1. ABSTRACT

The Spectrum Efficient National Surveillance Radar (SENSR) program is exploring the feasibility of combining the functions of multiple national aircraft and weather surveillance radar networks into a single network of polarimetric phased array radar (PPAR) systems. One of the main challenges on this path is the use of PPAR for weather observations. In planar PPAR, this is due to the fact that the array copolar and cross-polar patterns vary with beam steering resulting in significant cross coupling between the horizontal (H) and vertical (V) channels. One proposed cross coupling mitigation technique is a 180° pulse-to-pulse phase change of signals injected in either the H or V ports of the transmission elements. Herein, this technique is evaluated using a ten-panel dual-polarization phased-array mobile demonstration system (referred to as the Ten Panel Demonstrator or TPD). This system has been developed by the MIT Lincoln Laboratory and is operated by the National Severe Storms Laboratory (NSSL).

2. THEORY

Received signal in the simultaneous transmit and simultaneous receive (STSR) mode from the m-th transmission can be represented as:

\[ V'_m(m) = V'^{CO}_m(m) + V'^{X}_m(m) + V'^{XPC}_m(m) \]  
(1)

\[ c \] horizontal (H) or vertical (V) channel

\[ V'^{CO}_m(m) \] - copolar signal

\[ V'^{X}_m(m) \] - cross-polar signal not affected by phase codes

\[ V'^{XPC}_m(m) \] - cross-polar signal affected by phase codes

The estimated received power from M pulses is

\[ \frac{1}{M} \sum m \left[ k(m) \right] + \frac{1}{M} \sum m \left[ V'^{CO}_m(m) + V'^{X}_m(m) \right] + \frac{2}{M} \sum m \text{Re} \left[ \left( V'^{CO}_m(m) + V'^{X}_m(m) \right) \right] V'^{XPC}_m(m) + \frac{1}{M} \sum m \left[ V'^{XPC}_m(m) \right] \]  
(2)

In (2), the expected value of the second sum is zero. In spectral domain, the third sum is shifted by the unambiguous velocity with respect to the first sum. If sufficiently separated, it may be removed via filtering. If this component is not removed, it may cause the bias in spectrum width estimates.

3. THE TEN PANEL DEMONSTRATOR

4. BEAM STEERING 7° OFF PRINCIPAL PLANE AT VERTICAL INCIDENCE (BIRD BATH)

5. BEAM STEERING 15° OFF PRINCIPAL PLANE AT VERTICAL INCIDENCE (BIRD BATH)

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