



Prepared  
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# Type test according to IEC 60502-2:2005 On M5AX2B cable 12/20 (24) kV 3x240 mm<sup>2</sup> AL/CuT/STA/PVC

## 1 INTRODUCTION

Type test according to IEC 60502-2 (second edition 2005-03) has been performed at the University of Rome – Electrical engineering department, on the cable 12/20 (24) kV 3x240 mm<sup>2</sup> AL manufactured by medcables/ teffahta Lebanon.

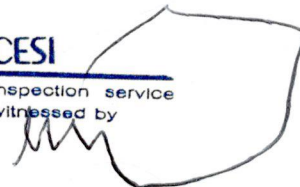
Identification of the object for the testing has been verified by Bureau Veritas.  
The process of tests and results has been witnessed by CESI as a National accredited authority.  
Type tests followed by Enel Distribution technical staff.

## 2 SUMMARY

The cable passed all tests Positively without remarks.



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### 4 CABLE SPECIFICATION

Type: MEDCABLES 24 kV 3x240/35  
 Rated voltage: 12/20 (24) kV Conductor:  
 3x240 mm<sup>2</sup>. Al, round.  
 Conductor screen: Extruded semi conducting compound.  
 Insulation: XLPE  
 Insulation screen: Extruded semi conducting compound. **Strippable.**  
 Shield: 32 mm<sup>2</sup>. Woven bands of tinned copper threads.  
 Armour: Steel Tape Armour.  
 Sheath: Red PVC  
 Construction no: M5AX2B

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## 5 ELECTRICAL TESTS

### 5.1 Partial discharge test at ambient temperature before bending test

	Core 1	Core 2	Core 3	Requirements
Noise level, pC	0,4	0,4	0,4	Not specified
Discharge level at 21 kV, pC	1,7	1,4	1,0	≤ 5

### 5.2 Bending test

According to IEC 60502-2 section 18.1.3.

The sample was bent around a cylinder with a diameter of 1100 mm, at ambient temperature for one complete turn then unwound. The cable was then rotated 180° longitudinally and then the process was repeated. This cycle of operation was carried out totally three times.

### 5.3 Partial discharge test after bending

According to IEC 60502-2 section 18.1.4.

	Core 1	Core 2	Core 3	Requirements
Noise level, pC	0,5	0,5	0,5	Not specified
Discharge level at 21 kV, pC	0,8	0,7	0,7	≤ 5

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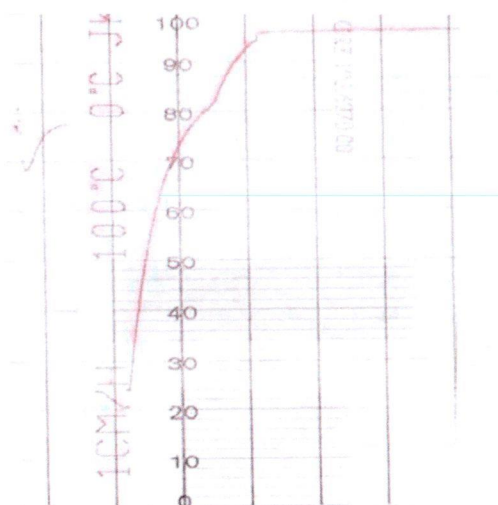
5.4 Tan delta measurement

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According to IEC 60502-2 section 18.1.5.

The sample was heated with current through the conductor, until the temperature stabilized at 95-100 °C, see figure 1.

Figure 1



	Core 1	Core 2	Core 3	Requirements
Loss factor at ambient temp, measured at 2 kV	$3,3 \times 10^{-4}$	$3,6 \times 10^{-4}$	$3,5 \times 10^{-4}$	$< 40 \times 10^{-4}$
Loss factor at 95-100°C, measured at 2 kV	$6,4 \times 10^{-4}$	$6,4 \times 10^{-4}$	$7,9 \times 10^{-4}$	$< 40 \times 10^{-4}$



