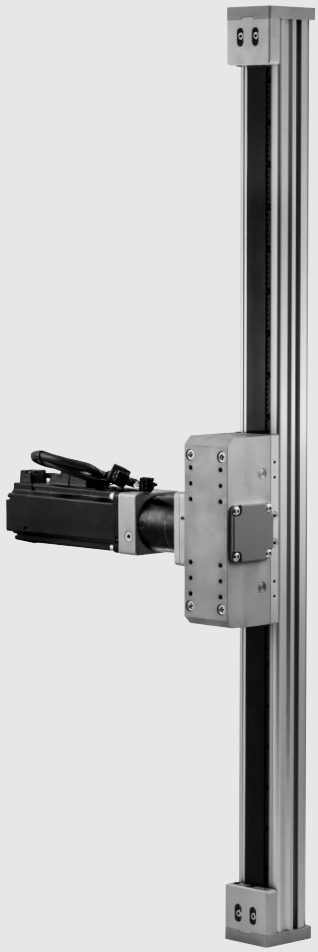
ELECTRIC CANTILEVER AXIS

ELECTRIC AXIS
BELT-DRIVEN RODLESS, SERIES ELEKTRO VBK

Belt-driven rodless electric axis with load-bearing structure consisting of an anodized aluminum extruded profile and linear guide system comprising a rail and ball-recirculation pads.
The motor and gearbox unit is fixed to the central body (so-called "cantilever" solution).
The typical application foresees that the central body remains fixed and the extruded profile moves.
The VBK can be mounted in both horizontal and vertical orientations; for example can be used as a Z axis in a cartesian portal, typically with a BK Series Gantry.
Motion transmission is obtained by means of a polyurethane toothed belt reinforced with steel cables.
The parabolic profile of the belt tooth ensures high efficiency, reduced noise and vibrations.
The central body houses the transmission group consisting of a driving pulley and two idle rollers ("omega" configuration).
The axis, which can be ordered with a stroke per mm, comes complete with an adjustable belt-tensioning system and independent channels for pad re-lubrication.
Threaded and centering holes are present on the central body and on the heads allowing multiple mounting options.
The extrusion has the characteristic V-Lock profile as well as an internal opening where to pass cables and pipes.
It is possible to purchase the axis with or without drive. The standard drive includes a brushless motor with brake, combined with a precision planetary gearbox available in two different gear ratios.
The motor unit can be mounted on either side of the central body.



TECHNICAL DATA		
Admissible ambient temperature	°C	from 0 to +40
Maximum relative humidity		90% at 40°C; 57% at 50°C (no condensate)
Maximum duty cycle		100%
Minimum stroke	mm	110
Maximum stroke	mm	1000
Repeatability	mm	± 0.05
Uncontrolled impact at the end of stroke		NOT ALLOWED (it provides an extra-stroke minimum 10 mm)
Homing position sensor		Inductive sensors
Work position		Any
Degree of protection		IP 20
Noise level	dBA	<66
Type belt		RPP 5 mm pitch in polyurethane with steel tensioning cables
Maximum belt extension		0.10%
Pulley feed/revolution	mm	110
Driving pulley pitch diameter	mm	35.01
Maximum axial force ■	N	550
Maximum number of revs	1/min	1000
Maximum speed (without load)	m/s	3
Maximum acceleration (without load)	m/s^2	30
Maximum driving torque applicable to the pulley	Nm	10
Maximum applicable motor shaft diameter ▲	mm	14

■ Maximum load admissible on the belt: for the sizing, perform the checks as shown in the following pages.
▲ Compact configuration with the motor shaft partially inserted into the pulley axle.

METAL WORK PNEUMATIC

MASS AND MOMENT OF INERTIA

Mass of carriage	kg	2.08
Moving mass at stroke 0 (Mx)	kg	1.46
Moving mass at stroke 0 (excluding drive)	kg	3.54
Moving mass of brushless motor with brake + gearbox + flange and screws	kg	3.18
Moving mass for each mm of stroke	g/mm	3.6
J_0 at stroke 0	kgmm^2	610
J_1 each metre of stroke	kgmm	1.1
J_2 each kg of load	mm^2	306.5
J_3 gearboxe 1:3	kgmm^2	8
J_3 gearboxe 1:5	kgmm^2	6

The reduced moment of inertia of total mass at the driving shaft is: $J_{tot} = [J_1 \cdot \text{Stroke [mm]} + J_2 \cdot \text{Load [kg]} + J_0] \cdot \tau^2 + J_3$

$\tau = 1/u$

u = Gearing ratio

$J_3 = J_{\text{gear ratio}}$

In order to ensure the proper functioning of the system and avoid instability, it is necessary to limit the ratio K between the reduced moment of inertia at the motor shaft $\mathbf{J_{total}}$ and the moment of inertia at the motor $\mathbf{J_{motor}}$

$1<K= J_{total} / J_{motor} <40$

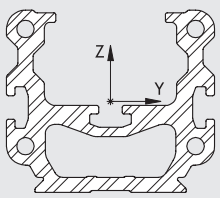
These figures apply to motors supplied by Metal Work. Motors of other makes could require different maximum values.
This limit also depends on the level of control of the required movement: e.g. if the movements need to be coordinated, the ratio between the inertias must be considerably reduced.
Indicatively, it is **advisable NOT to exceed** the following values:

1<K<10 with motors BRUSHLESS

It is worth noting that system operation can be enhanced by varying the drive parameters.
For BRUSHLESS motors supplied by Metal Work, a "tuning" procedure is envisaged to optimise motor operation depending on the mechanics applied to the axle.

