Dynamic and Steady State Performance Evaluation of M-Type PMU

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Outline

- POWERGRID

- URTDSM Project

- Establishment of PMU Test Lab

- PMU Test Lab Setup

- Testing Equipment

- Challenges Faced

- Future Road-Map

- A "Navaratna" Central Public Sector Enterprise.
- Central Transmission Utility (CTU) of India.
- India's largest Electric Power Transmission Utility.
- Operates ~90% of Inter-State / Inter-Regional Networks

Tr. Lines and inter-regional capacity	MVA & Sub Stations
• 131,728 ckm • 61,150 MW	• 266,163 MVA • 213 Nos

Key Area Of Operation

Transmission	Consultancy	Telecom	Smart city / Distribution Solutions

*as on 31.08.2016; ref : http://www.powergridindia.com/

URTDSM Project
[Unified Real Time Dynamic State Measurement]

- Intent of this Project:
  - to provide complete observability of the Indian Power system in real time using PMUs and PDCs.

- Approach on PMU Placement:
  - All substations at 400 kV and above
  - All generating stations at 220 kV and above
  - HVDC terminals and inter-regional and inter-national tie lines
  - Both ends of all the transmission lines at 400kV and above

URTDSM Status*
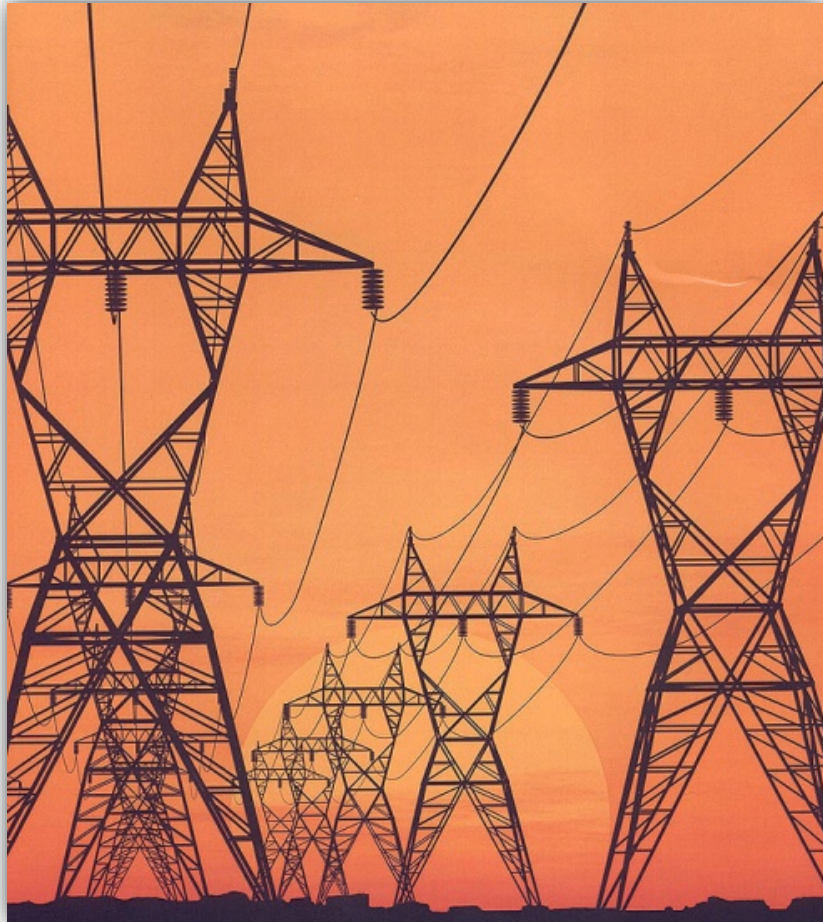
Total in Scope for Ph-1

354 S/S

1186 PMUs

Installed*

153 S/S

537 PMUs

*as on Sept'16

Establishment of PMU Test Lab

- PMU Test Lab is developed by POWERGRID with the support of Prof. Arun G. Phadke, VTU and Mr. Gerard N. Stenbakken from NIST.

- Development of Lab was based on the compliance verification requirements for both steady-state and dynamic tests, as specified in the IEEE C37.118 and IEEE Synchrophasor Measurement Test Suite Specification.

