

Application Note

Read Range Test with Voyantic Tagformance

Rev 1.1

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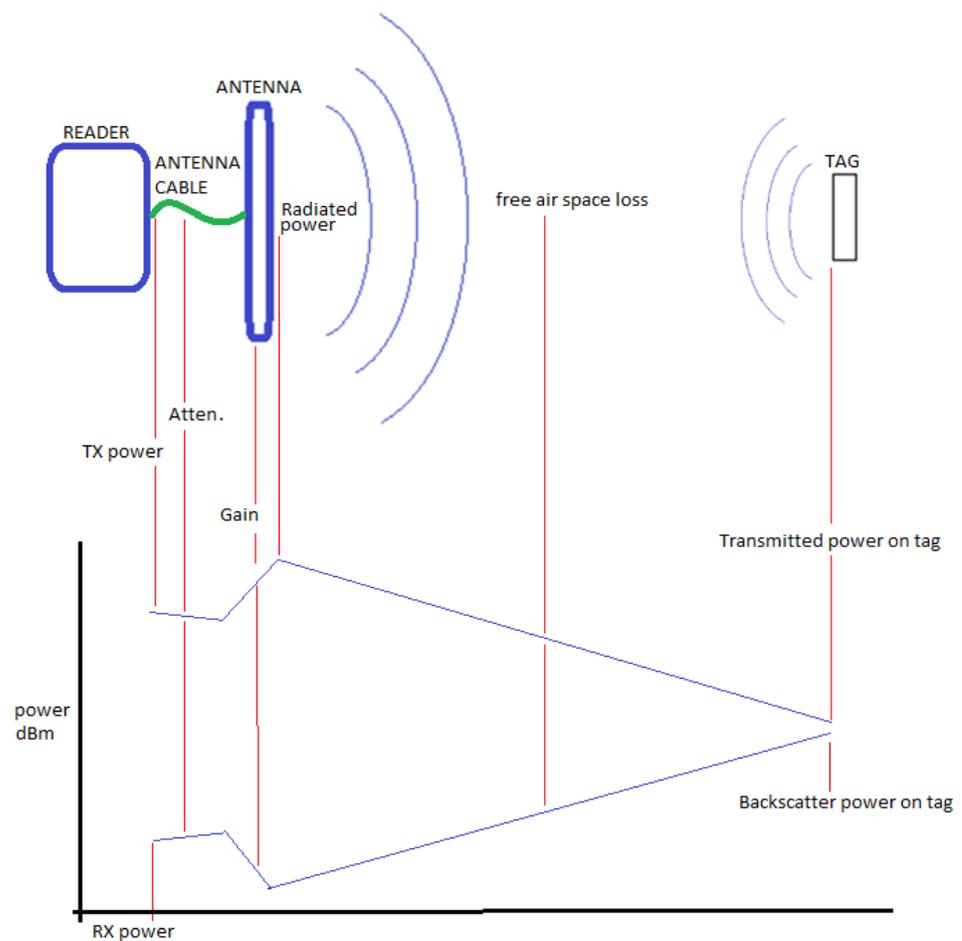
1 Introduction

This application note describes the Read Range test functionality of the Voyantic Tagformance system.

2 RAIN RFID System Read Range

The read range of a RAIN RFID system depends on 4 system parameters.

- a) Radiated power of the RAIN RFID reader
- b) Sensitivity of the RAIN RFID tag
- c) Backscatter signal strength of the RAIN RFID tag
- d) Sensitivity of the RAIN RFID reader.



a) Radiated Power of the RAIN RFID Reader

Radiated power describes the strength of the signal outgoing from the reader – how loudly the reader shouts. Radiated power can be further broken down to different parameters of the reader system:

Radiated power (dBm) = Output power (aka TX power of the reader at the reader port, aka transmit power) - path loss in the cable between the reader port and the antenna (dB) + antenna gain (dB).

Only a small portion of the reader's energy reaches the tag. The difference between the radiated power and the power that reaches the tag is described by free air space loss (dB).

b) Sensitivity of the RAIN RFID Tag

Tag sensitivity describes how weak a signal the reader can utilize for replying – how well the tag hears.