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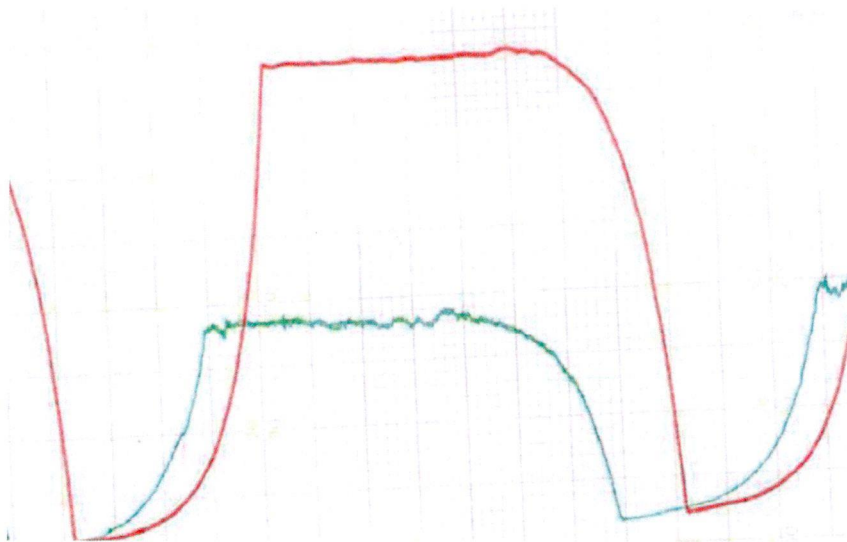
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### 5.5 Heating cycle test

According to IEC 60502-2 section 18.1.6.

The sample was heated with current through the conductor until the temperature stabilized at 95-100 °C. The sample was then heated for 8 h followed by 4 h of natural cooling. This heat cycle was performed 20 times, see figure 2 below.

Figure 2



After the heating cycle voltage test a partial discharge test at ambient temperature was performed.

	Core 1	Core 2	Core 3	Requirements
Noise level, pC	0,2	0,2	0,2	Not specified
Discharge level at 21 kV, pC	0,4	0,7	0,6	≤ 5

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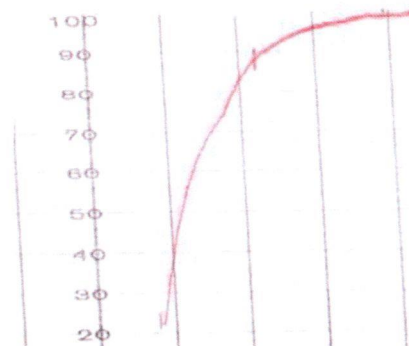
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### 5.6 Impulse voltage test

According to IEC 60502-2 section 18.1.7.

The test was performed at a conductor temperature of 95-100 °C, see figure 3. The cable withstood 10 positive and 10 negative impulses of 125 kV, see appendix.

Figure 3



### 5.7 AC voltage test after impulse voltage test

According to IEC 60502-2 section 18.1.7.

42 kV AC was applied between the conductor and the metallic screen for 15 minutes. No breakdown occurred.

### 5.8 Voltage test for 4 h

According to IEC 60502-2 section 18.1.8.

48 kV AC was applied between the conductor and the metallic screen for 4 hours. No breakdown occurred.

### 5.9 Examination

The cable was examined after all tests and nothing notable was found



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**5.10 Resistivity of semi-conducting screens**

According to IEC 60502-2 section 18.1.9.

**5.10.1 Conductor screen**

	Core 1	Core 2	Core 3	Requirements
Resistivity before ageing, $\Omega m$	107,6	136,7	110,5	$\leq 500$
Resistivity after ageing, $\Omega m$	142,9	113,0	116,3	$\leq 500$

**5.10.2 Insulation screen**

	Core 1	Core 2	Core 3	Requirements
Resistivity before ageing, $\Omega m$	9,0	9,5	9,7	$\leq 1000$
Resistivity after ageing, $\Omega m$	1,8	1,9	1,9	$\leq 1000$



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## 6 NON-ELECTRICAL TESTS

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### 6.1 Thickness of the insulation

According to IEC 60502-2 section 19.1.

	Core 1	Core 2	Core 3	Requirements
Average thickness, mm	5,55	5,53	5,51	≥ 5,45
Minimum thickness ( $t_{min}$ ), mm	5,50	5,49	5,43	≥ 4,85
Maximum thickness ( $t_{max}$ ), mm	5,59	5,56	5,53	Not specified
$(t_{max}-t_{min})/t_{max}$	0,09	0,07	0,10	≤ 0,15

### 6.2 Thickness of the non-metallic sheath

According to IEC 60502-2 section 19.2.

