Design Project: Radio transmitter

Your project is to design and build a simple radio transmitter, capable of reception in either the AM or FM broadcast bands. This transmitter must comply with all current FCC guidelines (to be researched by the student).

Deadlines (set by instructor):

- Project design completed:
- Components purchased:
- Working prototype:
- Finished system:
- Full documentation:

Question 1

Research the FCC (Federal Communication Commission) guidelines on low-power radio transmitters requiring no licenses. Determine what the maximum power output is, frequency range(s), antenna lengths, transmission time, and any other restrictions relevant to building a small transmitter circuit.

file 01529

Answer 1

I cannot answer the question here, as FCC guidelines are subject to change.

Notes 1

This will be an interesting topic for you and your students to explore as they begin to design their transmitter circuits. In fact, it should be the very first step in the design process!

Question 2

In the very early days of radio communication, a popular style of transmitter was the *spark gap* circuit. Explain how this circuit functioned, and why it is no longer used as a practical transmitter design.

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Answer 2

"Spark gap" transmitter circuits were built very much like you would expect, from their names: an air gap through which a high-voltage electric spark jumped. Because the pulse durations of the sparks were so short, the equivalent output frequencies spanned a very wide range, ultimately rendering this technology impractical due to interference between multiple transmitters.

Notes 2

Anyone who has ever heard "popping" noises on an AM radio produced by a (pulsed) electric fence of the type used around farms to keep animals from wandering off will understand how spark-gap transmitters broadcast across a large range of frequencies.

This question could very well lead into a fascinating discussion on Fourier transforms, if your students are so inclined. According to Fourier theory, the shorter the duration of a pulse, the broader its frequency range. The product of uncertainties for the pulse's location in time and its frequency is equal to or greater than a certain constant. Theoretically, a pulse of infinitesimal width would encompass an infinitely wide (infinitely uncertain) range of frequencies.

Incidentally, the math behind this is precisely the same as for Heisenberg's Uncertainty Principle: that quantum physics theory which states the certainty of a particle's position is inversely proportional to the certainty of its momentum, and visa-versa. Contrary to popular belief, this phenomenon is not an artifact induced by the act of measuring either position or momentum. It is not as though one could obtain perfectly precise measurements of position *and* momentum if only one had access to the perfect measuring device(s). Rather, this Principle is a fundamental limit on the certainty *possessed* by a particle with regard to its position and momentum. Likewise, an infinitesimal pulse *has no definite frequency.*

Question 3

How is the frequency of your transmitter's oscillator circuit established? What would you have to do to change that frequency?

file 01531

Answer 3

The answer to this question, of course, will vary according to the design of oscillator used in your transmitter circuit. Note that there is likely more than one way to change the frequency of your circuit, so be prepared to give multiple answers during discussion!

Notes 3

This question helps students research and understand their particular oscillator circuit(s). Be it Hartley, Colpitts, or some crystal-controlled topology, students need to know how and why the oscillation frequency is fixed.

Question 4

Explain the difference between AM (*Amplitude Modulation*) and FM (*Frequency Modulation*).
file 01530

Answer 4

This is an easy question to find the answer to. I'll leave the job to you!

Notes 4

Ask your students to explain which type of modulation their transmitter circuit will use, and what advantages one modulation type may have over the other.