



Prediction of the failures of the electronic components submitted to severe vibratory environments

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THALES

- Introduction**

- Magnetical components**

- Relays GP250**

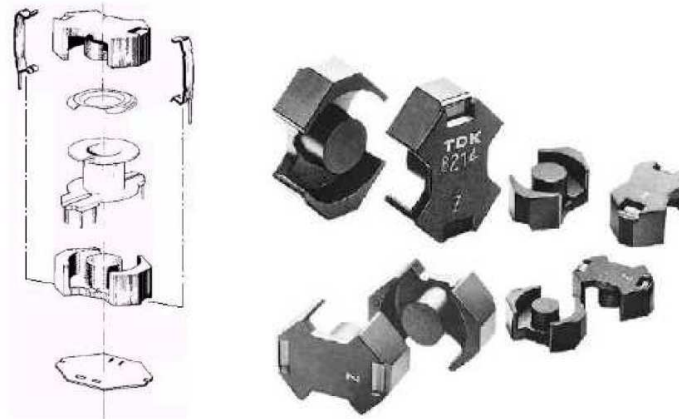
- Relays K41R**

- Structural parts of electronic units are not sensitive to pyroshocks**

- Electronic designs use some sensitive components**
 - Relays
 - Magnetic components
 - ...

- ETCA pyroshock tests facilities can be used to perform components characteristics studies and determine mechanical limits (and/or electrical abnormal behaviours) of sensitive components**

- ❑ Magnetic components used by ETCA often have a magnetical circuit maked of « ferrite »
- ❑ This material have good electrical properties but is « fragile »



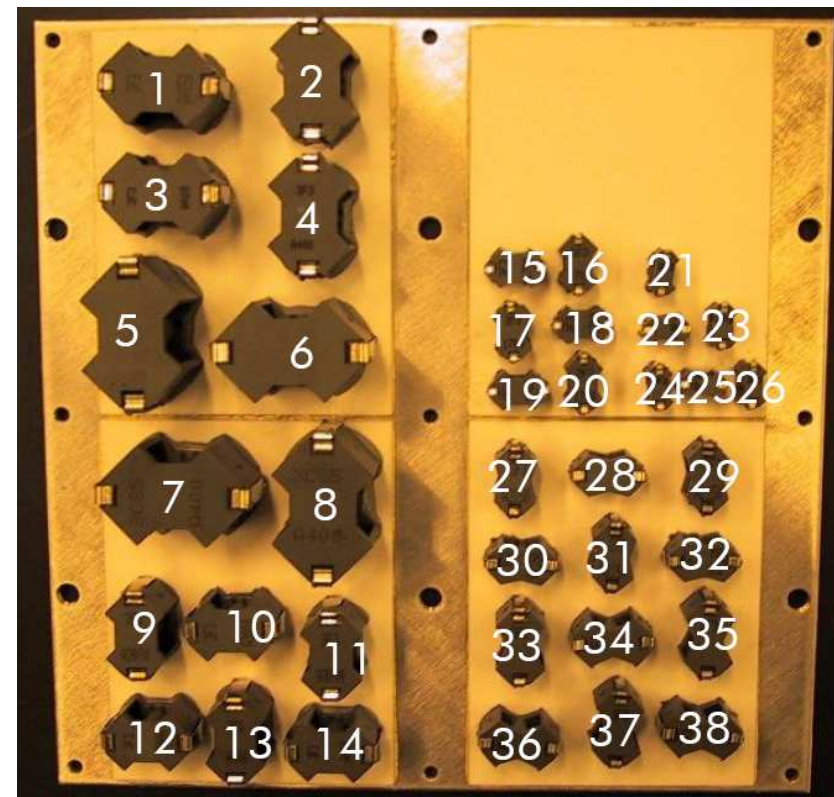
→ Interest to know the mechanical limits of this type of components (used in many ETCA equipments)

History

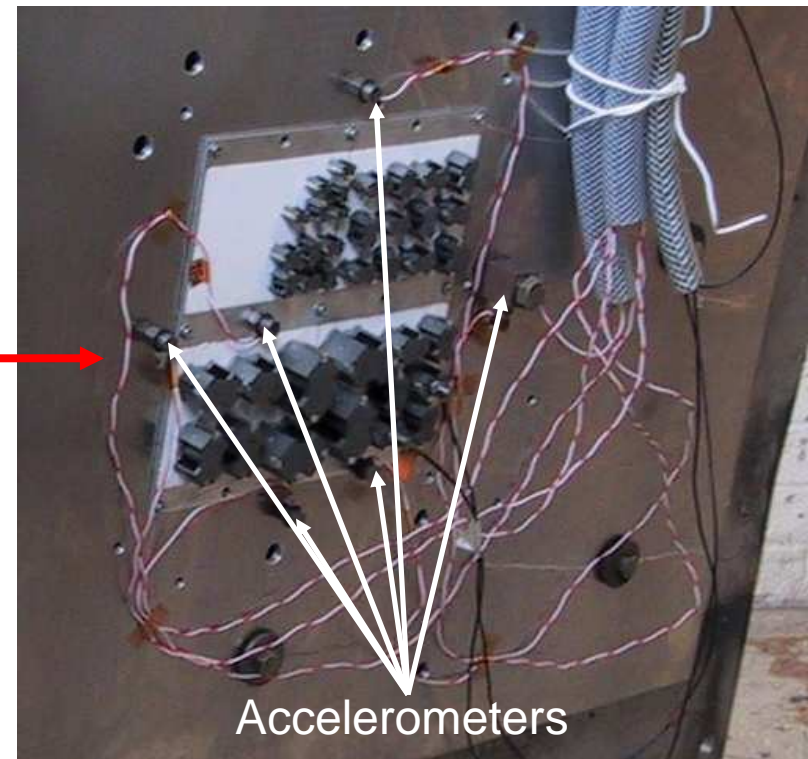
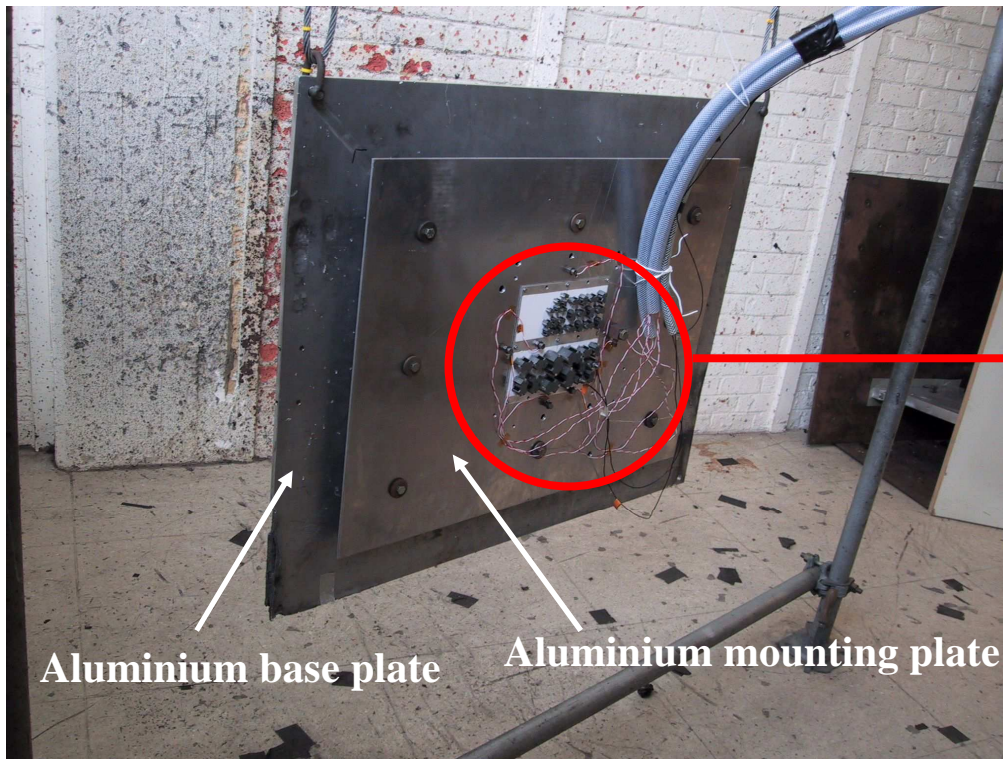
- Some degradations were observed by ETCA during hybrids qualification on two sizes of RMs: RM10 & RM12
- Failures can sometimes be observed → The component keeps its electrical properties
- No problem observed during a qualification in using a RM7

Description of the test set-up

- ❑ Substrates (alumina) with standard dimensions (97 x 75 x 0.635 [mm])
- ❑ Substrates glued with TK7755
- ❑ RM glued on substrates with ME 7155



Pyroshock test set-up



Test sequence

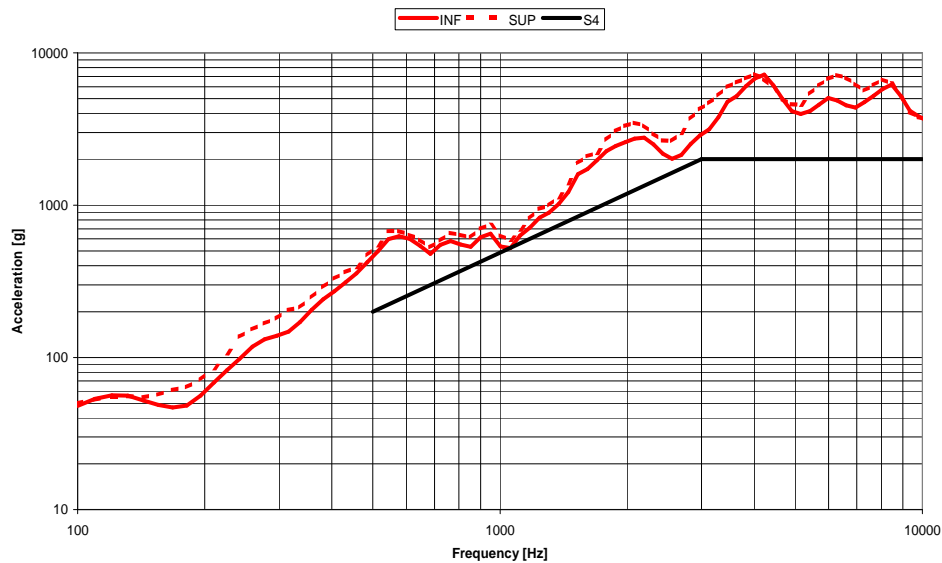
Successive shocks
in increasing amplitude

