NRSC STANDARD

NATIONAL RADIO SYSTEMS COMMITTEE

NRSC-1-C
NRSC AM Preemphasis/ Deemphasis and Broadcast Audio Transmission Bandwidth Specifications
April, 2018

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FOREWORD

This Standard was developed by the National Radio Systems Committee (NRSC) and first published in July 1988 as EIA-549 and ANSI/EIA-549-1988. It was incorporated into the FCC rules in 1989 as a part of the *First Report and Order to FCC*, Mass Media Docket No. 88-376, in which the Commission defined a "presumptive compliance option" that temporarily allowed analog AM stations incorporating equipment compliant with the NRSC-1 Standard to be considered compliant with revised RF emission requirements. Co-convenors of the NRSC at the time of first adoption of this Standard were Charles T. Morgan, Susquehanna Radio Corp., Bart Locanthi, Pioneer North America, Inc., and Alan Boyer, Sony Corporation of America. NRSC Subgroup convenors were John Marino, NewCity Communications and William F. Gilbert, Delco Electronics Corp.

While the period of presumptive compliance has long since passed, incorporation of NRSC-1 transmission hardware remains the primary means for AM stations to comply with emission requirements, as defined in the NRSC-2 Standard and FCC Rules, 47 CFR §73.44 (analog AM) or the NRSC-5 Standard and FCC Rules, 47 CFR §73.404(a) (hybrid AM IBOC). The first revision (NRSC-1-A) was developed by the AM Broadcasting (AMB) Subcommittee of the NRSC, co-chaired by Stanley Salek, Hammett & Edison, Inc., and Jeff Littlejohn, Clear Channel Broadcasting, Inc. The second revision (NRSC-1-B) was developed by the AM & FM Analog Broadcasting (AFAB) Subcommittee of the NRSC, co-chaired by Stanley Salek, Hammett & Edison, Inc., and Gary Kline, Cumulus Media. This third revision (NRSC-1-C) was developed by the Document Maintenance Working Group, chaired by John Kean of Cavell-Mertz & Associates, of the AM & FM Analog Broadcasting (AFAB) Subcommittee of the NRSC, chaired by Martin Stabbert of Townsquare Media Group. The NRSC chairman at the time of adoption of NRSC-1-A and NRSC-1-B was Milford Smith, Greater Media, Inc.

The NRSC is jointly sponsored by the Consumer Technology Association and the National Association of Broadcasters. It serves as an industry-wide standards-setting body for technical aspects of terrestrial over-the-air radio broadcasting systems in the United States.

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1 SCOPE

The National Radio Systems Committee (NRSC) is a joint committee composed of interested parties including representatives of AM broadcast stations, AM receiver manufacturers, and broadcast equipment manufacturers. This document describes an NRSC Standard that specifies the preemphasis of AM broadcasts, the deemphasis of AM receivers, and the audio bandwidth of AM stations prior to modulation. This version of the Standard is the result of a periodic review of the preceding version of the Standard. Note that the fundamental technical specifications in this version of the Standard remain unchanged from the original version. However, information relating to hybrid AM IBOC has been revised in this version.

The Standard applies to analog AM monophonic ("mono") and AM stereophonic ("stereo") L+R transmissions, to the analog portion of hybrid AM IBOC transmissions, and to dual bandwidth and single bandwidth AM receivers. Compliance with the Standard is strictly voluntary. To the NRSC's knowledge, no industry group or entity is or will be adversely affected by issuance of this document. Every effort has been made to inform and accommodate any and all interested parties. The NRSC believes that implementation of the Standard reduces AM interference and increases useful AM service areas.

2 REFERENCES

2.1 Normative References

The following normative references are incorporated by reference herein. At the time of publication the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of this Standard and/or the reference listed below. In case of discrepancy, normative references shall prevail.

[1] *NRSC-2-C, Emission Limitation for Analog AM Broadcast Transmission*, National Radio Systems Committee, April 2018
[2] *NRSC-5-D, In-band/on-channel Digital Radio Broadcasting Standard*, National Radio Systems Committee, April 2017

2.2 Normative Reference Acquisition

Documents [1]-[2] are distributed free of charge via the NRSC website at: http://www.nrscstandards.org.

2.3 Informative References

The following references contain information that may be of interest to those implementing this Standards document. At the time of publication the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below.

[1] *Bandwidth Options for Analog AM Broadcasters*, NRSC-G100-A, September 2012
[2] *Consumer Testing of AM Broadcast Transmission Bandwidth and Audio Performance Measurements of Broadcast AM Receivers*, NPR Labs, September 8, 2006
[3] *Summary Report: Consumer Testing of AM Broadcast Transmission Bandwidth and Audio Performance Measurements of Broadcast AM Receivers*, NRSC-R101, December 2006

2.4 Informative Reference Acquisition

Documents [1]-[3] are distributed free of charge via the NRSC website at: http://www.nrscstandards.org.

