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Electromagnetic compatibility (EMC) — Product family standard for machine tools —

Part 1: Emission

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National foreword

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Compatibilité électromagnétique (CEM) – Norme de famille de produits pour les machines-outils Partie 1: Emission

Elektromagnetische Verträglichkeit (EMV) – Produktfamiliennorm für Werkzeugmaschinen Teil 1: Störaussendung

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 210, Electromagnetic compatibility (EMC).

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50370-1 on 2005-02-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2006-02-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2008-02-01

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directive 89/336/EEC. See Annex ZZ.

The purpose of this product family standard is

- to establish uniform requirements for the electromagnetic emission of the machine tools contained in the scope,
- to fix test specifications of emission,
- to refer to Basic Standards for methods of testing,
- to standardise conditions during the tests and test report format for the assessment of conformity.

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Contents

1 Scope

This standard deals with the electromagnetic emission (radio frequency protection) of machine tools, excluding electro discharge machines (EDM), designed exclusively for industrial and similar purposes that use electricity, the rated voltage of the machine tool not exceeding 1 000 V AC or 1 500 V DC between lines.

Machine tools may incorporate motors, heating elements or their combination, may contain electric or electronic circuitry, and may be powered by the mains, or any other electrical power source.

This standard does not cover fixed installations as defined in the Guide to the Application of Directive 89/336/EEC, published by the European Commission.

Emission requirements in the frequency range 9 kHz to 400 GHz are covered. No measurements need to be performed at frequencies where no requirements are specified.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 55011	Industrial, scientific and medical (ISM) radio-frequency equipment – Radio disturbance characteristics – Limits and methods of measurement (CISPR 11, mod.)
EN 55022	Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement (CISPR 22, mod.)
EN 61800-3	Adjustable speed electrical power drive systems — Part 3: EMC product standard including specific test methods (IEC 61800-3)
CISPR 16-1	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 document, the following terms and definitions apply.

3.1
machine tool (MT)
machine, not portable as a whole during its operation, driven by an external electrical energy source and intended to work typically metal products in the solid state, with material removal (cutting processes as turning, milling, grinding, drilling, machining...) or without material removal (forming processes as bending, forging, etc.)

The machine tool is normally equipped with a power supply, an electrical and electronic assembly for power and control and one or more power drive systems for the movement of mobile elements or parts

3.2
module
unit consisting of mechanical, pneumatic, hydraulic, electrical and/or electronic parts (examples: machine bed, tool holder, sensor, spindle unit, cabinet including NC-controller and human-machine-interface, programmable logic controller - PLC, power drive...), intended exclusively for an industrial assembly operation for incorporation in an apparatus or system. A component can be considered as a module

3.3
electromagnetically relevant component/module
An electromagnetically relevant component or module for emission aspects is defined as one that, due to its electromagnetic characteristics, is liable to cause electromagnetic disturbances such that it will influence the emission characteristics of typical assemblies into which it may be incorporated

3.4
port
particular boundary of the specified machine tool or module with the electromagnetic environment of the process
(IEV 131-02-21 modified)

NOTE By boundary is meant the physical limits of the complete machine tool or module.

3.5
power interface
connections needed for the distribution of electrical power within the machine tool

3.6
entire electrical set
assembly of all electro-magnetic relevant modules separated from the mechanical structure of the machine tool allowing the assembly to be tested in a reference test site

3.7
type test
test of one or more devices made to a certain design to show that the design meets certain specifications (IEV 151-04-15)

3.8
equipment
generic term, referring to the entire machine tool, the entire electrical set or an electrical/ electromechanical module

4 System configuration

A basic configuration may consist of (see Figure 1)

- an electrical feeding section,
- control and protection circuits and equipment,
- one or more basic power conditioning units (example: drive modules) performing control and/or conversion of electrical energy,
- one or more actuators and their associated transducers,
- control and sequencing systems such as NC-controllers, programmable controllers and their associated peripherals, programming and debugging tools, test equipment and human-machine interfaces,
- peripherals (transducer(s), operator station, emergency stop devices, etc.),
- the structure and the moving parts driven by the actuator(s).

