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Industrial automation systems and integration — Distributed installation in industrial applications —

Part 3: Power distribution bus

Systèmes d'automatisation industrielle et intégration — Installation distribuée dans les applications industrielles —

Partie 3: Bus de distribution d'énergie

Reference number
ISO 23570-3:2006(E)

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 23570-3 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 1, *Physical device control*.

ISO 23570 consists of the following parts, under the general title *Industrial automation systems and integration — Distributed installation in industrial applications*:

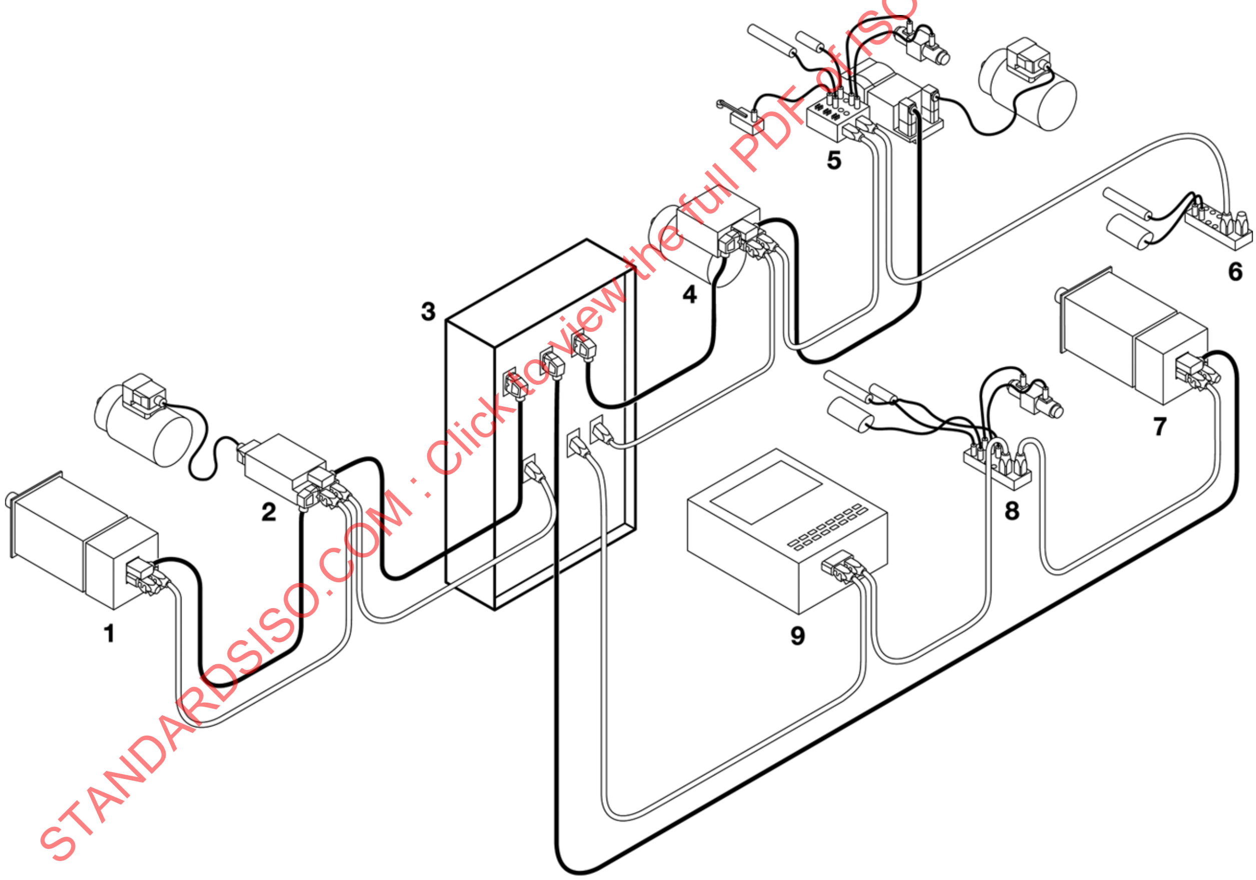
— *Part 1: Sensors and actuators*

— *Part 2: Hybrid communication bus*

— *Part 3: Power distribution bus*

Introduction

Modern machine tools for the discrete parts manufacturing industry are complex systems, consisting of subsystems for material preparation (metal removal, material forming, etc.), material handling, fixturing and transfer lines for moving parts from one station to another. Each subsystem, in turn, is itself a complex system, including many sensors, actuators and control elements that receive and transmit electric signals and/or require electric power. To reduce down time in case of failure, most of them use cable assemblies for quick replacement. Proper operation of the system as a whole requires co-ordination of the subsystems, which requires more cables and connectors. As a consequence of this complexity, a large variety of cables and connectors are required for the proper operation of such a machine tool. The increasing number of sensors, actuators and control elements leads to an increasing variety of such cable assemblies. This variety results in increased maintenance costs due to complexity, large spare parts inventory, and increased training costs for maintenance personnel.



Key

1 motor with integrated electronics (e.g. a stepping motor)
2 fixed speed motor with separate motor controller
3 power distribution and control cabinet
4 fixed speed motor with attached motor controller
5 variable speed motor with integrated I/O module together with sensors and actuators
6 I/O module with a set of sensors
7 motor with integrated electronics (e.g. a stepping motor)
8 I/O module connected to a set of sensors and actuators including a hydraulic/pneumatic valve
9 remote control terminal

Figure 1 — System components addressed in ISO 23570

ISO 23570 prescribes a set of requirements for cables, connectors and parameter selections within these elements, which, if implemented completely, will greatly reduce the wiring complexity and maintenance cost of such machine systems. Benefits will occur to the manufacturer of such systems in decreased complexity costs and to the user of such systems in decreased down time because of decreased parts inventory and simplified maintenance training.

The technology described in ISO 23570 may have applicability to other industries and processes; there is no intention of restricting it to discrete parts manufacturing.

There are three main areas addressed within ISO 23570:

— the interconnection of sensors and actuators to the system backbone;

— a hybrid system backbone containing an information path (a fieldbus) and a source of power to the field devices;

— a power trunk capable of providing power to all the auxiliary motors in the system.

Large power devices, such as spindle motors for metal removal are not covered by ISO 23570.

Machine tools described in ISO 23570 are subject to constraints imposed by national and international safety standards. It is the intention of ISO 23570 to specify system elements that support the compliance to such standards.

In Figure 1, the solid cable represents the power distribution bus providing three-phase AC power for electric motors. The open cable represents a hybrid communication bus, containing both a fieldbus communication channel and low voltage power.

