency range definition for use in Table 14

f_3 (MHz)	f_4 (MHz)
20 below the left edge of the band	20 above the right edge of the band

4.4.1.6.3 Minimum standard

The FER in all the tests shall not exceed 1% with 95% confidence.

4.4.1.7 Limitations on emissions

4.4.1.7.1 Definition

Conducted spurious emissions are spurious emissions generated or amplified in the sector equipment and appearing at the receiver RF input ports.

4.4.1.7.2 Method of measurement

a) Connect a spectrum analyzer (or other suitable test equipment) to a receiver RF input port.

b) For each band class that the sector supports, configure the sector to operate in that band class and perform step c) through step e).

c) Disable all transmitter RF outputs.

d) Perform step e) for all receiver input ports.

e) Sweep the spectrum analyzer over a frequency range from the lowest intermediate frequency or lowest oscillator frequency used in the receiver or 1 MHz, whichever is lower, to at least 2600 MHz for Band Classes [2] 0, 2, 5, 7, 9, 10, 11 and 12, at least 3 GHz for Band Class 3 or at least 6 GHz for Band Classes 1, 4, and 8. For Band Class 6, sweep the spectrum analyzer over a frequency range from 30 MHz to at least 12.75 GHz and measure the spurious emissions levels.

4.4.1.7.3 Minimum standard

The mean conducted spurious emission shall not exceed the levels in Table 16.

Table 16—General spurious emission minimum requirement

Band	Maximum level	Measurement bandwidth
30 MHz – 1 GHz	–57 dBm	100 kHz
1 GHz – 12.75 GHz	–47 dBm	1 MHz
Within access node Receive band	–80 dBm	30 kHz
1884.5 – 1919.6 MHz	–41dBm	300 kHz
NOTE—The frequency range between 2.5 $\times$ CBW_l below the first carrier frequency and 2.5 $\times$ CBW above the last carrier frequency transmitted by the AN is excluded from the requirement. However, frequencies that are more than 10 MHz below the lowest frequency of the AN transmitter operating band or more than 10 MHz above the highest frequency of the AN transmitter operating band shall not be excluded from the requirement.		

Current region-specific radio regulation rules shall also apply.

For example,

1) A Band Class 3 sector operating under Japan regional requirements shall limit conducted emissions to less than –54 dBm, measured in a 30 kHz resolution bandwidth at the sector RF input ports, for all other frequencies.

2) A Band Class 6 sector operating under Japan regional requirements shall limit conducted emissions to less than –41 dBm, measured in a 300 kHz resolution bandwidth at the sector RF input ports, for frequencies within the Personal Handy-phone System (PHS) band from 1884.5 MHz to 1919.6 MHz.

4.4.2 AN Transmitter MPS

4.4.2.1 Frequency tolerance

4.4.2.1.1 Definition

The frequency tolerance is defined as the maximum allowed difference between the actual transmit carrier frequency and the specified transmit frequency assignment. This test shall apply to every band class that the sector supports.

4.4.2.1.2 Method of measurement

Frequency shall be measured using appropriate test equipment with sufficient accuracy to ensure compliance with the minimum standard. Frequency should be measured as part of the error vector magnitude (EVM) test of 4.4.2.2.1.

4.4.2.1.3 Minimum standard

For all operating temperatures specified by the manufacturer, the average frequency difference between the actual transmit carrier frequency and specified transmit frequency assignment shall be less than 5×10^{-8} of the frequency assignment (±0.05 ppm).

4.4.2.2 Modulation requirements

4.4.2.2.1 Error vector magnitude

4.4.2.2.1.1 Definition

The error vector magnitude is measured by determining the root mean square error between the ideal constellation point and the actual one to be received after equalizing for some of the access node transmitter imperfections. This test is performed with a single carrier and single sector only. This test also evaluates the resulting spectral flatness that is a consequence for EVM being computed for equalized waveform. The equalized waveform may not capture any ripples or droop in the transmit waveform.

The test shall be carried out for every band class and CBW supported by the sector.

4.4.2.2.1.2 Method of measurement

a) Configure the sector under test as shown in Figure 5.

b) Connect the EVM measuring equipment to the sector RF output port.

c) Configure the access node to use the tile assignment for a given maximum transmission bandwidth in Table 17.

d) Fix the access node transmit power to the maximum supported when testing for QPSK and 8-PSK, 5 dB below maximum when testing for 16QAM and 10 dB below maximum when testing for 64-QAM.

e) Measure the EVM as follows:

1) The transmitted signal is cable-connected to the receiver with one receive antenna. Denote the received samples by r .
2) After down conversion, the EVM analyzer determines the beginning of the cyclic prefix of the received signal. It computes the frequency offset for the given PHY frame n[4], $f_{o,n}$, and corrects for it by applying a phase ramp on each sample of r with a slope of $f_{o,n}$. Denote the resulted signal by y .
3) The EVM analyzer then performs a Fast Fourier Transform (FFT) operation with an FFT window that centers the channel in the cyclic prefix. Consequently, the frequency domain tones are then corrected with a phase ramp of slope CP/2; denote the resulted samples by Z .
4) The EVM analyzer estimates the complex channel response for every sample in the assignment. Channel estimation is done within every tile by first averaging the pilots in the tile then doing linear interpolation in time and frequency to get the channel response on the data tones. Denote the frequency domain channel estimate on a given tone by H .
5) The EVM analyzer performs channel equalization to get samples $\hat{X} = \frac{Z}{H}$.
6) The EVM analyzer computes the EVM metric as

$$EVM\left(\hat{X}\right) = \sqrt{\frac{\sum_{j=1}^{N_f}\sum_{k=1}^{N_p}\left(X_I(j,k) - \hat{X}_I(j,k)\right)^2 + \left(X_Q(j,k) - \hat{X}_Q(j,k)\right)^2}{\sum_{j=1}^{N_f}\sum_{k=1}^{N_p}\left(X_I(j,k)\right)^2 + \left(X_Q(j,k)\right)^2}}$$

where

a_I, a_Q	are the real and imaginary parts of a
$\hat{X}$	is the frequency domain equalized sample by the EVM analyzer as explained above
X[5]	is the frequency domain ideal transmitted constellation point by the AN
N_p	is the number of modulation symbols in all assignment tiles in one frame
N_f	is the total number of frames used for averaging EVM, i.e., $N_f = N_s \times N_{f,SF}$,

N_s being the number of super frames and $N_{f,SF}$ is the number of frames in a super frame. This test shall run for $N_s = 1$ super frames. The number of frames used in each super frame, $N_{f,SF}$, shall be at least 3.

[4] The EVM equalizer may also use an average estimate of the frequency offset or an estimate that is constant over a super frame.

[5] It may not be possible for the EVM analyzer equipment to have the ideal transmitted constellation point. In this case, we can map $\hat{X}$ to the nearest constellation point from a Euclidean distance sense and denote the hard-decision constellation point by X . In this case, the EVM calculation is optimistic since there is a probability that hard decision is wrong so that the real constellation point is farther from the hard decision one, i.e., EVM calculated is smaller than actual.

f) Measure the spectral flatness factor defined as follows:

1) From channel estimation we have the estimated frequency response H_i for tone i, $i = 1, 2, \cdots, M$, where M is the total Number of tones in an OFDM symbol

2) Obtain the magnitude square $B_i = |H_i|^2$ for each tone and average it over multiple OFDM symbols to obtain $\overline{B}_i$, for $i = 1, 2, \cdots, M$

3) Compute the spectral flatness metric $F = 10\log_{10}\left(B_{\max}/B_{\min}\right)$, where $B_{\max} = \max_{i=1,2,\cdots M} \overline{B}_i$, $B_{\min} = \min_{i=1,2,\cdots M} \overline{B}_i$

Table 17—AN assignment used for EVM computation

Channel BW (MHz)	5	10	20
Nominal maximum number of tiles (N_T) for maximum transmission BW	30	60	120
Nominal maximum transmission BW (MHz)	4.61	9.22	18.44

4.4.2.2.1.3 Minimum standard

The measured EVM at the transmit power specified shall be less than the values in Table 18.

Table 18—Error vector magnitude limits as a function of modulation type

AN type	Modulation type	EVM (%)	C/N (dB)	Power below Maximum Transmit Power (dB)
Wide area	QPSK	17.5	15.13	0
	8-PSK	12.5	18.06	0
	16QAM	9	20.91	5
	64-QAM	5	26.02	10

The measured spectral flatness metric shall be less than 3 dB.

4.4.2.3 Limitations on emissions

4.4.2.3.1 Conducted spurious emissions

4.4.2.3.1.1 Definition

The conducted spurious emissions are emissions at frequencies that are outside the assigned MBWA Channel, measured at the sector RF output port.

4.4.2.3.1.2 Method of measurement

The test shall be carried out for every band class and CBW supported by the sector.

a) Configure the sector under test and an access terminal as shown in Figure 2. The AWGN generators are not applicable in this test.

b) Connect a spectrum analyzer (or other suitable test equipment) to the sector RF output port, using an attenuator or directional coupler if necessary.

c) Fix the access node transmit power to the maximum supported for the configuration.

d) Measure the spurious emissions using appropriate measurement bandwidth.

e) For Adjacent Carrier Leakage Ratio (ACLR) measurement, measure the in-band power and also the power in the first and second adjacent channels for the specified channel bandwidths. Compute the difference between the in-band power and the power in the adjacent channels to measure the ACLR.

4.4.2.3.1.3 Minimum standard

In the sequel the following definitions are to be observed:

— Δf is the separation between the carrier edge frequency and the nominal –3 dB point of the measuring filter closest to the carrier frequency

— Δf_{max} is the offset to the frequency 10 MHz outside the operating band edge minus half of the bandwidth of the measuring filter.

When transmitting in band classes less than 1 GHz, the spurious emissions shall be less than the limits specified in Table 19. When transmitting in band class 0, the spurious emissions shall be less than the limits specified in Table 20.

When transmitting in band classes greater than 1 GHz, the spurious emissions shall be less than the limits specified in Table 21. When transmitting in band class 1 or 15, the additional spurious emissions shall be less than the limits specified in Table 22. The out-of-band spurious emissions shall be less than the limits specified in Table 23 and Table 24. The spurious emissions shall be less than the limits for the protection of the access node receiver as specified in Table 25.

The measured ACLR shall be equal to or more than the limits specified in Table 26.

Table 19—Band classes less than 1 GHz transmit spurious emission limits

Frequency offset, Δ f, MHz	Emission limit	Unit	RBW, kHz	Comments: Restrictions	Comments: Applicable range
0–5	–7 –7/5 × Δ f	dBm	100	all CBW ≥ 5 MHz	**f_c < 1 GHz**
5–10	–14	dBm	100	all CBW ≥ 5 MHz	**f_c < 1 GHz**
10 – Δ f_{max}	–16	dBm	100	all CBW ≥ 5 MHz	**f_c < 1 GHz**

Table 20—Band class 0 additional transmitter spurious emission limits

Frequency offset, Δ f, MHz	Emission limit	Unit	RBW, kHz	Comments: Restrictions	Comments: Applicable range
0–1	–10	dBm	100	CBW = 5 MHz	**f_c < 1 GHz**
0–1	–13	dBm	100	CBW = 10 MHz	**f_c < 1 GHz**
0–1	–16	dBm	100	CBW = 20 MHz	**f_c < 1 GHz**
1–5	–13	dBm	100	all CBW ≥ 5 MHz	**f_c < 1 GHz**
5–10	–14	dBm	100	all CBW ≥ 5 MHz	**f_c < 1 GHz**
10 – Δ f_{max}	–16	dBm	100	all CBW ≥ 5 MHz	**f_c < 1 GHz**

Table 21—Band classes greater than 1 GHz transmitter spurious emission limits

Frequency offset, Δ f, MHz	Emission limit	Unit	RBW, kHz	Comments: Restrictions	Comments: Applicable range
0–5	–7 –7/5 × Δ f	dBm	100	all CBW ≥ 5 MHz	**f_c > 1 GHz**
5–10	–14	dBm	100	all CBW ≥ 5 MHz	**f_c > 1 GHz**
10– Δ f_{max}	–15	dBm	1000	all CBW ≥ 5 MHz	**f_c > 1 GHz**

Table 22—Additional band class 1 and 15 transmitter spurious emission limits

Frequency offset, Δ f, MHz	Emission limit	Unit	RBW, kHz	Comments: Restrictions	Comments: Applicable range
0–1	–10	dBm	100	CBW=5 MHz	**f_c > 1 GHz**
0–1	–13	dBm	100	CBW=10 MHz	**f_c > 1 GHz**
0–1	–16	dBm	100	CBW=20 MHz	**f_c > 1 GHz**
1–10	–13	dBm	1000	all CBW ≥ 5 MHz	**f_c > 1 GHz**
10– Δf_{max}	–15	dBm	1000	all CBW ≥ 5 MHz	**f_c > 1 GHz**

Table 23—Out-of-band spurious emission limits for Category A

Band	Maximum level	Measurement bandwidth	Note
9kHz – 150kHz	–13 dBm	1 kHz	Note 1
150kHz – 30MHz		10 kHz	Note 1
30MHz – 1GHz		100 kHz	Note 1
1GHz – 12.75 GHz		1 MHz	Note 2

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.

