

TAP-4 CHECKLIST

Zensol recommends to check this list of important points in order to be well prepared to perform tests using the TAP-4. This process will also help you analyze the results more effectively.

A. Before testing (11 points)

Step	Description	Result	
A1	Make of transformer		
A2	Transformer build date		
A3	Make and model of OLTC		
A4	OLTC build date		
A5	Number of taps (according to EDF, HQ, etc. standards)		
A6	Number of OLTCs similar to the one tested		
A7	OLTC user manual	YES	NO
A8	Picture of the transformer	YES	NO
A9	Picture of the OLTC	YES	NO
A10	Do you know where to install the accelerometers?	YES	NO
A11	Do you know where to install the current clamp?	YES	NO

B. During the tests (7 points)

Step	Description	Result	
B1	History of interventions on the OLTC	YES	NO
B2	Agree with customer on test sequence -Off line: recommend testing all taps -On line: to be defined with the customer	OFF LINE ON LINE	
B3	Picture of tap configuration	YES	NO
B4	Overall picture of transformer with OLTC	YES	NO
B5	Picture showing location of accelerometer	YES	NO

B6	Picture showing location of current clamp	YES	NO
B7	Ensure presence and viability of data files for analysis (raw data)	YES	NO

C. After testing (7 points)

Systematic analysis method			
Step	Description	Result	
C1	Calculate envelopes	YES	NO
C2	Perform an Excel export to obtain an overview of the results	YES	NO
C3	Attempt to associate the impacts with the OLTC mechanism in order to identify and locate events in the vibro-acoustic trace	YES	NO
C4	<p>With all the elements gathered before and during the tests, we recommend the following visual analysis:</p> <p>Impact analysis:</p> <ul style="list-style-type: none"> - Time between impacts (examine tool) - Shape (scale tool) - Amplitudes (examine tool) - Relative to the end of the current (examine tool) <p>Superposing and comparing traces:</p> <ul style="list-style-type: none"> - odd-numbered vs. even-numbered taps - rise vs. fall between impacts - taps of an OLTC compared to one of the same type - current traces between taps or between OLTCs of the same type - high frequency vs. low frequency envelopes 		
C5	Observation and identification of anomalies		
C6	Recommendations for future tests		
C7	Transfer and sharing of data and pictures with Zensol on DB TAP in an anonymous manner. The DB TAP goal is to build a base of healthy and unhealthy reference signatures.	YES	NO

EXAMPLE

A. BEFORE TESTING

The screenshot shows the 'Identification' software window with the following fields and callouts:

- A1. Make of transformer:** Points to the '1) Make of transformer' field containing 'GE'.
- A2. Transformer build date:** Points to the '2) Transformer build date' field containing '1985'.
- A3. Make and model of OLTC:** Points to the '3) Make and model of' field containing 'MR - Typ'.
- A4. OLTC build date:** Points to the '4) OLTC build date' field containing '1990'.
- A5. Number of taps (according to EDF, HQ, etc. standards):** Points to the '5) Number of taps' field containing '33'.

Other visible fields include:

- '6) Location' with value '0'.
- 'Taps names' with a dropdown menu showing '1, 2, 3, 4...'
- 'Tests Informations' section with fields for '9) Operation counter' (0), '10) *Start position' (dropdown), '11) Oil temperature (°C)' (0), and '12) Date of the test' (15-09-2011_10h47).
- '*Test Type' section with radio buttons for 'Online' (selected), 'Offline (All Taps)', and 'Offline (Only some Taps)'. Below it is '14) Nb of Taps' (0).
- 'Changes made' section with checkboxes for 'Lubrication', 'Mechanical adjustments', and 'Contacts changes'.
- 'Notes -- Details' section with a text area.
- 'Acquisition Type' section with radio buttons for 'Acquisition with TRIG' (selected) and 'Acquisition in secs' (0). 'Start' is set to '2.0 A' and 'End' to '0.5 A'.
- 'Connections' section with checkboxes for 'ACC1' (checked), 'ACC2', and 'ACC3'.
- 'Base test plan: operator_e.wcf'.
- 'OK' and 'Annuler' buttons at the bottom right.

A6. Number of OLTCs similar to the one tested:

6

A7. OLTC user manual:



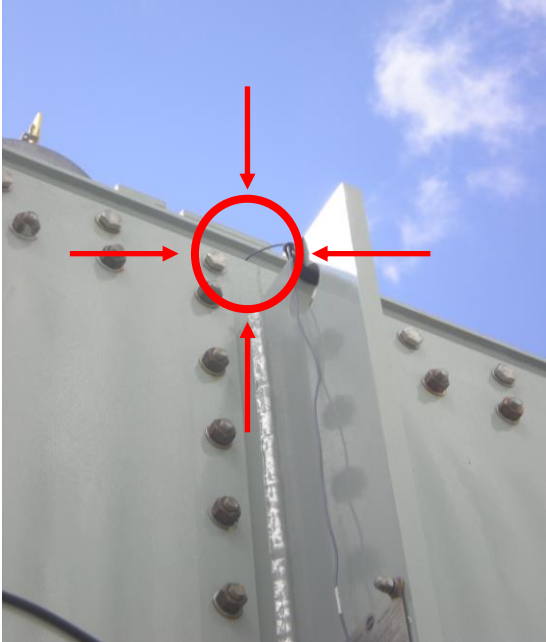
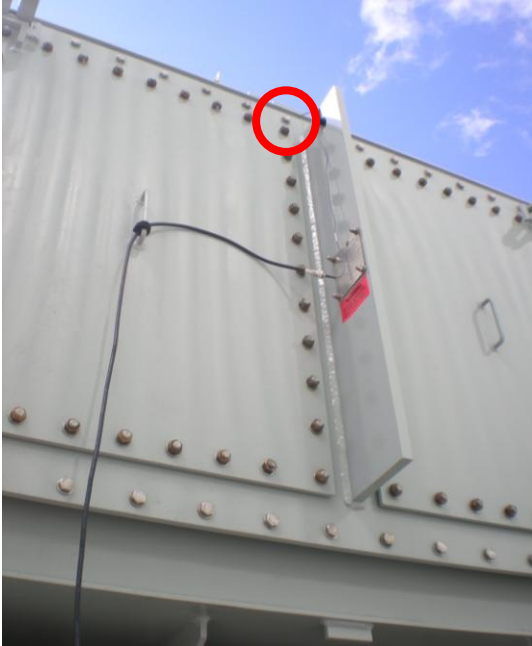
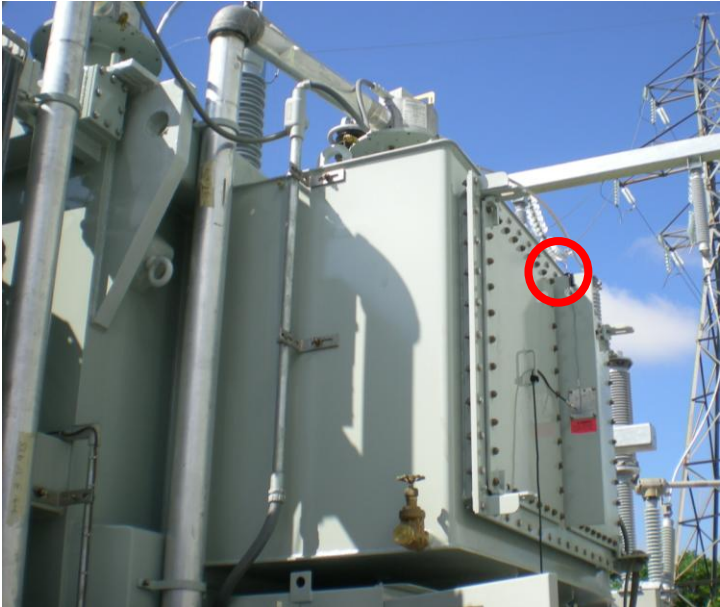
A8. Picture of the transformer:



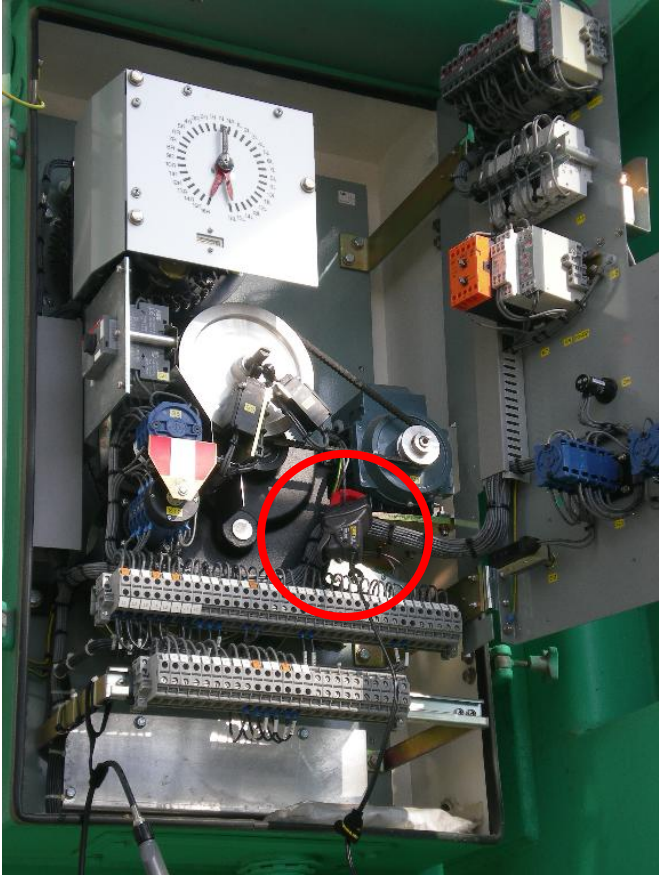
A9. Picture of the OLTC:



A10. Do you know where to install the accelerometer?



A11. Do you know where to install the current clamp?



