SIST

SLOVENSKI STANDARD
SIST EN 50522:2022

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Nadomešča:
SIST EN 50522:2011

Ozemljitev elektroenergetskih postrojev, ki presegajo 1 kV izmenične napetosti

Earthing of power installations exceeding 1 kV a.c.

Erdung von Starkstromanlagen mit Nennwechselspannungen über 1 kV

Prises de terre des installations électriques en courant alternatif de puissance supérieure à 1 kV

Ta slovenski standard je istoveten z: **EN 50522:2022**

<u>**ICS:**</u>

29.240.01	Omrežja za prenos in distribucijo električne energije na splošno	Power transmission and distribution networks in general

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EUROPEAN STANDARD

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Supersedes EN 50522:2010 and all of its amendments and corrigenda (if any)

English Version

Earthing of power installations exceeding 1 kV a.c.

Prises de terre des installations électriques de puissance en courant alternatif de tension supérieure à 1 kV

Erdung von Starkstromanlagen mit Nennwechselspannungen über 1 kV

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Contents

Page

European foreword

This document (EN 50522:2022) has been prepared by CLC/TC 99X “Power installations exceeding 1 kV AC (1,5 kV DC)”.

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2023-01-10
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2025-01-10

This document will supersede EN 50522:2010 and all of its amendments and corrigenda (if any).

EN 50522:2022 includes the following significant technical changes with respect to EN 50522:2010:

— Text sections in italic which were indicating that the section is a copy of an IEC 61936-1 text replaced by reference note to IEC 61936-1 due to copyright reasons.

— Clause 3 is updated regarding touch voltages.

— Improved figures in Clause 3 for distribution of earth fault currents.

— The process of designing earthing system is clarified in 5.4 and Figure 9.

— Rearranged Annex A and B including prospective permissible touch voltage and permissible step voltage.

— Introduction of stainless steel in Annex C and Annex D.

— More details and figures regarding fences in Annex G.

— Enlarged table of reduction factors and application on cables in Annex I.

— New figures in Annex J (J.4 and J.5).

— Details on soil resistivity measurements and touch voltage measurements including flow chart in Annex L.

— Clause 10 was Annex M in previous version.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users’ national committee. A complete listing of these bodies can be found on the CENELEC website.

1 Scope

This document is applicable to specify the requirements for the design and erection of earthing systems of electrical installations, in systems with nominal voltage above 1 kV AC and nominal frequency up to and including 60 Hz, so as to provide safety and proper functioning for the use intended.

NOTE 1 The technical and procedural principles of this document can be applied when third parties' installations and facilities are planned and/or erected in the vicinity of HV electrical power installations.

For the purpose of interpreting this document, an electrical power installation is considered to be one of the following:

a) substation, including substation for railway power supply;

b) electrical power installations on mast, pole and tower;

   switchgear and/or transformers located outside a closed electrical operating area;

c) one (or more) power station(s) located on a single site;

   the electrical power installation includes generators and transformers with all associated switchgear and all electrical auxiliary systems. Connections between generating stations located on different sites are excluded;

d) the electrical system of a factory, industrial plant or other industrial, agricultural, commercial or public premises;

e) electrical power installations on offshore facilities for the purpose of generation, transmission, distribution and/or storage of electricity;

f) transition towers/poles between overhead lines and underground lines.

The electrical power installation includes, among others, the following equipment:

— rotating electrical machines;

— switchgear;

— transformers and reactors;

— converters;

— cables;

— wiring systems;

— batteries;

— capacitors;

— earthing systems;

— buildings and fences which are part of a closed electrical operating area;

— associated protection, control and auxiliary systems;

— large air core reactor.

NOTE 2 In general, a standard for an item of equipment takes precedence over this document.

This document does not apply to the design and erection of earthing systems of any of the following:

— overhead and underground lines between separate installations;

— electrified railway tracks and rolling stock;

— mining equipment and installations;

— fluorescent lamp installations;

— installations on ships according to IEC 60092 (all parts) and offshore units according to IEC 61892 (all parts), which are used in the offshore petroleum industry for drilling, processing and storage purposes;

— electrostatic equipment (e.g. electrostatic precipitators, spray-painting units);

— test sites;

— medical equipment, e.g. medical X-ray equipment.

NOTE 3 The standard EN 50341 series, Overhead lines exceeding AC 1 kV, specifies requirements for the design and erection of earthing systems in overhead lines.

NOTE 4 The scope of this document does not include the requirements for carrying out live working on electrical power installations.

NOTE 5 The scope of this document considers safety requirements for HV installations and its influences on LV installations. For electrical installation up to 1 kV, the standard HD 60364 series applies.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 60909 (series), *Short-circuit currents in three-phase a.c. systems* (IEC 60909 series)

EN IEC 62561-2, *Lightning protection system components (LPSC) - Part 2: Requirements for conductors and earth electrodes (IEC 62561-2)*

HD 60364-1, *Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, definitions (IEC 60364-1)*

IEC 60479-1:2018, *Effects of current on human beings and livestock – Part 1: General aspects*

IEC 61936-1:2010, *Power installations exceeding 1 kV a.c. - Part 1: Common rules*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61936-1:2010 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
earth ring electrode
earth electrode embedded in the soil around a building or pole as a closed ring

3.2
effective touch voltage
touch voltage
U_T
voltage between conductive parts when touched simultaneously

Note 1 to entry: The value of the effective touch voltage could be appreciably influenced by the impedance of the person in electric contact with these conductive parts.

Note 2 to entry: The person is touching the conductive parts with bare skin.

[SOURCE: IEC 60050-195:1998, 195-05-11, modified]

[SOURCE: IEC 61936-1:2010, 3.7.14, modified – Note 2 added]

3.3
permissible touch voltage
U_{Tp}
limit value of touch voltage U_T

Note 1 to entry: See Figure 8.

3.4
prospective touch voltage
U_{vT}
voltage between simultaneously accessible conductive parts when those conductive parts are not being touched

Note 1 to entry: See Figure 1.

[SOURCE: IEC 60050-195:1998, 195-05-09, modified]

[SOURCE: IEC 61936-1:2010, 3.7.15, modified – note added]

3.5
prospective permissible touch voltage
U_{vTp}
limit value of prospective touch voltage U_{vT}

3.6
transferred potential
potential rise of an earthing system caused by a current to earth transferred by means of a connected conductor (for example a metallic cable sheath, PEN conductor, pipeline, rail) into areas with low or no potential rise relative to reference earth, resulting in a potential difference occurring between the conductor and its surroundings

Note 1 to entry: See Figure 1.

[SOURCE: IEC 61936-1:2010, 3.7.17, modified – reference Figure 1 added]

3.7
global earthing system
equivalent earthing system created by the interconnection of local earthing systems that ensures, by the proximity of the earthing systems, that there are no touch voltages exceeding permissible limit values

Note 1 to entry: Such systems permit the division of the earth fault current in a way that results in a reduction of the earth potential rise at the local earthing system. Such a system could be said to form a quasi equipotential surface.

Note 2 to entry: The existence of a global earthing system may be determined by sample measurements or calculation for typical systems. Typical examples of global earthing systems are in city centres; urban or industrial areas with distributed low- and high-voltage earthing (see Annex N).

[SOURCE: IEC 61936-1:2010, 3.7.19, modified "that there are no touch voltages exceeding permissible limit values" and Note 2 reference to Annex added]

3.8
system with isolated neutral
system in which the neutrals of transformers and generators are not intentionally connected to earth, except for high impedance connections for signalling, measuring or protection purposes

[SOURCE: IEV 601-02-24, modified]

3.9
system with resonant earthing
system in which at least one neutral of a transformer or earthing transformer is earthed via an arc suppression coil and the combined inductance of all arc suppression coils is essentially tuned to the earth capacitance of the system for the operating frequency

Note 1 to entry: In case of no self-extinguishing arc fault there are two different operation methods used:

- automatic disconnection;
- continuous operation during fault localization process.

  In order to facilitate the fault localization and operation there are different supporting procedures:

  - short term earthing for detection;
  - short term earthing for tripping;
  - operation measures, such as disconnection of coupled busbars;
  - phase earthing.

Note 2 to entry: Arc suppression coil may have high ohmic resistor in parallel to facilitate fault detection.

3.10
system with low-impedance neutral earthing
system in which at least one neutral of a transformer, earthing transformer or generator is earthed directly or via an impedance designed such that due to an earth fault at any location the magnitude of the fault current leads to a reliable automatic tripping due to the magnitude of the fault current

[SOURCE: IEV 601-02-25, modified, 601-02-26, modified]

3.11
earth fault current
I_F
current which flows from the main circuit to earth or earthed parts at the fault location (earth fault location)

Note 1 to entry: See Figures 2 to 7.

Note 2 to entry: For single earth faults, this is:

— in systems with isolated neutral, the capacitive earth fault current,

— in systems with high resistive earthing, the RC composed earth fault current,

— in systems with resonant earthing, the earth fault residual current,

— in systems with solid or low impedance neutral earthing, the line-to-earth short-circuit current.

Note 3 to entry: Further earth fault current could result from double earth fault and line to line to earth fault according to EN 60909 (all parts).

[SOURCE: IEC 61936-1:2010, 3.7.25, modified – reference to Figures added]

3.12
current to earth
I_E
current flowing to earth via the impedance to earth

Note 1 to entry: See Figure 2.

Note 2 to entry: The current to earth is the part of the earth fault current I_F, which causes the potential rise of the earthing system. For the determination of I_E see also Annex L.

3.13
reduction factor
r
factor r of a three-phase line is the ratio of the current to earth over the sum of the zero sequence currents in the phase conductors of the main circuit ($r = I_E / 3\,I_0$) at a point remote from the short-circuit location and the earthing system of an installation

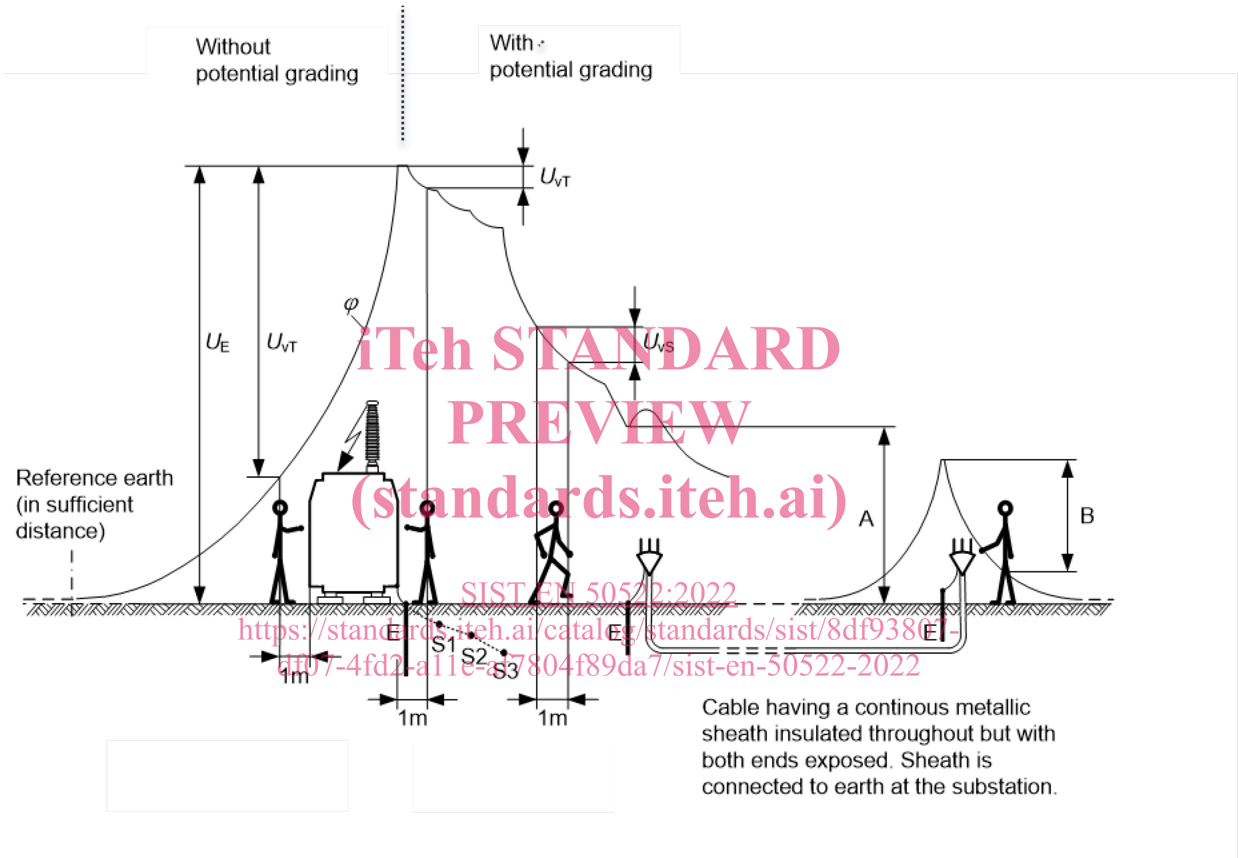
3.14
horizontal earth electrode
electrode which is generally buried at a depth of up to approximately 1 m. It can consist of strip, round bar or stranded conductor and can be laid out to form a radial, ring or mesh earth electrode or a combination of these

3.15
cable with earth electrode effect
cable whose sheaths, screens or armourings have the same effect as a horizontal electrode consisting of bare round earth-wire

3.16
foundation earth electrode
conductive structural embedded in concrete which is in conductive contact with the earth via a large surface

[SOURCE: IEV 826-13-08, modified]

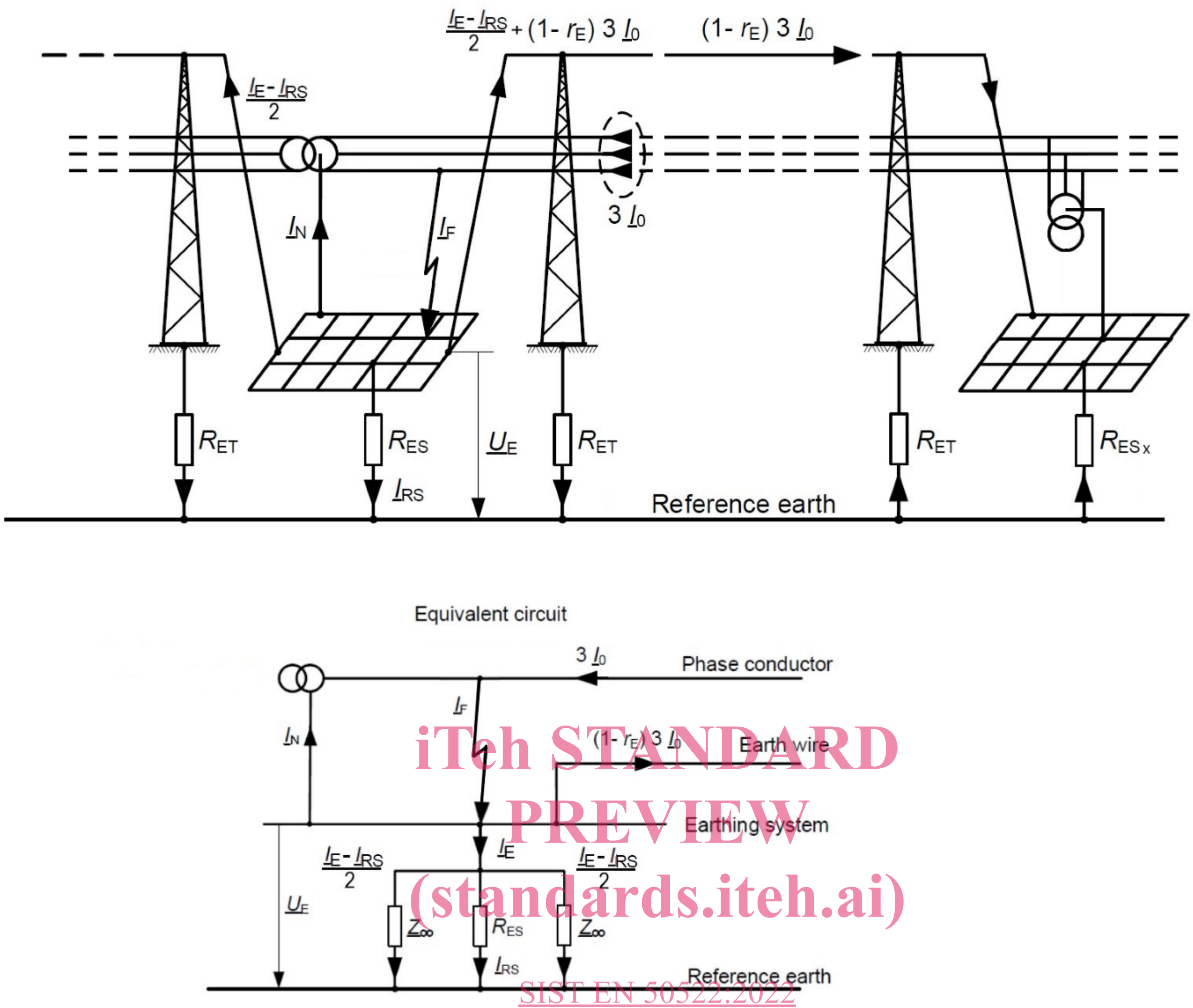
3.17
potential grading earth electrode
conductor which due to shape and arrangement is principally used for potential grading rather than for establishing a certain resistance to earth



Key

E	Earth electrode
S1, S2, S3	Potential grading earth electrodes (e.g. ring earth electrodes), connected to the earth electrode E
U_E	Earth potential rise
U_{vS}	Prospective step voltage
U_{vT}	Prospective touch voltage
A	Prospective touch voltage resulting from transferred potential in case of single side cable sheath earthing
B	Prospective touch voltage resulting from transferred potential in case of cable sheath earthed on both sides
φ	Earth surface potential

Figure 1 — Example for the surface potential profile and for the voltages in case of current carrying earth electrodes



$$\underline{I}_F = 3\,\underline{I}_0 + \underline{I}_N$$
$$\underline{I}_E = r_E \cdot (\underline{I}_F - \underline{I}_N)$$
$$\underline{U}_E = \underline{I}_E \cdot \underline{Z}_E$$

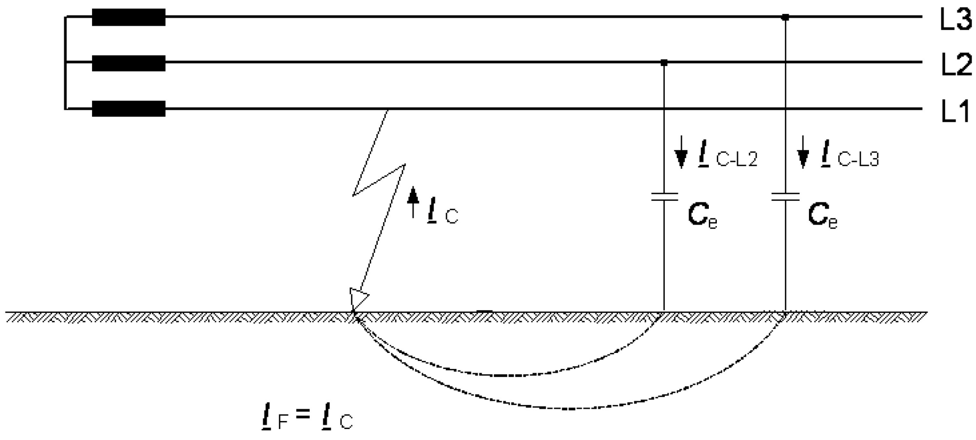
$$\underline{Z}_E = \frac{1}{\frac{1}{R_{ES}} + n\,\frac{1}{\underline{Z}_\infty}}$$

For equal earth wire tower footing impedances of the overhead lines

Key

$3\,\underline{I}_0$	Three times zero sequence current of the line
$\underline{I}_N$	Current via neutral earthing of the transformer
$\underline{I}_F$	Earth fault current
$\underline{I}_E$	Current to earth (cannot be measured directly)
$\underline{I}_{RS}$	Current via the resistance to earth of the mesh earth electrode
r_E	Reduction factor of the overhead line
R_{ES}, R_{ESx}	Resistance to earth of the mesh earth electrode
R_{ET}	Resistance to earth of the tower
$\underline{Z}_\infty$	Chain impedance (several number of towers with resistance to earth, R_{ET}) represents a value of the overhead line assumed to be infinite
$\underline{Z}_E$	Impedance to earth
$\underline{U}_E$	Earth potential rise
n	Number of overhead lines leaving the substation (here: $n = 2$)

Figure 2 — Example for currents, voltages and resistances for an earth fault in a transformer substation with low impedance neutral earthing



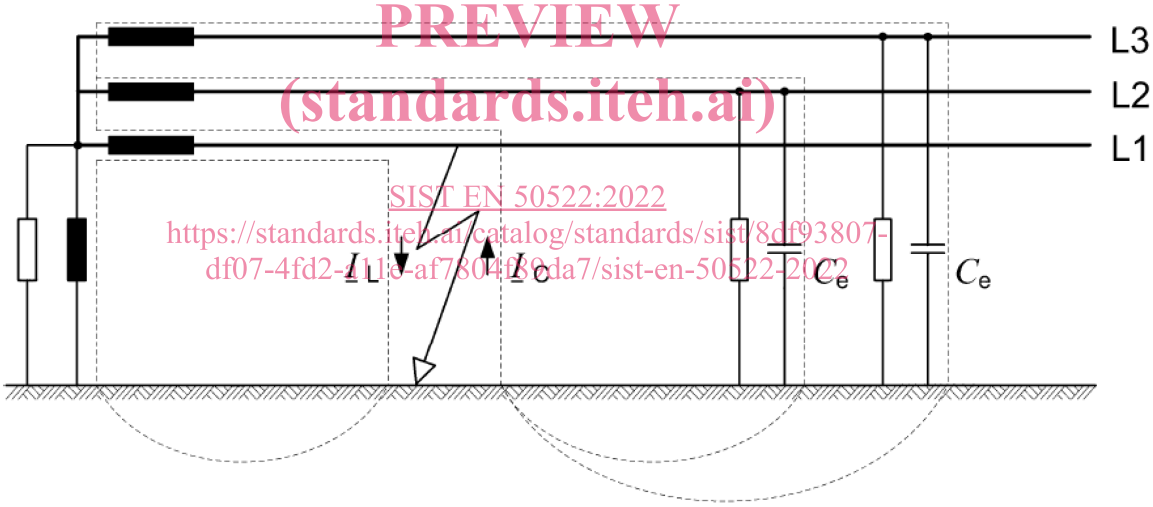
Key

$\underline{I}_F$ Earth fault current

$\underline{I}_C$ Capacitive earth fault current (complex value, including ohmic component)

NOTE $\underline{I}_C$ may include ohmic component.

Figure 3 — Earth fault current in a system with isolated neutral



$$\left|\underline{I}_F\right| = \left|\underline{I}_{RES}\right| = \sqrt{\left|\underline{I}_C + \underline{I}_L\right|^2 + \left|\underline{I}_H\right|^2}$$

Key

$\underline{I}_F$ Earth fault current

$\underline{I}_C$ Capacitive earth fault current (complex value, including ohmic component)

$\underline{I}_L$ Sum of the currents of the parallel arc-suppression coils (complex value, including ohmic component)

$\underline{I}_H$ Harmonic current (different frequencies)

$\underline{I}_{RES}$ Earth fault residual current

NOTE $\underline{I}_R$ is the ohmic part of the complex value of ($\underline{I}_C$ + $\underline{I}_L$).

Figure 4 — Earth fault current in a system with resonant earthing