AKADEMIA GÓRNICZO-HUTNICZA
IM. STANISŁAWA STASZICA W KRAKOWIE

Microstrip antenna arrays utilizing slot-coupled feeding networks

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Outline

- Aim of the research
- Series feeding networks of antenna arrays
- 2 x 8 microstrip antenna array fed with the use of series-series feeding network – concept of inclined-slot coupler
- 4 x 4 broadband microstrip antenna array – experimental verification of inclined-slot coupler concept
- 4 x 4 antenna lattice with switched polarization fed with the use of inclined-slot couplers and modified Butler matrix
- List of publications related to the presented topic

AGH

Aim of the research

- Dissipation losses reduction within antenna array’s beam-forming network.
- Investigation on possibility of obtaining both linear horizontal and vertical radiation patterns and both right-handed and left-handed circular radiation patterns with the use of the same aperture.
- Development of new design techniques for low-loss antenna array beam-forming networks.

Series feeding networks of antenna arrays

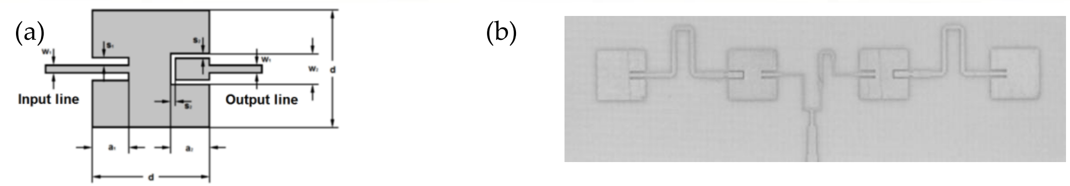


Fig. 1 ‚Through-element’ series-feeding technique: basic two-port radiating element (a) and photograph of the manufactured series-fed antenna array (b). Source: K. Wincza, S. Gruszczynski, J. Borgosz, "Microstrip antenna array with series-fed 'through-element' coupled patches," *Electronics Letters*, vol.43, no.9, pp.487-489, Apr. 2007.

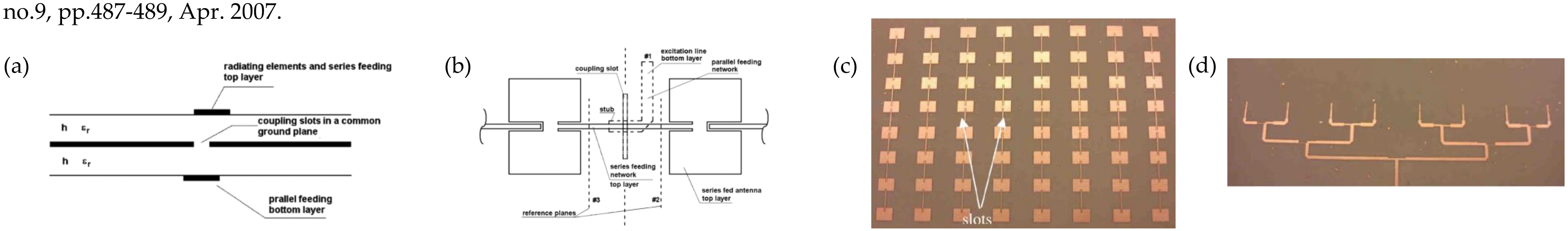


Fig. 2 Concept of the two-way slot-coupled power divider: cross-sectional view of the utilized dielectric structure (a), schematic diagram of the proposed slot-coupled power divider (b) and photographs of the manufactured 8 x 8 linear antenna array (c) and corporate feeding network of particular linear antenna arrays (d). Source: K. Wincza, S. Gruszczynski, "Microstrip Antenna Arrays Fed by a Series-Parallel Slot-Coupled Feeding Network," *IEEE Antennas and Wireless Propagation Letters*, vol.10, pp.991-994, 2011.

