Installation Instructions

INOZet®

Pendulum Bridges

Original instructions in German!
Keep for future use!

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Edition: D

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1 Safety

1.1 Warranty and Liability

As a basic principle our »General conditions of sales and supply« do apply. These are made available to the user latest with the conclusion of the contract.

⚠ CAUTION ***Without the permission of the manufacturer it is not allowed to do modifications, mountings or conversions to the INOZet® pendulum bridges. All conversion measures require a written confirmation from the manufacturer.***

⚠ CAUTION ***Only use original spare- and expendable parts. It is not guaranteed that externally procured parts meet the required tolerance and safety standards.***

NOTICE ***The manufacturer only provides a full guarantee for the spare parts ordered from him.***

1.2 Designated Use

The INOZet® pendulum bridges are solely to be used for the clamping of components for mechanical machining in turning machines (also refer to chapter „6“ Technical Data).

Any other use is considered improper. The manufacturer is not liable for damages resulting from improper use.

Designated use also includes the adherence to all instructions contained in this documentation.

1.3 Obligations

The user commits himself to

- only allow trained expert staff (specialised in metal) or CNC lathe operators to work with the INOZet® pendulum bridges. They have to be familiar with the functioning of the pendulum bridges themselves as well as the functioning of the machine tool and its safety- and emergency systems and they need to know how to handle them reliably.
- adhere to the basic regulations concerning work safety and accident prevention.

⚠ DANGER ***The user is ultimately responsible for the saftey. This responsibility cannot be delegated.***

2 Technical Description

2.1 General information

The INOZet® pendulum bridges are solely designated for clamping of components for mechanical machining in turning machines (also see chapter „6“ Technical Data).

Clamping is concentrical and the bridges can be used both as compensating oscillating and as locked 6-point clamping.

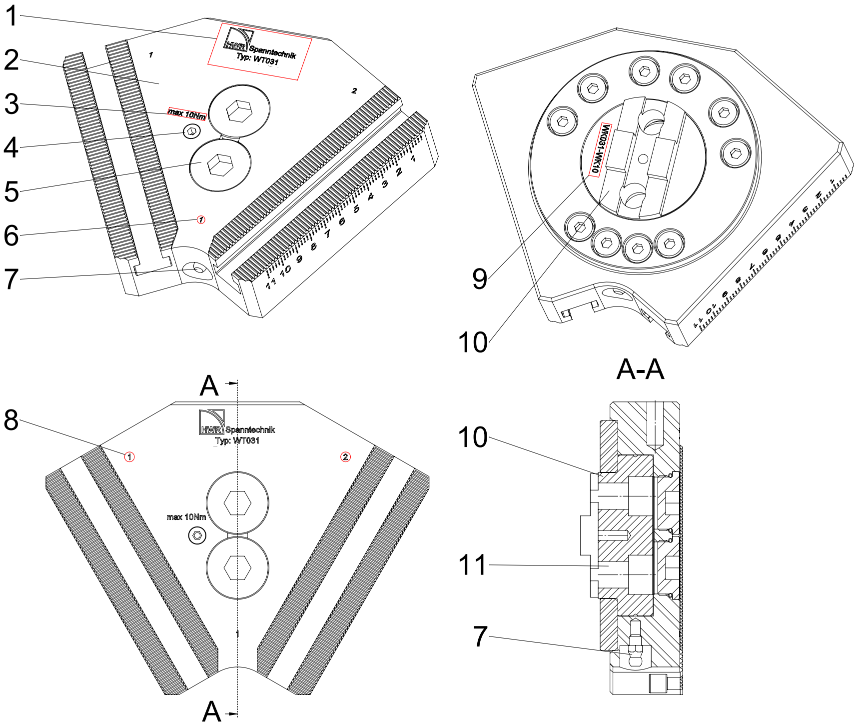
Oscillating bridges are particularly suitable for clamping of deformation sensitive parts (e.g. raw parts) and locked bridges are suitable for further processing of the workpiece with cut soft jaws.

The pendulum bridges can be installed on the base jaws of any current chuck.

⚠ CAUTION ***the INOZet®-clamping system must only be used with clamping jaws of HWR Spanntechnik GmbH (see. chapter „6“ Technical Data).***

2.2 Overview of the INOZet® pendulum bridges

2.2.1 Set-up



1 Manufacturer type

2 Pendulum element

3 Max. tightening torquet locking bolt

4 Locking bolt

5 Screw plugs

6 Allocation for base jaw

7 Grease nipple

8 Allocation for clamping jaw

9 Designation swivel bearing

10 Swivel bearing

11 Through holes for fastening screws

Fig. 2-1: Set-up of the INOZet® pendulum bridges

INOZet® pendulum bridges are available with “serration” (metric and imperial) and "slot and tenon".

2.2.2 Functional Description

INOZet® pendulum bridges get installed on the base jaws of the chuck. Clamping of the workpiece is effected by 6 clamping jaws which are fastened on the pendulum bridges by T-nuts.
Due to the doubling of the clamping points the clamping pressure is introduced into the workpiece more evenly and thus reduces the chance of deformation.

⚠ CAUTION ***Adhere to the max. speed of the INOZet® pendulum bridges and of the chuck of the machine tool. Additionally do make sure to adhere to the max. clamping force of the chuck as a function of the clamping set-up. Guideline for the calculation is directive VDI 3106.***

1. Operation – oscillating, compensating 6-point clamping

- Turning of the locking bolt (1, Fig. 2-2) **anti-clockwise**
- Pendulum bridge oscillates
- Clamping of the workpiece with gripper jaws

2. Operation - locked 6-point clamping

- Turning of the locking bolt(s) (1, Fig. 2-2) **clockwise**

NOTICE ***Adhere to the fastening torque for locking bolts (see Table 6-2).***

- Pendulum bridge is locked
- Clamping of the workpiece with cut soft jaws

⚠ CAUTION ***To ensure correct functioning – oscillating or locked – the locking bolt has to be turned fully.***

