intercomplex Ltd.®
4002 Пловдив, бул. "Пещерско шосе" № 201, тел. (032) 241 415, тел./факс: (032) 241 414, e-mail: office@intercomplex.bg
1113 София, ул. "Акад. Г. Бончев" № 20, тел. (02) 971 70 41, факс: (02) 971 71 41, e-mail: office.sf@intercomplex.bg

Приложение ТС II.2
към Технически изисквания и спецификации
по процедура № PPD 19 – 129

Обособена позиция 2

ТЕХНИЧЕСКО ОПИСАНИЕ НА ВИСОКОВОЛТОВИ ПРЕДПАЗИТЕЛИ СРЕДНО НАПРЕЖЕНИЕ (СрН) ЗА ЗАЩИТА НА НАПРЕЖЕНОВИ ИЗМЕРВАТЕЛНИ ТРАНСФОРМАТОРИ

Предпазителите са предназначени за използване в разпределителни уредби с номинално напрежение 20 kV за защита от токове на къси съединения на страна 20 kV на напреженовите измервателни трансформатори (НИТ).

Херметизирани предпазители от клас с ограничен диапазон на функциониране (back-up предпазители), с тяло изработено от глазиран електропорцелан, без ударно устройство.

Предпазителите се обозначават с допълнителна табелка, съдържаща информация за техните обявени данни.

Металните части на предпазителите имат антикорозионно покритие, осигуряващо добър електрически контакт. Тялото е изработено от глазиран кафяв електропорцелан с еднородна глазура, без пукнатини, язви и други нетехнологични неравности. Материалът на стопяемия елемент е от чисто сребро (Ag 99.9%), без внаждания.

Предпазителите отговарят на посочените по-долу стандарти и на техните валидни изменения и допълнения:

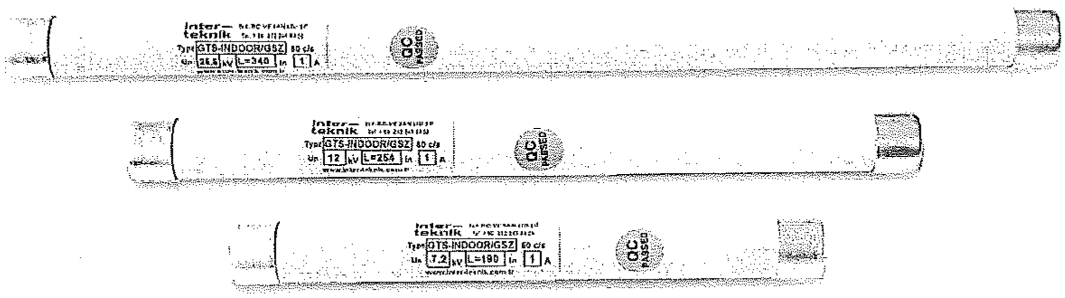
1. БДС EN 60282-1:2010 „Предпазители за високо напрежение. Част 1: Токоограничаващи предпазители (IEC 60282-1:2009)“;
2. БДС EN 62271-105:2012 „Комутационни апарати за високо напрежение. Част 105: Комутационни апарати за променливо напрежение, комбинирани с предпазител за обявено напрежение над 1 kV до 52 kV включително (IEC 62271-105:2012)“;
3. БДС EN 60672-1:2003 „Керамични и стъклени изолационни материали. Част 1: Термини и определения и класификация (IEC 60672-1:1995)“;
4. БДС EN 60672-2:2003 „Керамични и стъклени изолационни материали. Част 2: Методи за изпитване (IEC 60672-2:1999)“;
5. БДС EN 60672-3:2003 „Керамични и стъклени изолационни материали. Част 3: Спецификации за отделни материали (IEC 60672-3:1997)“.

Всички електрически и механични параметри на предпазителите като: разсейвана мощност, Джаулов интеграл, минимален ток на изключване, сила на ударното устройство, геометрични размери и др. са посочени в таблиците от Техническите изисквания и спецификации, както и в каталога, част „Технически данни“.

09.03.2020 г.

На основание чл.36а ал.3 от ЗОП

211



Features

- ***Non-aging design***
- ***High breaking currents up to 63 kA***, along with small rated currents
- ***A big range of specific dimensions*** to fit in your installation
- ***Technical assistance*** in fuse selection & operation
- ***Project-basis design***

Overview

Voltage transformers are designed to convert a primary high voltage of a power grid into an acceptably lower voltage to feed measuring and protective devices. Voltage transformer are low power high impedance items that operate at low current levels. In contrast to the low operating currents, fault currents in case of insulation failure may be extremely high as voltage transformers are often installed at the substation bus. Therefore, HV current-limiting fuses having ***high breaking capacity*** will preferably be used to isolate failed voltage transformers from the power system and to prevent potentially catastrophic consequences. Inter-Teknik fuses combine ***low continuous current ratings*** with ***high rated maximum breaking current.***

Fuse Selection Criteria

1. Optimum protection against damage to other equipment in the event of an insulation failure of the voltage transformer requires selecting a possibly small current rating.

2. Major fuse selection criterion is to ***withstand magnetizing inrush currents i***n order to avoid nuisance tripping. As a rule, this condition excludes effective overload protection of a voltage transformer.

Practical Tools for Selection

1. The pre-arcing I^2t of the fuse should be at least 5 times greater than the inrush I^2t. This will give a reasonable safety margin for preventing nuisance tripping of the fuse.

ВЯРНО С ОРИГИНАЛА

2. If inrush I^2t values are unavailable, the fuse rated current may be selected 15 to 20 times the voltage transformer rating.

Tips to Avoid Failures

Fuse-element design of fuses at very low rated currents, are by nature susceptible to mechanical and inrush damage. Certain precautions should be taken as follows;

1. In small metal-enclosed grounded fuse compartments, the effect of sustained partial discharges-***"corona"***- generated by high electric stress at the fine fuse-wire, need to be considered as electro-erosion that will degrade the delicate fuse-element with time.

   Solution: Partial discharge measurement with the fuse installed is recommended to avoid that risk.

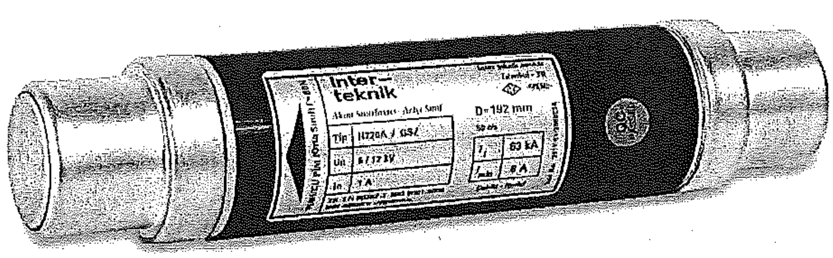
2. In some applications, particularly in networks with isolated neutral, there is a risk that the inherent capacitance of the circuit will give rise to a discharge current through the primary windings of the voltage transformer that triggers relaxation oscillations; also known as ***ferroresonance.*** Such chaotic oscillations may last until destruction of the voltage transformer.

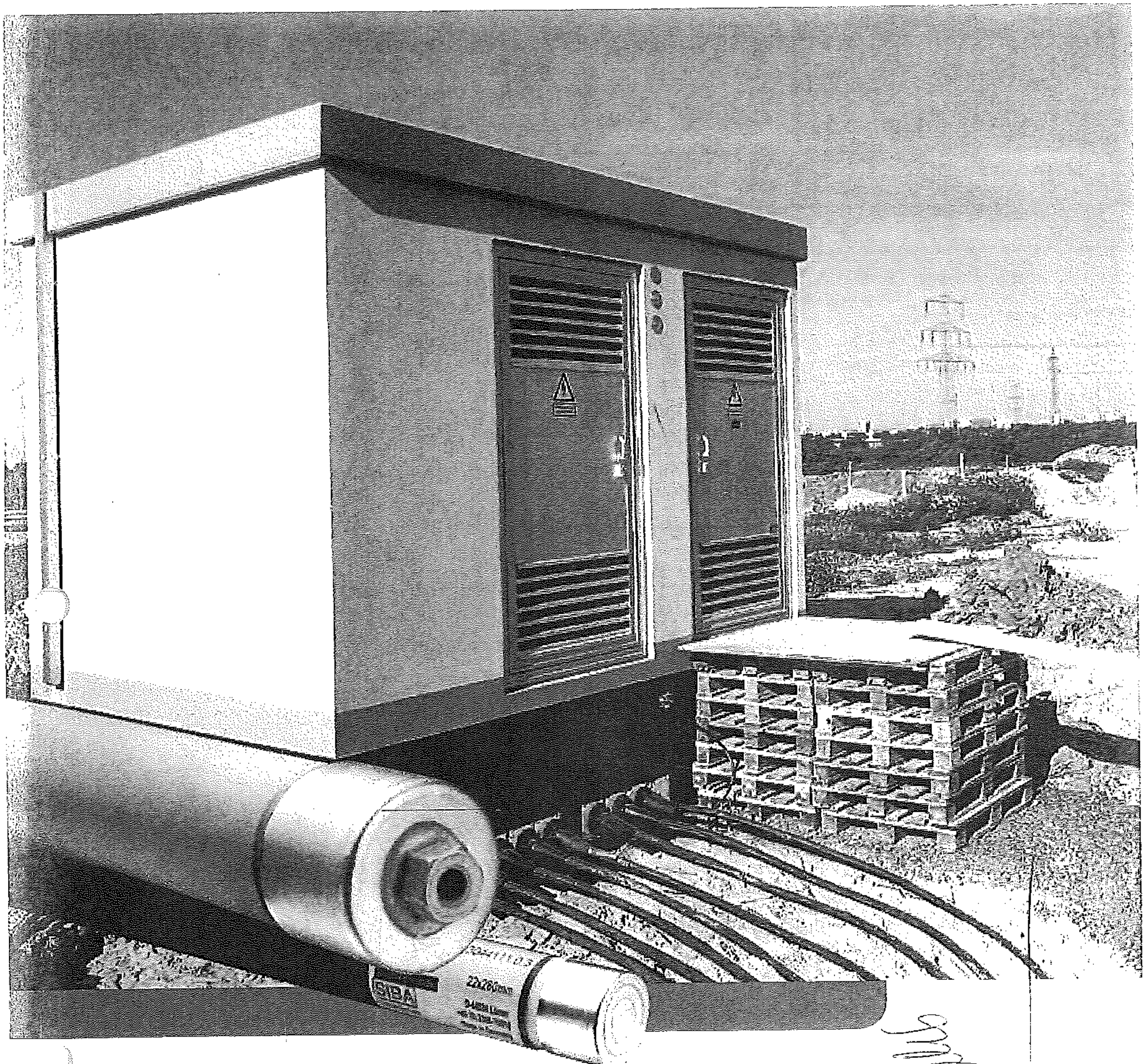
   Solution: Precautions, such as damping resistors installed at the LV windings, should be taken ensuring that the fuse would not operate under these conditions.

3. Risks of mechanical damages during transport or operation should be minimized.

   Solution: Due to delicate nature of these fuses, ***fuse-link handling guide*** should be strictly followed.

Similar to other applications, we provide our clients with a non-ageing, high quality, high breaking capacity solution. With our dedication to fuse manufacturing, we offer flexibility of providing our customers with specific dimensions and characteristics depending on the project requirements.





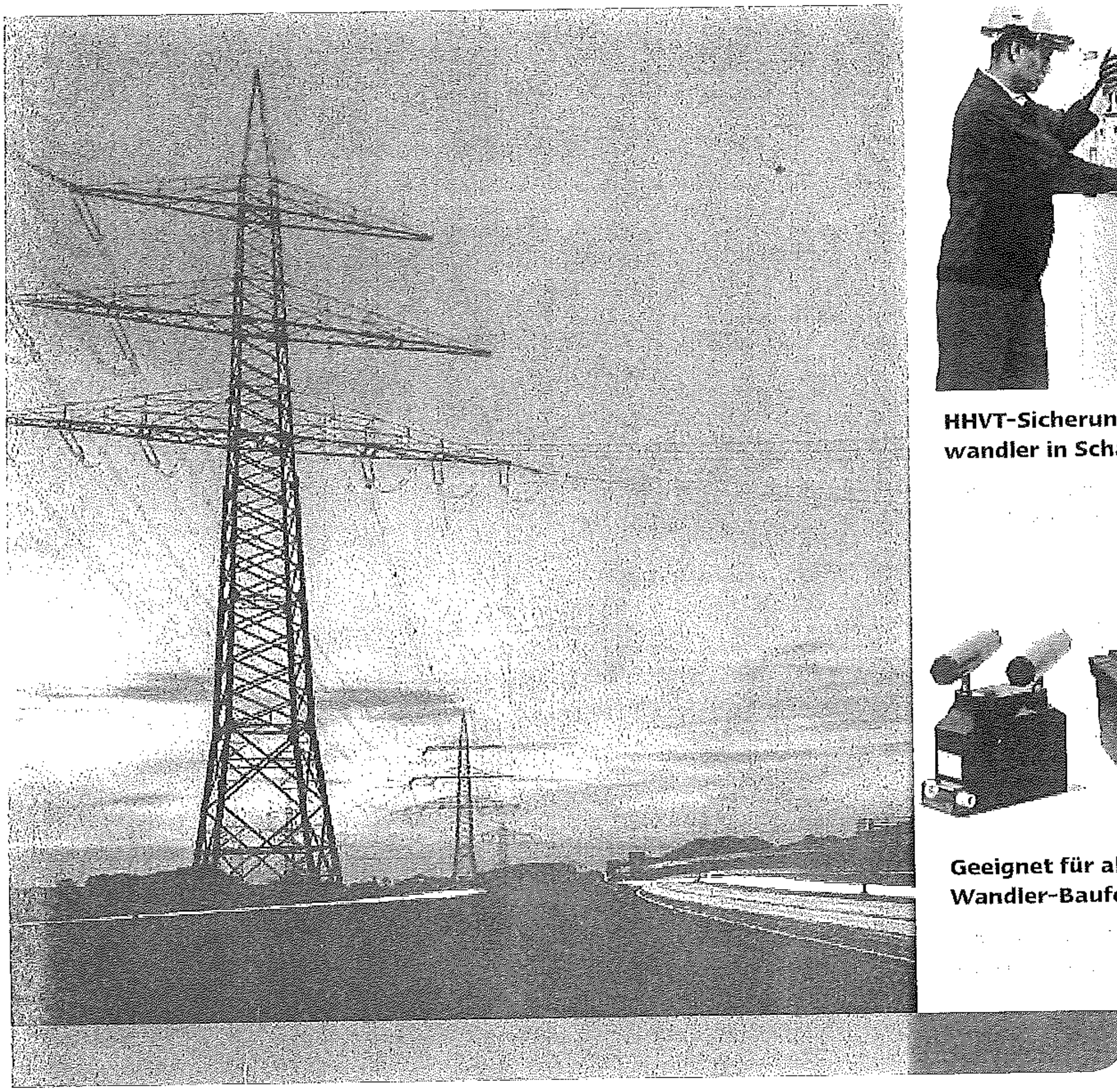
Baustein belastbarer Netze

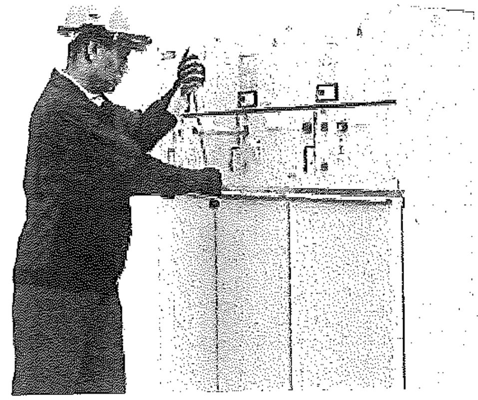
Sicherungen für Spannungswandler

MADE IN GERMANY

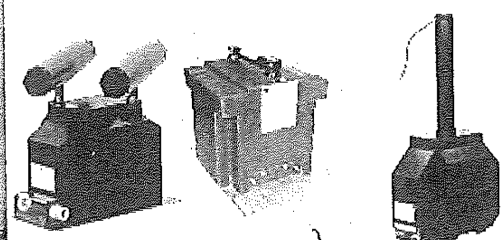
Sie profitieren. Mit Sicherheit.
Our Protection. Your Benefit.

SIBA
Sicherungen | Fuses





HHVT-Sicherungen für Spannungswandler in Schaltanlagen



Geeignet für alle Wandler-Bauformen

Sicheres Netz:
Komponenten, die gut geschützt sind

- Ob in intelligenten Ortsnetzstationen, die helfen, die Energiewende zu meistern oder in Schaltanlagen, deren Spannungswandler ganz bestimmten Kunden-Anforderungen genügen müssen: SIBA sorgt für besonderen Schutz dieser unverzichtbaren Bausteine der Energieversorgung – mit unseren HHVT-Sicherungen.
- Schon standardmäßig bietet unsere HHVT-Palette optimale Werte: sehr kleine Bemessungsströme zum schnellen Abschalten von Fehlerströmen (Berstschutz), geringste Abmessungen und extrem hohe Kurzschlussleistung.
- Wir haben jahrzehntelange Erfahrung mit HHVT-Sicherungen für Spannungswandler in Netzen mit hohen Belastungen – etwa in Netzen mit hohen Spannungsschwankungen und hohen transienten Stromanteilen (Inrush). Das hilft uns auch dabei, immer wieder neuen Herausforderungen zu begegnen.

Safe Grid:
Thanks to well protected components

- Whether installed in smart substations that help master Germany's energy transition or in switchgear whose voltage transformers have to meet strict customer requirements: HV fuse links from SIBA protect components that are indispensable to our energy supply.
- Even in standard configuration our HV fuse links offer optimal parameters: very low rated currents that are able to interrupt fault currents (ideal burst protection), smallest dimensions and extremely high short-circuit capacity.
- We have decades of experience with HV fuse links for voltage transformers in grids with high loads – e.g. grids with high voltage fluctuations and high transient in-rush currents. This also enables us meet new challenges time after time.

Art.-Nr.	Abmessungen Measures Ø x L	U_r	I_r
	mm	kV	A/E
30 383 11.	24 x 142	7,2	0,5 A–3 A
			0,5 E–4 E
30 377 11.	24 x 195	7,2	0,5 A–3 A
			0,5 E–7 E
30 371 11.	39,6 x 220	7,2	0,5 A–5 A
30 440 11.	22 x 160	12	0,1 A–2 A
30 378 11.	24 x 195	12	0,5 A–3 A
30 372 11.	39,6 x 220	12	0,5 A–5 A
30 435 11.	39,6 x 327	15,5	0,5 E–7 E
30 379 11.	24 x 359	17,5	0,5 A–3 A
			0,5 E–7 E
30 444 11.	39,6 x 220	17,5	0,5 A–3 A
30 373 11.	39,6 x 340	17,5	0,5 A–5 A
30 441 11.	22 x 280	24	0,1 A–2 A
30 506 11.	24 x 310	24	0,5 A–5 A
30 380 11.	24 x 359	24	0,5 A–3 A
30 507 11.	39,6 x 240	24	0,5 A–2 A
30 374 11.	39,6 x 340	24	0,5 A–5 A
30 381 11.	24 x 359	36	0,5 A–3 A
[illegible]442 11.	36,5 x 418	36	0,3 A–2 A
30 375 11.	39,6 x 440	36	0,5 A–3 A
30 509 11.	39,6 x 327	40,5	0,5 A–2 A

3044011. 

22 x 160 mm

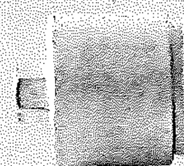
3037711. 

24 x 195 mm

3043511. 

39,6 x 327 mm

Bauformen HHVT für Innenraum-Anwendungen



Bauformen HHVT zum Mitvergießen im Wandlergehäuse mit rauer Oberfläche und Abdichtung

Fotos/Photos: Fotolia/ rcfotostock, Siemens, Ritz, SIB

Protection that fits: Individual solutions for manufacturers and users

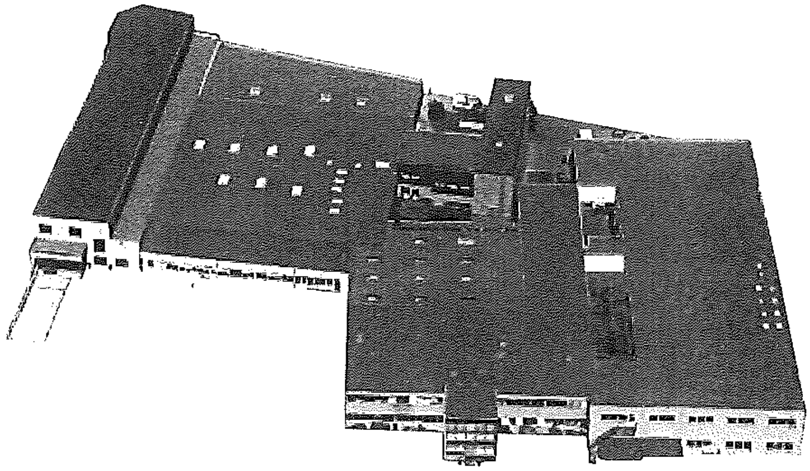
- Whether you plan to shield your transformer/converter application against even lower fault currents or need fuse links that are smaller than even our tiniest model: We will develop the right product together with you.
- Specialty fuses that are designed to be encapsulated in the resin filling of a transformer housing pose a special challenge: Process parameters such as temperature, chemical resistance and mounting must all be taken into account. Also in this case we are able to provide a solution that fits your needs.
- Whether as an external clip-on variant, inside an external attachment to the transformer or encapsulated inside the housing – even when supplying from stock we are able to satisfy a wide range of scenarios. And if not, we will come up with a tailor-made workaround.
We invite you to challenge us!

Passender Schutz: Individuelle Lösungen für Hersteller und Anwender

- Ob Sie Ihre Wandleranwendung vor noch geringeren Fehlerströmen absichern wollen als bisher oder ob Sie Sicherungen brauchen, die noch kleiner als unsere kleinsten sind: Wir entwickeln zusammen mit Ihnen das passende Produkt.
- Spezialsicherungen fürs Mitvergießen im Wandlergehäuse sind eine Herausforderung: Hier müssen oft besondere Prozessparameter wie Temperatur, Chemikalienbeständigkeit und Befestigung berücksichtigt werden. Auch das lösen wir ganz individuell.
- Ob als Clip-Lösung für die externe Montage, ob im Spezialgehäuse am Wandler selbst oder mitvergossen – bereits ab Lager können wir viele Anwendungsfälle bedienen. Wenn nicht, sorgen wir für maßgeschneiderte Abhilfe.
Fordern Sie uns!

Hauptsitz / Head Office
SIBA GmbH
Borker Straße 20-22
D-44534 Lünen
Postfach 1940
D-44509 Lünen
Tel.: +49-2306-7001-0
Fax: +49-2306-7001-10
info@siba.de
www.siba.de

SIBA Unit Miniature Fuses
Tel.: +49-2306-7001-290
Fax: +49-2306-7001-99
elu@siba.de



Deutschland / Germany

SIBA Vertriebsbüro Freiberg
Untergasse 12
D-09599 Freiberg
Tel.: +49-3731-202283
F 9-3731-202462
alexander.kolbe@siba.de

SIBA Vertriebsbüro Rhein/Ruhr
Espelweg 25
D-58730 Fröndenberg
Tel.: +49-2373-1753141
Fax: +49-2373-1753142
joerg.mattusch@siba.de

SIBA Vertriebsbüro Süd-West
Germersheimer Str. 101a
D-67360 Lingenfeld
Tel.: +49-6344-937510
Fax: +49-6344-937511
erwin.leuthner@siba.de

SIBA Vertriebsbüro Kassel
Sieberweg 20
D-34225 Baunatal
Tel.: +49-5601-965300
F 49-5601-965301
fischer@siba.de

SIBA Vertriebsbüro Bayern
Kirchstraße 12
D-86316 Friedberg
Tel.: +49-821-58955260
Fax: +49-821-58955261
guenter.heinz@siba.de

International

SIBA Sicherungen- und Schalterbau Ges.m.b.H & Co. KG (Austria)
Ortsstraße 18 · A-2331 Vösendorf bei Wien
Tel.: +43-1-6994053 und 6992592
Fax: +43-1-699405316 und 699259216
info.siba@aon.at
www.siba-sicherungen.at

SIBA GmbH Beijing Rep. Office (China)
Room 207A, Building B, He Qiao Mansion No. 8
Guanghua Road, Chaoyang District,
Beijing 100026
Tel.: +86-10-65817776
Fax: +86-10-65812979
siba_china@sibafuse.cn
www.sibafuse.cn

SIBA Písek s.r.o. (Czech Rep.)
U Vodárny 1506 · 397 01 Písek
Tel.: +420-38-2265746
Fax: +420-38-2265746
sibacz@iol.cz · www.siba-pojistky.cz

SIBA Sikringer Danmark A/S (Denmark)
ehemals/former Ole Andersen A/S
Lunikvej 24 B · DK-2670 Greve
Tel.: +45-86828175 · Fax: +45-86814565
info@sikringer.dk · www.siba-sikringer.dk

SIBA Nederland B.V. (Netherlands)
Van Gentstraat 16
NL-5612 KM Eindhoven
Tel.: +31-40-2467071
Fax: +31-40-2439916
info@sibafuses.nl · www.siba-zekeringen.nl

SIBA Polska sp. z o.o. (Poland)
ul. Grzybowa 5G
05-092 Łomianki Dąbrowa Leśna
Tel.: +48-22-8321477
Fax: +48-22-8339118
siba@sibafuses.pl
www.siba-bezpieczniki.pl

„SIBA GmbH" (Russia)
ul. Petrovka 27
Moskva 107031
Tel.: +7-495-9871413
Fax: +7-495-9871774
info@siba-predohraniteli.ru
www.siba-predohraniteli.ru

SIBA Fuses SA PTY. LTD. (South Africa)
P.O. Box 34261
Jeppestown 2043
Tel.: +27-11334-6560 / 4
Fax: +27-11334-7140
sibafuses@universe.co.za
www.siba-fuses.co.za

SIBA Far East Pte. LTD. (South East Asia)
24 Sin Ming Lane, # 07 – 105
Midview City, Singapore 573970, Republic of Singapore
Tel.: +65-66599449
Fax: +65-66594994
info@sibafuse.com.sg
www.sibafuse.com.sg

SIBA (UK) LTD. (United Kingdom)
19 Duke Street
Loughborough, Leics. LE11 1ED
Tel.: +44-1509-269719
Fax: +44-1509-236024
siba.uk@btconnect.com
www.siba-fuses.co.uk

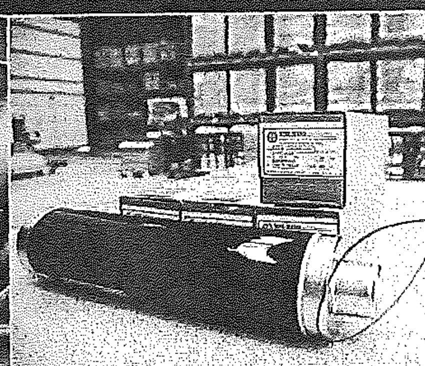
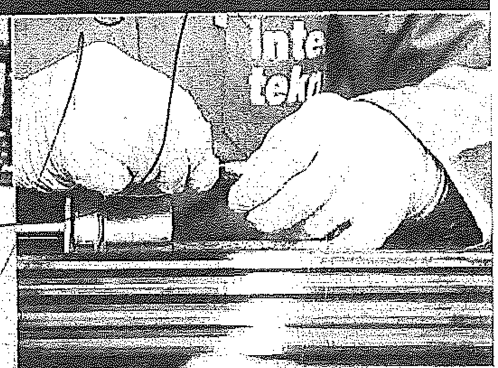
SIBA Fuses LLC (United States of America)
29 Fairfield Place
West Caldwell, NJ 07006
Tel.: +1-973575-7422 (973-575-SIBA)
Fax: +1-973575-5858
info@sibafuses.com
www.sibafuses.com

Weitere Vertriebspartner weltweit / Further distribution partners worldwide: www.siba.de / www.siba-fuses.com

SIBA Sicherungen | Fuses

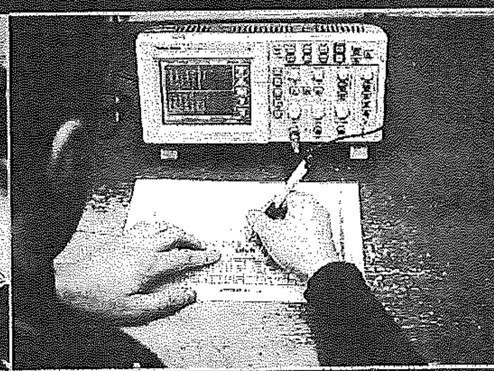
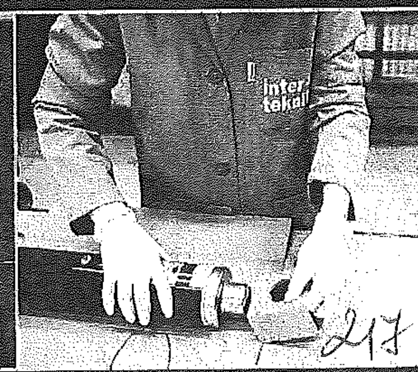
Sie profitieren. Mit Sicherheit.
Our Protection. Your Benefit.

inter–
teknik

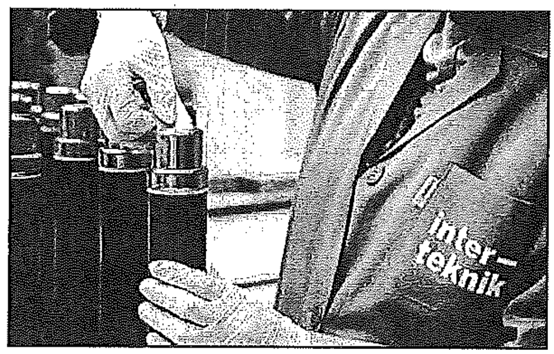
HIGH VOLTAGE FUSES

• CURRENT LIMITING TYPE • HIGH BREAKING CAPACITY • BACK-UP CLASS

HIGH VOLTAGE FUSES

- *CURRENT LIMITING TYPE*
- *HIGH BREAKING CAPACITY*
- *BACK-UP CLASS*



Standarts: TS EN 60282-1, VDE 0670/4, DIN 43625

İNTER – TEKNİK fuse links are automatic, selectively acting medium voltage switching devices which will protect your transformers, motors, overhead lines, voltage transformers, capacitor banks and installations safely from the thermal and dynamic effects of short circuits within the voltage range of 6-36 kV.

Our experience from 1969 to date, together with extreme care in production, conscious quality control and emphasis on continuous development is the basis of the superior quality of İNTER – TEKNİK fuses.

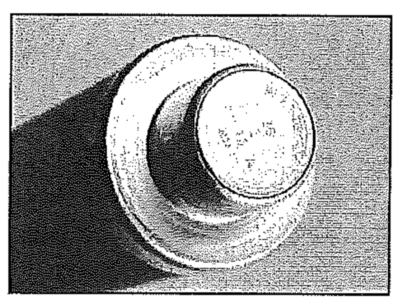
Although there are various types of h.v. fuses, the more reliable and economic CURRENT LIMITING TYPES are mostly preferred in many countries as well as ours. This type works quietly in a completely closed environment. While it functions, no flame or gas overflows outside the system. Therefore no filter, flame cell or special ventilation system is necessary.

The types of fuses with high breaking capacity are used for the short circuit protection of m.v. installations. When they are placed in front of transformers, capacitors, motors, cable outlets or voltage transformers, they protect against the heat or other bad effects of shortcircuit by quick circuit breaking capabilities.

Fuses are the most effective and economic ways of protection against short circuits in m.v. installations.

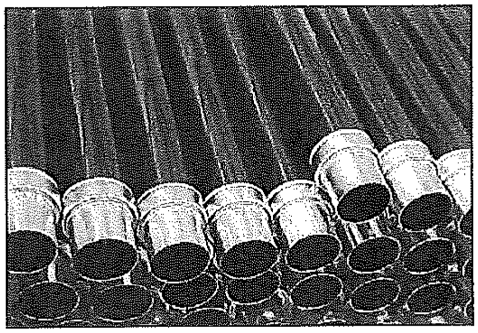
Fuses are not suitable devices for protection against overload. They work safely only over the Imin value. Namely it does not operate safely within the range of In (rated current value) and Imin value, and in some cases the fuses may be damaged. Depending on the quality of the melting line used and the construction of the fuse, Imin shows changes.

Naturally the expansion of the safe operating area for a fuse is a great advantage. For this reason Imin should be as small as possible.

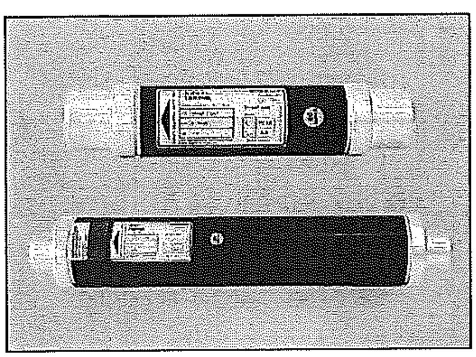


If loading between In rated current and Imin is a must and cannot be prevented, then it is recommended to use load break switches with thermal protective fuses. In that case, before the extreme heat produced in the fuse reaches the tolerance level of the electro porcelain tube of the fuse, the thermic system works to loosen the striker pin which in turn switches off the loadbreak switch in three phases, thus minimizing the risk

CONSTRUCTION



Against short-circuits, fuses provide the most effective and affordable solution



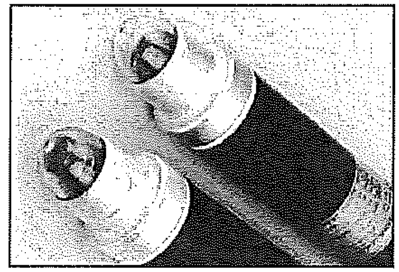
The principle component of the fuse link insert is a starshaped rod. The **pure silver** wire or band is wound around the starshaped rod, thus forming completely similar small cells all along the body. The lengths and cross section of the silver in each cell is completely the same. Many partial arcs form all along the melting line and the thermal heat is evenly distributed in the fuse body thus attaining a higher breaking capacity. The tubes are definitely durable to extrame heat, non inflammable and insulated. More over, especially the outdoor type fuses are durable to atmospheric changes, corrosion, salts, acids and alkali gases. They do not absorb water or moisture. In case the fuse is blown, the body provides insulation. Therefore it must provide the needed insulation level rain or shine. To attain these properties, the ideal material to be used is **electro porcelain.**

To be durable enough to resist the high pressure and heat that will form, the porcelain tubes should be at the least, conforming with the C120 – C130 IEC 672 standards. Metal caps on both ends are made of electrolytic copper of 1 – 1,2 mm. thickness and are nickel or silver plated (4 – 6 microns) against oxidation. The caps are tightly pressed onto the porcelain tubes using silicone seal. Metal pieces in the inner body are manufactured from electrolytic copper. Depending on the In value, they are either silver coated or copper striped of oil. To obtain perfect current conductivity and fuse characteristics the silver wires and bands are welded onto the metal body by point-welding source. The inner body and outer body are also attached by point welding source.

The mechanic strength and water insulation of our fuses are attained by mounting the metal and optical glass caps on both sides, sealing with high heat resistent silicone and special pressing methods.

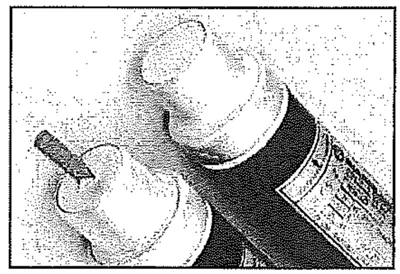
TYPES

The sizes of all our fuse types conform with TS EN 60282-1, DIN43625, and are suitable for indoor and outdoor use.


FUSE WITH OPTICAL INDICATOR

OPTICAL INDICATOR (TYPE: .../OPT)

The fuses with optical indicators, types H220 and H221, have a mechanism showing that the fuse is blown. When the fuse is blown, a small red cap falls into the transparent capsule at the end of the tube.


FUSE WITH STRIKER PIN

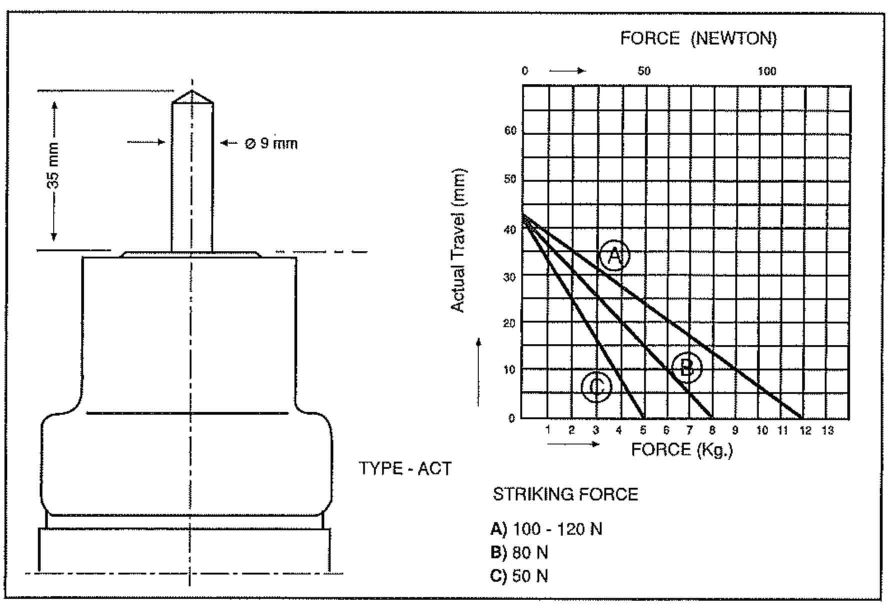
STRIKER PIN (TYPE: .../ACT)

TS EN 60282-1, Table XII – (Medium)

When a fuse is blown a pin is strongly pushed out. Hence, you can see the blown fuse and also automatically initiate another system (e.g. : a switch, notification of an alarm system).

