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The Virginia Tech PMU and PDC Test System

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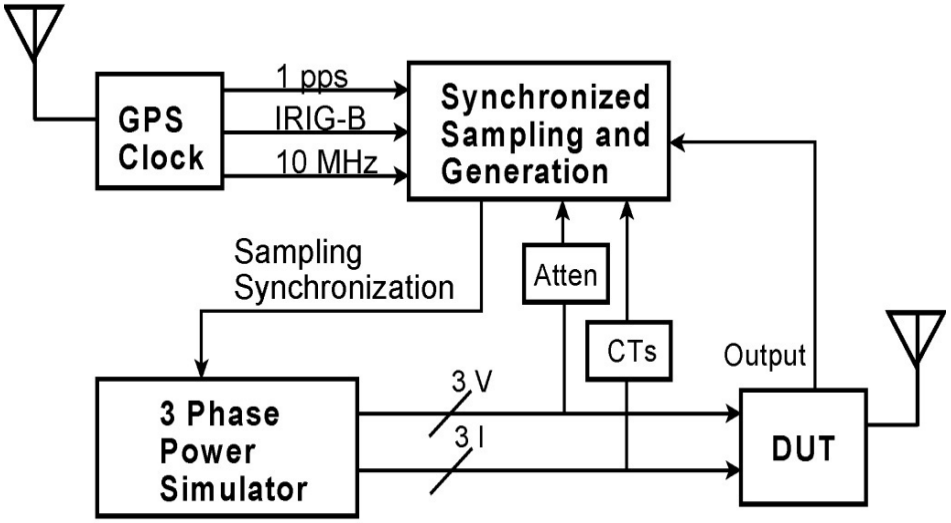
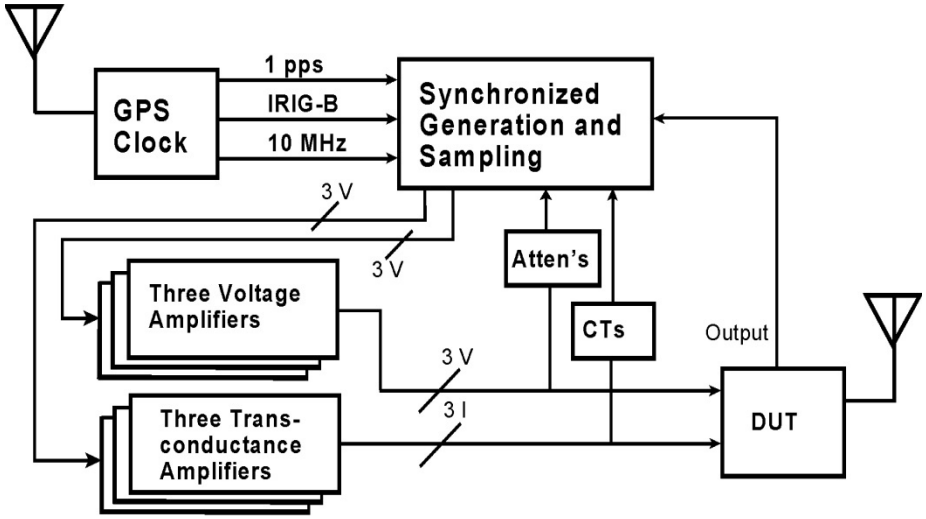
NIST PMU Test System



NIST PMU Steady State Testing System [1]



NIST PMU Dynamic Testing System [1]