The centre of the figure shows a control cabinet (3) serving three sets of distribution buses. This box contains the fieldbus communication front end, the low voltage power supplies and the three-phase power supplies.

To the left of the control cabinet are (1) a motor with integrated electronics and (2) a fixed speed motor with a separate motor controller. Both units are linked to the control cabinet by both the communication bus and the power distribution bus.

To the right of the control cabinet are (4) a fixed speed motor with an attached motor controller, (5) a variable speed motor with an integrated I/O module connected to several sensors and actuators, and (6) another I/O module connected to several sensors and actuators, including a hydraulic/pneumatic valve. The I/O module (6) is linked to the control cabinet only by the hybrid communication bus.

In front of the control cabinet are three more units, (7) a motor with integrated electronics, (8) another I/O module connected to several sensors and actuators including a hydraulic/pneumatic valve, and (9) a remote control terminal.

The figure is intended to illustrate the variety of interconnections possible employing the elements of ISO 23570.

ISO 23570-1 provides the requirements for sensors, actuators, and I/O modules that support this system requirement. ISO 23570-2 provides the requirements for a shared communication and low voltage power distribution system. ISO 23570-3 provides the requirements for distribution of power to the low power motor systems.

While significant reduction in maintenance and operational costs may be achieved by adoption of individual parts of ISO 23570, the greatest benefit will occur only if all parts are implemented.

Industrial automation systems and integration — Distributed installation in industrial applications —

Part 3: Power distribution bus

1 Scope

The scope of ISO 23570 is the interconnection of elements in the control system of machine tools and similar large pieces of industrial automation. This specification includes cable types, sizes and sheath colours, connector types and contact assignments, and diagnostic functions appropriate to the sensors and actuators.

This part of ISO 23570 covers the interconnection of three-phase auxiliary motors with their power source.

NOTE ISO 23570 does not address the design or operation of such equipment with respect to safety issues. Appropriate safety standards should be consulted for such requirements.

2 Conformance

Producers of power bus cable assemblies may claim conformance to this part of ISO 23570 if they meet the requirements of Clause 5.

Producers of motor controllers may claim conformance to this part of ISO 23570 if they meet the requirements of Clause 5 and the requirements of Clause 6.

Producers of connectors may claim conformance to this part of ISO 23570 if they meet the requirements of Clause 5 or the requirements of Clause 6.

Producers of motors and motor cable assemblies may claim conformance to this part of ISO 23570 if they meet the requirements of Clause 6.

Producers of discrete part manufacturing equipment may claim conformance to this part of ISO 23570 if all the components of the discrete part manufacturing equipment that are subject to the requirements of Clause 5 and/or Clause 6 meet those requirements.

3 Normative references

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

IEC 60529:2001-02 Ed. 2.1, *Degrees of protection provided by enclosures (IP code)*

4 Terms and definitions

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

4.1
IP Code
coding system to indicate the degrees of protection provided by an enclosure against access to hazardous parts, ingress of solid foreign objects, ingress of water and to give additional information in connection with such protection

[IEC 60529]

5 Requirements for power bus

5.1 General

This part of ISO 23570 specifies a cable system capable of supplying three-phase power to auxiliary motors present in the system. Motors, that power cutting spindles, are outside the scope of this part of ISO 23570.

All components specified by ISO 23570 shall be rated IP65 and IP67 as defined in IEC 60529.

NOTE 1 Components and systems covered by this part of ISO 23570 may also be subject to requirements on EMC.

NOTE 2 For the purposes of this part of ISO 23570, auxiliary motors are defined to be motors capable of providing 5,5 kW output or less.

5.2 Cables and cable assemblies

The cable for the power bus shall contain seven wires. The minimum cross-sectional area of a wire shall be 2,5 mm^2.

Cables shall have an outer sheath whose material is resistant to all common industry coolants. The supplier of cable assemblies shall provide a list of lubricants and coolants that are compatible with the cable. The sheath colour shall be black.

NOTE See Annex D for further elaboration of the colour specification.

A cable connector meeting the requirements of 5.3 shall terminate each end of a cable assembly. One end of the cable assembly shall have a male connector; the other end shall have a female connector.

Some uses of such cables may require constant flexing such as use in drag chain operations. The cable shall be characterized as to whether it is suitable for such an operation.

All low voltage control cables that are not otherwise specified in ISO 23570 shall have a sheath colour of grey.

5.3 Connectors

The connectors shall have a positive coupling facility ensuring that the connectors are fully mated. The coupling facility shall require either no tools or simple hand tools to couple or uncouple. Connectors shall be polarized so as to avoid incorrect mating.

The contacts for the wires shall be matched in size to the cable wires to ensure physical integrity of the connection and adequate electrical conductance. The contacts for the wires shall have a current-carrying capacity of 10 A or greater per contact.

The connectors shall have six contacts plus protective earth. Table 1 provides the contact assignments for these connectors.

Table 1 — Contact assignment for power bus connectors

Contact	Assignment
1	Phase 1 power
2	Phase 2 power
3	Phase 3 power
4	Neutral
11	Brake
12	Brake
PE	Protective earth

NOTE Annex A provides further specification for connectors satisfying these requirements.

5.4 Motor controllers

Each motor controller shall be equipped with two connectors each meeting the requirements of 5.3, one male connector and one female connector.

NOTE 1 The intention is that the motor controller will be placed in the power bus so that the power is fed to the male connector. Strict adherence to the requirements for cable assemblies and for power supplies provided in this part of ISO 23570 will ensure that this occurs.

The use of the neutral circuit and the brake circuit specified in 5.3 is optional, depending on the requirements of the motors being controlled.

NOTE 2 This clause specifies requirements for motor controllers with respect to the power bus. Further requirements on motor controllers are specified in 6.1.

NOTE 3 If a motor controller is addressable as part of a fieldbus network, further requirements for this motor controller are specified in ISO 23570-2.

In some applications, it may be required that the motor controller be able to be removed from the power bus for servicing without interrupting the power service to other units. The details of how this is to be accomplished are outside the scope of this part of ISO 23570. Motor controllers shall be characterized as to whether they are suitable for such an operation.

5.5 Power supplies

Each power supply output shall be equipped with a female connector meeting the requirements of 5.3 for transmission of power to the auxiliary motors.

NOTE If a power supply is addressable as part of a fieldbus network, further requirements for this power supply are specified in ISO 23570-2

5.6 Cable assembly termination

The final motor controller on the power bus shall include a cover on its downstream plug to meet environmental requirements.

6 Connection of motors to motor controllers

6.1 Connectors

6.1.1 General

The connectors shall have a positive coupling facility ensuring that the connectors are fully mated. The coupling facility shall require either no tools or simple hand tools to couple or uncouple. Connectors shall be polarized so as to avoid incorrect mating.

