

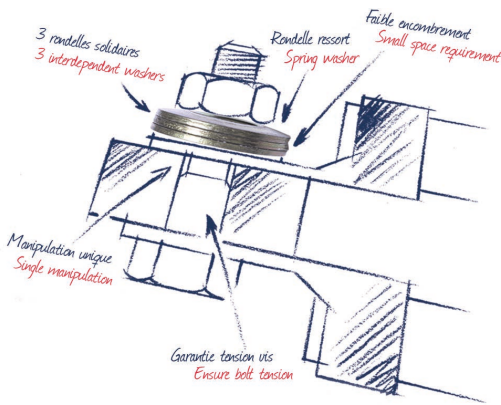
SPRING WASHER TREP®



Secure tightening !

TECHNICAL DOCUMENTATION

TREP® TAPERED SPRING WASHER



AN EXCLUSIVE, UNIVERSAL PRODUCT

GrisGroup is the exclusive owner and manufacturer of the TREP® brand, an anti-loosening security system for all your mechanical bolted assemblies and all your electrical connection assemblies.

The TREP® spring washer consists of 3 or 4 interdependent smooth tapered spring washers assembled with a metal insert.

THE MAIN CHARACTERISTICS OF THESE COMPACT, HIGH-ENERGY-CONCENTRATION WASHERS ARE:

- Guaranteed resistance to loosening
- Sustained tensioning of assembled elements
- Even distribution of bearing pressure
- High-stiffness, low-deformability elastic system
- Ability to accommodate thermal expansion
- Capacity to compensate and/or take up play (expansion, wear, etc.)
- Easy assembly thanks to crimping (handling of a single part instead of 3 or 4)
- No swaging of clamped parts

All these qualities make TREP® spring washers unique and universal in applications where safety is paramount.

INDUSTRY BRANCHES



TRUCKS



RAILWAY



PUBLIC WORKS
EQUIPMENT



ELECTRICAL
EQUIPMENT



AGRICULTURAL
MACHINERY



SHIPBUILDING

TREP® TAPERED SPRING WASHER



RESISTANCE TO LOOSENING UNDER HIGH TENSION!

In assemblies containing bolts of a high property class, resistance to loosening is achieved through the elasticity and taper of the TREP® spring washer. These features promote even distribution of the clamping force and maintenance of constant pressure in the assembled components.

At nominal tightening, one of the main characteristics of the TREP® spring washer is to accurately maintain a high level of tension in the bolt by drawing on a substantial reserve of elastic energy stored in a small volume.

Its operating principle is simple: clamped between two parts by a nut or bolt head, the interdependent spring washers flatten and act as a compressed spring between two components.

Even if tightening relaxes, the pressure is sustained by the spring effect delivered through the system's elasticity. The fastening is therefore totally reliable and wholly secure!

In addition, its taper promotes even distribution of the clamping force between the assembled items, as can be seen from the diagrams below. The colour gradient provides a good illustration of the uniformly distributed pressure at the component interface.

These diagrams clearly show that items clamped with an untapered washer are subject locally to higher and less evenly spread forces than parts assembled with a TREP® spring washer.

Laser marking of TREP® and TREP *plus*® washers

Improving the quality of GrisGroup products is a constant concern. The competitiveness of our products in relation to the competition in order to eliminate copies available on the market is at the heart of our thinking.

GrisGroup applies laser marking with the TREP® trademark to all TREP® and TREP *plus*® washers. This marking is carried out at the Lesménils site using equipment adapted to the laser marking of steels.

This marking provides a remarkable advance in terms of safety and service, with the guarantee of installing an original product.

Our customers can therefore be sure of using genuine GrisGroup washers, while the company protects its reputation and image.

The laser markings are sufficiently durable and legible throughout the life of the assembly on which the washers are installed.

GrisGroup has ensured that the laser marking does not compromise the quality in terms of corrosion resistance or these characteristics of TREP® and TREP *plus*®.

CASE OF STRESS : INDESSERRABILITY

The elastic properties of TREP® spring washers ensure that the system will withstand loosening in high-stress applications where residual tension in the bolt is of vital importance.

After nominal tightening, a **mechanical assembly** may be subject to a variety of crushing or fatigue stresses. Unscrewing, although less frequent, is also possible, and marring may likewise occur.

In an **electrical assembly**, marking and marring of components are more frequent and problematic the lower the hardness of the mating surfaces. The use of a TREP® spring washer has also proved the most effective solution on the market to combat harmful stresses induced by thermal expansion.

