

How to Select RF Test Socket

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Introduction

The classic function of a socket is to provide a replaceable connection mechanism from the IC (Integrated Circuit) to the circuit board with minimal signal loss. This allows the IC to function as it is soldered into the PCB (printed circuit board) but can be replaced by another IC for testing. Selecting the right RF test socket is an important decision that requires careful consideration of several factors – frequency, insertion loss, return loss, impedance matching, contact force, contact resistance, durability, thermal performance, etc. In this article, we will review those factors with example scenarios.

Device Under Test

The first step in selecting the RF test socket is to identify the type of device under test (DUT). The DUT can be a package or a bare die. The package can be a ceramic, plastic, or metal casing that houses the die, while the bare die has no casing or packaging. Some RF test sockets are designed for a specific type of DUT, while others are designed to accommodate different types of DUTs. Therefore, it's essential to choose a test socket that is compatible with the type of DUT you'll be testing. Figure 1 shows an RF test socket for QFP device packaged in metal casing. Unique aspect of the socket is that one side is open for RF traces from PCB to DUT since those traces cannot have any interference from socket dielectric materials.

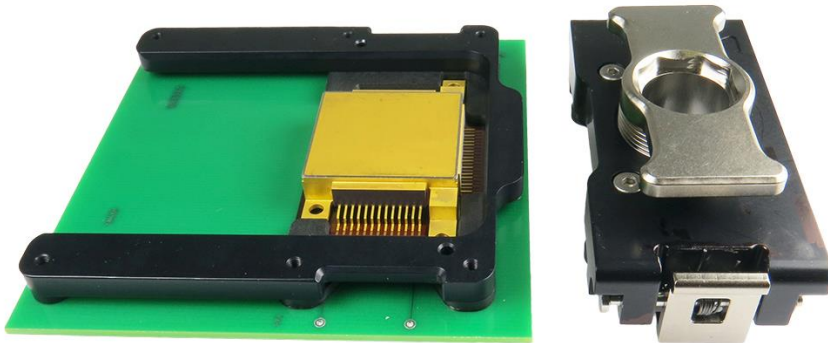


Figure 1: RF test socket for QFP device packaged in metal casing

Frequency

The frequency range of the RF test socket is one of the most important factors to consider when selecting a socket. It refers to the range of frequencies that the socket can accommodate while maintaining proper signal transmission and reception. It should match the frequency range of the device being tested. If the frequency range of the test socket is too low, it will not be able to accurately test devices that operate at higher frequencies. Conversely, if the frequency range of the test socket is too high, it may not provide reliable test results for devices that operate at lower frequencies. It is essential to select an RF test socket that matches the frequency range of the device being tested to ensure accurate test results.

Insertion Loss

Insertion loss is a critical parameter to consider when selecting an RF test socket. It refers to the amount of signal power that is lost as the signal passes through the socket. Insertion loss is typically expressed in decibels (dB) and can vary depending on the frequency range of the signal being transmitted and the specific characteristics of the test socket. In RF applications, insertion loss can have a significant impact on the performance of the device being tested. High insertion loss can cause signal degradation and distortion, leading to inaccurate test results. Low insertion loss is desirable to ensure accurate and reliable signal transmission and reception. Our example RF test socket constructed with high performance and low inductance elastomer interconnect between DUT and PCB. Figure 2 shows insertion loss curve for elastomer socket that is graphed for frequency range up to 100GHz.

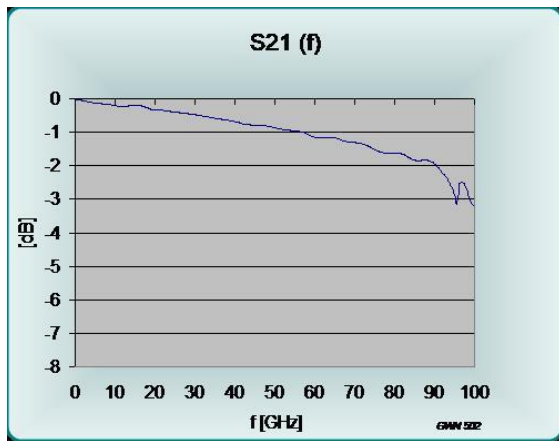


Figure 2: Insertion loss curve for elastomer socket that is graphed for frequency range up to 100GHz.