The contacts for the wires shall be matched in size to the cable wires to ensure physical integrity of the connection and adequate electrical conductance. The contacts for the wires shall have a current-carrying capacity of 10 A or greater per contact.

6.1.2 Motor connector

The motor shall contain a male connector having 11 contacts (10 contacts plus protective earth). Table 2 provides the contact assignments for this connector.

Table 2 — Contact assignment for motor connector

Contact	Assignment
1	Winding U1 – L1
2	Winding V1 – L2
3	Winding W1 – L3
4	Brake
5	Brake
6	Winding W2
7	Winding U2
8	Winding V2
9	Temperature sensor
10	Temperature sensor
PE	Protective earth

NOTE 1 Annex B provides further specification for connectors satisfying these requirements.

NOTE 2 By proper use of this connector, a motor can be operated either in star or delta configuration or optionally perform speed control.

6.1.3 Motor controller connector

The motor controller shall provide a connection to the motor by one of the following three methods.

a) The controller shall provide a cable assembly as specified in 6.2 a), hard wired to the controller.

b) The controller shall provide a female 11-contact connector (ten contacts plus protective earth) mounted on the controller meeting the connector requirements of 6.1.2. A cable assembly as specified in 6.2 b) shall be provided.

c) The controller shall provide a female 9-contact connector (eight contacts plus protective earth) mounted on the controller. A cable assembly as specified in 6.2 c) shall be provided.

Table 3 provides the contact assignments for these 9-contact connectors.

Table 3 — Contact assignment for motor controller connectors

Contact	Assignment
1	Phase L1 power
2	
3	Phase L3 power
4	Brake
5	Temperature sensor
6	Brake
7	Phase L2 power
8	Temperature sensor
PE	Protective earth

NOTE Annex C provides further specification for 9-contact connectors satisfying these requirements.

Figure 2 illustrates the three types of connector cable assemblies specified in items a) to c) of this subclause. The motor has a connector as specified in 6.1.2. At the motor controller, the cable may be hard wired [6.2 case a)], use a connector as specified in [6.2 case b)], or use the connector specified in [6.2 case c)].

6.2 Cables

Cables shall have an outer sheath whose material is resistant to all common industry coolants. The supplier of cable assemblies shall provide a list of lubricants and coolants that are compatible with the cable. Cables may be shielded or unshielded. Shielded cables shall have a sheath colour of orange; unshielded cables shall have a sheath colour of black.

NOTE 1 See Annex D for further elaboration of the colour specification.

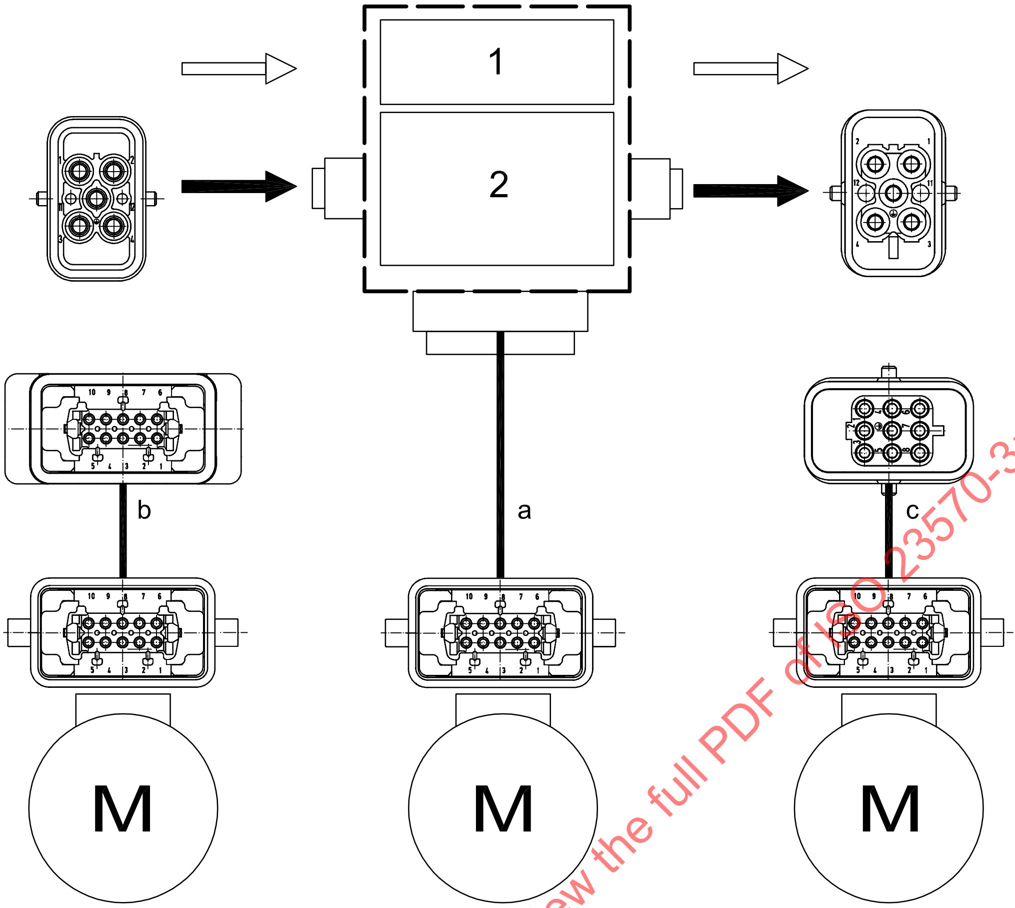
The conductors for the brake control circuit shall be shielded. The conductors for the temperature sensor shall be shielded. Further specifications for the cable depend on which configuration is selected for implementation.

a) The cable assembly is an integral part of the motor controller. The cable shall have eleven conductors (ten plus PE). It shall be terminated in a female connector meeting the requirements of 6.1.2. Table 4, column a), provides the connector wiring assignments for this choice.

b) The cable shall have eleven conductors (ten plus PE). It shall be terminated on one end with a male connector meeting the requirements of 6.1.2, and on the other end with a female connector meeting the requirements of 6.1.2. Table 4, column b), provides the connector wiring assignments for this choice.

c) The cable shall have eight conductors (seven plus PE). It shall be terminated on one end with a male connector meeting the requirements of 6.1.3, and on the other end with a female connector meeting the requirements of 6.1.2. Table 4, column c), provides the connector wiring assignments for this choice.

NOTE 2 Selection between star and delta operation of the motor can be made by the use of a shunt within the female connector of this cable assembly.