B. DURING THE TESTS

B1. History of interventions on the OLTC:

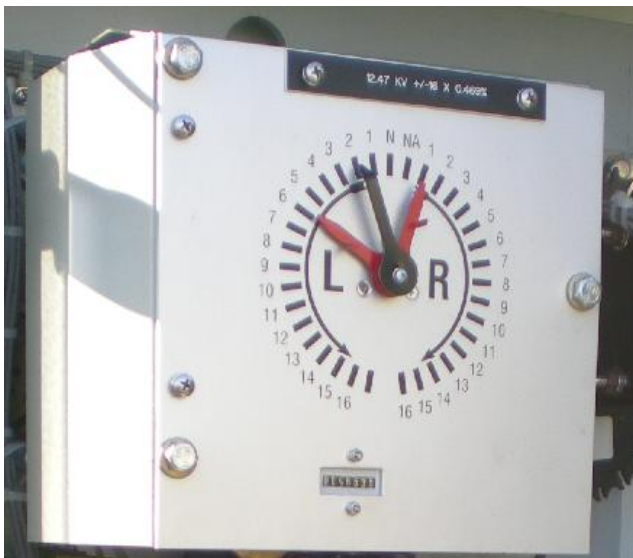
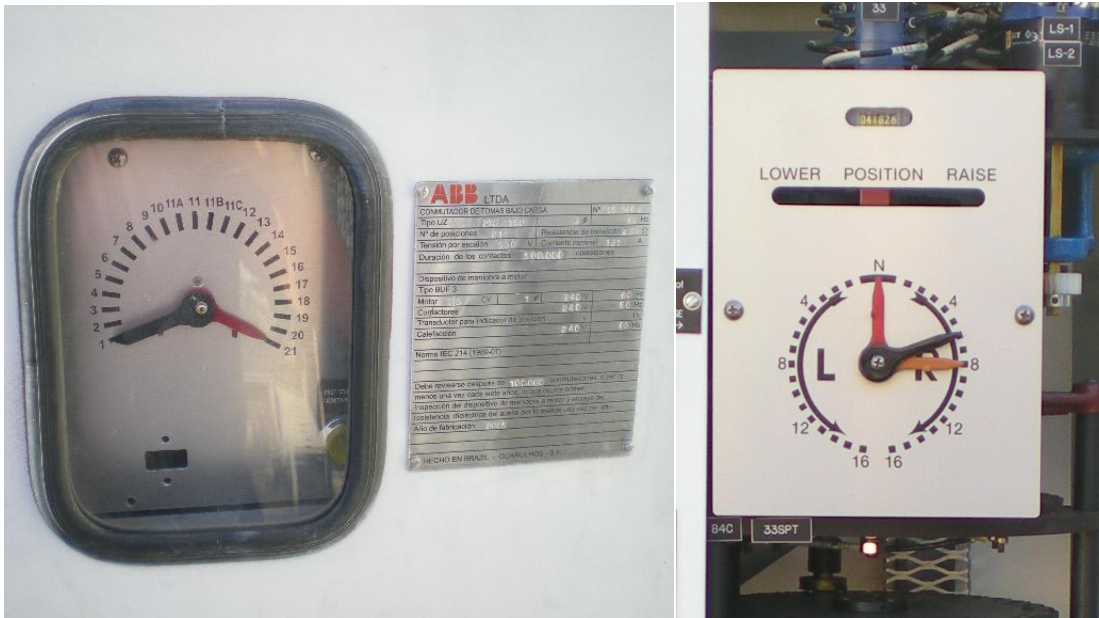
YES.

B2. OFFLINE or ONLINE transformer:

Example 1 : OFFLINE

Example 2 : ONLINE – Tested tap : 5.

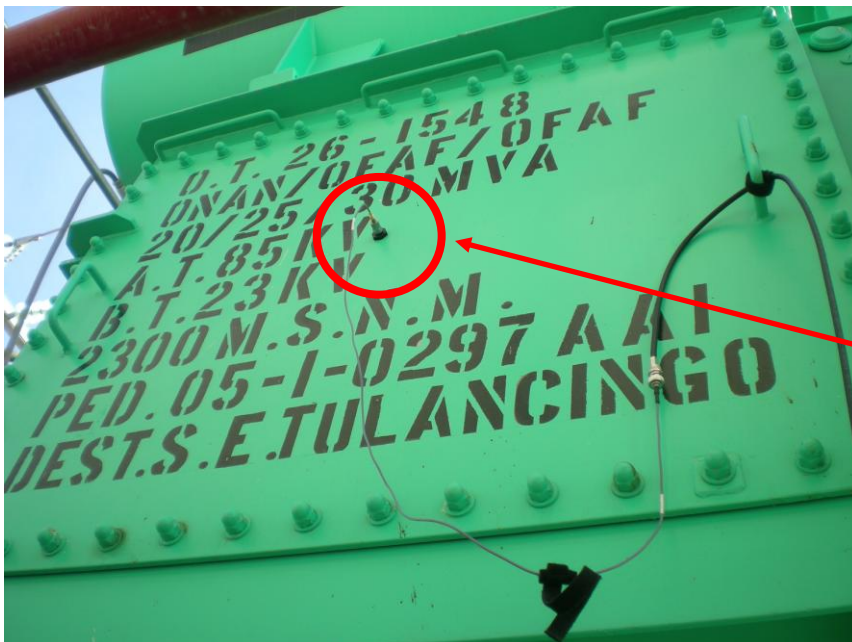
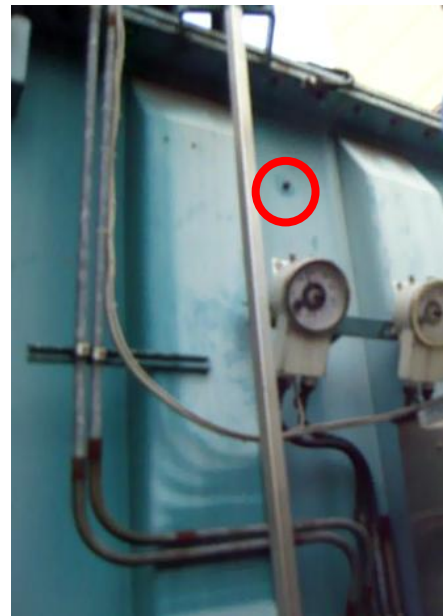
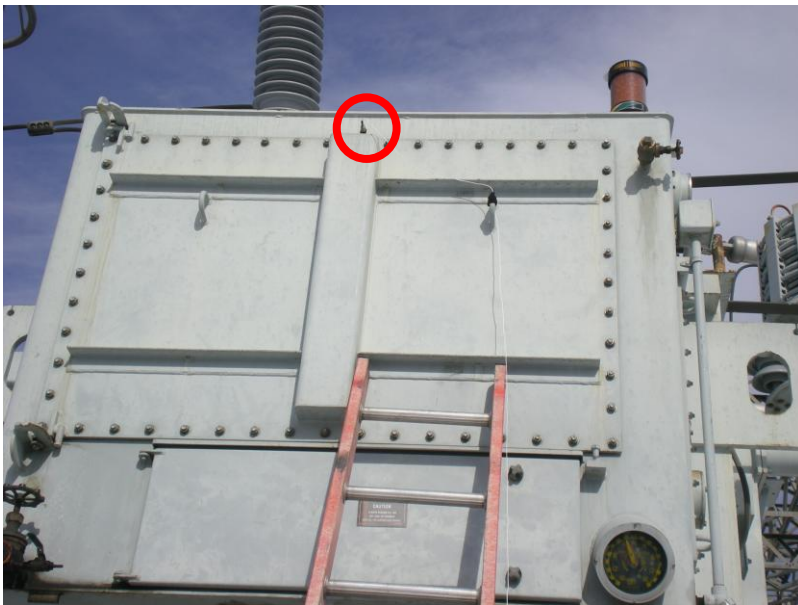
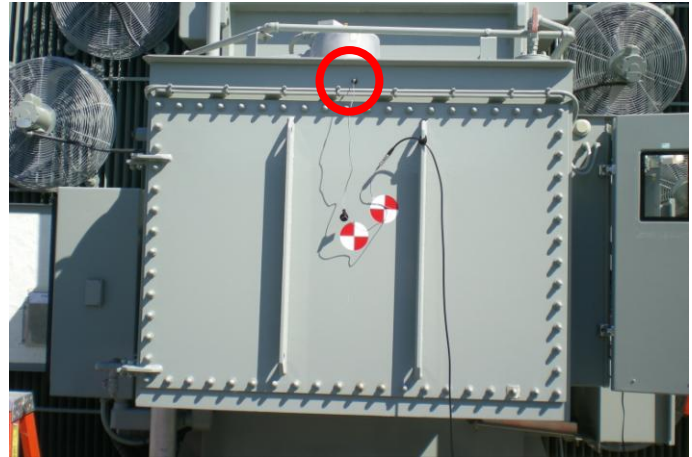
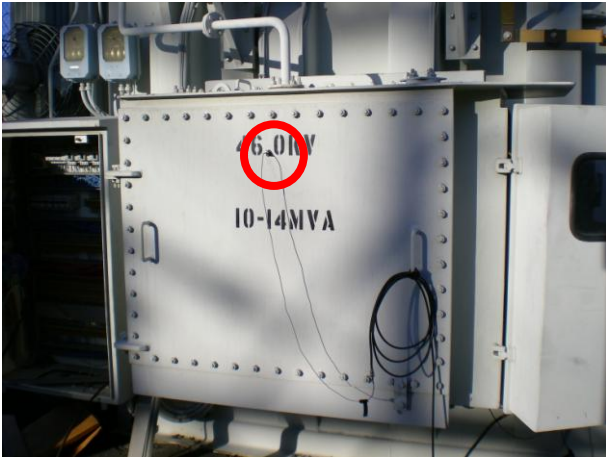
B3. Picture of tap configuration:



B4. Overall picture of transformer with OLTC:

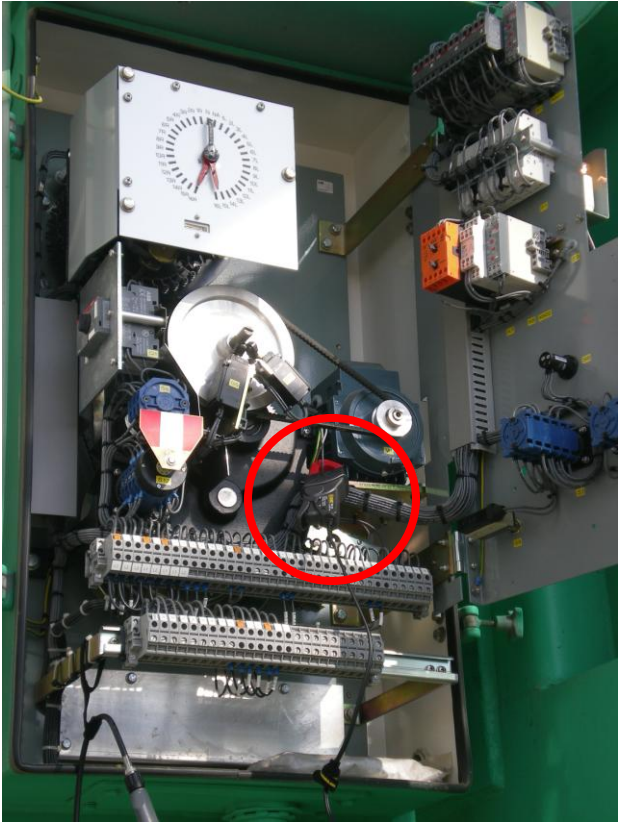
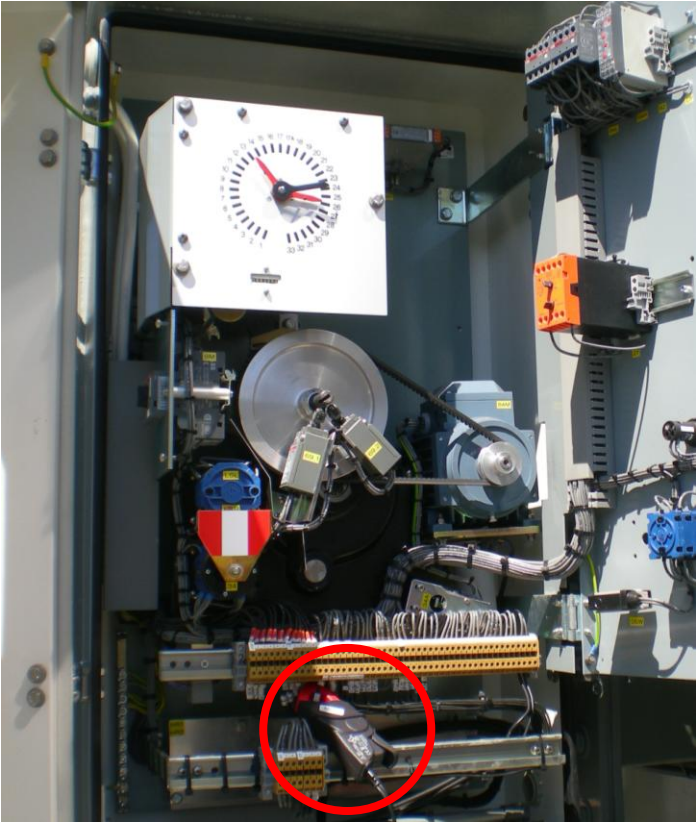
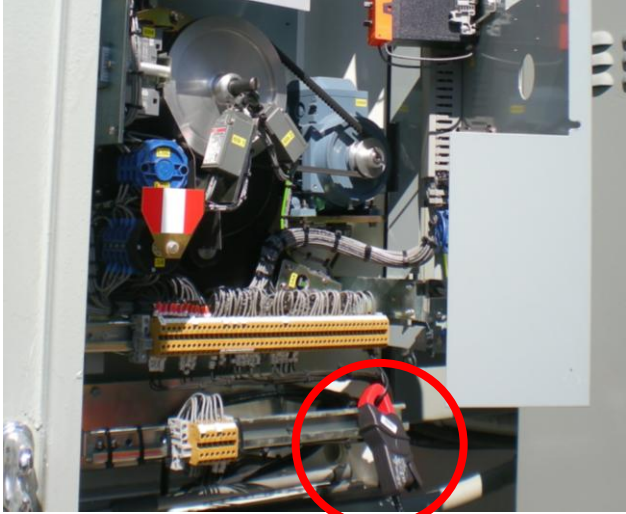
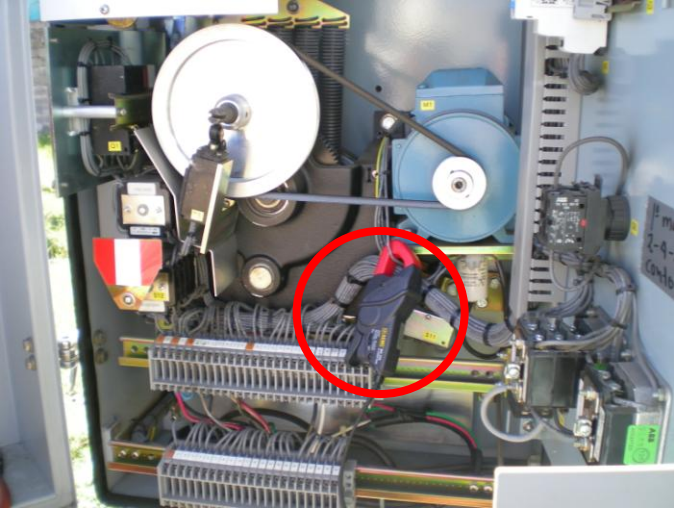


B5. Picture showing location of accelerometer:



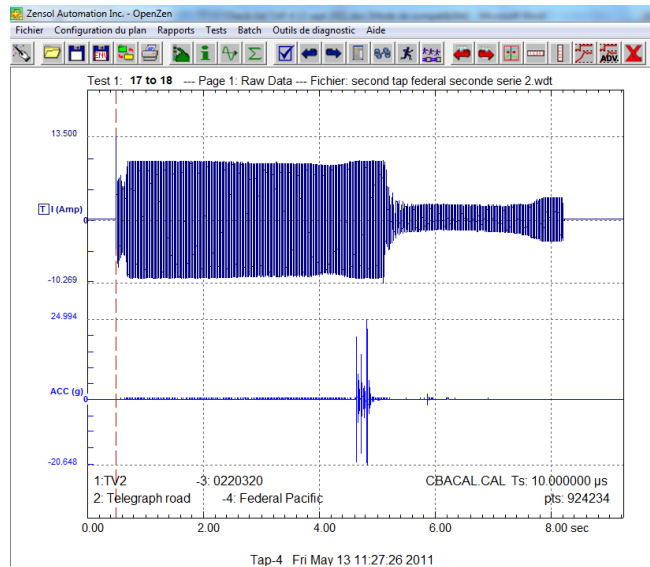
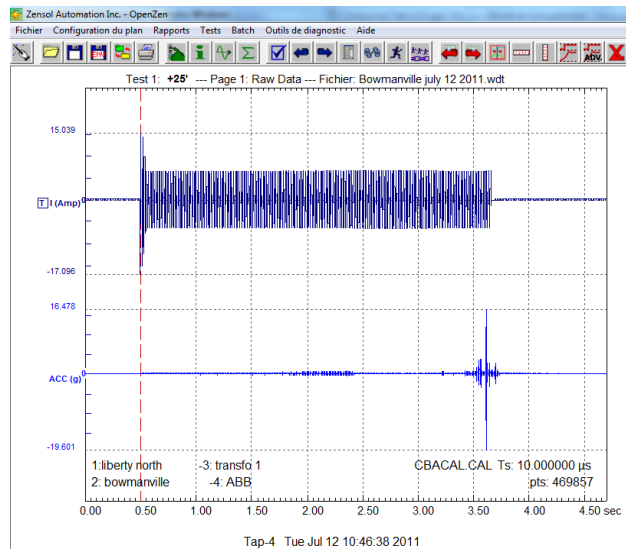
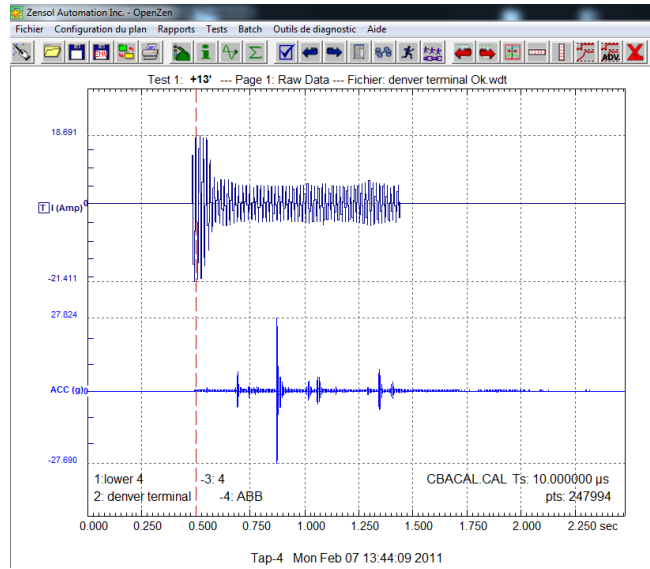
WRONG
INSTALLATION

B6. Picture showing location of current clamp:



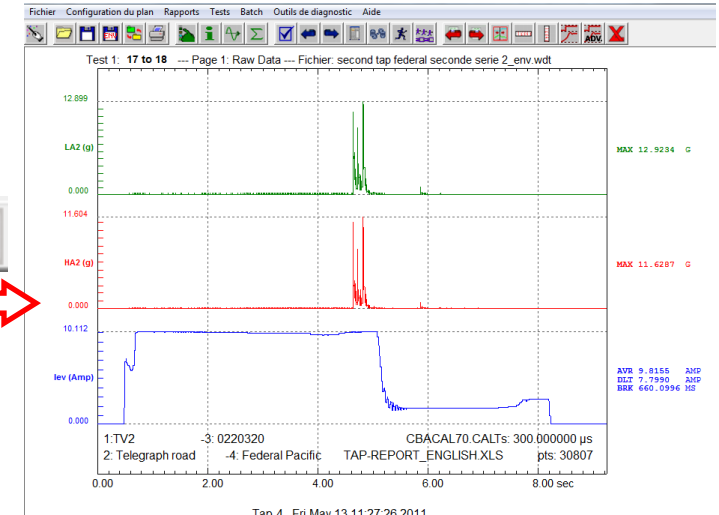
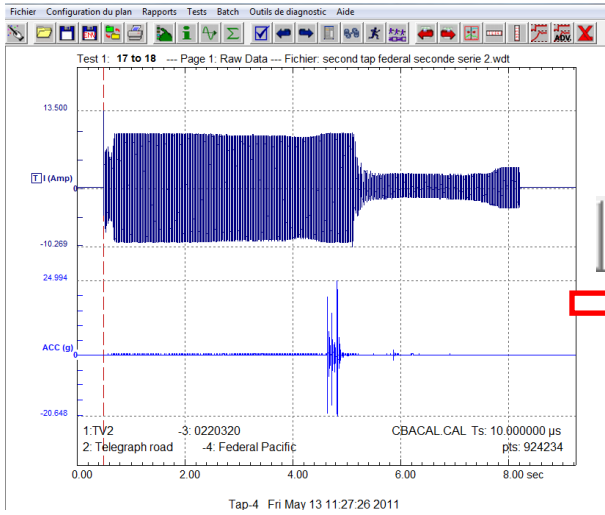
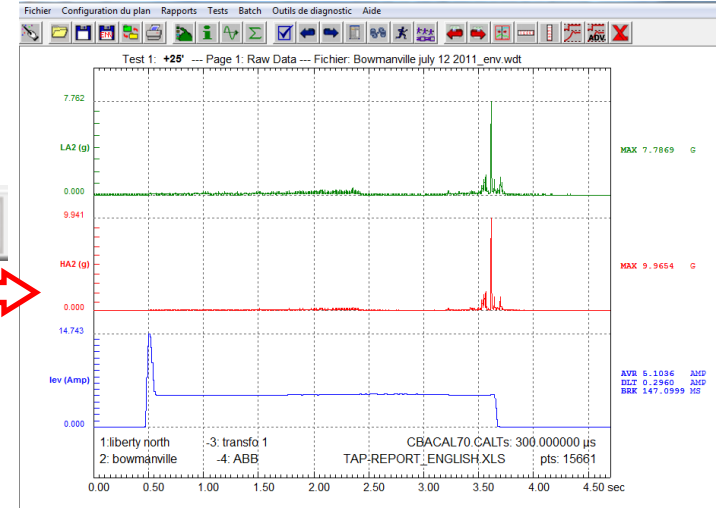
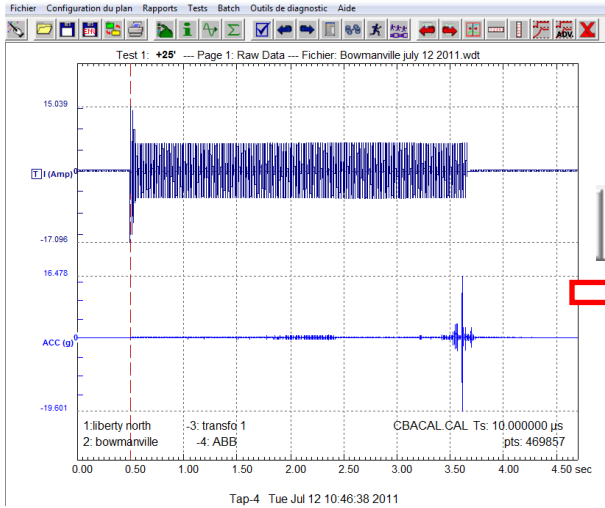
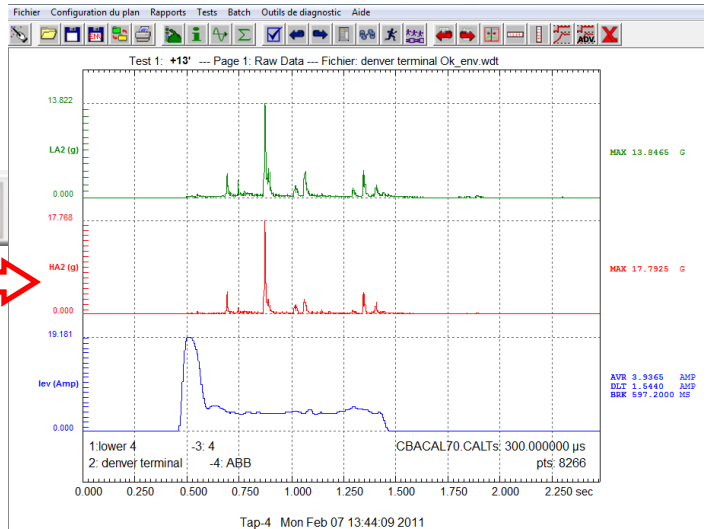
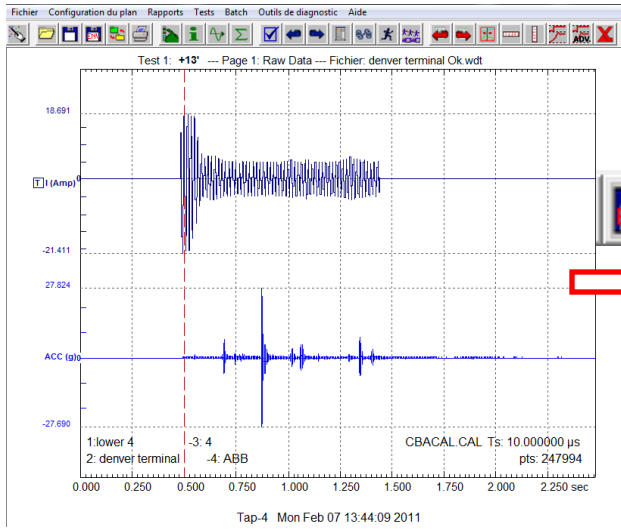
B7. Ensure presence and viability of data files for analysis (raw data):

Extension : « .wdt »

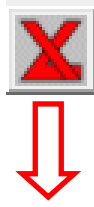


C. AFTER TESTING

C1. Calculate envelopes:



C2. Perform an Excel export to obtain an overview of the results:



Test Summary Sheet before export:

TAP-Report_English.xls [Mode de compatibilité] - Microsoft Excel

Test Summary - TAP-4												
@LR0	@R0	@LR4	@R4	Test time	Values lower then threshold							
@LR1	@R1	@LR5	@R5		Values in the average							
@LR2	@R2	@LR6	@R6		Values higher then threshold							
@LR3	@R3	@LR7	@R7									
Length Summary												
Average operation length: #DIV/0! ms Total number of operations: 0												
Fastest operation: #N/A 0 ms Operations 30% faster then average: 0												
Slowest operation: #N/A 0 ms Operations 30% slower then average: 70												
Current average Summary												
Current Average: #DIV/0! Amp Total number of operations: 0												
Lowest current: #N/A 0.00 Amp Currents 30% lower then average: 0												
Highest current: #N/A 0.00 Amp Currents 30% higher then average: 70												
Inrush Summary												
Inrush Average: #DIV/0! Amp Total number of operations: 0												
Lowest inrush: #N/A 0.00 Amp Inrushs 30% lower then average: 0												
Highest inrush: #N/A 0.00 Amp Inrushs 30% higher then average: 70												
End of operation Summary												

Prêt Référence circulaire: G59 Nb (non vides):

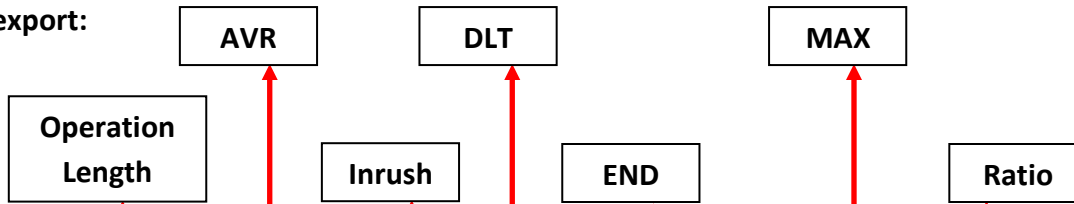
Tap details sheet before export:

TAP-Report_English.xls [Mode de compatibilité] - Microsoft Excel

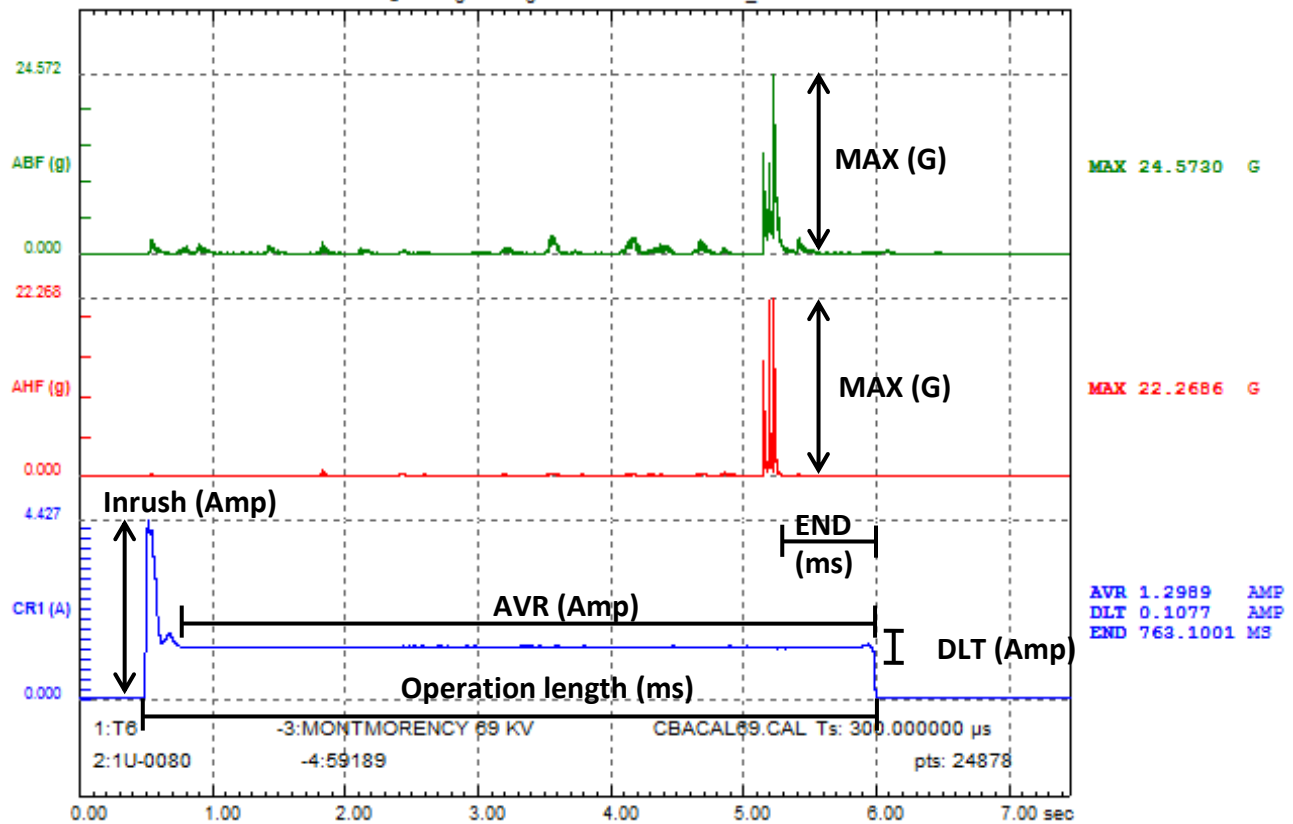
Results - TAP-4												
@LR0	@R0	@LR4	@R4	Test time	Values lower then threshold							
@LR1	@R1	@LR5	@R5		Values in the average							
@LR2	@R2	@LR6	@R6		Values higher then threshold							
@LR3	@R3	@LR7	@R7									
Test num.	Tap name	Operation length	Current average	Inrush	Current delta	ad of operation time	ACCELEROMETER1			ACCELEROMETER2		
	Time in ms		Current in Amps			Time in ms	HF MAX	LF MAX	HF/LF RATIO	HF MAX	LF MAX	
Averages:	0.00	0	0	0	0	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	
1	@NomTest1 @DureeOperat @Moyenne1	@Inrush1	@Delta1	@TFrein1	@HFMax1	@LFMax1	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
2	@NomTest2 @DureeOperat @Moyenne2	@Inrush2	@Delta2	@TFrein2	@HFMax2	@LFMax2	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
3	@NomTest3 @DureeOperat @Moyenne3	@Inrush3	@Delta3	@TFrein3	@HFMax3	@LFMax3	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
4	@NomTest4 @DureeOperat @Moyenne4	@Inrush4	@Delta4	@TFrein4	@HFMax4	@LFMax4	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
5	@NomTest5 @DureeOperat @Moyenne5	@Inrush5	@Delta5	@TFrein5	@HFMax5	@LFMax5	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
6	@NomTest6 @DureeOperat @Moyenne6	@Inrush6	@Delta6	@TFrein6	@HFMax6	@LFMax6	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
7	@NomTest7 @DureeOperat @Moyenne7	@Inrush7	@Delta7	@TFrein7	@HFMax7	@LFMax7	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
8	@NomTest8 @DureeOperat @Moyenne8	@Inrush8	@Delta8	@TFrein8	@HFMax8	@LFMax8	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
9	@NomTest9 @DureeOperat @Moyenne9	@Inrush9	@Delta9	@TFrein9	@HFMax9	@LFMax9	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
10	@NomTest10 @DureeOperat @Moyenne10	@Inrush10	@Delta10	@TFrein10	@HFMax10	@LFMax10	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
11	@NomTest11 @DureeOperat @Moyenne11	@Inrush11	@Delta11	@TFrein11	@HFMax11	@LFMax11	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
12	@NomTest12 @DureeOperat @Moyenne12	@Inrush12	@Delta12	@TFrein12	@HFMax12	@LFMax12	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
13	@NomTest13 @DureeOperat @Moyenne13	@Inrush13	@Delta13	@TFrein13	@HFMax13	@LFMax13	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
14	@NomTest14 @DureeOperat @Moyenne14	@Inrush14	@Delta14	@TFrein14	@HFMax14	@LFMax14	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
15	@NomTest15 @DureeOperat @Moyenne15	@Inrush15	@Delta15	@TFrein15	@HFMax15	@LFMax15	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
16	@NomTest16 @DureeOperat @Moyenne16	@Inrush16	@Delta16	@TFrein16	@HFMax16	@LFMax16	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
17	@NomTest17 @DureeOperat @Moyenne17	@Inrush17	@Delta17	@TFrein17	@HFMax17	@LFMax17	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
18	@NomTest18 @DureeOperat @Moyenne18	@Inrush18	@Delta18	@TFrein18	@HFMax18	@LFMax18	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
19	@NomTest19 @DureeOperat @Moyenne19	@Inrush19	@Delta19	@TFrein19	@HFMax19	@LFMax19	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	
20	@NomTest20 @DureeOperat @Moyenne20	@Inrush20	@Delta20	@TFrein20	@HFMax20	@LFMax20	@VALEURI	@VALEURI	@VALEURI	@HFMax2	@LFMax2	

