

LPB

TECHNICAL NOTE NUMBER 6

ON UNLICENSED FM STEREO

RADIATING CABLE

INFORMATION SUPPLIED BY:

Dave Strobe Of SANDIES

225 Lincoln Highway Suite 167 Fairless Hills, PA 19030

Phone - 215 547-2570 Fax - 215 701-9197 Email - www.sandiesusa.com

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UNLICENSED FM STEREO RADIATING CABLE

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1.0 UNLICENSED FM STEREO RADIATING ("LEAKY") CABLE

An increasing number of college radio stations and others are broadcasting to a limited area in FM stereo (or FM mono) using a special radiating ("leaky") coaxial cable, without any requirement for FCC licensing, completely in compliance with the FCC Rules.

Broadcasting using radiating cable offers a number of advantages to college broadcasters by comparison with an "over-the-air" Noncommercial Educational FM Station licensed by the FCC. First, there is no licensing procedure, associated cost, or processing delays. Second, the frequency is not limited to the "Educational Band" (88.1- 91.9 MHz), but is permitted in the full 88.1 to 107.9 MHz FM Band. Third, there are no restrictions on the broadcast of commercial advertising. Fourth, using radiating cable is typically less expensive, often much less expensive than a licensed Noncommercial Educational FM transmission system.

Applicable FCC Rules are found in Part 15. Compliance is not difficult.

2.0 THE F.C.C. RULES

The FCC Rules place two requirements on the operator (radio station) of special radiating coaxial cable in the FM band, and one on the equipment supplier.

1. Operation may not cause any interference to a licensed broadcaster, or to any other service authorized by Part 15 of the FCC Rules [§15.5(b)]. Compliance is accomplished by choosing a frequency which is locally quiet (i. e., you can't hear anything on it).

2. The field strength shall not exceed 250 $\mu\text{V}/\text{m}$ (microvolts per meter) at a distance of 3 meters from the radiating cable [§15.239(b)]. This is actually a strong signal, and compliance is easily approximated using a standard pocket radio. Equipment supplied by LPB has been preadjusted for compliance.

3. The FM Transmitter (or FM Stereo Modulator) must be Certified by the FCC in compliance with the technical specifications of Part 15.

2.1 Frequency Protection

Choice of a frequency must be done quite carefully in the band 88.1 to 107.9 MHz, to avoid any existing licensed Station, and any current Construction Permit to build a new licensed FM Station. College unlicensed broadcasters use publications and jingles referencing their frequency to build listeners at the school. After some time at "94.1 on your dial", a new nearby commercial station could suddenly appear licensed on 94.1 MHz. In such an event, there is no alternative to moving to a new frequency, for the licensed broadcaster has the frequency protection. Part 15 requires that you cease operation immediately if you present the licensed broadcaster any interference, interpreted as any difficulty in receiving the licensed station anywhere within or near its licensed 0.5 mV/m field strength contour.

2.2 FCC Inspection

The FCC has many other things to worry about, they have no interest in an FM radiating cable station if it does not create interference to licensed broadcasters. Frequency selection and good engineering are the keys. As long as a station is in compliance with the FCC Part 15 Rules listed above, in the highly unlikely event of an FCC inspection, the FCC Field Engineer will go away satisfied!

3.0 UNDERSTANDING FIELD STRENGTH

An understanding of the nature of the field strength in the vicinity of our "antenna" (the radiating cable) is the key to an appreciation of why and how FM stereo radiating cable broadcasting is successful.

The Radiation and Induction Fields

A mathematical analysis of the signal strength produced by an antenna shows $47,715/f$ meters (f is the frequency in kilohertz, kHz) as the distance at which the character of the field strength changes. From $47,715/f$ outwards is predominantly the Radiation Field (or Far Field) of an antenna, wherein the signal strength decreases in direct proportion to increasing distance ($1/r$).

In contrast, from $47,715/f$ inwards to the antenna is predominantly the Induction Field (or Near Field). In the Induction Field the signal strength increases as we move closer (decrease distance) to the "antenna" at a third power of distance ($1/r^3$), i.e., the signal strength increases by $2^3 = 8$ (is multiplied by 8) each time we cut the distance to the source (r) in half. Unlicensed AM carrier current and AM radiating cable broadcasting operate in the Induction Field.

