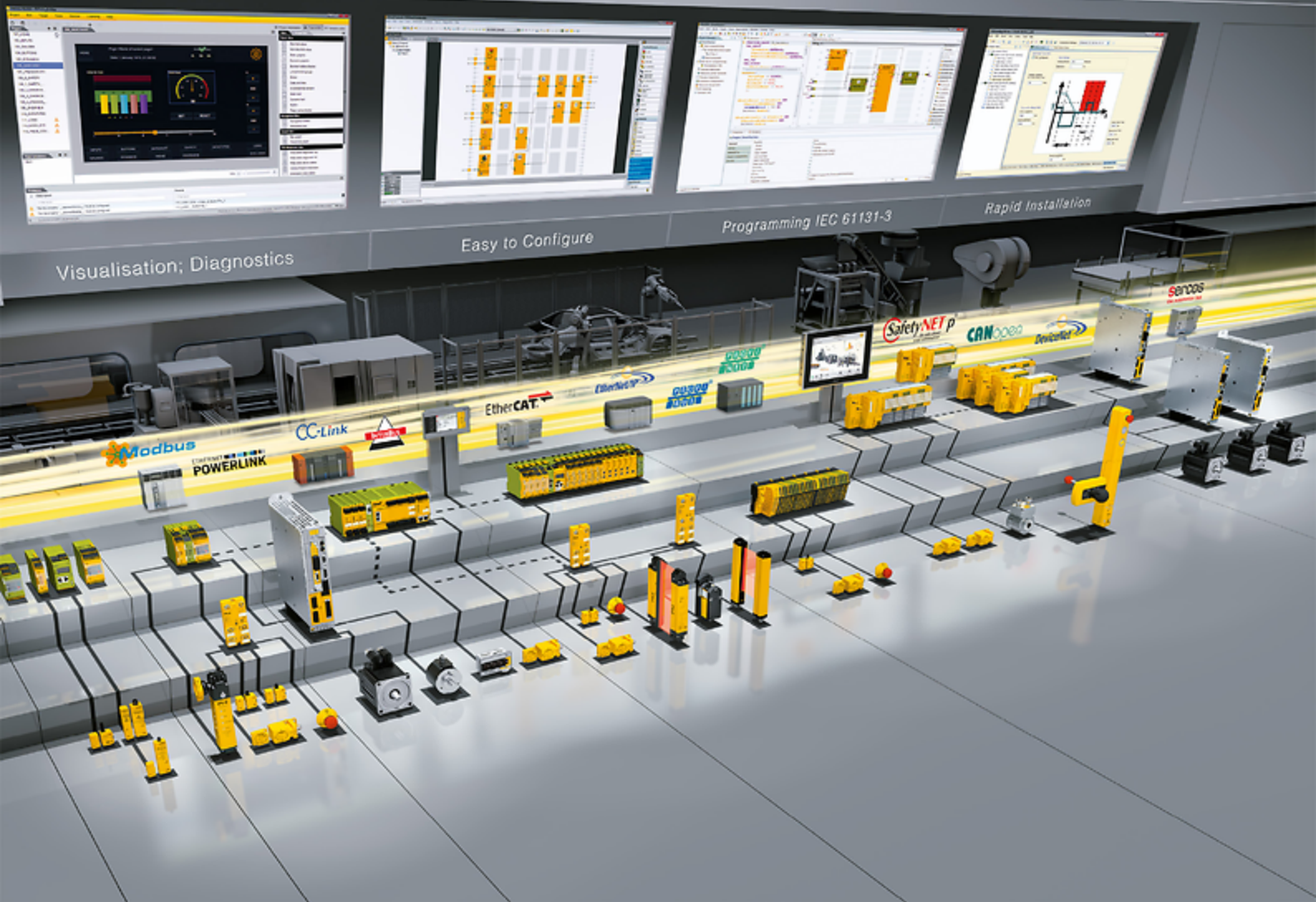


Intern



Connection method

Pilz

	Table of contents	2
1	Foreword	4
2	User information	5
2.1	Directives and standards	5
2.2	Timeliness	5
2.3	Original language	5
2.4	Limitation of liability	5
2.5	Formatting conventions	6
2.5.1	Display of warning messages and information	6
2.5.2	Distinction of text elements	7
2.5.3	Conventions for cables	7
2.6	Trademarks	7
3	Safety notes	8
4	Overview	9
4.1	Encoder cables	9
4.2	Power cable	10
4.3	One Cable Solution EnDat 3	10
5	Length definition for ready-made cables	11
6	Encoder cables	12
6.1	Connection description and technical data	12
6.1.1	EnDat 2.1/2.2 digital encoders	12
6.1.1.1	Connection description	12
6.1.1.2	Technical data	15
6.1.2	EnDat 3 encoders	18
6.2	Determining the cable code for ready-made cables	18
6.2.1	Codes for EZ synchronous servo motors	18
6.3	Ready-made encoder cables	19
7	Power cables	20
7.1	Connection description	20
7.2	Technical data	25
7.3	Power cables for synchronous motors	31
7.3.1	Determining the cable code for ready-made cables in 3 steps	31
7.3.1.1	Sizes for EZ synchronous servo motors	32
7.3.1.2	Checking the minimum cross-section and contact length	34
7.3.1.3	Codes for EZ synchronous servo motors	35
7.3.2	Ready-made power cables	36
7.4	Accessories	37
7.4.1	PMC TEP output choke	37
8	One Cable Solution	39
8.1	Connection description	39
8.2	Technical data	40
8.3	Determining the cable code for ready-made cables in 3 steps	45
8.3.1	Sizes for EZ synchronous servo motors	46

8.3.2	Checking the minimum cross-section and contact length	48
8.3.3	Codes for EZ synchronous servo motors	49
8.4	Ready-made hybrid cables	50
8.5	Accessories	51
8.5.1	PMC TEP output choke	51
9	Appendix	53
9.1	Terminal specifications	53
9.1.1	PMC SC6 drive controller – X20	53
9.1.2	PMC SI6 drive controller – X20	53
9.2	EMC recommendations	54
9.3	Further information	55
9.4	Formula symbols	55
	Glossary	56
	List of figures	57
	List of tables	58

1 Foreword

A drive controller, cable and motor that are not coordinated with one another can lead to impermissibly high voltage peaks in the drive system, which may cause damage to the motor. The legal requirements of (EMC) Directive 2014/30/EU must also be observed.

The combination of Pilz motors with Pilz cables and Pilz drive controllers ensures compliance with legal requirements.

Pilz offers a range of cables to match. Cables are available in different lengths and are ready-made on both ends.

Using unsuitable cables may void any claims made under the warranty.

Features

- ▶ One Cable Solution EnDat 3 available
- ▶ Torsional stress $\pm 30^\circ/\text{m}$
- ▶ Bending resistance
- ▶ Oil resistance
- ▶ Chemical resistance

2 User information

This documentation describes the available Pilz power, encoder and hybrid cables. It provides you with assistance in selecting the right cable and with relevant information about properly connecting to the motor and drive controller without any errors.

2.1 Directives and standards

The following European directives and standards are relevant for Pilz cables:

- ▶ Low Voltage Directive 2014/35/EU
- ▶ EN 60204-1:2019-06: Safety of machinery – Electrical equipment of machines – Part 1
- ▶ DIN VDE 0298-4:2023-06: Use of cables and insulated lines for power systems – Part 4

Subsequent references to the standards do not specify the respective year in order to improve readability.

2.2 Timeliness

Check whether this document is the most up-to-date version of the documentation. We make the latest document versions for our products available for download on our website:

<https://www.pilz.com/en-INT>.

2.3 Original language

The original language of this documentation is German; all other language versions are derived from the original language.

2.4 Limitation of liability

This documentation was created taking into account the applicable standards and regulations as well as the current state of technology.

No warranty or liability claims for damage shall result from failure to comply with the documentation or from use that deviates from the intended use of the product. This is especially true for damage caused by individual technical modifications to the product or the project configuration and operation of the product by unqualified personnel.

2.5 Formatting conventions

Orientation guides in the form of signal words, symbols and special text markups are used to emphasize specific information so that you are able identify it in this documentation quickly.

2.5.1 Display of warning messages and information

Warning messages are identified with symbols. They indicate special risks when handling the product and are accompanied by relevant signal words that express the extent of the risk. Furthermore, useful tips and recommendations for efficient, error-free operation are specially highlighted.



ATTENTION!

Attention

This indicates that damage to property may occur

- if the stated precautionary measures are not taken.



CAUTION!

Caution

This word with a warning triangle indicates that minor personal injury may occur

- if the stated precautionary measures are not taken.



WARNING!

Warning

This word with a warning triangle means there may be a considerable risk of fatal injury

- if the stated precautionary measures are not taken.



DANGER!

Danger

This word with a warning triangle indicates that there is a considerable risk of fatal injury

- if the stated precautionary measures are not taken.



Information

Information indicates important information about the product or serves to emphasize a section in the documentation that deserves special attention from the reader.

2.5.2 Distinction of text elements

Certain elements of the continuous text are distinguished as follows.

Important information	Words or expressions with a special meaning
Interpolated position mode	Optional: File or product name or other name
<u>Detailed information</u>	Internal cross-reference
http://www.samplelink.com	External cross-reference

2.5.3 Conventions for cables

In the cable connection descriptions, core colors are shortened and used as follows.

Cable colors

BK:	BLACK	PK:	PINK
BN:	BROWN	RD:	RED
BU:	BLUE	VT:	VIOLET
GN:	GREEN	WH:	WHITE
GY:	GRAY	YE:	YELLOW
OG:	ORANGE		

Formatting conventions

Two-colored core:	WHYE	WHITEYELLOW (white-yellow core)
Single-colored core:	BK/BN	BLACK/BROWN (black or brown core)
Core pair:	BU-BK	BLUE-BLACK (blue and black core)

2.6 Trademarks

The following names are trademarks or registered trademarks of other companies:

EnDat®	EnDat® and the EnDat® logo are registered trademarks of Dr. Johannes Heidenhain GmbH, Germany.
speedtec®	speedtec® is a registered trademark of TE Connectivity Industrial GmbH, Germany.

All other trademarks not listed here are the property of their respective owners.

Products that are registered as trademarks are not specially indicated in this documentation. Existing property rights (patents, trademarks, protection of utility models) are to be observed.

3

Safety notes



WARNING!

Risk of fatal injury if safety notes and residual risks are not observed!

Failure to observe the safety notes and residual risks in the drive controller and motor documentation may result in accidents causing serious injury or death.

- Observe the safety notes in the drive controller and motor documentation.
- Consider the residual risks in the risk assessment for the machine or system.

4 Overview

4.1 Encoder cables


Design	Motor plug connector size	
	con.15	con.17
Quick lock	✓	
speedtec quick lock		✓

Encoder	Motor plug connector size	
	con.15	con.17
EnDat 2.1/2.2 digital	✓	✓
Resolver (on request)	✓	✓



Information

In combination with an EnDat 3 encoder, you require hybrid cables which feature encoder communication and power transmission in a shared cable.

For an overview of the motor connection using hybrid cables, see [One Cable Solution EnDat 3](#) [ 10].

