THE EXAM CORNER #7

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This is the second of three articles on the topic of emissions. In this section, the examiners are mostly focused on how a receiver converts RF emissions back into audio frequencies that we can hear.

Again, I will briefly discuss what you need to know about an aspect of that subject, then show you the only exam questions that could appear on that aspect, and follow with hints as to how you can remember the right answer. The correct answer is in bold.

● The process of combining two RF signals having different frequencies is known as "mixing" or "heterodyning". Mixing two RF signals results in two new RF signals, one at a frequency equal to the sum of the original two, and one equal to the difference. For example, mixing a 10 MHz signal and a 2 MHz signal results in 12 MHz (the sum) and 8 MHz (the difference). Conventional receivers typically generate a variable frequency oscillator (VFO) signal which is mixed with the incoming signal in order to produce a difference signal at a specific intermediate frequency (IF) that the receiver is designed to handle. This is called a "superheterodyne" receiver (the results that it achieved were considered super when it was invented 100 years ago). However, simple arithmetic dictates there is another incoming signal frequency which, when mixed with the same VFO signal, will also produce an (accidental) output at the same IF frequency – this is called an "image response".

G8B03 What is another term for the mixing of two RF signals?

A. Heterodyning
B. Synthesizing
C. Cancellation
D. Phase inverting

G8B01 What receiver stage combines a 14.250 MHz input signal with a 13.795 MHz oscillator signal to produce a 455 kHz intermediate frequency (IF) signal?

A. Mixer
B. BFO
C. VFO
D. Discriminator

G8B02 If a receiver mixes a 13.800 MHz VFO with a 14.255 MHz received signal to produce a 455 kHz intermediate frequency (IF) signal, what type of interference will a 13.345 MHz signal produce in the receiver?

A. Quadrature noise
B. Image response
C. Mixer interference
D. Intermediate interference

Hint: if you're interested in the math, the image frequency is two times the IF frequency below the VFO frequency – in other words, the same distance below the IF frequency as the VFO is above it – so it's sort of a mirror image. But you don't have to know the math for the exam, just that it's called an image response.

We will see mixer and superhet-related questions again in another lesson. For some reason the examiners did not put those questions all in one place in the materials.

● "Bandwidth" is the width of the modulated signal (the number of kHz that the signal occupies), Narrower bandwidth allows more signals to use the same band at the same time without overlapping; wider bandwidth allows transmission of data more rapidly. For FM, the bandwidth equals two times the "deviation"

(the standard frequency variation for the mode) plus two times the modulating audio frequency (the numbers are doubled because modulation occurs in both sidebands).

G8B10 What is the relationship between transmitted symbol rate and bandwidth?

A. Symbol rate and bandwidth are not related
B. Higher symbol rates require wider bandwidth
C. Lower symbol rates require wider bandwidth
D. Bandwidth is always half the symbol rate

G8B06 What is the total bandwidth of an FM phone transmission having 5 kHz deviation and 3 kHz modulating frequency?

A. 3 kHz
B. 5 kHz
C. 8 kHz
D. 16 kHz
Hint: 2 times 5 plus 2 times 3; 2 times because of two sidebands.

● PACTOR is a digital mode, which was used more when the questions were written several years ago than it is now. The bandwidth of a PACTOR3 signal at maximum data rate is 2300 Hz. Why they picked that one to put in the question pool rather than much more common modes, I don't know.

G8B05 What is the approximate bandwidth of a PACTOR3 signal at maximum data rate?

A. 31.5 Hz
B. 500 Hz
C. 1800 Hz
D. 2300 Hz

● The receiver should be set to match the bandwidth of the signal being received, blocking out ambient noise and other signals outside the target signal's bandwidth and thereby improving the signal to noise ratio.

G8B09 Why is it good to match receiver bandwidth to the bandwidth of the operating mode?

A. It is required by FCC rules
B. It minimizes power consumption in the receiver
C. It improves impedance matching of the antenna
D. It results in the best signal to noise ratio

● For technical reasons, it is often better to generate VHF FM signals at relatively low frequencies and then use a "multiplier" circuit to multiply the frequency up to the desired band. A multiple of a given frequency is called a "harmonic". In using a multiplier to generate a desired harmonic, the "deviation" (discussed above) is also multiplied so, for example, if the FM signal is going to be multiplied by 12 to reach the desired band, then the deviation of the initially-generated signal will have to be 1/12 of the desired final deviation so it will come out to the desired number when multiplied by 12.

G8B04 What is the stage in a VHF FM transmitter that generates a harmonic of a lower frequency signal to reach the desired operating frequency?

A. Mixer
B. Reactance modulator
C. Pre-emphasis network
D. Multiplier

G8B07 What is the frequency deviation for a 12.21 MHz reactance modulated oscillator in a 5 kHz deviation, 146.52 MHz FM phone transmitter?

A. 101.75 Hz
B. 416.7 Hz
C. 5 kHz
D. 60 kHz
Hint: the answer is 1/12 of 5 kHz since this is a 12-times multiplier. Sorry, this is a rare example of the examiners including Extra Class-level material in the General Class question set. It may be easier to just remember the answer than to worry about completely understanding the math.

- We covered duty cycle in connection with RF safety; it is the average percentage of the maximum RF output that is actually going out over a period of time. Here the examiners are bringing up another aspect of duty cycle – some transmission modes like FM are "always on" so they have very high duty cycles if lengthy transmissions are made and may burn out transmitter components if used in a way that exceeds the transmitter's ratings.

G8B08 Why is it important to know the duty cycle of the mode you are using when transmitting?

A. To aid in tuning your transmitter
B. Some modes have high duty cycles which could exceed the transmitter's average power rating.
C. To allow time for the other station to break in during a transmission
D. All of these choices are correct

That's the end of installment #7, and the second of the three exam sections on emissions. One question on the exam is guaranteed to come from the list above (so there will be a total of three exam questions on emissions).

Comments are welcome -- contact me at aa8sw@att.net, or Robert at ak3q@ak3q.com.