RESEARCH DEVELOPMENT AND TESTING NATIONAL INSTITUTE FOR ELECTRICAL ENGINEERING

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acreditat pentru ÎNCERCARE
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SR EN ISO/CEI 17025:2005
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TEST REPORT
No. 43634 / 09.01.2013

1.CUSTOMER: SCHIRTEC AG
Ignaz – Köck Strasse 10 A – 1210 Wien, Austria

2.MANUFACTURER: SCHIRTEC AG
Ignaz – Köck Strasse 10 A – 1210 Wien, Austria

3. TESTED PRODUCT: Early Streamer Emission (E.S.E.) Lightning Conductor type

SCHIRTEC – DA (S - DA)

4. REFERENCE STANDARD: NFC 17-102 : 2011, Annex C
UNE 21186 : 1996 / 1M: 2009, Anexo C

5. TEST PERFORMED: - Determination of the initiation advance of the E.S.E. lightning conductor

6. TEST DATE: 09.01.2013

7. TEST RESULTS: There are presented the measurements results.

8. The report contains: 14 pages

9. The test report is edited in 4 copies, copy no.1 remain in laboratory and copies 2, 3 and 4 are sent to the customer.

HEAD OF HV DIVISION
Eng. PĂTRU Ion

ICMET DIVIZIA DE ÎNALTĂ TENSIUNE CRAIOVA

HEAD OF HV LABORATORY
Eng. BADEA Ion

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2. *Publication or reproduction of the contents of this report in any other form unless its complete photocopying is not allowed without writing approval of Division to which laboratory belongs.*
3. *All signatures of the present report are original ones.*

Content **page**

- Identification of the test product 3
- Tests program 3
- Responsible for tests 3
- Opinions and interpretation (if necessary) 3
- Present at the tests 3
- Tested material 4
- Type of tests 4
- Specification 3
- Test equipment 4
- Test circuit 4
- Mounting arrangement 5
- Test procedure 5
- Test on SRLC before and after test of ESELC type SCHIRTEC – DA 6
- Test on ESELC type SCHIRTEC – DA 7
- Table with measuring results on SRLC before and after test on ESELC 8
- Table with measuring results on ESELC type SCHIRTEC – DA 9
- Experimental wave 10
- Photos 11
- Test circuit diagram 12
- Test set-up on early streamer 13
- Lightning protection type SCHIRTEC – DA - technical drawing 14

1. Identification of the test product:

Type: SCHIRTEC – DA

Serial / year: - / -

Technical Specification / Drawing: - / SCH.103

Contract // Test order: 7946 / 20.09.2012 // 22016 / 03.10.2012

Product receiving date: 07.01.2013

Product condition at receiving: New

2. Test program: - Determination of the initiation advance of the E.S.E. lightning conductor

3. Responsible for tests: Eng. M. Boruz

4. Opinions and interpretation (if necessary):

5. Present at the test:

1. Tested material

Early Streamer Emission (E.S.E.) Lightning Conductor type SCHIRTEC – DA.
See photo on page 11 and drawing on page 13.

2. Type of tests

A switching impulse and a DC voltage both having negative polarity were applied on the upper metallic plane.

3. Specification

NFC 17-102 : 2011, Annex C
UNE 21186 : 1996 / 1M: 2009, Anexo C

4. Test equipment

Laboratory inner dimensions: 48 m x 32 m x 27 m (height)

Altitude:	100 m above sea level
4200 kV	High Voltage Impulse Generator type SPF 340; 340 kWs, TUR Dresden - Germany
1000 kV	Rectifier cascade type GS 1000 / 30; 30 mA; TUR Dresden – Germany
1400 kV	Damped capacitive divider, ICMET Craiova, Romania;
TR – AS	Transient – Recorder, Dr.Strauss System Electronik, GmbH- Germany
Keithley	Digital multimeter, serial no. 1070037 – USA.

5. Test circuit

See the test circuit diagram on page 12.
The measuring system consists of:

- 1400 kV damped capacitive divider, calibration certificate no. 223 / 2010-05 DKD – K – 18701;
- Transient recorder, TR-AS 100-10/4 calibration certificate no. 633 D – K – 15205-01-00 / 2012.05;
- DC measuring system that consists of DC resistive divider and digital multimeter type Keithley, calibration certificate no. 211 / 2010-06 DKD – K – 18701.

