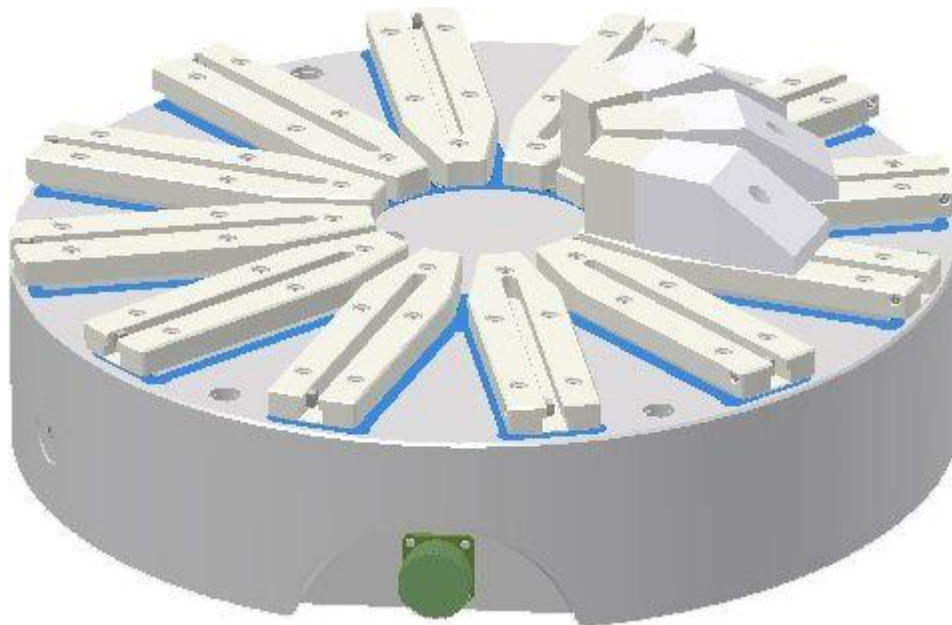


Electro-permanent magnetic chucks for turning

MGT - MTR SERIES

Assembly and operating manual



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Reg. No. 003496 QM08



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Table of contents

1. About this manual	4
1.1 Warnings	4
1.1.1 Signal words	4
1.1.2 Symbols.....	4
2. Basic safety notes	5
2.1 Intended use	5
2.2 Environmental and operating conditions.....	6
2.3 Product safety	6
2.4 Personnel qualification	6
2.5 Using personal protective equipment	7
2.6 Notes on specific risks.....	7
3. Warranty	8
4. Scope of supply	9
5. Technical data	10
5.1 Rating plate	12
6. Description	13
6.1 Description of functioning	13
7. Installation	25
8. Commissioning and normal operation	26
8.1 Commissioning.....	26
8.2 Normal operation.....	27
9. Troubleshooting	30
10. Repairs and maintenance	30
11. Transport and storage	32
11.1 Transport.....	32
11.2 Storage.....	32
12. Disposal	33
12.1 Procedure for final decommissioning and disposal of the product.....	33
13. Spare parts	33
14. Accessories	34
14.1 Pole extensions	34
14.2 Flexible extensions.....	35

1. About this manual

This manual is an integral part of the product and contains important information for safe and proper assembly, commissioning, operation, maintenance and ensures easier troubleshooting.

Before using the product, carefully read the instructions, especially chapter 2 "Basic safety notes".






1.1 Warnings

The following signal words and symbols are used to highlight hazards.

1.1.1 Signal words

DANGER	Dangers for persons. Non-compliance will inevitably cause irreversible injury or death.
WARNING	Dangers for persons. Non-compliance may cause irreversible injury or death.
CAUTION	Dangers for persons. Non-compliance may cause minor injuries.
ATTENTION	Information about avoiding material damage.

1.1.2 Symbols

	Warning about a danger point
	Warning about dangerous electrical voltage
	Magnetic field hazard
	Falling pieces hazard
	General mandatory sign to prevent material damage

2. Basic safety notes

2.1 Intended use

The intended use of the electro-permanent magnetic chucks for turning is to clamp any ferromagnetic material being processed on lathes, work centres etc., making use of magnetic force.

This series of chucks, exploiting the radial pole pitch, is designed for grinding and turning/milling of rings or discs. The homogeneous magnetic force attenuates or prevents deformation of the piece due to the concentrated clamping force.

The ease with which the workpiece is anchored and released also considerably increases the productivity of the machine tools avoiding equipment clamping and changes.

The electro-permanent characteristic of this magnetic chuck also allows it to operated in full safety in case of a sudden power failure. This is because the system only needs to be powered when magnetising and demagnetising the chuck. Therefore during an eventual power failure, the tool machine would stop while the magnetic chuck remains magnetised.

The requirements of the applicable standards must be observed and complied with. The chucks must be used only in the context of their defined application parameters.

To use this unit as intended, it is also essential to observe the technical data and installation and operation notes in this manual and to comply with the maintenance intervals.



ATTENTION

The electro-permanent chucks **must not** be put into service until the machine tool, for which the chucks were provided, meets the requirements of the Machinery Directive 2006/42/EC!!

2.2 Environmental and operating conditions

- Only use the electro-permanent magnetic chucks within their defined application parameters. See "Technical data".
- Make sure that the workplace is clean and the ambient temperature corresponds to the specifications.

2.3 Product safety

Using electro-permanent chucks can be dangerous if:

- the electro-permanent chucks are not used as intended.
- installation and maintenance of the electro-permanent chuck are not carried out properly.
- the safety and installation notes are not observed.

Avoid any working method that may interfere with the function and operational safety of the electro-permanent chucks.



Wear protective equipment.



NOTE

More information is contained in the relative chapters.

2.4 Personnel qualification

Assembly, commissioning, maintenance and repair of the electro-permanent chucks may be performed only by trained specialist personnel. Every person appointed by the operator to work on the electro-permanent chucks must have read and understood the assembly and operating manual in its entirety, especially the chapter "Basic safety notes". This applies particularly to personnel only appointed occasionally, such as maintenance personnel.

	 DANGER
	<p>Hazard due to a magnetic field.</p> <p>Since these are electro-permanent chucks of magnetic systems, the following categories of people are strictly prohibited from coming into contact with them:</p> <ul style="list-style-type: none">• People with pacemakers.• People with metal or electronic prostheses.• People using insulin pumps.• People with muscle stimulation systems.• Pregnant women <p>These persons must always keep a safe distance of at least 2 m from the magnetic system.</p>

	 DANGER
	<p>Electric shock hazard. The electro-permanent chucks are electrically powered systems, often in contact with emulsified water or different types of liquids. It is therefore strictly prohibited to touch the magnetic chuck or any part connected to it (circular connector, for example) when being magnetised and demagnetised.</p>

2.5 Using personal protective equipment

When using this product, observe the relative industrial safety regulations and use the personal protective equipment (PPE) required!

