

ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

ECMA STANDARD

for

ELECTRICAL SAFETY REQUIREMENTS
FOR DATA PROCESSING MACHINES

June 1969

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BRIEF HISTORY

Technical Committee TC 12 of ECMA have been set up in 1966 with a view to considering safety requirements in general, and more particularly the safety regulations of the European countries, and then to establishing appropriate safety recommendations specifically aimed at Data Processing machines or units so that they are intrinsically safe and safe for operating and maintenance personnel.

This Standard ECMA-22 is directed to the electrical safety requirements. Further work on mechanical and physical safety is on its way, which will lead to further standards.

Adopted as Standard ECMA-22 by the General Assembly of June 12, 1969.

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1 INTRODUCTION

1.1 FOREWORD

These requirements cover electrically operated machine units which, separately or assembled in systems, electronically accumulate, process, and/or store data without the interposition of an operator. Acceptance and divulgence of data may or may not be by electronic means.

These requirements cover units rated at 440 volt or less.

1.2 SCOPE

Purpose of this specification is to consider national and international safety regulations with a view to establishing appropriate safety recommendations for data processing machines or units so that they are intrinsically safe and safe for operating personnel. These data processing machines or units are class 1.

1.3 DEFINITIONS

1.3.1 Electrical Shock

The physiological effects due to flow of electric current through the human body.

1.3.2 Stationary

A unit is said to be stationary if it is fixed or not moved from one place to another in normal use.

1.3.3 Movable

Any non-stationary unit is movable.

1.3.4 Removable Part

A part capable of being removed without tools.

1.3.4.1 Tool

Tool denotes a screw driver, a coin, a key or any other object which may be used to operate a screw, a lock or similar fixing means.

1.3.5 Degrees of Insulation

1.3.5.1 Functional Electrical Insulation

The electrical insulation necessary for the proper functioning of the equipment and for basic protection against electrical shock.

1.3.5.2 Protective Electrical Insulation

An independent electrical insulation provided in addition to the functional electrical insulation in order to ensure protection against electrical shock in case of failure of the functional electrical insulation.

1.3.6 Live Part

A part at a voltage in excess of extra low voltage which may cause a significant electrical shock.

1.3.7 Accessible Part

A part which can be touched by the standard test finger.

1.3.8 Clearance

Length of the shortest imaginary thread spanned in air between two non-insulated parts.

1.3.9 Creepage Distance

The shortest distance measured over the surface of insulation between two non-insulated conductive parts minus distance over ungrounded metal parts.

1.3.10 Extra Low Voltage

A voltage not exceeding 42 volt between conductors and earth, the no-load voltage not exceeding 50 volt.

1.3.11 Thermal Release

A device which prevents continuous excessively high temperatures in certain parts of the apparatus by disconnecting those parts from their supply.

1.3.12 Earthing Conductor

Conductor which provides the electric connection from a point in a unit to earth.

1.3.13 Operator Access Area

Any part of a unit to which access can be gained without the use of tool.

1.3.14 Non-Operator Area

Any part unit to which access can only be gained with the use of tools.

1.3.15 Class 1 Appliance

Denotes an appliance having at least functional insulation throughout and provided with an earthing terminal or earthing contact and, for appliances designed for connection by means of a flexible cable or cord, provided with either an appliance inlet with earthing contact, or a non-detachable flexible cable or cord with earthing conductor and a plug with earthing contact.

1.3.16 Energy Hazard

Is considered to exist at any exposed energized part of a piece of equipment if, between the exposed energized part and an adjacent exposed live or dead metal part of different polarity, there exists a potential of 2 volt or more and an available continuous power level at 240 volt-amperes (or more).

Note: Unless otherwise stated all voltage values indicated in volt are meant as volt r.m.s.

2 ELECTRICAL SAFETY

2.1 PROTECTION AGAINST ELECTRICAL SHOCK

2.1.1 Machines shall be so constructed and enclosed that there is adequate protection against accidental contact with live parts and between exposed parts that could cause an energy hazard. This requirement applies to all positions of the machine even after removal of all parts and opening of all covers which may be detached or opened without the use of a tool.

