BRITISH STANDARD

BS EN
50370-2:2003

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

Part 2: Immunity

The European Standard EN 50370-2:2003 has the status of a British Standard

ICS 25.080.01; 33.100.20

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 50370-2:2003.

The UK participation in its preparation was entrusted by Technical Committee GEL/210, EMC policy committee, to Subcommittee GEL/210/12, Basic and generic standards, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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English version

Electromagnetic compatibility (EMC) - Product family standard for machine tools Part 2: Immunity

Compatibilité électromagnétique (CEM) - Norme de famille de produits pour les machines-outils Partie 2: Immunité

Elektromagnetische Verträglichkeit (EMV) - Produktfamiliennorm für Werkzeugmaschinen Teil 2: Störfestigkeit

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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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 50370-2 on 2002-11-01.

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)	2003-11-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2005-11-01

This standard is intended for publication in the Official Journal of the European Communities as harmonized standard for the assessment of conformity with the protection requirements of the Electromagnetic Compatibility Directive (89/336/EEC).

The purpose of this product family standard is

- to establish uniform requirements for the electromagnetic immunity of the machine tools contained in the scope,
- to fix test specifications of immunity,
- to refer to basic standards for methods of testing,
- to standardise conditions during the tests, performance criteria and test report format for the assessment of conformity.

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, Annexes A, B and C are normative and Annexes D and E are informative.

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Contents

1 Scope

This standard deals with the electromagnetic immunity of machine tools designed exclusively for industrial and similar purposes that use electricity, the rated voltage of the machine tool not exceeding 1 000 V a.c. or 1 500 V d.c. 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 immunity standard may also be used for assessment of equipment used in other environments, which require less stringent immunity levels (residential, light industry…) than the industrial environment.

This standard is not intended for the EMC conformity assessment of modules to be placed on the market separately.

This standard is not intended for complying with Machinery Directive 98/37/EC. Hence safety considerations are not covered by this standard.

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.

This standard does not apply to apparatus intended to be used in locations where special electromagnetic conditions prevail, such as the presence of high electromagnetic fields (e.g. in the vicinity of a broadcast transmitting station) or where high pulses occur on the power network (e.g. in a power generator station). In these instances special mitigation measures may have to be employed.

Immunity requirements in the frequency range 0 Hz to 400 GHz are covered. No measurements need to be performed at frequencies where no requirements are specified.

2 References

2.1 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 61000-4-2	Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test (IEC 61000-4-2)
EN 61000-4-3	Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques – Radiated, radio-frequency electromagnetic field immunity test (IEC 61000-4-3)
EN 61000-4-4	Electromagnetic compatibility (EMC) — Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test (IEC 61000-4-4)
EN 61000-4-5	Electromagnetic compatibility (EMC) — Part 4-5: Testing and measurement techniques – Surge immunity test (IEC 61000-4-5)

EN 61000-4-6 [1)]	Electromagnetic compatibility (EMC) — Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6)
EN 61000-4-8	Electromagnetic compatibility (EMC) — Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test (IEC 61000-4-8)
EN 61000-4-11	Electromagnetic compatibility (EMC) — Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests (IEC 61000-4-11)
IEC 60050	International Electrotechnical Vocabulary (IEV)

2.2 Other references

ISBN 92-828-0762-2	1997	Electromagnetic Compatibility (EMC) - Guide to the application of Directive 89/336/EEC

3 Terms, definitions and abbreviations

3.1 Terms and definitions

3.1.1
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...)

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

3.1.2
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

3.1.3
electromagnetically relevant component/module
an electromagnetically relevant component or module for immunity aspects is defined as one that, due to its electromagnetic characteristics, is liable to have its performance degraded by electromagnetic disturbances such that it will influence the EMC characteristics or the intended operation of typical assemblies into which it may be incorporated

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1) At draft stage.

3.1.4
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.

3.1.5
signal interface
input/output (I/O) connection for a line connecting the supervision, control and/or protection module(s) to other parts or modules of the machine tool

3.1.6
power interface
connections needed for the distribution of electrical power within the machine tool

NOTE A port of a module may be connected to a port of the machine tool, or may form an interface to another module within the machine tool.

