

FROM THE WEBMASTER OF HOBBYBROADCASTER.NET, BILL DEFELICE

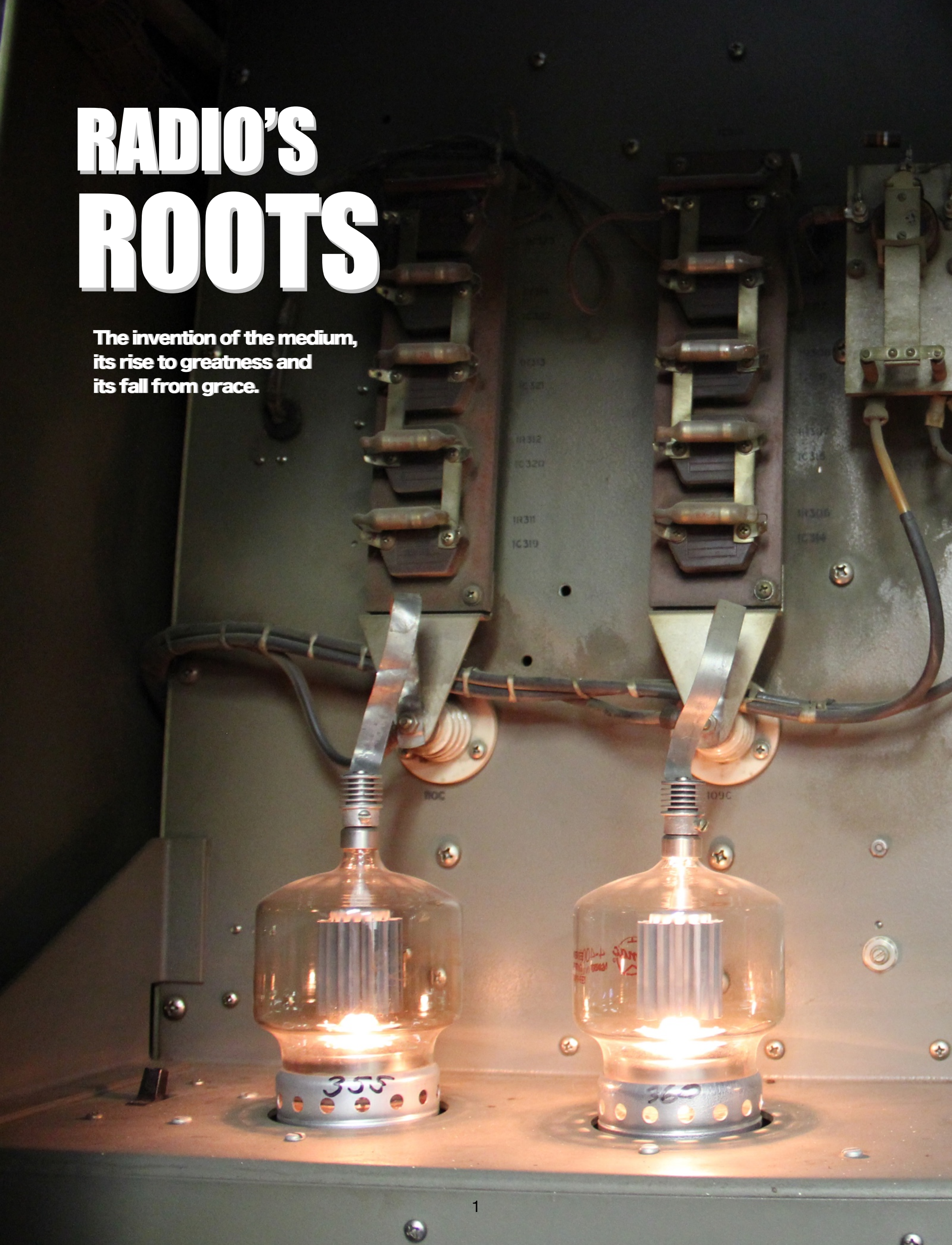
PART 15 BROADCASTING

Build Your Own Legal, License-Free Low Power Radio Station



RADIO'S ROOTS

The invention of the medium,
its rise to greatness and
its fall from grace.



Radio's earliest broadcast took place on January 13, 1910. Lee DeForest, inventor of the Audion electron tube, is credited with the first public radio broadcast of tenor Enrico Caruso's Metropolitan Opera House performance in New York City.