Prêt Référence circulaire: N10

Results after export:



Results - TAP-4										
3	Default Test Plan for	@R1	Compteur	59189	Test time					
4	Exploitation	T6	# Série	@R5						
5	Inventaire	1U-080	Temp. Huile	30	@R8					
6	Poste	MONTMORENCY 69 KV	Type Essai	HORS_SERVICE						
7										
8	Test num.	Tap name	Operation length	Current average	Inrush	Current delt	End of operation time	HF MAX	LF MAX	HF/LF RATIO
9			Time in ms	Current in Amps	Time in ms	Acceleration in G				
10		Averages:	6237.81	1.299904281	4.543144906	0.1532005	1145.206284	22.1206286	26.6634957	0.84245729
11	1	+8	5510.00	1.298856	4.387579	0.107729	761.100098	22.268593	24.573019	0.90622129
12	2	+9	11185.00	1.30213	4.632944	0.368353	755.800781	22.852091	28.730633	0.79539114
13	3	+10	11190.00	1.305267	4.66041	0.332341	762.5	22.036751	29.754477	0.74061967
14	4	+11	5525.00	1.300699	4.383917	0.103456	1133.799805	20.001513	21.398794	0.93470282
15	5	+12	5520.00	1.300251	4.668955	0.11078	770.5	29.452614	27.467167	1.07228438
16	6	+13	5515.00	1.300914	4.517586	0.104677	1135.300293	16.676355	23.110386	0.72159569
17	7	+14	5510.00	1.29969	4.514534	0.107118	766.900391	20.454306	32.237839	0.6344813

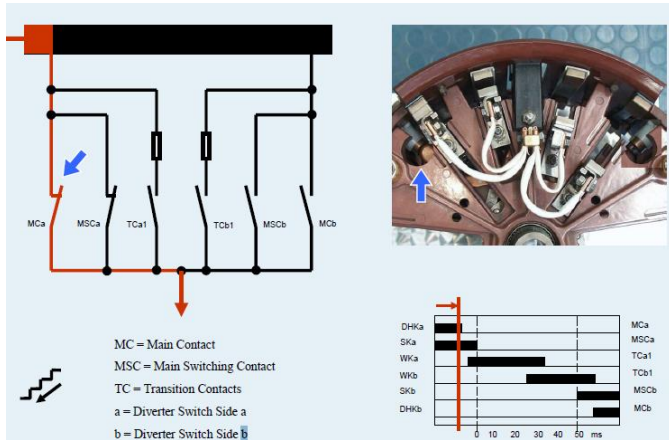


C3. Attempt to associate the impacts with the OLTC mechanism:

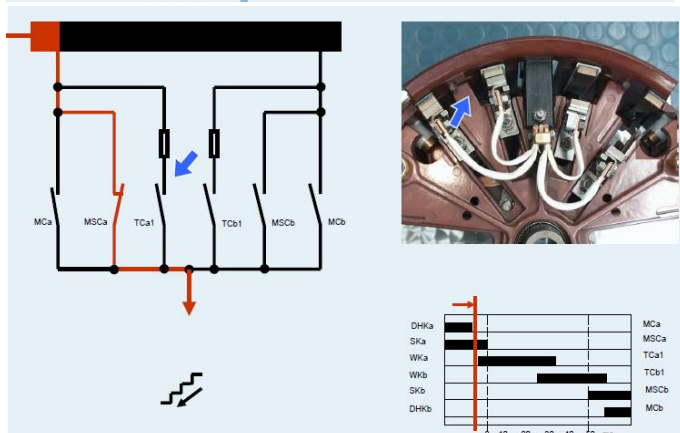
Example in preparation: MR Reinhausen M-type tap changer.



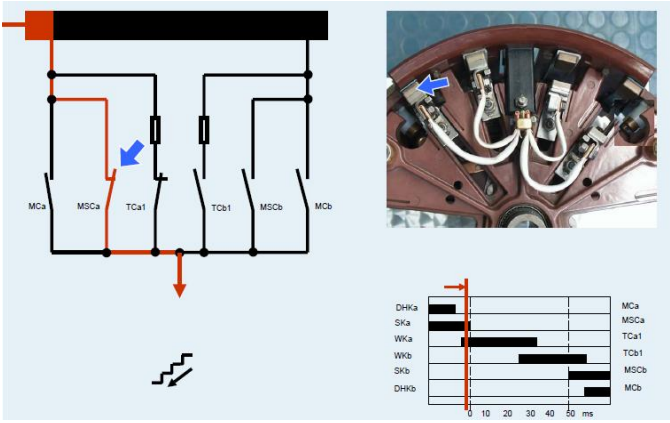
This presentation allows to highlight the electrical, mechanical events and recorded impacts.



