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Tagging Smallish Objects

The size of a typical ultrahigh-frequency (UHF) RFID tag used for tagging pallets and cases in the supply chain is about 10 centimeters (4 inches). As companies move to item-level tagging, we need smaller tags that will fit on items such as wine bottles or paperback books. Some companies, such as Impinj and Quanray Electronics, have developed 1-centimeter tags that can be used for item-level tagging when a long read range is not needed. But for some items, that's still too big. For example, we need tiny tags for jewels, pens and lipsticks. Also, tiny tags could be embedded into those objects.

For more than a year and a half, the Auto-ID Lab at Fudan University in Shanghai, China, has been working to develop such a tiny tag. We now have a prototype EPC Gen 2 tag that is less than 1 millimeter. We achieved this by integrating the RFID antenna in the silicon chip, so the size of the whole tag is just the size of the silicon chip. This will also reduce the cost of the tag, because it eliminates the off-chip antenna and the process of bonding a silicon chip to the antenna.

Right now, the read range for the tag is 1 centimeter (0.4 inch). While that's too short to be useful, it does prove that the chip antenna is working. We are currently working to optimize the tag so that it can be read from a longer distance.

It was quite challenging to develop the chip antenna. As you may know, the tag chip operates using the electromagnetic energy transmitted from the interrogator and received by the tag antenna. The energy received is proportional to the area of the tag antenna, so a 1-square-millimeter-area antenna can get less than 1 percent of the energy that a 1-square-centimeter-area antenna gets.

To enhance the performance of the tag, we developed a mathematical model to calculate the energy received by the antenna. We also developed a guideline to optimize the antenna design so the antenna can get the maximum energy. The mathematical model can be used to verify the optimization.

We are also developing a circuit model for the on-chip antenna, to simulate the performance of the tag with other electronic components in the tag chip. It will help the circuit designer estimate the performance of the tag after it is manufactured.

The read distance of the tag is directly related to the power consumption of the tag chip. As the energy received from the electromagnetic field is proportional to the area of the antenna, which is less than the total area of the chip in the on-chip antenna, the energy that can be provided to operate the chip is very tiny. We are designing circuits that can run under very low supply voltage and consume very little power. Our goal is to develop a Gen 2 tag with an on-chip antenna that can be read from a distance of 5 to 10 centimeters before the end of next year.

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