In theory, the tag's sensitivity can also be broken down to the gain of the tag's antenna and chip sensitivity. But these components are rarely separated; usually only the combined tag sensitivity is used to describe the tag.

The tag uses a part of the received energy to operate the chip.

c) Backscatter Signal Strength of the RAIN RFID Tag

The part of the signal that is not used by the chip is backscattered. The backscatter signal is the signal returning from the tag to the reader – how loudly the tag shouts back, or rather whispers.

At the tag the backscatter signal strength can be - in theory - broken to chip backscatter strength and antenna gain.

Again, a large part of the signal is dissipated in the free air space loss between the tag and the reader.

The reader antenna receives a small portion of the backscatter signal strength.

d) Sensitivity of the RAIN RFID Reader

The sensitivity of a reader describes how weak backscatter signals the reader can receive and interpret – how well the reader can hear the whisper of the tag.

The sensitivity of the reader can again be broken down to antenna gain, cable loss and reader receiver sensitivity (RX sensitivity).

2.1 Forward Link and Reverse Link

The forward link describes the communication link from the reader to the tag. It consists of the reader transmitting the signal (radiated power of the RAIN RFID reader), and the tag receiving the signal (sensitivity of the RAIN RFID tag).

The reverse link describes the communication from the tag to the reader. It consists of tag backscattering the signal to the reader (backscatter signal strength of the RAIN RFID tag); and the reader receiving the backscatter signal (sensitivity of the RAIN RFID reader).

3 Read Range Test

In the Read Range test, tag sensitivity is tested across a frequency band, and at each frequency the backscatter signal strength is measured with several transmit power levels at each frequency.

3.1 Raw data

In the 'Raw Data' view of the Tagformance GUI, the backscatter signal strength is color coded. A lighter color represents a stronger backscatter signal strength, and a darker color a weaker backscatter signal strength. The black area shows frequency and transmit power combinations where the tag did not reply.



3.2 Results

3.2.1 Reader Parameters

When reader parameters are input to the Tagformance software, it automatically calculates the read range that would be acquired with the given combination of tag and reader.

For integrated readers (reader and antenna in one unit), radiated power is commonly used, and only the reader sensitivity is entered (antenna gain is set to 0).

When the reader and the antenna are separate units, reader power is entered as port power, and sensitivity is the reader receiver sensitivity. Antenna gain is input separately.

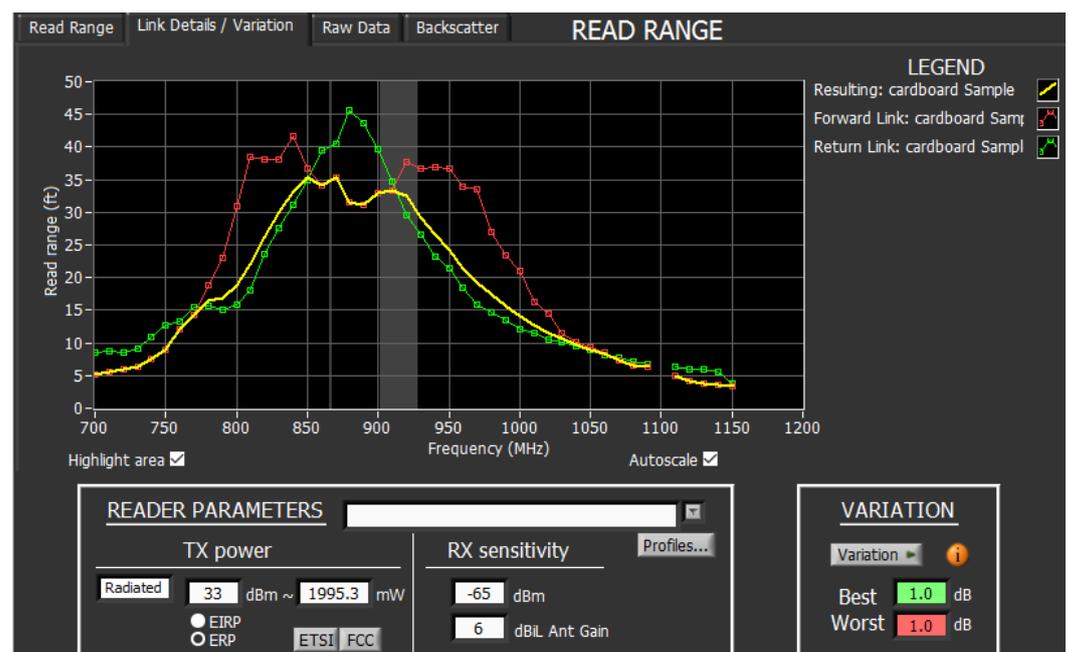
Reader parameters can be found on reader datasheets, or tested with the Voyantic Readformance reader tester.