2.1.2 Parts at potentials exceeding the extra low voltage are considered as live parts.

Note: Parts having potentials above the extra low voltage which cannot supply more than 3,5 mA through a 2000 ohm resistor are not considered as live parts.

2.1.3 Tests

2.1.3.1 Compliance is checked by inspection and by a test with the standard test finger shown in Fig. 1. In addition external apertures other than apertures in earthed metal parts are tested with the test pin shown in Fig. 2.

2.1.3.2 The finger and the test pin are applied without appreciable force in every possible position, except that machines normally used on the floor or having a mass exceeding 40 kg are not tilted.

2.1.3.3 Apertures preventing the entry of the finger are further tested by applying a straight unjointed test finger of the same dimensions with a force of 30 N, and if this test finger enters, the test with the test finger of Fig. 1 is repeated, the finger being, if necessary, pushed through the aperture.

2.1.3.4 An electrical contact indicator is used to show contact.

2.1.3.5 During the tests the distance between live parts and accessible metal parts shall not become less than the values given in 2.6.4.

2.1.4 Parts providing protection against accidental contact shall have adequate mechanical strength and shall not work loose during normal operation.

2.1.5 Handles, operating levers, knobs and the like, the shafts of which may become alive in the case of an insulation fault, shall either be of insulating material or shall be adequately covered by insulating material.

2.1.6 Test Finger and Test Pin

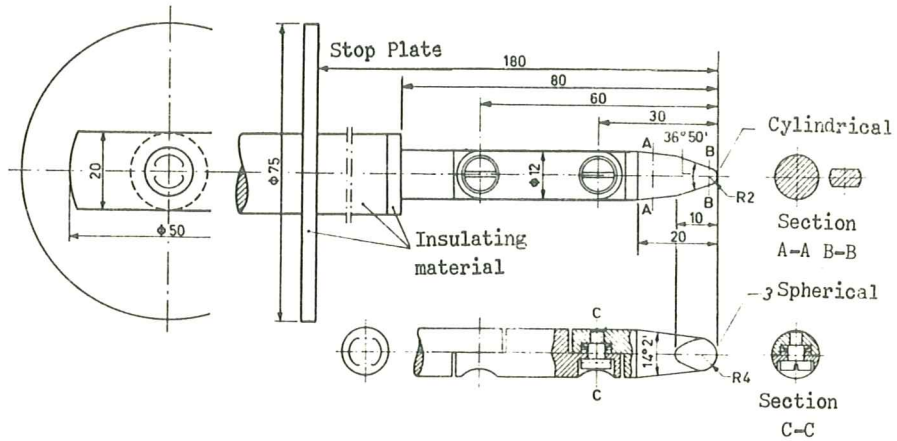


Figure 1

Dimensions in mm

Tolerances:

on angles ± 5

on linear dimensions:

less than 25 mm $- 0,05$

over 25 mm $\pm 0,2$

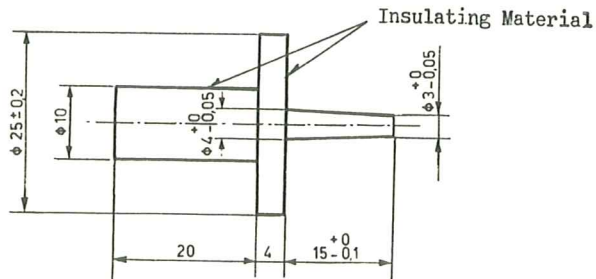


Figure 2

2.1.7 Interlocks

Operator access areas having accessible live parts shall have interlocked guard covers such that

- i) the cover cannot be removed until the parts are de-energized, or
- ii) removal or opening of the cover switches off the current.

It shall not be possible to touch parts while they are live with the test finger (2.1.6) with the cover in any position including partially open.

The guard interlock switches shall be so arranged that inadvertent operation is prevented. Where it may be necessary to over-ride an interlock for servicing purposes an over-ride system shall be provided which cannot be left on when the unit is returned to normal usage by the operator.

Over-ride device shall be mounted outside the operator access area.

2.2 SAFETY EARTHING

2.2.1 Accessible metal parts excluding insulated, small screws and rivets which may become alive in the event of a fault, shall be reliably earthed.

