10.9 TENSION CONTROL BOLT

EN 14399-10 HIGH-STRENGTH PRE-LOADING HRC BOLT

HRC Type (Tension Control) Bolt Assemblies

These are high resistance calibrated (HRC) bolts designed to provide a predetermined clamping force by shearing off a special spline tip at the end of the bolt thread when tightened to the correct torque value. This type of high-strength bolting with use of a calibrated mechanism ensures consistent pre-load during tightening, the sheared spline effectively indicates correct tension.

KEY FEATURES:

- Designed for simplified bolt fastening
- Reduces installer error, completion is confirmed by the shearing off of bolt end
- More accurate performance – bolting can easily be completed with an electric shear wrench
- EN 14399-10 specifies the design and properties of HRC bolt assemblies
- Surface finish GEOMET® to EN ISO 10683, or Hot-dip Galvanizing to EN ISO 10684

SURFACE COATING

GEOMET®

GEOMET® is a zinc-aluminum flake coating primarily used for corrosion protection of fasteners, including bolts, screws, and other metal components. It is a non-electrolytic process, meaning it avoids hydrogen embrittlement, making it ideal for high-strength steel components.

- High Corrosion Resistance (600-1,000+ hours NSS) ISO 9227
- Coating thickness typically ranges from 5–15 microns.
- No Hydrogen Embrittlement (Unlike electroplating)
- Thin Uniform Layering – Ideal for threads & tight tolerances
- Temperature Resistant (Up to ~300°C)
- Eco-Friendly (No hexavalent chromium)

GEOMET® is commonly used in the renewable energy sector, automotive, and construction industries where high corrosion resistance is needed.

HOT-DIP GALVANIZING

Hot-dip galvanizing is covered under EN ISO 10684 (Fasteners – Hot dip galvanized coatings), which applies to bolts, nuts, and washers. EN 14399 allows HDG, but it must be applied in combination with proper thread adjustments and lubrication to ensure compliance.

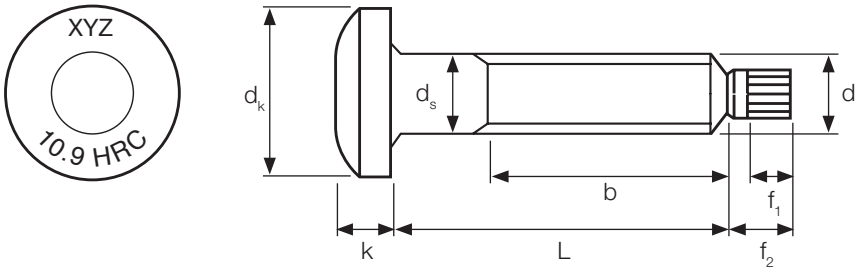
- High Corrosion Resistance (800-1,500+ hours NSS) ISO 9227
- Higher coating thickness typically ranges from 40–85 microns (depends on steel grade and size).
- Factory lubricated to achieve required friction coefficient.
- Traditional, proven protection method with thicker coatings.

Commonly selected for where extreme corrosion resistance is needed such as marine, bridge and exposed steel structure.

10.9 TENSION CONTROL BOLT

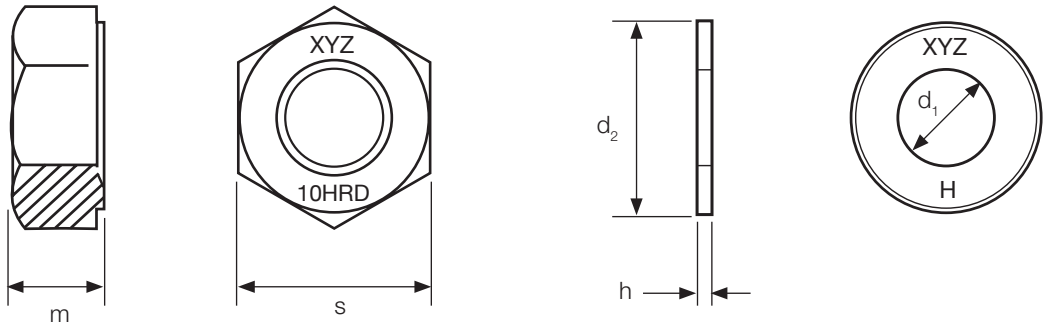
EN 14399-10 HIGH-STRENGTH PRE-LOADING HRC BOLT