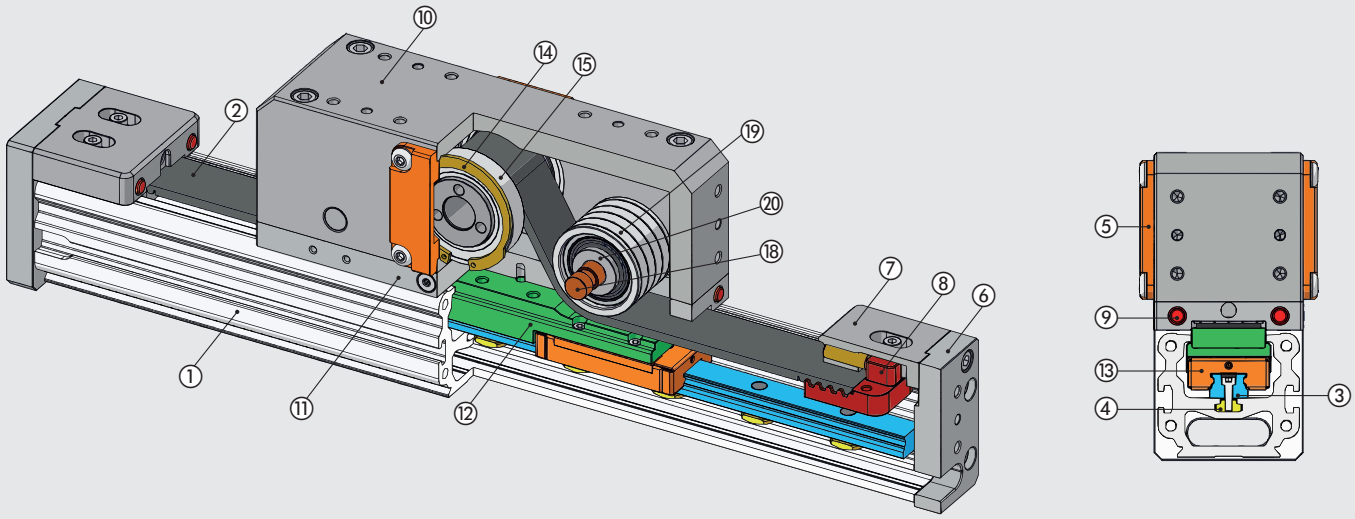
MOMENTS OF INERTIA – ALUMINIUM SECTION

Moment of inertia in relation to the Y-axis (Iy)	10^3 mm^4	176.52
Moment of inertia in relation to the Z-axis (Iz)	10^3 mm^4	323.34