Since then radio has made great strides.

Broadcast radio became the traveling companion for the motorist starting in 1930, as the 5T71 car radio was introduced by Motorola.

Twenty-four years later it was the transistor that brought us America's first solid-state radio. The Regency TR-1 allowed radio entertainment to be truly portable for everyone.



Regency TR-1

Radio has been a source of information for more than 100 years. It was on the scene reporting disasters like the Hindenburg tragedy of 1937, the Challenger space shuttle disaster of 1986 and through the tragic events that unfolded on September 11, 2001.

Local radio had its finger on the pulse of the city as their news staff reported on everything from neighborhood crime, governmental happenings, high school sports, community events, traffic and inclement weather advisories.

As an entertainment medium radio came of age with the advent of rock and roll music. Many great on-air personalities like Alan "The King of Rock and Roll" Freed, Robert W. Morgan, Scott Muni, Dan Ingram, Casey Kasem, Don Imus, Wolfman Jack, 'The Real' Don Steele, John 'Records' Landecker, Larry Lujack, Charlie Van Dyke, Walt "Baby" Love, Alison Steele and Bawana Johnny made up just a tiny fraction of the greats who helped mold radio into the go-to place for music, fun and information. These talented people not only entertained their audiences but they related and connected with those who listened. Radio was one of the earliest forms of social media.



During the past couple of decades the Federal Communications Commission, the regulatory agency that oversees the use of the radio spectrum in the United States, loosened restrictions on licensed broadcasters. This made it possible for a single corporate entity to acquire large numbers of broadcast properties across the country. This deregulation has been credited with today's downward spiral of broadcast radio.

As a cost-savings measure many of these large-scale station operators jettisoned their locally hosted and produced programs for syndicated shows or satellite-delivered programming. It's not uncommon to hear multiple stations playing the same syndicated morning program with the only local content being an occasional traffic, weather or news break ... *if you're lucky!*

Radio is being controlled by the bean counters and programmed by consultants who believe **THEY** know what **YOU** want to listen to. It's no wonder why the masses are moving to alternative forms of entertainment such as portable mp3 audio players and online streaming media.

So the question remains, is there anything on the radio that's worth listen to? Maybe you've wasted time tuning your car radio in some futile attempt to find something other than some boring syndicated talk show or that dull morning show coming to you from parts unknown.

You're probably not alone unless you're lucky enough to live where local broadcast stations are still owned by "mom 'n' pop" operators or smaller groups who retain roots to the local community. This is in sharp contrast to large corporate-owned stations that air homogenized music playlists and pre-recorded announcers devoid of personality.

If you're tired of the same old thing on your radio you're invited to read on.

A CANDLE IN A SEA OF DARKNESS

You might believe you have no choice of what's available on your local radio dial. The complexities of building a full power, licensed radio station will escape all but the wealthy.

Pirate radio stations are illegal, can create interference with licensed radio broadcasters and can cause you to end up with an unexpected visit from an FCC field agent, liable for a hefty fine, or WORSE.

You do, however, still have an opportunity to get on the air.

Build Your Own Radio Station ... LEGALLY!

Title 47 of the United States Code of Federal Regulations contains the regulations associated with telecommunications. The groundwork for these regulations occurred in 1934 when the Federal Radio Commission was replaced with the Federal Communication Commission. First making its appearance in 1949, Title 47 C.F.R. Part 15 outlines the operation of restricted radiation devices. These regulations were first used to regulate the operation of devices such as phono oscillators, which allowed people to play their phonograph records for listening onto nearby radio receivers. These same regulations would be expanded through the years to regulate different portions of the radio spectrum. Part 15 compliant broadcasting on the AM and FM broadcast bands lends itself perfectly for a personal or campus-limited radio station for educational institutions.

Back in 1974 FCC Secretary Vincent Mullins was quoted in order 87(4), stating “... *The intent of Part 15 is to provide the radio enthusiast with an opportunity to experiment with radio, and to entertain friends or neighbors within a very limited communications range.*”

The Part 15 regulations provide specific details regarding a given signal's field strength and/or power, transmitter frequency accuracy and permitted harmonic and spurious emission limits. These regulations apply to both AM and FM systems whether they are home brewed, constructed using a kit, or are certified, commercially manufactured transmitters.

