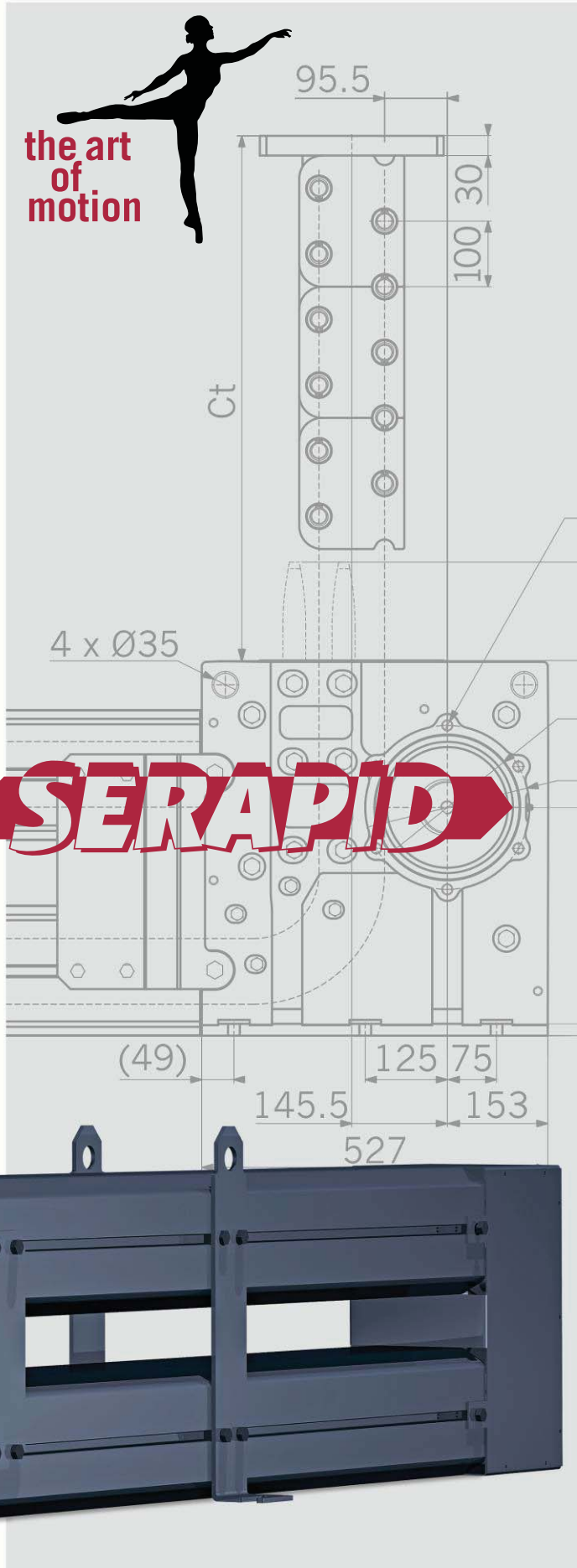
technical guide

LinkLift

LinkLift

the lift system for the entertainment industry

the art of motion



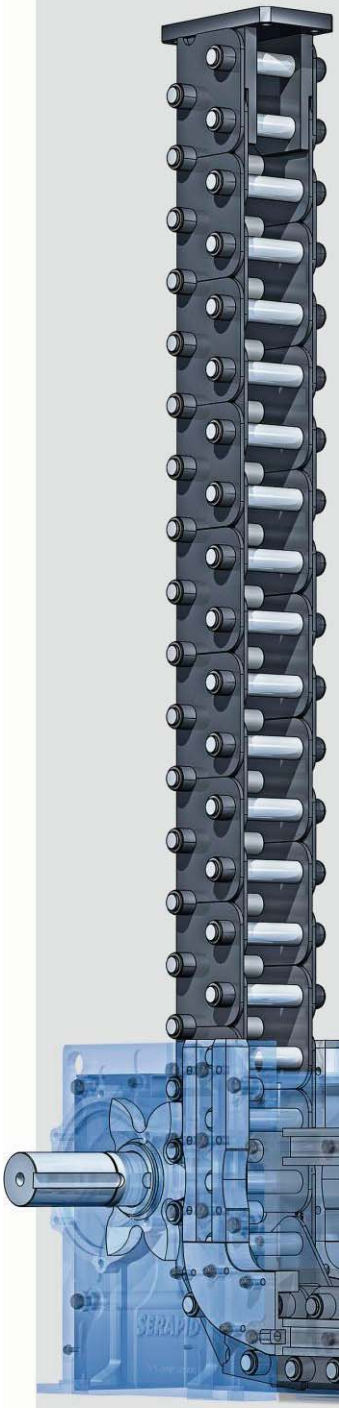
SERAPID

performance
operation
installation

The purpose of this brochure is to present the range of SERAPID LinkLift products intended for use in a theatre or auditorium environment. This type of environment involves orchestra pit lifts, stage platforms, auditorium lifts, scenery lifts, get-in lifts, choral risers and elevating tables. If your application does not fall within this scope, please submit your specifications to our technical services department.

link-lift

Contents



The LinkLift standard model range

Model	LL 30	LL 50	LL 50R	LL 80	LL 80R	LL 100	LL 100R
Static capacity per lifting column [1]							
max. load [kN] : stroke limit [m]	**20** : 1.9	**50** : 2	**70** : 1	**100** : 3.5	**125** : 2	**130** : 6	**200** : 3.5
load limit [kN] : **max. stroke** [m]	20 : **1.9**	10 : **4**	10 : **4**	40 : **6.4**	40 : **6.4**	70 : **8**	70 : **8**
Dynamic capacity per lifting column [1]							
max. load [kN] : stroke limit [m]	**10** : 1.9	**15** : 3.5	**30** : 3	**50** : 6	**90** : 4	**75** : 7.5	**150** : 5
load limit [kN] : **max. stroke** [m]	10 : **1.9**	10 : **4**	10 : **4**	40 : **6.4**	40 : **6.4**	70 : **8**	70 : **8**
Other specifications							
nominal speed up to [mm/s] [2]	200	300	300	300	300	300	300
system efficiency rate [%]	80	80	80	80	80	80	80
chain pitch [mm]	30	50	50	80	80	100	100
pinion segment radius [mm]	30	50	50	80	80	100	100
minimum height [mm] [2]	190	290.5	290.5	460	460	572	572
weight of chain [kg/m]	15	21	22	46	50	71	74
weight of drive housing [kg]	8	29	33	80	85	192	213

[1] **Note:** Load capacity and stroke are given relative to each other – a lower stroke allows a higher load and vice versa. For example: "**50** : 2" means the maximum **load** is 50 kN up to a stroke limit of 2 m; "10 : **4**" means the maximum **stroke** is 4 m up to a load limit of 10 kN. The graphs on page 4 show the operating ranges in detail. Please note maximum speed cannot be combined with maximum load or stroke.

[2] **Note:** For speeds above 200 mm/s, the drive housing must be fitted with long guides. This will increase the lowest possible position of the platform by 75 to 150 mm. (See also page 5.)

Key benefits of the LinkLift:

- heavy load capacity, long stroke
- high stability and rigidity
- entirely mechanical
- telescopic, space saving
- works in tension and compression
- accurate repeatable positioning in millimetre range
- standard speeds up to 300 mm/s, higher on demand
- maintains position with no drift
- smooth motion and uniform speed
- high reliability and long life with low maintenance
- flexible configuration, easy installation

Basic technology

The LinkLift works entirely mechanically. Essentially it is a chain driven from its horizontal storage position into vertical working position in order to lift a load. The links of this chain are special: block-shaped, with square cross-sections, ensuring the centre of gravity is in the geometric centre. The chain is driven by two or four pinions. Vertical guides inside the drive housing support and ensure correct alignment and locking of the links, as the lifting column builds in a linear upward movement. The lift system does not operate in isolation, but requires guiding of the load, e.g. using wall-mounted or scissor guides. In order for the system to hold a position, brakes will be required.

