LPVT'S – The Missing Enabler

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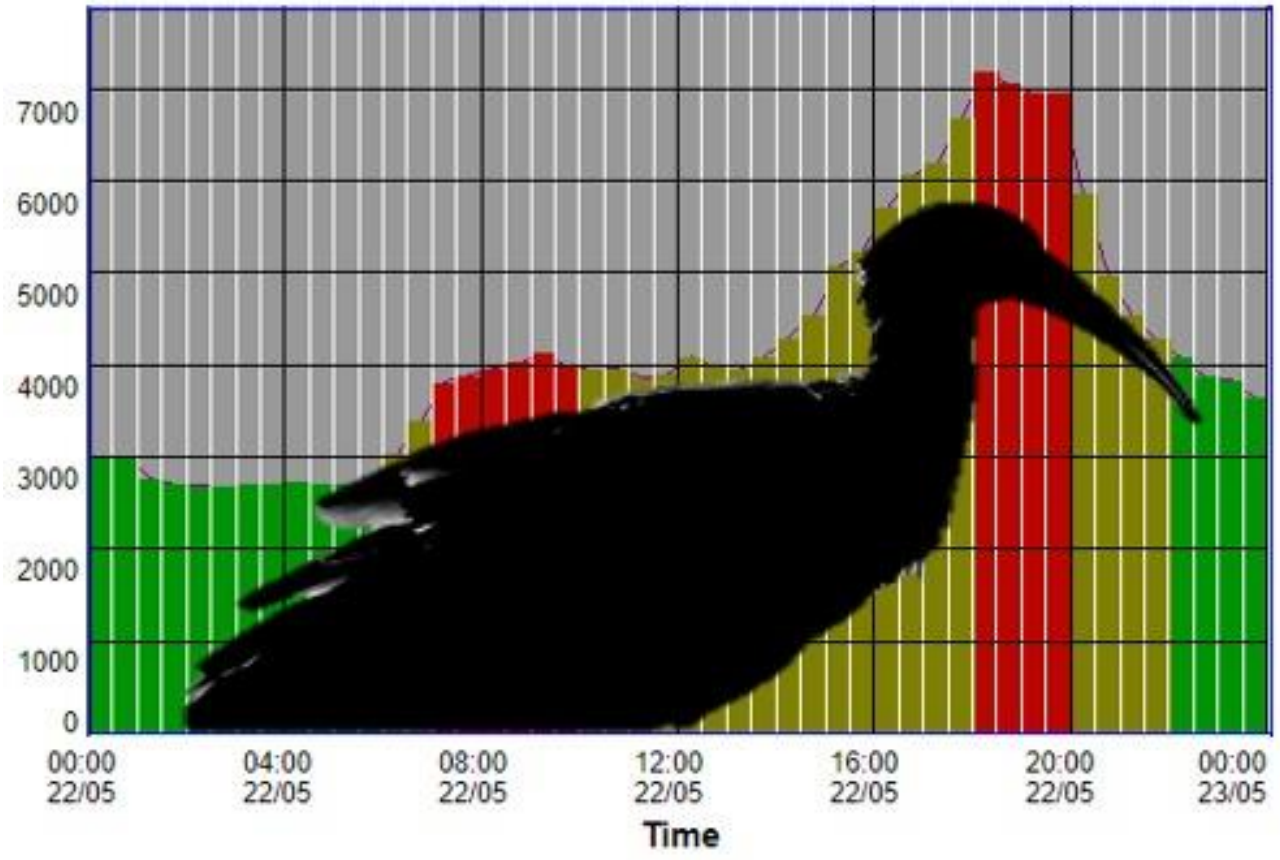
AMEU/SARPA 9 September 2022

Background Problem Statement

- A Drive for Green Energy Adoption
- Higher Levels of Renewable Saturation
- Typical Large Power Users become “Prosumers”



