

RF and Microwave Simulator Adds Power and User Convenience

This issue's cover features Version 6.0 of =SuperStar=, a significant upgrade to this fast, engineer-friendly simulation software

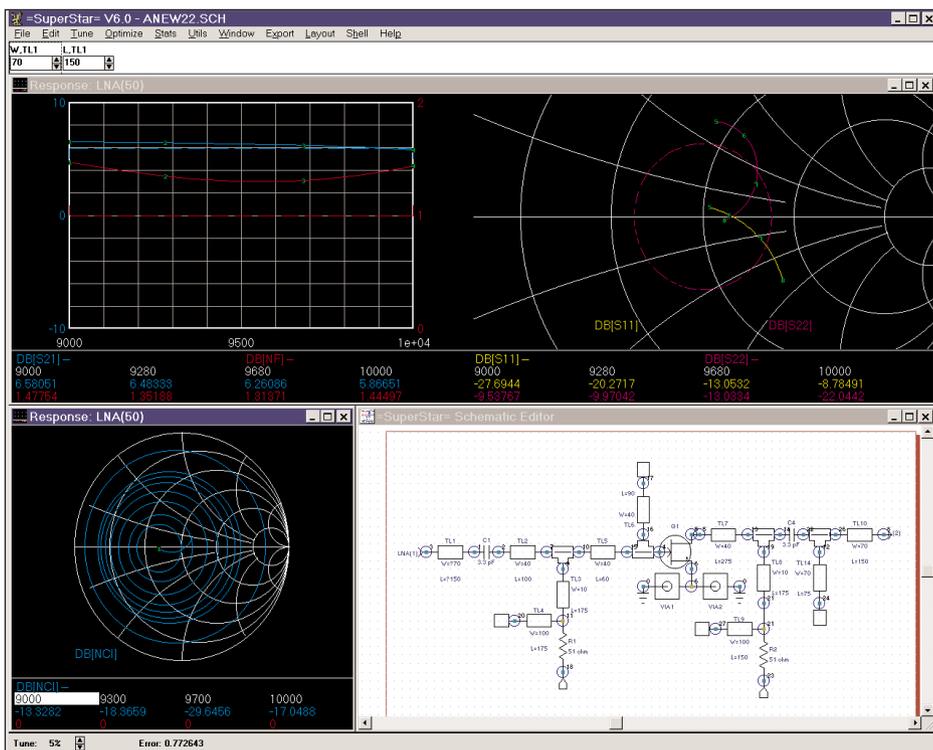
By Rob Lefebvre
Eagleware

Circuit simulation software is the cornerstone of most RF engineers' design tools. Choosing a simulator which is powerful and accurate while being easy to use is one of the more important decisions an engineer will make. A simulator must be able to handle real engineering problems such as component parasitics and tolerances. It must be fast enough so that the engineer can concentrate on the design. The simulator must be accurate and bug-free so that the engineer has confidence in the results. It also must integrate with the engineer's other tools. Finally, a simulator must be easy to use so that the engineer retains confidence in his or her own ability to use the tools.