the lift system for the entertainment industry

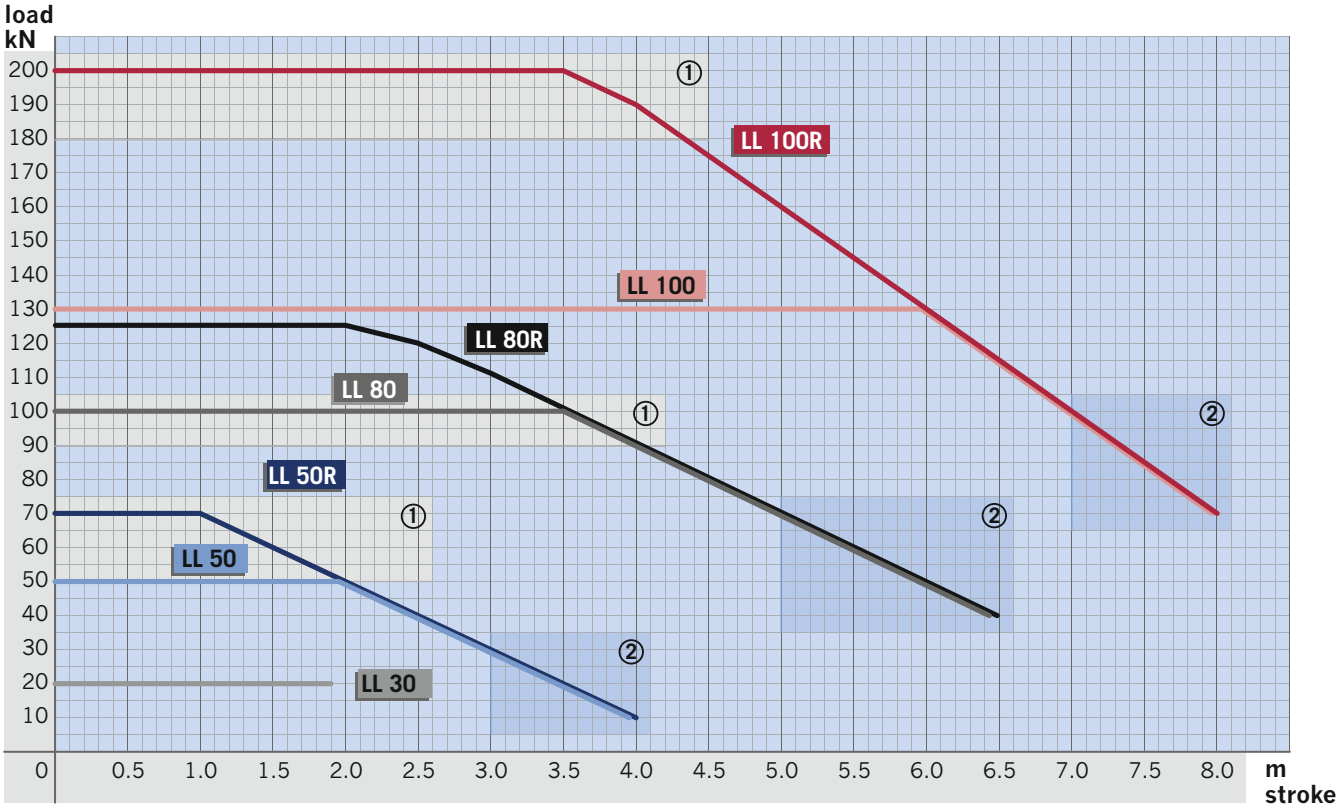
As a chain the LinkLift is also able to maintain the load in tension. This is particularly advantageous when the system is subjected to external dynamic loads, e.g. on cruise liners or in seismic risk environments. The platform is always held down firmly. An eccentric load being moved on a platform will not affect the stability of the system during operation.

In the standard magazine, the chain is stored on two levels to minimise storage length. Also available are low-profile magazines with only one strand, e.g. for scissors tables, as well as other configurations for special applications.

- patented worldwide, TÜV certified
- DIN 56950 compliant
- ISO 9000 certified

SERAPID

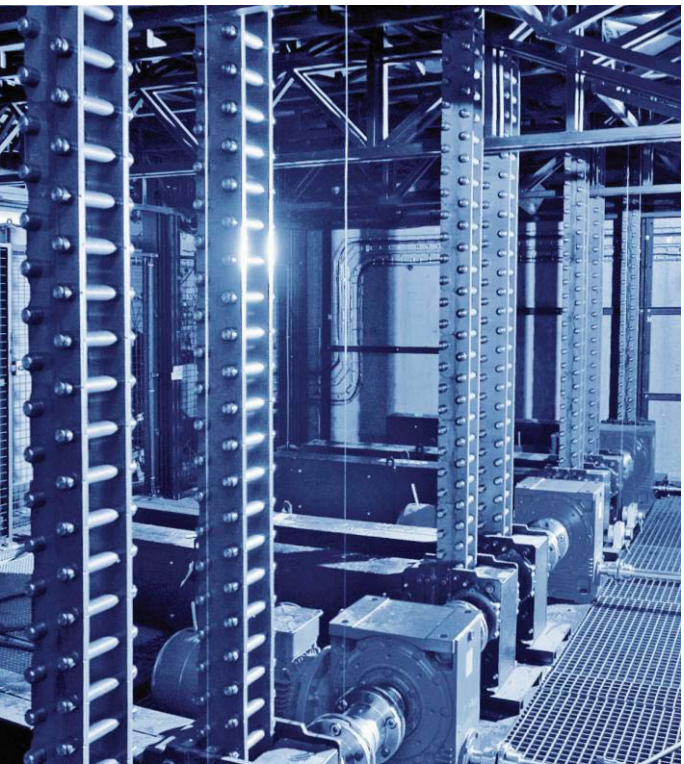
Static operating ranges



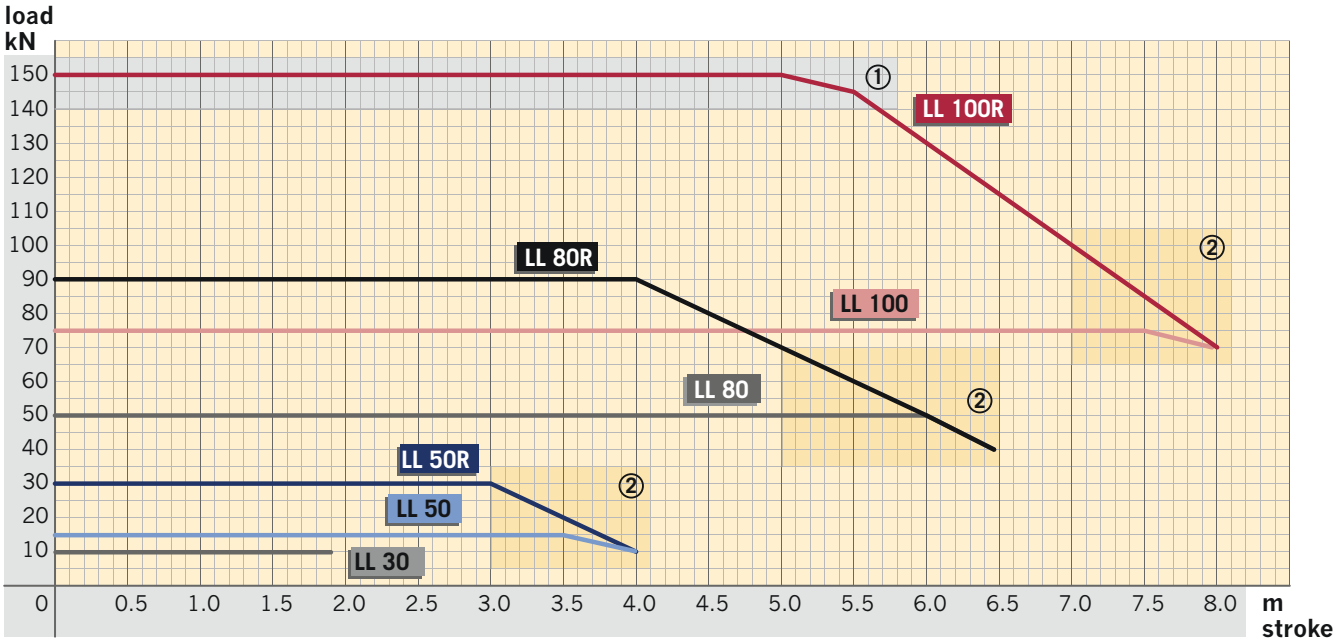
Understanding performance limits

The above performance graphs are drawn for each LinkLift model from the point of greatest load to the point of highest stroke, showing the admissible combinations of maximums. Stroke increases with decreasing load (from left to right) and load increases with decreasing stroke (from right to left). The respective values represent the mandatory limits of performance; the operating ranges thus defined are guaranteed.