Technical Details:

Part 15 regulations limit the useable coverage to prevent harmful interference to licensed radio services. Excerpts of the applicable FCC regulations have been provided for reference.

FM Broadcasting:

Broadcasting with a Part 15 compliant FM radio signal is quite limited in coverage area. The regulations for compliant Part 15 FM operation are determined by the measured field strength radiated from the transmitter's antenna and not specified as an electrical power output in watts,

§ 15.239 Operation in the band 88-108 MHz.

(a) Emissions from the intentional radiator shall be confined within a band 200 kHz wide centered on the operating frequency. The 200 kHz band shall lie wholly within the frequency range of 88-108 MHz.

(b) The field strength of any emissions within the permitted 200 kHz band shall not exceed 250 microvolts/meter at 3 meters. The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in § 15.35 for limiting peak emissions apply.

(c) The field strength of any emissions radiated on any frequency outside of the specified 200 kHz band shall not exceed the general radiated emission limits in § 15.209.

The equipment used to accurately measure an FM signal is quite expensive and is usually found in the possession of radio stations, professional broadcast engineers and FCC field inspectors. A general rule of thumb is that a Part 15 compliant FM signal will not be receivable past 200 feet on typical radio. The majority of Part 15 radio enthusiasts prefer to broadcast on the AM band due of the limitations imposed with compliant Part 15 FM.

AM Broadcasting:

While other FCC regulations factor into legal, unlicensed broadcasting it's these three regulations that apply to Part 15 compliant operation on the AM broadcast band:

§ 15.209: Radiated emission limits; general requirements.

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified for 490 kHz through 1705 KHz, inclusive of the AM broadcast band, is calculated with the formula: 24000 divided by the frequency in Kilohertz, with the resulting number equaling the field strength in microvolts per meter, with a measurement distance of 30 meters away from the antenna.

This is the most restrictive regulation to operate a Part 15 AM signal under. The field strength is quite low under this mode of operation and you would need a field intensity meter to confirm legal compliance of the transmitter's emitted radio signal.

The FCC saw fit to make a regulation that's not only friendlier toward the hobbyist and radio experimenter but provides for somewhat better legal range.

§ 15.219 Operation in the band 510-1705 kHz.

(a) The total input power to the final radio frequency stage (exclusive of filament or heater power) shall not exceed 100 milliwatts.

(b) The total length of the transmission line, antenna and ground lead (if used) shall not exceed 3 meters.

It is recognized that Part 15.219 allows hobbyists to operate a Part 15 transmitter without the requirement of specialized test equipment to verify compliant operation. This regulation also provides a real chance for attainable legal range beyond that imposed under Part 15.209.

There is also one additional rule that is applicable to Part 15 broadcasting on the grounds of an educational institution, allowing a school-based AM station to adequately cover the campus grounds.

§ 15.221 Operation in the band 525-1705 kHz.

(a) Carrier current systems and transmitters employing a leaky coaxial cable as the radiating antenna may operate in the band 525-1705 kHz provided the field strength levels of the radiated emissions do not exceed 15 uV/m, as measured at a distance of $47,715/(\text{frequency in kHz})$ meters (equivalent to $\text{Lambda}/2\text{Pi}$) from the electric power line or the coaxial cable, respectively. The field strength levels of emissions outside this band shall not exceed the general radiated emission limits in § 15.209.

(b) As an alternative to the provisions in paragraph (a) of this section, intentional radiators used for the operation of an AM broadcast station on a college or university campus or on the campus of any other education institution may comply with the following:

(1) On the campus, the field strength of emissions appearing outside of this frequency band shall not exceed the general radiated emission limits shown in § 15.209 as measured from the radiating source. There is no limit on the field strength of emissions appearing within this frequency band, except that the provisions of § 15.5 continue to comply.

(2) At the perimeter of the campus, the field strength of any emissions, including those within the frequency band 525-1705 kHz, shall not exceed the general radiated emission in § 15.209.

Specialized installations for educational institution campuses can be engineered to use carrier current (AM) or radiating coaxial cable (AM or FM) but these installations require highly specialized RF measurement equipment for installation and compliance certification.