	Measured value	Requirements
Average thickness, mm	2,32	Not specified
Minimum thickness, mm	2,43	≥ 2,0
Maximum thickness, mm	2,76	Not specified

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**6.3 Mechanical properties of the insulation**

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According to IEC 60502-2 section 19.3.

**6.3.1 Before ageing**

	Core 1	Core 2	Core 3	Requirements
Tensile strength, MPa	23,9	23,3	23,6	≥ 12,5
Elongation at break, %	472	496	495	≥ 200

**6.3.2 After ageing**

	Core 1	Core 2	Core 3	Requirements
Tensile strength, MPa	23,2	23,0	25,0	Not specified
Variation of tensile strength, %	- 3	- 1	5,6	± 25
Elongation at break, %	540	536	529	Not specified
Variation of elongation at break, %	14	8	7	± 25

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6.4 Mechanical properties of the non-metallic sheath

According to IEC 60502-2 section 19.4.

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6.4.1 Before ageing

	Measured value	Requirements
Tensile strength, MPa	30,5	≥ 12,5
Elongation at break, %	813	≥ 300

6.4.2 After ageing

	Measured value	Requirements
Tensile strength, MPa	23,1	Not specified
Variation of tensile strength, %	- 24	Not specified
Elongation at break, %	744	≥ 300
Variation of elongation at break, %	- 8	Not specified

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**6.5 Additional ageing test on pieces of the complete cable**

According to IEC60502-2 section 19.5.

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**6.5.1 Insulation**

**6.5.1.1 Before ageing**

	Core 1	Core 2	Core 3	Requirements
Tensile strength, MPa	23,9	23,3	23,6	≥ 12,5
Elongation at break, %	472	496	495	≥ 200

**6.5.1.2 After ageing**

	Core 1	Core 2	Core 3	Requirements
Tensile strength, MPa	25,0	25,1	25,7	Not specified
Variation of tensile strength, %	4,5	8	9	± 25
Elongation at break, %	489	494	498	Not Specified
Variation of elongation at break, %	3,5	- 0,3	0,6	± 25

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**6.5.2 Sheath**

6.5.2.1 Before ageing

	Measured value	Requirements
Tensile strength, MPa	30,5	$\geq 12,5$
Elongation at break, %	813	$\geq 300$

6.5.2.2 After ageing

	Measured value	Requirements
Tensile strength, MPa	28,4	Not specified
Variation of tensile strength, %	- 7	Not specified
Elongation at break, %	825	$\geq 300$
Variation of elongation at break, %	1,5	Not specified

**6.6 Pressure test at high temperature on the non-metallic sheath**

According to IEC 60520-2 section 19.7.

	Measured value	Requirements
Depth of indentation, %	8	$\leq 50$

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According to IEC 60502-2 section 19.11.

	Core 1	Core 2	Core 3	Requirements
Elongation under load, %	70	70	50	$\leq 175$
Residual elongation, %	0	0	0	$\leq 15$

**6.8 Water absorption test on the insulation**

According to IEC 60502-2 section 19.13.

	Core 1	Core 2	Core 3	Requirements
Water absorption, mg/cm <sup>2</sup>	0	0,04	0,01	$\leq 1$

**6.9 Carbon black content of the red PVC-oversheath**

According to IEC 60502-2 section 19.15.

	Measured value	Requirements
Carbon black content, %	2,0-3,0*	1,5-3,0

\*Value from manufacturer

**6.10 Shrinkage test for the XLPE-insulation**

According to IEC 60502-2 section 19.16.

	Core 1	Core 2	Core 3	Requirements
Shrinkage, %	1,0	1,25	1,25	$\leq 4$

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**6.11 Shrinkage test for the PVC-oversheath**

According to IEC 60520-2 section 19.20.

Due to that the cable sample was bent, the shrinkage was measured on the inside as well as on the outside of the cable sample.

	Measured value	Requirements
Shrinkage on the inside of the cable sample, %	0,2	≤ 3
Shrinkage on the outside of the cable sample, %	0,8	≤ 3

**6.12 Strippability test for the insulation screen**

According to IEC 60502-2 section 19.21.

