BS EN 60952-2:2013

BSI Standards Publication

Aircraft batteries

Part 2: Design and construction requirements

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National foreword

This British Standard is the UK implementation of EN 60952-2:2013. It is identical to IEC 60952-2:2013. It supersedes BS EN 60952-2:2004, which will be withdrawn on 13 August 2016.

The UK participation in its preparation was entrusted to Technical Committee PEL/21, Secondary cells and batteries.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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English version

Aircraft batteries - Part 2: Design and construction requirements
(IEC 60952-2:2013)

Batteries d'aéronefs -
Partie 2: Exigences de conception et de construction
(CEI 60952-2:2013)

Flugzeugbatterien -
Teil 2: Anforderungen für Planung und Konstruktion
(IEC 60952-2:2013)

This European Standard was approved by CENELEC on 2013-08-13. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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CENELEC

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

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Ref. No. EN 60952-2:2013 E

Foreword

The text of document 21/804/FDIS, future edition 3 of IEC 60952-2, prepared by IEC/TC 21 "Secondary cells and batteries" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60952-2:2013.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2014-05-13
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-08-13

This document supersedes EN 60952-2:2004.

EN 60952-2:2013 includes the following significant technical changes with respect to EN 60952-2:2004:

The inclusion of those formats that can be standardized along with their connectors and electrical interfaces.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60952-2:2013 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60952-1	2013	Aircraft batteries - Part 1: General test requirements and performance levels	EN 60952-1	2013

CONTENTS

AIRCRAFT BATTERIES –

Part 2: Design and construction requirements

1 Scope

This part of IEC 60952 series defines the physical design, construction and material requirements for nickel-cadmium and lead-acid aircraft batteries containing vented or valve-regulated cells or monoblocs. The batteries are used for both general purposes and specific aerospace applications.

The specific topics addressed in this part serve to establish acceptable quality standards required to qualify a battery as airworthy as defined in Clause 3 of IEC 60952-1:2013.

A preferred range of aircraft batteries is specified in Annex A, but this part of IEC 60952 series may be used for other battery sizes, arrangements and ratings. For particular applications, other design requirements may be stipulated. These will be in addition to the requirements of this part and will be covered by specific documents.

It is recognised that additional data may be required by other organisations (national standards bodies, AECMA, SAE, etc.). The present standard can be used as a framework to devise tests for generation of the required data.

2 Normative references

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

IEC 60952-1:2013, *Aircraft batteries – Part 1: General test requirements and performance levels*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60952-1:2013 apply.

4 General construction requirements

4.1 General

Batteries complying with this standard shall be capable of meeting the requirements of IEC 60952-1 upon commissioning in accordance with manufacturer instructions or as specified in the product specification. Batteries designed for utilisation in the aerospace environment shall be sufficiently robust and shall withstand the rigors of normal application, handling, manoeuvres and the full range of operating conditions permitted for the aircraft concerned.

Proper integration of nickel-cadmium, and lead-acid batteries into aviation-related equipment requires cooperation between the battery supplier, aircraft designer, and the avionic equipment designer. Only through this cooperative exchange of the aircraft performance requirements and the battery's capabilities and limitations can an effective pairing of aircraft, avionics equipment and battery be realised.

Overall, the stated requirements and guidelines contained in this document are generic in nature, and serve only as a baseline for the design and test for specific battery and equipment pairings.

Below are general requirements pertinent to the safety, quality control, configuration control, qualification, storage, shipping, and disposal of nickel-cadmium, nickel metal-hydride, and lead-acid aircraft batteries.

4.2 Safety

Safety is the prime consideration in the use of nickel-cadmium, and lead acid batteries on aircrafts. The training of installers, end users and personnel involved in the assembly, handling, installation, maintenance and disposal of nickel-cadmium, nickel metal hydride, and lead-acid batteries with respect to their special characteristics is a necessary safety element.

Extreme care shall be taken in the handling, shipping, and storage of nickel-cadmium, nickel metal-hydride, and lead-acid aircraft batteries. Safety concerns include the possibility of fire, explosion, and corrosive nature of the electrolyte and the venting of toxic or flammable gases.

The battery shall be constructed so as to avoid the occurrence of short-circuiting of the battery and its components.

Terminals of batteries should be covered with non-conductive protection to avoid possibility of shorting during handling, shipping, and storage.

The battery shall be constructed such that there will be no ignition source inside the battery sufficient to cause ignition of hydrogen/oxygen mixtures in the event of failure of the venting system. All auxiliary equipment such as thermal sensors, thermostats, heaters and switching devices shall be so designed that they cannot be the source of an explosion. The current-carrying components of the battery shall be dimensioned and constructed so as to provide no ignition source under any external short circuit conditions.

The battery shall be so constructed that any debris due to any internal explosion failure shall be contained within the casing.

The battery should be constructed of materials that, in the absence of externally supplied energy, will not support combustion.

4.3 Safety philosophy

Aircraft designers must ensure that operational parameters and the environment in which the battery is to be used are not more severe than that to which it has been designed and tested. Operation at discharge rates and temperatures exceeding design limits, improper maintenance, and improper storage may result in dangerous battery failure. Additionally, the improper application of batteries may compromise the safety of the aircraft by it not being capable of delivering adequate power during an emergency to support aircraft essential loads for the design duration.

Nickel-cadmium, nickel metal-hydride, and lead-acid batteries and the aircraft equipment for which they are the power source must be designed such that no single failure in either can cause a safety hazard to the passengers or crew of the aircraft.

4.4 Factors influencing safety

The battery application and design should be such to avoid the occurrence of short-circuiting of the battery and its components. The battery shall be constructed to minimise ignition sources inside the battery. The battery should be constructed of self-extinguishing materials.

Installers and users of nickel-cadmium, nickel metal-hydride, and lead-acid batteries must be informed that cells and batteries other than those authorized/approved for a particular application shall not be substituted even though they may be of the same physical dimensions, capacity, and voltage.

Safe use of nickel-cadmium, nickel metal-hydride, and lead-acid batteries involves more than battery selection and testing. Other design and operation factors can have a similar impact on safe use. For example:

a) Multiple batteries – In general, the use of a single battery is preferred over the use of a number of batteries in series and/or parallel. However, in many aircraft applications due to either handling requirements (weight) or space restriction, separation into more than one battery case may be necessary.
b) Mixing of cells or batteries – Mixing of cells or batteries from different manufacturers is not an acceptable practice. Cells or batteries of different capacities in series connection will result in the lower capacity battery(ies) being driven into deep discharge (forced discharge). Cells or batteries may have different capacities on account of their differences in design, manufacturing process, storage, use, age or history. Therefore, mixing cells or batteries with different part numbers, made by different manufacturers or from different sources, shall not be allowed. Refer to the OEM maintenance manuals for proper replacement of each manufacturer's cells within a battery.
c) Battery polarity – Installing one or more batteries incorrectly, with the battery output terminals reversed, will result in the reversed battery being charged by other batteries in the circuit during discharge and discharged by the charging system during charge.
d) Exposed terminals – Batteries should be designed and/or packaged in such a way as to prevent short circuits, and assure proper battery installation. Leaving battery output terminals or leads exposed may result in external short-circuiting of the battery during shipping, handling, testing and installation. Terminals of batteries should be covered with non-conductive protective device to avoid any possibility of shorting during handling, shipping, and storage. Aircraft vibration and/or contact oxidation may result in poor electrical connections. Proper connector design and maintenance procedures are necessary.
e) High terminal voltage – Batteries supplying 50 V or above present a personal safety hazard due to the possibility of lethal shock and shall be labelled to clearly indicate the hazard.

4.5 Regulatory information[1]

Regulation of equipment installed in aircraft, and component parts of that equipment, are the responsibility of the Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA). In the case of equipment installed in aircraft at the time of manufacture of the aircraft, the aircraft's Type Certificate (TC) specifies the approved aircraft type design including any battery equipment. Amendments, Supplemental Type Certificates (STC) and Part Manufacturer Approval (PMA) may be approved subsequent to the original issue of a TC. It is also possible to obtain FAA regional or field approval for modification or addition of equipment mounted in aircraft. It is to note that although PMA is acceptable for a complete OEM battery replacement, it is not acceptable for individual cells.

1 This subclause is non-normative and is added for information only.

The distinction should be made based on whether equipment containing nickel-cadmium, nickel metal-hydride, and lead-acid batteries are installed as part of the aircraft's equipment or are carried as cargo: in the former case, the FAA regulates, and in the latter case, regulation is by the Office of Hazardous Materials Transportation.

The following references apply:

Title 14 Code of Federal Regulations for Aeronautics and Space, I, I, I-59 Federal Aviation Administration, Department of Transportation

Part 23 Airworthiness Standards: Normal Utility, Acrobatic, and commuter category Airplanes Section 23-1301 Function and installation, 23-1309 Equipment, systems, and installations, and 23-1353 Electrical equipment and installations including Advisory Circular 23.1309-1C

Part 25 Airworthiness Standards: Transport Category Airplanes Sect ion 25-1301 Function and installation, 25-1309 Equipment, systems, and installations, and 25-1353 Electrical equipment and installations including Advisory Circular 25. 1309-IA

Part 27 Airworthiness Standards: Normal Category Rotorcraft Section 27-1301 Function and installation, 27-1309 Equipment, systems, and installations, and 27-1353 Electrical equipment and installations including Advisory Circular 27 – IA

Part 29 Airworthiness Standards: Transport Category Rotorcraft Section 29-1301 Function and installation, 29-1309 Equipment, systems, and installations, and 29-1353 Electrical equipment and installations including Advisory Circular 29 – 2C

Part 21 Certification Procedures for Products and Parts Section 21.303 – Replacement and Modification Parts Section 21.143 – Quality Control Data Requirement – Prime Manufacturer

4.6 Configuration control

After qualification, the manufacturer shall maintain configuration control on all parts, processes and materials to ensure consistent performance. All design changes shall be processed in accordance with 14 Code of Federal Regulation (CFR) 21.611.

