**HID**

# The Four Most Important Certifications for Rugged RFID Tags

## Understanding Standardized Testing and Ratings Data in Order to Select the Right RFID Tag for a Particular Harsh Environment

### *Executive Summary*

Many radio frequency identification transponder manufacturers have developed tags designed to withstand harsh industrial and environmental conditions, including such extremes as chemical explosion, collision, fire and submersion. These "rugged" tags enable companies in myriad fields, including construction, energy, manufacturing, transportation and waste management, to track and manage assets in challenging settings.

Before investing in any of the many rugged RFID tags on the market, proper research aside from reviewing numbers on a manufacturer's data sheet is needed. It is critical to understand the most relevant certifications and testing criteria for high-durability RFID tags, to ensure the tags are engineered to meet the demands they'll face in the real-world environment.

In this paper, HID Global will explore those certifications and tests, as well as the key design properties built into today's highly durable RFID tags. This information will enable distributors, systems integrators, software developers and other companies to map their needs more closely to the manufacturer's specifications, in order to identify, track and manage an organization's assets more effectively.


Hazardous


Water Resistant


High Impact


Fire Resistant


Vibration


Extreme Cold


Direct Sunlight

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## Rugged RFID Essentials

Many companies have been using conventional RFID tags successfully for years to optimize their logistics processes and streamline maintenance procedures. In a typical supply-chain or retail environment, standard tags for tracking assets and managing inventory generally work well.

However, many applications in industries including construction, energy, manufacturing, transportation and waste management require tags designed specifically to survive—and operate—in far more intense conditions. Consider this list of potentially destructive environmental hazards:

- Dirt and dust
- Water and harsh chemicals
- Extreme temperatures
- Sudden impact or shock
- Pounding, vibration or intense pressure
- Bending or twisting

### *All Rugged Tags Are Not Alike*

To choose the best passive RFID tags for a particular harsh environment, an organization must begin by evaluating the basic tag properties: frequency, standards compliance, memory, form factor and affixation.

### The Frequency Factor

Frequency is a primary consideration when selecting passive RFID tags largely because tag frequency directly affects read range, also radio waves behave differently at different frequencies with respect to surrounding environmental conditions. Each of the common frequencies offers advantages and disadvantages, thus the decision-making must be based on the needs of the particular application.

- **Low Frequency: LF tags** operate at 125 kHz or 134 kHz, have a relatively slow data-transfer rate and are typically used for applications that only read a UID from a single tag at a time. LF tags lend themselves to use in rugged-tag applications in which the tag is in close proximity to water or metal. For example, LF tags have been embedded in meat hooks that are subjected to impact and washed with strong chemicals.

- **High Frequency: HF tags** operate at 13.56 MHz. HF tags have a faster data-transfer rate than LF tags, offer more and read/write memory compared to LF Tags and support anti-collision to enable reading multiple tags at once. Like LF tags, HF tags work well around metal and water and are often used for tracking containers, cylinders, tools and garments. Non-industrial use cases are e.g. libraries, access control, payment or NFC applications.

- **Ultrahigh Frequency: UHF tags** operate in the 856 MHz to 960 MHz spectrum. Most UHF tags are based on the EPC Gen 2 air-interface protocol (ISO/IEC 18000-6C standard), they are also called RAIN® RFID tags. The biggest benefit RAIN UHF tags offer over LF and HF tags is a longer read range—up to ~9 meters (about 30 feet) or more. RAIN UHF tags also have the highest data transfer rate, which can be significant if a tagged object will be in the read field for only a short period of time or many tags need to be read at once. RAIN UHF tags do by default not perform as well around water and metal. As a result an organization may need to choose a

specially designed tag if the desired application involves such elements. Rugged passive RAIN UHF tags are often used for tracking pipes, roll cages and other metal objects that move through the supply chain and get knocked around in the process.

Read range is in general depending on many factors like tag and antenna size, orientation of the tag in the RF field and the operating environment and surrounding materials in general. Typically LF and HF tags are operated with a reading distance below 50 cm (20 in) whereas UHF tags are typically operated with a reading distance of a few meters and the option to read multiple tags at once e.g. goods on a pallet or truck moving through a reader gate.