Note that the stroke always comprises the entire active length of the column, including, if applicable, dead stroke as well as over and under travel.



Dynamic operating ranges



Special components

To ensure stability in the upper portions of the operating ranges, the LinkLift's drive system uses special components, in particular a double-key or splined shaft and longer drive guides.

① For loads above this limit, the drive system is equipped with a double-key or splined drive shaft.

② For strokes above this limit, the drive system is fitted with long drive guides.

In addition, all LinkLift models except the LL 30 are fitted with long drive guides for speeds exceeding 200 mm/s.

Long guides increase the lowest possible position of the platform above the nominal closed height of the LinkLift as follows:

LinkLift 50 / 50R: 366 mm (+ 75.5 mm)
LinkLift 80: 580 mm (+ 120 mm)
LinkLift 100 / 100R: 722 mm (+ 150 mm)

Operating conditions and principles

Fig. 1

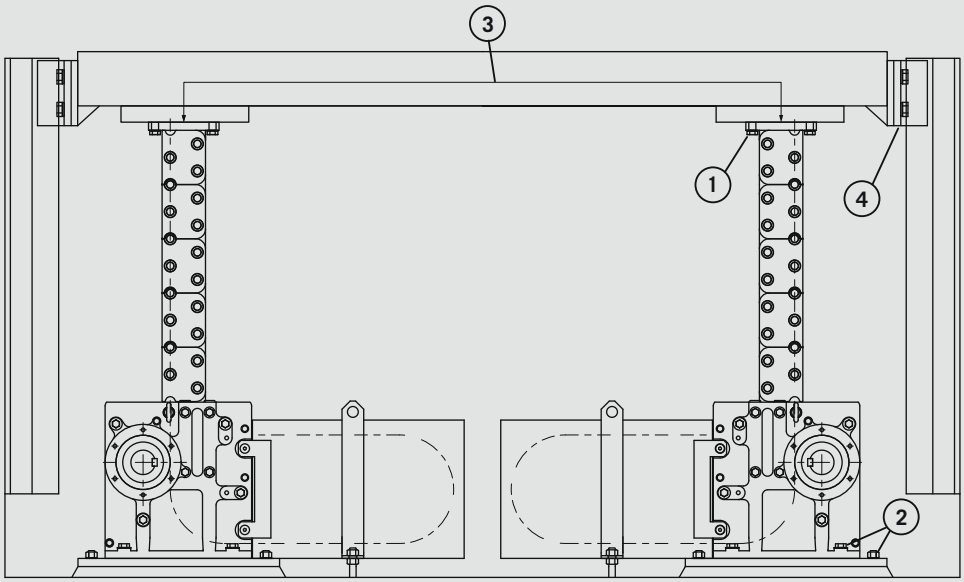


Fig. 2

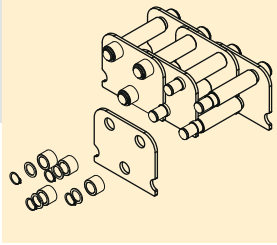


Fig. 3

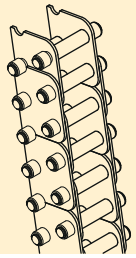


Fig. 4

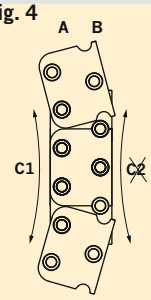
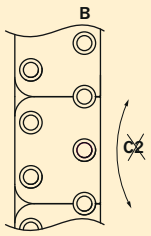


Fig. 5



To ensure stability and optimum performance, the LinkLift must be operated only under the following conditions. See **Fig. 1.**

① The top mounting plate must be fixed rigidly to the platform. A pivoting attachment is generally not provided. (For exceptions, contact us.)

② The drive housing must be fixed to the base firmly without any play and in parallel alignment with the top mounting plate.

③ The load's transfer path must be vertical and in parallel with the lifting columns.

④ The platform must be guided parallel to the lifting columns, so any horizontal movement is prevented.

Fig. 2: The chain is an assembly of various metal parts: plates, shafts, rollers and washers secured by circlips. All are lubricated for protection against corrosion.

Fig. 3: Once they have been passed through the drive housing, the links lock into one another to form a single-block column.

Fig.4: The shafts in the inner line (A) connect the links permanently, yet flexibly, so the chain can bend in the direction C1.

Fig. 5: The outer line of shafts (B) is where the drive pinions engage. These shafts also serve to lock the chain under load, as they are pressed into notches on the next lower link. Therefore the column cannot bend in the direction C2.

Installation Manual providing further information and set-up instructions: delivered with each system or available on our website www.serapid.com

Tolerances and noise

Fig. 1

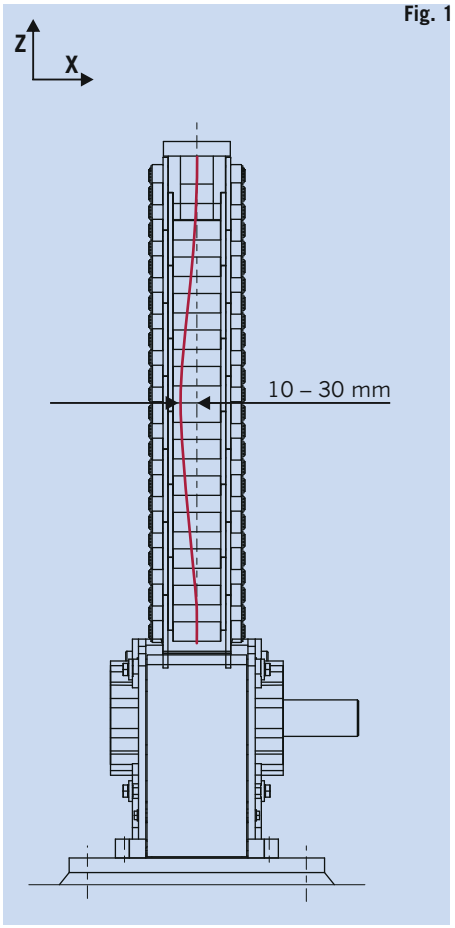
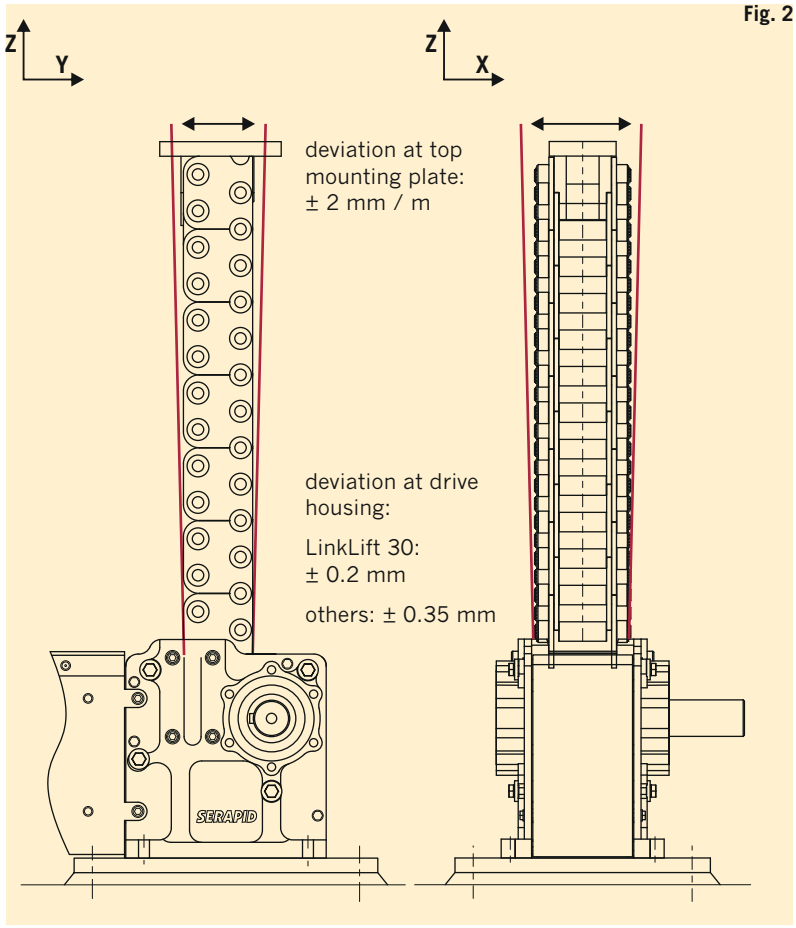


