Report to the CIGRE Australian Technical Council

Study Committee SC A3 and Australian Panel AU A3 activities

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AU A3 Report 2025

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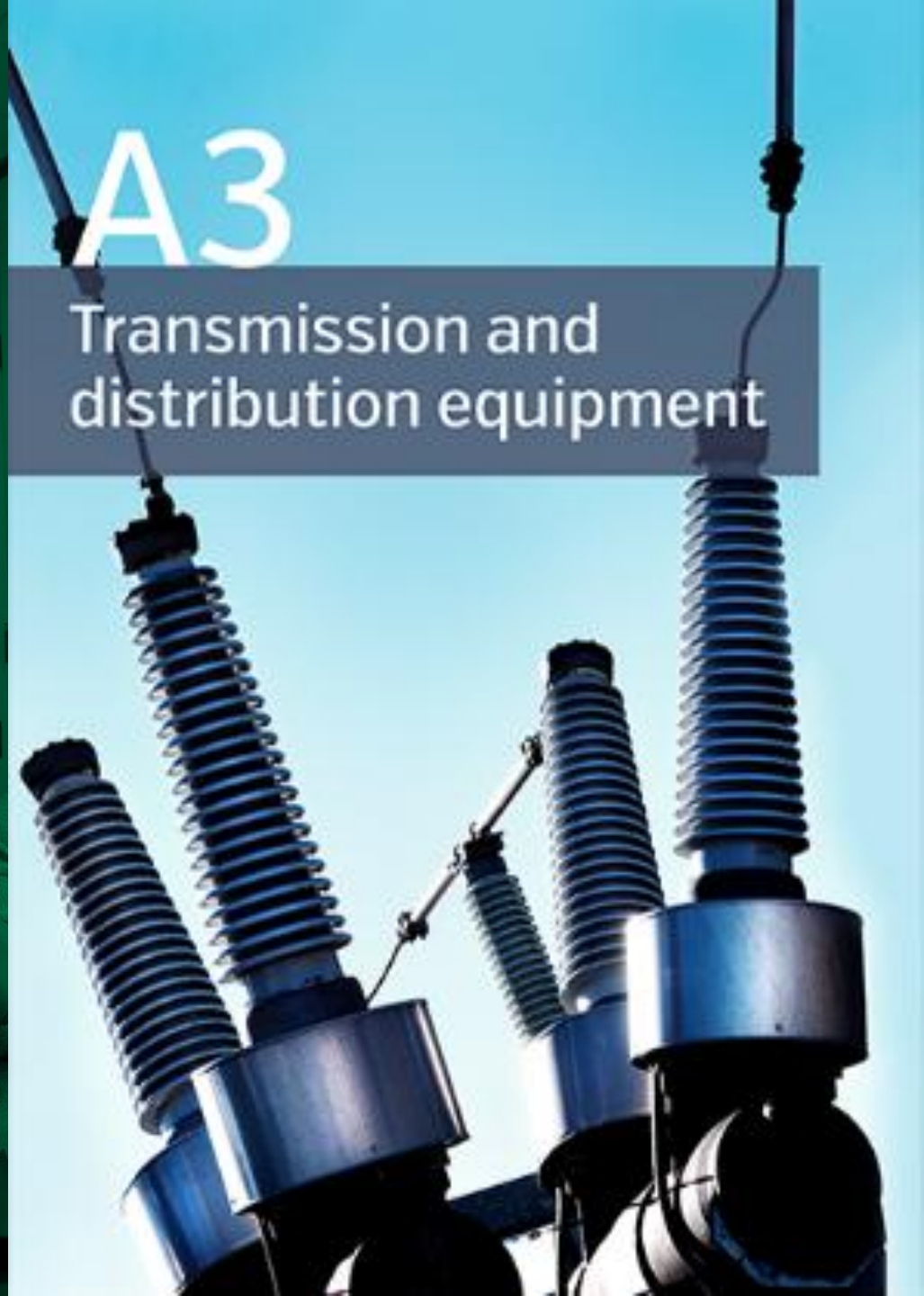
cigre

