ZENSOL

OLTC DIAGNOSIS GUIDE

WWW.ZENSOL.COM

Your OLTC Diagnosis Guide

Thi s booklet's goal is to present you a complete diagnostic solution for on line tap changers. This solution, developed by Zensol in 2009, is in continuous evolution.

Zensol is the leader in the application of the vibro-acoustic method to tap changers (OLTCs). Our instruments have allowed the implementation of this method at Hydro-Québec, a world leader in hydroelectricity, As it gains in popularity and respectability, our method is spreading more and more throughout the world.

Thanks to vibrations, we are able to detect many mechanical and electrical problems in tap changers, a highly used component, which is responsible for more than 50% of all major failures on high-voltage transformers.

Adequate preventive maintenance minimizes the risk of grave consequences and loss of revenue.

You will find, in this booklet, details about our OLTC Analyzer, the TAP-4, an instrument developed in cooperation with Hydro-Québec and commercialized since 2009. The OTM-X, on the market since 2014, will be introduced after that. It is the only standalone vibroacoustic event recorder for on line tap changers on the market.

The software and various cables and accessories required by these two instruments will also be presented. Finally, the services offered by Zensol and delivered by professionals, including data analysis, field services, as well as training and seminars will be detailed.

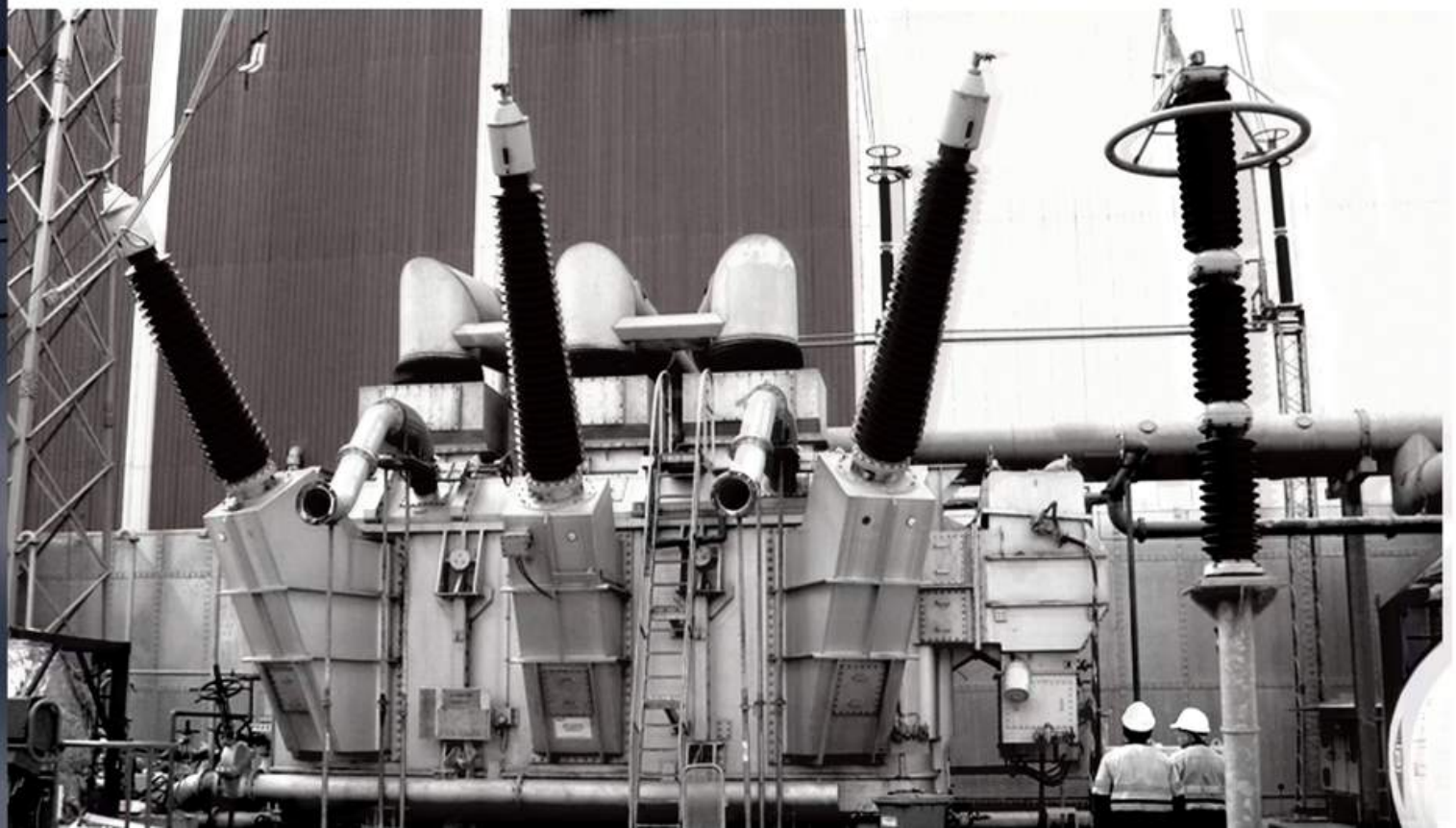
Index

What is a transformer?