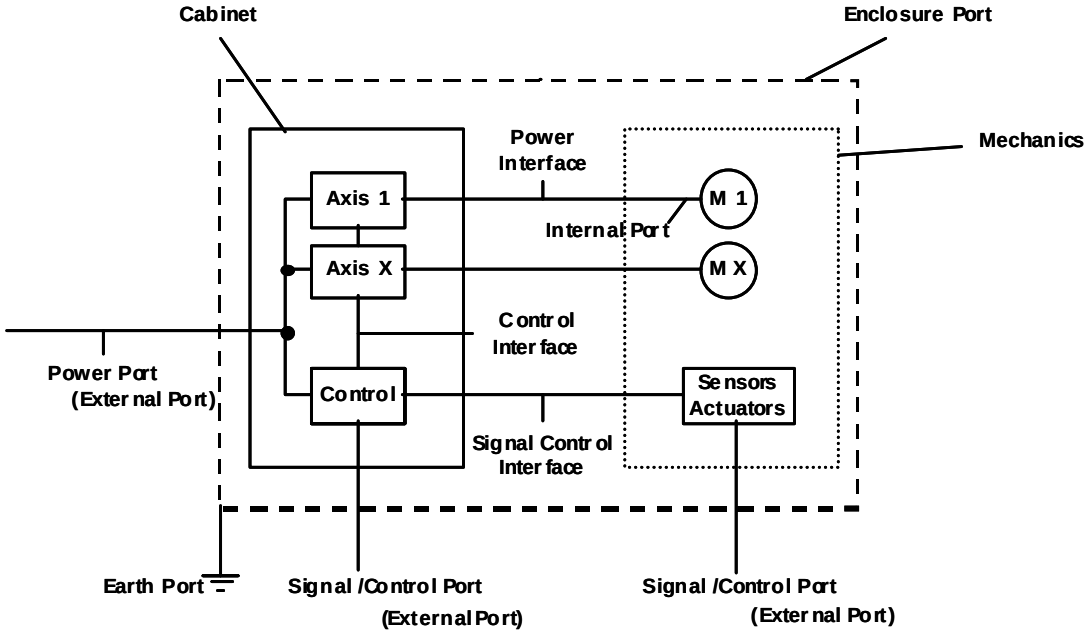


Figure 1 – System configuration and example of ports

4.1 Test approach

Type testing of a finished product is the normal method for conformity assessment against the requirements of a standard, but complete testing of an entire machine tool at a conventional EMC test site is only technically possible and economically feasible for a limited number of machines. A distinction shall be drawn between type-testable machines and machines which, because of the weight, dimensions, operation or unreasonable testing costs and testing delay, cannot be type-tested as a whole at a conventional EMC test site.

Furthermore, it is necessary to take into account single-piece production and the multitude of types as well as expansions and modifications.

Distinctions shall be drawn between the following cases and shall be taken into account:

– type-testable machines;
– machines which are not type-testable;
– multitude of types;
– modifications, additions and expansions.

Each testing procedure for conformity assessment is based on one or a combination of various tests:

– type test at the EMC test site;
– visual inspection of entire machine tool;
– additional tests on entire machine tool [1)].

1) Such tests are usually performed in the manufacturers premises.

5 Emission measurements

Emission measurements shall be performed in accordance with EN 55011 and CISPR 16.

The content of these standards are not repeated here however modifications or additional information needed for the practical application of the testing procedures are given in the present product standard. (These conditions may include in situ measurements as long as they are in accordance with the test methods specified in EN 55011 and CISPR 16).

5.1 Classification and testing procedures

The emission testing procedures are described in the following paragraphs. A flow chart providing an overview of the test procedures is included in the informative Annex E.

5.1.1 Machine tool containing no electromagnetically relevant components

If the machine tool contains no electromagnetically relevant components, no tests have to be carried out.

