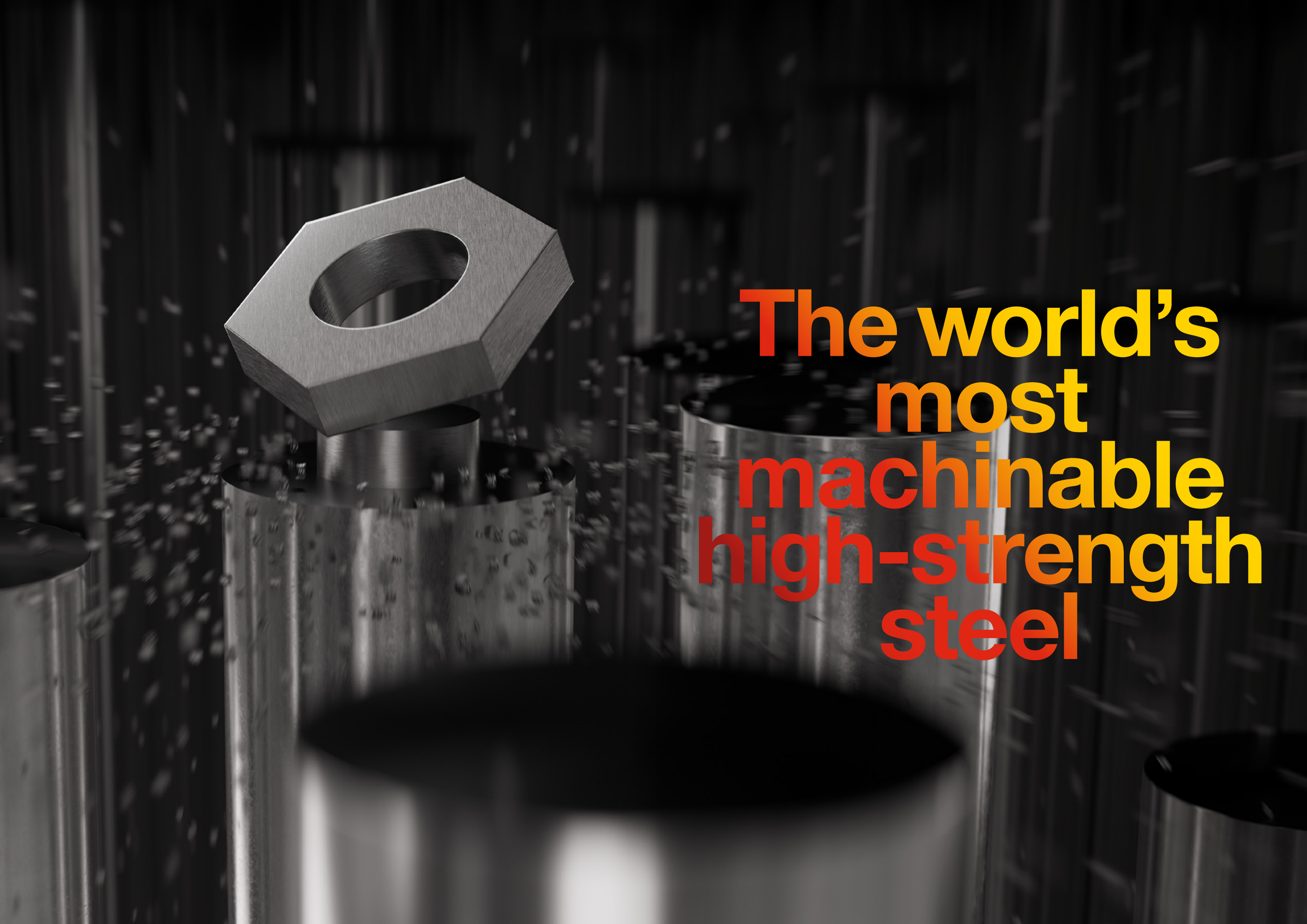
Steel
beyond
limits

# ETG® 88/100

Swiss
Steel
Group



# The world's most machinable high-strength steel

# Steel beyond limits

## This steel isn’t just steel – it’s a mindset.

Build to create better. Believe in the possibilities of engineering. The smallest component. The most precise edge. The longest resilience.

ETG® 88/100 isn’t just a premium product – it’s a mindset. A symbol of strength, creativity, and potential. For over 30 years, high-strength steels have defined our courage as a company of innovators, visionaries, and limit-pushers, willing to go beyond.




# Why choose ETG® 88/100?

**ETG® 88/100 steels combine two characteristics that usually work against each other: strength and machinability. ETG® can replace a whole range of standard steels, improving the quality, safety, and reliability of precision parts as well as optimizing production times and cost per unit.**

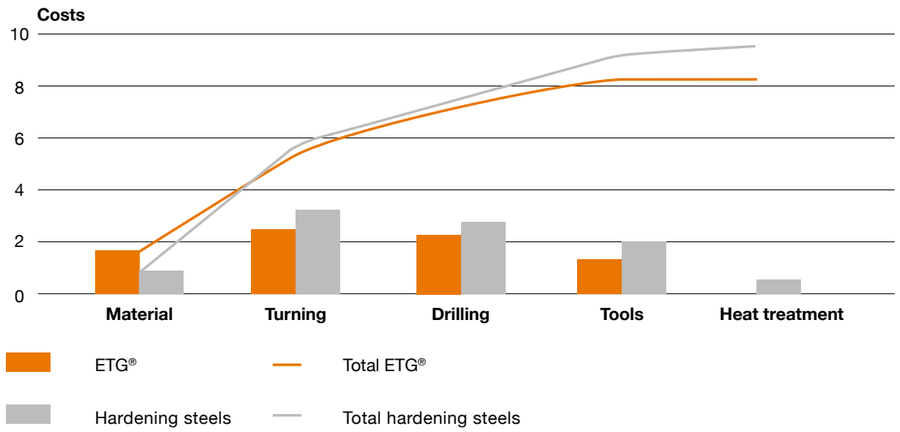
## High strength

The high strength of ETG® steels lies in the range of quenched and tempered steels. How we process the steel guarantees consistent mechanical properties over the entire cross-section and dimension range. As delivered.