STRIKE PIN FORCE

There are three options:
A) 100 – 120 N
B) 80 N
C) 50 N
The preference should be stated while ordering. If it's necessary to open a switch mechanically, then the choices A or B are advisable.



THERMAL PROTECTION (current limiting type, back-up class)

The operation of medium voltage fuses with thermal protection is determined by minimum breaking current (Imin). These fuses only work safely over the Imin value. Namely, between the values In (rated current) and Imin a safe operation cannot be guaranteed.

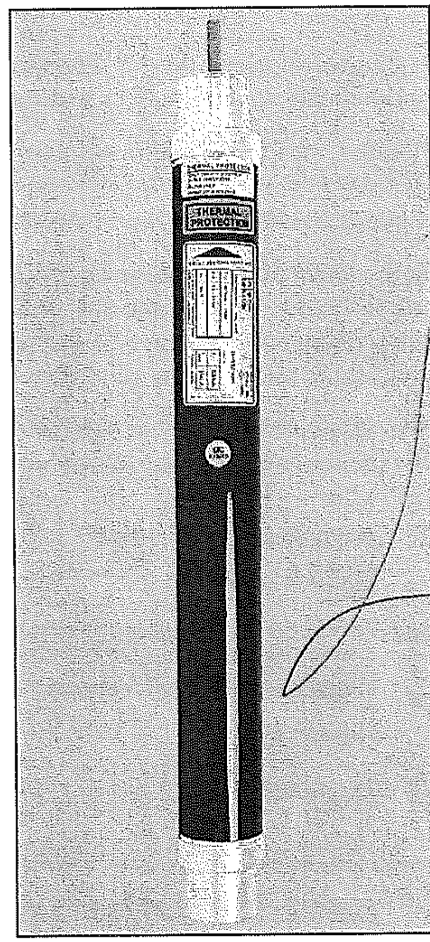
The over loading of fuses in between these values may cause explosion and big damage.

The melting element of the fuse will melt in just one or a few small pieces and the arc produced here will continue to travel within the circuit, leading to extreme thermal forces.

In order to eliminate this problem, our fuses type H220 ACT and type H221 ACT, have a thermal protection system. In this special design, the fuses have a striker device inside the fuse link which is released before the temperature reaches a value endangering the thermal strength of the porcelain tube, and initiates opening of all poles by the help of a switch – disconnector.

Fuses with the thermal protection system should be used in combination with a switch. When used in combination with automatic breaking switch or especially with SF6 gas insulated "Ring Main Unit" pannels, fuses with thermal protection system should be preferred.

Please do not hesitate to contact us for more information on thermal protection.



The risk causes by the extreme thermal forces may be avoided with the use of thermal protection feature.

SHORT CIRCUIT CURRENT LIMITATIONS

Our high-voltage high-breaking-capacity fuse links open the circuit during the current rise in the first loop of short-circuit current. They are thus current-limiting.

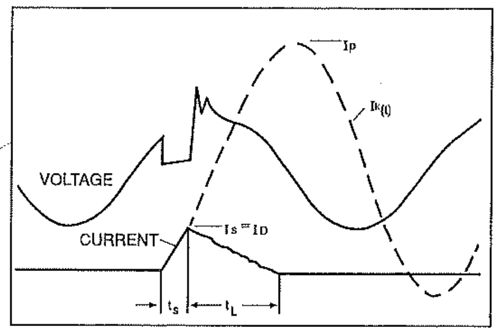
The figure below shows the progress of a short-circuit operation. Without a fuse in the circuit, the short-circuit current would rise as the prospective current I_k shown as a broken line.

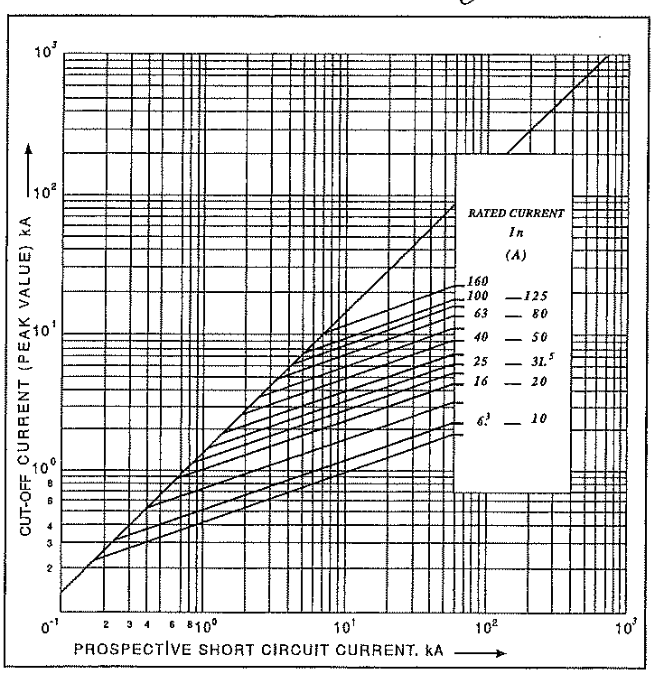
However, the current-limiting action of the fuse-link permits the melting current I_S to rise only to the cut-off value I_D (full line). The current decreases during the arcing time t_L with increasing arc length and is finally broken in the area of a voltage zero passage.

The current-limiting action of the fuse-links relieves the apparatus and parts of the system of thermal and dynamic stresses. It is clear that the application of current-limiting fuse-links is particulary advantageous in older installations which have not been designed for the increasing short-circuit levels of the system.

The value of the cut-off current is influenced by the design of the fuse-link. It further depends on the rated current and the instant on the voltage wave at which the short-circuit occurs.

- I_S **Melting current**
- I_D **Cut-off current**
- $I_{k(t)}$ **Prospective short-circuit current (fuse replaced by metallic link)**
- I_p **Impulse short-circuit current**
- T_S **Pre-arcing time**
- T_L **Arcing time**





The cut-off current of our h.v. h.b.c. fuse links, which can be taken from the diagram, are a function of the prospective short-circuit current (r.m.s. value of the symmetrical component) and of the rated current.

The prospective short-circuit current is expressed by the r.m.s. value of the symmetrical component of the current which would flow at the location of installation if the fuse were replaced by a solid link.

The cut-off currents determined from the diagram are the maximum values which might occur for a given r.m.s. value of the symmetrical component of the prospective short-circuit current with any degree of asymmetry and the highest rate of current rise. Actual values are thus, as a rule, less than the values determined here.

RATED BREAKING CURRENT CAPACITY

The rated breaking current capacity depends on the inner structure of the fuse. The special construction of the fuse link insert ensures that short pre-arcing and arcing times are obtained on operation and that multiple partial arcs are formed. Accordingly the amount of heat generated in the fuse link is relatively small and uniformly divided over the whole length of the fuse elements. These factors provide the increase in the rated current breaking capacity of a fuse. (Please check the rated breaking current values of İNTER –TEKNİK fuses on the back over)

DANGEROUS EXTREME VOLTAGES

When the short circuit current is broken, the voltage will jump. Not to let any damage happen to devices in the installation due to this voltage jump, peak value is limited as 2.UN.($\sqrt{2}$) in theTS and VDE norms. The advantage of using these fuses to protect your transformers, cable outlets and voltage transformers is obvious.

MINIMUM OPERATING VOLTAGE

- In cases where higher breaking capacity is needed or,
- When an installation with low operating voltage is going to be renewed to a higher operating voltage unit (e.g.: because the voltage will be 30 kV, the old installation with an operating voltage of 10 kV will be renewed as 30 kV series) a higher Un valued fuse might be used. If the operating voltage is small in regard to the Un value of the fuse, the voltage jump while the circuit breaks may be extremely ½, meaning that in an operating voltage of 10 kV, a fuse with Un = 20 kV can be safely used.

  For this reason, keeping in mind that the breaking capacity should be suitable to the operating voltage, while giving your orders you should also state the D dimension of the fuse you have selected. Example: In an installation where operational voltage is 10 kV, a fuse of D=442mm can be used (equivalent to a fuse Un=24 kV)

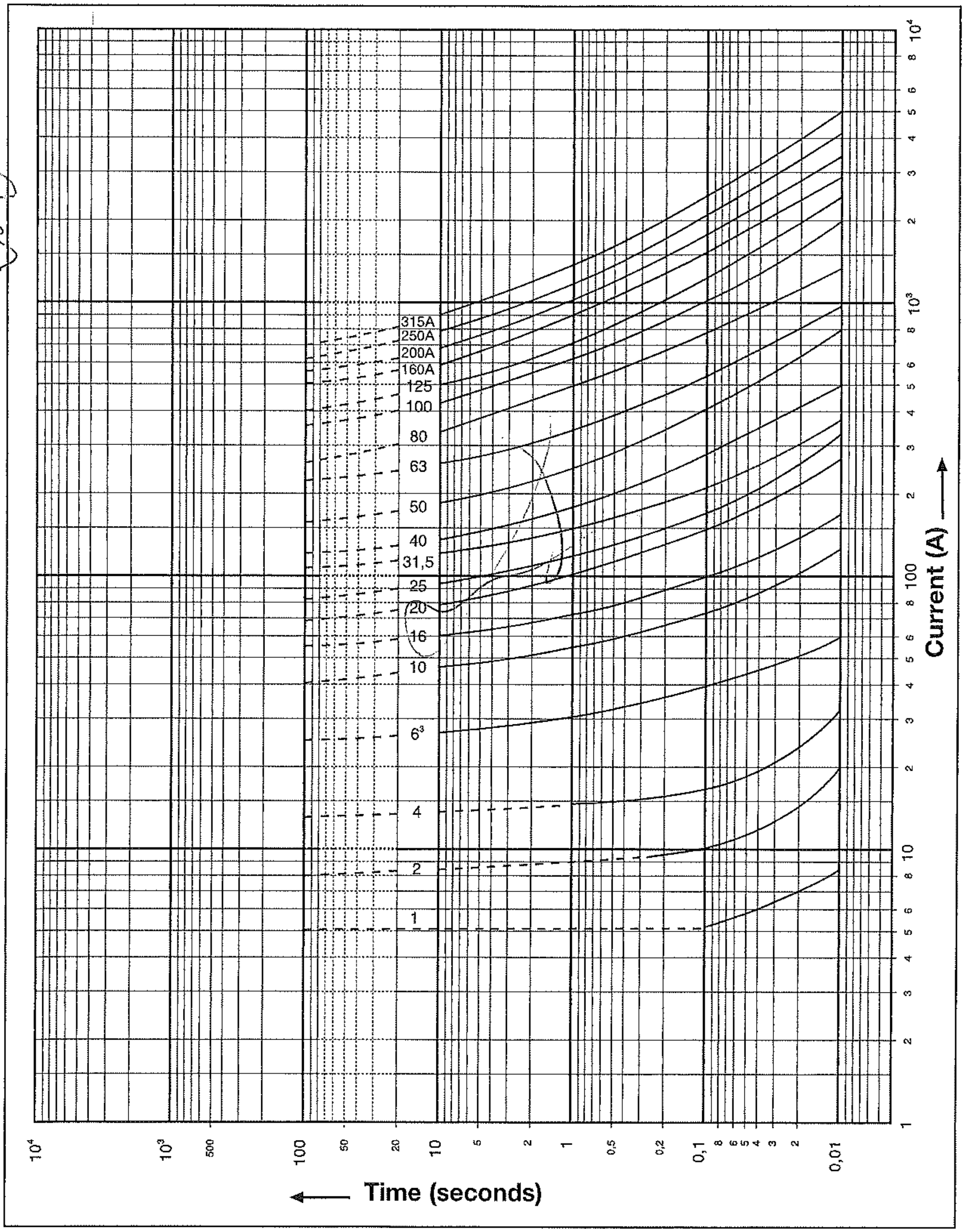
POWER DISSIPATION

The heat produced in the fuse should be released to the atmosphere. In indoor areas and insulated panels, heat is a vital factor effecting the nominal values of the devices.

Approximate power dissipation of the fuse may be calculated as ($R.I^2.K.$); the fuses inner resistance (R value at temparature 20°C) increases due to heating. The K factor indicating this increase is about 1,4 – 2 at the In value. For current values lower than In, this factor takes a value of 1,1 – 1,4.

220

TIME CURRENT CHARACTERISTICS
OF THE
MEDIUM VOLTAGE HIGH BREAKING CAPACITY FUSES



SELECTIONS

RATED VOLTAGE

Must be properly selected in accordance with the operational voltage.

RATED BREAKING CURRENT

Proper fuse selection according to the short circuit load of the network is important. In some special occasions, if necessary, a fuse of a higher voltage group may be selected or two fuses may be connected in serial, thus obtaining a higher rated breaking current capacity.

RATED CURRENT

This value denotes the naming of the fuse. Essentially the selection of the fuse according to the purpose and the place of use is very important. Heat is one of the most important factors. For example in the protection of a transformer, if a fuse of In=6 A is suitable outdoors, when the same transformer is used in a completely closed indoor area, then a fuse In=10 A may be necessary. In extreme cases where higher current values are necessary, two fuses with the same value connected parallel can be used. But as the two fuses standing side by side will give heat to each other, a specific tolerance level should be set.

DERATING FACTOR

The rated current is the current which a fuse link can carry continuously without altering the time/ current characteristic curve. At higher ambient temperatures as well as higher power losses generated by fuses of very high rated currents, it is necessary to pay special attention to derating factors.

Depending on usage conditions and due to the overheating of the fuse body, it is advisable to reevaluate the choice of fuse rating and use a fuse with a greater In value.

In fuses that operate with melting fuse elements, the heat of the fuse body is the main factor that effects the functioning of the fuse. As it functions, the heat produced in the fuse should be transferred to the atmosphere in an effective way. If the body of a used. For example, under normal conditions a fuse In=40 A might be suitable for the protection of a transformer, but if because of environmental factors the fuse heats excessively, then a fuse of In=50 or 63 A should be used.

As the plants of our day are huge and growing in size, they require fuses with very high In values for their protection. Meanwhile, as the In value of fuses increase, due to physical limitations of material and production methods, it becomes very difficult to keep the heat of the fuse at normal temperatures. Therefore, especially under these circumstances special attention should be given to the DERATING FACTOR.

Due to their high starting currents, in the protection of electrical appliances such as motors, transformers or capacitors, fuses with in In values should be selected. In other words, under normal operating conditions the current passing through the fuse will be approximately half, under 25% overload it will be about 75% of the In value of the fuse. Generally the nominal current of the fuse should be 2 or 3 times larger then that of the normal circuit current. It is important to keep this fact in mind.

This means the fuses will warm less. As you evaluate, special attention should be given to this issue. For this reason, on the labels of these fuses both current values are indicated. For example "250 RC 160" means:
- the nominal current of the fuse In=250 A. (the starting current is taken into consideration)
- the current value of the continuous current through the circuit RC (rated current) is 160 A.

MOTOR PROTECTION IEC 60644

The first important criteria in fuse selection is the value and the duration of the INRUSH current of the motor.The fuse should stand this inrush current. In selecting the fuse from the time-current curves, the tolerance on current rates given in the standards should not be neglected (± 20% on current value). The second criteria is the frequency of starting the motor which can lead to the aging of the fuse, which in turn might result in changes in the characteristics of the fuse. Depending on the frequency of the period of starting, the In value of the fuse may be uprated. In selecting your fuse, please keep in mind following: Usually fuse+switch combinations are used for motor protection. If one of the fuses blow due to a fault, the striker pin initiates the switch to break the current in three phases.

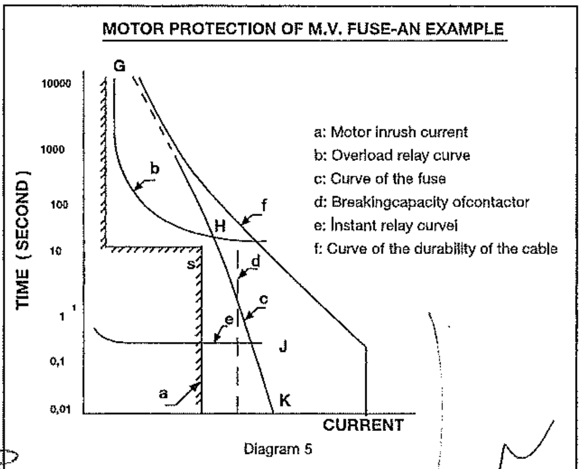
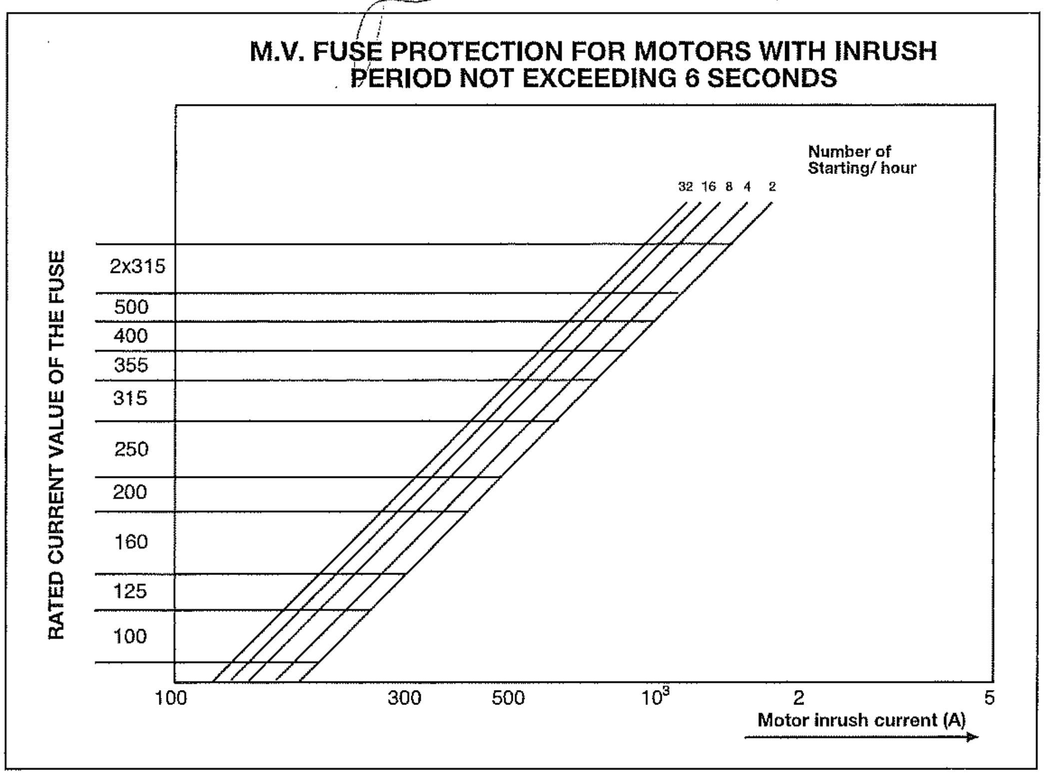


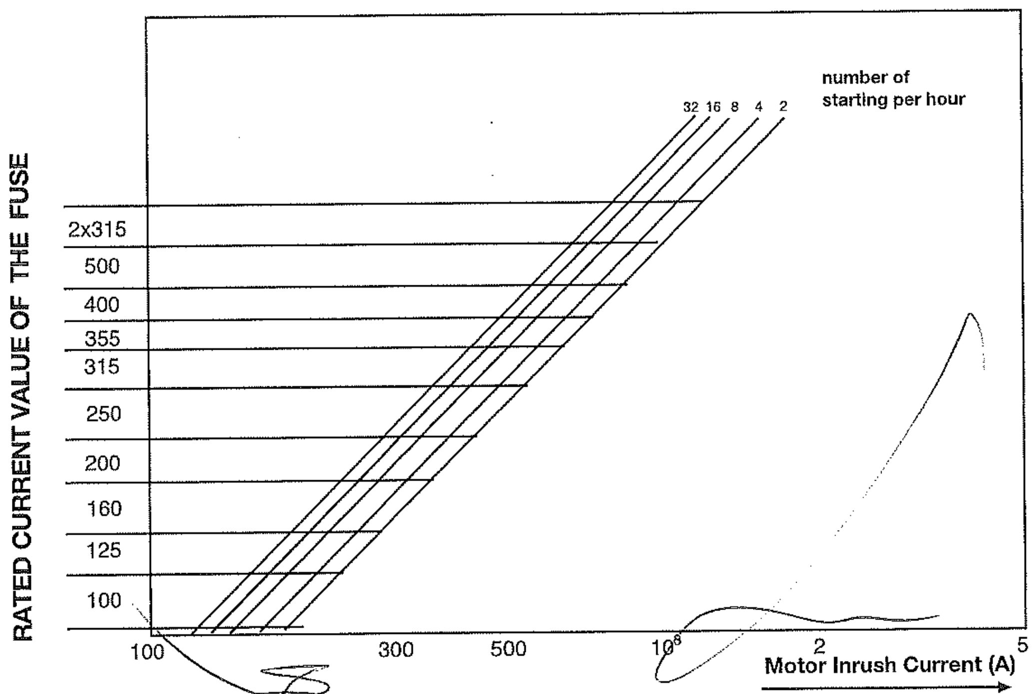
Diagram 5

- The breaking capacity of the fuse should be greater than the short circuit load of the establishment.
- The In value of the fuse should be greater than the nominal power and overload value of the motor. Derating should be done according to the medium in which the fuse will be used, meaning the In value of the fuse should be increased accordingly.
- The In value should be decided upon with an acceptable margin so that the fuse does not blow during starting current period.
- Depending on the number of starting/shutting of the motor, there will be material fatigue. In value should be increased accordingly.
- The minimum breaking current (Imin) value of the fuse should be smaller than the value of point H (see diagram 5).

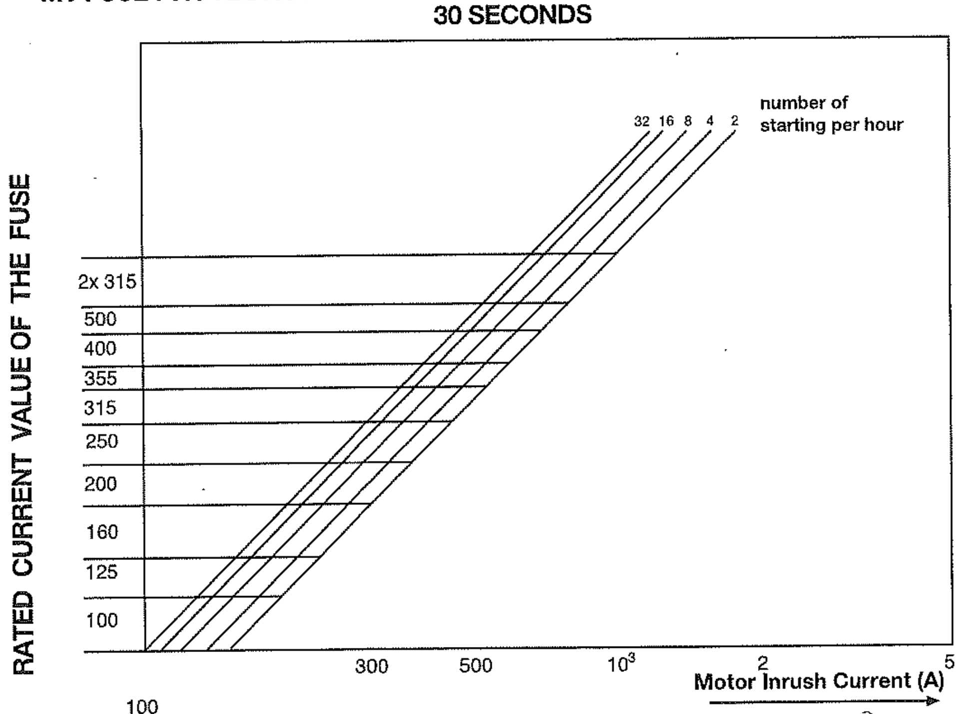
For the coordination between the fuse and the protection relay of the switch, and for all the above listed issues please use the diagram.



MV FUSE PROTECTION FOR MOTORS WITH INRUSH PERIOD NOT EXCEEDING 15 SECONDS



MV FUSE PROTECTION FOR MOTORS WITH INRUSH PERIOD NOT EXCEEDING 30 SECONDS



FUSE PROTECTION OF TRANSFORMERS IEC 60787

All tests and practices show that, when chosen correctly, current limiting h.v. fuses effectively protect transformers by breaking fault currents.

Various criteria have to be observed in selecting h.v.h.b.c. fuse-links for the short circuit protection of transformers. Here are some of them:

1- The rated current of the h.v.h.b.c. fuse-link must not be less than a certain value so as to protect operation of the fuse-link from the transformer inrush current on switching on.
2- The rated current of the fuse-link must be low enough so that the value of the current which might happen during a short-circuit on the low voltage side of the transformer will not be less than Imin value of the fuse.This means that the fuse will perform its breaking safely.
3- The rated current of the medium-voltage fuse link must be sufficiently high to premit the overloading of the transformer and assure selectivity between the fuses on the low voltage side.
4- The rated current of the h.v.h.b.c. fuse-link must be as low as possible so that the fuse can break the current quickly when a fault occurs in the transformer coils and assure the selectivity between the fuse and relay at the start of the mv supply feeder.

Taking the above mentioned points into account, selecting the h.v.h.b.c. fuse links in accordance with the tables below is recommended.

H.V. and L.V. FUSE SELECTING TABLES FOR THE PROTECTION OF DISTRIBUTION TRANSFORMERS

Rated Voltage U_{1N} = 6/7,2 kV U_{2N} = 400V						
Trans. Rated Power (kVA)	Transformer Rated Current		M.V. Fuse Rated Current		L.V. Fuse Rated Current	
	prim. (A)	sec. (A)	min. (A)	max. (A)	min. (A)	max. (A)
25	2,4	36	6,3	6,3	31,5	40
50	4,8	72	10	16	63	80
75	7,2	108	16	25	100	125
100	9,6	144	20	31,5	125	160
125	12,0	180	25	40	160	200
160	15,4	231	31,5	50	200	250
200	19,2	290	40	63	250	315
250	24,0	360	50	80	315	400
315	30,3	455	63	100	400	500
400	38,5	576	80	125	500	630
500	48,1	720	100	160	630	720
630	60,6	910	125	200	800	900
800	77,0	1160	160	200	1000	1200
1000	96,2	1440	200	200	1200	-

Rated Voltage U_{1N} = 10/12 kV U_{2N} = 400V						
Trans. Rated Power (kVA)	Transformer Rated Current		M.V. Fuse Rated Current		L.V. Fuse Rated Current	
	prim. (A)	sec. (A)	min. (A)	max. (A)	min. (A)	max. (A)
25	1,45	36	4	6,3	31,5	40
50	2,9	72	6,3	16	63	80
75	4,3	108	10	16	100	125
100	5,8	144	16	25	125	160
125	7,2	180	16	25	160	200
160	9,2	231	20	31,5	200	250
200	11,5	290	25	31,5	250	315
250	14,4	360	31,5	50	315	400
315	18,2	455	40	63	400	500
400	23,1	576	50	80	500	630
500	28,9	720	63	100	630	720
630	36,4	910	80	125	800	900
800	46,2	1160	100	125	1000	1200
1000	57,7	1440	125	160	1200	-

Trans. Rated Power (kVA)	Rated Voltage U_{1N}= 15/17,5 kV U_{2N} = 400V						Rated Voltage U_{1N}= 20/24 kV U_{2N} = 400V						Rated Voltage U_{1N}= 30/36 kV U_{2N} = 400V					
	Transformer Rated Current		M.V. Fuse Rated Current		L.V. Fuse Rated Current		Transformer Rated Current		M.V. Fuse Rated Current		L.V. Fuse Rated Current		Transformer Rated Current		M.V. Fuse Rated Current		L.V. Fuse Rated Current	
	prim. (A)	sec. (A)	min. (A)	max. (A)	min. (A)	max. (A)	prim. (A)	sec. (A)	min. (A)	max. (A)	min. (A)	max. (A)	prim. (A)	sec. (A)	min. (A)	max. (A)	min. (A)	max. (A)
25	0,95	36	4	6,3	31,5	40	0,7	36	4	6,3	31,5	40	0,5	36	2	6,3	31,5	40
50	1,9	72	6,3	10	63	80	1,4	72	6,3	6,3	63	80	1,0	72	4	6,3	63	80
75	3	108	10	10	100	125	2,2	108	6,3	6,3	100	125	1,5	108	6,3	6,3	100	125
100	4	144	10	16	125	160	2,9	144	10	10	125	160	1,9	144	6,3	6,3	125	160
125	4,8	180	16	20	160	200	3,6	180	10	16	160	200	2,4	180	6,3	10	160	200
160	6,1	231	16	25	200	250	4,6	231	16	20	200	250	3,1	231	10	16	200	250
200	7,7	290	20	25	250	315	5,8	290	16	20	250	315	3,8	290	10	16	250	315
250	9,6	360	25	31,5	315	400	7,2	360	20	25	315	400	4,8	360	16	20	315	400
315	12,1	455	25	31,5	400	500	9,1	455	20	25	400	500	6,1	455	16	25	400	500
400	15,3	576	25	40	500	630	11,5	576	25	40	500	630	7,7	576	16	25	500	630
500	19,7	720	31,5	50	630	720	14,4	720	31,5	50	630	720	9,6	720	25	31,5	630	720
630	24,9	910	40	63	800	900	18,2	910	40	63	800	900	12,1	910	31,5	40	800	900
800	30,8	1160	63	80	1000	1200	23,1	1160	50	63	1000	1200	15,4	1160	40	50	1000	1200
1000	38,6	1440	80	100	1200	-	28,9	1440	63	80	1200	-	19,2	1440	40	50	1200	-
1250	48,1	1800	100	100	-	-	36,1	1800	80	80	-	-	24	1800	50	63	-	-
1600	61,6	2304	125	125	-	-	46,2	2304	100	100	-	-	30,7	2304	63	80	-	-
2000	77,0	2880	160	160	-	-	57,8	2880	125	125	-	-	38,5	2880	2 x 50		-	-

FUSE PROTECTION OF CAPACITOR BANKS

The existence of numerous types of electrical facilities and unknown circuit parameters usually complicates fuse selection. When selecting, keep in mind the following criteria:

- The In value of the fuse should be high enough to withstand the continuous maximum load current and the allowable harmonic content.
- The In value of the fuse should be able to tolerate the inrush value of the condenser bank.
- Voltage increases caused by temporary situations should not be neglected and for security purposes, a higher current class fuse should be selected.
- As for practical information, the In value of the fuse should not be lower than 1,6 – 2 times that of the condenser's full load current value.

WIRE AND LINE PROTECTION

It should not be forgotten that wires and lines will be exposed to overloading from time to time. This situation may cause overloads between the In value and Imin value of the fuse, eventually causing extreme heating and damage. For this reason the fuse should be selected according to the maximum load that the cable or line can carry.

OTHER POINTS

- It is not correct to use a fuse that has been dropped or exposed to any sort of impact without testing it.
- In a three – phase installation, unless you are definitely sure that only the blown fuse was exposed to a faulty current, all three must be replaced, because the fuses that are not blown also might have reached a point very close to functioning and their characteristics might have changed.
- As a precaution, the blown fuse should be changed 5 – 10 minutes after it has blown.

VOLTAGE TRANSFORMER PROTECTION

Because of the low capacity of voltage transformers, h.v. fuses cannot protect the voltage transformer from their own default currents effectively. More often, they are used to seperate the defected voltage transformer from the system. The principle in choosing the fuse is to use a fuse big enough to endure the inrush voltage of the transformer. This means that the fuse should be at the most I_n=1-2 A. The very thin melting line used in the fuses with small In values may lead to a "corona" effect. Therefore, the fuse should definitely be used as far away from earthed metal parts as possible.

THINGS TO INDICATE WHILE ORDERING

Type	: H220 – H221
Indicator	: OPT (Optical) or ACT (striker pin)
If ACT, the force of the striker pin	: F=50 N, F=80 N, F=120 N
Therml protection	:TRM
Rated voltage (Un) kV	: from the table
Length (D) mm	: from the table
Rated current (In) A	: from the table

Example 1-	H220/ACT	F=80 N		Example 2-	H221/OPT	
	Un=36 kV	D=537 mm			Un=12 kV	D=442 mm
	In=40 A	I_1= 31,5 kA			In= 160 A	I_1=63 kA

223

POTENTIAL TRANSFORMER PROTECTION FUSE

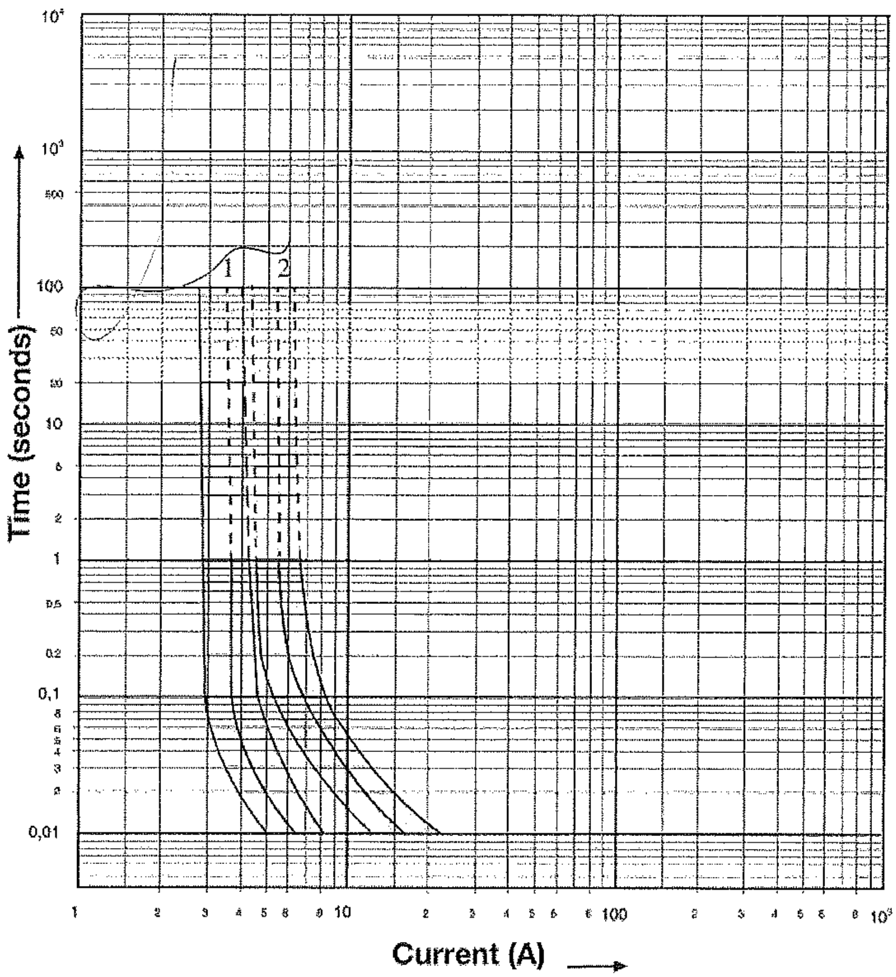
5,5 kV- 36 kV .Type: GTS
(without indicator, indoor type)

Rated voltage Un (kV)	Rated current In (Amp)	L mm	D mm	Breaking capacity I1 (kA)	Minimum breaking current I_3 (A)	Power loss (W)	Pre arching I^2t (A^2s)	Cold resistance R (mΩ)	Weight (kr)
5,5	1	127	20,5	63	8	2,5	1,8	1650	0.090
	2				16	9,0	2,9	1300	
7,2 / 8,25	1	190	20,5	63	8	3,1	1,8	2480	0,130
	2				16	12,0	2,9	2100	
7,2/12/15,5	1	254	20,5	63	8	3,8	1,8	2850	1,175
	2				16	18,0	2,9	2400	
15,5/25,5	1	340	20,5	63	8	4,2	1,8	3300	0,230
	2				16	24	2,9	2600	
*36	1	400	36,5	40	8	6,3	1,8	5000	0,935
	2				16	27,8	2,9	3900	

* Optional: if demanded, the fuse can be produced with indicator.
Note: please indicate Un, In and L values while you are giving orders.