Encoder	Supply cores	Pilot cores	Cable Ø	Bending radius 1 (min.)	Bending radius 2 (min.)
EnDat 2.1/2.2 digital	2 × 0.25 mm ²	3 × 2 × 0.14 mm ²	Max. 6.7 mm	67.0 mm	33.5 mm
Resolver (on request)	2 × 0.25 mm ²	3 × 2 × 0.25 mm ²	Max. 10.3 mm	103.0 mm	51.5 mm
Bending radius: 1 = free to move, 2 = fixed installation					

Intern

4.2 Power cable

Design	Motor plug connector size		
	con.15	con.23	con.40
Quick lock	✓		
speedtec quick lock		✓	✓

Power cores (3 + PE)	Brake cores	Temperature sensor cores	Cable Ø	Bending radius 1 (min.)	Bending radius 2 (min.)
4 × 1.0 mm ²	2 × 0.5 mm ²	2 × 0.34 mm ²	Max. 10.1 mm	101.0 mm	50.5 mm
4 × 1.5 mm ²	2 × 1.0 mm ²	2 × 0.5 mm ²	Max. 12.2 mm	122.0 mm	61.0 mm
4 × 2.5 mm ²	2 × 1.0 mm ²	2 × 1.0 mm ²	Max. 15.1 mm	151.0 mm	75.5 mm
4 × 4.0 mm ²	2 × 1.5 mm ²	2 × 1.0 mm ²	Max. 16.8 mm	168.0 mm	84.0 mm
4 × 10.0 mm ²	2 × 1.5 mm ²	2 × 1.0 mm ²	Max. 22.3 mm	223.0 mm	111.5 mm
4 × 16.0 mm ² (on request)	2 × 1.5 mm ²	2 × 1.5 mm ²	Max. 25.0 mm	250.0 mm	125.0 mm
4 × 25.0 mm ² (on request)	2 × 1.5 mm ²	2 × 1.5 mm ²	Max. 27.5 mm	275.0 mm	137.5 mm

Bending radius: 1 = free to move, 2 = fixed installation

4.3 One Cable Solution EnDat 3

Design	Motor plug connector size
	con.23
speedtec quick lock	✓

Power cores (3 + PE)	Brake cores	Pilot cores	Cable Ø	Bending radius 1 (min.)	Bending radius 2 (min.)
OCS-Basic					
4 × 1.0 mm ² (on request)	2 × 0.75 mm ²	2 × AWG22	Max. 13.6 mm	136.0 mm	68.0 mm
4 × 1.5 mm ² (on request)	2 × 1.0 mm ²	2 × AWG22	Max. 13.7 mm	137.0 mm	68.5 mm
OCS-Advanced					
4 × 1.5 mm ²	2 × 0.75 mm ²	2 × AWG22	Max. 14.7 mm	147.0 mm	73.5 mm
4 × 2.5 mm ² (on request)	2 × 0.75 mm ²	2 × AWG22	Max. 16.8 mm	168.0 mm	84.0 mm

Bending radius: 1 = free to move, 2 = fixed installation

5 Length definition for ready-made cables

The following length definitions apply to ready-made cables from Pilz.

Encoder cables

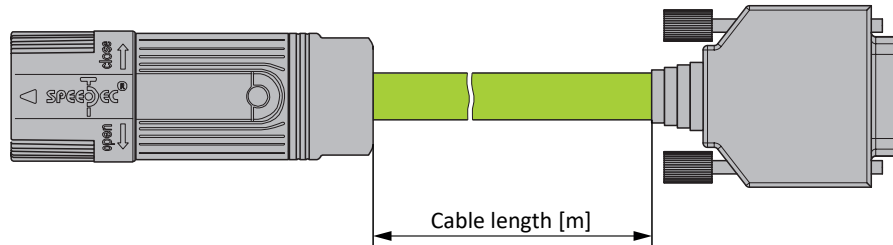


Fig. 1: Length definition for ready-made encoder cables

Power cable

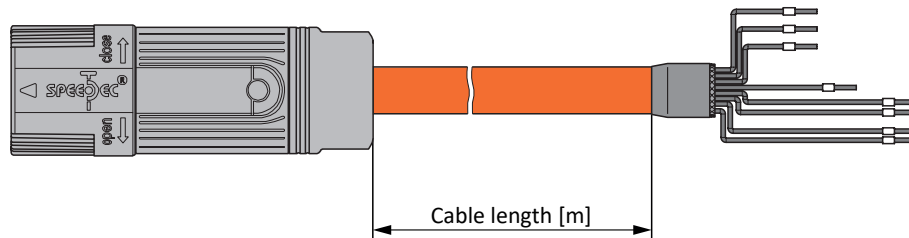


Fig. 2: Length definition for ready-made power cables – PMC SC6, PMC SI6

One Cable Solution

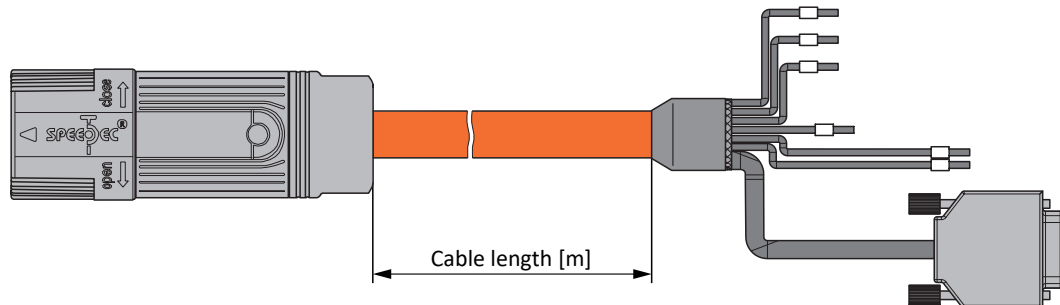


Fig. 3: Length definition for ready-made hybrid cables

6 Encoder cables

The motors are equipped with encoder systems and plug connectors as standard.

Pilz provides suitable cables in various lengths, conductor cross-sections and connector sizes.

Depending on the respective motor types, different encoder systems can be used.

6.1 Connection description and technical data

Connection descriptions and technical data of the available encoder cables can be found in the following chapters.

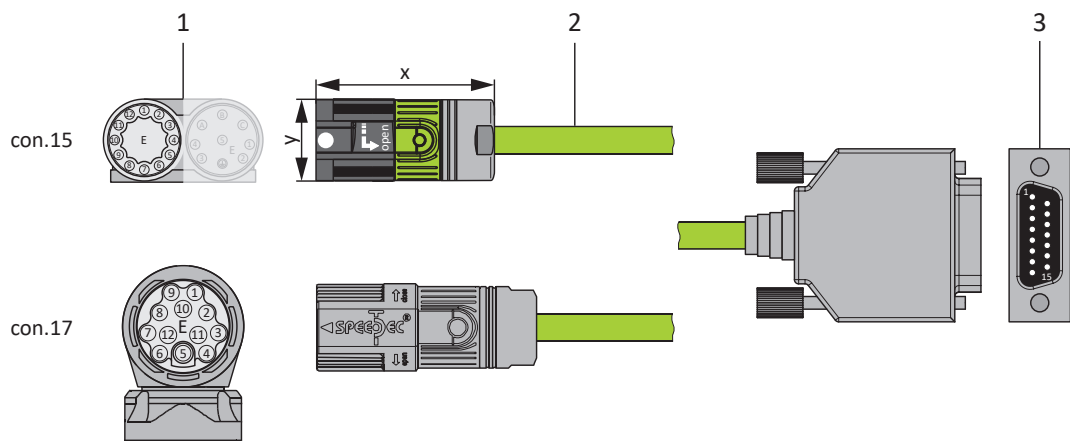
6.1.1 EnDat 2.1/2.2 digital encoders

Suitable encoder cables are described below.

6.1.1.1 Connection description

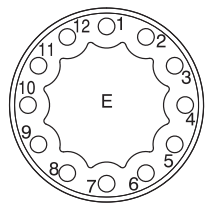
Depending on the size of the motor plug connector, encoder cables are available in the following designs:

- ▶ Quick lock for con.15
- ▶ speedtec quick lock for con.17



- 1 Plug connectors
- 2 Encoder cables
- 3 D-sub X4

Encoder cables – con.15 plug connectors

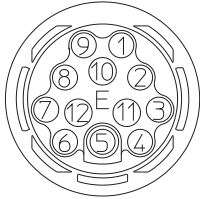
Connection diagram	Motor (1)			Cable (2)	Drive controller (3)
	Pin	Designation	Core color	Core color	Pin X4
	1	Clock +	VT	YE	8
	2	—	—	—	—
	3	—	—	—	—
	4	—	—	—	—
	5	Data -	PK	BN	13
	6	Data +	GY	WH	5
	7	—	—	—	—
	8	Clock -	YE	GN	15
	9	—	—	—	—
	10	0 V GND	WHGN	BU	2
	11	—	—	—	—
	12	U ₂	BNGN	RD	4
	Housing	Shield	—	—	Housing

Tab. 1: con.15 encoder cable pin assignment, EnDat 2.1/2.2 digital

Length x [mm]	Diameter y [mm]
42	18.7

Tab. 2: con.15 connector dimensions

Encoder cables – con.17 plug connectors

Motor (1)				Cable (2)	Drive controller (3)
Connection diagram	Pin	Designation	Core color	Core color	Pin X4
	1	Clock +	VT	YE	8
	2	—	—	—	—
	3	—	—	—	—
	4	—	—	—	—
	5	Data -	PK	BN	13
	6	Data +	GY	WH	5
	7	—	—	—	—
	8	Clock -	YE	GN	15
	9	—	—	—	—
	10	0 V GND	WHGN	BU	2
	11	—	—	—	—
	12	U ₂	BNGN	RD	4
	Housing	Shield	—	—	Housing

Tab. 3: con.17 encoder cable pin assignment, EnDat 2.1/2.2 digital

Length x [mm]	Diameter y [mm]
56	22

Tab. 4: con.17 connector dimensions

6.1.1.2 Technical data

IP protection class of the plug connectors

The plug connectors meet the IP 66/67 protection class (in accordance with IEC 60529). This information applies if both parts of the plug connector are connected together properly. Plug connectors have to be protected against environmental factors that affect functionality (dust, moisture, etc.) in accordance with the type approval laws.

Conductor design

Flexible, bare copper; all elements mounted in a round design at optimum length with filler

Peak operating voltage

Voltage: max. 300 V

Test voltage

Core/core and core/shield: 2000 V × 5 min

Limit temperature

Temperature range by operating mode	DIN VDE	UL/CSA
Permanently installed	-50 °C to +90 °C	Up to +80 °C
Free to move	-40 °C to +90 °C	Up to +80 °C

Tensile stress when being laid

- ▶ Free to move: 20 N per mm² conductor cross-section
- ▶ Permanently installed: 50 N per mm² conductor cross-section

Smallest permissible bending radius

- ▶ Freely movable: 10 x d_{out}
- ▶ Permanently installed: 5 x d_{out}

Torsional stress

± 30°/m

Bending resistance

Trailable with 5 million bending cycles at a travel velocity of 180 m/min and an acceleration of 5 m/s² under optimum ambient conditions

Resistance

- ▶ Oil-resistant: in accordance with EN 50363-10-2
- ▶ Chemical: UV-resistant in accordance with EN 50289-4-17, hydrolysis-resistant in accordance with EN 50396, microbacteria-resistant

Outer sheath

PUR

Banding

Fleece tape with overlapping

Core insulation

PP

Core identification

Pair	Colors	
2 × 0.14	YE	GN
2 × 0.14	BN	WH
2 × 0.14	PK	GY
2 × 0.25	BU	RD

Sheath identification

Green color (similar to RAL 6018) imprinted with STOBBER and No. "5050044"

Shield design

- ▶ Copper braid, tin-plated
- ▶ Cover: ≥ 90%

Insulation material

Halogen-free in accordance with EN 60754-1, silicone-free, CFC-free, free from paint-wetting impairment substances (PWIS)

Flammability

Combustion behavior: flame retardant and self-extinguishing in accordance with IEC 60332-1-2, UL/CSA FT1, UL VW-1

RoHS conformity

Free of hazardous substances in accordance with the RoHS-2 Directive 2011/65/EU and RoHS-3 Directive 2015/863

Conductor cross-sections

Cable diameter	Description	Weight
Max. 6.7 mm	(3 x 2 x 0.14 mm ² + 2 x 0.25 mm ²)	85 g/m

"(...)" = Shield

Design

UL/CSA (E172204, E170315 or E356538); for UL file number, see cable imprint

Capacitance, inductance, DC resistance

Operating capacitance in accordance with EN 50289-1-5	
Pair 0.14 mm ²	Max. 100 nF/km
Pair 0.25 mm ²	Max. 100 nF/km

Inductance in accordance with EN 50289-1-12	
Pair 0.14 mm ²	Max. 0.8 mH/km
Pair 0.25 mm ²	Max. 0.8 mH/km


DC resistance at 20 °C	
Pair 0.14 mm ²	139.3 Ω/km
Pair 0.25 mm ²	78.0 Ω/km

6.1.2 EnDat 3 encoders



Information

In combination with an EnDat 3 encoder, you require hybrid cables which feature encoder communication and power transmission in a shared cable.

