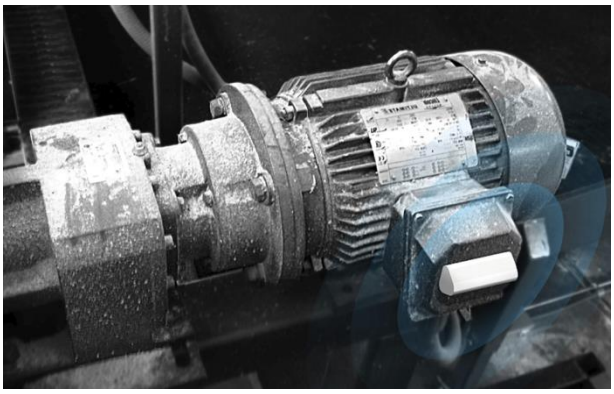
WHITE PAPER

RFID Tag / BLE Beacon Fixation Guide

Introduction



This guide is designed to educate integrators and end users on various available techniques for RFID tag or BLE beacon fixation.

Product Selection

As many factors can impact 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 representative or consult the HID RFID Tag Selector.

General Tag Placement

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

Orientation

Most RFID tags read best when presented in a specific orientation relative to the reader antenna. A tag in the wrong orientation may experience radically reduced read range or may not read at all.

Experiment to determine the best orientation for a specific tag/reader combination, and ensure the tag is applied in the proper orientation.

Proximity to Metal

Metal presents a particular challenge to RFID. Most RFID tags experience reduced performance when used near metal. A tag placed directly on a metal surface will likely not read at all.

Some RFID tags are specifically designed for use on or near metal. These tags typically have a special housing which provides a gap of controlled thickness between the tag antenna and the metal surface or have a built-in metal foil (so the tag brings its own metal to work anywhere). The tags are also 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 other side of the metal surface.

Some tags are optimized to work on metal only. These include the IronTag®, Keg Tag, InLine Tag™ Plate and Brick Tag Ceramic. 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 result in a reduction in performance. Other tags like the flat InLine™ Ultra variants or BEEKs™ Beacons work equally well on metal and non-metal surfaces due to their built-in metal foil.

Note that the InLine Tag Ultra Curve tag has a curvature radius of 450mm, and therefore works best when affixed to a curved metallic surface with curve radius between: 420 mm and 550 mm (e.g. standard size steel kegs). The Keg Tag UHF has a curve radius of 126/163 mm and is therefore suitable for smaller steel kegs.

For more details, see the chapter “RFID Tags in and on-Metal” at page 8.

Proximity to Other Tags

RFID tags placed in close proximity can interfere with each other. This is especially true for UHF tags. Be sure to follow minimum spacing guidelines for a specific tag.

Moisture

Although most tags are physically unaffected by water, the read range of some tags diminishes significantly in the presence of moisture. As a general rule, the higher the frequency, the more likely the read-range will be impacted by moisture. While LF tags are essentially unaffected by water, UHF read range is strongly reduced while the tag is wet. If it is suspected that a tag will be exposed to moisture, rain or snow, be sure to test the tag in the moist environment to ensure that it will perform as expected.

Mechanical Strength

Ensure maximum contact between the tag and the surface. This is especially important for adhesive fixation. Maximum contact will help to ensure that the tag remains in place when exposed to mechanical shock and vibration.

Obstructions

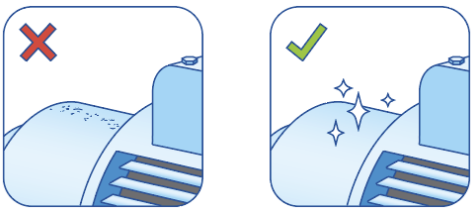
In general, RFID tags do not require line-of-sight to read. Be sure however, to test tags in their final operating environment, to prevent any unforeseen interference from obstructions.

Fixation Methods

Although multiple fixation methods are available for most tags, some methods may yield better results in a specific application.

When selecting a method of tag fixation, be sure to test the method both for strength and for readability of the tag prior to putting it into practice.

