Logo Antenna for 5.8 GHz Wireless Communications (invited)

Jørgensen, Kasper Lüthje; Jakobsen, Kaj Bjarne

Published in:
FERMAT

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

Forum for Electromagnetic Research Methods and Application Technologies (FERMAT)

Logo Antenna for 5.8 GHz Wireless Communications

Kasper L. Jørgensen and Kaj B. Jakobsen
Department of Electrical Engineering, Technical University of Denmark, DK-2800 Lyngby, Denmark.
s113030@student.dtu.dk, kbj@elektro.dtu.dk

Abstract: A logo antenna for the 5.8\GHz ISM band is presented. The idea behind the logo antenna is to use the company or university logo as part of the antenna. When disguised as a logo, it may be more acceptable to place the antenna at optimal locations to obtain good coverage. In the present work the university logo has been used. The designed logo antenna has a measured and simulated 3-dB bandwidth of 153.1\MHz (2.6\%) and 165.6\MHz (2.9\%), respectively. The aperture fed, omnidirectional logo antenna is little hand sensitive.

Keywords: Embroidered antenna, Internet of THings (IoT), Body-centric communications, Body area network (BAN), Loacal Area Network (LAN)

REFERENCES:

[1] H. C. Oersted, “Experimenta circa effectum conflictus electrici in acum magneticam,” Hafniae, 1820.

[2] A. Ittipiboon, D. Roscoe, M. Cuhaci, and Y. Antar, “Slot-coupled excitation of microstrip dipole antennas,” Electronics Letters, vol. 28, no. 2, pp. 193–194, Jan 1992.

[3] C. Mak, K. Luk, and K. Lee, “Microstrip line-fed l-strip patch antenna,” Microwaves, Antennas and Propagation, IEE Proceedings, vol. 146, no. 4, pp. 282–284, Aug 1999.

[4] P. Salonen and Y. Rahmat-Samii, “Textile antennas: Effects of antenna bending on input matching and impedance bandwidth,” Aerospace and Electronic Systems Magazine, IEEE, vol. 22, no. 12, pp. 18–22, Dec 2007.

[5] E. Moradi, T. Bjorninen, L. Ukkonen, and Y. Rahmat-Samii, “Effects of sewing pattern on the performance of embroidered dipole-type rfid tag antennas,” Antennas and Wireless Propagation Letters, IEEE, vol. 11, pp. 1482–1485, 2012.

[6] L. Zhang, Z. Wang, and J. Volakis, “Textile antennas and sensors for body-worn applications,” Antennas and Wireless Propagation Letters, IEEE, vol. 11, pp. 1690–1693, 2012.

[7] Z. Wang, L. Zhang, Y. Bayram, and J. Volakis, “Embroidered conductive fibers on polymer composite for conformal antennas,” Antennas and Propagation, IEEE Transactions on, vol. 60, no. 9, pp. 4141–4147, Sept 2012.

[8] T. Acti, A. Chauraya, S. Zhang, W. Whittow, R. Seager, J. Vardaxoglou, and T. Dias, “Embroidered wire dipole antennas using novel copper yarns,” Antennas and Wireless Propagation Letters, IEEE, vol. 14, pp. 638–641, 2015.

Kasper L. Jørgensen recevied the B.Sc.E.E. from the Technical University of Denmark, Lyngby, in 2014, and is currently working on his M.Sc.E.E from the Technical University of Denmark. Currently, he is a Fulbright Visiting Student Scholar at Ohio State University, USA.

Kaj B. Jakobsen received the B.Sc.E.E. and the M.Sc.E.E. degrees from the Technical University of Denmark, Lyngby, in 1985 and 1986, respectively, the Ph.D. degree in electrical engineering from University of Dayton, Dayton, OH, USA, in 1989, and the HD in Organization and Management, Copenhagen Business School, Copenhagen, Denmark, in 2000.

From 1986–1989, he was a Fulbright Scholar at the Department of Electrical Engineering, University of Dayton, OH, USA. Since 1990, he has been with the Department of Electrical Engineering, Technical University of Denmark, where he is an Associate Professor. His research interests are in body-centric wireless networks, wireless body area networks, and body sensor networks. In 1989, he received the NCR Stakeholder Award and was appointed Teacher-of-the-Year at the Technical University of Denmark in 1994.