For an overview of the motor connection using hybrid cables, see [One Cable Solution EnDat 3](#) [ 10].

6.2 Determining the cable code for ready-made cables

The motor model, encoder model and encoder interface of the drive controller provide you with the cable code, which you in turn can use to determine the identification numbers of ready-made cables.



Information

Note that the cable codes used in this documentation are intended only to refer to the overview and selection tables within this manual. The cable codes are not part of the ordering process and are not printed on the cables.

6.2.1 Codes for EZ synchronous servo motors

The size of the motor plug connector of EZ series synchronous servo motors depends on the size of the motor:

- ▶ con.15 for motors of sizes 2 to 3
- ▶ con.17 for motors of size 4 or larger

The encoder interface for connecting the cable varies based on the encoder model and drive controller series.

Cables

Type		EnDat 2.1/2.2 digital	
		con.15	con.17
SC6, SI6	X4	<u>SZ1</u>	<u>SZ2</u>

Tab. 5: Encoder cable codes for EZ synchronous servo motors

6.3 Ready-made encoder cables

The cable code provides you with the identification numbers for ready-made cables up to 20 m in length. Other lengths and extension cables are available on request.



Information

Note that the maximum overall length of the cable and extension is 100 m.

EnDat 2.1/2.2 digital – Cable type: PMCcable FD

Code	Size	Cable length [m]				
		2.5	5	10	15	20
SZ7	con.15	8C000107	8C000103	8C000104	8C000105	8C000106
SZ2	con.17	8C000113	8C000109	8C000110	8C000111	8C000112

Tab. 6: Ready-made cables up to 20 m for EnDat 2.1/2.2 digital encoders

7 Power cables

The synchronous servo motors are equipped with plug connectors as standard.

Pilz provides suitable cables in various lengths, conductor cross-sections and connector sizes.

7.1 Connection description

Depending on the size of the motor plug connector, power cables are available in the following designs:

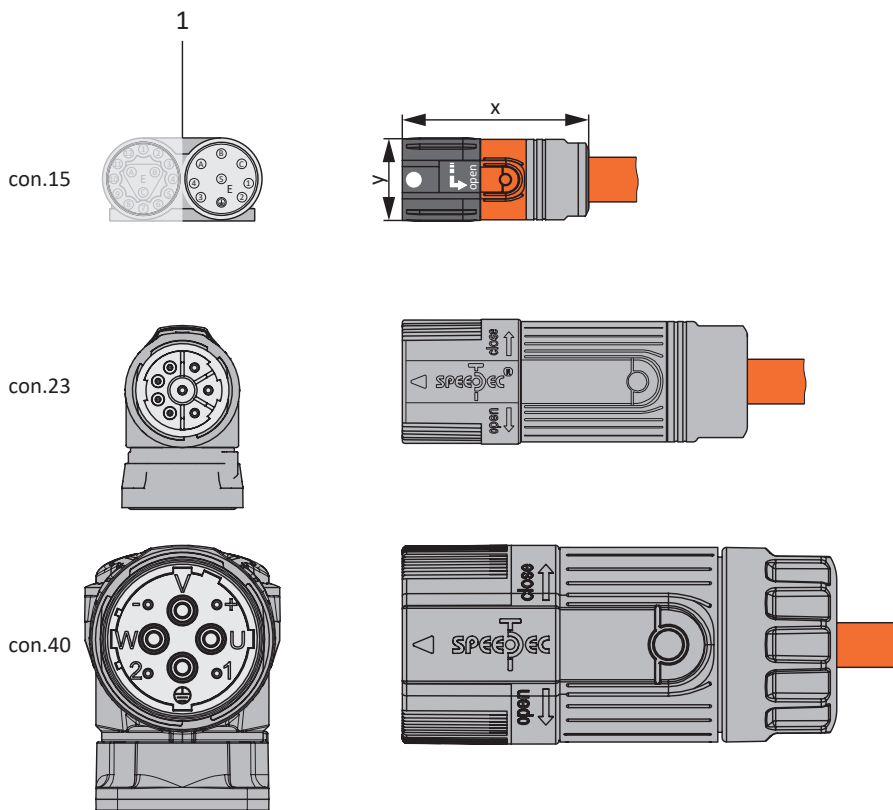
- ▶ Quick lock for con.15
- ▶ speedtec quick lock for con.23 and con.40



Information

Observe the designations on the identification clips for the correct connection of the cores.

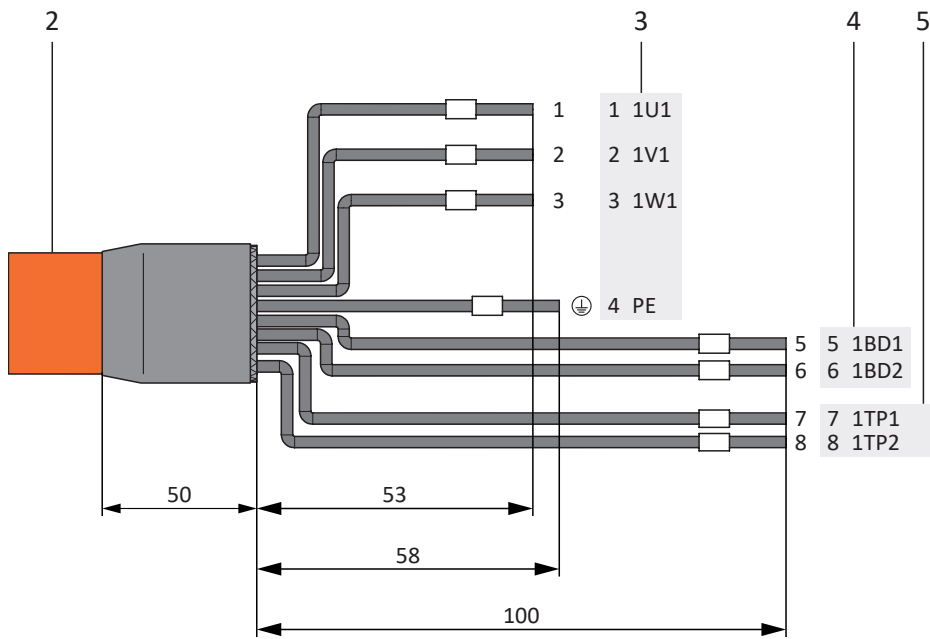
Motor-side connection



1 Plug connectors

Intern

Drive controller-side connection



- 2 Power cable with cable shield
- 3 Connection to terminal X20, motor
- 4 Connection of terminal X2, brake
- 5 Connection to terminal X2, temperature sensor

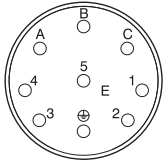

Maximum cable length

Motor type	Connection	Size 0 to 2	Size 3
Synchronous servo motor	Without output choke	50 m, shielded	100 m, shielded
Synchronous servo motor	With output choke	100 m, shielded	—

Tab. 7: Maximum cable length of the power cable [m]

Intern

Power cables – con.15 plug connectors

Motor (1)				Cable (2)	Drive controller (3) – (5)		
Motor connection diagram	Pin	Designation	Int. motor Core color	Identification/ Core color	Pin X20	Pin X2	Pin X2
	A	1U1	BK	1	1	—	—
	B	1V1	BU	2	2	—	—
	C	1W1	RD	3	3	—	—
	1	1TP1	BK ^{a)}	7	—	—	7
	2	1TP2	WH ^{a)}	8	—	—	8
	3	1BD1	RD	5	—	5	—
	4	1BD2	BK	6	—	6	—
	5	—	—	—	—	—	—
		PE	GNYE	GNYE	4	—	—
Housing	Shield	—	—	Shield contact	—	—	

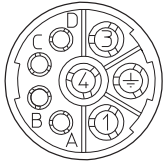

Tab. 8: con.15 power cable pin assignment

a) Color depends on the type of temperature sensor (PTC), which is specified on the motor nameplate.

Length x [mm]	Diameter y [mm]
42	18.7

Tab. 9: con.15 connector dimensions

Power cables – con.23 plug connectors

Motor (1)				Cable (2)	Drive controller (3) – (5)		
Motor connection diagram	Pin	Designation	Int. motor Core color	Identification/ Core color	Pin X20	Pin X2	Pin X2
	1	1U1	BK	1	1	—	—
	3	1V1	BU	2	2	—	—
	4	1W1	RD	3	3	—	—
	A	1BD1	BK/RD ^{a)}	5	—	5	—
	B	1BD2	BK	6	—	6	—
	C	1TP1	BK ^{b)}	7	—	—	7
	D	1TP2	WH ^{b)}	8	—	—	8
		PE	GNYE	GNYE	4	—	—
	Housing	Shield	—	—	Shield contact	—	—

Tab. 10: con.23 power cable pin assignment

a) Color depends on the type of motor

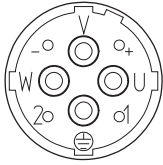
b) Color depends on the type of temperature sensor (PTC) which is specified on the motor nameplate.

Length x [mm]	Diameter y [mm]
78	26

Tab. 11: con.23 connector dimensions

Intern

Power cables – con.40 plug connectors

Motor (1)				Cable (2)	Drive controller (3) – (5)		
Motor connection diagram	Pin	Designation	Int. motor Core color	Identification/ Core color	Pin X20	Pin X2	Pin X2
	U	1U1	BK	1	1	—	—
	V	1V1	BU	2	2	—	—
	W	1W1	RD	3	3	—	—
	+	1BD1	RD	5	—	5	—
	-	1BD2	BK	6	—	6	—
	1	1TP1	BK ^{a)}	7	—	—	7
	2	1TP2	WH ^{a)}	8	—	—	8
	⊕	PE	GNYE	GNYE	4	—	—
	Housing	Shield	—	—	Shield contact	—	—

Tab. 12: con.40 power cable pin assignment

a) Color depends on the type of temperature sensor (PTC), which is specified on the motor nameplate.

Length x [mm]	Diameter y [mm]
99	46

Tab. 13: con.40 connector dimensions

7.2 Technical data

IP protection class of the plug connectors

The plug connectors meet the IP 66/67 protection class (in accordance with IEC 60529). This information applies if both parts of the plug connector are connected together properly. Plug connectors have to be protected against environmental factors that affect functionality (dust, moisture, etc.) in accordance with the type approval laws.