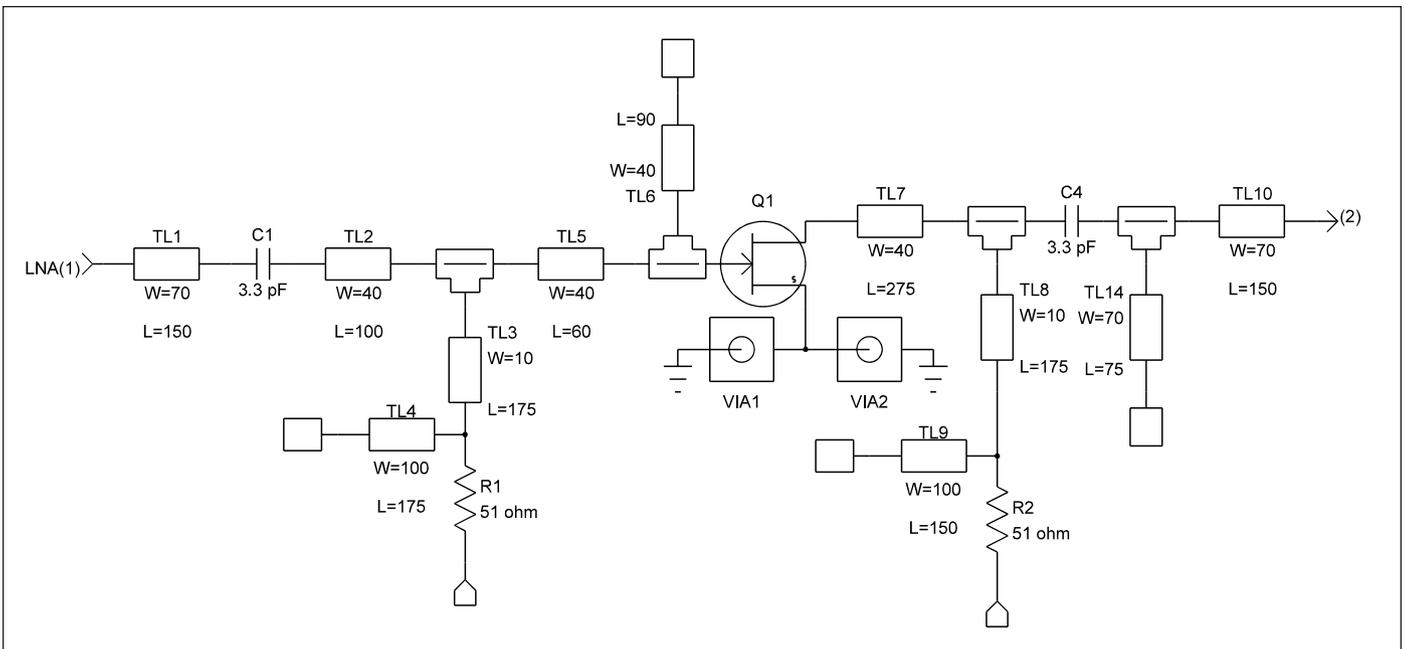
Power for practical engineering

=SuperStar=, the core of the Eagleware GENESYS suite, has been evolving with the RF and microwave industry since 1985. With each new version, Eagleware has focused attention on engineers and the job they must perform,

improving many different areas. =SuperStar= can now be easily extended with user models to handle even the most difficult simulations. =SuperStar= is the fastest RF and microwave simulator available. Its accuracy has been verified in the field by its many users and in Eagleware's own laboratory. Files can be exchanged with other programs, such as AutoCAD, Gerber Editors, network analyzers, desktop publishing tools, and Eagleware's GENESYS synthesis programs.



■ Figure 1. Eagleware's =SuperStar= provides state-of-the-art simulation, offering accuracy, integration and usability.



■ Figure 2. This 9-10 GHz low noise amplifier is an example of a practical design using =SuperStar=.

Eagleware has been constantly updating =SuperStar= and the GENESYS suite since 1985. Careful attention to customer suggestions has resulted in many user interface refinements. Many interface standards have come and gone and software vendors must keep up with the latest standards to have an easy to use product. The latest Eagleware software is 32-bit and runs under Windows 3.1/95/NT.

=SuperStar= includes thorough online Help files, allowing the engineer to search through not only procedure information but also general reference information. For example, GENESYS Help includes a table of dielectric constants for common materials to simplify entry of substrate parameters.

Eagleware realizes that in a professional environment, having user-friendly software is not enough; there must also be someone available to answer your questions. In this light, Eagleware RF and microwave engineers provide free technical support to all customers.