- Use protective gloves, safety shoes and safety goggles.
- Observe safe distances.
- Observe the minimum safety requirements to use the equipment.

2.6 Notes on specific risks

- Perform any installation, modifications, maintenance or adjustments with the magnetic chuck demagnetised.
- Always make sure that no residual magnetic energy remains in the system.
- Perform maintenance, changes and integrations outside the danger zone.
- For all work, secure the electro-permanent chucks against accidental operation.

3. Warranty

The warranty is valid for 12 months from the delivery date of the product under the following conditions:

- Intended use in 1 work shift
- Comply with the maintenance and lubrication intervals
- Observe the environmental and operating conditions

Parts touching the work piece and wearing parts are excluded from the warranty.

Procedure in the event of a warranty claim

The buyer agrees to send a written detailed report on defects detected on the control unit to SCHUNK within 10 days after identification.

4. Scope of supply

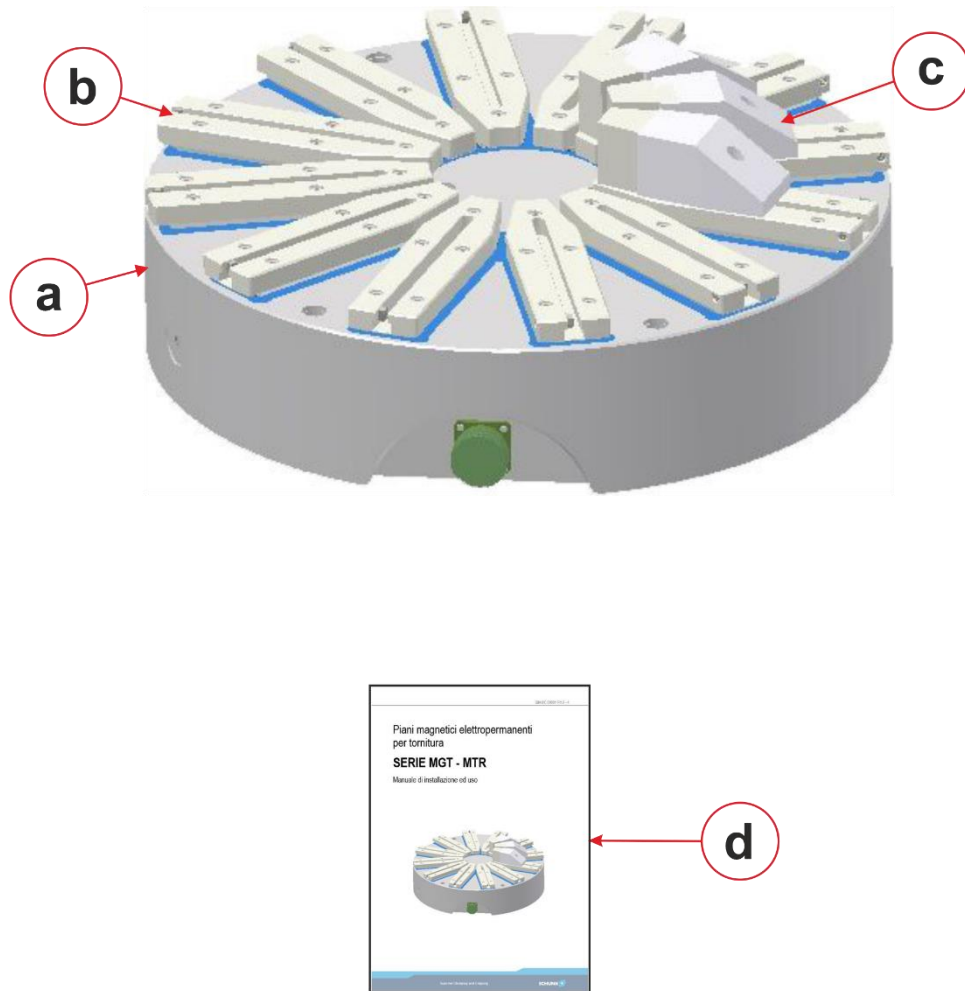


Fig.1

The supply includes:

- a. Magnetic chuck
- b. Upper pole shoes
- c. Pole extensions (on-demand)
- d. Assembly and operating manual

5. Technical data

MTR					
Product code	5018223	5018224	5018225	5043707	5018226
Single block height (mm)	133	133	133	117	117
Weight (kg)	140	220	300	500	780
OD mag (mm)	400	500	600	800	1000
ID mag (mm)	60	70	140	250	250
Poles	12	12	12	18	18
Height AlNiCo (mm)	16	16	16	16	16
Neo / Demag	Neo	Neo	Neo	Neo	Neo
Max upper pole shoe width (mm)	60	60	60	80	80
T-slot (mm)	10	10	10	10	10
Tooling top centring	absent	absent	absent	absent	absent
Quick connector	CIR 24	CIR 24	CIR 24	CIR 24	CIR 24
Rear centring	D 16 H7 + 2x M4	D 16 H7 + 2x M4	D 16 H7 + 2x M4	D 16 H7 + 2x M4	D 16 H7 + 2x M4
Fixing holes	3 x M12 DIN 912	4 x M12 DIN 912	8 x M12 DIN 912	9 x M12 DIN 912	12 x M12 DIN 912
Maximum clamping force (N/cm ²)	160	160	160	160	160
Min thickness (mm)	16	22	26	35	36
Max speed (rpm)	1000	800	650	500	400
Max speed with ext (rpm)	600	550	500	300	300
No. of channels	1	1	1	2	2
Control unit	UC 3 channels	UC 3 channels	UC 3 channels	UC 3 channels	UC 3 channels

MGT					
Product code	5018226	5018227	5043708	5043759	5043760
Single block height (mm)	133	117	117	117	117
Weight (kg)	290	460	720	1120	1900
OD mag (mm)	600	800	1000	1250	1600
ID mag (mm)	140	250	250	400	600
Poles	12	18	18	24	32
Height AlNiCo (mm)	32	32	32	32	32
Neo / Demag	Demag	Demag	Demag	Demag	Demag
Max upper pole shoe width (mm)	60	80	80	80	80
T-slot (mm)	10	10	10	10	10
Tooling top centring	absent	absent	absent	absent	absent
Quick connector	CIR 24	CIR 24	CIR 24	ILME	ILME
Rear centring	D 16 H7 + 2x M4	D 16 H7 + 2x M4	D 16 H7 + 2x M4	D 16 H7 + 2x M4	D 16 H7 + 2x M4
Fixing holes	8 x M12 DIN 912	9 x M16 DIN 912	12 x M16 DIN 912	12 x M16 DIN 912	12 x M16 DIN 912
Maximum clamping force (N/cm ²)	160	160	160	160	160
Min thickness (mm)	13	17	18	18	18
Max speed (rpm)	650	500	400	320	240
Max speed with ext (rpm)	500	300	300	250	200
No. of channels	1	3	3	6	8
Control unit	UC 3 channels	UC 3 channels	UC 3 channels	UC 12 channels	UC 12 channels