3 INTRODUCTION

On September 5, 1985, the NRSC adopted a resolution to study proposals to standardize AM transmission preemphasis and AM receiver deemphasis with the objective of establishing an industry-wide AM preemphasis/deemphasis voluntary standard. After twelve months of study, on September 10, 1986 the NRSC released a draft voluntary standard that proposed a specific AM preemphasis/deemphasis curve as well as a 10 kHz standard analog AM bandwidth. The bandwidth specification evolved from NRSC deliberation on the causes and cures of AM interference, and ways to technically encourage the production of higher fidelity AM receivers. After a three month public comment period, the NRSC, on January 10, 1987, formally adopted the original Standard and authorized its publication by the National Association of Broadcasters (NAB) and the Electronic Industries Association (EIA).

The original purpose of the NRSC-1 voluntary standard was to create a transmission/reception system where (1) AM broadcast stations know that receiver manufacturers are aware of the standard AM broadcast characteristics and are likely to design receivers to optimize their audio response characteristics accordingly, and (2) AM receiver manufacturers will be able to rely on AM broadcast characteristics to design receivers that best enhance the listener experience. The complementary “matching” preemphasis and deemphasis characteristics described herein are intended to optimize the consumer’s overall satisfaction with the technical quality of listening to AM radio. The NRSC believes that the public interest is served by maintaining a compatible transmission/reception system through standards that encourage interoperability of transmission and reception systems.

This document also describes a specification for the maximum audio bandwidth transmitted by AM broadcast stations. When first implemented (after adoption of the original Standard), the 10 kHz bandwidth specification reduced second-adjacent channel interference and led to (1) a significant reduction of second-adjacent channel interference as perceived on “wideband” AM receivers; and (2) a corresponding increase in the interference-free service areas of AM stations.[1] The 10 kHz bandwidth limitation may also have reduced the incidence of first-adjacent channel interference to “narrowband” receivers by reducing the unwanted energy in the desired first-adjacent station’s passband.

However, with a ±10 kHz spectrum occupancy and 10 kHz channel spacing, there is implicit spectral overlap between first adjacent stations that is only ameliorated by managing the D/U ratios through station assignments. Further reduction of transmitted bandwidth to the vicinity of ±5 kHz would further reduce the incidence of first-adjacent channel interference, particularly to narrowband receivers.[2] This Standard establishes a 10 kHz bandwidth as the maximum, but in no way requires stations to fully utilize a 10 kHz bandwidth.

The introduction of hybrid AM IBOC service, commencing with the FCC’s authorization of IBOC service in October 2002, brought with it new audio bandwidth requirements for broadcasters electing to transmit hybrid AM IBOC signals. The NRSC-5-D Standard establishes three RF bandwidth modes for the analog portion of the hybrid AM IBOC signal, consisting of 5 kHz and 8 kHz (standard or MA-1) modes, and 9.4 kHz (reduced digital bandwidth or “modified MA-1”) mode. Compliance with these modes is measured dynamically in the RF domain using the techniques discussed in normative reference [2].

[1] Substantial research into the behavior of modern consumer AM receivers has been added to the literature since the adoption of the original Standard—see informative references [1]-[3].

[2] Additional information regarding the benefits of reduced bandwidth is included in informative reference [1].

4 BASIC DEFINITIONS

Preemphasis — The boosting of high audio frequencies prior to modulation and transmission.

Deemphasis — The attenuation of high audio frequencies during the process of reception and demodulation.

“Narrowband” receivers — A subjective term to describe receivers whose audio frequency response is significantly attenuated above 5 kHz. Response characteristics of narrowband AM receivers are known to vary widely; an engineering study conducted in 2006 indicated that the vast majority of receivers have bandwidths less than 5 kHz.[3]

“Wideband” receivers — A subjective term to describe receivers whose perceptible audio frequency response extends above 5 kHz. Response characteristics of wideband AM receivers are known to vary widely.

“Excessive” preemphasis — Preemphasis that produces no discernible benefit when received by a “narrowband” receiver but increases interference to adjacent channel AM stations.

5 AM TRANSMISSION PREEMPHASIS

5.1 In General

Preemphasis is employed in an attempt to compensate for the “narrow” response of most AM receivers. If AM preemphasis were applied liberally, there is an increased potential for interference to the reception of a station on a channel near in frequency to the heavily preemphasized station. Whether such interference is objectionable will depend on (1) the response characteristics of the AM receiver, (2) the amount and nature of transmission preemphasis, (3) the extent to which the AM station is employing compression/limiting techniques, (4) whether the AM transmission system is bandlimited in the audio processor, transmitter or antenna, and (5) the signal strengths and desired-to-undesired (D/U) ratio of the two AM signals in question.

Preemphasis is useful for improvement of the AM transmission-reception system audio response only to a limited extent for receivers using IF transformers. Many receivers using ceramic filters with narrow response characteristics cannot be improved by use of excessive preemphasis. These receivers cannot “hear” the transmission of preemphasized high audio frequencies. Excessive preemphasis catering to narrowband receivers will foster adjacent channel interference and cause wideband radios to sound shrill or strident.

5.2 Description of the Modified 75 µs Preemphasis Curve

Each AM broadcast station (whether analog mono, analog stereo, or hybrid AM IBOC) shall broadcast with (analog) audio preemphasis as close as possible (within the capabilities of the station’s transmission system) to the recommended standard, without exceeding it. The curve applies for audio frequencies up to 10 kHz.

