Aeronautical Frequency Committee (AFC) VHF Ground Station Installation Guidelines

ASRI
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Annapolis, MD
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U.S.A.

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Executive Summary

Radio communications are required for the safe and proper operation of aircraft and airlines at airports. Airport operators, station operating personnel, technicians and contractors need to be familiar with these guidelines before installing VHF radio systems.

This document is only an introduction and overview of the requirements that should be met in order to install VHF air/ground radio stations at airports in a proper, acceptable and legal manner. For more information, please refer to the references listed at the end of this document.

Within the United States the Federal Communications Commission (FCC) regulates aeronautical stations which communicate with aircraft both in flight and on the ground. Radio stations used for this purpose are defined as 'Aeronautical Enroute Stations' and they make up the ground portion of the "Aeronautical Mobile Route (R) Service". The FCC rules conform to applicable statutes, international treaties, agreements and recommendations to which the United States is a party and incorporate regulations, defined by the International Telecommunications Union (ITU) and standards and recommended practices developed by the International Civil Aviation Organization (ICAO). The FCC has designated Aviation Spectrum Resources Incorporated (ASRI) as the single licensee for frequencies assigned under the Aeronautical Enroute Service (Subpart I, FCC RR) within the United States and it's territories with some exceptions in Alaska. These stations may be authorized for either voice or data link communications between ground sites and aircraft.

The Aeronautical Mobile Route (R) Service is reserved for communications relating to the *safety* and *regularity* of flight along national and international civil air routes. A significant portion of these frequencies are combined as networked voice or data systems and provide the airlines with required pilot to dispatcher communications. Due to heavy use of this spectrum, frequency changes involve extensive coordination with multiple operators throughout the entire coverage area and are only entertained as a last resort. The use and operation of these frequencies by aircraft operators is governed by the Federal Communications Commission. The airlines use these frequencies to meet communications requirements in the Federal Aviation Regulations (FARS) published by the Federal Aviation Administration (FAA).

Most of the Aeronautical Enroute frequencies used at airports provide both enroute aircraft communications and on the ground radio coverage. Many provide FAA pre-departure communications such as clearance delivery and the current ATIS information before the aircraft can safely depart. All company messages such as weight and balance, gate assignments, maintenance problems, special passenger requirements and security messages also pass over these frequencies both from the local airline office and the airline's operations and dispatch centers. In order to meet the requirements for providing these communications, radio sites must be located on or near the terminal gates and areas in which the aircraft operate. In addition, aircraft antennas normally used for operational control communications are mounted on the aircraft belly making communications difficult when the aircraft is parked at the gate unless the base station antennas are near the gate areas. Due to the many operators and networks at some airports, many radios and antennas are often required by airport authorities to be located within a small area. The co-location of radio station installations in common areas can present interference, reliability and coverage problems. The locations of FAA and other airport radios and communications systems can also be a factor when installing new radios.

The purpose of these installation guidelines is to help prevent and mitigate these interference problems while still meeting regulatory and industry standards.

The references below provide for a more comprehensive understanding of the industry agreed upon policies and procedures. These policies should be understood before any new stations are installed. Additionally, consideration should be given during the design phase for any new airport construction or modification to maintain interference free and reliable VHF air/ground systems. Listed below are normal requirements to maintain a legal and interference free environment:

- All VHF radio stations must be licensed by the FCC (Aeronautical Enroute Stations are normally coordinated and licensed through ASRI).
- All aeronautical ground radios should be FCC Type Accepted equipment. Avoid using aircraft radios in ground based installations as these radios are not normally acceptable to the FCC for ground installations.
- All transmitters must have a label on the front indicating their operating frequency.
- Radios must be located in secure areas or cabinets and should be protected from moisture and excessive heat.
- The more space between VHF air ground radio antennas the better. Sixty feet should be considered the minimum acceptable. This distance allows enough isolation for most current production transceivers. The use of cavity filters may be required if the distance cannot be maintained or when using older equipment or for closely spaced frequencies.
- Antennas should be located to allow for the maximum line-of-sight use for approaching and departing aircraft - no obstructing buildings, towers, terrain, etc.
- Antenna installation should use only approved mounts, hardware and be properly grounded to the roof top lightning protection system.
- Tag each antenna with call sign, frequency and owner contact information. This step makes future installation surveys easier and avoids potential interference. Use weatherproof tags.
- Good quality coax or heliax transmission line should be used. Consideration for signal loss and signal leakage must be given. Example: LMR-400 coax for runs up to 60 feet, LDF4 heliax for runs up to 100 feet. Avoid transmission line runs any longer then 100 feet.
- Use good quality transmission line connectors. Avoid connectors that use ferrous metals (i.e. nickel plated iron/steel) since they will corrode and could be the cause of later interference.
- The indoor connection should terminate at an approved lightning surge suppression device.
- All spare transmission lines that are installed for future use should be terminated into a 50 ohm load, labeled and weatherproofed.
- Decommissioned antennas and transmission lines should be removed.
- Radios and equipment racks should be properly grounded to the building earth ground system.
- Radios that interface to remote locations should have proper surge protection on the telephone interface lines.
- Radios used in the aeronautical service should use the minimum power needed to accomplish the mission. Normally, use 25 watts or less for enroute networked radios and 10 watts or less for on-ground or local use radios does the job.
- Bandpass cavity filters to provide additional isolation between radio systems should be used when warranted. Notch type cavity filters can be used in extreme cases.
- Many requirements for VHF radio installations also apply to airport UHF Business Radio installations.

References:

1. FCC: 47 CFR-Telecommunications, Part 87-Aviation Services, Subpart I-Aeronautical Enroute and Aeronautical Fixed Stations
2. FAA: Federal Aviation Regulations Part 1, 91, 119, 121, and 135.
3. The Aeronautical Frequency Committee (AFC) Manual, Chapter 3 and Appendix 6.
4. The Aviation Spectrum Resources, Inc. Aeronautical Ground Station Manual

For copies of the references or for any questions on this handout, please contact Aviation Spectrum Resources, Inc. (ASRI) at 410-266-4800 or at info@asri.aero. Also see our web site at www.asri.aero

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1 Introduction

These guidelines provide direction and recommendations for the installation of aviation VHF Ground Stations that are licensed by Aviation Spectrum Resources, Inc. (ASRI) in the Aeronautical Enroute bands. The guidelines are intended to help installers minimize the possibility of mutual RF interference when co-locating radio systems.

Generally, the most recent licensee deployed at a location is responsible for mitigating interference caused by the addition of their system, assuming incumbent systems meet these installation standards and generally accepted practices. This may include, but is not limited to, the purchase and installation of cavity filters on other tenant's systems. The standards herein have been developed in an attempt to minimize such situations.

1.1 Frequency Management (Pre-Installation/Site Survey):

- Identify all existing co-located base stations. A co-located base station is defined as any base station that operates on an antenna within 200 feet of the proposed antenna location.
- Determine the distance between all co-located antennas relative to the proposed antenna and record the results. Use maximum antenna separation to provide the greatest transmitter isolation with co-located base stations, minimizing the risk of transmitter intermodulation (IM).
- Identify the operating frequency of these co-located stations and correlate them to the antenna distances above.
- Conduct an intermodulation study on all frequencies located within 200 feet of the station being installed. The study should identify all 3^{rd} and 5^{th} order products that fall within the Aeronautical Frequency band. Consult with ASRI to determine if these frequencies are in use at this location. If they are, coordination with the using agencies should be done.

