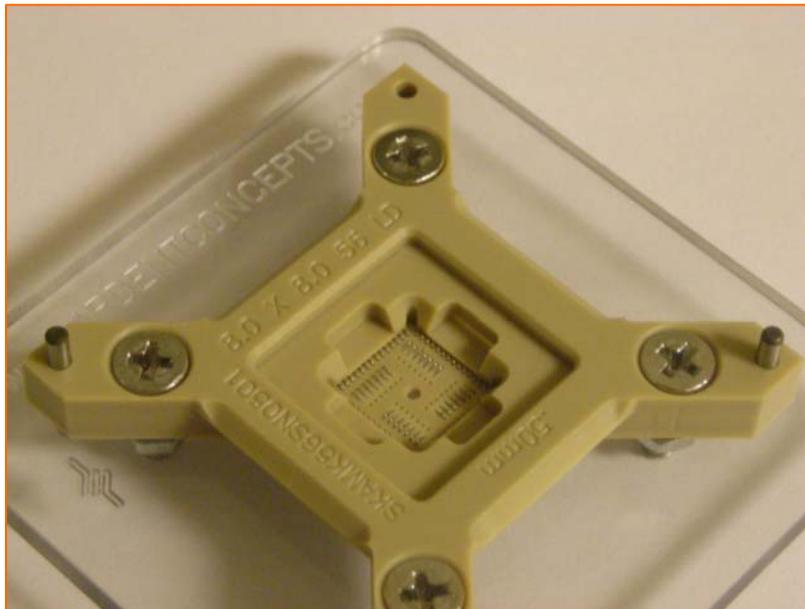


RC Scrub-R™

High Performance Test Socket Systems for Micro Lead Frame Packages

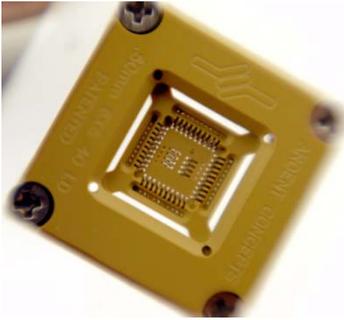


Abstract

RC Scrub-R ATE test sockets from Ardent Concepts provide excellent AC performance, long lifecycle/durability, and ease of field maintenance. RC Scrub-R™ test sockets help IC test managers increase yields, decrease board wear and handler down-time, and improve reliability of test set-ups for high volume parts. This white paper provides detailed technical information on various studies performed on RC Scrub-R sockets during extensive field and lab testing.

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Introduction

Handler-ready ATE test sockets are expected to be highly durable over long periods of time. Handler down-time is unacceptable, and yields must be maximized to ensure profitability on highly cost-sensitive packaged parts. Let's face it, **test is overhead**.

Ardent Concepts, an Innovator in High Performance Interconnect, has developed the RC Scrub-R™ Family of Test Socket products to help customers increase yields, maximize uptime, minimize board wear, and lower consumables cost from the lab to the production test floor.

This white paper provides customer experience data and lab studies from a series of extensive tests on the reliability, repeatability, durability and signal integrity of the RC Scrub-R™ test socket system.

Key Specification for RC Scrub-R™ Test Socket System

Electrical	
<-1dB Insertion loss	Though 32.7 GHz
Characteristic Impedance	51.6 Ω
Self-Inductance	.29 nH
DC Resistance	< 80 m Ω
Current Carrying Capacity	2 amps
Mechanical	
Pin Lifecycle	500K – 2Million
Socket Body Lifecycle	> 2 Million
Board Wear Translation	Zero
Test Height	.94mm
Contact Force	11-17 grams
Scrub Translation at DUT	.10mm
Materials	
Contact	Paliney 7
Housing	Torlon, Vespel, Ultem, LCP, Peek
Environmental	
Temperature Range	-55 – 150 C

Leadless Package testing presents a unique set of test challenges for high volume production test environments.

Traditional socket solutions are often complicated, expensive and difficult to maintain in the field.

RC Scrub-R™ from Ardent Concepts is a simple 1-piece wire form contact which scrubs across the surface of the device lead during compression.

