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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Explosive atmospheres –
Part 18: Equipment protection by encapsulation "m"

Atmosphères explosives –
Partie 18: Protection du matériel par encapsulage «m»

IEC 60079-18:2009

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FOREWORD

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International Standard IEC 60079-18 has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

This third edition cancels and replaces the second edition of IEC 60079-18 (2004) and IEC 61241-18 (2004), and constitutes a technical revision.

The significant technical changes with respect to the previous edition are as follows:

– Incorporation of level of protection “mc”
– Equipment protection levels (EPL Ma, Ga, Da, Mb, Gb, Db, Gc, Dc)
– Incorporation of the dust requirements
– Incorporation of switching contacts for level of protection “ma”

The text of this standard is based on the following documents:

FDIS	Report on voting
31/784/FDIS	31/801/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This standard is to be read in conjunction with IEC 60079-0:2007, *Explosive atmospheres – Part 0: Equipment – General requirements.*

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The list of all parts of IEC 60079 series, under the general title *Explosive atmospheres*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of June 2009 have been included in this copy.

EXPLOSIVE ATMOSPHERES –

Part 18: Equipment protection by encapsulation “m”

1 Scope

This part of IEC 60079 gives the specific requirements for the construction, testing and marking of electrical equipment, parts of electrical equipment and Ex components with the type of protection encapsulation “m” intended for use in explosive gas atmospheres or explosive dust atmospheres.

This part applies only for encapsulated electrical equipment, encapsulated parts of electrical equipment and encapsulated Ex components (hereinafter always referred to as “m” equipment) where the rated voltage does not exceed 11 kV.

The application of electrical equipment in atmospheres, which may contain explosive gas as well as combustible dust simultaneously may require additional protective measures.

This standard does not apply to dusts of explosives, which do not require atmospheric oxygen for combustion, or to pyrophoric substances

This standard does not take account of any risk due to an emission of flammable or toxic gas from the dust.

This standard supplements and modifies the general requirements of IEC 60079-0. Where a requirement of this standard conflicts with a requirement of IEC 60079-0, the requirement of this standard shall take precedence.

2 Normative references

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

IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*

IEC 60079-7, *Explosive atmospheres – Part 7: Equipment protection by increased safety “e”*

IEC 60079-11, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety “i”*

IEC 60079-15, *Explosive atmospheres – Part 15: Equipment protection by type of protection "n"*

IEC 60079-26, *Explosive atmospheres – Part 26: Equipment with equipment protection level (EPL) Ga*

IEC 60079-31, *Explosive atmospheres – Part 31: Equipment dust ignition protection by enclosures “t”*

IEC 60127 (all parts), *Miniature fuses*

IEC 60243-1, *Electrical strength of insulating material – Test methods – Part 1: Tests at power frequencies*

IEC 60691, *Thermal-links – Requirements and application guide*

IEC 60730-2-9, *Automatic electrical controls for household and similar use – Part 2-9: Particular requirements for temperature sensing controls*

IEC 60738-1, *Thermistors – Directly heated positive temperature coefficient – Part 1: Generic specification*

IEC 61241-11, *Electrical apparatus for use in the presence of combustible dust – Part 11: Protection by intrinsic safety 'iD'*

IEC 61558-2-6, *Safety of power transformers, power supply units and similar – Part 2: Particular requirements for safety isolating transformers for general use*

IEC 62326-4-1, *Printed boards – Part 4: Rigid multilayer printed boards with interlayer connections – Sectional specification – Section 1: Capability detail specification – Performance levels A, B and C*

ISO 62, *Plastics – Determination of water absorption*

ANSI/UL 248-1, *Standard for low-voltage fuses – Part 1: General requirements*

ANSI/UL 746B, *Standard for polymeric materials – Long term property evaluations*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-0 and the following definitions specific to encapsulation "m" apply.

NOTE Additional definitions applicable to explosive atmospheres can be found in IEC 60050-426.