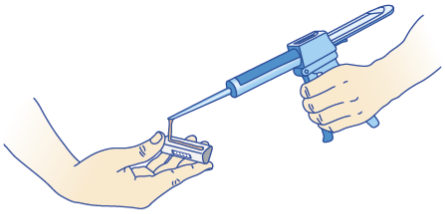
Adhesive Fixation



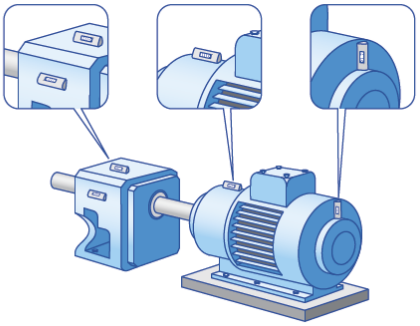
Adhesive fixation may be one of the simplest methods to implement and typically results in the maximum possible read range for a specific tag. Regardless of the adhesive used, always ensure that the tag and surface are clean, dry and free of debris to ensure maximum bond strength.

Where environmental conditions permit, a peel-and-stick adhesive may be sufficient to secure a tag to a surface. When a stronger adhesive bond is required, a silicone sealant (i.e. Dow Corning AS 7096) or acrylic adhesive (i.e. 3M 300LSE tape,

Henkel Loctite 4090 or 3M Scotch-Weld DP810 glue) may be used. Special glues exist for medical grade applications.



The BEEKS CM v2 BLE beacon has been designed for advanced condition monitoring and is able to record vibration data up to 25.6 KHz. For optimal functionality of this beacon, we suggest to mount it with industrial glue like the LOCTITE 330, the DEVCON 5 MINUTE EPOXY or the DEVCON DEVWELD. For simple status monitoring like whether a machine is on or off, the beacon may also be affixed with a strong double-sided sticky tape.



For silicone sealants, fixation must occur at room temperature and at approximately 50% humidity. Ensure the thickness of the adhesive (space between the tag and the surface) does not exceed 2 mm. Although the bond may set quickly, total curing time may be up to several days.

Apply acrylic adhesives at temperatures greater than +21°C (+70°F). Once applied, pressure and moderate heating can be used to create an even stronger bond.

With any adhesive fixation method, following the instructions from the adhesive manufacturer typically results in the strongest bond.

As an example, the IronTag® comes with an optional sticker “3M VHB 9473” that endures the same temperatures as the tag (236°F/180°C for 400h). Sticker temperature tolerance (Long Term) 300°F/149°C: Maximum temperature where tape supports 250g in static shear for 10,000 minutes (166h). Temperature tolerance (Short Term) 500°F/260°C: 4-hour conditioning at the indicated temperature with 100g static load. This should be easily sufficient as the tag weighs only 15g. As always, it should be tested in the actual conditions where the tag will finally be used.

Bond strength is dependent upon the amount of adhesive-to-surface contact developed. Firm application pressure helps develop better adhesive contact and improve bond strength. To obtain optimum adhesion, the bonding surfaces must be clean, dry, and well unified. Some typical surface cleaning solvents are isopropyl alcohol/water mixture or heptane. Ideal tape application temperature range is 70°F to 100°F (21°C to 38°C). Initial tape application to surfaces at temperatures below 50°F (10°C) is not recommended because the adhesive becomes too firm to adhere readily. However, once properly applied, low temperature holding is generally satisfactory.

In general, mechanical fastening will be more reliable than gluing when the requirement involves multi-year fixation in potentially harsh environments, as glues age over time. It is recommended to consult the glue vendor when special environmental conditions apply.

Mechanical Fastener

Some tags, such as the SlimFlex™ Tag, IN Tag™, IronTag® 206, World Tag™, Poly Tag, InLine Tag™ and InLine Tag™ Plate series have holes through which a screw or rivet can be used to secure the tag mechanically. (Figure 1) This method is recommended for applications that involve a high risk of mechanical stress, aging or in which the temperature during fixation is too low to promote a strong bond using the adhesive method. Select a screw or rivet that is appropriate for the surface material to which the tag is being applied.

Figure 1: Holes designed to receive a screw or rivet

Take caution when using screws or rivets with large metal heads, as the metal content can de-tune the tag, resulting in a reduced read range. Likewise, a large metal ring or washer used with an IN Tag, World Tag or other circular tag may render the tag virtually unreadable.

