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# DEVICE CHARACTERIZATION USING THE AUTOMATED TUNER SYSTEM (ATS)

## Abstract

The art of device characterization has evolved from a split apart fixture with tuning elements to the fully corrected automated tuner system of today. This paper will look at where we have been, what is available today so the devices of tomorrow can be developed.

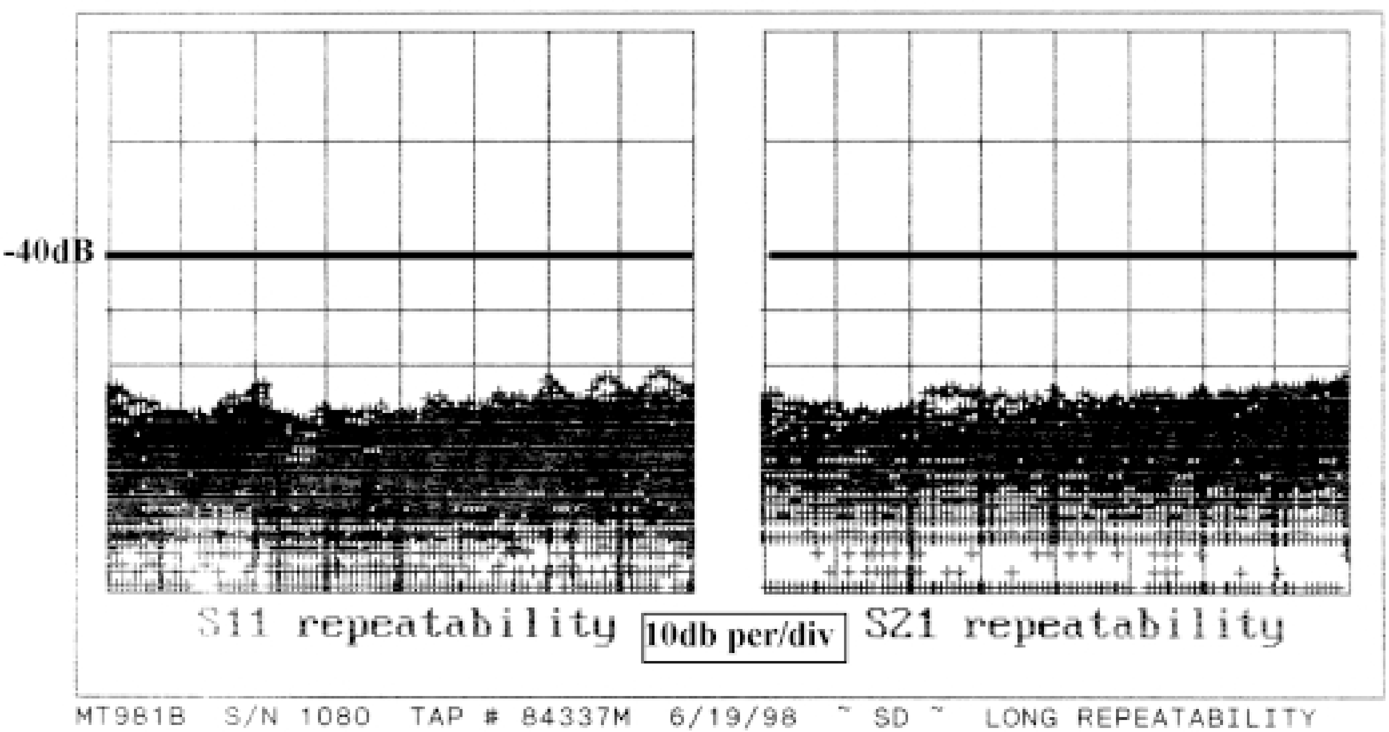
## Introduction

In the not so distant past, an engineer would spend days and weeks evaluating a single device to find out what it could do. This information would be fed back to the device engineer so he could set up the next lot start. This process would add cost and delay to the product. With the advent of faster and more powerful computers came the ability to automate much of this task. It started with the same fixture but the data being taken with computers. This saved time, but the art of tuning the test amp was up to the highly skilled engineer. Along came the Automated Tuner System (**ATS**) and now we are looking at a whole new ball game. Cycle time of data collection and device development has been reducing ever since.

## Requirements Of The ATS

The needs of today's engineer are very stringent. They need a tuner system that is highly repeatable and easily verifiable. The system also needs to work for long periods without much maintenance. Maury tuners give error free service for years without much in the way of maintenance or repeated characterization. The tuners only need light oiling once or twice a year. The repeatability of the tuners is better than -40 dB at the worst case points. Repeatability is defined as:

**Repeatability =20log (|meas1-meas2|)**




**Measured Data of Repeatability**

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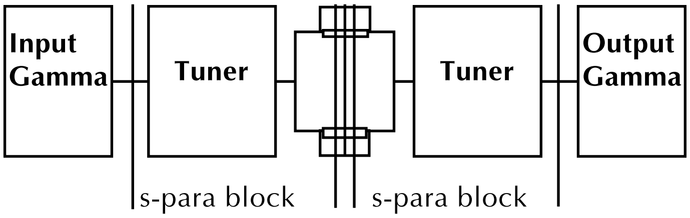
The integrity of the data from the system needs to be verified in a simple and systematic way. To do this with the Maury **ATS**, we use the openness of the system software “SNP” to write a user defined test.