Conductor design

Conductor cross-section $4 \times 1.0 \text{ mm}^2$ to $4 \times 16.0 \text{ mm}^2$

Flexible, bare copper; all elements mounted in a round design with filler

Conductor cross-section $4 \times 25.0 \text{ mm}^2$

Bare copper, class 6 in accordance with DIN EN 60228; 4 cores and 2 pairs with filling elements twisted around the center

Voltage

Conductor cross-section $4 \times 1.0 \text{ mm}^2$ to $4 \times 16.0 \text{ mm}^2$

- ▶ Nominal voltage (DIN VDE): power cores $U_o/U = 0.6/1.0 \text{ kV}$
- ▶ Peak operating voltage (DIN VDE): pilot cores max. 350 V
- ▶ Voltage (UL/CSA): power cores 1000 V
- ▶ Voltage (UL/CSA): pilot cores 1000 V

Conductor cross-section $4 \times 25.0 \text{ mm}^2$

- ▶ Nominal voltage (DIN VDE): power cores $U_o/U = 0.6/1.0 \text{ kV}$
- ▶ Nominal voltage (DIN VDE): pilot cores $U_o/U = 300/500 \text{ V}$
- ▶ Voltage (UL/CSA): power cores 1000 V
- ▶ Voltage (UL/CSA): pilot cores 1000 V

Test voltage

Conductor cross-section $4 \times 1.0 \text{ mm}^2$ to $4 \times 1.5 \text{ mm}^2$

- ▶ Core/core and core/shield: power cores $4000 \text{ V} \times 5 \text{ min}$
- ▶ Core/core and core/shield: pilot cores $2000 \text{ V} \times 5 \text{ min}$

Conductor cross-section $4 \times 2.5 \text{ mm}^2$ to $4 \times 25.0 \text{ mm}^2$

- ▶ Core/core and core/shield: power cores $4000 \text{ V} \times 5 \text{ min}$
- ▶ Core/core and core/shield: pilot cores $4000 \text{ V} \times 5 \text{ min}$

Current carrying capacity

Conductor cross-section $4 \times 1.0 \text{ mm}^2$ to $4 \times 4.0 \text{ mm}^2$

Power cores in accordance with DIN VDE 0298, part 4, tables 11 and 17; pilot cores in accordance with DIN VDE 0891, part 1

Conductor cross-section $4 \times 10.0 \text{ mm}^2$ to $4 \times 25.0 \text{ mm}^2$

Power and pilot cores in accordance with DIN VDE 0298, part 4, tables 11 and 17

Intern

Power cores							
Conductor cross-section [mm ²]	1.0	1.5	2.5	4.0	10.0	16.0	25.0
Nominal current $I_{N,CAB}$ [A]	13.1	15.7	22.6	29.6	53.0	71.0	94.0

Pilot cores – Brake and temperature sensor					
Conductor cross-section [mm ²]	0.34	0.5	0.75	1.0	1.5
Nominal current $I_{N,CAB}$ [A]	4.4	7.8	10.4	13.1	15.7

Limit temperature

Temperature range by operating mode	DIN VDE	UL/CSA
Permanently installed	-50 °C to +90 °C	Up to +80 °C
Free to move	-40 °C to +90 °C; from 4 × 16.0 mm ² : -30 °C to +80 °C	Up to +80 °C

Tensile stress when being laid

- ▶ Free to move: 20 N per mm² conductor cross-section
- ▶ Permanently installed: 50 N per mm² conductor cross-section

Smallest permissible bending radius

Routing method	4 × 1.0 mm ² to 4 × 10.0 mm ²	4 × 16.0 mm ² to 4 × 25.0 mm ²
Freely movable	10 × d _{out}	7.5 × d _{out}
Permanently installed	5 × d _{out}	4 × d _{out}

Torsional stress

± 30°/m

Bending resistance

Trailable with 5 million bending cycles at a travel velocity of 180 m/min and an acceleration of 5 m/s² under optimum ambient conditions

Resistance

Conductor cross-section 4 × 1.0 mm² to 4 × 16.0 mm²

- ▶ Oil-resistant: in accordance with EN 50363-10-2
- ▶ Chemical: UV-resistant in accordance with EN 50289-4-17, hydrolysis-resistant in accordance with EN 50396, microbacteria-resistant

Conductor cross-section 4 × 25.0 mm²

- ▶ Oil-resistant: in accordance with EN 50363-10-2 and EN 60811-2-1
- ▶ Chemical: resistant to acids, alkalis, cleaning agents, and dusts

Outer sheath

PUR

Banding

Fleece tape with overlapping

Core insulation

PP

Core identification**Conductor cross-section $4 \times 1.0 \text{ mm}^2$**

Power cores: black color with printed numbers (1, 2, 3); yellow-green for grounding conductor; pilot cores: white color with printed numbers (5, 6 and 7, 8); cores with core clips

Conductor cross-section $4 \times 1.5 \text{ mm}^2$

Power cores: black color with printed numbers (1, 2, 3); yellow-green for grounding conductor; pilot cores: black color with printed numbers (5, 6 and 7, 8); cores with core clips

Conductor cross-section $4 \times 2.5 \text{ mm}^2$ to $4 \times 25.0 \text{ mm}^2$

Power cores: black color with printed numbers (U/L1/C/L+, V/L2/, W/L3/D/L-); yellow-green for grounding conductor; pilot cores: black color with printed numbers (5, 6 and 7, 8); cores with core clips

Sheath identification**Conductor cross-section $4 \times 1.0 \text{ mm}^2$ to $4 \times 1.5 \text{ mm}^2$**

Orange color (similar to RAL 2003) imprinted with STOBBER and number (1.0 mm^2 : "5050042"; 1.5 mm^2 : "5050043")

Conductor cross-section $4 \times 2.5 \text{ mm}^2$ to $4 \times 25.0 \text{ mm}^2$

Orange color (similar to RAL 2003) with imprint of cable manufacturer

Shield coverage factor

Braiding made of tin-plated copper wires, cover $\geq 85\%$

Insulation material

Halogen-free in accordance with EN 60754-1, silicone-free, CFC-free, free from paint-wetting impairment substances (PWIS)

Flammability**Conductor cross-section $4 \times 1.0 \text{ mm}^2$ to $4 \times 16.0 \text{ mm}^2$**

Combustion behavior: flame retardant and self-extinguishing in accordance with IEC 60332-1-2, UL/CSA FT1, UL VW-1

Conductor cross-section $4 \times 25.0 \text{ mm}^2$

Combustion behavior: flame retardant and self-extinguishing in accordance with IEC 60332-1-2, UL758 cable flame test

RoHS conformity

Free of hazardous substances in accordance with the RoHS-2 Directive 2011/65/EU and RoHS-3 Directive 2015/863

Conductor cross-sections and weights

Cable diameter	Description	Weight
Max. 10.1 mm	$(4 \times 1.0 + (2 \times 0.5) + (2 \times 0.34)) \text{ mm}^2$	0.215 kg/m
Max. 12.2 mm	$(4 \times 1.5 + (2 \times 1.0) + (2 \times 0.50)) \text{ mm}^2$	0.285 kg/m
Max. 15.1 mm	$(4 \times 2.5 + 2 \times (2 \times 1.0)) \text{ mm}^2$	0.320 kg/m
Max. 16.8 mm	$(4 \times 4.0 + (2 \times 1.5) + (2 \times 1.0)) \text{ mm}^2$	0.430 kg/m
Max. 22.3 mm	$(4 \times 10.0 + (2 \times 1.5) + (2 \times 1.0)) \text{ mm}^2$	0.805 kg/m

"(...)" = shield; other cross-sections on request

End sleeves

End sleeves in accordance with DIN 46228-4		
Conductor cross-section [mm ²]	0.34 – 1.5	2.5 – 25.0
Contact length [mm]	10	18

Design

UL/CSA (E172204, E170315 or E356538); for UL file number, see cable imprint

Capacitance, inductance, DC resistance

Operating capacitance in accordance with EN 50289-1-5	
Conductor cross-section 4 × 1.0 mm²	
Cores 1.0 mm ²	Max. 200 nF/km
Pair 0.5 mm ²	Max. 200 nF/km
Pair 0.34 mm ²	Max. 185 nF/km
Conductor cross-section 4 × 1.5 mm²	
Cores 1.5 mm ²	Max. 200 nF/km
Pair 1.0 mm ²	Max. 200 nF/km
Pair 0.5 mm ²	Max. 200 nF/km
Conductor cross-section 4 × 2.5 mm²	
Cores 2.5 mm ²	Max. 200 nF/km
Pair 1.0 mm ²	Max. 200 nF/km
Conductor cross-section 4 × 4.0 mm²	
Cores 4.0 mm ²	On request
Pair 1.0 mm ²	On request
Pair 1.5 mm ²	On request

Intern

Operating capacitance in accordance with EN 50289-1-5

Conductor cross-section 4 × 10.0 mm ²	
Cores 10.0 mm ²	Max. 210 nF/km
Pair 1.0 mm ²	Max. 210 nF/km
Pair 1.5 mm ²	Max. 262 nF/km
Conductor cross-section 4 × 16.0 mm ²	
Cores 16.0 mm ²	Max. 265 nF/km
Pair 1.5 mm ²	Max. 262 nF/km
Conductor cross-section 4 × 25.0 mm ²	
Cores 25.0 mm ²	Max. 235 nF/km
Pair 1.5 mm ²	Max. 180 nF/km

Inductance in accordance with EN 50289-1-12

Conductor cross-section 4 × 1.0 mm ²	
Cores 1.0 mm ²	Max. 0.7 mH/km
Pair 0.5 mm ²	Max. 0.7 mH/km
Pair 0.34 mm ²	Max. 0.7 mH/km
Conductor cross-section 4 × 1.5 mm ²	
Cores 1.5 mm ²	Max. 0.7 mH/km
Pair 1.0 mm ²	Max. 0.7 mH/km
Pair 0.5 mm ²	Max. 0.7 mH/km
Conductor cross-section 4 × 2.5 mm ²	
Cores 2.5 mm ²	Max. 0.7 mH/km
Pair 1.0 mm ²	Max. 0.7 mH/km
Conductor cross-section 4 × 4.0 mm ²	
Cores 4.0 mm ²	Max. 0.7 mH/km
Pair 1.0 mm ²	Max. 0.7 mH/km
Pair 1.5 mm ²	Max. 0.7 mH/km
Conductor cross-section 4 × 10.0 mm ²	
Cores 10.0 mm ²	Max. 0.7 mH/km
Pair 1.0 mm ²	Max. 0.7 mH/km
Pair 1.5 mm ²	Max. 0.7 mH/km
Conductor cross-section 4 × 16.0 mm ²	
Cores 16.0 mm ²	Max. 0.7 mH/km
Pair 1.5 mm ²	Max. 0.7 mH/km

Intern

Inductance in accordance with EN 50289-1-12

Conductor cross-section 4 × 25.0 mm²

Cores 25.0 mm ²	Max. 0.38 mH/km
Pair 1.5 mm ²	Max. 0.32 mH/km

DC resistance at 20 °C

Conductor cross-section 4 × 1.0 mm²

Cores 1.0 mm ²	19.5 Ω/km
Pair 0.5 mm ²	39.0 Ω/km
Pair 0.34 mm ²	57.4 Ω/km

Conductor cross-section 4 × 1.5 mm²

Cores 1.5 mm ²	13.3 Ω/km
Pair 1.0 mm ²	19.5 Ω/km
Pair 0.5 mm ²	39.0 Ω/km

Conductor cross-section 4 × 2.5 mm²

Cores 2.5 mm ²	7.98 Ω/km
Pair 1.0 mm ²	19.5 Ω/km

Conductor cross-section 4 × 4.0 mm²

Cores 4.0 mm ²	4.95 Ω/km
Pair 1.0 mm ²	19.5 Ω/km
Pair 1.5 mm ²	13.3 Ω/km

Conductor cross-section 4 × 10.0 mm²

Cores 10.0 mm ²	1.91 Ω/km
Pair 1.0 mm ²	19.5 Ω/km
Pair 1.5 mm ²	13.3 Ω/km

Conductor cross-section 4 × 16.0 mm²

Cores 16.0 mm ²	1.21 Ω/km
Pair 1.5 mm ²	13.3 Ω/km

Conductor cross-section 4 × 25.0 mm²

Cores 25.0 mm ²	0.78 Ω/km
Pair 1.5 mm ²	13.3 Ω/km

7.3 Power cables for synchronous motors

Proceed as follows:

- ▶ Determine the size of the plug connector and the minimum cross-section of the cable based on the motor
- ▶ Check whether the minimum cross-section is sufficient for your application; adjust it if necessary
- ▶ Determine the cable code based on the plug connector size and conductor cross-section, which you can use in turn to get the identification numbers of ready-made cables

7.3.1 Determining the cable code for ready-made cables in 3 steps



Information

Note that the cable codes used in this documentation are intended only to refer to the overview and selection tables within this manual. The cable codes are not part of the ordering process and are not printed on the cables.

