

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

GROUP SAFETY PUBLICATION  
PUBLICATION GROUPEE DE SÉCURITÉ

**Safety of transformers, reactors, power supply units and combination thereof –  
Part 2-14: Particular requirements and tests for variable transformers and power  
supply units incorporating variable transformers**

**Sécurité des transformateurs, bobines d'inductance, blocs d'alimentation et des  
combinaisons de ces éléments –  
Partie 2-14: Exigences particulières et essais pour les transformateurs variables  
et les blocs d'alimentation incorporant des transformateurs variables**



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IEC 61558-2-14

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

# SAFETY OF TRANSFORMERS, REACTORS, POWER SUPPLY UNITS AND COMBINATION THEREOF –

## Part 2-14: Particular requirements and tests for variable transformers and power supply units incorporating variable transformers

## FOREWORD

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International standard IEC 61558-2-14 has been prepared by technical committee 96: Transformers, reactors, power supply units and combination thereof.

This first edition cancels and replaces the chapter IV of the IEC 60989 published in 1991. It is a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) update of the existing text;
- b) complete editorial review.

The text of this standard is based on the following documents:

FDIS	Report on voting
96/395/FDIS	96/398/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This part has the status of a group safety publication in accordance with IEC Guide 104:2010, *The preparation of safety publications and the use of basic safety publications and group safety publications*.

This part is intended to be used in conjunction with the latest edition of IEC 61558-1 and its amendments. It is based on the second edition (2005) of that standard and its Amendment 1 (2009).

This part supplements or modifies the corresponding clauses in IEC 61558-1, so as to convert that publication into the IEC standard: *Particular requirements and tests for variable transformers and power supply units incorporating variable transformers*.

A list of all parts of the IEC 61558 series, under the general title: *Safety of transformers, reactors, power supply units and combination thereof*, can be found on the IEC website.

(standards.iteh.ai)

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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Where a particular subclause of Part 1 is not mentioned in this part, that subclause applies as far as is reasonable. Where this part states "addition", "modification" or "replacement", the relevant text of Part 1 is to be adapted accordingly.

In this part, the following print types are used:

- requirements proper: in roman type;
- *test specifications: in italic type*;
- explanatory matter: in smaller roman type.

In the text of this part, the words in **bold** are defined in Clause 3.

Subclauses, notes, figures and tables additional to those in Part 1 are numbered starting from 101; supplementary annexes are entitled AA, BB, etc.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,
- replaced by a revised edition, or
- amended.

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It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 12 months from the date of publication.

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## SAFETY OF TRANSFORMERS, REACTORS, POWER SUPPLY UNITS AND COMBINATION THEREOF –

### Part 2-14: Particular requirements and tests for variable transformers and power supply units incorporating variable transformers

#### 1 Scope

##### *Replacement:*

This part of IEC 61558 deals with safety of **variable transformers** for general applications and **power supply units** incorporating **variable transformers** for general applications.

**Transformers** incorporating **electronic circuits** are also covered by this standard.

NOTE 1 Safety includes electrical, thermal, mechanical and chemical aspects.

Unless otherwise specified, from here onward, the term **transformer** covers **variable transformers** for general applications and **power supply units** incorporating **variable transformers** for general applications.

The **rated supply voltage** does not exceed 1 000 V a.c. and the **rated supply frequency** does not exceed 500 Hz.

This standard is applicable to **transformers** and **power supply units** (linear) with **internal operational frequencies** not exceeding 500 Hz.

This standard used in combination with Part 2-16 for **switch mode power supply units (SMPS)** is also applicable to power supplies with **internal operational frequencies** higher than 500 Hz. Where the two requirements are in conflict the most severe take precedence

This part does not apply to **transformers** covered by IEC 60076-11.

This part is applicable to **stationary** or **portable**, single-phase or polyphase, air-cooled (natural or forced) **independent** or **associated dry-type transformers**.

- **variable auto-transformers** and **power supply units** incorporating **variable auto-transformers**;
- **variable separating transformers** and **power supply units** incorporating **variable separating transformers**;
- **variable isolating transformers** and **power supply units** incorporating **variable isolating transformers**;
- **variable safety isolating transformers** and **power supply units** incorporating **variable safety isolating transformers**.

The windings may be encapsulated or non-encapsulated.

