Understanding ATEX and IECEx Labels

The ATEX Directive 94/9/EC controls all manufacture and import of equipment for use in explosive atmospheres, including non-electrical items. ATEX requires that the equipment be safe, and bear a label indicating the conditions under which it is approved for use. All ATEX equipment must bear the CE marking. Import, sale or workplace use of equipment without ATEX approval is illegal.

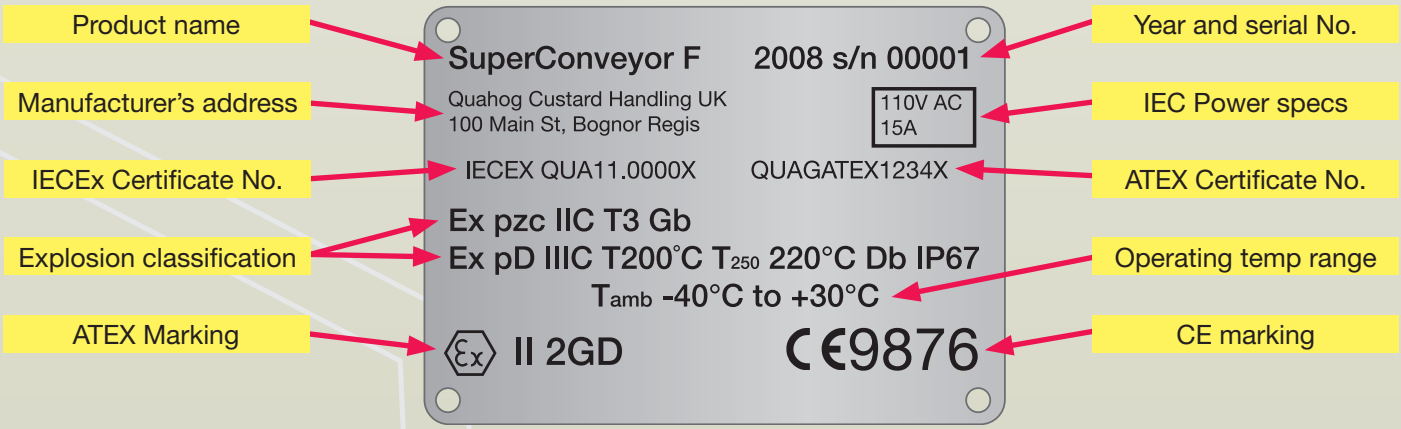
ATEX covers equipment that satisfies three criteria:

1. It must be purposely-designed for use within an explosive atmosphere at normal temperatures and pressures.
2. The atmosphere may contain gas, vapour, mist or dust as a fuel, but must be based on air as the oxidiser.
3. The equipment must have an ignition source in and of itself, such as a spark, hot surface, etc.

Because of these criteria, simple items such as hammers are not covered as they do not generate sparks in and of themselves (only when struck against another item), and some mechanical devices such as hand-operated valves are excluded under statements issued by the EEC, as they are not considered to move fast enough to generate any frictional heat sufficient to cause ignition.

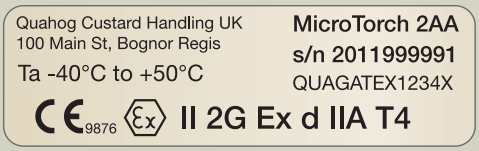
The IECEx scheme is controlled by the International Electrotechnical Commission, and covers electrical equipment for use in explosive atmospheres. IECEx uses different codes and approvals systems, but also requires detailed information on the product label. IECEx does not currently apply to non-electrical equipment.

Many modern devices will carry both ATEX and IECEx approval, and so the label will display codes and information from both schemes. Some of that information is common, some is not. A typical ATEX and IECEx label is shown below.



The minimum information on the label required by ATEX 94/9/EC is as follows:

- Name and address of the manufacturer(s) who hold the production quality assurance certificate. Where an item is manufactured in several locations as part of an assembly chain, all addresses must be shown.
- The CE marking - shall be at least 5mm in height wherever possible, and shall be followed by the serial number of the Notified Body certifying the production assurance system or type examination.
- Type or model reference, and serial number (if any).
- Year of manufacture - this may be part of the serial number, to simplify printing of labels or castings.
- The ATEX Marking - the "hexagon" symbol, immediately followed by the equipment group and category.
- Additional marking "as required for safe use" - such as the explosion classification, ambient temperature limit, supply voltage, etc. - the Directive requires this information to be shown but does not define exactly what it is, rather the various product standards (EN and IEC) will each define certain fields and symbols to display.