**6.12.1 Before ageing**

	Core 1	Core 2	Core 3	Requirements
Adhesion of the insulation screen to the insulation, N	6,9 - 7,4	7,4 - 7,9	6,6 - 7,4	4-45

**6.12.2 After ageing**

	Core 1	Core 2	Core 3	Requirements
Adhesion of the insulation screen to the insulation, N	7,3 - 7,8	7,2 - 7,8	8,2 - 8,6	4-45

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### 6.13 Water penetration test of the conductors

According to IEC 60502-2 section 19.22.

#### F.3 Requirements

During the period of testing no water shall emerge from the ends of the test piece.

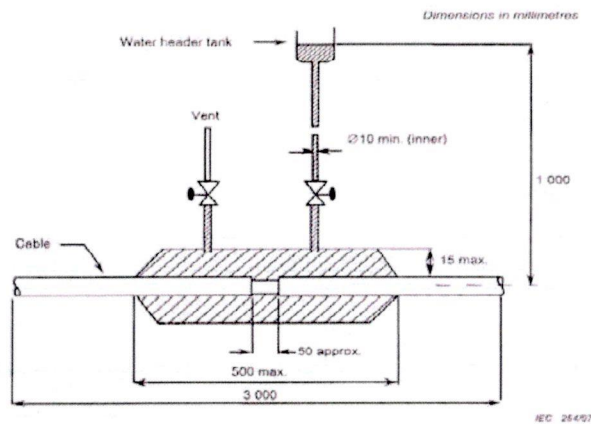


Figure F.1 – Schematic diagram of apparatus for water penetration test

The test assembly was mounted in such a way that the relevant interstices were readily exposed to the water. Water was filled into the assembly so that the opening in the test piece was subjected to water with a pressure head of 1 meter. The cable was kept so for 24 hours.

Subsequently the test piece was subjected to 10 complete heating cycles. The heating period was 8 hours followed by 4 hours of natural cooling.

The conductor temperature was raised to a value of 95°C.

During the test no water is allowed to emerge from the ends of the cable. After 10 cycles no water had emerged from the ends of the test cable.

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## USED INSTRUMENTS

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No	Instrument
1	Automatic measure machine, KSM
2	Die Elastocon EP 04/ISO 37-2
3	Equipment for pressure test
4	Equipment for pressure test
5	Equipment for pressure test
6	Fiber Thermometer
7	Heating chamber, Elastocon EB04
8	Heating chamber, Elastocon EB10
9	Heating chamber, Elastocon EB10
10	Heating chamber, Elastocon EB10
11	Heating chamber, Elastocon EB10
12	Heating chamber, Elastocon EB10
13	Heating chamber, Memmert UE 500
14	Hounsfield test equipment
15	HV Series Resonant Test System
16	Measure ruler
17	Measure ruler
18	Measure tape, T.A. Ljungberg 2m
19	Micro ohmmeter, Tettex AG
20	Micrometer, Mitutoyo 0-25 mm
21	Miniature Discharge Simulator
22	Oscilloscope
23	Peak Voltmeter
24	Precisa weighing machine
25	Pulse Discrimination unit
26	Recorder
27	Recorder

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Instrument	
28	Schering Bridge
29	Set of weights for pressure test
30	Set of weights for pressure test
31	Set of weights for pressure test
32	Set of weights to hot set
33	Sliding Divider
34	Timer
35	Timer
36	Vacuum drying oven, Binder VD53
37	Voltage Divider



