JOHNSON COUNTY RADIO AMATEURS CLUB, INC.
P.O. Box 93
Shawnee Mission, KS 66201

FEEDBACK

JANUARY 2021

Hambone Gets Sidebanded

A Hambone story by Jaimie Charlton

"They shouldn't allow substitute teachers to give quizzes, it's just not fair!" complained Hambone to his uncle Elmer and his younger brother Dude who happened to be sitting out around their blazing firepit enjoying the crisp air of an early December evening in Kansas.

Dude, after taking a sip of his hot cocoa inquired, "What's the matter, Hammy, are you still whining about that quiz you bombed?"

"I'm not whining! I'm merely stating how the school should run classes when the regular teacher has to step away, that's all."

"Oh, you're whining all right, Bro. I know whining when I hear it and you're definitely whining."

Sensing that more than more than a spirited debate was in the making, Elmer took another sip of his enhanced hot cocoa and stepped in. "So, Hambone, why do you think a quiz was unfair?"

"Well, Unck, it was supposed …"

Before Hambone could finish, Dude blurted out, "Because he got the only 'F' in the class!"

"You got an 'F'?" asked Elmer.

Head bowed, looking at the ground, Hambone continued, "Yes, but let me explain. I thought that session was supposed to be an easy lecture. What with a sub and all. It was about modulation and sidebands. You know, AM, FM, single sideband, that sort of ham radio stuff I already know. So, while that sub teacher was lecturing, I did my chemistry homework, which I got an 'A' on, by the way.

That substitute obviously didn't know the rule that says subs never give quizzes or assignments of any kind. She tricked us and gave a quiz. That's why I say it was a quiz full of trick questions."

"What were some of the 'trick' questions?" asked Elmer.

"On one she asked, how much bandwidth is a steady, continuous carrier on 14.051 MHz taking up?

I said that it takes only a few Hertz of bandwidth because it's in the CW part of the twenty-meter ham band. It was marked wrong."

"It was marked wrong," replied Elmer, "Because it is wrong. A steady carrier takes no bandwidth at all."

"Unck, that can't be. I have to open up the bandwidth filters on my transceiver to about 200Hz to receive CW signals which are really just steady carrier waves."

see HAMBONE on page 3

JANUARY MEETINGS

***January 8** – Program Planning for 2021*

***January 22** – TBA, depending upon what we decide on January 8.*

The Johnson County Radio Amateurs Club normally meets on the 2nd and 4th Fridays of each month at 7:00 PM at the Overland Park Christian Church (north entrance), 7600 West 75th Street (75th and Conser), west of the Fire Station.

Much of the membership travels to the Pizza Shoppe at 8915 Santa Fe Drive for pizza buffet and an informal continuation/criticism/clarification of the topics raised at the meeting ... or anything else.

LEAVE THE CHURCH, TURN RIGHT (WEST) ON 75TH. TURN LEFT (SOUTH) ON ANTIOCH. TURN RIGHT (WEST) ON SANTA FE. PIZZA SHOPPE IS JUST PAST THE SONIC ON YOUR LEFT.

IN THIS ISSUE

1 - Hambone Gets Sidebanded - A Hambone Story - Jaimie Charlton, ADØAB

2 – December Meeting / President's Corner

>> THE FEEDBACK <<

A publication of the
Johnson County Radio Amateur Club, Inc.

Bill Gery, KA2FNK, President

Jaimie Charlton, ADØAB, Vice President

Ted Knapp, NØTEK, Secretary

Cal Lewandowski, KCØCL,Treasurer / FEEDBACK distribution

*   *   *

Chip Buckner, ACØYF, Editor

Charlie Van Way, NØCVW, Photography

Deb Buckner, KDØRYE, Contributing Editor

All email addresses are available at w0erh.org

Photos by NØCVW

JCRAC – December 11, 2020

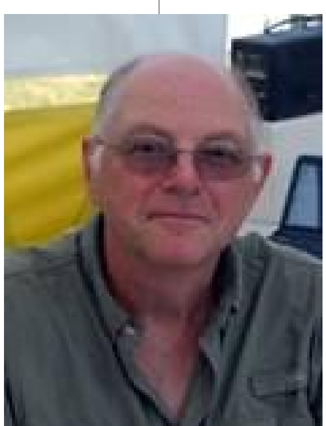
Meeting Date: Friday, December 11, 2020.

