

RECOMMENDATION ITU-R M.1808*

Technical and operational characteristics of conventional and trunked land mobile systems operating in the mobile service allocations below 869 MHz to be used in sharing studies

(Questions ITU-R 1-3/8 and ITU-R 7-5/8)

(2007)

Scope

This Recommendation provides technical and operational characteristics of conventional and trunked land mobile systems to be used in sharing studies. Given the variety of those systems within the mobile service below 869 MHz, a range of parameters and typical values are provided for different analogue as well as digital systems. This Recommendation is not intended to deal with characteristics of digital cellular land mobile systems.

The ITU Radiocommunication Assembly,

considering

- a) that the bands below 470 MHz allocated to the mobile service are heavily used for conventional and trunked land mobile systems;
- b) that there is a need for technical and operational characteristics of conventional and trunked land mobile systems to be used in sharing studies;
- c) that some mobile bands below 960 MHz are used for public protection systems;
- d) that the use of digital mobile radio systems is increasing;
- e) that the minimum receiver performance figures contained in equipment standards are not necessarily those on which systems are planned;
- f) that receiver performance characteristics for digital equipment differ from those for analogue;
- g) that previous radiocommunication conferences have invited ITU-R to continue its studies for all services,

noting

- a) that Recommendation ITU-R M.478 contains technical characteristics of equipment and principles governing the allocation of frequency channels between 25 and 3 000 MHz for the FM land mobile service;

* In case of discrepancy between the values in this Recommendation and the output of the Regional Radiocommunication Conference 2006 (RRC-06), the latter will prevail for the parties to the RRC-06 Agreement.

- b) Recommendation ITU-R M.1073 – Digital cellular land mobile telecommunication systems;
- c) Recommendation ITU-R M.1032 – Technical and operational characteristics of land mobile systems using multi-channel access techniques without a central controller;
- d) Recommendation ITU-R M.1033 – Technical and operational characteristics of cordless telephones and cordless telecommunication systems;
- e) that Report ITU-R M.2014 contains a description of efficient ways to use the spectrum in digital land mobile systems for dispatch traffic;
- f) that Recommendation ITU-R SM.329 contains material on unwanted emissions in the spurious domain;
- g) that Recommendation ITU-R SM.1541 contains material on unwanted emissions in the out-of-band domain;
- h) that Recommendation ITU-R SM.1539 contains variations of the boundary between the out-of-band and spurious domains required for the application of Recommendations ITU-R SM.1541 and ITU-R SM.329;
- j) that Recommendation ITU-R SM.1540 deals with unwanted emissions in the out-of-band domain falling into adjacent allocated bands;
- k) that degradation of mobile reception curves in Report ITU-R M.358 can be used to determine protection ratios for mobile digital systems;
- l) that some countries have deployed systems below 960 MHz with specifications that are set out in Recommendation ITU-R M.1457 and with characteristics similar to those described in Report ITU-R M.2039;
- m) that Report ITU-R BT.2069 contains information on spectrum usage and operational characteristics of terrestrial electronic news gathering (ENG), television outside broadcast (TVOB), and electronic field production (EFP) systems,

recommends

- 1 that for interservice and intraservice frequency sharing studies in bands below 960 MHz the representative technical and operational characteristics of conventional and trunked land mobile systems given in Annex 1 should be used.

Annex 1

Representative technical and operational characteristics of conventional and trunked land mobile systems operating in the mobile service allocations below 869 MHz to be used in sharing studies

1 Introduction

The bands below 869 MHz that are allocated to the mobile service are often used for conventional and trunked land mobile systems. These bands are also heavily used by public safety agencies, utilities and transportation companies because the propagation characteristics at these frequencies allow large area coverage with little infrastructure.

Due to the wide variety of conventional and trunked land mobile systems and equipment, it is difficult to use a single specific value for many characteristics, therefore a range of values, along with typical values are provided. When sharing studies are developed, appropriate consideration of the variable conditions encountered in the operating environment should be taken into account when choosing the characteristics for the land mobile station under study. To the extent possible, the actual performance and implementation specific characteristics of systems under consideration should be used.

