E1 HEMP Survivability of Solar Panel Inverters

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Abstract—This paper reports on the laboratory simulation of E1 HEMP effects on sample DC-to-AC inverters such as might be used for a home solar photovoltaic system.

Keywords- solar inverter, solar photovoltaic (PV) system, E1 HEMP vulnerability

I. INTRODUCTION

The U.S. electric power grid is vulnerable to HEMP from a high altitude nuclear burst. It is not known with any certainty how extensive the resulting outage would be, in spatial extent or time. Such an event has never occurred for the modern electric grid. Simulations have been done, but the grid and HEMP are so complicated that there is no way to know the reliability of those calculations. For example, one concern is that E1 HEMP will strike every part of the grid essentially simultaneously, and then also be hit shortly thereafter by E3 HEMP. E1 will induce very high-level transients on the power lines, which could disrupt or destroy connected electronics. Besides all of the user's equipment powered by the grid, there is also concern over all of the power system electronics, such as in power substations (protective relays), used to control and make the grid reliable. Could there be further problems from failures to the relays during the critical instance of the E1 HEMP event? Besides this potential E1 vulnerability, there is also speculation that E3 HEMP could, even independent of any E1 effect, cause permanent damage to the large high-voltage transformers. Extreme case scenarios consider that the power grid could be out for a very long time, possibly years if many large transformers are damaged from E3.

More and more home solar power systems are being installed, and so one hope is that coupled with more frugal use of power, solar PV systems could provide a backup until the grid is restored. However there are several possible issues with this idea, including:

1. Would the solar PV systems survive the HEMP?
2. Could the solar PV systems be started up if the power grid is down?

Both issues were addressed in the tests discussed in this paper.

II. TEST PROCEDURES

The home solar PV systems tested here consisted of one solar panel and one micro-inverter. Samples of two types of solar panels and three types of inverters were tested. The connected power grid was simulated by use of a 230 VAC battery inverter, so it did not need to actually connect to our local power grid. This test procedure partially answered our second question: yes, it is possible to start up an inverter even without the power grid operating.

For the first question, E1 HEMP [1] can illuminate the cabling on either side of the inverter – DC wires from the solar panels into the inverter, and AC wires out of the inverter. Of course it would be best if all such wiring followed good shielding practices, such as using metal conduits, but this is often not done, and the inverters are not even constructed to easily allow conduit connections. The main purpose of the tests were to see if coupled pulses [2], as simulated by a direct-injection pulser, could cause problems for the inverter. Fig. 1 shows a sample setup. The pulser in the background used a capacitive trench to couple the pulse. The inverter and battery is on the pallet on the ground. The tests also included applying a protective device, which is the gray box between the solar panel on the left and the capacitive trench in the center.

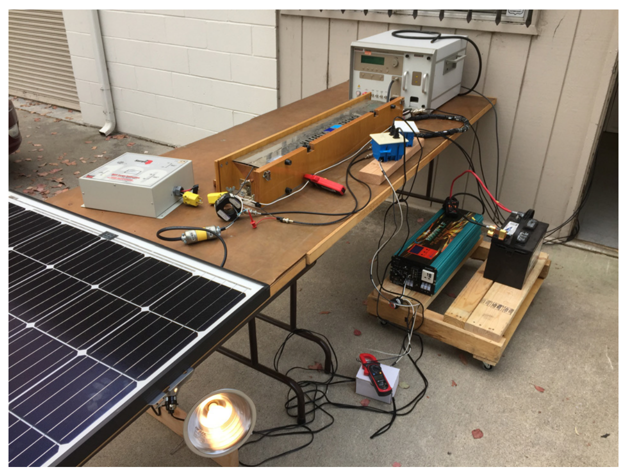

Figure 1. Sample test setup.

III. RESULTS

Up to the highest pulser level we did not cause damage, but could cause upset. Full results will be given in the talk.

REFERENCES

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