A New Active Steering Antenna for IoT Devices

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***Abstract*— This paper presents the benefits of using active antennas, especially active steering antennas for Internet of Things (IoT) devices. An active steering antenna for ISM 2.4 GHz frequency band is implemented on an existing commercial product within the original device antenna volume. The active steering antenna concept is originally developed through Electromagnetic (EM) simulations using CST Microwave Studio and later implemented and tested on the commercial device. The antenna structure has adaptive radiation patterns to optimize the signal strength between the device and the gateway.**

Keywords*— *Active steering; Active antennas; IoT

I. INTRODUCTION

Interest to Internet of Things (IoT) devices has increased greatly lately and new products have emerged to commercial markets. Sensors for measuring e.g. temperature, humidity, and movement are one of the increasing markets for IoT. Designing antennas for small device itself is a complicated task. But the IoT sensors add new and often contradicting challenges for antenna designers. Due to the small form factor the sensors have normally limited power source and thus sensor's antenna(s) should have high gain towards the gateway to minimize the power needed to successfully transmit the data. On other hand the sensor(s) can be placed arbitrarily in relation to the gateway so high directive antennas are not preferred and antennas with omnidirectional patterns are more suitable.

II. PROPOSED ANTENNA AND SIMULATION RESULTS

The proposed antenna is based on an Isolated Magnetic Dipole (IMD) antenna [1]. The antenna structure is placed on Printed Circuit Board (PCB) made of FR-4 substrate with dimensions of 66x35x1.6 mm. The antenna consists of a feed monopole with two parasitics controlled by Ethertronics EC482 processor [2]. The EC482 chipset is used to dynamically select the optimal radiation pattern in active measurements using the MCD (Modal Cognitive Diversity) algorithm developed by Ethertronics. The proposed antenna concept was first developed with CST simulations and then implemented on the commercial device and tested both in passive measurements and field tests.

A. Simulation Results

The Fig. 1 shows the CST simulation model. The patented antenna is located on the top left corner of the PCB. The feed monopole is in the middle and the two parasitic elements connected to the EC482 are on the adjacent sides of the PCB.

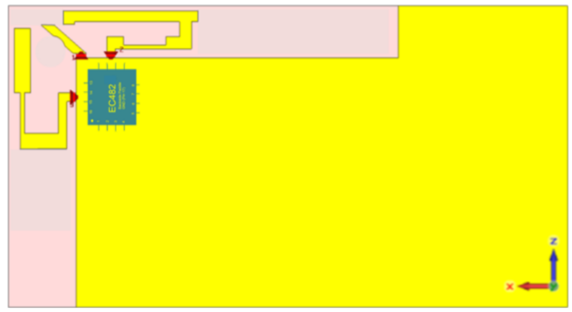

Fig. 1: CST simulation model

The Fig. 2(a) and 2(b) presents the simulated antenna's simulation results for the magnitude of reflection coefficient (dB) and total efficiency (dB) for all the three modes of the antenna. Each mode has a specific radiation pattern. Fig. 2(c) presents the simulated antenna radiation patterns in 2D format at 2450 MHz. The results illustrate the antenna's three distinctively different modes.

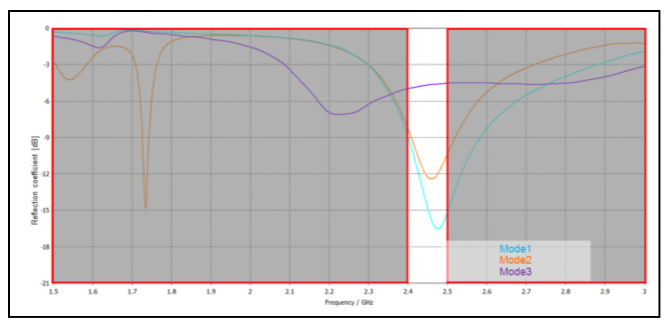

Fig. 2(a): Magnitude of reflection coefficient in dB

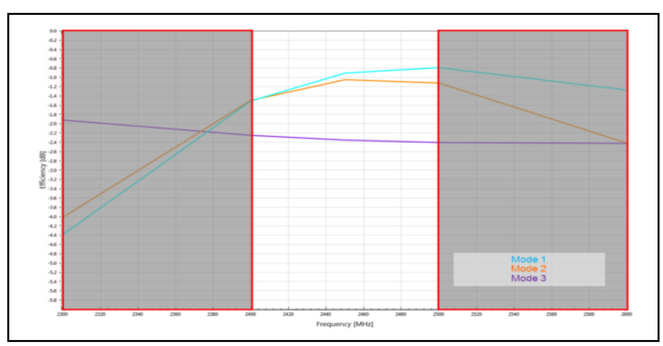

Fig. 2(b): Total Efficiency in dB

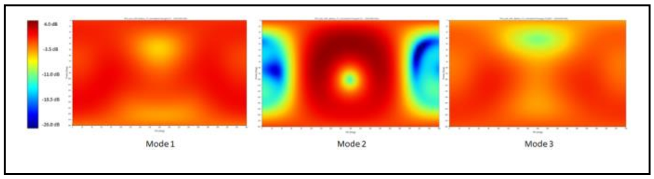

Fig. 2(c): 2D radiation patterns

III. Device measurements

To verify the simulation results, a set of passive and active devices were prepared and measured in an anechoic chamber and a field test was performed.

