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Radiocommunication Sector of ITU

Recommendation ITU-R M.1808-1
(11/2019)

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 in bands below 960 MHz

M Series

Mobile, radiodetermination, amateur and related satellite services

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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R M.1808-1*

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 in bands below 960 MHz

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

(2007-2019)

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.

Keywords

Land Mobile Systems

Abbreviations/Glossary

BER	Bit error ratio
ENG	Electronic news gathering
EFP	Electronic field production
LNA	Low noise amplifier
PPDR	Public protection and disaster relief
SINAD	Signal plus noise plus distortion to noise plus distortion ratio
TVOB	Television outside broadcast

Related ITU-R Recommendations and Reports

Recommendation ITU-R SM.329 – Unwanted emissions in the spurious domain

Recommendation ITU-R P.372 – Radio noise

Recommendation ITU-R P.452 – Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz

Recommendation ITU-R M.478 – Technical characteristics of equipment and principles governing the allocation of frequency channels between 25 and 3 000 MHz for the FM land mobile service

Recommendation ITU-R M.1033 – Technical and operational characteristics of cordless telephones and cordless telecommunication systems

Recommendation ITU-R M.1073 – Digital cellular land mobile telecommunication systems

Recommendation ITU-R SM.1539 – Variation 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

Recommendation ITU-R SM.1540 – Unwanted emissions in the out-of-band domain falling into adjacent allocated bands

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* 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.

Recommendation ITU-R SM.1541 – Unwanted emissions in the out-of-band domain

Recommendation ITU-R P.1546 – Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 4 000 MHz

Recommendation ITU-R P.2001 – A general purpose wide-range terrestrial propagation model in the frequency range 30 MHz to 50 GHz

Recommendation ITU-R M.2009-1 – Radio interface standards for use by public protection and disaster relief operations in some parts of the UHF band in accordance with Resolution **646 (Rev.WRC-12)**

Report ITU-R M.2014 – Digital land mobile systems for dispatch traffic

Report ITU-R BT.2069 – Tuning ranges and operational characteristics of terrestrial electronic news gathering (ENG), television outside broadcast (TVOB) and electronic field production (EFP) 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

that some countries have deployed systems below 960 MHz with specifications that are set out in the Recommendations and related publications referenced above,

recommends

that for sharing studies in bands below 960 MHz the representative technical and operational characteristics of conventional and trunked land mobile systems operating below 869 MHz 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 governmental and public safety agencies, by industries, including 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, etc. 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 Consideration of the operating environment

When considering the radio-frequency noise contribution from the operating environment to determine the noise level, N, for land mobile systems pertinent to this Recommendation, Recommendation ITU-R P.372 should be used.

For carrier-to-interference analysis, Recommendations ITU-R P.452 and/or ITU-R P.1546 and/or ITU-R P.2001 should be used to estimate carrier and interference levels in the operating environment for land mobile systems pertinent to this Recommendation.

2.3 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 ratio (BER) is used (%).

SINAD[1] 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 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%.

2.4 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 Attachment 1 to 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.

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[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 for 25 kHz analogue FM based systems.

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.

Attachment 1
to Annex 1

TABLE 1A

Base station characteristics for frequency sharing below 869 MHz

Frequency band (MHz)	**30 to 88**		**138 to 174**		
Type of emission	**Analogue**	**Digital**	**Analogue**	**Digital (System A)**	**Digital (System B)**
System-wide					
Channel bandwidth (kHz)	16	25/75	12.5/15/25/30	6.25/7.5/12.5/15	12.5/15
Modulation type	FM	CPM, 4CPM, 8CPM, BPSK, QPSK, 8-PSK, 16-QAM,64-QAM	FM	C4FM	C4FM, H-DQPSK, 4FSK
Type of operation	Simplex/duplex	Simplex/duplex	Simplex/duplex	Duplex	Simplex/Duplex
Typical SINAD (dB) or BER (%)	10 dB	5%	12 dB	5%	2 to 5%
Transmitter					
Output power (W)	0.4 to 50	0.4 to 50	5 to 125 (30) (100)	20 to 125 (60) (100)	20 to 125 (60) (100)
e.r.p. (dBW)	–1.8 to 19	–1.8 to 19	7 to 26 (19) (24)	13 to 26 (18) (24)	13 to 26 (18) (24)
Necessary bandwidth (kHz)	16	25/75	11/11/16/16	5.5/5.5/8.1/8.1	8.1/7.6
Coverage radius (km)	1 to 200	1 to 200	1 to 75 (50)	1 to 75 (50)	1 to 75 (50)
Antenna gain (dBd)	0	0	0 to 9 (6)	0 to 9 (6)	0 to 9 (6)
Antenna height (m) (relative to ground level)	5 to 10 (8)	5 to 10 (8)	10 to 150 (60)	10 to 150 (65)	10 to 150 (65)