## Machinability excellence

ETG® steels have low residual stresses and maintain dimensional stability. Their short-breaking chips support safer and leaner production practices. And improve machine uptimes.

### Comparison of component costs ETG® / Hardening steels



# Advance your component capabilities

Exceptional materials. Impressive attributes.
Proven, high-performance applications.
Unmatched for over 30 years.

## Up to 50% stronger than standard steels

High tensile and yield strengths as delivered

## Excellent machinability

ETG® allows very high cutting speeds, enabling the process time to be reduced by up to 50%

## Increased machine uptime, by up to 20%

Short breaking chips and increased tool lifetimes

## Downsizing component costs by up to 30%

Weight-saving opportunities

## A sustainable solution

Generally no heat treatment necessary. Reduction of production processes and $CO_2$. Up to 50% savings on component costs

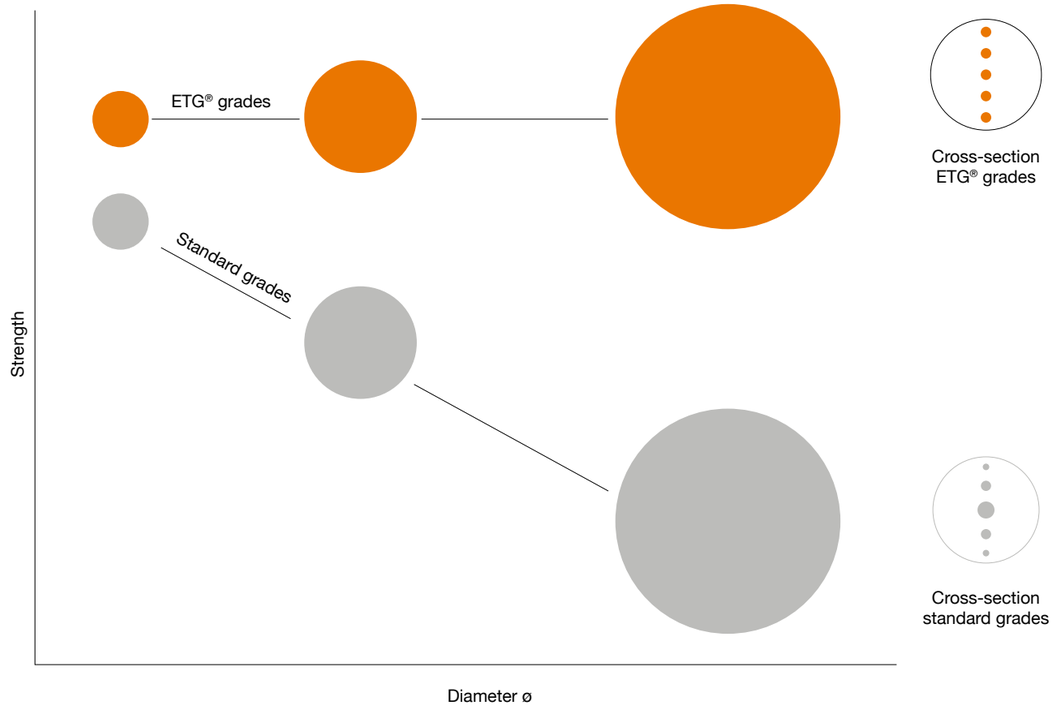
## Component quality and reliability

Consistent and reliable properties from batch to batch


# Comparing ETG® 88/100 to standard steels

**ETG® High-Strength Special Steels to substitute standard grade steels. The guaranteed yield strength for all sizes means that ETG® can be used for a very wide range of applications, replacing a whole range of standard steels. The deciding factor is what it will be used for.**

**Uniform mechanical properties over the entire dimension range and cross-section.**



## Strength values of standard steels compared to ETG®
## Guaranteed yield strength $R_{p0,2}$ [N/mm²] according to EN 10277 + 'key to steel' *

| Free-cutting tempering steels | | | Size range (mm) | | | | |
|---|---|---|---|---|---|---|---|
| **Material number** | **EN reference** | **Process** | **5-10** | **10-16** | **16-40** | **40-63** | **63-100** |
| 1.0726 | 35S20 | +C | 480 | 400 | 360 | 340 | 300 |
| 1.0756 | 35SPb20 | +C + QT | – | – | 380 | 320 | 320 |
| | | +QT + C | 490 | 490 | 455 | 400 | 385 |
| 1.0760 | 38SMn28 | + C | 550 | 500 | 420 | 400 | 350 |
| 1.0761 | 38SMnPb28 | +C + QT | – | – | 420 | 400 | 380 |
| | | +QT + C | 595 | 545 | 490 | 490 | 440 |
| 1.0762 | 44SMn28 | + C | 600 | 530 | 460 | 430 | 390 |
| 1.0763 | 44SMnPb28 | +C + QT | – | – | 420 | 410 | 400 |
| | | +QT + C | 595 | 545 | 490 | 490 | 490 |
| 1.0727 | 46S20 | + C | 570 | 470 | 400 | 380 | 340 |
| 1.0757 | 46SPb20 | +C + QT | – | – | 430 | 370 | 370 |
| | | +QT + C | 595 | 560 | 490 | 490 | 455 |
| 1.0728* | 60S20 | + C | 645 | 540 | 430 | 355 | 335 |
| 1.0758* | 60SPb20 | +C + QT | 570 | 570 | 490 | 450 | 450 |





