Dynamic Test: Conveyor Portal Test Methodology

For Applied Tag Performance Testing

Rev 1.1.4

Test Methodology

5 April 2006

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Abstract

This document defines test methodology for testing RFID Tagged Product as it travels through **Conveyor Portals**, one of several dynamic system elements under the “Applied Tag Performance” (ATP) dynamic test scenarios.

Status of This Document

This section describes the status of this document at the time of its publication. This test method has been formally accepted by the EPCglobal Technical Steering Committee and the EPCglobal Business Steering Committee.

The test methodology described in this document SHALL be only used to test tagged items.

Terminology and Typographical Conventions

Within this specification, the terms SHALL, SHALL NOT, SHOULD, SHOULD NOT, MAY, NEED NOT, CAN, and CANNOT are to be interpreted as specified in Annex G of the ISO/IEC Directives, Part 2, 2001, 4th edition [ISODir2]. When used in this way, these terms will always be shown in ALL CAPS; when these words appear in ordinary typeface they are intended to have their ordinary English meaning.

All sections of this document are normative, except where explicitly noted as non-normative.

The following typographical conventions are used throughout the document:

- ALL CAPS type is used for the special terms from [ISODir2] enumerated above.
- Monospace type is used to denote programming language, UML, and XML identifiers, as well as for the text of XML documents.

➢ Placeholders for changes that need to be made to this document prior to its reaching the final stage of approved EPCglobal specification are prefixed by a rightward-facing arrowhead, as this paragraph is.

Table of Contents

1 Purpose

The purpose of this document is to define criteria to test the performance of RFID tagged cases with respect to readability within **Conveyor Portal** configurations. The intent is to achieve consistent performance for the reading of RFID tags as they pass through the Conveyor Portals in actual supply chain implementations. This document may also be used as guideline to assist in the development and implementation of conveyor portal RFID systems.

2 Targeted Audience

This document is intended for use by EPCglobal Accredited Test Centers which will perform dynamic testing of applied tags to gauge readability within **Conveyor Portals**.

3 Scope

This document covers the requirements for testing the performance on selected and applied tags on cases of product. The cases to be tested are goods packaged within the case or carton exactly as they are to be packaged when shipped through the supply chain. The tag is the model of tag intended to be used when tagged cases are shipped through the supply chain. The location of the tag on the case is the location that will be used when tagged cases are shipped in the supply chain.

The tags to be tested through the Portal structures are anticipated to be in the UHF band of ~850 – 960 MHz.

The test criteria outlined in this document will be performed on passive tags.

4 Definitions

Antenna Array – One or many antennas arranged such that the interrogation field of each antenna is combined to cover a larger surface area or volume. Generally only one antenna is on at a time, requiring that each antenna be sequentially addressed.

Case – Usually a corrugated box that contains one individual product or multiple samples of identical products. Case dimensions can be as small as 10 x 10 x 15 cm (4” x 4” x 6”) to 120 x 74 x 76 cm (48”x 29”x 30”).

dBm – The official unit of RF measure for this standard will be determined at a later date. It will be either “dBm eirp” or “dBm erp”.

DC – Distribution Center. This is also used to describe general Warehousing facilities.

Dock Door Portal – The specific case of a Door Portal that is configured around loading docks that lead to parked trucks.

Door Portal – A configuration of readers and antennas that surround a passage way through which tagged material may be conveyed by mobile material handling equipment or personnel.

Flex Conveyor – A semi rigid, accordion style configuration of rollers that allows material to be transported from static conveyor systems, and be dynamically extended to reach inside trucks for hand stacking. A section of Flex Conveyor may pass through a configured door portal leading to the truck.

Each – An individual unit. A case could consist of Multiple Eaches.

Interrogation Path – The path that tagged material will travel through as it passes through the portal configuration.

Interrogation Field – The area across which RF energy from the readers and antennas configured in the portal are sufficient to read a tag in the field.

Motion Detector – A device that senses motion, and will create a trigger that a reader can use to activate an antenna, to perform a tag read.

Nominal Refrigerated Environment – The temperature and humidity the SKU is expected to be experiencing at the read point in question.

Pallet – Supporting structures made of wood, plastic or metal that allows the transport of material with mobile equipment such as fork lifts trucks or “walkies”. They are used to transport single SKUs, multiple same type SKUs or a mixture of SKUs types. For example, a typical domestic US pallet base has a size of 102 x 122 x 12.7 cm (40”x 48”x 5”). The standard EU pallet base is 120 x 80 x 14.4 cm (47.25” x 31.5” x 5.67”).

Pallet Tag – A tag that is attached to the exterior of the unit load after the unitizing process to specifically identify the contents of the pallet load. Tag is not attached or imbedded into a wood, polymer or other type of pallet assembly.

X, XX, or XXX – These terms are currently being used as place holders for undefined values.   These values will be determined by the findings of the Field Strength Measurement Team (FSMT), Static Test Specification Team, Pilot Testing Program, and various, ongoing, Round Robin Testing Programs.

