FM Radio Broadcasting and 3D Printing for Christmas Lighting

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May 11, 2019

So you've decided to play some music

- While all types of displays can benefit from broadcast music, Synchronized displays require it.
- You need to broadcast your music over the radio so folks can stay in their cars and to be nice to the neighbors
- Oh, by the way, if you do this you need 2 transmitters
- Let's look at the technology, the options, and the legalities

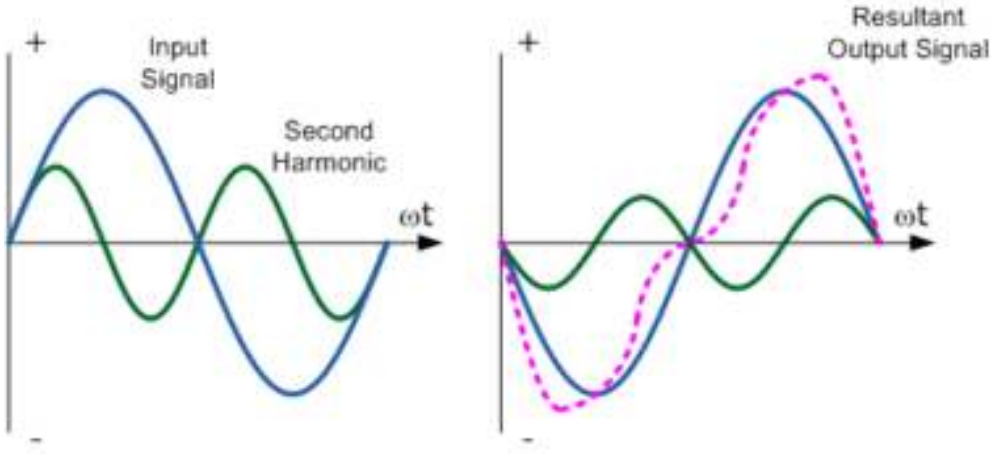
YOU are a Radio Station !

- FM vs. AM
  - You can legally transmit further with AM than FM
- There is no difference between you and your local NPR station other than power and licensing.
- No license is needed for low power transmissions. (much more on this topic later…)
- Since power is very limited, you should focus on quality.

Why is quality important?

- Sound Quality, for listening enjoyment

- Radiation Quality so you don't interfere (more later)



Legalities

FCC Part 15

- It's perfectly legal to make and operate your own 88-108MHz FM transmitter, provided:

  - the radiated FM power is below a certain field strength at a certain distance from the radiation source; there's a table in the FCC books.

  - your signal does not interfere with any FCC licensed broadcast station. If you broadcast on or near the broadcast frequency of an existing FM station in your area so that your next door neighbor can't pick up that station, it's illegal even if your field strength lies within limits.

  See FCC Part 15 rules for all the juicy bits. For example:

- Page one of the technical power rule: AM - .05 watts (or 100mw to the final RF), and FM - 0.01 microwatts. But these are difficult to measure since calibrated RF meters are expensive, the general intent of the rule is defined as an 'Approx. Maximum Coverage Radius' or **200 feet** (radius) for both AM and FM low power transmitting.
- If you are going beyond 200 feet you can ‘attenuate’ your transmission. You do this with a device you place between the transmitter and the antenna. A unit with a value of 15db to 20db should do the trick.

Attenuators – Reduce your Strength

If your transmitter is too powerful, there is a way to reduce the strength of the radiated power output.

An Antenna *Attenuator* will absorb some of the energy thereby reducing the final about of output power.

by AIM-Cambridge / Emerson Connectivity Solutions

Attenuators - Interconnects PADS BNC 50 OHM BNC(M) (F) 20db

★★★★★ ▾ 3 customer reviews

Price: $19.99 ✓Prime

Note: Available at a lower price from other sellers, potentially without free Prime shipping.

Want it Sunday, July 10? Order within 1 hr 33 mins and choose **Two-Day Shipping** at checkout. Details

Only 6 left in stock.

Sold by Electric Test and Fulfilled by Amazon. Gift-wrap available.