Expanded uncertainty of measurements parameter inside of limits, prescribed by IEC 60060 – 2 / 2010 for SI Approved Measuring Systems (3 % for peak values and 10 % for time parameters).

6. Mounting arrangement

See the test set up on page 13
See photo on the pages 11

The tested lightning conductor is set on a 5 x 5 m grounded metallic plane and connected to ground.
A square metallic plane dimensions: 4.5 m / 4.5 m / 0.2 m with the edges rounded, is suspended above the lightning conductor and connected to the high voltage.

7. Test procedure

A DC voltage was applied on the upper square metallic plane for polarization.
The negative impulse wave was adjusted to obtain a flashover.
The height of the lightning conductor (h) and the distance between the ground and the square plane (H) were measured at the beginning of each test.
The atmospheric conditions were taken before and after each test.
The peak value (Up) of the impulses and the triggering time (T_B) were recorded for each impulse.
One hundred significant impulses were applied on the lightning conductor.
The early streamer emission lightning conductor (ESELC) was compared with a simple rod lightning conductor (SRLC).
Tests were performed in the same conditions and configuration for each lightning conductor: ESELC and SRLC.
The test on SRLC (100 significant impulses) was performed in two series and circled by the test on the ESELC.

Height of lightning conductor (h) adjusted to:	1327 mm
Distance between ground / square plane (H) adjusted to:	2710 mm
h / H:	0.490
Polarization voltage:	55 kV
Peak time / Rise time of the full wave:	480 µs / 253 µs
Time interval between consecutive impulses:	2 min

8. TEST ON SRLC BEFORE AND AFTER TEST OF ESELC type SCHIRTEC – DA

8.1. Test date: 09.01.2013

8.2. Atmospheric conditions

	FIRST SERIES	SECOND SERIES
BEFORE TEST	p = 1000 mb t = 10.9 ^{0}C hr = 61 %	p = 999 mb t = 10.2 ^{0}C hr = 62.9 %
AFTER TEST	p = 999 mb t = 10.8 ^{0}C hr = 62.2 %	p= 999 mb t = 10 ^{0}C hr = 63 %

8.3. Results

See tables from page 8

Number of significant impulses: 100

Average of significant T_B:

- calculated from the experimental wave T'_{PTS} = 322.2 µs Stdev: 18.03 %
- transferred on the reference waveform: T_{PTS} = 447.57 µs

See curves from page 10

9. TEST ON ESELC type SCHIRTEC – DA

9.1. Reception date: 07.01.2013

9.2. Test date: 09.01.2013

9.3. Atmospheric conditions

BEFORE TEST	p = 999 mb t = 10.7 ^{0}C hr = 63 %
AFTER TEST	p= 999 mb t = 10.5 ^{0}C hr = 63 %

9.4. Results

See tables from page 9

Number of significant impulses: 100

Average of significant T_B:

- calculated from the experimental wave T'_{PDA}= 263 µs Stdev: 13.01 %
- transferred on the reference waveform: T_{PDA} = 374.2 µs

See curves from page 10

Measuring uncertainty for ΔT is 5.7 %.
The uncertainty stated is the expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. The value of measurand lies within the assigned range of values with probability of 95 %.

Triggering advance: $\Delta T = T_{PTS} - T_{PDA} = 447.57 - 374.2 = 73.37$ µs ± 4.18 µs

