

Small Commercial Inverter Laboratory Evaluations of UL 1741 SA Grid-Support Function Response Times

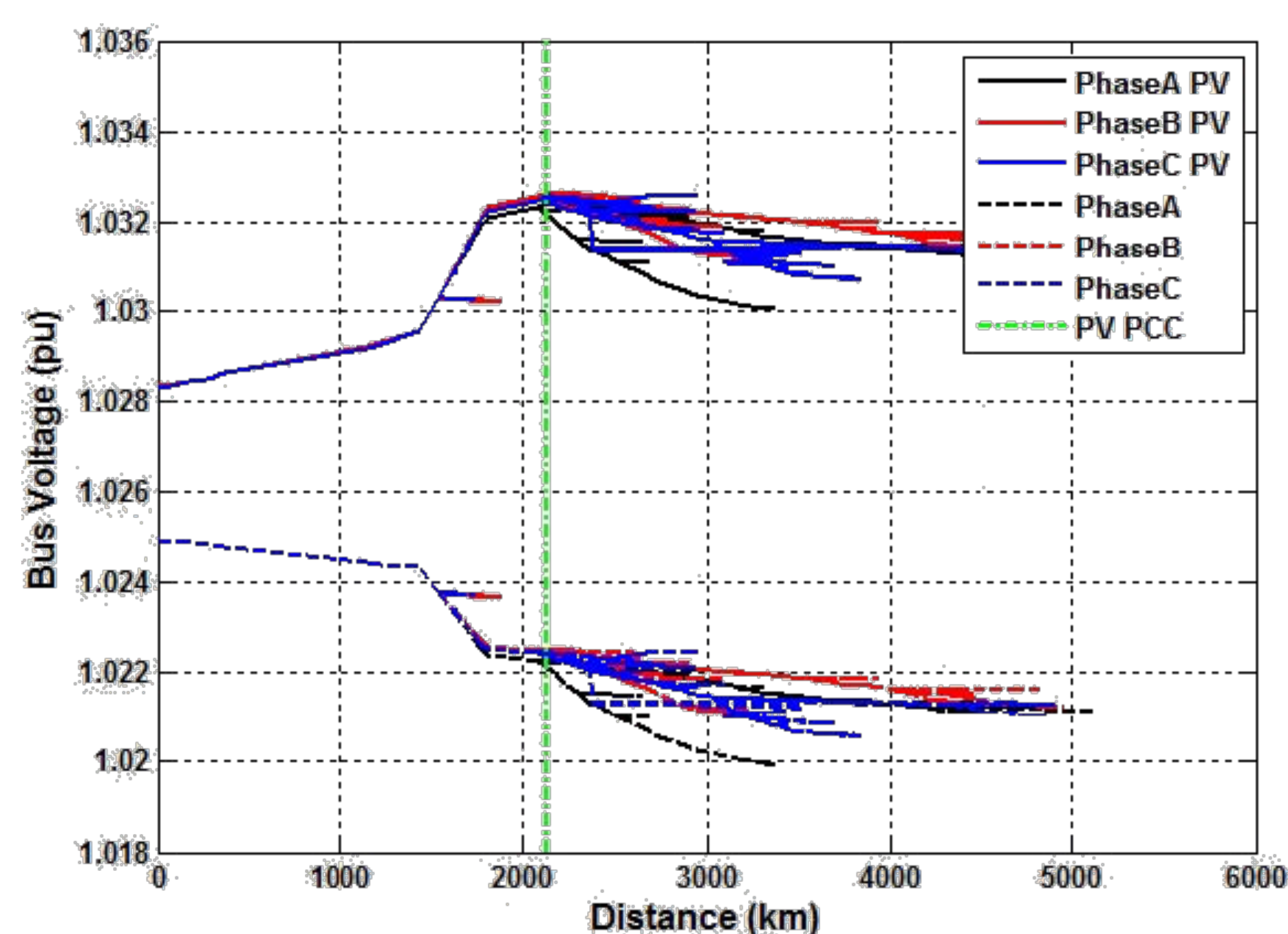
Sigifredo Gonzalez,¹ Jay Johnson,¹ Matt Reno¹, Timothy Zgonena²
¹Sandia National Laboratories, Albuquerque, New Mexico, 87185 USA
²UL, Northbrook, Illinois, 60062, USA