### RFID Standards

There are various air-interface protocol standards that govern how tags and readers communicate at each of the previously mentioned frequencies. When choosing a ruggedized tag for harsh environments, an organization may want to ensure it uses the same air-interface protocol as other RFID equipment within its facilities to ensure interoperability.

If there are no RFID systems in use, a company will likely want to choose a tag based on an international standard to ensure the company can purchase readers from a variety of manufacturers and that will work with other tags in the future.

### Don't Forget Memory

The passive microchips built into most rugged RFID tags can store limited data; however, the amount of data can vary from 64 or 96 bits to about 8 kilobytes. To put that in perspective, 96 bits is equivalent to about 12 characters; a kilobyte amounts to about a half-page of text.

If simply identifying an object—say, an engine block that will be painted and then baked in an oven—a 96-bit serial number may be sufficient. However, if tracking and recording the usage of a drill pipe for an oil company is desired, a read/write tag that can store more data is more suitable.

### Form Follows Function

Given the various environmental challenges that abound, it's no surprise that low quality RFID paper labels may not hold up in rough-and-tumble surroundings. High-quality rugged tags are made of sturdier components and housed in more protective materials—heavy-duty plastics and polymers—to withstand more of a wallop.

High-quality rugged tags are available in a multitude of shapes and sizes to accommodate the configuration of the objects they're designed to track, from metal airplane parts to military weapons, and i-beams for construction products.

### Attaching Tags to Objects

One of the main issues with rugged tags is the process of how to attach them. Tag manufacturers have developed a variety of attachment methods—some tags can be screwed, clamped, plugged into or even embedded inside an object based on the item's size, shape and material.

Another issue is whether the tag will interfere with the object's operation. For instance, a large tag cannot be affixed to a pipe that needs to be put into a tight hole. In this case, tags can be engineered to fit inside a cavity drilled or manufactured into an item. In some cases, companies may also be concerned about tampering of the tag, as a result the method of attachment and durability of the housing must be appropriate for these applications.

Often, the goal is to engineer the housing and mounting components for adaptability to curved or irregularly shaped objects providing a secure fit while also ensuring that the tags can be read through or around metal, wood or other materials at various angles and specified distances. Such concerns can play a primary role in the choice of high-durability tags.

## Deciphering the Four Most Relevant Certifications

Once an organization makes it decisions regarding frequency, standards, memory, form factor and method of attachment, they are ready to read up on the broader certifications and test methods that apply to rugged RFID tags. This will allow a company to differentiate not only conventional tags from more durable models, but to make an educated and informed decision among the various high-durability tags available that may be suited to their needs. Among the chief certifications are ATEX (protection against explosion), IP (solids and liquids), IK (impact) and UL 94 (fire).

### Certification #1

### *ATEX/IECEx Certification: Protection against Explosion*

ATEX (*ATmospheres EXplosives*) is a two-part guideline developed by the European Union (EU) for the operation of equipment in areas in which there is danger of an explosion occurring. ATEX 95 (directive 94/9/EC) details the protective requirements for equipment in potentially explosive environments; ATEX 137 (directive 99/92/EC) stipulates the minimum safety and health protection requirements for workers in those environments. IECEx is a similar test of standards defined by worldwide industry organizations and certification bodies. For simplicity, HID will focus on ATEX certification in this document.

While every ATEX-certified RFID tag is by definition safe for some potentially explosive environment, some are better suited to certain situations than others. It is critical to understand the distinctions between the various ATEX certifications, which are presented in long character strings to represent various safety-related features.

According to the ATEX rules, employers must classify potentially hazardous explosive areas into one of three zones. Zone 0 is used to designate an area in which there is always a danger of an explosion from vapors; zone 1 is for an area, in which under normal conditions, an explosion is often but not always a danger; zone 2 is where there is occasionally a danger of explosion; a safe area, under the regulations, is an area where there isn't a threat of an explosion. Zones 20, 21 and 22 correlate to the zones described above, but are for specific areas with hazardous dust rather than vapors.