- Set up is designed to collect DUT (PMU) phasor data, computes the input test signal phasor and compares them simultaneously.
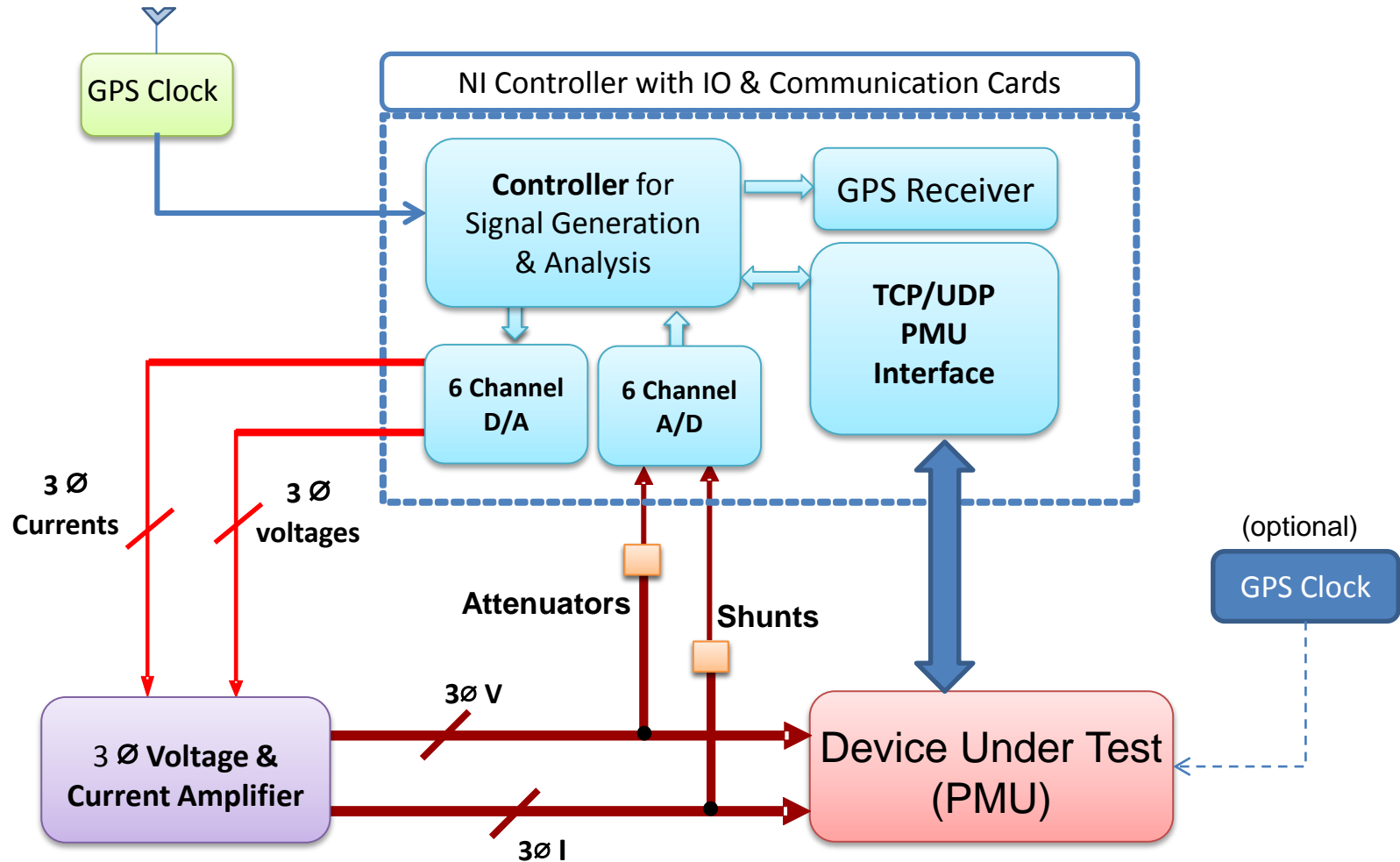
PMU Lab Testing Equipment