> Crushing in a assembly

When crushing occurs as a result of expansion of materials, wear or vibration, the TREP® spring washer takes up the play and through its elasticity helps maintain optimum tension in the assembly.

→ **In an assembly containing a TREP® spring washer, tightening remains optimal.**

For example, for an assembly of diameter 10 class 8.8.

- With an untapered washer, such as a flat, serrated, torque or toothed washer, the assembly will very quickly become under-tightened as soon as crushing reaches 0.038 mm.
- With a tapered washer, under-tightening will occur at 0.18 mm of crushing.
- But with a TREP® spring washer, under-tightening only occurs at a much later stage when crushing exceeds 1 mm!

> Fatigue stress

The fatigue test supplies important information as it provides a measure of the durability of the products.

→ **These tests revealed that assemblies containing TREP® spring washers retain their properties even after 1 000 000 cycles.**

Fatigue testing has established that an assembly containing a TREP® spring washer has a better fatigue life than any other system.

At the CETIM approved national laboratory we conducted a series of tests to determine the fatigue life of an assembly. The bolts in the assembly were instrumented with strain gauges to monitor the tension.



Vibrophore machine

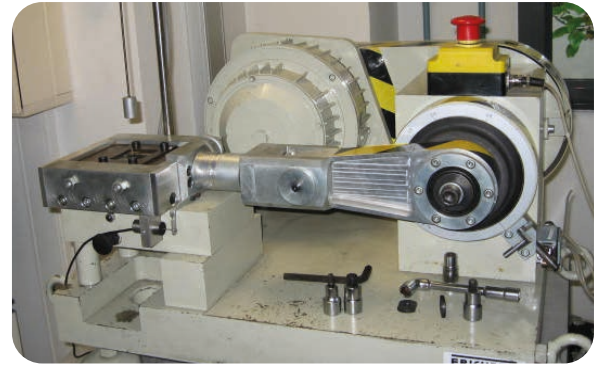
CASE OF STRESS : INDESSERRABILITY

> Unscrewing test

The TREP® spring washer also offers high resistance to unscrewing without damaging the surfaces it is fastened to.

→ Junker tests show that the more conical washers you add to the assembly, the more the unscrewing is limited.

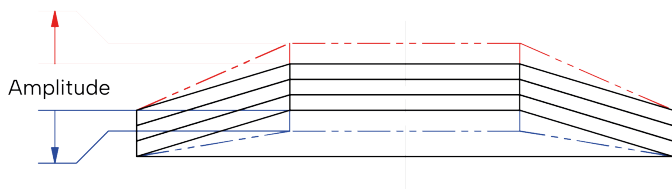
TREP® fastenings with 3 or 4 tapered washers are therefore extremely reliable in an assembly where unscrewing must be limited. They are also practical to use as the washers are interdependent.



Junker Test

> Thermal expansion in an electrical assembly

What is required in an electrical connection is an element possessing both stiffness and range of movement: two conditions fulfilled by TREP® spring washers.



The TREP® :

- is sufficiently stiff not to flatten out completely under preload or nominal tightening.
- has sufficient range of movement to accommodate any thermal expansion that may occur during the life of the assembly.

Example of numerical application to diameter 10 for aluminium connections subject to a 40° c temperature variation.

Generic formula :

$$Q_t \approx \left[\frac{l_p}{\frac{1}{K_B} + \frac{1}{K_P}} \right] \times (\alpha_p - \alpha_B) \Delta T$$

Where :

K = stiffness

α = linear thermal

l = expansion coefficient

l = tightened height

For TREP® spring washers,

the additional stress obtained is limited to 300 N:

$$Q_t \approx \left[\frac{20}{\frac{28,8}{210000 \times 58} + \frac{20}{75000 \times 150} + \frac{4}{210000 \times 150} + \frac{1}{40000}} \right] \times (23,8 - 12) \times 10^{-6} \times 40 \approx 300 \text{ N}$$

• For serrated tapered washers,

the additional stress is much higher at 2400 N:

$$Q_t \approx \left[\frac{20}{\frac{25,6}{210000 \times 58} + \frac{20}{75000 \times 150} + \frac{4}{210000 \times 150} + \frac{1,6}{210000 \times 150}} \right] \times (23,8 - 12) \times 10^{-6} \times 40 \approx 2400 \text{ N}$$

→ Therefore, the effects of expansion on the assembly are reduced to one-eighth when TREP® spring washers are used. These results also explain why the use of TREP® safety spring washers is recommended in French standard NFF 61-021 to compensate for thermal expansion.

