CQ de WA2LQO

Seventy Four Years: 1944 -2018

The official independent voice of the Grumman Amateur Radio Club.

DECEMBER 2018 VOLUME 91 NUMBER 12

MEETING – THE NOVEMBER AND DECEMBER MEETINGS WERE COMBINED AS OUR HOLIDAY DINNER ON DECEMBER 12TH

PRESIDENT'S NOTE by ED GELLENDER, WB2EAV

HOLIDAY DINNER PARTY

On Wednesday December 12, in lieu of our November and December club meetings, we held our annual Holiday dinner party at Kwong Ming Chinese restaurant in Wantagh. We have eaten there a number of times in recent years, this year things again worked out nicely. We had a small group of eight, but everyone had a really nice time and enjoyed the food.

HAM RADIO UNIVERSITY

Late every year, I always include my obligatory shameless plug for Ham Radio University, and this year is no exception. It is a terrific opportunity to attend seminars on ham radio and to catch up with old friends. The admission price is ridiculously low at $5 for a full day immersion. The keynote speaker is the newly installed ARRL Chief Executive Officer Howard Michel WB2ITX. The new ARRL Hudson Division Director, Ria Jairan N2RJ will also be there, as well as the continuing NLI Section Manager Jim Mezey W2KFV.

It is on Saturday January 5, 2019 from 9AM until 3PM, at Hillwood Recital Hall at CW Post University in Old Brookville; right near the Tilles Center, where many of us have attended concerts and the like.

Note that I am delivering a presentation at HRU from 11:00 to 11:50 AM in room "D," on the progression of radio receiver design over the past 120 years or so. It will be based on a PowerPoint presentation that I delivered to a professional group recently.

Directions: NY107 north from LIE exit 41-N. Go 3 1/2 miles to Northern Blvd (NY25A) and turn left. Make a left at the "LIU POST" main entrance (second traffic light) and follow signs to the Tilles Center. Go past the Tilles Center and follow the access road until it turns left and goes along the back of the buildings. You will see
Hillwood Commons on the left, next to the radio tower for WCWP. Park and enter Hillwood Commons just to the right of the tower.

The website hamradiouniversity.com has everything you need to know.

Let me try an experiment. Starting with this issue, and going over the next few months, I am going to serialize the paper I am delivering at Ham Radio University (without most of the figures).
Here is the first installment. Let me know what you think.

Ed WB2EAV

Serialized Paper - Radio Receivers from Spark to 16-QAM

From a paper being delivered at Ham Radio University 2019 by Ed Gellender WB2EAV.

This paper covers the development of radio receivers from the late 1800s to the present, simultaneously in separate dimensions: Time and Frequency. As communications technology has progressed since the late 1800s, so has the upper frequency limit. The advancement of technology and upper frequency have happened in parallel so organizing this course in chronological order dovetails well with increasing frequencies.

In the last few decades, incredible advances in computer technology have led to the ability to digitize received signals for computer processing. This brings tremendous advantages, as adding software capabilities does not require hardware changes. For example, a receiver can be configured with a wide selection of filter bandwidths to allow matching the filter to the incoming signal. Such a system would be unaffordable in hardware. As analog-to-digital conversion becomes possible at ever higher frequencies, the conversion point has been migrating closer and closer to the antenna.

We are now in the era of the software-defined-radio. Regardless, the physics of the universe still applies; and the techniques developed over the last century are still relevant, even if incorporated into a computer program. George Santayana warned that those who ignore history are doomed to repeat it. While he did not have the evolution of communications gear in mind, his rule applies here too.

The electromagnetic spectrum shows the relationship between all electromagnetic waves by frequency. There is no lower limit, as the spectrum truly goes down to frequencies where no useful attributes have ever been discovered. Similarly, there is no upper limit. For this paper, we limit ourselves to the part of the electromagnetic spectrum that is called the radio spectrum, roughly 10^3 to 10^{12} Hz. The development of radio has slowly moved from low to high frequency across the spectrum.

James Clerk Maxwell and the Aether

When experimenters learned how to create a vacuum, they quickly discovered that both sound and light waves propagate through the air, but only light waves will travel through a vacuum. They were concerned enough about why sound needs a propagation medium, yet light doesn't, to propose a theory that a yet-unidentified medium, named the Aether (pronounced like the organic chemical, ether), provides a medium for light waves to propagate through a vacuum.

The English mathematician James Clerk Maxwell was working with those experimenters, applying rigorous mathematical treatment to their findings. In 1861 he published what is now known as Maxwell's equations, showing no need for a propagation medium, at one time rendering the Aether a historic footnote, while creating a new understanding of the electromagnetic spectrum.

To this day, radio waves are still said to propagate through the Aether, long after everyone knows the theory was soundly debunked. Also, pundits have taken liberty with a line from the first page of Genesis: "God said 'let there be light' …. and then there was light" by replacing the original Aramaic lettering of "let there be light" with Maxwell's equations (which look every bit as mysterious to the layman as Aramaic).

