

# service & SUPPORT

**Help when selecting a pulse encoder cable**

MICROMASTER 4  
SINAMICS G120

**SIEMENS**

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<http://support.automation.siemens.com/WW/view/en/24843650>

## 1 Help when selecting a pulse encoder cable

### Overview

Various encoder types can be used to sense the required speed and position signals.

The MICROMASTER 4 pulse encoder module is designed so that all of the usual digital HTL and TTL pulse encoders can be used together with MICROMASTER 430/440 drive inverters.

The same applies to the SINAMICS G120 with CU240S series - whereby the encoder signal evaluation is integrated in the CU240S.

Examples in this case include the 1XP8001-1 (HTL) and 1XP8001-2 (TTL) pulse encoders.

The cables matching the 1XP8001-1 encoder are described in the following text. These descriptions are based on the appropriate calculations.

### 1.1 Permissible cable length

The permissible cable length depends on the selected encoder. The longest cables can be achieved when using bipolar TTL encoders.

Unipolar HTL encoders only permit the shortest lengths. In this case, the encoder power supply voltage plays a decisive role (the higher the signal amplitude; power supply voltage; the lower the distance).

The maximum cable length for HTL encoders used as unipolar encoder (in this case only one signal is evaluated) is 100 m.

The maximum cable length for HTL encoders used as bipolar encoder (in this case both signals A+/A- or B+/B- are evaluated) is 300 m.

The minimum cross section of the power supply conductor is 0.75 mm<sup>2</sup>

## Cable lengths for TTL/RS422 encoders depending on the pulse frequency

The maximum permissible cable lengths for TTL/RS422 encoders - depending on the pulse frequency - are shown in the following diagram:

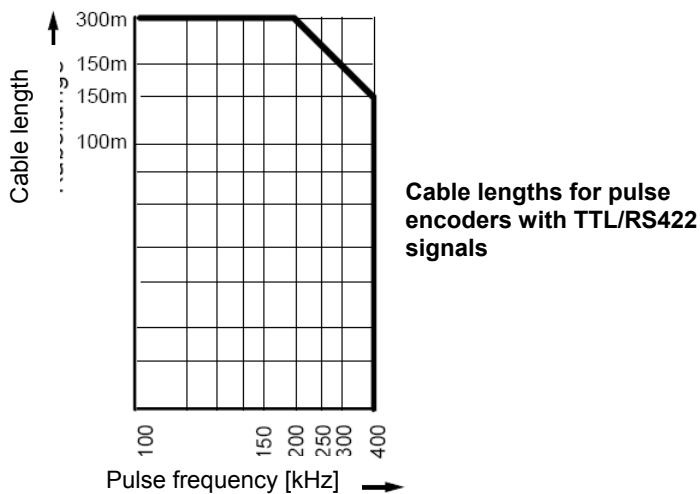


Fig. 1-1 Maximum cable lengths for pulse encoders with TTL/RS422 signals

## 1.2 Examples to calculate encoder cables for 1XP8001-1 pulse encoders

For long cables it must be carefully ensured that sufficient voltage is available for pulse encoder operation.

Cable capacitance (capacitance per unit length) of the pulse encoder cable:

- Core - shield: Approx. 265 pF/m
- Core - core: Approx. 120 pF/m

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### 1.2.1 Encoder used as unipolar encoder as a function of the sampling frequency

When just the positive (non-inverted) track of the encoder is used and at high sampling frequencies ( $f_{\max}$ ) the maximum cable length is reduced to 100 m.

$$L \leq 100 \text{ m } f_{\max} \leq 160 \text{ kHz } (U_{a1}, U_{a2}, U_{a0}, \overline{U_{aS}})$$

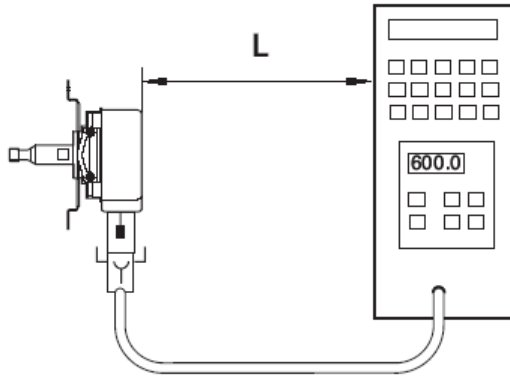


Fig. 1-2

When the sampling frequency is reduced - e.g.  $f_{\max} \leq 120 \text{ kHz}$  - the signal cable length can be increased up to 200 m.

