

TEST REPORT

RFK 600 15KΩ REINFORCED INSULATION REV. D3
TESTS: HEATING, RAIN, MOISTURE AND SALT MIST

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2 Revision index

Rev.	Date	Paragraphs	Comments
0	25/06/2012		First issue

3 Identification data

Test	Date	Witnessed by	Paragraph
Ohmic value	28/10/2011	Pisano	4
Dielectric strength and insulation resistance	28/10/2011	Pisano	5
Test Campaign			
1 Heating test	28/10 ÷ 02/11/2011	Pisano	6
2 Rain test	02/11/2011	Pisano	7
3 Moisture test	03 ÷ 08/11/2011	Pisano	8
4 Salt spray fog	09 ÷ 18/11/2011	Pisano	9

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4 Ohmic value

Description:	Ohmic value measurement at ambient temperature		
Standard reference:	MIL-PRF-26G 14/06/2001 Par.3.6;4.6.1 Method 303 di MIL-STD-202		
Test environment:	Temperature: 21 °C – R.H. 30%		
Measuring device:	A99 – DMM TTI 1906 104series – Last calibration: 2011/12/07		
Samples ID	Accepted Value Ω	Measured Value Ω	Result
D3			
R1	15000 ±5%	14620	OK
R2	15000 ±5%	14531	OK
R3	15000 ±5%	14725	OK
R4	15000 ±5%	14825	OK
R5	15000 ±5%	14624	OK
R6	15000 ±5%	14633	OK
EXTERNAL HOLE			
R1	15000 ±5%	14710	OK
R2	15000 ±5%	14860	OK
R3	15000 ±5%	14489	OK
R4	15000 ±5%	15208	OK
R5	15000 ±5%	14698	OK
R6	15000 ±5%	15114	OK
TIE-BEAM			
R1	15000 ±5%	14999	OK
R2	15000 ±5%	14877	OK
R3	15000 ±5%	15190	OK
R4	15000 ±5%	15550	OK
R5	15000 ±5%	14568	OK
R6	15000 ±5%	14955	OK

5 Dielectric Strength (D.S.) and Insulation Resistance (I.R.)

Samples ID	D.S. @ 6000 V	I.R. @ 1000Vdc (GΩ)	Result
D3			
R1		150	OK
R2		150	OK
R3		200	OK
R4		200	OK
R5		200	OK
R6		200	OK
EXTERNAL HOLE			
R1		150	OK
R2		200	OK
R3		150	OK
R4		200	OK
R5		200	OK
R6		200	OK
TIE-BEAM			
R1		150	OK
R2		200	OK
R3		150	OK
R4		150	OK
R5		150	OK
R6		150	OK

1,6mA
(current measured when
all the 18 resistance
are connected in parallel)

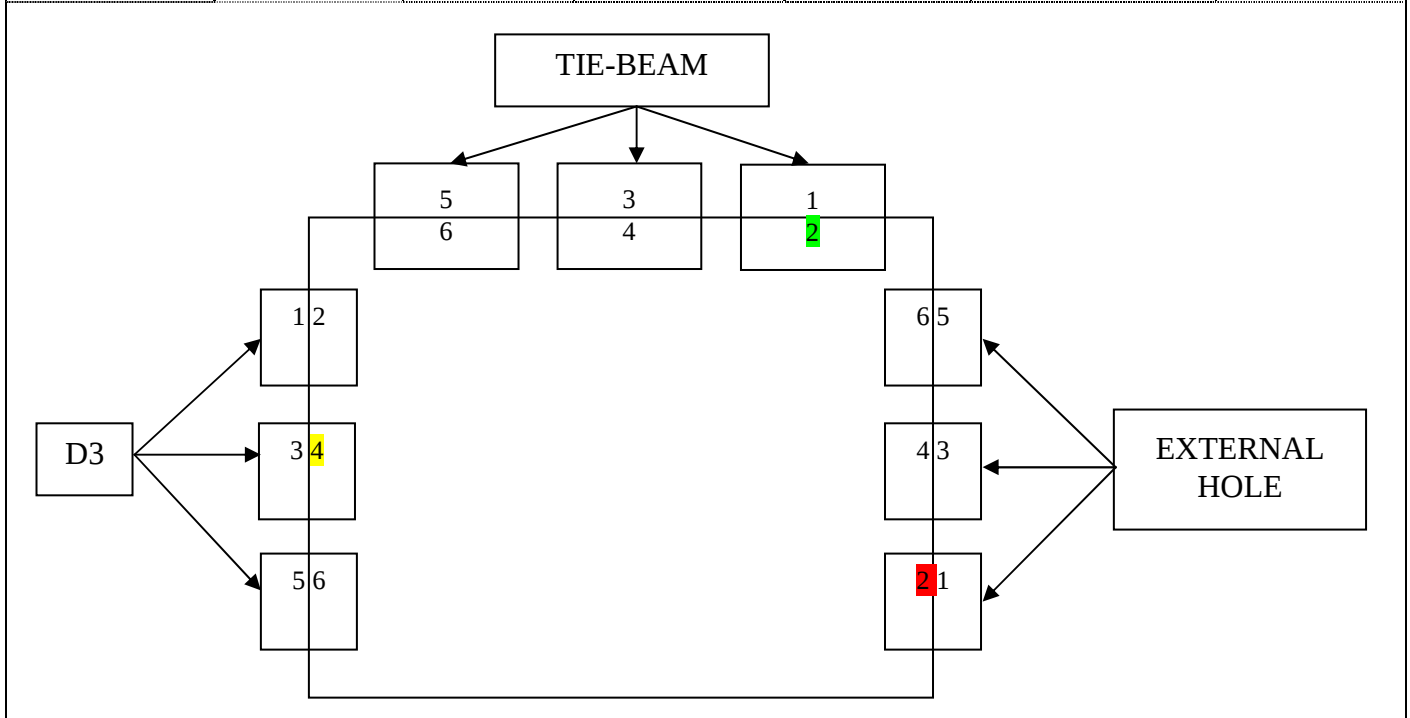
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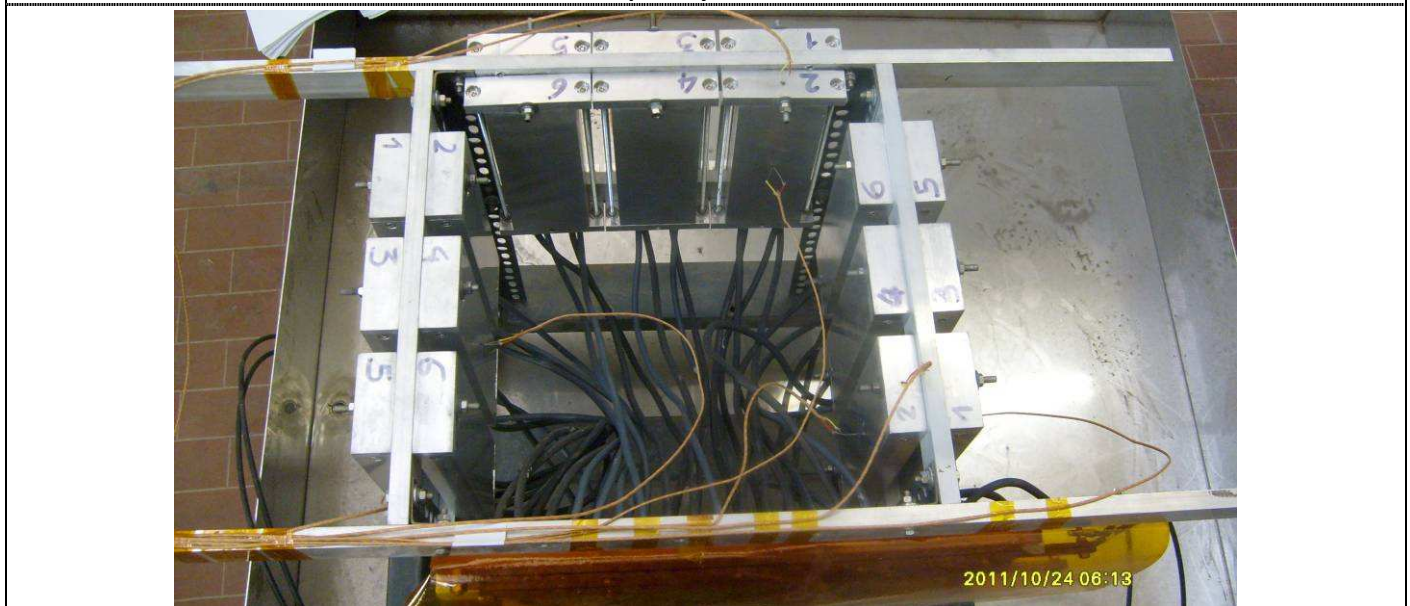
6 Heating test

