The ARRL Extra Class License Manual, 8th Edition, 2nd Printing

On page 1-28 there are two incorrect statements with regard to FCC requirements for RF power amplifiers. Under the RF Power Amplifiers heading, about half-way through the third paragraph, there is a sentence that should read, "The amplifier must not be capable of reaching its designed output power when driven with less than 50 watts." The book incorrectly gives the power as 40 watts. Near the end of the fourth paragraph the text incorrectly states that an amplifier must not produce 3 dB or more gain for input signals between 26 and 28 MHz. That sentence should read: "The amplifier must not produce any gain (0 dB) for input signals between 26 MHz and 28 MHz.

After correcting a number of errors in the way equations printed in the first printing of this book, several new errors occurred in the printing process. We apologize for this frustrating problem with printed equations.

On page 4-22, the equations in the top half of the page are all missing their mathematical operator symbols. The correct text, including equations, for all of page 4-22 is given below:

You can calculate the second-order intercept point when you know the input power of one of the input signals and the power of the IMD product signal.

$$IP_2 = \frac{2 \times P_A - P_{IM_2}}{2 - 1} \qquad \text{(Equation 4-9)}$$

where:

IP_2 is the second-order intercept point

P_A is the input power of one of the signals on the receiver input

P_{IM} is the power of the intermodulation distortion (IMD) products

For example, suppose that we use two tones with a strength of –30 dBm each to test a certain receiver. Then we measure the second-order IMD products to be –70 dBm. We want to find the second-order intercept point for this receiver. We can use Equation 4-9.

$$IP_2 = \frac{2 \times P_A - P_{IM_2}}{2-1} = \frac{2 \times -30\ \text{dBm} - \left(-70\ \text{dBm}\right)}{2-1}$$

$$IP_2 = \frac{-60\ \text{dBm} + 70\ \text{dBm}}{1} = +10\ \text{dBm}$$

There is a similar equation to calculate the third-order intercept point.

$$IP_3 = \frac{3 \times P_A - P_{IM_3}}{3-1} \qquad \text{(Equation 4-10)}$$

where:

IP_3 is the third-order intercept point

P_A is the input power of one of the signals on the receiver input

P_{IM} is the power of the intermodulation distortion (IMD) products

As an example of finding the third-order intercept point, suppose that we use two tones with a strength of –30 dBm each to test our receiver again. This time we measure the third-order IMD products to be –70 dBm. We want to find the third-order intercept point for this receiver. Now we can use Equation 4-10.

$$IP_3 = \frac{3 \times P_A - P_{IM_3}}{3-1} = \frac{3 \times -30\ \text{dBm} - \left(-70\ \text{dBm}\right)}{3-1} = \frac{-90\ \text{dBm} + 70\ \text{dBm}}{2}$$

$$IP_3 = \frac{-20\ \text{dBm}}{2} = -10\ \text{dBm}$$

The larger the value for the third-order intercept point, the better the receiver will be.

Intermodulation distortion (IMD) dynamic range measures the impact on the receiver of the production of spurious signals that result when two or more signals mix in the receiver. When the IMD dynamic range is exceeded, false signals begin to appear along with the desired signal. (Undesired signals are strong enough to mix with other signals and produce spurious signals that show up in the receiver passband along with the desired signal.)

On page 4-23, please cross out the paragraph under Equation 4-11 that begins "The vertical bars around the expression indicate that you should take the absolute value of the quantity." Equation 4-11 does not require the use of absolute value, and the vertical bars are not included in the equation as printed.

Some text fell off the bottom of page 4-30 during the second printing revision. Starting with the last sentence at the bottom of the page, the text should read:

The interference is intermittent, and by listening on another receiver tuned to 146.52 MHz, you determine that the interference does not occur every time the other ham transmits. What are the two most likely frequencies for the second signal that may be causing this intermod in your receiver?

On page 5-7, the equation for series capacitance, C_T (series) has an extra μF after the last equal sign. The right side of that equation should read:

C_T (series) …. $= 50 \times 10^{-6}$ F

On page 5-19, Figure 5-14, the oscillator frequency was cut off the left side of the drawing. The oscillator frequency of 10. kHz should be included on the drawing. This frequency is used in the example calculations included in the text.

On page 5-21, Figure 5-15, an incorrect oscillator frequency is shown. The frequency must be 10. MHz, as given in the text explaining the example calculations.

A problem similar to the one on page 4-22 occurred on page 5-30, with numerous mathematical operator symbols missing from the equations. The correct text, with equations, for all of page 5-30 is given below:

Don't be confused by the change of sign in front of the *j* here. That comes about because of a rule of algebra for complex numbers. When you have a *j* operator in the denominator, you must eliminate it before performing the division. That is accomplished using a technique called complex conjugates. If you multiply a complex number by the same number, but with an opposite-sign *j* operator, you get a $-j^2$ term. But since $j = \sqrt{-1}$, $-j^2 = -(\sqrt{-1})^2 = -(-1) = +1$! The only catch is that there is another rule of algebra that says if you multiply the denominator of a fraction by some number, you must multiply the numerator by the same value. Here are the steps involved:

$$B = \frac{1}{X} = \frac{1}{-j\,3183\ \Omega} \times \frac{+j\,3183\ \Omega}{+j\,3183\ \Omega} = \frac{+j\,3183\ \Omega}{-j^2\,(3183\ \Omega)(3183\ \Omega)} = \frac{+j}{-(-1)(3183\ \Omega)}$$

$B = +j\,3.14 \times 10^{-4}$ S

From this example you can see that the only real effect of this process is that the sign in front of the *j* operator changes when you convert from reactance to susceptance. If you have a complex number that includes a real and an imaginary part, the process becomes just a little more involved.

