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1 DOCUMENT INFORMATION

1.1 DOCUMENT SUMMARY

DOCUMENT ITEM	CURRENT VALUE
DOCUMENT TITLE	Tagged-Item Performance Protocol (TIPP) Tagged-Item Grading: Overview
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DOCUMENT DESCRIPTION	Provides an overview of the tagged-item grading solution and the relevant documents

1.2 TIPP DOCUMENT SERIES

This document is part of a series of documents laying out the tagged-item grading system for specifying tagged-item performance between retailers and suppliers. The series include the following four documents:

- The document entitled [TIPP Tagged-Item Grading: Overview](#) provides an overview of the tagged-item grading guideline. *(This is the current document.)*
- The document entitled [TIPP Tagged-Item Grading: Grade Definitions](#) defines the grade specifications.
- The document entitled [TIPP Tagged-Item Grading: Testing Methodology](#) presents the test procedure and measurement methods to qualify or establish the grade for a tagged item.
- The document entitled [TIPP Tagged-Item Grading Testing Configurations](#) defines the orientation for various types of tagged items (which is critical for repeatable testing using the TIPP procedure).

1.3 SCOPE

This document provides an overview of the tagged-item grading guideline adopted by the Tagged-Item Performance Protocol (TIPP) Workgroup of the GS1 Item Level RFID Getting Started Group. It is intended for parties learning about the TIPP grading guidelines and methodology including retailers, suppliers and solution providers. This document is not a normative standard or guideline, but serves to orient the reader to the methodology and provide references to the normative documents.

NOTE: As with all GS1 Standards and solutions, the Tagged-Item Grading System is voluntary, not mandatory. It should be noted that use of the words “must” and “require” throughout this document relate exclusively to technical recommendations for the proper application of the testing protocol to support the integrity of your application.

1.4 CONTRIBUTORS

NAME	ORGANIZATION	
SWEENEY, PAM	Macy's	Workgroup Co-Chair
PURCELL, BEBE	VF Corporation	Workgroup Co-Chair
DIETRICH, PAUL	Wrada	Editor and Facilitator
MORGAN, GENA	GS1 US	Facilitator
CHINWALA, MAC	Alien Technology, Corporation	
MITCHELL, NEIL	Alien Technology, Corporation	
MITCHELL, MICHAEL	Alien Technology, Corporation	
ERVIN, PATRICK	Alien Technology, Corporation	
PATTON, JUSTIN	Auburn University	
CP, SENTHILKUMAR	Auburn University	
VARGAS, JULIE	Avery Dennison Corporation	
SOWLE, ELIZABETH	Avery Dennison Corporation	
PERNICE, BOB	Avery Dennison Corporation	
DYCHE, GEORGE	Avery Dennison Corporation	
BARTON, KRIS	Avery Dennison Corporation	
LI, MORUI	Checkpoint Systems, Inc.	
RACETTE, TOM	Checkpoint Systems, Inc.	
COODUVALLI, UMESH	Checkpoint Systems, Inc.	
NUCE, MELANIE	GS1 US	
JAVICK, PATRICK	GS1 US	
ALLIGOOD, TYNDALL	Hanes Brands	
ARNSTEIN, LARRY	Impinj, Inc.	
LIU, JEREMY	Invengo Technology Corp.	
GOMILLION, JOE	Invengo Technology Corp.	
COMPITELLO, BILL	Invengo Technology Corp.	
SMITH, KAREN	Jockey International, Inc.	
MIRSBERGER, MICHAEL	Jockey International, Inc.	
LEMARRE, PAM	Jockey International, Inc.	
STEGALL, GARY	Kayser-Roth	
CULLEN, BRAD	Kohl's Department Stores Inc.	
SOMERS, JOE	Kohl's Department Stores Inc.	
FORECKI, ABBY	Kohl's Department Stores Inc.	
CAVADEL, GLENN	Kohl's Department Stores Inc.	
HOCHKOEPLER, ERNESTO	Levi Strauss & Company	
CISTERNINO, JOHN	Levi Strauss & Company	
SMITH, ANDREA	Lord & Taylor	
DESMONS, DIMITRI	LSIS Co., Ltd.	
WHITNEY, KRIS	Macy's	
WILKERSON, BRETT	MSM Solutions	