6.1 Thermocouples layout

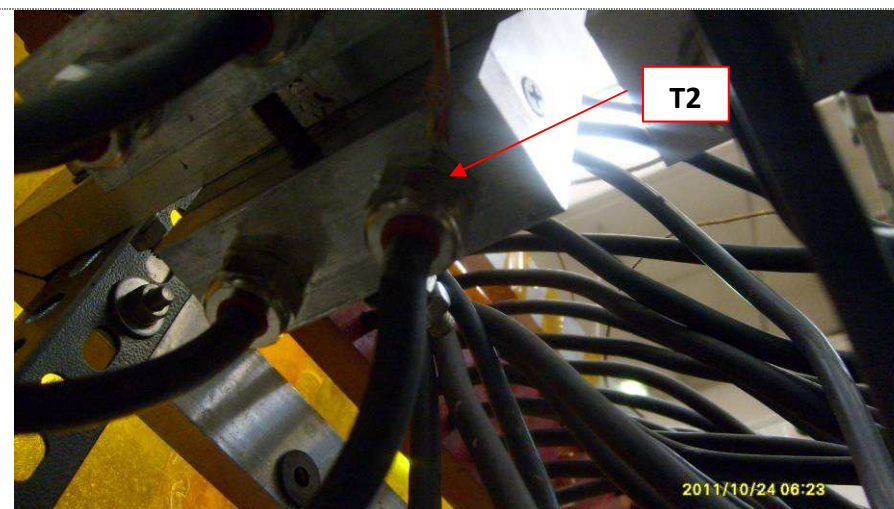
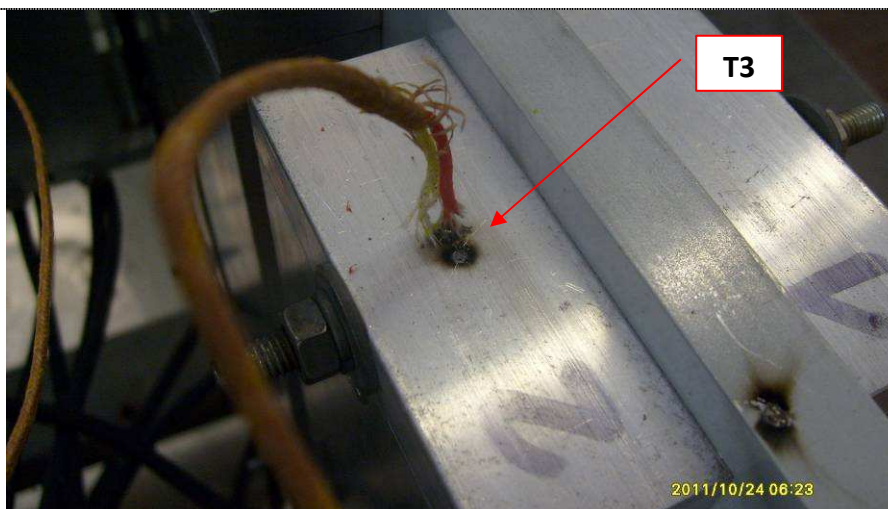
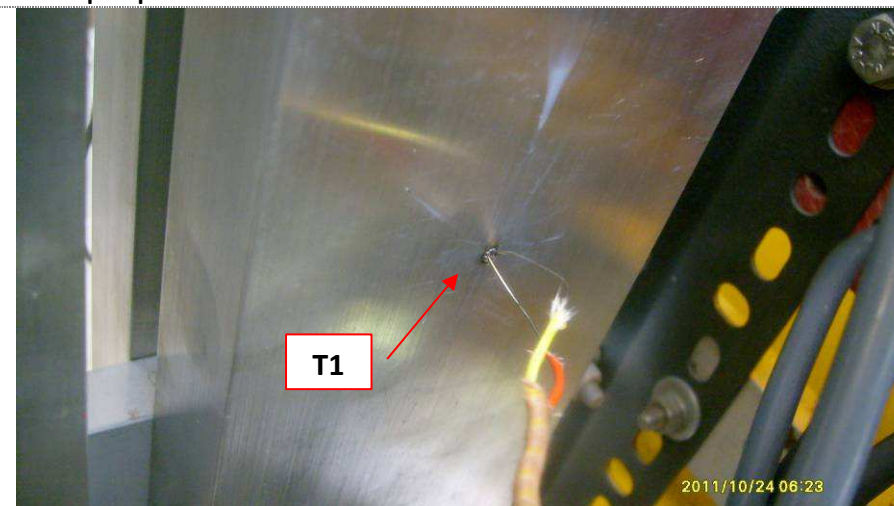
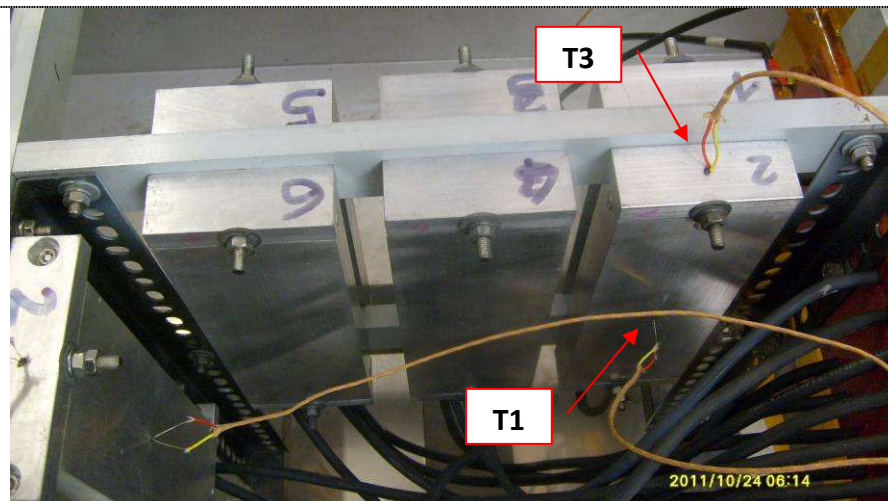
	Enclosure – Central position		Top		Bottom – blocked into PG sealing	
	Sample ID	Tc #	Sample ID	Tc #	Sample ID	Tc #
D3	R4	T7	R4		R4	T8
Tie-Beam (TB)	R2	T4	R2	T6	R2	T5
External Hole (EH)	R2	T1	R2	T3	R2	T2



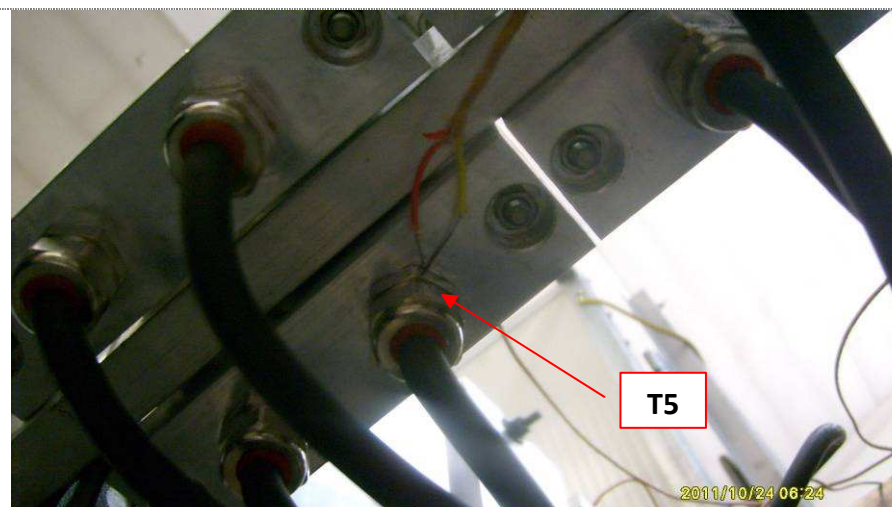
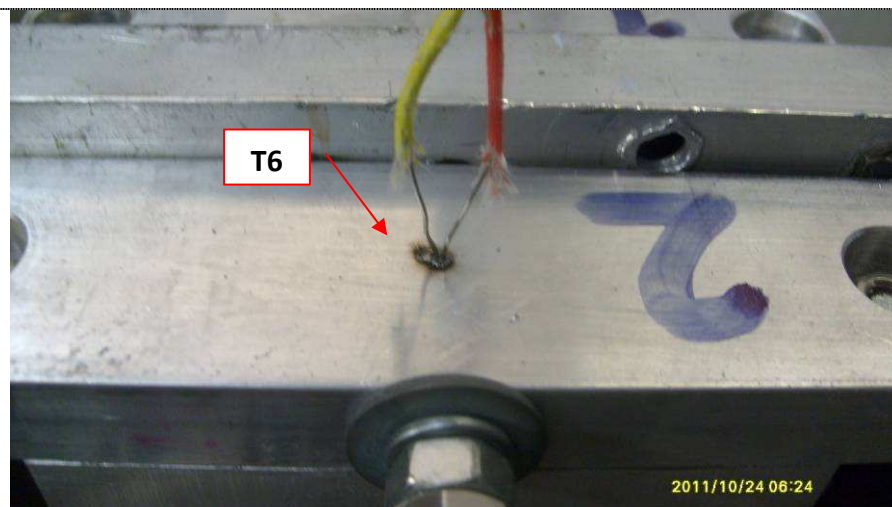
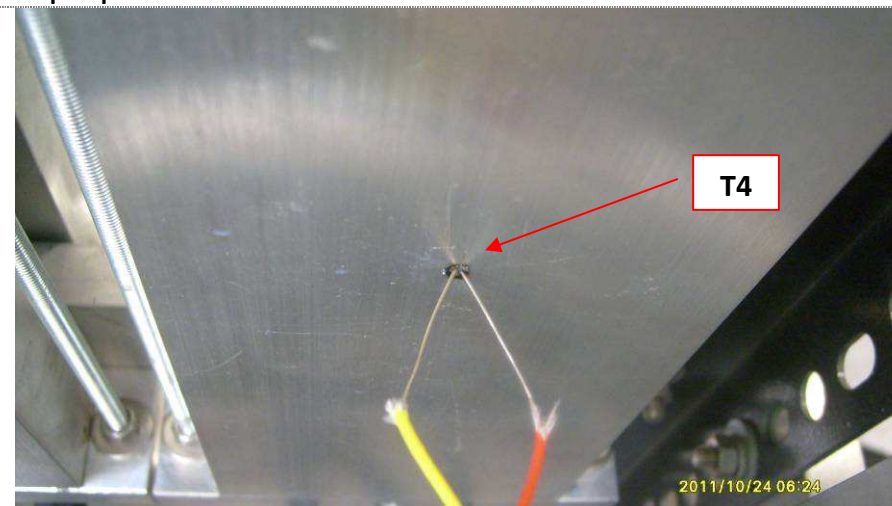
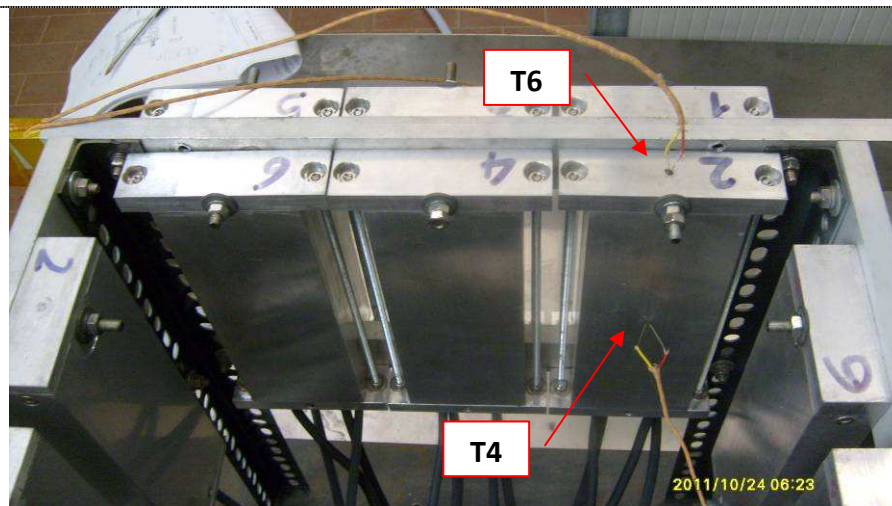
Thermocouples layout – overall view