3.1
encapsulation "m"
type of protection whereby parts that are capable of igniting an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way as to avoid ignition of a dust layer or explosive atmosphere under operating or installation conditions

3.2
compounds
any thermosetting, thermoplastic, epoxy resin or elastomeric materials with or without fillers and/or additives, in their solid state

3.3
temperature range of the compound
range of temperatures within which, the properties of the compound, in either operation or storage, permit compliance with the requirements of this standard

3.4
continuous operating temperature (COT) of the compound
temperature range within which, according to the details given by the manufacturer, the properties of the compound, during operation, satisfy the requirements of this standard on a permanent basis during the foreseen lifetime of the equipment

3.5
encapsulation
process of applying the compound to enclose any electrical device(s) by suitable means

3.6
free surface
compound surface exposed to the explosive atmospheres and/or dust layers

3.7
normal operation
operation of equipment conforming electrically and mechanically with its design specification and used within the limits specified by the manufacturer

NOTE 1 The limits specified by the manufacturer may include persistent operational conditions, for example operation of a motor on a duty cycle.

NOTE 2 Variation of the supply specifications within stated limits and any other operational tolerance is part of normal operation.

3.8
void
unintentional space created as a consequence of the encapsulation process

3.9
free space
intentionally created space surrounding components or space inside components

3.10
switching contact
mechanical contact, which makes and breaks an electrical circuit

3.11
adhesion
moisture, gas and dust tight permanent bonding of a compound to a surface

3.12
countable fault
fault, which occurs in parts of electrical equipment conforming to the constructional requirements

3.13
infallible separation or insulation
separation or insulation between electrically conductive parts that is considered as not subject to short circuits as specified in IEC 60079-18. The probability of such fault modes occurring in service or storage is considered to be so low that they are not to be taken into account

3.14
non-countable fault
fault, which occurs in parts of electrical equipment not conforming to the constructional requirements of IEC 60079-18

3.15
solid insulation
insulation material, which is extruded or moulded, but not poured

NOTE Insulators fabricated from two or more pieces of electrical insulating material, which are solidly bonded together may be considered as solid. Varnish and similar coatings are not considered to be solid insulation.

4 General

4.1 Level of protection (Equipment protection level (EPL))

Electrical equipment with encapsulation “m” shall be either

a) level of protection “ma” (EPL “Ma, Ga, Da”),

b) level of protection “mb” (EPL “Mb, Gb, Db”) or in

c) level of protection “mc” (EPL “Gc, Dc”).

The requirements of this standard shall apply to all levels of protection “m” (EPL`s) unless otherwise stated.

4.2 Additional requirements for level of protection “ma”

The working voltage at any point in the circuit shall not exceed 1 kV.

Components without additional protection shall be used only if they cannot damage the encapsulation mechanically or thermally in the case of any specified fault.

Alternatively, where a fault of an internal component may lead to failure of the encapsulation “m” due to increasing temperature, the requirements of 7.9 shall apply.

4.3 Rated voltage and prospective short circuit current

The rated voltage and the prospective short circuit current shall be specified such that the limiting temperature is not exceeded for the relevant level of protection “ma”, “mb” or “mc”.

5 Requirements for compounds

5.1 General

The documentation shall specify the compound(s) used and the processing method(s).

As a minimum, those properties of the compound(s) on which the encapsulation “m” depends shall be provided.

NOTE Due consideration should be given in the selection of compounds to allow for the expansion of components during operation and in the event of allowable faults.

5.2 Specification

The specification for the compound shall include the following:

a) the name and address of the manufacturer of the compound,

b) the exact and complete reference of the compound and if relevant, percentage of fillers and any other additives, the mixture ratios and the type designation,

c) if applicable, any treatment of the surface of the compound(s), for example varnishing,

d) if applicable, to obtain correct adhesion of the compound to a component, any requirement for pre-treating of the component for example cleaning, etching,

e) the dielectric strength in accordance with IEC 60243-1 at the maximum temperature of the equipment determined according to 8.2.2 if available. If not available, the requirements of 5.3.2 shall be applied,

f) temperature range of the compound(s) (continuous operating temperature),

g) in the case of “m” equipment where the compound is part of the external enclosure, the temperature index TI value as defined by IEC 60079-0. As an alternative to the TI, the

relative thermal index (RTI-mechanical impact) may be determined in accordance with ANSI/UL 746B,

h) the colour of the compound used for the test samples, where the compound specification will be influenced by changing the colour.

NOTE It is not a requirement of this standard that conformity to the manufacturer's specification of the compound needs to be verified.