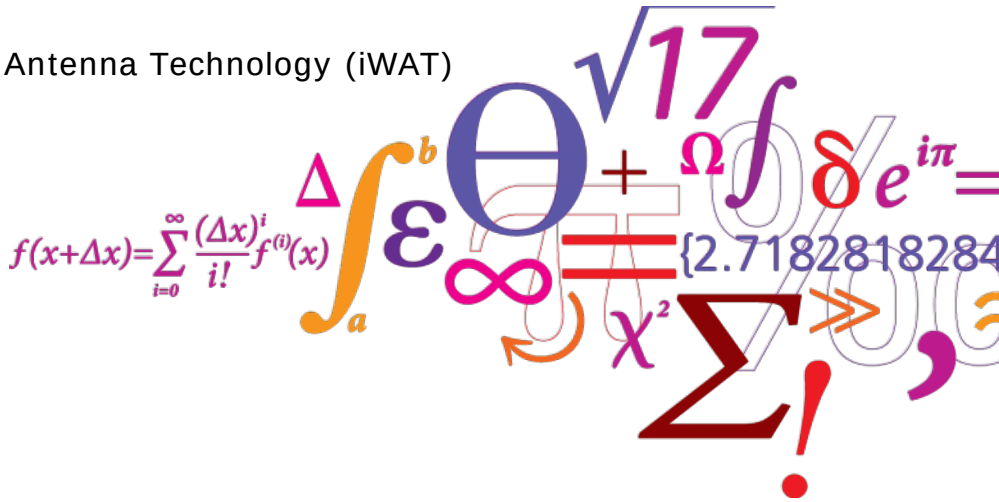
Logo Antenna for 5.8 GHz Wireless Communications

Kasper L. Jørgensen and Kaj B. Jakobsen

Department of Electrical Engineering, Technical University of Denmark, DK-2800 Lyngby, Denmark.

s113030@student.dtu.dk, kbj@elektro.dtu.dk

Presented at the 2016 International Workshop on Antenna Technology (iWAT)



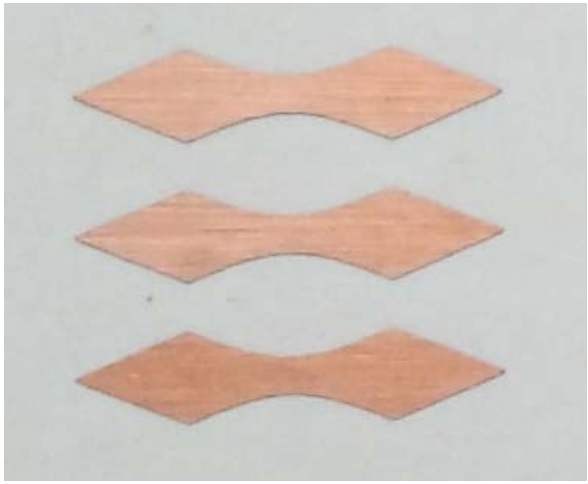
DTU Electrical Engineering
Department of Electrical Engineering

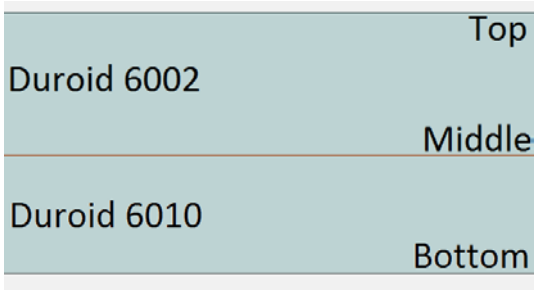
Introduction

Internet of Things (IoT), wearable devices, body-centric communications, and wireless networks are areas that have seen large interest in recent years. One thing the three areas have in common is the need for a good connection between several units. The connection between the units can be done by the use of the 5.8 GHz ISM band, which in turn requires an antenna to transmit and receive data. A good placement for the antenna is not always easy to obtain. A company logo on the other hand can be placed in most places. Therefore our suggestion is to use the logos placement to get a prominent placement for the antenna. When the logo is turned into an antenna, it makes the antenna hidden to the naked eye. The logo presented in this article is the logo of the Technical University of Denmark (DTU), which was founded in 1829 by Hans Christian Ørsted [1]. The three bars in the DTU logo represent the three lions of the university seal. In order to get a clean representation of the logo, a slot in the ground plane is used to couple to the logo[2, 3]. The logo antenna has potential as an antenna in an office environment, building or auditorium numbers, and as embroidered antennas for wireless body-centric communications, e.g., for RFID [4-8].

