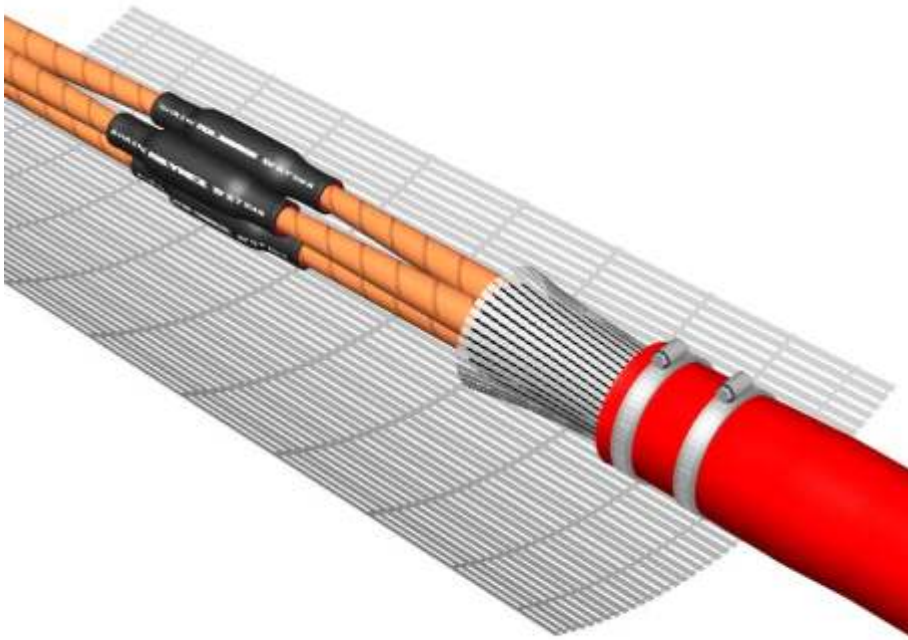


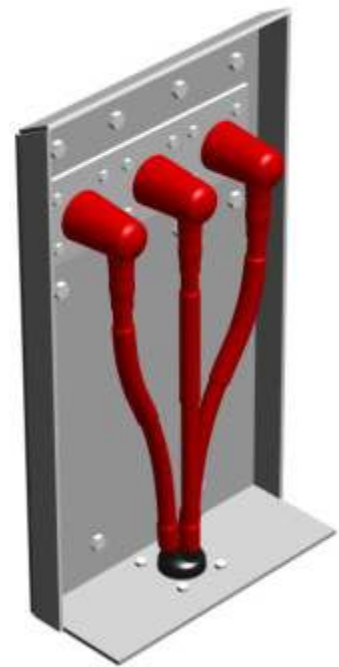
ASTA

TEST REPORT

NO: 2212



UNIVERSAL 12kV HEATSHRINK JOINT
TO SUIT 3 CORE XLPE / PILC CABLES
INLINE OR TRANSITION



HEATSHRINK TERMINATIONS
3 CORE 12kV PILC AND XLPE



SHRINK
POLYMER
SYSTEMS

ASTA TEST REPORT

Laboratory Ref. No. AR/L/06/21

Test Report No. 2212

APPARATUS: 12kV 3-core 95mm² 8m length indoor cable fitted with a universal straight joint and PILC (impregnated paper) terminations on one end and XLPE (polymeric) terminations at the other end.

DESIGNATIONS: 5PUJ 12U-95-185-3
3TIS-12P-C
3TIS-12X-C

MANUFACTURER: Shrink Polymer Systems, Unit P1-P3 Grovemere Court, Bicton Industrial Park, Kimbolton, Cambs, England, UK

TESTED FOR: Shrink Polymer Systems, Unit P1-P3 Grovemere Court, Bicton Industrial Park, Kimbolton, Cambs, England, UK.

TESTED BY: The Tony Davis High Voltage Laboratory, Building 20, Highfield Campus, University Road, University of Southampton.

DATE(S) OF TESTS: December 2005 – March 2006

The apparatus, constructed in accordance with the description, drawings and photographs attached hereto, has been examined and tested in accordance with client's instructions and :-

BS 7888 – 4.2 : 1998, Table 1 (Test Sequence A1) & Table 3 (Test Sequence B1)

TESTS

Tests on a length of INDOOR insulated cable with a universal straight transition joint & terminations
Tests from BS 7888-4.2, Table 1 – for indoor terminations
Tests from BS 7888-4.2, Table 3 – for universal transition joints

This is not a certificate of rating. A certificate of rating was not issued as part of the tests were made in accordance with client's instructions.

The documents forming part of this Test Report are :-

- (1) Record of Proving Tests Page Nos. 1 to 6
- (2) Diagram Nos. TLAB/05/11a.
- (3) Oscillogram Nos. Fig 1, Fig. 2, Fig. 3, Fig. 4, TN051209/D1-D6, TN060321/D1-D6
- (4) Drawing Nos. System A54 Pg 1-Pg 7, System A56 Pg 1-Pg 8, System A171 Pg 1-Pg 10
- (5) Photograph Nos. P/06/69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79 & 80

The Record of Proving Tests applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designation with that tested rests with the Manufacturer.

Abdul Majid ASTA Observer
Abdul Majid
C. Mick-Lewis DIRECTOR

16th October 2006 Date

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Apparatus Tested	Page 2
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DIAGRAMS

TLAB/05/11a Typical test circuit for impulse tests

OSCILLOGRAMS

Fig. 1 Calibration / Thermal Cycle
 Fig. 2 Elevated temperature of the external surface during lightning impulse tests
 Fig. 3 Electrical heat cycles in AIR
 Fig. 4 Electrical heat cycles in WATER
 TN051209/D1–D6 Lightning impulse voltage tests at elevated temperature (showing 1st & 10th impulse)
 TN060321/D1–D6 Lightning impulse voltage tests at ambient temperature (showing 1st & 10th impulse)

DRAWINGS

Drawing No.	Issue Status	Description
System A54 Pg 1-Pg 7	Rev.-, dated 27-07-06	Installation Instruction. Heatshrink Terminations for 3 Core Polymeric Cables 7.2kV to 36kV
System A56 Pg 1-Pg 8	Rev.-, dated 27-07-06	Installation Instruction. Heatshrink Terminations for 3 Core PILC Belted / Screened Cables 12kV
System A171 Pg 1-Pg 10	Rev.-, dated 27-07-06	Installation Instruction. Heatshrink Uniset Resin Joint to Suit 3 Core 12kV PILC / SWA PICAS or XLPE / SWA Cables Inline or Transition. Reference Type : SPUJ 12U

PHOTOGRAPHS

P/06/69 View of cables during thermal CALIBRATION tests
 P/06/70 View of cable during DC & AC tests at ambient temperature
 P/06/71 View of cable after lightning impulse voltage tests at elevated temperature
 P/06/72 View of cable inside a large duct during electrical heat cycling tests in air & water
 P/06/73 View of cable inside a large duct during electrical heat cycling tests in water
 P/06/74 View of cable during DC, AC, lightning impulse & AC voltage tests at ambient temperature
 P/06/75 View of transition joint cable during final examinations (showing being cut with bandsaw)
 P/06/76 View of transition joint cable during final examinations (showing section cut)
 P/06/77 View of transition joint cable during final examinations (showing sections of both extruded XLPE insulation and paper PILC insulation–laid out for inspection)
 P/06/78 View of transition joint cable showing a 45° cut section in extruded XLPE insulation.
 (no ingress of moisture detected)
 P/06/79 View of transition joint cable showing a 45° cut section in paper PILC insulation.
 (no ingress of moisture detected)
 P/06/80 View of paper PILC insulation section showing samples of paper flakes immersed in cable oil at 135° C (no froth observed–indicating no ingress of moisture)

This is not a Certificate of Rating

Laboratory Reference No. AR/L/06/21
Client's Ref. No. Q2005/242

Date of Tests December 2005 – March 2006

1. Apparatus Tested

12kV 3-core 95mm² 8m length indoor cable fitted with a universal straight joint and PILC (impregnated paper) terminations on one end and XLPE (polymeric) terminations at the other end.

Transition joint – connecting extruded (XLPE) insulation cable to impregnated paper (PILC) insulated cable

U₀ = 6.35kV – the rated power frequency voltage between conductor and earth

U_m = 12kV – the maximum value of the highest system voltage for which the cable accessory may be used

The apparatus under test was constructed in accordance with the installation instructions listed on page 1

2. Test Specification

The tests were made to client's instructions and generally in accordance with :

BS 7888 – 4.2 : 1998, Table 1 (Test Sequence A1) & Table 3 (Test Sequence B1)

3. Test Arrangements

Due to laboratory limitations testing of cables were conducted at Southampton University and were witnessed by Mr Abdul Majid, NaREC Testing Authority Observer.

Calibration of test cable conductor temperature

To determine cable conductor temperature, a temperature calibration test was made in accordance with BS 7888–2, Annex B.2, by direct injection of a given current.

Thermocouples were used to measure the cable inner conductor and external surface temperatures in accordance with BS 7888–2, Annex B, Figures B.1 & B.2.

The cable was heated until the cable conductor temperature reached the maximum rated conductor temperature as specified in BS 7888–3, Table 1 for impregnated paper (80°C+ 0K–5K).

The heating continued until the conductor and external surface temperatures had stabilised and did not show any variation greater than 2K within a 2hr period.

The corresponding external cable surface temperature (measured) was used during the elevated temperature tests.

Fig. 1 – Calibration / thermal cycle

Fig. 2 – Elevated temperature of the external surface during lightning impulse tests

Fig. 3 – Electrical heat cycles in Air

Fig. 4 – Electrical heat cycles in Water

Note on electrical heat cycles

Initial 63 cycles were made in AIR on both terminations and universal straight joint. Then a further 63 cycles were made with terminations being in AIR and universal straight joint in WATER - thus completing the 126 cycles.

Each cycle consisted of an 8-hour duration (Figure 1) in accordance with BS7888–2, sub-clauses 9.1 & 9.2

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4. Tests Made

Tests to BS7888–4.2, Table 1 (indoor terminations for impregnated paper insulated cables - Test Seq. A1)

1. DC dry negative polarity voltage test at –38.1kV for 15 minutes
2. AC dry voltage test at 28.6kV for 5 minutes
3. Ten (positive & negative) lightning impulse voltages at 95kVpk (at elevated temperature)
4. 126 electrical heat cycles in air energised at 9.5kV
5. AC dry voltage test at 19.1kV for 4 hours
9. Ten (positive & negative) lightning impulse voltages at 95kVpk (at ambient temperature)
10. AC dry voltage test at 15.9kV for 15 minutes
12. Examination

Tests to BS7888–4.2, Table 3—Joints & transition joints for impregnated paper insulated cables (Test Seq. B1)

1. DC dry negative polarity voltage test at –38.1kV for 15 minutes
2. AC dry voltage test at 28.6kV for 5 minutes
4. Ten (positive & negative) lightning impulse voltages at 95kVpk (at elevated temperature)
5. 63 electrical heat cycles in air energised at 9.5kV
6. 63 electrical heat cycles in water energised at 9.5kV
7. AC dry voltage test at 15.9kV for 4 hours
11. Ten (positive & negative) lightning impulse voltages at 95kVpk (at ambient temperature)
12. AC dry voltage test at 15.9kV for 15 minutes
13. Examination

5. Test Results

Recorded atmospheric conditions are detailed on Table 1

Results of DC voltage tests are detailed on Table 2

Results of AC voltage tests at 4.5U₀ are detailed on Table 3

Sample of results of cable conductor, external surface and ambient temperature during 2hr stabilization period as detailed in Table 4

Results of lightning impulse voltage tests at elevated temperature are detailed on Table 5

Results of AC voltage tests at 3U₀ are detailed on Table 6

Results of lightning impulse voltage tests at ambient temperature are detailed on Table 7

Results of AC voltage tests at 2.5U₀ are detailed on Table 8

Examination

Visual inspection of encapsulation exposed at the section end of the joints showed no cracks or large voids

45° cut on PILC (paper) end showed no ingress of water on the inside insulation

45° cut on XLPE (polymeric) end showed no ingress of water on the inside insulation

No froth was observed on unrolled insulation paper put into 135°C hot oil, indicating that there was no moisture entered into the paper during the electrical heat cycling in water.