5 Conveyor Portal Test Equipment Configuration

5.1 Conveyor Portal Diagrams

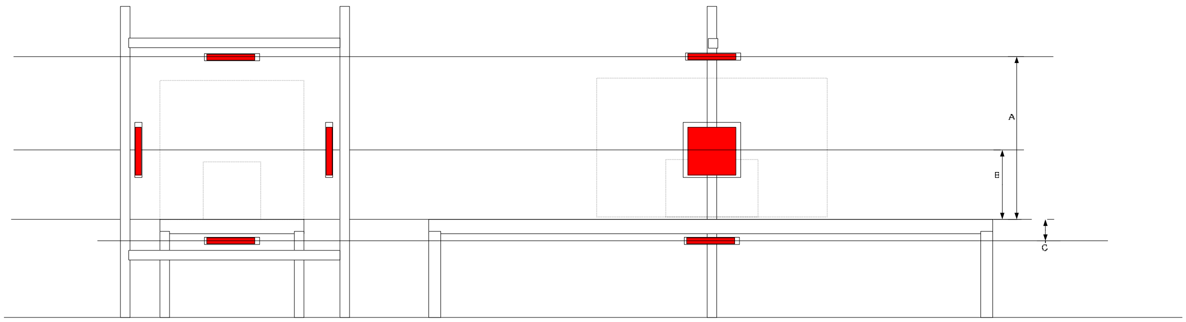


Figure 1: Conveyor Portal**.** End and side conveyor portal views are shown. Antennas are shown in red. Dotted line boxes show largest & average case size.

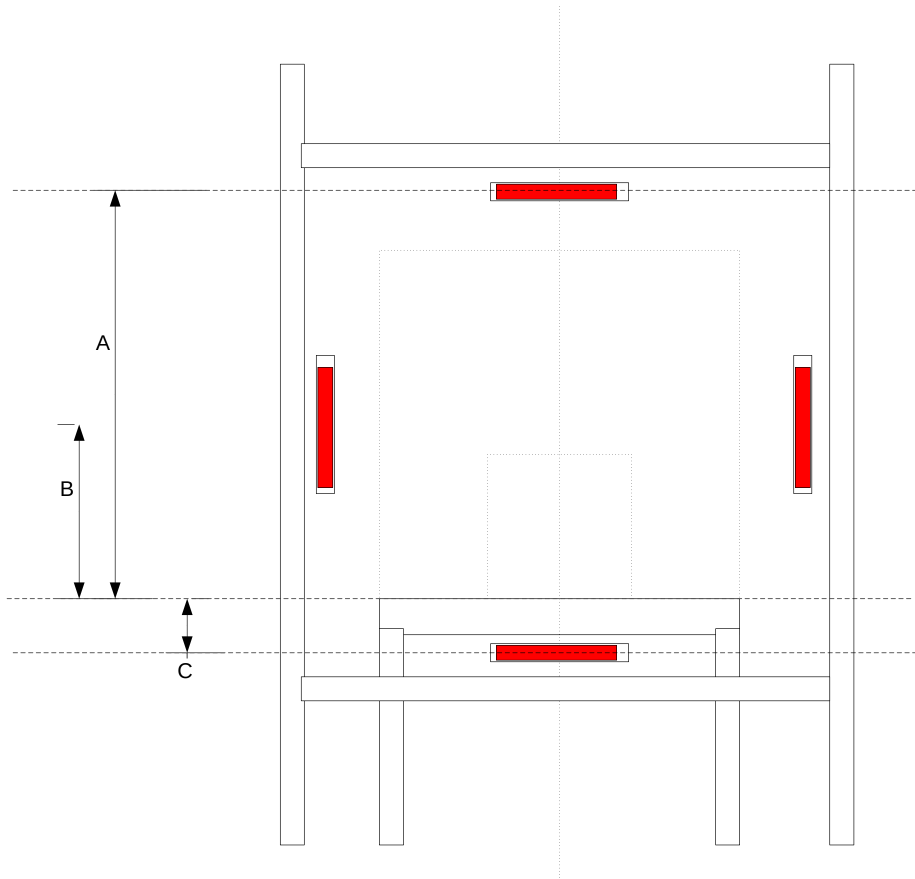


Figure 2 Conveyor Portal End View

Measurements:

A = Top Antenna to conveyor deck dimension = 965.2mm (38 inches)

B = Side Antenna to conveyor deck dimension = 381.0mm (15 inches)

C = Bottom Antenna to conveyor deck dimension = 203.2mm (8 inches)

Width (distance between the two side-mounted antennas) = 1118mm (44 inches)

These dimensions allow a case of dimensions 736.6 x 762.0 x 1219.2mm (29" x 30" x 48") to pass through the conveyor read point.