M.V. PONTENTIAL TRANSFORMER PROTECTION FUSE

Type: GTS 1 and 2 A. (without indicator)



OVERVIEW OF STANDARD AND NON-STANDARD DIMENSIONS OF H.V. FUSE DIMENSIONS

		Rated Current (A)																		
Rated voltage	Body length(mm)	1	2	4	6.3	10	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315
36kV	537	537 x Ø53										537 x Ø68	537 x Ø86							
36kV	442	442 x Ø53						442 x Ø68				442 x Ø86								
36kV	367	367 x Ø53						367 x Ø68			367 x Ø86									
36kV	292	292 x Ø53			292 x Ø68			292 x Ø86												
24kV	442	442 x Ø53										442 x Ø68			442 x Ø86					
24kV	537	442 x Ø53										442 x Ø68			442 x Ø86					
24kV	367	367 x Ø53						367 x Ø68				367 x Ø86								
24kV	292	292 x Ø53						292 x Ø68			292 x Ø86									
24kV	192	192 x Ø53			192 x Ø68			192 x Ø86												
17.5kV	367	367 x Ø53										367 x Ø68			367 x Ø86					
17.5kV	537	537 x Ø53										537 x Ø68				537 x Ø86				
17.5kV	442	442 x Ø53										442 x Ø68			442 x Ø86					
17.5kV	292	292 x Ø53						292 x Ø68					292 x Ø86							
17.5kV	192	192 x Ø53			192 x Ø68			192 x Ø86												
12kV	292	292 x Ø53										292 x Ø68			292 x Ø86					
12kV	537	537 x Ø53											537 x Ø68			537 x Ø86				
12kV	442	442 x Ø53											442 x Ø68			442 x Ø68				
12kV	367	367 x Ø53										367 x Ø68			367 x Ø86					
12kV	192	192 x Ø53						192 x Ø68					192 x Ø86							
7.2kV	192	192 x Ø53										192 x Ø68			192 x Ø86					
7.2kV	537	537 x Ø53											537 x Ø68				537 x Ø86			
7.2kV	442	442 x Ø53											442 x Ø68				442 x Ø86			
7.2kV	367	367 x Ø53											367 x Ø68				367 x Ø86			
7.2kV	292	292 x Ø53											292 x Ø68				292 x Ø86			

inter-
teknik

For detailed information please visit our website. Meanwhile, we're glad to offer our technical expertise whenever required, so you are most welcome to contact us for your technical inquiries.

www.inter-teknik.com.tr

Head Office

Kemankeş Cad. Fransız Geçidi
İş Merkezi No:53 Kat:1 C Blok D:16
Karaköy, Beyoğlu / İstanbul-TR
T *+90 212 249 84 58 / 244 32 49*

Factory

Şekerpınar Mah. Marmara Geri
DönüşümcülerYapı Koop. Defne Sok.
No:3 Çayırova / Kocaeli-TR
T *+90 262 658 93 11*

Приложение ТС 11.2
Приложение ТС 11.3

SIBA SICHERUNGEN/FUSES

HHZ-BV 12 - 36 kV

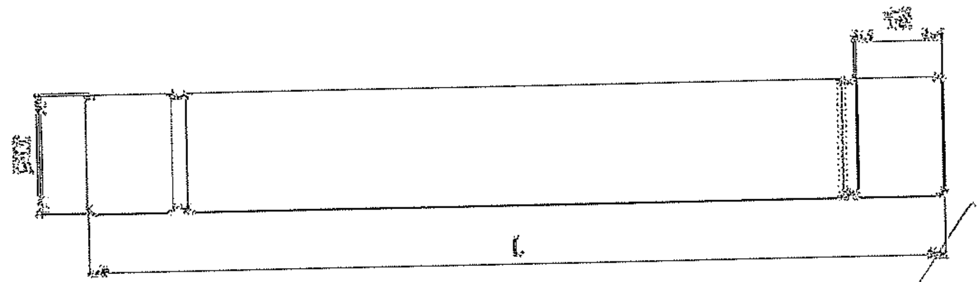
Високоволтови предпазители Ср.Н. - цилиндрични
HH-Sicherungseinsätze - zylindrisch
HV-Fuse-Links - cylindrical

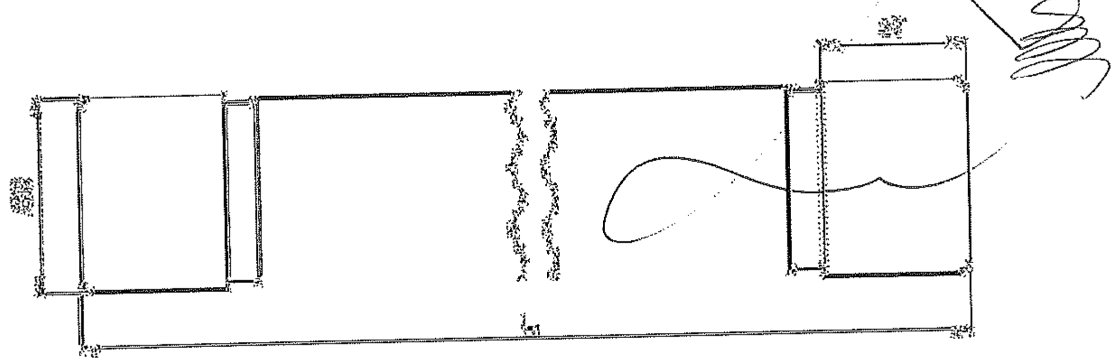
Тип **Type** Type	**HHZ**
Клас **Betriebsklasse** Class	**BV - Teilbereich zum Schutz von Spannungswandlern (VT)** Back-Up for Voltage / Potential Transformer Protection (PT)
Номинално напрежение **Bemessungsspannung** Rated voltage	**12 - 36 kV**
Размер **Größe** Size	**Виж чертежите** **siehe Abmessungen** see dimensions
Ном. изключвателна способност **Bemessungsausschaltvermögen** Rated breaking capacity	**AC 63 kA @ Ur < 36 kV** **AC 40 kA @ Ur ≥ 36 kV**
Стандарт **Standard** Standard	**IEC 60282-1**
Условия на приложение **Betriebsbedingungen** Service conditions	**Приложение - закрит монтаж съг. § 2.1** **Innenraumanlagen gem. § 2.1** Indoor applications acc. § 2.1
Продуктов код **Artikel-Nummer** Article-Number	**Виж размерите** **siehe Abmessungen** see dimensions

Съдържание
Inhalt
Contents

ВЯРНО С ОРИГИНАЛА

Размери
Abmessungen
Dimensions

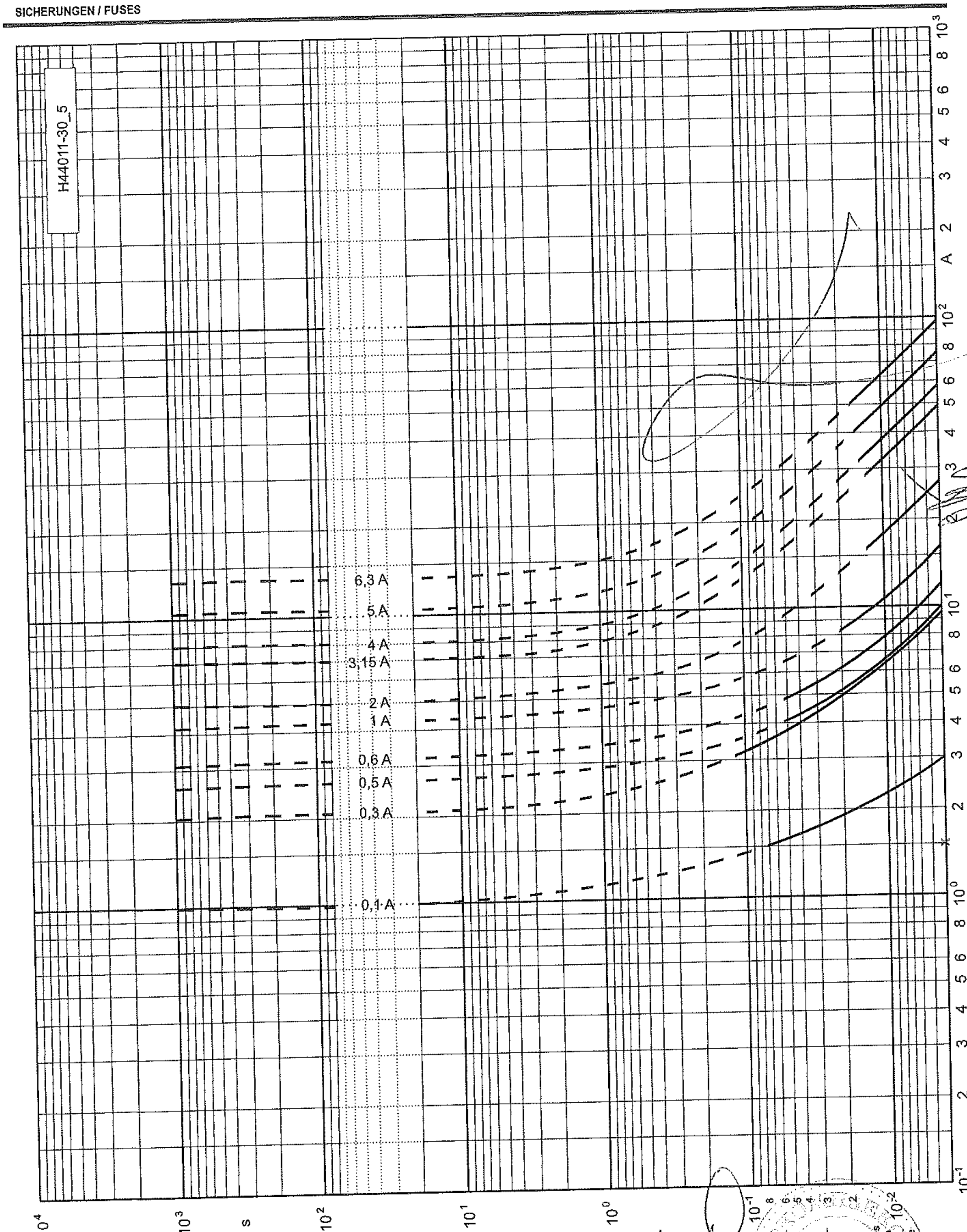




U_n [kV]	**Artikel Nr.** **Продукт №** Article No.	I_n [A]	**L** [mm]	**D** [mm]
6/12	30 440 11	0,1 - 6,3	160	22
10/24	30 441 11	0,1 - 6,3	280	22
	30 443 11	0,1 - 2	250	22
20/36	30 442 11	0,1 - 2	418	36,5

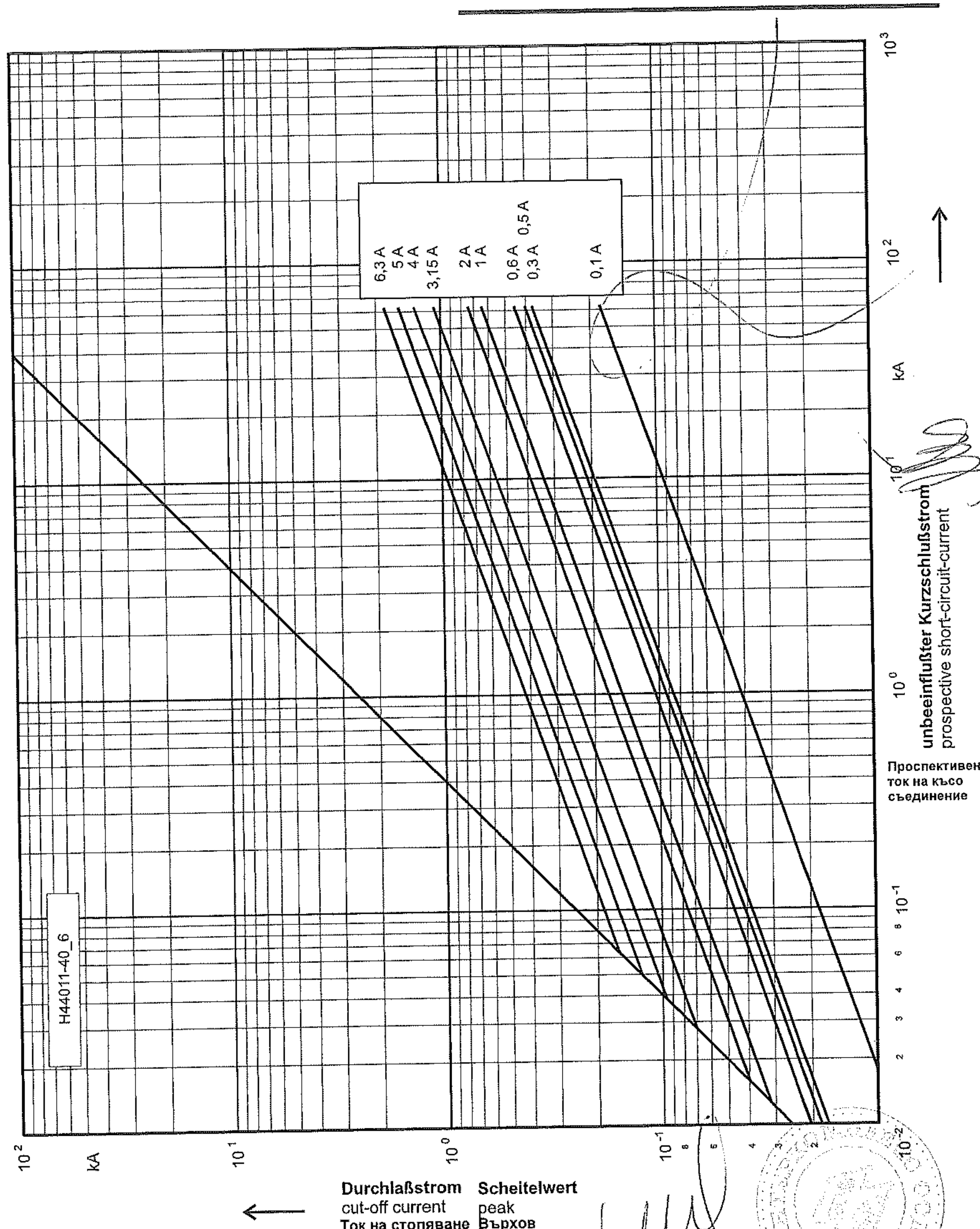
ВЯРНО С ОРИГИНАЛА

226



Време на стопяване
Virtuelle Schmelzzeit
Virtual Pre-arcing time

Графика на изключване
Durchlassstrom
Cut-off current



Електрически характеристики
Elektrische Daten
Electrical data

Ном. Напрежение Bemessungs-spannung Rated voltage [kV]	Продукт № Artikel Nr. Article No.	Ном. ток Bemessungs-strom Rated current [A]	Минимален ток на изключване Kleinster Ausschaltstrom Minimum breaking current [A]	Джаулов интерграл Schmelz-integral Pre arcing I^2t-value [A^2s]	Сума интеграл Ausschalt-integral Total I^2t-value [A^2s]	Загуба на мощност Leistungs-abgabe Power loss [W]	Съпротивление студен предпазител Kaltwider-stand Cold resistance R [mΩ]
6/12	30 440 11	0,1	1,5	0,035	0,35	2,0	20000
		0,3	3,1	0,36	3,6	4,0	3800
		0,5	4,0	0,4	3,4	1,0	3490
		0,6	4,8	0,6	5,1	1,3	2930
		1	8	1,8	13	2,5	1650
		2	16	2,9	21	9,0	1300
		3,15	25	9,2	55	12	735
		4	32	17	90	14	540
		5	40	29	116	18	410
		6,3	50	47	150	25	325
10/24	30 441 11 30 443 11*	0,1	1,5	0,035	0,35	4	40000
		0,3	3,1	0,36	3,6	7	7700
		0,5	4,0	0,4	3,4	1,9	6980
		0,6	4,8	0,6	5,1	2,3	5860
		1	8	1,8	13	4,2	3300
		2	16	2,9	21	16	2600
		3,15	25	9,2	55	22,5	1470
		4	32	17	90	28	1080
		5	40	29	116	35	820
		6,3	50	47	155	48	650
20/36	30 442 11	0,1	1,5	0,035	0,35	7	64000
		0,3	3,1	0,36	3,6	11	12500
		0,5	4,0	0,4	3,4	2,9	10500
		0,6	4,8	0,6	5,1	3,5	8800
		1	8	1,8	13	6,3	5000
		2	16	2,9	21	24	3900

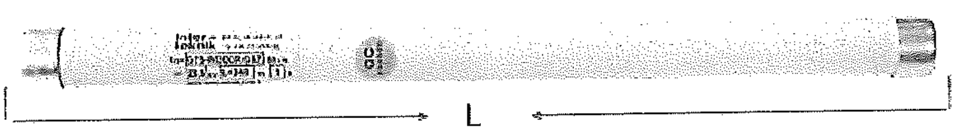
* = only upto 2 A

* = само до 2 A

inter-teknik

ПРЕДПАЗИТЕЛИ ЗА ЗАЩИТА НА ТРАНСФОРМАТОРИ

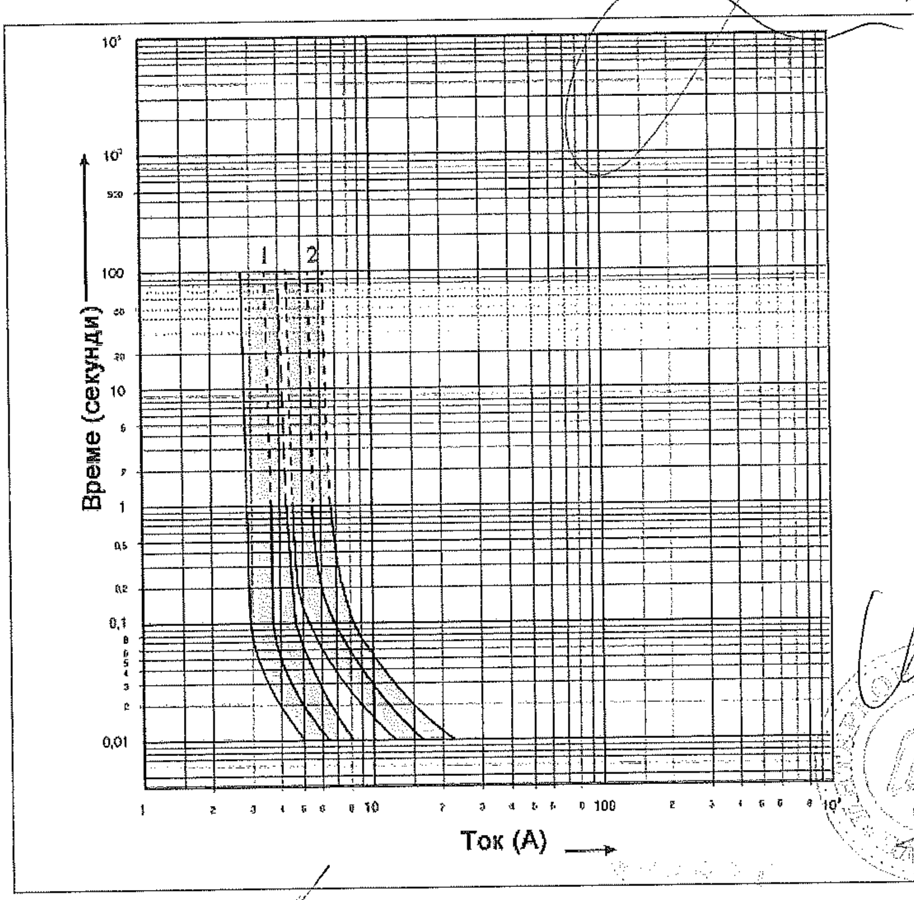
5,5 kV - 36 kV Тип: GTS
(без индикатор,
вътрешен монтаж)



Ном. напрежение Un (kV)	Ном. ток In (Amp)	L mm	D mm	Изключвателна възможност I1 (kA)	Мин. ток на изключване I3 (A)	Загуба на мощност (W)	Джаулов интеграл I^2t (A^2s)	Студено съпротивление R (mΩ)	Тегло (кг)
5,5	1	127	20,5	63	8	2,5	1,8	1650	0.090
	2				16	9,0	2,9	1300	
7,2 / 8,25	1	190	20,5	63	8	3,1	1,8	2480	0,130
	2				16	12,0	2,9	2100	
12/12/15,5	1	254	20,5	63	8	3,8	1,8	2850	1,175
	2				16	18,0	2,9	2400	
15,5/25,5	1	340	20,5	63	8	4,2	1,8	3300	0,230
	2				16	24	2,9	2600	
*36	1	400	36,5	40	8	6,3	1,8	5000	0,935
	2				16	27,8	2,9	3900	

* Опция: При изискване предпазителите могат да бъдат произведени с индикатор.
Забележка: Моля, посочете Un, In и L стойности при заявка

ПРЕДПАЗИТЕЛИ ЗА ЗАЩИТА НА ТРАНСФОРМАТОРИ
ТИП: GTS 1A И 2A (БЕЗ ИНДИКАТОР)



Приложение ТС 11.4

IPH BERLIN

IPH Institut "Prüffeld für elektrische Hochleistungstechnik" GmbH
Landsberger Allee 378A, 12681 Berlin, GERMANY
Member Laboratory of the
SHORT-CIRCUIT TESTING LIAISON (STL)
Member of CESI-GROUP

Certificate No. 07267-17-0663

Copy No. 1

TYPE TEST CERTIFICATE

OF COMPLETE TYPE TESTS

TEST OBJECT:	High-voltage fuses - Current-limiting fuses						
DESIGNATION:	30 441 11						
	Rated voltage:	24	kV	Rated current of the fuse-link:	0.5, 2 and 6.3	A	
	Rated frequency:	50	Hz	Rated breaking current:	63	kA	
SERIAL NO.	Test samples						
MANUFACTURER	SIBA GmbH Borker Straße 20-22 44534 Lünen GERMANY						
CLIENT	SIBA GmbH Borker Straße 20-22 44534 Lünen GERMANY						
DATE(S) OF TEST	21 September 2017, 5 October 2017						
TESTED BY	IPH Institut "Prüffeld für elektrische Hochleistungstechnik" GmbH						

The apparatus, constructed in accordance with the description, drawings and photographs incorporated in this certificate has been subjected to the series of proving tests in accordance with

IEC 60282-1: 2009-10+A1: 2014, Sub-clause 6.6

This Type Test Certificate has been issued by IPH following exclusively the STL Guides.

The results are shown in the record of Proving Tests and the oscillograms attached hereto. The values obtained and the general performance are considered to comply with the above Standard(s) and to justify the ratings assigned by the manufacturer as listed on the ratings page.

The Certificate applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designations with that tested rests with the Manufacturer.

This Certificate comprises 61 sheets in total.

На основание чл.36а ал.3 от ЗОП

[redacted]

PRÜFFELD FÜR ELEKTRISCHE HOCHLEISTUNGSTECHNIK GMBH INSTITUT IPH BERLIN

Independent test laboratory accredited by the German Accreditation Body DAkkS, Deutsche Akkreditierungsstelle GmbH, in the fields of high-voltage switchgear and their components, cables and conductors as well as industrial low-voltage apparatus.
Institut „Prüffeld für elektrische Hochleistungstechnik" GmbH (IPH Berlin) is a subsidiary of CESI S.p.A. Milan.

DAkkS Deutsche Akkreditierungsstelle D-PL-12107-01-00

ВЯРНО С ОРИГИНАЛА

Contents Sheet

This test document comprises 61 sheets.

Distribution Copy No. 1

Copy No. 1 in English: SIBA GmbH

1. Present at the test

Mr.	Georgias	IPH test engineer in charge
Mr.	Moritz	IPH test engineer
Mrs.	Hauschild	IPH test engineer
Mr.	Schaefer	Test engineer FGH Engineering & Test GmbH
Mr.	Kräwer	Test engineer FGH Engineering & Test GmbH
Mr.	Wilhelm	SIBA GmbH

2. Test performed

Breaking tests (Test duties 1, 2, 3)

3. Identity of the test object

3.1 Technical data and characteristics

Test object:	High-voltage fuses - Current-limiting fuses		
Type:	30 441 11		
Manufacturer:	SIBA GmbH Borker Straße 20-22 44534 Lünen GERMANY		
Serial No.:	Test samples		
Year of manufacture:	2017		
Rated characteristics:	Rated voltage	24	kV
	Rated current of the fuse-link	0.5, 2 and 6.3	A
	Rated frequency	50	Hz
	Rated breaking current	63	kA
	Class	Back up	
	Transient recovery voltage u_c/t_3	0.47	kV/µs
	u_c	42.5	kV
Characteristics:	Striker characteristic	None	
	Length	280	mm

Note:

The fuses are part of a homogeneous series 0.5 A / 1 A / 2 A / 3.15 A / 4 A / 5 A / 6.3 A according to IEC 60282-1, Sub-clause 6.6.4.

Rated current of the fuse-link	A	0.5	1	2	3.15	4	5	6.3
Minimum breaking current	A	4	7.6	15	25	32	40	50
Parallel melting elements		1	1	1	1	1	1	1
I_3/S	A/mm²	1684	1512	2515	2228	2079	1989	1965

3.2 Identity documents

The manufacturer confirms that the test object has been manufactured in compliance with the drawings given in this document. IPH did not verify this compliance in detail.
The identity of the test object is fixed by the following drawings and data submitted by the client:

Name of drawing	Drawing No.	Date of drawing	Author	Notes
HHZ-BV Fuse-link for Potential Transformers 24kV	30 441 11.	06.10.17	SIBA GmbH	Sheet 59
Melting Element	30 441 01	05.10.17	SIBA GmbH	Sheet 60
HHZ-BV 6-36 kV Virtual Pre-arcing time	H44011-30 Rev. 4	13.10.17	SIBA GmbH	Sheet 61
Prüfprotokoll Artikel Nummer 3044111 Un 10/24 kV In 0.5 A	8623	18.07.17	SIBA GmbH	1)
Prüfprotokoll Artikel Nummer 3044111 Un 10/24 kV In 2 A	6711	13.03.14	SIBA GmbH	1)
Prüfprotokoll Artikel Nummer 3044111 Un 10/24 kV In 3.15 A	8624	18.07.17	SIBA GmbH	1)
Prüfprotokoll Artikel Nummer 3044111 Un 10/24 kV In 6.3 A	8626	19.07.17	SIBA GmbH	1)
Wickelkörper Ø9,2 mm	30 376 11-4	17.05.17	SIBA GmbH	1)
Isolierrohr	30 440 11-1	17.05.17	SIBA GmbH	1)
Test Report	L15033	15.05.15	FGH GmbH	1)

1) These documents were submitted for the identification of the test object. They are not part of this test document and are retained in the IPH archives.

Entry of test object at IPH: 13 September 2017

233

4. Breaking tests

4.1 Test laboratory

FGH, High-power test laboratory (Test duty 3)
IPH, High-power test laboratory, test bay 2 (Test duties 1, 2, 3)

4.2 Normative document

IEC 60282-1: 2009-10+A1: 2014, Sub-clause 6.6

4.3 Required test parameters

Parameters			Test duties 1	Test duties 2	Test duties 3
Power-frequency recovery voltage		kV	20.9	20.9	24.0
Prospective current		kA	63.0	-	0.0076 / 0.05
Current at initiation of arcing/ I_2			-	0.85 to 1.06	-
Power factor			0.07 to 0.15		0.4 to 0.6
Test frequency		Hz	50		
Prospective TRV	u_c	kV	42.5	44.0	Not specified
	u_c/t_3	kV/µs	0.47	0.167 to 0.125	Not specified
Maintained voltage after breaking		s	≥ 15	≥ 60	
Number of tests			3	3	2

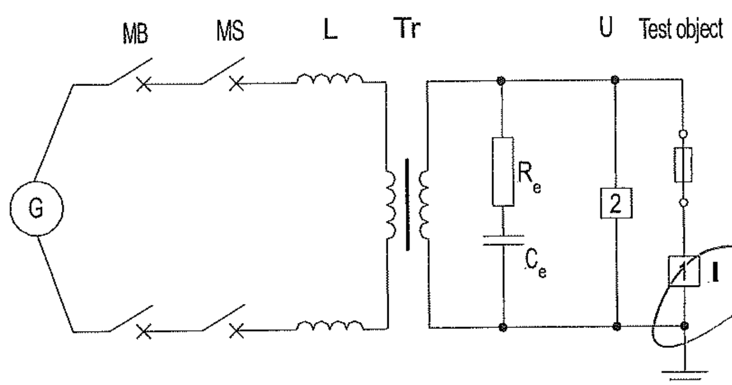
4.4 Test arrangement

The breaking tests were performed with single-phase alternating current and with single fuses. The fuses to be tested were mounted on a rigid earthed metal structure in the normal service position according to IEC 60282-1: 2009-10, Sub-clause 6.6.1.5.

4.5 Test and measuring circuits

Technical data of test circuits

Test requirement		Breaking tests in test duty 1
Test No.		117 3645 to 117 3652
Number of phases	(Test circuit)	2
Number of poles/phases	(Test object)	1
Test frequency	Hz	50
Power factor cos φ		< 0.15
Earthing conditions	Generator, grid	Not earthed
	Short-circuit transformers	Earthed



E	Power supply	1, 2	Measuring points
MB	Master breaker	I	Current measurement
MS	Making switch	U	Voltage measurement
L	Current limiting reactor	R_e, C_e	TRV elements
Tr	Short-circuit transformer		

Figure 1: Test circuit diagram

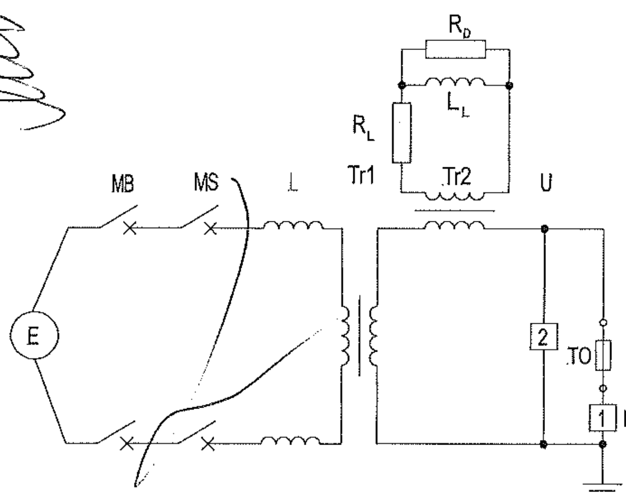
Technical data of measuring circuits

Measuring point	Symbol in the oscillograms	Measuring quantity	Measuring sensor/device
1	I	Breaking current	Shunt
2	U	Voltage	RC divider
Recording instrument: AD 3000 multichannel transient recorder system			

234

Test and measuring circuits (continued)

Test requirement		Breaking tests, test duties 2 and 3
Test No.	Test duty 2	117 3624 to 117 3638
Test No.	Test duty 3	117 3639 to 117 3644
Number of phases	(Test circuit)	2
Number of poles/phases	(Test object)	1
Test frequency	Hz	50
Power factor cos φ		0.5
Earthing conditions	Network	Not earthed
	Short-circuit transformer	Earthed



E	Power supply voltage circuit (network)	U	Voltage measurement
MB	Master breaker	I	Current measurement
MS	Making switch	1-2	Measuring points
L	Current limiting reactor	R_L, L_L	Load elements
Tr1	Short-circuit transformer	TO	Test object
Tr2	Transformer of the load circuit	R_D	Damping resistor

Figure 2: Test circuit diagram, test duties 2 and 3

Technical data of measuring circuits

Measuring point	Symbol in the oscillograms	Measuring quantity	Measuring sensor/ device
1	i	Breaking current	Current transformer
2	u	Voltage	RC divider
Recording Instrument: AD 3000 multichannel transient recorder system			

Test and measuring circuits (continued)

Test requirement		Breaking tests, test duty 3
Test No.	115-12/	60 to 62
Number of phases	(Test circuit)	2
Number of poles/phases	(Test object)	1
Test frequency	Hz	50
Power factor cos φ		0.53
Damping resistor	kΩ	45.1
Earthing conditions	Network	Not earthed
	Short-circuit transformer	Earthed

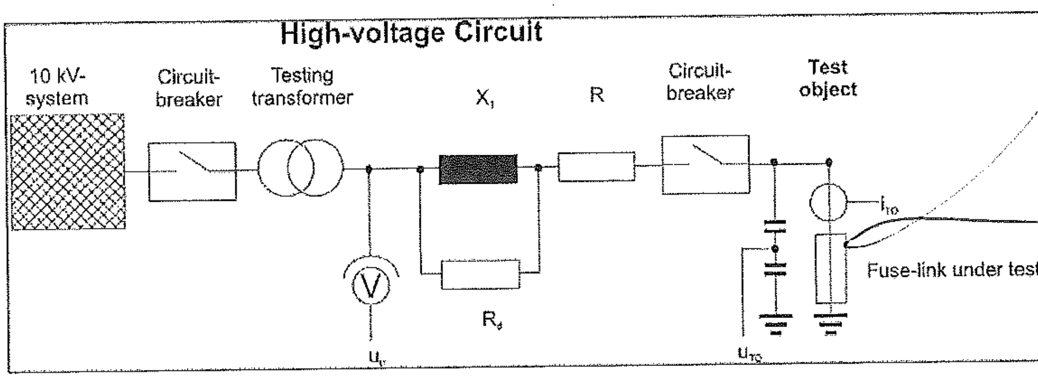


Figure 3: Test circuit diagram, test duty 3

Technical data of measuring circuits

Measuring point	Symbol in the oscillograms	Measuring quantity	Measuring sensor/ device
1	i TO	Breaking current	Current transformer
2	u Netz	Voltage	Voltage transformer
3	u TO	Voltage	Capacitive voltage divider

4.6 Test results

Test duty:	1
Date of test:	15 September 2017
Test circuit:	See Sheet 7
Condition of test object before test:	New
Prospective transient recovery voltage:	u_c = 42.9 kV t_3 = 83 µs u_c/t_3 = 0.517 kV/µs

Test No.		117 3647	117 3648	117 3649
Test sample No.		17	18	19
Rated current of fuse-link	A	6.3	6.3	6.3
Resistance	mΩ	643	644	645
Test voltage	kV	21	21	21
Prospective peak current	kA	163	163	163
Prospective breaking current I_p	kA	63.5	63.5	63.5
Power factor cos φ		0.06	0.06	0.06
Making angle	°el.	68.4	74.3	51.9
Initiation of arcing after voltage zero	°el.	76.7	79.3	52.0
Cut-off current	A	891	1506	1776
Melting time	ms	0.46	-	0.007
Arcing time	ms	0.05	0.06	0.010
Operating time	ms	0.51	0.1	0.017
Melting integral	A²s	50.8	27.0	8.26
Arcing integral	A²s	7.11	41.6	5.67
Operating Integral	A²s	58.7	68.9	17.1
Arcing energy	kVAs	0.85	1.74	-
Peak switching voltage	kV	66.6	98.9	73.4
Recovery voltage	kV	20.9	20.9	20.9
Maintaining voltage after breaking	s	15	15	15
Fuse operated correct	y/n	y	y	y
Switching voltage us ≤ permissive value	y/n	y	y	y
Current limiting (id ≤ cut-off characteristics)	y/n	y	y	y
Emission of flames or sand	y/n	n	n	n
Damages (external)	y/n	n	n	n
Operation of striker correct	y/n	y	y	y
Evaluation		OK	OK	OK

Notes:

OK - Passed

Test No. 117 3645, current setting at 53 %
Test No. 117 3646, voltage operation

Condition of test object after test:

It was possible to remove the fuse-link in one piece after operation.

Test results (continued)

Test duty: 1

Date of test: 15 September 2017

Test circuit: See Sheet 7

Condition of test object before test: New

Prospective transient recovery voltage: u_C = 42.9 kV t_3 = 83 µs u_c/t_3 = 0.517 kV/µs

Test No.		117 3650	117 3651	117 3652
Test sample No.		20	21	22
Rated current of fuse-link	A	0.5	0.5	0.5
Resistance	mΩ	7460	7460	7390
Test voltage	kV	21	21	21
Prospective peak current	kA	163	163	163
Prospective breaking current I_p	kA	63.5	63.5	63.5
Power factor cos φ		0.06	0.06	0.06
Making angle	°el.	47	79	88
Initiation of arcing after voltage zero	°el.	47	79	88
Cut-off current	A	688	1034	1100
Operating time	ms	0.019	0.017	0.019
Peak switching voltage	kV	29.6	29.7	29.8
Recovery voltage	kV	20.9	20.9	20.9
Maintaining voltage after breaking	s	15	15	15
Fuse operated correct	y/n	y	y	y
Switching voltage us ≤ permissive value	y/n	y	y	y
Current limiting (id ≤ cut-off characteristics)	y/n	y	y	y
Emission of flames or sand	y/n	n	n	n
Damages (external)	y/n	n	n	n
Operation of striker correct	y/n	y	y	y
Evaluation		OK	OK	OK

Notes:

OK - Passed

Condition of test object after test:

It was possible to remove the fuse-link in one piece after operation.