Return Loss

Return loss is the next critical parameter to consider when selecting an RF test socket. It refers to the amount of reflected signal power that is returned back to the source due to a mismatch in impedance between the device being tested and the test fixture. Return loss is typically expressed in decibels (dB) and can vary depending on the frequency range of the signal being transmitted and the specific characteristics of the test socket. In RF applications, return loss can have a significant impact on the performance of the device being tested. High return loss can cause signal distortion and inaccurate test results, as the reflected signals interfere with the transmitted signals. Low return loss is desirable to ensure accurate and reliable signal transmission and reception. Figure 3 shows return loss curve for elastomer socket that is graphed for frequency range up to 90GHz. For example, if the device frequency is 50GHz, insertion loss is -0.8dB and return loss is -13dB when signal passes through elastomer socket. Is the loss acceptable will be the important question to be answered from DUT design intent?



Figure 3: Return loss curve for elastomer socket that is graphed for frequency range up to 90GHz

Impedance

Impedance is a critical parameter to consider in RF applications and refers to the total opposition that a circuit presents to the flow of an alternating current (AC) at a given frequency. Impedance is typically represented by a complex number, with magnitude and phase components. In RF applications, impedance matching is important to ensure maximum power transfer between the source and load circuits. When there is a mismatch in impedance between the source and load circuits, some of the power is reflected back to the source, which can cause signal degradation, distortion, and poor performance. In order to ensure proper impedance matching in RF applications, it is important to select components and test equipment that are designed to operate at the same characteristic impedance. Test sockets used in RF testing applications should be designed to provide the appropriate impedance for the specific device being tested, and should be selected based on their ability to maintain impedance stability over the entire frequency range of the signal being transmitted.

Contact Force

Contact force is a critical parameter to consider when selecting a test socket for any type of device. It refers to the amount of force that is applied to the device being tested to ensure proper electrical contact between the device and the test equipment. The contact force is typically measured in pounds (lbs) or Newtons (N). In general, a higher contact force provides better electrical contact between the device and the test equipment, which can lead to more accurate and reliable test results. However, excessive contact force can damage the device being tested or the test socket itself, leading to premature wear and failure. Factors that can affect contact force in a test socket include the size and shape of the contact pins, the material and hardness of the contact pads, and the overall design of the socket. When selecting a test socket, it is important to consider the recommended contact force and verify its performance using appropriate test equipment and procedures. The contact force should be measured and compared to the recommended specification to ensure that it falls within the acceptable range for the device being tested.

Contact resistance

Contact resistance is an important parameter to consider when selecting an RF test socket. It refers to the resistance of the contact between the device under test (DUT) and the socket contacts. The contact resistance can affect the accuracy of the test results, especially when testing high-frequency devices. High contact resistance can cause signal loss, which can lead to inaccurate measurements. Therefore, it's important to choose a test socket with low contact resistance. A low contact resistance ensures that the signal is transmitted efficiently from the DUT to the test equipment, resulting in accurate measurements. Contact resistance can be influenced by a variety of factors, such as the type of contact material, the contact force, the plating material, and the cleanliness of the contacts. The contact force is particularly important, as a higher force can help ensure a good contact and reduce contact resistance. However, too much force can damage the DUT, so it's important to strike the right balance. In addition, the type of contact material used in the socket can affect contact resistance. Materials such as gold and palladium are commonly used in RF test sockets because they provide good electrical conductivity and are resistant to corrosion. In our example, contact material is gold plated brass wires embedded in silicone rubber and the connection is made when gold plated wires protrude DUT on the top side and wipe PCB contact pads on the bottom side.

Durability

Durability is an important factor to consider when selecting a RF test socket. It refers to the ability of the socket to withstand repeated use over time without experiencing significant wear or failure. A durable test socket can help to minimize the need for frequent replacement or repair, and can ensure consistent and reliable test results over the lifetime of the socket. Factors that can affect the durability of a test socket include the quality and hardness of the materials used to manufacture the socket, the design of the contact pins and pads, the type and frequency of testing, and the overall environmental conditions in which the socket is used. To ensure the durability of a test socket, it is important to select a socket that is specifically designed for the type of device being tested, and that has been thoroughly tested and validated for performance and reliability. It is also important to follow the manufacturer's recommended procedures for handling, cleaning, and maintaining the socket, to help extend its lifespan and prevent premature wear or failure. Regular inspections and maintenance of the test socket can also help to identify and address any potential issues before they lead to more serious problems. For example, cleaning the socket regularly can help to remove any debris or contaminants that could interfere with proper electrical contact, while inspecting the contact pins and pads for signs of wear or damage can help to identify potential issues early on. In summary, selecting a durable test socket that is designed for the specific requirements of the application, following recommended maintenance and handling procedures, and performing regular inspections can help to ensure reliable and consistent performance over the lifetime of the socket. Figure 4 shows elastomer socket contact resistance up to 2000 insertion cycles while the contact force was maintained at 40grams per contact.

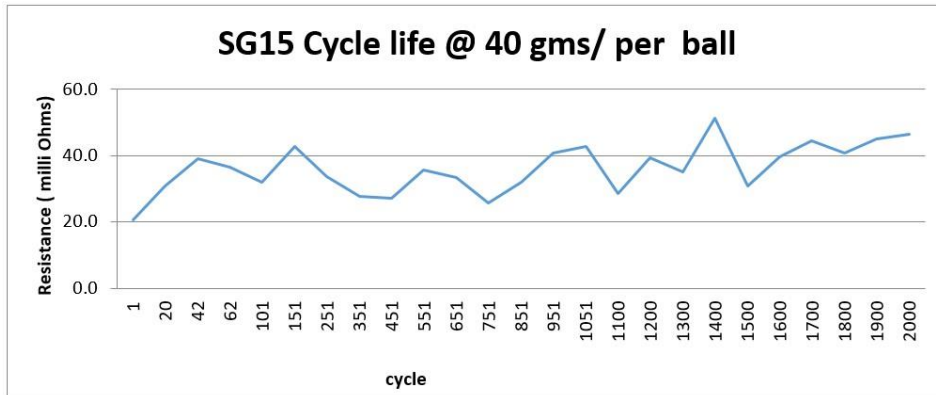


Figure 4: Elastomer socket contact resistance up to 2000 insertion cycles while the contact force was maintained at 40grams per contact

Thermal performance

Thermal performance is an important consideration when selecting an RF test socket because temperature variations can affect the accuracy of the RF measurements. Temperature changes can cause the socket contacts to expand or contract, which can result in changes to the contact resistance and insertion loss of the socket. Therefore, it's important to choose a test socket that has good thermal performance. A test socket with good thermal performance is designed to minimize temperature variations and maintain a stable operating temperature. This is typically achieved through the use of specialized materials and design features with springs that help to reduce the effects of temperature changes. One common design feature used to improve thermal performance is the use of a thermal interface material (TIM) between the DUT and the compression mechanism. TIMs are materials that are used to fill gaps between the DUT surface and the test hardware, providing a more efficient path for heat transfer. This helps to reduce temperature variations and improve the overall thermal performance of the socket. Another design feature used to improve thermal performance is the use of specialized materials in test hardware that are designed to have low thermal resistance. These materials, such as copper or aluminum, can help to dissipate heat more efficiently and reduce temperature variations. When selecting an RF test socket, it's important to consider the thermal performance and choose a socket that has been designed with this in mind. This will help to ensure that the socket maintains a stable operating temperature and provides accurate and reliable test results, even when subjected to temperature variations.

Conclusion

In summary, make sure the socket is designed to handle the frequency range of your device. There are different types of RF test sockets, including single-contact, dual-contact, and redundant contact sockets. Choose the type that best suits your device and test requirements. Signal integrity is critical when testing RF devices. Look for a socket that provides good signal integrity and minimal signal loss. The socket must be durable enough to withstand repeated use over time. Look for sockets that are made from high-quality materials and have a proven track record of reliability. Make sure the socket is compatible with your test equipment, including the test fixture and tester. Ease of use is an important consideration when selecting a test socket. The usability of a test socket can have a significant impact on the overall testing process, including the speed and efficiency of testing, the accuracy and reliability of test results, and the ease of

training and support for testing personnel. Some RF test sockets can be customized to meet specific testing needs. Look for sockets that can be customized to meet your unique requirements.

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