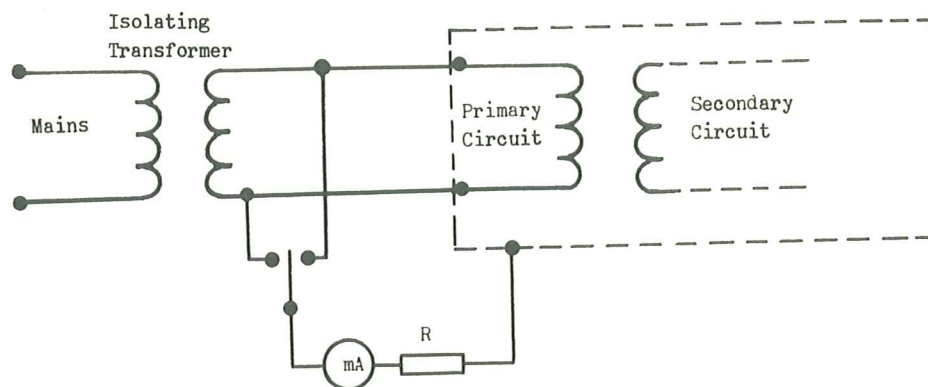
2.2.2 Appliances to be permanently connected to fixed wiring and appliances with non-detachable flexible cords or cables shall have, adjacent to the main terminals, an earthing terminal clearly and indelibly marked with the symbol:



2.2.3 The metal of the earthing terminal shall be such that there is no danger of corrosion due to contact with the copper of the earthing conductor or any other metal.

- 2.2.4 Either the screw or the other part of the earthing terminal shall be made of brass or another non-corroding metal and the contact surfaces shall be bare metal.
- 2.2.5 It shall not be possible to loosen the earthing terminal screw without the aid of tools.
- 2.2.6 The earthing conductor shall have neither switch nor fuses.
- 2.2.7 Earthing conductors may be bare or insulated. Insulated earthing conductors shall be coloured green/yellow. The combination of the colours green and yellow shall be such that on any 15 mm length of core, the colour green shall cover at least 30 % and not more than 70 %, the colour yellow shall cover the remainder of the surface.
- 2.2.8 Size of earthing conductor in any earthing circuit within the machine shall not be less than that of the associated current carrying conductor.
- 2.2.9 Leakage Current
- 2.2.9.1 Pluggable single phase units on which both current carrying conductors and the earthing conductor are connected via the plug, used with or without filters, shall have, under normal or abnormal conditions their leakage current below:
- 3,5 mA in the case of stationary units
0,75 mA in the case of movable units.

2.2.9.1.1 Measuring arrangement



The unit is to be tested with a supply voltage equal to 1,1 times rated voltage. The resistance of the measuring circuit is 2000 ± 100 ohm, and the measuring instrument has an accuracy of 5 % for all frequencies within the range 20 to 5000 Hz, but is insensitive to higher frequencies.

2.2.9.2 Pluggable three phase units with or without filters shall have their leakage current below 3,5 mA under normal or abnormal conditions.

2.2.9.3 Permanently wired single or three phase units, i.e. the earthing conductor of which is permanently connected at both the unit and wall ends, may have a leakage current under normal conditions not exceeding 250 mA and under abnormal conditions not exceeding 1 A subject to compliance with 2.2.9.3.1.

2.2.9.3.1 A readily visible label reading "Warning-High earthing conductor current. Never operate with earthing conductor disconnected".

2.2.9.3.2 Measuring arrangement (see 2.2.9.1.1). However, the resistance of the measuring circuit shall be maximum 10 ohm.

Note: Abnormal operation (see 2.2.9.1, 2.2.9.2 and 2.2.9.3) signifies only a single fault condition.

2.3 SUPPLY CONNECTION

2.3.1 Supply Cord

2.3.1.1 Units which are not intended to be permanently connected to fixed wiring shall be provided with either a non-detachable flexible cable or cord or an appliance inlet. If an appliance inlet is used, it shall be so placed that the connector can be inserted without difficulty.

