# *Installing EZNEC Pro2+ v7.0 – Pro4+ v7.0*

This document is meant for beginner EZNEC users and those with little experience. However, the more experienced user may be interested in installing the external engines NEC-5 and NEC-4.2.
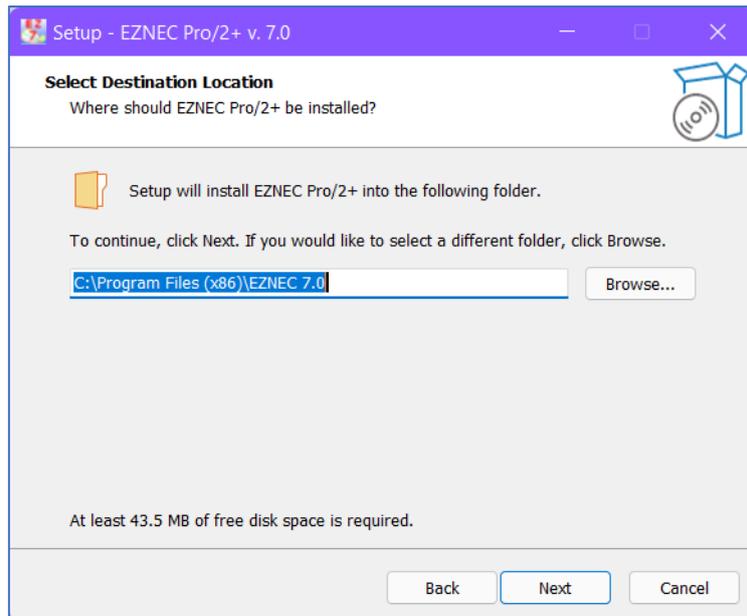
Installing the EZNEC program traditionally happens with a few default steps. However, I recommend accepting the default presented folder destinations.
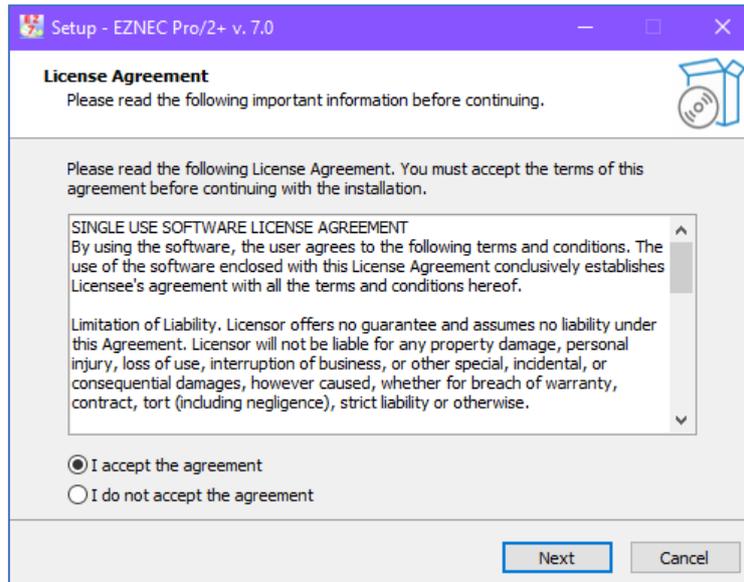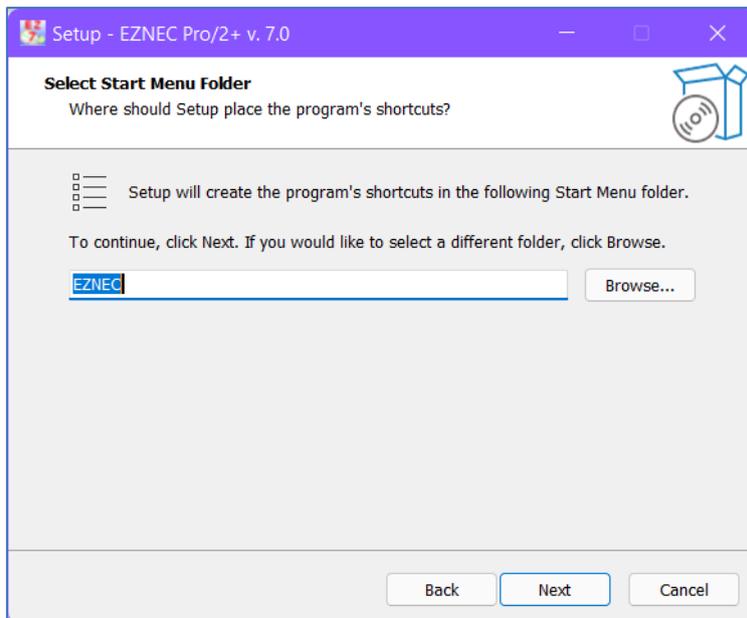

Step 1. *Without accepting the agreement, no installation!*
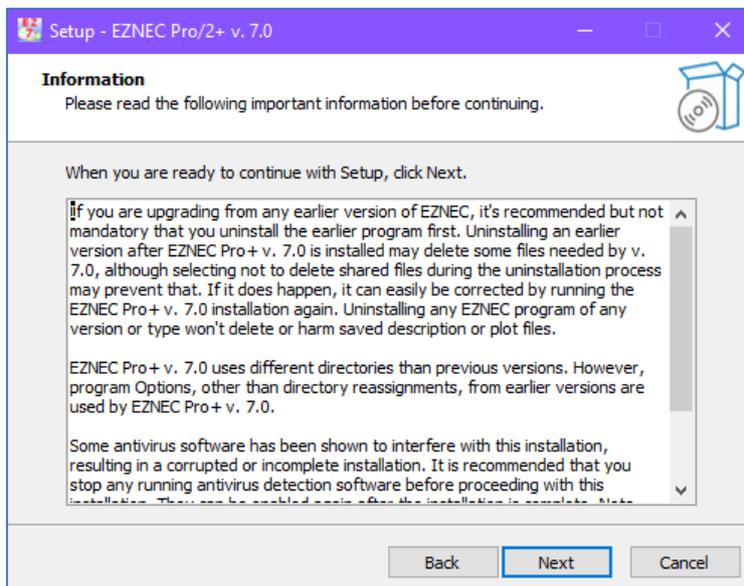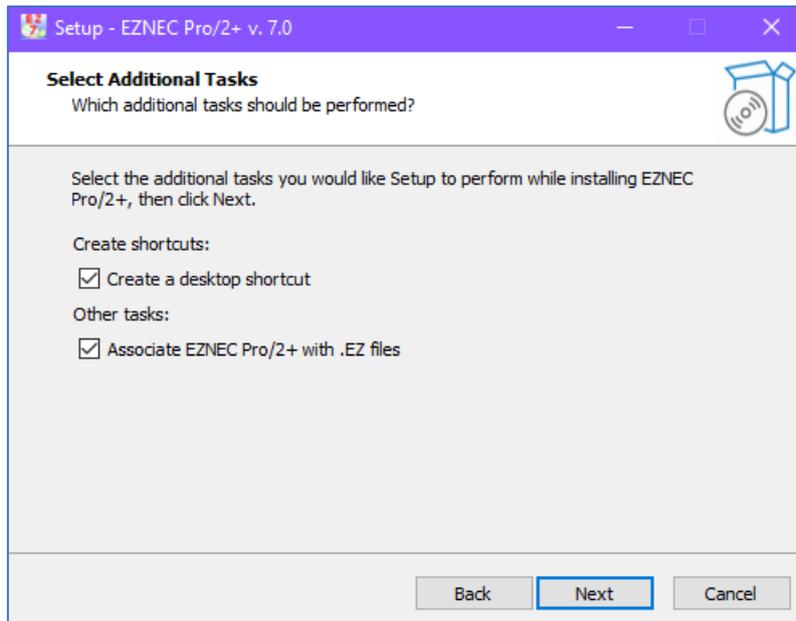