EXAMPLES Machine tools containing only components such as squirrel cage motors and electromechanical switches.

5.1.2 Machine tool containing electromagnetically relevant components

If the machine tool contains electromagnetically relevant components such as electronic control and power parts (sub-assemblies, sub-systems, etc.), one of the procedures laid down in Table 1 shall be carried out. The test procedure is chosen by the manufacturer based on the characteristics of the machine tool.

Table 1 – Testing procedures

Test procedure	**Procedure A** (Applicable for the entire MT)	**Procedure B** (Applicable for the entire electrical set)	**Procedure C** (Applicable for electrical or electromechanical modules)
Type test	Required	Required	Required
Visual inspection of entire MT	Not required	Required	Required
Additional tests on entire MT [a]	Not required	Not required	Required
[a] Such tests are usually performed in the manufacturers premises.			

5.1.2.1 Test procedure A

The machine tool shall be tested according to the emission requirements laid down in this standard (see 5.2 to 5.4 and Annex A).

During measurement, the machine tool shall operate as specified by the manufacturer.

5.1.2.2 Test procedure B

The entire electrical set of the machine tool shall be tested according to the specific emission requirements laid down in this standard (see 5.2 to 5.4 and Annexes A and B) while simulating specific functions to be specified by the manufacturer.

5.1.2.3 Test procedure C

The machine tool shall be divided into modules by the manufacturer in any appropriate fashion to enable the procedure C to be carried out.

After having divided a machine tool into modules, the manufacturer shall classify each module as electromagnetically relevant or irrelevant concerning the emission of the machine tool.

Electromagnetically irrelevant modules need not be tested.

Electromagnetically relevant modules shall be subjected to the following steps:

1) determine which power ports of the machine tool are electrically connected to which port or interfaces of the module (see Annex C, Table C.1);
2) the tests should be applied to all power ports of the module which will be used as external ports in the complete machine tool;
3) the enclosure ports of all modules are considered to be connected to the enclosure port of the machine tool;
4) the module shall be tested according to the emission requirements laid down in this standard (see 5.2 to 5.4 and Annexes A and C) or according to a harmonised European emission standard relevant for the module.

NOTE The machine tool builder does not need to repeat measurements on an EMC compliant module as declared by its manufacturer.

5.2 Configuration of equipment under test

External ports (Signal/Control Ports) not used during the tests shall be connected to a cable of 1,5 m length.

External ports, which are only accessible for commissioning, service and maintenance purposes should not be considered during measurement.

NOTE This should also be considered while applying 6.4.1 “Interconnecting cables” of EN 55011.

Measurements are applied to the relevant ports of the machine tool or the modules as specified in 5.1.2.1 to 5.1.2.3 and the respective annexes.

The machine tool or the module shall be measured while connected to the minimum configuration of auxiliary equipment necessary to operate the machine tool or the module as intended.

Auxiliary equipment is equipment which is not part of the machine tool but is required to operate it, for example, programming devices.

During measurement, all devices mounted within the machine that might influence the machine emission shall be in operation (for example automatic tool changer, integrated work piece handling etc.).

NOTE All devices, which are not relevant for the test, for example chip conveyer, coolant equipment or automatic bar loader and feeding systems need not to be present.

The measurements shall be carried out within the specified or typical environmental range for the machine tool and at its rated supply voltage and frequency.

Reference settings below maximum shall be used, preferably at approximately 50 % level.

5.2.1 Configuration of equipment - Procedure A

The machine tool shall be completely set-up and fully assembled. In the sense of a worst case configuration, a machine tool with the maximum amount of axes, spindles, turrets and other for this (modular) machine tool available modules is selected.

During the measurement the machine tool shall be ready for use, this means the machine tool chassis shall be completely installed and closed, the electrical cabinet shall be closed and also the guards of the working area shall be closed.

During the measurement, the machine tool shall run with a representative working program (e.g. program steps, cycle time, speed, power, torque, heating elements with absolute and incremental temperature) in a repetitive manner - but without load. Some machine tools (e.g.: laser machining…) are required to run under machining conditions in order to satisfy this requirement.