| Hardening steels | | | Size range (mm) | | | | |
|---|---|---|---|---|---|---|---|
| **Material number** | **EN reference** | **Process** | **5-10** | **10-16** | **16-40** | **40-63** | **63-100** |
| 1.0501/1.0502 | C35/C35Pb | +C | 510 | 420 | 320 | 300 | 270 |
| 1.1181 | C35E | +C + QT | – | – | 370 | 320 | 320 |
| 1.0503/1.1195 | C45/C45Pb | +C | 565 | 500 | 410 | 360 | 310 |
| 1.1191 | C45E | +C + QT | – | – | 430 | 370 | 370 |
| 1.0601/1.0602 | C60/C60Pb | +C | 630 | 550 | 480 | – | – |
| 1.1221 | C60E | +C + QT | – | – | 520 | 450 | 450 |
| 1.7213 | 25CrMoS4 | +C + QT | – | – | 600 | 450 | 450 |
| 1.7213 | 25CrMoS4 | +QT + C | 700 | 700 | 600 | 520 | 450 |
| 1.7227 | 42CrMoS4 | +C + QT | – | – | 750 | 650 | 650 |
| 1.7227 | 42CrMoS4 | +QT + C | 770 | 750 | 720 | 650 | 660 |
| 1.6582 | 34CrNiMo6 | +C + QT | – | – | 900 | 800 | 800 |
| 1.6582 | 34CrNiMo6 | +QT + C | 770 | 750 | 720 | 650 | 650 |

1 N/mm² = 1 MPa  + C = Cold drawn  + C + QT = Cold drawn and tempered  + QT + C = Tempered and cold drawn

| High-strength special steels | | | |
|---|---|---|---|
| ETG® 88 | drawn | ← | 685 → |
| ETG® 100 | drawn | ← | 865 → |

As mechanical properties are uniform across the entire size range and over the entire material cross-section, customers can benefit either from a smaller component size and thus a lower component weight, or from higher component performance without needing to increase component dimensions.

# A product range of endless possibilities

## Chemical composition
## Analysis by mass in %

| Element | C | Si | Mn | P | S |
|---|---|---|---|---|---|
| min. | 0.42 | 0.10 | 1.35 | – | 0.24 |
| max. | 0.48 | 0.30 | 1.65 | 0.04 | 0.33 |

The analysis corresponds to SAE 1144 and 44SMn28 (1.0762)
Piece analysis and melt analysis may vary according to EN 10087

## Product range

| Steel category | Process | Size range mm | Tolerance |
|---|---|---|---|
| ETG® 88 | drawn, round | ≥ 5.0 – ≤ 20.5 | h9 |
| | drawn, round | > 20.5 – ≤ 64.0 | h11 |
| | drawn, round | > 64.0 – ≤ 114.3 | h12 |
| | ground, round | ≥ 5.0 – ≤ 100.0 | ≥ IT 6 |
| ETG® 100 | drawn, round | ≥ 6.0 – ≤ 64.0 | h11 |
| | drawn, round | > 64.0 – ≤ 70.8 | h12 |
| | ground, round | ≥ 6.0 – ≤ 70.8 | ≥ IT 6 |
| ETG® 88 | drawn, hexagonal | SW 13 – 27 | h11 |

Bar lengths: standard 3 m, other lengths upon request
Color coding end face: ETG® 88 white, ETG® 100 gold
The surface finish and surface quality class 3 (hex: QC 2) as per EN 10277-1

Other categories to meet special requirements (e. g. mechanical properties) are available to special order.





## Mechanical properties
## Typical values

| Static | | | ETG® 88 | ETG® 100 |
|---|---|---|---|---|
| Dimensions | Ø | mm | 5.0 – 114.3 | 6.0 – 70.8 |
| Yield strength (drawn) | $R_{p0.2}$ | N/mm² | ≥ 685 | ≥ 865 |
| Yield strength (ground) | $R_{p0.2}$ | N/mm² | ≥ 685 | ≥ 800 |
| Tensile strength | $R_m$ | N/mm² | 800 – 950 | 960 – 1,100 |
| Ultimate elongation | $A_5$ | % | ≥ 7 | ≥ 6 |
| Reduction of area | Z | % | ap. 30 | ap. 20 |
| Elastic modulus | – | N/mm² | ap. 200,000 | ap. 200,000 |
| Tensile strength (transverse) | $R_m$ | N/mm² | ap. 600 | ap. 720 |
| Hardness | – | – | – | – |
| HRC | – | – | ap. 28 | ap. 32 |
| HB 30 | – | – | ap. 280 | ap. 320 |
| Lateral shear strength | $\tau_s$ | N/mm² | ap. 510 | ap. 590 |
| Torsional shear strength | $\tau_t$ | N/mm² | ap. 440 | ap. 540 |
| Notched impact energy | $Av_{RT}$ | J | ap. 25 | ap. 10 |

| Dynamic | | | | |
|---|---|---|---|---|
| Tension/compression | $\sigma_w$ | N/mm² | ap. 350 | ap. 370 |
| Pulsating | $\sigma_{sch}$ | N/mm² | ap. 250 | ap. 270 |
| Reverse bending | $\sigma_{bw}$ | N/mm² | ap. 390 | ap. 420 |
| Torsional reversal | $\tau_{tw}$ | N/mm² | ap. 195 | ap. 225 |
| Torsional pulsating | $\tau_{sch}$ | N/mm² | ap. 345 | ap. 390 |

