

White Paper

**WHY GEN 2 IS THE RFID FOR
CONSUMER GOODS MANUFACTURERS
AND HOW TO MAKE SURE GEN 2
PERFORMANCE WILL MEET THEIR NEEDS**

For the first time, consumer goods (CG) manufacturers can implement a radio frequency identification (RFID) technology that was developed to meet their inventory and supply chain management needs, and to overcome limitations in previously available technology. The new UHF Generation 2 (Gen 2) standard from EPCglobal provides the worldwide compatibility, reliability, security and other features necessary to make RFID practical and effective for the CG supply chain. EPC standards were developed by users, for users and pave the way for development of competitive, interoperable products. These factors are leading reasons EPC technology is on pace for adoption at a rate unparalleled in the more than 50-year history of the RFID industry and significantly faster than bar coding.

What is Gen 2?

"Gen 2" refers to the Class 1 Generation 2 UHF RFID standard from EPCglobal. The standard provides specifications so manufacturers can produce RFID chips and readers that can be used anywhere in the world and will be interoperable among vendors. The standard was created to facilitate the use of Electronic Product Code™ (EPC) numbers, which uniquely identify objects, such as pallets, cases or individual products.

Gen 2 and other EPC standards are administered by EPCglobal, which is a subsidiary of GS1, the same not-for-profit organization that issues U.P.C. numbers and manages the EAN.UCC system. For more information visit www.epcglobalinc.org.

This white paper will show why Gen 2 will become the dominant RFID standard in the consumer goods industry, describe its advantages to other RFID technologies, explain how its features satisfy real-world needs and how to differentiate among standard-compliant products.

In the U.S. alone, more than 200 end-user organizations have joined EPCglobal, in addition to dozens of technology developers, standards bodies and research organizations. Wal-Mart, the world's largest company, and the U.S. Department of Defense, which operates the world's largest supply chain, have each committed to using Generation 2 EPC technology and will require their suppliers to include Gen 2-compliant tags on shipments. Many other leading retailers and consumer goods manufacturers have chosen EPC as the foundation for their RFID efforts. A joint report from the Grocery Manufacturers of America (GMA), the Food Marketing Institute (FMI) and the National Association of Chain Drug Stores (NACDS) called for EPC to be adopted as the global standard for electronic product identification and predicted pallet- and case-level EPC tagging will be widespread by 2007.

Why the EPC System

The EPC system is unique because it creates unique serialization that meets consumer goods and retail industry needs, builds on existing EAN.UCC bar code numbering schemes, and also defines technical specifications that meet real-world performance requirements. First and foremost, Gen 2 tags and readers can be used throughout the world. Many Generation 1 products and implementations were developed around U.S. Federal Communications Commission (FCC) radio regulations. FCC-compliant products based on Generation 1 specifications were not compatible with regulations for other countries. . Users needed to acquire site licenses to use the technology elsewhere in the world, which proved to be a major implementation obstacle. Gen 2 gives users the ability to implement a single system that can be used throughout the world, without ever having to obtain licenses to use the technology in specific countries or specific sites.

The ability to produce products for a global customer base also delivers economy of scale for RFID product design and manufacture. The results should be similar to the impact that ratification of the IEEE 802.11b standard had on the wireless networking industry. Wireless networking was available prior to the 802.11b standard, but was only used in select niches because the technology was expensive, highly proprietary and offered no multi-vendor interoperability. The 802.11b standard created a very competitive marketplace marked by rapid implementation, falling prices and widespread adoption.

Gen 2 has brought the major technology providers together which will create multiple interoperable offerings. Major silicon providers will be able to focus on a single technology and will be able to mass produce chips that will drive the costs down significantly. Likewise, interrogator manufacturers will be able to focus on a single protocol implementation to attain volumes which will drive down costs and improve performance.

Generation 2 will deliver more than competitive benefits to users – it will provide significant performance benefits compared to other RFID technologies. Gen 2 provides specific advantages in six performance areas that are most important to CPG industry applications: speed, efficiency, reliability, range, security and cost. The following sections describe the CPG industry's real-world performance requirements and how Gen 2 satisfies them.

