Welcome to LV Webinar, 16 April 2020

IEC TS 63107

Integration of arcing fault mitigation devices into power switchgear and control gear assemblies according to IEC61439-2

Welcome

Cristian La Salvia

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Welcome to LV Webinar, 16 April 2020

Agenda

- 09:45 – 10.00 Webinar introduction and CESI presentation (*C.La Salvia*)
- 10:00 – 10:40 LV Technical seminar (*R.Borchert*)
- 10:45 – 11.00 Q&A Session and conclusion

LIVE Registration and today presentation will be available for download in the CESI website, in the next days

www.cesi.it/webinars

CESI Group: the Making of a Global Company

KEMA

1927
Founded by Dutch power companies

1972
CHALFONT
Test lab built as part of ITE Corporation Research Center in Chalfont

ZKU

1953
Founded as part of Research Institute of Czech Technical University of Prague

CESI

1956
Created as a testing company with first Italian large scale test facilities

ISMES

1951
Started as a safety testing facility for hydraulic dams, quickly developed in other important sectors

IPH BERLIN

1956
Founded as national German High-Power test lab

FGH

1921
Founded as Study Society for High Voltage Systems (SfH)

EnerNex

2003
Funded to improve operation and reliability of power grids through advanced tecnology

CESI | GEPL

2019
Created as Joint Venture Company between CESI and GCC ETL

Today

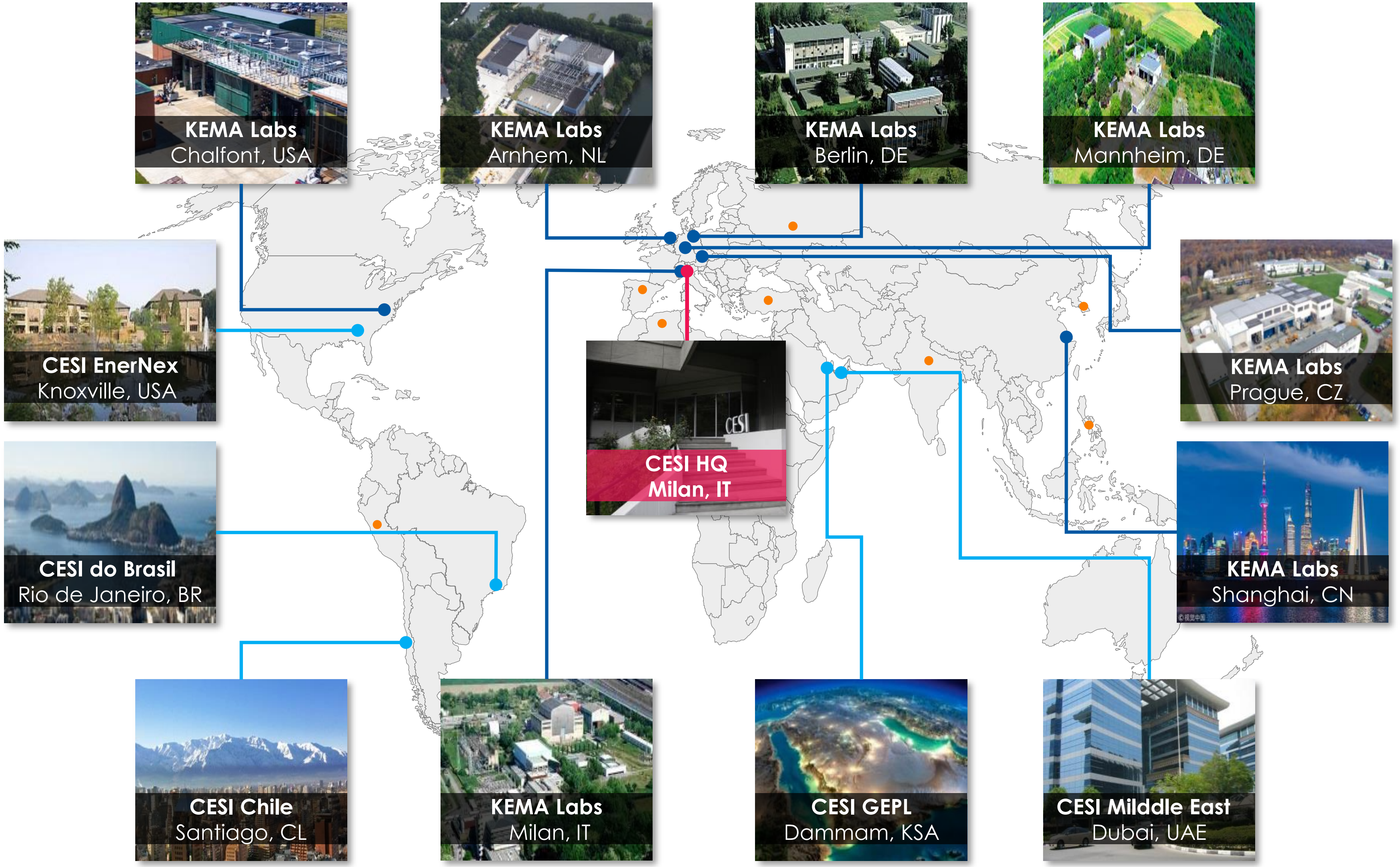
A Global Player in Engineering, Testing and Power Systems Consulting

~2.000
Professionals

2.000+
Clients

70+
Countries Served

12
Global Sites



● Commercial Network ● CESI Global Office ● KEMA Labs Site

High-end, Tailor Made Solutions for our Global Clients

Testing, Inspection & Certification

KEMA Labs

The Global Leader in Independent Testing, Inspection and Certification for the Electricity Sector

Energy Consulting

CESI

Our Expertise in The Energy Industry at Your Disposal Through Ad-hoc Consultancies

Environmental Consulting & Civil Engineering

ISMES

Renewable Engineering, Remediation, Compliance and Monitoring Services to Drive Circular Economy

Space Solar Cells

CESI

Production of Advanced Multi-junction Solar Cells for Space Applications

30.000 MVA, Next to Our Clients

Arnhem, NL

13.000 MVA

- **Short Circuit HV** up to 1200 kV, 100 kA
- **High Power Trafo** up to 800 kV
- **Dielectric Test HV** up to 550 kV
- **Cable Prequalification** up to 550 kV
- **Temperature Rise** up to 25 kA

Prague, CZ

2.500 MVA

- **Short Circuit MV** up to 36 kV, 25 kA
- **Power arc insulators** up to 63 kA
- **Power Trafo** up to 230 kV, 63 MVA
- **Short-time current** up to 280 kA/2.5s

Milan, IT

4.000 MVA

- **Short Circuit HV** up to 420 kV, 63 kA
- **Direct Test** up to 36kV/31.5kA
- **Dielectric Test HV** up to 1.600 kVac
- **Cable Prequalification** up to 800kV
- **Temperature Rise** up to 10kA

Mannheim, DE

800 MVA

- **HVDC cable** up to 600 kV
- **Direct Test short-circuit** up to 800 MVA
- **Dielectric Test HV** up to 800 kV
- **Cable Prequalification** up to 400 kV
- **Pollution test** up to 600 kV

Berlin, DE

3.000 MVA

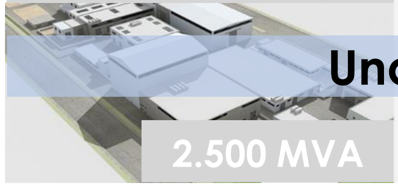
- **Short Circuit LV** to 250kAac/150kAdc
- **Direct Test** up to 36kV/25kA
- **Dielectric Test HV** up to 550 kV
- **Cable Prequalification** up to 500 kV
- **Temperature Rise** up to 50kA

Chalfont, USA

3.200 MVA

- **Short Circuit MV** up to 36 kV, 25 kA
- **Short Circuit LV** up to 300 kA
- **Dielectric Test HV** up to 245 kV
- **Temperature Rise** up to 30 kA

Dammam, KSA



2.500 MVA

Under Construction

- **Short Circuit HV** up to 550 kV/63 kA
- **Direct Test** up to 40kV/80kA
- **Dielectric Test HV** up to 1.600 kVac
- **Cable Prequalification** up to 800 kV
- **Short Circuit LV** up to 250kAac/150kAdc

Low voltage Expertise

DC Switchgear and assemblies for railways application

Berlin

Power tests up to 200MVA
Voltage up to 8kV DC

According to
EN50123-IEC61992
EN50526 IEC60310 (EN60310)
IEC60077 (EN60077)IEC 61287-1
and many others

AC/DC Switchgear assemblies

Berlin, Prague, Chalfont

All Type Test up to 6300 A

According to IEC61439-1, IEC61921, IEC60146 and many other IEC standard
UL508/UL845/UL98/
UL891/UL681/CSA C22

AC/DC Circuit breakers and fuses

Berlin, Chalfont

Complete type test sequence according to IEC60947, IEC60898 and many others
Overload tests up to 10kA
AC 1ph and 3ph

UL248/UL1077/UL1066/UL489

AC/DC Power tests

Berlin, Chalfont

Making and Breaking capacity test up to 180kA
Short-circuit withstand current up to 200kA
Internal arc test