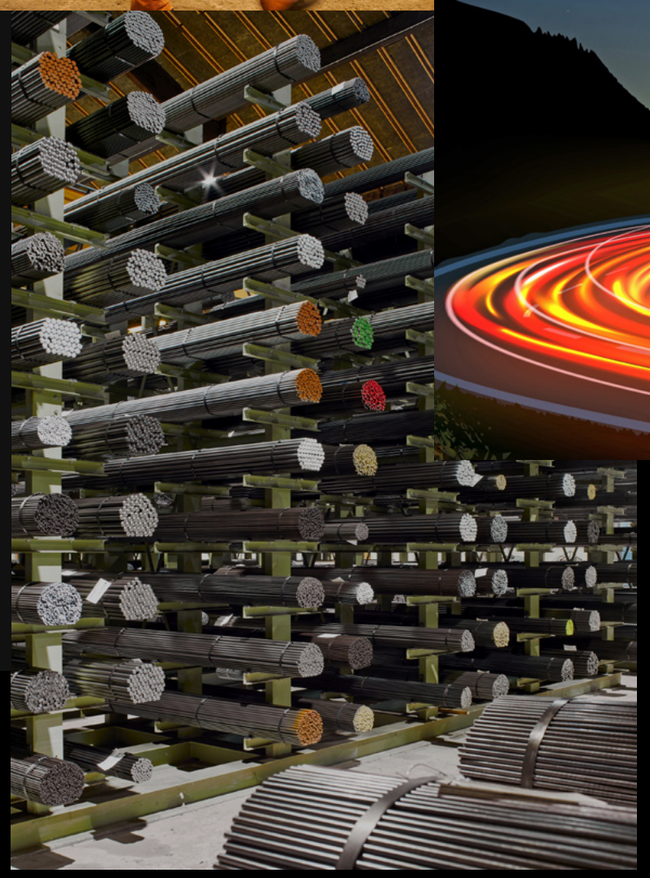
## Fatigue strength values for gear wheels

| **Tooth root stress for pulsating load** | | | **ETG® 88** | **ETG® 100** |
|---|---|---|---|---|
| as drawn | $\sigma_{FLim}$ | N/mm² | 248 | 272 |
| nitrocarburised | $\sigma_{FLim}$ | N/mm² | 301 | 327 |

| **Tooth root stress for alternating load** | | | **ETG® 88** | **ETG® 100** |
|---|---|---|---|---|
| as drawn | $\sigma_{WLim}$ | N/mm² | 174 | 190 |
| nitrocarburised | $\sigma_{WLim}$ | N/mm² | 211 | 229 |

1 N/mm² = 1 MPa
Straight teethed gears (m = 2 mm, z = 17)
Tooth system quality 7 acc. to DIN 3961...67
Standard values acc. to DIN 3990 resp. ISO 6336

# Let's defy convention



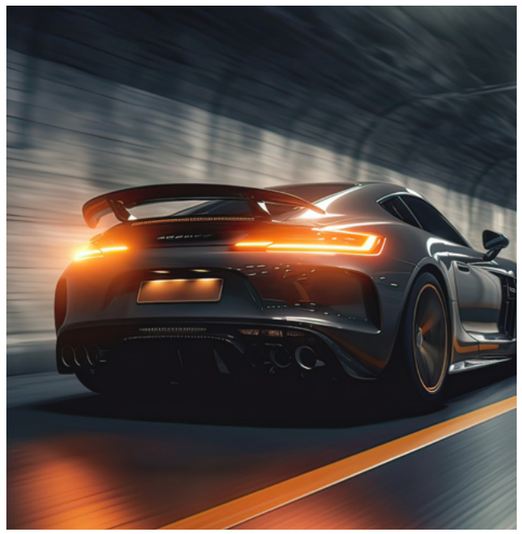
# Applications

## Across industries and across the world, our clients are building the impossible. Together, we’re shaping a smarter, greener, and more efficient future for everyone.

## Mobility

Go small. Downsize components to lower overall product weight.

ETG® steel components are besting standard steels in anything that moves.





Applications

## Mechanical engineering

Get precise. Produce precision components for load-bearing parts and systems.

ETG® 88/100 steel with short-breaking chips makes machining processes safer.

## Hydraulics

Load up. Improve the robustness of industrial hydraulic systems.

ETG® steels meet demands for high static loads, and simplify the production of your components.

# Machining Parameters

## Orientation values for various machining processes
## Machining guidelines $v_C$ [m/min] and f [mm/E]

| Machining process | $v_c$ / f | Process | ETG® 88 | ETG® 100 |
|---|---|---|---|---|
| **Multi-spindle CNC turning** (Carbide tooling, coated) | $v_c$ | roughing | 230 – 290 | 210 – 270 |
| | f | | 0.20 – 0.60 | 0.20 – 0.60 |
| | $v_c$ | finishing | 240 – 300 | 220 – 280 |
| | f | | 0.20 – 0.60 | 0.20 – 0.60 |
| | $v_c$ | plunging/ parting-off | 160 – 240 | 140 – 220 |
| | f | | 0.15 – 0.50 | 0.15 – 0.50 |
| **Multi-spindle CAM turning** (Straight turning – carbide tooling, coated) | $v_c$ | roughing | 180 – 240 | 170 – 230 |
| | f | | 0.05 – 0.20 | 0.05 – 0.20 |
| | $v_c$ | finishing | 190 – 250 | 180 – 240 |
| | f | | 0.05 – 0.20 | 0.05 – 0.20 |
| | $v_c$ | plunging/ parting-off | 120 – 180 | 110 – 170 |
| | f | | 0.10 – 0.40 | 0.10 – 0.40 |
| **Short-bed turning CNC** (Carbide tooling, coated) | $v_c$ | roughing | 230 – 290 | 210 – 270 |
| | f | | 0.20 – 0.60 | 0.20 – 0.60 |
| | $v_c$ | finishing | 240 – 300 | 220 – 280 |
| | f | | 0.20 – 0.60 | 0.20 – 0.60 |
| | $v_c$ | plunging/ parting-off | 160 – 240 | 140 – 220 |
| | f | | 0.15 – 0.50 | 0.15 – 0.50 |





