Adhesive Tag Fixation: A guide how to bond RFID Tags

INTRODUCTION
Modern adhesives are a viable option for efficient and durable bonding between different materials. This guide is designed to educate integrators and end users on various techniques for RFID tag fixation, resulting from extensive testing results of Henkel adhesives with HID Global RFID tags.
RFID Tag Product Selection

As many factors can impact RFID product selection, it is assumed that the appropriate frequency and tag form factor have already been identified. For assistance with identifying the proper technology for a specific application, contact an HID Global representative, visit the RFID Tag selector website or consult the HID RFID Tag Positioning paper or Comparison chart.

General Tag Placement

In selecting an appropriate tag location, several factors should be considered.

**O R I E N T A T I O N**

Most RFID tags read best when presented in a specific orientation relative to the reader antenna. A tag placed in the wrong orientation may experience a radically reduced read range or may not read at all. Experiment to determine the best placement for a specific tag/reader combination, and ensure the tag is applied in the proper orientation.

**P R O X I M I T Y T O M E T A L**

Metal presents a particular challenge to RFID. Most RFID tags show reduced performance when used near metal. Generic tags placed directly on a metal surface will likely not read at all. However, advanced RFID tags are specifically designed for use on or near metal. These tags typically have a special housing incorporating a gap of controlled width between the tag’s antenna and the underground surface or are tuned to optimize performance near metal.

Mount-on-Metal tags by design can only be read from the exposed portion of the tag, opposite the metal. It is impossible to read a Mount-on-Metal tag from the opposite side of the metal surface. If the tag is optimized to work on metal only, it is important to ensure that for those tags the housing is in close contact with the metal surface. Any non-metallic spacer placed between the tag and the surface may reduce performance. Other tags like the flat InLine Tag™ Ultra variants work equally well on metal and non-metal surfaces due to their built-in metal foil. This tag is tuned to work on metal and if there is none, the metallic back of the tag is sufficient to achieve the same performance on non-metallic underground.
Advantages of DBond™ Technology

PROXIMITY TO OTHER TAGS
RFID tags placed in close proximity can interfere with each other. This is especially true for UHF tags. It is important to follow the minimum spacing guidelines for each specific tag.

MOISTURE
Although most tags are physically unaffected by water, the read range of some tags diminish significantly in the presence of moisture. As a general rule, the higher the frequency, higher probability the read range will be impacted by moisture. If it is suspected a tag will be exposed to moisture, rain or snow prior to deployment, test the tag in the moist environment to ensure it performs as expected.

MECHANICAL STRENGTH
Ensure maximum contact between the tag and the surface during application. This is especially important for adhesive fixation. Maximal contact ensures the tag remains in place when exposed to mechanical shock and vibration.

OBSTRUCTIONS
In general, RFID tags do not require line-of-sight to read. However, testing the tags in their final operating environment is recommended to prevent any unforeseen interference from obstructions.

Fixation Method

There are numerous fixation possibilities such as adhesive fixation, mechanical fastening, textile fixation or welding. Although multiple fixation methods are available for most tags, certain methods may yield better results in a specific application. Adhesive fixation, for instance, is one of the simplest and most flexible methods to implement.

When selecting a tag fixation method, be sure to test the method both for strength and for readability of the tag prior to putting it into practice. This document focuses exclusively on adhesive fixation. For
ADHESIVE FIXATION

WHY ADHESIVES?
There are multiple advantages of adhesive fixation method:

ADHESIVES PROVIDE SOLUTIONS FOR DIFFICULT DESIGN CHALLENGES.
Adhesives can join various dissimilar substrates such as plastics, metals and many other materials. This technique can bond soft or flexible materials without losing their strength. Furthermore, different adhesive technologies are available to meet specific user requirements like high temperature resistance, high toughness, fast curing and high strength. All of these features are maintained even in corrosive environments.

ADHESIVES CREATE INNOVATIVE DESIGNS, IMPROVE THE COSMETIC APPEARANCE AND REDUCE WEIGHT.
The conventional methods; welding, riveting or other mechanical fastening negatively affect the visual appearance of specific parts, whereas adhesives do not cause a change in the texture of the joined material. Moreover, it is more challenging to join thin-walled parts (< 0.5 mm) with the conventional methods. Adhesives are particularly attractive for lightweight constructions or very tiny tags like the HID Brick Tag (see image on the right).

ADHESIVES INCREASE THE RELIABILITY OF THE BONDED PRODUCT.
Choosing mechanical fasteners result in localized stress peaks that often lead to fastener failure. Adhesives distribute the stress more uniformly over the entire bond face, causing a much better absorption of stress loads. In addition, welding temperatures may change the texture and mechanical properties of the materials, leading to a lack of stability. Also, using an adhesive is the ideal solution for non-invasive applications. For example, liquid or gas container surface cannot be damaged by screw affiliation. In addition, adhesives can act as sealants, preventing a loss of pressure or liquids.

SAVE COSTS USING ADHESIVES.
Reliable bonded assemblies reduce failure rates and costly downtimes. Moreover, adhesive solutions simplify processing through ease of automation, which reduces assembly costs and increases throughput. The material cost of bonding per unit is typically also lower compared to most fastening devices.
Selecting the Right Adhesive

The right choice of adhesive depends on many factors such as the substrates used, application method, required gap, environmental conditions, and process requirements.

The type of substrate is an important criterion, as adhesives tend to give better results on different surfaces mainly due to their chemistry. Therefore, the material of the tag and the surface to be bonded are important.