5.3 Properties of the compound

5.3.1 Water absorption

If the equipment is to be exposed to dampness, the compound shall be tested in accordance with 8.1.1. If this test is not performed, the equipment shall be marked "X" in accordance with the marking requirements of IEC 60079-0 and the restriction of use to dry environments clarified in the instructions.

5.3.2 Dielectric strength

Where the dielectric strength according to IEC 60243-1 is not available at the maximum temperature of the equipment as defined according to 8.2.2, see 5.2 e), a test shall be performed in accordance with 8.1.2.

6 Temperatures

6.1 General

The maximum value of the continuous operating temperature of the compound shall not be exceeded under normal operation. The maximum surface temperature, determined in accordance with IEC 60079-0 shall not be exceeded under normal operation and under fault conditions as defined in 7.2.1. The "m" equipment shall be protected in such a way that the encapsulation "m" is not adversely affected under these fault conditions.

NOTE Normal operation includes operation at the extremes of voltage tolerances of the supply normally 90 % to 110 % if not otherwise specified.

6.2 Determination of the limiting temperature

6.2.1 Maximum surface temperature

The maximum surface temperature shall be determined using the test method given in 8.2.2 in accordance with the supply conditions specified in 4.3. This temperature shall be used to determine the temperature class for explosive gas atmosphere or the maximum surface temperature in degrees Celsius for explosive dust atmosphere of the equipment.

6.2.2 Temperature of the compound

The hottest component(s) shall be determined. The maximum temperature in the compound, adjacent to the hottest component(s), shall be determined using the test method given in 8.2.2 for normal operation.

As an alternative the determination of the temperature of the hottest component may be done by calculation, manufacturer's specification or by a practical test prior to encapsulating the components.

6.3 Temperature limitation

Where the equipment may be subject to fault in accordance with 7.2.1, or where there is the possibility of an increased temperature, for example by an unfavourable input voltage in accordance with 7.2.1 or an unfavourable load, this shall be taken into account in determining the limiting temperatures.

When a protective device is required to limit temperatures for safety reasons, it shall be an internal or external, electrical or thermal device, as defined in 7.9.

7 Constructional requirements

7.1 General

Where the compound forms part of the external enclosure it shall comply with the requirements of IEC 60079-0 for non metallic enclosures and parts of non metallic enclosures.

If the surface of the compound is totally or partly surrounded by an enclosure and the enclosure is part of the protection, the enclosure or parts of the enclosure shall comply with the enclosure requirements of IEC 60079-0

If additional protective measures are required to be provided by the user in order to satisfy the requirements of this standard, for example, additional mechanical protection, to indicate this specific condition of use the equipment shall be in accordance with the "specific conditions of use" marking requirements of IEC 60079-0.

Appropriate action shall be taken to accommodate the expansion of components during normal operation and in the event of faults according to 7.2.

In 7.2 to 7.9 the requirements differ according to whether the compound adheres to the enclosure. Where adhesion is specified, the aim is to prevent the ingress of explosive atmospheres and moisture at the boundary surfaces (for example enclosure-compound, compound-parts that are not completely embedded in the compound, such as printed wiring boards, connection terminals, etc.). Where adhesion is required to maintain the type of protection, it shall be maintained after completion of all the prescribed tests.

NOTE The choice of the compound(s) to be used for a specific application is dependent on the task each compound has to perform. In general, testing a compound once is not sufficient for universal use for encapsulation "m".

7.2 Determination of faults

7.2.1 Fault examination

The encapsulation "m" shall not be invalidated even under the most adverse input rating, but between 90 % and 110 % of the rating and most adverse output load and up to two internal countable faults for level of protection "ma", and up to one internal countable fault for level of protection "mb.

No faults are taken into account for level of protection "mc".

NOTE Examples of faults are: a short circuit in any component; the failure of any component and a fault in the printed wiring board.

Components meeting the requirements of 7.2.2 are not considered to fail and infallible separation distances shall only be considered to fail in accordance with 7.2.4.

The failure of some components may result in an unstable condition, for example, alternating between high and low resistance. In those cases, the most onerous condition shall be considered.

If a fault leads to one or more subsequent faults, for example, due to the overload of a component, the primary and subsequent fault(s) shall be considered to be a single fault.

