INTERNATIONAL STANDARD

ISO 16230-1

First edition
2015-09-15

Agricultural machinery and tractors — Safety of higher voltage electrical and electronic components and systems —

Part 1: General requirements

Tracteurs et matériels agricoles — Sécurité des composants et des systèmes électriques et électroniques haute tension —

Partie 1: Exigences générales

Reference number
ISO 16230-1:2015(E)

© ISO 2015



COPYRIGHT PROTECTED DOCUMENT

© ISO 2015, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword ..... **v**

Introduction ..... **vi**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **2**

4 General requirements **4**
4.1 Standards 4
4.2 Component selection 4

5 Protection of persons against electric shock **4**
5.1 General 4
5.2 Protection against direct contact 4
5.2.1 Protection measures 4
5.2.2 Enclosure requirements 5
5.3 Connectors 5
5.4 Protection against indirect contact 5
5.4.1 IT system 5
5.4.2 General 5
5.5 Protection by potential equalization (equipotential bonding) 6
5.5.1 Potential equalization for components 6
5.5.2 Potential equalization for sockets 6
5.6 Isolation resistance requirements 6
5.6.1 Electric power train consisting of separate DC or AC buses 6
5.6.2 Electric power train consisting of combined DC- and AC-buses 6
5.6.3 Insulation monitoring 7
5.7 Parasitic coupling 7
5.7.1 Protective measures — Parasitic coupling 7
5.8 Test procedure for the protection against electric shock 7

6 Additional requirements for electrical sockets connecting to implements or attachments **7**
6.1 Mated connection — General 7
6.2 Connect/Disconnect 7
6.3 Protection of electrical equipment 8
6.3.1 Short-circuits and overloads 8
6.3.2 Heat generating components 8

7 Conductors and cables used in higher voltage distribution — General requirements **8**
7.1 Identification Colours 8
7.2 Identification of conductors for multicore cable 8
7.3 Creepage and clearance distances 8
7.4 Cable and wire insulation 8
7.5 Cross-sectional area 8
7.6 Multicore cables 9
7.7 Wiring that flexes 9
7.8 Flame retardancy 9
7.9 Protection of cables 9
7.9.1 Outer covering 9
7.9.2 General requirements — Protection 9

8 Wiring practices — General **9**
8.1 Fastening and clamping 9
8.2 Routing 10

9 System requirements **10**
9.1 Power on/power off procedure 10
9.1.1 Active state 10

© ISO 2015 – All rights reserved

9.1.2 Deactivated state 10
9.1.3 System state indication 10
9.2 Fault modes (indication) 10
10 Marking and symbols 10
11 Information for use 11
12 Service literature 11
12.1 General 11
12.2 Reduction of electrical hazards while servicing 11
12.2.1 Description of effects of electricity on the human body 11
12.2.2 Statements regarding risk reduction 11
12.3 Special procedures 12
12.3.1 Machine identification 12
12.3.2 First responder information 12
13 Technical documentation 12
13.1 General 12
13.2 Information to be provided 12
13.3 Overview diagrams and function diagrams 13
13.4 Circuit diagrams 13
13.5 Parts list 13
Annex A (informative) **List of hazards 14**
Bibliography 15

 © ISO 2015 – All rights reserved

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 3, *Safety and comfort*.

ISO 16230 consists of the following parts, under the general title *Agricultural machinery and tractors — Safety of higher voltage electrical and electronic components and systems*:

— *Part 1: General requirements*

© ISO 2015 – All rights reserved

Introduction

Electrification is an enabling technology regarding increased power density and greater flexibility in machine form packaging. Customer benefits are increased fuel economy through efficiency gains and enhanced power delivery options not possible with current mechanical systems.

Agricultural machinery electrical systems have traditionally been in the 12 V DC range. Electrification is introducing significantly higher voltages to the Agricultural machinery and mobile equipment sector (see scope definition) usually observed only in industrial/building applications and other transportation sectors. Increased voltage potential requires special safety considerations in this new environment.