Change is deemed as any modification to:

a) drawing lists,
b) outline drawings,
c) manufacturing drawings,
d) master parts list or bill of materials,
e) processes and specifications,
f) acceptance test procedures, functional test requirements, or test instruction sheets agreement,
g) software (if any),
h) identification markings,
i) installation instructions and limitations.

4.7 General requirements

The following requirements apply:

a) **WARNING**: Any change from the original battery manufacturer's design and construction requires re-qualification. During maintenance, do not mix cells or components of different construction or manufacturers in the same battery as this could result in a safety issue.

b) The terminal arrangements should be such as to obviate the possibility of incorrect connection. The type of arrangement shall be selected from the examples shown in Annex B.

c) The containers shall be constructed of impervious material. The battery manufacturer shall declare the flammability characteristics of the outer containers.

4.8 Installation considerations

The following installation requirements apply:

a) Location: Batteries and their containers shall be securely fixed in positions such that they are easily accessible for inspection, replacement and necessary tests.

b) Temperature of electrolyte: The method of installation shall ensure that, under normal operating conditions, the temperature of the electrolyte is maintained within the limits necessary for satisfactory operation. This shall normally be achieved by suitable location of the batteries within the aircraft.

c) Ventilation: Ventilation adequate for the prevention of dangerous concentrations of ignitable or toxic gases shall be provided for the battery and compartment in which batteries are installed. These arrangements shall take account of the quantities of gas likely to be released under conditions of thermal instability of the battery.

d) Corrosion: Batteries should be accommodated on a tray which is resistant to corrosion, by the electrolyte. This tray should be so installed that it will not normally be removed with the battery.

e) Flammability: Battery case material requirements may vary according to the location of the battery within the aircraft. For example, batteries located within an area which may be subject to a fuel fire shall be fire proof, batteries in crew or passenger compartments shall be flame resistant, while batteries installed in flame resistant or fireproof battery boxes may be flammable. Consideration shall be given to toxic fumes given off by many flame retardant materials when they burn.

4.9 Workmanship

The battery shall be manufactured in such a manner as to be uniform in quality and shall be free from defects that will affect life, functioning, and appearance. Batteries shall not have loose contacts, improper moulding or fabrication, damaged or improperly assembled contacts, peeling, flaking or chipping of plating or finish, mechanical damage due to testing environments, nicks or burrs of metal parts of surfaces, nor improper or incorrect marking. A description of the requirements is shown in Table 1. Upon delivery, prior to testing and following testing, the batteries shall be examined for compliance.

Table 1 – Workmanship requirements

Number	Description	Inspection method
1	Electrical contact surfaces obstructed by insulation compounds	Visual
2	Pitting or blow holes on the external cell container	Visual
3	Electrolyte leakage	Visual
4	Location and polarity of terminals not as specified	Visual
5	Terminal and identification markings not as specified	Visual
6	Terminal seals missing or defective	Visual
7	Corrosion	Visual
8	Particles of foreign material	Visual
9	Welds containing blow holes, cracks, or slag inclusions	Visual
10	Burrs on battery container or cover	Visual
11	Improper colour on outside of container and cover	Visual

5 Electrolytes

5.1 General

Those batteries designated as sealed do not require the addition of distilled/de-ionised water to the electrolyte during use or qualification testing. Maintainable types require the electrolyte to be adjusted to a certain level within the cell. The addition of distilled/de-ionised water should only be made when the battery is fully charged, as the level will vary depending upon its state of charge. The manufacturer shall define the procedure for determining and adjusting the electrolyte levels.

a) Potassium hydroxide electrolyte: nickel-cadmium batteries shall use an electrolyte consisting of an aqueous solution of potassium hydroxide.

b) Sulphuric acid electrolyte: the electrolyte shall be an aqueous solution of sulphuric acid.

5.2 Electrolyte resistance

Components used inside the battery shall demonstrate resistance to electrolyte as required by IEC 60952-1.

5.3 Electrolyte level

The cells of all flooded batteries shall have a clearly defined means of identifying the proper electrolyte fill level. This may be by means of a permanent index mark in the filler neck, step, notch, slot or some other obvious method. A specific method may be defined in the product specification.

5.4 Leakage

Electrolyte leakage of batteries and components shall be evaluated according to the requirements of IEC 60952-1.

6 Dissimilar metals

Where dissimilar metals are used in intimate contact, suitable protection against galvanic corrosion shall be applied.

7 Corrosion prevention – Vented nickel-cadmium batteries only

After the battery has been assembled, all exposed metal surfaces of the cells, inter-cell connectors, and associated hardware shall be coated with an electrolyte resistant, corrosion preventive compound. Vent valve rubber sleeves, vent openings, and the interfaces between current carrying surfaces shall not be exposed to the corrosion preventive film. The coating shall be applied evenly and without voids.

8 Battery containers and components

8.1 General

The dimensions and locations of receptacles, hold-downs and vent tubes shall conform to the format examples in Annex A.

8.2 Battery containers and covers

The battery container and cover shall be free of rough spots, pits, blowholes and other deformations. The product specification may specify whether the lid shall be removable.

8.3 Electrical bonding

Where metallic hold downs are used, provision shall be made to provide a bare conductive surface on all hold down bars, brackets, or attachment points, for electrical bonding with the airframe unless detailed otherwise in the product specification. This may be accomplished by leaving part of the outer 22 mm of the hold down bar uncoated or by spot facing the coating to bare metal.

8.4 Cell jars and monoblocs

The cell container and cover shall be free of rough spots, pits, blowholes and other deformations.

They shall be made from insulating material, which is resistant to the operating conditions. Where it is necessary to join components together, this shall be achieved by a permanent weld or an adhesive, which is resistant to atmospheric pressure.

The cell container utilised in nickel-cadmium batteries shall be made of self-extinguishing non-porous, alkali-resistant material, such as polyamide.

The cell container utilised in lead acid batteries shall be made of non-porous, acid-resistant material, such as polypropylene, polystyrene and polycarbonate.

9 Venting arrangements

9.1 Battery requirements

The design of the battery shall employ a method of ambient air dilution of the gases generated during overcharge. The purging system may be either by natural ventilation or by assisted ventilation.

In natural ventilation, the battery container and/or cover shall have sufficient holes or louvers to ensure gas dissipation in still air. Such holes or louvers shall be adequately protected to prevent access by foreign objects.

For assisted ventilation, the liberated gases from all the cells shall pass into a venting chamber, having ports for the purging air. The battery manufacturer shall declare compliance with the appropriate clause in IEC 60952-1. There are two preferred methods of achieving a purging airflow.

a) The entry of air into the battery is via an entry housing with an integral non-return valve. It shall not be possible to connect a pipe to the inlet side of the valve. The air is taken from the battery by a pipe connection.
b) The air is taken to and from the battery by pipe connections and the direction of ventilation is immaterial.

The manufacturer shall declare compliance with 6.5 of IEC 60952-1:2013.

9.2 Cell requirements

9.2.1 Vented filler cap for vented cell

Each cell shall be fitted with a vent filler cap made of non-conductive material, which is resistant to electrolyte and equipped with a sealing device.

The vent filler cap shall contain a device to permit the escape of gas. For aerobatic use, specified vent filler caps can be used to prevent the escape of liquid when the battery is inverted.

The vent filler cap shall fulfil its function in all specified tests, at the pressure defined by the manufacturer.

9.2.2 Valve for valve regulated cell

Each cell shall be fitted with a valve designed to allow the escape of gas in case of abusive conditions.

10 Inter-cell connectors for nickel-cadmium batteries

10.1 General

Exposed inter-cell connections shall be designed and installed in such a way as not to interfere with the removal of the cell vented filler caps. Epoxy or other plastics shall not be used to cover the internal connectors or their fasteners. The manufacturer shall provide details of the correct torque setting for the inter-cell connectors for each type of battery supplied.

Inter-cell connectors may be designed to be either removable or non-removable at the request of the purchaser. Non-removable connecting links are described in 10.2. All inter-cell connectors shall conform to the following guidelines:

a) be constructed of adequate size to match the current capabilities of the battery;
b) be constructed so as to not create corrosion or reactions from dissimilar metals; and
c) be capable of withstanding exposure to electrolyte.

10.2 Special purpose inter-cell connections – non-removable

Certain styles of low-maintenance, limited-repair nickel-cadmium batteries may be requested with non-removable inter-cell connectors. The mounting hardware for this type of application prevents the removal of the individual cells for maintenance. The inter-cell connections shall not interfere with the removal of removable charger harnesses and tamper-resistant hardware shall not be used on receptacles or harnesses. To impede cell removal, the inter-cell connectors used in limited repair batteries shall be attached to the cell posts by the use of tamper-resistant means, such as tamper-resistant fasteners, that shall be difficult to remove but which shall not damage the cell upon removal. Rivets, welding, or adhesive methods shall not be used to attach the inter-cell connectors of limited repair batteries.

11 Handles

Each handle shall be capable of supporting the weight of the battery by a factor of at least 1,5 times the weight of the battery.

WARNING: Battery vent tubes are not intended for use as lifting handles.

Other requirements for battery lifting handles, if required, shall be defined in the product specification and shall detail appropriate human factors such as sufficient space for cold weather protection as well as providing clearance for ancillary equipment.

12 Latches

Latches may be used to fasten the battery cover to the container body by a system of catches mounted on the container body and strikes mounted on the cover. The position of the latches and mounting method may be defined in the product specification.

13 Materials and components for flooded nickel-cadmium batteries

For flooded nickel-cadmium batteries, aluminium, polycarbonate, or polyester shall not be used in the construction of any nickel-cadmium battery, cell or component covered by this standard. Except for the hold-down pad, neoprene shall not be used in the construction of any nickel-cadmium battery, cell, or component covered by this specification. When specified by the procuring activity or the qualification activity, the manufacturer shall supply a certification of conformity of the material or component. In the absence of certification from the source, a certificate of analysis or certified inspection data will be required.

14 Gas barriers and thermal runaway – nickel-cadmium only

Microporous polypropylene film or other non-cellulosic ion permeable thin film gas barriers have proven, through extensive testing and field experience, to prevent thermal runaway due to gas barrier degradation.