Key

1 communications

2 power electronics

[a] Motor controller with a cable assembly terminated with an 11-contact female connector (ten contacts plus protective earth) [see 6.2. a)].

[b] Motor controller with a 11-contact connector (ten contacts plus protective earth) joining the controller and the motor cable assembly [see 6.2. b)].

[c] Motor controller with a 9-contact connector (eight contacts plus protective earth) joining the controller and the motor cable assembly [see 6.2. c)].

Figure 2 — Use of the three types of connectors

Table 4 — Cable wiring assignments

Function	a)		b)		c)	
	controller	motor	controller	motor	controller	motor
	fixed	Annex B connector	Annex B connector	Annex B connector	Annex C connector	Annex B connector
Winding U1 – L1	—	1	1	1	1	1
Winding V1 – L2	—	2	2	2	7	2
Winding W1 – L3	—	3	3	3	3	3
Brake	—	4	4	4	4	4
Brake	—	5	5	5	6	5
Winding W2	—	6	6	6	—	6
Winding U2	—	7	7	7	—	7
Winding V2	—	8	8	8	—	8
Temperature sensor	—	9	9	9	5	9
Temperature sensor	—	10	10	10	8	10
Protective earth	—	PE	PE	PE	PE	PE

Annex A
(normative)

Design specification for power bus connectors

A.1 Male power bus connector

Figure A.1 is a drawing of the male power bus connector. The centre (unnumbered) contact provides a PE contact.

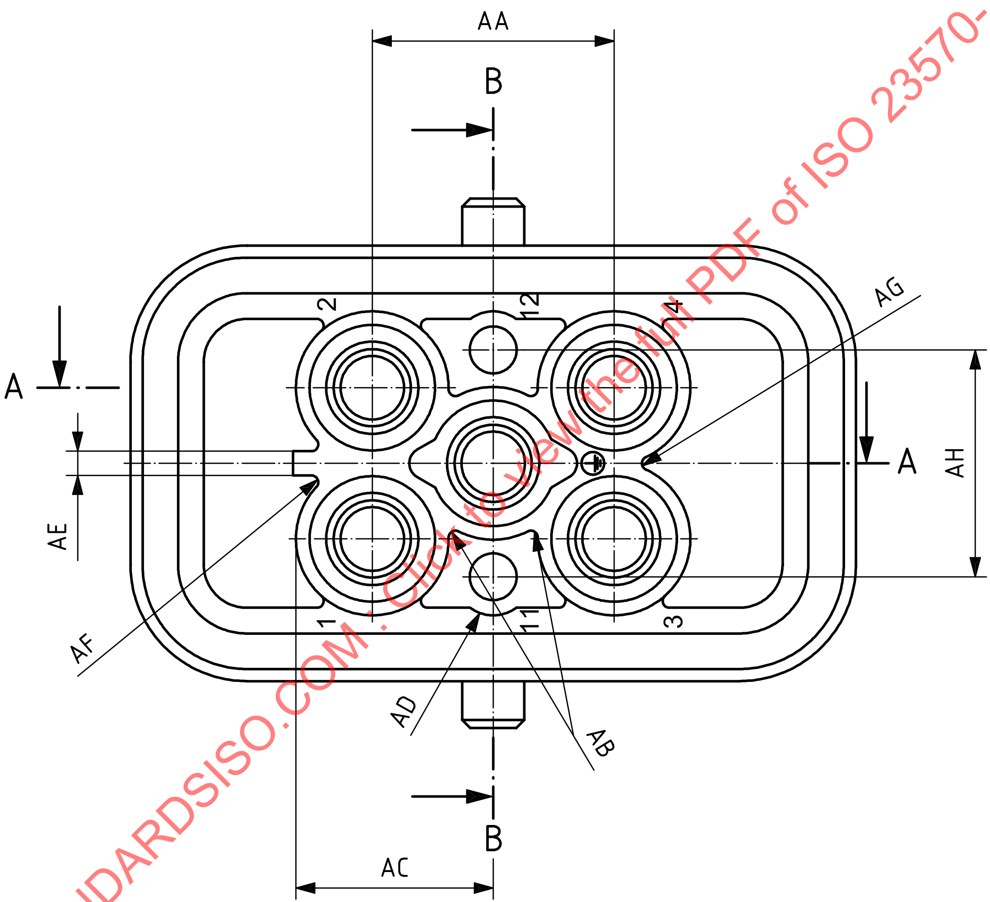
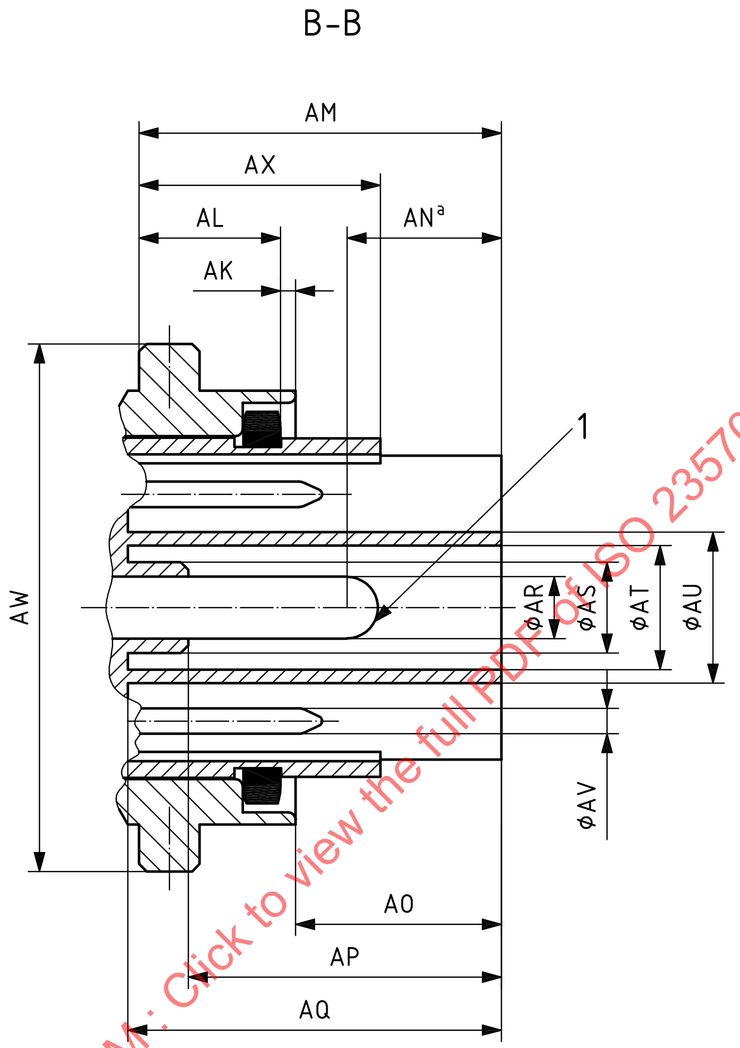


Figure A.1 — Male power bus connector

Figure A.2 provides a view through section B-B of the connector.