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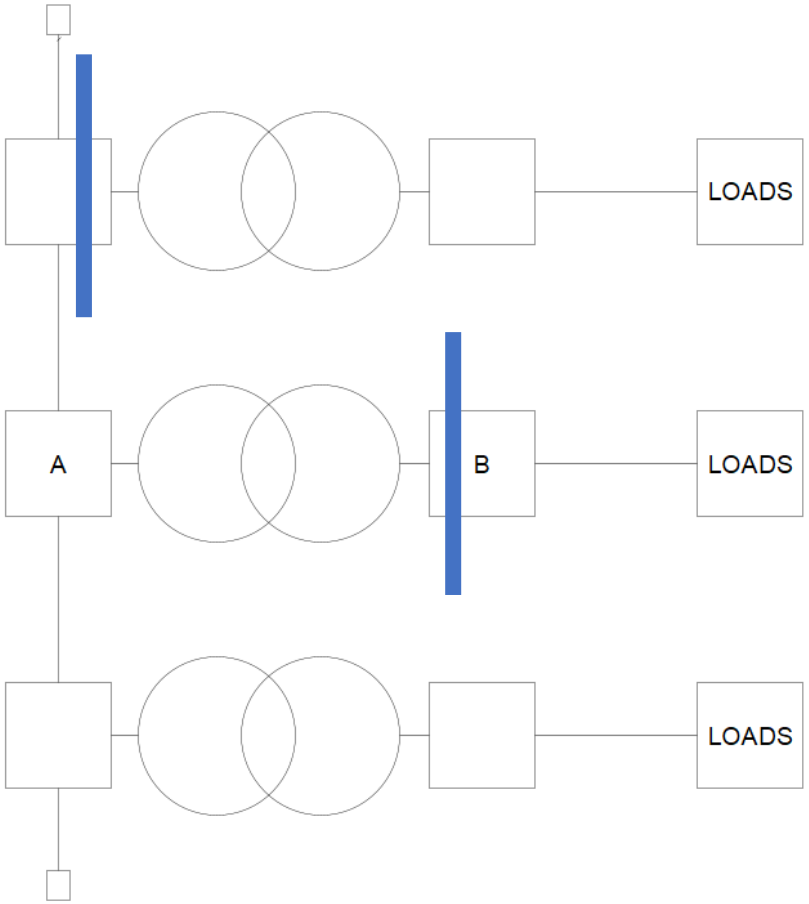
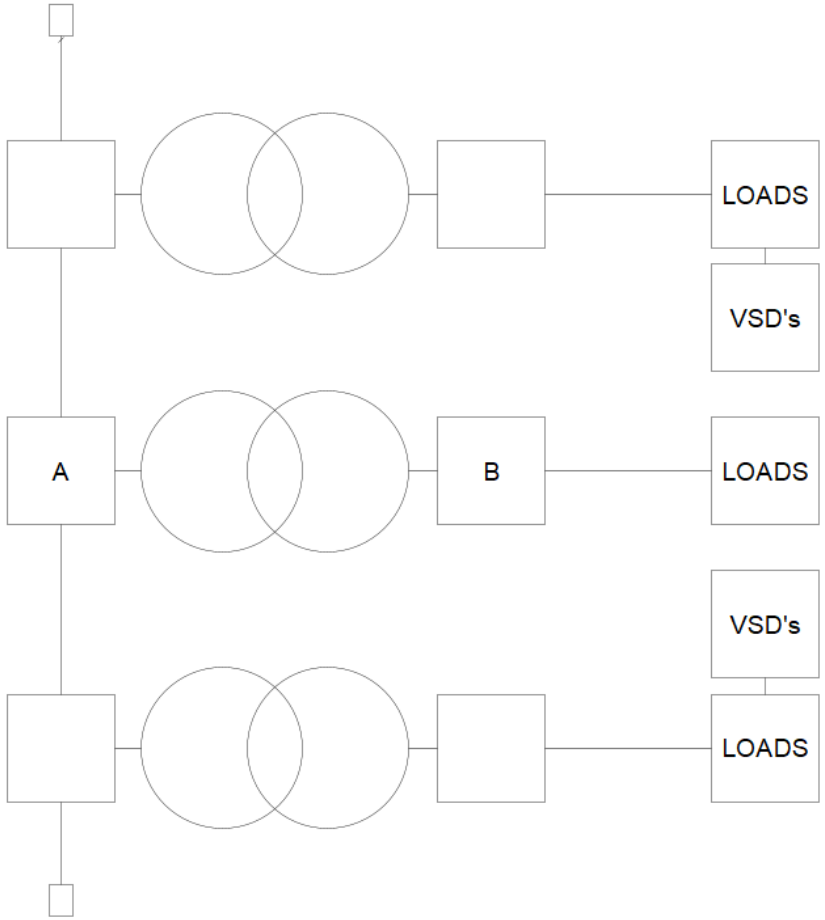
Distribution Network Evolution



