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CUTTING THROUGH... VARIOUS SOLUTIONS TO INTERFERENCE

94.7 FM STE MEM1 96.5

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This information is available in a series of brochures, a videocassette and a CD-ROM. The Industry Canada Internet site http://strategis.ic.gc.ca, under the heading *Marketplace Services* includes useful information and advice for solving interference problems.

Aussi disponible en français.

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CUTTING THROUGH...VARIOUS SOLUTIONS TO INTERFERENCE

Radio and television signals can be distributed and transmitted in various ways. To ensure good reception, here are some methods to solve interference problems.

ANTENNAS

Because an antenna is designed for a specific use, it has limited potential. It is essential to choose the proper antenna.

1. Ensure that you are using the proper type of antenna.

2. Check that it is properly installed and in good working order.

In all cases, to ensure good signal reception, the antenna must be properly connected to the receiver terminals.

A simple visual inspection of the antenna or the antenna lead wire may reveal a problem. A new antenna or additional filters may be necessary. A clearer picture is obtained when you use an antenna that's capable of supplying a stronger signal to the television receiver from the desired transmitter.

■ Which antenna should I choose?

Indoor antennas

■ **For television**, the most common VHF antenna is rabbit ears that can pick up channels 2 to 13. The UHF antenna, typically a loop, in turn picks up channels 14 to 69. These antennas are effective within a radius of 15 kilometres of the transmission tower. Reception may be less than perfect if buildings or other obstacles block the signals. These types of antennas often must be moved to obtain better pictures. For the VHF channels, in addition to moving the antenna, changing the length of its telescoping sections by sliding them in and out may improve reception. When the channel is changed, however, the whole process often must be repeated.

■ **Many AM and FM radios** have built-in antennas.

For AM radios, the antenna installed inside the case is normally a length of wire formed into a loop, or a length of wire coiled around a ferrite core.

FM radios are equipped with an antenna visible outside the case, similar to rabbit ears or a dipole, consisting of flat wire or ribbon wire attached to the wall or the back of the stereo system.

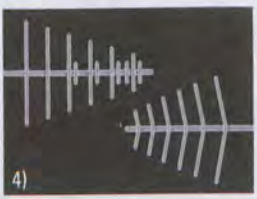
Personal portable FM radios use the headphone wires instead.

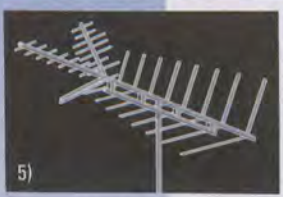
All these antennas offer the advantage of being directional. The orientation of the antenna or radio contributes to better reception. Move the radio or antenna into different positions to find which one produces the best signal quality. You may have to change the position again if you switch to another station. However, you may be able to find a compromise between all these positions that will allow you to listen to most of the desired stations.

Some antennas may be sold with a built-in signal booster. Before you buy one, check whether you really need it, because when transmitter antennas are close by, the signal booster tends to get overloaded by very strong undesirable signals.

Outdoor antennas

Outdoor antennas take several forms: 1) parabolic dish, 2) dipole antenna, 3) single-channel unidirectional antenna, 4) multichannel VHF or high-gain Yagi antenna, 5) VHF/UHF/FM antenna, 6) UHF reflector antenna, 7) rear-screen model and 8) antennas with a built-in signal booster.





Outdoor antennas are generally larger and more effective than indoor antennas. In general, the higher the antenna and the more metal rods it has to pick up the signal, the more effective it is. It is important to choose an antenna on the basis of where it will be located in relation to the transmitter, and which channels you wish to pick up.

Always point the smallest elements toward the desired station. If you have a V antenna, point the open end of the V toward the station.

For AM radio, the most common outdoor antenna is the long-wire antenna. It consists of a long length of wire stretched between insulators on two outdoor poles or trees.

■ Pointing the antenna

Antennas are often pointed in the wrong direction. Although a mis-pointed antenna can pick up useful signals, unfortunately they can only be weaker.

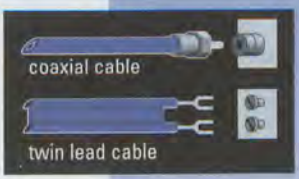
NOTE! Wind can change the orientation of an antenna.

Occasionally, some obstacles block the arrival of desired signals. Reception is sometimes better if the antenna is not pointed directly at the station broadcasting these signals.