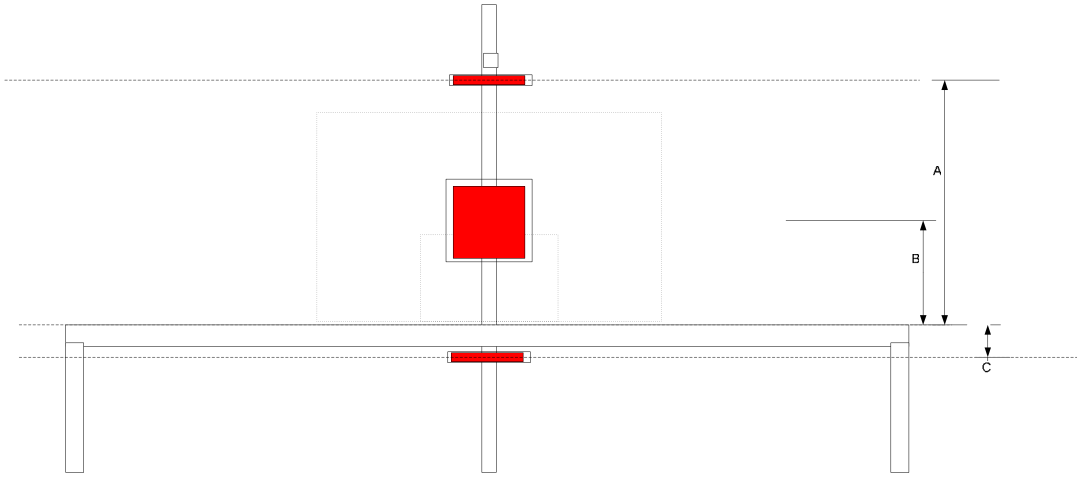


Figure 3 Conveyor Portal Side View

5.2 Conveyor Portal Attributes

A. The conveyor portal test configuration SHALL consist of a supporting structure which surrounds the conveyor bed and serves as a mounting for the reader's antennas.

B. The conveyor bed at the read point MAY be composed of either of the following transport mechanisms:

Belt   Belt carcass *must* be composed of single-ply interwoven

- PVC or
- Polyester or
- Urethane or
- Nylon

construction with a *maximum* of one longitudinal splice of the following type

- Alligator or
- Staple or
- Clipper

Belt *may not* be steel belted.

Belt *may* contain any of the following topcoat characteristics/finishes

- Cleated
- Smooth Cover
- Friction Coating
- Brushed

- Skim Coating
- Waffletop
- Z-Belt
- Low Friction
- Inverted Diamond
- Matte Finish
- Satin Finish
- Fine Fabric Impression

Belt bed must be solid metal and absent of RF-lucent inserts or windows.

Roller	Roller pin *must* display or contain any of the following characteristics

Roller Tube *may* be either

- Steel or
- Aluminum
- Roller Tube may not be of polymer construction or any other RF-lucent material.

Spindle *may* be either

- Female threaded or
- Spring-loaded

Drive mechanism may be either

- Tangential or
- Roller-to-roller

Power mechanism may be either

- Metal chain or
- Polymer belt

C. Conveyor speed shall be 190.5 meters/minute (625 feet/minute). Slower speeds may also be utilized, but results for testing done at less than 625 ft/min are not universally accepted and may result in test data that is not valid for some end user applications. Actual speed must be reported (see Section 8). Reported speed must be controlled to within +/- 5%.

D. Each portal will consist of at least two antennae mounted on each side of the conveyor. Up to four antennas (the two required antennas and two optional antennas, one above and / or below the conveyor bed may be installed. (See Figures 1, 2, and 3)

E. Construction and set up of the reader and antenna will be such that the RF field strength at all points in the read field shall not exceed a maximum of XX dBm. Additionally, the continuous RF field present in this Interrogation Path should be a minimum of XX dBm, as energies less than this may result in the underperformance of tag SKU combinations that would otherwise be found acceptable

F. The support structure of the portal MAY be constructed of any material.

G. Large exposed metal surfaces such as walls, screens, and sheet-metal, within 5 meters (16.4 feet) of the RF field will be covered with RF absorbing materials to prevent reflections and standing waves. Materials with dimensions<<1 wavelength (<< about 33cm {13 inches}), such as antenna mounts, need not be covered.

H. The following types of circularly polarized antennas MAY be used:

- Combined transmit and receive antennas.
- Separate transmit and receive antennas.

I. The antennas shall be positioned parallel to the conveyor path. The antennas should always be positioned bore sight to bore sight. The tilting or turning of antennas is not acceptable.

J. The reader shall continuously switch between antennae for an even amount of time per antennae. The reader shall continuously switch between antennas in the following sequence during reader queries:

   a. Side antenna #1 – to the right of each case as each case passes through the read zone, with radiation directed towards each case

   b. Top antenna – mounted above the conveyor with radiation directed downward towards each case

   c. Side antenna #2 – to the left of each case as each case passes through the read zone, with radiation directed towards each case

   d. Bottom antenna -- mounted below the conveyor with radiation directed upwards towards each case

K. Antennas will use the maximum power allowed per regulatory environment with a gain of 6dB.

L. A minimum gapping distance of 305mm (12 inches) will be maintained between cases. Labs MAY employ any manual or automatic means to prevent cases from compressing together.