TABLE 1A (*end*)

Frequency band (MHz)	**30 to 88**		**138 to 174**		
Type of emission	**Analogue**	**Digital**	**Analogue**	**Digital (System A)**	**Digital (System B)**
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	1	1	0 to 7 (2)	3 to 9 (6) (2)	3 to 9 (6) (2)
Receiver					
Noise figure (dB)	5 to 12 (8)	5 to 12 (8)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)
IF filter bandwidth (kHz)	16	25/75	8/11/12.5/16	5.5/5.5/5.5/5.5	5.5/7.0
Sensitivity (dBm)	−112	−112 to −121 (−115)	−116 to −121 (−119)	−116 to −121 (−119)	−116 to −121 (-119)
Antenna gain (dBd)	0	0	0 to 9 (6)	0 to 9 (8)	0 to 9 (8)
Antenna height (m) (relative to ground level)	5 to 10 (8)	5 to 10 (8)	10 to 150 (60)	10 to 150 (65)	10 to 150 (65)
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	1	1	0 to 6 (3)	0 to 6 (3)	0 to 6 (3)

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 1B

Frequency band (MHz)	**223 to 328.6**	**335.4 to 399.9**		**350 to 399.9**
Type of emission	**Digital**	**Digital (System A)**	**Digital (System B)**	**Digital**
System-wide				
Channel bandwidth (kHz)	25 to 1250	25 to 1250	12.5/15	25/50
Modulation type	CPM, 4CPM, 8CPM, BPSK, QPSK, 8-PSK, 16-QAM, 64-QAM	CPM, 4CPM, 8CPM, BPSK, QPSK, 8-PSK, 16-QAM, 64-QAM	C4FM, H-DQPSK, 4FSK	pi/4DQPSK, pi/8DQPSK, 4-QAM, 16-QAM, 64-QAM
Type of operation	Simplex/duplex	Simplex/duplex	Simplex/Duplex	Duplex TDMA
Typical SINAD (dB) or BER (%)	5%	5%	2 to 5%	2%
Transmitter				
Output power (W)	0.4 to 50	0.4 to 50	20 to 125 (60) (100)	25 to 40
e.r.p. (dBW)	–1.8 to 19	–1.8 to 19	13 to 26 (18) (24)	23 to 25
Necessary bandwidth (kHz)	25 to 1 250	25 to 1 250	8.1/7.6	23.4
Coverage radius (km)	1 to 200	1 to 200	1 to 75 (50)	1 to 50 (20)
Antenna gain (dBd)	0 to 11	0 to 11	0 to 9 (6)	0 to 13 (9)
Antenna height (m) (relative to ground level)	5 to 10	5 to 10	10 to 150 (65)	10 to 100 (50)

TABLE 1B (*end*)

Frequency band (MHz)	**223 to 328.6**	**335.4 to 399.9**		**350 to 399.9**
Type of emission	**Digital**	**Digital (System A)**	**Digital (System B)**	**Digital**
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional directional sectorized
Antenna polarization	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	3	3	3 to 9 (6) (2)	0 to 9 (4)
Receiver				
Noise figure (dB)	5 to 12 (7)	5 to 12 (7)	6 to 12 (7)	6 to 9 (6)
IF filter bandwidth (kHz)	25 to 1250	25 to 1250	5.5/7.0	18
Sensitivity (dBm)	−95 to −121	−95 to −121	−116 to −121 (–119)	–104 to –115 (–115)
Antenna gain (dBd)	0 to 11	0 to 11	0 to 9 (8)	0 to 13 (15)
Antenna height (m) (relative to ground level)	5 to 10	5 to 10	10 to 150 (65)	10 to 100 (30)
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional directional sectorized
Antenna polarization	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	3	3	0 to 6 (3)	0 to 13 (4)

