EQUINOX POWER SOLUTIONS
Redefining Assets Reliability

14th AEDU Technical Conference – Namibia

– Enhancing Network Reliability with Advanced Testing & Monitoring

Paul Talla – Managing Director

What we do:

We specialize in **testing, diagnostics and online monitoring systems** for electrical equipment in Medium and high voltage substations and Rotating Machines. We are the African most trusted partner.

Portable Test and Diagnostic Equiments

Advanced Online monitoring system

Professional Field Services & Training

Our Technical Partners

doble isa MS MORGAN SCHAFFER PHENIX TECHNOLOGIES TECHIMP Vanguard Instruments

EQUINOX POWER SOLUTIONS
Redefining Assets Reliability

About us

- **History:** founded in 2015
- **Experience:** More than 10 years experience in the field of high voltage electricity
- **Clients:**
  - *Electrical network managers (production, transport et distribution)*
  - *Manufacturers of high voltage electrical equipment*
  - *Industries*

- **Branches :** Cameroun, Rwanda and Namibia
- **Logistic Office:** London , UK

Field Service available in selected countries
Cameroon, South Africa and Namibia

Our Portfolio Segmentation

Sensing Technology

RUGGED MONITORING

UVIRCO TECHNOLOGIES

Test & Diagnostic

FLUKE Reliability

PRÜFTECHNIK

doble

TECHIMP

isa

Vanguard Instruments

PHENIX TECHNOLOGIES

Conditions Monitoring

doble

MORGAN SCHAFFER

Industrial Technologies

DODGE

Danfoss

weg

schaffner MORE POWER TO YOU

Outstanding portfolio of market leading brands

Our Energy Business Unit

The Benefits of Connected Reliability

Moves Maintenance from Reactive to Proactive

Saves Costs and Boosts Productivity

Encourages a Strategic Approach to Adopting New Tech & Systems

Moves the Needle on High-Impact KPIs

Growth Drivers

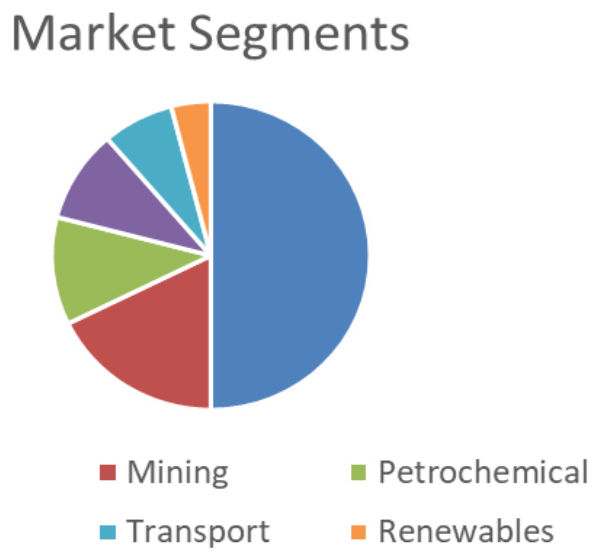
- Aging infrastructure and drive for Grid Automation
- Condition based maintenance replacing traditional methods.

Target Market and Portfolio Offering









On-line Monitoring

Off-line Testing & Assessment

Enterprise Asset Management

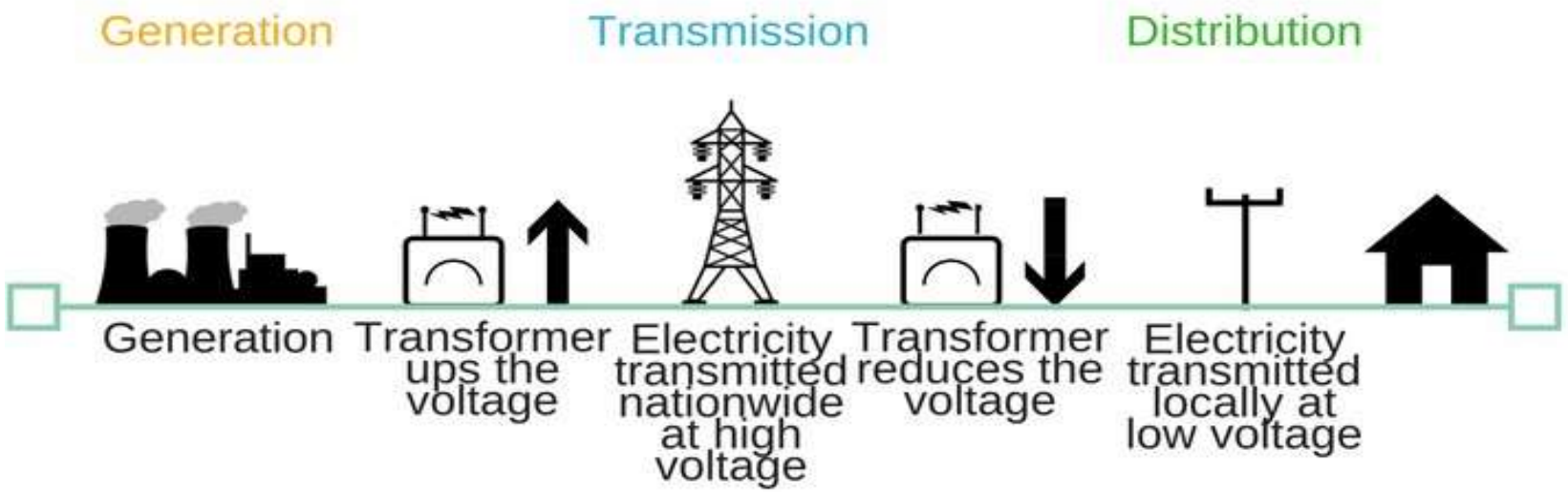
In-service Testing & Assessment

Protection Testing

Consulting & Testing Services

Solutions for the entire Power System

Power systems



Customers:

Power plants

Transmission & Distribution utilities

EPCs, integrators, services providers, testing service companies

OEM's

Industrials

Other: university, research lab, equipment rental companies

Our Test, Diagnostic and Monitoring Solutions

Electrical Test Equipment

Essential for day-to-day maintenance tests of electrical assets. Useful in specific phases of the asset lifecycle:

- Procure
- Operate
- Maintain
- Decommission.