Test results (continued)

Test duty:	2
Date of test:	15 September 2017
Test circuit:	See Sheet 8
Prospective transient recovery voltage:	u_C = 44.5 kV t_3 = 345 µs u_c/t_3 = 0.129 kV/µs

Test No.		117 3625	117 3626	117 3627
Test sample No.		1	2	3
Rated current of fuse-link	A	6.3	6.3	6.3
Resistance	mΩ	637	638	638
Test voltage	kV	21.0	21.0	21.0
Prospective peak current	A	729	729	729
Prospective breaking current I_p	A	271	271	271
Power factor cos φ		0.03	0.03	0.03
Making angle	°el.	7.2	14.0	4.86
Initiation of arcing after voltage zero	°el.	67.5	75.1	66.1
Melting current i_s	A	235	237	240
Cut-off current	A	241	237	251
i_s / I_p		0.87	0.87	0.89
Melting time	ms	3.35	3.39	3.40
Arcing time	ms	6.26	5.59	6.22
Operating time	ms	9.61	8.98	9.63
Melting integral	A^2s	45.4	46.7	46.3
Arcing integral	A^2s	110	65.9	98.9
Operating integral	A^2s	155	113	145
Arcing energy	kVAs	22.9	19.0	21.9
Peak switching voltage	kV	54.8	69.0	63.3
Recovery voltage	kV	21.2	21.0	21.0
Maintaining voltage after breaking	s	60	60	60
Fuse operated correct	y/n	y	y	y
Switching voltage us ≤ permissive value	y/n	y	y	y
Current limiting (Id ≤ cut-off characteristics)	y/n	y	y	y
Emission of flames or sand	y/n	n	n	n
Damages (external)	y/n	n	n	n
Operation of striker correct	y/n	y	y	y
Evaluation		OK	OK	OK

Notes:

OK - Passed

Test No. 117 3624, current setting

Condition of test object after test:

It was possible to remove the fuse-link in one piece after operation.

Test results (continued)

Test duty: 2

Date of test: 15 September 2017

Test circuit: See Sheet 8

Prospective transient recovery voltage: u_c = 45.7 kV t_3 = 342 µs u_c/t_3 = 0.134 kV/µs

Test No.		117 3631	117 3632	117 3633
Test sample No.		6	7	8
Rated current of fuse-link	A	2	2	2
Resistance	mΩ	2632	2566	2513
Test voltage	kV	21.0	21.0	21.0
Prospective peak current	A	168	168	168
Prospective breaking current I_p	A	63.0	63.0	63.0
Power factor cos φ		0.04	0.04	0.04
Making angle	°el.	2.88	4.14	4.14
Initiation of arcing after voltage zero	°el.	63.9	67.3	67.3
Melting current i_s	A	56.4	57.7	57.7
Cut-off current	A	65.9	67.9	67.5
i_s / I_p		0.90	0.92	0.92
Melting time	ms	3.39	3.51	3.51
Arcing time	ms	7.37	6.65	7.24
Operating time	ms	10.8	10.2	10.8
Melting integral	A^2s	2.65	2.78	2.80
Arcing integral	A^2s	16.0	11.6	15.2
Operating integral	A^2s	18.6	14.4	18.0
Arcing energy	kVAs	7.38	6.82	7.40
Peak switching voltage	kV	44.7	51.1	46.3
Recovery voltage	kV	21.0	20.9	20.9
Maintaining voltage after breaking	s	60	60	60
Fuse operated correct	y/n	y	y	y
Switching voltage us ≤ permissive value	y/n	y	y	y
Current limiting (id ≤ cut-off characteristics)	y/n	y	y	y
Emission of flames or sand	y/n	n	n	n
Damages (external)	y/n	n	n	n
Operation of striker correct	y/n	y	y	y
Evaluation		OK	OK	OK

Notes:

OK - Passed

Test No. 117 3630, current setting

Condition of test object after test:

It was possible to remove the fuse-link in one piece after operation.

Test results (continued)

Test duty: 2

Date of test: 15 September 2017

Test circuit: See Sheet 8

Prospective transient recovery voltage: u_c = 44.3 kV t_3 = 321 µs u_c/t_3 = 0.138 kV/µs

Test No.		1173635	1173636	1173638
Test sample No.		9	10	12
Rated current of fuse-link	A	0.5	0.5	0.5
Resistance	mΩ	7320	7430	7190
Test voltage	kV	21.0	21.0	21.0
Prospective peak current	A	55.6	55.6	55.6
Prospective breaking current I_p	A	23.6	23.6	23.6
Power factor cos φ		0.13	0.13	0.13
Making angle	°el.	13.9	1.08	7.38
Initiation of arcing after voltage zero	°el.	71.5	63.2	63.5
Melting current I_s	A	20.1	20.2	20.9
Cut-off current	A	26.7	26.6	26.3
I_s / I_p		0.85	0.86	0.89
Melting time	ms	3.21	3.45	3.12
Arcing time	ms	6.46	6.93	7.09
Operating time	ms	9.67	10.4	10.2
Melting integral	A^2s	0.36	0.34	0.37
Arcing integral	A^2s	1.89	2.19	2.57
Operating integral	A^2s	2.24	2.53	2.94
Arcing energy	kVAs	2.45	2.55	2.67
Peak switching voltage	kV	48.2	46.3	44.2
Recovery voltage	kV	21.5	21.6	21.6
Maintaining voltage after breaking	s	60	60	60
Fuse operated correct	y/n	y	y	y
Switching voltage us ≤ permissive value	y/n	y	y	y
Current limiting (Id ≤ cut-off characteristics)	y/n	y	y	y
Emission of flames or sand	y/n	n	n	n
Damages (external)	y/n	n	n	n
Operation of striker correct	y/n	y	y	y
Evaluation		OK	OK	OK

Notes:

OK - Passed

Test No. 117 3634, current setting

Condition of test object after test:

It was possible to remove the fuse-link in one piece after operation.

Test results (continued)

Test duty: 3

Date of test: 15 September 2017

Test circuit: See Sheet 8

Test No.		117 3640	117 3641
Test sample No.		13	14
Rated current of fuse-link	A	6.3	6.3
Resistance	mΩ	645	646
Test voltage	kV	24.1	24.1
Prospective breaking current I_p	A	50.0	50.0
Power factor cos φ		0.43	0.43
Melting time	ms	22.5	22.9
Arcing time	ms	3.93	3.63
Operating time	ms	26.4	26.5
Melting integral	A^2s	48.8	50.3
Arcing integral	A^2s	6.8	5.85
Operating integral	A^2s	56.0	56.4
Peak switching voltage	kV	33.8	33.5
Recovery voltage	kV	24.1	24.1
Maintaining voltage after breaking	s	60	60
Fuse operated correct	y/n	y	y
Switching voltage us ≤ permissive value	y/n	y	y
Current limiting (id ≤ cut-off characteristics)	y/n	y	y
Emission of flames or sand	y/n	n	n
Damages (external)	y/n	n	n
Operation of striker correct	y/n	y	y
Evaluation		OK	OK

Notes:

OK - Passed

Test No. 117 3639, current setting

Condition of test object after test:

It was possible to remove the fuse-link in one piece after operation.

238

Test results (continued)

Test duty: 3

Date of test: 15 September 2017

Test circuit: See Sheet 8

Test No.		117 3643	117 3644
Test sample No.		15	16
Rated current of fuse-link	A	2	2
Resistance	mΩ	2588	2496
Test voltage	kV	24.9	24.9
Prospective breaking current I_p	A	16.0	16.0
Power factor cos φ		0.43	0.43
Melting time	ms	14.5	14.3
Arcing time	ms	2.25	2.51
Operating time	ms	16.7	16.8
Melting integral	A^2s	3.39	3.27
Arcing integral	A^2s	0.46	0.55
Operating integral	A^2s	3.77	3.72
Peak switching voltage	kV	40.4	36.8
Recovery voltage	kV	24.9	24.9
Maintaining voltage after breaking	s	60	60
Fuse operated correct	y/n	y	y
Switching voltage us ≤ permissive value	y/n	y	y
Current limiting (id ≤ cut-off characteristics)	y/n	y	y
Emission of flames or sand	y/n	n	n
Damages (external)	y/n	n	n
Operation of striker correct	y/n	y	y
Evaluation		OK	OK

Notes:

OK - Passed

Test No. 117 3642, current setting

Condition of test object after test:

It was possible to remove the fuse-link in one piece after operation.

Test results (continued)

Test duty: 3

Date of test: 16 January 2013

Test circuit: See Sheet 9

Test No.	115-12/	61	62
Test sample No.		17	18
Rated current of fuse-link	A	1	1
Resistance	mΩ	3760	3600
Power factor cos φ		0.56	0.56
Prospective breaking current (RMS)	A	7.57	7.57
Pre-arcing / Melting time	ms	39.0	35.5
Arcing time	ms	4.13	2.09
Arcing Joule integral	A^2s	0.30	0.06
Max. switching voltage	kV	35.9	37.4
Power frequency recovery voltage	kV	24.5	24.5
Duration of power frequency recovery voltage	s	› 60	› 60
Fuse operated correct	y/n	y	y
Switching voltage us ≤ permissive value	y/n	y	y
Emission of flames or sand	y/n	n	n
Damages (external)	y/n	n	n
Operation of striker correct	y/n	y	y
Evaluation		OK	OK

Notes:

OK - Passed

Test No. 115-12/60, current setting

Condition of test object after test:

It was possible to remove the fuse-link in one piece after operation.

239

5. Evaluation of test

The fuses were capable of correctly breaking in test duties 1, 2 and 3.

It was possible to remove the fuse-links in one piece after operation.

The fuse-links had not emitted flames.

The striker operated correctly.

After the fuses had operated, the components of the fuses were in the original state.

The test object has PASSED the breaking tests.

6. Time-current characteristic tests

6.1 Test laboratory

Low-voltage test laboratory, test room 4

6.2 Normative document

IEC 60282-1: 2009-10, Sub-clause 6.7

6.3 Required test parameters

Test voltage		Any
Time range	s	0.01 to 600
Test frequency	Hz	50
Number of tests		1

6.4 Test arrangement

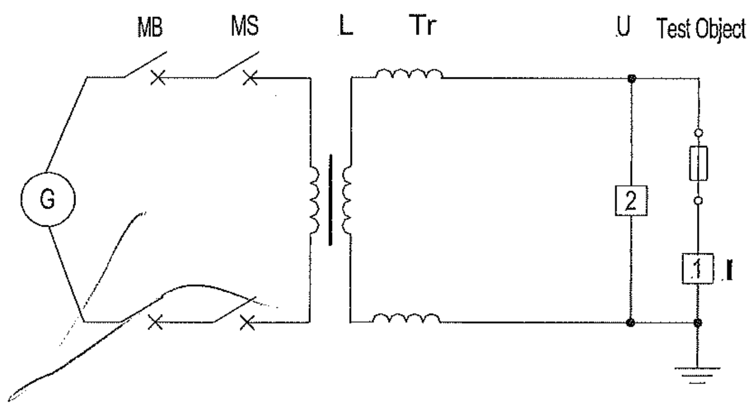
The tests were performed with single-phase alternating current and with single fuses. The fuses to be tested were mounted in a fuse holder as in normal service.

240

6.5 Test and measuring circuits

Technical data of test circuits

Test requirement		Time-current characteristic tests
Test No.		417 7805 to 417 7836
Number of phases	(Test circuit)	2
Number of poles/phases	(Test object)	1
Test frequency	Hz	50
Earthing conditions	Generator, grid	Not earthed
	Short-circuit transformers	Earthed



E	Power supply	1 - 2	Measuring points
MB	Master breaker	I	Current measurement
MS	Making switch	U	Voltage measurement
L	Current limiting reactor		
Tr	Short-circuit transformer		

Figure 4: Test circuit diagram

Technical data of measuring circuits

Measuring point	Symbol in the oscillograms	Measuring quantity	Measuring sensor/ device
1	i	Breaking current	Shunt
2	u	Voltage	RC divider
Recording instrument: BE 256 multichannel transient recorder system			

6.6 Test results

Test duty: Time-current characteristic tests

Date of test: 5 October 2017

Test circuit: See Sheet 20

Condition of test object before test: New

Ambient temperature: 21 °C

Test No.		4177805	4177809	4177810	4177811	4177812	4177836
Test sample No.		1	2	3	4	5	6
Rated current of fuse-link	A	0.5	0.5	0.5	0.5	0.5	0.5
Test voltage	V	210	250	250	245	245	245
Test current	A	2.85	3.17	4.35	3.53	7.3	1.95
Ratio		5.7 x Ir	6.4 x Ir	8.7 x Ir	7 x Ir	14.6 x Ir	3.9 x Ir
Operating time	ms	›1141	›3143	23.1	93.7	13.0	›600000
Resistance	Ω	7.31	6.91	7.34	7.08	7.15	7.27
Note		1)	1)	-	-	-	1)
Evaluation		OK	OK	OK	OK	OK	OK

Notes:

OK - passed

1) No operation

The test object kept the time-current characteristics.

Test results (continued)

Test duty:	Time-current characteristic tests
Date of test:	5 October 2017
Test circuit:	See Sheet 20
Condition of test object before test:	New
Ambient temperature:	21 °C

Test No.		4177813	4177814	4177817	4177818	4177819	4177820	4177835
Test sample No.		1	2	4	5	6	7	8
Rated current of fuse-link	A	2	2	2	2	2	2	2
Test voltage	V	245	245	245	245	210	170	125
Test current	A	6.1	5.7	6.65	12.3	9.8	7.9	4.2
Ratio		3.1 x Ir	2.9 x Ir	3.3 x Ir	6.2 x Ir	4.9 x Ir	4.0 x Ir	2.1 x Ir
Operating time	ms	>639	>3141	>658	24.4	43.0	92.9	>600000
Resistance	Ω	2.59	2.58	2.6	2.53	2.67	2.59	2.62
Note		1)	1)	1)	-	-	-	1)
Evaluation		OK	OK	OK	OK	OK	OK	OK

Notes:

OK - passed

1) No operation

The test object kept the time-current characteristics.

Test results (continued)

Test duty: Time-current characteristic tests

Date of test: 5 October 2017

Test circuit: See Sheet 20

Condition of test object before test: New

Ambient temperature: 21 °C

Test No.		4177821	4177822	4177823	4177824	4177825	4177834
Test sample No.		1	2	3	4	5	6
Rated current of fuse-link	A	3.15	3.15	3.15	3.15	3.15	3.15
Test voltage	V	170	210	255	270	320	129
Test current	A	8.4	11.1	14.5	15.5	18.6	4.8
Ratio		3.1 x Ir	2.9 x Ir	3.3 x Ir	6.2 x Ir	4.9 x Ir	1.5 x Ir
Operating time	ms	›3338	343	63.4	53.6	33.7	›600000
Resistance	Ω	1.43	1.44	1.45	1.45	1.43	1.44
Note		1)	-	-	-	-	1)
Evaluation		OK	OK	OK	OK	OK	OK

Notes:

OK - passed

1) No operation

The test object kept the time-current characteristics.

Test results (continued)

Test duty:	Time-current characteristic tests
Date of test:	5 October 2017
Test circuit:	See Sheet 20
Condition of test object before test:	New
Ambient temperature:	21 °C

Test No.		4177826	4177827	4177828	4177829
Test sample No.		1	2	3	4
Rated current of fuse-link	A	6.3	6.3	6.3	6.3
Test voltage	V	320	370	404	450
Test current	A	17.4	24.2	26.6	29.6
Ratio		2.8 x Ir	3.8 x Ir	4.2 x Ir	4.7 x Ir
Operating time	ms	235	113	93.1	64.4
Resistance	Ω	0.651	0.652	0.659	0.651
Note		-	-	-	-
Evaluation		OK	OK	OK	OK

Test No.		4177830	4177831	4177832	4177833
Test sample No.		5	6	7	8
Rated current of fuse-link	A	6.3	6.3	6.3	6.3
Test voltage	V	306	257	220	155
Test current	A	19.8	16.3	14.1	10.2
Ratio		3.1 x Ir	2.6 x Ir	2.2 x Ir	1.6 x Ir
Operating time	ms	284	947	›3506	›600000
Resistance	Ω	0.651	0.649	0.653	0.655
Note		-	-	1)	1)
Evaluation		OK	OK	OK	OK

Notes:

OK - passed

1) No operation

The test object kept the time-current characteristics.

7. Temperature-rise tests and power-dissipation measurement

7.1 Test laboratory

Low-voltage test laboratory, test room 7

7.2 Normative document

IEC 60282-1: 2009-10+A1: 2014, Sub-clause 6.5

7.3 Required test parameters

The tests shall be made with 100% of the rated current of the fuse-link.

7.4 Test arrangement

The fuse to be tested was mounted in a fuse holder as in normal service. The connections to the test circuit were according to IEC 60282-1: 2009-10+A1: 2014, table 12.

See Photo 4, Sheet 29

7.5 Test results

Date of test: 7 November 2017

Rated current [A]	-	6.3
Resistance of fuse [mΩ]	-	0.65
Test current [A]	-	6.3
	max. permissible Temp.-rise [K]	Temperature rise [K]
Upper terminal	65	22.4
Upper contact	65	51.8
Tube	115	109.8
Lower contact	65	47.3
Lower terminal	65	21.7
av. Amb. -Temp. [°C]	-	26.9
Voltage drop [V]	-	8.03
Power dissipation [W]	-	50.6

7.6 Evaluation of test

The permissible temperature limits and temperature rises for components and materials according to IEC 60282-1: 2009-10, table 6 were not exceeded.

The tests have been PASSED.

8. Photos

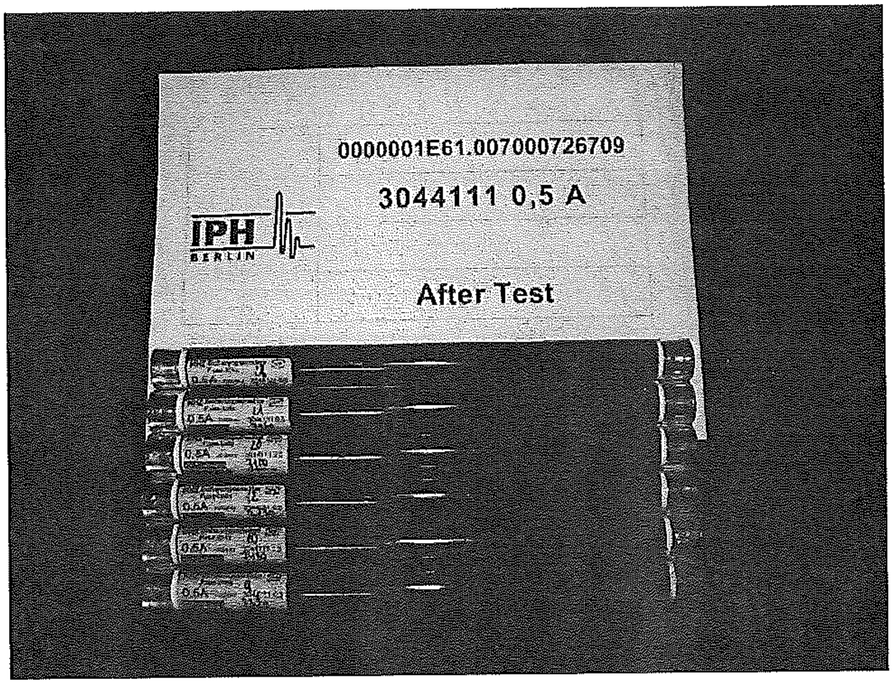


Photo 1: Test samples 0.5 A after tests

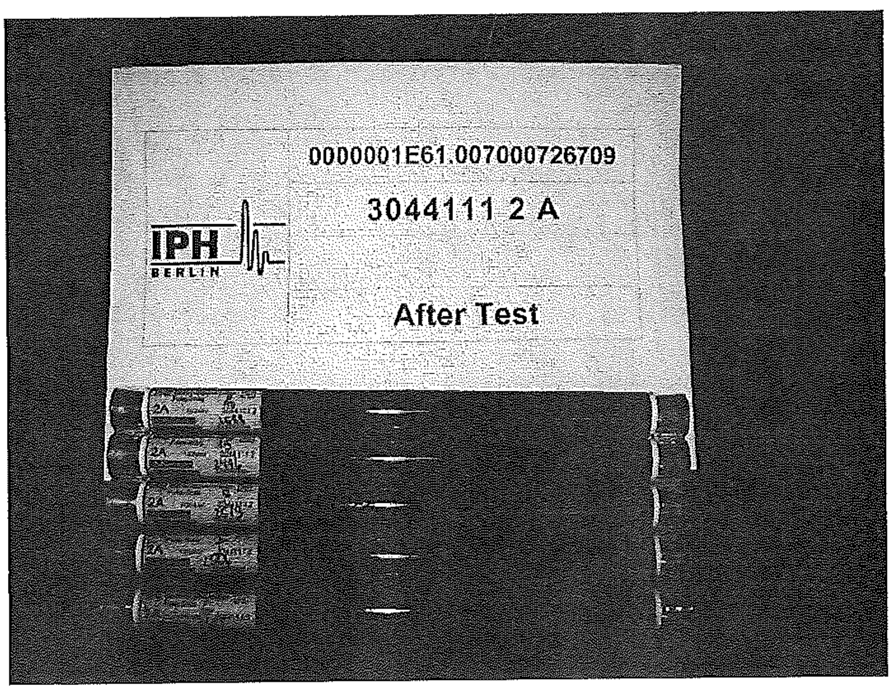


Photo 2: Test samples 2 A after tests

244

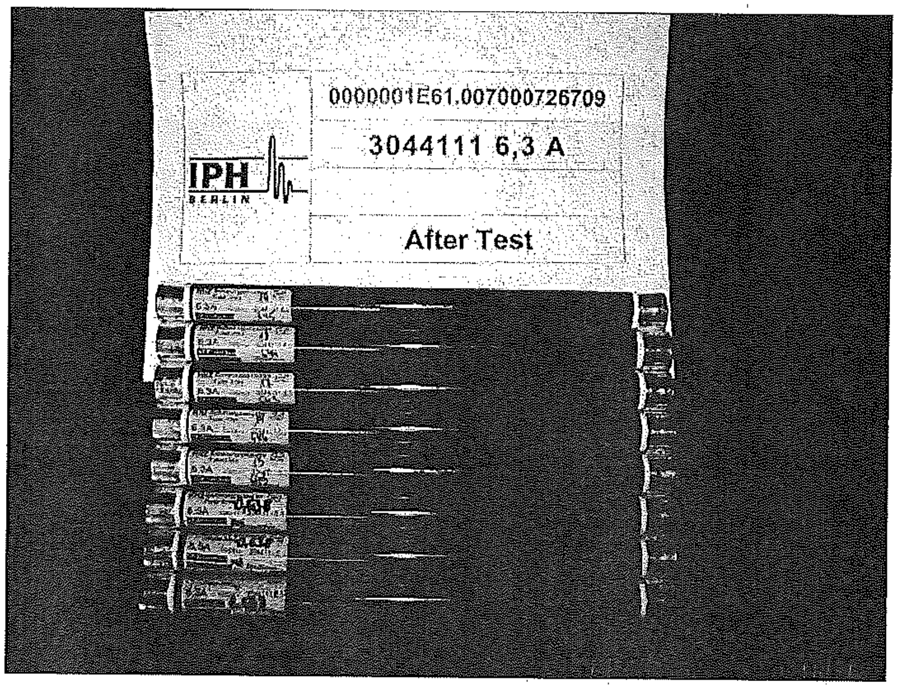


Photo 3: Test samples 6.3 A after tests

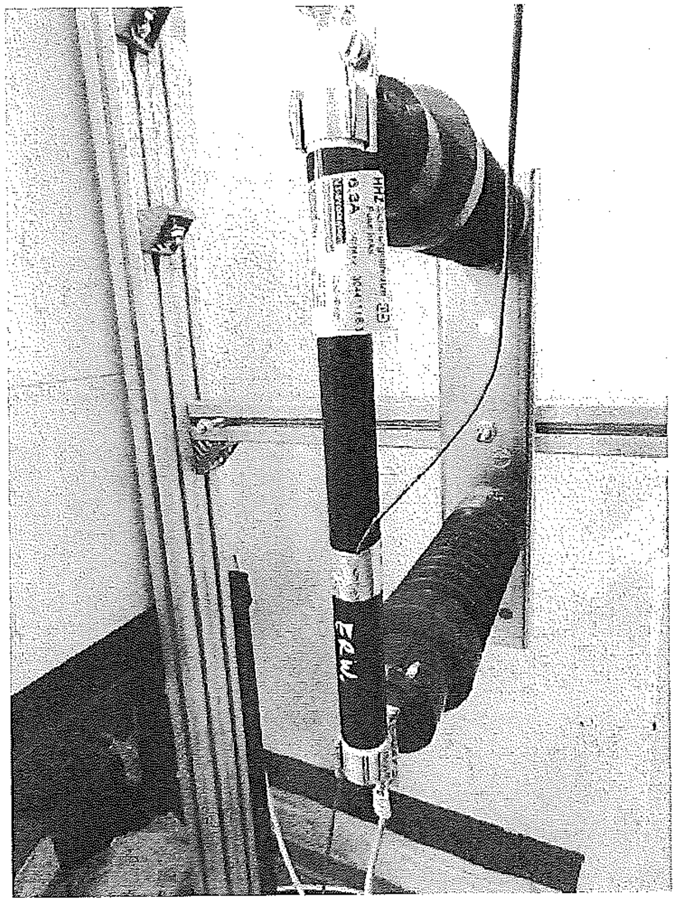
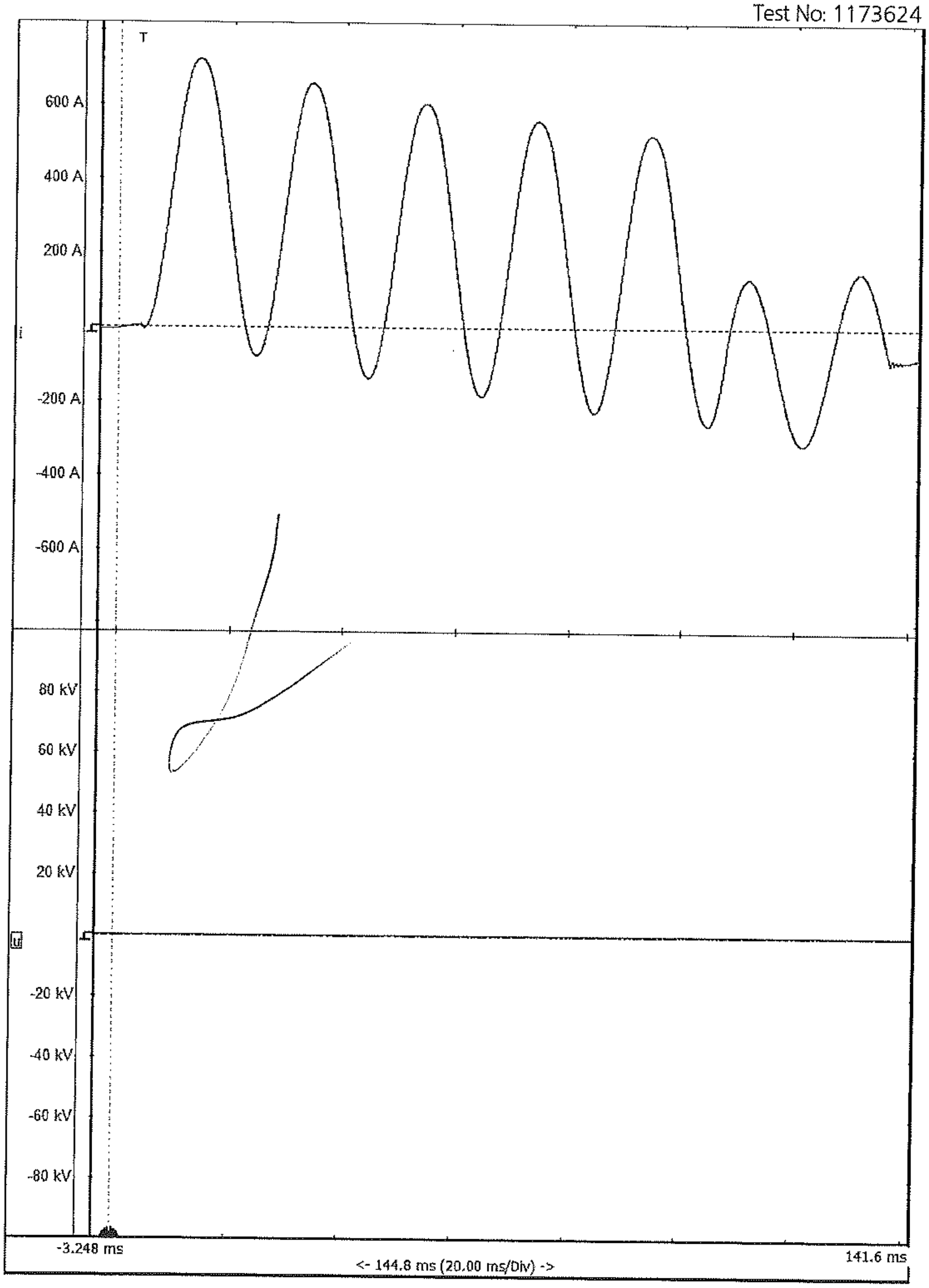


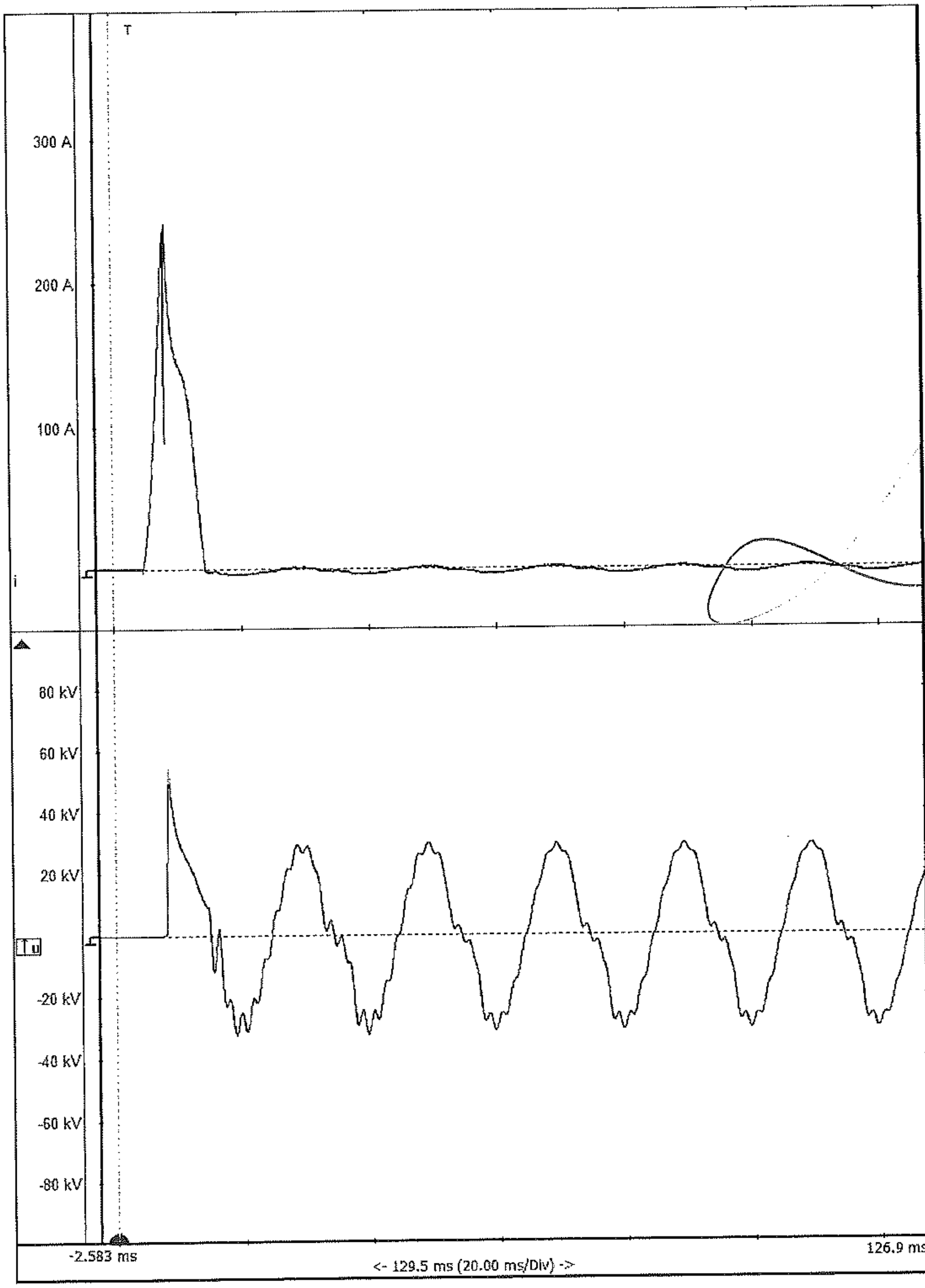
Photo 4: Fuse during temperature-rise test