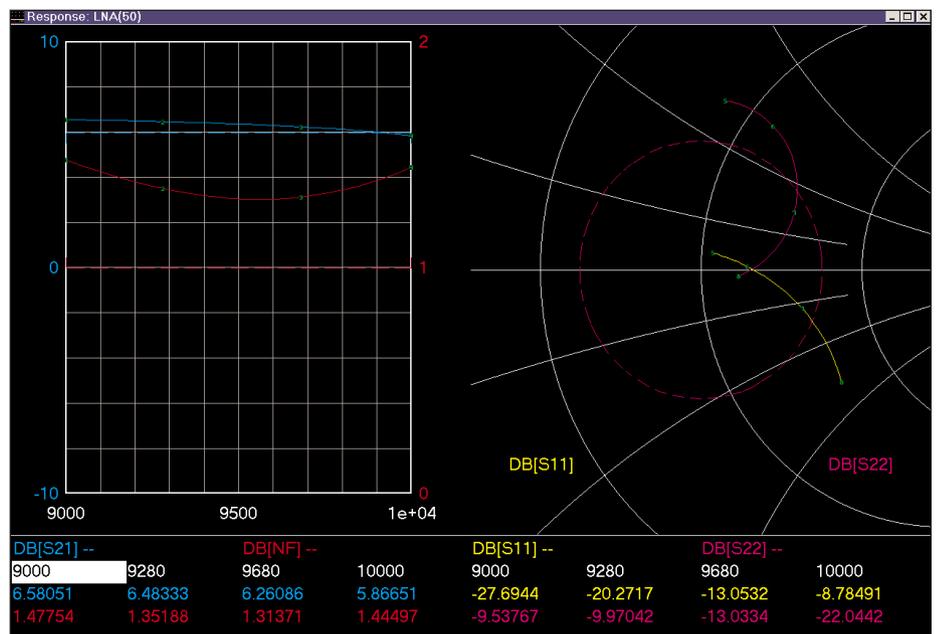
Low noise amplifier example

To illustrate the capabilities of =SuperStar=, a low noise amplifier (LNA) has been designed. This 9 to 10 GHz amplifier provides 6 dB of

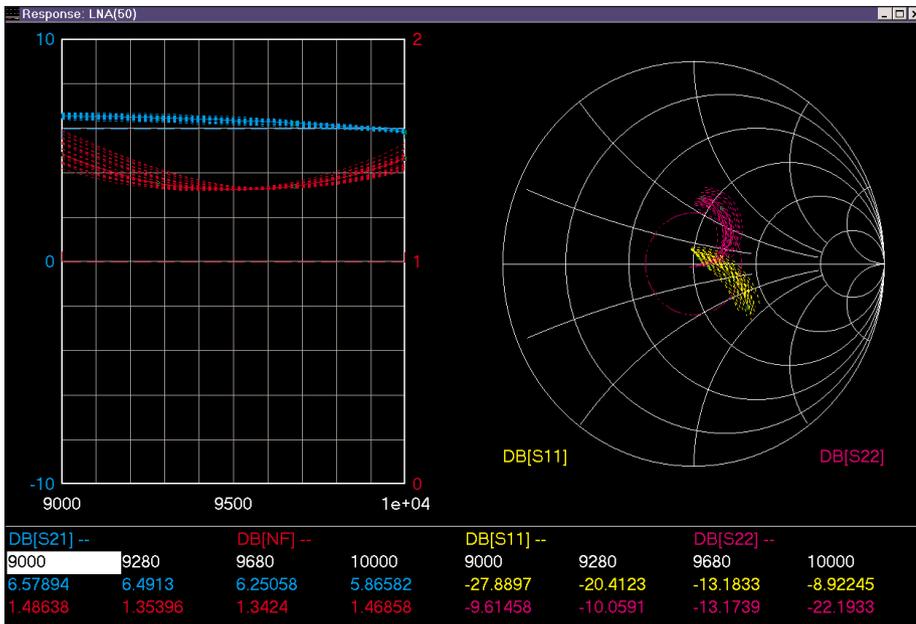
gain, a noise figure of less than 1.5 dB, and a VSWR of less than 2.2 across the band. A schematic is shown in Figure 2. The amplifier uses an HP-Avantek 10135 transistor biased at 2 V and 25 mA. The substrate chosen is an Arlon material with $K=3.5$. The circuit makes extensive use of microstrip transmission lines for biasing and match-

ing, and an accurate simulation must include the effects of the microstrip tees, ends, and viaholes.