7.3.1.1

Sizes for EZ synchronous servo motors

Determine the size of the plug connector and the minimum cross-section of the cable based on the motor.

EZ motors – IC 410 convection cooling

	n_N 2000 rpm				n_N 3000 rpm				$n_N = 4000$ rpm / 4500 rpm				n_N 6000 rpm			
	K_{EM} [V/ 1000 rpm]	I_0 [A]	Plug con. size	Minimum cross- section [mm ²]	K_{EM} [V/ 1000 rpm]	I_0 [A]	Plug con. size	Minimum cross- section [mm ²]	K_{EM} [V/ 1000 rpm]	I_0 [A]	Plug con. size	Minimum cross- section [mm ²]	K_{EM} [V/ 1000 rpm]	I_0 [A]	Plug con. size	Minimum cross- section [mm ²]
EZ202U	—	—	—	—	—	—	—	—	—	—	—	—	40	1.03	con.15	1.0
EZ203U	—	—	—	—	—	—	—	—	—	—	—	—	40	1.64	con.15	1.0
EZ301U	—	—	—	—	40	2.02	con.15	1.0	—	—	—	—	40	2.02	con.15	1.0
EZ302U	—	—	—	—	86	1.67	con.15	1.0	—	—	—	—	42	3.48	con.15	1.0
EZ303U	—	—	—	—	109	1.71	con.15	1.0	—	—	—	—	55	3.55	con.15	1.0
EZ401U	—	—	—	—	96	2.88	con.23	1.0 / 1.5	—	—	—	—	47	5.36	con.23	1.0 / 1.5
EZ402U	—	—	—	—	94	4.8	con.23	1.0 / 1.5	—	—	—	—	60	7.43	con.23	1.0 / 1.5
EZ404U	—	—	—	—	116	6.6	con.23	1.0 / 1.5	—	—	—	—	78	9.78	con.23	1.0 / 1.5
EZ501U	—	—	—	—	97	4	con.23	1.0 / 1.5	—	—	—	—	68	5.8	con.23	1.0 / 1.5
EZ502U	—	—	—	—	121	5.76	con.23	1.0 / 1.5	—	—	—	—	72	9.8	con.23	1.0 / 1.5
EZ503U	—	—	—	—	119	7.67	con.23	1.0 / 1.5	—	—	—	—	84	11.6	con.23	1.0 / 1.5
EZ505U	—	—	—	—	141	10	con.23	1.0 / 1.5	103	13.4	con.23	1.5	—	—	—	—
EZ701U	—	—	—	—	95	8	con.23	1.0 / 1.5	—	—	—	—	76	9.38	con.23	1.0 / 1.5
EZ702U	—	—	—	—	133	9.6	con.23	1.0 / 1.5	—	—	—	—	82	16.5	con.23	2.5
EZ703U	—	—	—	—	122	14	con.23	1.5	99	17.8	con.23	2.5	—	—	—	—
EZ705U	—	—	—	—	140	19.5	con.40	2.5	106	25.2	con.40	4.0	—	—	—	—
EZ802U	—	—	—	—	136	22.3	con.40	4.0	90	33.3	con.40	4.0/10.0	—	—	—	—
EZ803U	—	—	—	—	131	31.1	con.40	10.0	—	—	—	—	—	—	—	—
EZ805U	142	37.9	con.40	10.0	—	—	—	—	—	—	—	—	—	—	—	—

Tab. 14: Plug connector size and minimum cross-section, EZ synchronous servo motors with convection cooling

Intern

Minimum cross-section specification for motors with integrated holding brake: The smaller cross-section applies to cable lengths up to max. 12.5 m.

EZ motors – IC 416 forced ventilation

	n_N 2000 rpm				n_N 3000 rpm				$n_N = 4000$ rpm / 4500 rpm				n_N 6000 rpm			
	K_{EM} [V/ 1000 rpm]	I_0 [A]	Plug con. size	Minimum cross- section [mm ²]	K_{EM} [V/ 1000 rpm]	I_0 [A]	Plug con. size	Minimum cross- section [mm ²]	K_{EM} [V/ 1000 rpm]	I_0 [A]	Plug con. size	Minimum cross- section [mm ²]	K_{EM} [V/ 1000 rpm]	I_0 [A]	Plug con. size	Minimum cross- section [mm ²]
EZ401B	—	—	—	—	96	3.6	con.23	1.0 / 1.5	—	—	—	—	47	6.83	con.23	1.0 / 1.5
EZ402B	—	—	—	—	94	5.8	con.23	1.0 / 1.5	—	—	—	—	60	9.34	con.23	1.0 / 1.5
EZ404B	—	—	—	—	116	8.7	con.23	1.0 / 1.5	—	—	—	—	78	12	con.23	1.0 / 1.5
EZ501B	—	—	—	—	97	5	con.23	1.0 / 1.5	—	—	—	—	68	7.5	con.23	1.0 / 1.5
EZ502B	—	—	—	—	121	8.16	con.23	1.0 / 1.5	—	—	—	—	72	13.4	con.23	1.5
EZ503B	—	—	—	—	119	11.8	con.23	1.0 / 1.5	—	—	—	—	84	15.9	con.23	2.5
EZ505B	—	—	—	—	141	14.7	con.23	1.5	103	19.4	con.23	2.5	—	—	—	—
EZ701B	—	—	—	—	95	10	con.23	1.0 / 1.5	—	—	—	—	76	12.4	con.23	1.0 / 1.5
EZ702B	—	—	—	—	133	12.9	con.23	1.0 / 1.5	—	—	—	—	82	22.1	con.23	2.5 / 4.0
EZ703B	—	—	—	—	122	20	con.23	2.5	99	24.2	con.23	4.0	—	—	—	—
EZ705B	—	—	—	—	140	26.5	con.40	4.0	106	32.8	con.40	10.0	—	—	—	—
EZ802B	—	—	—	—	136	28.9	con.40	4.0 / 10.0	90	45.1	con.40	10.0	—	—	—	—
EZ803B	—	—	—	—	131	42.3	con.40	10.0	—	—	—	—	—	—	—	—
EZ805B	142	53.9	con.40	16.0	—	—	—	—	—	—	—	—	—	—	—	—

Tab. 15: Plug connector size and minimum cross-section, EZ synchronous servo motors with forced ventilation

Minimum cross-section specification for motors with integrated holding brake: The smaller cross-section applies to cable lengths up to max. 12.5 m.

7.3.1.2 Checking the minimum cross-section and contact length

Pilz offers cables with a minimum cross-section for the motors as standard. Depending on the application, however, larger conductor cross-sections may be required. For this reason, take into account the following points in addition for dimensioning the cable:

Stall current I_0 of the motor

For designing the cable, note the stall current I_0 of the motor.

Permitted current carrying capacity of the conductors

Observe the permitted carrying capacity of the cable depending on the ambient and usage conditions. The following standards describe this topic:


- ▶ General requirements for machine cabling: EN 60204-1
- ▶ Detailed information: DIN VDE 0298-4

Cable length

Observe the length of the power and brake cores:

- ▶ The length of the power cores affects the possible short-circuit currents that have to be handled by the device protection
- ▶ The length of the brake cores can cause problems due to a voltage drop

Terminal specifications of the drive controller or output choke

The selected cable must be covered by the specification of the terminals of the drive controller or output choke (see [Terminal specifications](#) [ 53]).

Plug connector size of the motor

Depending on the plug connector size of the motor, different power core cross-sections are available.



Information

Select a larger conductor cross-section if required by your application.

Contact length of the cable

If the end sleeve does not have the length required in accordance with the terminal specification, select a cable with a longer contact length. If the end sleeve is longer than the length required in accordance with to the terminal specification, shorten the end sleeve to the appropriate length.

7.3.1.3

Codes for EZ synchronous servo motors

The conductor cross-section of the cable and the drive controller series provide you with the cable code, which you in turn can use to determine the identification numbers of ready-made cables.



Information

For drive controllers of sizes 0 to 2, you also need an output choke for an overall length of 50 m or more in order to reduce interference pulses and protect the drive system. For drive controllers of sizes 0 to 2 with output chokes as well as drive controllers of size 3, the maximum overall length of the cable and extension is 100 m.

Cables for con.15

Cables	SC6, SI6
4 × 1.0 mm ² , 8-core	LSI6H

Tab. 16: Power cable codes for EZ synchronous servo motors, con.15

Cables for con.23

Cables	SC6, SI6
4 × 1.0 mm ² , 8-core	On request
4 × 1.5 mm ² , 8-core	LSI6B
4 × 2.5 mm ² , 8-core	LSI6C
4 × 4.0 mm ² , 8-core	LSI6D

Tab. 17: Power cable codes for EZ synchronous servo motors, con.23

Cables for con.40

Cables	SC6, SI6
4 × 2.5 mm ² , 8-core	LSI6I
4 × 4.0 mm ² , 8-core	LSI6E
4 × 10.0 mm ² , 8-core	LSI6G

Tab. 18: Power cable codes for EZ synchronous servo motors, con.40

7.3.2 Ready-made power cables

The cable code provides you with the identification numbers for ready-made cables up to 20 m in length. Other lengths and extension cables are available on request.



Information

For drive controllers of sizes 0 to 2, you also need an output choke for an overall length of 50 m or more in order to reduce interference pulses and protect the drive system. For drive controllers of sizes 0 to 2 with output chokes as well as drive controllers of size 3, the maximum overall length of the cable and extension is 100 m.

Power cables – Cable type: PMCable M3

Code	Size	Cable length [m]				
		2.5	5	10	15	20
LSI6H	con.15	8C000131	8C000127	8C000128	8C000129	8C000130
LSI6B	con.23	8C000173	8C000169	8C000170	8C000171	8C000172
LSI6C	con.23	8C000143	8C000139	8C000140	8C000141	8C000142
LSI6D	con.23	8C000149	8C000145	8C000146	8C000147	8C000148
LSI6I	con.40	8C000161	8C000157	8C000158	8C000159	8C000160
LSI6E	con.40	8C000167	8C000163	8C000164	8C000165	8C000166
LSI6G	con.40	8C000155	8C000151	8C000152	8C000153	8C000154

Tab. 19: Ready-made power cables up to 20 m

7.4 Accessories

You can find information about the available accessories in the following chapters.

7.4.1 PMC TEP output choke

Output chokes are required for connecting size 0 to 2 drive controllers to synchronous servo motors or asynchronous motors from a cable length > 50 m in order to reduce interference pulses and protect the drive system. If Lean motors are connected, output chokes must not be used.



Information

The following technical data only applies to a rotating magnetic field frequency of 200 Hz. For example, this rotating magnetic field frequency is achieved with a motor with 4 pole pairs and a nominal speed of 3000 rpm. Always observe the specified derating for higher rotating magnetic field frequencies. Also observe the relationship with the clock frequency.