3 new from $12.88

Specifications for this item

Brand Name	AIM-Cambridge / Emerson Connectivity Solutions
Part Number	27-9300-20

Legalities to Realities & a fairy tale

- Be Smart… Only what you need, this isn't a contest
- Run a very 'clean' signal (high quality and/or filter)
- A caveat about tinkering with an FM broadcast band transmitter: *A few years back, a guy around here built one that covered about a square mile. Unfortunately for him, he also had a spur dead center on one of two of the approach / departure frequencies for the local regional airport / air national guard facility. Finding hidden transmitters is a competitive sport in ham radio, and this transmitter was found within minutes. Because of the proximity of the FM BCB to aeronautical and public service frequencies, I would be very circumspect about modifying one or building an amp for one without some RF experience and access to a spectrum analyzer or some other means of checking for spurious or harmonic output. In fact, I just wouldn't do it - it's not legal and there are better ways to skin t*

Actual FCC Powerpoint Slide !

Bad transmission -> potential problems

- just to also let you know what's in the frequencies everyone needs to be majorly concerned about when broadcasting in the 88-108 FM Band....

  108–118 MHz: Airport navigation beacons
  118–137 MHz: Airband for air traffic control, AM,
  121.5 MHz is Airband emergency frequency

  2nd harmonic of the FM band is 176-216 Mhz (TV Channels 7-13) Also used by some wireless microphones
- If you decide to ignore the FCC rules and get caught doing something in violation, you can be fined thousands of dollars. More importantly, they will take your Transmitter without a Search Warrant !
- IF the FCC fines you, they don't forgive you, regardless of your intent or lack of intent. Only forgiveness I've seen is for financial reasons.
- FCC posts all fines online

Moving Along……What frequency ?

- Get this task done NOW ! Not November.
- You need to start work on frequency selection and worry about the transmitter later. You need to be listening for Silence NOW.
- Pick TWO possibilities. Why? Seasonal Broadcasters & Signage
- Start with the Radio Locator: https://radio-locator.com/cgi-bin/vacant

- The listing for Delaware, Ohio zip 43015

Vacant Channels	Next Best Channels	Third Best Channels
87.9 FM BEST! 88.3 FM BEST!	90.9 FM GOOD 94.1 FM GOOD 100.1 FM GOOD 107.3 FM GOOD	88.1 FM OK 93.9 FM OK 100.9 FM OK 101.5 FM OK 101.9 FM OK 102.7 FM OK 103.3 FM OK 106.9 FM OK 107.1 FM OK

- http://www.fcc.gov/mb/audio/fmq.html is the FCC station listing

Frequency chosen, now a SIGN

- The most common mistake I see with folks signs is that they spend too much text on the fluff, and not enough on Frequency Numbers. *(Don't ask me how I know about this)*
- You want the biggest Frequency Numbers you can fit on the Sign.
- Need to well illuminate your sign.
- Lots and lots of ways to do signs.
  Vinyl banners, Mini-lights in coro, Back-lit Stencils on glass, wireframes, Digital Displays (P5 & P10 panels)
- My simple sign & frame:
  - **Shindigz and Vistaprint** – look for specials. My Shindigz signs cost 1 cent !
  - Nothing special. Just their standard vinyl
  - Grommets & no-grommets (get the Harbor Freight kit with coupon)

Sign Examples

Build a Sign – show & tell

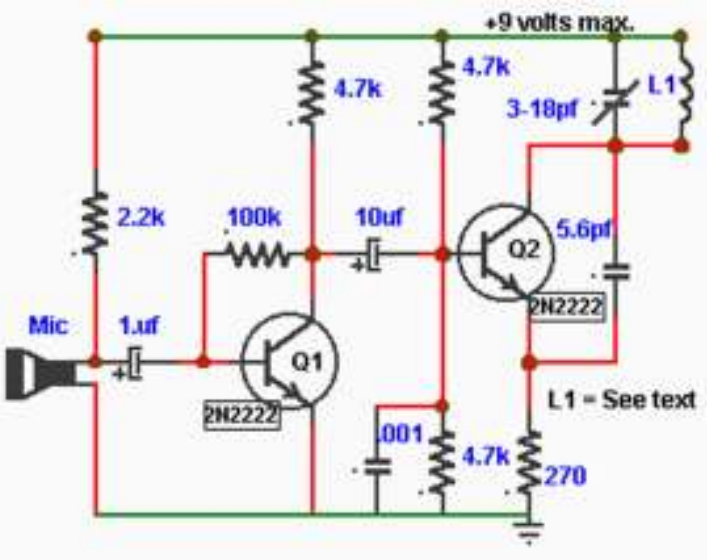
- ½” PCV – 2 * 10’ pipe and 4 * 90 degree elbows
- Ball end elastic cord set from Harbor Freight, 2 sets, 8 cords
- tinsel

What the heck is RDS ? (Radio Data System)

- **Definition:** This technology allows stations to transmit additional types of information via encoded digital signals that can be received and displayed by the user's Radio. For instance: an RDS-capable Radio can display the title and artist or current song playing, local traffic information, an advertiser's phone number while a commercial is playing, etc
- The rub? you sometimes have to get creative in attaching an RDS Encoder to your transmitter.