***Step 2.*** *Important information is displayed, and click Next to continue.*

Step 3. *Accept the default destination folder [C:\Program Files (x86)\EZNEC 7.0]*

Step 4. *Accept the default Start Menu folder [EZNEC].*

Step 5. *It is recommended to create a desktop shortcut. When you used a previous EZNEC program version, it is also recommended to associate EZNEC Pro with your previously created (.EZ) model files.*
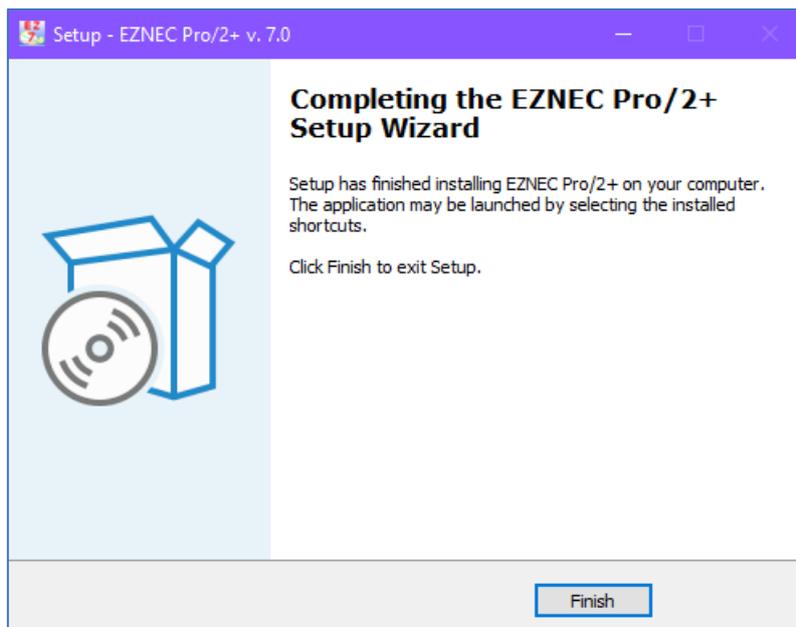
__Step 6.__ Click Finish, and the program is installed.

When the installation is done, the program itself is situated in folder **C: > Program Files (86) > EZNEC 7.0 - Figure 1,** and a folder **EZNEC 7.0** is created in the root **C: - Figure 2.**

When and while EZNEC is running, the **C: > EZNEC 7.0** folder is used to select, write, or retrieve data. When we open this folder, we choose the **Docs > Ant** folder – **Figures 3** and **4.**

When you start for the first time, EZNEC program, this message is displayed – **Figure 1**. After clicking the **OK** button, the Control Center screen is displayed – **Figure 2**, and then every time you launch EZNEC.

I recommend downloading **Chapter 2**, "Starting Modeling with EZNEC" of my book "Advanced Antenna Modeling," to introduce you to EZNEC's most frequently used controls and data-entry mechanisms.
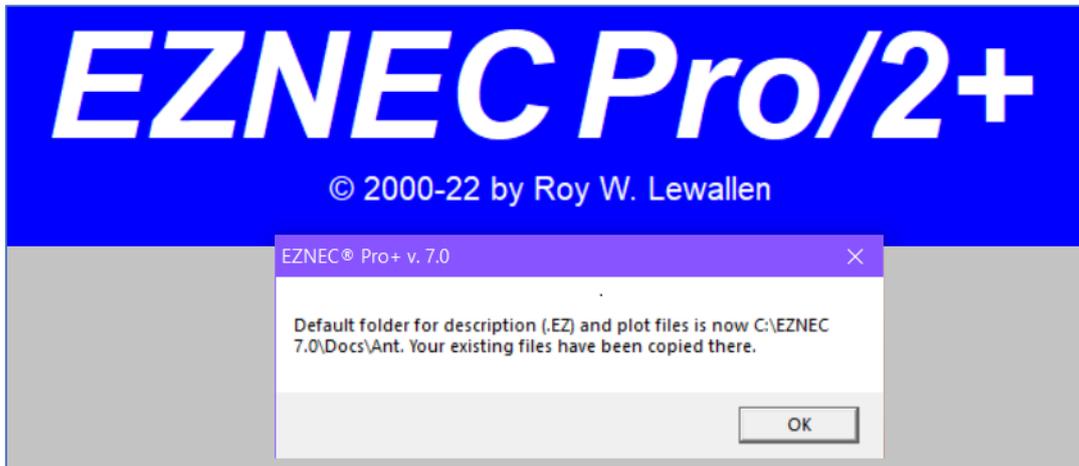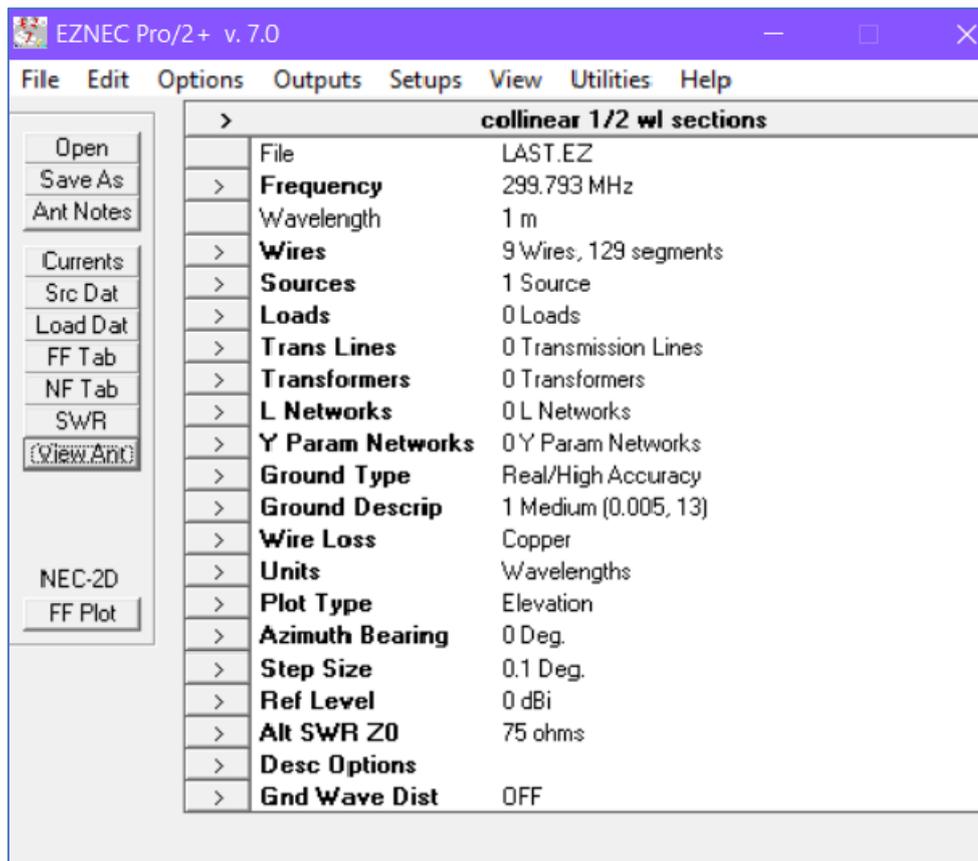