The NRSC standard AM transmission preemphasis curve is shown in Figure 1 and Table 1. The curve describes the recommended net transmission system static audio response of an AM station.

[3] See informative reference [2].

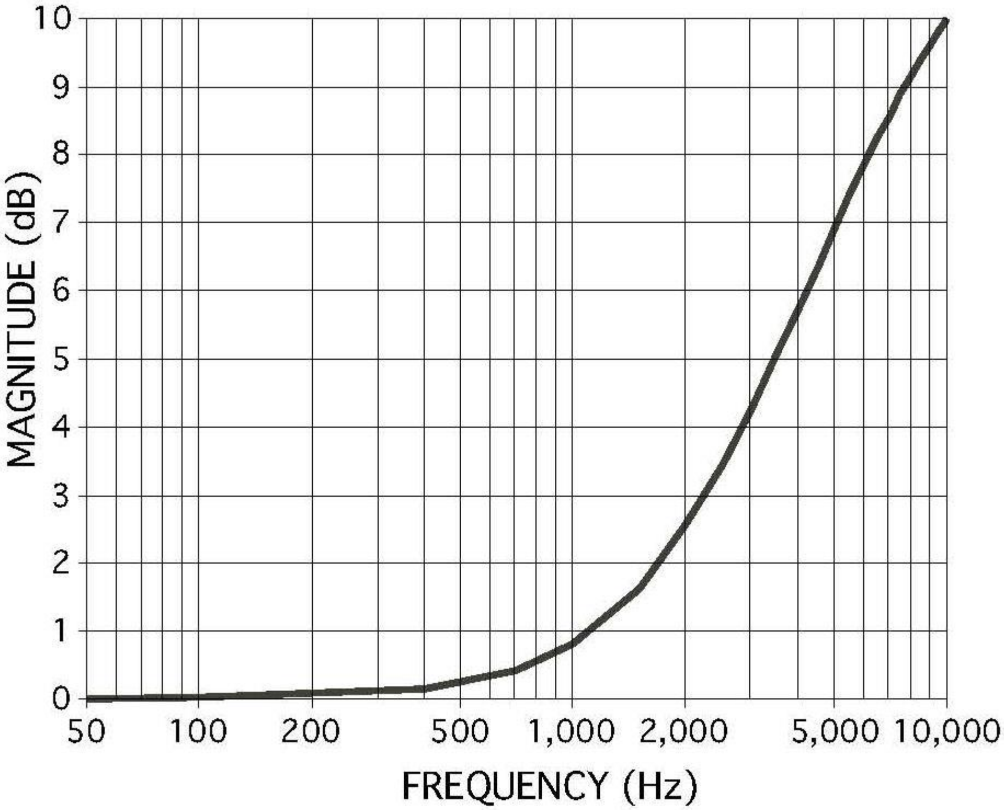

Figure 1. Modified 75 µs AM Standard Preemphasis Curve

Table 1. Modified 75 µs AM Standard Preemphasis Curve (tabular form)

Frequency (Hz)	Magnitude (dB)	Phase (deg)
50	0.00	1.0
100	0.01	2.0
400	0.14	8.0
700	0.42	13.7
1000	0.81	18.7
1500	1.63	25.5
2000	2.54	30.4
2500	3.44	33.6
3000	4.28	35.7
3500	5.05	36.9
4000	5.75	37.4
4500	6.37	37.4
5000	6.92	37.1
5500	7.41	36.6
6000	7.85	35.9
6500	8.24	35.2
7000	8.58	34.3
7500	8.89	33.4
8000	9.16	32.5
8500	9.41	31.6
9000	9.62	30.8
9500	9.82	29.9
10000	10.00	29.0

The recommended preemphasis curve is a single zero curve with a break frequency at 2122 Hz. It is similar to the 75 µS curve used for FM broadcasting. To reduce the peak boost at high frequencies, a single pole with a break frequency of 8700 Hz is employed. NRSC analysis in 1988 showed that the proposed curve was compatible with most existing AM receivers. Since the original adoption of the Standard the broadcast and consumer electronics industries have been aware of the specifications, which have fostered compliant AM broadcast devices over the subsequent years.

5.3 Methods for Determining Performance

The NRSC AM preemphasis curve is a <u>static</u> curve, and cannot be measured dynamically. NRSC studies have shown that the dynamic and non-linear functions performed by most AM station audio processors will modify any given preemphasis curve. In addition, it is the audio response of the entire AM transmission systems that indicates performance in accordance with the Standard. For these reasons, measuring a station's preemphasis curve for the purpose of determining compliance with the NRSC Standard shall be performed in accord with the following specifications:

5.3.1 Use of Audio Tones

Compliance with the curve shall be measured by sweeping the station's transmission system with audio tones. The dynamic functions of the AM station's processor, but not the frequency shaping circuits, must be disabled (i.e., in "proof" mode).

5.3.2 Location of Measurement

The net transmission system audio response is best measured by detecting the over-the-air signal. This will ensure that the AM transmitter and antenna combination is faithfully reproducing the preemphasized audio.[4] Alternatively, if the transmitter and antenna combination is reasonably broadband, performance can be determined by static measurement of the audio signal prior to modulation.