Your Part 15 compliant station cannot interfere with licensed broadcasters or other authorized spectrum users regardless of the chosen regulation you decide to operate under. You're responsible for interference caused by the operation of your transmitting equipment and must immediately discontinue all operation should you create harmful interference. Likewise, under Part 15 regulations you must accept interference to your signal. What this means is you need to exercise care to operate your Part 15 station on a clear frequency.

YOUR JOURNEY BEGINS

A general guide to help you build your own station



People decide to start their own Part 15 compliant radio station for a variety of reasons. Anybody from mobile disc jockeys, music lovers, persons employed in full power licensed broadcasting, educational institutions and electronics enthusiasts are just some who might want to build their own station.

The one thing the Part 15 broadcast enthusiast absolutely needs is accurate information and resources to help them on their journey. You don't want to end up on the wrong end of the law for operating an illegal, pirate radio station. Besides being classified as a federal crime, some states including Florida, New York and New Jersey have laws on their books making pirate radio a felony, punishable by legal action and possible arrest.

Comprehensive Broadcaster Resources:

As of the publication date, HobbyBroadcaster.net is the only website of its kind dedicated to legal low power license-free radio enthusiasts operated by a broadcast engineer with more than 4 decades experience in the radio industry. The site includes legal and technical references, a comprehensive resources directory, equipment reviews and Part 15 station and broadcaster profiles. Additionally, an active forum community where those interested in various aspects of legal, license-free low power radio broadcasting may ask for assistance as well as network with other like minded individuals. The information presented is equally valuable to the novice operator as well as those having professional experience at full power, licensed broadcast radio facilities.

Antique radio collectors often build up their own small scale station. This allows them to enjoy the restored radios in their collection by playing those classic programs that originally aired when those very radios came off the assembly line. Popular forums for antique radio collectors include [Antique Radios](#), [Antique Radio Lab](#) and [Tube Radio Forum](#).

Another interest group adopting the use of legal Part 15 radio are holiday light display enthusiasts. They use the power of unlicensed, legal low power AM and FM broadcasting to entertain those who stop to see their holiday light shows. These enthusiasts synchronize music to their displays which can be enjoyed on the visitor's car radios. Forums for this growing interest group includes [DIY Light Animation](#), [Falcon Christmas](#), [Light-O-Rama Forums](#) and [Planet Christmas](#).

Amateur radio operators, or "hams" are often well versed in electronics and audio equipment and might find your station project interesting. You may be able to recruit some help from the local ham radio group.

Stations located on K-12 or college / university grounds may be able to get a hand from a local, licensed radio station. Your local station may have surplus equipment pulled out of service which they may consider donating to your school for a tax deduction. Their station engineer may even lend a hand in advising how to design and build your studios to help students and faculty use the station not only as a personal enrichment opportunity, but to augment your school's teaching curriculum.

This ebook is not meant to be a full step-by-step guide that will walk you through every aspect of building your Part 15 radio station. It would be beneficial if you have experience with electronics and audio or can find friends who can help you out in the areas you need assistance. The resources mentioned above are great starting points for anyone looking to build their own station.

Building Your Station:

Building your station can be as simple or elaborate as both your imagination and finances allow. The casual hobbyist may choose to construct a simple, budget-friendly station while individuals desiring to emulate an actual radio station experience or an educational institutions wanting to teach broadcasting to their students may choose to equip their stations with professional-grade equipment, creating a full featured radio studio. Building your station the way you want is all part of the fun.

Some basic equipment you'll need to build your station include the following:

Program sources: Microphones, CD or other audio players such as turntables, cassette, open reel tape, minidisc, telephone hybrid, etc.

Automation system: Computer running an appropriate software program that allows reproduction of audio stored in wav, mp3, ogg or other similar data format allowing for manual or continuous audio playback capable of seamlessly segueing between program elements for a professional on-air presentation.

Audio mixer: Controls the levels and mixes the audio sources together. Sometimes called the audio board or audio console.

Audio Processors: Compressors, limiters, automatic gain controller, etc., to keep your station's audio loud enough to stay above the noise and to prevent your audio from becoming too loud or distorted while broadcasting.

Transmitter: The actual device that converts your audio to a radio-frequency signal that can be heard on an AM or FM broadcast band receiver.

Radio: To monitor how your station sounds on the air.

The Crown Jewel of Your Station - The Transmitter:

The transmitter is the most critical piece of equipment for your station.

