THE EXAM CORNER #9

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This is the first of four articles on the topic of antennas and feed lines. This large allocation of space on the exam reflects the importance of the topic – all signals to our radios go in and out through an antenna, and the efficacy of the station is largely determined by how well the antenna works. This first section largely focuses on feed lines.

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.

● While "resistance" is opposition to the flow of a direct current, alternating current like RF is more complex because the flow of current is affected by capacitance and inductance as well as resistance. The mathematical combination of resistance, and "reactance" caused by capacitance and inductance, is called "impedance". That math gets very complicated but fortunately you do not need to know it for the General Class exam – just remember that "impedance" is akin to resistance to the flow of radio frequency energy.

Each type of feed line has a "characteristic impedance" that depends on its construction. The two main types of feed line are two parallel conductors (like "ladder line" or old-fashioned TV twin-lead), and coaxial (a center conductor surrounded by insulation and the other conductor in the form of a metallic wrap or braid). The characteristic impedance of a parallel feed line is determined by the size (radius) of the conductors and the distance between them. TV twin-lead has a characteristic impedance of 300 ohms (and amateurs use somewhat similar parallel feedlines with impedances in the same range). Amateurs often use coaxial feedlines with impedances of 50 and 75 ohms (modern transceivers usually have 50-ohm outputs that need to be matched).

G9A01 Which of the following factors determine the characteristic impedance of a parallel conductor antenna feed line?

A. The distance between the centers of the conductors and the radius of the conductors
B. The distance between the centers of the conductors and the length of the line
C. The radius of the conductors and the frequency of the signal
D. The frequency of the signal and the length of the line

G9A03 What is the characteristic impedance of flat ribbon TV type twinlead?

A. 50 ohms
B. 75 ohms
C. 100 ohms
D. 300 ohms

G9A02 What are the typical characteristic impedances of coaxial cables used for antenna feed lines at amateur stations?

A. 25 and 30 ohms
B. 50 and 75 ohms
C. 80 and 100 ohms
D. 500 and 750 ohms

● What happens if there is an impedance mismatch? Such as, the radio and the transmission line are 50 ohms but the antenna is 200 ohms? This will cause a portion of the transmitted power to be reflected back by the antenna.

G9A04 What might cause reflected power at the point where a feed line connects to an antenna?
A. Operating an antenna at its resonant frequency
B. Using more transmitter power than the antenna can handle
C. A difference between feed line impedance and antenna feed point impedance
D. Feeding the antenna with unbalanced feed line

● The amount of reflection is measured by the "standing wave ratio" (SWR). Standing waves are a very confusing concept to most people – for the General Class exam, you do not have to know any of the technical details about standing waves. Just pretend, whenever you see standing wave ratio or SWR, that it said "impedance mismatch ratio" instead. Then it becomes very simple arithmetic. In the example I gave above, where there is a 50 to 200 ohm mismatch, 200 is equal to 4 times 50, so the SWR is 4:1. Note, it does not matter what order in which the numbers appear in the question, the larger number always goes first in the answer followed by :1 – so it's always 4:1, never 1:4.

G9A09 What standing wave ratio will result when connecting a 50 ohm feed line to a non-reactive load having 200 ohm impedance?
A. 4:1
B. 1:4
C. 2:1
D. 1:2
Hint: 200 is 4 times 50, and the larger number always goes first – always 4:1, never 1:4.

G9A10 What standing wave ratio will result when connecting a 50 ohm feed line to a non-reactive load having 10 ohm impedance?
A. 2:1
B. 50:1
C. 1:5
D. 5:1
Hint: again, it does not matter what order the numbers appear in the question, it's always 5:1, not 1:5.

G9A12 What standing wave ratio will result when connecting a 50 ohm feed line to a non-reactive load having 25 ohm impedance?
A. 2:1
B. 2.5:1
C. 1.25:1
D. You cannot determine SWR from impedance values

G9A13 What standing wave ratio will result when connecting a 50 ohm feed line to an antenna that has a purely resistive 300 ohm feed point impedance?
A. 1.5:1
B. 3:1
C. 6:1
D. You cannot determine SWR from impedance values

● If there is a perfect match, such as a 50-ohm feed line and a 50-ohm antenna, then the SWR is 1:1 and there is no reflection, so no standing waves.

G9A07 What must be done to prevent standing waves on an antenna feed line?
A. The antenna feed point must be at DC ground potential
B. The feed line must be cut to a length equal to an odd number of electrical quarter wavelengths
C. The feed line must be cut to a length equal to an even number of physical half wavelengths
D. The antenna feed point impedance must be matched to the characteristic impedance of the feed line

G9A11What standing wave ratio will result when connecting a 50 ohm feed line to a non-reactive load having 50 ohm impedance?

A. 2:1
B. 1:1
C. 50:50
D. 0:0

● The last group of questions deals with transmission line losses. Obviously feed lines are not perfect conductors and like any electrical conductor, some of the energy passing through them is lost (converted to heat). This loss of power is also called "attenuation", which increases as the frequency of the signal goes higher. The losses are typically expressed as decibels (dB) per 100 feet of line.

G9A05 How does the attenuation of coaxial cable change as the frequency of the signal it is carrying increases?

A. Attenuation is independent of frequency
B. Attenuation increases
C. Attenuation decreases
D. Attenuation reaches a maximum at approximately 18 MHz

G9A06 In what units is RF feed line loss usually expressed?

A. Ohms per 1000 feet
B. Decibels per 1000 feet
C. Ohms per 100 feet
D. Decibels per 100 feet

● Transmission line losses and measured SWR affect each other. High SWR means a portion of the signal is being reflected back and forth within the feed line, and every time the reflected power passes through, a portion of it is lost as heat – so high SWR increases transmission line losses. An SWR meter at the transmitter is measuring the amount of power reflected back from the antenna, so if a lot of the reflected power is lost in the transmission line, then the SWR will read artificially low.

G9A14 What is the interaction between high standing wave ratio (SWR) and transmission line loss?

A. There is no interaction between transmission line loss and SWR
B. If a transmission line is lossy, high SWR will increase the loss
C. High SWR makes it difficult to measure transmission line loss
D. High SWR reduces the relative effect of transmission line loss

G9A15 What is the effect of transmission line loss on SWR measured at the input to the line?

A. The higher the transmission line loss, the more the SWR will read artificially low
B. The higher the transmission line loss, the more the SWR will read artificially high
C. The higher the transmission line loss, the more accurate the SWR measurement will be
D. Transmission line loss does not affect the SWR measurement

● Finally, the examiners have included one overly-technical question since matching networks are beyond the scope of the General Class exam, so this is an exception to the general rule that the exam is not intended to be tricky. It is <u>not</u> an exception to the rule that you should go with the obvious answer, though – when an answer essentially repeats the question, that's the one that you want.

G9A08 If the SWR on an antenna feed line is 5 to 1, and a matching network at the transmitter end of the feed line is adjusted to 1 to 1 SWR, what is the resulting SWR on the feed line?

A. 1 to 1
B. 5 to 1
C. Between 1 to 1 and 5 to 1 depending on the characteristic impedance of the line
D. Between 1 to 1 and 5 to 1 depending on the reflected power at the transmitter
Hint: note the question says – the SWR on a feed line is 5 to 1. They are telling you the answer!

That’s the end of installment #9, and next we will continue with the rest of the four exam sections on antennas. One question on the exam is guaranteed to come from the list above.

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