Comparative Study of SMT Grounding Pads: Conductive Silicone vs. Foil-Wrapped Designs

EXECUTIVE SUMMARY

This report presents a comparative evaluation of two surface-mount technology (SMT) grounding pads used for printed circuit board (PCB) applications: the Nolato Compashield SMT pad and a reference pad from a leading market competitor. Both products are designed as solderable silicone gaskets with conductive layers, offering an alternative to traditional metal spring clips. The study examines technical differences, particularly in conductive mechanisms, and assesses performance through a series of tests including impedance, electrical resistance under varying compression and environmental conditions, and visual inspection. The results highlight how design choices affect grounding reliability, resistance to environmental stress, and overall suitability for high-quality, cost-effective PCB grounding in electronics manufacturing. While the foil-wrapped reference pad exhibited lower DC resistance and impedance at low compression, making it suitable for low-stress, DC applications, its reliability was limited under environmental or mechanical stress. The Nolato Compashield SMT pad, though initially having higher resistance, demonstrated greater robustness and maintained functionality after aging and repeated compression. Therefore, the Nolato pad is suitable for applications where components face significant environmental or mechanical challenges.

INTRODUCTION

Effective grounding of printed circuit boards (PCBs) is a critical requirement in electronic equipment manufacturing. Grounding pads, such as SMT (Surface-mount technology) pads ensure reliable contact between the PCB and the chassis or shielding, mitigating issues such as static electric discharge, electromagnetic interference (EMI), and ground potential differences. Traditional solutions, such as metal spring clips, “fingers”, often introduce challenges including surface wear, fatigue failure, increased impedance, assembly issues, and suboptimal contact area.

To address these challenges, advanced grounding pads have been developed. However, not all SMT pads perform equally. This paper compares the performance of the Nolato Compashield SMT pad to that of reference design from a leading supplier. Both pads were designed for solderable PCB grounding applications.

TECHNICAL DESCRIPTION

Both products are solderable silicone gaskets with conductive layers, designed for SMT compatibility. This design reduces cost and enhances quality compared to traditional spring-based solutions. The Nolato pads were manufactured with three co-extruded layers, which were extruded directly onto a metal strip to achieve optimal integration before being cut to custom lengths. The reference pad featured a metallized polymer foil wrapped around an extruded silicone core. The primary distinction lies in the conductive mechanism: Nolato pads utilized two conductive silicone layers, while the reference design relied on a conductive film applied to the exterior surface of the silicone gasket.

Both the foil-wrapped reference pads and the Nolato pads aim at solving the problem of ensuring reliable PCB grounding, protecting against static discharge and EMI, and reducing cost and improving quality via direct extrusion. They also avoid drawbacks of metal springs such as surface wear, fatigue, assembly issues, and high impedance.

The comparative evaluation was conducted using test PCBs with both Nolato pads and the foil-based reference pads. Key tests included:

- Impedance comparison
- Electrical resistance before and after accelerated ageing (Temperature Cycling and Damp Heat Steady State) at compression degrees of 11%, 31%, and 53%
- Electrical resistance and Compression force vs. Compression degree at 0 - 80% compression
- Visual Inspection

The accelerated aging tests exposed the pads to relatively extreme environmental conditions, involving temperature cycling between -40 °C and 125 °C for 1000 cycles, as well as a damp, heat steady state at 85 °C and 85% RH for 1000 hours, both during which the pads were compressed up to 53% degree. All methods are described under the Methods section of this paper.

RESULTS AND DISCUSSION

IMPEDANCE COMPARISON

Impedance measurements (described in the Methods section) show that both products performed similarly across the tested frequency range, indicating comparable grounding performance before ageing or mechanical stress exposure (Figure 1).