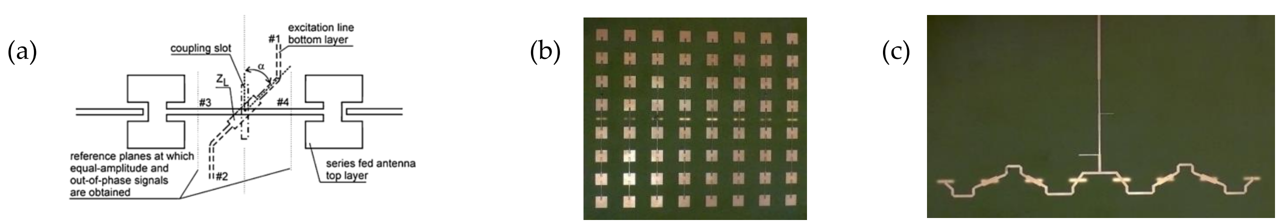


Fig. 3 Concept of the three-way slot-coupled power divider presented in [1]: schematic diagram of the proposed power divider (a) and photographs of the manufactured 8 x 8 linear antenna array (b) and series feeding network of particular linear antenna arrays (c)

2 x 8 microstrip antenna array fed with the use of series-series feeding network – concept of inclined-slot coupler

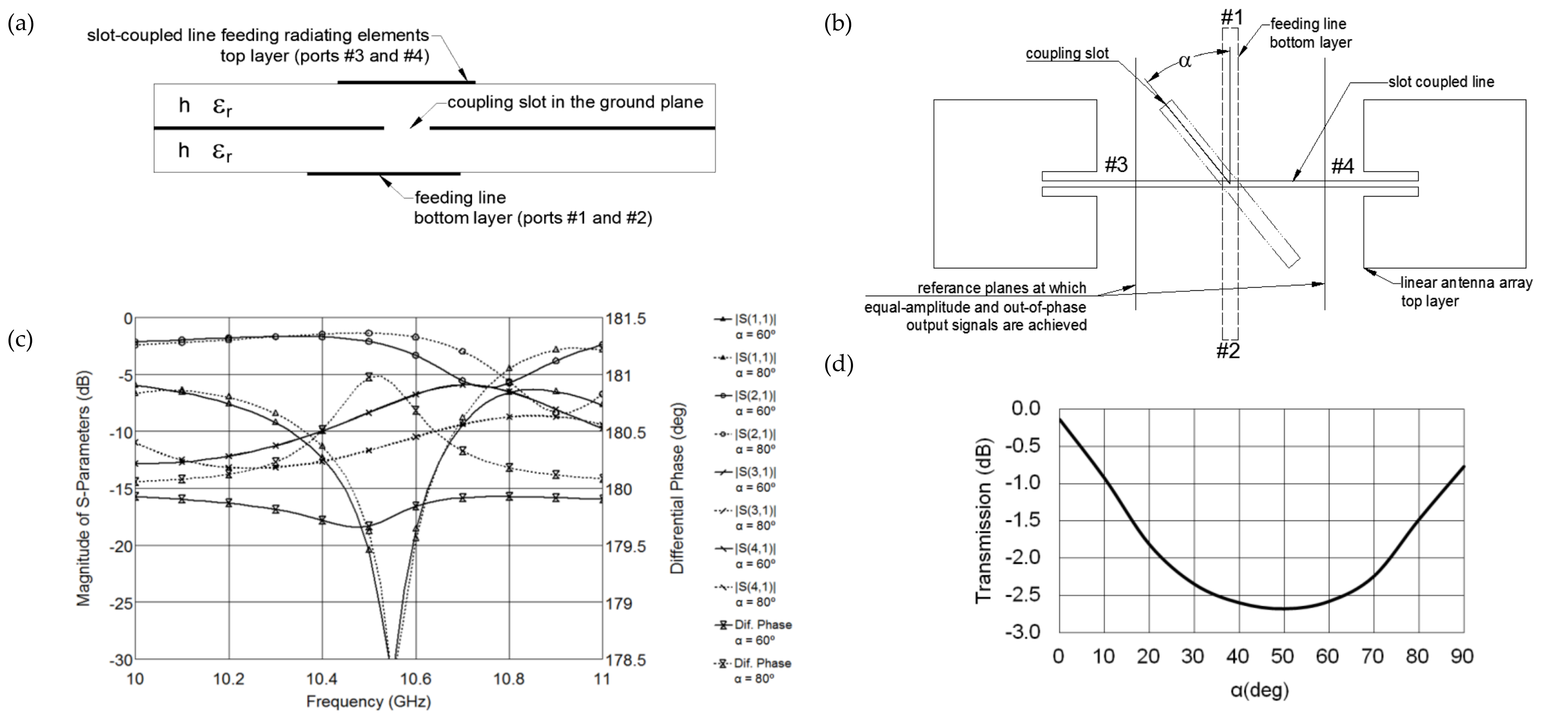
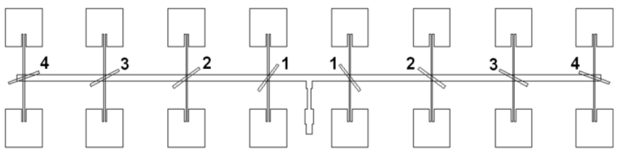