Fig. 2



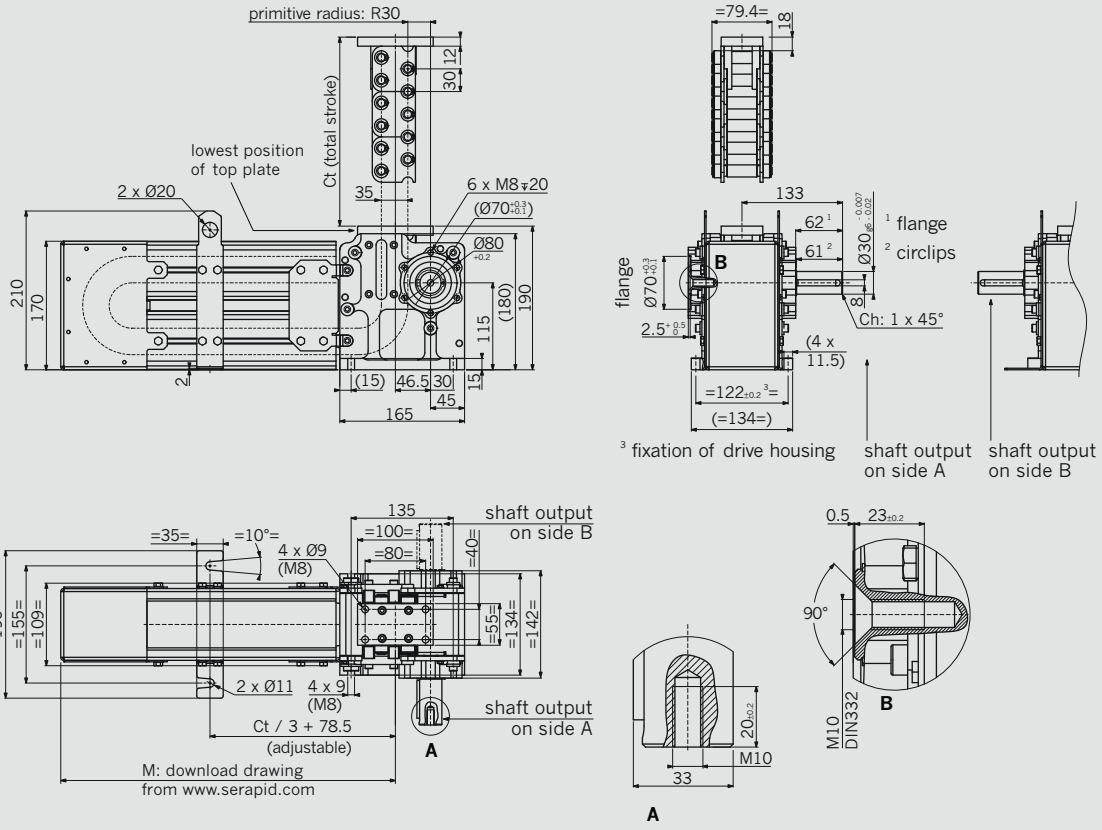
The rigidity of the lifting column is a result of its design, but also of the conditions of its use. During operation the column may deflect by 10 to 30 mm in the X-axis. **(Fig. 1)** This is perfectly normal and may vary depending on the position of the load or the lifting height. – Deflection in the Y-axis, even in the intended bending direction, does not occur as long as the platform is sufficiently guided.

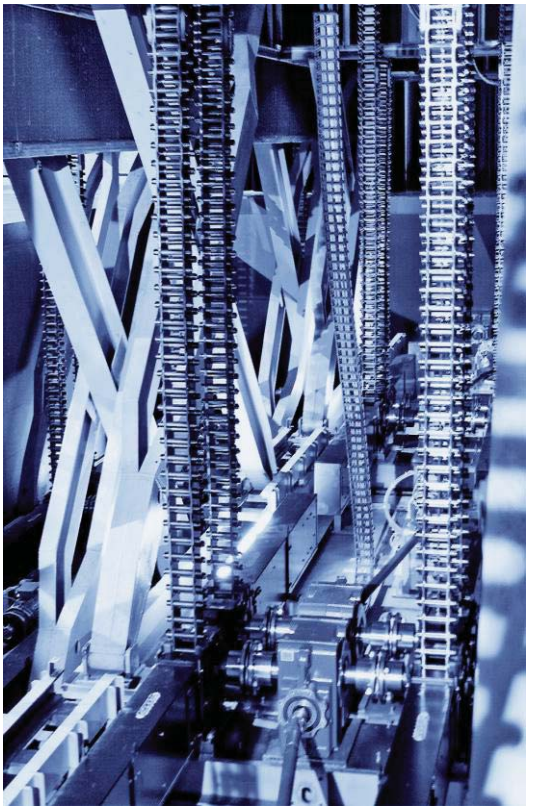
Ideally, the chain would move in an absolutely vertical line. However, misalignment and play in the platform guides invariably cause deviations in the X- or Y-axis. Up to 2 mm per metre is still acceptable. **(Fig. 2)** For optimum alignment, the fixings on the top plate are only hand-tightened to the platform at first, then, after a few moderate warm-up runs, they are torqued down with the platform in low position.

The LinkLift is particularly silent in the nominal speed range. The low noise emission is mainly due to the slow rotation of the high-quality drive pinions. Noise measurements taken in front row seats of several theatres have revealed sound pressure values of between 42 and 50 dBA. If noise level management is a predominant issue for you, feel free to contact our technical services. (See also page 14.)