1. GPS Receiver with Antenna

2. Controller for Signal Generation & Analysis

3. Power amplifier

4. Shunts and Attenuators

5. Data Acquisition (IO Cards)

6. Software to create Test Conditions

7. Oscilloscope
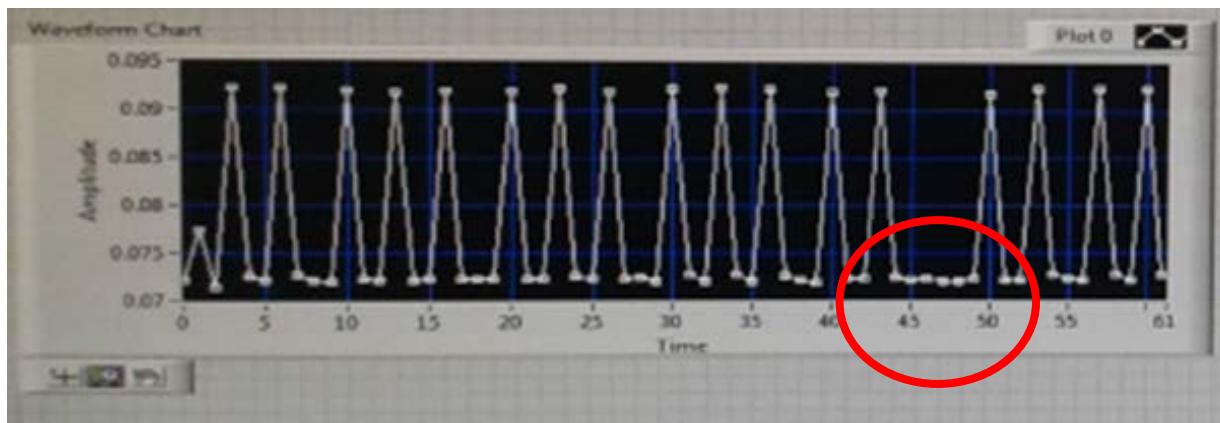

NI Controller with IO & Communication Cards

PMU Test Lab Setup

Ref: Reports by Prof. A. G. Phadke & Mr. Gerard N Stenbakken

Challenges Faced

During first time testing the steady state and dynamic condition of PMU is evaluated and the findings are as follows:

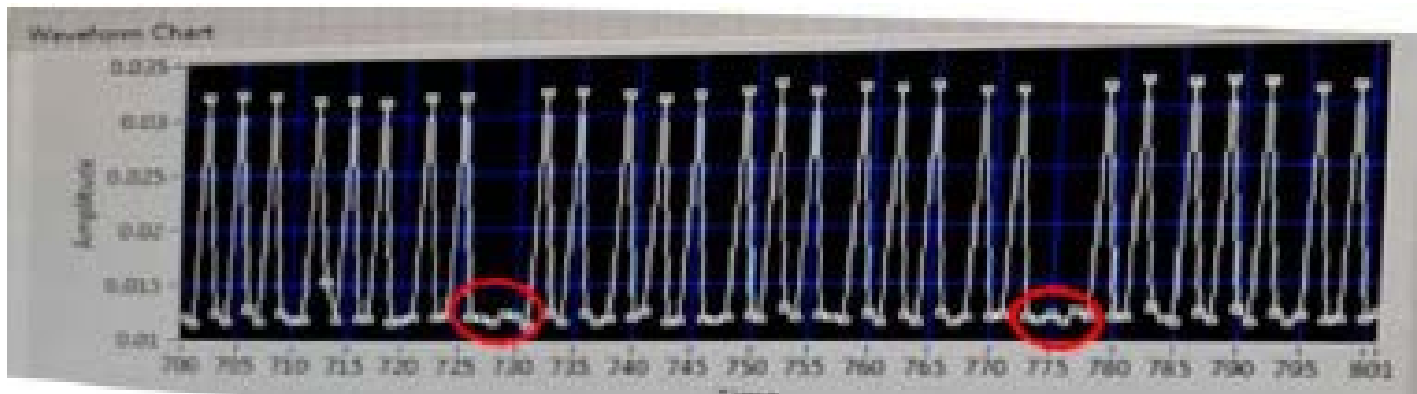1. Alarm was observed at frequency 45 Hz and 55 Hz and Missing data were observed for 47 Hz and 49 Hz.

Challenges Faced

2. At frequency 45 Hz, data was found missing at timestamps 85 and 86.

- Similarly, at 47 Hz, data were missing at time stamp 175 and 235.

- A similar pattern was observed for other frequency sets.

Missing Data at Some Points for frequency test

Challenges Faced

3. Due to frequency shift, frame is skipped after every 0.4 Hz, i.e. during a shift from 45.2 to 45.6 Hz, frames corresponding to 45.4 Hz were missing.