Within the working cycle, each EMC-relevant module and each drive of the machine shall be accessed, and furthermore, therein real cutting conditions shall be simulated; no fictive or unrealistic feed rates, nor special NC-modes for testing (e.g. “dry-run”) are allowed. (Normally the test cycle is a part program from the machine tool builder to check the accuracy or the function(´s) of a machine tool which is available since a long time and with great experience based on it).

5.2.2 Configuration of equipment - Procedure B

During measurements, the entire electrical set of the machine tool is operated as intended in a defined typical operating mode while simulating specific functions as described by the manufacturer consistent with usual operation.

A typical machine tool test condition could be the following:

– performing a simulation cycle in order to exercise all electromagnetically relevant components or modules;

– setting of the different function levels, e.g. program steps, cycle time, speed, power, torque, heating elements absolute and incremental temperature.

Type and length of cabling and the connection of the cable shield should be the same as in the actual machine tool.

5.2.3 Configuration of equipment - Procedure C

Test conditions for modules shall be representative of the main functions performed in the applications for which they are intended.

The configuration and loading of ports shall be justified (see test plan).

Cables used during measurement should be of the type specified in the individual equipment requirements.

5.3 Type test of machine tools with various configurations

Machine tools may be based on different configurations, to perform different tasks. These configurations are variants of a complete or complex configuration. The manufacturer (assembler or integrator) can follow the approach below, suggested as a way to simplify his tasks while fully complying with this standard.

The manufacturer should attempt to define the EMC configuration most likely to create the highest emissions. This representative configuration should be defined according to the classification and test approach indicated in 5.1, so that the other possible configurations are deemed to be covered. This assessment should be supported by a technical documentation (e.g. by a block diagram showing electrical and electromechanical modules and associated interconnections).

Once the representative configuration mentioned above is in conformity according to one of the selected test procedures and test arrangements described in 5.1.2 and 5.2, any of the assessed variants or configurations are deemed to fulfil the requirements of this standard without further verification.

When the manufacturer modifies the assessed configuration(s), the new machine tool variant(s) shall be assessed to verify whether it should be considered as a new representative configuration.

Table 2 – Approach to assessment of different configurations

Situation of machine tool	Action
Machine tool manufactured in one or various configurations	Test representative configuration (EMC worst case configuration) according to 5.1 to 5.2.
Machine tool modified using electromagnetically irrelevant component	Machine tool is deemed to fulfil the relevant emission tests without testing.
Modified using electromagnetically relevant components	Reassess the validity of the representative configuration. In case of non-validity, test the new representative configuration according to 5.1 to 5.2.

This “worst case” may be identified by a simple consideration of the various combinations, limited testing, or both. The “worst case” may often be the most complex variant.

5.4 Test plan and test report

5.4.1 Test plan

It is a recommended practice that EMC tests are performed according to an EMC test plan agreed upon by the parties involved in the test.

An EMC test plan is a document setting out the specific practices, resources and sequences of activity relevant to a particular product, service, contract or project.

The configuration, operation and performance of the EUT (equipment under test) and auxiliary equipment are essential information for planning and carrying out EMC tests. Furthermore, the responsibilities for operating the EUT shall be established before the tests commence. (See informative Annex D).

5.4.2 Test report

The test report shall contain or enclose the following minimum information:

- identification of the manufacturer or his representative, and the product under test;
- the functions of the machine tool which have been assessed;
- for procedure C the functions of the electromagnetically relevant module(s) which has/have been assessed;
- identification of the ports classified as signal, control, power;
- the operating conditions;

- the simulation cycle adopted for the test condition;
- environmental conditions;
- a description of the test facility and the instrumentation used;
- test distance, position and reference point of antenna;
- a description of the test set-up (e.g. photographs);
- a description of the EUT, cables (type, length, connectors) and auxiliary equipment;
- operating mode(s) of the EUT;
- the test results.

