## Aspects of Analog Receiver Errors with Applications to Digital Beam Forming Systems

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Due to recent advancements in the development of miniature high performance receivers, digital beam forming (DBF) is now being more commonly utilized in modern radar and communication systems. With its potential for significantly increased flexibility as compared to its analog counterpart, DBF is being increasingly utilized to perform critical functions, including beam forming and jammer cancellation. Key to the realization of the full potential of DBF is the accurate sampling of the signals incident at the aperture of the antenna system. Correlated errors not historically considered with centralized analog architectures- a key difference between analog and digital beam forming- are often important for DBF systems as they utilize parallel distributed receivers. This paper examines the results of the investigation of several types of analog receiver systems, subsystems, and component level errors. These results show that given prior knowledge of certain errors, including amplitude ripple in the receiver transfer function, and IQ imbalance, the impact of each can be mitigated. This paper also reviews the impact that non-linear component distortions may have on DBF systems with respect to in-band frequencies amplitude distortions that cannot be removed.

In this paper, several types of analog receiver errors which may occur at the system, subsystem and/or component levels are considered. A summary of relevant background information is provided which includes a discussion of fundamental errors to consider in developing and utilizing DBF systems. The goal is to develop an understanding of analog receiver errors in order to expand upon this understanding as part of future research, and to obtain physical insight into their potential impact on system performance.

A MATLAB simulation of a DBF system is presented, with a focus on demonstrating the potential impact of distributed receiver errors on adaptive beam forming for jammer cancellation. A quadrature receiver signal model which includes amplitude errors and IQ imbalance is developed and used to demonstrate the generation and impact of time side lobes (TSLs) and Doppler performance on DBF systems. Finally, errors originating from non-linear receiver components including low-noise amplifiers and mixers will be investigated. It will be shown that in certain instances signal distortion from non-linear components can lead to erroneous beam forming which can only be avoided through careful system design and/or the implementation of highly specialized mitigation techniques.