According to IEC61439-IEC61641,IEEE and many others

KEMA Labs

Cristian La Salvia, Ronald Borchert

LIVE Webinar *April 16, 2020*

A brand new Low Voltage standard

IEC TS 63107 ED1: Integration of arcing fault mitigation devices into power switchgear and control-gear assemblies (PSC-ASSEMBLIES) according to IEC61439-2

Ronald Borchert – LV Senior test engineer

<u>Member of committees</u>

IEC/SC121B Low Voltage Switchgear and controlgear assemblies

PT63107: Integration of arc fault mitigation system

DKE UK 431.1 Low Voltage switchgear and controlgear assemblies

DKE UK 431.1.4

Summary

1. Integration in the international standard system
2. Scope
3. Components and basic structure
4. Protected and non-protected areas
5. Design verification

Integration in the international standard system

Product standards

IEC 61439-1

Low-voltage switchgear and controlgear assemblies – General rules

IEC 61439-2

Low-voltage switchgear and controlgear assemblies – Power switchgear and controlgear assemblies

IEC TR 61641

Enclosed low-voltage switchgear and controlgear assemblies – Guide for testing under conditions of arcing due to internal fault

IEC TS 63107

IEC 60947-9-1

Arc quenching devices

IEC 60947-9-2

Active arc-fault combined mitigation systems - Optical-based internal arc-detection and combined mitigation devices

Integration in the international standard system

Standards for protective measures and erection of electrical equipment

IEC 61482-1-1

Live working – Protective clothing against the thermal hazards of an electric arc – Test method 1: Determination of the arc rating of flame resistant materials for clothing

IEC 60364-4-42

Protection for safety – Protection against thermal effects

IEC TS 63107

IEC 61482-1-2

Live working – Protective clothing against the thermal hazards of an electric arc – Test method 2: Determination of arc protection class of material and closing by using a constrained and directed arc (box test)

IEC 60364-5-53

Selection and erection of electrical equipment – switchgear and controlgear

Summary

Scope

- The TS states requirements for integration and testing of IAMS in Low-voltage PSC-assemblies according to IEC 61439-2 to demonstrate their correct operation.
- It does not address personnel safety or damage to the PSC-assembly. These requirements are dealt with IEC TR 61641.
- IAMS consist of control devices (IACD) ***<u>and</u>*** arc-fault reduction devices (IARD) complying with their relevant product standards.
- Requirements with respect to construction and performance as well as to testing for the reliable function of an IAMS under built-in conditions are addressed .

Summary

1. Integration in the international standard system
2. Scope
3. Components and basic structure
4. Protected and non-protected areas
5. Design verification

Components and basic structure

IAMS (Internal Arc-fault Mitigation System)

IACD

Internal Arc-fault Control Device

- Sensors
- Interfaces
- Control unit

IARD

Internal Arc-fault Reduction Device

- AQD (Arc Quenching Device) in connection with a SCPD
- IALD (Internal Arc-fault Limitation Device), but no SCPD
- SCPD

Note: IACD and IARD can be one combined device.

And now it’s time for fun……

Scan with your **Mobile** the **QR Code** and **answer** the **questions live** within 2 minutes!

And now it's time for fun……

Scan with your **Mobile** the **QR Code** and **answer** the **questions live** within 90 seconds!

Summary

1. Integration in the international standard system
2. Scope
3. Components and basic structure
4. Protected and non-protected areas
5. Design verification

Protected and non-protected areas

There can be IAMS-protected and unprotected areas within a switchgear and controlgear assembly.

An IAMS-protected area has to meet the following behavioral requirements:

- The detection of an arcing fault is guaranteed.
- Unintentional tripping (e.g. caused by a switching arc) is prevented.
- The detected arcing fault is limited and ultimately extinguished.

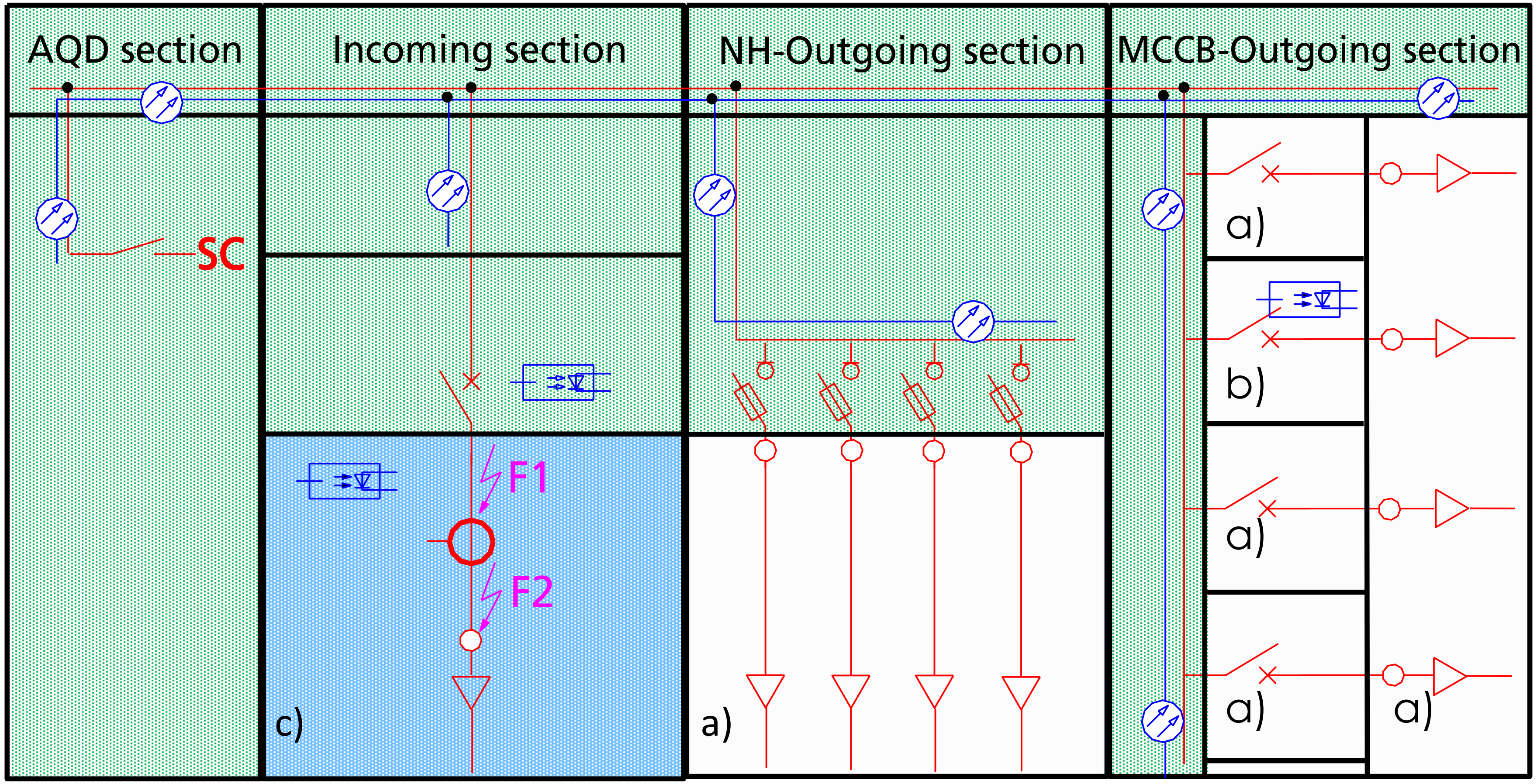
Protected and non-protected areas

The declaration of each IAMS-protected area includes the following parameters:

- Range of the prospective short-circuit current that is present at the input terminals of the PSC-assembly.
- The range of rated operational voltages correlating to the range of the prospective short-circuit current.
- The highest arc energy that has been determined as electrical energy in the design verification tests.

