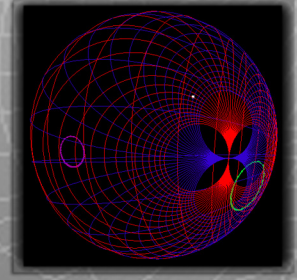
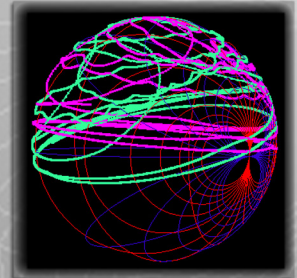
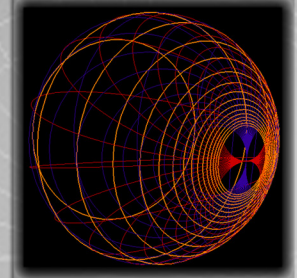
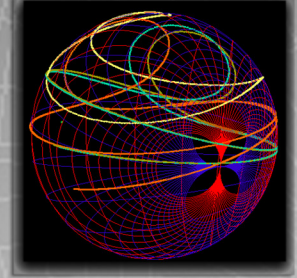
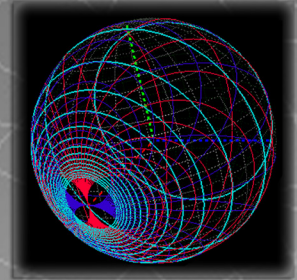
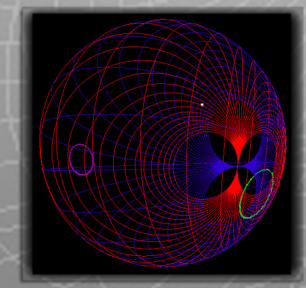
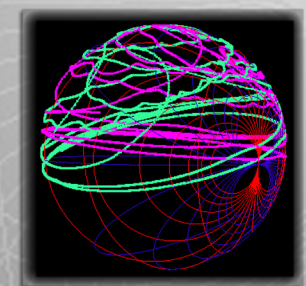
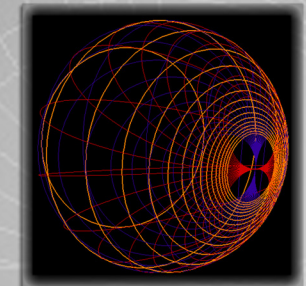
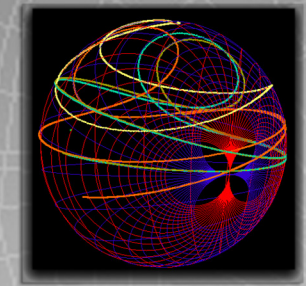
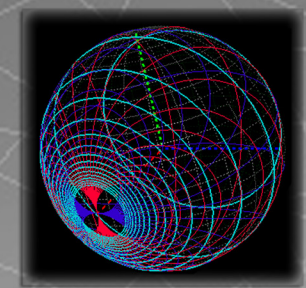
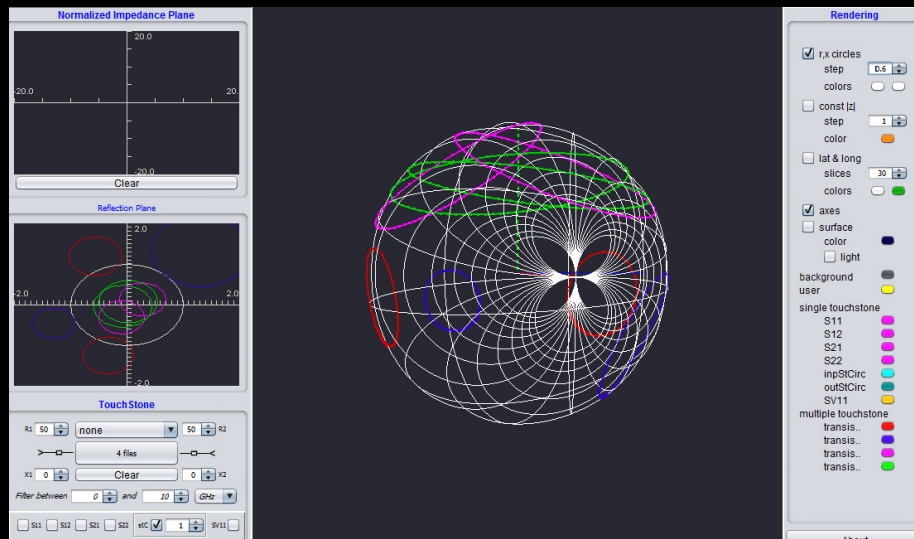
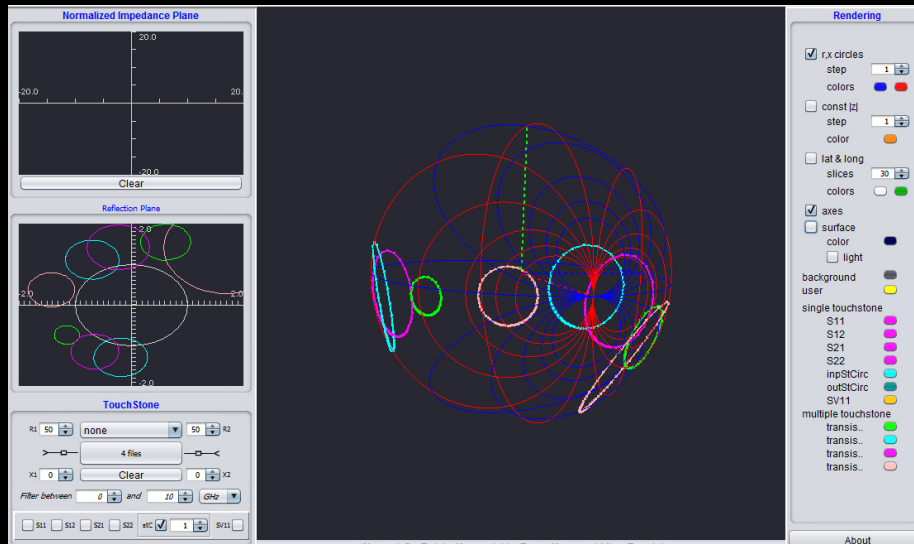