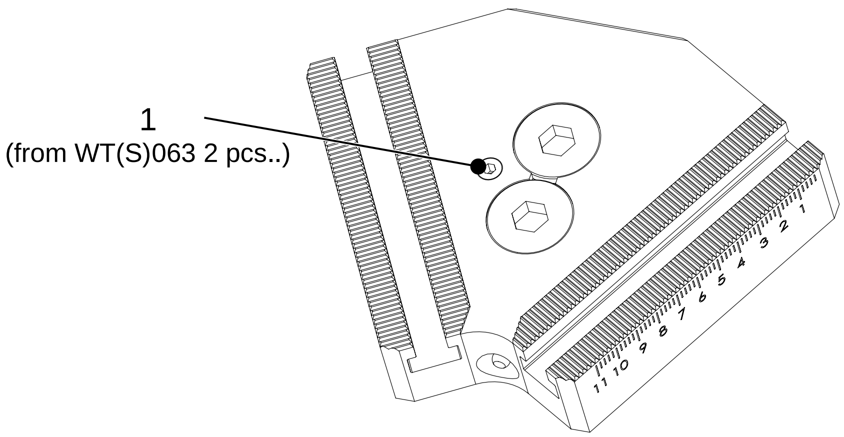


Fig. 2-2: Functioning of the INOZet® pendulum bridges

3 INSTALLATION

⚠ CAUTION ***The installation of the INOZet® pendulum bridges may only be carried out by trained and qualified staff who is also trained and qualified in the use of the machine tool.***

3.1 CLAMPING SYSTEM TRANSPORT WITH EYEBOLTS

Depending on the size and weight of the INOZet®- clamping system the pendulum bridges have to be installed on the chuck by using appropriate hoisting gear.

NOTICE ***The eyebolt is marked with the permitted payload.***

Step 1 Prior to transport fasten the eyebolt to the bridge segment.

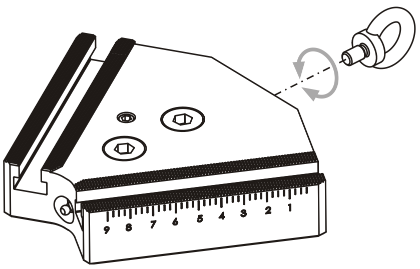


Fig. 3-1: Transport with eyebolt

Step 2 Attach appropriate hoisting gear and do the transport by adhering to the relevant safety measures.

⚠ CAUTION ***Do not remove hoisting gear and eyebolt before safe installation of the pendulum bridges on the machine tool.***

3.2 INSTALLATION ON THE CHUCK

Step 1 Prior to the installation on the chuck do a visual check for the faultless condition of pendulum bridges.

Step 2 Clean the reference area of the chuck of the machine tool and the reference area of the INOZet® pendulum bridges. There may not be any dirt or chippings in these areas. Make sure that all bore holes are clean and deburred.

Step 3 Loosen and remove the plug screws (1, Fig. 3-2) and take the first clean pendulum bridge carefully and slowly to the chuck of the machine tool, if need be use some hoisting gear.

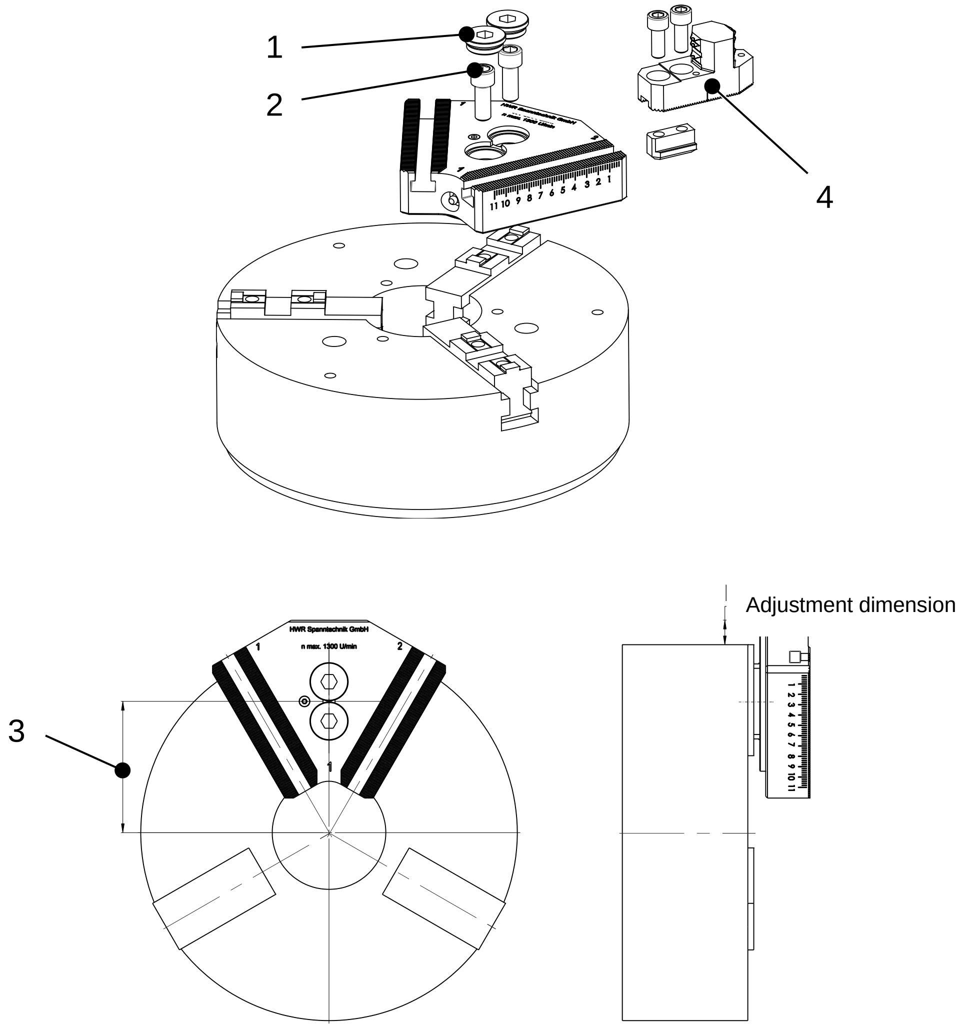


Fig. 3-2: Installation of the INOZet® pendulum bridges (example slot and tenon)

NOTICE ***Adhere to the adjustment dimensions and notes on the specific instruction sheet.***

Step 4 For finding the ideal clamping position (3, Fig. 3-2) adhere to the chuck specific „instructions for INOZet®“ (separate sheet included in the shipment).
Usually the clamping position of the pendulum bridges will be found at half the travel of the base jaw. Deviations may be possible due to the serration for example.

NOTICE ***Exceptions are quick release systems and scrolls where base jaws can be removed.***

Step 5 Turn in the fastening bolts (2, Fig. 3-2) – property class 12.9, and tighten them alternately. The bolts are part of the shipment.

NOTICE ***Adhere to the bolting torque for fastening bolts (see Table 6-1).***

Step 6 Put back in the plug screws for protection against dirt.

Step 7 Install the remaining two pendulum bridges in the same way. If need be remove the hoisting gear and the eyebolt.