5.1 Rating plate

The rating plate is on the side of the electro-permanent chuck:
It bears the following information:

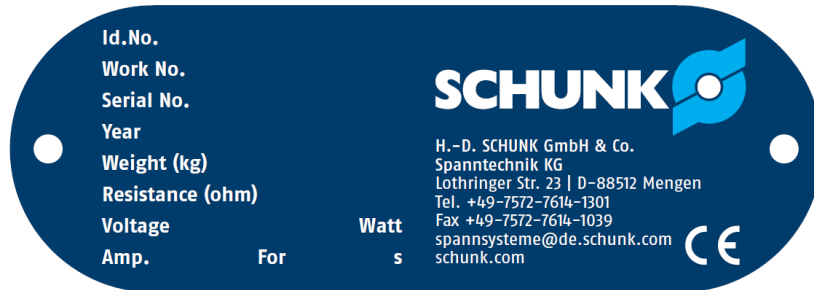


Fig.2

Information	Description
Id. No.	Product code
Work no.	Production order number
Serial No.	Product serial number
Year	Year of manufacture
Weight	Weight
Resistance	Ohmic Resistance
Voltage	Supply voltage
Watt	Power (not provided)
Amp. for. s	Current per second (not provided)

The rating plate must never be removed!

Please always have the serial no. at hand when contacting SCHUNK about technical matters.

Another plate, also on the side of the electro-permanent chuck, says to read the user manual to know the maximum speed of the product.

6. Description

6.1 Description of functioning

The electro-permanent magnetic chucks are capable of blocking all ferromagnetic materials. However they do not block the following materials:

- aluminium and its alloys
- bronze
- brass
- non-magnetic cast-iron
- some STAINLESS steels (such as austenitic, though they can be slightly magnetisable following hardening due to plastic deformation).

Even among ferromagnetic materials, the greater or lesser clamping force of the piece on the chuck depends on the reluctance of the part to be anchored.

This reluctance depends on the chemical composition of the material.

This composition can significantly reduce (by up to 20 - 30%) the maximum value of the attraction force that is reached for mild steel.

Material	Efficiency
Conventional steel (Fe 360 - C40)	100%
Ferromagnetic raw steel	90%
Magnetic stainless steel	65%
Cast-iron	50%

The following are some variables to keep in mind when using a radial magnetic chuck:

a. Thermal treatments carried out on workpiece

Some thermal treatments reduce the magnetic attraction properties. Therefore, pay the utmost attention to materials which have undergone one of the following treatments:

- hardening in all possible variants
- tempering
- cementing
- nitriding

b. Contact surface

The total anchoring force increases proportionally to the contact surface, until that surface is less than or equal to 40% of the total magnetic area available on the magnet.

Considering the types of pieces the radial pole chucks have been designed and recommended for, so as to achieve the best performance from the magnetic product, always provide the largest possible contact area, consistent with the shape of the piece and the processes to be carried out.

c. Air gap

Filth and/or cutting fluid can generally constitute an air gap, in addition to modifying the friction coefficient with the piece. Possible air gaps can be formed by:

- superficial faults of the piece such as geometrical defects (e.g. incorrect planarity), accidental damage (e.g.: deep scratches, dents) or burr. The air gap is equal to the maximum value of the offsets allowed on the piece
- finishing degree of the contact surface of the piece.

The air gap can be assessed by means of indicative values in the following table

Contact surface quality	Prior processing	Equivalent air gap (mm)
Polished or with signs of processing barely perceivable, no accidental scratch	Grinding, tool finishing, cold plastic deformation	0
Roughly trimmed, casted, carefully sandblasted	Roughing, sandblasting, hot plastic deformation	0.2
Low quality cut or casted, clearly scratched or dented	Castings, saw cutting	0.5

- Presence of non-magnetic elements between workpiece and magnet (coatings or linings, different types of filth, rust, oil or cutting fluid in general). The air gap is equal to the thickness of the elements in the contact zone.

d. Clamping force tangential to the contact surface (slipping)

In the majority of applications on radial magnetic chucks, stresses are tangential with respect to the piece-magnet contact surface (or its extensions).

Therefore the appropriate friction coefficient must be considered in order to calculate the tangential anchoring force, starting from the vertical anchoring force:

$$F_{\text{tangential}} = f \times F_{\text{perpendicular}}$$

The following are the indicative friction coefficient values:

- well finished surfaces and with plenty of cutting fluid: $f = 0.1$
- roughly trimmed surfaces with "dry" processing: $f = 0.3$

e. Maximum rotation speed

The maximum rotation speed of a radial chuck depends on several factors.

The simplest situation, namely magnetic chuck only equipped with upper pole shoes (no extension or workpiece), the maximum speed values can be found in the table below:

DIAMETER	TYPE	ID	MAGNETIC CHUCK WITH UPPER POLES
400	MTR	5018223	1000
500	MTR	5018224	800
600	MTR	5018225	650
	MGT	5018226	
800	MTR	5043707	500
	MGT	5018227	
1000	MTR	5018226	400
	MGT	5043708	
1250	MGT	5043759	320
1600	MGT	5043760	240

For magnetic chucks equipped with upper pole shoes and pole extensions, the maximum speed values can be found in the table below:

DIAMETER	TYPE	ID	POLE EXTENSIONS ID		
			5010154	5010155	5010156
400	MTR	5018223	600	500	n.a.
500	MTR	5018224	550	450	n.a.
600	MTR	5018225	500	415	n.a.
	MGT	5018226			
800	MTR	5043707	430	360	250
	MGT	5018227			
1000	MTR	5018226	390	320	225
	MGT	5043708			
1250	MGT	5043759	320	290	200
1600	MGT	5043760	240	240	180

* Values verified considering a screw tightening torque of 24 Nm.

f. Residual magnetism In the piece

All workpieces with chucks and magnet-mechanical equipment feature a residual magnetism value: this value can range from a few Gauss (< 20) to higher values.

Residual magnetism depends on :

- *Type of chuck:* MGT chucks feature lower residual magnetism while MTR chucks are designed and built for greater magnetic clamping force and therefore cannot supply low residual demagnetization cycles: it is therefore recommended to always use pole extensions (even all fixed) with these chucks, to avoid eventual problems in removing the piece from the chuck at the end of the process, due to excessive residual magnetism. This effect is more sensitive the larger the piece is.
- *Material the piece is made of:* steel alloys tend to “retain” a larger residual flux value which increases as the content of the alloy elements increase.
- *Thermal treatments undergone by the piece:* hardened structures have greater residual magnetism.
- *Shape of the piece:* residual magnetism tends to lodge in holes, cracks, grooves.