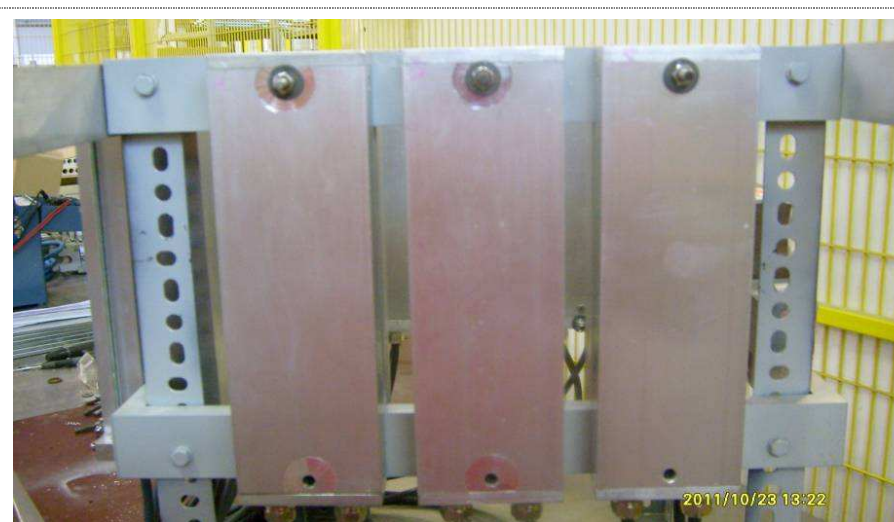
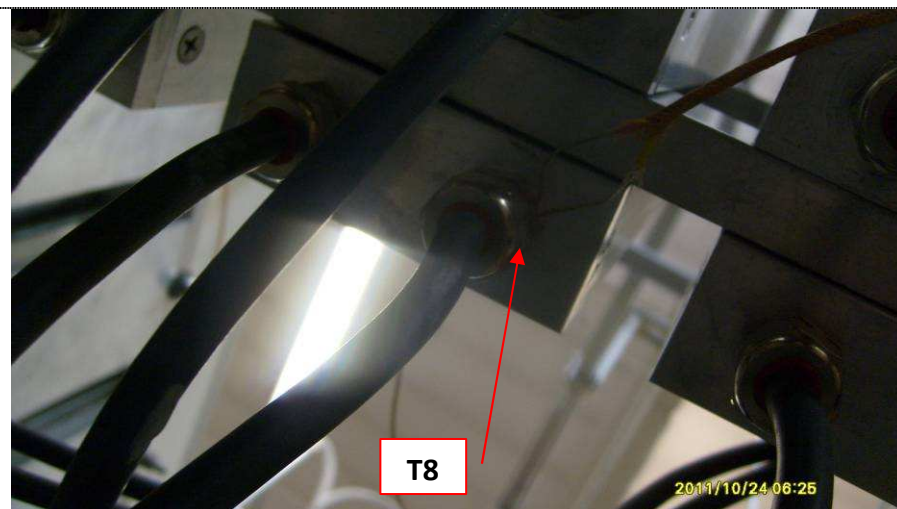
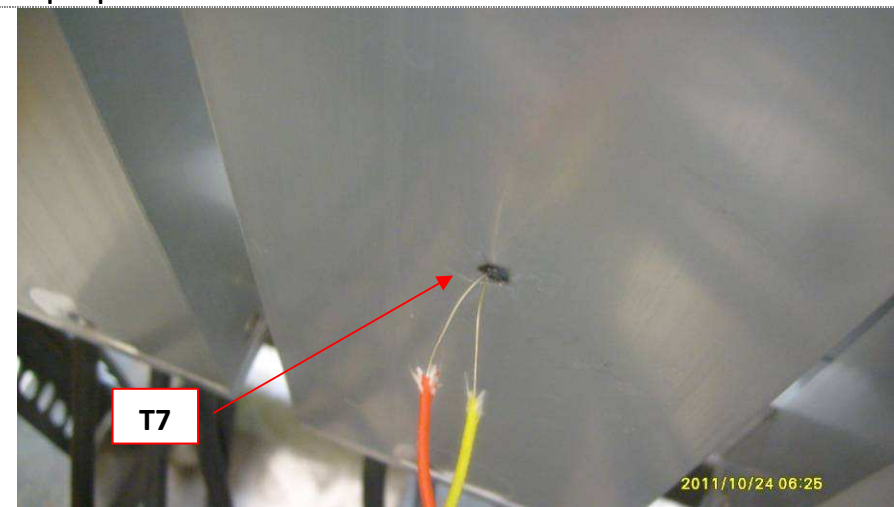
Details about EXTERNAL HOLE thermocouples positions on R2



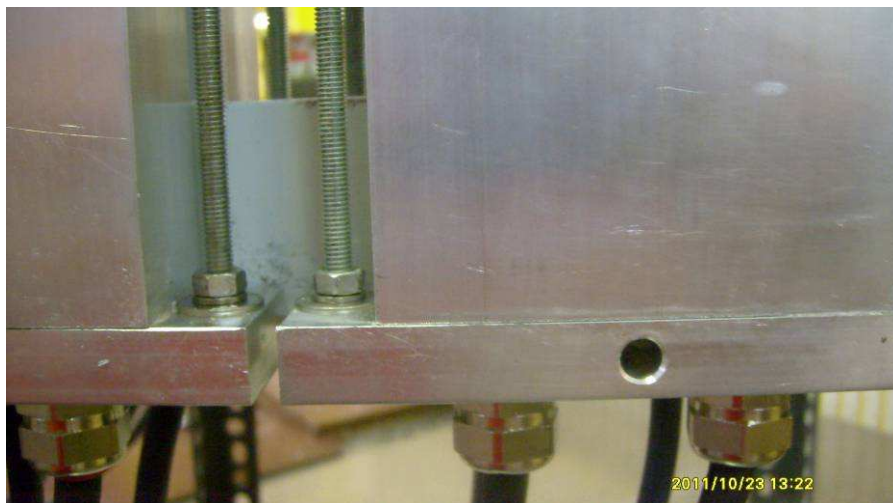
Details about TIE-BEAM thermocouples positions on R2



