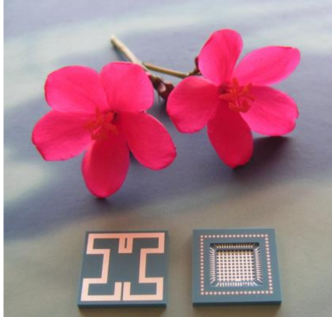
Antenna-in-Package (AiP) Technology and Applications

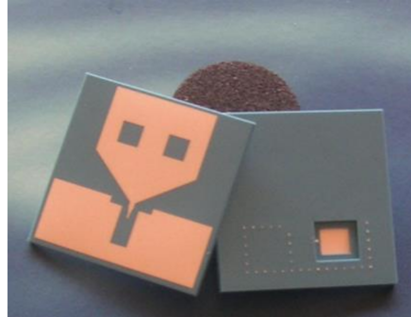
Abstract

AiP technology well balances performance, size, and cost. Hence, it has been widely adopted by chipmakers for highly-integrated radio and radar applications. Recently, scalable large AiPs and multiple small AiPs have been successfully demonstrated for base stations, mobile phones, and networked cars for 5G mobile networks at 28 GHz. Therefore, it is believed that AiP technology will cause fundamental changes in the design of antennas for mobile communications for 5G and beyond as well as Internet-of-Thing devices. This course is aimed at researchers and engineers carrying out work relating to the design of antennas for highly-integrated radio and radar systems.

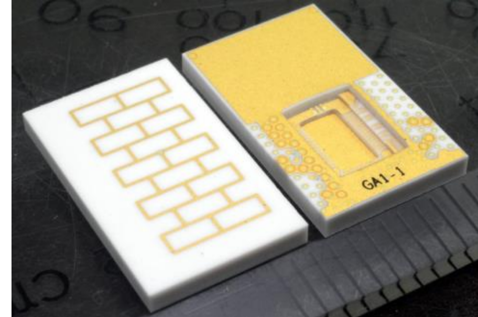
Graphical abstract



(a)For WLAN Radio



(b) For UWB Radio



(c) For 60-GHz Radio

Recommended prerequisites

The course requires a basic knowledge on Basic Antennas and Microwave Engineering.

Learning objectives

After the course the participant will be able to know how AiP technology has been developed, as we know it today. Understand the antennas specifically developed and the antennas widely adopted for AiP technology. Get to know materials and processes for high volume manufacturing of AiP. Get to know some fundamental about probe-based antenna measurement setups. Appreciate AiP examples developed for 5G New Radio, 60-GHz Gesture Radars, etc.

Course outline

1. An introduction to the trend of the design of radio and radar system on a chip (SoC) or in a package (SiP). This trend calls for novel antenna solutions.
2. A historical note on the early development of AiP technology. It will be pointed out that researchers in university labs devoted their efforts for Bluetooth radios at 2.4 GHz or other RF applications, while researchers in company labs for 60-GHz radios and other mmWave applications. At 2.4 GHz, a key challenge was how to miniaturize the antenna size, while at 60 GHz, it was how to minimize the interconnect loss between the die and antenna.
3. A coverage of antennas and packages, materials and processes, testing and characterization for AiP design. For antennas, it will include basic types, specifically developed, and those widely adopted such as microstrip patch, grid array, Yagi-Uda, and magneto-electric dipole. For packages, it will limit to leadless types such as ball grid array (BGA) and Quad Flat No Lead (QFN). For materials and processes, it will highlight low-temperature co-fired ceramic (LTCC), high density interconnect (HDI), and fan-out wafer level packaging (FOWLP). For testing and characterization, it will focus on probe-based measurement setup and testing method.
4. A description of performance improvement techniques of antennas for AiP technology.
5. Real AiP examples for various applications such as 5G New Radio and 60-GHz radio.

Instructor 1 – Biography

Yueping Zhang is a full Professor of Electronic Engineering with the School of Electrical and Electronic Engineering at Nanyang Technological University, Singapore, a Distinguished Lecturer of the IEEE Antennas and Propagation Society (IEEE AP-S), and a Fellow of IEEE. Prof Zhang was a Member of the Field Award Committee of the IEEE AP-S (2015-2017) and an Associate Editor of the IEEE Transactions on Antennas and Propagation (2010-2016). Prof Zhang has published numerous papers, including two invited papers in *the Proceedings of the IEEE* and one invited paper in *the IEEE Transactions on Antennas and Propagation*. He holds 7 US patents. He received the prestigious IEEE AP-S Sergei A. Schelkunoff Prize Paper Award in 2012. Prof Zhang has made pioneering and significant contributions to the development of AiP technology. His current research interests include the development of antenna-on-chip (AoC) technology and characterization of chip-scale propagation channels at terahertz for wireless chip area network (WCAN).

Key bibliography

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