



International
Standard

ISO 27186

**Active implantable medical
devices — Four-pole connector
system for implantable cardiac
rhythm management devices —
Dimensional and test requirements**

*Dispositifs médicaux actifs implantables — Systèmes de
branchement à quatre pôles pour dispositifs implantables de
gestion du rythme cardiaque — Exigences de dimensions et
d'essai*

**Third edition
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 150, *Implants for surgery*, Subcommittee SC 6, *Active implants*.

This third edition cancels and replaces the second edition (ISO 27186:2020), which has been technically revised.

The main changes are as follows:

- the requirement in [4.3.10](#) and the test method in [Annex Q](#) for lead insertion force have been added and the rationale for both has been added in [Annex R](#);
- the requirement in [4.5.1](#) for connector cavity insertion and withdrawal force have been revised to improve accuracy and reproducibility, the test method for these has added in [Annex S](#), and the rationale for both has been added in [Annex T](#);
- the heading of [4.3.1](#) has been revised to distinguish this requirement from the lead insertion force requirement;
- the clause headings within [Annex O](#) have been aligned with those in the main text;
- annex titles have been aligned to better reflect content;
- editorial changes have been made to the main text and annexes have referred to in the main text where relevant.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The four-pole connector system was created to reduce:

- the number of individual lead connectors,
- pocket bulk associated with existing bifurcated or trifurcated leads,
- interaction of lead bodies in the pocket, and
- set screw connections.

The four-pole connector system is intended to provide interchangeability between implantable leads and pulse generators from different manufacturers.

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Active implantable medical devices — Four-pole connector system for implantable cardiac rhythm management devices — Dimensional and test requirements

WARNING — The low-voltage only connector cavity specified in this document is not to be used if the implantable pulse generator is capable of introducing dangerous non-pacing stimuli (e.g. defibrillation shocks) through the contacts of that connector cavity. Likewise, the high-voltage lead connector specified in this document is not to be used on leads intended for low-voltage only therapy.

1 Scope

This document specifies a four-pole connector system for implantable cardiac rhythm management (CRM) devices that have electrogram sensing and pacing functions with or without defibrillation capability. This document includes requirements for the connector portion of an implantable lead and for the mating connector cavity attached to an implantable pulse generator. Key dimensions and performance requirements are specified together with appropriate test methods.

This document establishes two types of connector assembly with their configurations, which are not intended to be interchangeable:

- a high-voltage connector: a connector that can have either
 - two low-voltage contacts combined with one or two high-voltage contacts, or
 - only two high-voltage contacts;
- a “low-voltage only connector”: a connector that has either three or four low-voltage contacts.

This document specifies a dimensional lockout feature that prevents the low-voltage contacts of the lead connectors from contacting the high-voltage contacts of high-voltage connector cavities.

This document does not replace or provide alternatives for unipolar or bipolar connector International Standards that currently exist (such as ISO 11318^[2] and ISO 5841-3^[1]).

This document is not applicable to high-voltage systems with intended outputs greater than 1 000 V or systems with an electric flow greater than 50 A.

This document is not applicable to systems which include sensors or unique electrodes that are not capable of conventional pacing electrogram sensing or defibrillation functions.

This document does not specify all connector features and it does not address all aspects of functional compatibility, safety or reliability of leads and pulse generators assembled into a system.

This document does not include requirements for accessories or adaptors used with four-pole connectors. Refer to [Annex P](#) for more information on connector-related products.

NOTE 1 The safety, reliability, biocompatibility, biostability and function of any particular part are the responsibility of the manufacturer.

NOTE 2 Lead and pulse generator connector systems not conforming to this document can be safe and reliable and can have clinical advantages.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 7436, *Fasteners — Slotted set screws with cup point*

ASTM B348, *Standard Specification for Titanium and Titanium Alloy Bars and Billets*

ASTM F562, *Standard Specification for Wrought 35Cobalt-35Nickel-20Chromium-10Molybdenum Alloy for Surgical Implant Applications*

ASTM F746, *Standard Test Method for Pitting or Crevice Corrosion of Metallic Surgical Implant Materials*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 axial pin movement

M

axial movement of a *lead connector pin* (3.18) with reference to the *lead connector* (3.16) body as present in some designs, particularly those with a rotating connector pin