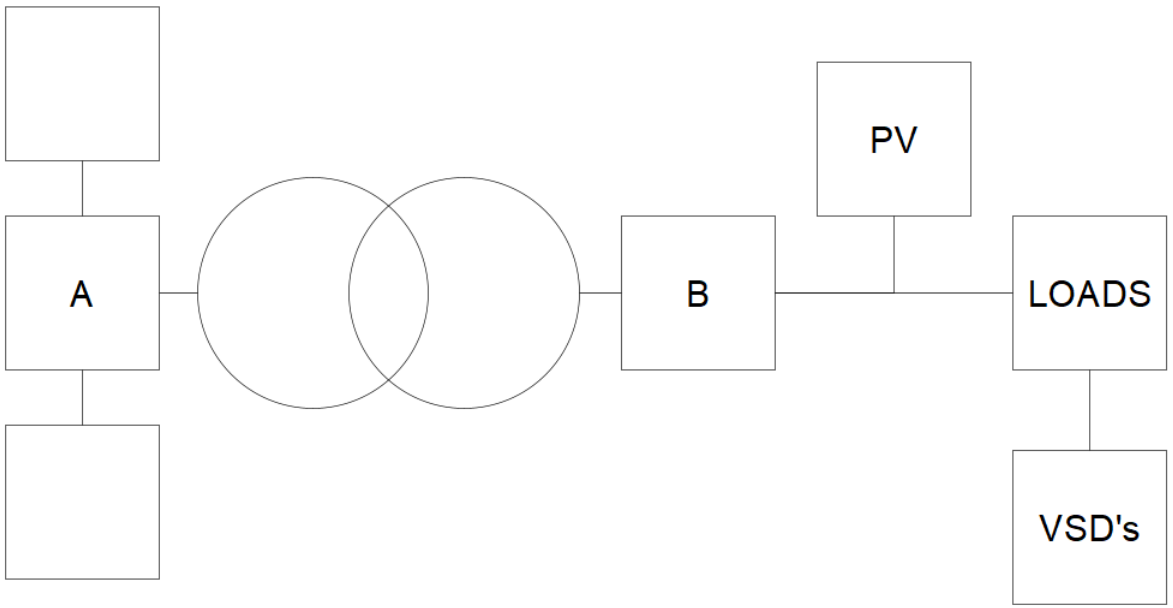
- Mostly Inductive and Resistive Loads

Distribution Network Evolution



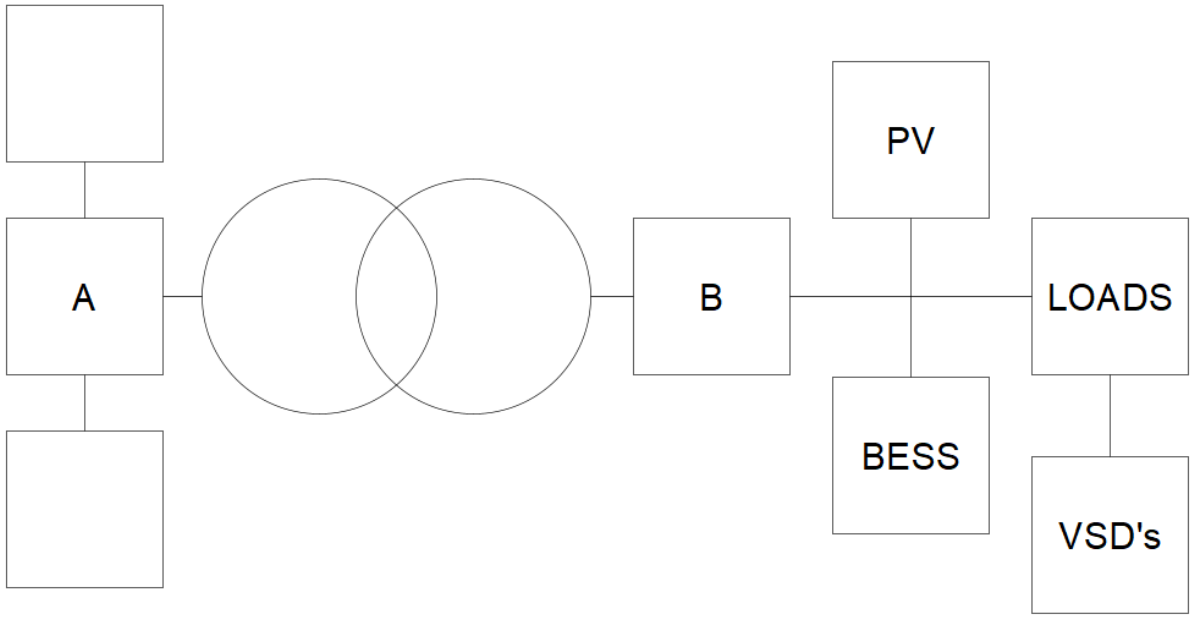
- Introduction of Electronic Loads and Non-Linear Elements together with Inductive and Resistive Loads

Distribution Network Evolution



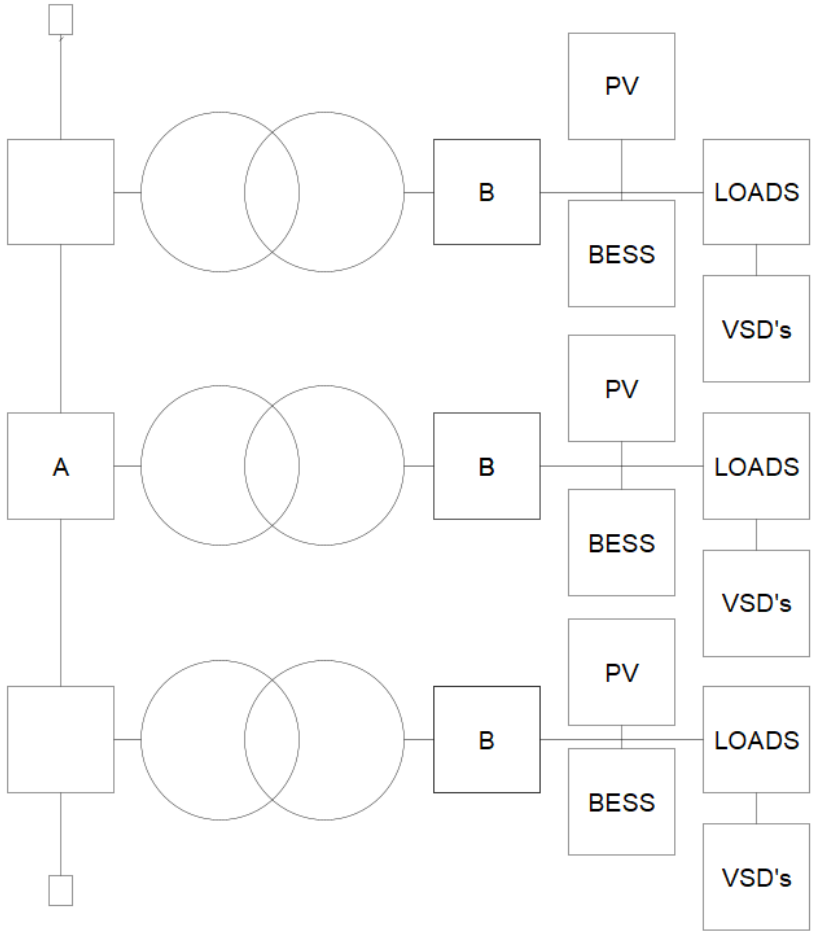
- Then came Solar PV together with Electronic Loads and Non-Linear Elements together with Inductive and Resistive Loads

Distribution Network Evolution



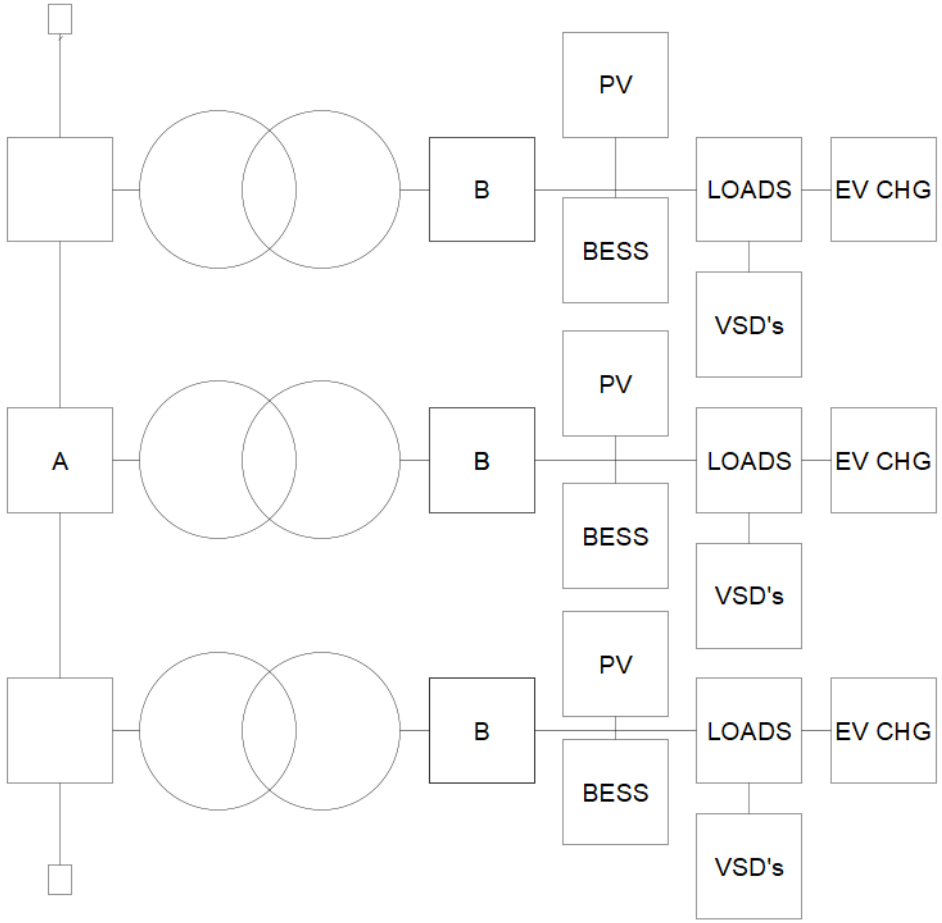
- Now we are in the BESS Era, together with Solar PV, with Electronic Loads and Non-Linear Elements together with Inductive and Resistive Loads

