

# User Guide for YagiQ antenna calculator

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**YagiQ** is MS Excel spread sheet for antenna **Q factor** <sup>(8,9)</sup> and **Figure Of Merit (FOM)** calculation. These figures are calculated by using and combining **idealized** performances of antenna (Gain, Input Impedance, SWR and Antenna Noise Temperature) that are simulated in antenna software. **Q** and **M** factors are averaged over **144...146 MHz** band. Antenna Figure of Merit is calculated according to formula:

$$M = 10 * \log ( G/T + G/(1+Q) + G/SWR ) \text{ [dB]}$$

where are:

**M = antenna overall, real, figure of merit**, given in dB.

**G = antenna gain**, given as pure numbers (**not in dB!**).

**T = real, average, equivalent, antenna noise temperature** given i Kelvin.

**Q = antenna radiation quality factor**

**SWR = antenna match**, given as voltage standing wave ratio (VSWR) on antenna feeder.

**YagiQ** can be used as additional post processing software together with **4nec2** <sup>(6)</sup>, **Eznec** and other similar programs for antenna simulations which can export data in .txt , space (tab) separated values, or similar format.

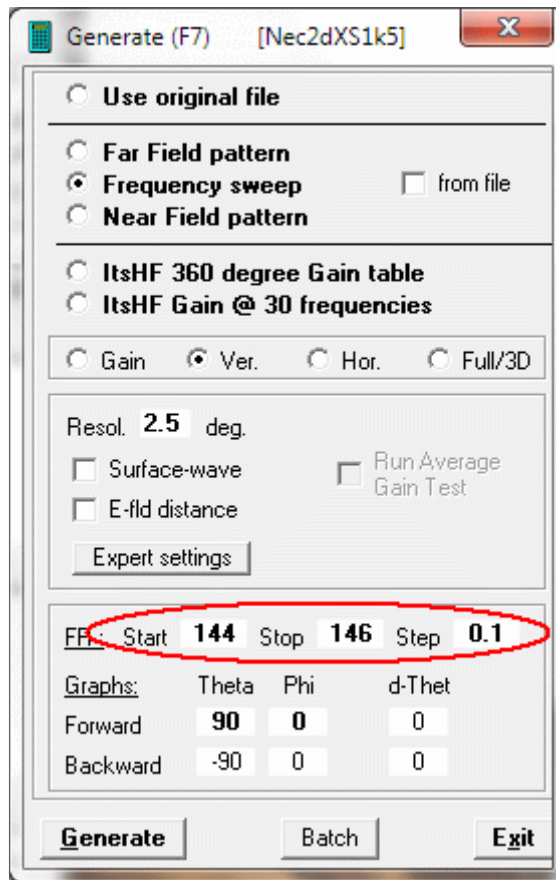
FOM of antenna is defined as figure that shows **overall** performances of antenna, including its Q-factor as measure of **antenna sensitivity** to real, practical environment impact, such as rain, ice, snow, fog, other antennas and constructions in its vicinity. <sup>(1, 2, 3)</sup>

**Higher the average F.O.M. value means better overall performances of antenna.**  
**Lower Q factor of antenna gives less sensitive antenna to environmental impacts.**  
**Less difference of antenna Q and M factors for dry and wet antenna show more antenna performance stability under environmental influences in practice.**