3.2 bipolar

having two poles or electrodes

3.3 connector system

assembly consisting of a *lead connector* (3.16) and a *connector cavity* (3.4) that are electrically and mechanically joined

3.4 connector cavity

cavity within the *pulse generator* (3.27) which is intended to receive a *lead connector* (3.16)

3.5 contact mechanism

conductive hardware within the *connector cavity* (3.4) provided for making electrical connection to corresponding contacts on a *lead connector* (3.16)

3.6 distal

farthest from a point of reference

Note 1 to entry: The point of reference for a lead is the *lead connector pin* (3.18). Therefore, the most distal electrode of a lead is the electrode that is farthest from the lead connector pin.

3.7 fixation zone

specified area on the *lead connector pin* (3.18) and within the *connector cavity* (3.4) where the *lead connector* (3.16) is mechanically secured within the connector cavity

3.8

four-pole

having four poles or electrodes

Note 1 to entry: Generally, a four-pole implantable cardiac defibrillator (ICD) lead has two *low-voltage* (3.21) electrodes and two *high-voltage* (3.12) electrodes. A four-pole low-voltage only lead has four low-voltage electrodes.

3.9

functional contact zone

area within the *connector cavity* (3.4) where electrical contact with a *lead connector* (3.16) occurs

3.10

functional seal zone

area within the *connector cavity* (3.4) where sealing contact with a *lead connector* (3.16) occurs

3.11

grip zone

area of the *lead connector* (3.16) which is provided for grasping during insertion and withdrawal of the lead connector from the *connector cavity* (3.4)

3.12

high voltage

electrical potential greater than 20 V and that can go up to 1 000 V

Note 1 to entry: High voltages are generally used for defibrillating the heart.

3.13

high-voltage connector

lead connector (3.16) or *connector cavity* (3.4) that has at least one *high-voltage* (3.12)

Note 1 to entry: A high-voltage connector can also contain *low-voltage* (3.21) contacts.

3.14

insertion indicator zone

area on the pin of the *lead connector* (3.16) allocated for manufacturers to provide a visual indicator for use in verifying full insertion of a lead connector into a *connector cavity* (3.4)

3.15

integrated bipolar

two lead poles or *lead electrodes* (3.20) that are electrically common

Note 1 to entry: A typical integrated bipolar ICD lead has a *distal* (3.6) shock electrode that doubles as a *proximal* (3.26) pace or sense ring electrode and is electrically attached to two separate *lead connector contacts* (3.17).

3.16

lead connector

part of a lead that is intended for insertion into the *connector cavity* (3.4) of a *pulse generator* (3.27)

3.17

lead connector contact

conductive element on the *lead connector* (3.16) which include the *lead connector pin* (3.18) and *lead connector rings* (3.19)

3.18

lead connector pin

most *proximal* (3.26) conductive element of a *lead connector* (3.16) provided for making electrical contact as well as for securing the lead connector within the *connector cavity* (3.4)

3.19

lead connector ring

annular conductive element on the *lead connector* (3.16) intended for making electrical contact within the *connector cavity* (3.4)

Note 1 to entry: The *four-pole* (3.8) connector has three lead connector rings and a *lead connector pin* (3.18).

3.20

lead electrode

distal (3.6) part of a lead through which electrical impulses are transmitted to or from cardiac tissue

Note 1 to entry: *High-voltage* (3.12) electrodes are capable of delivering high-voltage electrical impulses. *Low-voltage* (3.21) electrodes are used for transmitting and sensing low-voltage impulses and are generally not suitable for delivering high-voltage.

3.21

low-voltage

electrical potential less than or equal to 20 V

Note 1 to entry: Low voltage is generally used for pacing and sensing the heart.

3.22

low-voltage only connector

lead connector (3.16) or *connector cavity* (3.4) that has only *low voltage* (3.21) contacts

3.23

pin visibility zone

area within the *connector cavity* (3.4) which is allocated for visual verification that the *lead connector* (3.16) is fully inserted

Note 1 to entry: The pin visibility zone corresponds to the *insertion indicator zone* (3.14) of the lead connector.

3.24

pristine contact zone

area on the *lead connector* (3.16) intended for making electrical contact with the mating contact in the *connector cavity* (3.4)

Note 1 to entry: The pristine contact zones of the lead connector align with the *functional contact zones* (3.9) of the connector cavity when the connectors are mated.

