



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: 1,57/1,83/1,98/2,36/3,18/3,96/4,75/6,35mm
 Chemical composition: Cu 61.5%, Zn 35.4%, Pb 3.1%
 Temper as machined: H02/H04
 Modulus of elasticity: 14×10^6 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/in³
 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: 1,83/1,98mm
 Chemical composition: Cu 88%, Sn 4%, Zn 4%, Pb 4%
 Temper as machined: H04
 Modulus of elasticity: 15×10^6 psi
 Tensile strength: $70-80 \times 10^3$ psi
 Hardness as machined: 83 Rockwell B
 Density: .321 lbs/in³
 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: 2,01/2,36/3,18/3,96mm
 Chemical composition: Cu 99.44%, Te .55%, P .008%
 Temper as machined: H02
 Modulus of elasticity: 17×10^6 psi
 Tensile strength: 43×10^3 psi
 Hardness as machined: 43 Rockwell B
 Density: .323 lbs/in³
 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: 19×10^6 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/in³
 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: 245×10^3 psi min.
 Yield Strength (0.2% offset): 200×10^3 psi min.
 Elongation: 9% min.
 Hardness: 49 Rockwell C
 Density: .294 lbs/in³
 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: 0,25, 0,51, 0,79, 1,19, 1,57, 2,36, 3,18mm (natural color, beige)
FR-4 Epoxy/Glass Laminate, 1,40mm thick (black)
G-30 Polyimide/Glass Laminate, 1,57mm 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 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) or Class B (5µm),
 Bright finish (Matte available to order)
ELECTRO-SOLDER (60/40) per ASTM B 579, SC2 (8µm),
 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) or Class B (5µm),
 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, 1,27µm min. nickel or 2,54µm min. copper is recommended by ASTM B 545 & 579. ASTM B 488 also recommends a 1,27µm 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) or Class 2.5 (2.5µm)
 Also available for military & "non-magnetic" applications:
COPPER per ASTM B 734, Class 2.5 (2.5µm) or Class 5 (5µm)