Several other procedures can generate magnetism of steel: welding, non-destructive tests, etc.: always check for the possible presence of residual magnetism in the piece before using a magnetic chuck, so as to better understand the actual contribution of the chuck to the final total residual magnetism.

g. Times and maximum operating frequency

With the term “Operating time” (or “activation time”) we mean the time required to bring the chuck to full magnetisation or demagnetisation status, from when the command is given from the control unit (by pressing the relative keys).

The operating times (mag / demag) depend on the following factors:

- *Type of chuck* (e.g.: MTR, MGT or MGR): chucks with low residual demagnetisation cycles take longer in the demag operation than the mag operation
- *Size of the chuck:* operations take longer the larger the diameter of the chuck
- *Supply voltage of the control unit:* 220 / 230 V voltages require longer times with the same chuck
- *Maximum residual magnetism allowed on the piece*

The term “Cycle”, for radial pole chucks, means the following operating sequence:

1. Mag: low power level for positioning
2. Mag: work level
3. Demag: to remove the piece

The average number of cycles allowed on the chucks described here must not exceed the following values:

- MTR chucks: 1 cycle every 5 minutes
- MGT chucks: 1 every 10 minutes

h. Times and maximum operating frequency

This procedure describes a simplified calculation proposal for the final user, to determine:

- the sustainability of the clamping conditions;
- any reductions of the maximum rotation speed in turning respect to the preset values.

The main factors that affect the safety margins in processes with radial chucks are:

- shape and material of the piece to be processed;
- type of magnetic chuck used;
- forces impressed by shavings removal action;
- possible eccentricities due to errors regarding piece shape or centring.

i. Representation of the forces acting on the piece

The following diagram depicts the forces acting on the piece, which will tend to move or shift the piece.

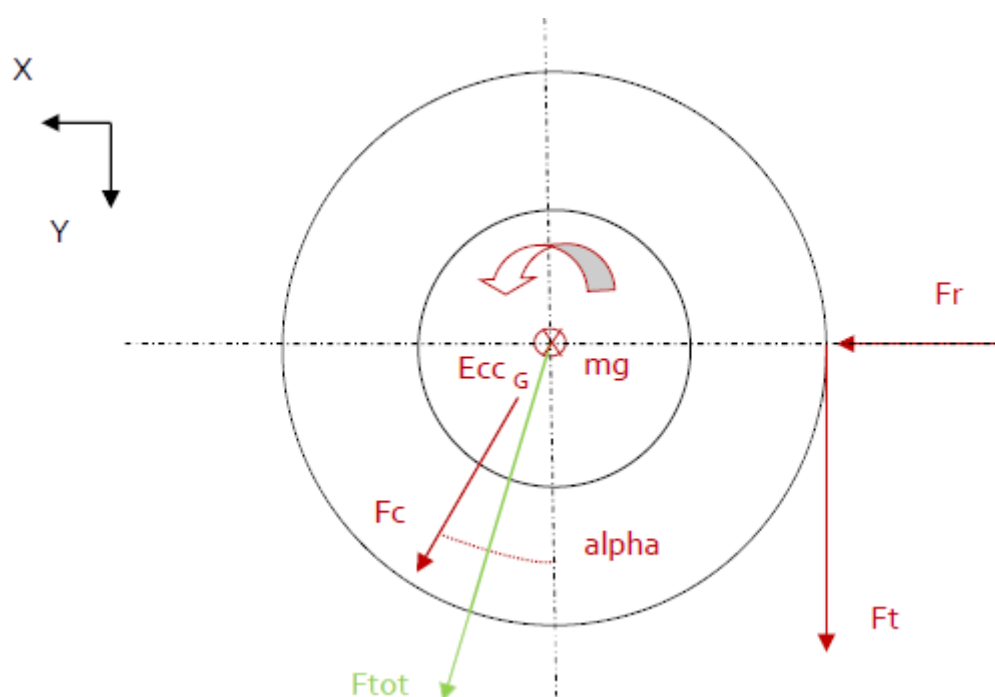


Fig.3

Where:

- Fr is the radial force acting on the piece through processing
- Ft is the tangential force acting on the piece through processing
- mg is the weight of the piece
- Ecc is the eccentricity of the piece
- Fc is the force due to the eccentricity of the piece
- $Ftot$ is the total force acting on the piece, resulting from the above-mentioned forces

To calculate the total force acting on the piece, simply calculate the forces acting along the x axis and along the y axis as follows:

$$F_x = F_c * \sin \alpha + F_r \quad (1)$$

$$F_y = F_c * \cos \alpha + F_t \quad (2)$$

The Force F_{tot} acting in the middle of the piece will be equal to:

$$F_{tot} = \sqrt{F_x^2 + F_y^2} \quad (3)$$

Assuming to divide the forces acting on the piece by the number of poles of the radial chuck and further dividing the forces due to slipping by the forces due to simple rotation will give the following type of representation:

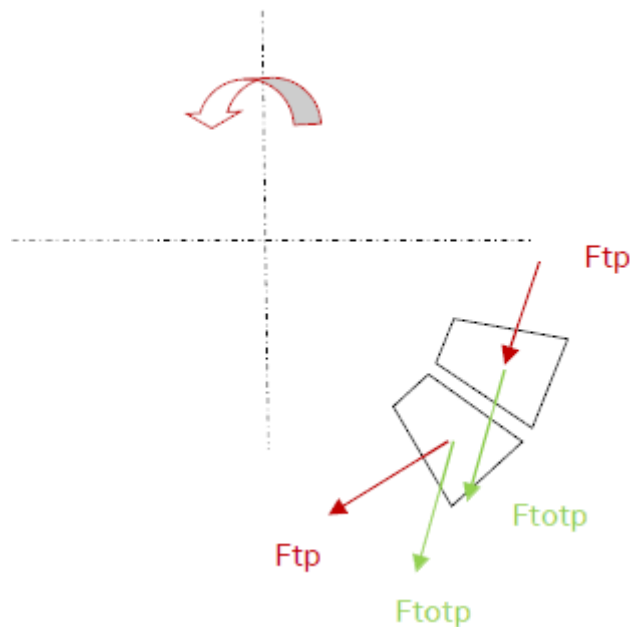


Fig.4

Where:

- F_{tp} is the component of the single pole of the force F_t (rotation)
- F_{totp} is the component of the single pole of the force F_{tot} (slipping)
- n_p is the number of poles the chuck is made up of
- D_p is the average diameter of the contact area between poles and piece
- D_{lav} is the application diameter of the cutting forces

The forces indicated above are found by the following formulas:

$$F_{tp} = F_t * \frac{D_{lav}}{D_p * n_p}$$

$$F_{totp} = \frac{F_{tot}}{n_p}$$

There will be one pole on which the two contributions add up because going in the same direction and orientation.