$$L \leq 200 \text{ m } f_{\max} \leq 120 \text{ kHz } (U_{a1}, U_{a2}, U_{a0}, \overline{U_{aS}})$$

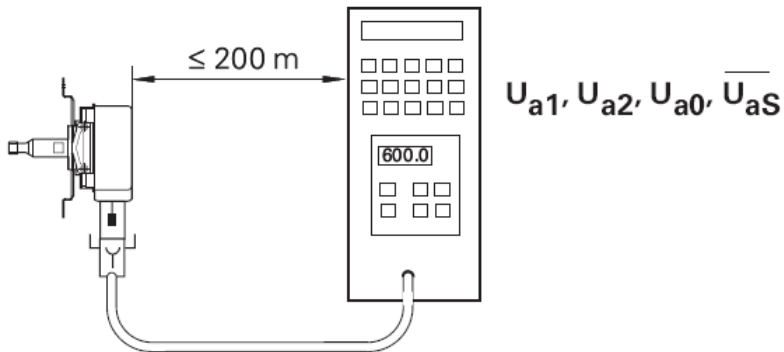


Fig. 1-3

## 1.2.2 Using the encoder as bipolar encoder as a function of the sampling frequency

The cable length can be increased up to 300 m if the encoder signal is interrogated in a bipolar fashion (both signals A+/A- or B+/B- are evaluated).

In this case the minimum cross-section of the power supply core is 0.75 mm<sup>2</sup>

$$L \leq 300 \text{ m } f_{\text{max}} \leq 160 \text{ kHz } (U_{a1}, U_{a2}, U_{a0}, \overline{U_{a1}}, \overline{U_{a2}}, \overline{U_{a0}}, \overline{U_{aS}})$$

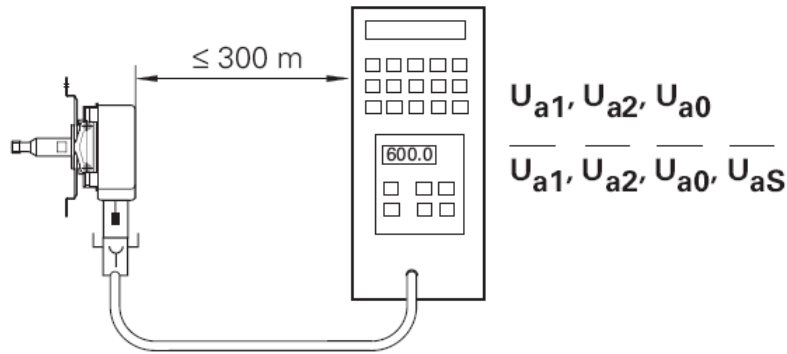


Fig. 1-4

## 1.3 The matching encoder cable

Pre-fabricated encoder cables are listed in the SIMOVERT MASTERDRIVES Catalog DA65.10 (Order No. [MLFB]: 6SX7002... ).

If another cable is used as encoder cable it must be carefully ensured that shielded cables are used that have the following features/properties:

- min. cross-section of the individual cores: 0.25 mm<sup>2</sup>
- max. cable capacitance (capacitance per unit length): 120 pF/m
- twisted pairs

### 1.3.1 Information regarding encoder operation

The following information must be carefully observed in order that the encoder can be safely and reliably operated:

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**From 50 kHz and above or 50 m cable length:**

2 cores connected in parallel each with 0.25 mm<sup>2</sup> cross section should be used to connect the power to the encoder (this configuration is used in order to reduce the voltage drops)

**For cables 100 m long and longer**

4 cores connected in parallel should be used for the power supply for the encoder. Or, as an alternative, one cable is used with a minimum conductor cross-section of 1 mm<sup>2</sup> (at +18V).

**For cables longer than 150 m**

For cable lengths above 150 m we recommend that the inverted encoder outputs be used.

Information regarding encoder cables for other encoders, please refer to the appropriate Operating Instructions and Catalogs.

## 2 Pre-fabricated encoder cables

Both pre-fabricated as well as non pre-fabricated encoder cables (i.e. cables sold by the meter), types "L" and "N" are available for 1XP8001-1 encoders; these are listed in the SIMOVERT MASTERDRIVES Catalog DA65.10 (Order No. [MLFB]: 6SX7002... ).

### 2.1 Type "L" encoder cables

#### 2.1.1 Pre-fabricated encoder cables 6SX7002-0AL00... (length ≤ 150 m)

Tracks: A, B, plus power supply.

Shielded encoder cable 2 x 2 x 0.25 mm<sup>2</sup>, pre-fabricated (motor side: 12-pin encoder coupling; open on the drive inverter side - i.e. it is connected at the drive inverter using terminals).

