

Title: High gain on-metal RFID tag

Abstract

This article represents multipurpose passive RFID tag, which was especially designed for marking objects containing metallic surfaces. The article also gives short description of the basic differences in design between the featured tag and the common wide-spread ultrahigh frequency (UHF) tags. The results of the tag comparison testing and the experiments that were carried out are also shown in report. In conclusion the author shows main advantages of the new tag and the most perspective fields of application.

Problems of metallic surfaces electronic tagging

The radiofrequency technology at the moment is on a stage of rapid development, including more and more new spheres. Active RFID usage, however, meets obstacles when dealing with physical peculiarities of UHF radio wave propagation. One of such "negative" features is conducting surfaces' radio wave shielding, which leads to a sharp read range decrease of the tag placed on such a surface. Such decrease proves to be destructive for the RFID system on the whole. Thus, common RFID tags are not usually designed for mounting onto metallic surfaces or placing nearby them.

Nevertheless, many potential fields of application for RFID demand taking in account metal influence, concerning positioning of the tag. For example tagging automobiles at the conveyerized assembly and also cars identification in logistics system or on the roads; container and railroad cars tagging etc. The possibilities are not limited to the examples listed above. The multipurpose passive RFID tag PatchTag was especially designed for such cases. It performs equally well both on metallic and non-metallic surfaces.

Common tags design and characteristics

At the moment there exist many different UHF RFID tags. Despite the fact that they differ quite a lot both by appearance and by size, all of them possess the half-wavelength dipole as the basic element of configuration (Fig. 1,a). Different complications of the tag design have a few purposes: matching input impedance of the antenna with impedance of the identification microchip; tag downsizing; matching increase range of antenna of the tag with ID-chip. On the whole such design is not effective enough because antennas of such type do not have direction in one of the planes (Fig. 1,b).

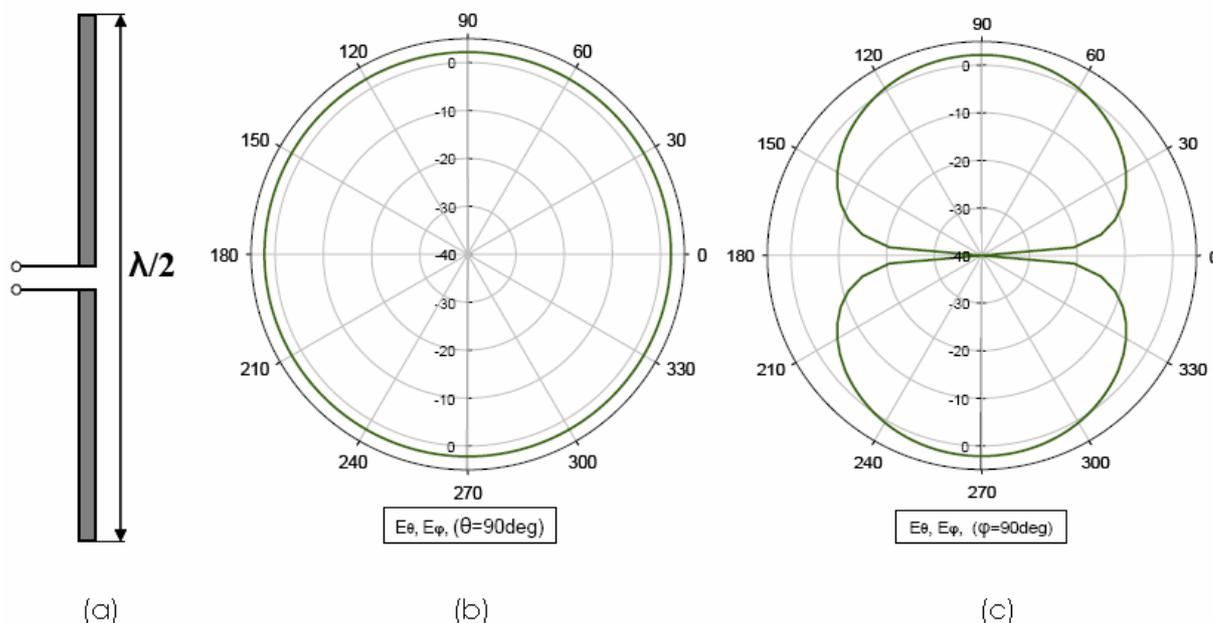


Fig. 1. Elementary half-wavelength dipole (a) and its directional diagram in vertical (b) and horizontal (c) planes