Dimensions of each LinkLift model

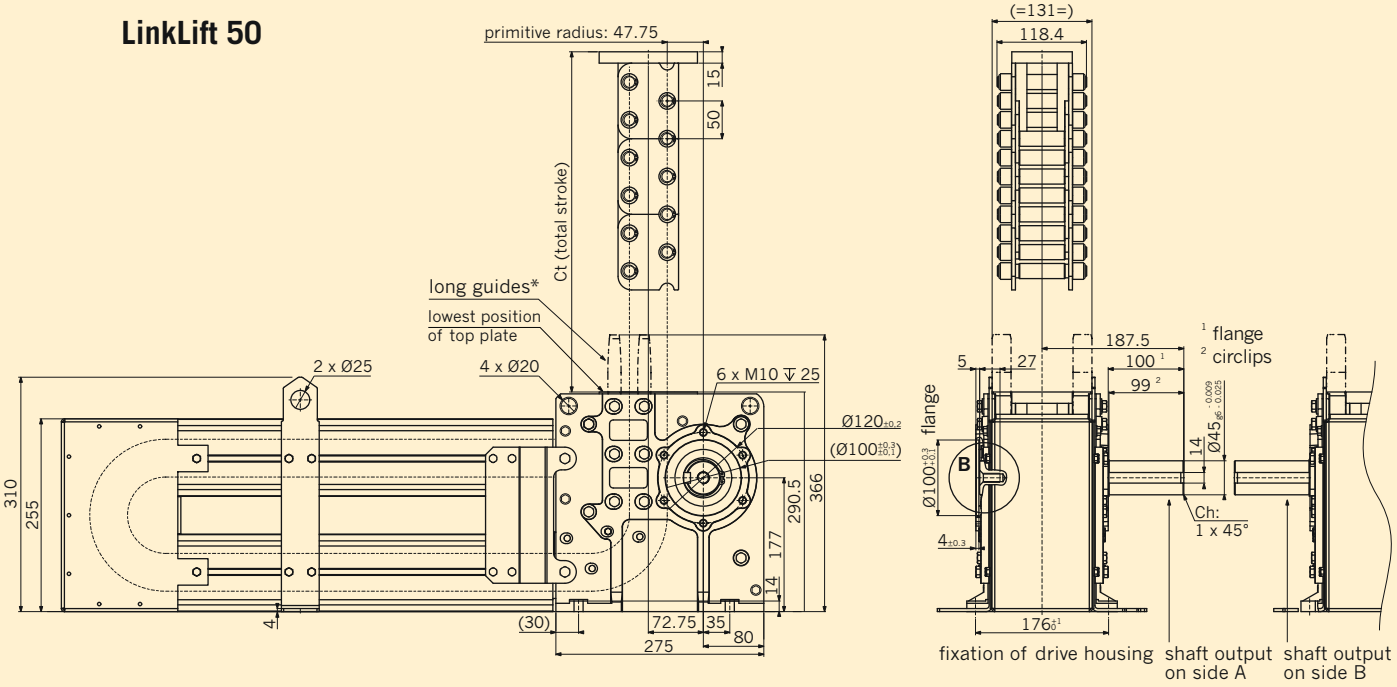
LinkLift 30

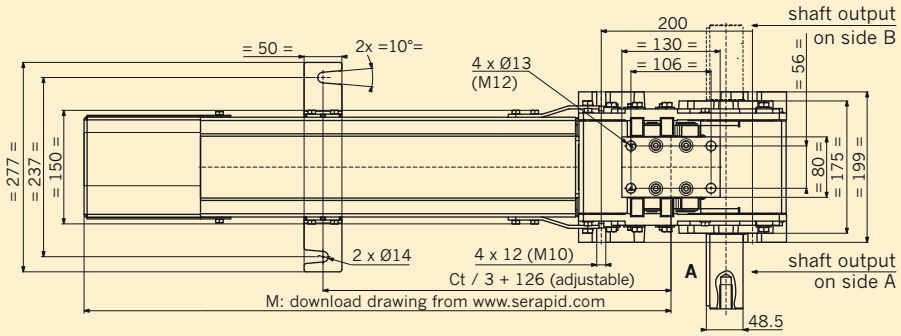


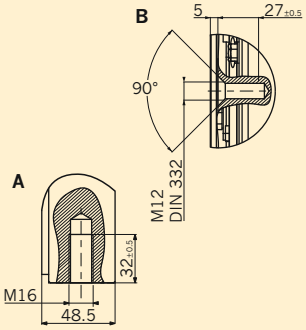


LinkLift 50 / 50R

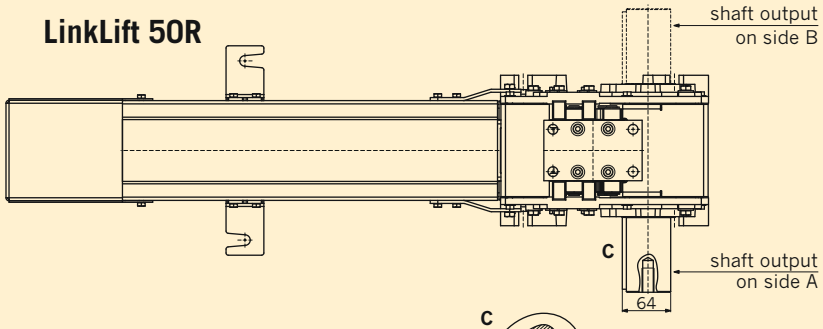
LinkLift 50

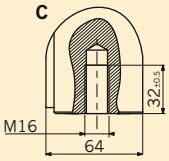


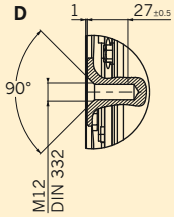


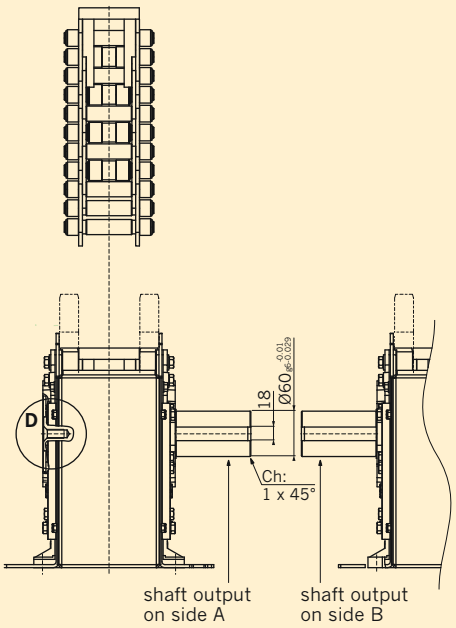


