An In-Situ Measurement System Using Downconversion

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Due to the recent auctioning of the 24 GHz frequency band for use in fifth-generation (5G) wireless communications many weather forecasters fear that the interference from 5G transmitters could negatively affect the ability to accurately predict the weather. This is because of the weather radiometers that passively operate within the 23.6-24.0 GHz range and the 50-58 GHz range, which are susceptible to out of band and harmonic emissions from the 5G transmitters. This could potentially result in a significant delay in accurate weather forecasting (E. Niller, "5g networks could throw weather forecasting into chaos," 2019. [Online].) which would heavily impact the ability for weather forecasters to properly warn others and begin emergency procedures for weather events such as tornadoes and hurricanes in a timely manner.

In order to reduce the out of band interference that the 23.6-24.0 GHz and 50-58 GHz radiometers face from 5G transmitters a brokering system can be used to coordinate the 5G transmission with radiometer measurements. To respond to the brokering system effectively the 5G system should make use of reconfigurable technology including impedance tuners at the output of power amplifiers to maintain performance while adapting. However, using impedance tuners to adjust the output of the power amplifiers in each element of the 5G array will result in varied distortions that will result in massive changes in the transmission pattern of the system. To counteract this in real-time, the system can implement an in-situ approach that has been developed and showcased in a recent journal paper (A. C. Goad, C. Baylis, T. Van Hoosier, A. Egbert and R. J. Marks, "In Situ RF Current Assessment for Array Transmission and Optimization," in *IEEE Transactions on Microwave Theory and Techniques*, doi: 10.1109/TMTT.2023.3298193.). By using this in-situ method, coupled voltage measurements are used to determine the current presented to each antenna element, when combined with an array antenna characterization, allowing users to determine the array transmission pattern and adapt their input signals to produce the desired transmissions while the system is operating.

Given the limitations of acquiring hardware and measurement equipment to accurately perform this measurement on a 24 GHz array, the measured signals must be downconverted to a lower frequency with readily available measurement equipment. In order to use this measurement method for a 5G application, the system integrates downconversion circuitry with the high frequency coupler to bring the in-situ measurement frequency from the 24 GHz range down to near baseband (< 1 GHz). The measurement can then be performed with widely available low frequency voltage measurement equipment, either in a laboratory setting using an oscilloscope or network analyzer, or on an integrated system using direct sampling analog-to-digital converters.