Figure 1. *When starting EZNEC Pro+ v. 7.0.*

Figure 2. *The EZNEC Control Center screen.*

Figures 3 through **7** demonstrate the important folders used by EZNEC.

Figure 3. The ***Program Files (x86)*** *folder.*

Figure 4. The root ***C: > EZNEC 7.0*** *folder.*

Figure 5. The ***C: > EZNEC 7.0 > Docs*** *folder.*

Figure 6. The ***C: > EZNEC 7.0 > Docs > Ant*** *folder.*

Opening the **Ant** folder displays the EZNEC accompanying example model files – **Figure 7**. You may create a new folder in the **Docs** to save your antenna model creations (for example, folder: '**My models'**), but you might also make such a folder in the **Documents** folder as I always do to store the model files while writing my books.

Notice the **Legacy** folder, which is essential when using external engines **NEC-4.2** and/or **Nec-5**; see later.

*Figure 7. The accompanying example EZ files and the **Legacy** folder. This folder becomes essential when using external engines.*

Installing & Using External NEC-4.2 and -5

Both **EZNEC Pro/2+** and **EZNEC Pro/4+** can use external NEC-4.2 and NEC-5 calculating engines which are purchased from LLNL. You'll need to use the "command line" or "console" application among the various programs you'll receive. A modified version of the NEC-5 console application, **NEC5CL_x13.exe,** is now available from LLNL. It has a number of bugs fixed that were in the original NEC-5 distribution. You should use this for your **EZNEC Pro+** NEC-5 calculating engine unless a later modified version is available when you read this.

The NEC5_x13 LLNL distribution includes a 32- bit version (**NEC5CL_x13_32bit.exe**) that should be used only on 32 bit systems because its memory access limitations haven't been as extensively tested as the 64-bit version.

At this time of writing, the NEC-4.2 application is **NEC42W64CL.exe** (64 bit) or **NEC42W32CL.exe** (32 bit). Use the one appropriate for your operating system. The 64-bit version will allow access to much more memory and handle many more segments.

EZNEC Pro/2+ and **EZNEC Pro/4+** are able to do calculations with several different types of calculating engines. A new user can start with the integral NEC-2 or NEC-4.2 calculating engine and may never need either of the others. Users

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needing to model antennas such as loaded or trapped Yagis or wanting to include buried conductors in a model will need to add either NEC-4.2 or NEC-5. **EZNEC Pro/4+** includes a debugged **NEC-4.2** calculating engine, but NEC-5 is highly recommended for use with both **EZNEC Pro/2+** and **EZNEC Pro/4+**.

From 1 February 2022, Pro/2+ v 7.0 and Pro/4+ v7.0 are available. Pro/2+ has a built-in NEC-2D engine, and Pro/4+ has built-in NEC-2D and NEC-4D engines. The "D" means double-precision, and "NEC-4" means actually NEC-4.2. Both programs can also use external NEC-4.2 and NEC-5 calculating engines. Those external engines must be purchased separately from LLNL.

Here's a summary of which features are available with which engines.

Feature Availability vs Engine Choice for EZNEC Pro/2+ and EZNEC Pro/4+				
	Calculating Engine			
Feature	EZCalcD (NEC-2D)	EZCalc4D (NEC-4D)	External NEC-4.2	External NEC-5
Insulated wires	✔	✔	✔	
Buried wires		✔	✔	✔
Unconnected 1-seg wires with insertion objects	✔	✔	✔	
Split sources	✔	✔	✔	
Two ground media	✔	✔	✔	
Two ground media with MININEC ground	✔	✔		
Ground Wave calculation with MININEC ground	✔	✔		✔
Near Field calculation with MININEC ground	✔	✔		✔
Real/High Accuracy (GN2) ground	✔	✔	✔	
Real/Extended Accuracy (GN3) ground		✔	✔	✔

Notes:
1) Features not listed such as lossy transmission lines, L networks, and transformers are available with all engines.
2) The EZCalc4D engine is available only to existing EZNEC Pro/4 users.
3) External NEC-4.2 and/or NEC-5 engines must be purchased from LLNL.

AC6LA

Figure 8. *Courtesy Dan Maguire, AC6LA, the author of* [**AutoEZ**]

MAJOR DIFFERENCES

NEC-2
- It does not allow buried conductors
- Subject to stepped diameter errors
- Sensitive to insertion object placement, especially sources
- The enhanced version included in **EZNEC Pro/2+** and **EZNEC Pro/4+**

NEC-4.2
- Allows buried conductors
- Not subject to stepped diameter errors
- Sensitive to insertion object placement, especially sources
- The enhanced version included in **EZNEC Pro/4+**
- External NEC-4.2 program (purchased from LLNL*) can be used with **EZNEC Pro/2+** and **EZNEC Pro/4+**
- External NEC-4.2 program relatively expensive and slow

NEC-5
- Allows buried conductors
- Not subject to stepped diameter errors
- Insensitive to insertion object placement
- Not subject to several other NEC-2 and NEC-4.2 sensitivities and restrictions.
- Requires different insertion object placement than NEC-2 and -4.2.
- It is not included in **EZNEC Pro/2+** or **EZNEC Pro/4+**.
- External NEC-5 program (purchased from LLNL*) can be used with **EZNEC Pro/2+** and **EZNEC Pro/4+**.
- The external NEC-5 program is relatively inexpensive and fast.

***LLNL** = **Lawrence Livermore National Laboratory**

As mentioned above, the EZNEC Pro/2+ and Pro/4+ programs can make use of an external NEC-5 engine purchased from LLNL. Roy Lewallen has made several corrections to bugs that were present in NEC-5. To purchase NEC-5, including the Lewallen, click the above link.