Protected and non-protected areas

Example for an optical based IAMS and an AQD as IARD



IAMS-protected area

Non IAMS-protected area

Conditionally IAMS-protected area

a) No sensor
b) Sensor is installed but unintended operation by switching arc is possible
c) Sensor is installed but the correct functioning depends on the location of the fault, the switching status of the incoming switch and the effect of any back-up protection that may be present

Fibre optic sensor

Point sensor

SC Short-circuit

F1, F2 Fault locations

Summary

1. Integration in the international standard system
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Design Verification

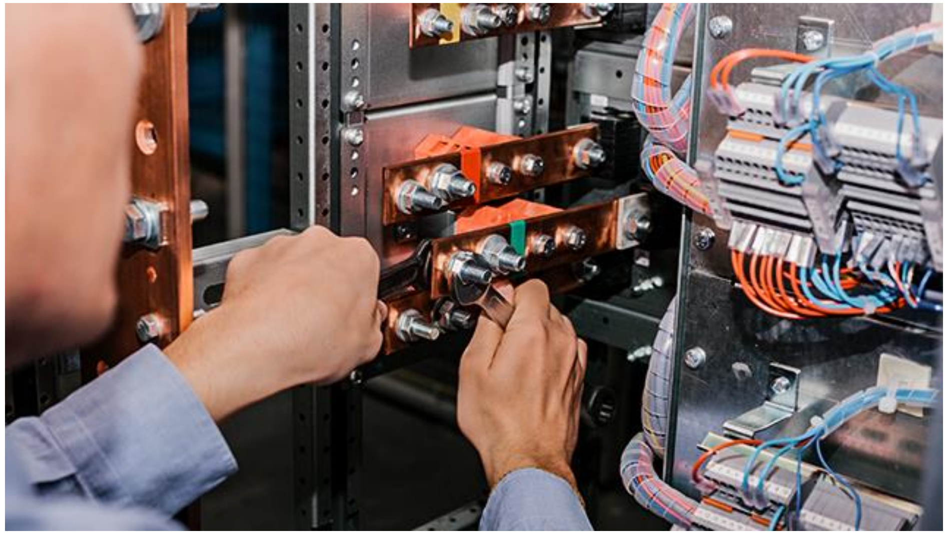
The complete design verification acc. to IEC 61439-2 includes the following:

a) Construction

10.2	Strength of materials and parts
10.3	Degree of protection of enclosures
10.4	Clearances and creepage distances
10.5	Protection against electric shock and integrity of protective circuits
10.6	Incorporation of of switching devices and components
10.7	Internal electrical circuits and connections
10.8	Terminals for external conductors

b) Performance

10.9	Dielectric properties
10.10	***Verification of temperature rise***
10.11	***Short-circuit withstand strength***
10.12	Electromagnetic compatibility
10.13	Mechanical operation



The technical standard specifies some additional tests to demonstrate the correct functioning of the entire arc protection system under built-in conditions.

Design verification-Additional tests

10.10.1 Additional tests to verify the temperature-rise

10.11.1 Additional tests to verify the short-circuit withstand strength of the AQD-circuit (wanted, internal, metallic short-circuit)

10.101.2 Verification of arc-fault detection by test

10.101.3 Verification by test that unintended operation will not occur

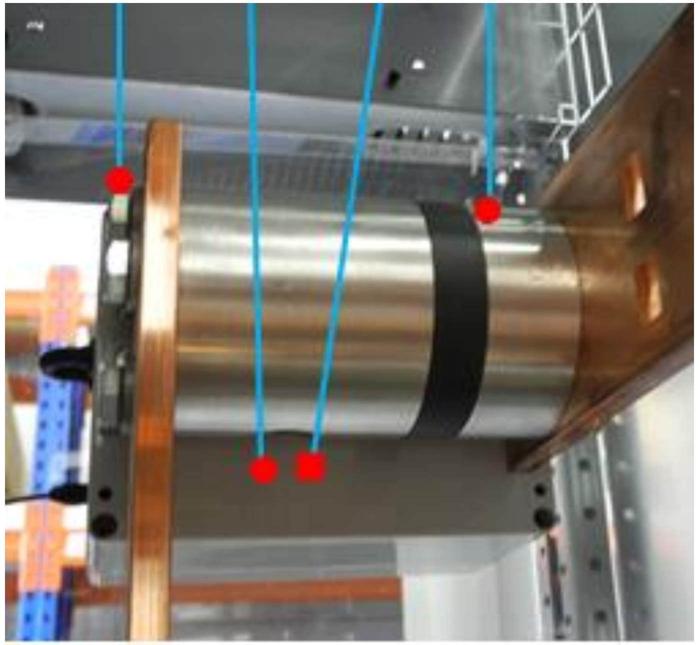
10.101.4 Verification of an IAMS in PSC-assemblies by test

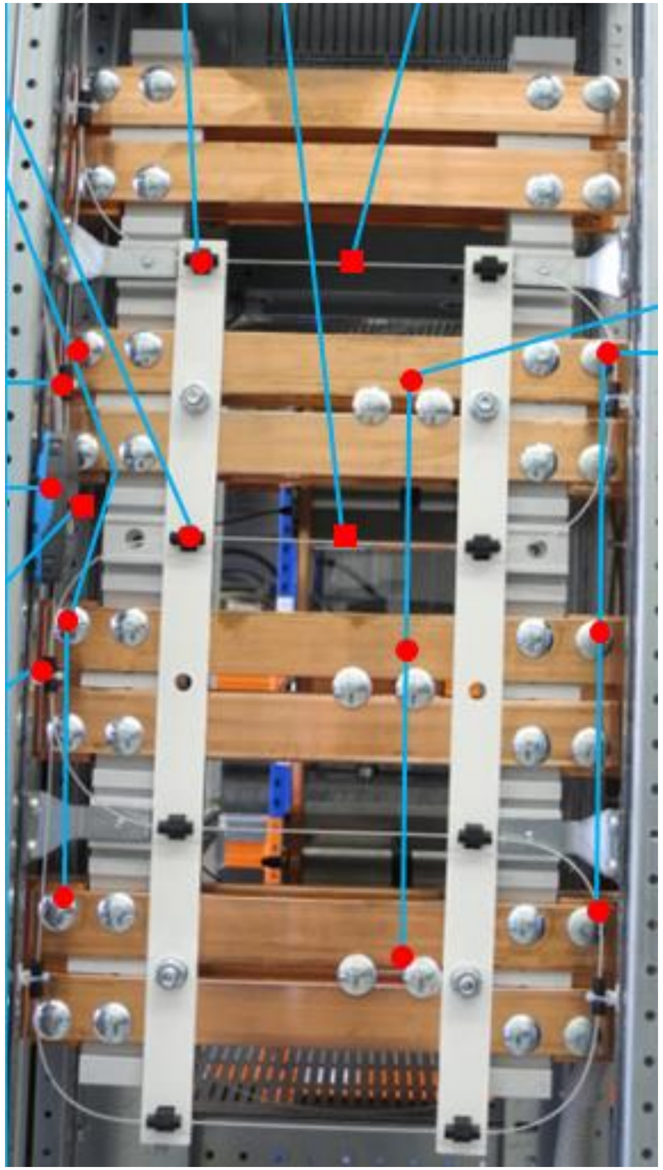
10.101.5 Performance after powering or repowering

Design verification-Temperature-rise test

Temperature measuring points on the optical sensors

and on the AQD





By courtesy of Siemens AG and DEHN SE+Co KG

Design verification-Short-circuit test

10.11.1 General

Addition:

If present, the AQD main circuit including the incoming circuit

and the connection to the connection point of the

AQD have to be tested.

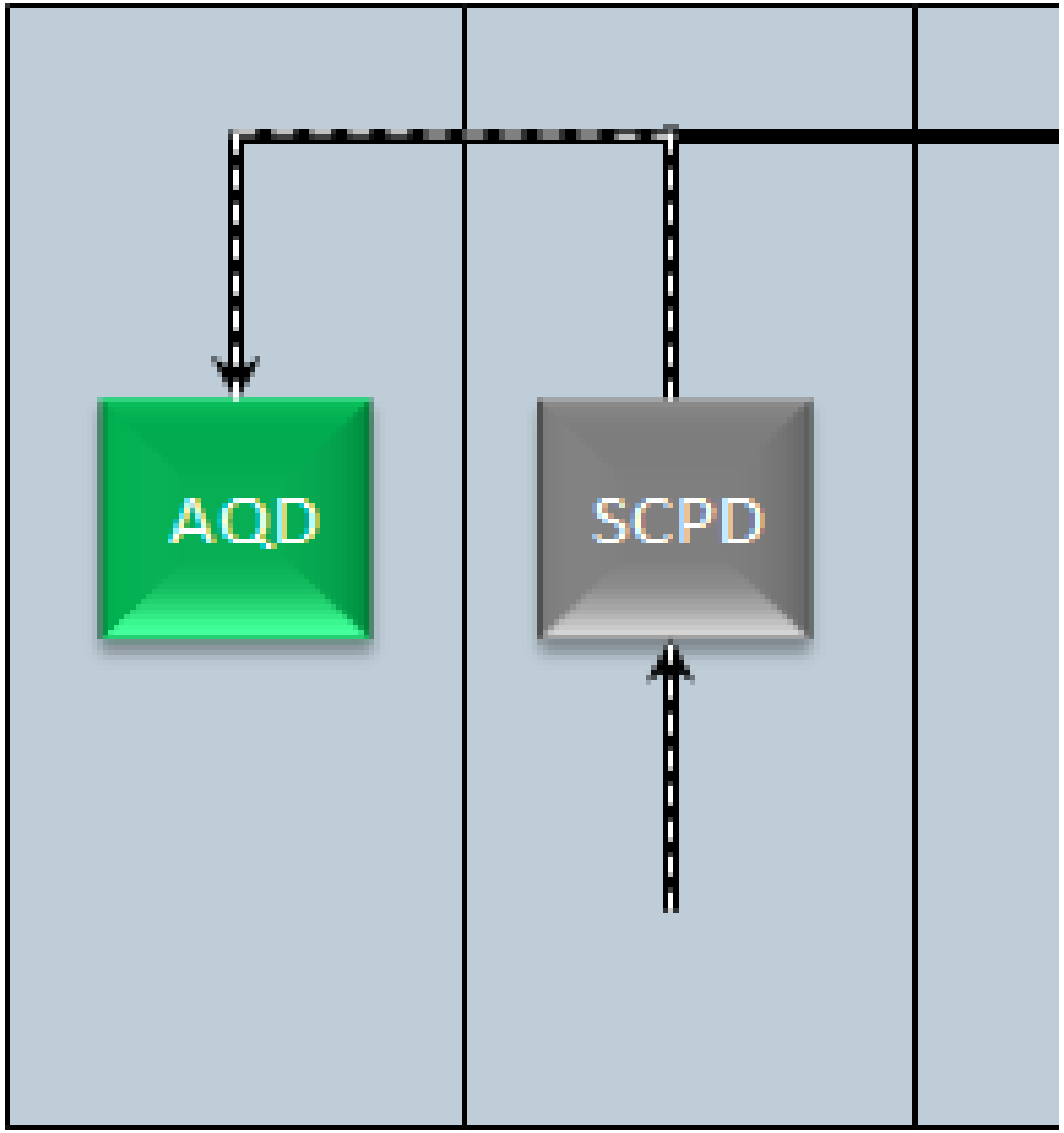
10.11.5.5 Evaluation

Addition:

In applications with an IAMS using an AQD, no crack(s)

within the busbar system are allowed.

<u>**Note**</u>: The use of resettable (Reusable) AQD can draw additional requirements.



Design verification-Arc fault detection

For the lowest rated operational voltage, this test has to be carried out with the lowest, single-phase short-circuit current declared by the manufacturer. The ignition of the arc should take place at the point of an IAMS-protected area at which the occurrence of an arcing fault is most likely.

If the manufacturer does not specify a minimum short-circuit current value, the test should be carried out with 10 kA.

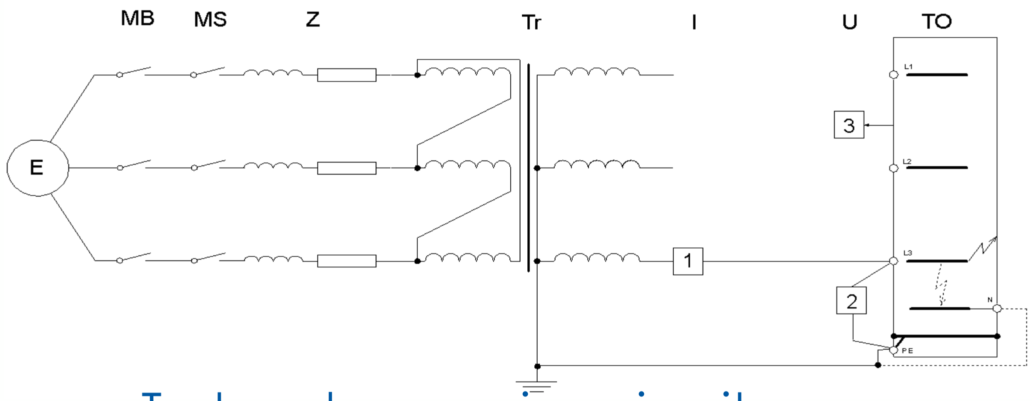
In addition, unfavorable conditions such as shading of the sensor have to be taken into account. This is particularly the case with internal separations and in cable outlets.

Design verification-Arc fault detection

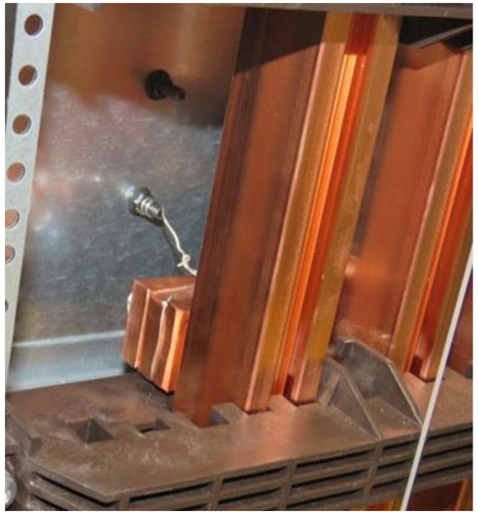
Ignition points

Network	Number of phases	Number of active conductors	Ignition between
TN-C	1	2	L and PEN
	3	4	LX and PEN
TN-S	1	2	L and PE or N
	3	4	LX and PE or N
TT	1	2	L and N
	3	3	LX and LY
	3	4	LX and N
IT	1	2	L1 and L2
	3	3	LX and LY
	3	4	LX and N

Design verification-Arc fault detection

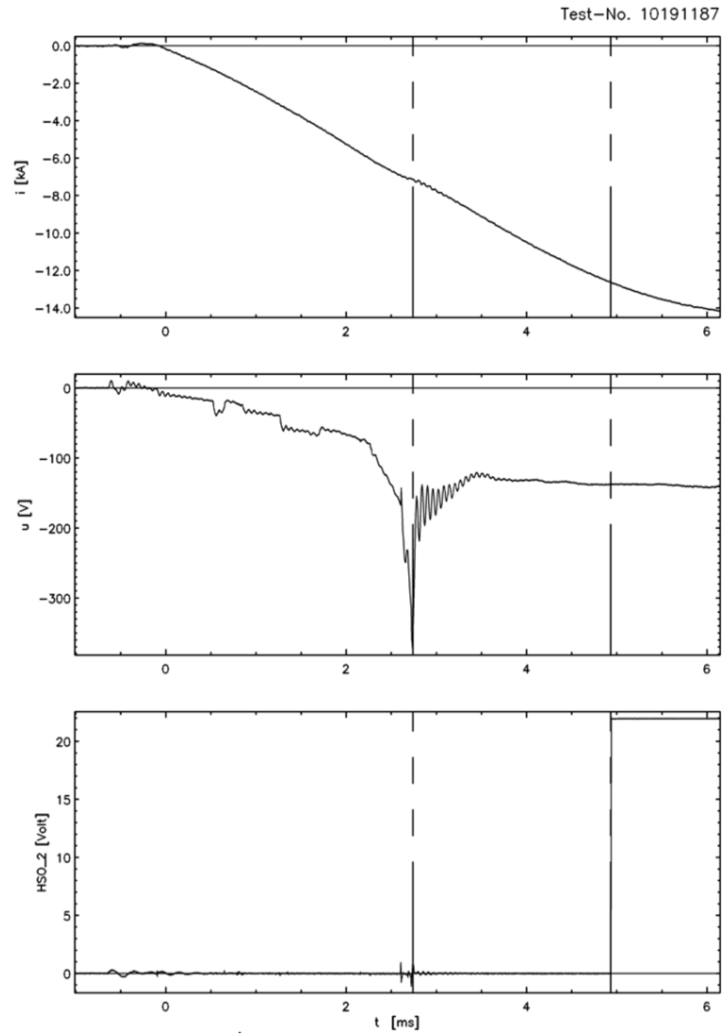


Test and measuring circuits



Ignition point

Status indication



Oscillogram

By courtesy of Siemens AG and DEHN SE+Co KG

Design verification- Verification that unintended operation will not occur

Switching arcs emit e.g. light and heat with an accompanying increase in pressure, which, depending on the sensor system, **can cause an unwanted activation** of the arc protection system.

Air-insulated switches have to be considered for the operating conditions short circuit, overload and normal load.

If circuit breakers are installed as SCPD, the test has to be carried out with the highest let-through energies, i.e.:

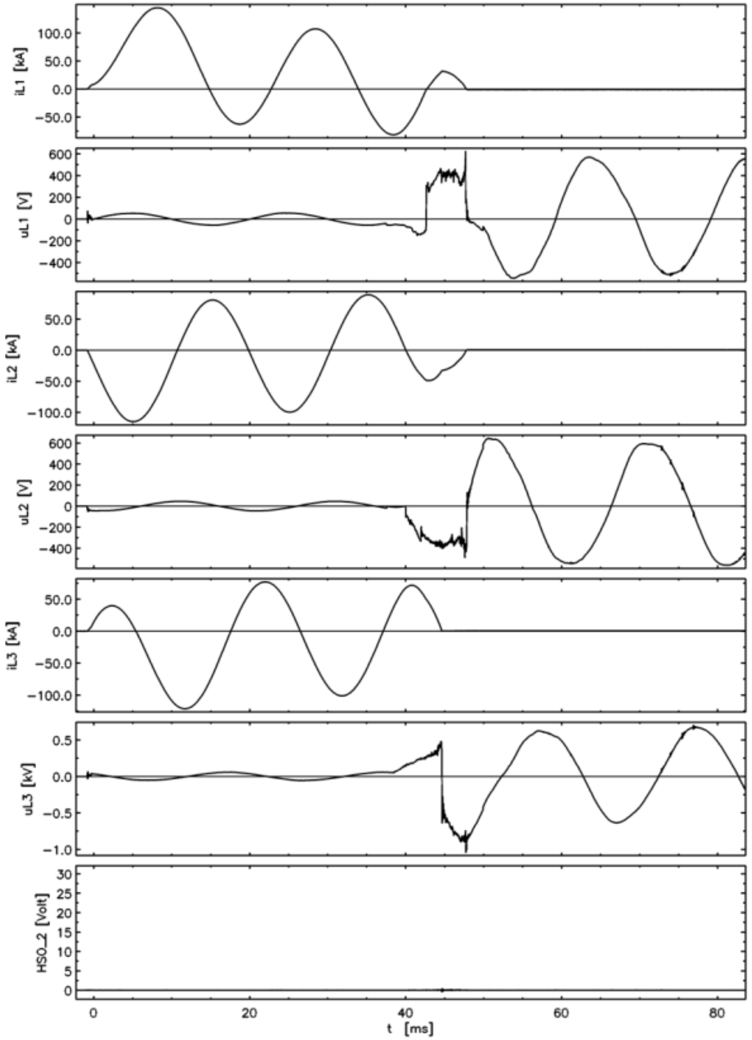
- with the highest prospective short-circuit current and the corresponding rated operational voltage as well as
- at the highest setting of the overcurrent releases as specified by the manufacturer.

