Agilent PN 4291-2

Evaluating Temperature Characteristics using a Temperature Chamber and the Agilent 4291B

Product Note

Agilent 4291B RF Impedance/ Material Analyzer

Introduction

In the research and development of electronic components and materials, development cycle time must be reduced. In accordance with this trend, more emphasis is being placed on improving the efficiency of temperature characteristics evaluation, which plays a major role in ensuring end-product reliability and performance.

This note introduces an efficient and highly reliable method for evaluating temperature characteristics using a combination of the Agilent Technologies 4291B RF Impedance/Material Analyzer and a Tabai Espec temperature chamber.

Agilent 4291B Overview

The 4291B RF analyzer (Figure 1) provides impedance and material measurements up to 1.8 GHz. This analyzer provides a complete measurement solution for a wide range of applications, from evaluating electronic materials used in RF components to evaluating various impedance parameters of components.

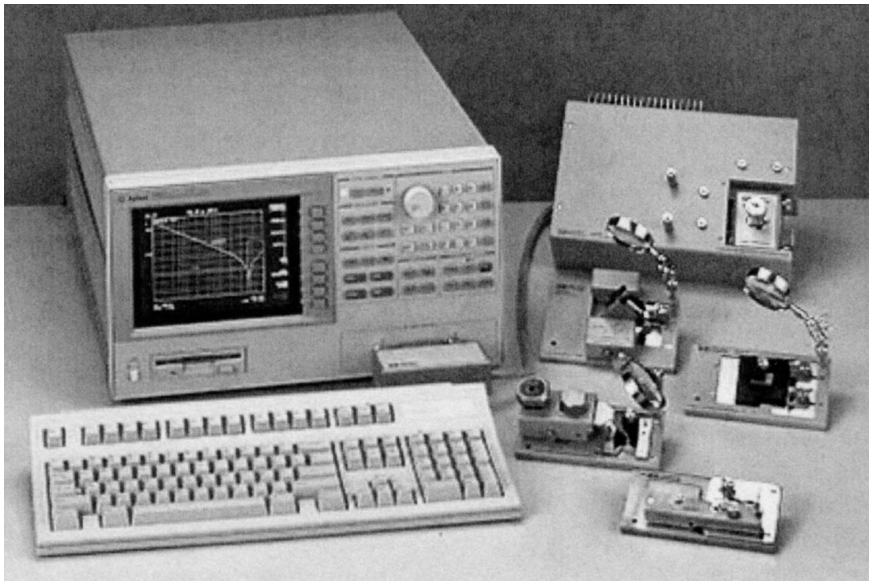

Figure 1. Agilent 4291B RF Impedance/Material Analyzer with SMD fixture

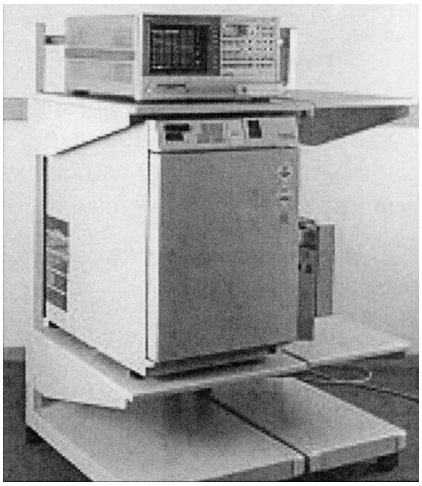

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Table 1. Agilent 4291B Specification Summary

Frequency Range	1 MHz to 1.8 GHz
Measurement Parameters	|Z|, θz, |Y|, θy, R, X, G, B, Cp, Cs, Lp, Ls, Rp, Rs, D, Q, |Γ|, θΓ, Γx, Γy
Basic Accuracy (Z)	±0.8%
Impedance Range	0.1 Ω to 50 kΩ
Oscillator Level	0.2 mV to 1 V (≤1 GHz) 0.2 mV to 0.5 V (> 1 GHz)
DC Bias (Opt. 001)	0 V to ±40 V, 0 to ±100 mA

New capabilities for evaluating RF components

- Highly accurate impedance measurement in the RF band

  A wide frequency range, from 1 MHz to 1.8 GHz, is available, making it possible to measure the impedance of RF components at operating frequencies. Impedance can be measured with a basic accuracy of ±0.8%, and Q (quality factor) with an accuracy of 15% for measurements of Q = 100 at 1 GHz.

