Radar Emissions and Their Detection: A Tutorial

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Abstract. Radar transmitters produce signals that are uniquely different from those generated by most communication systems. Significant among these differences are: Radar emissions are typically pulsed at duty cycles of about 0.1%, whereas communication signals have high duty cycles often approaching 100%; radar emissions are not channelized; radar effective isotropic radiated power (EIRP) levels are often very high, on the order of a gigawatt or more; radar beam scanning causes emissions received at any given location to occur in intermittent bursts; and radar out-of-band and spurious emissions are subject to different physical and legal limitations than communication signals. With emphasis being placed upon a variety of spectrum-efficiency and spectrum-sharing schemes that may involve spectrum used by radars, it is critically important that spectrum managers and engineers understand these differences and how to cope with them in relatively densely crowded electromagnetic environments. Furthermore, it is important that such personnel understand clearly the needs and requirements for measuring radar emissions and that they also understand how to apply legal emission mask limits to their measurements.

This tutorial provides introductory information for such personnel in three major sub-topic areas: The fundamentals of radar emissions; the most efficient methods for measuring radar emissions; and how to apply the United States government's emission mask limit (the Radar Spectrum Engineering Criteria, or RSEC) to such measurements.

Typical radar emissions are described for high-power air search units, maritime search and navigation systems, and airborne radars. US radar bands are summarized. US radar nomenclatures are described. The typical range of parameters such as pulse widths, pulse repetition rates, beam-scanning techniques, and peak power levels are reviewed. Some operational idiosyncrasies of some types of radars are reviewed.

Obstacles to efficient and effective observation and measurement of radar signals are described, and methods for overcoming these obstacles are provided. In particular, it is shown that conventional swept-frequency methods that work well for observing communication signals do not work well for radars, with the result that radar signals may be missed if such techniques are used. A much more effective stepped-frequency technique is described. Finally, the application of the RSEC mask to measurements is described. Personnel who complete the tutorial should gain enhanced abilities to observe and analyze radar signals and to apply their knowledge to spectrum management and engineering problems.