The purpose of this standard is to provide direction on safety of electrical systems as defined in the scope (50 V AC to 1000 V AC and 75 V DC to 1500 V DC) on Agricultural machinery and tractors.

In addition, this part of ISO 16230 defines requirements that can apply to the electrical equipment of agricultural tractors and machines. Example areas include, but are not exclusive to the following:

— protection against electric shock;

— wiring practices;

— marking warning signs — safety symbols;

— operator manual considerations.

Supporting electrical equipment standards like IEC 60204-1 and ISO 6469 were considered. Additional parts of this International Standard are expected to deal with external machine interface (power distribution and communication).

This part of ISO 16230 is a type-C standard as defined in ISO 12100.

When requirements of this type-C standard are different from those stated in type-A or B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard

 © ISO 2015 – All rights reserved

Agricultural machinery and tractors — Safety of higher voltage electrical and electronic components and systems —

Part 1: General requirements

1 Scope

This part of ISO 16230 is applicable to tractors and self-propelled ride-on machines, mounted implements, and towed implements used in agriculture and forestry. This part of ISO 16230 specifies general requirements that relate to the protection and safety of operators and bystanders on machines with on-board voltages in the range of 50 V AC to 1000 V AC and 75 V DC to 1500 V DC. This part of ISO 16230 applies to electrical equipment and parts of the electrical equipment on such machines and includes general requirements related to the protection and safety of operators, bystanders, and first responders.

This part of ISO 16230 deals with significant hazards, hazardous situations, and events, as listed in Annex A, relevant to this agricultural machinery when used as intended and under the conditions of misuse foreseeable by the manufacturer during normal operation and service.

This part of ISO 16230 is not applicable to the following:

— specific design elements of external interfaces (e.g. the interface between a tractor and implement);

— externally powered equipment (e.g. line powered equipment, equipment without on-board power generation);

— purpose built forestry machines;

— stationary electrical generators.

This part of ISO 16230 is not applicable to machines which are manufactured before the date of its publication.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3864-1, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*

ISO 6469-3:2011, *Electrically propelled road vehicles — Safety specifications — Part 3: Protection of persons against electric shock*

IEC 60204-1:2005 + AMD1:2008, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60364-4-41, *Low-voltage electrical installations — Part 4-41: Protection for safety — Protection against electric shock*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles,*

IEC 61140:2009, *Protection against electric shock — Common aspects for installation and equipment*

© ISO 2015 – All rights reserved

ECE R100, *Protection against electric shock*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
barrier
part providing protection against *direct contact* (3.7) from any usual direction of access

3.2
basic insulation
insulation applied to *live parts* (3.15) for protection against *direct contact* (3.7) under fault-free conditions

Note 1 to entry: Basic insulation does not necessarily include isolations used exclusively for functional purposes.

3.3
basic protection
protection against *direct contact* (3.7) with *live parts* (3.15) under fault-free conditions

3.4
conductive part
part capable of conducting electric current

3.5
connector
assembly of contacts and housing which terminates conductors for the purpose of providing connection and disconnection to a suitable mating connector

3.6
creepage distance
shortest distance along a surface of a solid insulating material between two *conductive parts* (3.4)

3.7
direct contact
contact of persons with *live parts* (3.15)

3.8
double insulation
insulation system comprising both *basic insulation* (3.2)and *supplementary insulation* (3.22)

3.9
electric shock
physiological effect resulting from an electric current passing through a human body

3.10
equipotential bonding
provision of electric connections between *conductive parts* (3.4), intended to achieve equipotentiality

3.11
exposed conductive part
conductive part (3.4) of the electric equipment that can be touched by a test finger according to IPXXB after removing *barriers* (3.1)/enclosures that can be removed without using tools and that is not normally live, but which can become live under fault conditions

Note 1 to entry: Protection degrees (e.g. IPXXB) are defined in ISO 20653.

© ISO 2015 – All rights reserved