**RF Industry Icon Podcast: Ajay Poddar**

Welcome to this episode of the RF Industry Icons podcast, I'm Pat Hindle and today I am talking with Ajay Poddar, Chief Scientist at Synergy Microwave, and also a Professor, Lecturer and IEEE Fellow. Welcome Ajay!

**Let's start with your early years, can you tell us about growing up in India and how you first developed an interest in science and technology? And, also your education and affiliations with Industry and Academic Institutions.**

I was born in India in a farmer's family. My birthplace Dhamdaha is remotely located in District-Purnia, State-Bihar, India, nearby the border of Nepal. During my childhood, I spent time with my grandparents, helped them in the agriculture fields, learned basic things about organic farming from my grandparents. I went to primary school in my village that was remotely located. In general, children studied in the open space because of the lack of proper classrooms and also no electricity at night. Life in remote villages was not easy as compared to city life in India, and there was a large gap in the standard of living. My parents encouraged me toward STEM education and also volunteering services for helping the local communities. I found working in the agriculture fields involved very hard work without proper tools and electricity needed for smart agriculture. I had a great desire to help underprivileged school students, therefore STEM education and engineering became my natural choice. I was motivated for scientific work by great scientists (Michael Faraday, Nikolay Tesla, Marie Curie, and others) who were struggling for basic things needed for life in their childhood, and also the life of Mother Teresa influenced me for volunteering service for humanity. I gradually developed an interest in science and technology intending to improve the quality of life of the underprivileged. While advancing in technology should establish its resolutions, unfortunately, there is a substantial portion of the population worldwide that does not have access to some of the basic stuff (food, clean water, electricity, internet, mobile phone, and others) that many of us take for granted. In my opinion, admission to these basic things to improve the quality of life is being considered as a "Human Right."

I would like to share my educational background and affiliations briefly. I am an IEEE Fellow, graduated in Electronics & Communication Engineering from NIT-C (National Institute of Technology Calicut), India; M. Tech (Master of Technology) from IIT-D (Indian Institute of Technology Delhi) India; Doctorate (Dr.-Ing.) from TUB (Technical University Berlin), Germany; Post Doctorate (Dr.-Ing. habil) from BTU (Brandenburg Technical University) Cottbus, Germany.

From 1991-to 2001, I have worked as a Senior Scientist in DRDO (Defense Research & Development Organization) in India. From 2001, I have been working as a Chief Scientist at Synergy Microwave Corp, New Jersey, USA; responsible for the design and development of signal generation and signal processing electronics for industry, medical and space applications. I am also serving as a visiting professor at Oradea University in Romania, the Indian Institute of Technology Jammu in India, a Guest lecturer at Technical University Munich in Germany; and a member of the advisory committee in several academic institutions.

**You went to IIT in Delhi, India for your studies, what were your interests at that time?**

I went to IIT for my graduate study. During that time I used to read the newspapers, highlighting casualties caused by landmines in different parts of the world. Landmines and

explosive remnants of war victims occur in every region of the world, causing a large number of sufferers and injuries to both humans and animals. Landmines are rarely removed, and new mines are being laid under the soil and water in the region as and when conflict begins. Agrarians, wanderers, herders and animals are the ones who suffer most from the arbitrary use of landmines. Mine clearance practice is costly and also not free from fatalities. These issues led to my interest in studying electronic detection and know-how for accident-free disposal of mines. Microwave electronics, RADAR, Signal Generation and signal processing electronics are pre-requisite studies for the development of sensors for landmine detections. I was very lucky and fortunate to be supervised and guided by my honorable teacher Prof. (Ms.) Bharathi Bhat now retired from IIT Delhi, India. She was different, actively involved in mentoring the young generations; and her teaching helped many graduate students to gain deeper insights into the life cycle and understand electronics and microwave engineering to address the environmental and humanitarian issues. During my Graduate Engineering Program in IIT Delhi, she motivated me to focus on affordable Engineering Technology (biomedical electronics, RADAR, and wireless communication) for offsetting poverty and hunger and promoting clean water and sanitation, climate action, affordable and clean energy, human well-being, economic growth and responsible consumption and production. History has revealed that transformative technology improves the standard of living, progresses the quality of life, and stimulates coordination and agreement. However, new technologies also can undermine hope and destroy the ecosystem of our Planet Earth if not used appropriately. For example, increased levels of air and water pollution, energy consumption in terms of their production, and associated electronic waste cause issues of systematic long-term risk. The use of new technologies would be a good vehicle for sustainable development but they also raise thought-provoking questions.

**You worked at the Defense Research and Development Organization of India working on many scientific projects, including the design of a Ka- and X-band RADAR, what experiences did you have there and what was the most interesting project you worked on?**

Well, I have worked on several scientific projects at the Defense Research and Development Organization of India. As I said that my fundamental instinct was to learn science and technology and look for the opportunity to apply for the benefit of humanity. Historically, all the important science and engineering projects begin for military application at Defense Establishments and later applied for commercial applications. For example, Internet, the ARPANET was established by the Advanced Research Projects Agency (ARPA) of Unites States Department of Defense, building on the ideas of J. C. R. Licklider, Bob Taylor initiated the ARPANET project in 1966 to enable access to remote computers.