1.2 Antennas:

- The antenna should be installed using a vendor approved mount only.
- The antenna mount and ancillary hardware should be either stainless steel or hot-dipped galvanized steel only.
- The connection between the antenna and the transmission line (and all other RF connections external to the building) must be weather proofed.
- All decommissioned and unused antennas should be removed from the site.
- Typically base station antennas are assumed to be omni-directional with unity gain (2.15 dBi)

1.3 Transmission lines:

- All outdoor transmission lines shall be of the solid outer conductor type. Good quality cable should be used. Examples are Heliax or LMR series type.
- Transmission lines that are in excess of 60’ in length external to the building or shelter must be grounded within 2’ of the antenna connection using a vendor approved grounding kit and connected to the building grounding system. The grounding kit must be weather proofed after installation using butyl rubber or vulcanizing tape; either of which should then be encapsulated with electrical tape.
- All transmission lines must be grounded within the building or shelter using a vendor approved grounding kit bonded to earth ground.
- All transmission lines must be terminated with a vendor approved connector. It is highly recommended that connectors using ferrous metals (i.e. nickel plated iron/steel) not be used due to corrosion and them being a possible source of Passive Intermodulation.
- The indoor connector should terminate at an approved surge suppression device (Polyphaser).
- All transmission lines should be labeled at the following locations: at the antenna, at the building penetration and at the radio (or cavity). The labels shall indicate the owner and the transmission frequency. All labels shall be installed on the transmission line in a manner/location that is visible from common areas (one should not be required to open cabinets or racks to find the labels).
- All “spare” transmission lines that are installed for future use/maintenance (or decommissioned) should be properly terminated with a 50 ohm load on at least one end , properly weatherproofed and marked.
- All transmission lines used between indoor equipment (commonly referred to as jumpers) should be of the double shielded coaxial type (RG-223, RG-393, RG-142, etc)

1.4 Rack/Equipment:

- All radio equipment must be FCC type accepted.
- Normally use 25 watts or less for enroute stations and 10 watts or less for in-range or local use radios.
- All radios should be installed in secure cabinets or be in secure areas.
- Radios should be in areas protected from excessive heat and moisture.
- All equipment racks are to be properly grounded to the building earth ground system.
- All equipment that has provisions for an external earth ground should be connected to the building system ground.
- All equipment should be secured in the rack using the vendor recommended mounts and fasteners.
- All transmitters must be labeled with the operating frequency on their face.

1.5 TELCO:

- For installations in remote locations not serviced directly by an airport telecommunications room, it is recommended that surge protection be installed on all telco lines.

1.6 RF Isolation (transmitter IM prevention):

In general, to minimize the possible occurrence of IM interference, use antenna spacing to obtain a nominal RF isolation of 45 dB for each system from all other transmitters. This is achieved with 25’ of vertical separation between antennas in the aviation VHF band. If vertical separation is not an option, then 60’ of horizontal separation will provide approximately 30 dB of isolation.

The following approach should be used for installations in moderate to high density RF locations, when additional isolation is required.

- Maximize antenna separation between co-located base stations and determine the free-space loss between each existing antenna and the proposed antenna location.
- Using the TnRd curves for the specified radios, determine what the required isolation values are for both the transmitter noise and transmitter carrier.

- Some guidelines are provided below based on the Motorola VHF Quantar 100 Watt VHF station transmitter sideband noise specifications and adjacent channel rejection ratio for the receiver curves
  - A transmitter to receiver separation of 0.2MHz to 1 MHz requires 73dB + 6dB margin = 79dB transmitter noise filtering to not have transmitter noise above the –123dBm Noise floor of the receiver. At 2MHz, 76dB is required, at 3MHz, 75dB is required and at 5 MHz, 71dB is required.
  - A transmitter to receiver separation of 0.2MHz to 2 MHz requires 66dB = 6dB margin = 72dB transmitter carrier filtering to prevent a single 100 Watt transmitter from degrading the receiver sensitivity. At 5MHz separation, 69dB is required.
- If the transmitters have a single stage isolator built into them, the use of an external isolator on the transmitter multicoupler is not required when there is at least 45dB filter isolation between transmitters on the same antenna.
- Choose appropriate equipment to meet the required isolation values. For example, the use of C2037 as transmitter combiners at 3.2dB insertion loss will provide 15dB isolation at 150 KHz and 45dB at 300 KHz. At 1.7 dB insertion loss, these values are achieved at 250 and 650 KHz respectively. When set to 3.2dB insertion loss, the receiver frequencies can be as close a 1.3 MHz away on the same antenna or 0.4 MHz on separated antennas to achieve 79dB isolation.
- Increase the transmitter conversion efficiency (IM attenuation). The only effective way to achieve this is to consider replacing the transmitter with a transmitter that has better performance characteristics. Therefore, this should be considered a last resort.