Visual inspection
between each shocks

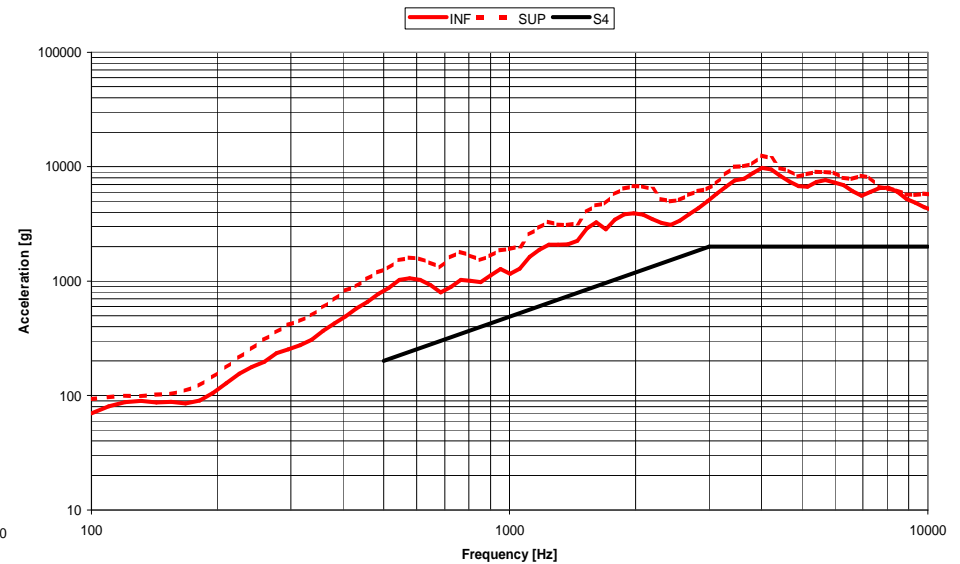
N°	Dimension	Air-gap	Orientation (X=alumina length)	Distance between RM and fixation point [mm]	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917
21	4		X	52										
22	4		Y	43										
24	4		X	39										
23	4		X	33										
25	4		Y	29										
26	4		X	18										
16	5		X	53										
18	5		Y	45										
15	5		Y	42										
20	5		X	39										
17	5		X	31										
19	5		Y	24										
31	6		X	57										
28	6		Y	46										
32	6		Y	43										
30	6		Y	42										
29	6		X	29										
27	6		X	26										
34	7		Y	61										
37	7		X	50										
35	7		X	48										
33	7		X	45										
38	7		Y	30										
36	7		Y	26										
13	8	X	X	48										
12	8	X	Y	28										
14	8	X	Y	27										
9	8		X	42										
11	8		X	42										
10	8		Y	62										
4	10	X	X	52										
3	10	X	Y	50										
2	10		X	29										
1	10		Y	34										
8	12	X	X	31										
7	12	X	Y	37										
5	12		X	34										
6	12		Y	37										

Analysis (Based only on out of plane shock level)

RM12

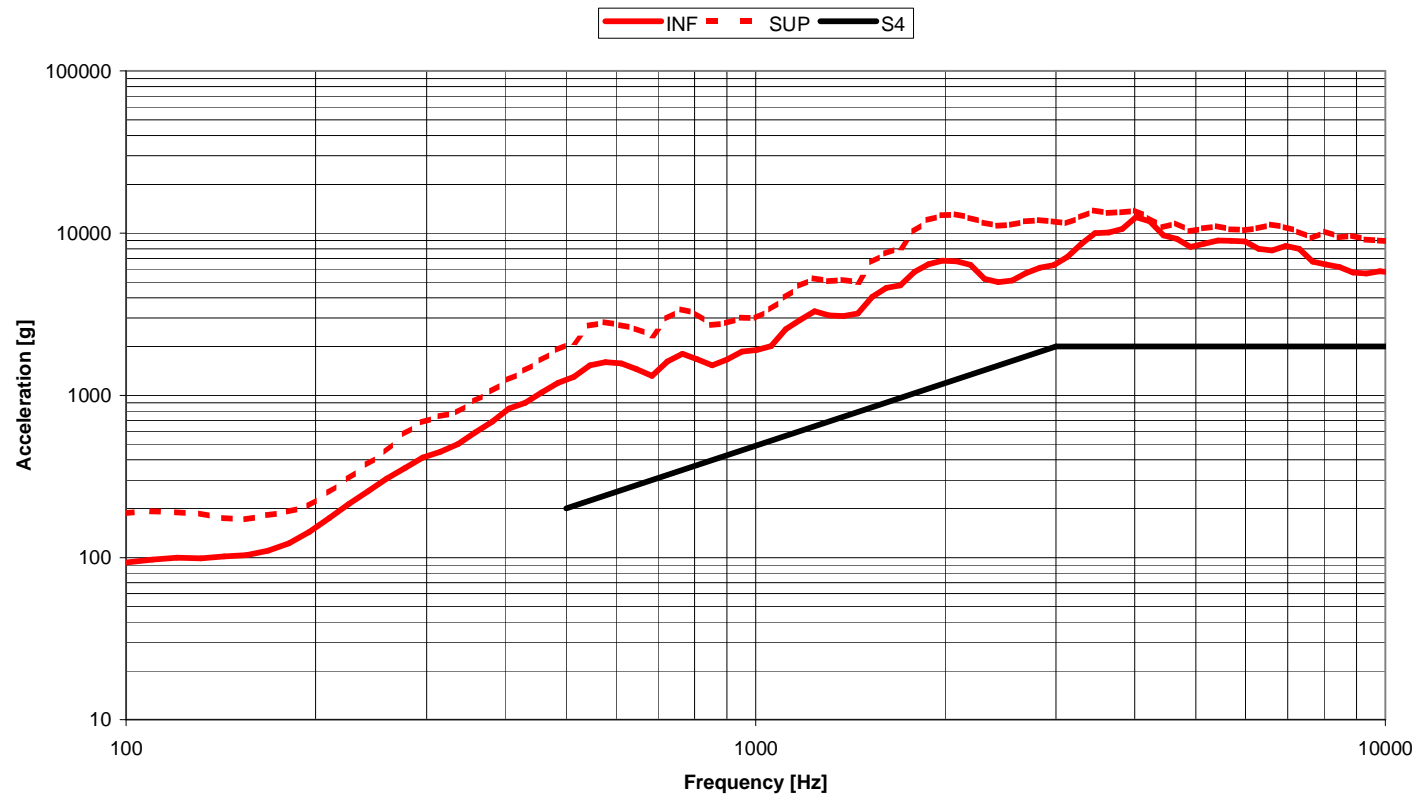


RM10



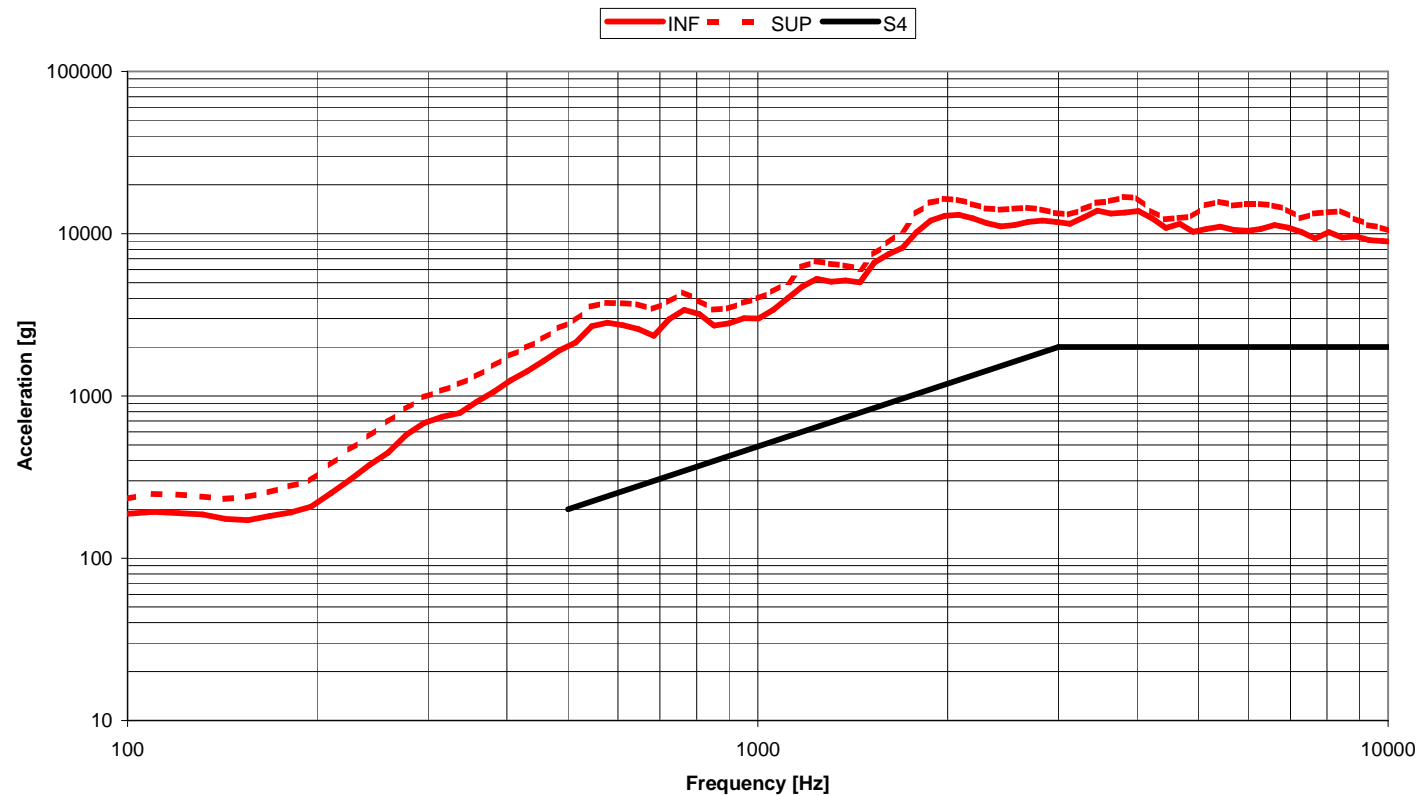
Analysis (Based only on out of plane shock level)