For power system expertise



SC A3 Themes

Scope

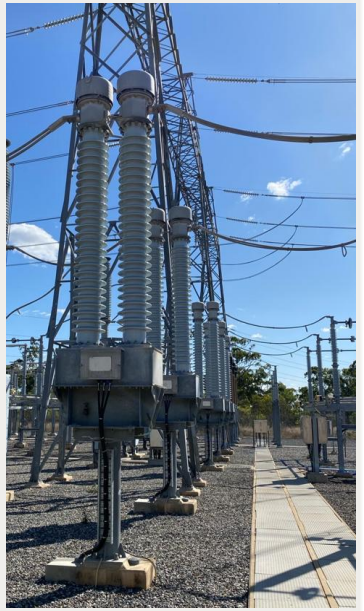
- SC A3 is responsible for AC and DC T&D equipment. The scope covers the full asset life cycle: **Conception → R&D→ Design → Production → Operation → End-of-Life**
- Focus areas:
  - Technical, safety, economic & environmental aspects
  - Integration with the evolving power system
  - Performance, testing & specification
  - Life cycle assessment & risk management
  - Education & training

Equipment covered: Switching Equipment, Instrument Transformers, Surge Arresters, Capacitors, Bushings, Insulators, GIS, Fault Current Limiters, Power MVTs.

Key Priorities

- Impact of inverter-based and intelligent technologies
- Changing power flow and increased equipment stresses
- Influence of severe weather on the equipment
- Reliability improvements, advanced monitoring and metering
- Interaction with future networks and distributed generation
- Deregulation and energy flow optimization
- Development of MVDC, HVDC, and larger capacity equipment




SC A3 Themes

Key Priorities *(Cont'd)*

- New switching devices, fault limiters, and insulation (SF6 free) technologies
- Life cycle management, diagnostics, and environmental concerns
- Energy storage including batteries, hydro pump storage and hydrogen
- Addressing industry skill gaps through training and education

SC A3 Snapshot

SC A3 Structure

Chairman:
Nicola Gariboldi (ITA)

2 Secretaries
Frank Richter (GER), and
Paolo Mazza (ITA)

Members:
24 regular members
16 observer member
6 additional members

Technical work:
3 Advisory Groups
13 Working Groups
2 Preparatory Task Forces

Other:
Participation of approx, 250 experts,
3 % from NGN

SC A3 Preferential Subject 2024 - 2026

- **PS1: Transformation of T&D equipment for evolving grid condition**
  - Innovative current limiting solutions for distribution & transmission networks
  - Innovation in and field experience of T&D equipment to enhance system flexibility, resilience, stability and connectivity
  - Application of T&D equipment in meshed DC-grids.
- **PS2: Sustainability and circular economy of T&D equipment**
  - Use of recycled material and refurbished components in T&D equipment.
  - Alternatives to SF6 and field experience in applications; impact of PFAS regulations on T&D equipment design
  - Impact of low power instrument transformers and smart sensors
- **PS3: Asset management of T&D equipment**
  - Integration of sensors in T&D Equipment for enhanced monitoring
  - Efficient data management and information sharing for T&D condition assessment
  - Utilizing digital twins, IoT, and AI for T&D equipment management.