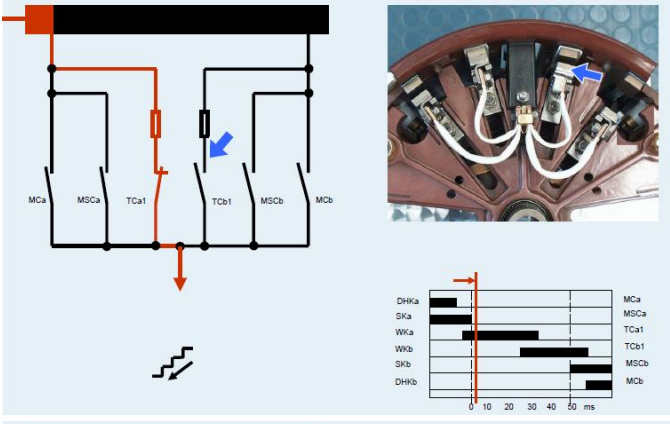
CURVE OF THE IMPACT ASSOCIATED



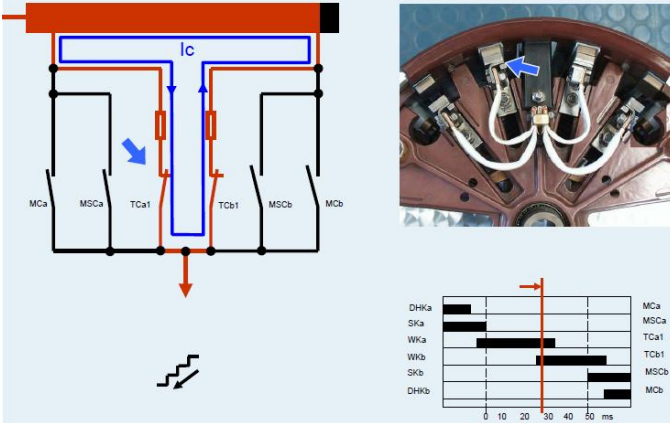
CURVE OF THE IMPACT ASSOCIATED



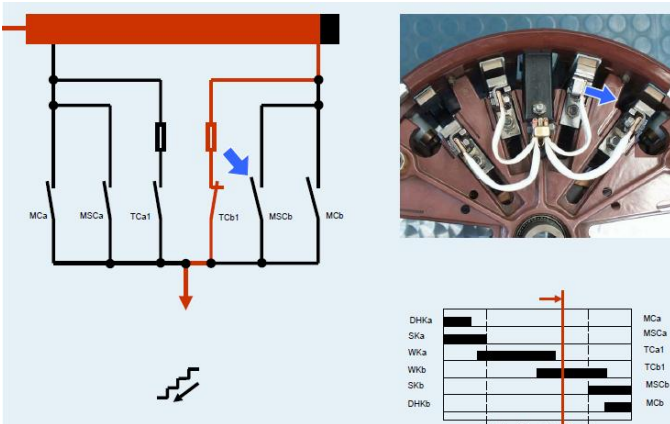
CURVE OF THE IMPACT ASSOCIATED



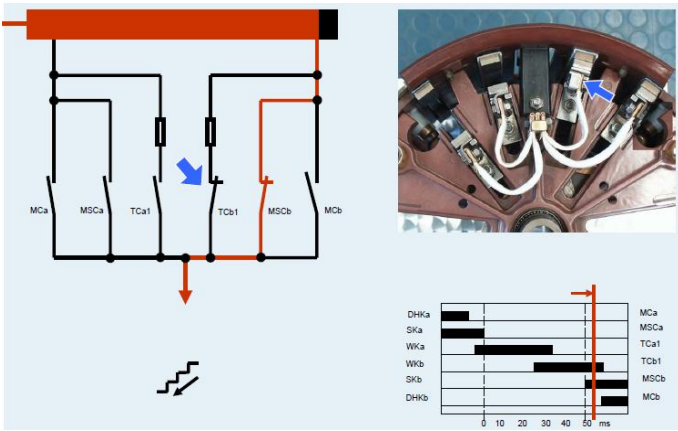
CURVE OF THE IMPACT ASSOCIATED



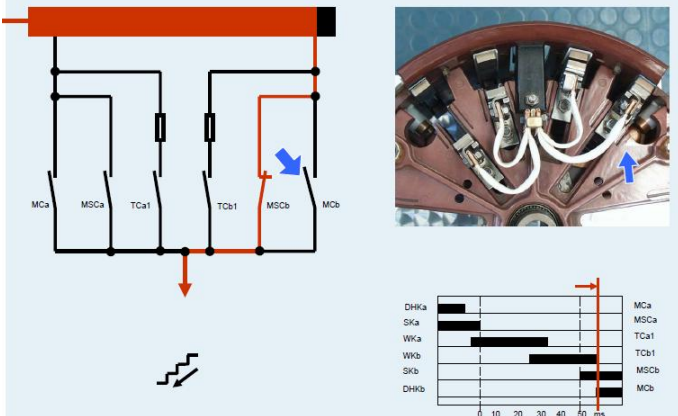
CURVE OF THE IMPACT ASSOCIATED



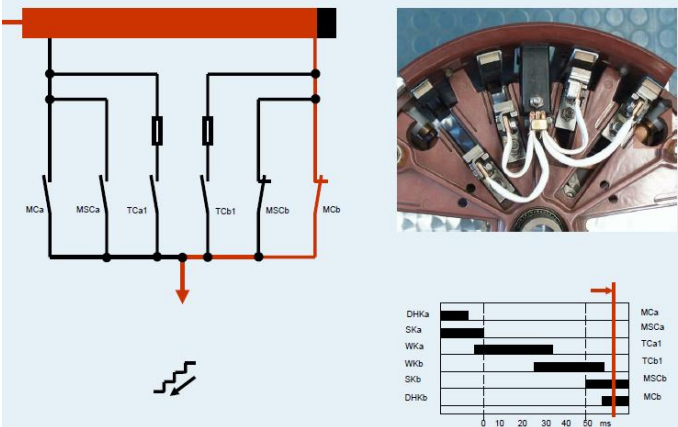
CURVE OF THE IMPACT ASSOCIATED



CURVE OF THE IMPACT ASSOCIATED



CURVE OF THE IMPACT ASSOCIATED

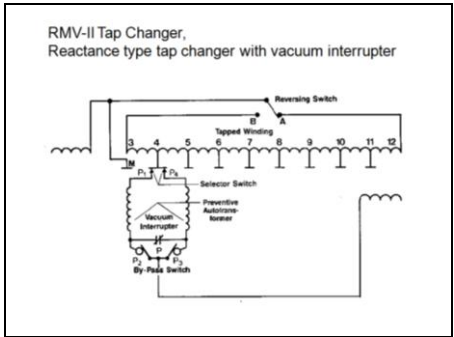


CURVE OF THE IMPACT ASSOCIATED

Example: Reinhausen RMV-II Tap Changer

RMV-II Tap Changer,
Reactance type tap changer
with vacuum interrupter

Acoustic signature of tap changers
with 33 positions or 17 positions

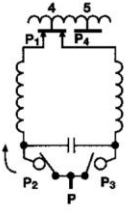


RMV-II Tap Changer,
Sequence of impact recorded in the acoustic signature

First event
By-pass switch P3 is open to force the load current through the vacuum interrupter. This event cause a **small acoustic impact**.
Timing: ~ 0.3 – 0.4 sec (after motor current inception)

RMV-II Tap Changer,
Reactance type tap changer with vacuum interrupter

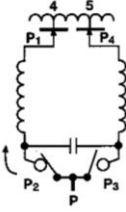
Second event
Vacuum switch is open interrupting the current in P4 selector.
Vacuum switch operation cause a **large acoustic impact**.
Timing: ~ 0.6 – 0.7 sec



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RMV-II Tap Changer,
Reactance type tap changer with vacuum interrupter

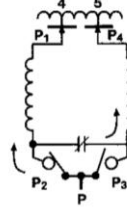
Third event
Selector switch P4 moves from tap 4 to tap 5.
No current is interrupted.
Operation of selector switch cause practically **no acoustic impact**.
Timing: ~ 0.9 - 1.6 sec



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RMV-II Tap Changer,
Reactance type tap changer with vacuum interrupter

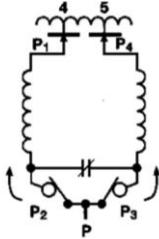
Fourth event
Vacuum switch is closed to connect tap 5 in parallel with Tap 4.
Vacuum switch operation cause a **large acoustic impact**.
Timing: ~ 1.6 – 1.7 sec



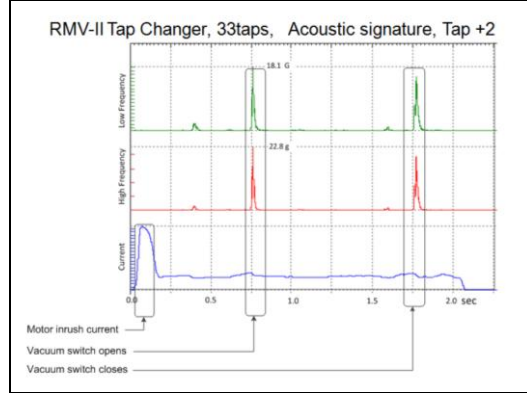
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RMV-II Tap Changer,
Reactance type tap changer with vacuum interrupter

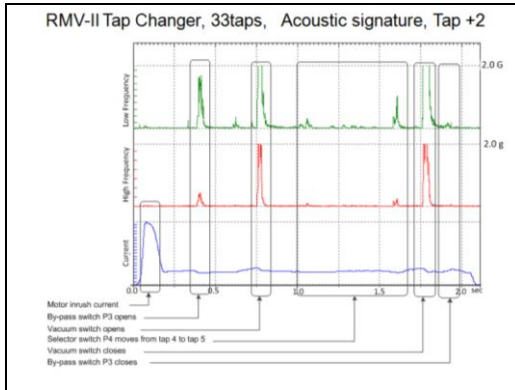
Fifth event
By-pass switch P3 is closed, so that vacuum switch do not carry any current in normal operation.
This event cause a **very small impact**.
Thus, Timing: ~ 1.7 – 1.9 sec



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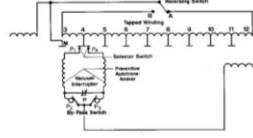
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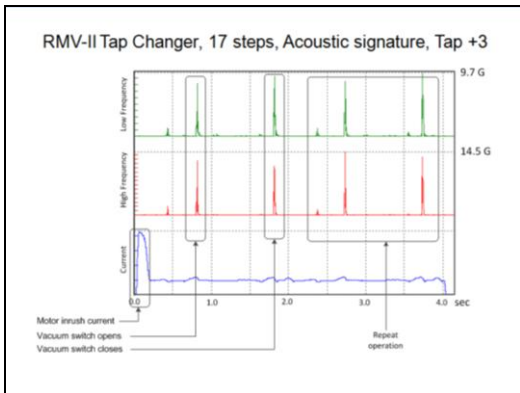
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RMV-II Tap Changer
17 Positions

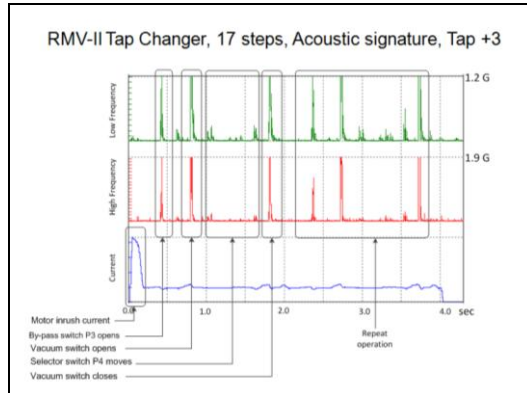
- Same unit as tap changer with 33 position
- Control system is set to force two steps every time.