6. Conclusion

The results of the tests show that the MV cable has satisfactorily satisfied the criteria of tests from BS 7888–4.2, Tables 1 & 3

Table 1
Recorded atmospheric conditions

Atmospheric Conditions			
Date of Test(s)	08–12–2005	09–12–2005	20–03–2006
Atmospheric Pressure (millibar)	759.7	775.5	756.7
Ambient Temperature (°C)	16.5	15.0	15.0

Table 2
Results of DC voltage tests at 6U₀

Test Arrangement	DC Test Voltage (kV)	Test Duration (minutes)	Comments	Test Number
HT on commoned phases L1, L2, L3 with cable screen EARTHED	– 38.1	15	Withstand	TN051208/D1

Table 3
Results of AC voltage tests at 4.5U₀

Test Arrangement	Test Voltage (kVrms)	Test Duration (minutes)	Comments	Test Number
L3	28.6	5.0	Withstand	TN051208/D2
L2	28.6	5.0	Withstand	TN051208/D3
L1	28.6	5.0	Withstand	TN051208/D4

Note

HT applied to each phase in turn with the other two phases and screen EARTHED

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Table 4
Sample of results of cable conductor, external surface
and ambient temperature during 2hr stabilization period

Time (seconds)	Conductor Temperature (°C)	External surface Temperature (°C)	Ambient Temperature (°C)
10800	82.13	63.15	15.65
11800	82.09	63.03	16.18
12800	82.29	63.56	15.90
13800	82.40	63.42	15.94
14800	82.16	63.44	16.05
15800	81.41	63.61	16.06
16800	82.34	63.48	16.08
17800	82.28	63.13	16.09
18800	81.80	62.69	16.24

Note:

For the elevated temperature tests, the cable is energised and heated to the stabilized external surface temperature for at least 2hrs (i.e to 63°C) before application lightning impulse tests

Table 5
Results of lightning impulse voltage tests at elevated temperature (63°C)

Test Arrangement	Polarity ±	Applied Test Voltage (kVpk)										Test Number
		1	2	3	4	5	6	7	8	9	10	
L3	—	96.1	96.0	95.2	95.8	94.9	95.2	95.4	95.2	95.6	95.4	TN051209/D1
	+	95.0	94.5	94.8	94.6	95.4	95.5	95.5	95.7	95.6	95.2	TN051209/D2
L2	+	95.0	95.5	95.7	95.6	95.3	95.9	94.5	95.4	95.3	94.7	TN051209/D3
	—	95.1	95.7	95.9	95.7	95.4	95.3	95.4	95.5	95.4	95.6	TN051209/D4
L1	+	95.0	95.5	95.7	95.6	95.3	95.9	94.5	94.4	95.3	94.7	TN051209/D5
	—	94.7	94.5	94.9	95.1	95.2	94.9	95.2	95.3	94.2	95.4	TN051209/D6

This is not a Certificate of Rating

Table 6
Results of AC voltage tests at 3.0U_o

Test Arrangement	Test Voltage (kVrms)	Test Duration (hours)	Comments	Test Number
L1	19.1	4.0	Withstand	TN051208/D4
L2	19.1	4.0	Withstand	TN051208/D5
L3	19.1	4.0	Withstand	TN051208/D6

Note

HT applied to each phase in turn with the other two phases and screen EARTHED

Table 7
Results of lightning impulse voltage tests at ambient temperature (15⁰C)

Test Arrangement	Polarity ±	Applied Test Voltage (kVpk)										Test Number
		1	2	3	4	5	6	7	8	9	10	
L2	—	95.0	95.2	95.4	95.3	95.2	95.1	95.1	95.1	95.2	95.2	TN060321/D1
	+	94.5	94.8	94.8	94.6	95.2	95.1	95.2	94.9	95.0	95.1	TN060321/D2
L1	+	94.7	94.7	94.6	94.7	94.8	94.8	94.7	94.6	94.8	94.6	TN060321/D3
	—	94.6	95.2	95.5	95.7	95.5	95.3	95.3	95.2	95.4	95.3	TN060321/D4
L3	—	95.5	95.4	95.3	95.6	95.4	95.5	95.5	95.2	95.5	95.4	TN060321/D5
	+	94.6	95.0	95.2	94.1	94.8	95.0	94.8	95.4	95.0	95.4	TN060321/D6

Table 8
Results of AC voltage tests at 2.5U_o

Test Arrangement	Test Voltage (kVrms)	Test Duration (minutes)	Comments	Test Number
L1	15.9	15.0	Withstand	TN060321/D7
L2	15.9	15.0	Withstand	TN060321/D8
L3	15.9	15.0	Withstand	TN060321/D9

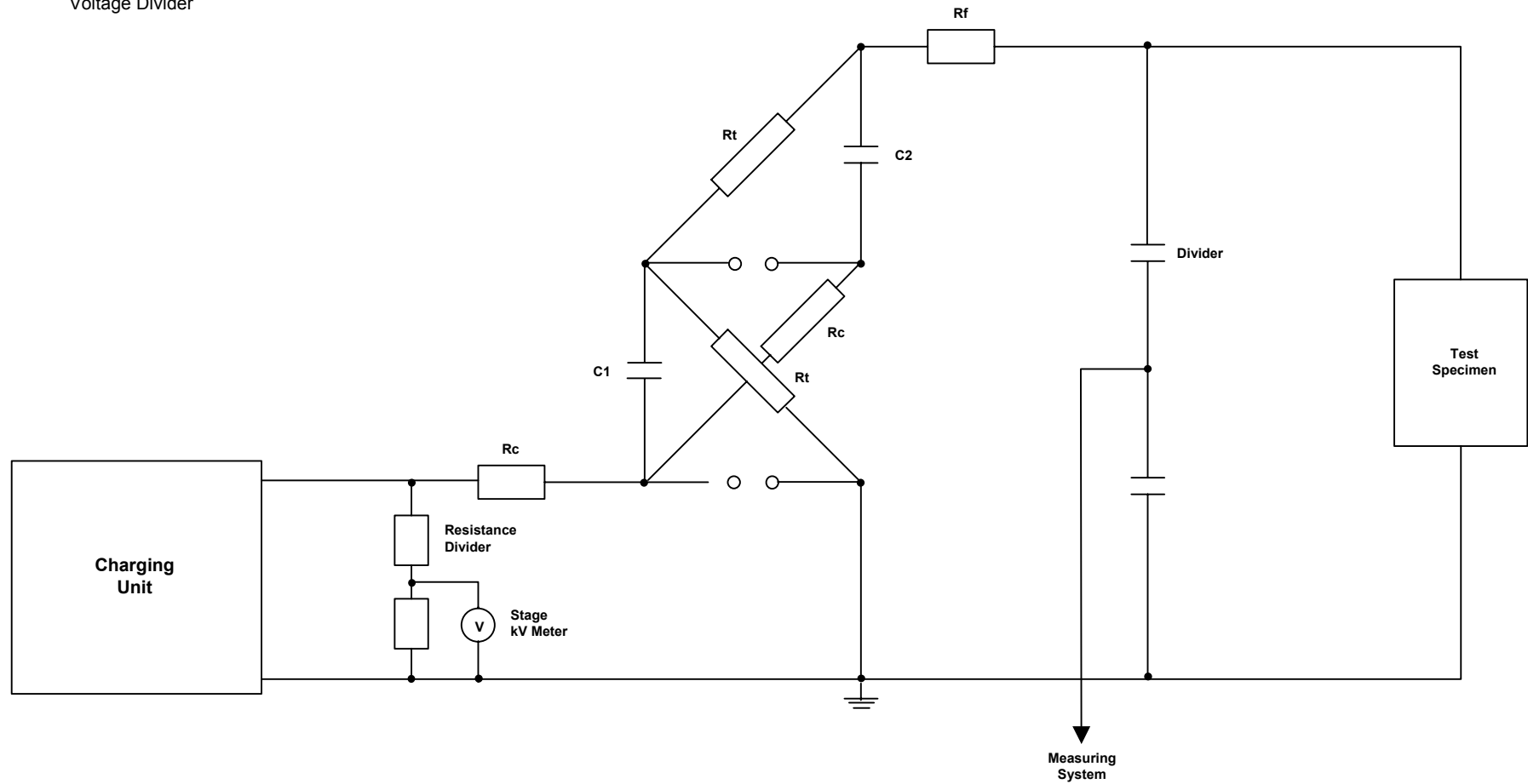
Note

HT applied to each phase in turn with the other two phases and screen EARTHED

This is not a Certificate of Rating

Impulse Generator

Number of Stages - Variable
Stage Capacitors - C1, C2, etc.
Tail Resistors - R_t
Front Resistor - R_f
Charging Resistors - R_c
Voltage Divider