Details about D3 thermocouples positions



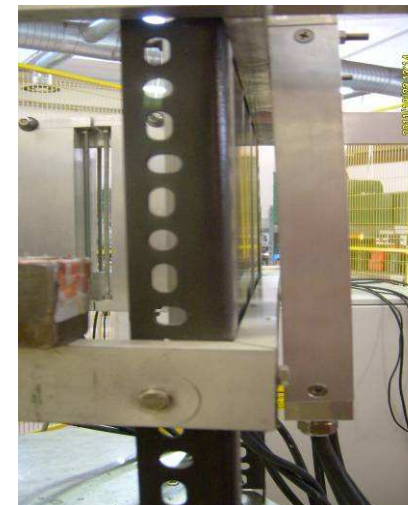
Details about TIE-BEAM mounting



Details about EXTERNAL HOLE mounting



Details about D3 mounting

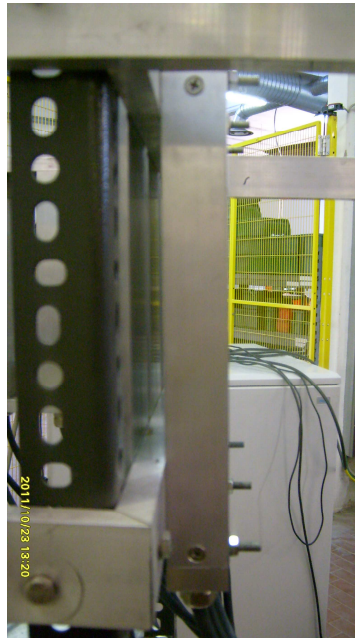


Details about EXTERNAL HOLE mounting

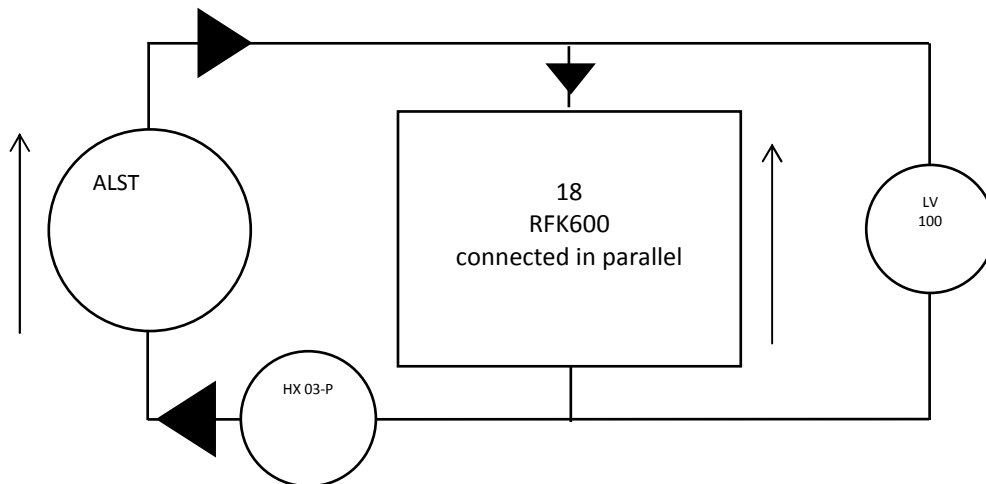
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Details about EXTERNAL HOLE mounting



6.2 Circuit diagram for heating test

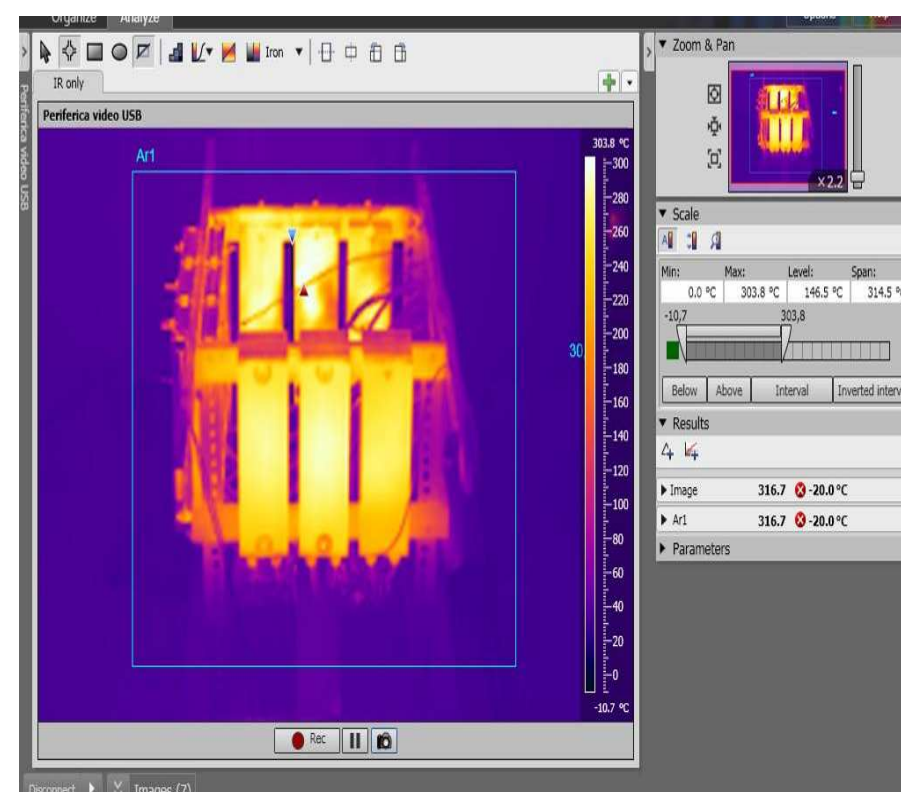
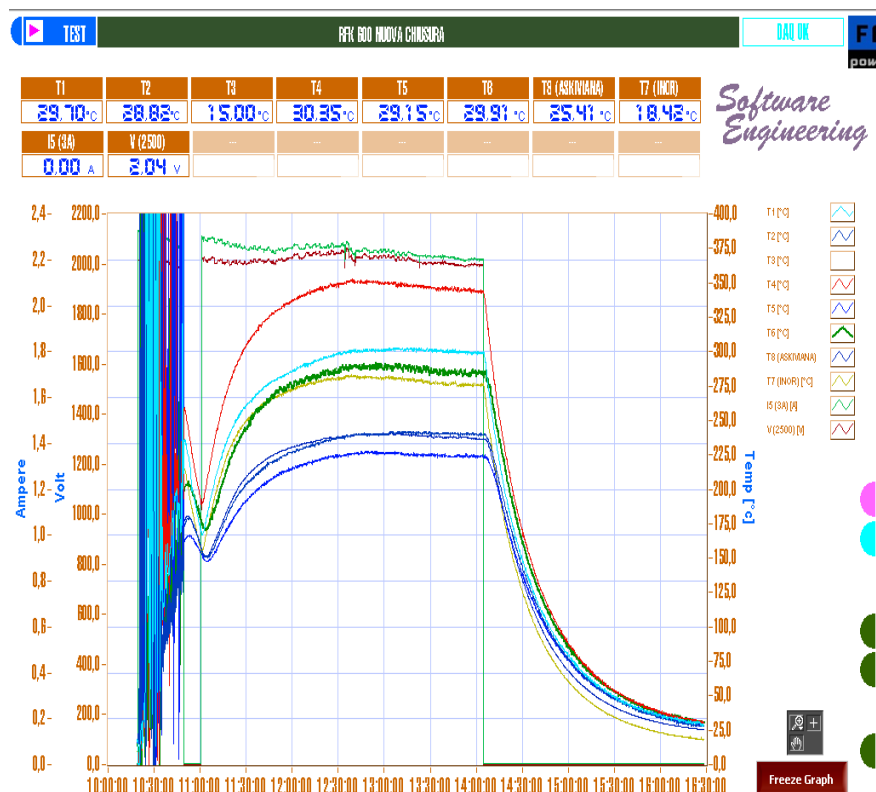


6.3 Heating Test

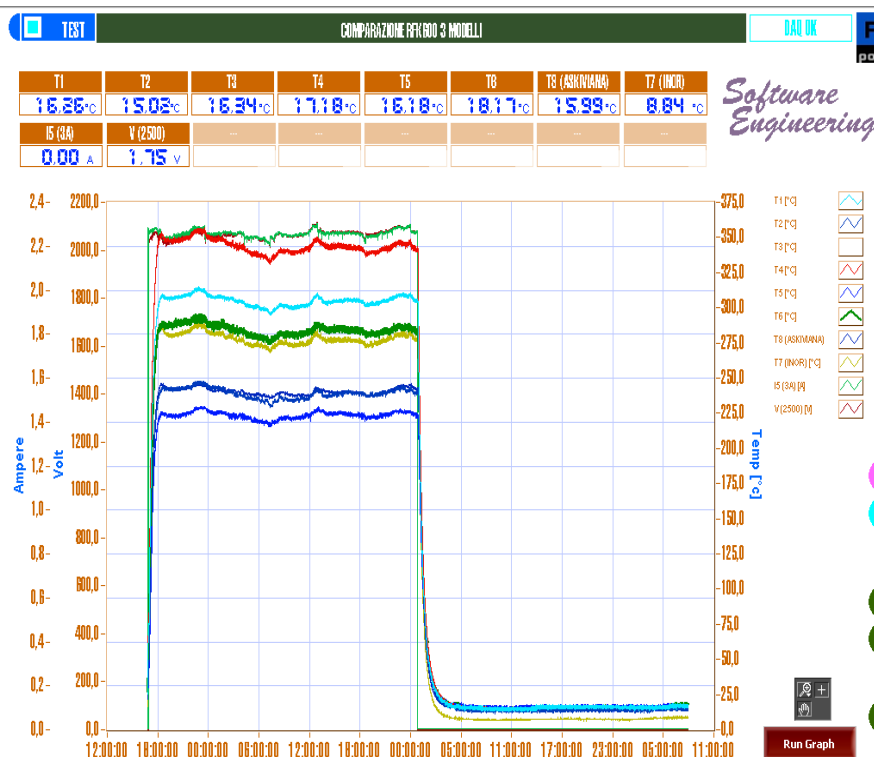
All the RFK600 configurations were fed by continuous service at nominal power for 32 hours.

The heating test thermal measurement and results are reported in the following page.