Zone de rupture des RM's 6, 7 & 8



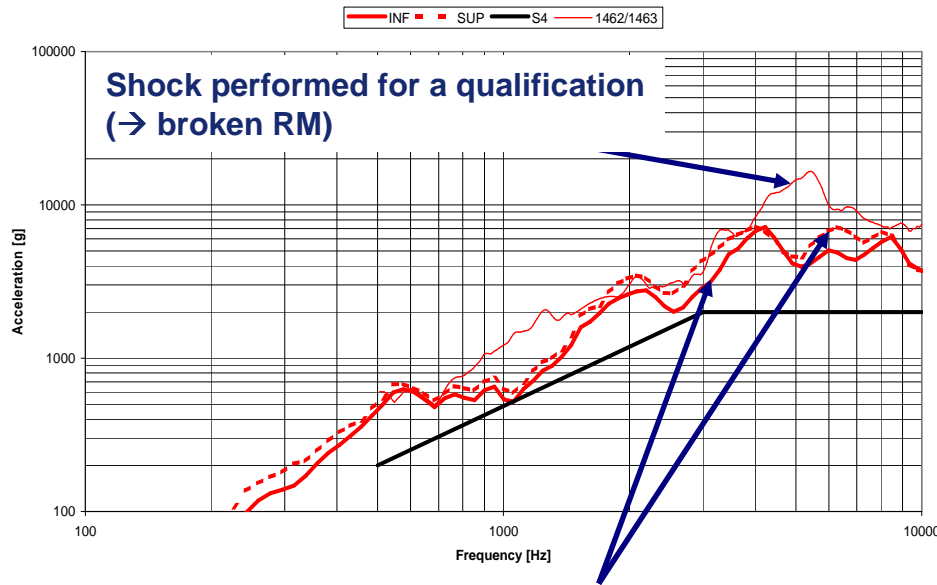
Analysis (Based only on out of plane shock level)

Zone de rupture des RM's 4 & 5



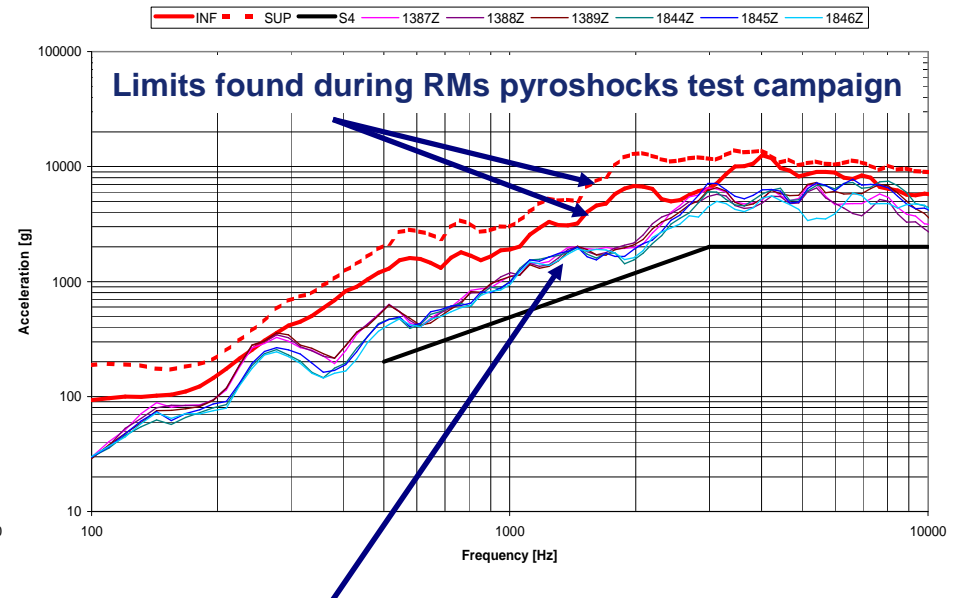
Comparison with History (Based only on out of plane shock level)

RM12 - caractérisation technologique et héritage - confrontation



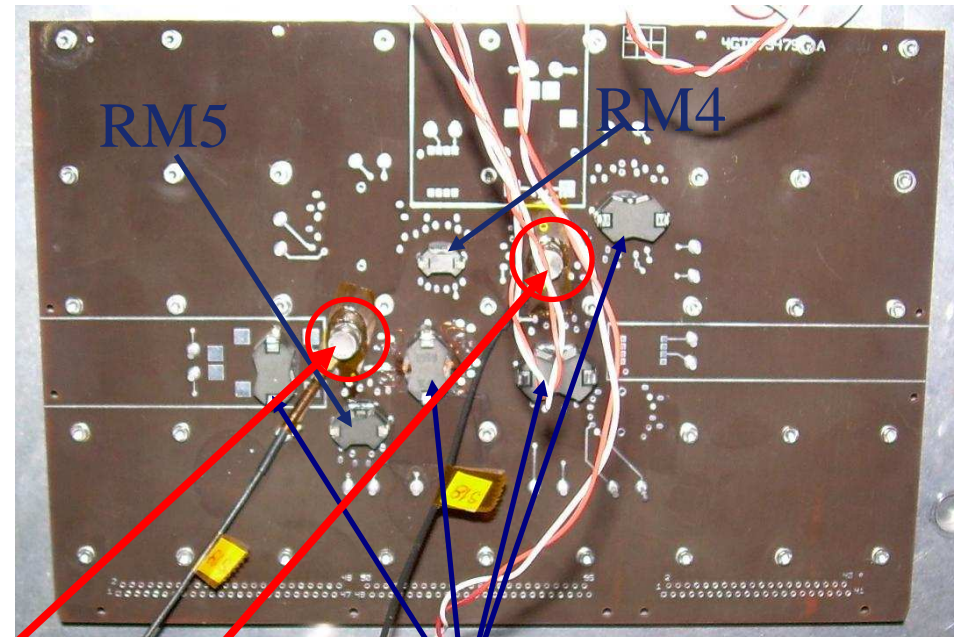
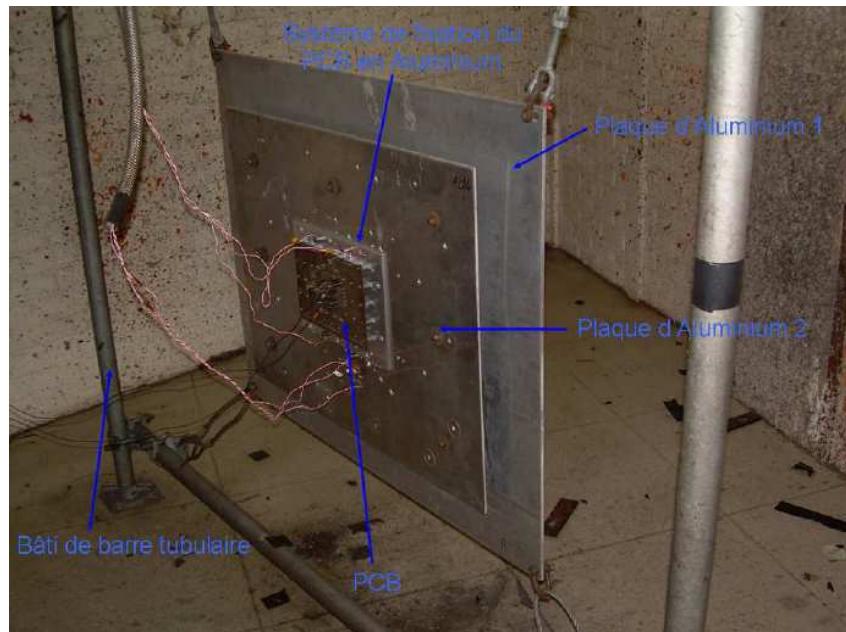
Limits found during RMs pyroshocks test campaign
→ Good adequation between determined technological limits and history

Zone de rupture des RM's 6, 7 & 8



Shocks performed for equipments qualification without damage of RMs → Good adequation between determined technological limits and history

- Same methodology has been followed for RMs reported on a PCB

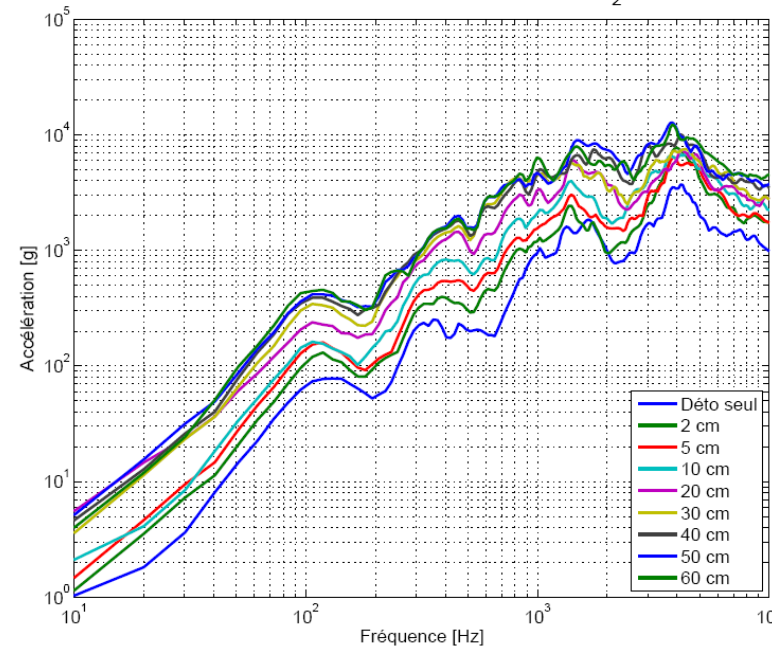


(1 RM7 reported with winding)

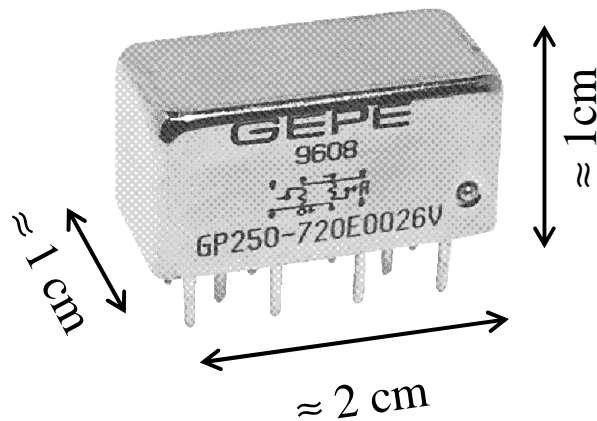
□ Results

Test n°	Charge	Etat RM	Remarques
1	Détonateur seul	OK	—
2	2 cm de cordeau explosif	OK	—
3	5 cm	OK	—
4	10 cm	OK	—
5	20 cm	OK	—
6	30 cm	OK	—
7	40 cm	OK	—
8	50 cm	Casse RM5.2 + RM4.1 fissuré	Acc_S18 décollé
9	60 cm	Casse RM5.2 + Casse RM4.1	—