Test on SRLC before and after test on ESELC type SCHIRTEC – DA

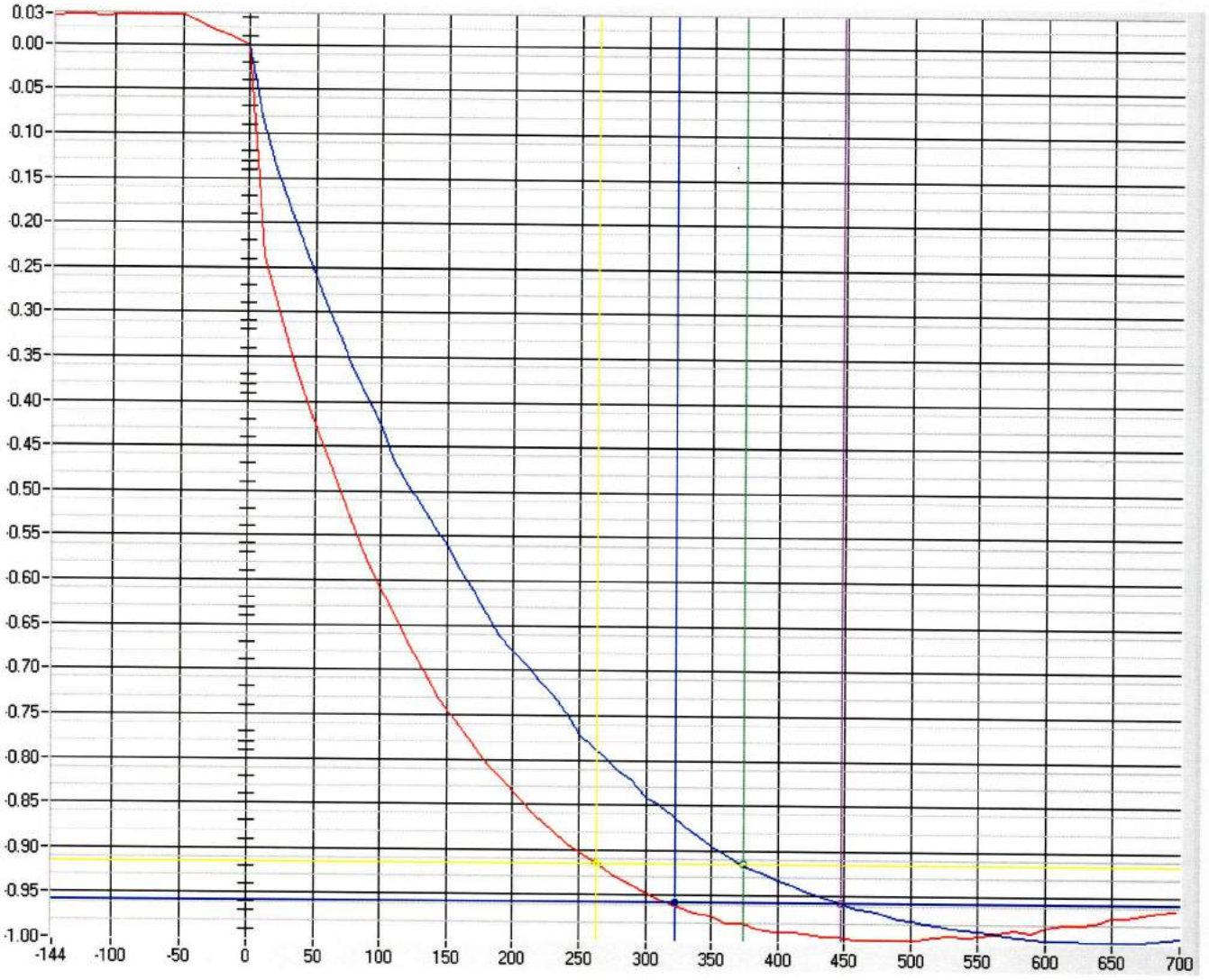
Impulse no.	T_B µs	Impulse no.	T_B µs	Impulse no.	T_B µs
1	300	41	342	80	350
2	286	42	371	81	344
3	281	43	284	82	347
4	274	44	380	83	305
5	334	45	314	84	252
6	298	46	335	85	306
7	458	47	251	86	268
8	529	48	263	87	357
9	395	49	269	88	275
10	526	50	284	89	255
11	330	Second	series	90	354
12	314	51	298	91	333
13	421	52	426	92	275
14	259	53	351	93	329
15	300	54	314	94	311
16	300	55	301	95	257
17	257	56	303	96	332
18	263	57	275	97	310
19	370	58	298	98	346
20	279	59	359	99	400
21	313	60	294	100	210
22	335	61	316		
23	249	62	407		
24	291	63	266		
25	413	64	250		
26	328	65	342		
27	298	66	296		
28	296	67	381		
29	319	68	394		
30	299	69	298		
31	268	70	319		
32	358	71	332		
33	243	72	361		
34	314	73	325		
35	426	74	312		
36	258	75	362		
37	340	76	346		
38	246	77	407		
39	429	78	271		
40	239	79	371		