The Meeting started at 7:00 PM.

Herb and Diana Fiddick led the club in a round of Christmas song bingo.

PRESIDENT'S CORNER

2020 is behind us. We became very familiar with the words "virtual" and "Zoom" meeting. Our club meeting will continue to be conducted using Zoom for the start of 2021, Let us hope that by late spring we will be able to once again have in face meetings



… and pizza.

2020 taught us much, though. Field Day was different for sure, but successful. No chigger bites! We did miss the Saturday evening dinner and the Sunday morning donuts. Watching everyone on Field Day Zoom meeting kept us all in touch. It was great to watch everyone operate.

The Breakfast Club transformed into a daily net for months and then picked up a new dimension with the "Virtual Breakfast Club"--"virtual", there is that word--taking over the daily get together and the "On Air" becoming a Tuesday and Thursday net.

We need to thank the on air and zoom meeting net controls.

COVID put my travel plans on hold. I am sure that your plans were affected, too too. I did rebuild the ham shack and return to model building in 2020. I hope you all kept safe and found interests, old and new as I did.

Please note that our first "Zoom meeting " of the year will be January 8. There is that the other 2020 word, again – "Zoom".

Have program ideas ready for 2021.

– Bill Gery – WA2FNK

from HAMBONE on page 1

"That's where you went wrong, Hammy," replied Elmer. "Whenever you modify, or modulate, a signal you increase its bandwidth. Even if you are simply turning it on and off as in CW. Turning it on and off is a form of modulation and that increases its bandwidth. In fact, the more abruptly you turn that signal on and off, the more bandwidth it takes. That's what causes key clicks. The technical term is the rise/fall time of the envelope.

The shorter the rise/fall times, the 'wider' the signal and the crisper the sound, but the greater the key clicks. Lengthening the rise/fall time reduces the key clicks and the bandwidth but, smears out the signal making it harder to hear the difference between dots and dashes. The trick is to find an acceptable rise/fall time that minimizes key clicks yet remains crisp enough for easy copy.

Next question."

"Well, okay, Unck. But I still think that's a nitpicky trick question. I've never heard of anybody just sending a carrier.

Another question asked something like: does the carrier of and FM broadcast station ever disappear due to the signal modulating it? If so, describe the signal.

I said that the carrier never disappears unless the station goes off the air, LOL. Modulating only wiggles its frequency up and down a little. That's why it's called frequency modulation. It does not change the carrier power.

She marked it wrong."

"She was right to mark it wrong. The carrier can disappear." said Elmer.

At this point Dude chimes in, "But Unck, how can the carrier ever disappear if its frequency is only wiggled a little bit? Does it have something to do with wiggling so much the carrier gets cut out by the transmitter's filters?"

"No boys," continued Uncle Elmer, "It is the nature of an FM signal. Although the process of producing a frequency modulated signal is as simple as wiggling the carrier's frequency, the results are far more complicated.

In describing the characteristics of an FM signal it is useful to use a measurement known as the *modulation index*. The modulation index is calculated by dividing the deviation, or wiggle, of the carrier in hertz by the frequency, also in hertz, of the signal causing that wiggle. The Greek letter, beta, β, is often used to denote the modulation index. Since I know you like math so much, the formula is:

$$B = \Delta Fc/Fm$$

Where:

ΔFc = carrier frequency deviation in Hz

Fm = the modulating tone frequency (audio) in Hz.

The modulation index is the key value used to describe the characteristics of the sidebands and bandwidths of FM signals."

