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White Paper

Surge Protection Optimized for HEMP Threats

Secure Mission-Critical Networks and Equipment from Growing Risk

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A Considerable Threat

It's not just something from science fiction. High-altitude electromagnetic pulse (HEMP) is a threat that government organizations, military agencies, communications leaders, and network engineers continue to research, developing systems, standards and equipment to address this ever-present danger. But what is HEMP?

Broadly defined, HEMP refers to a nuclear explosion detonated high above our planet's surface, delivering an electromagnetic pulse over a broad area. The higher the altitude, the greater the area potentially impacted on earth. The threat of terrorism and the growth of nuclear powers around the globe push the need for preparation against this possibility.

Measuring HEMP

HEMP Measurements focus on three pulses: E1 in nanoseconds, E2 in microseconds (similar to lightning), and E3—a longer phase potentially lasting minutes on grid systems, similar to a solar flare.

The sheer energy associated with a HEMP event is potentially staggering. The "coupling" nature of the EMP phases (E1, E2 and E3) with the transmission of RF/data lines impacted multiplies the transient energy strength and network damage. In short, power grids, communications networks and other physical infrastructure are vulnerable, and the damage is likely catastrophic.

The Significance of Surge Protection

So how does surge protection fit into preparation against HEMP? Basic surge protection devices (SPDs) provide a front-line level of protection against for mission-critical network equipment. Without surge protection, the threat of a pulse is a threat against network operability.

The deployment of SPDs in all mission-critical applications protects equipment ranging from power cords, data lines and antennas to sensitive electronics that deliver data to users around the globe.

Standards that Guide Surge Protection

The National Coordinating Center for Communications (NCC), part of the U.S. Department of Homeland Security, issues detailed recommendations and technical data for HEMP protection. As detailed in Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment (NCC, February 5, 2019), the NCC outlines surge protection strategies for combatting the threat of EMP.

Initial Considerations

In this document, the NCC lists three essential considerations for prioritizing EMP-protected equipment:

- Step 1: Rank the importance of critical infrastructure.
- Step 2: Prioritize end-to-end substructures needed to meet essential needs and maximize benefits.
- Step 3: Prioritize components and develop plans for protecting the end-to-end functions.

Multiple questions and factors influence decisions within these steps.

HEMP Protection Levels

Using standards developed by the International Electrotechnical Commission (IEC), the NCC organizes equipment, components and facilities into four main levels of protection based primarily on time and effect.

Level 1: Lowest cost; longer mission outages permitted

- NCC Recommendation: Lightning protection SPDs
- Basic steps such as unplugging power and antenna lines, turning off equipment, etc.
- Incorporate EMP-protected backup power or generation source

Level 2: Only hours of mission outages permitted

- NCC Recommendation: EMP SPDs for all critical equipment, including power cords, data lines and antenna connections
- Increase protection, shielding, power supply hardening, etc.
- EMP protected backup power that is not vulnerable to EMP coupled through the power grid

Level 3: Only minutes of mission outages permitted

- NCC Recommendation: EMP-tested SPDs and equipment
- Engineer to IEC EMP and IEMI protection standards (IEC SC 77C)
- Shielding should be 30+ dB of protection through 10 GHz, with shielded racks, rooms and facilities

Level 4: Only seconds of mission outages permitted

- NCC Recommendation: Military EMP standards (MIL-STD-188-125-1, see below) and 80+ dB hardening through 10 GHz
- Use EMP shielding in rooms, racks, and buildings as needed, as well as EMP-protected double-door entryways
- Consider double surge protection on critical external lines entering EMP-protected areas

More details are available for each level in the NCC document listed above.

Military Standards

In military circles, the HEMP threat is well documented and continually addressed. MIL-STD-188-125-1 sets critical standards for mission-critical equipment.

MIL-STD 188-125-1 describes the threat environment, test methods and minimum protection requirements for HEMP hardening of fixed and transportable ground-based facilities that perform critical, time-urgent command, control, communications, computer, and intelligence (C4I) functions. The standard assumes the need for absolute critical command and control with no margin for disruption of command chain communications.

Because of the complexity and detail of MIL-STD 188-125-1, businesses and other organizations may find compliance costly and time-consuming. The answer, however, is not to choose parts of the standard to target or to forego applying it in entirety; rather, system designers will benefit instead from identifying core components and key services, then applying the standard in these targeted areas.

HEMP Impact Effects

Standards generally measure the pulse effects of a HEMP event into three categories:

E1—Nanoseconds

- Shortest wavelength
- Attaches most effectively to small electrical systems
- Fast rise time impacts cell phones, computers, engine controls, etc.

E2—Microseconds

- Wavelength similar to lightning
- Attaches effectively to facilities wiring
- Gamma signal impacts electronics, telecommunications, control systems, etc.

E3—Longer Sustained Phase

- Wavelength similar to geomagnetic disturbance, solar storm or flare
- Long relative time duration—a pseudo-DC signal
- Capable of coupling to large portions of the power grid

SPD Selection and Planning

Deploying SPDs to key specifications takes on extra significance in these scenarios given the potential for catastrophic damage in a HEMP-type event. The significantly faster rise times of an EMP surge require additional considerations.

According to the NCC document, a rule of thumb for determining voltage requirements is to take the typical voltage, add a safety margin, then multiply by a factor of three for the EMP overshoot. The basic elements of this approach apply to both power and data lines, with the additional use of a low-pass filter on power lines.

Antenna lines also require SPD voltage level well above the transmitter peak voltage level. In all of these applications, choosing reliable, non-degrading SPDs from a trusted supplier is paramount.

Key Areas of Protection

By prioritizing EMP surge protection and grounding, network engineers can minimize the potential for downtime due to a HEMP event. Critical areas of protection include:

- Land and mobile communications networks
- Utility networks and grids
- TV/radio broadcasting facilities
- Process control in banking/finance
- Road/rail signaling systems
- Transport/communications infrastructure
- Field military forces and support facilities
- Backup power and energy storage systems
- Internet of things (IoT) platforms

Surge Protection Optimized for HEMP

Engineering experience and a rich history of innovative, patented and highly reliable surge protection solutions make Transtector Systems and PolyPhaser ideal choices for HEMP protection. Key HEMP-tested products meet stringent Military Standard 188-125-1 requirements, with engineering and testing specific to HEMP demands.

Mission-critical Transtector and PolyPhaser solutions include:

- AC EMP surge protection
- DC EMP surge protection
- Network signal EMP surge protection
- RF EMP surge protection
- Custom E3 mitigation solutions
- Available for same-day shipping

For details and additional information, visit transtector.com or call +1 208 635 6400.