■ An adequate installation

The antenna mast or tower must include a connection of 10-gauge, or larger, copper or aluminum wire connected to a metal rod anchored in the ground. This lightning protection installation will conduct any electrical charge that strikes the antenna into the ground. Protection against lightning strikes is particularly important for high antennas and remote locations.

A good antenna lead wire will securely connect the antenna to the television. There are two types on the market: twin lead wire and coaxial cable. The latter is used most often, because it provides better protection against interference.



Cable television requires the use of coaxial cable.

Do not hesitate to consult a professional installer, because antennas and antenna lead wires are the source of many interference problems.

And don't forget to disconnect your rabbit ears if you are using an outdoor antenna or if you subscribe to cable!

■ Check the antenna and the antenna lead wire

Beware of corrosion! It reduces the effectiveness of antennas. Corrosion can be especially serious in coastal regions where the humid air contains salt. Antennas near industrialized areas also suffer from corrosion. A layer of alumina forms over time on aluminum antennas and ultimately reduces the level of signals to the television.

The antenna lead wire can also become so deteriorated that the two wires cause a short circuit. In this case, the antenna lead wire will have to be replaced.

SIGNAL BOOSTERS

Do you still have poor reception?

Perhaps a signal booster is needed. This small, inexpensive device is attached to the antenna and must be compatible with the type of antenna lead wire used.

It may be built into certain outdoor or indoor antennas. Check your antenna before buying a signal booster.

This device boosts the signal picked up by the antenna and can improve reception quality considerably. On the other hand, it may be sensitive to other transmitter signals in the area and affect the reception quality on your television set.

INSTALLATION AND MAINTENANCE SUMMARY

1. Check the type and condition of the antenna

A damaged, bent or corroded antenna will not pick up signals as effectively.

2. Check antenna orientation

A mispointed antenna does not pick up signals well. The smallest elements must be turned toward the desired station. If the antenna is V-shaped, point the open end of the V in the desired direction.

You should still turn the antenna in various directions to determine which position provides the best reception.

3. Check the condition of the antenna lead wire

With time, antenna lead wires can become brittle and corroded; water can infiltrate and cause a short circuit.

4. Check for corroded terminals

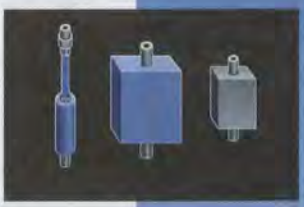
Corroded terminals contribute to interference.

5. Check that the signal booster and splitter boxes are working properly

It is important that these be compatible with the channels you wish to pick up.

CAUTION! Be very careful of electrical wires around the house when making your checks. Better yet, call in a qualified professional.

FILTERS



Various types of filters available on the market are effective in eliminating interference on the television, VCR or radio. Interference caused by radio transmitters can be eliminated by installing certain filters at outlets or along certain wires, but often this requires proceeding by trial and error.

When selecting the proper filter, it is helpful to know what frequency the interfering device operates on. We have included this information in appendices 1 to 3 to help you make the best choice.

Here are the most commonly used filters.

- **high-pass filter**: this filter is installed on the terminals on the back of the television. It reduces or eliminates interference from GRS transmitters (better known as CB radios), from amateur radio transmitters and from industrial, scientific or medical equipment.
- **notch filter**: this filter is installed on the terminals on the back of the television or radio. It reduces or eliminates particular unwanted signals that the high-pass filter cannot screen out. Some notch filters are designed specifically to counter FM band signals that can interfere with signals on the television set. This filter is also effective on some radio frequency bands when interference is caused by an adjacent station that is too powerful or when a transmitter located

nearby causes radio interference. FM band notch filters are sometimes built into signal boosters.

- **band-pass filter**: this filter is installed on the terminals on the back of the television. It allows desired signals to pass while rejecting others.

■ Installation

For television, the first step is to install a high-pass filter, available in certain specialty stores. These small devices, with two connections, are installed on the terminals on the back of a television set.

High-pass filters can also be installed on the back of the VCR or in front of the signal booster. When an antenna with a built-in signal booster is used, the installation of a high-pass filter can be more complicated.

1. Identify the type of wire so you can buy the proper filter.

coaxial cable: This is a round cable that requires a filter with an impedance of 75 ohms.

twin lead wire: This wire requires a filter with an impedance of 300 ohms.

2. Buy the right high-pass filter.

You can identify the type of high-pass filter required by means of the terminals on the back of the television set. The filter impedance is usually indicated on the product label.

3. Read the instructions carefully.

Install the filter in accordance with the instructions. It must be installed on the back of the television, as close as possible to the antenna terminals.

