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: 1,83/1,98mm
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/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 MPSI
Tensile strength: 43 KSI
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 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/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 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/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. In stock thicknesses available: 0,25, 0,51, 0,79, 1,19, 1,57, 2,36, 3,18mm (natural color, beige). Other thicknesses available upon request.

G-30 Polyimide/Glass Laminate, 1,57 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 4	Stanyl	TE250-F6 or F9	554°F (290°C) @ 264 psi
PPS	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 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 & 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 and 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 and "non-magnetic" applications:

COPPER per ASTM B 734, Class 2.5 (2,5µm) or Class 5 (5µm)

Pins & Receptacles

Pin & receptacle shells are manufactured by precision high-speed turning machines. The base materials for these components are copper alloys.

Receptacles are a two piece construction consisting of a plated contact press-fit into a plated shell. The contacts are stamped from beryllium copper strip.

Materials

Pins & Receptacle Shells:
Brass Alloy 360 UNS C36000 ASTM-B16, and 385 UNS 38500 ASTM B455 (Up to a 6,35mm diameter)
Phosphor Bronze alloy 544 UNS C54400 ASTM-B139 (Up to a 1,83mm diameter)
Tellurium Copper alloy 145 UNS C14500 ASTM-B301 (Up to a 3,96mm diameters)

See page 154 and 203 for a complete list of standard available stock diameters.
(For the availability of larger diameter materials contact Technical Services).

Contacts:
Beryllium copper UNS C17200 ASTM-B194 (For most applications)
Beryllium Nickel UNS N03360 (For high temperature applications)

(For individual contact specifications see pages 250 - 262)
The materials listed above are all RoHS compliant.

Dimensional, Mechanical & Environmental Data

Standard tolerances for pins & receptacle shells:
Diameters +/- 0,051mm
Lengths +/- 0,13mm
Angles +/- 2°

Mechanical Life (Durability): Mill-Max receptacles are capable of 1,000 minimum insertion/extraction cycles for a broad range of applications. Mating pin size, shape and finish, along with application specific variables, will affect the life of a contact.

Contact Forces: See individual contact specifications on pages 250 - 262.

Environmental Data:
- Operating temperature range: -55/+125° C (min. / max. discontinuous)
- Vibration (No electrical discontinuity Greater than 1 µs): 10-2000 HZ, 15 G
- Shock (No electrical discontinuity Greater than 1 µs): 50 G

Electrical data is dependent on the contact used in the receptacle. See page 248 for free air current ratings of the contacts.

Platings

GOLD per ASTM B 488 and MIL-G-45204, Type 1, Code C
SILVER per ASTM B 700, Grade B, Class S
TIN per ASTM B 545, Type 1
TIN/LEAD (93/7) per ASTM B 545
ELECTRO-SOLDER (60/40) per ASTM B 579, Bright
NICKEL per SAE-AMS-QQ-N-290
ELECTROLESS NICKEL per MIL-C-26074
COPPER per SAE-AMS-2418

Connectors

Connectors are headers, sockets and interconnects. They consist of pins, receptacles or spring pins assembled into thermoplastics or machined laminate insulator bodies. They are available in DIP, SIP, strip, BGA and PGA packages in grids of 1mm, 1,27mm, 1,78mm, 2mm, 2,54mm, .8mm for BGA's and 2,54mm interstitial for PGA's.

Electrical Data

SERIES:	100-700	80X	830	850
• Rated current (Amps):	3	3	3	1
• Rated voltage:	100 VRMS/150 VDC			
• Contact resistance:	10 mΩ max.			
• Insulation resistance:	10,000 MΩ min.			
• Dielectric strength: (700 VRMS min. for series 117 Shrink DIP)	1000 VRMS min.			
• Air and creepage distance (mm): (0,30 for series 117 Shrink DIP)	0,71	0,84/0,71	0,51	0,41/0,51
• Capacitance(pF max):	.8	1	1	1

Electrical data above does not apply to BGA, PLCC, USB or spring-loaded connectors. Electrical data for these products can be found on the following pages: BGA – Page 141; PLCC - Page 141; USB - Pages 147 - 150; Spring-Loaded connectors – Pages 6 - 19
Current ratings are for a 10° C temperature rise above ambient (20°C)

Operating temperature range: -55/+125° C (min./max. discontinuous)

General tolerances for assembled connector products:
- Lengths: +/- 0,25mm
- Connector Flatness: 0,13mm (up to 25,4mm in length)
- Co-planarity of SMT Connectors: 0,13mm (up to 25,4mm in length)
- For connectors exceeding 25,4mm in length the flatness/co-planarity may exceed 0,13mm. Please contact Technical Services for more information.

(Note: Specifications and tolerances are provided wherever possible. Due to the wide variety of connectors Mill-Max offers, the specific tolerances vary from product to product. If you need information regarding the tolerance of a particular part, please contact Technical Services.)

Materials

Insulator Bodies:
Standard material is glass filled thermoplastic polyester (PCT), self extinguishing, rated UL 94 V-0.

Some surface mount, pin grid array, spring pin and shrouded connector insulators are molded from high temperature Nylon 46 or PPS, rated UL 94 V-0.

FR-4 epoxy laminate is a thermoset material used in custom insulators and high temperature applications. It is especially useful because of its low Temperature Coefficient of Expansion (TCE). See chart below:

TCE for molded insulator	30 ppm/° C
TCE for 4-Layer PCB	13 ppm/° C
TCE for unclad epoxy	12 ppm/° C

The above insulator materials are all suitable for lead free soldering processes up to 260° C.

For complete material properties of plastics used by Mill-Max see page 263.

For inquiries regarding other insulator materials, please contact Technical Services.

Spring Pins

Spring pins consist of precision-machined brass components assembled together with beryllium copper or stainless steel springs. External components and internal springs are gold-plated. Spring pins are designed to be used at mid-stroke. Over compression can cause damage restricting the movement of the plunger.

Materials

External Components (Body, Piston, Base, Tail):
Brass Alloy 360 UNS C36000 ASTM-B16

Springs

Beryllium copper UNS C17200 ASTM-B197
Stainless Steel 302

Dimensional, Mechanical & Environmental Data

Standard tolerances for spring pins at initial height:
Diameters +/- 0,051mm
Lengths +/- 0,15mm

Mechanical life (durability): Tested to 1,000,000 cycles
Force tolerance: +/- 20 g (See individual spring pin data on pages 6 - 19 for forces)
Stroke tolerance: +/- 0,13mm

Environmental Data:

- Operating temperature range: -55/+125° C (min. / max. discontinuous)
- Vibration (No electrical discontinuity Greater than 1 μs): 0-200 HZ, 10 G
- Shock (No electrical discontinuity Greater than 1 μs): 50 G

For complete material properties of metals, platings and plastics used by Mill-Max see page 263.

Where applicable, Mill-Max products and procedures are designed to meet the following standards:

MIL-STD 1916 - DOD preferred methods for acceptance of product
MIL-STD 202G - Test methods for electronic and electrical component parts
MIL-STD 45662 - Calibration system requirements, or ISO 10012
MIL-F-14072 - Finishes for ground based electronic equipment
MIL-I-45208 - Inspection system requirements or equivalent
MIL-S-83505 - General specification for sockets (lead, electronic components)
MIL-DTL-83734 - General specification for DIP sockets

In the interest of improved design, quality and performance, Mill-Max reserves the right to make changes in its specifications without prior notice.

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