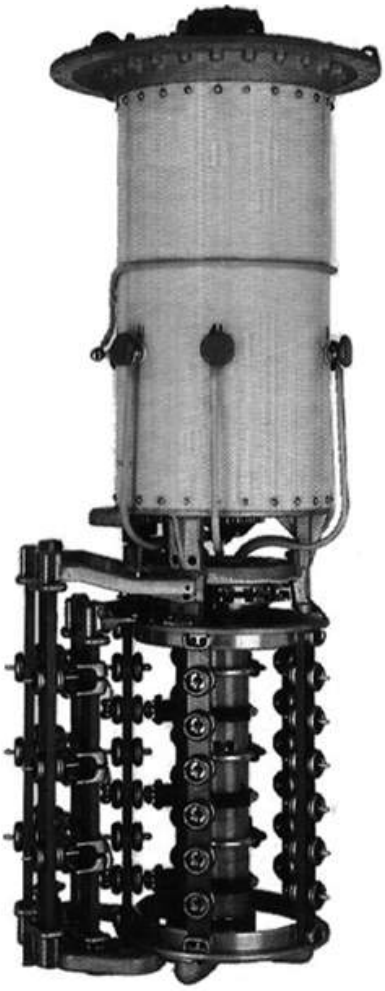
It is a piece of equipment able to change the voltage and current intensity values on an electrical network. Its use is fundamental to the transport of electrical energy.

Indeed, electricity sent with high voltage is more efficient than at low voltage, making it necessary to use transformers to raise or lower the voltage near consumption centers.

In case of failure, repair costs can reach several hundreds of thousands of dollars. That's why it's necessary to prevent failures before they happen.



What is a tap changer?



MR

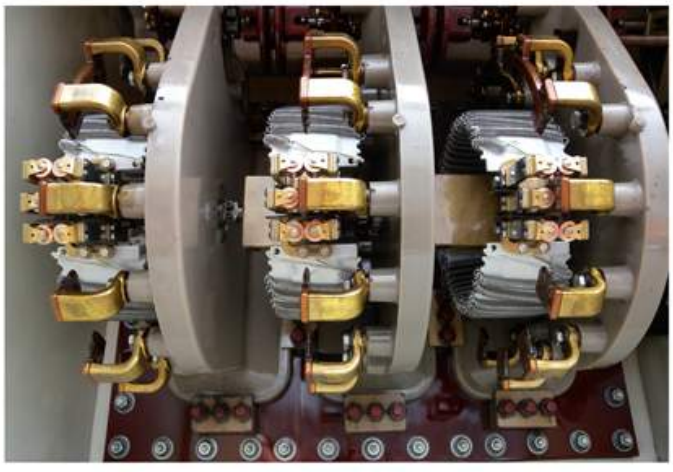


ABB UZ

The load on an electrical network is never constant. The power required by consumers varies according to the time of day and according to the seasons. To maintain a stable voltage, tap changers are used.

They are electromechanical devices mounted inside or outside a transformer. They have two main parts, a selector and a commutator, and have several taps to allow the transformer to stabilize the electrical network by maintaining a constant voltage.

Some equipment may soak in oil. This isolates the contacts and is also used as cooling medium to dissipate the heat generated by electric arcs that occur during a tap change. The tap changer must be subject to careful maintenance, since the smallest fault can damage the transformer.

Our IEEE and CIGRÉ recognized method

The vibroacoutic method was developed and tested in the field by Hydro-Québec for over 15 years. Its diagnostic potential has been recognized in two transformer maintenance guides: IEEE.PC57.143 and Cigré A2.34.

Anomalies detected by the vibroacoustic method

The innovative measurement technique based on recordings by the TAP-4 and OTM-X, as well as the analysis of vibroacoustic signals, allow the compilation of a complete overview of the mechanical and electrical state of an OLTC.

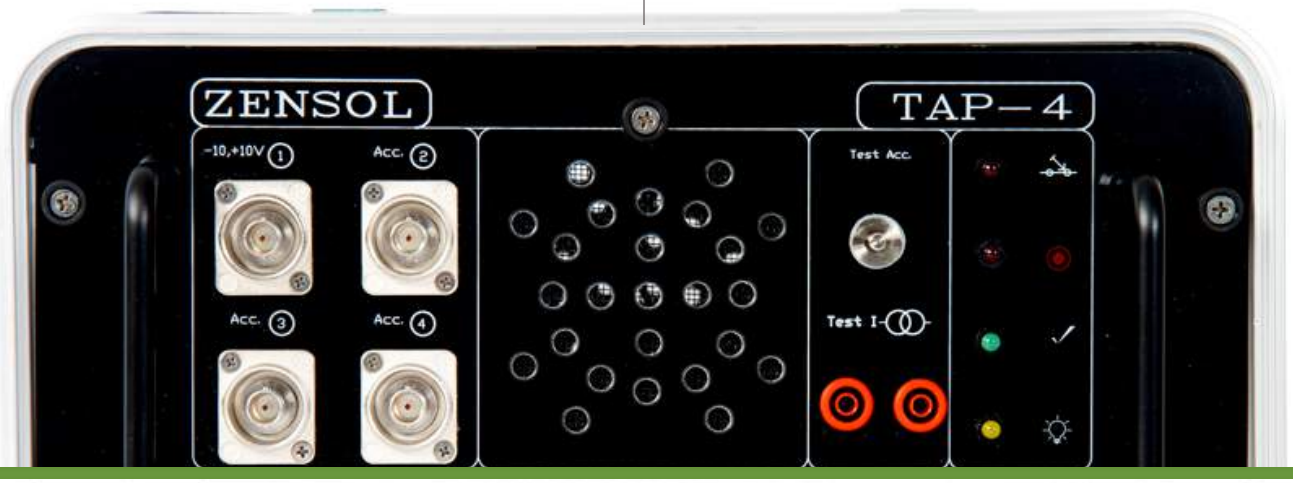
Thanks to the TAP-4 and OTM-X, you can detect a wide variety of mechanical and electrical problems:

- Wear, slacking and bouncing of contacts.
- Arcing in the commutators.
- Arcing in the selectors.
- Brake failures.
- Incorrect contact alignment.
- Drive mechanism problems.

