



Extreme Alloys for Extreme Environments

# Elite Bearing Alloys

Material Data

Unique high performance material  
for bearing applications.

Freerun<sup>®</sup> SL - Self Lubricating bearing  
material

Freerun<sup>®</sup> LW - Long Wearing bearing material



# Elite Bearing Alloys

Highly Engineered Alloys for Extreme Environments

## What is Freerun®?

Why settle for standard bearing material or complicated combinations of material? Freerun is a solid bearing material which comes in a self lubricating (Freerun®SL) format and a long wearing format (Freerun®LW).

## How special is Freerun®?

As a bearing material, these alloys are designed to wear. Freerun® alloys have the benefit of reducing friction, whilst increasing strength. This means will not only last longer, but will be able to take higher loads and perform in more extreme environments.

Copper Alloys Ltd has developed a range of materials called Freerun® optimised for use in extreme and aggressive bearing applications.

## The metallurgy of Freerun® solid bearing metal

By applying the proprietary process technology called Microfine® unique to Copper Alloys, it is possible to significantly enhance mechanical properties.

This unique combination allows previously 'cast only' alloys to be manufactured with a fine grain structure. This facilitates the application of mechanical work in order to push the mechanical properties to the extreme.

### *New material technology*

The result is two of the most advanced solid bearing materials.





# Elite Bearing Alloys

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## Freerun<sup>®</sup> SL

### Self-Lubricating Alloy

Ideal when lubrication is difficult or unfeasible, or to be used as a contingency against lubrication failure.

This is a Leaded Phosphor Bronze conforming to UNS C93800 and supplied in three grades **SL340** (hard wearing), **SL300** (medium wearing) and **SL240** (soft wearing) with increasing self-lubrication and reducing yield strength.

### Chemical Composition

#### Freerun<sup>®</sup> Self Lubricating Alloy

| Cu      | Sn      | Pb    | Zn   | Ni    | Fe     | Sb   | S     | P    | Al     | Si     |
|---------|---------|-------|------|-------|--------|------|-------|------|--------|--------|
| Balance | 6.3-7.5 | 13-16 | 0.8* | 1.0** | 0.15*1 | 0.8* | 0.05* | 1.5* | 0.005* | 0.005* |

### Engineering Advantages

- High mechanical strength, three times greater than the all industry standards whilst still retaining good ductility
- Super strength, four-times the strength with reduced ductility
- High fatigue strength
- High lead content gives excellent resistance to seizure
- Increased hardness improves the wear resistance
- Excellent corrosion resistance
- Good machinability at 80% of free machining brass

### The benefits of composition

Freerun<sup>®</sup> SL is a self-lubricating metal. It's composition is designed specifically to enable in to meet a number of national material standards.

Freerun<sup>®</sup> SL also meets the following industry standards:

- EN 1982-2008 C496K
- ASTM C93800
- BS1400 LB1
- SAE 67





## Freerun<sup>®</sup> SL

### Mechanical Properties

| Material                    | Condition | Yield Strength<br>(0.2% N/mm <sup>2</sup> ) | Tensile Strength<br>(0.2% N/mm <sup>2</sup> ) | Elongation<br>(%) | Hardness<br>HB | Static Friction<br>Coef ficient* |
|-----------------------------|-----------|---|---|-------------------|----------------|----------------------------------|
| Freerun <sup>®</sup> SL-250 | Soft      | 160   | 250   | 15                | 85             | μ 0.011-0.20                     |
| Freerun <sup>®</sup> SL-300 | Half Hard | 340   | 300   | 6                 | 120            | μ 0.011-0.20                     |
| Freerun <sup>®</sup> SL-350 | Hard      | 440   | 350   | 3                 | 140            | μ 0.011-0.20                     |

*Freerun<sup>®</sup> SL bearing alloy also meets the following material specification requirements*

|               |     |     |     |   |     |     |
|---------------|-----|-----|-----|---|-----|-----|
| ASTM C95800   | N/A | 110 | 172 | 5 | N/A | N/A |
| EN1982 CC496K | N/A | 90  | 200 | 8 | 65  | N/A |