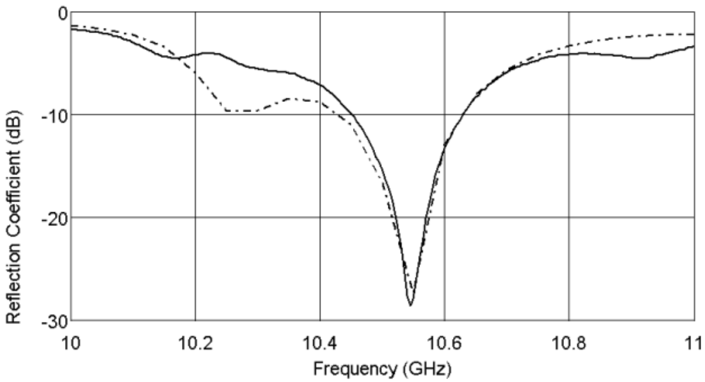
Fig. 4 Concept of the modified three-way inclined-slot coupler presented in [2]: cross-sectional view of the utilized dielectric structure (a), schematic diagram of the proposed power divider (b), S-parameters of the proposed power dividers for two different inclination angles (c) and the relation between transmission coefficient and slot inclination angle (d)

2 x 8 microstrip antenna array fed with the use of series-series feeding network – concept of inclined-slot coupler

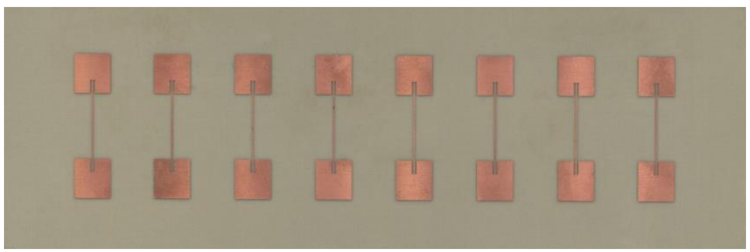


(a)

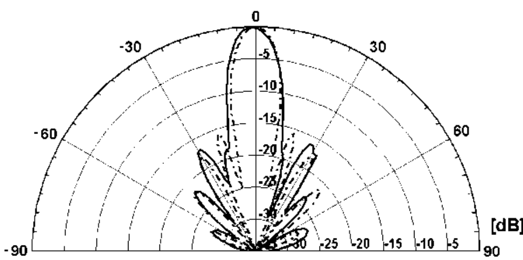
No.	α [deg]	Amplitude coefficient
1	52,0	1,00
2	35,0	0,71
3	28,0	0,52
4	19,5	0,63



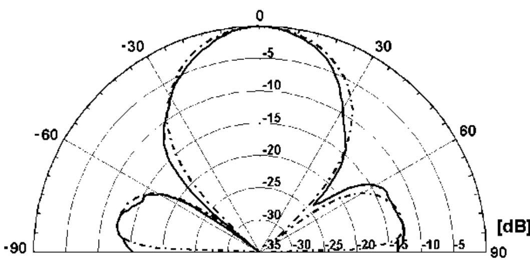
(d)



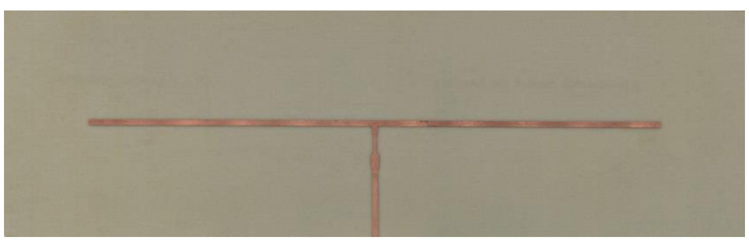
(b)



(e)