NAME	ORGANIZATION	
STOTT, NIGEL	NXP Semiconductors	
KOLARIC, VLATK	NXP Semiconductors	
BOUCHER, PIERRE	Peerless Clothing	
WEISENFELD, GALE	PVH Corp.	
NAGY, CHRIS	PVH Corp.	
TEITELBAUM, MICHAEL	r-pac International Corp.	
ARGUIN, PAUL	r-pac International Corp.	
REESE, CHRIS	Smartrac Technology Group	
KOSKELAINEN, TUOMAS	Smartrac Technology Group	
STIGALL, RANDY	Smartrac Technology Group	
WOOD, ROBERT	SML	
STONE, MIKE	SML	
RAMZAN, MO	SML	
DEW, TOMMY	SML	
DAILY, MIKE	SML	
CONSIDINE, THOMAS	SML	
CALDERBANK, PHIL	SML	
REPELLIN, LUCIEN	Stealth Network Communications	
NYSWONGER, MARGARET	Stealth Network Communications	
GROBLER, MIKE	Tageos	
MEDLIN, STAN	VF Corporation	
ISLEY, DAVID	VF Corporation	
CRAFT, JAY	VF Corporation	
PARTANEN, JUHO	Voyantic Ltd.	
BLACK, TIM	Xtreprise	

2 INTRODUCTION

In an open retail supply chain, retailers and suppliers negotiate about tagging specifications, including tag size, materials, barcode quality, font size, color, etc. The purpose of this document is to define how UHF¹ Gen2 RFID² -tagged item **performance** requirements can be included in such specifications in order to:

- Give retailers (or store operations) **independence** in setting RFID performance requirements. This means that different retailers do not have to agree on the performance levels (and use-cases) that they need, or even which product categories to tag.
- Provide suppliers (or supply operations) **flexibility** in how they meet those requirements. This means that suppliers have the responsibility to meet the required performance but may innovate within their supply chain on the best way to do it.
- Allow repeatable testing to ensure that a supplier's tagged items meet the performance requirement(s) of the retailer.

Unlike barcodes where label quality and performance can be assessed on its own, the fitness of an RFID tag for use in a given situation depends on many external factors. This reality has led some to conclude that it is difficult to meet the above goals for an open and efficient RFID tagging supply chain. Yet, there is a solution that is based on specifying and testing the performance of **tagged items** rather than the tags or inlays alone. Section 3 is a short review of RFID technology and terminology with factors that impact the performance of tagged items in practice. Section 4 introduces the concept of tagged-item grading. Section 5 introduces the tagged-item grading method for specifying and assuring RFID performance in an open, retail supply chain that takes many of the performance factors into consideration.

3 RFID TECHNOLOGY AND PERFORMANCE FACTORS

UHF Gen 2 tags include some form of antenna attached to a UHF Gen 2 chip. The chip itself is very small and generally difficult to see, but the antenna is a larger scale structure generally about the same size as a typical hang-tag or adhesive label. RFID-enabled tags are often, but not always, constructed using an inlay. An inlay is a combination of an RFID chip and an antenna that is ready to be used in a finished tag of some kind. Finished tags can be as simple as a pressure sensitive label that is little more than an inlay with adhesive; or they can be constructed by embedding inlays into hang-tags or tamper resistant security tags (known as "hard-tags"). RFID tags are attached to the product to create a RFID-tagged item.

An RFID reader is a radio device, either mobile or fixed, with an antenna for communicating with tags. A reader sends out a relatively strong radio signal that powers up and communicates with nearby tags (up to several meters). The tags send back relatively weak signals that must be detected by the reader. The GS1 Gen 2 standard³ defines the way readers and tags communicate so that multiple readers can successfully interact over the air with large quantities of tags in the same physical environment.

¹ UHF = Ultra High Frequency

² RFID = Radio Frequency Identification

³ [EPC® Radio-Frequency Identity Protocols: Class-1 Generation-2 UHF RFID Protocol for Communications at 860 MHz – 960 MHz \(Version 1.2.0\)](#)

Unlike barcode scanners which rely on line-of-sight, RFID readers and RFID-tagged items interact via radio signals that can pass through many kinds of materials including the paper and plastic often used in retail packaging, but typically with some performance impact. The ability for an RFID reader to communicate with a group of RFID-tagged items in a given situation depends on multiple factors. This includes the radio frequency (RF) characteristics of the tagged item; the RF characteristics of the reader; the distance between the reader and the tagged item; the interaction of the tagged product with the store fixtures; employee execution (i.e., data capture methods); and various other factors.