3.2.2 Read Range

The Read Range tab shows only the actual read range curve. Because additional information is filtered out, this view is ideal for comparing tags.

3.2.3 Link Details / Variation

Link Details / Variation tab is the main result of the read range test. It shows the forward link read range, the reverse link read range, and the resulting read range with the entered reader parameters.



When the radiated or port power; antenna gain of the reader; or the reader sensitivity is changed, the read range result changes.

Forward Link

'Forward link' describes a theoretical situation where the reader's sensitivity is infinitely good: When the tag replies, the reader can always hear the replied backscatter signal.

Reverse Link

'Reverse link' describes a theoretical situation where the reader has always just enough power to wake up the tag. The tag replies at the threshold level. In this case the read range is only limited by the tag's backscatter signal strength and the reader's receiver sensitivity.

The curve that is lower in the graph is the limiting factor. In the image on page 5, at 800 MHz, the reverse link curve is lower and the read range is limited in practice by receiver sensitivity. At 875 MHz the red curve is lower, and read range is limited by reader power and tag sensitivity.

Resulting Read Range

The 'Resulting' curve is a combination of the forward link and reverse link.

If the forward link is the limiting factor, the resulting read range is equal to the forward link limited range. If a tag approaches the reader in this situation:

- At first the tag is too far to receive enough power to wake up, and at the same time too far to backscatter a strong enough signal for the reader to hear.
- When moving closer, there is a distance where backscatter signal would be strong enough for the reader to hear, but the tag still does not receive enough power to wake up. (This distance is the read range reverse.)
- When the distance shortens further, the sensitivity threshold limit is reached and the tag wakes up. (This is the read range forward.) The reader is immediately able to receive the backscatter response.
- Read range is the same as the read range forward.

If the reverse link is the limiting factor, the resulting read range is usually between the forward link and reverse link read ranges. This is because the theoretical reverse link read range describes a situation where there is just enough power for the tag to wake up. In a typical situation, the reader's power is higher than the bare minimum needed to wake up the tag. As a result, the tag receives more power than the required minimum, backscatters with a higher power, and the resulting read range is higher than the theoretical reverse link limited read range. In this situation when a tag approaches the reader:

- Again, at first the tag is too far to receive enough power to wake up, and at the same time too far to backscatter a strong enough signal for the reader to hear.
- Now, when moving closer the tag reaches a distance where it receives enough power to wake up (read range forward). The tag backscatters a signal but the reader cannot yet receive it. (Backscatter signal strength at threshold level.)

- When the tag moves closer to the reader, the chip receives more and more power, and the backscatter signal increases. At some point, the tag backscatters a strong enough signal for the reader to receive it. Because the reader is closer to the tag, the backscatter signal is also stronger than at the threshold level. This distance is the actual read range.
- When the tag moves still closer, there is a point where the reader would have could receive also the backscatter signal with the signal strength at threshold level. (Read range reverse.)
- Read range is in between the read range forward and read range reverse.

3.2.4 Backscatter

At the Backscatter tab transmit power can be input, and the curve shows backscatter signal strength as a function of frequency using the input transmit power.

4 Equipment Used in the Test

The read range test requires a Tagformance Pro device; UHF RFID hardware license; an accessory set such as Hand Carry Kit, Field Engineer Kit or Measurement Cabinet; and the Tag Designer Suite (TDS) software.

5 Notes and Tips

For getting accurate results, a measured setup is recommended. It is recommended to verify the setup by testing the reference tag with a threshold sweep and comparing the result to the reference curve.

It is possible to save reader profiles to the software. With a library of reader profiles, it is easy to check system level read range with various readers just by testing the tag or a tagged item.