Documentation for AAT.EXE Program
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by R. Dean Straw, N6BV
Senior Assistant Technical Editor, ARRL

AAT is a software tool designed to put an antenna tuner through a huge battery of tests. The name "AAT" is short for "Analyze Antenna Tuner." AAT uses the same core algorithms as the TLA program, but it uses them automatically to evaluate 2,277 combinations of resistance and reactance in the amateur bands from 1.8 to 29.7 MHz. At each impedance, AAT sees if the tuner can make a match, while meeting performance criteria set by the operator.

USING AAT

The best way to learn how to use AAT is to actually try it out. Let's assume that you want to evaluate a Tee-network on the ham bands between 1.8 to 29.7 MHz.

First, you need to get into the subdirectory containing AAT.EXE, and then you can boot up the program. You do this using the CD [change directory] command in DOS.

If you have done a standard installation using the INSTALL program provided with the diskette in the back of the 18th Edition of The ARRL Antenna Book, the default directory for AAT is \ANTBOOK\XMSNLINE.

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CD \ANTBOOK\XMSNLINE [Enter]
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Now, Type:

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AAT [Enter]
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and you will see the AAT's main menu.

SETUP CHOICES - D (Defaults)

The Defaults stored in the program represent realistic values for typical components, but you may want to change them to whatever you like. For example, an unloaded Q of 200 for a roller inductor is pretty typical. If the inductor is located very close to a metal chassis, however, the unloaded Q can drop as low as 50 to 75. This induces extra losses in the inductor.

An unloaded Q of 1000 for an air-variable capacitor with wiping contacts is also pretty typical. A vacuum-variable capacitor, which has bellows-type contacts, may have an unloaded Q of 5000. Even at Qu = 1000, however, the main losses in a tuner are not likely to be in the variable capacitors -- they'll still be in the coil, because of its lower unloaded Q.

You may set the power into the tuner from the transmitter to whatever you like. The default setting is 1500 W, the maximum amateur limit in the USA.

You may also change the value of the resistance the tuner is striving to achieve at its input when it is tuned properly. For example, some designs use a 1:4 autotransformer at the input to transform 12.5 ohms at the input of the tuning network to 50 ohms for the transmitter. This strategy allows components with practical values to be used for certain standard types of marine antennas (a 35-foot whip, usually), but it does result in higher losses in the tuner than a straightforward 50 ohm resistance at the tuner's input.

SETUP CHOICES -- M (Min/Max)

AAT needs to know the range of capacity in the tuning capacitors. AAT assumes that identical capacitors will be used in the input and output for Pi-network and Tee-network tuners. AAT does allow you to specify a fixed padding capacitor at the output to augment the output capacity at 160 and 80 meters.

To use the M function in AAT, first, you would want to choose suitable variable capacitors for the input and output capacitors. Let's assume for your Tee-network tuner that you decide to use the popular Johnson 154-16-1, which is rated for a minimum to maximum range from 32 to 241 pF, at 4500 V peak. Stray capacity in the circuit is estimated at 10 pF, making the actual range from 42 to 251 pF. So, you would enter 42 when AAT asks for the minimum capacity, and 251 when it asks for the maximum.

Note: if you decide to use a dual-section type of variable capacitor, where you switch in manually one or both sections, specify the minimum capacity of one section (plus an estimated stray capacity -- usually 10 pF is about right), and enter for the maximum capacity the sum of the two sections, plus double the stray (about 20 pF typically). For example, if each section of a dual-section capacitor ranges from 24 to 191 pF, then you would use for the minimum value 24 + 10 = 34 pF, and 191 + 191 + 20 = 402 pF for the maximum value.

The program next asks you if you want to specify a fixed capacitor across the output variable capacitor for 160/80 meters. If you do want to switch in such a fixed padder capacitor, answer "Y" for yes. Then you may specify the value. AAT will only allow you to specify a value less than or equal to the maximum capacity you entered in the last step. This is so that the tuning range of the capacitor with and without the switched-in padder will cover a continuous range.

Next, you choose the maximum inductance for the variable inductor to be used in your tuner. Many people use the popular Johnson 229-203-1, which has a maximum inductance of 28 microhenries, and an unloaded Q of at least 200.

SETUP CHOICES -- P (Power Loss)

Let's say that you decide to set a power-loss limit of 20%, equivalent to a power loss of about 1 dB. Bear in mind that for 1500 W input to the tuner, you will burn up 300 W of power inside for a 20% power loss! Whatever value you enter for percentage power loss, AAT will compute and display the equivalent in dB.

SETUP CHOICES -- V (Voltage Limit)

AAT allows you to specify two different voltage limits for the variable capacitors used in a Tee or Pi-network tuner. For the L-network, a single value for the voltage rating is used. The voltage limit you enter is the peak voltage rating, sometimes known as the "peak withstanding voltage" on capacitor specification sheets.

NETWORK CHOICES 1 TO 4

AAT's opening menu shows the choices you have to operate the program, including the default values stored internally. Hitting a number 1 to 4 tells the program to make its calculations for the network type you have chosen. AAT will ask you to confirm that you really want to go ahead using the values on-screen for the components.

OUTPUT FROM AAT

After AAT goes through its full range of computations, it will exit back to DOS, with two messages: the filenames for the SUM and the LOG files it creates, along with the time taken to do its computations. The time to do a computation for a Tee-network tuner with large variable capacitors and a switched fixed output capacitor can seem very long.

The first file AAT creates is a summary (TEENET.SUM, in this example) and the second is a detailed log (TEENET.LOG) of successful matches -- together with matches that came close, except for exceeding a voltage rating. Both files are ASCII text files, and can be read using a standard word processor.

As explained in detail in the 18th Edition of The ARRL Antenna Book, the numbers in the "matching map" grid represent the power loss percentage for each impedance where a match is indeed possible.

For the Pi-network and the Tee-network, which have three variable components, the program varies the output capacitor in discreet steps of capacitance. It is possible for AAT to miss very critical matching combinations because of the size of the steps necessary to hold execution time down. You can sometimes find such critical matching points manually using the TLA program.

On a 100-MHz Pentium, AAT takes almost four minutes to evaluate all 2,277 combinations for the default component values. On a 33-MHz '486DX machine it really seems to crawl. Because of such execution-time considerations, AAT does an extensive search, but not an exhaustive one.

AAT produces similar tables for Pi-network and L-network configurations, mapping the matching capabilities for the component combinations chosen. All computations are, of course, only as accurate as the assumed values for unloaded Qu in the components. The unloaded Qu of variable inductors can vary quite a bit over the full amateur MF and HF frequency range.

In general, L-networks will exhibit the least loss among the various network configurations, but they often require awkward values for inductance and capacitance. The Tee-network configuration is often used because it can accommodate a wider range of impedances with practical values of variable capacitors and inductors, albeit with sometimes disastrous internal losses. The Pi-network configuration is flexible, but it too will often require very large values for capacitors.

Computations produced by AAT have been compared to measured results on real antenna tuners and they correlate well when measured values for unloaded inductor Qu are plugged into AAT. Individual antenna tuners may well vary, depending on what sort of stray inductance or capacitance is introduced during construction.

EXITING CLEANLY

AAT displays everything in color. If for some reason you use <Ctrl>C or <Ctrl>Break to exit the program, you will be left in DOS, with a messy blue background. Either type CLS [Enter] or MODE=CO80 [Enter] to restore the screen to normal.