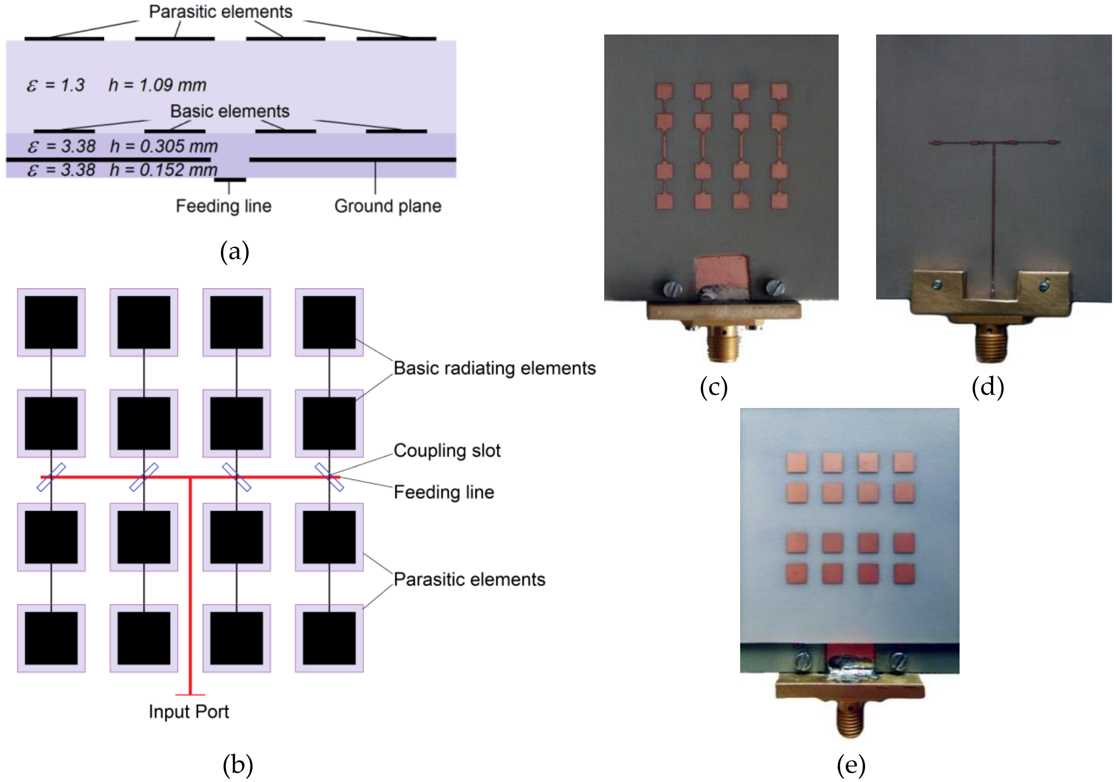
(f)



(c)

Fig. 5 2 x 8 antenna array utilizing series-series feeding network presented in [2]: antenna array layout (a), photographs of the manufactured antenna array showing two-element linear antenna arrays (b) and feeding network realized as a straight transmission line (c), simulated and measured reflection coefficient of 2 x 8 antenna array (d) as well as simulated and measured normalized radiation patterns obtained in E-plane (e) and H-plane (f)

4 x 4 broadband microstrip antenna array – experimental verification of inclined-slot coupler concept