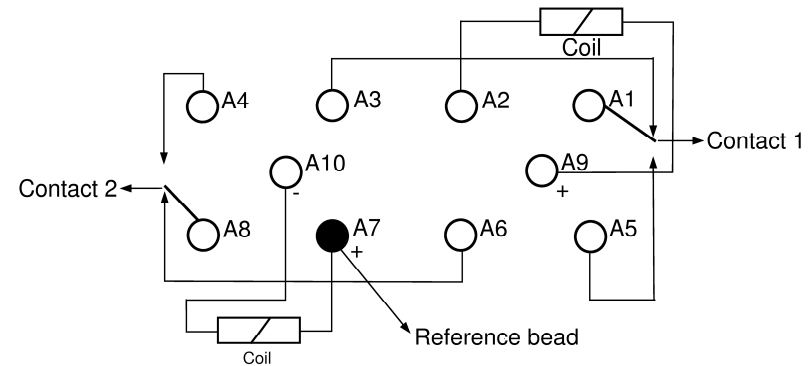
SRC's - Accéléromètre S19 suivant Z_2



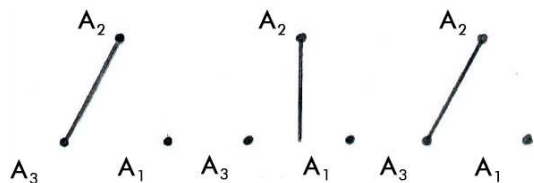
Latching GP250 Relay



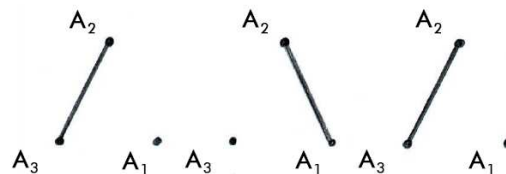
Electric Diagram



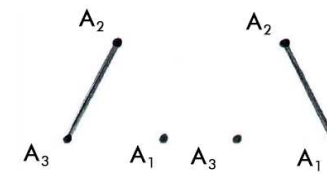
3 events can appear during a pyroshock:



Micro-switch

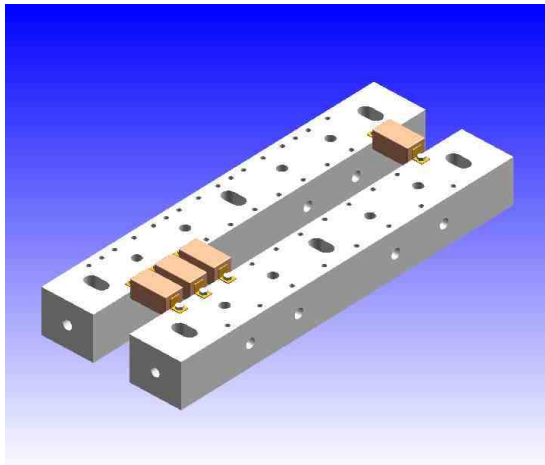


Provisional-switch

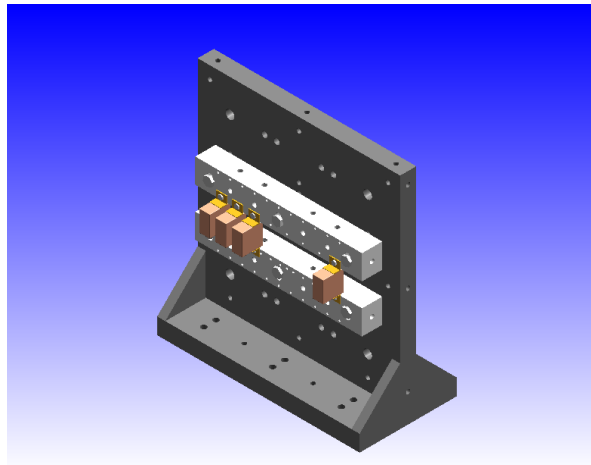


Permanent-switch

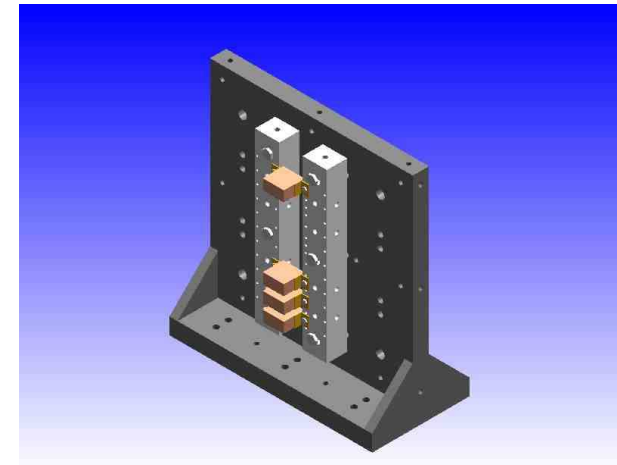
- C.A.D. model of the fixing device of the relays on the test setup



Configuration 1

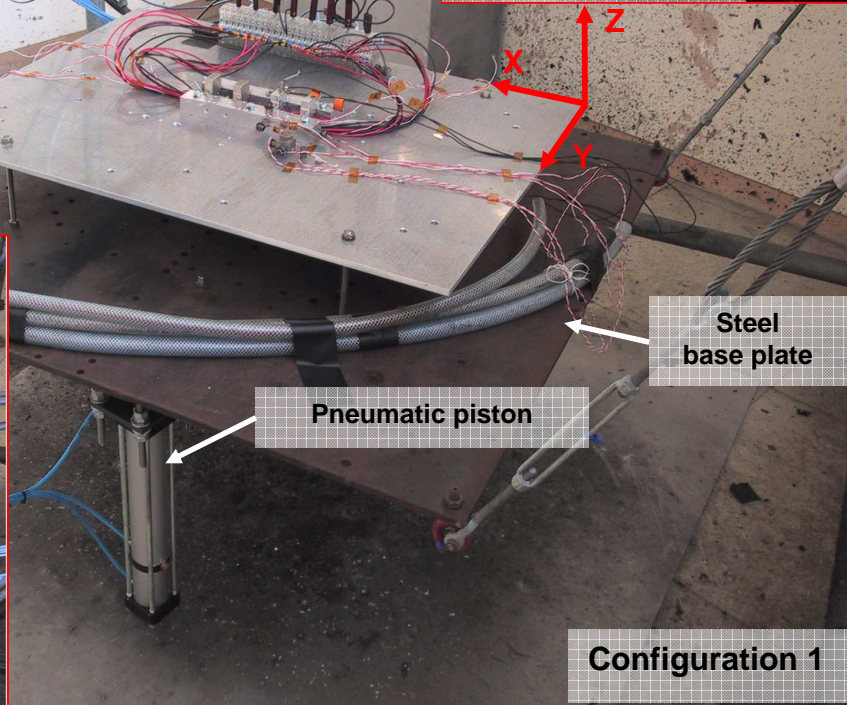
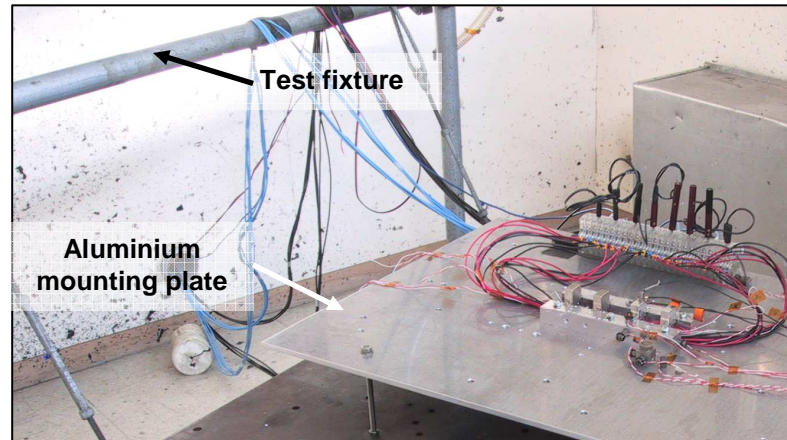
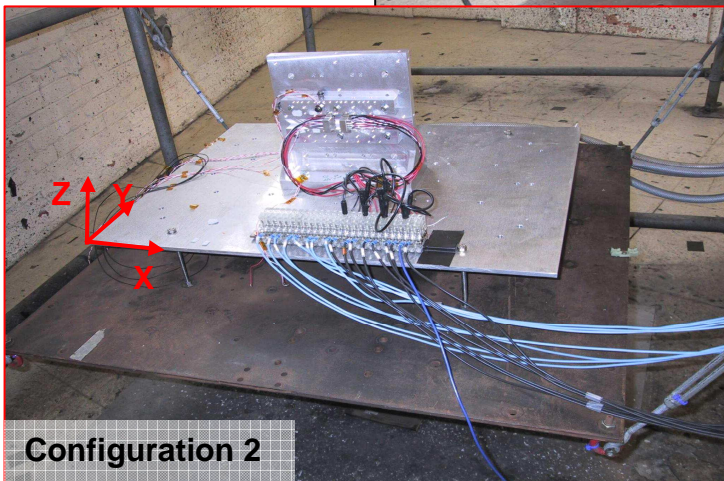
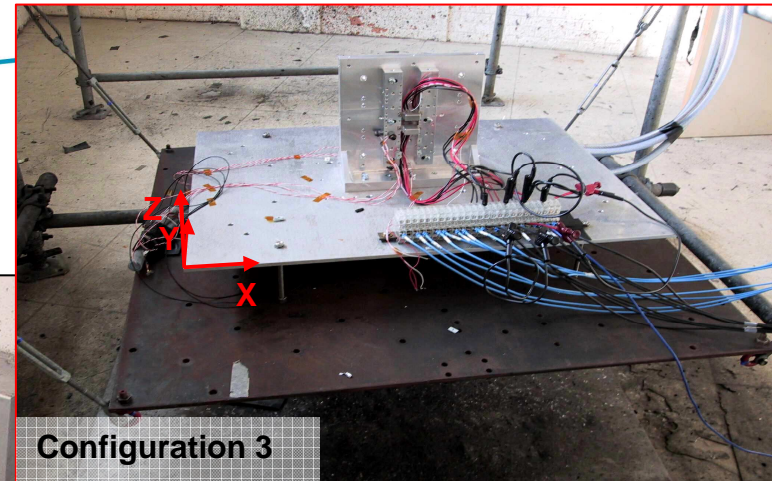
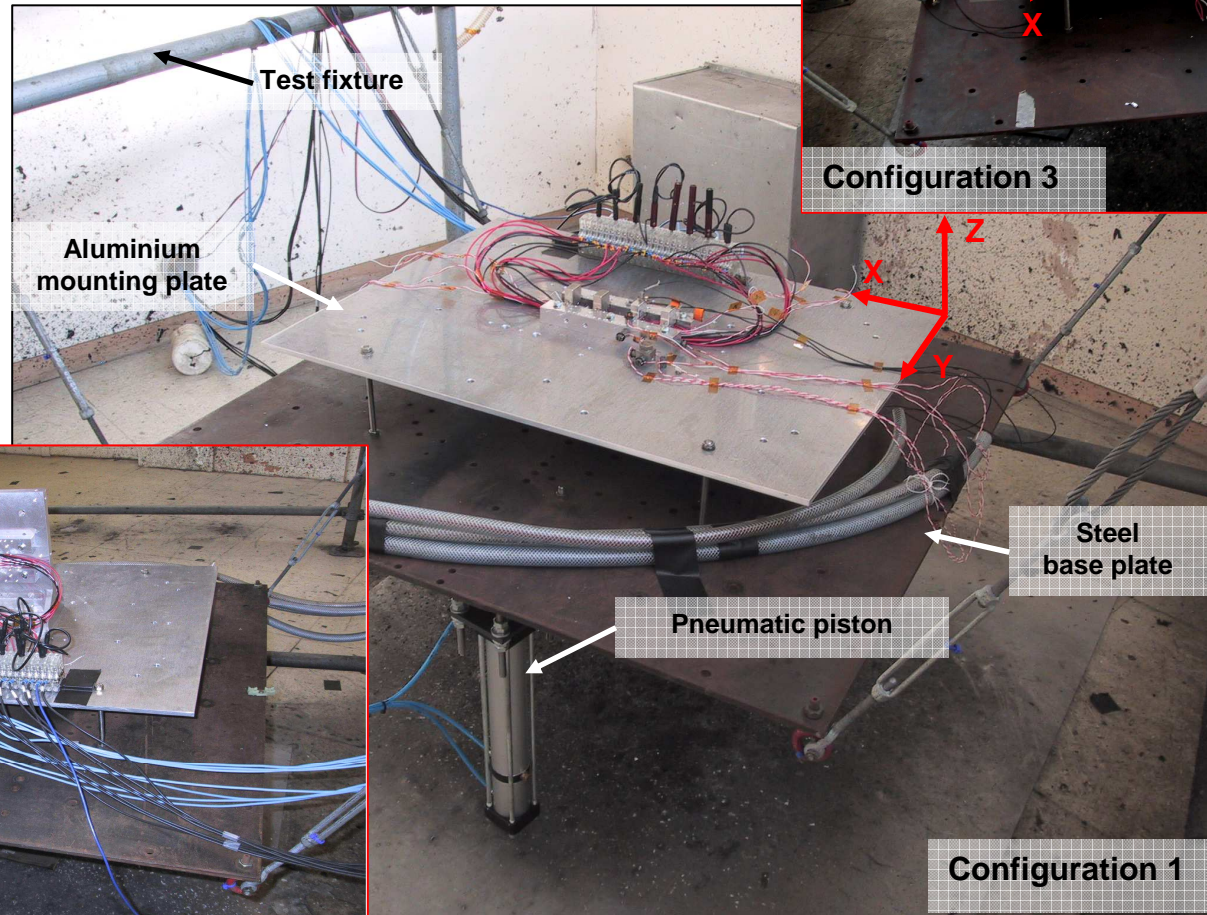