9. Oscillograms

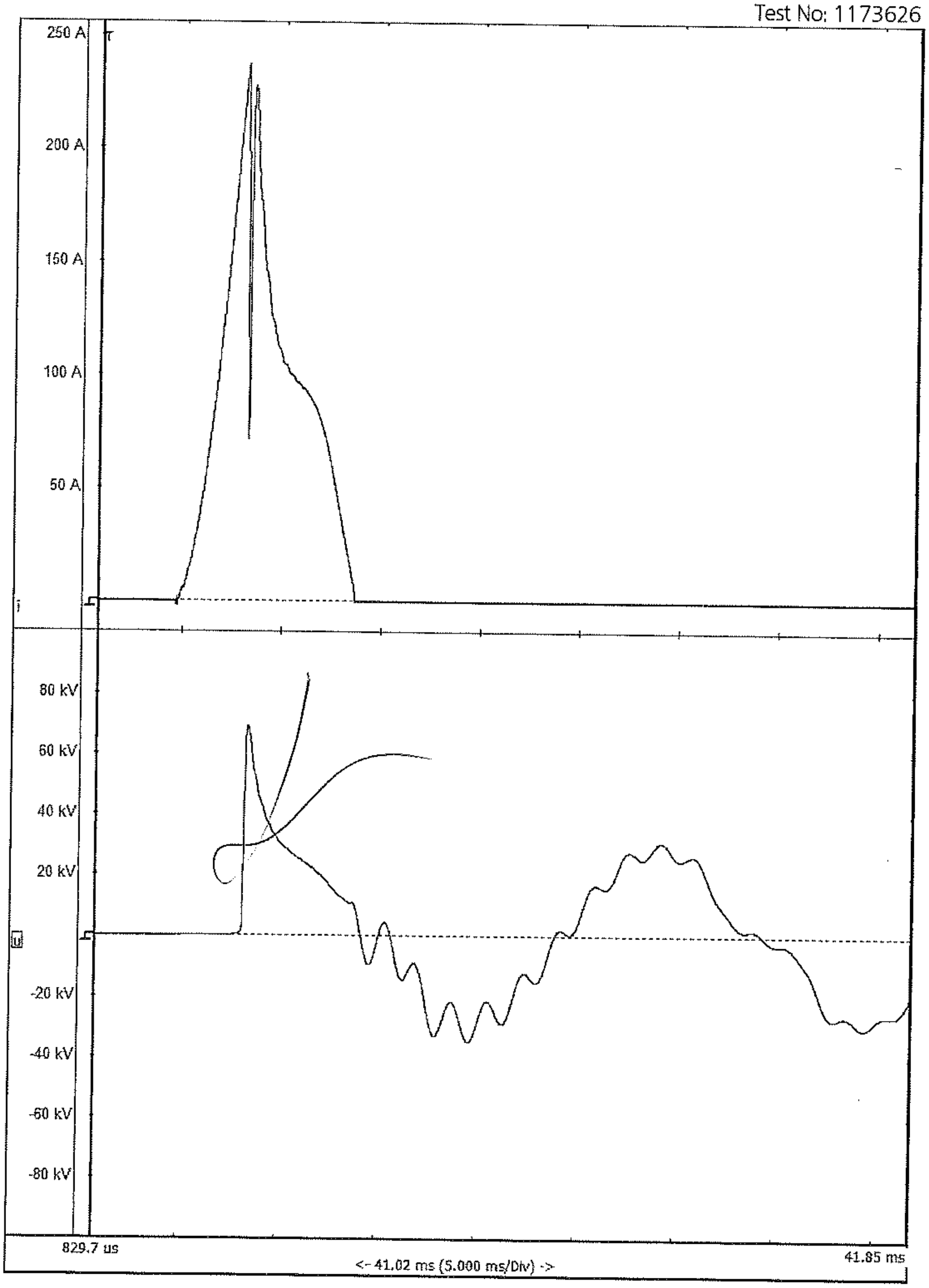
Test No: 1173624



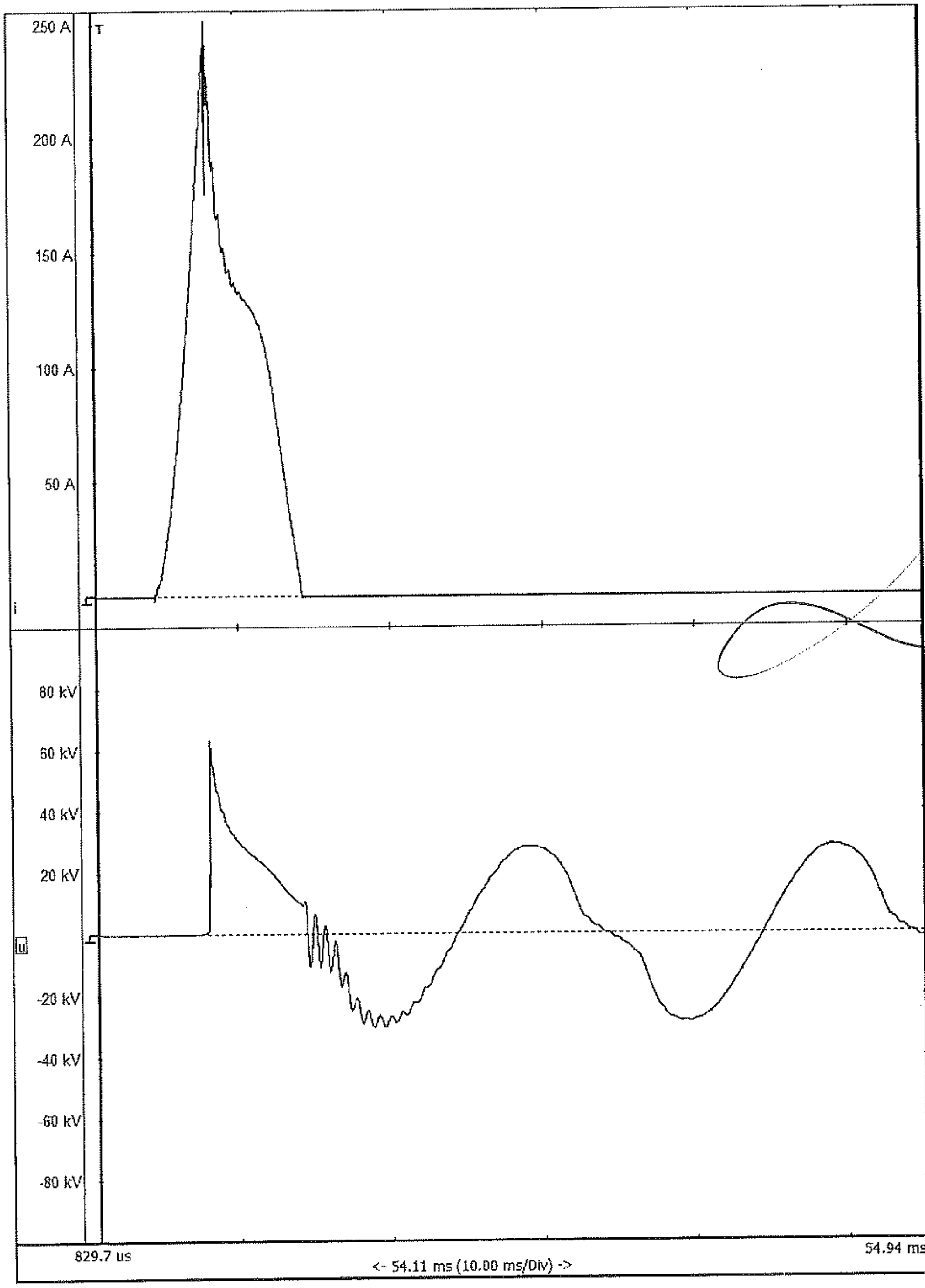
Test No: 1173625



Test No: 1173626

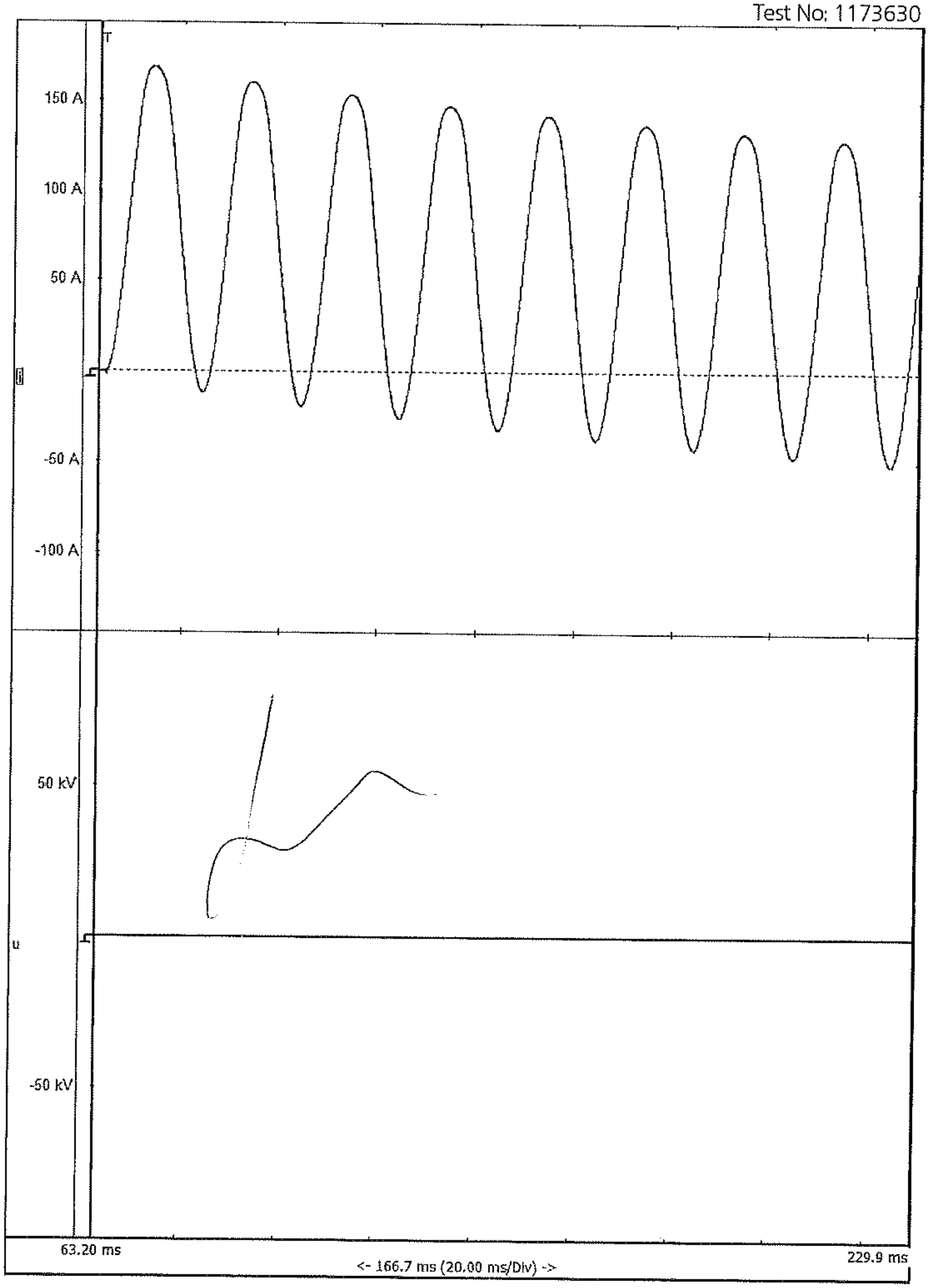


Test No: 1173627

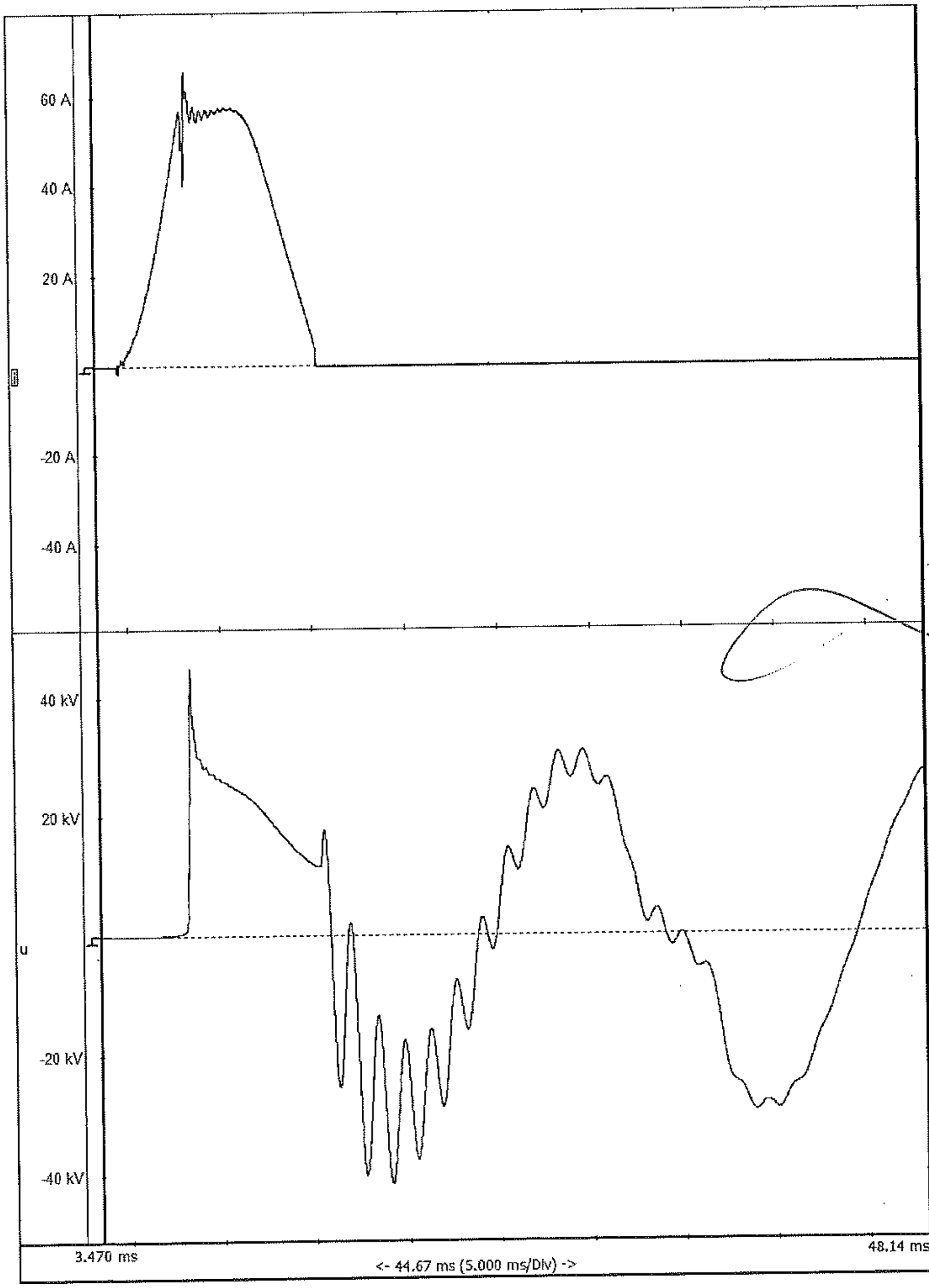


24

Test No: 1173630

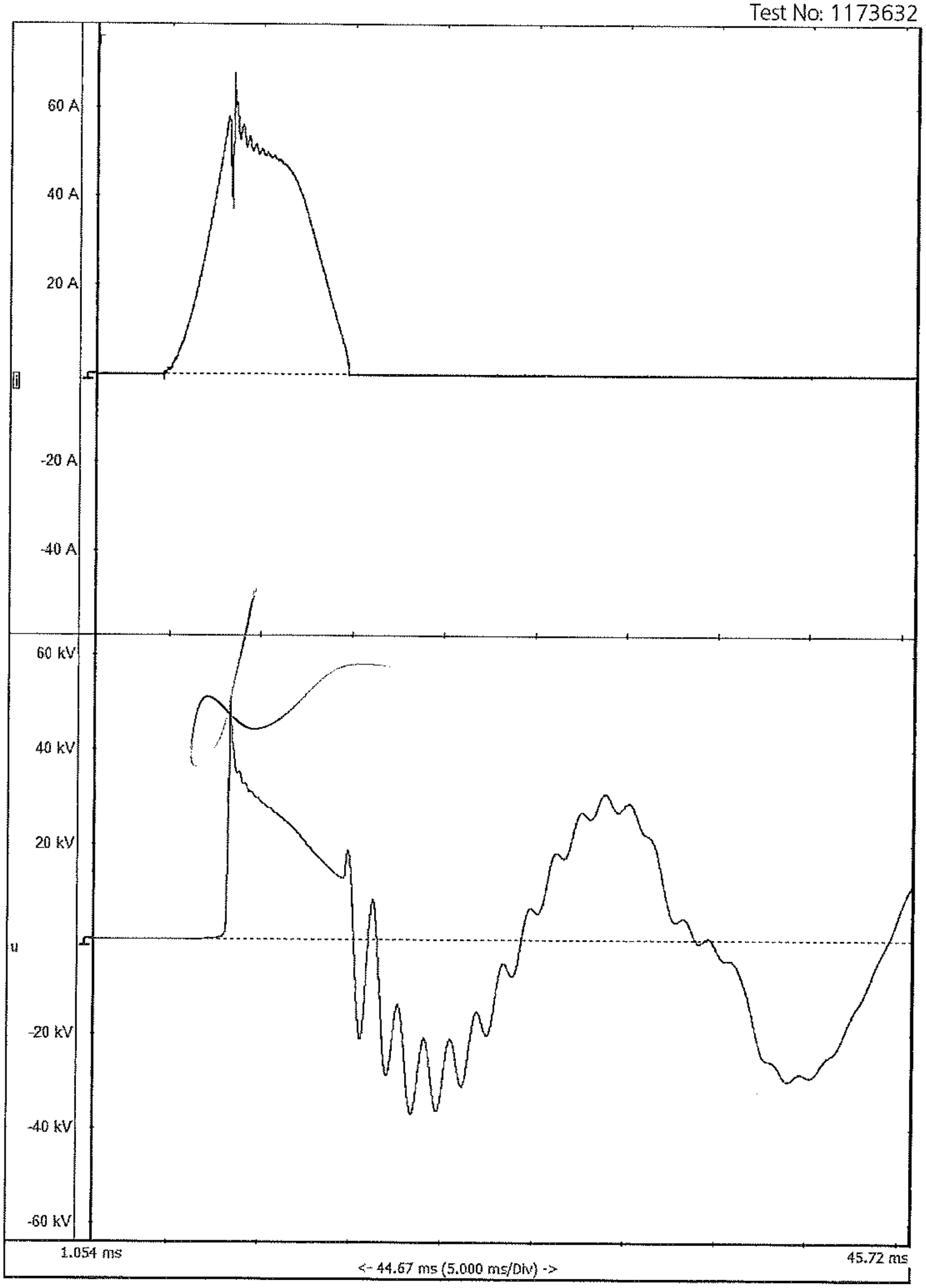


Test No: 1173631

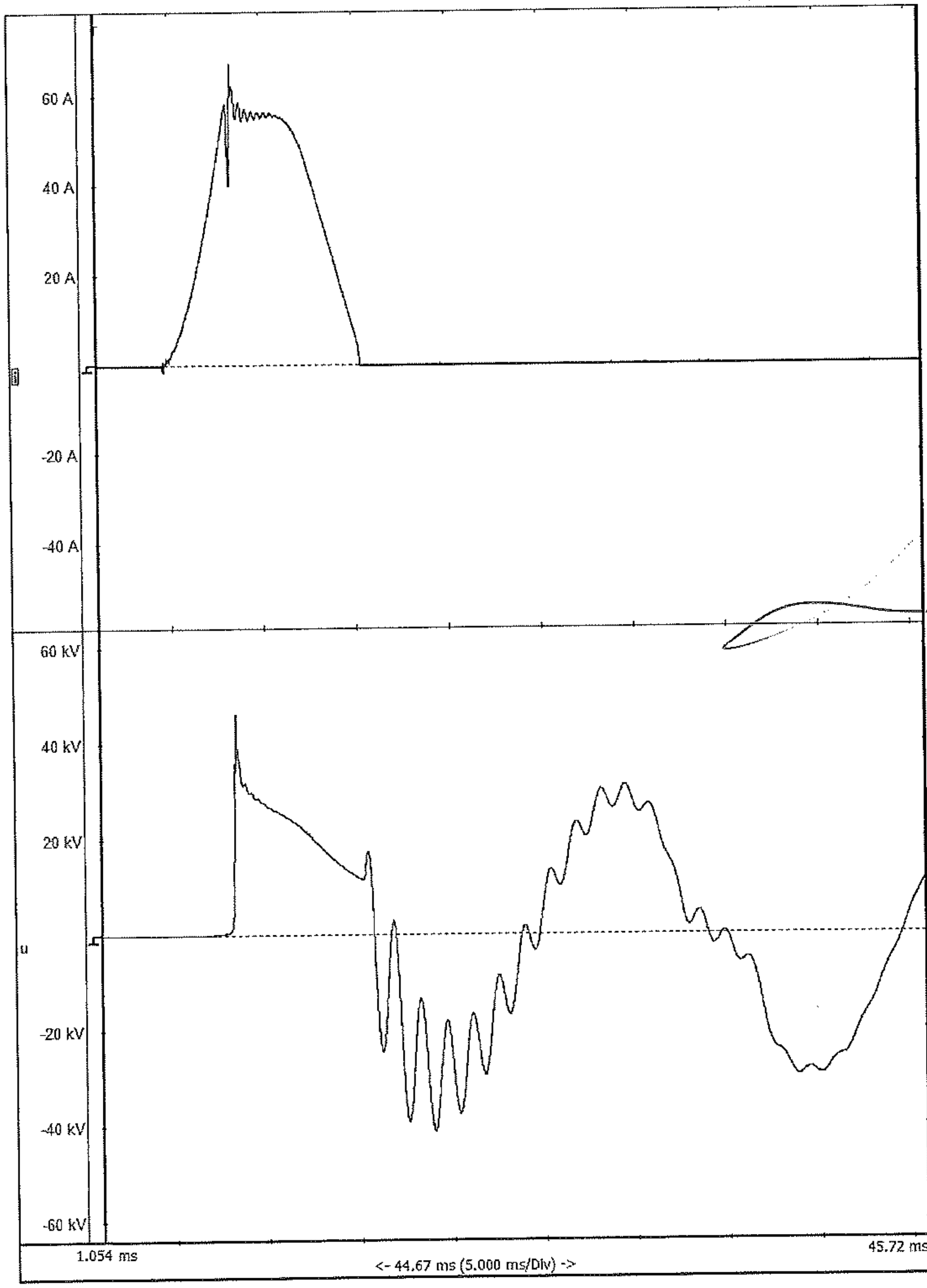


248

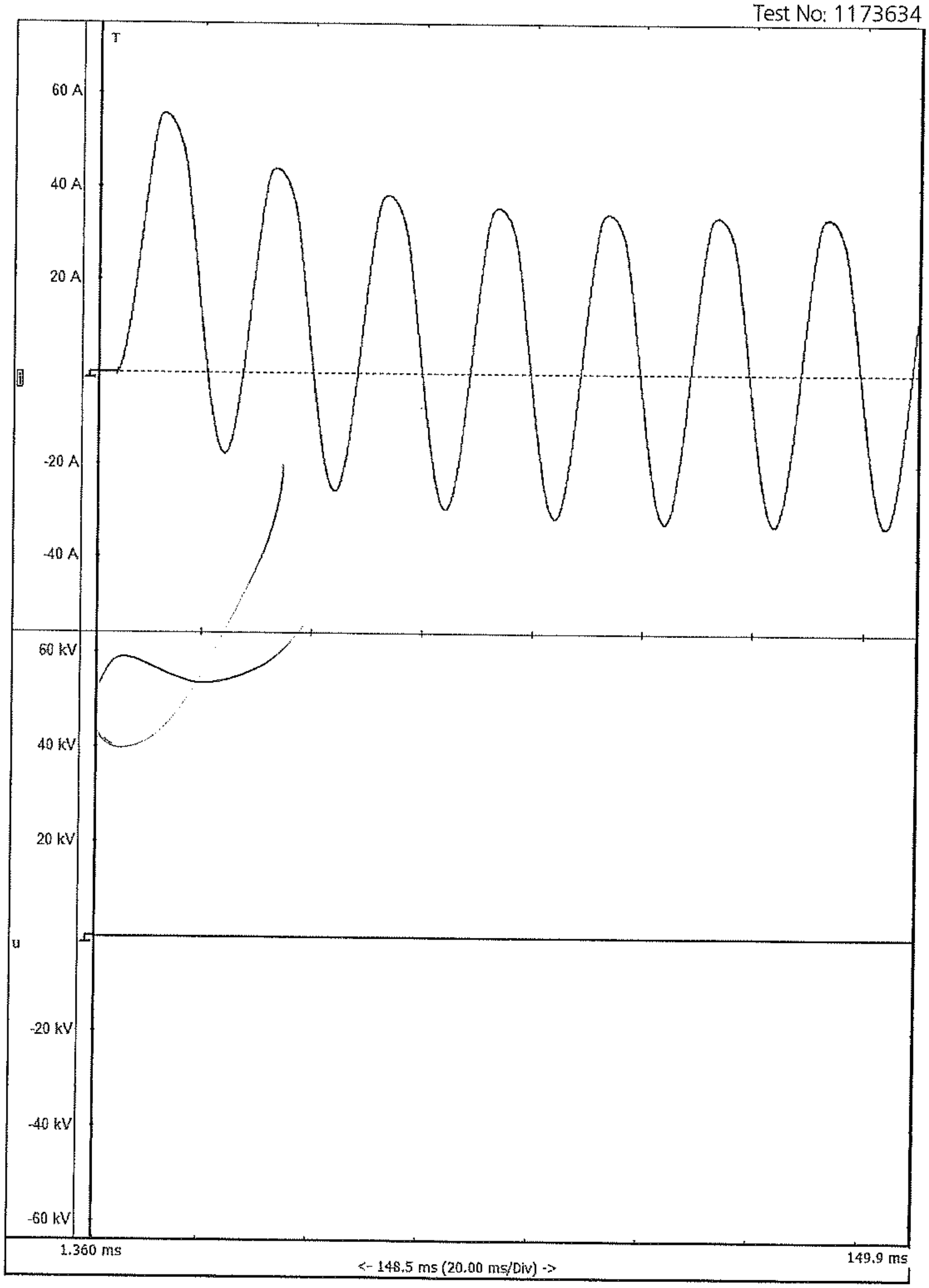
Test No: 1173632



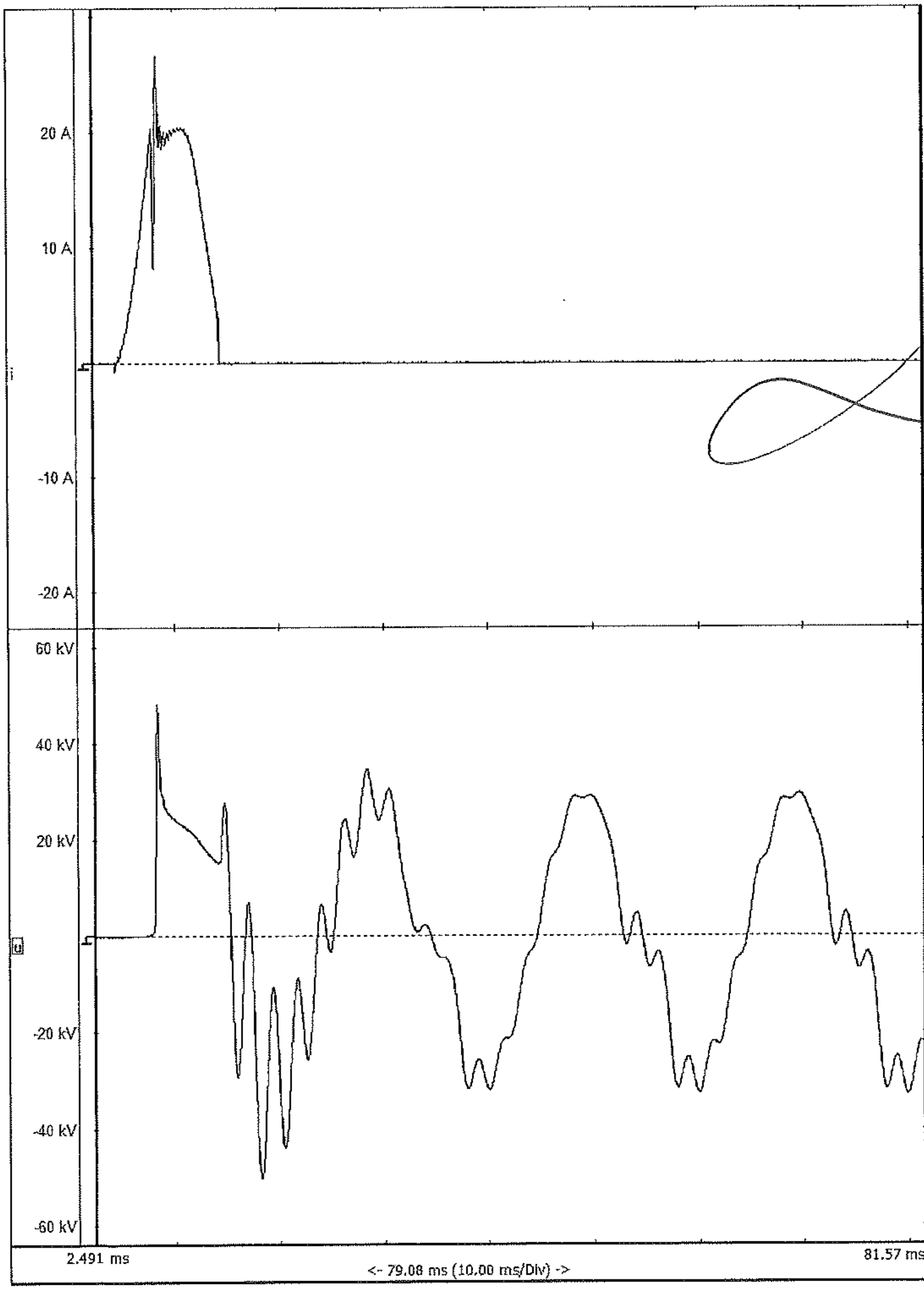
Test No: 1173633



Test No: 1173634

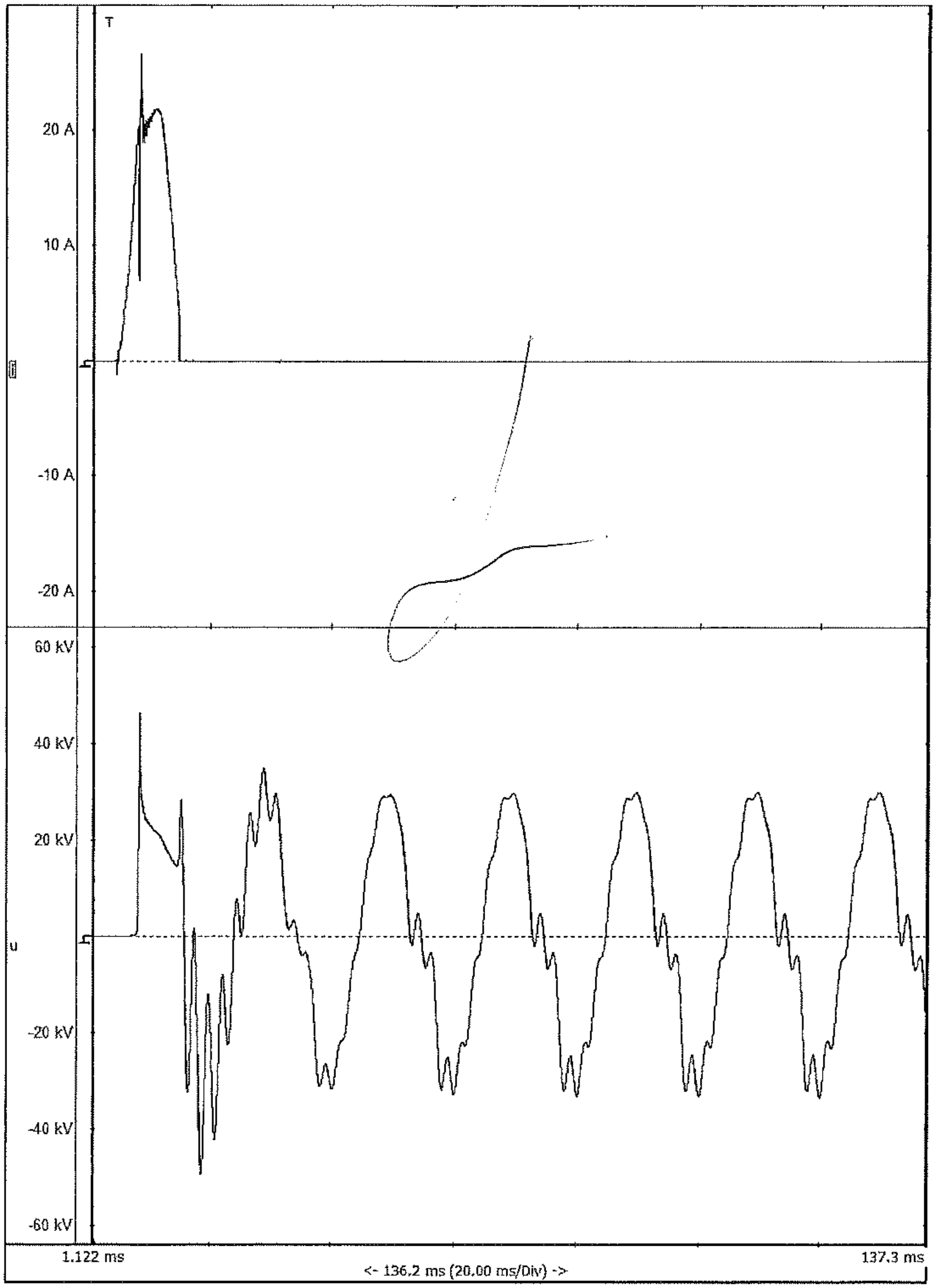


Test No: 1173635

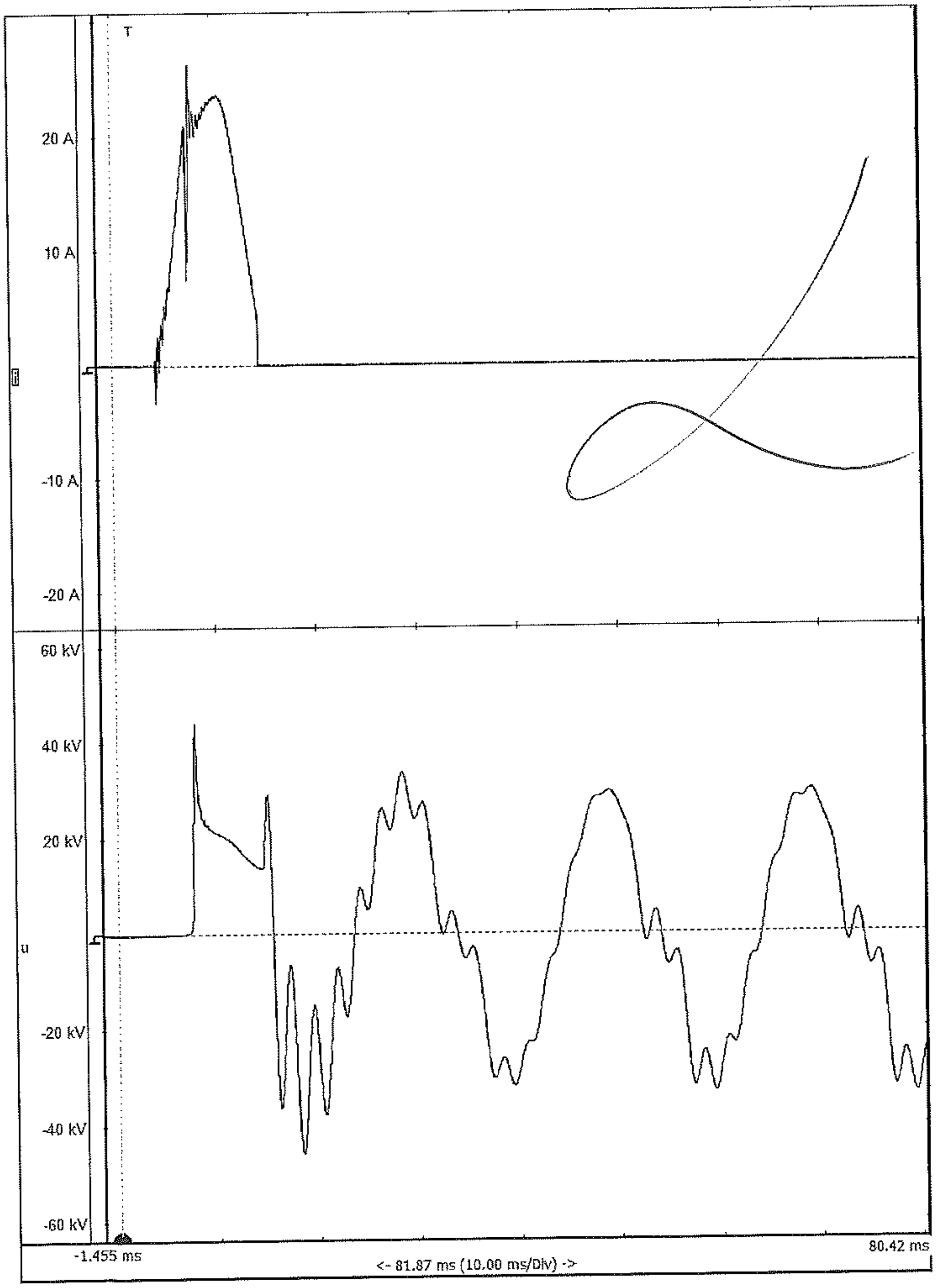


250

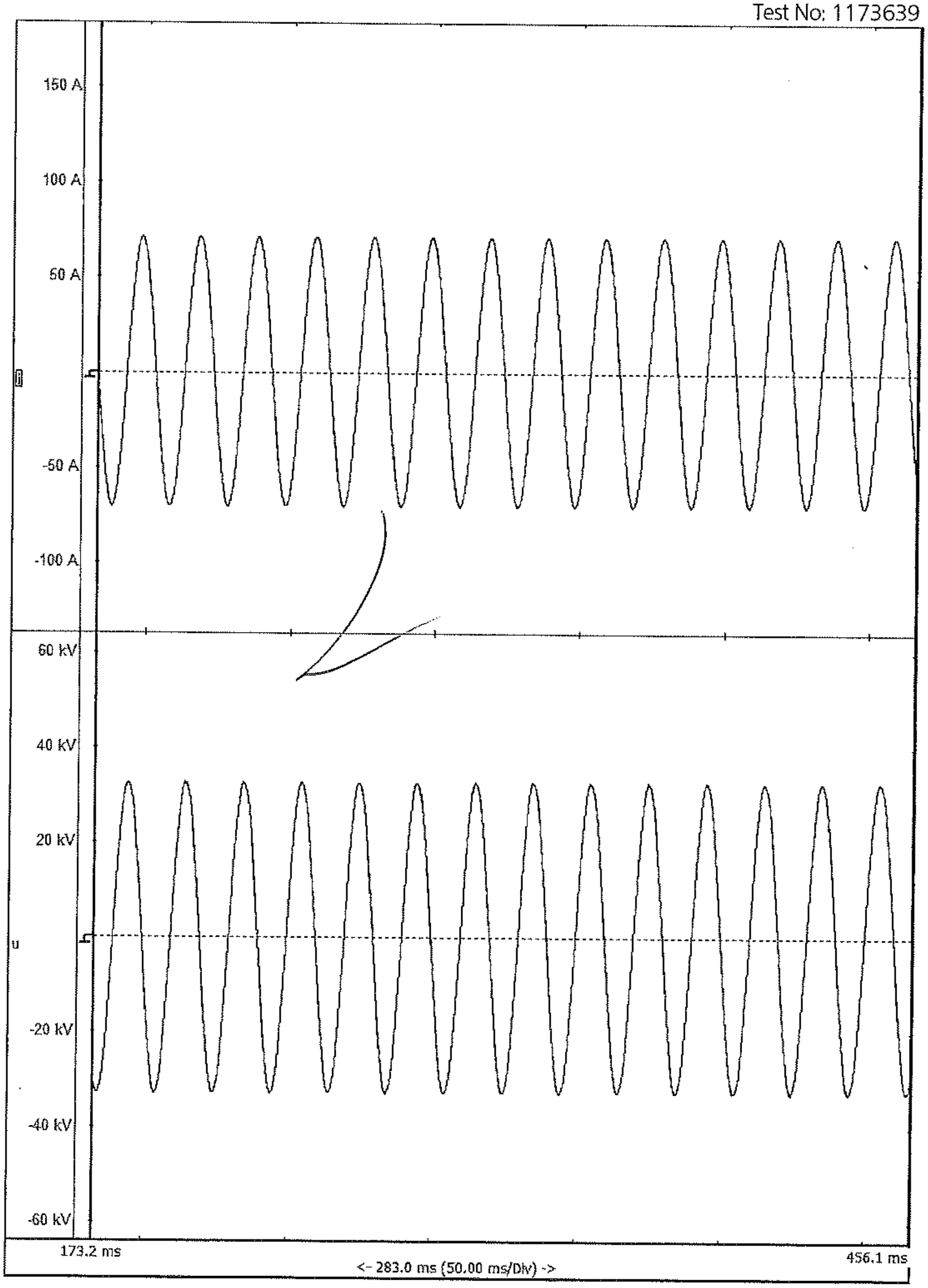
Test No: 1173636



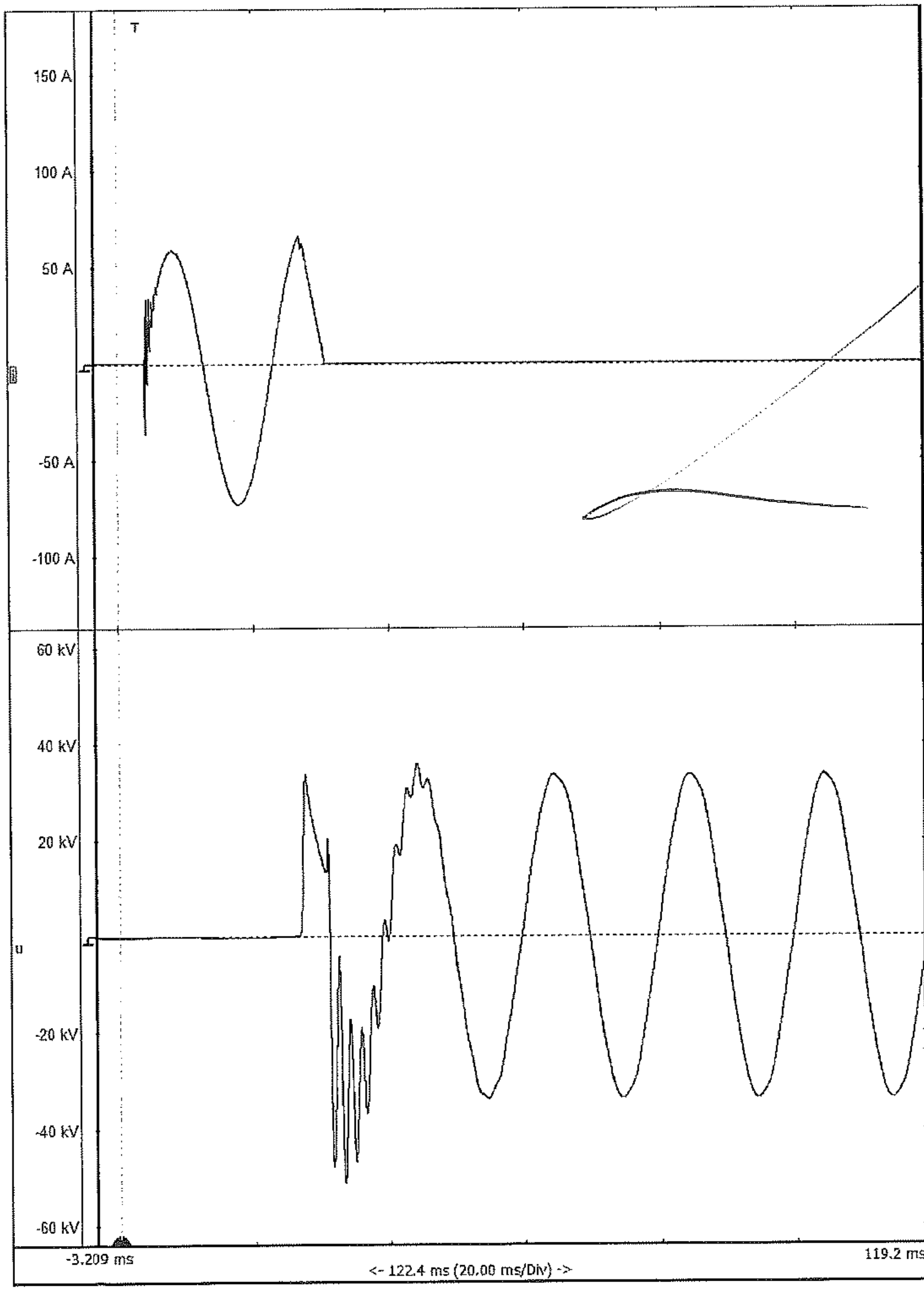
Test No: 1173638



Test No: 1173639

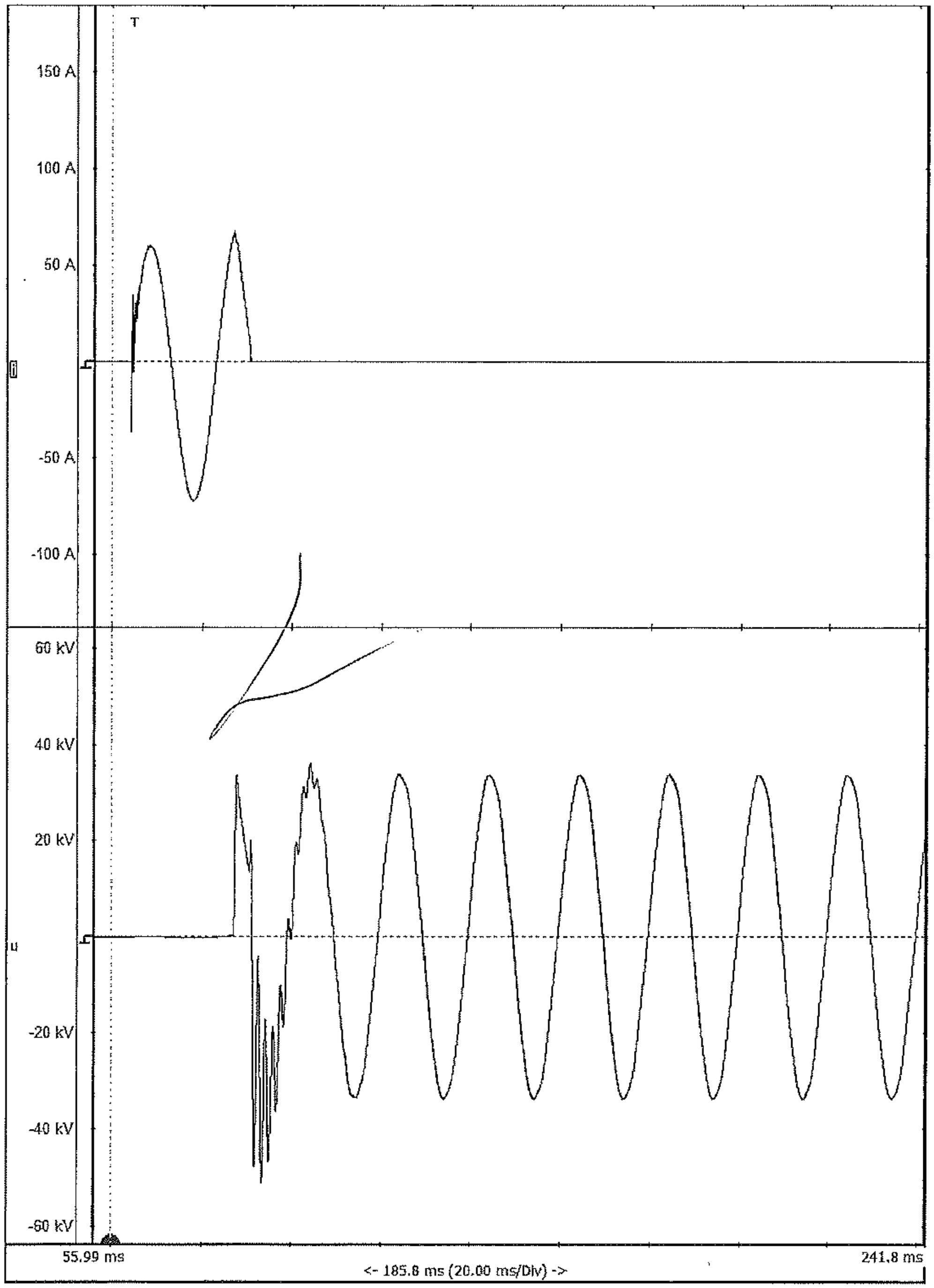


Test No: 1173640

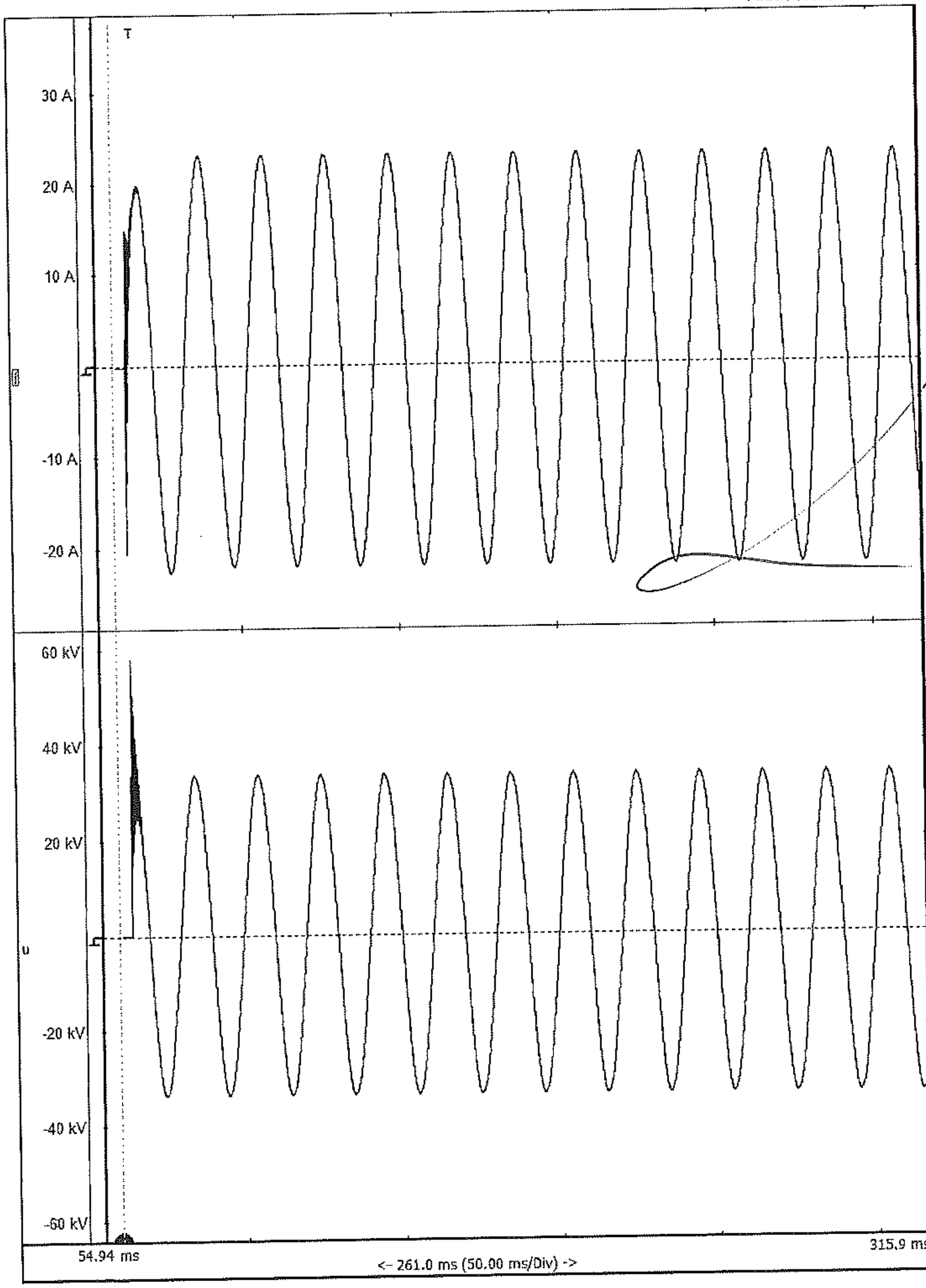


252

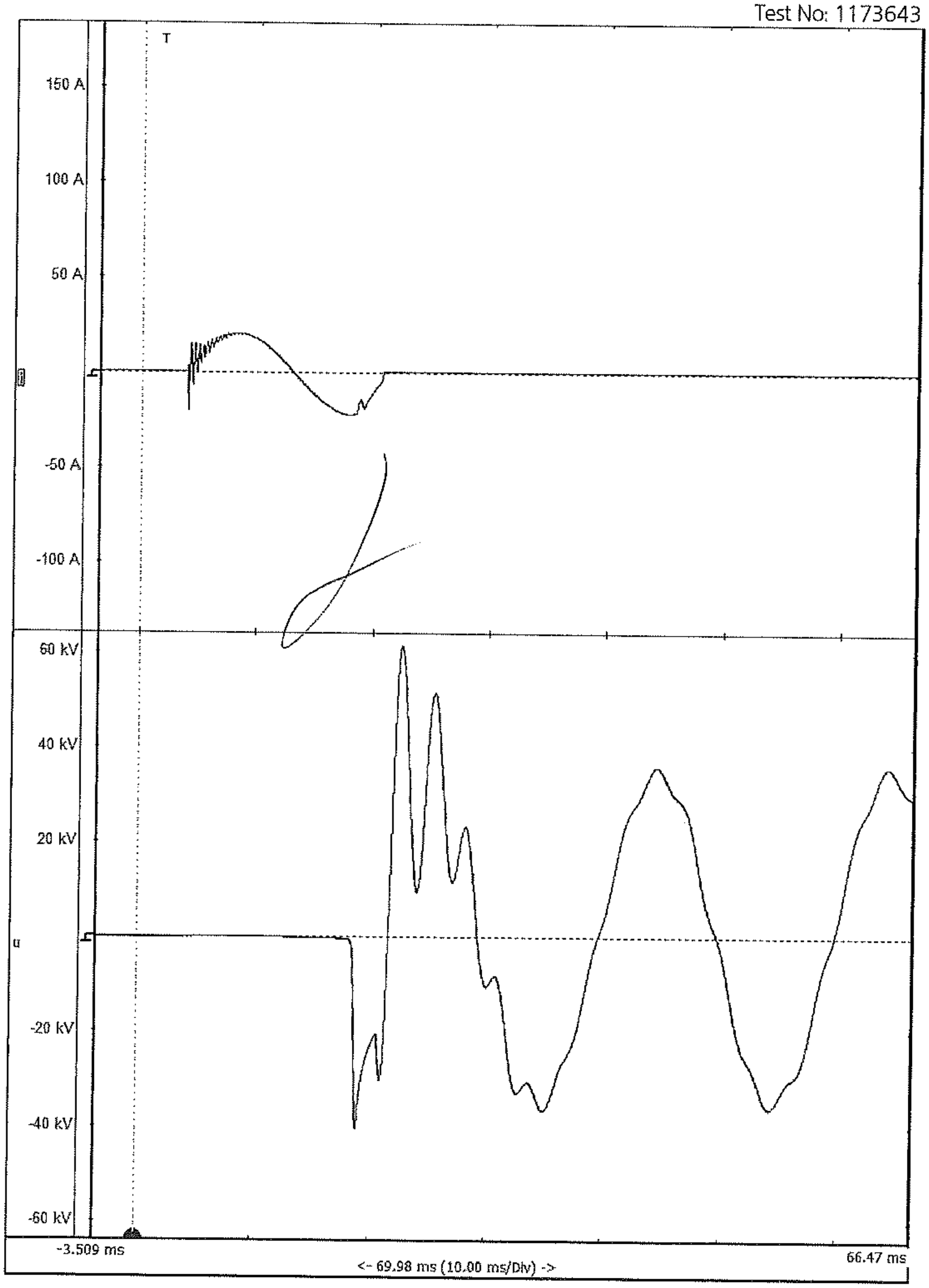
Test No: 1173641



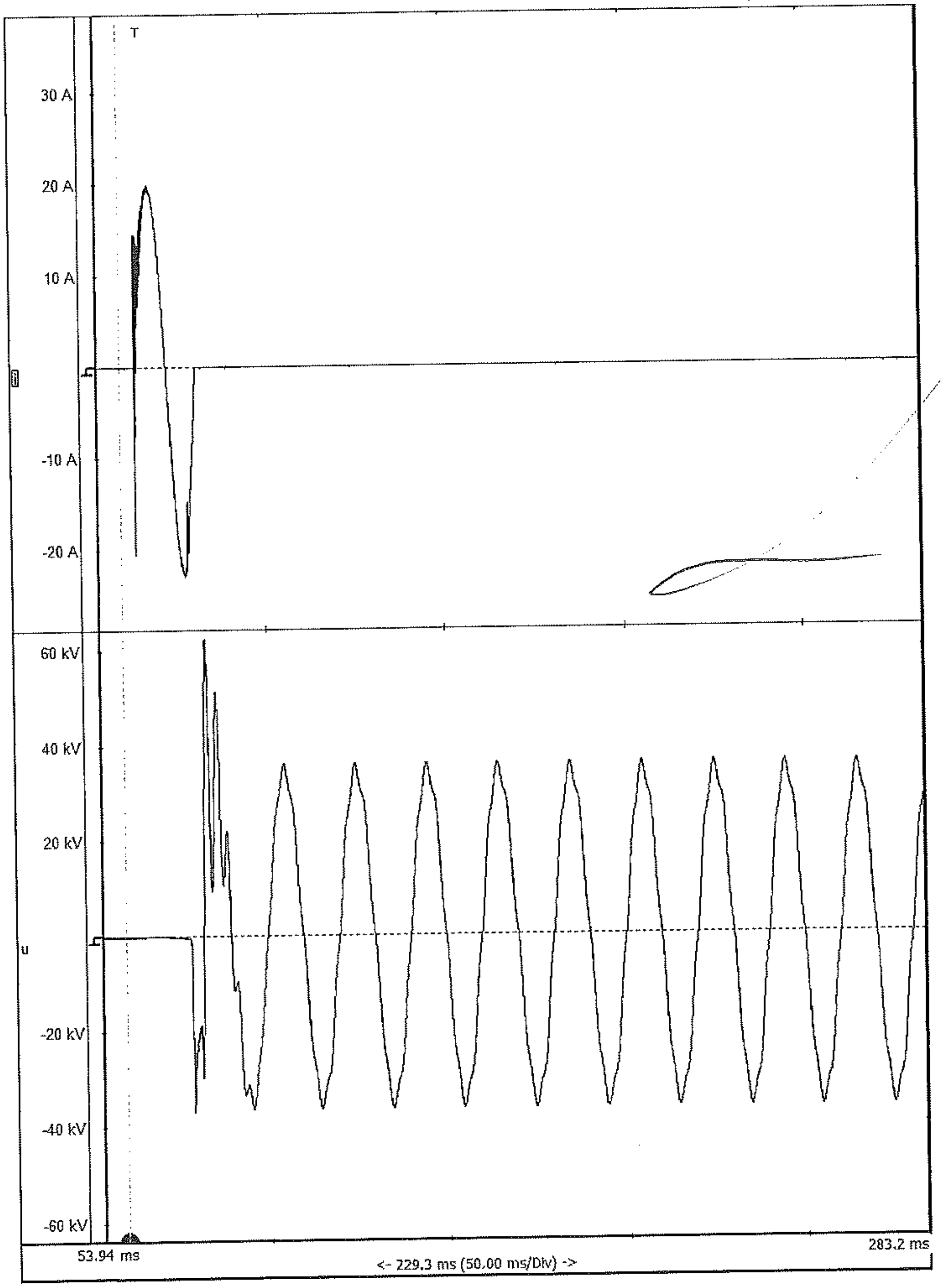
Test No: 1173642



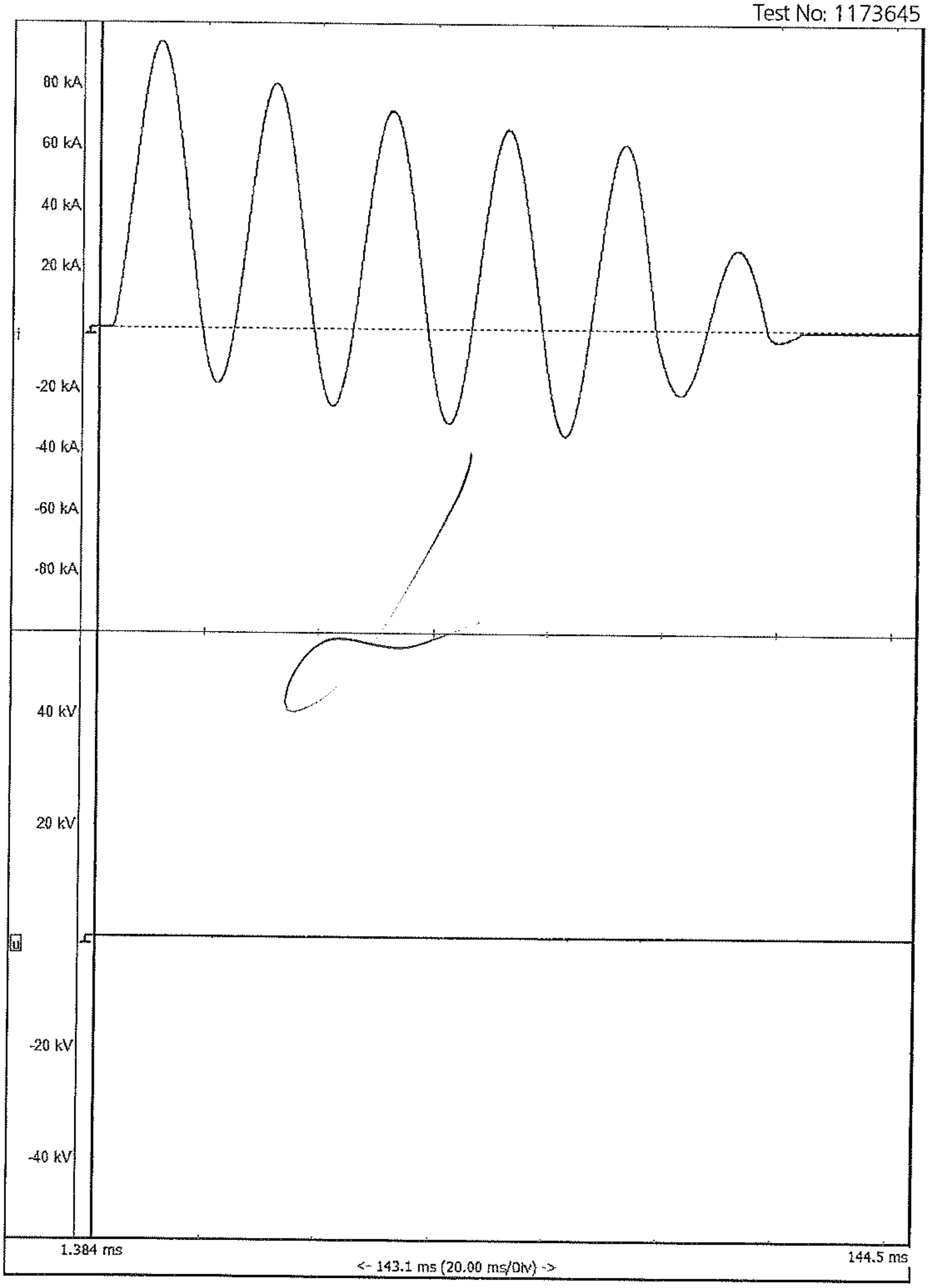
Test No: 1173643



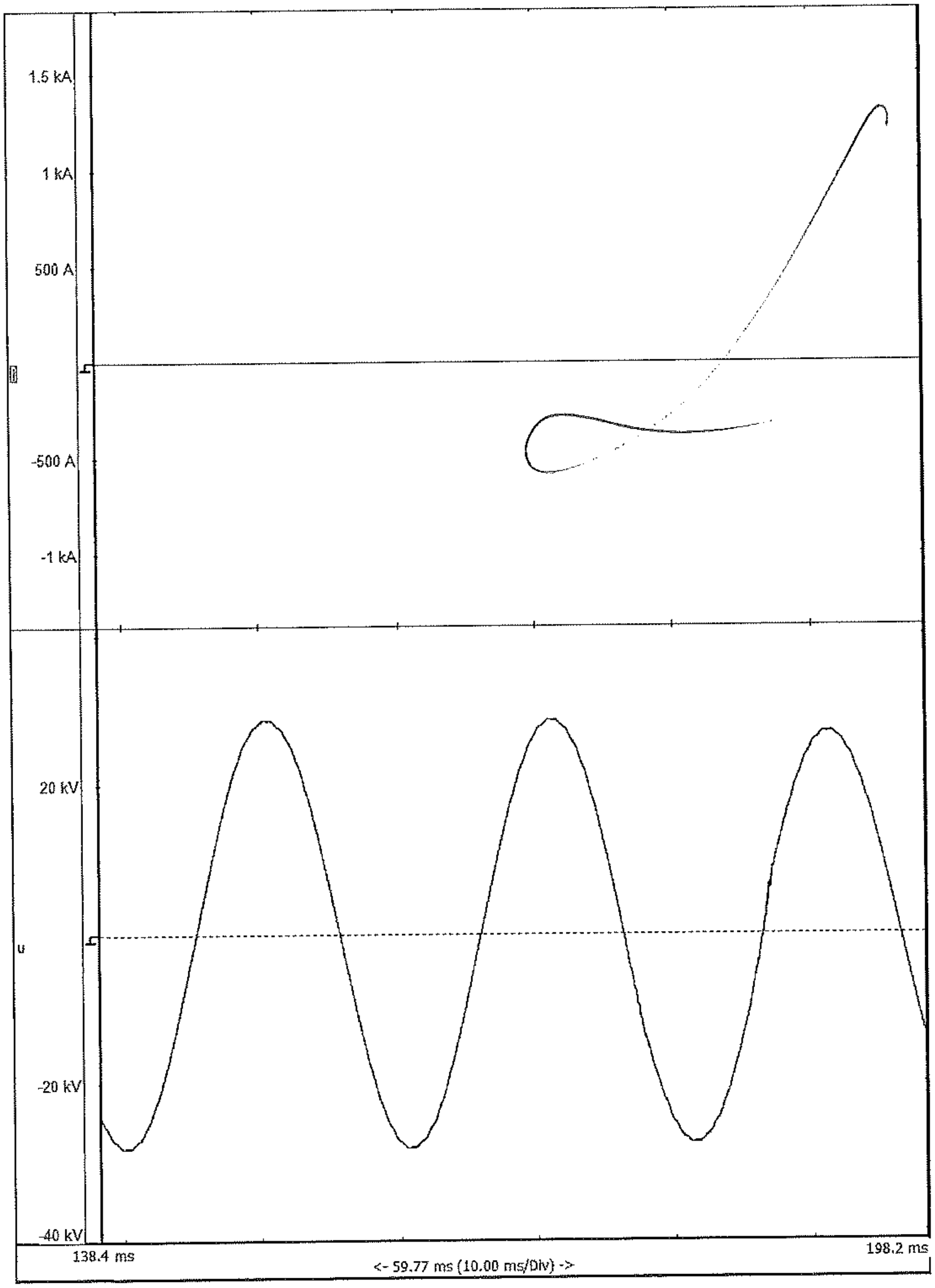
Test No: 1173644



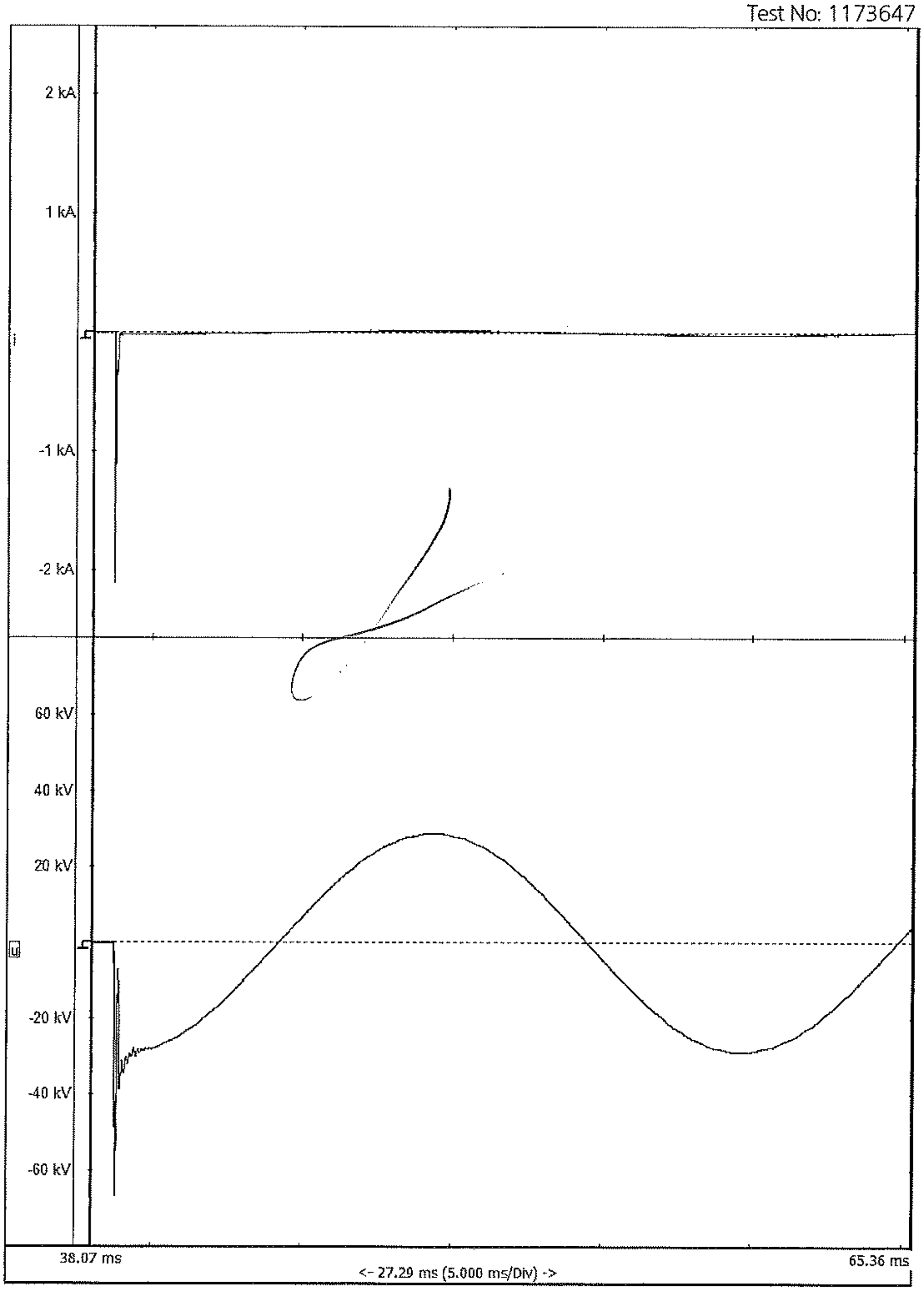
Test No: 1173645



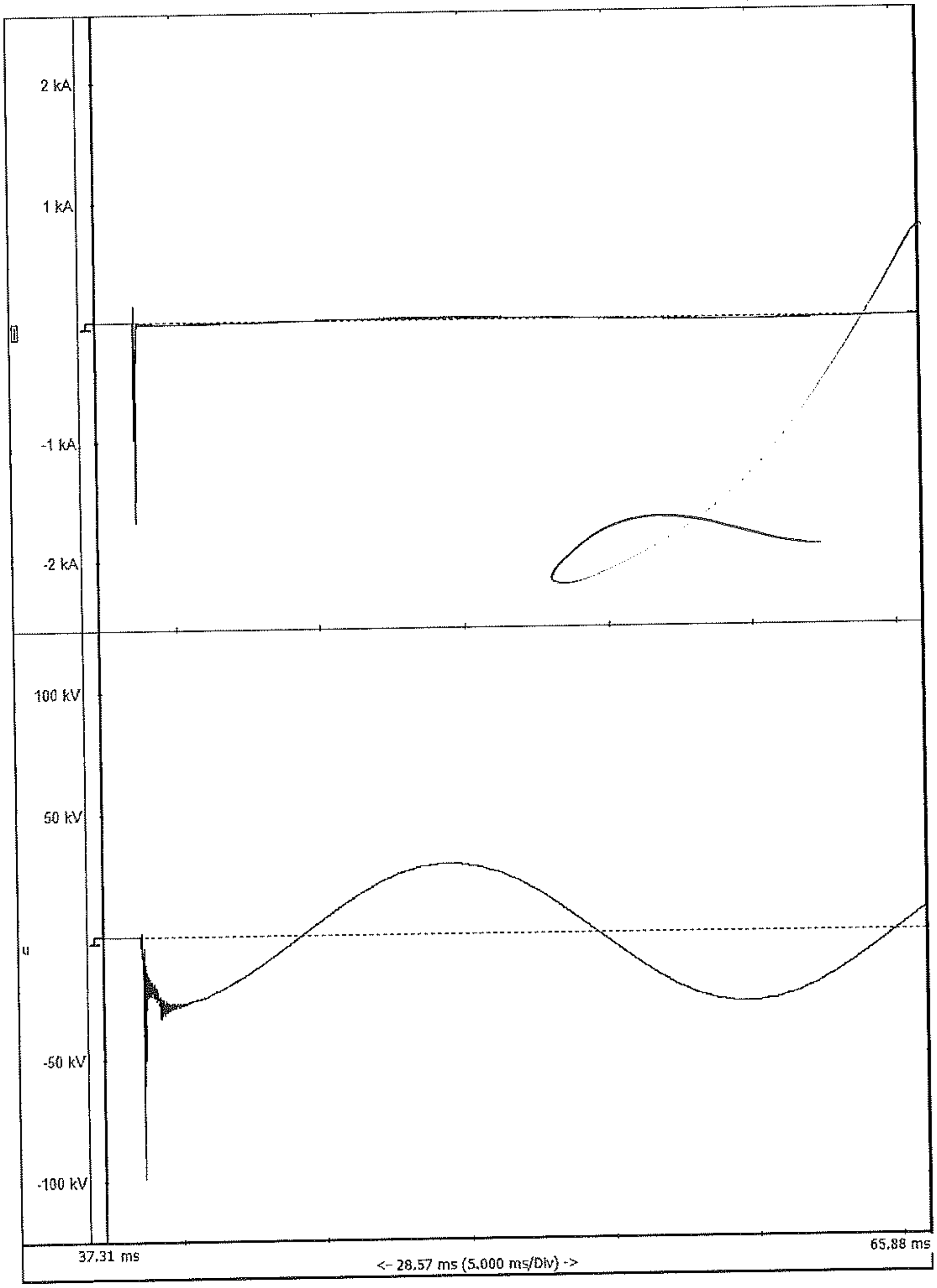
Test No: 1173646



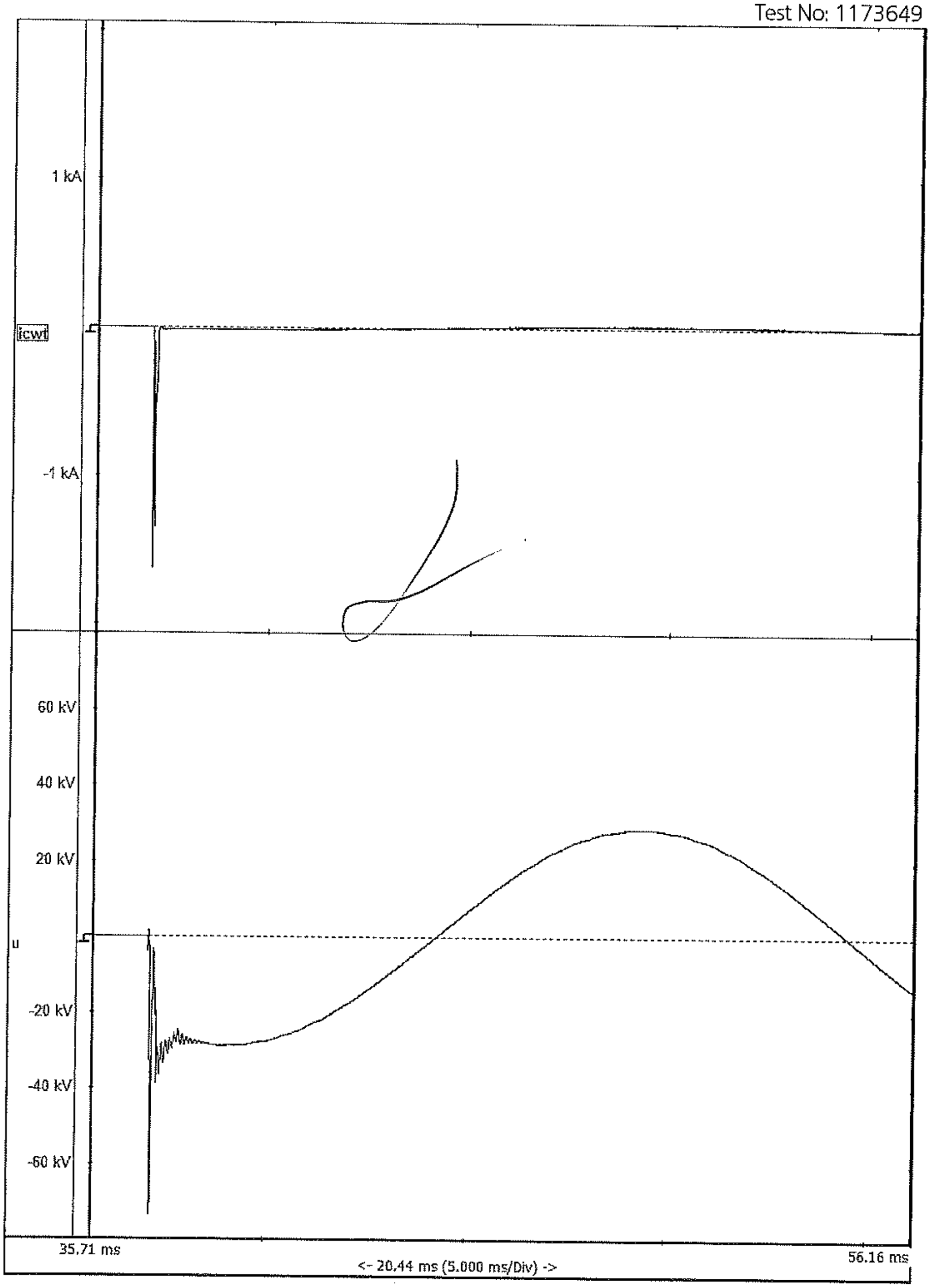
Test No: 1173647



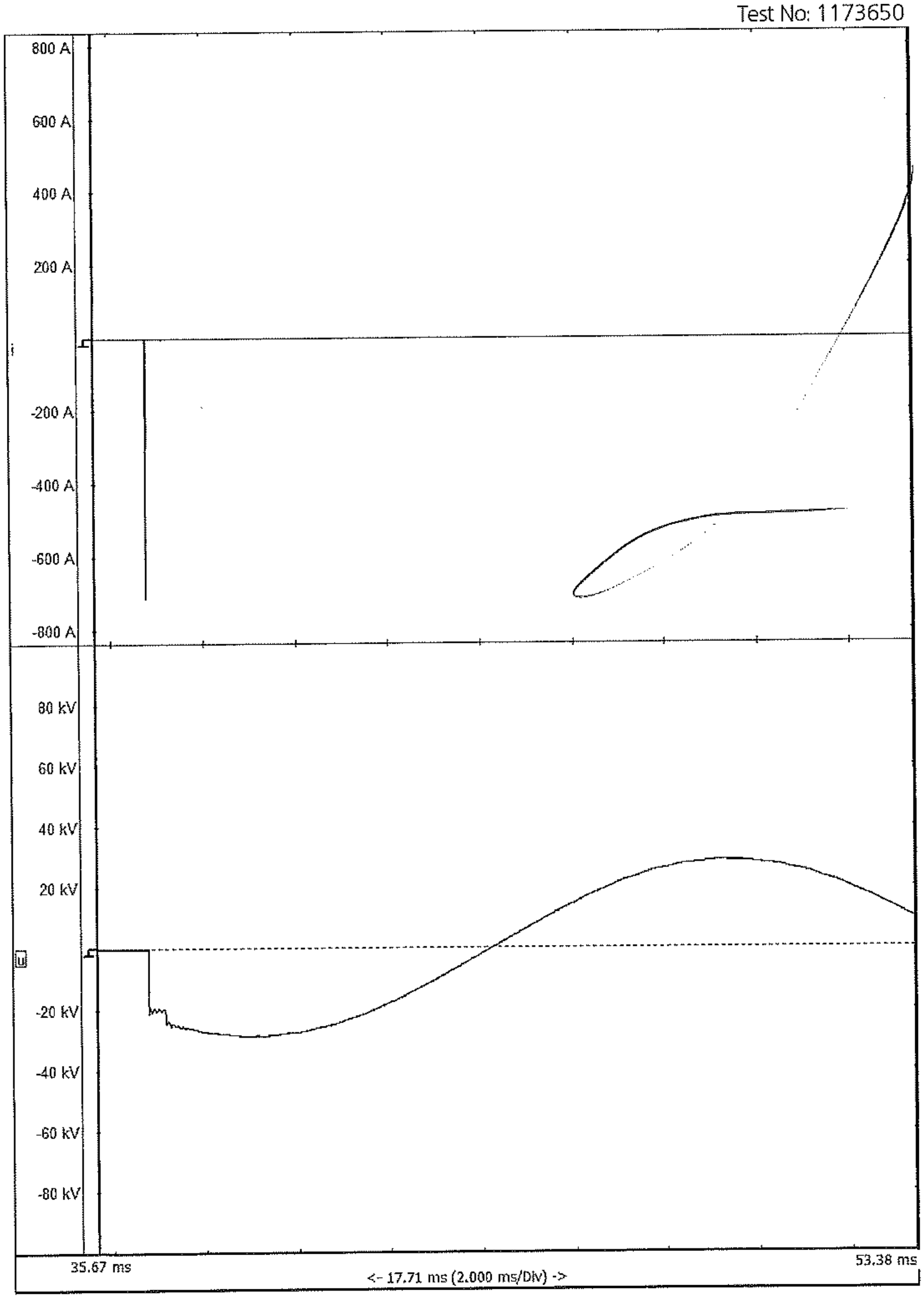
Test No: 1173648



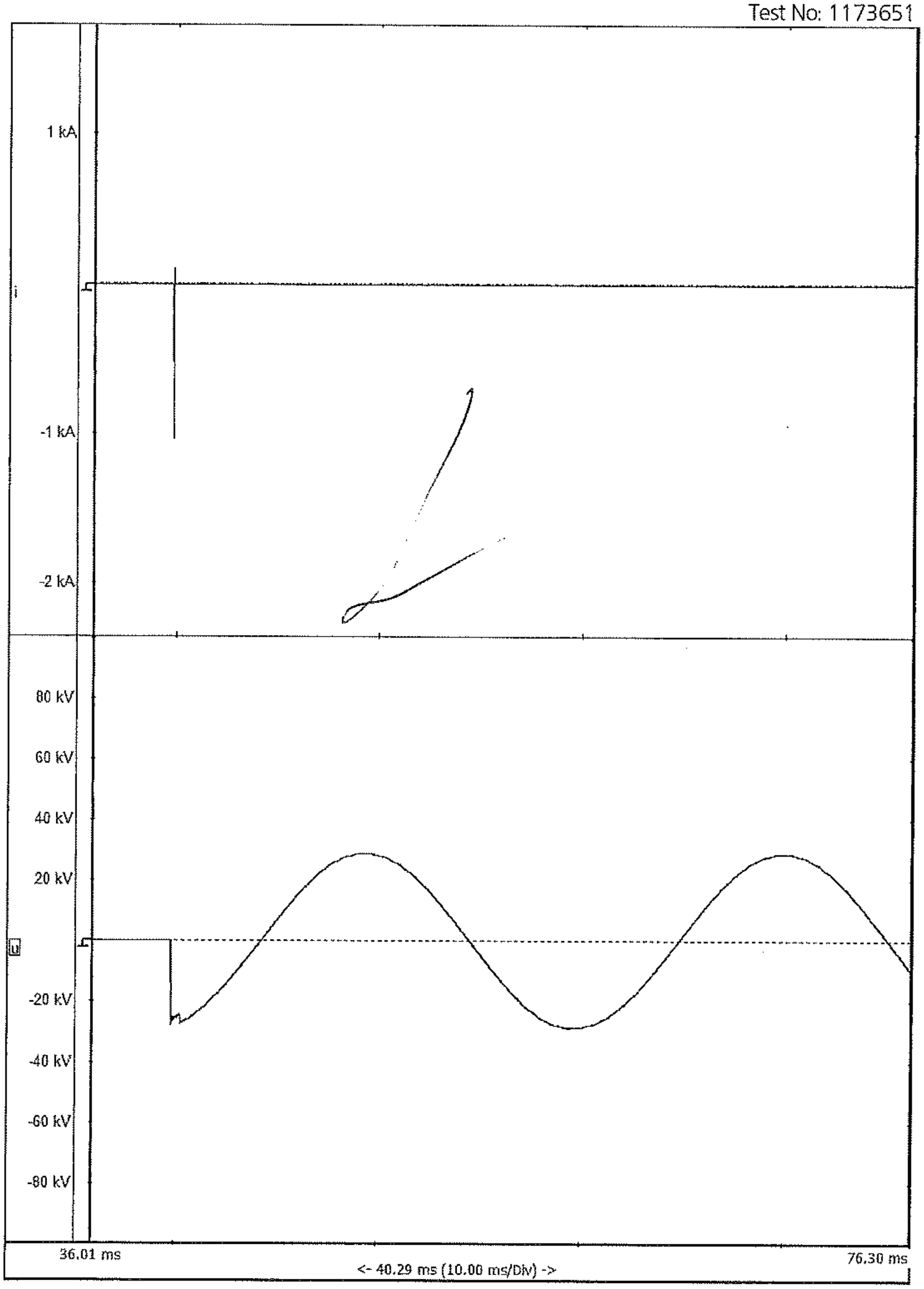
Test No: 1173649



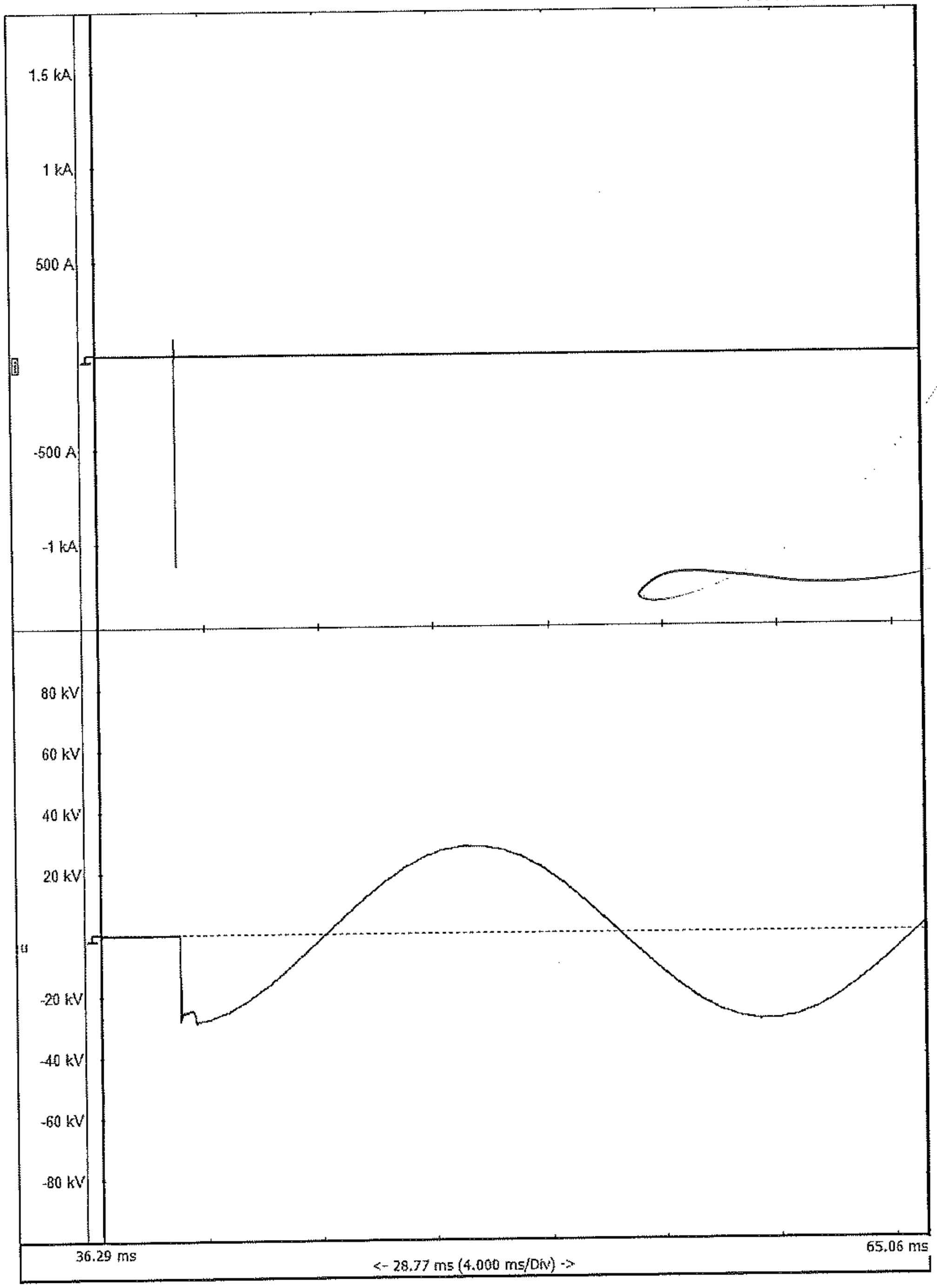
Test No: 1173650

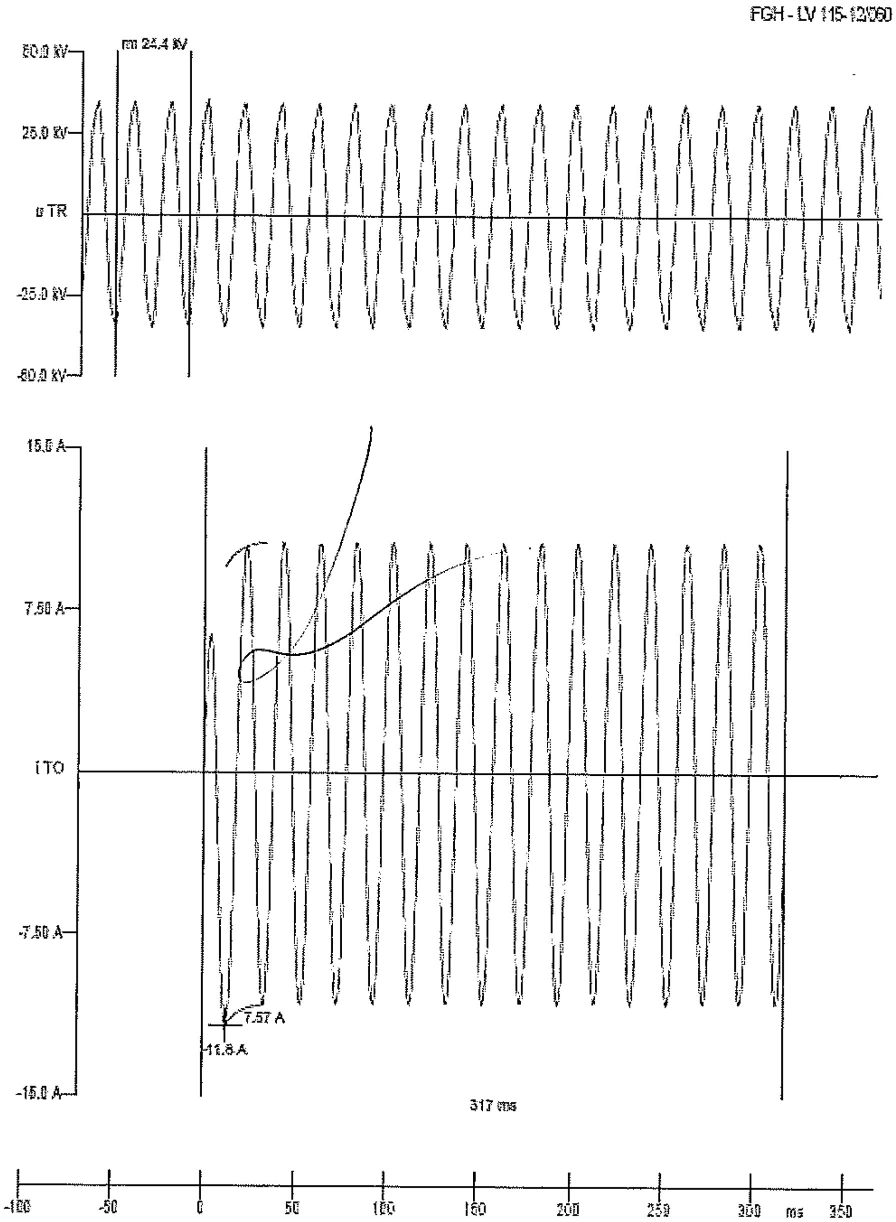


Test No: 1173651

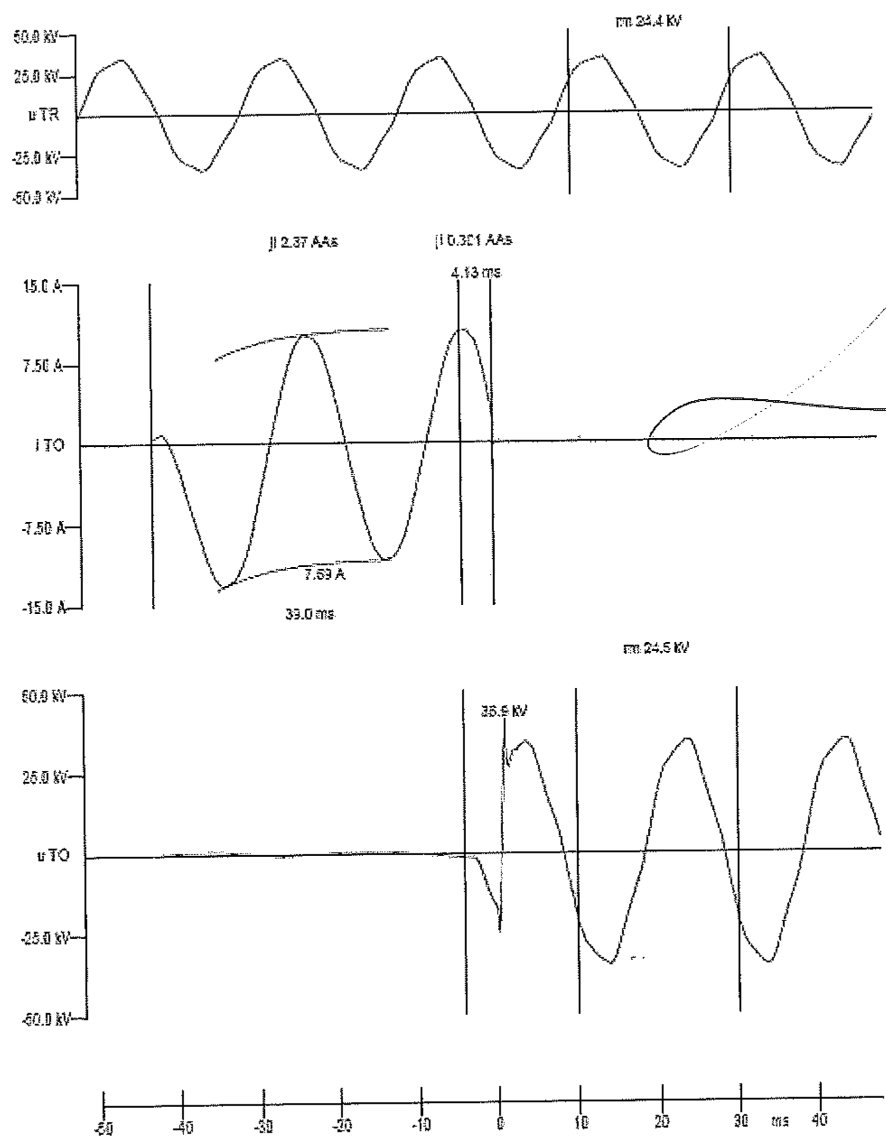


Test No: 1173652



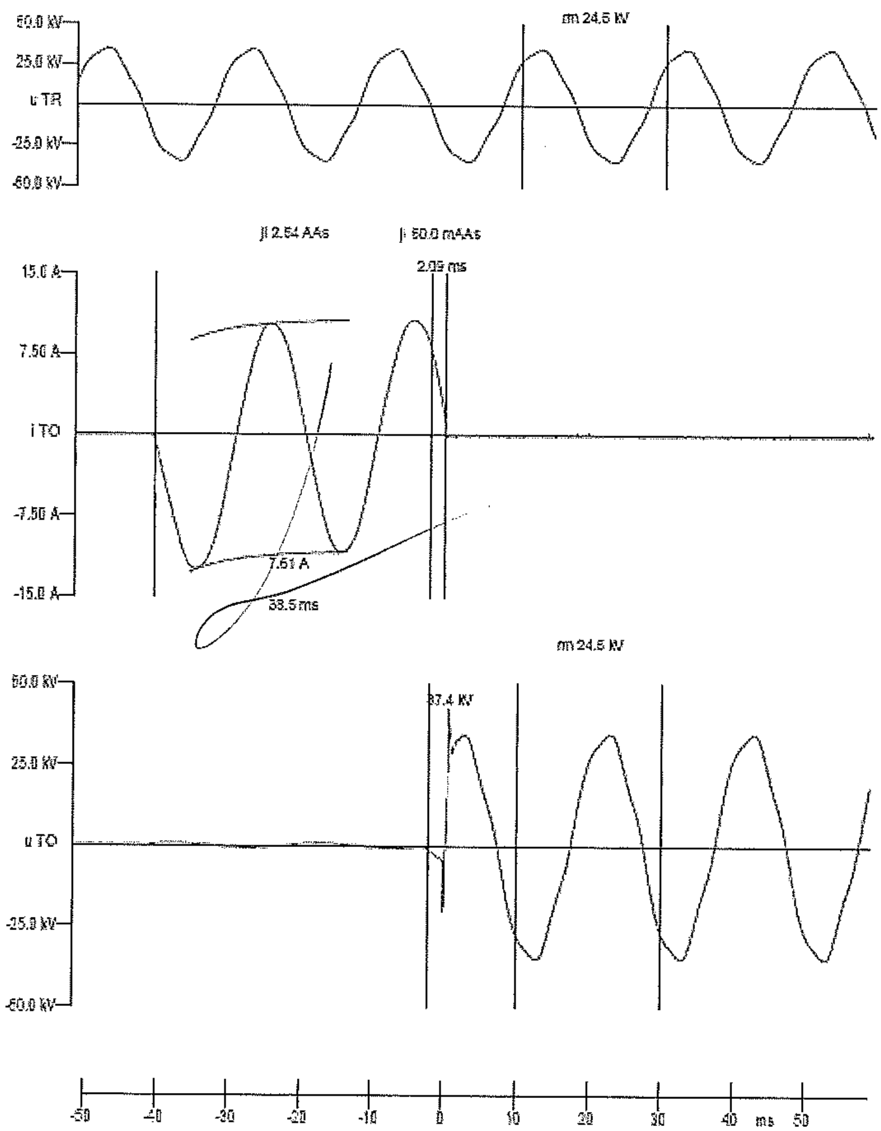

FGH - LV 115-12/060
50.0 kV
m 24.4 kV
25.0 kV
u TR
-25.0 kV
-50.0 kV
15.0 A
7.50 A
i TO
-7.50 A
7.57 A
11.8 A
-15.0 A
317 ms
-100
-50
0
50
100
150
200
250
300
ms
350

FGH - LV 115-12/061



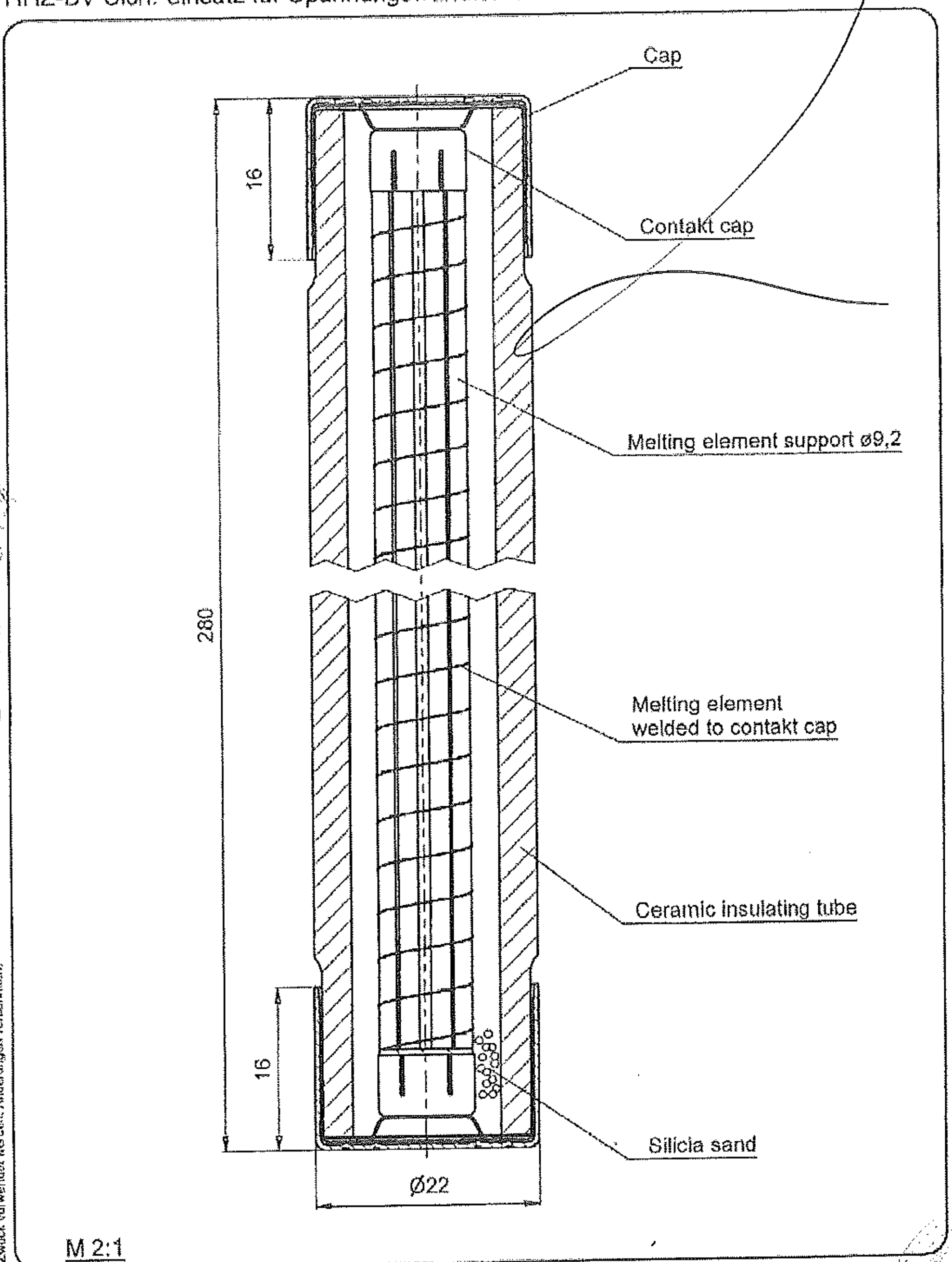
259

FGH - LV 115-12/062



10. Drawings

HHZ-BV Fuse-link for Potential Transformers 24kV 30 441 11.
HHZ-BV Sich.-einsatz für Spannungswandler 24kV



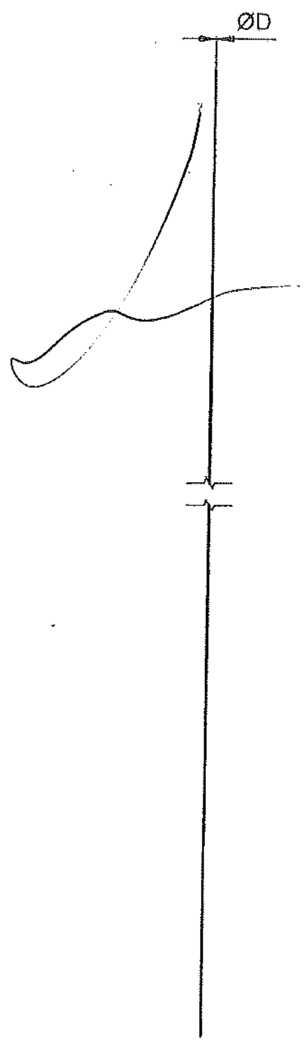
30 441 11._bsk 06.10.17/52

SIBA
SIBA GmbH
Borker Straße 20-22 D-44534 Lünen Tel. ++49 (0) 2306 70010
Postfach 1940 D-44534 Lünen Fax ++49 (0) 2306 700110

Melting Element

Schmelzleiter

30 441 01/



Un (kV)	In (A)	Quantity Anzahl	D ø (mm)	Length Länge (mm)	Material Werkstoff
24	0,5	1	0,055	1000	Ag
	1		0,08		
	2		0,09		
	3,15		0,12		
	4		0,14		
	5		0,16		
	6,3		0,18		

Ersatz für Zeichnung vom

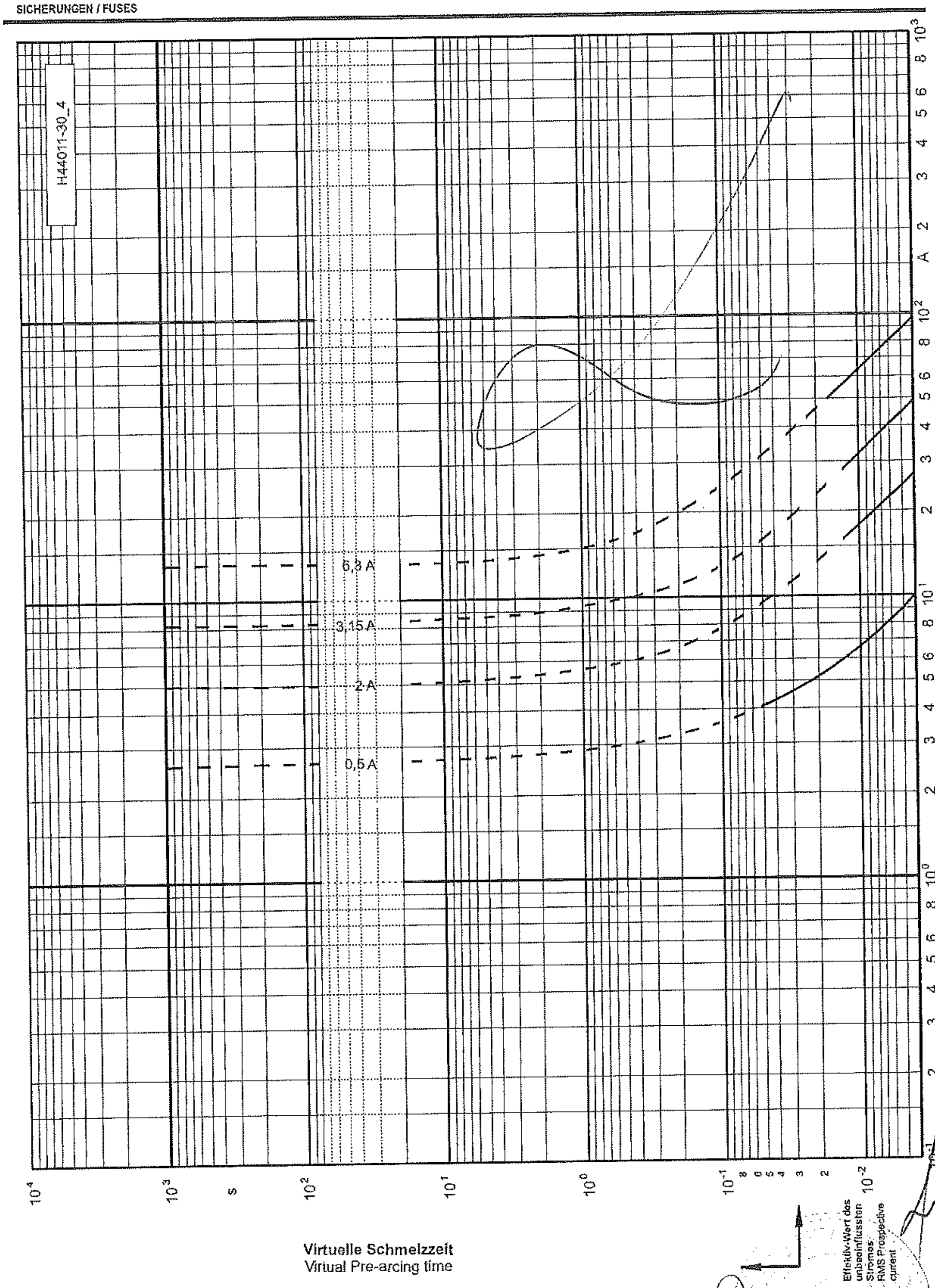
Prüfmaße Test dimensions	Werkstoff / Material	Oberflächenbeschaffenheit / Surface	Gewicht / Weight	Oberfläche / Surface	Volumen / Volume