\*estimated with grease and without against mild steel

### Physical Properties

|                                   | Imperial  | Metric                                     |
|-----------------------------------|---|--|
| Melting Point - Liquidus          | 1730° F   | 943° C                                     |
| Melting Point - Solidus           | 1570° F   | 854° C                                     |
| Incipient Melting                 | 600° F  | 316° C                                     |
| Density                           | 0.334 lb/in <sup>3</sup> at 68° F                   | 9.25 gm/cm <sup>3</sup> @ 20° C            |
| Specific Gravity                  | 9.250   | 9.25                                       |
| Electrical Resistivity            | 91.10 ohms-cmil/ft @ 68° F                          | 15.15 microhm-cm @ 20° C                   |
| Electrical Conductivity           | 11 %IACS @ 68° F                                    | 0.066 MegaSiemens/cm @ 20° C               |
| Thermal Conductivity              | 30.20 Btu • ft/(hr • ft <sup>2</sup> • °F) at 68° F | 52.3 W/m • °K at 20° C                     |
| Coef ficient of Thermal Expansion | 10.30 • 10 <sup>-6</sup> per of (68-392° F)         | 18.5 • 10 <sup>-6</sup> per °C (20-200° C) |
| Specific Heat Capacity            | 0.090 Btu/lb/°F at 68° F                            | 377.1 J/kg • °K at 293° K                  |
| Modulus of Elasticity in Tension  | 10500 ksi   | 72400 MPa                                  |
| Compressive Strength              | 18900psi  | 130MPa                                     |
| Machinability                     | 80%   | 80%  |
| Magnetic Permeability             | 1.0μ  | 1.0μ                                       |





# Elite Bearing Alloys

Highly Engineered Alloys for Extreme Environments

## Freerun<sup>®</sup> LW

### Long Wearing Alloy

Originally developed for the military aerospace bearings, Copper Alloys' proprietary process technology enables extreme wear resistance and survivability.

### Engineering Advantages

- High strength, double industry standards
- Excellent wear resistance whilst maintaining low friction
- Can sustain high load and fatigue resistance
- A fine grain size allowing ultrasonic inspection
- Properties can be adapted to suit specific applications
- Decades of successful operation in critical engineering industries

Based on the nominal composition CuSn8P, this is a Phosphor Bronze conforming to UNS C52100 and supplied in several grades including LW-600 (hard wearing) and LW-400 (soft wearing) with increasing tensile strength and reducing friction.

Freerun<sup>®</sup> LW also meets the following industry standards:

- NF L 14-702
- ASTM C52100
- CW453K
- CW459K

### Chemical Composition

#### Freerun<sup>®</sup> Long Wearing Alloy

| Cu      | Sn        | Pb    | Zn   | P         | Others |
|---------|-----------|-------|------|-----------|--------|
| Balance | 7.25-9.75 | 0.01* | 0.5* | 0.05-0.35 | 0.5*   |

### The benefits of composition

Freerun<sup>®</sup> SL is a lead-free anti-galling bearing metal that is designed to last. Its composition is designed specifically to enable it to meet industry and national material standards.





## Freerun<sup>®</sup> LW

### Mechanical Properties

| Material                    | Condition    | Yield Strength<br>(0.2% N/mm <sup>2</sup> ) | Tensile Strength<br>(0.2% N/mm <sup>2</sup> ) | Elongation<br>(%) | Hardness<br>HB | Friction<br>Coef cient* |
|-----------------------------|--------------|---|---|-------------------|----------------|-------------------------|
| Freerun <sup>®</sup> LW-400 | Soft Wearing | 400   | 450   | 40                | 150            | μ 0.011-0.30            |
| Freerun <sup>®</sup> LW-600 | Hard Wearing | 600   | 700   | 20                | 229            | μ 0.011-0.30            |