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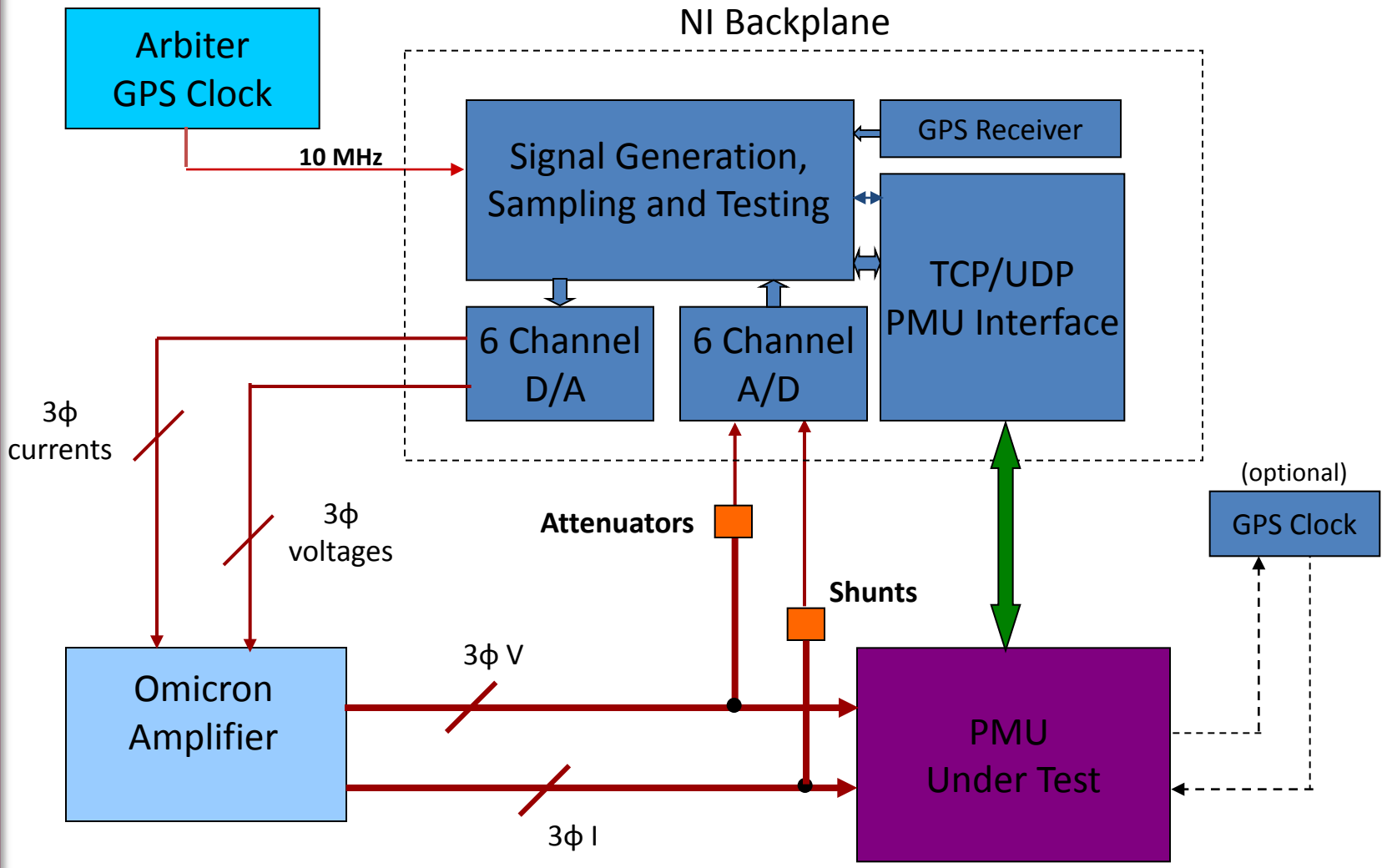