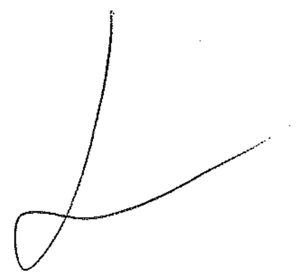
Maßstab / Scale		Datum / Date	Name	Gesehen / observed
1:1	Gez./ drawn	05.10.17	Duro	
A4	Gepr./ checked	05.10.17		

SIBA D-44534 Lünen Germany

SIBA
SICHERUNGEN / FUSES

HHZ-BV 6 - 36 kV





DNV·GL

KEMA TEST REPORT

5033-17

Object	HV current-limiting fuse-links		
Type	GTS-INDOOR/GSZ	**Serial No.**	-
	24 kV – 2,1 A – 63 kA – 50 Hz		
Manufacturer	İnter-Teknik Elektrik Ticaret ve San. Ltd. Şti., Kemankeş Cad. No:53, Fransız Geçidi İş Mrk. C Blok D:16, 34425 Karaköy, Beyoğlu, Istanbul, Turkey *)		
Client	İnter-Teknik Elektrik Ticaret ve San. Ltd. Şti., Kemankeş Cad. No:53, Fransız Geçidi İş Mrk. C Blok D:16, 34425 Karaköy, Beyoğlu, Istanbul, Turkey		
Tested by	KEMA Laboratories Prague, Zkušebnictví, a.s., Podnikatelská 547, Prague 9, the Czech Republic		
Date of tests	06 February 2017		
Test specification	The tests have been carried out in accordance with the client's instructions. Test procedure and test parameters were based on IEC 60282-1:2009, +A1:2014.		

This report applies only to the object tested. The responsibility for conformity of any object having the same type references as that tested rests with the manufacturer.
*) as declared by the manufacturer

This report consists of 27 pages in total.

На основание чл.36а ал.3 от ЗОП

KEMA Laborato

Version: 1

INFORMATION SHEET

1 KEMA Type Test Certificate

A KEMA Type Test Certificate contains a record of a series of (type) tests carried out in accordance with a recognized standard. The object tested has fulfilled the requirements of this standard and the relevant ratings assigned by the manufacturer are endorsed by DNV GL. In addition, the object's technical drawings have been verified and the condition of the object after the tests is assessed and recorded. The Certificate contains the essential drawings and a description of the object tested. A KEMA Type Test Certificate signifies that the object meets all the requirements of the named subclauses of the standard. It can be identified by gold-embossed lettering on the cover and a gold seal on its front sheet.
The Certificate is applicable to the object tested only. DNV GL is responsible for the validity and the contents of the Certificate. The responsibility for conformity of any object having the same type references as the one tested rests with the manufacturer.
Detailed rules on types of certification are given in DNV GL's Certification procedure applicable to KEMA Laboratories.

2 KEMA Report of Performance