Professional Services

Diversified offer according to the electrical asset lifecycle:

- Installation and commissioning
- Diagnostic test
- Data analysis
- Consultancy
- Training.

Monitoring Systems

Shift from a time-based maintenance to a condition-based maintenance.

Focus on predictive maintenance and shift in focus from electric asset value cost to network outage costs.

Strong evolution of digitalization trend in the power industry.

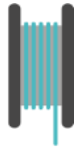
Portable Test Equipment


Power Transformers


HV Breakers


GIS


Relays, meters and transducers


HV & MV Cable


Current and Voltage Transformer


VSD

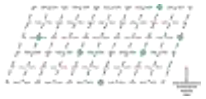

MV Switchgear


Rotating machines


Line impedance


Batteries


Surge Arrester


Ground grid


Isolators






Protection Relays
Single-phase secondary injection

1 U / 1I

T1000+

1 I up to 250A
1 V up to 250 V (1I 40 A)
Vdc Aux..
2 digital inputs
2 digital outputs
Local control

3U / 1I

RELTEST1000

15 I up to 15 A
3 V up to 400 V
Vdc Aux…
2 digital inputs
4 digital outputs
Local or remote control
TDMS software, manual control
Option: 6 low-level outputs

1 U / 1I

Vanguard RFD-200 S3

1 I up to 250A
1 U up to 250 VAC
1 U up to 300 VAC
3 AC current output ranges, 0-10, 40 and 100A, up to 250A for 1s
Local control

Protection Relays

Three-phase secondary injection

isa ALTANOVA GROUP

3 U / 3I and +

DRTS

3I3U or 3I4U or 6I4U or 6I6U
Up to 32A by I output and 300V by U output
Automatic simulation on all types of relays

Aux Vdc (for relay power)
12 inputs and 4(+4) digital outputs
2 analog inputs

Local or remote control
TDMS Pro software with manual control and automatic test modules.

Options: 6 low-level outputs, Synchronization, Disturbance recorder, Current amplifier, Polarity meter, CEI61850-8 / CEI61850-9

doble

3U / 3I and +

F6150

Injection up to 6 voltages and 6 currents
Automatic simulation on all types of relays
Local control via web interface (option)
(control by PC, tablet, smartphone)

Possibility of use in amplifiers for real-time simulators (RTDS®, OPAL-RT,® ...)
High precision and power

IEC 61850 option

doble

3 U / 3I and +

F8000

Model F8200: 4 modules to choose from
Model F8300: 7 modules to choose from
Possible modules:
Current 2 x 25 A at 150 VA each
Voltage 2 x 150V to 150VA each
Binary Inputs/Outputs: x 4

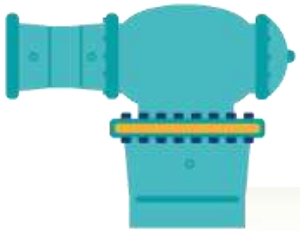
+ 1 control module: communications (3x Ethernet ports, 2 SFP ports, 2 USB ports), IRIG-B SYNCHRONIZATION, IEEE 1588 / IEC 61850-9-3 Protocol (PTP), GPS, CEI61850-8, IEC 61869-9 & IEC 61850-9-2LE

Protection Relay
Digital Network Analyzer CEI61850

F6880_DNA

Digital Network Analyzer:
Detects and responds to problems
in IEC 61850 networks
3 x RJ-45 10/100/1000 Mbps ports
2 x 1 Gbps Copper/Fiber SFP Ports
2 x USB 3.0 Type-A & B ports

HV Circuit Breakers



CBA1000

2 chambers per phase
4 auxiliary contacts
Local or remote control

Base :
Time & Sync Opening/Closing
Peak/shape/values Current of the coils
interlocking/tripping (up to 4)

Options :
- Double-ground test clamp set
- 1 µOhmmeter for statiq./dynam.
- Speed and motion analyzer
- Min. voltage (missing coil)
- Motor current, SF6 density

CBA3000

8 or 16 or 24 inputs for Main and auxiliary contacts
+ Local or remote control

Base :
Time & Sync Opening/Closing
Peak/shape/values Current of the coils
engaged/tripped (up to 6)

Options :
- Set of double-ground test clamps
- 3 µOhmmeters for statiq./dynam.
- Speed and motion analyzer
- Min. voltage (missing coil)
- Motor current, SF6 density

Power Transformer

T2000 T3000

CT, VT, Power Transformer:

- Ratio and polarity (CT/VT)
- Load (CT/VT)
- Saturation curve (CT)
- Impéd. Short Circuit (PT)
- Resistance (PT)
- Relay Testing (T3000 only)

Primary Injection: 800A, 2kV
Second injection. : 800, 40 or 10A
Local control
Option Ext : 400A dc

STS5000

CT, VT, Power Transformer:

- Ratio and polarity (CT/VT)
- Load (CT/VT)
- Saturation curve (CT)
- Impéd. Short Circuit (PT)
- No-load current (PT)
- SRM/DRM Resistance (PT)

Options : One-wiring test

- Ten Delta 12kV + chokes (for rotating machines)
- Current amp (up to 5kA)
- Line Printing and Ground Tests
- Demagnetization
- 800Aac,400Adc ,2kV,140V,6° dc/ac
- Local or remote control

M7100

Three-phase Power Transformer Tester

- Ratio and polarity
- Tan Delta
- Imped. short circuit
- Demagnetization
- SRM/DRM Resistance (PT)
- 12kVac, 250Vac, 35A dc/ac
- Local or remote control

Power Transformer

MORGAN SCHAFFER

MORGAN SCHAFFER

insideview

M5500

Frequency Response Analyzer (SFRA): Detects mechanical faults or winding deformations related to short circuit, mechanical stress, or transportation.
Fast field instrument for high-quality measurements

- Very easy to use
- Delivers accurate results in seconds
- Industry’s Benchmark

MYRKOS

Portable Chromatograph for Measuring Gases Dissolved in Oil

- Measures the 9 key gases
- Lab or field version
- Most accurate technology on the market
- Ease of use
- Reliable and robust even in daily use on site

INSIDEVIEW

Insulating oil diagnostic software, to manage a complete fleet of transformers, load adjusters, oil circuit breakers and oil cables.