BOLT DIMENSIONS



EN 14399-10 HRC Bolt Dimensions										
Thread, d	Thread Pitch	Head Dia, d_k [mm]	Head Height, k [mm]	d_s [mm]	Steel Hole Clearance Dia. [mm]	Thread Length, b [mm]			Length of spline end, f_1 [mm]	Break off length, f_2 [mm]
		min.	min.	min.		L ≤ 125	125 < L 200	L > 200	min.	max.
M12	1.75	21	7.2	11.30	14	30	-	-	11.0	16.0
M16	2.00	27	9.2	15.30	18	38	44	-	13.0	18.0
M20	2.50	34	12.1	19.16	22	46	52	65	15.0	20.0
M22	2.50	38.5	13.1	21.16	24	50	56	69	15.5	21.0
M24	3.00	43	14.1	23.16	27	54	60	73	16.0	21.5
M27	3.00	48	16.1	26.16	30	60	66	79	19.0	24.0
M30	3.50	52	18	29.16	33	66	72	85	21.0	26.0
M36	4.00	66	22	35	39	78	84	97	25.0	31.0

* Dimension apply before surface coating



EN 14399-10 HRD Nut Dimensions				
Thread, d	Nut Height, m		Across Flats, s	
	max. [mm]	min. [mm]	max. [mm]	min. [mm]
M12	12.35	11.65	22	21.16
M16	16.35	15.65	27	26.16
M20	20.65	19.35	32	31
M22	22.65	21.35	36	35
M24	24.65	23.35	41	40
M27	27.65	26.35	46	45
M30	30.65	29.35	50	49
M36	36.80	35.20	60	58.80

EN 14399-5 Hardened Washer Dimensions			
Nominal Size	ID, d_1 max. [mm]	OD, d_2 max. [mm]	Thickness, h nom. [mm]
M12	13.27	24	3
M16	17.27	30	4
M20	21.33	37	4
M22	23.33	39	4
M24	25.33	44	4
M27	28.52	50	5
M30	31.62	56	5
M36	37.62	66	6

10.9 TENSION CONTROL BOLT

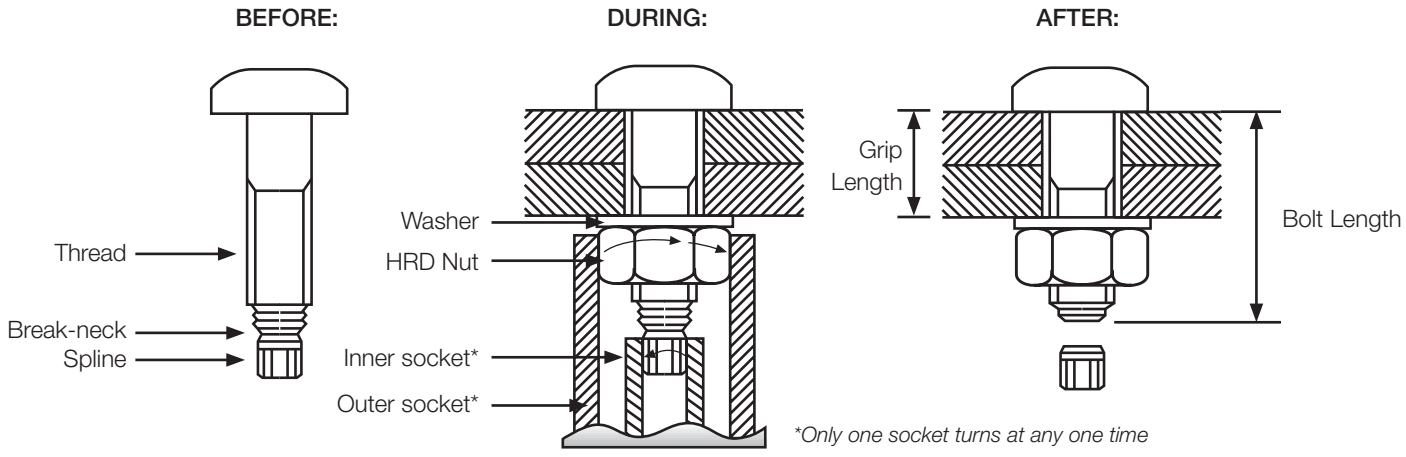
EN 14399-10 HIGH-STRENGTH PRE-LOADING HRC BOLT

