
**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



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Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Conformance	1
3 Normative references	1
4 Terms and definitions	2
5 Requirements for power bus	2
5.1 General.....	2
5.2 Cables and cable assemblies	2
5.3 Connectors	2
5.4 Motor controllers	3
5.5 Power supplies.....	3
5.6 Cable assembly termination	3
6 Connection of motors to motor controllers	4
6.1 Connectors	4
6.2 Cables	9
Annex A (normative) Design specification for power bus connectors	13
Annex B (normative) Design specification for type 1 motor/controller connectors	19
Annex C (normative) Design specification for type 2 motor/controller connectors	23
Annex D (normative) Design specification for type 3 motor/controller connectors	28
Annex E (informative) Reference colours	37
Bibliography	38

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, *Automation systems and integration*, Subcommittee SC 1, *Physical device control*.

This second edition cancels and replaces the first edition (ISO 23570-3:2006), of which it constitutes a minor revision.

The following significant changes have been made to the first edition:

- a) addition of a third variant of motor connectors which is especially suitable for smaller motors, either in physical size, in power capacity, or both, and which can be used to interconnect the motor controller and the auxiliary motors;
- b) extension and reorganization of the contents of Clause 6 in order to describe the new motor connector;
- c) addition of a new Annex D, which describes the design elements of the new motor connector;
- d) renumbering of previous Annex D as Annex E.

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.

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. The manufacturer of such systems will benefit in terms of decreased complexity costs, and the user of such systems will benefit in terms of 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, i.e. there is no intent to restrict it to discrete parts manufacturing.

The following three main areas are 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, and
- 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. ISO 23570 is intended to specify system elements that support the compliance to such standards.

Figure 1 illustrates the system components addressed in ISO 23570. In the figure, the solid cable represents the power distribution bus providing three-phase a.c. power for electric motors. The open cable represents a hybrid communication bus, containing both a fieldbus communication channel and low voltage power.

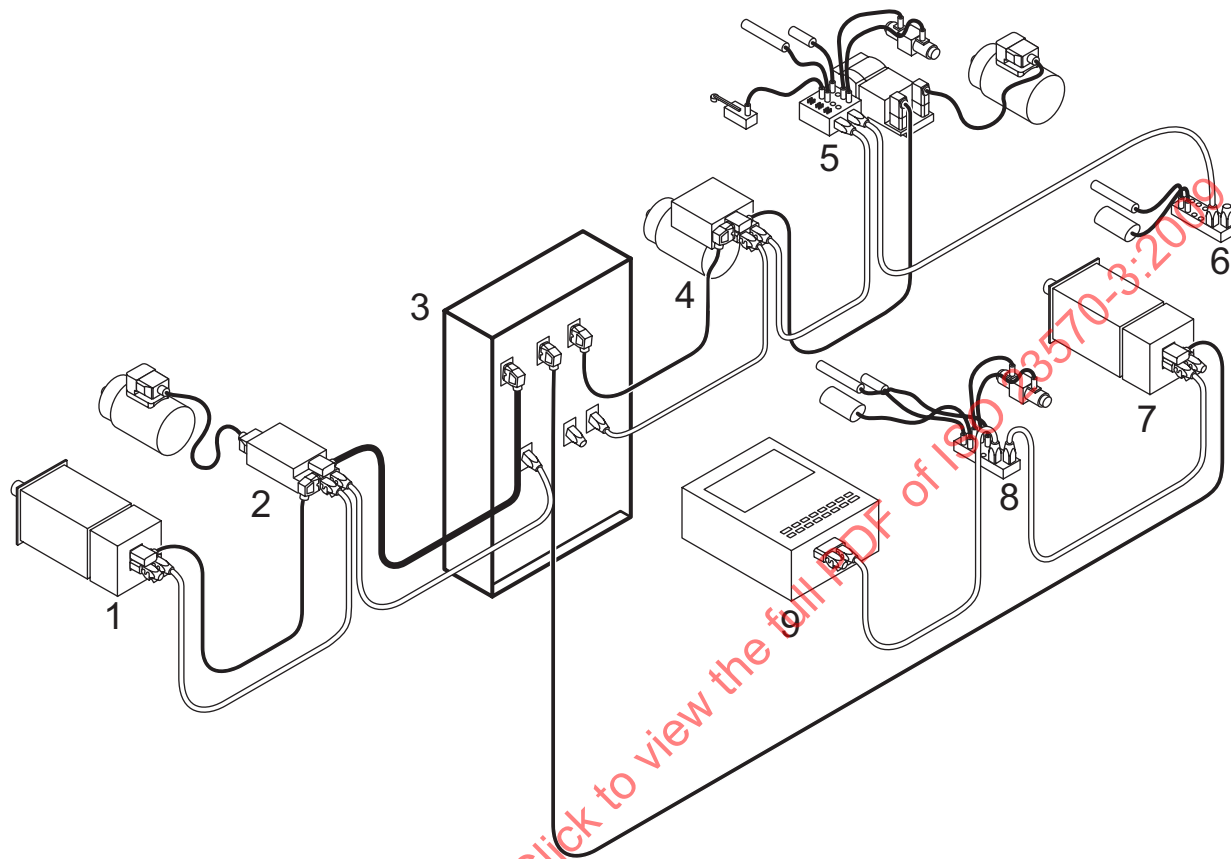
The centre of the figure shows a control cabinet (3) serving three sets of distribution buses. This box contains the fieldbus communication front end, the low voltage power supplies and the three-phase power supplies.

To the left of the control cabinet are a motor with integrated electronics (1) and a fixed speed motor with a separate motor controller (2). 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 a fixed speed motor with an attached motor controller (4), a variable speed motor with an integrated I/O module connected to several sensors and actuators (5), and another I/O module (6) 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: a motor with integrated electronics (7), another I/O module connected to several sensors and actuators including a hydraulic/pneumatic valve (8), and a remote control terminal (9).

Figure 1 is intended to illustrate the variety of interconnections possible using the elements of ISO 23570.



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 23570-1 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. This part of ISO 23570 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.

This part of ISO 23570 provides requirements for the distribution of power to the low power motor systems.

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

Part 3: Power distribution bus

1 Scope

ISO 23570 specifies the interconnection of elements in the control system of machine tools and similar large pieces of industrial automation, including 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 specifies the interconnection of single-phase or three-phase auxiliary motors with their power source.

ISO 23570 does not address the design or operation of such equipment with respect to safety issues. It is advisable that appropriate safety standards 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, *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

International Protection 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 60529:2001]

4.2

auxiliary motor

motor capable of providing 5,5 kW power output or less

5 Requirements for power bus

5.1 General

This part of ISO 23570 specifies a cable system capable of supplying 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 Components and systems covered by this part of ISO 23570 can also be subject to requirements on EMC.

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 mm².

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 E 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 operation. Cables shall be characterised as to whether it is suitable for such 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 polarised 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. In some applications only one male connector could be sufficient terminating the power bus.

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 subclause specifies requirements for motor controllers with respect to the power bus. Further requirements on motor controllers are specified in 6.2.2 and 6.2.3.

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 can 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 characterised as to whether they are suitable for such 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 polarised 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.

Three types of connectors are specified both for the motor and the motor controller; they differ in physical size and number of contacts.

- a) The type 1 connector has 11 contacts (10 contacts plus PE) and is a large size connector. Annex B provides further specification for this connector. This connector supports two ancillary circuits:

- AN1 is normally assigned to motor brakes;
- AN2 is assigned to a temperature sensor.

NOTE 1 By proper use of the female connector of this type, a three phase motor can be configured to operate with either star or delta wiring (see 6.1.4).

- b) The type 2 connector has 9 contacts (8 contacts plus PE) and is a medium size connector. Annex C provides further specification for this connector. This connector supports two ancillary circuits:

- AN1 is normally assigned to motor brakes;
- AN2 is assigned to a temperature sensor.

- c) The type 3 connector has 13 contacts (12 contacts plus PE) and is a small size connector. Annex D provides further specification for this connector. This connector supports three ancillary circuits:

- AN1 is normally assigned to motor brakes but may be customized to other functions;
- AN2 is assigned to the primary temperature sensor;
- AN3 is customized to match the application – such uses may include a secondary temperature sensor, fan control or stagnation heating.

NOTE 2 By proper use of the female connector of this type, a three phase motor can be configured to operate with either star or delta wiring (see 6.1.4).

6.1.2 Motor connector

The motor shall be provided with a male connector of one of the three types specified in 6.1.1. Table 2 provides the contact assignments for these connectors and references to the annexes providing further specifications.