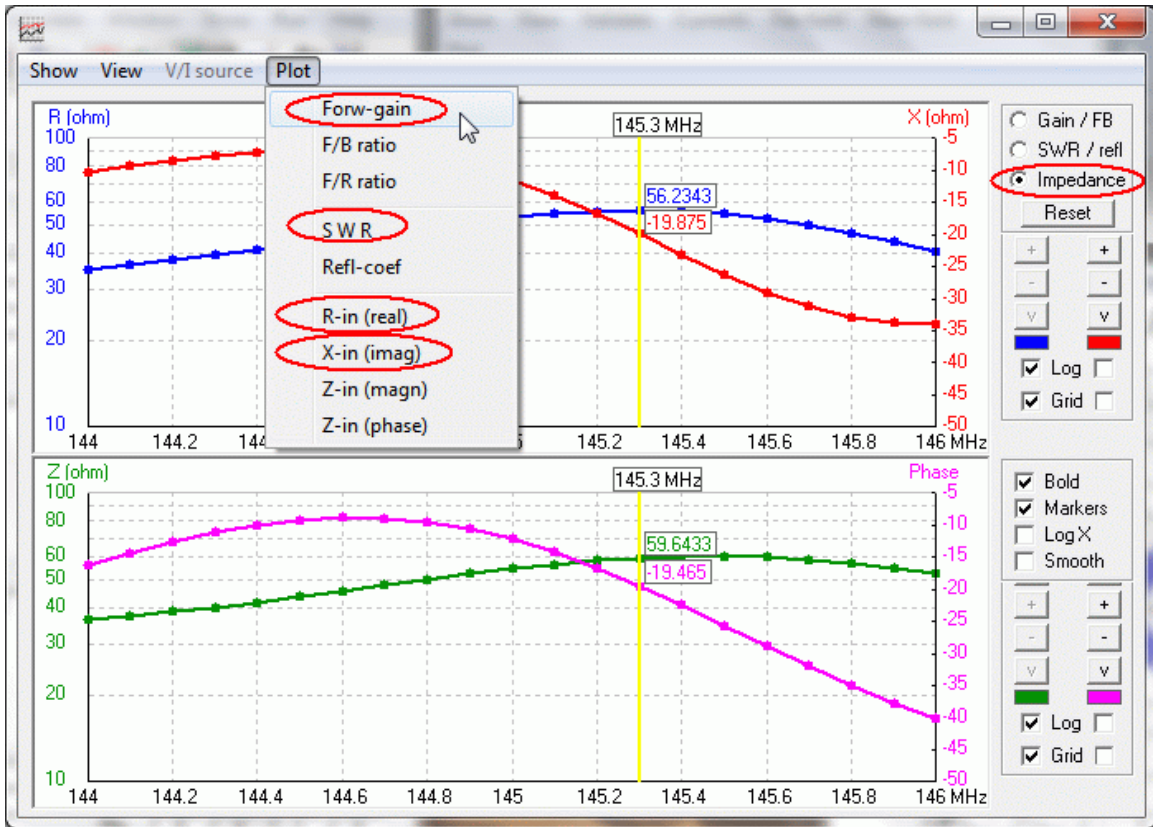
Program also calculates **Specific M** that is average **M** divided by wavelength. This number shows how much antenna quality is “squeezed” per wavelength of boom length. **Higher Specific M for same antenna length means better antenna!** General trend of **Specific M** is to decrease with boom length that means fewer amount of decibels per wavelength can be attained from longer antennas. However, when we compare antennas with same or similar boom length difference in antenna quality clearly is visible. Numbers in brackets added to the end of some antenna names denotes impedance at which simulation program was set up during antenna simulations, because this antenna has some impedance matching device, impedance transformation balun, etc. Program is bilingual in Serbian and English.

How to use program:

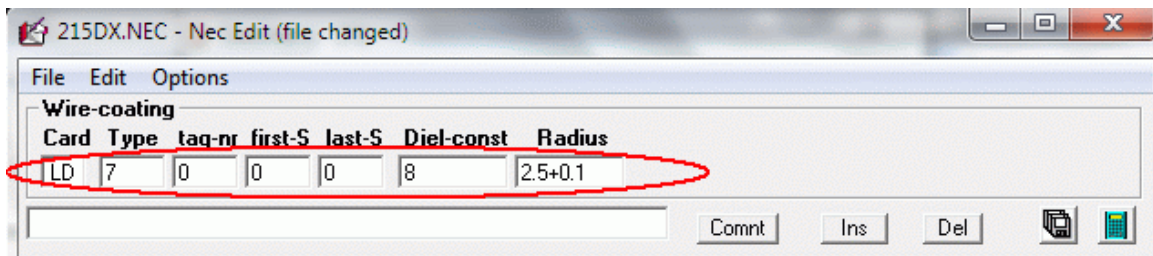
1. In simulation software, for instance **4nec2**, simulate antenna in frequency band **144 ... 146 MHz** with **0.1 MHz** step. Free **4nec2** program can **convert Eznec .ez** files to **.nec** files that can be used for mentioned simulation.