On that pole, the force acting on the piece will be:

$$F_{pmax} = F_{tp} + F_{totp} = F_t * \frac{D_{lav}}{D_p * n_p} + \frac{F_{tot}}{n_p} \quad (4)$$

For side mechanical seals which, with their action, compensate all the slipping thrusts F_{totp} , the above formula will be reduced as follows:

$$F_{pmax} = F_{tp} = F_t * \frac{D_{lav}}{D_p * n_p} \quad (4')$$

In magnetised chuck conditions, a magnetic force that tends to clamp the piece and to keep it from moving will then act on each pole. This force is represented by the following formula:

$$F_{mag} = \left(P_{mag} * A_c * F_{rid} + \left(\frac{mg}{n_p} \right) \right) * f_r \quad (5)$$

Where:

- P_{mag} is the magnetic pressure of the pole on the piece
- A_c is the actual contact area between pole and piece
- F_{rid} is a reduction factor due to extensions and/or air gaps
- f_r = friction factor
- mg/n_p is the weight of the piece acting on the single pole

The above formula is valid for direct contact between pole and piece or with fixed extensions. It is reduced as indicated below for poles with a flexible extension mounted on them and is based on the assumption that the weight of the piece is supported by only fixed extensions.

$$F_{mag} = (P_{mag} * A_c * F_{rid}) * f_r \quad (5')$$

When all the forces acting on the piece are known, the end-user must calculate the forces, making sure to always comply with the equation:

$$F_{mag} > SF * F_{pmax}$$

Where SF is a safety coefficient that takes on different values depending on the type of contact (with or without extensions).

j. Calculation procedure for the end-user

1. Determination of the cutting forces F_r and F_t borne by the User
2. Calculation of the eccentricity force F_c [daN], achieved with the following formula:

$$F_c = m * \left(2\pi * \frac{n}{60}\right)^2 * \frac{ecc}{10000}$$

Where:

- m [kg] is the mass of the piece
 - n [$\frac{giri}{min}$] is the rotation speed
 - ecc [mm] is the eccentricity of the centre of gravity
3. Determination of the maximum value of F_{tot} by means of relations (1), (2) and (3)
The angle α , necessary to calculate F_{tot} as the following value:

F_r/F_t	0.15	0.2 – 0.3	0.5	1
Angle α	8°	17°	27°	45°

4. Calculation of the F_{pmax} through the equation (4)
5. Determination of the actual contact area A_c between magnetic chuck and piece.
The contact area can be calculated by the formulas indicated below, variable depending on the shape of the pole in contact with the piece and the type of contact.

- *With direct contact (no extensions), triangular pole (clamping on innermost part of magnetic chuck)*

$$A_c = \pi * \frac{OD^2 - ID^2}{400 * np} - (res + cava) * \frac{OD - ID}{200}$$

- *With direct contact (no extensions), rectangular pole (clamping on outermost part of magnetic chuck)*

$$A_c = (OD - ID) * \frac{Wp - cava}{200}$$

- With indirect contact (use of extensions)

$$A_c = \frac{\min(OD; D_p - L_{esp}) - \max(ID; D_p - L_{esp})}{100} * W_{esp}$$

Where:

- OD [mm] = outside diameter of piece impression on magnet
- ID [mm] = inside diameter of piece impression on magnet
- W_p [mm] = pole / upper pole shoe width
- res [mm] = resin width
- $cava$ [mm] = width of slot on pole / upper pole shoe
- W_{esp} [mm] = width of pole extension contact areas
- L_{esp} [mm] = length of pole extension contact areas

6. Determination of reduction factor F_{rid}

This is the product of two factors, namely:

$$F_{rid} = F_{esp} * F_{gap}$$

The first F_{esp} takes account of use of the extensions which always entail a loss in magnetic performance and is calculated by the table below:

F_{esp}		Contact		
		<u>Direct</u>	EP85-F (fixed)	EP85-B (flexible)
Type of chuck	MTR	1	0.85	$1.05/np+0.5$
	MGT	1	0.9	$1.2/np+0.5$

The first F_{gap} takes account of the air gap on the surface of the piece and is calculated by the table below:

F_{gap}	Piece surface		
	<u>Ground</u>	Roughly trimmed	Forged
	1	0.9	0.5

7. Determination of friction coefficient f_r
Lacking specific information, consider $f_r = 0.15$
8. Determination of magnetic pressure P_{mag}
At the maximum magnetic performance, consider $P_{mag} = 16 \text{ daN/cm}^2$
9. Calculation of the F_{mag} through the equation (5)
10. Determination of the safety coefficient SF , calculated by the following table

SF_{amm}			
Contact	Direct	RVF (fixed)	RVF+RVB (fixed + flexible)
Magnetic only	2.5	2.5	2.5
With side stops	2	2	2

SF_{amm} takes account of:

- Uncertainties in assessing the cutting forces
 - Uncertainties in assessing the actual eccentricity of the piece
 - Errors due to simplifications introduced in the proposed calculation model
- If $SF < SF_{amm}$ recalculate with the lower n values.

k. Max derating n in eccentricity and safety conditions

This problem only occurs in the absence of side seals and in the presence of eccentricity. Otherwise the limitations given by the magnetic chuck and by the pole extensions apply for the max rotation speed. Equations (5) and (5') make it possible to obtain F_{pmax} ; while (4) makes it possible to obtain F_{tot}

$$F_{tot} = \frac{\left(P_{mag} * A_c * F_{rid} + \frac{mg}{np}\right) * f_r}{SF_{min}} * np - Ft * \frac{D_{lav}}{D_p} \quad (6)$$

$$F_{tot} = \frac{(P_{mag} * A_c * F_{rid}) * f_r}{SF_{min}} * np - Ft * \frac{D_{lav}}{D_p} \quad (6')$$

The equation (6) is valid for direct contact or with all fixed extensions, (6') for fixed + flexible extensions. Now (3), (2) and (1) allow you to find the maximum allowed F_c value.

This *rad* the ratio between F_r/F_t is found (in daN):

$$F_c \max = -F_t * (\cos \alpha + rad * \sin \alpha) + \sqrt{F_t^2 * (\cos \alpha + rad * \sin \alpha)^2 - F_t^2 * (1 + rad^2) + F_{tot}^2} \quad (7)$$

If the cutting forces make SF less than SF_{min}, the F_{tot} and F_{cmax} values will be negative. In this case, the calculation of the maximum speed linked to eccentricity loses physical sense. Please note: $F_c \max$ it is possible to calculate the max rotation speed given a certain eccentricity:

$$n \max \left(\frac{giri}{min} \right) = \frac{3000}{\pi} \sqrt{\frac{F_c \max}{ecc * m}} \quad (8)$$

Or else the maximum admissible eccentricity, given a rotation speed

$$ecc \max (mm) = \frac{10000 * F_c \max}{m} * \left(\frac{30}{\pi * n} \right)^2 \quad (9)$$

I. Calculation examples

Example 1: Checking max no-load speed (without processing)