[www.3dsmithchart.com](http://www.3dsmithchart.com)





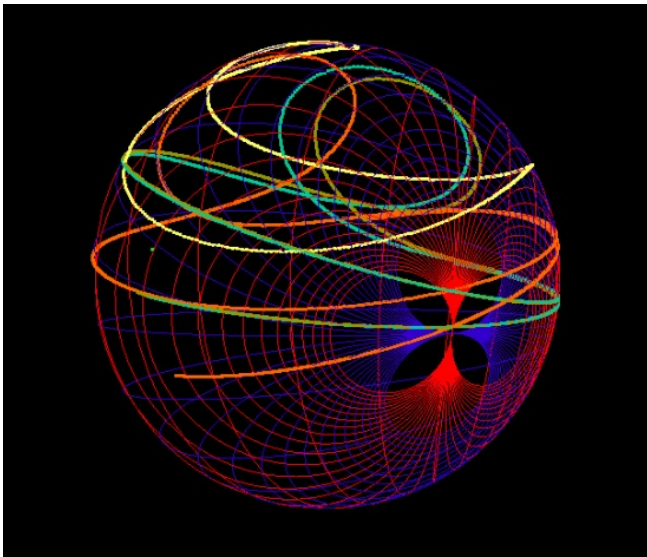
# The first 3D Smith Chart Program

for active and passive microwave circuits

(a Java tool for Windows, Mac and Linux)

# Concept

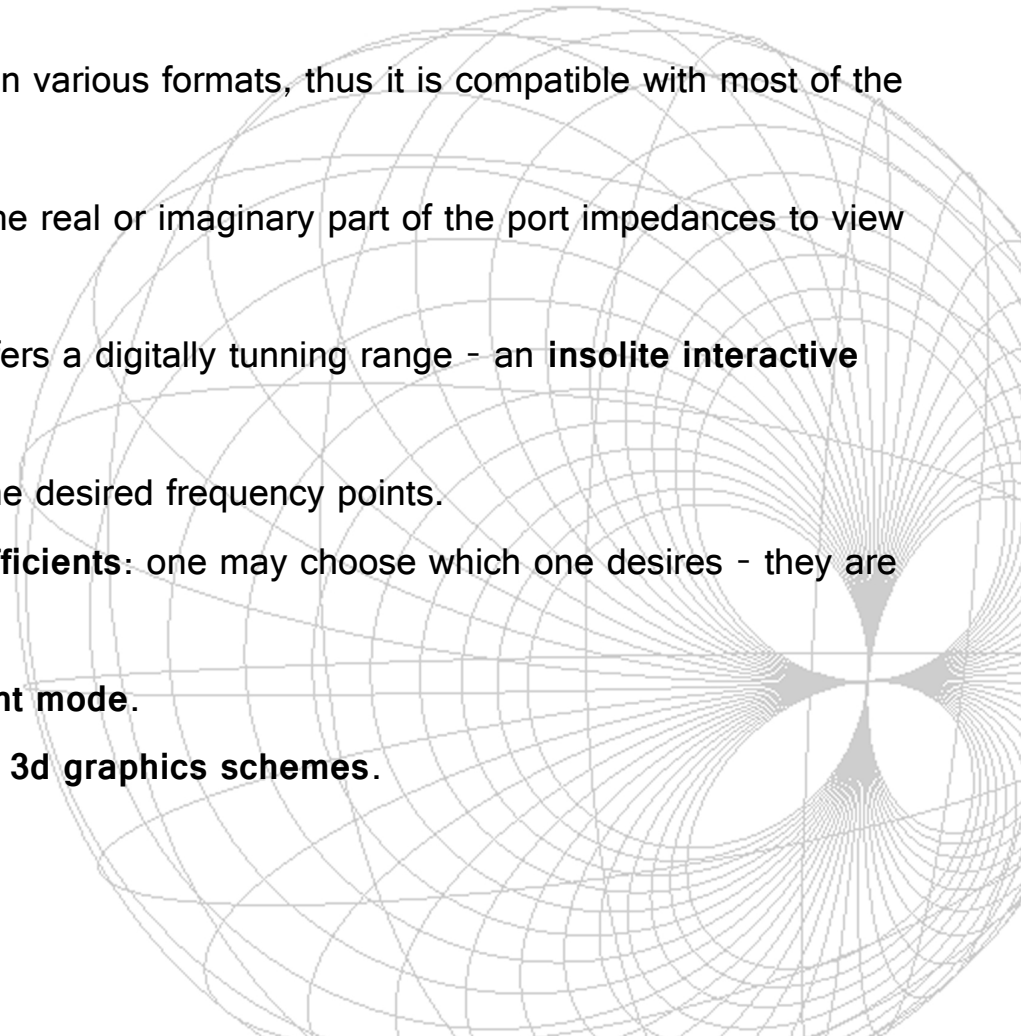
The **3D Smith Chart** is a new 3D Java telecommunications design tool with applications mainly in high frequency engineering. It uses the innovative **3D Smith Chart** concept proposed in 2011-2013[1-5] which generalizes the Smith Chart on the surface of the unit ball:



- The North hemisphere (the surface) embodies **the classical Smith chart**, the South hemisphere (the surface), **all negative resistance circuits**.
- The East hemisphere embodies **all inductive circuits**.
- The West hemisphere embodies **all capacitive circuits**.
- Along a latitude the magnitude of the reflection coefficient is constant.
- Along a longitude ( meridian) the phase of the reflection coefficient is constant.
- The North Pole is the perfect matching point while the South pole represents the infinite mismatch.

# Features

- **Didactical mode:** one can draw impedances paths in the impedance plane and see their reflection coefficients in 2D and on the **3D Smith Chart**.
- **Measurement & design** - can read touchstone (s2p) files in various formats, thus it is compatible with most of the microwave design and measurements tools.
- **Works with complex port impedances:** one may change the real or imaginary part of the port impedances to view the reflection coefficients
- **Plots the S11, S21, S12, S22,** reflection coefficients and offers a digitally tuning range - an **insolite interactive sweeping range facility**.
- **Plots stability circles** - input and output stability circles at the desired frequency points.
- **Computes the power wave and the voltage reflection coefficients:** one may choose which one desires - they are the same for real ports but different for complex matching.
- **Offers an impedance plane mode or a reflection coefficient mode.**
- **Uses reconfigurable graphical characteristics, zooms and 3d graphics schemes.**



# Advantages

The tool aims to be a unique graphical aid for the measurement and design of all microwave circuits.

- **Complete tool:**

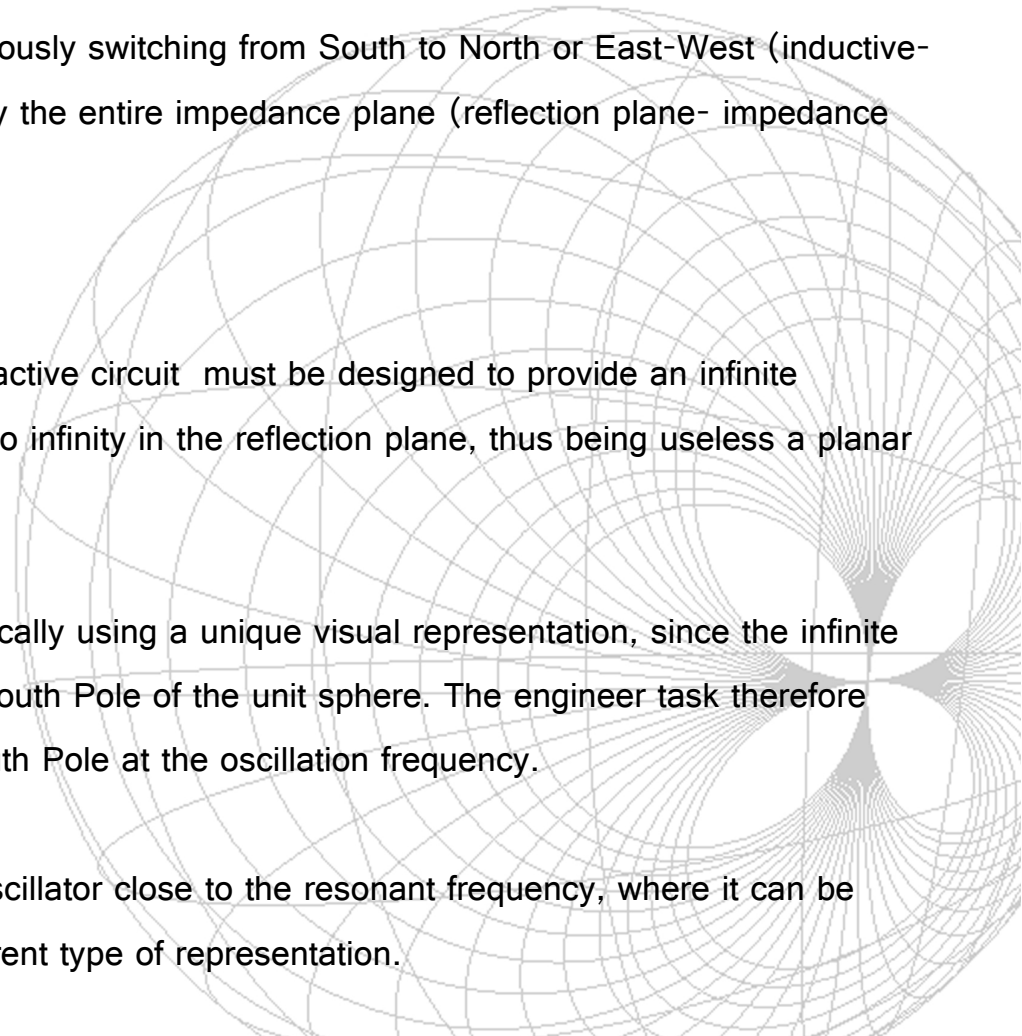
It can deal with active and passive microwave circuits simultaneously switching from South to North or East-West (inductive-capacitive). One can rotate the **3D Smith Chart** and see directly the entire impedance plane (reflection plane- impedance plane handy switching).