| | | | | |
|---|---|---|---|---|
| **Plain turning CNC** (Carbide tooling, coated) | $v_c$ | roughing | 160 – 220 | 150 – 210 |
| | f | | 0.05 – 0.35 | 0.05 – 0.30 |
| | $v_c$ | finishing | 170 – 230 | 160 – 220 |
| | f | | 0.05 – 0.25 | 0.05 – 0.20 |
| | $v_c$ | plunging/ parting-off | 80 – 140 | 60 – 120 |
| | f | | 0.05 – 0.25 | 0.05 – 0.25 |
| **Drilling** (Insert drill bit – Carbide tooling, coated) | $v_c$ | – | 120 – 180 | 110 – 170 |
| | f | – | 0.10 – 0.30 | 0.10 – 0.30 |
| **Drilling** (HSS, coated) | $v_c$ | – | 30 – 70 | 25 – 65 |
| | f | – | 0.05 – 0.20 | 0.05 – 0.20 |
| **Reaming** (Carbide tooling, coated) | $v_c$ | – | 25 – 40 | 25 – 40 |
| | f | – | 0.15 – 0.30 | 0.15 – 0.30 |
| **Thread (Internal/External threading)** Chase threading – Carbide tooling, coated | $v_c$ | – | 70 – 150 | 60 – 140 |
| Cutting – Carbide tooling, coated | $v_c$ | – | 12 – 20 | 12 – 20 |
| Forming – HSS, coated | $v_c$ | – | 10 – 30 | 10 – 30 |

Values depending on the machine statics, cutting edge geometry, cooling lubricant, dimensions and drill diameter.

The special manufacturing processes used for ETG® steels result in a unique combination of high strength combined with outstanding machining properties.

# General recommendations

## General recommendations regarding the use of our ETG® steels

Complex components and demanding manufacturing processes require the right material. The more complex the components and the more sophisticated the manufacturing process, the more important it is to use the right material. The job of our technical support staff is to support customers in choosing the materials.

- As with all drawn steels, loads should be applied longitudinally wherever possible. With lateral loading, the tensile strength and yield strength are reduced. Wall thicknesses of less than 1 mm are in the critical boundary range.

- In view of the notch sensitivity, sharp-edged changes in cross-section should be avoided, especially if sudden stresses may occur. Particular care should be taken when using this material at temperatures below 0 °C.

- For bolts, screws and gear wheels, the applicable standards should be consulted.

- ETG® is suitable for threaded bolts with clamping nuts. It is not suitable though for screws with heads under stress except in the case of special fabrication solutions. ETG® 88 and ETG® 100 do not meet the strength required for classes 8.8 and 10.9 according to DIN EN ISO 898-1.

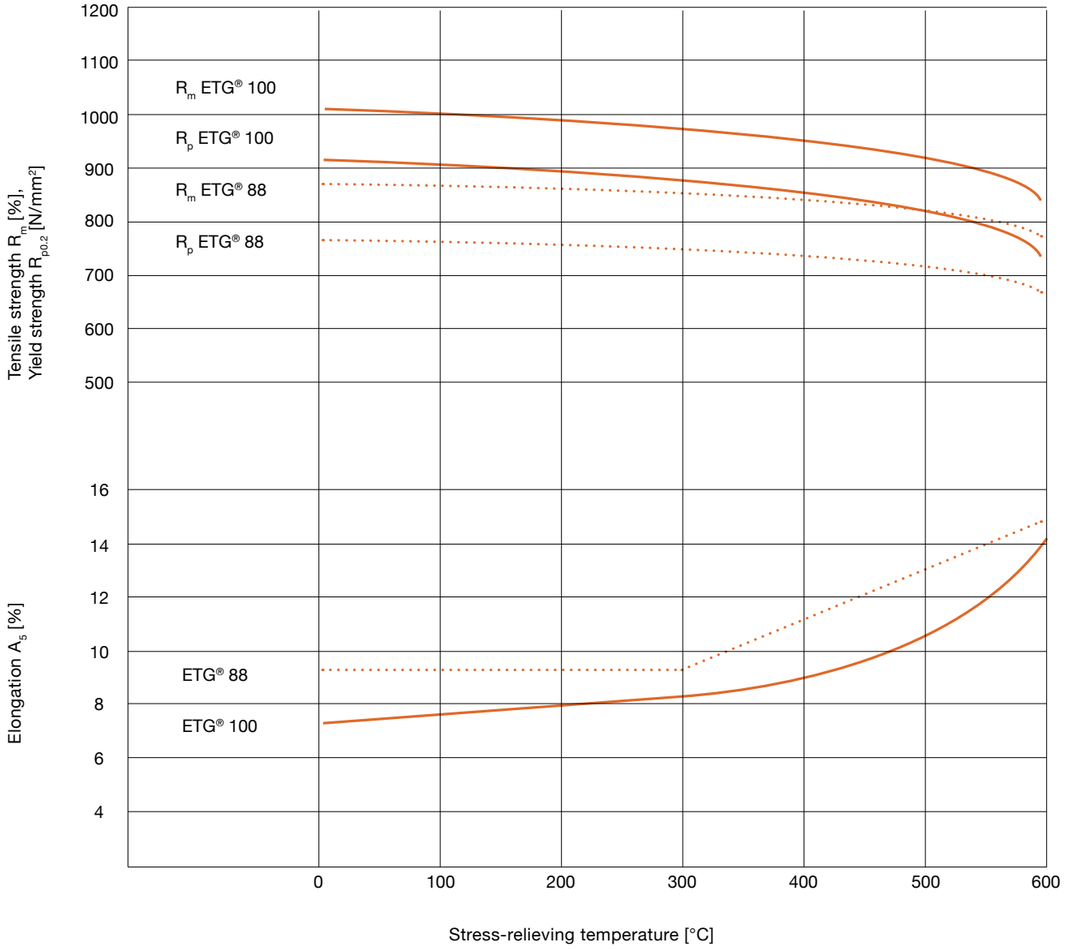
- In contrast with cold-drawn steel bars, ETG® 100 has low internal stress. However, this stress can cause distortion in situations such as: asymmetrical machining, long, narrow components and thin-walled components. We recommend stress-relieving the material for workpieces of this nature. The stress-relieving temperature should be at least 300 °C.