In addition the IronTag® 206 has extensions on the edges that allow it to be clamped by metal.

Some versions of the SlimFlex™ tag are meant to be fixed to objects with standard cable ties. When the tag is mounted vertically to the object's surface, the effect of the object being wet or metallic is greatly reduced. In addition, there is the HID Seal Tag available, which features a built-in cable tie, which makes fixation quick and easy and provides tamper evidence.

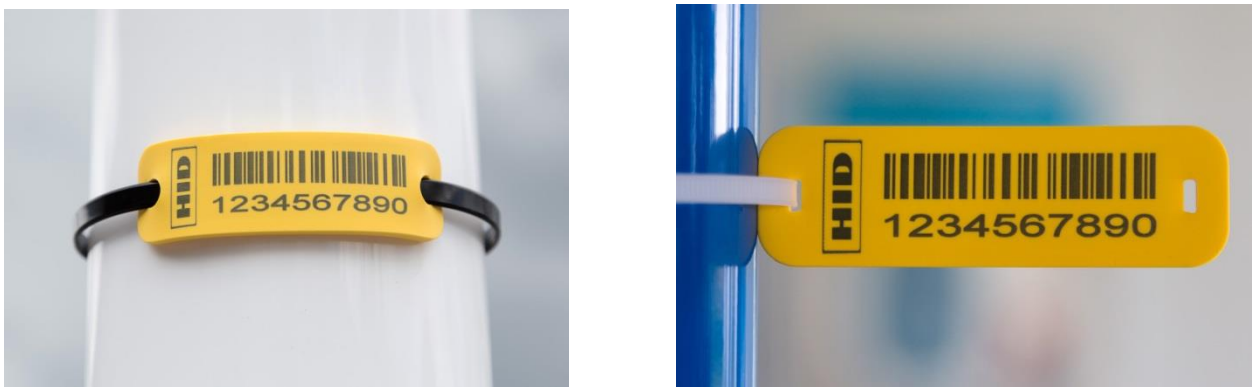
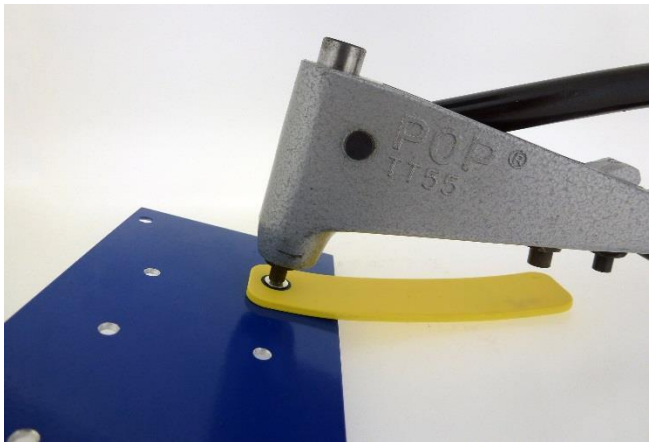
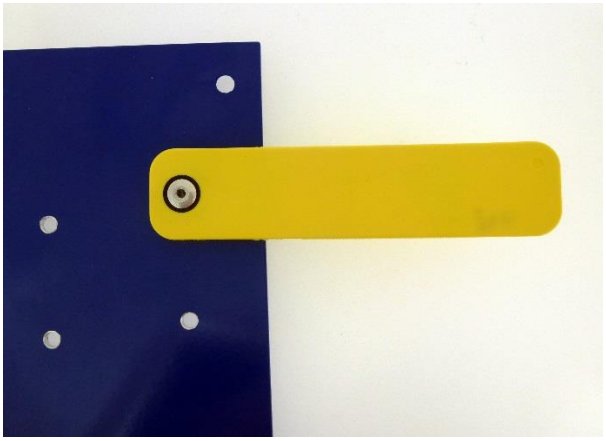


Figure 2: Different mounting options for Slim Flex Standard 301 and 200

Again, be sure to test readability of the tag before putting this or any fixation method into practice.

