Inspections, acceptance testings and certificates
Test method: Hardness measurement

The hardness measurement serves to determine the resistance of a material against the penetration of a test specimen which acts upon it with a specific type, force and time. Depending on the applied procedure, the hardness value is determined from the measured depth or size of the impression the test specimen makes on the workpiece.
The most common standardised methods are shown in Table 1. If in doubt, the Vickers Hardness test shall be applied for the mechanical fasteners.
The measurements are taken on prepared samples. Here it needs to be differentiated between:

- **"Routine testing"**
  The measurement is taken on an even cut on the surface of the sample. Common hardness test procedures are Rockwell (HRC) and Vickers (HV 10 – HV 30).
- **"Arbitration testing"**
  The measurement is taken on a lengthwise or diagonal polished section of the cut-up specimen. The testing procedure according to ISO 898 is Vickers (HV).

With the acceptance test of "Mechanical fasteners" hardness measurements are only part of routine and comparative checks. They are not themselves decisive for determining mechanical characteristics.

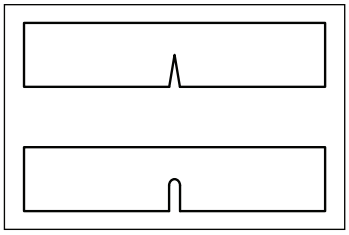
For screws, the tensile test is determining the tensile strength, yield strength limit and elongation. For nuts, proof load tests and expansion tests are applicable. (ISO 898-1, DIN 267-21, ISO 898-2).
Table 2 shows a conversion of the hardnesses according to Vickers, Rockwell and Brinell into each other and for the tensile strength of non-alloy to low-alloy steels in hot-formed or heat-treated conditions. Beside these, the hardness ranges of screws, nuts and washers of the various strength classes are specified according to the standard.

Low load-hardness testing

The low load-hardness test with test loads between 2 and 30 N (HV 0.2 to HV 3) is the link between the conventional hardness testing (HV 5 to HV 100) and micro-hardness testing. It is suitable for determining the hardness in surface layers and for absorbing hardness gradient curves.
For fasteners, especially quenched and tempered screws from property class 8.8 or higher, the low load-hardness testing according to ISO 898-1 is used to determine the carburisation state in the thread range.

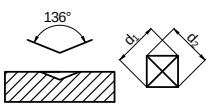
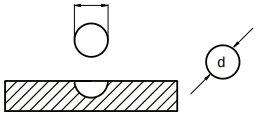
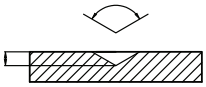
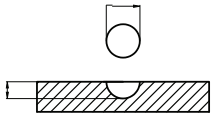
Impact testing

Impact testing is used to measure the toughness. This shows the extent of the damage which needs to be done in order to shatter a sample. Tough steels can absorb a lot. Brittle steels require less effort. The result of impact testing is used in particular to estimate the usability of steel at low temperatures.
For testing, quadratic test specimens with a defined chamfer are made out of the screws. ISO-V and ISO-U samples are distinguished from each other. In practice, using the ISO-V sample was approved as this reacts more sensitively to the embrittlement of the screw due to the stronger notch effect compared to the ISO-U sample.



ISO-V and ISO-U sample

Table 1: Comparison of hardness measuring procedures

Procedure, Marking	Vickers HV	Brinell HB	Rockwell	
			HRC	HRB
Standard	ISO 6507-1,2 (DIN 50133)	ISO 6506 (DIN 50351)	ISO 6508/EN 10004 (DIN 50103-1)	
Suitable for materials	Metallic materials with very low to very high hardness level (specification of medium hardness)	Metallic materials with very low to high hardness level (specification of partial hardness)	Hardened steels, hardened and tempered alloys	Materials of medium hardness, steels with low to medium C-content of brass, bronze ...
Tensile strength range approx. (R_m in N/mm²)	< 250 – 2000	255 – 1520	770 – 2000	250 – 800 250 – 800
Penetrator	Diamond pyramids, quadratic base area, surface angle 136° 	Ball from hardened steel, diameter: 10/15/2.5 or 1mm 	Diamond cone, cone angle 120° Tip: Radius of curvature 0.2mm 	Ball from hardened steel Diameter: 1/16" = 1.5875mm 
General dwell time (for arbitration tests, min.)	Material-dependent 10 – 30 (30) sec.	Material-dependent 10 – 30 (30) sec.	Material-dependent 2 – 25 (30) sec. (two-stage impression Test load F_0 + Test load F_1 = Total test load F)	
Code (examples)	640 HV 30 — applied test load F = 294 N/30 kp; Vickers Hardness determined hardness value 180 HV 50/30 — Dwell time/sec.	350 HB — Hardness Brinell determined hardness value for ball diameter of 10mm Test load 29420 N/3000 kp Dwell time 10–15 sec. 120 HB 5/250/30 — Ball Ø; Test load/kp; Dwell time/sec.	45 HRC — Rockwell Hardness Procedure C; determined hardness value	45 HRB — Rockwell Hardness Procedure B; determined hardness value