Table 24—Out-of-band spurious emission limits for Category B

Band	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

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.

Table 25—Wide area access node spurious emission limits for protection of access node receiver

Operating bands	Access network class	Maximum level	Measurement bandwidth
All	Wide area	–96 dBm	100 kHz

In addition to the previous requirements, current region-specific radio regulation rules shall also apply.

Table 26—ACLR limits

ACLR limit for first and second adjacent channel relative to assigned channel frequency (dB)				
Channel BW (MHz)		**MBWA[a] 5.0 MHz**	**MBWA[a] 10 MHz**	**MBWA[a] 20 MHz**
5	ACLR 1	45	—	—
	ACLR 2	45	—	—
10	ACLR 1	—	45	—
	ACLR 2	—	45	—
20	ACLR 1	—	—	45
	ACLR 2	—	—	45

[a] Measured on the maximum transmission BW on the first or second adjacent channels.

4.4.2.3.2 Inter-sector transmitter intermodulation

4.4.2.3.2.1 Definition

The inter-sector transmitter intermodulation occurs when an external signal source is introduced to the antenna connector of the sector. This test verifies that conducted spurious emissions are still met with the presence of the interfering source.

4.4.2.3.2.2 Method of measurement

The test shall be carried out for every band class and the maximum bandwidth (denoted by B in the following steps) supported by the sector.

a) Connect the two sectors under test and two access terminal simulators as shown in Figure 6. Configure the setup so that Sector 2 total power is 30 dB less than the power of Sector 1. The frequency offset of the center frequency of the interference signal shall be B/2 + 2.5 MHz and –B/2 – 2.5 MHz from the desired signal carrier center frequency, but excluded are interference frequencies that are partially or completely outside of operating frequency band of the base station.

b) Connect a spectrum analyzer (or other suitable test equipment) to the sector RF output port, using an attenuator or directional coupler if necessary.

c) Fix the Sector 1 transmit power to the maximum supported for the configuration.

d) Set up a connection between the access terminal simulator 1 and sector 1 and access terminal simulator 2 and sector 2.

e) Measure the spurious emissions for sector 1.

4.4.2.3.2.3 Minimum standard

The sector shall meet the conducted spurious emission requirements in 4.4.2.1.

4.5 Access terminal (AT) MPS

4.5.1 AT Receiver MPS

The receiver performance includes the following tests: sensitivity, dynamic range, high throughput, intermodulation spurious response attenuation, blocking and ACS tests.

4.5.1.1 Receiver sensitivity, dynamic range, and high throughput

4.5.1.1.1 Definition

The receiver sensitivity, REFSENS, of the access terminal receiver is the minimum received power, measured at the access terminal antenna connector, at which the packet error rate (PER) for a specified packet format does not exceed a specified value. The receiver dynamic range is the input power range at the access terminal antenna connector over which the PER for a specified packet format does not exceed a specific value. The high throughput level is the minimum mean power, measured at the access terminal antenna connector, at which the PER for a specified packet format corresponding to some specified high throughput does not exceed a specific value.

4.5.1.1.2 Method of measurement

The test shall be carried out for every band class and channel bandwidth supported by the terminal using the relevant column in Table 27.

a) Connect the sector to the access terminal antenna connector as shown in Figure 7. The AWGN generator and the CW generator are not applicable in these tests.

b) Ensure that MAC and Physical layer configuration meet the requirements specified in the column of Table 27 corresponding to CBW used for the specified test.

c) Set up a connection between the access terminal and the access node and ensure that the configuration specified in step b) is in use.

d) Instruct the access node to transmit power control commands such that the mean transmit power from the access terminal is 20 dBm.

e) For sensitivity test, adjust the received power level to the level specified in Table 28 for the corresponding channel bandwidth used for the test. For high throughput test and Dynamic Range test, adjust the received power level to the level specified in Table 29 for the corresponding channel bandwidth used for the test.

f) Measure the FER for the test.

Table 27—Test parameters for receiver sensitivity, high throughput, and dynamic range

Transmission configuration for reference channel	Sensitivity test			High throughput and dynamic range test		
	A1	A2	A3	A4	A5	A6
Allocated tiles	30	60	120	30	60	120
Guard Band (tiles per side)	1	2	4	1	2	4
Symbols per tile	8	8	8	8	8	8
Modulation	QPSK	QPSK	QPSK	64-QAM	64-QAM	64-QAM
Packet format	1	1	1	6	6	6
Number of HARQ transmissions	1	1	1	1	1	1
Payload size (bits)	2544	5120	10264	11496	23016	40,640
Tones per tile	16	16	16	16	16	16
Data channel CRC (bits)	24	24	24	24	24	24
Cyclic Prefix (µsec)	13.02	13.02	13.02	13.02	13.02	13.02
Symbol duration (µs)	120.44	120.44	120.44	120.44	120.44	120.44
Frame duration (µs)	963.52	963.52	963.52	963.52	963.52	963.52
PHY layer throughput (kbps)	2669	5338	10676	11956	23912	41514
Channel bandwidth (MHz)	5	10	20	5	10	20
Transmission bandwidth (MHz)	4.61	9.22	18.44	4.61	9.22	18.44

Table 28—Received power levels corresponding to sensitivity test

Transmission configuration	Received signal level or REFSENS level, dBm
A1 in Table 27	–96 + x + y
A2 in Table 27	–93 + x + y
A3 in Table 27	–90 + x + y
NOTE 1—x is the SNR required to decode the packet format and y is the implementation loss. x = –1dB and y = 2dB. NOTE 2—The requirement shall be met at maximum transmit power of 21 dBm.	

Table 29—Received levels corresponding to high throughput and dynamic range test

Transmission configuration	Received signal level, dBm (High throughput test)	Received signal level, dBm (Dynamic range test)
A4 in Table 27	–96 + x + y	–25
A5 in Table 27	–93 + x + y	–25
A6 in Table 27	–90 + x + y	–25
NOTE 1—x is the SNR required to decode the packet format and y is the implementation loss. x = 12 dB and y = 2 dB. NOTE 2—The requirement shall be met at maximum transmit power of 21 dBm.		

4.5.1.1.3 Minimum standard

The FER in all the tests shall not exceed 1% with 95% confidence.

4.5.1.2 Intermodulation spurious response attenuation

This test shall be performed for each band class supported by the access terminal. This test specifies the intermodulation spurious response attenuation requirements for channel bandwidth greater than or equal to 5 MHz.

4.5.1.2.1 Definition

The intermodulation spurious response attenuation is a measure of a receiver's ability to receive a MBWA signal on its assigned channel frequency in the presence of two interfering CW tones (narrowband test) and an interfering 5 MHz MBWA signal along with an interfering CW tone (broadband test). These tones are separated from the assigned channel frequency and are separated from each other such that the third order mixing of the two interfering CW tones can occur in the non-linear elements of the receiver, producing an interfering signal in the band of the desired signal. The receiver performance is measured by the FER.

4.5.1.2.2 Method of measurement

The test shall be carried out for every band class and channel bandwidth supported by the terminal.

a) Connect the sector to the access terminal antenna connector as shown in Figure 7.

b) Ensure that MAC and Physical layer configuration meet the requirements specified in the column of Table 27 corresponding to channel bandwidth used for the specified test.

c) Set up a connection between the access terminal and the access node and ensure that the configuration specified in step b) is in use.

d) Instruct the access node to transmit power control commands such that the mean transmit power from the access terminal is 20 dBm.

e) Adjust the received power level of the desired signal and the interferers to the level specified in Table 30 (for broadband blocker) or Table 31 (for narrowband blocker) for the channel bandwidth used for the test.

f) Measure the FER for the test.

Table 30—Test parameters for intermodulation spurious response attenuation for broadband interference

Transmission configuration	Signal level	First blocker (CW)		Second blocker (Note 1)	
		Level (dBm)	Frequency offset (MHz)	Level (dBm)	Frequency offset (MHz)
A1 in Table 27	<REFSENS> + 3 dB dBm/4.61 MHz	–46	±10	–46	±20
A2 in Table 27	<REFSENS> + 3 dB dBm/9.22 MHz	–46	±12.5	–46	±25
A3 in Table 27	<REFSENS> + 3 dB dBm/18.44 MHz	–46	±17.5	–46	±35

NOTE 1—The second blocker is a 5 MHz MBWA signal occupying the maximum transmission BW (i.e., 5 MHz minus guard band).
NOTE 2—Frequency offset is measured from the carrier frequency of the MBWA signal under test to the carrier frequency of the blocker.
NOTE 3—The requirements shall be met while the access terminal is transmitting a MBWA signal occupying the maximum transmission bandwidth (i.e., the channel bandwidth minus guard band) of the desired signal at a mean power of 20 dBm.

Table 31—Test parameters for intermodulation spurious response attenuation for narrowband interference

Transmission configuration	Signal level	First blocker (CW)		Second blocker (CW)	
		Level (dBm)	Frequency offset (MHz)	Level (dBm)	Frequency offset (MHz)
A1 in Table 27	<REFSENS> + 10 dB dBm/4.61 MHz	–44	±3.5	–44	±5.9
A2 in Table 27	<REFSENS> + 10 dB dBm/9.22 MHz	–44	±6	–44	±8.4
A3 in Table 27	<REFSENS> + 10 dB dBm/18.44 MHz	–44	±11	–44	±13.4

NOTE 1—The requirements shall be met while the access terminal is transmitting a MBWA signal occupying the maximum transmission bandwidth (i.e., the channel bandwidth minus guard band) of the desired signal at a mean power of 20 dBm.
NOTE 2—Frequency offset is measured from the carrier frequency of the MBWA signal under test to the carrier frequency of the blocker.

4.5.1.2.3 Minimum standard

The FER in all the tests shall not exceed 1% with 95% confidence.

4.5.1.3 Adjacent channel selectivity

This test shall be performed for each band class supported by the access terminal for channel bandwidth greater than or equal to 5 MHz.

4.5.1.3.1 Definition

The ACS is a measure of the ability to receive a MBWA signal on the assigned frequency in the presence of a 5 MHz MBWA signal at a given frequency offset from the center frequency of the assigned channel.

4.5.1.3.2 Method of measurement

The test shall be carried out for every band class and channel bandwidth supported by the terminal.

a) Connect the sector to the access terminal antenna connector as shown in Figure 8.

b) Ensure that MAC and Physical layer configuration meet the requirements specified in the column of Table 27 corresponding to channel bandwidth used for the specified test.

c) Set up a connection between the access terminal and the access node and ensure that the configuration specified in step a) is in use.

d) Instruct the access node to transmit power control commands such that the mean transmit power from the access terminal is 20 dBm.

e) Adjust the received signal power and interference power to the level specified in Table 32 for Test 1 for the channel bandwidth used for the test.

f) Measure the FER for the test.

g) Adjust the received signal power and interference power to the level specified in Table 32 for Test 2 for the channel bandwidth used for the test.

h) Measure the FER for the test.