Configuration 2

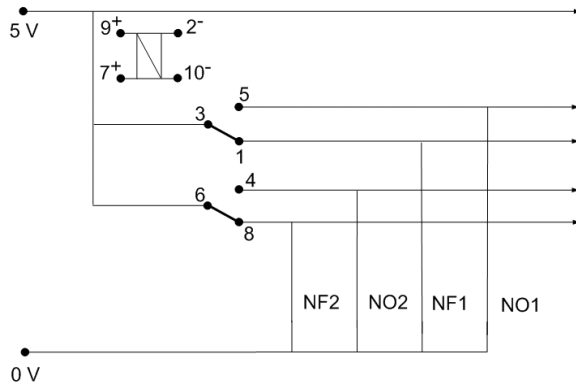


Configuration 3

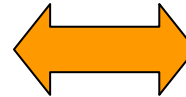
Test setup



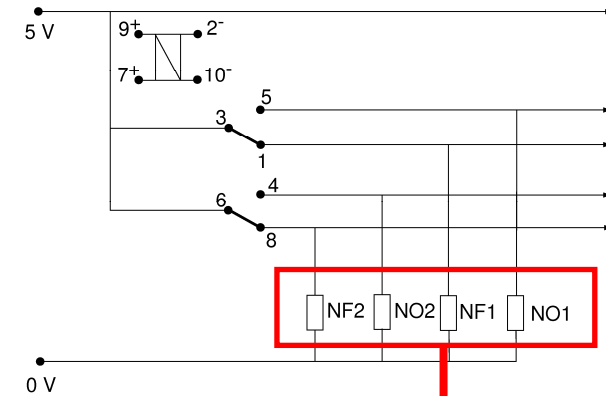
Electrical configuration without current



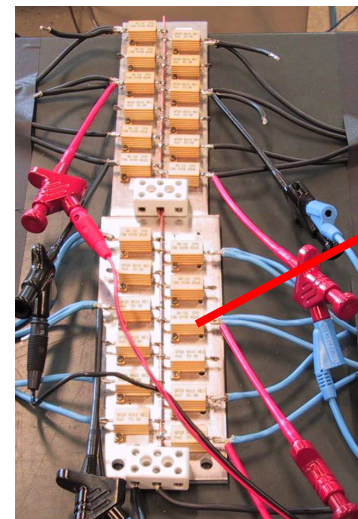
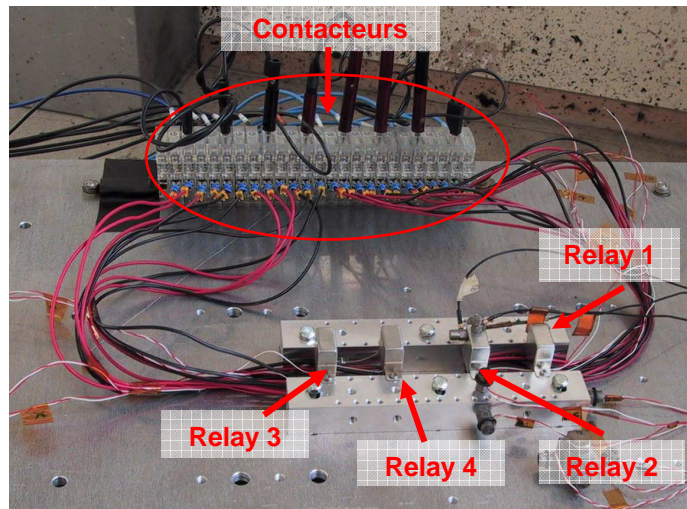
Two electrical configurations



Electrical configuration with current

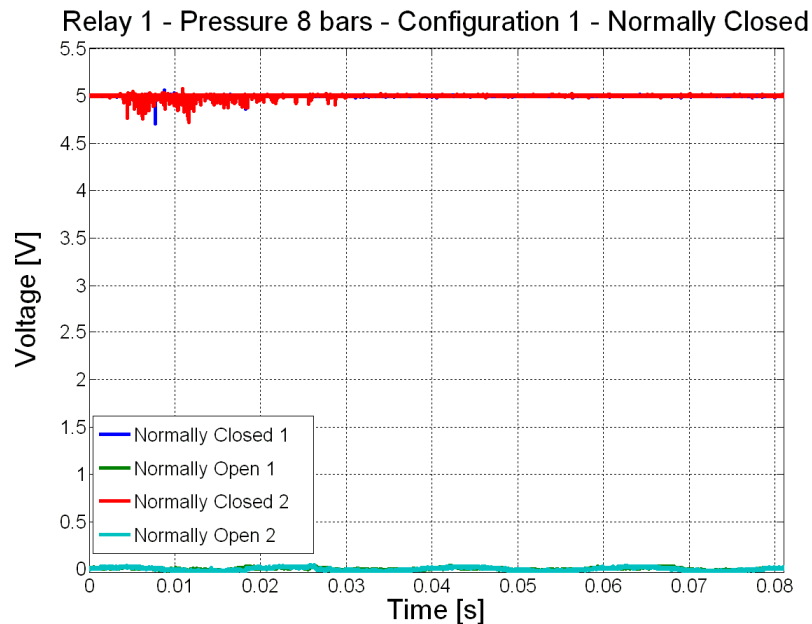


Resistors

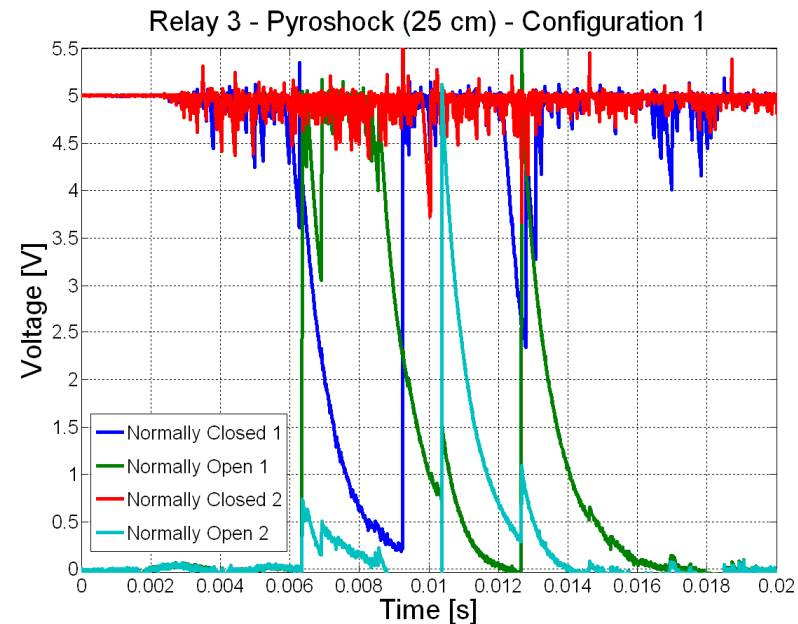


Results Without current – Configuration 1

Measured Voltage Pneumatic piston (8 bars)