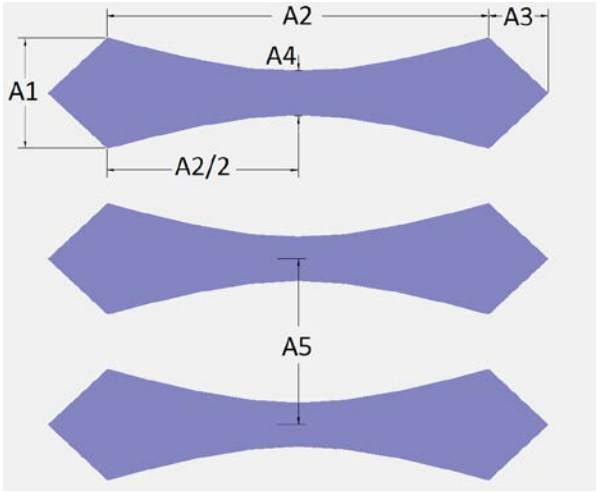
Design (1)

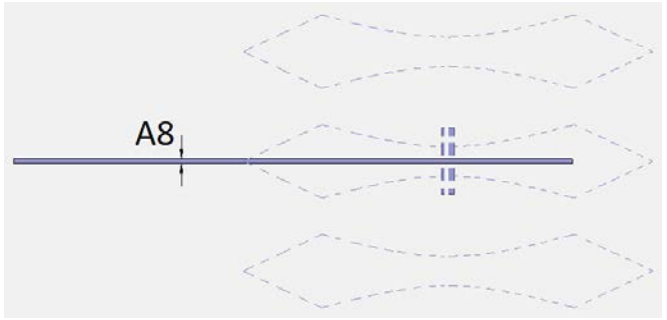
The proposed logo antenna is designed by the use of Ansoft HFSS version 15. The logo antenna is seen to the top right. In the top right corner the DTU logo is shown for reference. The antenna design is based on mimicking the chosen logo as close as possible, while the antenna still works as specified. The antenna is fed through a slot. This reduces unwanted radiation from the feed network and makes it possible to get a clean logo. The antenna is designed by the use of two substrates. For the top substrate layer a Rogers RT/duroid 6002 is used (layer thickness = 0.762 mm, relative permittivity ε_r = 2.94, and loss tangent $tan\delta$ = 0.0012), and the bottom substrate layer is a Rogers RT/duroid 6010 (layer thickness = 0.635 mm, ε_r = 10.2, and $tan\delta$ = 0.0023), see bottom right.

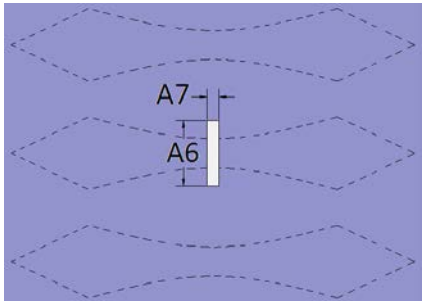




Design (2)







Parameter	Value (mm)
A_1	1.8
A_2	8.4
A_3	3.8
A_4	1.4
A_5	5.3
A_6	3.2
A_7	0.6
A_8	0.2

The electrical size of the logo at 5.8 GHz is $ka = 0.41$, where k is the free space propagation constant, and a is the radius of the sphere circumscribing the logo of the antenna on the ground plane only. The logo antenna is placed on the top copper layer and is shown in the figure. The design parameters are given in the table.