⚠ CAUTION ***Make sure that the distance of all pendulum bridges to the centre of the chuck is identical.***
Pay attention to sufficient screw-in depth (min. 1.25 x thread diameter).

Step 8 Install the clamping jaws (4, Fig. 3-2) on the pendulum bridges by using the T-nuts. Utilise the scale of the pendulum bridges and the marking on the clamping jaws as an adjustment aid.

NOTICE ***Adhere to the appropriate Installation Instructions of HWR Spanntechnik GmbH when installing the clamping jaws.***
Adhere to the maximum fastening torques for fastening bolts (see table 6-1).

The disassembly is to be effected in reverse order. in reverse order of steps 1-8.

3.3 Function Test

The functioning of the pendulum bridges has to be tested after the installation and before the initial operation:

- locked or
- oscillating (neutral position / spring reset),
  i.e. the pendulum bridges can be turned to the right and to the left and return to the neutral position independently

4 APPLICATION

4.1 CLAMPING OF THE WORKPIECE

For clamping and releasing of the workpiece adhere to the correspondent chapter in the associated installationn instructions of HWR Spanntechnik GmbH.

Make sure to use the correct clamping jaws:

Machining

⚠ CAUTION ***For every chucking a calculation of the required clamping force in accordance with VDI 3106 has to be carried out***

Heavy workpieces are not to be put directly on the jaws or pendulum bridges as the weight may affect the pivot function.

⚠ CAUTION ***Soft jaws may only be cut in the locked position of the INOZet® clamping system.***

For further machining of the workpiece in cut soft jaws the pendulum bridges have to remain locked in order to ensure concentric clamping.

⚠ DANGER ***The clamping diameter may not exceed the chuck diameter!***

4.2 MAXIMUM SPEED

The determination of the maximum speed has to be carried out in accordance with VDI 3106, see Chap. 6.6.

4.3 ROUTINE JOBS DURING OPERATION

- Carry out a regular visual check for dirt. If necessary the operation has to be stopped for cleaning of the pendulum bridges and the machine tool (see chapter 5 „Maintenance”).
- Additionally adhere to the operating manual of the machine tool.

⚠ CAUTION ***Irregular lubrication / maintenance of the chuck leads to loss of clamping force (30-40%) and can therefore lead to failure of the clamping set-up.***

5 Maintenance

In order to guarantee failure-free operation the INOZet® pendulum bridges and the machine tool have to undergo regular service and maintenance.

Switch off the machine tool prior to the service and maintenance operation and secure the machine from restarting (see operating manual of the machine tool).

CAUTION ***Repair and replacement work of the INOZet® pendulum bridges may only be carried out by trained and instructed staff that has also been trained and instructed in the operation of the machine tool.***

5.1 Service plan

Before each use:	Visual check of condition and function
During operation:	Regular visual check for dirt and condition
After each use:	Manual cleaning
Every 100 operating hours:	Greasing of the nipples (2-3 strokes) with lubricating grease EP-01 (available at HWR Spanntechnik GmbH)
After a long standstill and hardening of the lubricating grease:	Cleaning and re-lubricating

Tabelle 5-1: Service work

5.1.1 Lubricants

Only use grease EP-01 from HWR-Spanntechnik GmbH.

5.2 Disassembly / cleaning / assembly of the pendulum bridges

Clean all components of the pendulum bridges after removal of the fastening bolts (1, fig. 7-1), the retainer ring (12, fig. 7-1) and removal of the pivot bearing (2, fig. 7-1). If need be use cold cleaner.

NOTICE ***After removal of the retainer ring (12, fig. 7-1) and removal of the pivot bearing (2, fig. 7-1) the pressure spring (10, fig. 7-1, from size WT(S)080 amount 2) has to be compressed with a device (e.g. bar clamp) for fitting it back into the bearing.***

Check all components. Defective parts have to be replaced. In case of doubt contact the manufacturer.

5.3 Disposal

Have a trained person disassemble the pendulum bridges appropriately and strip them down into their components.

Handle and dispose used substances and materials, especially lubricants and solvents appropriately and in accordance with the national directives.

6 TECHNICAL DATA

6.1 MAXIMUM FASTENING TORQUE FOR BOLTS

Strength class	Norm	Thread								
		M5	M6	M8	M10	M12	M14	M16*	M20	M24
		max. fastening torque [Nm]								
12.9	ISO 4762 (DIN 912)	10	16	30	50	70	105	150	200	350
10.9	ISO 4762 (DIN 912)	10	15	27	43	63	86	120	184	250

Table 6-1: Maximum fastening torque for bolts

*) Exceptions are the fastening torques of the M16 bolts of the following INOZet® pendulum bridges: WT(S)025 und WT(S)031, 120 Nm fastening torque.

⚠ CAUTION ***Higher fastening torques may block the pendulum mechanism.***

6.2 FASTENING TORQUE FOR FIXING BOLTS

3-jaw sets	WT(S)021 - WT(S)031	WT(S)038 - WT(S)045	WT(S)050 - WT(S)125
4-jaw sets	WT(S)025-4 – WT(S)050-4	WT(S)063-4	WT(S)070-4 – WT(S)125-4
Fastenig torque [Nm]	10	15	20