NOTE The dimension AK is not relevant for the male fixed connector.

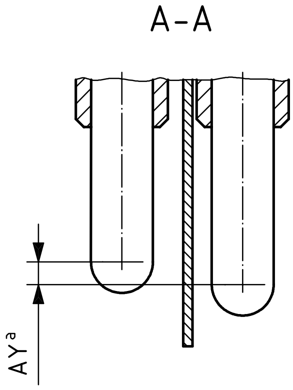
Key

1 PE-contact

[a] The centre contact is longer than the power contacts so that it makes contact upon insertion before the other contacts.

Figure A.2 — Male connector section view B-B

Figure A.3 provides a view through section A-A of the connector. Note that this section has an offset so as to pass through contact 2 and the centre contact.



NOTE This part of ISO 23570 specifies only those dimensions necessary to achieve the objectives of this document, hence, some entries are not present. An actual implementation will need to specify all the dimensions.

[a] The power contacts are shorter so that the centre contact (protective earth) makes contact upon insertion, before the other contacts.

Figure A.3 — Male connector section view A-A

Table A.1 provides the dimensions for this connector. All dimensions are in millimetres unless otherwise indicated.

Table A.1 — Dimensions of male connector

Letter	Maximum	Minimum	Nominal
AA	16,1	15,9	16,0
AB	0,6	0,4	0,5
AC	13,4	13,0	13,2
AD	2,7	2,6	2,6
AE	1,7	1,3	1,5
AF	0,7	0,3	0,5
AG	0,7	0,3	0,5
AH	15,1	14,9	15,0
AK		0,5	
AL	10,1	9,6	9,85
AM	24,2	23,6	23,9
AN	10,3		
AO	13,6		

Letter	Maximum	Minimum	Nominal
AP		20,2	
AQ		24,4	
AR	4,0	3,95	4,0
AS	6,1		
AT	8,3	8,2	8,2
AU	10,1	9,9	10,0
AV	1,62	1,54	1,6
AW	36,1		
AX	16,2	15,6	15,9
AY		1,2	

The dimensions are as shown for the male cable connector. For the fixed male connector, AK = 0.

A.2 Female power bus connector

Figure A.4 is a drawing of the female power bus connector.

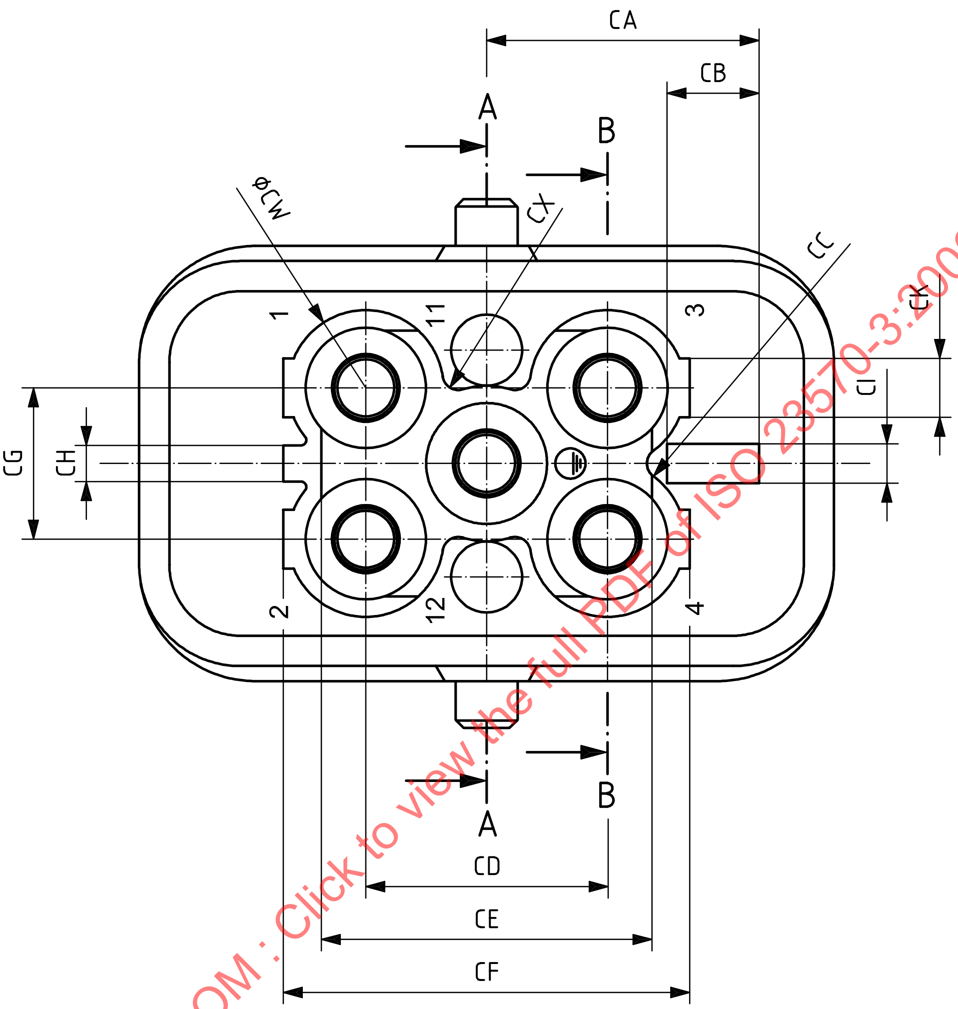
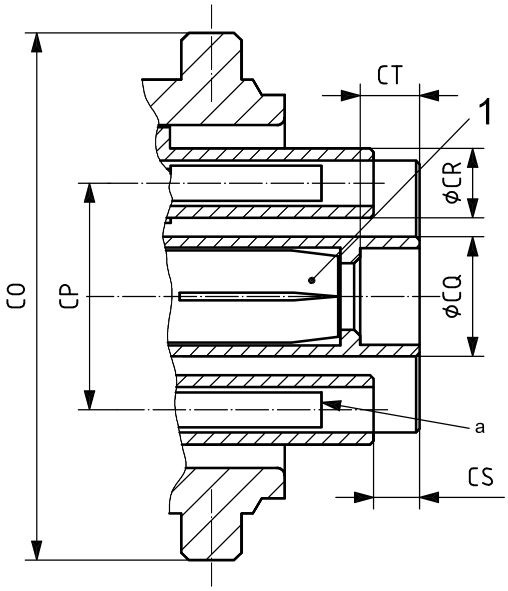


Figure A.4 — Female power bus connector

Figure A.5 provides a view through section A-A of the connector.