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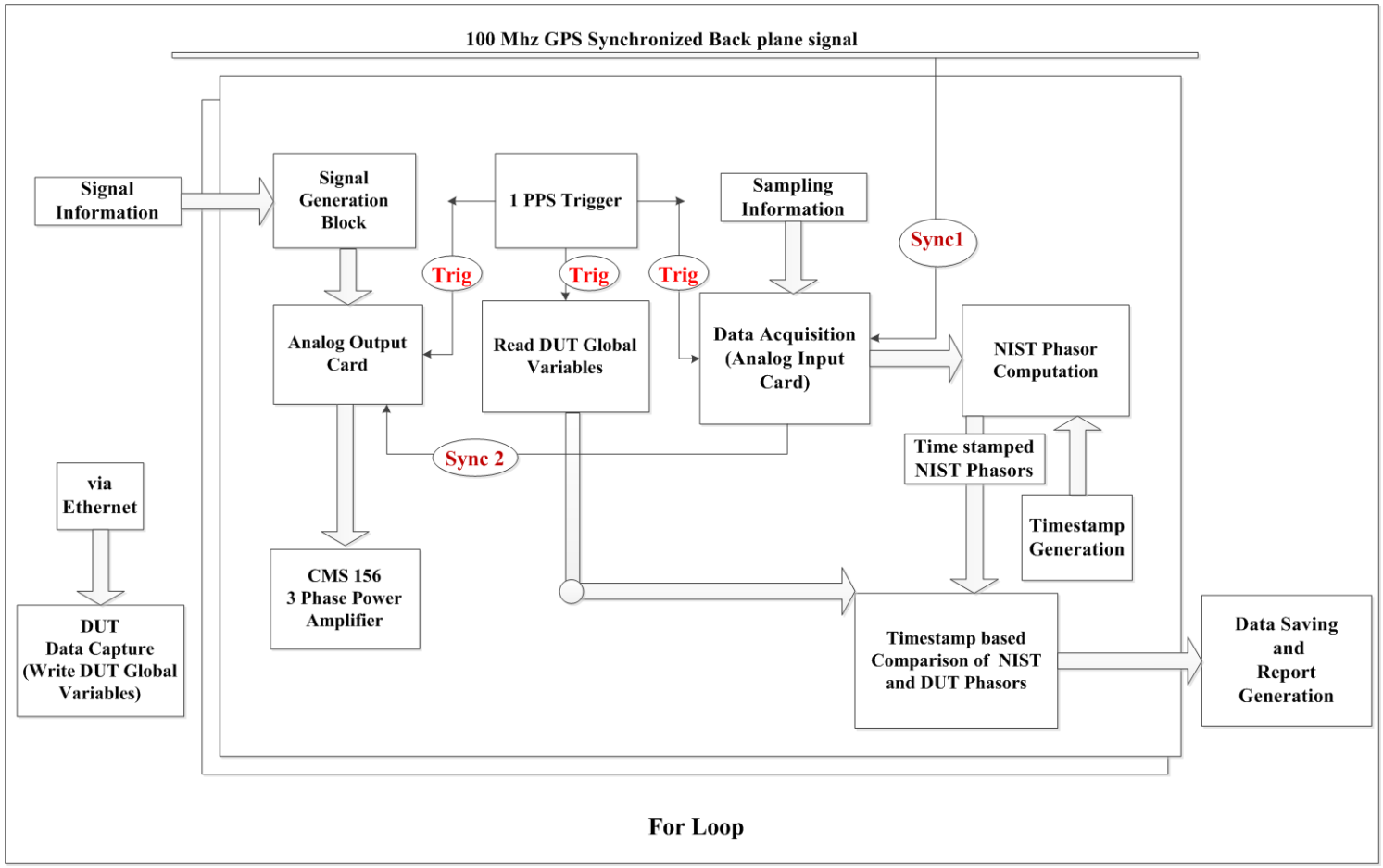