SC A3 2025 Events

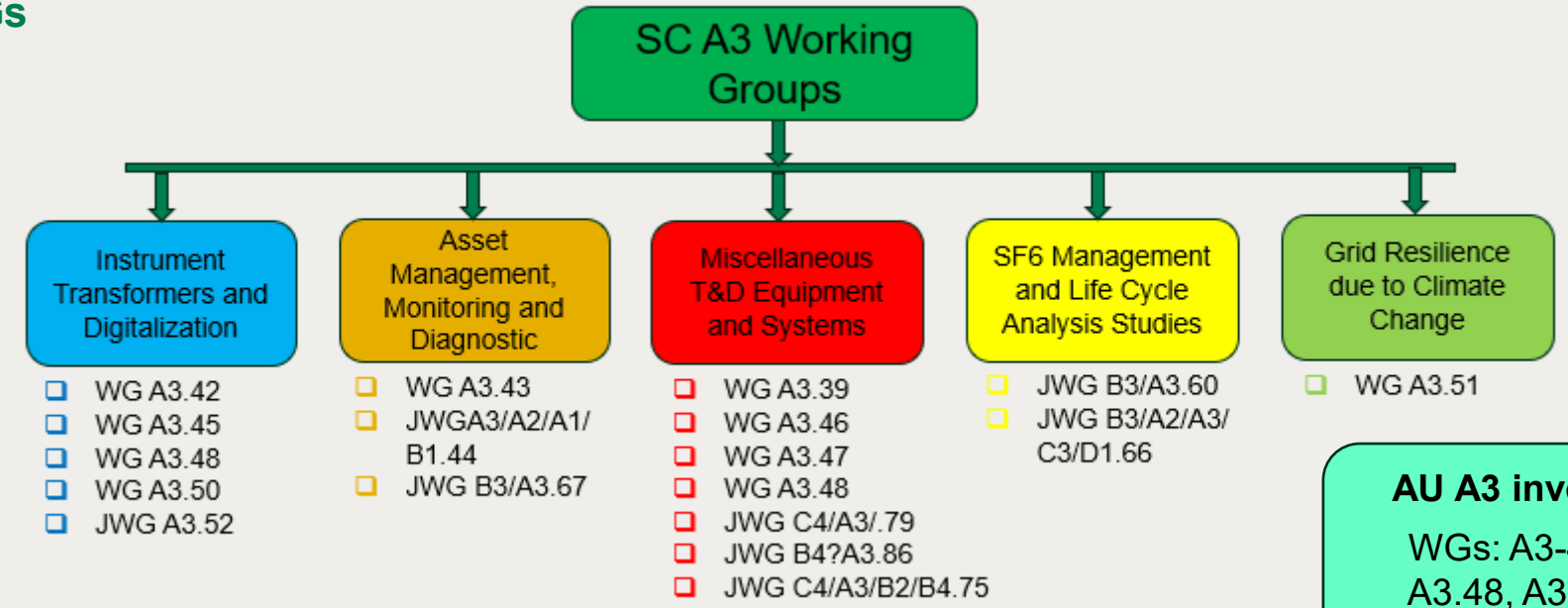
- Klingenberg (Germany)
- Trondheim (Novey)
- Montreal (Canada)

SC A3 Future Events

- 2026 Paris France)
- 2027 Bangkok (Thailand)
- 2027 Tokyo (Japan)

SC A3 Working Groups

Ongoing WGs



AU A3 involvement in WGs

WGs: A3-42, A3.43, A3.46, A3.48, A3.49, A3.50, A3.51 A3-47

New Approved WGs - *Looking for experts*

WG / JWG	Number	Title	Convener name (location)
JWG	A3/D2.52	Application of Digital Twin in Switchgear	Mantilla Javer (CH) javier.mantilla@hyundai-electric.ch
JWG	A3/A2/B3/B4/C4.53	Inductive load Switching in Transmission and Distribution systems	Heinrich Christian (GER) christian.heinrich@siemens.com

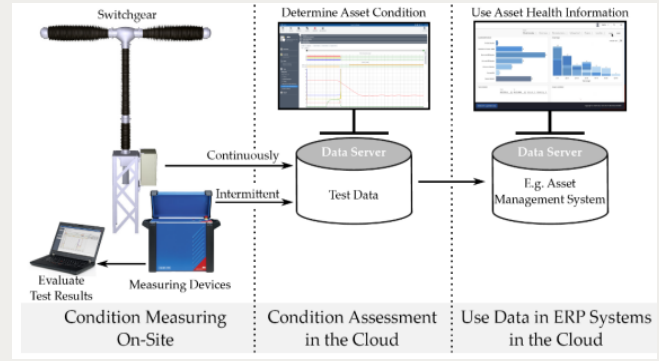
The Terms of Reference (TOR) for ongoing and new Working Groups (WGs) are available at: http://www.cigre.org/

SC A3 Publications

Technical Brochures

TB 953 - Tools for life cycle of T&D switchgear based on data from condition monitoring

