



# TECHNICAL REPORT

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## Electrical steel – Reverse bend test method for electrical steel strip and sheet

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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ICS 29.030

ISBN 978-2-8322-5616-9

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

### **ELECTRICAL STEEL – REVERSE BEND TEST METHOD FOR ELECTRICAL STEEL STRIP AND SHEET**

#### FOREWORD

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IEC TR 63114, which is a technical report, has been prepared by IEC Technical Committee 68: Magnetic alloys and steels.

The text of this technical report is based on the following documents:

|               |                  |
|---------------|------------------|
| Enquiry draft | Report on voting |
| 68/565/DTR    | 68/579A/RVDTR    |

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

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

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

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- withdrawn,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

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

## INTRODUCTION

Before the preparation of this document, the working group discussed the actual situation of industry concerning the application of reverse bend tests for the evaluation of the ductility of electrical steel strip and sheet, including non-oriented and grain-oriented materials. The following points were noted:

- The reverse bend test is widely used in industry for the evaluation of ductility of electrical steel, and is referenced by the products standards;
- In actual industry practice, the reverse bend test mainly uses as test specimens Epstein strips of 30 mm in width;
- The product standards of IEC 60404-8-4 [1]<sup>1</sup>, IEC 60404-8-7 [2] and IEC 60404-8-8 [3] refer to ISO 7799 for the reverse bend test. However, ISO 7799 specified the width of test specimen to be less than the width of the Epstein strip (30 mm). Therefore, the Epstein strip does not meet with the requirement of ISO 7799;
- There are two modes for the reverse bend test, Europe generally adopts the method of reverse bend test according to ISO 7799 (defined as Mode A), alternatively America and Asia generally adopt that according to ASTM A720 [4] (for non-oriented materials) and JIS C2550 [5] (defined as Mode B), see also the references [6-7];

NOTE ASTM A721 [8] defined a bend method, which is different from the reverse bend test, to determine the ductility of grain-oriented materials.

- The apparatus and the requirements for the reverse bend test are slightly different between Mode A and Mode B, especially on the gap between the specimen and the round edges of the clamp and the requirement that a tensile force is applied to the test specimen; This may cause different deformation mechanisms during bending;
- A comparison test between the two modes has been carried out. It was revealed that number of bends obtained with Mode A and Mode B are different.

The above points indicate the need for a standardization of the reverse bend test method particular to electrical steel to explain how to use the two modes in industry.

This document describes the general principle and technical details of the reverse bend test especially for the evaluation of the ductility of electrical steel with respect to the two modes, Mode A according to ISO 7799 and Mode B according to ASTM A720 and JIS C2550.

Annex A provides information on a specially designed apparatus for the reverse bend test, which can be used for both modes.

Annex B gives test results on the dependence of the number of bends on the tensile force applied to the specimen. The results were obtained using the apparatus described in Annex A in different conditions for Mode A and for Mode B.

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<sup>1</sup> Numbers in square brackets refer to the Bibliography.

## **ELECTRICAL STEEL – REVERSE BEND TEST METHOD FOR ELECTRICAL STEEL STRIP AND SHEET**

### **1 Scope**

This Technical Report describes the general principle and technical details of the reverse bend test method used for evaluating the ductility of electrical steel strip and sheet.

This test method is applicable to Epstein test strip specimens obtained from non-oriented and grain-oriented electrical steel of any grade. The test specimens shall not be annealed.

### **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.

IEC 60404-2, *Magnetic materials – Part 2: Methods of measurement of the magnetic properties of electrical steel strip and sheet by means of an Epstein frame*

ISO 7799, *Metallic materials – Sheet and strip 3 mm thick or less – Reverse bend test*