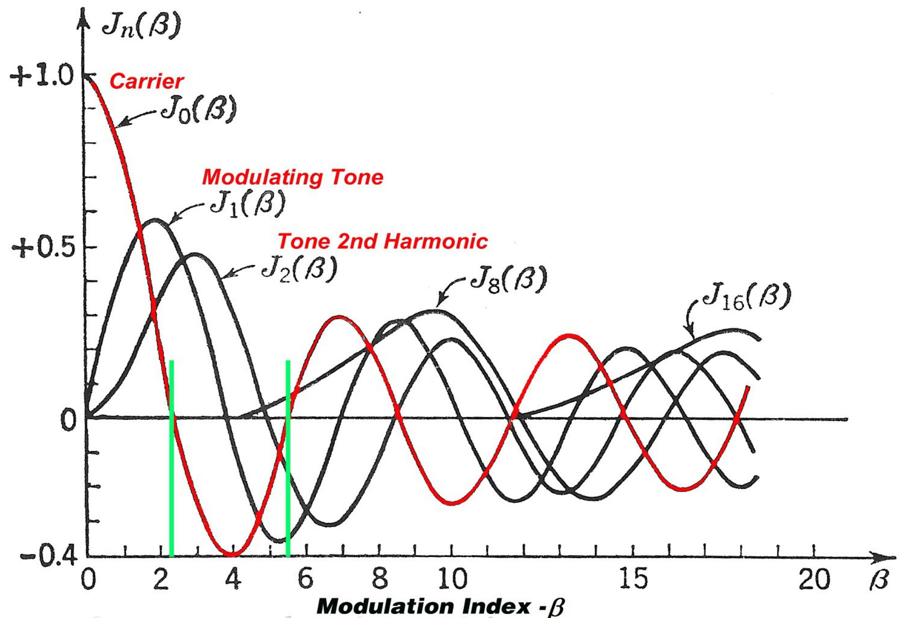
Trying to redeem himself, Hambone offered, "I thought the bandwidths were set by the FCC. For example, plus and minus three kilohertz for narrowband and plus and minus seventy-five kilohertz for broadcast band represent 100% modulation."

"That's true, Hammy. But it doesn't tell anything about the signals' spectrums and that's what the question is asking."

"Okay, Unck, how do we find the spectrum of an FM signal?"

"The calculation is pretty complex, but the result, called a *Bessel Function*, is very interesting. Have a look at this graph I made for a recent presentation." Said Elmer as he produced an illustration seemingly from nowhere.

see HAMBONE on page 4



Strengths of sidebands (J_1, J_2 etc.) in an FM signal at various modulation indices. Green lines indicate where the carrier goes to zero.

Illustration 1: Bessel function graph

from HAMBONE on page 3

"This is really a graph of Bessel functions, but it shows the sidebands of an FM signal very clearly. Each function, J, denotes a sideband of the signal. For example, J_0 shows the carrier's magnitude, or strength, for various modulation indices. Function J_1 shows the strength of the first sideband which is removed from the carrier by the frequency of the modulating tone. The frequency of the second sideband, J_2, is removed from the carrier's frequency by the second harmonic of the modulating tone and so on."

"Unck," Hambone interrupted, "I thought sidebands always appeared in pairs. You know, one sideband above the carrier frequency and one below."

"They do, Hammy. This Bessel function graph merely shows how the numbers and magnitudes of FM sidebands change as the modulation index increases. It's to give you an idea why an FM signal is so much more complicated than an AM signal."

Elmer unzipped his jacket revealing a nice new pocket protector filled with colored markers. From another pocket he extracted a small version of his ubiquitous yellow pad and began to sketch (Illustration 2) and speak.

"Here's what the spectrum of an FM signal with modulation index equal to 5 being modulated by a single sine wave looks like. As you can see, the sidebands do occur in pairs, one above and one below the carrier's frequency. Also, notice in this sketch there's eight significant sideband pairs even though the audio, or modulating signal, is only a single tone.

A third, and what I think is the most amazing, thing about FM is that the carrier changes strength even though we are only wiggling its frequency."

"That is amazing, how does that happen?" asked Dude.