6 AM RECEIVER DEEMPHASIS

6.1 In General

Receiver deemphasis results from the selectivity characteristics of a receiver's RF and IF stages and the response characteristics of the receiver AF section. A standard deemphasis curve permits AM stations to know, with certainty, the likely overall response characteristics of AM receivers.

6.2 Description of the Standard Deemphasis Curve

AM receivers shall complement the recommended transmission preemphasis characteristic described in Section 5 by incorporating a net receiver system audio response described in Figure 2 and Table 2. (The net system audio response of an AM receiver is the combined RF, IF, and AF audio response.) The NRSC deemphasis curve is characterized by a single pole at 2122 Hz and a single zero at 8700 Hz. It is the precise complement of the preemphasis standard described in Section 5. The preemphasis/deemphasis voluntary standards apply only for audio frequencies below 10 kHz; the implementation of preemphasis/deemphasis standards produces a transmission/reception system that is essentially flat to nearly 10 kHz and limited only by the bandwidth of the AM transmission system and the AM receiver.

[4] However, the deemphasis characteristics of the device used to demodulate the AM transmission must be accounted for. Additionally, some AM stations with transmitter or antenna limitations may not be able to pass preemphasized audio without introducing "splatter" interference and/or overmodulation. If a particular AM station transmission system cannot reasonably accommodate the NRSC recommended curve, it is suggested that a lower amount of preemphasis be used until the system limitations are corrected to allow the NRSC curve to be faithfully implemented.

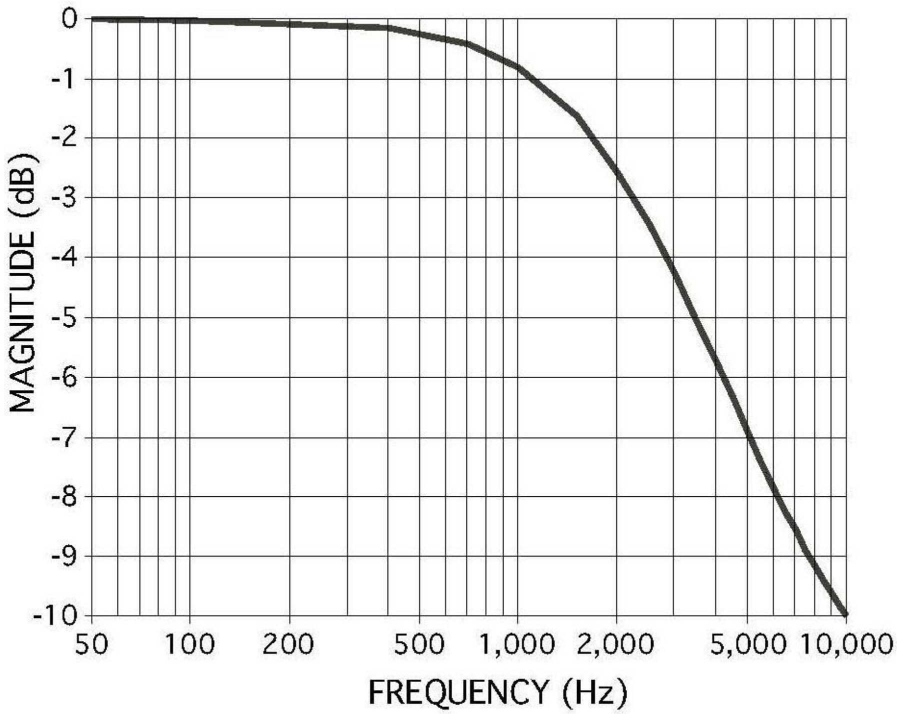

Figure 2. Modified 75µs AM Standard Deemphasis Curve

Table 2. Modified 75µs AM Standard Deemphasis Curve (tabular form)

Frequency (Hz)	Magnitude (dB)	Phase (deg)	Frequency (Hz)	Magnitude (dB)	Phase (deg)
50	0.00	-1.0	5000	-6.92	-37.1
100	-0.01	-2.0	5500	-7.41	-36.6
400	-0.14	-8.0	6000	-7.85	-35.9
700	-0.42	-13.7	6500	-8.24	-35.2
1000	-0.81	-18.7	7000	-8.58	-34.3
1500	-1.63	-25.5	7500	-8.89	-33.4
2000	-2.54	-30.4	8000	-9.16	-32.5
2500	-3.44	-33.6	8500	-9.41	-31.6
3000	-4.28	-35.7	9000	-9.62	-30.8
3500	-5.05	-36.9	9500	-9.82	-29.9
4000	-5.75	-37.4	10000	-10.00	-29.0
4500	-6.37	-37.4			

6.3 Methods for Determining Performance

The deemphasis characteristic shall be determined by measuring the overall frequency response in accordance with Section 8, *Method of Testing Amplitude Modulation Broadcast Receivers for Audio Frequency Response*.

The frequency response shall be measured for mono reception, and, if appropriate, for stereo reception. For dual bandwidth receivers, the frequency response shall be measured in both bandwidth positions.