MECHANICAL PROPERTIES

Product Characteristic		Standard
Materials		Steel
General Requirements		EN 14399-1 & EN 14399-2
Mechanical Properties	HRC Bolt	10.9 PC
	HRD Nut	10 PC
	Hardened Washer	300HV - 370 HV (Vickers Hardness)
Dimensions & Tolerances	HRC Bolt	EN 14399-10
	HRD Nut	EN 14399-10
	Hardened Washer	EN 14399-5
Surface Finish / Coating	Normal	as processed [a]
	Hot Dip Galvanised	EN ISO 10684
	Geomet®	EN ISO 10683 [b]
	Additional protection against corrosion	After tightening, the non-coated area appearing at the end of the bolt resulting from the fracture of the spline-end may be protected against corrosion by applying an efficient protective treatment (e.g. by a complementary zinc-rich paint).

a "As processed" means the normal finish resulting from manufacture without or before any coating. **b** Other coatings may be negotiated between the purchaser and the manufacturer provided they do not impair the mechanical properties or the functional characteristics. **Coatings of cadmium or cadmium alloys are not permitted**.

BOLTING



DETERMINING REQUIRED BOLT LENGTH

Bolt length is determined by adding the nut and washer height plus 2 thread pitch values to the required grip length.

Bolt Length = Grip Length + Added Length

Nominal Dia.		M12	M16	M20	M22	M24	M27	M30	M36
Added Length	[mm]	19	25	29	32	35	39	42	53

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GRIP TOLERANCES FOR TCB

- HRD nut and washer (single) and a standard shear wrench

Dia.	Bolt Size x L, [mm]	Grip Length, [mm]	
		min.	max.
M20	M20 x 50	12	21
	M20 x 55	13	26
	M20 x 60	14	31
	M20 x 65	17	36
	M20 x 70	24	41
	M20 x 75	27	46
	M20 x 80	34	51
	M20 x 85	39	56
	M20 x 90	42	61
	M20 x 95	49	66
	M20 x 100	54	71
	M20 x 105	59	76
	M20 x 110	64	81
	M20 x 115	69	86
	M20 x 120	74	91
	M20 x 125	79	96
	M20 x 130	81	101
	M20 x 135	86	106
	M20 x 140	91	111
	M20 x 150	101	121
	M20 x 160	111	131
	M20 x 170	121	141
	M20 x 185	136	156
	M20 x 200	151	171
	M20 x 220	171	191
M24	M24 x 60	16	25
	M24 x 65	17	30
	M24 x 70	18	35
	M24 x 75	19	40
	M24 x 80	20	45
	M24 x 85	31	50
	M24 x 90	35	55
	M24 x 95	41	60
	M24 x 100	45	65
	M24 x 105	51	70
	M24 x 110	55	75
	M24 x 115	61	80

Dia.	Bolt Size x L, [mm]	Grip Length, [mm]	
		min.	max.
M24	M24 x 120	64	85
	M24 x 125	71	90
	M24 x 130	71	95
	M24 x 140	81	105
	M24 x 150	91	115
	M24 x 160	101	125
	M24 x 170	111	135
	M24 x 180	121	145
	M24 x 190	131	155
	M24 x 200	141	165
	M24 x 210	151	175
	M24 x 220	161	185
	M24 x 230	171	195
	M24 x 240	181	205
	M24 x 260	201	225
	M24 x 280	221	245
M27	M27 x 70	15	31
	M27 x 80	15	41
	M27 x 90	32	51
	M27 x 100	42	61
	M27 x 110	52	71
	M27 x 120	61	81
	M27 x 130	71	91
	M27 x 140	81	101
	M27 x 150	91	111
	M27 x 160	101	121
	M27 x 170	111	131
	M27 x 180	121	141
	M27 x 190	131	151
	M27 x 200	141	161
	M27 x 220	161	181
M30	M30 x 80	19	38
	M30 x 90	19	48
	M30 x 100	42	58
	M30 x 110	52	68
	M30 x 120	62	78
	M30 x 130	72	88

Dia.	Bolt Size x L, [mm]	Grip Length, [mm]	
		min.	max.
M30	M30 x 140	82	98
	M30 x 150	92	108
	M30 x 160	102	118
	M30 x 170	112	128
	M30 x 180	122	138
	M30 x 190	132	148
	M30 x 200	142	158
	M30 x 210	152	168
	M30 x 220	162	178
	M30 x 240	182	198
	M30 x 260	202	218
	M30 x 280	222	238
M36	M36 x 100	24	47
	M36 x 110	32	57
	M36 x 120	44	67
	M36 x 130	54	77
	M36 x 140	64	87
	M36 x 150	74	97
	M36 x 160	84	107
	M36 x 170	94	117
	M36 x 180	104	127
	M36 x 190	114	137
	M36 x 200	124	147
	M36 x 210	134	157
	M36 x 220	144	167
	M36 x 240	164	187
	M36 x 260	184	207
	M36 x 280	204	227

