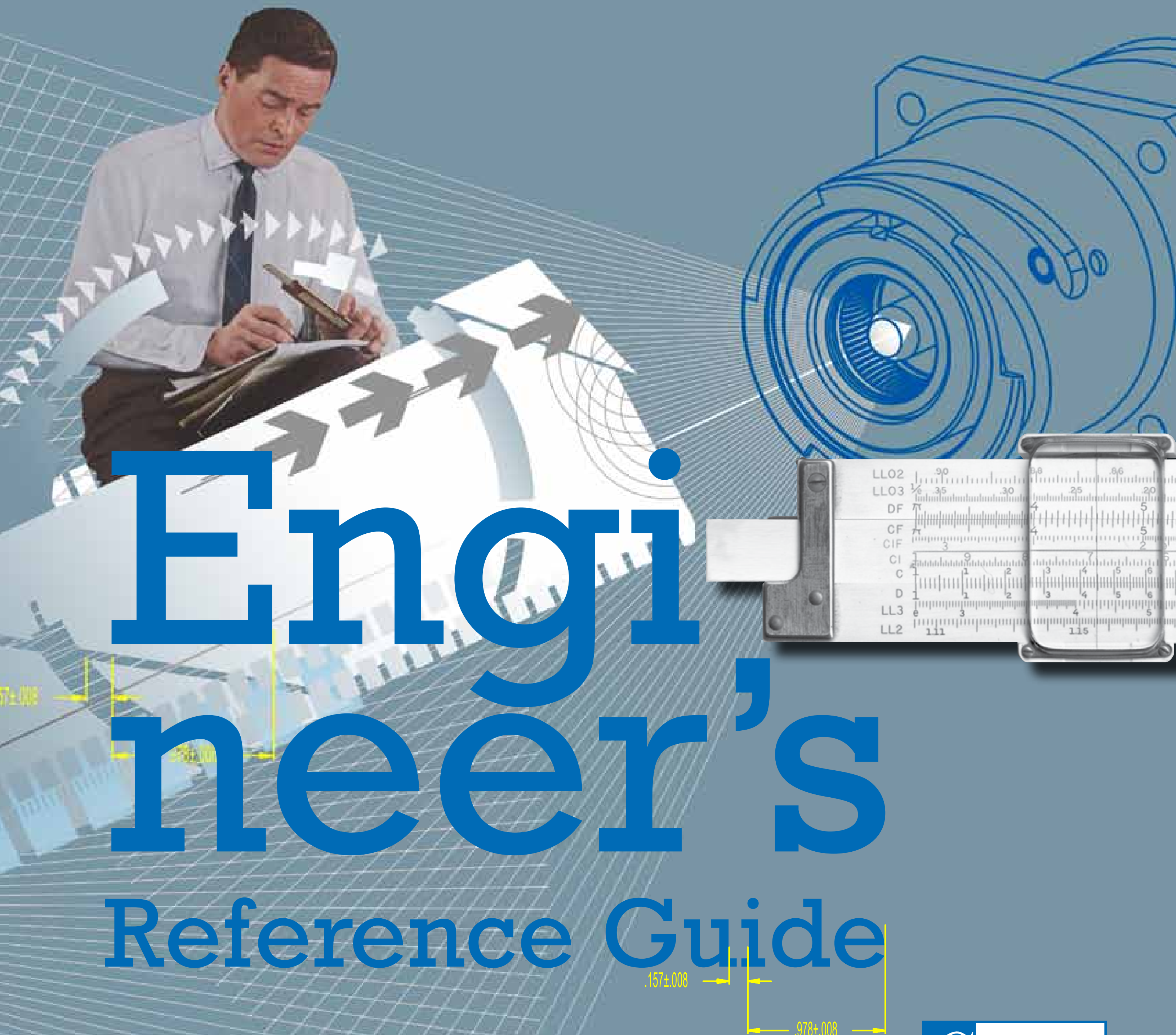
# QwikConnect

GLENAIR ▪ JULY 2012 ▪ VOLUME 16 ▪ NUMBER 3




# Engineer's Reference Guide

Glenair®

> ***Measurement is the act of determining the size, length, weight, time, temperature or amount of something. The science of measurement is called metrology.***