Dedicating over 3 years to R&D, Customer Beta testing, and key technical data gathering, Ardent Concepts has developed the most versatile, field serviceable and most consistently reliable RF test socket for micro lead frame devices in the Industry.

In this white paper you will find key measurement information which substantiates the above claims, along with specific data, customer pictures, and repeatable test parameters.

Key Information about the RC Scrub-R Contact Set

The Secret is the Scrub.....

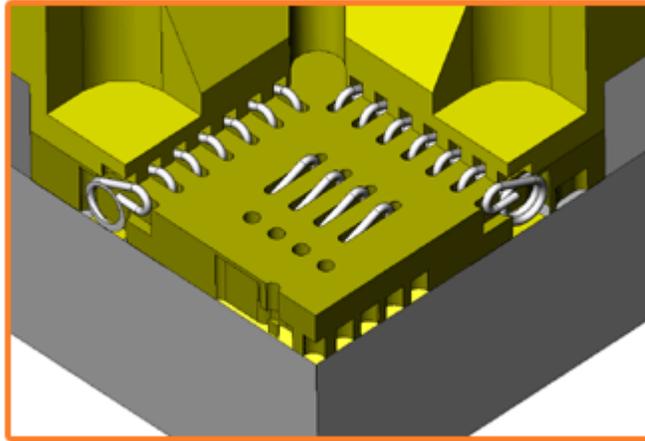


Figure 1: Cross Section of RC Scrub-R Contact Set

With a unique material base of semi-precious alloy, RC Scrub-R provides *linear scrub action* on the device pad while at the same time limiting the action on the board side. The result is a very consistent oxide penetration on new devices with almost zero board wear. Good scrubbing action is key to maintaining low and consistent DC resistance, which helps improve yields.

Keeping it Simple.....

Many chip scale test socket technologies employ complicated mechanisms and difficult to assemble components, from 3 and 4 piece “pogo” style contacts to elastomeric buttons and support beams which provide the much needed compliance necessary to make good contact. Many of these systems have complicated repair and maintenance requirements, and often require that the entire contact set be replaced. This can be a large hidden cost of ownership for many socket systems.

RC Scrub-R is the most elegant, most simple, and easiest to repair socket ever introduced. With one piece of thermally stable plastic and the extremely replacement friendly RC Scrub-R spring contact set, the whole system consists of only 2 parts (in some cases, a removable guide plate is designed as a consumable).

Many Test Socket companies employ contact sets developed by other companies.

RC Scrub-R Sockets utilize patented, production proven technology developed and extensively tested by Ardent.

What does this mean on the production test floor?

- Fewer components = fewer potential points of failure
- Simple replacement procedures for contacts = quick and easy repair and maintenance
- Fewer wear items = lower initial cost and lower overall cost through the life of each program

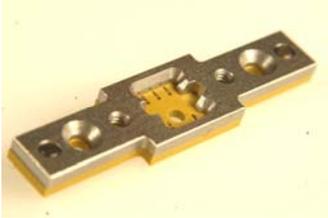


Figure 2: Snap In Contact Sets With No Beams or Elastomers

Contact Evidence & Witness Marks

RC Scrub-R sockets employ a patented 'offset coil' contact set which creates lateral translation on the device under test while preventing board wear. The scrubbing action of the contact tip cuts through tin oxides and contaminants, resulting in exceptionally high yields due to consistent DC resistance. This all metal contact set solution is unique in the industry.

RC Scrub-R™ socket systems can operate without frequent cleaning through hundreds of thousands of cycles.

The solution is compatible with pick-and-place, gravity-fed, and turret handlers, and can be used at high and low temperatures.

The contacts are individually replaceable and they offer RF and DC performance similar to the production proven RC Spring Probe vertical contact system.