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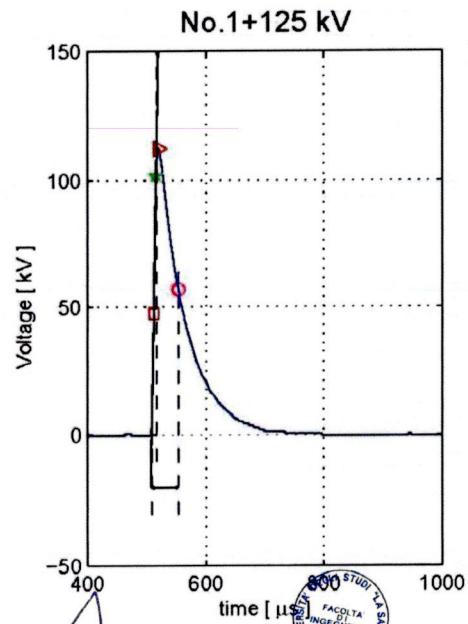
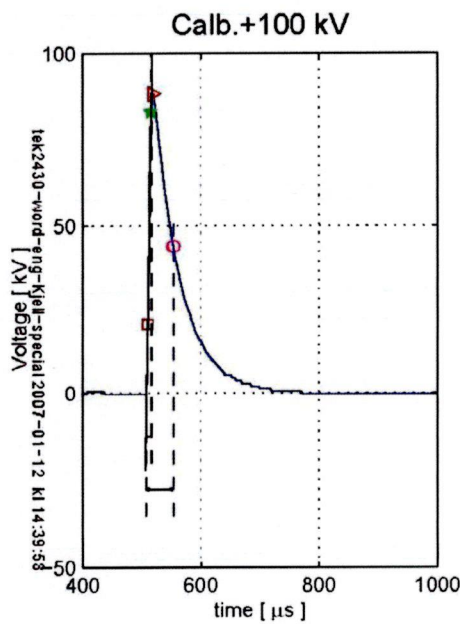
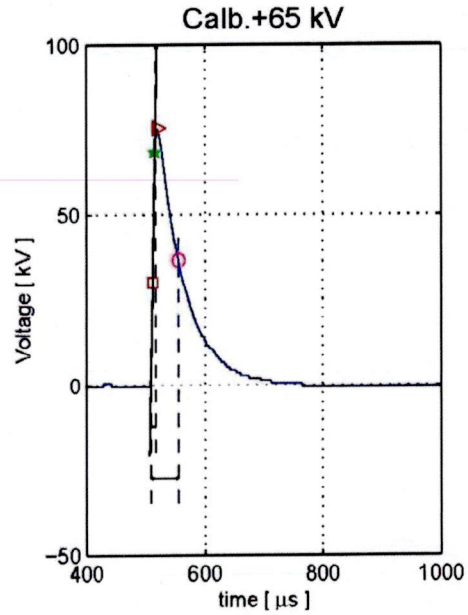
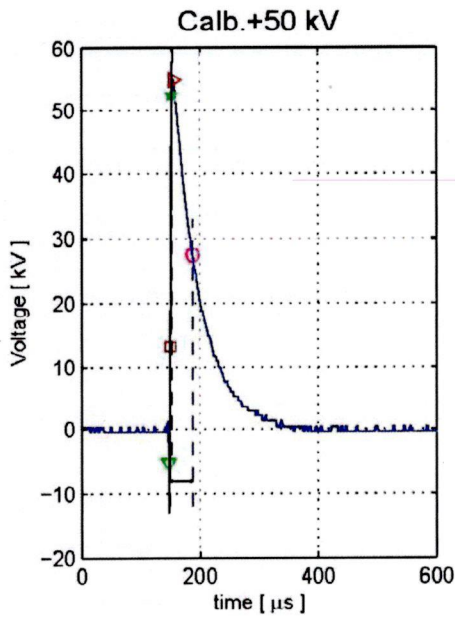
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8 APPENDIX

