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Questions & Answers on SHORT-WAVE LISTENING

by H. Charles Woodruff

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Preface

Short-wave listening is a very interesting and worthwhile hobby, which can provide you with a great variety of entertainment. A flip of the tuning dial of your short-wave receiver lets you listen in on the world from the comfort and convenience of your easy chair. On these frequencies, you can hear the news of the world as it happens. Not only can you learn of the folklore, history, ideology, and political aspirations of a foreign country, but of a host of activities that go to make up the everyday action of life. Among these activities are marine and aviation radiocommunications that the ship or airplane captain carries out routinely with others engaged in similar ventures; police and fire calls directed toward the saving of life and property; amateur radio operators talking to fellow enthusiasts all over the world; and international short-wave broadcasting, in which patriots devote hundreds of broadcasting hours each week toward presenting their country to the world.

Questions & Answers on Short-Wave Listening, written for the layman in his own language, helps answer some of the questions that may come to his mind as he becomes more interested in his new-found hobby.

The book is divided into five parts. Part 1 introduces the subject with facts covering international short-wave broadcasting, short-wave frequency allocation, and the different phases of the short waves. Part 2 pertains to the HOW of short-wave transmission; while Part 3 enlightens the avocationist on the HOW of short-wave reception. Part 4 familiarizes the short-wave listener with receivers and receiver controls. A variety of short-wave receivers are listed in the appendix. These present a cross section of receiver electronics that range in complexity from very simple to sophisticated, and in price from a few dollars to many hundreds of dollars.

The thrill of the unexpected is what makes short-wave listening stimulating. Spin the dial and see for yourself.

H. CHARLES WOODRUFF

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Part 1

Short-Wave Broadcasting

1 What Signals are Transmitted on Short Wave?

Whereas only music, news, and local radio programming are transmitted on the commercial broadcast band, a myriad of communications are carried on via the short waves. These communications run the gamut from marine and aircraft distress signals, transoceanic radiotelephone, teletype and amateur radio communications, to international short-wave radio broadcasting, police emergency calls, satellite communications, and time signals. While tuning across the short-wave spectrum of radio-receiving frequencies, the whole world seems to open up to the listener.

Those interested in amateur radio can listen to rag chewing of "ham" operators from all over the world. Police calls can be extremely interesting; hearing patrol cars and fire trucks dispatched throughout the streets of a large city in protection of life and property can be exciting indeed. Marine radio signals either between ships at sea or between ships and land-based stations are very thrilling.

Radio reception in the regions of the short waves is rich and varied. It offers a pastime that is thrilling, self-satisfying, and stimulating to the imagination.

2 What Is International Short-Wave Broadcasting?

International short-wave broadcasting is the transmission of radio programming by high-powered transmitters to the remote parts of a country, or for the purpose of an international exchange of news, music, and cultural ideas between nations. Nearly 200 countries are involved in international short-wave broadcasting. There are more than 3000 powerful short-wave stations broadcasting to the world. These stations transmit news and cultural programming of the folklore and history of a country. Editorial comments of world events are also transmitted. For example, Fig. 1-1 shows the staff of Radio Japan,

Courtesy Radio Japan

Fig. 1-1. Staff of announcers of Radio Japan. Program transmissions from Radio Japan are transcribed into nearly every major language of the world.

and Fig. 1-2 shows an interview of a Japanese personality by a member of Radio Japan. Radio Japan transmits in more than 30 different languages or dialects to nearly every country of the world, and uses more than 250 transmitting hours per week.

Courtesy Radio Japan

Fig. 1-2. A prominent personality being interviewed by a member of Radio Japan's staff of announcers.

Courtesy Voice of America

Fig. 1-3. The Voice of America News Room furnishes newscasts for broadcasting in 36 languages.

The staff and facilities of the Voice of America are shown in Figs. 1-3 through 1-6. Transmitters in the United States and many foreign countries are used to bring news, music, entertainment, and American history, in 50 different lan-

Courtesy Voice of America

Fig. 1-4. Voice of America relay station, Monrovia, Liberia.

guages, to nearly every country of the world. Hundreds of broadcasting hours a week are used for these messages. Millions of people tune in the broadcasts of these stations and rely upon them for honest news coverage.

To the short-wave listener, these broadcasts can offer a stimulating pastime—listening to ideas and world problems from the minds of citizens of other nations. It is true that some editorials are somewhat biased; nevertheless, they make one realize that there is another side to the world news events.

Courtesy Voice of America

Fig. 1-5. The Apollo 9 Astronauts, Col. McDivitt, Col. Scott, and Mr. Schweickart, appeared as guests on the Voice of America program, "Press Conference USA," moderated by William McCrory (left).

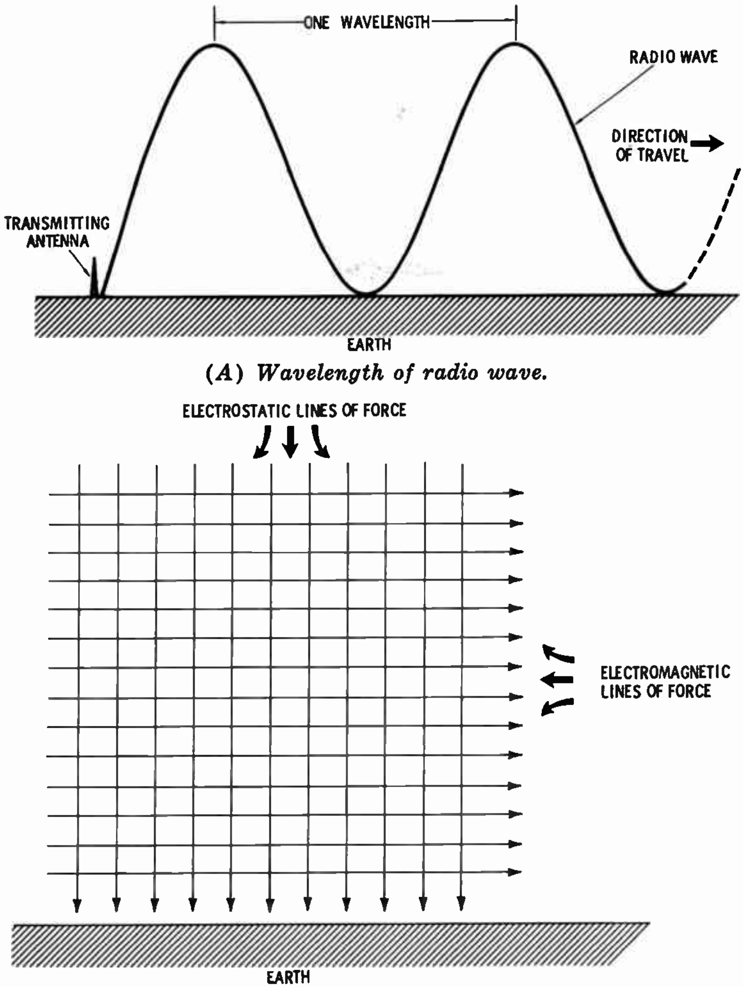
3 What Do the Terms Wavelength, Kilohertz, and Megahertz Mean?

Wavelength, kilohertz, and megahertz are used as means of measuring radio transmitted signals, much in the same way as inches and feet are used as means of measuring land distances. The terms kilocycles and megacycles have been used in the past in discussing radio frequencies. However, because the rest of the world has used the expression since the inven-

Courtesy Voice of America

Fig. 1-6. High-speed tape recorders in the Washington studios of Voice of America.

tion of radio, the United States now uses the terms "hertz," "kilohertz," and "megahertz." The use of the word "hertz" is in honor of Heinrich Hertz, an inventor who contributed much to the early development of radio. To properly express the idea of frequency, a unit of time must be combined with cycles; thus, we would say that the frequency is so many "cycles per second." But with the term "hertz," the idea of time is "built-in." Hertz means cycles per second. So, when we say "The fre-



(*A*) *Wavelength of radio wave.*

(*B*) *Lines of force.*

Fig. 1-7. Some aspects of electromagnetic radio waves.

quency is 100 hertz," it is the same as saying "The frequency is 100 cycles per second."

As a radio signal is radiated from the transmitting antenna, it travels through space much like the waves on the surface of a pond. This is illustrated in Fig. 1-7. The distance as measured between two identical points of the wave is termed one wavelength. Radio waves travel at a speed of 300,000,000 meters per second, or 186,000 miles per second (the speed of light). Let us assume that a signal is being emitted from an antenna at a frequency of 9,600,000 hertz. The wavelength of the signal can be determined by dividing 300,000,000 (the distance in meters the electromagnetic wave travels in one second) by 9,600,000 (the number of hertz). Thus:

$$\frac{300,000,000}{9,600,000} = 31 \text{ meters wavelength}$$

As mentioned earlier, the frequency of a radio signal can be more readily expressed in kilohertz and megahertz. Therefore, in our example, 9,600,000 hertz becomes 9,600 kilohertz, and to further shorten the expression, 9.6 megahertz.

4 What Are the Frequencies for International Short-Wave Broadcasting?

Space does not permit a complete list of all the transmission bands on short-wave frequencies; however, the operating bands of international short-wave broadcasting are listed in Table 1-1. All international short-wave broadcasting stations are grouped together in "bands." Usually a station will operate in the band best suited for its transmission at a particular time of day. This will be explained in Question 11.

Table 1-1. International Short-Wave Broadcasting Frequencies

Frequency in Kilohertz	Meter Band
5950- 6200	49 Meters
7000- 7300	41 Meters
9500- 9775	31 Meters
11,700-11,975	25 Meters
15,100-15,450	19 Meters
17,700-17,900	16 Meters
21,450-21,750	13 Meters
25,600-26,100	11 Meters

As noted, international short-wave broadcasting is carried on in eight bands, usually referred to by band number, such as: the 41 meter band, or the 16 meter band. To clarify this statement, a station operating in the 16-meter band is operating between 17,700 kilohertz and 17,900 kilohertz.

Conversion from meters to frequency in kilohertz, or, conversely, from frequency to meters, is accomplished by the following formulas:

$$\lambda = \frac{300{,}000}{f}$$

$$\text{or } f = \frac{300{,}000}{\lambda}$$

where,

λ is the wavelength in meters,
f is the frequency in kilohertz.

5 What Is the Best Frequency for Short-Wave Listening?

To answer this question, we must first ask ourselves about what type of signals we wish to receive.

Part 2 of the *FCC Rules and Regulations* contains a multi-page listing of radio frequencies and the type of service they carry. The complete volume can be obtained from the Government Printing Office for a moderate fee. An excerpt of the Part 2 frequency allocation is contained in Table 1-2.

Generally speaking, the higher frequency bands are better during the daylight hours, and the lower frequency bands are better at night.

Table 1-2. Short-Wave Frequency Allocations

Frequency (kHz)	Service
1605- 1800	Fixed, Mobile, Aeronautical, Radionavigation.
1800- 2000	Amateur radio, Loran.
2000- 2107	Maritime mobile.
2107- 2170	Maritime mobile, Land mobile, Coast, Fixed.
2170- 2194	Mobile (distress & calling), Aeronautical fixed, International.
2194- 2300	Fixed, Maritime mobile, Land mobile, Aeronautical fixed.
2300- 2495	Fixed, Mobile, Broadcasting (foreign).
2495- 2505	Standard frequency.
2505- 2850	Fixed, Maritime mobile, Land mobile, Aeronautical fixed, Fixed public.
2850- 3200	Aeronautical mobile.
3200- 3400	Fixed, Maritime mobile, Land mobile, Aeronautical fixed, Fixed public, Broadcasting (foreign).

Table 1-2. Short-Wave Frequency Allocations—(*Continued*)

Frequency (kHz)	Service
3400- 3500	Aeronautical mobile.
3500- 4000	Amateur radio.
4000- 4063	Aeronautical fixed, Fixed, Fixed public.
4063- 4438	Maritime mobile.
4438- 4750	Aeronautical fixed, Fixed public, Aeronautical mobile, Fixed, Fixed public.
4750- 4995	Broadcasting (foreign), Aeronautical fixed, Fixed public.
4995- 5005	Standard frequency.
5005- 5950	Broadcasting (foreign), Aeronautical fixed, Fixed public, Aeronautical mobile, Fixed.
5950- 6200	International broadcasting.
6200- 6525	Maritime mobile.
6525- 6765	Aeronautical mobile.
6765- 7000	Fixed, Aeronautical fixed, Fixed public.
7000- 7300	Amateur radio, International broadcasting (foreign 7100-7300 kHz).
7300- 8195	Aeronautical fixed, Fixed, Fixed public.
8195- 8815	Maritime mobile.
8815- 9040	Aeronautical mobile.
9040- 9500	Aeronautical fixed, Fixed public.
9500- 9775	International broadcasting.
9775- 9995	Aeronautical fixed, Fixed public.
9995-10,005	Standard frequency.
10,005-10,100	Aeronautical mobile.
10,100-11,175	Fixed, Aeronautical fixed, Fixed public.
11,175-11,400	Aeronautical mobile.
11,400-11,700	Fixed, Aeronautical fixed, Fixed public.
11,700-11,975	International broadcasting.
11,975-12,330	Fixed, Aeronautical fixed, Fixed public.
12,330-13,200	Maritime mobile.
13,200-13,360	Aeronautical mobile.
13,360-14,000	Fixed, Aeronautical fixed, Fixed public.
14,000-14,350	Amateur radio.
14,350-14,990	Fixed, Aeronautical fixed, Fixed public.
14,990-15,010	Standard frequency.
15,010-15,100	Aeronautical fixed.
15,100-15,450	International broadcasting.
15,450-16,460	Fixed, Aeronautical fixed, Fixed public.
16,460-17,360	Maritime mobile.
17,360-17,700	Fixed, Aeronautical fixed, Fixed public.
17,700-17,900	International broadcasting.
17,900-18,030	Aeronautical mobile.
18,030-19,990	Fixed, Aeronautical fixed, Fixed public.
19,990-20,010	Standard frequency.
20,010-21,000	Fixed, Aeronautical fixed, Fixed public.
21,000-21,450	Amateur radio.
21,450-21,750	International broadcasting.

Frequency (kHz)	Service
21,750-21,850	Fixed, Aeronautical fixed, Fixed public.
21,850-22,000	Aeronautical fixed, Aeronautical mobile.
22,000-22,720	Maritime mobile.
22,720-23,200	Fixed, Aeronautical fixed, Fixed public.
23,200-23,350	Aeronautical fixed, Aeronautical mobile.
23,350-24,990	Fixed, Aeronautical fixed, Aeronautical mobile.
24,990-25,010	Standard frequency.
25,010-25,600	Fixed, Land mobile, Industrial.
25,600-26,100	International broadcasting.
26,100-28,000	Fixed, Land mobile, Citizens.
28,000-29,700	Amateur radio.

A good band to listen to is the 61-meter band (4750 to 4995 kHz). This is considered a domestic band by some countries. South American countries use this band much as we use our broadcast band. Signals in this band can be heard very well at night, with best results being obtained during the winter months.

6 How Can I Find Out What Programs are Being Broadcast on the International Short-Wave Broadcast Bands, and on What Frequencies?

Listings of international short-wave broadcasting stations, transmission periods, and frequencies of transmission are contained in numerous newspapers and publications. One such book is *Short-Wave Listener's Guide*, published by Howard W. Sams & Co., Inc. Frequencies and times of broadcasting are periodically changed to accommodate the programming needs of the station, ionospheric propagation changes, and political whims of the country. Therefore, books listing international short-wave broadcasting stations are frequently revised. It is suggested that the short-wave listener keep an up-to-date copy in his possession at all times.

As one traverses the international short-wave broadcasting bands, a hundred different languages can be heard. Most of the stations listed in publications printed in this country cover the transmissions made in the English language only. But one sweep across the receiver dial and you will realize that most of the languages are foreign and seem to be from every corner of the earth. This is what makes short-wave listening the fascinating pastime that it is.

7 Why Do the International Short-Wave Broadcasting Bands Seem to Become More Crowded as I Tune Up in Frequency?

In modern short-wave receivers, tuning is accomplished by varying the capacitance of a tuning condenser that is connected in parallel with a suitable inductance coil. The range of frequency covered by a given change in capacity is a logarithmic function. Simply put, this means that a variance of, for example, 30 pF in the vicinity of 2000 kilohertz will produce a change in frequency of about 40 kilohertz, while a change of capacity of 30 pF at 20,000 kilohertz will change the frequency as much as 200 kilohertz. For this reason, the short-wave bands appear to become more crowded as you tune your receiver to higher frequencies.

8 What Stations are Located Between the International Short-Wave Broadcasting Stations?

Nearly every imaginable type of radio transmitting station on the short waves, ranging from ships at sea and aircraft in the sky, to amateur radio and transoceanic phone and satellite communications, can be found at these frequencies.

Part 2 of the *FCC Rules and Regulations*, published by the Government Printing Office, lists all radio services and to what band of frequencies they are assigned. This is a very worthwhile document for the short-wave listener (see Question 5).

9 Can I Correspond with International Short-Wave Broadcasting Stations That I Hear?

Most short-wave broadcasting stations, upon receipt of a card or letter from you, will reciprocate by sending you an identification card. These cards, called QSL cards, are sometimes very colorful and are very highly prized by short-wave listeners. QSL is one of the international "Q" signals used by all countries to facilitate communications between them. The signal QSL means "I give you acknowledgment of receipt." When thumbtacked on the wall or bulletin board near the short-wave receiver, the cards make a very nice display, as well as a conversation piece.

The acknowledgment letter or card you send to the foreign station should contain the exact time and date (GMT) the station was heard, its frequency (as accurately as possible), program identification, receiving conditions (static, interference, etc.), the type of receiver used, the type of antenna used, and the signal strength of the station.

Be sure to include your name and address.

10 Should I Keep a Record of What I Hear on Short Wave?

Yes, keep a record, by all means. Keeping a log of the stations and broadcasts you hear enhances short-wave listening. One can be made quite easily. Any kind of notebook will do. Rule off each page with column headings, as indicated in Fig. 1-8. A record similar to the one illustrated will not only serve as a handy reference for future listening, but it is also nice to have when describing short-wave listening to your friends and relatives.

DATE	TIME	STATION	FREQUENCY	SIGNAL STRENGTH	RECEIVING CONDITIONS	PROGRAM INFORMATION

Fig. 1-8. Record-keeping log of short-wave stations heard.

11 Are the Summer Months or the Winter Months Best for International Short-Wave Broadcast Reception?

Good and enjoyable international short-wave broadcast reception can be had every month of the year. The hobby need not be limited to seasons. During the summer months, because the ionosphere tends to be higher above the earth, it is necessary to use the higher frequencies for reception. During the winter months, with less-direct sunlight in the northern hemisphere, the ionospheric layers are lower, necessitating the use of the lower frequencies. Consult the short-wave broadcasting schedules published in various books and magazines. These schedules can be extremely helpful.

12 Are International Short-Wave Broadcasts Sponsored as Domestic Broadcasts in the U.S.A.?

No. International shortwave broadcasts are chiefly used by government agencies to enhance their country's image in the eyes of other countries. The exchange of cultural and humanistic ideas can vary from lessons in a foreign language, folklore, and national history, to hard-core propaganda or anti-American editorials. Listen to whatever country you choose. The short-wave bands are filled with programs.

13 Can Just Anyone File for an International Short-Wave Broadcasting Permit?

For the most part, any citizen of the U.S.A. can file for an international short-wave broadcasting permit or license. However, since commercialism is not permitted, only organizations with private financial backing could conceivably enter into such a venture.

Because the international short-wave broadcasting bands are very crowded, the FCC limits the number of broadcasting hours on each band. This assignment of transmission hours, and, consequently, the number of stations, changes with the seasons of the year and with the varying sunspot cycle. It can be seen, therefore, that with Radio Free Europe, Voice of America, and short-wave transmitters owned and operated by various religious organizations, very few frequencies remain in the international shortwave broadcasting spectrum for stations owned by private citizens.