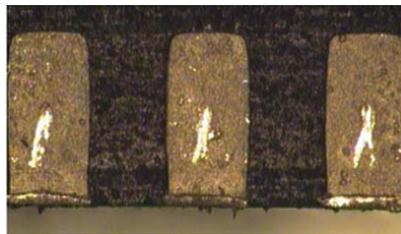


Figure 3: Witness Marks on Tin Lead Pads - QFN Device

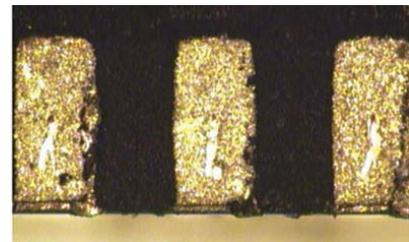


Figure 4: Witness Marks on Matte Tin Pads - QFN Device

Matching Existing Board Layouts & Contact Offset

Many ATE test sockets which provide “scrub” on the DUT require an offset. RC Scrub-R is designed to match with a .6mm offset between the DUT pad and the load board pad. In some situations, customers may be able to extend the board pad inward to accommodate a z-axis footprint for soldering down devices, making it a more versatile solution for multiple board uses.

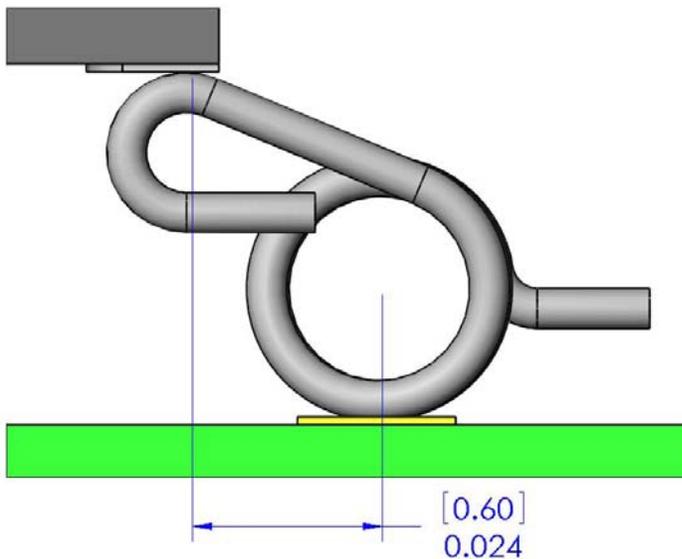


Figure 5: RC Scrub-R Pin Offset Definition

The board side contact points are always .5mm away from the package borders for devices whose pads extend to the edges of the device. Example: For a 7x7mm device, the distance between contact points from side to side is $7 + .5 + .5$ or 8mm. Of course, you don't want your contact points to coincide with the edges of the PCB pads, so a .25mm pad extension inward and outward provides room for error.

Board Wear Implications and Witness Mark Evidence

The unique geometry of the RC Scrub-R socket system provides *significant* performance advancements over rolling beam style socket technology. The lack of lateral translation on the board side essentially **eliminates board plating wear** over extended cycles. In the images shown here, board finish is hard gold, 50 micro inches of gold over 200 micro inches of nickel over standard copper thickness.

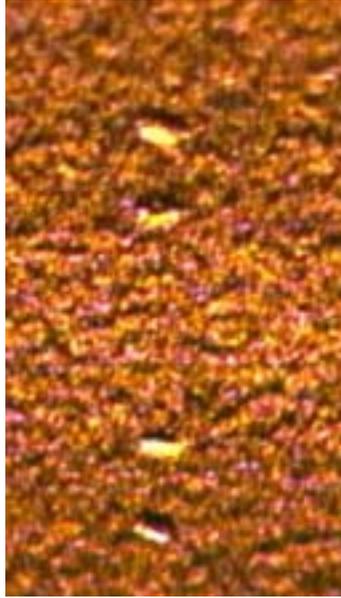


Figure 6: Board Side Witness Marks at 250K Cycles

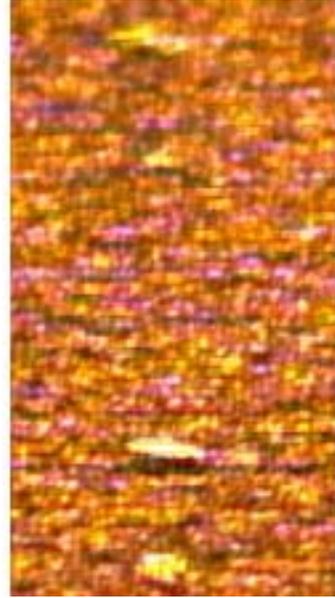


Figure 7: Board Side Witness Marks at 1 Million Cycles

Force vs. Resistance vs. Deflection Testing

To validate consistent DC resistance over extended cycling, Ardent performed extensive cycle testing with resistance measurements taken at various intervals.