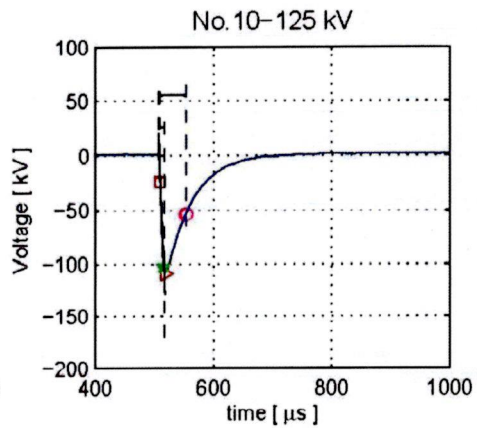
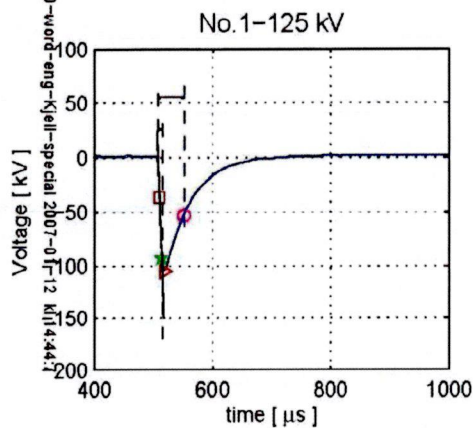
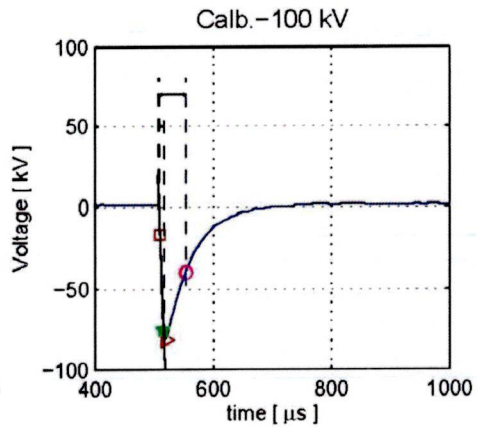
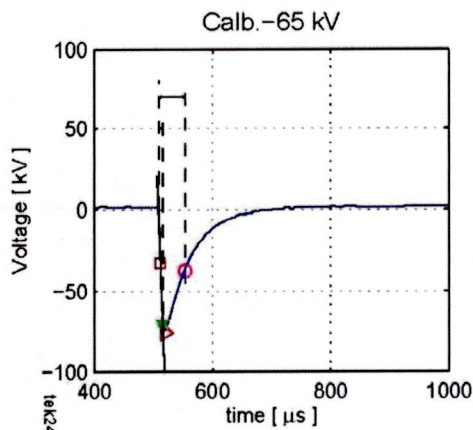
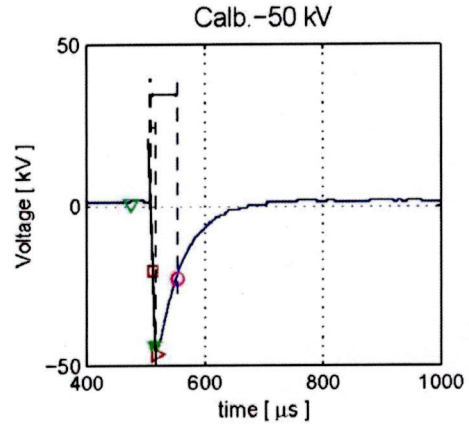
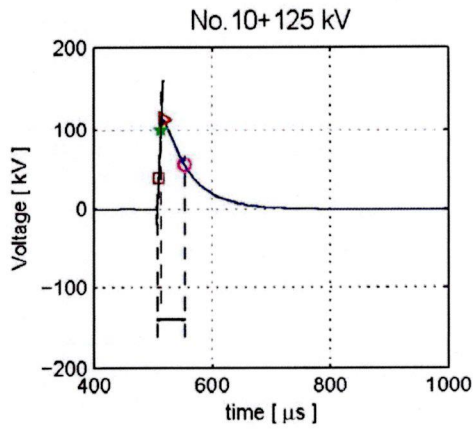