With its reinforced hole, the SlimFlex™ Tag Washer is specifically designed to be affixed with aluminium rivets to hang down from metal plates or bars e.g. to tag metallic cages.





Textile Fixation

LinTag™ transponders apply securely and discreetly to textiles, enabling RFID tracking of high-volume, commercially laundered bed linens, towels and garments. These robust transponders withstand the rigors of repeated washings, including exposure to water, cleaning chemicals, sterilizing heat and pressure. The patented design guarantees consistent performance over the life of the tag.

LinTag™ is available in 3 versions: To be embedded into a pocket or hem, to be heat-sealed or to be sewn directly onto linen. There is a separate whitepaper available to describe the fixation details for LinTag™ along with educational videos for heat-seal and stitching.

Welding

Some HID tags include a stainless steel ring which can be used to weld the tag to a steel surface, creating by far the strongest bond of all potential tag fixation options.

Of the various welding techniques available, “resistive spot welding” is most recommended for attaching a weldable tag to a steel surface. Figure 3 shows a typical “single-sided” resistive spot welding tool.

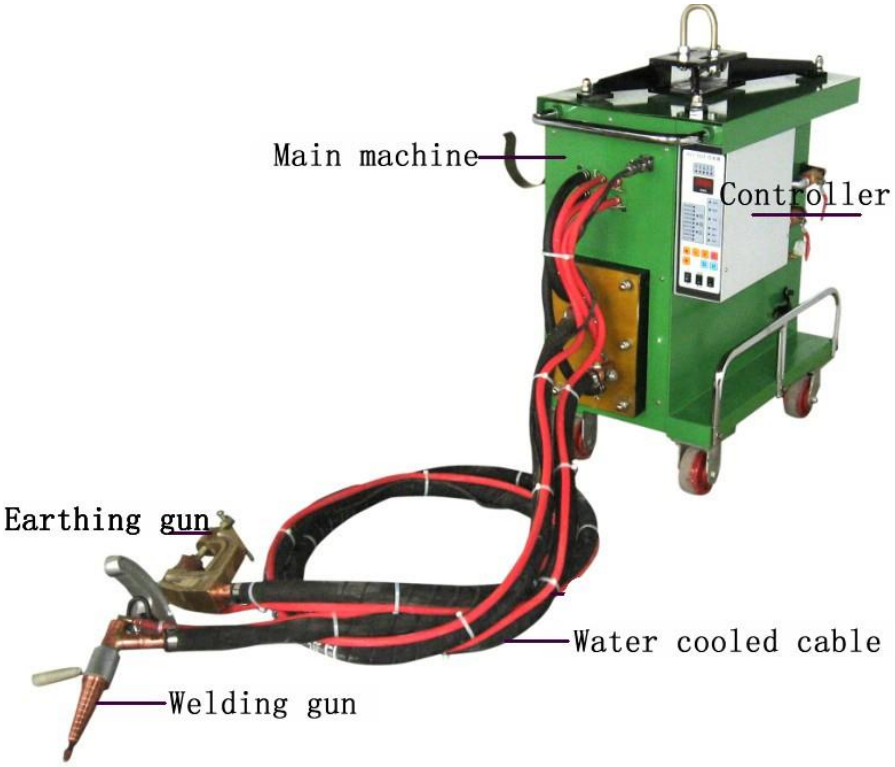


Figure 3: Typical portable one sided resistive spot welding tool

Note: Welding is a complex procedure, and should only be carried out by a trained professional! Ensure all precautions are in place prior to starting the project. Ensure the operator has been properly trained in the use of the equipment, has the necessary personal protective equipment (PPE), has performed a Hazardous Operations Assessment (HAZOP) and is familiar with the work and materials.

Prior to welding the tag, use an air tool, such as that shown in Figure 4 to thoroughly clean the metal surface. (One minute recommended for this process.)

Figure 4: Typical air tool to clean metal surface

Set the parameters of the welding tool to a setting that will accommodate a stainless steel ring of less than 0.5 mm thickness. As welding tools vary, so will the optimum parameter settings.

Experimentation may be necessary to determine the appropriate setting, which will solidly weld the tag while avoiding any deformation of the plastic tag housing.