Table 32—Test parameters for adjacent channel selectivity

Transmission configuration	Frequency offset, MHz	Signal level unit	Test 1		Test 2	
			Signal level	Interferer level (dBm/4.61 MHz)	Signal level	Interferer level (dBm/4.61 MHz)
A1 in Table 27	± 5	dBm/4.61 MHz	<REFSENS> + 14 dB	–52 + x + y	–55	–25
A2 in Table 27	± 10	dBm/9.22 MHz	<REFSENS> + 14 dB	–52 + x + y	–52	–25
A3 in Table 27	± 20	dBm/18.44 MHz	<REFSENS> + 14 dB	–52 + x + y	–49	–25

NOTE 1—x is the SNR required to decode the respective transmission configuration and y is the implementation loss. x = –1 dB and y = 2 dB.
NOTE 2—Frequency offset is measured from the carrier frequency of the MBWA signal under test to the carrier frequency of the blocker.
NOTE 3— The requirements shall be met while the access terminal is transmitting a MBWA signal occupying the maximum transmission bandwidth (i.e., the channel bandwidth minus guard band) of the desired signal at a mean power of 20 dBm.

4.5.1.3.3 Minimum standard

The FER in Tests 1 and 2 shall not exceed 1% with 95% confidence. For any signal level between the levels defined in Test 1 and 2, the FER shall not exceed 1% FER with 95% confidence.

4.5.1.4 Receiver blocking characteristics

This test shall be performed for each band class supported by the access terminal for channel bandwidth greater than or equal to 5 MHz.

4.5.1.4.1 Definition

The blocking characteristic is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response (or the adjacent channel covered by the ACS test), without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit. The blocking performance shall apply at all frequencies except those at which spurious response occurs.

The specifications are divided into in-band, out-of-band, and narrow band blocking.

In-band blocking: The in-band blocking specifications pertain only to the cases where the blockers are located at a carrier frequency offset up to ± 15MHz from the signal carrier frequency; the blockers are MBWA signals with a channel bandwidth of 5 MHz.

Out-of-band blocking: The out-of-band blocking specifications pertain to those cases where the blockers are located at a carrier frequency offset greater than 15 MHz from the signal carrier frequency; the blockers are CW. The out-of-band blocking is divided into the following three basic frequency ranges:

- Frequency Range 1: 15 MHz < Blocker carrier frequency offset from the signal ≤ 60 MHz
- Frequency Range 2: 60 MHz < Blocker carrier frequency offset from the signal ≤ 85 MHz
- Frequency Range 3: Blocker carrier frequency offset from the signal > 85 MHz

In addition a fourth range is defined that is the transmit channel of some band classes.

Narrowband blocking: The narrow band blocking specifications pertain to a case of a CW blocker close to the signal channel edge.

4.5.1.4.2 Method of measurement

The test shall be carried out for every band class and channel bandwidth supported by the terminal.

a) Connect the sector to the access terminal antenna connector as shown in Figure 8.

b) Ensure that MAC and Physical layer configuration meet the requirements specified in the column of Table 27 corresponding to channel bandwidth used for the specified test.

c) Set up a connection between the access terminal and the access node and ensure that the configuration specified in step b) is in use.

d) Instruct the access node to transmit power control commands such that the mean transmit power from the access terminal is 20 dBm.

e) For in-band blocking test, adjust the desired signal and blocker signal level to the level specified Table 33 for case 1 for the channel bandwidth used for the test. For out-of-band blocking test, adjust the desired signal and blocker signal level to the level specified in Table 34 for case 1 for the channel bandwidth used for the test. For narrowband blocking test, adjust the desired signal and blocker signal level to the level specified in Table 36 for the channel bandwidth used for the test.

f) Measure the FER for the test.

g) For In-band blocking test, adjust the desired signal and blocker signal level specified in Table 33 for case 2 for the channel bandwidth used for the test.

h) Repeat step e) and step f) for in-band blocking.

i) For out-of-band blocking test, adjust the desired signal and blocker signal level to the level specified in Table 34 for cases 2 through 4 for the channel bandwidth used for the test.

j) Repeat step e) through f) for out-of-band blocking.

Table 33—Test parameters for receiver blocking characteristics (in-band)

Channel bandwidth	Transmission configuration	Signal level unit	Signal level	Case 1 (Note 1)		Case 2 (Note 1)	
				Blocker level dBm/4.61 MHz	Blocker offset, MHz	Blocker level dBm/4.61 MHz	Blocker offset, MHz
5 MHz	A1 in Table 27	dBm/4.61 MHz	<REFSENS> + 3 dB	–56	±10	–44	≤ –15 and ≥ 15
10 MHz	A2 in Table 27	dBm/9.22 MHz	<REFSENS> + 3 dB	–56	±12.5	–44	≤ –17.5 and ≥ 17.5
20 MHz	A3 in Table 27	dBm/28.44 MHz	<REFSENS> + 3 dB	–56	±17.5	–44	≤ –22.5 and ≥ 22.5

NOTE 1—The Blocker is a 5 MHz MBWA modulated signal occupying the maximum transmission bandwidth (5 MHz minus guard band).
NOTE 2—Frequency offset is measured from the carrier frequency of the MBWA signal under test to the carrier frequency of the blocker.
NOTE 3—The requirements shall be met while the access terminal is transmitting a MBWA signal occupying the maximum transmission bandwidth (i.e., the CBW minus guard band) of the desired signal at a mean power of 20 dBm.
NOTE 4—Note that the specifications shall apply even if the blockers fall outside the band class of operation.

Table 34—Test parameters for receiver blocking characteristics (Out-of-Band)

Parameter	Unit	Case 1 (frequency range 1)	Case 2 (frequency range 2)	Case 3 (frequency range 3)	Case 4 (frequency range 4)
Signal level	dBm/4.61 MHz (A1 in Table 27)	<REFSENS> + 3 dB	<REFSENS> + 3 dB	<REFSENS> + 3 dB	<REFSENS> + 3 dB
	dBm/9.22 MHz (A2 in Table 27)				
	dBm/18.44 MHz (A3 in Table 27)				
Blocker level (CW)	dBm	–44	–30	–15	–15
Blocker offset for all band classes	MHz	$f_{FL}-15$ to $f_{FL}-60$ and $f_{FL}+15$ to $f_{FL}+60$	$f_{FL}-60$ to $f_{FL}-85$ and $f_{FL}+60$ to $f_{FL}+85$	f_{FL} – 85 to 1 MHz and $f_{FL}+85$ to 12750	—
Blocker Offset for BC 0 and BC 1	MHz	—	—	—	$f_{RL,low}$ to $f_{RL,high}$

NOTE 1—The spec needs to be met while the AT is transmitting a MBWA signal occupying the maximum transmission BW (i.e., the CBW minus guard band) of the desired signal at a mean power of 20 dBm.
NOTE 2—f_{FL} is the carrier frequency of the desired receive signal.
NOTE 3—$f_{RL,high}$ and $f_{RL,low}$ are the lowest and the highest frequency edges for reverse link in band class 0 and 1. For example, for band class 0, $f_{RL,low}$= 824 MHz and $f_{RL,high}$= 849 MHz.

Table 35—Spurious response specifications

Channel bandwidth	Signal level unit	Signal level	Blocker level (Note 1) In dBm
5 MHz	dBm/4.61 MHz	<REFSENS> + 3 dB	–44
10 MHz	dBm/9.22 MHz	<REFSENS> + 3 dB	–44
20 MHz	dBm/18.44 MHz	<REFSENS> + 3 dB	–44

NOTE 1— The Blocker is CW and is located at spurious response frequencies.
NOTE 2—The spec needs to be met while the AT is transmitting a MBWA signal occupying the maximum transmission BW (i.e., the CBW minus guard band) of the desired signal at a mean power of 20 dBm.

Table 36—Narrow band blocking specifications

CBW (MHz)	Transmission configuration	Signal level	Blocker Offset from carrier (MHz)	Blocker level (dBm)
5 MHz	A1 in Table 27	<REFSENS> + 10 dB dBm/4.61 MHz	2.7	–57
10 MHz	A2 in Table 27	<REFSENS> + 10 dB dBm/9.22 MHz	5.2	–57
20 MHz	A3 in Table 27	<REFSENS> + 10 dB dBm/18.44 MHz	10.2	–57
NOTE— The spec needs to be met while the AT is transmitting a MBWA signal occupying the maximum transmission BW (i.e., the CBW minus guard band) of the desired signal at a mean power of 20 dBm.				

4.5.1.4.3 Minimum standards

In-band blocking: The FER in cases 1 and 2 shall not exceed 1% with 95% confidence.

Out-of-band blocking: The FER in cases 1 through 4 shall not exceed 1% with 95% confidence. For frequency ranges 1, 2, and 3, up to 24 exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a 1 MHz step size. For these exceptions the requirements in Table 35 apply. For frequency range 4, up to 8 exceptions are allowed for spurious response frequencies in each assigned frequency channel when measured using a 1 MHz step size. For these exceptions the requirements in Table 35 apply.

Narrowband blocking: The FER shall not exceed 1% with 95% confidence.

4.5.1.5 Conducted spurious emissions

4.5.1.5.1 Definition

The conducted spurious emissions are spurious emissions generated or amplified in a receiver that appear at the access terminal antenna connector.

4.5.1.5.2 Method of measurement

a) Connect a spectrum analyzer (or other suitable test equipment) to the access terminal antenna connector.

b) For each band class that the access terminal supports, configure the access terminal to operate in that band and perform step c) and step d).

c) Enable the access terminal receiver, so that the access terminal continuously cycles between the system determination and acquisition

d) Sweep the spectrum analyzer over a frequency range from the lowest intermediate frequency or lowest oscillator frequency used in the receiver or 1 MHz, whichever is lowest, to at least 2600 MHz for band classes 0, 2, 5, 7, 9, 10, 11, and 12, 3 GHz for band class 3 or at least 6 GHz for band classes 1, 4, and 8, and measure the spurious emission levels. For band class 6, sweep the spectrum analyzer over a frequency range from 30 MHz to at least 12.75 GHz and measure the spurious emissions levels.

4.5.1.5.3 Minimum standard

The mean conducted spurious emissions with ten or more averages for an access terminal shall be as follows:

a) Less than –76 dBm for band classes 0, 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, and 12, or –81 dBm for band class 3, measured in a 1 MHz resolution bandwidth at the access terminal antenna connector, for frequencies within the access terminal receive band associated with each band class that the access terminal supports.

b) Less than –61 dBm, measured in a 1 MHz resolution bandwidth at the access terminal antenna connector, for frequencies within the access terminal transmit band associated with each band class that the access terminal supports.

c) Less than –57 dBm for band class 6, measured in a 100 kHz resolution bandwidth at the access terminal antenna connector, for frequencies from 30 MHz to 1 GHz.

d) Band class 3, measured in a 30 kHz resolution bandwidth at the access terminal antenna connector, for all other frequencies. Less than –47 dBm for band class 6, measured in a 1 MHz resolution bandwidth at the access terminal antenna connector, for all frequencies in the range from 1 GHz to 12.75 GHz.

Current region-specific radio regulation rules shall also apply.

For example, a band class 6 access terminal operating under Japan regional requirements shall limit conducted emissions to less than –41 dBm, measured in a 300 kHz resolution bandwidth at the access terminal antenna connector, for frequencies within the PHS band from 1884.5 MHz to 1919.6 MHz.

4.5.2 AT Transmitter MPS

4.5.2.1 Frequency accuracy requirements

4.5.2.1.1 Definition

The frequency accuracy is the ability of an access terminal transmitter to transmit at an assigned carrier frequency.

4.5.2.1.2 Method of measurement

The method of measurement specified in 4.5.2.2.2 may be used to perform this test.

4.5.2.1.3 Minimum standard

The modulated carrier frequency of the access terminal shall be accurate to within the accuracy range of 0.1 ppm observed over a period of at least one PHY frame in the time domain and at least one sub-zone = 128 subcarriers in the frequency domain.

4.5.2.2 Error vector magnitude (EVM)

4.5.2.2.1 Definition

The error vector magnitude is measured by determining the root mean square error between the ideal constellation point and the actual received one after equalizing for some of the access terminal transmitter imperfections. This test also evaluates the resulting spectral flatness that is affected as a consequence of equalizing the transmit waveform that can introduce ripples or droops in the transmit waveform. This test specifies the EVM and frequency accuracy requirements for channel bandwidth greater than or equal to 5 MHz.