Design verification- Verification that unintended operation will not occur

The test has to be carried out with the intended switchgear that delivers the greatest emissions. The safety distances to earthed metal parts can provide an indication of this.

Design verification- Verification that unintended operation will not occur

Circuit-breaker section



Oscillogram

Status indication

By courtesy of Siemens AG and DEHN SE+Co KG

Design verification- Verification of an IAMS in PSC assemblies by test

The intend of this test is to demonstrate that the entire IAMS is functioning correctly. In addition, the arcing energy released within the switchgear (purely electrical) has to be determined.

If circuit breakers are installed as SCPD, the test must be carried out with the highest let-through energies, i.e.:

- with the rated short-circuit current and the rated short-time current at the corresponding rated operational voltage as well as
- at the highest release settings as specified by the manufacturer.

Note: The test can be carried out in conjunction with IEC TR 61641.

Design verification- Verification of an IAMS in PSC assemblies by test

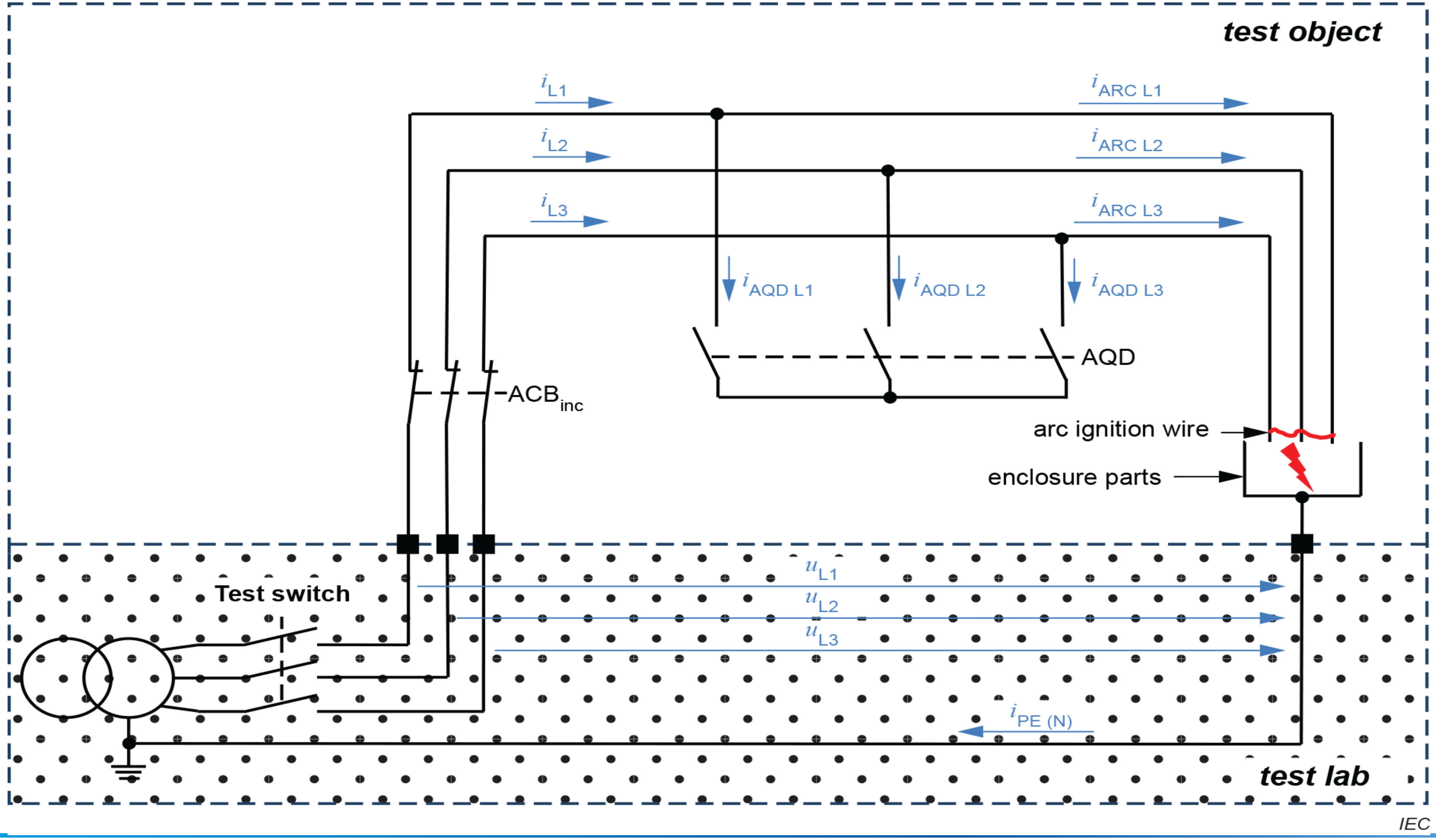
The arc has to be ignited three pole in three-phase systems . In single phase systems as follows :

Network	Ignition between
TN-C	L and PEN
TN-S	L and PE or N
TT	L and N
IT	L1 and L2

The test (ignition) has to be carried out in the IAMS-protected area that is closest to the incoming terminals.

Design verification- Verification of an IAMS in PSC assemblies by test

Description of the extinction of an internal arc-fault by an IAMS using an AQD as IARD (Annex JJ)



Design verification- Verification of an IAMS in PSC assemblies by test

The following sequence of events will occur:

a) Test switch (making switch of the test laboratory) is closed.

b) The arc-ignition wire is melting.

c) The arc is ignited (time t_o in accordance to IEC 60947-9-2).

d) The arc is recognized by the IACD.

e) Only AQD or both, AQD and incoming SCPD are triggered by the IACD.

f) The low-impedance state of the AQD is established.

g) The current is almost completely commutated into the AQD circuit.

h) The incoming SCPD has cleared all line currents.

Note: Due to the definition of t_o, the event d) can occur before c).