5.3 Conveyor Portal Dimensions

Dimensions are based on specifications from *EPCglobal Physical Operation Requirements*, 31 October 2004:

A. Minimum case dimensions shall be 10 cm x 10 cm x 15 cm (4 inches x 4 inches x 6 inches)

B. Conveyable case LxWxH dimension range of 10 cm x 10 cm x 15 cm (4 inches x 4 inches x 6 inches) minimum to 74 cm x 76 cm x 122 cm (48 inches x 29 inches x 30 inches) maximum.

6 Conveyor Portal: Environmental Conditions

6.1 RF Spectrum Requirements

6.1.1 RF Spectrum Measurement Technique

A. A simple dipole antenna of known gain will be placed within 1 meter of the portal.

B. Frequency Range: RF power within +/- 1 MHz of the center frequency of the portal reader will be measured.

C. The peak power (maximum hold) within this band will be measured for a duration of 2 minutes.

Measurement Sequence

A. RF Spectrum will be audited, measured, and recorded before conducting dynamic portal tests.

B. RF Spectrum will be measured and recorded on completion of each dynamic portal test.

C. Both measurements (“before” and “after” must be within specification, or the dynamic test must be repeated.

6.1.2 RF Conditions Specification

Parameter	Specification
RF Spectrum Peak power	Less than –24 dBm at all frequencies.

Note: This requirement will be reviewed and addressed by the through Field Strength Measurement Team (FSMT).

6.2 Temperature and Humidity Requirements

Parameter	Specification
Ambient Temperature	between 10 degrees C (50 degrees F) and 45 degrees C at time of testing (113 degrees F)
Ambient Humidity	Up to 95 % RH at time of testing

6.3 Special Environmental Conditions

6.3.1 Refrigerated Environment

This special case test will be performed at the temperature and relative humidity found in the refrigerated environment

Parameter	Specification
Ambient Temperature	Nominal refrigerated environment temperature +/- 3 degrees C (5 degrees F).
Ambient Humidity	Nominal refrigerated environment relative humidity +/- 5%

7 Conveyor Test Methodology

7.1 Sample Size

A. Sample Size Basis: Dynamic testing is performed to assess the "readability" of a case.

B. Each tagged case will be measured during each "iteration" or "pass" through the dynamic portal.

C. For each case orientation, 10 iterations will be measured and recorded. This results in:

   a. 10 iterations x 12 orientations = 120 data points per test trial

   b. Lab MAY choose to pass a single case in each orientation through the dynamic portal 10 times, or a group of x cases of each orientation 10/x times.

   c. Labs MAY record and report which antenna(s) read each of the cases in each iteration and for each orientation, resulting in up to 480 data points per test trial.

7.2 RFID Tag Selection

Tags to be used during the testing will be selected using the tag selection technique – See Appendix A. Those tags selected will be of median responsiveness as described in Appendix A.

The tags used for testing SHALL be used as intended by the manufacturer. For tags intended to be attached by adhesive, they must be affixed to the package utilizing stock adhesive. Tags may not be affixed to packages using adhesive strip tape, spray adhesive, or any other method which does not faithfully replicate a "real world" application. No artificial layers of any material can be placed between the tag and the tagged item. The individual tags are not expected to be reusable.

7.3 Case Orientation and dynamics

The orientation of cases in the supply chain is not controlled. Often, cases tumble when placed on a conveyor or during conveying. In order to create a reproducible test environment, cases SHALL be placed on the conveyor in such a manner as to ensure the orientation is accurate and identical within the trial. Dynamic testing shall test the 12 non-redundant, orthogonal, orientations for a rectangular case per trial. Each trial SHALL be repeated ten times.

Parameter	Specification
Distance between cases during test	>= 305 mm (12 inches)
Case orientations to be tested	1. Tag Top side 2. Tag Top side, case rotated 90 degrees 3. Tag Bottom side 4. Tag Bottom side, case rotated 90 degrees 5. Tag Right side 6. Tag Right side, case rotated 90 degrees 7. Tag Left side 8. Tag Left side, case rotated 90 degrees 9. Tag Front side 10. Tag Front side, case rotated 90 degrees 11. Tag Back side 12. Tag Back side, case rotated 90 degrees Note: if a case cannot be tested in all 12 orientations (for example, if has a very small dimension that it cannot balance on) then the relevant orientations will be tested and reported, with no reads reported for the other orientations. See section 8.
Case rotation allowance	Case rotation in the horizontal plane will be controlled to within +/- 10 degrees during test. Rotation within this range is permitted as the case moves through the portal system.