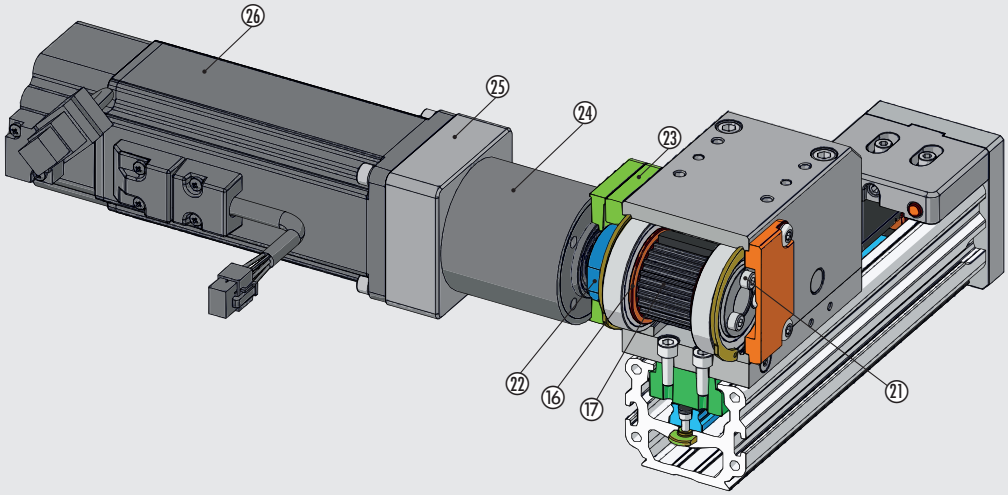


NOTES

COMPONENTS



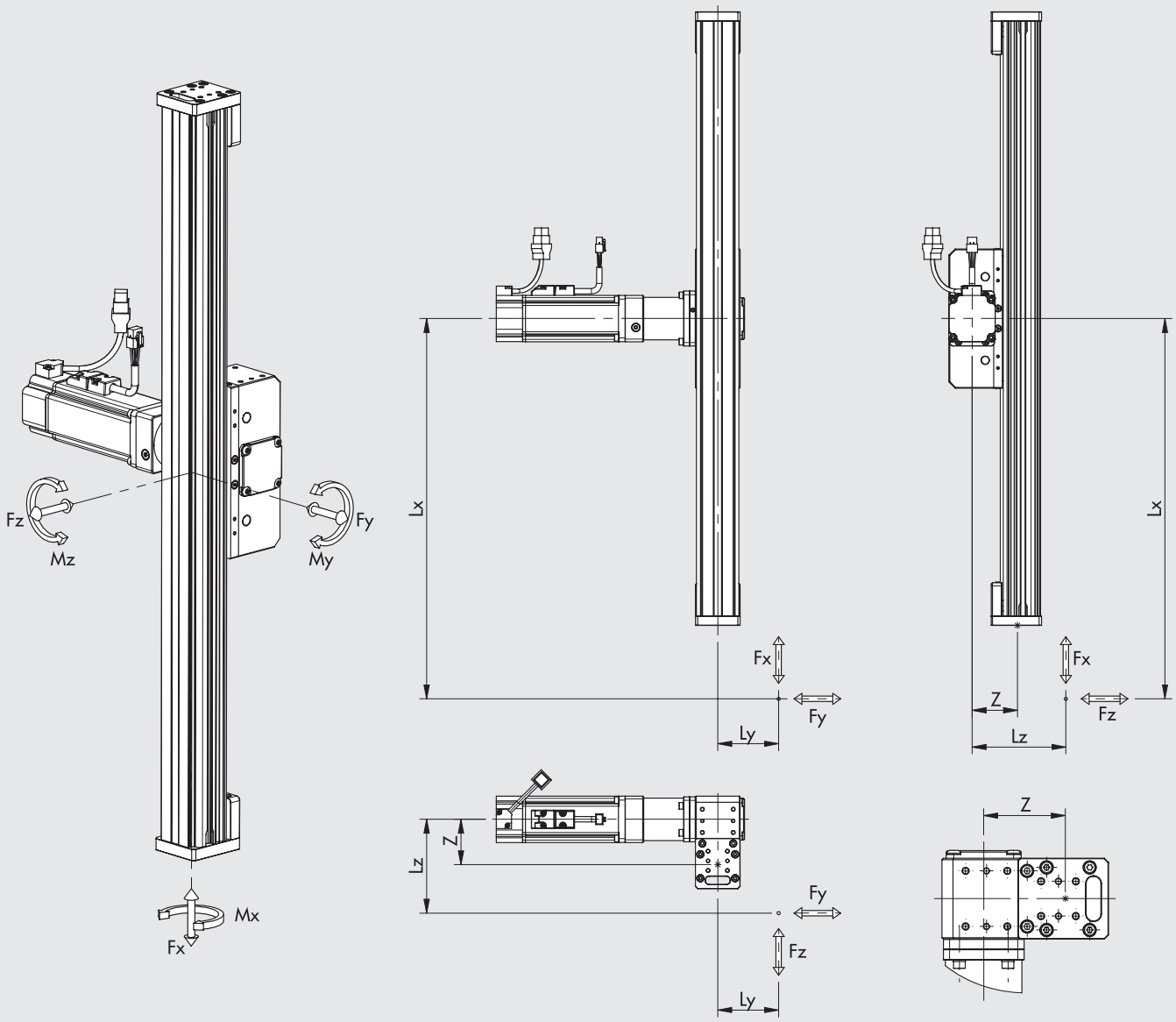
VERSION WITH MOTOR



① BARREL: anodized aluminium
② TOOTHED BELT: polyurethane with steel cables
③ GUIDING RAIL FOR PADS: hardened steel
④ GUIDE-LOCKING INSERTS: stainless steel
⑤ COVER: painted aluminium
⑥ HEAD: anodized aluminium
⑦ UPPER BELT-LOCKING PLATE: anodized aluminium
⑧ LOWER BELT-LOCKING PLATE: anodized aluminium
⑨ BUFFER: polyurethane
⑩ CENTRAL BODY: anodized aluminium
⑪ INTERMEDIATE PLATE: anodized aluminium
⑫ PAD SUPPORT: anodized aluminium
⑬ BALL RECIRCULATION PAD: stainless steel / technopolymer
⑭ BEARING-LOCKING SNAP RING: zinc-plated steel
⑮ HIELDED BALL BEARING: hardened steel
⑯ BELT FLANGES: zinc-plated steel
⑰ TOOTHED PULLEY: nickel-plated aluminium
⑱ FIXED PINS: stainless steel
⑲ DRIVEN ROLLERS: nickel-plated aluminium
⑳ BEARING CONTAINMENT BUSHES: anodized aluminium
㉑ ELASTIC COLLAR-LOCKING SCREWS: zinc-plated steel
㉒ ELASTIC COLLAR: anodized aluminium
㉓ MOTOR-FIXING FLANGE: anodized aluminium
㉔ GEARBOX
㉕ MOTOR INTERFACE FLANGE: anodized aluminium
㉖ MOTOR

METAL WORK PNEUMATIC

DIAGRAM OF FORCES AND MOMENTS



STATIC VERIFICATION

When the axis is subjected simultaneously to torque and force, keep to the following equations, where the lengths have to be given in metres.

Z [m]	Fy0 max [N]	Fz0 max [N]	Mx0 max [Nm]	My0 max [Nm]	Mz0 max [Nm]
0.059	9080	9080	70	642	642

N.B.: The table shows the maximum loads applicable to the guide system beyond which serious damage could be caused. Refer to the Deformation/Load charts on the following pages to verify the axles load conditions.

$Mx = Fz \cdot Ly + Fy \cdot (Lz - Z) \quad My = Fx \cdot (Lz - Z) + Fz \cdot Lx \quad Mz = Fx \cdot Ly + Fy \cdot Lx$

$$\frac{|Mx|}{Mx0\ max} + \frac{|My|}{My0\ max} + \frac{|Mz|}{Mz0\ max} + \frac{|Fx|}{Fx0\ max} + \frac{|Fy|}{Fy0\ max} \leq 1$$

DYNAMIC VERIFICATION

When the axis is subjected simultaneously to torque and force, keep to the following equations, where the lengths have to be given in metres.

Z [m]	Fy max [N]	Fz max [N]	Mx max [Nm]	My max [Nm]	Mz max [Nm]
0.059	4540	4540	35	321	321

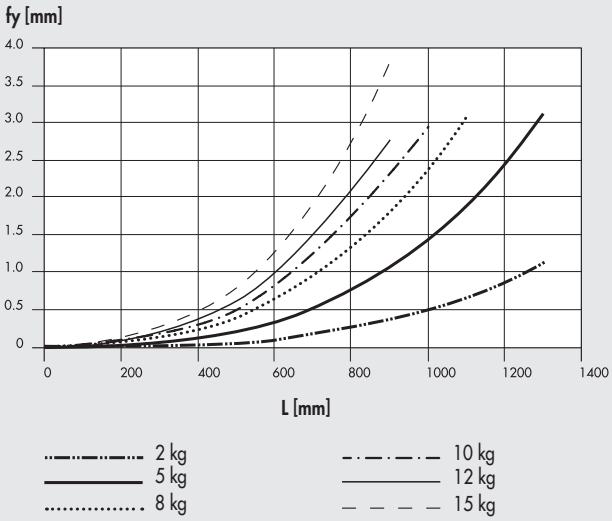
N.B.: The values in the table refer to the guide system and are calculated on the basis of a theoretical operating life of 10,000 km.