- Comprehensive dissolved gas and oil quality analysis
- Data centralization
- Integration of laboratory or other data

Measurement

T2000 T3000

CT, VT, Power Transformer:

- Ratio and polarity (CT/VT)
- Load (CT/VT)
- Saturation curve (CT)
- Short Circuit Impedance (PT)
- Continuity Resistor (PT)
- Relay Testing (T3000 only)

Primary Injection: 800A, 2kV
Secondary injection: 800, 40 or 10A
Local control
Ext. Opt: 400A dc

STS5000

CT, VT, Power Transformer:

- Ratio and polarity (CT/VT)
- Load (CT/VT)
- Saturation curve (CT)
- Short Circuit Impedance (PT)
- No-load current (PT)
- Continuous Socket Resistance (PT)

Options :

- Tan Delta + chokes (for Tan Delta rotating machines)
- Current amplifiers (up to 5kA)
- Line Impedance, Ground Resistivity, Ground Resistance, Step&touch Voltage
- 800° ac, 400° dc, 2kVac, 140V & 6Aac/dc
- Local or remote control

iCT1

CT, VT. Tests of up to 5 simultaneous takes:
Ratio (up to 1:20000) and phase error

- Excitation curve (up to 2 kV or 30 kV option)
- Winding Resistance
- Secondary charge
- Accuracy and ALF/ISF
- Demagnetization functions
- Nominal Value Search Function

6 Aac/dc, 2k Vac, accuracy class 0.1
Local or remote control
Option: 30 kV – DC method

Surge arresters

isa
ALTANOVA GROUP

SCAR10

On-line diagnostic of metal oxide surge arresters

- Leakage Current Recording
- Cost-effective solution for metal-oxide surge arrester monitoring
- Harmonic analysis with compensation
- Battery Powered Instrument
- In-Service Diagnostic Solution

doble®

LCM500

On-line diagnostic of metal oxide surge arresters

- Leakage Current Recording
- Industry-leading solution for metal-oxide surge arrester monitoring
- Harmonic analysis with compensation
- Wireless Sensors
- Battery-powered instrument
- In-Service Diagnostic Solution

Batteries

BTS200 Battery Tester

Measurement of:
- Battery voltage
- Current discharge test
- Battery capacity

Test in:
- Constant Current
- Constant power
- Load Profile

For a battery up to 240 V
and current up to 130A

Partial Discharges Analyzer

AQUILA - Portable PD analyzer

- One device for condition-based maintenance of HV and MV cables, transformers, rotating machines and switchgears
- Innovative instrument for Partial Discharge testing (recording & processing)
- Ultra-Wide Band, fast integrated processing capability
- PD Pulse detector and waveform analyser
- Multiple Connectivity (Wi-Fi, Fibre Optics, USB, Bluetooth)
- NEW PD Pro software – the integrated software for Partial Discharge testing and reporting – IEC60270 compliant
- TECHIMP's patented T/F Map technology able to differentiate between noise signals and different multiple PD signals.

Spark P3 - Universal PD & EMI analyzer

Spark P3 is a universal partial discharge (PD) and electromagnetic interference (EMI) analyzer that uses a software defined radio signal detector to identify characteristics of insulation system deterioration that could lead to the failure of high voltage equipment. It detects signals from suitable sensors in a frequency range between 9 kHz to 2 GHz for PD and EMI, and DC to 500k Hz for acoustic and reference voltage measurements.
covering a wide range of test objects and usable sensors, including:

- Rotating machines (PD couplers, HFCT sensors)
- Power transformers (HFCT sensors, UHF antennas, acoustic microphones)
- Instrument transformers (HFCT sensors)
- Switchgear (GIS and AIS – TEV sensors, UHF antennas, HFCT, acoustic sensors, spacer sensors, window sensors)
- Cables and accessories (HFCT, UHF sensors, acoustic sensors)

Advanced Online Monitoring System: EDS MKIII Expert Diagnostic System

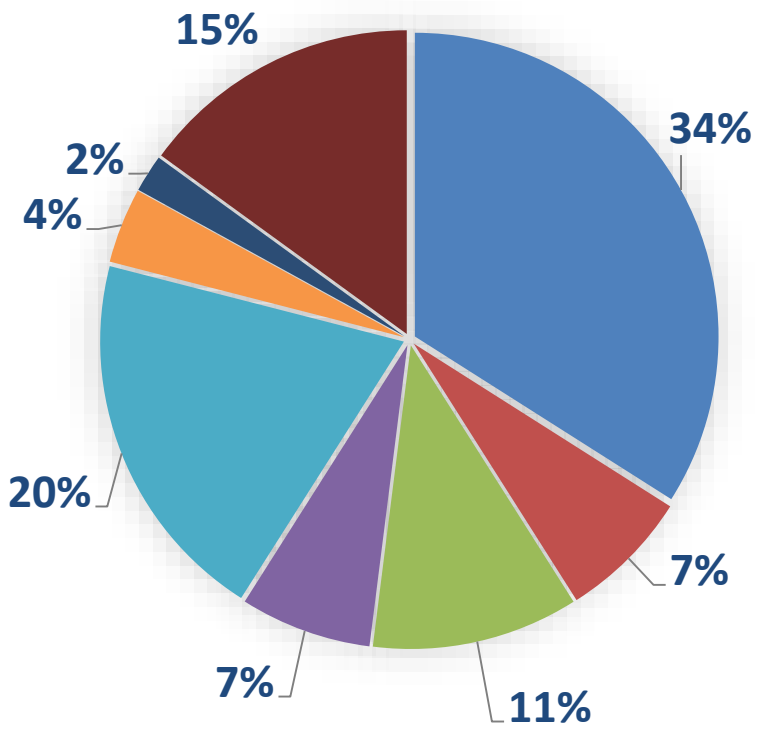
MAIN APPLICATIONS	EDS – Expert Diagnostic System – is an Overall Condition Monitoring System designed to monitor the main substation assets: current transformer, voltage transformer, power transformers, circuit breakers, surge arresters and GIS switchgear, which integrates all the real time conditions from all relevant substation assets in a single system.
MEASUREMENT MODULES	- Individual modules depending on the application and configuration chosen: AGD, bush monitoring, partial discharge, etc. - Compatibility with any type of instrument, sensor or other data source
SYSTEM TURNKEY	- Project-by-project system architecture design - System supply (sensors, data acquisition unit boxes, central unit, software, etc.) - Commissioning
COMMUNICATION	IEC62541/IEC61850/ IEC60870/DNP3/MODBUS/… Ethernet, USB, RS485, CEI61850, Modbus, DNP3
ENTERPRISE EQUIPMENT MANAGEMENT SOFTWARE	**TiSCADA** • Detailed analysis (unique predictive system for failure and consequence analysis) • A single platform for all monitored equipment **DOBLEARMS** • Detailed analysis (unique predictive system for failure and consequence analysis) • Instant update of risks (reliability, availability, customer impact, environmental, security, finance)