6 Product documentation

Information shall be provided regarding any measures necessary for installation, operation or maintenance to ensure compliance with the EMC requirements, for example the use of grounding, shielded or special cables and maximum length as well as the correct bonding.

Machine tools are primarily intended for use in an industrial environment. In the documentation for the user a statement shall be included drawing attention to the fact that there may be potential difficulties in ensuring radio frequency protection in other environments.

The chosen procedure for complying to this standard (A, B or C) should be reported in the product documentation.

Annex A
(normative)

Type test requirements

Port	Frequency range	Limits **> 16 A per phase**	Limits **≤ 16 A per phase**	Basic standard
Enclosure	30 MHz – 230 MHz	50 dB (µV/m) quasi-peak, measured at 10 m distance	40 dB (µV/m) quasi-peak, measured at 10 m distance	EN 55011
	230 MHz – 1 000 MHz	50 dB (µV/m) quasi-peak, measured at 10 m distance	47 dB (µV/m) quasi-peak, measured at 10 m distance	
AC mains	0,15 MHz – 0,50 MHz	100 dB (µV) quasi-peak, 90 dB (µV) average,	79 dB (µV) quasi-peak, 66 dB (µV) average,	EN 55011
	0,50 MHz – 5 MHz	86 dB (µV) quasi-peak, 76 dB (µV) average,	73 dB (µV) quasi-peak, 60 dB (µV) average	EN 55011
	5 MHz – 30 MHz	90 dB (µV) quasi-peak, decreasing with log of frequency down to 70 dB 80 dB (µV) average, decreasing with log of frequency down to 60 dB	60 dB (µV) quasi-peak, 60 dB (µV) average,	EN 55011
Telecommunications/network ports, as defined in EN 55022 shall comply with the provisions of EN 55022.				

Annex B
(normative)

Entire electrical set

The entire electrical set (as defined in 3.6) is type tested following the measurement and test methods of the appropriate basic standards as one unit while simulating specific functions.

Furthermore, assembling guidelines shall be drawn up by the manufacturer to complete the machine tool.

In order to verify that the design rules have been respected, visual inspections shall be conducted.

The test report should specify procedure B as the method, which has been chosen to achieve compliance.

Annex C
(normative)

Modules used for machine tools

The machine's interfaces to the environment are the measuring points relevant for the type test of machine tools. The Modules should be appropriately specified. The relevant tests are shown in Table C.1.

Furthermore, assembling guidelines shall be drawn up by the manufacturer to complete the machine tool. In order to verify that the design rules have been respected, visual inspections shall be conducted. A test schedule shall be prepared which specifies which tests are to be performed on one representative finished machine at which location.

If the machine tool manufacturer deviates from the measures described in the installation guidelines of the module manufacturer, the deviations shall be justified by an analysis based on additional tests and/or calculations and/or experience.

The manufacturer shall document all this data, the specification of the modules, the assembling guidelines, the result of the visual inspections, the selected tests and the analysis.

The test report should specify procedure C as the method, which has been chosen to achieve compliance.

A statement is given in the manufacturers documentation: “This machine tool is assembled from tested modules”.

Table C.1 – Machine tools emission tests – List of ports and interfaces to be tested according to the test procedures described in Annex A

Port	Port of module	Port of MT	Additional test on MT
RF-field strength	Enclosure	Enclosure	Not required
Conducted voltage	AC-mains	AC-Mains	According to Annex A
Telecommunications/network ports, as defined in EN 55022 shall comply with the provisions of EN 55022.			

