

## Measurement of a Four Channel Analog Beamformer for Anti-jam GPS Applications

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GPS signal characteristics are well known for use in private and commercial applications. Because of this, malicious actors may jam GPS receivers with RF interference, denying position, navigation, and timing data to users. Jamming may be mitigated by the use of a controlled reception pattern antenna (CRPA) which places pattern nulls in the direction of incoming jammers. This is accomplished by taking a weighted summation of the output of multiple antenna elements. Complex valued weights may be applied digitally or with hardware to change the magnitudes and phases of each CRPA channel. The weights may be determined through an iterative algorithm, such as Frost's algorithm (O.L. Frost, Proc. IEEE, 1972, pp. 926-935), which dynamically minimizes received power subject to given constraints. In addition to spatial diversity, antenna polarization can be exploited to cancel interference of linear-polarized (LP) jammers while maintaining gain for circular-polarized (CP) GPS signals.

In our measurements, four antenna channels are used in three different CRPA configurations: dual-linear antennas with an LP reference antenna, dual-linear antennas with a synthesized CP reference, and CP antenna elements. Weights may be generated in either the time-domain or the phasor-domain. Phasor-domain weights are generated with individual element patterns for a given direction using power inversion, whereas time-domain weights are generated with stored time samples through the use of Frost's algorithm. Complex valued weights are applied to the CRPA using eight-bit digital phase shifters and seven bit attenuators, and the CRPA reception pattern is measured in an anechoic chamber. Measured patterns for three CRPA configurations will be presented alongside patterns simulated using full-wave electromagnetic modeling software, and comparisons will be made between time-domain and phasor-domain weights, and between jammer suppression measured by the reception pattern versus measured from weighted time samples.