Summary

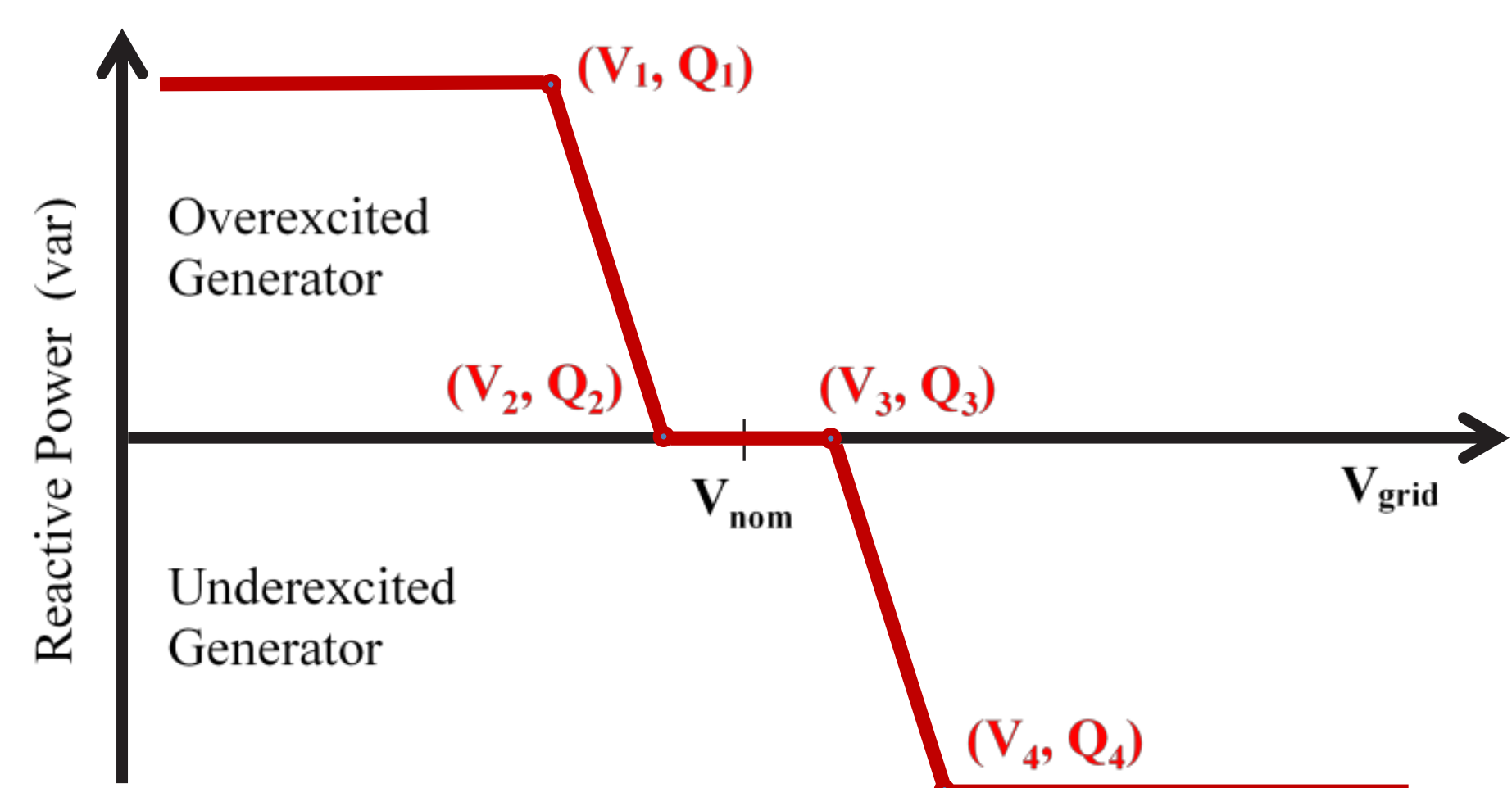
Photovoltaic (PV) distributed energy resource (DER) growth is expected to cause challenges for grid operators who must maintain grid stability, reliability, and resiliency. To minimize adverse effects photovoltaic inverters implement grid-support functions. Some fear these inverter functions will conflict with traditional distribution system voltage regulation equipment. However, based on this study, no adverse interactions were discovered between PV inverters with volt-var functions and load tap changing transformers or capacitor banks.