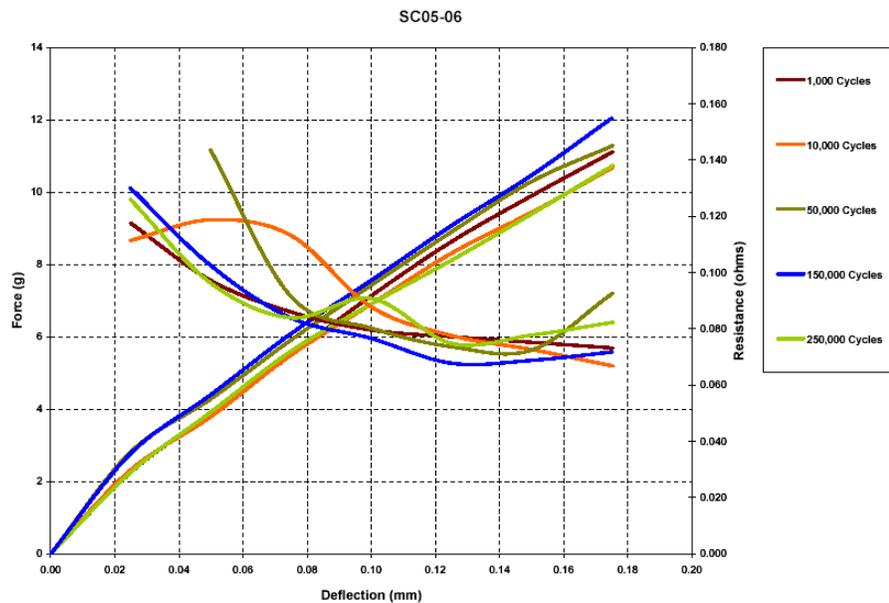


Figure 8: Force vs. Deflection vs. Resistance

Board Wear is one of the biggest challenges customers face when using a rocking beam style contact system.

RC Scrub-R Eliminates board wear by focusing the translation or 'scrub' at the DUT point of interface.

Current Carrying Capacity Testing

To provide customers with specific current carrying capacity of the RC Scrub-R socket system, contacts are inserted in a Torlon 4203 QFN insulator at .5mm pitch. The thermocouple bead is placed about .5mm away from the contact to be energized touching the vertical face of the ground slug cavity. The pin is energized with a power supply set to constant current values at given intervals. At each interval, the socket temperature is allowed to reach steady state before a measurement is taken. A thermometer is used to monitor ambient temperature. The data in the chart is corrected for changes in room temperature. The supply current is stepped up until a 30°C rise above ambient is reached.