Now we will turn to Equation 5-18, and write our impedance equation, choosing a value of 1 for the voltage:

$$Z = \frac{E}{I_R + I_X} = \frac{1\,V}{\left(2.5\times10^{-4} + j\,3.14\times10^{-4}\right)\,A}$$

This is where we hit the first snag. We can either multiply the numerator and denominator of this fraction by the complex conjugate of the denominator, or we can convert the rectangular-coordinate form to polar-coordinate form. When you change to polar-coordinate form there is no *j* operator left in the expression. To divide by a number that is in polar-coordinate form, you just divide by the magnitude and subtract the angle from the numerator angle. (In this case the numerator angle is 0°.) Since the mathematics are a bit simpler using polar-coordinate form, let's use that method.

The numerator is especially easy. Since it is a value of 1, and there is no imaginary component, the angle will be zero; 1 V, $\underline{/0°}$. To calculate the magnitude of the denominator we use the Pythagorean Theorem (from Equation 5-17).

$$|I| = \sqrt{\left(2.5 \times 10^{-4}\ A\right)^2 + \left(3.14 \times 10^{-4}\ A\right)^2}$$

$$|I| = \sqrt{\left(6.25 \times 10^{-8}\ A^2\right) + \left(9.86 \times 10^{-8}\ A^2\right)} = \sqrt{16.11 \times 10^{-8}\ A^2}$$

$$|I| = 4.01 \times 10^{-4}\ A$$

To calculate the phase angle, you will have to use the tangent function from trigonometry:

$$\tan \theta = \frac{\text{side opposite}}{\text{side adjacent}} = \frac{3.14 \times 10^{-4}\ A}{2.5 \times 10^{-4}\ A} = 1.256$$

Page 6-35 demonstrates the calculation of inductance when using ferrite toroidal inductor cores. Equation 6-9 gives an equation, and then there is a specific example, calculating the inductance of a 10-turn coil wound on an FT-50 sized core made from 43-mix material. The inductance value for that coil is incorrectly shown with a value in microhenrys (μH). That value should be given in millihenrys (mH) as:

L (For Ferrite Cores) = 0.0523 mH

Page 7-15 also has several equations that are missing the mathematical operator symbols. Shown below is the correct text, with equations for that page, starting with Equation 7-3 near the top of the page:

$$R_1 = \frac{Q}{2\pi f_0 A_V C_1} \quad \text{(Equation 7-3)}$$

$$R_2 = \frac{Q}{\left(2Q^2 - A_V\right)\left(2\pi f_0 C_1\right)} \quad \text{(Equation 7-4)}$$

$$R_3 = \frac{2Q}{2\pi f_0 C_1} \quad \text{(Equation 7-5)}$$

$$R_4 = R_5 \approx 0.02 \times R_3 \quad \text{(Equation 7-6)}$$

Single filter sections can be cascaded for greater **selectivity**. One or two sections may be used as a band-pass or low-pass section for improving the audio-channel passband characteristics during SSB or AM reception. Up to four filter sections are frequently used to obtain selectivity for CW or RTTY reception. The greater the number of filter sections, up to a practical limit, the sharper the filter skirt response will be. Not only does a well-designed RC filter help to reduce QRM, but it also improves the signal-to-noise ratio in some receiving systems.

The component values shown in Figure 7-15 illustrate the design of a single-section band-pass filter. The value of f_o was chosen as 900 Hz for the calculation, but for CW reception you may prefer frequencies between 200 and 700 Hz. An A_V (gain) of 1 and a Q of 5 were chosen for this example. Both the gain and the Q can be increased for a single-section filter if desired, but for a multisection RC active filter, it is best to restrict the gain to 1 or 2 and limit the Q to no more than 5. This helps prevent unwanted filter "ringing" and audio instability. Filter ringing occurs when the filter shape, as measured in the frequency domain (bandwidth), is too narrow for the signal being received.

Standard-value 680-pF capacitors are chosen for C_1 and C_2. For certain design parameters and C_1-C_2 values, unwieldy resistance values may result. If this happens, select a new value for C_1 and C_2. Use Equations 7-3 through 7-6 to calculate the required resistance values.

$$R_1 = \frac{Q}{2\pi f_0 A_V C_1} = \frac{5}{6.28 \times 900\text{ Hz} \times 1 \times 680 \times 10^{-12}\text{ F}} = \frac{5}{3.84 \times 10^{-6}}$$

$$R_1 = 1.30 \times 10^6\ \Omega = 1.3\text{ M}\Omega$$

$$R_2 = \frac{Q}{\left(2Q^2 - A_V\right)\left(2\pi f_0 C_1\right)} = \frac{5}{\left(2 \times 5^2 - 1\right)\left(6.28 \times 900\text{ Hz} \times 680 \times 10^{-12}\text{ F}\right)}$$

On page 8-4 there is an error in the first full paragraph at the top of the page. Starting near the end of the 5th line of that paragraph, the sentence should read:

The method involves squaring the instantaneous values for a large number of points along the waveform (a calculus procedure), then finding the average of the squared values, and taking the square root of that number.

On page 10-9, questions E1A10 and E1A11 have been withdrawn from the question pool by the Volunteer Examiner Coordinators' Question Pool Committee.

On page 10-23, question E1F05 has been withdrawn.

On page 10-28, in question E1G06, there is a typographical error in answer choice A. Arecibo was spelled incorrectly in the original question from the Volunteer Examiner Coordinators' Question Pool Committee.