The EVM for any assignment size in tiles is computed as follows in Equation (1).

$$EVM\left(\hat{X}\right)=\sqrt{\frac{\sum_{j=1}^{N_f}\sum_{k=1}^{N_p}\left(X_I(j,k)-\hat{X}_I(j,k)\right)^2+\left(X_Q(j,k)-\hat{X}_Q(j,k)\right)^2}{\sum_{j=1}^{N_f}\sum_{k=1}^{N_p}\left(X_I(j,k)\right)^2+\left(X_Q(j,k)\right)^2}} \qquad (1)$$

where

a_I, a_Q are the real and imaginary parts of a

$\hat{X}$ is the frequency domain equalized sample by the EVM analyzer as explained below

X[6] is the frequency domain ideal transmitted constellation point by the AN

N_p is the number of modulation symbols in all assignment tiles in one frame

N_f is the total number of frames used for averaging EVM, i.e., $N_f = N_s \times N_{f,SF}$, N_s being the number of super frames and $N_{f,SF}$ is the number of frames in a super frame

4.5.2.2.2 Method of measurement

The test shall be carried out for every band class and channel bandwidth supported by the access terminal.

a) Connect the sector to the access terminal antenna connector as shown in Figure 7. The AWGN generator and the CW generator are not applicable in this test.

b) Ensure that the AT is assigned a number of tiles as specified in Table 37.

c) Set up a connection between the access terminal and the access node and ensure that the configuration specified in step b) is in use.

d) Instruct the access node to transmit closed loop power control commands to the access terminal such that the mean output power of the access terminal measured at the antenna connector is 4 dB lower than its maximum allowable output power.

e) Measure EVM, frequency error and spectral flatness using an EVM-meter described as follows:

   1) The transmitted signal is cable-connected to the receiver with one receive antenna. Denote the received samples by r

   2) After down conversion, the EVM analyzer determines the beginning of the cyclic prefix of the received signal. It computes the frequency offset for the given PHY frame n[7], $f_{o,n}$, and corrects for it by applying a phase ramp on each sample of r with a slope of $f_{o,n}$. Denote the resulted signal by y

   3) The EVM analyzer then performs an FFT operation with an FFT window that centers the channel in the cyclic prefix. Consequently, the frequency domain tones are then corrected with a phase ramp of slope CP/2; denote the resulted samples by Z

   4) The EVM analyzer estimates the complex channel response for every sample in the assignment. Channel estimation is done within every tile by first averaging the pilots in the tile then doing linear interpolation in time and frequency to get the channel response on the data tones. Denote the frequency domain channel estimate on a given tone by H

   5) The EVM analyzer performs channel equalization to get samples $\hat{X} = \frac{Z}{H}$

   6) The EVM analyzer computes the EVM metric as defined in Equation (1)

   7) This test shall run for at least $N_s = 2$ super frames. The number of frames used in each super frame, $N_{f,SF}$, shall be at least 1

f) The spectral flatness is measured as follows: From channel estimation we have the estimated frequency response H_i for tone i, $i = 1, 2, \cdots, M$, where M is the number of tones in the

[6] It may not be possible for the EVM analyzer equipment to have the ideal transmitted constellation point. In this case, we can map $\hat{X}$ to the nearest constellation point from a Euclidean distance sense and denote the hard-decision constellation point by X. In this case, the EVM calculation is optimistic since there is a probability that hard decision is wrong so that the real constellation point is farther from the hard decision one, i.e., EVM calculated is smaller than actual.

[7] The EVM equalizer may also use an average estimate of the frequency offset or an estimate that is constant over a super frame.

assignment in one OFDM symbol. We obtain the magnitude square $B_i = |H_i|^2$ for each tone and average it over multiple OFDM symbols to obtain $\overline{B}_i$, for $i = 1, 2, \cdots, M$. Next we compute the following spectral flatness metric $F = 10\log_{10}\left(B_{\max}/B_{\min}\right)$, where $B_{\max} = \max_{i=1,2,\cdots M} \overline{B}_i$, $B_{\min} = \min_{i=1,2,\cdots M} \overline{B}_i$.

Table 37—Access terminal assignment used for EVM computation

Channel bandwidth (MHz)	5	10	20
Nominal maximum number of tiles for maximum transmission bandwidth	30	60	120
Nominal maximum transmission bandwidth (MHz)	4.61	9.22	18.44

4.5.2.2.3 Minimum standard

The measured EVM shall be less than the values specified in Table 38.

Table 38—Access terminal assignment used for EVM computation

AN Type	Modulation type	EVM (%)	C/N (dB)
Wide Area	QPSK	17.5	15.14
	8-PSK	14	17.07
	16QAM	12.5	18.06
	64-QAM	8.9	21

The measured spectral flatness metric shall be less than 4 dB. The frequency error from the carrier center frequency shall be less than ± 0.1 ppm.

4.5.2.3 Maximum RF output power

4.5.2.3.1 Definition

The maximum radiated RF output power is determined by the measurement of the maximum power that the access terminal transmits as measured at the access terminal antenna connector plus the antenna gain recommended by the access terminal manufacturer.

4.5.2.3.2 Method of measurement

The test shall be carried out for every band class and channel bandwidth supported by the access terminal. This test shall be carried out for any packet format index corresponding to modulation order of 64-QAM.

a) Connect the sector to the access terminal antenna connector as shown in Figure 7. The AWGN generator and the CW generator are not applicable in this test. Connect a spectrum analyzer (or other suitable test equipment) to the access terminal antenna connector.

b) Set up a connection between the access terminal and the access node.

c) Instruct the access node to transmit 'up' power control commands continuously to the access terminal.

d) Measure the mean access terminal output power at the access terminal antenna connector.

4.5.2.3.3 Minimum standard

The minimum standard applies to the maximum radiated power from the access terminal using the antenna gain recommended by the access terminal manufacturer. The maximum output power from the access terminal shall be 23 dBm while complying with the general spectral emissions mask Table 39 For complying with additional spectral emissions mask-1 (Table 40) and additional spectral emissions mask-2 (Table 41), the maximum output power requirements for general emissions mask may be reduced by an applicable output power backoff reduction for Table 40 and Table 41 of 0.5 dB and 1.0 dB, respectively. These proposed requirements shall be allowed a tolerance of ± 2 dB.

4.5.2.4 Maximum output power boost

The MBWA specifications define special assignments where the signal content is confined to a narrow band or to some part of the band. The idea of the special assignments is to utilize the fact that in most cases when maximum power is needed, BW is not needed as much. The scheduler can then allocate the AT an assignment that is as far from the edge as possible to facilitate meeting the emission requirements. The assignment can also be as small as one tile and requires full power (edge of the cell scenario) and due to being narrowband it still meets emission requirements with higher radiated power. The specifications define the following three different special assignment types:

— Case 1: 16 tones at the edge of the band
— Case 2: 128 tones not at the edge of the band
— Case 3: 128 tones at the edge of the band

The AT maximum transmit power is allowed to increase up to 2 dB above the level specified in 4.5.2.3.3 for special assignments cases 1 and 2 provided that the emission requirements in 4.5.2.5 are met. The AT maximum transmit output power is allowed to increase up to 0.5 dB for special assignment case 3 provided that the emission requirements in 4.5.2.5 are met.

4.5.2.5 Conducted spurious emissions

Specifications of the emission requirements include a general Spectral Emissions Mask (SEM) and two additional spectral emission masks (A-SEM1and A-SEM2, respectively). The additional requirements are to be signaled to the access terminal via some broadcast control channel. The concept of additional requirement being signaled to access terminal is helpful since the deployment of various technologies and the channelization on each band is not readily available.

4.5.2.5.1 Definition

The conducted spurious emissions are emissions at frequencies that are outside the assigned MBWA Channel, measured at the access terminal antenna connector. This test measures the spurious emissions during continuous transmission.

4.5.2.5.2 Method of measurement

The test shall be carried out for every band class and channel bandwidth supported by the access terminal. This test shall be carried out for any packet format index corresponding to modulation order of 64-QAM.

a) Connect the sector to the access terminal antenna connector as shown in Figure 7. The AWGN generator and the CW generator are not applicable in this test. Connect a spectrum analyzer (or other suitable test equipment) to the access terminal antenna connector.

b) Set up a connection between the access terminal and the access node.

c) Instruct the access node to transmit ‘up’ power control commands continuously to the access terminal.

d) Measure the spurious emission levels.

e) For adjacent channel power leakage ratio measurement, measure the in-band power and also the power in the first and second adjacent channels for the specified channel bandwidths. Compute the difference between the in-band power and the power in the adjacent channels to measure the adjacent channel power leakage ratio.

4.5.2.5.3 Minimum standard

The spurious emissions with ten or more averages shall be less than the limits specified for general spectral emissions mask in Table 39.

Table 39—General spectral emission mask for different bandwidths

Offset from channel edge (MHz)	5 MHz Emissions in dBm/measurement BW	10 MHz Emissions in dBm/measurement BW	20 MHz Emissions in dBm/measurement BW	Measurement BW
± 0–1	–15	–18	–21	30 KHz
± 1–5	–10	–10	–10	1 MHz
± 5–6	–13	–13	–13	1 MHz
± 6–10	–25	–13	–13	1 MHz
± 10–15		–25	–13	1 MHz
± 15–20			–13	1 MHz
± 20–25			–25	1 MHz

The spurious emissions with ten or more averages shall be less than the limits specified additional spectral emission masks (A-SEM1) in Table 40.

Table 40—Additional spectral emission mask (A-SEM1) for different bandwidths

Offset from channel edge (MHz)	5 MHz Emissions in dBm/measurement BW	10 MHz Emissions in dBm/measurement BW	20 MHz Emissions in dBm/measurement BW	Measurement BW
± 0–1	–15	–18	–21	30 KHz
± 1–5	–13	–13	–13	1 MHz
± 5–6	–13	–13	–13	1 MHz
± 6–10	–13	–13	–13	1 MHz
± 10–15		–13	–13	1 MHz
± 15–20			–13	1 MHz
± 20–25			–13	1 MHz

The spurious emissions with ten or more averages shall be less than the limits specified for additional spectral emission masks (A-SEM2) in Table 41.

Table 41—Additional spectral emission mask (A–SEM2) for different bandwidths

Offset from channel edge (MHz)	5 MHz Emissions in dBm/measurement BW	10 MHz Emissions in dBm/measurement BW	20 MHz Emissions in dBm/measurement BW	Measurement BW
± 0–1	–15	–18	–21	30 KHz
± 1–5.5	–15	–13	–13	1 MHz
± 5.5–10	–25	–25	–25	1 MHz
± 10–15		–25	–25	1 MHz
± 15–25			–25	1 MHz

In additional to the spectral emission mask requirements, for frequency offsets greater than Δ_{SEM} from the channel edge specified in Table 42, the spurious emissions with ten or more averages shall also be less than the requirements in Table 43 for ITU category A and in Table 44 for ITU category B.

Table 42—Δ_{SEM} as a function of the channel BW

Channel bandwidth (MHz)	5	10	20
Δ_{SEM} **(MHz)**	10	15	25

Table 43—Spurious requirements—ITU Category A

Frequency range	Maximum level	Measurement BW
$9KHz \le f < 150KHz$	–13dBm	1Khz
$150KHz \le f < 30MHz$	–13dBm	10KHz
$30MHz \le f < 1GHz$	–13dBm	100KHz
$1GHz \le f < 10GHz$	–13 dBm	1 MHz

Table 44—Spurious requirements—ITU Category B

Frequency range	Maximum level	Measurement BW
$9KHz \le f < 150KHz$	–36 dBm	1 Khz
$150KHz \le f < 30MHz$	–36 dBm	10 KHz
$30MHz \le f < 1GHz$	–36 dBm	100 KHz
$1GHz \le f < 12.75GHz$	–30 dBm	1 MHz

When transmitting in band class 6, the spurious emissions with ten or more averages shall also be less than the requirements in Table 45 to support coexistence with PHS.

Table 45—PHS coexistence emission requirements

Frequency range	Maximum level	Measurement BW
$1844.5MHz \le f < 1919.6MHz$	–41dBm	300 KHz

The measured adjacent channel leakage ratio (ACLR1) and alternate channel leakage ratio (ACLR2) shall be greater or equal to the values specified in Table 46.

