Innovation, Sciences et
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Spectrum Management and Telecommunications

Guidelines on External Filtering for Land Mobile Radio Systems

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Preface

Issue 1 of GL-09, *Guidelines on External Filtering for Land Mobile Radio Systems* is hereby released.

These technical guidelines describe the changes to Innovation, Science and Economic Development Canada's processes used in technical analyses and interference investigations following the adoption of the new Spectrum Management System (SMS).

Issued under the authority of
the Minister of Innovation, Science and Economic Development

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Director General
Engineering, Planning and Standards Branch

Contents

1. Introduction and purpose 1
1.1 Definitions 1
2. Background 2
3. Multi-channel sites 2
4. Approach to filtering 3
4.1 External filtration levels 3
4.2 Levels of external filtration used in technical analysis 3
Annex A: Three cavity multicoupler at maximum insertion loss 5
Annex B: One cavity bandpass filter with minimum insertion loss 7

1. Introduction and purpose

The analysis of interference on sites in the land mobile service has long been a part of Innovation, Science and Economic Development Canada's (ISED or the Department) licensing activities. Recent changes in the Department's spectrum management program have led to changes to ISED's approach to managing land mobile frequencies. As a result, ISED's approach to dealing with the analysis of frequency compatibility during the authorization process and interference resolution for sites in the land mobile service has changed. This guideline is intended to provide applicants and licensees with guidance on how the Department processes land mobile radio licence applications with respect to technical analysis and interference investigations.

1.1 Definitions

Congestion zones

High-congestion zone (A) in respect of a regional area set out in column I of an item of Schedule V, the area bounded by the geographical coordinates set out in columns II to X of that item (see *Radiocommunication Regulations*).

Medium-congestion zone (B) in respect of a regional area set out in column I of an item of Schedule VI, the area bounded by the geographical coordinates set out in columns II to XI of that item, but does not include any area that is included in a high-congestion zone (see *Radiocommunication Regulations*).

Low-congestion zone (C) refers to any area that is not a medium-congestion zone or a high-congestion zone (see *Radiocommunication Regulations*).

Frequency bands

Ultra high frequency (UHF) range refers to the frequency bands between 406.1 and 960 MHz allocated to the land mobile service.

Very high frequency (VHF) range refers to the frequency bands between 30 and 222 MHz allocated to the land mobile service

Sites

Site is a distinct location where one or more radio apparatus may be located. Locations that are more than 30 metres apart are considered to be different sites.

Multi-channel site is a site where multiple transmitters and receivers are operating at short separation distances and where interference problems (such as intermodulation, transmitter noise, and receiver desensitization) from the simultaneous operation of multiple channels within these short separation distances can occur. For example, a site where only one channel can be selected at a time would not be considered a multi-channel site.

2. Background

When multiple radio communication systems are operating at short separation distances, external devices offering better protection are often required to avoid interference problems. In this context, ISED evaluates compatible frequencies taking into consideration the frequency response of the proposed and existing radio communication systems. However, this offers no guarantee of compatible operation when these systems are in close vicinity or if they are sharing a common feedline. Sometimes, greater isolation by means of a more selective filtration device—beyond the inherent selectivity of the receiver used—is required for ensuring channel compatibility. To minimize the risk of interference in these scenarios, the Department expects that applicants will call upon internal or external technical expertise to determine the best antenna, feedline, and external filter configuration for their radio system, thus ensuring compatibility between all channels on a multi-channel site. Operators and consulting engineers in the field are in the best position to evaluate solutions for their own installations at these sites in the land mobile service.

3. Multi-channel sites

When managing the radio spectrum, ISED assigns channels to specific users that will minimize the risk of interference to or from other licensed radio systems. ISED is well positioned to perform this type of electromagnetic compatibility analysis due to its knowledge of the broader radio environment and its use of computer modelling software to select a channel that minimizes interference to and from other licensed radio systems over which a licensee has no direct control. When assigning frequencies for land mobile radio systems, the Department selects the best possible channel available to minimize the potential for intermodulation, transmitter noise and receiver desensitization.