For the radio enthusiast with ample electronics experience the FCC allows you to construct your own transmitters as long as the builder complies with some additional rules.

§ 15.23 Home-built devices.

(a) Equipment authorization is not required for devices that are not marketed, are not constructed from a kit, and are built in quantities of five or less and are for personal use.

(b) It is recognized that the individual builder of home-built equipment may not possess the means to perform the measurements for determining compliance with the regulations. In this case, the builder is expected to employ good engineering practices to meet the specified technical standards to the greatest extent practicable. The provisions of § 15.5 apply to this equipment.

For the radio enthusiast without an advanced understanding of electronics there are transmitter kits available for folks wanting to build it themselves without the hurdles of having to design and test a successfully operating prototype. Kit transmitters allow the broadcaster to both practice soldering skills and save some money over pre-assembled transmitters, though these transmitters traditionally lack the performance of their commercially manufactured counterparts.



Hamilton Rangemaster



i.AM.Radio Transmitter

While more expensive, a certified AM transmitter offers both pre-assembled convenience along with FCC acceptance. By using an FCC certified transmitter and installing it in the approved manner you'll not only be sure to have an improved chance of compliant operation under Part 15 regulations, but improved odds of building a better sounding station. Among the transmitters with FCC certification are three top performers, the [Grain Industries GI-100/1000](#), the [ChezRadio Procaster](#) and the well known [Hamilton AM1000 Rangemaster](#). One certified transmitter with motorized automatic antenna tuning is the Radio Systems [i.AM.Radio](#).

Transmitters that operate under Part 15.219 are limited to a total combined antenna and ground lead length of 3 meters, or approximately 9.84 feet. With the exception of the desktop operation mode of the i.AM.Radio transmitter this means that most installations will require the transmitter to be located on or within close proximity of the earth to remain compliant with this regulation. Transmitters mounted close to the earth can take advantage of using a ground radial system to improve range. With the short vertical antenna allowed under Part 15.219 your ground radials need to be buried below the earth to prevent them from radiating the signal of your transmitter or exceeding the allowed total antenna and ground lead lengths.



ChezRadio Procaster

When elevating the transmitter appreciably you must take adequate precautions to both maintain the specified total antenna / ground lead length limit and preventing the ground lead from radiating. Lacking attention to these details may subject you to a notice of unlicensed operation (NOUO) or, at the very least, a visit from an FCC field agent should they receive a complaint about your station. This worry can be virtually eliminated with the transmitter mounted at earth level.

Frequency Selection for Carrier Current Operation:

Typically, carrier current is more efficient when operating on the lower portion of the AM broadcast band. Not many people care to experiment with carrier current AM transmission due to expense of the equipment along with the dangers in dealing with coupling a transmitter to the AC power lines. There is a high potential for damage to property, personal injury or death due to the lethal voltages of a typical building's electrical system. Should you decide to venture down the path of carrier current transmission it's strongly recommended you consult with a qualified, licensed electrician if you lack the necessary skills and knowledge to safely proceed.

Frequency Selection for Antenna-based AM Transmitters:

You'll most often discover AM transmitters which utilized an free radiating antenna will perform more efficiently at the upper end of the broadcast band. The best results usually occur with operating frequencies between from 1600 to 1700 KHz, often referred to as the expanded, or X-band.

Special Notes for ALL Part 15 AM Broadcasters:

Operation on 1710 KHz is governed under a different Part 15 regulation, § 15.223, which significantly limits allowed field strength from that allowed under § 15.219. Those wishing to operate in a compliant and legal manner should avoid 1710 KHz although some transmitters may include the ability to tune and operate on that frequency.

Useable nighttime coverage will be substantially diminished due to the skywave interference from other stations. Under Part 15 regulations you must accept any interference to your signal.

Station Identification:

There are some general guidelines when it comes to operating your station, including identifying your broadcast. A mention of this is contained within Part 73, the regulations which pertain to licensed broadcast stations:

§ 73.3550 Requests for new or modified call sign assignments.

(I) Users of nonlicensed, low-power devices operating under part 15 of this chapter may use whatever identification is currently desired, so long as propriety is observed and no confusion results with a station for which the FCC issues a license.