*Freerun<sup>®</sup> Long Wearing alloy also meets the following material specification requirements*

|             |           |      |     |    |      |     |
|-------------|-----------|------|-----|----|------|-----|
| NF L 14-702 | Half Hard | 290  | 440 | 25 | >100 | N/A |
| ASTM C52100 | Hard      | 230* | 419 | 20 | 90   | N/A |
| CW453K      | R390/H085 | 280  | 390 | 45 | >100 | N/A |
| CW459K      | R450/H135 | 280  | 450 | 26 | 135  | N/A |

\*estimated with grease and without against mild steel

### Physical Properties

|                                  | Imperial   | Metric                                     |
|----------------------------------|--|--|
| Melting Point - Liquidus         | 1880° F  | 1027° C                                    |
| Melting Point - Solidus          | 1620° F  | 882° C                                     |
| Density                          | 0.318 lb/in <sup>3</sup> at 68°F                 | 8.8 gm/cm <sup>3</sup> @ 20° C             |
| Specific Gravity                 | 8.800  | 8.80                                       |
| Electrical Resistivity           | 79.80 ohms-cmil/ft @ 68°F                        | 13.27 μ cm @ 20° C                         |
| Electrical Conductivity          | 13 %IACS @ 68° F                                 | 0.076 MegaSiemens/cm @ 20° C               |
| Thermal Conductivity             | 360 Btu · ft/(hr · ft <sup>2</sup> · °F) at 68°F | 62.3 W/m · °K at 20° C                     |
| Coef cient of Thermal Expansion  | 10.10 · 10 <sup>-6</sup> per of (68-392° F)      | 18.2 · 10 <sup>-6</sup> per °C (20-200° C) |
| Specific Heat Capacity           | 0.090 Btu/lb/°F at 68°F                          | 377.1 J/kg · °K at 293° K                  |
| Modulus of Elasticity in Tension | 16000 ksi  | 110000 MPa                                 |
| Modulus of Rigidity              | 6400 ksi   | 41370 MPa                                  |





## Guide to Relative Performance of Bearing Materials

| Bearing Material        | Load Capacity and Fatigue | Maximum Operating Temp. | Conformability and Embeddability | Resistance to Seizure | Hardness and wear resistance |
|-------------------------|---------------------------|-------------------------|----------------------------------|-----------------------|------------------------------|
| Tin Bronze              | High                      | High                    | Moderate                         | Moderate              | High                         |
| Freerun <sup>®</sup> LW | Very High                 | High                    | Poor                             | Moderate              | Very High                    |
| Leaded Bronze           | Moderate/High             | High                    | Good                             | Good                  | High                         |
| Freerun <sup>®</sup> SL | Moderate                  | High                    | Very Good                        | Very Good             | Low                          |
| Aluminium Bronze        | Very High                 | Very High               | Poor                             | Moderate              | Very High                    |
| Gunmetal                | Moderate/High             | High                    | Good                             | Moderate/Good         | High                         |

### Fabrication Properties

| Joining Technique              | Suitability |
|--------------------------------|-------------|
| Soldering                      | Excellent   |
| Brazing                        | Excellent   |
| Oxyacetylene Welding           | Fair        |
| Gas Shielded Arc Welding       | Good        |
| Coated Metal Arc Welding       | Fair        |
| Spot Weld                      | Good        |
| Seam Weld                      | Fair        |
| Butt Weld                      | Excellent   |
| Capacity for Being Cold Worked | Good        |
| Capacity for Being Hot Formed  | Poor        |

### Formats

- Available in a range of formats made to order and ex-stock including bar, rings, tubes and sections
- Available in proof machined and finished machine (to print) condition



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## The Elite Bearing Alloys

Brought to you by Copper Alloys Ltd.  
creators of the most advanced alloys  
ever made, including Thermalloy, T-1000  
and the game-changing CNC-1.

Visit [www.copperalloys.net/elite-alloys](http://www.copperalloys.net/elite-alloys) to find out  
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Unique high performance material for advanced  
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