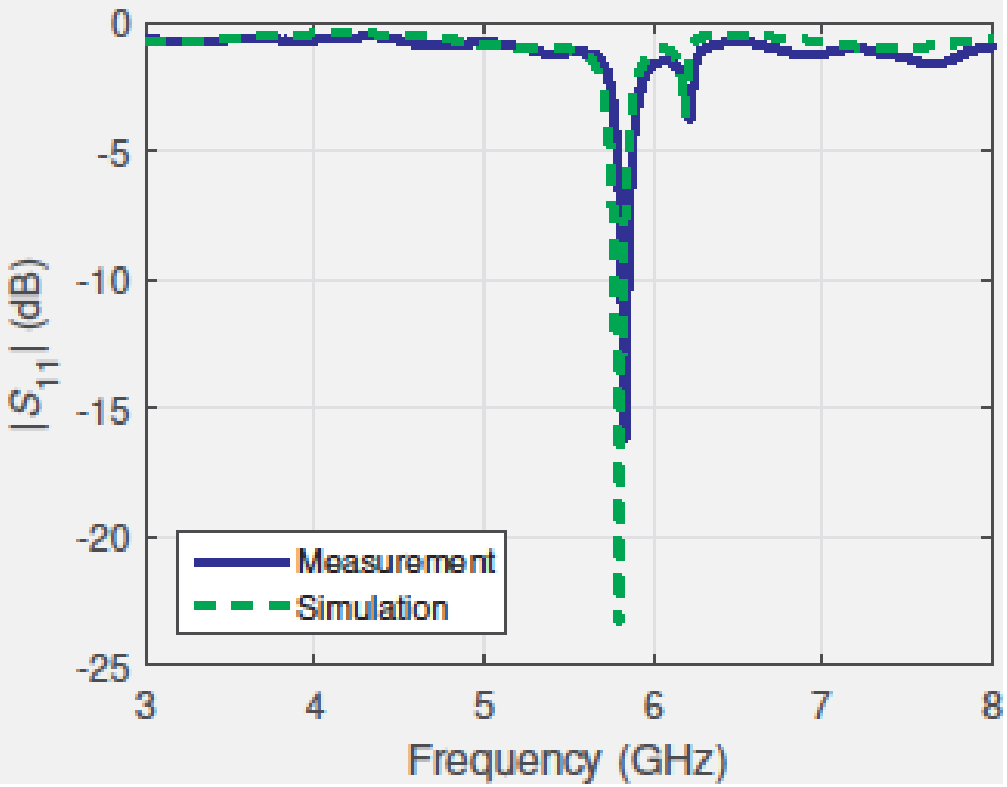
Results (1): Reflection Coefficient

- At the lower and higher frequencies there is a difference of less than 0.2 dB and 0.8 dB between measurement and simulation, respectively.

- Measured center frequency is slightly higher than simulated.

- Measured center frequency lies at 5.831 GHz and the simulated center frequency lies at 5.797 GHz.

- Excellent agreement between measurement and simulation.



Results (2): Electrical Bandwidth

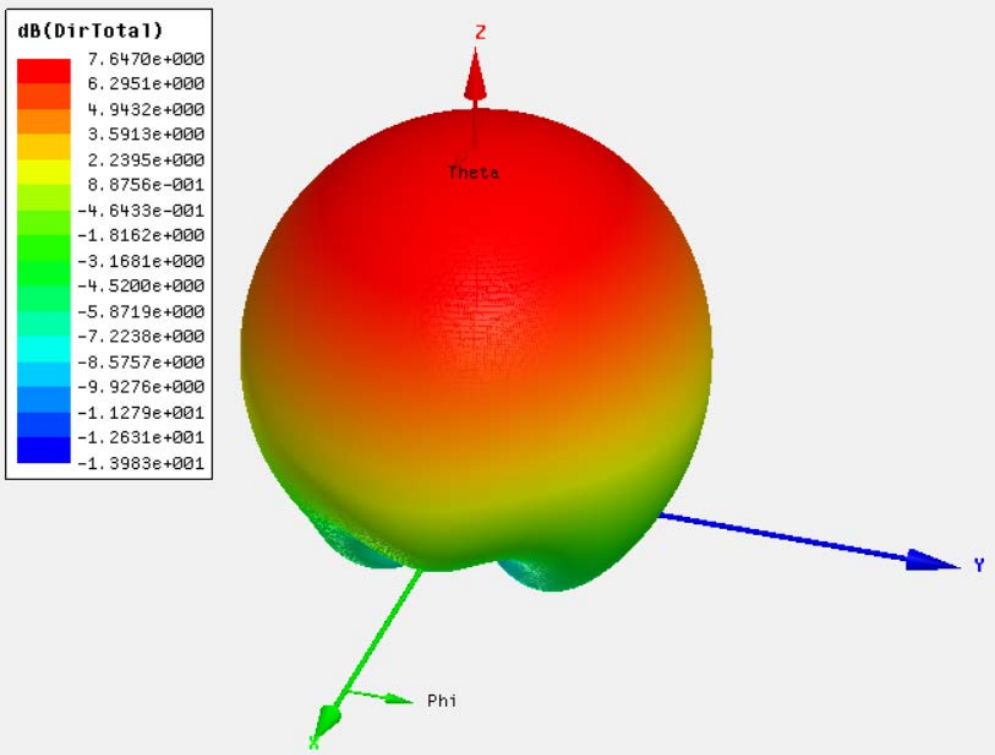
3-dB Bandwidth:

- 153 MHz (measured)
- 166 MHz (simulated)
- 150 MHz (required)

Parameter	HFSS		Measurement	
	(MHz)	(%)	(MHz)	(%)
f_c	5797		5831	
$BW_{3\,dB}$	165.6	2.9	153.1	2.6
$BW_{6\,dB}$	90.6	1.6	78.1	1.3
$BW_{10\,dB}$	50.0	0.8	40.6	0.7
$BW_{14\,dB}$	28.1	0.5	15.6	0.3

Results (3): Radiation Pattern

- Maximum directivity 7.6 dBi
- Omnidirectional radiation
- Only radiation in the upper half space as required
- No balun is needed
- Suitable for embroidery [8]



Conclusion

A logo antenna for the 5.8 GHz ISM band was presented. The idea behind the logo antenna is to use the company or university logo as part of the antenna. Logos are omnipresent, e.g., on buildings, aisles, doors, staircases and clothing. The optimal places for good coverage are often no-go for the placement of an antenna due to regulation, conservation, and architecture. When the antenna is disguised as a logo, it may be acceptable to place the antenna at optimal locations in order to get good coverage. The logo antenna has a measured and simulated 3 dB bandwidth of 153.1 MHz (2.6 %) and 165.6 MHz (2.9 %), respectively. The logo antenna is fed via an aperture and was not sensitive when touched by hand even though no balun was used. The radiation pattern is omnidirectional in the upper half-space.

References

[1] H. C. Oersted, “Experimenta circa effectum conflictus electrici in acum magneticam,” Hafniae, 1820.

[2] A. Ittipiboon, D. Roscoe, M. Cuhaci, and Y. Antar, “Slot-coupled excitation of microstrip dipole antennas,” Electronics Letters, vol. 28, no. 2, pp. 193–194, Jan 1992.

[3] C. Mak, K. Luk, and K. Lee, “Microstrip line-fed l-strip patch antenna,” Microwaves, Antennas and Propagation, IEE Proceedings, vol. 146, no. 4, pp. 282–284, Aug 1999.

[4] P. Salonen and Y. Rahmat-Samii, “Textile antennas: Effects of antenna bending on input matching and impedance bandwidth,” Aerospace and

Electronic Systems Magazine, IEEE, vol. 22, no. 12, pp. 18–22, Dec 2007.

[5] E. Moradi, T. Bjorninen, L. Ukkonen, and Y. Rahmat-Samii, “Effects of sewing pattern on the performance of embroidered dipole-type rfid tag antennas,” Antennas and Wireless Propagation Letters, IEEE, vol. 11, pp. 1482–1485, 2012.

[6] L. Zhang, Z. Wang, and J. Volakis, “Textile antennas and sensors for body-worn applications,” Antennas and Wireless Propagation Letters, IEEE, vol. 11, pp. 1690–1693, 2012.

[7] Z. Wang, L. Zhang, Y. Bayram, and J. Volakis, “Embroidered conductive fibers on polymer composite for conformal antennas,” Antennas and Propagation, IEEE Transactions on, vol. 60, no. 9, pp. 4141–4147, Sept 2012.

[8] T. Acti, A. Chauraya, S. Zhang, W. Whittow, R. Seager, J. Vardaxoglou, and T. Dias, “Embroidered wire dipole antennas using novel copper yarns,” Antennas and Wireless Propagation Letters, IEEE, vol. 14, pp. 638–641, 2015.