2 Interference Identification, and Elimination

As the proliferation of VHF air to ground base radios continues, the incidence of radio interference (RFI) is increasing. Identifying the source of the interference often can be very difficult. Sometimes the source of the interference is the sufferer's own equipment.

2.1 Technical Terms and Their Meanings Related to Interference

2.1.1 Intermodulation

Intermodulation (IM) or intermodulation distortion (IMD) is a frequency conversion process that occurs when two or more signals pass through a non-linear system or device(s)/component(s) within a system. The essential result of the process is that energy contained in the input signal of a non-linear system is transformed at its output into a set of frequency components at the original frequencies plus additional components at new frequencies that were not contained in the input. The IM phenomenon is often referred to as mixing.

For example, consider a signal composed of two fundamental tones f_1 and f_2 that could represent two transmitter signals co-located at a communications site. If this composite signal is passed through a non-linear device (of third-order), the most general form of the output signal will contain frequency components at dc, f_1, f_2, second-order products and harmonics as well as the third-order products at $2f_1 - f_2$, $2f_2 - f_1$. These last products are often troublesome because they fall closest to the original tones at f_1 and f_2. It is possible that the newly generated third-order products could fall close to or within the receive band of a communication system located at the same site, which could degrade the performance of the receiver.

As another example, consider the same two tones at f_1 and f_2 passing through a stronger non-linear device of fifth-order. The set of most potentially troublesome IM products that can be produced by a fifth-order non-linear system would fall at the frequencies

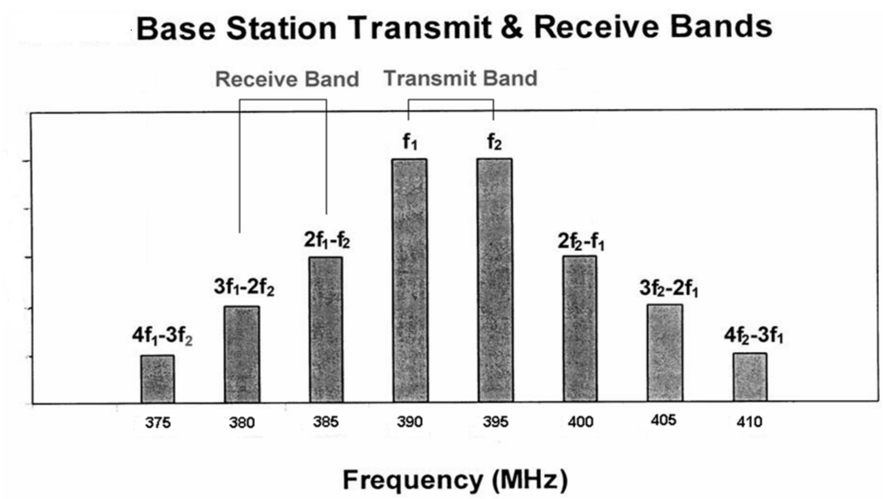
$2f_1 - f_2$, $2f_2 - f_1$, third-order products,
$3f_1 - 2f_2$, $3f_2 - 2f_1$, fifth-order products.

Note that the order of the non-linearity is determined by the sum of the coefficients. If the non-linearity were stronger still (such as a seventh-order), it would have an output containing the following most potential interfering carriers

$2f_1 - f_2$, $2f_2 - f_1$, third-order products,
$3f_1 - 2f_2$, $3f_2 - 2f_1$, fifth-order products,
$4f_1 - 3f_2$, $4f_2 - 3f_1$, seventh-order products.

With respect to the original tones at f_1 and f_2, the third-order components are closest, the fifth-order are the next closest and the seventh-order are furthest removed but still 'close' to f_1 and f_2. This pattern continues for devices of increasing non-linear severity.