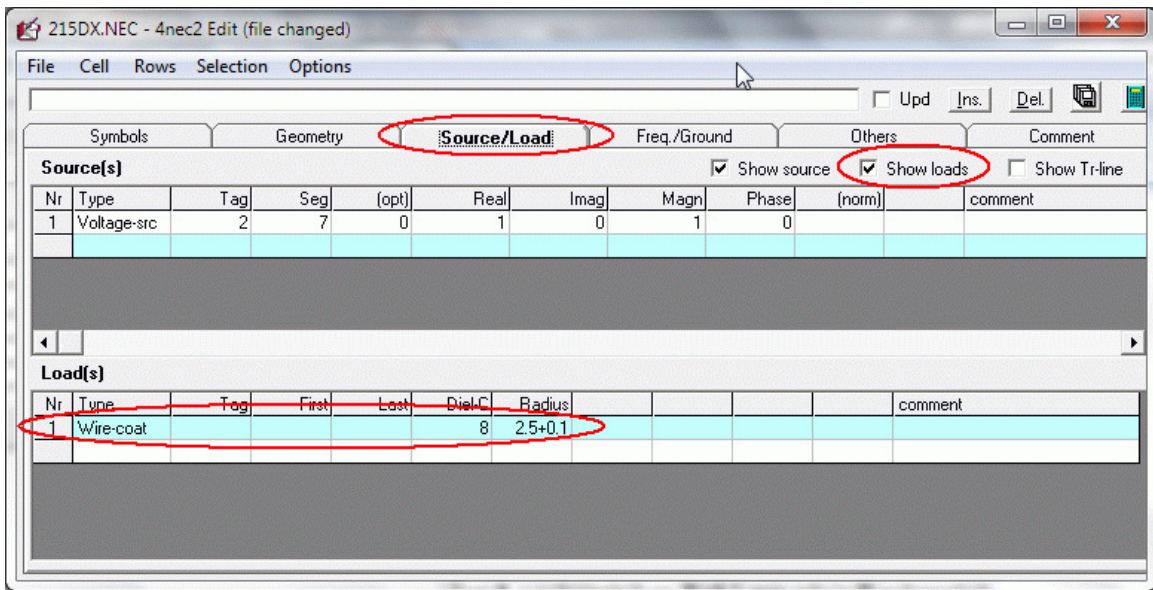


2. Save calculated values for **Gain**, **SWR**, real (**R**) and imaginary (**X**) part of input impedance in files with corresponding names and **.TXT** extension.



- It would be possible to predict, with rather good probability, how antenna will behaves under **wet weather** conditions that give you insight into the sensitivity of antenna **to real ambient influences**. This can be accomplished by antenna simulation with elements that have water on its surface (**Wire-coating**) using NEC editor and LD7 card. Value for **Relative Dielectric Permittivity (Er)** of wire coating material “water foam” (water and air mixture) should be **8** (eight) and radius **R+0.1 mm**, where **R** is radius of **bare** metal element. This gives 0.1 mm wire coating to **all** elements with radius **R**, which approximately corresponds to wet elements under rain weather conditions. If antenna has many different radiuses of elements, **each** element has to get its LD7 card with corresponding radius and 0.1 mm of wire coating.<sup>(1, 2, 3)</sup> If only one element, for instance driving dipole, has different radius, then in **first** LD7 card set all antenna elements on same radius (tag-nr = 0) and then, in **second** LD7 card, set different radius **only** to driving dipole. After accomplishing this task save calculated values on the similar way as it has done for dry antenna in paragraph 2.