The chart on the right shows an overview of the different adhesive technologies and their performance on different substrates. Further, selecting the right adhesive depends on the application method: Are the tags mounted in an automatic process or are they mounted manually? If manually, where and by whom is the RFID tag going to be applied? Will there be special training required for these people? Are there any time or other relevant constraints?
Once these questions are answered, the bond line needs to be addressed: How big is the required gap between the tag and the surface? The gap might have an impact on the signal strength of the chip, and different adhesives are needed for different gap dimensions. As an advantage of adhesives, minor irregularities or curvature of the bonding surfaces may be compensated by the glue.

The environmental conditions have a major impact. In order to select the right adhesive, an assessment of different environmental factors is needed. Factors such as permanent or repeated exposure to water or moisture as well as the influences of light, heat or cold affect adhesion selection. The process itself and the desired production speed must be considered as well during adhesive selection. The required fixation time of the tags, the frequency of bonding or involvement of other process steps in parallel also play a key role in selecting the right adhesive.
Wettability of the surface strongly influences adhesion characteristics and the strength of adhesion can be promoted by using surface treatment techniques. Poor wetting can occur due to contamination, coatings (e.g. corrosion protection) or substrate incompatibility (i.e. surface energy incompatibility). The surface energy of substrate typically needs to exceed the surface tension of adhesive for successful bonding. Materials with high surface energy such as metals, glass and some plastics, like PC and ABS, have a better compatibility with most of the adhesives. These plastics are used in HID World Tag, InLine Tags and Keg Tag. Materials with low surface energy such as polyolefins or thermoplastic elastomers usually require additional surface treatment to overcome incompatibility problems. The use of correct surface treatment techniques prior to bonding will ensure the best outcome. Various treatment techniques can be used as required, such as cleaning, chemical and physical surface treatments or mechanical treatments in order to promote adhesion.

Contamination on the surface usually reduces the bonding strength of the adhesive joint. Cleaning helps to eliminate these contaminants. Contaminants may originate from a variety of sources, e.g. from machining like drilling or grinding, preservative oil, handling, washing/cleaning, manufacturing (e.g. mould release agents), the material itself, the environment, or oxide layers.

A distinction can be made between solvent cleaners and aqueous cleaners; each has advantages over the other. The Henkel product range includes both types of cleaners, which all have special main features, such as natural extracts, heavy duty or fast drying.

Chemical treatments, for instance activators or primers, help to modify the surface energy of the substrate and to activate the passive surfaces. Plasma or corona treatments are well-known examples of physical treatment. These treatments form new/additional active centers on the material surface for better adhesion. They require specific equipment and are more frequently used in complex industrial settings. Thus, they might be considered less relevant for on-site manual tag bonding processes.

Mechanical treatments may also be used to improve adhesion. Grit blasting for instance, is an efficient mechanical treatment method. It removes the formed oxide layer, increases the surface area, and ensures a well-defined surface.
Henkel conducted tests to get an initial assessment of the bonding quality on various tags.

The tested tags were: World Tag (20 mm, 30 mm, 50 mm), Epoxy Tag (LF Disc 30mm, UHF), InLine Tag (Ultra, Ultra Curve, Plate), In Tag (200, 300, 500), Iron Tag (176, 206), Keg Tag (UHF), a LogiTag (121), Poly Tag (340) and SlimFlex Tag (200, Mini).

The mating materials were selected based on the specifications provided by HID datasheets. Mild steel was used for metal applications and polycarbonate was used for plastic applications. All parts were cleaned with Loctite Cleaners prior to bonding to maintain a contamination-free bond face.

Plastic parts were cleaned with Loctite 7070 and metal parts were cleaned with Loctite SF 7063. The mild steel specimens were additionally grit-blasted to improve adhesion. Subsequently, adhesive was applied using Loctite 4090 for all tags except SlimFlex tags. These tags did not achieve a sufficient level of bonding due to their challenging surface character. A primer, Loctite SF 770 was used to make the low-energy surface of SlimFlex tags suitable for Loctite cyanoacrylate adhesives. After activation of the passive surface of SlimFlex tags, they were bonded with Loctite 406. The qualitative ratings of these results are shown in the upper table, where 1 indicates weak adhesion, 2 represents strong adhesion and 3 means strong adhesion with substrate failure (i.e. the tag or the substrate breaks before the adhesion gives up).

Overall, Loctite 4090 shows very good adhesion with a variety of different tags. SlimFlex tags showed the best results using Loctite 406 in combination with a primer (Loctite SF 770).
The aging performance of adhesives was also monitored. One representative tag from each tag class was selected. These samples were bonded and aged at 40°C and 98% RH for 1,000h in a climate chamber. The results are presented in the bar chart above. The bonded parts showed good stability at aging conditions compared to their initial strength, which underlines the successful applicability of Henkel solutions for tag fixation.

The chart below provides a brief summary of different adhesives and their performance with regards to strength and speed.

### Summary

Henkel offers a comprehensive portfolio of tailor-made solutions across various industries. With powerful innovations and leading technologies under top-brands such as LOCTITE, Henkel creates sustainable value for its customers. A global team of experts partners with industrial customers to deliver best-in-class service. For more information on Henkel adhesives visit [www.henkel-adhesives.com](http://www.henkel-adhesives.com)

All HID Global RFID tags support a multitude of use cases and environmental conditions. Additionally, HID Global offers customization services including, special tag designs, custom tag colors, laser engraving, programming or packaging. For more detailed information on our tag portfolio, visit our tag selector page at [www.hidglobal.com/rfid](http://www.hidglobal.com/rfid)

For further assistance, please contact your local HID partner or tagsales@hidglobal.com.