	Dissolved gaz analysis	Dynamic resistance	Motor current	Motor current and Zensol vibroacoustic testing
Drive			x	x
Synchronisation		x		x
Selector			x	x
Motor			x	x
Brake				x
Lubrification			x	x
Alignment			x	x
Arcing	x			x
Contact wear				x
Changing		x		x
Transition		x		x

TAP-4

OLTC ANALYZER



What is the TAP-4

The TAP-4 is the first portable instrument using the vibroacoutic method to perform tests on On Line Tap Changers (OLTC) for transformers. Just like a stethoscope, the unit listens to the heartbeat of your OLTC without opening it. It can create a complete overview of the internal state and can detect a wide variety of mechanical and electrical malfunctions.

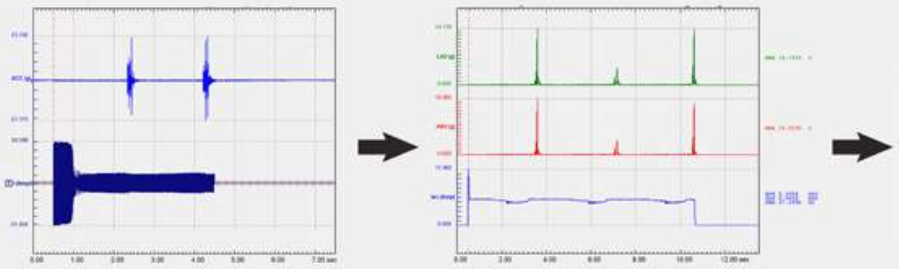
The TAP-4 is used with a simple current transducer and up to 3 accelerometers, allowing simple and precise readings of the main components of an OLTC, the motor and mechanism. It is a multipurpose measuremnt apparatus, able to test all OLTC types (ABB, Federal Pioneer, Ferranti, MR, etc.) Its portability and resistance to impacts and extreme climate conditons (-40°C to +70°C) make it a precious and highly appreciated instrument.

Simple to use, the OpenZen-TAP software drives the instrument and records and analyzes OLTC events.

Key points

- Very precise measurements (100 kHz) allow the very fast sampling time (10 µs) required for fine analysis of the vibrations.
- Adaptable to all OLTC types.
- Tests may be conducted either on line or off line.
- Non-invasive tests.

Data processing makes analysis easier



Nom de prise	Durée de l'opération	COURANT				ACCELEROMETRE1		
		Moyenne du courant	Inrush	Delta du courant	Temps de fin d'opération	MAX HF	MAX BF	RATIO HF/BF
	Temps en ms	Courant en ampères			Temps en ms	Accélération en G		
Médiane:	**1850.00**	**2.052795**	**10.762663**	**0.158982**	**35.9000245**	**20.698068**	**13.871399**	**1.543429**
1 --> 2	2525.00	2.042415	10.808553	0.146744	11.100098	22.262745	15.008675	1.483325
2 --> 3	1885.00	2.05768	10.836086	0.177338	23.199951	24.271753	15.155006	1.601567
3 --> 4	1820.00	2.067137	10.750425	0.158982	43.800049	25.261013	14.873013	1.698446
4 --> 5	2595.00	2.060483	10.842205	0.149804	35.999756	23.154453	14.083434	1.644091
5 --> 6	1875.00	2.052825	10.774899	0.189575	39.5	22.195677	14.24196	1.558471
6 --> 7	1870.00	2.05981	10.72901	0.158982	35.800293	19.701948	13.923384	1.415026
7 --> 8	1880.00	2.054258	10.750425	0.162041	45.600098	16.008606	9.856592	1.624152
8 --> 9	6480.00	2.052765	10.777959	0.192635	51.799805	27.067291	17.709707	1.528387
9 --> 10	8765.00	2.050617	10.698417	0.183456	18.799805	22.395359	15.696127	1.426808
10 --> 11	2625.00	2.055974	10.704535	0.140626	34.200195	24.466862	17.096945	1.431066

There are 2 tools to help analyze data: converting raw data into HQ envelopes and export to Zensol format.

Quick and Easy Connection

- The accelerometer is placed as close as possible to the taps.
- The AC clamp is placed at the motor outlet.
- The test plan generator is easy to follow for performing tests.
- A diagnosis can be made in 15 minutes for an online test, and 1 hour for an off-line test.

TAP-4
Technical Specifications

www.zensol.com www.zensol.net

MEASUREMENT SPECIFICATIONS

Sampling frequency: 100 kHz
Sampling time: 10 µs
Recording time: unlimited
Precision: +/- 1 mV
Signal to noise ratio: better than 80 dB

Instant data transfer to PC via USB link.

Self-diagnostic function for AC clamp.
Self-diagnostic function for accelerometers.

The OpenZen software gives complete control over the system.

3 ACCELEROMETER INPUTS

Accelerometer type: ICP
Sensitivity: 100 mV/g
Range: +/- 50g
Frequency range: 1 to 20000 Hz
Drive current; 4 to 20 mA

1 CURRENT INPUT

Resolution: 16 bits conversion
Voltage range: +/- 10V
Frequency range; DC to 200 kHz
Signal to noise ratio: better than 80 dB

GENERAL

Dimensions: 12.9 x 13.7 x 7 inches (33 x 35 x 18 cm)
Weight: 15.43 lbs (7 kg)
Operating temperature: 0 to 50°C (32°F to 122°F)
Storage temperature: -40°C to 70°C (-40°F to 176°F)
Power supply: 100-240 VAC 50/60 Hz

STRONG

Able to sustain shocks and falls without damage
Case made of reinforced polyethylene with molded reinforcements for maximum protection
No fragile components such as integrated printers, screens or keyboards.

SYSTEM INCLUDES

OpenZen software with upgrades
Manuals
USB cable
Ground cable
Power cable

OPTIONAL ACCESSOIRIES

Accelerometer and AC or AC/DC current clamp
Accelerometer cable (10-32 to BNC)
BNC to BNC cables (10' to 50')
BNC-BNC extensions
Carrying cases for accessories
Accelerometer mounting bases
Glue

OTM-X

STANDALONE OLTC EVENT RECORDER

What is the OTM-X

The OTM-X is the only standalone recorder on the market using the vibroacoustic method and the motor current test, allowing the OLTC state to be watched in real time. This powerful Zensol instrument contains a powerful autonomous computer that records every tap change operation, whether the transformer is on line or not.