At FM frequencies, 88.1 MHz to 107.9 MHz (1 MHz=1000 kHz), $47,715/f$ is approximately 0.5 meters, less than 2 feet. Thus FM stereo radiating cable operates in the Radiation Field where the signal strength decreases linearly with distance.

Field Strength and Coverage Distance

Note that the permitted field strength of $250 \mu\text{V/m}$ at 3 meters from the antenna (cable) is measured in the Radiation Field, which began at 0.5 meters. Mathematically, the product of the field strength and distance is constant, equal to 750. That is, at 30 meters, the field strength is $750/30 = 25 \mu\text{V/m}$; at 50 meters, it is $750/50 = 15 \mu\text{V/m}$; and at 75 meters, field strength is $750/75 = 10 \mu\text{V/m}$.

The final measurement is important, since a portable (Walkman-type) radio can discriminate FM to about $10 \mu\text{V/m}$, when the FM signal should become indistinguishable from background noise. A good component stereo receiver can pick up clear FM stereo at $10 \mu\text{V/m}$. 75 meters is approximately 250 feet. So coverage distance for FM, under ideal conditions, may be 250 feet on either side of the radiating cable., a 500-foot wide zone. Ideal conditions include a completely quiet FM frequency, no interference of any sort, and open-air transmission with no impeding objects.

In the real world, ideal conditions are quite rare, and floors and walls of buildings can cause the signal strength to be dramatically reduced. Still, we have encountered conditions when FM stereo radiating cable on the sixth floor of a high-rise dorm provided clear signal on the first floor, and also on the seventeenth floor, over 110 feet away, through 11 stories of floors and walls.

4.0 IMPLEMENTATION

Unlike licensed Educational FM broadcasting, Part 15 has no restrictions against selling and broadcasting commercial advertising. FM stereo radiating cable college stations can and do actively solicit local and national advertising accounts to offset their operating costs. Thus it provides a realistic training ground for a career in commercial broadcasting.

4.1 The Economics of Coverage

Several features of unlicensed FM stereo radiating cable broadcasting permit surprising economics. First, there are three types of radiating cable available; for a coverage zone up to 200 feet LPB NF-1D is sufficient; up to 800 feet LPB NF-2D; for longer zones Andrew Radiax. Any cable may be extended with the use of an additional LPB RB-1 Linear Amplifier. Cable cost factors per foot are about 1:2:4.

Second, the zone of coverage under ideal conditions is 500 feet wide. That means a 17-story high-rise dorm can be covered for the same cost as an equal length of 2-story dorm. However, the 2-story dorm with radiating cable in the attic may also provide nearby dorms (within, say 175 feet) with good reception, for free!

The economics clearly favor a campus with small dorms close together, or a campus with high-rise dorms, and are least favorable for a campus with widely scattered small dorms. Often, a campus has "all of the above". Fortunately, FM stereo radiating cable systems are modular in nature; more coverage can be added later without affecting anything already in place.

4.2 Equipment Operation

Good sense suggests that transmitters be turned OFF during long inoperative periods, such as summer vacation. They should also be inspected on a scheduled basis, perhaps at the beginning of each semester. LPB radiating cable has proven extremely reliable for many years. LPB FM equipment is designed for unattended continuous operation; when properly installed, it generally delivers flawless service.

4.3 Professional Assistance

Design of an FM stereo radiating cable installation within the FCC Part 15 Rules is not a simple task. Even the most capable broadcast engineers have little or no experience with design or maintenance of unlicensed systems. LPB has designed, manufactured, installed and maintained Part 15 unlicensed systems since 1960, and introduced unlicensed FM stereo radiating cable systems in 1990. Before purchasing equipment, consult LPB for professional assistance.

4.5 Other Applications

We have used the college application to make several points. The reader can readily generalize to other applications with the same characteristic of a concentrated special-interest listenership group. For example, FM stereo radiating cable systems are found in health spas, sports stadiums, convention halls, summer camps, and a widening variety of other applications.

6.0 CONCLUSION

This LPB Tech Note is a summary of what LPB personnel have learned about limited area FM stereo special radiating cable broadcasting since we began installations in 1990. We have developed new techniques and equipment, and, we believe, have improved both equipment and coverage within the boundaries of Part 15 of the FCC Rules. Many other interesting and related applications of this technology have grown. We hope this information will assist you in understanding and implementing it. Call us at LPB if we can be of help with your specific needs.

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