4 THE TAGGED-ITEM GRADING CONCEPT

4.1 TAGGED-ITEM SPECIFICATION

The TIPP Workgroup developed a tagged-item specification format that includes thresholds for the relevant performance factors such that two tagged items that have similar specifications will perform similarly within the same use case. Developing the specification format involved evaluating a large set of performance factors and selecting the ones most relevant to use case performance. This tagged-item specification includes only tagged-item performance factors. It does not directly measure RFID silicon (chip) performance, antenna performance, or RF properties of the retail item. RF properties of the retail item, packaging, placement of the RFID components on (or in) the item, and the RFID components all have a significant impact on performance. By establishing a performance specification for the combination of all of these subcomponents, we have arrived at a “simple-as-possible” specification ***while still allowing independent measurement and validation of the specification by both retailer and supplier.***

The specification does not include retail use case factors like shelf material, product layout, execution factors, reader performance, etc. A retailer accounts for their individual use case factors by selecting different thresholds within the tagged-item specification. For example, a use case that requires reading from longer distances would likely require the tagged item to be more sensitive to low energy reader signals.

4.2 TAGGED-ITEM GRADES

The TIPP Workgroup worked with retailers to build tagged-item performance specifications for their individual use cases. After evaluating these specifications in a technical review, the group concluded that some specifications were quite similar, while others were distinctly different. The group produced a set of “grades” grouping similar performance specifications. Grades are simply tagged-item performance specifications given shorthand names. Each grade was constructed by coalescing several tagged-item performance specifications.

Establishing grades for tagged items further simplifies the specification of performance between retailer and supplier. Retailers specify a grade level to suppliers along with their other tagging requirements. Suppliers test tagged items to ensure they meet the grade level. Following the specifications in Section 4.1 provides retailers with a degree of assurance that tagged items which meet the grade level will perform to their use case specification, regardless of the subcomponents used by the supplier to create the tagged item. Tagged-item grading allows retailers and suppliers to work ***independently*** but succeed together because any item that meets a retailer’s grade performs predictably in their usage environment.

By specifying tagged-item performance grade, the retailer has a method to communicate their RF performance requirement using the grade without sharing the details of the use case. Using barcodes as an analogy, the retailer does not have to share details about the brand of barcode readers they use, the lighting conditions in their stores, speed in which they scan the barcodes, or the distance between the barcode reader and barcode.

They communicate a grade requirement and they know that if a barcode meets the grade requirement then it will work predictably in their store.

The supplier has the responsibility and capability to see which of their tagged-item solutions meet the retailer's grade requirement while having more control over their supply chain and technology decisions. Using barcodes as an analogy, the supplier measures the grade of the barcode with a barcode grader and they know that it satisfies their obligations to the retailer if it meets the required grade.

Retailers typically do not have the same grade requirements. Some retailers have challenging use cases that depend on a high tagged-item performance grade, which may be more expensive, while others do not. Suppliers that receive different grade requirements from different retailers choose how best to meet these grade levels. Flexibility for suppliers and independence for retailers are the benefits of the tagged-item grading concept.

4.3 FUTURE GRADES

When deploying systems, the retailer can consider all of the factors that would affect the performance of RFID in their use case, and determine the performance requirements needed to ensure that tagged items can operate successfully under the influence of these factors. The retailer typically chooses an existing grade to communicate these performance requirements. However, new use cases may necessitate a tagged-item performance specification that is considerably different than existing grades. These are opportunities to define new grades to augment the existing set of grades. It is expected that the definition of new grades will be done within the GS1[®] community as part of a standards development process.

5 TAGGED-ITEM GRADING METHOD & REFERENCE DOCUMENTS

The TIPP tagged-item grading method includes the following components:

- ***A set of initial grades that define performance requirements for the set of relevant item factors.*** (The grade definitions are defined in the document entitled [TIPP Tagged-Item Grading: Grade Definitions](#).)
- ***A grade-validation test procedure that allows retailer, supplier and solution providers to independently validate the grade of a tagged-item.*** (The normative test procedures are defined in the document entitled [TIPP Tagged-Item Grading: Testing Methodology](#).)
- ***A product catalogue that defines the orientation and layout of common retail items.*** (The product catalogue is provided in the document entitled [TIPP Tagged-Item Grading: Testing Configurations](#).)