This combination enables you to permanently plug in the OTM-X to your network thanks to an Ethernet connection. Thus you will be able to access your data wherever you are and whenever you wish.

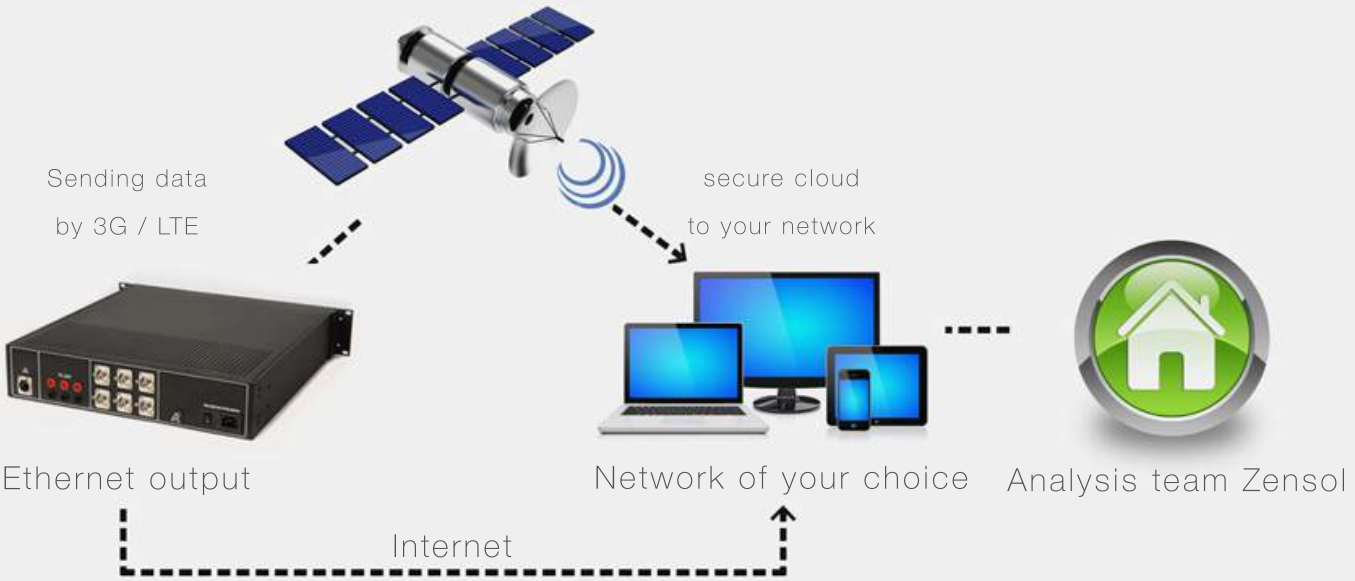
The OTM-X is an ideal tool to keep an eye on strategic or hard to access OLTCs (an example has already been seen in the petroleum industry).

The OpenZen-OTM software is then used to process, calculate and analyze the results.

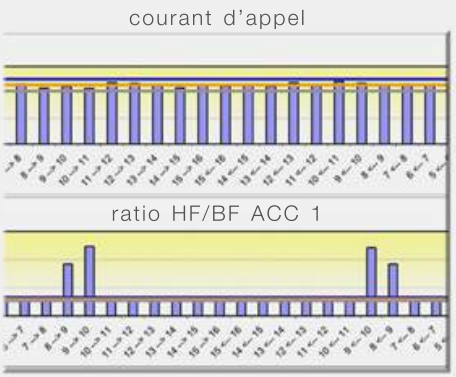
Key points

- The only standalone recorder using the vibroacoutic method on OLTCs.
- Able to continuously follow the evolution of an OLTC wherever and whenever you wish.
- Tests all OLTC types or any other mechanical equipment.
- Powerful memory capacity (over 200 GB).
- Very accurate measurements thanks to a high sampling rate (10 µs/100 kHz) on six parallel inputs.

Data Transfer



Analysis Tools



Exportable Reports

Zensol trending report helps you plan, prioritze, and target your interventions

OTM-X Technical Specifications

www.zensol.com www.zensol.net

MEASUREMENT SPECIFICATIONS

Sampling time: 10 µs to 26 ms
Sampling frequency: 38 Hz to 100 kHz
Recording time: 10 ms to 30 min
A/D conversion: 16 bits
Local storage capacity: 64GB/200GB

VIBRATION (ACCELEROMETER) INPUTS

Number: 3
Accelerometer type: ICP
Resolution: 16 bit A/D converter
Frequency range: 1 Hz to 20 kHz
Signal to noise ratio: better than 80 dB

MULTIPURPOSE ANALOG INPUTS

Number: 3
Resolution: 16 bits conversion
Frequency range; DC to 200 kHz
Accuracy: +/- 0.3 mV
Input voltage range: +/- 10 VAC (compatible with all transducer types)

COMMAND OUTPUTS

Number: 3
Type: solid state, optoisolated
Voltage range: 0-200 VDC
Maximum load current: 3.5 Amps
Turn-on time: 75 µs maximum
Turn-off time: 750 µs maximum
Can be independently turned on and off

REMOTE ACCESS

Uninterrupted control over data, test plans, programs, etc.
Able to perform remotely controlled tests.
Data is easily accessed via your network.
Completely automated scheduled tasks.