The detailed design, installation and operation of a radio system are the responsibilities of the licensee. This includes ensuring electromagnetic compatibility between systems sharing the same site, a common antenna structure, and/or a shared feed line system. The analysis of compatibility and prevention of interference between radio systems in these situations requires detailed knowledge of the specific installation, equipment, and site configuration and can therefore best be performed by either the operators or consulting engineers. Compatibility issues can be addressed during system design and installation between entities that already share a business relationship.

As such, ISED will no longer regularly review on-site compatibility evaluations during the licensing process. Licensees are responsible for maintaining full on-site technical compatibility at all times. As per existing RP-Gen, *General Spectrum Policy Principles and Other Information Related to Spectrum Utilization and Radio System Policies* any operator proposing changes to a radio system is responsible for accommodating original users. ISED will continue to assess compatibility in the radio frequency (RF) environment with transmitter and/or receivers located at separate sites.

As a consequence, ISED will no longer be requiring site configuration or external filtering information to be provided with land mobile licence applications for a multi-channel site. ISED may request more detailed information if required to complete a frequency assignment or to complete an interference investigation.

4. Approach to filtering

In the past, the term 'filter' was used to refer to a very particular type of filter, which was an add-on device that provided additional isolation beyond the inherent selectivity of a land mobile base station or repeater, as compared to the more general concept of 'filtration.' As of February 22, 2016, ISED considers that the term 'filter' be used in the general sense to refer to anything that provides frequency discrimination, whether inherent or external. The term 'external filter' is used to distinguish these add-on devices from the more general concept of 'filtration.'

ISED no longer collects nor maintains a detailed list of external filter models and characteristics. Rather, where the use of external filters is recommended for the VHF and UHF bands, ISED assumed that the external filters are in place and conducts the technical analysis accordingly (see table 1). If interference is received, the extent that applicants have met or exceeded the required level of additional isolation determines whether protection from interference is offered. ISED reserves the right to require more isolation in the event of interference, caused or received.

4.1 External filtration levels

ISED considers four standard masks of supplemental attenuation: medium and high isolation for each of the VHF and UHF frequency ranges. These masks are based on real-life external filters, so that the levels of attenuation are achievable, but they are not intended to reflect the specifications of a particular installation or to endorse or require the use of a particular model or brand.

The four standard masks are specified in annexes A and B.

4.2 Levels of external filtration used in technical analysis

In performing electromagnetic compatibility analyses, ISED considers that minimum levels of external filtration are applied to radio systems operating at multi-channel sites. These levels vary depending on the congestion zone and the number of licensees on the site and are categorized by six cases. The minimum isolation requirement applied to each case is summarized in table 1 below.

If ISED's technical analysis, or real-life interference caused or received, reveals that additional external filtration is required to promote the efficient use of spectrum, the Department will advise the applicant or licensee that this requirement will be added as a frequency condition on the licence.

Table 1: Isolation requirements for the six cases

Case	Case description	Level of external filtration
1	Stations on a multi-channel site in a high-congestion zone (A)	High isolation (e.g. multicoupler)
2	Stations on a multi-channel site in a medium-congestion zone (B)	High isolation (e.g. multicoupler) if the site includes more than one licensee
3	Stations on a multi-channel site in a medium-congestion zone (B)	Medium isolation (e.g. bandpass) if the site includes only one licensee
4	Stations on a multi-channel site outside high (A) and medium (B) congestion zones	Medium isolation (e.g. bandpass) if the site includes more than one licensee
5	Stations on a multi-channel site outside high (A) and medium (B) congestion zones	No additional isolation if the site includes only one licensee
6	All other cases	No additional isolation