The **rated output** does not exceed:

- 40 kVA for single-phase **variable auto-transformers** and **power supply units** incorporating single-phase **variable auto-transformers**;



- 200 kVA for poly-phase **variable auto-transformers** and **power supply units** incorporating poly-phase **variable auto-transformers**;
- 1 kVA for single-phase **variable separating transformers** and **power supply units** incorporating single-phase **variable separating transformers**;
- 5 kVA for poly-phase **variable separating transformers** and **power supply units** incorporating poly-phase **variable separating transformers**;
- 25 kVA for single-phase **variable isolating transformers** and **power supply units** incorporating single-phase **variable isolating transformers**;
- 40 kVA for poly-phase **variable isolating transformers** and **power supply units** incorporating poly-phase **variable isolating transformers**;
- 10 kVA for single-phase **variable safety isolating transformers** and **power supply units** incorporating single-phase **variable safety isolating transformers**;
- 16 kVA for poly-phase **variable safety isolating transformers** and **power supply units** incorporating poly-phase **variable safety isolating transformers**.

This part is applicable to **transformers** without limitation of the **rated output** subject to an agreement between the purchaser and the manufacturer.

NOTE 2 **Transformers** intended to supply distribution networks are not included in the scope.

**For variable auto-transformers and power supply units incorporating variable auto-transformers:**

- the **no-load output voltage** or the **rated output voltage** does not exceed 1 000 V a.c. or 1 415 V ripple free d.c.;
- for **independent auto-transformers** the **rated output voltage** does exceed 50 V a.c or 120 V ripple-free d.c. but not exceed 250 V a.c.

NOTE 3 Normally, the **variable auto-transformers and power supply units** are intended to be associated with the equipment to provide voltages different from the supply voltage for the functional reasons. The protection against electric shock can be provided by other features of the equipment, such as the **body**.

**Variable auto-transformers and power supply units** incorporating **variable auto-transformers** intended to be used by technically skilled or trained personnel are considered as **associated transformers** and **associated power supply units** and may have a **rated output voltage** less than 50 V a.c.

**For variable separating transformers and power supply units incorporating variable separating transformers:**

- the **no-load output voltage** or the **rated output voltage** does not exceed 1 000 V a.c. or 1 415 V ripple free d.c.;
- for **portable separating transformers** the **rated output voltage** does exceed 50 V a.c or 120 V ripple-free d.c.;
- covered by this part may only be used where **double or reinforced insulation** between circuits is not required by the installation rules or by the end product standard.

NOTE 4 Normally, **variable separating transformers and power supply units** are intended to be associated with equipment to provide voltages different from the supply voltage for the functional reasons. The protection against electric shock can be provided (or completed) by other features of the equipment, such as the **body**. Parts of **output circuits** can be connected to the protective earth.

NOTE 5 **Variable separating transformers and power supply units** incorporating **variable separating transformers** intended to be used by technically skilled or trained personal are considered as **associated transformers** and **associated power supply units** and can have a **rated output voltage** less than 50 V a.c. or 120 V ripple-free d.c.

**For variable isolating transformers and power supply units incorporating variable isolating transformers:**

- the **no-load output voltage** or the **rated output voltage** does not exceed 500 V a.c. or 708 V ripple free d.c. The **no-load output voltage** and the **rated output voltage** may be up to 1 000 V a.c. or 1 415 V ripple free d.c. for special applications or in accordance with national wiring rules;
- for **independent isolating transformers** the **rated output voltage** does not exceed 250 V a.c.;
- are used where **double** or **reinforced insulation** between circuits is required by the installation rules or by the end product standard.

**For variable safety isolating transformers and power supply units incorporating safety isolating transformers:**

- the **no-load output voltage** or the **rated output voltage** does not exceed 50 V a.c. or 120 V ripple-free d.c.;
- are used where **double** or **reinforced insulation** between circuits is required by the installation rules or by the end product standard.

This part is not applicable to external circuits and their components intended to be connected to the input terminals and output terminals of the **transformers**.

NOTE 6 Attention is drawn to the following:

- for **transformers** intended to be used in vehicles, on board ships, and aircraft, additional requirements (from other applicable standards, national rules, etc.) can be necessary;
- measures to protect the **enclosure** and the components inside the **enclosure** against external influences such as fungus, vermin, termites, solar-radiation, and icing are also considered;
- the different conditions for transportation, storage, and operation of the **transformers** are also be considered;
- additional requirements in accordance with other appropriate standards and national rules can be applicable to **transformers** intended for use in special environments, such as tropical environment.

Future technological development of **transformers** can necessitate a need to increase the upper limit of the frequencies, until then this part may be used as a guidance document.

## 2 Normative references

This clause of Part 1 is applicable except as follows.

*Addition:*

IEC 61558-1:2005, *Safety of power transformers, power supplies, reactors and similar products – Part 1: General requirements and tests*

Amendment 1 (2009)

## 3 Terms and definitions

This clause of Part 1 is applicable, except as follows:

### 3.1 Transformers

*Addition:*

#### 3.1.101

#### **variable transformer**

**transformer** having unlimited numbers of transformation ratios and adjustable by means of a movable **current collector** positioned along a continuous path of locally exposed winding turns

**3.1.102****variable auto transformer**

**variable transformer** in which input and output voltages are derived from a common winding

**3.2 General terms**

*Addition:*

**3.2.101****current collector**

assembly of moving contact parts which serve to transmit current from a point on the contact path to the tapping point at the bushings or terminals

**3.2.102****drive**

mechanical assembly used for moving the **current collector**

**3.2.103****fixed winding**

winding or part of the winding with no means for varying the transformation ratio

**3.2.104****variable winding**

winding or part of the winding with a contact path used for varying the transformation ratio

**3.5 Ratings**

*Modification:*

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**3.5.5** is not applicable.

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*Addition:*

**3.5.101****rated output voltage range**

output voltage range (for poly-phase **transformer** and **power supply units**, the phase-to-phase voltage) at **rated supply voltage**, **rated supply frequency**, **rated output current**, and **rated power factor** assigned to the **transformer** or **power supply unit** by the manufacturer

**4 General requirements**

This clause of Part 1 is applicable.

If the **current collector** may not stay permanently in the same position it has to be marked on the transformer.

**5 General notes on tests**

This clause of Part 1 is applicable except as follows:

**5.3** *Addition:* The test of 16.101 shall be conducted before all other tests.

## 6 Ratings

This clause of Part 1 is applicable except as follows.

*Addition:*

**6.101** The **rated output voltage** shall not exceed:

- 1 000 V a.c. or 1 415 V ripple-free d.c. for **variable auto-** and **separating transformers**;
- 500 V a.c. or 708 V ripple-free d.c. for **variable isolating transformers**; the **rated output voltage** may exceed these limits in order to be in accordance with the national wiring rules, however, it shall not exceed 1 000 V a.c. or 1 415 V ripple free d.c.;
- 250 V a.c. for **portable auto-transformers**, **portable separating transformers** and **independent isolating transformers**;
- 50 V a.c. or 120 V ripple-free d.c. for **variable safety isolating transformers**.

This standard is also applicable for **variable transformers** of a **rated output voltage** of more than 1 000 V a.c. or 1 415 d.c. Such **transformers**, however, are classified as special **transformers** and are subject to agreement between purchaser and manufacturer. Such special **variable transformers** have no limitation in terms of their **rated output voltage**.

The **rated output voltage** shall exceed:

- 50 V a.c. or 120 V ripple-free d.c. for **variable independent auto-** and **independent separating transformers**.

**6.102** The rated output shall not exceed the following,

- 40 kVA for single-phase **variable auto-transformers**;
- 200 kVA for poly-phase **variable auto-transformers**;
- 1 kVA for single-phase **variable separating transformers**;
- 5 kVA for poly-phase **variable separating transformers**;
- 25 kVA for single-phase **variable isolating transformers**;
- 40 kVA for poly-phase **variable isolating transformers**;
- 10 kVA for single-phase **variable safety isolating transformers**;
- 16 kVA for poly-phase **variable safety isolating transformers**.

**Transformers** without limitation of the **rated output** shall be subject to agreement between the purchaser and the manufacturer.

**6.103** The **rated supply** and **internal operational frequencies** shall not exceed 500 Hz.

**6.104** The **rated supply voltage** shall not exceed 1 000 V a.c.

*Compliance with the requirements of 6.101 to 6.104 is checked by inspection of the marking.*

## 7 Classification

This clause of Part 1 is applicable.

## 8 Marking and other information

This clause of Part 1 is applicable except as follows:

**8.1 b) Replacement:**

**rated output voltage range** in volts or kilovolts;

For **transformers** incorporating a rectifier, the **rated output voltage range** after the rectifier shall be marked with the arithmetic mean value. If, however, the output voltage is given as an r.m.s. value, this shall be stated.

NOTE An r.m.s. value is distinguished from an arithmetic mean value by the use of r.m.s. in the marking.