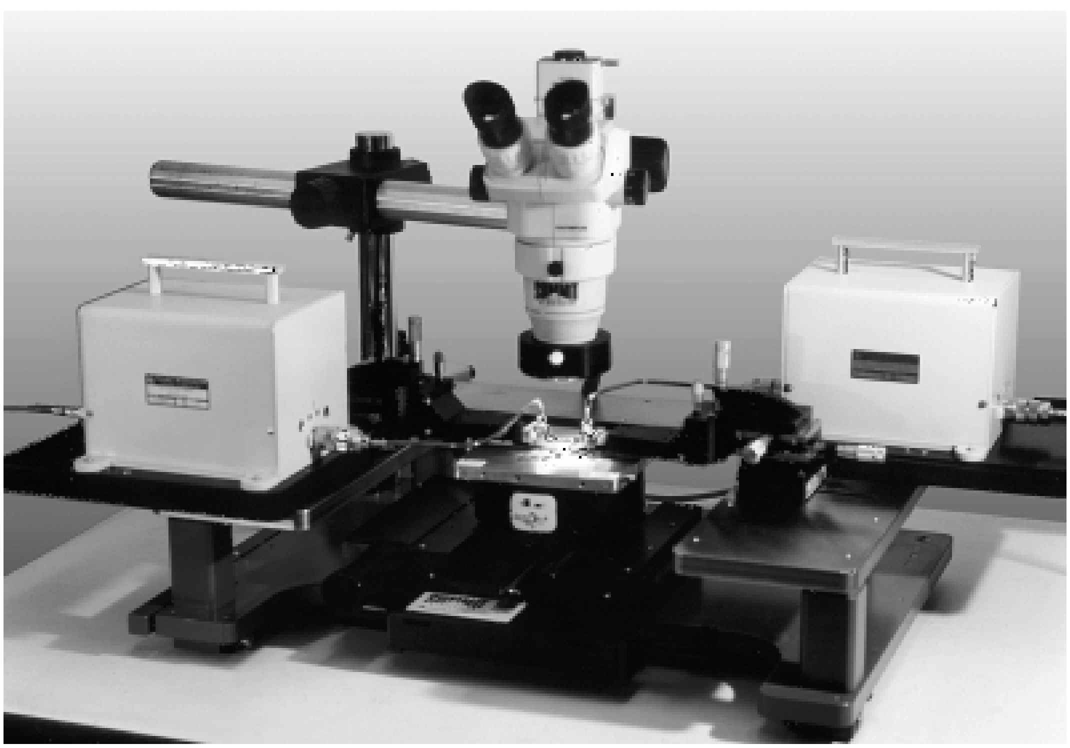



As shown in the basic block diagram, we know the s-parameters of every block in the system. Knowing this, we can compare gain/loss from calculations versus system measurements. Deltas in the range of +/- .2 are good, and you know that all reference planes are right, and all input and output gammas of the system are right. Once the configuration and needs are known for the system, the goal now turns to the job at hand - reducing the cycle time of device development to get the product to the market faster and at a lower cost.

## Device Design

The job of the device engineer is to develop the semiconductor structure to give the performance needed for a given application. Once this is done, the device design makes its way through the wafer fab. The first testing done on the wafers will typically be a DC functionality test to see if the devices act like transistors/FETs. The DC data can tell us a lot about the devices but the critical test is RF testing. A s-parameter sweep of the smaller die will tell us how the device operates in a linear manner. However, it will not directly tell how its large signal performance will be. To do this, an on wafer test is best for the smaller device. Use smaller devices because if you try to make a large die RF probeable, there will be complications. To start with, the heat dissipation will play a larger role and the “source/base” manifold will add a tremendous amount of parasitic.

The Maury **ATS** is a tool suited for an on wafer test as well as for packaged die. The SNP software will interface with any automated probe station that can be controlled by GPIB. The results of this testing can then be shown on a wafer map.



**On Wafer ATS System**



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With the data from an on wafer source/load pull, an intelligent decision can be made as to what wafers will be cut up and packaged for the full size device testing.

