A Solid-State C-Band FMCW Sensor System for Precipitation Measurement

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In this paper the development of an innovative low cost scanning radar system for areal rainfall measurements is presented. The overall objective of the MARG (Microwave Areal Rain Gauge) project is to develop a reliable and accurate rainfall measurement system tailored to the needs of the end-user, providing exceptional accuracy and short measurement cycles in an optimized range for localised measurement of rain intensity and its spatial distribution.

The radar frontend is based on solid state microwave technology and utilizes frequency modulated continuous wave (FMCW) operation in C-band. The use of C-band frequencies avoids signal blocking due to attenuation even in strong precipitation events; therefore an operational range of up to 30 km with a range resolution of 50 meters can be achieved. The RF output power of 20 watts (continuous wave) is provided by a state-of-the-art solid state power amplifier build in GaN-pHEMT technology operating at a power added efficiency of around 35%. The radar signal generation and the processing are done in the digital domain. The digital radar processing module is based on a field-programmable gate array with integrated CPU and DSP capabilities and high speed DAC and ADC interfaces. It further implements programmable waveform generation, direct IF processing with digital up and down conversion and FFT signal processing implemented in hardware. Furthermore a complete software stack including an operating system with standard network connection is available.

The developed radar software generates both reflectivity and Doppler fields, and includes clutter filtering capabilities. The rainfall estimation is done with adjustable parameters and uses different algorithms for mean bias correction, range correction and interpolation with rain-gauge networks. Additionally calibration with a connected disdrometer is possible. Rainfall data and derived products, e.g. rainfall accumulation maps, can be provided to the users via web services in a separate MARG user-centre module.