The ATEX groups

Immediately to the right of the official "hexagon" symbol will be the ATEX group code(s). There are two groups, I and II.

Group I (mining) is divided into two categories: M1 (the equipment will be in an energized state when the atmosphere is present) and M2 (it will be de-energized when the atmosphere is present).

For example the marking Ex **M2** indicates equipment which can be used in mines susceptible to firedamp and flammable dust, but when an explosive atmosphere is present it must be de-energized.

Group	Definition
I	The underground parts of mines, and to those parts of surface installations of mines, that are liable to be endangered by firedamp (methane) and/or combustible dust.
II	All other industries

Group II is divided into three categories, 1, 2 and 3, based on how frequently the explosive atmosphere will be present. Within the ATEX code, the permitted fuel types are shown by "G" for gases, mists and vapours, and/or "D" for flammable dusts. In the IECEx scheme we also have group III, referring to dusts in non-mining applications.

IECEx and the ATEX "Workplace" Directive 1999/92/EC also use "zones", and differentiate between gas- and dust-based fuels by prefixing the zone number with "2" if the fuel is a dust. It is important to remember that ATEX '94 category numbers are one higher than zone numbers, so "zone 0" = "category 1".

IEC & ATEX '99 Zone		ATEX '94 Category	Protection level	Description
Gases & vapours	Dusts			
0	20	1	Very high	Explosive atmospheres are present continually or for long periods or frequently.
1	21	2	High	Explosive atmospheres are likely to occur under normal operations, occasionally.
2	22	3	Normal	Explosive atmospheres are not expected to occur under normal operations. Where they do occur, it will be for a short period only.

Many products are approved for use in more than one group, or are designed for "boundary" installation (where they span a bulkhead between two zones) or "contained" installation where they are placed in an area that is different to the classification of the atmosphere they are handling—for example an extract fan may be carrying gases from a category IIA enclosure, but itself is only designed to be installed in a category IIC area. In these cases the ATEX marking will show both categories, divided by a forward slash. ***Where a device performs as an external safety device only (such as the control panel for a series of zone-0 fire detectors) but is not in and of itself approved for use in that category, the number will be shown in brackets.*** A hyphen indicates the equipment is not approved for Ex use.

The table below shows some typical examples of ATEX markings. Note how some of these examples refer to equipment which cannot be used in an EX location! The presence and position of the hyphen is all-important.

ATEX Marking	Explanation
Ex I M2	Mining equipment, category 2, for de-energized use.
Ex II 1 GD	Non-mining equipment, category 1 (zone 0), for gases and dusts
Ex II 2(1) G	Non-mining equipment, suitable for use in category 2 (zone 1) containing a safety device for connection to equipment in caegory 1 (zone 0).
Ex II (1) GD	A non-mining safety device with intrinsically-safe circuits, for use with category 1 equipment, ***but which itself cannot be installed in an EX zone***.
Ex II (2)G (1)G	A non-mining safety device which protects both category 1 and category 2 equipment, ***but which itself cannot be installed in an EX zone***.
Ex II 1/2 G	A device installed on the boundary of category 1 and 2 (zones 0 and 1).
Ex II 3/- D	A device handling dust from category 3 but which cannot be installed in an Ex zone.
Ex II -/1 G	A device handling non-explosive gas, but installed within category 1 (zone 0).

The Explosion Classification

Every product will have at least one Explosion Classification. This is a code indicating the protection concepts and approved environments in which this item can be used. Where equipment is rated for use in more than one ATEX Group, there will be an Explosion Classification for each. Where equipment has been certified under both ATEX and IECEx, there may be additional Explosion Classifications from the IECEx scheme, which are not part of the ATEX system (e.g. a classification for Group III).

The Classification begins with “Ex” or “EEx” — the latter denotes that the equipment has been certified against an EN standard, and “Ex” denotes it has been certified against an international or IEC standard.