The cell plate separator usually consists of a gas barrier sandwiched between two layers of absorbent cloth-like material and is folded between the plates of the cell to insulate them electrically and mechanically. The gas barrier allows ions to pass but not oxygen. If oxygen, which is generated on the positive plates, can pass over to the negative plates during charge, it will recombine, generate heat and possibly cause a very dangerous thermal runaway condition. When the electrolyte reserve is used up, the top of the cell electrodes will no longer be below the electrolyte. Oxygen can then circumvent the gas barrier at the top of the cells and thermal runaway will occur.

In addition, the response of the cell voltage to the charge is highly dependent on the material used for the cell plate separator. Cells that contain gas barriers described above will produce a distinct charge voltage that can differ from cells with other gas barriers. Moreover, it is known that when cells within a battery do not have uniform voltage during charge, the battery will be susceptible to thermal runaway.

The manufacturer shall define the process for ensuring thermal stability of the battery in the maintenance procedure.

15 Dimensions, mass, markings and identification requirements

15.1 Dimensions and mass

The dimensions and mass of the battery shall comply with the requirements of the format (see Annex A or, where invoked, the product specification).

15.2 Colour

If a specific colour is required, this shall be as specified on the product specification.

15.3 Marking

15.3.1 Battery marking

The manufacturer's marking and labelling on the battery exterior shall contain the following minimum information in a legible and durable form:

a) manufacturer's name;
b) manufacturer's type or part number;
c) modification numbers or letters;
d) nominal battery voltage;
e) rated capacity or EOL;
f) battery polarity;
g) chemical system (e.g. nickel-cadmium or lead-acid);
h) date of manufacture;
i) manufacturer's serial number;
j) number of cells (nickel-cadmium), if required;
k) contract number, if required;
l) national or NATO stock number, if required.

Additional markings may be required in the product specification or procurement document, or by local law or regulation.

15.3.2 Cell marking

Removable cells shall be clearly and indelibly inscribed with the following information:

a) manufacturer's name;
b) unencrypted date;
c) batch or serial number;
d) chemical system or recycling information in accordance with national legislation.

15.3.3 Polarity marking

The container body or electrical main connector shall be conspicuously and durably marked "+" in the location shown on the applicable format. For individual removable cells, each cell will bear clear and distinct polarity markings.

16 Heaters – Battery heating system

A battery heating system may be fitted to a battery in order to extend low temperature operability. All the requirements of IEC 60952-1 are applicable to batteries fitted with heaters. In addition, the following design requirements are applicable.

a) The characteristics of the supply voltage and maximum current to the heater system shall be defined by the product specification taking into account the heater load.
b) The maximum heat output of the system shall not damage battery components with which it is in contact.
c) Each independent or parallel-connected heating circuit of the heater system shall be equipped with a minimum of two control devices connected in series with its power supply connection.
d) The heating system connector, heater control devices, elements and associated cabling shall be rated in accordance with the maximum heater load, voltage and duty.
e) All heater system components, including control devices, except the external connection to the heater power supply shall be located inside the battery container. The positioning of heating elements shall be such as to minimise thermal gradients within the battery.
f) All heater system components, except the connector terminals to the external heater power supply, shall be electrically insulated and installed in a manner which minimises potential battery damage due to electrical shorting, sparking, or other electrical hazards and which minimises potential damage to the insulation of the heater system components themselves.
g) All heater control devices shall be sealed in a manner which prevents, during their operation, the ignition of explosive gas mixtures which may occur within the battery.
h) If, in the event of control device failure, the temperature of any exterior surface of the battery container can exceed 49 °C within a period of 2 h of heater operation at an ambient temperature of (23 ± 2) °C, a warning label shall be attached to the battery surface containing the words “CAUTION, HOT SURFACE”.

17 Electrical connectors – Strength of receptacle

The connectors shall conform to the requirements of Annex B of this document or as specified in the appropriate product specification.

Once fitted, the connector shall be assessed for torsional strength in accordance with IEC 60952-1.

18 Temperature monitoring

Thermal switches and temperature sensors, where used, should be so installed that they may be tested. Temperature sensors shall be monitored throughout all electrical tests defined in IEC 60952-1 in order to demonstrate that there is no erroneous operation.

As good practice, the temperature monitoring connector should be separate from the main power connector.

19 Storage

Nickel-cadmium, nickel metal-hydride, and lead-acid batteries should be stored in a dry and well-ventilated area and should not normally be kept in the same area as flammable materials. Humidity or temperature control is not necessary in most instances but for maximum shelf life, the temperature should be below 30 °C. Generally, exposure to temperatures above 50 °C should be kept to a few days in any year. Storage temperatures above 70 °C shall be avoided.

Nickel-cadmium, nickel metal-hydride, and lead-acid batteries should not be stored in the same location/facility due to possible contamination.

Proper battery storage depends on the battery chemistry. Some batteries should be stored shorted, some completely discharged while others require an occasional recharge to obtain their maximum storage life. Aircraft manufacturers and users should consult the battery manufacturer for proper battery storage.

20 Transportation

The transport as cargo of some nickel-cadmium, nickel metal-hydride, and lead-acid batteries is regulated. The appropriate regulations of each country should be consulted before transporting nickel-cadmium, nickel metal-hydride, and lead-acid batteries.

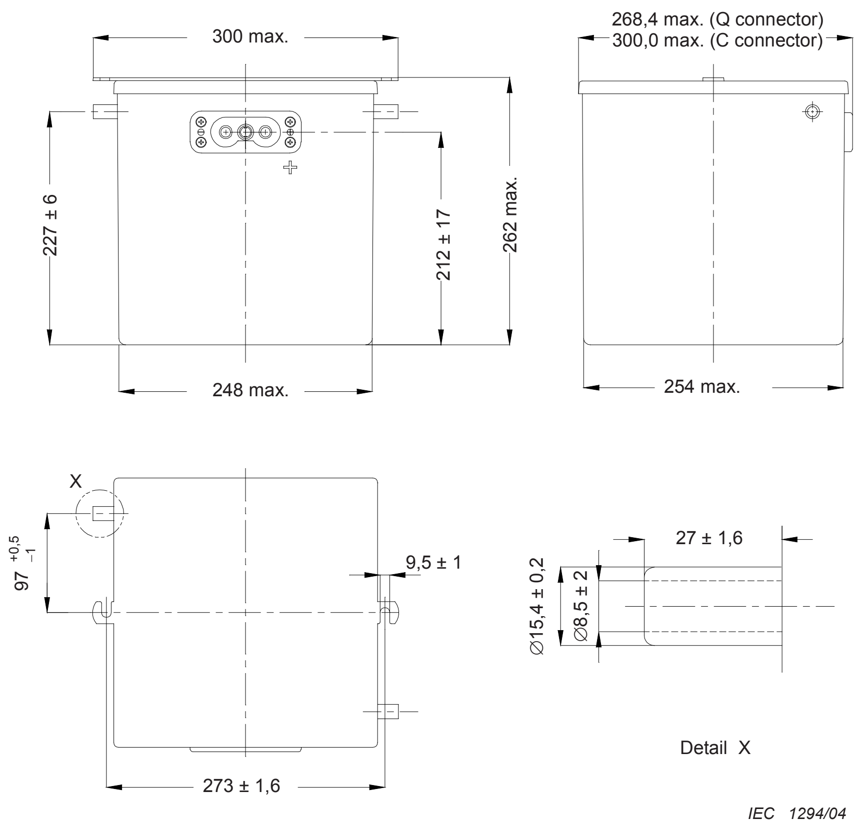
21 Disposal and recycling

The proper disposal of nickel-cadmium, nickel metal-hydride, and lead-acid batteries is a matter of concern to battery producers, consumers and governmental bodies. Manufacturers material safety data sheets (MSDS) should be consulted for relevant information. Batteries should be recycled or sent to the manufacturer for recycling in accordance with all applicable federal, state and local regulations for the particular system being used.

Annex A
(normative)

Battery formats

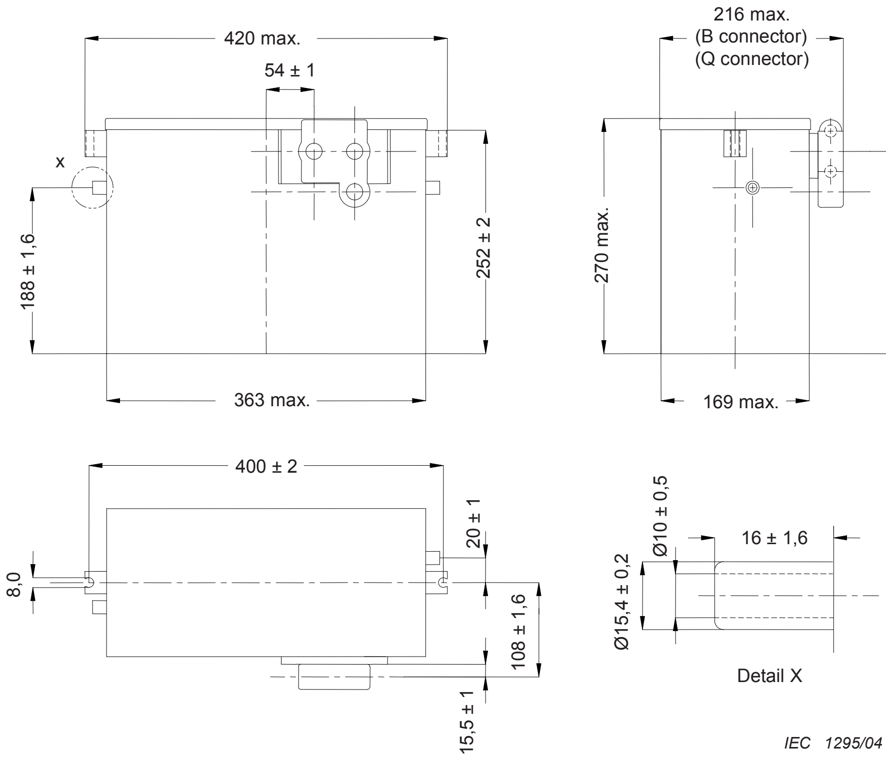
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	34 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	40 kg
The battery may be fitted with one of the two ventilation systems according to 9.1. If assisted ventilation is to be applied, this shall be indicated by the manufacturer.	

