

A Surveillance System Development for the EMP, TEMPEST, HPEM Hardening Shelter

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The EMP threat may have acquired new, urgent and relevance as the proliferation of nuclear weapons and missile technology accelerates of the North Korea, for example, is assessed as already having developed few atomic weapons, and is on the verge of North Korea already has missiles capable of delivering a nuclear warhead over the South Korea and few thousand of km. ITU K.78, K81 and IEC recommended its counter-measuring for the industrial facilities.

This system was developed to keep on its performance of hardening shelter for the EMP, TEMPEST and HEMP. The hardening shelter performances show a drop and decreased in its efficiency passing a year. RF shielding fingers made by the Beryllium copper is easily apt to corrode quickly in the higher humidity underground and be destroyed by the mechanical axial twist. Some of worst case, door couldn't closed and open for the finger corrosion if operator didn't care the hardening shelter.

In case of the MOV varistor used in the EMP/ TEMPEST filter, it could be worn out because MOV varistor is also working against the repeat lightning stroke. Main breaker like a MCCB could be trip and couldn't reload it if the insulation resistance of MOV varistor was falling down on certain value. Any other factors to reduce the hardening shelter efficiency, mechanical crack of the shielding metal and extension of cable could be reduce the shielding effectiveness. This system provided the various functions to keep on the hardening shelter performance against the EMP, TEMPEST and HPEM with the sake of convenient maintenance.



Fig.1. Various reasons why we need a surveillance system in the hardening shelters

Trend of the international standards;

ITU, IEC were recommended the standard to apply for the industrial facilities against EMP and HPEM. MIL STD 188-125-1, 2 are still a basic standard for the Military transportation and fixed facilities. All of the related standards are summarized on the Table 1. Someone said that IEC standard are well defined than military standard 188-125.

System configurations;

A surveillance system of the EMP, TEMPEST, HPEM hardening shelter are consist of the 3 kind of main functions as shown in Fig. 2.

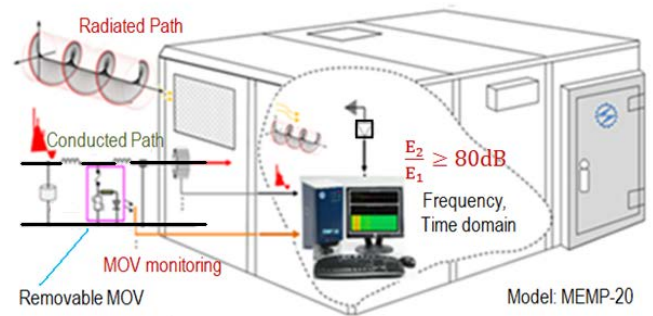


Fig.2. A surveillance system of EMP, HEMP, TEMPEST (Patent listed number: 10-1203952)

First, this system keeps on a close monitoring over the shielding effectiveness in the shielded room by way of the public broadcasting field strength or intentional extra radiator in the air. Second, conducted monitoring function has a two kind of way to monitor the power line status. MOV, Varistor failures be caused by the insulation degradations can be continually tested by the optical link and insertion loss of the line filters is also monitored on the time and frequencies domain.

Pick up circuits of the MOV, Varistor failures is shown on the Fig.3

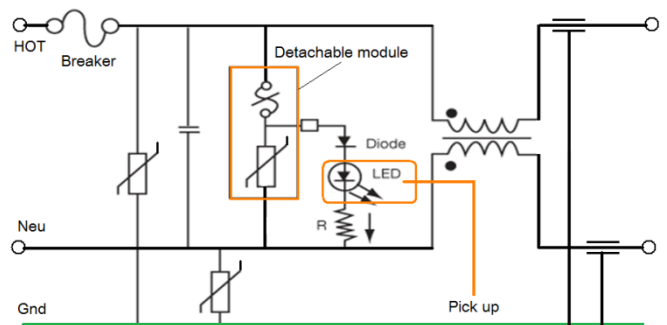


Fig.3. Pick up circuit of the MOV, varistor failures

For the conducted monitoring functions, various power

factors just like a THD and the others could be controlled by this system via the optical link. All of the status data from the shelters are collected and analysis to the control center on the network. It also provided the emergency treatment manual regarding replacement of the spare parts and countermeasure from emergency events. Detections circuits and MOV block could be easily replaced by the detachable modules without electrical hazards and time delay.

Fig. 4 shows the detachable MOV module on the EMP filter. The detachable MOV module strongly recommended to the EMP filter in order to reduce a repair time and guarantee a worker's safety against electric hazards.

The insertion loss of the EMP filter could be measured by way of the current transformers without circuit connection.



Fig.4 The detachable MOV varistor on the line filter (Patent listed number: 10-1217031)

This EMP power line filter was delicately designed to reduce the lead length and contact resistance in order to pass the PCI test requirements on the MIL STD 188-125.

