HEIDENHAIN


Functional Safety

Product Information

# LC 115/LC 195 S
# LC 415/LC 495 S

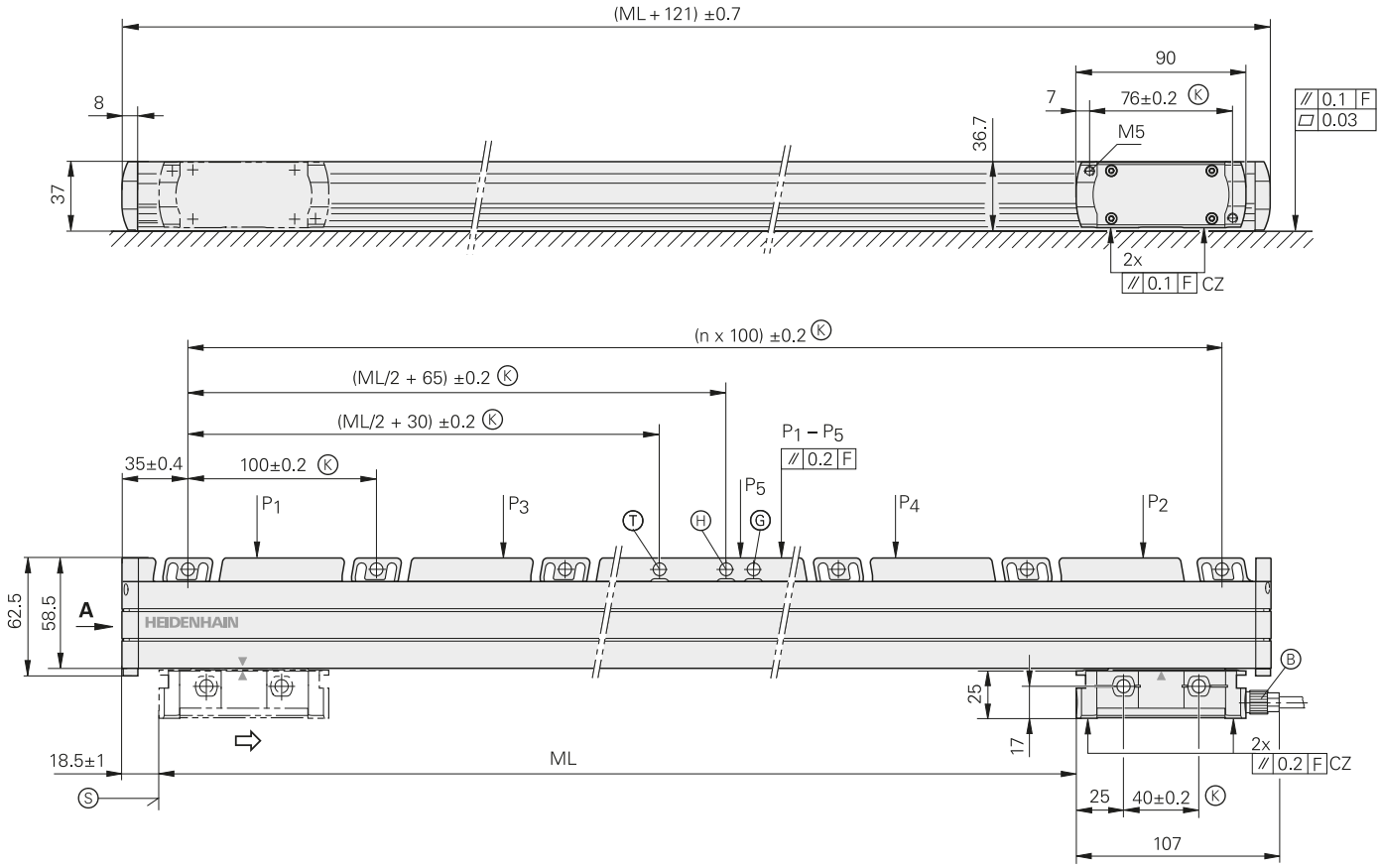
Absolute Linear Encoders for Safety-Related Applications