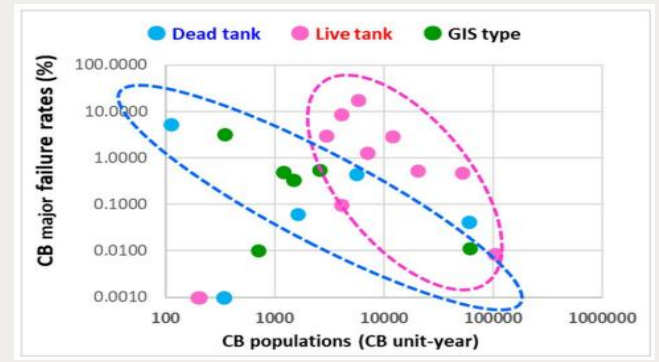
- Technical Brochure on circuit breakers, reclosers, and fault interrupters
- Methodology for assessing switchgear condition
- Considers mechanical, dielectric, and electrical degradation factors
- Aims to promote standardized evaluation and maintenance practices



TB 947 - Fourt CIGRE international reliability survey on equipment operated in 2014-17 - Part 1: General results on T&D equipment

- Fourth CIGRE reliability survey covering multiple equipment types
- Comparison with previous survey results
- Indicates strong service reliability and fewer major failures

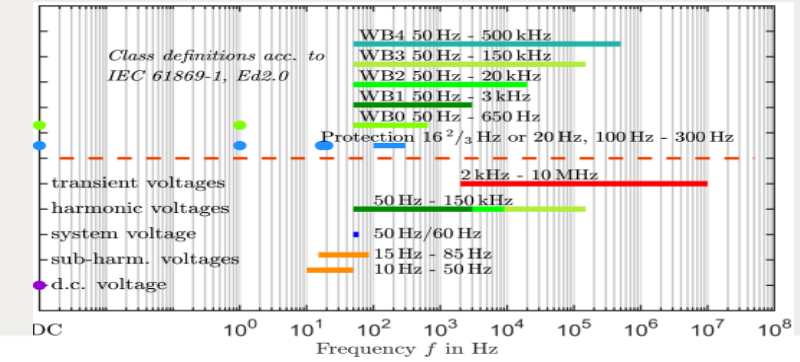
https://e-cigre.org/home.asp



Tutorials (Presented at Montreal Symposium)

A3.45 - Methods for determining the frequency response characteristics of voltage measurement systems

Focus: Covers conventional and low-power voltage transformers, assessing their performance across frequencies. Addresses modern grid requirements, provides testing and modelling guidance, and supports application-specific technology selection.

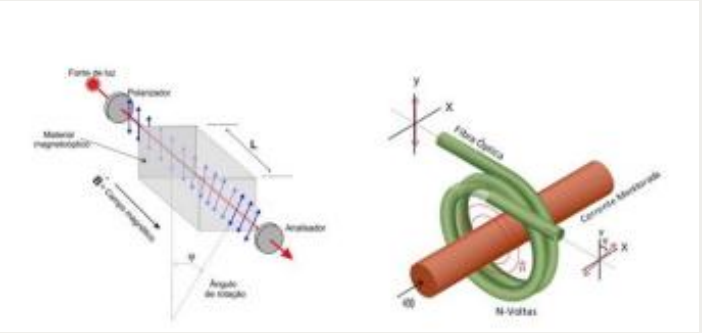


SC A3 Publications

Tutorials *(Cont'd)*

A3.50 - On-site calibration and verification of the accuracy of instrument transformers

Focus: Examines the accuracy of instrument transformers for voltage, current, and energy measurement, comparing well-established laboratory calibration methods with the more limited on-site calibration experience.



Update on SF6 Alternative Equipment

- Already available
- Under development and Testing
- Future Development

	LTCB	DTCB	GIS	GIL	IT
CO2+O2	72.2kV;145kV; 420kV; 245kV 550kV		420kV	NA	NA
C4FN	NA	72.5kV;145kV; 550kV; 245kV;	72.5kV;145kV; 420kV; 550kV;	420kV	
N2/O2	72.5kV;145kV; 245kV;420kV; 550kV	72.5kV;145kV; 245kV;420kV; 550kV	72.5kV;145kV; 245kV;420kV; 550kV	420kV; 550kV	72.5kV;145kV;245kV; 420kV; 550kV

Figure 7 - Comparison between the CO_2/O_2 breaker(left) and the SF_6 breaker (right)