Results may be presented graphically, with modulation frequency plotted logarithmically as abscissa and the output in decibels as ordinate.

The frequency response can be stated as follows (see Figure 3):

- *Audio Bandwidth:* 50 Hz to N Hz, where N Hz is the frequency at which the high frequencies are finally rolled off 3 dB from the flat response expected in the presence of complementary transmitter preemphasis and receiver deemphasis;

- *Flatness:* +1.5, -3 dB from 50 to N Hz; flatness is indicated by the maximum positive and negative deviation of the measured curve from the 0 dB reference at 400 Hz.

An AM receiver is compliant with the de-emphasis specification if it meets the flatness specification across its audio bandwidth.

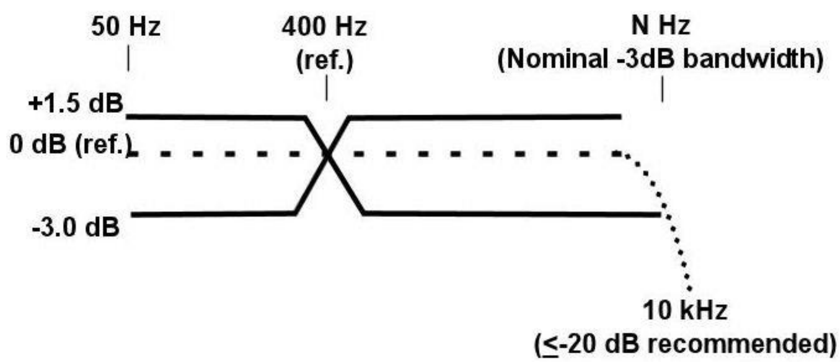

Figure 3. Frequency Response

6.4 Notch Filters

A notch filter is a very selective filter that attenuates the spectrally pure carriers of first adjacent channel AM stations. Although an optional enhancement to an AM receiver, using notch filters is recommended. If used, the notch filter should (1) have as high a "Q" as is practical, (2) adequately suppress the interfering carriers, and (3) not unduly degrade the desired bandwidth performance of the AM receiver.

7 AUDIO BANDWIDTH FOR AM TRANSMISSION

7.1 In General

Each AM broadcast station (whether analog mono, analog stereo, or hybrid AM IBOC) shall modulate its transmitter with an (analog) audio bandwidth not exceeding that described by the specifications in this Section. Appropriate and carefully designed audio low-pass filters as the final filtering prior to modulation can be used to implement these specifications. The purpose of these bandwidth specifications is to remove interference by controlling the occupied RF bandwidth of AM stations.

7.2 10 kHz Bandwidth for Analog AM Transmission

The analog AM audio bandwidth transmission standard is specified in Figure 4, showing the signal power measured in a 300 Hz resolution bandwidth as described later in this section. The audio envelope input spectrum to the AM transmitter shall be -15 dB at 10 kHz, smoothly decreasing to -30 dB at 10.5 kHz, then remaining at -30 dB from 10.5 kHz until 11.0 kHz. At 11.0 kHz, the relative amplitude shall be -40 dB, smoothly decreasing to -50 dB at 15 kHz. Above 15 kHz, the relative amplitude shall remain below -50 dB. The reference level is 1 dB above a 200 Hz sine wave at 90% negative modulation.