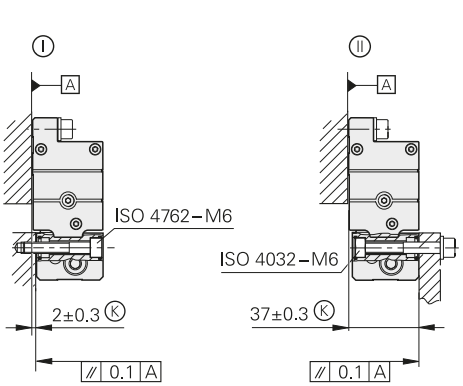
**June 2013**

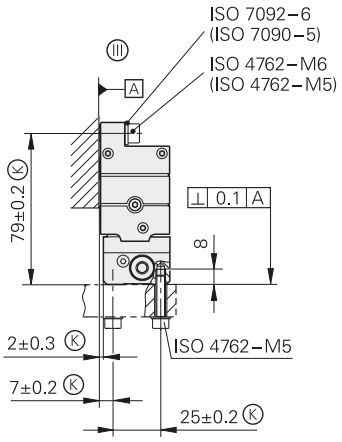
# LC 115/LC 195 S

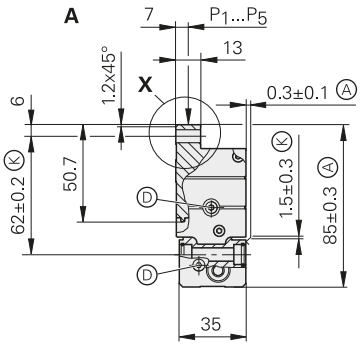
**Absolute linear encoder for safety-related applications**

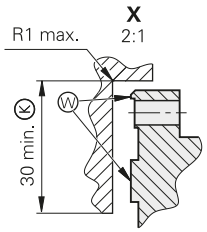
- **Safe absolute values**
- **Resolution 0.001 µm**
- **Increased reliability through optimized sealing lip design**




mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

Ⅰ, Ⅱ,
Ⅲ = Mounting options
F = Machine guideway
P = Gauging points for alignment
Ⓚ = Required mating dimensions
Ⓐ = Alternative mating dimensions
Ⓑ = Cable connection usable at either end
Ⓓ = Compressed-air connection usable at either end
Ⓣ = Mechanical fixed point (should be preferred)
Ⓗ = Mechanical fixed point, compatible to predecessor model
Ⓖ = Mechanical fixed point, with spacing interval of 100 mm
Ⓢ = Beginning of measuring length ML (= 20 mm absolute)
Ⓦ = Mating surfaces
⇨ = Direction of scanning unit motion for output signals in accordance with interface description