Description	Heating test ambient continuing 100%				Temperatures							
					Centre			Top		Bottom		
					D3 – R4	TB – R2	EH – R2	TB – R2	EH – R2	D3 – R4	TB – R2	EH – R2
					T7	T4	T1	T6	T3	T8	T5	T2
Power supply	ALST	Transducers	LV-100,HX 03-P	ΔT	212°C	323°C	275°C	262°C	-	253°C	200°C	215°C
Data	28/10/11 ± 28/10/11			Min	30°C	30°C	28°C	30°C	-	30°C	28°C	28°C
Duration	3 h	Time	11:00/14:00	Max	242°C	353°C	303°C	292°C	-	283°C	228°C	242°C
P _{ave}	4155 W	I	2,33 A	V	1947 V			TAU		/		



Description	Heating test ambient continuous 100%				Temperatures							
					Centre			Top		Bottom		
					D3 – R4	TB – R2	EH – R2	TB – R2	EH – R2	D3 – R4	TB – R2	EH – R2
Power supply	ALST	Transducers	LV-100,HX 03-P	ΔT	T7	T4	T1	T6	T3	T8	T5	T2
Data	28/10/11 30/10/11			Min	232°C	343°C	302°C	282°C	191°C	275°C	218°C	237°C
Duration	32h 10m	Time	16:47/00:51	Max	14°C	14°C	13°C	14°C	12°C	14°C	12°C	11°C
P _{ave}	4495 W	I	2,28 A	V	246°C	357°C	315°C	296°C	204°C	289°C	230°C	248°C
						1977 V		TAU			1700"	



A failure in all TIE-BEAM configuration was observed after heating test (as you can see in the pictures reported here above): the cap has been disassembled by the enclosure due to the expansion of the air inside. **TIE-BEAM configuration has not been tested in the following steps of the present campaign.**

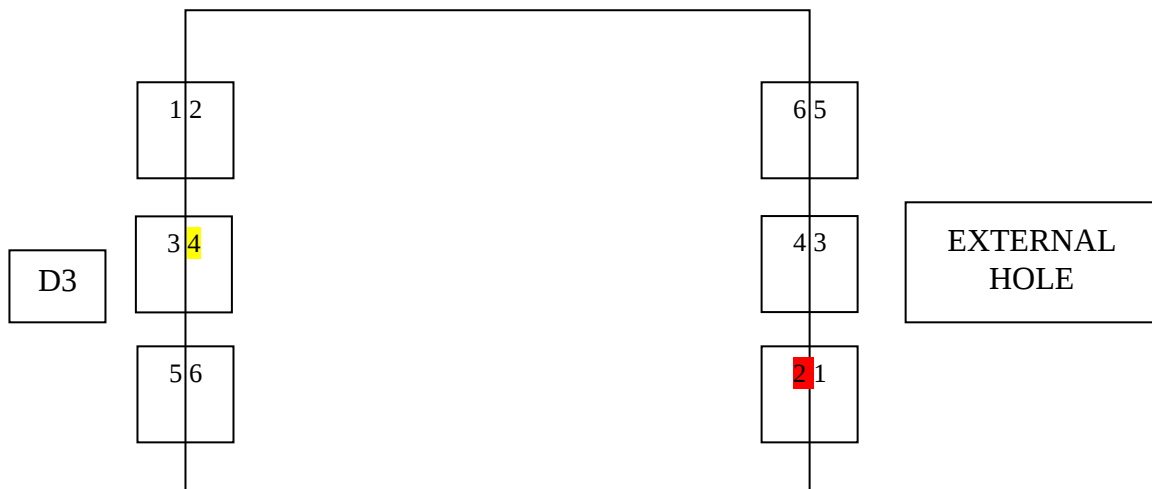
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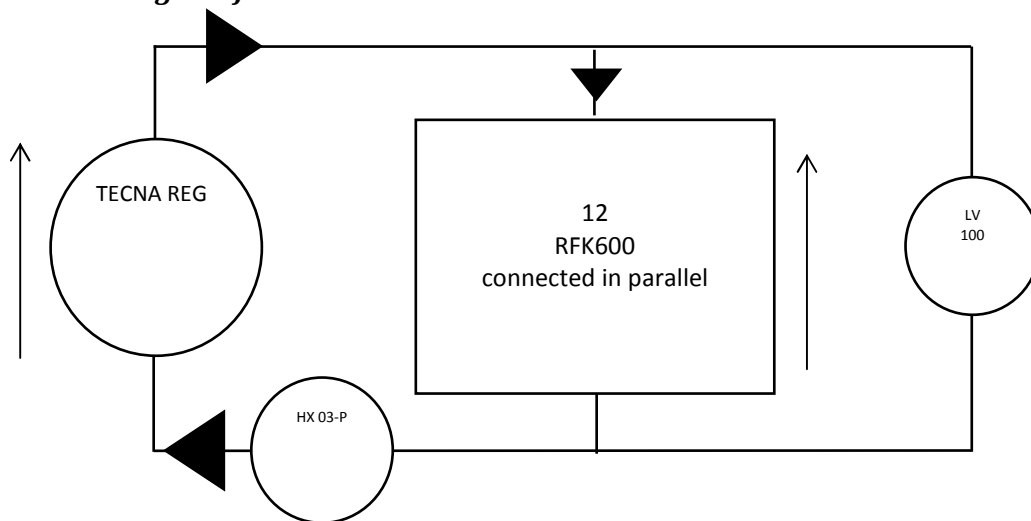
7 Rain test

7.1 Thermocouples layout

	Enclosure – Central position		Top		Bottom – blocked into PG sealing	
	Sample ID	Tc #	Sample ID	Tc #	Sample ID	Tc #
D3	R4	T7	R4	T6	R4	T8
External Hole (EH)	R2	T1	R2	T3	R2	T2