CASE OF STRESS : INDESSERRABILITY

> Marring phenomenon

TREP® spring washers provide a large reservoir of anti-loosening energy whatever the hardness of the material, since they do not need to be anchored in the mating surface to operate efficiently.

In contrast to serrated or torque washers, which always mar the bearing surface and render the assembly non-mechanical, the TREP® spring washer is geometrically designed not to cause this phenomenon.

Nevertheless, as a precaution when systems are assembled on soft materials, it is advisable to interpose an appropriately sized flat washer.

THE TREP *plus*® SPRING WASHER, THE SOLUTION FOR SOFT MATERIAL

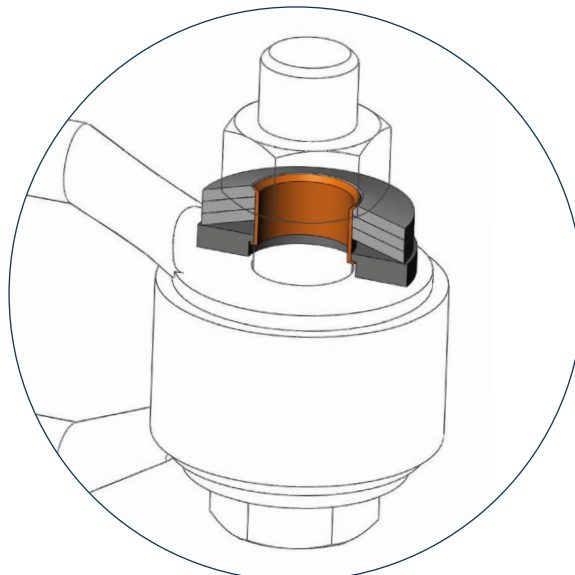
That is why, alongside our TREP® spring washers, we have developed the TREPplus® spring washer for use specifically on soft materials such as copper, aluminium or brass.

This is a system consisting of 3 or 4 smooth tapered spring washers together with a flat washer of larger outside diameter, all rendered interdependent by a metal insert.



MAIN CHARACTERISTICS:

- Distribution of clamping force over a large surface area
- Secure, easy assembly thanks to crimping
- Integral component
- No slipping



Materials & treatments

TREP® and TREP INOX® spring washers are manufactured in compliance with RoHS and ELV directives.

- TREP® SPRING WASHERS are made from carbon steel C > 0.75%.
Their spring characteristics are obtained after core hardening.
- TREP INOX® SPRING WASHERS are made from tempering stainless steel X8 CrNiMoAl.
Their spring characteristics are obtained after precipitation hardening heat treatment.

Whichever version is chosen, our TREP® and TREP INOX® spring washers perform the same duties and achieve the same results in a compact format.

Hardness

Family	Range	Unprotected
TREP®	3L04 - 3L20 4L06 - 4L60	40 - 48 HRC
TREP INOX®	3L04 - 3L16 4L08 - 4L24	40 - 48 HRC



High-temperature resistance

The high-temperature resistance of TREP® and TREP INOX® spring washers is identical to that exhibited by bolts and nuts of similar materials. Mechanical characteristics are guaranteed up to 200° C. Contact us for applications up to 700° C.

Corrosion resistance / salt spray resistance

TREP® and TREP INOX® spring washers are available in a range of finishes to suit different environments and stresses. Depending on the requirements, they can withstand up to 600 hours of salt spray and red rust in accordance with ISO 9227. For longer periods, please contact us.

No lubrication needed

If you use TREP® spring washers in your assemblies, tightening is guaranteed regardless of the friction coefficients. No lubrication is required and no chemical additives are necessary.

Quality tests

TREP® and TREP INOX® spring washers are guaranteed to comply with all their mechanical characteristics. We can send you the results of inspections, tests and trials as required.



