INTERNATIONAL STANDARD

**ISO 14982**

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# Agricultural and forestry machinery — Electromagnetic compatibility — Test methods and acceptance criteria

*Machines agricoles et forestières — Compatibilité électromagnétique — Méthodes d'essai et critères d'acceptation*

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## 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 14982 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 2, *Common tests*.

Annexes A to E form an integral part of this International Standard. Annexes F to H are for information only.

## Introduction

In the past years more and more electronic devices designed to control, supervise and indicate multiple functions have been used in agricultural machines and tractors. The electrical and electromagnetic environment in which these devices work needs to be taken into consideration.

Electrical and high frequency disturbances emerge during the normal operation of many parts of the machine devices. They are generated within a large frequency range with different electrical characteristics and, by conduction and/or radiation, can be imparted to other electronic devices and systems of the machine.

Narrowband signals generated by sources of interference inside or outside the agricultural machines and tractors can also be coupled in electrical and electronic systems where they can influence the normal function of electrical devices. Sources of narrowband electromagnetic disturbances are, for example, machines with integrated micro-processors.

The elaboration of this International Standard is based upon the Commission Directive 95/54/EC (31 October 1995) "Commission Directive 95/54/EC of 31 October 1995 adapting to technical progress Council Directive 72/245/EEC on the approximation of the laws of the Member States, relating to the suppression of radio interference produced by spark-ignition engines fitted to motor vehicles and amending Directive 70/156/EEC on the approximation of the laws of the Member States relating to the type approval of motor vehicles and their trailers". This procedure was chosen due to the large conformity of the disturbance phenomena in many domains (motor vehicles, tractors, self-propelled machinery), similar operation and ambient conditions and the possibility of using the same measuring rig and measuring apparatus. As far as possible, the measuring procedures described in Directive 95/54/EC have been replaced by equivalent internationally standardized measuring procedures. However, it was not possible to refer to International Standards for radiated broadband and narrowband electromagnetic disturbances from machines and for radiated broadband and narrowband electromagnetic disturbances of electrical/electronic sub-assemblies (ESA). Therefore the necessary procedures are described in detail in annexes B, C, D and E. International standardization of the measuring procedures for all types of machines would be desirable for the future.



The electrostatic discharge and the conducted transients are considered to be relevant for agricultural machines and tractors and therefore (in contrast with the Directive 95/54/EC) are included in this International Standard.

Electrostatic discharges are relevant because also control elements can be positioned outside the cabin and potential differences can emerge at contact. Conducted transients have to be taken into account because agricultural machines often represent open systems and several machines are combined with one another. Up to now, however, only conducted transients along supply lines in 12 V- and 24 V-onboard systems have been dealt with. The manufacturer is therefore responsible for ensuring that the equipment may withstand conducted transients which may occur at the switching under load and interactions between systems. Internal cabling and networks should comply with the state of the art. Conducted transients at signal lines have not yet been treated.

This International Standard has been established as a means of achieving conformity with the requirements of the EMC Directive (89/336/EEC) and the EMC requirements of the Machine Directive (89/392/EEC).

# Agricultural and forestry machinery — Electromagnetic compatibility — Test methods and acceptance criteria

## 1 Scope

This International Standard specifies test methods and acceptance criteria for evaluating the electromagnetic compatibility of tractors and all kinds of mobile (including hand-held) agricultural machinery, forestry machinery, landscaping and gardening machinery [referred to hereafter as machine(s)] as supplied by the machine manufacturer. It is applicable to machines and electrical/electronic sub-assemblies (ESA's) which are manufactured after the date of publication of this International Standard.

Electrical/electronic components or sub-assemblies intended for fitting in machines are also within the scope of this standard, except regarding immunity for those parts whose functions are not involved in the direct control and modification of the state of the functions of the machine.

This International Standard is not applicable to machines directly supplied with low voltage current from public electrical mains. Exceptions to machines or electrical/electronic systems or ESA's that may not require testing in accordance with this International Standard are given in clause 7.



## 2 Normative references



The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7637-0:1990, *Road vehicles — Electrical disturbance by conduction and coupling — Part 0: Definitions and general.*

ISO 7637-1:1990, *Road vehicles — Electrical disturbance by conduction and coupling — Part 1: Passenger cars and light commercial vehicles with nominal 12 V supply voltage — Electrical transient conduction along supply lines only.*

ISO 7637-2:1990, *Road vehicles — Electrical disturbance by conduction and coupling — Part 2: Commercial vehicles with nominal 24 V supply voltage — Electrical transient conduction along supply lines only.*

ISO/TR 10605:1994, *Road vehicles — Electrical disturbance from electrostatic discharge.*

ISO 11451-1:1995, *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Vehicle test methods — Part 1: General and definitions.*

ISO 11451-2:1995, *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Vehicle test methods — Part 2: Off-vehicle radiation source.*

ISO 11452-1:1995, *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Component test methods — Part 1: General and definitions.*

ISO 11452-2:1995, *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Component test methods — Part 2: Absorber-lined chamber.*

ISO 11452-3:1995, *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Component test methods — Part 3: Transverse electromagnetic mode (TEM) cell.*

ISO 11452-4:1995, *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Component test methods — Part 4: Bulk current injection (BCI).*

ISO 11452-5:1995, *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Component test methods — Part 5: Stripline.*

IEC 50-161:1990, *International electrotechnical vocabulary — Chapter 161: Electromagnetic compatibility*.

CISPR 12:1990, *Limits and methods of measurement of radio interference characteristics of vehicles, motor boats, and spark-ignited engine-driven devices.*

CISPR 16-1:1993, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 1: Radio disturbance and immunity measuring apparatus*.

## 3 Definitions

For the purposes of this International Standard, the following definitions apply.

**3.1**
**electromagnetic compatibility**
ability of a machine or components or a separate technical unit to function satisfactorily in its electromagnetic environment, without introducing intolerable electromagnetic disturbances to anything in that environment

[IEC 50-161:1990, 161-01-07]



**3.2**
**electromagnetic disturbance**
any electromagnetic phenomenon which may degrade the performance of a machine or component or separate technical unit

NOTE — An electromagnetic disturbance may be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself

[IEC 50-161:1990, 161-01-05]

**3.3**
**electromagnetic immunity**
ability of a machine or component or separate technical unit to perform in the presence of specified electromagnetic disturbances without degradation of performance

[IEC 50-161:1990, 161-01-20]

**3.4**
**electromagnetic environment**
totality of electromagnetic phenomena existing at a given location

[IEC 50-161:1990, 161-01-01]

**3.5**
**reference limit**
limit value with which the production shall conform

**3.6**
**reference antenna**
⟨frequency range 30 MHz to 80 MHz⟩ shortened balanced dipole which is a half-wave resonant dipole at 80 MHz frequency [see CISPR 16-1:1993]

**3.7**
**reference antenna**
⟨frequency range above 80 MHz⟩ balanced half wave resonant dipole tuned to the measurement frequency [see CISPR 16-1:1993]

**3.8**
**broadband emission**
emission which has a bandwidth greater than that of a particular measuring apparatus or receiver

[IEC 50-161:1990, 161-06-11]

**3.9**
**narrowband emission**
emission which has a bandwidth less than that of a particular measuring apparatus or receiver

[IEC 50-161:1990, 161-06-13]

**3.10**
**electrical/electronic system**
electrical and/or electronic component or set of components intended to be part of a machine, together with any associated electrical connections

**3.11**
**electrical/electronic sub-assembly**
**ESA**
electrical and/or electronic component or set of components intended to be part of a machine, together with any associated electrical connections and wiring, which performs one or more specialised functions



**3.12**
**machine type**
⟨electromagnetic compatibility⟩ machines which do not differ in such essential respects as:



— the structural shape;

— the general arrangement of the electrical and/or electronic components and the general wiring arrangement;

— the primary material of which the design of the machine consists (for example a steel, aluminium or fibreglass covering parts)

**3.13**
**ESA type**
⟨electromagnetic compatibility⟩ ESA's which do not differ in such essential respects as:

— the function performed by the ESA;

— the arrangement of the electrical and/or electronic components, if applicable;

— the primary material of the casing

**3.14**
**electrostatic discharge**
**ESD**
transfer of electric charge between bodies of different electrostatic potential in proximity or through direct contact

[IEC 50-161:1990, 161-01-22]

**3.15**
**conducted transients**
transient voltage or current distributed in the power supply wiring of a machine or component or separate technical unit via a conductor between the source of the transient and the drain

## 4 Fulfilment of the requirements

The requirements of this International Standard shall be met by a machine (and its electrical/electronic installation or its ESA) operating in accordance with its final purpose. According to the choice of the machine manufacturer, the following alternatives are possible to demonstrate conformity with this International Standard.

a) The requirements of this International Standard are deemed to be fulfilled for a complete machine when the requirements identified in clauses 5 and 6, as applicable, are fulfilled. If the machine manufacturer has chosen this alternative, no routine tests of the electrical/electronic systems or ESA's are required.

b) The requirements of this International Standard are also deemed to be fulfilled if it is confirmed by the machine manufacturer that all electrical/electronic systems or ESA's are in accordance with this International Standard and have been installed in conformance with the recommended requirements of the ESA.

c) The requirements of this International Standard are also deemed to be fulfilled when the machine has no such equipment for which an immunity or interference test is required. In this case no tests are necessary (see clause 7).

## 5 Testing

### 5.1 Procedure

A kind of "type testing" has been chosen as test procedure, in which a type (designated "test specimen" hereafter) which has been chosen from the series according to certain criteria is tested (see definitions 3.12 and 3.13).



In every test procedure reference limits are determined to which the complete production has to correspond. Tightened limit values apply for the test specimen (except for the electrostatic discharge and the conducted transients) which shall be 2 dB (20 %) below the reference limits (at emission) respectively 2 dB (25 %) above the reference limits (at immunity).



NOTE 1 — This additional margin is used in order to account for the minor differences between the test specimen and the series-product (equivalence of the test specimen) and the minor differences of different testing laboratories (reproducibility of results).

If the test specimen fulfils the tightened limit values, it is assumed that all series-products which are represented by the test specimen comply with the reference limits.

NOTE 2 — This means that the reference limits are taken as basis for a 100 % testing of the production and for an inspection.

Referring to the electrostatic discharge and conducted transients, the reference limits are also valid for the test specimen.

NOTE 3 — The test procedure for the electrostatic discharge and the conducted transients depend in a less substantial way from the environmental influences and minor modifications of the test specimen and consequently the additional margin does not apply.

### 5.2 General requirements for immunity testing

No disturbances shall occur during testing which may affect the driver's direct control of the machine. The driver's direct control of the machine is exercised by means of, for example, steering, braking, the ground speed, or engine speed control. This also concerns movements of parts of the machine and modifications of the state of function which may generate hazards or mislead others.

# 6 Test/measurement methods and reference limits

## 6.1 Broadband electromagnetic emissions from machines

### 6.1.1 Method of measurement

The electromagnetic emissions shall be measured using the method described in annex B at either of the defined antenna distances. The choice is left to the user of this International Standard.

### 6.1.2 Broadband reference limits

If measurements are made using the method described in annex B using a machine-to-antenna distance of 10 m ± 0,2 m, the emission reference limits shall be 34 dB(μV/m) (50 μV/m) in the 30 MHz to 75 MHz frequency band and 34 dB(μV/m) to 45 dB(μV/m) (50 μV/m to 180 μV/m) in the 75 MHz to 400 MHz frequency band; this limit increases logarithmically (linearly) with frequencies above 75 MHz as shown in figure A.1. In the 400 MHz to 1 000 MHz frequency band the limit remains constant at 45 dB(μV/m) (180 μV/m).

If measurements are made using the method described in annex B using a machine-to-antenna distance of 3 m ± 0,05 m, the emission reference limits shall be 44 dB(μV/m) (160 μV/m) in the 30 MHz to 75 MHz frequency band and 44 dB(μV/m) to 55 dB(μV/m) (160 μV/m to 562 μV/m) in the 75 MHz to 400 MHz frequency band; this limit increases logarithmically (linearly) with frequencies above 75 MHz as shown in figure A.2. In the 400 MHz to 1 000 MHz frequency band the limit remains constant at 55 dB(μV/m) (562 μV/m).

On the test specimen, the measured values, expressed in dB(μV/m) (μV/m), shall be at least 2 dB (20 %) below the reference limits.



## 6.2 Narrowband electromagnetic emissions from machines

### 6.2.1 Method of measurement



The electromagnetic emission shall be measured using the method described in annex C at either of the defined antenna distances. The choice is left to the user of this International Standard.

### 6.2.2 Narrowband reference limits

If measurements are made using the method described in annex C using a machine-to-antenna distance of 10 m ± 0,2 m, the emission reference limits shall be 24 dB(μV/m) (16 μV/m) in the 30 MHz to 75 MHz frequency band and 24 dB(μV/m) to 35 dB(μV/m) (16 μV/m to 56 μV/m) in the 75 MHz to 400 MHz frequency band; this limit increases logarithmically (linearly) with frequencies above 75 MHz as shown in figure A.3. In the 400 MHz to 1 000 MHz frequency band the limit remains constant at 35 dB(μV/m) (56 μV/m).

If measurements are made using the method described in annex C using a machine-to-antenna distance of 3 m ± 0,05 m, the emission reference limits shall be 34 dB(μV/m) (50 μV/m) in the 30 MHz to 75 MHz frequency band and 34 dB(μV/m) to 45 dB(μV/m) (50 μV/m to 180 μV/m) in the 75 MHz to 400 MHz frequency band; this limit increases logarithmically (linearly) with frequencies above 75 MHz as shown in figure A.4. In the 400 MHz to 1 000 MHz frequency band the limit remains constant at 45 dB(μV/m) (180 μV/m).

On the test specimen, the measured values, expressed in dB(μV/m) (μV/m), shall be at least 2 dB (20 %) below the reference limits.

## 6.3 Immunity of machines to electromagnetic radiation

### 6.3.1 Test method

The immunity to electromagnetic radiation of the machine shall be tested according to ISO 11451-1 and ISO 11451-2. The determination of the reference point(s) and the operating mode(s) shall be machine-specific and noted in the test report. Immunity testing should be conducted as outlined in ISO 11451-1 except forward power may be used as the control regardless of the standing wave ratio of the system. The test report shall indicate which control method was used. The substitution method and the 80 % amplitude modulation (AM) with sinusoidal wave of

1 kHz (see ISO 11451-1) is determined as test method. Testing shall be done in the frequency band 20 MHz to 1 00 MHz. Polarization may be vertical or horizontal based on worse case conditions and shall be noted in the test report.

#### 6.3.2 Machine immunity reference limits

The reference limit shall be 24 V/m referring to the root mean square value of the unmodulated signal. The maximum value of the test signal with modulation shall comply with the maximum value of an unmodulated test signal. The reference limits, increased by 25 %, apply for the test specimen. The general requirements for immunity testing determined in 5.2 shall be fulfilled.

### 6.4 Broadband electromagnetic emissions radiated from ESA's

#### 6.4.1 Method of measurement

The electromagnetic interference shall be measured using the method described in annex D.

#### 6.4.2 ESA broadband reference limits

If measurements are made using the method described in annex D, the emission reference limits shall be 64 dB(μV/m) to 54 dB(μV/m) (1 600 μV/m to 500 μV/m) in the 30 MHz to 75 MHz frequency band; this limit decreases logarithmically (linearly) with frequencies above 30 MHz, and 54 dB(μV/m) to 65 dB(μV/m) (500 μV/m to 1 800 μV/m) in the 75 MHz to 400 MHz frequency band and increases logarithmically (linearly) with frequencies above 75 MHz as shown in figure A.5. In the 400 MHz to 1 000 MHz frequency band, the limit remains constant at 65 dB(μV/m) (1 800 μV/m).

On the test specimen, the measured values, expressed in dB(μV/m) (μV/m) shall be at least 2 dB (20 %) below the reference limits.



### 6.5 Narrowband electromagnetic emissions radiated from ESA's



#### 6.5.1 Method of measurement

The electromagnetic interference shall be measured using the method described in annex E.

#### 6.5.2 ESA narrowband reference limits

If measurements are made using the method described in annex E, the emission reference limits shall be 54 dB(μV/m) to 44 dB(μV/m) (500 μV/m to 160 μV/m) in the 30 MHz to 75 MHz frequency band; this limit decreases logarithmically (linearly) with frequencies above 30 MHz, and 44 dB(μV/m) to 55 dB(μV/m) (160 μV/m to 562 μV/m) in the 75 MHz to 400 MHz frequency band and increases logarithmically (linearly) with frequencies above 75 MHz as shown in figure A.6. In the 400 MHz to 1 000 MHz frequency band the limit remains constant at 55 dB(μV/m) (562 μV/m).

On the test specimen, the measured values, expressed in dB(μV/m) (μV/m) shall be at least 2 dB (20 %) below the reference limits.

### 6.6 Immunity of ESA's to electromagnetic radiation

#### 6.6.1 Test method

Any combination of the test methods of ISO 11452-2, ISO 11452-3, ISO 11452-4 or ISO 11452-5 may be used for the immunity testing of ESA's to electromagnetic energy. The selected test methods shall cover the frequency band 20 MHz to 1 000 MHz. An amplitude modulation (AM) of 80 % together with a sinusoidal wave of 1 kHz (see ISO 11452-1) shall be used. If the substitution method is determined as the calibration method for the anechoic chamber test, the forward power may be used as the control regardless of the standing wave ratio of the system. In the case of ESA's, the substitution method or the closed loop method may be used for the field calibration. The test report shall indicate which control method was used.

### 6.6.2 ESA immunity reference limits

The immunity reference limits shall be as follows:

48 V/m for the stripline testing method (ISO 11452-5);

60 V/m for the TEM cell testing method (ISO 11452-3);

48 mA for the Bulk Current Injection (BCI) testing method (ISO 11452-4); and

24 V/m for the radiated field (absorber lined chamber) testing method (ISO 11452-2) in vertical polarization only.

The reference limits, increased by 25 %, apply for the test specimen. The reference limits apply to the root mean square value of the unmodulated signal. The maximum value of the test signal with modulation shall comply with the maximum value of an unmodulated test signal. The ESA shall not exhibit any operational change which is unacceptable for its application on the machine. See 5.2 for further definition of operational change which is unacceptable.

## 6.7 Electrostatic discharge

### 6.7.1 Test method

The method described in ISO/TR 10605 shall be used as the method of measurement of the machine or on the ESA in areas where an ESD in standard use is possible (e.g. by touching by the operator).

### 6.7.2 Reference limits



Test level I (± 4 kV) at functional status class A according to ISO/TR 10605 applies.



## 6.8 Conducted transients



### 6.8.1 Method of testing

The method described in ISO 7637-0, ISO 7637-1 and ISO 7637-2 shall be used as method of testing.

### 6.8.2 Reference limits

Test level I at functional status class A according to ISO 7637-1 and ISO 7637-2 applies. Table 1 shows the field of application of the different check pulses in the 12 V- and 24 V-onboard system.[1)] The function performance status shall be specified before the testing of every different check pulse.

1) The emission of transients is under consideration for a revision of ISO 7637-1 and ISO 7637-2. This has to be taken into account for the future.