VT System Software Design

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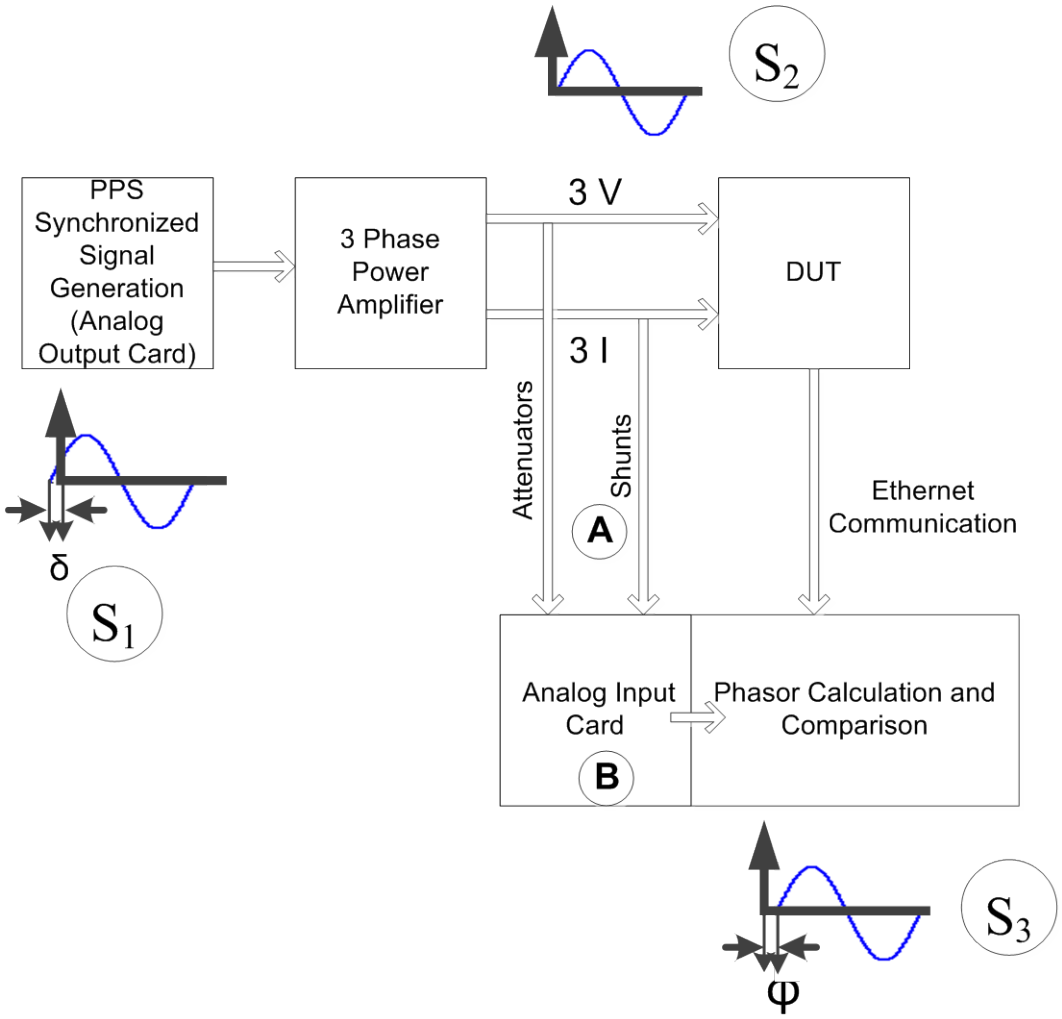
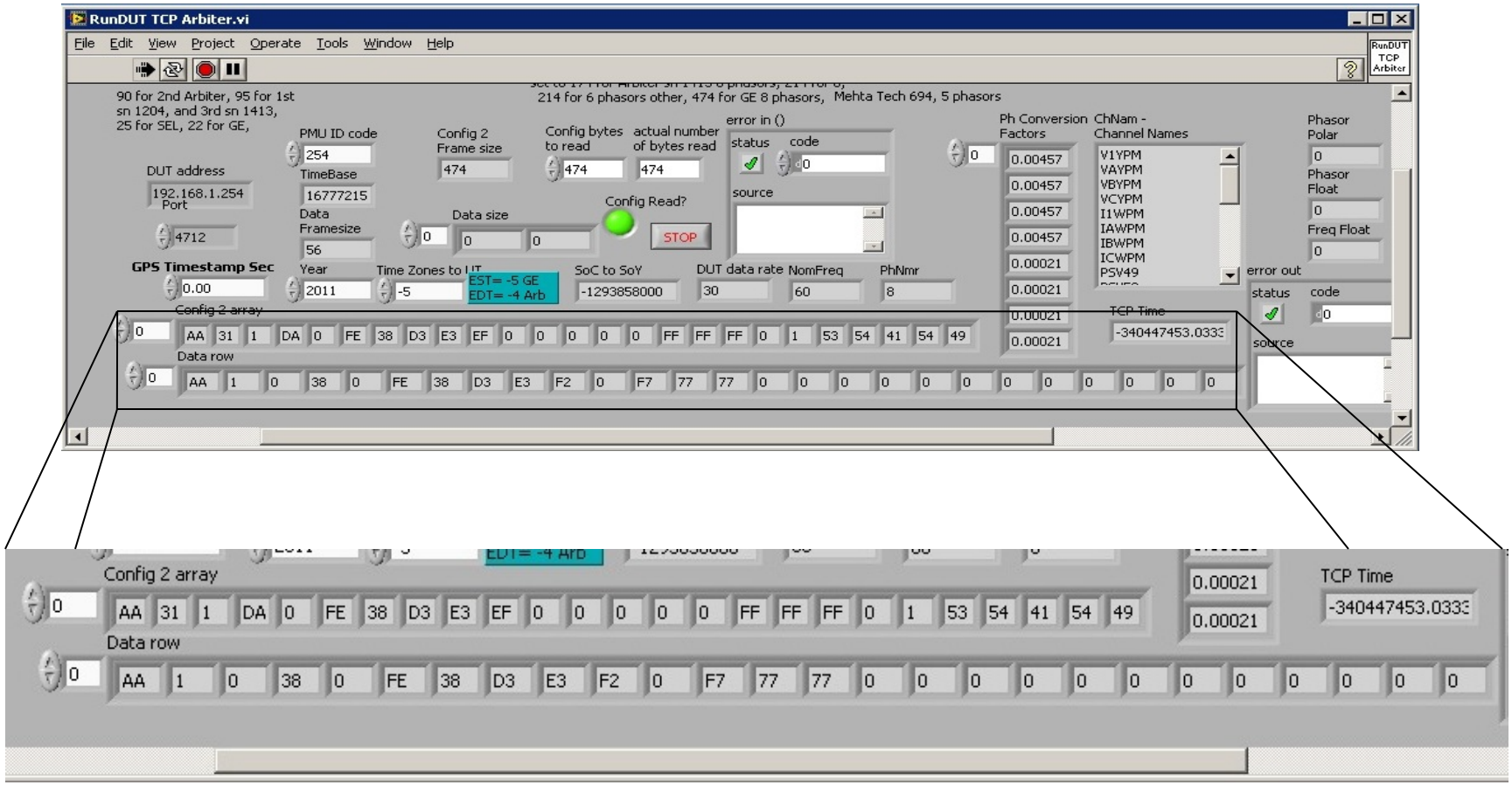