TECHNICAL CHARACTERISTICS

Fields of application of TREP® spring washers

	MECHANICAL component assembly	ELECTRICAL connection assembly
REQUIREMENTS	<ul style="list-style-type: none"> Clamp components in the assembly to one another Avoid any slippage or separation between parts (see fixing insulators) 	<ul style="list-style-type: none"> Control clamping force to ensure there is sufficient contact surface area (avoid overheating and achieve good electrical contact) Take up play due to thermal expansion and creep of materials
TIGHTENING TORQUE STANDARDS	Tightening torque must be calculated for a Re \geq to 85%, depending on screw/nut quality class.	Tightening torque must be calculated to apply a tension value \geq 50% of the flattening load of the TREP® washer (see <i>technical data table</i>).
MAIN STRESSES	<ul style="list-style-type: none"> External force (axial or transverse to bolt) Vibrations Fatigue 	<ul style="list-style-type: none"> Thermal expansion of different materials (steel, copper, aluminium). Creep of materials (copper, aluminium, etc.)
TYPE OF TREP® TO BE USED	<ul style="list-style-type: none"> Screw/nut class \geq 5.6 → TREP® 4L – Steel or Stainless steel Screw/nut class \geq 8.8 → TREP® 3L or 3L+ – Steel or Stainless steel 	<ul style="list-style-type: none"> Nut/screw class 5.6 to 8.8 → TREP® 3L or 3L+ – Steel or stainless steel
TREP® RESPONSES	TREP® spring washer when flat: <ul style="list-style-type: none"> High load in a small volume Keeps components in tension Distributes the load 	TREP® spring washer at approximately 50% of its flattening load (+ flat washer): <ul style="list-style-type: none"> «Absorbs» play as a flexible component, unlike fully flattened products (stiff component)
SIZING	Application on round holes: Recommended dimensions at «F» level according to ISO 273 («M» tolerated). For other dimensions, please consult us. Application on oblong hole, please consult us.	

Choose a TREP® spring washer with 3 or 4 elements

1) FOR MECHANICAL ASSEMBLIES WHERE THE WASHERS ARE TIGHTENED FLAT :

• TREP® 3L for high bolt property classes \geq à 8.8

The use of TREP® spring washers with three elements, known as «3Ls», is appropriate for high bolt property classes from 8.8 to 12.9. 3Ls are not compatible below class 8.8 as the tensions in the bolts are too low to fully flatten the washers.

• TREP®4L for less high bolt property classes \leq à 8.8

TREP® spring washers with four elements, known as «4Ls», are more flexible. The flattening force is less than for 3Ls and the range of movement is greater. TREP® 4L spring washers are therefore recommended for less high bolt property classes from 5.6 to 8.8.

2) FOR TIGHTENING ELECTRICAL CONNECTIONS WHERE THE WASHERS ARE NOT TIGHTENED FLAT :

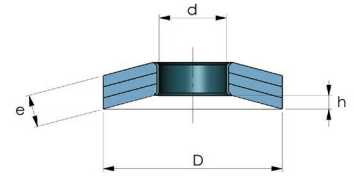
• **TREP®3L** : The use of TREP®3L spring washers is recommended by standards NFF 61-021 and NFF 61-022 used in electrical assemblies. As the bolt property classes are less high because of the use of soft materials, the TREP®3L spring washers are deliberately not fully flattened in order to accommodate any thermal expansion due to electrical overheating.

• **NOT suitable for TREP®4L** : Whatever the bolt property classes, TREP®4L spring washers are always tightened fully flat. That is why they are not recommended for electrical connections.

Dimensions of TREP® spring washers

TREP® 3L spring washer

Reference STEEL	Reference STAINLESS STEEL	Ø	d (mm)	D (mm)	e (mm)	h (mm)	Calculated flat load (N)	1000 items (kg)
TR3L04	TX3L04	M4	4,5	10	1,5	0,50	2 700	0,7
TR3L05	TX3L05	M5	5,5	12	2,4	0,30	5 300	1,5
TR3L06	TX3L06	M6	6,5	14	2,4	0,60	7 800	2,1
TR3L08	TX3L08	M8	8,5	18	3,6	0,56	14 600	5,2
TR3L10	TX3L10	M10	10,5	22	4,5	0,60	20 600	10
TR3L12	TX3L12	M12	12,5	27	5,4	0,80	29 800	18
TR3L14	TX3L14	M14	15,0	30	6,0	1,05	45 000	25
TR3L16	TX3L16	M16	17,0	34	6,6	1,25	55 200	35
TR3L18	-	M18	19,0	36	7,5	1,09	66 200	42
TR3L20	-	M20	21,0	40	9,0	1,15	99 000	60

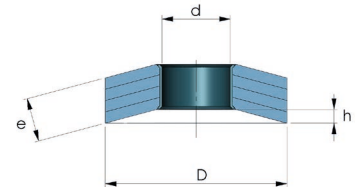


TREPPlus® 3L spring washer

Reference STEEL	Reference STAINLESS STEEL	Ø	d (mm)	D (mm)	e (mm)	h (mm)	D Plate (mm)	e Plate (mm)	H totale (mm)	Calculated flat load (N)	1000 items (kg)
TRP3L08	TXP3L08	M8	8,5	18	3,6	0,56	22	2,0	6,6	14 600	10
TRP3L10	TXP3L10	M10	10,5	22	4,5	0,60	27	2,5	8,0	20 600	19
TRP3L12	TXP3L12	M12	12,5	27	5,4	0,80	32	3,0	9,6	29 800	33
TRP3L14	TXP3L14*	M14	15,0	30	6,0	1,05	35	3,0	10,4	45 000	42
TRP3L16	TXP3L16	M16	17,0	34	6,6	1,25	39	3,0	11,2	55 200	55
TRP3L18	TXP3L18*	M18	19,0	36	7,5	1,09	42	4,0	13,0	66 200	75
TRP3L20	TXP3L20*	M20	21,0	40	9,0	1,15	46	4,0	14,5	99 000	60

