Portal Field Strength Measurement Test Method

For Applied Tag Performance Testing

Rev 1.2

Approved by the EPCglobal Technical Steering Committee
and EPCglobal Business Steering Committee on July 14, 2009

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Foreward

This document describes the test method for measuring the field strength in a portal. The method was developed for tags and readers compliant with the “EPCglobal™ Class-1 Generation-2 UHF RFID Protocol for Communications at 860-960 MHz” standard. This document is intended for use by labs or end users performing testing of RFID tags applied to cases and pallets.

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1 Introduction and Scope

Well performing portals are essential to the success of any RFID installation. It is critical then that a common methodology be developed to measure the performance of an RFID portal. To do so, one must take into account arrangement of readers in a portal and dimensions of the active interrogation field. In this test method, the specific points in a conveyor portal and a door portal for collecting power level measurements are described. The user should be aware that this test method does not account for field nulls.

To produce meaningful measurements of portal performance for analysis, data are collected on the power level of portal readers at a specified read using a probe antenna. A minimal amount of test equipment is required, and has been purposely kept to standard instruments that are easily obtainable. The required devices include a calibrated dipole antenna and a standard spectrum analyzer.

2 Normative references

EPCglobal™: *EPC™ Radio-Frequency Identity Protocols, Class-1 Generation-2 UHF RFID, Protocol for Communications at 860 MHz – 960 MHz*

EPCglobal™: *EPC™ Item-Level Tagging Requirements*

ISO/IEC 18000-6, Information technology — Radio-frequency identification for item management — Part 6: Parameters for air interface communications at 860 MHz to 960 MHz

3 Procedure

3.1 Measurement Points

3.1.1 Conveyor Portal

In Figure 1, the measurement points for a conveyor portal interrogation field from the side view are shown.

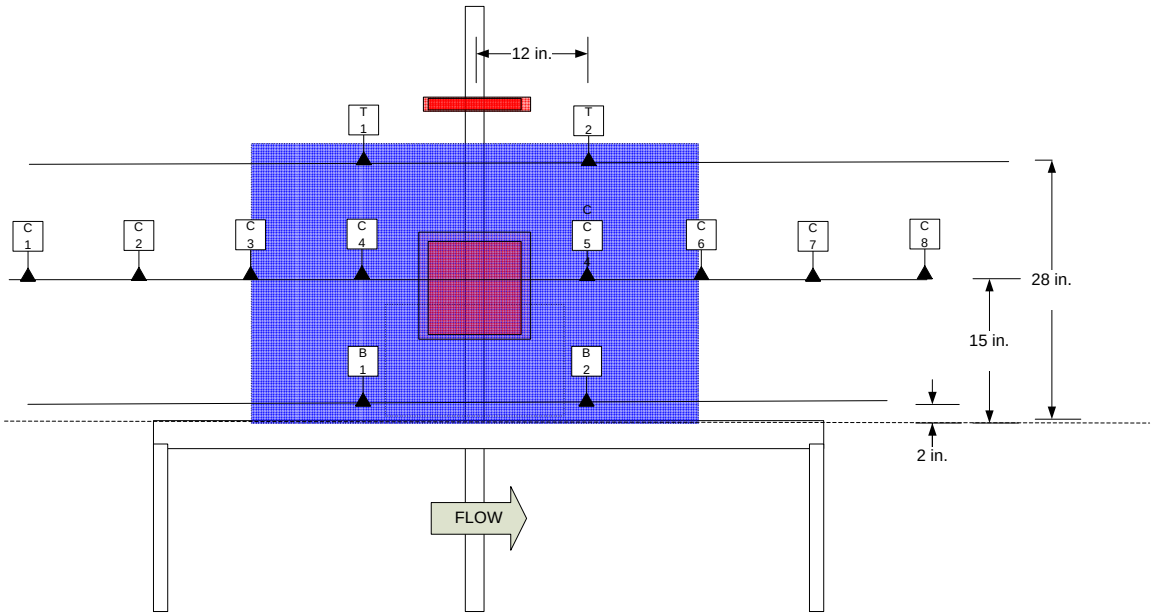

Figure 1 Conveyor Portal measurement points from the side view

In Figure 2, the measurement points for a conveyor portal from the end view are shown.

