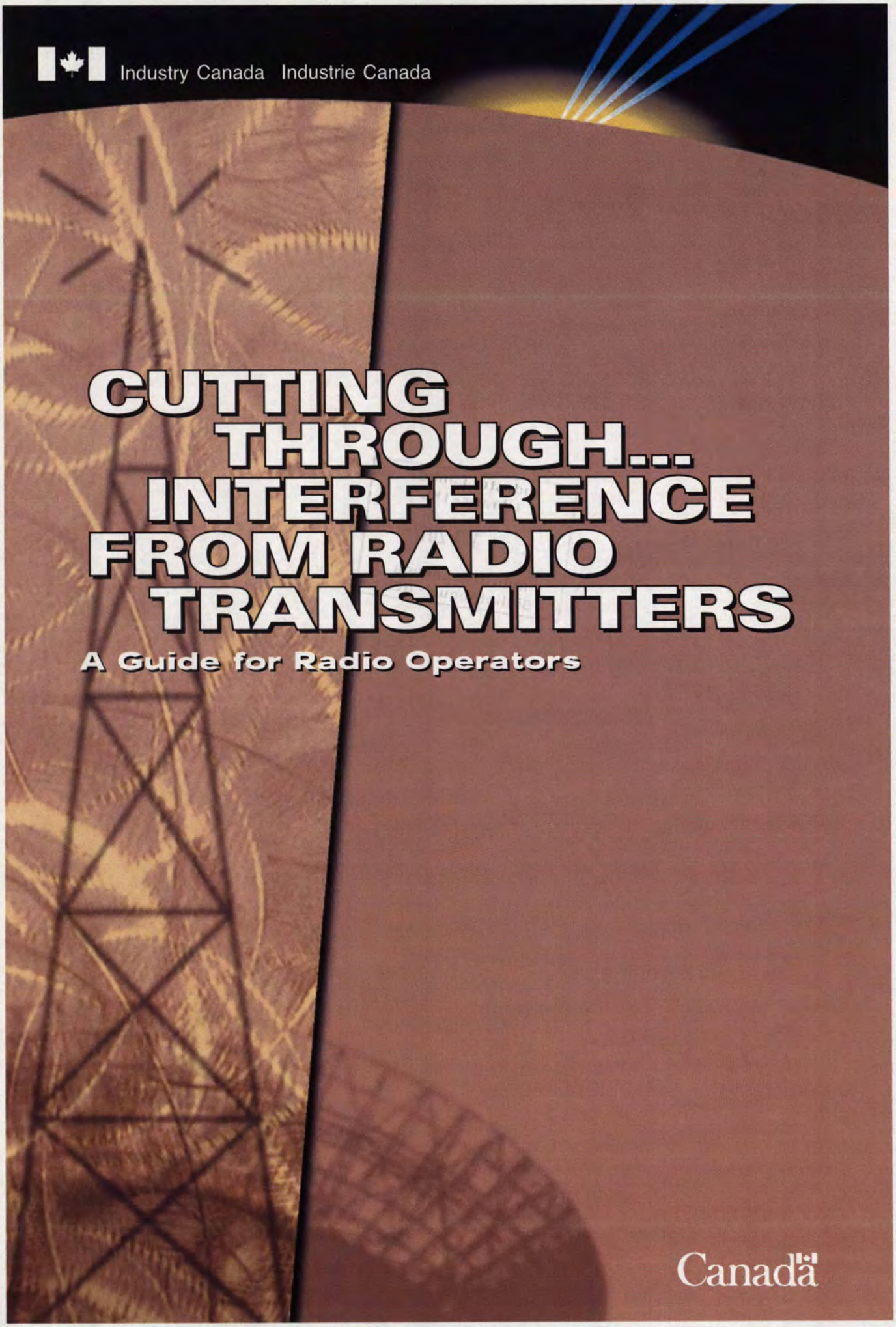
Industry Canada Industrie Canada
CUTTING THROUGH... INTERFERENCE FROM RADIO TRANSMITTERS
A Guide for Radio Operators
Canada

Aussi disponible en français.

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CUTTING THROUGH... INTERFERENCE FROM RADIO TRANSMITTERS

A Guide for Radio Operators

This brochure is primarily for amateur and General Radio Service (GRS, commonly known as CB) radio operators. It provides basic information to help you install and maintain your station so you get the best performance and the most enjoyment from it. You will learn how to identify the causes of radio interference in nearby electronic equipment, and how to fix the problem.

What type of equipment can be affected by radio interference?