"It happens due to the magic of mathematics, but it is very real. It makes sense because the power in all those sidebands must come from somewhere and

see HAMBONE on page 5

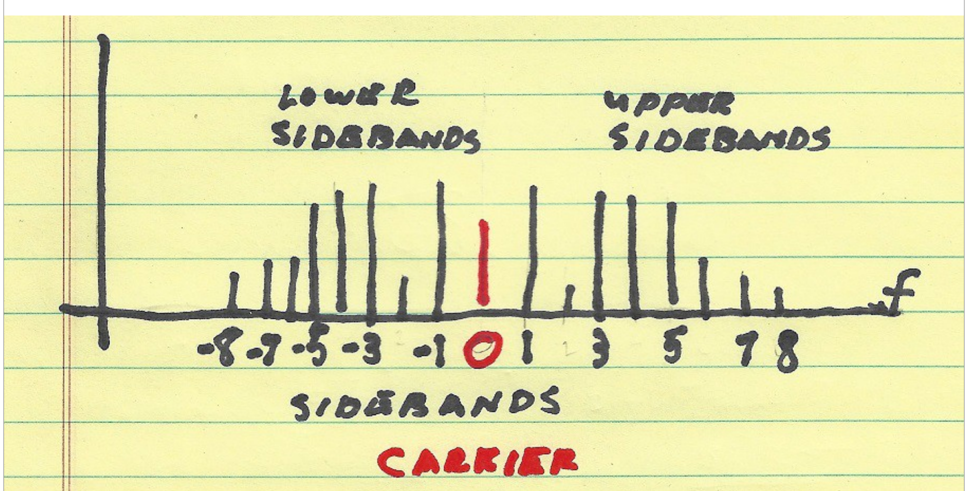


Illustration 2: FM spectrum

from HAMBONE on page 4

the only source is the carrier. Since the total power in an FM signal is constant, the carrier has to go up and down as sidebands are added and removed."

"That's nice Unck. We are very impressed by your vast knowledge of weird math. But what does it have to do with the answer to Hammy's question," asked Dude.

"It has everything to do with it!" Elmer shot back. "For example, if you look at the Bessel function graphs you will see that if you set your deviation and modulation frequency so that your modulation index is 2.405 or 5.52, the carrier completely disappears! I've marked the carrier graph in red and two of the points where it goes to zero in green so you can easily find it."

"That never happens in real life, does it?" asked Dude.

"Sure it does. An FM broadcast station's carrier will completely disappear if a 13.59 KHz tone – which could be part of a musical selection – is loud enough to give 75KHz deviation or 100% modulation.

So, contrary to Hammy's opinion, the answer to the question is, yes, the carrier can disappear."

"Oh, okay," mumbled Hambone hoping this session would come to an end. But Elmer went talking and sketching.

"Here's the spectrum of an amplitude modulated, or AM, carrier being modulated by a single sine wave tone. It's the same situation as the FM signal we just discussed. Notice that there are only two sidebands, one above the carrier and one below. They change with the modulating audio, but the carrier remains constant. But there is something odd about an AM signal. Can either of you guess what it (Illustration 3) is?"