Phase Delay Calibration

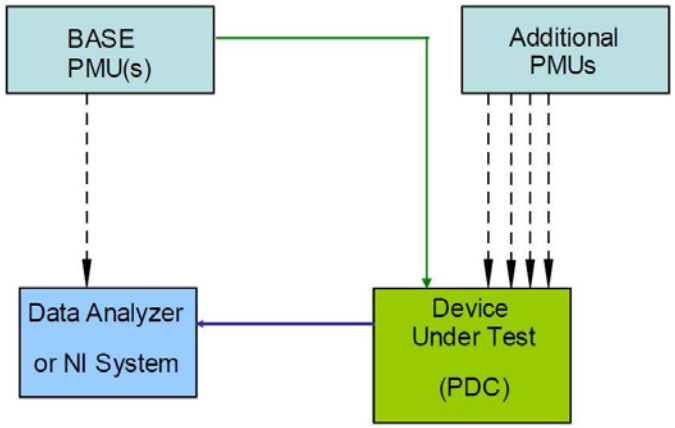
PDC Test System

- Performance Requirements
  - PDC Processing Time
    - Latency
  - Data re-sampling
    - Up-sampling
    - Down-sampling
  - Communication Requirements
    - TCP/IP
    - UDP/IP
    - IP Multicast

Flag/Reporting Rate Check and re-sampling are performed with the PMU Test System



Latency Test System

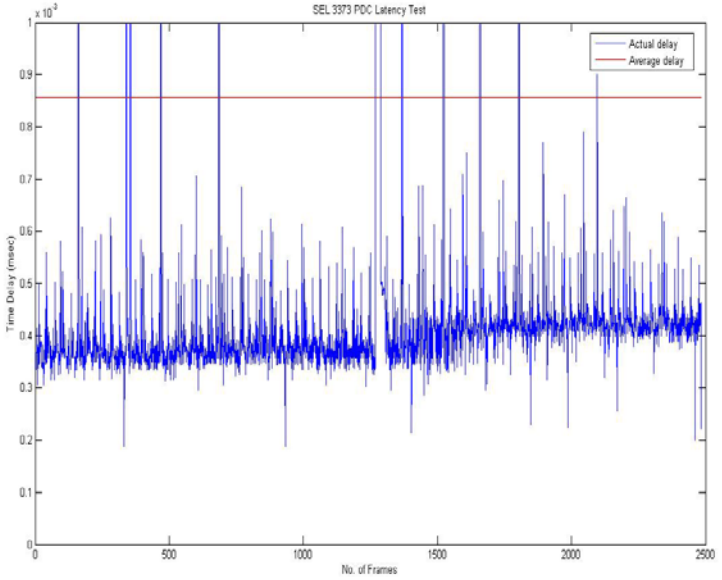


A dual Port PMU is used as a base PMU

Wireshark is used in the Data Analyzer to capture data and compute delays

Initial data shows problem with OS delay

System is being implemented in a Linux OS to reduce OS effects



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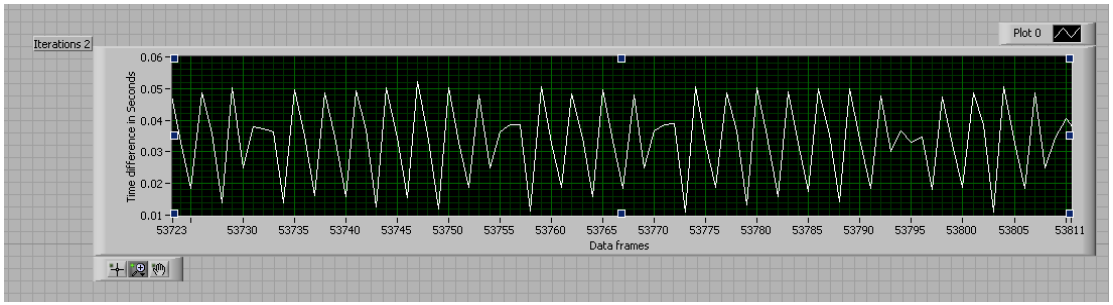
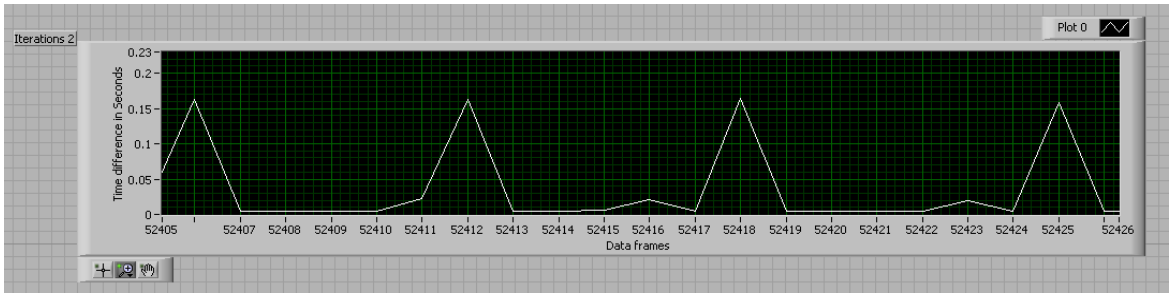
DUT Latency