Background

As more variable solar resources are implemented, they cause greater voltage swings on distribution circuits. These voltage deviations can be compensated for using grid-support functions such as volt-var.



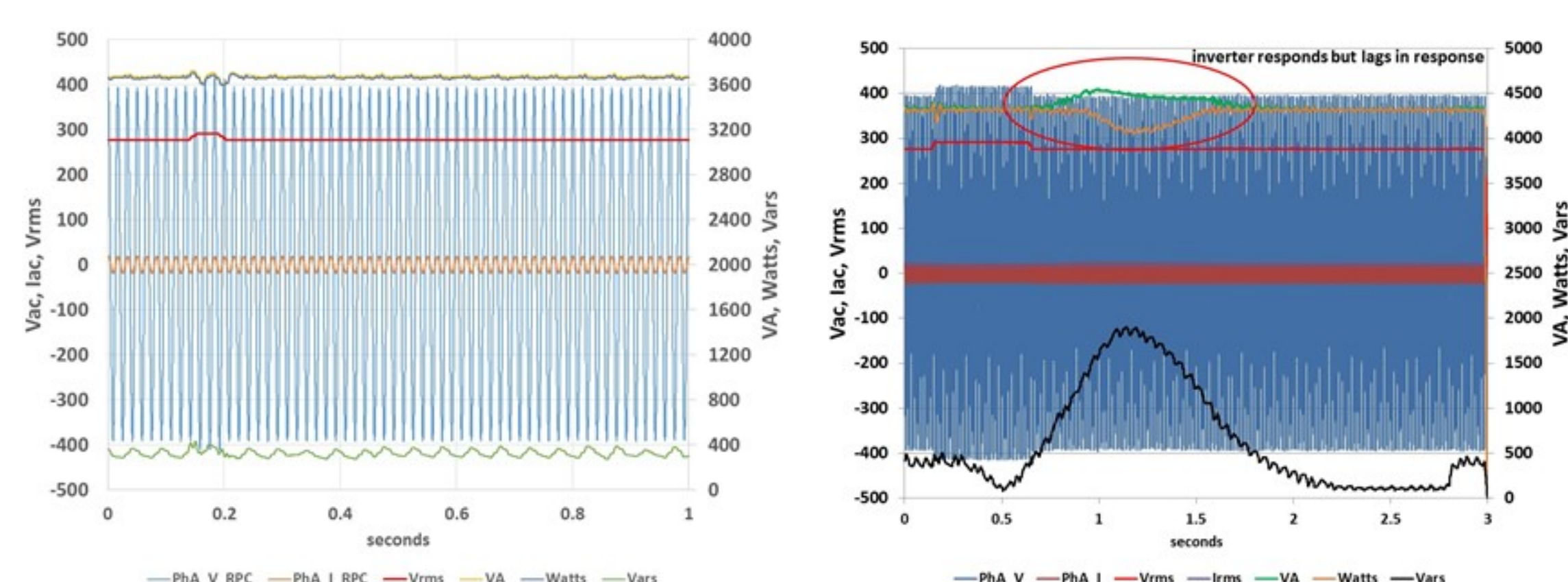
3-phase voltage along a feeder with and without PV.



Volt-var grid-support function that provides voltage regulation on distribution circuits.