2 Technical characteristics of conventional and trunked land mobile systems

When performing sharing studies, the following technical characteristics of conventional and trunked land mobile systems should be used.

2.1 Interference criteria

There are many methodologies used to ensure coexistence between conventional and trunked land mobile systems (e.g. field-strength contours, carrier-to-interference). For simplicity, an I/N of -6 dB could be used to determine the impact of interference. For applications with greater protection requirements, such as public protection and disaster relief (PPDR), an I/N of -10 dB may be used to determine the impact of interference.

2.2 Performance criteria

Conventional and trunked land mobile systems are designed to meet certain performance criteria. For analogue systems this criteria is usually a SINAD value (dB). For digital systems a bit error rate (BER) is used (%).

SINAD¹ is the ratio of the total received power (signal + noise + distortion) to the received unwanted power (noise + distortion). It is measured at the receiver audio output and provides a quantitative measurement of the quality of an audio signal. Report ITU-R M.358-5 suggests that a SINAD ratio of 12 dB is convenient for establishing degradation protection for land mobile systems but SINAD values between 12 and 20 dB are often used when designing these systems.

For digital modulation schemes, SINAD is inappropriate; therefore a BER is commonly used. This parameter is critical because, unlike analogue systems, there is no graceful degradation. There is

¹ SINAD is also used to measure the performance of land mobile equipment. Receiver parameters such as sensitivity and adjacent channel rejection are usually measured with respect to a 12 dB SINAD.

a breakpoint beyond which errors cannot be corrected which can result in a total loss of intelligibility. Conversely, a decrease in overall BER can yield an increase in intelligibility. Typically, conventional and trunked land mobile systems are designed to achieve a BER of 2-5%.

2.3 Conventional and trunked land mobile equipment characteristics

The technical characteristics for conventional and trunked land mobile base stations and mobile stations that should be used in sharing studies are provided in Tables 1 and 2 of Appendix 1 of this Annex.

3 Operational characteristics of land mobile systems

In performing sharing studies, the following operational characteristics of conventional and trunked land mobile systems should be taken into account.

3.1 Conventional systems

Conventional systems allow a user the use of only one channel. If that assigned channel is already in use then the user must wait until the channel becomes available. Management of the channels used in a conventional system is done by the users.

3.2 Trunked systems

Trunked systems employ access control techniques to share channel capacity among multiple users. In a trunked system a control channel is used and the decision as to which channel is used is invisible to the user. The design of a trunked system allows it to support more users on fewer channels than a conventional system.

High capacity mobile systems use trunking to increase the overall statistical traffic capacity. Interference cannot only affect an in-progress communication, but may also cause unused channels in a trunking group to be unavailable for subsequent legitimate uses, thereby limiting the capacity of the system for the duration of the interference. Interference to the control channel may result in loss of access to all channels on the trunked system.

3.3 Simulcast deployment

Simulcast refers to a technique that uses multiple base stations or repeaters with overlapping coverage, transmitting simultaneously and using the same frequency at every site. This technique is used to conserve frequencies.

3.4 Multicast deployment

Multicast refers to a technique that uses multiple base stations or repeaters with overlapping coverage, transmitting simultaneously and using different frequencies at each site. Frequencies are reused in cellular pattern which ensures that the same frequency is never used in an adjacent cell. This technique is used where frequency availability is not a problem.

3.5 Repeater operation

Many land mobile systems involve the use of a high elevation repeater site to increase system coverage and/or overcome geographic propagation obstacles that prohibit line-of-sight communication. In practice, the source transmits to a repeater where the received signal is decoded and analysed to ensure it is valid for the system. If valid, the signal is encoded and retransmitted on a separate frequency to be received by the target, such as a fleet of mobiles or another repeater. Interference experienced early in this chain of events, can be retransmitted throughout the repeater

system. Sharing studies involving repeater systems should consider whether there will be interference to the mobiles or the repeaters.

3.6 Voting receiver systems

Voting is a technique used to provide reception over a wide area, to enhance talk-in performance, especially in public safety systems. Multiple receivers are deployed throughout an area, to enable a portable radio to access a repeater or a base station anywhere in the coverage area.