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 1C

Frequency band (MHz)	**406.1 to 470**					**470-512**
Type of emission	**Analogue**	**Digital (System A)**	**Digital (System B)**	**Digital (System C)**	**Digital (System D)**	**Digital**
System-wide						
Channel bandwidth (kHz)	12.5/25	6.25/12.5	1 250	25/50	25 to 1250	25 to 1250
Modulation type	FM	C4FM	BPSK, QPSK, 8-PSK, 16-QAM	pi/4DQPSK, pi/8DQPSK, 4-QAM, 16-QAM and 64-QAM	CPM, 4CPM, 8CPM, BPSK, QPSK, 8-PSK, 16-QAM, 64-QAM	CPM, 4CPM, 8CPM, BPSK, QPSK, 8-PSK, 16-QAM, 64-QAM
Type of operation	Simplex/ duplex	Duplex	Duplex	Duplex TDMA	Simplex /duplex	Simplex /duplex
Typical SINAD (dB) or BER (%)	12 dB	5%	2-5%	2%	5%	5%
Transmitter						
Output power (W)	5 to 125 (25) (100)	1 to 125 (30) (100)	1 to 125 (20)	25 to 40	0.4 to 50	0.4 to 50
e.r.p. (dBW)	3 to 27 (20) (26)	3 to 27 (20) (25)	3 to 27 (22)	23 to 25	–1.8 to 19	–1.8 to 19
Necessary bandwidth (kHz)	11/16	5.5/8.1	1 250	23.4	25 to 1 250	25 to 1 250
Coverage radius (km)	1 to 60 (50)	1 to 60 (50)	1 to 60 (50)	1 to 50 (20)	1 to 200	1 to 200
Antenna gain (dBd)	0 to 11 (9)	0 to 11 (9)	0 to 15 (12)	0 to 13 (9)	0 to 11	0 to 11
Antenna height (m) (relative to ground level)	10 to 150 (60)	10 to 150 (60)	10 to 150 (30)	10 to 100 (50)	5 to 10	5 to 10

TABLE 1C (*end*)

Frequency band (MHz)	**406.1 to 470**					**470-512**
Type of emission	**Analogue**	**Digital (System A)**	**Digital (System B)**	**Digital (System C)**	**Digital (System D)**	**Digital**
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional/ sectorized	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	0 to 9 (3)	0 to 9 (4)	0 to 9 (3)	0 to 9 (4)	3	3
Receiver						
Noise figure (dB)	6 to 12 (7)	6 to 12 (7)	5 to 12 (5)	6 to 9 (6)	5 to 12 (7)	5 to 12 (7)
IF filter bandwidth (kHz)	8/12.5	5.5/5.5	1 250	18	25 to 1 250	25 to 1 250
Sensitivity (dBm)	−115 to −120 (−119)	−115 to −120 (−119)	−115 to −120 (−117)	−104 to −115 (−115)	−95 to −121	−95 to −121
Antenna gain (dBd)	0 to 11 (9)	0 to 11 (9)	0 to 15 (12)	0 to 13 (15)	0 to 11	0 to 11
Antenna height (m) (relative to ground level)	10 to 150 (60)	10 to 150 (60)	10 to 150 (30)	10 to 100 (30)	5 to 10	5 to 10
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional/ sectorized	Omnidirectional directional sectorized	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	0 to 9 (3)	0 to 9 (4)	0 to 9 (3)	0 to 13 (4)	3	3