Distribution Network Evolution



- Driving a Green Economy may soon have your network looking like this

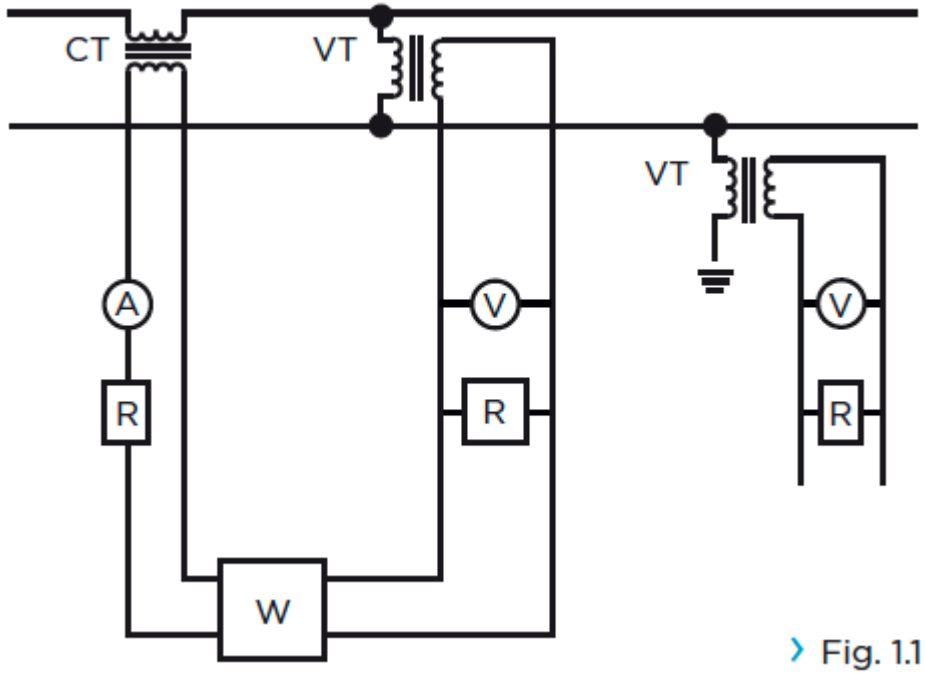
Distribution Network Evolution



- Even V2G potentially

Conventional Instrument Transformers

- Bulky
- Low Bandwidth
- Dangerous to Open-Circuit (CT's)
- Dangerous to Short-Circuit (VT's)



› Fig. 1.1

Pause

“Insanity is doing the same thing over and over again and expecting different results." – Smart Guy

Low Power Instrument Transformers

- The definitive way to measure voltage within MV networks
- Successors to conventional instrument transformers
- Lower-Cost
- Compact
- Broader frequency response
- Easier to Install

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Standards

- Electronic voltage transformers
  - IEC 60044-7
- Low-power passive voltage transformers
  - IEC 61869-11