3.1.7
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

3.1.8
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)

3.1.9
equipment
generic term, referring to the entire machine tool, the entire electrical set or an electrical/ electromechanical module

3.2 Abbreviations

NOTE Only the abbreviations used in the English version of this part of EN 50370 are mentioned in this subclause.
The German and French versions of this part may use other abbreviations. Refer to 3.2 of each language version for details.

a.c.	alternating current
AM	amplitude modulation
CRT	cathode ray tube
d.c.	direct current
EDM	electrical discharge machining
EM	electromagnetic
EFT	electrical fast transient
EMC	electromagnetic compatibility
ESD	electrostatic discharge
EUT	equipment under test
I/O	input/output
LED	light emitting diode
MT	machine tool
PLC	programmable logic controller

r.m.s. root mean square

T_h hold time

T_r rise time

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).

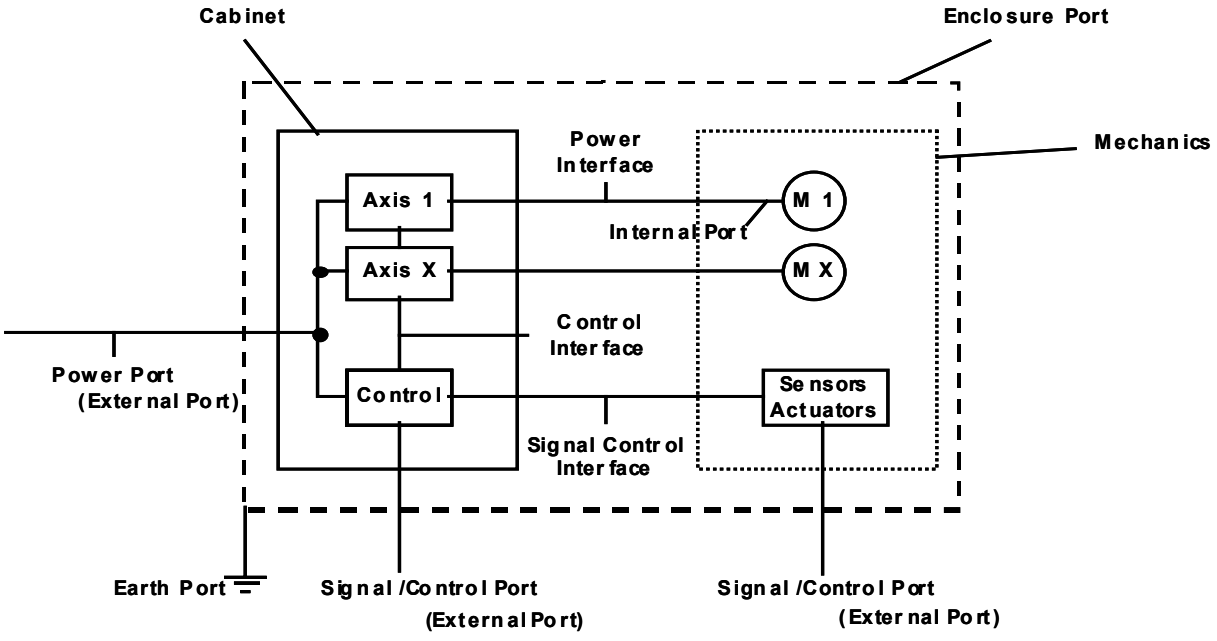


Figure 1 – System configuration and example of ports

4.1 Test approach

Type testing of a finished product is the normal method for conformity assessment, 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 assessment of conformity could be based on one or a combination of various tests:

- type test at the EMC test site;
- visual inspection of entire machine tools;
- additional tests on entire machine tools at manufacturers premises.

4.2 Void

5 Immunity tests

5.1 Classification and testing procedures

The immunity 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 electric motors, electromechanical switches, thermostats, (rechargeable) batteries etc.

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 – Test 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	Optional (see note)	Required
Additional tests on entire MT at manufacturers premises	Not required	Optional (see note)	Required
NOTE Visual inspection or additional tests as decided by the manufacturer.			

5.1.2.1 Test procedure A

The machine tool shall be tested according to the immunity requirements laid down in this standard (see 5.2 to 5.6 and Annex A).

For tests, the machine tool shall operate as specified by the manufacturer.

The performance criteria (Table 2) shall be used to check the performance of a machine tool before, during and after each immunity test.