7.2.2 Components considered as not subject to fail

For levels of protection “ma” and “mb” the following components shall be considered as not to fail if they are encapsulated according to the requirements of this standard, if they are suitable for the service temperature and if they are not operated at more than 2/3 of their rated voltage, rated current or rated power specified by the manufacturer of the respective component:

– resistors, if they comply with the current limiting resistors of IEC 60079-11,
– single-layer, spirally wound coils,
– plastic foil capacitors,
– paper capacitors,
– ceramic capacitors,
– shunt semiconductors, if they are used in accordance with the shunt safety assemblies of IEC 60079-11,
– series semiconductor devices used to limit current:
  – a single device is adequate for level of protection “mb”
  – two devices shall be used for level of protection “ma”.

For levels of protection “ma” and “mb” coils, motor windings and transformers that comply with IEC 60079-7, including also those that have wire diameters of less than 0,25 mm shall be considered as not subject to failure if they are encapsulated according to the requirements of this standard.

7.2.3 Isolating components

The following components for the segregation of different circuits shall be considered to provide isolation and are not considered to fail across the segregation:

- optocouplers and relays, if the rated insulation voltage conforms to $2U$ + 1 000 V r.m.s. $^{+5}_{0}$ % or 1 500 V r.m.s. whichever is greater (U is the sum of the rated r.m.s. voltages of both circuits);
- transformers, complying with IEC 61558-2-6 or IEC 60079-11.

7.2.4 Infallible separation distances

It is not necessary to consider the possibility of a fault occurring as described in 7.2.1 in respect of voltage breakdown, if the distances between bare current-carrying parts

– of the same circuit, or
– of a circuit and earthed metal parts, or
– of two separate circuits (sum of the working voltages shall be taken as the voltage for Table 1; where one of the working voltages is less than 20 % of the other, it shall be ignored),

comply with the requirements of 7.2.4.1 and if applicable 7.2.4.2.

7.2.4.1 Distances through the compound

Distances through compound shall be considered to be infallible against short circuit for level of protection “ma” and level of protection “mb” if they comply with the values in Table 1, provided that the distances in the compound are fixed or secured mechanically before encapsulation.

Distances between the minimum distances given for level of protection “mc” and the infallible distances given for level of protection “ma” and “mb” are not considered infallible and shall be

assessed as a “countable fault”. Distances less than those given for level of protection “mc” are considered as short-circuits if this impairs the type of protection “m”.

For level of protection “mc” the values of Table 1 are the constructional requirements and may be achieved by mechanically fixing before encapsulation.

Table 1 – Distances through the compound

Voltage *U* r.m.s. or d.c. (see note) V	**Minimum distance** mm		
	“ma”	“mb ”	“mc ”
≤32	0,5	0,5	0,2
≤63	0,5	0,5	0,3
≤400	1	1	0,6
≤500	1,5	1,5	0,8
≤630	2	2	0,9
≤1 000	2,5	2,5	1,7
≤1 600	-	4	4
≤3 200	-	7	7
≤6 300	-	12	12
≤10 000	-	20	20
NOTE Voltages shown are derived from IEC 60664-1. For all voltages, the actual voltage may exceed the value given in the table by up to 10 %. This is based on the rationalisation of supply voltages given in Table F.3b of IEC 60664-1.			

7.2.4.2 Distances through solid insulation

The distance through solid insulation, on which the type of protection “m” depends, shall be at least 0,1 mm and shall comply with the dielectric strength test of 8.2.4.

7.3 Free space in the encapsulation

7.3.1 Group III “m” equipment

The compound shall be free of voids.

The sum of the free spaces is not limited, but the volume of each individual free space is limited to 100 cm^3. The thickness of the compound surrounding such free spaces shall meet the requirements of Table 2.

Table 2 – Minimum thickness of compound adjacent to free space for Group III “m” equipment

Level of protection	**Minimum thickness of compound adjacent to free space to:**	**Free space ≤ 1 cm^3**	**Free space > 1 cm^3 ≤ 100 cm^3**
“ma”	Free space or free surface	3 mm	3 mm
	Non-metallic or metal enclosure with adhesion	3 mm (enclosure + compound)[a]	3 mm (enclosure + compound)[a]
	Non-metallic or metal enclosure without adhesion	3 mm	3 mm