Table 6-2: Fastenig torque for fixing bolts

6.3 OVERVIEW OF INOZET® PENDULUM BRIDGES

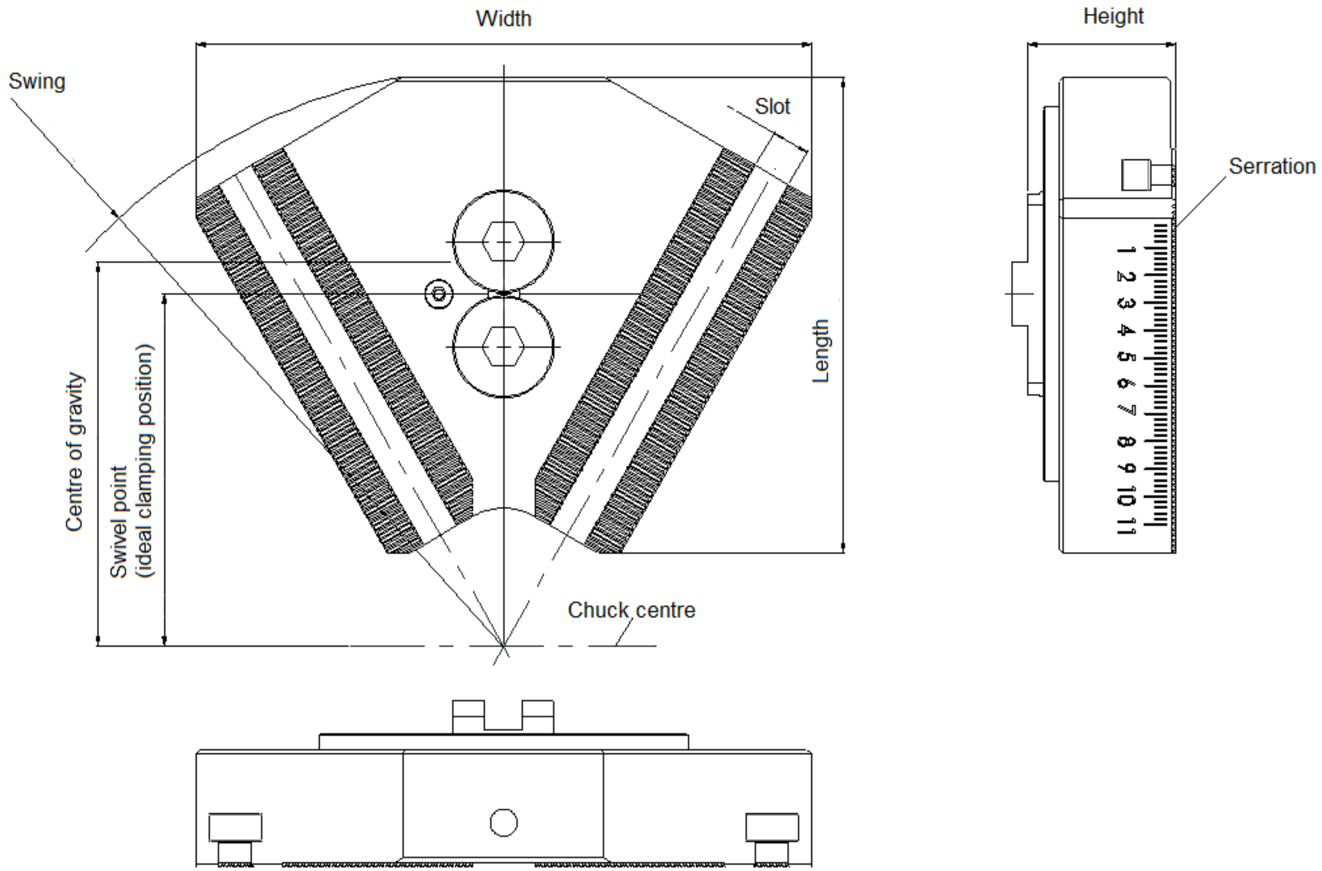


Fig. 6-1:Overview for the technical data of the INOZet® pendulum bridges

6.4 TECHNICAL DATA INOZET® PENDULUM BRIDGES

INOZet® type	Max. clamping force [kN]	Width [mm]	Height ca. (varying by connection) [mm]	Length [mm]	Serration [mm]	Slot [mm]	Schwin without jaws [mm]	Clamping range, internal [mm]	Clamping range, external [mm]	Gripper jaw	Soft jaw	T-nut
WT(S) 021-…	85	123	37,5	95	2 x 60°	10	228	78-210	50-210	WU10	WI10	GP05
WT(S) 022-…	85	140	37,5	105	2 x 60°	10	270	78-225	50-225	WU10	WI10	GP05
WT(S) 025-…	190	170	40	128	2 x 60°	12	320	95-250	60-250	WU12	WI12	GP07
WT(S) 031-…	200	195	47	149	2 x 60°	12	380	100-315	65-315	WU12	WI12	GP07
außer:												
WT(S) 031-21-…	200	200	47	162	2 x 60°	12	405	139-315	65-315	WU12	WI12	GP07
WT(S) 038-…	250	239	56	182	3,5 x 60°	16	475	112-380	70-380	WU16	WI16	GP11
WT(S) 040-…	250	249	59	194	3,5 x 60°	16	490	112-400	70-400	WU16	WI16	GP11
außer:												
WT(S) 040-20-…	250	270	59	202	3,5 x 60°	16	510	112-400	70-400	WU16	WI16	GP11
WT(S) 045-…	250	270	59	202	3,5 x 60°	16	510	112-450	80-450	WU16	WI16	GP11
WT(S) 050-…	300	302	68	223	3,5 x 60°	21	580	130-500	85-500	WR21	WP21	GP13
WT(S) 053-…	300	318	71	225	3,5 x 60°	21	595	145-530	100-530	WR21	WP21	GP13
WT(S) 063-…	360	373	74	249	3,5 x 60°	21	700	215-630	170-630	WR21	WP21	GP13
WT(S) 080-…	360	458	77	288	3,5 x 60°	25	880	304-800	250-800	WR25	WP25	GP21
WT(S) 100-…	400	558	82	286	3,5 x 60°	25	1055	524-1000	470-1000	WR25	WP25	GP21
WT(S) 125-…	400	695	82	287	3,5 x 60°	25	1300	754-1250	700-1250	WR25	WP25	GP21

Table 6-3: Technical data der INOZet® pendulum bridges

6.5 TECHNICAL DATA OF INOZET® PENDULUM BRIDGES FOR INOFLEX® CHUCKS

INOZet® type	Max. clamping force [kN]	Width [mm]	Height ca. (varying by connection) [mm]	Length [mm]	Serration [mm]	Slot [mm]	Schwing without jaws [mm]	Clamping range,internal [mm]	Clamping range, external [mm]	Gripper jaw	Soft jaw	T-nut
WT(S)025-4-…	130	120	44	95	2x60°	10	262	93-260	63-260	WU10-8	WI10-8	GP05
WT(S)031-4-…	180	154	51	123	2x60°	12	336	119-315	82-315	WU12-8	WI12-8	GP07
WT(S)040-4-…	220	196	50	161	3,5x60°	16	440	134-400	90-400	WR16-8	WP16-8	GP11
WT(S)050-4-…	230	230	56	178	3,5x60°	16	540	159-500	115-500	WR16-8	WP16-8	GP11
WT(S)063-4-…	230	280	61	205	3,5x60°	16	670	226-630	182-630	WR16-8	WP16-8	GP11
WT(S)070-4-…	125	314	68	234	3,5x60°	16	745	294-700	250-700	WR16-8	WP16-8	GP11
WT(S)080-21-4-...	125	338	72	268	3,5x60°	16	830	297-800	250-800	WR16-8	WP16-8	GP11
WT(S)080-4-…	230	345	74	268	3,5x60°	21	830	297-800	250-800	WR21-8	WP21-8	GP13
WT(S)081-4-…	125	338	72	268	3,5x60°	16	830	344-800	260-800	WR16-8	WP16-8	GP11
WT(S)100-4-…	180	442	80	270	3,5x60°	21	1055	526-1000	470-1000	WR25-8	WP25-8	GP21
WT(S)120-4-…	180	500	80	281	3,5x60°	25	1200	526-1150	470-1150	WR25-8	WP25-8	GP21