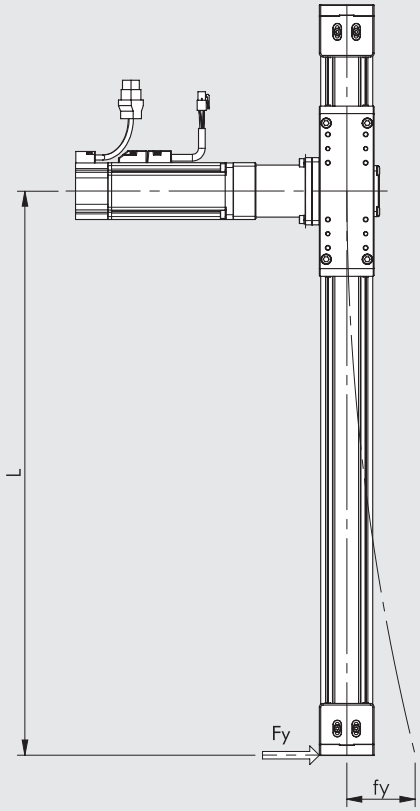
$Mx = Fz \cdot Ly + Fy \cdot (Lz - Z) \quad My = Fx \cdot (Lz - Z) + Fz \cdot Lx \quad Mz = Fx \cdot Ly + Fy \cdot Lx$

$$\frac{|Mx|}{Mx\ max} + \frac{|My|}{My\ max} + \frac{|Mz|}{Mz\ max} + \frac{|Fx|}{Fx\ max} + \frac{|Fy|}{Fy\ max} \leq 1$$

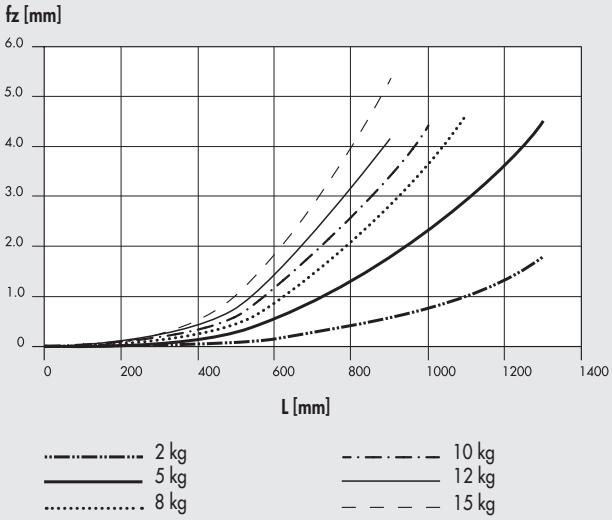
DEFORMATION ACCORDING TO LOAD AND DISTANCE

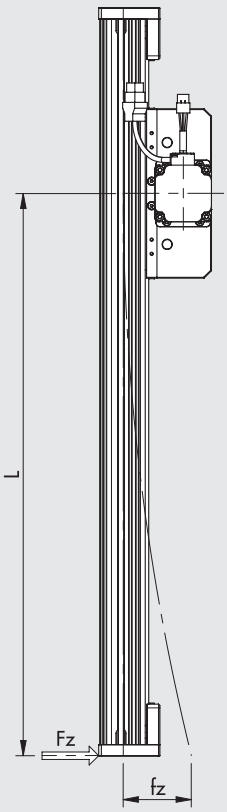
DEFLECTION IN Y DIRECTION





DEFLECTION IN Z DIRECTION



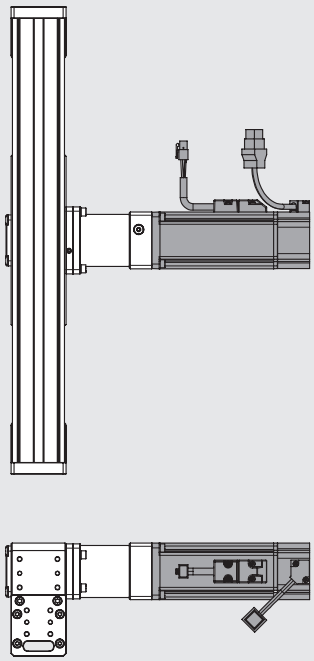


N.B.: The deformations shown in the graphs have been measured under static conditions.

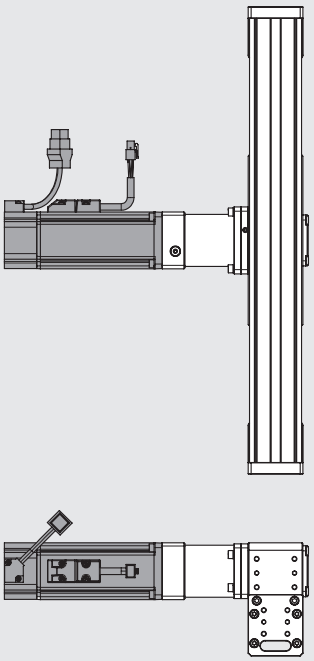
METAL WORK PNEUMATIC

VERSIONS

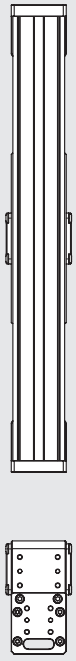
RIGHT MOTOR



LEFT MOTOR



WITHOUT MOTOR

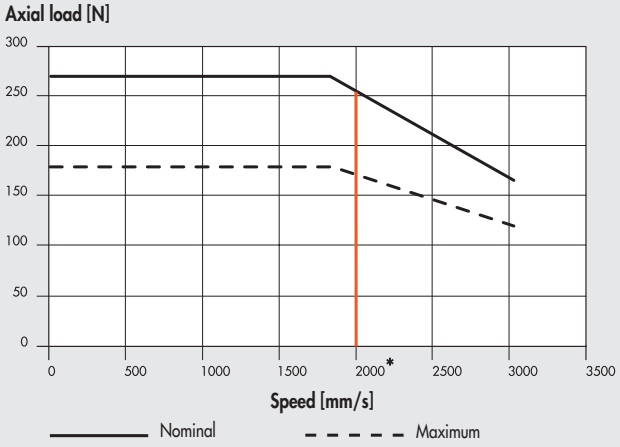


AXIAL LOAD CURVES AS A FUNCTION OF SPEED (AXIS COMPELTE WITH MOTOR AND DRIVE)