Table 2. Summary of the shelter monitoring system

Paths	Main monitoring function
Path 1	EMP, HPEM detection and direction finder
Path 2	Maintaining the shielding effectiveness of the hardening shelter on the air
Path 3	Keep up the Insertion loss of the lin filters
Path 4	Surveillance of the MOV, varistor wear out and degradation of the insulation resistance

EMP,HPEM detection and direction finder;

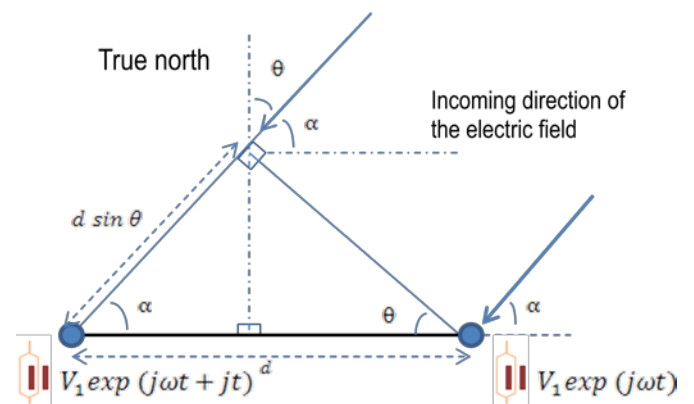
We couldn't realized the HEMP burst for a while because EMP didn't influence on the human being and building damage. Most of the old direction finder which is working on the ac power could be stopped or damaged by the E1 or E3 pulse except the special designed system for EMP.

Therefore, we need to developed the new direction finder for the EMP, HPEM detection. This direction finder adapt the **Mach zehnder electric field sensors** with the optical fiber. Fig 5 shows the full optical direction finder. Detection and direction finder of the MZ type EMP, HPEM is consist of the n- 3 axis MZ field sensors, optic

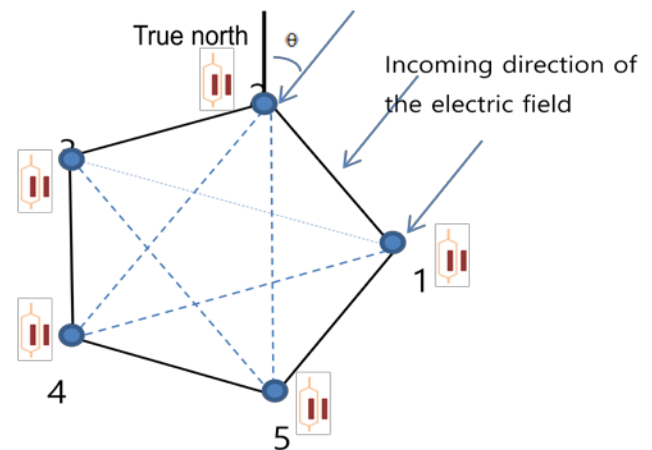
source with control, spectrum analyzer and S/W. EMP, HPEM detection and direction finding algorithms are described on the Fig. 6.



Fig.5 EMP, HPEM detection and direction finder (Patent listed number: 10-1203951)



a) Two MZ elements direction finder



b) Five MZ elements direction finder

Fig. 6. Theory of the direction finder using the 3 axis Mach Zehnder optical field sensors.

2 kind of X,Y,Z axis direction finder circuit was shown on the Fig.6. Radiated source direction and burst height are calculated by the comparison of the phase delay of receiving signal depending on the each location of the MZ field sensor.

Accuracy of the direction finding is depending on the number of the MZ field sensor and distance between the

Table 1. A summary of EMP, HPEM related standards

Electric high power energy			Related standards	
Environment	Type	Waveform	HEMP, HPEM Environments	System Immunity
Nearby Lightning	Natural	Pulse	MIL STD 464	MIL STD 461F CS116 MIL STD 461F CS116 RTCS/DO160 Sec 22 IEC 61000-4-5,9,10,12
Direct Lightning	Natural	Pulse	MIL STD 464 IEC 1312-1 RTCA/DO 160	RTCA/DO 160, Sec. 23
HEMP (E1, E2, E3)	Hostile	Pulse	ITU K.78 (HEMP) MIL STD 2169B MIL STD 188-125-1,2 MIL STD 464 IEC 61000-2-9,10,11,13 IEC 61000-4-33(sensors) NATO AEP 9,18	ITU K78 (HEMP) MIL STD 461F CS116 MIL STD 461F RS105 RTCS/DO160 Sec 22 IEC 61000-4-20,25,32 IEC 61000-6-6
HERF	Electronic Operations	CW, Modulated CW	MIL STD 464	MIL STD 461 CS114 MIL STD 461 RS103 RTCA/DO -160 Sec 20 IEC 61000-4-3, 6
RF Weapons HPEM UWB	Hostile	CW, Modulated CW Pulse	ITU-T K.81	ITU-T K.81
Others	MIL HDBK 423: HEMP protection. MIL HDBK 419: Earth and bonding MIL STD 2169: HEMP environmental. ANSI 63.14: EMC.EMP national standard MIL STD 220C : Method of insertion loss measurement for the filter			