Speed

Consumer goods manufacturers use RFID to record goods in, track and count inventory, verify that outgoing shipments include all the cases necessary to complete the order. Systems therefore must be able to read tags at the speed items move on conveyors and forklifts. The Gen 2 standard does not state a minimum reading speed for products because too many variables (e.g. interference, number of items to be identified, reader power output) impact performance. However, the specifications in the Gen 2 standard should enable readers to perform up to 1,500 tag reads per second in North America and 600 reads per second in Europe, which has more restrictions on power and bandwidth. These speeds are more than twice as fast as Gen 1 and support the ability to identify objects on conveyor belts moving 600 feet per minute, and those being carried by forklifts that pass through reader portals at eight miles per hour. The write rate, which is highly dependent on the amount of data being written, is about 10 tags per second and is fairly consistent worldwide.

Selective reading is an important requirement for CG applications. For example, workers at a distribution center often need to quickly locate specific items from incoming shipments so they can be cross docked to fulfill waiting orders. The Gen 2 spec supports "group select," a feature that is very important for providing high-speed reading and sortation. Group select enables RFID interrogators to be set to seek and read select groups of tags (based on data structure) and to ignore others in the read field. For example, EPC interrogators could be set to seek specific cases in a shipment and to alert the operator once the case is identified. The rest of the shipment could be identified after the needed item was read and pulled from the pallet to complete an order. Interrogators can also be set to ignore case tags and only record pallet tags. The feature reduces the amount of data the system must process, which enables faster reading and decreases network traffic, keeping overall system performance from bogging down operations.

Users need to be assured that all selected tags will be identified as they pass through the read field; it is more important for reads to be right than to be fast. Tags on the edges of the reading field don't receive full power from the reader, and therefore may not remember if they have been identified. "Persistence" is a feature that gives tags the ability to remember their status if they lose access to reader power. Persistence greatly improves read performance, especially in large tag populations. Persistence was not included in Gen 1 technology, and not all Gen 2-compliant products support it, so it is important to investigate this capability when evaluating equipment.

Bandwidth Efficiency

One of the most important and valuable features of Gen 2 technology is that it can be used throughout the world and previous generations could not. Global compatibility overcomes a fatal flaw of the previous generation EPC technology and was developed in direct response to CG manufacturer needs. The same EPC tag can be applied at a factory in Asia, read throughout the logistics processes and used at distribution centers in North America and Europe. Multiple Gen 2 tags are not necessary to meet different international wireless regulations, and site licenses are never required for Gen 2 systems. RF regulations still vary by country, but Gen 2 satisfies international requirements because tags are frequency agile, which means they support a range of frequencies (860-960MHz).

The Gen 2 standard also has specifications so users can manage bandwidth efficiently and optimize their system performance. The standard actually defines three separate Gen 2 reader environments – single reader, multi reader and dense reader. Specifications for readers operating in each of these environments are intended to provide improved performance based on the number of devices present. EPC Gen 2 tags are not made specifically for different reader types and can be read and written to by products from each category.

The single reader specification is intended for implementations where there will only be one interrogator per facility. Single reader mode allows bare-bones compliance with FCC requirements for bandwidth management. It provides acceptable performance, but is not a good neighbor to other RF devices that may be operating nearby. Wireless phones, older, non-802.11 wireless networks and other devices in the UHF frequency band could interfere.

Multi-reader products are more RF friendly and are intended for operations with up to about 10 readers present without causing significant performance problems.

Dense reader mode is for use in facilities with more than 10 readers, which includes most distribution centers and factories where RFID systems operate. RF channels are used very precisely to minimize the chance of interference. For example, tags and readers communicate on different channels, which reduces collisions and makes them easier to manage. Using separate channels also minimizes interference and aids high-speed reading.

Dense reader mode is the safest choice for implementing EPC equipment. It provides the most focused and efficient use of bandwidth, which optimizes performance and protects against interference. Neither single- or multi-reader mode products are practical option for most consumer goods distribution or manufacturing operations, which would likely involve more than 10 devices in operation at dock doors, packaging lines, storage locations and shipping areas.

Just one single-reader or multi-reader device in a dense environment could easily overpower other devices and cause interference that prevents tags from being read. Therefore, starting a pilot with a single-reader mode interrogator and planning to add more units as needs grow is not a sound approach. Single-reader mode products are the easiest to design and cheapest to produce. Legacy RFID equipment that is said to be upgradeable to comply with the Gen 2 standard may only be upgradeable to single reader mode. There are extremely limited opportunities to use single reader model products in real-world environments, so it is important for customers to specify dense reader mode compliance where it is called for, keeping potential future system expansion in mind.