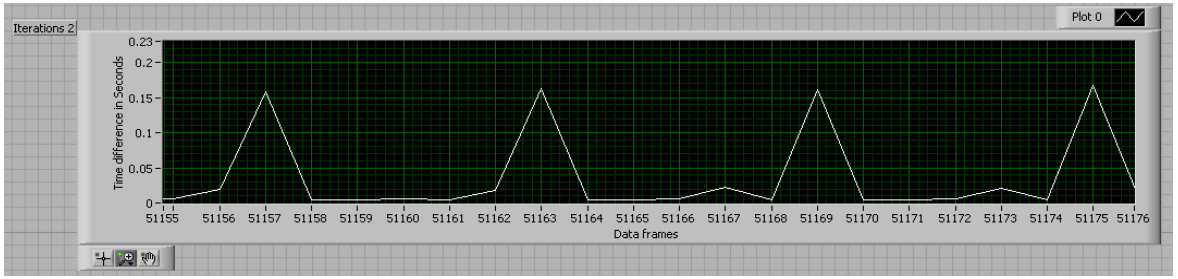
- Time difference between data frames ≠ (1/frame rate)
- Huge delays between data frames



DUT A: Time Difference between data frames(1.5 ms -50ms)



DUT B: Time Difference between data frames(1 ms -150 ms)



DUT C: Time Difference between data frames(1 ms -150 ms)

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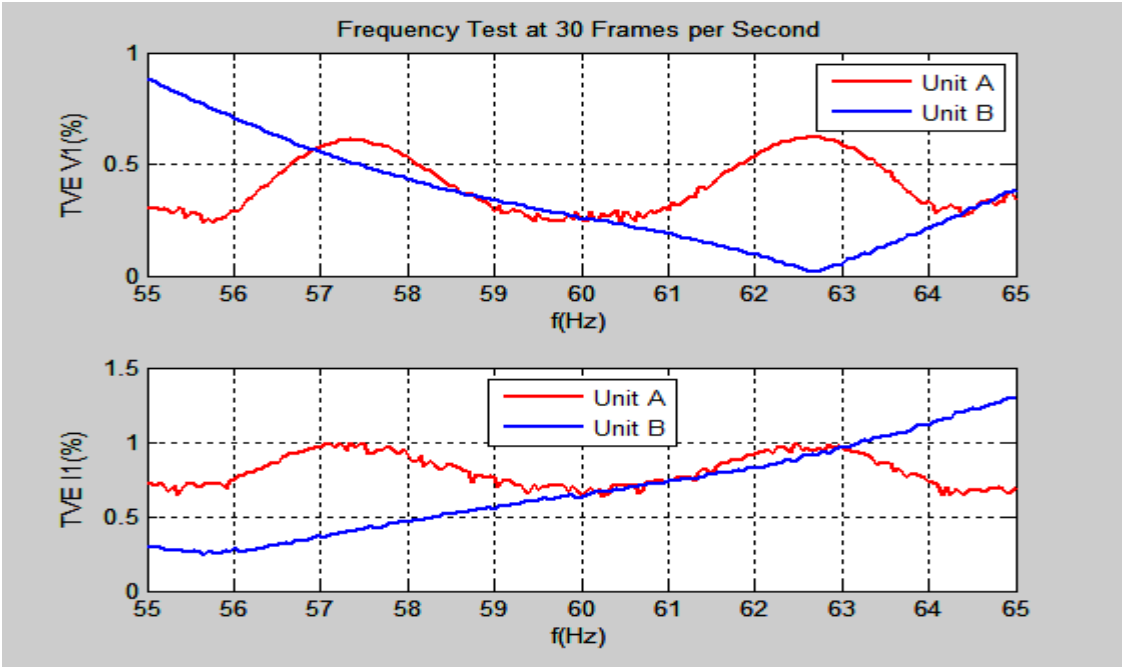