A KEMA Report of Performance is issued when an object has successfully completed and passed a subset (but not all) of test programmes in accordance with a recognized standard. In addition, the object's technical drawings have been verified and the condition of the object after the tests is assessed and recorded. The report is applicable to the object tested only. A KEMA Report of Performance signifies that the object meets the requirements of the named subclauses of the standard. It can be identified by silver-embossed lettering on the cover and a silver seal on its front sheet.
The sentence on the front sheet of a KEMA Report of Performance will state that the tests have been carried out in accordance with ...... The object has complied with the relevant requirements.

3 KEMA Test Report

A KEMA Test Report is issued in all other cases. Reasons for issuing a KEMA Test Report could be:
- Tests were performed according to the client's instructions.
- Tests were performed only partially according to the standard.
- No technical drawings were submitted for verification and/or no assessment of the condition of the object after the tests was performed.
- The object failed one or more of the performed tests.

The KEMA Test Report can be identified by the grey-embossed lettering on the cover and grey seal on its front sheet.
In case the number of tests, the test procedure and the test parameters are based on a recognized standard and related to the ratings assigned by the manufacturer, the following sentence will appear on the front sheet. The tests have been carried out in accordance with the client's instructions. Test procedure and test parameters were based on ..... If the object does not pass the tests such behaviour will be mentioned on the front sheet. Verification of the drawings (if submitted) and assessment of the condition after the tests is only done on client's request.
When the tests, test procedure and/or test parameters are not in accordance with a recognized standard, the front sheet will state the tests have been carried out in accordance with client's instructions.

4 Official and uncontrolled test documents

The official test documents of DNV GL are issued in bound form. Uncontrolled copies may be provided as a digital file for convenience of reproduction by the client. The copyright has to be respected at all times.

TABLE OF CONTENTS

1 IDENTIFICATION OF THE OBJECT TESTED

1.1 Ratings/characteristics of the object tested

Type	GTS-INDOOR/GSZ	GTS-INDOOR/GSZ
Year of the manufacture	2017	2017
Voltage	24	24 kV
Number of poles	1	1
Frequency	50	50 Hz
Current:		
Fuse-links	1	2 A
Maximum breaking current (I_1)	63	63 kA
Minimum breaking current (I_3)	-	- A
Resistance	-	- mΩ
Striker type	-	-
Class	-	-

1.2 Description of the object tested

AC HV current-limiting fuse-links for indoor use.