Note from EN 1090-2 section 8.2.2: Reference Min Grip: For preloaded bolts, at least four full threads (in addition to the thread run out) shall remain clear between the bearing surface of the nut and the non-threaded part of the shank. **Note from EN 14399-10 Annex A:** Reference Max Grip: Due to manufacturing issues, the length of protrusion shall be at least the length of two thread pitches (instead of 1P) measured from the outer face of the nut to the end of the bolt after the spline ends shears off.

INSTALLATION PROCEDURE - GENERAL

Tightening of a connection needs the components to be brought into a snug tight condition before commencement of pre-loading. Both **snug (stage 1)** and **full preload tightening (stage 2)** shall be carried out from the most rigid part of the connection to the least rigid part.

- When a bolt group comprises more than four bolts, tightening should be from the centre of the joint outwards and ensuring all plies are properly pulled together in full contact.
- To achieve uniform pre-loading, more than one cycle of tightening may be necessary.
- Assemblies where the nut does not run freely after initial loosening should be discarded. Check that the nut runs freely along bolt length prior to installation.
- Before commencement of tensioning, all components in the joints shall be fitted together and all bolt assemblies shall be brought to snug tight as part of stage 1 of the installation process.

Important Note – correct storage and handling of pretensioned bolts is critical to the maintain correct friction factor.

- All assemblies must be protected from dirt and moisture.
- Store assemblies in original packaging.
- Only remove bolts from packaging at installation as required
- Never use additional lubrication
- Dirty, oily, rusted assemblies should not be used
- All changes to the coating or foreign mater will affect tensions required

SNUG FIT AND TENSIONING:

STAGE 1 – Snug fitting (snugging) can be accomplished by two methods.

1. Using the shear wrench but only part tightening the assemblies and **NOT** shearing off the spline. When using this method, there will be a distinct change in the sound/tone of the wrench motor. This indicates that pre-tensioning has commenced as the bedding load is being applied. **If pre-tensioning has occurred, then when the power trigger is disengaged and the motor stops, the wrench gearing will backtrack and reverse allowing the tool to be easily removed from that particular bolt.**
   Or:
2. Using a standard nut runner or wrench with a deep socket to pull all surfaces into contact without involving the bolt spline.

STAGE 2 - Preload tensioning tightening can only be achieved using a torque controlled (TC) shear wrench. When the spline end shears off at the break neck, full preload has bee generated.

If the bolting assembly cannot be installed using shear wrenches, tightening shall be carried out in a conventional manner by using a direct tension indicator (DTI) in accordance with EN 14399-9. DTI thickness should also be considered when calculating the minimum and maximum grip lengths

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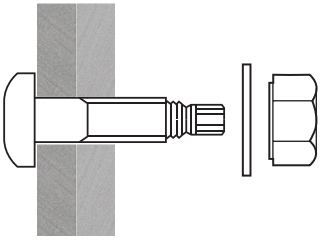
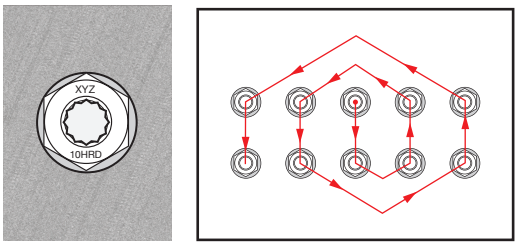
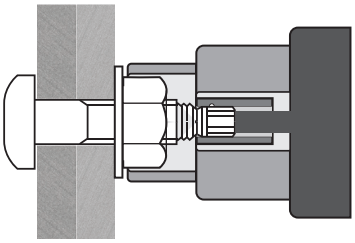
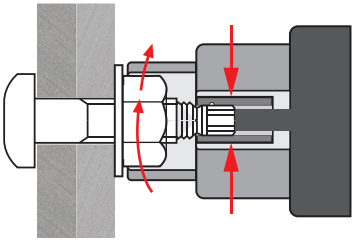
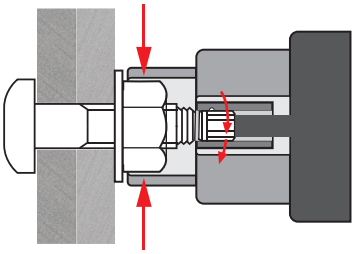
Installation Steps:		
1		Ensure connection surface and bolt holes are clean, dry and free of any moisture caused by rain or condensation. **Remove the bolt from packaging only when ready to install**. Insert the bolt into the connection, place the washer followed by the nut.
2		Nut markings should be outermost to ensure Quality Assurance is visible. Both **snug (stage 1)** and **full preload tightening (stage 2)** shall be carried out from the most rigid part of the connection to the least rigid part.
3		Engage the inner socket over the bolt spline and outer socket over the nut and are fully engaged. Commence initial snug fit installation process. See Stage 1 – Snug Fitting on previous page
4		With the use of a non-impacting shear wrench commence pre-load tensioning stage 2. Once the power trigger is activated the outer socket will rotate clockwise tightening the nut whilst the inner socket holds the bolt spline.
5		**When the correct preload is reached the outer socket will stop rotating,** and the inner socket will rotate counter-clockwise shearing the spline off.