Heinrich Hertz

In 1887, Heinrich Hertz was working on practical applications of Maxwell's findings and demonstrated that under the proper conditions, inducing a spark on one side of a room could induce a simultaneous

spark in a circle of wire with a narrow gap across the room. Hertz found that the intensity of the distant spark depended strongly on the size of the wire circle. He realized the loop size was "tuning" the receiving loop to match the frequencies emitted by the sender sparks, arguably the first demonstration of a radio transmitter and receiver.

For many years, the concept of frequency was referred to by the dimensions "cycles per second." In the late 1960's Hertz was honored for his work by renaming the unit of frequency as Hertz, (abbreviated Hz), where one Hertz is one cycle per second.

Electrical Resonance

While this paper does not go into circuitry, one such aspect of electronic design will repeatedly occur, and that is resonant circuits. Let us address it early on.

A pendulum swings at a reliable rate, accurate enough that every grandfather clock uses a pendulum to track time. Many other forms of mechanical resonance are commonplace, especially in music: A piano key strikes the string, a church bell is hit with a hammer. When struck, these devices ring, or resonate, at well-defined frequencies, which in the case of musical instruments are known as notes.

In electronics, an inductor and a capacitor can be connected to provide an analogous electrical ringing resonance. Applying a narrow pulse will cause the circuit to ring like a bell, even though it cannot be heard directly. Actually, with properly sized components, including a loudspeaker, a ringing sound can be generated. However, audio frequencies are so low relative to radio frequencies that listening to them is impractical. Instead, test equipment called oscilloscopes shows instantaneous voltage in a circuit as a function of time. Viewing a narrow pulse applied to a resonant circuit on an oscilloscope will show the abrupt start of a sinusoidal vibration that slowly decays with time.

Applying a continuous signal of a single frequency to such a circuit will produce a large increase in amplitude only at the resonant frequency. This characteristic appears everywhere in radio.

Inductors are coils of wire that may be wound around a metal core. Inductors are used to convert energy between electrical currents and magnetic fields. Power utility transformers working at 60 Hz are built of huge inductors with thousands of turns of wire tightly wrapped around laminated iron cores. With increasing frequency, the appropriate size of inductors is reduced, until at 200 MHz a typical inductor may only be a few turns of wire an inch (2.5cm) in diameter and equally long, with no core other than air. Values of inductors (or coils) use units called Henrys (after the early scientist Joseph Henry) or the letter H. However, one Henry is a large inductor, while at the frequencies and power levels of radio work, inductors are usually encountered with values stated in microhenries (10^{-6} Henry, or uH) or even nanohenries (10^{-9}H or nH). Inductors are symbolized in the literature by the letter L.

Capacitors at their simplest are two plates of metal separated by a nonconductor, used to store an electrostatic charge. They are symbolized by the letter C and their basic unit is the Farad (referenced by the letter F), but capacitors – much like inductors – usually are sized such that they are represented by microfarads (10^{-6} F or uF), and picofarads (10^{-12} F or pF; sometimes called uuf or "mickey mikes"). Note that nanofarads (10^{-9} F or nF) are rarely used, with values like 0.001 uF or 1000 pF substituting.

Combinations of inductors and capacitors allow energy to flow between electrostatic and magnetic fields in a manner analogous to the way a pendulum swing depends on transferring between potential energy and kinetic energy. This L-C resonance is used to build frequency selective

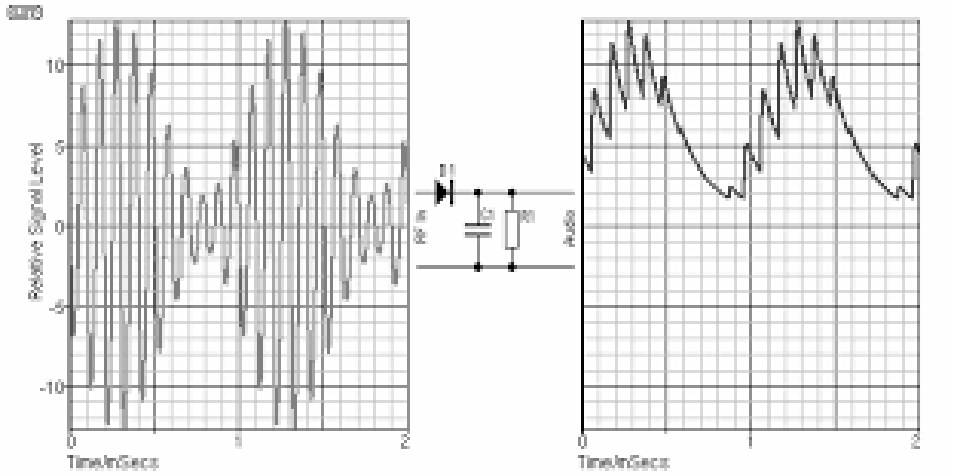
networks, referred to as L-C networks, which are everywhere in radio.