Equipment must be certified as safe to operate in these zones. The rules apply primarily to electrical equipment, such as RFID readers, which could spark and cause an explosion. Passive RFID tags are by definition "intrinsically safe", according to IEC 60079-14 Ed. 5.0, but can also be optionally explicitly certified for use in one or more of the ATEX zones.

When a product is ATEX certified, the designation often includes additional valuable information to the customer, as illustrated in the example to the right.

> **An ATEX certification of *II 2G Ex ia IIA T5 Gb* means:**
>
> *II:* all other explosive areas (except mining)
>
> *2:* can be used in Zone 1 or 21 (area in which under normal operation a potentially explosive atmosphere can occasionally form)
>
> *G:* gas (as opposed to D – dust)
>
> ***Ex:* ATEX-certified**
>
> *ia:* intrinsic safety (permitted for Zone 0) The development of inadmissibly high temperatures, ignition sparks and arcs are avoided due to the restriction of energy in the circuit.
>
> *IIA:* Explosion group, such as propane
>
> *T5:* 212°F / 100°C (highest temperature the item can withstand)
>
> *Gb:* Equipment Protection Level (EPL) = Zone 1 or 21

**Certification #2**

*IP Certification: Protection against Solids and Liquids*

The IP (Ingress Protection) rating system, developed by the European Committee for Electro Technical Standardization (CENELEC) and now used by the National Electrical Manufacturers Association (NEMA) defines the degree to which an electrical enclosure is sealed to prevent environmental elements from entering and damaging the internal components or data housed inside.

The first number of what is typically a two-digit IP rating refers to protection against solid particles. The lowest rating ("1") means particles of 50 millimeters or larger (a worker's finger, for instance) cannot get past the unit's housing. The highest rating ("6") indicates that the device is dust-tight.

The second digit in an IP rating that represents protection against liquids - "1" signifies that dripping water can seep into the electrical device; "7" means the unit can survive short-term submersion and "8" indicates safety from long-term soaking.



For example, an RFID tag rated IP 68 is generally considered not only "solid-proof", but also waterproof; it has been submerged in water 1 meter (3.28 feet) to 2 meters (6.56 feet) deep for 24 hours with no water entry into the housing or ingress into the enclosure material itself.

IP 69K is the highest IP rating and indicates extreme resistance to high steam and pressure. Testing involves spraying extremely hot water (175 degrees Fahrenheit/80 degrees Celsius) at 8 to 10 megapascals and a flow rate of 14 to 16 liters per minute through a nozzle 10 to 15 centimeters from the tag at a series of angles from zero to 90 degrees for 30 seconds per angle. The tag sits on a turntable that rotates once every 12 seconds (5 rotations per minute). The pictures to the right display IP69K test equipment.



The optional third character in some IP69 ratings (the K in IP 69K, for instance) relates to impact resistance, but it has been largely replaced by a separate designation (see "IK Certification" below).
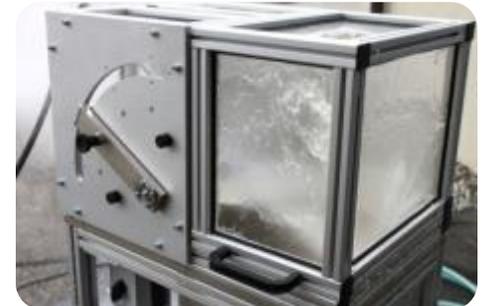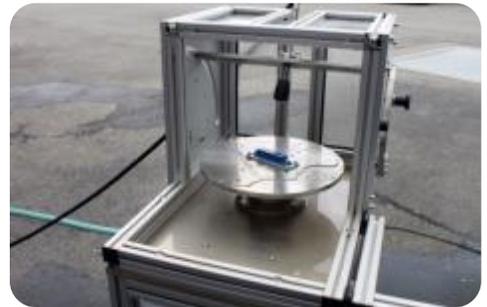
**Certification #3**

*IK Certification: Impact Resistance*

The IK rating, a standard created by the EU (defined in EN/IEC 62262), signifies the amount of external mechanical impact an electronic device can withstand. IK ratings range from as low as IK00 (unrated and/or untested) to IK10 (maximum impact resistance). "IK01" designates that an RFID tag survived impact tests of .15 joules, using 200 grams (.44 pounds) swung on a pendulum from a distance of 7.5 centimeters (2.9 inches). At the other end of the spectrum, "IK10" indicates that a tag passed impact tests of 20 joules, or 5 kilograms (11 pounds) swung on a pendulum from a distance of 40 centimeters (15.7 inches).