Enough of that Lets see some TRANSMITTERS

- A few ways to go……
- Buy Ready to Go, out of the box
- Solder kits from the USA & China
- Total DIY from scratch parts



- For any FM transmitter, you need to look for three things:
  - PLL - Phase Locked Loop
    - PLL gives you an automatic temperature compensating frequency lock
  - Stereo (Mono can be done, but a mixer may be needed)
    Mono FM travel farther for the same power as stereo
  - A transmission power that won't get you a visit from the FCC

High End Choices, Best of Breed

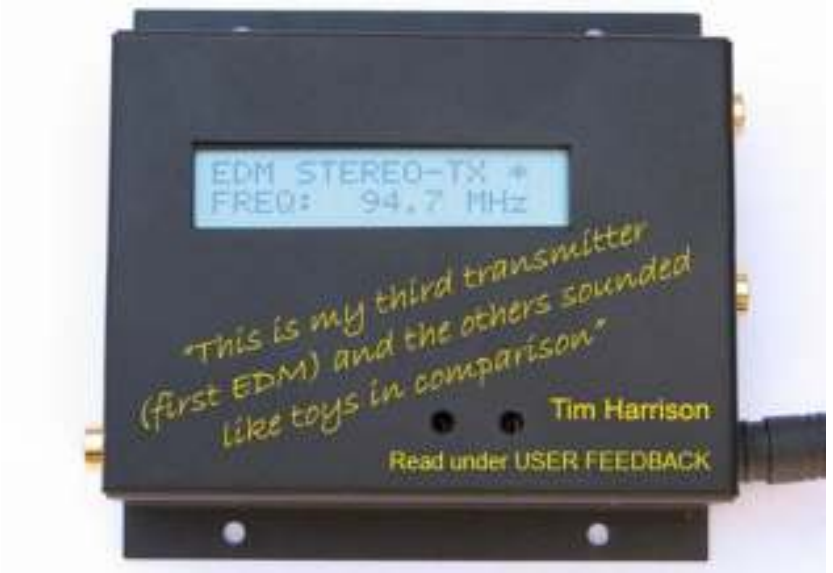
- Ramsey – Been around a long time, Built & Kits
  Excellent Reputation for product and support
  - FM2[illegible]
    Synthesized FM Stereo Transmitter
    ($[illegible])
  - FM3[illegible]
    Digital FM Stereo Transmitter
    ($199)

- Remaining Inventory is on Amazon.
- Search Ramsey transmitter

High End Choices, Best of Breed

- EDM – thoughtful design, Only 'Kits' (*very* pseudo kits) Excellent Reputation for product quality

- Prices range from $136 to $270
- Many packages to choose from including options for RDS & custom cases and ready to go Antennas
- 4 Year Warranty !
- Full RF Output Control in two ranges (1-10 mW/ 2-100 mW)