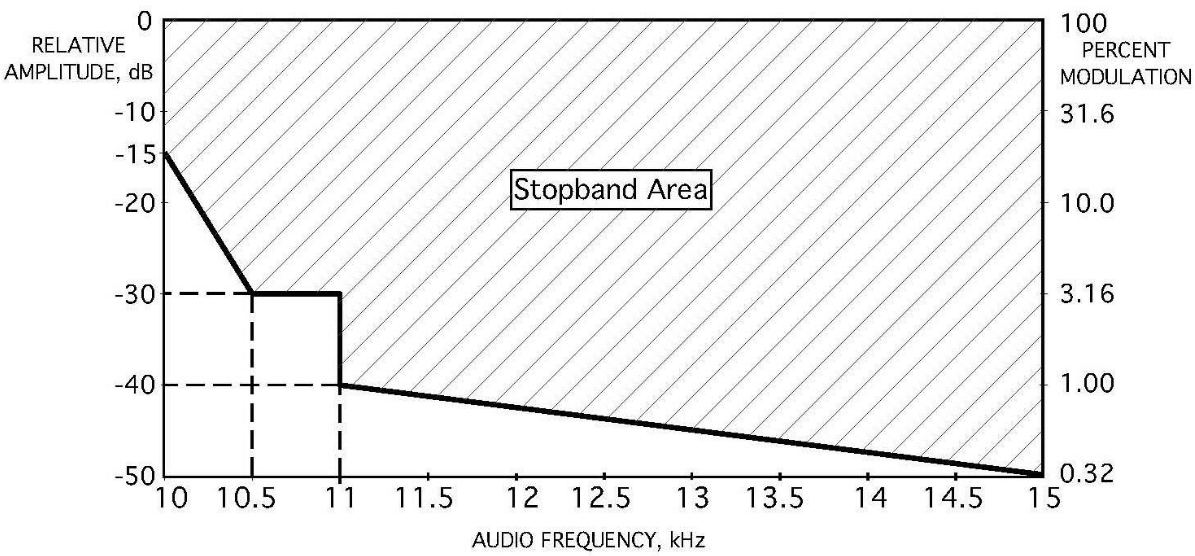

Figure 4. NRSC Stopband Specification for Analog AM Transmission

7.3 Bandwidths for Analog Portion of Hybrid AM IBOC Transmission

Each hybrid AM IBOC broadcast station shall modulate its transmitter with an analog audio bandwidth no wider than that described by the desired 5, 8, or 9.4 kHz mode as defined in normative reference [2]. Additional information may be found in informative reference [1]. The filters used to achieve the defined IBOC analog bandwidth characteristics are most likely to be implemented digitally in AM IBOC transmission equipment; however, appropriate and carefully designed audio low-pass filters as the final filtering prior to modulation may also be used to implement these specification. The purpose of these bandwidth specifications is to prevent interference by controlling the occupied RF bandwidth of AM stations and to insure compliance with the NRSC-5-D Standard.

7.4 Method for Determining Performance

An AM station is determined to be in compliance with the NRSC-1 audio bandwidth characteristic by measurement of the station's audio bandwidth in accordance with the following parameters:

7.4.1 <u>Analog AM Transmission</u>

7.4.1.1 Location of Measurement

Audio bandwidth measurements shall be obtained at the audio input terminals to the AM transmitter. For AM stereo stations, audio bandwidth shall be measured at the L+R audio input terminals to the RF modulator. Note that the NRSC bandwidth Standard characterizes an audio bandwidth that represents station program material that has been modified by possibly non-linear circuits in the station's audio processor. For this reason, the NRSC recommends use of a test signal that adequately characterizes typical audio program material, rather than relying on static audio test tones. However, it may still be useful to measure bandwidth statically at the time that AM preemphasis is measured.

7.4.1.2 Use of Standard Test Signal

Audio bandwidth shall be measured using a test signal consisting of USASI (United States of America Standards Institute) noise that is pulsed by a frequency of 2.5 Hz at a duty cycle of 12.5%. See Figure 5. USASI noise is intended to simulate the long-term average spectra of typical audio program material. Pulsing of the noise is intended to simulate audio transients found in audio program material. USASI noise is a white noise source (i.e., noise with equal energy at all frequencies) that is filtered by (1) a 100 Hz, 6 dB per octave high-pass network and (2) a 320 Hz, 6 dB per octave low-pass network. See Figure 5. A pulsed USASI noise generator is shown in Figure 6. Using the attenuator pad, the ratio of peak-to-average amplitude shall be 20 dB at the audio output of the pulser. The station's audio processor must be in normal operating mode.

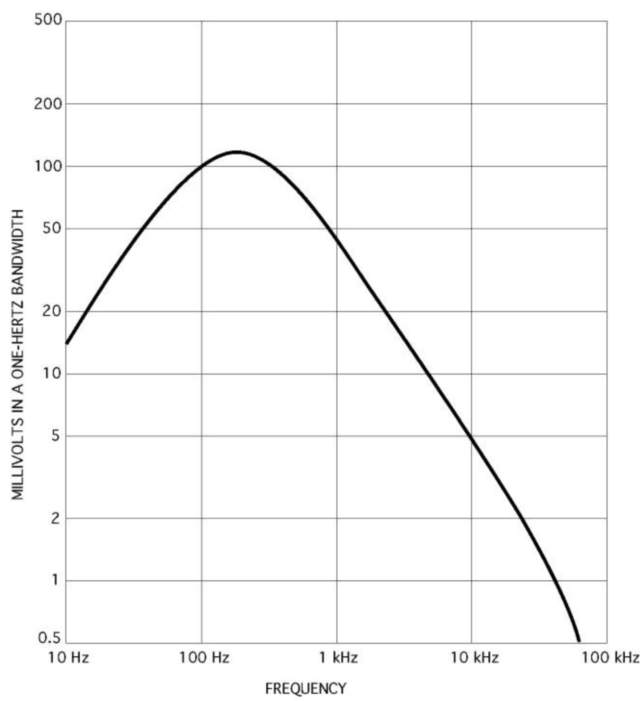

Figure 5. Spectra of USASI Noise

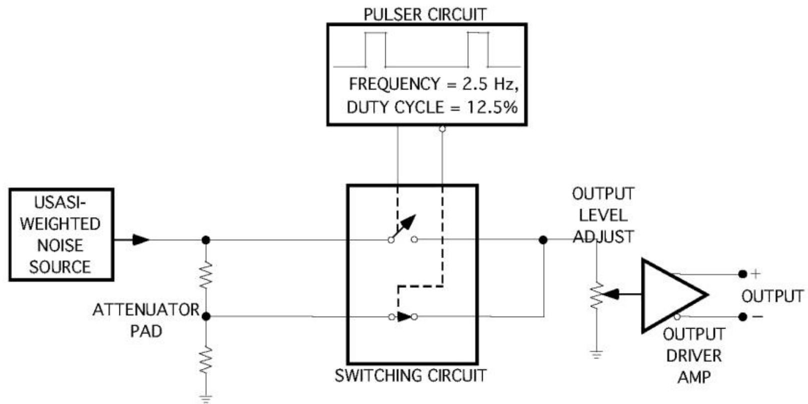

Figure 6. Pulsed-USASI Noise Generator

7.4.1.3 Use of Standard Measurement Devices

A suitable swept-frequency or FFT (Fast Fourier Transform) spectrum analyzer shall be used to measure compliance with the NRSC bandwidth specification in Section 7.2, above. An AM modulation monitor or suitable diode detector is used to demodulate the broadcast signal at the AM transmitter's output sample point.