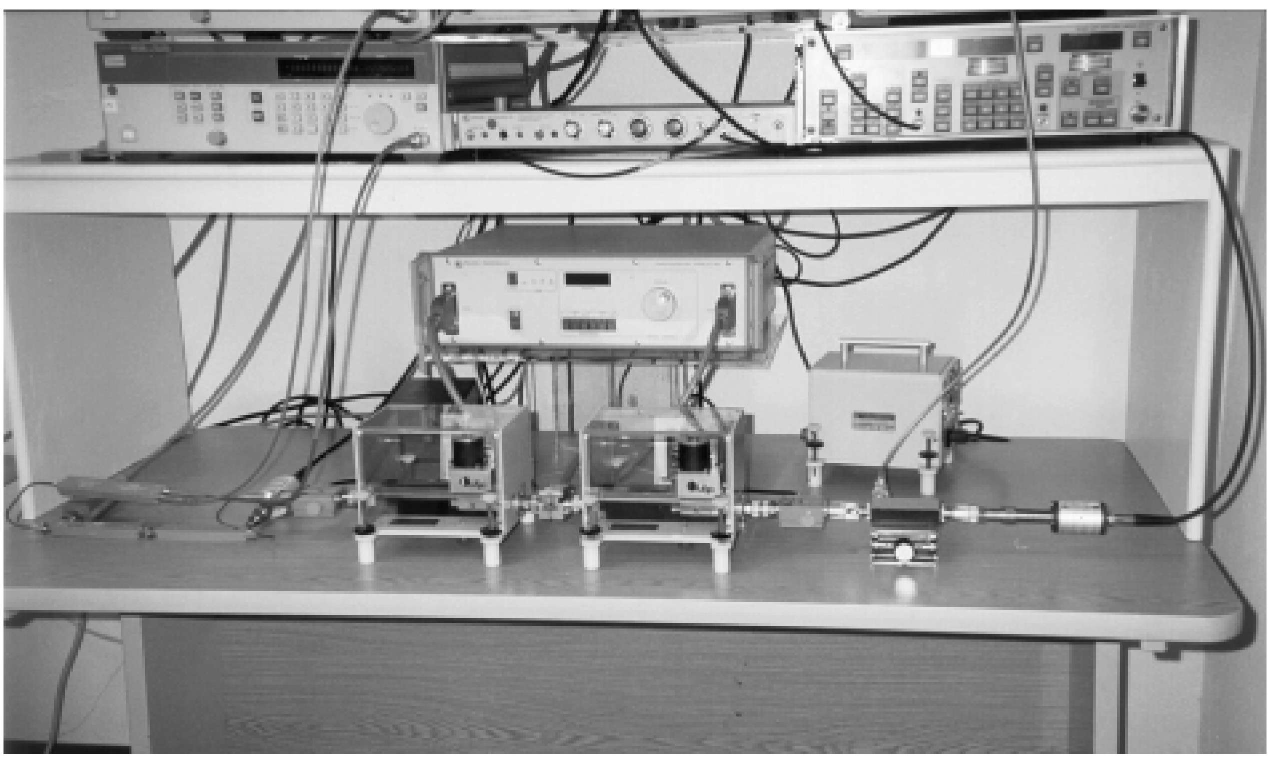
This is where the real proof is as to whether the device has improved or if it is useful for the product. At this stage of the testing, the test system needs to be able to handle the power that the device could put out. If it is for a hand held radio, then we are looking at powers from about 1 to 6 watts. But if the device is for the base station market, the powers can get as high as 100 to 500 watts depending on the application.

The Maury tuners in the band of .4 to 4 GHz will handle up to 100 watts of average power and up to 1K watt peak. With powers this high, the fixture now plays a bigger part in the test set up. To keep heating down, a pulsed system is very often used. Because the Maury **ATS** is an open system, pulsed measurements can be handled just like any other configuration.

The goals and needs of each test application are going to be different. With this in mind, the **ATS** system was designed to be very flexible. The **ATS** supports many different configurations to meet the needs of an environment that is ever changing. The SNP software has all of its equipment drivers open to the user and the source code is provided. When the need arises for that test requirement that is not standard, we provide the ability to execute custom test code. The "user function" code is run every time a test is run and the data is passed back so that the custom data is now part of the data set.

## Circuit Design

Very often, while the device is in development, a model is also being generated so that the circuit designer can use it. To reduce the cycle time even farther, the same load pull data can be used to verify the model. When the device development is done, the circuit designer now has the task of making a



**Packaged Device Test Bench**

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usable product. The data taken on the **ATS** system can now be embedded with the simulated matching circuit using s-parameters. To do this, the designer first must make a 2-port s-parameter file for both the input and output halves. With this in hand, the performance of the amplifier can be seen with real data for the device, not the model. This is one more check in the cycle of design to verify that the product will work. This is what it's all about: the product working, and the first to market on or under budget. The Maury **ATS** system is the best tool for this task.

## Conclusion

The pressure to get the product to market with the lowest cycle time demands a test environment that is both flexible and reliable. With the Maury **ATS** system, you get both. The best in class hardware with an open and reliable software solution.

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