Annex A: Three cavity multicoupler at maximum insertion loss

Figure A1: Three cavity multicoupler at maximum insertion loss for the VHF band

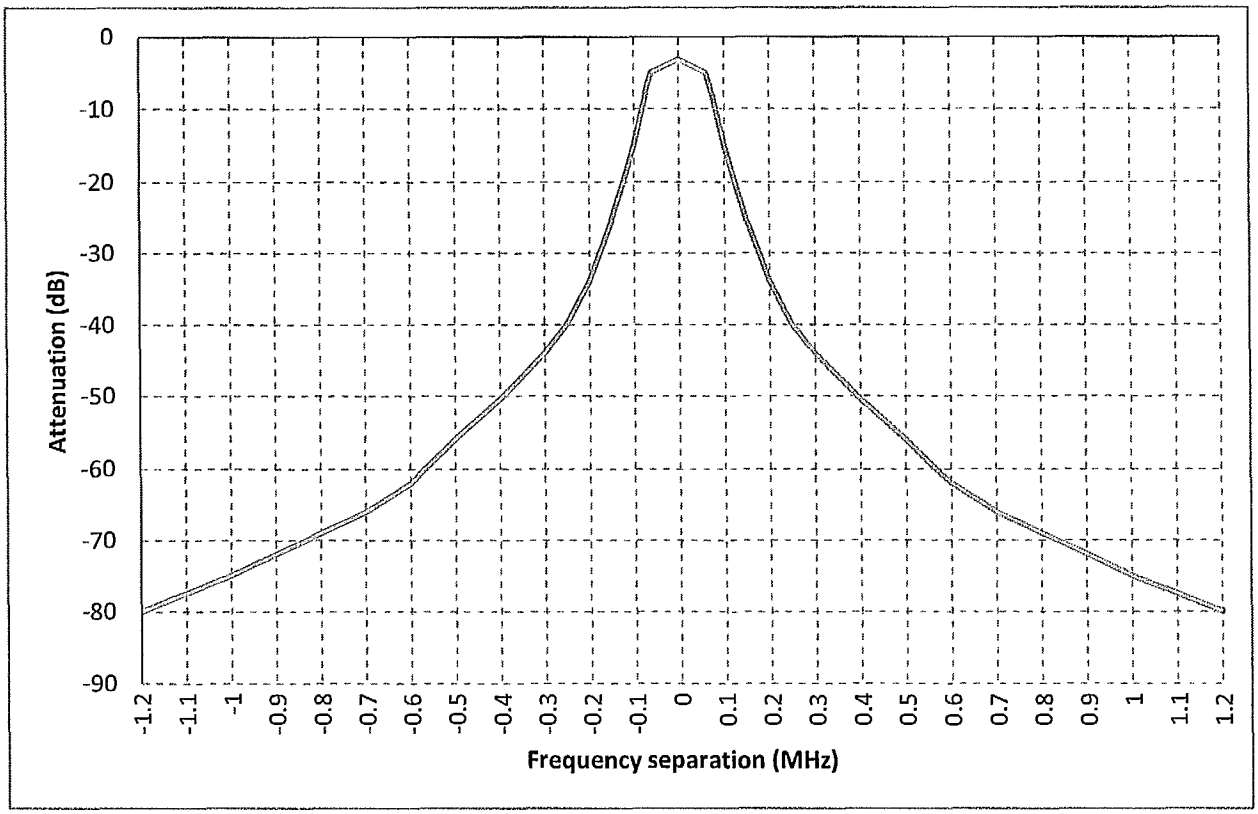

Table A1: Three cavity multicoupler at maximum insertion loss for the VHF band

Frequency separation (MHz)	0	±0.06	±0.07	±0.1	±0.15	±0.2
Attenuation (dB)	-3.2	-5	-7	-15	-25.5	-34
Frequency separation (MHz)	±0.25	±0.3	±0.4	±0.5	±0.6	±0.7
Attenuation (dB)	-40	-44	-50.5	-56	-62	-66
Frequency separation (MHz)	±0.75	±0.8	±0.9	±1	±1.2	N/A
Attenuation (dB)	-67.5	-69	-72	-75	-80	N/A