Comprehensive Transformer Monitoring

Analysis of HV transformers failures

HV transformer faults in CELG (Brasil) 1979..2007

Windings and bushing failures represent about 50% of the overall failures, while tanks and cooling system add and other 15% approximately.
Winding failures are basically due to the lack of insulation inside the tank



- Winding
- Cooling system
- Unidentified components
- Tanks and accessories
- OLTC+DTC
- Oil (insulating)
- Core
- Bushings

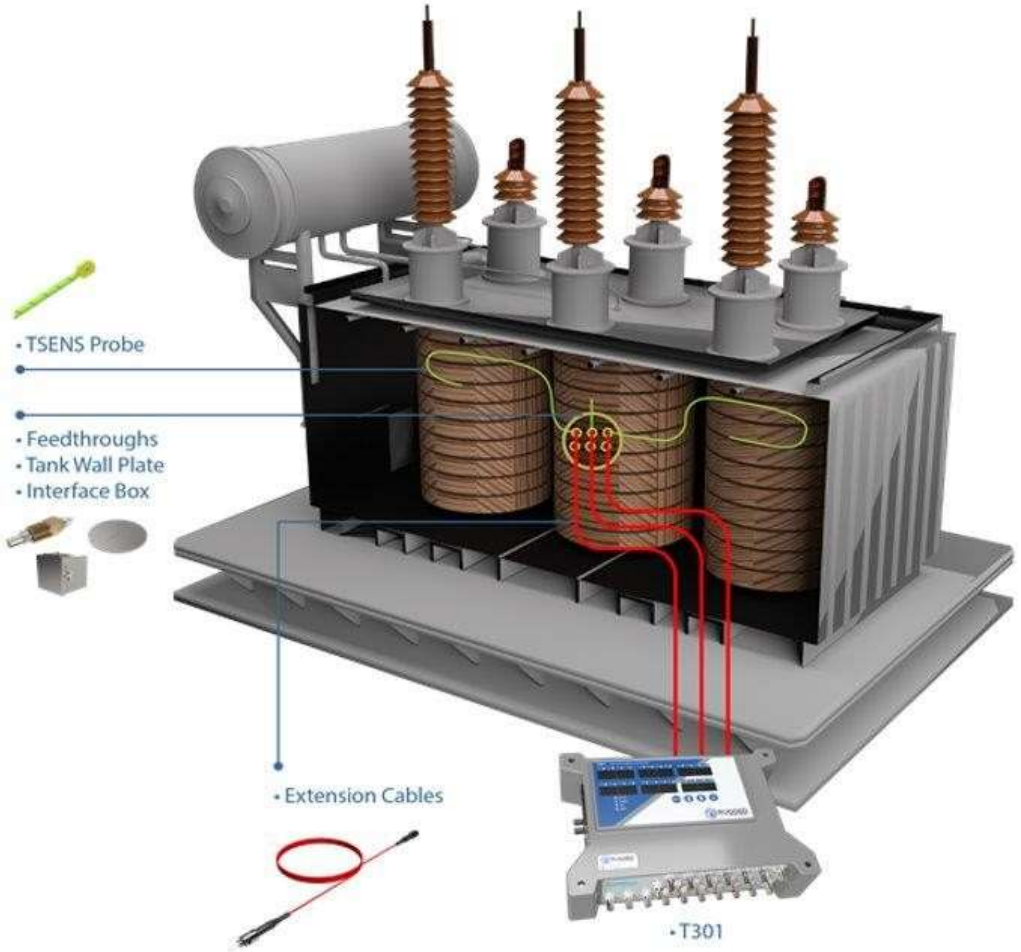
80% coverage

The most part of the components that generate failures are monitored by Equinox Power Solutions

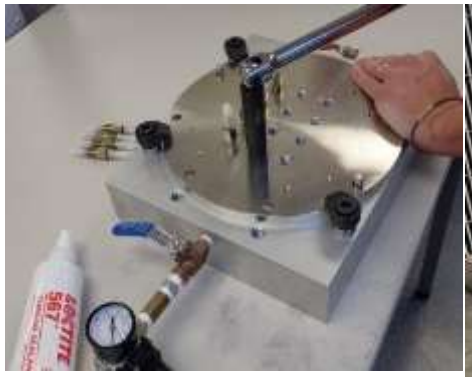
Ref. : Cacilda de Jesus Ribeiro; André Pereira Marques and others.
Faults and Defects in Power Transformers – A Case Study

Transformer Fiber Optic Temperature

Sensor and Monitor



Fiber Optic Temperature Sensors installed on the Spacer



Calisto – Introduction

"The most accurate online DGA monitor solution"

Condition Monitoring Solution

- Precise and accurate DGA analysis
- Protects your transformer in between oil samples.
- The Calisto takes the recognised laboratory technology and brings it to your transformer.

