

“Status and Current Trends on Time-Modulated Arrays at the ELEDIA Research Center”

Author: Prof. Andrea MASSA

Co-Authors: Dr. Paolo ROCCA, Dr. Lorenzo POLI

Abstract

Time modulated arrays (TMAs) are antenna systems where a set of radio frequency (RF) switches is used in the beam forming network to modulate the static excitation weights of an ordinary phased array. The on-off commutation of the switches, controlled by periodic pulse sequences, generates harmonics, called sideband radiation (SR), which unavoidably reduce the antenna directivity and gain at the antenna working frequency.

Till nowadays, most of the research activities have been devoted to the use of TMAs as advanced phased arrays with the aim of synthesizing a desired pattern at the antenna working frequency while minimizing the power losses in the SR. More recent studies have instead considered the exploitation of the harmonics generated by the time-modulation process. As a matter of fact, multiple harmonic patterns having different spatial distribution can be used for electronic beam scanning, estimation of the directions of arrival, transmission-reception of multiple signals for cognitive radio applications, or secure communications at the physical level.

The key features and advantages of TMA are:

- the introduction of time as an additional degree of freedom in the array design requires the use of suitable and effective design/optimization methods to achieve the desired performance;
- the simplicity of the antenna reconfiguration based on the redefinition of the pulse sequence controlling the RF switches makes TMA an enabling technology for software-defined antenna systems;
- the multiple harmonics exploitation enables the use of TMAs for innovative applications where classical phased arrays are not applicable.

The seminar is aimed at presenting an overview of the status as well as the current trends on TMAs at the ELEDIA Research Center, also envisaging further potential developments and applications.

Andrea Massa received the “laurea” degree in Electronic Engineering from the University of Genoa, Genoa, Italy, in 1992 and Ph.D. degree in EECS from the same university in 1996. From 1997 to 1999, he was an Assistant Professor of Electromagnetic Fields at the Department of Biophysical and Electronic Engineering (University of Genoa). From 2001 to 2004, he was an Associate Professor at the University of Trento. Since 2005, he has been a Full Professor of Electromagnetic Fields at the University of Trento, where he currently teaches electromagnetic fields, inverse scattering techniques, antennas and wireless communications, wireless services and devices, and optimization techniques. At present, Prof. Massa is the director of the ELEDIA Research Center at the University of Trento with a staff of more than 25 researchers. Moreover, he is Adjunct Professor at Penn State University (USA) and he has been Visiting Professor at the Missouri University of Science and Technology (USA), at the Nagasaki University (Japan), at the University of Paris Sud (France), at the Kumamoto University (Japan), and at the DigiTEo (Paris – France).

Prof. Massa serves as Associate Editor of the “IEEE Transaction on Antennas and Propagation” and Associate Editor of the “International Journal of Microwave and Wireless Technologies” and he is member of the Editorial Board of the “Journal of Electromagnetic Waves and Applications”, and a permanent member of the “PIERS Technical Committee” and of the “EuMW Technical Committee”. He has been appointed in the Scientific Board of the “Società Italiana di Elettromagnetismo (SIEm)” and elected in the Scientific Board of the Interuniversity National Center for Telecommunications (CNIT). Recently Prof. Massa has been appointed by the National Agency for the Evaluation of the University System and National Research (ANVUR) as a member of the Recognized Expert Evaluation Group (Area 09, ‘Industrial and Information Engineering’) for the evaluation of the researches at the Italian University and Research Center in the period 2004-2010. Moreover, he has been appointed as the Italian Member of the Management Committee of the COST Action TU1208 “Civil Engineering Applications of Ground Penetrating Radar”.

His research activities are mainly concerned with direct and inverse scattering problems, propagation in complex and random media, analysis/synthesis of antenna systems and large arrays, design/applications of WSNs, cross-layer optimization and planning of wireless/RF systems, semantic wireless technologies, material-by-design (metamaterials and reconfigurable-materials), and theory/applications of optimization techniques to engineering problems (telecommunications, medicine, and biology).

Prof. Massa published more than 500 scientific publications among which about 250 on international journals and more than 270 in international conferences where he presented more than 50 invited contributions. He has organized 45 scientific sessions in international conferences and has participated to several technological projects in the European framework (10 EU Projects) as well as at the national and local level with national agencies (40 Projects/Grants).