- Stress-relieving is not usually necessary with ETG® 88, as its internal stress levels are so low.

- For high-precision threaded spindles (i. e. lead screws), ETG® 100 should only be used in stress-relieved form (approx. 580 – 600 °C, min. 2 h).

# Longitudinal strength

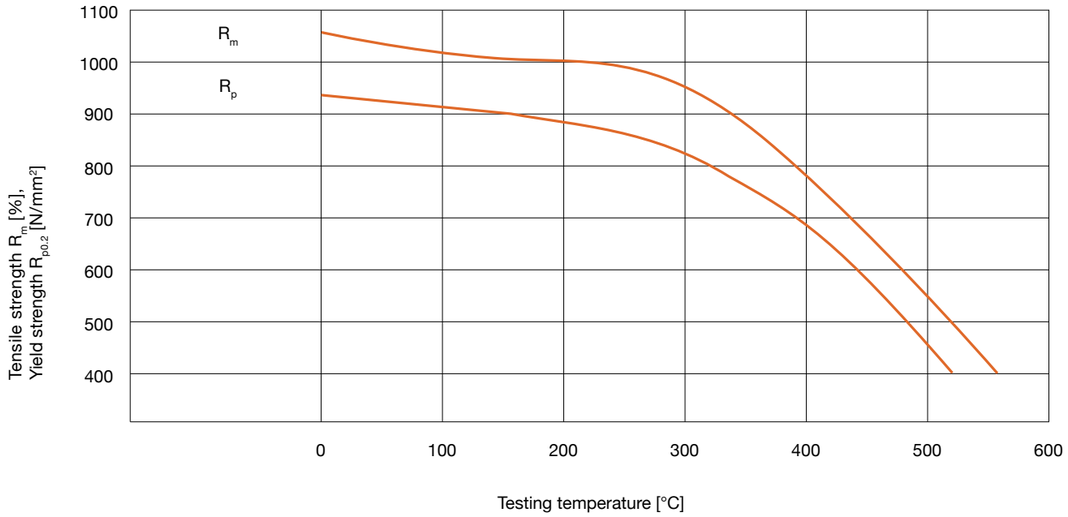
## Longitudinal strength
## in relation to stress-relieving temperature
## Typical values, stress-relieving time approx. 2 h