Early radio receivers

Many experimenters began building on Hertz's work; mostly in developing more sensitive receivers. An incredibly simple device is worthy of note – the crystal set. (To this day crystal sets are still available as kits, and children often find them interesting).

A crystal set uses a long wire as an antenna to pick up as much signal as possible, and couple it to a coil and capacitor set up as a L-C resonant circuit at a frequency matching a nearby transmitter. The coil is usually made of enamel-insulated ("magnet") wire, with the enamel sanded off a strip so a movable arm can move a contact point along the coil to adjust the inductance and thus tune the frequency. A rectifying diode set up as a "peak detector" (see figure) removes the radio frequency component, while maintaining the amplitude variations ("modulation envelope"), leaving a 120 Hz raspy buzz for spark signals (as spark transmitters ran directly off 60 Hz power), or the voice program for an AM signal. The first diodes were a crystal of galena ore and a short length of wire ("cat whisker") that the operator would move around the crystal until he found a sensitive point. A pair of high-impedance headphones would turn the resulting signals into sound. (note: modern low impedance headphones are not usable).

PEAK DETECTOR



Marconi and King Spark

In the early 1900s it was realized that recent work with sparks causing action at a distance led to the tantalizing idea of finally enabling communication between ships at sea. The existing Morse Code protocols and hand-keys long-used for telegraph messages lent themselves perfectly.

At first, the concept of long range communication was in doubt; Light only travels in a straight line; obviously other electromagnetic signals will do the same. It appeared at first that these spark-induced signals would only be good for short distances. However, the age of miracles was not over, and God has provided us a planet and atmosphere that can provide various forms of ducting and reflections to allow such signals to bend over the horizon. There will be more on this later.

Experiments progressed until Gugliemo Marconi was able to (barely) communicate across the Atlantic in 1902. Within a few years "wireless" equipment was installed on every ocean going vessel. A typical station used a multi-kilowatt spark generator that would hurl blue lightning when the operator pressed his Morse Code key. Huge sparks, and high voltages and currents on the hand key, made it a noisy and dangerous job (but the ultraviolet emissions did produce artificial suntans).

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TREASURER'S REPORT – Ed, WB2EAV
Ed reports that finances continue to be in good shape.
REPEATER REPORT
146.745 Repeater is intermittent.
VE REPORT – Ed, WB2EAV
One applicant took the General exam and passed. Three applicants took the Technician test and all passed. Two of them then took the General, and one passed. VEs: WB2EAV, KD2EXM, WB2QGZ.
GARC NETS: Net Controller Karen W2ABK **40 Meters: 7.289 MHz at 7:30 AM EST Sundays**
2 Meters (repeaters) Thursdays: 146.745 MHz (-600 kHz) at 8:15 PM
145.330 MHz (-600 kHz) at 8:30 PM. Tone for both repeaters: 136.5 Hz.
ARES/RACES NETS: Mondays.
PROGRAM:
WEBSITE
The GARC web site can be found at http://www.qsl.net/wa2lqo. Webmaster is Pat Masterson, KE2LJ. Pictures of GARC activities, archives of newsletters, roster of members, and other information about the GARC may be found there. Please inform Pat Masterson if you need to delete, update or edit your roster information.
MEETINGS
Board and General Meetings are now combined. Unless otherwise notified, meetings start at 5:30 PM on the FOURTH Wednesday of the month, at HAYPATH ROAD Town Park in OLD BETHPAGE. **[The holiday dinner replacing both the November and December meetings took place on Wednesday December 12]**
GARC Officers:

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GARC VE EXAMS We normally proctor exams for all classes of ham licenses on the second Tuesday of each month, starting at 5:30 PM, BUT sessions may be cancelled if no applicants make appointments. The fee is $14. All applicants must pre-register with Ed Gellender wb2eav@yahoo.com All new applicants should be aware that they must write their Social Security number on the application form if they have not gotten an FRN number. Applicants for an upgrade must leave with the examiner a copy of their current license. All applicants must show a photo ID such as a driver's license. Study material may be obtained from ARRL-VEC at http://www.arrl.org, or W5YI-VEC at http//www.W5YI.org. All VECs use and update the same Q&A pools.

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Sparks generate a broadband spectrum. A transmitter needed a tuning section with coils and capacitors to work with the antenna to select and transmit only the desired frequency. Similarly the receiver had to peak the sensitivity at the desired frequency where shipboard operators would all tune. These seemed to gravitate to the area around 250 kHz, which became a standard emergency frequency.

The disastrous sinking of the RMS Titanic in April 1912 was the result of a long string of mistakes, arrogance, and just-plain stupidity. The only positive thing that came out of the entire affair was the reception of distress messages via wireless by the RMS Carpathia, whose Captain, crew, and passengers set the standard for emergency response from then on, efficiently rescuing survivors.

<To be continued next month; Coming attractions: CW pushes out spark>