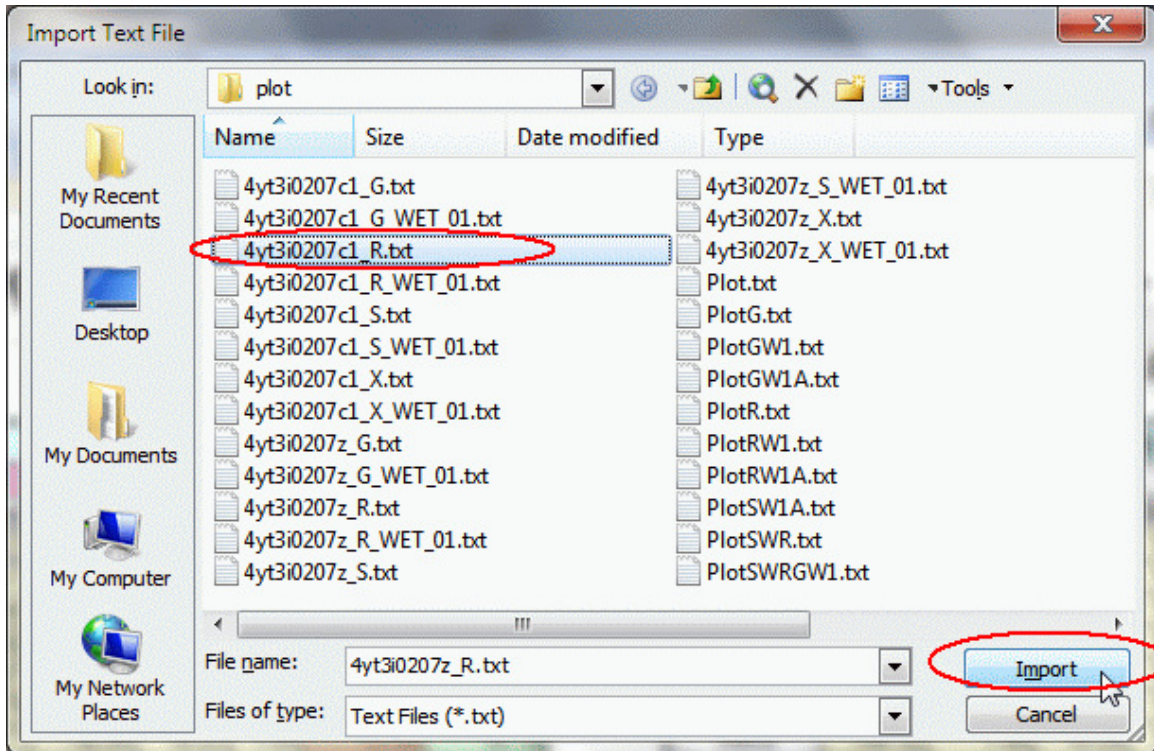


4. In Excel program, after the start up, allow using macros (click **Enable Macros**).

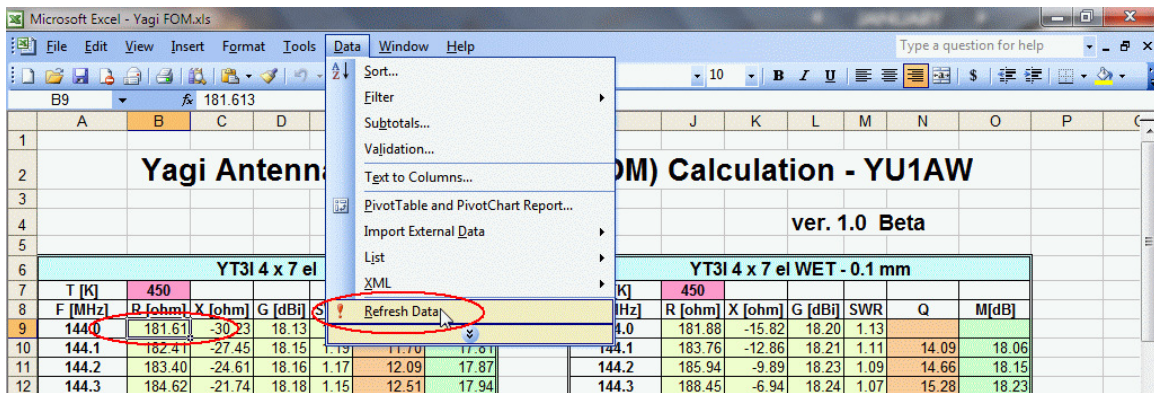
**First Step:** Antenna name, Boom Length (given in mm) and possible Antenna Noise Temperature should be edited manually in corresponding fields.

**Secon Step: Automatic** input of new data is possible with command **Ctrl + a**, for dry and wet antenna. In window that appears choose corresponding file and click **Import**.

Do the same for all columns: **R**, **X**, **G** and **SWR**. Be careful to **not** mix data. After you finish loading new data in all columns, **Q** factor and **FOM** are automatically calculated and corresponding diagrams are drown.



(The same is possible to do **manually**: with mouse left click activate first cell of column in which will be loaded new data from corresponding file you prepared in previous step. After that open **Data** menu and click **Refresh Data**, see next picture).