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 1D

Frequency band (MHz)	**746-806**		**806-869**			
Type of emission	**Digital (System A)**	**Digital (System B)**	**Analogue**	**Digital (System A)**	**Digital (System B)**	**Digital (System C)**
System-wide						
Channel bandwidth (kHz)	6.25/12.5/25	12.5/25	12.5/25	12.5	25/50	12.5
Modulation type	C4FM, F4GFSK	C4FM, H-DQPSK, 4FSK, pi/4DQPSK, pi/8DQPSK, 4-QAM, 16-QAM and 64-QAM	FM	C4FM	pi/4DQPSK, pi/8DQPSK, 4-QAM, 16-QAM and 64-QAM	C4FM, H-DQPSK,4FSK
Type of operation	Simplex/ duplex	Simplex / Duplex TDMA	Simplex /duplex	Duplex	Duplex TDMA	Simplex / Duplex TDMA/FDMA
Typical SINAD (dB) or BER (%)	5%	2 to 5%	12 dB	5%	2%	2 to 5%
Transmitter						
Output power (W)	1 to 125 (100)	1 to 125 (100)	5 to 125 (100)	1 to 125 (100)	25 to 40	1 to 125 (100)
e.r.p. (dBW)	3 to 27 (24)	3 to 27 (24)	3 to 27 (24)	3 to 27 (24)	23 to 25	3 to 27 (24)
Necessary bandwidth (kHz)	6/8.1/12.5	6/8.1/12.5	11/16	8.1	23.4	8.1
Coverage radius (km)	1 to 60 (50)	1 to 60 (50)	1 to 60 (50)	1 to 60 (50)	1 to 50 (20)	1 to 60 (50)
Antenna gain (dBd)	0 to 13 (9)	0 to 13 (9)	0 to 13 (9)	0 to 13 (9)	0 to 9 (9)	0 to 13 (9)
Antenna height (m) (relative to ground level)	10 to 150 (60)	10 to 150 (60)	10 to 150 (60)	10 to 150 (60)	10 to 100 (40)	10 to 150 (60)

TABLE 1D (*end*)

Frequency band (MHz)	**746-806**		**806-869**			
Type of emission	**Digital (System A)**	**Digital (System B)**	**Analogue**	**Digital (System A)**	**Digital (System B)**	**Digital (System C)**
Radiation pattern	Omnidirectional	Omnidirectional / directional sectorial	Omnidirectional	Omnidirectional	Omnidirectional / directional sectorial	Omnidirectional / directional sectorial
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	0 to 9 (5)	0 to 9 (4)	0 to 9 (5)	0 to 9 (5)	0 to 9 (4)	
Receiver						
Noise figure (dB)	6 to 12 (7)	6 to 9 (6)	6 to 12 (7)	6 to 12 (7)	6 to 9 (6)	6 to 12 (12)
IF filter bandwidth (kHz)	5.5/5.5/12.5	18	8/12.5	5.5	18	5.5
Sensitivity (dBm)	−115 to −120 (−119)	−104 to −115 (−115)	−115 to −120 (−119)	−115 to −120 (−119)	−104 to −115 (−115)	−115 to −120 (−119)
Antenna gain (dBd)	0 to 13 (9)	0 to 13 (15)	0 to 13 (9)	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 100 (30)	10 to 150 (60)	10 to 150 (60)	10 to 100 (40)	10 to 150 (60)
Radiation pattern	Omnidirectional	Omnidirectional, directional sectorized	Omnidirectional	Omnidirectional	Omnidirectional, directional sectorized	Omnidirectional / directional sectorial
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	0 to 9 (5)	0 to 13 (4)	0 to 9 (5)	0 to 9 (5)	0 to 13 (4)	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 2A