- Analyzer functions ease system configuration and integration

  The Agilent 4291B includes the following features to simplify configuring a temperature characteristic testing system. (See Figure 2.)

  1. Standard 1.8-m cable
  A 1.8-m cable makes it possible to extend the test station to the temperature chamber without increasing the measurement error.

  2. High temperature test heads
  The high temperature test heads (Option 013: for high impedance, Option 014: for low impedance) can be used within the range of –55 °C to 200 °C, maintaining high accuracy.

  3. GPIB
  The GPIB is included as standard equipment and is indispensable for configuring an automatic measurement system.

  4. Built-in Agilent IBASIC
  With built-in IBASIC, the temperature chamber can be controlled via the GPIB using the controller built into the analyzer.

  5. Application Program Available
  An application program for controlling the temperature of the chamber and evaluating the temperature characteristics based on the measured results from the 4291B is included with the optional high temperature test heads.

  These features make system configuration with the temperature chamber extremely easy, and significantly reduce the time required for software development and other integration tasks.

Overview of the Tabai Espec Temperature Chamber

The Tabai Espec temperature chamber, model SU-240-Y, is a compact bench-top unit. The chamber provides high performance levels (e.g., temperature range and distribution), which are equivalent to those available with standard, larger-sized temperature chambers. The SU-240-Y is designed to integrate easily with the 4291B. This is specifically advantageous for the research and development of electronic components and materials that require evaluation over a range of temperatures.

Chamber features

- High performance with compact dimensions

  This unit has a temperature range of -30 °C to +150 °C, which is equivalent to a standard chamber. The upper limit temperature of +150 °C is available with the standard unit. This high performance also extends to the temperature distribution and temperature adjustment range, accommodating full environmental test equipment in a compact size.

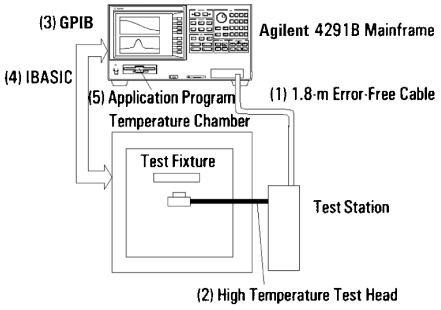

Figure 2. Analyzer-Temperature chamber system configuration

- Compact size saves space

  The compact design is beneficial for laboratories with limited space. The freezer uses a rotary compressor, reducing size and weight even further.

- GPIB as standard

  GPIB, a standard feature, is used for connecting to the 4291B (using the Agilent IBASIC function) or to an external controller, allowing remote control of the chamber functions.

- Measuring port

  A measuring port (Figure 3) is available for installing the high temperature test head of the 4291B, eliminating the need to create additional measurement cable access holes.

- Thermocouple for measurement of temperature around the DUT

  A thermocouple is available for measuring the temperature around the DUT. Using this facility, temperature characteristics can be evaluated accurately by monitoring the temperature near the DUT.

System configuration

To configure a system using the temperature chamber, the following should be added to the 4291B.

- Option 013: High temperature test head for high-impedance measurement or Option 014: High temperature test head for low-impedance measurement

Temperature characteristics can be evaluated more efficiently and reliably by using the 4291B to control the functions of the chamber. A system configuration for this purpose is shown in Figure 2.