Tags with ratings of IK07 and above have been tested not just with impact from greater distances at greater speeds, but also with steel objects for impact; tests for lower ratings are conducted using a lighter polyamide.

**Certification #4**

*UL 94: Flame Resistance*

For applications in which a tag might come in contact with fire, a company might want to have the tag undergo UL94 testing. Underwriters Laboratories, a US-based product testing company, developed this test to determine how flame retardant a product is. UL94 (also known as IEC 60695-11-10) rates products from least to most flame retardant. These values are specified for standardized specimens of a particular (housing) material of a tag and not for a tag itself:
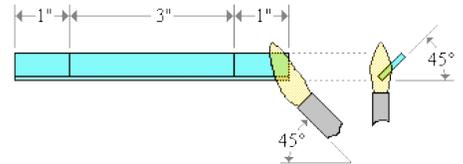
- HB: slow burning on a horizontal specimen; burning rate < 76 mm/min for thickness < 3 mm.
- V2 burning stops within 30 seconds on a vertical specimen; drips of flaming particles allowed.
- V1: burning stops within 30 seconds on a vertical specimen; drips of particles allowed as long as they are not inflamed.
- V0: burning stops within 10 seconds on a vertical specimen; drips of particles allowed as long as they are not inflamed.
- 5VB: burning stops within 60 seconds on a vertical specimen; no drips allowed; plaque specimens may develop a hole.
- 5VA: burning stops within 60 seconds on a vertical specimen; no drips allowed; plaque specimens may not develop a hole.

Two critical issues to consider for tags that will be exposed to flames are whether the tag housing will melt and cause a potential fire hazard and whether the tag will survive the flame. HID Global makes the IronTag, which can operate even after being exposed to a welding torch (2,300 degrees Celsius) for nine seconds.

To view a video of HID's extreme tag testing, visit http://youtu.be/wLLBNLYUnd8

*More Tests for Rugged Tags*

In addition to undergoing rigorous testing and meeting the standards discussed above, many rugged RFID tags are capable of rising to myriad other challenges. Depending on the requirements of an application, a rugged tag manufacturer could design and test tags that can withstand force, vibration, repetitive bending and/or twisting, pounding pressure and shock, freezing or below-freezing temperatures or extreme heat, even fire.

To measure a tag's ability to resist force, HID Global compresses with a defined force measured in Newton for a defined time, usually 10 seconds. To put this in perspective, 1 Newton is the force of Earth's gravity on a mass of about 100 grams. Most HID tags are tested for 500 to 1,000 Newton force from different sides. If the tag is a disc, such a test ensures that the housing does not crack open when strong force is applied at the edge of the disc.

A shaking table is the primary tool used to test whether tags meet the generally accepted vibration standard (IEC 68.2.6). Sudden acceleration and deceleration are the critical elements in testing for shock resistance (IEC 68.2.29).

It is important to understand that terms such as "waterproof," "fireproof" and "shockproof" are often used in a general fashion and don't necessarily mean a tag has undergone the appropriate testing to pass proper certification in each of those categories. Studying a tag manufacturer's data sheet to see what temperature, shock and other elements the tag can survive will be helpful in the selection process. If the data sheet does not include detailed specifications, it is important to inquire about what testing was completed to ensure the tag will perform in the environment in which it will be used.

## HID Global Products

With the industry's most diverse range of rugged RFID tags, pursuit and awarding of relevant certifications and the company's uniquely rigorous in-house testing and customization options, HID Global offers RFID tag product solutions for a wide range of applications. HID's versatile product lineup encompasses a wide selection of tag frequencies, chip configurations and memory capacities, components and housing materials, dimensions and mounting options. The organization combines European precision engineering with fully automated production at its Malaysia facilities, which are ISO 9001:2008 certified for quality management. In addition to submitting its products for external certifications, HID puts its rugged tags through extensive testing in its own labs, using company-designed methodology and equipment, including industrial washing machines, ovens and freezers, drop stations and more.