Land Mobile station characteristics for frequency sharing below 869 MHz

Frequency band (MHz)	**30 to 88**		**138 to 174**		
Type of emission	**Analogue**	**Digital**	**Analogue**	**Digital (System A)**	**Digital (System B)**
System-wide					
Channel bandwidth (kHz)	16	25/75	12.5/15/25/30	6.25/7.5/ 12.5/15	12.5
Modulation type	FM	CPM, 4CPM, 8CPM, BPSK, QPSK, 8-PSK, 16-QAM, 64-QAM	FM	C4FM	C4FM, H-CPM, 4FSK
Type of operation	Simplex/ duplex	Simplex/ duplex	Simplex/duplex	Duplex	Simplex/duplex
Typical SINAD (dB) or BER (%)	10 dB	5%	12 dB	5%	2 to 5%
Transmitter					
Output power (W)	H: 0.2 to 10 V: 0.4 to 50	H: 0.2 to 10 V: 0.4 to 50	1 to 100 (H: 5 V: 30, 50)	1 to 100 (H: 5 V: 30, 50)	1 to 100 (H: 5 V: 30, 50)
e.r.p. (dBW)	H: −17 to 0 V: −7 to 14	H: −17 to 0 V: −7 to 14	−3 to 18 (H: −3 V: 14, 16)	−3 to 18 (H: −3 V: 14, 16)	−3 to 18 (H: −3 V: 14, 16)
Necessary bandwidth (kHz)	16	25/75	11/11/16/16	5.5/5.5/8.1/8.1	7/8.1
Antenna gain (dBd)	H: −12.15 V: −5.15	H: −12.15 V: −5.15	−10 to 4 (H: −10, V: 0)	−10 to 4 (H: −10, V: 0)	−10 to 4 (H: −10, V: 0)
Antenna height (m) (relative to ground level)	H: 1.5 V: 2 to 5	H: 1.5 V: 2 to 5	(2)	(2)	2
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical

TABLE 2A (*end*)

Frequency band (MHz)	**30 to 88**		**138 to 174**		
Type of emission	**Analogue**	**Digital**	**Analogue**	**Digital (System A)**	**Digital (System B)**
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 (H: 0, V: 1)
Receiver					
Noise figure (dB)	5 to 12 (8)	5 to 12 (8)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)
IF filter bandwidth (kHz)	16	25/75	8/11/12.5/16	5.5/5.5/5.5/5.5	5.5/7.0
Sensitivity (dBm)	−112	−112 to −121 (−115)	−116 to −121 (−119)	−116 to −121 (−119)	−116 to −121 (−119)
Antenna gain (dBd)	H: −12.15 V: −5.15	H: −12.15 V: −5.15	−10 to 4 (H: −10, V: 0)	−10 to 4 (H: −10, V: 0)	−10 to 4 (H: −10, V: 0)
Antenna height (m) (relative to ground level)	H: 1.5 V: 2 to 5	H: 1.5 V: 2 to 5	(2)	(2)	-2
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	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 (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).

NOTE 5 –For Handheld and Vehicular mobile stations, the Antenna polarization could slightly differ from pure Vertical.

TABLE 2B

Frequency band (MHz)	**223 to 328.6**	**335.4 to 399.9**		**350 to 399.9**
Type of emission	**Digital**	**Digital (System A)**	**Digital (System B)**	**Digital**
System-wide				
Channel bandwidth (kHz)	25 to 1250	25 to 1250	12.5	25/50
Modulation type	CPM, 4CPM, 8CPM, BPSK, QPSK, 8-PSK, 16-QAM, 64-QAM	CPM, 4CPM, 8CPM, BPSK, QPSK, 8-PSK, 16-QAM, 64-QAM	C4FM, H-CPM, 4FSK	pi/4DQPSK, pi/8DQPSK, 4-QAM, 16-QAM and 64-QAM
Type of operation	Simplex/ duplex	Simplex/ duplex	Simplex/duplex	Simplex/duplex
Typical SINAD (dB) or BER (%)	5%	5%	2 to 5%	2%
Transmitter				
Output power (W)	H: 0.2 to 10 V: 0.4 to 50	H: 0.2 to 10 V: 0.4 to 50	1 to 100 (H: 1-5 V: 30, 40)	1 to 30
e.r.p. (dBW)	H: −12 to 5 V: −7 to 14	H: -12 to 5 V: −7 to 14	−3 to 18 (H: −3 V: 14, 16)	0
Necessary bandwidth (kHz)	25 to 1 250	25 to 1 250	7/8.1	22
Antenna gain (dBd)	H: −7.15 V: −2.15	H: −7.15 V: −2.15	−10 to 4 (H: −10, V: 0)	-2 to 4
Antenna height (m) (relative to ground level)	H: 1.5 V: 2.5 to 5	H: 1.5 V: 2.5 to 5	2	1.5
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical

TABLE 2B (*end*)

Frequency band (MHz)	**223 to 328.6**	**335.4 to 399.9**		**350 to 399.9**
Type of emission	**Digital**	**Digital (System A)**	**Digital (System B)**	**Digital**
Total loss (dB)	0 to 3 (H: 0, V: 3)	0 to 3 (H: 0, V: 3)	0 to 3 (H: 0, V: 3)	0 to 1 (0)
Receiver				
Noise figure (dB)	5 to 12 (7)	5 to 12 (7)	5 to 12 (7)	6 to 12 (7)
IF filter bandwidth (kHz)	25 to 1 250	25 to 1 250	5.5//7.0	22
Sensitivity (dBm)	−95 to −121	−95 to −121	−95 to −121	−101 to −112 (−112)
Antenna gain (dBd)	H: −7.15 V: −2.15	H: −7.15 V: −2.15	H: −7.15 V: −2.15	−2 to 4
Antenna height (m) (relative to ground level)	H: 1.5 V: 2.5 to 5	H: 1.5 V: 2.5 to 5	H: 1.5 V: 2.5 to 5	−1.5
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical
Total loss (dB)	0 to 3 (H: 0, V: 3)	0 to 3 (H: 0, V: 3)	0 to 3 (H: 0, V: 3)	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).

NOTE 5 –For Handheld and Vehicular mobile stations, the Antenna polarization could slightly differ from pure Vertical.

TABLE 2C

Frequency band (MHz)	**406.1 to 470**					**470-512**
Type of emission	**Analogue**	**Digital (System A)**	**Digital (System B)**	**Digital (System C)**	**Digital (System D)**	**Digital**
System-wide						
Channel bandwidth (kHz)	12.5/25	6.25/12.5	1 250	25 to 1250	25/50	25 to 1250
Modulation type	FM	C4FM	BPSK, QPSK, 8-PSK, 16-QAM	CPM, 4CPM, 8CPM, BPSK, QPSK, 8-PSK, 16-QAM, 64-QAM	pi/4DQPSK, pi/8DQPSK, 4-QAM, 16-QAM, 64-QAM	CPM, 4CPM, 8CPM, BPSK, QPSK, 8-PSK, 16-QAM, 64-QAM
Type of operation	Simplex/duplex	Duplex	Duplex	Simplex/duplex	Simplex/duplex	Simplex/duplex
Typical SINAD (dB) or BER (%)	12 dB	5%	2-5%	5%	2%	5%
Transmitter						
Output power (W)	1 to 50 (H: 4 V: 40, 50)	1 to 50 (H: 4 V: 40, 50)	0.1 to 40 (0.2)	H: 0.2 to 10 V: 0.4 to 50	1 to 30	H: 0.2 to 10 V: 0.4 to 50
e.r.p. (dBW)	0 to 20 (H: 0 V: 15, 16)	0 to 20 (H: 0 V: 15, 16)	−7 to 20 (−7)	H: –12 to 5 V: –7 to 14	0	H: –12 to 5 V: –7 to 14
Necessary bandwidth (kHz)	11/16	5.5/8.1	1 250	25 to 1250	22	25 to 1250
Antenna gain (dBd)	−6 to 4 (H: −6, V: 0)	−6 to 4 (H: −6, V: 0)	0 to 4 (0)	H: –7.15 V: –2.15	–2 to 4	H: –7.15 V: –2.15
Antenna height (m) (relative to ground level)	(2)	(2)	(1.5)	H: 1.5 V: 2 to 5	1.5	H: 1.5 V: 2 to 5
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical

TABLE 2C (*end*)