ETHERNET PORT

Bandwidth: 10/100 Mb/s
Remote control and recovery of data

USB PORT

Bandwidth: 12/480 MB/s

OPTIONAL ACCESSORIES

Accelerometers
Current probes
Local memory extensions
USB memory card
USB Bluetooth card
USB WiFi card
BNC to 10-23 cables
BNC to BNC extensions (25' and 50')
Cable reel with four 50' extensions
Accelerometer mounting bases
Glue
Watertight case

GENERAL CHARACTERISTICS

Rack Mount version
Dimensions: 19 x 3.5 x 18 inches (48.2 x 8.8 x 45.7 cm)
Weight: 13.2 lbs (6 kg)

Portable version
Dimensions: 17" x 16.5" x 10" (43 x 42 x 25.4 cm)
Weight: 25.3 lbs

Power supply: 100-240 VAC 50/60 Hz
Operating temperature: 0 to 50°C (32°F to 122°F)
Storage temperature: -20°C to 70°C (-4°F to 158°F)

ANALOG TRIGGERING

Works with any analog input
AC or DC signals
Upward or downward transition
Works in noisy environments

TRANSDUCERS
CABLES
CASES

TRANSDUCERS

Accelerometer base

Reference: TAP-BASE
Mounting base for accelerometers

Accelerometer ICP 10g

Référence: ACC-10g
For on line tap changers
Measurement range:
+/- 500 mV/g +/- 10g

Accelerometer ICP 50g

Référence: ACC-50g
For on line tap changers
Measurement range:
+/- 100 mV/g +/- 50g

AC Current Clamp

Référence: CT-CLAMP-AC
Measures AC currents from 20 to 200 Amps

AC/DC Current Clamp

Reference:
CT-CLAMP-AC/DC
Measures AC or DC currents up to 30 Amps

Dynamic Resistance

Combined with vibroacoustic tests, contact dynamic resistance measurements can help to precisely synchronize contact motion.

CABLES

USB Cable

Reference: USB-CAB
Length: 3 feet

Accelerometer Cable

Reference; C-BNC-03
Includes 10-32 to BNC connectors

Coaxial extension cable

Reference: C-BNC-BNC
Male-to-male with female adapter
Lengths: 25 feet (7.62 m) and 50 feet (15.24 m)

Cable reel

Reference: BNC-REEL-4X50
Reel with four 50 foot BNC extensions

Ground cable

Reference: GND-25\
Grounding cable
Length: 25 feet (7.62 m)

Power supply cable

Reference: CAB-ALIM

CASES AND BAGS

Reference: Z-VAL-7

Rigid transport case with wheels for TAP-4 cables and accessories, it may also be used to protect the OTM-X.
Dimensions: 22" x 17" x 10" (56 x 43.2 x 25.4 cm)

Reference: Z-VAL-3

Rigid transport case with wheels for TAP-4 cables and accessories.
Dimensions: 35" x 14" x 36" (88.9 x 35.6 x 25.4 cm)

Reference: Z-VAL-3 and Z-VAL-7

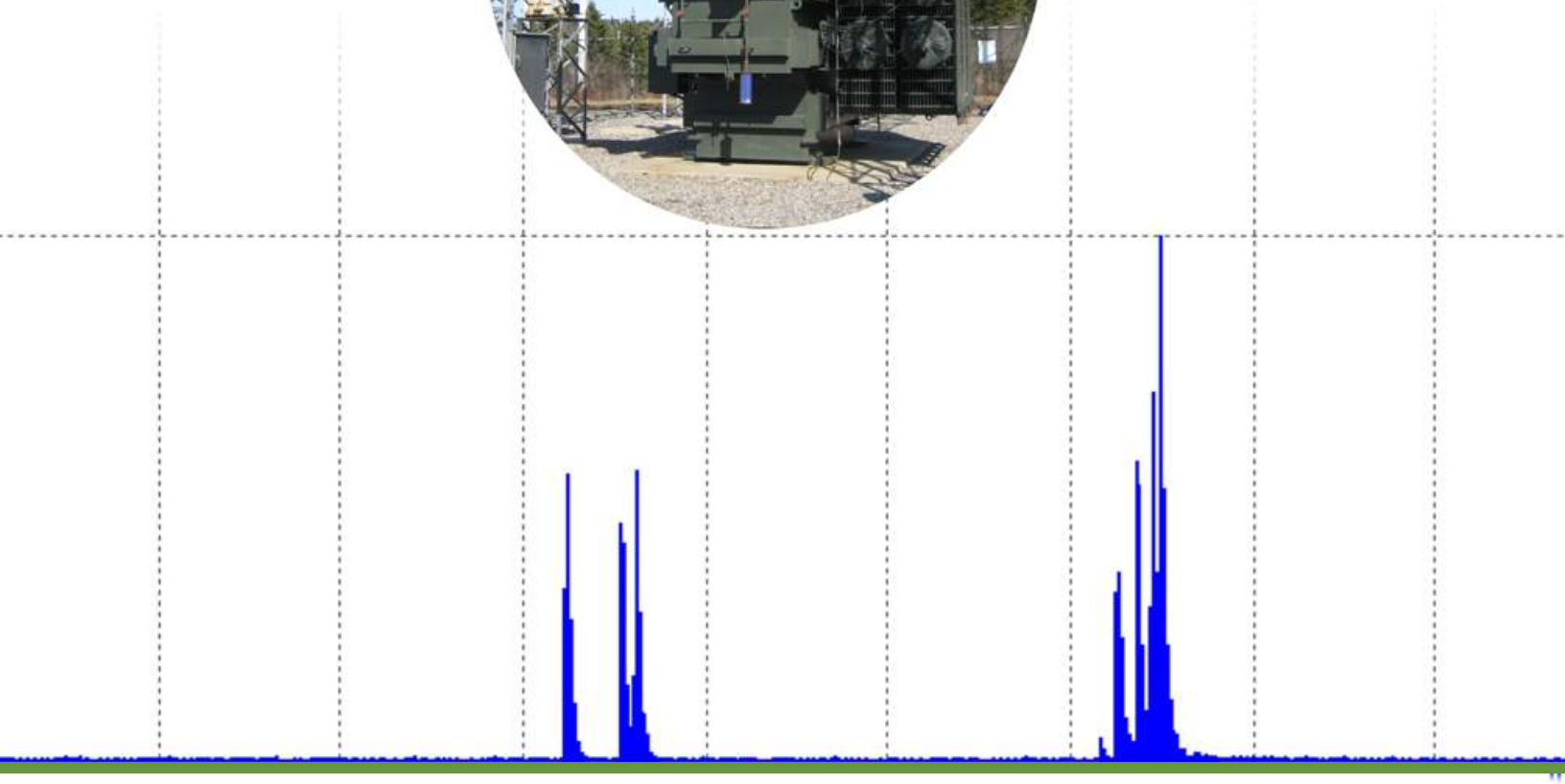
Sturdy, waterproof and easily carried, it protects your products from impacts and the elements.