Figure A2: Three cavity multicoupler at maximum insertion loss for the UHF band

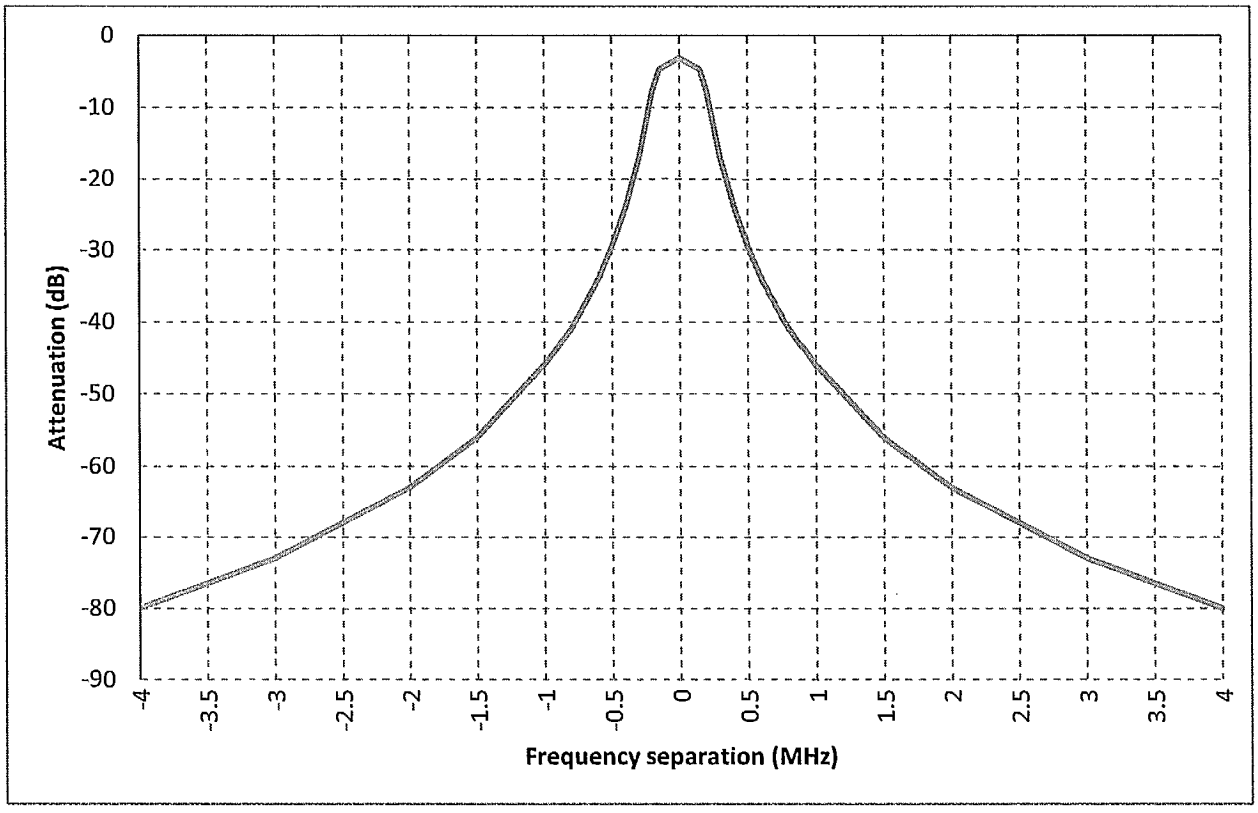

Table A2: Three cavity multicoupler at maximum insertion loss for the UHF band

Frequency separation (MHz)	0	±0.15	±0.2	±0.3	±0.4	±0.5
Attenuation (dB)	-3.2	-4.8	-7.8	-17	-24	-29.5
Frequency separation (MHz)	±0.6	±0.8	±1	±1.5	±2	±3
Attenuation (dB)	-34	-41	-46	-56	-63	-73
Frequency separation (MHz)	±4	N/A	N/A	N/A	N/A	N/A
Attenuation (dB)	-80	N/A	N/A	N/A	N/A	N/A