Reliability

The Gen 2 standard includes several improvements over the Generation 1 specifications and other forms of RFID to make reading performance more reliable. There are also ways to implement the standard and compliant equipment to further improve data integrity and system reliability.

Trials of previous generation EPC technology produced false positive readings of tags that did not exist. These “ghost tags” are recorded when the reader picks up portions of data from different tags and interprets them as the identification of a single (non-existent) tag. The Gen 2 standards developers recognized this flaw and modified the reading and verifications protocols to prevent ghost tags from being recognized.

The Gen 2 standard also provides new flexibility for tag data content, and options for validating additional data. Gen 2 allows rewritable memory and supports larger memory sizes to accommodate additional data. The ability to record new data on tags at different points in the supply chain creates value-added application possibilities, such as generating electronic pedigrees, writing receiving, storage and handling data to the tag for automated stock rotation, FIFO and other inventory management applications. Shipments can also be associated with specific customers to facilitate returns processing, recalls and anti-diversion security programs.

Unlike CDs, Flash memory and other storage media, Generation 1 RFID tags do not automatically verify data written to them. Generation 1 technology users experienced lost and corrupted data, so verification was made a requirement for the Generation 2 standard. Gen 2 adds support to verify data written to tags. Generation 2 is by design a more robust and reliable protocol that overcomes the Generation 1 data reliability problem. Insist on products that provide write verification.

Security

Standard EPC Gen 2 tags are password protected against tampering. Disabling (killing) tags in the field so their data can never again be accessed is a requirement in the retail and consumer goods industries to satisfy consumer privacy concerns, so the standard supports this ability. Killing tags also requires a password, to prevent unauthorized and accidental disablement.

There are multiple ways to implement additional security, which will create differentiation among Gen 2-compliant products. “Cloaking” is the ability to set tags so they will only communicate with authenticated readers. Readers must provide a password before the tag will respond with any communication. Passwords may also be assigned to enable writing to tags or to disable tags.

Tracking by lot code, expiration date, and other new applications likely will emerge to take advantage of the data content flexibility that Gen 2 allows. Supplemental data doesn’t automatically get the same protection as the originally encoded EPC number, so users must take steps to secure and validate data. Security is required to ensure additional data written to tags is protected. Supplemental tag data also can be password protected so it is available only to select business partners or internal process users. Write protection and password protection are not standard features and will not be supported in all Gen 2 products.

Range

A major reason EPC Gen 2 adoption is poised for rapid growth is because it can be used around the world with enough read range for RFID to be used in common supply chain business processes. Gen 2 systems should be able to read tags from 2 to 10 meters away, which will enable EPC tags and readers to be integrated into conveyor belt, automated sortation, forklift and dock door systems. High frequency 13.56 MHz RFID technology, which is available for use worldwide and is supported in several international standards, proved insufficient for these applications during user trials because it provides only a fraction of the range of the Gen 2 UHF frequency band.

Range will be different in every implementation because it depends on several variables, notably the power output of the reader (which is governed by different national telecommunications regulations), the amount of RF devices operating in the environment, and other potential sources of interference. Because of these differences, users can get more range from Gen 2 systems in North America than some other regions. Therefore it is important to test and evaluate equipment for all the locations and environments in which it will be used.

The physical properties of the materials being tagged also impact range. A pallet of paper towels won't read the same way as a pallet of beverages. Liquid, which absorbs RF signals, and metal, which reflects them, are two of the largest inhibitors to RFID range. Experimentation is needed to find the best location to place RFID labels on pallets and cases containing different objects.

Cost

The previous sections have described how Gen 2 is the first RFID standard to fully address CG supply chain user requirements. Gen 2's capabilities are a reason it is widely predicted to become the dominant RFID technology. The other major reason is cost. In addition to its performance advances, EPC Gen 2 products will cost significantly less than alternative RFID technologies.

Gen 2's more robust protocol is a major factor in holding down cost. The protocol will compensate for defects in the silicon fabrication process, so there will be a higher yield of good chips. It will also compensate for some antenna alignment sensitivity, so more good inlays will be produced. Gen 2 can withstand a wider range of temperatures than previous-generation EPC technology, which will also improve tag yields.