Designed to fit your monitoring program

- The Calisto monitor can operate as a standalone DGA monitor or as part of a our Entreprise Condition Monitoring Platform.

Calisto models

- Fault detection monitors.
- Fault diagnostic monitors.

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Redefining Assets Reliability

Monitoring modules and parameters

GTMS is a modular and configurable monitoring system that can also be combined according to the customer requirements. GTMS allows to monitor the following parameters:

Generic transformer parameters

- Line currents
- Oil temperatures (bottom, top, cooling system)
- Core and windings temperatures
- Cooling system current consumption (fan and pumps)
- Hot spot temperature according to IEC 60076-7
- Loss of life

Bushing monitoring

- Absolute Tan Delta (6 bushings HV & LV)
- Relative Tan Delta
- Bushing Capacitance measurement
- Leakage current of each bushing
- Tandelta degradation over time
- The fast change in bushing capacitance
- Measure the temperature of the bushing
- Bushings currents and current imbalance
- HV or LV Voltage (for TD calculation)

Dissolved gas monitoring

- Hydrogen (H2)
- Oxygen (O2)
- Methane (CH4)
- Carbon Monoxide (CO)
- Carbon Dioxide (CO2)
- Ethylene (C2H4)
- Ethane (C2H6)
- Acetylene (C2H2)
- Nitrogen (N2)
- Moisture-in-Oil
- Oil Temperature

Partial discharge monitoring

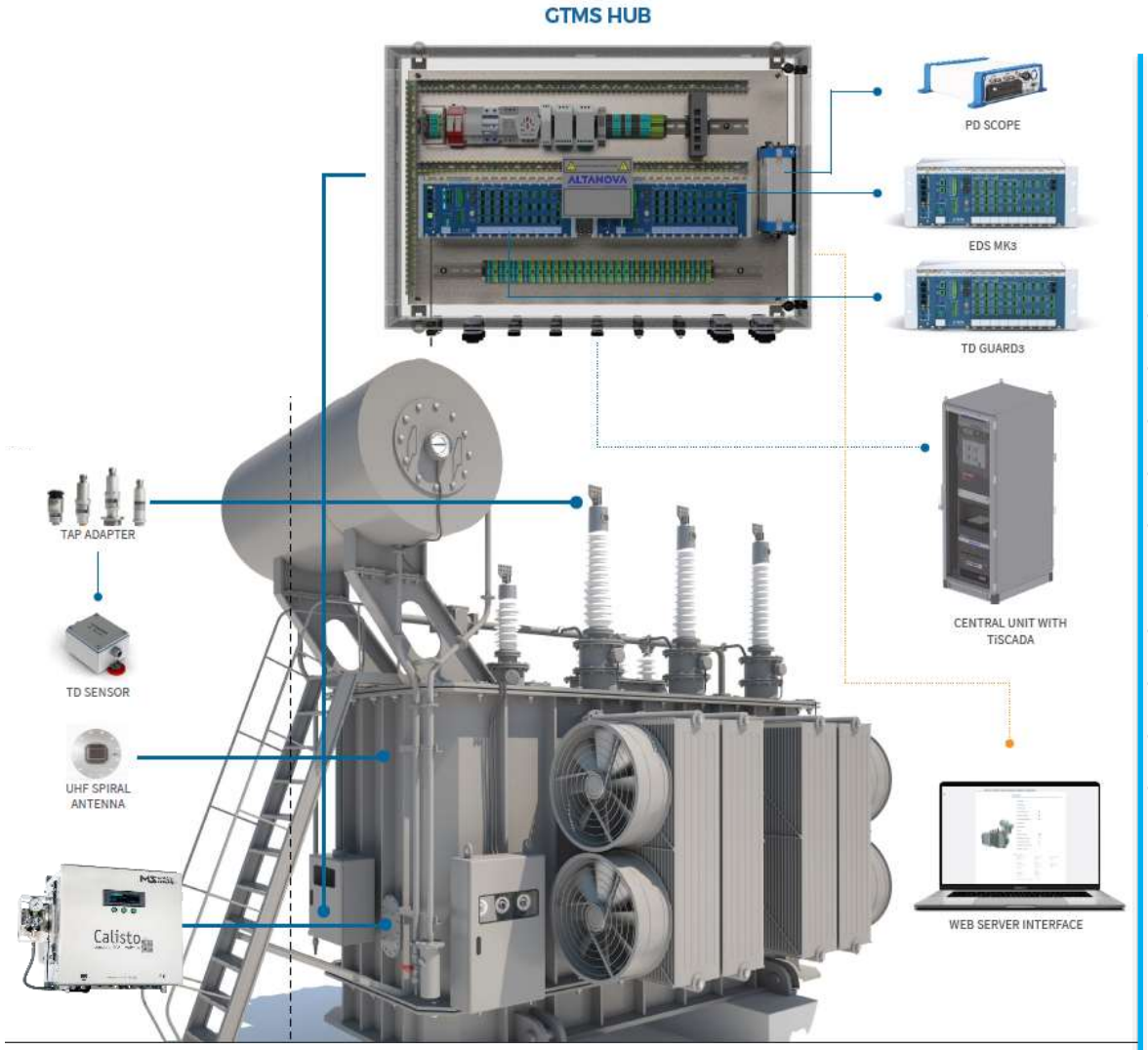
- Partial Discharge
- PRPD Pattern
- Pulse shape

All the measurements have a warning and alarm threshold in order to highlight the problem to the SCADA system and prevent failures.

Monitoring layout

The modules can be used all together, for a global monitoring system, individually or in combination.