LinkLift 50R







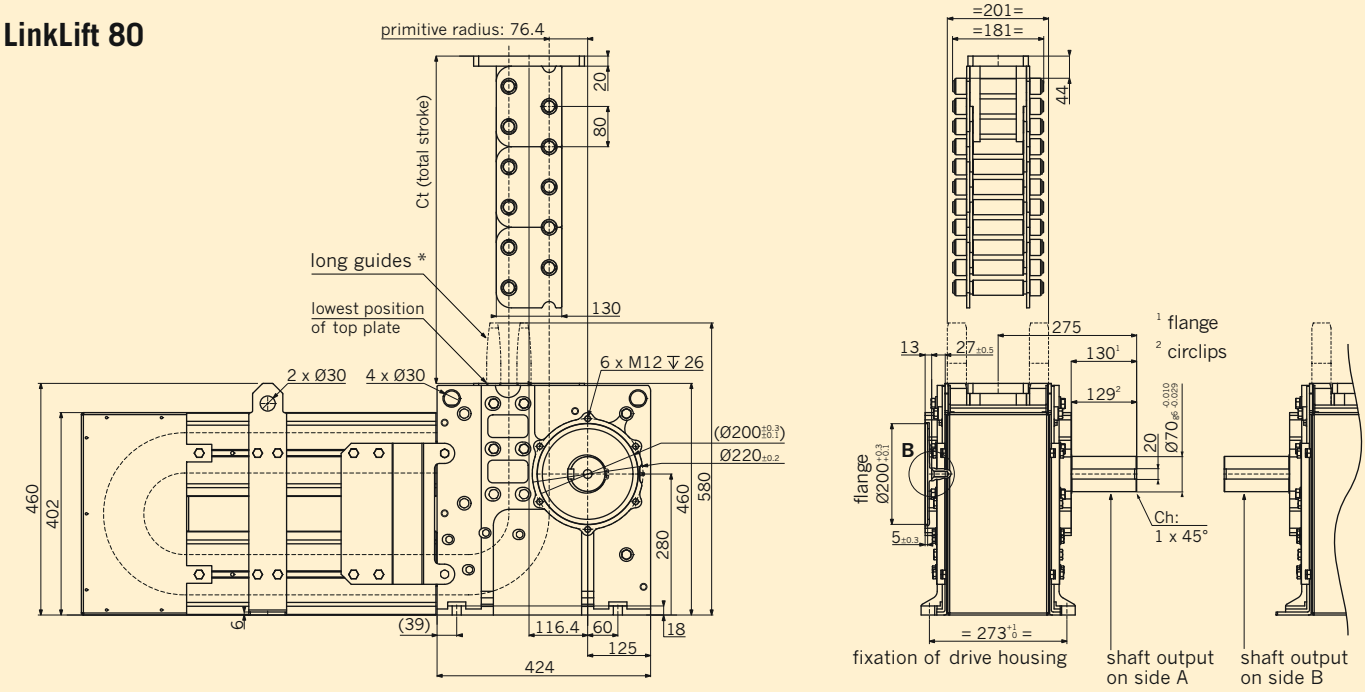


***Note:** On long guides see page 5.

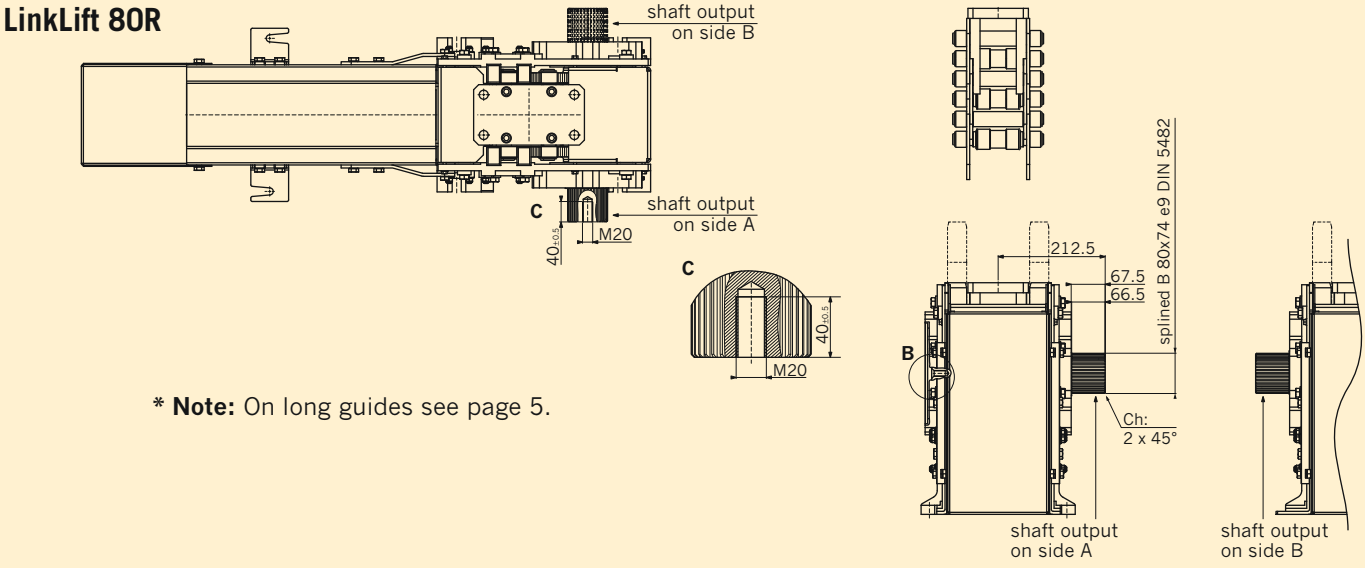
Dimensions of each LinkLift model

LinkLift 80 / 80R

LinkLift 80



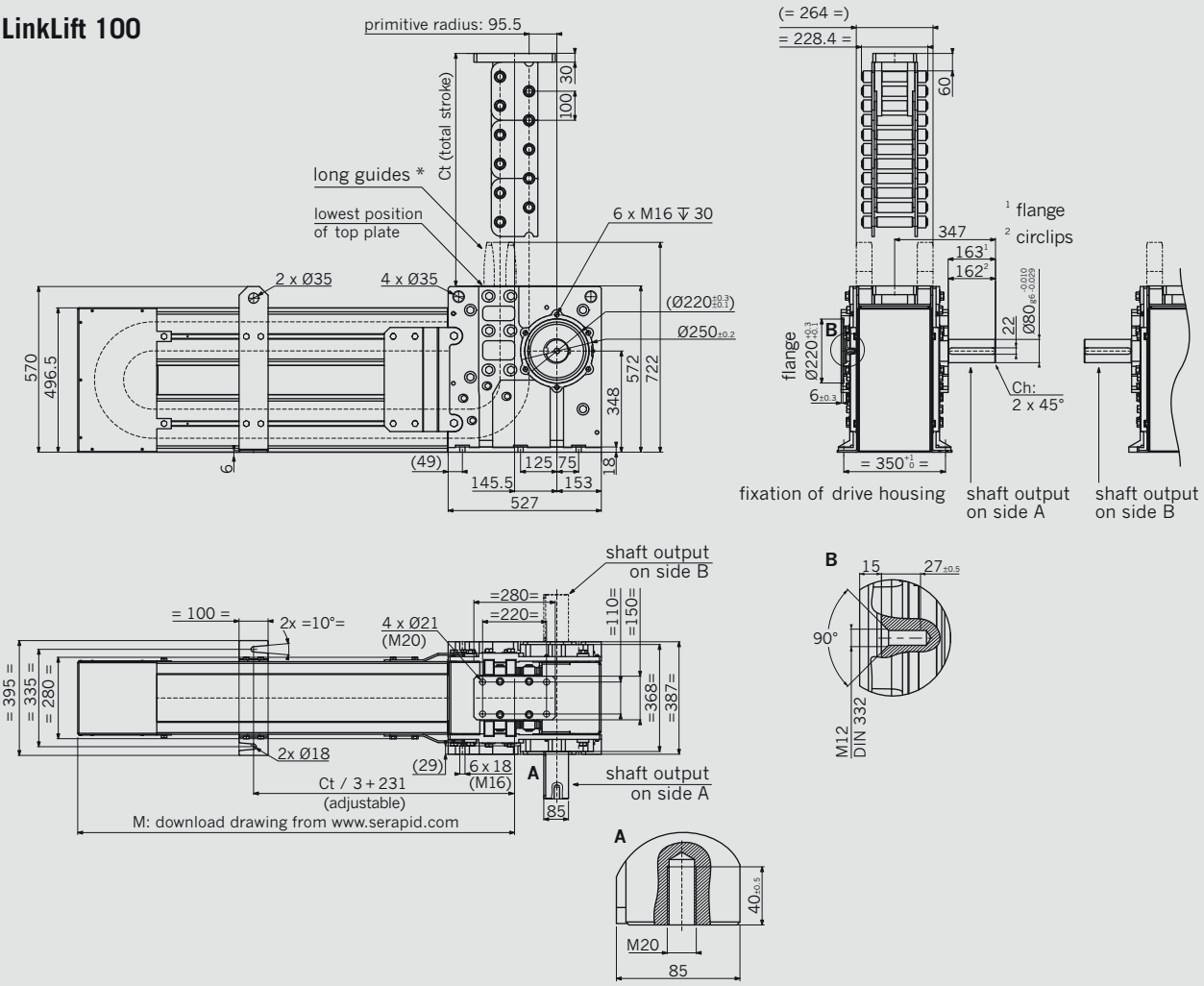
LinkLift 80R



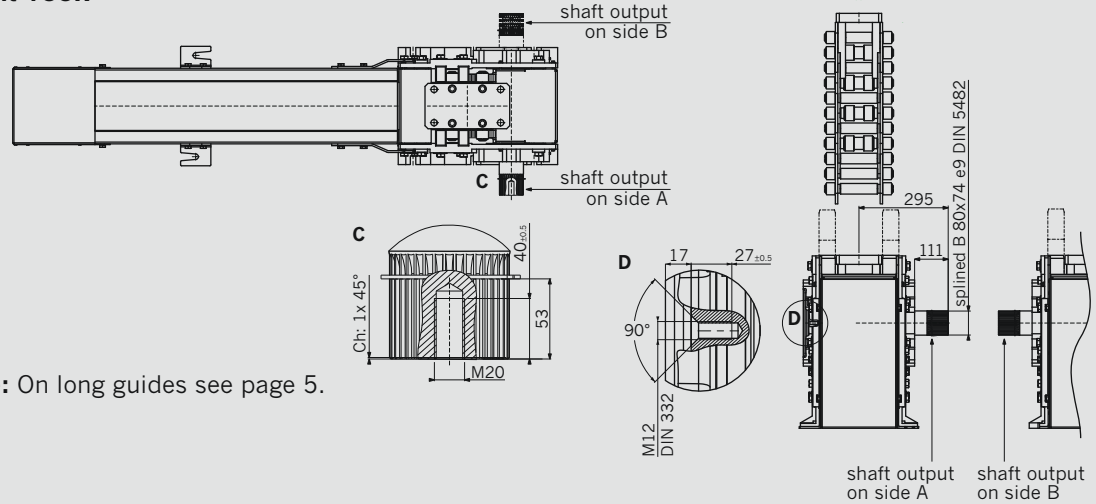
*** Note:** On long guides see page 5.

