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Accurate Calibration Approaches for an X-Band Polarimetric Weather Radar

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Turkey's first transportable X-Band Polarimetric Weather Radar has been designed and manufactured by Remote Sensing Technologies Corporation (RST). Since the radar has a polarimetric ability, the accurate full path calibration was an essential goal of the design for both transmit and receive paths. This feature is rare in commercially available radars. It should be noted that the radar has two parallel channels with horizontal and vertical alignment in order to transmit dual polarized and calculate meteorological information such as differential reflectivity (Zdr) from received powers. The imbalance between horizontal and vertical channel must be corrected within the operation for accurate Zdr calculation for both transmit and receive paths. The reasons for imbalance are various imperfections of the RF components, unequal power division of the transmitter path, gain variations on different down-converter paths etc. Two stages calibration has been performed in the X-Band Polarimetric Weather Radar for accurate calibration and elimination of imbalance in horizontal and vertical channels for both transmit and receive paths. The first one is performed by an X-band synthesizer. The second stage is sun calibration. Details of these two are explained below.

An X-band synthesizer designed by the RST is used as calibration source. It can be tuned automatically in 100 kHz steps throughout the channel. An integrated power meter measures the output power of the calibration source using directional coupler at output of the calibration source. Then, output power at through port of the coupler is divided by two and injected to both horizontal and vertical channels with directional couplers. These couplers protect the transmitter and calibration source from each other. Both receive and transmit paths have the same active and passive components except down-converters at the receive path. When the calibration mode is activated, calibration signals pass through the active and passive components in both channels. Also the signals pass through low noise amplifier and then down-converter stage, that is designed by RST to achieve high dynamic range at the receive path. The overall gain of the down-converters in both paths are not the same due to component imperfections, soldering, electronic noise etc. The down-converted IF signals are digitized with ADC’s for both channels and the obtained data is sent to digital signal processor for further calibration processing. It is considered that not only the RF and baseband parts may cause imbalance in two paths, but also ADC imperfections can have an effect. Digital signal processing stage considers all these imbalance contributions including integrated power meter readings at X-Band and calculates power and phase imbalance of two channels. This calibration is activated periodically, because changes in temperature, aging etc. cause change in component characteristics. As a result the accurate calibration of the hardware is done for polarimetric transmit and receive paths except the antenna. The antenna gain for the horizontal and vertical channels may be different, and also the orthomode transducer may translate channels to horizontal and vertical with different power levels. Therefore, sun calibration is used to correct antenna orthogonal channel and orthomode transducer channel imbalances. However, sun calibration is not required to be performed with same period as done for other hardware. Antenna ports and orthomode transducer are waveguide components and they are not much sensitive to temperature changes as active components. Accurate calibration procedures are successfully performed for RST X-Band Polarimetric Radar and the differential reflectivity is corrected by performing the calibration stages with specified periods.