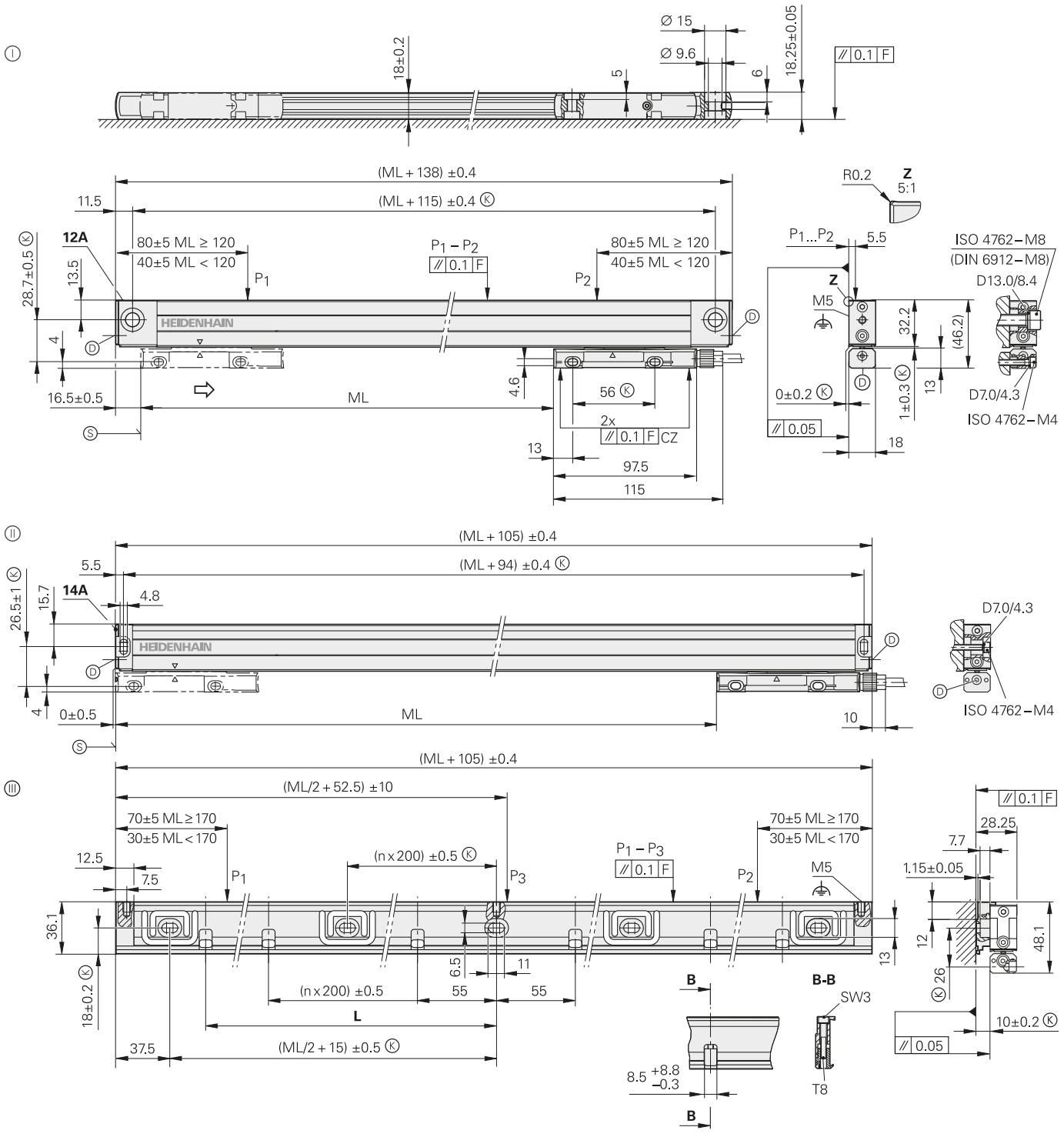

| Specifications | LC 115 | LC 195 S |
|---|---|---|
| **Measuring standard**<br>Coefficient of linear expansion | DIADUR glass scale with absolute track and incremental track, grating period 20 µm<br>$\alpha_{therm} \approx 8 \times 10^{-6}$ K$^{-1}$ | |
| **Accuracy grade*** | ± 3 µm up to measuring length 3040 mm; ± 5 µm | |
| **Measuring length ML*** in mm | 140 240 340 440 540 640 740 840 940 1040 1140 1240 1340<br>1440 1540 1640 1740 1840 2040 2240 2440 2640 2840 3040 3240 3440<br>3640 3840 4040 4240 | |
| **Functional safety**<br>For applications up to | • SIL 2 according to EN 61508 (further basis for testing: EN 61800-5-2)<br>• Category 3, PL "d" according to EN ISO 13849-1:2008 | |
| PFH | ≤ 15 x $10^{-9}$; *ML > 3040:* 25 x $10^{-9}$<br>For application height ≤ 6000 m above sea level | ≤ 25 x $10^{-9}$; *ML > 3040:* 40 x $10^{-9}$<br>for application height ≤ 1000 m above sea level |
| Safe position[1] | *Encoder:* ± 550 µm; *ML > 3040:* ± 2050 µm (safety-related measuring step: SM = 220 µm)<br>*Mechanical connection:* fault exclusions for loosening of the housing and scanning unit (page 6) | |
| **Interface** | EnDat 2.2 | DRIVE-CLiQ |
| Ordering designation | EnDat 22 | DQ 01 |
| Resolution | *Accuracy ± 3 µm:* 0.001 µm, *accuracy ± 5 µm:* 0.010 µm | |
| Calculation time $t_{cal}$<br>Clock frequency | ≤ 5 µs<br>≤ 16 MHz | –<br>– |
| **Electrical connection** | Separate adapter cable connectable at both ends of mounting block | |
| Cable length | ≤ 100 m (with HEIDENHAIN cable),<br>clock frequency ≤ 8 MHz | ≤ 30 m (longer cables on request) |
| Power supply | 3.6 to 14 V DC | 10 V to 28.8 V DC |
| Power consumption (max.) | *At 14 V:* ≤ 1.3 W; *at 3.6 V:* ≤ 1.1 W | *At 10 V:* ≤ 1.5 W; *at 28.8 V:* ≤ 1.7 W |
| Current consumption (typical) | *At 5 V:* 140 mA (without load) | *At 24 V:* 46 mA (without load) |
| **Traversing speed** | ≤ 180 m/min | |