It is generally considered bad practice to use made up call letters as it may confuse the listener to the legitimacy of your station. Compliant Part 15 operators may prefer to use a slogan as identification for their station, such as *Windwood Estates 1650 AM, River Bend 1700* or a similar tag line.

Licensed broadcasters are required to identify their stations hourly, as close to the top of the hour as possible. While there is no legal requirement to do so you might wish to identify your station in a similar fashion to avoid confusion with anyone mistaking your signal for an illegal or "pirate" station. You might even wish to add to your station identification a statement along the lines of "*operating under Part 15 regulations as authorized by the Federal Communication Commission.*" If you have a website for your station you may wish to refer listeners to it so you can provide additional information about your station.

I've Built My Station, Now What?

You've finally built your station. You've connected your studio to your transmitter, tested and fine tuned everything. You may be asking yourself "what do I do now?"

As mentioned earlier, many antique radio collectors play old-time radio programs so they can enjoy the radios they've restored. There are plenty of online sources where you can either download for free or purchase collections of OTR programs that these radios received when they were originally purchased.

Many Part 15 operators want to emulate the experience of a modern day broadcast station. Some are influenced by stations they grew up listening to while others might have fond memories of a station they partied to during their college years. Those who have worked in commercial broadcasting might want to have a station reminiscent of a particular station they enjoyed working at.

By using a computer and appropriate software you can create a professional sounding station by playing the music into your broadcast console, but music is only the tip of the iceberg for programming. You can play news, weather, talk shows and special interest programs, too. You can even make your station self-sufficient by selling commercials as there's no limitation under Part 15 regulations.

Expanding the Possibilities:

You can employ a larger legal coverage area by using multiple transmitters for campus-limited radio or a personal station. Care must be taken so that the overlapping signals do not create interference in the fringe signal areas of each transmitter. This is an excellent way to provide coverage to a larger school campus or perhaps even a small town.

In Print, Online and Beyond:

If you're looking to get your station noticed there are many ways you can spread the word, but be forewarned. Prior to doing any sort of promotional activities you should make certain that your station's transmitter(s) has been installed in a 100 percent legal and by the book manner. You may find people who don't understand that Part 15 radio isn't "pirate" radio and they may take issue with your station, especially if you ruffle the feathers of a nearby licensed station. You may discover something as innocent as a simple newspaper story can attract the regional FCC field office, prompting them to investigate and visit your station. Doing things correctly the first time will save you headaches down the road.

You have a myriad of possibilities to get your station noticed. Business cards, bumper stickers and window stickers can be low cost options. Station swag like coffee cups, caps and shirts can quickly become listener favorites. If you venture out and do on-location "remote" broadcasts you can do listener contests and give away this swag to your station's fans. You can get even more popular by harnessing the world of online social media. Facebook and Twitter allow you to extend your reach to make your station known to those who haven't discovered your broadcasting endeavors. A station website can provide you with a way to target your local audience with personalized content. Having your site's content hosted by your own web provider will prevent it from being censored by online venues that may not agree with your views or may take issue with you and your station.

If you plan on turning your station into a business it's advised to research music licensing to stay legal. At this time only [BMI](#) is currently accommodating music licensing for Part 15 broadcast signals.

While it can become an expensive addition you may decide to stream of your station's programming online. Not only will you gain an audience beyond the reach of your transmitter but you'll also be able to monitor your station's programming from most any computer or smartphone. Keep in mind that you'll have to pay for online streaming servers and bandwidth in addition to streaming music royalties that are determined by the amount of listeners and their time spent listening online.