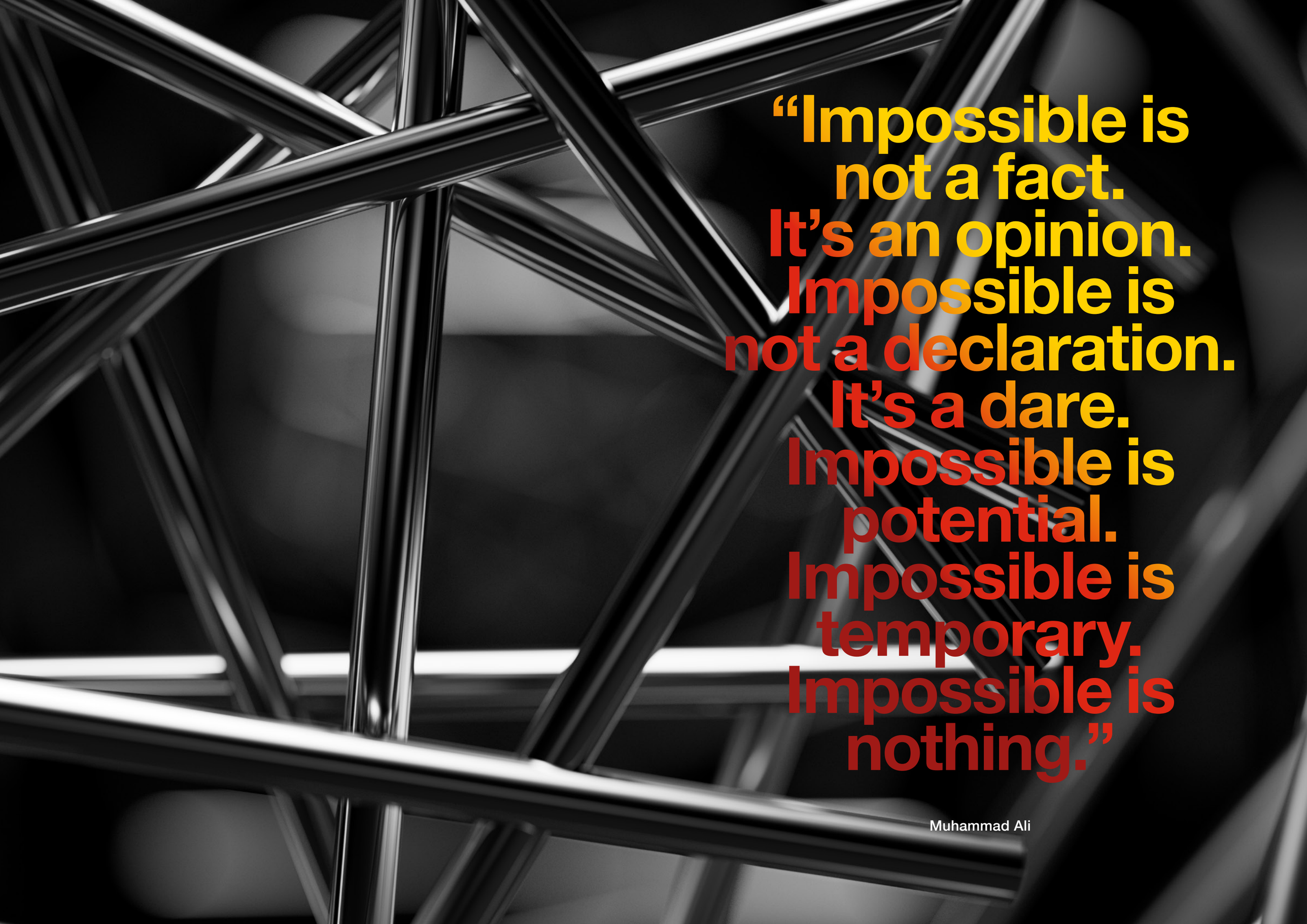







## High-temperature longitudinal strength for ETG® 100
## in relation to hardening temperature
## Typical values




“Impossible is
not a fact.
It’s an opinion.
Impossible is
not a declaration.
It’s a dare.
Impossible is
potential.
Impossible is
temporary.
Impossible is
nothing.”
Muhammad Ali

# Heat treating

## Recommendations for heat treating ETG® 88/100

- Avoid hardening caused by sharp edges, keyways or cross holes.
- Hardening thin-walled components across the full thickness of the wall is not recommended.
- When components with very complex geometries need to be hardened (e. g. spherically shaped areas, deep slots or notches, tight curves), they should undergo stress-relief annealing at 180 – 200 °C prior to hardening.
- As the ETG® 88/100 steels exhibit somewhat more pronounced banding than other Q&T steels, we recommend maintaining the hardening temperature at least 100 °C above $A_{c3}$.
- Like all rolled-and-drawn material, ETG® has a slightly decarburised boundary zone and thus a slightly reduced hardening effect in this zone.
- Hardening of drawn surfaces should be avoided due to the possible presence of surface imperfections. Due to the notch effect, hardening stresses at these imperfections may cause cracking.
- When hardening gear wheels, the tooth root should also be hardened to a depth of 0.2 mm.
- To avoid quench cracking due to stresses introduced during the hardening process, the hardened components should be tempered (~140 °C, 1 h) soon after hardening.
- Compared with ETG® 100, ETG® 88 is less susceptible to quench cracking due to its lower residual stress.

## Information for heat treating ETG® steels

The high-strength of ETG® steels lies in the range of tempered steels, which means that in most cases no additional heat treatment is necessary. If greater abrasion resistance or fatigue strength is needed, various surface hardening processes can be used. The high basic strength guarantees a good underlying structure and ideally fulfils the prerequisites for the following heat treatment processes:

- Induction hardening (high frequency)
- Nitrocarburising
  - Salt bath nitrocarburising
  - Gas nitrocarburising
  - Plasma nitrocarburising



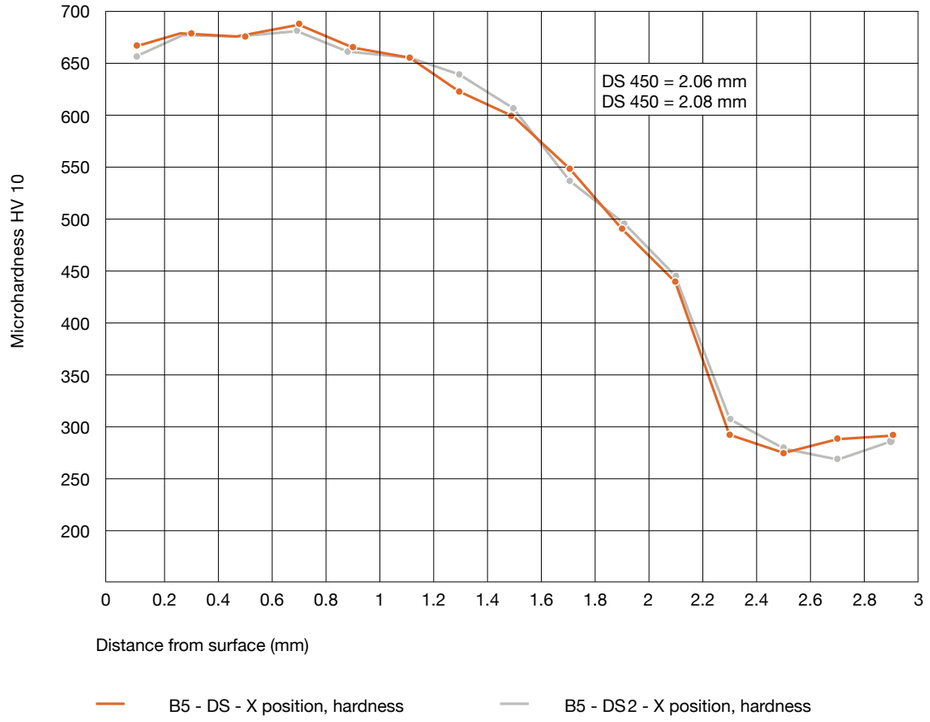


## Induction hardening (HF)

- Treatment temperature: 930 – 980 °C
- Quenching media: polymer
- Achievable hardness: 50 – 55 HRC

The depth of hardening should be kept to a minimum, generally not more than 1 mm. For complicated parts, an initial stress-relieving at 550 – 580 °C is recommended. Using water as a quench medium results in higher hardness, however there is a danger that quench cracking will occur.