5.1.2.2 Test procedure B

The entire electrical set of the machine tool shall be tested according to the specific immunity requirements laid down in this standard (see 5.2 to 5.6 and Annexes A and B) while simulating specific functions to be specified by the manufacturer.

The performance criteria (Table 2) shall be used to check the performance of a machine tool before, during and after each immunity test.

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 immunity of the machine tool.

Electromagnetically irrelevant modules need not be tested.

Electromagnetically relevant modules shall be subjected to the following steps:

1) determine which 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 shall be applied to all 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 immunity requirements laid down in this standard (see 5.2 to 5.6 and Annexes A and C) or according to a harmonised European generic, product family or product immunity standard for the industrial environment.

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

5.2 Test arrangements

Tests shall be 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.

However, if several process measurement and control ports or signal interfaces have the same physical configuration (layout) it is sufficient to test one port or interface of that type.

The tests shall be carried out as single tests in sequence. The sequence of testing is optional.

These tests shall be performed normally in the test conditions as specified in the basic immunity standards (these test conditions may include in situ testing, as long as they are specified in the basic immunity standards).

The description of the test, the test generator, the test methods, and the test set-up are given in the relevant basic immunity reference standards.

The content of these basic standards are not repeated here, however modifications or additional information needed for the practical application of the tests are given in this standard.

5.3 Performance assessment and criteria

The assessment of performance degradation used during and/or at the conclusion of the tests, shall be simple, but at the same time give adequate proof that the essential functions of the machine tool are operative.

The performance criteria shall be used to check the performance of a machine tool or modules against external disturbances.

Since machine tools and their modules represent a very broad and inhomogeneous group of products, a precise definition of performance criteria cannot be given.

Nevertheless a functional description and a definition of performance criteria and monitoring methods, during or as a consequence of the EMC testing, shall be specified by the manufacturer and included in the test report, based on the general criteria and examples of malfunctioning contained in Table 2, which cannot be considered exhaustive.

It is the responsibility of the manufacturer to define the representative parameters for each specific performance and the permissible degradation of performance or loss of function of the machine tool or the module(s).

Table 2 classifies the effects of a given disturbance into three performance criteria: A, B and C, each of which defines a specified level of performance.

Table 2 – Performance criteria definition

Item	**Performance Criterion A** *No noticeable change in operating characteristic* **No changes**	**Performance Criterion B** *Noticeable change in operating characteristics* **Self recoverable**	**Performance Criterion C** *Shut-down, triggering of protective devices* **Not self recoverable**
Specific performance: ***General behaviour against loss of data***	No loss of data Machine tool is operable	No loss of data Machine tool may halts the program Data and position are kept. Program continues after re-initiating cycle start	Loss of data Recoverable by restart or by new set-up
Specific performance: ***Part program execution***	No change in operation Machine tool runs in continuous mode without noticeable changes of operating characteristic	As in class A except when changes in operation cause the machine tool to halt program, without loss of data (data and position are kept) Program continues after re-initiating cycle start	Shut down, changes in operation, etc. Program execution restored by operation of control or by any operation specified in the instructions for use
Specific performance: ***Stability of mode of operation***	No change in mode of operation occurs	Not applicable	Loss or change of selected mode. Restarting operation by operator is allowed [a]
Specific performance: ***Operation of power electronics, drives, spindles etc.***	Control function within specific limits No message(s) about exceeding control-limits occur(s), neither on the control display, nor on the power or drive unit	Control function temporary outside limits. Error-message(s) about exceeding the control-limits occur(s) (on the control display or power-/drive unit) Program halts in hold state (defined state) without loss of data (data and position are kept) Program continues after re-initiating cycle start	Shut down of the unit by protective or safety devices Restarting operation by operator is allowed
Specific performance: ***Information processing and sensing functions***	No disturbances in communication with other units	Temporary communication problems between operating units Both units (transmitter/ receiver) stay stable and the next communication event is performed well	Totally loss of communication control between partner units Restarting operation by operator is allowed
Specific performance: ***Operation of display units and control panels***	No visible change in display information Only slight influences in Intensity, brightness or slight movement of characters	Temporary visible changes of display information Only slight and temporary undesired lamp and LED illumination [b]	Permanent loss of display information or obviously wrong information, including incorrect illumination of lamps, LED´s etc.