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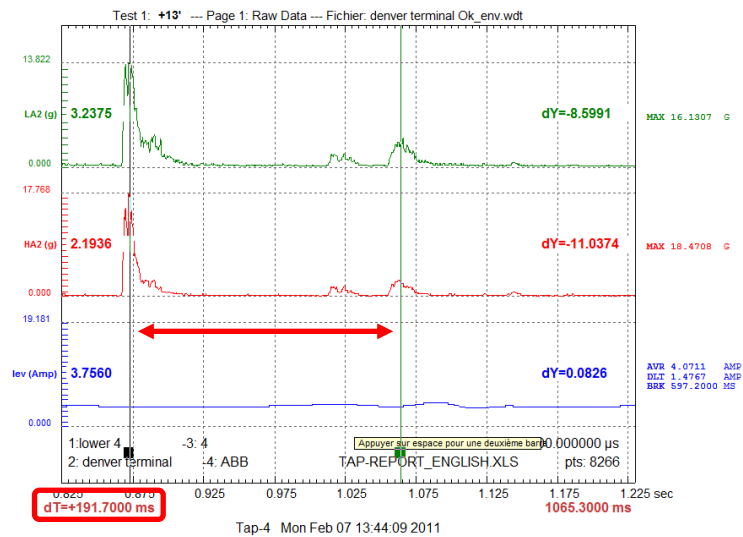


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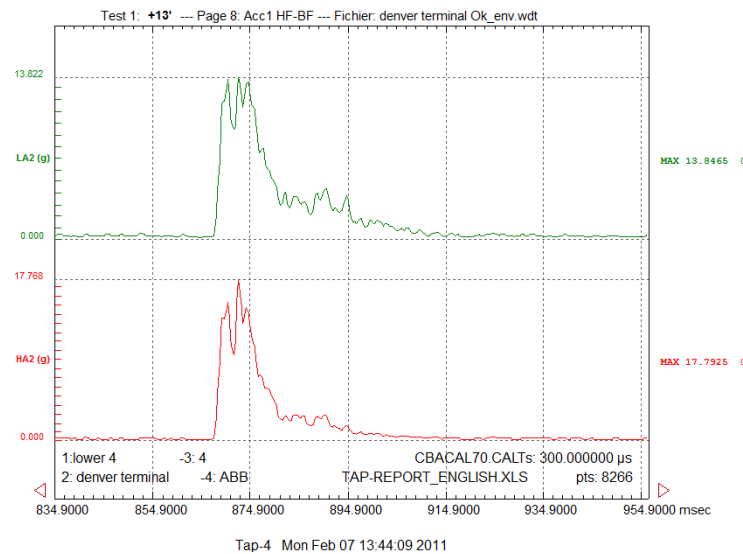


12/12

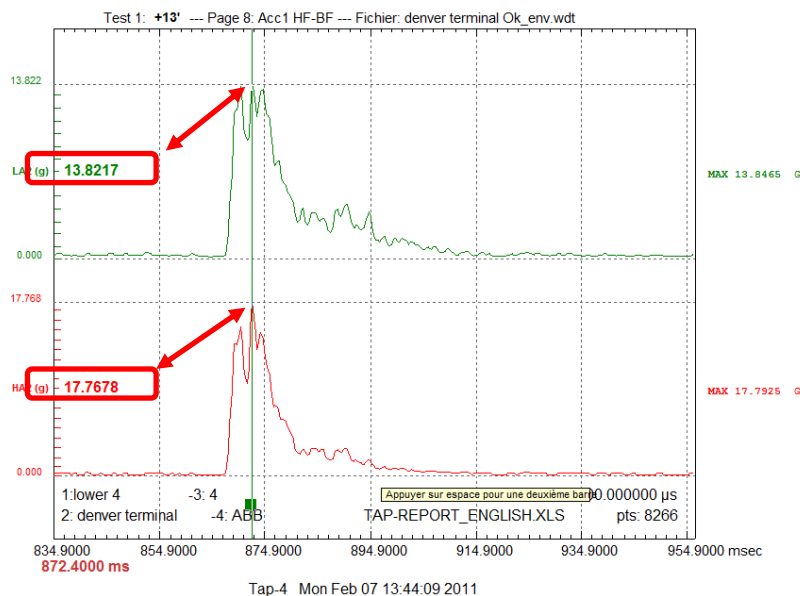
C4. Suggested analysis:



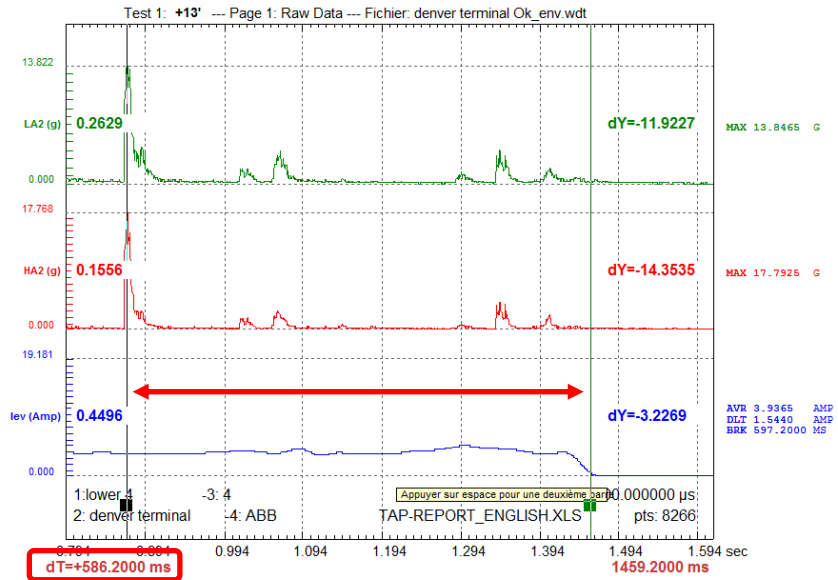
Time analysis between impacts



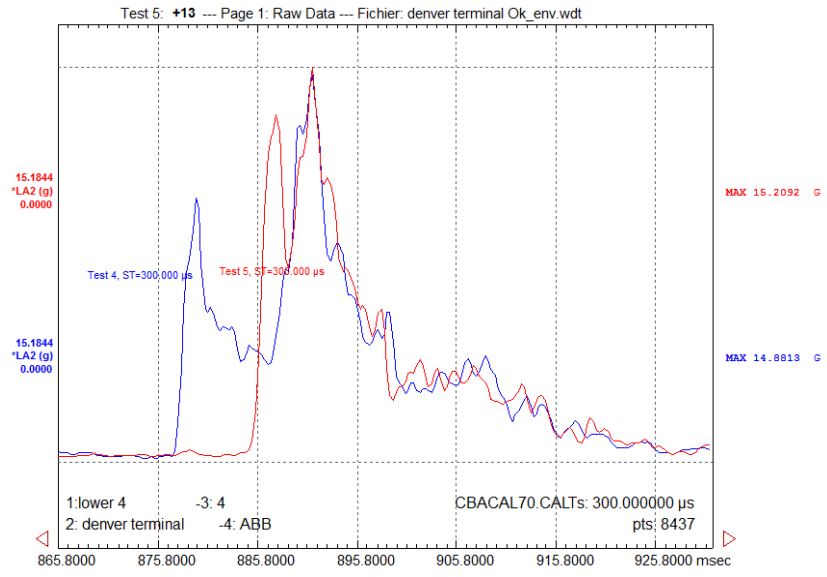
Shape analysis of impacts



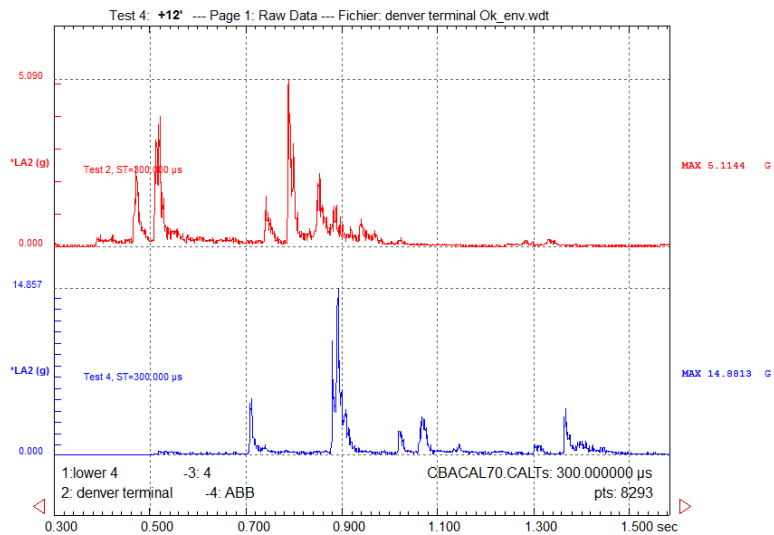
Amplitude analysis of impacts



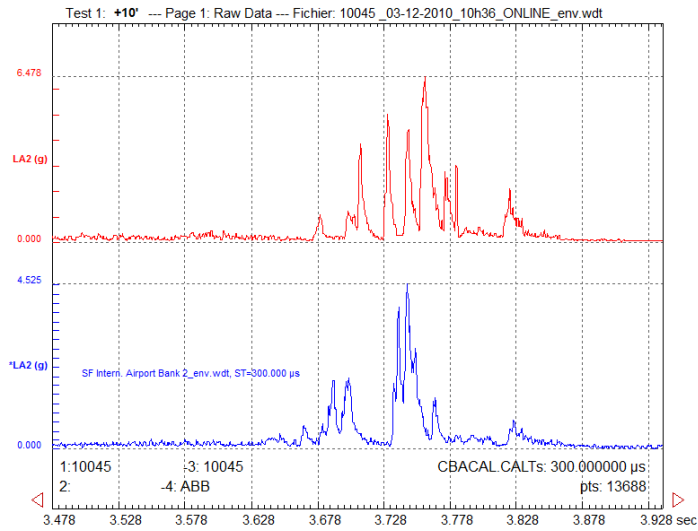
Time between impact and end of current



Superposition odd tap versus even tap

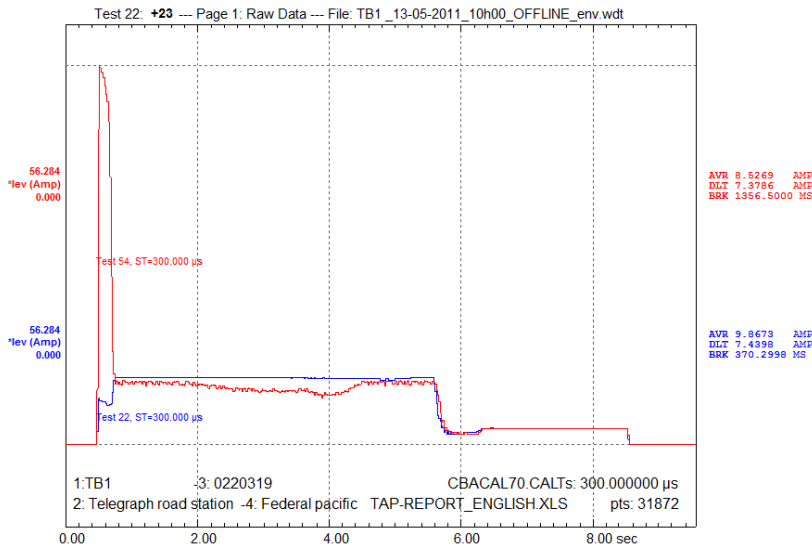


Comparison upward movement versus downward movement



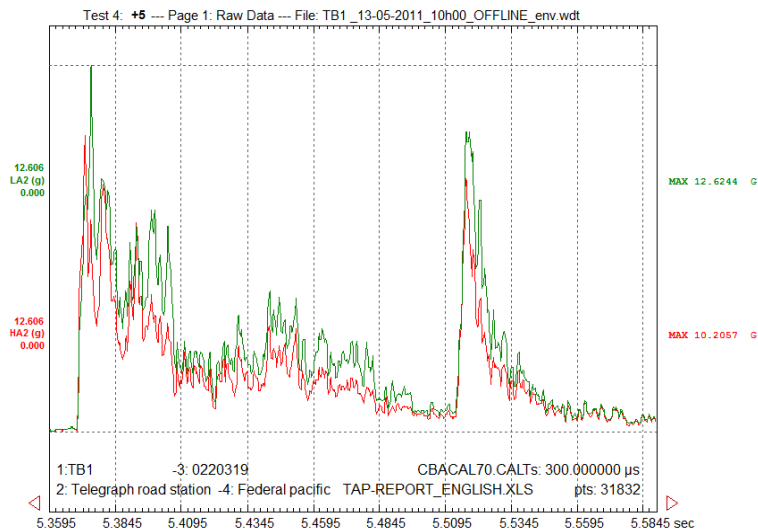
Tap-4 Vie Dic 03 10:41:14 2010

Comparison of two tap changers of the same kind



Tap-4 Fri May 13 10:57:15 2011

Superposition current of an upward movement versus a downward movement

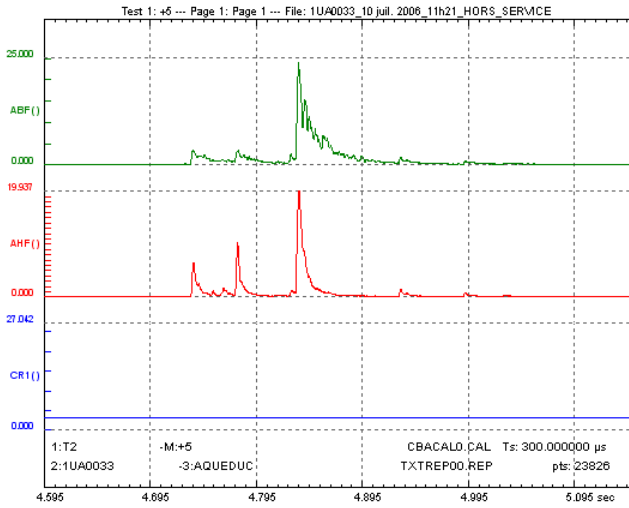


Tap-4 Fri May 13 10:57:15 2011

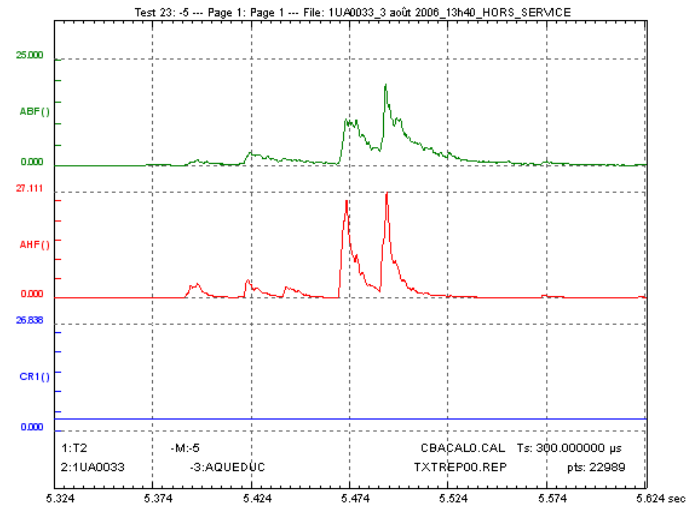
Superposition high frequency versus low frequency

C5. Observation and identification of anomalies:

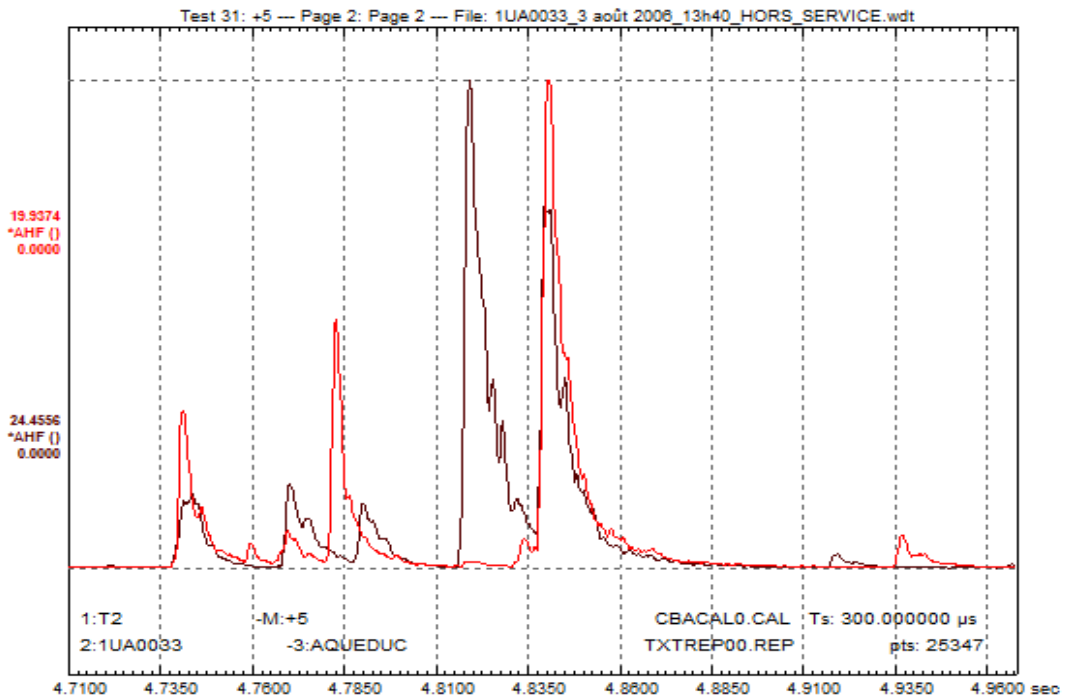
-Contact wear example:



Amplification of the signature before inspection



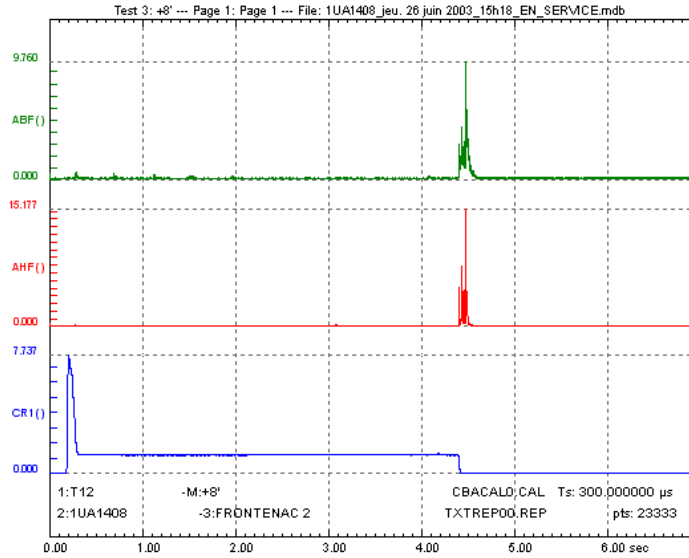
Amplification of the signature after repair



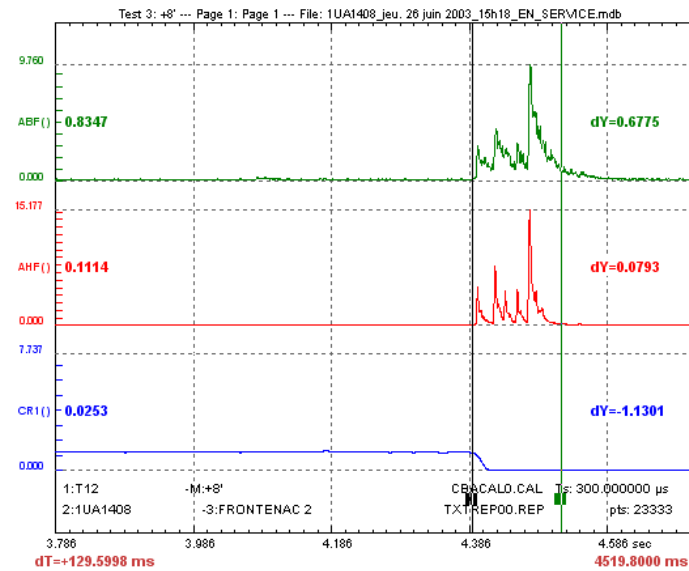
Superposition of the new contact's signature versus old contact's signature.

-Asynchronism example:

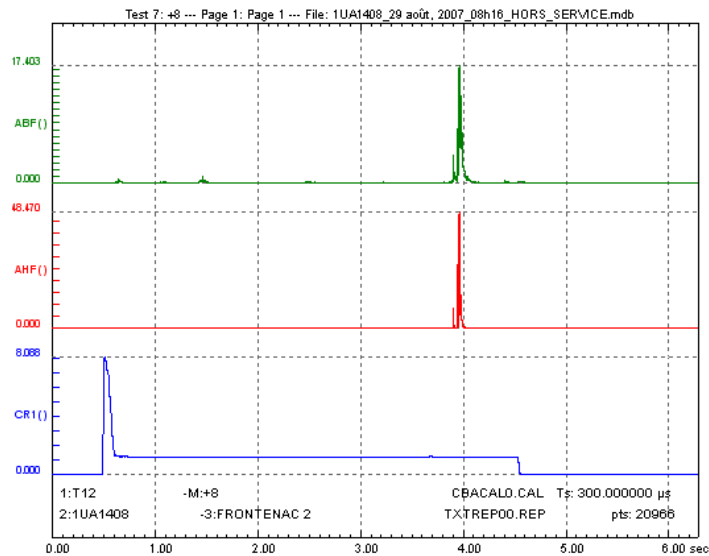
Recorded signals



Amplified signals



After repair:
Signature without
asynchronism



C6. Recommendations for future tests :

The impact's amplitude is very low. It would be preferable to change the location of the accelerometer for the next tests in order to have higher amplitudes.

C7. Transfer and sharing of data and pictures with ZENSOL on DB TAP:

YES.