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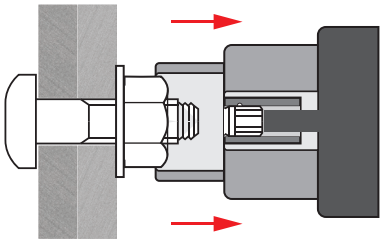
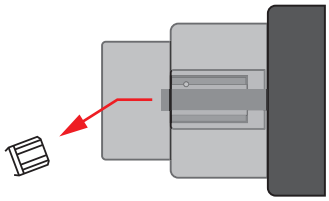
EN 14399-10 HIGH-STRENGTH PRE-LOADING HRC BOLT

Installation Steps:		
6		Release the power trigger and pull the wrench away from the nut. The spline will be retained within the inner socket.
7		Use the ejector lever to eject the spline into a waste container.

BOLT TENSION

HRC Bolt Tension at Fracture of Spline-End, F_r (EN 14399-10)								
	M12	M16	M20	M22	M24	M27	M30	M36
Stress Area, A_s [mm²]	84.3	157	245	303	353	459	561	817
Minimum Individual Value, F_{ri} [kN]	59.0	109.9	171.5	212.1	247.1	321.3	392.7	571.9
Mean Value, $F_{r\,mean}$ [kN]	64.9	120.9	188.7	233.3	271.8	353.4	432.0	629.1

Where,

Minimum individual value $F_{ri} \geq 0.7 f_{ub} \times A_s$

Mean value $F_{r\,mean} \geq 0.77 f_{ub} \times A_s$

Coefficient of variation of $F_r \leq 0.06$

f_{ub} is the nominal strength of the bolt = 1000MPa for 10.9 PC

QUALITY ASSURANCE

HRC Assemblies, (bolts, nuts and washers) are supplied in a fully assembled condition ready for use. The components of the assembly, as supplied, have been tested as a batch and must not be mixed with components from any other batch of HRC assemblies.

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‘FAIL 2 SAFE’ BOLTS

As with any threaded fastener assembly occasional failures can occur, the ductile failure mode of the TCB system is by bolt breakage. Failures during installation can be directly linked to identifiable issues in the assembly process, some factors can involve but are not limited to:

- Using a TCB as a slave bolt
- Misalignment of steel
- Foreign materials in the threads such as grit, mastic, oil etc
- High temperatures
- Excessive moisture
- Excessive paint thickness

These issues alter the coefficient of friction between mating threads, resulting in a different preload force for the same applied torque. Since a shear wrench operates by following the path of least resistance during installation, this can trigger the following sequence of events:

- If the coefficient of friction has been reduced, the shear wrench continues to rotate the outer socket instead of the inner socket counter-rotating and removing the spline at the intended preload.
- The continued rotation of the nut by the shear wrench increases the tension in the bolt which can either, cause the bolt to pass its yield point, deform in the thread with the nut then jamming and fracturing the bolt from torsional force (this is the HR bolting system failure mode), or the bolt and nut strip and fuse together. In either case the spline remains intact.

"Regardless of the outcome—whether the assembly fractures or the spline remains intact—the operator will be able to identify a 'fail-to-safe' condition."

These assemblies must be removed and replaced with new.

Example 1: Thread Stripping

Example 2: Torsional fracture

When inspected, if the spline has been sheared off then the bolting assembly is installed correctly.

Note – It isn’t possible for a TC bolt to fail later once installed correctly with the spline shearing off unless there is either the application of additional forces or there are deficiencies in the fastener’s mechanical properties.

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