Low Power Instrument Transformers

Voltage Sensors

Current Sensors

KECA 80 C85

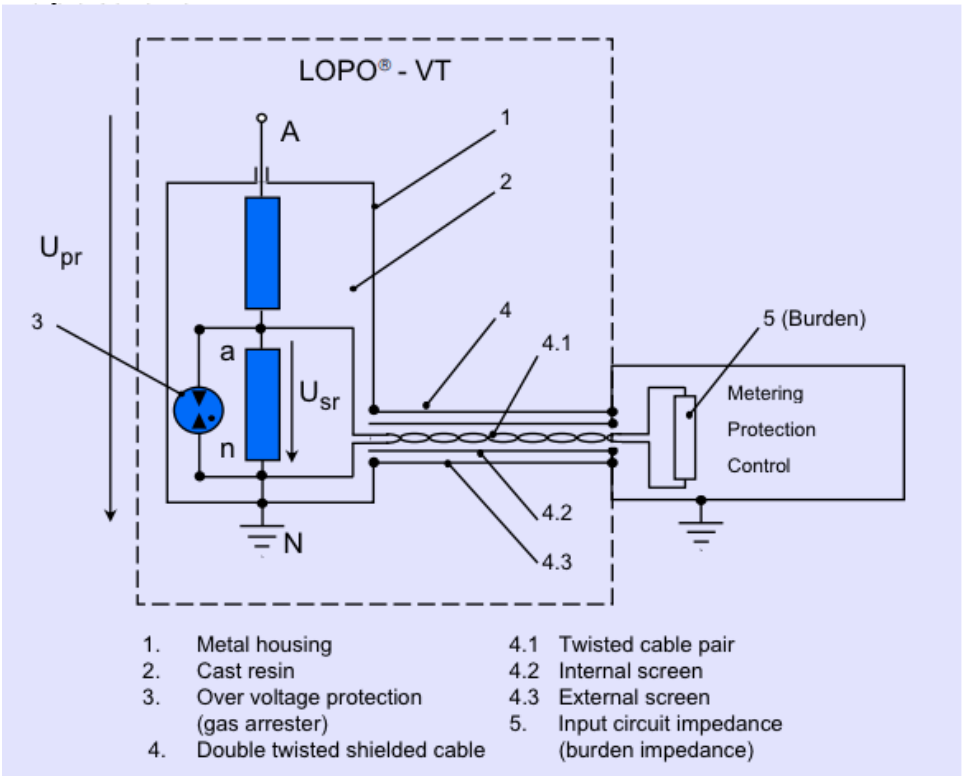
KECA 80 D85

Low Power Instrument Transformers

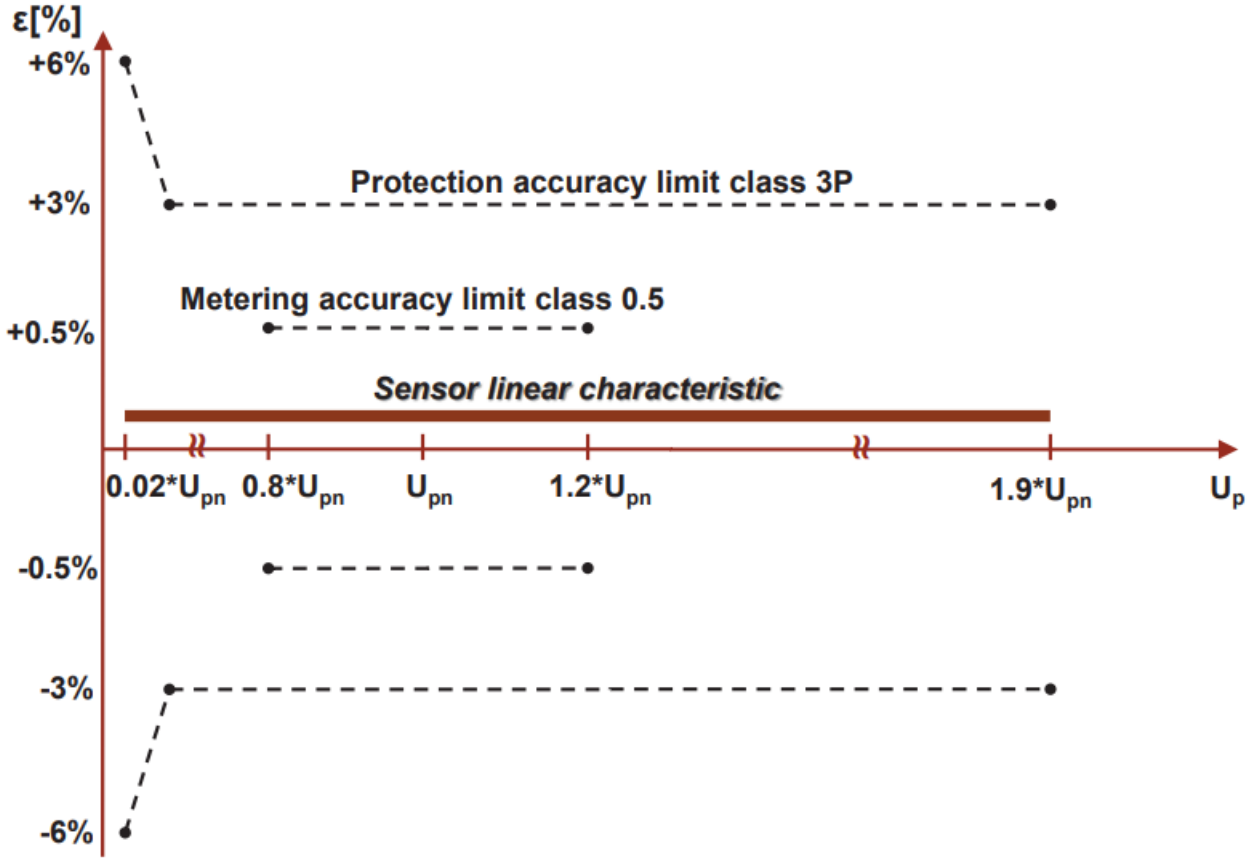
Principle of Operation

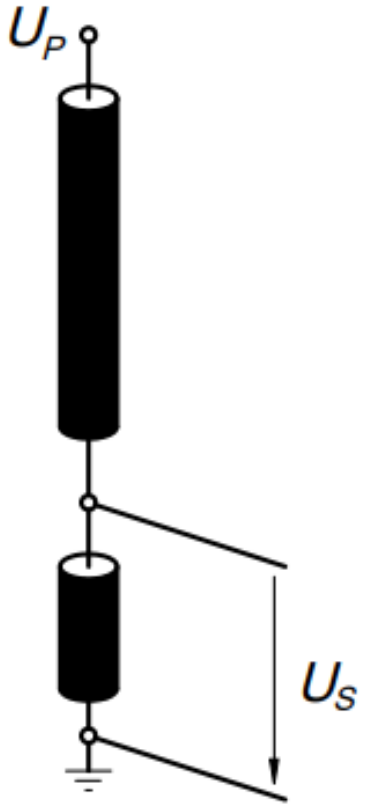
- Linearity
- Reduced resonance impact
- Extended bandwidth
- Smaller in size