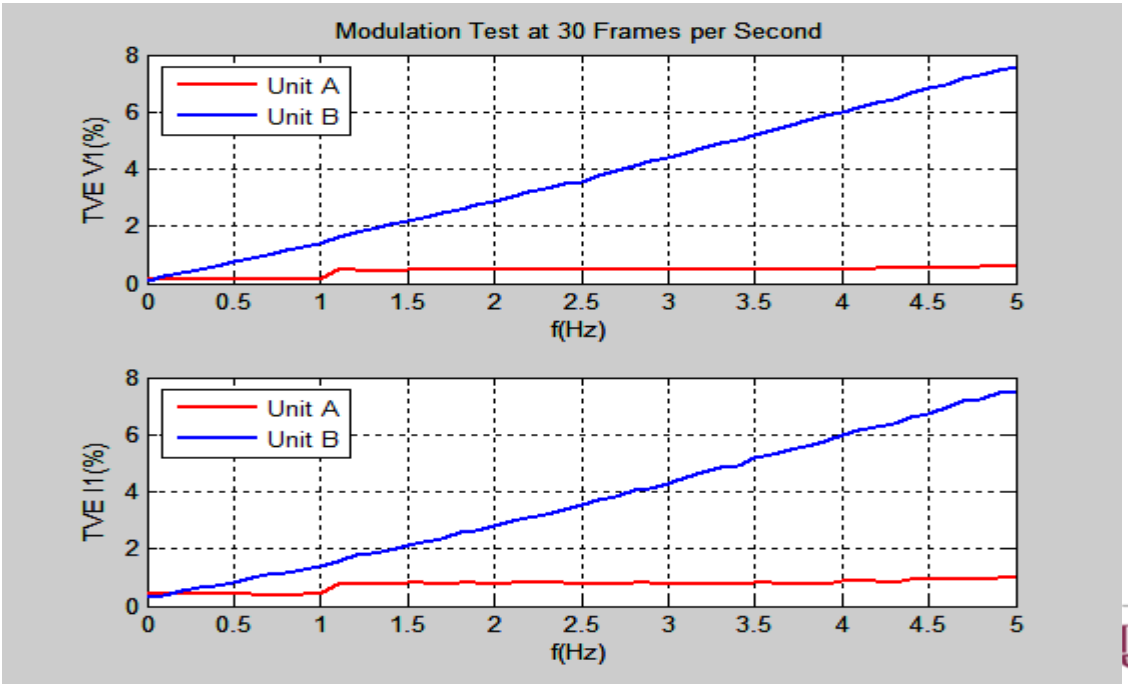

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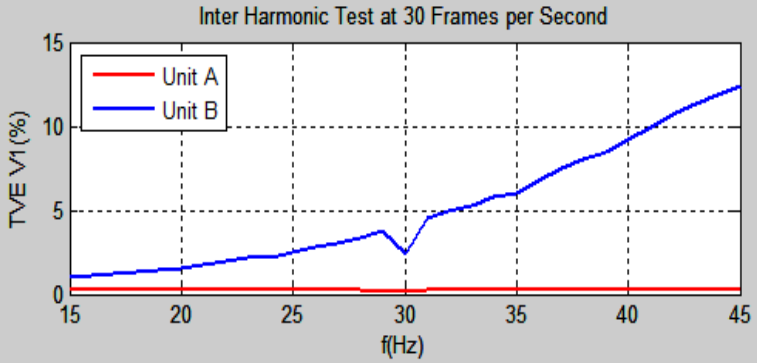