Properties

Technical data	PMC TEP3720-0ES41	PMC TEP3820-0CS41	PMC TEP4020-0RS41
ID No.	8C000099	8C000100	8C000101
Voltage range	3 × 0 to 480 V _{AC}		
Frequency range	0 – 200 Hz		
Nominal current I _{N,MF} at 4 kHz	4 A	17.5 A	38 A
Nominal current I _{N,MF} at 8 kHz	3.3 A	15.2 A	30.4 A
Max. permitted motor cable length with output choke	100 m		
Max. surrounding temperature $\vartheta_{amb,max}$	40 °C		
Protection class	IP00		
Winding losses	11 W	29 W	61 W
Iron losses	25 W	16 W	33 W
Connection	Screw terminal		
Max. conductor cross-section	10 mm ²		
UL Recognized Component (CAN; USA)	Yes		
Marks and test symbols	cURus, CE		

Tab. 20: PMC TEP technical data

Intern

Dimensions

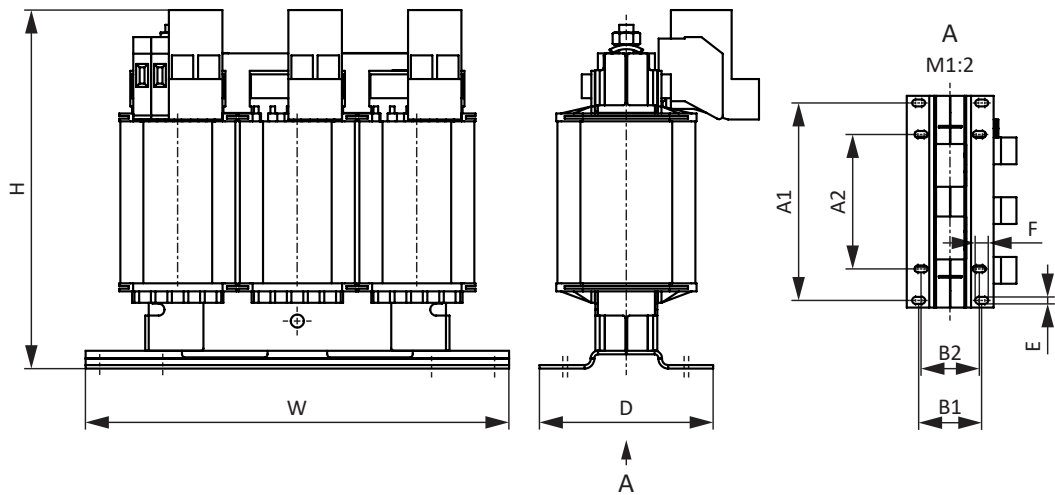


Fig. 4: PMC TEP dimensional drawing

Dimension	PMC TEP3720-0ES41	PMC TEP3820-0CS41	PMC TEP4020-0RS41
Height H [mm]	Max. 150	Max. 152	Max. 172
Width W [mm]	178	178	219
Depth D [mm]	73	88	119
Vertical distance – A1 fastening bores [mm]	166	166	201
Vertical distance – A2 fastening bores [mm]	113	113	136
Horizontal distance – B1 fastening bores [mm]	53	68	89
Horizontal distance – B2 fastening bores [mm]	49	64	76
Drill holes – Depth E [mm]	5.8	5.8	7
Drill holes – Width F [mm]	11	11	13
Screw connection – M	M5	M5	M6
Weight without packaging [g]	2900	5900	8800

Tab. 21: PMC TEP dimensions and weight

More information on chokes can be found in the manuals of the drive controllers (see Detailed information).

8 One Cable Solution

The synchronous servo motors are equipped with plug connectors as standard.

A motor connection as a One Cable Solution (OCS) combined with an EnDat 3 encoder requires hybrid cables which feature encoder communication and power transmission in a shared cable.

Pilz provides suitable cables in various lengths, conductor cross-sections and connector sizes.

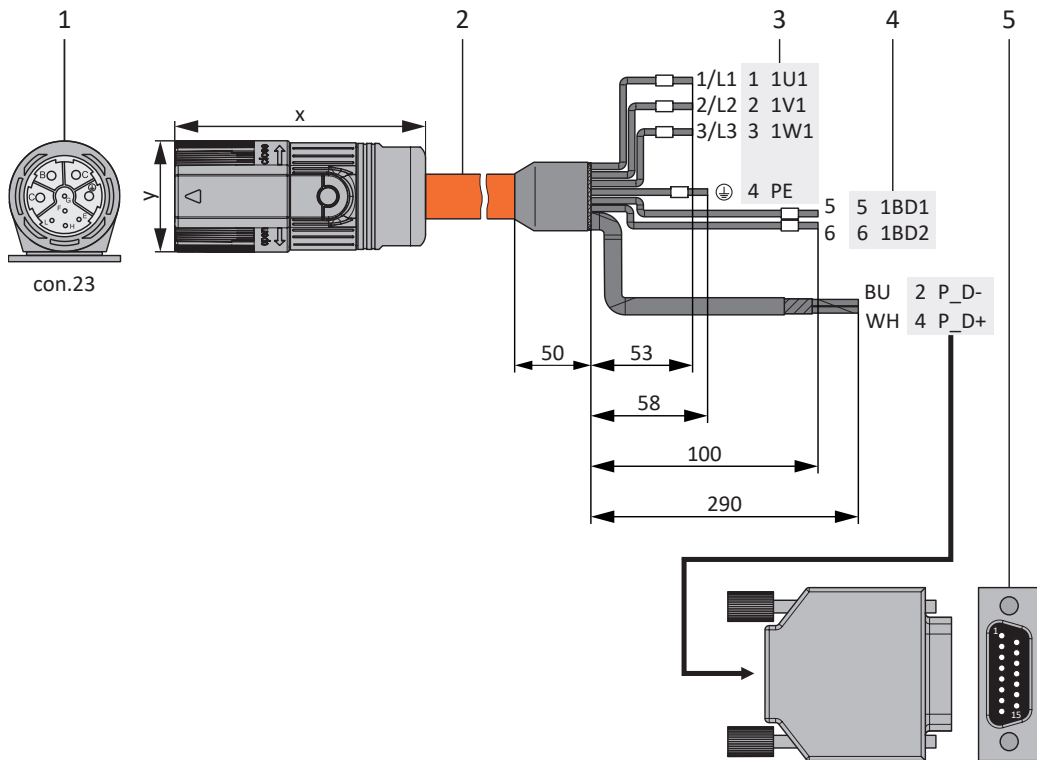


Information

For connecting as a One Cable Solution, use exclusively hybrid cables from Pilz. The use of unsuitable cables or poorly made connections can cause subsequent damage. For this reason, we reserve the right to reject claims under the warranty in this case.

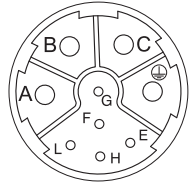

8.1 Connection description

The hybrid cables are available in plug connector size con.23 with a speedtec quick lock.



- 1 Plug connectors
- 2 Hybrid cables
- 3 Connection to terminal X20, motor
- 4 Connection of terminal X2, brake
- 5 D-sub X4

Hybrid cables – con.23 plug connectors

Motor (1)				Cable (2)	Drive controller (3) – (5)		
Connection diagram	Pin	Designation	Core color	Core No./ Core color	Pin X20	Pin X2	Pin X4
	A	1U1	BK	1/L1	1	—	—
	B	1V1	BU	2/L2	2	—	—
	C	1W1	RD	3/L3	3	—	—
	E	P_D-	YE	BU	—	—	2
	F	P_D shield	—	—	—	—	Housing
	G	1BD1	RD	5	—	5	—
	H	P_D+	VT	WH	—	—	4
	L	1BD2	BK	6	—	6	—
		PE	GNYE	GNYE	4	—	—
	Housing	Shield	—	—	—	Shield contact	—

Tab. 22: con.23 hybrid cable pin assignment

Length x [mm]	Diameter y [mm]
78	26

Tab. 23: con.23 connector dimensions

8.2 Technical data

IP protection class of the plug connectors

The plug connectors meet the IP 66/67 protection class (in accordance with IEC 60529). This information applies if both parts of the plug connector are connected together properly. Plug connectors have to be protected against environmental factors that affect functionality (dust, moisture, etc.) in accordance with the type approval laws.

Conductor design

OCS-Basic

Flexible, bare copper; all elements mounted in a round design at optimum length with filler

OCS-Advanced

Finely stranded wire made of bare copper wires in accordance with EN 60228 (VDE 0295), class 6; 4 cores and 2 pairs twisted with optional filling elements

Voltage

- ▶ Nominal voltage (DIN VDE): power cores $U_o/U = 0.6/1.0$ kV
- ▶ Nominal voltage (DIN VDE): pilot cores $U_o/U = 0.6/1.0$ V
- ▶ Voltage (UL/CSA): power cores 1000 V
- ▶ Voltage (UL/CSA): pilot cores 1000 V

Test voltage

OCS-Basic

- ▶ Core/core and core/shield: power cores 4000 V × 5 min
- ▶ Core/core and core/shield: pilot cores 3000 V × 5 min

OCS-Advanced

- ▶ Core/core and core/shield: power cores 4000 V × 5 min
- ▶ Core/core and core/shield: pilot cores 4000 V × 5 min

Current carrying capacity

Power cores in accordance with DIN VDE 0298, part 4, tables 11 and 17; pilot cores 0.75 mm² and 1 mm² in accordance with DIN VDE 0298, part 4; pilot cores AWG22 (0.34 mm²) based on DIN VDE 0891, part 1

Power cores			
Conductor cross-section [mm ²]	1.0	1.5	2.5
Nominal current $I_{N,CAB}$ [A]	13.1	15.7	22.6

Pilot cores			
Conductor cross-section [mm ²]	AWG22 (approx. 0.34)	0.75	1.0
Nominal current $I_{N,CAB}$ [A]	4.4	10.4	13.1

Limit temperature

Temperature range by operating mode	
Permanently installed	-40 °C to +80 °C
Free to move	-30 °C to +80 °C

Tensile stress when being laid

- ▶ Free to move: 20 N per mm² conductor cross-section
- ▶ Permanently installed: 50 N per mm² conductor cross-section

Smallest permissible bending radius

- ▶ Free to move: 10 x d_{out}
- ▶ Permanently installed: 5 x d_{out}

Torsional stress

± 30°/m

Bending resistance

Cycles

Min. 5 million cycles

Travel velocity

Max. 240 m/min

Acceleration

- ▶ Max. 30 m/s² to 5 m travel path
- ▶ Max. 15 m/s² to 10 m travel path
- ▶ Max. 5 m/s² to 20 m travel path

Resistance

OCS-Basic

- ▶ Oil-resistant: in accordance with EN 50363-10-2
- ▶ Chemical: UV-resistant in accordance with EN 50289-4-17, hydrolysis-resistant in accordance with EN 50396, microbacteria-resistant

OCS-Advanced

- ▶ Oil-resistant in accordance with EN 60811-404
- ▶ Chemical: good against acids, bases, solvents, hydraulic fluids

Outer sheath

PUR

Banding

Fleece tape with overlapping

Core insulation

PP

Core identification

Power cores		
	OCS-Basic	OCS-Advanced
Core 1	Black imprinted with U/L1/C/L+	Black imprinted with 1
Core 2	Black imprinted with V/L2	Black imprinted with 2
Core 3	Black imprinted with W/L3/D/L-	Black imprinted with 3
Grounding conductor	Green-yellow	Green-yellow

Pilot cores		
	OCS-Basic	OCS-Advanced
Pair 1	Black and white	Black with numbers 5 + 6
Pair 2	White and blue	White and blue

Sheath identification

OCS-Basic

Orange color (similar to RAL 2003) with imprint of cable manufacturer

OCS-Advanced

Orange color (similar to RAL 2003) imprinted with STOBBER

Shielding

- ▶ Core shielding of the pilot cores in pairs with tin-plated copper braid, optical coverage $\geq 85\%$ and metallized plastic non-woven fabric
- ▶ Complete shielding of tin-plated Cu braid, optical coverage $\geq 85\%$