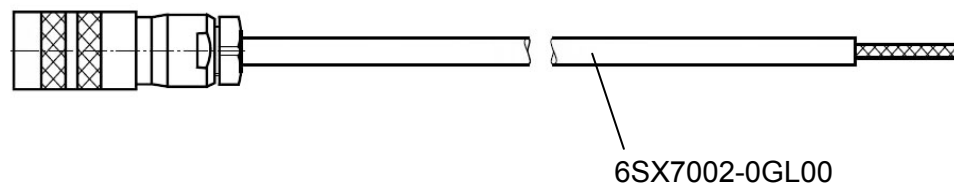


Fig. 2-1 Pre-fabricated encoder cable 6SX7002-0AL00...

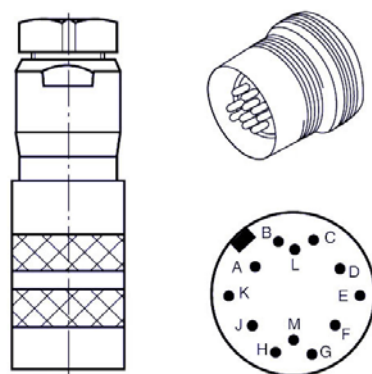


Fig. 2-2 Connector

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| Description                                | Order No.          |
|--|--------------------|
| Encoder cable with coupling<br>(connector) | 6SX7002-0AL00-...0 |

**Length code:**

|            |           |          |
|------------|-----------|----------|
| 1 = 0 m;   | A = 0 m;  | A = 0 m; |
| 2 = 100 m; | B = 10 m; | B = 1 m; |
|            | C = 20 m; | C = 2 m; |
|            | D = 30 m; | D = 3 m; |
|            | E = 40 m; | E = 4 m; |
|            | F = 50 m; | F = 5 m; |
|            | G = 60 m; | G = 6 m; |
|            | H = 70 m; | H = 7 m; |
|            | J = 80 m; | J = 8 m; |
|            | K = 90 m; | K = 9 m; |

**Example:**

|            |           |
|------------|-----------|
| 1 m: ...   | - 1 A B 0 |
| 8 m: ...   | - 1 A J 0 |
| 17 m: ...  | - 1 B H 0 |
| 59 m: ...  | - 1 F K 0 |
| 111 m: ... | - 2 B B 0 |

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## Assignment of the signal conductors of the cable 6SX7002-0AL00...

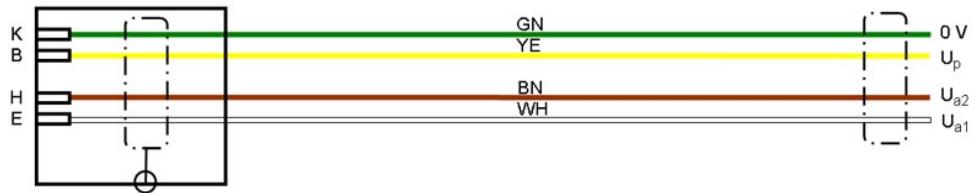


Fig. 2-3 Assignment of the signal conductors of the cable 6SX7002-0AL00...

Table 2-1 Connecting the encoder cable 6SX7002-0AL00...

| Signal/Function               | Signal marking  | PIN labeling on the encoder side | Color of the signal wire on the converter side |
|-------------------------------|-----------------|----------------------------------|--|
| Channel A non-inverting input | U <sub>a1</sub> | E                                | white  |
| Channel B non-inverting input | U <sub>a2</sub> | H                                | brown  |
| Power supply U <sub>p</sub>   | U <sub>p</sub>  | B                                | yellow   |
| Supply reference              | 0 V             | K                                | green  |

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## 2.1.2 Non pre-fabricated cables sold by the meter 6SX7002-0GL00...

Cable assembly, non pre-fabricated (without coupling), shielded encoder cable 2 x 2 x 0.25 mm<sup>2</sup>.

Table 2-2 Non pre-fabricated cables sold by the meter 6SX7002-0GL00...

| Article No.        | Length |
|--------------------|--------|
| 6SX7002-0GL00-1FA0 | 50 m   |
| 6SX7002-0GL00-2AA0 | 100 m  |
| 6SX7002-0GL00-3AA0 | 200 m  |
| 6SX7002-0GL00-6AA0 | 500 m  |

**Note:** Connector accessories can be ordered in EWN under the following numbers (internal Siemens); order from receiver [BZ-Empfänger]

"AC 008096"

Coupling socket (straight connector) EWN:18394000101000

Angled socket (angled connector) EWN:18394000102000

Retaining kit EWN:18394000001000

Protective cap EWN:10992058601000

Type "N" encoder cables

### 2.1.3 Pre-fabricated encoder cable 6SX7002-0AN... (length ≤ 150 m)

Tracks: A, A inv.; B, B inv.; N, N inv.; plus power supply (two cables in parallel).