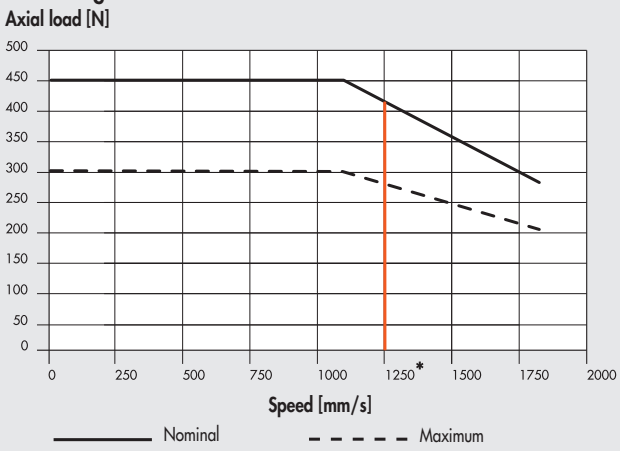
N.B.: Check that the following constraints are met for each cycle phase:
- the maximum premissible load and related acceleration values specified in the data sheets;
- the values specified in the force and moment calculation diagram (including moment of inertia).
- deformation according to load.

The following diagrams show the axial load with changing speed (mm/s). Each diagram shows two separate curves:
- **NOMINAL AXIAL LOAD** curve: the nominal axial load delivered by the motor with a duty cycle of 100%
- **MAXIMUM AXIAL LOAD** curve: the axial load delivered by the motor with a duty cycle of less than 100%.

With 1:3 gearbox

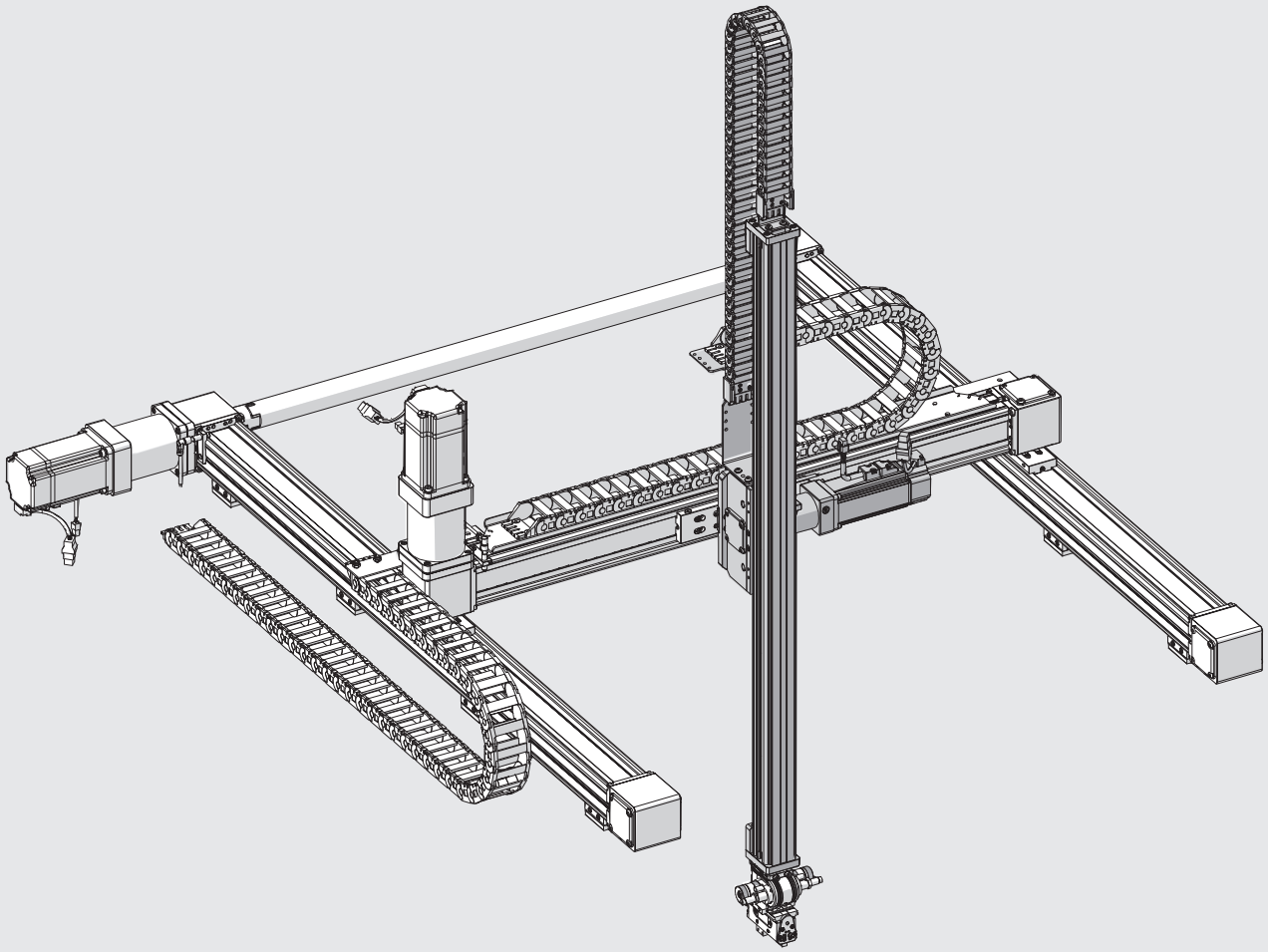


With 1:5 gearbox



* = limit of gearbox continuous operation: higher speeds can be reached only for "duty cycle" ≤60% and for a maximum number of 1000 accelerations per hour.