The opportunity of working on the RADAR projects helped me in designing the signal generation and signal processing electronics for Transmitter/Receiver modules for defense, industrial, aerospace and medical applications. The most interesting project was FM-CW RADAR-based sensors for several applications that include humanitarian applications. To name a few, 35/64/94 GHz Proximity Sensors Projects, RF MEMS, and MetaMobius coupled strips for antennas and resonator applications, and signal processing electronics.

**For your Ph.D., you attended TUB in Germany – why did you decide to leave to go there instead of staying in India?**

During 1990, India was lacking foundry support for developing the integrated chip solutions for emerging RF MEMS technology and peripheral electronic modules to support technology-driven products. I left India for pursuing higher study and also the opportunity for working in a company that provides the freedom of research work not limited to commercial applications but also scientific contributions, targeting humanitarian applications.

**Is there where you met Ulrich Rohde and how did you decide to come to the US and work at Synergy Microwave?**

I read Dr. Rohde's PLL Synthesizer book during my undergrad study 1986-1990 and was following his research areas on signal generation and signal processing electronics. If I remember correctly, Prof. D. Sundararajan convinced me to join Synergy Microwave. Prof. Sundararajan, Prof. Rohde, and I published several papers on Mobius-Strips and applications in signal generation and signal processing electronics. Sadly, Prof. Sundararajan passed away untimely in 2014, he is dearly missed. The scientific journey in Synergy Microwave has been very rewarding. Dr. Rohde and I have worked on several research projects that include DARPA and SBIR Projects in the last 20 plus years, published jointly 250 plus scientific papers in journals and international conferences, over two dozen patents, and co-authored three technical books, and five books are under contract with Wiley and other publishers.

**You have done some revolutionary work at Synergy, the first that comes to mind is the Mobius metamaterial-inspired energy-efficient electronic circuits and Synergy recently released Mobius Coupled Dielectric Resonator Oscillators to the market as a result – what inspired you to research this area, and what advantages does this technology have for oscillators?**

My Post Doctorate research work was based on Mobius metamaterial-inspired energy-efficient electronic circuits for applications in signal generation and signal processing electronics. Dielectric Resonators (DRs), for example, exhibit a high quality (Q) factor and have been used in high spectral-purity signal sources at RF and microwave frequencies. However, the DR requires precise machining for fabrication, careful placement of the dielectric puck for optimal coupling, and involves manual mechanical tuning of the DR for desired frequency operation. The Mobius metamaterial-inspired Dielectric Resonator allows ease in fabrication, reduction in size, improved Figure of Merit (FOM), and low cost power-efficient signal source solutions. The Mobius metamaterial-inspired DROs developed by Synergy Microwave are used widely in military and commercial applications, including wireless LAN and other communications systems, test and measurement, electronic warfare, missile, radar and medical electronics.

The current and emerging markets demand high-performance tunable signal sources at X-band and Ka-band frequencies. I have worked on voltage-controlled oscillators with a wide tuning range and low phase noise which is needed to support 5G and IoT, with operating frequencies up to 60 GHz and more. The patented oscillator design using metamaterial to obtain high Q resonators and the use of the Mobius Loop as a way to tune the frequency has proven to be very effective as the frequency increases. More recently, my contributions on "metamaterial-Inspired Mobius Resonator loop, MIMO Antenna, RF MEMS Electronics, Opto-Electronics and Casimir force of interactions" are a consequence of my Doctorate research working with Dr. Ulrich Rohde-Synergy Microwave, Dr. Tatsuo Itoh-University of California, Los Angles (UCLA), Dr. Afshin Daryoush-Drexel University, and Dr. Shiban Koul-IIT Delhi. Dr. Rohde

and I worked on these new technologies for the applications in current and later generation electronics and communication systems. These state-of-the-art technologies are developed in collaboration with IIT Delhi, India; Drexel University, USA and UCLA, USA; and patented for securing the IP rights in favor of Synergy Microwave.

**You also worked on electro-optical oscillators, how are those architected differently from traditional oscillators, and what advantages does that technology offer?**

Electro-Optical Oscillator offers significant advantages brought by photonics technology, such as high frequency, large bandwidth and immunity to electromagnetic interference. With the rapid development of low-loss optical fiber, high-quality-factor optical resonator cavity, and photonic integration technologies, integrated tunable mmWave electro-optical oscillator is feasible in a compact size and low power consumption. The operating frequency can be extended as high as 100 GHz, and these features are very promising, which otherwise was not possible with traditional microwave resonator oscillators. The technology offers reliable frequency sources for various practical applications, such as communication links, signal processing, RADAR, metrology, radio astronomy and reference clock distribution.

