



## DETAILED PROPERTIES OF MILL-MAX RAW MATERIALS (including RoHS 2002/95/EC requirements)

### PROPERTIES OF METALS USED BY MILL-MAX

Copper alloy rod and wire for precision-machined pins, receptacles & solder terminals (**Alloys C36000 & C54400 contain 3 to 4% lead to permit "free machining" and is permitted by EC Directive 2002/95 Annex 6; so all pin materials are RoHS compliant.**)

**BRASS ALLOY 360** (UNS C36000) per ASTM B 16  
**PHOSPHOR BRONZE Alloy 544** (UNS C54400) per ASTM B 139  
**TELLURIUM COPPER Alloy 145** (UNS C14500) per ASTM B 301

Spring alloy strip for stamping "multi-finger" spring contacts  
**BERYLLIUM COPPER Alloy 172** (UNS C17200) per ASTM B 194  
**BERYLLIUM NICKEL Alloy 360** (UNS N03360)

#### Properties of BRASS:

Stock diameters available: .062/.072/.078/.093/.125/.156/.187/.250"  
Chemical composition: Cu 61.5%, Zn 35.4%, Pb 3.1%  
Temper as machined: H02/H04  
Modulus of elasticity:  $14 \times 10^6$  psi  
Tensile strength:  $70-90 \times 10^3$  psi  
Hardness as machined: 80-90 Rockwell B

After machining, brass parts are often annealed (softened) for subsequent bending, swaging or crimping. A partial anneal down to 60-10 RB is recommended for 90° bends, a full anneal down to 35±15 RB is recommended for pins or terminals that are swaged (riveted) to a circuit board or crimped to a wire.

Density: .307 lbs/in<sup>3</sup>  
Electrical conductivity: 26% IACS\*  
Melting point: 900°C/885°C (liquidus/solidus)

#### Properties of PHOSPHOR BRONZE:

Used for pins requiring more durability than brass.  
Stock diameters available: .072/.078"  
Chemical composition: Cu 88%, Sn 4%, Zn 4%, Pb 4%  
Temper as machined: H04  
Modulus of elasticity:  $15 \times 10^6$  psi  
Tensile strength:  $70-80 \times 10^3$  psi  
Hardness as machined: 83 Rockwell B  
Density: .321 lbs/in<sup>3</sup>  
Electrical conductivity: 19% IACS\*  
Melting point: 1000°C/930°C (liquidus/solidus)

#### Properties of TELLURIUM COPPER:

Used for pins requiring a higher current carrying capacity than brass or phosphor bronze.  
Stock diameters available: .079/.093/.125/.156"  
Chemical composition: Cu 99.44%, Te .55%, P .008%  
Temper as machined: H02  
Modulus of elasticity:  $17 \times 10^6$  psi  
Tensile strength:  $43 \times 10^3$  psi  
Hardness as machined: 43 Rockwell B  
Density: .323 lbs/in<sup>3</sup>  
Electrical conductivity: 93% IACS\*  
Thermal conductivity: 91% IACS\*  
Melting point: 1075°C/1051°C (liquidus/solidus)

#### Properties of BERYLLIUM COPPER:

Chemical composition: Cu 98.1%, Be 1.9%  
Temper as stamped: TD01  
Properties after heat treatment (TH01):  
Modulus of Elasticity:  $19 \times 10^6$  psi  
Tensile Strength:  $175-205 \times 10^3$  psi  
Yield Strength (0.2% offset):  $150-185 \times 10^3$  psi  
Elongation: 3-10%  
Stress Relaxation†: 96% of stress remains after 1,000 hours @ 100 °C  
70% of stress remains after 1,000 hours @ 200 °C  
Hardness: 36-43 Rockwell C  
Density: .298 lbs/in<sup>3</sup>  
Electrical Conductivity: 22% IACS\*  
Melting point: 980°C/865°C (liquidus/solidus)

†Since BeCu loses its spring properties over time at high temperatures; it is rated for continuous use up to 150°C. For "down-hole" and "burn-in" applications up to 300°C, Mill-Max offers four contacts (#24, #26, #27 & #38) made from Beryllium Nickel Alloy 360 (UNS N03360)