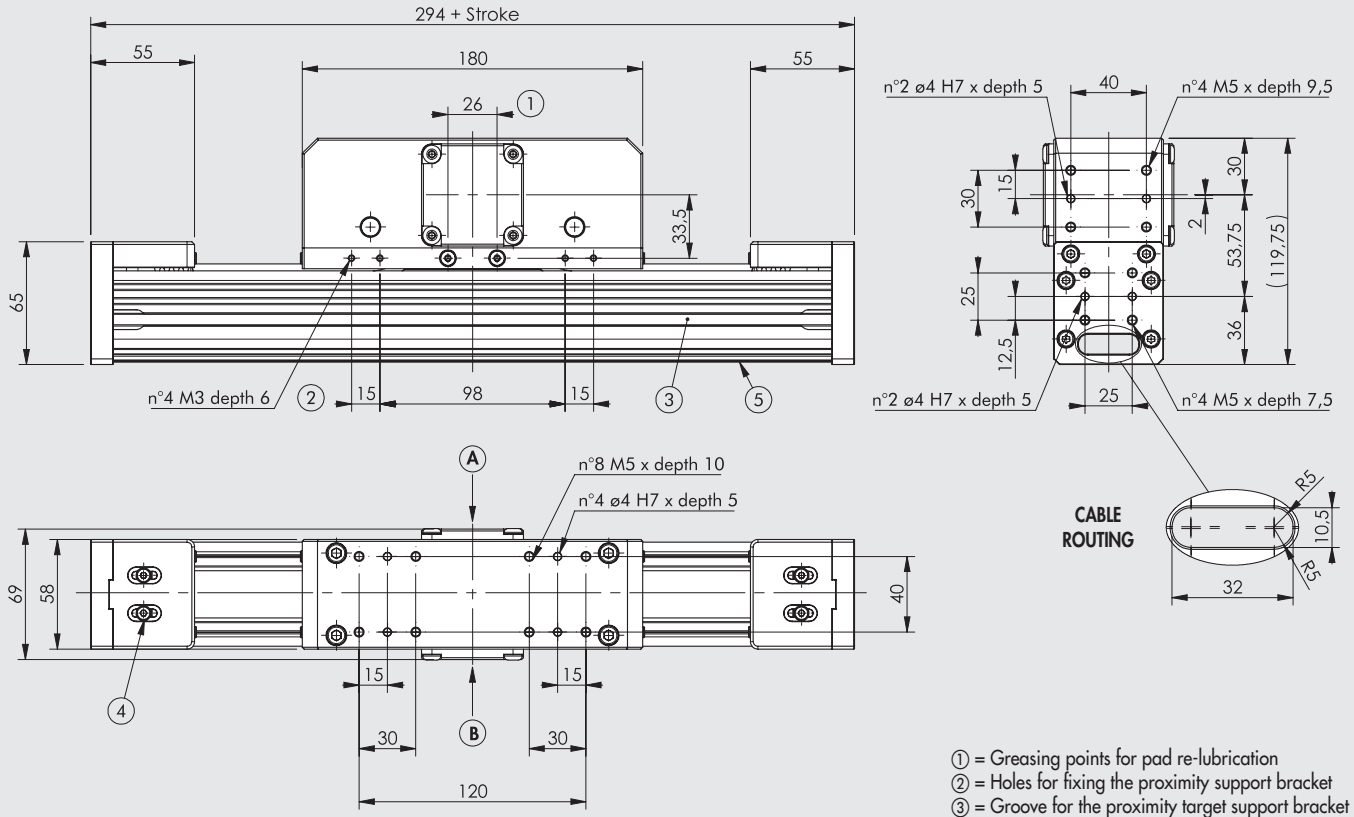
EXAMPLES OF APPLICATION



NOTES

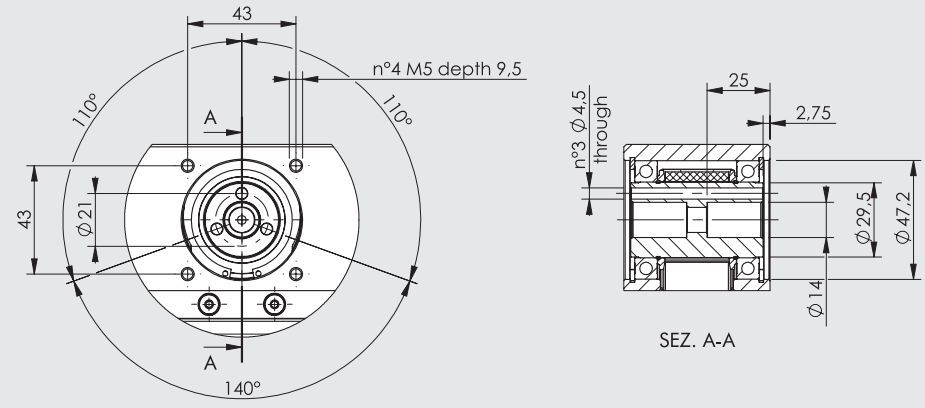
METAL WORK PNEUMATIC

DIMENSIONS VERSION WITHOUT MOTOR

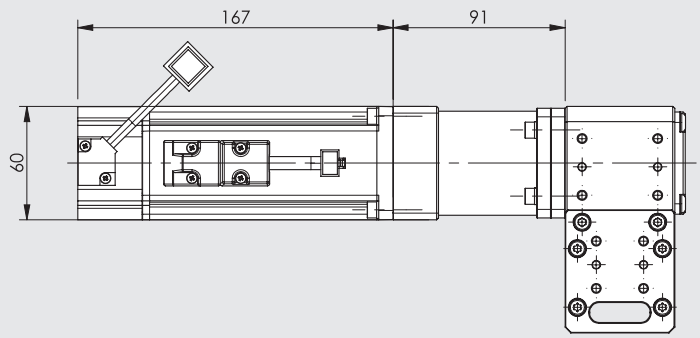


① = Greasing points for pad re-lubrication
② = Holes for fixing the proximity support bracket
③ = Groove for the proximity target support bracket
④ = Belt-tensioning screws
⑤ = Dovetail for "V-Lock" fixing.
For standard dimensions, see **chapter V-Lock adaptors**.