When more than two tones of sufficient strength are present at a site, the generated IM products will consist of the set of tones occurring at all linear combinations of the original tones (up to the order of the non-linearity). Some of these IM tones will be potentially threatening to system performance, with the exact threat being dependent upon the particular frequencies and bandwidths of the receivers present at the site.



The third order-difference intermodulation products generated by two sources are usually the most serious due to the fact that they fall within the same aeronautical band: 2F1-F2 and 2F2-F1. Fifth order products 3F1-2F2 and 3F2-2F1 also fall within the same band but are normally much less amplitude. For example if F1 equaled 130.4 MHz and F2 equaled 130.6 MHz the following products could be generated:

130.2 MHz, 130.8 MHz (3^{rd} order)
130.0 MHz, 131.0 MHz (5^{th} order)

Note: For transmitters, the European Telecommunications Standards Institute (ETSI) EN 300 676 Standard, section 7.8, defines a test method and specifies limits for intermodulation attenuation caused by the presence of the carrier and an interference signal entering the transmitter via the antenna. This test method is a good way to determine any deficiencies in transmitter design. Any modern equipment should be able to exceed the specified limit. See Section 2.3 "Calculating Transmitter Intermodulation Susceptibility".

2.1.2 Blocking or Desensitization

Blocking or desensitization results when a strong unwanted signal at the receiver input causes a change in the desired signal level. This unwanted signal can effectively “block” the desired signal, thus the term. ETSI EN 300 676 section 8.9 defines a test method and specifies limits for the blocking ratio. The limit specified for a base station, shall not be less than 80 dB. Modern VHF base station receivers should be 10 to 20 dB’s above the ETSI limit.

2.1.3 Spurious Emissions

Spurious emissions are any emissions from a transmitter which are not part of the theoretical output. Any radiation from a receiver (normally local oscillator leakage) is spurious. Section 87.139 of the FCC rules specifies the limits associated with this measurement for type acceptance. ETSI EN 300 676 section 7.5, 7.6 and 7.7 defines a test method and specifies limits for these emissions but also includes near in noise and adjacent channel power limits. ETSI EN 300 676 section 8.10 defines spurious radiation related to the receiver.

2.1.4 Cross Modulation

Cross modulation in regard to receiver operation is related to the transfer of modulation to the desired signal from a strong adjacent transmitter. Unlike “blocking or desensitization” where the undesired signal attenuates the desired signal cross modulation appears along with the desired signal. Common cases of this are due to receiver front end design and “local oscillator” noise allowing the mix to take place. This mix can be from the synthesizer noise floor of either the transmitter or receiver.

2.2 Reducing Interference Related to Airport Installations

Interference is normally related to intermodulation, blocking or desensitization, spurious emissions and/or cross modulation due to transmitters too closely coupled to receivers. To resolve this we need to add attenuation between those transmitters or receivers by increasing separation distance or by additional filtering. Additionally, the design of the equipment plays a major role as to how well the equipment will play together.

A quick way to determine if the intermodulation is being generated within the receiver front end is to add a small attenuator in the path. If the interference drops by other than the value of the attenuator, the interference is caused by the receiver. Example a 3 dB attenuator caused a 9 dB reduction of the interference level. This also applies when using a Spectrum Analyzer to determine if the test is valid. If the interference drops by the amount of the attenuator then the problem is external (most likely coupling between two other transmitters).

2.2.1 Space or Path Attenuation

The approximate straight line path attenuation space to radio waves is given by the formula

L = 36.58 + 20 Log F +20 Log D
L = path loss in decibels,
F = Frequency in MHz
D = distance between points in statute miles

Using the above formula at aeronautical VHF:

60 feet is equal to 40 dB path loss
(This relationship is important to remember)

200 miles is equal to 125 dB path loss
(For a 20 watt ground transmitter an aircraft receiver 200 miles away would have a signal level -82 dBm)

If we double the distance we increase the path loss by 6 dB. If we halve the distance we decrease the path loss by 6 dB. The following table might make this clear:

15 feet is equal to 28 dB path loss
30 feet is equal to 34 dB path loss
60 feet is equal to 40 dB path loss
120 feet is equal to 46 dB path loss
240 feet is equal to 52 dB path loss
480 feet is equal to 58 dB path loss – and so on

An example of how this applies with some older equipment is using two Wulfsberg WCS-100 transceivers that both transmit at 43 dBm (20 watts), would present +3 dBm to the other receiver if we had 60 feet between the individual antennas. Knowing the receiver characteristics, it would require almost 1.0 MHz difference in frequency for co-existence with no degradation. The Wulfsberg's performance has been the benchmark for many years.