| **Required moving force** | ≤ 4 N | |
| **Vibration** 55 to 2000 Hz<br>*affecting the*<br>**Shock** 11 ms<br>**Acceleration** | *Housing:* ≤ 200 m/s$^2$ (EN 60068-2-6)<br>*Scanning unit:* ≤ 200 m/s$^2$ (EN 60068-2-6)<br>≤ 300 m/s$^2$ (EN 60068-2-27)<br>≤ 100 m/s$^2$ in measuring direction | |
| **Operating temperature** | 0 °C to 50 °C | |
| **Protection** EN 60529[2] | IP 53 when installed according to instructions in the brochure, IP 64 with sealing air from DA 400 | |
| **Weight** | 0.55 kg + 2.9 kg/m measuring length | |

***** Please select when ordering. [1] Further tolerances may occur in the subsequent electronics after the position value comparison (contact the manufacturer of the subsequent electronics). [2] In the application the LC must be protected from the intrusion of particles and liquids.

# LC 415/LC 495 S

**Absolute linear encoder for safety-related applications**

- **Safe absolute values**
- **0.001 µm resolution**
- **Low overall height**




| ML | 70 | 120 | 170 | 220 | 270 | 320 | 370 | 420 | 470 | 520 | 570 | 620 | 670 | 720 | 770 | 820 | 920 | 1020 | 1140 | 1240 | 1340 | 1440 | 1540 | 1640 | 1740 | 1840 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L | 37.5 | 55 | 75 | 100 | 115 | 140 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 | 400 | 450 | 500 | 555 | 610 | 655 | 710 | 760 | 810 | 855 | 910 | 1010 |

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

Ⓘ = End block 12A; for mounting with and without mounting spar
Ⓘ = End block 14A; for mounting with mounting spar
(If attached directly with M4 screws, specifications are restricted.)
Ⓘ = Mounting spar MSL 41
F = Machine guideway
P = Gauging points for alignment
Ⓓ = Inlet for compressed air
Ⓚ = Required mating dimensions
Ⓢ = Beginning of measuring length ML (= 20 mm absolute)
⇨ = Direction of scanning unit motion for output signals in accordance with interface description


