Problem:
Radar Reflectivity Factor ($Z$) is most commonly calculated from noise subtracted power (NSP) measurements. Low peak power solid state radars often average many hundreds or even thousands of samples to boost sensitivity, thereby extending the signal power measurement range 10 to 20 dB below the receiver noise floor. As a result, a significant portion of the measurements are made well below unity SNR, where to avoid large errors in the estimated signal power, the required noise component measurement accuracy can be difficult to achieve. For example, when integrating 2000 pulses, signals that are 10 dB below the noise level can be detected with a high probability of detection (>90%) at a false alarm rate of 0.01. However, at this low SNR level, a ±0.25 dB error in the estimated noise component introduces approximately +2 to -4 dB error in the calculated signal power.

Coherent Power:
The Coherent Power (CP) technique is an alternative method for measuring the radar received signal power without the need for estimating the noise power. CP can be implemented with dual-polarized radars operating in simultaneous transmit and receive (STAR) mode by computing the lag-0 cross correlation magnitude, aka copolar power (Keranen and Chandrasekar 2014), or using time delayed CP by computing the lag-1 autocorrelation magnitude. The time delayed CP estimate is the magnitude of the autocorrelation function at lag $mT_s$:

$$P_{cc} = \frac{1}{N} \sum_{k=0}^{N-1} V^*(k)V(k+m),$$

where $V(k)$ is the complex voltage sample, consisting of the zero mean Gaussian $I$ and $Q$ signal and noise components:

$$V(k) = i_s(k) + jQ_s(k) + i_n(k) + jQ_n(k).$$

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