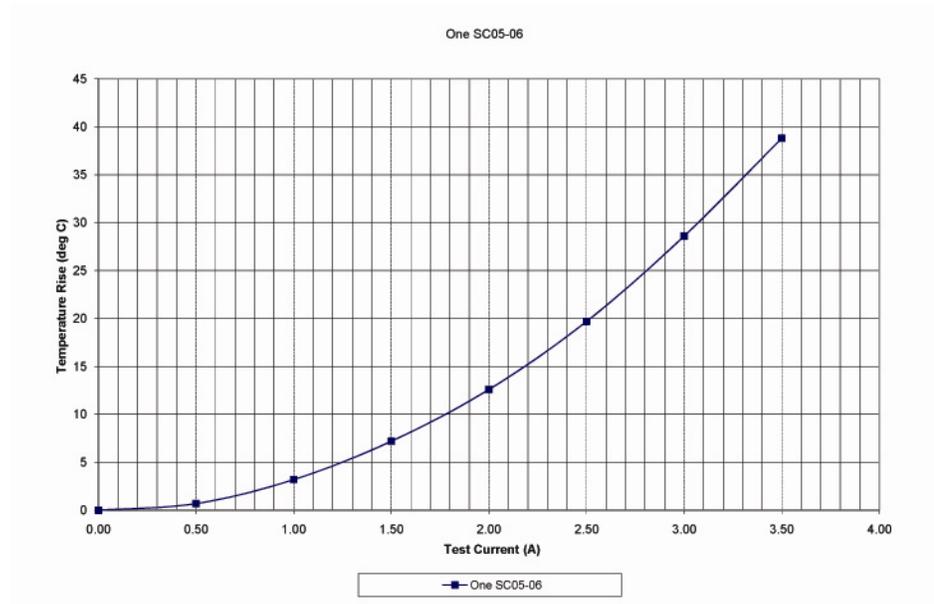


Figure 9: Current Carrying Capacity of One Pin Energized

AC Performance Testing

Maintaining low and consistent DC resistance over extended cycles is a key requirement for improving yields.

RC Scrub-R sockets offer a repeatable DC resistance value due to the self-cleaning mechanism provided by the 'scrubbing' DUT interface.

In order to demonstrate the multi-GHz performance of the RC Scrub-R test socket system, Ardent commissioned a study with Gatewave Northern to measure the AC Values. Bandwidth, capacitance, and inductance values of the system were tested in a controlled environment. The objective of these measurements is to determine the AC performance of the Ardent Concepts contactor in 0.5 mm configuration. A signal pin surrounded by grounded pins is selected for the signal transmission configuration. Measurements in both frequency and time domain form the basis for the evaluation. Parameters to be determined are pin capacitance and inductance of the signal pin, the propagation delay, and the attenuation in the frequency range from 50 MHz to 30 GHz.

Capacitance and inductance for the equivalent circuits were determined through a combination of measurements in time and frequency domain. Frequency domain measurements were acquired with a network analyzer (HP8722C). The instrument was calibrated up to the end of the 0.020" diameter coax probe. The probe was then connected to the fixture and the response measured from one side of the array. When the pins terminate into an open circuit compression plate, a capacitance measurement results. When a short circuit compression plate is used, inductance can be determined. Time domain measurements are obtained via Fourier transform from VNA tests. These measurements reveal the type of discontinuities at the interfaces. ¥

Insertion Loss

An insertion loss measurement is shown below for the frequency range of 50 MHz to 40 GHz.

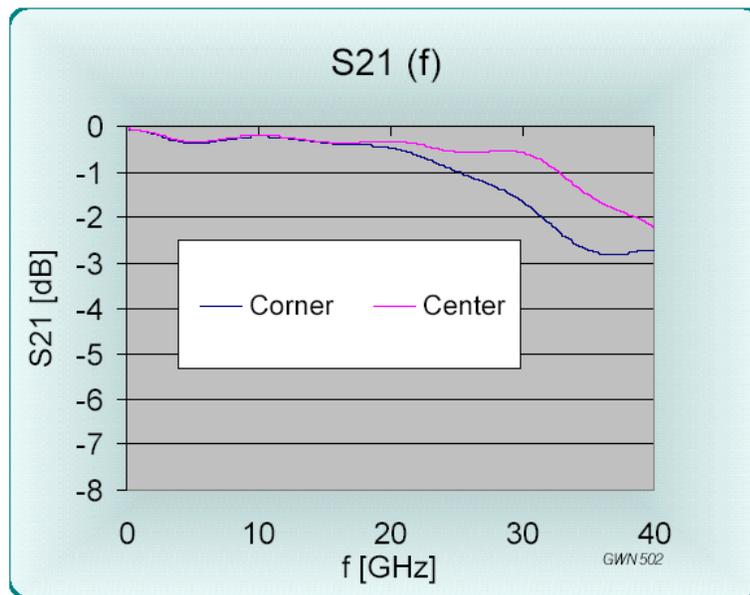


Figure 11: AC Curve Showing Insertion Loss less than -1dB to 32.7 GHz and -3dB point not reached before 40 GHz

Crosstalk as a Function of Frequency

Increasing speeds with many of today's devices requires a low-loss interconnect solution. RC Scrub-R sockets are rated to 32.7 GHz and have low inductance values.

