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# Tagged-Item Performance Protocol (TIPP) Tagged-Item Grading Grade Definitions Guideline

Provides the specific definitions for RFID performance grades

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## Log of Changes

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0.9	26 Feb 2015	D.Buckley	Created with kind permission of GS1 US from the document <i>Tagged-Item Performance Protocol (TIPP) Tagged Item Grading: Testing Methodology 9/16/2014 R1.0 Dec 18 2014</i>
1.0	Nov 2016	P Dietrich	Multiple revisions from internal comment review. Initial release following Work Request 14-219

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## 1 Introduction

This document introduces the TIPP grades, explains the TIPP grade naming system, and defines the specifications for tagged-item sensitivity and backscatter for each grade. The document is intended for parties learning about the TIPP grading guidelines and methodology including retailers, suppliers and solution providers.

The Tagged-Item Performance Protocol (TIPP) Workgroup developed a tagged-item grading system to facilitate the specification of tagged-item performance between retailers and suppliers. This system defines a set of "grades" constructed by coalescing several tagged-item performance specifications that are based on a proven set of grade factors defined by Arkansas Radio Compliance (ARC) at Auburn University's RFID Lab. These factors include sensitivity, backscatter power, orientation, and frequency. Each grade is represented by a name that comprises four designators: test configuration, performance level, family, and (optionally) frequency. As such, TIPP grades are simply tagged-item performance specifications given a shorthand names.

## 2 Grade identifiers

TIPP provides a shorthand naming system for its grades. The naming system provides 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 four components:

- **A single letter (e.g. 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, V, or D) specifying the family to which the grade belongs.** The set of all TIPP grades is divided into families to group together grades with common performance characteristics. Grades within a family are "ordered". 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.
- **An optional 4<sup>th</sup> component , If present, the 4<sup>th</sup> component specifies the test frequency range.**
  - *If the 4<sup>th</sup> component is not specified, the grade is tested over the frequency range 865-868 MHz and 902-928 Mhz.*
  - *If the 4<sup>th</sup> component is specified as FCC, the grade is tested only over the frequency range 902 -928 MHz*
  - *If the 4<sup>th</sup> component is specified as ETSI, the grade is tested only over the frequency range 865 – 868 MHz*

Grades having the same frequency designator can be compared within their families as specified above. If two grades have different frequency designators, they cannot be ranked by performance-number. An example grade S15B-FCC meets the S15B grade specification tested only over the frequency range of 902-928 MHz.



### 3 Pass/Fail Criteria with Minimum Success Rate

The solution brings a new dimension to the grade definitions called "minimum success rate"<sup>1</sup>. These are percentage values that are separately defined for each antenna and orientation line. By default this number is 100%, which is also aligned with the original TIPP US guideline. However also a lower percentage can now be defined to allow the tagged item to fail one or more of the specified test nodes.

Sensitivity					
Minimum success rate	Orientation angle	Antenna			
		100%	100%	100%	100%
		1	2	3	4
100%	0				
100%	30				
100%	60				
100%	120				
100%	150				
100%	180				

If the pass/fail criteria for a grade is not specified or absent, every entry with a performance number must pass the grade test procedure. For entries that contain no performance number, no testing is required.

For example, there are potential 4 columns and 10 rows of potential performance data. A 50% pass/fail criterion in a column of would mean that at least half of the entries specified in the column must meet the performance level. If the column contains 10 performance levels, that at least five must be met. If the column contains less than 10 levels (they are unspecified and thus no testing is required), then at least half of those specified must meet the performance level.

### 4 Grade definitions

Each grade is defined by a set of tables that specify the tagged-item sensitivity and backscatter at various orientations. The entries in the table specify the power at the tagged-item in Decibel-milliwatts (dBm) according to the test procedures defined in the [TIPP Tagged-Item Grading: Testing Methodology](#). If an entry in a table is blank, then there is no specification for that orientation. To determine if a tagged item meets a given grade, the test must be performed according to the test procedures defined in the [TIPP Tagged-Item Grading: Testing Methodology](#) using tag placement and configurations specified in the [TIPP Tagged-Item Grading Testing Configurations](#).

<sup>1</sup> The original TIPP US Guideline had strict pass/fail interpretation of the test results: if the tested item failed even one of the specified test nodes, the whole test sequence was determined as a failure. Considering the complexities of both the TIPP test procedure, the evolution of tagging and packaging solutions and especially the statistical nature of RFID reads in general, the TIPP global grading system is improved to also consider the occasional non-fatal read failures.