Insulation material

Halogen-free in accordance with EN 60754-1, silicone-free, CFC-free, free from paint-wetting impairment substances (PWIS)

Flammability

OCS-Basic

Combustion behavior: flame retardant and self-extinguishing in accordance with IEC 60332-1-2, UL/CSA FT1, UL VW-1

OCS-Advanced

Combustion behavior: flame retardant and self-extinguishing in accordance with IEC 60332-1-2, UL758 cable flame test

RoHS conformity

Free of hazardous substances in accordance with the RoHS-2 Directive 2011/65/EU and RoHS-3 Directive 2015/863

Conductor cross-sections

Cable diameter	Description	Weight
OCS-Basic		
Max. 13.6 mm	(4G 1.0 + (2 x 0.75) + (2 x AWG22))	0.23 kg/m
Max. 13.7 mm	(4G 1.5 + (2 x 1.0) + (2 x AWG22))	0.26 kg/m
OCS-Advanced		
Max. 14.7 mm	(4G 1.5 + (2 x 0.75) + (2 x AWG22))	0.32 kg/m
Max. 16.8 mm	(4G 2.5 + (2 x 0.75) + (2 x AWG22))	0.40 kg/m

"(...)" = Shield

End sleeves

End sleeves in accordance with DIN 46228-4		
Conductor cross-section [mm ²]	0.34 – 1.5	2.5
Contact length [mm]	10	18

Design

UL/CSA (OCS Basic: E356538, OCS Advanced: E170315); for UL file number, see cable imprint

Capacitance, inductance, DC resistance

Operating capacitance in accordance with EN 50289-1-5	
OCS-Basic, conductor cross-section 4 × 1.0 mm²	
Cores 1.0 mm ²	Max. 130 nF/km
Pair 0.75 mm ²	Max. 150 nF/km
Pair AWG22	Max. 80 nF/km
OCS-Basic, conductor cross-section 4 × 1.5 mm²	
Cores 1.5 mm ²	Max. 150 nF/km
Pair 1.0 mm ²	Max. 150 nF/km
Pair AWG22	Max. 80 nF/km
OCS-Advanced, conductor cross-section 4 × 1.5 mm²	
Cores 1.5 mm ²	Max. 130 nF/km
Pair 0.75 mm ²	Max. 140 nF/km
Pair AWG22	Max. 80 nF/km
OCS-Advanced, conductor cross-section 4 × 2.5 mm²	
Cores 2.5 mm ²	Max. 130 nF/km
Pair 0.75 mm ²	Max. 140 nF/km
Pair AWG22	Max. 80 nF/km

Inductance in accordance with EN 50289-1-12	
OCS-Basic, conductor cross-section 4 × 1.0 mm²	
Cores 1.0 mm ²	0.7 mH/km
Pair 0.75 mm ²	0.7 mH/km
Pair AWG22	On request
OCS-Basic, conductor cross-section 4 × 1.5 mm²	
Cores 1.5 mm ²	0.7 mH/km
Pair 1.0 mm ²	0.7 mH/km
Pair AWG22	On request
OCS-Advanced, conductor cross-section 4 × 1.5 mm²	
Cores 1.5 mm ²	0.45 mH/km
Pair 0.75 mm ²	0.3 mH/km
Pair AWG22	0.5 mH/km
OCS-Advanced, conductor cross-section 4 × 2.5 mm²	
Cores 2.5 mm ²	0.45 mH/km
Pair 0.75 mm ²	0.3 mH/km
Pair AWG22	0.5 mH/km

Intern

DC resistance at 20 °C	
OCS-Basic, conductor cross-section 4 × 1.0 mm²	
Cores 1.0 mm ²	Max. 19.5 Ω/km
Pair 0.75 mm ²	Max. 26.0 Ω/km
Pair AWG22	Max. 59.4 Ω/km
OCS-Basic, conductor cross-section 4 × 1.5 mm²	
Cores 1.5 mm ²	Max. 13.3 Ω/km
Pair 1.0 mm ²	Max. 19.5 Ω/km
Pair AWG22	Max. 59.4 Ω/km
OCS-Advanced, conductor cross-section 4 × 1.5 mm²	
Cores 1.5 mm ²	Max. 13.3 Ω/km
Pair 0.75 mm ²	Max. 26.0 Ω/km
Pair AWG22	Max. 55.0 Ω/km
OCS-Advanced, conductor cross-section 4 × 2.5 mm²	
Cores 2.5 mm ²	Max. 7.98 Ω/km
Pair 0.75 mm ²	Max. 26.0 Ω/km
Pair AWG22	Max. 55.0 Ω/km

8.3

Determining the cable code for ready-made cables in 3 steps



Information

Note that the cable codes used in this documentation are intended only to refer to the overview and selection tables within this manual. The cable codes are not part of the ordering process and are not printed on the cables.

8.3.1 Sizes for EZ synchronous servo motors

Determine the size of the plug connector and the minimum cross-section of the cable based on the motor.

EZ motors – IC 410 convection cooling

	n _N 3000 rpm			n _N 4500 rpm			n _N 6000 rpm		
	K _{EM} V/1000 rpm	Plug con. size	Minimum cross- section mm ²	K _{EM} V/1000 rpm	Plug con. size	Minimum cross- section mm ²	K _{EM} V/1000 rpm	Plug con. size	Minimum cross- section mm ²
EZ202U	—	—	—	—	—	—	40	con.23	1.0 / 1.5
EZ203U	—	—	—	—	—	—	40	con.23	1.0 / 1.5
EZ301U	40	con.23	1.0 / 1.5	—	—	—	40	con.23	1.0 / 1.5
EZ302U	86	con.23	1.0 / 1.5	—	—	—	42	con.23	1.0 / 1.5
EZ303U	109	con.23	1.0 / 1.5	—	—	—	55	con.23	1.0 / 1.5
EZ401U	96	con.23	1.0 / 1.5	—	—	—	47	con.23	1.0 / 1.5
EZ402U	94	con.23	1.0 / 1.5	—	—	—	60	con.23	1.0 / 1.5
EZ404U	116	con.23	1.0 / 1.5	—	—	—	78	con.23	1.0 / 1.5
EZ501U	97	con.23	1.0 / 1.5	—	—	—	68	con.23	1.0 / 1.5
EZ502U	121	con.23	1.0 / 1.5	—	—	—	72	con.23	1.0 / 1.5
EZ503U	119	con.23	1.0 / 1.5	—	—	—	84	con.23	1.0 / 1.5
EZ505U	141	con.23	1.0 / 1.5	103	con.23	1.5	—	—	—
EZ701U	95	con.23	1.0 / 1.5	—	—	—	76	con.23	1.0 / 1.5
EZ702U	133	con.23	1.0 / 1.5	—	—	—	82	con.23	2.5
EZ703U	122	con.23	1.5	99	con.23	2.5	—	—	—
EZ705U	140	con.23	2.5	—	—	—	—	—	—

Tab. 24: Plug connector size and minimum cross-section, EZ synchronous servo motors with convection cooling

Minimum cross-section specification for motors with integrated holding brake: The smaller cross-section applies to cable lengths up to max. 12.5 m.

Intern

EZ motors – IC 416 forced ventilation

	n _N 3000 rpm			n _N 4500 rpm			n _N 6000 rpm		
	K _{EM} V/1000 rpm	Plug con. size	Minimum cross- section mm ²	K _{EM} V/1000 rpm	Plug con. size	Minimum cross- section mm ²	K _{EM} V/1000 rpm	Plug con. size	Minimum cross- section mm ²
EZ401B	96	con.23	1.0 / 1.5	—	—	—	47	con.23	1.0 / 1.5
EZ402B	94	con.23	1.0 / 1.5	—	—	—	60	con.23	1.0 / 1.5
EZ404B	116	con.23	1.0 / 1.5	—	—	—	78	con.23	1.0 / 1.5
EZ501B	97	con.23	1.0 / 1.5	—	—	—	68	con.23	1.0 / 1.5
EZ502B	121	con.23	1.0 / 1.5	—	—	—	72	con.23	1.5
EZ503B	119	con.23	1.0 / 1.5	—	—	—	84	con.23	2.5
EZ505B	141	con.23	1.5	103	con.23	1.5	—	—	—
EZ701B	95	con.23	1.0 / 1.5	—	—	—	76	con.23	1.0 / 1.5
EZ702B	133	con.23	1.0 / 1.5	—	—	—	—	—	—
EZ703B	122	con.23	2.5	—	—	—	—	—	—

Tab. 25: Plug connector size and minimum cross-section, EZ synchronous servo motors with forced ventilation

Minimum cross-section specification for motors with integrated holding brake: The smaller cross-section applies to cable lengths up to max. 12.5 m.

8.3.2 Checking the minimum cross-section and contact length

Pilz offers cables with a minimum cross-section for the motors as standard. Depending on the application, however, larger conductor cross-sections may be required. For this reason, take into account the following points in addition for dimensioning the cable:

Stall current I_0 of the motor

For designing the cable, note the stall current I_0 of the motor.

Permitted current carrying capacity of the conductors

Observe the permitted carrying capacity of the cable depending on the ambient and usage conditions. The following standards describe this topic:


- ▶ General requirements for machine cabling: EN 60204-1
- ▶ Detailed information: DIN VDE 0298-4

Cable length

Observe the length of the power and brake cores:

- ▶ The length of the power cores affects the possible short-circuit currents that have to be handled by the device protection
- ▶ The length of the brake cores can cause problems due to a voltage drop

Terminal specifications of the drive controller or output choke

The selected cable must be covered by the specification of the terminals of the drive controller or output choke (see [Terminal specifications](#) [ 53]).

Plug connector size of the motor

Depending on the plug connector size of the motor, different power core cross-sections are available.



Information

Select a larger conductor cross-section if required by your application.

Contact length of the cable

If the end sleeve does not have the length required in accordance with the terminal specification, select a cable with a longer contact length. If the end sleeve is longer than the length required in accordance with to the terminal specification, shorten the end sleeve to the appropriate length.

8.3.3 Codes for EZ synchronous servo motors

The conductor cross-section of the cable and the drive controller series provide you with the cable code, which you in turn can use to determine the identification numbers of ready-made cables.

Cables for con.23

Cables	SC6, SI6
OCS-Basic: 4 × 1.0 mm ² , 8-core	On request
OCS-Basic: 4 × 1.5 mm ² , 8-core	On request
OCS-Advanced: 4 × 1.5 mm ² , 8-core	HK2G
OCS-Advanced: 4 × 2.5 mm ² , 8-core	On request

Tab. 26: Hybrid cable codes for EZ and EZS synchronous servo motors, con.23

8.4 Ready-made hybrid cables

The cable code provides you with the identification numbers for ready-made cables up to 25 m in length. Other lengths are available on request.



Information

For drive controllers of sizes 0 to 2, you also need an output choke for an overall length of 50 m or more in order to reduce interference pulses and protect the drive system. For drive controllers of sizes 0 to 2 with output chokes as well as drive controllers of size 3, the maximum overall length is 100 m.

OCS-Advanced hybrid cables – Cable type: PMCable M4

Code	Size	Cable length [m]								
		2.5	5	7.5	10	12.5	15	18	20	25
HK2G	con.23	8C000181	8C000175	8C000182	8C000176	8C000183	8C000177	8C000178	8C000179	8C000180

Tab. 27: Ready-made OCS-Advanced hybrid cables up to 25 m

8.5 Accessories

You can find information about the available accessories in the following chapters.

8.5.1 PMC TEP output choke

Output chokes are required for connecting size 0 to 2 drive controllers to synchronous servo motors or asynchronous motors from a cable length > 50 m in order to reduce interference pulses and protect the drive system. If Lean motors are connected, output chokes must not be used.



