The following discussion illustrates the 482 MHz instruments used in the operational network of the DWD.

A block diagram of the general hardware architecture is given in Fig. Radar_Block. The central unit is the radar controller, which uses a highly stable coherent oscillator as the single reference for all signals. It generates all control signals needed to operate the radar through Direct Digital Synthesis (DDS). The electromagnetic pulse to be transmitted is created by a waveform generator which acts essentially as an amplitude and phase modulator. After a frequency up-conversion and amplification (through a linear power amplifier), the transmit signal is delivered to the antenna and the resulting electromagnetic wave is radiated into free space. As the same antenna is also used for signal reception, a duplexer is necessary to protect the sensitive receiver electronics from the strong transmit signal. It is comprised of a ferrite circulator and additional receiver protecting limiters.

The antenna is a phased array comprised of coaxial-collinear (CoCo) elements, e.g. Balsley and Ecklund (1972). A relay-switched true-time delay phase shifting unit generates the necessary phasing of the individual elements required to steer the beam in three fixed directions for each CoCo sub-array. For the five-beam pointing configuration two such CoCo sub-arrays are combined. Due to the finite extent of the antenna array, the beam can not be made infinitely narrow. This results in unwanted radiation through so-called sidelobes in other than the boresight direction and can be visualized through the antenna radiation pattern, which shows the distribution of the total radiated power P as a function of spherical antenna coordinates θ and ϕ. Fig. radiation_pattern shows the ideal radiation pattern for the DWD 482 MHz network wind profiler calculated with the method of Law et.al. (1997). Note that the sidelobe level will be somewhat more irregular and higher in reality because of stochastic excitation differences of array elements due to hardware imperfections.

The receiver is of the classical superheterodyne type. A rather broadband low-noise amplifier with an excellent noise-figure is necessary to raise the signal level of the weak atmospheric return for further processing. After frequency down-conversion to an intermediate frequency (IF), the signal is bandpass-filtered, demodulated and A/D converted for further digital processing in the radar processor. To maximize the per-pulse signal-to-noise ratio (SNR) for optimal signal detection, the bandwidth of the bandpass filter is matched to the transmitted pulse, see Doviak and Zrnic (1978). Actual technical implementations differ, for example the received signal can be digitized either at IF (so called digital IF receivers) or at base-band, after further analog down-conversion by a quadrature detector (analog receiver).

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