

# Grid Thumper™



## HIGHLIGHTS

**Grid Thumper: a new way to test the stability of microgrids, back-up power systems, and distribution grids**

When subjected to stand-alone certifications, individual pieces of grid equipment (generators, inverters, UPS, transfer switches, etc.) almost always operates correctly. When they're connected together as a system, exactly how their control loops will interact is unknown.

Grid Thumper rigorously tests complete, connected systems, including active distribution grids, detecting harmful instabilities that would otherwise be invisible. It uses patent-pending technology to briefly connect large, time-synchronized resistive and reactive loads – up to a megawatt, often for a tiny fraction of a second – then ultra-precise PSL PQube 3 and microPMU sensors record the grid's system response.

Grid operators, data centers, hospitals, military bases, sports and entertainment venues, can all gain peace of mind that their critical power systems will perform as expected when needed most.

## GRID STABILITY CHARACTERISTICS REVEALED

- What is the natural frequency (i.e., frequency where forced oscillations will have the greatest effect)?
- What is the damping coefficient (i.e., how long do oscillations "ring")?
- How far on the grid do oscillations travel?
- How resilient are back-up generators and UPSs?

## FEATURES

- 1 MW resistive, 1200 KVAR reactive, pulsed distribution grid load (expandable)
- Satellite synchronized to one microsecond
- Easily shipped within North America and internationally
- 100 V ~600 V, 50/60 Hz – utility and commercial & industrial (C&I) applications
- Multiple data communication options: Ethernet, 4G cellular modem, WiFi
- Time stamped measurements (Volts, Amps, phase angles), 120 samples per second
- Controlled pulses: 1 millisecond through continuous
- Adjustable power settings: 10 kW ~ 1.1 MW, balanced or unbalanced
- Data recording with PSL micro-synchrophasor microPMU and PQube 3 power quality analyzer

## BENEFITS

- Optimized for live grids, non-disruptive use
- Programmable pulse strength and repetition of pulse waves
- Monitors local and distant effects with multiple microPMUs
- Time correlation – pulls stability signals out of grid noise, even with small pulses

# Grid Thumper™

## APPLICATIONS

### CHARACTERIZE NORTH AMERICAN T&D GRIDS SUSCEPTIBILITY TO UNDAMPED FORCED OSCILLATIONS

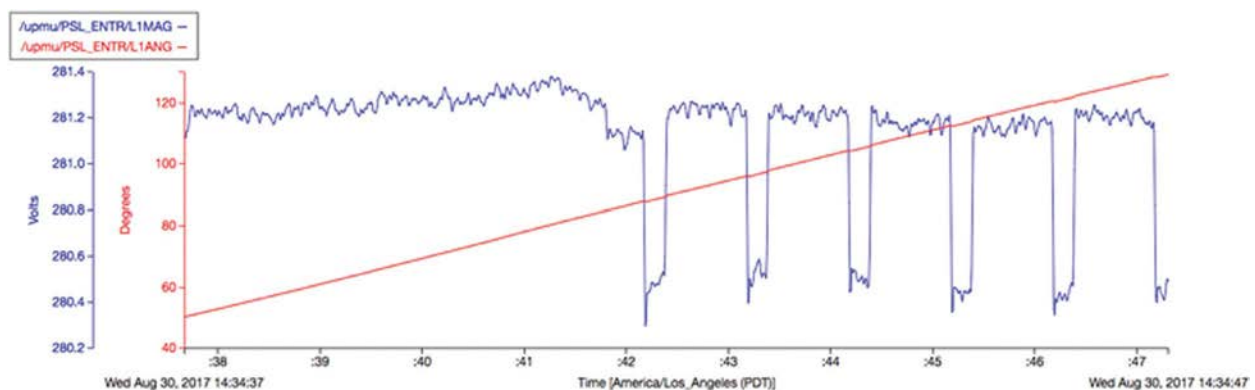
- Use Grid Thumper to create precisely controlled forced oscillations
- Use fleets of new and existing PMUs and microPMUs across each grid to characterize the observed behavior
- Results could indicate mitigation strategies to increase grid stability and resilience

### MEASURE ACTUAL CONTROL LOOPS & DAMPING OF POPULATION OF DG INVERTERS AND LARGE ELECTRONIC LOADS

- Solar inverters, battery storage, fuel cells
- EV chargers, VFD's, etc.
- Goal: understand population response to transient grid conditions, enhance grid stability, avoid oscillations in DG population while increasing penetration and stability

### DISTRIBUTION GRID VULNERABILITIES TO SOPHISTICATED CYBER ATTACK

- Entire distribution grid is vulnerable to low-energy cyber attack on customer loads (not on utility controls)
- Goal: demonstrate, reproduce, and understand the attack and develop utility countermeasures



GRID THUMPER TEST EVENT – 20 KW, 20% DUTY CYCLE

## MICROGRID AND DIESEL GENERATOR TESTING

- Pre-programmed load profile customized for each system
- Documented performance under controlled adverse conditions
- Assure reliable operation during mission-critical events

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