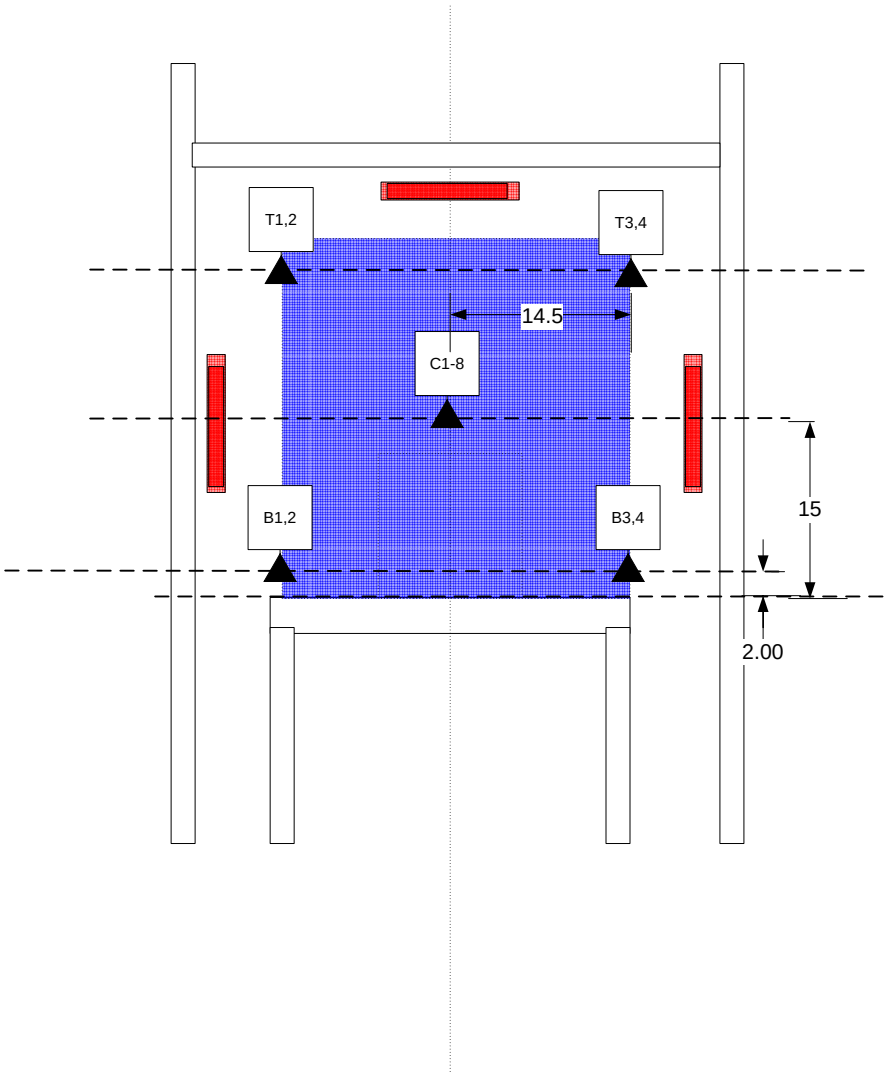

Figure 2 Conveyor Portal measurement points from the end view

Cases shall have maximum dimensions of 48in. x 29in. x 30in. (120cm x 74cm x 76 cm).

Measurement coordinates are shown in Table 1 according to the following scheme:

- X axis: Along the path of travel through the portal (along the conveyor bed); zero at the portal centerline.
- Y axis: Across the conveyor bed; zero at the center of the conveyor bed.
- Z axis: Vertical; zero at the conveyor "deck" level.

Table 1 Conveyor Measurement point definitions

Description	Point	X (in.)	Y (in.)	Z (in.)
centerline (C)	C1	-48	0	15
	C2	-36	0	15
	C3	-24	0	15
	C4	-12	0	15
	C5	+12	0	15
	C6	+24	0	15
	C7	+36	0	15
	C8	+48	0	15
bottom (B)	B1	-12	-14.5	2
	B2	+12	-14.5	2
	B3	-12	+14.5	2
	B4	+12	+14.5	2
top (T)	T1	-12	-14.5	28
	T2	+12	-14.5	28
	T3	-12	+14.5	28
	T4	+12	+14.5	28

3.1.2 Door Portal

In Figure 3, the measurement points for a pallet in a door portal from the side view are shown.