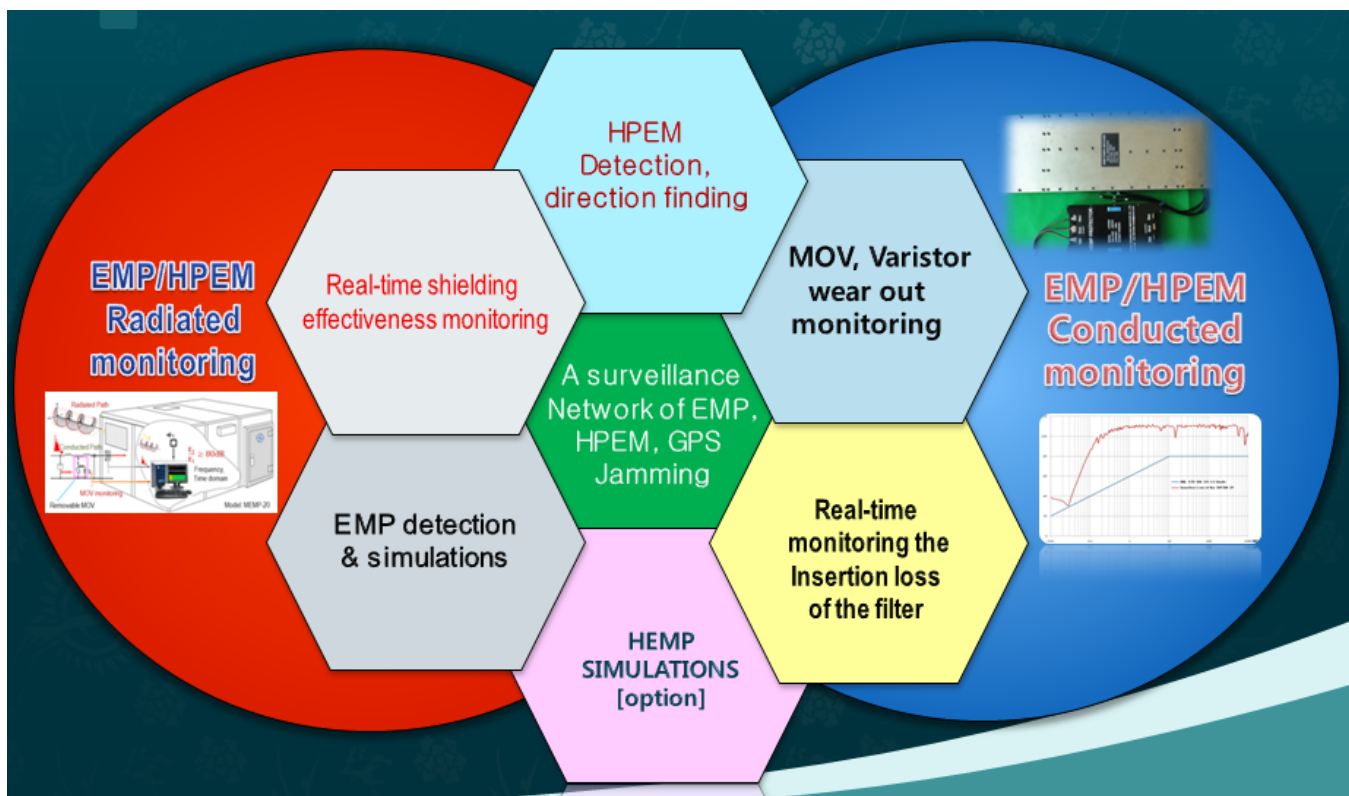


Fig.7 The multi purposed monitoring system of the EMP, HPEM, TEMPEST hardening shelter

field sensors. This newly developed direction finder using a MZ field sensor has various specialties as followings;

- High accuracy. 2 degree.
- Very short signal detection, ns.
- No power supply to the detectors.
- Very wide frequency range from kHz- 10GHz.
- Wide field strength from 0.5V/m(30uV/) to MV/m.
- No phase delay, reflections and attenuation on the transmission lines.
- No influence from the temperature and EM interference.
- Light weight of the external field sensors
- No needs to change the antennas.
- Classified function between EMP, HPEM and lightning.
- Jammer Direction finder for the High power GPS and HPEM
- Calculation of the transmitter power and nuclear bomb size.
- Network management of many hardening shelters simultaneously and it could reduce the recovery time

The multi purposed monitoring system were summarized on the Fig.7.

Conclusion;

This system can contribute to maintain and keep on the EMP, TEMPEST and HPEM hardening shelter performances which were invested a big amount state budget. Most of peoples who are working in the shelter easily didn't pay an attention or forget a critical mission until giving an alarm.

Also, newly developed detector and direction finder adapting a mach zehnder sensor is very useful for the EMP detection and HPEM direction finding.



Dr. Min, Gyung-Chan, Ph.D., is the president of the Korea Technology Institute Co., LTD. He has more than 33 years of experience working on the EMC engineering, EMP shelter design, test system development and antenna calibration. You can contact with Dr. Min, minkti@naver.com or www.emc.re.kr