Table 46—ACLR specifications

Channel bandwidth (MHz)	5 MHz	10 MHz	20 MHz
ACLR1 (dB)	30	30	30
ACLR2 (dB)	36	36	36
Signal and adjacent channel measurement BW (MHz)	4.61	9.22	18.44

In addition to the previous requirements, current region-specific radio regulation rules shall also apply.

4.6 Functional block diagrams

4.6.1 Access node (AN) Side

Figure 2 through Figure 6 show the test setups used for access node testing. These are functional diagrams only. Actual test setups may differ provided the functionality remains the same.

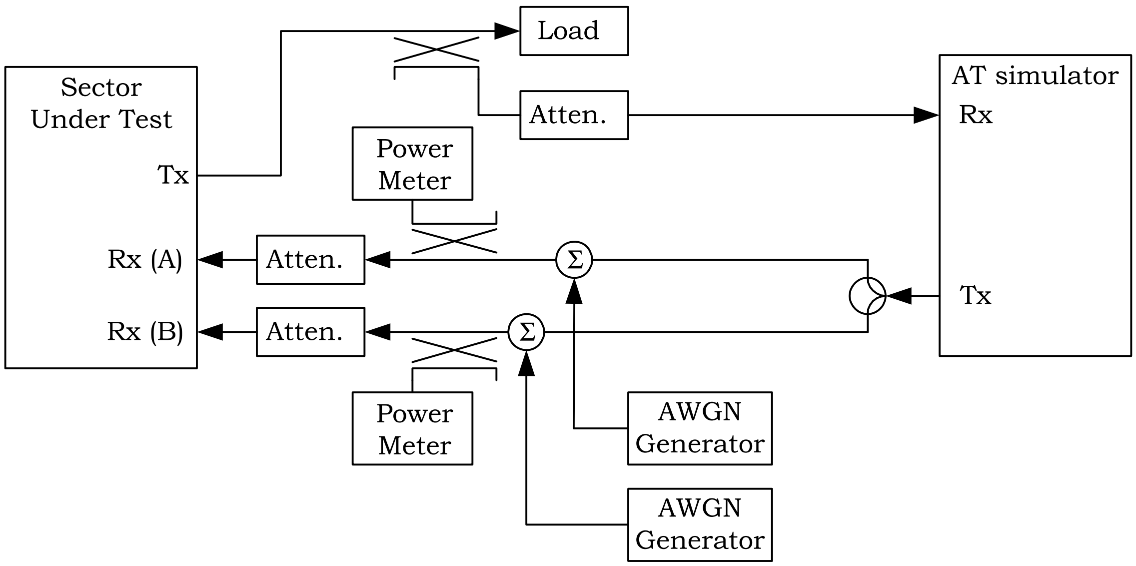

Figure 2—Functional setup for access node AWGN demodulation tests and sensitivity test

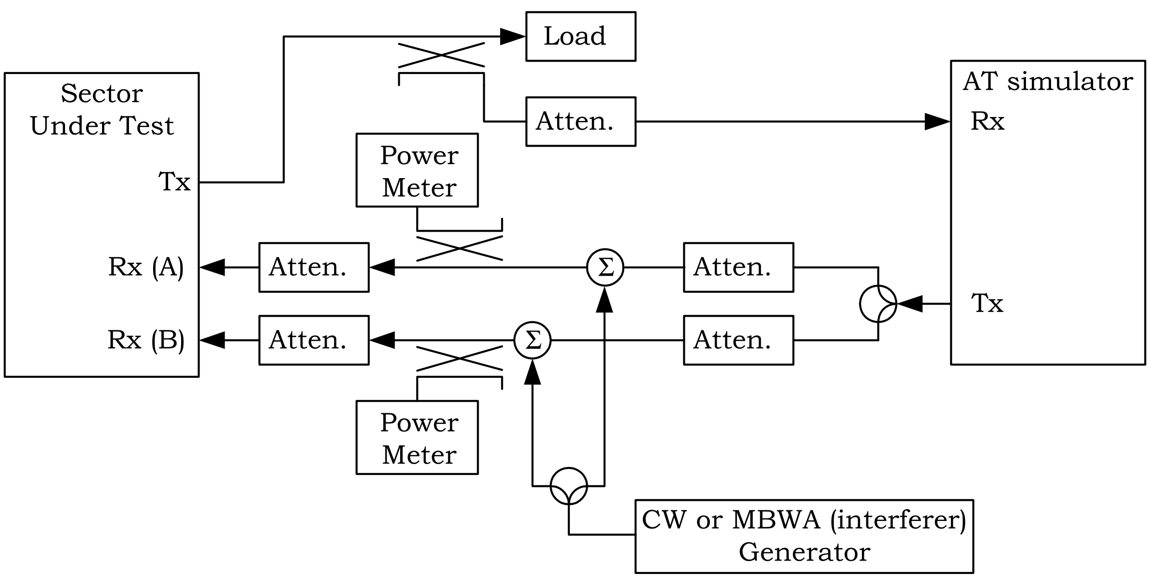

Figure 3—Functional setup for Access Node Desensitization Tests

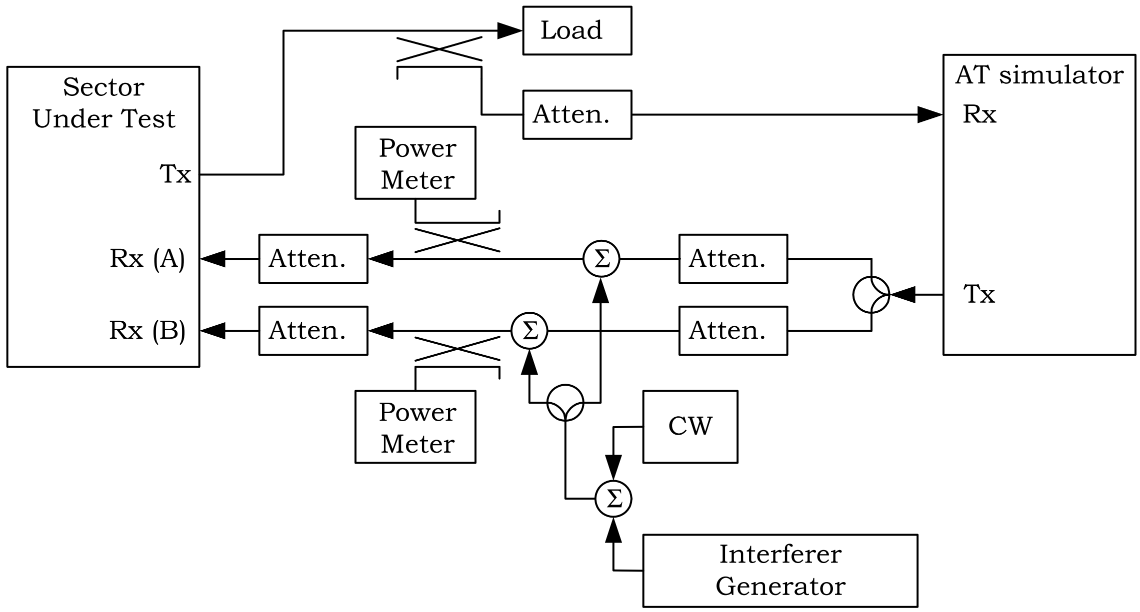

Figure 4—Functional setup for Access Node Intermodulation Spurious Response Tests

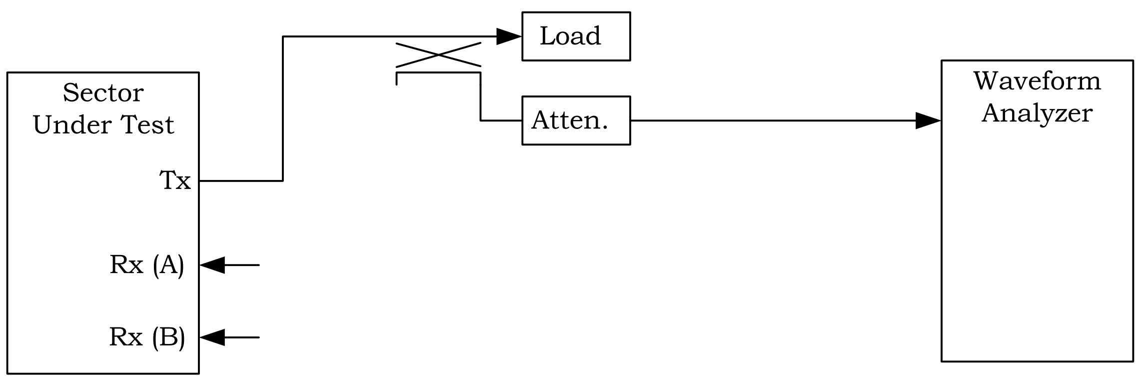

Figure 5—Functional setup for Waveform Quality Test

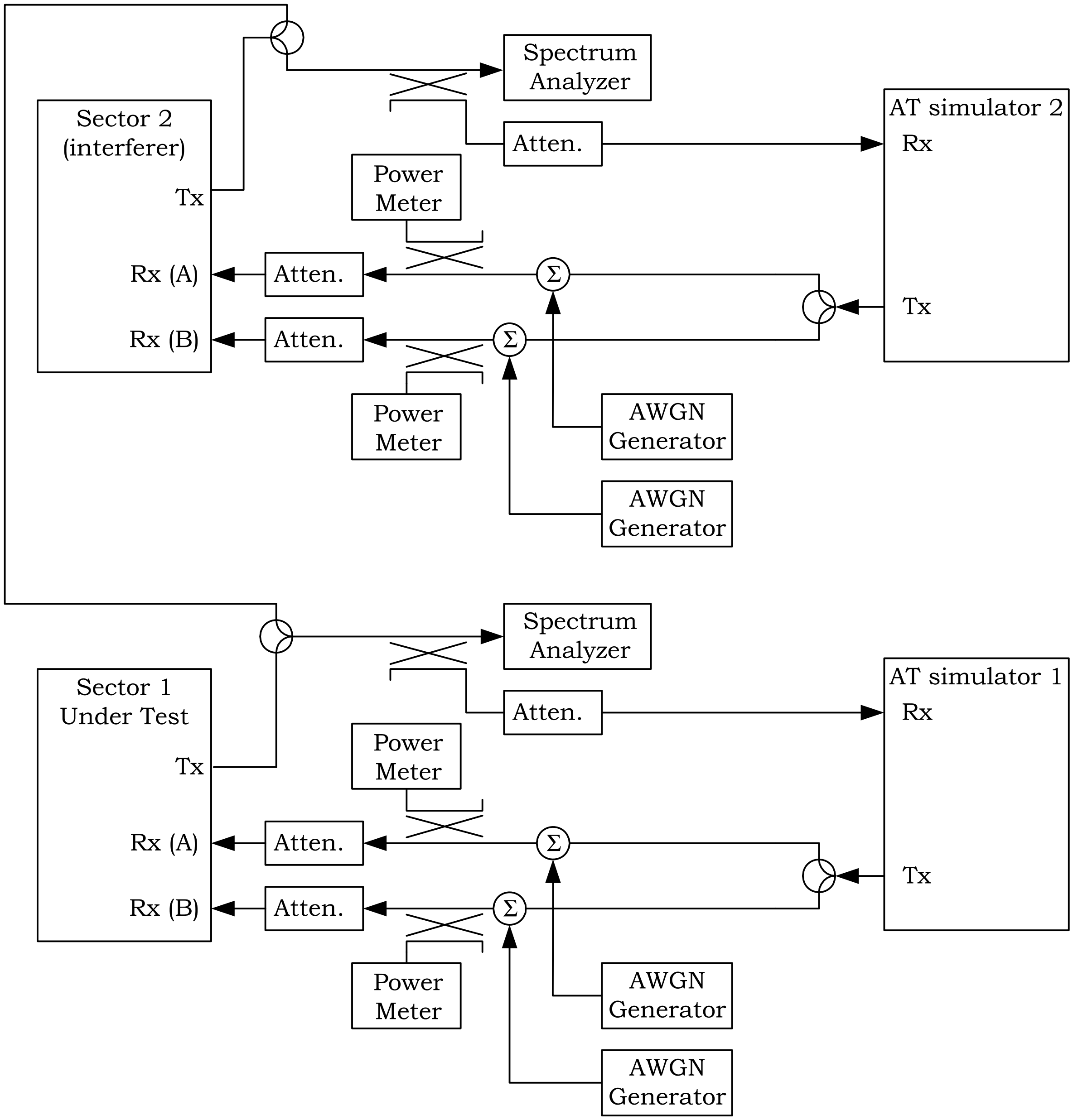

Figure 6—Functional setup for emissions tests

4.6.2 AT side

Figure 7 and Figure 8 show the functional block diagrams of the set-up for the following different tests:

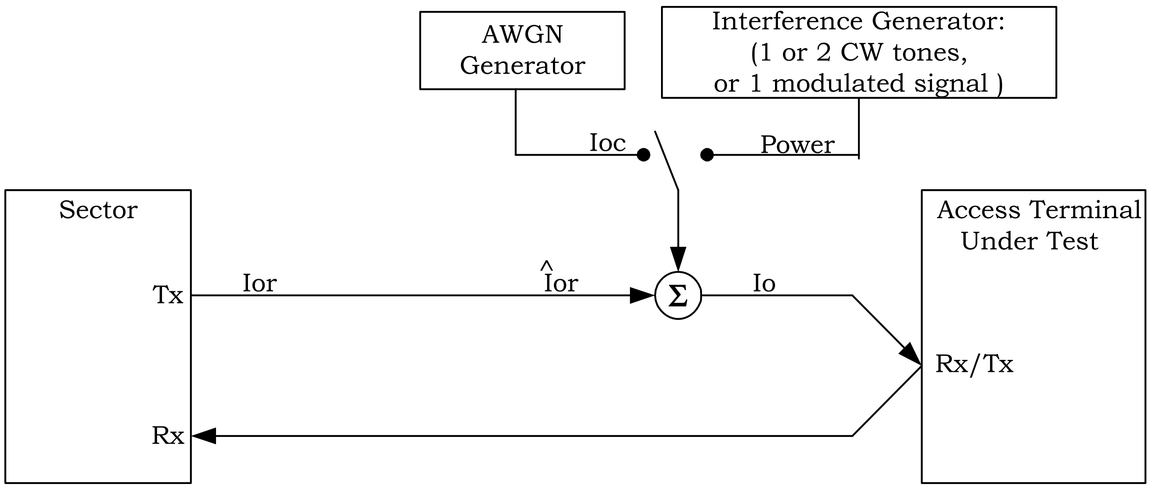

Figure 7—Functional set-up for tests without fading

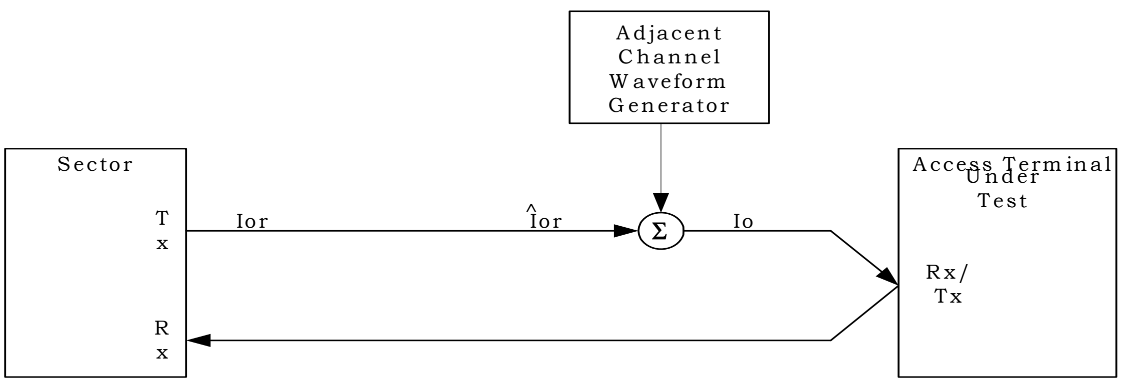

Figure 8—Functional set-up for test for adjacent channel selectivity

5. Minimum performance requirements for the 625k-MC Mode

5.1 General

The clause covers the minimum performance specifications for the 625k-MC mode, for both the base station (BS) and user terminal (UT) sides on the transmitter and the receiver.

Throughout this clause the following parameters are used:

— **N_f:** The number of frequency carriers supported by a given 625k-MC system is designated N_f and depends on the allocated spectrum.

— **P_R:** Average Square Root Raised Cosine (SRRC) filtered input power for a given carrier to a radio receiver. Input power is measured at the antenna, and is not reduced to account for cable losses. Averaging takes place between the start of the first useful symbol and the end of the last useful symbol of an uplink or downlink time slot. Ramp-up, ramp-down, and guard symbols are excluded.

— **P_{RAT}**: The rated power per data stream P_{RAT} is defined as the highest SRRC-filtered power level such that when the base station opens a data stream with a user terminal, the power available to the new stream is at least P_{RAT}, while meeting all 625k-MC specifications. For the case of a multi-antenna base station, P_{RAT} is the incoherently summed power of signal for the new data stream from all antennas.

In all of the measurements described in the following clauses, the BS shall be configured to operate in single-antenna mode unless otherwise stated explicitly.

5.2 Base station (BS) MPS

5.2.1 BS Receiver MPS

5.2.1.1 Receiver sensitivity

5.2.1.1.1 Definition

Receiver sensitivity level requirements for the base station receiver are based on FER in the presence of Additive Gaussian White Noise (AWGN). Signal power measurements are to be made on SRRC-filtered waveforms.

5.2.1.1.2 Method of measurement

For every ModClass, the test shall be carried out as described as follows:

a) Configure the base station (BS) under test to function in single-antenna mode.

b) Connect the BS under test and a 625k-MC mode signal generator as shown in Figure 9.

c) Disable both interference generator and AWGN generator by setting their output powers to zero.

d) Set the BS to receive the specified modulation class.

e) Adjust 625k-MC signal generator to deliver the specified modulation class signal and maintain its power at the receiver port of BS at the value as specified in Table 47.

f) Measure FER value.

5.2.1.1.3 Minimum standard

The receiver sensitivity level of the base station receiver shall be no greater than the values specified in the Table 47.

Table 47—BS receiver sensitivity for FER = 10^{-2}

Modulation class	Receiver sensitivity (dBm)
Mod 0	–108.6
Mod 1	–107.0
Mod 2	–105.3
Mod 3	–102.4
Mod 4	–100.2
Mod 5	–97.9
Mod 6	–95.9
Mod 7	–94.6
Mod 8	–92.6
Mod 9	–90.6

5.2.1.2 Adjacent channel selectivity

Adjacent channel selectivity (ACS) measures the receiver's ability to receive a desired signal on its assigned carrier in the presence of a modulated interfering signal on an adjacent carrier.

5.2.1.2.1 Definition

Given a single data stream active on carrier $n:0 \leq n < N_f$, with 3 dB more received power than the tabulated value of receiver sensitivity for 10^{-2} FER and a second stream of uncorrelated data on carrier $m:m \neq n, 0 \leq m < N_f$, the ACS is defined as the ratio of input powers (expressed in dB) of stream m relative to stream n when the power of stream *m* is increased so that the FER for stream n is 10^{-2}.

5.2.1.2.2 Method of measurement

a) Configure the base station (BS) under test to function in single-antenna mode.
b) Connect the BS under test and a 625k-MC mode signal generator as shown in Figure 9.
c) Disable AWGN generator by setting their output powers to zero.
d) Adjust 625k-MC signal generator to deliver the specified modulation class signal and maintain its power at the receiver port of BS 3 dB more received power than at the value as specified in Table 47.
e) Set Interference Generator to deliver the desired ModClass.
f) Measure FER value.

5.2.1.2.3 Minimum standard

The ACS shall be at least 30 dB 625 kHz or more apart.

5.2.1.3 Maximum non-distortion input level

5.2.1.3.1 Definition

Non-distorting input power is defined as the maximum SRRC-filtered receive power at any antenna port such that the FER does not exceed 10^{-2}.

5.2.1.3.2 Method of measurement

a) Configure the base station (BS) under test to function in single-antenna mode.
b) Connect the BS under test and a 625k-MC mode signal generator as shown in Figure 9.
c) Disable both interference generator and AWGN generator by setting their output powers to zero.
d) Set the BS to receive the specified modulation class.
e) Adjust 625k-MC signal generator to deliver the specified modulation class signal at a power of –45 dBm.
f) Measure FER value.

5.2.1.3.3 Minimum standard

The non-distorting input power shall be greater than –45 dBm.

5.2.1.4 Desired Signal Strength Indicator estimator accuracy

5.2.1.4.1 Definition

The Desired Signal Strength Indicator (DSSI) is required to support open loop power control. The DSSI is an estimate of SRRC-filtered input power P_R for a given active data stream. The DSSI estimator accuracy is expressed as a decibel ratio between the actual value of P_R and the estimated value.

5.2.1.4.2 Method of measurement

a) Configure the BS under test to function in single-antenna mode.
b) Connect the BS under test and a 625k-MC mode signal generator as shown in Figure 9.
c) Disable both interference generator and AWGN generator by setting their output powers to zero.
d) Set the BS to receive the correct modulation class.
e) Adjust 625k-MC signal generator to deliver the specified modulation class signal.
f) Measure DSSI.

5.2.1.4.3 Minimum standard

DSSI estimator accuracy shall be within the permitted range as shown in Table 48.

Table 48—Range of acceptable DSSI report values

Input power P_R (dBm)	Min DSSI report	Max DSSI report
$–45 < P_R$	–49	$P_R + 4$
$–105 < P_R \leq –45$	$P_R – 4$	$P_R + 4$
$–110 < P_R \leq –105$	$P_R – 6$	$P_R + 6$
$P_R \leq –110$	No minimum	–104

5.2.1.5 Signal Interference Noise Ratio (SINR) estimator accuracy

5.2.1.5.1 Definition

The SINR estimator is used for closed loop power control. SINR estimator accuracy is defined as the difference between the output value of the SINR estimator and the received SINR at the antenna connector. TCH bursts from an established stream shall be present at the antenna (for testing purposes, the stream may or may not be communicating with the base station under test). The SRRC-filtered input power of the bursts and the SRRC-filtered input power of added Gaussian noise are measured independently of the base station. Then the SINR estimator accuracy is the decibel ratio of the externally measured burst to noise power and the base station SINR estimator output. SINR should be calculated from the training sequence portions of the bursts. The SINR estimator error is the difference between the output value of the SINR estimator and the SINR present at the antenna.

5.2.1.5.2 Method of measurement

a) Configure the BS under test to function in single-antenna mode.
b) Connect the BS under test and a 625k-MC mode signal generator as shown in Figure 9.
c) Disable interference generator by setting its output power to zero.
d) Set the BS to receive the correct modulation class.
e) Set received power for specified modulation class in 625k-MC (Desire) generator.

f) Set 500 kHz band width in AWGN generator.

g) Measure SINR.

5.2.1.5.3 Minimum standard

SINR estimator accuracy shall be within the permitted range of the template shown in Table 49.

Table 49—Range of acceptable SINR report values

Input SINR (dB)	5^{th} percentile (dB)	95^{th} percentile (dB)
S < –5	No minimum	–2 dB
–5 ≤ S < 29	S – 4 dB	S + 3 dB
29 ≤ S	26 dB	S + 3 dB

5.2.2 BS Transmitter MPS

5.2.2.1 Carrier frequency error

5.2.2.1.1 Definition

Carrier frequency error is the difference between the programmed and actual transmitted base station carrier frequency, measured in parts per million (PPM).

5.2.2.1.2 Method of measurement

a) Configure the BS under test to function in single-antenna mode.

b) Connect the BS under test and a spectrum analyzer and vector signal analyzer as shown in Figure 10.

c) Set the BS to transmit the desired modulation class.

d) Measure carrier frequency error by using vector signal analyzer.

5.2.2.1.3 Minimum standard

Carrier frequency error shall not exceed 0.05 PPM.

5.2.2.2 Modulation accuracy

5.2.2.2.1 Definition

The modulation accuracy (MA) is the ratio of the root mean square EVM to the reference amplitude, averaged over the useful symbols of an uplink time slot. The error vector is the difference between the theoretically optimal desired waveform and the transmitted waveform at the symbol points, after receive SRRC filtering is applied to both waveforms and the initial phase, amplitude, frequency offset, and timing offset have been identified by a least-squares search.