LinkLift 100 / 100R

LinkLift 100



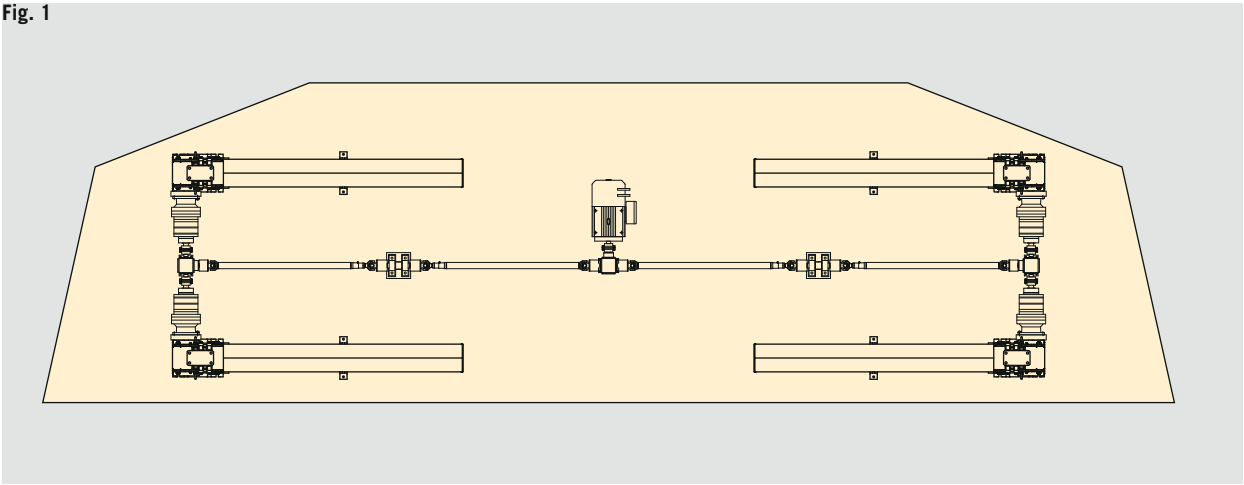
LinkLift 100R



*** Note:** On long guides see page 5.

Key figures for selecting a LinkLift model

Fig. 1



LinkLift performance data

Model	LL 30	LL 50	LL 50R	LL 80	LL 80R	LL 100	LL 100R
Static capacity per lifting column							
max. load [kN] : stroke limit [m]	**20** : 1.9	**50** : 2	**70** : 1	**100** : 3.5	**125** : 2	**130** : 6	**200** : 3.5
load limit [kN] : **max. stroke [m]**	20 : **1.9**	10 : **4**	10 : **4**	40 : **6.4**	40 : **6.4**	70 : **8**	70 : **8**
Dynamic capacity per lifting column							
max. load [kN] : stroke limit [m]	**10** : 1.9	**15** : 3.5	**30** : 3	**50** : 6	**90** : 4	**75** : 7.5	**150** : 5
load limit [kN] : **max. stroke [m]**	10 : **1.9**	10 : **4**	10 : **4**	40 : **6.4**	40 : **6.4**	70 : **8**	70 : **8**

A classic example

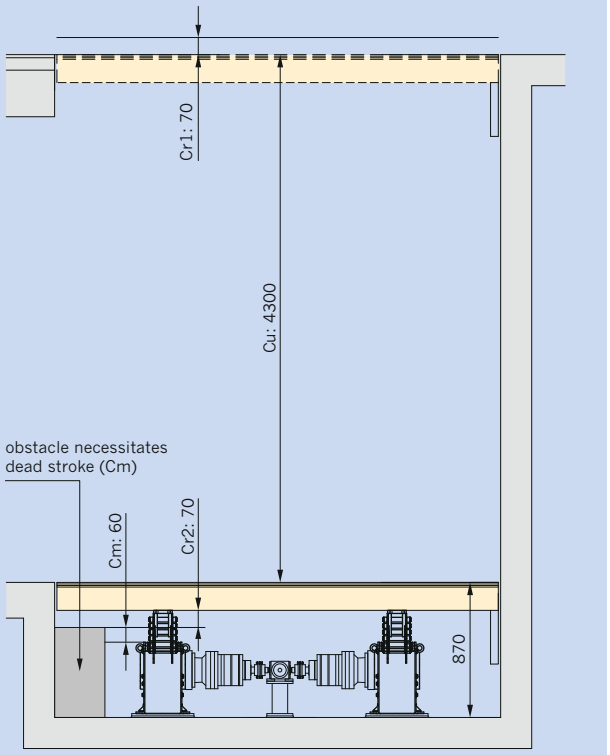
To illustrate the selection of a LinkLift model, we show here a typical application in stage engineering. The data is only for demonstration purposes. Local regulations, which have been left out of consideration, may lead to a different choice. – We will require the following basic data:

- **platform dimensions** (Fig. 1): 12 x 3.6 m, with an effective area of 34 m².
- **depth of the pit:** 0.87 m
- **working stroke (Cu):** 4.3 m (Fig. 2)
- **dead stroke (Cm):** distance between top mounting plate and drive housing, if chains cannot be entirely withdrawn; here 60 mm.
- **over and under travel (Cr1, Cr2):** reserve stroke beyond high or low position of the platform, depending on safety regulations; here 70 mm each.
- **static payload:** 5 kN/m²
- **dynamic payload:** 2.5 kN/m²
- **platform dead weight:** 1.2 to 1.5 kN/m². This value may vary greatly with the structure design and material. In the case of a scissor platform, half of the weight of the scissors must be taken into the calculation.
- **elevation speed:** 50 mm/s
- **acceleration or deceleration forces:** insignificant here on account of the speed

The total stroke (Ct) is the sum of working stroke, dead stroke (if required), and over and under travel strokes:
Ct = Cu + Cm + Cr1 + Cr2 = **4.5 m**
This makes the LinkLift 80 a good candidate.

The total static load (Fs) is the force applied on the columns when the platform is not in motion:
Fs = platform area x (static payload + platform weight)
= 34 m² x (5 kN/m² + 1.5 kN/m²) = **221 kN.**
With 4 columns, the load is **55 kN** per column (assuming even distribution of the total load), which again points to the LinkLift 80.

Fig. 2



The total dynamic load (Fd) is the force applied on the columns when the platform is being lifted:
Fd = platform area x (dynamic payload + platform weight + acceleration force)
= 34 m² x (2.5 kN/m² + 1.5 kN/m²) = **136 kN,** with acceleration neglected (using frequency control). With 4 columns, the load is **34 kN** per column (assuming even distribution of the total load), which once more points to the LinkLift 80.

The total number of columns and their type must also be determined according to the platform proportions and the distribution of forces. Moreover, the available maximum height under the lift platform will also be a limiting factor on choosing the LinkLift.
A smaller unit could be chosen by increasing the number of columns if the stroke is compatible.

Motorisation of the LinkLift

The following basic formulae are used to calculate the torque, speed and power required to operate one or several LinkLift systems.

The maximum torque (M) per column is calculated from the total static (Fs) or dynamic load (Fd), whichever is the higher. This value is divided by the number of columns. The weight of the chain (Pc; see table, page 2) is then added. Friction forces occurring in the guides are insignificant. Forces of inertia must be added if the system does not include a speed variation control.

$$Fs = \frac{S \times Fu_s + Ps}{Nc} \text{ [N]}$$

$$Fd = \frac{S \times Fu_d + Ps}{Nc} \text{ [N]}$$

$$Pc = Ct \times m \text{ [N]}$$

$$M = \frac{(\max(Fs;Fd) + Pc) \times p \times 10^{-3}}{\eta} \text{ [Nm]}$$

The rotation speed of the drive shaft (N) is calculated from the chain pitch (p) and the lifting speed (V). We generally recommend a frequency converter to minimise shock; otherwise, the speed must not exceed 30 mm/s.

$$N = \frac{V}{2\pi \times p \times 10^{-3}} \text{ [rpm]}$$

The output power (P) required per column is calculated from the torque (M) and the shaft rotation speed (N):

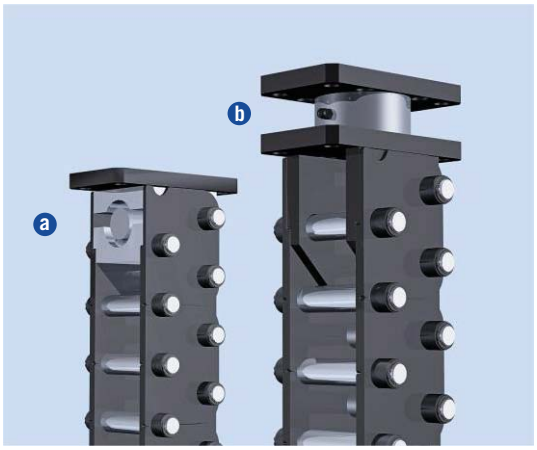
$$P = \frac{M \times N \times \pi \times 10^{-3}}{30} \text{ [kW]}$$

Fs	total static load [N]
Fd	total dynamic load [N]
S	platform area [m²]
Fu_s	static payload [N/m²]
Fu_d	dynamic payload [N/m²]
Ps	weight of platform [N]
Nc	number of lifting columns
Pc	weight of chain [N]
Ct	total stroke [m]
m	mas of chain [N/m]
M	maximum torque [Nm]
p	chain pitch [mm]
η	system efficiency (= 0,8)
N	shaft rotation speed [rpm]
V	lifting speed [m/min]
P	output power [kW]

