

## PROPERTIES OF METALS USED BY MILL-MAX

Copper alloy rod and wire for precision-machined pins, receptacles & solder terminals (**RoHS-2 directive 2011/65/EU, exemption 6c**) allows up to **4% lead as an alloy agent in copper. All Mill-Max pin materials are:**

**BRASS ALLOYS;** 360 per ASTM B 16, and 385 per ASTM B455

**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 Alloy 360 ASTM B 16:

Chemical composition: Cu 63% (max), Pb 3.7% (max), Fe .35% (max), Zn remainder

Temper as machined: H02/H04

Yield Strength: 25-45 ksi

Tensile strength: 57-80 ksi

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.

Electrical conductivity: 26% IACS \*

Melting point: 1000°C/840°C (liquidus/solidus)

### Properties of BRASS Alloy 385 ASTM B 455:

Chemical composition: Cu 60% (max), Pb 3.5% (max), Fe .35% (max), Zn remainder

Temper as machined: H02/H04

Yield Strength: 16 ksi (min)

Tensile strength: 48 ksi (min)

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.

Electrical conductivity: 28% IACS \*

Melting point: 1000°C/840°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 MPsi

Tensile strength: 70-80 KSI

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 MPsi

Tensile strength: 43 KSI

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 MPsi

Tensile Strength: 175-205 KSI

Yield Strength (0.2% offset): 150-185 KSI

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 nine contacts (#19, #24, #25, #26, #27, #33, #38, #56, #58) 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 MPsi

Tensile Strength: 245 KSI min.

Yield Strength (0.2% offset): 200 KSI 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. In stock thicknesses available: .010", .020", .031", .047", .062", .093", .125" (natural color, beige). Other thicknesses available upon request.

**G-30** Polyimide/Glass Laminate, .062" thick (natural color, brown)

### 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 and 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 and "non-magnetic" applications:

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

Class 5 (5µm/200µ")

### TEMPERATURE COMPARISON OF MOLDED INSULATORS

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

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

**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 & a nickel underplate)