2 GENERAL INFORMATION

2.1 The tests were witnessed by

Name	Company
Gökhan Bayraktar	İnter-Teknik Elektrik Ticaret ve San. Ltd. Şti., Istanbul, Turkey

2.2 The tests were carried out by

Name	Company
Richard Abrahamčík	KEMA Laboratories Prague, Zkušebnictví, a.s., Prague, the Czech Republic

2.3 Accuracy of measurement

The guaranteed uncertainty in the figures mentioned, taking into account the total measuring system, is less than 5%, unless mentioned otherwise.
The reported expanded uncertainties of measurements are stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a probability of approximately 95 %. Determination is based on ENV 13005(GUM).

Version: 1

264

3 LEGEND

Explanation of the letter symbols and abbreviations on the oscillograms

I	Current through test object
U	Voltage across test object
Uv	Transient recovery voltage
t	Time

4 SUMMARY OF TESTS

Breaking tests – TD1 (1 A)							
Test no.		pojb06bd .003	pojb06bd .004	pojb06bd .025	pojb06bd .026	pojb06bd .027	
Phase		R, T	R, T	R, T	R, T	R, T	
Prospective current	kA	-	-	63,6	63,6	63,6	
Initiation of arcing after voltage zero	°	-	-	59	76	74	
Pre-arcing time	ms	-	-	0,008	0,005	0,007	
Cut-off current	kA	-	-	0,22	0,24	0,24	
Instantaneous current at initiation of arcing	kA	-	-	0,11	0,02	0,11	
Recovery voltage	kV	-	-	21,5	21,5	21,5	
Switching voltage, peak	kV	-	-	38,0	42,4	42,1	
Arcing time	ms	-	-	0,06	0,09	0,08	
Total operating time	ms	-	-	0,07	0,09	0,09	
Melt I²t	A²s	-	-	0,0277	0,0004	0,0229	
Total I²t	A²s	-	-	0,965	0,861	0,983	
Energy	J	-	-	65,0	77,7	70,8	
Peak value of current	kA	77,7	-	-	-	-	
Symmetrical current, beginning	kA	31,8	-	-	-	-	
Duration	s	0,215	-	-	-	-	
Peak value of TRV	kV	-	43,9	-	-	-	
Time coordinate of TRV	µs	-	81,0	-	-	-	
Rated voltage	kV	-	-	24	24	24	
Rated current	A	-	-	1	1	1	
Duration of recovery voltage	s	-	-	15	15	15	
Manufacturer of fuse-link		-	-	Inter-Teknik	Inter-Teknik	Inter-Teknik	
Resistance before test	mΩ	-	-	7262	7269	7703	
Resistance after test	MΩ	-	-	>100	>100	>100	
Ambient temperature	°C	-	-	21,3	21,3	21,3	
Fuse-link No.		-	-	24 / 1 / 1	24 / 1 / 2	24 / 1 / 3	

Remarks	
pojb06bd.003	Checking of prospective current at reduced voltage. After recalculation for 100%: prospective current 63,6 kA, cosφ=0,10.
pojb06bd.004	Checking of TRV.
pojb06bd.025	Fuse cleared.
pojb06bd.026	Fuse cleared.
pojb06bd.027	Fuse cleared.

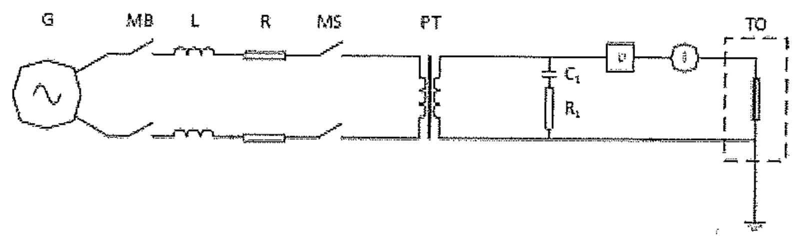
265

Breaking tests – TD1 (0,5 A)							
Test no.		pojb06bd .028	pojb06bd .029	pojb06bd .030			
Phase		R, T	R, T	R, T			
Prospective current	kA	63,6	63,6	63,6			
Initiation of arcing after voltage zero	°	75	75	54			
Pre-arcing time	ms	0,007	0,003	0,008			
Cut-off current	kA	0,12	0,12	0,11			
Instantaneous current at initiation of arcing	kA	0,05	0,02	0,06			
Recovery voltage	kV	21,4	21,5	21,2			
Switching voltage, peak	kV	45,4	45,5	39,2			
Arcing time	ms	0,11	0,12	0,11			
Total operating time	ms	0,12	0,12	0,12			
Melt I^2t	A^2s	0,0032	0,0004	0,0077			
Total I^2t	A^2s	0,493	0,496	0,487			
Energy	J	140,5	143,1	131,1			
Rated voltage	kV	24	24	24			
Rated current	A	0,5	0,5	0,5			
Duration of recovery voltage	s	15	15	15			
Manufacturer of fuse-link		Inter-Teknik	Inter-Teknik	Inter-Teknik			
Resistance before test	mΩ	26415	26348	26208			
Resistance after test	MΩ	>100	>100	>100			
Ambient temperature	°C	21,3	21,3	21,3			
Fuse-link No.		24 / 0,5 / 1	24 / 0,5 / 2	24 / 0,5 / 3			

Remarks	
pojb06bd.028	Fuse cleared.
pojb06bd.029	Fuse cleared.
pojb06bd.030	Fuse cleared.

Version: 1

5.2 Test circuit S01



G	= Generator	TO	= Test Object	U	= Voltage Measurement to earth
MB	= Master Breaker	L	= Reactor	I	= Current Measurement
MS	= Make Switch	R	= Resistor	PT	= Power Transformer
		C	= Capacitor		

Supply		
Power	MVA	1316
Frequency	Hz	50
Phase(s)		1
Voltage	kV	20/88
Current	kA	63
Impedance	Ω	0,331
Power factor		0,1
Neutral		not earthed

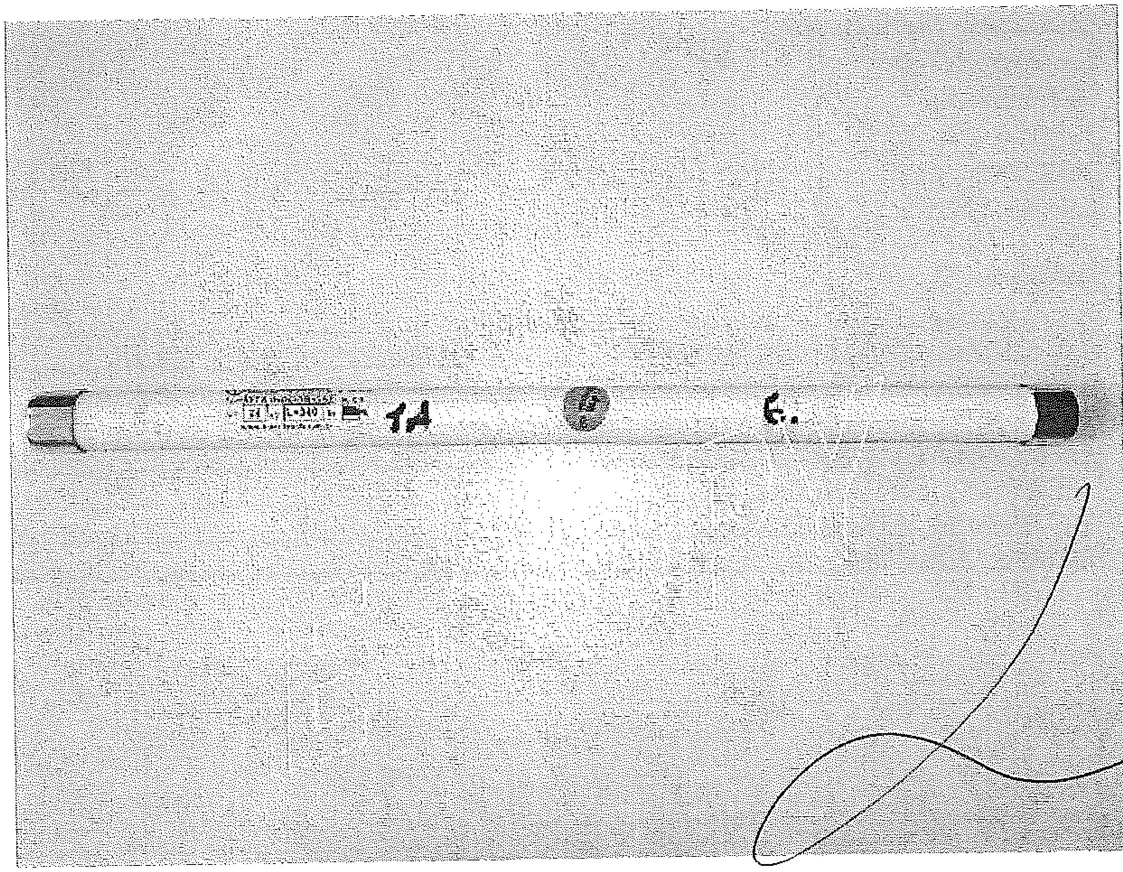
TRV control elements added (supply)		
C_1	μF	1,010
R_1 (in parallel)	Ω	-
R_1 (in series)	Ω	20
L_1	mH	-
C_d	nF	-
Neutral		not earthed

Prospective TRV of supply		
u_c	kV	43,9
t_3	μs	81
t_d	μs	-
RRRV	kV/μs	0,542

Load	
Short-circuit point	earthed

Remarks:

5.3 Photographs before test



267

5.4 Test results and oscillograms

Overview of test numbers

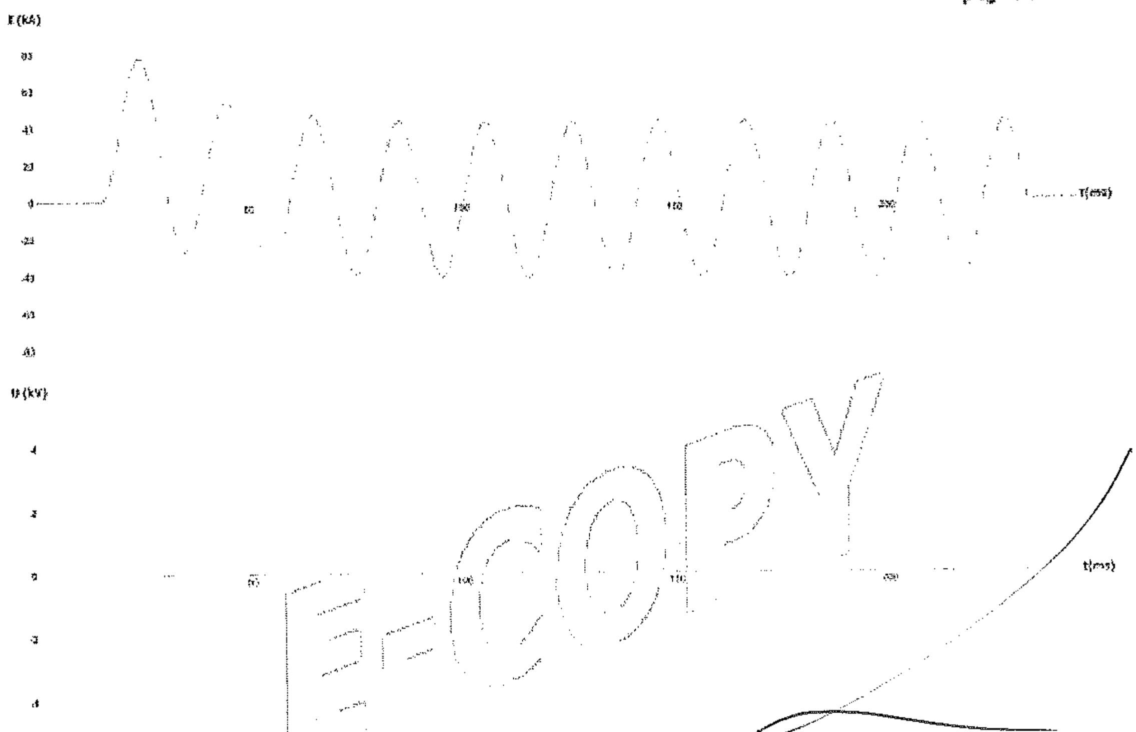
pojb06bd.003
pojb06bd.004
pojb06bd.025
pojb06bd.026
pojb06bd.027

Remarks

Test number	Required breaking capacity – current I_1	Required short-circuit duration
pojb06bd.003	63 kA	-
Checking of prospective current at reduced voltage; after recalculation for 100%: prospective current 63,6 kA, cosφ=0,10.		
pojb06bd.025	63 kA	-
pojb06bd.026	63 kA	-
pojb06bd.027	63 kA	-

Checking of prospective current – TD1

pojb06bd.003



Test number: **pojb06bd.003**

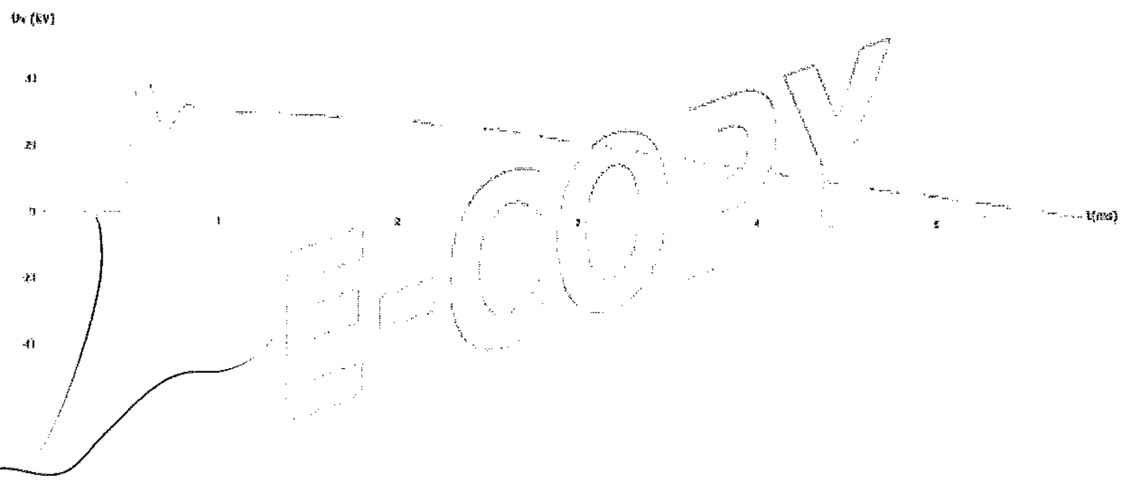
Phase		R, T
Peak value of current	kA	77,7
Symmetrical current, beginning	kA	31,8
Duration	s	0,215

Rated voltage	- kV	Resistance before test	- mΩ
Rated current	- A	Resistance after test	- MΩ
Duration of recovery voltage	- s	Ambient temperature	- °C
Manufacturer of fuse-link	-	Fuse-link No.	-

Remarks:	Checking of prospective current at reduced voltage. After recalculation for 100%: prospective current 63,6 kA, cosφ=0,10.

Checking of prospective TRV

pojb06bd.004



Test number: **pojb06bd.004**

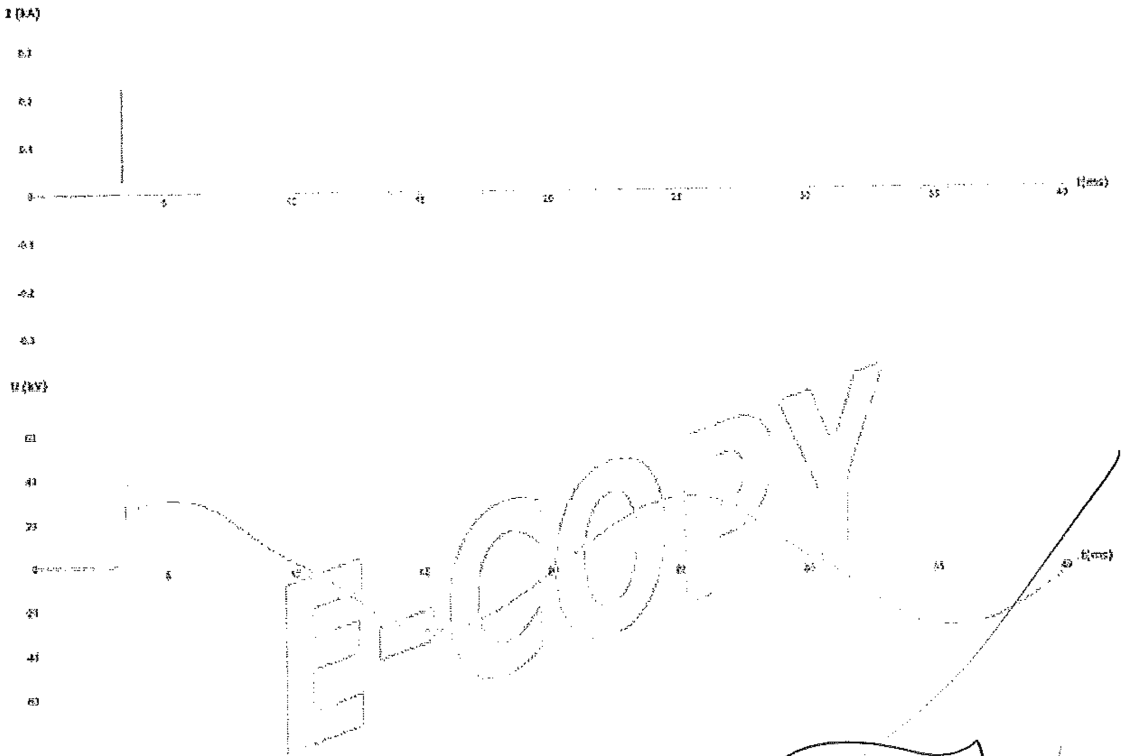
Phase		R, T
Peak value of TRV	kV	43,9
Time coordinate of TRV	µs	81,0

Rated voltage	- kV	Resistance before test	- mΩ
Rated current	- A	Resistance after test	- MΩ
Duration of recovery voltage	- s	Ambient temperature	- °C
Manufacturer of fuse-link	-	Fuse-link No.	-

Remarks: Checking of TRV.

Breaking tests – TD1

pojb06bd.025



Test number: **pojb06bd.025**

Phase		R, T
Prospective current	kA	63,6
Initiation of arcing after voltage zero	°	59
Pre-arcing time	ms	0,008
Cut-off current	kA	0,22
Instantaneous current at initiation of arcing	kA	0,11
Recovery voltage	kV	21,5
Switching voltage, peak	kV	38,0
Arcing time	ms	0,06
Total operating time	ms	0,07
Melt I^2t	A^2s	0,0277
Total I^2t	A^2s	0,965
Energy	J	65,0

Rated voltage	24 kV	Resistance before test	7262 mΩ
Rated current	1 A	Resistance after test	>100 MΩ
Duration of recovery voltage	15 s	Ambient temperature	21,3 °C
Manufacturer of fuse-link	İnter-Teknik	Fuse-link No.	24 / 1 / 1

Remarks: Fuse cleared.

269

Version: 4

Breaking tests – TD1

pojb06bd.026

Test number: **pojb06bd.026**

Phase		R, T
Prospective current	kA	63,6
Initiation of arcing after voltage zero	°	76
Pre-arcing time	ms	0,005
Cut-off current	kA	0,24
Instantaneous current at initiation of arcing	kA	0,02
Recovery voltage	kV	21,5
Switching voltage, peak	kV	42,4
Arcing time	ms	0,09
Total operating time	ms	0,09
Melt I^2t	A^2s	0,0004
Total I^2t	A^2s	0,861
Energy	J	77,7

Rated voltage	24 kV	Resistance before test	7269 mΩ
Rated current	1 A	Resistance after test	>100 MΩ
Duration of recovery voltage	15 s	Ambient temperature	21,3 °C
Manufacturer of fuse-link	İnter-Teknik	Fuse-link No.	24 / 1 / 2

Remarks: Fuse cleared.

Breaking tests – TD1

pojb06bd.027

Test number: **pojb06bd.027**

Phase		R, T
Prospective current	kA	63,6
Initiation of arcing after voltage zero	°	74
Pre-arcing time	ms	0,007
Cut-off current	kA	0,24
Instantaneous current at initiation of arcing	kA	0,11
Recovery voltage	kV	21,5
Switching voltage, peak	kV	42,1
Arcing time	ms	0,08
Total operating time	ms	0,09
Melt I²t	A²s	0,0229
Total I²t	A²s	0,983
Energy	J	70,8

Rated voltage	24 kV	Resistance before test	7703 mΩ
Rated current	1 A	Resistance after test	>100 MΩ
Duration of recovery voltage	15 s	Ambient temperature	21,3 °C
Manufacturer of fuse-link	İnter-Teknik	Fuse-link No.	24 / 1 / 3

Remarks: Fuse cleared.

Version: 1

5.5 Condition/inspection after test

Externally no visible change.
Fuse-link intact.

6 BREAKING TESTS – TD1 (2 A)

Standard and date

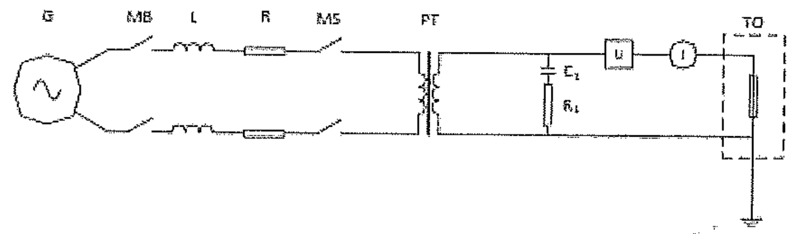
Standard	Client's instructions, based on IEC 60282-1, subclause 6.6
Test date	06 February 2017

6.1 Condition before test

Fuse-link mounted vertically in open air.
Fuse-base new.
New fuse-link before each test.

271

6.2 Test circuit S01



G = Generator	TO = Test Object	U = Voltage Measurement to earth
MB = Master Breaker	L = Reactor	I = Current Measurement
MS = Make Switch	R = Resistor	PT = Power transformer
	C = Capacitor	

Supply		
Power	MVA	1315
Frequency	Hz	50
Phase(s)		1
Voltage	kV	20,88
Current	kA	63
Impedance	Ω	0,331
Power factor		0,10
Neutral		not earthed

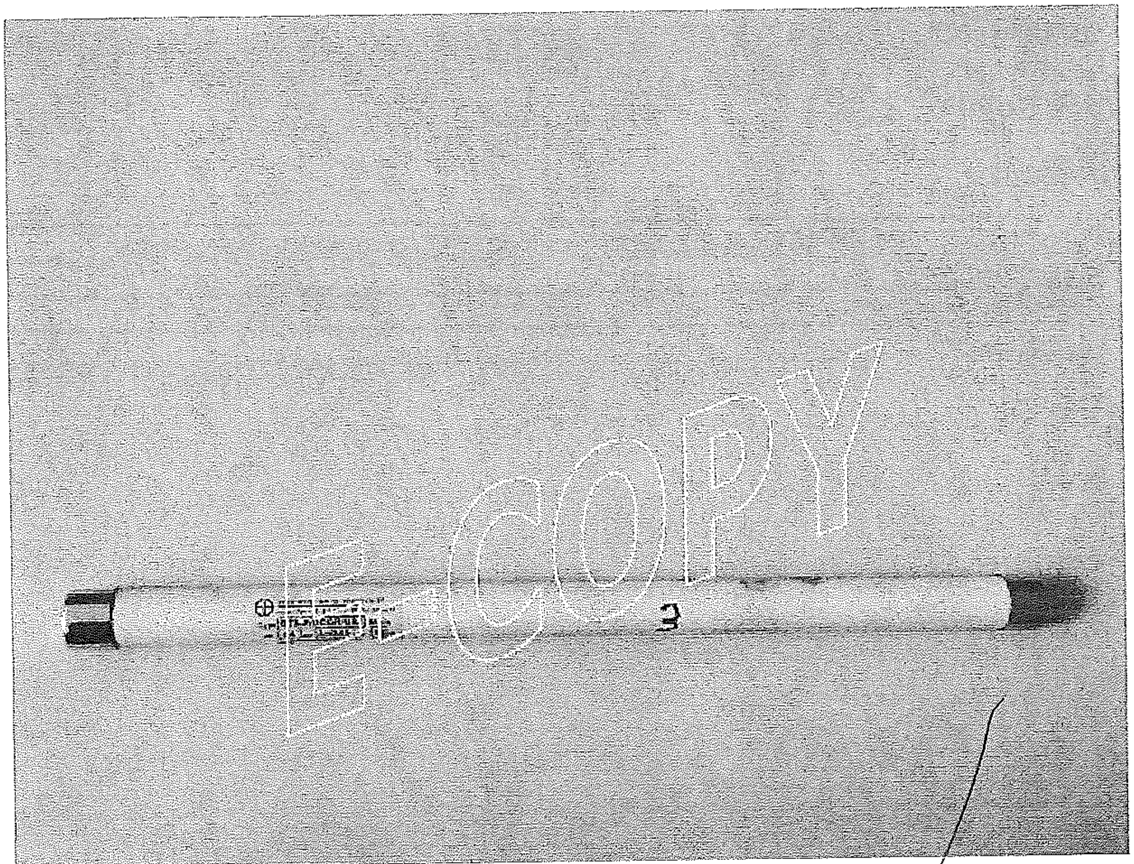
Load	
Short-circuit point	earthed

TRV control elements added (supply)		
C_1	μF	1,010
R_1 (in parallel)	Ω	-
R_1 (in series)	Ω	20
L_1	mH	-
C_d	nF	-
Neutral		not earthed

Prospective TRV of supply		
u_c	kV	43,9
t_3	μs	81
t_d	μs	-
RRRV	kV/μs	0,542

Remarks:	-

6.3 Photographs before test



282

6.4 Test results and oscillograms

Overview of test numbers

pojb06bd.028

pojb06bd.029

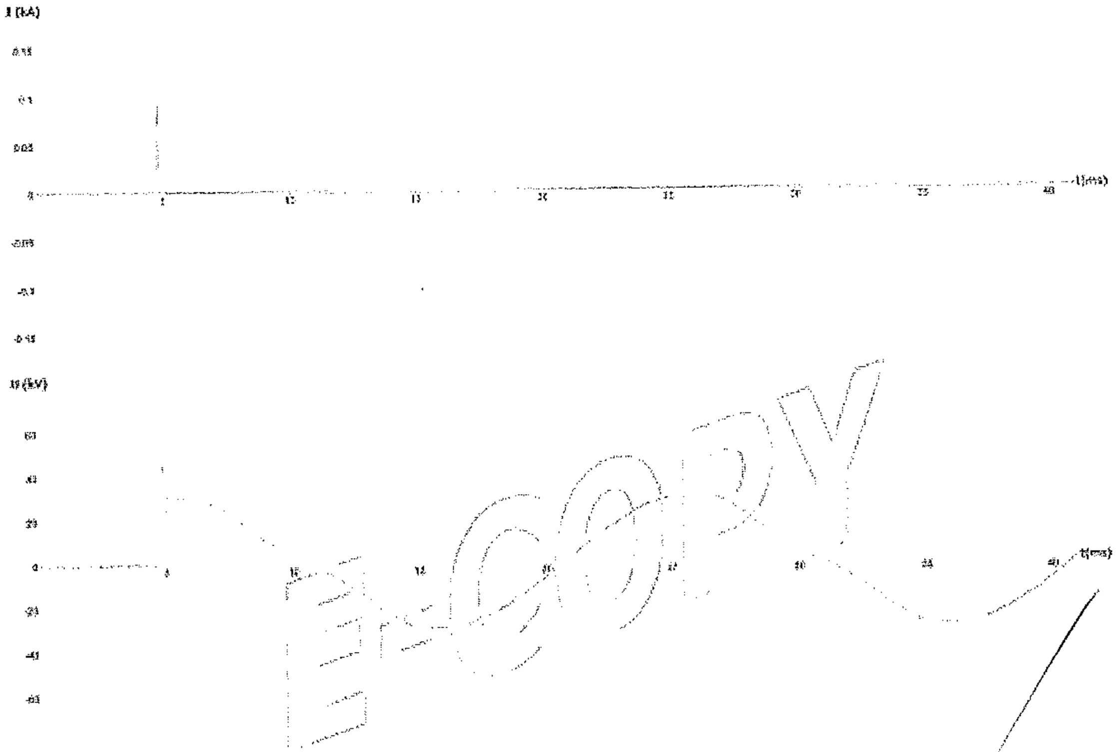
pojb06bd.030

Remarks

Test number	Required breaking capacity – current I_1	Required short-circuit duration
pojb06bd.028	63 kA	-
pojb06bd.029	63 kA	-
pojb06bd.030	63 kA	-

Breaking tests – TD1

pojb06bd.028



Test number: **pojb06bd.028**

Phase		R, T
Prospective current	kA	63,6
Initiation of arcing after voltage zero	°	75
Pre-arcing time	ms	0,007
Cut-off current	kA	0,12
Instantaneous current at initiation of arcing	kA	0,05
Recovery voltage	kV	21,4
Switching voltage, peak	kV	45,4
Arcing time	ms	0,11
Total operating time	ms	0,12
Melt I²t	A²s	0,0032
Total I²t	A²s	0,493
Energy	J	140,5

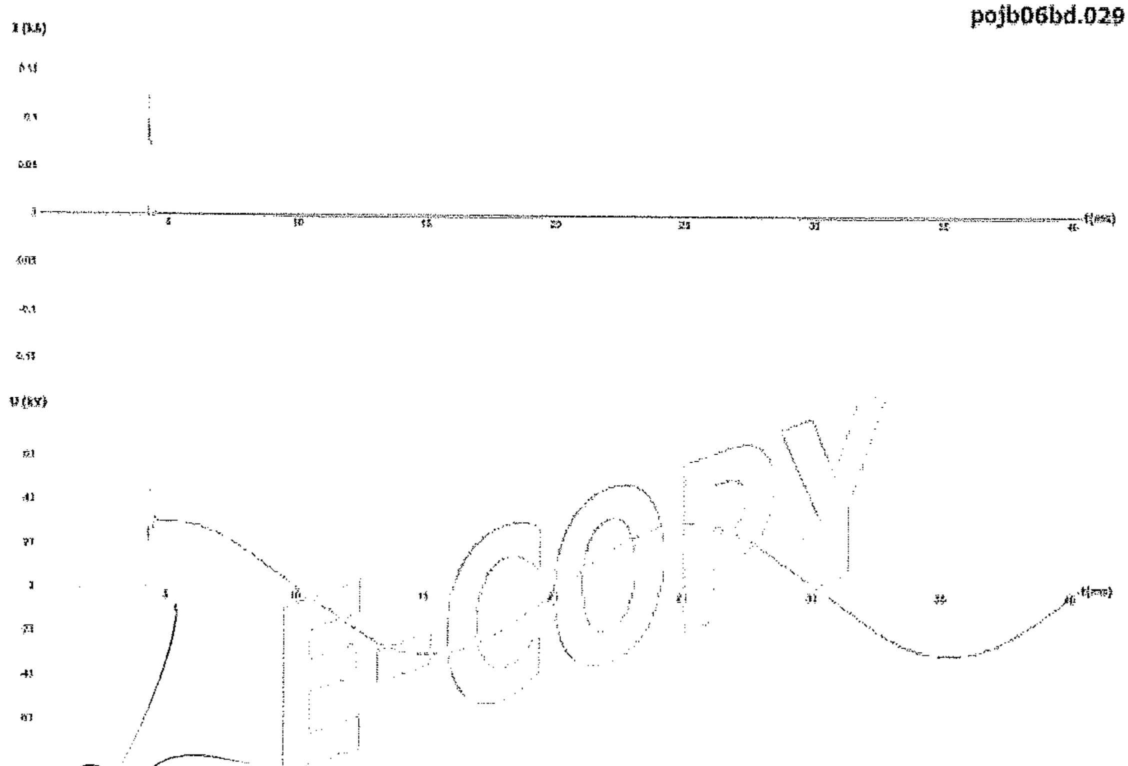
Rated voltage	24 kV	Resistance before test	26415 mΩ
Rated current	2 A	Resistance after test	>100 MΩ
Duration of recovery voltage	15 s	Ambient temperature	21,3 °C
Manufacturer of fuse-link	İnter-Teknik	Fuse-link No.	24 / 2 / 1

Remarks:	Fuse cleared.

283

Breaking tests – TD1

pojb06bd.029



Test number: **pojb06bd.029**

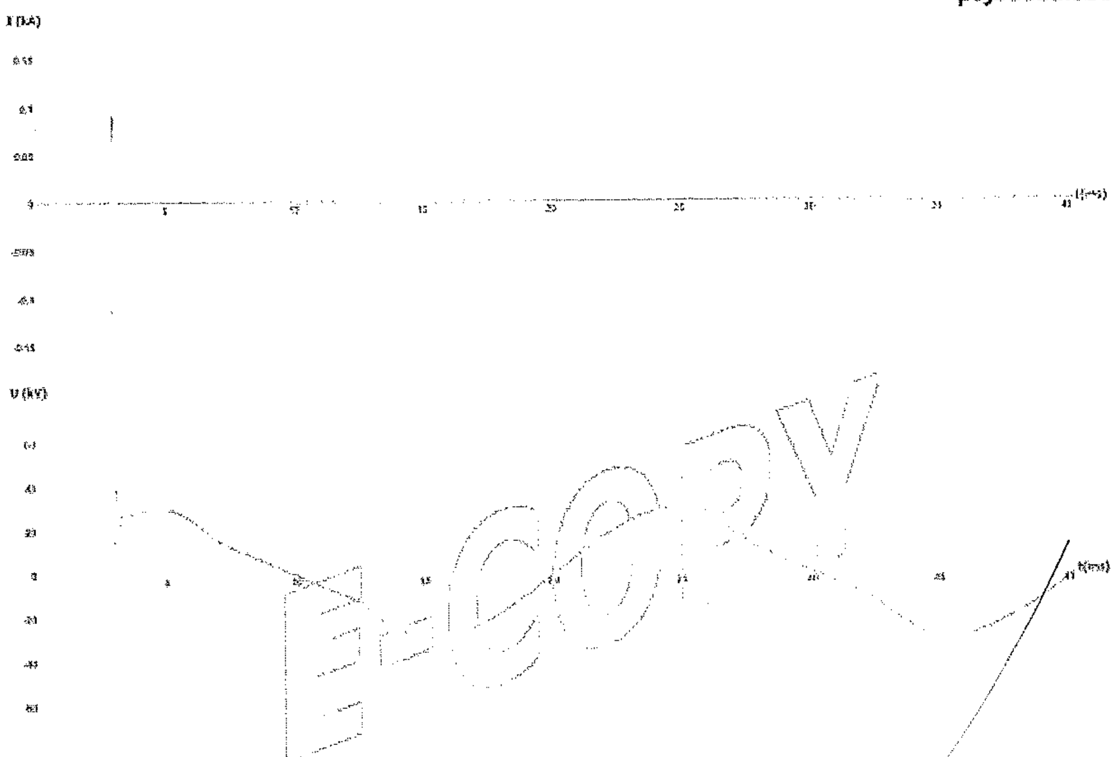
Phase		**R, T**
Prospective current	kA	63,6
Initiation of arcing after voltage zero	°	75
Pre-arcing time	ms	0,003
Cut-off current	kA	0,12
Instantaneous current at initiation of arcing	kA	0,02
Recovery voltage	kV	21,5
Switching voltage, peak	kV	45,5
Arcing time	ms	0,12
Total operating time	ms	0,12
Melt I^2t	A^2s	0,0004
Total I^2t	A^2s	0,496
Energy	J	143,1

Rated voltage	24 kV	Resistance before test	26348 mΩ
Rated current	2 A	Resistance after test	>100 MΩ
Duration of recovery voltage	15 s	Ambient temperature	21,3 °C
Manufacturer of fuse-link	Inter-Teknik	Fuse-link No.	24 / 2 / 2

Remarks: Fuse cleared.

Breaking tests – TD1

pojb06bd.030



Test number: **pojb06bd.030**

Phase		R, T
Prospective current	kA	63,6
Initiation of arcing after voltage zero	°	54
Pre-arcing time	ms	0,008
Cut-off current	kA	0,11
Instantaneous current at initiation of arcing	kA	0,06
Recovery voltage	kV	21,2
Switching voltage, peak	kV	39,2
Arcing time	ms	0,11
Total operating time	ms	0,12
Melt I²t	A²s	0,0077
Total I²t	A²s	0,487
Energy	J	131,1

Rated voltage	24 kV	Resistance before test	26208 mΩ
Rated current	2 A	Resistance after test	>100 MΩ
Duration of recovery voltage	15 s	Ambient temperature	21,3 °C
Manufacturer of fuse-link	İnter-Teknik	Fuse-link No.	24 / 2 / 3

Remarks: Fuse cleared.

6.5 Condition/inspection after test

Externally no visible change.
Fuse-link intact.