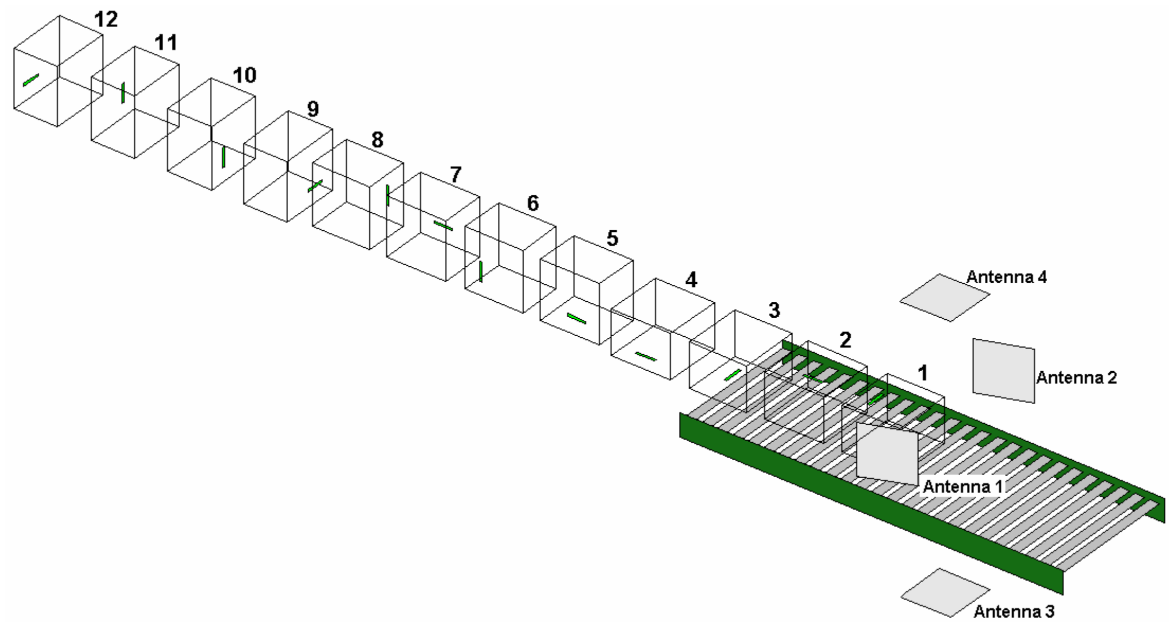


Figure 4 Case Orientation Illustration

Note that antenna 1 and 2 are drawn with a slight angle relative to the conveyor. Labs will not angle antennas.

7.4 Reader Operation

7.4.1 Read "frame"

A. A Reader frame is defined as the period of time during which the reader is actively scanning for tags.

B. The reader frame will be divided such that equal time is provided for each of the four antennas. (Total time in the frame will vary with speed and case size and case spacing)

C. The reader will be set into single protocol mode. The reader will be configured with manufacturer recommended settings for use as a conveyor reader.

7.4.2 Reader Test Sequence

A. The reader system waits for the beginning of a frame.

B. During the frame, the reader system looks for valid tag IDs as it switches among the four antennas

C. On completion of the frame, the reader system stops read operations, and records the EPC codes that were read.

D. The reader system *MAY* also record the time sequence of successful tag reads and/or the read count for each ID and/or the read count on each antenna.

E. The reader system prepares for the next iteration of the test sequence.

F. The test cases MAY be stopped and adjusted (rotation, spacing adjustments) on the conveyor after any iteration, or travel continuously on a loop.

7.5 Recording of Data

A. Every time a case passes through the portal, and is read, the EPC code will be recoded electronically along with the iteration number and information about the case's orientation during that iteration. If a case is not read, there will not be an entry for that EPC and iteration number in the electronic record.

B. Additional, optional information MAY be recorded for each read event: it is recommended that for each read event, the number of reads obtained on each antenna be recorded. Also recommended, if available, is an indication of received tag signal strength per antenna per read event.

C. The collection of read events for a conveyor test will be accompanied by the following information:

- The time and date of the start, and end, of the test
- The temperature and relative humidity at both the start and end of the test
- The Spectral Noise information measured at both the start and end of the test

8 Reporting Requirements

8.1 Required Information

All read events and accompanying data (iteration number, orientation, and optional information about the read event) will be reported in a human and machine readable file, such as a comma delimited text file.

The following will also be measured or verified, and reported, for each tagged case tested:

- An identification of the testing lab, and the particular conveyor used for the testing if the testing lab has multiple conveyors
- The exact speed at which the lab performed dynamic tests
- The Brand, model number, serial number, and firmware version(s) of the reader
- The model and serial numbers of the reader antennas
- The actual tuning parameters and settings of the reader, including power levels, and duty cycles (should be 25% on each antenna).
- The time and date of the start, and end, of the test
- The temperature and relative humidity at both the start and end of the test
- The Spectral Noise information measured at both the start and end of the test
- Manufacturer, model, and calibration date of the Spectrum Analyzer and antenna in use to make RF measurements.
- Information identifying the Case, such as brand code or text description or SKU number.
- Information identifying the tag, such as the tag manufacturer's part number and lot number
- The position of the tags on the cases used in the testing
- Photographs or drawings of a case, a tag, and of a tag applied to a case in the location to be tested

8.2 Optional Information

- The report MAY optionally contain the computed read rate and other statistics derived from the Required Data and Optional Data.

8.3 Example File Format

Two comma delimited text files will be returned. One has the information about the test set-up, and the other contains the read information.