If you have already purchased NEC-5, you can use the LLNL download page as provided at the time of purchase to get an update. A username and password are required. The revised download page looks like this, and what you want is the smaller "**NEC5 X13**" package.
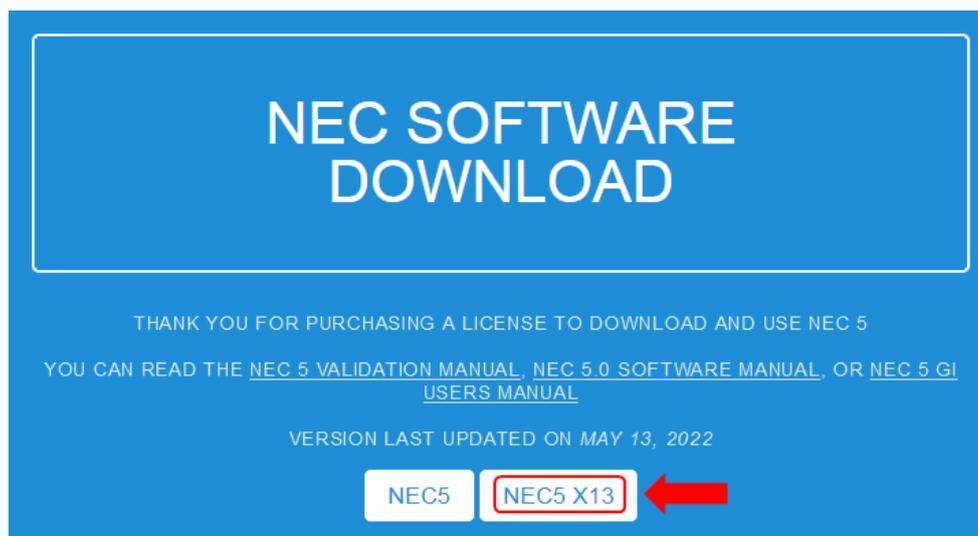

Figure 9.

Technical information on the x13 fix can be found in file "NEC-5 bugs and fixes.txt" which is included in the LLNL NEC-5 x13 download package.

Note that the full LLNL "NEC5" package includes *interactive* engines NEC5x32.exe and NEC5x64.exe. Mind thrse will not work with Windows 11. These have not been corrected, nor have any possible bugs in the *graphical interface* program NEC5GI.exe been found or fixed. The interactive engines are not used with EZNEC Pro/2+ or Pro/4+; EZNEC uses the "console window," aka "command line" engine **NEC5CL_x13.exe**.

Instructions for using the corrected NEC5CL_x13.exe engine with EZNEC can be found in the Pro+ Help under **Contents > Building The Model > Installing & Using External NEC-4.2 NEC-5.**

Watch out for this little gotcha. Suppose you have downloaded the NEC5CL_x13.exe engine, placed that .exe file in the C:\EZNEC 7.0\Docs folder, and made that location the EZNEC default for finding the NEC-5 engine. That doesn't mean that actually using the NEC-5 engine will be the default. To do that, you also need to select **Options > Calculating Engine > External NEC-5** and then (important) again select **Options** and click **Save As Default** from the bottom of the list of choices.

Before you can use either the NEC-4.2 or NEC-5 engines, you must copy the application(s) in the **C: > EZNEC 7.0 > Docs > Ant > Legacy** folder – **Figure 10.**
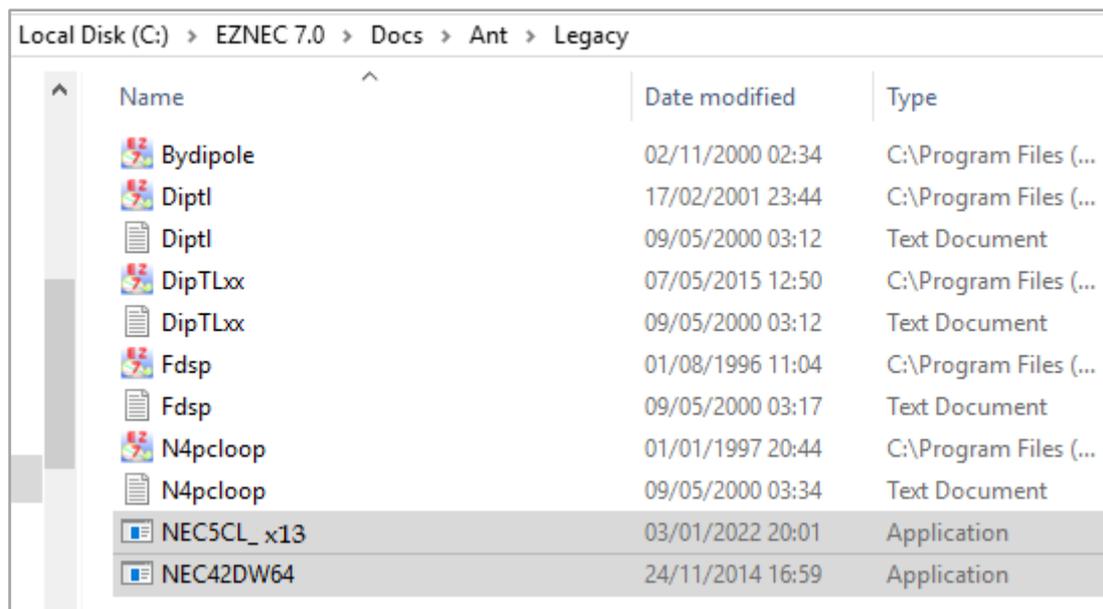

Local Disk (C:) › EZNEC 7.0 › Docs › Ant › Legacy

Name	Date modified	Type
Bydipole	02/11/2000 02:34	C:\Program Files (...
Diptl	17/02/2001 23:44	C:\Program Files (...
Diptl	09/05/2000 03:12	Text Document
DipTLxx	07/05/2015 12:50	C:\Program Files (...
DipTLxx	09/05/2000 03:12	Text Document
Fdsp	01/08/1996 11:04	C:\Program Files (...
Fdsp	09/05/2000 03:17	Text Document
N4pcloop	01/01/1997 20:44	C:\Program Files (...
N4pcloop	09/05/2000 03:34	Text Document
NEC5CL_x13	03/01/2022 20:01	Application
NEC42DW64	24/11/2014 16:59	Application

Figure 10. The Legacy folder where the external engines are copied.

After copying the NEC application(s) to the system, start **EZNEC Pro+**. Open the **Options** menu (in the EZNEC Control Center screen), and select **External Calculating Engine File**, then the file type (NEC-4.2 or NEC-5). The **Legacy** folder opens or you navigate to the NEC application(s) location. Select the application, and click **Open** – **Figure 11**. You should see a message asking if you want to make it your default file for that external calculating engine type and click **Yes** – **Figure 12**. If you don't see the message, open the **Options** menu again and click **Save As Default** at the bottom. Repeat for the other calculating engine type if you have both. In the future, you can change the file which will be used, either temporarily or as a new default, by the same method. *NOTE:* The information format sent between **EZNEC** and the external engine is different for NEC-4.2 and NEC-5. **EZNEC**

assumes when told to run an external calculating engine that it's the correct type. Attempting to run an NEC-4.2 external calculating engine when NEC-5 is the selected type in **EZNEC**, or vice-versa will result in errors and possibly a crash. So be sure that the NEC application specified as the NEC-4.2 External Calculating Engine File really is an NEC-4.2 console application, and likewise for NEC-5.