#### Properties of BERYLLIUM NICKEL:

Chemical composition: Ni 97.6%, Be 1.9%, Ti 0.5%  
Modulus of Elasticity:  $27-30 \times 10^6$  psi

Tensile Strength:  $245 \times 10^3$  psi min.  
Yield Strength (0.2% offset):  $200 \times 10^3$  psi min.  
Elongation: 9% min.  
Hardness: 49 Rockwell C  
Density: .294 lbs/in<sup>3</sup>  
Electrical Conductivity: 7% IACS\*  
Melting point: 1,325°C/1,195°C (liquidus/solidus)

\*International Annealed Copper Standard, i.e.: as a % of pure copper.

### PROPERTIES OF PLASTICS USED BY MILL-MAX

Standard plastics used for catalog products:

#### Injection Molded

**PCT** Polyester, High Temp (Thermx CG933, black)  
**Nylon46**, High Temp (Stanyl TE250F6 {30% glass} or TE250F9 {45% glass}, black)  
**PPS**, High Temp (Ryton R-4-200)

#### Machined

**FR-4** Epoxy/Glass Laminate. Thicknesses available: .010", .020", .031", .047", .062", .093", .125" (natural color, beige)  
**FR-4** Epoxy/Glass Laminate, .055" thick (black)  
**G-30** Polyimide/Glass Laminate, .062" thick (natural color, brown)

### TEMPERATURE COMPARISON OF MOLDED INSULATORS

MATERIAL	BRAND	GRADE	HEAT DEFLECTION TEMP. (per ASTM D 648)
PCT Polyester	Thermx	CG-933	529°F (276°C) @ 66 psi
Nylon 46	Stanyl	TE250-F6 or F9	554°F (290°C) @ 264 psi
PPS	Ryton	R-4-200	>500°F (>260°C) @ 264 psi

Note: Materials above 446°F (230°C) are considered suitable for "eutectic" reflow soldering, above 500°F (260°C) for "lead-free" reflow soldering.

**PCT is the standard plastic used with RoHS "lead-free" plated pins.**

### MILL-MAX STANDARD PLATINGS (FINISHES):

**GOLD** per ASTM B 488, Type 1 (99.7% min. gold),  
Code C (130-200 HK {Knoop hardness}),  
Class (thickness) per customer's requirements  
**SILVER** per ASTM B 700, Type 1 (99.9% min. silver),  
Grade B (Bright),  
Class S (anti-tarnish treatment),  
Thickness (7.5µm/300µ") used for solder terminals)  
**TIN/LEAD** (93/7) per ASTM B 545 (Appendix X6.3.2.5 to eliminate whisker growth)  
Class A (2.5µm/100µ")  
or Class B (5µm/200µ"),  
Bright finish (Matte available to order)  
**ELECTRO-SOLDER** (60/40) per ASTM B 579, SC2 (8µm/300µ"),  
Bright finish (Matte available to order)

#### Standard finishes available for RoHS "lead-free" applications:

**GOLD** per ASTM B 488, Type 1 (99.7% min. gold),  
Code C (130-200 HK {Knoop hardness}),  
Class (thickness) per customer's requirements  
**TIN** (100%) per ASTM B 545, Class A (2.5µm/100µ")  
or Class B (5µm/200µ"),  
Matte finish (With whisker and oxide inhibitors and a nickel underplate)

#### ALL MILL-MAX PARTS REQUIRE AN UNDERPLATE:

Brass parts need a barrier plate to prevent zinc diffusion, 50µ" min. nickel or 100µ" min. copper is recommended by ASTM B 545 & 579. ASTM B 488 also recommends a 50µ" min. nickel barrier plate beneath gold to prevent copper diffusion inherent with all copper alloy products.

### MILL-MAX STANDARD UNDERPLATES:

**NICKEL** per ASTM B 689, Type 2 (Bright),  
Class 1.25 (1.25µm/50µ") or Class 2.5 (2.5µm/100µ")

Also available for military & "non-magnetic" applications:

**COPPER** per ASTM B 734, Class 2.5 (2.5µm/100µ")  
or Class 5 (5µm/200µ")