Frequency band (MHz)	**406.1 to 470**					**470-512**
Type of emission	**Analogue**	**Digital (System A)**	**Digital (System B)**	**Digital (System C)**	**Digital (System D)**	**Digital**
Total loss (dB)	0 to 1 (H: 0, V: 1)	0 to 1 (H: 0, V: 1)	0 to 1 (0)	0 to 3 (H: 0, V: 3)	0 to 1 (0)	0 to 3 (H: 0, V: 3)
Receiver						
Noise figure (dB)	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)	8/12.5	5.5/5.5	1250	25 to 1 250		25 to 1 250
Sensitivity (dBm)	−115 to −120 (−118)	−115 to −120 (−118)	−115 to −120 (−120)	−95 to −121	−101 to −112 (−112)	−95 to −121
Antenna gain (dBd)	−6 to 4 (H: −6, V: 0)	−6 to 4 (H: −6, V: 0)	0 to 4 (0)	H: −7.15 V: −2.15	−2 to 4	H: −7.15 V: −2.15
Antenna height (m) (relative to ground level)	(2)	(2)	(1.5)	H: 1.5 V: 2.5 to 5	−1.5	H: 1.5 V: 2.5 to 5
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	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 (0)	0 to 3 (H: 0, V: 3)	0 to 1 (H: 0, V: 1)	0 to 3 (H: 0, V: 3)

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).

TABLE 2D

Frequency band (MHz)	**746-806**		**806-869**			
Type of emission	**Digital (System A)**	**Digital (System B)**	**Analogue**	**Digital (System A)**	**Digital (System B)**	**Digital (System C)**
System-wide						
Channel bandwidth (kHz)	6.25/12.5/25	12.5	12.5/25	12.5	25/50	12.5
Modulation type	C4FM, F4GFSK	C4FM, H-CPM, 4FSK	FM	C4FM	pi/4DQPSK, pi/8DQPSK, 4-QAM, 16-QAM and 64-QAM	C4FM, H-CPM, 4FSK
Type of operation	Simplex/ duplex	Simplex/duplex	Simplex/ duplex	Duplex	Simplex/duplex	Simplex/duplex
Typical SINAD (dB) or BER (%)	5%	2 to 5%	12 dB	5%	2%	2 to 5%
Transmitter						
Output power (W)	1 to 40 (H: 3, 5 V: 30)	1 to 50 (H: 4 V: 40, 50)	1 to 40 (H: 3, 5 V: 30)	1 to 40 (H: 3, 5 V: 30)	1 to 30	1 to 40 (H: 3, 5 V: 30)
e.r.p. (dBW)	0 to 20 (H: 3, 5 V: 14)		0 to 20 (H: 3, 5 V: 14)	0 to 20 (H: 3, 5 V: 14)		
Necessary bandwidth (kHz)	6/8.1/12.5	7.0/8.1	11/16	8.1	22	7.0/8.1
Antenna gain (dBd)	−2 to 4 (H: −2, V: 0)	−2 to 4 (H: −2, V: 0)	−2 to 4 (H: −2, V: 0)	−2 to 4 (H: −2, V: 0)	−2 to 4	−2 to 4 (H: −2, V: 0)
Antenna height (m) (relative to ground level)	(2)	2	(2)	(2)	1.5	2
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical

TABLE 2D (*end*)

Frequency band (MHz)	**746-806**		**806-869**			
Type of emission	**Digital (System A)**	**Digital (System B)**	**Analogue**	**Digital (System A)**	**Digital (System B)**	**Digital (System C)**
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)
Receiver						
Noise figure (dB)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)	6 to 12 (7)
IF filter bandwidth (kHz)	5.5/5.5/12.5	5.5/5.5/12.5	8/12.5	5.5	22	8.1
Sensitivity (dBm)	−115 to −120 (−118)	−116 to −121 (−119)	−115 to −120 (−118)	−115 to −120 (−118)	−101 to −112 (−112)	−116 to −121 (−119)
Antenna gain (dBd)	−2 to 4 (H: −2, V: 0)	−2 to 4 (H: −2, V: 0)	−2 to 4 (H: −2, V: 0)	−2 to 4 (H: −2, V: 0)	−2 to 4	−2 to 4 (H: −2, V: 0)
Antenna height (m) (relative to ground level)	(2)	-2	(2)	(2)	−1.5	−2
Radiation pattern	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional	Omnidirectional
Antenna polarization	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 (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.

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