Most experts agree that the use of as much space as possible between base station antennas provides the most effective insurance against interference. A properly designed vertically stacked antenna can provide almost 40 dB of isolation (the patterns are within their nulls). This can provide an alternative when horizontal spacing doesn't permit.

Additionally the selection of the individual frequencies to co-locate plays an important role (keep close-in frequencies as far apart as possible).

2.2.2 Cavity Filters

The use of bandpass and notch cavity filters can provide the additional electrical space to allow transmitters and receivers to co-exist when physical space can not be achieved. The disadvantage of cavity filters is their size, cost and insertion loss. At times more then one filter is needed in each antenna path to achieve the necessary isolation to avoid harmful interference.

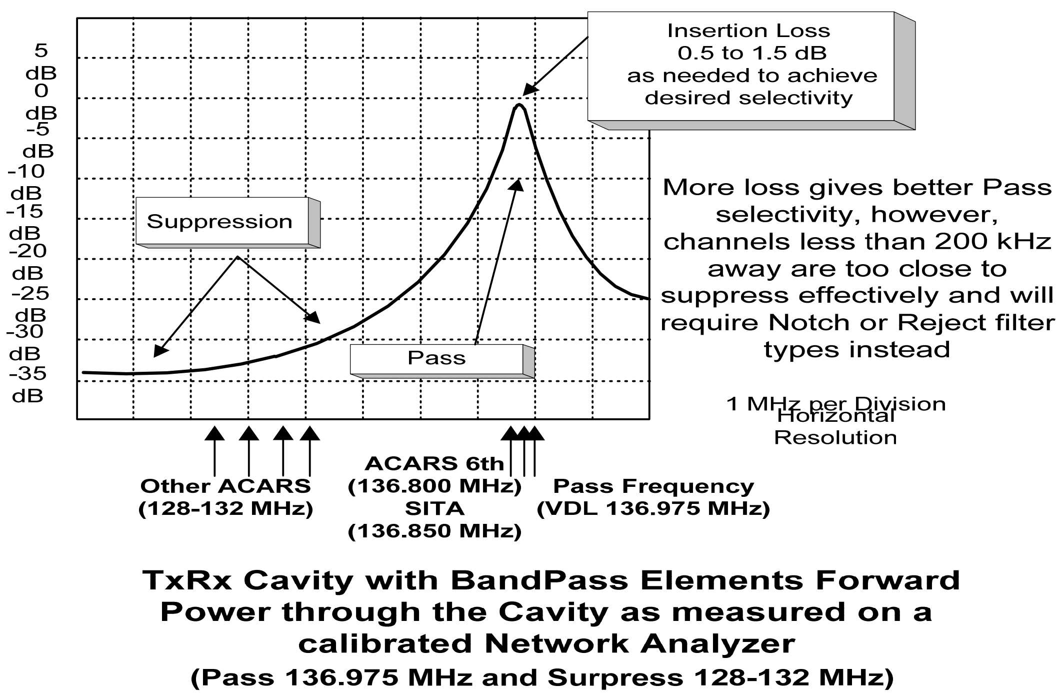


Figure 2-1: Cavity Filter with BandPass Elements

As can be seen in figure 2-1 a single bandpass cavity can provide almost 35 dB additional isolation when the frequencies you want to protect are a number of MHz away. Cascading filters can be used to improve filter action. The summation effect is greater than just adding the results of the two cavities together.

The use of notch filters can greatly improve two close-in frequencies. At times cascading a notch with a bandpass is necessary. The major disadvantage other than size and cost is that a notch needs to be inserted in the antenna line for every close-in frequency (station) you need to protect. Using a notch on the closest frequency and bandpass to protect far away frequencies is used when physical space can not be achieved.