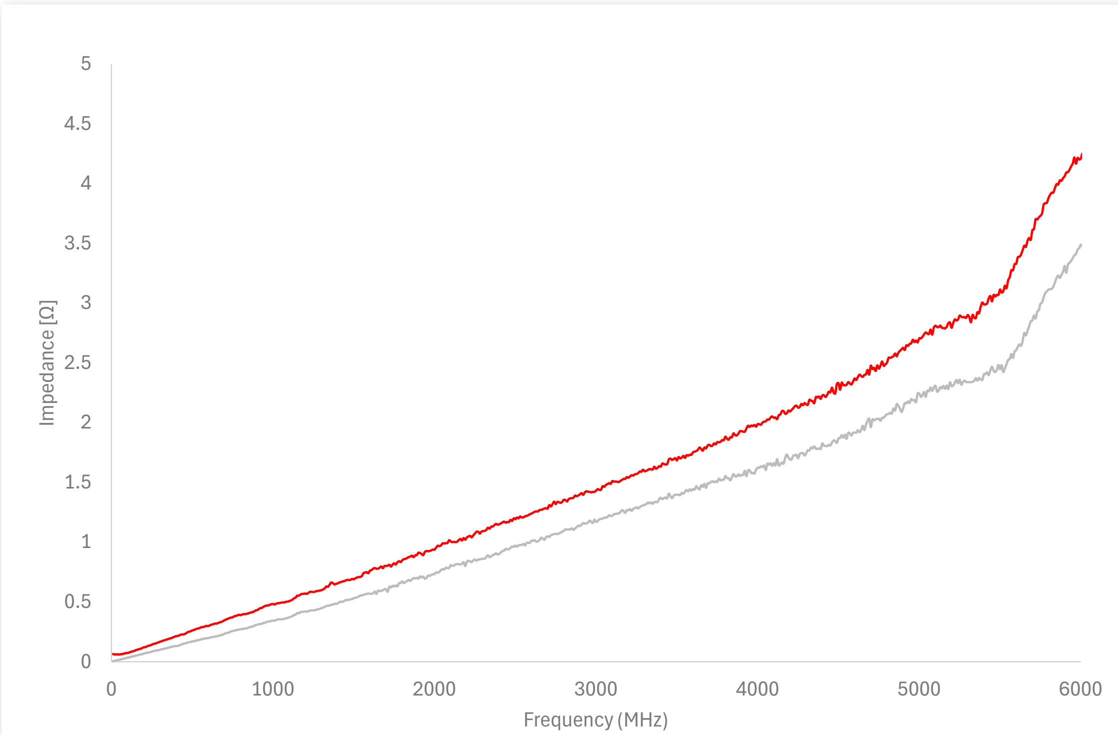

Figure 1. Impedance measured 0 - 6 GHz for the Nolato- (red) and reference (grey) pads.

ELECTRICAL RESISTANCE AND COMPRESSION

The compression force as well as the electrical resistance of the pads as of function of compression were measured as described in the Methods section. The Nolato pad maintained structural integrity and function up to 80% compression (Figure 2, 3). Resistance increased from 0.056 Ω (before compression) to 0.132 Ω (after 80% compression). The reference pad exhibited very low initial resistance (0.008 Ω). However, it suffered significant mechanical failure between 70% and 80% compression (Figure 2 and 4). No functional contact was observed after 80% compression. This type of latent damage can cause a component to function correctly for a period after the initial event, only to fail under normal operating conditions or further stress.