[a] Examples: The machine tool turns off; the machining process stops without reason; the control unit gets blocked; the keyboard gets blocked; the operating system gets blocked and the machine stops; some outputs of the control unit turn on/off meaning the triggering of devices like pumps, contactors, electrical valves, etc.

[b] Examples: The monitor turns off but the machine carries on operating properly; alarm indications turn on without reason; incoherent error messages, incompatible with the actual status of the machine, appear on the monitor (e.g. motor position error message with no movement).

5.4 Conditions during tests

If the machine tool or the module can be connected to auxiliary equipment, then the machine tool or the module shall be tested while connected to the minimum configuration of auxiliary equipment necessary to exercise all existing ports.

The tests concerning electromagnetic fields and radio-frequency common mode are carried out during the scan time while at random the selected modes of the equipment under test (EUT) are set into operation. In the case of a machine tool with an automatic cycling programme, the scan time shall be started at random.

The configuration and mode of operation during the tests shall be precisely noted in the test report (see 5.6 and Annexes A to C).

Testing a specific function as given in Table 2 requires special test equipment with adapted immunity against the parasitic coupling of the test disturbance as well as an adapted and immune load to be available at the test site.

5.4.1 Procedures A and B

The tests shall be made while the machine tool is operated as intended in a defined typical operating mode as described by the manufacturer consistent with usual operation.

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

A typical machine tool test condition could be the following:

- performing a simulation cycle in order to exercise all electromagnetically relevant components or modules. In principle, the simulation cycle is run in unloaded conditions. Some machine tools (e.g.: electrical discharge machining (EDM), laser machining…) are required to run under machining conditions in order to satisfy this requirement;
- setting of the different function levels, e.g. program steps, cycle time, speed, power, torque, heating elements absolute and incremental temperature.

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

All immunity tests to transitory phenomena such as electrostatic discharge (ESD), fast transients or surges are carried out during each mode of operation of the machine tool (or phase as part of the mode of operation) selected for the test.

Where a single cycle lasts longer than the scan time, the test shall be repeated until the cycle is finished.

5.4.2 Procedure C

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

5.5 Test plan and test report

5.5.1 Test plan

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

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 Annex D).

5.5.2 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;
- the acceptable level of performance or degradation of performance during and/or after the test in accordance with the performance criteria as defined in 5.3;
- the method of observing a degradation of performance of the machine tool or the module;
- 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.

5.6 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 be the most susceptible to the relevant disturbances. 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 3 – 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 5.4
Machine tool modified using electromagnetically irrelevant component	Machine tool is deemed to fulfil the relevant immunity 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 5.4

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.

5.7 Test precautions

Immunity tests may cause disturbances to equipment operating nearby and may be harmful to personnel.

Suitable precautions shall be taken.

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 to functional earth.

Annex A
(normative)

Type test requirements

Table A.1 – Machine tools immunity tests – Enclosure port

Environmental phenomena	Test specification	Units	Basic standard	Performance criteria
Power-frequency magnetic field [a]	50 30	Hz A(r.m.s.)/m	EN 61000-4-8	A
Radio-frequency EM field Amplitude modulated	80 – 1 000 10 80	MHz V/m (r.m.s., unmodulated) % AM (1 kHz)	EN 61000-4-3	A
Electrostatic discharge [b]	+/- 4 (contact) +/- 8 (air)	kV (charge voltage)	EN 61000-4-2	B

[a] Applicable only to machine tools containing devices susceptible to magnetic fields, e.g. Hall elements, electrodynamic microphones, etc. For CRT's, the acceptable jitter depends upon the character size and is calculated for a test level of 1 A/m as follows: J = (3C + 1)/40 where jitter J and character size C are in millimetres. As jitter is linearly proportional to the magnetic field strength, tests can be carried out at other test levels extrapolating the maximum jitter level appropriately.

[b] Not applicable to signal lines and/or parts accessible only for maintenance.

Table A.2 – Machine tools immunity tests – Ports for signal ports

Environmental phenomena	Test specification	Units	Basic standard	Performance criteria
Radio-frequency common mode Amplitude modulated [a]	0,15 – 80 10 80	MHz V (r.m.s., unmodulated) % AM (1 kHz)	EN 61000-4-6	A
Fast transients [b]	+/- 1,0 5/50 5	kV (peak) T_r/T_h ns Repetition frequency kHz	EN 61000-4-4 (capacitive clamp)	B
Surge, common mode [c]	1,2/50 (8/20) +/- 1	T_r/T_h µs kV	EN 61000-4-5	B

[a] Applicable only to ports or interfaces with cables whose total length according to the manufacturer's functional specification may exceed 3 m.