Australian Panel AU A3 – Transmission & Distribution

The AU A3 Panel Meeting: Adelaide 5th September 2025

Currently 27 members, 2 new representatives (2 x NGN)

- The AU Panel has representatives from both AU and NZ

Current 2025-26 AU A3 Panel Focus Areas

- Reduction of life cycle costs, placing more emphasis on reliability, condition monitoring and increased life expectancy
- Digitalization - digital interfaces for field to improve data input, efficiency and accuracy - data management and Health Index
- SF6 management and mitigation strategy to reduce SF6 emission
- SF6 alternative - Trial projects, Transpower, Ausgrid, Transgrid, Essential Energy
- Renewable projects, solar, wind, BESS batteries and impact to HV equipment
- Control Switching (Capacitor Banks, Reactors, Lines and Transformers)
- Equipment availability, long lead times
- Spare part management, obsolescence for legacy breakers
- Medium Voltage switchgear lifetime management
- Data management and Health Index
- Equipment failures issues - *refer to next slide for CTs*

Australian Panel AU A3 – Transmission & Distribution

CTs Failures

Incident: Explosive CT failures caused tank rupture, fire, and damage to nearby equipment — creating safety, environmental, and supply security risks

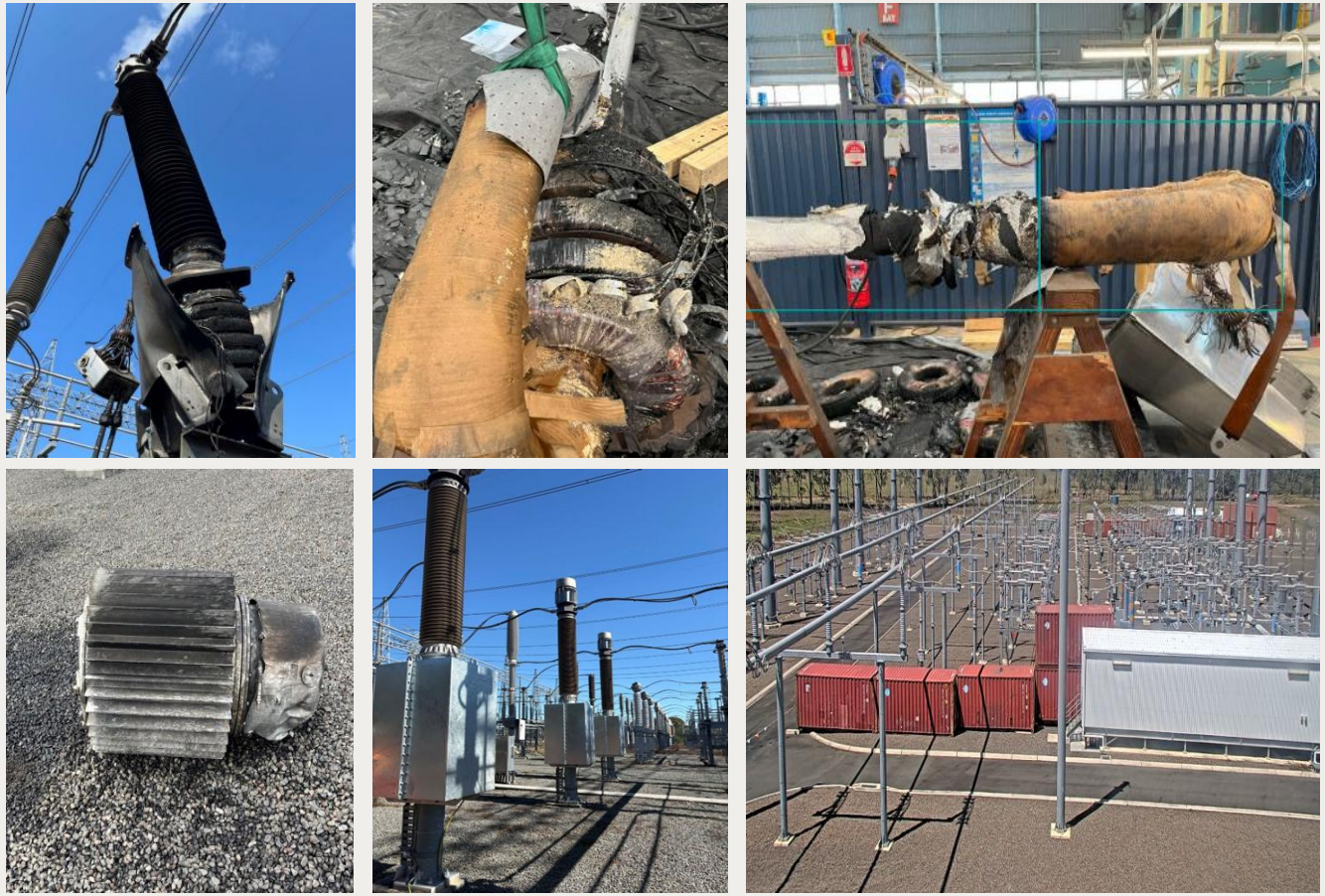
Interim Actions:

- Establish 30m Restricted Exclusion Zone (REZ)
- Use temporary protective containers for nearby work
- Erect shield around CT tank to safely reduce REZ to 10m

Permanent Solutions (Options):

- Replace CTs with safer designs:
  - Head tank design instead of hairpin, polymer instead of porcelain
  - SF6 or alternative medium (non-oil)
  - Higher BIL rating and on-line condition monitoring

Proposal: Form working group with major utilities and CIGRE experts to investigate root causes and share best practices



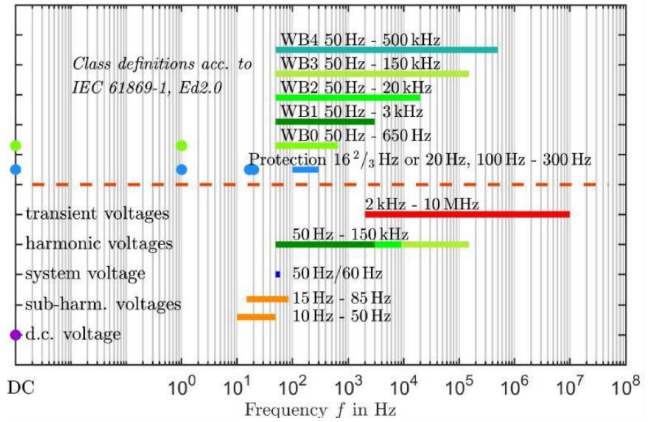
Next meeting hosted by GE in Sydney, June 2026

Case Study

Power Quality (PQ) Voltage Measurement Options

Frequency Dependant Measurement Requirements for Voltage Measurement System:

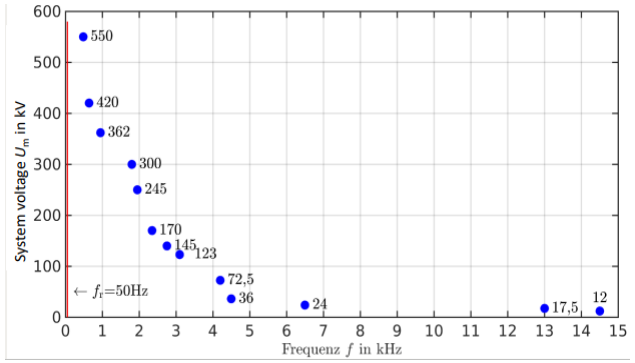
- Typical measuring range is from 50Hz to 2500Hz (50th harmonic)
- IEC 61891 standards are extending the requirements to measure up to 99th harmonics



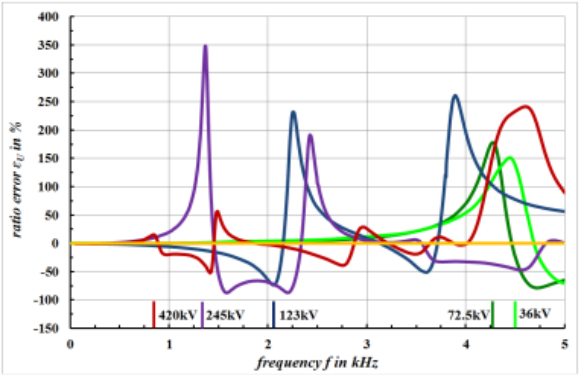
- **DC:** DC offset in AC grid
- **Subharmonics:** Sweeps, dips, swells, flicker, ferroresonance, unbalance interruptions
- **System:** Rated frequency of the system
- **Harmonics/Inter-harmonics:** Up to 50th harmonics
- **Conducted emissions:** High frequency signals independent of rated frequency
- **Transient:** Lightning impulse, switching impulse, chopped impulses, chopped under SF6 or other gasses, travelling wave, disconnectors operations, CB operations, TOV, rapid voltage changes