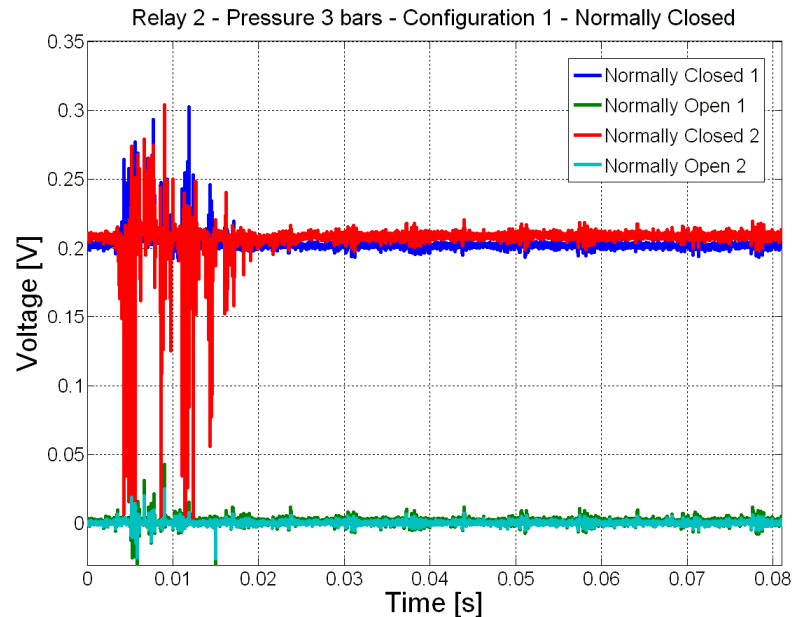
Measured Voltage Pyrotechnic shock (25 cm)



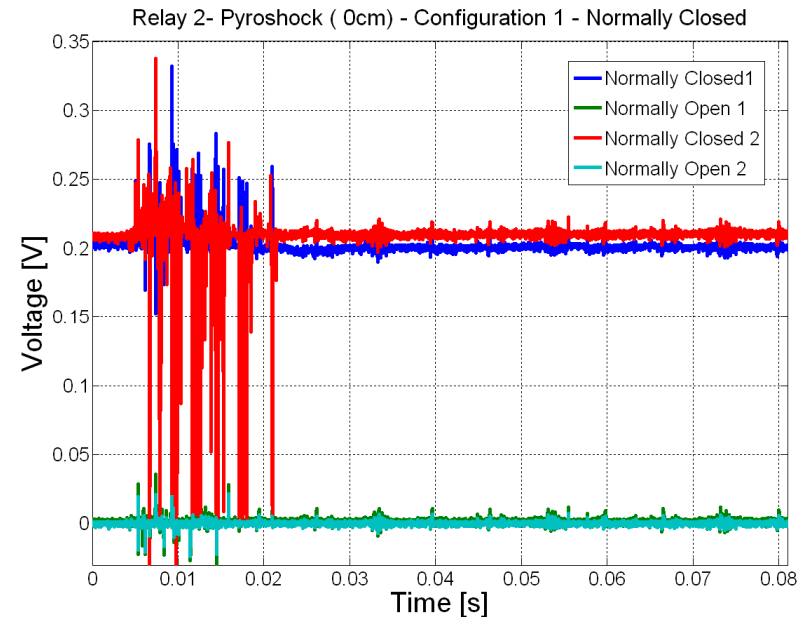
Electrical dysfunctions can be identified from the evolution of the voltage measured on the connections of the relay during the shock.

Results With current – Configuration 1

Measured Voltage Pneumatic piston (3 bars)

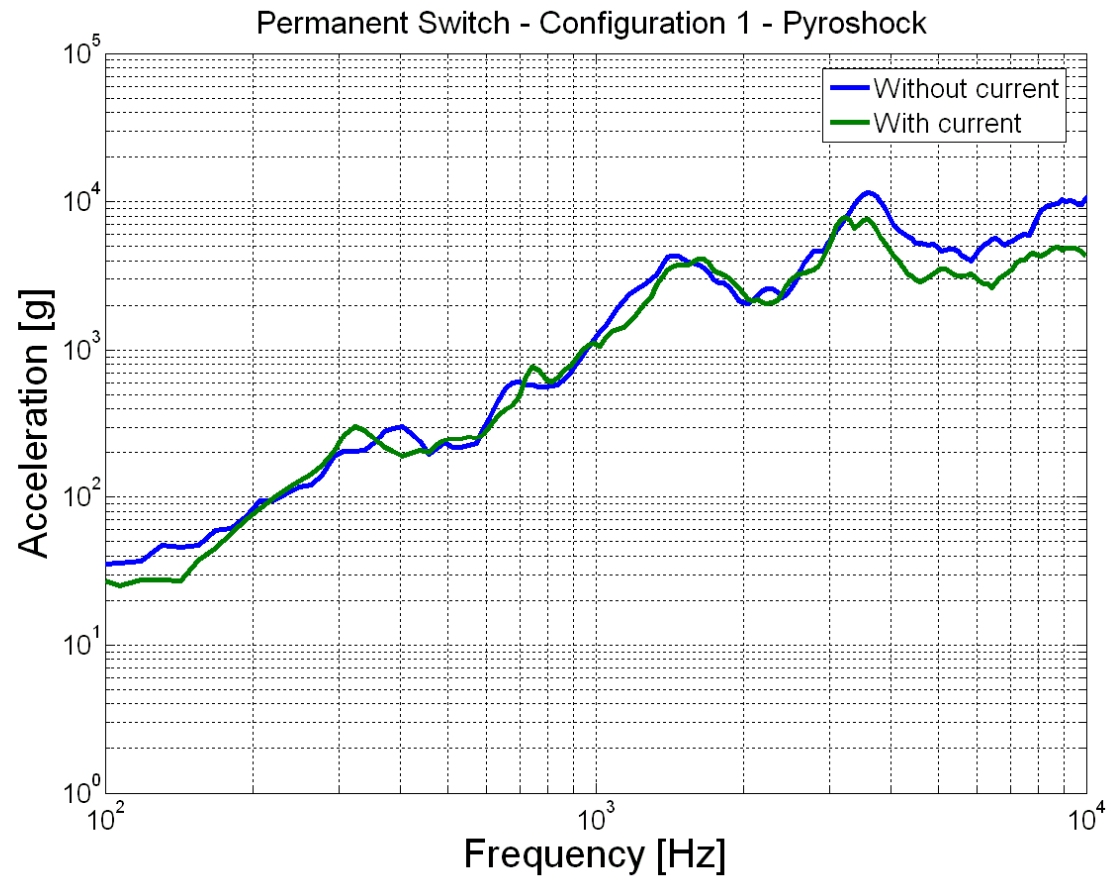


Measured Voltage Pyrotechnic shock (0 cm)

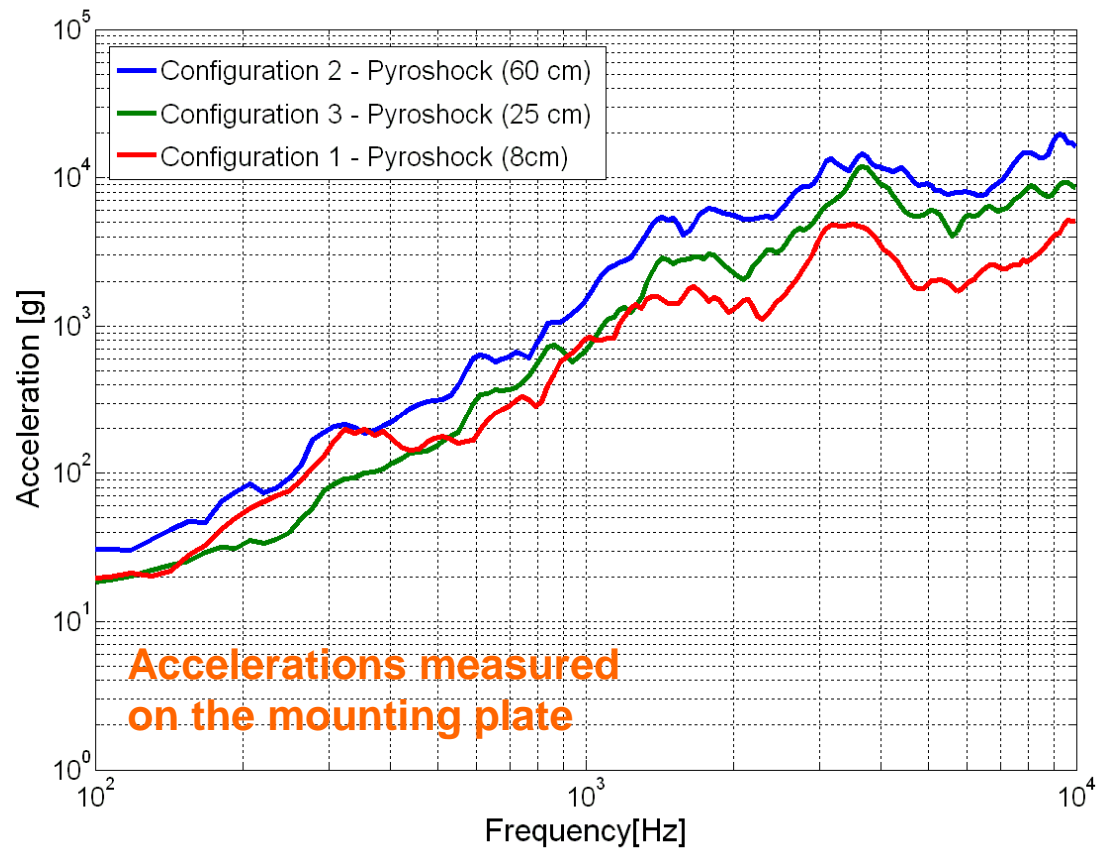


With current, It's more difficult to identify the electrical dysfunctions from the evolution of the voltage measured on the connections of the relay.