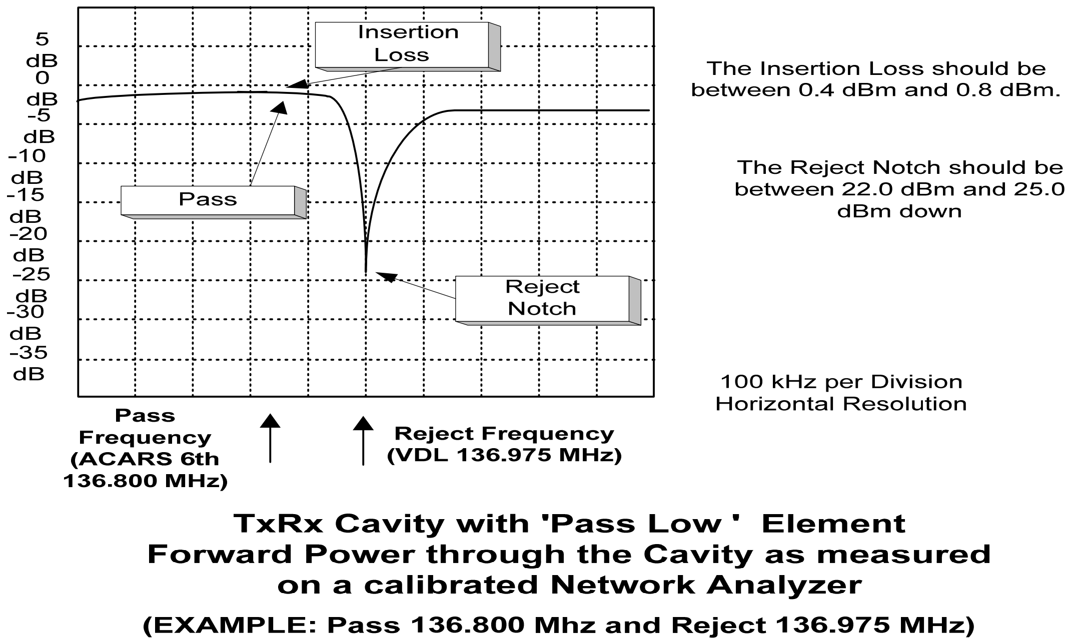


Figure 2-2: Cavity Filter with 'Pass Low' Element

As can be seen in figure 2-2 a single notch cavity filter can provide 25 dB of additional isolation when two stations are only 200 kHz apart. It also shows that the protection is limited to the one frequency of interest.

2.2.3 Ferrite Isolators

Ferrite isolators are commonly used in transmitter combiners in conjunction with cavity filters. They operate by allowing RF energy to pass effectively in one direction and attenuate the return path to the transmitter. When applied to a single station transceiver the complexity of switching the device in the transmitter path and out of the receive path becomes a problem. Additionally, the failure mode of this device is such that it is the cause of interference when the transmitter would operate fine without. These devices are costly to provide and are only used when there is no other solution.

2.2.4 Crystal Filters

Crystal filters are an effective way to improve the performance of receivers where the intermodulation is generated within the receiver. This also helps reduce blocking, desensitization, and cross modulation effects to the protected receiver. Some disadvantages are:

- Their very high cost.
- Approximate 5 dB additional path loss
- They need to be inserted in the receive path only (difficult with some transceivers)
- They are physically fragile
- Easily damaged from nearby lightning strikes.

2.2.5 Antenna Gain

At 400 miles the signal from a VHF ground station would only have a path loss in free space of 131 dB. This would equate to a signal level at the aircraft of -88 dBm if a line of sight condition existed from a 20 watt transmitter. This clearly shows that we are limited by the line of sight and not path loss. Using gain antennas when not necessary can contribute to the interference to nearby stations. The exception to this statement relates to extended range stations that operate far away from other ground stations.

