



# HEIDENHAIN

**Functional  
Safety**



Product Information

**LC 115**

**LC 415**

Absolute Linear Encoders for  
Safety-Related Applications

September 2011





Specifications	LC 115
<b>Measuring standard</b> Coef. of linear expansion	DIADUR glass scale with absolute track and incremental track, grating period 20 $\mu\text{m}$ $\alpha_{\text{therm}} \approx 8 \times 10^{-6} \text{ K}^{-1}$
<b>Accuracy grade*</b>	$\pm 3 \mu\text{m}$ up to measuring length 3040 mm; $\pm 5 \mu\text{m}$
<b>Measuring length ML*</b> in mm	140 240 340 440 540 640 740 840 940 1040 1140 1240 1340 1440 1540 1640 1740 1840 2040 2240 2440 2640 2840 3040 3240 3440 3640 3840 4040 4240
<b>Functional safety</b> for applications up to	<ul style="list-style-type: none"> <li>SIL 2 according to EN 61508 (further basis for testing: EN 61800-5-2)</li> <li>Category 3, PL "d" according to EN ISO 13849-1:2008</li> </ul>
PFH	$\leq 15 \times 10^{-9}$ ; $ML > 3040$ : $25 \times 10^{-9}$ (probability of dangerous failure per hour)
Safe position	<i>Encoder</i> : $\pm 550 \mu\text{m}$ ; $ML > 3040$ : $\pm 2050 \mu\text{m}$ (after position comparison in the subsequent electronics) <i>Mechanical connection</i> : fault exclusions for loosening of the housing and scanning unit (page 6)
<b>Absolute position values</b>	EnDat 2.2 (Fanuc, Mitsubishi and Siemens interfaces planned for mid-2012)
Ordering designation	EnDat 22
Resolution	<i>Accuracy <math>\pm 3 \mu\text{m}</math></i> : 0.001 $\mu\text{m}$ , <i>accuracy <math>\pm 5 \mu\text{m}</math></i> : 0.010 $\mu\text{m}$
Clock frequency	$\leq 16 \text{ MHz}$
Calculation time $t_{\text{cal}}$	$\leq 5 \mu\text{s}$
<b>Electrical connection</b>	Separate adapter cable connectable at both ends of mounting block
Cable length	$\leq 100 \text{ m}$ (with HEIDENHAIN cable), clock frequency $\leq 8 \text{ MHz}$
Power supply	3.6 V DC to 14 V DC
Power consumption (maximum)	<i>At 14 V</i> : $\leq 1.5 \text{ W}$ ; <i>at 3.6 V</i> : $\leq 1.1 \text{ W}$
Current consumption (typical)	<i>At 5 V</i> : $\leq 225 \text{ mA}$ (without load)
<b>Traversing speed</b>	$\leq 180 \text{ m/min}$
<b>Required moving force</b>	$\leq 4 \text{ N}$
<b>Vibration</b> 55 Hz to 2000 Hz affecting the <b>Shock</b> 11 ms <b>Acceleration</b>	<i>Housing</i> : $\leq 200 \text{ m/s}^2$ (EN 60068-2-6) <i>Scanning unit</i> : $\leq 200 \text{ m/s}^2$ (EN 60068-2-6) $\leq 300 \text{ m/s}^2$ (EN 60068-2-27) $\leq 100 \text{ m/s}^2$ in measuring direction
<b>Operating temperature</b>	0 °C to 50 °C
<b>Protection</b> EN 60529 <sup>1)</sup>	IP 53 when installed according to instructions in the brochure, IP 64 with sealing air from DA 300
<b>Weight</b>	0.4 kg + 3.3 kg/m measuring length