3.25

pristine seal zone

area on the *lead connector* (3.16) intended for sealing with the mating seals in the *connector cavity* (3.4)

Note 1 to entry: The pristine seal zones of the lead connector align with the *functional seal zones* (3.10) of the connector cavity when the connectors are mated.

3.26

proximal

nearest to a point of reference

Note 1 to entry: The point of reference for a lead is the *lead connector pin* (3.18). Therefore, the most proximal electrode of a lead is the electrode closest to the lead connector pin.

3.27

pulse generator

device that delivers electrical energy to affect cardiac rhythms

3.28

sealing mechanism

circumferential barriers within the *connector cavity* (3.4) intended to maintain electrical isolation between electrically insulated parts of an assembled and implanted *connector system* (3.3)

3.29

securing mechanism

mechanism within the *connector cavity* (3.4) intended for mechanically securing the *lead connector* (3.16)

EXAMPLE Set screw.

3.30

strain relief zone

area on the *lead connector* (3.16) provided for making a gradual transition from a more rigid section to a more flexible section

Note 1 to entry: The gradual transition results in an area over which strain is distributed so that concentrated mechanical forces do not occur when the lead is flexed.

3.31

tripolar

having three poles or electrodes

4 Requirements

4.1 General

Not all connector features or pulse generator features are specified nor do the requirements in this document address all aspects of functional compatibility, safety or reliability of leads and pulse generators assembled into a system. Each manufacturer is responsible for any requirements and tests necessary to address these as well as the biocompatibility and biostability of their material choices.

The test methods provided for the requirements are type (qualification) tests and are not intended to be used as routine production tests. Alternate test methods may be used, including those which result in equivalent or more stringent test conditions. However, in the event of dispute, the test methods described in this document shall be used.

The following tests shall be conducted under ambient conditions unless otherwise specified. Each manufacturer is responsible for any preconditioning required to represent “as-shipped” configurations, as well as for selection of appropriate sample sizes.

Leads and pulse generators marked in accordance with [Table 1](#) and [Table 2](#) shall conform with all requirements in this document.

Refer to [Annex O](#) for the rationale on standardization and for more information on the requirements in this clause.

4.2 Lead connector physical requirements

4.2.1 Dimensions

4.2.1.1 General

Lead connectors shall have the dimensions specified in [Figure 1](#) and [Figure 2](#) and shall meet the requirements in [4.2.1.2](#) to [4.2.1.11](#) in accordance with each zone.

4.2.1.2 Total axial pin movement, *M*

Total axial pin movement is the difference in lead connector pin length from when the connector pin is fully seated against datum A to when the connector pin is fully extended from datum A. The total axial pin movement shall not be greater than 0,25 mm.

4.2.1.3 Pristine contact zones

The minimum length of each of the pristine contact zones, expressed in millimetres, shall be:

$$0,90 + M$$

where M is the total axial pin movement in millimetres.

Lead connectors shall have an electrically conductive contact surface over the entire length of each of the pristine contact zones. Contact surfaces may extend beyond the pristine contact zones.

The surface roughness in these zones shall be of a maximum $Ra = 0,8 \mu\text{m}$. The entire surface area shall be considered when measuring surface roughness. No indentations, protrusions, gaps or steps exceeding surface roughness allowance are allowed in these zones.

4.2.1.4 Pristine seal zones

The minimum length of each pristine seal zone, expressed in millimetres, shall be:

$$1,81 + M$$

where M is the total axial pin movement in millimetres.

Lead connectors shall have a seal surface over the entire length of each of the pristine seal zones. Seal surfaces may extend beyond the pristine seal zones. No indentation, protrusions, gaps or steps exceeding surface roughness allowance are allowed in these zones.

For surfaces of materials with hardness 75D or less, the surface roughness in this zone shall be a maximum of $Ra = 0,8 \mu\text{m}$. The entire surface shall be considered when measuring surface roughness except that uniform linear protrusions, such as caused by mould parting lines, may be excluded from the measurement if they do not exceed 0,025 mm in height as measured radially or 0,12 mm in width.