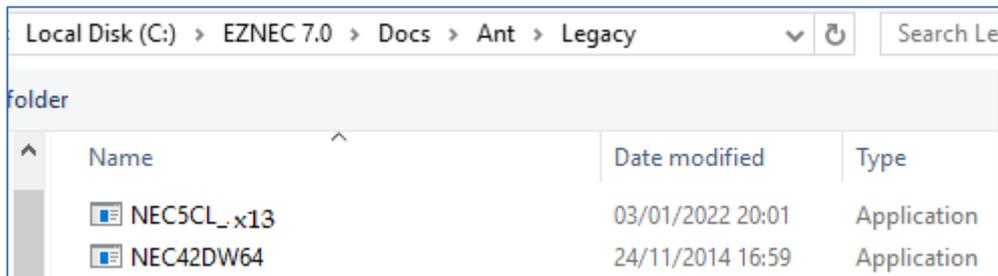Now EZNEC knows you have an external engine(s) enabled.

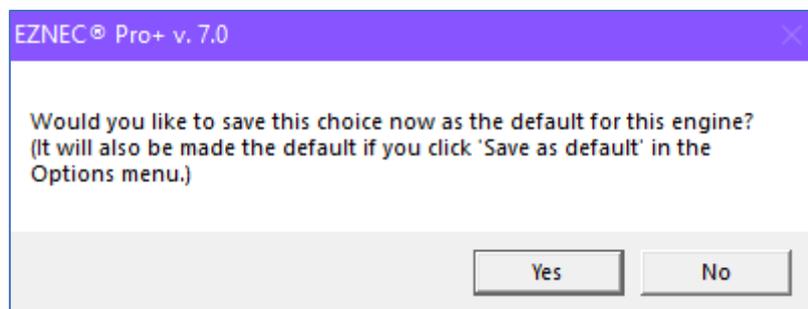***Figure 11.*** *The folder where the NEC-4.2 and NEC-5 applications are stored.*

Figure 12. *Choice confirmation popup message.*

Using the External Engine: Choose the calculating engine you want to use by opening the **Options** menu and selecting **Calculating Engine**. The choice you make will remain active only until you end the program unless you reopen the **Options** menu and click **Save As Default** at the bottom of the list. The **EZNEC** interface is the same when using external and internal calculating engines, with a couple of exceptions:

- Some features aren't available with various calculating engines. See the Calculating Engines topic for details.
- Insertion object placement is different with NEC-5 than with internal or external NEC-2 or NEC-4.2 engines. See NEC-5 Object Placement for details.

Internal calculating engines communicate with the main **EZNEC** program as they run to provide calculation progress information. When an external calculating engine is running, there is no such communication, so what you see will be different. This is described in The Calculation Progress Window topic.

Before doing any calculation with an internal calculating engine, **EZNEC** checks available RAM and sends information to the internal calculating engine telling it how much memory is needed for the immediate calculating run. This communication doesn't occur with external engines that manage their own memory requirements independently of **EZNEC**. Any difficulties with external engine

memory access or allotment that might occur are due solely to the internal design of those applications.

Option > Calculating Engine – This allows you to choose the engine used for calculations. The calculating engine being used is shown just above the FF Plot button in the Control Center. See Calculating Engines for more details about the various choices. ***Note:*** This selection is independent of and not shared with older **EZNEC** versions.

- **EZCalcD (NEC-2D)** - Internal double-precision NEC-2 calculating engine.
- **EZCalc4D (NEC-4D)** (***EZNEC Pro/4+*** only) - Internal double-precision NEC-4.2 calculating engine, recommended for general use with **EZNEC Pro/4+**. It's up to ten times faster than the standard external NEC-4.2 engine and has greater accuracy for a number of situations. External NEC-4.2 - External NEC-4.2 calculating engine furnished by the user. Some features available with the internal EZCalc4(D) engines, such as ground wave and near field analysis with MININEC type ground, aren't available.
- **External NEC-5** - External NEC-5 calculating engine furnished by the user.
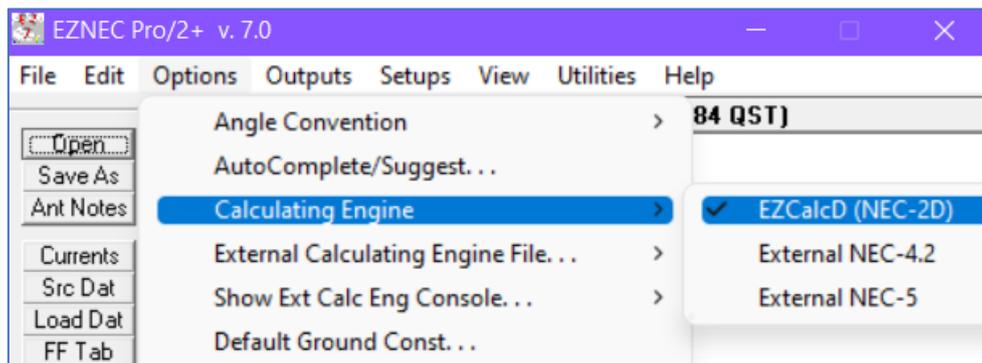
Figure 13. *Choosing a calculation engine with EZNEC Pro/2 v. 7.0*
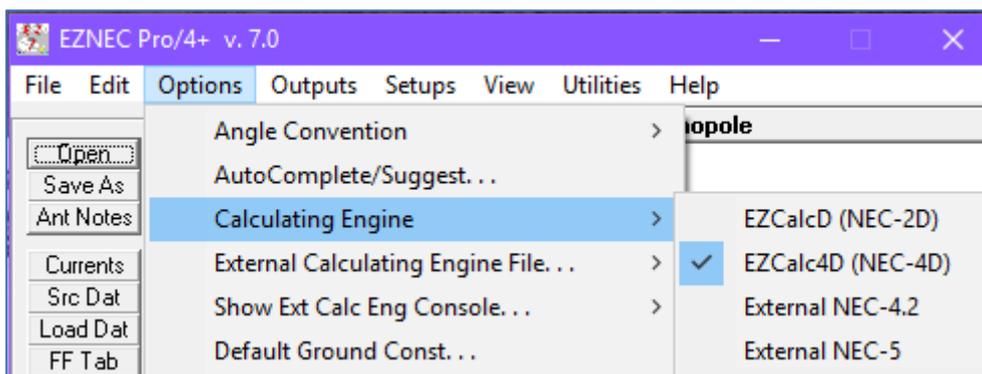
Figure 14. *Choosing a calculation engine with EZNEC Pro/4 v. 7.0*

Option > External Calculating Engine File - This allows you to choose the location and name of external NEC-4.2 and NEC-5 calculating engine executable (.exe) files.