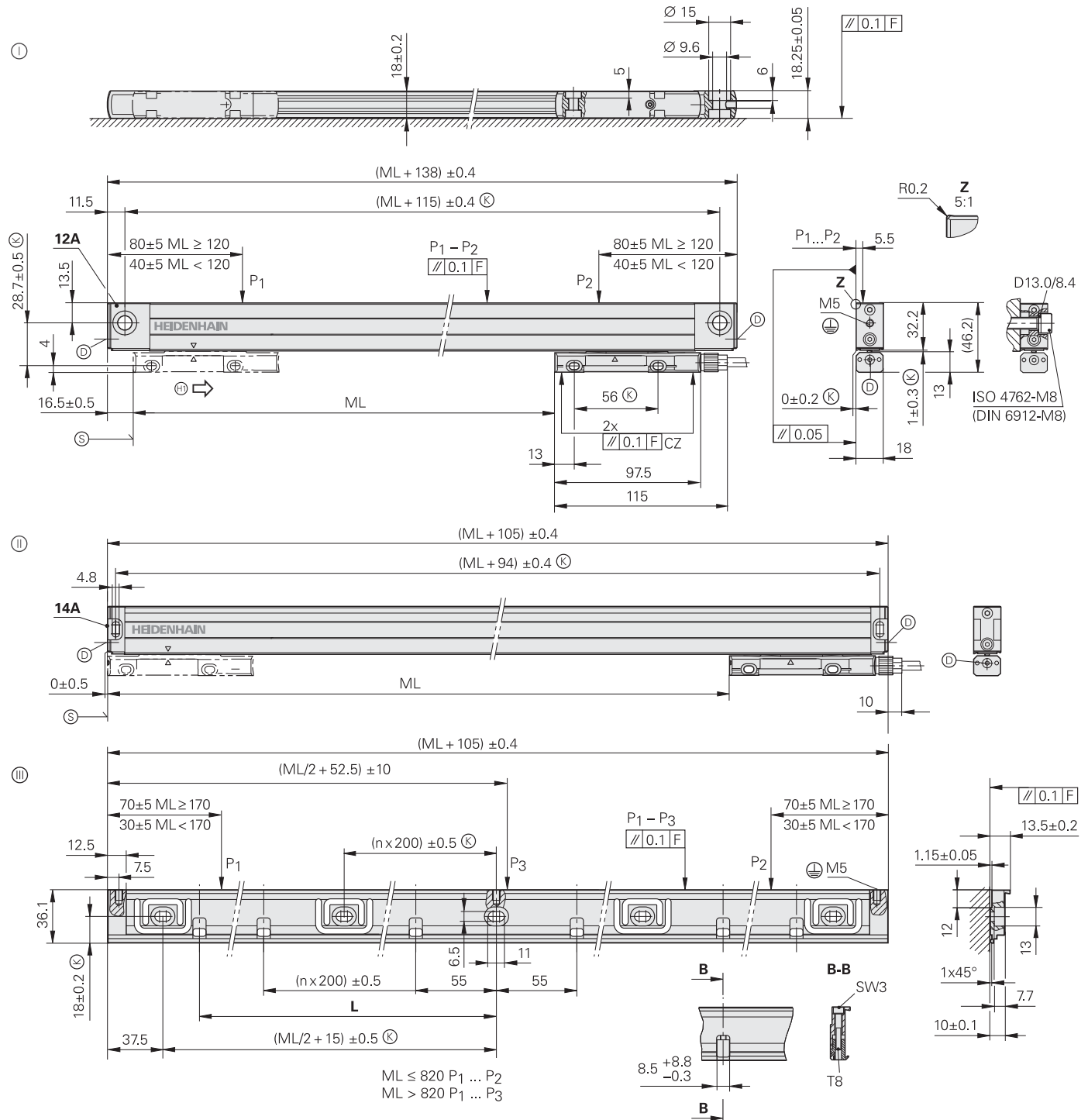
\* Please select when ordering

<sup>1)</sup> In the application the LC must be protected from the intrusion of particles and liquids