Table 6-4: Technical data of INOZet® pendulum bridges for INOFlex® chucks

6.6 CALUCLATION OF CLAMPING FORCE AND SPEED

Missing information or data can be requested from the manufacturer

6.6.1 USED SYMBOLS AND ABBREVIATIONS

Character Symbol	Unit	Explanation	Charac-ter Symbol	Unit	Explanation
Anz_{InoZet}	-	Number of INOZet®-pendulum bridges	m_B	kg	Mass of the clamping jaw
Anz_{AB}	-	Number of INOZet®-top jawsn	m_{AB}	kg	Mass of the top jaw
d_{Sp}	m	Clamping diameterr	m_{InoZet}	kg	Mass of the top jaw
F_{Fl}	N	Centrifugal force	m_N	kg	Mass of the T-nut
F_{Sp}	N	Effective clamping force	n	min^{-1}	Speed
$F_{Sp\,min}$	N	Required minimum clamping force	n_{max}	min^{-1}	Maximum allowed speed engraved on the chuck
F_{Sp0}	N	Initial clamping force (at stand-still)	n_{Zul}	min^{-1}	Allowed speed
F_{SpZ}	N	Cutting force	r_s	m	Center of gravity radius
K_1	-	Correction factor INOZet® clamping jaws 0,9239 (3 jaw chuck) 0,8660 (4 jaw chuckr)	r_{sAB}	m	Center of gravity radius of top jaw
M_C	kgm	Centrifugal moment	r_{InoZet}	m	Center of gravity radius of INOZet® pendulum bridge
$M_{C_{AB}}$	kgm	Centrifugal moment of the top jaw of the chuck	S_{Sp}	-	Safety factor clamping force
$M_{C_{GB}}$	kgm	Centrifugal moment of the base jaw of the chuck	S_Z	-	Safety factor machining
$M_{C_{InoZet}}$	kgm	Total centrifugal moment of the INOZet®-pendulum bridge	y_{AB}	m	Distance between the cen-tre of gravity of the INOZet® top jaw and the clamping surface
$M_{C_{Sp}}$	kgm	Centrifugal moment of the INO-Zet®-top jaws	$\sum S$	kN	Maximum clamping force, engraved on the chuck

Table 6-5: Used symbols, units and abbreviations

6.6.2 CALCULATION OF THE REQUIRED CLAMPING FORCE AT A GIVEN SPEED

The initial clamping force F_{Sp0} is the sum of all clamping jaw forces that act radially on the workpiece by actuating the clamping chuck at standstill. All clamping jaws generate a total centrifugal force F_{Fl} under speed influence. The total centrifugal force has an influence on the effective clamping force F_{Sp}. In case of external clamping the centrifugal force reduces the effective claming force and in case of internal clamping it increases the same.

$$F_{Sp} = F_{Sp0} \mp F_{Fl} \quad (1)$$

$(-)$ **External clamping**, clamping from outside to inside

$(+)$ **Internal clamping**, clamping from inside to outside

⚠ DANGER

In case of external clampig the effective clamping force decreases with increasing speed by the amount of centrifugal force. These forces act contrary to each other. If the required minimum clamping force $F_{Sp\min}$ is not reached the workpiece is released uncontrolled. The calculated speed must not be exceeded and the required minimum clamping force must not be undercut.

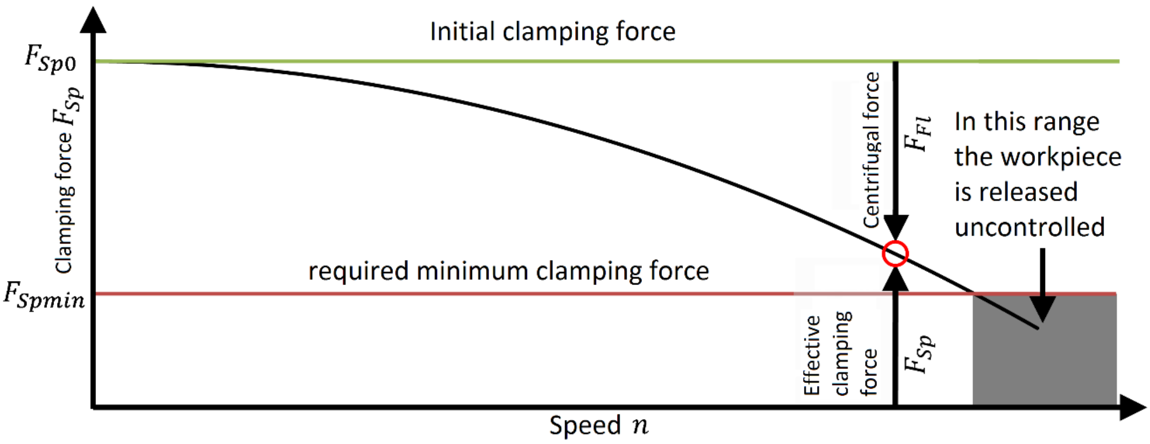


Fig. 6-2: Decrease of the clamping force with the speed in case of external clamping

The effective clamping force F_{Sp} required for the machining process is the product of the cutting force F_{SpZ} and the safety factor S_Z. The safety factor takes into account uncertainties of the calculated cutting force. According to VDI 3106 $S_Z \geq 1{,}5$ applies, this factor depends on the accuracy of the influencing parameters, such as the loads, tension coefficients and other influencing parameters.

$$F_{Sp} = S_Z \cdot F_{SpZ} \quad (2)$$

According to VDI 3106 a safety factor $S_{Sp} \geq 1{,}5$ has to be taken into account for the static initial clamping force F_{Sp0}.

$$F_{Sp0} \geq S_{Sp} \cdot \left(S_Z \cdot F_{SpZ} \pm F_{Fl} \right) \quad (3)$$

$(+)$ **External clamping**, clamping from outside to inside

$(-)$ **Internal clamping**, clamping from inside to outside

⚠ DANGER ***The calculated initial clamping force F_{Sp0} must not exceed the clamping force engraved on the chuck $\sum S$.***

NOTICE ***The maximum clamping force can also be found in the technical data in the operating manual of the chuck.***

The total centrifugal force F_{Fl} depends on the total mass of all jaws, the centre of gravity radius of the jaws and the speed.