Both radio and non-radio devices can be adversely affected by radio signals. Radio devices include AM and FM radios, televisions, cordless telephones and wireless intercoms. Non-radio electronic equipment includes stereo audio systems, wired telephones and regular wired intercoms. All of this equipment can be disturbed by radio signals.

What can cause radio interference?

Interference usually occurs when radio transmitters and electronic equipment are operated within close range of each other. Interference is caused by:

- incorrectly installed radio transmitting equipment;
- an intense radio signal from a nearby transmitter;
- unwanted signals (called spurious radiation) generated by the transmitting equipment; and
- not enough shielding or filtering in the electronic equipment to prevent it from picking up unwanted signals.

What can you do?

1. Try to prevent interference problems before they happen.

- Consult with municipal authorities to find out what regulations apply to antennas and tower structures. When you have an installation plan that meets municipal requirements, speak to your neighbours. Explain what you want to do and why. Assure them that you will do your best to prevent any problems. Remind them that GRS and amateur radio operators often perform an important public service by assisting local authorities during emergencies and large public events.

- Make sure your equipment is installed correctly. The radio station's antenna should be as far away from neighbouring houses as possible and away from power lines which could affect its operation. Read carefully the section, **Installing Your Radio Station,** in this brochure.
- Operate your station with your neighbours in mind. Limit transmitter power, where possible, to the minimum level required for adequate communications. For GRS stations where transmit power amplifiers are not permitted, the maximum output to the antenna should not be more than 4 watts (single sideband; 12 watts peak).
- Make sure your equipment is maintained in good condition according to its technical requirements. From time to time, you should verify that the transmitting frequency is correct, the bandwidth is within operating limits and the station's cables, antenna and ground system are in good condition.

2. Be sensitive to interference problems and try to solve them as quickly as possible.

- Work with your neighbours to find out what's causing the problem and what makes it better.
- While you are trying to find a technical solution for the interference, restrict your transmitter power and operating times. Consider shutting your station down altogether until the problem is corrected.
- Read the section of this brochure, **Solving Interference Problems,** to help you find a solution.
- Consider joining a radio club in your area. Another operator's experience may help you solve your interference problems.

INSTALLING YOUR RADIO STATION

Each part of a radio station must be installed properly and checked to make sure it meets all technical standards. GRS stations must use approved equipment that meets Industry Canada Radio Standards Specifications (RSS-136).

If you make any modification or adjustment to the installation, you should verify the station's technical performance again.

Antenna

The antenna can be a major source of interference. If the length of the antenna is not properly matched to the transmitter, it can sometimes generate unwanted signals that are transmitted more effectively than the desired operating frequency.

Location

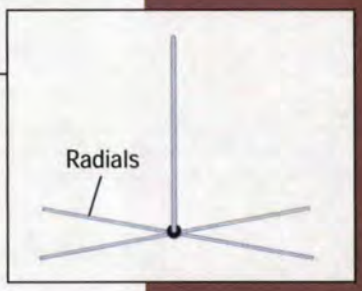
To reduce the potential for problems, the radio station's antenna should be located:

- as far away from neighbouring houses as possible, and preferably higher than them;
- away from power lines which could affect its operation;
- away from cables for the telephone, cable television or television antennas; and
- as far away from any electronic equipment as possible.

Installing a transmitting antenna in an apartment or on a balcony is not recommended.

Type of antenna

If you are using a vertical antenna, choose a ground plane type that has three or four radials. This will help minimize the signal received in neighbouring homes. A mobile antenna, which is designed to use a car's body as the ground plane, should not be used as a base station antenna without an appropriate ground plane.



Antenna transmission line

What to use

A good quality coaxial cable will convey the transmitter's radio signal to the antenna with a minimum loss of signal strength. At the same time, it will not radiate signals directly. Coaxial cables are generally made of two concentric conductors separated by an insulating material and covered by a weather-resistant outer jacket. RG-8/U cable, approximately one centimetre in diameter, is often used. To shield the centre conductor properly, the braided metal sheath should have at least 95 percent coverage.

All radio frequency (RF) connectors must be properly installed according to the manufacturer's instructions. Pre-made cables are recommended for GRS use. These cables already have their connectors installed and come in lengths that minimize problems from standing waves (or reflected waves). Standing waves reduce the level of the transmitted signal and make it more likely that the cable will transmit unwanted signals. In severe cases, standing waves may damage the transmitter or cause it to malfunction.

Location

Find out where other cables are located before deciding where to install the antenna and its feed line. The transmitting antenna's cable must not run close to, or parallel to, nearby telephone, cable television or television antenna cables.