6 GRADE DEFINITIONS

The grade definitions are defined in the document entitled [*TIPP Tagged-Item Grading: Grade Definitions*](#).

6.1 GRADE FACTORS

TIPP includes a proven set of grade factors defined by Arkansas Radio Compliance (ARC) at Auburn University's RFID Lab. These factors include:

Sensitivity – A tagged item's sensitivity is the minimum power needed to be received by the tagged item to ensure that it powers on and executes a specific Gen2 command sequence. Sensitivity is typically a negative number and is specified in Decibel-milliwatts (dBm). Smaller (i.e., more negative) numbers represent a more sensitive (i.e., higher performing) tagged-item.

Backscatter Power – UHF passive tags do not transmit responses, but reflect (or backscatter) the transmitter's power back. The factors presented in Section 3 all influence an individual tagged item's backscatter power level. Backscatter power is typically a negative number and is measured in units of dBm. Larger (i.e., less negative) numbers represent a stronger backscatter power.

Orientation – Orientation is the angle between the tagged item and the reader (or test equipment). Orientation is measured in degrees. The TIPP grades define sensitivity and backscatter requirements at various orientations.

Frequency – Frequency is the frequency of the radio wave used to activate the tagged item. TIPP grades measure sensitivity and backscatter power across a wide frequency range and use the worst-case value across frequency.

6.2 GRADE IDENTIFIERS

TIPP provides a shorthand naming system for its grades. The naming system allows a convenient way to reference the large set of performance factors contained within each grade definition. TIPP grades are named with a multi-dimensional naming system. A TIPP grade has three components:

- **A single letter S or M denoting the test configuration for the tagged item.**
 - **S** stands for single item. When a grade specifies **S**, the test procedure is performed on a single item and must meet the item factors specified by the grade definition.
 - **M** stands for multiple items. When a grade specifies **M**, the test procedure is performed on a stack of 2 items and a stack of 11 items, and must meet the item factors specified by the grade definition.
- **A number (e.g. 5, 10, 20, etc.) that specifies item factor performance levels.**
 - The initial TIPP numbers are multiples of five to allow space in between existing grades if needed in the future. *(However, it is not anticipated that any intermediate performance levels would be needed.)*
 - Larger numbers correspond to higher performing tagged-items.
- **A letter (e.g. B or D) specifying the family to which the grade belongs.** Within a family, tagged items automatically pass lower numbered grades if they pass higher numbered grades. For example, a tagged-item that passes M15B also passes M10B because they are both in the B family. However the same tagged-item might not pass M15D because it is in the D family, or S15B because it is an S (single item) grade instead of an M (stacked) grade. As tag and reader technologies and use-cases progress, new grades within families and new families of grades with different characteristics will be needed.

TIPP grades are multi-dimensional, but ordered within the performance and orientation dimension. For example, a TIPP grade M20D would be higher performing than M10D. A tagged item that meets grade M20D also meets grade M15D, M10D, M5D. Similarly a tagged item that meets grade MXD would also meet MYB (where $X \geq Y$).

However, tagged items that meet S15B do not necessarily meet the corresponding M15B grade. A grade S15B and M15B are similar (but not necessarily identical) performance level and orientation responses, but one requires a single item for its test configuration while the latter requires a stack of items. A retailer may specify that a tagged item must simultaneously meet an M and S grade to satisfy a use case. For example, retailer may require that tagged denim must meet grades S15B and M20D.

6.3 THE GS1 US GRADE SUBMISSION PROCEDURE

GS1 US defined a [Tagged Item Performance Protocol \(TIPP\)](#) to establish a set of performance grades for RFID tagged-items and a test procedure to validate the grade of a tagged item. Grades themselves are not directly related to item category or use case, but it is expected that as use cases expand and new technology becomes available, new grades will need to be developed to span the range of performance required. The [GS1 US Grade Submission Procedure](#) defines a draft process for establishing new grades.