⚠ DANGER ***According to DIN EN 1550, for safety reasons, the total centrifugal force F_{Fl} must not exceed a maximum of 67% of the initial clamping force F_{Sp0}.***

The total centrifugal force F_{Fl} is calculated with the following formula 4:

$$F_{Fl} = \sum \left(m_{AB} \cdot r_{AB} \right) \cdot \left(\frac{\pi}{30} \cdot n \right)^2 = \sum M_c \cdot \left(\frac{\pi}{30} \cdot n \right)^2 \quad (4)$$

In Formula 4, the given speed n will be used in min^{-1}. Centrifugal moment M_C is the product of the mass of the clamping jaw m_B and the center of gravity radius r_s.

$$M_c = m_B \cdot r_s \quad (5)$$

For chucks with split jaws, consisting of a base jaw and a top jaw, in which the top jaw must be offset to change the clamping range and the base jaw approximately retains its radial position, the centrifugal moments of the base jaw $M_{C_{GB}}$ and the top jaw $M_{C_{AB}}$ are added together.

$$M_c = M_{C_{GB}} + M_{C_{AB}} \quad (6)$$

The centrifugal moment of the base jaw $M_{C_{GB}}$ is to be taken from the technical data.

With the INOZet® pendulum bridge, the centrifugal moment of the INOZet® pendulum bridge $M_{C_{InoZet}}$ and the INOZet® clamping jaws $M_{C_{Sp}}$ are added together.

$$M_c = M_{C_{GB}} + M_{C_{InoZet}} + M_{C_{Sp}} \quad (7)$$

The total centrifugal moment $M_{C_{InoZet}}$ of the INOZet®-pendulum bridge is calculated as follows:

$$M_{C_{InoZet}} = (m_{InoZet} + m_N) \cdot r_{InoZet} \cdot Anz_{InoZet} \quad (8)$$

The mass m_{InoZet} and the centre of gravity radius r_{InoZet} of the INOZet®-pendulum bridge is to be taken from the technical data.

Especially when calculating the top jaws of the INOZet® pendulum, a correction factor K_1 is required because the jaws are at an angle to the base jaw.

$$M_{C_{Sp}} = m_{AB} \cdot \left(\frac{d_{Sp}}{2} + y_{AB} \right) \cdot K_1 \cdot Anz_{AB} \quad (9)$$

$K_1 = 0,9239$ for a 3 jaw chuck

$K_1 = 0,8660$ for a 4 jaw chuck

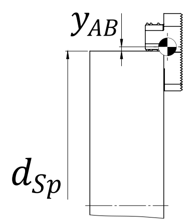


Fig. 6-3: Centre of gravity of the clamping jaws

6.6.3 CALCULATION EXAMPLE: THE REQUIRED CLAMPING FORCE AT A GIVEN SPEED

The following data are known about the machining process

• External clamping (clamping from outside to inside)	(application-specific)
• Machining force $F_{SpZ} = 2800\,N$	(application-specific)
• Maximum Speed $n_{\max} = 2100\ \min^{-1}$	(application-specific)
• Maximum clamping force $\sum S = 210\,kN$	(application-specific)
• Cetrifugal moment $M_{C_{AB}} = 1{,}354\,kgm$	(application-specific)
• Machining speed $n = 600\min^{-1}$	(application-specific)
• Clamping diameter $d_{Sp} = 0{,}42\,m$	(application-specific)
• Weight oft he pendulum bridge $m_{InoZet} = 5{,}8376\,kg$	(application-specific)
• Centre of gravity radius of the pendulum bridge $r_{InoZet} = 0{,}1467\,m$	(application-specific)
• Mass of the mounting T-nut of the pendulum bridge $m_N = 0{,}3860\,kg$	(application-specific)
• Weight of the top jaw $m_{AB} = 0{,}9679\,kg$	(application-specific)
• Distance of the centre of gravity to the clamping surface $y_{AB} = -0{,}0013\,m$	(application-specific)
• Safety factor $S_Z = 1{,}5$	(Acc. to VDI 3106)
• Safety factor $S_{Sp} = 1{,}5$	(Acc. to VDI 3106)
• Correction factor $K_1 = 0{,}8660$ (see page 6-5 or 6-8)	(application-specific)

NOTICE ***The calculation does not take into account the jaw fixing T-nuts and jaw fixing screws.***

In the first step, the necessary effective clamping force F_{Sp} required to absorb the cutting force F_{SpZ} is calculated.

$$F_{Sp} = S_Z \cdot F_{SpZ} = 1{,}5 \cdot 2800\,N$$

$$F_{Sp} = 4200\,N = 4{,}200\,kN$$

Next, centrifugal forces F_{Fl} and individual centrifugal moments must be determined.

First, the centrifugal moment $M_{C_{InoZet}}$ of the INOZet® pendulum bridge is determined.

$$M_{C_{InoZet}} = \left(m_{InoZet} + m_N\right) \cdot r_{InoZet} \cdot Anz_{InoZet} = \left(5{,}838\,kg + 0{,}3860\,kg\right) \cdot 0{,}1467\,m \cdot 4$$

$$M_{C_{InoZet}} = 3{,}652\,kgm$$

The centrifugal moment $M_{C_{Sp}}$ of the clamping jaws on the INOZet®-pendulum bridge is determined as follows:

$$M_{C_{Sp}} = m_{AB} \cdot \left(\frac{d_{Sp}}{2} + y_{AB}\right) \cdot K_1 \cdot Anz_{AB}$$

$$M_{C_{Sp}} = 0{,}9679kg \cdot \left(\frac{0{,}4200m}{2} + (-0{,}0013m)\right) \cdot 0{,}8660 \cdot 8$$

$$M_{C_{Sp}} = 1{,}3995kgm$$

The centrifugal force F_{Fl} is determined by means of the centrifugal moment M_c.

$$F_{Fl} = \sum M_c \cdot \left(\frac{\pi}{30} \cdot n\right)^2 = \left(M_{C_{GB}} + M_{C_{InoZet}} + M_{C_{Sp}}\right) \cdot \left(\frac{\pi}{30} \cdot n\right)^2$$

$$F_{Fl} = (1{,}3540kgm + 3{,}652kgm + 1{,}3995kgm) \cdot \left(\frac{\pi}{30} \cdot 600\,\text{min}^{-1}\right)^2$$

$$F_{Fl} = 6{,}4055kgm \cdot \left(\frac{\pi}{30} \cdot 600\,\text{min}^{-1}\right)^2$$

$$F_{Fl} = 6{,}4055kgm \cdot \left(\frac{\pi}{30} \cdot 600\,\text{min}^{-1}\right)^2$$

$$F_{Fl} = 25288N = 25{,}288kN$$

After all effective forces are known, the initial clamping force F_{Sp0} can now be calculated.

