

Extra Class License Manual – Supplemental Information and Errata

The following text is intended to support or correct the 12th edition of the *Extra Class License Manual* and the 5th edition of the *Extra Class Q&A*. Recent changes in this version of the document are in red.

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The question pool for the current Extra Class license took effect on July 1, 2020.

Question Pool Changes

E6B06 – This question has two correct choices (A and D) and has been withdrawn.

Supplemental Information

Extra Class License Manual

Significant Digits in Answers: Students may be confused when making calculations because the answer in the question pool or example does not reflect the exact number produced by a calculator. For example, when calculating reactance in Example 4.4 on page 4-22, using the formula for X_L a calculator will display a value of 396.2052. Following the rules of significant digits, the answer should be rounded to 400. A tutorial on significant digits is available online at chemcollective.org/activities/tutorials/stoich/significant_figures as well as through the online Khan Academy (www.khanacademy.org). Although the question pool is not completely consistent regarding significant digits in calculations, the student should expect answers to be rounded or refer to “best representations” to accommodate different methods of calculation. The associated question to this calculation (E5C15) asks only which of the graphed points “best represents” the resulting impedance, for example. High precision is not required in any exam question.

Chapter 2

Page 2-3

The essential reason for the bureau system (<http://www.arrl.org/incoming-qsl-service>) was postage costs and postal system reliability when it was devised. Before Logbook Of The World became so popular, most QSLing was by paper cards. Within the US, a postcard stamp wasn't so costly but to send international mail was much more expensive, especially if you sent return postage and an SASE. It costs well over a dollar to send a card even without return postage! An active station could easily spend hundreds or thousands of dollars on postage if all QSLs were sent direct. Volume is way down these days but there are still a lot of paper cards going back and forth. Getting a paper card from a new station is a lot of fun, as you probably know. So most stations will send a paper card for a first contact and then rely on the electronic systems for subsequent QSOs.

Chapter 4

Page 4-27

Figure 4.24 shows the intersection of two lines representing reactance vs frequency: the curved line, decreasing to the right, shows capacitive reactance $X_C = 1/2\pi fC$, and the straight line rising to the right shows inductive reactance $X_L = 2\pi fL$. At the frequency where the lines cross, $X_C = X_L$ and the circuit is resonant. The scales of both axes are linear, resulting in the curved and straight lines. In most engineering manuals and texts, however, reactances are plotted on a log-log chart where both types of reactance are plotted as straight lines. This makes it a lot easier to see where the resonant frequency is for a wide range of capacitance, inductance, and frequencies. You can see this kind of chart in the Electrical Fundamentals chapter of the *ARRL Handbook* or online at www.rfcafe.com/references/electrical/frequency-reactance-nomograph.htm.

Chapter 5

Page 5-20

The description of the XOR function wasn't clear: the output will be 0 if both inputs are 0 or if both inputs are 1. The output of the XOR gate is 1 if one and only one of the inputs is 1. The exam question E7A09 asks about the XNOR function which inverts the XOR outputs so that the output is 0 if one and only one of the inputs is 1.

Page 5-21

In Figure 5.38 - the first line of the state table (B) for $S = 0$ and $R = 0$ is saying "If S and R are both zero, the states of the Q and not-Q outputs are unchanged."

In the bottom line of the truth table, the output states are uncertain for $S = 1$ and $R = 1$ because both Q and not-Q attempt to go to the *same* state, which is not allowed for complementary

outputs. Either 0 or 1 would be possible - see [https://en.wikipedia.org/wiki/Flip-flop_\(electronics\)](https://en.wikipedia.org/wiki/Flip-flop_(electronics)). Whether it is 0 or 1 depends on exact timing of signal changes and similar concerns. This is one reason why the S-R flip-flop isn't often used in favor of a clocked D-type or J-K flip-flop.

Chapter 6

The symbol // (two parallel slashes) is used to mean “in parallel with” instead of showing the full equation for the paralleled components. Using // is often clearer than the full equation when attempting to explain a design or relationship.

Page 6-13

In Figure 6-12, the symbol β (beta) is used to represent the feedback ratio through the feedback network. While this is standard terminology (en.wikipedia.org/wiki/Barkhausen_stability_criterion), beta is also used to represent the ratio of collector to base current in a bipolar transistor. The context of the discussion should be used to alert the reader which meaning of the symbol is used. There are many symbols with multiple uses in electronics – caution is advised, along with a good glossary.

Page 6-14

Clarifying the RF Oscillators section's first paragraph, what Hartley and Colpitts came up with was two different ways in which feedback and a filter could be combined with an amplifier to make an oscillator. (see Figure 6.12 for the general case) In the case of Figure 6.14A and B, the amplifying device is a transistor although when the original circuits were invented, only vacuum tubes were available.