Design verification- Verification of an IAMS in PSC assemblies by test

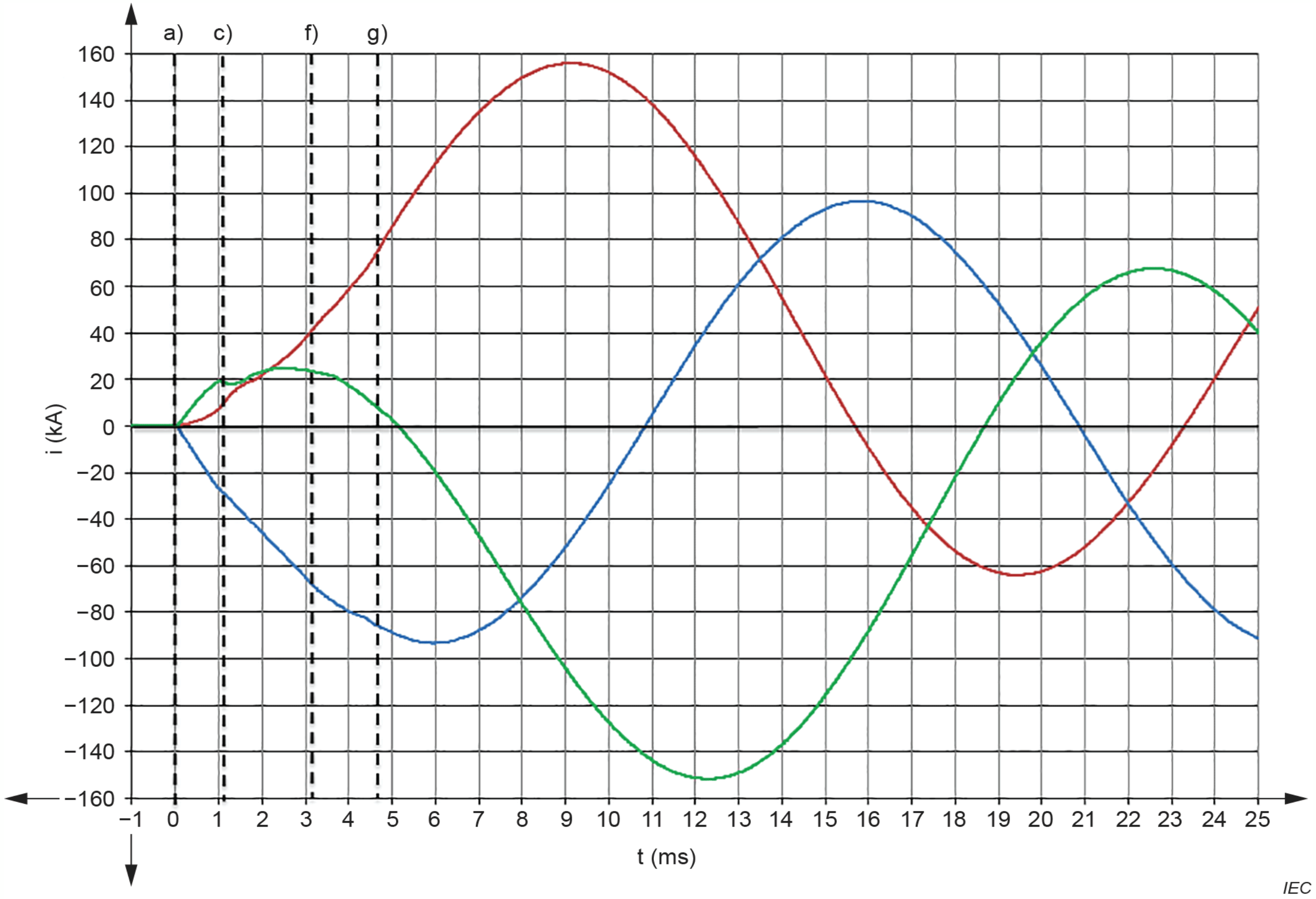
Currents in the incoming circuit

a) Test switch (making switch of the test laboratory) is closed.

c) The arc is ignited (time t_o in accordance to IEC 60947-9-2).

f) The low-impedance state of the AQD is established.

g) The current is almost completely commutated into the AQD circuit.



Design verification- Verification of an IAMS in PSC assemblies by test

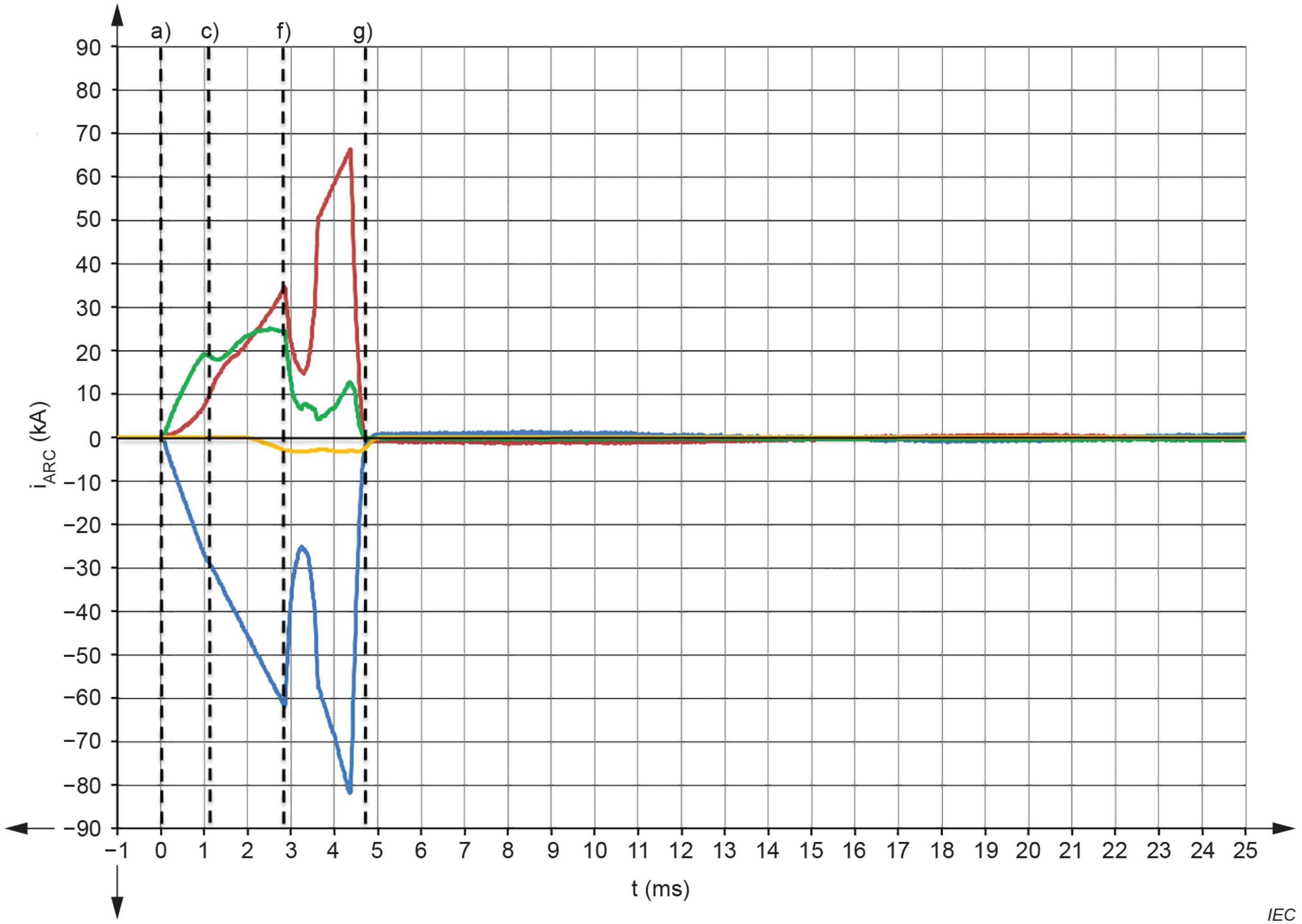
Currents in the arc-fault circuit

a) Test switch (making switch of the test laboratory) is closed.

c) The arc is ignited (time t_o in accordance to IEC 60947-9-2).

f) The low-impedance state of the AQD is established.

g) The current is almost completely commutated into the AQD circuit.



Design verification- Verification of an IAMS in PSC assemblies by test

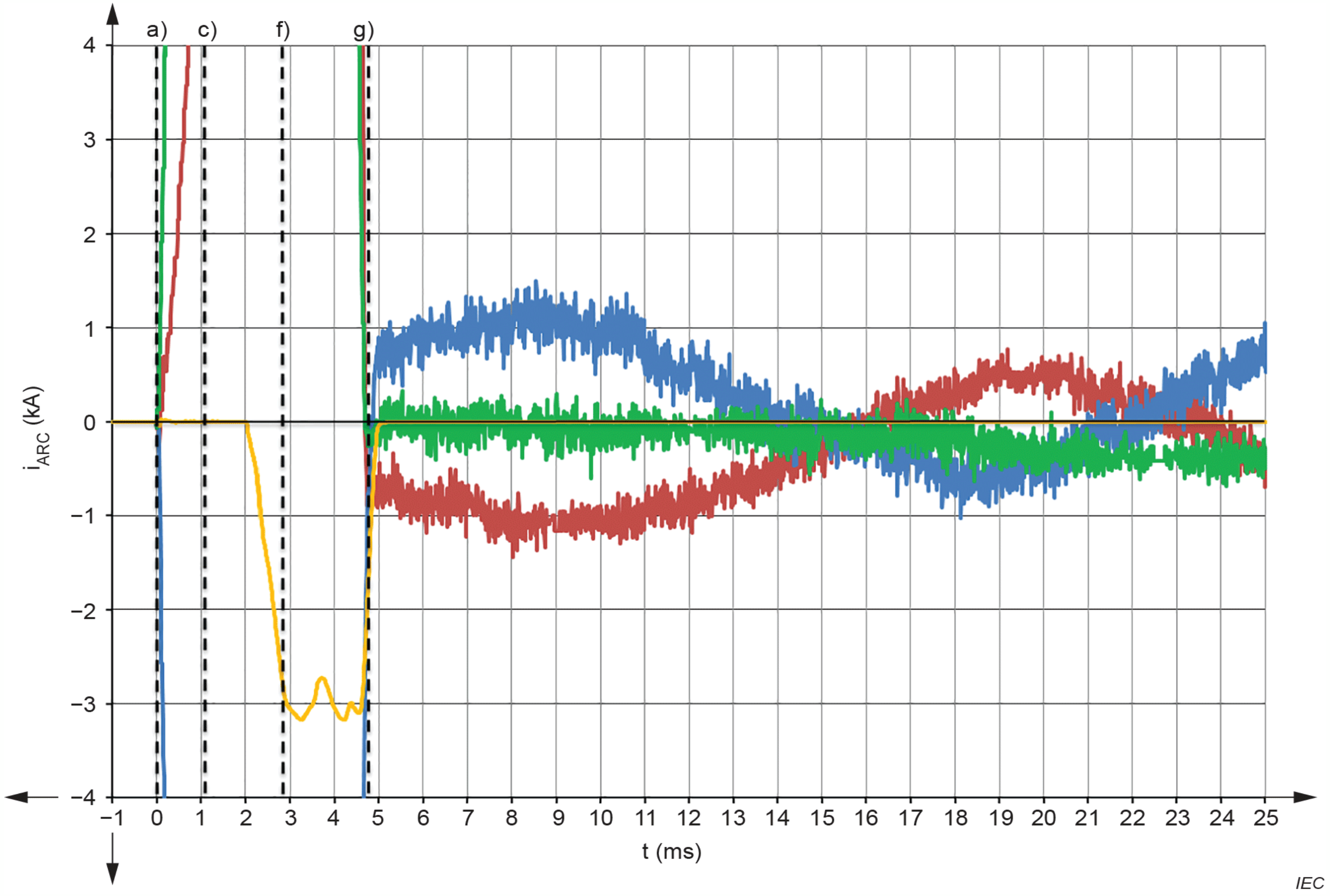
Currents in the arc-fault circuit (magnified scale)

a) Test switch (making switch of the test laboratory) is closed.

c) The arc is ignited (time t_o in accordance to IEC 60947-9-2).

f) The low-impedance state of the AQD is established.

g) The current is almost completely commutated into the AQD circuit.