- Antenna Noise Temperature  $T_a$  can be calculated with program **TANT** written by Siniša, **YT1NT**<sup>(7)</sup>. It is **highly recommended** that for Sky Noise Temperature you instead of **unreal** (absolute minimum valid for only one point on the sky) use far more **real** average temperature of galactic sky noise on **144 MHz** and change to **Sky Temperature = 400 K**. For **Earth Temperature** you can leave **1000 K**, which means some **urban noise** is included.

Default value  $T_a=450$  K is estimated usual **real** value for Yagi antennas on 144 MHz band in relatively quiet rural locations.<sup>(4, 5, 10)</sup> It can be easily edited according to new value calculated for particular antenna.

```

C:\Users\dragan\AppData\Local\Temp\Rar$EX02.176\Tant.exe
TANT 1.2 <April 23, 2006> by Sinisa YT1NT VE3EA
Computes Antenna Temperature and G/T Ratio
for elevations from 0 to 90 degrees in steps of 5 degrees.
(Uniform Sky and Earth temperatures assumed.)

Please Select:
1. Far Field Pattern file = 3D.txt
2. Sky Temperature [K] = 400.00
3. Earth Temperature [K] = 1000.00
4. Compute
5. Help
6. Quit

Only 8+3 DOS filenames can be used.

Please select option 1-6.

```

6. After finishing loading data for dry and wet antenna you can copy and sort results into FOM table for comparison with other antennas, using **Ctrl + m** command.
7. If you want to copy data and diagrams of antenna in **new Excel sheet** you can do this with **Ctrl + c** command. FOM table can be copied with **Ctrl + t** and diagrams with **Ctrl + d** command. With **Control + e** command selected data in FOM table will be **erased**. Please **don't erase rank** numbers. If mistakenly erased it has to be written manually. After data erasing use **Control + u** command to **sort table** data again.

**For more thorough explanation of method used in this program please read given References!**

**It is very important that all antennas should be compared under the same conditions!**

**YagiQ** is written in **Excel 2003**, and should work in all other versions of MS Excel™. It is **Beta version** and I ask all users to send me remarks and suggestions on my e-mail address. It would be appreciated and it will help me improve YagiQ. It can be used for any type of antenna in the same way. Program is under freeware license and can be distributed for free in its original integral form without limitations.

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[www.qsl.net/yu1aw](http://www.qsl.net/yu1aw)

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**YagiQ Free Download:** <http://www.qsl.net/yu1aw/Misc/YagiQ.zip>

## Reference:

1. Antenna Q factor: [http://www.qsl.net/yu1aw/Misc/yagi\\_q\\_factor.pdf](http://www.qsl.net/yu1aw/Misc/yagi_q_factor.pdf)
2. Old and new antennas: [http://www.qsl.net/yu1aw/Misc/yagi\\_old.pdf](http://www.qsl.net/yu1aw/Misc/yagi_old.pdf)
3. Antenna sensitivity: [http://www.qsl.net/yu1aw/Misc/yagi\\_sens\\_pract.pdf](http://www.qsl.net/yu1aw/Misc/yagi_sens_pract.pdf)
4. VHF Antenna Noise Temp: <http://www.qsl.net/yu1aw/Misc/vhfnoisetemp.pdf>
5. Ant. Noise Temp.: [http://www.qsl.net/yu1aw/Misc/coax\\_influ\\_noise\\_temp.pdf](http://www.qsl.net/yu1aw/Misc/coax_influ_noise_temp.pdf)
6. 4nec2 : <http://home.ict.nl/~arivoors>
7. TANT: [http://www.dual.rs/yu1cf/razno/news/news\\_item.asp?NewsID=6](http://www.dual.rs/yu1cf/razno/news/news_item.asp?NewsID=6)
8. A.D. Yaghjian and S.R. Best, “**Impedance, bandwidth, and Q of antennas**”, *IEEE Transactions on Antenna and Propagation*, vol.AP-53, April 2005, pp 1298-1324.
9. Small Antennas, Chapter 1, J. Chalas, K. Fujimoto, J. L. Volakis, and K. Sertel, “**Survey of Small Antenna Theory**”, pp 68-74, 102-103.
10. D. Dobričić, “**Determining the Parameters of a Receive System in Conjunction with Cosmic Radio Sources**”  
<http://www.qsl.net/yu1aw/Misc/CosmV.pdf>