The next graph shows forward crosstalk from port 1 to port 4 (S41, far end crosstalk {FEXT}) and backward crosstalk from port 1 to the adjacent terminal (port 3, S31, near end crosstalk {NEXT}). The -20 dB point is not reached before 22.9 GHz (S41). ¥

¥ - Courtesy of Gatewave Northern

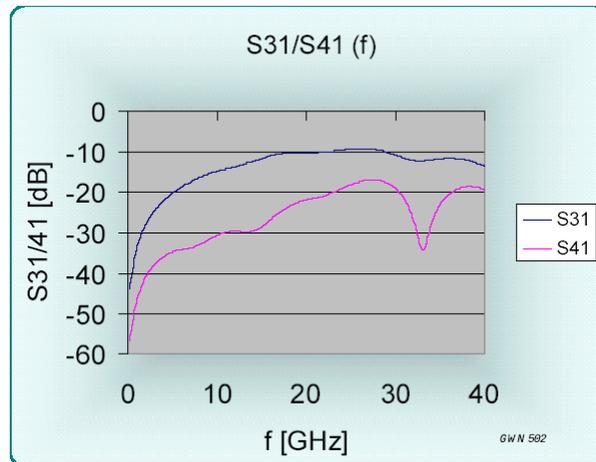


Figure 12: Crosstalk as a function of frequency.

Handler Cycle Life Testing

In order to validate the lifecycle testing of the RC Scrub-R socket system, Ardent worked closely with several customers to prove out lifecycle in the field at Asian production facilities on an SRM gravity fed handler system using new virgin devices. Custom experience varied according to part type, environment, DUT pad materials and handler speeds. Minimum customer lifecycle for field pin replacement was measured at 500K cycles for matte tin devices, with over 2 Million insertions achieved on NiPaAu devices. Two examples of specific customer feedback are provided below.

Customer 1: Matte Tin Pads:

Package : (2X2)

Device : QFN

Contact Pin Insertion : > 500 thousand touch down

Contact Socket Insertion : > 1 million touch down

Customer #2: NiPaAu Pads:

Package: (3x4)

Device: MEMS

Via Email: "Was looking at the<product deleted> line yesterday and received some feedback from the product line test manager and the technicians on the line working with your sockets. Just thought you might like to know that there are three handlers running 1.9m <product deleted> per week and still ramping. Total to date is about 5.6M insertions. They have not replaced one pin yet! I sent 400 to hold them over, until they could order some. There are 6 sockets on the line running 24\7. They do have to clean with a brush but there are no issues with the pins on the contact side or on the board side."

Field Service and Replacement

A common issue with ATE test socket is field service readiness. RC Scrub-R sockets are designed to be easily repaired and/or maintained in the factory.

In most cases, forced air is sufficient for cleaning debris from the socket system when in-situ. Ardent recommends a cleaning interval of forced air applied to the socket every 100K insertions. In addition, the socket can be removed from the handler and placed in an ISO bath to remove debris and improve electrical contact.

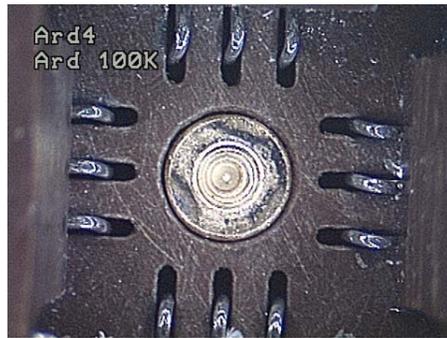


Figure 13: Debris on Scrub-R DUT Side

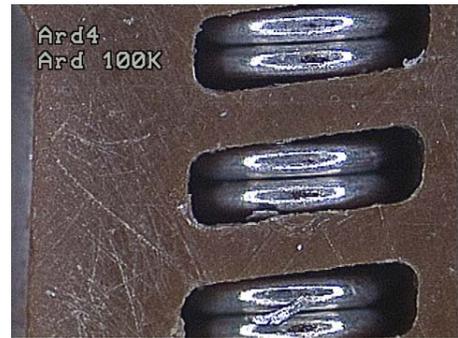


Figure 14: Board Side Pin Wear

The simple snap-fit design of the all metal contact makes for a very quick field swap-out of damaged or worn pins with simple tools and little to no training required. Each socket is shipped with a set of repair instructions.