Gain factor of such antennas makes about 2,2 dBi. When tags are placed on the metallic surfaces the read range decreases a few times if compared to the range of stable registration in the air.

Design features and configuration peculiarities of the new tag

Printed antenna's design was accepted as the basic when developing the PatchTag (Fig. 2).



Fig. 2. PatchTag

Antennas of such type feature radiation directivity in both horizontal (Fig. 3) and azimuthal (Fig. 4) planes. Such design made it

possible to increase the tag's gain factor three times if compared to the usual tags.

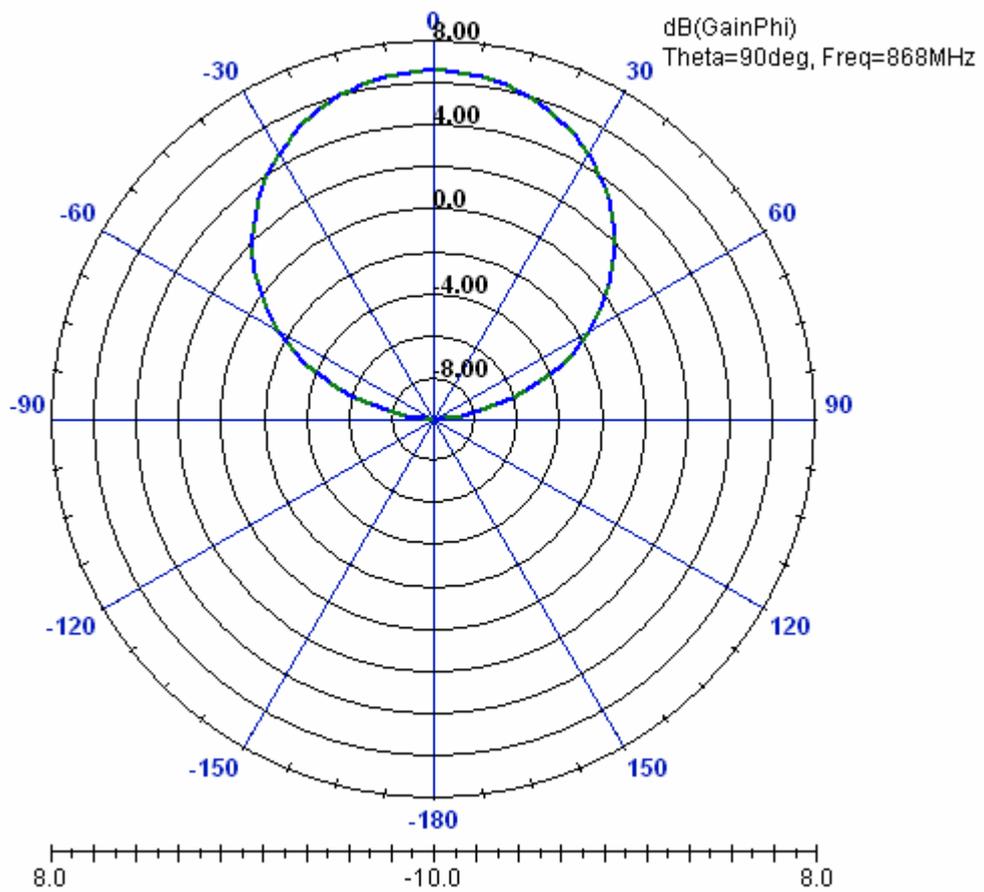


Fig. 3. Radiation pattern of the tag's antenna in horizontal plane

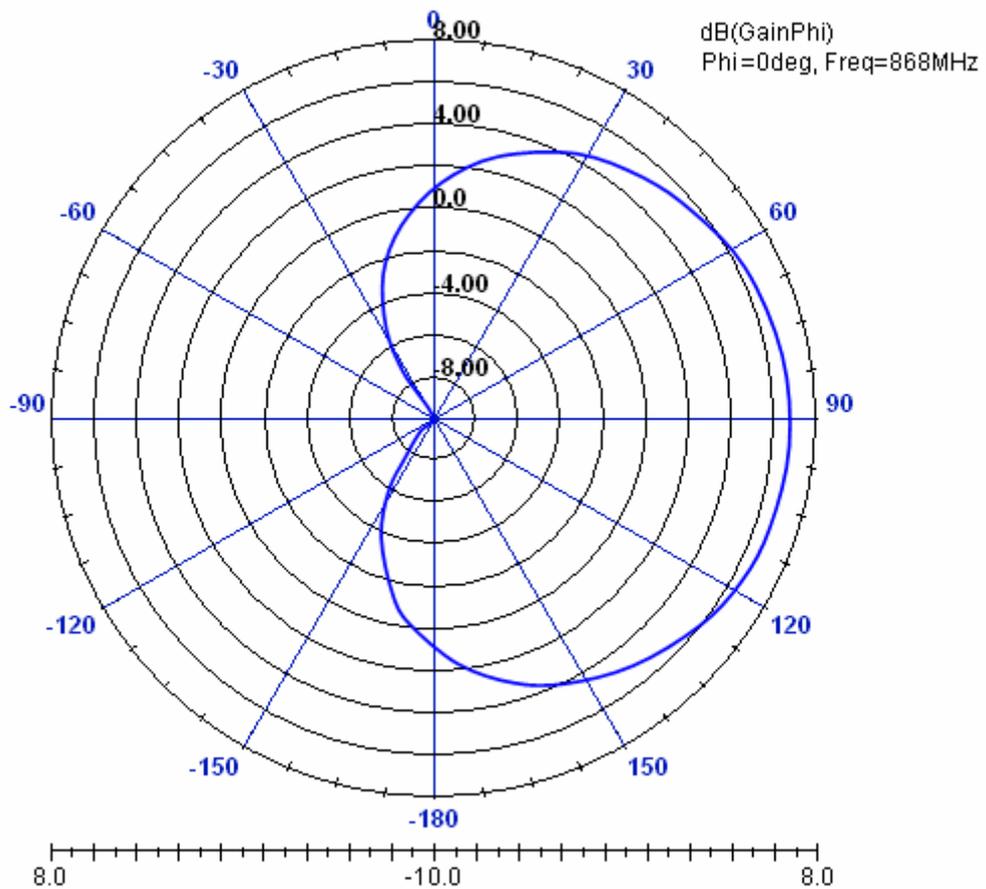


Fig. 4. Radiation pattern of the tag's antenna in vertical plane

The width of the directional diagram (by 3 dB level) in horizontal and vertical planes makes up 70 and 130 degrees accordingly. Thus, due to bigger radiation concentration in a certain direction PatchTag antenna's gain factor is more than gain factor of the antennas, which are designed as dipoles and makes about 6.5 dBi at the maximum point.

Integrated chip ASIC Philips SL3S3001 FTI (ISO 18000-6B) enclosed in TSSOP8 body was used for the tag. According to Philips

Semiconductors data sheets the chip impedance of the TSOOP-8 case is $Z_{chip}=(12-j422) \Omega$ [1]. The tag's design is constructed in such a way that there is no need for extra elements in order to match the antenna input impedance with the chip impedance. Characteristic of antenna and chip matching in operating band is shown at Fig. 5. As one can see from the diagram return loss in 865-870 MHz frequency band does not exceed -33 dB.