Handle with care

To prevent standing waves, take care not to puncture, flatten or bend the cable too sharply when you are installing it. To prevent wind damage, make sure the transmission line is properly secured so it does not blow around. To prevent rain from penetrating the connectors and cable, make sure all outdoor connections are well sealed.

Grounding

All radio station equipment must be properly grounded, separate from the ground for the house's AC electrical distribution system. If the grounding is not kept separate, reflected radio frequency energy in the form of standing waves can be conducted into the electrical wiring of the building and into neighbourhood power distribution lines. Do not overlook this potential source of interference.

What to use and how to do it

- Use only copperclad or galvanized solid ground rods, since other metals will corrode and result in an ineffective ground. It is recommended that all station components (transmitters, receivers, meters, filters, tuners, etc.) use the same common ground.
- Use a rod that is a minimum of 2.5 metres in length driven into the ground and connected to the transmitter with the shortest possible length of 6-gauge, or larger, copper wire. Securely fasten the ground wire to the rod; do not simply twist the wire around the rod.
- Be sure to ground the antenna as well. This is particularly important for vertical antennas. Unless the antenna is physically close to the radio equipment, a separate ground rod should be used for each location. If the ground cable is not insulated, use standoff insulators to protect it from coming into contact with eavestroughs or railings.
- Do not use your house or apartment plumbing as a ground, even if the pipe is made of copper or steel. There may be a bad electrical connection between the point of attachment and the earth.
- Check, clean and tighten all connections regularly to ensure a good ground.

The **Canadian Electrical Code** contains regulations concerning the grounding of telecommunication devices. You can obtain a copy of the code (Catalogue No. CSA C22.1-1990) by writing to the Canadian Standards Association, 178 Rexdale Boulevard, Rexdale, Ontario M9W 1R3. Tel: (416) 747-4044; Fax: (416) 747-2475.

Cabinet

Every radio device should be enclosed in a box or cabinet, preferably the original one designed for the apparatus. The cabinet provides proper shielding of the electronic circuits and components. All parts of the cabinet should be held firmly in place, with tightly fastened screws.

Power line filter

Radio transmitters designed for fixed-base use are equipped with internal power supplies that have filtering to prevent radio frequency energy from entering the power lines. Do not use a mobile transceiver in the home if it is powered by an ordinary battery charger. These chargers are not normally equipped with power line filters and may allow unwanted radio signals to be conducted into the power line of the house. If you want to use a mobile transceiver as a base station, make sure you also use a proper filtered power supply.

Microphone

Over-modulating a transmitter can result in unwanted radio signals that disturb adjacent radio channels. Be particularly careful if you are using an amplified microphone-monitor and adjust the transmitter's modulation level regularly. Some transmitters have built in modulation meters which make monitoring easier. If your transmitter doesn't have a modulation meter, you can use an oscilloscope to set the initial modulation levels of an amplified microphone or the microphone gain of a transmitter.

The microphone cable, like all metal wires, can also act as an antenna. If the connection between the sheath and the connector has deteriorated, or if the connection is corroded, the microphone may pick up radio signals that will distort or reduce the quality of the transmitted audio signal.

Standing wave ratio meter

If you have a standing wave ratio (SWR) or power meter installed on the RF cable at the transmitter's output, the cable to and from the meter should be as short as possible and of good quality.

SOLVING INTERFERENCE PROBLEMS

If you experience interference or get complaints from your neighbours, you should first ensure that your radio equipment is operating properly. If the transmitter is the source of interference, there are three possible causes.

Poor installation of the equipment

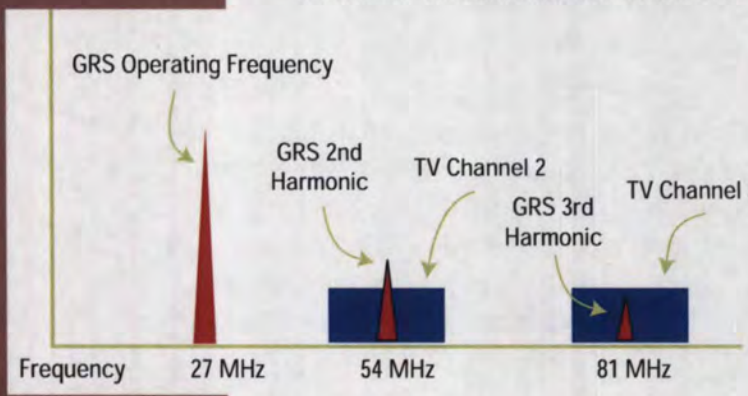
- Check that the antenna and all equipment were installed correctly and are still in good condition. Make sure your antenna is in a good location.