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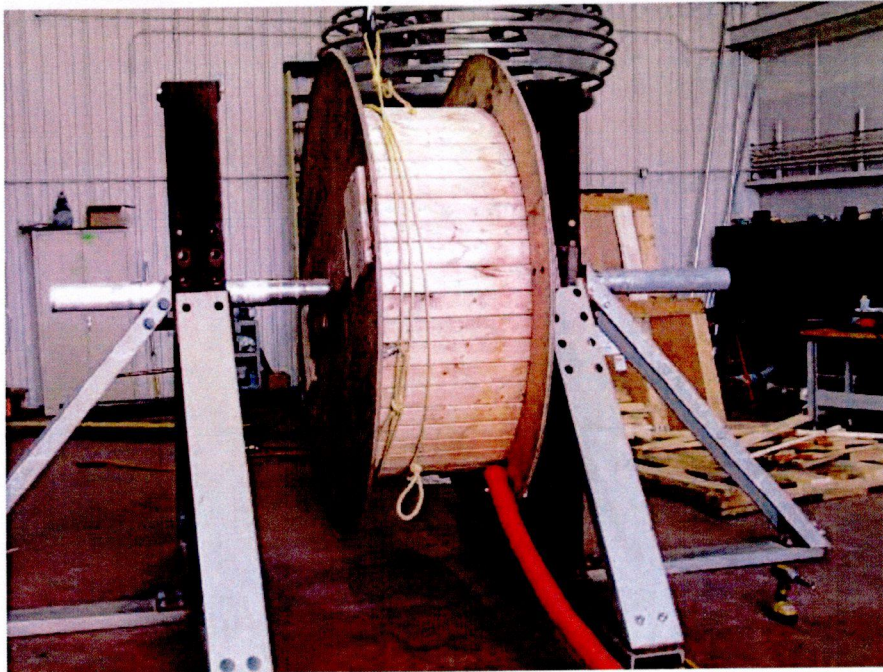
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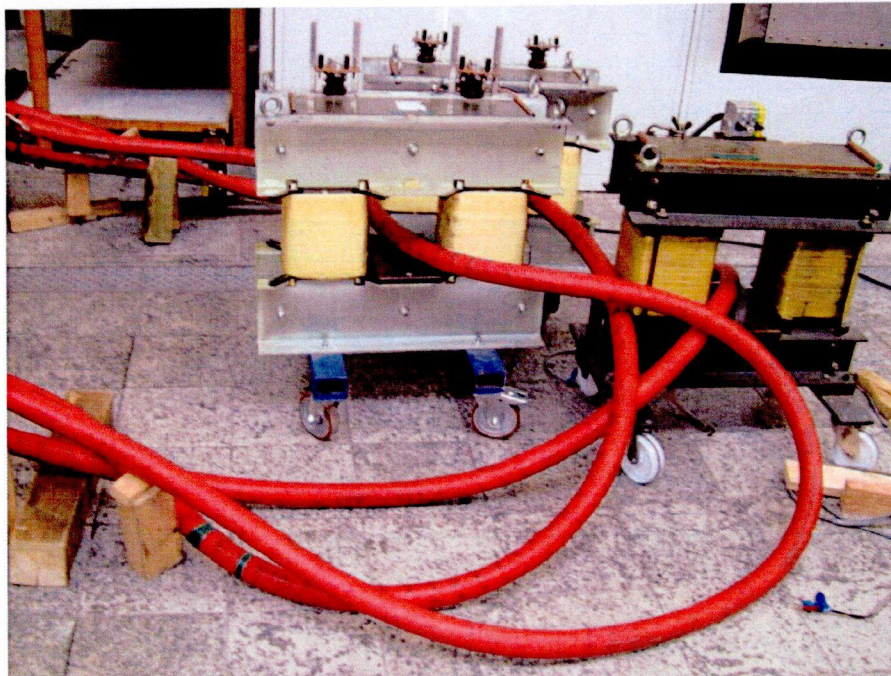
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Setup of Bending Test