- **Oscillator design:**

To obtain an oscillator at a specified frequency, the microwave active circuit must be designed to provide an infinite reflection coefficient at such a frequency. This requires moving to infinity in the reflection plane, thus being useless a planar Smith chart representation.

The **3D Smith Chart** allows solving this type of problems graphically using a unique visual representation, since the infinite mismatch point is placed in a bounded and finite position: the South Pole of the unit sphere. The engineer task therefore consists in designing the circuit to put the impedance in the South Pole at the oscillation frequency.

The 2D Smith chart is incapable to plot the impedance of the oscillator close to the resonant frequency, where it can be successfully plotted in the **3D Smith Chart** without using a different type of representation.



# Advantages

- **Amplifier stability analysis:**

One of the applications that reveals the limitations of the planar Smith chart and the advantages of the **3D Smith Chart** is the stability analysis of microwave amplifiers.

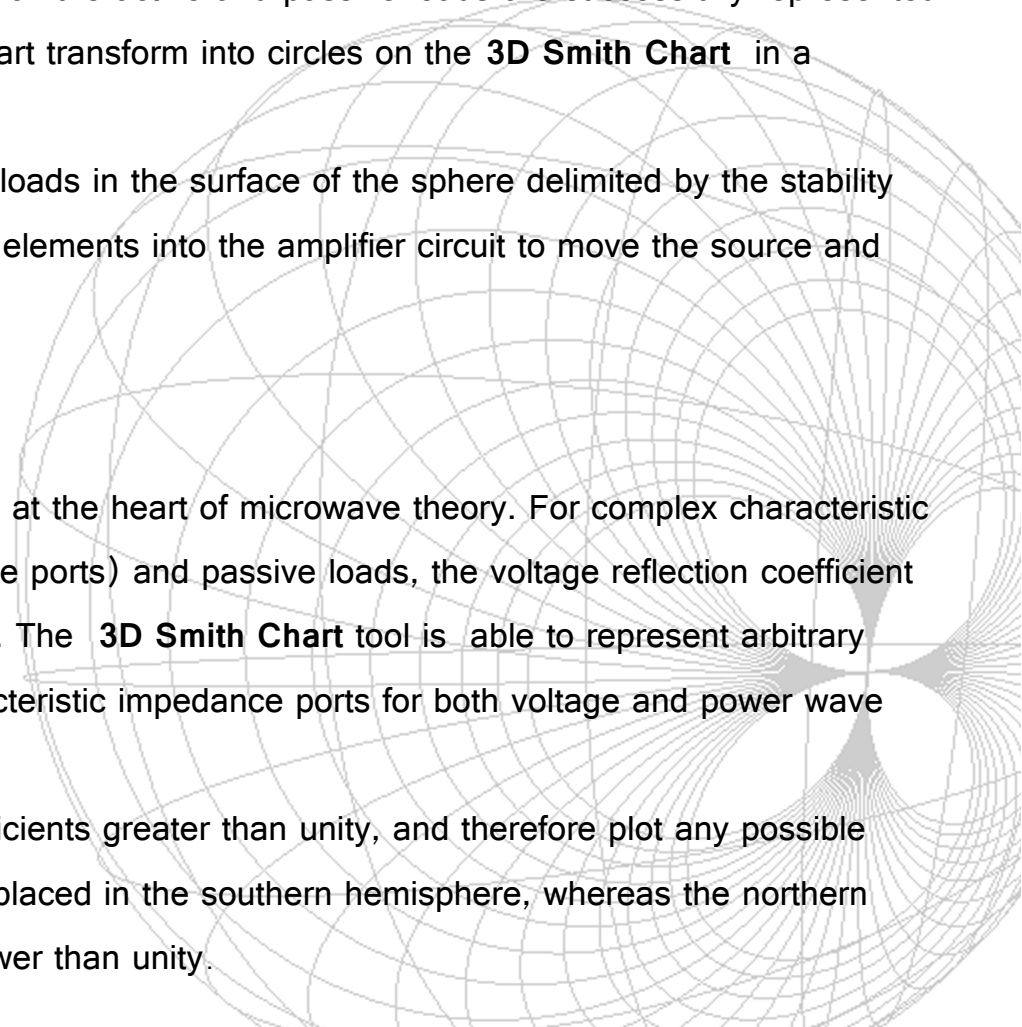
The **3D Smith Chart** does not require any type of scaling, since all the active and passive loads are successfully represented in a bounded surface, the stability circles in the planar Smith chart transform into circles on the **3D Smith Chart** in a compact manner.