GEARBOX-MOTOR (A) - (B) INTERFACE



DIMENSIONS VERSION WITH MOTOR



N.B.: The indicated dimensions are valid for both versions with motor installed on the right and on the left.

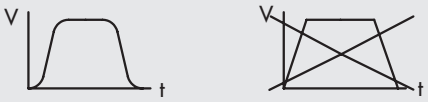
ORDERABLE CODES BRUSHLESS MOTOR + BRAKE WITH GEARBOX
Reduction 1:3
374V10_ _ _ _367220
374V10_ _ _ _397220
Reduction 1:5
374V10_ _ _ _369220
374V10_ _ _ _399220

_ _ _ _ = Enter the stroke in mm to complete the code.
See Key to Codes for an explanation of encoding.

MOTOR-DRIVE COUPLINGS

MOTOR CODES		DRIVES CODES
	Metal Work	37D2300000
	Manufacturer	DELTA ASD-A2-0421-M
Metal Work Manufacturer		(400W)
BRUSHLESS MOTORS WITH BRAKE		
37M4220001	DELTA ECMA-C20604SS (400W)	√

The motor must be controlled in such a way as to avoid sudden changes in speed.



KEY TO CODES AXIS ELECTRIC WITHOUT MOTOR

CYL	37	4	V	1	0	0500	3	T
	TYPE			SIZE	CARRIAGE TYPE	STROKE	GUIDE TYPE	
	37 Electric actuators	**4** Electric axis rodless elektro	**V** VBK	**1** VBK-1	**0** STD	from 110 to 1000 mm	**3** Heavy (steel guide and pads ball-recirculation)	**T** Without motor (plugged outlets)

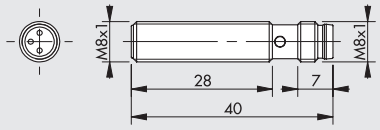
KEY TO CODES AXIS ELECTRIC MOTOR

CYL	37	4	V	1	0	0500	3	6	DRIVE 9	2	2	0
	TYPE			SIZE	CARRIAGE TYPE	STROKE	GUIDE TYPE	MOTOR POSITION	MOTOR ◆	FLANGE	TORQUE	
	37 Electric actuators	**4** Electric axis rodless elektro	**V** VBK	**1** VBK-1	**0** STD	from 110 to 1000 mm	**3** Heavy (steel guide and pads ball-recirculation)	**6** Right **9** Left	**7** Brushless with BRAKE + 1:3 gearbox **9** Brushless with BRAKE + 1:5 gearbox	**2** 60	**2** 1.2÷2.19 Nm	**0** Base

◆ On request available versions with gearbox with reduction ratios other than those eventually foreseen as standard.

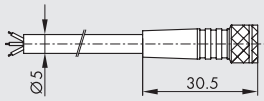
ACCESSORIES

QUICK-FIT INDUCTIVE SENSOR M8



Code	Description
W095K030010	PNP M8 inductive sensor with push-in LED

CABLE WITH STRAIGHT CONNECTOR FOR PUSH-IN INDUCTIVE SENSOR (MOBILE INSTALLATION)

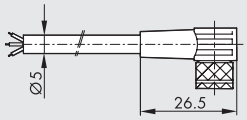


Pin	Cable color
1	Brown
3	Blue
4	Black

Code	Description
02400A0100	M8 female 3 PIN HIGH FLEX CL6 connector with cable L = 1 m
02400A0250	M8 female 3 PIN HIGH FLEX CL6 connector with cable L = 2.5 m
02400A0500	M8 female 3 PIN HIGH FLEX CL6 connector with cable L = 5 m
02400A1000	M8 female 3 PIN HIGH FLEX CL6 connector with cable L = 10 m

Note: Mobile laying cable, class 6 according to IEC 60228

CABLE WITH 90° CONNECTOR FOR PUSH-IN INDUCTIVE SENSOR (MOBILE INSTALLATION)

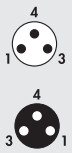


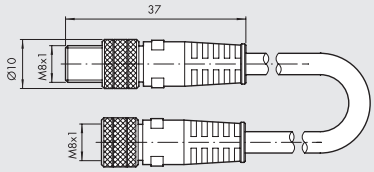
Pin	Cable color
1	Brown
3	Blue
4	Black

Code	Description
02400B0100	M8 female 3 PIN 90° HIGH FLEX CL6 connector with cable L = 1 m
02400B0250	M8 female 3 PIN 90° HIGH FLEX CL6 connector with cable L = 2.5 m
02400B0500	M8 female 3 PIN 90° HIGH FLEX CL6 connector with cable L = 5 m
02400B1000	M8 female 3 PIN 90° HIGH FLEX CL6 connector with cable L = 10 m

Note: Mobile laying cable, class 6 according to IEC 60228

M8 M – M8 F CONNECTOR FOR PUSH-IN INDUCTIVE SENSOR (MOBILE INSTALLATION)

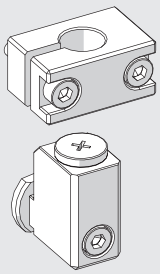




Code	Description
0240009009	M8-M8 3-pin straight connector with cable L = 3 m

Note: Can be used for direct connection to the modules with digital INPUT of the EB 80 and CM valves

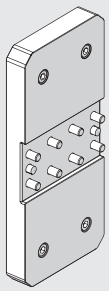
BRACKET FOR INDUCTIVE SENSOR

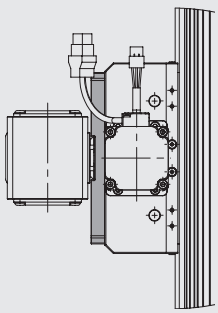


Code	Description
095BK1V001	Bracket for inductive sensor Ø8 VBK-1

Note: supplied complete with 1 sensor support, 1 support with target assembly screws and insert