$$F_{Sp0} = S_{Sp} \cdot \left(F_{Sp} + F_{Fl}\right) = 1{,}5 \cdot \left(4200N + 25288N\right)$$

$$F_{Sp0} = 44232N = 44{,}232kN \rightarrow \underline{\underline{F_{Sp0} = 45kN}}$$

6.6.4 CALCULATION OF THE PERMISSIBLE SPEED AT A GIVEN INITIAL CLAMPNG FORCE

The following formula is used to determine the permissible speed:

$$n_{zul} = \frac{30}{\pi} \cdot \sqrt{\left(\frac{F_{Sp0}}{S_{Sp}} - S_Z \cdot F_Z\right) \cdot \frac{1}{\sum M_C}} \qquad (10)$$

DANGER ***For safety reasons, the calculated speed must not exceed the speed engraved on the chuck.***

6.6.5 CALCULATION EXAMPLE: THE PERMISSIBLE SPEED AT A GIVEN INITIAL CLAMPING FORCE

The following data are known about the machining process

- External clamping (clamping from outside to inside) (application-specific)
- Initial clamping force $F_{Sp0} = 60000\,N$ (application-specific)
- Total centrifugal moment $\sum M_C = 6{,}4055\,kgm$ (application-specific)
- Machining force $F_{SpZ} = 2800\,N$ (application-specific)
- Maximum speed $n_{\max} = 2100 \min^{-1}$ (application-specific)
- Safety factor $S_Z = 1{,}5$ (Acc. to VDI 3106)
- Safety factor $S_{Sp} = 1{,}5$ (Acc. to VDI 3106)

NOTICE ***The calculation does not take into account the jaw fixing T-nuts and jaw fixing screws.***

The permissible speed is calculated as follows:

$$n_{zul} = \frac{30}{\pi} \cdot \sqrt{\left(\frac{F_{Sp0}}{S_{Sp}} - S_Z \cdot F_Z\right) \cdot \frac{1}{\sum M_C}}$$

$$n_{zul} = \frac{30}{\pi} \cdot \sqrt{\left(\frac{60000N}{1{,}5} - 1{,}5 \cdot 2800N\right) \cdot \frac{1}{6{,}4055kgm}}$$

$$n_{zul} = 713{,}898 \min \rightarrow \underline{\underline{n_{zul} = 713 \min}}$$

The calculated speed is lower than the maximum allowed speed of the chuck $n_{\max} = 2100 \min^{-1}$ and is therefore permissible.

6.7 TECHNICAL DATA FOR THE CALCULATION

6.7.1 TECHNICAL DATA OF THE INOFLEX® CHUCKS

INOFlex® type	$M_{C_{GB}}$ [kgm]	INOFlex® type	$M_{C_{GB}}$ [kgm]	INOFlex® type	$M_{C_{GB}}$ [kgm]	INOFlex® type	$M_{C_{GB}}$ [kgm]	INOFlex® type	$M_{C_{GB}}$ [kgm]	INOFlex® type	$M_{C_{GB}}$ [kgm]	INOFlex® type	$M_{C_{GB}}$ [kgm]
VD026	0,3384	VM026	0,2741	VK026	0,3472	VK-S 026	0,3392	VT026	0,3556	VT-S 026	0,3210	VL042	0,8822
VD031	0,7044	VM031	0,5413	VK031	0,7528	VK-S 031	0,5158	VT031	0,5504	VT-S 031	0,4866	VL057	1,6768
VD040	1,4888	VM040	1,2766	VK040	1,5992	VK-S 040	1,4119	VT040	1,3540	VT-S 040	1,3193	VL060	2,5447
VD050	3,0260			VK050	3,3904	VK-S 050	2,7899	VT050	2,7046	VT-S 050	2,7289	VL070	3,5139
VD063	4,9568			VK063	5,5796	VK-S 063	4,5675	VT063	4,2923	VT-S 063	4,4448	VL077	4,3590
VD080	8,2100			VK080	8,7400	VK-S 080	7,4460	VT080	6,9755	VT-S 080	7,7847	VL080	4,6807
VD100	12,5364					VK-S 100	11,9538					VL095	11,2289
VD120	17,1088											VL100	11,6287
												VL110	13,8733
												VL120	16,5674

Table 6-6: Technical Data of the INOFlex® chucks

6.7.2 TECHNICAL DATA OF THE INOZET® PENDULUM BRIDGES

INOZet® type	m_{InoZet} [kg]	$r_{InooZet}$ [m]	Anz_{InoZet} [-]	INOZet® type	m_{InoZet} [kg]	$r_{InooZet}$ [m]	Anz_{InoZet} [-]	INOZet® type	m_{InoZet} [kg]	$r_{InooZet}$ [m]	Anz_{InoZet} [-]
WT(S)021-…	1,7478	0,0687	3	WT(S)031-4-…	3,6606	0,1111	4	WT(S)050-…	17,3976	0,1754	3
WT(S)022-…	2,3414	0,0813	3	WT(S)038-…	9,1591	0,1412	3	WT(S)050-4-…	7,7764	0,1832	4
WT(S)025-…	3,4465	0,0961	3	WT(S)040-…	10,2413	0,1467	3	WT(S)053-…	18,5293	0,1848	3
WT(S)025-4-…	1,9200	0,0847	4	WT(S)040-20-…	11,2196	0,1567	3	WT(S)063-…	25,3907	0,2251	3
WT(S)031-…	5,2790	0,1119	3	WT(S)040-4-…	5,8376	0,1467	4	WT(S)063-4-…	13,6131	0,2329	4
WT(S)031-21-…	5,7403	0,1176	3	WT(S)045-…	11,5123	0,1567	3	WT(S)070-4-…	21,2772	0,2560	4

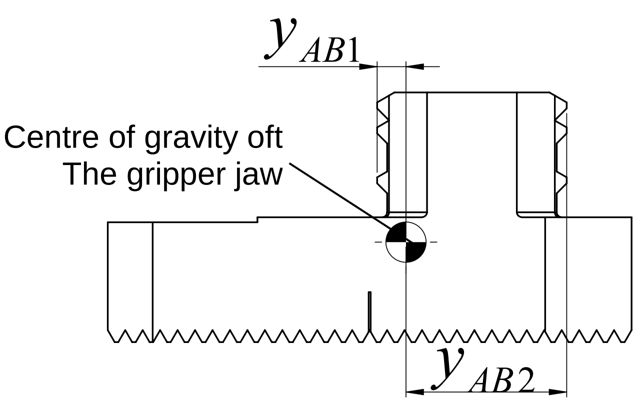
Table 6-7: Technical Data of the INOZet® pendulum bridges