The MA for a transmitted burst is defined by Equation (2):

$$MA = \min_{c_o, \omega_o, \tau_o} \sqrt{\frac{\sum_k \left| d(kT_s) - c_0 \cdot e^{j\omega_o kT_s} \cdot x(kT_s - \tau_0) \right|^2}{\sum_k \left| d(kT_s) \right|^2}} \quad (2)$$

where

t	is the time, with the burst's first useful symbol occurring at $t = 0$
$x(t)$	is the complex transmitted voltage waveform at time t, after SRRC filtering
$d(t)$	is the complex desired (ideal) waveform at time t, after SRRC filtering
c_0	is the complex amplitude value that minimizes least-squares error for the training sequence(s)
ω_0	is the least-squares optimized real-valued frequency offset
τ_0	is the least-squares optimized positive or negative timing offset
k	is an integer index variable that runs over the useful symbols of the burst, including the training sequences and payload but not the ramp-up or ramp-down symbols

Note that in the 625k-MC mode all bursts have a training sequence or a preamble consisting of symbols with unity amplitude. The value of c_0 for a measured burst should be estimated from the mean signal phase and amplitude at the symbol points in its training sequence or preamble. Note that the same reference amplitude [the denominator in the Equation (2)] applies to all symbols in a burst, whether they are part of a preamble, training sequence or payload. Scaling between constellation points of different modclasses is described in Table 444 of IEEE Std 802.20-2008.

Most instruments designed to report "error vector magnitude," or EVM use the maximum constellation point amplitude as the reference amplitude, rather than c_0. Measurements on QAM payloads obtained from such instruments shall be adjusted for this difference to obtain MA.

Let a single stream be active on frequency carrier n, with transmitted power level P_{RAT} for the entire array. The MA for the array shall be the highest MA for the individual transmitters in that array.

5.2.2.2.2 Method of measurement

a) Configure the base station under test to function in single-antenna mode.

b) Connect the BS under test and a spectrum analyzer and vector signal analyzer as shown in Figure 10.

c) Set the BS to transmit the desired ModClass (modulation class).

d) Measure MA with vector signal analyzer.

5.2.2.2.2.1 Minimum standard

The MA for the array shall not exceed 3.5% for all modulation classes with equal weighting over all N antennas and total transmitted power P_{RAT}.

5.2.2.3 Conducted Spurious Emission

5.2.2.3.1 Adjacent Carrier Power

5.2.2.3.1.1 Definition

Adjacent carrier power (ACP) is the SRRC filtered power radiated from all antennas on any carrier adjacent to carrier n, averaged over the entire downlink time slot s. The result is expressed in dBm.

5.2.2.3.1.2 Method of measurement

a) Configure the base station under test to function in single-antenna mode.
b) Connect the BS under test and a spectrum analyzer and vector signal analyzer as shown in Figure 10.
c) Set the BS to transmit the desired ModClass (modulation class).
d) Measure ACP with spectrum analyzer.

5.2.2.3.1.3 Minimum standard

ACP shall be less than (P_{RAT} – 43) dBm in the adjacent carrier within the carrier allocation, and less than (P_{RAT} – 50) dBm for carriers with center frequency more than 625 kHz away from f_n.

5.2.2.3.2 Multicarrier intermodulation products

5.2.2.3.2.1 Definition

Given any unoccupied carrier, the multicarrier intermodulation product (MCIP) is defined as the highest SRRC filtered output power on that unoccupied carrier, summed over all antennas, with equal power on all other carriers and equal composite power on all antennas. The measurement is expressed in dBm.

5.2.2.3.2.2 Method of measurement

a) Configure the base station under test to function in single-antenna mode.
b) Connect the BS under test and a spectrum analyzer and vector signal analyzer as shown in Figure 10.
c) Setup BS to transmit the desired ModClass.
d) Measure MCIP in spectrum analyzer.

5.2.2.3.2.3 Minimum standard

MCIP shall be less than (P_{RAT} – 40) dBm with one unoccupied carrier, equal power on all occupied carriers, and equal composite power on all antennas.

5.2.2.3.3 Out-of-band spurious emissions

5.2.2.3.3.1 Definition

Out-of-band spurious performance is defined as any radio emanation outside the 625k-MC band allocated to the base station.

5.2.2.3.3.2 Method of measurement

a) Configure the base station under test to function in single-antenna mode.

b) Connect the BS under test and a spectrum analyzer and vector signal analyzer as shown in Figure 10.

c) Set the BS to transmit the desired ModClass (modulation class).

d) Measure spurious emission with spectrum analyzer.

5.2.2.3.3.3 Minimum standard

The base station shall meet all regulatory requirements in the jurisdiction within which it is installed. Emissions shall not exceed the limits as specified in Table 50.

Table 50—Out-of-band spurious emissions limits

Offset from nearest 625k-MC band edge	Emission limit
0 kHz to 500 kHz	–3 dBm / 100kHz
500 kHz to 5 MHz	–16 dBm / 100kHz
Beyond 5 MHz	–20 dBm / 100kHz

5.3 User terminal (UT) MPS

5.3.1 UT Receiver MPS

5.3.1.1 Receiver sensitivity

5.3.1.1.1 Definition

The receiver sensitivity level is that minimum SRRC-filtered receive power at the UT antenna port such that the FER does not exceed a specific value.

5.3.1.1.2 Method of measurement

a) Configure the user terminal (UT) under test to function in single-antenna mode.

b) Connect the UT under test and a signal generator as shown in Figure 11.

c) Disable both interference generator and AWGN generator by setting their output powers to zero.

d) Set the UT to receive the desired ModClass (modulation class).

e) Adjust 625k-MC signal generator to transmit the desired ModClass with the corresponding power level as defined in the Table 51.

f) Measure FER values.

5.3.1.1.3 Minimum standard

The receiver sensitivity level of the user terminal receiver shall be no more than the values specified in Table 51.

Table 51—UT receiver sensitivity for FER = 10^{-2}

Modulation class	Receiver sensitivity (dBm)
Mod 0	–107.5
Mod 1	–105.7
Mod 2	–104.2
Mod 3	–101.3
Mod 4	–100.1
Mod 5	–96.9
Mod 6	–94.8
Mod 7	–93.5
Mod 8	–91.6
Mod 9	–89.2

5.3.1.2 Adjacent channel selectivity

5.3.1.2.1 Definition

Adjacent channel selectivity (ACS) measures the receiver's ability to receive a desired signal on its assigned carrier $n{:}0 \le n < N_f$ in the presence of a modulated interfering signal on an adjacent carrier. The ACS is the ratio (in dB) of the interfering signal receive power at the UT antenna connector and desired signal receive power at the UT antenna connector when the desired signal receive power is at 3 dB above the receiver sensitivity values in Table 51 and the interfering signal power is such that the desired signal FER reaches 10^{-2}.

5.3.1.2.2 Method of measurement

a) Configure the user terminal under test to function in single-antenna mode.
b) Connect the UT under test and a signal generator as shown in Figure 11.
c) Disable the AWGN generator by setting its output powers to zero.
d) Set the UT to receive the desired ModClass (modulation class).
e) Set 625k-MC signal generator to the desired ModClass at a power level 3 dB greater than the corresponding value in the Table 51.
f) Set Interference Generator to deliver the desired ModClass.
g) Measure FER.

5.3.1.2.3 Minimum standard

Table 52—ACS characteristics

Desired signal modulation class	ACS
0–6	20 dB
7–8	17 dB
9–10	11 dB

5.3.1.3 Maximum non-distortion input level

5.3.1.3.1 Definition

The maximum receive power at the UT antenna port such that the FER does not exceed 10^{-2}.

5.3.1.3.2 Method of measurement

a) Configure the user terminal under test to function in single-antenna mode.
b) Connect the UT under test and a signal generator as shown in Figure 11.
c) Disable the interference generator and AWGN generator (set their output powers to zero).
d) Set the UT to receive the desired ModClass.
e) Adjust 625k-MC signal generator to deliver the desired ModClass at –35 dBm.
f) Measure FER.

5.3.1.3.3 Minimum standard

The maximum input power of the UT shall be greater than –35 dBm.

5.3.1.4 Out-of-band blocking characteristics

5.3.1.4.1 Definition

Out-of-band blocking measures the receiver’s ability to receive a desired signal on its assigned carrier in the presence of a CW interfering signal in the vicinity of its assigned carrier. The out-of-band blocking performance is the power of the CW signal, expressed (in dBm) measured at the UT antenna connector, when the desired signal power at the UT antenna connector is fixed at 3 dB above the receiver sensitivity values in Table 51 and when the CW signal power is such that the desired signal FER is 10^{-2}.

5.3.1.4.2 Method of measurement

a) Configure the user terminal under test to function in single-antenna mode.

b) Connect the UT under test and a signal generator as shown in Figure 11.

c) Disable the interference generator and AWGN generator (set their output powers to zero).

d) Set the UT to receive the desired ModClass.

e) Set 625k-MC signal generator to the desired ModClass at a power level 3 dB greater than the corresponding value in Table 51.

f) Set the Interference Generator in CW mode to generate the signal at the desired Power Level.

g) Measure FER.

5.3.1.4.3 Minimum standard

The out-of-band blocking shall be as specified in the Table 53.

Table 53—Out-of-band blocking characteristics

Parameter	**Value**		
Desired Signal Power	Receiver Sensitivity + 1.8 dB		
Interference Signal Frequency	0.1 to (X – 15) MHz	(Y + 15) to 12750 MHz	Spurious frequencies
Interference Signal Power	≤ –23dBm	≤ –23dBm	≤ –40dBm

where

X – lower end of spectrum allocation

Y – upper end of spectrum allocation

5.3.1.5 Desired Signal Strength Indicator (DSSI) estimator accuracy

5.3.1.5.1 Definition

The DSSI estimator is required to support open loop TX gain control. The difference between the output value of the DSSI estimator and the RF input level of the UT receiver P_R expressed in dB. The DSSI estimator reports a value of SRRC filtered RF power, at the antenna connector.

5.3.1.5.2 Method of measurement

a) Configure the user terminal under test to function in single-antenna mode.
b) Connect the UT under test and a signal generator as shown in Figure 11.
c) Disable the interference generator and AWGN generator (set their output powers to zero).
d) Set the UT to receive the desired ModClass.
e) Set 625k-MC signal generator to the desired ModClass.
f) Measure DSSI.

5.3.1.5.3 Minimum Standard

DSSI Estimator accuracy shall be within ±4 dB for signals having P_R greater between –105 dBm and –45 dBm. DSSI Estimator accuracy shall be within ±6 dB for signals having P_R between –110 dBm and –105 dBm. Refer to the Table 54.

Table 54—Acceptable DSSI report values

Input Power P_R (dBm)	Min DSSI report	Max DSSI report
$-45 < P_R$	–49	$P_R + 4$
$-105 < P_R \leq -45$	$P_R - 4$	$P_R + 4$
$-110 < P_R \leq -105$	$P_R - 6$	$P_R + 6$
$P_R \leq -110$	No minimum	–104

5.3.1.6 SINR estimator accuracy

5.3.1.6.1 Definition

The SINR Estimator is required for closed loop power control. The SINR Estimator Accuracy is the difference between the output value of the SINR estimator and the received SINR at the antenna connector. For bursts with training sequences, SINR should be calculated from the training sequences alone.

5.3.1.6.2 Method of measurement

a) Configure the user terminal under test to function in single-antenna mode.

b) Connect the UT under test and a signal generator as shown in Figure 11.

c) Disable the interference generator by setting their output powers to zero.

d) Set the UT to receive the desired ModClass.

e) Set 625k-MC signal generator to the desired ModClass.

f) Setup AWGN generator to deliver the noise of bandwidth 500 KHz.

g) Measure SINR.

5.3.1.6.3 Minimum standard

SINR estimator accuracy shall be within the permitted range of the template shown in the Table 55.

Table 55—Range of acceptable SINR report values

Input SINR (dB)	5^{th} percentile (dB)	95^{th} percentile (dB)
S < –3	No Minimum	0 dB
–3 ≤ S < 28	S – 3 dB	S + 3 dB
28 ≤ S	25 dB	S + 3 dB

5.3.2 UT Transmitter MPS

5.3.2.1 Nominal output power

5.3.2.1.1 Definition

Nominal output power is the SRRC-filtered transmit power that the UT supports, while meeting all 625k-MC protocol specifications. The nominal output power depends on the UT's power class.