Typical Test Circuit for Impulse Tests

TLAB/05/11a

Calibration / Thermal Cycle

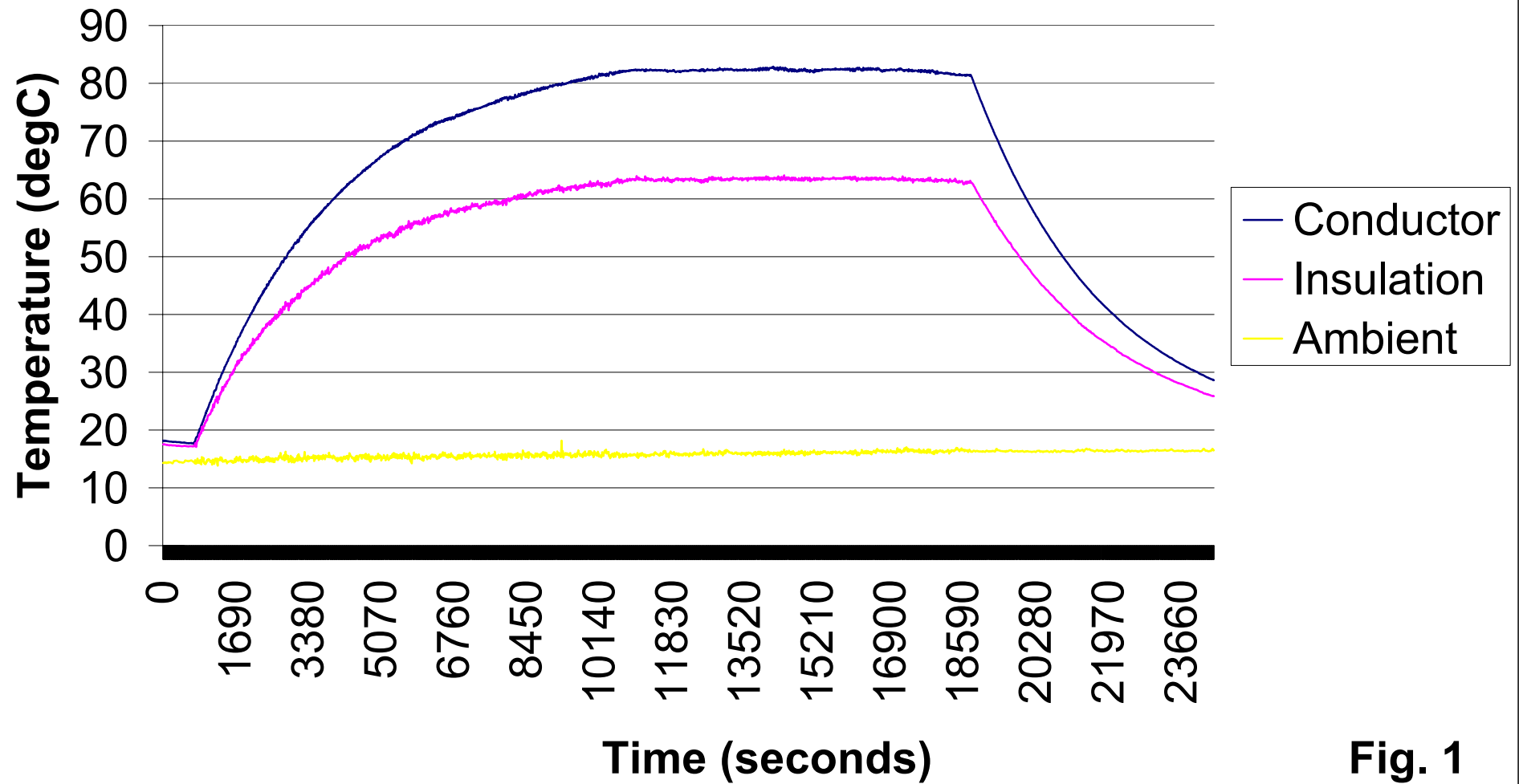


Fig. 1

Elevated temperature of the external surface during lightning impulse tests

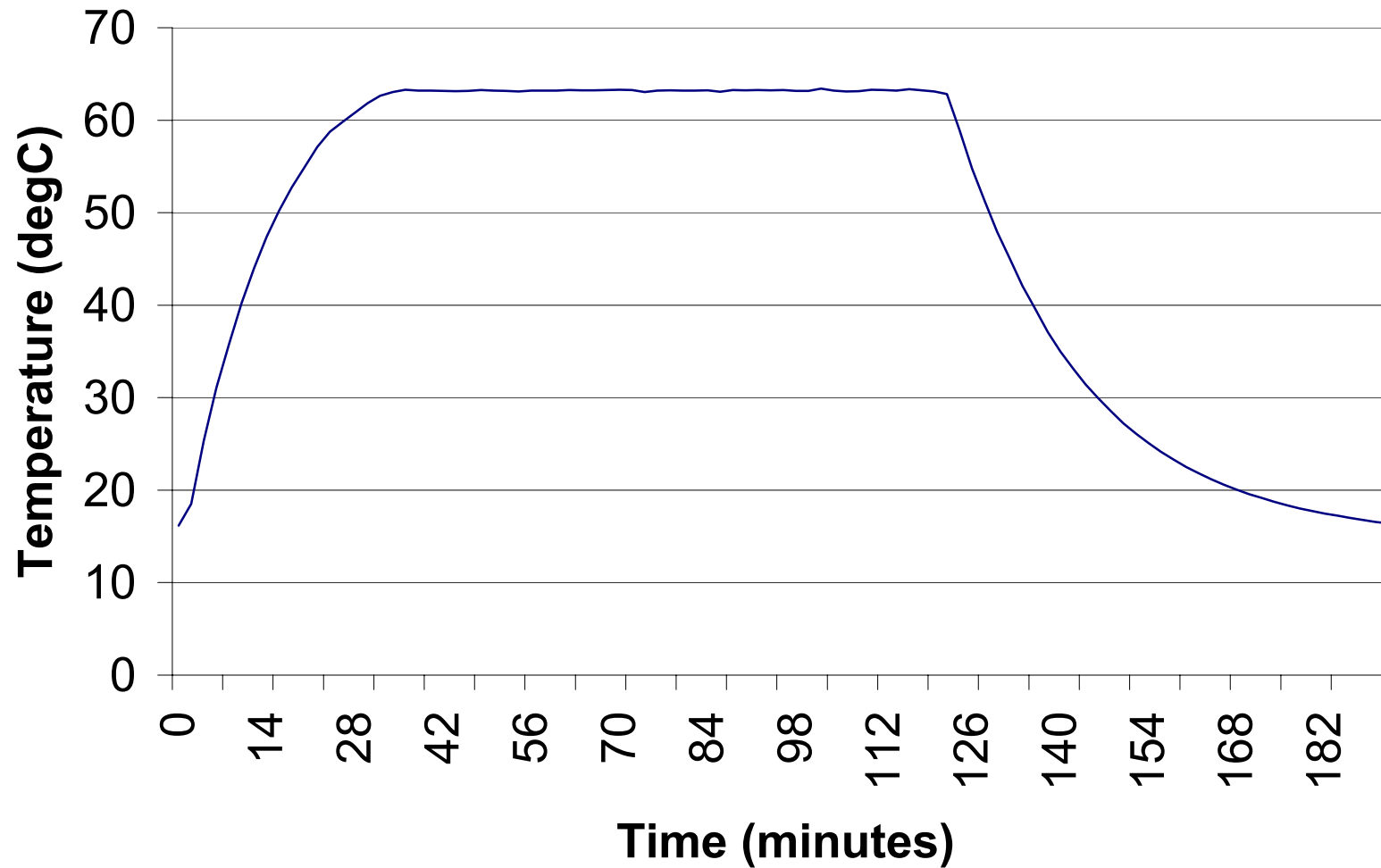
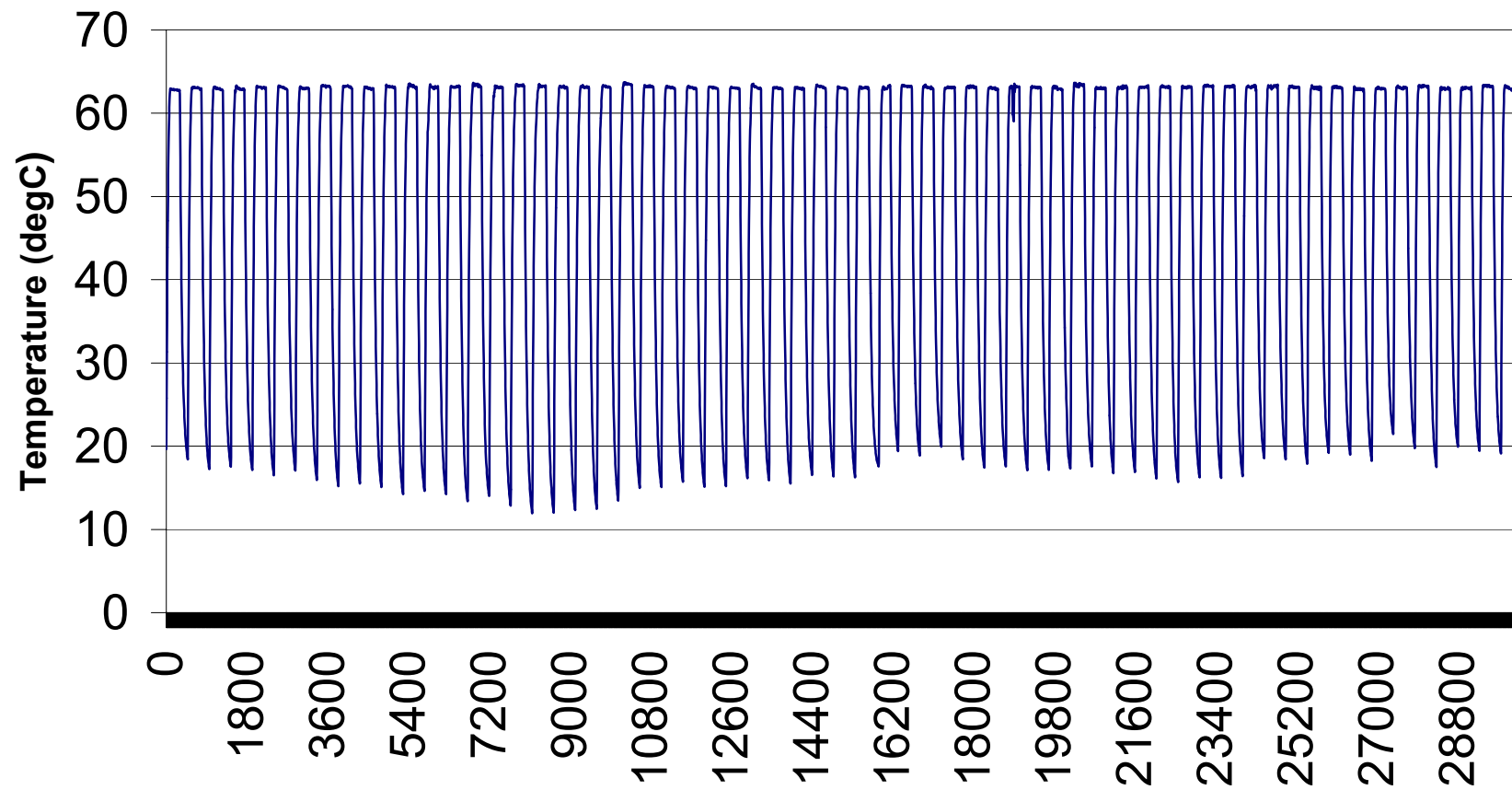


Fig. 2

Electrical heat cycles in AIR



Time (seconds)