Design verification- Verification of an IAMS in PSC assemblies by test

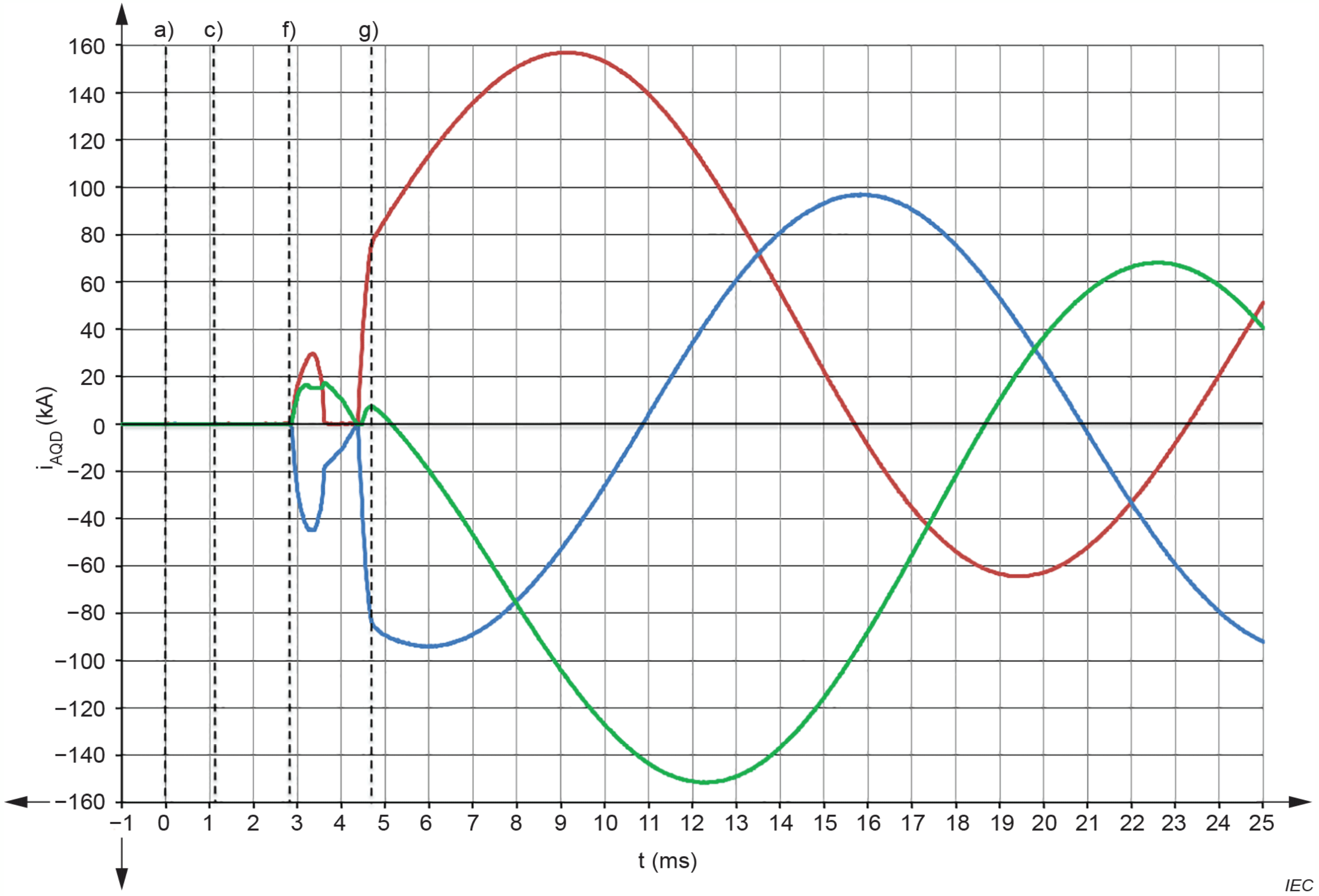
Currents in the AQD circuit

a) Test switch (making switch of the test laboratory) is closed.

c) The arc is ignited (time t_o in accordance to IEC 60947-9-2).

f) The low-impedance state of the AQD is established.

g) The current is almost completely commutated into the AQD circuit.



Design verification- Verification of an IAMS in PSC assemblies by test

Voltages at the incoming terminals

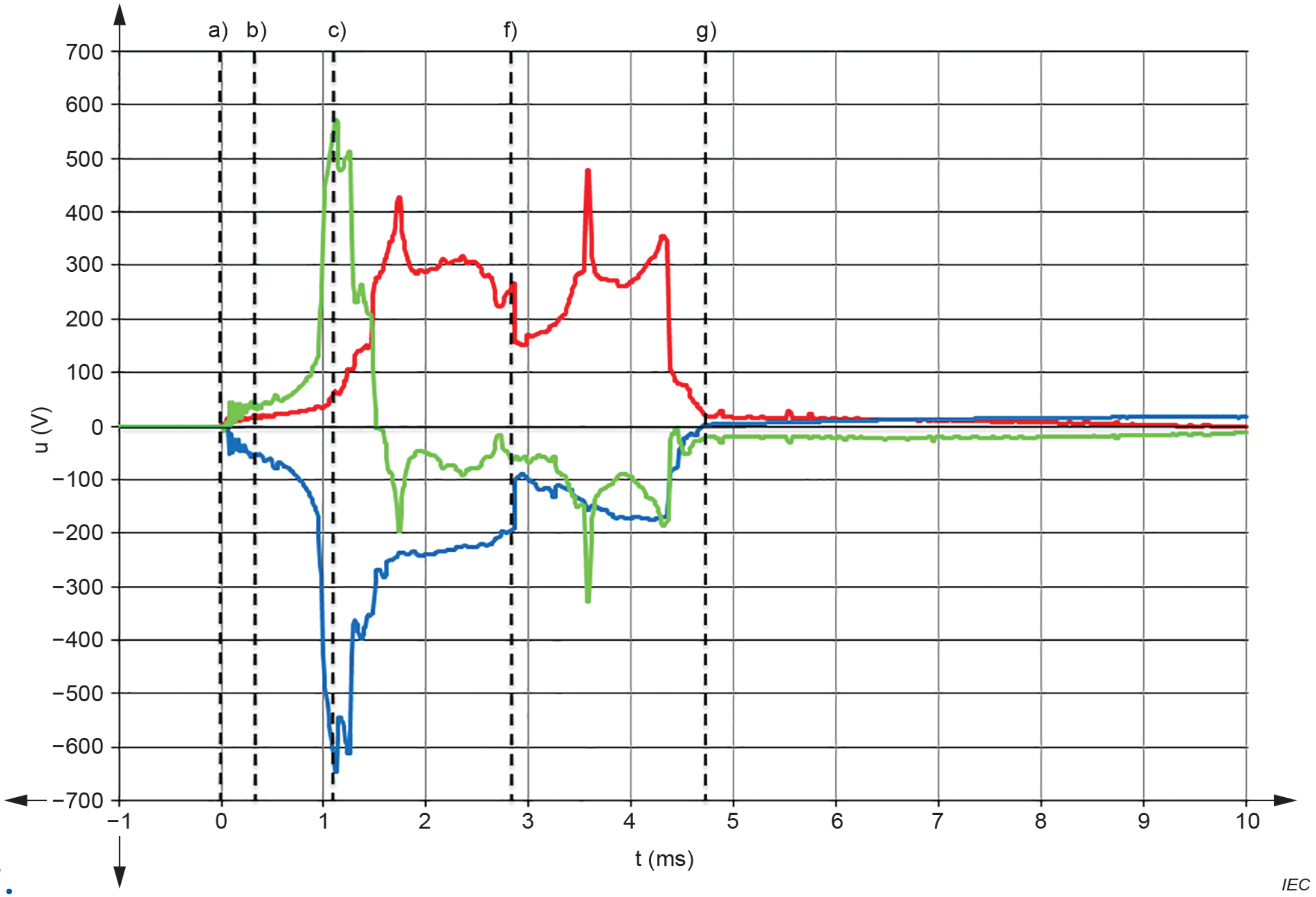
a) Test switch (making switch of the test laboratory) is closed.

b) The arc-ignition wire is melting.

c) The arc is ignited (time t_o in accordance to IEC 60947-9-2).

f) The low-impedance state of the AQD is established.