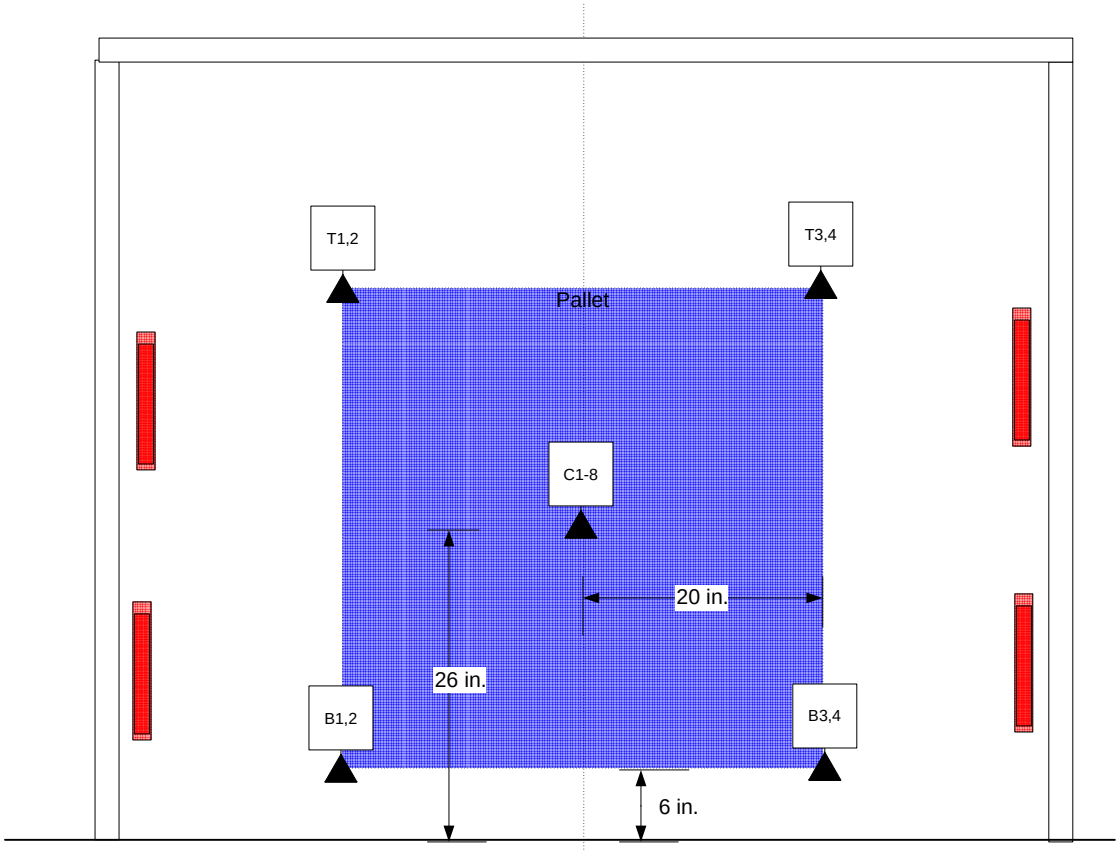

Figure 3 Door Portal measurement points from the end view

In Figure 4, the measurement points for the same door portal but from the side view are shown.