Fig. 3

Electrical heat cycles in WATER

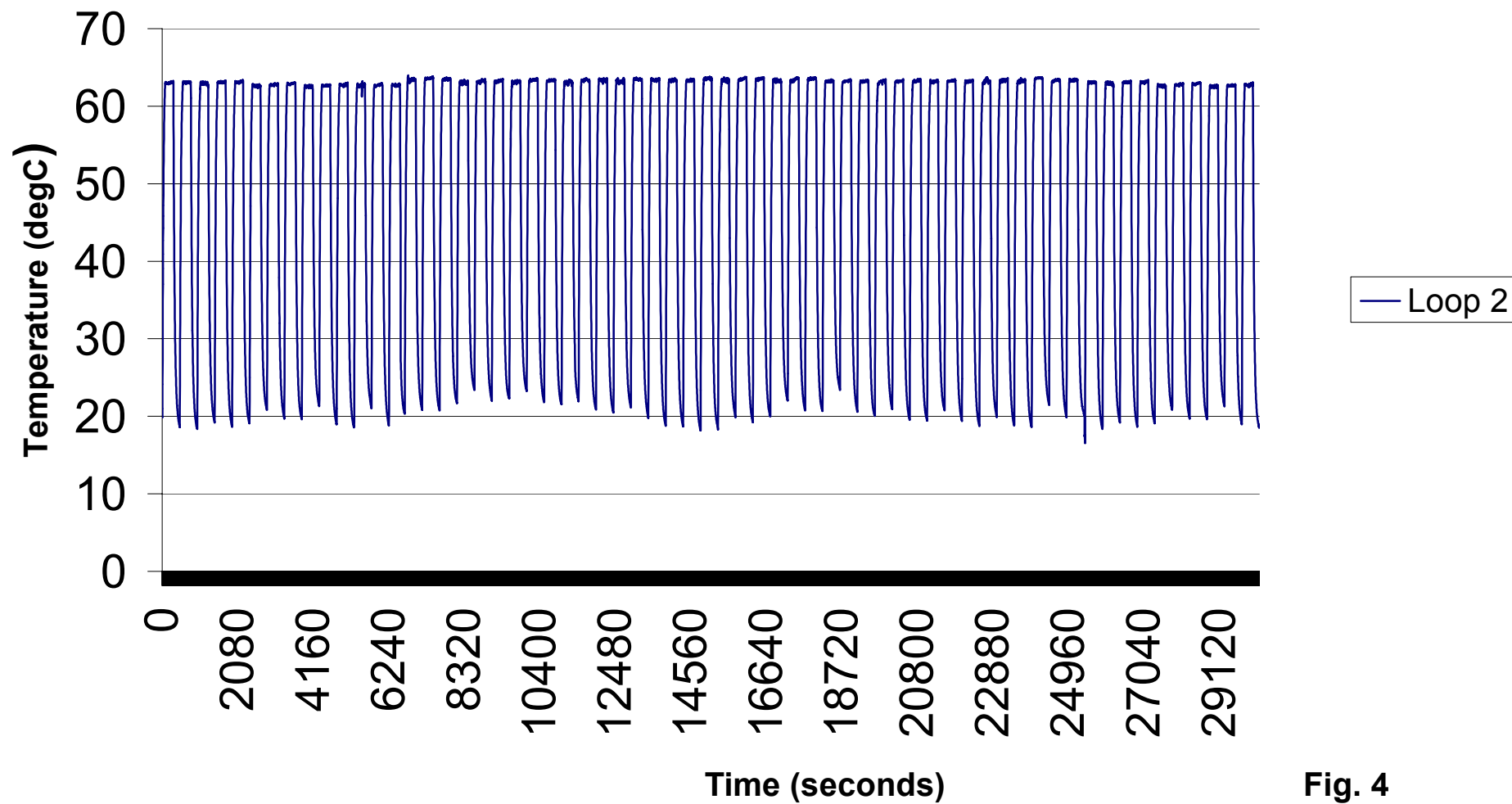


Fig. 4

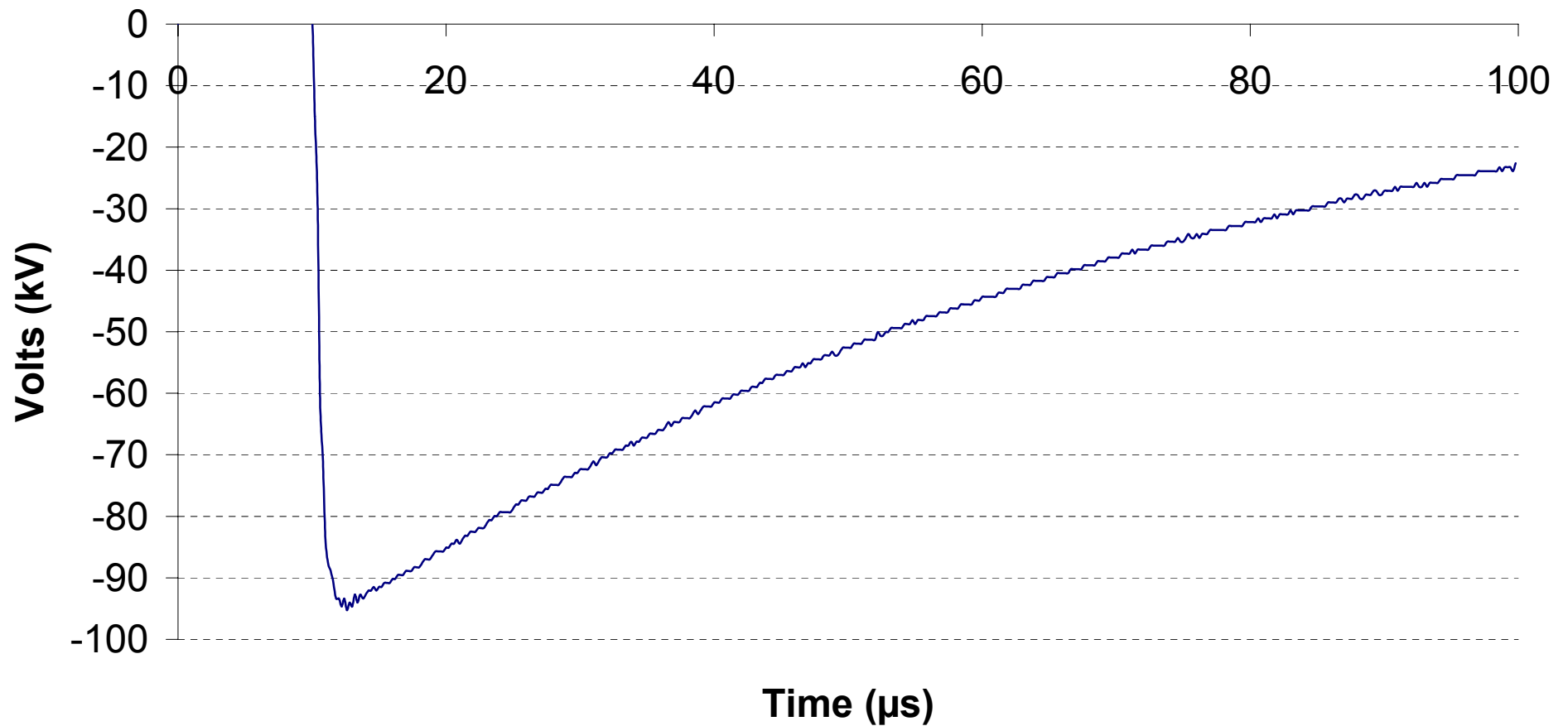
L3

lightning impulse voltage test at elevated temperature

shot 1 of 10

Vpk = -96.1kV ; T1=1.44 μ s ; T2=48 μ s

(TN051209/D1)

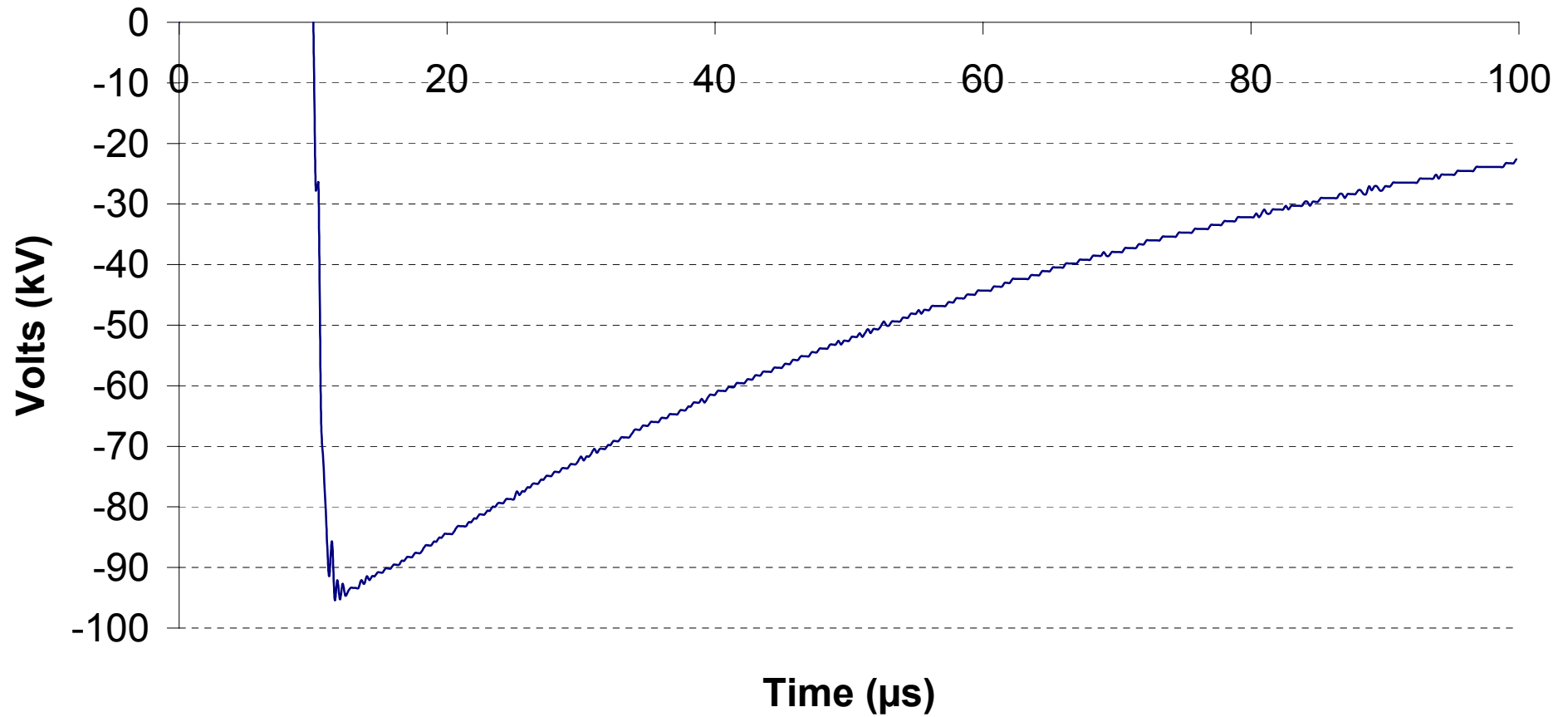


L3

lightning impulse voltage test at elevated temperature

shot 10 of 10

Vpk = -95.4kV ; T1=1.44 μ s ; T2=48 μ s
(TN051209/D1)



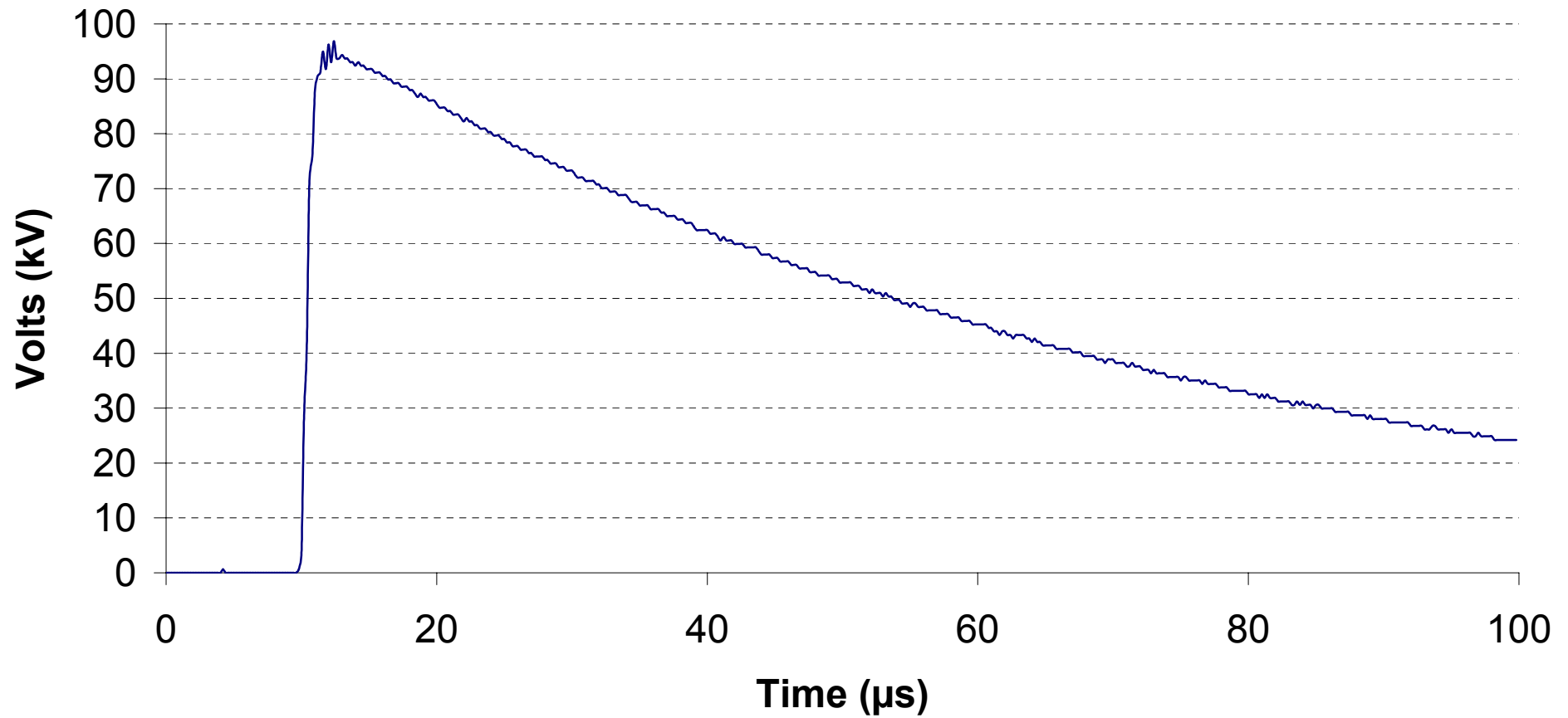
L3

lightning impulse voltage test at elevated temperature

shot 1 of 10

V_{pk} = +95.0kV ; T₁=1.44μs ; T₂=48μs

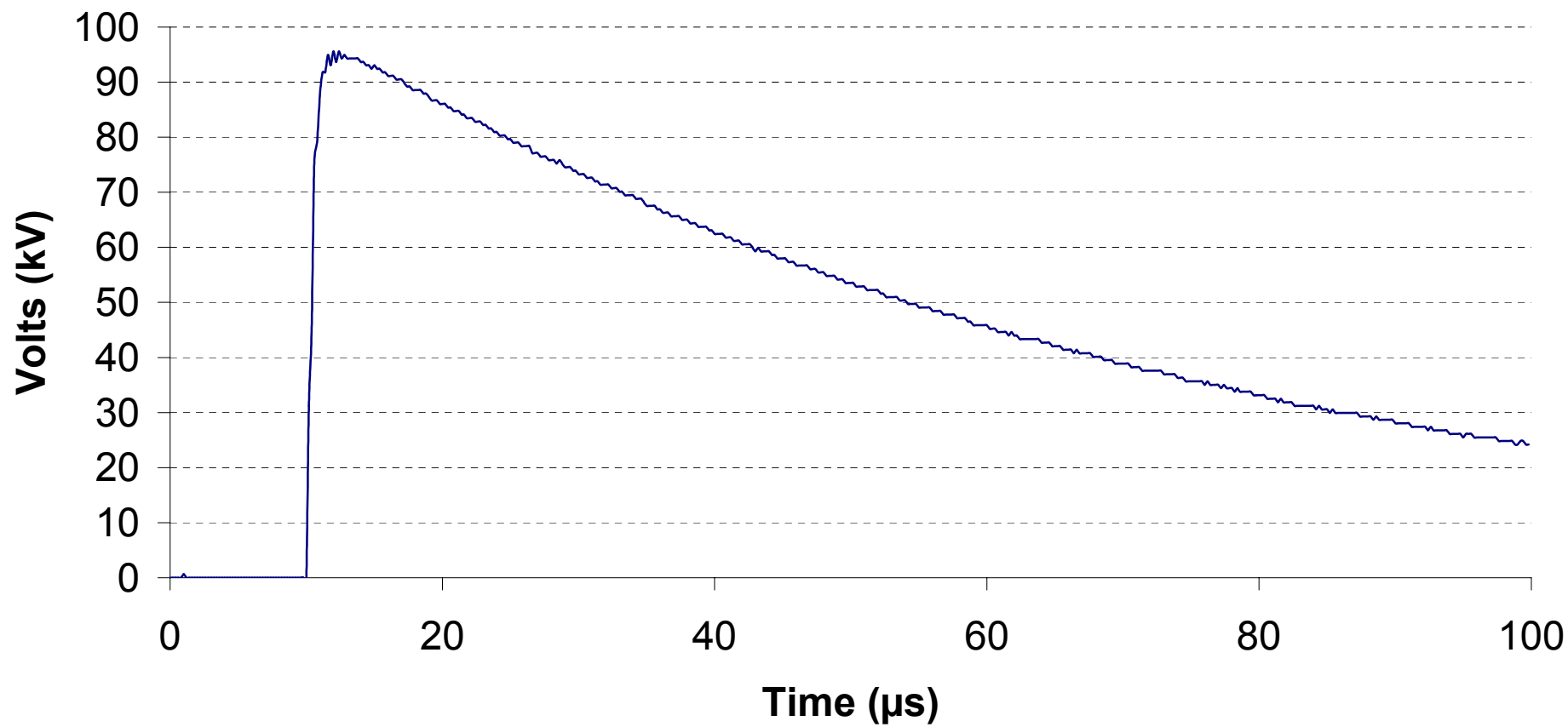
(TN051209/D2)