14 What Is GMT?

GMT stands for Greenwich Mean Time. Because of the many time zones throughout the U.S.A. and the world, it would be very difficult to describe the time of a particular international event in the terms of local time. It would immediately bring the question, "How many hours difference between the particular point being described and my own local time?" Imagine, if you can, an announcer in Pakistan saying that a particular event happened at 4:00 P.M. You would ask, "What is that time in relation to me?"

Standard time is reckoned from Greenwich, England. England established this as the prime meridian in the 1700s when she was a great sea power and was able to exert the most influence upon the world. Celestial navigation was in its infancy at that time and a standard time zone was needed from which to reckon latitude and longitude. The world is divided into 24 zones, each 15 degrees of arc, or one hour apart in time. The meridian of Greenwich (0 degrees) extends through the center of the initial zone, and the zones are numbered eastward from 1 to 12 with the prefix "minus" indicating the number of hours to be *subtracted* to obtain Greenwich Time.

Zones westward are similarly numbered, but prefixed "plus," showing the number of hours that must be *added* to get Greenwich Time. While these zones apply generally to sea areas, it should be noted that the Standard Time maintained in many countries does not coincide with zone time. A graphic representation of the zones is shown on the Standard Time Chart of the world (Chart 5192) published by the Naval Oceanographic Office, Washington, D.C.

The United States and its possessions are divided into eight Standard Time Zones, as set forth by the Uniform Time Act of 1966, which also provides therein for the use of Daylight Saving Time. Each zone is approximately 15 degrees of longitude in width. All places in each zone use the time counted from

Table 1-3. Standard Time Differences

At 12 O'clock noon Eastern Standard Time, the standard time in foreign cities is as follows:

Alexandria	7:00 P.M.	Liverpool	6:00 P.M.
Amsterdam	6:00 P.M.	London	6:00 P.M.
Athens	7:00 P.M.	Madrid	6:00 P.M.
Auchland	5:00 A.M.*	Manila	1:00 A.M.*
Baghdad	8:00 P.M.	Melbourne	3:00 A.M.*
Bangkok	12:00 Midnight	Mexico City	11:00 A.M.
Belfast	6:00 P.M.	Montevideo	2:00 P.M.
Berlin	6:00 P.M.	Montreal	12:00 Noon
Bogota	12:00 Noon	Moscow	8:00 P.M.
Bombay	10:30 P.M.	Oslo	6:00 P.M.
Bremen	6:00 P.M.	Paris	6:00 P.M.
Brussels	6:00 P.M.	Peking	1:00 A.M.*
Bucharest	7:00 P.M.	Rangoon	11:30 P.M.
Budapest	7:00 P.M.	Rio de Janeiro	2:00 P.M.
Buenos Aires	1:00 P.M.	Rome	6:00 P.M.
Calcutta	10:30 P.M.	Saigon	1:00 A.M.
Cape Town	7:00 P.M.	Santiago (Chile)	1:00 P.M.
Caracas	1:00 P.M.	Seoul	2:00 A.M.*
Copenhagen	6:00 P.M.	Shanghai	1:00 A.M.*
Dawson (Yukon)	8:00 A.M.	Singapore	12:30 A.M.*
Delhi	10:30 P.M.	Stockholm	6:00 P.M.
Djakarta	12:00 Midnight	Sydney (Aust.)	3:00 A.M.*
Dublin	6:00 P.M.	Teheran	8:30 P.M.
Gdansk	6:00 P.M.	Tel Aviv	7:00 P.M.
Geneva	6:00 P.M.	Tokyo	2:00 A.M.*
Halifax	1:00 P.M.	Valparaiso	1:00 P.M.
Havana	12:00 Noon	Vancouver	9:00 A.M.
Hong Kong	1:00 A.M.*	Vienna	6:00 P.M.
Istanbul	7:00 P.M.	Warsaw	6:00 P.M.
Jerusalem	7:00 P.M.	Wellington (N.Z.)	5:00 A.M.*
Johannesburg	7:00 P.M.	Winnipeg	11:00 A.M.
Le Havre	6:00 P.M.	Yokohama	2:00 A.M.*
Leningrad	8:00 P.M.	Zurich	6:00 P.M.
Lima	12:00 Noon		
Lisbon	6:00 P.M.		

* Indicates morning of the following day.

the transit of the "mean sun" across the Standard Time meridian which passes near the middle of that zone.

These time zones are designated as Atlantic, Eastern, Central, Mountain, Pacific, Yukon, Alaska-Hawaii, and Bering, and the time in these zones is basically reckoned from the 60th, 75th, 90th, 105th, 137th, 141st, and 157th meridians west of Greenwich Time by 4, 5, 6, 7, 8, 9, 10, and 11 hours, respectively.

Table 1-3 lists the standard time difference of foreign cities as compared to 12 noon, Eastern Standard Time.

15 Are There Many Short-Wave Listeners in the U.S.A.?

Yes. A recent issue of a leading electronics magazine indicated that there are more than 10 million short-wave receivers in the United States capable of receiving the international short-wave broadcast bands. The number is increasing yearly. This large number of short-wave receivers in the public hands is due chiefly to the recent upsurge in the number of portable transistor models in nearly every department and discount store. This type of moderately priced short-wave radio, though not the best the industry has to offer, can afford the user many enjoyable hours of short-wave listening.

A short-wave receiver, expensive or not, lets you listen to the happenings of the world as they are happening. With a short-wave receiver, you are no longer restricted to reception from stations in your immediate town or city, but rather the voices of the world are open to you. Just imagine listening to London, Madrid, Tokyo, and Berlin—even to broadcasts from behind the iron curtains of Russia, or Communist China, all at the turn of a radio dial. Whatever your listening pleasures might be, you can find them on the short-wave bands.

16 Are There Short-Wave Listener's Clubs That I Can Join?

Yes. There are numerous clubs devoted to short-wave listening. Here, club members exchange ideas, suggestions, foreign-broadcasting schedules, and other material important to their hobby. Some clubs are local; others are nationwide. Most short-wave listener's clubs issue periodic bulletins listing club activities and recent short-wave observations. Information and applications for the largest club can be obtained by writing to *Popular Electronics* magazine.

17 How Are Short-Wave Frequencies Allocated?

It was not long after the beginnings of radio in the early 1900s that it was realized by most of the major countries that because radio signals knew no geographic boundaries, any short-wave broadcasts of a particular country could be received by others. Therefore, it was agreed that some mutual control of frequencies was needed.

All principal countries sent delegates to a conference held at Geneva, Switzerland. It was here that rules and regulations governing all radio transmissions were written. Frequencies were assigned for all types of communications including international communications, domestic communications channels, military frequencies, amateur-radio bands, and numerous other services. Types of transmissions were grouped together according to services and were assigned to "bands of frequencies." Later, when engineers recognized that receiving conditions varied with the time of day and the time of year, frequency bands for the same services were allotted at different wavelengths.

Nearly every year since the first conference at Geneva, other meetings have been held to resolve new problems confronting the world of radio communications. The rules and regulations agreed upon by such an arrangement are considered binding, because each country realizes that chaos would result if discipline were not observed. For the most part, the rule of the majority is adhered to.

18 How Is the Operation of American International Short-Wave Broadcasting Governed?

Rules and regulations as laid down by the FCC, within the framework of the International Telecommunication Union of Geneva, govern the transmissions of international short-wave broadcasting by the United States. The FCC is the governing body for all radio emissions made by stations licensed by it.

The rules and regulations governing international short-wave broadcasting (Part 73) are less stringent than those governing commercial broadcasting.

19 Are the International Short-Wave Broadcasting Frequencies Policed Similarly to the Domestic Bands?

The international broadcast bands are policed according to the desires of a specific country to adhere to the rules and regulations laid down by the Geneva conventions. Most countries do police the stations licensed by them—short-wave as well as medium- and long-wave transmissions.

However, if a country chooses to disregard the ruling of the International Telecommunication Union on a particular telecommunications matter—and there are some countries that so choose—there is not much that can be done. Some governments resort to willful jamming of the radio signals of others, and act in defiance of the rules. The only thing that can be done if this occurs is to shift to another frequency and hope that the offending station does not follow.

20 What Is Radio Jamming?

In some instances, a particular country does not want its citizens to receive short-wave radio broadcasts beamed to it by some other country. To render such broadcasts ineffective, officials resort to an interference known as *jamming.*

The jamming signal usually is provided by a radio transmitter radiating a powerful rf carrier on exactly the same frequency as the undesired station. The jamming signal is sometimes modulated by a rapidly varying audio tone. Jamming was extensively carried on during World War II against enemy radar systems and communications centers. It is being continued in some areas today to prevent some broadcasts from entering a particular country.

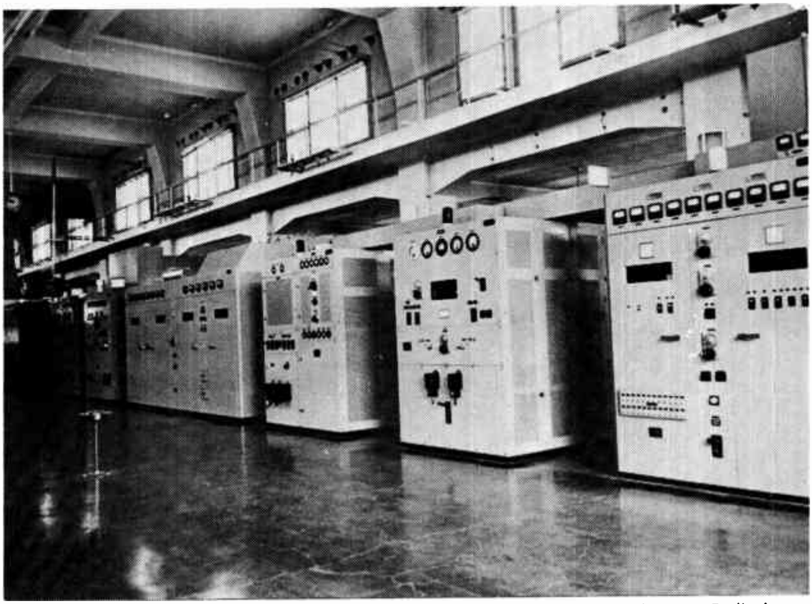
As you tune across the short-wave bands, you will be able to pick out these jamming stations by a characteristic buzzing or rapidly fluctuating signal. Note the effectiveness of the interfering signal.

21 What Are Clandestine Broadcast Stations?

As mentioned in Question 13, short-wave stations are licensed by their respective governments under the direction and rules of the International Telecommunication Union at Geneva, Switzerland. However, in some instances, opposing political parties within a country wish to make their voices heard. These opposing political parties will usually install transmitting equipment in covered trucks for portability. The operators of these stations risk their lives to get their messages out to the rest of the world. Tune carefully across the dial of your short-wave receiver. You might hear one of these stations.

22 What Types of Emissions Are Used in International Short-Wave Broadcasting?

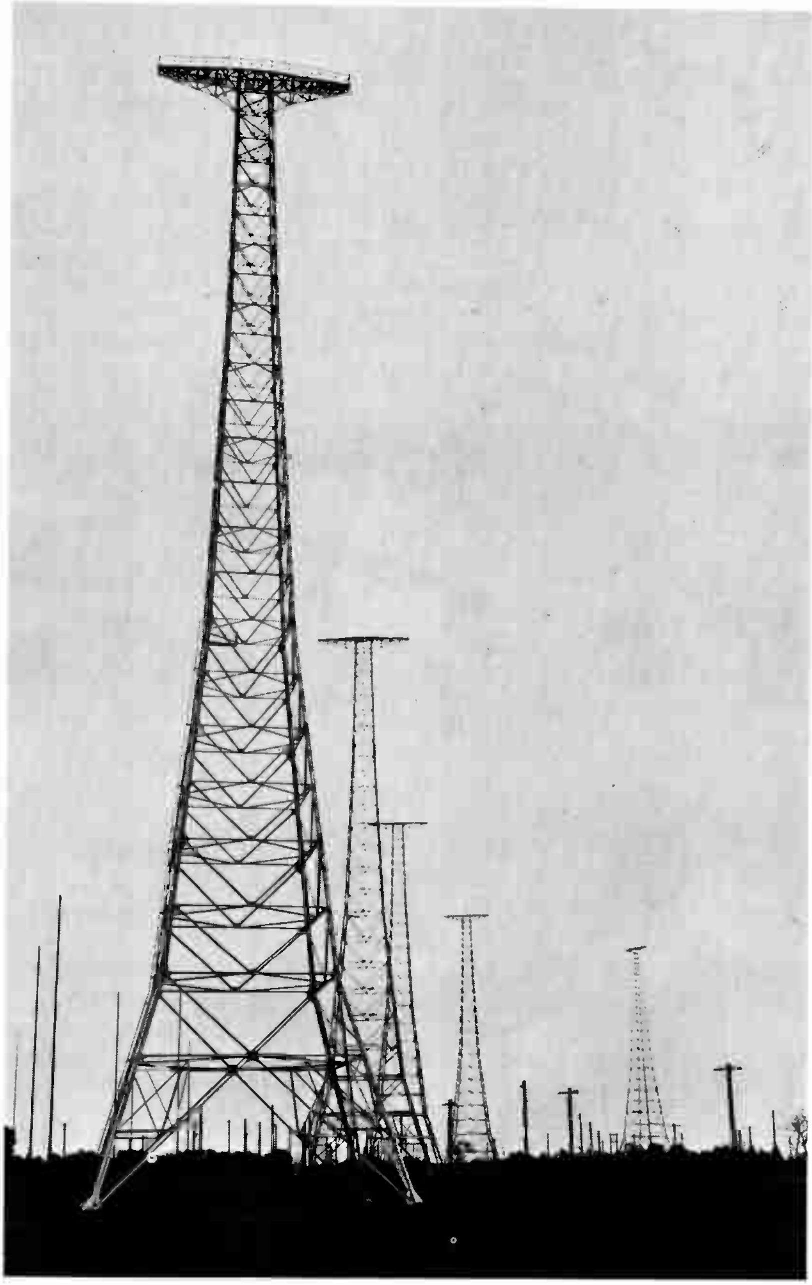
Reference to the "type of emission" of a radio transmitting station refers to the manner in which intelligence is being transmitted. The various types of emissions and their meaning were established by the International Telecommunication Union at Geneva, Switzerland. Emissions and their designations are listed in Table 1-4.



Courtesy Radio Japan

Fig. 1-9. High-powered short-wave transmitters of the Voice of Japan (Yamata facilities). High power is required to overcome ionospheric losses and to override interference.

Amplitude modulation (A3) emission is generally used for international short-wave broadcasting. This is the simplest form from the standpoint of receiver tuning, since it does not require precise adjustment of the tuning dial. Furthermore, most available receivers that tune that portion of the radio spectrum are of the a-m type.



Courtesy Radio Japan

Fig. 1-10. Antenna towers of the Voice of Japan (Yamata).

Table 1-4. Types of Radio Emission

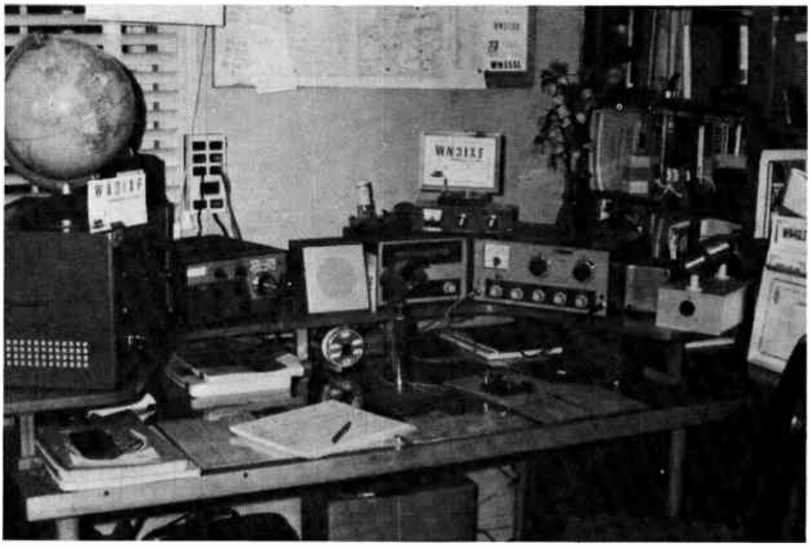
Type of Emission	Designator
Continuous Wave (Telegraph; cw)	A1
Amplitude Modulated Telephone	A3
Facsimile	A4
Television	A5
Frequency Modulated Telephone	F3

Stations transmitting in the international short-wave broadcast band usually operate with at least 50,000 watts of power, some with power up to 500,000 watts. Many use directional antennas. Fig. 1-9 shows a few of the high-powered transmitters used by the Voice of Japan. Their directional antennas are shown in Fig. 1-10. Installations of this magnitude are necessary to overcome interference from other transmissions (willful or otherwise), ionospheric losses, and high noise level at the receiving end.

23 What Is Amateur Radio?

Amateur radio is a scientific hobby enjoyed by more than one-half million operators (or "hams," as they call themselves). Certain frequencies have been set aside in the short-wave spectrum for their use. Here, they can operate their transmitters and carry on an exchange of ideas (usually technical) with each other. A rather stringent examination supervised by the FCC is required, plus a display of knowledge of the International Morse Code, to obtain an operator and station license.

Amateur radio is not only a very interesting hobby, but also a very worthwhile one. Great public service has been performed on the amateur radio bands in providing emergency communications during times of disaster. This has always been a recognized effort on the part of the "ham." More recently



Courtesy A.R.R.L.

Fig. 1-11. Ham station WA3IXF.

their efforts have been extended to provide a means of communications between members of the armed forces overseas and their families and friends at home during the Korean and the Vietnamese wars. The well-outfitted "ham" station of WA3IXF is shown in Fig. 1-11.

24 What Are the Amateur-Radio Bands?

When you are listening on the short-wave frequencies from the high-frequency edge of the broadcast band upward, you can hear transmissions of some sort almost anywhere. However, listening can be very rewarding in the short-wave bands of amateur radio.

Four amateur-radio bands are within the tuning range of most short-wave receivers. Some of the more sophisticated radio receivers are capable of receiving six bands. The frequencies are listed in Table 1-5. Amateur-radio operators usually converse with other amateurs on electronic technical subjects; however, a short-wave listener can often hear plenty of other

Table 1-5. Amateur-Radio Frequencies

Frequency (kHz)	Meter Band
1800- 2000	160 Meters
3500- 4000	80 Meters
7000- 7300	40 Meters
14,000-14,350	20 Meters
21,000-21,450	15 Meters
28,000-29,700	10 Meters

interesting chatter on these bands. The two lower-frequency amateur-radio bands (160 meters and 80 meters) can be considered best for local reception (200 miles or less), the 80-meter band being the most used. The 40-meter band is best for moderate distances of 1000 miles or so, while signals from all parts of the world can be heard on the three higher bands.

If you learn the International Morse Code, you will be able to enjoy a whole new type of amateur radio (see Question 35).

25 What Is Citizens-Band Radio Service?

Citizens-band radio, or "CB" as it is more commonly called, is a band of frequencies that have been set aside within the past few years for use by the general public for their own convenience. Low powered transmitters and walkie-talkies are available for these frequencies in all price ranges. Only low power is authorized by the FCC on this band; therefore the usable range is quite limited. However, due to varying ionospheric conditions, stations a great distance away can sometimes be heard. A word of caution—The FCC prohibits communications to be carried on between stations far removed from each other.

Station and operator licenses are quite easily obtained for operation in the "CB" bands. No electronic skills are necessary. For this reason, many stations are on the air. If you are thinking seriously about operating "CB," it is suggested that you obtain one of the many books presently devoted to the subject. Frequencies assigned by the FCC for "CB" operation are listed in Table 1-6.

Table 1-6. Frequencies Assigned to Citizens-Band Radio Service

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	26.965	12	27.105
2	26.975	13	27.115
3	26.985	14	27.125
4	27.005	15	27.135
5	27.015	16	27.155
6	27.025	17	27.165
7	27.035	18	27.175
8	27.055	19	27.185
9	27.065	20	27.205
10	27.075	21	27.215
11	27.085	22	27.225
		23	27.255

26 Is It Possible to Enjoy Short-Wave Listening in My Automobile?

A few years ago, some car radios were manufactured with short-wave bands together with the conventional broadcast bands, but they have been discontinued. Receivers capable of being installed in automobiles are available, however, that can tune the amateur radio bands, and many are presently in service. If you want to receive short-wave signals while in your car, we suggest that you use a portable short-wave transistor receiver.