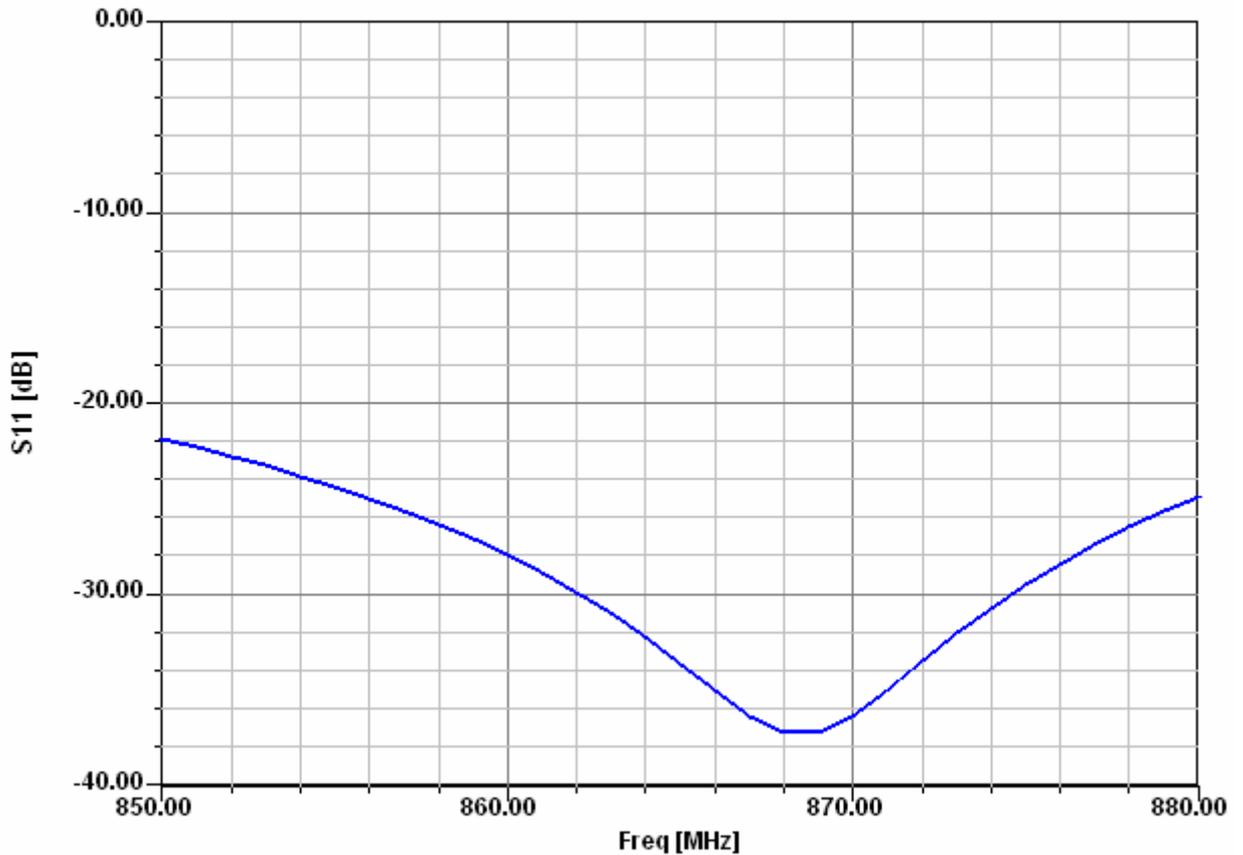


Fig. 5. The antenna matching with ASIC Philips SL3S3001 FTI (ISO 18000-6B) integrated chip input impedance

Test results

In order to estimate PatchTag's work efficiency comparative testing with tags by other companies, also fitted for the metallic surfaces, was held. The read range was measured in following positions:

- a) the tag was placed in the air;
- b) the tag was mounted on the metallic surface;
- c) the tag was placed on the metallic surface and directed at an angle of

45 to the reader's antenna in vertical plane;

- d) the tag was placed on the metallic surface and directed at an angle of 45 to the reader's antenna in horizontal plane.