L3

lightning impulse voltage test at elevated temperature

shot 10 of 10
Vpk = +95.2kV ; T1=1.44 μ s ; T2=48 μ s
(TN051209/D2)

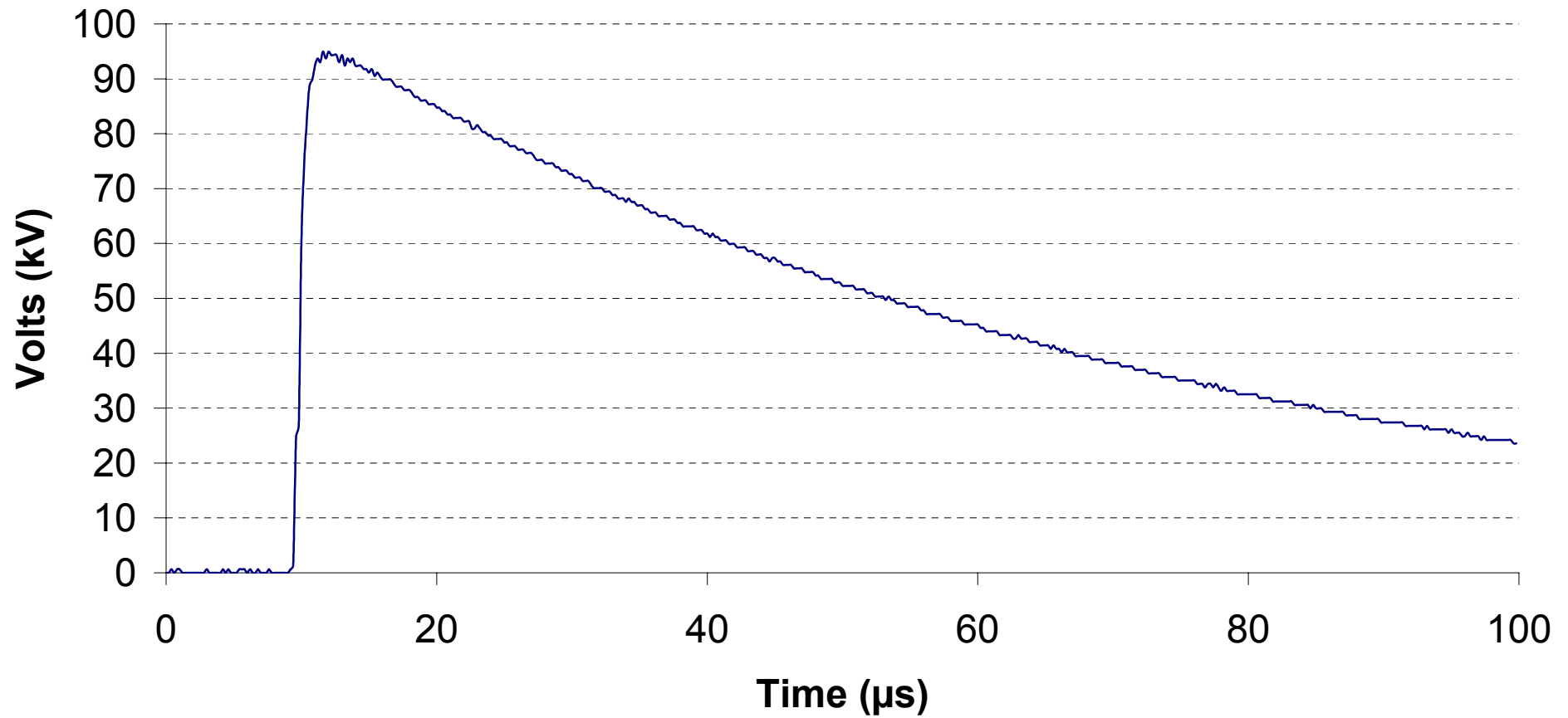


L2

lightning impulse voltage test at elevated temperature

shot 1 of 10

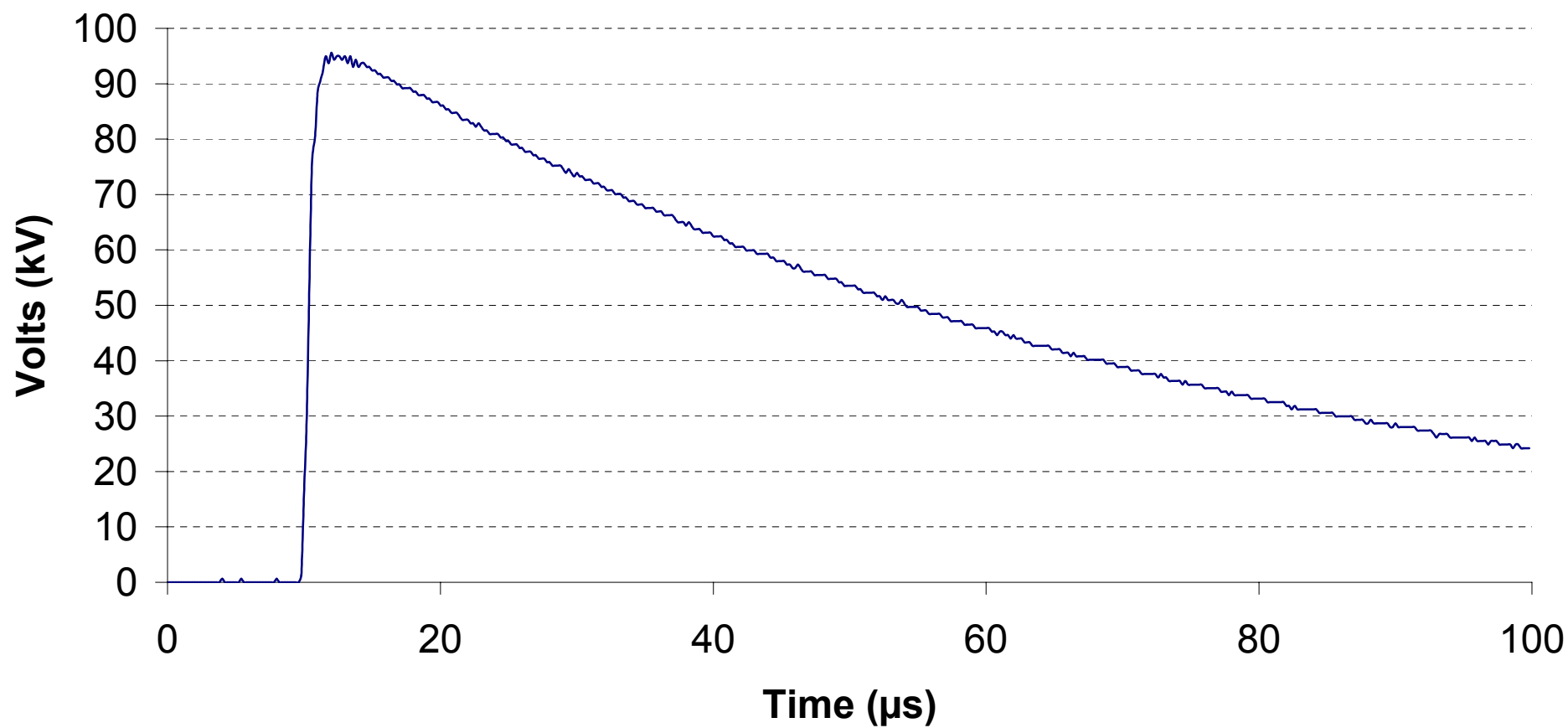
Vpk = +95.0kV ; T1=1.44 μ s ; T2=48 μ s
(TN051209/D3)



L2

lightning impulse voltage test at elevated temperature

shot 10 of 10
Vpk = +94.7kV ; T1=1.44 μ s ; T2=48 μ s
(TN051209/D3)



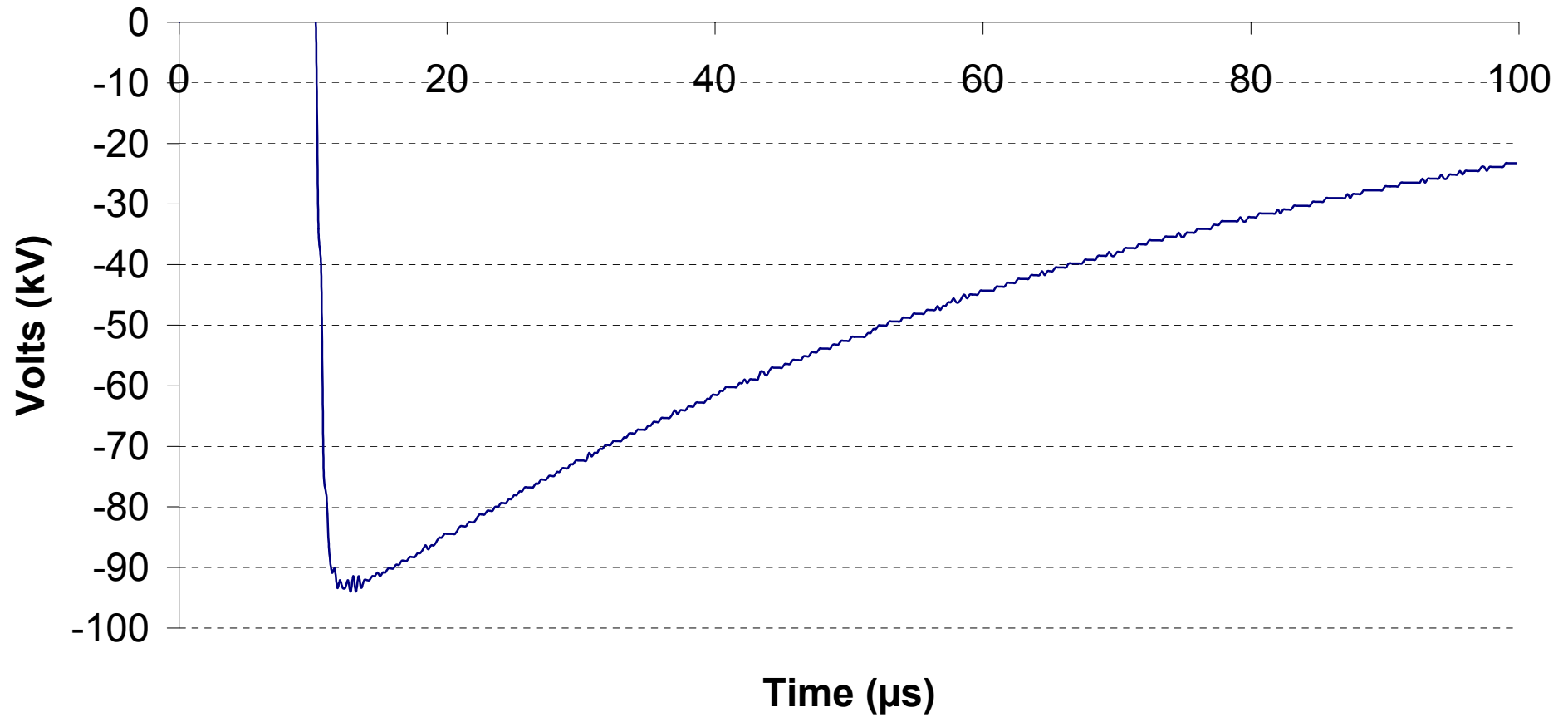
L2

lightning impulse voltage test at elevated temperature

shot 1 of 10

Vpk = -95.1kV ; T1=1.44 μ s ; T2=48 μ s

(TN051209/D4)