### 4.1 Performance grade S05V

Test frequency Range: Unless otherwise specified in the grade nomenclature the test frequency range is 902 MHz to 928 MHz and 865 MHz to 868 MHz. The pass/fail criteria are 100% for all rows and columns and are omitted here for brevity.

Sensitivity				
	Antenna			
	1	2	3	4
0	-3.5			
30	1			
60				
120				
150	1			
180	-3.5			
210	1			
240				
300				
330	1			

Backscatter				
	Antenna			
	1	2	3	4
0	-29			
30				
60				
120				
150				
180	-29			
210				
240				
300				
330				



## 4.2 Performance grade S05B

Test frequency Range: Unless otherwise specified in the grade nomenclature the test frequency range is 902 MHz to 928 MHz and 865 MHz to 868 MHz. The pass/fail criteria are 100% for all rows and columns and are omitted here for brevity.

Sensitivity				
Orientation	Antenna			
	1	2	3	4
0	-3.5	-3.5	-2.5	-2.5
30	1	2	4	2
60				
120				
150	1	2	4	2
180	-3.5	-3.5	-2.5	-2.5
210	1	2	4	2
240				
300				
330	1	2	4	2

Backscatter				
Orientation	Antenna			
	1	2	3	4
0	-29	-30	-30	-29
30				
60				
120				
150				
180	-29	-30	-30	-29
210				
240				
300				
330				

### 4.3 Performance grade S15B

Test frequency Range: Unless otherwise specified in the grade nomenclature the test frequency range is 902 MHz to 928 MHz and 865 MHz to 868 MHz. The pass/fail criteria are 100% for all rows and columns and are omitted here for brevity.

Sensitivity				
	Antenna			
	1	2	3	4
0	-6.5	-6.5	-5.5	-5.5
30	-2	-1	1	-1
60				
120				
150	-2	-1	1	-1
180	-6.5	-6.5	-5.5	-5.5
210	-2	-1	1	-1
240				
300				
330	-2	-1	1	-1

Backscatter				
	Antenna			
	1	2	3	4
0	-31	-32	-32	-31
30				
60				
120				
150				
180	-31	-32	-32	-31
210				
240				
300				
330				

#### 4.4 Performance grade S15D

Test frequency Range: Unless otherwise specified in the grade nomenclature the test frequency range is 902 MHz to 928 MHz and 865 MHz to 868 MHz. The pass/fail criteria are 100% for all rows and columns and are omitted here for brevity.

Sensitivity				
	Antenna			
	1	2	3	4
0	-6.5	-6.5	-5.5	-5.5
30	-5	-5	-4	-4
60				
120				
150	-5	-5	-4	-4
180	-6.5	-6.5	-5.5	-5.5
210	-5	-5	-4	-4
240				
300				
330	-5	-5	-4	-4

Backscatter				
	Antenna			
	1	2	3	4
0	-33	-32	-33	-33
30				
60				
120				
150				
180	-33	-32	-33	-33
210				
240				
300				
330				

#### 4.5 Performance grade S20B

Test frequency Range: Unless otherwise specified in the grade nomenclature the test frequency range is 902 MHz to 928 MHz and 865 MHz to 868 MHz. The pass/fail criteria are 100% for all rows and columns and are omitted here for brevity.

Sensitivity				
	Antenna			
	1	2	3	4
0	-9.5	-9.5	-8.5	-8.5
30	-5	-4	-2	-4
60				
120				
150	-5	-4	-2	-4
180	-9.5	-9.5	-8.5	-8.5
210	-5	-4	-2	-4
240				
300				
330	-5	-4	-2	-4

Backscatter				
	Antenna			
	1	2	3	4
0	-32	-33	-33	-32
30				
60				
120				
150				
180	-32	-33	-33	-32
210				
240				
300				
330				

### 4.6 Performance grade M05B

Test frequency Range: Unless otherwise specified in the grade nomenclature the test frequency range is 902 MHz to 928 MHz and 865 MHz to 868 MHz. The pass/fail criteria are 100% for all rows and columns and are omitted here for brevity.