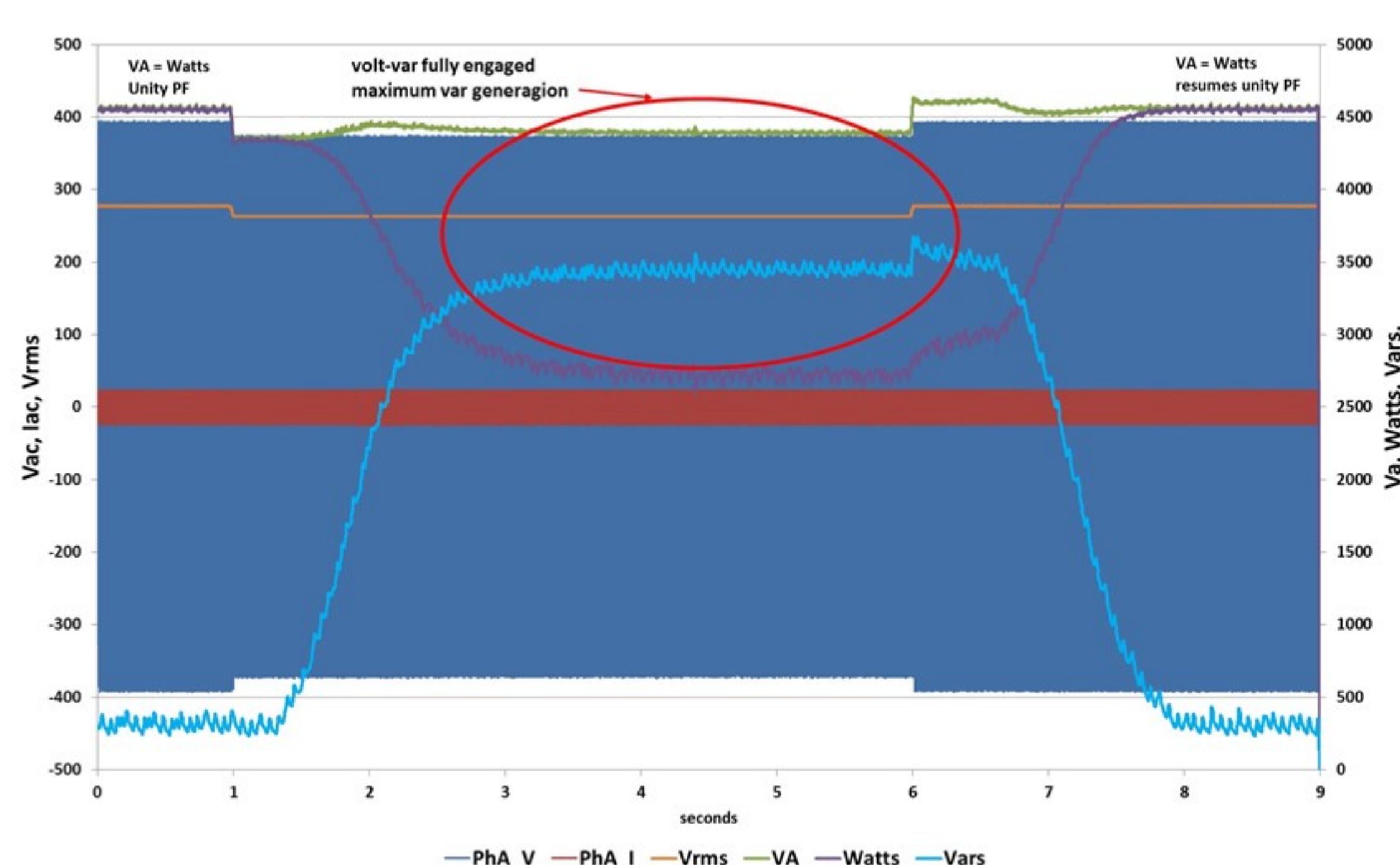
Results

Sandia conducted experiments to analyze the response time of the volt-var function under a variety of voltage surges and sags. The magnitude of variation and the duration of the anomaly determined the reactive power delivery.



3-cycle voltage surge.

30-cycle voltage surge.



300-cycle voltage sag.