Conventional EM Voltage Transformer

- First resonance depending on system voltage
- Ratio and phase resonant peaks due to internal capacitance and inductive effect of the winding and insulation
- Non - linearity occurs at higher frequences



36kV - (light green); 72.5kV - (dark green)
123kV - (blue); 245kV - (purple); 420kV - (red)

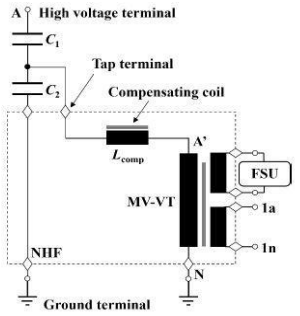


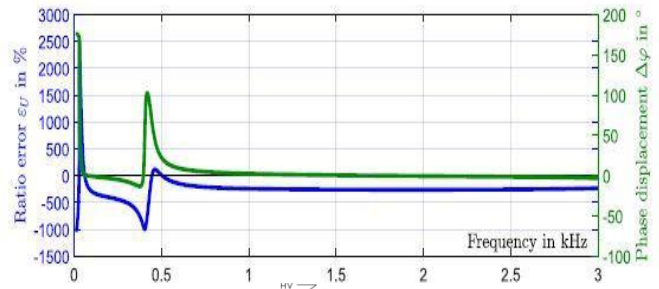
Case Study

Power Quality (PQ) Voltage Measurement Options

Conventional Capacitive Voltage Transformer

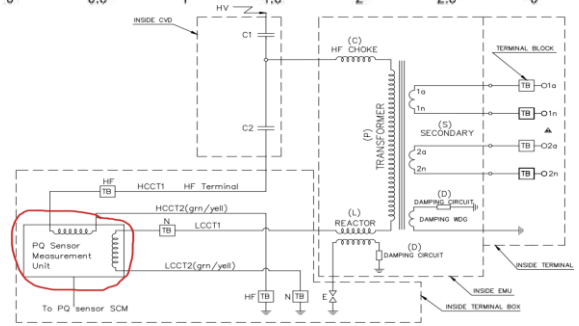
- CVTs designed to tune fundamental frequency 50/60Hz
- Interaction between capacitance and inductance of compensating coils and MV VT winding produce non-linear output up to 400HZ and is stable from 500Hz up to 5kHz
- At very high frequency non-linearity occur





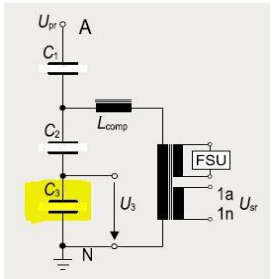
Capacitor Voltage Transformer with PQ Sensor

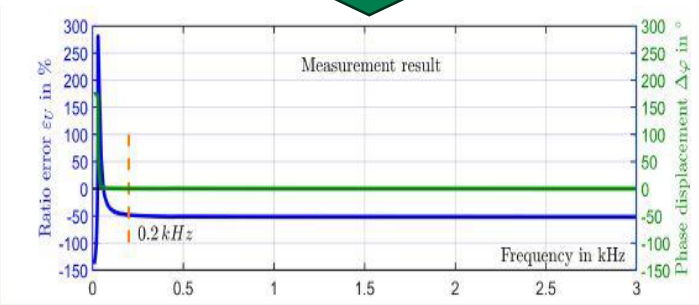
- PQ sensor connected into CVT terminal box
- The output harmonic accuracy is < 3% up to 2.5kHz and < 5% up to 5kHz harmonics
- Very sensitive for temperature higher than 40°C



Conventional Capacitive Voltage Transformer + C3 (HMD)