Next will be the “protection concept”, a case-sensitive code showing what measures the equipment uses to effect safety. These codes are described on the next pages.

Next may be the Gas Group or Dust Group to which this Classification refers. See later for explanations of these.

Next is temperature class, either using a T-number for ATEX, or the temperature value in °C for IECEx (see below).

The equipment protection level (EPL) from IEC/EN 60079 is usually last in the sequence, but there may be an IP rating.

The example Explosion Classification on the right reads as follows:

EEx q IIA T5 Ga

- **EEx** — This product complies with an EN standard.
- **q** — The “protection concept” is “powder-filled”.
- **IIA** — Suitable for use with Gas Group IIA (propane).
- **T5** — Maximum surface temperature 100°C.
- **Ga** — Very high equipment protection level, will be safe even after two malfunctions. Suitable for zone 0.

Temperature classes

The maximum possible surface temperature of equipment is shown in the ATEX Explosion Classification as a “T” value, ranging from T1 to T6 in order of decreasing value (so T6 is “safer”). New in IEC 60079-0:2011 is the concept of marking a range of certified temperatures with an ellipsis, such as “**T4 ... T6**”.

Class	Max surface temp
T1	450 °C
T2	300 °C
T3	200 °C
T4	135 °C
T5	100 °C
T6	85 °C

Under IECEx, the maximum possible surface temperature is printed as a real value in °C, so the code may be “**T200°C**” rather than “**T3**”. For dust-based atmospheres, the IECEx sequence will also show the maximum surface temperature in °C with a certain covering of dust. For example the code “**T250 300°C**” means that with a 250 millimetre covering of dust, the maximum surface temperature of the equipment is 300°C.

When selecting equipment, it is crucial that the self-ignition temperature of the fuel is significantly-above the maximum possible surface temperature. As the surface temperature and performance of equipment will depend on the external (ambient) temperature, the permitted ambient temperature range is also usually shown on the ATEX product label. ***Where it is not shown, the assumed range is -20°C to +40°C.***

Equipment Protection Level (EPL)

ATEX has an absolute approach to the selection of equipment, so a device approved for Category 2 (zone 1) is always considered suitable for that application. Under IECEx, users should take a risk assessment approach, and while the base classification of the equipment is important, there may be situations where a safer device is required (for example when the consequences of an explosion are so severe they cannot be accepted, even rarely). It is also possible in exceptional situations that a device with a lower safety classification may be appropriate.

IECEx defines three levels of equipment protection, a, b and c — the EPL code prefixes them with “M” for mines, “G” for gases or “D” for dusts. Level “c” is for surface industries only - only “Ma” and “Mb” are permitted.

Some protection concept codes include the EPL — for example the Intrinsic Safety protection concept codes are “ia”, “ib” and “ic”, referring to EPLs a, b and c respectively. In these cases there is no requirement to mark the EPL as a separate part of the Explosion Classification, so “Ex ia IIA Ga T5” and “Ex ia IIA T5” are identical.

EPL	Definition	Recommended for
a	“Very high” protection - safe after two consecutive malfunctions	M1, M2, 1GD, 2GD, 3GD
b	“High” protection - safe after one malfunction	M2, 2GD, 3GD
c	“Normal” protection - safe under normal operating conditions	3GD (surface use only)

IP Protection rating

The “Ingress Protection” rating defined in IEC/EN 60529 is a measure of the resistance of an enclosure to penetration by dust or liquid, and is not specifically an Ex concept. Several of the EN/IEC standards do require the IP rating to be shown as part of the Explosion Classification, **but having an IP rating in and of itself is not proof the equipment is safe to use in an explosive atmosphere**. Note that the IP rating system considers ingress which is “harmful”, so an IPx8 product may still show some ingress of water when submersed, but not enough to cause any malfunction.