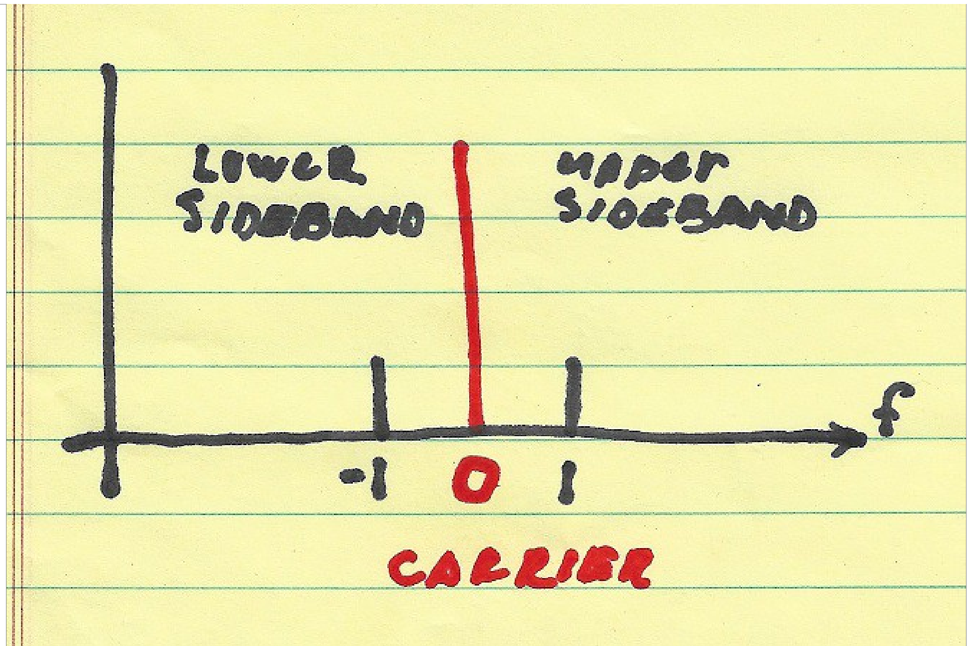


Illustration 3: AM spectrum

Not wanting to be fooled by their very tricky uncle, both boys shook their heads and remained silent.

"Well," Elmer continued, "Even though we call it amplitude modulation and the transmitter increases and decreases the strength of the carrier according to the modulating signal, the strength of the radiated carrier never really changes. All of the power the modulator adds to or subtracts from the carrier appears only in those two sidebands!"

"And your point, Uncle?" asked Hambone.

"My point is that in the FM signal, where we only wiggle the frequency, the strength of the carrier goes up and down. But in the AM signal, where we intentionally change the strength of the carrier according to the modulating signal, the carrier remains constant. I think that's weird."

"Hey Hammy, you're batting zero for two, why don't you tell Unck what the third strike, er, problem was?" said Dude who wanted to inflict the maximum embarrassment on his brother.

"I, I don't quite remember it.""That's okay, I remember what the guys at the frat house were saying about it," offered Dude. "You know, the ones who passed the test?"

see HAMBONE on page 6

from HAMBONE on page 5

Dude continued, "The problem said that station A has a single sideband transmitter set to transmit on exactly 14.000 MHz upper sideband and the operator plays a one kilohertz tone into the microphone. Station B happens to be tuning around the twenty-meter band and hears the signal. What does station B hear?"

"Oh, okay, I remember this one, now," said Hambone. "I still think I was right when I said Station B hears a one kilohertz tone at the frequency of 14.001 MHz."

"Well, you were wrong, again," said Elmer becoming impatient at the depth of his nephew's ignorance of even simple radio principles.

"Station B only sees a carrier at 14.001MHz. He doesn't know anything more about it. He has no idea that it originated as a onekilohertz tone modulating at 14MHz upper sideband transmitter. It could have just as easily originated from a 13.999 upper sideband transmitter modulated by a two kilohertz tone, a 14.002 MHz lower sideband transmitter modulated by a one kilohertz tone or even a CW transmitter operating on 14.001 MHz.

You see, without some sort of a reference, a single sideband signal is just a frequency or series of frequencies, but you can't tell what they are."

"Okay, Unck," retorted Hammy, "how come I can tune in and understand single sideband phone stations?"

"You can tune them in because you recognize human speech when you hear it. You tune your radio until the signal 'sounds right' to you. That works because your receiver is simulating a reference carrier.

If an alien unfamiliar with human speech, on some distant planet picked up that signal, he would not be able to tune it in 'correctly' because he would not know what it was supposed to sound like.

An interesting side effect of single sideband (pun intended) is that some multimode transceivers actually generate CW by modulating their transmitter with a keyed tone. The signal generated is indistinguishable from a regular CW transmitter."

"The guys on the eighty-meter nets say different" counter Hambone.

"I know. Many hams wrongly believe that single sideband signals contain absolute tones etc just like AM or FM signals. That's because they haven't thought through exactly how a single sideband signal is generated, transmitted, received and changed back into voice

As Mark Twain allegedly said, "*It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.*"

"Who's Mark Twain?"

"I give up!"

>> JCRAC FEEDBACK <<