

# Technical Data Sheet

## UGIMA®-X 4404

### Chemical analysis (%)

| C     | Si    | Mn    | Ni          | Cr          | Cu     | Mo        | P      | S             |
|-------|-------|-------|-------------|-------------|--------|-----------|--------|---------------|
| ≤0.03 | ≤ 1.0 | ≤ 2.0 | 10.0 – 12.0 | 16.5 – 17.5 | ≤ 0.75 | 2.0 – 2.5 | ≤ 0.04 | 0.020 – 0.030 |

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### General presentation

UGIMA®-X 4404 is a stainless steel of highly improved machinability manufactured only by Ugitech.

Its properties are identical to those of other 1.4404s except for its machinability, which is even better than that of UGIMA® 4404 and UGIMA® 4404 HM, the 1.4404 grades from Ugitech with already improved machinability:

- UGIMA®-X 4404 is a stainless steel resulting from an improved production and control process in the inclusive UGIMA® population developed by Ugitech.
- UGIMA®-X 4404 represents a technological advance which has advantages whatever the machining conditions, machinery or tools used; its machinability is optimal at high cutting conditions.

- Compared to the UGIMA® 4404, the grade already improved in terms of machinability, increases of 15% and 20% have been achieved in turning and drilling respectively, and compared to UGIMA® 4404 HM turning is increased by 7% and drilling increased by 12 %.

### Classification

Improved Machinability Austenitic Stainless Steel with Molybdenum

### Designation

#### Material No.

| Europe – EN |                 | USA – UNS | Japan – JIS | World – ISO                      |
|-------------|-----------------|-----------|-------------|----------------------------------|
| 1.4401      | X5CrNiMo17-12-2 | S31600    | SUS316      | 4401-316-00-I<br>X5CrNiMo17-12-2 |
| 1.4404      | X2CrNiMo17-12-2 | S31603    | SUS316L     | 4404-316-03-I<br>X2CrNiMo17-12-2 |

#### Other material name

| USA (AISI) | France (AFNOR) | Germany (DIN) | UK (BS) | Sweden (S.S) |
|------------|----------------|---------------|---------|--------------|
| 316        | Z7CND 17-11-02 | 1.4401        | 316S31  | 2347         |
| 316L       | Z3CND 17-11-02 | 1.4404        | 316S11  | 2348         |

### Mechanical properties

#### Tensile data

|                          | Yield stress | Tensile strength | Elongation | Reduction of Area |
|--------------------------|--------------|------------------|------------|-------------------|
|                          | Rp0,2% (MPa) | Rm (MPa)         | A (%)      | Z (%)             |
| Solution annealed        | ≥ 220        | 500 – 600        | ≥ 45       | ≥ 70              |
| Work-hardened by drawing | 320 – 660    | 560 – 800        | ≥ 32       | ≥ 60              |



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Limit values for information only; approximate ranges allowing for the different cold drawing rates it is possible to apply (cold drawing rate ↑ = hardness and strength ↑)

### Physical properties

| Temperature | Density  | Elastic modulus | Thermal conductivity | Expansion coefficient<br>From 20 to 500°C | Electrical resistivity | Specific heat |
|-------------|----------|-----------------|----------------------|---|------------------------|---------------|
| (°C)        | (kg/dm³) | (GPa)           | (W/m.K)              | (K <sup>-1</sup> )                        | (μΩ.mm)                | (J/kg.K)      |
| 20          | 7.90     | 196             | 15.0                 | -   | 750                    | 500           |
| 200         | -        | -               | -                    | 16.5 x10 <sup>-6</sup>                    | -                      | -             |

(Indicative values)

### Magnetic properties

Like most austenitic stainless steels, UGIMA®-X 4404 is almost non-magnetic after a solution annealed heat treatment. However, after cold drawing, mild ferromagnetic behavior may be observed due to the destabilization of the austenite.

### Corrosion resistance

UGIMA®-X 4404 has the same corrosion resistance as UGIMA® 4404. It therefore has excellent corrosion resistance in natural atmospheres: watercourses, rural and urban atmospheres, industrial atmospheres, even in the presence of moderate concentrations of chlorides and acids, in food and farm-produce environments and in numerous acid (sulfuric, phosphoric and organic) and chlorinated atmospheres, under certain temperature and concentration conditions.

| Environment        | Behavior  |
|--------------------|-----------|
| Nitric acid        | Good      |
| Phosphoric acid    | Moderate  |
| Sulfuric acid      | Moderate  |
| Acetic acid        | Good      |
| Sodium             | Moderate  |
| NaCl (Saline mist) | Good      |
| Humidity           | Excellent |
| Petrol             | Moderate  |
| Seawater           | Moderate  |

UGIMA®-X 4404 effectively resists intergranular corrosion even after welding and passes the standardized tests:

- AFNOR NFA05-159,
- ASTM A262 75 PRACTICE E,
- DIN 50914,

And, on request, special tests.