2.2.6 Frequency Change

Frequency change as a solution to an interference problem should only be done when all other possible solutions have been tried and found to be inadequate. Since there are so many "networked frequencies" this option can be extremely costly since it would also affect stations not located near the interference and the change itself could cause additional interference problems.

2.3 Calculating Transmitter Intermodulation Susceptibility

Intermodulation attenuation is the capability of a transmitter to avoid the generation of signals in the non-linear elements caused by the presence of the carrier and an interfering signal entering the transmitter via the antenna.

It is specified as the ratio, in dB, of the power level of the third order intermodulation product to the carrier power level. The test is performed with 30 dB of isolation between the test transmitters.

ETSI EN 300 676 section 7.8 defines a test method and sets a limit of 40 dB below the carrier power level. Most modern transmitters meet or exceed the specified level. Some of the older transmitters fall short of the specified level.

Below are two examples that identify when additional space isolation is necessary between two transmitters with their antennas in close proximity. Normally this space isolation can be obtained by the addition of cavity filters on the offending transmitter. It can also be determined when it’s not necessary to add a cavity filter even though there is a receiver nearby and a mathematical third order product has been identified.

2.3.1 Example 1:

Transmitter ‘A’ - 130.4 MHz, 20 watts (+43 dBm), 60 dB IM attenuation
Transmitter ‘B’ - 131.0 MHz, 7 watts (+38.5 dBm), 40 dB IM attenuation
Physical space between transmitter antennas equals 60 feet (40 dB isolation)

40 dB space minus 30 dB test isolation equals 10 dB additional IM attenuation. Now transmitter ‘A’ has 70 dB and transmitter ‘B’ has 50 dB IM attenuation under this installation.

Third order products –
2F1 - F2 = 129.8 MHz (mostly from transmitter ‘A’)
2F2 - F1 = 131.6 MHz (mostly from transmitter ‘B”)

Checking the airport database identifies stations nearby on both of these frequencies.
129.8 MHz is 1000 feet away (64 dB of path attenuation) identified as ‘C’
131.6 MHz is 2000 feet away (70 dB of path attenuation) identified as ‘D”

Transmitter ‘A’ to station ‘C’
+43 dBm – 70 dB = -27 dBm on 129.8 MHz from antenna ‘A’
-27 dBm – 64 dB (path loss) = -91 dBm signal level at station ‘C’

Transmitter ‘B’ to station ‘D’
+38.5 dBm – 50 dB = -11.5 dBM on 131.6 MHz from antenna ‘B’
-11.5 dBm – 70 dB (path loss) = -81.5 dBm signal level at station ‘D’

This clearly identifies that approximately 10 dB additional isolation is necessary from transmitter ‘A’ and 20 dB additional isolation is necessary from transmitter 'B'.

3 Conclusion

Understanding the transmitter, receiver and transceiver performance related to the interference susceptibility is necessary for co-locating equipment. Test methods like ETSI EN 300 676 are a good start to insure interference free installations and understanding the limitations involved with co-locating equipment. Using the lowest power necessary to achieve communications is a good way to work together. Airports should allow the different airlines their own antenna space, thereby limiting the interference potential to other users. Coordination between the users is also necessary to identify and fix interference issues.

Airports should refrain from designing/building antenna farms which condense or co-locate users to small physical areas, greatly increasing the potential for harmful interference.

For Further Information

For further information and guidance, contact Aviation Spectrum Resources, Inc. (ASRI) as follows:

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ETSI Reference Document Ordering Information

Website to order ETSI Reference Document: www.webstore.ansi.org

Document Number: ETSI EN 300 676-v1.2.1-2000-05

Current Price (NOV07): $38.00

Document Title: Electromagnetic compatibility and Radio spectrum Matters (ERM) - Ground-based VHF hand-held, mobile and fixed radio transmitters, receivers and transceivers for the VHF aeronautical mobile service using amplitude modulation; - Technical characteristics and methods of measurement

Document Description: International standard for ground based radio equipment used in aeronautical VHF communication systems employing double sideband amplitude modulation and 8,33 kHz channel spacing. The civil aeronautical authorities wish to apply this standard in the European air space.