Reference: Z-BAG

Bag for carrying cables and accessories for the TAP-4.

SOFTWARE

OLTC ANALYZER



OPENZEN
TAP and OTM Software

OpenZen is a universal recording and analysis software. It drives the TAP-4 and OTM-X from a single graphical user interface.

Thanks to a vibroacoustic signature, the user may interpret the recorded events. It is thus possible to perform efficient, targeted maintenance on OLTCs and issue a quick intervention diagnosis.

Characteristics of OpenZen-TAP

- Helps in decision-making thanks to interpretation methods based on actual cases.
- Applicable to all OLTC types (ABB, Federal Pioneer, Ferranti-Packard, GE, Huaming, Reinhausen, Westinghouse...).
- Quick (less than 10 minutes) and automated test sequence.
- Simple and minimal operator action.
- Delivers individual results for each tap.
- Ability to compare tests between each other.

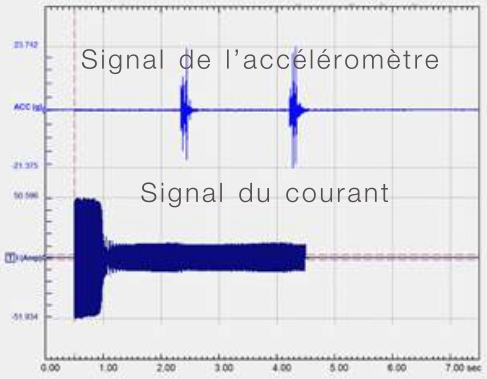
Caracteristiques of OPENZEN-OTM

- Complete and continuous control over data, test plans, and programs.
- Includes all the necessary tools to analyse test results in the field or in the lab.
- Used for processing, calculation and interpretation of test results, and on line help needed for transformer maintenance professionals.
- Very easy management of thousands of test results.
- Easy access to automatic follow-up file.

What the software allows you to do

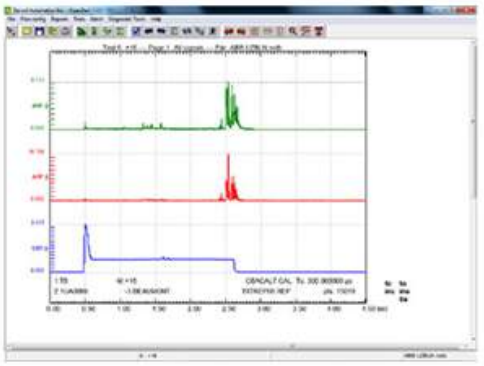
Achieve accurate results

The software enables you to accurately zoom in on your data, both vertically and horizontally. The extreme precision of the unit allows the software to see sampling times down to 5 µs for comparing impact and motion timing.



Exporting raw data to envelopes

The software gives you reliable recorded data. It also gives you the possibility to extract your raw data to envelope curves, allowing you to filter them. Various options are offered to make test analysis easier, such as data superposition for a better understanding of the results.

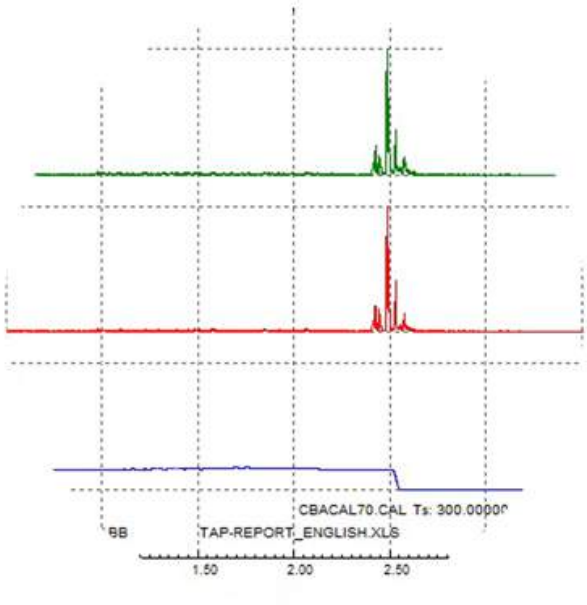


Excel Reports

Once your data is visualized, the software offers you to export them to an Excel file that summarizes your tests in a single table. You will see the currents in Amps, operation times, impact forces, etc. It will also help you to single out any troublesome taps. Moreover, graphics illustrating the details are included in the software.

SEMINARS

OLTC



Zensol is not only a manufacturer of test instruments. Our team regularly organizes technical seminars in the field of high-voltage substation maintenance for circuit breakers, transformers and OLTCs in particular.

These seminars are held :

- Anywhere in the world
- On demand, according to each of our schedules
- Delivered by highly qualified specialists

At Zensol, we like sharing our knowledge. During our seminars, we offer theory and technical training in our field of expertise.