The instability regions in the **3D Smith Chart** correspond to the loads in the surface of the sphere delimited by the stability circles and not containing the North Pole. the engineer can add elements into the amplifier circuit to move the source and load instability circles to the South Hemisphere.

- **Complex impedances matchings:**

The usage of **voltage and power wave reflection** coefficients is at the heart of microwave theory. For complex characteristic impedances (i.e., lossy transmission lines or complex impedance ports) and passive loads, the voltage reflection coefficient can exceed unity without violating the of conservation of energy. The **3D Smith Chart** tool is able to represent arbitrary loads and their variation with frequency even for complex characteristic impedance ports for both voltage and power wave reflection coefficients definitions.

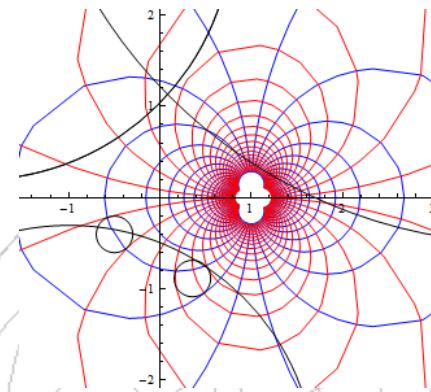
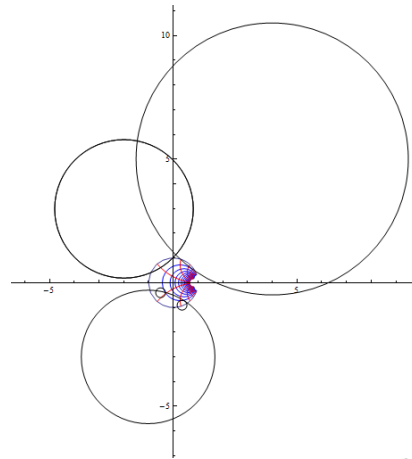
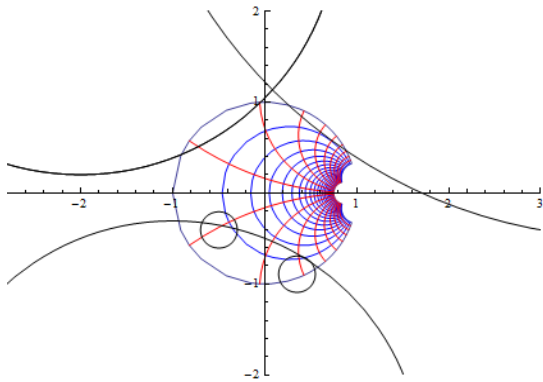
This new and compact graphic tool can illustrate reflection coefficients greater than unity, and therefore plot any possible loads. The loads whose reflection coefficients exceed unity are placed in the southern hemisphere, whereas the northern hemisphere contains all the loads with a reflection coefficient lower than unity.