Table 2 — Contact assignment for motor male connector

Contact	Type 1 connector assignment ^a		Type 2 connector assignment ^b		Type 3 connector assignment ^c	
	Motor		Motor		Motor	
	Three phase	Single phase	Three phase	Single phase	Three phase	Single phase
1	Winding end U1	Winding end U1	Winding end U1	Winding end U1	Winding end U1	Winding end U1
2	Winding end V1	Winding end U2 (N)	—	—	Winding end V1	Winding end U2 (N)
3	Winding end W1	—	Winding end W1	—	Winding end W1	—
4	AN1	AN1	AN1	AN1	AN3	AN3
5	AN1	AN1	AN2	AN2	Winding end W2	—
6	Winding end W2	—	AN1	AN1	Winding end U2	—
7	Winding end U2	—	Winding end V1	Winding end U2 (N)	Winding end V2	—
8	Winding end V2	—	AN2	AN2	AN3	AN3
9	AN2	AN2	—	—	AN1	AN1
10	AN2	AN2	—	—	AN2	AN2
11	—	—	—	—	AN1	AN1
12	—	—	—	—	AN2	AN2
PE	Protective earth	Protective earth	Protective earth	Protective earth	Protective earth	Protective earth
^a See Clause B.1. ^b See Clause C.1. ^c See Clause D.1.						

6.1.3 Motor controller connector

The motor controller shall provide a connection to the motor by a female connector of one of the three types specified in 6.1.1, either mounted on the controller or as a termination of the cable assembly hard wired to the controller.

Table 3 provides the contact assignments for these three types of connectors and references to the annexes providing further specifications.

Table 3 — Contact assignment for controller female connector

Contact	Type 1 connector assignment ^a		Type 2 connector assignment ^b		Type 3 connector assignment ^c	
	Motor		Motor		Motor	
	Three phase	Single phase	Three phase	Single phase	Three phase	Single phase
1	Phase L1 power	L1 power	Phase L1 power	L1 power	Phase L1 power	L1 power
2	Phase L2 power	L2 power (N)	—	—	Phase L2 power	L2 power (N)
3	Phase L3 power	—	Phase L3 power	—	Phase L3 power	—
4	AN1	AN1	AN1	AN1	AN3	AN3
5	AN1	AN1	AN2	AN2	Shunt selector W2	—
6	Shunt selector W2	—	AN1	AN1	Shunt selector U2	—
7	Shunt selector U2	—	Phase L2 power	L2 power (N)	Shunt selector V2	—
8	Shunt selector V2	—	AN2	AN2	AN3	AN3
9	AN2	AN2	—	—	AN1	AN1
10	AN2	AN2	—	—	AN2	AN2
11	—	—	—	—	AN1	AN1
12	—	—	—	—	AN2	AN2
PE	Protective earth	Protective earth	Protective earth	Protective earth	Protective earth	Protective earth
^a See Clause B.2. ^b See Clause C.2. ^c See Clause D.2.						

6.1.4 Motor configuration determination

In addition to single phase motors, this part of ISO 23570 supports the operation of three phase motors in both the delta and the star configuration. Such configuration as a delta or star operated motor may be made in one of the three ways described below.

a) Within the motor itself

In this case, no further specification is required and the pins labelled “shunt selector” in Table 3 are not used. This case will be denoted as the internal selection (I).

b) Within the female cable connector that couples to the motor (see 6.1.3)

This configuration is possible only if the motor connector and its matching connector are type 1 or type 3. This case will be denoted as the local selection (L).

c) **Within the motor controller**

This configuration is possible only if both the motor connector and the controller connector are not type 2. This case will be denoted as the remote selection (R). Cables that support this mode of selection require three more conductors than those that support local or internal selection. See Table 5.

6.1.5 Type 3 coding keys

The type 3 connector has a design feature that prevents the improper mating of connectors that are being used for different purposes. This feature consists of two coding keys, each of which may have one of four positions. This allows for a total of 16 different coding specifications. The keys mechanically prevent a male connector from being mated to a female connector that does not have the same selection in the coding keys. Annex D provides design details for these coding keys. Type 1 and type 2 connectors do not have a similar feature.

It is recommended that the coding keys be used to identify

- a) the actual motor wiring configuration being employed (three phase star, three phase delta, or single phase), and
- b) the configuration of the ancillary circuits.

Suppliers of motor controllers or motors fitted with type 3 connectors shall indicate the coding key assignment used and the wiring configuration of their product. Suppliers of cables fitted with type 3 connectors shall use the same coding key assignment for both ends of the cable.

NOTE Table 4 provides an example of the use of these coding keys. Rows of this table can be used as a model for the information required by this subclause. The second column ("View") shows the appearance of the coding keys as viewed in the male connector; the view of the coding keys in the female connector is the mirror image of this view. For reference, see the figures in Annex D. Figure D.4 illustrates the case A=2, B=4, and D.9 illustrates the case A=4, B=2. In all cases, pins 10 and 12 are used for the primary temperature sensor that is integrated in the motor windings.

Table 4 — Definition of functional coding keys for connector

Coding Key Position (motor connector - female)		View (motor connector - male)		Power contacts			Control contacts		
A	B	A	B		Pin (motor side)	Pin (shunt motor-cable side)	Pin 10/12	Pin 4/8	Pin 9/11
1	1	▼	▼	Single-phase connection	1/ 2 (N)	—	Primary temperature	Secondary temperature	Brake
1	2	▼	▲	Single-phase connection	1/ 2 (N)	—	Primary temperature	Ventilator	Brake
1	3	▼	■	Single-phase connection	1/ 2 (N)	—	Primary temperature	Stagnation heating	Brake
1	4	▼	▣	Single-phase connection	1/ 2 (N)	—	Primary temperature	Customized (Ventilator)	Customized (Stagnation heating)
2	1	▲	▼	Three-phase star connection	1/2/3/ 5/6/7	5 - 6 - 7	Primary temperature	Secondary temperature	Brake
2	2	▲	▲	Three-phase star connection	1/2/3/ 5/6/7	5 - 6 - 7	Primary temperature	Ventilator	Brake
2	3	▲	■	Three-phase star connection	1/2/3/ 5/6/7	5 - 6 - 7	Primary temperature	Stagnation heating	Brake
2	4	▲	▣	Three-phase star connection	1/2/3/ 5/6/7	5 - 6 - 7	Primary temperature	Customized (Ventilator)	Customized (Stagnation heating)
3	1	■	▼	Three-phase Delta connection	1/2/3/ 5/6/7	1 - 5 2 - 6 3 - 7	Primary temperature	Secondary temperature	Brake
3	2	■	▲	Three-phase Delta connection	1/2/3/ 5/6/7	1 - 5 2 - 6 3 - 7	Primary temperature	Ventilator	Brake
3	3	■	■	Three-phase Delta connection	1/2/3/ 5/6/7	1 - 5 2 - 6 3 - 7	Primary temperature	Stagnation heating	Brake
3	4	■	▣	Three-phase Delta connection	1/2/3/ 5/6/7	1 - 5 2 - 6 3 - 7	Primary temperature	Customized (Ventilator)	Customized (Stagnation heating)
4	1	▣	▼	Three-phase connection	1/2/3/ 5/6/7	—	Primary temperature	Secondary temperature	Brake
4	2	▣	▲	Three-phase connection	1/2/3/ 5/6/7	—	Primary temperature	Ventilator	Brake
4	3	▣	■	Three-phase connection	1/2/3/ 5/6/7	—	Primary temperature	Stagnation heating	Brake
4	4	▣	▣	Three-phase connection	1/2/3/ 5/6/7	—	Primary temperature	Customized (Ventilator)	Customized (Stagnation heating)

6.2 Cables

6.2.1 General requirements

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 See Annex E for further elaboration of the colour specification.

The conductors for the ancilliary circuits such as brake control circuit or temperature sensor shall be shielded.

The cable shall have 8, 10, 11 or 13 conductors (7, 9, 10 or 12 plus PE) depending on the selected type of connectors specified in 6.2.3. It shall be terminated in a female connector meeting the requirements of 6.1.3.

a) For a type 1 connector, the cable shall have

- 11 conductors if Delta/star selection is made within the controller itself;
- 8 conductors if the selection is made within the motor or within the female connector of the motor cable.

b) For a type 2 connector, Delta/star selection is not possible in the connector. The cable shall have 8 conductors.

c) For a type 3 connector, the cable shall have

- 13 conductors if Delta/star selection is made within the controller itself;
- 10 conductors if the selection is made within the motor or within the female connector of the motor cable.