4. Contact your cable television company.

Even if you subscribe to cable television, you can still install a filter. However, contact your cable television company, and NEVER try to change the cable installation by yourself.

5. Install the filter.

a. Disconnect the antenna lead wire from the terminals on the television or VCR.

b. Connect the antenna lead wire to the filter input terminals.

c. For twin lead wire, connect a 5 cm long jumper wire between the television terminals and the filter. Coaxial cable normally comes complete with a short length of cable.

d. If the antenna system includes a booster, the filter must be installed ahead of the booster, as close to it as possible; the installation of another filter before the television terminals may also be necessary. However, if the booster is fairly close to the receiver, only the filter installed ahead of the booster will be needed.

e. The jumper wires between the filter and the booster, and between the booster and the television terminals, should be as short as possible.

f. In the instructions supplied with the filter, the installation of a ground may be required. The wire should be as short as possible and should be connected between the ground connection on the high-pass filter and a metal cold-water pipe or metal rod anchored in the ground. Use a 10-gauge, or larger, copper or aluminum wire.

g. Do you still have interference after installing a high-pass filter? A technician should install a high-pass filter inside the television, on the tuner input terminals.

CAUTION! All modifications inside your television set must be made only by a qualified technician.

■ Homemade solution

When you know the frequency of the interference signal, a homemade solution is possible. When the signal from an adjacent television signal is too strong, or interference is caused by a transmitter in the area, a notch filter can be installed between the terminals on your television and the antenna. Such a filter can be made using pieces of wire identical to that of the antenna lead wire. Although it may not be as effective as a commercial filter, this homemade filter, known as a quarter-wave tuned stub, is satisfactory in some instances. To find out more about this homemade solution, which requires some technical knowledge, turn to Appendix 4 at the end of this brochure.

To install notch or band-pass filters, do not hesitate to consult a specialist.

Isolation transformer

Sometimes, certain interference signals can move over the braided shield of a coaxial cable. To eliminate this interference, install two 75 to 300 ohm impedance matching transformers on the back of the television, connecting together the 300 ohm ends. Connect one of the 75 ohm ends to the antenna cable and the other to the television terminals.

SHIELDING

In the case of audio rectification, when one of the components or wires in the equipment is acting as an antenna and picking up unwanted signals, various types of shielding or shielded cable are often required to block these signals from the various entry points. Power cords, turntable cartridges, tape deck heads or speaker wires are often the source of the problem. A selection of effective shielding products is available in certain specialty stores.

In the case of audio equipment, to determine whether the power cord is the source of the interference simply unplug it for a brief time and check whether the interference persists. During this time, the equipment should continue operating for a few moments; and if the interference is still present, the equipment is the problem. If the interference stops immediately, the problem may be in the power cable. Here is how to eliminate these interference signals.

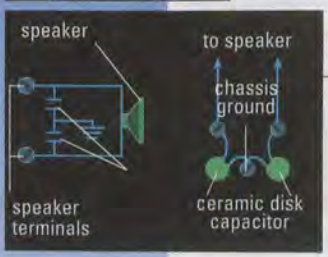
- Remove all extension cords.
- Wind the power cord around an induction coil to block the unwanted signal. A ferrite core is very effective.

- Install a commercially available plug-in filter.

Speaker wires

Speaker wires are one of the main entry points for interference on a stereo system. Like an antenna, these wires can pick up radio signals and couple them to the amplifier.

- Eliminate any excessive length of speaker wires.
- If the interference persists, replace the wires with shielded audio cable.



- A specially designed filter for audio circuits can also be installed between the terminals and speakers.
- You can also coil unshielded wire around a ferrite core or install a bypass capacitors on the speaker terminals.

Interconnecting wires

Interconnecting wires are also good at picking up interference. These wires are found between components of a stereo system and must be as short as possible.

- Replace long cords with shorter ones.
- Coil up excess lengths of cord and firmly wrap them with adhesive tape, creating a good homemade filter.
- Check that these wires are in good condition and have not corroded.
- Replace the wires with properly shielded cable or use ferrite beads.
- Ensure that each device is properly grounded.

NOTE! Before purchasing these filters, ensure that they can be returned for a refund if they do not solve the problems.

Equipment

A difficult case! You must proceed by trial and error. Disconnect all pieces of equipment connected to the affected system and reconnect them one by one until the interference resumes. You may then have to replace the unshielded input wires with shielded wires. Review the "interconnection wires" step for this operation. If the problem persists, you are probably having direct pickup interference by the internal circuits requiring it to be repaired or replaced.