Figure A.1 – Format A

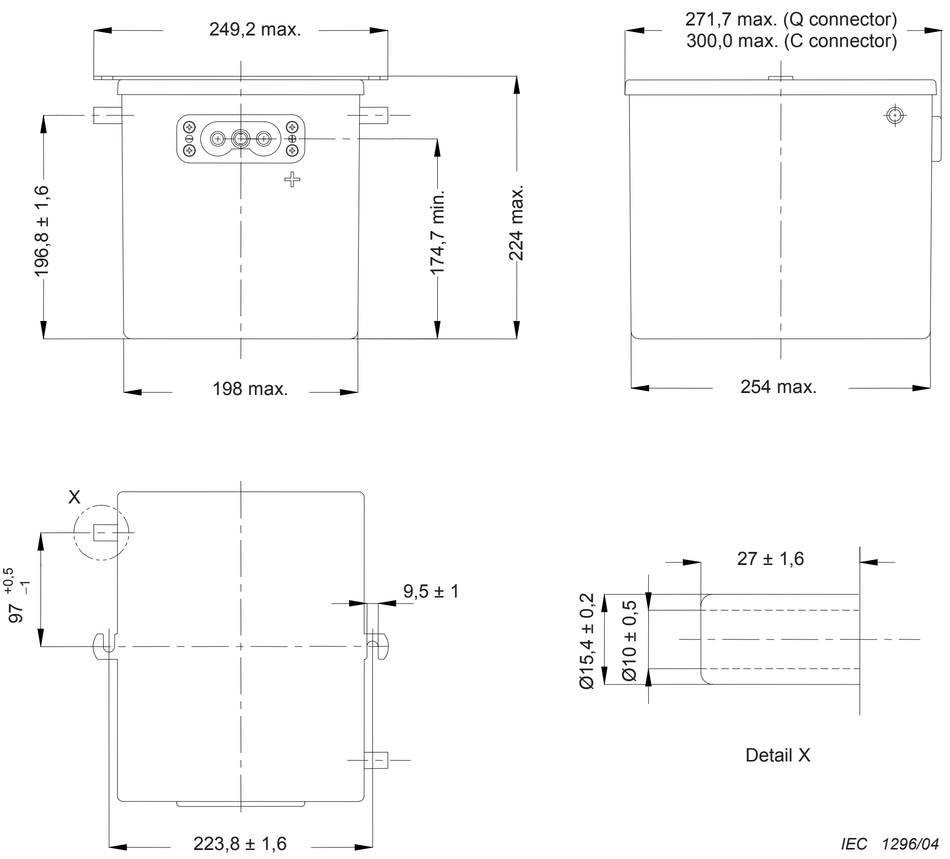
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	34 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	40 kg
The battery may be fitted with one of the two ventilation systems according to 9.1. If assisted ventilation is to be applied, this shall be indicated by the manufacturer.	

Figure A.2 – Format B

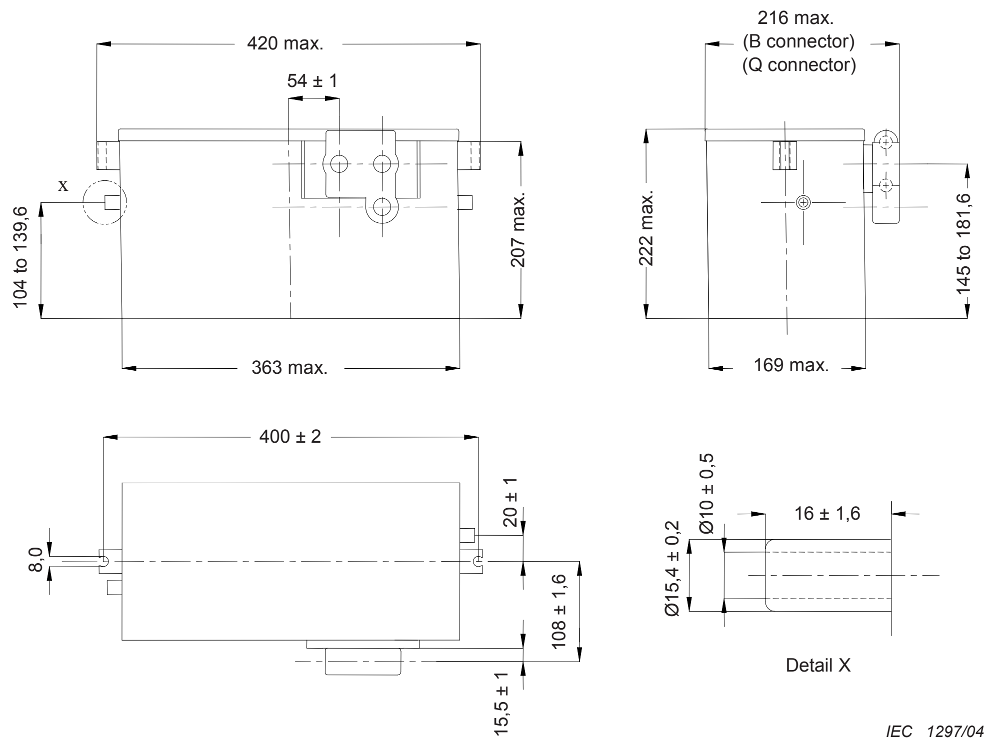
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	22 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	27,5 kg
The battery may be fitted with one of the two ventilation systems according to 9.1. If assisted ventilation is to be applied, this shall be indicated by the manufacturer.	

Figure A.3 – Format C

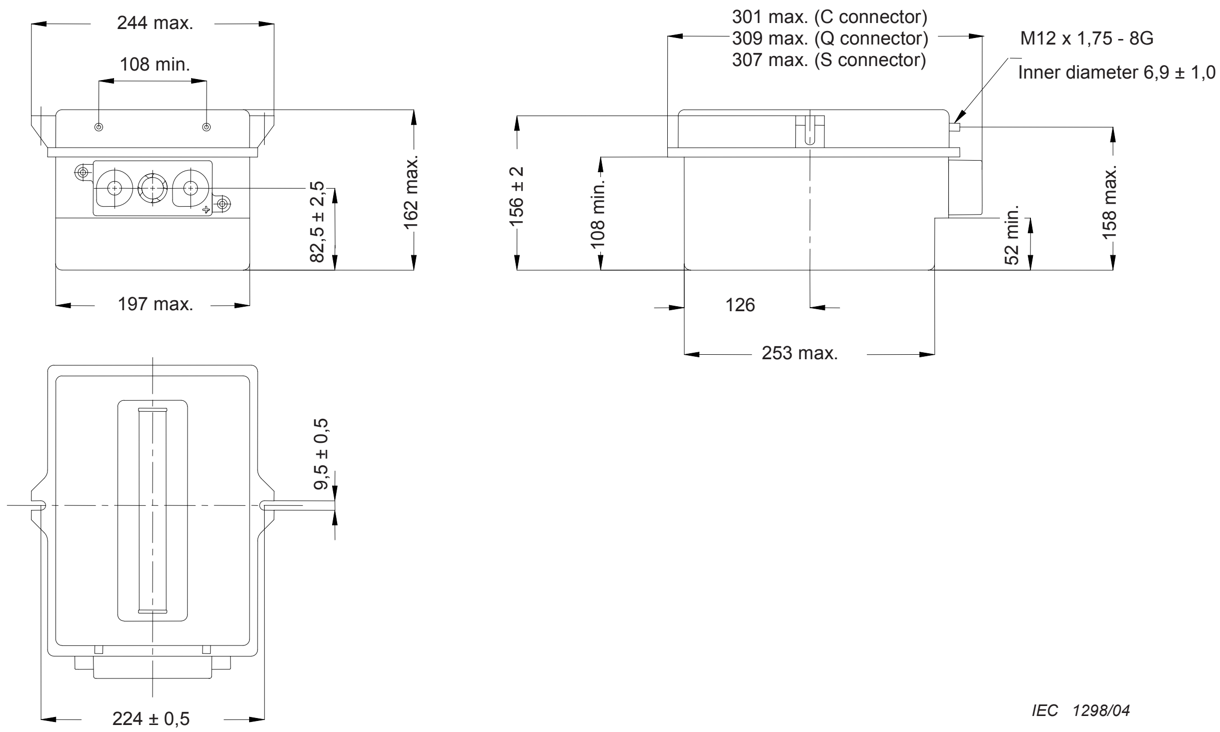
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	22 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	29 kg
The battery may be fitted with one of the two ventilation systems according to 9.1. If assisted ventilation is to be applied, this shall be indicated by the manufacturer.	

Figure A.4 – Format D

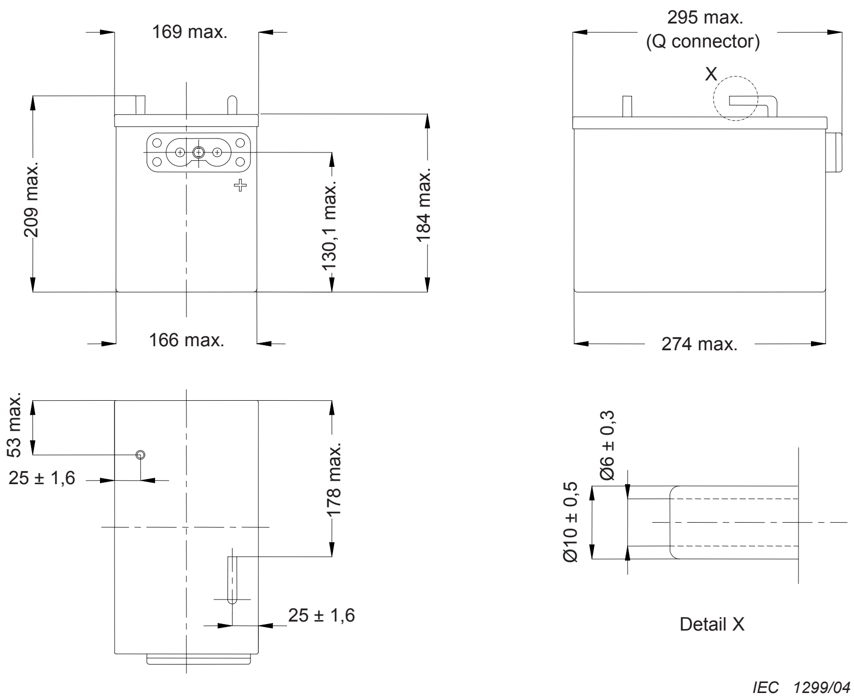
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	18 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	19 kg
The battery may be fitted with one of the two ventilation systems according to 9.1. If assisted ventilation is to be applied, this shall be indicated by the manufacturer.	