Table 5 shows the possible configurations between the female and the male connectors. The entry indicates the number of connectors needed in each cable. 6.1.4 provides a description of (R), (L) and (I).

Table 5 — Conductor requirements of possible cable configurations

Female connector		Male connector		
Type	Selection ^a	Type 1	Type 2	Type 3
Type 1	Remote (R)	11	—	11
	Local (L), internal (I)	8	8	8
Type 2	Internal (I)	8	8	8
Type 3	Remote (R)	11	—	13
	Local (L), internal (I)	8	8	10
^a See 6.1.4.				

6.2.2 Hard wired motor controller cable

In this configuration, a cable of suitable length shall be hard wired to the motor controller assembly and terminated in a female connector as described in 6.2.1. The motor shall be equipped with a matching male connector. There are three possible variations of this configuration, corresponding to whichever of the three

types of connector is selected for implementation. The supplier shall indicate which of the connectors is being used and the length of the cable supplied.

Figure 2 provides an example which illustrates a connection between motor and motor controller using this configuration. Connector type 3 is shown in this example.

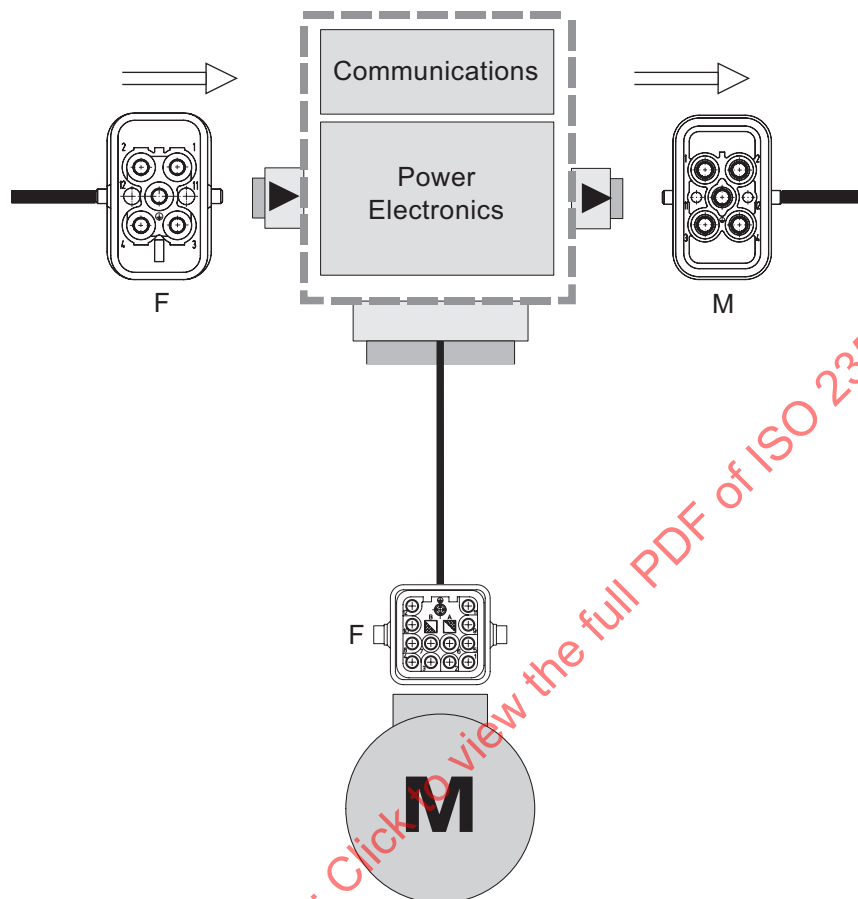


Figure 2 — Example of use of the hard wired type of motor/controller connection

6.2.3 Motor controller with separate cable

In this configuration, the motor controller shall be fitted with a surface mounted female connector as described in 6.1.3. The motor shall be equipped with a male connector as described in 6.1.2. There are nine possible variations of this configuration, corresponding to whichever of the three connectors is selected for implementation at the motor controller and to whichever of the three connectors is selected for implementation at the motor.

The cable shall be terminated on one end (controller side) with a male connector meeting the requirements of 6.1.2, and on the other end (motor side) with a female connector meeting the requirements of 6.1.3. Of the nine possible configurations, we can distinguish the four major cases described below.

- If the male connector is a type 2 connector (3 cases), the cable shall have 8 conductors (7 plus PE). If the female connector is a type 2, the Delta/star determination can only be internal (I). If the female is a type 1 or 3 connector, the Delta/star determination can be either internal (I) or local (L). See 6.1.4.
- If both connectors are type 3 connectors (1 case) the cable shall have 13 conductors (12 plus PE) if the Delta/star selection is made within the controller itself (R); 10 conductors if the selection is made at the motor, (I) or (L).

- c) If the female connector is a type 1 and the male is a type 1 or type 3 (2 cases), the cable shall have 11 conductors (10 plus PE) if the Delta/star selection is made within the controller itself (R); 8 conductors if the selection is made at the motor, (I) or (L).
- d) If the Delta/star selection is to be made within the controller (R), the male connector shall not be type 2.

Table 6 shows the wiring assignments of the connectors. If Delta/star selection is made within the motor or within the female connector at the motor, shunt selector conductors W2, U2 and V2 need not be implemented within the cable assembly.

Table 6 — Cable wiring assignment

Function	Male connector on controller side			Female connector on motor side		
	11 contact connector type 1 ^a	8 contact connector type 2 ^b	13 contact connector type 3 ^c	13 contact connector type 3 ^d	8 contact connector type 2 ^e	11 contact connector type 1 ^f
L1	1	1	1	1	1	1
L2 (N)	2	7	2	2	7	2
L3	3	3	3	3	3	3
Shunt selector W2	6	—	5	5	—	6
Shunt selector U2	7	—	6	6	—	7
Shunt selector V2	8	—	7	7	—	8
AN1	4	4	9	9	4	4
AN1	5	6	11	11	6	5
AN2	9	5	10	10	5	9
AN2	10	8	12	12	8	10
AN3	—	—	4	4	—	—
AN3	—	—	8	8	—	—
Protective earth	PE	PE	PE	PE	PE	PE
^a See Clause B.1. ^b See Clause C.1. ^c See Clause D.1. ^d See Clause D.2. ^e See Clause C.2. ^f See Clause B.2.						

In addition to the conductor requirements stated above, cables may be required to have a surrounding screen, suitably grounded, to meet applicable EMC requirements. (See 6.2.1 for other shielding requirements.)

Figure 3 provides an example which illustrates a connection between motor and motor controller using this configuration. In this example, the motor controller is fitted with a type 2 connector and the motor with a type 1 connector.

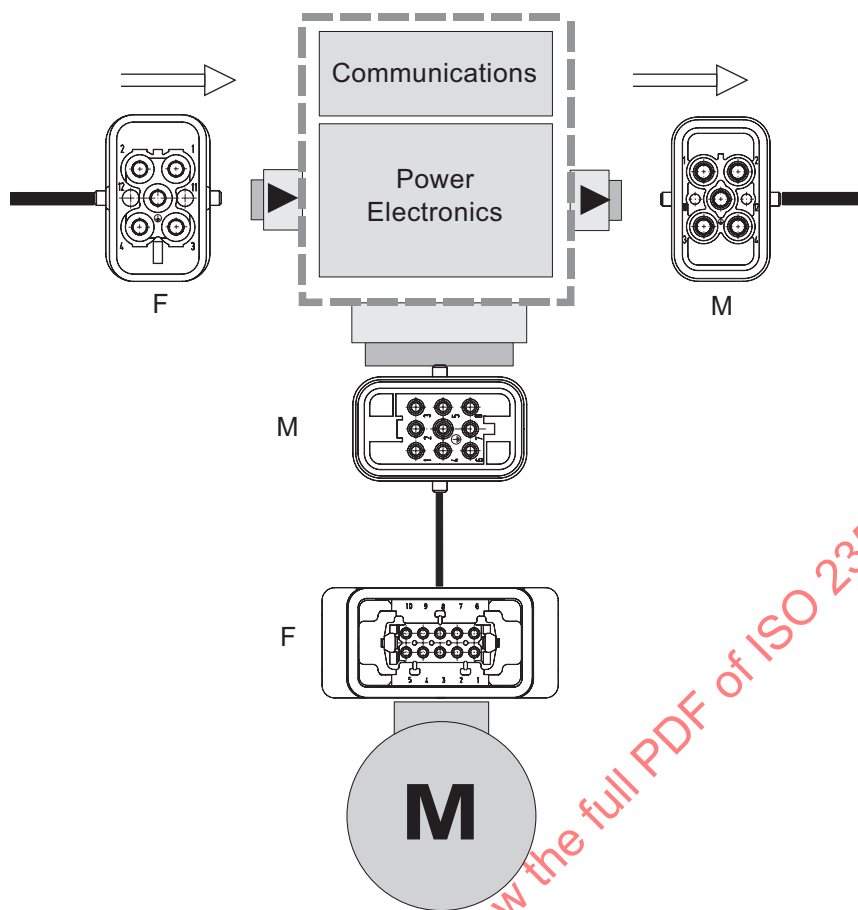


Figure 3 — Example of use of the separate cable type of motor/controller connection