File #1

```
Test Lab, ABC Co.
Conveyor, Building 2
Speed (meters/minute), 190.5
Reader, READERCO
Reader Model, FastReader
Reader Serial, 12345
Reader Firmware, MainBoard FW 5.0.1 DSPBoard FW 2.2
.
.
.
Total Iterations, 10
Total Orientations, 12
Total Reads, 119
Read Rate Percentage, 99.17
```

(Note that the last two lines contain optional information derived from the required information in both data files)

File #2

```
EPC, Iteration Number, Orientation Number, Ant 1 reads, Ant 2 reads, Ant 3 reads, Ant 4 reads
1234 AAAA 0000 0000 0000 0FFF, 1, 1, 2, 1, 2, 0
1234 AAAA 0000 0000 0000 1000, 1, 2, 3, 0, 1, 1
1234 AAAA 0000 0000 0000 1001, 1, 3, 2, 0, 1, 2
.
.
.
```

9 APPENDIX A

Tag selection method

(NOTE: This Appendix will be updated to correlate with the Static Test Standard)

This brief suggests a way to select tags that can be used in EPCglobal related static and dynamic pilot tests.

Randomly select a quantity of tags from a source. It is preferable that the tags be from the same source, preferably the same lot, supplied by a converter or tag manufacturer.

Measure the free space maximum read distance of each tag. This may be done in two ways:

A. Method one – measuring actual maximum free space read distance

1. Set up a reader and an antenna. Antenna may be linearly or circularly polarized. (Tag will have to be oriented properly, aligned to the field, if LP antenna is used).

2. The reader and antenna must be set up in a room such that multi-path effects are minimized. (Suggest that ceiling be at least 6 meters (20 feet) high, the antenna is mounted at least 2.1 meters (7 feet) above the ground, distance between antenna and wall facing antenna, if any, be at least 15.25 meters (50 feet)). Alternately, the reader and antenna may be set up outside, perhaps in a parking lot.

3. Mount the tag on an RF friendly material (E.g., Styrofoam, cardboard). Cellophane or masking tape may be used to mount the tag. Place the tag on a mount, preferably with wheels, such that the tag is aligned to center of the antenna (bore sight). For the mount, avoid metal. Wood or plastic is recommended.

4. Adjust reader power to a set value, 1 Watt.

5. Set the reader to a single frequency, say 915 MHz. (Note: this may not be possible due to regulatory requirements.

6. Verify that antenna is radiating, by measuring the field at the face of the antenna. A dipole antenna connected to an average power meter may be used. Expect to see +10 to +20 dBm power at the face of the antenna, as the dipole is moved over the face of the antenna.

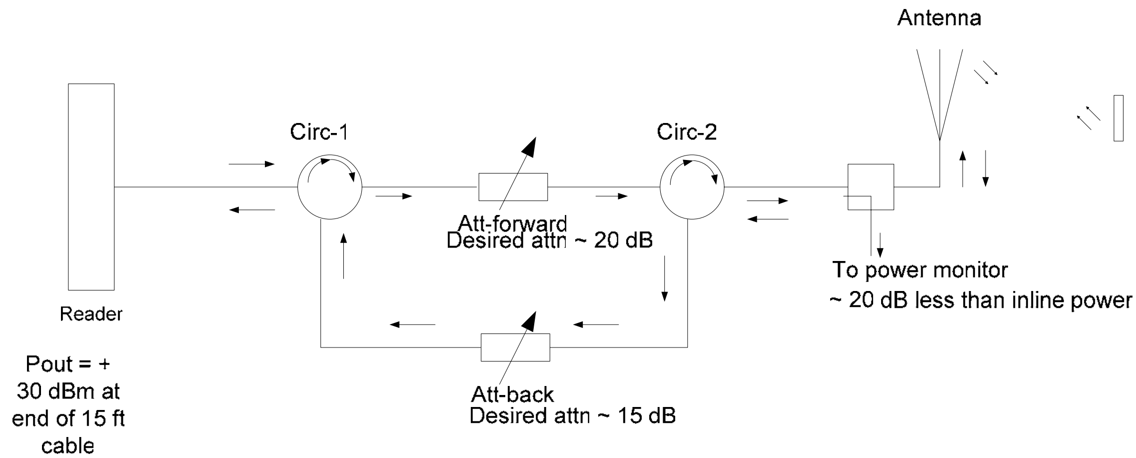
7. Stick masking tape on the floor from the antenna out to about 6 meters (20 feet). Mark it in feet and inches to create a ruler. Or use a tape measure laid out on the floor.

8. Position the tag about 6 meters (20 feet) away from the reader. Wheel the mount in slowly. Note the point where the reader begins to read the tag. Verify this position by moving the tag forward or backward a couple of times. Note this distance from tag to reader as the maximum free space read distance, **Dmax**.

B. Method 2 - measuring maximum tag sensitivity

1. Set up the antenna in an anechoic chamber. (See EPCglobal Guide lines for static test anechoic chamber, for details on the chamber).