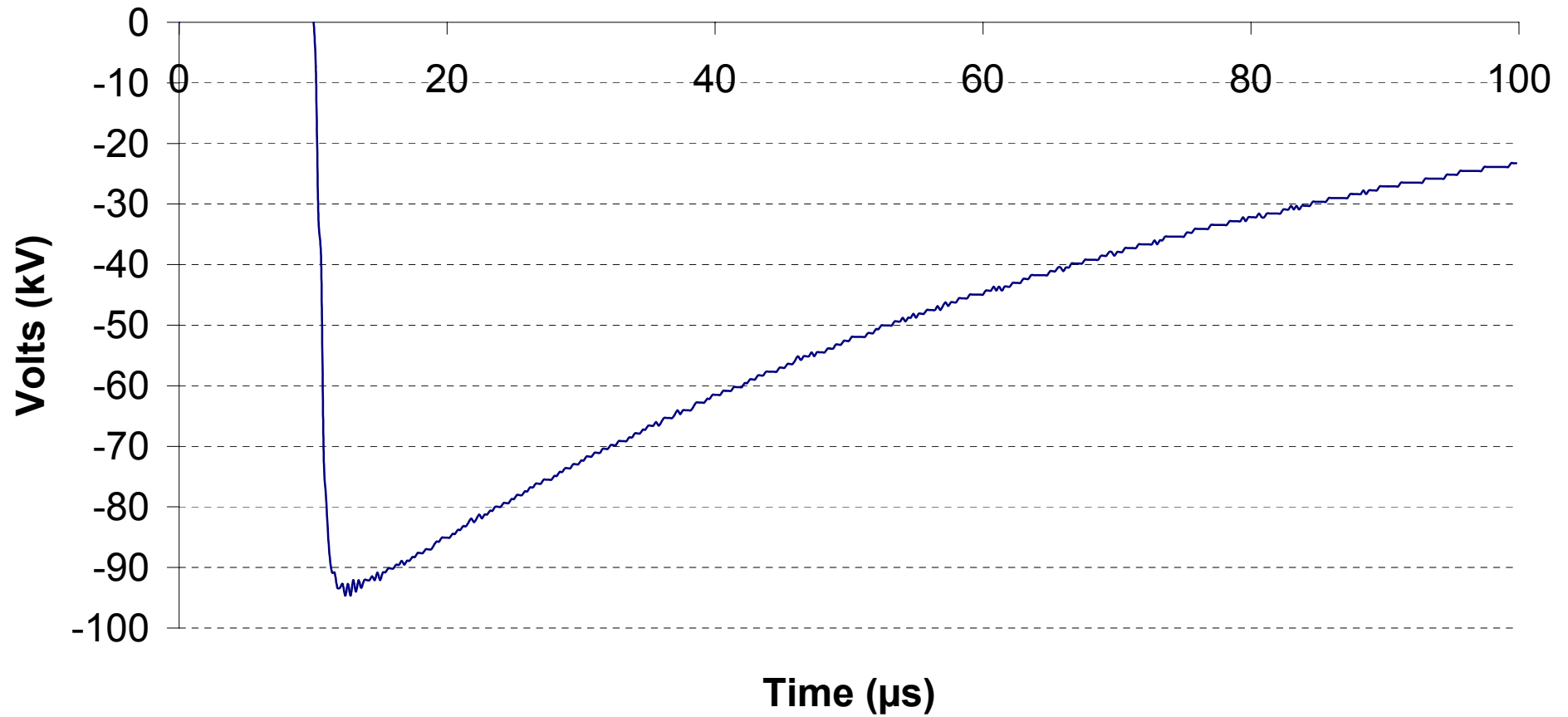
L2

lightning impulse voltage test at elevated temperature

shot 10 of 10

Vpk = -95.6kV ; T1=1.44 μ s ; T2=48 μ s

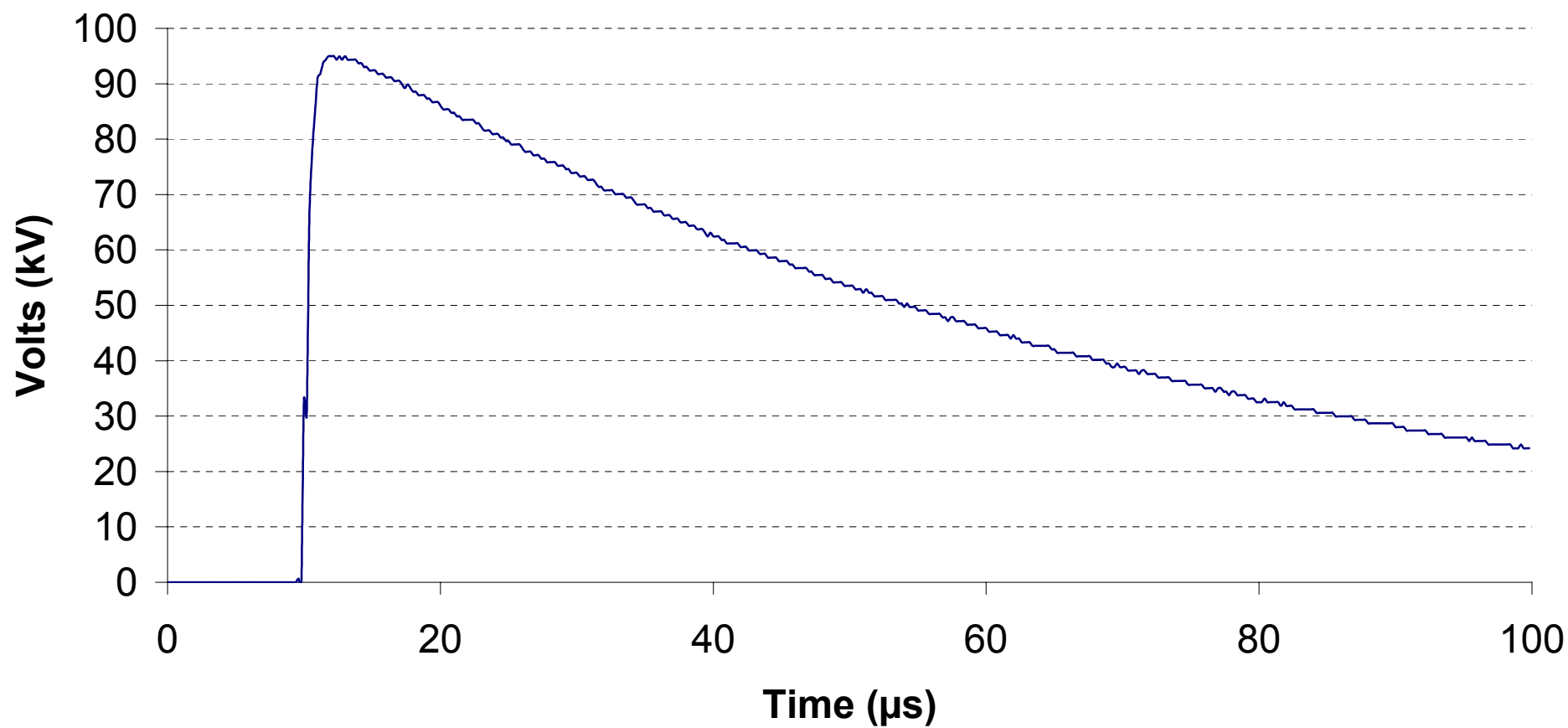
(TN051209/D4)



L1

lightning impulse voltage test at elevated temperature

shot 1 of 10
Vpk = +95.0kV ; T1=1.44 μ s ; T2=48 μ s
(TN051209/D5)

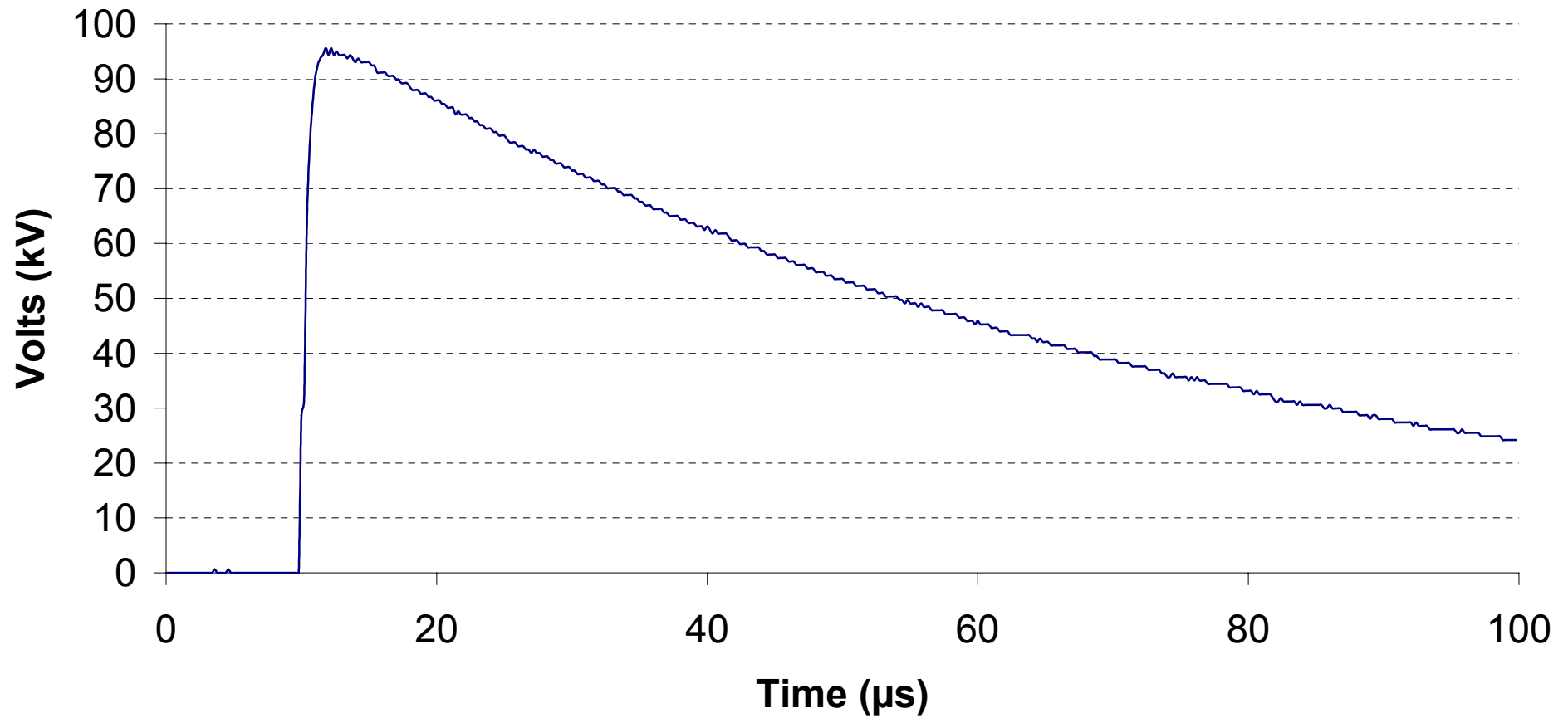


L1

lightning impulse voltage test at elevated temperature

shot 10 of 10

V_{pk} = +94.7kV ; T₁=1.44μs ; T₂=48μs
(TN051209/D5)