2.3.1.2 Non-detachable flexible cables or cords shall be not lighter than ordinary tough rubber sheathed flexible cord (code designation: CEE (2) 53) or the equivalent Polyvinyl Chloride insulated flexible cord (CEE (13) 53). The cord shall be colour coded as follows:

TABLE I

	Single Phase	Three phases
Phase	Brown	Black, Brown, Black or Black, Brown, Brown
Neutral	Blue	Blue
Earth	Green/Yellow	Green/Yellow

2.3.1.3 If the cord is electrically shielded by, e.g. a copper braid, then in addition the copper braid must be protected by an outer insulating jacket.

2.3.1.4 The nominal cross-section of the conductor of the cords shall be not less than that shown hereafter:

TABLE II

Rated current of machine in A	Nominal cross-section mm ²
≤ 6	0,75
≤ 10	1
≤ 16	1,5
≤ 25	2,5
≤ 32	4
≤ 40	6
≤ 63	10

2.3.1.5 A strain relief must be provided wherever a supply cord leaves or enters a machine. The strain relief shall be capable of withstanding a 147 N pull on the cord for one minute from any angle the construction of the machine permits without any movement of the cable that would place strain on the terminal connections or damage the cord insulation.

The jacket of the cord must extend beyond the strain relief for a distance equal at least to the diameter of the cord.

2.3.1.6 Inlet openings shall be so designed that there shall be no risk of damage to the protective covering of the cord.

2.3.1.7 Movable units shall be so designed that, should a conductor become free from its terminal, it cannot accidentally come into contact with accessible unearthed metal parts.

2.3.1.8 The length of the grounding conductor between the strain relief and terminating screw shall be such that in the event of strain relief failure, the earthing conductor is the last to be under strain.

2.3.1.9 Detachable supply cords and flexible cables used for an intermediate connection between different units, shall not be provided with means for connection such that accessible metal parts are live when one end of the flexible cable or cord is disengaged.

Compliance is checked by inspection and, if necessary, by a test with the standard test finger.

2.3.2 Terminals

2.3.2.1 The connection of the attachment cord, if it terminates at a terminal block, shall be made by means of screws, nuts or equally effective devices.

2.3.2.1.1 Screws, nuts, etc. which clamp external conductors, shall have a metric ISO thread or a thread comparable in pitch and mechanical strength. They shall not serve to fix any other component except that they may also clamp internal conductors if these are so arranged that they are unlikely to be displaced when fitting supply conductors.

2.3.2.1.2 Terminals shall be so fixed that, when the clamping means are tightened or loosened, they will not work loose, internal wiring is not subjected to stress, and creepage distances and clearances are not reduced below the values specified under 2.6.4.

2.3.2.1.3 The terminals shall have dimensions such that good mechanical strength is assured up to the maximum wire size for which the machine has been designed and shall be so designed that no undue damage can occur to the conductor.

2.3.2.2 Plugs and sockets for connecting equipment to the mains supply shall be provided with an earth connection.

2.3.3 If more than one supply plug is provided for a unit or an interconnected group of units, it shall be designed so that physical disconnection of any one supply plug automatically removes the hazardous voltage from the pins of this plug.

2.4 POWER CONTROL

2.4.1 Units or Groups of Units permanently connected to Supply Mains

2.4.1.1 Where a unit or group of units are permanently connected to the supply mains a switch or contactor shall be provided to disconnect the equipment from the supply. This switch or contactor may be incorporated in the equipment or provided as part of the installation.

2.4.1.2 The means of operating the switch or contactor shall be accessible to the operator and shall be identified where there is a danger of confusion. The on/off condition shall be reliably indicated at the operating point.

2.4.1.3 The current and voltage rating of the switch or contactor shall be sufficient to ensure the interruption of all phase conductors under normal and fault conditions (even if a short circuit occurs in the unit).

2.4.2 Pluggable Units or Groups of Units

- 2.4.2.1 Self contained pluggable units need not have a main line switch if the supply plug is accessible to the operator.
- 2.4.2.2 When connecting and disconnecting the supply plug, the earthing pin of this plug shall not connect later than the phases contact and shall not disconnect before the phases disconnect.
- 2.4.2.3 Where a group of units having individual pluggable or permanent supply connections are interconnected in such a way that hazardous voltage or energy levels may be transmitted between units, a switch or contactor according to 2.4.1 shall be provided to disconnect supply from all units which may transmit or receive hazardous voltage or energy levels via interconnections.