Digit	First digit - against solid bodies	Second digit - against liquids
0	NO PROTECTION	NO PROTECTION
1	Objects > 50mm	Vertical (90°) dripping water (showerproof)
2	Objects > 12mm	70° to 90° dripping water (rainproof)
3	Objects > 2.5mm	Sprayed water up to 60° from vertical
4	Objects > 1mm	Splashed water from any direction
5	Dust-protected (minor ingress)	Jets of water from any angle, hose diameter 6.3mm
6	Dust-tight (no ingress)	Heavy jets from any angle, hose diameter 12.5mm
7		Immersion to a depth of 100cm
8		Submersion to a specified death over 100cm

IEC/ATEX protection concepts for electrical equipment

Where equipment contains electrical circuitry, there are a number of ways to prevent sparks, heat or short-circuits from causing ignition of the explosive atmosphere. Broadly-speaking they take three approaches - sealing the enclosure to prevent the fuel entering; filling the enclosure with a material which acts as a barrier (a powder, liquid, solid or pressurized inert gas); or reducing the energy carried by the circuits to a point where sparks and arcs cannot transfer enough energy to ignite the atmosphere (a method called "intrinsic safety"). Intrinsic safety is the only electrical protection concept approved for use in zone 0.

These protection concepts are defined in the multipart IEC/EN 60079 standard, and each is suitable for certain zones and fuel types. How they work are explained on the next page.

Protection code		Concept	Suitable for IEC zones	
Gas	Dust		Gas	Dust
Ex d		Flameproof	1	
	Ex ta	Enclosed		20
	Ex tb			21
	Ex tc			22
Ex pxb	Ex pD	Pressurized	1	21 / 22
Ex pyb	Ex pD		1	21 / 22
Ex pzb	Ex pD		2	21 / 22
Ex q		Powder-filled	1	
Ex o		Oil-filled	1	
Ex e		Increased safety	1	
Ex ia	Ex ia	Intrinsic safety	0	20
Ex ib	Ex ib		1	21
Ex ic	Ex ic		2	22
Ex nA		Non-sparking	2	
Ex nR		Restricted breathing	2	
Ex nL		Energy-limited	2	
Ex nC		Enclosed break	2	
Ex ma	Ex ma	Encapsulation	0	20
Ex mb	Ex mb		1	21
Ex mc	Ex mc		2	22
Ex s	Ex s	"Special" - now obsolete	varies	varies

ATEX protection concepts for mechanical equipment

Code	Concept
fr	Flow restriction
d	Flameproof
c	Constructional safety
b	Control of ignition sources
k	Liquid immersion
g	Inherent safety*
p	Pressurization*

ATEX covers nonelectrical equipment where it has the potential to generate ignition, by heat or the creation of a nonelectrical spark (such as in a flint cigarette lighter). The mechanical protection concept is based on an assessment of risk, and the number of protection concepts varies, so in a situation where the equipment must be safe both in normal operation and in the event of a malfunction, at least two protection concepts must be applied (as the "malfunction" could be the failure of the primary protection concept!).

Mechanical protection concepts are defined in the multipart EN 13463 standard. They are not fuel-specific. There is no IECEx standard, as IEC only covers electrical equipment.

Protection concepts explained

Protection Concept	Gas / Dust	Method of protection
Flameproof	G	The enclosure can withstand an internal explosion without rupturing, but internal explosions are still possible. The fuel is able to enter the enclosure.
Enclosed	D	The enclosure is sealed to prevent ingress of dust, and has a surface temperature below the self-ignition value of the dust. The enclosure is not necessarily gas-tight and so is not suitable for dusts which emit flammable gases on heating.
Pressurized	GD	The enclosure is maintained at higher than atmospheric pressure, using an inert gas. The fuel is not able to enter the enclosure.
Powder-filled	G	The circuitry is fully-immersed in a non-conductive powder. The fuel is able to enter the enclosure
Oil-filled	G	The circuitry is fully-immersed in a non-conductive oil. The fuel is able to enter the enclosure but does not mix with the oil.
Increased Safety	G	Safety measures are used so as to reduce the probability of an internal source of ignition (spark, hot surface, etc.) in normal operation, though they may occur during malfunctions. The fuel is able to enter the enclosure.
Intrinsic Safety	GD	During normal operation and specified fault conditions, the circuitry cannot discharge sufficient energy into a spark or thermal event to cause ignition of the fuel. The fuel is able to enter the enclosure.
Encapsulation	GD	The enclosure is filled with a solid resin or polymer. The fuel is not able to enter the enclosure.
Flow restriction	GD	The enclosure is protected by seals, though there is some leakage through the seals as the internal temperature and pressure vary in normal use. The fuel is able to enter the enclosure.
Constructional safety	GD	The mechanical parts of the equipment must be designed so as to prevent any sparks or thermal ignition sources from being created, by selection of materials and operating speeds. Only applies to mechanical equipment with moving parts.
Control of ignition sources	GD	Ignition sources are not present in normal operation, though may occur during malfunctions. Systems are in place to detect any such malfunction and prevent the ignition arising.
Liquid immersion	GD	The equipment within the enclosure is immersed in an inert liquid, isolating any ignition sources and cooling the components (e.g. a gearbox), though the enclosure may not be totally filled. The fuel is able to enter the enclosure.
Inherent safety	GD	The mechanical components have sufficiently-low potential energy as to prevent the formation of an ignition source. The fuel is able to enter the enclosure.