Typically, a signal is received by many receivers and a decision is made to use the best signal. Interference to any one of these receivers may block the wanted signal.

4 Antenna system

4.1 Antenna height

Generally, in conventional and trunked land mobile systems the system coverage increases when the antenna height is increased. These systems usually consist of mobile and portable units located at or near ground level that communicate with base stations located at higher elevations. Base station receive antennas are situated at much greater elevations than the mobile stations, especially for some wide-area systems with hill-top or building-top sites. Base stations at high elevations will likely receive greater interfering signals and be more susceptible to aggregate interference than a mobile unit.

4.2 Tower-top low noise amplifier (LNA)

Mast-top LNAs are used to enhance received signal strength at base station receivers which effectively increases system coverage. Commercial amplifiers are generally designed to have a broad bandwidth usually encompassing entire frequency bands and employ little to no filtering. Sharing studies must consider that unwanted signals will also be amplified indiscriminately. These unwanted amplified signals can also increase the incidence of (third-order) intermodulation interference in receivers and reduce the overall system receive sensitivity, also called desensitization.

Appendix 1
(to Annex 1)

TABLE 1

Base station characteristics for frequency sharing below 869 MHz

Frequency band (MHz)	138 to 174		406.1 to 470			746-806	806-869	
Type of emission	Analogue	Digital	Analogue	Digital	Digital	Digital	Analogue	Digital
<i>System-wide</i>								
Channel bandwidth (kHz)	12.5/15/25/30	6.25/7.5/12.5/15	12.5/25	6.25/12.5	1 250	6.25/12.5/25	12.5/25	12.5
Modulation type	FM	C4FM	FM	C4FM	BPSK, QPSK, 8-PSK, 16-QAM	C4FM, F4GFSK	FM	C4FM
Type of operation	Simplex/duplex	Duplex	Simplex/duplex	Duplex	Duplex	Simplex/duplex	Simplex/duplex	Duplex
Typical SINAD (dB) or BER (%)	12 dB	5%	12 dB	5%	2-5%	5%	12 dB	5%
<i>Transmitter</i>								
Output power (W)	5 to 125 (30) (100)	20 to 125 (60) (100)	5 to 125 (25) (100)	1 to 125 (30) (100)	1 to 125 (20)	1 to 125 (100)	5 to 125 (100)	1 to 125 (100)
e.r.p. (dBW)	7 to 26 (19) (24)	13 to 26 (18) (24)	3 to 27 (20) (26)	3 to 27 (20) (25)	3 to 27 (22)	3 to 27 (24)	3 to 27 (24)	3 to 27 (24)
Necessary bandwidth (kHz)	11/11/16/16	5.5/5.5/8.1/8.1	11/16	5.5/8.1	1 250	6/8.1/12.5	11/16	8.1
Coverage radius (km)	1 to 75 (50)	1 to 75 (50)	1 to 60 (50)	1 to 60 (50)	1 to 60 (50)	1 to 60 (50)	1 to 60 (50)	1 to 60 (50)
Antenna gain (dBd)	0 to 9 (6)	0 to 9 (6)	0 to 11 (9)	0 to 11 (9)	0 to 15 (12)	0 to 13 (9)	0 to 13 (9)	0 to 13 (9)
Antenna height (m) (relative to ground level)	10 to 150 (60)	10 to 150 (65)	10 to 150 (60)	10 to 150 (60)	10 to 150 (30)	10 to 150 (60)	10 to 150 (60)	10 to 150 (60)

TABLE 1 (*end*)