Key

1 PE-contact

[a] The power contacts are shorter so that the centre contact (protective earth) makes contact upon insertion, before the other contacts.

Figure A.5 — Female connector section view A-A

Figure A.6 provides a view through section B-B of the connector.

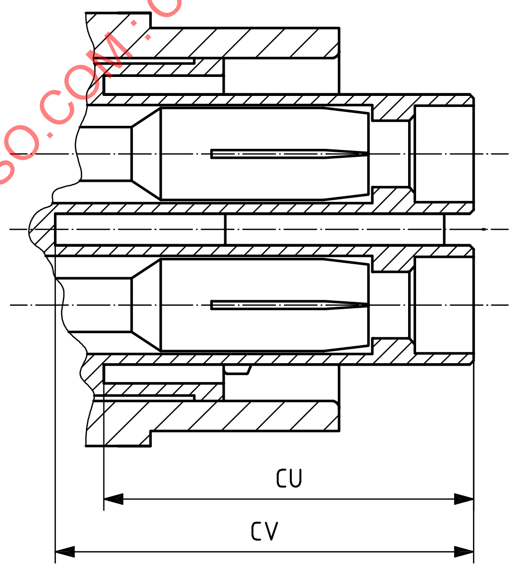


Figure A.6 — Female connector section view B-B

Figure A.7 provides a side view of the connector.

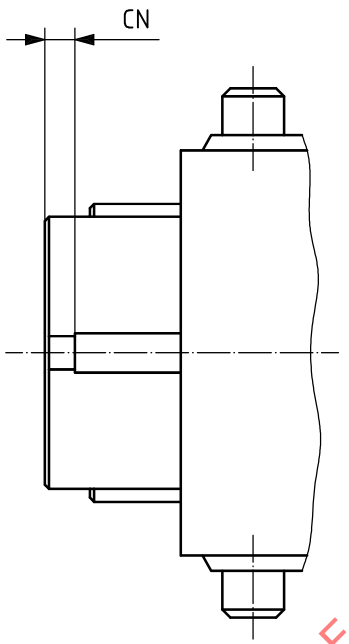


Figure A.7 — Female connector side view

Table A.2 provides the dimensions for this connector. All dimensions are in millimetres unless otherwise indicated.

NOTE This part of ISO 23570 specifies only those dimensions necessary to achieve the objectives of this document, hence, some entries are not present. An actual implementation will need to specify all the dimensions.

Table A.2 — Dimensions of female connector

Letter	Maximum	Mininum	Nominal
CA	18,4	18,0	18,2
CB	6,2	6,0	6,0
CC	1,2	0,8	1,0
CD	16,1	15,9	16,0
CE	22,1	21,9	22,0
CF	27,1	26,8	26,8
CG	10,1	9,9	10,0
CH	2,7	2,3	2,5
CI	2,7	2,3	2,5
CK	4,2	3,8	4,0
CN	2,3	1,7	2,0
CO	36,1		
CP	15,1	14,9	15,0
CQ	8,0	7,8	7,9

Letter	Maximum	Mininum	Nominal
CR	4,7	4,5	4,6
CS	3,3	2,7	3,0
CT	4,1	3,7	3,9
CU		24,3	
CV		27,5	
CW	10,5	10,3	10,4
CX	1,2	0,8	1,0

Annex B
(normative)

Design specification for motor connectors

B.1 Male motor cable connector

Figure B.1 is a drawing of the male motor connector.