- Generic transformer parameters
- Bushing monitoring
- Dissolved gas monitoring
- Partial discharge monitoring



PD & TD Monitoring

- Partial Discharge
- Tap adaptors
- UHF sensors (window or drain-valve)
- 3 / 6 channel Acquisition Units PDHub
- Unsurpassed T/F-Map Technology

- Bushing Monitoring
- Capacitance
- Tan-δ
- Δtan-δ

Monitoring of MV Switchgear

Monitoring of MV Switchgear

Global Monitoring Systems for MV Switchgear

- Partial Discharge Monitoring
  - 1 – 40 channel DAUs
  - HFCT, TEV, TEM US & FMC sensors
- Circuit Breaker Monitoring
  - Parameters similar to HV CBM
- Temperature
  - Passive SAW Technology
  - PT1000
- Humidity

EQUINOX POWER SOLUTIONS
Redefining Assets Reliability

Partial Discharge Monitoring

Sensors

- HFCT – High Frequency Current Transformer
- TEV – Transient Earth Voltage
- TEM – Transversal Electromagnetic Waves
- UHF – Ultra High Frequency
- US - Acoustic

- TEV Sensor
- Contact Temperature Sensor
- Contact Ultrasonic Sensor

➔ Installed below AIS Panel in cable floor

AIS Panel

Temperature & Humidity

Sensors

- Passive SAW Technology
- Laser cut CMOS technology
- PT1000

- HFCT Sensor
- Airborne Ultrasonic Sensor

➔ Installed below GIS Panel

- Contact Temperature Sensor

➔ Installed above GIS Panel

GIS Panel

Critical Asset Monitoring (CAM) Platform

Real-time, Continuous Monitoring for the 3 Primary Failure Modes of Electrical Power Critical Assets

SENSORS

PASSIVE (Addresses overheating)

- sensor modules – NO power wiring or battery required
- 20+ year sensor life expectancy

Partial Discharge

Addresses conductor insulation breakdown

Humidity

Addresses air dielectric breakdown

MONITORING UNITS

CAM-5

- Touch panel HMI
- Monitoring capabilities: SAW
  - SAW & Ambient Temp,
  - PD (Trend)
  - Humidity
- Display and log data for up to 9 external Readers. Onboard data storage
- Multiple communication protocols

Reader

- Remote Monitoring
- Modbus RTU (RS485)

Medium Voltage CABLES

MV Monitoring System solutions

FALCON 1 channel

FALCON 4 channels

FALCON MK II
up to 40 channels

Falcon Family measure, storage, analysis and alarms

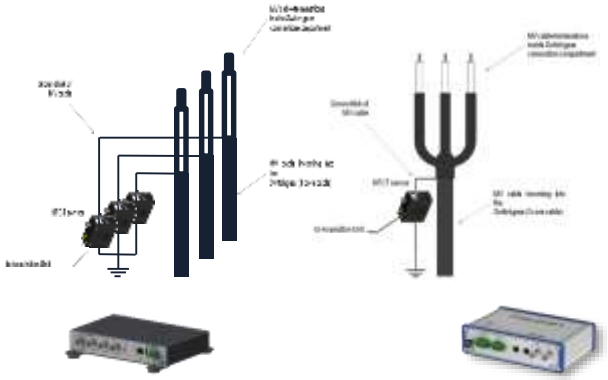
MEASURE
Automatic detection of partial discharges through sensors located on a cable termination

STORAGE
Historical archive of measures up to two years

ANALISYS
Automatic recognition of critical issues in evolution

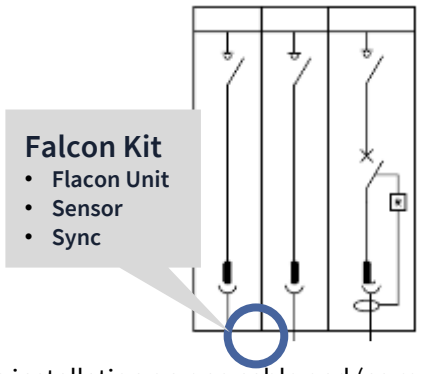
ALARMS
Maintenance work only where necessary and before failure event

Typical installations on MV cable termination



FALCON 4 channels

FALCON 1 channel



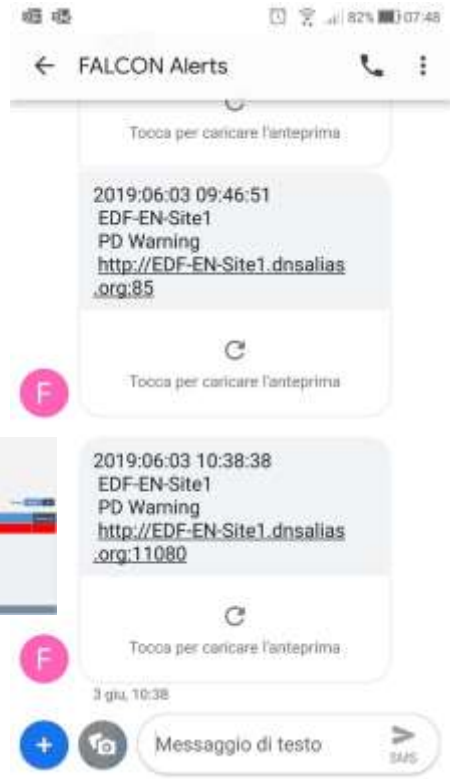
system installation on one cable end (as reference)

Plug & Play

FALCONs are Plug & Play devices that can be installed with a few simple operations.
It configures itself automatically, and once powered, it is immediately operational.

Embedded User interface

Local HMIs – no SW installation is required



SMS & emails

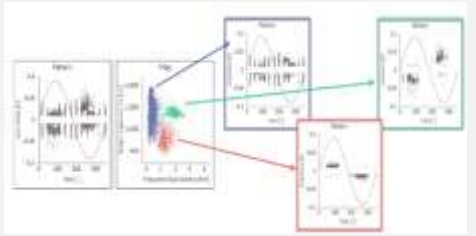
Challenges and Technology Highlight

Ensuring accurate measurements in harsh environments.

Focus on quality and data processing

Integrating monitoring systems into existing infrastructure.