LF (circular) tags can be easily welded using 4 weld points, evenly spaced around the perimeter of the tag, as in Figure 5. For UHF (long, rectangular) tags, a minimum of 6 weld points is recommended; one in each of the 4 corners and 1 at the midpoint on each side along the length of the tag, also shown in Figure 5. Figure 6 shows a UHF tag welded with 8 weld points.

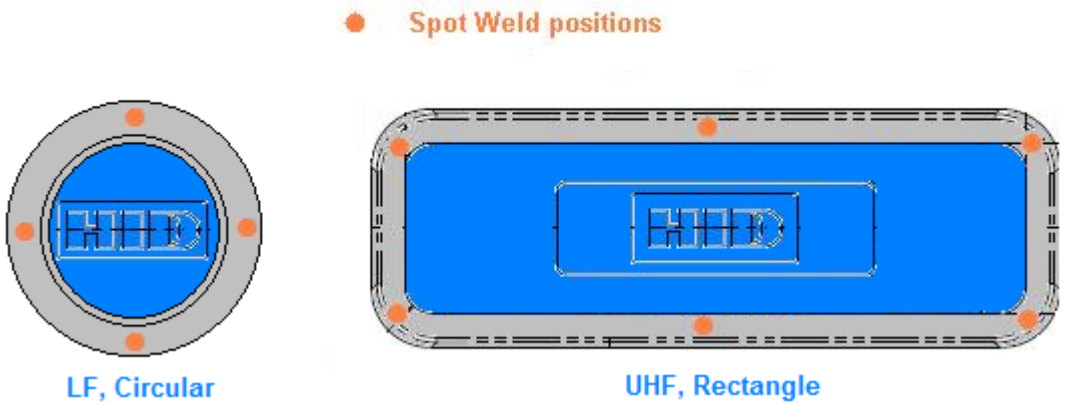


Figure 5: Recommended positions of Spot weld points

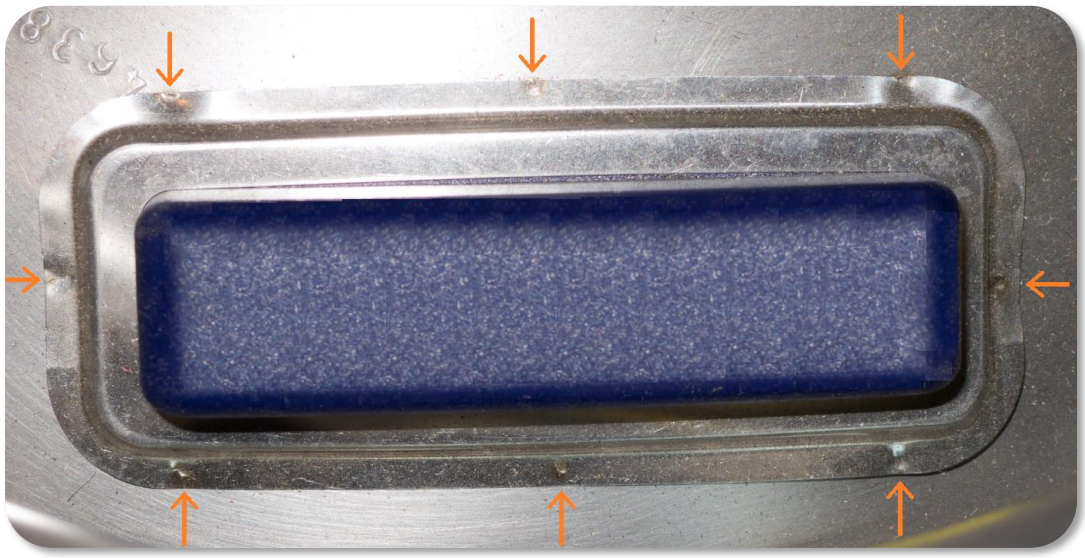


Figure 6: A UHF tag having a total of 8 weld points

The tag shown in Figure 6 was welded using a PW B70H portable resistive Spot Welder with a 4 mm electrode tip, and a weld time of 7-8 cycles at 3000 Amps.

In a repetitive process in which one person is handling surface preparation, and another is operating the welding machinery, the entire process can be optimized to just under 3 minutes per tag. In a fully automated process, total time including surface preparation and welding may take less than two minutes.