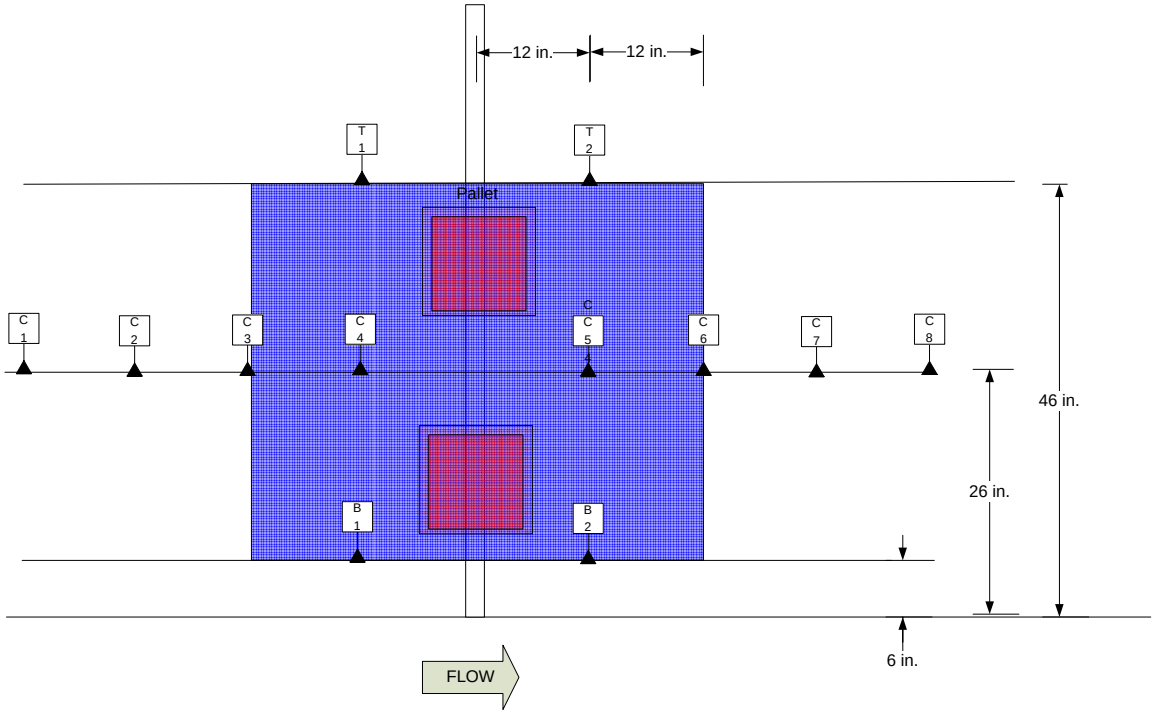

Figure 4 Door portal measurement points from the side view

Pallets shall have dimensions, LxWxH, of 40in. x 48in. x 40 in. (120cm x 100cm x 100cm).

Measurement coordinates are shown in Table 2 according to the following scheme:

- X axis: Along the path of travel through the portal (along the travel path through the portal); zero at the portal centerline.
- Y axis: Across the portal opening; zero at the center of the portal.
- Z axis: Vertical; zero at the floor level.

140 **Table 2 Door Portal Measurement point definitions**

Description	Point	X (in.)	Y (in.)	Z (in.)
Centerline	C1	-48	0	26
	C2	-36	0	26
	C3	-24	0	26
	C4	-12	0	26
	C5	+12	0	26
	C6	+24	0	26
	C7	+36	0	26
	C8	+48	0	26
Bottom	B1	-12	--20	6
	B2	+12	-20	6
	B3	-12	+20	6
	B4	+12	+20	6
Top	T1	-12	-20	46
	T2	+12	-20	46
	T3	-12	+20	46
	T4	+12	+20	46

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3.2 Instruments and Setup

3.2.1 Probe antenna

The antenna must be a calibrated dipole type. The antenna must have a known and traceable calibration which provides antenna gain at frequencies from 800 to 1000 MHz. The dipole length must be adjustable, allowing it to be tuned for the frequency range being measured.

3.2.1.1 Antenna Alignment during measurement

The dipole antenna must be aligned along the “X” axis (along the path of travel) for all measurements (Figure 5).

Figure 5 Probe antenna positioning

The antenna must be held in place during the measurement using an RF friendly, non-metallic pedestal. A holding fixture constructed of PVC irrigation pipe is an example of such a device (Figure 6).