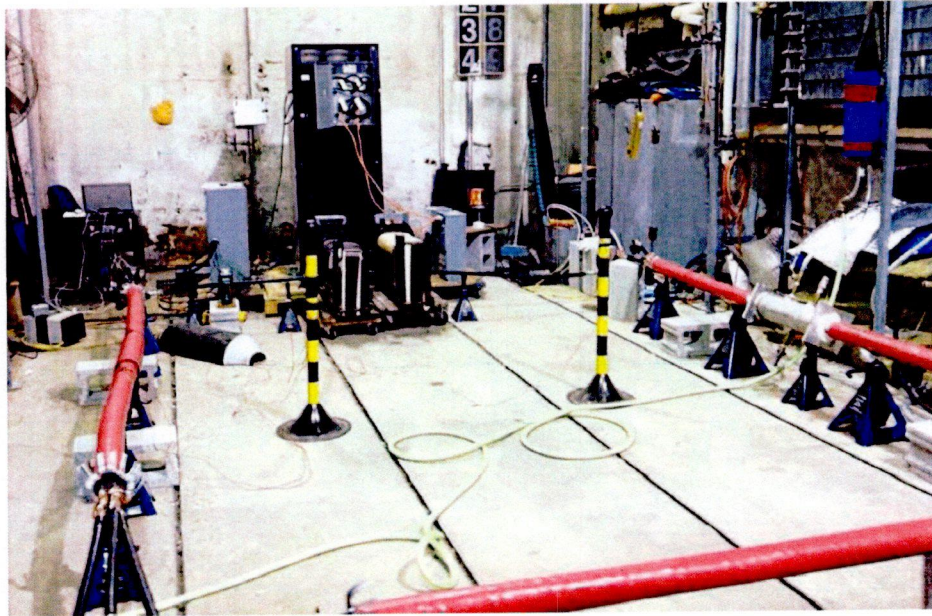


During Heat cycles Tests

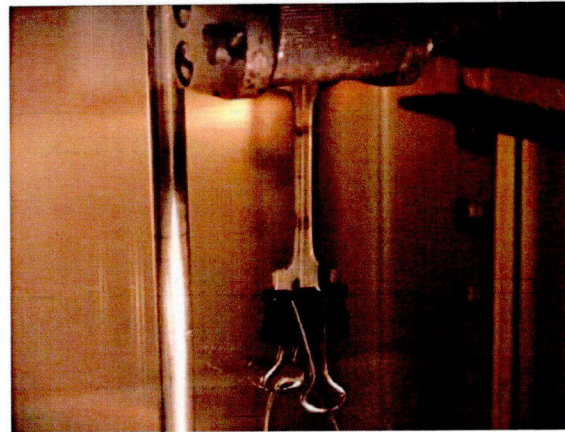
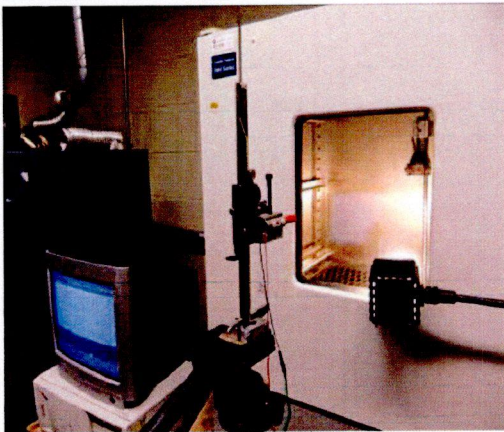




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Water Penetration Test



Hot Set Test

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**TECHNICAL INFORMATION**

<b>Manufactured by</b>	<b>Medcables / Tefhahta</b>
<b>Country</b>	<b>Lebanon</b>

**AL / S.C. / XLPE / S.C. / CuT / P.V.C. / STAP.V.C**

<b>Applicable standard</b>	<b>IEC 60502 - 2</b>
<b>Medium voltage</b>	<b>M5AX2B</b>

**WEIGHT & DIMENSIONAL DATA**

<b>Section</b>	<b>mm<sup>2</sup></b>	<b>3 x 240</b>
<b>Rated voltage</b>		12/20 kv (24) kv
<b>Conductor</b>	<b>mm<sup>2</sup></b>	240
<b>Conductor screen</b>		Semi conductor extruded bonded
<b>Conductor screen Thickness</b>	mm	0,5
<b>Insulation</b>	mm	XLPE cross linking extruded
<b>Insulation Thickness</b>	mm	5,5
<b>Insulation screen</b>		Strippable semiconducting material
<b>Insulation screen Thickness</b>	mm	0,5
<b>Metallic Screen cross section 32</b>	mm <sup>2</sup>	(40 x 0.1) 2 copper tape
<b>Bedding Diameter</b>	mm	77,44
<b>Inner bedding Thickness</b>	mm	2.15 P.V.C.
<b>Armouring</b>		(50 x 0.5) 2 Glvanized steel tape
<b>Approx. Overall Diameter ± 8 %</b>	mm	89,2
<b>Approx weight</b>	kg/km	7720
<b>Outer sheath material</b>		P.V.C.
<b>Outer sheath Thickness</b>	mm	3,9
<b>Outer sheath Color</b>		RED
<b>Marking</b>		Ink jet printing

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Mediterranean cables company, Tefhahta - Zahrani, Lebanon

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AL / S.C. / XLPE / S.C. / CuT / P.V.C. / STAP.V.C

M5AX2B 3x240mm<sup>2</sup> AL

## Electrical data

DC resistance	at 20C °	Ω / km	0,125
	at 90C °	Ω / km	0,159
Inductance		mH / km	0,335
Capacitance		μF / km	0,3
Reactance		Ω / km	0,05
Voltage Drop per phase		V/A.km	0,231
Adiabatic Short Circuit current of conductor (1s) = 22.6 K A			
Adiabatic Short circuit current of screen (1s) = 5.1 K A			
Continuous Current Rating AIR Laying = 454 Amp			
Continuous Current Rating GROUND laying = 413 Amp			
PACKING			
Length on drum		m	250
Drum size (Wood)		mm	2 200
Maximum Bending Radius			8 x Da

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