T_B : Break-down time

Test on ESELC type SCHIRTEC – DA

Impulse no.	T_B µs	Impulse no.	T_B µs	Impulse no.	T_B µs
1	268	41	215	80	251
2	271	42	231	81	341
3	234	43	250	82	270
4	240	44	317	83	306
5	249	45	289	84	260
6	283	46	241	85	285
7	297	47	279	86	250
8	210	48	250	87	241
9	287	49	381	88	274
10	271	50	271	89	255
11	307	Second	series	90	267
12	271	51	275	91	250
13	265	52	222	92	275
14	248	53	261	93	245
15	340	54	247	94	247
16	261	55	232	95	250
17	257	56	210	96	267
18	266	57	212	97	262
19	211	58	202	98	263
20	217	59	279	99	287
21	266	60	241	100	280
22	254	61	200		
23	362	62	269		
24	234	63	298		
25	284	64	233		
26	291	65	287		
27	321	66	241		
28	261	67	237		
29	303	68	263		
30	269	69	226		
31	321	70	257		
32	250	71	318		
33	242	72	256		
34	218	73	225		
35	241	74	241		
36	231	75	238		
37	324	76	280		
38	250	77	276		
39	207	78	271		
40	317	79	254		

T_B : Break-down time



Where:

- On OX axes there is represented time in μs;
- On OY axes there is represented amplitude U / U_{peak};
- Red line is the experimental wave form;
- Blue line represents the standard waveform.

T'_{PTS} = 322.2 μs
T'_{PDA} = 263 μs
T_{PTS} = 444.57 μs
T_{PDA} = 374.2 μs
$\Delta T = T_{PTS} - T_{PDA}$ = 73.37 μs

Photo 1

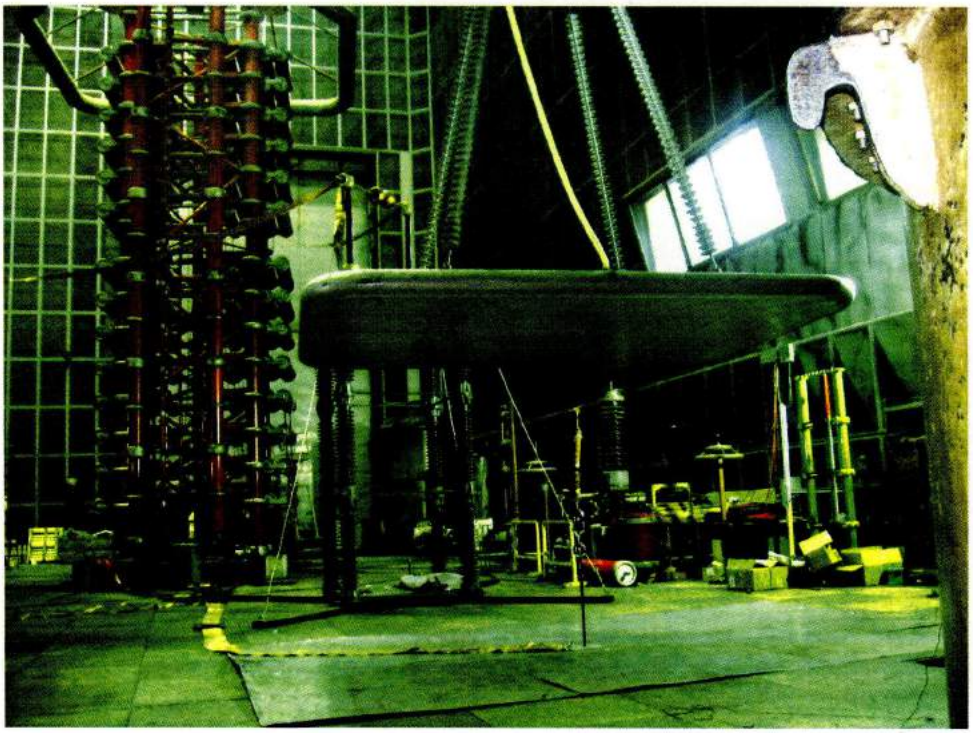
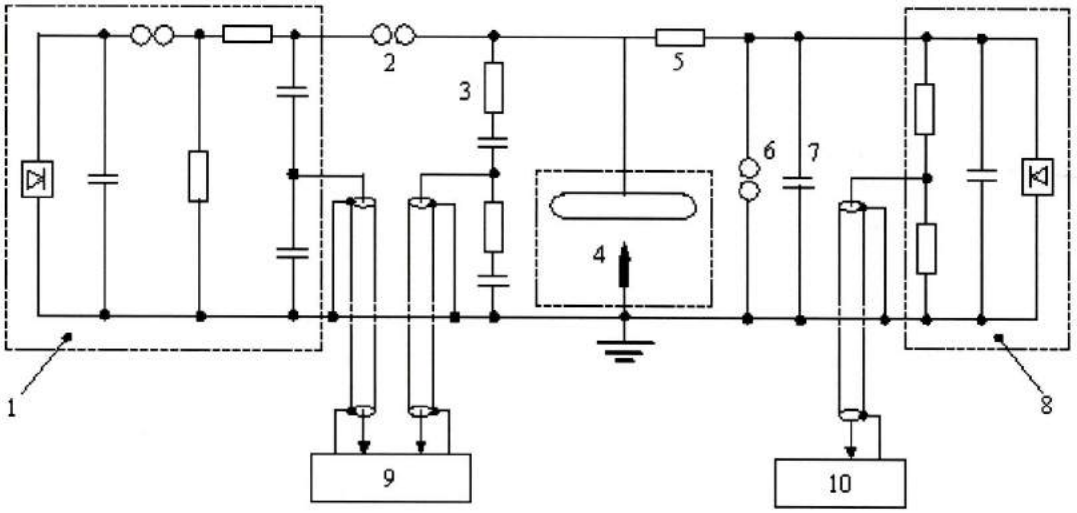