2.5 PROTECTION AGAINST OVERLOAD

- 2.5.1 Units shall be so designed that the risk of fire or electric shock due to electrical or mechanical overload or failure, or abnormal or careless operation is limited as far as possible.

Fusible links, thermal cut-outs, overcurrent releases and the like may be used to provide adequate protection against the risk of fire.

- 2.5.2 Where overload protection is provided in primary power circuits by means of overcurrent releases or fuses the minimum number and location of overcurrent devices shall be as follows:

TABLE III

Supply Connections	Minimum Number of Overcurrent Devices	Location
2 wire	1	Either conductor (phase conductor where applicable).
3 wire	2	Any two phase conductors.
4 wire (3 phase and neutral)	3	Each phase conductor.

2.5.3 Motors connected to Primary Power Circuits

2.5.3.1 Motors shall be protected against overheating due to overload.

2.5.3.2 Motors may be protected against overload

- a) by means of a device responsive to motor current or temperature. If a temperature sensing device is used it shall be integral with the motor;
- b) by use of motors which do not overheat under locked rotor conditions.

TEST: Compliance will be checked by connecting the motor to 1,1 times the rated voltage with the rotor locked. The temperature rise of the windings measured by the resistance method shall not exceed the following values in the steady state:

TABLE IV

Insulation Class	Measured Temp. Rise ($^{\circ}$ C)
Y	95
A	120
E	145
B	160
F	205
H	245
C	-

Note: The values in the table are based on an ambient temperature not normally exceeding 25° C, but occasionally reaching 35° C. The values are obtained from IEC 85 as follows:

$$\begin{aligned} \text{Max. temperature rise } (^{\circ}\text{C}) \\ = 1,7 (\theta - 35) \end{aligned}$$

Where θ = maximum recommended working temperature given in IEC 85.

2.5.4 Mains Transformers

2.5.4.1 Transformers shall be protected against overheating due to external overload.

2.5.4.2 Transformers may be protected against overload by

- a) External overcurrent protection
- b) Integral temperature sensing devices
- c) Use of current limiting transformers

TEST: Each secondary winding of a mains transformer shall be short circuited in turn with the transformer connected to 1,1 times the rated mains voltage at rated frequency. Fuses and thermal cut-outs shall remain connected for the test. In the steady state the temperature rise of the windings measured by the resistance method shall not exceed the values given in 2.5.3.2.

2.5.5 Overload Protection Devices shall

- a) operate automatically at current values which are suitably related to the safe current ratings of the circuits;
- b) be of adequate making and breaking capacity;
- c) be so positioned and constructed as to prevent their operation causing danger from overheating, arcing or the scattering of hot metal.

Where overload protection devices in primary power circuits also provide protection against earth faults (i.e. shorts from phase to earth) they shall be connected in the live conductor of a single-phase supply having earthed neutral, the live conductors of a multi-phase supply having earthed neutral, all conductors of an unearthed supply.

Any such device which is connected in an earthed neutral conductor shall be connected also in all the live conductors of the supply so that operation of the overcurrent protection device breaks all supply conductors.

2.5.6 Where overcurrent or short circuit protection is provided by fuses:

- a) the fuse rating shall be indicated adjacent to the fuseholder;
- b) where a mains input switch is fitted it shall be connected on the supply side of the fuse.

Note: In addition to the above requirements for overload protection designers must ensure that adequate protection is afforded against earth faults and short circuits. In particular where overcurrent protection is used if this does not have adequate breaking capacity, back-up short circuit protection must be provided in the equipment or the installation.

2.6 COMPONENTS

This section presents the safety requirements for components in a machine.

Where failure or degradation of a component may result in a shock or fire hazard the component shall be so designed and used as to prevent excessive electrical, mechanical or thermal conditions occurring. Where breakdown may result in a hazard, the following tests shall be applied.