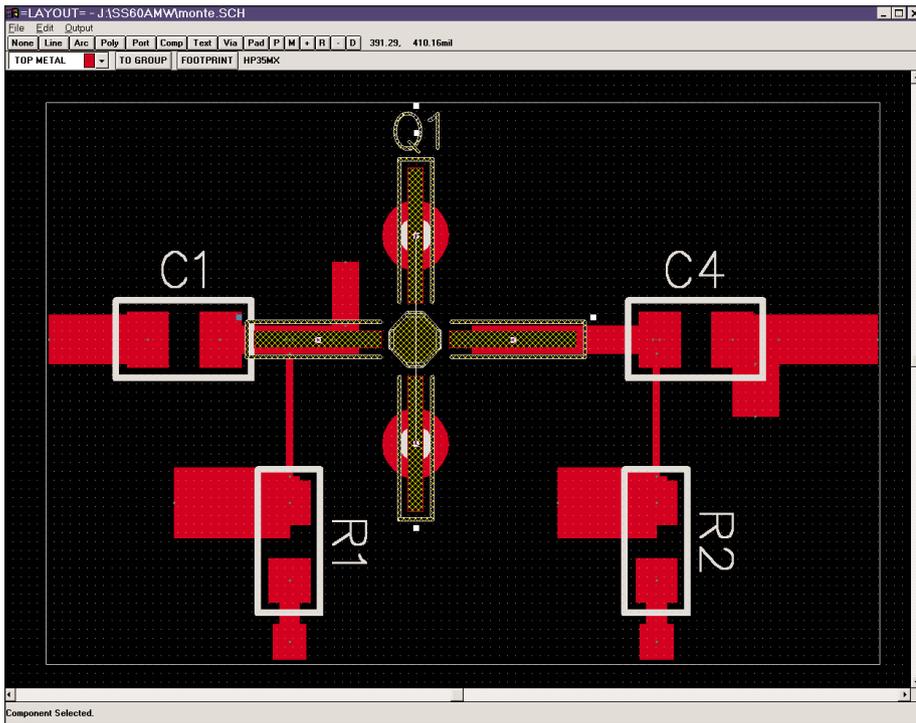
The circuit was drawn into the built-in =SCHEMAX= schematic editor. =SuperStar= was then used to optimize for $S_{21} > 6$ dB, $S_{22} < -12$ dB, and $NF < 1$ dB. Not all of these targets were able to be met, so the optimizer chose a compromise



■ Figure 3. Optimized LNA results. The graph shows S21 in blue and NF in red. The zoomed-in Smith chart shows S11 in yellow and S22 in purple. Optimization targets are shown as dashed traces.



■ Figure 4. Monte Carlo results with 5% parts, ±2 mil etching and ±0.18 dielectric constant. These results could be improved by using ±1 mil etching, but using only 10% parts.



■ Figure 5. =LAYOUT= screen with final LNA.

between them. The resulting output and optimization targets are shown in Figure 3.

Manufacturing analysis

=SuperStar= can help to determine and improve manufacturability.

The first step is to specify component tolerances and run a Monte Carlo analysis. For this amplifier, 5 percent capacitors and resistors were used, the substrate dielectric constant variation was ±0.18 and the etching on the microstrip lines

could vary ±2 mils. The resulting Monte Carlo analysis is shown in Figure 4, which shows the expected variation in performance with real-world component and manufacturing tolerances.

If the performance variation is found to be unacceptable, there are several options available to the engineer, including:

- *Sensitivity Analysis* — The sensitivity of performance to each circuit element can be displayed, and the items which have a greater impact on performance can be set to a tighter tolerance. In the LNA example, the resistor and capacitor values have a negligible effect on performance, while over/under etching has a large effect.
- *Yield Optimization* — In some circuits, the nominal component values can be adjusted to provide higher yield while using the same part tolerances. =SuperStar= contains advanced yield optimization algorithms to determine these more tolerant values.

Laying out the LNA

A PCB for the amplifier was created using =LAYOUT=, the built-in PCB layout editor. All microstrip lines and discontinuities were automatically dimensioned, allowing for easy layout construction. Footprints for the resistors and capacitors were standard 1206 sizes, and an HP35MX footprint is used for the transistor. A =LAYOUT= screen showing the final LNA is shown in Figure 5. To finish the layout, Gerber files can be exported in both 274D and 274X format, and an Excellon drill list can be produced.

