Discrimination of High-Altitude EMP in the Presence of Lightning Environments for Ground-Based Sensors

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This paper discusses techniques for reliably detecting the presence of a high-altitude EMP event. This involves emphasizing detector response to HEMP relative to lightning based on the properties of the two environments. Various hardening and redundancy features are included.

For both military and civilian purposes, one would like to reliably detect the presence of the high-altitude nuclear electromagnetic pulse (HEMP) resulting from an exoatmospheric nuclear detonation. Knowing that there are other potential electromagnetic environments, in particular lightning, one would like his EMP detector not to be triggered by such events. So the problem is to design a set of detectors which are insensitive to lightning, but sensitive to HEMP.

The HEMP environment is described in [C. E. Baum, "From the Electromagnetic Pulse to High-Power Electromagnetics", Proc. IEEE, 1992, pp. 789-817][IEC 61000-2-9, "Description of HEMP Environment—Radiated Disturbance", 1996]. For present purposes we are concerned with the large (up to 50 kV/m) fast (few ns rise) early-time pulse. By comparison the lightning environment (cloud to ground) can have currents as large as 100 kA (or even larger), and a maximum rate of rise of around 7×10^{11} A/s (or say 10^{12} A/s).

For the present discussion let us assume that our EMP detector is to be placed on the ground surface. (An airborne detector will have a different optimal design.) So we must look at the relative signals from HEMP and natural lightning at the ground surface, and design our detector accordingly.

It appears quite possible to make a reliable HEMP detector which avoids false positives and can even (by redundancy) avoid false negatives. Its sensitivity can be designed appropriately and can even be designed so that its sensitivity can be adjusted as conditions warrant.

The present paper is concerned with a ground-based HEMP detector. An airborne HEMP detector has different design requirements. In particular the platform (e.g., aircraft) can strongly influence the sensor response. This can be minimized by techniques discussed in [D. V. Giri and C. E. Baum, "Airborne Platform for Measurement of Transient or Broadband Electromagnetic Fields", Sensor and Simulation Note 284, May 1984; Electromagnetics, 1989, pp. 69-84.].