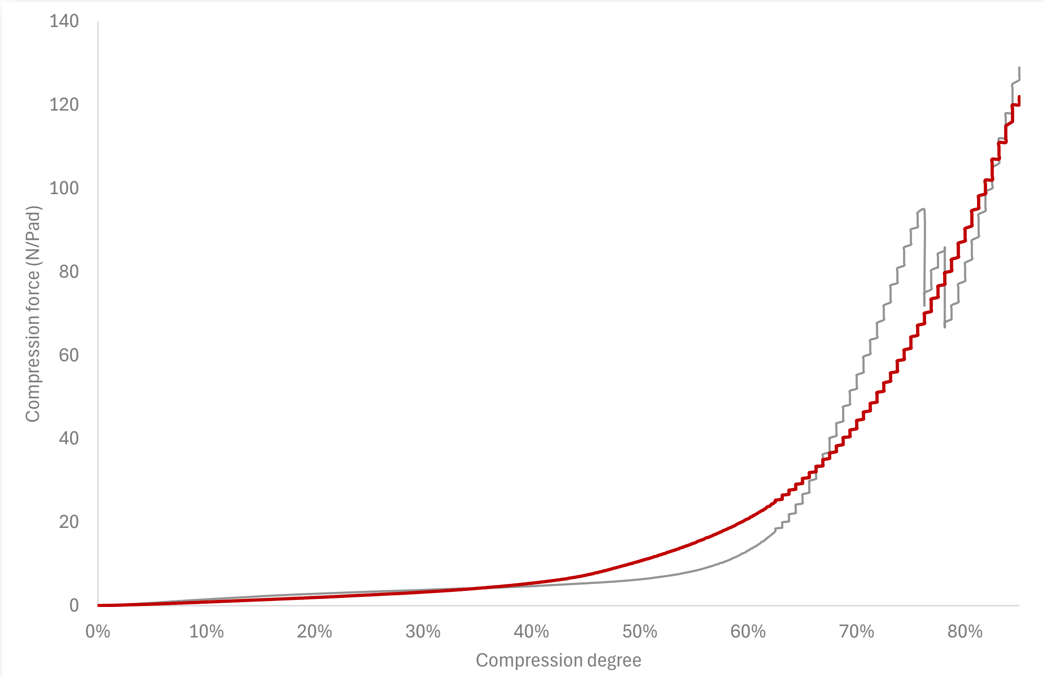

Figure 2. The compression force of the Nolato SMT Pad (red line) and the reference pad (grey line) plotted against the compression degree. The mechanical failure of the reference pad could be seen as the jigsaw pattern in the data line around 70 - 80%.