Annex A (normative)

Design specification for power bus connectors

A.1 Male power bus connector

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

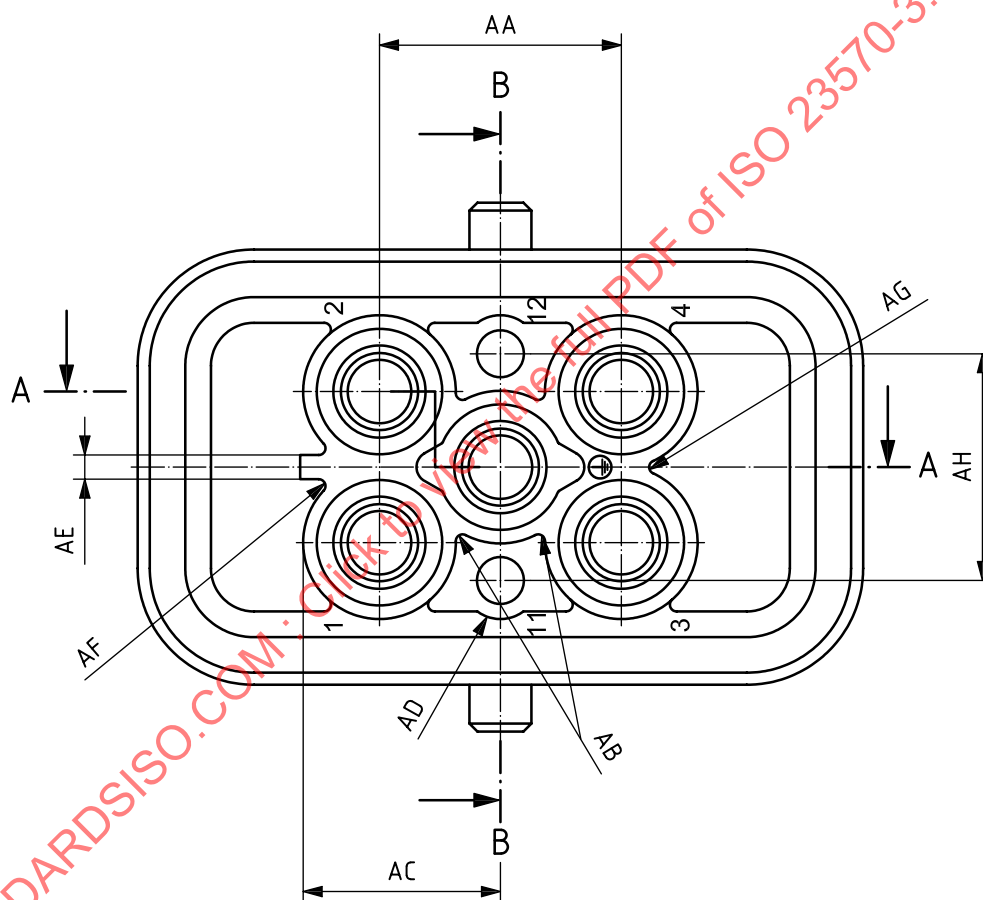


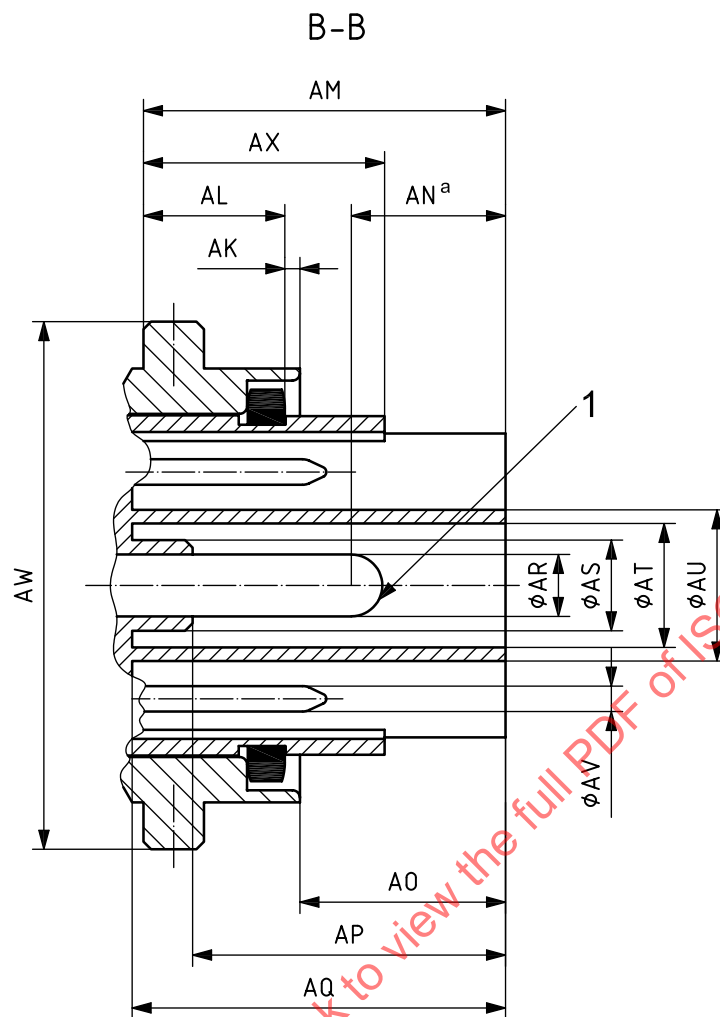
Figure A.1 — Male power bus connector

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

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.

Table A.1 provides the dimensions, in millimetres, for this connector.

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



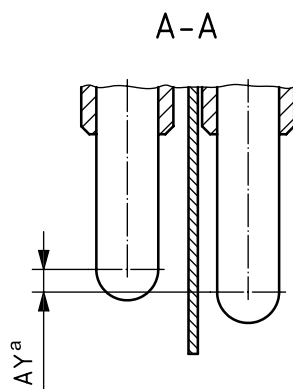
Key

1 PE contact

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

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

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



^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 — Dimensions of male connector

Dimensions in millimetres

Dimension	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	—	—
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	—
NOTE 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 provides a drawing of the female power bus connector.