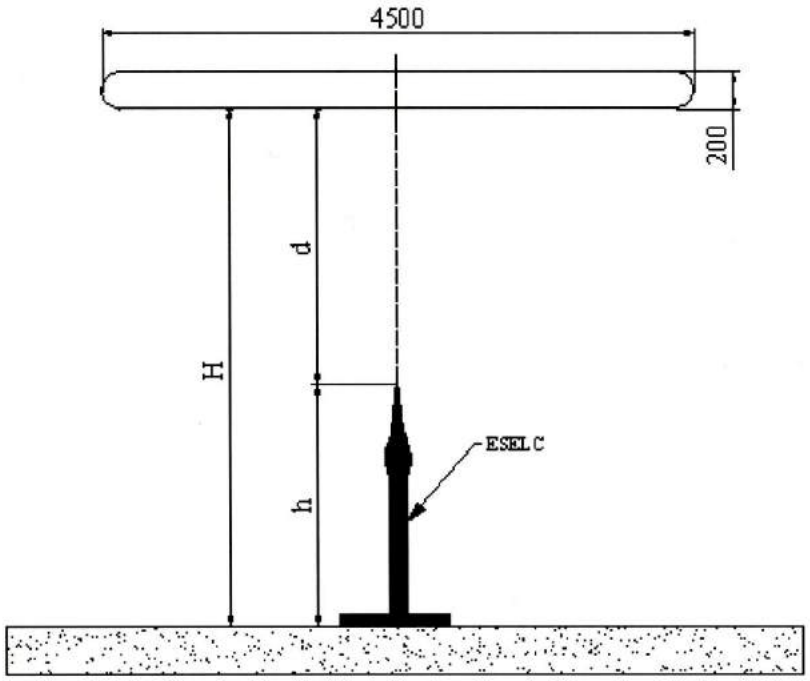
Photo 2

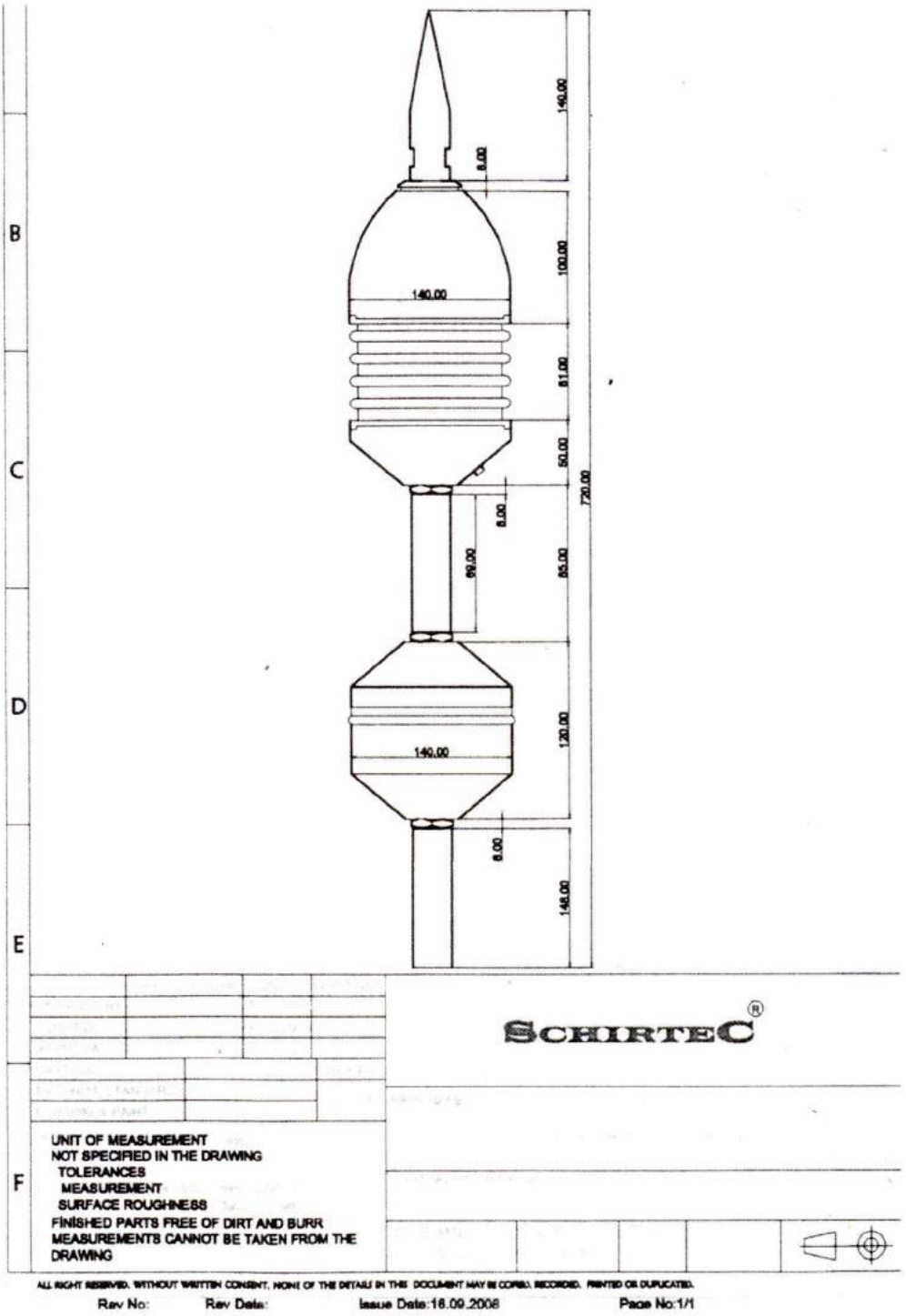
Test circuit diagram on lightning conductor



1 - HV Impulse Generator 4.2MV-336kWs
2 - Serial protective gap, Φ=250mm
3 - Damped resistive-capacitive divider, 1400 kV
4 - Test configuration
5 - Resistance 2MΩ
6 - Parallel protective gap, Φ=500mm
7 - Capacitor 4.5nF
8 - Rectifier cascade GS 1000/30
9 - Transient recorder TR-AS 100-10
10 - Digital multimeter KETHLEY serial no.1070037

TEST SET UP ON EARLY STREAMER
EMISSION LIGHTNING CONDUCTOR





Rev No: Rev Date: Issue Date:16.09.2008 Page No:1/1