5.3.2.1.2 Method of measurement

a) Configure the user terminal under test to function in single-antenna mode.

b) Connect the UT under test and a spectrum analyzer and vector signal analyzer as shown in Figure 12.

c) Set UT to transmit the Desired ModClass signal.

d) Measure output powers.

5.3.2.1.3 Minimum standard

Table 56 defines the nominal output power by class that the UT shall support. The UT transmit power shall not be less than 3 dB below the nominal power stated in Table 56. A user terminal may restrict its transmit power to 6 dB less than the tabulated value when operating on carriers 0 (lowest carrier) or $N_f – 1$ (highest carrier) if this is needed to meet out-of-band emission requirements.

Table 56—Nominal UT transmit power per carrier

Modulation format	Nominal output power		
	Power Class 1	Power Class 2	Power Class 3
64-QAM	29 dBm	24 dBm	19 dBm
32-QAM	29 dBm	24 dBm	19 dBm
24-QAM	29 dBm	24 dBm	19 dBm
16-QAM	30 dBm	25 dBm	20 dBm
12-QAM	30 dBm	25 dBm	20 dBm
8PSK	31 dBm	26 dBm	21 dBm
QPSK	31 dBm	26 dBm	21 dBm
π/2 BPSK	32 dBm	27 dBm	22 dBm

5.3.2.2 Carrier frequency error

5.3.2.2.1 Definition

The difference between the commanded and actual UT carrier frequency during any active uplink burst, using the received base station broadcast channel (BCH) frequency as a reference.

5.3.2.2.2 Method of measurement

a) Configure the user terminal under test to function in single-antenna mode.

b) Connect the UT under test and a spectrum analyzer and vector signal analyzer as shown in Figure 12.

c) Set UT to transmit the Desired ModClass signal.

d) Measure carrier frequency error with vector signal analyzer.

5.3.2.2.3 Minimum standard

The carrier frequency error of the UT shall be within ±100 Hz.

5.3.2.3 Modulation accuracy (MA)

5.3.2.3.1 Definition

The MA is the ratio of the root mean square EVM to the reference amplitude, averaged over the useful symbols of an uplink time slot. The error vector is the difference between the theoretically optimal desired waveform and the transmitted waveform at the symbol points, after receive SRRC filtering is applied to both waveforms and the initial phase, amplitude, frequency offset, and timing offset have been identified by a least-squares search.

The MA for a transmitted burst is defined by Equation (3):

$$MA = \min_{c_o, \omega_o, \tau_o} \sqrt{\frac{\sum_k \left| d(kT_s) - c_0 \cdot e^{j\omega_o kT_s} \cdot x(kT_s - \tau_0) \right|^2}{\sum_k \left| d(kT_s) \right|^2}} \tag{3}$$

where

t	is the time, with the burst's first useful symbol occurring at $t = 0$
$x(t)$	is the complex transmitted voltage waveform at time t, after SRRC filtering
$d(t)$	is the complex desired (ideal) waveform at time t, after SRRC filtering
c_0	is the complex amplitude value that minimizes least-squares error for the training sequence(s)
ω_0	is the least-squares optimized real-valued frequency offset
τ_0	is the least-squares optimized positive or negative timing offset
k	is an integer index variable that runs over the useful symbols of the burst, including the training sequences and payload but not the ramp-up or ramp-down symbols

Note that in the 625k-MC mode all bursts have a training sequence or a preamble consisting of symbols with unity amplitude. The value of c_0 for a measured burst should be estimated from the mean signal phase and amplitude at the symbol points in its training sequence or preamble. Note that the same reference amplitude [the denominator in Equation (3)] applies to all symbols in a burst, whether they are part of a preamble, training sequence or payload. Scaling between constellation points of different modclasses is described in Table 444 of IEEE Std 802.20-2008.

Most instruments designed to report "error vector magnitude," or EVM use the maximum constellation point amplitude as the reference amplitude, rather than c_0. Measurements on QAM payloads obtained from such instruments shall be adjusted for this difference to obtain MA.

Let a single stream be active on frequency carrier n, with transmitted power level P_{RAT} for the entire array. The MA for the array shall be the highest MA for the individual transmitters in that array.

5.3.2.3.2 Method of measurement

a) Configure the user terminal under test to function in single-antenna mode.

b) Connect the UT under test and a spectrum analyzer and vector signal analyzer as shown in Figure 12.

c) Set UT to transmit the desired ModClass signal.

d) Measure MA with vector signal analyzer.

5.3.2.3.3 Minimum standard

The MA of the transmitter shall be in accordance with the specifications given in Table 57.

Table 57—Modulation accuracy for various modulation formats

Modulation format	Modulation accuracy
64-QAM	< 4%
32-QAM	< 5.5%
24-QAM	< 6%
16-QAM	< 6%
12-QAM	< 7%
8PSK	< 9%
QPSK	< 10%
π/2 BPSK	< 10%

5.3.2.4 Conducted Spurious Emission

5.3.2.4.1 Adjacent Carrier Power Ratio

5.3.2.4.1.1 Definition

Adjacent Carrier Power Ratio (ACPR) is expressed as a decibel ratio of undesired SRRC-filtered power transmitted by the UT on adjacent channels relative to the desired transmitted signal. The desired transmit signal power is averaged over the useful symbols of an uplink burst. Both the undesired and desired signals are measured as SRRC-filtered power.

5.3.2.4.1.2 Method of measurement

a) Configure the user terminal under test to function in single-antenna mode.

b) Connect the UT under test and a spectrum analyzer and vector signal analyzer as shown in Figure 12.

c) Set UT to transmit the Desired ModClass signal.

d) Measure ACP with spectrum analyzer.

5.3.2.4.1.3 Minimum standard

The ACPR for any carrier frequencies within the carrier allocation shall not exceed than the values in Table 58. If the ACPR limit in the table, together with the transmit power results in an ACPR limit less than –40 dBm, –40 dBm is applied as the limit instead of the tabulated value.

Table 58—Maximum ACPR when the transmit power is greater than +10 dBm

Carrier	Frequency Offset (Δf)	ACPR
First Adjacent Carrier	625 kHz	–35 dBc
Second Adjacent Carrier	1250 kHz	–45 dBc
Other Inband Carrier	1250 kHz < Δf < 5000kHz	–50 dBc

5.3.2.4.2 Out-of-band spurious emissions

5.3.2.4.2.1 Definition

Out-of-band spurious emission performance is evaluated by measuring the peak transmit power over all the useful symbols of a burst, in which UT transmits at maximum power.

5.3.2.4.2.2 Method of measurement

a) Configure the user terminal under test to function in single-antenna mode.
b) Connect the UT under test and a spectrum analyzer and vector signal analyzer as shown in Figure 12.
c) Set UT to transmit the Desired ModClass signal.
d) Measure spurious emission with spectrum analyzer.

5.3.2.4.2.3 Minimum standard

Out-of-band spurious emission of the UT shall be within local regulatory limits.

UT out-of-band emissions at frequency offsets more than 4687.5 kHz from the edge of the nominal carrier bandwidth shall be less than –30 dBm, measured within a 1 MHz bandwidth.

5.4 Functional test setup

Figure 9 through Figure 12 illustrate the test setups used for base station and user terminal testing. These are functional diagrams only. Actual test setups may differ provided the functionality remains the same.

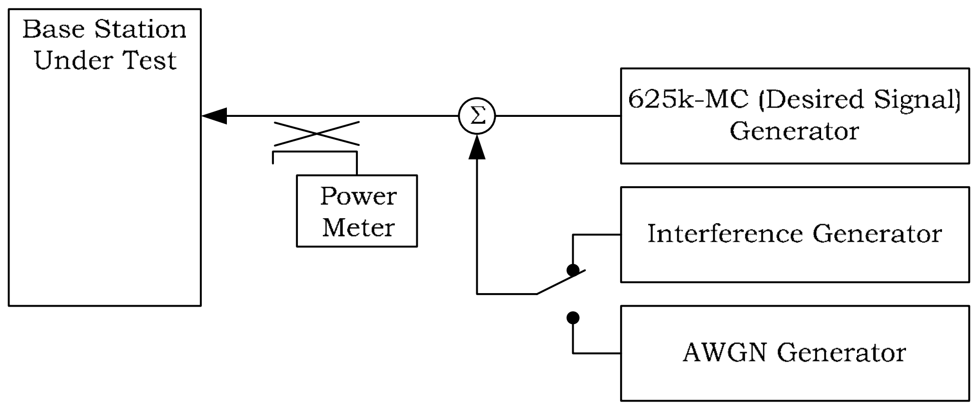

Figure 9—Functional setup for base station receiver tests

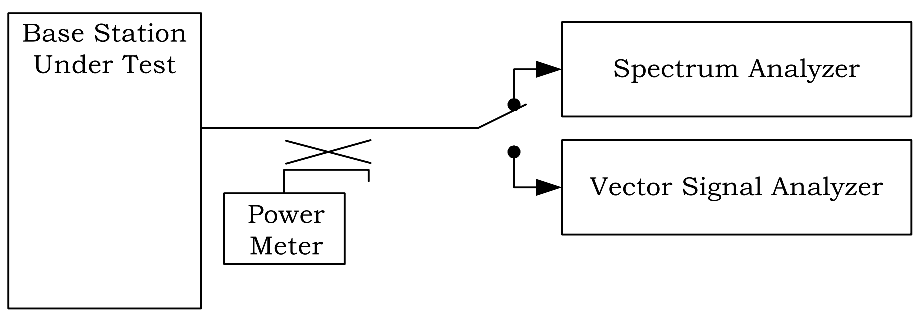

Figure 10—Functional setup for base station transmitter tests

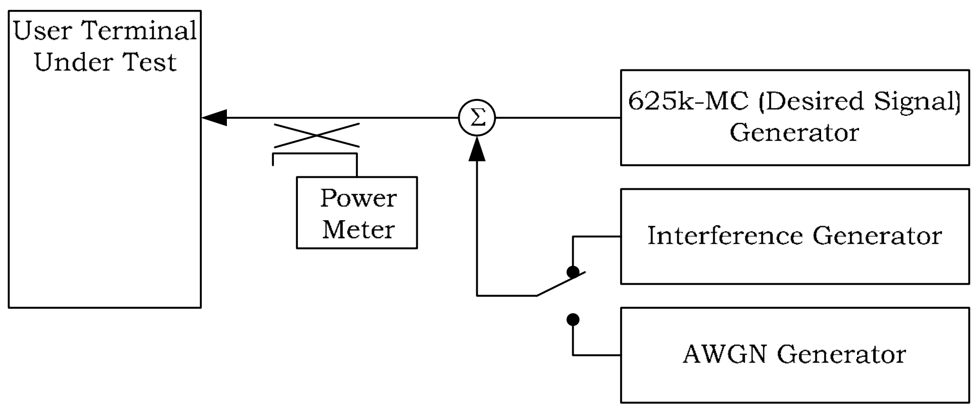

Figure 11—Functional setup for user terminal receiver tests

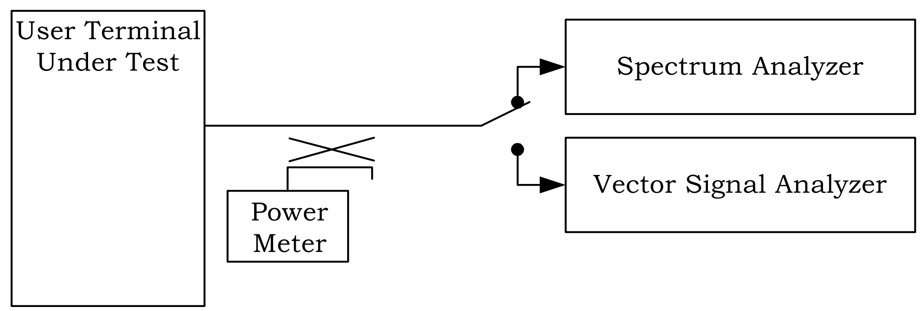

Figure 12—Functional setup for user terminal transmitter tests