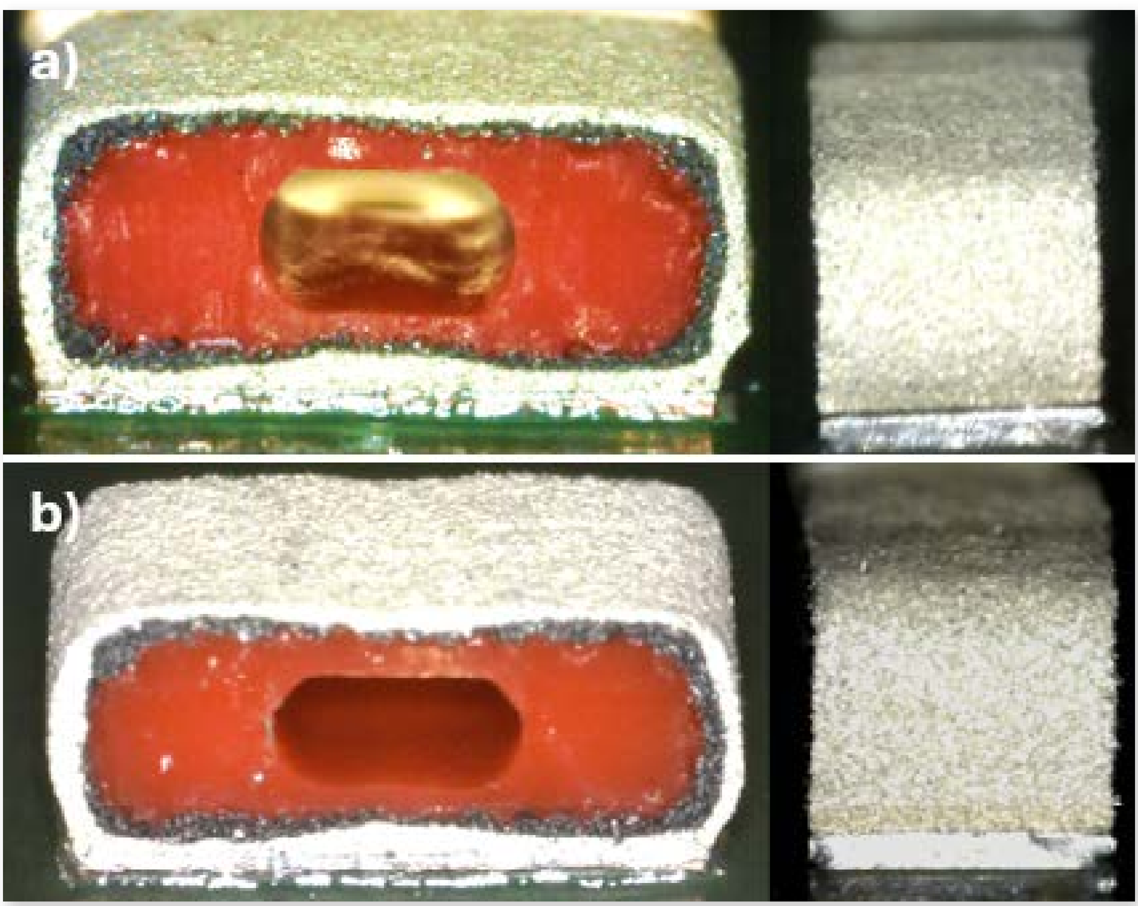

Figure 3. Nolato Compashield SMT Pad before compression (a) and after 80% compression (b). No mechanical failure could be seen.