The results of the experiment are shown in the diagram (Fig. 6). The read range is measured in percents relatively to the maximum distance of tag registering in this experiment.

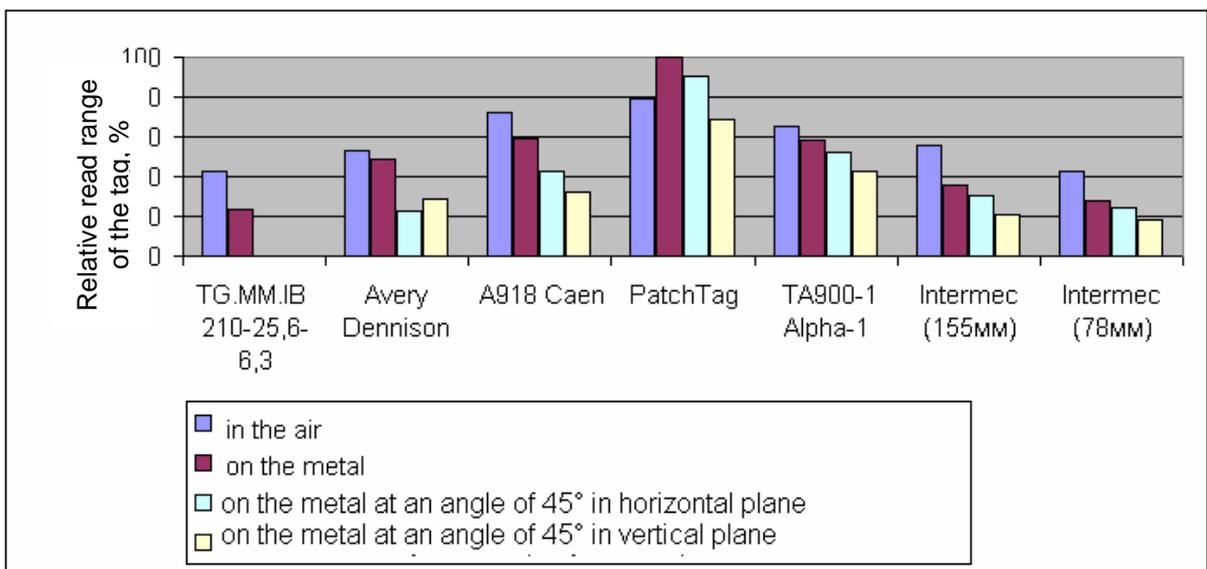


Fig. 6. Relative read ranges of PatchTag and other tags

The results of the experiment show that PatchTag not only performs better than the other tags on non-metallic surfaces, but also improves its characteristics being mounted on the metal, while the other tags read range decreases. Moreover, PatchTag also performs more effectively at registration at some angle, which makes it possible to use it much more efficiently for registering moving objects due to active read range increase.

Besides comparative testing, some additional experiments were held "in the field". The tag was mounted in two positions: on glass (dielectric) and on the automobile's body (metallic surface), which was going through the registering points at certain speed. The experiments showed that PatchTag's read range (usual antenna with circular polarization and 8 dBi gain factor and 2 W reader were used) makes 8 meters on non-metallic surface and more than 10 meters on the metallic surface of the automobile at the speed of more than 120 km/h.

The figures mentioned above make it possible to use multipurpose tag PatchTag

even in very harsh environments, which certainly broadens its possible fields of application. The new tag allows realizing some automation projects which were hard to fulfill before. For instance:

toll roads where one needs not to retard the speed before passing the check point (the tag allows to register the cars at a high speed and at sensible distance from antennas);

railroad cars identification during all their route (the registration check points can be placed not only at the stations where the cars move slowly but also during the driving);

automation of the metallic products manufacturing (PatchTag can be easily mounted on such places where the common tags perform badly or do not work at all).

References

1. SL3S3001 FTT (TSOOP8 Package Specification) from October 02, 2003.