Shielded encoder cable 5 x 2 x 0.25 mm<sup>2</sup>, pre-fabricated (motor side: 12-pin encoder coupling; open on the drive inverter side; this means that it is connected to the drive inverter using terminals). The cable is equipped with various connectors.

| Description                             | Order No.           |
|---|---------------------|
| Encoder cable with coupling (connector) | 6SX7002-0AN..0-...0 |

#### Lengths code:

|            |           |          |
|------------|-----------|----------|
| 1 = 0 m;   | A = 0 m;  | A = 0 m; |
| 2 = 100 m; | B = 10 m; | B = 1 m; |
| 3 = 200 m; | C = 20 m; | C = 2 m; |
|            | D = 30 m; | D = 3 m; |
|            | E = 40 m; | E = 4 m; |
|            | F = 50 m; | F = 5 m; |
|            | G = 60 m; | G = 6 m; |
|            | H = 70 m; | H = 7 m; |
|            | J = 80 m; | J = 8 m; |
|            | K = 90 m; | K = 9 m; |

#### 6SX7002-0AN00-...0

Pre-fabricated signal cable (1XP8 in 1LA-MASTERDRIVES) encoder HTL/TTL tracks A, B, N and inverted with direct connection

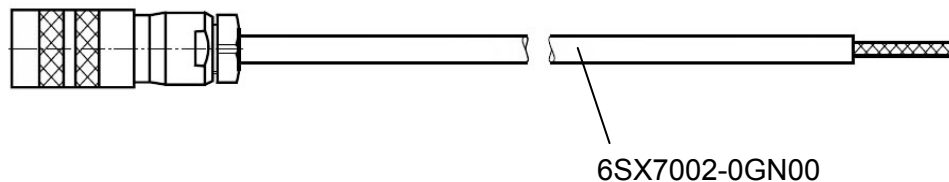


Fig. 2-4 Pre-fabricated encoder cable 6SX7002-0AN00...

## 6SX7002-0AN10-...0

Pre-fabricated signal cable (basis 6SX7002-0AN00), encoder HTL/TTL, tracks A, B, N with 90 Degree angled connector

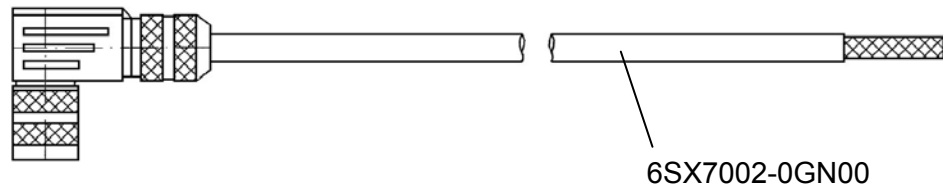


Fig. 2-5 Pre-fabricated encoder cable 6SX7002-0AN10...

## 6SX7002-0AN30-...0

Pre-fabricated signal cable (1XP8 direct connection), encoder HTL/TTL, tracks A, B, N and inverted with sub-D connector

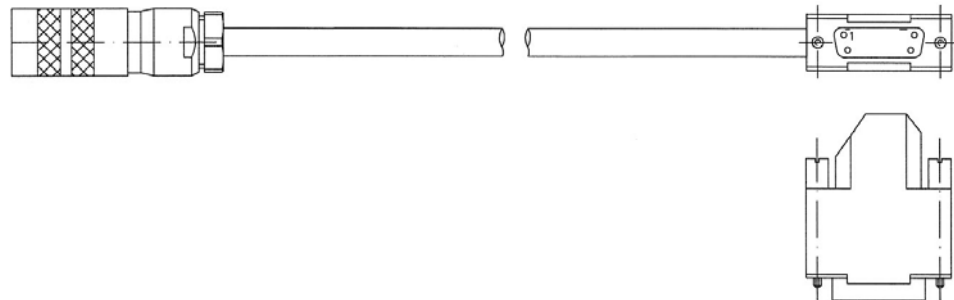


Fig. 2-6 Pre-fabricated encoder cable 6SX7002-0AN30...