Page 6-37

The phrase “As a pulse becomes narrower and narrower, its frequency spectrum spreads out more and more” can be hard to understand. Without getting into the full mathematics of the spectrum of pulses, we can simplify the reasoning a bit as follows: As the pulse becomes narrower in time, higher and higher frequency components are required to make the sharp edges with the short duration between them. At the extreme, the spectrum of a zero-width impulse has components at all frequencies. This is why impulse noise, such as from arcs and spark discharges, has such a wide spectrum and creates interference across a wide frequency range. Similarly for key clicks - the sharper the keying, the worse the clicks become.

Page 6-41

The function of the linear regulator circuit on the exam (Figure E7-3) is easier to understand if both Figure 6.46 and Figure E7-3 are available while reading the explanation of the circuit's

function on page 6-45. The schematic in Figure 6.46 is more typical of an actual linear regulator than the exam figure which is somewhat oversimplified.

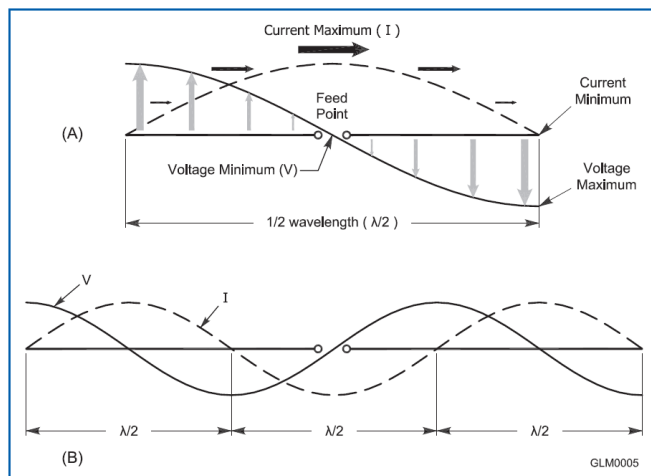
Chapter 7

Page 7-16

The maximum input signal level that can be digitized correctly is established by the converter's reference voltage. Some converters use an external reference voltage and others have an internal voltage reference.

Chapter 9

A resonant antenna has a feed point impedance that is all resistance. i.e. $Z = R + j0$. Yet the current and voltage appear to be 90 degrees out of phase at resonance – why?



The drawing above shows the current and voltage distributions. The distributions along the wire are just the magnitude of the waveforms (like the envelope of a modulated signal) and doesn't say anything about the phase of the actual waveform. It is the distributions that are 90 degrees out of phase, not the waveforms. At the center, the voltage waveform reaches a minimum while the current waveform is at a maximum - yet both waveforms are in-phase (at resonance), resulting in a purely resistive impedance.

Page 9-23

In Equation 9.4B, because System Gain is given in dB, the anti- or inverse log function must be used to calculate ERP in watts. $\log^{-1}(x)$ is also the same thing as 10^x .

Page 9-30

In Example 9.8, the question pool's correct answer for E9F06 does not take into account the velocity factor for the specified feed line ($VF = 0.95$ to 0.99). However, 10.6 meters (C) is the closest answer, satisfying the question's "approximate length" wording.

Page 9-31

In the explanation of the function of the hairpin inductor, it is correct that the hairpin is a shunt inductor. [E9E05] This shunt inductor then combines with the capacitive reactance of the antenna's driven element to form an L network, matching the antenna's feed point impedance to 50 ohms.

Extra Class Q&A

E4C08 – the explanation has been extended to read, "Overload of a software defined radio (SDR) is reached when the combination of all signals at the receiver's analog-to-digital converter exceed the maximum level, also called "clipping," for which the converter generates a unique digital value. Maximum signal value is controlled by the converter's reference voltage."

E3F06 – see the preceding entry for page 9-30 of the manual.

Errata

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Page 3-20

The correct wording for question E1F08 is “Which of the following types of amateur station communications are prohibited?”

Page 5-24

In equation 5.7 – the denominator should be $C_1[R_1 + (2 \times R_2)]$

Page 6-12

In the first paragraph of section 6.2, the word “basic” should be “basics”.

Page 6-28

The section title “Software-Defined Radio (SDR) Systems” should be blue and in all capital letters.

Page 6-34

A band-pass filter’s shape factor is the ratio of the filter’s wide bandwidth at the -60 dB level to narrow bandwidth at the -6 dB level, so the calculation of shape factor should be $5.4 / 1.8 = 3.0$.

Page 6-38

Figure 6.39 – the arrowhead on the horizontal line at upper right from the summing symbol to the output label should point to the output label.

Page 8-11

In the final paragraph on PSK, the referenced equation should be 8.3, not 8.1.

Page 9-3

In equation 9.2, change 2.5 dB to 2.15 dB as in equation 9.1.

Extra Class Q&A

E3C09 – The explanation should state that each successive level in a flare’s intensity represents a 50% increase, not a doubling.

E3F09 – The explanation should use a $V_F = 0.80$, not 0.66, and the correct answer is 8.3 meters which is answer (B).

E4C08 – The correct answer should be (D) not (C).

E7A09 – The explanation should read “...produces a logic 0 at its output when one and only one of its inputs is logic 1.”