0 Technical Data for INOZet® Pendulum Bridges [continued]

INOZet® type	m_{InoZet} [kg]	$r_{InooZet}$ [m]	Anz_{InoZet} [-]	INOZet® type	m_{InoZet} [kg]	$r_{InooZet}$ [m]	Anz_{InoZet} [-]	INOZet® type	m_{InoZet} [kg]	$r_{InooZet}$ [m]	Anz_{InoZet} [-]
WT(S)080-…	36,9513	0,2950	3	WT(S)081-4-…	26,4230	0,2869	4	WT(S)120-4-…	42,9125	0,4288	4
WT(S)080-21-4-…	26,5901	0,2869	4	WT(S)100-…	48,0280	0,3784	3	WT(S)125-…	62,5171	0,4893	3
WT(S)080-4-…	26,0037	0,2873	4	WT(S)100-4-…	36,4888	0,3862	4				

Table 6-7: Technical data of INOZet® pendulum bridges [continued]

6.7.3 Technical Data for INOZet® Gripper Jaws



INOZet®-gripper jaw type	m_{AB} [kg]	y_{AB1} [m]	y_{AB2} [m]	Anz_{AB} [-]
WU10	0,3312	0,002	0,0261	6
WU10-8	0,3312	0,002	0,0261	8
WU12	0,5798	0,0037	0,0314	6
WU12-8	0,5798	0,0037	0,0314	8
WU16	0,9824	-0,0017	0,0397	6
WR16	0,9679	-0,0013	0,0393	6
WR16-8	0,9679	-0,0013	0,0393	8
WR21	1,8005	-0,0004	0,0442	6
WR21-8	1,8005	-0,0004	0,0442	8
WR25	4,5261	-0,0128	0,0668	6
WR25-8	4,5261	-0,0128	0,0668	8

Table 6-8: Technical Data of INOZet® gripper jaws

6.7.4 TECHNICAL DATA FOR INOZET® SOFT TOP JAWS

INOZet® Top jaw type	m_{AB}	Anz_{AB}	INOZet® Top jaw type	m_{AB}	Anz_{AB}	INOZet® Top jaw type	m_{AB}	Anz_{AB}
	[kg]	[-]		[kg]	[-]		[kg]	[-]
WI10	0,4915	6	WI42	0,5946	6	WP51	1,3488	6
WI10-8	0,4915	8	WI43	0,5624	6	WP52	2,239	6
WI12	0,9897	6	WI50	0,6274	6	WP53	1,9648	6
WI12-8	0,9897	8	WI51	1,3557	6	WP60	1,1824	6
WI16	1,3908	6	WI52	2,2806	6	WP61	2,6556	6
WI21	2,4805	6	WI53	1,9963	6	WP62	3,607	6
WI25	6,7378	6	WP16	1,3666	6	WP63	3,5993	6
WI30	0,2132	6	WP16-8	1,3666	8	WP70	3,2627	6
WI31	0,4804	6	WP21	2,6267	6	WP71	6,6458	6
WI32	0,3074	6	WP21-8	2,6267	8	WP72	9,9187	6
WI33	0,2799	6	WP25	6,9659	6	WP73	9,5597	6
WI40	0,4187	6	WP25-8	6,9659	8			
WI41	0,9551	6	WP50	0,6198	6			

Table 6-9: Technical data of INOZet® soft top jaws

6.7.5 TECHNICAL DATA FOR INOZET® T-NUTS

T-nut type	m_N	T-nut type	m_N	T-nut type	m_N	T-nut type	m_N
	[kg]		[kg]		[kg]		[kg]
GN25	0,3860	GP05	0,0629	TT20	0,2136	WN26	0,1715
		GP07	0,1104	TT60	0,4740	WN30	0,4182
		GP11	0,2151	TT65	0,3790	WN50	0,8988
		GP13	0,4025	TT70	0,1912	WN70	0,2800
		GP21	1,2629			WN75	0,2712

Table 6-10: Technical data of T-nuts

7 SPARE PARTS

When ordering parts please specify the type (e.g. WT(S)031) and the pivot bearing type (e.g. WK031-WK10)

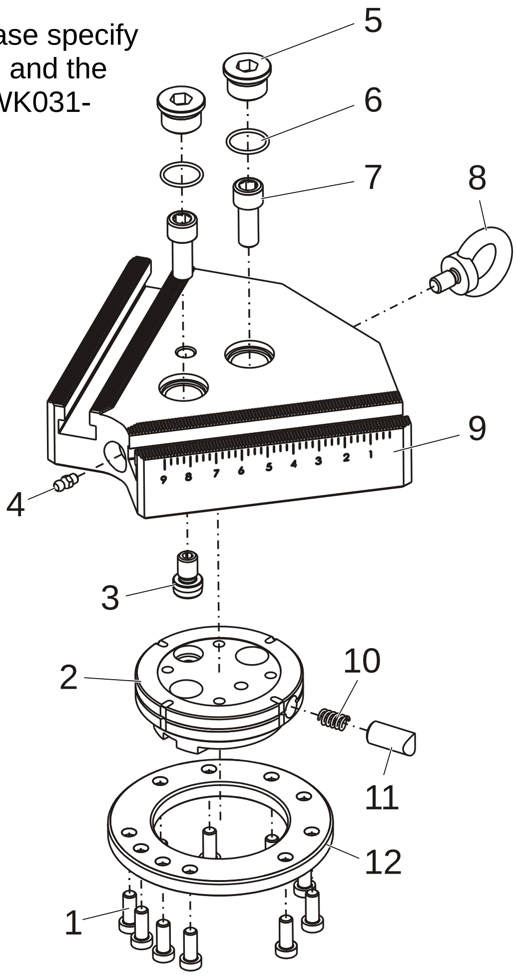


Fig..7-1: Spare Parts

Pos.	Part name	Amount
1	Fastening bolt	Amout varying depending on type / size
2	Pivot bearing	1
3	Fixing bolt	1 (from WT(S)063 amount 2)
4	Grease nipple	1
5	Locking bolt	2
6	O-Ring	2
7	Fastening bolt	2
8	Ring bolt	1
9	Pendulum element	1
10	Pressure spring	1 (from WT(S)063 amount 2)
11	Reset bolt	1 (from WT(S)063 amount 2)
12	Retainer ring	1

Table 7-1: Spare parts list