UGIMA®-X 4404 can be used in marine environments and in highly oxidizing chemical atmospheres.

The use of UGIMA®-X 4404 is compatible with all fluids, lubricants, oils and greases applied in industry and machining. Optimum corrosion resistance is achieved on a surface free from residual machining oils or foreign particles (iron, for example).

The pickling of UGIMA®-X 4404 is comparable to that of a standard 1.4404 such as UGI® 4404.

The decontamination of steels is not recommended because of the complexity and cost of this operation; however, if this is necessary, the recommended decontamination / passivation treatment is as follows:

- 1 volume nitric acid 52% (36° Baumé)
- 1 volume water
- at room temperature
- short duration
- finish with thorough washing



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The corrosion resistance of a stainless steel depends on a number of factors, both in terms of the composition of the aggressive atmosphere (chloride concentration, presence or absence of oxidants, temperature, pH, whether or not there is agitation, etc.) and in terms of the material (surfaces free from ferrous particles, surface condition such as cold drawing, polishing, etc.). Precautionary measures must also be taken for certain tests, e.g. for saline mist (ISO 9227): for example, the use of marking labels placed on the sample must be avoided as these could cause corrosion run-outs and minimize the duration of resistance in the test.

### Hot transformation – Forging

The forging of UGIMA®-X 4404 pose no particular problems:

- Heating without special precautions up to 1150°-1180°C.
- Forging between 1180°C and 950°C (the best results being obtained between 1100 and 1180°C).
- Cooling in air or water, if no deformation is feared. Priority will be given to cooling in water for high charges (avoid cooling stacked forgings in air).

### Heat treatment

The heat treatment of UGIMA®-X 4404 consists of quenching the metal in water or air after keeping it for an extended period (at least half an hour) at a high temperature of between 1000 and 1100°C. This solution annealing heat treatment enables all traces of cold drawing to be removed whilst providing the steel with its lowest level of mechanical properties.

### Machinability

Due to specific optimization of the entire oxide population in the grade, UGIMA®-X 4404 guarantees exceptional machinability performances for a 1.4404. Such performances are provided especially in very high or severe cutting conditions.

Its performance is based on very good chip breaking, increased tool service lives and very good surface finish after machining.

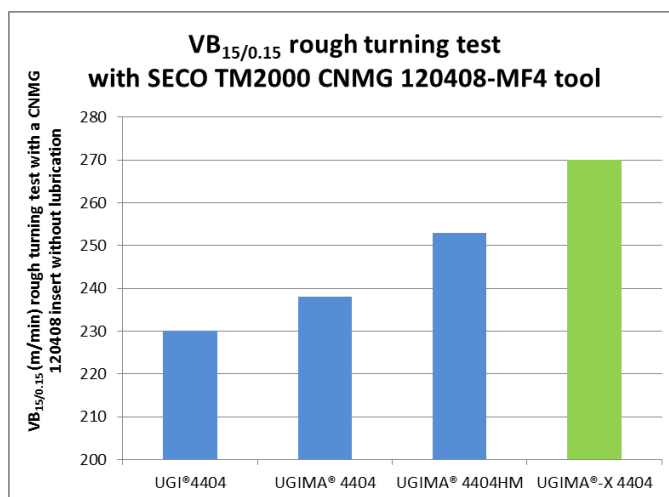
To obtain the maximum benefit from the potential of this grade, in terms of parts and working environment, contact our Technical Support Department.

### Turning

#### VB<sub>15/0.15</sub>

In terms of tool insert wear (VB<sub>15/0.15</sub> tests, representative of the potential rough turning productivity), the accessible cutting conditions of UGIMA®-X 4307 increase by 4% compared with the already improved UGIMA® 4307, and industrial machinability dispersion, already good in UGIMA® 4307, is significantly improved.

The VB<sub>15/0.15</sub> tests obtained with the SECO TM2000 CNMG 120408-MF4 inserts are shown in the chart below.



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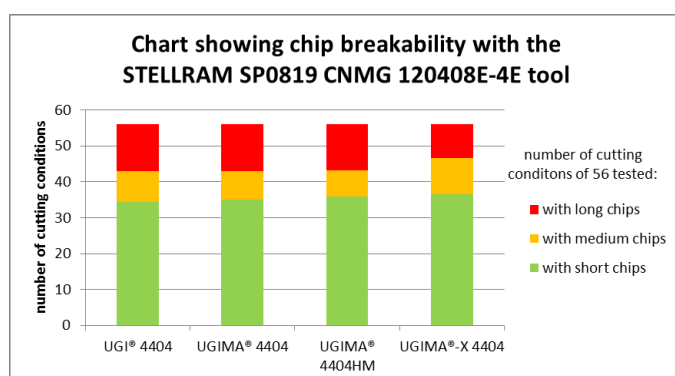
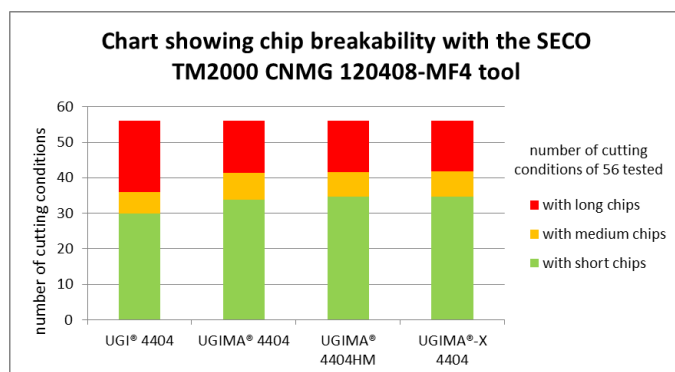
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### Chip Breaking Zones (CBZ)