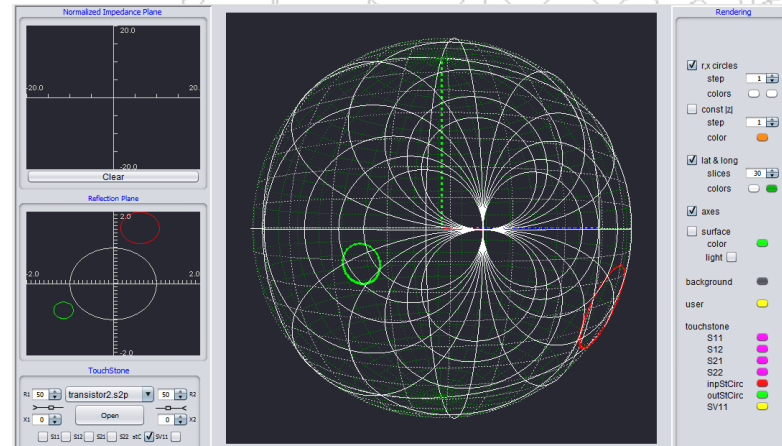
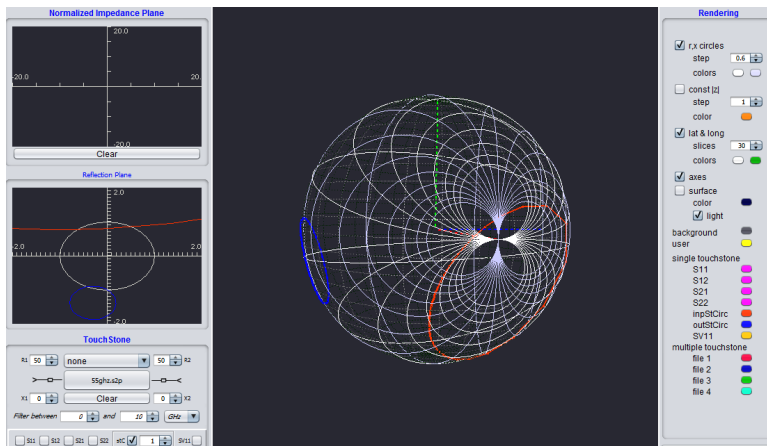
# Advantages

- **Amplifier stability circles**

2D Smith Chart limitations

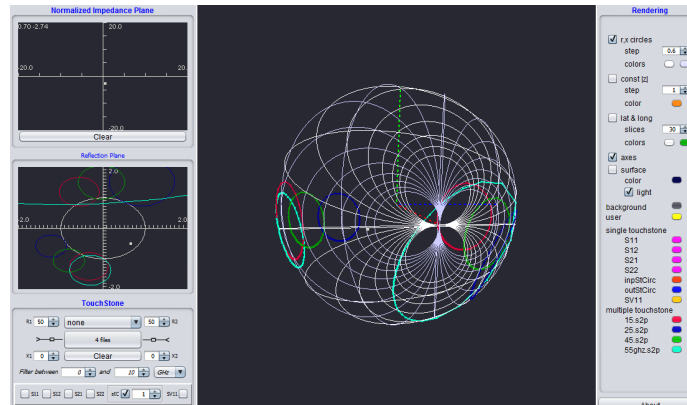
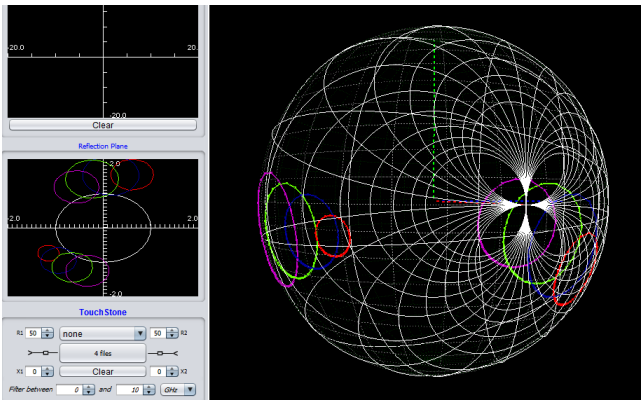


## 3D Smith Chart tool



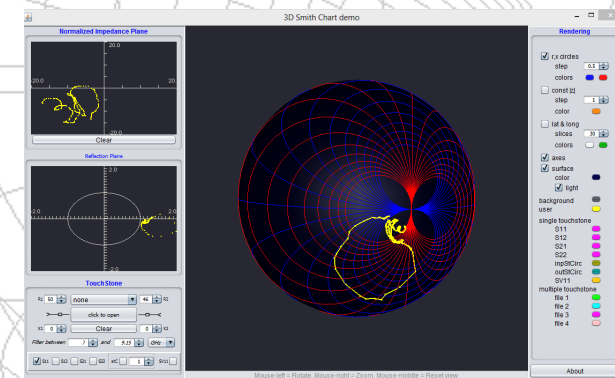
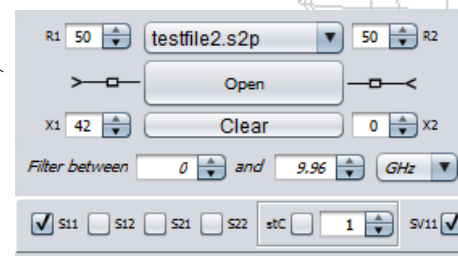
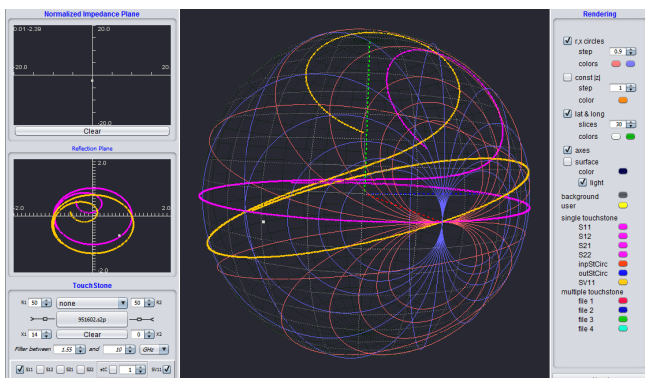
# Advantages