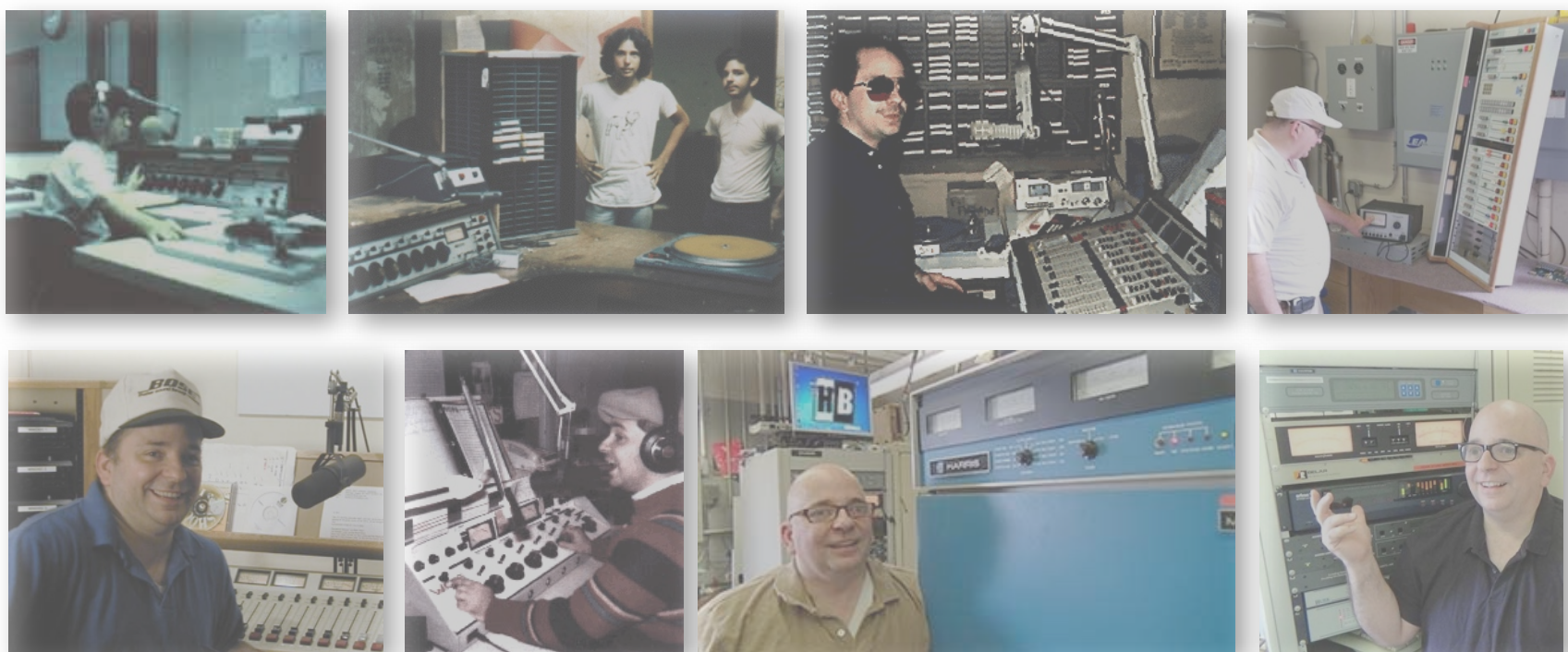
About The Author:

Bill DeFelice has been involved with broadcasting for more than 4 decades. While interested in radio and electronics as a youngster it wasn't until his freshman year when Bill would discover his calling for broadcasting. He breezed through the test for the then-required FCC third class radiotelephone permit with broadcast endorsement, thanks to his involvement with the 330 watt community FM station located at the local high school. As the station's student chief engineer Bill learned about various aspects of the broadcasting including audio production, on-air presentation, engineering as well as FCC law. He also assisted in a major studio relocation as part of the high school renovation of 1976 and 1977.

The experience he gained would eventually pay off with more opportunities. Bill later became Director of Engineering for Minuteman Broadcasting's WMMM / WCFS 1260 AM Stereo in Westport, Connecticut and provided engineering services for stations ranging from 1000 watt AM outlets all the way to a regional 50,000 watt FM station. He served as secretary and newsletter coordinator for the Society of Broadcast Engineers New York Chapter 15 and is an SBE certified audio and video engineer.

Specializing in studio construction and broadcast automation, Bill continues consulting and freelance engineering services in addition to his computer and electronics technologist role in the field of education. It was the latter that would lead him to a renewed interest in Part 15 broadcasting.

As part of a major construction project at one of his district's two high schools, rooms were constructed not only for a television production suite but for a campus radio station. The district lacked any action plan on how to implement the station project and Bill was called upon for guidance. While well-versed in what was needed to be done it was during the research process he soon discovered the lack of quality resources for Part 15 broadcasters, not only for those utilizing the technology for campus-limited broadcasting in a K-12, college and university environment but for the hobbyist community. It was this very lack of online resources that inspired him to create the HobbyBroadcaster.net website.



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