4. For few tests TVE found to be higher than 1% as required by the standard.
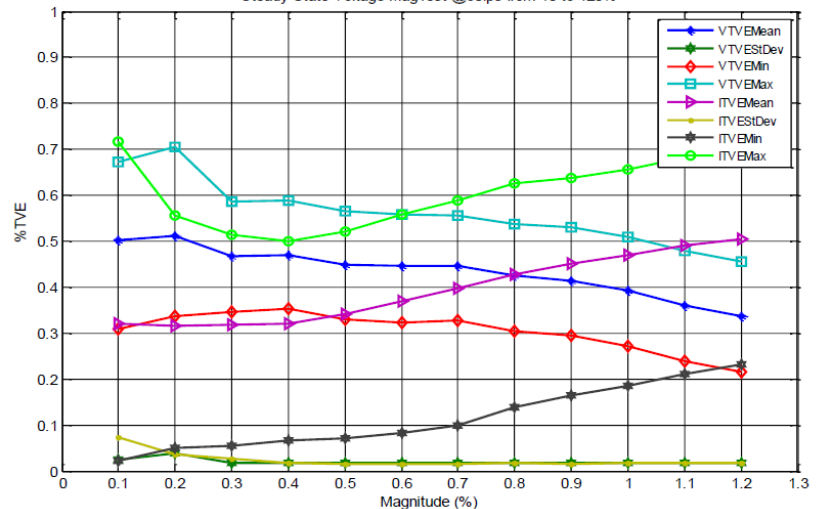
Challenges Faced