27 How Do Radio Direction Finders Work?

Though not considered a short-wave receiver in the true sense of the word, a radio direction-finder receiver does tune a portion of the short-wave spectrum and performs a very valuable service. Hence, it deserves an explanation in this book.

Most marine direction finders tune the low-frequency band, 140 Hz to 400 kHz, the broadcast band, and the marine frequencies 2000 to 3000 kHz. Those installed on larger vessels are quite elaborate and will sense directions with great accuracy. Those available at radio stores, moderately priced, and considered portable, are somewhat smaller and less elaborate, but nevertheless useful.

Basically, the direction-finder receiver is similar to any receiver of good quality. The feature that gives it direction-finding properties is its special antenna. The antenna, called a "loop antenna," consists of several turns of wire, usually wound around a rectangular frame or around a special type of iron rod called a "ferrite rod." The loop (or rod) is mechanically arranged so that it can be rotated on a vertical axis.

If the loop (usually with the receiver attached) is placed in a space away from surrounding metal objects, and the dial is tuned to a station, the incoming signal will sound very much like the sound of a conventional receiver. The signal strength is noted either aurally or with a tuning indicator. The loop antenna is then slowly rotated on its horizontal axis. It will be noted that at one point during the rotation, the signal strength will drop sharply to zero or nearly zero. With careful adjustment, the "null" can be made quite sharp. If the direction of the radio station is known, it will be noted that the loop antenna

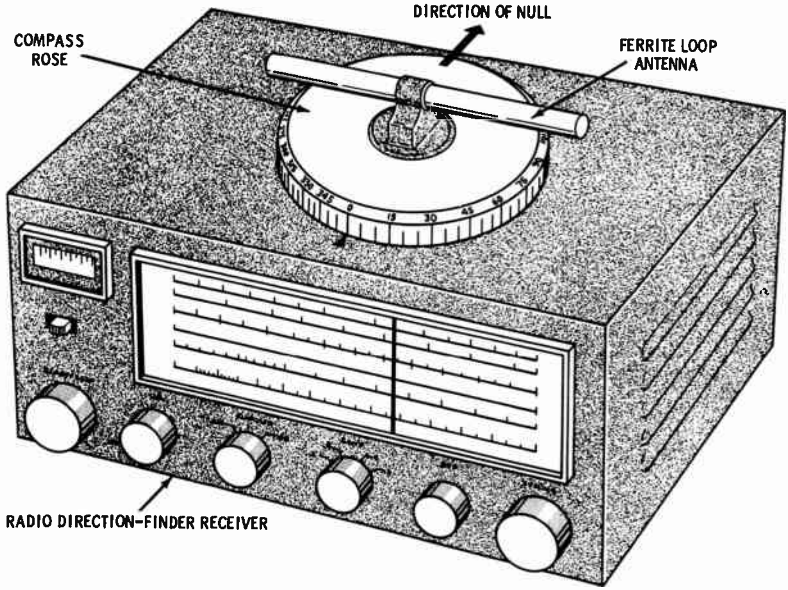


Fig. 1-12. Direction finder using ferrite rod as a "loop" antenna.

is at right angles to the signal source at the null point. A dial is usually installed at the base of the antenna with a graduated scale from 0 to 360 degrees. The null as noted will point in the direction of the radio signal and its direction can be read from the scale (see Fig. 1-12). The radio direction finder as purchased from a radio parts store is a very useful electronic device to the small-boat operator.

28 What Are the Marine Radio Frequencies?

The marine radiotelephone frequency bands are listed in Table 1-7. These frequencies are used for ship-to-ship and ship-to-shore radiotelephone communications. The lower frequency band, 2000 to 3000 kHz, is primarily used for distances up to 200 miles. You will be able to hear skippers of deep-sea fishing boats communicating with each other regarding their catch and where the best fishing areas are located.

Telephone companies located in coastal cities maintain radiotelephone stations in this band where ships at sea can place telephone calls to phone numbers on land. Most short-wave receivers are able to tune these frequencies.

Table 1-7. Maritime Phone and CW Frequencies

2000 kHz	to	2850 kHz
4063 kHz	to	4438 kHz
6200 kHz	to	6525 kHz
8195 kHz	to	8815 kHz
12,330 kHz	to	13,200 kHz
16,460 kHz	to	17,360 kHz
22,000 kHz	to	22,720 kHz

The higher frequency bands listed in Table 1-7 are used when distances greater than 200 miles are required.

Whereas most ship to shore communications are carried on using International Morse Code, the voice channels on the higher frequencies are used when passengers of large ocean vessels far out at sea wish to place telephone calls to persons ashore.

29 What Are the Public-Safety Frequencies?

The public-safety frequencies are those used by fire departments, police departments, U.S. forestry stations, and other types of services for the public aid. On these frequencies, car-to-car and car-to-station calls are transmitted. These frequencies are usually up in the very high frequency areas beyond the tuning range of the average short-wave receiver. Most of the public-safety stations operate in the range of 155 MHz to 175 MHz. Special short-wave receivers that can tune these frequencies, are available from most radio wholesale houses. Exploring these frequencies can be very exciting.

30 What Is Transoceanic Telephone?

Transoceanic radiotelephone is a radiotelephone circuit between one country and another across the ocean. These communications can usually be heard above 15,000 kHz in the bands listed in Question 5 labeled Fixed public. Some telephone conversations are carried on via submarine cable laid on the ocean floor; however, most are done by radiotelephone.

Most telephone circuits can be received quite well by a short-wave receiver just as any other radiotelephone signal can be received but some are carried on using a system known as speech inversion. Through a complex electronic process, the high-frequency portions of the human voice are converted to low frequencies and the low frequencies are converted to high frequencies. The result is a totally unrecognizable voice signal. The transmission is "unscrambled" at the receiving end back into its original form. This type of transmission offers the user a small amount of privacy.

31 What Is Radioteletype?

Radioteletype, which is usually transmitted by short wave, is a form of special communications. It uses a typewriter-like machine to convert a particular type of coded radio signal into alphabetical characters typed on a sheet of paper, in much the same manner as by teletype machines in the local Western Union offices.

The message to be transmitted is typed in the same manner as it would be on a typewriter, but the printing is done at the receiving point. To eliminate the possibility of errors in the transmission, the message is usually typed on a long, narrow tape and checked at the transmitting station before it is sent. It also has the advantage that the complete message may be typed out in advance of actual transmission at any convenient speed; when transmitted, however, it is sent at the normal maximum speed of the machine.

In the special code used for teletype, every character has five elements sent in sequence. Each element has two possible states, either "mark" or "space," which are indicated by different types of electrical impulses. In customary practice, the carrier signal of a teletype transmitting station is shifted 425 cycles above and below its normal channel frequency. One signal is used for the "mark" signal, while the other is used for the "space" character.

When tuning across the short-wave bands, you can readily identify this frequency shift as a two-tone signal rapidly alternating in frequency. The BFO control on the receiver must be on to receive the signal.

Teletype transmissions can usually be heard on nearly every short-wave band on your receiver.

32 What Are Standard-Frequency Stations?

Standard-frequency stations are government-operated stations that transmit signals on certain frequencies with exceptional accuracy. Nearly every technically oriented country has one such radio station. In the U.S.A., the call letters of the frequency standard stations are WWV and WWVH. The stations are located in Colorado and Hawaii. The stations serve not only as a frequency standard but also transmit precision time signals and ionospheric propagation reports. See Fig. 1-13 for a diagram of their daily schedule of broadcast.

33 Are There Other Time Signals Besides Those of WWV?

Time signals are also sent from the U.S. Naval Observatory at Arlington, Virginia. To receive these signals, the receiver must have a BFO control (see Question 65).

Naval Observatory time signals are being broadcast at numerous times throughout the day by five widely separated Navy radio stations: NSS, Washington, D.C.; NBA, Canal Zone; NPG, San Francisco, California; NPM, Honolulu; and NPN, Guam. The hours of transmissions and the frequencies of emission are listed in Table 1-8. Each tabulation gives the call letters, location of the station, and the frequency of transmission in kilohertz. The hours of transmission are stated in Greenwich Mean Time (GMT).

The time signal itself is graphically displayed in Fig. 1-14. Essentially, the signal is a series of rhythmic cw signals or "beeps," beginning five minutes before the hour and providing the listener with five separate time checks—one at the 56th minute; one at the 57th minute; one at the 58th minute; one at the 59th minute; and one on the hour. Due to mechanical or operator variance, the signal may not necessarily begin on the 55th minute. However, this is of no consequence, since the beginning is not to be used as a marker.

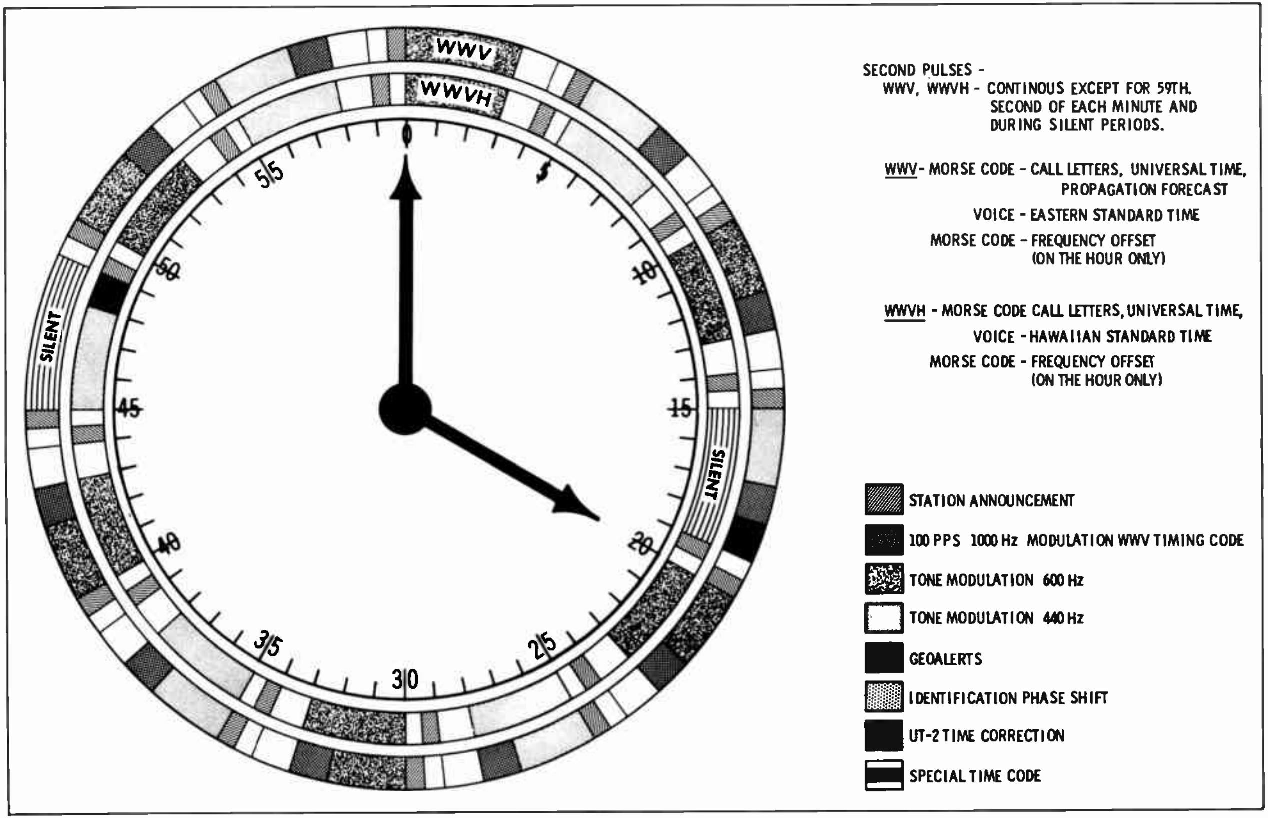


Fig. 1-13. Hourly broadcasts of WWV and WWVH standard frequency stations. Transmitting frequencies of these stations are 2.5 MHz, 5 MHz, 10 MHz, 20 MHz, and 25 MHz.

Table 1-8. Time and Frequencies of US Naval Time Signals

NSS Annapolis, Md. Time: 0000, 0200, 0600, 0800, 1200, 1400, 1800. Freq. 5870, 9425, 13575, 17050, 23650.
NPG San Francisco, Calif. Time: 0000, 0600, 1200, 1800. Freq. 6428, 9277, 12966, 17055, 22635.
NPM Honolulu, Hawaii Time: 0600, 1200, 1800. Freq. 9050, 13655, 17122, 22593.
NPN Guam Time: 0000, 0600, 1200, 1800. Freq. 8150, 13530, 17530, 21760.
NBA Canal Zone, Panama Time: 0500, 1000, 1700, 2300. Freq. 11080, 17697, 22515.

All times in GMT. All frequencies in kHz.

As the signal proceeds through the 55th minute, the halfway point is indicated by the omission of the 29th second. As the beeps continue, it will be noted that the 51st second is also blank, followed by signals on the 52nd, 53rd, 54th, and 55th seconds. These four beeps following the 51st second form a code reference alerting the listener to the approaching 56th-minute time signal. The 55th second cw signal is followed by a 4-second silent period, which is ended by the time signal, precisely indicating the 56th minute. This is the end of the first time check.

The 1-second "beeps" continue through the 56th minute as indicated in the figure, with the 29th second blank as in the

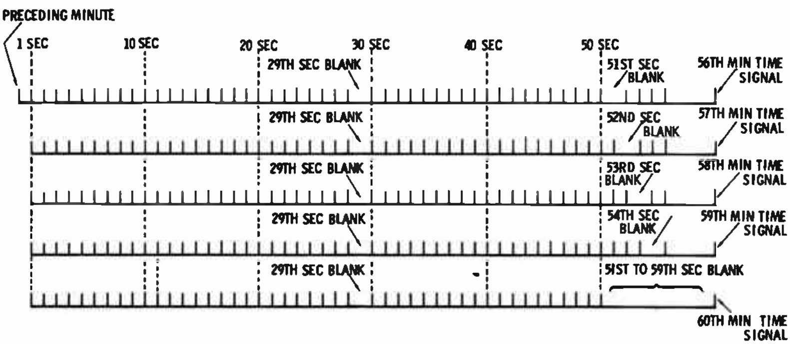


Fig. 1-14. Typical Naval Observatory time signal.

preceding minute; again denoting the halfway point. As the signal approaches the end of the 56th minute, the 52nd second is omitted (instead of the 51st second as in the preceding check), followed by the 53rd-, 54th-, and 55th-second markers, and then by the 4-second silent period. The silent period is ended by the time signal, precisely indicating the 57th-minute. During this second time check, the three 1-second signals at the 53rd-, 54th-, and 55th-second markers serve as the code reference for the 57th-minute check.

Table 1-9. Foreign Radio Time Signal Service

Call Sign	Location	Carrier Frequency	Modulation (Hz)
ATA	New Delhi, India	10 MHz	1; 1000
FFH	Paris, France	2.5; 5; 10 MHz	1; 440; 1000
IAM	Rome, Italy	5 MHz	1; 440; 600; 1000
JJY	Tokyo, Japan	2.5; 5; 10; 15 MHz	1; 1000
MSF	Rugby, England	2.5; 5; 10 MHz	1; 1000
——	Moscow, USSR	10; 15 MHz	1
CHU	Ottawa, Canada	3330; 7335; 14,670 kHz	1

This procedure is repeated for the 58th- and 59th-minute time checks with the 53rd and 54th seconds omitted, respectively. A long dash, preceded by the 9-second silent period, composed of the omission of the 51st- through the 59th- second "beep," denotes the hour. The *beginning* of the long dash indicates the "on time."

Nearly every major country broadcasts some form of time signals by radio. A few are listed in Table 1-9.

34 Can I Receive Radio Signals from Man-Made Satellites?

Some satellite transmissions are carried on at approximately 15,000 kHz, and might possibly be heard on a short-wave receiver. However, most of the communications are carried on in the uhf bands in the vicinity of 400 MHz to 500 MHz, considerably higher in range than the conventional short-wave receiver commercially available. Furthermore, transmissions sent back to earth from a revolving satellite are of very low power. This is necessary to conserve space, weight, and electrical power. Because of this very low power, special directional antennas are used to receive the very weak signals.

35 What Is CW?

Continuous wave, more commonly referred to as cw, is radio intelligence sent in Morse code. Cw signals can be identified by a characteristic series of short dots and dashes. These have probably been heard by everyone even remotely interested in short-wave communications.

These radio signals can only be heard when the BFO control (see Question 65) is in the ON position on your receiver. Most communications receivers have this control; however, receivers designed exclusively for international short-wave broadcast reception do not.

Numerous books, pamphlets, and learning aids have been published on the art of learning the International Morse code. Listed in Fig. 1-15 are the alphabet and numerals. An excellent training aid is *International Code Training System,* published by Howard W. Sams & Co., Inc.

A	• –	M	– –	Y	– • – –
B	– • • •	N	– •	Z	– – • •
C	– • – •	O	– – –	1	• – – – –
D	– • •	P	• – – •	2	• • – – –
E	•	Q	– – • –	3	• • • – –
F	• • – •	R	• – •	4	• • • • –
G	– – •	S	• • •	5	• • • • •
H	• • • •	T	–	6	– • • • •
I	• •	U	• • –	7	– – • • •
J	• – – –	V	• • • –	8	– – – • •
K	– • –	W	• – –	9	– – – – •
L	• – • •	X	– • • –	0	– – – – –

Fig. 1-15. International Morse code.

Part 2

Short-Wave Transmission

36

What Is Propagation?

The ability of a radio signal or radio wave to travel through space from the transmitting antenna to the antenna of a receiver is called *propagation.*

Radio waves are sent out from the transmitting antenna in all directions at the speed of light. One wave travels along the ground, and is known as the *ground wave.* The ground wave is of little consequence on short-wave reception, because absorption quickly reduces its signal strength to zero, usually within 100 miles or less. A second wave of electrical energy is emitted from the antenna at various angles to the surface of the earth. This signal is the *sky wave* and is the one that is used for long distance short-wave communications.

The sky wave, upon leaving the transmitting antenna, travels upward from the surface of the earth at such an angle that it would continue out into space were its path not bent sufficiently to bring it back to earth. The medium that causes this bending is the *ionosphere* (see Fig. 2-1).

The ionosphere consists of layers of ionized gas located between 60 and 150 miles above the surface of the earth. The ionosphere acts as a mirror that reflects the radio waves back to earth. A sky wave thus reflected will return to earth a considerable distance from the transmitter. This is called single-hop ionospheric propagation. A sky wave may be further propagated by being reflected once again back to the ionosphere

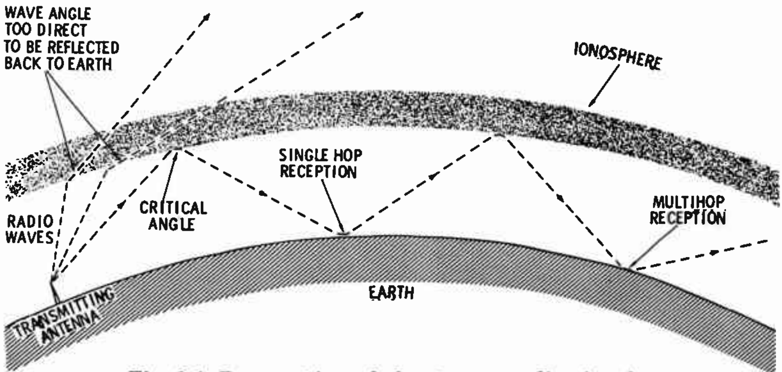


Fig. 2-1. Propagation of short-wave radio signals.

and down to the earth at a still greater distance from its source. This is known as multihop propagation.

The amount of refraction the sky wave undergoes depends on its frequency and the amount of ionization in the upper reaches of the atmosphere, which is the effect of ultraviolet radiation from the sun. Because of the varying amount of sunlight between night and day at different seasons of the year, short-wave radio waves undergo considerable change during a 24-hour period.

37 What Is Skip Distance?

At certain distances between the transmitting antenna and the receiver, it is impossible to receive the radio signal being transmitted. This area is called *skip distance.* As can be seen in Fig. 2-2, the skip area lies between the end of the ground wave and the first ionospheric sky-wave reflection. As stated, more bending is required to return a radio wave to earth when the angle is high, and at times the bending will not be sufficient to return the wave to earth. This fact is illustrated in the figure, where angle "A" and smaller angles will produce a usable signal at the surface of the earth, while waves transmitted at higher angles penetrate the ionosphere and are not returned. The area

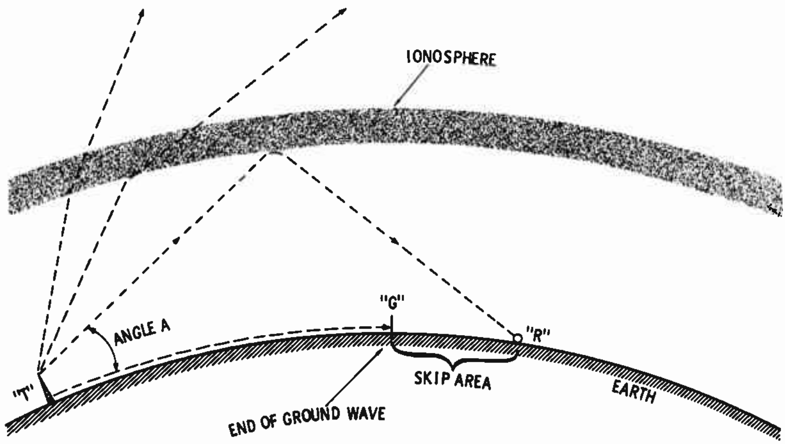


Fig. 2-2. The skip-distance phenomenon in short-wave transmission and reception.

between "T" and "R," therefore, is the shortest possible distance, at the particular frequency, over which signals can be received by ionospheric refraction. A receiver located in the area between "G" (the end of the ground wave) and "R" would be unable to receive the transmitted signal.

38 What Are Day Effect and Night Effect?

These atmospheric conditions are very pronounced on all radio frequencies and are due chiefly to sky-wave absorption in the ionosphere. Generally speaking, the absorption is much greater on wavelengths below 6000 kilohertz during daylight hours than at night; therefore, much of the international communication is carried on at higher frequencies over the sunlighted portions of the earth. During the dark hours, these frequencies would penetrate the ionosphere; therefore, lower frequencies are used at night.

39 What Causes Fading?

This adverse receiving condition is a result of a variation in signal strength at the receiver antenna input and is caused by the radio signal arriving at the receiver by two or more different routes. The wave arriving by one route is out of phase with the wave coming along the other path. The end result is that the two waves have a tendency to cancel each other. Maximum fade-out occurs when the two waves arrive at the antenna terminal exactly 180 degrees out of phase. Fig. 2-3 shows that one wave arriving at the antenna of the receiver is the sky wave and the other is the ground wave. As the ionized layer fluctuates higher and lower, the sky wave path is lengthened or shortened, thus shifting the phase of the total received signal at the receiver, causing fading.

The total signal energy may also be made up of two sky waves arriving over different paths, as shown in Fig. 2-3. Still

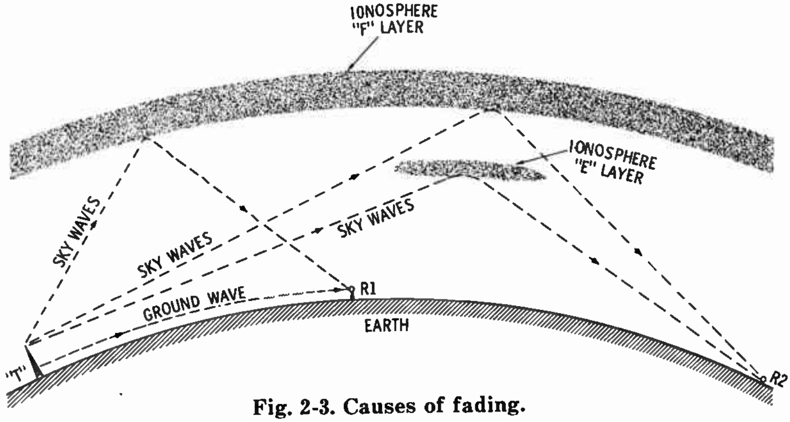


Fig. 2-3. Causes of fading.

conditions may consist of a ground wave and two sky waves, all arriving at the receiver by different paths. However, regardless of the number of wave combinations, a difference in phase relation will cause fading.

Fading is usually more pronounced at night than during the day and more pronounced over land than over water. The only remedies for this condition are a change in operating frequency or the installation of a second antenna some distance from the first. Thus, when the phase of the incoming signal is being cancelled at antenna number one, the signal will probably be in phase at antenna number two.

40 What Is A Directional Antenna?

The purpose of an antenna is to feed as much signal voltage and as little noise to the receiver as possible. No antenna, except a single vertical element, receives energy equally well from all directions. All horizontal antennas have some directional properties, depending upon the length and height of the wire above ground. In the case of a simple quarter-wave, horizontal wire, best reception will be at right angles to the wire. For example, if the wire is run in a north/south direction, best reception will be from stations lying to the east or west (see Fig. 2-4).

The function of a directional antenna when used for receiving, is to pass on to the receiver a maximum signal voltage from

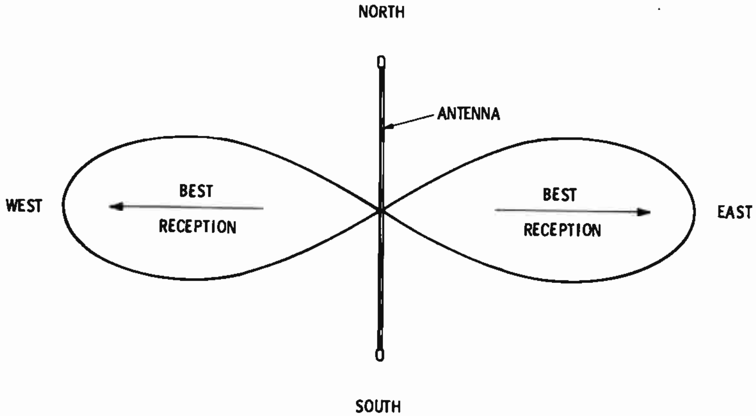


Fig. 2-4. Receiving characteristics of a horizontal antenna.

some particular geographic direction while reducing reception in others. For reception, one might find useful an antenna giving little or no gain in the direction from which it is designed to receive signals if the antenna is able to *discriminate against interfering signals and static arriving from another direction.* This type of unwanted signal or interference rejection can be achieved if the noise happens to be power-line noise or noise generated in the wiring in the house or electrical appliances. An antenna may be erected in a noise-free area with a shielded coax cable running through the noise area to the receiver terminals (see Fig. 2-5).

If reception is confined to a narrow beam, the signal intensity from the desired direction can be increased a great many times. Directional antennas can be designed to produce a gain as high as 23 dB or more over that of a single wire. These types of antennas are known as *rhombic antennas*, diamond-shaped paral-

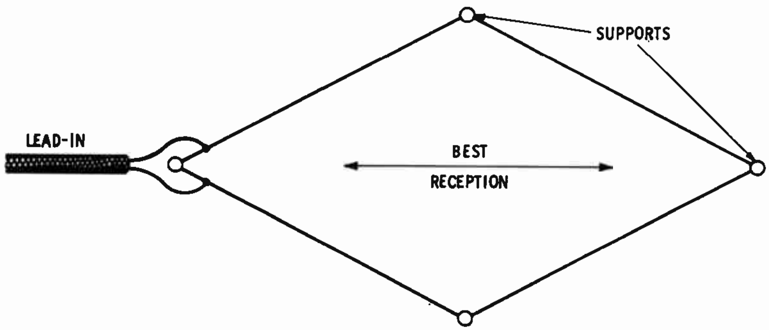


Fig. 2-5. Receiving characteristics of a rhombic antenna.

lelograms with oblique angles (see Fig. 2-6). Unfortunately, these types of antennas require considerable space and once erected cannot be rotated. Therefore, generally speaking, these antennas must be ruled out for receiving.

An antenna wire backed up by a second piece of wire or aluminum tubing and spaced about ¼ to ½ wavelength behind the antenna makes a very good directional antenna and possesses a fair amount of gain. However, once again, because of its size, it is used only in special cases.

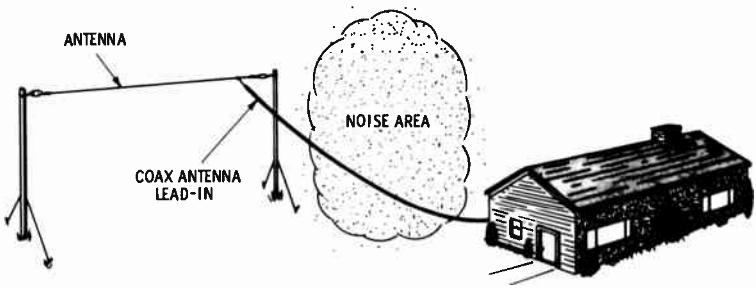


Fig. 2-6. Shielded coax cable running through a noise area to receiver.

In conclusion, therefore, for short-wave reception where various bands are to be used, the following conditions would seem to give the best and most economical results: A single-wire antenna installed between two fairly high supports (20 to 50 feet); antenna as long as practical (20 to 100 feet); antenna oriented at right angles to the general direction from which signals are to be received; and installation in an area that is as noise-free as possible.

41 How Important Is A Good Ground?

Most modern receivers are grounded through the connecting power lines and internal power supply and do not require a separate ground connection. However, in some instances, man-made and atmospheric noise can be reduced if an external ground is used. Most receivers have a ground terminal located on the rear apron (see Fig. 2-7).

A six-foot steel rod driven into moist earth makes an excellent ground. A short piece of No. 12 or No. 14 copper wire between the metal rod and the ground terminal on the receiver will be satisfactory. A ground connection to a nearby water pipe might give only fair results. Plumber's sealing compound applied to the threads of the pipe during installation may act as a high-resistance connection between lengths of pipe and thereby produce unsatisfactory results.

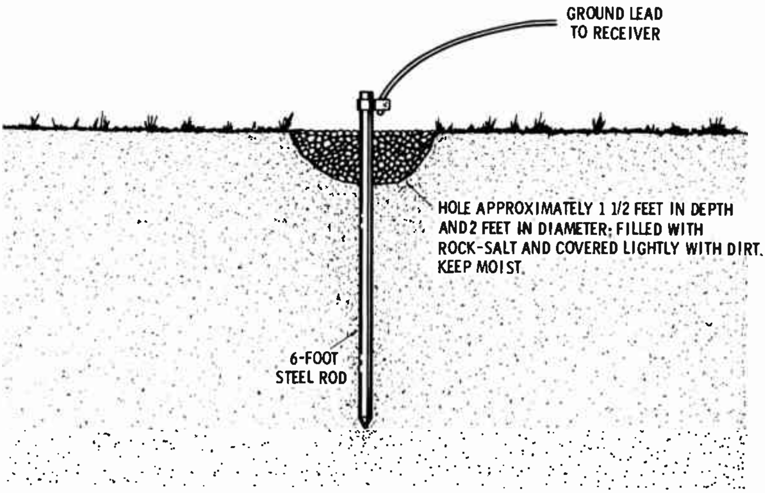


Fig. 2-7. A good ground system.

What Is Static Level on the Short-Wave Bands?

Static, sometimes referred to as atmospherics, is usually caused by local or distant thunderstorms or by electrical discharges. This results in damped waves of an intermittent nature. These waves, depending on their energy level, are disturbing to radio reception. These disturbances are also called *strays, X's,* and other names.

Atmospherics produce various kinds of noise in the radio receiver, such as crashes, and grinding and clicking noises. A continuous hiss is sometimes produced by snow or hail or by magnetic storms. Local lightning produces sharp clicks and crashes.

In the tropics, atmospherics are more evident than they are in cooler climates. Radio communication is sometimes rendered impossible in the tropics because of the severity. The degree of the disturbance caused depends upon the ratio of atmospherics to signal energy, X/S. This ratio is a way of expressing the static level. Radiotelegraph signals can seldom be copied when the ratio X/S is greater than 4. Radiotelephone signals, such as those used in international radio broadcasting, usually become unintelligible when the ratio X/S is greater than 2.

The ratio X/S can sometimes be decreased by the use of directional receiving antennas (see Question No. 40).

Static is caused by the accumulation of electrical charges on the antenna; that is, the source of the disturbance is the antenna conductor itself, as in contrast to atmospherics, which are caused outside of the antenna proper. Static charges are more easily built up in the antenna conductor if it is insulated from ground. When the charge of electrical energy has reached the discharge value, it discharges through the receiver, causing a clicking or crashing noise.

The amount of static that accumulates on a receiving antenna depends on weather conditions. Minimum static accumulates when the air is clear and dry. As the air fills with dust, smoke, or moisture, static electricity is deposited on the antenna wires; the denser the air content, the denser and heavier is the static charge deposited on the antenna, and the greater the disturbance to radio reception.

43 Can I Do Anything to Lessen Static?

The radio lisener can do little to lessen static generated in the atmosphere. There are, however, a few things he can do to reduce man-made static.

1. Erect the receiving antenna as far from power lines as possible.
2. In some instances, the antenna can be erected in a reasonably static-free area and a shielded coax cable can be run through the interference area to the receiver terminals.
3. A receiving antenna cut to the frequency, or at least to the band that is to be operated, will accentuate the received signal, thereby improving the signal-to-noise ratio.

4. As most man-made static is essentially vertically polarized, an antenna with horizontal polarization will give minimum noise pickup. Therefore, a horizontal antenna is recommended wherever possible.
5. An antenna-matching device as described in Question 66 may also improve the signal-to-noise ratio.

44 What Is Wheel Static?

Wheel static is a type of radio noise heard in car radios that shows up at speeds in excess of about 20 miles per hour. It is caused by friction of the tires on the road, and usually occurs on dry, smooth streets. It is characterized by a steady popping noise.

Wheel static can usually be stopped by installing static collectors in the dust covers of the front wheels. Static collectors are small circular springs with a sharp point at the end which bears against the end of the front axle.

45 What Is Automobile Ignition Noise?

The controlled sparking at the spark plugs and distributor terminals of an automobile engine can often cause a high-speed click to radiate as rf energy into the surrounding atmosphere, to be picked up by nearby sensitive radio receivers. This clicking can become very bothersome at higher frequencies. The radiation of this type of interference usually can be reduced to a negligible amount by inserting a high resistance (10,000 ohms) spark suppressor in each spark wire as close to the spark plug as possible. A second suppressor may also be necessary in the center tower of the distributor. These resistors tend to dampen or smooth out the abruptness of the on-off condition of the spark.

In most later-model automobiles, carbon resistance wire is used throughout the entire ignition system. This method is very effective in reducing ignition noise. In fact, in some states, because of the large number of automobiles, the law makes it mandatory to use carbon wire in the ignition system.

46 What Are Lightning Arresters?

A lightning arrester is a device that can be installed in the antenna lead-in wire ahead of its connection to the receiver terminals. It provides a means of dissipating harmlessly to ground the voltage built up on the antenna by a nearby lightning flash.

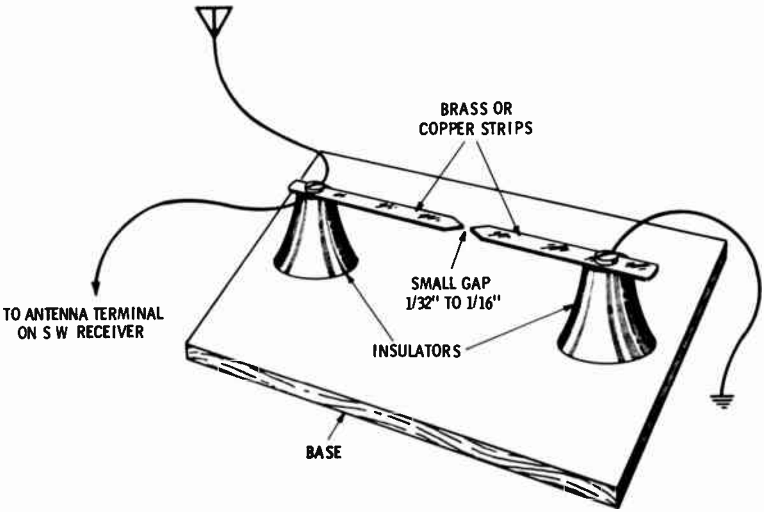


Fig. 2-8. Lightning arrester.

A lightning arrester usually consists of two sharp-pointed copper rods mounted point-to-point in an insulated material with a small gap existing between them. Experiments with lightning phenomena have revealed that a sharp pointed metal object will divert high-voltage discharges to ground. By mounting two such objects in proximity to each other, a lightning flash can be made to discharge itself across the gap, eliminating the possibility of damage to the radio receiver. A simple lightning arrester can be made from two standoff insulators and two pieces of ½″ by ½″ or ¼″ by ¼″ brass or copper strips mounted as shown in Fig. 2-8.

Part 3

Short-Wave Reception

47 What Is the Best Radio Receiver for Receiving Short-Wave Stations?

In the early 1930s, the only type of receiver available was a type called the "regenerative autodyne" (see Fig. 3-1). In a regenerative receiver, the radio-frequency energy carried in the plate circuit of the detector is used for radio-frequency amplification of the received signal by a feedback of radio-frequency voltage to the grid of the tube through an inductive feedback system.

In the figure, coil L2 is used to feed back the signal voltage in the plate circuit to the grid coil L1. This produces a greatly amplified signal variation and, consequently, a louder response in the headphones.

This type of a receiver left much to be desired. Therefore, with the continuing advance in the state of the art and the ever increasing number of transmitting stations on both medium wave as well as short wave, it became apparent that the sensitivity and selectivity of the regenerative receiver was insufficient, and that a more sophisticated method of reception was necessary. From this need, the "superheterodyne receiver" resulted.

The superheterodyne receiver, Fig. 3-2, utilizes a very different type of detection. A received signal, let us say 5000 kilohertz is passed through the rf amplifier into the *mixer* circuit. Here it is "mixed" with a high frequency oscillator signal, usually 455 kilohertz higher in frequency than the incoming signal—in this case 5455 kilohertz. The two signals combine in the mixer circuit to form a third frequency—the mathematical difference between the two, or 455 kilohertz. The circuits

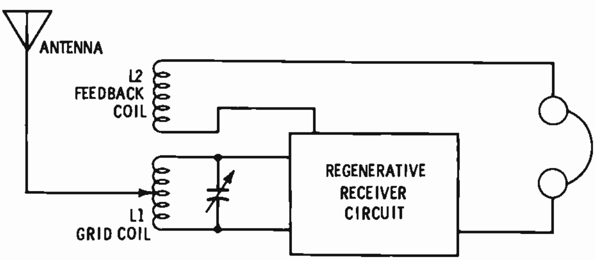


Fig. 3-1. Diagram of regenerative receiver.

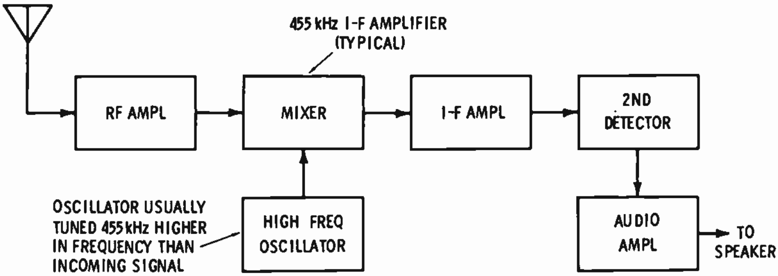


Fig. 3-2. Block diagram of superheterodyne receiver.

of the new "intermediate frequency" amplifier are tuned to the new frequency. The signal is amplified in the i-f amplifier, rectified, and passed on to the audio amplifier.

The tuned circuits in the front end of the receiver are mechanically connected together so as to maintain the 455-kilohertz difference on all of the tuned frequencies. At the 455-kilohertz frequency of the i-f amplifier, it is possible to obtain considerably greater amplification and selectivity than in the regenerative receiver. The superheterodyne principle of reception is used by all modern short-wave receivers.

48 Do I Need An Expensive Receiver to Receive Short-Wave Stations?

No. Although it is preferable, an expensive receiver is not necessary to receive short-wave stations.

Short-wave receivers, as with anything else, vary greatly in price. Several companies have inexpensive "kits" for sale from which you can assemble your own receiver. These can be bought for as low as $15. Whereas an inexpensive receiver such as this leaves a lot to be desired, many short-wave stations can be heard and many hours of enjoyment can be had from owning one. Short-wave receivers in the medium price field can be purchased for between $50 to $150. Some produce very good results. Receivers in the $150 class and above can be considered in the excellent class, possessing many extra features that go to make up a truly fine radio receiver.

It is best that you visit a local radio store and operate the various receivers that are on display, then choose one that seems to satisfy your requirements and your pocketbook.

49 Are the New Transistor Portable Receivers Considered Good?

The principal advantage of the transistor receiver is its low voltage and current requirements. For convenience of use, some of them are also designed to operate on 115 volts ac as well as on internal batteries. The second advantage (but of lesser importance) is its small size as compared to the vacuum-tube receivers. The quality of the received signal, the selectivity, and the sensitivity of the rf and i-f amplifiers compare favorably with the vacuum-tube receiver, if the intermediate-frequency and radio-frequency amplifiers are of the multistage type. More transistor stages are usually required to obtain the same relative signal amplifications as compared to tube-type receivers.

When choosing a transistor-type short-wave receiver, determine that it has at least one stage of rf amplification ahead of the mixer circuit. Amplification and selectivity preceding the mixer stage is a "must" in short-wave receivers. Determine also that the transistor receiver has at least two (preferably three) stages of i-f amplification. Two stages will afford a minimum of intermediate-frequency amplification.

If reasonable care is taken in selection, a transistorized short-wave receiver can give satisfactory performance.

50 What Are the Advantages of the Superheterodyne Receiver?

The advantages of this type of receiver are attributed to the use of a fixed-tuned intermediate-frequency amplifier. Since all incoming signals, regardless of their frequency, are converted to the i-f, this section of the receiver may be designed for optimum selectivity and amplification without resorting to extremely complicated tunable band-pass arrangements or a large number of stages, which would be necessary if the signal-frequency tuning circuits were designed to have a comparable degree of selectivity and gain.

A second advantage is that high amplification is easily obtained in the i-f amplifier since it is operating at a relatively low frequency, where conventional tubes and transistors can provide a great amount of usable gain, more than could be obtained at the higher short-wave frequencies.

51 What Is Dual Conversion?

As described in Question 30, the received signal in a superheterodyne receiver is combined with a local-oscillator signal to produce an intermediate frequency, usually 455 kilohertz. This relatively low intermediate frequency is suitable for reception of radio signals up to about 10 megahertz, but at higher frequencies, a very bothersome condition called image response arises.

An image frequency can best be described by an example: Let us assume that a radio signal of 15,000 kilohertz is to be received. The local oscillator must be adjusted to 15,455 kilohertz to get an intermediate frequency of 455 kHz. However, if a sufficiently strong signal at 15,910 (15,455 + 455) kilohertz is on the air, and the front end of the receiver is lacking in selectivity, it too will produce a 455 kilohertz signal which will be passed on to the i-f amplifiers and the receiver speaker.

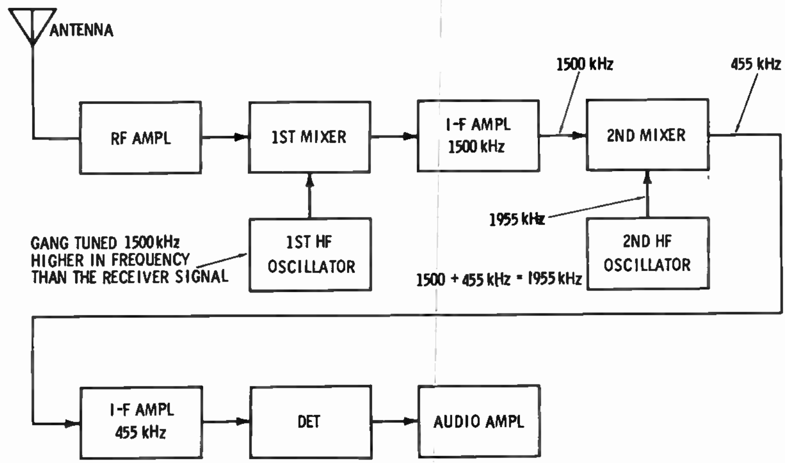


Fig. 3-3. Block diagram of dual-conversion short-wave receiver.

This very bothersome condition can be eliminated in two ways: One—several rf amplifier stages can be installed ahead of the mixer circuits with their tuned circuits providing additional selectivity to the received frequency; two—an intermediate frequency of 1500 kilohertz or more can be used, thus increasing the frequency difference between the desired frequency and the undesired one, and thereby lowering the signal strength of the unwanted signal.

When a high intermediate frequency is chosen in this manner, the signal is usually converted a second time to the lower 455 kilohertz frequency so that additional amplification can be obtained. This is known as "dual conversion" (see Fig. 3-3).

52 What Is A Radio Converter?

For receiving amplitude-modulated short-wave radio signals, an ordinary broadcast-band receiver can be used in conjunction with a short-wave *converter*. A converter usually consists of an rf amplifier, mixer, and local oscillator, so constructed as to couple the desired short-wave radio signal into the antenna connector of the car radio or home broadcast set (see Fig. 3-4). In actual operation, the broadcast receiver is set to a frequency near 1600 kHz. The converter is then tuned to the desired short-wave frequencies. In this manner the broadcast receiver performs a function not unlike the i-f amplifier of a regular receiver.

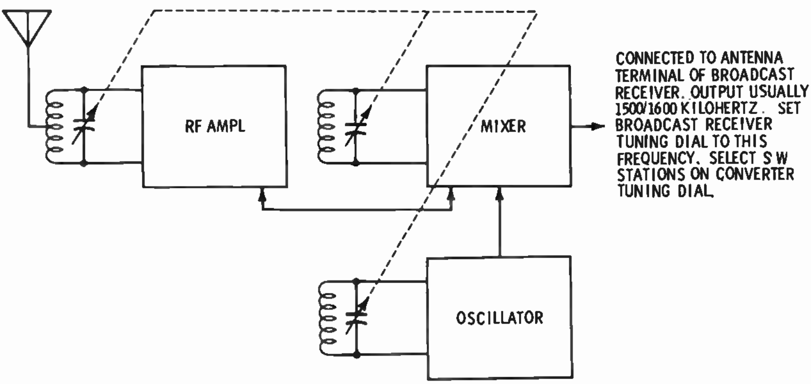


Fig. 3-4. Block diagram of short-wave converter.

53 What Is Single Sideband?

As will be explained in Question 60, the process of modulating a carrier sets up new groups of radio frequencies both above and below the frequency of the carrier itself. These new frequencies that accompany the modulation are called *sideband frequencies*, and they are numerically equal to the carrier frequency plus the modulating frequency, and the carrier frequency minus the modulating frequency. The frequency bands occupied by a group of them when the modulating frequency is complex are called *sidebands*. The band higher than the carrier frequency is called the *upper sideband*. The band lower than the carrier frequency is called the *lower sideband*. The modulation (that is, the intelligence) in the signal is carried in *both* sidebands.

In later years, with advanced electronic technology and with the need to reduce bandwidth in order to accommodate more stations, engineers have been able to remove the *carrier* and *one of the sidebands*, without affecting the overall intelligence of the signal. This type of modulation is presently being used by radio amateurs and some public-safety transmitters and will very probably become more popular in the future.

Some of the more expensive receivers available to the short-wave listener have built-in circuitry to permit single-sideband reception, with a switch to control either upper sideband or lower sideband.

54 Are There Any Special Places in the Home That Are Better Than Others for Short-Wave Reception?

A short-wave receiver can be operated in about any part of the home. The location of the receiver is chiefly a matter of preference. However, a few considerations should be observed. Because reception of international broadcast signals from foreign countries can be enjoyed by the entire household, the living room or den would be a very good place to locate the receiver.

Also, because an outside antenna is preferable to receive the very weak signals, the receiver should be installed near a window; this permits easy access for the antenna lead-in wire and ground.

If the short-wave enthusiast is also handy at woodworking, he might consider constructing a built-in shelving for the receiver and external speaker, or perhaps a bench or table as shown in Fig. 3-5.

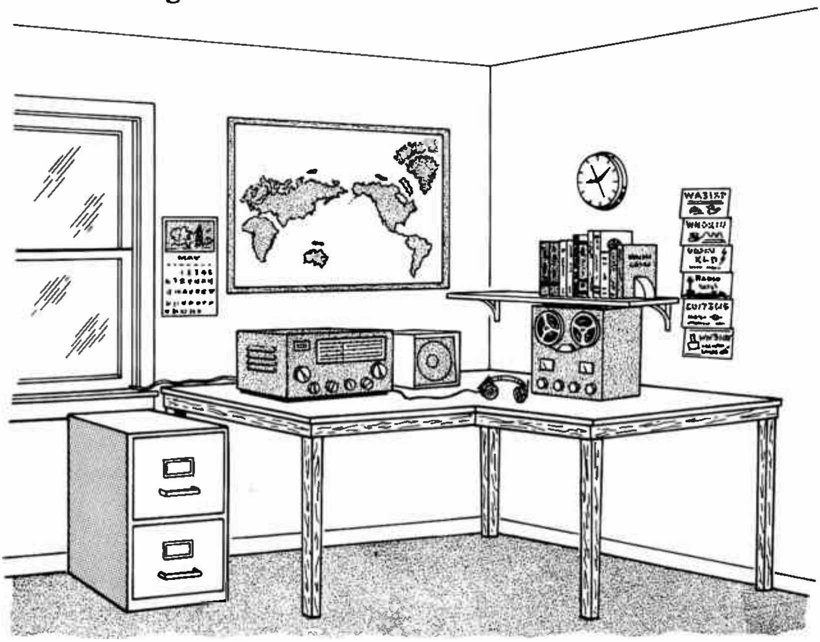


Fig. 3-5. Setup for short-wave listening in the home.

Consideration should be given to the locations of a 115-Vac wall socket if the receiver is ac operated. A good wall map mounted nearby can be of great help in locating some of the smaller countries, and will add to the overall pleasure of the hobby.

55

Can A Television Receiver Cause Interference to a Short-Wave Receiver?

In some cases, a nearby television receiver can cause oscillator signals to appear across the tuning range of a short-wave receiver, especially noticeable when the BFO control is turned on. The cw "whistles" are spaced approximately 15 kHz apart and are more pronounced on the high frequencies. They are harmonics of the horizontal oscillator that provides the high voltage and raster for the picture.

The only cure is to either turn off the TV receiver or move the short-wave receiver as far away as possible.

56

Are Any Special Precautions Necessary When Tuning the Short Waves?

The most important precaution that must be taken when tuning the short waves is to tune the desired band very slowly, especially if one is using a receiver that does not have a bandspread feature. The percentage of frequency band coverage is proportionately greater as the frequency increases. Therefore, for a given dial rotation, more kilohertz will be covered on the short waves than will be covered on the broadcast band.

Therefore, it is essential that a short-wave listener tune *very* slowly through the desired frequencies, or he will pass over some of the signals.

Part 4

Receivers and Receiver Controls

57 What Is a General-Coverage Receiver?

Some receivers are designed to cover certain designated short-wave bands or portions of the short-wave spectrum, such as amateur radio bands, or the international short-wave broadcasting band, or the marine radiotelephone bands. Other receivers are designed to cover a large portion of the short-wave frequencies. These types of receivers, usually designed to cover continuously from 1600 kilocycles to 30 megacycles, are known as "general coverage receivers."

In most cases, a general-coverage receiver has in conjunction with the main tuning dial a second tuning dial having a very narrow tuning range. The second dial is used for fine tuning.

58 Is It Possible for Me to Build My Own Short-Wave Receiver?

Although most short-wave listeners buy ready-made short-wave receivers, it is not necessary to do so. If he has the electronic talent, a short-wave listener may build his own receiver from parts purchased from a local radio-parts house, using a schematic or wiring diagram. Unfortunately, however, this requires a great deal of engineering ability and, for the most part, can be considered beyond the capability of the average short-wave listener.

There are, however, several electronics companies (Knight, Heathkit, and Lafayette) which sell short-wave receivers and other electronics equipment in the form of "kits" in which all parts are included with easy-to-follow wiring and assembly instructions. These can be put together with a minimum amount of electronic know-how and the end product is very good. The kits are modestly priced and worth looking into by those who have to watch their cash outlay for a short-wave receiver. Kit-type receivers are included in the appendix at the end of this book.

59 What Are Bandset and Bandspread Tuning?

To extend the tuning range of some receivers while at the same time retaining some degree of bandspread, some receiver manufacturers connect two tuning capacitors in parallel across the tuning circuit in the front end of a short-wave receiver. The bandspread capacitor is somewhat smaller than the bandset capacitor (see Fig. 4-1). The bandspread capacitor is used to tune across the desired frequency for fine tuning. The bandset capacitor is used to cover a large portion of the tuning spectrum and is set near the desired frequency. Since the tuning range of a tuned circuit is proportional to the ratio of the maximum to minimum capacity across it, a wide variation in the amount of bandspread is made possible by the proper choice of the two capacitors.

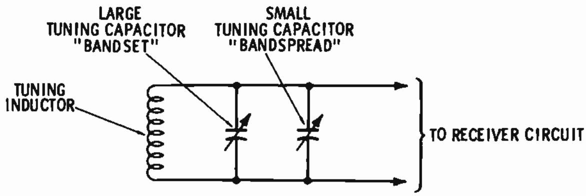


Fig. 4-1. Bandset and bandspread tuning circuit.

60 What Is Amplitude Modulation?

The system of modulation most widely employed at the present time for the transmission of voice and music by international short-wave broadcasting stations is *amplitude* modulation. This is a form of radiotelephone transmission whereby music or the human voice is superimposed on a basic carrier frequency by maintaining a constant carrier frequency but increasing and decreasing the amplitude of the signal at an audible rate.

When a carrier wave is modulated by an audio frequency, a result of the process of modulation is the production of additional frequencies that are equal to the sum of the carrier and the modulation frequency, and the difference between the two frequencies. For example, if the carrier frequency of an international short-wave broadcasting station operating in the 31-meter band on 9600 kilohertz is being modulated by a frequency of 5000 hertz (5 kHz), two sidebands are formed, one on either side of the carrier frequency. One equals the sum of the two frequencies, 9605 kHz, and the other equals their difference, 9595 kHz.

If the signal modulating the carrier consists of a number of different frequencies, as is the case in a broadcasting station, sidebands are formed by each of the modulating frequencies. The signal radiated by the short-wave transmitter will occupy a band of frequencies including the carrier and the highest modulation frequency on either side of the carrier frequency. One equals the sum of the two frequencies, 9605 kHz, and the other equals their difference, 9595 kHz.

If the signal modulating the carrier consists of a number of different frequencies, as is the case in a broadcasting station, sidebands are formed by each of the modulating frequencies. The signal radiated by the short-wave transmitter will occupy a band of frequencies including the carrier and the highest modulation frequency on either side of the carrier. Or, in the example just given, from 9595 to 9605 kilohertz. Thus, the total band taken up by the transmitted signal would be

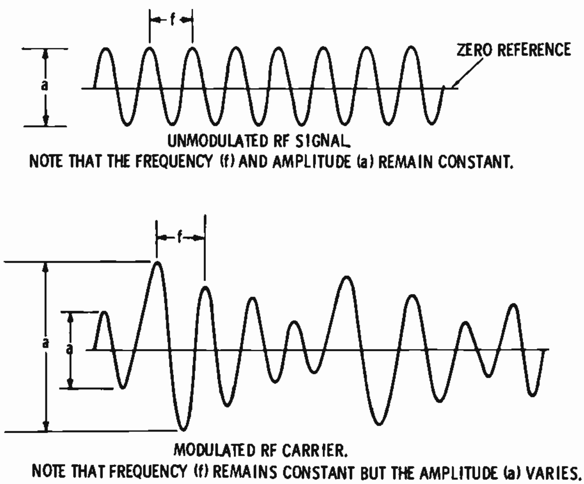


Fig. 4-2. Amplitude modulation.

twice the modulation frequency, or 10,000 hertz wide. For good musical fidelity, a response of at least 5000 to 6000 Hz is required.

Fig. 4-2 illustrates an amplitude-modulated signal. When this signal is detected and amplified at the receiver, the carrier is filtered out, leaving the superimposed intelligence.

61 What Is Frequency Modulation?

This type of modulation is similar to amplitude modulation only in that it is intelligence impressed on a radio-frequency carrier wave. In this method of transmission, the amplitude of the transmitted wave is made to remain constant but the frequency is shifted back and forth across a mid-frequency at an audible rate (see Fig. 4-3). When this signal is detected at the receiver, the intermediate frequency is moved above and below its mid-point. The fluctuating i-f voltage is rectified and passed on to the audio amplifiers.

Because of the greater bandwidth needed for fm transmission, this type of communication is used exclusively on the higher frequencies.

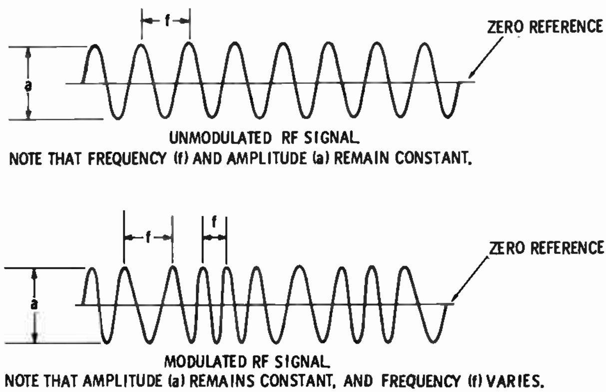


Fig. 4-3. Frequency modulation.

62 What Is the Bandswitch on a Short-Wave Receiver?

As stated earlier, there are seven bands of international short-wave broadcasting stations scattered throughout the short-wave spectrum. To cover these widely separated tuning areas with one sweep of the tuning dial would for many reasons be impractical. The chief reason is that each band of stations would be compressed into a very small portion of the dial, making it nearly impossible to separate the individual stations.

To eliminate this condition and establish a more usable arrangement, it is necessary to divide the short-wave spectrum into smaller individual segments each covering a relatively small number of kilohertz. The bandswitch on a short-wave receiver does just this. It switches different inductors into the tuning circuits so that each may be tuned with a small tuning capacitor, and tuning is made more practical. The bandswitch usually divides the short-wave frequencies into from three to five segments. The tuning range of each switch position is usually labeled on the front panel of the receiver.

63 What Is the Difference between the Volume Control and the Gain Control?

Some of the more sophisticated communications receivers have both an rf GAIN control and a VOLUME control.

Audio amplifiers are employed in nearly all short-wave receivers. The audio stages follow the second-detector circuitry in superheterodyne receivers, as shown in Fig. 4-4. The volume control consists of a variable carbon resistor installed between the second-detector stage and the first audio stage. By rotating the control in a clockwise direction, more audio voltage can be impressed on the grid of the audio stages, thus increasing the volume.

The rf gain control is usually a variable resistor installed in the cathode circuit of the rf amplifier ahead of the first detector or mixer, as shown in the figure. This variable device ad-

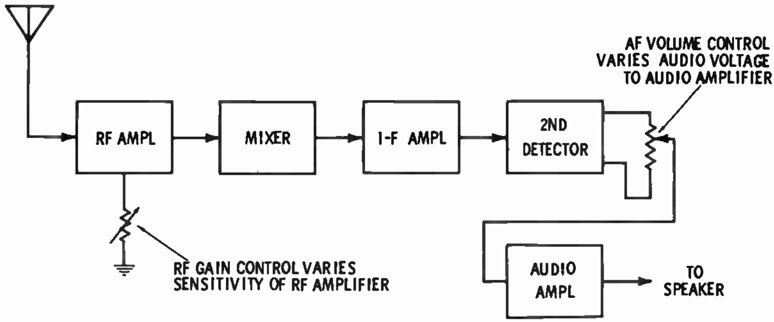


Fig. 4-4. Block diagram showing gain and volume controls.

justs the "gain" or amplification of the incoming signal before it reaches the remainder of the receiving circuitry. In this manner, strong signals can be prevented from overloading the receiver circuits.

64 What Is an Antenna Trimmer?

Most of the better short-wave receivers have at least one rf amplifier. At least one stage is considered essential. This rf stage of the receiver is usually "gang-tuned" with the mixer and oscillator stages. Antennas of different lengths and different characteristics, when connected to the receiver (or rf amplifier), will tend to detune the antenna stage. The antenna

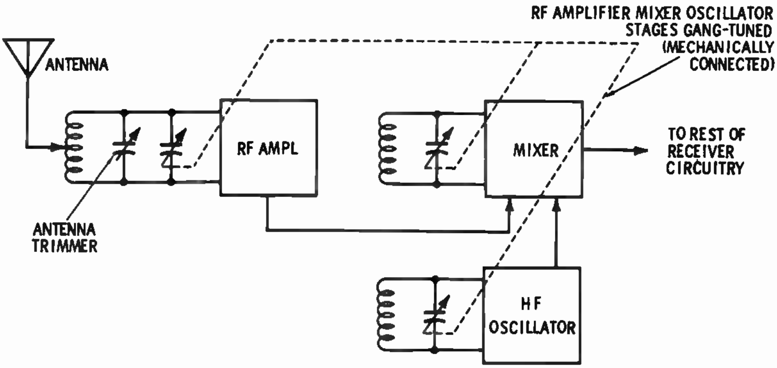


Fig. 4-5. Diagram showing use of antenna trimmer.

trimmer capacitor is connected across the antenna stage as shown in Fig. 4-5. Adjusting it will bring the antenna or rf stage back in tune.

65 What Is the BFO Control on a Short-Wave Receiver?

The beat frequency oscillator, usually called the BFO, is a necessary added feature to a short-wave receiver for the reception of cw radiotelegraph signals on a superheterodyne circuit. The BFO is coupled into the second-detector circuit of the receiver, as shown in Fig. 4-6, and supplies a signal voltage of nearly the same frequency as that of the intermediate frequency. If the i-f amplifier, for example, is tuned to 455 kHz and the BFO is tuned to the 456 kHz, the two signals beat together to produce an audible tone of 1000 hertz in the output of the second detector. Cw signals are detected in this manner. It can also be used as an aid in tuning very weak signals.

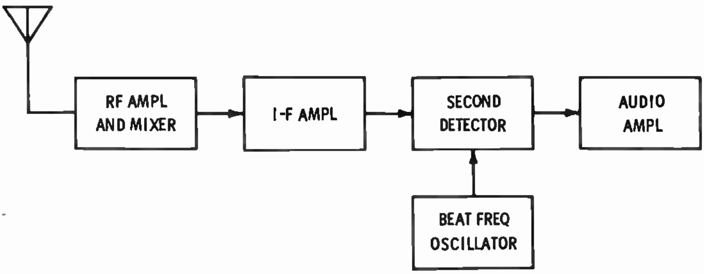


Fig. 4-6. Block diagram of superheterodyne receiver with BFO.

66 What Is an Antenna Tuner?

In many instances, reception can be improved by the addition of an antenna coupler or antenna tuner, installed between the antenna lead-in and the antenna terminals located on the receiver. This device "tunes the antenna" to the desired frequency, thereby making it more receptive to the incoming signal on a particular frequency. Such a device is shown in Fig. 4-7.

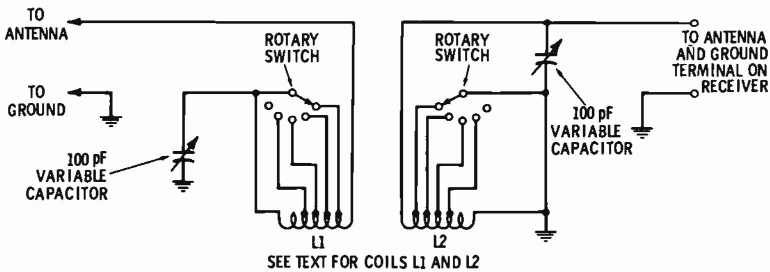


Fig. 4-7. Essentials of an antenna tuner.

Coils L1 and L2 are wound on a ¾-inch diameter polystyrene, mica, or cardboard form, end to end. There are approximately 10 turns for L1 and a like number for L2. Taps are brought off at 3 turns, 6 turns, 7 turns, 8 turns, and at the end of each coil. Leads are soldered to a rotary tap switch. Each coil is shunted by a 150 pF capacitor.

The antenna tuner is tuned by first adjusting the tap switch, then swinging the tuning capacitors completely through their tuning ranges, picking the adjustment that allows the best and loudest reception of the signal. The parts may be mounted on a piece of varnished plywood, peg board, or metal chassis. The layout is not critical. However, the leads should be kept as short as possible.

67 What Is a Frequency Meter?

A frequency meter is an electronic device that when used in conjunction with a short-wave receiver will provide the operator with a means of measuring the frequency of the incoming signal with a high degree of accuracy.

Most of the moderately priced receivers have receiver dial calibrations in the order of every 500 kHz or more. Some of the more expensive units provide logging to within 50 kHz or so. For precision calibration, this degree of error is unacceptable. Therefore, it is necessary to use a device of precision quality to determine the exact frequency. The frequency meter is such a precise instrument.

The frequency meter usually consists of an oscillator with an extremely high degree of rigidity built into it. It further offers a very large degree of bandspread and finely calibrated dial divisions. With these features, plus a very stable electronic circuit, it is possible to measure frequency with extreme accuracy.

68 What Is Automatic Volume Control?

Automatic volume control (avc), also known as automatic gain control (agc), is electronic circuitry that automatically regulates the volume of an incoming radio signal to prevent "blasting." Because short-wave signals are sometimes subject to rapid fading, this feature is included in most short-wave receivers.

The output volume of a radio signal is usually controlled in a short-wave receiver by rectifying a portion of the rf carrier level of the station being received and applying it as a negative "bias" to the rf and/or i-f amplifiers of the receiver. If atmospheric conditions should tend to make the signal level stronger, the negative bias voltage would also increase. A negative voltage applied to the rf and i-f amplifiers of a receiver would *decrease* their amplification, thus lowering the volume of the signal. In this manner, the receiver volume is held relatively constant.

69 What Is Automatic Frequency Control?

Automatic frequency control (afc) is electronic circuitry incorporated in a few receivers that tends to keep the receiver automatically tuned to a particular station frequency. This feature is used primarily on the higher frequencies, especially on the fm channels. A sample of the incoming radio signal is rectified and applied to the local oscillator. The center frequency is set at "zero" voltage. A tendency for the signal to drift in one direction produces a positive voltage. A drift in the other direction produces a negative voltage. This positive or negative voltage when applied to the local oscillator in the receiver causes the receiver to automatically adjust its "tuning" in the opposite direction of the drift, thus causing the receiver to adjust back on tune.

70 What Is a Noise Limiter?

In addition to tube and circuit noise, much of the noise interference experienced in the reception of high-frequency signals is caused by domestic electrical equipment and by automobile ignition systems. This type of noise is characterized by a "pistol shot" or "machine gun" sound, consisting of separated impulses of high amplitude.

Impulse noise, because of the extremely short duration of the pulses as compared to the time between them, must have high pulse amplitude to contain much average energy. Hence, noise of this type strong enough to cause much interference generally has an instantaneous amplitude much higher than that of the signal being received.

Noise peaks such as those described are usually eliminated or reduced in the second detector stage of the receiver by applying a voltage proportional to the *average* signal level to a series "valve" circuit. The average voltage obtained from the signal opens the "valve" or receiver limiter circuit by a prescribed amount. When a high-amplitude noise burst comes through the receiver it is instantaneously shorted to ground. Fortunately, the noise impulse is of such short duration that the blank space or "hole" in the desired signal is unnoticed.

71 What Are Crystal Selectivity and Crystal Phasing?

The selectivity characteristic of a short-wave receiver is its ability to pass the desired signal through its i-f amplifiers with a reasonably good fidelity while rejecting all adjacent signals. To obtain even a fair degree of fidelity to international broadcast stations, the bandwidth of the i-f amplifiers must be at least 5 kilohertz, but the "skirts" must drop off abruptly. With the short-wave bands becoming increasingly crowded, the satisfactory rejection of unwanted signals has become nearly impossible with the conventional i-f amplifier receiver system.

The most satisfactory method of obtaining high selectivity is by the use of a quartz crystal as a selective filter in the i-f amplifier. Compared to a good tuned circuit, the "Q" (or the ability of the circuit to reject adjacent signals) is extremely high. The crystal is ground so that it resonates at the desired intermediate frequency, and is used as a selective coupler between i-f stages.

The crystal-selectivity control provides a means of adjusting the degree of receiver selectivity. The crystal-selectivity feature is usually found in the more expensive short-wave receivers. The phasing control provides a means of varying the resonant frequency of the circuit over a considerable range.

72 What Is a Frequency Calibrator and What Is It Used For?

Because of the over-crowded conditions that exist on the short-wave bands and because of the lack of precise tuning-dial calibration on most receivers, some means should be used to establish a few known frequencies across the tuning dial of your receiver. The most commonly used device is a crystal-controlled oscillator whose natural frequency and harmonics are precisely oriented on certain known frequencies. Without such a calibrated crystal oscillator, it would be difficult to spot a particular frequency.

Usually an oscillator of this type provides an rf signal every 100 kHz across the entire tuning range of the short-wave receiver. Although this does not make possible the exact measurement of an unknown frequency, it is quite possible to estimate the unknown frequency if it is compared with the known oscillator. Counting the number of dial divisions between the two adjacent 100-kHz points on the tuning dial and dividing the number by 100 to find how many kilohertz there are per receiver dial division will give you reasonable accuracy.

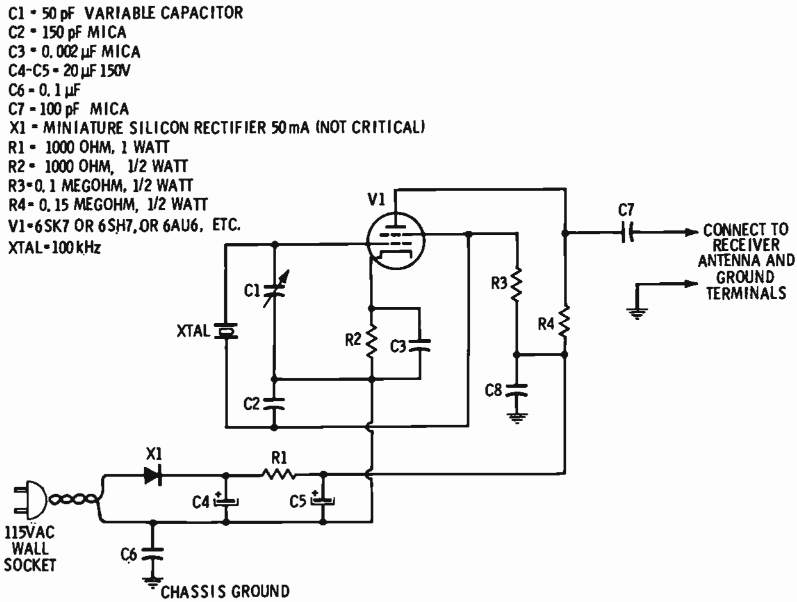


Fig. 4-8. Schematic of a frequency calibrator.

Frequency standards are available in kit or preassembled form at most radio-parts stores for a reasonable price. If you desire to build one of your own, Fig. 4-8 is a simple schematic. The parts may be purchased from any radio-parts wholesale house.

73 Does Speaker Size Affect Fidelity?

Speakers used in short-wave receivers are nearly always of the low impedance, permanent-field, magnetic type, with the output terminals of the audio amplifiers of the receiver connected directly to the voice coil.

For reasonably good fidelity, a speaker should be at least five inches in diameter. Of equal importance, however, is the size and weight of the permanent magnet used for the field. To withstand a fair amount of volume for extended periods of time, a speaker should have at least a 1½-ounce magnet. A speaker should be mounted in a suitable enclosure if full frequency response is to be obtained.

74 What Are Headphones?

The function of headphones, as with the speaker, is to make audible the rectified high-frequency oscillations delivered by the detector or audio amplifier of the receiver. The advantage in using headphones is that they afford means whereby one may listen to a radio in private. In the magnetic type of headphone, the signal voltage is applied to a coil or a pair of coils having a great many turns of very fine wire wound on a permanent magnet. A thin, circular diaphragm of iron is placed close to the open ends of the magnet. It is tightly clamped by the earpiece assembly around its circumference, and the center is drawn toward the permanent magnet under some tension.

When there is alternating current in the windings of the field, the current alternately aids and opposes the steady field of the permanent magnet so that the diaphragm alternately is drawn nearer to the magnet, then is allowed to spring farther away from it. Motion of the diaphragm sets the air into corresponding vibrations. Its operation is quite similar to that of the speaker, but on a much smaller scale.

In recent years, headphones have been made very small—so small, in fact, that they may be placed directly in the ear.

75 What Is the "S" Meter?

The "S" meter, often called a signal-strength indicator or tuning indicator, is usually a milliammeter installed in the better short-wave receivers to provide a visual indication of the strength of the received radio signal. The kind usually found on modern receivers has a face marked with numerals 0 through 9, as shown in Fig. 4-9. These are known as "S" units; each represents approximately a 3-decibel increase in signal strength above the preceding "S" number. When a radio receiver is tuned across an incoming signal, the needle on the "S" meter will rise from zero to some higher value and then drop off as the tuning dial is rotated through the signal. The

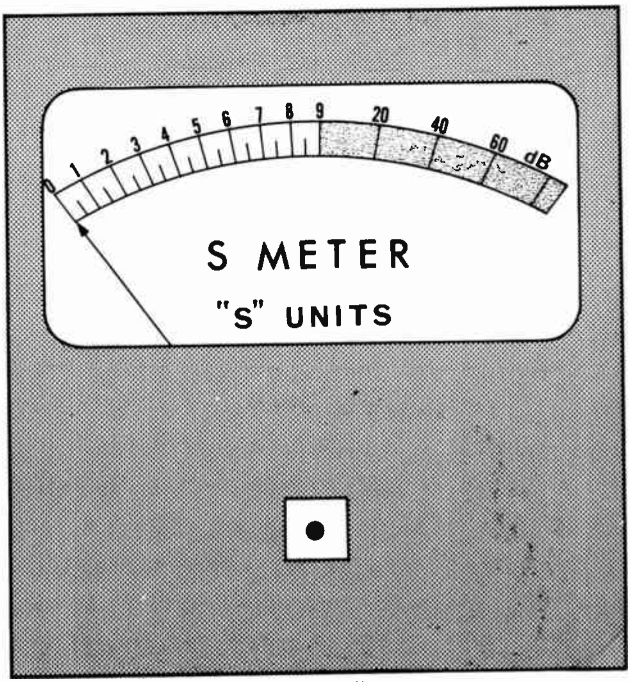


Fig. 4-9. Typical "S" meter.

point indicated by maximum deflection of the needle indicates the "on" tuning condition. A tuning indicator of this type is usually installed in the screen-grid circuit of the i-f and/or rf circuits that are controlled by the automatic-gain control system of the receiver. Since the agc voltage generated by the received signal is proportional to its strength, the i-f or rf circuits become a good measuring device.

The indicating range of some "S" meters is extended beyond the S-9 indication with numerals up to about 40 or 50. These indicate a signal in excess of S-9, as, "20 dB over S-9."

76 What Is Audio-Amplifier Distortion?

Distortion can be rather broadly defined as any unwanted change in the original signal. Often, the distortion takes the form of additional frequencies that are harmonics of the applied frequencies.

The total distortion in any amplifier is practically dependent upon the magnitude of the second-, and, to a lesser degree, the third-harmonic frequency components. Although it is possible to reduce these components by operating the amplifier circuit at reduced volume level, the harmonic can never be completely eliminated in the single amplifier.

If the combined second- and third-harmonic frequency energy components do not exceed more than 5 percent of the fundamental frequency, a minimum degree of distortion may be expected.

77 What Is Push-Pull Audio Amplification?

The audio amplifier in most short-wave radio receivers has a single tube or transistor in the final power-amplifier output circuit. A single-ended amplifier such as this will produce a fair amount of volume, but with about 8- to 10-percent distortion because of its unbalanced condition. If more volume is

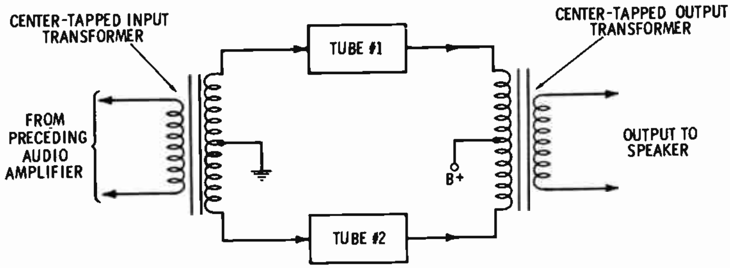


Fig. 4-10. Diagram of a push-pull audio amplifier.

required or if low distortion is desired, a system of amplification known as push-pull amplification is generally used.

If the input power to an amplifier is divided by a center-tapped input transformer, as shown in Fig. 4-10, with the voltage applied alternately to one tube or transistor, then to the other, a balanced input circuit can be achieved. If the outputs can then be applied across a similarly constructed output transformer, the output can be considered symmetrical.

The asymmetrical condition of a single stage or circuit will usually produce a signal component having twice the frequency of the fundamental. This is called the second-harmonic frequency. Obviously, the combining of the fundamental and harmonic frequencies will produce distortion. In the push-pull amplifier, it is possible to balance out this second-harmonic frequency so that the fundamental frequency alone will be present in the output secondary winding and consequently in the speaker.

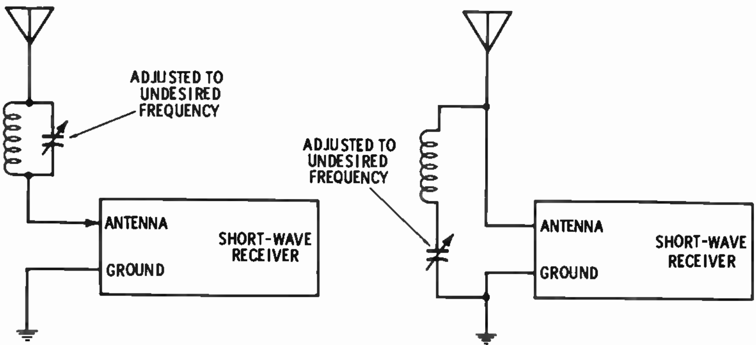
78 What Is Power Regulation and Why Is It Important in Short-Wave Listening?

Power regulation, when used in this sense, means the ability of the 115 V ac power supplied by the local power company to remain at exactly 115 volts under varying load conditions. A fluctuating line voltage will cause a fluctuation of the voltage available in the short-wave receiver. This, in turn, causes the local oscillator to shift frequency, detuning the receiver. Later models of ac-operated receivers are equipped with voltage-regulator circuits that tend to nullify the effect of this voltage fluctuation by stabilizing the internal voltage.

79 What Are Wave Traps?

It is sometimes necessary to introduce additional tuned impedance in the antenna circuit that will offer high or low reactance at certain frequencies, thus making it possible to accept or reject these frequencies, as desired. This is made possible by the use of wave traps.

Fig. 4-11A illustrates a parallel-tuned wave-trap circuit that may be designed to eliminate undesirable frequencies by adjusting the parallel-resonant trap circuit (L1-C1) to that of the rejected frequency, while the tuned circuits of the receiver are tuned to the desired signal.



(A) Parallel-tuned. *(B) Series-tuned.*

Fig. 4-11. Two types of wave trap.

Fig. 4-11B illustrates a series-tuned wave-trap circuit. This type of wave trap is connected between the antenna and ground terminals of the receiver. To be effective, the trap circuit L1-C1 must be tuned to resonance at the frequency of the unwanted signal. Under these conditions, the trap offers a minimum impedance to the undesirable signal, thereby bypassing it to ground at the same time that the circuits in the receiver are being tuned to the desired frequency.

80 What Is a Receiver Squelch Feature?

Receiver squelch is a noise-suppression circuit that renders the receiver inoperative when no signal is being received. The use of this arrangement serves to reduce the inherent noises in a modern high-gain receiver.

A tube or transistor is usually connected across the audio circuit of the receiver and is biased so that it renders the circuit inoperative. Upon the receipt of a radio signal, a portion of the avc voltage (see Question 68) is applied to the shorted circuit. The negative avc voltage tends to electrically remove the short circuit and to permit the audio-amplifier stage to operate normally. If the receiver is tuned between stations or if the radio signal is otherwise removed, the amplifier is once again shorted and the speaker is quieted.

The squelch circuit is usually used only on high-frequency police bands or high air-control frequencies.

Appendix

Short-Wave Receivers

The radio receivers illustrated and described on the following pages do not necessarily constitute an endorsement, but serve only as a cross section of the receivers available for short-wave listening. As the reader can see, the receivers range in price from modest to expensive and in electronic workmanship from the simple to the complex. Whatever the listener's desires and pocketbook dictate, the electronic industry can supply.

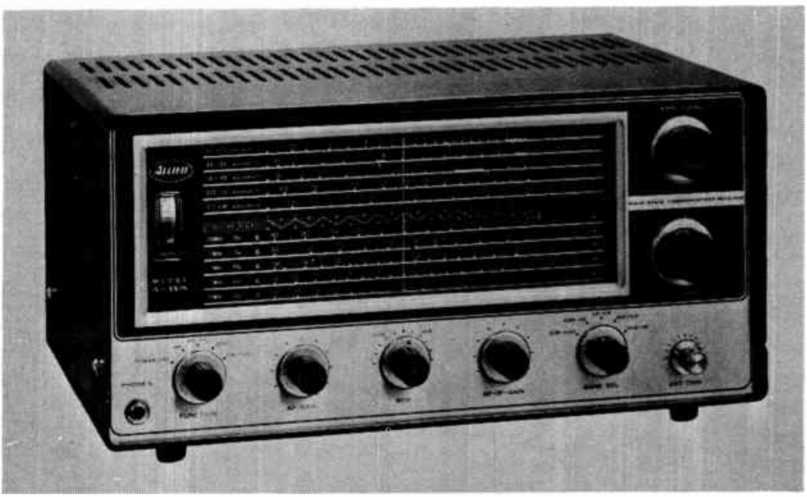
ALLIED MODEL A-2515

The Allied Model A-2515 is an Amateur/SWL receiver. Its solid-state circuit has two field-effect transistors in the rf stage for high sensitivity. It has a large, illuminated slide-rule dial. Four mechanical filters provide good station separation. This model has dual power supplies—117Vac or 12Vdc—and it can be used in the home or in the auto.

SPECIFICATIONS

Band Coverage:
- Band A—150 to 400 kHz.
- Band B—550 to 1600 kHz.
- Band C—1.6 to 4.8 MHz.
- Band D—4.8 to 14.5 MHz.
- Band E—10.5 to 30 MHz.

Sensitivity: 2 microvolts for 10-dB S/N.
Selectivity: 1.5-kHz bandwidth at 6-dB down; 5 kHz at 50-dB down.
Signal-to-noise ratio: 30-dB down.
I-f rejection: 40 dB.
Intermediate frequency: 455 kHz.
Audio output: 1.3 watts.
Power sources: 117 Vac or 12 Vdc.
Power consumption: 10 watts.
Semiconductors: 11 transistors, 12 diodes, and a zener diode.



Courtesy Allied Radio Corp.

Fig. A-1. Allied A-2515 solid-state multiband receiver.

ALLIED MODEL A-2516

The Allied Model A-2516 is an amateur-radio receiver of professional quality with dual-conversion, crystal-control and solid-state features. It covers the 80-to-10 meter bands, plus frequency standard at 10 MHz. It has an antibacklash, double-geared tuning dial that reads directly to 1 kHz and a 28 to 1 dial ratio. This model features a mechanical i-f filter.

SPECIFICATIONS

Band coverage: All amateur-radio bands from 80 meters (3.5 to 4.0 MHz) to 10 meters (28 to 30 MHz).
Sensitivity: 2 microvolts.
Selectivity: 1.5-kHz bandwidth at 6-dB down; 6-kHz bandwidth at 60-dB down.
Signal-to-noise ratio: 30-dB down.
Audio power: 1.5 watts.

Controls and features:
- Main tuning dial
- Bandswitch
- Mode control
- Volume control
- 8-ohm output for external speaker
- 500-ohm output for headphones
- Avc and ANL features for constant-level audio
- S-meter
- Switch for external calibrator

Courtesy Allied Radio Corp.

Fig. A-2. Allied Model A-2516 communications receiver.

COLLINS MODEL 51S-1

The Collins Model 51S-1 is a very good, general-coverage, radio receiver with many fine features, that is capable of receiving signals from 2 to 30 MHz. Available also is a preselector that, when used with this receiver, permits reception down to 200 kHz. This solid-state receiver can operate on 115 Vac or 28 Vdc.

SPECIFICATIONS

Band coverage: Continuous from 2 to 30 MHz in 1-MHz steps.
Sensitivity: 0.6 microvolt.
Selectivity: Optional filters—from 300 Hz to 5 kHz.
Frequency stability: 100 Hz per week.
Spurious response: Not less than 70 dB.
Calibration: 1 kHz per dial division.
Audio output: 1 watt at 10% distortion.
Power consumption: 125 watts.

Controls and features:

- Main tuning dial
- "S" meter
- Mode switch
- Rf gain
- Af gain
- ON/OFF/STANDBY switch
- Rejection tuning

Courtesy Collins Radio

Fig. A-3. Collins Model 51S-1.

COLLINS MODEL 75S-3B

The Collins Model 75S-3B is an amateur-radio band receiver. This model is a precision unit that provides the user with an excellent stability. Through the use of a mechanical filter it offers a variety of selectivity curves. Coverage outside the amateur-radio bands can also be accomplished by the use of additional crystals.

SPECIFICATIONS

Band coverage: Primarily an amateur-radio receiver; however, any 200 kHz range can be tuned with the use of optional crystals (except 5.0 to 6.5 MHz).
Sensitivity: 0.5 microvolt.
Selectivity: 2.1 kHz; optional filters—0.2, 0.5, 0.8, 1.5, 3.1, and 4.0 kHz.
Image rejection: 50-dB down.
Calibration accuracy: 1 kHz.
Frequency stability: 100 Hz per week.
Audio output: 3 watts.
Power source: 115 Vac.
Power consumption: 40 watts.
Transistor circuitry.

Courtesy Collins Radio

Fig. A-4. Collins Model 75S-3B.

Controls and features:

- Main tuning dial
- Bandswitch
- Gain control
- Rejection tuning
- BFO control
- "S" meter
- Preselector tuning
- Mode switch
- Phone jack
- ON/OFF switch

DRAKE MODEL SPR-4

The Drake Model SPR-4 is designed especially for short-wave listening to the international short-wave broadcast bands. The receiver has a crystal-controlled first i-f and tunes the short-wave bands in 500-kHz segments. Dual power supplies can be used on 115 Vac, 220 Vac, or 12 Vdc.

SPECIFICATIONS

Band coverage:

- Band A—0.5 to 1.0 HMz.
- Band B—1.0 to 1.5 MHz.
- Band C—6.0 to 6.5 MHz.
- Band D—7.0 to 7.5 MHz.
- Band E—9.5 to 10.0 MHz.
- Band F—11.5 to 12.0 MHz.
- Band G—15.0 to 15.5 MHz.
- Band H—17.5 to 18.0 MHz.
- Band I—21.5 to 22.0 MHz.

Sensitivity: Better than 2 microvolts.
Selectivity: Selectable—0.4 kHz, 2.4 kHz, and 4.8 kHz.
Intermediate frequency: 1st—5645 kHz, 2nd—50 kHz.

Courtesy R. L. Drake Company

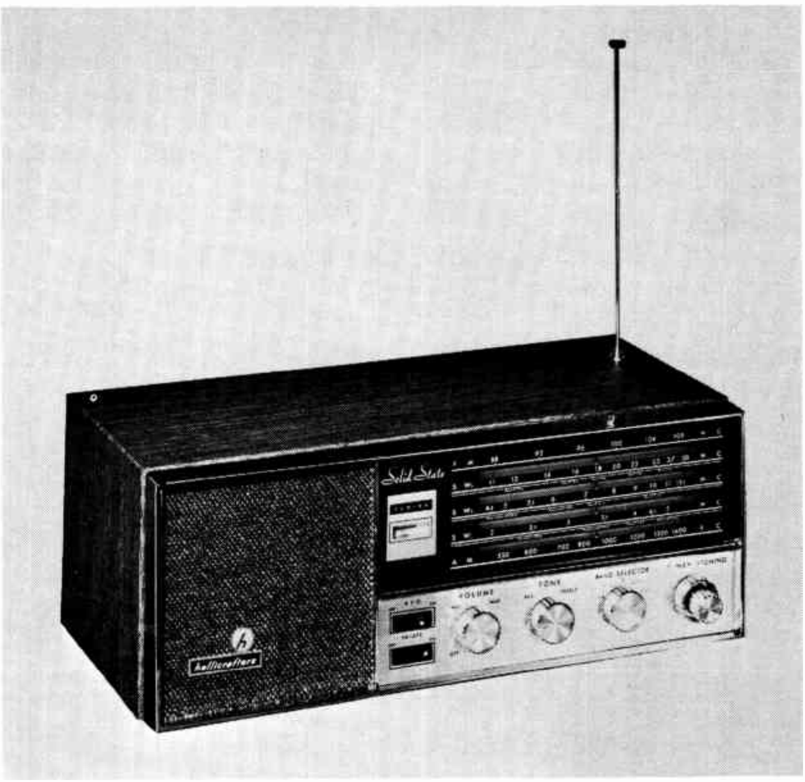
Fig. A-5. Drake Model SPR-4 communications receiver.

Controls and features:

- Large tuning dial, calibrated to 1 kilohertz
- Bandswitch
- Volume control
- Preselector tuning
- Mode control
- "S" meter

HALLICRAFTERS MODEL S-240

The Hallicrafters Model S-240 is an all-transistor receiver that combines good looks with good quality. It covers the broadcast band, fm band, and short-wave bands. It has class-B push-pull audio output and a headphone jack for private listening.



Courtesy Hallicrafters

Fig. A-6. Hallicrafters Model S-240.

SPECIFICATIONS

Band coverage:
- 550 to 1600 kHz.
- 2 to 5 MHz.
- 4.8 to 11 MHz.
- 11 to 30 MHz.
- 88 to 108 MHz. (fm)

Selectivity: 6 dB.
Intermediate frequencies: 455 kHz and 10.7 MHz.
Fm bandwidth: 120 to 185 kHz.
Audio Output: Over 1 watt.
Complement: 11 transistors and 6 diodes.

Controls and features:
- Main tuning dial
- Band selector
- Volume control
- Tone control
- BFO control
- Afc control

HALLICRAFTERS MODEL SX-122A

The Hallicrafters Model SX-122A is a general-coverage type receiver that permits the user to enjoy reception to 34 MHz. It incorporates such features as product detector and dual conversion on all bands. This receiver has a 50-kilohertz selective i-f system with three ranges of selectivity.

SPECIFICATIONS

Band coverage:
- Band 1—0.53 to 1.5 MHz.
- Band 2—1.7 to 4.9 MHz.
- Band 3—4.6 to 13 MHz.
- Band 4—12 to 34 MHz.

Courtesy Hallicrafters

Fig. A-7. Hallicrafter Model SX-122A.

Bandspread coverage: Amateur-radio bands from 80 to 10 meters.

Controls and Features:

- Main tuning dial
- Bandspread dial
- Rf-gain control
- Audio-gain control
- Noise-limiter control
- Antenna-trimmer control
- Bfo control
- Selectivity control
- Temperature-controlled high-frequency oscillator
- Function switch
- Bandswitch
- Phone jack
- Calibrator control
- "S" meter

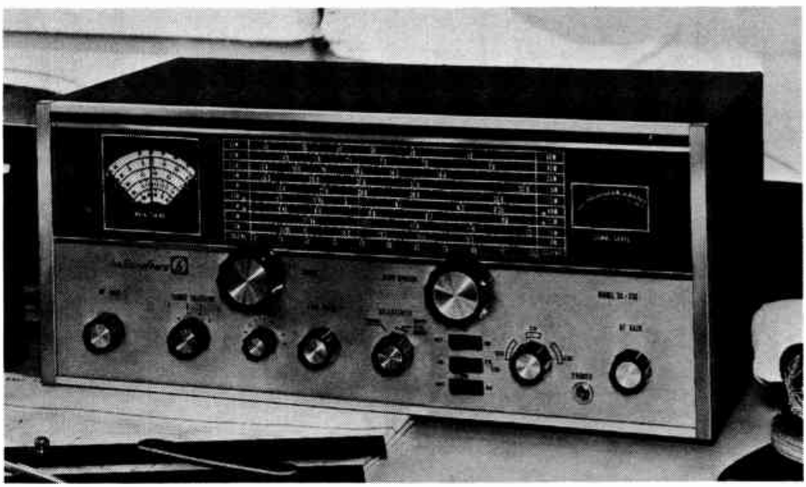
HALLICRAFTERS MODEL SX-133

The Hallicrafters Model SX-133 is a general-coverage, short-wave receiver for international short-wave listening, amateur bands, and marine ship-to-shore frequencies. It features electrical bandspread tuning and single-sideband reception.

SPECIFICATIONS

Band coverage:

- Band 1—0.53 to 1.6 MHz.
- Band 2—1.6 to 4.7 MHz.
- Band 3—4.5 to 13.0 MHz.
- Band 4—11.9 to 31.5 MHz.



Courtesy Hallicrafters

Fig. A-8. Hallicrafters Model SX-133.

Bandspread coverage: All amateur bands, plus 49 meters, 31 meters, 25 meters, and 19 meters.

Controls and features:

Main tuning dial	Noise limiter
Bandspread dial	Mode switch
Volume control	Crystal calibrator
Rf gain	Antenna trimmer
Bandswitch	Crystal phasing
BFO control	"S" meter

The Model SX-133 has one tuned rf-amplifier stage, selectable automatic noise limiter, calibrated BFO, and crystal filter.

HAMMARLUND MODEL HQ-180A

The Hammarlund Model HQ-180A is a general-coverage receiver that offers improved mechanical and electrical stability. It has vacuum-tube circuitry with a continuously running filament transformer that reduces hf oscillator and mixer warm-up time to a minimum. It offers triple conversion for maximum selectivity.

Courtesy Hammarlund Manufacturing Company, Inc.

Fig. A-9. Hammarlund Model HQ-180A.

SPECIFICATIONS

Band coverage:

Band 1—540 to 1050 kHz.
Band 2—1050 to 2050 kHz.
Band 3—2.05 to 4.04 MHz.
Band 4—4.0 to 7.85 MHz.
Band 5—7.85 to 15.35 MHz.
Band 6—15.35 to 30.0 MHz.

Sensitivity: 0.8 microvolt.
Selectivity: Adjustable; 0.5, 2, 4, and 6 kHz.
Power output: 1 watt.
Frequency conversions: 0.54 to 7.85 MHz, dual; 7.85 to 30.0 MHz, triple.
Power source: 115/230 Vac.
Power consumption: 120 watts.

Controls and features:

Main tuning dial
Bandspread dial
Rf-gain control
Volume control
OFF, SSB, CW switch
BFO function switch
Selectivity control
Band selector switch
Function switch
Phone jack
ON/OFF switch
"S" meter
Send/receive switch

HAMMARLUND MODEL HQ-200

The Hammarlund Model HQ-200 is a general-coverage, tube-designed unit with a selectivity feature continuously variable from 100 Hz to 12 kHz. Its optional features are a 100-kHz crystal calibrator and a matching speaker.

SPECIFICATIONS

Band coverage: 540 kHz to 30 MHz in five ranges.
Sensitivity: Better than 1.5 microvolts.
Selectivity: Variable from 100 Hz to 12 kHz.
Signal-to-noise ratio: 10-dB down.
Audio output: 2.5 watts.
Power source: 117/230 Vac.

Controls and features:

Calibrated bandspread dial
Noise limiter
"S" Meter
Terminals for antenna and ground connections
Main tuning dial
Bandspread dial
Sensitivity control
Audio control
Band switch
Avc switch
Mode-selector switch
Antenna trimmer
Q-multiplier

Courtesy Hammarlund Manufacturing Company, Inc.

Fig. A-10. Hammarlund Model HQ-200.

HEATHKIT MODEL GR-64

The Heathkit Model GR-64, like all Heath units, is supplied in kit form. It is easy to assemble and will perform very well. It covers the short-wave frequencies in three bands, plus the general broadcast band. This model features bandspread to facilitate tuning, and has a logging scale to help you come back to the same spot on the dial.

Courtesy Heath Company

Fig. A-11. Heathkit Model GR-64.

SPECIFICATIONS

Band coverage:

Band A—0.55 to 1.6 MHz.
Band B—1.5 to 4.0 MHz.
Band C—4.0 to 10.0 MHz.
Band D—8.5 to 30 MHz.

Intermediate frequency: 455 kHz.
Power requirements: 120 Vac or 240 Vac.
Power consumption: 30 watts.
Speaker size: 5-inch.

Controls and features:

- Main tuning dial
- Bandspread dial
- Volume control
- Bandswitch
- BFO control
- A-M/CW/STBY Switch
- Illuminated 7" slide-rule dial
- Built-in a-m rod antenna
- External antenna connection on rear
- Headphone jack

HEATHKIT MODEL GR-78

The Heathkit Model GR-78 is a solid-state, general-coverage receiver kit. It is modestly priced, but will give good performance for both the amateur-radio operator and the short-wave listener. The GR-78 utilizes double conversion and a crystal marker for ease in determining spot frequencies.

SPECIFICATIONS

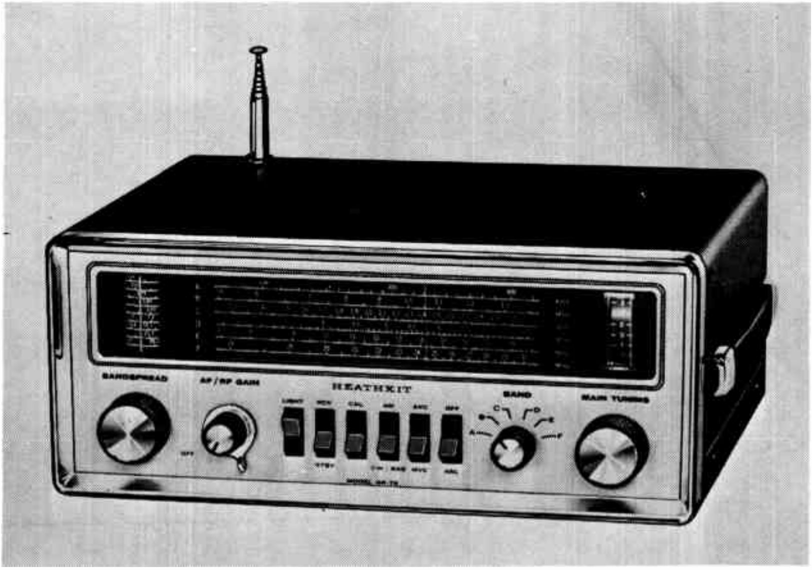
Band coverage:

Band A—190-410 kHz (Long wave).
Band B—0.55 to 1.3 MHz.
Band C—1.3 to 3.0 MHz.
Band D—3.0 to 7.5 MHz.
Band E—7.5 to 18 MHz.
Band F—18 to 30 MHz.

Sensitivity: 1.5 microvolts.
Selectivity: 7.5 kHz at 6 dB down.
Intermediate frequency: 455 kHz and 4.035 MHz.
500-kHz marker.

Controls and features:

- Main tuning dial
- Bandspread dial
- Af-gain control
- Rf-gain control
- Bandswitch
- Receive/standby switch
- Mode switch
- ANL switch
- Panel-light switch



Courtesy Heath Company

Fig. A-12. Heathkit Model GR-78.

HEATHKIT MODEL GR-81

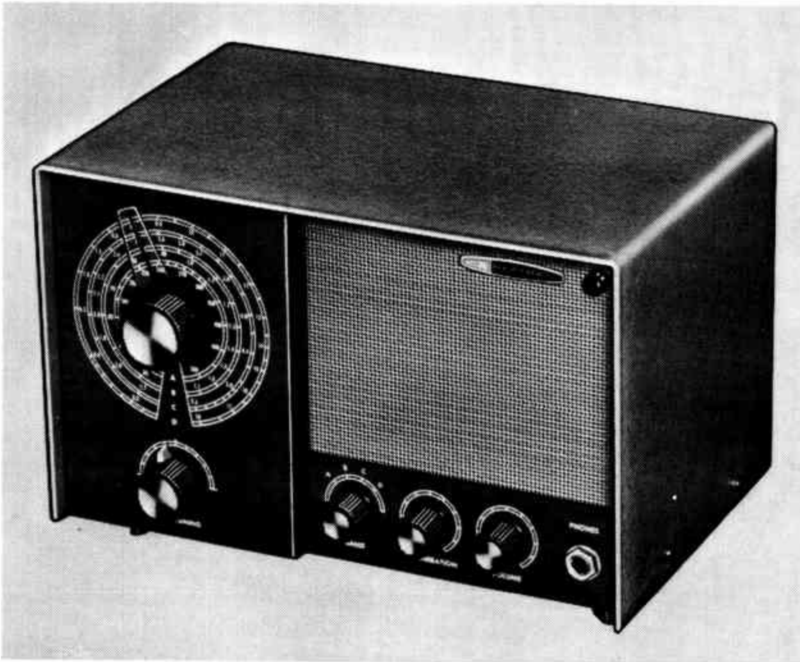
The Heathkit Model GR-81 is designed for the beginner. It features a regenerative-detector circuit and two stages of audio amplification at a modest price. Though it is considered a "starter kit," it offers to the user many enjoyable hours of short-wave listening.

SPECIFICATIONS

Band coverage: From 140 kHz to 18 MHz in four bands.
Power requirements: 105-125 Vac.
Power consumption: 30 watts.

Controls and features:

- Main tuning dial
- Regeneration control
- Built-in speaker
- Bandswitch
- Volume control



Courtesy Heath Company

Fig. A-13. Heathkit Model GR-81.

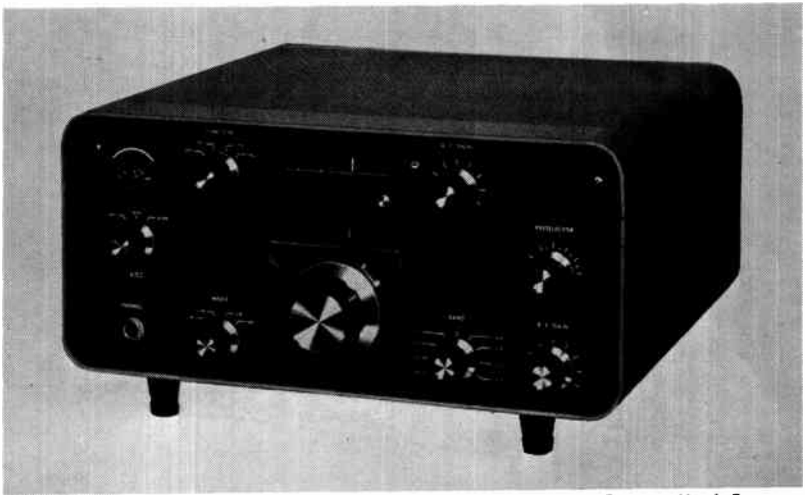
HEATHKIT MODEL SB-310

The Heathkit Model SB-310 is a professional-type receiver that is considered to be Heathkit's finest. It utilizes a separate speaker with high-fidelity output. This model has a crystal-controlled front end for the same tuning rate on all bands.

SPECIFICATIONS

Band coverage:

- Band 1—3.5 to 4 MHz.
- Band 2—5.7 to 6.2 MHz.
- Band 3—7.0 to 7.5 MHz.
- Band 4—9.5 to 10.0 MHz.
- Band 5—11.5 to 12.0 MHz.
- Band 6—14.0 to 14.5 MHz.
- Band 7—15.0 to 15.5 MHz.
- Band 8—17.5 to 18.0 MHz.
- Band 9—26.9 to 27.5 MHz.



Courtesy Heath Company

Fig. A-14. Heathkit Model SB-310.

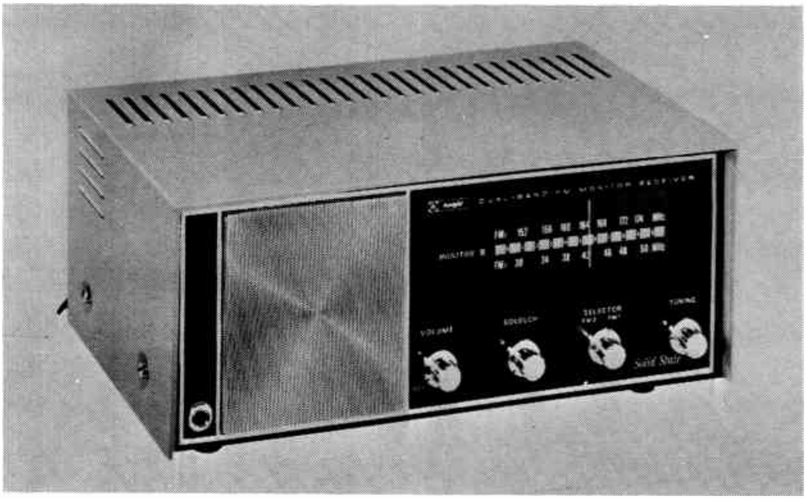
Sensitivity: 0.3 microvolt.
Dial accuracy: 400 Hz.
Selectivity: 2.0 kHz at 60 dB down.
Audio output: 1 watt.
Frequency stability: 100 Hz drift per hour.
Image rejection: 60 dB or better.
Power requirements: 125 or 210 Vac.
Power consumption: 40 watts.

Controls and features:

Main tuning	Audio-gain control
Bandswitch	Preselector tuning
Mode switch	Function switch
"S" Meter	Agc control

KNIGHT MODEL MONITOR III

The Knight (Allied) Model Monitor III is a receiver kit used for the reception of vhf Public Service signals, such as police calls, fire alarms, civil defense, weather-bureau signals, mobile-radiotelephone, etc. The receiver covers both 30 to 50 MHz and 152 to 174 MHz bands. It offers solid-state design and instant operation. Fm circuitry, push-pull audio output, tuned rf stage, and avc are all features of this model. Adjustable squelch keeps down ambient noise when the receiver is tuned or when the station is not on the air.



Courtesy Allied Radio Corp.

Fig. A-15. Knight Model Monitor III.

SPECIFICATIONS

Band coverage: 30 to 50 MHz and 152 to 174 MHz.
Sensitivity: Better than 4 microvolts for 20-dB S/N.
Intermediate frequency: 10.7 MHz.
Power supply: Full-wave, transformer operated.
Audio output: 1 watt.
Headphone output: 8 ohms.
Semiconductors: 20 transistors and 10 diodes.

Controls and features:

Monitor speaker
Headphone jack
ON/OFF volume
Squelch control
Band selector
Main tuning

KNIGHT MODEL R-195

The Knight (Allied) Model R-195 is supplied in kit form. It provides continuous coverage from 550 kHz to 30 MHz. The receiver is very easily assembled with simplified premounted circuits. It offers good performance and much enjoyment in receiving short-wave broadcasting stations.

Courtesy Allied Radio Corp.

Fig. A-16. Knight Model R-195.

SPECIFICATIONS

Band coverage:
- Band A—200 to 400 kHz.
- Band B—550 to 1600 kHz.
- Band C—1.8 to 4.9 MHz.
- Band D—4.8 to 12 MHz.
- Band E—11 to 30 MHz.

Sensitivity: 2 microvolts.
Selectivity: 1.5 kHz bandwidth to 6 dB down.
Intermediate frequency: 455 kHz.
Audio Output: 1.5 watts.

Controls and features:
- Main tuning dial
- Bandspread dial
- Bandswitch
- Mode control (AM-SSB-CW)
- Af-gain control
- Rf-gain control
- Noise-limiter switch
- "S" meter

KNIGHT MODEL STAR ROAMER

The Knight (Allied) Model Star Roamer is supplied in kit form. The receiver is a four-tube design, providing automatic volume control, noise limiter, electrical-bandspread control, antenna-trimmer control, and signal-strength meter. I-f control also provides for cw reception. The receiver has a built-in antenna for broadcast band and terminals on the rear for connection to outside antenna for short-wave reception.

Courtesy Allied Radio Corp.

Fig. A-17. Knight Model Star Roamer.

SPECIFICATIONS

Band Coverage:

- Band 1—200 to 400 kHz.
- Band 2—550 to 1850 kHz.
- Band 3—1800 to 4820 kHz.
- Band 4—4.8 to 12.2 MHz.
- Band 5—12 to 30 MHz.

Intermediate frequency: 455 kHz (controlled regeneration, increased sensitivity, and cw reception).
Power requirements: 110-125Vac.
Speaker size: 4-inch.
Receiver type: Superheterodyne.

Controls and features:

- Regenerative i-f
- Headphone jack
- Bandspread dial
- Band selector
- Avc ON-OFF switch
- "S" meter
- Antenna trimmer
- Volume control
- Main tuning control
- Four-tube circuit

LAFAYETTE MODEL EXPLOR-AIR MARK V

The Lafayette Model Explor-Air Mark V is an a-m broadcast and short-wave receiver compactly designed in a walnut-grained, metal cabinet. It is a five-band, ac-transformer-powered unit with individually tuned circuits for each band. This model is modestly priced.

SPECIFICATIONS

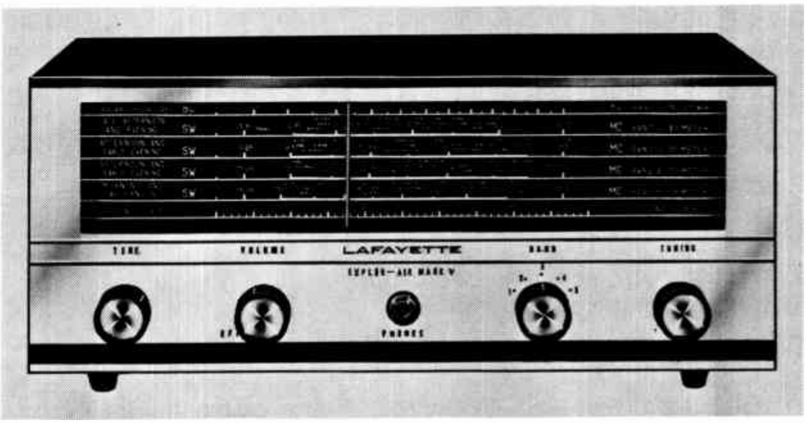
Band coverage:

Band 1—550 to 1600 kHz.
Band 2—5.9 to 6.25 MHz.
Band 3—9.45 to 9.8 MHz.
Band 4—11.45 to 12 MHz.
Band 5—15.05 to 15.5 MHz.

Sensitivity: 5 microvolts.
Selectivity: 1.5 kHz bandwidth at 30-dB down.
Intermediate frequency: 455 kHz.
Speaker: 4″ built-in.
Power source: 105-125 Vac.

Controls and features:

Slide-rule dial
Main tuning control
Volume control
Band selector
Tone control
Phone jack

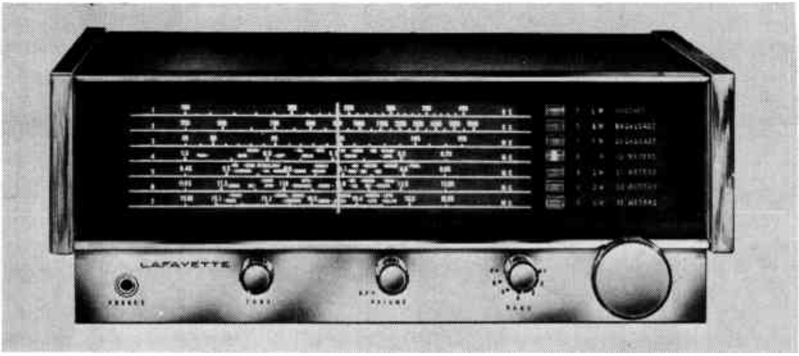


Courtesy Lafayette Radio Electronics Corp.

Fig. A-18. Lafayette Model Explor-Air Mark V.

LAFAYETTE MODEL EXPLOR-AIR MARK VI

The Lafayette Model Explor-Air Mark VI is a receiver that features a transformer-operated power supply and a 455-kHz mechanical filter. It provides seven full-dial bands of coverage with rear-panel terminals for a-m and fm antennas. The illuminated tuning dial is labeled with names of primary cities and countries for ease in tuning for international short-wave broadcasting stations.



Courtesy Lafayette Radio Electronics Corp.

Fig. A-19. Lafayette Model Explor-Air Mark VI.

SPECIFICATIONS

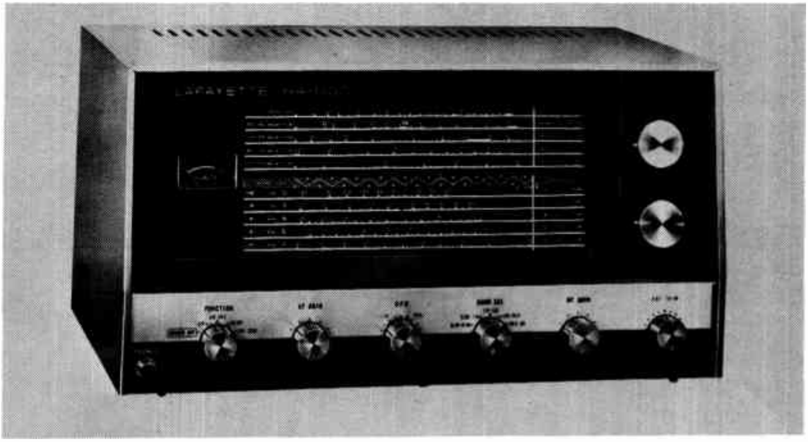
Band coverage:
- Band 1—150 to 400 kHz.
- Band 2—550 to 1600 kHz.
- Band 3—Fm broadcast; 88 to 108 MHz.
- Band 4—5.9 to 6.25 MHz.
- Band 5—9.45 to 9.85 MHz.
- Band 6—11.85 to 12.05 MHz.
- Band 7—15.05 to 15.55 MHz.

Sensitivity: 2 microvolts.
Selectivity: 1.5 kHz bandwidth to 6-dB down.
Image ratio: 45dB.
Power sources: 105-125 Vac; 24 Vdc.
Power consumption: 10 watts.

Controls and features:
- Main tuning dial
- Volume control
- Bandswitch
- Tone control
- Headphone jack
- 8-ohm extension-speaker jack on rear panel
- Two built-in 4" speakers

LAFAYETTE MODEL HA-600

The Lafayette Model HA-600 is a general-coverage type receiver utilizing two field-effect transistors in the front-end rf stages to assure high sensitivity and low noise factor. Tuned rf and mixer stages combined with a 455-kHz mechanical filter are used to increase selectivity.



Courtesy Lafayette Radio Electronics Corp.

Fig. A-20. Lafayette Model HA-600.

SPECIFICATIONS

Band coverage:
- 150 kHz to 400 kHz.
- 550 kHz to 1600 kHz.
- 1.6 MHz to 4.5 MHz.
- 4.5 MHz to 14 MHz.
- 10.5 MHz to 30 MHz.

Bandspread:
- 3.5 MHz to 4.0 MHz.
- 7.0 MHz to 7.145 MHz.
- 7.145 MHz to 7.3 MHz.
- 14.0 MHz to 14.4 MHz.
- 21 MHz to 21.4 MHz.
- 28 MHz to 29.8 MHz.

Sensitivity: 2 microvolts.
Selectivity: 6 kHz at 60 dB down.
Intermediate frequency: 455 kHz.
Audio output: 3 watts.
Power sources: 105-120 Vac; 12 Vdc.
Semiconductors: 2 field-effect transistors; 10 transistors; and 8 diodes.
Controls and features:
- Main tuning dial
- Bandspread dial
- Function switch
- "S" meter
- Bandswitch
- Rf-gain control
- BFO control
- USB/LSB selector switch
- Product detector

LAFAYETTE MODEL HA-800

The Lafayette Model HA-800 is a 6- to 80-meter amateur-radio receiver with a solid-state power supply permitting operating on either 117 Vac or 12 Vdc. This receiver is transistorized and contains two mechanical i-f filters.

SPECIFICATIONS

Band coverage: All amateur-radio bands from 6 meters (50 to 54 MHz) to 80 meters (3.5 to 40 MHz).
Sensitivity: 1 microvolt.
Selectivity: 6 dB at 2.5 kHz; 60 dB at 6 kHz.
Intermediate frequencies: 1st i-f, 2.608 MHz; 2nd i-f, 455 kHz.
I-f rejection: Better than 40 dB.
Audio output: 1 watt.
Power sources: 105-120 Vac; 12 Vdc.
Power consumption: 8.5 watts.

Controls and features:

- Tuning dial
- "S" meter
- Bandswitch
- Rf-gain control
- Volume control
- Antenna trimmer
- BFO control
- Function switch
- Noise-limiter switch

Courtesy Lafayette Radio Electronics Corp.

Fig. A-21. Lafayette Model HA-800.

Index

Questions & Answers on
SHORT-WAVE LISTENING

by H. Charles Woodruff

Many persons who daily tune in their favorite radio or TV programs are totally unaware that dozens of other stations can be heard on the short-wave frequencies. This book is designed to help them get the most out of the many opportunities for interesting listening available to the owner of a short-wave receiver. The book is written in the popular question-and-answer format, which presents a wealth of information in a style that is easy to grasp.

In Part 1, the author covers topics of general interest, such as what frequencies are best for short-wave listening, what are the better months, broadcasting permits, listener's clubs, foreign and domestic broadcasts, news stations, amateur radio, citizens band, listening from an automobile, time signals, and many others.

Part 2 deals with various natural phenomena including skip distance, day and night effects, fading, and static. Parts 3 and 4 take up construction, operating theory, and features of short-wave receivers. Topics discussed are single and dual conversion, bandset and bandspread tuning, automatic volume control, automatic frequency control, noise limiters, crystal filters, S meters, and others. The appendix lists the specifications of several representative short-wave receivers and should prove helpful in selecting the receiver best suited to one's needs.

ABOUT THE AUTHOR

H. Charles Woodruff has long been interested in radio. He received his first ham license at the age of 16 and has had a wide variety of experience in radiocommunication and related electronics. From 1934 until after World War II he served in the U.S. Navy. One of his duties was as communications and electronics officer. He has been employed as a field engineer for vhf and uhf communications and as a technical publications supervisor for a large electronics corporation. He is the author of *Short-Wave Listener's Guide,* also published by Howard W. Sams & Co., Inc.

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