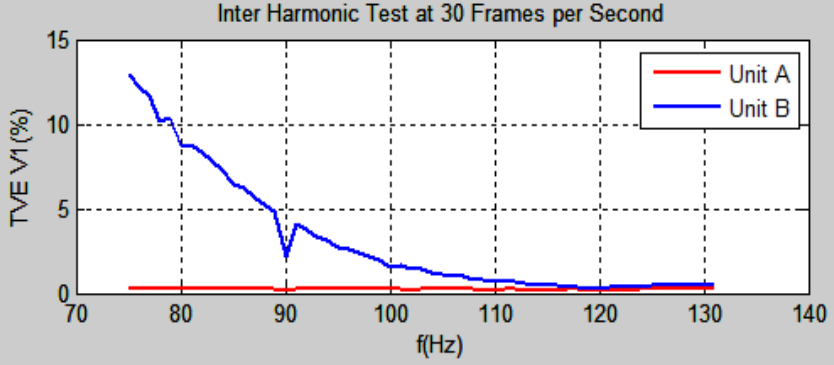

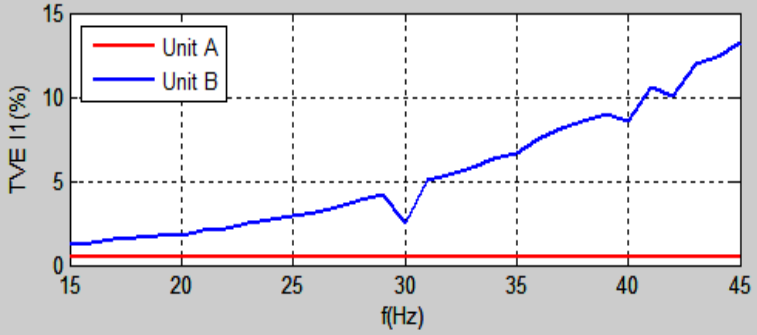

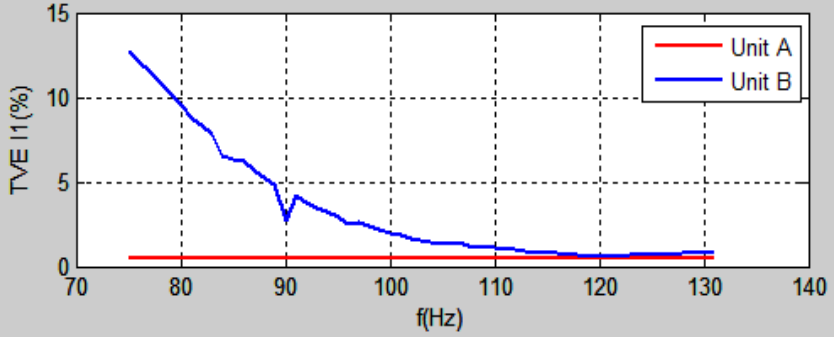

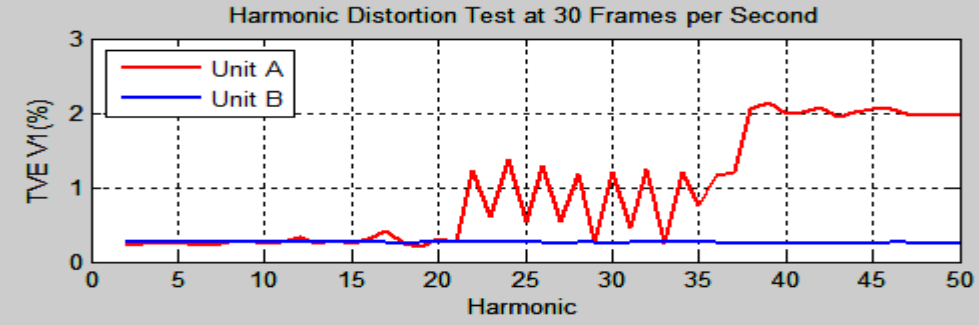

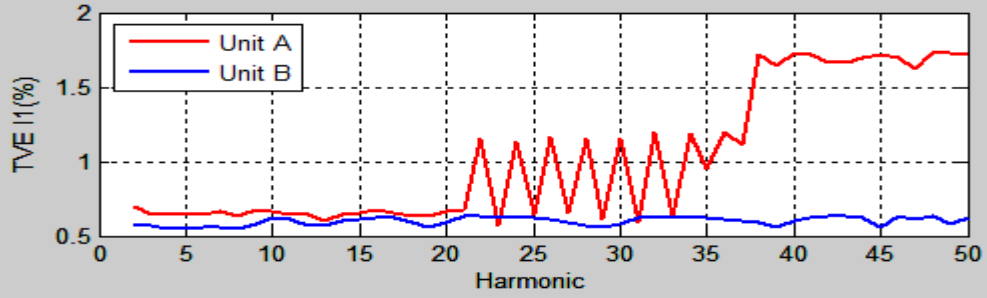

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References

[1] Stenbakken, G.; Nelson, T.; “Static Calibration and Dynamic Characterization of PMUs at NIST”; IEEE Power Engineering Society General Meeting, 2007; pp 1-4.

[2] IEEE Standard for Synchrophasors for Power Systems, IEEE Standard C37.118-2005, March, 2006.

[3] IEEE C37.111-1999, IEEE Standard Common Format for Transient Data Exchange for Power Systems, June 1999.

[4] IEEE C37.118-2011 “Standard for Synchrophasor Measurements for Power Systems”

[5] PMU System Testing and Calibration Guide. Technical Report for NASPI, Performance and Standard Task Team, team leader G.Stenbakken.

[6] IEEE Standard 1588-2002, IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems