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Tap-changers - Part 2: Application guide

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INTERNATIONAL STANDARD

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

TAP-CHANGERS –

Part 2: Application guide

FOREWORD

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International Standard IEC 60214-2 has been prepared by IEC technical committee 14: Power transformers.

This standard cancels and replaces IEC 60542 (1976) and its amendment 1 (1988). This first edition constitutes a technical revision of that standard.

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

FDIS	Report on voting
14/490/FDIS	14/492/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.

IEC 60214 consists of the following parts, under the general title *Tap-changers*:

Part 1: Performance requirements and test methods

Part 2: Application guide

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

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- withdrawn;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

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

The recommendations in this application guide represent advice to the tap-changer manufacturer and purchaser.

It is stressed that the responsibility for the correct application of the fully assembled tap-changers in connection with the transformer lies with the manufacturer of the transformer.

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TAP-CHANGERS –

Part 2: Application guide

1 Scope

This part of IEC 60214 is intended to assist in the selection of tap-changers designed in accordance with IEC 60214-1 for use in conjunction with the tapped windings of transformers or reactors. It is also intended to assist in understanding the various types of tap-changers and their associated equipment available. The application guide covers on-load tap-changers (resistor and reactor types) and off-circuit tap-changers.

2 Normative references

The following referenced documents are indispensable for the application 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.

IEC 60076-1:1993, *Power transformers – Part 1: General*
Amendment 1(1999)¹

IEC 60076-3:2000, *Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air*

IEC 60076-5:2000, *Power transformers – Part 5: Ability to withstand short circuit*

IEC 60076-11:2004, *Power transformers – Dry-type transformers*

IEC 60214-1:2003, *Tap-changers – Part 1: Performance requirements and test methods*

IEC 60296:2003, *Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear*

IEC 60354:1991, *Loading guide for oil-immersed power transformers*

IEC 60599:1999, *Mineral oil-impregnated electrical equipment in service – Guide to the interpretation of dissolved and free gases analysis*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60214-1 apply.

4 Symbols and abbreviations

DGA Dissolved gas analysis
HVDC High-voltage direct current
PST Phase-shifting transformer

¹ There exists a consolidated edition 2.1 (2000) that includes edition 2.0 and its amendment.

5 Types of tap-changer

5.1 General

Tap-changers are devices that will vary the turns ratio of a transformer and hence regulate the voltages of that transformer. Tap-changers that can perform this operation can broadly be divided into two fundamental types as follows:

- on-load tap-changers;
- off-circuit tap-changers.

5.2 On-load tap-changers

5.2.1 General

The on-load tap-changer is designed to change tap position and hence vary the turns ratio of the transformer whilst it is both energized and on load. It performs this function without any interruption of the supply. This is achieved with mechanically operated devices that will select the various tap positions and switch the load currents and step voltages.

On-load tap-changing can be employed by using various switching principles.

The two most common switching principles are:

- high-speed transition resistor type switching; and
- transition reactor (preventive autotransformer) type switching.

5.2.2 Resistor-type on-load tap-changers

5.2.2.1 General

Resistor-type on-load tap-changers can be divided into two distinctive types:

- external out-of-tank tap-changers (air environment), as described in 5.2.2.2;
- in-tank tap-changers (liquid environment), as described in 5.2.2.3.

The operating sequences of the different resistor type tap-changers are shown in IEC 60214-1, Table A.1.

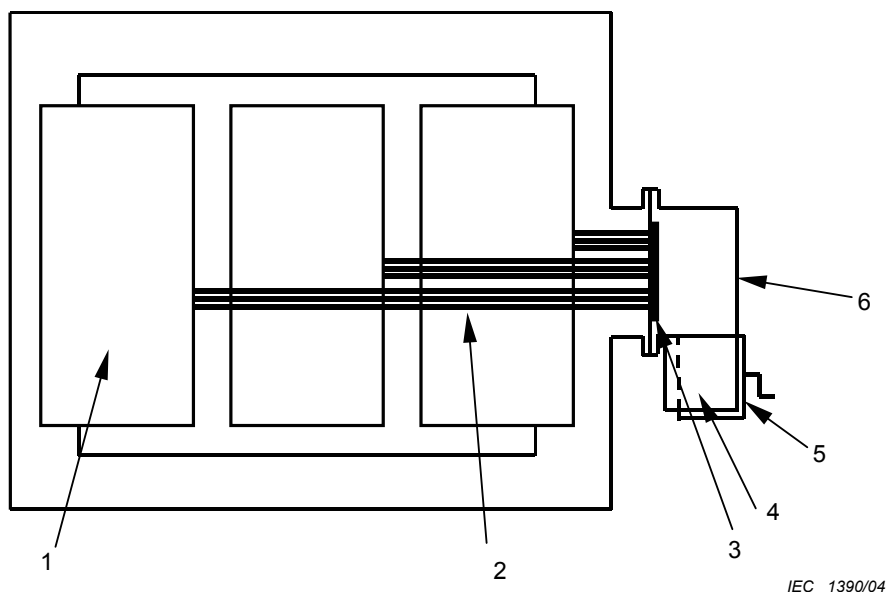
5.2.2.2 External resistor-type on-load tap-changers

5.2.2.2.1 General

These tap-changers are self-contained in their own tanks (except dry-type tap-changers) and mounted on the side or end of the transformer. Four types of tap-changer arrangements are considered, all employing the high-speed transition resistor switching principle.

5.2.2.2.2 External separate selector and diverter compartments

This type of tap-changer has two separate compartments, one for the pre-selection of the transformer taps called the tap selector compartment and the other for the on-load switching called the diverter switch compartment. The two compartments have separate liquid chambers and both are isolated from the liquid in the main transformer tank, although the tap selector compartment and the main tank may share the same conservator. The taps from the transformer are taken to the selector contacts through a liquid-tight barrier board. The tap selector compartment contains clean liquid enabling it to withstand the required higher voltages across the contacts. The diverter switch compartment isolates the carbonized liquid and gases. As can be seen from Figure 1, the tap-changer bolts on the side or end of the transformer. This arrangement is generally used for the larger MVA transformers.

**Key**

- | | | |
|------------------------|--------------------------------|----------------------------|
| 1 Transformer windings | 3 Liquid and gas tight barrier | 5 Drive mechanism |
| 2 Tap leads | 4 Diverter switch compartment | 6 Tap selector compartment |

**Figure 1 – External separate selector and diverter compartments
(for mounting on the end or side of the transformer)**

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The switching can be by arc extinction in the liquid or by vacuum interrupters/power electronics.

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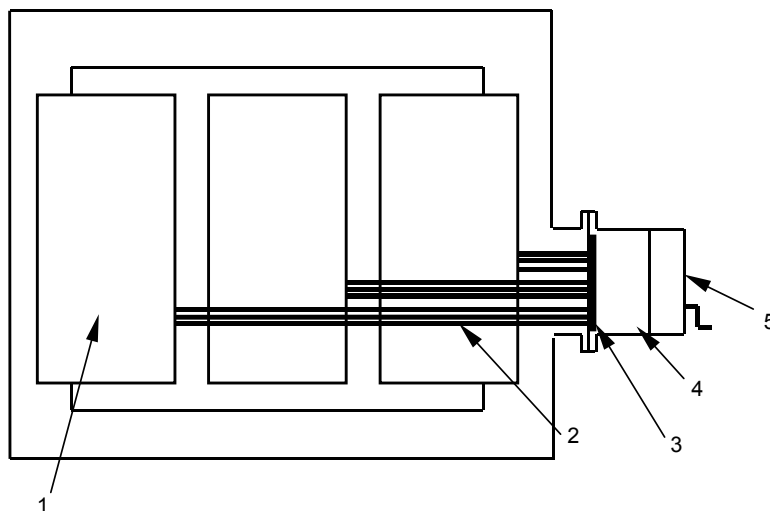
5.2.2.2.3 External mounted separate selector and diverter in single compartment

This type of tap-changer uses separate selector and diverter contact systems in a similar way to the double compartment arrangement in 5.2.2.2.2 but combines them in a single compartment.

The switching can be by arc extinction in the liquid or by vacuum interrupters/power electronics.

5.2.2.2.4 External mounted selector switch tap-changers

Selector switch tap-changers are contained in a single compartment, normally bolted on the side or the end of the transformer (see Figure 2). Again, the transformer taps are taken to the tap-changer contacts through a liquid-tight barrier board. The selection and switching are carried out using common contacts in the same liquid and chamber. These tap-changers tend to be used on the smaller MVA and voltage class transformers.



IEC 1391/04

Key

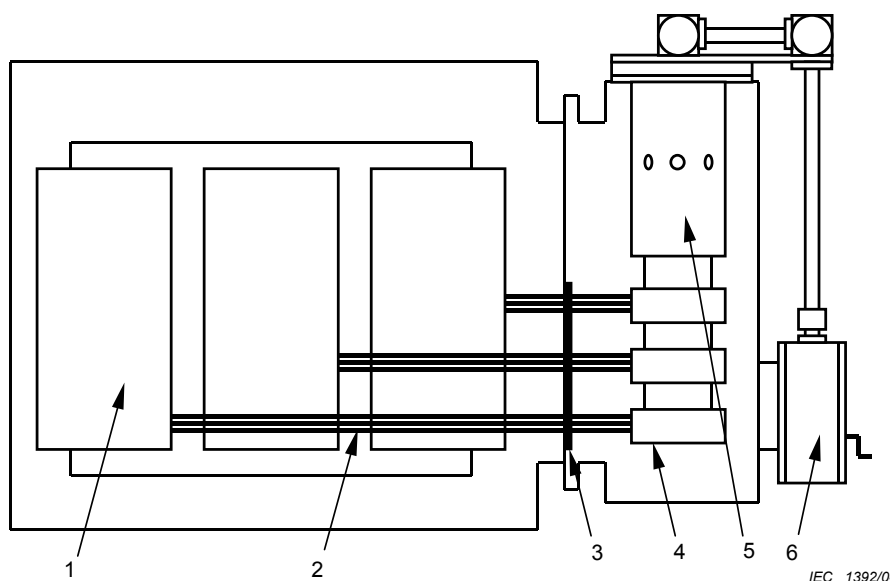
- | | | |
|------------------------|--------------------------------|-------------------|
| 1 Transformer windings | 3 Liquid and gas tight barrier | 5 Drive mechanism |
| 2 Tap leads | 4 Selector switch compartment | |

Figure 2 – External mounted selector switch tap-changer (for mounting on the end or side of the transformer)

5.2.2.2.5 External mounted in-tank with separate barrier board

By using an in-tank tap-changer in a separate pocket with a liquid-tight barrier board between the tap-changer and the transformer, it effectively becomes a separate bolt-on type of tap-changer. The liquid from the selector is totally isolated from the transformer although the selector compartment and the main tank may share the same conservator.

Figure 3 shows how this arrangement works and gives all the advantages of the separate tank tap-changer for the higher voltage classes.



IEC 1392/04

Key

- | | | |
|------------------------|--------------------------------|-------------------|
| 1 Transformer windings | 3 Liquid and gas tight barrier | 5 Diverter switch |
| 2 Tap leads | 4 Tap selectors | 6 Drive mechanism |

Figure 3 – External mounted in-tank with separate barrier board