Table 2. Tabai Espec Chamber SU-240-Y Specification Summary

Temperature and Humidity Control	Balanced Temperature Control Humidity Control System (BTC system)
Refrigeration System	Mechanical single-stage condensation method
Temperature Range	-30 °C to +150 °C
Temperature Control Stability	±0.3 °C (-30 °C to 100 °C), ±0.5 °C (101 °C to 150 °C)
Temperature Uniformity[1]	±0.5 °C (-30 °C to 100 °C), ±0.8 °C (101 °C to 150 °C)
Temperature Heat-up time	within 70 minutes from -30 °C to 150 °C
Temperature Pull-down time	within 70 minutes from 20 °C to -30 °C
Lowest Attainable Temperature[2]	-30 °C
Capacity	21 liters
Inside Dimensions	W = 30 cm × H = 30 cm × D = 24 cm (excluding protrusion)
Outside Dimensions	W = 44 cm × H = 69 cm × D = 74 cm (excluding protrusion)

1. At 23 °C ambient without DUT
2. Ambient below 30 °C without DUT

Measurement procedures

The following are general procedures for evaluating temperature characteristics using the 4291B and the Tabai Espec temperature chamber:

1. Configure an automatic measurement system as described previously

2. Load the application program

Using the IBASIC function of the 4291B, load the application program that comes with the high temperature test head for the 4291B. The application program interactively controls settings, measurements, and analysis.

3. Set up the Agilent 4291B/temperature chamber

The program is first used to set up the 4291B and temperature chamber. For the 4291B, the parameters for measurement and sweep must be defined. For the temperature chamber, the upper limit/lower limit/step values of temperature as well as the repeating pattern of temperature control must be set (Figure 4).

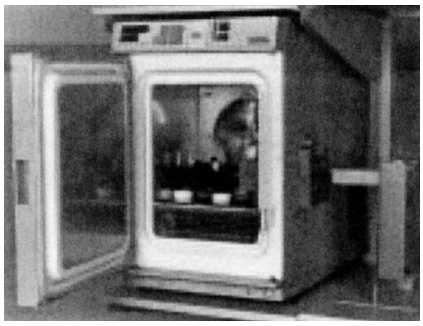

Figure 3. Measuring Port of the Tabai Espec temperature chamber SU-240-Y

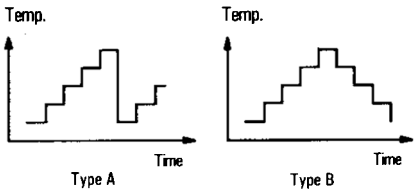

Figure 4. Repeating patterns of temperature control

To ensure highly accurate measurements, the Agilent 4291B requires further calibration at the 7-mm measurement terminal as well as OPEN/SHORT/LOAD compensation in the test fixture. These should be carried out at the standard temperature of the temperature characteristics. (The standard temperature is normally 23 °C ± 5 °C)

4. Connect the DUT
Connect the DUT to the test fixture positioned in the temperature chamber.

5. Make the measurement
When the measurement has started, the program automatically controls the temperature chamber and 4291B based on the settings made in Step 3. Temperature characteristics data is collected.

6. Graphically analyze the measurement results
After the measurement is complete, use the program to graphically display the measurement results as illustrated in Figure 5 to evaluate the parameters of interest.

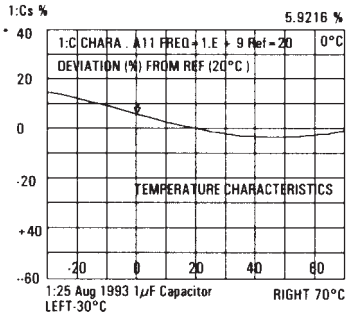

Figure 5. Evaluating the temperature characteristics of a capacitor

Conclusion

By using the Agilent 4291B RF Impedance/Material Analyzer in combination with the Tabai Espec temperature chamber SU-240-Y, an automatic measurement system can easily be configured. Temperature characteristics of various electronic components and materials can then efficiently and accurately be evaluated over frequencies from 1 MHz to 1.8 GHz.

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