High production volumes and competition will have the largest impact on Gen 2 tag and equipment costs and should make the technology cost effective for companies at all levels of the CG supply chain. Prior to Gen 2 standard development, vendor support for different forms of RFID technology was fractured, resulting in limited supplier options. Gen 2 represents the first EPC technology that all the leading silicon suppliers, including Philips, Texas Instruments, Impinj and others, have committed to producing. Manufacturers of antennae/inlays, read/write equipment, printer/encoders and industrial computers also strongly support the Gen 2 standard in their product lines. Many middleware and software applications are being developed to support Gen 2 data structures. As a result, Gen 2 is expected to become the most competitive product segment within the RFID industry, giving users more product choices and benefits of competition than they have ever enjoyed before.

Not All Gen 2 Products Are Created Equal

Gen 2 provides the interoperability, international support and performance required of supply chain RFID technology. However, standard-compliant Gen 2 products will not provide standard performance. Some Gen 2 features are optional and not all products will support them. Optional features include the ability to validate and secure data written to tags, the ability to recognize tags that enter the read field late, group select capability, the ability to kill tags in the field, and conformance with dense reader mode.

Differences in features and performance must be considered when planning systems, evaluating products and assessing implementation expenses. A good starting point for comparison is to determine the features needed from the Gen 2 system and to create a checklist for meaningful product comparisons. Figure 1 proves an example.

Figure 1: User requirements for Gen 2 functionality checklist

	Product A	Product B	Product C
Can the product perform in dense reader mode?			
If no, expected cost to upgrade to dense reader mode			
Is persistence provided?			
Is group select supported?			
Is write verification performed?			
Can data be write protected?			
Is cloaking available?			
Is password protection available?			
Can the readers kill tags?			
Is remote management and configuration possible?			

Intermec Intellitag® Gen 2 RFID systems

All the features on the checklist are standard in Intermec’s Intellitag® Generation 2 products. Many of these features are based on Intermec’s patent-protected intellectual property, and are available exclusively through Intermec and our licensees. Intermec EPC interrogators are built for dense reader mode performance and we were the first manufacturer to demonstrate an ETSI-certified, Gen 2-compliant EPC interrogator that meets European radio regulations.

Intermec donated a substantial amount of intellectual property to EPCglobal to help establish the robust Gen 2 standard, so we are very well positioned to support the features and performance users need in our products. Intermec is intimately familiar with the Gen 2 standard, the variations of how it can be implemented, and its potential performance in real-world systems. Intermec Intellitag Gen 2 systems are designed to move beyond the limitations in the basic Gen 2 standard to provide high-level performance.

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Conclusion

The consumer goods industry has followed RFID development for years because of the technology's outstanding potential to provide unprecedented supply chain visibility and track-and-trace capabilities, drive labor out of product handling, storage and distribution, reduce shrink and improve inventory management. Gen 2 systems make these applications practical by delivering the performance and value the CG industry has been waiting for. However, Gen 2 standard-compliant products will not provide standardized performance. The features and variables outlined in this paper show how important performance differences can arise from different Gen 2 products. Successful systems require careful product evaluation to ensure the system will provide the needed performance and value.

In its years of RFID development, Intermec has placed high value on creating systems that meet market required functionality with high reliability and exceptional value. Users seem to agree. Intermec was honored to be recognized in 2004 as the best radio frequency identification (RFID) hardware provider by the readers of Consumer Goods Technology magazine. The Reader's Choice Awards are determined by polling the magazine's readership about which vendors they use in a variety of categories and then asking them to rate them on a scale of one-to-five on their customer experience, including factors such as return on investment, usability, performance, implementation and customer service.

To learn more about how your company can benefit from Intermec Intellitag Gen 2 systems, contact Intermec Technologies Corp., 6001 36th Ave. West, Everett, WA 98203 USA; 800-347-2636; or www.intermec.com. To learn more about Intermec's parent company UNOVA, visit www.unova.com.

Intermec Technologies Corp., a UNOVA Inc. (NYSE:UNA) company, is a leader in global supply chain solutions and in the development, manufacture and integration of wired and wireless automated data collection, Intellitag® RFID (radio frequency identification), mobile computing systems, bar code printers and label media. The company's products and services are used in many industries to improve productivity, quality and responsiveness of business operations, from supply chain management and enterprise resource planning to field sales and service.



IF5 RFID Network Reader

IP3 RFID Portable Reader



IV7 RFID Forklift Mount Reader



Intellitag PM4i RFID/Label Printer



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