2. The following test set up is suggested.



In the above set up, the circulators circ-1 and circ-2, and the return path attenuator Attn-back, may be removed in the interests of simplicity, if desired. In that case, the forward signal path is simplified to reader – attenuator – power monitor – antenna. This simplified setup is assumed for the following instructions.

3. Place a dipole measurement antenna at the position at which tag will be placed. (See point 5). Starting from no attenuation, increase the attenuation in steps, typically less than 1 dB per step, while noting the average power measured by the dipole, as well as the power at the monitor port. This allows the calibration of power at the tag position with power being read at the monitor port. Alternately, in the absence of the monitor port, the received power at the tag location may be directly calibrated to attenuation values off the attenuator.

4. With no attenuation, let the maximum received power at the tag location be **Pmax** dBm.

5. Position the tag in the anechoic chamber at a distance of 1 to 2 meters (4 to 6 feet) from the antenna face, tag aligned to antenna center (bore sight). Set the attenuation to minimum. Ensure that tag is being read by the reader.

6. Decrease the power (increase the attenuation) in steps while monitoring the read rate of the tag, until tag is un-detected by the reader. Note either the monitored power value,

or the attenuation value. Use either to find the corresponding received power at the tag, **Pmin** dBm.

7. Calculate the maximum tag sensitivity, **Tmax** = **Pmax** – **Pmin** dB.

C. Selecting "average" tags

1. Use either method A or method B described above to screen the sample selection of tags.

2. Sort the tags according to the maximum read distance or maximum tag sensitivity, depending on the test method used.

3. Now that the total tag distribution is available, for the tests under consideration, choose "average" tags, i.e., tags with **Dmax** within one foot of each other, or tags with **Tmax** within 2 dB of each other.

This will ensure that the selected tags are relatively identical in performance, based on free space maximum read distance or free space maximum tag sensitivity.

10 APPENDIX B

Procedure for the Determination of relative RFID Interrogator Electromagnetic Field Strength

(NOTE: This Appendix will be updated to correlate with the outcome of Field Strength Measurement Team (FSMT) findings and the Static Test Standard)

Required test equipment:

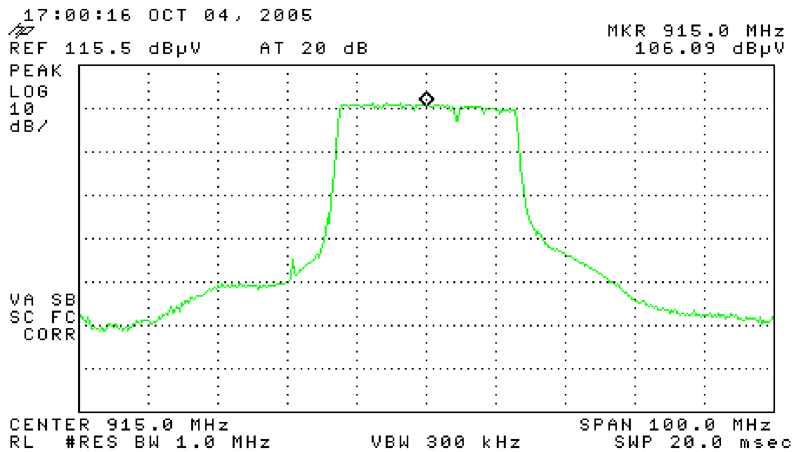
1) Spectrum Analyzer, with an upper frequency threshold of at least 1 GHz
2) EMCO 7405-905 whip antenna or equivalent
3) Low loss RG58 interconnecting coaxial cable, 4.5 to 6.0 meters (15' or 20') in length
4) 6 dB to 30dB, 50 Ohm attenuators

After warm-up and self-calibration of the Spectrum analyzer, connect the whip antenna to its input port, with a 30 dB attenuating pad in line, and preset the Spectrum Analyzer to the following:

i) Center frequency: Frequency(s) of Interest
ii) Span: 100 MHz
iii) Reference level: 120 dB
iv) Resolution Bandwidth: 1 MHz
v) Amplitude Offset: 30 dB (or the face value of the attenuator in line)

Locate the antenna in proximity of the center volume of the read envelope and take notice of any ambient noise that may interfere with your measurement. To do this, place the Spectrum Analyzer in an integrating mode (Max hold function) for a minute or so until the integration has basically stabilized, so as to have a steady representation of all the electromagnetic pollutants falling into the frequency band of interest.

Energize the scanning equipment and gradually increase its power level from the lowest setting to about half-power. You should clearly notice strong frequency-hopping emissions. One minute integration should produce an envelope very similar to the one depicted below.



At this point, it would be desirable to map the active scanning volume in order to reveal eventual shadow or dead zones. Perhaps, you should start by positioning the antenna on the center of the conveyor belt and at the scanners center-line, about 10 cm (4 inches) height. After clearing the Spectrum Analyzer from the previous plot, reintegrate for another minute and record the new level at 915 MHz. Move the antenna along the conveyor belt, in 25 cm (10 inch). increments, and record the results of the measurements. Given symmetry of field, measurements in only one direction from the scanning centerline should be sufficient.