- Additional C3 capacitor added to CVT and output measurement voltage taken across C3
- Very flat frequency response up to 5kHz
- Very sensitive for temperature - depending on capacitor type



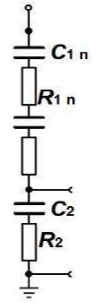


Case Study

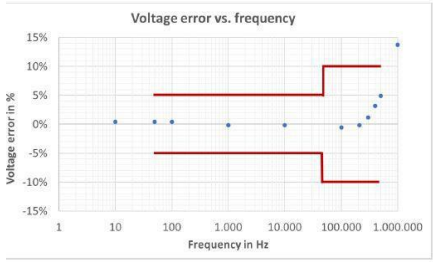
Power Quality (PQ) Voltage Measurement Options

- Low-power passive voltage transformers (36-500kV) used for volage measurement up to transient
- Stable frequency response up to 100kHZ
- Accuracy class 0.2 available
- IEC 61869 compliant
- Usses triaxial cable connection up to 150m
- Similar type and routine test as HV Con. ITs

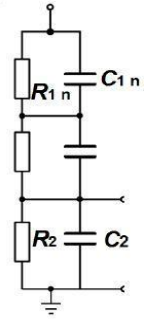
Capacitive/Resistive (CR) Divider



CR - Divider

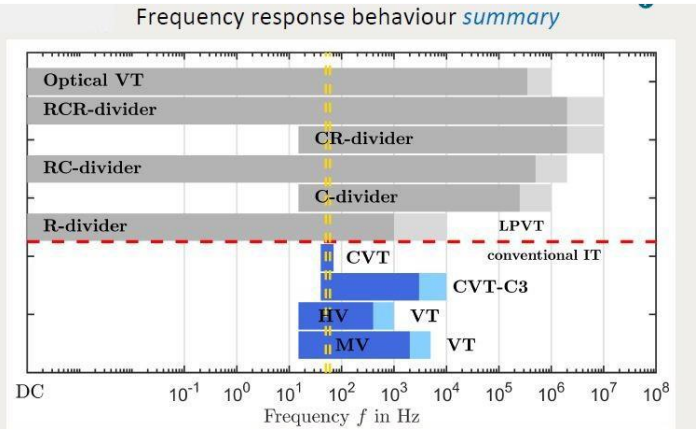


Resistive/Capacitive/(RC) Divider

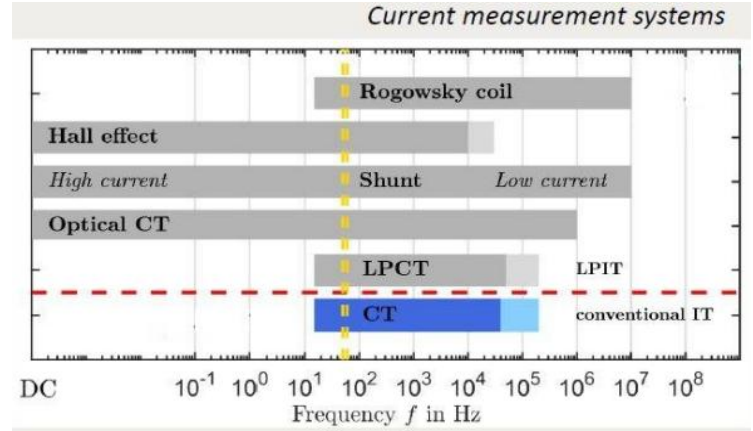


RC - Divider

Summary



	MVT	CVT	CVT + PQ Sensor	CVT + C3/HMD	CR Divider	RC divider
Accurate amplitude and phase measurements up to 50th harmonic	X*	X	✓	✓	✓	✓
Accurate impulse and switching response	X	X	X	X	✓✓	✓
Temperature and environmental conditions do not change the accuracy of PQ measurement	✓	✓	X	X	✓	✓
Cost efficiency for PQ measurement	$$	N/A	$$	$	$$$	$$$
Load changes do not influence the accuracy of PQ measurement	✓	N/A	✓	X	✓	✓
Cable length at low voltage does not influence the accuracy of PQ measurement	✓	N/A	✓	✓*	✓*	✓*




Thank you
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For power system expertise