RFID Tags in and on-Metal

Many of HIDs tags are suitable for embedding into metal. HID today does not make tags with metallic housings, but produces the RFID components other companies use to embed RFID into metal. HID tags suitable for embedding into metal are the following:

- Industrial Glass Tags (LF)
- Clear-Disc (LF, HF)
- LogiTag® 120 (LF), 121 (HF)
- INTag™ (LF, HF)

In general, LF technology is suitable for embedding a tag into a full metallic housing with no opening. HF demands at least a small opening in the metal to power the antenna, but has the advantage that most HF chips can be used with NFC handsets. Read range for in-metal tags are typically near contact ~1-2 inch, also due to the fact that often very small tags are used. UHF is not suitable to embed into metal without a big opening, but can successfully be used on-metal. Dedicated on-metal UHF tags of HID include:

- Brick Tag Ceramic
- InLine Tag™ Ultra (incl. a welding option) and InLine Tag™ Plate
- IronTag®
- Keg Tag
- INTag™
- TapMark™ Tag

There are also dedicated on-metal HF tags and stickers available from HID Global.

Embedding tags into metal is typically used to tag metallic assets like tools or engine parts.

Main advantages are:

- The RFID component is fully protected from the environment, especially against heavy impact or scratches
- The tag is not visible and cannot be removed (if it is embedded into the asset itself instead of being "just" a tag with metallic housing)
- The surface of the tagged asset does not change compared to a non-tagged asset (if the tag is embedded into the asset itself), this is relevant for some use cases like engine parts. Also cleaning the assets is easier.

Main disadvantages are:

- Design and production process of the asset changes to embed the RFID tag
- Limited capabilities for retrofitting in-metal
  (either drill a hole into the asset or use on-metal tags)
- UHF/ long read ranges are not suitable for in-metal use (on-metal only).

The following graph illustrates how read range of an unshielded LF/HF disc tag is affected by the distance from metallic underground.