* Mechanical protection concepts “g” and “p” are recent introductions, and at the time of writing their associated EN standards remain provisional.

Gas groups

ATEX defines four groups of gases, based on how easily-ignitable they are (by a flame or spark; not via self-ignition). In Group I (mining) there is only one gas group, namely methane (aka "firedamp"). Group I equipment has no concept of a temperature class.

For each non-mining gas group there is a "test gas" used as the reference standard, though each contains many gases, which will have a different self-ignition temperature and a range of explosive concentrations. Common gases are defined in EN 60079-20 and some examples are shown in the table on the right.

Groups IIA, IIB and IIC are in increasing order of sensitivity to ignition sources, so equipment designed for use in gas group IIB is also safe to use in the less-ignitable gas group IIA, and equipment designed for use in gas group IIC can be used with gas groups IIA, IIB and IIC.

Equipment designed for gas group IIB may, on occasion, be certified for a specific gas from group IIC without having full gas group IIC approval. In this case, the chemical name or formula of the additional gas will be shown, for example " IIB + C_2H_2 " means the equipment is rated for gas group IIB, and is also rated for acetylene.

Gas Group	Test gas	Common gases and their temperature class
I (mining)	Methane	Methane (aka firedamp)
IIA	Propane	acetone - T1 petroleum fuel - T1 ammonia - T1 ethane - T1 methanol - T1 carbon monoxide - T1 propane - T1 n-butane - T2 ethanol - T2 diesel fuel- T3 kerosene - T3 avgas fuel - T3 ethyl nitrite - T6
IIB	Ethylene	coal gas - T1 ethylene - T2 ethyl oxide - T2 hydrogen sulphide - T3
IIIC	Hydrogen	hydrogen - T1 acetylene - T2 carbon disulphide - T6

Gas groups are only of importance when the protection concept used by a piece of equipment is related to the ignitability of the fuel — for example intrinsically-safe "Ex i" protection needs to know the minimum energy of a spark that could lead to ignition. Encapsulated "Ex m" equipment cannot expose the fuel to any source of ignition, and so does not need to refer to a gas group in the code sequence.

Dust groups

IEC 60079-0:2007 defines the new atmosphere group III for explosive dusts in surface industries (i.e. ATEX group II). There are three "dust groups" in the standard, defined by the properties of the dust:

Dust Group	Type	Characteristics
IIIA	Combustible flyings	Flammable particles of 500µm or less which can be suspended in air, can settle out under gravity, and can form an explosive mixture with air. Examples include starch and cotton.
IIIB	Non-conductive dust	Flammable dust with a resistivity greater than 10^3 Ohm-metres
IIIC	Conductive dust	Flammable dust with a resistivity less than 10^3 Ohm-metres

The self-ignition temperature of a dust suspended in the air is usually higher than the same dust accumulated on a surface. When selecting equipment for use in dusty environments, the surface temperature of the equipment should not exceed 66% of the suspended self-ignition temperature, and should be at least 75°C below the self-ignition temperature of a 5mm accumulated layer of the dust.

For example, cotton has self-ignition temperatures of 560°C (suspended) and 350°C (accumulated). Your equipment's maximum surface temperature must be less than 373°C (suspended) and 275°C (accumulated), so the limit is 275°C. Equipment classified T3 (200°C) is acceptable, but T2 (300°C) is not.