The test level is defined as the equivalent current into a 150 Ω load.

[b] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification may exceed 10 m if not involved in process, 3 m in all other cases.

[c] Applicable only to ports or interfaces with cables, which according to the manufacturer's functional specification may leave the building.

Table A.3 – Machine tools immunity tests – DC input and output power ports

Environmental phenomena	Test specification	Units	Basic standard	Performance criteria
Radio-frequency common mode Amplitude modulated	0,15 – 80 10 80	MHz V (r.m.s., unmodulated) % AM (1 kHz)	EN 61000-4-6	A
Fast transients	+/- 2,0 5/50 5	kV (peak) T_r/T_h ns Repetition frequency kHz	EN 61000-4-4	B

Table A.4 – Machine tools immunity tests – AC input and output power ports

Environmental phenomena	Test specification		Units	Basic standard	Performance criteria
Radio-frequency common mode. Amplitude modulated [a]	0,15 – 80 10 80		MHz V (r.m.s., unmodulated) % AM (1 kHz)	EN 61000-4-6	A
Fast transients [b]	+/- 2,0 5/50 5		kV (peak) T_r/T_h ns Repetition frequency kHz	EN 61000-4-4	B
Voltage dips (applicable only on the a.c. input)	30 0,5		% reduction Periods	EN 61000-4-11	B for 0,5 periods
	60 5	60 50	% reduction Periods		C for 5 and 50 periods [c]
Voltage interruptions (applicable only on the a.c. input)	> 95 250		% Periods	EN 61000-4-11	C [c]
Surge common mode differential mode	1,2/50 (8/20) +/- 2 +/- 1		T_r/T_h µs kV kV	EN 61000-4-5	B

[a] Not applicable to input ports intended for connection to a battery or a rechargeable battery, which shall be removed or disconnected from the apparatus for recharging. The test level is defined as the equivalent current into a 150 Ω load.

[b] Power ports with current rating < 100 A: direct coupling, using the coupling decoupling network. Power ports with current rating ≥ 100 A: capacitive clamp. The test level shall be 4 kV/2,5 kHz.

[c] Performance criterion C for electronic power converters: the operation of protective devices (e.g.: fuse, circuit breaker) is accepted.

Table A.5 – Machine tools immunity tests – Functional earth port

Environmental phenomena	Test specification	Units	Basic standard	Performance criteria
Radio-frequency common mode. Amplitude modulated [a]	0,15 – 80 10 80	MHz V(r.m.s., unmodulated) % AM (1 kHz)	EN 61000-4-6	A
Fast transients	+/- 1,0 5/50 5	kV (peak) T_r/T_h ns Repetition Frequency kHz	EN 61000-4-4 (capacitive clamp)	B

[a] The test level is defined as the equivalent current into a 150 Ω load.

Annex B
(normative)

Entire electrical set

The entire electrical set (as defined in 3.1.7) is type tested in accordance with 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 EMC design rules have been respected, visual inspections shall be conducted or a test schedule shall be prepared specifying which tests are to be performed on one representative finished machine at which location.

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 EMC design rules have been respected, visual inspections shall be conducted and a test schedule shall be prepared specifying 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 in an "EMC plan".

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 immunity tests – List of ports and interfaces to be tested according to the test procedures described in Annex A

Test	Port or interface of modules	Port of MT	Additional tests on entire MT
Power frequency magnetic field [a]	Enclosure	Enclosure	Not required
Radio frequency electromagnetic field	Enclosure	Enclosure	Not required
Electrostatic discharge	Enclosure [b]	Enclosure	According to levels in Annex A
Radio frequency common mode	All ports or interfaces used as external ports in the complete machine tool	Signal lines exceeding 3 m Power ports Earth port	Not required
Fast transients	All ports or interfaces used as external ports in the complete machine tool	Signal lines exceeding 3 m Power ports Earth port	According to levels in Annex A
Surge	All ports or interfaces connected to the respective ports of the machine tool	AC Power ports, signal ports [c]	Not required

[a] Only to modules containing devices susceptible to magnetic fields.