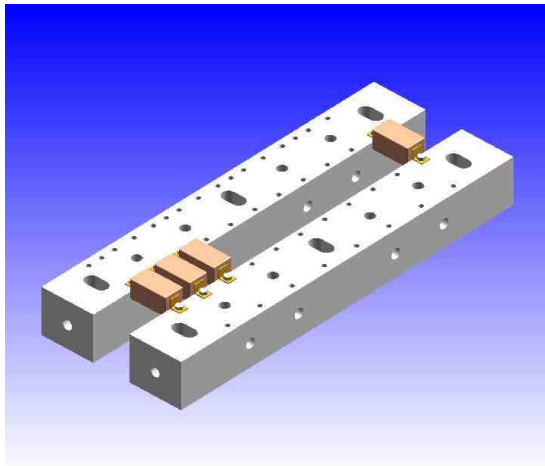
Permanent-switch of relay GP250 (with and without current)



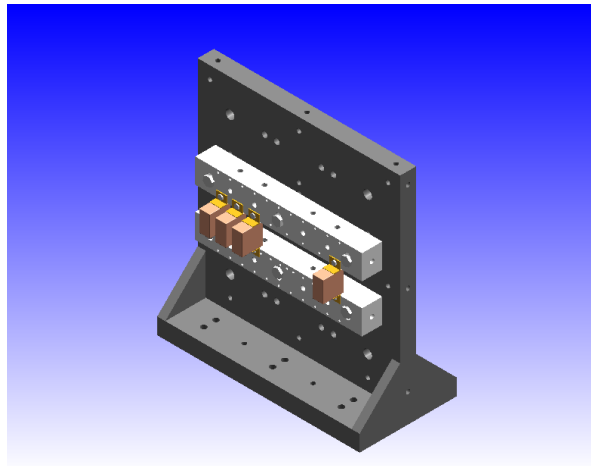
Permanent-switch of relay GP250 (with current)



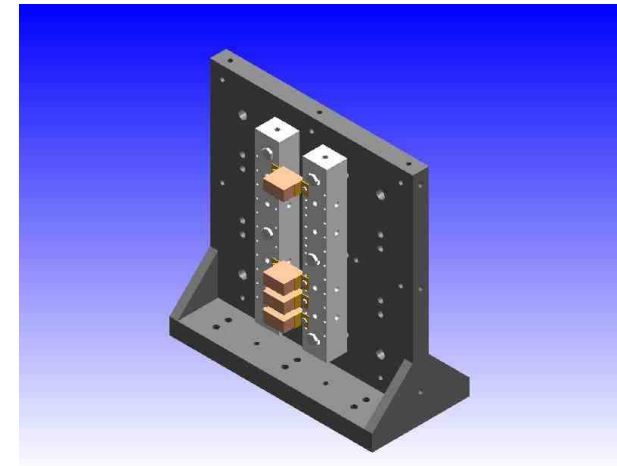
- **C.A.D. model of the fixing device of the relays on the test setup**



Configuration 1

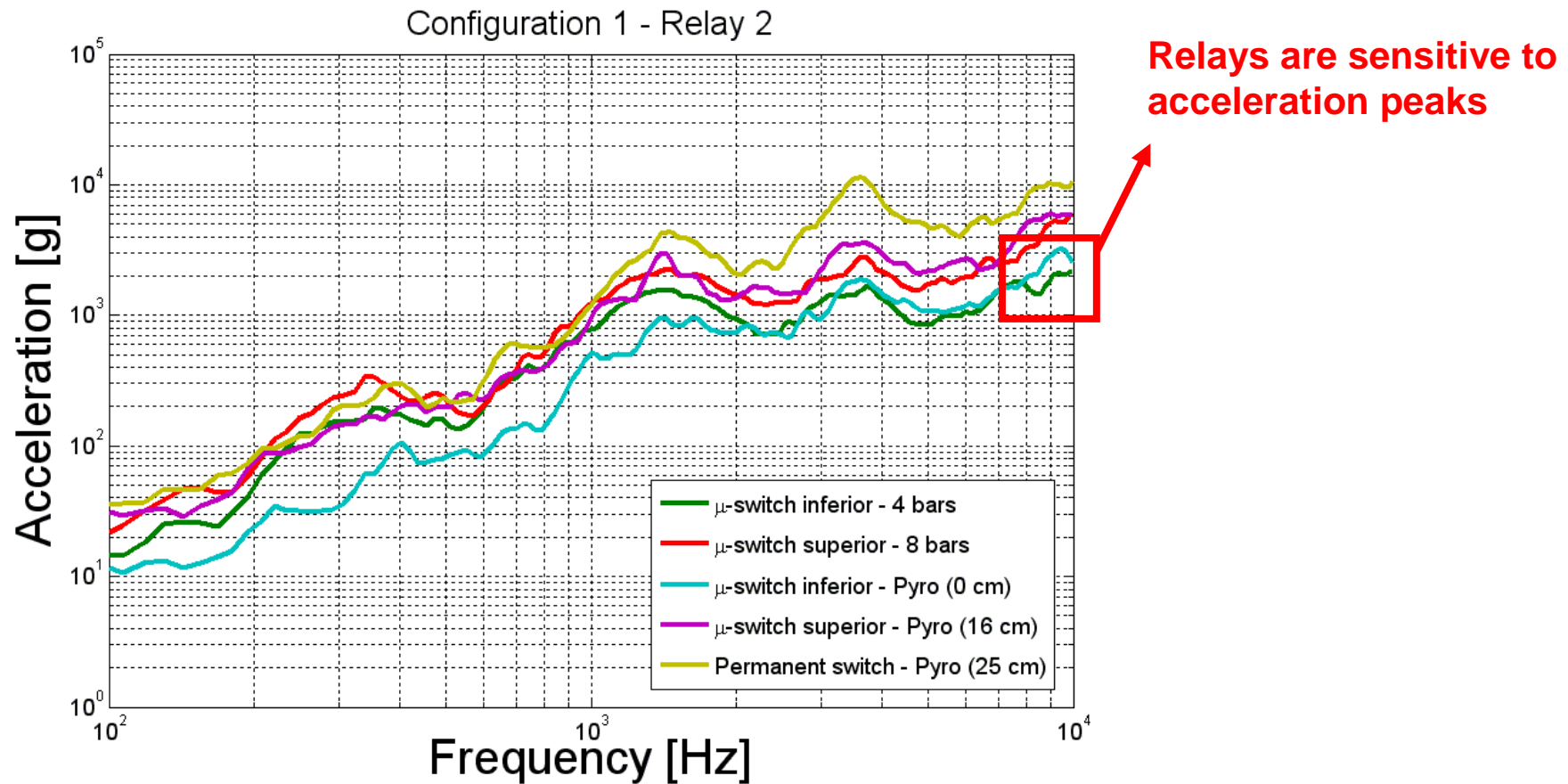


Configuration 2

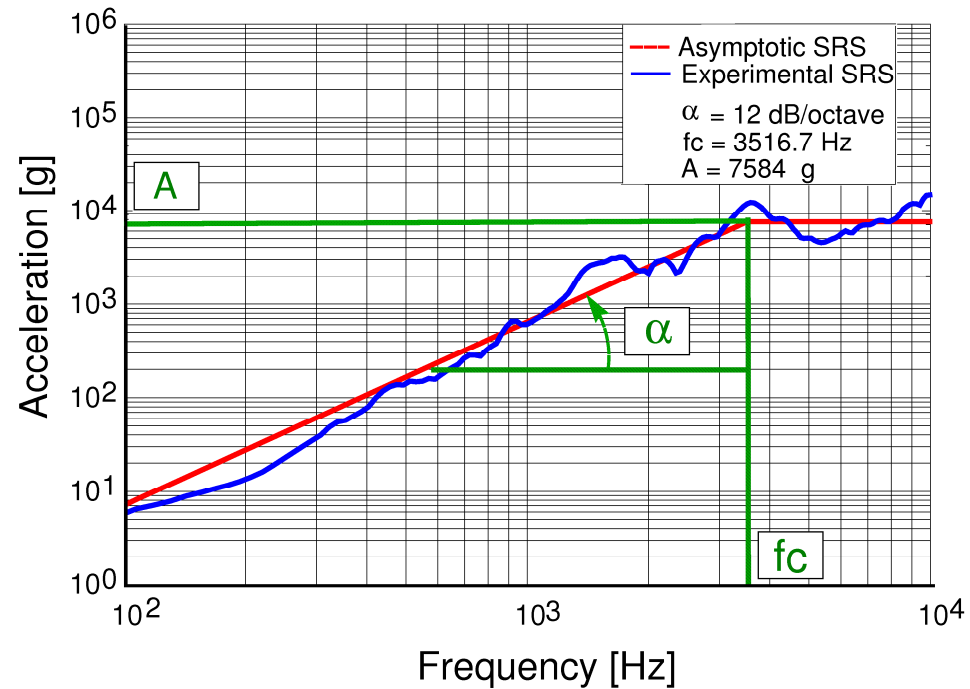


Configuration 3

- Limits of GP250 in regards of pyroshocks for the ETCA unit



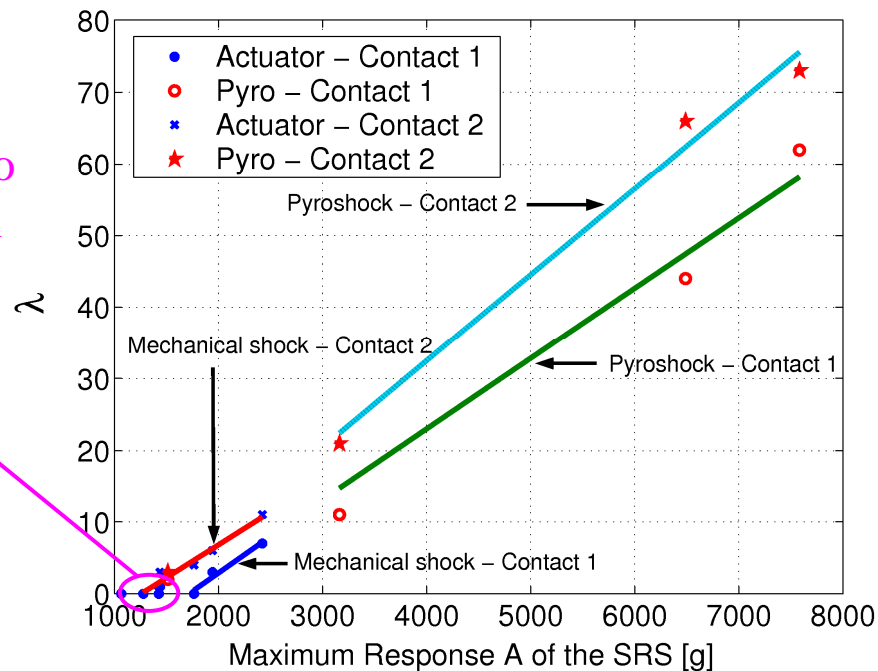
Asymptotic SRS



$$\log \left(SRS^{\text{asympt}}(f) \right) = \begin{cases} \alpha \log \left(\frac{f}{f_c} \right) + \log A & \text{si } f \leq f_c \\ \log A & \text{si } f > f_c \end{cases}$$