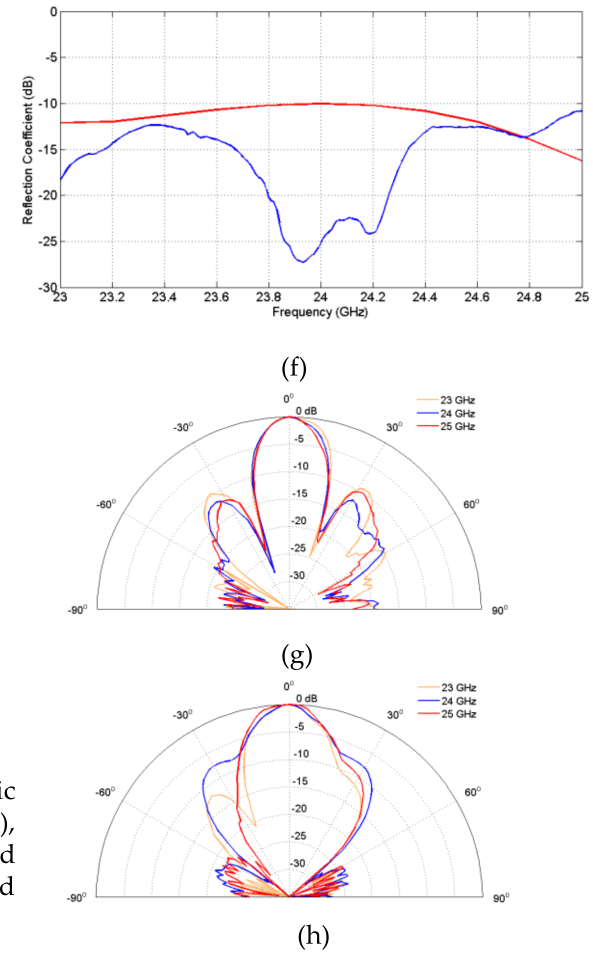


Fig. 6 4 x 4 broadband antenna array presented in [6]: cross-sectional view of the utilized dielectric structure (a), layout of the proposed antenna array (b), photographs showing linear antenna arrays (c), feeding network of particular linear antenna arrays (d) and parasitic radiating elements (e), simulated and measured reflection coefficient (f) and normalized radiation pattern obtained in E-plane (g) and H-plane (h) at three different frequencies

4 x 4 antenna lattice with switched polarization fed with the use of inclined-slot couplers and modified Butler matrix

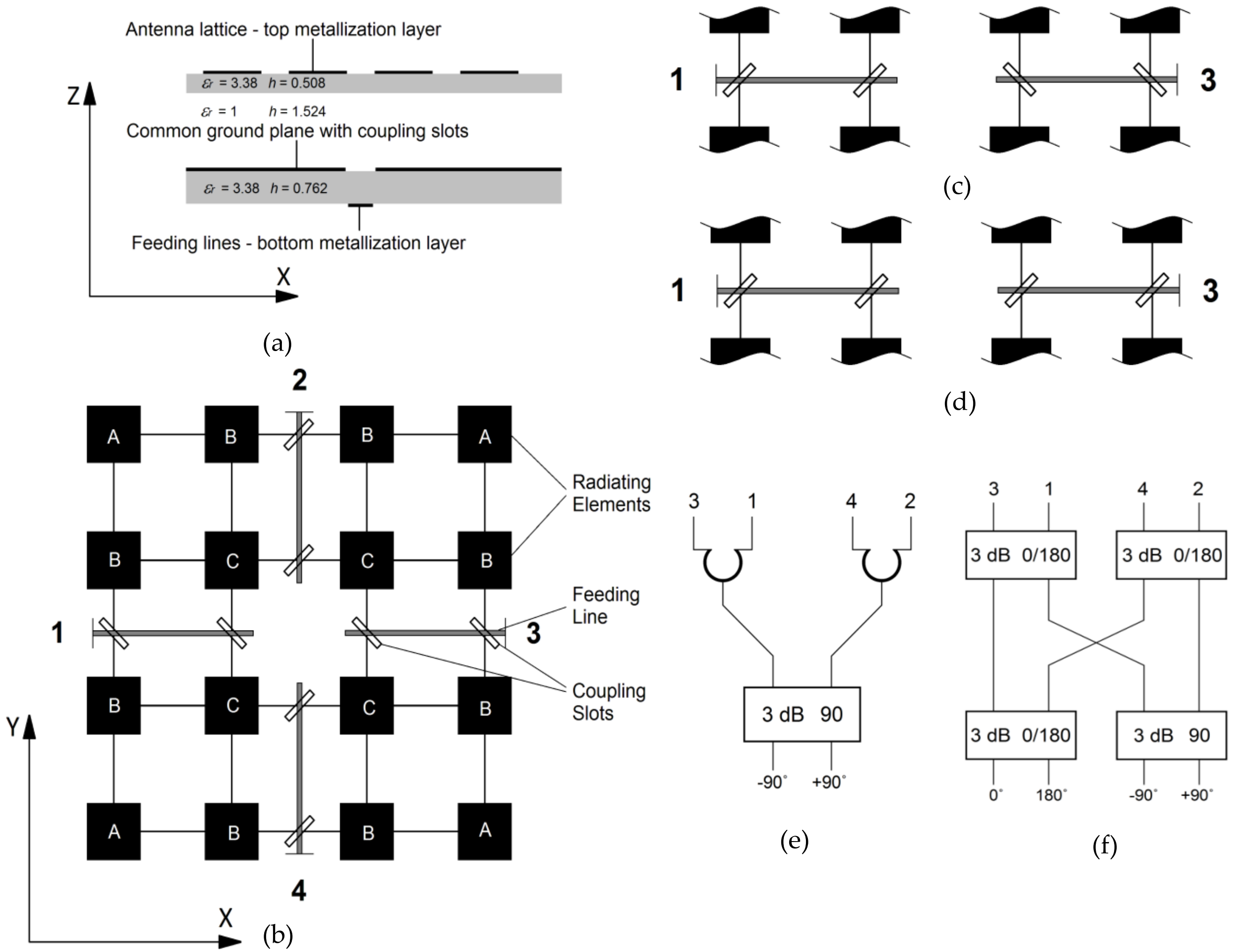
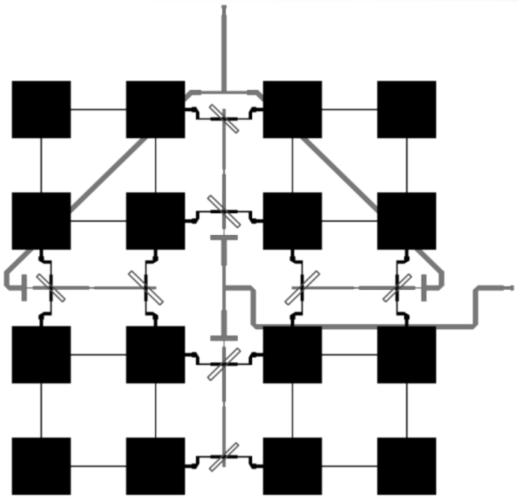
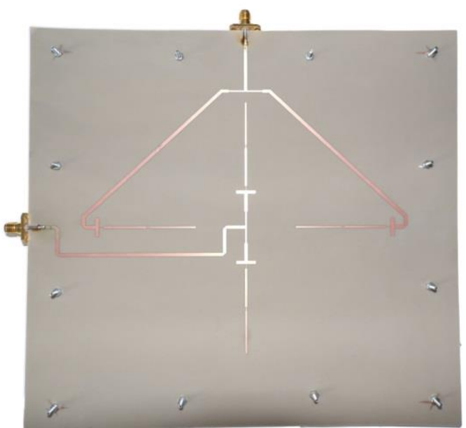