High End Choices, Best of Breed

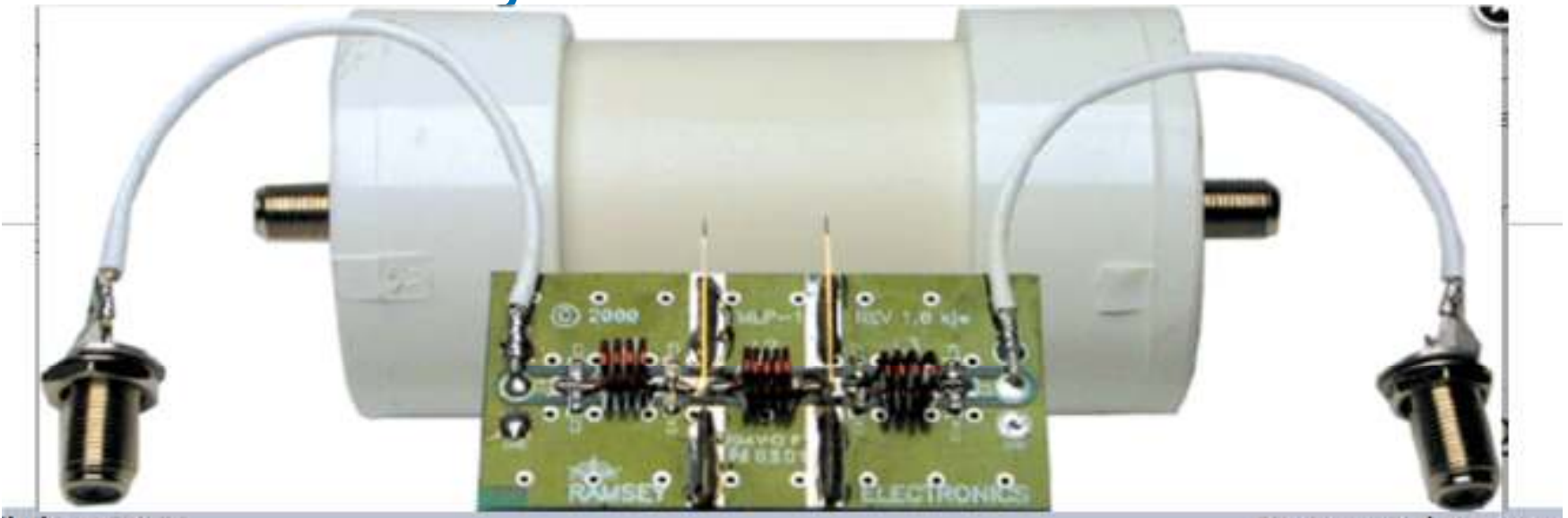
DECADE TRANSMITTERS

- Decade – MS100 series
  Considered the Cadillac of low power FM transmitters. A truly professional device.
- Full part 15 compliance, with documentation
- Made in Canada
- Two year warranty
- Prices are around $500
- The transmitter all others are compared to

What is left…

- There are many FM transmitters on the market from various Chinese companies. Virtually all are based on an all-in-one specialized IC from ROHM, the BH1415 (and derivations)
- There are many fine examples of transmitters using this technology. In fact, it may be the most used technology in this hobby. Purchase from: ebay, Amazon, Aliexpress
- The rub is this: not everyone builds a good transmitter around this chip. Some are great, some are garbage.
- So, whats a poor boy to do?

A little safety net never hurts



l Kits » FMLP1 My Account | Cart Con

FM Low Pass Filter Kit

Model # FMLP1

~~$28.99~~ $16.99

"Clean Up" your FM Broadcasts

Click to enlarge

Availability
Stock: in stock

The FM Low Pass Filter kit came about while designing the PX1, Professional FM Broadcaster. The FCC Ruling 99-25 created a class of radio stations designed to serve localized communities by authorizing new classes of non-commercial low power FM radio services (LPFM). In order to meet the stringent guidelines of the FCC, the PX1 underwent months of design sessions and many hours of painstaking tests. One of the secrets to its clean output is the FMLP1.

If you own one of those spectrally dirty "import exciters" you'll definitely want to add the FMLP1 to the clean up the output and properly match your power amplifier. Maximum input power 50 watts.

Build Your Own from assemblies

- Built from a complete transmitter assembly & a few parts
- Very inexpensive, Under $10 for everything but the power brick
- Low RF Power Output

Antennas

- Don’t run your transmitter without an Antenna !
  The radiated energy needs to go somewhere.
- Buy or Build
- 50 Ohm Cable, BNC connectors
  RG-8 ----> RG-8X
- NOT Ham Radio gear
- Higher off the ground is better
- Get it away from line of sight obstructions

- Two most common choices:
  - Dipole
  - Ground Plane

Antennas - Dipole

- **Wikipedia is always a good start: http://en.wikipedia.org/wiki/Dipole_antenna**

  Your first step is to determine where on the FM dial you're going to broadcast.
  Then, go out to your car (since your viewers will be using car radios) and enter in the recommended frequencies; choose the one with absolutely no current transmissions (be sure to do this in the evening, as radio transmissions are better at night).