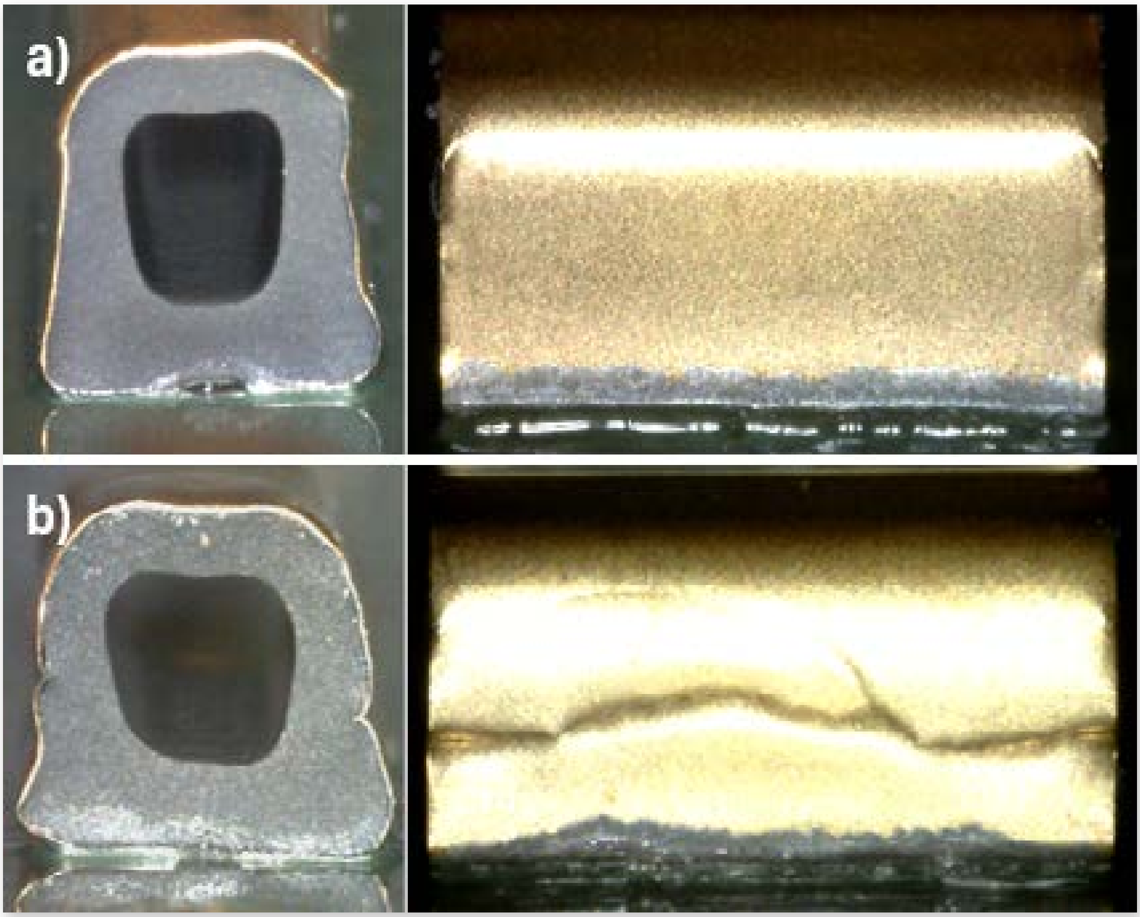

Figure 4. The reference pad before compression (a) and after 80% compression (b). Mechanical failure could be seen on both sides of the metallized foil.

ELECTRICAL RESISTANCE AFTER ACCELERATED AGING

Table 1. Resistance results of Nolato and reference SMT pads before and after damp heat steady state (1000 h, 85 °C / 85% RH) ageing.

Compression	Reference Before (Ω)	Reference After (Ω)	Nolato Before (Ω)	Nolato After (Ω)
11 %	0.007	0.007	0.054	0.056
31 %	0.007	0.252	0.055	0.107
53 %	0.007	No contact	0.05	0.192

Table 2. Resistance results of Nolato and reference SMT pads before and after ageing by temperature cycling (1000 cycles, -40 °C to 125 °C).

Compression	Reference Before (Ω)	Reference After (Ω)	Nolato Before (Ω)	Nolato After (Ω)
11 %	0.008	0.018	0.054	0.062
31 %	0.007	0.108	0.055	0.180
53 %	0.007	No contact	0.050	0.748

As mentioned previously, before being subjected to significant compression, the reference pad showed lower resistance than the Nolato pad. This was also the case after ageing. However, at 31% compression degree, the reference pad showed higher electrical resistance after steady state ageing. Moreover, at 53% compression, when subject to accelerated aging, both at damp heat steady state (Table 1) and temperature cycling (Table 2), the reference pad lost electrical contact. This indicated severe degradation even at moderate compression rates. Nolato Compashield SMT maintained function, though resistance increased at higher compression and after aging.

VISUAL INSPECTION

After 1000 hours of ageing in damp heat steady state (85 °C / 85% RH) and subsequent compression to 31% no visual defects could be seen on the Nolato SMT pad, whereas the reference pad displayed a significant crease in the foil (Figure 5). Moreover, after 54% compression and ageing by thermal cycling (1000 cycles, -40 °C to 125 °C) the crease on the side of the reference was even more significant, whereas the Nolato pads did not show any visible cracks or damages (Figure 6).

Figure 5. Nolato (left) and reference (right) pads after compression to 31 % and damp heat steady state (1000 h, 85 °C / 85% RH) ageing. The arrow is indicating a crease in the surface foil of the reference pad.

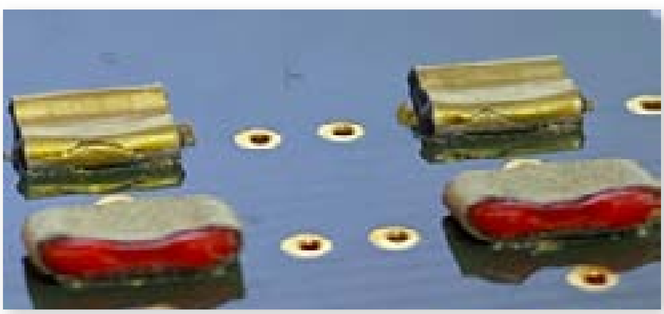

Figure 6. Nolato (foreground) and reference (background) pads after compression to 53% and thermal cycling ageing.