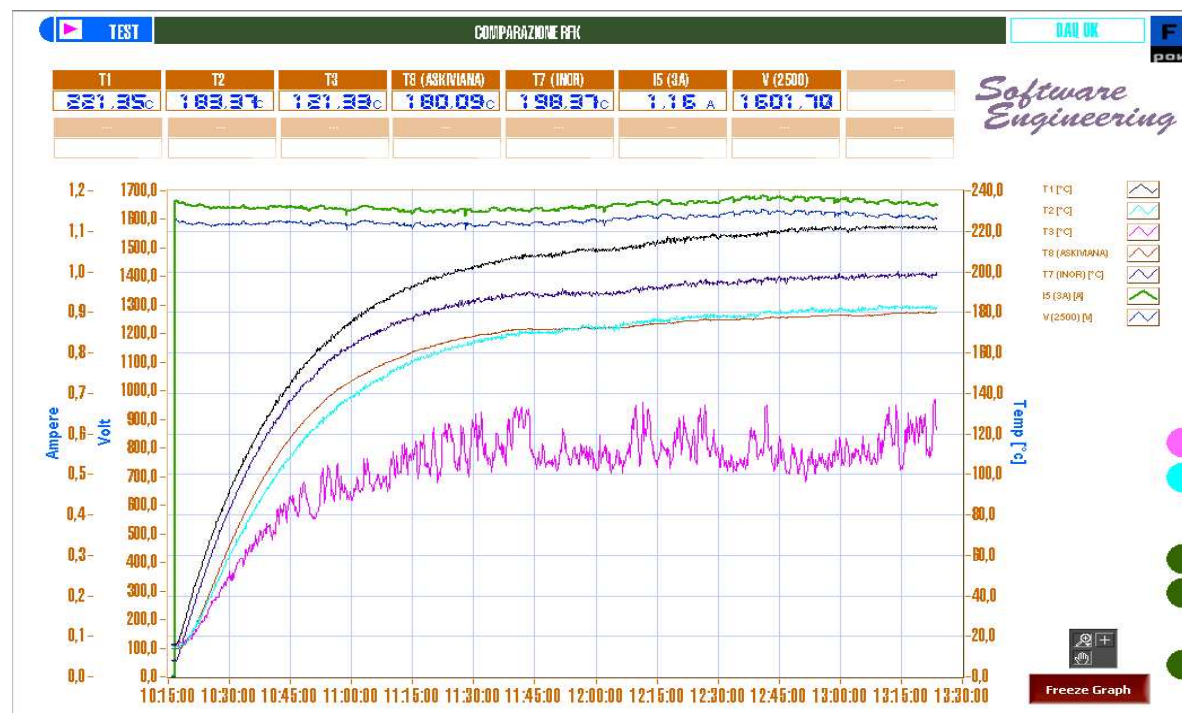


7.2 Circuit diagram for rain test



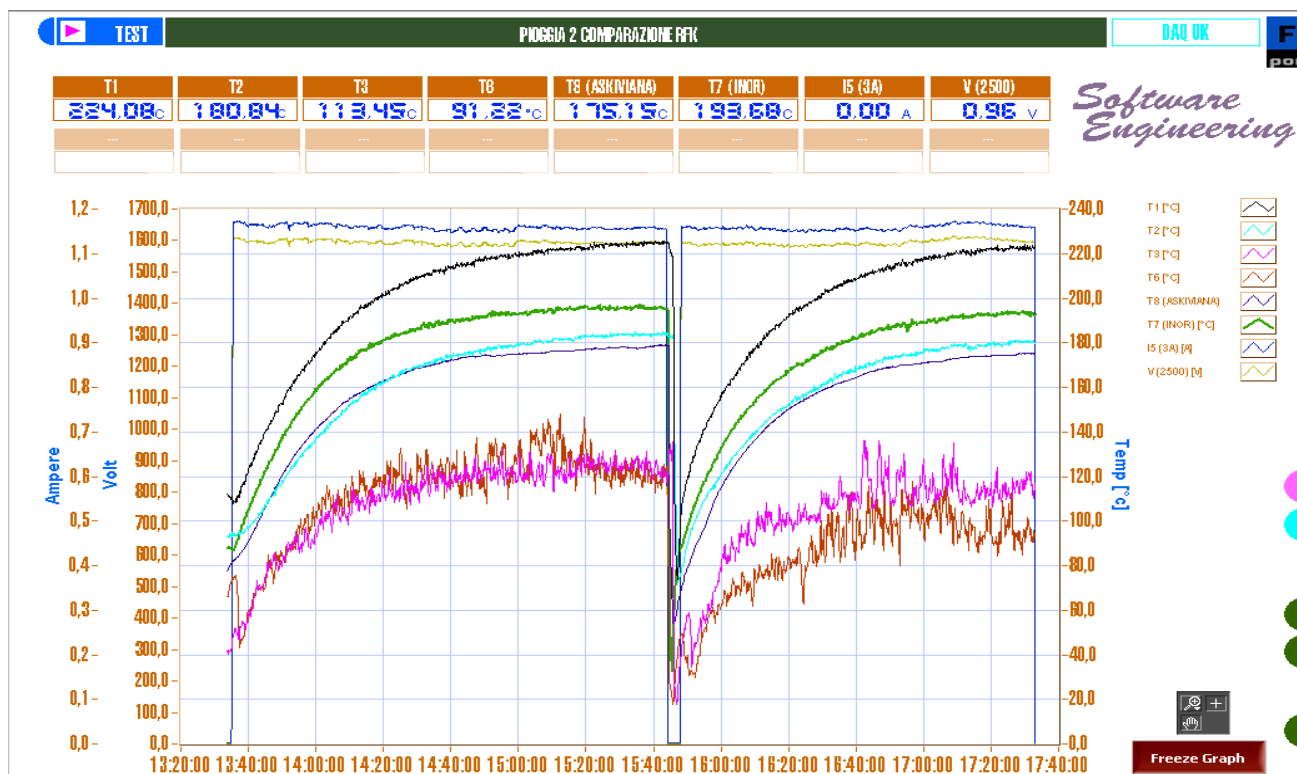
7.3 Rain Test #1

Description	Heating test ambient continuous				Temperatures				
					Centre		Top	Bottom	
					D3 – R4	EH – R2	EH – R2	D3 – R4	EH – R2
					T7	T1	T3	T8	T2
Power supply	TECNA REG	Transducers	LV-100,HX 03-P	ΔT	166°C	208°C	122°C	186°C	169°C
Data	02/11/2011	Time	10:15/13:25	Min	14°C	15°C	15°C	14°C	14°C
Duration	3h10m			Max	180°C	223°C	137°C	200°C	184°C
P _{ave}	1796 W	I	1,18 A	V		1545 V	TAU		1720"



7.4 Rain test #2 and #3

Description	Heating test ambient continuous				Temperature					
					Centre		Top		Bottom	
					D3 – R4	EH – R2	D3 – R4	EH – R2	D3 – R4	EH – R2
				ΔT	T7	T1	T6	T3	T8	T2
Power supply	TECNA REG	Transducers	LV-100,HX 03-P		165°C	211°C	133°C	123°C	183°C	172°C
Data	02/11/2011	Time	13:33/17:32	Min	14°C	13°C	15°C	13°C	14°C	13°C
Duration	3h59m	Tempo	14°C	Max	179°C	226°C	148°C	136°C	197°C	185°C
P _{ave}	1752 W	I	1,17A		V	1551 V	TAU		/	



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7.5 Pictures during rain test**7.6 Results**

The resistors are brought to a nominal working temperature by application of an appropriate power; the resistors' enclosures were then sprayed with water for 1 minute with a flow rate of approximately 1 liter per minute.

This procedure was carried out three times. At the end of the trial, the measurement of the insulation resistance was carried out in two different moments: immediately after rain test and after 15 hours.

The test is considered PASSED if the measured resistance will be at least the nominal value: 1 G Ω .

Samples ID	I.R. @ 1000Vdc (G Ω)			Result
	Beginning	After Rain Test	15h after Rain Test	
D3				
R1	150 G Ω	50 G Ω	100 G Ω	OK
R2	150 G Ω	70 G Ω	100 G Ω	OK
R3	200 G Ω	70 G Ω	100 G Ω	OK
R4	200 G Ω	70 G Ω	70 G Ω	OK
R5	200 G Ω	100 G Ω	100 G Ω	OK
R6	200 G Ω	100 G Ω	100 G Ω	OK
EXTERNAL HOLE				
R1	150 G Ω	8 G Ω	70 G Ω	OK
R2	200 G Ω	20 G Ω	50 G Ω	OK
R3	150 G Ω	10 G Ω	50 G Ω	OK
R4	200 G Ω	10 G Ω	50 G Ω	OK
R5	200 G Ω	10 G Ω	70 G Ω	OK
R6	200 G Ω	20 G Ω	70 G Ω	OK

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8 Moisture test

The RFK600 resistances were kept inside a climate chamber for 5 days in the following conditions:

Temperature: 80°C

Relative Humidity: 95%

The test is considered PASSED if the measured resistance will be at least the nominal value: 1 GΩ.

Description	Moisture test	Date	03/11/2011	Duration	5 gorni	T	80°C	Umidita	95%
Sample ID	I.R. @ 1000Vdc (GΩ)					Result			
	15h after Rain Test (initial condition)	After 48h in climatic chamber	After 96h in climatic chamber	After 120h in climatic chamber					
D3									
R1	100	50	50	50	OK				
R2	100	50	40	40	OK				
R3	100	70	50	50	OK				
R4	70	70	4	1	OK				
R5	100	50	100	80	OK				
R6	100	50	100	100	OK				
EXTERNAL HOLE									
R1	70	30	30	20	OK				
R2	50	50	30	10	OK				
R3	50	50	10	10	OK				
R4	50	50	10	4	OK				
R5	70	40	8	4	OK				
R6	70	50	30	20	OK				

Note:

The anomalous value for the sample D3-R4 could be the consequence of a non adequate sealing for the PG due to the presence of a thermocouple in it.

After the moisture test and before the salt spray fog test, all the samples were kept:

for 2 hours at 2°C in a climate chamber

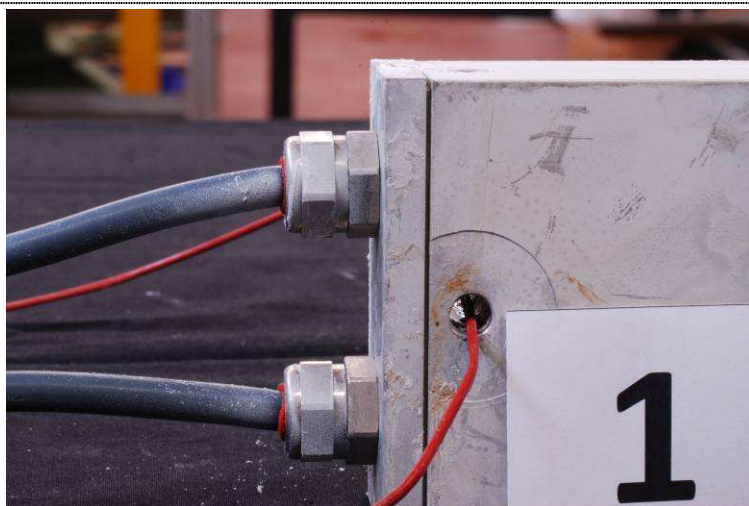
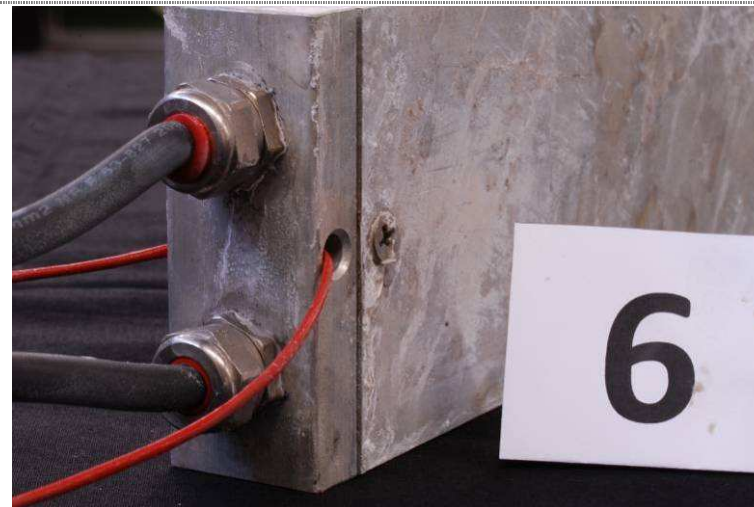
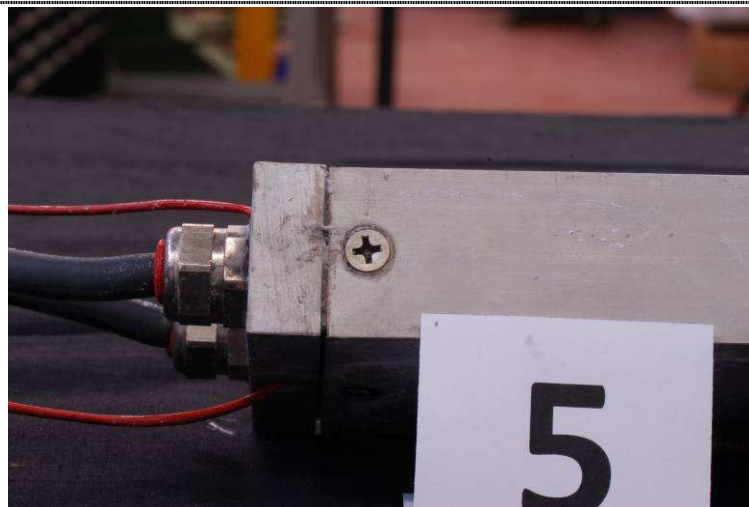
for 18 hours at ambient temperature in free environment