[b] For modules not accessible to users or service personnel with power connected, only the indirect discharge test shall be carried out

[c] Applicable only to ports or interfaces with cables, which according to the manufacturer’s functional specification may leave the building.

Annex D
(informative)

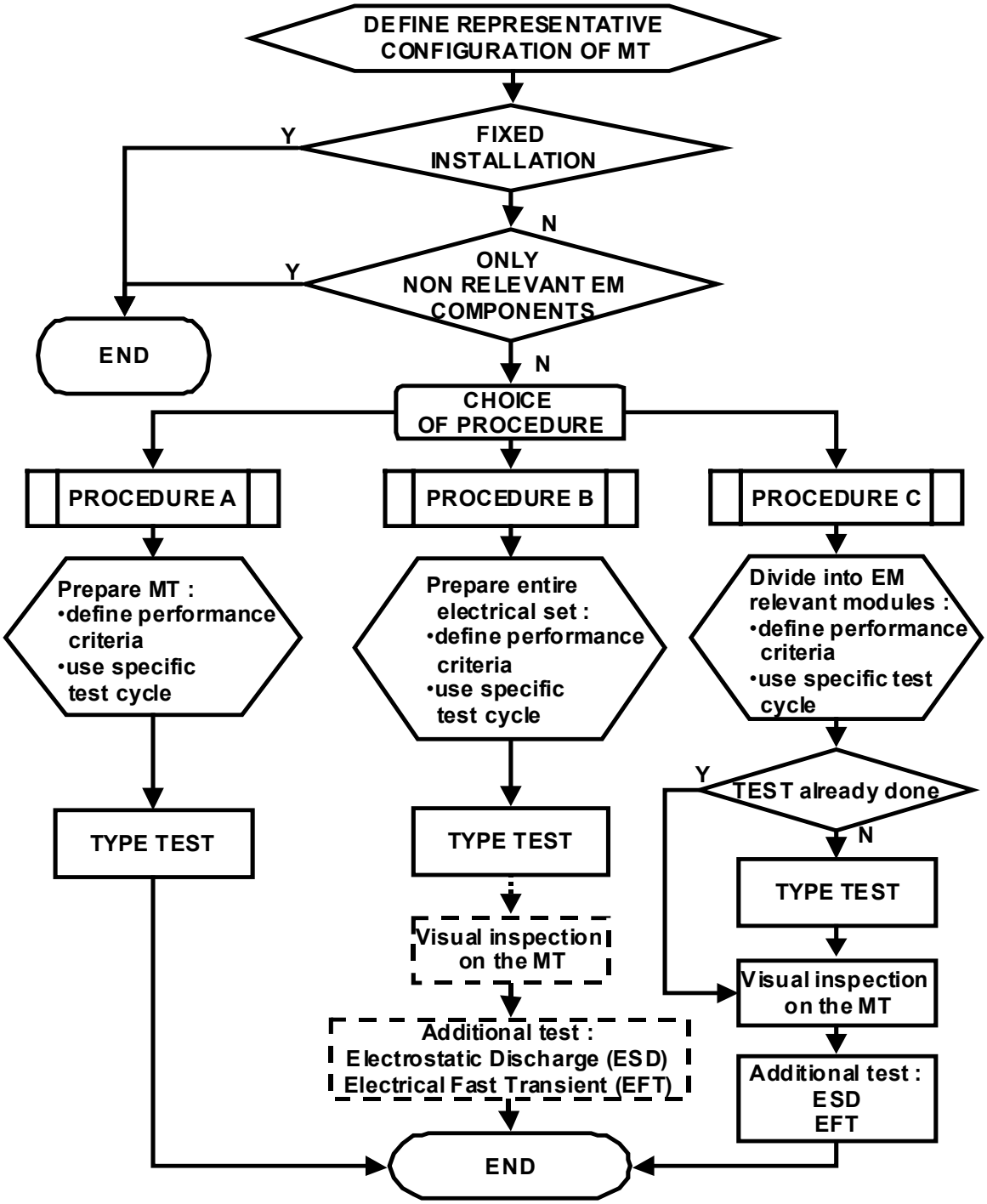
Test plan

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;
- criteria for terminating the test;
- test requirements on a port by port basis as in Annex A, including the rationale or justification why certain tests will not be informed;
- detailed description of the performance criteria of the EUT.

Annex E
(informative)

Test procedure flow chart



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