Information

The following technical data only applies to a rotating magnetic field frequency of 200 Hz. For example, this rotating magnetic field frequency is achieved with a motor with 4 pole pairs and a nominal speed of 3000 rpm. Always observe the specified derating for higher rotating magnetic field frequencies. Also observe the relationship with the clock frequency.

Properties

Technical data	PMC TEP3720-0ES41	PMC TEP3820-0CS41	PMC TEP4020-0RS41
ID No.	8C000099	8C000100	8C000101
Voltage range	3 × 0 to 480 V _{AC}		
Frequency range	0 – 200 Hz		
Nominal current I _{N,MF} at 4 kHz	4 A	17.5 A	38 A
Nominal current I _{N,MF} at 8 kHz	3.3 A	15.2 A	30.4 A
Max. permitted motor cable length with output choke	100 m		
Max. surrounding temperature $\vartheta_{amb,max}$	40 °C		
Protection class	IP00		
Winding losses	11 W	29 W	61 W
Iron losses	25 W	16 W	33 W
Connection	Screw terminal		
Max. conductor cross-section	10 mm ²		
UL Recognized Component (CAN; USA)	Yes		
Marks and test symbols	cURus, CE		

Tab. 28: PMC TEP technical data

Intern

Dimensions

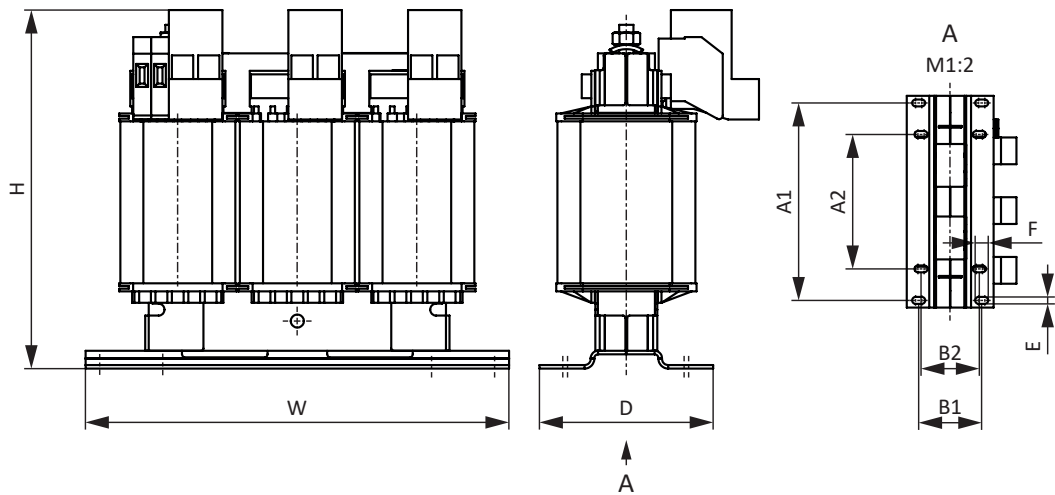


Fig. 5: PMC TEP dimensional drawing

Dimension	PMC TEP3720-0ES41	PMC TEP3820-0CS41	PMC TEP4020-0RS41
Height H [mm]	Max. 150	Max. 152	Max. 172
Width W [mm]	178	178	219
Depth D [mm]	73	88	119
Vertical distance – A1 fastening bores [mm]	166	166	201
Vertical distance – A2 fastening bores [mm]	113	113	136
Horizontal distance – B1 fastening bores [mm]	53	68	89
Horizontal distance – B2 fastening bores [mm]	49	64	76
Drill holes – Depth E [mm]	5.8	5.8	7
Drill holes – Width F [mm]	11	11	13
Screw connection – M	M5	M5	M6
Weight without packaging [g]	2900	5900	8800

Tab. 29: PMC TEP dimensions and weight

More information on chokes can be found in the manuals of the drive controllers (see Detailed information).

9 Appendix

9.1 Terminal specifications

The cores for the motor temperature sensor and brake in the power cable are manufactured with end sleeves with plastic collars and an insulation stripping length of 10 mm, appropriate for the drive controllers.

The requirements for terminal X20 for the motor connection depend on the series and size of the drive controller. You can find more information in the following chapters.

9.1.1 PMC SC6 drive controller – X20

The maximum and minimum conductor cross-sections of the end sleeve with plastic collar as well as the required insulation stripping length for the motor connection to terminal X20 can be found in the following table.

Type	Max. conductor cross-section	Min. conductor cross-section	Insulation stripping length
PMC SC6A062	2.5 mm ²	0.25 mm ²	10 mm
PMC SC6A162	4 mm ²	0.25 mm ²	12 – 15 mm
PMC SC6A261			

Tab. 30: PMC SC6 drive controllers, X20 motor connection terminal specification

9.1.2 PMC SI6 drive controller – X20

The maximum and minimum conductor cross-sections of the end sleeve with plastic collar as well as the required insulation stripping length for the motor connection to terminal X20 can be found in the following table.

Type	Max. conductor cross-section	Min. conductor cross-section	Insulation stripping length
PMC SI6A061	2.5 mm ²	0.25 mm ²	10 mm
PMC SI6A062			
PMC SI6A161	4 mm ²	0.25 mm ²	12 – 15 mm
PMC SI6A162			
PMC SI6A261			
PMC SI6A262	10 mm ²	0.75 mm ²	18 mm
PMC SI6A361			

Tab. 31: PMC SI6 drive controllers, X20 motor connection terminal specification

9.2 EMC recommendations



Information

The following information on EMC-compliant installation is only a recommendation. Depending on the application, the ambient conditions as well as the legal requirements, measures beyond these recommendations may be required.

Lay the power line, power cable and signal lines separately from each other, e.g. in separate cable ducts.

Only use shielded, low-capacitance cables as power cables.

If the brake line is carried in the power cable, it must be shielded separately.

Ground and insulate free line ends if they cannot be connected to the terminals provided for this purpose on the drive controller, e.g. using a connecting terminal.

Connect the shield of the power cable to the grounding conductor system over a wide area and in the immediate vicinity of the drive controller. For this purpose, use the shield contact provided for the drive controllers or suitable accessories.

The connection lines for braking resistors as well as the cores of the Quick DC-Link modules must be implemented as twisted pairs. At line lengths of 30 cm or more, the lines also must be implemented with shielding and the shield must be applied over a wide area in the immediate vicinity of the drive controller.

For motors with terminal boxes, connect the shield to the terminal box over large contact areas. For example, use EMC cable glands.

Connect the shield of the control lines on one side to the reference potential of the source, e.g. the PLC or CNC.

You may use chokes to improve the EMC and protect the drive system. Power chokes are used to dampen voltage and current peaks and reduce the load of the power feed-in of the drive controllers or supply modules. Output chokes reduce current peaks caused by line capacity at the power output of the drive controller.

9.3 Further information

Current document versions of the motor and drive controller manuals can be found at:
<https://www.pilz.com/en-INT>.

In the following table, you can find the IDs of the manuals:

Title	Documentation	Contents	ID
PMC EZ synchronous servo motors	Operating manual	Technical data, storage, installation, connection, commissioning, service	1005461
PMC SC6 drive controller	Manual	System design, technical data, project configuration, storage, installation, connection, commissioning, operation, service, diagnostics	1005343
Multi-axis drive system with PMC SI6 and PMC PS6	Manual	System design, technical data, project configuration, storage, installation, connection, commissioning, operation, service, diagnostics	1005342

9.4 Formula symbols

Symbol	Unit	Explanation
$\Delta\vartheta$	K	Temperature difference
d_{out}	mm	Outer diameter
I_0	A	Stall current
$I_{N,CAB}$	A	Nominal current of the cable
$I_{N,MF}$	A	Nominal current of the choke or motor filter
K_{EM}	V/1000 rpm	Voltage constant: peak value of the induced voltage between the phases U, V, W of the motor at operating temperature at a speed of 1000 rpm
M_N	Nm	Nominal torque
n_N	rpm	Nominal speed: The speed for which the nominal torque M_N is specified

Banding

Wrapping of a core bundle with relatively thin non-woven strips.

Bending radius

In the cabling, the slightest bend that a cable is allowed to have when routed. The radii are specified in relation to the cable diameter and depend on the design.

Bending resistance

Resistance to bending stress.

Current carrying capacity

Maximum permitted current that can be transmitted under specified conditions.

DC resistance

Overall sum of DC loop resistance of both wires of a pair.

Drag chain

Component in mechanical engineering that guides and protects flexible cables, pneumatic or hydraulic lines.

Outer sheath

Closed shell of the cable for the protection of the structural elements underneath.

Output choke

Choke type that delays the current increase at the input of the drive controller or supply module in order to reduce the harmonics in the supply grid and reduces the load of the power feed-in of the devices.

Pilot core

Individual core used for information transmission.

Plug connectors

Component for disconnecting and connecting cables. The connecting parts are appropriately aligned by the positive locking of the plug pieces, feature detachable, positive attachment by spring force (pin) and are often also secured against unintended disconnection by a screw connection.

Power core

Individual core used for power transmission.

Tensile stress

Type of loading in which a body is subjected to tensile stress.

Test voltage

Value specified by the manufacturer for an impulse withstand voltage that the insulation withstands temporarily.

Intern

Fig. 1	Length definition for ready-made encoder cables	11
Fig. 2	Length definition for ready-made power cables – PMC SC6, PMC SI6	11
Fig. 3	Length definition for ready-made hybrid cables	11
Fig. 4	PMC TEP dimensional drawing.....	38
Fig. 5	PMC TEP dimensional drawing.....	52

Tab. 1	con.15 encoder cable pin assignment, EnDat 2.1/2.2 digital	13
Tab. 2	con.15 connector dimensions.....	13
Tab. 3	con.17 encoder cable pin assignment, EnDat 2.1/2.2 digital	14
Tab. 4	con.17 connector dimensions.....	14
Tab. 5	Encoder cable codes for EZ synchronous servo motors.....	18
Tab. 6	Ready-made cables up to 20 m for EnDat 2.1/2.2 digital encoders	19
Tab. 7	Maximum cable length of the power cable [m].....	21
Tab. 8	con.15 power cable pin assignment.....	22
Tab. 9	con.15 connector dimensions.....	22
Tab. 10	con.23 power cable pin assignment.....	23
Tab. 11	con.23 connector dimensions.....	23
Tab. 12	con.40 power cable pin assignment.....	24
Tab. 13	con.40 connector dimensions.....	24
Tab. 14	Plug connector size and minimum cross-section, EZ synchronous servo motors with convection cooling	32
Tab. 15	Plug connector size and minimum cross-section, EZ synchronous servo motors with forced ventilation...	33
Tab. 16	Power cable codes for EZ synchronous servo motors, con.15	35
Tab. 17	Power cable codes for EZ synchronous servo motors, con.23	35
Tab. 18	Power cable codes for EZ synchronous servo motors, con.40	35
Tab. 19	Ready-made power cables up to 20 m.....	36
Tab. 20	PMC TEP technical data	37
Tab. 21	PMC TEP dimensions and weight.....	38
Tab. 22	con.23 hybrid cable pin assignment.....	40
Tab. 23	con.23 connector dimensions.....	40
Tab. 24	Plug connector size and minimum cross-section, EZ synchronous servo motors with convection cooling	46
Tab. 25	Plug connector size and minimum cross-section, EZ synchronous servo motors with forced ventilation...	47
Tab. 26	Hybrid cable codes for EZ and EZS synchronous servo motors, con.23	49
Tab. 27	Ready-made OCS-Advanced hybrid cables up to 25 m.....	50
Tab. 28	PMC TEP technical data	51
Tab. 29	PMC TEP dimensions and weight.....	52
Tab. 30	PMC SC6 drive controllers, X20 motor connection terminal specification	53
Tab. 31	PMC SI6 drive controllers, X20 motor connection terminal specification	53

Intern

► Support

Technical support is available from Pilz round the clock.

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