Figure A.5 – Format E

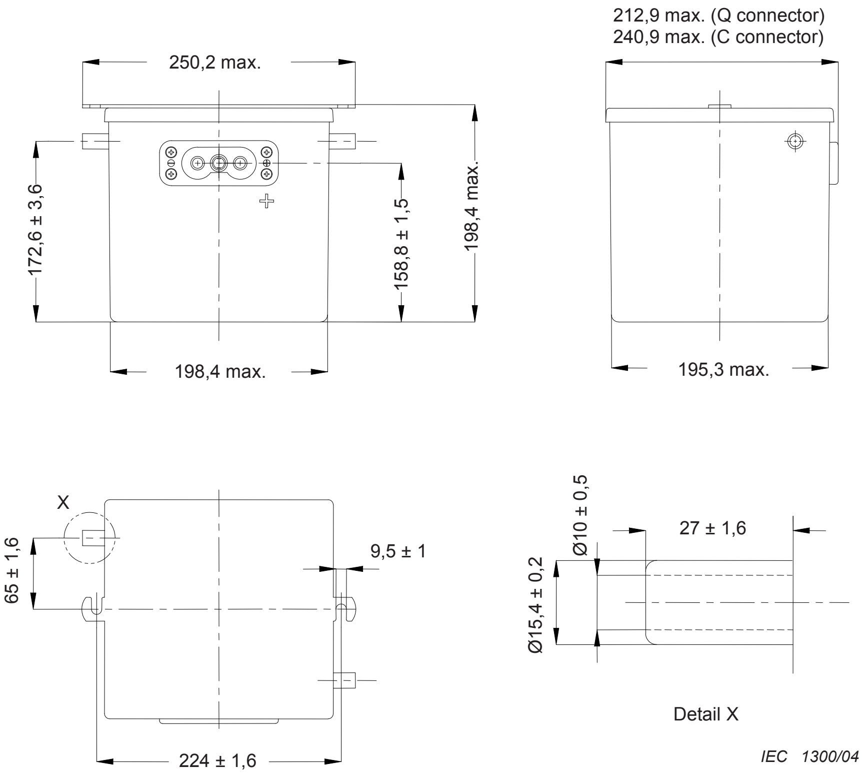
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	14 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	19 kg
The battery may be fitted with one of the two ventilation systems according to 9.1. If assisted ventilation is to be applied, this shall be indicated by the manufacturer.	

Figure A.6 – Format F

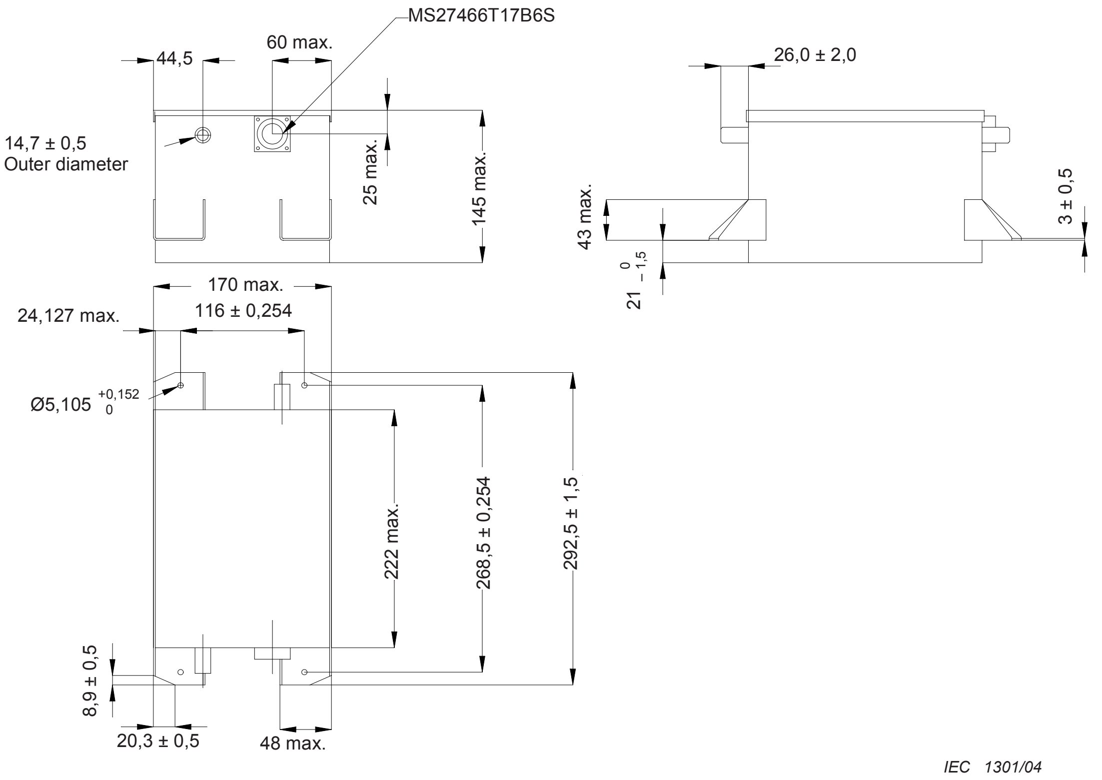
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	11 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	16 kg
The battery may be fitted with one of the two ventilation systems according to 9.1. If assisted ventilation is to be applied, this shall be indicated by the manufacturer.	

Figure A.7 – Format G

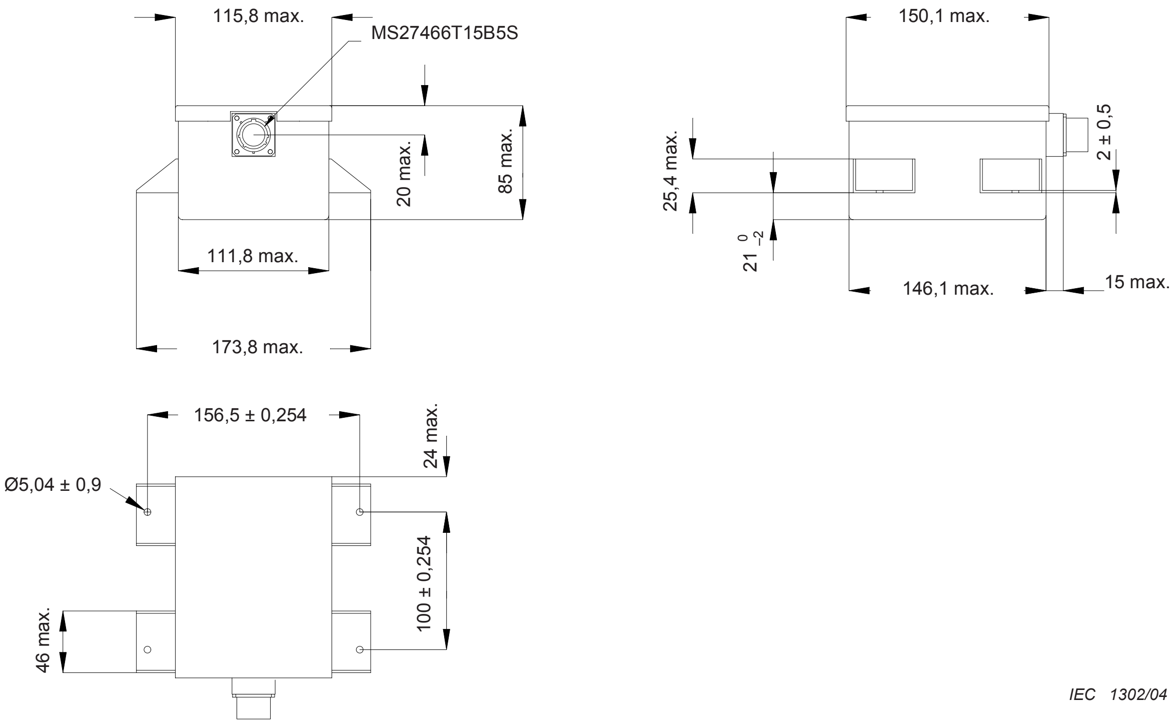
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	7,5 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	11,8 kg
The battery may be fitted with one of the two ventilation systems according to 9.1. If assisted ventilation is to be applied, this shall be indicated by the manufacturer.	