**8.1 h) Replacement of the first sentence by the following:**

Relevant graphical symbols shown in 8.11 indicating the kind of **transformers**;

**8.11 Addition:**

Symbol or graphical symbol	Explanation or title	Identification IEC 60417
	Fail-safe separating variable transformer	6014-1
	Non-short-circuit proof separating variable transformer	6014-2
	Short-circuit proof separating variable transformer (inherently or non-inherently)	6014-3
	Fail-safe isolating variable transformer	6015-1
	Non-short-circuit proof isolating variable transformer	6015-2
	Short-circuit proof isolating variable transformer (inherently or non-inherently)	6015-3
	Fail-safe safety isolating variable transformer	6016-1
	Non-short-circuit proof safety isolating variable transformer	6016-2
	Short-circuit proof safety isolating variable transformer (inherently or non-inherently)	6016-3
	Fail-safe variable auto-transformer	6018-1
	Non-short-circuit proof variable auto-transformer	6018-2
	Short-circuit proof variable auto-transformer (inherently or non-inherently)	6018-3

*Addition:*

**8.101** An instruction sheet showing the method of operation, use and maintenance shall be supplied with each **transformer** (e.g. in case of variable associated **auto-** or **separating transformers**, intended to be used only by technically skilled or trained personal).

If the **variable transformer** is not **short-circuit proof**, the information shall be given in the instruction sheet for use.

The overload protection and short-circuit protective devices in the primary circuit of **variable transformer** cannot provide adequate overload protection in the secondary circuit. It is, therefore, always necessary to provide secondary circuit protection.

**8.102** The **short-circuit voltage** at a certain position of the **current collector** shall be marked, when it is subject to an agreement between purchaser and manufacturer.

## 9 Protection against electric shock

This clause of Part 1 is applicable.

## 10 Change of input voltage setting

This clause of Part 1 is applicable.

## 11 Output voltage and output current under load

This clause of Part 1 is applicable except as follows:

*Addition:*

**11.101** When the **transformer** is connected to the **rated supply voltage**, at the **rated supply frequency**, and loaded with the **rated output current**, at the **rated power factor**, the maximum output voltage shall not differ from the rated value by more than 10 % at the highest output voltage.

The output voltage is measured when the **transformer** is connected to the **rated supply voltage**, at the **rated supply frequency**, and loaded with the **rated output current**, at the **rated power factor** and with the **current collector** in a position which will produce the highest voltage drop in steady state condition. In case of **variable auto-transformer**, the measurement is made with the **current collector** in the middle of the **input winding**.

The **current collector** should be placed in the most unfavourable position when tappings or elevated voltage are included in the construction.

## 12 No-load output voltage

This clause of Part 1 is applicable except as follows:

*Addition:*

The **no-load output voltage** is measured when the **transformer** is connected to the **rated supply voltage** at the **rated supply frequency** at ambient temperature.

**12.101** The **no-load output voltage** shall not exceed:

- 1 000 V a.c. or 1 415 V ripple-free d.c for **auto-** and **separating transformers**;
- 500 V a.c. or 708 V ripple-free d.c for **isolating transformers**. The **no-load output voltage** and the **rated output voltage** may be up to 1 000 V a.c. or 1 415 V ripple free d.c. for special applications;

NOTE The **no-load output voltage** and the **rated output voltage** can be up to 1 000 V a.c. or 1 415 V ripple free d.c. in accordance with national wiring rules.

- 50 V a.c. or 120 V ripple-free d.c for **safety isolating transformers**.

For **independent transformers**, this **output voltage** limitation applies even when **output windings**, not intended for interconnection, are connected in series.

The **no-load output voltage** shall exceed:

- 50 V a.c. for **variable independent auto-** and **variable independent separating transformers** or 120 V ripple-free d.c.;
- **variable independent auto-** and **variable independent separating transformers** and power supply units intended to be used by technically skilled or trained personnel are considered as associated transformers and associated power supply units and may have a rated output voltage less than 50 V a.c.

**12.102** The difference between the **no-load output voltage** and the **output voltage** under load shall not be excessive.

The difference is expressed as a percentage of the latter voltage calculated according to the following formula:

$$\frac{U_{\text{no-load}} - U_{\text{load}}}{U_{\text{load}}} \times 100 \%$$

where

$U_{\text{no-load}}$  is the **no-load output voltage**, and

$U_{\text{load}}$  is the output voltage under load,

It is measured when the **current collector** is placed in the most unfavourable position.