MGT 1000 magnetic chuck with extensions 5010155 and 5010158 at Ø 670, no side seals
 Piece: OD = 800, ID = 0 H = 250, mass = 988 kg, ecc = 5 mm, steel ($K_c 0,4 = 2200 \text{ N/mm}^2$)
 Processing: none, only rotation to clean shavings

$n \max$ chuck with extensions: 225 rpm

At that speed $F_c = 273,8 \text{ daN}$

$F_t = F_r = 0$

Therefore from (4) : $F_{pmax} = F_{totp} 15,22 \text{ daN / pole}$

Furthermore:

$A_c = 25 \text{ cm}^2$, $n_p = 18$, $P_{mag} = 16 \text{ daN/cm}^2$, $f_r = 0,15$, $F_{rid} = 0,567$

From (5') we reach $SF = 2,23 < SF_{amm} = 2,5$

The rotation speed must be reduced:

Again from (6') we find that it must be $F_{tot} \leq 244,7 \text{ daN}$

Therefore from (7) : $F_c \leq 244,6 \text{ daN} \rightarrow n$ from (8) $\leq 212,6 \text{ rpm}$

Example 2: calculation of max rotation speed / max eccentricity

MGT 1600 magnetic chuck with extensions 5010156 and 5010159 at \varnothing 907, no side seals

Piece: OD = 1000, ID = 915 H = 200, mass = 500 kg, ecc = 2,5 mm,

Material: tempered steel ($K_c 0,4 = 2850 \text{ N/mm}^2$), mag. yield 80%

Processing: turning ID at diam. 640, with $A_p = 2$, $F = 0,35$ ($F_t = 209,5 \text{ daN}$, $F_r = -41,9 \text{ daN}$)

Without considering the effect of eccentricity, the application would be $SF = 2,78$, without speed derating. Since eccentricity is present, the limit speed must be calculated to keep SF above the minimum value. With $SF_{\min} = 2,5$ you reach, by means of **(6')** and **(7)**:

$F_c \text{ max} = 38,3 \text{ daN}$

From **(8)** you obtain:

$N_{\text{max}} = 167 \text{ rpm}$

Eccentricity limits the rotation speed, as the resulting value is lower than 180 rpm due to structural factors of the chuck (use of extensions). The N_{max} value is therefore sufficient to execute the above-mentioned processing with acceptable cutting speeds. Otherwise, assuming that processing is carried out at 200 m/min ($n = 99,5 \text{ rpm}$), from equation **(9)** we obtain:

$\text{ecc max} = 7 \text{ mm}$

Example 3: Reduction of rotation speed and parameters

MGT 1000 magnetic chuck with extensions 5010155 and 5010158 at \varnothing 450, no side seals

Piece: OD = 600, ID = 400 H = 100, mass = 125 kg, ecc = 1,5 mm, structural steel

($K_c 0,4 = 2200 \text{ N/mm}^2$)

Processing: turning OD at diam. 350, with $A_p = 2$, $F = 0,3$, $V_c = 220$ (200 rpm)

First assessment: $SF = 2,4$

NOTE

Using equation **(7)** with $SF_{\min} = 2,5$ obtains $F_c \text{ max} < 0$; obviously the result does not have a physical sense.

Therefore we reduce speed to minimum value recommended by tool

E.g.: 180 m/min (164 rpm), by means of **(5')** ---> $SF = 2,43$

The value is still less than SF_{\min} . Not being able to reduce or cancel eccentricity, we are obliged to reduce the cutting parameters


$A_p = 1,75$ by means of **(5')** ---> $SF = 2,76$

NOTE:


Using extensions 5010156 and 5010159 at \varnothing 460 makes it possible to keep the original parameters, without speed limitations, except for those due to chuck plus extensions+ (225 rpm)


7. Installation

- Check the packaging of the electro-permanent magnetic chuck.
- Open the package and take the magnetic chuck out
- Check to make sure that the electro-permanent magnetic chuck was not damaged during transport!
- Compare the electro-permanent magnetic chuck with the specifications given in the order!
- Clean any rustproof oil from the electro-permanent magnetic chuck.
- Fasten the electro-permanent magnetic chuck to the support platform of the machine. It can be installed in the following ways:
- Positioned on spindle nose by means of adapter flange to be secured at the back of the magnetic chuck.
- Positioned on self-centring device already present on the machine
- Positioned on machine table provided with T-slot

	ATTENTION
	<p>Use class 8.8 clamping screws making sure to tighten them at a maximum torque of 86 Nm with a torque wrench</p> <p>To avoid excessive deformation of the magnetic chuck, the machine board on which the magnetic chuck will be attached must have a maximum planarity of 0.05</p>

- After installation, check that the chuck is fixed securely without being able to move in any direction.

	⚠ DANGER
	<p>Dangers caused by short-circuit.</p> <ul style="list-style-type: none"> • Never power the electro-permanent magnetic chuck if you detect any damage! • Notify the freight carrier or SCHUNK if you detect damage and/or missing components (providing all relevant details)!



	⚠ DANGER
	<p>Danger caused by incorrect installation.</p> <p>Pay special attention when centring the magnetic chuck on the machine, to avoid unbalancing which is harmful for processing and/or dangerous for the operator.</p>

8. Commissioning and normal operation



8.1 Commissioning



Connect the control unit to the electric mains as indicated in the manual of the electronic equipment. After setting up the connection to the electric mains, check the following operation:

- Ensure that the magnetic chuck is not magnetised; you can do this with the steel tip of a screwdriver.



	 WARNING
	Suspended loads hazard If workpiece handling requires the use of lifting equipment, cranes etc., abide by the respective safety distances!

- Position the piece on the magnetic chuck, paying attention to the instructions in chapter 6.
- The contact area between the magnetic plate and the discharge cable (reinforced) must be free of metal, chips and dirt in general. The area must also be absolutely dry. If there is dirt, water or chips, carefully clean the connecting elements and contact surfaces and remove any causes of problems.
- Remove the protective cap from the connection plug of the magnetic chuck and ensure that it is free of chips, dirt and liquids. Otherwise remove carefully anything that could cause problems to the electromechanical properties of the connection plug.
- Connect the discharge cable (reinforced) of the control unit with the magnetic chuck using the quick coupling.



	 CAUTION
	Danger due to faulty connection Problems may arise due to partial (de)magnetisation. The connector of the discharge cable must be properly fixed to the magnetic system! To this end, connect the discharge cable to the connector of the magnetic chuck, clamping the connector by means of the levers on the side.

	 DANGER
	Electric shock hazard due to a faulty connection. Touching live parts can cause death by electric shock. The following step may only be taken after properly installing and inspecting the protective devices.

- Follow the instructions in the control unit manual to magnetise the magnetic chuck.