Fig. 7 4 x 4 antenna lattice presented in [3]: cross-sectional view of the utilized dielectric structure (a), schematic diagram of the antenna lattice concept (b), axial symmetry (c) and central symmetry (d), feeding networks for antenna lattice with coupling slots exhibiting axial symmetry (e) and central symmetry (f), and block diagrams of antenna lattice with slots-exhibiting central symmetry and modified Butler matrix connection for achieving circular (g) and linear polarization (h)

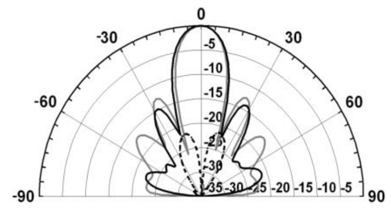
4 x 4 antenna lattice with switched polarization fed with the use of inclined-slot couplers and modified Butler matrix



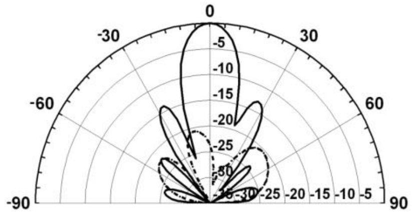
(a)



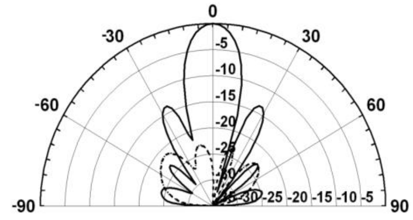
(b)



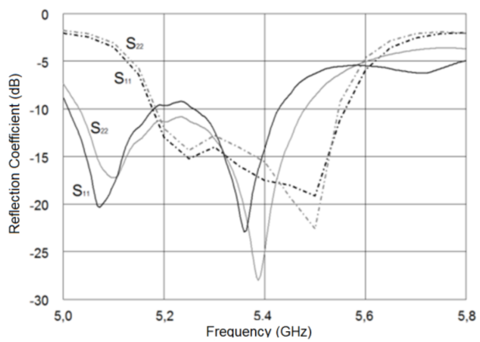
(c)