- Amplifier stability circles & computation of power wave and voltage reflection coefficient for complex port impedances & didactical mode



- Computes the power wave and the voltage reflection coefficients – works with complex port impedances too

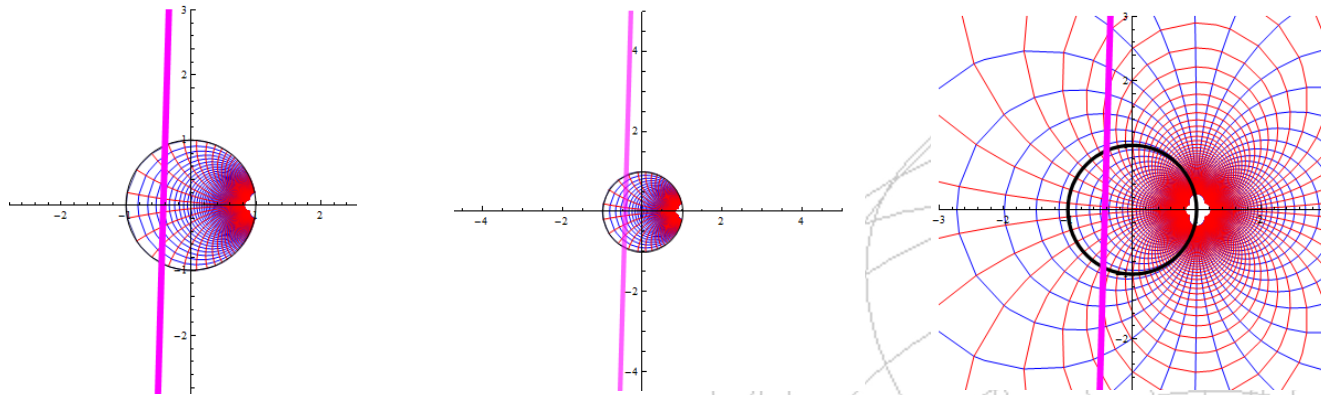
- Didactical mode-reflection coefficient of various impedances paths in the complex impedance plane