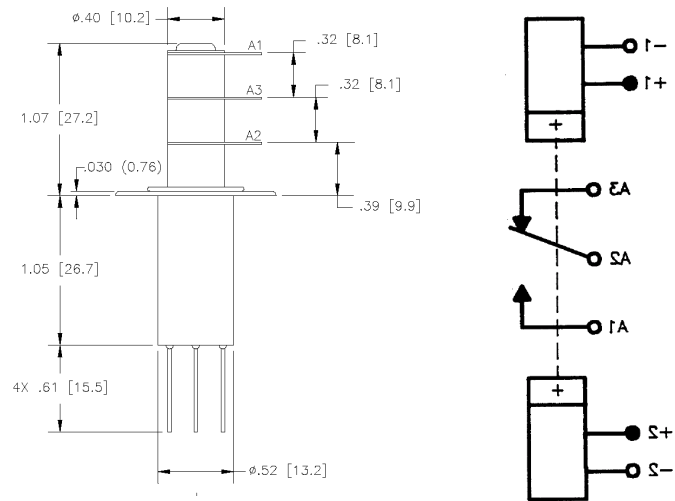
Relation between chatters and asymptotic amplitude of the Shock Response Spectrum (SRS) - Configuration 1

Minimum level leading to an electrical dysfunction is approximately 1200 g

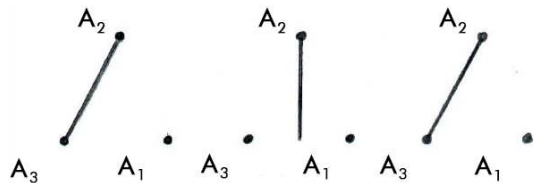


Parameter λ = number of times that the measured voltage moves away of 2% more than the reference voltage (5V) during the shock (80 ms)

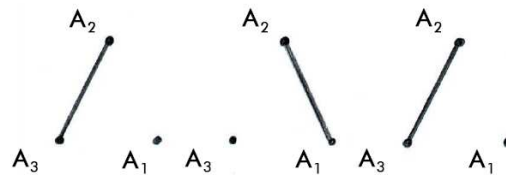
□ Schematic working



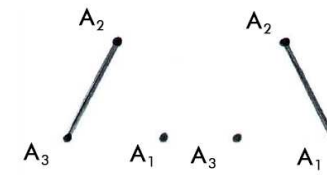
□ 3 events can appear during a pyroshock



Micro-switch

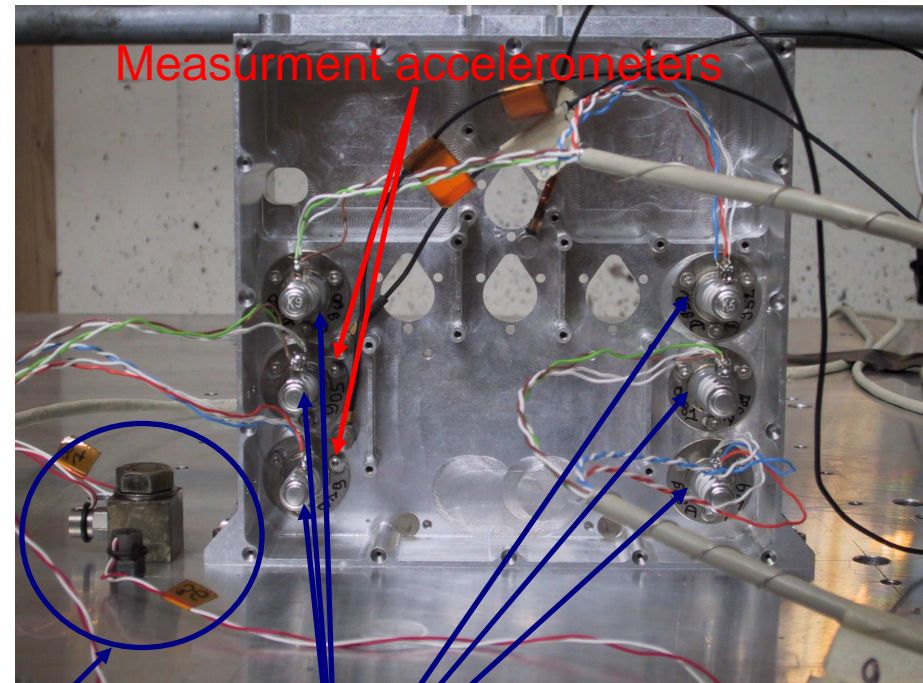
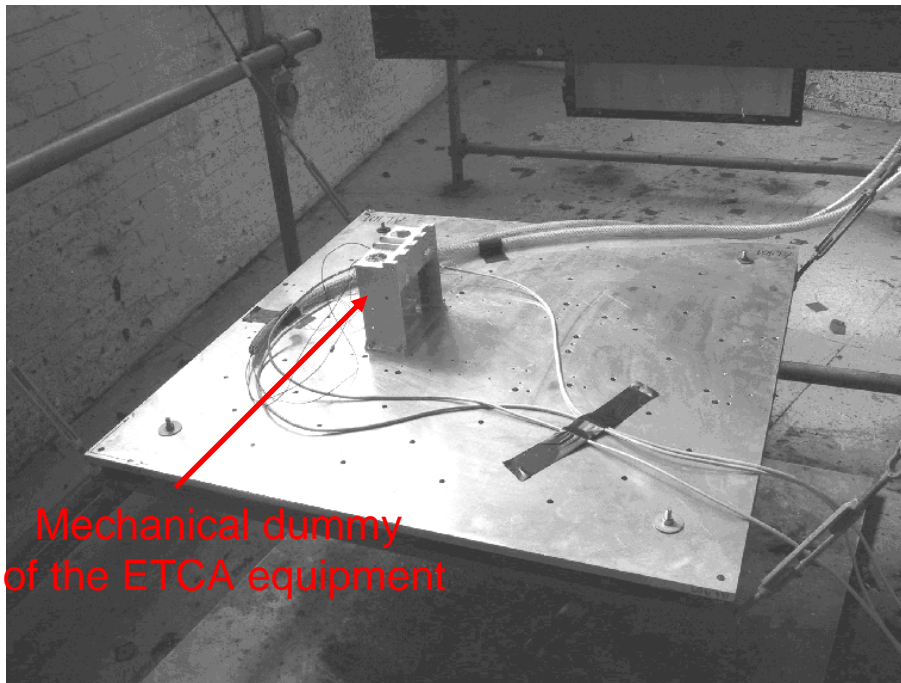


Provisional-switch



Permanent-switch

□ **Test set-up**

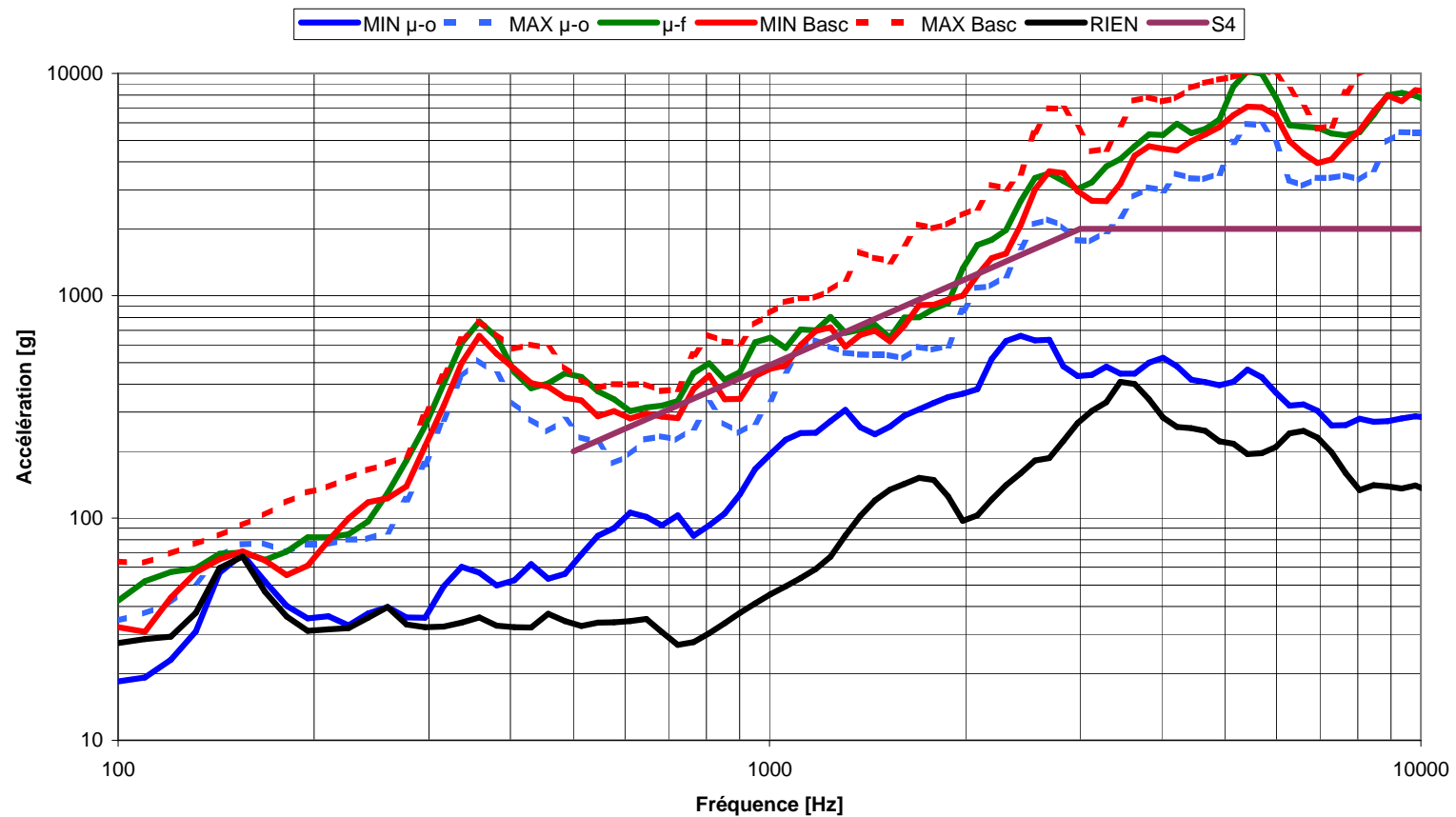


Control accelerometers

Relays K41-R

□ Limits of K41R in regards of pyroshocks for the ETCA unit

Limites comportementales K41-R (Axe Z)



- ETCA pyroshock test facilities are used to determine the limits of sensitive components in regards of pyroshocks**

- Test set-up have been used to know the limits of mechanical robustness of magnetic components, reported on substrate and PCB**

- Test set-up have been developped to determine the limits of different types of relays**

- All the results are used as reference for new design of electronic units, as well as the qualification status of ETCA products**

CONTACTS

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