

SOLAR WIND

Premise (summary)



- The same module response (to wind excitation) can be reproduced in a laboratory using vibration test systems (that is, modules can be modeled as spring/mass systems) (Source: Shock & Vibration Handbook)
- High level wind induced vibration response combined with lower levels (or durations) of TC and / or DH can reproduce module field failures in the laboratory easily and efficiently (Source: Westpak, Inc.)

Test Methodology Overview

- **Install test modules in field at a “known” windy spot with meteorological data availability (NREL at Golden, CO)**
- **Return test modules to lab and attempt to reproduce measured module field response in the lab using mechanical vibration input**
- **Repeat the process with small increases in excitation and/or duration until significant module change is noted**

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Data Recorders, Shipping Crates, Field Installation



Module A

data recorder



power supply

Module B



Custom shipping crates



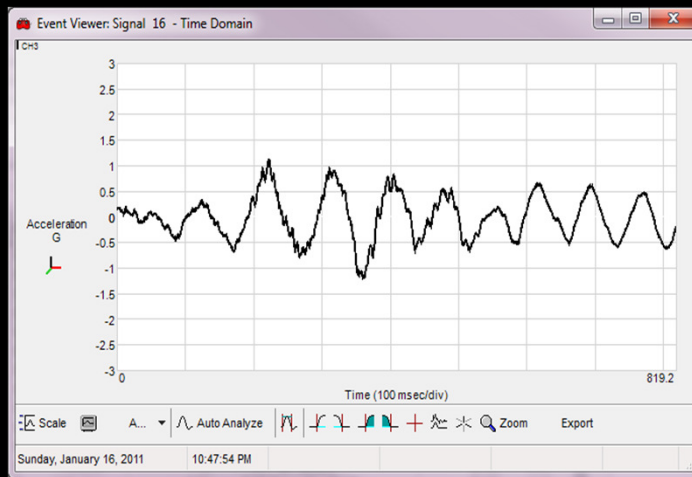
Module A

Module B

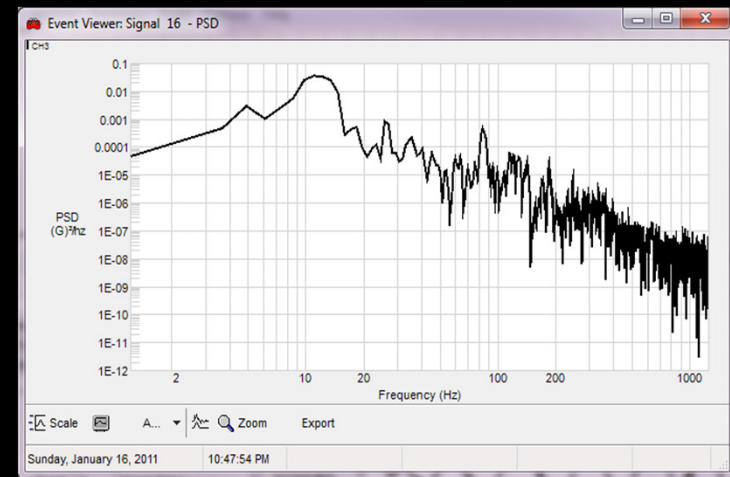
Field installation at NREL

Test modules with vibration data recorders attached

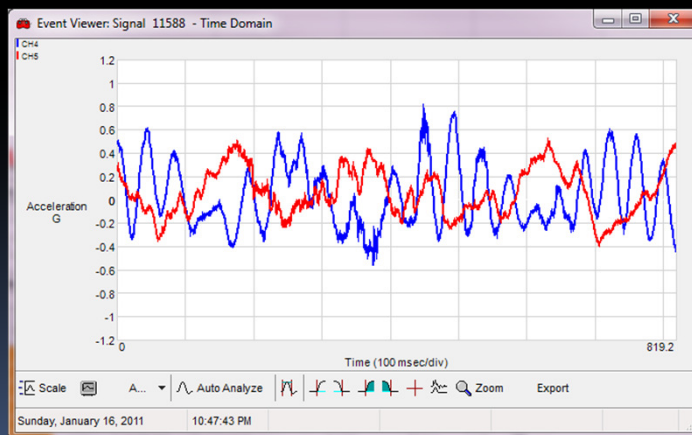
Spectra & time domain for Modules A and B at field (NREL): 50 - 60 MPH wind (Test1.o)



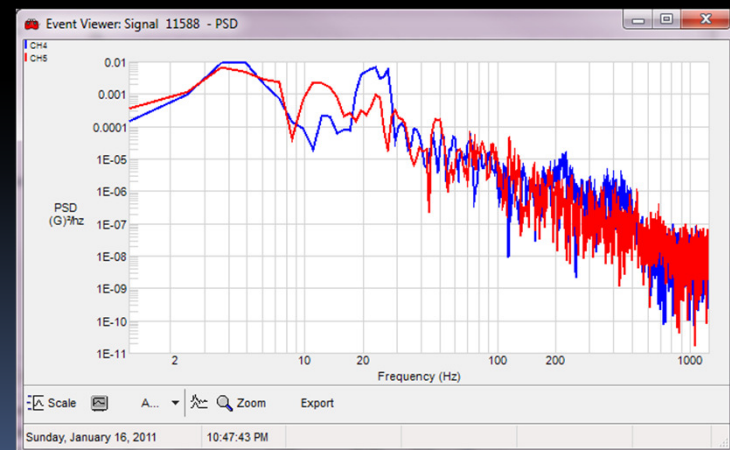
50-60 mph Wind Event (Time Domain) – 3X90 Module A



50-60 mph Wind Event (PSD) – 3X90 Module A

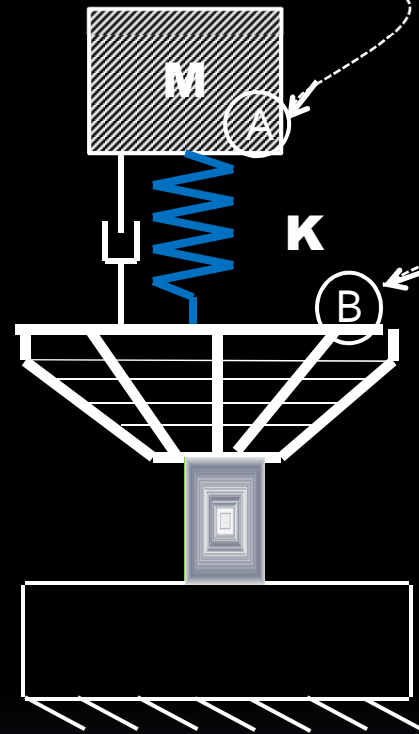


50-60 mph Wind Event (Time Domain) – 9X30 - Module B
Blue: Center of Module Red: Corner of Module



50-60 mph Wind Event (PSD) – 9X30 - Module B
Blue: Center of Module Red: Corner of Module

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Mass of PV module

Distributed flexibility of PV module and supporting structure

Electric-hydraulic vibration test system

B = Platform or table or location where RESPONSE is measured for test 2.0 and the location for the DRIVE or COMMAND signal for test 3.0.

A = Center of PV module where the DRIVE or COMMAND signal is given to match the field response in test 2.0 and to measure the RESPONSE of the module in test 3.0



Lab data is a reasonable match for field data for both modules.