9 Salt mist test

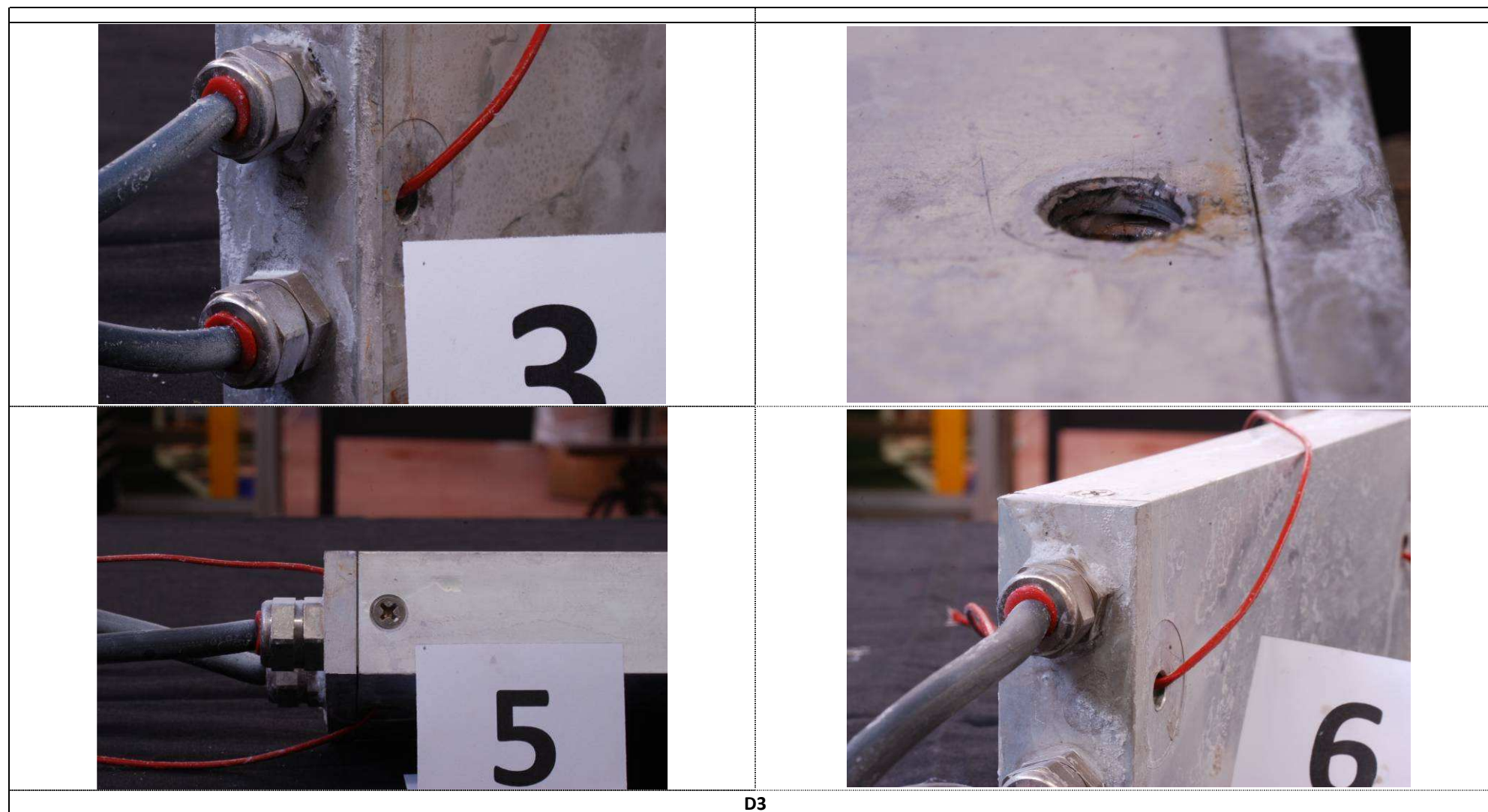
Description	Salt spray fog test				
Date	09/11/2011 ÷ 18/11/2011	Time	08:30h/12:25	Duration	216 h