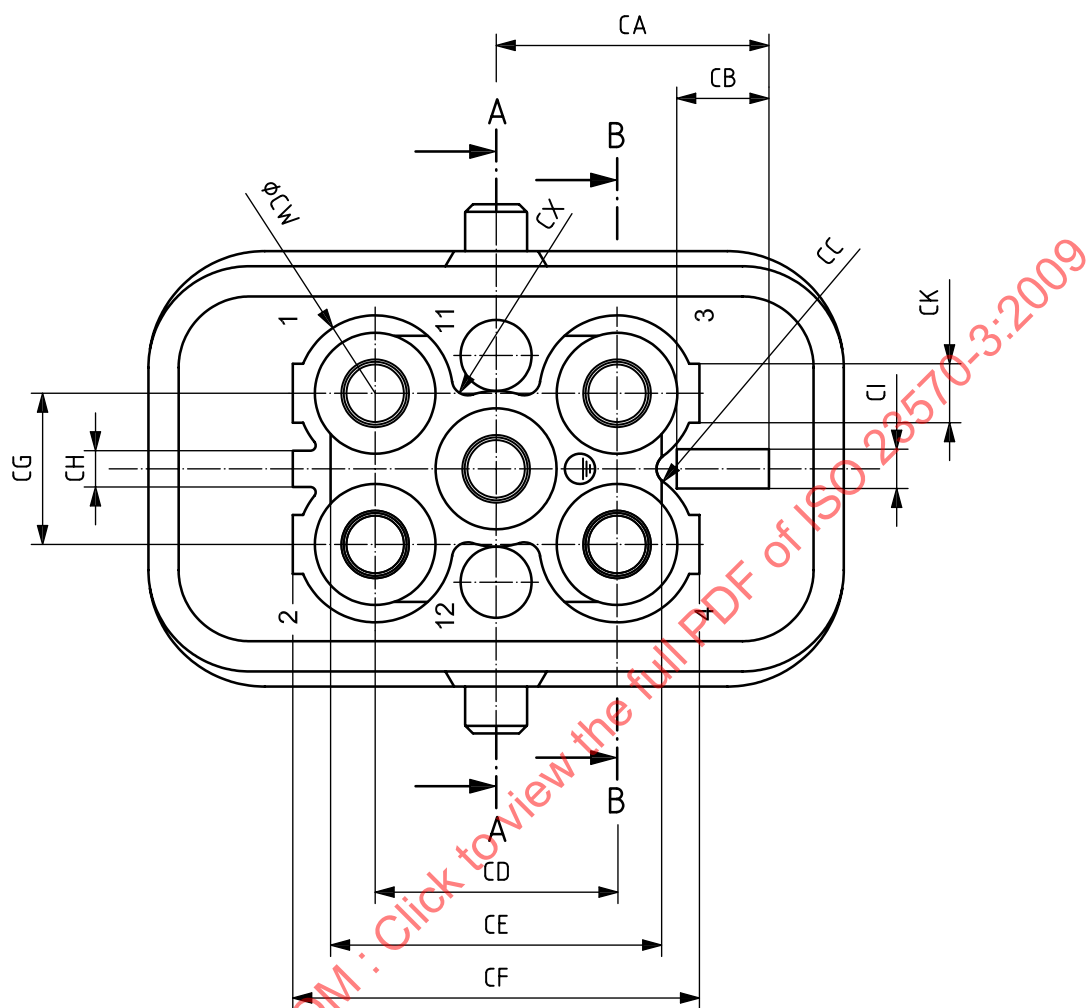


Figure A.4 — Female power bus connector

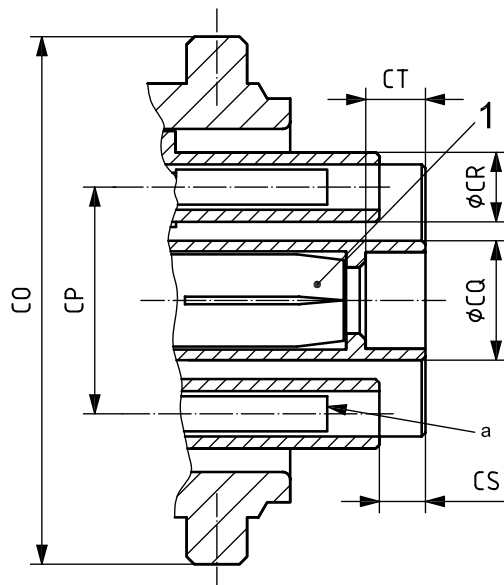
Figure A.5 provides a view through section A-A of the connector.

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

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

Table A.2 provides the dimensions, in millimetres, for this connector.

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

**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

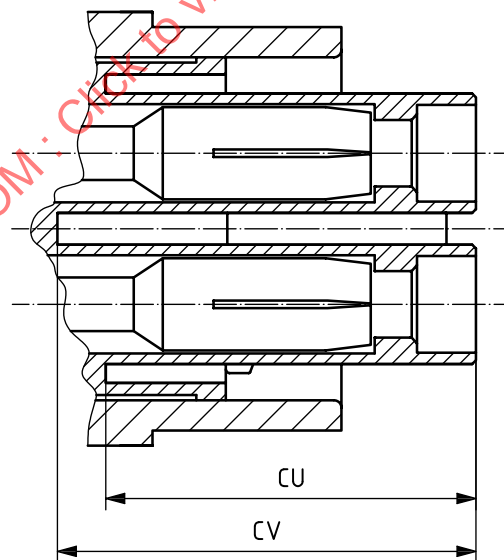


Figure A.6 — Female connector section view B-B

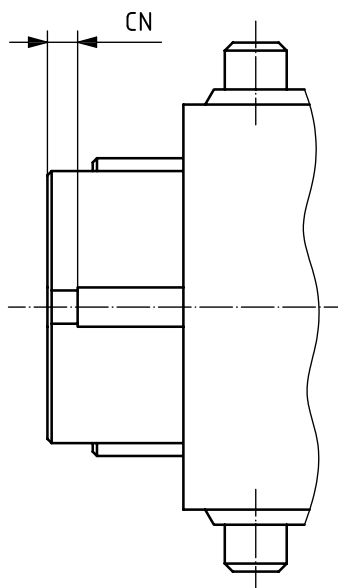


Figure A.7 — Female connector side view

Table A.2 — Dimensions of female connector

Dimensions in millimetres

Dimension	Maximum	Minimum	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
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 type 1 motor/controller connectors

B.1 Male connector type 1 (10 contacts + PE)

Figure B.1 provides a drawing of the male motor connector type 1.

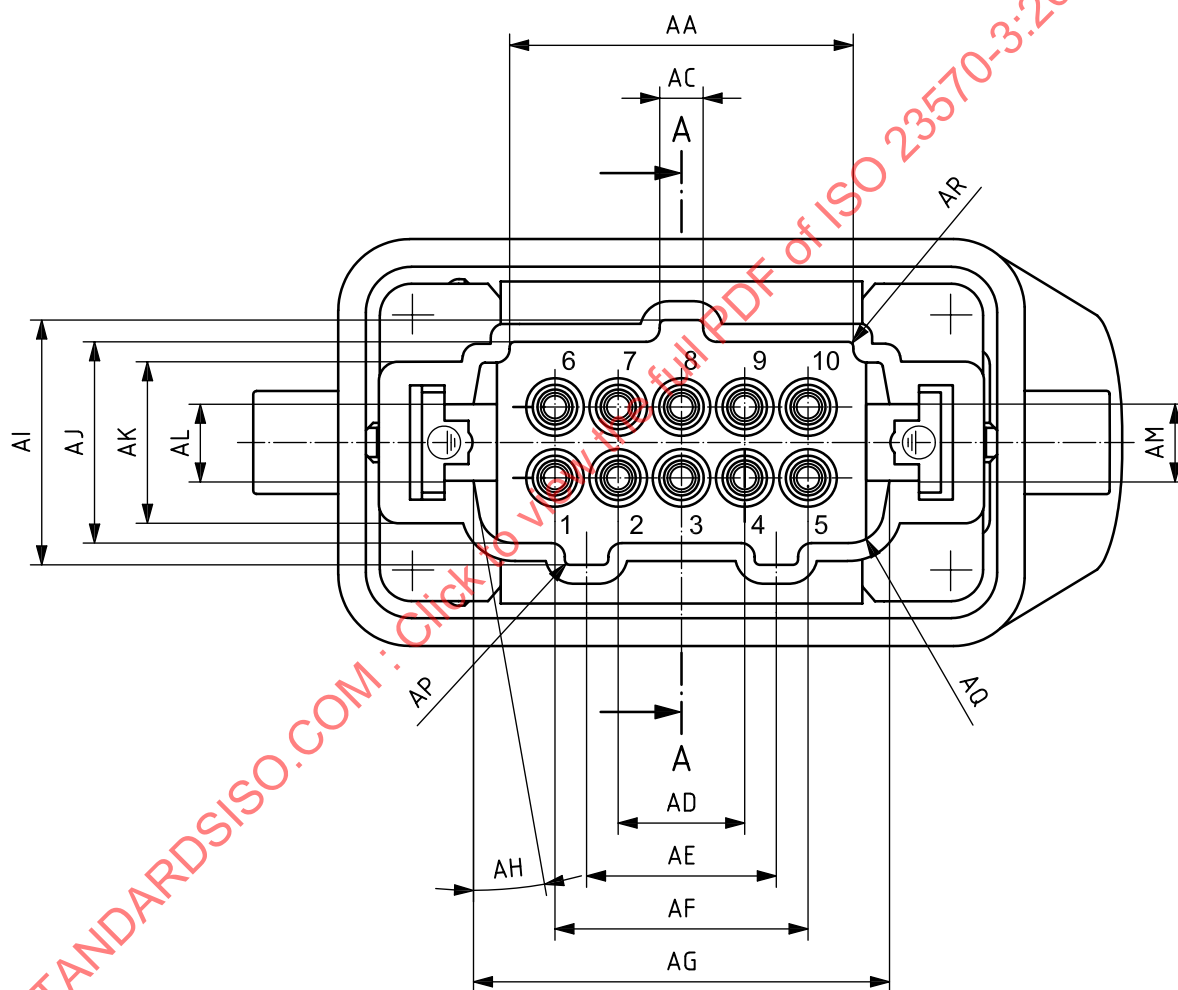


Figure B.1 — Male connector type 1

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

Table B.1 provides the dimensions, in millimetres (unless otherwise indicated), for this connector.