Focus on IoT and Modularity



TF-MAP®

Future-proof:

- ✓ Multi protocols (MQTT/IEC61850/Modbus/etc)
- ✓ Scalable and cost-effective monitoring solutions
- ✓ Maintenance free & Wireless Sensor Networks

Advanced Substation Monitoring

TFS 2100E Travel fault locator system

Enhancing Power Lines Reliability and Efficiency

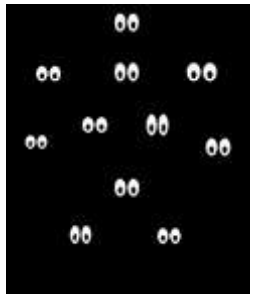
EQUINOX POWER SOLUTIONS
Redefining Assets Reliability

Travelling wave fault location system

- INTRODUCTION – Why ?

Why use fault location?

- **Reducing** costs related with “out of order” condition of transmission lines
- **Monitoring** the faults for natural events (wind, storm, lighting)
- **Locating** the faults with a very high accuracy
- **Distinguishing** between random faults caused by lightings or fire under the line, and **predictable discharge** due to contaminated insulator, a swaying or growing tree
- **Finding and repairing** trouble spots in time to prevent other discharges for repetitive faults, increasing the line reliability.



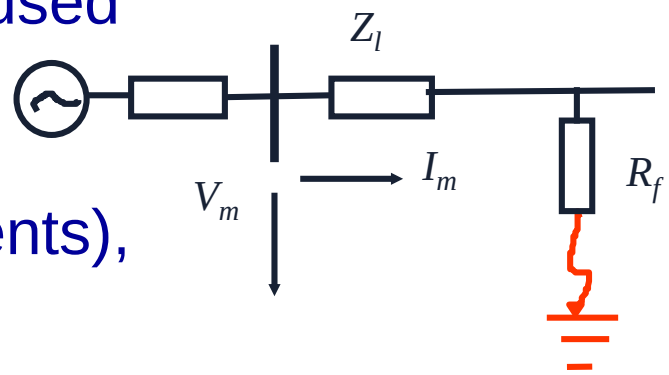
Travelling wave fault location system

INTRODUCTION - Methods

Fault location methods used

WAVEFORMS ANALYSIS

old method in non-digital time
when the oscillograph fault recorder were used



IMPEDANCE CALCULATION

widely used (based on sequence components),
Cost effective, but
poor accuracy
(errors > 10%, affected by remote fault in-feeding,
resistance fault, CT / VT errors, line parameters, …)
& only for normal AC power line

Travelling wave fault location system

INTRODUCTION - Methods

Fault location methods used

TRAVELLING WAVE METHOD:

The best solution

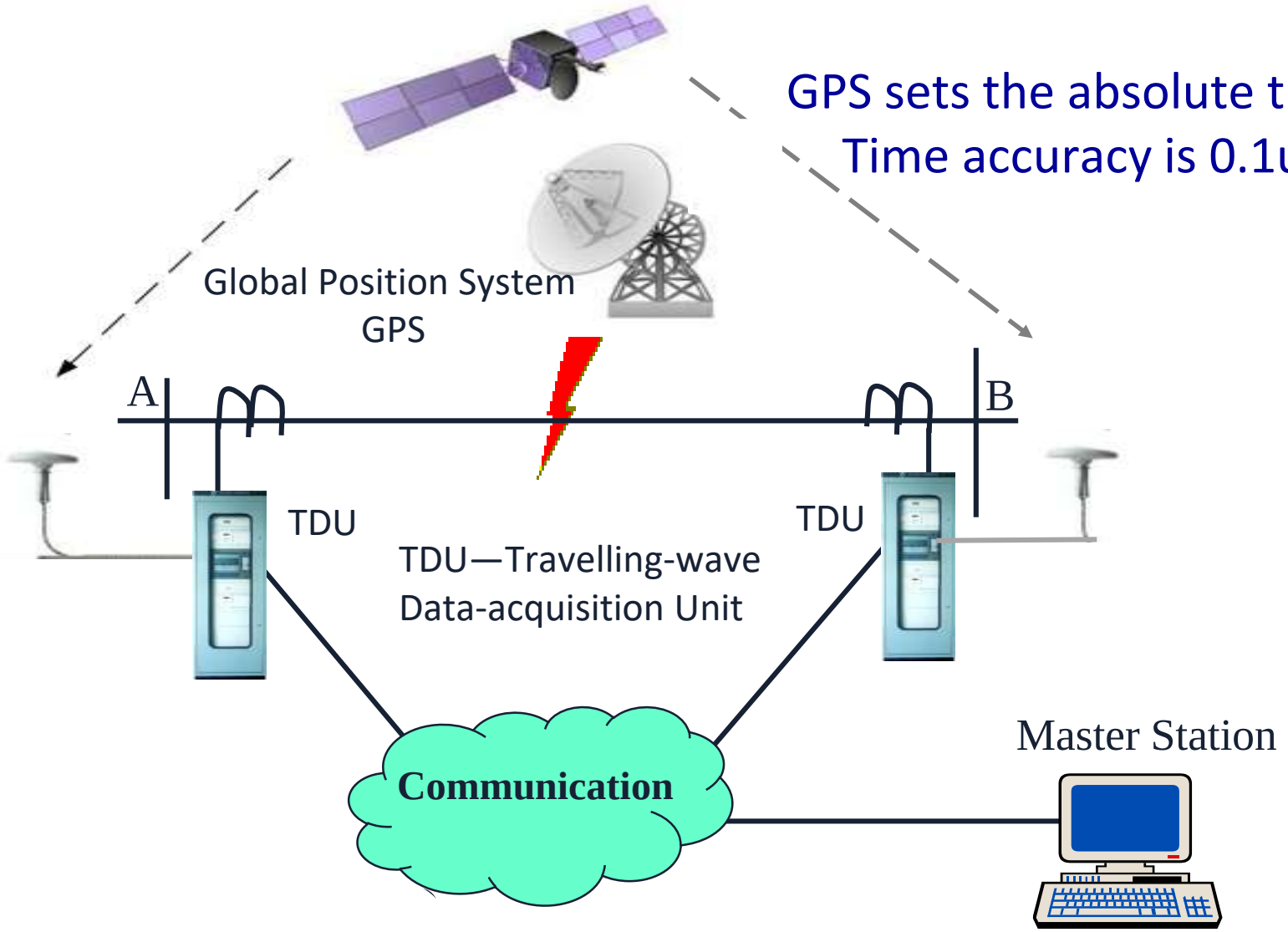
Determine the DISTANCE TO FAULT by MEASURING THE TIME for a surge to travel from fault to busbar