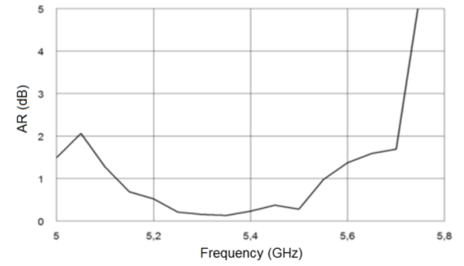
(d)



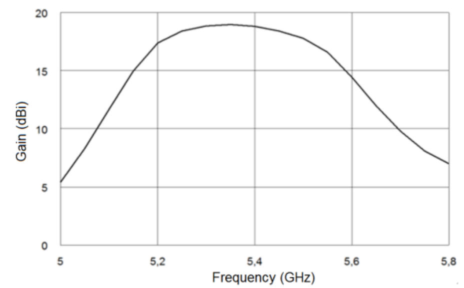
(e)



(f)



(g)



(h)

Fig. 8 Antenna lattice with slots exhibiting axial symmetry: layout of the designed antenna lattice (a), a photograph showing feeding lines integrated with T-junction power dividers placed at the bottom metallization layer (b), simulated normalized linear radiation patterns (c) and circular radiation patterns: LHCP (d) and RHCP (e), simulated and measured reflection coefficients (f), simulated axial ratio (g) and gain of the 4 x 4 antenna lattice (h)

4 x 4 antenna lattice with switched polarization fed with the use of inclined-slot couplers and modified Butler matrix

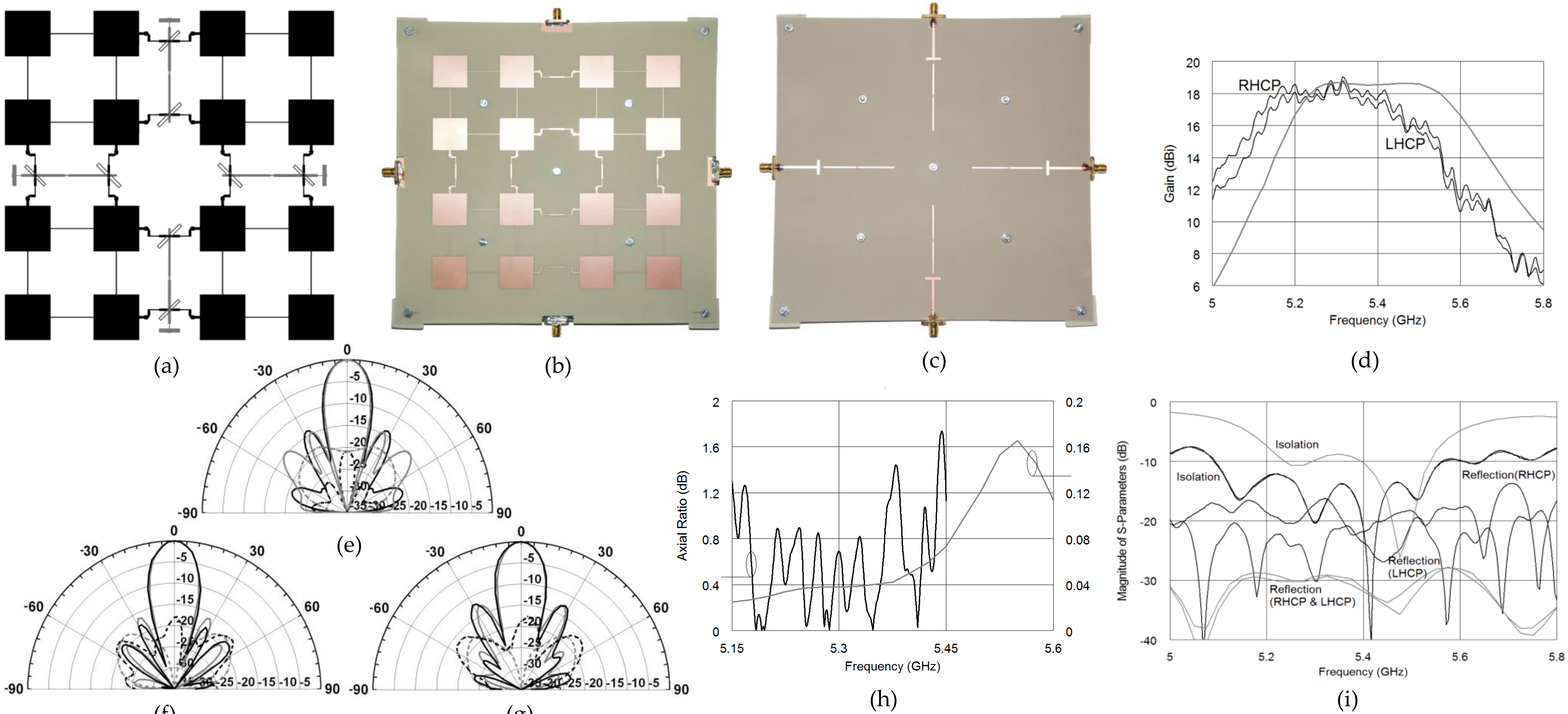
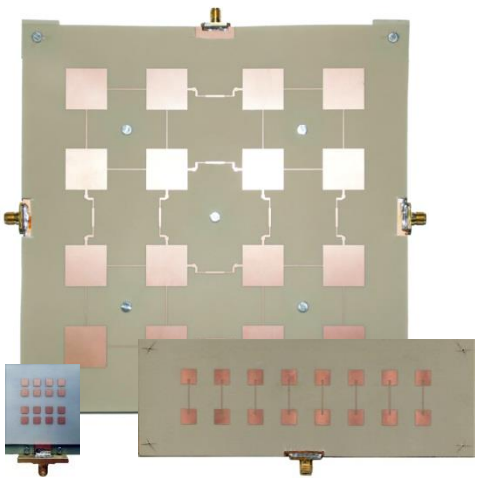