Figure A.8 – Format H

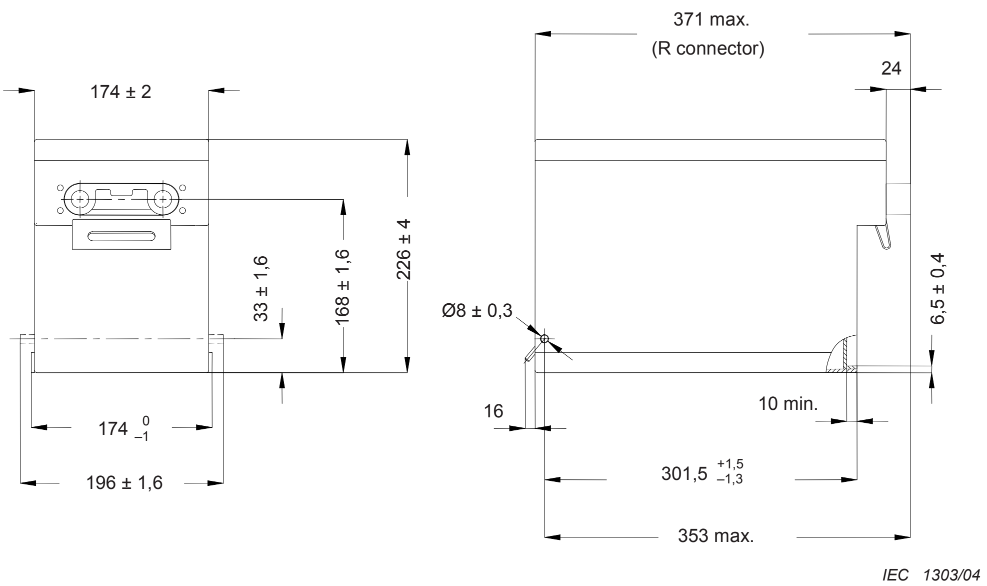
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	1,5 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	2,9 kg

Figure A.9 – Format I

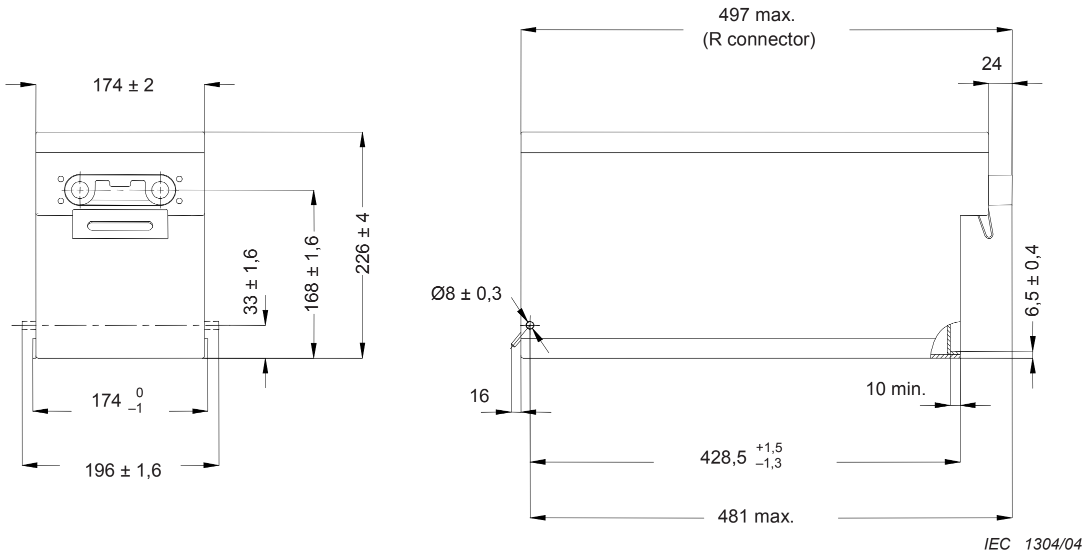
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	25 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	24,5 kg

Figure A.10 – Format J

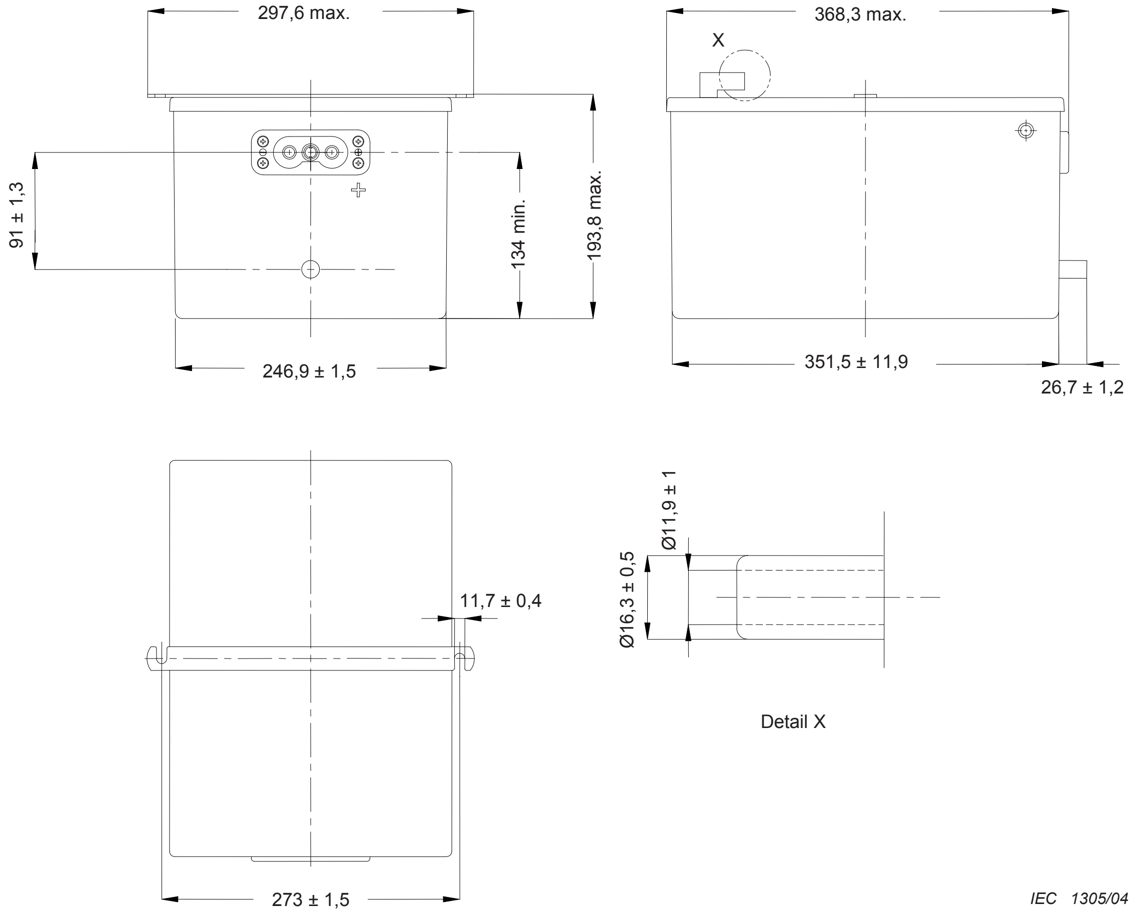
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	37 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	34,5 kg

Figure A.11 – Format K

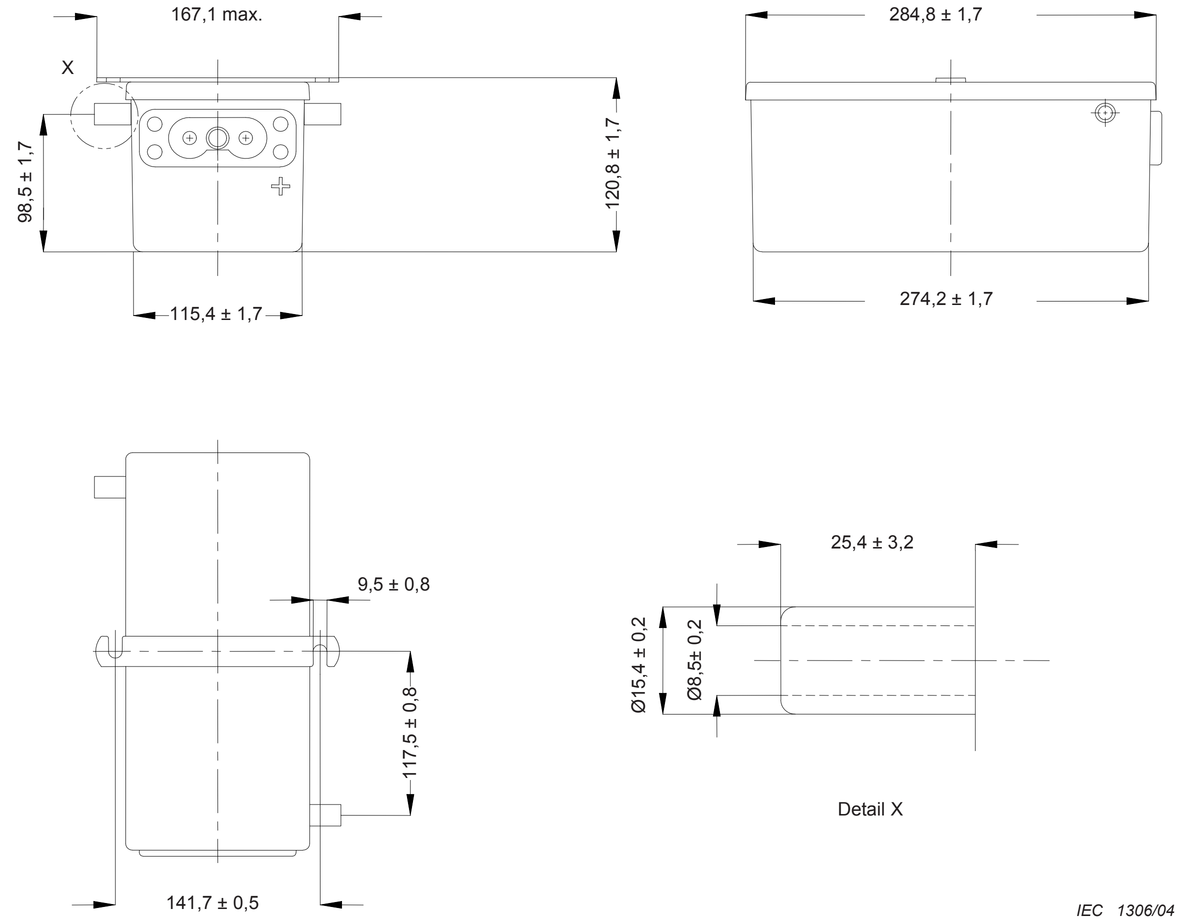
Dimensions in millimetres



Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013)	35 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	36,8 kg
The battery may be fitted with one of the two ventilation systems according to 9.1. If assisted ventilation is to be applied, this shall be indicated by the manufacturer.	