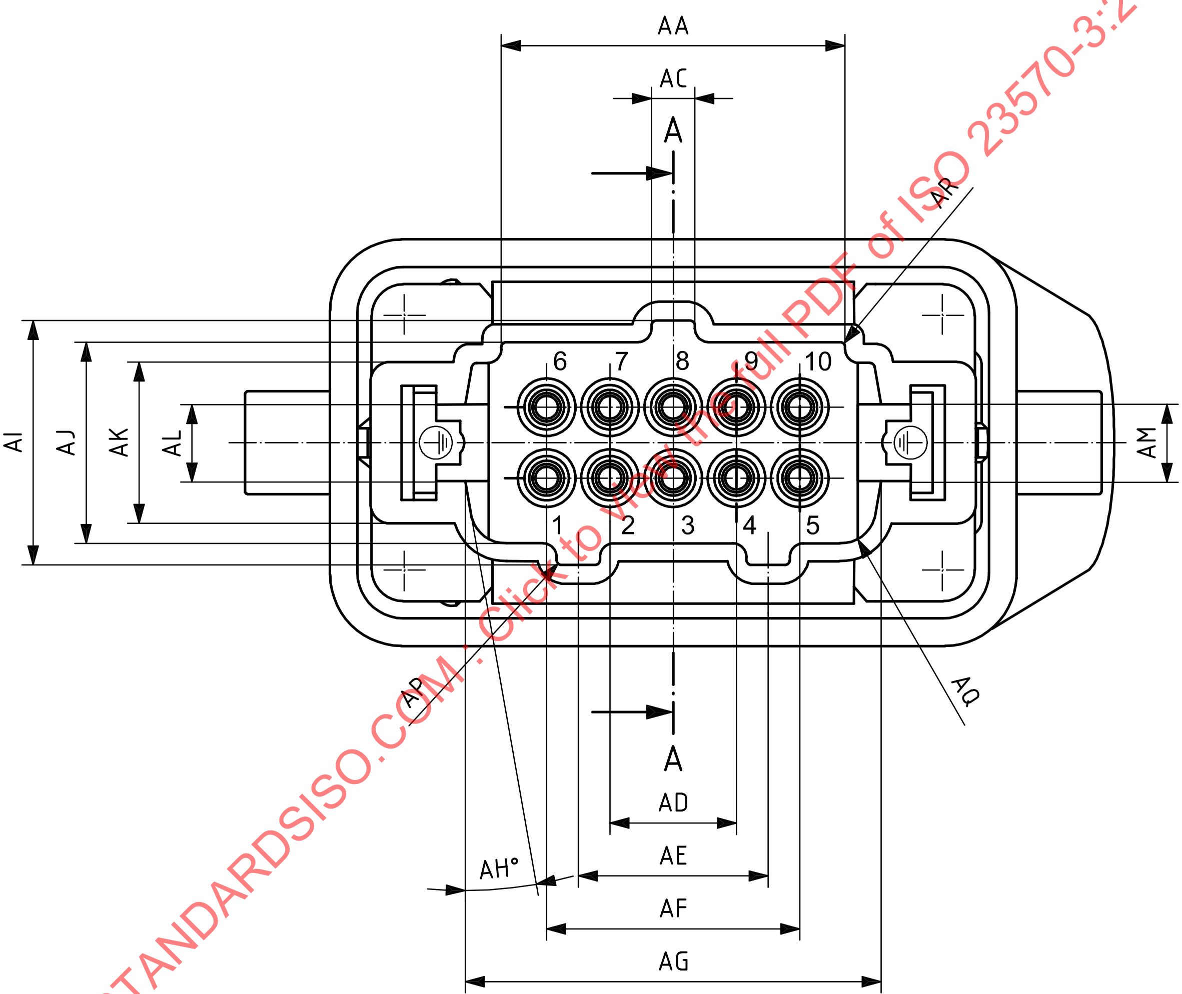


Figure B.1 — Male motor cable connector

Figure B.2 provides a section view through the mid-point of the connector.

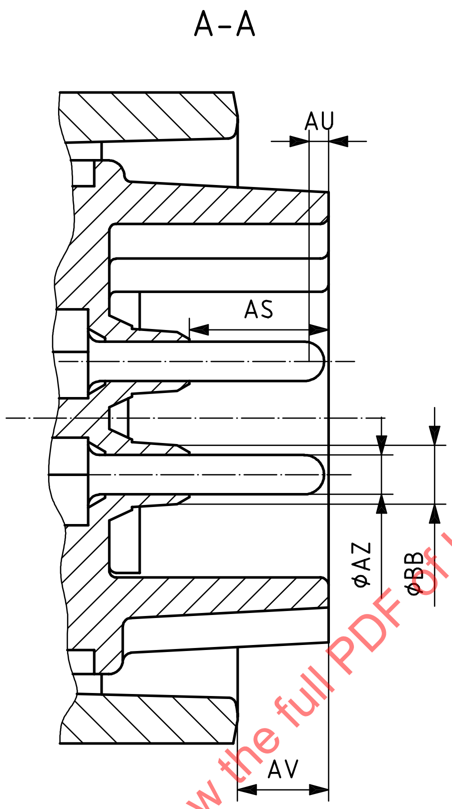


Figure B.2 — Male connector section view

Table B.1 provides the dimensions for this connector. All dimensions are in millimetres unless otherwise indicated.

NOTE This part of ISO 23570 specifies only those dimensions necessary to achieve the objectives of this document, hence, some entries are not present. An actual implementation will need to specify all the dimensions.

Table B.1 — Dimensions of male cable connector

Letter	Maximum	Mininum	Nominal
AA	37,1	36,3	36,3
AC	4,8	4,5	4,5
AD	13,5	13,3	13,4
AE	20,1	19,9	20,0
AF	26,9	26,7	26,8
AG		44,0	
AH	15,0°		
AI	26,1	25,8	25,8
AJ	21,4	21,2	21,2
AK	19,2	18,7	19,0
AL	7,6	7,4	7,5
AM	8,2	7,9	8,0

Letter	Maximum	Mininum	Nominal
AP	0,7	0,3	0,5
AQ	3,2		
AR	0,7	0,3	0,5
AS	9,5	8,9	9,3
AU	1,85		
AV	6,05	5,45	6,0
AZ	2,5	2,45	2,5
BB	4,2		

B.2 Female motor fixed connector

Figure B.3 is a drawing of the female motor connector.