Fig. 9 Antenna lattice with slots exhibiting central symmetry presented in [3]: layout of the designed antenna lattice (a), photographs showing series-fed radiating elements placed at the top metallization layer (b) and straight feeding lines placed at the bottom metallization layer (c), gain of the 4 x 4 antenna lattice(d) simulated normalized linear radiation patterns (e) and simulated and measured normalized circular radiation patterns: LHCP (f) and RHCP (g), simulated and measured axial ratio (h), and S-parameters at one of the antenna lattices inputs (i).

List of publications related to the presented topic



Magazines:

[1] I. Słomian, I. Piekarz, K. Wincza, S. Gruszczyński, „Microstrip antenna array with series feeding network designed with the use of slot-coupled three-way power divider”, *IEEE Antennas and Wireless Propagation Letters*, vol.11, pp.667–670, 2012.

[2] I. Słomian, K. Wincza, S. Gruszczyński, „Series-fed microstrip antenna array with inclined-slot couplers as three-way power dividers,” *IEEE Antennas and Wireless Propagation Letters*, vol.12, pp.62-64, 2013.

[3] I. Słomian, K. Wincza, S. Gruszczyński, „Series-fed microstrip antenna lattice with switched polarization utilizing Butler matrix,” *IEEE Transactions on Antennas and Propagation*, vol.62, no.1, pp.145-152, Jan. 2014.

[4] I. Słomian, K. Wincza, S. Gruszczyński, „Compact integrated feeding network for excitation of dual-circular polarization in series-fed antenna lattice”, submitted to *IEEE Transactions on Antennas and Propagation.*

Conferences:

[5] I. Słomian, I. Piekarz, K. Wincza, S. Gruszczyński, „Series-fed linear antenna array with slot coupler as power divider and 180° phase shifter,” in Proc. *19th International Conference on Microwaves, Radar and Wireless Communications (MIKON)*, 2012.

[6] I. Słomian, J. Sorocki, P. Kamiński, A. Rydosz, K. Wincza, S. Gruszczyński, „Broadband 4 x 4 microstrip antenna array utilizing slot-coupled power dividers,” in Proc. *International Microwave and Optoelectronics Conference (IMOC)*, 2013.

[7] I. Słomian, P. Kamiński, J. Sorocki, I. Piekarz, K. Wincza, S. Gruszczyński, „Multi-beam and multi-range antenna array for 24 GHz radar applications”, in Proc. *20th International Conference on Microwaves, Radar and Wireless Communications (MIKON)*, 2014.

[8] I. Słomian, K. Wincza, S. Gruszczyński, „4 x 2 broadband microstrip antenna array utilizing 4-way slot-coupled power divider”, accepted to be presented at *IEEE-APS Topical Conference on Antennas and Propagation in Wireless Communications*, 2014.