# LC 415

Absolute linear encoder for safety-related applications

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



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
- ML = Measuring length
- 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
<b>Measuring standard</b> Coef. of linear expansion	DIADUR glass scale with absolute track and incremental track, grating period 20 µm $\alpha_{\text{therm}} \approx 8 \times 10^{-6} \text{ K}^{-1}$
<b>Accuracy grade*</b>	± 3 µm; ± 5 µm
<b>Measuring length ML*</b> in mm	Mounting spar* or clamping elements* up to ML = 1240 optional, necessary as of ML 1340 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
<b>Functional safety</b> for applications up to	<ul style="list-style-type: none"> <li>• SIL 2 according to EN 61508 (further basis for testing: EN 61800-5-2)</li> <li>• Category 3, PL "d" according to EN ISO 13849-1:2008</li> </ul>
PFH	≤ 15 × 10 <sup>-9</sup> (probability of dangerous failure per hour)
Safe position	<i>Encoder</i> : ± 550 µm (after position comparison in the subsequent electronics) <i>Mechanical connection</i> : fault exclusions for loosening of the housing and scanning unit (page 6)
<b>Absolute position values</b>	EnDat 2.2 (Fanuc, Mitsubishi and Siemens interfaces planned for mid-2012)
Ordering designation	EnDat 22
Resolution	<i>Accuracy ± 3 µm</i> : 0.001 µm, <i>accuracy ± 5 µm</i> : 0.010 µm
Clock frequency	≤ 16 MHz
Calculation time t <sub>cal</sub>	≤ 5 µs
<b>Electrical connection</b>	Separate adapter cable connectable to mounting block
Cable length	≤ 100 m (with HEIDENHAIN cable), clock frequency ≤ 8 MHz
Power supply	3.6 V DC to 14 V DC
Power consumption (maximum)	<i>At 14 V</i> : ≤ 1.5 W; <i>at 3.6 V</i> : ≤ 1.1 W
Current consumption (typical)	<i>At 5 V</i> : ≤ 225 mA (without load)
<b>Traversing speed</b>	≤ 180 m/min
<b>Required moving force</b>	≤ 5 N
<b>Vibration</b> 55 Hz to 2000 Hz affecting the	<i>Scanning unit</i> : ≤ 200 m/s <sup>2</sup> (EN 60068-2-6) <i>Housing without mounting spar</i> : ≤ 100 m/s <sup>2</sup> (EN 60068-2-6) <i>Housing with mounting spar and cable outlet at right</i> : ≤ 150 m/s <sup>2</sup> , <i>at left</i> : ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)
<b>Shock</b> 11 ms <b>Acceleration</b>	≤ 300 m/s <sup>2</sup> (EN 60068-2-27) ≤ 100 m/s <sup>2</sup> in measuring direction
<b>Operating temperature</b>	0 °C to 50 °C
<b>Protection</b> EN 60529 <sup>1)</sup>	IP 53 <sup>1)</sup> when installed according to instructions in the brochure, IP 64 with sealing air from DA 300
<b>Weight</b>	<i>Encoder</i> : 0.2 kg + 0.5 kg/m measuring length, <i>mounting spar</i> : 0.9 kg/m

\* Please select when ordering

<sup>1)</sup> In the application the LC must be protected from the intrusion of particles and liquids

# Functional Safety

Safe position	Mechanical connection <sup>1)</sup>	Mounting	Fastening <sup>2)</sup>	Restriction of technical specifications
<b>LC 115</b>				
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
<b>LC 415</b>				
Housing	± 0 µm	End blocks 12A for M8	M8 ISO 4762 8.8/A70 M8 DIN 6912 8.8	No
	± 0 µm	Mounting spar MSL 41 ID: 770 902-xx	M6 ISO 4762 8.8/A70	For acceleration in measuring direction up to 60 m/s <sup>2</sup>
Scanning unit	± 0 µm	All mounting options	M4 ISO 4762 8.8/A70	No

<sup>1)</sup> Fault exclusions are only given for the mounting options explicitly stated

<sup>2)</sup> A suitable anti-rotation lock is to be used for the screw connections (for mounting or service)

The LC 115/LC 415 absolute linear encoders from HEIDENHAIN are suited for use in safety-related applications.

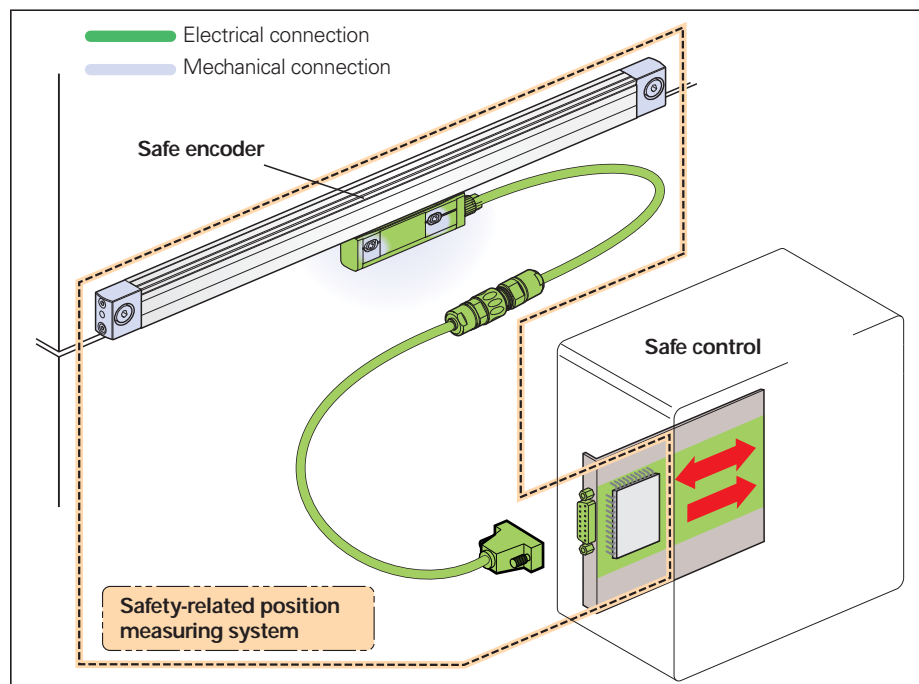
Like other new European and international standards, the new EC machinery directive 2006/42/EC places strict requirements on position encoders. With its LC 115 and LC 415 absolute linear encoders, HEIDENHAIN offers the ideal solution for position acquisition for linear axes in safety-related applications. 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 13 849).