	 CAUTION
	<p>Risk of injury due to workpieces coming undone as a result of faulty displays of the magnetic clamping system.</p> <p>Ensure that the workpiece is now properly clamped on the magnetic chuck. Take suitable safety precautions when doing so!</p>

- Manually check that the pieces are secured stably to the chuck. Do not hit the chuck with a hammer to test clamping of the piece. In that case the force would not be equally distributed on the piece but would be concentrated at one sole point, making the test unreliable.
- Demagnetise the chuck and check that the piece detaches.
- The contact area between the magnetic plate and the discharge cable (reinforced) must be free of metal, chips and dirt in general. The area must also be absolutely dry. If there is dirt, water or chips, carefully clean the connecting elements and contact surfaces and remove any causes of problems.
- Disconnect the discharge cable (reinforced) of the control unit from the magnetic chuck.
- Put back the protective cap to protect the connector of the magnetic chuck from dirt, liquids, chips etc.

	 WARNING
	<p>Suspended loads hazard</p> <p>If this work requires the use of lifting equipment, cranes etc., please keep the required safety distances!</p>



- Remove the piece from the magnetic chuck.

Please contact SCHUNK if the expected results are not achieved even if you closely followed the steps described.



8.2 Normal operation

To guarantee proper magnetisation or demagnetisation, please follow the following steps:



- Ensure that the magnetic chuck is not magnetised; you can do this with the steel tip of a screwdriver.

	 WARNING
	<p>Suspended loads hazard</p> <p>If workpiece handling requires the use of lifting equipment, cranes etc., abide by the respective safety distances!</p>

- Position the piece on the magnetic chuck, paying attention to the instructions in chapter 6.
- The contact area between the magnetic plate and the discharge cable (reinforced) must be free of metal, chips and dirt in general. The area must also be absolutely dry. If there is dirt, water or chips, carefully clean the connecting elements and contact surfaces and remove any causes of problems.
- Remove the protective cap from the connector of the magnetic chuck and ensure that it is free of chips, dirt or liquids. Otherwise remove carefully anything that could cause problems to the electromechanical properties of the connection plug.
- Connect the discharge cable (reinforced) of the control unit with the magnetic chuck using the quick coupling.



	 CAUTION
	<p>Danger due to faulty connection Problems may arise due to partial magnetisation or demagnetisation. The connector of the discharge cable must be properly fixed to the magnetic system! To this end, connect the discharge cable to the connector of the magnetic chuck, clamping the connector by means of the levers on the side.</p>

- Follow the instructions in the control unit manual to magnetise the magnetic chuck.

	 CAUTION
	<p>Risk of injury due to workpieces coming undone as a result of faulty displays of the magnetic clamping system. Ensure that the workpiece is now properly clamped on the magnetic chuck. Take suitable safety precautions when doing so.</p>

- Manually check that the pieces are secured stably to the chuck. Make sure that the workpiece is perfectly centred on the magnetic chuck. To this end, use the power adjustment as follows:
 - Select the first power levels (1-3)
 - Magnetise the magnetic chuck
 - Check the most convenient centring
 - Make the necessary position adjustments by acting on the workpiece
 - Magnetise the magnetic chuck at higher power levels
- The workpiece can now be machined.
- The contact area between the magnetic plate and the discharge cable (reinforced) must be free of metal, chips and dirt in general. The area must also be absolutely dry. If there is dirt, water or chips, carefully clean the connecting elements and contact surfaces and remove any causes of problems.
- Remove the protective cap from the magnetic chuck and re-connect control unit's connector to magnetic chuck's connector.

- Demagnetise the chuck according to the instructions in the control unit manual and check that the piece detaches.
- Remove the discharge cable from the magnetic chuck.
- Put back the protective cap to protect the connector of the magnetic chuck from dirt, liquids, chips etc.

	 WARNING
	<p>Suspended loads hazard If workpiece handling requires the use of lifting equipment, cranes etc., abide by the respective safety distances!</p>

- Remove the workpiece from the magnetic chuck.

Please contact SCHUNK if the expected results are not achieved even if you closely followed the steps described.

NOTE

For ferromagnetic pieces in steel alloy or with particular chemical properties, it may be difficult to detach the pieces from the magnetic chuck especially after long processes. This is not an issue with demagnetisation of the magnetic chuck, but rather magnetisation of the metal workpiece which a careful analysis shows is likely to be affected by very high magnetic residue.

9. Troubleshooting

Fault detected	Possible Cause	Suggested intervention
The piece is not sufficiently anchored to the magnetic chuck	The control unit did not carry out/finish the magnetisation phase correctly	See the use and maintenance manual of the unit
		Check the power supply for proper voltage
		Check the resistance of the magnetic chuck
The magnetic force decreases, without any change in the workpiece	Power adjusted at lower level than in the past	Check the power level
	Contact surfaces dirty	Clean the contact surfaces
	Imperfect contact between piece and pole extensions	Check that the fixed extensions are at the same height
	Chuck overheated	Check whether the overheated chuck alarm has triggered

NOTE

Should you have any problems or need any further information, please contact the technical assistance service.

10. Repairs and maintenance

It is recommended to check the status of the electro-permanent magnetic chuck on a regular basis. Regular and careful maintenance is a decisive factor for optimum safety, operation and performance and a longer service life of the product!

To ensure optimum availability and reliability of the electro-permanent magnetic chuck in the long run, the parts exposed to the greatest strain during operation must be inspected regularly.

Please follow the instructions and maintenance intervals given in the table below so as to avoid repairs of the electro-permanent magnetic chuck and resulting down-times, failures and inconvenience.

Activity	Description	Frequency			
		With every use	Once a week	Once a month	Once a year
Cleaning the connector	Checked the connector for chips, dirt etc. and remove as necessary	•			
Checking the connector cover	Check that the gasket of the connector cover is not worn or broken	•			
Checking the rating plate	Check that the rating plate is not damaged or illegible	•			
Inspect seals	Check all the seals of the system (connectors, caps, housings etc.).	•			
Check contact surfaces	Check for filth/air gap on the contact surfaces between magnetic chuck and workpiece	•			
Check screw tightening	Check that the screws on upper pole shoes and extensions, if any, are properly tightened		•		
Check product integrity	Check that there are no cracks/breakage on the entire product (including accessories)			•	
Check the residual current device	Check proper functioning of the safety system using suitable tests	Test as often and with the method recommended by manufacturer.			


Defective electrical and electromechanical components must always be replaced by SCHUNK Service personnel only. If components are replaced by the operator, this automatically renders the warranty invalid.

After maintenance and before reconnecting and restarting the control unit, reinstall all protective devices.

11. Transport and storage

11.1 Transport


The electro-permanent magnetic chuck can be lifted with a manually controlled magnetic lift of suitable capacity or else with eyebolts according to the holes applied on the sides.

	WARNING
	<p>Risk of injury and risk of damage to the electro-permanent magnetic chuck if it falls during transport!</p> <ul style="list-style-type: none">• The electro-permanent magnetic chuck could be very heavy and contain electric components. Persons may be injured and the electric components may get damaged!• Please consider the weight of the package stated on the side label for its handling and shipping.• Use the required personal protective equipment during its handling and shipping.