Figure A.12 – Format L

Dimensions in millimetres



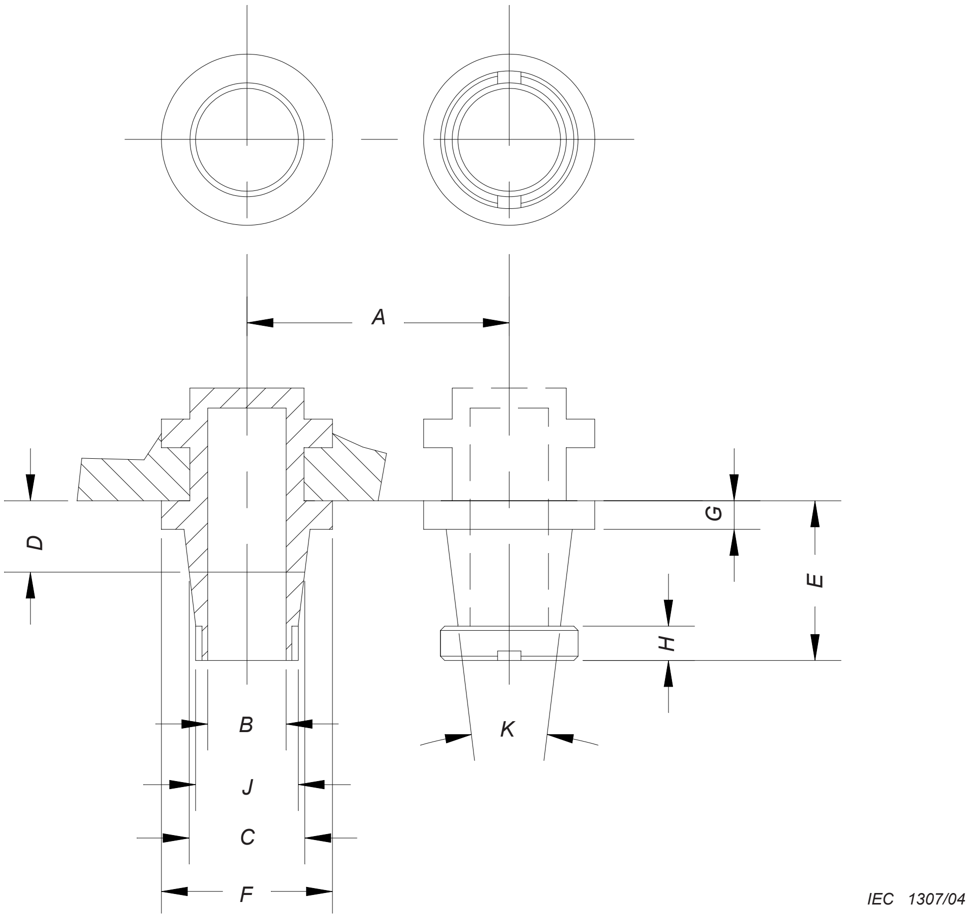
Minimum capacity C_1 (according to 3.3 of IEC 60952-1:2013):	5,5 Ah
No. of cells	19/20 Nickel-cadmium 12 Lead-acid
Nominal voltage	24 V
Maximum mass	8 kg
The battery may be fitted with one of the two ventilation systems according to 9.1. If assisted ventilation is to be applied, this shall be indicated by the manufacturer.	

Figure A.13 – Format M

Annex B
(normative)

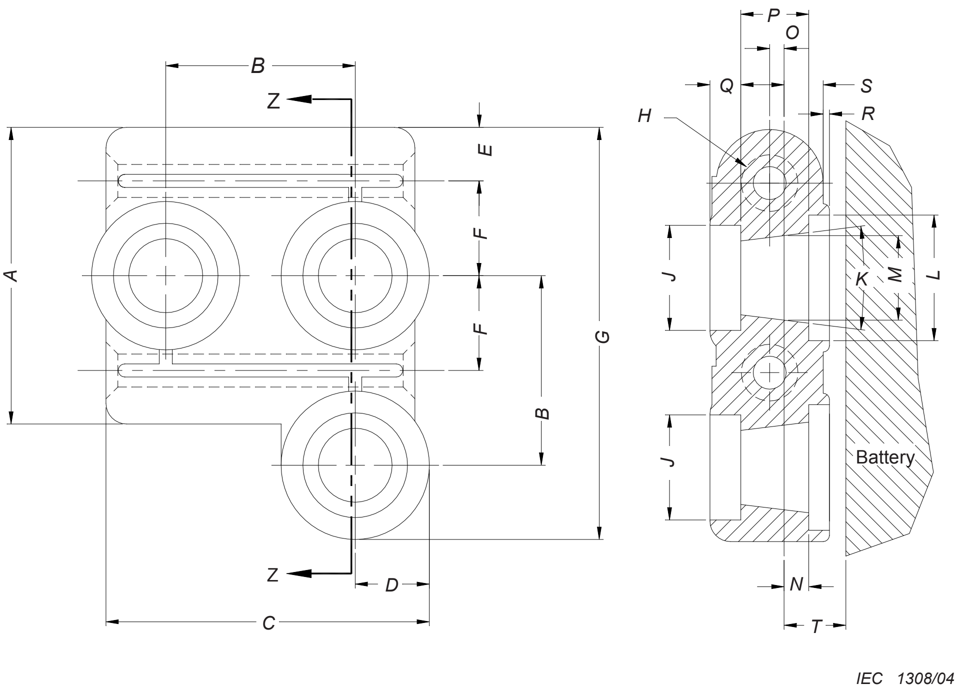
Connectors

The type connectors contained in this standard have been qualified for flight use on aircraft batteries. The user may specify a different connector such as a circular connector which has been qualified to a recognised specification and indicating that the connector has been qualified for flight use.



Dimension	mm	in
A	46 ± 0,1	1,811 ± 0,004
B	∅ 13,75 $^{+0,027}_{0}$	∅ 0,541 $^{+0,001}_{0}$
C	∅ 20,28	∅ 0,798
D	12,5 ± 1	0,492 ± 0,04
E	28 ± 1	1,102 ± 0,04
F	∅ 30 max.	∅ 1,181 max.
G	5 max.	0,197 max.
H	6 max.	0,237 max.
J	M18 × 1,0	
K	14° ± 10’	14° ± 10’

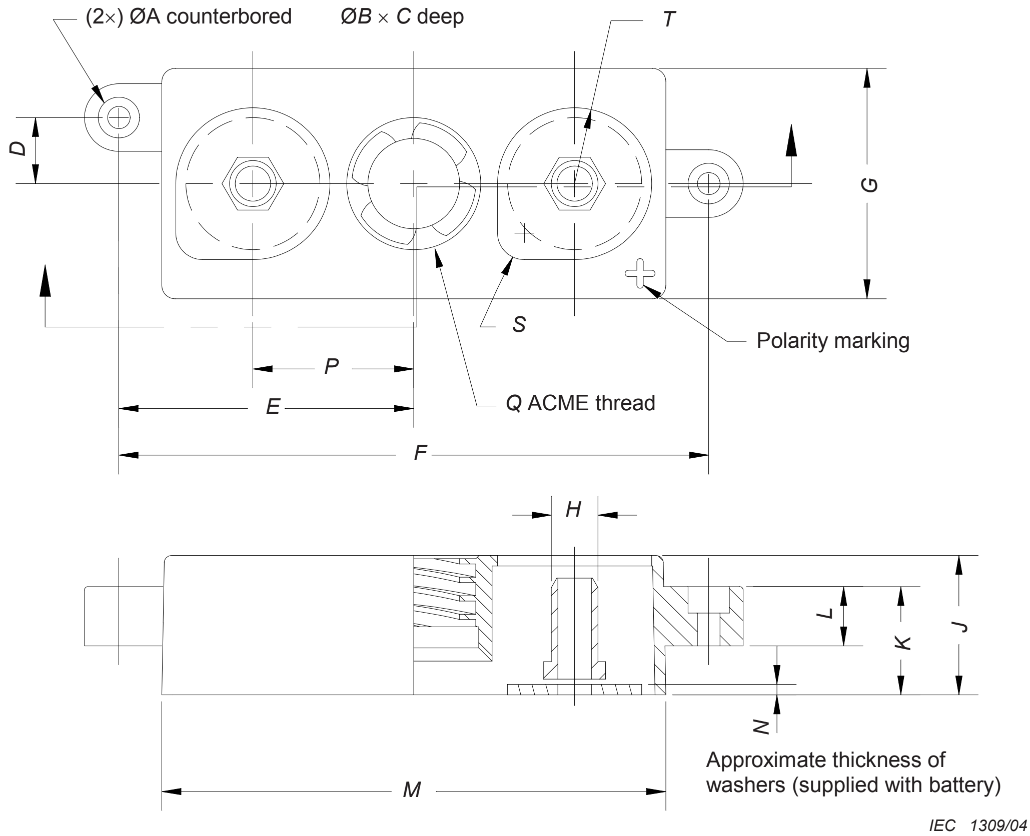
Figure B.1 – Connector Type A



Type B connector mates with Type A connector on battery.