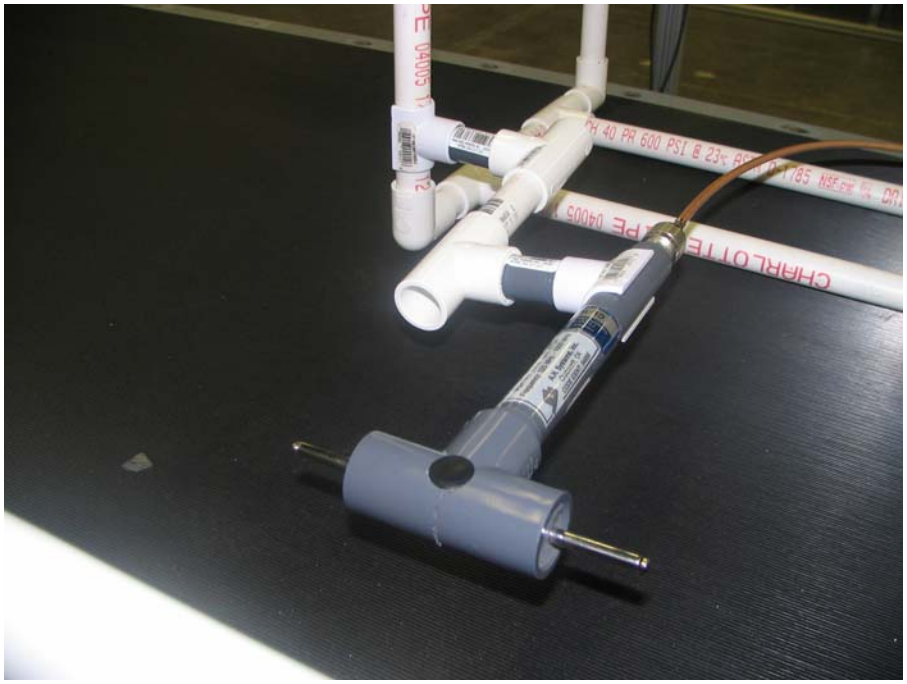

Figure 6 Fixture for Holding Probe Antenna

3.2.2 Coaxial Cable

The coaxial cable used for the measurement must have the following specifications:

Loss at 1 GHz per 100 ft	Less than 13.5 dB
Connector type	N type coaxial
Impedance	50 ohms
Length minimum (to ensure equipment is outside of portal)	20 feet

An example of a cable type that meet this specification is a Pasternack RG142B/U.

3.2.3 Spectrum Analyzer

The spectrum analyzer used for this measurement should have the following capabilities, and be set as follows:

Frequency center	915 MHz (866.5 MHz Europe)
Resolution Bandwidth (RBW)	1 MHz
Span	30 MHz
dBm per division (to achieve best resolution)	2 dBm/div
Attenuation	Adjust as needed to observe peak power on the display. This value will change at different observation points in the portal. An external attenuator may be necessary.
Number of samples held in peak hold mode	750 samples minimum
Reference level:	Adjust as needed to center peak readings in display.

3.2.3.1 Analyzer settings and measurement method

After warm-up and self-calibration of the spectrum analyzer, connect the probe antenna to input port, with a 30dB attenuating pad in line (if necessary), and preset the spectrum analyzer to the following:

IMPORTANT PRECAUTIONARY NOTE

It cannot be overemphasized: be very careful while taking measurements with the antenna in close proximity with the spectrum analyzer! 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.

Locate the antenna at the desired measurement point in the portal.

Place the analyzer outside of the portal area (>6ft. or 1.82m from the probe).

3.2.3.1.1 Observe interference

Take notice of any ambient noise that may interfere with your measurement. Eliminate these external interferers before proceeding.

Place the Spectrum Analyzer in an integrating mode (Max hold function) for one minute, allowing the integration to stabilize, so as to have a steady representation of all the electromagnetic interference falling into the frequency band of interest.

3.2.3.1.2 Set up Readers

Note and record the power settings of the RFID readers in use.

Energize the RFID reader(s) on the portal. Make sure all antennas are transmitting during the measurement (they are usually time multiplexed). You should clearly notice strong frequency-hopping emissions.

Allow at least 1.5 minutes in peak hold mode before taking the reading. The analyzer should return a display like the one in Figure 7:

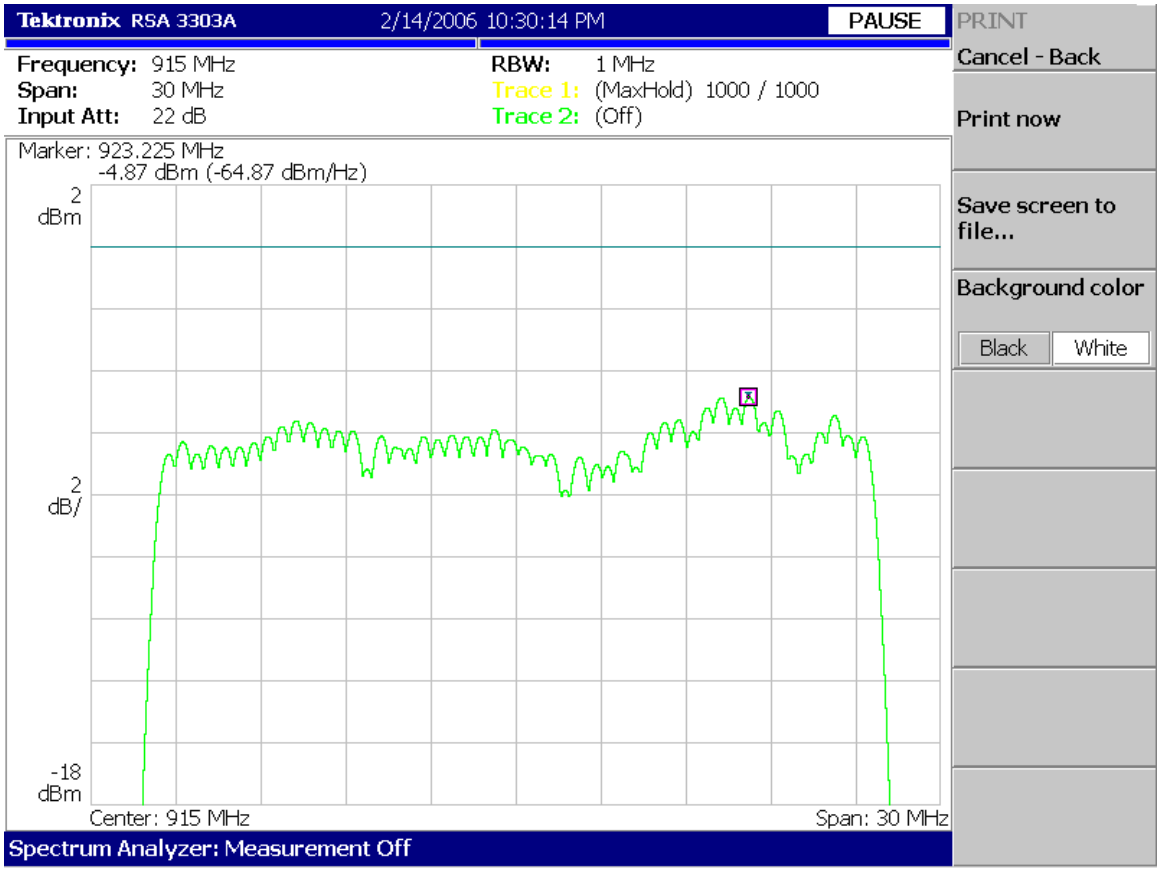

Figure 7 Example of the spectrum measurement

3.2.3.1.3 Record Measurements

Find the peak power reading in the range of 902-928 MHz (865-868 MHz for European equipment) and record this power level. Use the “Peak Search” feature of the analyzer if so equipped.

Reset the peak hold before performing the next measurement.

Move the probe to the next location.

3.3 Recording of Data

The following tables serve as a model for recording the measurements. Table 3 shows the settings that should be recorded for the test instruments used.

Table 3 Settings to be recorded for test instruments used.

Portal ID:	Conveyor
Reader Type:	Agile 2
Power Setting:	32.5 dBm
Antenna Config.:	Right (1), Top (2), Left (3)
Cable:	Pasternack RG142B/U, 6-ft, N-type, 50 Ohm Impedance
Attenuator:	20 dB
Freq. (Center):	915 MHz
Input Attenuation:	50 dB
Span:	100 MHz
Res. BandWidth:	1 MHz
Dipole Antenna:	FCC-4 (s/n: 475A)
Noise Measurement:	11:15 AM -24.6 dBm
	2:00 PM -17.63 dBm
Date:	10 Feb. 2006

A template for recording and analysis of power measurements is provided in Table 4.

Table 4 Power measurements to be recorded for analysis

Point	(A) Raw Power Measurement (dBm)	(B) Antenna Gain (dB) (-)	(C) Cable and connector loss (dB) (+)	(D) Attenuator (dB) (+)	(E) Field Strength (dBm)
C1	-24.5	1.1	0.65	30	5.05
C2	-26.5	1.1	0.65	30	3.05
etc					

A suitable spreadsheet calculator for these measurements can be constructed to calculate the net result. Column E is calculated as follows:

$$E = A - B + C + D$$

The results obtained from column E, when applied to the coordinates in a given portal field, provide a quantitative picture of the strength of the RF field in the interrogation zone. This snapshot of the total field strength enables a user to assess whether a portal has been set-up for optimal performance.

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226 4 Revisions

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Rev	Date	Description
1.0	2 February, 2006	Initial straw man protocol for review and pilot, based on technique from MetLabs. M.D. Alexis (Tyco)
1.1	14 February, 2006	Attenuator is optional – in some cases (low field measurements) use of the attenuator hurst measurement resolution. Modified some of the analyzer settings to get best repeatability Altered measurement to take the max field observed in the entire 902-928 MHz range, not the value at 915 MHz. This will have to be adapted to Euro and Asia frequency ranges. M.D. Alexis (Tyco)
1.2	14 August, 2008	Added Foreward, Introduction and Scope, and Normative References. Updated all formatting. Added descriptions in text for figures and tables. Added description for use of final result once calculated. G. B. Ow-Yang (EPCglobal Inc.)

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