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

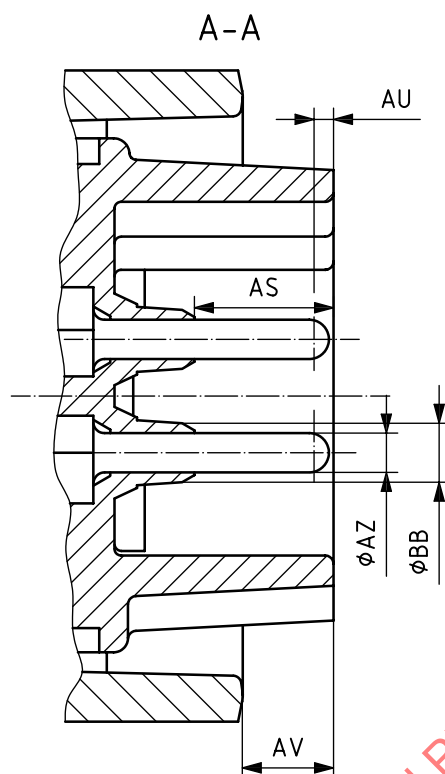


Figure B.2 — Male connector type 1 section view

Table B.1 — Dimensions of male connector type 1

Dimensions in millimetres
Angles in degrees

Dimension	Maximum	Minimum	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	—
angle 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
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 connector type 1

Figure B.3 provides a drawing of the female connector type 1.

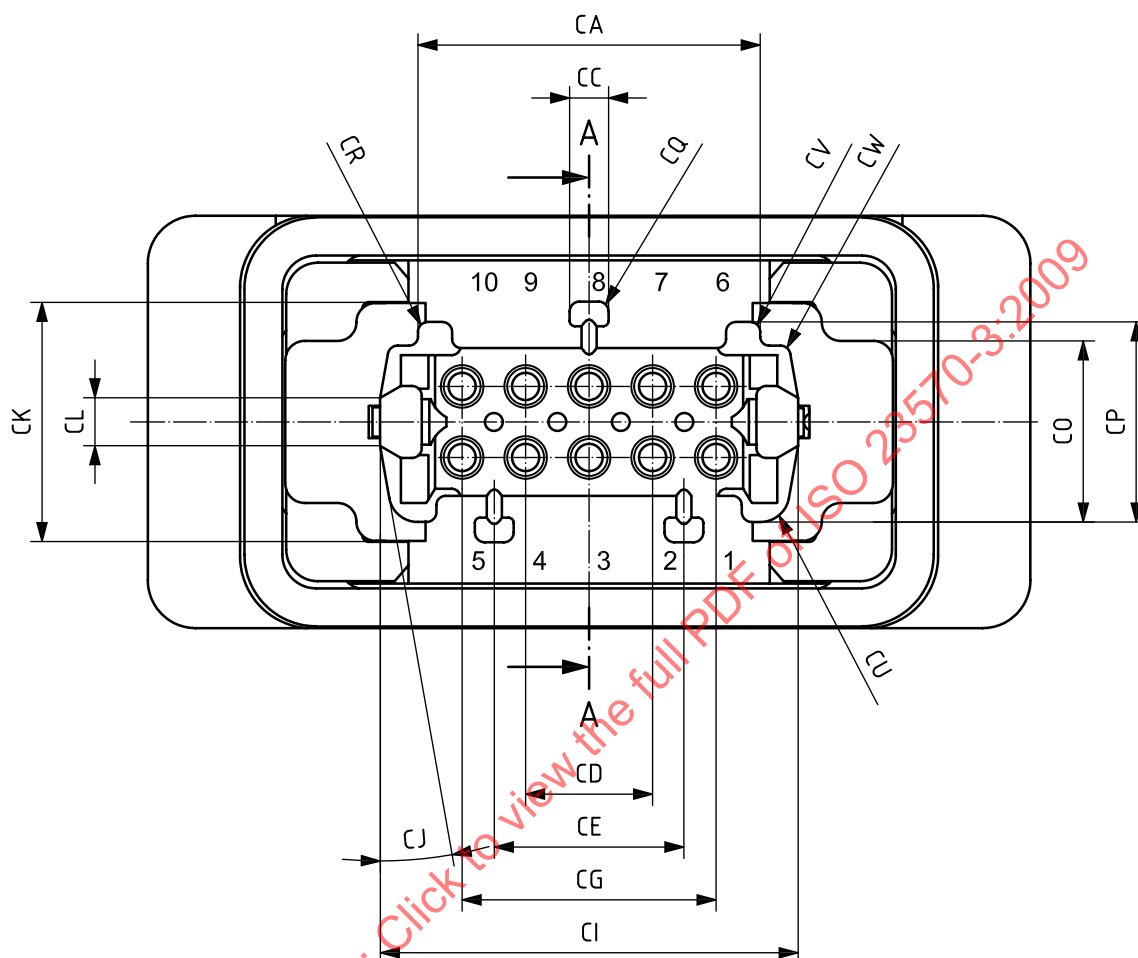


Figure B.3 — Female connector type 1

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

Table B.2 provides the dimensions, in millimetres (unless otherwise indicated), for this connector.

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

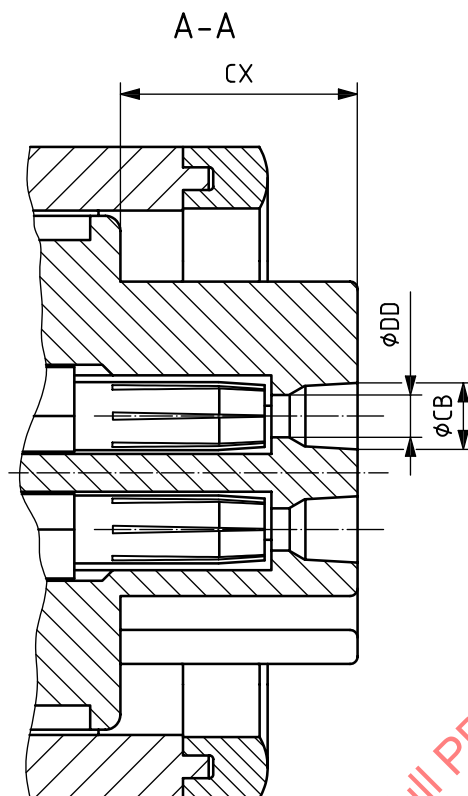


Figure B.4 — Female connector type 1 section view

Table B.2 — Dimensions of female connector type 1

Dimensions in millimetres
Angles in degrees

Dimension	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	—	—
angle CJ	15,0°	10,0°	10,0°
CK	25,3	25,0	25,3
CL	5,1	—	—
CO	18,5	18,0	18,5
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)

Design specification for type 2 motor/controller connectors

C.1 Male connector type 2 (8 contacts + PE)

Figure C.1 provides a drawing of the male connector type 2.