Enhancements and adaptations

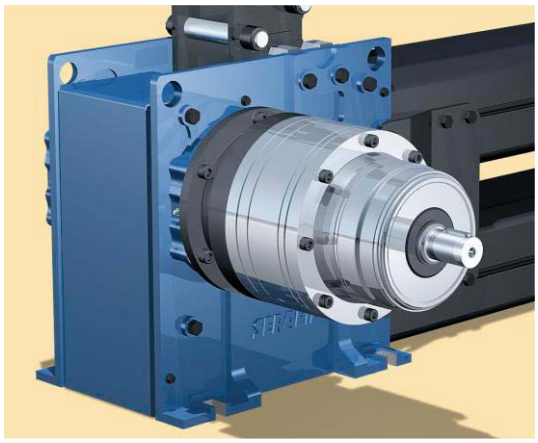
Load monitoring

The LinkLift load cell allows load monitoring at the top of the lift column, the point where the force is applied. The deformation body contains a force transducer with a thin film sensor for high accuracy. Compliance with SIL 3 specifications is obtained with an optional extension. – There are two mounting variants:
a. integrated under top plate
b. mounted onto top plate



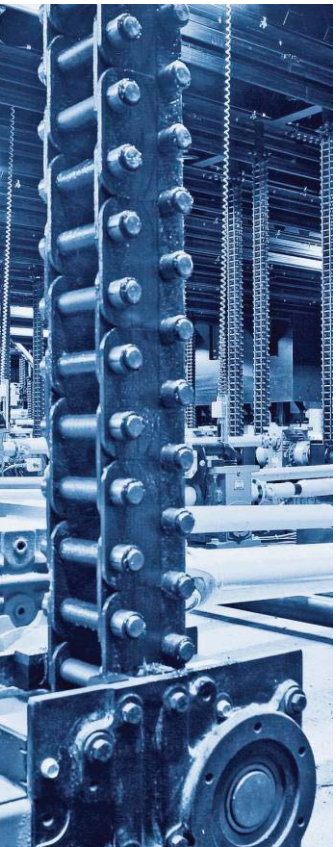
Planetary gearbox

All LinkLift models can be delivered with a planetary gearbox to reduce the drive torque. The gearbox is selected according to the motor power used. The gearbox comes premounted with the appropriate flanges on the drive housing.



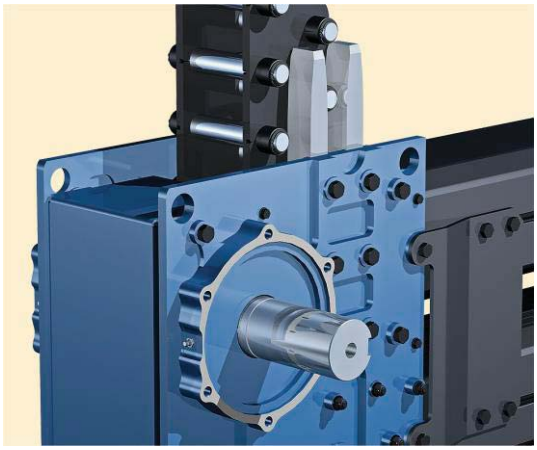
Positioning control using a CAM switch

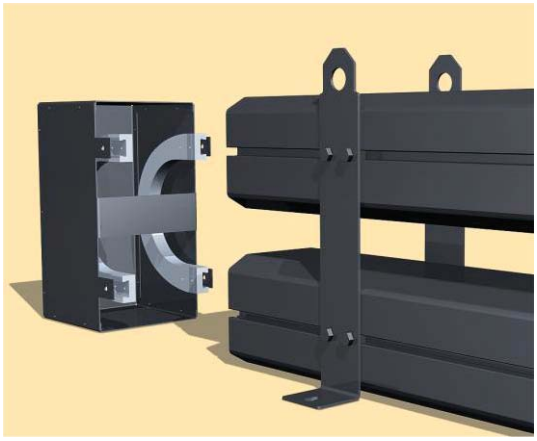
A CAM switch can be connected to the drive shaft with an appropriate mounting bracket. The switch is available with 2 to 6 positions which can be set independently of each other.



Positioning control using an encoder

An encoder can be connected to the drive shaft with an appropriate mounting bracket. With a resolution of 1024 points per travel, the positioning accuracy obtained at the end of the column is 0.5 mm.





Other options:

- special forms for drive shaft output
- mounting flange for gear reducer
- cardan / U-joint shafts and couplings
- low-profile, single-line magazine or multi-line magazine; special magazine designs on demand
- intermediary pick-up frame allowing lifting heights above standard
- end-of-stroke sensor
- special paint or coating
- design support, custom project study, assistance in configuration of lift systems

For further information, please call us or visit our website at

www.serapid.com

Long guides

The drive housings can be fitted with standard or long guides. The long guides are required in the following two cases:

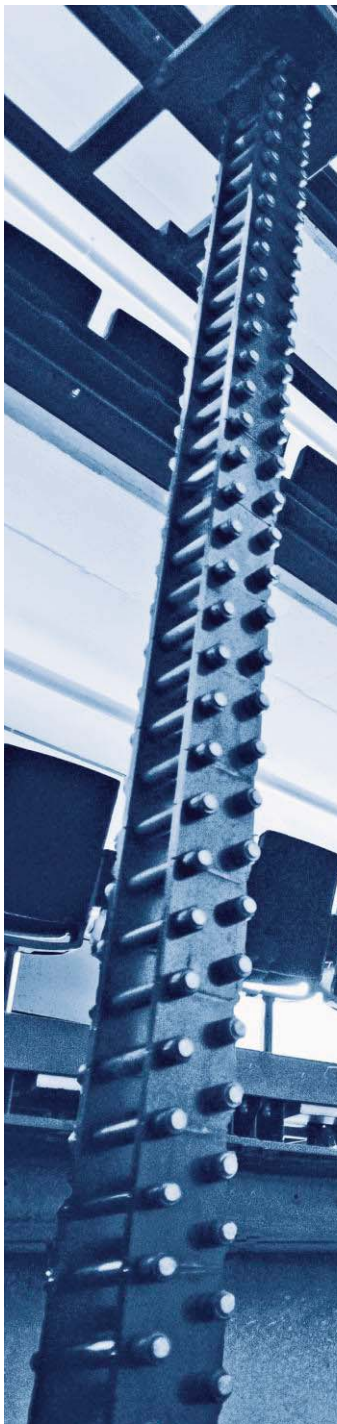
1. to reduce deflection when the stroke is long (see the load / stroke performance curves on pages 4 and 5).
2. to stabilise the chain when exiting or entering the drive housing at speeds above 200 mm/s.

Modular magazine

Our standard dual-line magazines consist of two parallel aluminum tubes with a 180° curve piece connecting them at one end; the tubes can be cut to any size. This allows the magazines to be fitted exactly to the length of the lifting column. In installed lift systems, if the stroke is to be extended, additional storage space can be obtained by simply replacing the tubes.

Important hints

- Apply local specifications pertaining to motion systems. The reference loads required by DIN 56950 are already included in our stated specifications.
- Consider the cumulated efficiency values of each part.
- Use planetary gear reducers mounted on the LinkLift to reduce the transmission torque.
- Systematically incorporate a safety brake or a double motor brake.
- Account for the uneven distribution of loads on the columns.
- Use torsion-stiff shafts and couplings.
- Power the motor using a frequency converter to avoid generating shock during start-up and shut-down.
- Consider the forces generated by a shut-down due to a power loss, particularly with speeds above 100 mm/s.



Ordering lifting columns

To place an order for LinkLifts, collect the relevant data as shown in the example on page 12. The length of the magazine corresponds to the total length of the chain. For exact dimensions, see the drawings on pages 8 to 11. The following information is required to make an order:

lifting columns	quantity
LinkLift model	30, 50, 50R, 80, 100, 100R
total stroke	Ct = Cu + Cm + Cr1 + Cr2
shaft output, side A	quantity
shaft output, side B	quantity

For the example given on page 12, the result would be:

lifting columns	4
LinkLift model	80
total stroke	4.5 m
shaft output, side A	2
shaft output, side B	2

the lift system for the entertainment industry

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