Frequency band (MHz)	138 to 174		406.1 to 470			746-806	806-869	
Type of emission	Analogue	Digital	Analogue	Digital	Digital	Digital	Analogue	Digital
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional/ sectorized	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	0 to 7 (2)	3 to 9 (6) (2)	0 to 9 (3)	0 to 9 (4)	0 to 9 (3)	0 to 9 (5)	0 to 9 (5)	0 to 9 (5)
<i>Receiver</i>								
Noise figure (dB)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)	5 to 12 (5)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)
IF filter bandwidth (kHz)	8/11/12.5/16	5.5/5.5/5.5/5.5	8/12.5	5.5/5.5	1 250	5.5/5.5/12.5	8/12.5	5.5
Sensitivity (dBm)	-116 to -121 (-119)	-116 to -121 (-119)	-115 to -120 (-119)	-115 to -120 (-119)	-115 to -120 (-117)	-115 to -120 (-119)	-115 to -120 (-119)	-115 to -120 (-119)
Antenna gain (dBd)	0 to 9 (6)	0 to 9 (8)	0 to 11 (9)	0 to 11 (9)	0 to 15 (12)	0 to 13 (9)	0 to 13 (9)	0 to 13 (9)
Antenna height (m) (relative to ground level)	10 to 150 (60)	10 to 150 (65)	10 to 150 (60)	10 to 150 (60)	10 to 150 (30)	10 to 150 (60)	10 to 150 (60)	10 to 150 (60)
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional/ sectorized	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	0 to 6 (3)	0 to 6 (3)	0 to 9 (3)	0 to 9 (4)	0 to 9 (3)	0 to 9 (5)	0 to 9 (5)	0 to 9 (5)

NOTE 1 – Simplex systems use the same frequency for both the base station and mobile station to transmit.

NOTE 2 – Frequency division duplex systems have different frequencies for the base station and mobile station which allows simultaneous communications.

NOTE 3 – Typical values are shown in parenthesis. In some instances, more than one typical value is provided.

NOTE 4 – e.r.p. is equal to the output power (dBW) plus antenna gain (dBd) minus total losses (dB).

TABLE 2 (end)

Frequency band (MHz)	138 to 174		406.1 to 470			746-806	806-869	
Type of emission	Analogue	Digital	Analogue	Digital	Digital	Digital	Analogue	Digital
Total loss (dB)	0 to 1 (H: 0, V: 1)	0 to 1 (H: 0, V: 1)	0 to 1 (H: 0, V: 1)	0 to 1 (H: 0, V: 1)	0 to 1 (0)	0 to 1 (H: 0, V: 1)	0 to 1 (H: 0, V: 1)	0 to 1 (H: 0, V: 1)
<i>Receiver</i>								
Noise figure (dB)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)	6 to 12 (8)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)
IF filter bandwidth (kHz)	8/11/12.5/16	5.5/5.5/5.5/5.5	8/12.5	5.5/5.5	1250	5.5/5.5/12.5	8/12.5	5.5
Sensitivity (dBm)	-116 to -121 (-119)	-116 to -121 (-119)	-115 to -120 (-118)	-115 to -120 (-118)	-115 to -120 (-120)	-115 to -120 (-118)	-115 to -120 (-118)	-115 to -120 (-118)
Antenna gain (dBd)	-10 to 4 (H: -10, V: 0)	-10 to 4 (H: -10, V: 0)	-6 to 4 (H: -6, V: 0)	-6 to 4 (H: -6, V: 0)	0 to 4 (0)	-2 to 4 (H: -2, V: 0)	-2 to 4 (H: -2, V: 0)	-2 to 4 (H: -2, V: 0)
Antenna height (m) (relative to ground level)	(2)	(2)	(2)	(2)	(1.5)	(2)	(2)	(2)
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	0 to 1 (H: 0, V: 1)	0 to 1 (H: 0, V: 1)	0 to 1 (H: 0, V: 1)	0 to 1 (H: 0, V: 1)	0 to 1 (0)	0 to 1 (H: 0, V: 1)	0 to 1 (H: 0, V: 1)	0 to 1 (H: 0, V: 1)

NOTE 1 – Simplex systems use the same frequency for both the base station and mobile station to transmit.

NOTE 2 – Frequency division duplex (FDD) systems have different frequencies for the base station and mobile station which allows simultaneous communications.

NOTE 3 – Typical values are shown in parenthesis, “H:” represents the value for handheld mobile stations and “V:” represents the value for vehicular mobile stations. In some instances, more than one typical value is provided.

NOTE 4 – e.r.p. is equal to the output power (dBW) plus antenna gain (dBd) minus total losses (dB).