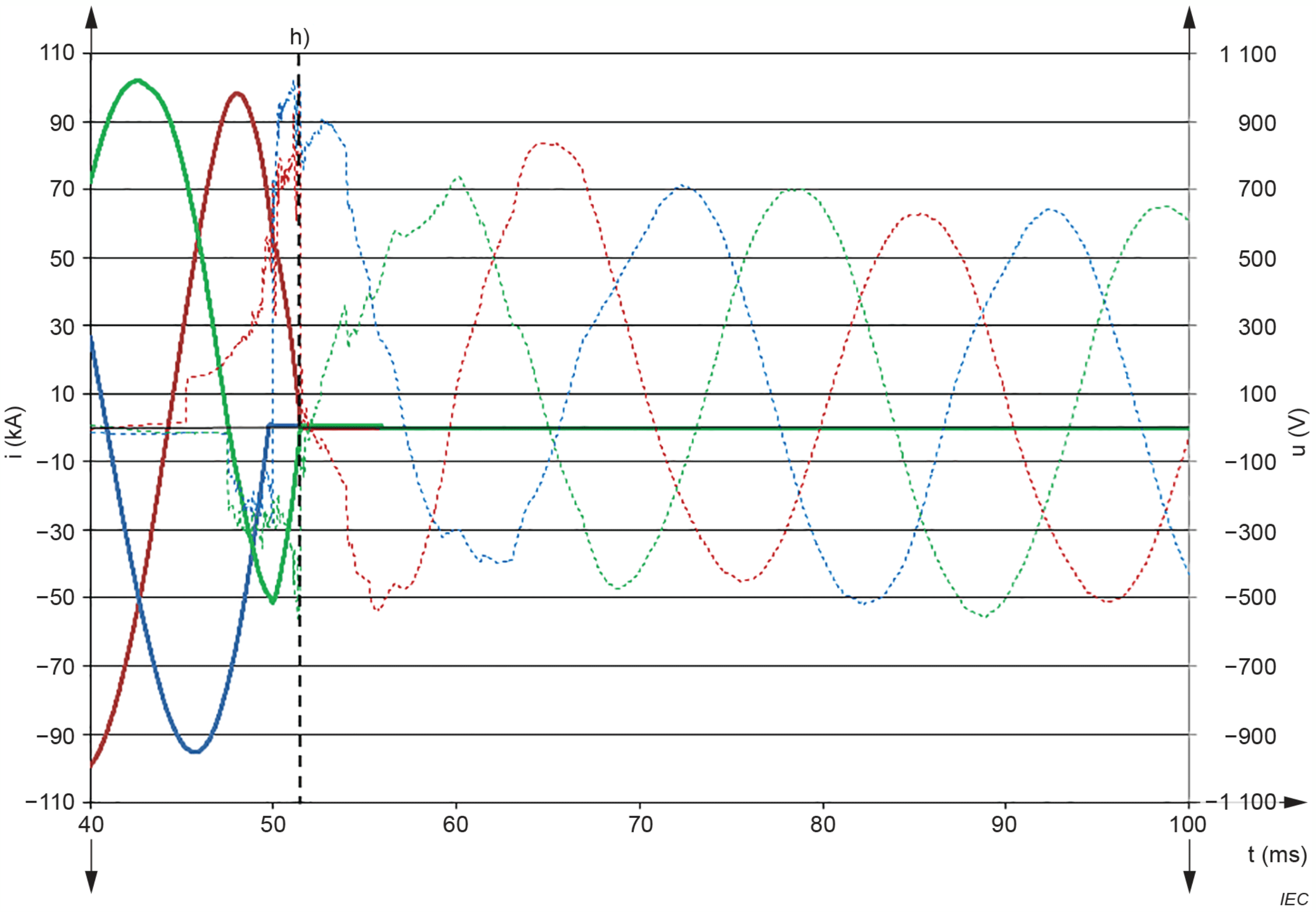
g) The current is almost completely commutated into the AQD circuit.



Design verification- Verification of an IAMS in PSC assemblies by test

Voltages at the incoming terminals (dotted curves) and incoming currents at the end of sequence

h) The incoming SCPD has cleared all line currents.



Design verification- Verification of an IAMS in PSC assemblies by test

Effective limitation of the increase in arc-energy

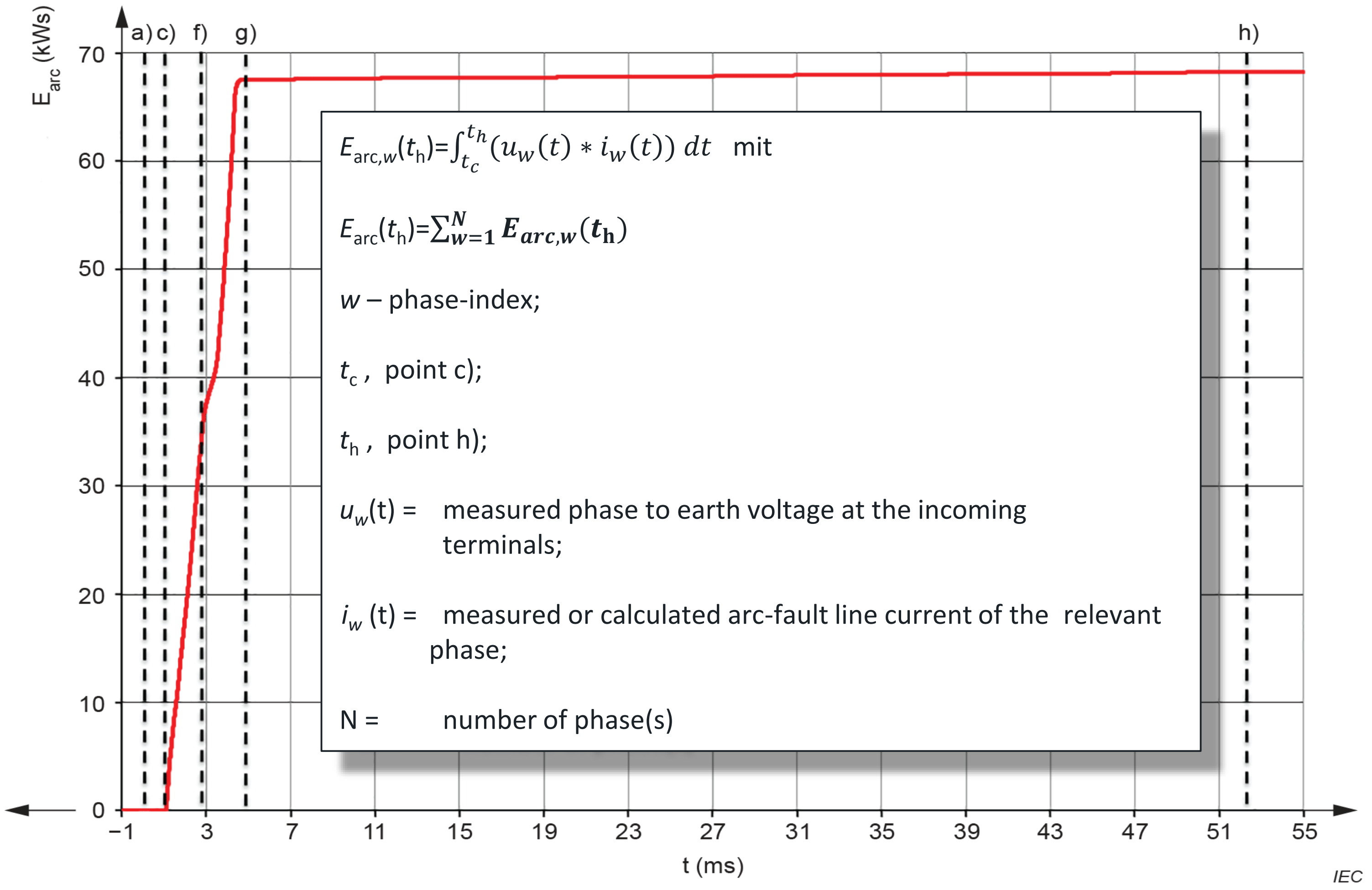
a) Test switch (making switch of the test laboratory) is closed.

c) The arc is ignited (time t_o in accordance to IEC 60947-9-2).

f) The low-impedance state of the AQD is established.

g) The current is almost completely commutated into the AQD circuit.

h) The incoming SCPD has cleared all line currents



Many thanks for your attention

Ronald Borchert

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16, April, 2020 - Webinar

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Q&A
KEMA Labs

Thank you

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