LPVT



Principle of Operation



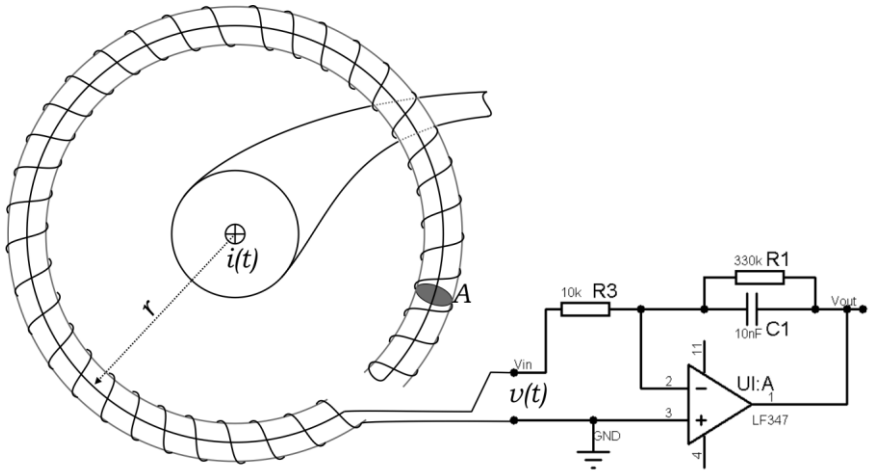


$$U_s = \frac{R_2}{R_1 + R_2} U_p$$

Principle of Operation

- Linearity
- Unsaturable
- Extended bandwidth
- Smaller in size

Rogowski Coil



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CT LAB - LPVT Amplifier

- 100kHz Bandwidth
- Powered from DC
- Output : 63,5 V

CT LAB – VECTO 3 Analyser

- 500kHz Sampling
- Up to 63rd Harmonic (3,15kHz) on traditional plot
- 25kHz Graphs in 200Hz Bands
- IEC61000-4-30 Ed3 Class A
- NRS048 Reporting via VECTO Grid OS (formerly Osprey Pro)

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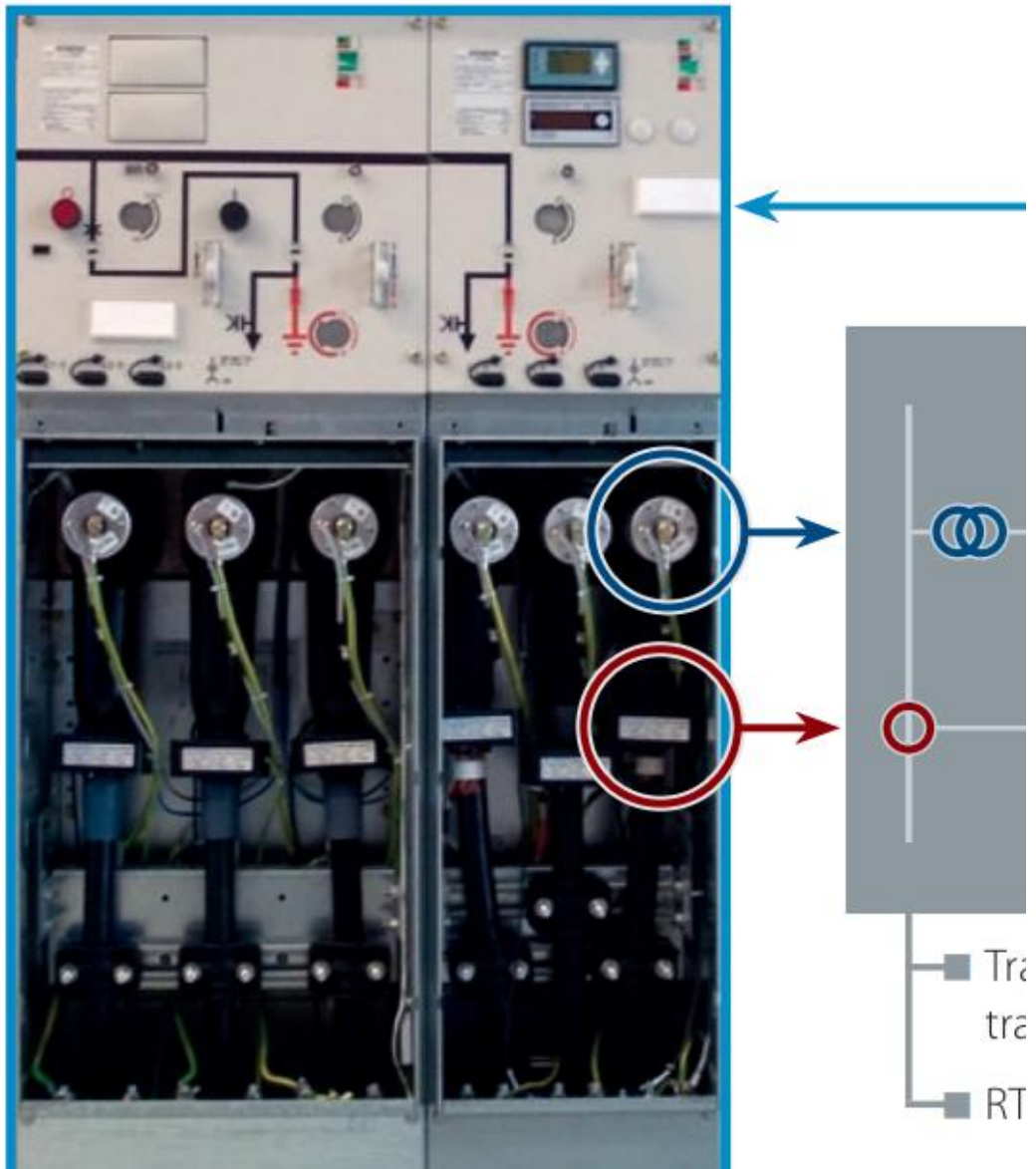
Intelligent Minisub Installation