(a) Spectrum Analyzer Setup. When a swept-frequency audio spectrum analyzer is used to measure compliance with the NRSC-1 audio bandwidth specification, the analyzer's setup shall consist of:

a. 300 Hz resolution bandwidth
b. 2 kHz/horizontal division
c. 10 dB/vertical division
d. Reference: 1 dB above 200 Hz (sine wave) 90% negative modulation
e. Display: maximum peak hold (or equivalent function)

The analyzer's operating span and sensitivity are adjusted as necessary to determine compliance.

(b) Fast Fourier Transform Analyzer. When a FFT analyzer is used to measure compliance with the NRSC bandwidth specification, the analyzer's setup shall consist of:

a. Reference: 1 dB above 200 Hz (sine wave) 90% negative modulation
b. Window: 300 Hz, Hanning
c. Horizontal span: 20 kHz
d. Dynamic range: 80 dB or available range
e. Display: Maximum peak hold (or equivalent function)

7.4.2 Hybrid AM IBOC Transmission

Compliance for the analog portion of hybrid AM IBOC transmissions is to be measured dynamically in the RF domain. The audio test signal may consist of that defined above in Section 7.4.1.2, or normal program audio may be utilized by the facility being evaluated. Specific RF mask envelopes and compliance measurement procedures are covered in normative reference [2].

8 Method of Testing Amplitude Modulation Broadcast Receivers for Audio Frequency Response

This section is informative.

This procedure suggests conditions and methods expressly for measurement of the audio frequency response of AM broadcast receivers relative to the modulation characteristics for transmission presented in this standard. It is adapted from portions of procedures from legacy standards of industry organizations (IEEE, IHF) but is not intended to replace comprehensive measurement procedures involving other RF and audio performance measurements.

8.1 RF Generator Requirements

This generates an adjustable-frequency RF carrier, with controlled attenuation of carrier level. It is typically provided with an input for amplitude modulation from a separate audio tone generator but may be equipped with an internal audio tone generator.

8.1.1 Frequency Range

As audio frequency response of a receiver may vary across the AM broadcast band, the generator should be capable of operation from 540 kHz to 1700 kHz in 10 kHz channel steps. It is expected that the RF generator has sufficient frequency stability to operate on any broadcast channel.

8.1.2 Carrier Output Purity

Carrier output purity is only important to the extent that the fundamental carrier modulation is unaffected for this test. Output range is limited to an RF level indicated herein for the audio test.

8.1.3 Amplitude Modulation

Linear amplitude-modulation capability is necessary from 30 Hz to at least 10 kHz. Linear modulation from the audio and RF generator produces sidebands with minimal distortion: for the purposes of this testing total harmonic distortion (THD) of less than 1 percent at 30 percent modulation depth is satisfactory. Audio frequency noise and hum should be minimal: RMS (root means square) level of no more than 30 dB below the audio signal at 30 percent modulation is satisfactory.

8.2 Dummy Antenna Requirements

A dummy antenna is important in comprehensive tests, such as receiver sensitivity and multi-carrier interference tests, to ensure that the actual RF signal power is accurately known. Therefore, the exact RF input voltage is not essential and a calibrated dummy antenna is not required: thus, the output of the RF generator may be connected directly to the AM receiver. However, a load resistor, e.g., 50 ohms, should be applied to the RF generator if RF level calibration is dependent on a matched load. As some receivers, particularly car radios, apply a DC voltage to the antenna input to power a low-noise amplifier, the tester should consider a decoupling capacitor between the matched load and the receiver input.

For the audio frequency response measurements herein the signal power is high, to override noise reduction features in the receiver, if any, that may affect audio frequency response. Alternatively, any such noise reduction features in the receiver should be disabled for this audio response testing, especially at any lower RF signal level.

8.3 Output Load

If so equipped, the receiver terminals to supply signal power to a loudspeaker(s) should be terminated with a resistive load having less than 10 percent reactive component at any frequency below 75 kHz. The resistor should have a nominal value that remains within 1 percent of the load specified by the manufacturer while dissipating the full output of the receiver. Receiver audio output terminals intended to supply a subsequent amplifier should be terminated with a 100 kΩ ±5% resistor, unless the manufacturer of the receiver specifies otherwise.

8.4 Output Meter

The audio voltmeter used for output measurements should have average rectifying characteristics and be calibrated to read the RMS voltage of a sine wave. Including any input filter, it should be accurate to ±3% of full-scale indication from 20 Hz to 20 kHz.