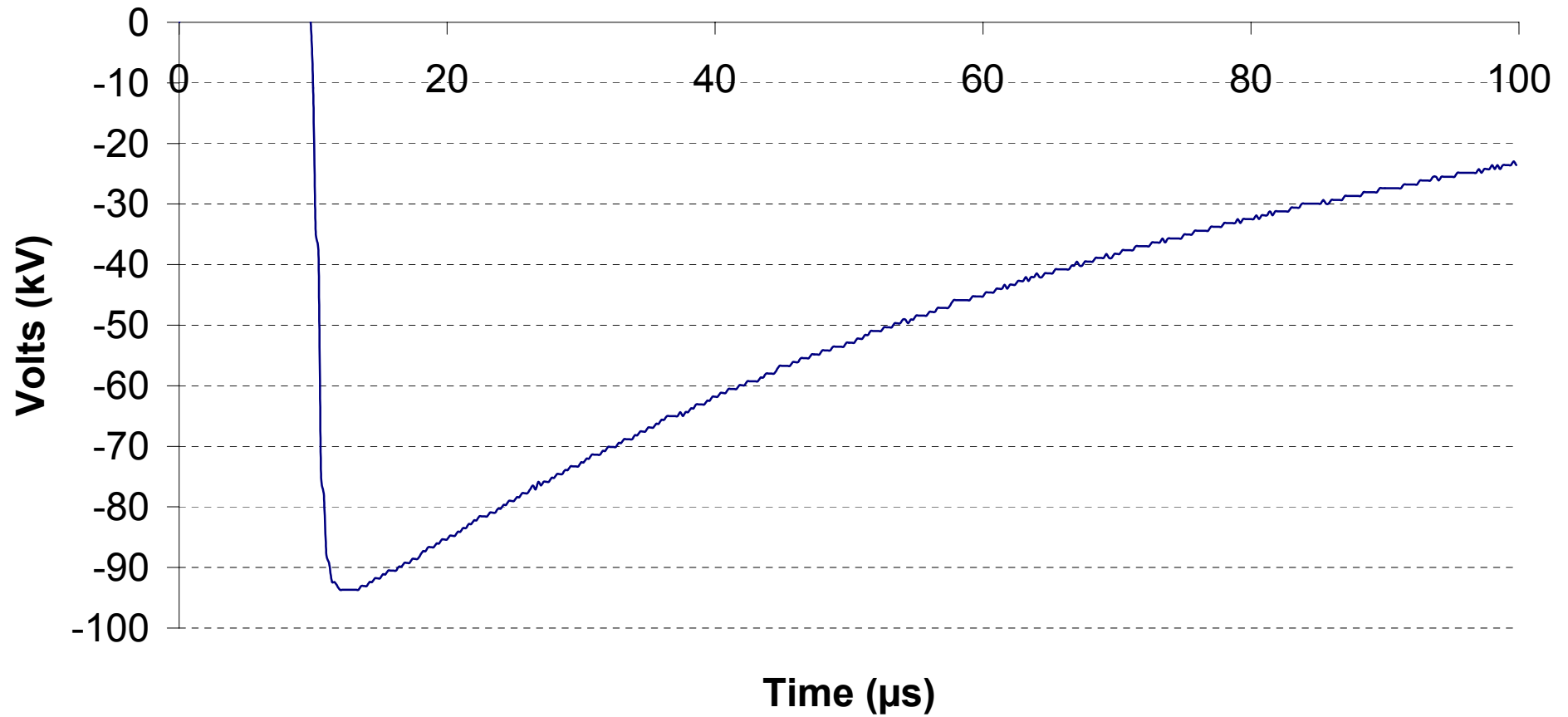


L1

lightning impulse voltage test at elevated temperature

shot 1 of 10

Vpk = -94.7kV ; T1=1.44 μ s ; T2=48 μ s
(TN051209/D6)

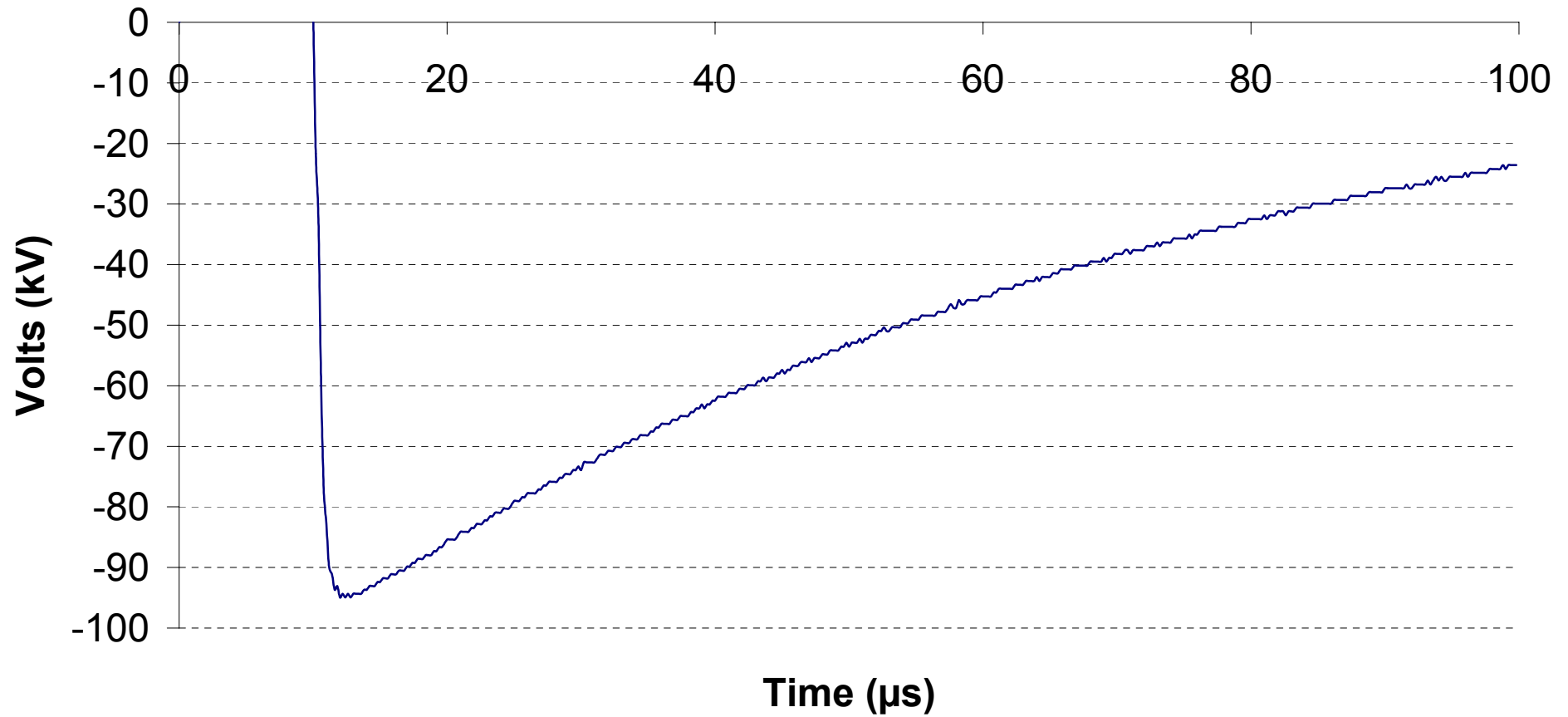


L1

lightning impulse voltage test at elevated temperature

shot 10 of 10

Vpk = -95.4kV ; T1=1.44 μ s ; T2=48 μ s
(TN051209/D6)



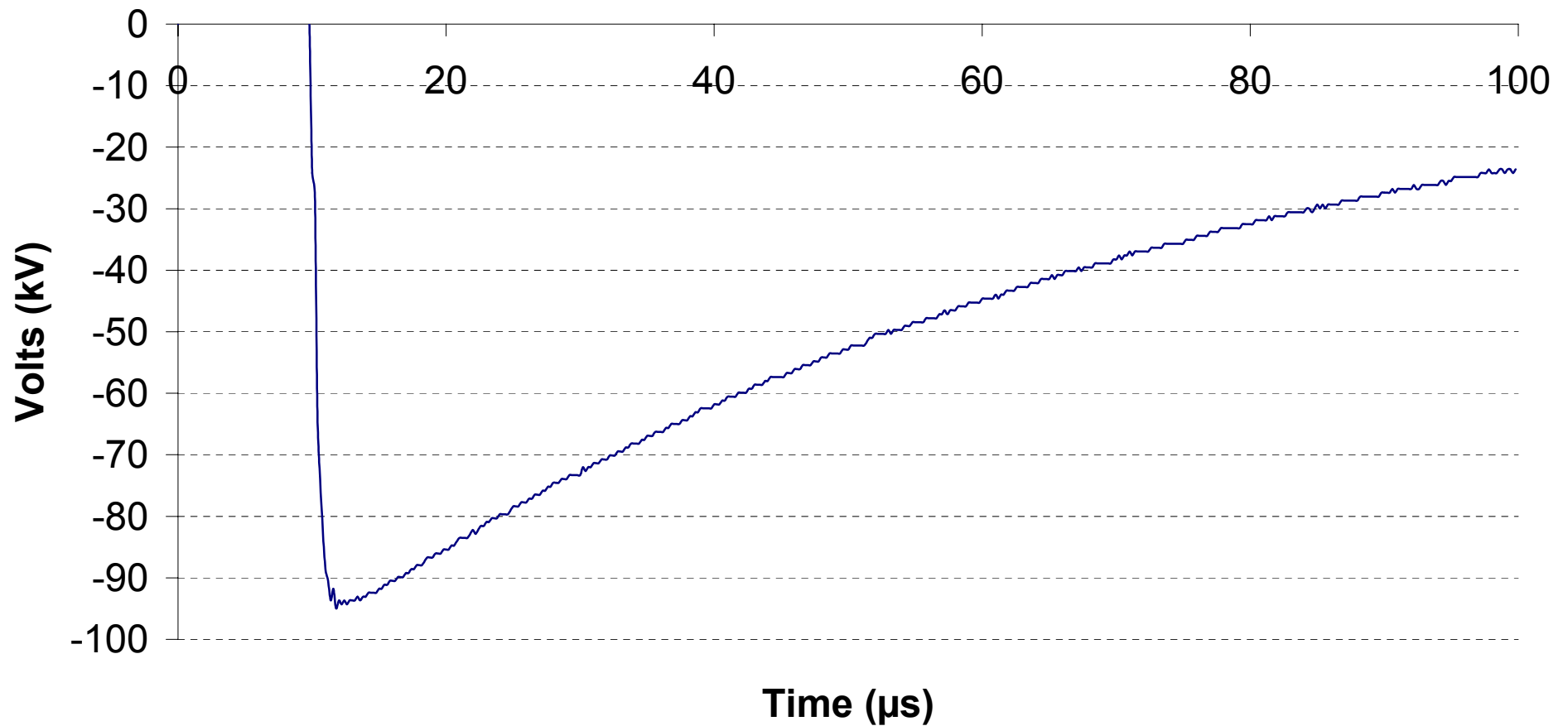
L2

lightning impulse voltage test at ambient temperature

shot 1 of 10

Vpk = -95.0kV ; T1=1.14 μ s ; T2=47.4 μ s

(TN060321/D1)



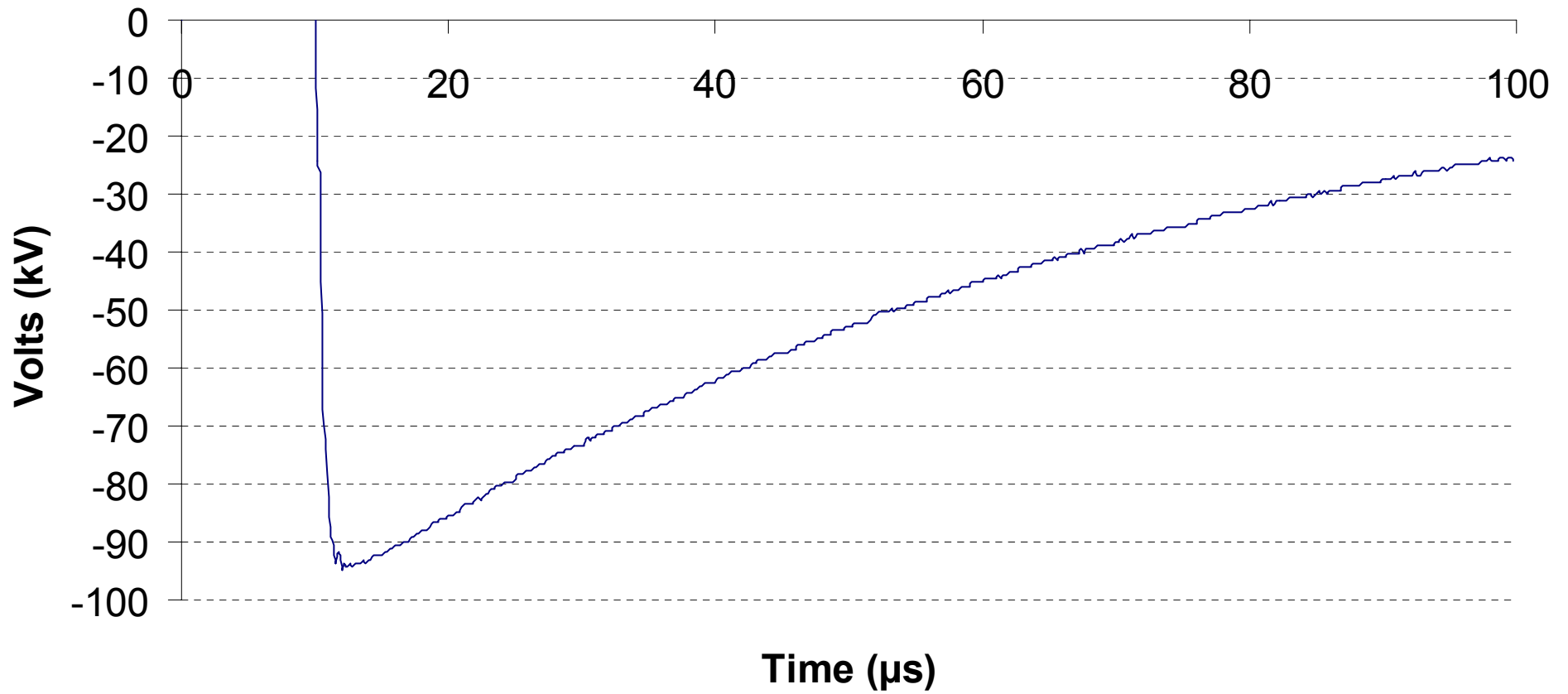
L2

lightning impulse voltage test at ambient temperature

shot 10 of 10

Vpk = -95.2kV ; T1=1.14 μ s ; T2=47.4 μ s

(TN060321/D1)