A sampling of HID's popular high-durability tags includes:

- The *IronTag®*, a compact tag designed to track aircraft and vehicle fleet components as well as other metal items. This model is built to withstand vibration, shock, chemical exposure and fluctuating temperatures. Its IP 69K rating means it is certified to survive high-pressure/ high-temperature washing; it is also resistant to the effects of fuels, oils, salt water and ultraviolet light, and brief exposure to flames. The IronTag can be mounted to most metal surfaces, using industrial glues or high-temperature stickers.



- The *SlimFlex™ Seal Tag*, which is encased in an innovative thermoplastic elastomer (TPE) housing for bendability is intended for mounting on curved or irregular surfaces—picture it inside a hard hat, for instance. The square form factor is particularly well suited to use on wood or plastic palettes due to its long read ranges even when wet. Durable laser engraving allows to display barcodes, logos or text for visual back-up. SlimFlex™ tags can be attached with industrial adhesives or screws. The Seal Tag option with built-in cable tie allows quick and easy fixation along with tamper evidence options.



- The *InLine Tag™ Ultra*, a family of extremely versatile units mountable on just about any surface offers high readability, high impact and chemical resistance, and waterproofing up to IP69K with varieties that curve to hug cylindrical containers, such as gas bottles. Affixation options include nails, screws, welding and glues.



- *Custom tags:* In addition to the rugged tags described above and numerous other options, HID works hand-in-hand with clients in a broad range of industries and organizations to develop rugged tags that accommodate specialized needs. Customization options range from adding a client's logo to the design of a rugged tag that already exists in HID's lineup,

programming a security code,  changing the chip for increased memory or faster data transfer, to designing a tag entirely from scratch to accommodate a customer's dimensional specifications, mounting requirements and more. In some cases, HID also may build dedicated equipment to test and produce customized rugged tags for clients to validate performance.

E.g. the image below shows HID HF Piccolino tags embedded into biological probe vials that are used to store specimens in liquid Nitrogen at -196°C (-321°F). Reading RFID equipped vials at such temperatures greatly speeds up the inventory process and reduces the risk of vials warming up above -136°C (-212 °F), which could destroy the biological probes.
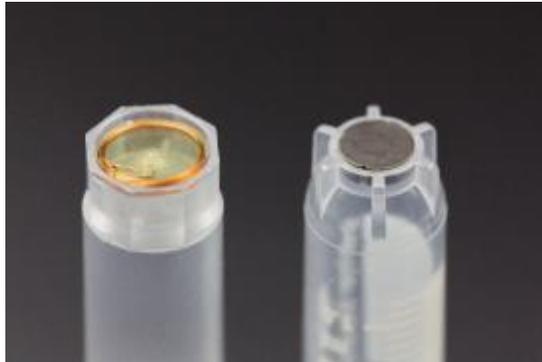


Visit www.hidglobal.com/products/rfid-tags to learn more about the company's high-durability tags offerings.  Download the tag product positioning whitepaper to ensure the best tag selection and assist in meeting customers' needs and company requirements.

## About HID Global

HID Global is the trusted source for innovative products, services, solutions, and know-how related to the creation, management, and use of secure identities for millions of end-users around the world. The company's served markets include physical and logical access control, including strong authentication and credential management; card printing and personalization; visitor management systems; highly secure government and citizen ID; and identification RFID technologies used in animal ID and industry and logistics applications. The company's primary brands include ActivID®, EasyLobby®, FARGO®, IdenTrust®, LaserCard®, Lumidigm®, Quantum Secure, Bluvision and HID®. Headquartered in Austin, Texas, HID Global has over 2,700 employees worldwide and operates international offices that support more than 100 countries. HID Global® is an ASSA ABLOY Group brand. For more information, visit www.hidglobal.com

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