

Technical Report for ATEX Solenoid Coil Classification

1. Report Overview

This report is based on EU ATEX Directive 2014/34/EU and international standard series IEC 60079. It systematically describes the ATEX classification system, protection types, parameter definitions and selection criteria for explosion-proof industrial solenoid coils. It is applicable for solenoid coil selection, equipment certification, site compliance audit and technical training in hazardous areas such as petrochemical, chemical, pharmaceutical and oil-gas industries.

Applicable object: Explosion-proof industrial solenoid coils & solenoid valve actuators

Compliance reference: EU ATEX Equipment Directive, IEC international explosion-proof standards

2. ATEX Equipment Group Classification

ATEX divides explosion-proof equipment into two groups according to application risk. Most industrial solenoid coils belong to Group II.

2.1 Group I

For underground mining applications with methane and coal-dust hazard. Requirements are extremely stringent and rarely applied to general-purpose solenoid coils.

2.2 Group II

For surface-based general industrial hazardous locations with gas, vapour or mist hazard. The vast majority of commercial ATEX solenoid coils fall under Group II, which is the main scope of this report.

3. Category vs Hazardous Zone Mapping

ATEX defines hazardous zones based on frequency and duration of explosive atmosphere, corresponding to equipment categories and Equipment Protection Level (EPL), separated for Gas(G) and Dust(D).

Category	Gas Zone	Dust Zone	EPL	Description
1G / 1D	Zone 0	Zone 20	Ga / Da	Very high protection; explosive atmosphere continuous / frequent
2G / 2D	Zone 1	Zone 21	Gb / Db	High protection; atmosphere likely under normal operation, most common for coils
3G / 3D	Zone 2	Zone 22	Gc / Dc	Enhanced protection; atmosphere occurs rarely and for short duration

Practical note: 2G covers Zone1 & Zone2; 3G is for Zone2 only.

4. Main Protection Types for ATEX Coils

Solenoid coils adopt different explosion-proof principles: intrinsically-safe, encapsulation and flame-proof for various power ratings and conditions.

4.1 Intrinsically safe (Ex ia / Ex ib)

Low-energy design. Energy released under normal or fault conditions cannot ignite explosive gas.

- Marking example: Ex ia IIC T6 Ga, Ex ib IIC T4 Gb
- Application: Low-voltage DC low-power coils, instrument signal coils
- Zone coverage: Ex ia for Zone0; Ex ib for Zone1
- Requirement: Must be used with certified intrinsic-safety barrier

4.2 Encapsulation (Ex mb, most widely used)

Coil windings fully potted with epoxy resin to isolate explosive atmosphere and prevent escape of spark or hot-spot. It is the dominant solution for solenoid valve coils.

- Marking example: Ex mb IIC T4 Gb
- Advantages: Compact dimension, good stability, cost-effective
- Zone coverage: Zone1, Zone21

4.3 Flame-proof enclosure (Ex d)

Robust metal housing contains internal explosion. Flame is cooled through flange gaps to prevent external ignition.

- Marking example: Ex d IIC T6 Gb
- Application: High-power solenoid coils, high-pressure equipment
- Features: Heavy and bulky housing, high protection capability
- Zone coverage: Zone1

Remark: Increased-safety Ex e is seldom applied to solenoid windings.

5. Gas Explosion Sub-group

Gas subgroups are defined by ignition sensitivity. Higher subgroup means more demanding hazard.

- IIA: Least severe, for propane, ethane
- IIB: Moderate severity, for ethylene
- IIC: Strictest requirement, for hydrogen, acetylene. IIC equipment is compatible with IIB & IIA.

6. Temperature Class (Maximum Surface Temperature)

Temperature class specifies maximum allowable surface temperature of coil housing. It must be lower than the ignition temperature of process media.

Temp. Class	Max Surface Temp.	Application Note
T1	450°C	High temperature resistant for general media
T2	300°C	General industrial service
T3	200°C	Common for general explosion-proof devices
T4	135°C	Most popular for solenoid coils, suitable for most oil-gas media
T5	100°C	Low surface temperature for sensitive media
T6	85°C	Strictest for media with very low ignition temperature

7. Full Marking Interpretation (Practical Example)

Full marking: II 2G Ex mb IIC T4 Gb; II 2D Ex tb IIIC T130°C Db IP65

Break-down:

1. II: Surface industry equipment group
2. 2G: Category 2 for gas, for Zone1 / Zone2
3. Ex mb: Encapsulation protection (mainstream for coils)
4. IIC: Suitable for high-risk gas such as hydrogen & acetylene
5. T4 Gb: Max surface temp.135°C, gas EPL Gb
6. 2D / Ex tb / IIIC / Db: Dust protection for Zone21 / Zone22
7. IP65: Ingress protection for outdoor & harsh industrial environment