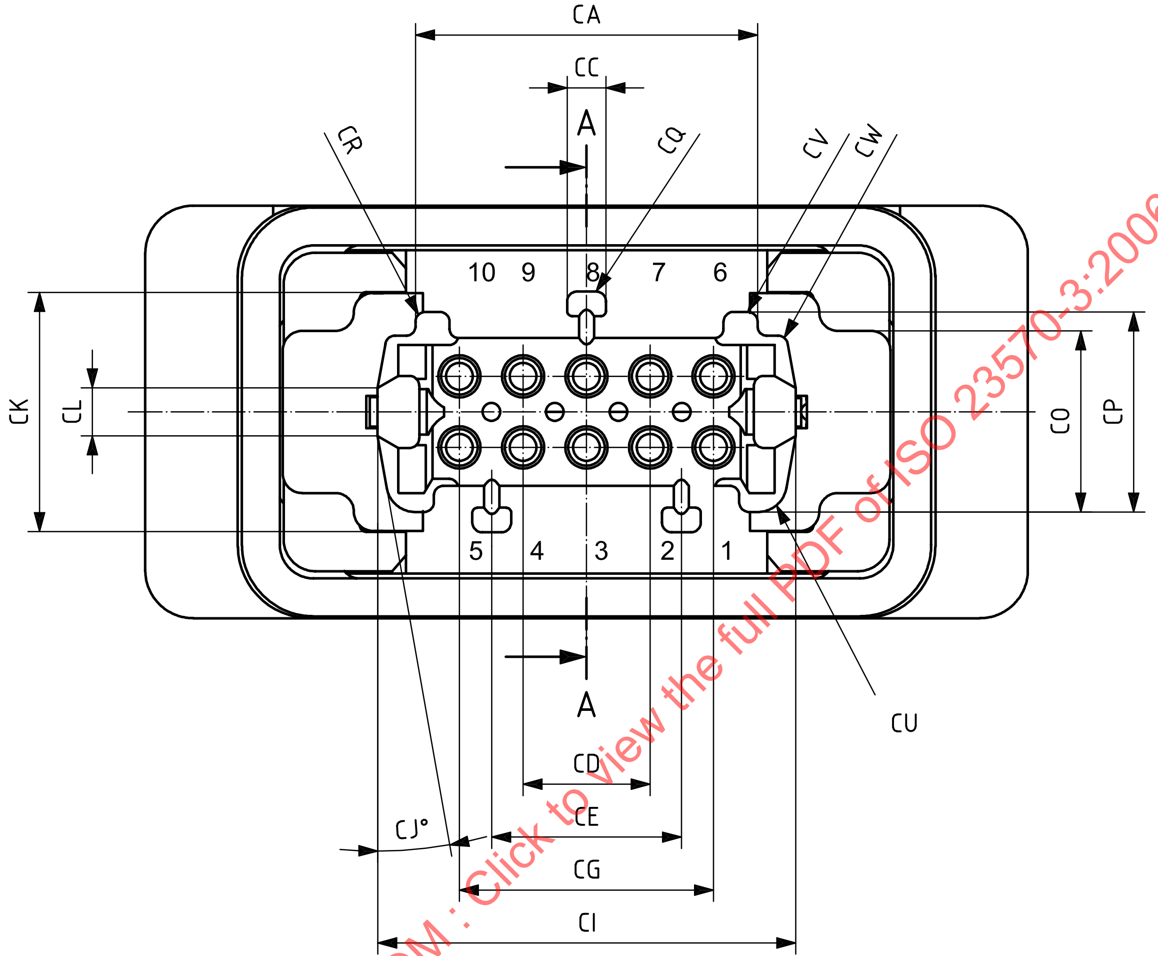


Figure B.3 — Female motor fixed connector

Figure B.4 provides a section view through the mid-point of the connector

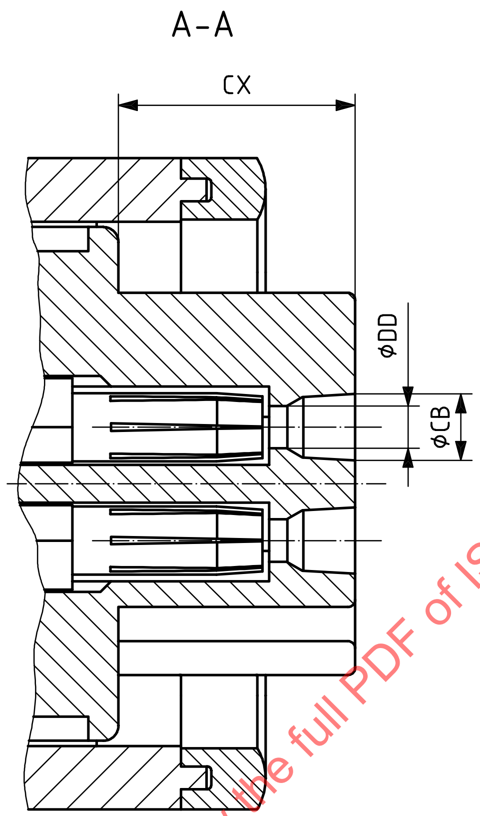


Figure B.4 — Female connector section view

Table B.2 provides the dimensions for this connector. All dimensions are in millimetres unless otherwise indicated.

NOTE This part of ISO 23570 specifies only those dimensions necessary to achieve the objectives of this document, hence, some entries are not present. An actual implementation will need to specify all the dimensions.

Table B.2 — Dimensions of female fixed connector

Letter	Maximum	Minimum	Nominal
CA	36,0	35,8	36,0
CB		4,4	
CC	4,2	3,8	4,0
CD	13,5	13,3	13,4
CE	20,1	19,9	20,0
CG	26,9	26,7	26,8
CI	44,0		
CJ	15,0°	10,0°	10,0°
CK	25,3	25,0	25,3
CL	5,1		
CO	18,5	18,0	18,5

Letter	Maximum	Minimum	Nominal
CP	21,0	20,8	21,0
CQ		0,5	
CR		0,5	
CU		2,5	
CV		0,5	
CW		0,8	
CX		13,5	

Annex C
(normative)

Motor controller connector

C.1 Male motor controller cable connector

Figure C.1 is a drawing of the male motor controller connector

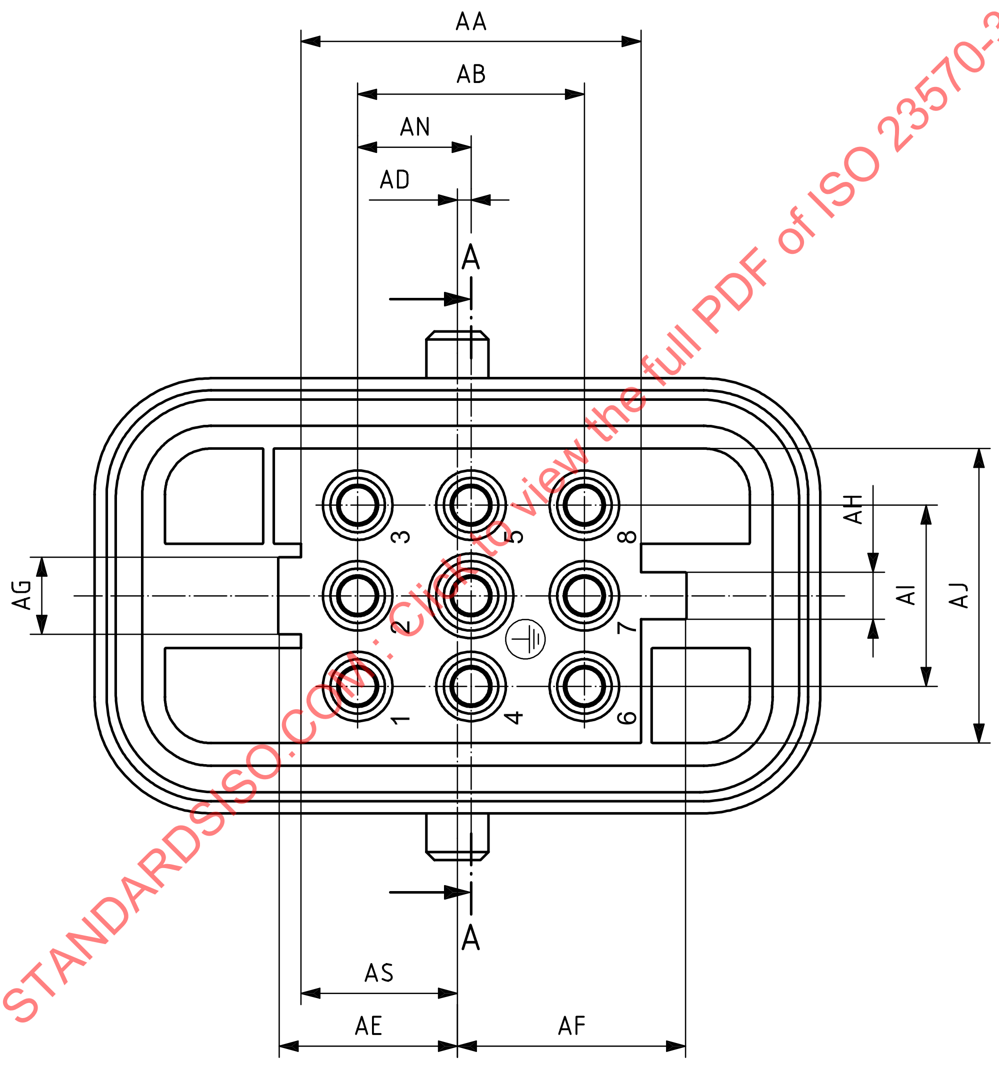


Figure C.1 — Male motor controller cable connector