The main function of a ground pad is to conduct electricity from one surface to another. The pads in this study performed this function in a slightly different manner: the Nolato pad has a layer of conductive silicone whereas the reference pad has a metallic foil attached to its outer surface. As described above: ageing and stress caused cracks and creases in the foil of the reference pad. Seemingly, the design of achieving conductivity through conducting silicone was more robust, than a metallized polymer film design.

CONCLUSION

Both the Nolato Compashield SMT pads and the foil-wrapped reference pads are advanced grounding pads for PCB applications. As described in the beginning of this paper, both pads aim to offset the problems of conventional metal springs, such as surface damage, fatigue, and high impedance. The DC resistance of the reference pad at low compression rates was eightfold lower than that of the Nolato pad. This implies that the reference pad might be the better choice for applications including only direct current (DC) and low mechanical stress. The impedance of the reference pad was also indeed lower throughout the measured frequency range. However, percentagewise the difference was decreasing at increasing frequencies. This means that the pads were approximately equal in AC applications involving low mechanical stress. Furthermore, given the mechanical failure of the reference pad, the Nolato Compashield SMT pad seems like the better choice in applications involving environmental and/or mechanical stress to the components.

METHODS

IMPEDANCE

Impedance was measured using a dedicated fixture designed for high-frequency characterization of SMT pads and compression spring contacts. The fixture consists of a base and lid printed circuit board assemblies (PCBA), with the device under test (DUT) mounted on the lid. Compression between the boards is controlled by shims to ensure consistent contact pressure.

Microwave signal paths in the fixture include coaxial, coplanar waveguide with ground, and inverted microstrip transmission lines. One path is used for calibration, while the other is used for measuring the DUT. Measurements were performed using a vector network analyzer (VNA) with a two-port shunt-through method.

The DUT shorts the microstrip, allowing the VNA to measure the residual voltage across the DUT, analogous to a four-wire DC resistance measurement but at high frequencies. The transmission parameter S21 is recorded and used to calculate impedance. The characteristic impedance of the signal path is nominally 50 Ω, but may vary with compression and component selection.

Gold-plated SMT pads are used to minimize contact resistance and oxidation. Calibration is performed on the same substrate as the DUT to reduce manufacturing variation. Measurements are repeated for different compressions and feed components to ensure repeatability.

Impedance is calculated from S21 using standard equations. Time-domain reflectometry is used to verify fixture impedance and identify mismatches. All measurements are performed under controlled conditions, and fixture improvements are considered to enhance reliability.

ELECTRICAL RESISTANCE VS. COMPRESSION

A square gold-plated electrode 10 x 10 mm was mounted on the upper grip jaw of a tensile tester (Hounsfield H5KS, Tinius Olsen, West Sussex, UK) and positioned to ensure full planar contact with the sample. The sample was put on a silver contact plate in the tensile tester. The plate and electrodes were connected to an ohmmeter by electrical cables. The electrodes were lowered until an initial resistance value of the sample was detected on the ohmmeter. The pre-load was 0.05N. The initial resistance response was recorded as zero value. Both force (N) and position (mm) were reset at this point. Compression of the gasket was performed by lowering the electrodes onto the sample at a constant rate of 1 mm/min. The resistance was recorded at 0%, 5% and 10%, and then each 10% until 80% compression degree was reached. All samples – both reference and Nolato pads – were soldered to a test PCB prior to testing. Due to their design, the reference pads behave differently during compression depending on if they are soldered or loose (unattached). In contrast, Nolato pads are unaffected, as they are extruded onto a metal strip during production.

ELECTRICAL RESISTANCE AFTER ACCELERATED AGING

Sample fixtures for ageing under compression consisted of a cover made of magnesium alloy AZ31B placed over the PCB fixture. Shims were used between covers and PCB's to obtain the compression degrees of 11%, 31%, and 53% respectively.