| Specifications | LC 415 | LC 495 S |
|---|---|---|
| **Measuring standard**<br>Coefficient of linear expansion | DIADUR glass scale with absolute track and incremental track, grating period 20 µm<br>$\alpha_{therm} \approx 8 \times 10^{-6}$ K$^{-1}$, (mounting type ①/②); *with mounting spar:* $\alpha_{therm} \approx 9 \times 10^{-6}$ K$^{-1}$ (mounting type ③) | |
| **Accuracy grade*** | ± 3 µm; ± 5 µm | |
| **Measuring length ML*** in mm | Mounting spar* or clamping elements* up to ML = 1240 optional, necessary as of ML 1340<br>70 120 170 220 270 320 370 420 470 520 570 620 670 720<br>770 820 920 1 020 1 140 1 240 1 340 1 440 1 540 1 640 1 740 1 840 2 040 | |
| **Functional safety**<br>For applications up to | • SIL 2 according to EN 61 508 (further basis for testing: EN 61 800-5-2)<br>• Category 3, PL "d" according to EN ISO 13 849-1:2008 | |
| PFH | ≤ 15 x 10$^{-9}$<br>For application height ≤ 6 000 m above sea level | ≤ 25 x 10$^{-9}$<br>For application height ≤ 1000 m above sea level |
| Safe position[1] | *Encoder:* ± 550 µm (safety-related measuring step: SM = 220 µm)<br>*Mechanical connection:* fault exclusions for loosening of the housing and scanning unit (page 6) | |
| **Interface** | EnDat 2.2 | DRIVE-CLiQ |
| Ordering designation | EnDat 22 | DQ 01 |
| Resolution | *Accuracy ± 3 µm:* 0.001 µm, *accuracy ± 5 µm:* 0.010 µm | |
| Calculation time $t_{cal}$<br>Clock frequency | ≤ 5 µs<br>≤ 16 MHz | –<br>– |
| **Electrical connection** | Separate adapter cable connectable to mounting block | |
| Cable length | ≤ 100 m (with HEIDENHAIN cable),<br>clock frequency ≤ 8 MHz | ≤ 30 m (longer cables on request) |
| Power supply | 3.6 to 14 V DC | 10 V to 28.8 V DC |
| Power consumption (max.) | *At 14 V:* ≤ 1.3 W; *at 3.6 V:* ≤ 1.1 W | *At 10 V:* ≤ 1.5 W; *at 28.8 V:* ≤ 1.7 W |
| Current consumption (typical) | *At 5 V:* 140 mA (without load) | *At 24 V:* 46 mA (without load) |
| **Traversing speed** | ≤ 180 m/min | |
| **Required moving force** | ≤ 5 N | |
| **Vibration** 55 to 2 000 Hz<br>*affecting the*<br><br>**Shock** 11 ms<br>**Acceleration** | *Scanning unit:* ≤ 200 m/s$^2$ (EN 60 068-2-6)<br>*Housing without mounting spar:* ≤ 100 m/s$^2$ (EN 60 068-2-6)<br>*Housing with mounting spar and cable outlet at right:* ≤ 150 m/s$^2$, *at left:* ≤ 100 m/s$^2$ (EN 60 068-2-6)<br>≤ 300 m/s$^2$ (EN 60 068-2-27)<br>≤ 100 m/s$^2$ in measuring direction | |
| **Operating temperature** | 0 °C to 50 °C | |
| **Protection** EN 60 529[2] | IP 53 when installed according to instructions in the brochure, IP 64 with sealing air from DA 400 | |
| **Weight** | *Encoder:* 0.2 kg + 0.55 kg/m measuring length; *mounting spar:* 0.9 kg/m | |

***** Please select when ordering. [1] Further tolerances may occur in the subsequent electronics after the position value comparison (contact the manufacturer of the subsequent electronics). [2] In the application the LC must be protected from the intrusion of particles and liquids.

# Functional safety

| Safe position | Mechanical connection[1] | Mounting | Fastening[2] | Restriction of technical specifications |
|---|---|---|---|---|
| **LC 115/LC 195 S** | | | | |
| Housing | ± 0 µm | | M6 ISO 4762 8.8/A70 | No |
| Scanning unit | ± 0 µm | Mounting options I and II | M6 ISO 4762 8.8/A70 | No |
| **LC 415/LC 495 S** | | | | |
| Housing | ± 0 µm | End blocks 12A for M8 | M8 ISO 4762 8.8/A70<br>M8 DIN 6912 8.8 | No |
| | ± 0 µm | Mounting spar MSL 41<br>ID: 770902-xx | M6 ISO 4762 8.8/A70 | For acceleration in measuring direction up to 60 m/s$^2$ |
| Scanning unit | ± 0 µm | All mounting options | M4 ISO 4762 8.8/A70 | No |

[1] Fault exclusions are given only for the mounting options explicitly stated
[2] A suitable anti-rotation lock is to be used for the screw connections (for mounting or service)