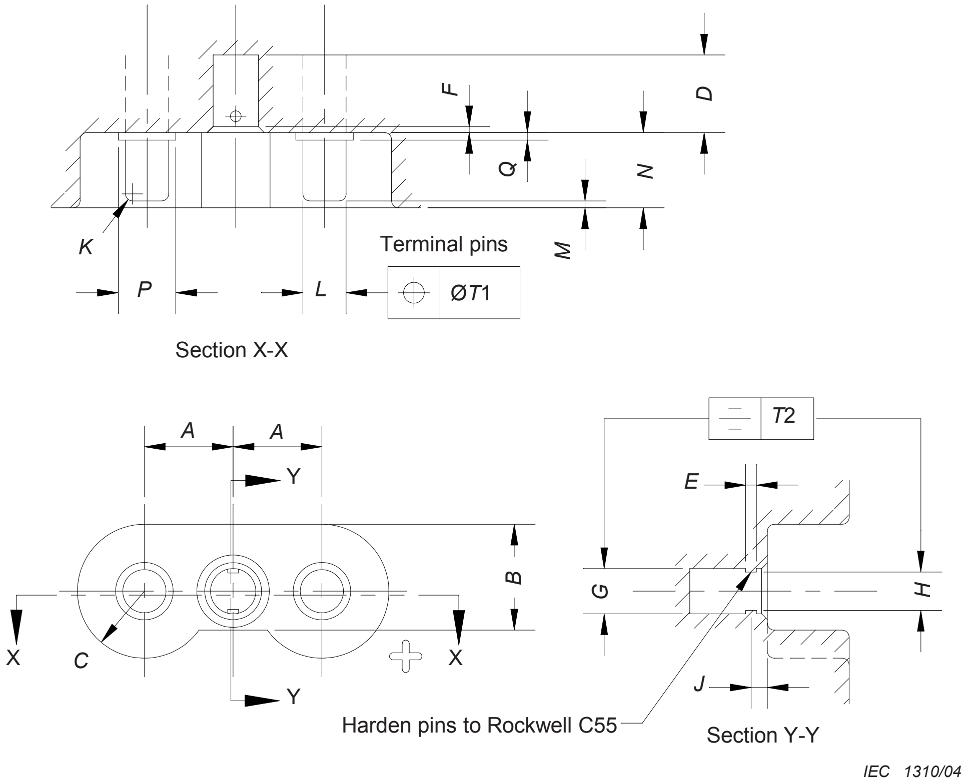
Dimension	mm	in
A	72 max.	2,835 max.
B	46 ± 0,1	1,811 ± 0,003
C	82 max.	3,215 max.
D	18 max.	0,708 max.
E	13 max.	0,511 max.
F	23 ± 0,1	0,905 ± 0,003
G	100 max.	3,937 max.
H	∅ 13,75 H 8	∅ 0,541 H 0,315
J	∅ 24,5 ± 0,5	∅ 0,964 ± 0,019
K	14°	14°
L	∅ 30,5 ± 0,5	∅ 1,201 ± 0,019
M	20,28	0,798
N	$6 ^{+0,15}_{0}$	0,236 ± 0,006
O	$3 ^{+0,1}_{-0,3}$	$0,118 ^{+0,003}_{-0,11}$
P	$16 ^{0}_{-0,2}$	0,629 ± 0,007
Q	8 ± 0,5	0,315 ± 0,019
R	1 ± 0,2	0,394 ± 0,008
S	10 ± 0,5	0,393 ± 0,019
T	15,5 ± 1,5	0,610 ± 0,059

Figure B.2 – Connector Type B



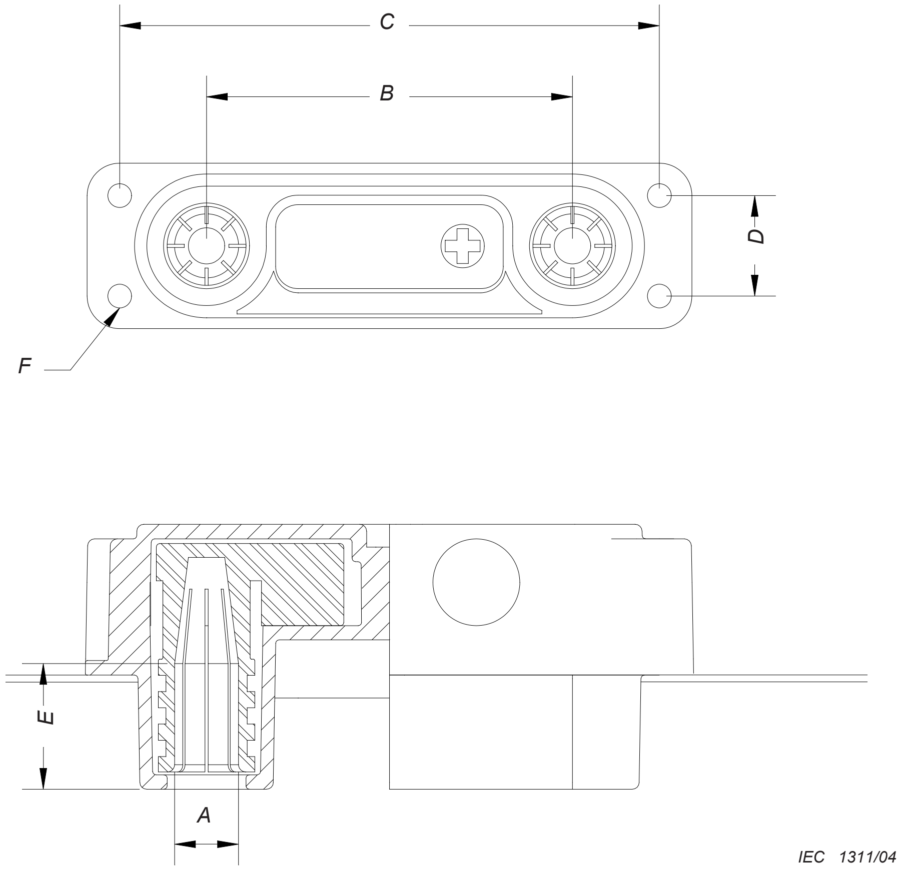
Dimension	mm	in
A	5,6	0,221
B	8,8	0,348
C	6,3	0,25
D	15,9	0,625
E	69,8	2,75
F	139,7	5,50
G	$55{,}5\ ^{+\,0{,}0}_{-\,0{,}5}$	$2{,}185\ ^{+\,0{,}0}_{-\,0{,}02}$
H	∅ 11,05 ± 0,12	∅ 0,435 ± 0,005
J	33,5	1,32
K	25,4 max.	1,00 max.
L	14,3	0,562
M	118,0	4,65
N	6,3	0,25
P	38,1	1,500
Q		1,156 -0,25P -1,00L
S	R 18,3	R 0,719
T	R 6,3	R 0,25

Figure B.3 – Connector Type C



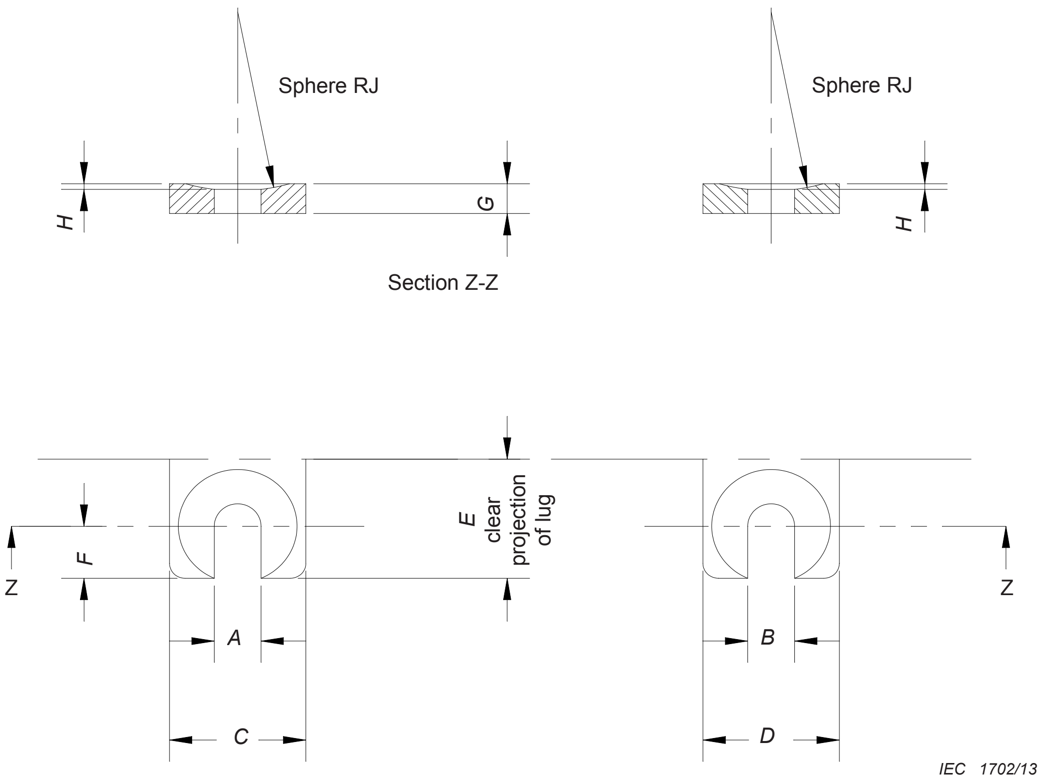
Dimension	mm	in
A	19,46 nom.	0,766 nom.
B	23,1 ± 0,13	0,914 ± 0,005
C	R 14,7 ± 0,13	R 0,578 ± 0,005
D	17,0 min.	0,670 min.
E	∅ 2,36 ± 0,05	∅ 0,093 ± 0,002
F	1,3 nom. (chamfer at 45°)	0,050 nom.
G	∅ 9,9 ± 0,13	∅ 0,391 ± 0,005
H	8,0 ± 0,05	0,307 ± 0,002
J	3,6 ± 0,13	0,141 ± 0,005
K	R 3,2 nom.	R 0,125 nom.
L	∅ 9,5 ± 0,13	∅ 0,375 ± 0,005
M	1,57 ± 0,13	0,062 ± 0,005
N	16,5 ± 0,13	0,650 ± 0,005
P	18,36 max., 15,77 min.	0,723 max., 0,620 min.
Q	1,7 max.	0,067 max.
*T*1	0,13	0,005
*T*2	0,25	0,010

Figure B.4 – Connector Type Q



Dimension	mm	in
A	∅ 14,0 ± 0,035	∅ 0,551 ± 0,001
B	80,0 ± 0,25	3,150 ± 0,010
C	118,0 ± 0,25	4,646 ± 0,010
D	22,0 ± 0,25	0,866 ± 0,010
E	26,0	1,024
F	M5 – 7H	

Figure B.5 – Connector Type R



Dimension	mm	in
A	9,53 ± 0,13	0,375 ± 0,005
B	11,10 ± 0,13	0,437 ± 0,005
C	27,26 ± 0,13	1,093 ± 0,005
D	29,36 ± 0,13	1,156 ± 0,005
E	23,8 min.	0,937 min.
F	11,10 ± 0,25	0,437 ± 0,010
G	6,35 ± 0,13	0,250 ± 0,005
H	1,19 ± 0,05	0,047 ± 0,002
J	38,10 nom.	1,500 nom.

Figure B.6 – Connector Type S

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