The fixtures were then placed in climates for accelerated ageing: Damp Heat Steady State (85 °C / 85% RH, 1000 hours) or temperature cycling (-40 °C to 125 °C, ramp 10 °C/min, hold 30 min, 1000 cycles), using suitable climate cabinets.

Post ageing, the electrical resistance of the SMT pads were measured using an Ohmmeter (Figure 7) by applying a 10 x 10 mm gold-plated electrode to the gasket on a silver contact plate, typically with a 6.5 N force. A compression stop of 1.2 mm which equaled 25% was used. After temperature cycling at 53%, both reference pads and Nolato pads were measured without the compression because the components had reduced height after aging.

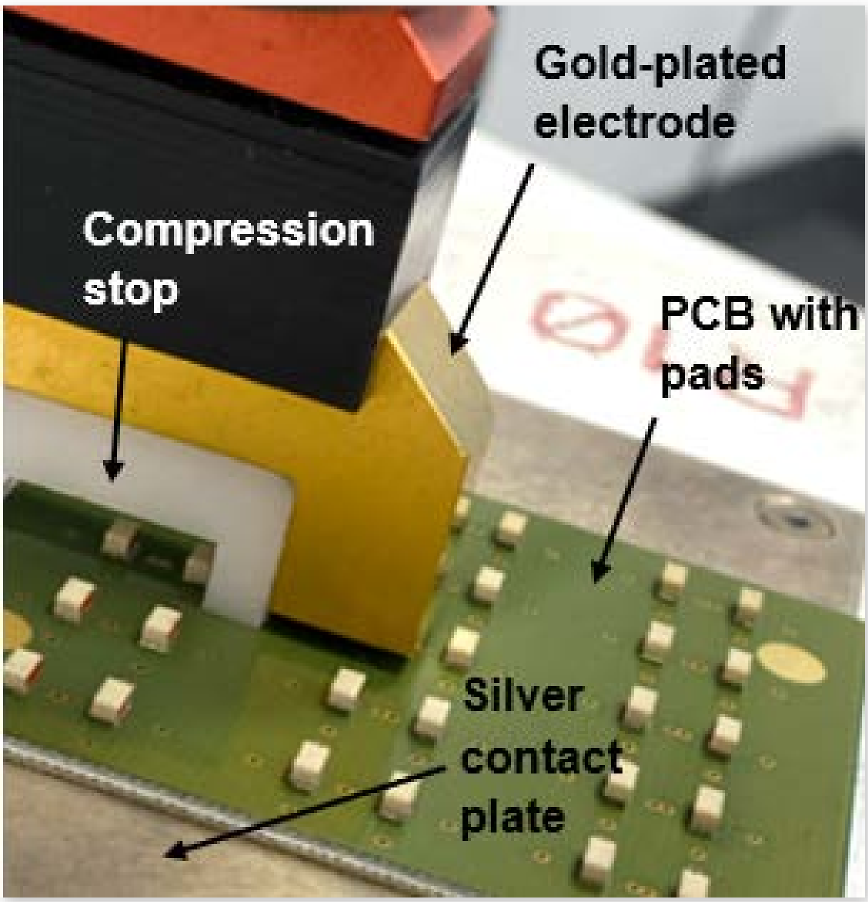

Figure 7. Experimental setup for measuring electrical resistance. The sample SMT pads are soldered to a PCB which is placed between a gold-plated electrode and a silver contact plate. A compression stop is determining the distance between electrode and the PCB, i.e. the compression rate during the measurements. The resistance between the gold-plated electrode and the silver contact plate is measured using an Ohmmeter.

Nolato Silikonteknik AB
Bergsmansvägen 4, SE-694 91 Hallsberg, Sweden
Tel +46 582 889 00 | Fax +46 582 889 99
silikonteknik@nolato.com | www.nolato.com/silikonteknik