An intense transmitter signal

- Follow the steps described below to test the components of your equipment. If everything is working properly but you still experience problems, consider decreasing the power level of your transmissions.

Unwanted signals

- Any signal other than the desired narrowband signal is called an unwanted signal, or spurious radiation. Spurious radiation includes harmonic radiation. Harmonics occur when signals are produced at two or three times the station's operating frequency in addition to the desired signals. If the harmonics fall on another locally used frequency, such as a television channel, they are likely to cause interference. The diagram at left shows how a signal from a GRS station may interfere with television reception.



The chart below shows the television channels that may be affected by various radio stations.

Affected TV Channels	Interfering Radio Station
54	
2	Amateur Harmonics from 14 and 28 MHz Bands GRS Harmonics (27 MHz)
60	
3	Amateur Harmonics from 21 MHz Band
66	
4	Amateur Harmonics from 14 MHz Band
72	
76	
5	GRS Harmonics (27 MHz)
82	
6	Amateur Harmonics from 14 /21/28 MHz Bands GRS Harmonics (27 MHz)

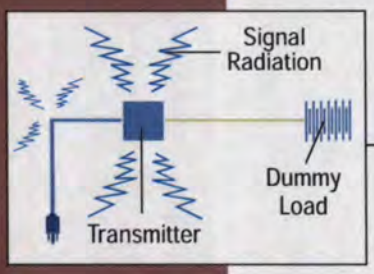
Affected TV Channels	Interfering Radio Station
174	
7	Nearby FM Commercial Stations (Industrial) - Amateur Harmonics from 28 MHz Band
180	
8	
186	
9	
192	
10	
198	
11	
204	
12	
210	
13	

How to check your equipment for unwanted signals

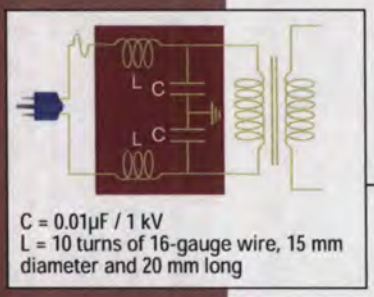
Follow the steps described below to:

- check your equipment for the source of unwanted signals; and
- correct the problem, if possible.

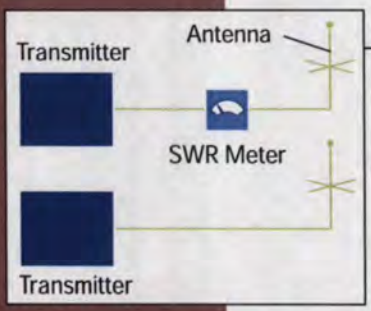
1. Some transmitters may radiate unwanted signals from their cabinet or conduct them through the power lines. To check for signals being conducted through the power lines, test the transmitter using a shielded dummy load. The diagram at left shows the correct set-up for the test.



If you still have interference while transmitting into the dummy load, the source of the unwanted signal is definitely the cabinet or the power line. Proper shielding and grounding may solve a problem in the cabinet. If the problem is in the power line, a power line filter should be installed. Various types of power line filters are available from radio supply shops and electrical parts distributors. The diagram at left shows how to construct your own filter.

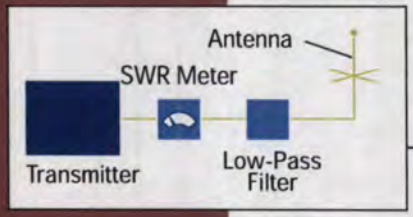


2. If the transmitter set-up includes any auxiliary RF devices, such as a standing wave ratio (SWR) meter, switches or antenna tuners, temporarily remove them from operation.



Test the equipment with no auxiliary RF devices installed. Test again as each device is installed. This method will help you find the exact source of the interference. If any device is the cause of the problem, try grounding it or remove it permanently.

3. If the RF devices are not causing the interference, try temporarily installing a low-pass filter in-line between the transmitter output and the antenna. A low-pass filter blocks all signals above its stated cut-off frequency, with no change to the desired signal. For example, certain models of low-pass filters allow frequencies of up to 30 MHz to pass through to the antenna, but they block (or greatly reduce) unwanted harmonic signals. The diagram at left shows how to install a low-pass filter.



If the low-pass filter reduces the interference, then the cause is harmonic radiation. Adjusting the transmitter's internal circuits may reduce the unwanted signals. You may need to call an experienced technician to make these adjustments.

Use a spectrum analyzer, a calibrated field intensity meter or a frequency-selective voltmeter to measure unwanted radiation. The diagram at right shows the proper set-up to use this measuring equipment.