Annex B: One cavity bandpass filter with minimum insertion loss

Figure B1: One cavity bandpass filter with a minimum insertion loss for the VHF band

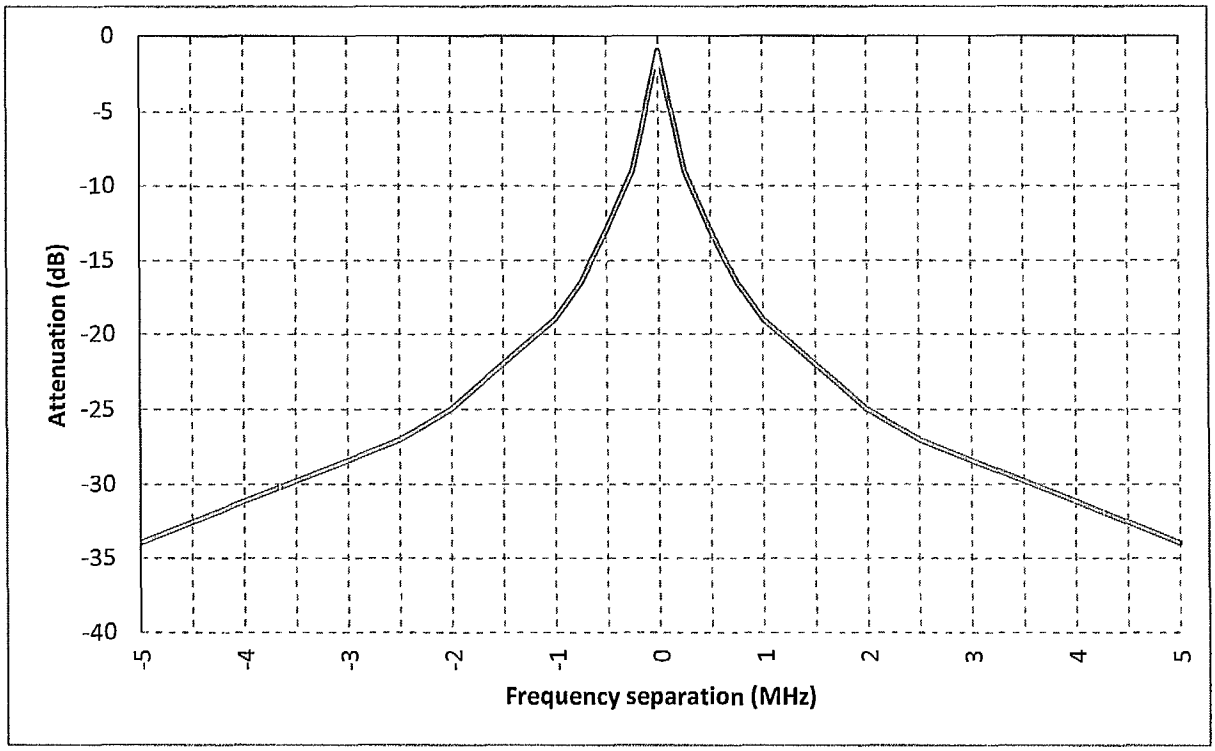

Table B1: One cavity bandpass filter with a minimum insertion loss for the VHF band

Frequency separation (MHz)	0	±0.25	±0.5	±0.75	±1	±1.5
Attenuation (dB)	-1	-9	-13	-16.5	-19	-22
Frequency separation (MHz)	±2	±2.5	±5	N/A	N/A	N/A
Attenuation (dB)	-25	-27	-34	N/A	N/A	N/A