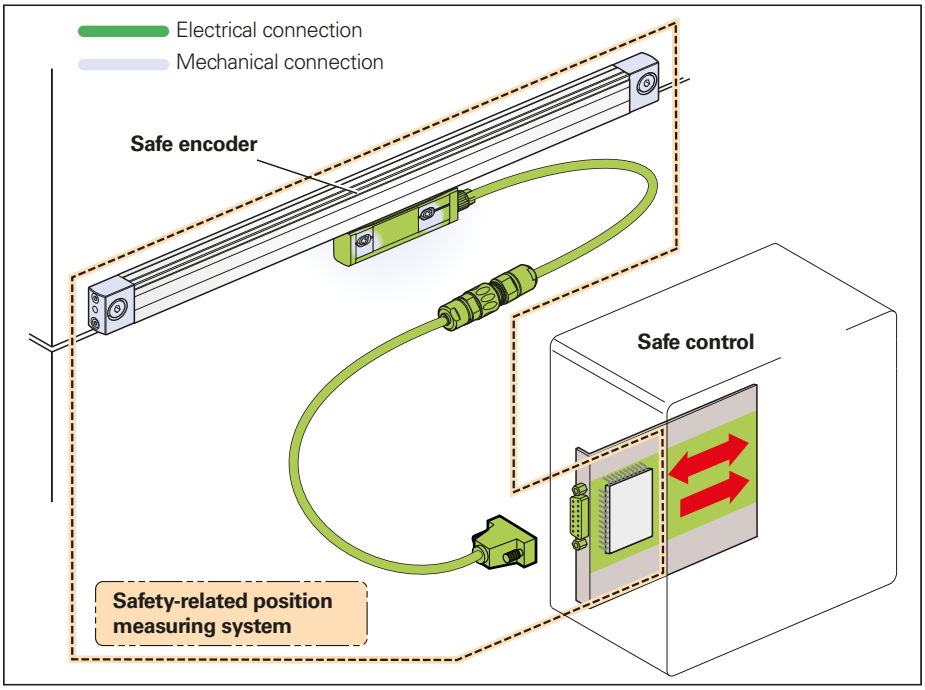
The LC 1x5/LC 4x5 absolute linear encoders from HEIDENHAIN are suited for use in safety-related applications.

Like other new European and international standards, the new EC machinery directive 2006/42/EC places strict requirements on position encoders. With its LC 1x5 and LC 4x5 absolute linear encoders, HEIDENHAIN offers the ideal solution for position acquisition for linear axes in safety-related applications. The encoders can be operated as single-encoder systems in conjunction with a safe control in applications with control category SIL-2 (according to EN 61 508) or performance level "d" (of EN ISO 13849).

Reliable transmission of the position is based on two independently generated absolute position values and on error bits. These are then provided to the safe control. The functions of the encoder can be used for numerous safety tasks in the complete system according to EN 61 800-5-2 (see table).

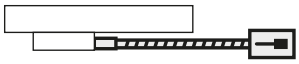
Unlike incremental encoders, the absolute LC 1x5/LC 4x5 linear encoders always provide a safe absolute position value—e.g. immediately after switch-on or restart. Their purely serial data transmission over the EnDat 2.2 bidirectional interface also offers other advantages, such as greater reliability, improved accuracy, diagnostic capabilities, reduced costs through simpler connection technology, and other benefits.

In addition to the data interface, the mechanical connection of the encoder to the motor is also relevant to safety. Table 16 of the standard for electrical drives, EN 61 800-5-2, defines the loss or loosening of the mechanical connection between the encoder and drive as a fault that requires consideration. Since it cannot be guaranteed that the control will detect such errors, in many cases the possibility of the mechanical connection becoming loose or lost must be eliminated. There are possibilities for attaching the LC 1x5/LC 4x5 that rule out such faults.