8. ATEX Coil Selection Procedure

Follow below steps for safe and compliant coil selection:

1. Identify hazardous medium: gas-only, dust-only or gas-dust mixed
2. Confirm hazardous zone: Gas Zone0/1/2; Dust Zone20/21/22
3. Confirm gas subgroup: select IIC if hydrogen or acetylene is present
4. Select temperature class: T4 / T5 / T6 according to media ignition temperature
5. Select protection concept
 - Low-power signal coils → Ex ia / ib intrinsically-safe (with safety barrier)
 - Standard solenoid valve coils → Ex mb encapsulation (preferred)
 - High-power coils → Ex d flame-proof

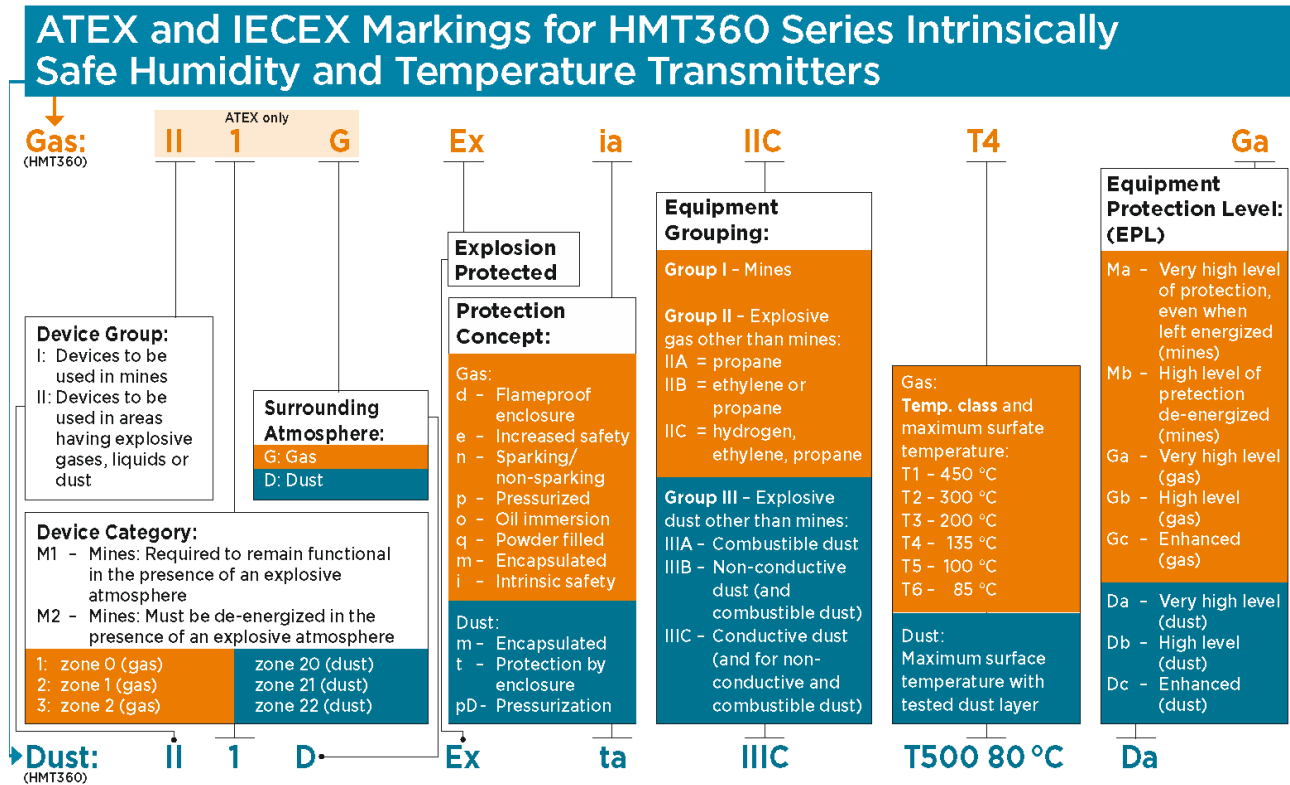
9. Conclusion

Key dimensions for ATEX solenoid coil classification are equipment group, hazardous-zone category, protection type, gas subgroup and temperature class. For general industrial applications, II 2G Ex mb IIC T4 is the most common and cost-effective specification covering most chemical, oil-gas and automation hazardous locations. Proper grade matching against site condition is required to mitigate explosion risk and satisfy ATEX and industrial safety requirements.