EXCELLENT ACCURACY as the velocity of TW are free from influences such as Fault resistance, VTs/CTs errors, inaccurate line parameters

Can be applied for ALL kinds of POWER LINES (HVDC, double circuit, T-branch, seriously compensated, overhead and cable mixed lines)

Travelling wave fault location system

- TFS2100E System – Overall view



Travelling wave fault location system

- TFS2100E System – Overall view

What does TFS2100E do?

1. CATCHES THE TRAVELING WAVE SIGNAL: TDU-100E

2. TAGS THE TIME STAMP: TDU-100E with internal GPS

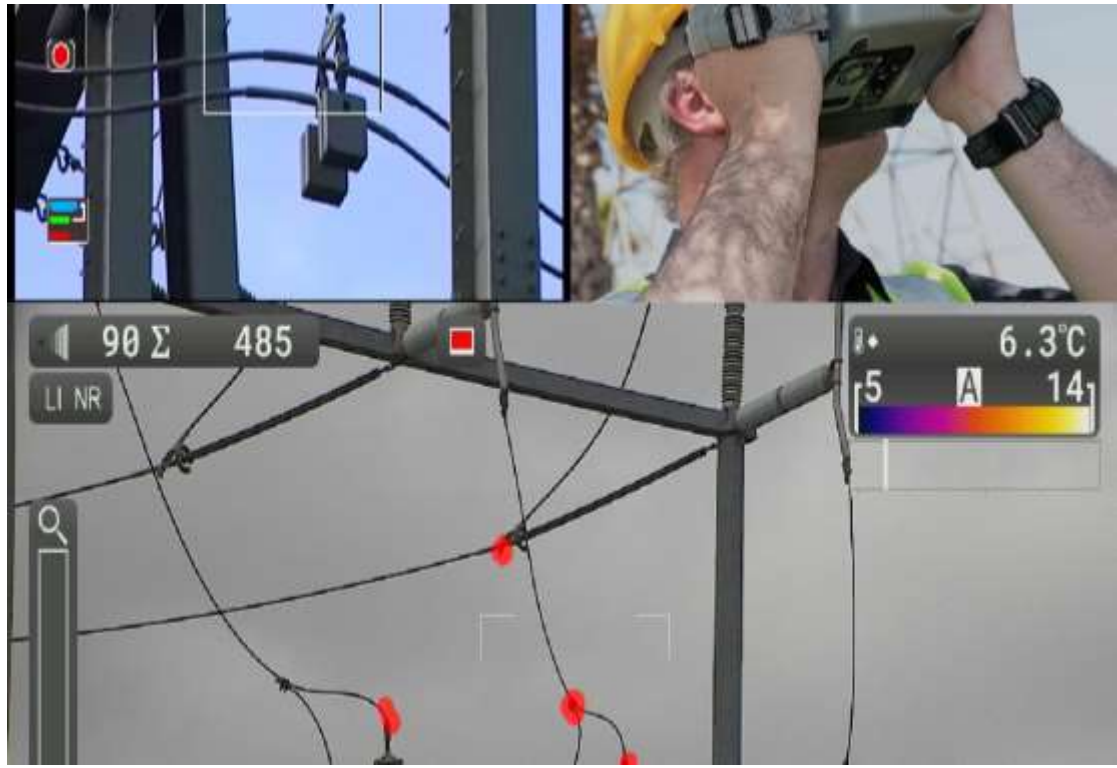
3. GETS THE FAULT RECORDS FROM REMOTE SUBSTATIONS: TAS 2100E MASTER UNIT SOFTWARE

4. ANALYZES RECORDS TO GET FAULT LOCATION: TAS 2100E MASTER UNIT SOFTWARE

COROCAM 8HD

- Multi-Spectral (UV, LWIR & Vis)
- High Resolving Power (HD + Zoom)
- High UV Sensitivity
- Viewfinder and LCD
- Ergonomic Design
- Advanced User Interface
- Day and Night operation
- Commercial batteries
- Spotlight

12 Month Warranty
I/O connectors (Ethernet, USB, RS232.485)



INSPECTING THE ELECTRICAL SUPPLY CHAIN

Thermal inspections allow the operator to locate hot spots resulting from:

- Thinned conductors
- Unbalanced phases
- Some types of damage

Hot spots occur only when there is current flow.

False positives are possible, usually due to thermal reflections.

Effective thermal inspections require suitable resolving power.

If the hot object is smaller than the area projected onto one pixel, then its temperature is averaged with the surrounding "cold" area projected onto that pixel. When the hot area is too small it will make an unnoticeable difference to the pixel temperature relative to its surrounds.

INSPECTING THE ELECTRICAL SUPPLY CHAIN

The Ultraviolet (C-band) is used to detect the emissions from electrical discharges, which occur due to:

- Excessive field intensities resulting from:
  - Bad design
  - Bad installation
  - Damage
- "Wet" pollution, resulting in surface arcing activity.

Electrical discharges can occur anywhere where there is a suitably large electric field (due to voltage applied).

False positives are rare.

The electrical discharge just indicates where the problem is, visual inspection is needed to determine what the problem is.

"…Condition Monitoring is like insurance……

***Everybody** agrees its prudent to have it, but **nobody** wants to pay for it. **Anybody** could see the benefits, and **Somebody** always asks why it was not fitted when its allgone wrong……"*