Safety-related position measuring system with mechanical connection and electrical interface

# Electrical connection
EnDat

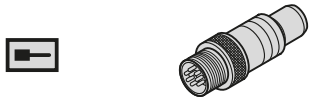
| **EnDat adapter cable**<br>[4(2 × 0.14 mm²)]; $A_V$ = 0.14 mm² | | **Cable Ø** | **LC 115**<br>**LC 415**<br>Without incremental signals |
|---|---|---|---|
| **With M12 coupling (male),** 8-pin |  | 4.5 mm | 533661-xx |
| **In metal armor** with M12 coupling (male), 8-pin |  | 10 mm | 550678-xx |

| **EnDat connecting cables**<br>[(4 × 0.14 mm²) + (4 × 0.34 mm²)]; $A_V$ = 0.34 mm² | | **Cable Ø** | **LC 115**<br>**LC 415**<br>Without incremental signals |
|---|---|---|---|
| **Complete** with M12 connector (female), 8-pin, and M12 coupling (male), 8-pin |  | 6 mm | 368330-xx |
| **Complete** with M12 connector (female), 8-pin, and D-sub connector (male), 15-pin, for IK 115/IK 215 |  | 6 mm | 524599-xx |
| **With one** M12 connector (female), 8-pin |  | 6 mm | 634265-xx |

**Note for safety-related applications:** Only completely assembled HEIDENHAIN cables are qualified. Be sure to exchange connectors or modify cables only after consultation with HEIDENHAIN Traunreut.
$A_V$: Cross section of power supply lines

## EnDat pin layout

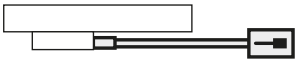
**8-pin coupling,** M12




| | Power supply | | | | Absolute position values | | | |
|---|---|---|---|---|---|---|---|---|
| | **8** | **2** | **5** | **1** | **3** | **4** | **7** | **6** |
| | **$U_P$** | **Sensor** $U_P$ | **0 V** | **Sensor** 0 V | **DATA** | **$\overline{\text{DATA}}$** | **CLOCK** | **$\overline{\text{CLOCK}}$** |
| | Brown/Green | Blue | White/Green | White | Gray | Pink | Violet | Yellow |

**Cable shield** connected to housing; **$U_P$** = Power supply voltage
**Sensor:** The sensor line is connected in the encoder with the corresponding power line.
Vacant pins or wires must not be used!

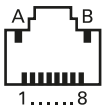
# Electrical connection
Siemens

| **Siemens adapter cables**<br>[2(2 × 0.17 mm²) + (2 × 0.24 mm²)]; $A_V$ = 0.24 mm² | | **Cable Ø** | **LC 195S**<br>**LC 495S** |
|---|---|---|---|
| **With M12 coupling (male),** 8-pin |  | 6.8 mm | 805452-xx |
| **In metal armor with M12 coupling (male),** 8-pin |  | 11.1 mm | 816675-xx |
| **With Siemens connector,** RJ45 |  | 6.8 mm | 805375-xx |

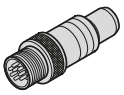
$A_V$: Cross section of power supply lines

## Pin layout—Siemens

**RJ45 connector**




**8-pin coupling,** M12




| | Power supply | | Absolute position values | | | |
|---|---|---|---|---|---|---|
| | | | Transmit data | | Receive data | |
|  | **A** | **B** | **3** | **6** | **1** | **2** |
|  | **1** | **5** | **7** | **6** | **3** | **4** |
| | **$U_P$** | **0V** | **TXP** | **TXN** | **RXP** | **RXN** |

**Cable shield** connected to housing; **$U_P$** = power supply voltage



HEIDENHAIN

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This Product Information supersedes all previous editions, which thereby become invalid. The basis for ordering from HEIDENHAIN is always the Product Information valid when the contract is made.

**Please note the following documents:**
Adhere to the information in the following documents to ensure the correct and intended operation of the encoder:

- Catalog: *Linear Encoders for Numerically Controlled Machine Tools* 571470
- Mounting Instructions: *LC 115/LC 195S* 743390
  *LC 415/LC 495S* (end block 14A) 737907
  (end block 12A) 737908
  (mounting spar MSL 41) 894918
- Technical Information: *Safety-Related Position Measuring Systems* 596632

For implementation in a control:

- Specification for safe control 533095