To confirm the above test results, we re-tested the same PMU with similar testing facility i.e. VTU, USA and results are shown below:
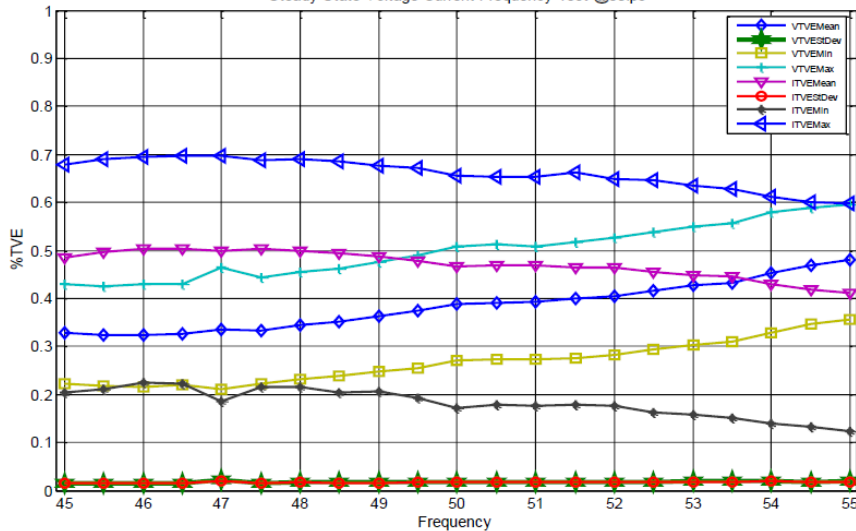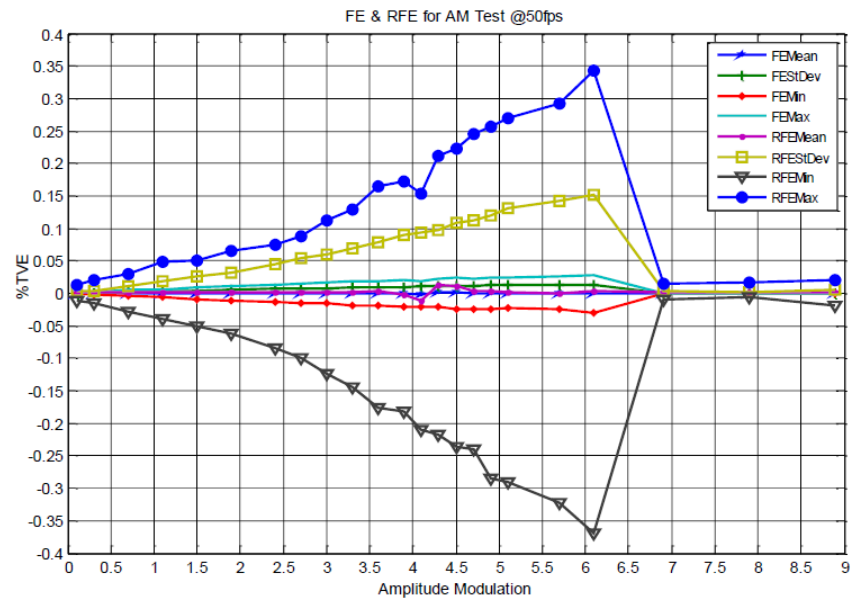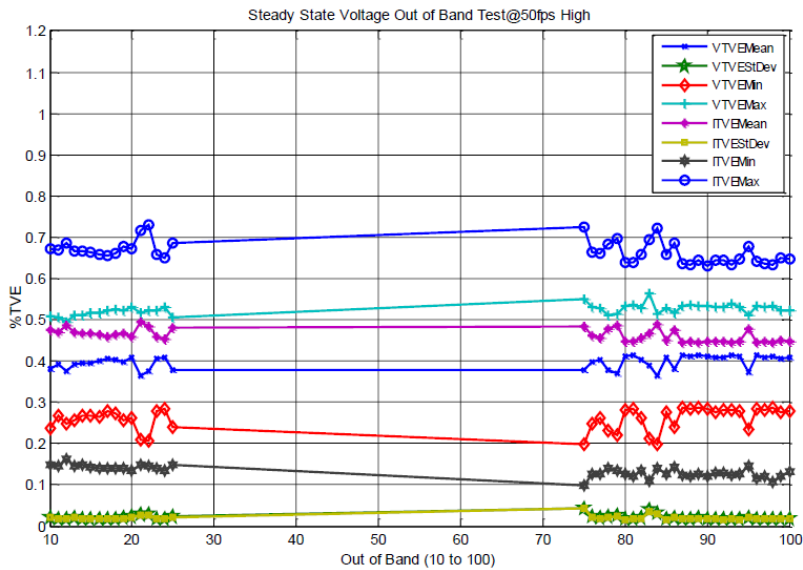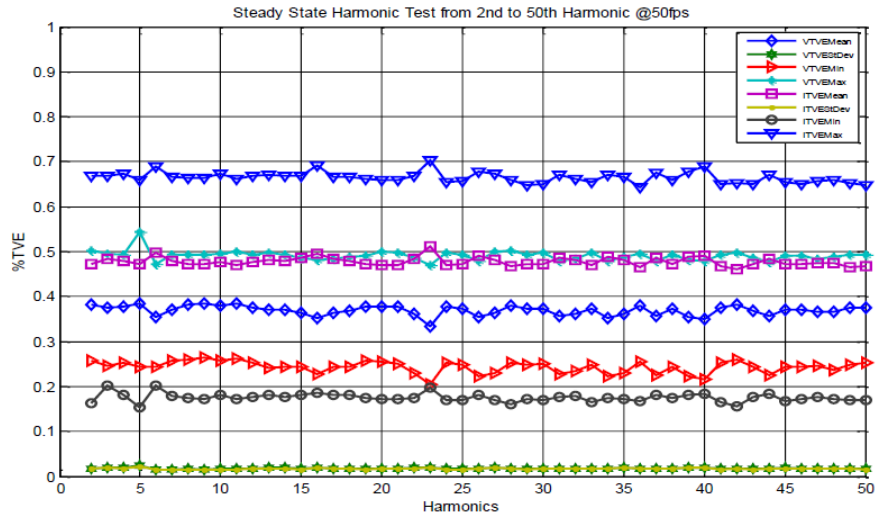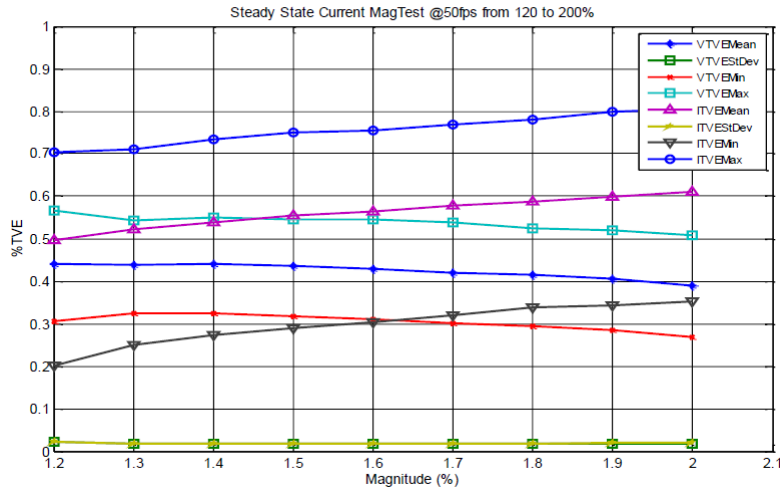
Challenges Faced

Challenges Faced

After doing Study & Analysis on Virginia Tech test results, we found the response as per the standard.

Only difference observed in test system at Power Grid Test Lab, India & Virginia Tech Set up was **Attenuator/Shunts** which consists of normal resistance of high temperature co-efficient.

The immediate action has been taken for necessary modifications as required.

Future Road-Map

for Development of PMU Test Lab

- International Certification of PMU Test Lab.

- Testing of PMUs using RTS Technology.

- Testing of PMUs designed for higher reporting rates.

- On- Site Testing of PMUs.

Thank You

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