Overview of our OLTC seminars

A tap changer is the part of a transformer that is the most used. It adjusts the load function of the network without interrupting service. The tap changer is the source of 50% of major transformer failures. Thus it is vital to maintain it, because poor maintenance can cause grave consequences and lead to a major loss of revenue.

Diagnostics using the vibroacoustic technique on tap changers is a relatively new technique, with its first developments occurring just 15 years ago.

This seminar makes a quick introduction to the method already used by many electricity companies, because it can detect a wide variety of problems and avoids major failures.

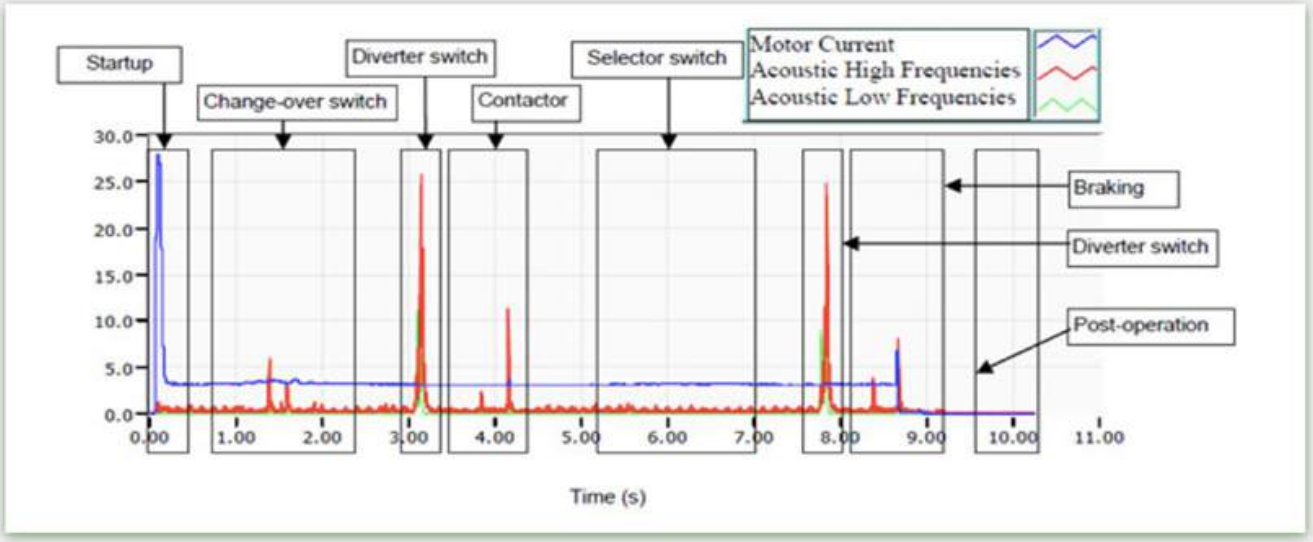
Subjects presented

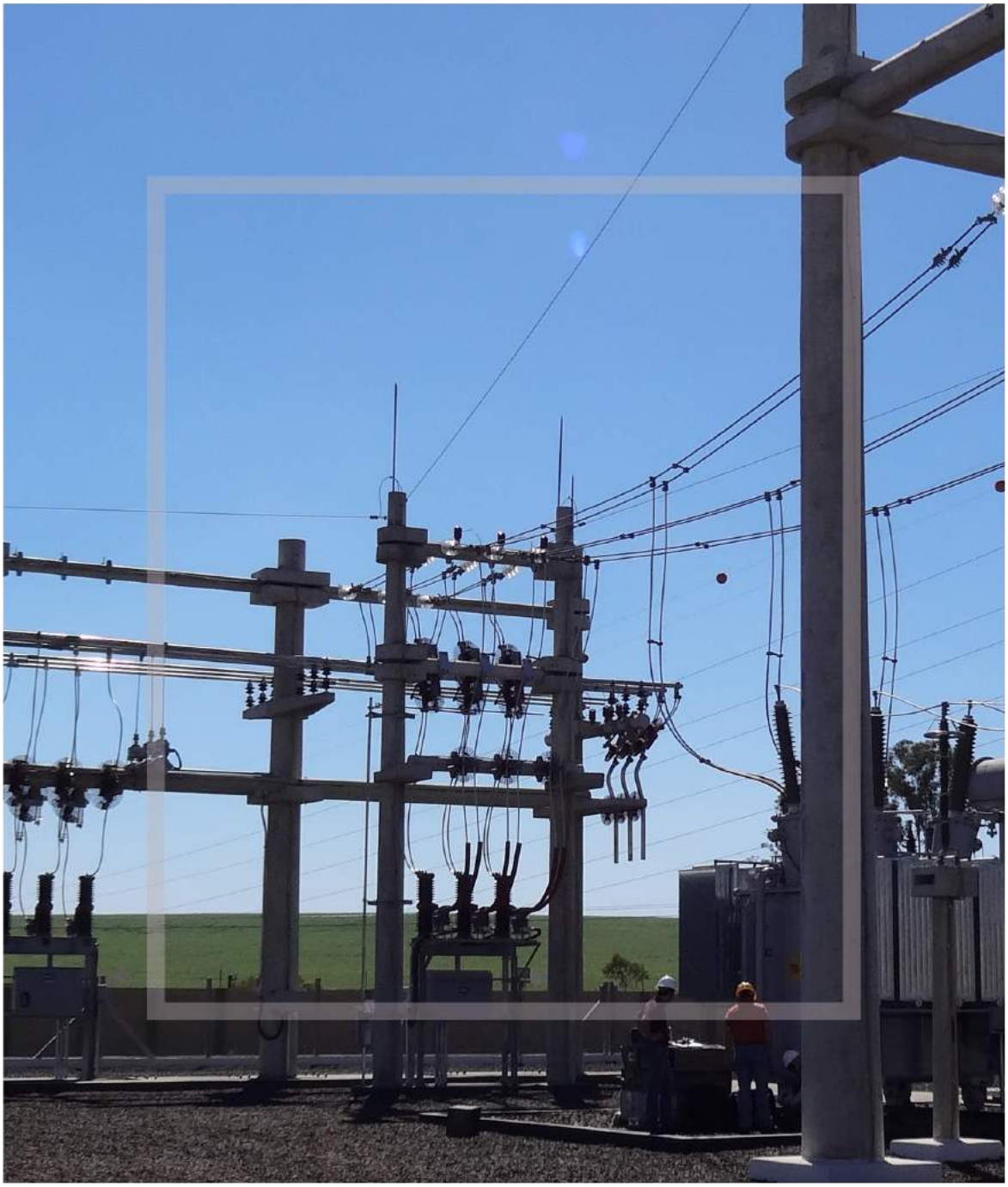
- Presentation of vibroacoustic diagnostics, recording methods and data processing
- Using the TAP-4 and OTM-X test instruments
- Using the OpenZen TAP and OTM software
- Cases studies and simulations