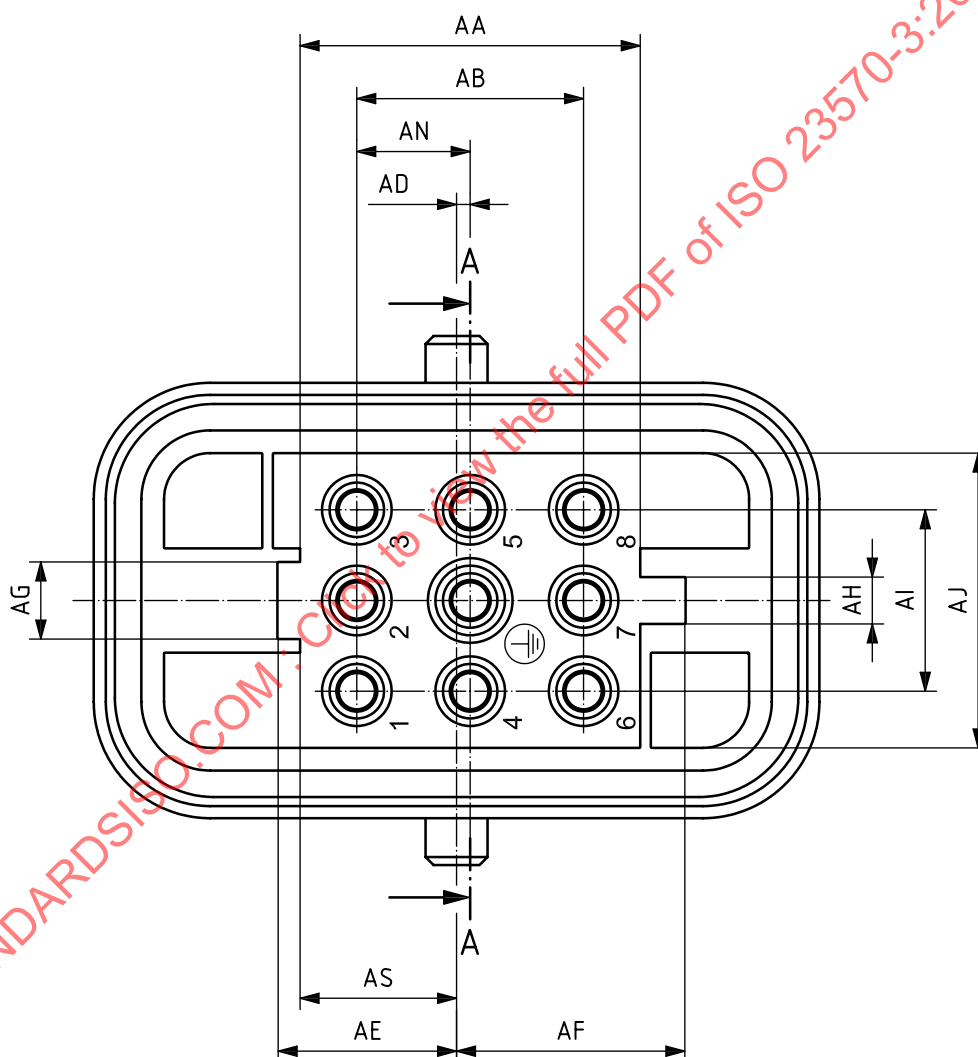
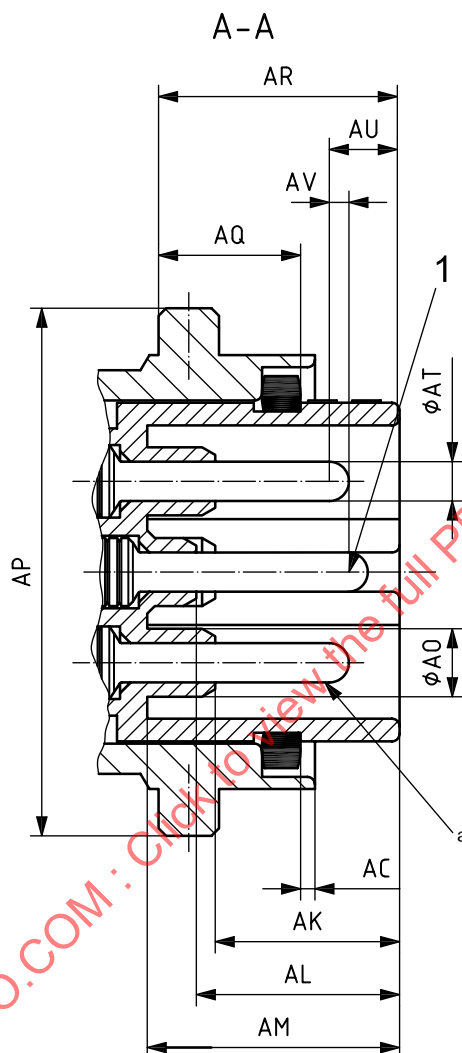


Figure C.1 — Male connector type 2

Figure C.2 provides a section view of this connector through the midpoint.

Table C.1 provides the dimensions, in millimetres, for this connector.

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



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 C.2 — Male connector type 2 section view

Table C.1 — Dimensions of male connector type 2

Dimensions in millimetres

Dimension	Maximum	Minimum	Nominal
AA	23,0	22,4	22,4
AB	15,1	14,9	15,0
AC	—	0,5	—
AD	1,0	0,8	0,9
AE	12,1	11,8	11,8
AF	15,4	15,1	15,1
AG	5,4	5,0	5,0
AH	3,4	3,0	3,0
AI	12,1	11,9	12,0
AJ	19,5	19,3	19,4
AK	—	12,1	—
AL	—	13,4	—
AM	—	16,7	—
AN	7,6	7,4	7,5
AO	4,7	—	—
AP	36,1	—	—
AQ	10,1	9,6	9,85
AR	16,2	15,6	15,9
AS	10,6	10,3	10,3
AT	2,5	2,45	2,5
AU	5,15	—	—
AV	1,55	0,95	1,25

C.2 Female connector type 2

Figure C.3 provides a drawing of the female connector type 2.

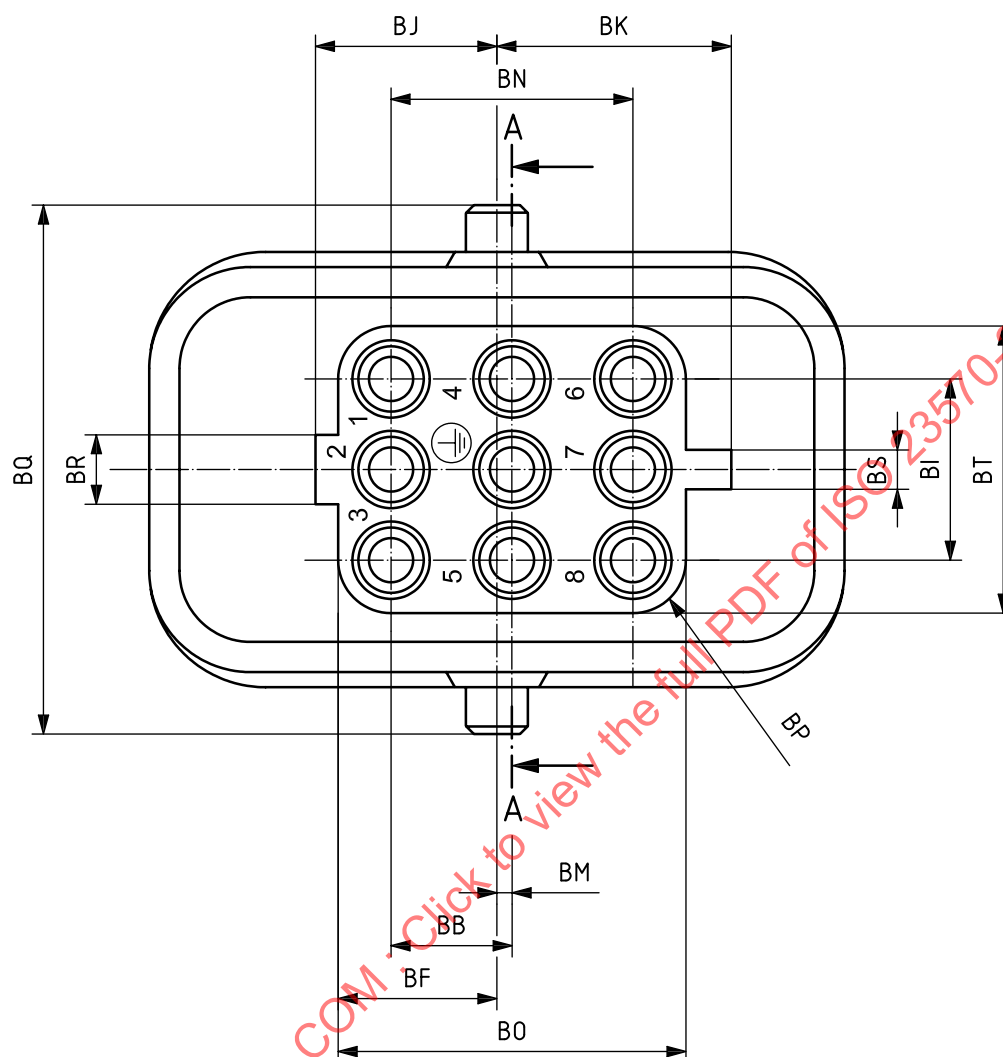
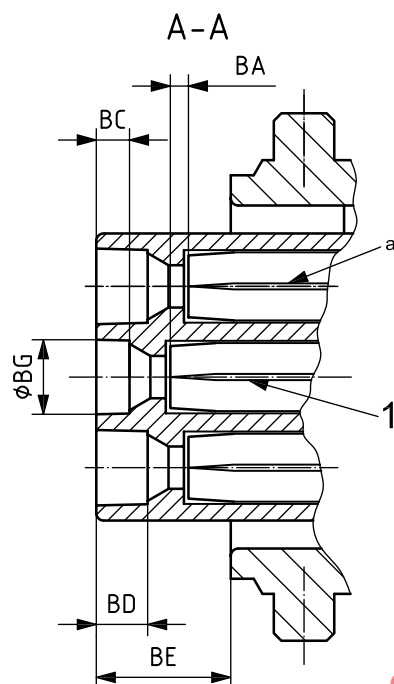


Figure C.3 — Female connector type 2

Figure C.4 provides a section view through the midpoint of this connector.