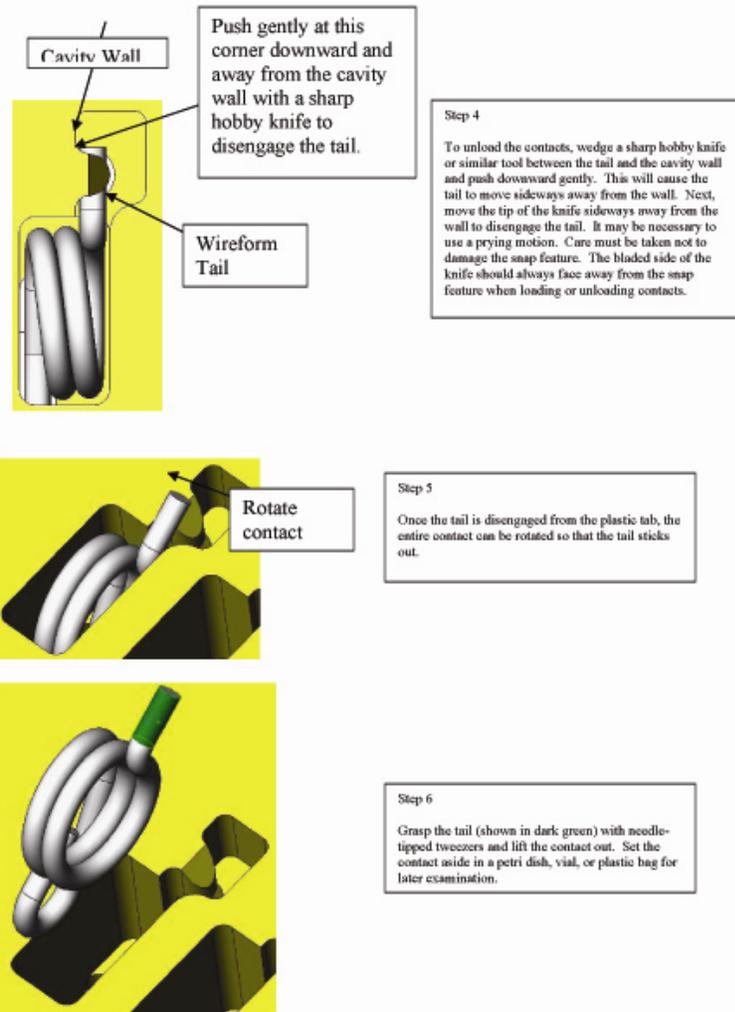


Figure 15: Removal of RC Scrub-R Contacts

The ability to quickly and easily refurbish sockets in the field is a key characteristic of RC Scrub-R sockets. Pins can be replaced with no special tools, and replacement parts are cost effective.