## Assignment of the signal conductors of the cable 6SX7002-0AN00...

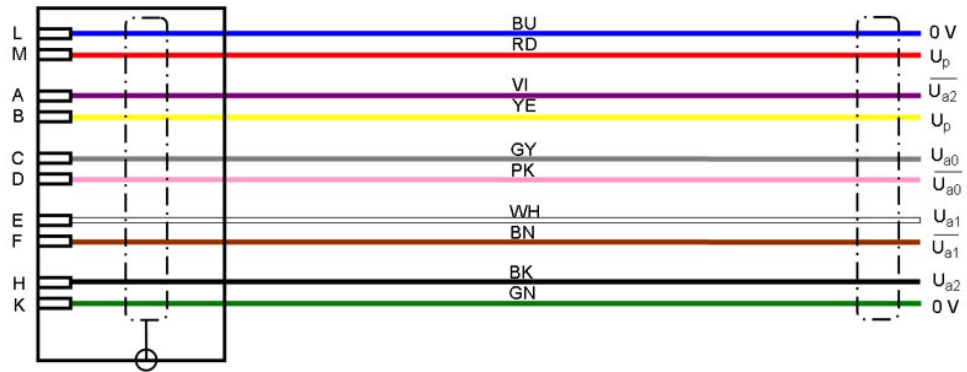


Fig. 2-7 Assignment of the signal conductors of the cable 6SX7002-0AN00...

Table 2-3 Connecting the encoder cable 6SX7002-0AN00...

| Signal/Function                      | Signal marking      | PIN labeling on the encoder side | Color of the signal wire on the converter side |
|--------------------------------------|---------------------|----------------------------------|--|
| Channel A non-inverting input        | $U_{a1}$            | E                                | white  |
| Channel A inverting input            | $\overline{U_{a1}}$ | F                                | brown  |
| Channel B non-inverting input        | $U_{a2}$            | H                                | black  |
| Channel B inverting input            | $\overline{U_{a2}}$ | A                                | purple   |
| Channel 0 (zero) non-inverting input | $U_{a0}$            | C                                | gray   |
| Channel 0 (zero) inverting input     | $\overline{U_{a0}}$ | D                                | pink   |
| Power supply $U_p$                   | $U_p$               | B, M                             | yellow, red parallel                           |
| Supply reference                     | 0 V                 | K, L                             | green, blue parallel                           |

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## 2.1.4 Non pre-fabricated cable sold by the meter 6SX7002-0GN00...

Cable assembly, non pre-fabricated (without coupling), shielded encoder cable 5 x 2 x 0.25 mm<sup>2</sup>.

Table 2-4 Non pre-fabricated cable sold by the meter 6SX7002-0GN00...

| Article No.        | Length |
|--------------------|--------|
| 6SX7002-0GN00-1FA0 | 50 m   |
| 6SX7002-0GN00-2AA0 | 100 m  |
| 6SX7002-0GN00-3AA0 | 200 m  |
| 6SX7002-0GN00-6AA0 | 500 m  |

**Note:** The connector is part of the motor/encoder supply; spare parts can be found on the Siemens A&D SD homepage (Index „spare parts“)

## 3 Appendix

### 3.1 Internet links

This list is by no means complete and only provides a selection of appropriate sources.

|     | Topic                  | Title  |
|-----|------------------------|--|
| \1\ | Operating Instructions | <a href="#">MICROMASTER Encoder Module</a>                                       |
| \2\ | Operating Instructions | <a href="#">Control Unit CU240S, CU240S DP, CU240S DP-F Software-Version 2.0</a> |
| \3\ | Mounting Instructions  | <a href="#">Rotary pulse encoder 1XP8002-1x HTL</a>                              |
| \4\ | Mounting Instructions  | <a href="#">Rotary pulse encoder 1XP8004-10 EnDat (P30)</a>                      |
| \5\ | Mounting Instructions  | <a href="#">Rotary pulse encoder 1XP8003-10 Resolver (P32)</a>                   |
| \6\ | Mounting Instructions  | <a href="#">Rotary pulse encoder 1XP8002-2x TTL</a>                              |
| \7\ | Mounting Instructions  | <a href="#">Rotary pulse encoder 1XP8004-20 SSI</a>                              |
| \8\ | Mounting Instructions  | <a href="#">Rotary pulse encoder 1XP8001-1, 1XP8001-2</a>                        |
| \9\ | FAQ                    | <a href="#">MM4: How to set up the encoder module</a>                            |

### 3.2 History

Table 3-1 History

| Version | Date          | Changes                  |
|---------|---------------|--------------------------|
| V1.0    | February 2007 | First issue              |
| V1.1    | March 2007    | Text revised             |
| V1.2    | July 2007     | Figures and tables added |