7 TEST PROCEDURE

The normative test procedures are defined in the document entitled [TIPP Tagged-Item Grading: Testing Methodology](#). The test procedure provides a repeatable way to verify the grade level of a tagged item. Suppliers creating tagging solutions may use this test procedure to validate solutions before shipping to retailers. Third party solution providers may use this test procedure to perform validation of tagged items on behalf of a retailer or supplier. Retailers may use this test procedure to audit the performance quality of tagged items shipped from suppliers.

Keeping the tests simple allows decentralization of testing, lower cost, and more innovation. Yet, testing laboratories can still play a key role in helping to execute the tests and assisting with cases in which the retailers and suppliers do not reach the same conclusions for specific items.

The tagged-item test procedure defines the method and criteria to establish that a tagged item meets a specified grade level. It has been proven during the protocol effort to yield consistent results across test facilities and test operators. The test procedure does not specify when, by whom, or how frequently the retailer and supplier should test items. There is currently no certification procedure to validate a party's ability to perform repeatable testing. Rapid innovation in testing equipment and procedures makes the formal certification process or procedure premature. Retailers may specify a minimum test (or retest) requirement of their suppliers. Suppliers, based on service level agreements, may determine their own acceptable test requirements that may meet or exceed anything specified by the retailer.

The test procedure pass/fail criteria are defined to ensure repeatable and unambiguous results. It intentionally does not specify what criteria a retailer uses to establish the consistency or quality of the tagged-item performance. For example, one retailer could ask that the supplier verify items periodically to meet their specified performance grade with some small (<1%) tolerance for failures. Another retailer may sample items through distribution and assess penalties for items failing to meet their specified grade. Yet another might have the technology to measure the grade of every single tagged item through their retail stores, and provide pass/fail feedback to their suppliers.

8 HOW THE METHODOLOGY WORKS

The TIPP grading methodology was tested with a prototype effort that included three retailers, five suppliers, three product categories, and thousands of items. From the experience of the participants, the methodology established works as follows:

1. Retailers pick a tagged-item grade that supports their use case.* This may involve several methods:
 - a. In the prototype effort, retailers built a tagged-item performance specification for their store use case, and then selected a grade level that matched most closely to their tagged-item performance specification
 - b. In production, it is likely that retailers will select a grade level based on some degree of past experience with similar use cases, and perform store testing to validate that tagged items of that grade level meet the in-store readability performance they desire.

** In some cases, the retailer may not have complete control over the grade shipped by the suppliers. For example, it may not be possible to meet a grade level for a specific retail item. In this case, the retailer may evaluate the in-store use case and make changes to the environment to ensure that the grade shipped provides the desired level of performance.*

2. Retailers communicate the grade level as part of a larger RFID-tagging specification, which can include other RFID-tagging requirements like placement, etc.
3. Suppliers measure tagging solutions using the Tagged-Item Testing Methodology, and verify that their tagging solutions meet the grade level specified by the retailer.
4. Suppliers ship the tagged items to the retailer. Retailers may verify (themselves or through a 3rd party) that the suppliers' items meet the specified grade level.
5. Retailers conduct performance audits to ensure tagged items with the specified grade level meet the desired retail store performance levels.

9 FUTURE REQUIREMENTS

The tagged-item protocol grades were developed using specific retailer use cases, and define required read sensitivity, backscatter and directionality of the tagged items. As retail use cases expand, additional grades can be developed which explore each of these parameters as needed. For example, M20G could represent a future stacked tagged item with strongest sensitivity at 90 degrees.

The tagged-item grading method was conceived to address the need to capture read performance requirements. But it can be extended to include write or encoding performance (i.e., writing EPCs) as a separate, independent grading scale but with a similar approach. For example, W10B could represent a future single tagged-item write grade.

In addition, retailers may require additional functionality in their RFID systems. In that case, the additional functionality must be added to the specification alongside the tagged-item read performance grade. Such additional functionality might include extended memory for data storage, data or product security features, and consumer security or application features.



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THE GLOBAL LANGUAGE
OF BUSINESS

CORPORATE HEADQUARTERS
Princeton Pike Corporate Center
1009 Lenox Drive, Suite 202, Lawrenceville, NJ 08648 USA
T +1 937.435.3870 E info@gs1us.org W www.gs1us.org

FOLLOW US:



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