2 stack sensitivity				
Orientation	Antenna			
	1	2	3	4
0	-0.5	1	1.5	1.5
30	2	4	4	3
60				
120				
150	2	4	4	3
180	-0.5	1	1.5	1.5
210	2	4	4	3
240				
300				
330	2	4	4	3

11 stack sensitivity				
Orientation	Antenna			
	1	2	3	4
0	5	5	6	6
30				
60				
120				
150				
180	5	5	6	6
210				
240				
300				
330				

2 stack backscatter				
Orientation	Antenna			
	1	2	3	4
0	-33	-34	-37	-36
30	-35	-35		
60				
120				
150	-35	-35		
180	-33	-34	-37	-36
210	-35	-35		
240				
300				
330	-35	-35		

11 stack backscatter				
Orientation	Antenna			
	1	2	3	4
0				
30				
60				
120				
150				
180				
210				
240				
300				
330				

### 4.7 Performance grade M10B

Test frequency Range: Unless otherwise specified in the grade nomenclature the test frequency range is 902 MHz to 928 MHz and 865 MHz to 868 MHz. The pass/fail criteria are 100% for all rows and columns and are omitted here for brevity.

2 stack sensitivity				
Orientation	Antenna			
	1	2	3	4
0	-3.5	-2	-1.5	-1.5
30	-1	1	1	0
60				
120				
150	-1	1	1	0
180	-3.5	-2	-1.5	-1.5
210	-1	1	1	0
240				
300				
330	-1	1	1	0

11 stack sensitivity				
Orientation	Antenna			
	1	2	3	4
0	2	2	3	3
30				
60				
120				
150				
180	2	2	3	3
210				
240				
300				
330				

2 stack backscatter				
Orientation	Antenna			
	1	2	3	4
0	-32	-33	-36	-35
30	-34	-34		
60				
120				
150	-34	-34		
180	-32	-33	-36	-35
210	-34	-34		
240				
300				
330	-34	-34		

11 stack backscatter				
Orientation	Antenna			
	1	2	3	4
0				
30				
60				
120				
150				
180				
210				
240				
300				
330				

### 4.8 Performance grade M15B

Test frequency Range: Unless otherwise specified in the grade nomenclature the test frequency range is 902 MHz to 928 MHz and 865 MHz to 868 MHz. The pass/fail criteria are 100% for all rows and columns and are omitted here for brevity.

2 stack sensitivity				
Orientation	Antenna			
	1	2	3	4
0	-7	-6	-3	-4
30	-3.5	-2.5	-2.25	-2
60				
120				
150	-3.5	-2.5	-2.25	-2
180	-7	-6	-3	-4
210	-3.5	-2.5	-2.25	-2
240				
300				
330	-3.5	-2.5	-2.25	-2

11 stack sensitivity				
Orientation	Antenna			
	1	2	3	4
0	-1	-2	-3	-2
30				
60				
120				
150				
180	-1	-2	-3	-2
210				
240				
300				
330				

2 stack backscatter				
Orientation	Antenna			
	1	2	3	4
0	-31	-30	-30	-25
30	-32			
60				
120				
150	-32			
180	-31	-30	-30	-25
210	-32			
240				
300				
330	-32			

11 stack backscatter				
Orientation	Antenna			
	1	2	3	4
0				
30				
60				
120				
150				
180				
210				
240				
300				
330				

### 4.9 Performance grade M20D

Test frequency Range: Unless otherwise specified in the grade nomenclature the test frequency range is 902 MHz to 928 MHz and 865 MHz to 868 MHz. The pass/fail criteria are 100% for all rows and columns and are omitted here for brevity.

2 stack sensitivity				
	Antenna			
	1	2	3	4
0	-8	-6.5	-7	-7
30	-5.5	-6.5	-5.5	-2.5
60				
120				
150	-5.5	-6.5	-5.5	-2.5
180	-8	-6.5	-7	-7
210	-5.5	-6.5	-5.5	-2.5
240				
300				
330	-5.5	-6.5	-5.5	-2.5

11 stack sensitivity				
	Antenna			
	1	2	3	4
0	-1	-4	-5	-1
30				
60				
120				
150				
180	-1	-4	-5	-1
210				
240				
300				
330				

2 stack backscatter				
	Antenna			
	1	2	3	4
0	-21	-26	-26	-24
30	-24	-25	-26	-27
60				
120				
150	-24	-25	-26	-27
180	-21	-26	-26	-24
210	-24	-25	-26	-27
240				
300				
330	-24	-25	-26	-27

11 stack backscatter				
	Antenna			
	1	2	3	4
0				
30				
60				
120				
150				
180				
210				
240				
300				
330				