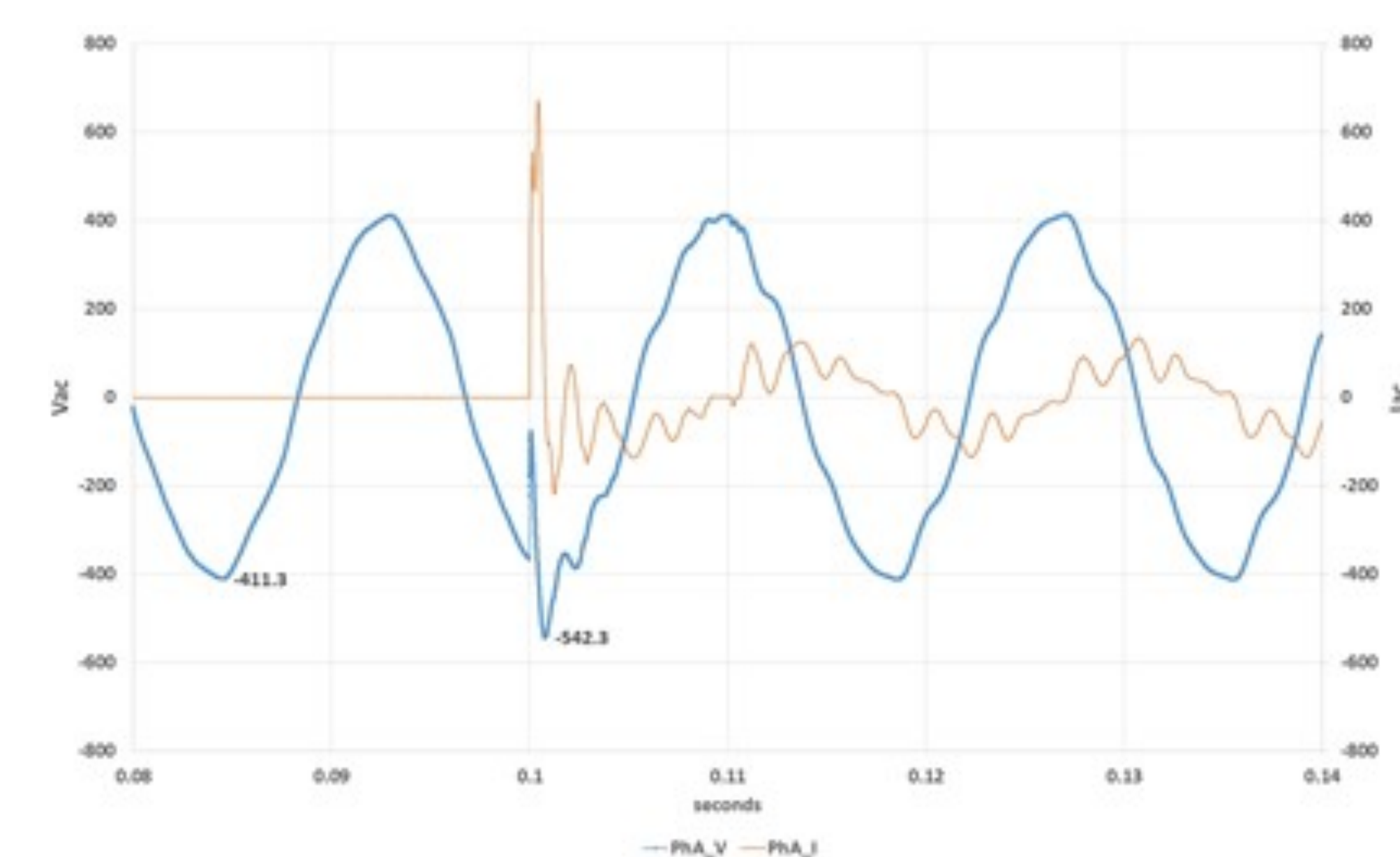
Volt-var ramp time is approximately 1 second to reach 95% of maximum reactive power output. There was no reactive power output for short duration voltage transients.

Volt-Var Interactions

Common distribution system voltage regulation devices include:

- substation transformer load tap changers (LTCs)
- substation and line voltage regulators
- capacitor banks

Each reacts at different time scales (<1 to 12 cycles), so they will not conflict or oscillate with volt-var operations because of the 1-second inverter ramp time. Common distribution system voltage regulation components will not conflict with volt-var operations.



The capacitor bank transient is less than 1 cycle so the volt-var function will not activate from the voltage spike.

References

- Fantozzi, G.V., "Selecting a capacitor-switching overvoltage control method effective in preventing nuisance tripping of adjustable-speed drives," EEI ES&E Committee Meeting, Clearwater Beach, Florida, April 4, 1995
- R. J. Broderick, J. E. Quiroz, M. J. Reno, A. Ellis, J. Smith, and R. Dugan, "Time Series Power Flow Analysis for Distribution Connected PV Generation," Sandia National Laboratories SAND2013-0537, 2013.