Audio rectification

This is one of the hardest forms of interference to eliminate, because it may require shielding, filtering or grounding. If your equipment is still under warranty, take it to the manufacturer or the manufacturer's authorized representative. If not, call in a qualified technician.

APPENDIX 1

ASSIGNMENT OF FREQUENCIES FROM 30 kHz TO 300,000 MHz

Band	Assignment
30-535 kHz	Includes maritime communications and navigation, international fixed public band, aeronautical radio navigation
535-1,705 kHz	Standard AM band broadcasting
1,705 kHz-30 MHz	Includes amateur radio, LORAN, government radiocommunications, international shortwave broadcasting, fixed and mobile communications, radionavigation, as well as industrial, scientific and medical equipment
26.965 to 27.405 MHz	General Radio Service (CB radio)
30-50 MHz	Government and non-government communications, fixed and mobile
50-54 MHz	Amateur radio
54-72 MHz	Television channels 2 to 4
72-76 MHz	Government and non-government services, fixed and mobile
76-88 MHz	Television channels 5 and 6
88-108 MHz	FM radio
108-137 MHz	Aeronautical navigation
137-174 MHz	Government and non-government communications, fixed and mobile, amateur
174-216 MHz	Television channels 7 to 13
216-470 MHz	Amateur radio, government and non-government communications, fixed and mobile, air traffic radionavigation
470-608 MHz	Television channels 14 to 36
608-614 MHz	Radio astronomy, mobile
614-806 MHz	Television channels 38 to 69

806-3,000 MHz	Aeronautical radionavigation, amateur radio, transmitter-studio links, government and non-government communications, fixed and mobile, television broadcasting, digital audio broadcasting
3,000-30,000 MHz	Government and non-government communications, fixed and mobile, amateur, radionavigation, direct-to-home satellite broadcasting
30,000-300,000 MHz	Experimental, government, amateur, fixed

APPENDIX 2

Television channel frequencies

Channel number	MHz frequency band	Picture carrier frequency, MHz	Sound carrier frequency, MHz
2	54-60	55.25	59.75
3	60-66	61.25	65.75
4	66-72	67.25	71.25
5	76-82	77.25	81.75
6	82-88	83.25	87.75
7	174-180	175.25	179.75
8	180-186	181.25	185.75
9	186-192	187.25	191.75
10	192-198	193.25	197.75
11	198-204	199.25	203.75
12	204-210	205.25	209.75
13	210-216	211.25	215.75
14	470-476	471.25	475.75
15	476-482	477.25	481.75
16	482-488	483.25	487.75
17	488-494	489.25	493.75
18	494-500	495.25	499.75
19	500-506	501.25	505.75
20	506-512	507.25	511.75
21	512-518	513.25	517.75
22	518-524	519.25	523.75
23	524-530	525.25	529.75
24	530-536	531.25	535.75
25	536-542	537.25	541.75
26	542-548	543.25	547.75
27	548-554	549.25	553.75
28	554-560	555.25	559.75
29	560-566	561.25	565.75
30	566-572	567.25	571.75
31	572-578	573.25	577.75
32	578-584	579.25	583.75
33	584-590	585.25	589.75
34	590-596	591.25	595.75
35	596-602	597.25	601.75
36	602-608	603.25	607.75
38	614-620	615.25	619.75
39	620-626	621.25	625.75
40	626-632	627.25	631.75
41	632-638	633.25	637.75

42	638-644	639.25	643.75
43	644-650	645.25	649.75
44	650-656	651.25	655.75
45	656-662	657.25	661.75
46	662-668	663.25	667.75
47	668-674	669.25	673.75
48	674-680	675.25	679.75
49	680-686	681.25	685.75
50	686-692	687.25	691.75
51	692-698	693.25	697.75
52	698-704	699.25	703.75
53	704-710	705.25	709.75
54	710-716	711.25	715.75
55	716-722	717.25	721.75
56	722-728	723.25	727.75
57	728-734	729.25	733.75
58	734-740	735.25	739.75
59	740-746	741.25	745.75
60	746-752	747.25	751.75
61	752-758	753.25	757.75
62	758-764	759.25	763.75
63	764-770	765.25	769.75
64	770-776	771.25	775.75
65	776-782	777.25	781.75
66	782-788	783.25	787.75
67	788-794	789.25	793.75
68	794-800	795.25	799.75
69	800-806	801.25	805.75