Eagleware's future plans

Since 1985, Eagleware has been growing with the RF and microwave industry, providing valuable simulation and synthesis tools to the engineer. Eagleware has established a tradition of responded to customer requests and suggestions, and is continuing to improve and expand the GENESYS suite.

At present, Eagleware is developing an electromagnetic simulator for

use with the existing =LAYOUT= program. Circuit theory simulators (such as =SuperStar= or SPICE) can accurately predict circuit behavior, but effects such as unwanted coupling between closely spaced traces and discontinuities are seldom modeled. In low frequency applications, this effect is often negligible and can be ignored. However, as frequency increases above a few gigahertz, unwanted coupling parasitics become a serious concern. An electromagnetic simulator accurately calculates field and current patterns for a microstrip or stripline structure, given its dimensions and electrical properties. Such a simulator can produce very accurate response predictions, at the expense of long simulation times. Eagleware's electromagnetic simulator will interface directly with the =LAYOUT= program for easy entry of the board to simulate.

Eagleware is also currently developing a phase-locked loop (PLL) synthesis program and a system simulator for use in simulating these PLLs. The operation of the PLL program will be very much like the existing synthesis programs in the GENESYS suite. Once a type of PLL is chosen, based on the end application (e.g. FM demodulation) and performance specifications are provided, the program will automatically calculate loop component values and display the open- and closed-loop frequency response. ■

Eagleware Corporation
1750 Mountain Glen
Stone Mountain, GA 30087
Tel: (770) 939-0156
Fax: (770) 939-0157
E-mail: eagleware@eagleware.com
Web: <http://www.eagleware.com>

Circle #200

Author Information

Rob Lefebvre is a Senior Engineer at Eagleware. He received his BS from Georgia Tech and has been with Eagleware for 8 years. Rob is the lead programmer for =SuperStar= and the Eagleware GENESYS suite. He can be reached at the address above.

What's new in Version 6.0?

Current and new =SuperStar= users will find these improvements included in Version 6.0:

- *True multi-port analysis.* Data for as many as nine ports can be viewed using standard notation (e.g. S32).
- *More output options.* Most common parameters can be displayed in many new formats, including H, S, Y, and Z parameters, and many other specialized parameters, such as GMAX, B1, and ZM1, have been added. All output parameters can now be used on graphs and tabular displays and can be used for optimization targets. Smith Chart zooming and "optimization target" overlays are also new.
- *Circle charts.* Gain, noise, and enhanced stability circles can be plotted on Smith or polar charts.
- *Advanced modeling and equations.* User models and inline functions can now be created and used within schematics and circuit files by assigning functions to element values, or by creating a custom model in the new model editor.
- *Excellon drill lists.* In response to customer requests, =LAYOUT= has been upgraded to export Excellon drill lists for PCB viahole placement.
- *Yield optimization.* A new algorithm finds those components whose variations due to part tolerances least affect the overall response. This is useful during the final stages optimization to ensure manufacturability.
- *Parameter sweeps.* In the past, =SuperStar= only provided frequency sweeps for horizontal axes. For two- and three-dimensional plots, =SuperStar= can now sweep parameter values (e.g., plotting S21 vs. tuning varactor capacitance in a VCO).
- *New Help files.* True Windows Help files are now included with full search capabilities.
- *Complete =SCHEMAX= integration.* =SuperStar= has been integrated with =SCHEMAX= and =LAYOUT= to provide one simple user interface. Users can now view schematics and simulations simultaneously, allowing easy component editing and simulation updates.
- *Backward compatibility.* Despite the additions and improvements to =SuperStar=, Eagleware has taken care to maintain the backward compatibility that seasoned users demand. While newcomers will appreciate =SuperStar='s fast and easy to use interface, old customers will still find the functionality that they have grown accustomed to.
- *Interface enhancements.* Many small changes to the interface have been made to simplify operation. For example, tuned values can be replaced automatically and the Monte Carlo Setup screen has been redone.