11.2 Storage

When storing the electro-permanent magnetic chuck for a longer period of time, observe the following instructions to ensure perfect operation up to the time of installation:

- Ensure adequate packaging! Advice: keep the product in its original packaging.
- The electro-permanent magnetic chuck and packaging should be inspected at regular intervals.
- Check that the packaging has not deteriorated due to shocks or bad weather.
- Make sure that the temperature remains between 15°C and + 70°C so as not to damage the magnetic chuck.

	ATTENTION
	<p>Dispose of all packaging properly.</p> <p>Unpacking and positioning the product on the machine tool may require the operation of two or more persons and the use of handling equipment like hoists, cranes etc.</p>

NOTE

The presence of magnetic residue on the surface of the new chuck is determined by the use of magnetic lifts when inserting the modules into the crates. This residue disappears as soon as the first demagnetisation cycle is performed.

12. Disposal



This product is made of ferrous material, resin and electrical components. If it is taken out of operation, it has to be disposed of in compliance with the applicable regulations.

As soon as the end of the lifecycle has been reached, the electro-permanent magnetic chuck has to be decommissioned, i.e. put into a state in which it can no longer be used for its original intended use and in which it is still possible to recycle the raw materials contained.

NOTE

SCHUNK assumes no liability for material damage or personal injury that may result from reusing individual components of the control unit for other purposes than the original intended use! SCHUNK provides neither implicit nor explicit declarations about any possible usability of recycled components after decommissioning the control unit.

12.1 Procedure for final decommissioning and disposal of the product

	 CAUTION
	<p>Risk of injury Decommissioning, disassembly and disposal of the electro-permanent magnetic chuck must be performed by qualified persons using suitable tools.</p>

- Ensure that the machine tool has safely come to a halt.
- Disconnect all the electrical, hydraulic and pneumatic connections that could cause unexpected movements of the machine or its components;
- Disconnect the product from all devices, etc.;
- Have the electro-permanent magnetic chuck disposed of by a company that specialises in the disposal of electrical and magnetic equipment.

13. Spare parts

Please contact SCHUNK service department for any spare parts request.

14. Accessories

14.1 Pole extensions

The term “pole extension” indicates a support (fixed height or self adjusting), in high-permeable magnetic material, capable of lifting the workpiece from the upper chuck of the pole shoes.

This support therefore allows you to:



- Correctly transmit the magnetic flux between magnet and workpiece;
- Bring the piece to the desired level depending on machine strokes, surfaces to process, tool size, etc.

The pole extensions are generally used to:

- Reach surfaces and parts of the piece otherwise too close to the magnet (e.g. complete turning of internal and/or external surfaces);
- Perform processes which otherwise would cause the tool to make impact with the magnet (e.g. vertical through bores etc.);
- Create additional references to facilitate centring and/or to add a side clamping.

Correct use of extensions generally entails:

- That each individual extension be mounted on just one pole by means of the specific T-nut to insert in the T-slot of the upper pole shoe and the specific orientation pin. It can either cover it wholly or partially: in any case, it is important that the individual extension does not rest on the two poles, as it would short-circuit the magnetic flux without transmitting it to the piece;
- During the radial adjustment of the extensions on the specific T-slots, reciprocal contact between adjacent extensions must be avoided (especially in smaller diameter areas), again to avoid dangerous short-circuits of the magnetic flux. The width of the extensions must always be checked depending on the radial positions required for those extensions;
- The correct tightening of the fixing screw of each extension once the radial position has been adjusted

	 CAUTION
	<p>Risk of injury Do not depend on magnetic force alone and/or on the action of the own-weight of the supported piece to maintain this position. Always carefully tighten all the fixing screws of the extensions. This is the only way to guarantee a correct contrast action of the centrifugal force that tends to thrust each extension outwards.</p>

It is recommended to cover the area occupied by the piece as much as possible with the extensions. It is ill-advised to only use some extensions arranged randomly, as the magnetic force would be very low due to the small amount of poles used in the magnetic transmission and, still worse, as it would risk not balancing the amount of positive poles with the same amount of negative poles thus further reducing the clamping force.

14.2 Flexible extensions

The top of these extensions is in contact with the piece and is mounted elastically on the main body (in contact with magnet/upper pole shoe): this way that part is kept perfectly in contact with the piece and adheres better when the magnet is activated.

This makes it possible to:

- achieve the best contact possible for pieces with non-flat clamping surfaces (due to original design and/or geometric errors)
- avoid elastic deformations of the piece which this way is attracted by the magnet, thus easily reaching low planarity errors.

Flexible extensions are recommended to flatten deformed and bent pieces.

In addition to the general points set forth above, the correct use of the flexible extensions entails:

- Coupling with a minimum of 3 fixed extensions that define the Z reference value for the piece. These fixed extensions will be turned/milled at the same level once installed on the magnetic chuck and whenever needed, so that their contact with the piece is always ensured and simultaneous
- Verifying that the useful stroke of the top of the flexible extensions is sufficient to cover level differences and/or geometric errors of the piece.

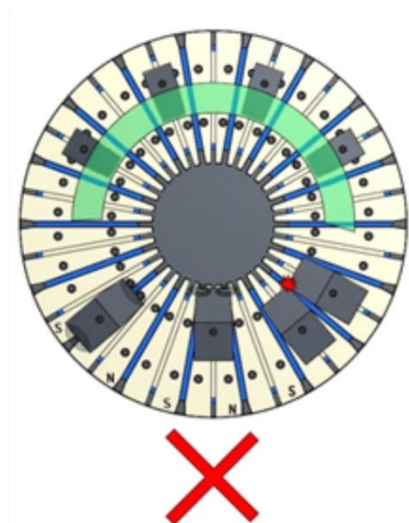
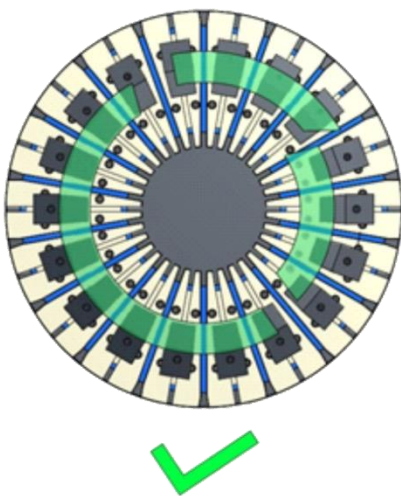
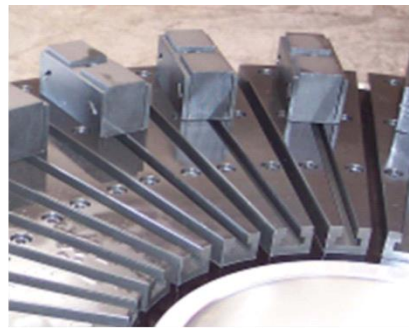


Fig.5