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PEOPLE WHO MADE IT HAPPEN

PAUL KHANNA | *www.phasematrix.com*

For more than 25 years, Paul Khanna has helped to advance signal generation in the microwave and wireless industry—and he continues that pioneering work today.

From DROs to YIGs and beyond, **DR. AMARPAL ("PAUL") KHANNA** *has made lasting contributions to the microwave & RF community—and he continues on that path today.*

THE PROFESSIONAL CAREER OF DR. Amarpal ("Paul") Khanna, IEEE Fellow and Phase Matrix, Inc.'s Vice President of Components, spans more than 25 years. His contributions have greatly advanced signal generation within the microwave and wireless industry. His most outstanding contributions are in the area of miniature, stabilized microwave oscillators.

Khanna's pioneering work with dielectric resonator oscillators (DROs) is recognized by most everyone in the field today. DROs are frequently used in communications systems and electronic-warfare (EW) applications because they are compact, rugged, and exhibit low phase noise. In the early 1980s, Khanna introduced two- and three-port oscillators using field-effect transistors (FETs) and dielectric resonators. This new technology enabled the proliferation of multi-output-port oscillator designs. Furthermore, Khanna developed new measurement methods for DROs and a plethora of practical design techniques.

In the late 1980s, Khanna invented a new class of oscillators that is utilized in both voltage-controlled oscillators (VCOs) and DROs. In this new technology, oscillations are switched on and off without affecting device bias conditions by quenching negative resistance with a PIN diode. This approach makes possible the design of fast-switching, fast-settling, spurious-free, wideband multi-oscillator assemblies. This ingenious "quenching" oscillator technology was key to the success of a major US military program that is still in use today.

One is tempted to refer to Khanna as "Dr. DRO"–although he could easily be called "Mr. YIG" as well. He completed a thorough investigation of wideband sources for network analyzers that resulted in the delivery of 2 to 22 GHz from a single source as well as 18 to 40 GHz from a single source that exhibited excellent phase noise and linearity. To this day, his are the best results reported using a single yttrium-iron-garnet (YIG) sphere and single transistor. His work led to the availability of instruments that are commonly found on most engineering benches, "which is a significant contribution to the microwave industry," explains Phase Matrix's General Manager, Pete Pragastis.

While at Hewlett Packard in the early 1990s, Khanna's team was the first to develop silicon bipolar transistors and gallium-arsenide (GaAs) monolithic-microwave-integrated-circuit (MMIC) -based MIC hybrid modules for millimeter-wave digital microwave radios. These replaced Gunn oscillator technology, providing an enhanced solution for the backhaul infrastructure of the fast-growing cell-phone industry at that time.

During his time at Agilent in the early 2000s, Khanna's work with high-speed clocks—a critical component in high-speed networks for optical communications for high-speed backbone communications—helped the industry meet the demand for faster communications networks. Khanna and his team made available high-performance, low-jitter clock modules capable of 40 Gb/s.

More recently, Khanna has participated in the intense oscilloscope-speed competition that is taking place between major oscilloscope manufacturers. At the heart of the LeCroy 30-, 36-, and 45-GHz real-time oscilloscopes is technology that was quickly developed by his team to leap ahead of the competition. Khanna introduced unique techniques for signal generation and diplexers that enabled these state-of-the-art oscilloscopes. Developed under his leadership, these front-end sub-assemblies represent the critical part of the world's highest-bandwidth, real-time DBI-based oscilloscopes. In terms of frequency, it is anyone's guess how high Khanna will help to take these oscilloscopes so that they can stay ahead of the pack.

Though Khanna's too-numerous-to-mention microwave technological contributions bewilder most, he further amazes the industry by generously sharing his knowledge. He serves as an adjunct professor at the University of Santa Clara in California. According to a former student of his, Irfan Ashiq, "Dr. Khanna not only presents the perfect mix of theory and practical application regarding microwave measurements–he also takes a sincere interest in our career paths and connections." Khanna has written more than 50 technical articles that have appeared in national and international publications. He has co-authored six textbooks as well.

In 1985, the United Nations invited Khanna to provide technical guidance to the Brazilian microwave community as a technical expert on DROs. He also continually serves the IEEE Microwave Theory and Techniques Society (MTT-S) in various capacities, including as past Chair of a local chapter, Founder-Chair of IEEE MTT Technical Committee on Frequency Generation and Conversion Technology, and as a member of the editorial board of several IEEE MTT publications. He has been involved with MTT-S's International Microwave Symposia (IMS) throughout the years in leadership positions. He was Technical Program Co-Chair for IMS 2006 in San Francisco and has been named to lead the IMS 2016 as General Chair.

Perhaps the most distinguishing moment for Khanna was being named a fellow of the IEEE in 2008. He was awarded this rank "for contributions to the design and measurement techniques of microwave oscillators," according to a January 23, 2008 press release issued by Phase Matrix. The release also noted that "the IEEE recognizes 'unusual distinction' and 'important individual contributions' to engineering and [the distinction] can be conferred 'only by invitation of the Board of Directors upon a person of outstanding and extraordinary qualifications and experience.'"

Khanna earned his Ph.D. in microwave and optical communications from the University of Limoges in France and a B.S. from Punjab Engineering College in India. He holds five US patents and two patents in France. He has led engineering teams at Avantek, Hewlett Packard, Agilent Technologies, and Celeritek. Khanna is Vice President of Components and Sub-Assemblies at Phase Matrix, a National Instruments Co., where he is responsible for microwave and millimeter-wave products based on state-of-the-art technology. Khanna's contributions to the microwave industry truly have been invaluable.