For surfaces in this zone made from materials with hardness above 75D, the surface roughness shall be a maximum of $Ra = 0,4 \mu\text{m}$ when the entire surface is considered, including any uniform linear protrusions.

4.2.1.5 Lead connector body

The diameter for all conductive components and surfaces within this zone shall be $3,2 \text{ mm} \pm 0,03 \text{ mm}$.

The diameter for all non-conductive components and surfaces within this zone shall be $3,2 \text{ mm} \pm 0,05 \text{ mm}$.

For all areas in this zone except pristine seal zones and pristine contact zones, the following requirements shall be applied.

- a) Any radial steps or protrusions, such as those caused by a mismatch of adjacent components or by welds, shall not exceed 0,05 mm (in height) and shall not cause the diameter to go outside the tolerance specified with the following exception. Uniform linear protrusions that do not exceed 0,025 mm in height as measured radially or 0,12 mm in width are allowed only for surfaces of materials that are at 75 Shore D or below.
- b) Any gap shall not exceed 0,1 mm in width when measured to include all edge breaks at the gap edge. There shall not be more than one gap between each pristine zone. For any gap that meets these requirements, the area within the gap need not meet the other requirements of this subclause, for example, diameter and radial step requirements.
- c) Any indentations, such as holes or weld depressions, shall not exceed 0,5 mm in diameter.
- d) The surface roughness for Key 3 of [Figure 1](#) shall be of a maximum $Ra = 0,8 \mu\text{m}$ from datum A to 16,04 mm and shall be of a maximum $Ra = 1,6 \mu\text{m}$ from 16,04 mm to the transition Key 7, excluding the chamfer area. Surface finish measurements are not required to include any surface features that meet the requirements in a) to c).

4.2.1.6 Strain relief zone

The diameter in the strain relief zone shall be 4,1 mm maximum and 3,8 mm minimum.

4.2.1.7 Grip zone

The diameter in the grip zone shall be 4,3 mm maximum.

4.2.1.8 Chamfer zone

The length of the chamfer in the chamfer zone, expressed in millimetres, shall be:

- a) minimally: 0,35;
- b) maximally:
0,7 – M

where M is the total axial pin movement in millimetres.

4.2.1.9 Transition zone

The transition between the Ø3,2 mm nominal and the Ø4,1 mm maximum shall occur within the theoretical envelope between datum B and Datum C. Datum B is defined by the 60° angle and the intersection of the Ø4,1 mm at the 17,7 mm dimension. Transition geometry does not need to match this angle.

The diameter in the transition zone shall not exceed 4,1 mm.

4.2.1.10 Insertion indicator zone

The insertion indicator zone is provided for an optional insertion indicator. If an insertion indicator is present, it shall meet the following requirements.

- a) The indicator shall not extend beyond the zone.
- b) The proximal edge shall meet the 5,10 mm ± 0,10 mm dimension.
- c) The diameter shall fall within the nominal diameter specified and the tolerance of $\frac{+0,03}{-0,10}$ mm.
- d) Any gaps shall not exceed 0,10 mm in width. For any gap that meets this requirement, the area within the gap does not to meet the other requirements of this subclause, such as the diameter and radial step requirements.
- e) Any radial steps shall not exceed 0,05 mm.

4.2.1.11 Pin pristine contact zone

Lead connectors shall have an electrical contact surface over the entire length of this zone.