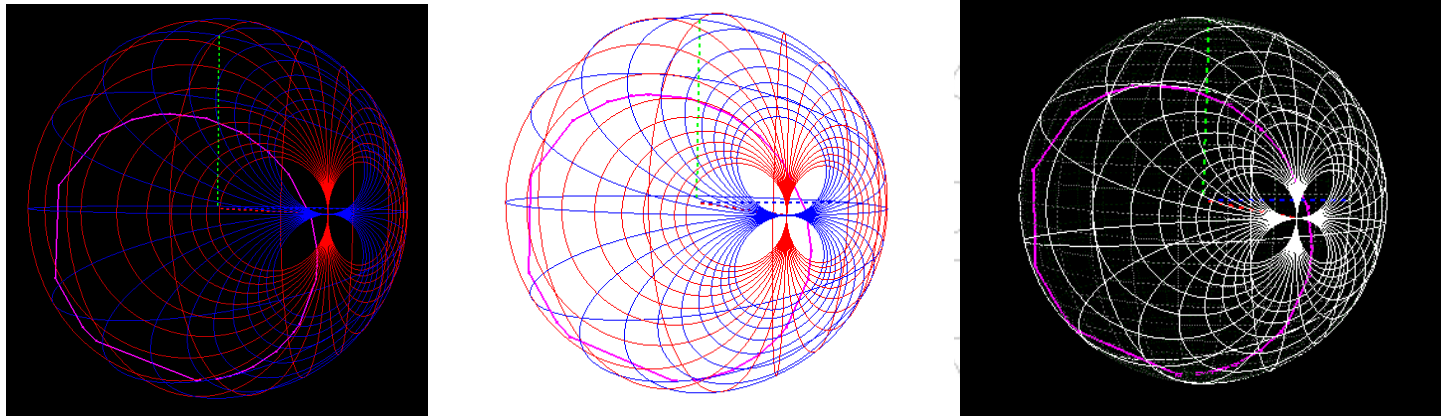
# Advantages

- Oscillator design

2D limitations



## 3D Smith Chart

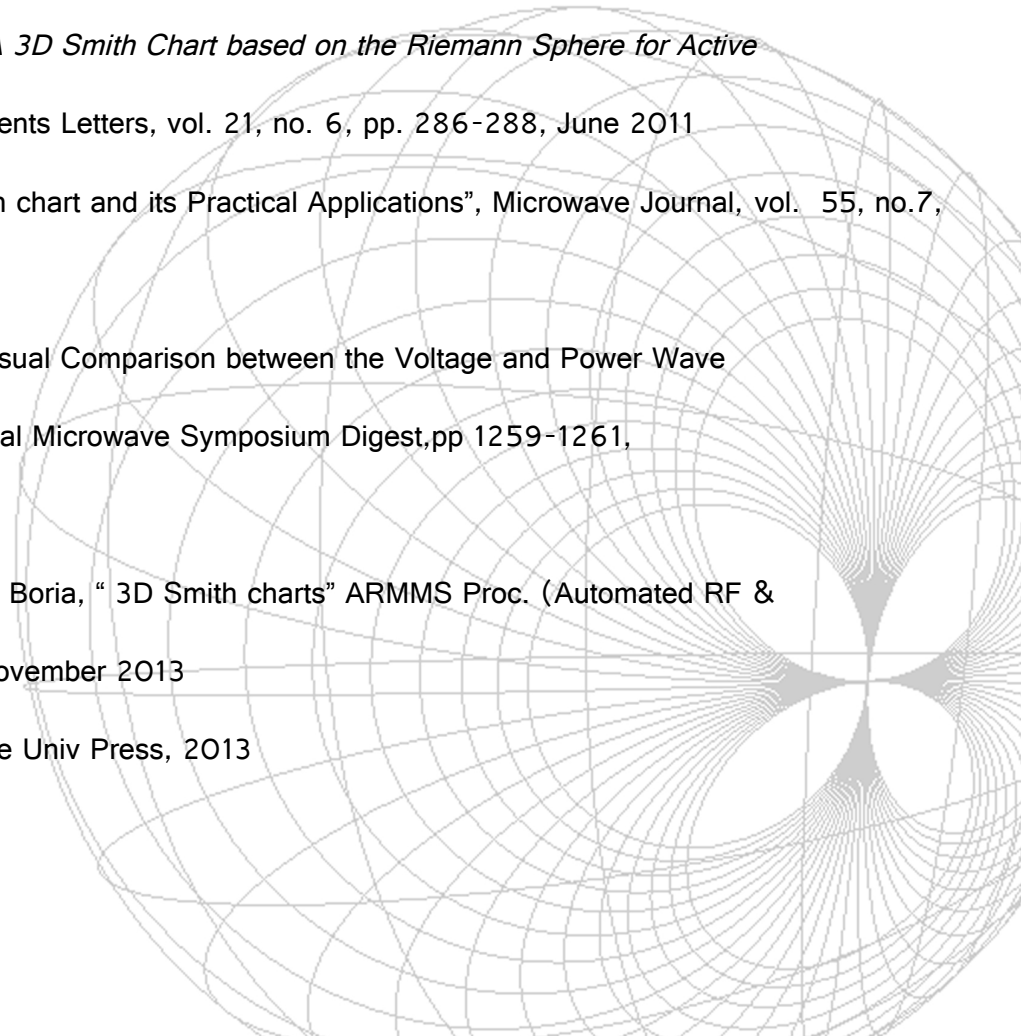


Moving towards infinite reflection coefficient cannot be visualized on a 2D Smith chart, while this becomes a simple notion of moving towards the South pole on the **3D Smith Chart**.

# Additional information

More upon the 3D Smith Chart concept can be found in the “**help file**” of the program and

- [1] Andrei.A. Muller, P. Soto, D. Dascalu, D. Neculoiu and V.E. Boria, “A 3D Smith Chart based on the Riemann Sphere for Active and Passive Microwave Circuits,” IEEE Microwave and Wireless Components Letters, vol. 21, no. 6, pp. 286-288, June 2011
- [2] Andrei.A. Muller, P. Soto, D. Dascalu, and V.E. Boria, “The 3D Smith chart and its Practical Applications”, Microwave Journal, vol. 55, no.7, July 2012 (pp64-74)
- [3] Andrei.A.Muller, P.Soto, A. Moldoveanu, V. Asavei, V.E Boria, “A Visual Comparison between the Voltage and Power Wave Reflection Coefficient of Microwave Circuits” IEEE Asia Pacific International Microwave Symposium Digest,pp 1259-1261, December 2012,Taiwan
- [4] Andrei.A.Muller, P.Soto, A. Moldoveanu, V. Asavei, E. Codesal, V.E Boria, “ 3D Smith charts” ARMMS Proc. (Automated RF & Microwave Measurement Society” (ARMMS)) England, Boston Lakes, November 2013
- [5] Book: S. Voinigescu, “High Frequency Integrated Circuits”. Cambridge Univ Press, 2013



You can visit us in our **website**:

[www.3dsmithchart.com](http://www.3dsmithchart.com)

For **price informations**, contact Carmen Sibaja Varo:

[carmen@3dsmithchart.com](mailto:carmen@3dsmithchart.com)

For **download & system requirements for tool running**, contact Cristi Burtan Fleischer:

[cristi@3dsmithchart.com](mailto:cristi@3dsmithchart.com)

For **tool usage & help**, contact Andrei Muller:

[andrei@3dsmithchart.com](mailto:andrei@3dsmithchart.com)

Tel. +34 711 73 74 18



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