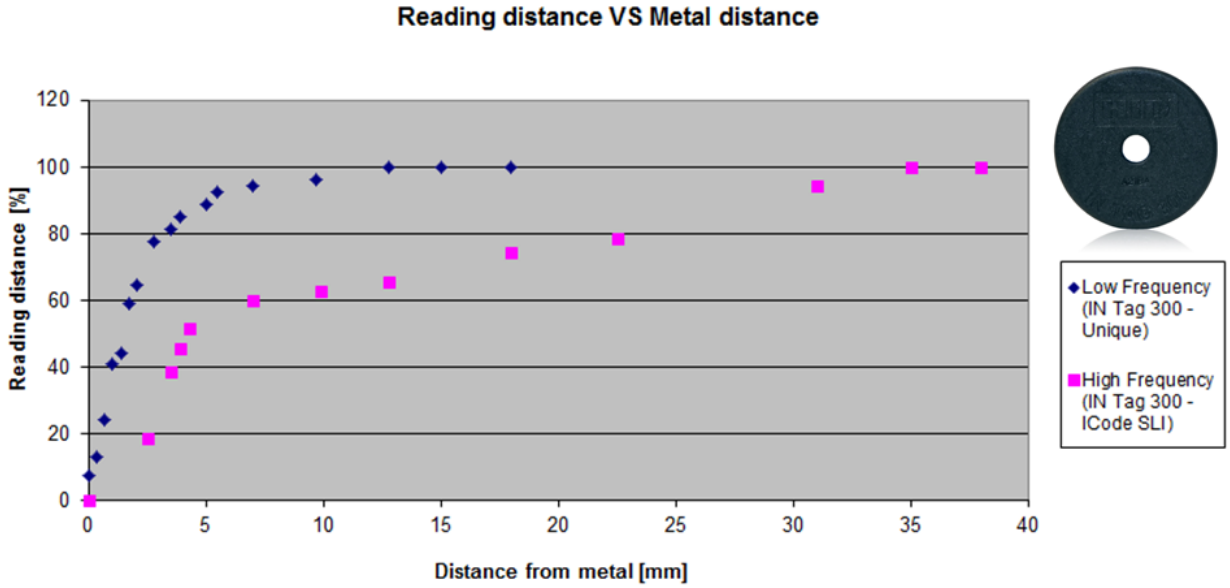


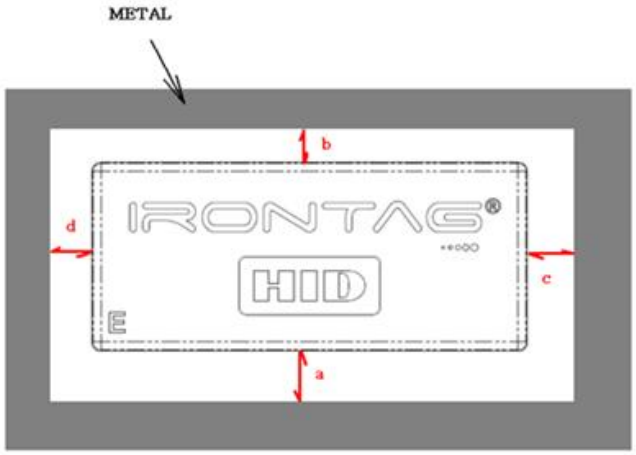
Figure 7: Read range % depending on distance from metal

- LF INTag 300 reaches >90% at ~6mm and >50% at ~2 mm
- HF INTag 300 reaches >90% at ~30mm and >50% at ~5 mm distance from metal

When a UHF on-metal tag shall be embedded into a metal cavity so that it does not elevate against the surrounding metal, it still needs some exposure to air around it for proper performance of the UHF antenna. The following graph illustrates this using the example of the IronTag:

Depth of recess in metal is 7 mm

dist[mm]				Rd@EU[m]
a	b	c	d	
none	none	none	none	5,25
12	12	12	12	4,5
7	7	7	7	3
5	5	5	5	3,5
0	0	0	0	1
5	5	0	0	2
0	10	5	5	3,5
0	5	5	5	3
5	0	5	5	1,5



According to these results, we advise:
b distance greater than 5 mm
d and c greater than 3 mm
a distance can be down to 0 mm.
depth of recess maximum is less than 7 mm (the less deeper the better)

Find below the read distance over ferquency graph obtainded that have been used in the table above

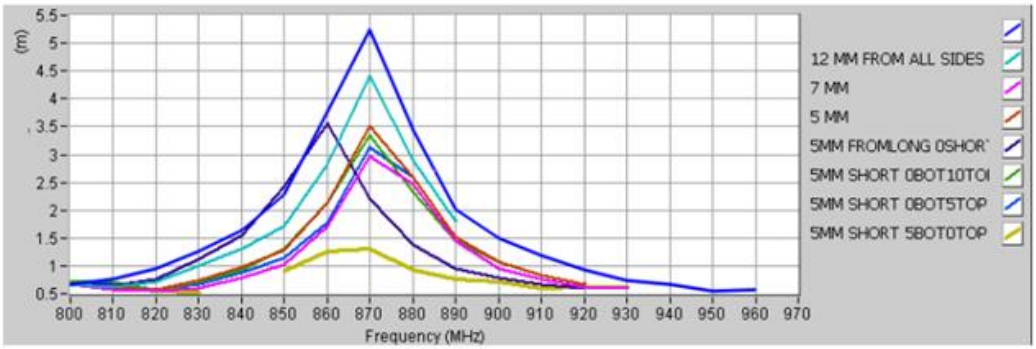


Figure 8: IronTag read range when placed in a metal cavity

Summary

HID has a long history of RFID tag production in all major frequencies LF / HF-NFC / RAIN UHF / BLE and with all major chip manufacturers. Its tags are designed by a Swiss/European engineering team and made in HIDs own ISO certified manufacturing plants in Malaysia by fully automated equipment. This ensures a constantly high tag quality at affordable costs. Custom designs are possible and manufactured with the same industrial processes and equipment that has a capacity of many million transponders per month. HID tags are officially certified (e.g. ATEX) and tested against international standards for robustness. A direct bonding patent allows the production of micro-sized transponders that are highly robust. HID is a reliable supplier with global support and a worldwide partner network.

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

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