Option > Show Ext Calc Eng Console - The "command line" or "console" type programs used as external calculating engines by EZNEC display a black window when running. The most commonly available NEC-4.2 program

shows a few intermediate steps during the calculation process, and the NEC- 5 program shows only one. But this might be of interest in some cases. This option allows you to have the window never appear, only when not running an SWR or frequency sweep, or always. The default is never, which is recommended for most operations.

ADDITIONAL DETAILS

NEC-2

NEC-2 is readily available in the public domain as both: source code and a compiled program. It has been the primary engine used by **EZNEC** since its introduction in 1995. Because NEC-2 is the only public domain version of NEC, it is the only one freely and publicly available for **EZNEC** use. The internal **EZNEC** NEC-2 calculating engine is highly modified and much faster than the original NEC-2 programs, and it has many added features and capabilities not present in the original program.

In many cases, NEC-2 will give results virtually identical to those of NEC-4.2 and NEC-5. However, there are some notable cases where it won't. **NEC-2 can't model buried conductors** - A system of buried ground radials can only be simulated by radial wires placed just above the ground. Ground system ohmic losses can also be included in a model by using MININEC-type ground, which uses perfect ground for impedance and current calculations and adding a lumped resistive load at the ground connection point.

NEC-2 is quite sensitive to the placement of insertion objects such as sources and loads, and failure to follow guidelines sometimes can result in significant errors. Problems can also occur when segments are too short or too long compared to the wire diameter. **EZNEC** contains guideline check routines to alert you to situations where this might be a problem and can detect many cases where a problem occurs. These are discussed in detail in Placing Insertion Objects on Segments, Placing Sources On Segments, and Segmentation Check.

Potentially, the most significant limitation of NEC-2 is that it produces an error when wires of different diameters are connected together. The error is usually relatively small, but it can be very significant when it occurs in a high Q antenna such as a Yagi. Yagis made from telescoping tubing of different diameters are subject to this problem. Available in **EZNEC** is Stepped Diameter Correction, which does an excellent job of correcting this, but only for Yagis and other antennas with full-size (that is, near half-wavelength) elements and no traps or loading. Alternative methods of remedying the stepped diameter error were added at **EZNEC** v. 6.0, which do a reasonably good job of correcting some antennas with loading coils and/or traps. But the exact conditions under which the method works well are unknown, and it's not possible to predict how accurate the result will be for a given antenna. If you don't have **EZNEC Pro/4+** and the stepped diameter error is a problem for your modeling, **it's highly recommended that you purchase NEC-5 to use with EZNEC Pro/2+**. It's available from LLNL for a very reasonable price and will also allow buried conductors.

NEC-4.2

Until recently, NEC-4.2 was considered to be the most advanced modeling program of its type, and it's in extensive use in many organizations and industries worldwide. Its results have been time-tested and found to be extremely accurate except for a few well-known situations.

NEC-4.2 is subject to the same insertion object placement and some of the segment length requirements described above for NEC-2 but is almost completely free of the stepped diameter problem of NEC-2. It can still appear, but only with colossal diameter steps and not with anything resembling telescoping tubing steps. So it's an excellent calculating engine to use for all types of Yagis and other high-Q antennas, as well as all the others that NEC-2 can handle. Models can include buried wires. **EZNEC Pro/4+** includes an integral enhanced NEC-4.2 program which is much faster and has a few more capabilities than the NEC-4.2 program available from LLNL. NEC-4.2 is not public domain, and licenses are administered by LLNL. All purchasers of earlier versions of **EZNEC Pro/4** provided a copy of their LLNL NEC-4.2 license prior to the purchase, which was the condition under which **EZNEC Pro/4** was allowed to incorporate it. I will attempt to make **EZNEC Pro/4+** available to those users free of charge. But since I will no longer be available to verify that any other potential users have purchased an NEC-4.2 license from LLNL, **EZNEC Pro/4** will regretfully no longer be available, and **EZNEC Pro/4+** will not be available except to existing **EZNEC Pro/4** users. There are, however, two ways that similar capabilities can be had with **EZNEC Pro/2+**:

1. Purchase an NEC-4.2 license from LLNL. You'll receive an NEC-4.2 program which you can use as an external calculating engine with **EZNEC Pro/2+**. It will run much more slowly than the internal **EZNEC Pro/4+** calculating engine and have a few limitations (see **Figure 8** above), but results will be virtually identical.
2. **Recommended.** Purchase an NEC-5 license from LLNL and use the provided program with EZNEC Pro/2+ (or EZNEC Pro/4+). The price is very reasonable, the speed is much faster than an external NEC-4.2 program, and NEC-5 has a number of advantages over NEC-4.2 as described in the NEC-5 description below.

NEC-5

NEC-5 is the newest of the NEC programs and is structured somewhat differently in order to eliminate some of the limitations, restrictions, and peculiarities of NEC-4.2. From all evidence, it succeeded very well. Like NEC-4.2, its licensing is administered by LLNL, but they generously decided to make it much less expensive, easily within reach of the average amateur. The "console" or "command line" program that comes with purchasing a license can be directly used as a calculating engine by **EZNEC Pro/2+** or **EZNEC Pro/4+**. The calculating speed isn't as great as EZNEC Pro+ integral NEC-2 or NEC-4.2 calculating engines, but it's much faster than an external NEC-4.2 program. **I highly recommend it for all but the most casual EZNEC Pro+ users.**

NEC-5 models can include buried conductors, it's almost completely insensitive to insertion object placement or segment length (except that segments shouldn't be

too long), and such things as the need to align segment junctions on closely spaced wires as in NEC-2 and -4.2. Both NEC-2 and NEC-4.2 have limits on the minimum sized loop that can accurately be modeled. NEC-5's minimum size is between those of NEC-2 and NEC-4.2. Other, usually minor disadvantages are:

- It requires more segments than NEC-2 or -4.2 to converge on an entirely accurate result fully.
- It cannot model wire insulation or more than one ground medium.
- It cannot use Real, High-Accuracy ground but only the potentially much slower (but more accurate) Extended-Accuracy ground.
- Insertion objects are placed at segment junctions rather than segment centers, which requires modification of some existing **EZNEC** models, and a learning curve for people familiar with **EZNEC** or other NEC-2 or -4 based programs. The NEC-5 Object Placement topic describes this in more detail.

The originally issued NEC-5 contained a number of bugs, some of which would affect results when used with **EZNEC Pro+**. LLNL is now making available a version that has had those fixed and allowing no-cost updates to that version from the original. At the time of this writing, the modified version is called NEC5 X11. You should obtain and use the updated version with **EZNEC Pro+**.

NEC-5 Object Placement

The question is, how seamless is the difference in source placement between NEC-2 and Nec-5?