FRONT FIXING BRACKET VBK-1 ON BK

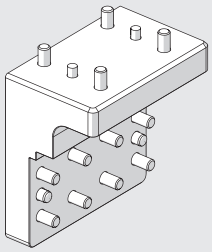


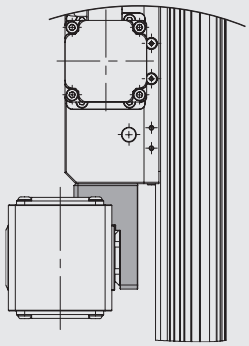


Code	Description	Weight [g]
095BK1V002	Front fixing bracket VBK-1 on BK	420

Note: supplied complete with n. 1 bracket, screws and pins for mounting

LATERAL FIXING BRACKET VBK-1 ON BK

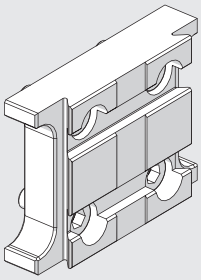


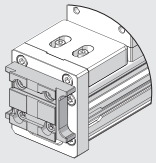


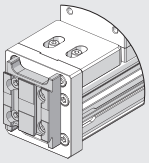
Code	Description	Weight [g]
095BK1V003	Lateral fixing bracket VBK-1 on BK	384

Note: supplied complete with n. 1 bracket, screws and pins for mounting

V-LOCK INTERFACE



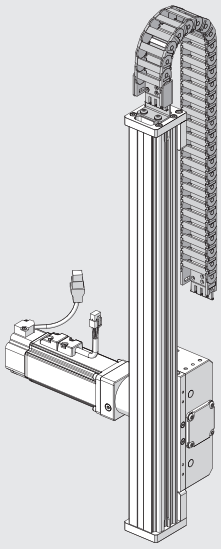


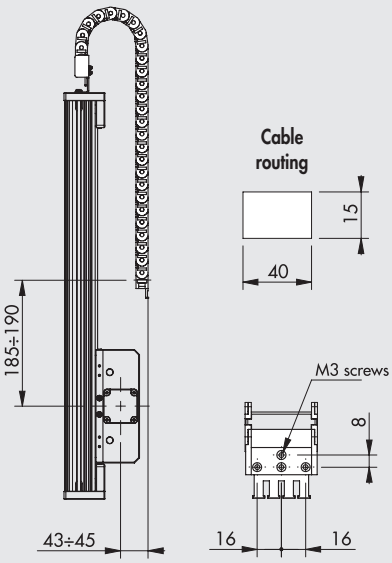


Code	Description	Weight [g]
095BK1V004	V-Lock interface VBK-1	65

Note: supplied complete with n. 1 V-Lock bracket, screws and pins for mounting
N.B. Can be mounted axially or at right angles

CABLE TRAY CHAIN





Code	Description
095BK1VC_ _ _ _	Cable tray chain kit for VBK-1

Note: Supplied complete with 1 bracket, 1 cable chain, screws and nuts for mounting

_ _ _ _ = to complete coding, enter the number of links, stroke function.

Use the following formula to identify the number of links required:

$$\textbf{no. of links} = \textbf{whole . top}\ \frac{(10 + \underline{\text{stroke}} - 5)}{20}$$ (stroke is expressed in mm)

Example: stroke 350 mm → no. of links = 28 → ordering code 095BK1VC0028

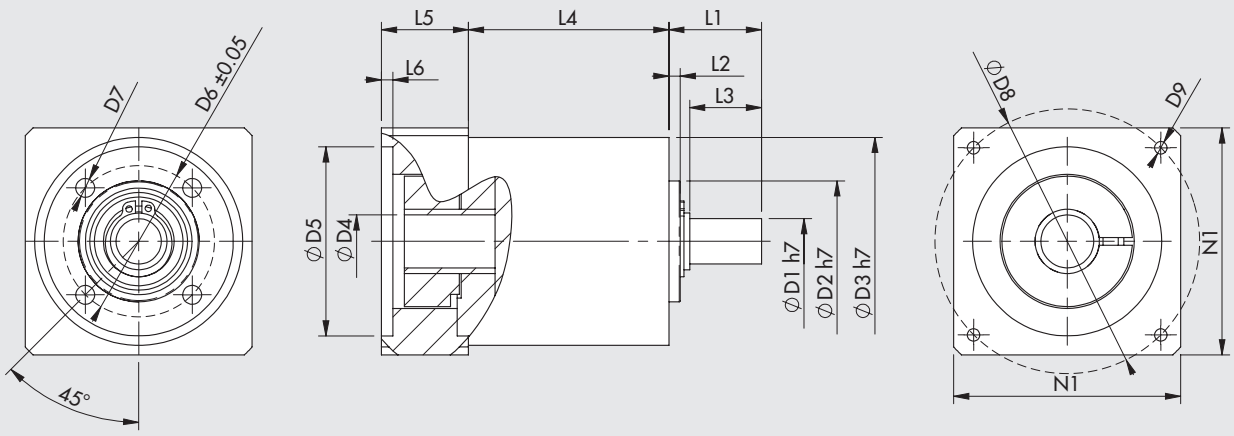
DRIVES

PFor motor-drive couplings see table on page **A5**.112

METAL WORK PNEUMATIC

SPARE PARTS

GEARBOXES



Code	Description	C_{OUT} nominal [Nm]	N_{IN} nominal [1/min]	J reduced to motor shaft [kgmm²]	Mass [kg]	D1	D2	D3	D4	D5	D6	D7	D8	D9	L1	L2	L3	L4	L5	L6	N1
37R0341000	Gearbox MP053 1:3	12	3300	8	0.8	12	32	55	14	50	40	M5	70	M4x10	24.5	3	19	53	23	3	60
37R0541000	Gearbox MP053 1:5	15	3500	6	0.8	12	32	55	14	50	40	M5	70	M4x10	24.5	3	19	53	23	3	60

C_{OUT} = rated output torque N_{IN} = nominal input speed J = mass moment of inertia of the gearhead

ELECTRIC MOTORS

For motor-drive couplings see table on page **A5**.112

NOTES