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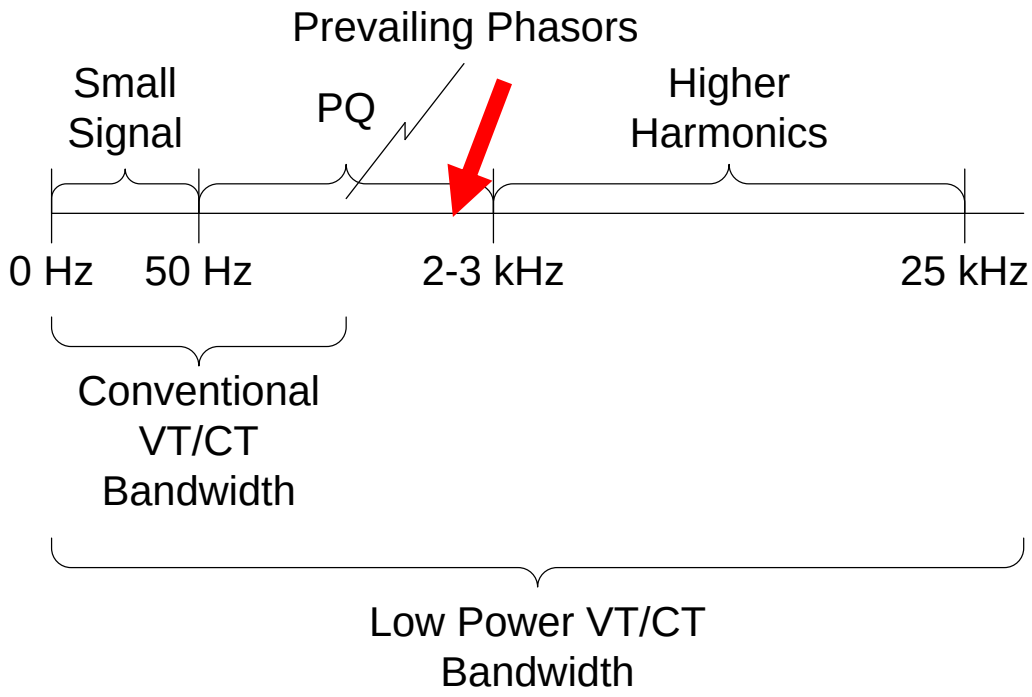
Advanced Datastream

- With the integration of renewables there is a need for advanced datastreams in technology for operation, analysis, control and management of renewable sources
- Advanced Datastreams:
  - Conventional PQ
  - Small Signal Oscillations – for stability analysis
  - Prevailing phasors – to identify harmonic sources
  - Higher order harmonics
  - Synchrophasor
- Need broadband sensors (VTs & CTs)
  - Low Power VT/CT

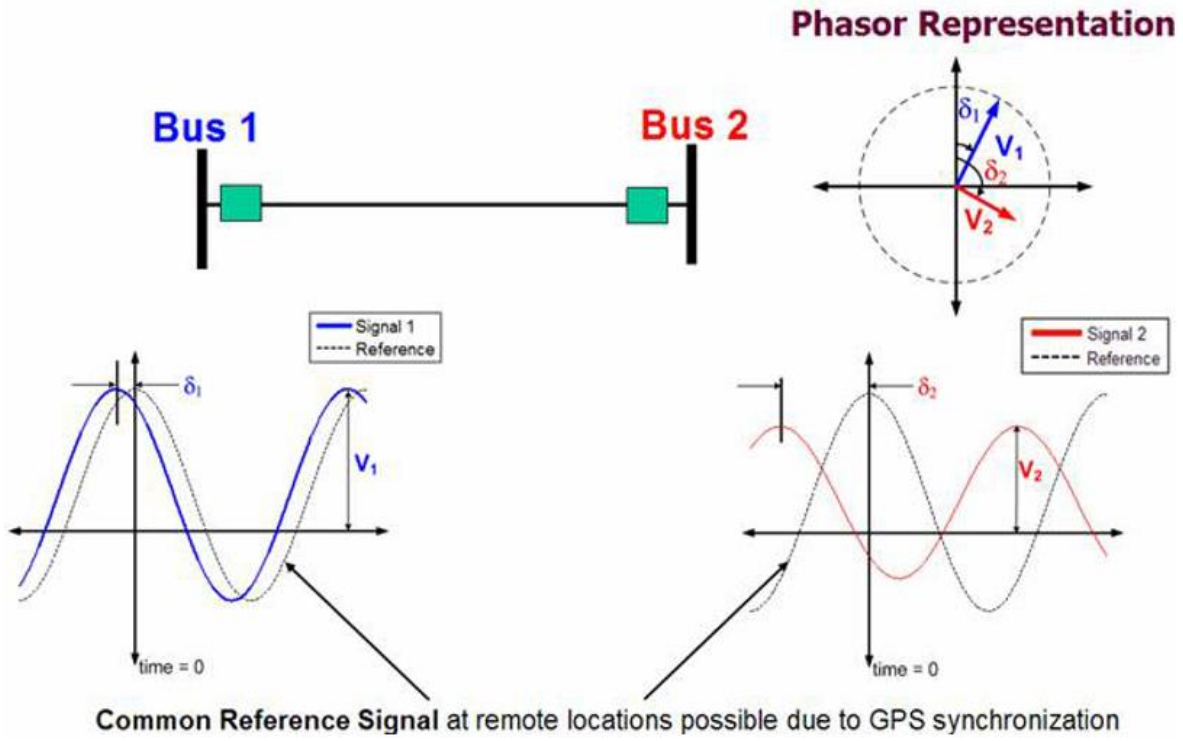


Phasor Measurement Unit (PMU)

What is a PMU?

- Estimate phasor quantities (magnitude & phase angle) of electrical signals
- Time synchronization is usually provided by GPS and allows synchronized real-time measurements of multiple remote points on the grid.
- Resulting measurement is known as a synchrophasor

- 1 sample per cycle
- Implemented dedicated PMU protocol
- Streamed to control room and requires dedicated software to visualise/analyse



Common Reference Signal at remote locations possible due to GPS synchronization

Small Signal Oscillations

What are small signal oscillations?

- Subsynchronous oscillations in Australia
- Stability issues specifically of concern in weak networks, with high level of renewable penetration
- Generation sources start oscillating (at +- 19 Hz) with rest of the power system
  - Amplitude
  - Phase
  - Normally in bursts/pulses
- Can cause control systems to become unstable

- Small signal stability analysis has become internationally a topic of discussion
- There is a need for a tool that can accurately (and with much lower data rate compared to synchro-phasors) identify and analyse grid oscillations

What new functionality does analysis of Small Signal Oscillations bring?