The easiest way to answer that is with a simple dipole model. To put a source in the center of a wire with NEC-2 or NEC-4 requires that the wire have an **odd** number of segments. With NEC-5, an **even** number of segments should be used. EZNEC Pro/2+ and Pro/4+ will **not** automatically change the number of segments in a wire or wires. Although that seems simple for simple models, doing so could lead to all kinds of confusion.

However, the new Pro/2+ and Pro/4+ programs will automatically change the **View Ant** window when the engine choice is changed. Below is a dipole with 11 segments. On the top, when an NEC-2 or -4 engine is active, the source icon is centered in a segment. In the middle, the engine choice has been changed to NEC-5. The source icon has been automatically and effectively moved to a segment junction with the **View Ant** window still open. On the bottom, with the engine choice still using NEC-5 but the segment number changed to 10 (an even number) – **Figure 15**.

This can simplify certain models, such as an inverted vee, where a source can be placed directly at the apex rather than using a "split source" to simulate this placement. It's also possible with NEC-5 to place a source, load, or another object at the very bottom of a vertical antenna.
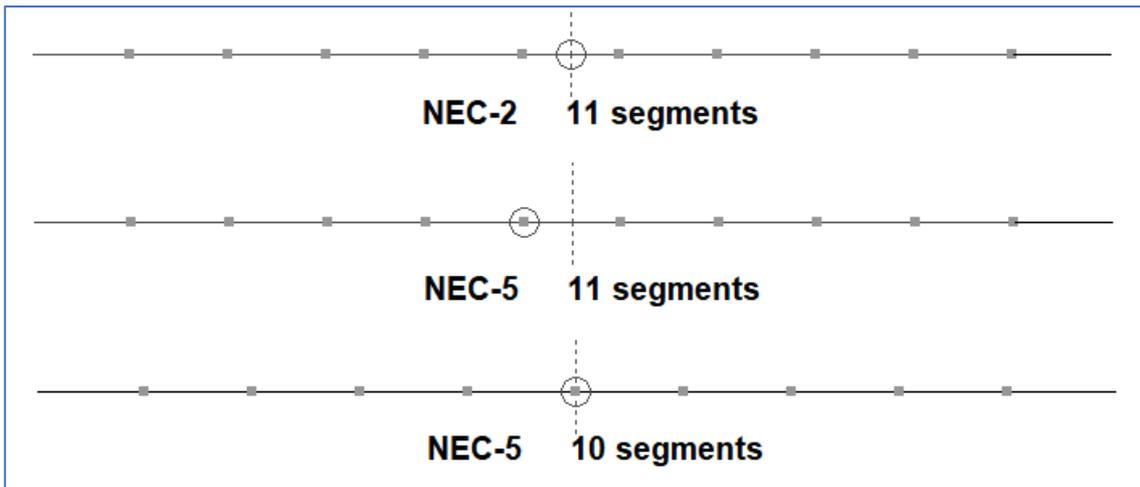
Figure 15. *The source placements with NEC-2 and Nec-5 and different segment numbers.*

Another question – **Figure 16**? Does this mean that "virtual" segments (V1 - V999) used as invisible placeholders for "insertion objects" cannot be used when running NEC5?

No, the contrary. Any .ez or .nec model using virtual wires will be accepted when using the NEC-5 engine.

Or does it mean that using a real, very short, 1-segment wire for the same purpose as a virtual segment doesn't work with NEC5?

Feature	Calculating Engine			
	EZCalcD (NEC-2D)	EZCalc4D (NEC-4D)	External NEC-4.2	External NEC-5
Unconnected 1-seg wires with insertion objects	✓	✓	✓	

Figure 16.

With NEC-5, all insertion objects are placed at segment junctions. A 1-segment wire that is not attached to any other wires has no segment junctions, so it cannot be used to hold insertion objects. Two very short 1-segment wires should be needed. However, Suppose a model file (.ez or .nec format) with an unconnected 1-segment "placeholder wire" is opened with Pro/2+ or Pro/4+ while NEC-5 is the active engine. In that case, that wire will be automatically converted to a virtual segment – **Figure 17**.
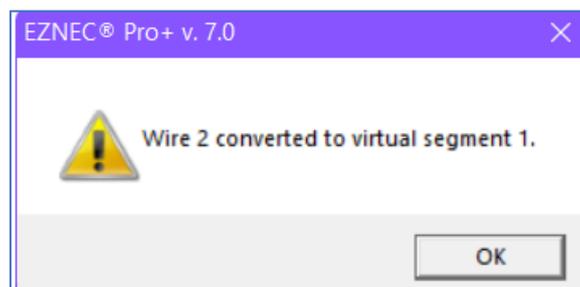

Figure 17. *When clicking OK, a short 1-segment real wire shall be automatically converted to a virtual segment.*

Let's look at the impedance and gain results computed with the different engines – **Table 1**. However, **take always care** to use an **even segment number** when using the **Ext. NEC-5 engine**.

Engine	Impedance R ± jX Ω	Gain dBi
NEC-2D	69.23 +0.04	7.30
NEC-4D	70.13 +0.00	7.25
Ext. NEC-4	70.13 +0.04	7.25
Ext. NEC-5 (11 seg.)	71.07 0.00	7.27
Ext. NEC-5 (10 seg.)	69.62 0.00	7.28

Table 1. *Impedance and gain of a 20-meter dipole 1/2 wavelength above average ground quality. The antenna was trimmed to resonance on 14.175 MHz for each engine case.*

The results shown in **Table 1** are computed using the conservative segment number of 20 seg./wavelength. But, to ensure that the results are correct, we need a convergence test (using a higher segment number). The three **Figures 18** to **20** are plots of using segment numbers from 20 to 400 with steps of 10. The plot curves show that the NEC-5 engine is susceptible to the segment per wavelength. Even for this simple dipole antenna, we need a minimal segment number of 100 to 150 to reach convergence.
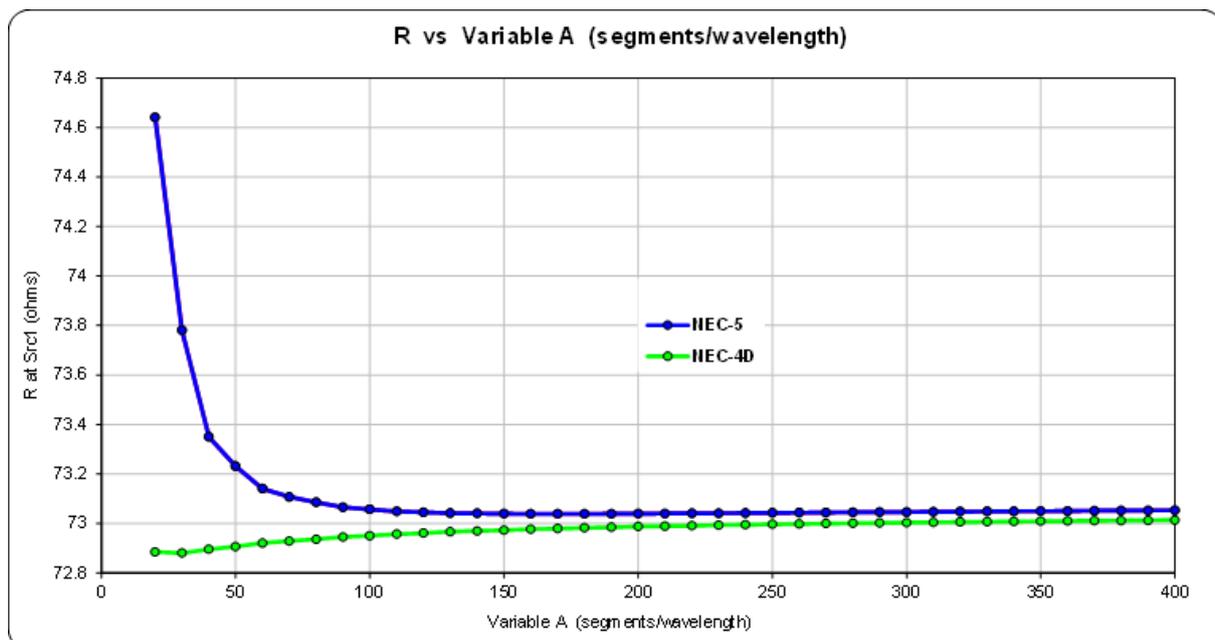