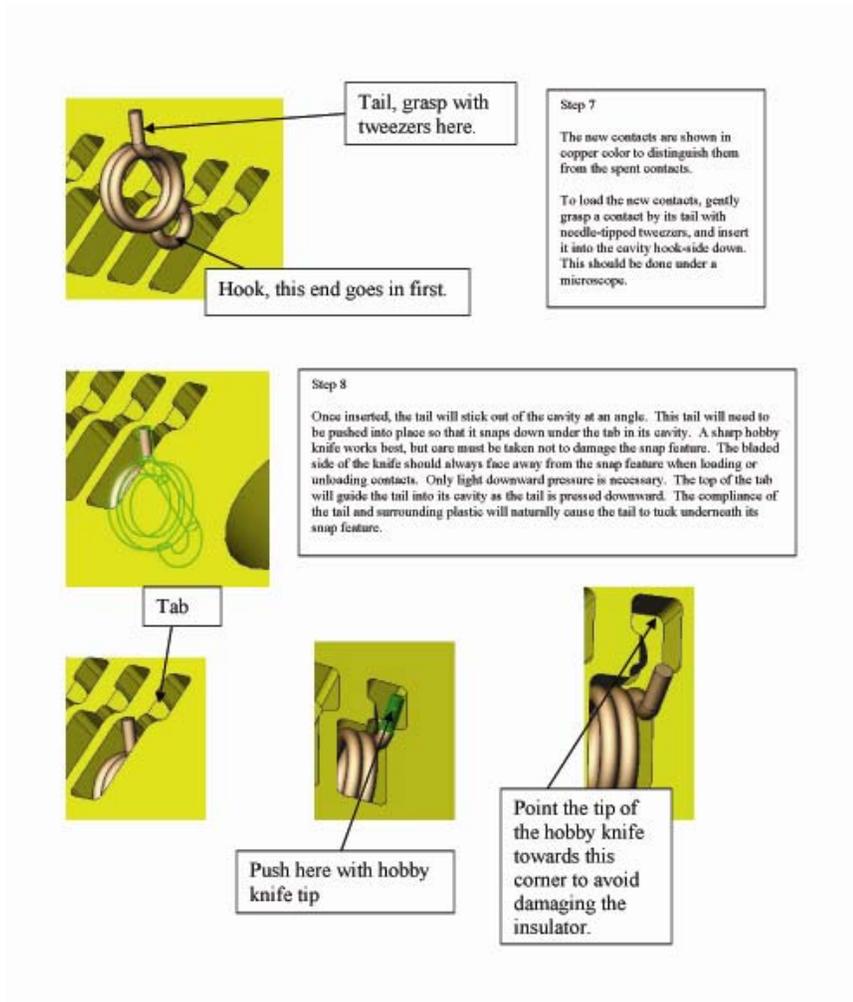


Figure 16: Installation of RC Scrub-R Contacts

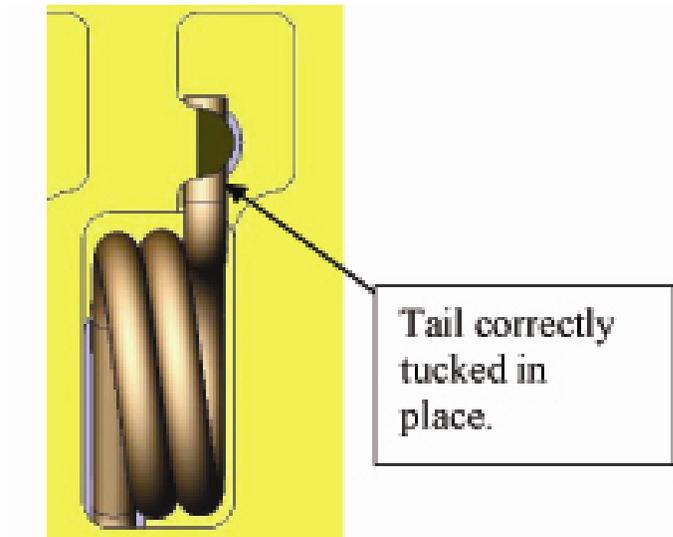


Figure 17: Final View of Replaced RC Scrub-R Contact

Summary

- ✦ Ardent Concepts has developed the RC Scrub-R Test Socket system to meet or exceed the harsh demands of high volume final test environments for QFN, MLF and other leadless packages.
- ✦ RC Scrub-R test sockets demonstrate little or no board wear over extensive cycles
- ✦ RC Scrub-R pins have a MTBF over 500K touchdowns and have proved capable of over 2 Million insertions in some conditions.
- ✦ RC Scrub-R test sockets represent a tremendous value in terms of initial cost, overall cost of ownership and handler down-time reductions.
- ✦ All RC Scrub-R test sockets are field-service ready
- ✦ DC Resistance Values for RC Scrub-R test sockets are low and consistent over extended cycles
- ✦ RC Scrub-R test sockets are compatible with most pick and place, gravity feed and turret style handler systems
- ✦ RC Scrub-R test sockets can handle up to 3 amps per pin with a 30 Degree temperature offset
- ✦ RC Scrub-R test sockets demonstrate an S21 bandwidth to 32.7 GHz @ <-1dB
- ✦ RC Scrub-R test sockets have a characteristic impedance value of 51.6 Ω

For More Information, or to request a socket drawing or detailed test data, please email info@ardentconcepts.com.

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