- Identify amplitude, phase angle and frequency of oscillation
- Identify contribution of a source with phase angle information
- Profile/trend oscillation data for analysis

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Small Signal Oscillations – Spectrum

1s Interval – 1 Hz Resolution

- Raw waveform window size = 1s
- Store first 60 values
  - @ 1 Hz Resolution
  - Amplitude and Phase Angle
- Fast data stream
  - Describes the dynamic behaviour

10s Interval – 0.1 Hz Resolution (HD)

- Raw waveform window size = 10s
- Store first 60 values
  - From a user defined frequency
  - @ 0.1 Hz Resolution (i.e. 6 Hz range)
  - Amplitude and Phase Angle
- Slower
  - But with 10 times higher resolution

- Expensive parameter
- To be used once an oscillation is identified using a monitor (Diagnostic)

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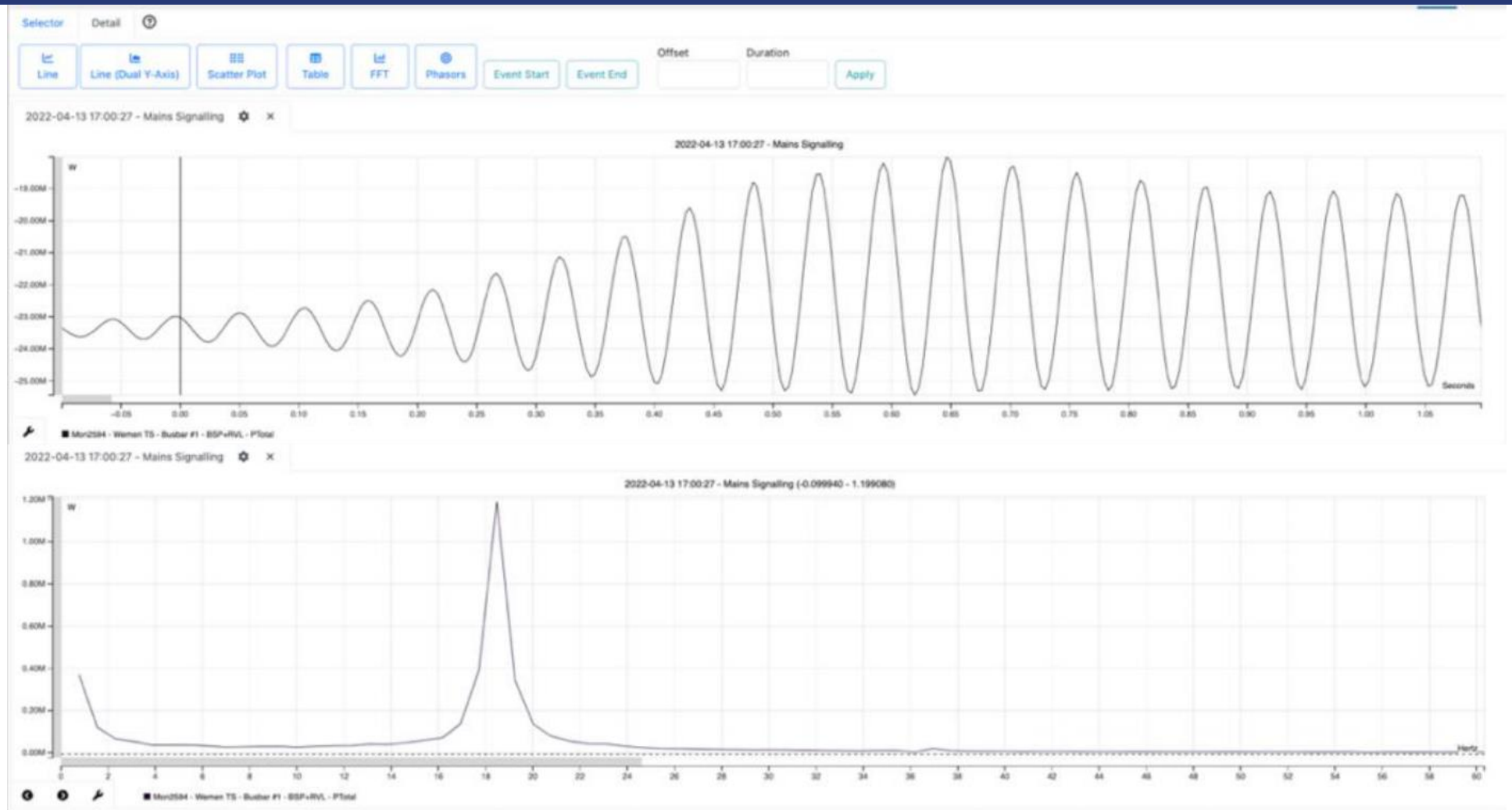
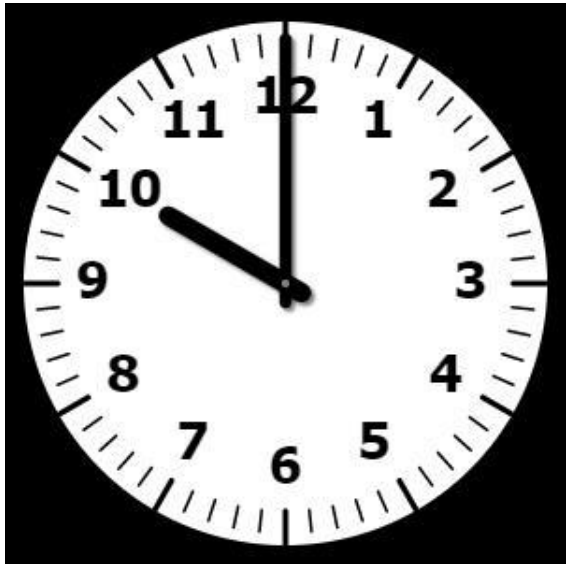
Example of Data found



Complimentary Online Training

Topic: Voltage Waveform Quality Assessment



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Questions? – Thank You

VECTO 3

Power Analyser | Power Quality Analyser | Micro Synchrophasor Analyser | Digital Fault Recorder | Modbus, DNP3, IEC61850 protocols

The grid-monitoring edge computer