ATEX Marking Full Breakdown (EU Directive 2014/34/EU)

Sample full marking label: II 2G Ex db IIC T4 Gb

Reading sequence: Equipment Group → Category / Medium → Ex protection type → Gas/Dust Group → Temperature Class → Equipment Protection Level (EPL)



1. Equipment Group (I / II)

Code	Description
I	Underground mining equipment (mine gas, coal dust)
II	Surface industrial equipment (petrochemical, chemical, pharmaceutical; general plant-site explosion-proof equipment belongs to Group II)

2. ATEX Category + Medium (G / D) → Corresponding Hazardous Zones

Format: Number + G / D

- G = Gas: flammable gas, vapour, mist
- D = Dust: combustible dust, fibres
- GD = Suitable for both gas and dust atmospheres

Marking	ATEX Category	Applicable Zone	EPL Equivalent
1G	Category 1	Zone 0 (gas present continuously)	Ga
2G	Category 2	Zone 1 (gas present occasionally)	Gb
3G	Category 3	Zone 2 (gas rarely present)	Gc
1D	Category 1	Zone 20 (permanent dust cloud)	Da
2D	Category 2	Zone 21 (dust cloud occurs occasionally)	Db
3D	Category 3	Zone 22 (dust cloud occurs rarely)	Dc

Example: II 2G → Surface industrial, Category 2, gas atmosphere; suitable for Zone 1 & Zone 2

3. Ex Protection Type (Core protection concept)

Ex indicates compliance with explosion-proof standards. Suffix letters denote protection types; suffix a/b/c represent protection levels.

Code	Protection Type	Description	Applicable Zones
d	Flameproof enclosure	Enclosure withstands internal explosion; prevents flame propagation to outside	Zone1/2, EPL Gb
e	Increased safety	No spark generation under normal operation; enhanced insulation & clearances	Zone1/2, EPL Gb
ia	Intrinsic safety ia	Limits circuit energy; safe even with 2 independent faults; the only type for Zone 0	Zone0/1/2, EPL Ga
ib	Intrinsic safety ib	Safe under 1 fault condition	Zone1/2, EPL Gb
ic	Intrinsic safety ic	Safe only under normal operation	Zone2, EPL Gc
p	Pressurised enclosure	Maintains positive internal pressure to exclude hazardous gas	Zone1/2
m	Encapsulation	Ignition source embedded within resin compound	Zone1/2
n	Non-sparking	Safe only in normal operation; Zone2 dedicated	Zone2
t	Dust protection enclosure (tb/tc)	Dust-specific protection	Zone20-22

Combined marking example: Ex db eb = combined flameproof + increased-safety protection

4. Gas Group (IIA / IIB / IIC)

IIC is the highest risk rating; downward compatible with IIB and IIA. Reverse compatibility does NOT apply.

Code	Representative Substances
IIA	Propane, butane, methane
IIB	Ethylene, ethylene oxide
IIC	Hydrogen, acetylene (highest hazard)

Dust Group (Series III)

- IIIA: Combustible fibres / flyings
- IIIB: Non-conductive dust (flour, wood dust)
- IIIC: Conductive metallic dust (e.g. aluminium dust, highest dust risk)

5. Temperature Class T1~T6

Maximum permissible surface temperature of equipment, must be lower than the ignition temperature of hazardous substances.

Temperature Class	Max Surface Temperature (°C)
T1	450°C
T2	300°C
T3	200°C
T4	135°C
T5	100°C
T6	85°C

Dust-rated equipment often marks absolute temperature value e.g. T135°C Db instead of T-code.

6. EPL — Equipment Protection Level (Ga/Gb/Gc / Da/Db/Dc)

Correlates with ATEX category; almost always printed on modern labels.

- Ga / Da: Highest safety level
 - Gb / Db: High safety level
 - Gc / Dc: Standard safety level
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Full Marking Example Breakdown

II 2G Ex db IIC T4 Gb

1. II : Surface industrial equipment
2. 2G : Category 2, gas atmosphere → suitable for Zone 1, Zone 2
3. Ex db : Flameproof enclosure, EPL = b
4. IIC : Suitable for high-risk gases such as hydrogen and acetylene
5. T4 : Maximum equipment surface temperature 135°C
6. Gb : Equipment Protection Level Gb

Additional Label Information

- CE + 4-digit number: CE mark plus Notified Body identification number
- Hexagonal Ex symbol: Dedicated ATEX explosion-proof logo
- Certificate number, manufacturer, serial number, ambient temperature operating range