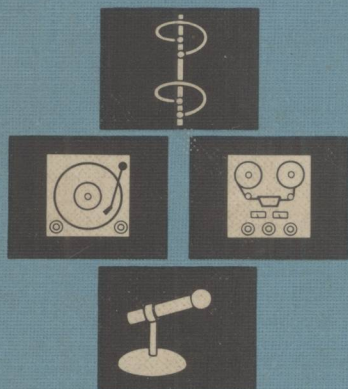


AM-FM BROADCASTING

Equipment, Operations, and Maintenance

by Harold E. Ennes



AM-FM Broadcasting
Equipment, Operations,
and Maintenance

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AM-FM broadcasting equipment,
operations, and maintenance

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Preface

Radio broadcasting is a highly specialized branch of electronics. Those who study for and take the examination for the FCC radiotelephone first-class operator license soon realize that their knowledge is incomplete when they assume the duties of actual broadcast operation. This text is intended for all who need a practical insight into the use of electronic circuitry as applied specifically to broadcasting.

The reader of this book must already have basic electronic training. However, advanced electronic training on a university level, while helpful, is not required.

The first ten chapters make up the engineering section of the text. This section is not intended as a design course for broadcast equipment; rather, it presents the engineering fundamentals needed by the chief engineer or maintenance technician, or trainee for these positions, of an a-m and/or fm broadcast station. Therefore, the design of networks for impedance-matching or bridging circuitry is included. A knowledge of mathematics at the high-school level is assumed, although a refresher course is included for reference.

The final four chapters are designed to answer the question, "I know the theory; now what do I do on the job?" The basic technical theory of radio broadcasting has remained essentially the same, but great advances have been made in the development of equipment and operations. These improvements have outmoded many techniques. Thus, the last chapters are devoted to a discussion of modern station operations.

In preparing the content, I have deliberately avoided tying down specific procedures to specific FCC rules. It is the duty of every engineer who is responsible for compliance with such rules (normally the chief engineer of the station) to subscribe to current FCC rules about broadcasting and to keep abreast of changes that occur. Therefore, whenever FCC rules are mentioned as examples, it must be understood that the presentation is for

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PREFACE

illustrative purposes only and is *not* necessarily the latest ruling of the Commission.

When maintenance and engineering personnel require a quick and easy reference, the extensive subject breakdown in the text and the complete index will prove helpful. Preventive maintenance and proof-of-performance testing are given full coverage.

An effort has been made to compile data which the broadcast engineer frequently needs but for which he must usually consult numerous sources. It is hoped that this volume will serve both as an informative text and as a useful reference source.

The author is indebted to the following for important contributions to this book: American Broadcasting Co.; CBS Laboratories; CCA Electronics Corp.; Electrodyne Co., Inc.; Gates Division Harris-Intertype Corp.; General Electric Co.; Marti Electronics, Inc.; Metron Instruments, Inc.; National Broadcasting Co.; RCA; Sansui Electric Co., Ltd.; Schafer Electronics Corp.; Sony Corp.; TelePro Industries, Inc.; and the 3M Co.

HAROLD E. ENNES

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Orientation in AM-FM Broadcasting

This book is concerned with basic training in a-m and fm broadcast engineering, where the following definitions apply: The abbreviation a-m stands for "amplitude modulation," in which the transmitted rf carrier is fixed in frequency but is increased or decreased in amplitude (modulated) by the applied sound. The abbreviation fm stands for "frequency modulation," in which the rf carrier remains constant in amplitude, but the frequency is varied (modulated) by the applied sound. In this chapter we will first consider specifics of a-m transmission, then fm transmission. After the characteristics of each have been explored, we will examine studio and transmitter requirements common to both systems.

1-1. THE STANDARD A-M BROADCAST CHANNEL

The following three definitions describe the foundation for the standard a-m station assignments. *Standard broadcast station* means a broadcasting station licensed to operate on a channel in the frequency band of 535 to 1605 kilohertz (kHz) and to transmit radiotelephone emissions primarily intended to be received by the general public. *Standard broadcast band* means the band of frequencies extending from 535 to 1605 kHz. *Standard broadcast channel* means the band of frequencies occupied by the carrier and two sidebands (upper and lower) of a broadcast signal with the carrier frequency at the center. Channels are designated by their assigned carrier frequencies. There are 107 carrier frequencies assigned to standard broadcast stations, beginning at 540 kHz and continuing in successive steps of 10 kHz to 1600 kHz.

When a radio carrier is modulated in amplitude, the original carrier plus upper and lower sidebands exist. The extent of the sidebands depends on the highest frequency that modulates the carrier wave at the specific time. Thus, if the highest modulating frequency is 5000 Hz (5 kHz), the limits of the transmission bandwidth are the carrier frequency plus and minus

5 kHz. For example, a carrier of 540 kHz amplitude modulated by a 5-kHz tone would have an upper sideband of 545 kHz and a lower sideband of 535 kHz.

When a-m broadcasting was first established, 5 kHz was about the highest audio frequency that could be expected from either microphones or phono pickups. Telephone lines carrying program transmissions between studio and transmitter, and overland routes carrying network radio programs, were equalized to 5 kHz, which was entirely adequate to meet the needs of the times. Each a-m station was assigned a channel of 10 kHz (plus and minus 5 kHz), as described above.

For example, Fig. 1-1 shows a station with an assigned carrier frequency of 1000 kHz. By FCC definition, a station on 540 kHz has a lower sideband

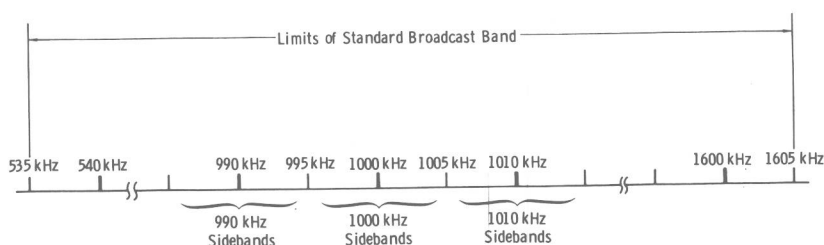


Fig. 1-1. Channels in standard broadcast band.

limit of 535 kHz, and a station on 1600 kHz has an upper sideband limit of 1605 kHz, thus fixing the assigned channel width at ± 5 kHz. In Fig. 1-1, the 1000 kHz carrier, when modulated with a 5000 Hz tone, would have sidebands from 995 kHz to 1005 kHz, which would just meet the sideband limits from the adjacent (upper and lower) assigned carriers.

Modern technology allows the gamut of audible frequencies to be picked up, recorded, or reproduced. This covers a frequency range of 30 to 15,000 Hz. Practically all modern a-m broadcast transmitters are capable of an audio frequency response within 1 dB from 30 Hz to 12 kHz. This is entirely practicable in spite of the theoretical bandwidth limitation on a-m channels. In practice, certain minimum mileage separations must exist between stations on the same or adjacent channels. This is considered in greater detail in Chapter 9.

1-2. CLASSES OF STANDARD BROADCAST CHANNELS AND STATIONS

Table 1-1 presents a general outline of the assignment of stations to channels in the standard broadcast band in the United States. Caution: Always keep abreast of current FCC Rules and Regulations, which are

subject to change. (NOTE: Some stations authorized under earlier allocation standards may not be operating in accord with Table 1-1.)

Clear Channels

A clear channel is one on which the dominant station or stations render service over wide areas. These stations are protected from objectionable interference within their primary service areas and over all or a substantial portion of their secondary service areas. Stations operating on these channels are classified as follows.

Class I Stations—A class I station is a dominant station operating on a clear channel and designed to render primary and secondary service over an extended area and at relatively long distances. Its primary service area is free from objectionable interference from other stations on the same and adjacent channels, and its secondary service area is free from interference except from stations on adjacent channels, and from stations on the same channel in accordance with the channel designation in current FCC rulings. The operating power must not be less than 10 nor more than 50 kW.

Class II Stations—A class II station is a secondary station that operates on a clear channel and is designed to render service over a primary service area, which is limited by and subject to such interference as may be received from class I stations. Whenever necessary, a class II station must use a directional antenna or other means to avoid interference with class I stations and with other class II stations.

Class II stations are divided into three groups as follows: A *class II-A* station is an unlimited-time class II station operating on one of the clear channels listed in Table 1-1 and assigned to a community within a state specified in current FCC rulings. A class II-A station must operate with power of not less than 10 kW at night nor more than 50 kW at any time. A *class II-B* station is an unlimited-time class II station other than those included in class II-A. A class II-B station must operate with power not less than 250 watts nor more than 50 kW. A *class II-D* station is a class II station operating daytime or limited time. A class II-D station must operate with power not less than 250 watts nor more than 50 kW.

Regional Channels

A regional channel is one on which several stations may operate with powers not in excess of 5 kW. The primary service area of a station operating on any such channel may be limited to a given field-intensity contour as a consequence of interference.

A *class III* station is a station that operates on a regional channel and is designed to render service primarily to a principal center of population and the surrounding rural area. Class III stations are subdivided into two classes. A *class III-A* station is a class III station that operates with power not less than 1 kW nor more than 5 kW and whose service area is subject to interference in accordance with current FCC rulings. A *class III-B* sta-

Table 1-1. Channels for A-M Stations

Freq (kHz)	Type of Channel*	Class of Station	Notes
540	C	II	Note 3
550	R	III	
560	R	III	
570	R	III	
580	R	III	
590	R	III	
600	R	III	
610	R	III	
620	R	III	
630	R	III	
640	C	I	Only One Class I Station
650	C	I	Only One Class I Station
660	C	I	Only One Class I Station
670	C	I & II	Only One Class I Station
680	C	I & II	
690	C	II	Note 1
700	C	I	Only One Class I Station
710	C	I & II	
720	C	I & II	Only One Class I Station
730	C	II	Note 2
740	C	II	Note 1
750	C	I	Only One Class I Station
760	C	I	Only One Class I Station
770	C	I	Only One Class I Station
780	C	I & II	Only One Class I Station
790	R	III	
800	C	II	Note 2
810	C	I & II	
820	C	I	Only One Class I Station
830	C	I	Only One Class I Station
840	C	I	Only One Class I Station
850	C	I & II	
860	C	II	Note 1
870	C	I	Only One Class I Station
880	C	I & II	Only One Class I Station
890	C	I & II	Only One Class I Station
900	C	II	Note 2
910	R	III	
920	R	III	
930	R	III	
940	C	I & II	
950	R	III	
960	R	III	
970	R	III	
980	R	III	
990	C	II	Note 1
1000	C	I & II	
1010	C	II	Note 1
1020	C	I & II	Only One Class I Station