Table C.2 provides the dimensions, in millimetres, for this connector.

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

**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 C.4 — Female connector type 2 section view**Table C.2 — Dimensions of female connector type 2**

Dimensions in millimetres

Dimension	Maximum	Minimum	Nominal
BA	1,55	0,95	1,25
BB	7,51	7,49	7,5
BC	—	2,15	—
BD	—	3,4	—
BE	9,0	8,2	8,5
BF	10,1	—	—
BG	—	4,8	—
BI	12,1	11,9	12,0
BJ	11,7	11,5	11,6
BK	15,0	14,8	14,9
BM	1,0	0,8	0,9
BN	15,1	14,9	15,0
BO	22,1	22,0	22,0
BP	3,7	3,5	3,5
BQ	36,1	—	—
BR	4,6	4,5	4,6
BS	2,6	2,5	2,6
BT	19,0	18,8	19,0

Annex D (normative)

Design specification for type 3 motor/controller connectors

D.1 Male Connector type 3 (12 contacts + PE)

Figure D.1 is a drawing of the male connector type 3.

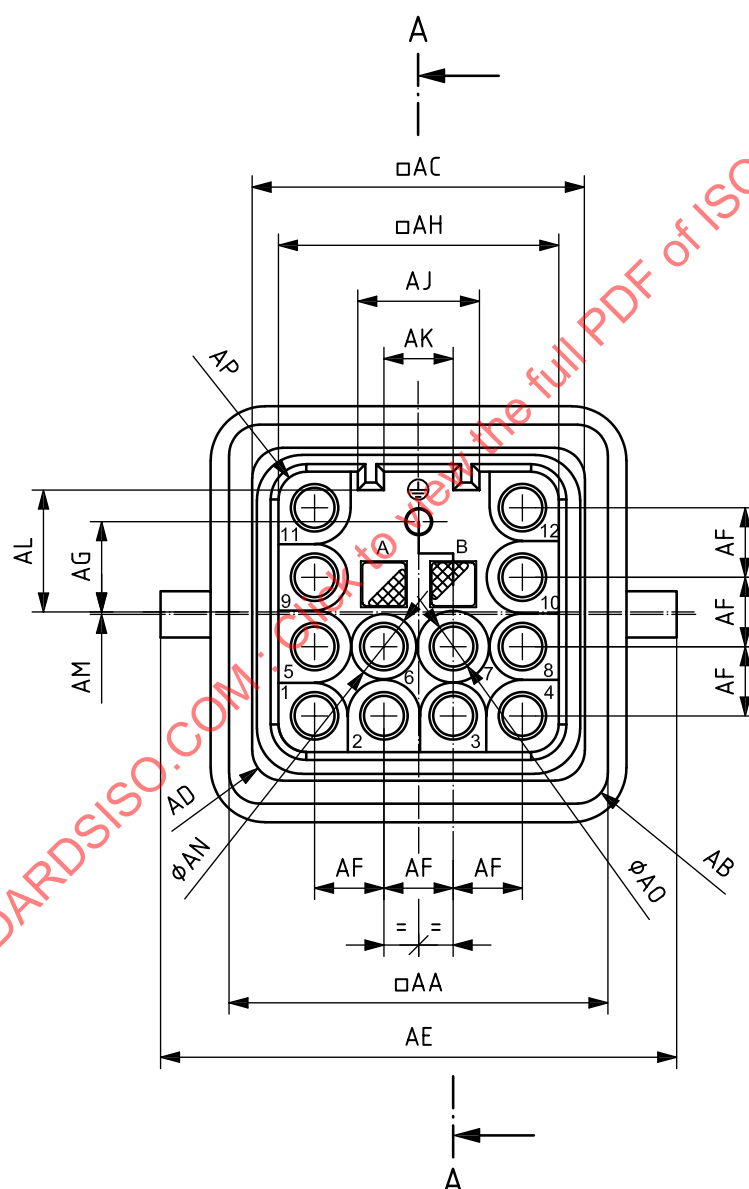


Figure D.1 — Male connector type 3

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

Figure D.3 provides a side view of the male connector type 3.

Figure D.4 provides the position of the two coding keys in the mating face of the male connector.

Figure D.5 provides a section view A-A with longitudinal position of coding keys in the connector type 3.

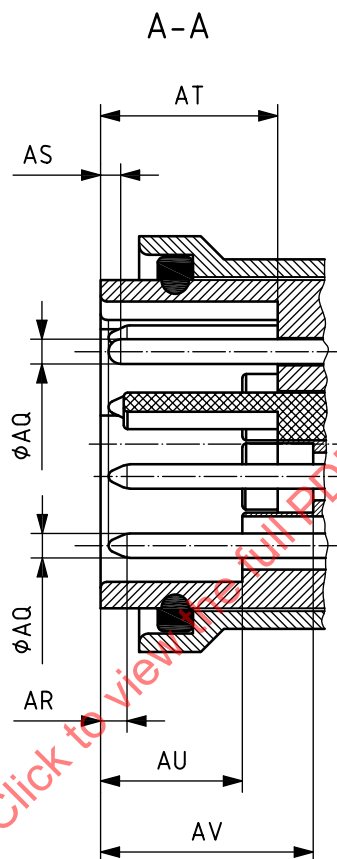


Figure D.2 — Male connector type 3 section view A-A

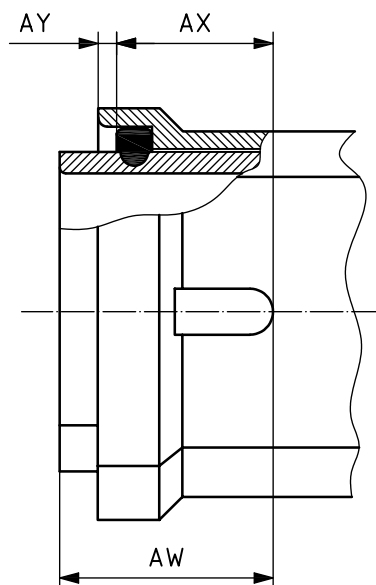


Figure D.3 — Male connector type 3 side view

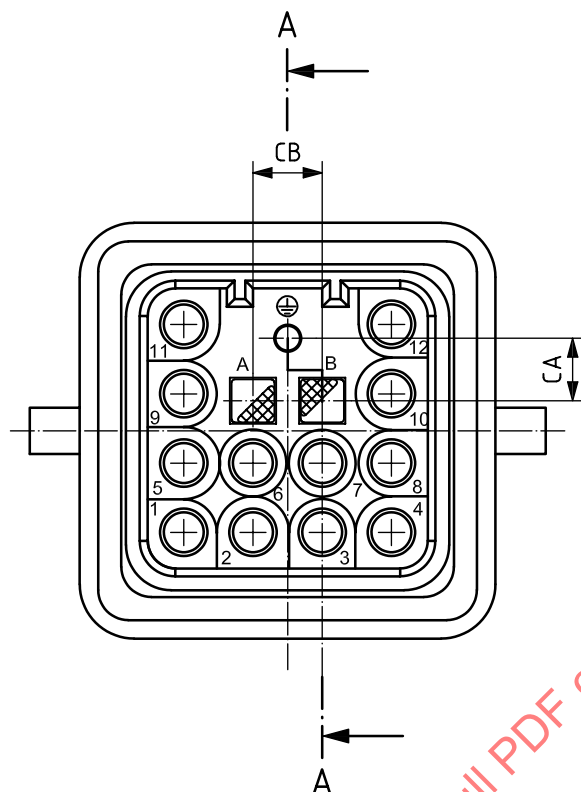


Figure D.4 — Position of coding keys on mating face of male connector type 3

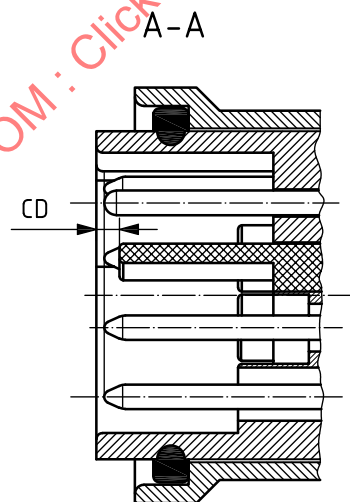


Figure D.5 — Recess of coding keys in male connector type 3