Important: To avoid damage to the measuring equipment, follow the manufacturer's specifications.

If adjusting the circuits does not solve the problem completely, it is recommended that you permanently install a low-pass filter in the transmitter antenna feed line after all the other accessories (see diagram at the bottom of page 10). Remember, use the shortest possible coaxial cables to link the transmitter and low-pass filter to the SWR meter, and make sure the filter is properly grounded.

Double-shielded cable, such as RG-214/U, or some types of RG-58A/U, may be used. However, because of its small size and flexibility, double-shielded RG-58A/U cable is sometimes preferred for interconnecting (patch) cables.

4. Take steps to reduce the signal level received by the affected electronic device. For example, try reducing the transmitter output, changing the antenna type or the location of the antenna. If a specific piece of electronic equipment is still experiencing interference, then the equipment likely does not have enough shielding or filtering to prevent it from picking up unwanted signals.

DOCUMENTATION AVAILABLE FROM INDUSTRY CANADA OFFICES

A. Cutting Through... Radio Interference

A series of brochures, a videocassette and a CD-ROM provide information on identification and resolution of radio interference to consumer electronic equipment.

The Industry Canada Internet site (http://strategis.ic.gc.ca), under the heading *Marketplace Services*, also contains useful information and advice for solving radio interference problems.

B. Other documents related to interference, the Amateur Service and the General Radio Service.

Electromagnetic Compatibility Advisory Bulletin

EMCAB-2 Criteria for Resolution of Immunity Complaints Involving Fundamental Emissions of Radiocommunications Transmitters

Radiocommunication Information Circulars

RIC-2 Standards for the Operation of Radio Stations in the Amateur Radio Service

RIC-3 Amateur Service:

1. Countries that Forbid Amateur Radiocommunications
2. Countries with which Agreements or Arrangements Have Been Concluded to Permit the Exchange of Third Party Traffic
3. Countries with which Reciprocal Operating Privileges Have Been Arranged

RIC-15 Radio Station Identification

RIC-17 Electromagnetic Immunity (Radio Sensitive Equipment)

RIC-18 General Radio Service

RIC-24 Information on the Amateur Operator's Certificate Examinations

~~RIC-25 Rules and Regulations Affecting the Amateur Service~~

Radio Standard Specifications

RSS-136 Land and Mobile Station Radiotelephone Transmitters and Receivers Operating in the 26.960 - 27.410 MHz General Radio Service Band

Client Procedures Circulars

CPC-2-0-02 Antenna Structure Clearance

CPC-2-0-03 Environmental Process, Radio Frequency Fields and Land-Use Consultation

GLOSSARY

Coaxial cable: Round cable in which one wire is centred inside and insulated from a metallic jacket. RG-8/U is the most widely used for interconnecting a transmitter to its antenna; its impedance is normally 50 ohms.

Dummy load: A device used at the end of a transmission line to convert transmitted energy into heat, so no energy is radiated outward or reflected back to its source.

Field intensity meter: Device used to measure the signal strength (or field strength) of a transmitted radio signal.

Filter: Electronic device that lets desired signals be transmitted but blocks undesired signals.

Frequency-selective voltmeter: Device that measures a circuit's voltage levels at preselected frequencies. The instrument can also be connected to a calibrated antenna to measure signal strength.

Ground/Grounding: Connection to the earth by means of a low-resistance conductor.

Harmonics: Undesired transmissions that occur at multiples of the original frequency. For example, harmonics of a station transmitting at 27 MHz (GRS) may occur at 54 MHz (frequency X 2) or 81 MHz (frequency X 3).

Modulation: Variation of the amplitude (voltage), frequency or phase of a radio wave, in order to carry information such as voices, pictures, music or data.

Oscilloscope: Device that shows the variations in amplitude (voltage) of a signal as it is being transmitted.

Radiation: Another word for transmission of radio waves into the air.

Sheath: The outside metallic braid of a cable.

Signal: Radio frequency (RF) energy which carries information such as voices, pictures, music or data.

Spectrum analyzer: Device that measures the frequency components of a radio signal. It provides a visual image of how the amplitude of a radio signal varies in relation to its frequency.

Standing waves: Undesired effects that occur when two or more waves of the same frequency are present at the same time. This may happen, for example, when the transmitter, transmission line or antenna are not properly matched to each other.

SWR meter: Device used to detect and measure the relative size of the standing waves in an antenna lead.

Transceiver: A radio transmitter and receiver combined in one unit, including a switching arrangement between the two.

NOTES