### Induction hardening in focus
### Hardness profile according to DIN EN ISO 2639

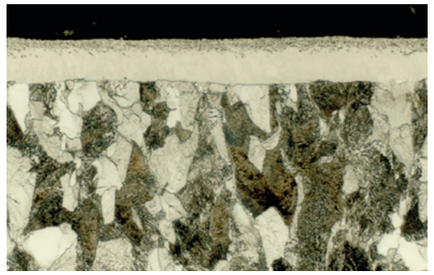


# Feel the heat of progress

# Nitrocarburising

## Nitrocarburising

Nitrocarburising improves the resistance of the steel to both wear and corrosion. It also increases the material's bending fatigue strength. ETG® 88/100 can be nitrocarburised by the salt bath, plasma or gas processes. In one study, ETG® 100 was nitrocarburised in a pit furnace at 520 °C and 570 °C for 10 h and 40 h and for 0.5 h and 4 h respectively. In each case an atmosphere with a nitriding potential of $K_N$ = 2 was used 2.5 % $CO_2$ was added at 570 °C.



ETG® 100, 520 °C 10h, $K_N$ = 2, Nital etchant

In applications with tight tolerances on dimensional stability, the material should undergo prior heat treatment at 520 – 570 °C. Plasma nitriding can also be used, as the process involves lower temperatures (approx. 480 – 510 °C). As the temperatures used in the plasma process are lower, there is less reduction in the core strength.

ETG® 100 exhibits a compact compound layer with little pore formation. The core hardness is approximately 315 HV 0.5. Similar results are achieved with ETG® 88. Nitrocarburising ETG® 100 will typically result in a reduction in tensile strength of between 100 MPa and 200 MPa. The reduction in tensile strength in the case of ETG® 88 is around 100 MPa.

## Nitrocarburising

| Treatment | Compound layer thickness | Porous zone | Thickness of nitriding layer | Case hardness |
|---|---|---|---|---|
| | µm | µm | mm | HV 0.5 |
| 520 °C N 10h | 8.8 | 2.5 | 0.25 | 540 |
| 520 °C N 40h | 10.5 | 3.5 | 0.38 | 580 |
| 570 °C NC 0.5h | 5.3 | 0.5 | 0.07 | 380 |
| 570 °C NC 4h | 17.8 | 3.5 | 0.20 | 480 |

Depending on the nitrocarburising process used, it may be necessary to temper the material at 350 °C for at least 2 hours to remove any hydrogen that has been introduced.





# Processing information

## Surface finish

The surface finish of ETG® 88/100 corresponds to the specifications in EN 10277-1.

ETG® 88/100 are tested for cracks as standard. We guarantee a surface finish of 3 for round bars and a surface finish of 2 for hexagonal bars. Please note that for a standard bar, the ends of the bar (up to 50 mm) cannot be tested.

If surface imperfections might cause problems (e.g. notch-stress concentration effect with surface hardening), the surface of the material must be removed to at least the allowable depth of imperfection.

## Welding

ETG® 88/100 have a limited weldability. Austenitic electrodes should be used and it should be noted that the strength will decrease significantly. The fracture strength depends on the strength of the weld metal. In order to avoid failures, we recommend carrying out tests before welding the part itself. Best results are achieved using tungsten inert gas (TIG) welding.

- Welding procedure: tungsten inert gas
- Welding consumable: X15CrNiMn 18 – 8 (1.4370)
- Preheat 300 °C
- Tensile strength of the welded joint: 490 – 670 N/mm²

ETG® is not suitable for laser welding.

## Non-cutting forming, thread rolling

Threads can be rolled on ETG®. However, worms, trapezoidal threads, etc. should be cut, not rolled.

## Other non-cutting processes

For solutions to punching, bending, swaging, forging, etc., which should not be carried out on ETG® 88 and ETG® 100, please contact our technical services.

## Brazing

ETG® can also be brazed, but with consequent loss of strength. It must be allowed to cool slowly, as there is a danger of stress cracks.

## Surface finishing

Most surface finishes can be applied to ETG® 88/100. For example, they can be hot galvanised, chromated, chromium plated, nickel plated or alkaline blackened without difficulty. Due to the manganese sulphide in the steel, special care must be taken when pickling and neutralising. The temperature at which surface finishing is carried out should not exceed 500 °C. Ground material is recommended.

# Steel beyond limits

## Beyond common mindset

A creative mindset we share with passion.

Beyond common steels, paired with innovation, support and services to match. With free calculations on process-saving potential and cost-free trials, we go beyond for our customers, enabling them to produce leaner, safer and more competitively.

Swiss Steel Group

### Our people

For over 30 years, we have partnered with customers and suppliers, universities and research institutes, to reach beyond the common mindset. Together, we push boundaries. Together, we redefine expectations.

### Our network

Global reach. Local touch. Access to our expertise and experience helps you operate lean and efficiently. On-site or remote, our quality technical services offer accessibility and fast communications so you operate leaner.

### Our production

We monitor our production processes to operate as lean and efficiently as possible. To keep our products as reliable as possible.

### Our testing process

Stringent production testing and quality control checks guarantee the consistency of high quality within very close tolerances.

# Together. For a future that matters.

We reserve the right to make changes and technical improvements without notice. Errors and omissions excepted. The product-specific data sheets take priority over the details given in the catalogue. The desired performance characteristics are only binding if they had been agreed upon exclusively at the time that the contract was made.

Swiss Steel Group

ETG® 88/100 is produced at Steeltec AG
and Steeltec GmbH

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