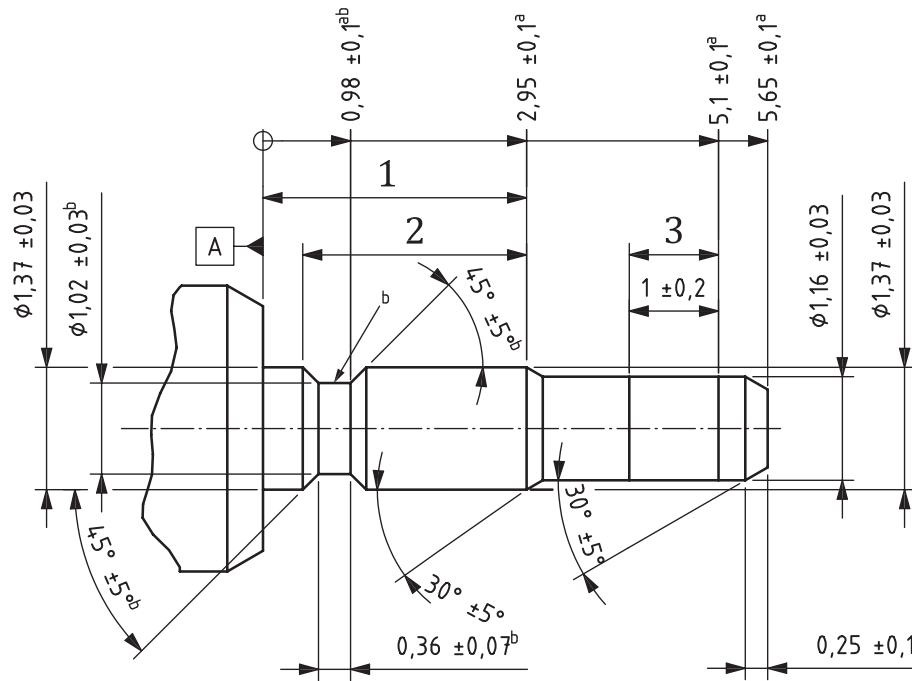
The surface roughness in this zone shall be of a maximum $Ra = 0,8 \mu\text{m}$.



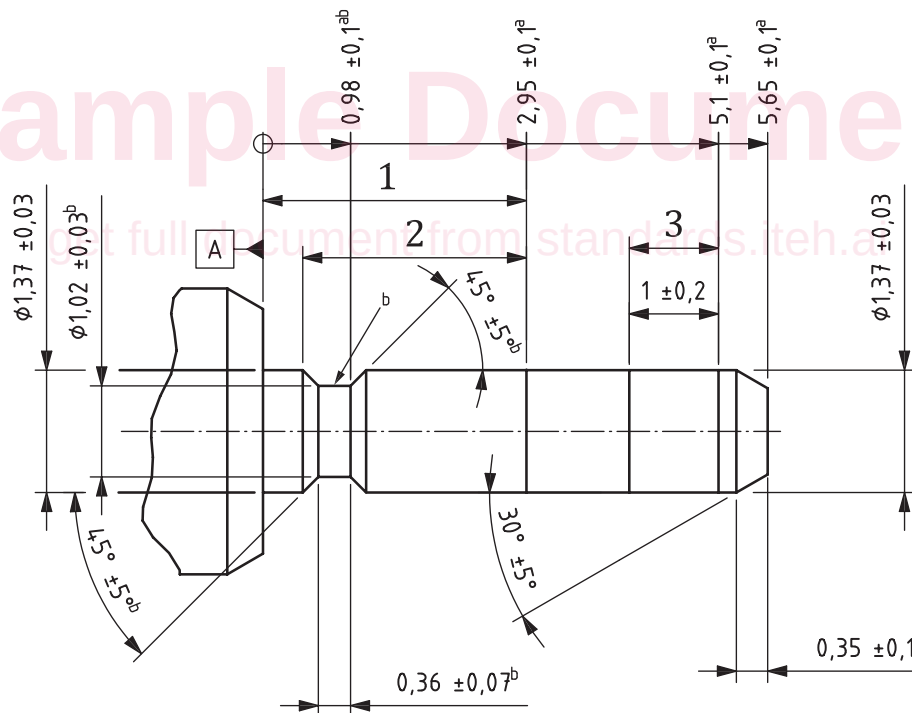
- 1 pristine contact zones
2 pristine seal zones
3 lead connector body
4 strain relief zone
5 grip zone
6 chamfer zone
7 transition zone
8 total axial pin movement, M

NOTE The diameter dimensions of the soft sections, in Key 4, Key 5 and Key 7, of the lead can be determined as the mean value of three measurements taken at locations oriented approximately 120° apart around the principal axis of the lead connector.

Figure 1 — Four-pole lead connector body



a) High-voltage lead connector pin



b) Low-voltage only lead connector pin

Key

- 1 pin fixation zone
- 2 pin pristine contact zone
- 3 insertion indicator zone
- a The dimension applies only when all axial movement has been biased by seating the connector pin against the connector body.
- b The dimension applies to the notch feature. The notch feature is optional and may be omitted.

Figure 2 — Four-pole lead connector high-voltage and low-voltage only pin details