9.1 Pictures after 72 hours

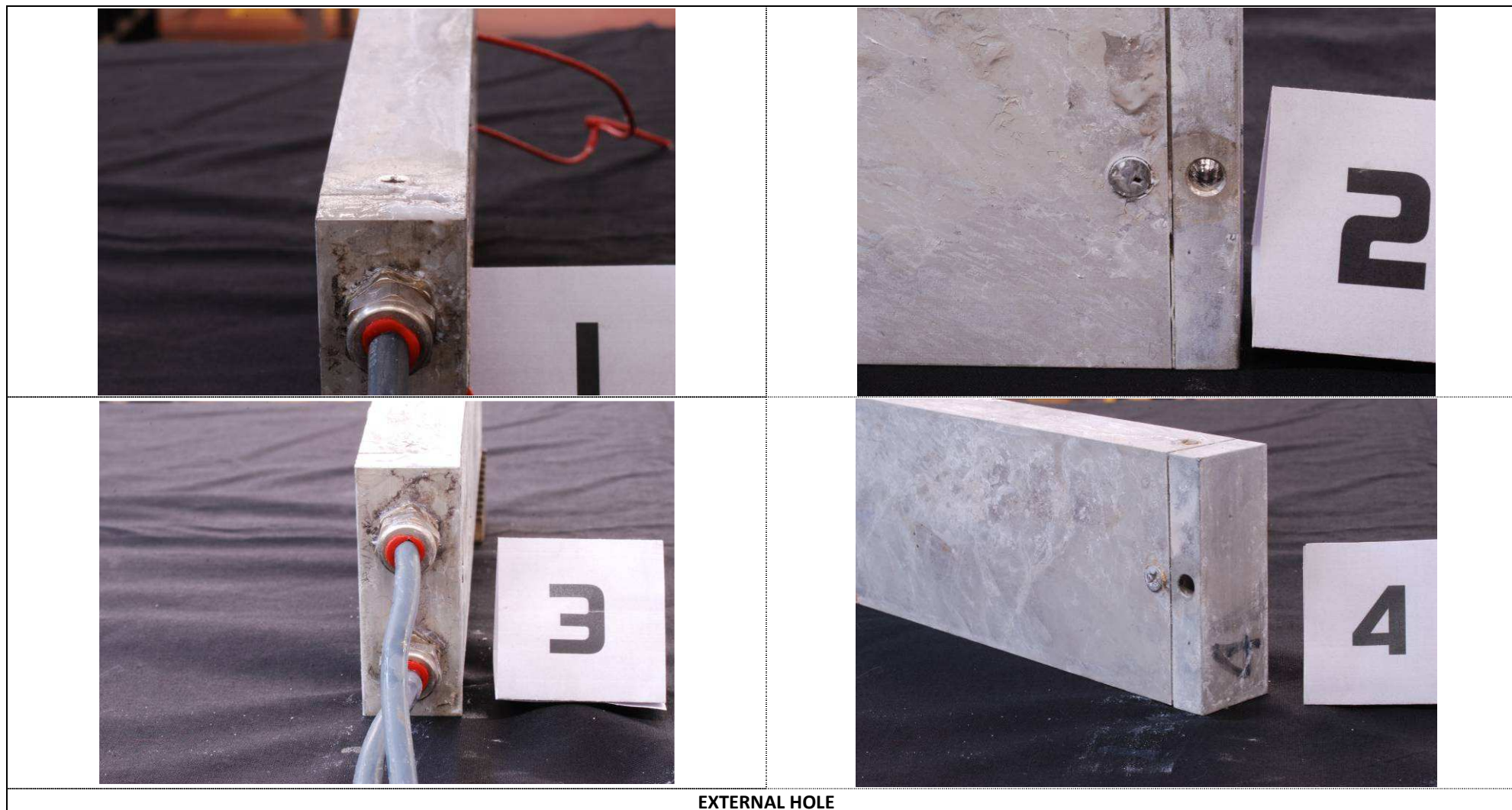

EXTERNAL HOLE



D3

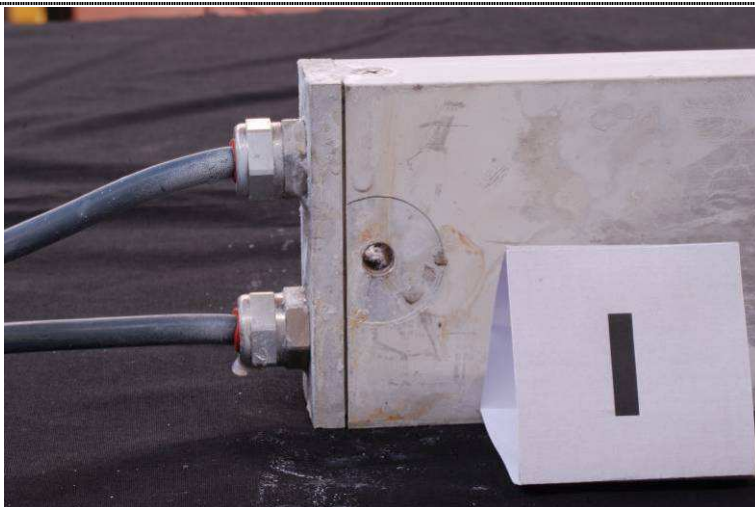
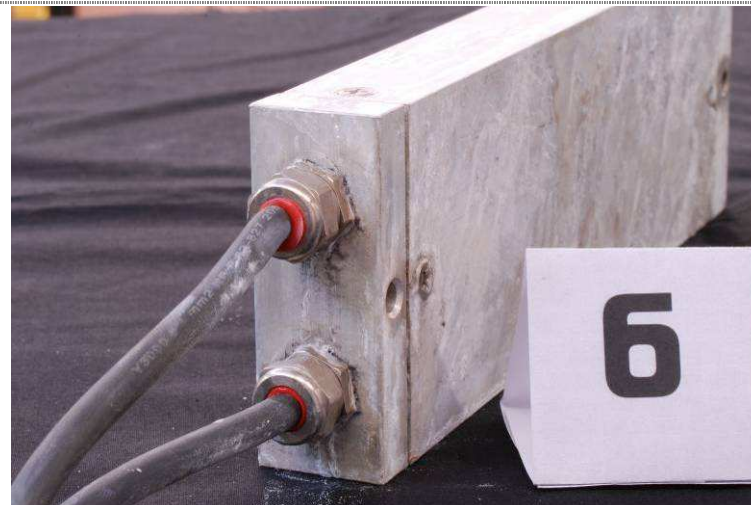
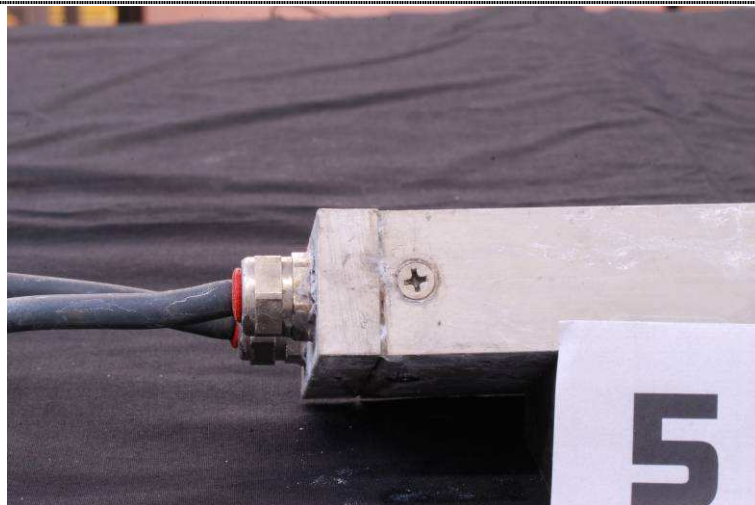


9.2 Pictures after 200 hours

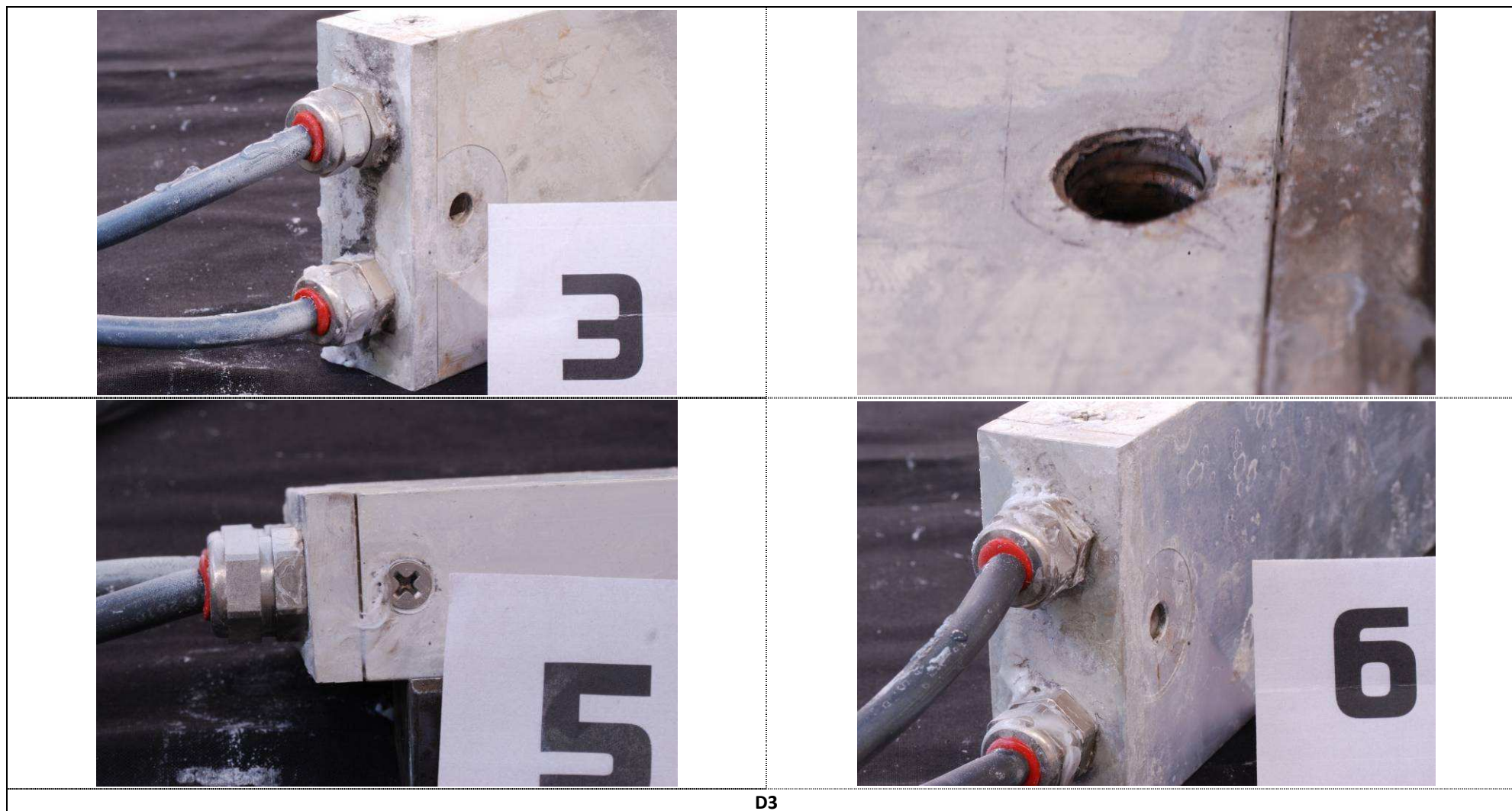


EXTERNAL HOLE

EXTERNAL HOLE



D3



D3

9.3 Results

The test is considered PASSED if the measured resistance will be at least the nominal value: 1 GΩ.

Sample ID	INSULATION RESISTANCE @ 1000Vdc		
	Before testing in salt spray fog chamber	After salt mist exposure for 72h	After salt mist exposure for 216h
D3			
R1	200 GΩ	20 GΩ	70 GΩ
R2	200 GΩ	20 GΩ	50 GΩ
R3	200 GΩ	30 GΩ	60 GΩ
R4	15 GΩ	8 GΩ	60 GΩ
R5	300 GΩ	20 GΩ	100 GΩ
R6	100 GΩ	30 GΩ	200 GΩ
EXTERNAL HOLE			
R1	200 GΩ	20 GΩ	50 GΩ
R2	50 GΩ	30 GΩ	50 GΩ
R3	100 GΩ	30 GΩ	30 GΩ
R4	50 GΩ	20 GΩ	20 GΩ
R5	50 GΩ	10 GΩ	10 GΩ
R6	100 GΩ	30 GΩ	20 GΩ

10 Conclusions

- **TIE-BEAM configuration** isn't considered adequate → heating test failed;
- In the following chart it is reported a brief summary of insulation value measured after each test of the present test campaign for the **configuration D3** and **EXTERNAL HOLE configuration**:

Sample ID	INSULATION RESISTANCE @ 1000Vdc			
	Before test campaign	After Rain Test	After Moisture Test	After Salt Mist Test
D3				
R1	150 GΩ	50 GΩ	50 GΩ	70 GΩ
R2	150 GΩ	70 GΩ	40 GΩ	50 GΩ
R3	200 GΩ	70 GΩ	50 GΩ	60 GΩ
R4	200 GΩ	70 GΩ	1 GΩ	60 GΩ
R5	200 GΩ	100 GΩ	80 GΩ	100 GΩ
R6	200 GΩ	100 GΩ	100 GΩ	200 GΩ
EXTERNAL HOLE				
R1	150 GΩ	8 GΩ	20 GΩ	50 GΩ
R2	200 GΩ	20 GΩ	10 GΩ	50 GΩ
R3	150 GΩ	10 GΩ	10 GΩ	30 GΩ
R4	200 GΩ	10 GΩ	4 GΩ	20 GΩ
R5	200 GΩ	10 GΩ	4 GΩ	10 GΩ
R6	200 GΩ	20 GΩ	20 GΩ	20 GΩ

- **EXTERNAL HOLE configuration** has passed all the test in the present campaign;
- **D3 configuration** has passed all the test in the present campaign;
- **D3 configuration** will be adopted as new **STANDARD CONFIGURATION** because the higher values (compared to EXTERNAL HOLE configuration) of the insulation resistance measured after each test could permit higher safety margin in term of ageing effect or critical operating conditions. The graph reported in the following page can explain in a simple way the reason of this choice.

Insulation resistance behaviour (1000 Vdc - values in G Ω)