In terms of chip breakability (CBZ tests, representative of the ability of the metal to limit machine downtime due to chips becoming entangled around the tools), the number of short chip cutting conditions for UGIMA®-X 4404 is slightly increased compared to those obtained with the already improved UGIMA® 4404 and UGIMA® 4404HM. This is shown in the following charts, which indicate the number of machining conditions producing short, medium and long chips (among those tested\*) for two reference turning inserts and for each stainless steel grade tested.

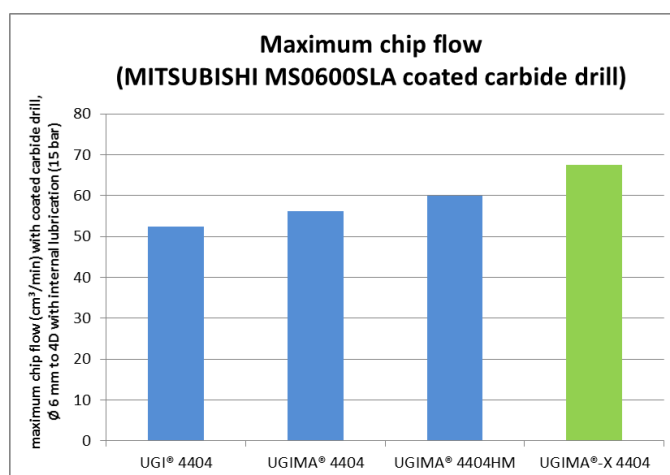


\* the conditions tested are as follows: at a constant cutting speed (200 m/min), the feed rate "f" is varied from 0.1 mm to 0.4 mm/rev, in increments of 0.05 mm/rev, and the cutting depth "ap" is varied from 0.5 mm to 4 mm, in increments of 0.5 mm; fifty-six conditions were tested using this method.

### Drilling

To compare UGIMA®-X 4404 to the other 1.4404 grades in drilling, tests were carried out using coated carbide drills of Ø6 mm, with central coolant (soluble oil at 15 bars). Tests were carried out at 4D (24mm depth) for different drilling conditions in order to find the domain (in terms of cutting speed and feed rates) in which 550 holes could be drilled with a drill without breaking it. The wider the domain, the better the grade. Maximum chip flow rates were consequently defined in line with the better productivity in obtaining the 550 holes with one drill. The higher this flow rate, the better the grade.

UGIMA®-X 4404 has a wider domain than that of UGI® 4404, even the already highly improved UGIMA® 4404HM; Because of this, the maximum chip flow rate of UGIMA®-X 4404 is improved by 12%, 20% and 30% compared to UGIMA® 4404 HM, UGIMA® 4404 and UGI® 4404 respectively, as shown in the following chart.



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### Welding

UGIMA®-X 4404 can be welded without undue difficulty, with or without welding filler wire. If a welding filler wire is required, use grades E316L (coated electrodes), ER316L (GTAW), or ER316LSi (GMAW).

In GMAW or GTAW welding, to avoid any risks of hot cracking, welding heat input should be limited (to avoid the sulfur segregation responsible for the hot cracking phenomena occurring during weld pool cooling). However, for laser welding, welding heat input must be maximized (to avoid too rapid cooling which brings about hot cracking of the welds by austenitic solidification).

No heat treatment is required after welding.

### Available products

| Product    | Shape     | Surface finish      | Tolerance | Dimension    |
|------------|-----------|---------------------|-----------|--------------|
| Bar        | Round     | Rolled and descaled | 12 to 13  | 22 to 130 mm |
|            | Round     | Turned and polished | 9 to 11   | 22 to 130 mm |
|            | Round     | Drawn               | 8 to 9    | 1.8 to 55 mm |
|            | Round     | Ground              | 7 to 9    | 1.8 to 80 mm |
|            | Hexagonal | Drawn               | 11        | 3 to 55 mm   |
| Drawn wire | Round     | Mat                 |           | 1 to 14 mm   |

Other formats: contact us

### Applications

- General component production
- Chemical industry
- Oil, petrochemical and nuclear industries
- Food-processing and agricultural industries
- Decorating and household equipment
- Building and construction, Transport
- Electronic equipment



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