Starting as a niche technology, applicable mainly to military and space-based systems, MMICs based on compound semiconductors, such as Gallium Arsenide (GaAs), have evolved into a mature technology for many RF and microwave applications. Successful MMIC developments as implemented in the X-band Active Phased Array Radar (APAR) have made TNO a world leader in this field. Since a few years TNO operates as a fabless supplier of MMICs and related Front-End modules.

TNO Defence, Security and Safety has extensive experience on modern radar systems and on the design of miniaturised microwave front-ends and antennas. All development activities are covered, from system specification to product engineering and testing, all in close cooperation with customers.

TNO works for civil, governmental and military customers and can make effective use of "dual use", "spin in" and "spin off" opportunities. Main military customers are the Royal Netherlands Forces, the Netherlands Ministry of Defence, national and international defence industries, NATO and government agencies. The civil customers range from small national companies to international industries. Examples of customers and research partners are Thales, Philips, Alcatel, ASTRON, United Monolithic Semiconductors (UMS), Mimix ASIA Inc., EADS Astrium, Fraunhofer IAF, FOI and Dutch and other European universities.

TNO has developed MMICs for applications ranging from 1 to 67 GHz. Successful implementations can be found in the X-Band Active Phased Array Radar (APAR), in production by Thales Netherlands, in the L-band Synthetic Aperture Radar (SAR) satellite system, developed by Astrium and in many European and ESA research projects. Recently, MMICs designed by TNO have been included in the catalogue of Mimix ASIA Inc., such as an X-band high power and driver amplifier, phase shifter, attenuator and multifunction chip.

As independent and fabless research organization TNO has established a close cooperation with most European and other worldwide foundries, such as UMS, OMMIC, Austriamicrosystems (AMS) and WiN Semiconductors. As such TNO has acquired a profound knowledge of existing processes and technologies such as MESFET, PHEMT, MHETF and HBT in GaAs, SiGe, GaN and SiC.

The combination of many years of design experience, in-house expertise of the systems
Defence, Security and Safety

MMIC Technology

and applications and the availability of state-of-the-art measurement facilities make TNO leading in the field of MMIC technology.

Main specialities include:
- working with non-released, experimental technologies
- technology characterization and device modelling
- feasibility studies
- full-custom MMIC design according to customer specifications
- High Power Amplifiers from S- to Ka-Band
- Multi Function Chips and Vector Modulators
- integrated front-end chips for (phased array) radar systems
- measurement services (active loadpull up to 20 GHz and small-signal up to 67 GHz)

Design examples

X-band Multi Function Chip, for phased array radar T/R modules, including an LNA, output driver, 6 bit phase shifter, 5 bit attenuator, T/R switches and a CMOS compatible digital I/O interface, developed in UMS PHEMT technology.

X-band High Power Amplifier, marketed by Mimix ASIA Inc. as XP1006, developed in WIN Semiconductor technology, 8.5 – 11 GHz 40 dBm saturated output power with 21 dB large signal gain.

X-band LNA designed in GaN technology as part of a European research project. The main feature of this design is the robustness and survivability against high input powers.

X-band FMCW radar frontend chip, design in IHP 0.25µm SiGe technology, consisting of an integrated LNA, PA and up/down conversion mixers.

TNO Defence, Security and Safety provides innovative contributions to the advance of comprehensive security and is a strategic partner of the Dutch Ministry of Defence to build up the defence knowledge-base. We employ our acquired knowledge for and together with contractors.

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