- 2.6.1 Components (including motors) used in primary power wiring which have functional insulation must be able to withstand a test voltage of 1500 volt for one minute without breakdown between live parts and non-current carrying parts.

Immediately before the test the components shall be conditioned for 48 hours at 90 - 94 % relative humidity and any temperature between 20°C and 30°C. The temperature must be maintained within an accuracy of $\pm 1^\circ\text{C}$ to avoid bedewing of specimen.

- 2.6.2 Components used in secondary circuits must be able to withstand the following test for one minute without breakdown.

The test potentials are DC and applied between current carrying and non-current carrying parts. If AC potentials are used, the DC criteria have to be multiplied by 0,707.

- 2.6.2.1 Secondary circuits of up to 90 volt shall withstand ten times the rated voltage.
 - 2.6.2.2 Secondary circuits of 90 to 300 volt shall withstand 900 volt.
 - 2.6.2.3 Secondary circuits of 300 to 1000 volt shall withstand three times the maximum secondary voltage.
 - 2.6.2.4 Secondary circuits of over 1000 volt shall withstand 1,25 times the maximum secondary voltage plus 1750 volt.
- 2.6.3 Components containing both primary and secondary potentials must be able to withstand the following tests for one minute without breakdown.
- 2.6.3.1 A test potential of two times rated voltage plus 1500 volt with a minimum of 2000 volt between primary and secondary parts and of 1500 volt between primary parts and exposed non-current carrying metal parts.

Immediately before the test the components shall be conditioned for 48 hours at 90 - 94 % relative humidity and any temperature between 20°C and 30°C. The temperature must be maintained within an accuracy of $\pm 1^{\circ}\text{C}$ to avoid bedewing of specimen.
 - 2.6.3.2 See par. 2.6.2 for dielectric strength tests for secondary circuits.

2.6.4 Spacings

For primary circuits the spacings between uninsulated live metal parts of opposite polarity and between an uninsulated live metal part and frame shall not be less

than indicated in Table V. Where breakdown may result in a hazard, secondary circuit spacings shall meet these requirements.

These spacings specified as the minimum acceptable do not apply to components where smaller distances are necessary to ensure proper functioning.

TABLE V

Normal potential difference in V Peak Values	Minimum clearance and creepage distances in mm	
	with protection against deposition of dirt	without protection against deposition of dirt
0-177	1,6	2,0
177-354	2,0	3,0
354-622	3,0	4,0
over 622	For secondary circuits, see par. 2.6.2	

2.6.5 Capacitors

Means of releasing internal pressures in capacitors must be provided without creating a hazard. Electrolytic capacitors storing more than 4 joules must have vents.

Note: Gases and liquids contained within the sealed cases of electrolytic, tantalum, and some types of AC capacitors may generate pressure internally, and possibly erupt, when

- a) the leakage current is excessive
- b) a reverse voltage is applied to polarized units, or
- c) an excessive potential is applied to polarized units.

2.7 TEMPERATURE LIMITS

2.7.1 Requirements

The temperature at any point of a system in normal use shall not give rise to hazardous conditions.

For the insulating materials the present IEC classification shall be considered together with the temperatures assigned to the different classes such as it results from the following Table VI:

TABLE VI

Insulation classes	Temperature (°C)
Y	90
A	105
E	120
B	130
F	155
H	180
C	> 180

Furthermore the temperature of accessible parts shall not exceed in normal use the following values:

TABLE VII

	Temperature (°C)	
	metal	non metal
Accessible parts which the operator needs to touch or handle for operational purposes	55	85
Other accessible parts	75	95

2.7.2 Test conditions

Compliance with the above mentioned requirements shall be checked by measuring the temperatures under the most adverse operating conditions permitted by the manufacturer's specifications.

Note: The term: "most adverse operating conditions" shall be taken to cover all factors which may influence the temperature such as mains supply voltage and frequency, ambient temperature, atmospheric pressure and relative humidity, conditions of air filters and operating mode.

Temperatures shall be measured:

- a) in the case of appliances for short time operation at the end of the rated operating time
- b) in the case of appliances for intermittent operation when the maximum values are reached
- c) in all other cases when the steady state is reached.