  Taking your chosen frequency, go to an on-line dipole calculator (there are dozens; here's one: http://www.radiobrandy.com/dipole1.html) and determine the length of the wires necessary (I used 12-gauge electrical wire).

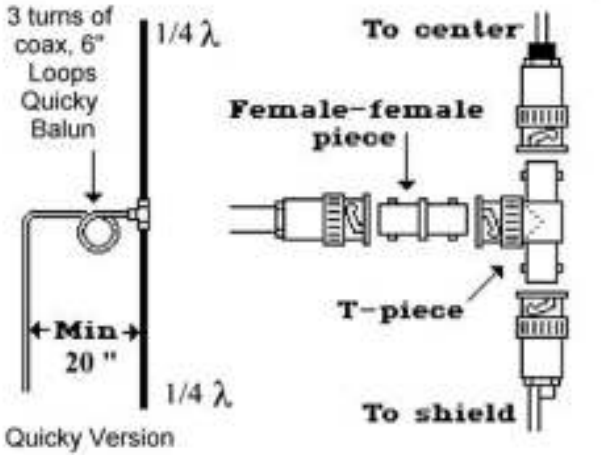
  That RadioBrandy page also shows how to build a dipole; there are many other sites that do as well. And here's Kevin Cook's pictures on how he built his dipole:

  http://www.c3inet.com/FM%20Transmitter/index.htm

  Placement? Depends upon the output of your transmitter. A big one -- one watt and above -- the dipole should probably go as low as you can place it. A small one, as high and as close to the street as possible.

- Attenuators

- **Dipole Antenna Calculator:**
  http://www.radiobrandy.com/dipole1.html



Antennas - Dipole

- A Dipole is a very simple yet effective antenna. Technically called a Half Wave antenna where the radiating element is 1/4 wave and the ground plane is 1/4 wave(typical 3db gain)

  If you were able to actually see RF the wavelength of the frequency of 98 Mhz is actually about 9 1/2 feet long. the formula to achieve this is the formula wavelength= 3.00 x 10 to the 8th power m/sec (the speed of light) / frequency in Hertz ... The Easiest way to remember is this: wavelength(Meters) = 300 / frequency in MHz

  What I have done is made my dipole for The center of the band 98Mhz when you get to higher power levels you really need to worry about tuning your antenna for the lowest SWR .

  one other good thing to do is just as the coax leaves the antenna make a coil 6" in dia 3 or 4 turns. Why do I do this? you ask... This creates a "balun" effective De-Couples the coax from the antenna. and keeps the antenna as a tuned circuit, otherwise your ground plane will be larger than your radiating element (Center Conductor) and throws it out of balance. you loose range .

  Tim Yoos, Broadcast Engineer

Antennas - Dipole

- This is the Joe Hinkle DIY Dipole Antenna
- I have a pdf that shows how to build and tune this antenna. Email me for a copy.

Antennas – Ground Plane

- http://fucimin.altervista.org/en/groundplane.html
- Email me for a pdf on how to Built this antenna yourself
- Ground plane are also known as ¼ wave antennas.
- They are generally considered superior to a Dipole

Music Licensing

LPFM Broadcasters

American Society of Composers, Authors and Publishers ("ASCAP"), Broadcast Music, Inc. ("BMI"), and SESAC are the main three performance rights organizations ("PROs") that control the vast majority of the licensing of musical works in the United States. They charge blanket fees that allow you to publicly perform everything in their catalogs, whenever you want.

If you subscribe to just one PRO, you must be careful to only play songs from their catalog. If you are a Low Power FM radio station ("LPFM"), the PROs provide you with these special rates for broadcast radio transmissions:

	2014	2015	2016
ASCAP (1-10 Watts)	$151	x	$154
BMI	$325	$332	$339
SESAC	$140	$143	$146

License Free Music & Programming

Play Christmas Music during Off Hours

ZaraStudio 3

- Solution for radio automation.
- Works with any Windows-compatible sound card.
- Supports the most common audio formats: MP3, WAV, MP2, OGG, WMA, FLAC, AAC+.
- Easy to use and maintain.

More information »

Interested in more information ?

If you are interested in pursuing more information on this topic, there is a very very good online community

HobbyBroadcaster.NET

The Reference for Legal License-Free Low-Power Radio Broadcasting

Now combined with

BusinessBroadcaster.net
&
CampusBroadcaster.net