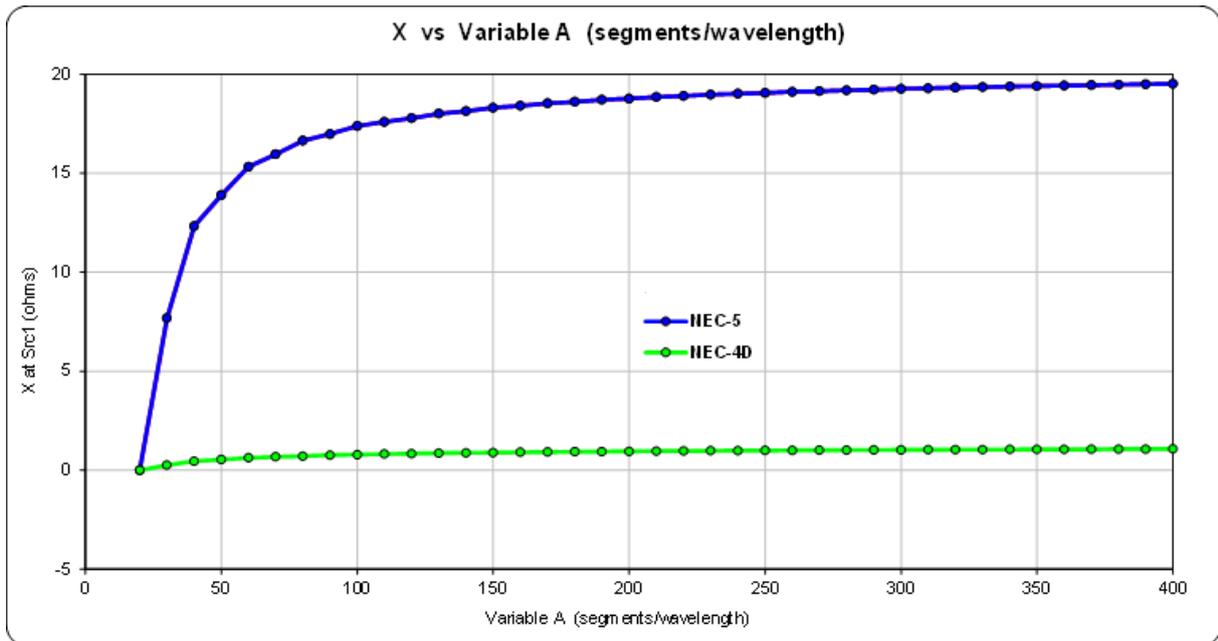**Figure 18.** *The impedance resistance plot using increasing segment numbers.*

Figure 19. *The impedance reactance (jX) plot using increasing segment numbers.*
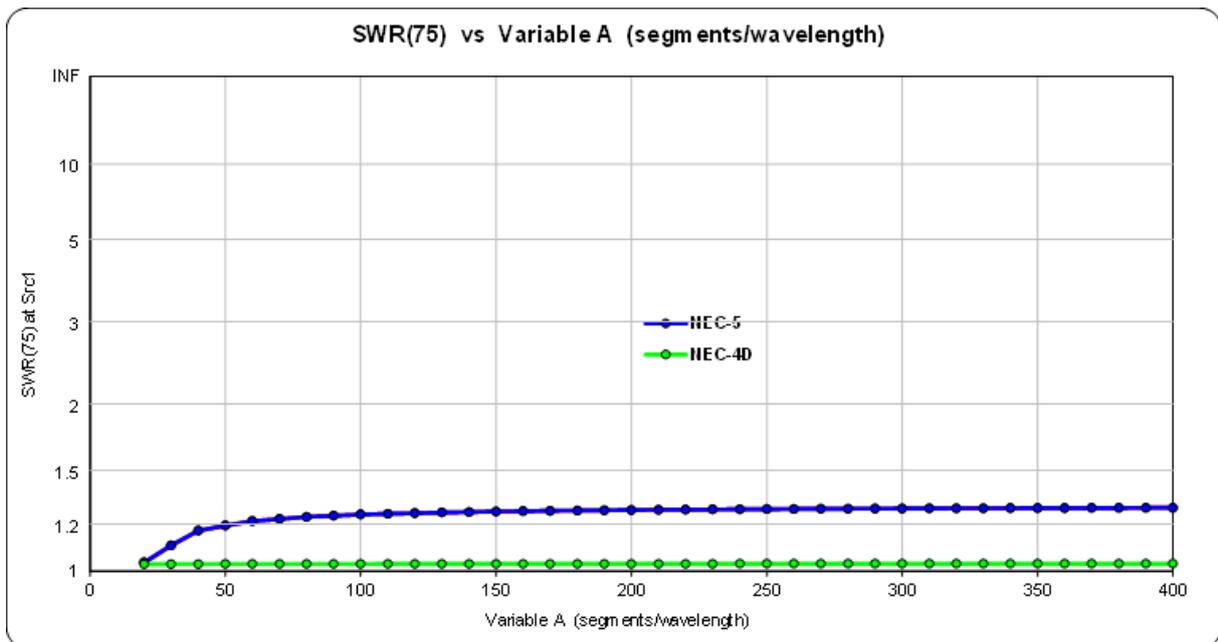

Figure 20. *The SWR-75 plot using increasing segment numbers.*

Note: the above plots are computed with **AutoEZ.**
Click here for the accompanying model files.

Using EZNZC Pro v. 7.0 is often discussed in the QRZ Forum

https://forums.qrz.com/index.php?threads/eznec-pro-2-and-eznec-pro-4-v-7-0.794085/page-4#post-6088392

This info-article will be continued with more extras soon. Stay informed.