Figure B2: One cavity bandpass filter with a minimum insertion loss for the UHF band

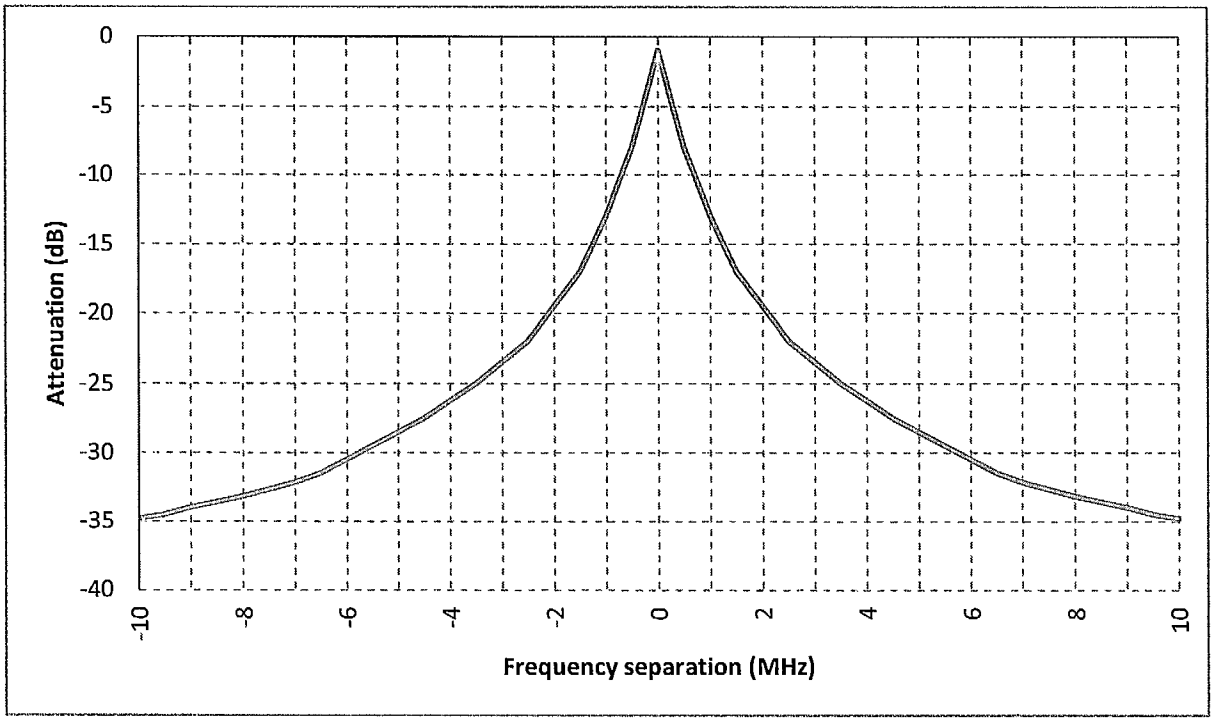

Table B2: One cavity bandpass filter with a minimum insertion loss for the UHF band

Frequency separation (MHz)	0	±0.5	±1	±1.5	±2	±2.5
Attenuation (dB)	-1	-8	-13	-17	-19.5	-22
Frequency separation (MHz)	±3	±3.5	±4	±4.5	±5	±5.5
Attenuation (dB)	-23.5	-25	-26.2	-27.5	-28.5	-29.5
Frequency separation (MHz)	±6	±6.5	±7	±7.5	±8	±8.5
Attenuation (dB)	-30.5	-31.5	-32.2	-32.7	-33.2	-33.6
Frequency separation (MHz)	±9	±9.5	±10	N/A	N/A	N/A
Attenuation (dB)	-34	-34.5	-34.8	N/A	N/A	N/A