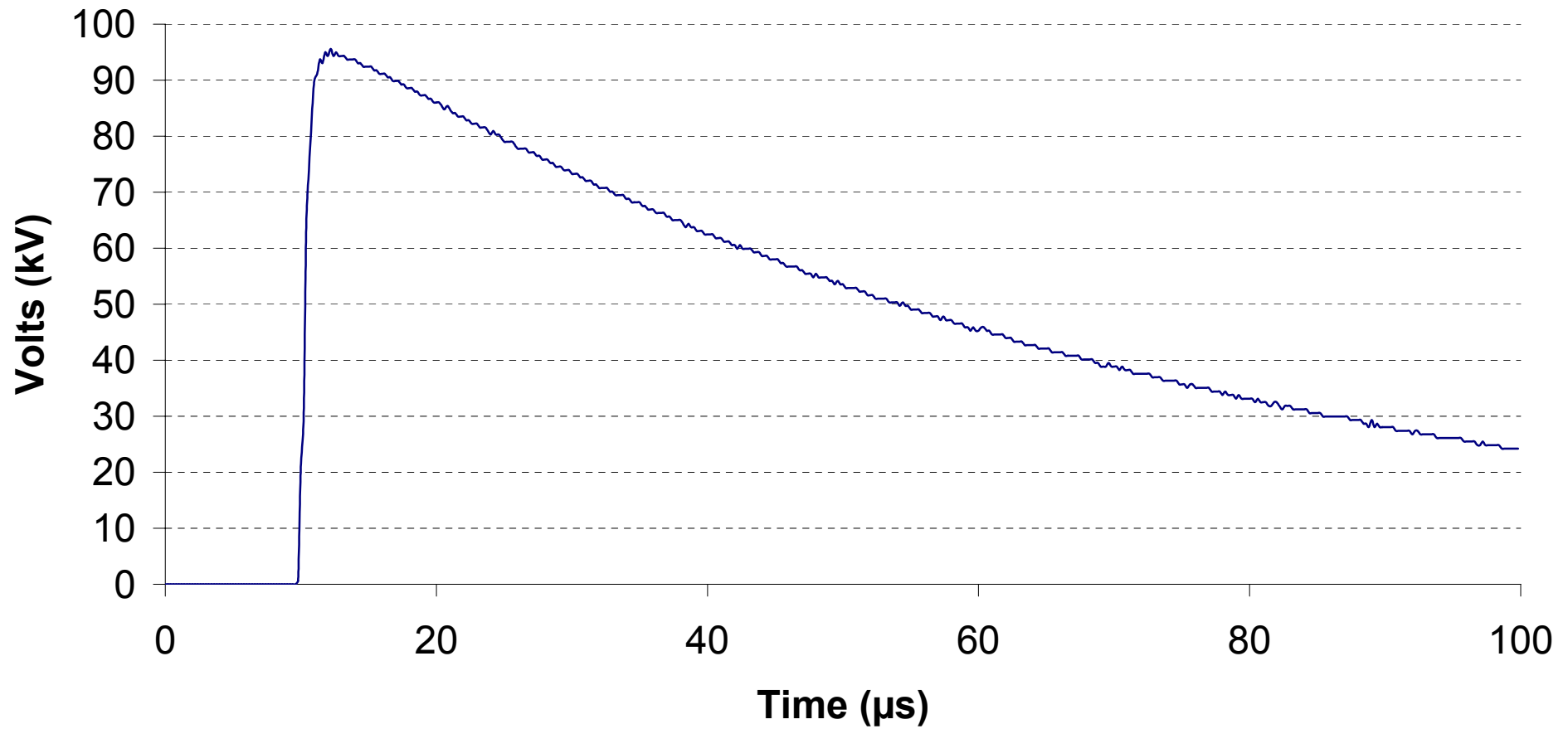
L2

lightning impulse voltage test at ambient temperature

shot 1 of 10

Vpk = +94.5kV ; T1=1.14μs ; T2=47.4μs

(TN060321/D2)



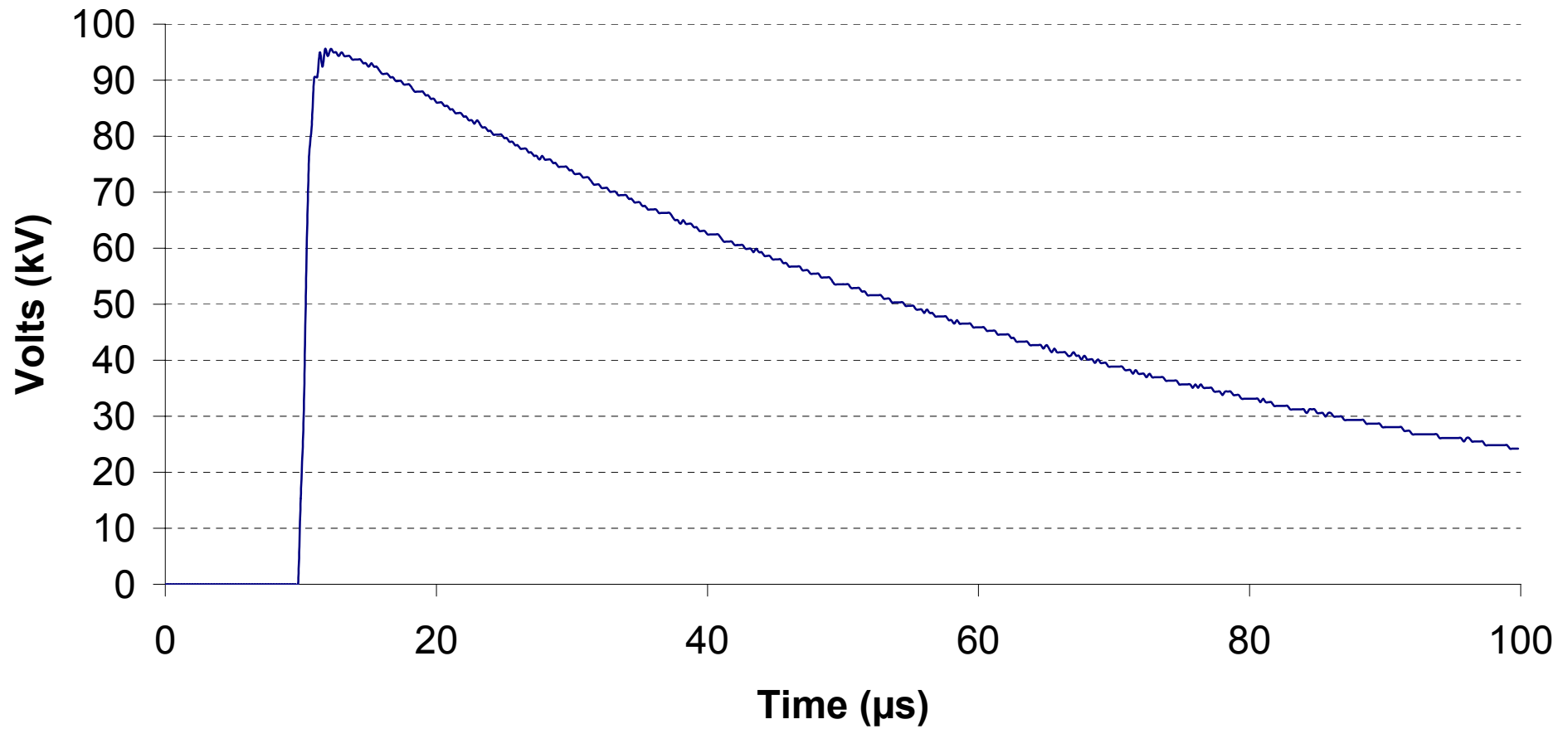
L2

lightning impulse voltage test at ambient temperature

shot 10 of 10

Vpk = +95.1kV ; T1=1.14μs ; T2=47.4μs

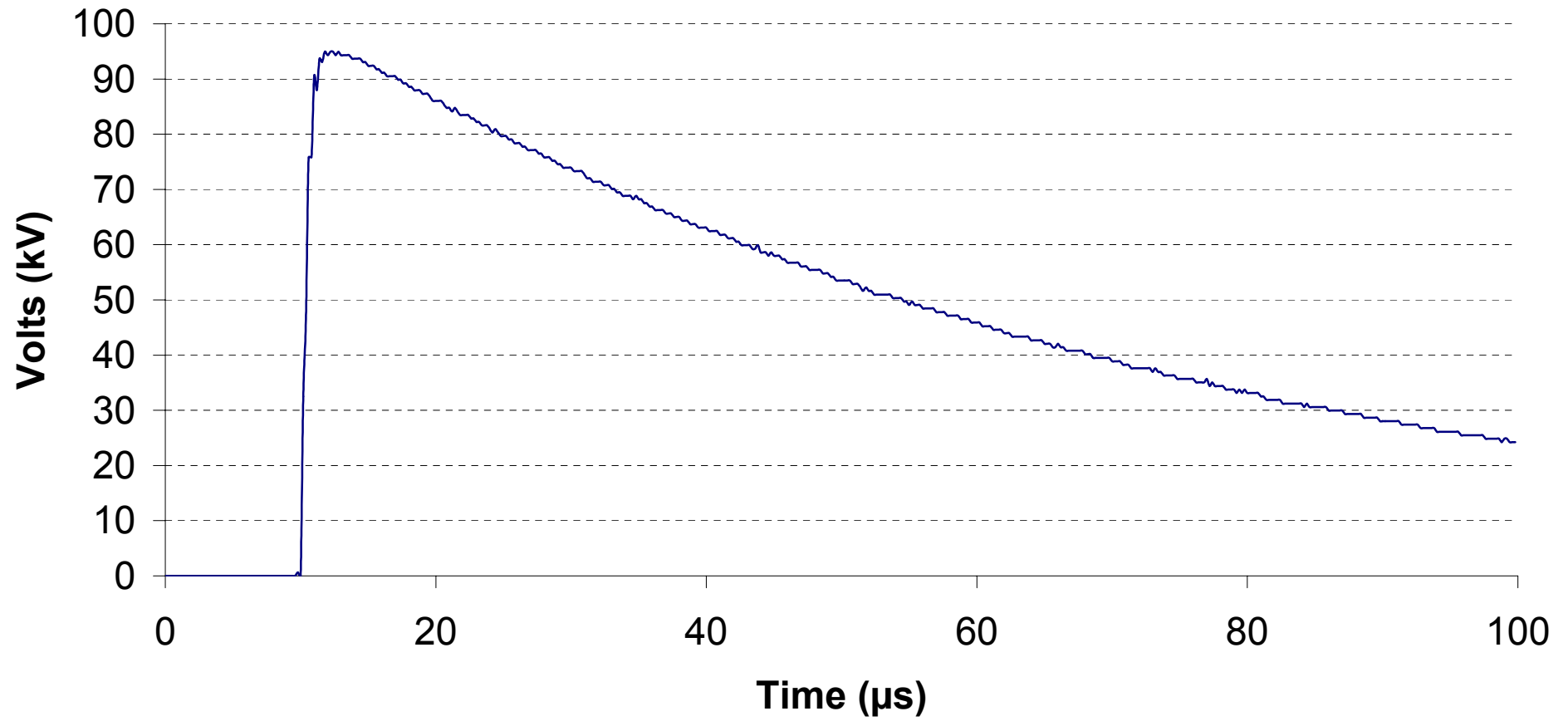
(TN060321/D2)



L1

lightning impulse voltage test at ambient temperature

shot 1 of 10
Vpk = +94.7kV ; T1=1.14μs ; T2=47.4μs
(TN060321/D3)



L1

lightning impulse voltage test at ambient temperature

shot 10 of 10

Vpk = +94.6kV ; T1=1.14 μ s ; T2=47.4 μ s

(TN060321/D3)