What you will learn

- A complete and detailed explanation of the entire process, from the measurements to the interpretation of the results.
- Why, how and when to use the vibroacoustic mehtod.
- Examples of analysis and actual cases.

Example analysis made by the vibro-acoustic method





SERVICE & TRAINING ON OLTCs

Services

Our experience at YOUR service

Our diagnostic team has tallied tests on more than 1000 transformers worldwide, thus acquiring the largest database of diagnostic cards and problems observed on various tap changers of various manufacturers. We offer analysis services, training and field testing.

Aimed at supervisors and maintenance teams, we analyze your data recorded by the TAP-4 /OTM-X. Our service team will deliver a professional analysis report, easy to read, including their recommendations.

Our highly specialized team will give you peace of mind over your field tests. We fulfill your needs by supplying the equipment, performing the tests and a detailed report. A trending file is also available and updaed at every test.

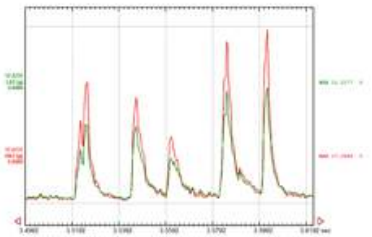
We also offer basic and advanced training on our instruments and software, for both new and long-time customers.

Level 1: How to use the system and the software to perform tests.
Level 2: How to use the diagnostic tools and flag problems.
Level 3: How to make an in-depth diagnostic and plan maintenance using the Zensol follow-up file.

Exemples of diagnostics

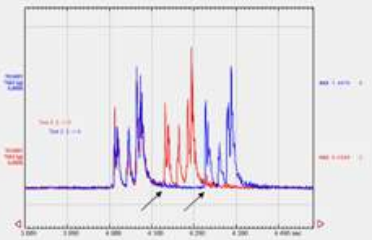
Contact wear

We analyze the ratio of high to low frequencies recorded by the accelerometer, allowing us to determine when to change the fixed and moving contacts of the OLTC.



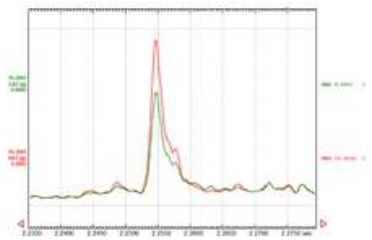
Timing problems

A defective drive motor, worn parts, or poor maintenance can compromise OLTC timing and its proper operation.



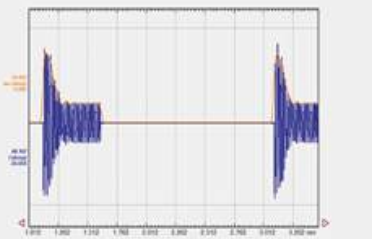
Arcing

When used on line, our analysis can detect electrical arcs which are the main cause of dissolved gases in the oil. The more the arcs occur often, and the higher their vibroacoustic amplitude, the more the oil will be affected.



Motor current

Our analysis made with a current clamp allows the observation of the motor's condition, the drive mechanism, lubrication of the gears, selector operation and, as shown, eventual relay problems.



Follow-up file

This easy to use file quickly compares your OLTCs and their trends. This tool will help you PLAN, PRIORITIZE, and TARGET your interventions.

Services

Do you have problems with your OLTC or do you wish to make a simple preventive analysis? Zensol gives you the possibility to test its instruments, which are compatible with all OLTC types and other vibroacoustic mechanisms:

TAP-4

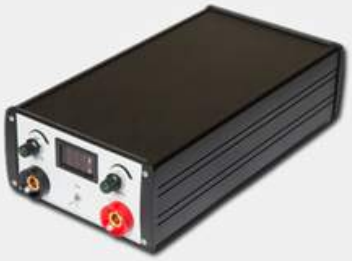
Our vibroacoustic experts will be pleased to meet you and issue a report on the condition of your OLTC, with their recommendations.

OTM-X

Our team can install the OTM-X to keep watch over your OLTC for a few weeks. After that, a follow-up will be made on the OLTC's operations.

Dynamic Resistance

Measurement of the dynamic resistance is an off-line test performed on OLTCs. This measurement is performed when operating the OLTC while injecting currents and voltages in order to record variations in resistance. Our service team knows how to perform dynamic resistance testing at the same time as vibroacoustic tests. The correlation of the signals of these two types of test allows our team to detect any anomalies in your OLTC.



Sharing KNOWLEDGE

To know more about tap changer diagnostics, please visit our web site, where you will find many articles.

Share your knowledge on tap changers (OLTCs) with us.
Submit your articles for eventual publication on our web site.

www.zensol.com/en/sharing-knowledge

HOURS

Monday to Friday
From 8:30am to 5pm

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