It is important to note here that the original device had a main and a diversity antennas but on the modified device, the active steering antenna, with three active modes, replaced the main antenna, while the original diversity antenna was completely removed.

A. Passive Measurements

Two passive devices were prepared for the measurement, one with the original antennas and a second one with an active steering antenna. In Fig. 3(a) and Fig. 3(b) the active steering antenna's combined radiation pattern and device original antennas combined pattern are presented in 2D format at 2450 MHz.

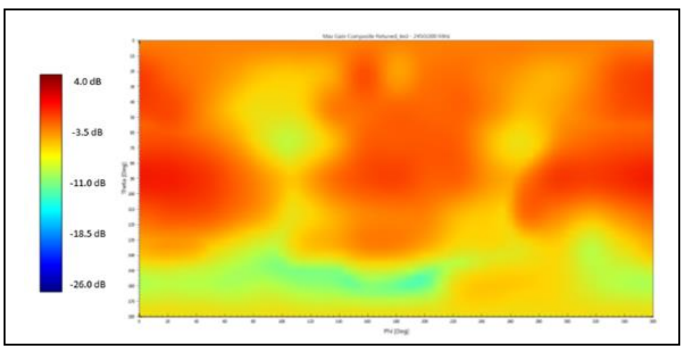

Fig. 3(a): combined gain pattern of active steering antenna

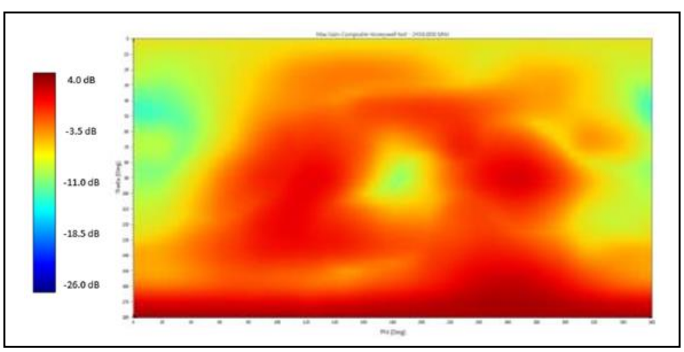

Fig. 3(b): combined gain pattern of device's original antennas

The results shows that with the active steering antenna distributed more evenly gain over the whole sphere compared to the original antennas , making it more omnidirectional and has thus better overall reception in different device orientations relative to the gateway.

B. Field Test

The field test was carried out in Ethertronics France office with two adjacent buildings. The gateway was placed on the second building ground floor and the active devices, one with active steering antenna and one with original device antenna, were placed in ten different locations as shown in Fig 4.

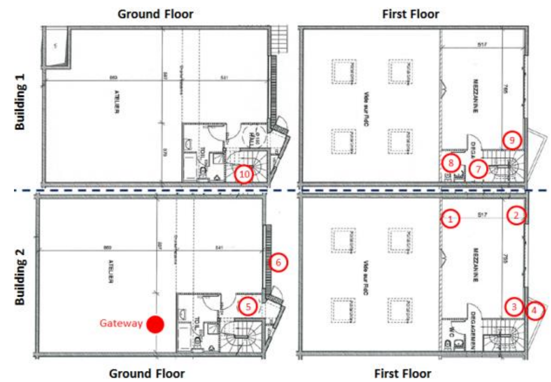

Fig.4: field test setup

In each location the device was positioned in four different positions relative to the gateway and a transmission between the gateway and the device was attempted. In Table I the successful transmissions per location is shown. As it can see from the results the active steering antenna provides significantly more (almost double) successful transmissions compared to the original antenna concept due the more evenly distributed gain.

TABLE I

Device location	Number of Successful Transmissions	
	Null Steering Antenna	Original Antenna
1	4	4
2	4	4
3	4	4
4	4	0
5	4	4
6	4	0
7	4	4
8	4	0
9	4	0
10	1	0

Conclusions

A novel antenna concept is presented for ISM 2.4 GHz band with adaptive radiation patterns. The passive antenna measurements and field test results shows the improved antenna performance compared to the traditional antenna solution. The improved antenna performance means that less power is needed to have successful transmission and thus longer battery life for the device.

References

[1] "Isolated Magnetic Dipole Antenna : Application to GPS" S.Rowson, G.Poilasne and L.Desclos Microwave and Optical Technology Letters, June 2004.

[2] Ethertronics EC482 WiFi Active Steering Processor, Product Brief