APPENDIX 3

Radio frequencies

General Radio Service (CB Radio) frequencies

26.965 MHz	27.215 MHz
26.975 MHz	27.225 MHz
26.985 MHz	27.235 MHz
27.005 MHz	27.245 MHz
27.015 MHz	27.255 MHz
27.025 MHz	27.265 MHz
27.035 MHz	27.275 MHz
27.055 MHz	27.285 MHz
27.065 MHz	27.295 MHz
27.075 MHz	27.305 MHz
27.085 MHz	27.315 MHz
27.105 MHz	27.325 MHz
27.115 MHz	27.335 MHz
27.125 MHz	27.345 MHz
27.135 MHz	27.355 MHz
27.155 MHz	27.365 MHz
27.165 MHz	27.375 MHz
27.175 MHz	27.385 MHz
27.185 MHz	27.395 MHz
27.205 MHz	27.405 MHz

Amateur radio service frequencies

Lower frequency limit	Upper frequency limit
1.800 MHz	2.000 MHz
3.500 MHz	4.000 MHz
7.000 MHz	7.300 MHz
10.100 MHz	10.150 MHz
14.000 MHz	14.350 MHz
18.068 MHz	18.168 MHz
21.000 MHz	21.450 MHz
24.890 MHz	24.990 MHz
28.000 MHz	29.700 MHz
50.000 MHz	54.000 MHz
144.000 MHz	148.000 MHz
220.000 MHz	225.000 MHz
430.000 MHz	450.000 MHz
902.000 MHz	928.000 MHz
1 240.000 MHz	1 300.000 MHz
2 300.000 MHz	2 450.000 MHz
3 300.000 MHz	3 500.000 MHz
5 650.000 MHz	5 925.000 MHz
10 000.000 MHz	10 500.000 MHz
24 000.000 MHz	24 250.000 MHz

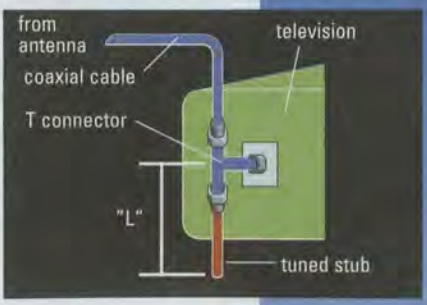
APPENDIX 4

HOMEMADE FILTER

Quarter-wave tuned stub (notch filter)

A short piece of feed line, cut to the correct length and connected in conjunction with the television receiver's antenna feed line, displays surprising characteristics. The short length of cable is frequency selective and can be used to eliminate an interfering signal by shorting it out. Such short lengths of transmission line used as filters are called stubs. It should be noted that while the stub reduces the strength of the undesired signal, it will also weaken, to a lesser extent, TV signals nearby. A switch can also be added to use the set with or without the stub. These stubs can also be connected to booster amplifier or distribution amplifier input terminals.

For interference on channel 2 caused by a radio transmitter operating at 46.400 MHz, the initial length of the stub is 108 cm if RG-59/U coaxial cable is used as television lead wire and 136 cm for a 300 ohm twin lead wire. After connecting the stub, cut off the loose end in sections of 0.3 to 0.5 cm at a time, until the interference is reduced or disappears.



For interference to television channel 7 caused by a radio transmitter operating at 170.880 MHz, the initial length of the stub is 30 cm for an RG-59/U coaxial cable and 38 cm for a 300 ohm twin lead cable. After connecting the stub, cut off the loose end in sections of 0.3 to 0.5 cm at a time, until the interference is reduced or disappears.

For interference from an FM radio station, the initial length of the stub must be 61 cm for RG-59/U cable and 74 cm for 300 ohm twin lead wire. For harmonics interfering with other television channels such as 5, 6 or 9 or for other types of cable, the initial length of the stub can be calculated with the formula shown in the box.

Half-wave tuned stub

Half-wave tuned stubs, also made of the same type of cable as it is attached to, is twice the length of a quarter-wave length stub, and has its dangling end wires shorted together.

FORMULA FOR CALCULATING THE LENGTH OF TUNED STUBS

Quarter-wave length: $L\ (cm) = \frac{7{,}500 \times V}{f}$

Half-wave length: $L\ (cm) = \frac{15{,}000 \times V}{f}$

where:

V = velocity factor of the line; and

f = frequency in MHz

N.B.

300 ohm twin lead wire, V = 0.83.

Coaxial lead, 75 ohms (RG-59/U), V = 0.66.

For other types of cable, the velocity factor can be obtained from the cable manufacturer.

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