8.5 Operating Conditions

Regular precautions should be taken to provide equipment grounding and a low-RF noise environment, provide a low-noise AC or battery supply, preconditioning warm-up of the measurement equipment and receiver under test.

8.6 General Test Procedures

8.6.1 Input Signal Levels

Input signal levels are expressed in terms of RMS voltage at the antenna terminals. The RF voltage delivered to the receiver may be calculated from $E = \sqrt{P \times R}$ taking the generator source impedance into account. Some AM receivers, including car radios, have a high input impedance, while others with external antenna terminals may exhibit a lower but unspecified impedance. This introduces a 6 dB ambiguity between open-circuited and terminated voltage. It is desirable to determine the receiver's input impedance to obtain an estimate of the equivalent input, in microvolts. The tester should attempt to obtain the assumed antenna model from the manufacturer to facilitate matching and accurate measurements.

8.6.2 Mean Signal Input Level

Considering the input impedance discussed in the above step, the recommended RF carrier input signal is 10,000 µV RMS.

8.6.3 Recommended Test Frequencies

The first recommended carrier frequency is 1000 kHz, which is near the center of the AM broadcast band. The recommended group of three carrier frequencies is 600 kHz, 1000 kHz and 1500 kHz.

8.6.4 Reference Modulation

Recommended test modulation refers to a signal that is amplitude modulated at 1000 Hz with 30% of full system modulation (-10.5 dB relative to 100% modulation). All test modulation should be performed flat, without pre-emphasis.

8.6.5 Recommended Tuning

Unless the receiver incorporates digital frequency tuning, a receiver is tuned accurately to a desired signal with Reference Modulation by first tuning it approximately and adjusting the tuning control so that audio frequency output is maximum. As the receiver's automatic gain control (AGC) may reduce this effect, the RF Generator level may be reduced until the receiver is below AGC threshold, at which point the tuning effect should be evident. The RF level is then restored to Mean Signal Input Level.

8.6.6 Recommended Test Output

The recommended output for receivers with amplifiers for driving loudspeakers should be set about 10 dB below rated output or clipping with Reference Modulation. This level is chosen so that audio distortion from the amplifier has minimum effect on the measurements.

8.6.7 Control Settings

Unless otherwise called for in the measurement procedures, the controls are set as described below. Settings should be noted in the test report.

8.6.7.1 Balance

Set for equal measured output on each channel at the volume setting above, if a stereo receiver.

8.6.7.2 Tone

Set for flat or "0" response, if indicated. This applies to all controls that affect the frequency response, including those marked bass, treble, etc. If no markings are provided, set for flattest electrical frequency response with the NRSC Standard pre-emphasized test modulation.

8.6.7.3 Audio Presets

Set controls to a position giving the flattest response, before tone controls are adjusted. Loudness contouring, if provided, should be disabled.

8.6.7.4 Selectivity

The selectivity control, if provided, should be set to the broadest or widest position.

8.6.8 Performance Tests

After determining the reference settings of the receiver from the foregoing, the audio frequency response may be determined. This includes two preliminary tests to ensure that the frequency response measurements are not affected by excessive noise or distortion.

8.6.8.1 Signal-to-Noise Ratio at 10,000 µV

This test is performed at 1000 kHz with an input signal level of 10,000 µV under standard conditions with Reference Modulation. A signal-to-noise ratio, including hum and noise, of 30 dB is satisfactory for further tests.

8.6.8.2 Audio Distortion at 10,000 µV

This test is performed at Reference Modulation. A THD measurement of less than 5 percent is satisfactory for further tests.

8.6.8.3 ***Frequency Response***

The frequency response test takes into account all characteristics of the receiver. All controls are set to the recommended control settings outlined above.

- The receiver is initially tuned to a signal at the Recommended Test Frequency of 1000 kHz and a signal level of 10,000 µV, amplitude modulated with Reference Modulation. Output is measured with all controls set as described above. The output variation is measured while the modulation frequency is varied continuously from 30 Hz to 10,000 Hz. The results are compared to *Figure 2. Modified 75µs AM Standard Deemphasis Curve*, shown above, and are expressed in dB with reference to the 1000 Hz output.
- If the frequency response of the receiver varies with volume control setting because of tone compensation features, then the curve should be repeated at 10 dB steps in the control setting. The modulation percentage may be reduced if necessary for measurements of higher volume settings.
- The response should be repeated at the other two Recommended Test Frequencies (i.e., 600 kHz and 1500 kHz) to determine if the overall audio frequency response changes with tuning frequency.
- If the receiver is equipped with any automatic controls that affect frequency response other than those above, the resulting effect should be determined by additional tests. Rated frequency response should be stated as: From 30 Hz to 10 kHz at a nominal modulation level of 30 percent. Measurements at other modulation levels (e.g., 50 percent, 70 percent, 90 percent) are generally useful but are not specifically required for this test.
- Repeat tests for higher and lower RF carrier levels such as 30,000 µV RMS and 3000 µV RMS to verify that the audio frequency response is unaffected.

NRSC Document Improvement Proposal

If in the review or use of this document a potential change appears needed for safety, health or technical reasons, please fill in the appropriate information below and email, mail or fax to:

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