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 115/LC 415 linear encoders 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 115/LC 415 that rule out such faults.



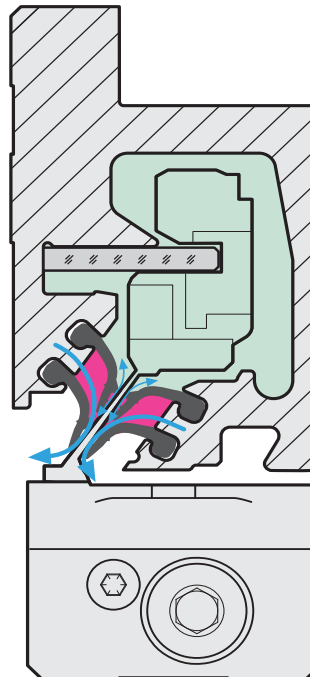
Safety-related position measuring system with mechanical connection and electrical interface

# Benefits

## LC 115: Increased reliability through optimized sealing system

The absolute linear encoders of the LC 100 and LC 400 series are specially designed for the requirements of machine tools. Thanks to the mechanical enclosure and single-eld scanning these devices can operate even in harsh operating environments. The full-size LC 100 series with its stable construction and mounting arrangement offers the greatest tolerance to repeated acceleration.

If the linear encoders are exposed to particularly heavy concentrations of coolant or dust, sealing air can be used to provide increased protection against the ingress of contamination. The LC 115 features an optimized sealing system with two successive pairs of sealing lips. When compressed air is introduced into the scale housing, a very effective sealing air between the two pairs of sealing lips is the result. This optimally protects the interior of the encoder from contamination.



## LC 415: Reduced height of the scanning unit

Linear encoders of the LC 400 series have smaller dimensions than those of the LC 100 series. They are generally chosen when installation space does not suffice for encoders with a large cross section.

The overall height of the LC 415 is significantly smaller when compared with the LC 483. The height of the scanning unit is now the same as for the LS 400 slim-line encoders. The housing dimensions and the position of the mounting holes for the scanning unit remain identical to the LC 483, so that the LC 415 can be mounted unaltered to existing geometries.



LC 415

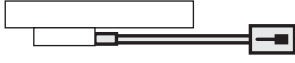
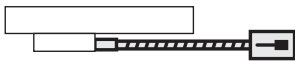





LC 483



LS 487


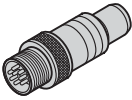



# Electrical Connection

Adapter cables		Cable Ø	LC 115 LC 415 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

Connecting cables		Cable Ø	LC 115 LC 415 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

HEIDENHAIN cables, complete with connectors, are required for use in safety-related applications!

## Pin layout

8-pin coupling, M12								
								
	Power supply				Absolute position values			
	8	2	5	1	3	4	7	6
	$U_P$	Sensor $U_P$	0V	Sensor 0V	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!

# HEIDENHAIN

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### Please note the following documents:

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

- Brochure: *Linear Encoders for Numerically Controlled Machine Tools* 571 470
- Mounting Instructions: LC 115 743 390
- LC 415 (end block 14A) 737 907
- (end block 12A) 737 908
- (mounting spar MSL 41) 894 918
- Technical Information: *Safety-Related Position Encoders* 596 632
- For implementation in a control:
- Specification for Safe Control 533 095

For catalogs, brochures and Product Information sheets, visit

www.heidenhain.de/docu