**You also developed some very intriguing MEMS switch technologies, what work did you do in this area, and how does that benefit MEMS devices?**

Micro-Electromechanical-systems (MEMS) technology provides a greatly reduced footprint and lower insertion loss compared to electromechanical switches. Innovations in this area are enabling higher frequencies and broader bandwidths than previously possible. The research and development effort was to overcome the stiction issues of the MEMS contact switches and improve the reliability. The development effort targets the use of defective ground structure (DGS) with secondary switches and metamaterial-inspired capacitive contacts to improve MEMS switch performance into the 100+GHz range with lower insertion loss and greater isolation than previous designs. In addition, using the new patented design techniques, the reliability has been improved by designing a new configuration to take advantage of the repulsive Casimir forces to reduce stiction.

We have patented the technology, reported three part articles on this topic in Microwave Journal and e-book, part 1 reports on MEMS switch topologies including a new DGS and metamaterial-inspired capacitive contact MEMS switch; part 2 reports methods to reduce stiction effects in resistive contact MEMS switch, and part 3 discusses methods to reduce static friction (or stiction) effects in a capacitive contact MEMS switch for applications in modern electronic circuits and 5G communications.

**You volunteer extensively in IEEE activities on the MTT-S AdCom, AP-S AdCom, Section Chair and Global Chair of AP-S Chapter Activity Committee, plus are involved in the IEEE SIGHT (Special Interest Group on Humanitarian Technology) and IEEE HAC (Humanitarian Activity Committee). Can you tell us about that work?**

During my initial career as a Scientist in DRDO, India from 1991-to 2001; I was fortunate to work for the honorable President of India Dr. Abdul Kalam, who was not only a great scientist, but a mentor, reformer and a noble person. Under his leadership in the role of Director of DRDO and Scientific Advisor to the Indian Government, Indian scientists developed many

successful projects on a limited budget and in record time. In addition to Defense Projects, Dr. Kalam was involved in many humanitarian technology projects, made untiring efforts to engage, collaborate and establish a partnership with industries, research establishments and academic institutions for affordable solutions. Dr. Kalam has encouraged me and many young scientists for joining IEEE for professional and volunteering activities. He passed away on July 27, 2015, but his guidance for advancing technology for humanity will remain in my consciousness forever. IEEE's tagline, "advancing technology for humanity," stimulates us to proceed in a direction to invent the technology and apply those to decipher basic needs found in the underserved regions of the world. IEEE is a truly global professional society with the intended goal to leverage engineering expertise and know-how toward promoting global development. I have served as an AdCom member of multiple IEEE societies, member and Chair of several IEEE global committees, including SIGHT (Special Interest Group on Humanitarian Technology) and HAC. I have been involved in humanitarian activities preceding the creation of IEEE SIGHT. Nevertheless, IEEE SIGHT offered me a global platform to transfigure know-how into sustainable humanitarian projects. This is a fundamental differentiation as equated to any other initiatives that eventually augment my volunteering services to the professional society. I have experienced and realized the empowerment of volunteerism, we are not perfect and have flaws, but each has our positive attributes that together can make a difference by contributing toward advancing technology for humanity. These volunteering services allowed me to serve members and the professional community worldwide. In my opinion, IEEE SIGHT/HAC Is a road map that enables volunteering forces to work together to arrive at a sustainable approach for advancing technology to make our planet a better place to live in for all of us. Additionally, attending underserved communities is a kind of deploying the prevailing technology to address humanitarian challenges and civic concerns. One can explore low cost affordable existing technology solutions to improve the quality of life; however, lack of mindfulness and monetary lucrativeness in these regions can slow down the dissemination of the existing expertise and know-how. To overcome this, continuing education and training programs for the local community can be effective if organized jointly with IEEE Local sections, UNESCO, UN and WHO.

**What future technologies are you most excited about and why?**

The current (5G) and later generation (6G plus) will enterprise the technological innovation and affordable engineering solutions to attain reliable connectivity worldwide. I am enthusiastic about some technologies (high frequency signal generation and signal processing electronics, network operating at the THz band with broader spectrum resources, artificial intelligence and machine learning, virtual reality and augmented reality, internet of things, blockchain, cybersecurity, CubeSats, sensors, edge computing, quantum computing, and MIMO networks), which will create more job opportunities. I am currently working on these technologies to fulfill the commercially viable solutions for 5G and emerging technology, also filed the patent applications: (1) Optoelectronic oscillator using monolithically integrated multi-quantum well Laser and Phase Modulator, (2) Conformal Antenna Module With 3D-Printed Radome, (3) Broadband metamaterial Enabled Electromagnetic Absorbers and Polarization Converters, (4) Tunable Bandpass Filter For Millimeter-Wave Signals, (5) Planar Multiband Frequency Selective Surfaces With Stable Filter Response, (6) 5G MIMO Antenna Array With Reduced Mutual Coupling, and (7) Microelectromechanical Switch With

metamaterial Contacts, (8) Four Port MIMO Antenna, (9) Four Port MIMO Antenna without Isolating Structure.

Thank you, Ajay for taking the time to talk with me today and share your experiences and stories with us. You are truly an RF Industry Icon with all of your revolutionary work in RF and microwave design in addition to your work with universities and the IEEE to improve society. For our listeners, please check out our other podcasts and future episodes of RF Industry Icons at podcasts.microwavejournal.com. Thanks for listening.