Annex D
(informative)

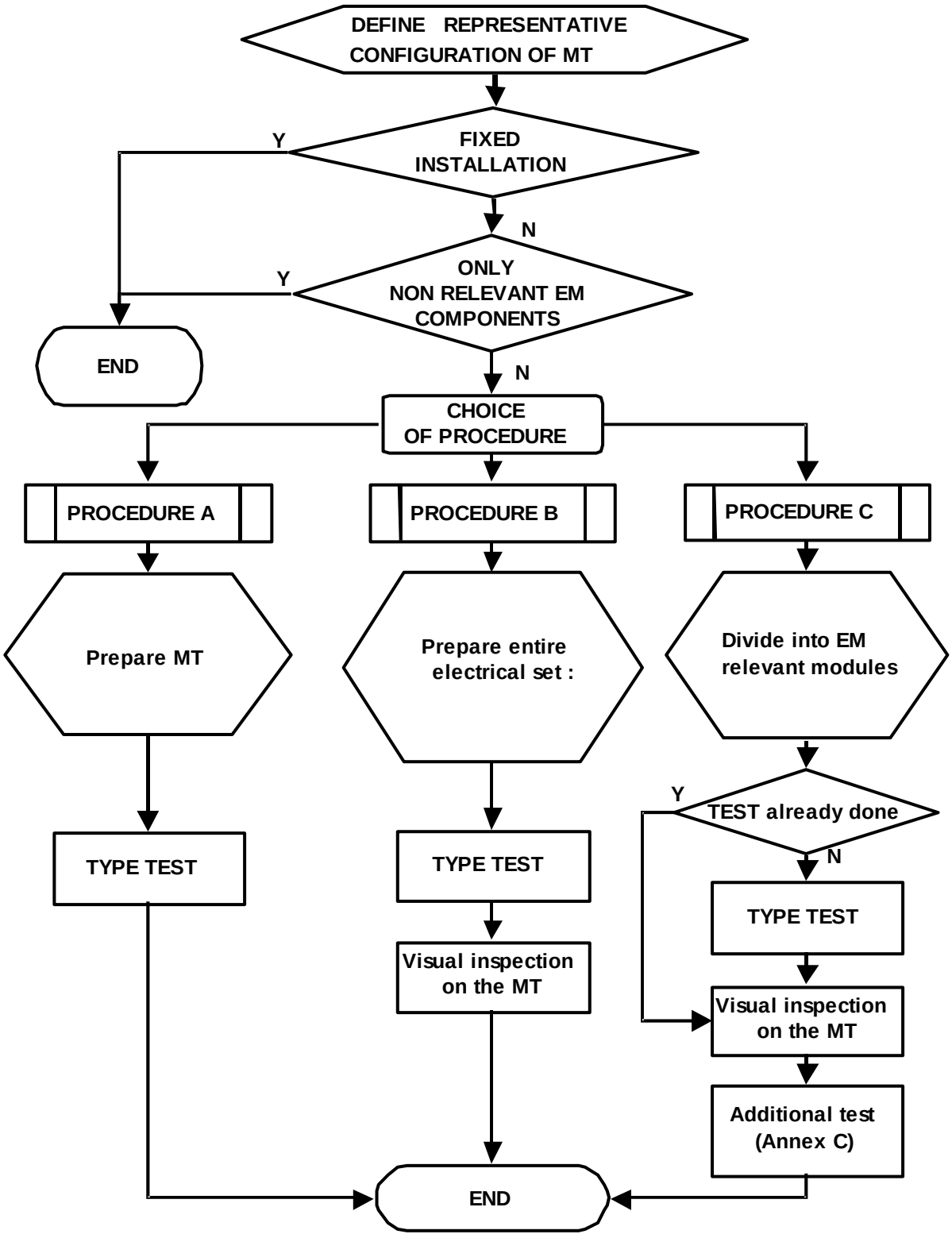
Test plan

An EMC test plan may include the following:

- description of EUT;
- description of peripherals (included in EUT/auxiliary equipment);
- EUT configuration (hardware and software);
- EUT operating instructions;
- test sequence;
- the role of the parties involved in the test;
- the justification of the configuration and loading of ports (procedure C).

Annex E
(informative)

Testing procedure flow chart



Annex ZZ
(informative)

Coverage of Essential Requirements of EC Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers the essential requirements as given in Article 4 a) of the EC Directive 89/336/EEC.

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive[s] concerned.

WARNING: Other requirements and other EC Directives may be applicable to the products falling within the scope of this standard.

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