It would be advisable to repeat all these measurements, performing a run with the antenna near the border of the belt (Beware! Please read attentively the precautionary note below) and two with the antenna raised a level approximating one-half of the scanning tunnel height.

For larger portals, doubling the above-cited distances should suffice

Please note that any measurements over 1.5 meters (5 feet) from the scanners center-line would be irrelevant because, despite transmitter field strength, the backscattering of the tags is the limiting factor.

IMPORTANT PRECAUTIONARY NOTE

It cannot be overemphasized: be very careful while taking measurements with the antenna in close proximity with the scanner! Voltages of well over 120 dBuV could be induced into the antenna and destroy, or at least seriously degrade, the sensitive input circuitry of the Spectrum Analyzer, usually limited to an absolute maximum of one volt. A 30 dB attenuating pad would be your best insurance policy against unintentional or accidentally destructive exposures.

General Notes

If a whip antenna is not available, a makeshift stub antenna, fabricated from a wire of precisely 81 mm length, will perform as an excellent substitute.

It would be advisable to locate the attenuating pad on the antenna side of the coaxial cable and coupled to a 90* (or a “T”) connector; this arrangement should minimize interferences of the cable while positioning the antenna.

If your Spectrum Analyzer does not offer the Amplitude Offset feature, please DO NOT forget to add the dB face value of the antenna attenuator to the recorded measurements.

11 APPENDIX C

Procedure for the determination of cable insertion losses

at RFID UHF Frequencies

(NOTE: This Appendix will be updated to correlate with the Static Test Standard)

For this determination, the following test equipment is suggested:

1) Spectrum Analyzer with Tracking Generator feature and with an upper frequency threshold of at least 1 GHz
2) 10 dB to 30dB, 50 Ohm attenuator
3) High quality RG58 cable, very short length (the calibration interconnect would do just fine)

After warm-up and self-calibration of the Spectrum analyzer, connect the attenuator to the Tracking generator output and a very short interconnect cable to the Spectrum Analyzer input. Preset the Analyzer as follow:

i) Center frequency: Frequency(s) of interest
ii) Span: 50 MHz
iii) Reference level: 120 dB
iv) Resolution Bandwidth: 10 kHz
v) Sweep in Continuous Mode
vi) Amplitude Offset: 30 dB (or the face value of the attenuator in line)

Start the sweep and integrate trace A (Max-hold) for a minute or so. Store the trace (View-hold function). This is your reference trace, as it accounts for the un-linearity of the attenuator and connections.

Replace the short interconnect with the cable that you intend to sweep.

Restart the scan on trace B. Integrate for a minute or so and store it; you will notice that trace B, to varying degrees, “slants downward” respect to trace A; the degree of this slope is the insertion loss in the frequency range of 890 MHz to 940 MHz.

It is now feasible to measure this insertion loss by moving the marker along the stored traces while invoking the differential measurement function.

If the Spectrum Analyzer does not offer this feature, it is possible to blank alternately one of the two traces and take amplitude readings at the marker position. The insertion loss will be the delta between trace A and trace B reading magnitudes.

REVISIONS

Rev	Date	Description
1.0.0	4/22/2005	Initial straw man proposal for Conveyor Portal. M. Alexis, M. Nixon - Tyco Safety Products.
1.0.1	4/25/2005	Minor changes prior to sub committee review. M Alexis.
1.0.2	5/10/2005	Added sections defining test procedure. M Alexis. J. Samuel at PG to join in authoring at this stage.
1.0.3	5/16/2005	Modified sections 5 through 7, added section 8 J. Samuel (JTS) – P&G
1.0.4	6/22/2005	Made changes throughout document per community's feedback, in advance of face-to-face meeting of subcommittee 6/23/2005 J. Samuel (JTS) – P&G
1.0.5	8/1/05	Brought to last call working draft level by J. Samuel (JTS) – P&G
1.0.6	8/15/2005	-Added restricted read windows to allow testing at various conveyor speeds (Conveyor Portal Attributes). - Removed average power measurement (noise measurement), use peak noise measurement only. (MDA, JTS)
1.0.7	8/15/05	Added refrigerated environmental conditions and proofed – J. Samuel (JTS) – P&G
1.0.8	8/15/05	Check for conformance to EPCglobal SDP. Ted Osinski.
1.0.9	10/10/05	Amended per Comment Resolution Committee and added Appendices A, B, and C– John Onderko and Gaylon Morris
1.1.0	10/19/05	Revised documents to include metric and SI units for all measurements. Corrected grammar in Appendix A. – Phil Layman
1.1.1	12/15/05	Amended per Comment Resolution Committee – Gaylon Morris
1.1.2	12/16/05	Amended Section 5.2 Conveyor Portal Attributes – John Onderko
1.1.3	1/12/06	Amended the "Status of This Document" section per co-chair conference call comments – 01/06/06
1.1.4	04/06/06	Amended to address Comment Resolution Committee changes received since 01/12/06 – Phil Layman