TREP® 4L spring washer

Reference STEEL	Reference STAINLESS STEEL	Ø	d (mm)	D (mm)	e (mm)	h (mm)	Calculated flat load (N)	1000 pcs (kg)
TR4L06	-	M6	6,5	17	2,4	0,80	3 300	3,6
TR4L08	TX4L08	M8	8,5	20	2,8	0,95	4 600	5,6
TR4L10	TX4L10	M10	10,5	23	3,2	1,05	5 800	7,9
TR4L12	TX4L12	M12	12,5	26	4,0	1,30	12 200	13
TR4L14	TX4L14	M14	15,0	29	4,8	1,30	17 000	18
TR4L16	TX4L16	M16	17,0	33	4,8	1,40	14 100	24
TR4L18	TX4L18	M18	19,0	37	6,0	1,52	23 400	35
TR4L20	TX4L20	M20	21,0	41	6,0	1,85	23 500	45
TR4L22	TX4L22*	M22	23,0	45	7,2	1,67	31 600	60
TR4L24	TX4L24	M24	25,0	50	7,2	1,84	26 900	81
TR4L27	-	M27	28,5	56	8,0	1,80	28 700	112
TR4L30	-	M30	32,0	60	8,8	2,30	44 300	135
TR4L33	-	M33	35,0	64	10,0	2,57	66 300	170
TR4L36	-	M36	38,0	68	10,0	2,50	50 800	190
TR4L39	-	M39	41,0	72	10,0	2,45	43 800	210
TR4L42	-	M42	44,0	76	10,0	3,20	57 800	223
TR4L45	-	M45	47,0	80	10,0	2,75	47 400	240
TR4L48	-	M48	50,0	85	10,0	2,85	41 300	280
TR4L52	-	M52	54,0	90	12,0	3,55	81 800	370
TR4L56	-	M56	58,0	95	12,0	3,22	67 600	405
TR4L60	-	M60	62,0	100	12,0	3,25	62 500	441



* not standard, please contact us

TECHNICAL SPECIFICATIONS TREP® CONICAL SPRING WASHERS

TREP® washer spring elements

	STEEL	STAINLESS STEEL ¹
Material standard	1.1248	1.4532
Material name	Steel C75	Inox X8CrNiMoAl 15-7-2 / Uranus R3 / Z8CNDA 15-07 / 15-7PH
Hardening	Through-hardened	
Hardness	40-48HRC	
Recommended temperature range	-20°C to 200°C	-100°C to 200°C
Corrosion resistance	Flake zinc plating: 600Hrs in salt spray according to formulator's data. Electrolytic zinc plating: 200Hrs in salt spray according to formulator's data.	PREN 26 ²
Coating	Without / Electrolytic zinc plating / Flake zinc plating	Without

¹ • The use of a precipitation-hardened stainless steel used by GrisGroup is the grade **that guarantees the spring function** of TREP® washers

• Our TREP INOX® washers are **slightly coloured due to the heat treatment applied**

• Our TREP INOX® washers are **magnetisable**

• The grade used for our TREP INOX® washers has **good corrosion resistance**. However, in rare cases, signs of surface oxidation may appear, which are aesthetic and localised, but their resistance remains assured and in no way alters their mechanical characteristics

• For the use of TREP INOX® washers in **aggressive environments** (alkaline or acidic detergents, chlorinated atmosphere, etc.), our technical teams are at your disposal to analyse your needs and advise you on the appropriate choices.

² The Pitting Resistance Equivalent Number (PREN) is a **theoretical way of comparing the pitting resistance** of different types of stainless steel, based on their chemical composition.

Flat washer for TREP Plus®

Material standard	1.0330	1.4301/1.4307
Material name	Steel DC01	Stainless steel 304/304L
Hardening	Through-hardened	
Hardness	> (200HV) Rm>=640MPa	> (200HV) Rm>=640MPa

TREP® TREP INOX® TREP PLUS®

are **registered trademarks** of GrisGroup



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