Summary

Every RFID reader and antenna has its own characteristics and performances. To find out what these different characteristics and performances exactly are can only be done by testing. The tests performed for this report have already been done for two other reader and antenna combinations, namely for RFID equipment from Symbol and Deister Electronic.
The goal of this report is to achieve the characteristics of the RFID equipment of Intermec and to compare these results with the results of the tests of the other two RFID equipments from Symbol and Deister Electronic.

Tests that are done to investigate the characteristics of the Intermec equipment are the read area test, multiple tags test, read rate test and the impact of materials test. The read area tests are done with 4 different tags of the same type because of possible variations in production, and these read area tests and multiple tag tests both are done with symbol dual dipole tags. The read rate tests and impact of materials tests are done with IBM Rafsec single dipole tags. This change of tag is done because the IBM single dipole tag is cheaper than the Symbol tag and therefore more likely to be encountered in a real life situation with many of cheap disposable products.

One of the results of the *Read area tests* is the best tag to antenna orientation for this RFID equipment. Orientation A, see figure 3.1, has the best readability, 88%, of all orientations and that is why this orientation is used for the other tests.

The *Multiple tag tests* are done with arrays of 10, 20 and 30 tags, and each array is tested with tag-to-tag distances of 2cm, 4cm and 6cm. An increase of tag-to-tag distance for 10 tags leads to a decrease in performance. For tag array sizes of 20 or 30 these performance differences are smaller, around 1%-2% with exception of one outlier. The increase of tag-to-tag distance with tag array sizes of 20 and 30 tags leads to the same readability with small variations. The results of the multiple tag tests compared to the results of the single tag test of orientation A shows that the influence of collision and interference that affect the readability starts at an array of 20 tags.

The goal of the *Read rate tests* is to determine the amount of successful readings per second per tag that can be achieved while varying the power. The first thing that is noticeable is the little variation between the read rate and the different power levels. Although the Intermec reader returns a different power setting percentage, the results strongly indicate that it actually does not change its power output. This suspicion is strengthened by the fact that the read rate for 10 tags is around 6 tags/s, resulting in 60 tag readings / s, which is the same for the read rate of arrays with 20 and 30 tags, respectively 20x3 and 30x2. The 60 tag readings / s are also close to the 70 tags/s ID rate given in the specifications of the reader. Further observations about the power–read rate performance can therefore not be done.

The goal of the *Impact of materials test* is to determine the impact, when the tag is mounted on a material, of different material types on the readability area of the tag. The different material types used are listed in table 5.1. The impact is defined as the ratio between the readability area of the mounted tag and the readability area of an unmounted tag in free space. The readability of the unmounted tag in free space is used as a reference value and has a value of 6%. Except for the glass jar the total readability of different materials without liquid (water) is around the reference value of 6%. The material glass shows an exceptional spike in readability, the reason behind this is not yet clear and would require more research. Liquids like water are reducing the readability to (near) 0 even while the tag is in front of the liquid. For some materials the readability percentage are the same but the area characteristics differ. Therefore a new performance indicator is introduced: the effective readability area (ERA).

$$ERA = R_{total} * \{ P_{100\%,connected} / P_{total} \}$$

Where: R_{total} = total readability [%]
$P_{100\%}$ = highest number of connected 100% readability grid points
P_{total} = total number of measured grid points

The graph of the new performance indicator ERA shows a more distinctive result between the different materials, because the number of 100% readings is now of importance. For instance the carton box performance is clearly better than the tag only reference measurement while in the normal readbility per material graph this was not the case.

For the multiple materials test different products, table 5.2, are put together in a box and are tested with two different orientations of the box. There is a clear difference between the readability results for these two orientations. Especially for the teapack where the orientation changes the readability from 0 to 100%. For the liquids a low readability was expected from the single material experiments and since the CD contained a thin layer of alumnium its 0% readability was also expected.

These results of the Intermec reader are compared with the results of the Symbol and Deister Electronic readers to determine which reader performs the best in certain areas and overall. The comparison is done with single tag readability, single tag range, multiple tags readability and read rate as performance indicators:

- The Deister Electronic reader has the best readability for orientation A, the best overall read range and the best multiple tags readability.
- Although the Symbol reader has the best read rate off all three readers, according to its specifications 200 readings per second, it will not be chosen as the reader with the best read rate because of the fact that this read rate was not verified by tests under the same conditions as the Deister Electronic and Intermec tests. The Deister Electronic reader is compared to the Intermec reader the reader with the best read rate.
- The readability of the Intermec, for a read range of connected ≥50% readings, is the best up to z=150, from there on the readability drops almost to none.

The Symbol reader tests were so much different from the other two reader tests that an accurate comparison between these three readers could not be made. It is therefore recommended that the Symbol reader is tested exactly the same as the other two readers for a better comparison.