## Standards

Units of measurement are generally not dictated by nature, rather, humans concoct a unit of measure and then agree to consider it a standard. There's no inherent length that equals one inch, nor is a mile ordained as superior to a kilometer. Out of convenience and necessity, measurement standards evolve to establish common benchmarks to facilitate scientific discoveries, law and commerce. We dedicate this issue of QwikConnect to the measurements commonly used in the interconnect industry, and hope that it will serve as a useful tool for interconnect engineers.

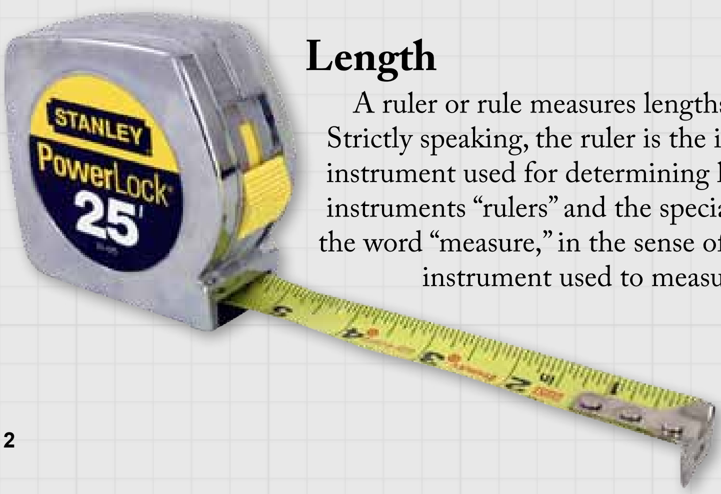
## Units of Measurement

Units of measurement are generally defined in science and overseen by governmental or supra-governmental agencies. The General Conference on Weights and Measures (CGPM), established in 1875 by the Treaty of the Meter, oversees the International System of Units (SI) and has custody of the International Prototype Kilogram. The meter, for example, was redefined in 1983 by the CGPM as the distance traveled by light in free space in 1/299,792,458 of a second while in 1960 the international yard was defined by the governments of the United States, United Kingdom, Australia and South Africa as being exactly 0.9144 meters.

The original SI units for the six basic physical quantities were: the meter, second, kilogram, ampere, kelvin, and candela. The seventh base unit, the mole, was added in 1971 by the 14th CGPM

| SI base units | | | | |
|---|---|---|---|---|
| **Unit name** | **Unit symbol** | **Quantity name** | **Quantity symbol** | **Dimension symbol** |
| meter | m | length | l, x, r | L |
| kilogram | kg | mass | m | M |
| second | s | time | t | T |
| ampere | A | electric current | I | |
| kelvin | K | thermodynamic temperature | T | Θ |
| candela | cd | luminous intensity | $I_v$ | J |
| mole | mol | amount of substance | n | N |

There are two types of SI units, base units and derived units. Base units are the simple measurements for time, length, mass, temperature, amount of substance, electric current and light intensity. Derived units are constructed from the base units, for example, the watt, i.e. the unit for power, is defined from the base units as $m^2 \cdot kg \cdot s^{-3}$. Other physical properties may be measured in compound units, such as material density, measured in $kg/m^3$.




## Length

A ruler or rule measures lengths or distances or it can be used to draw straight lines. Strictly speaking, the ruler is the instrument used to "rule" straight lines and the calibrated instrument used for determining length is called a "measure." Common usage calls both instruments "rulers" and the special name "straightedge" defines an unmarked rule. The use of the word "measure," in the sense of a measuring instrument, only survives in "tape measure," an instrument used to measure but not to draw straight lines.

## Time

Time keeps track of elemental changes over a non spatial continuum. We denote time by numbers and/or named periods such as hours, days, weeks, months and years. Time is an irreversible series of occurrences within this non spatial continuum. We also use time to denote an interval between two relative points on this continuum.

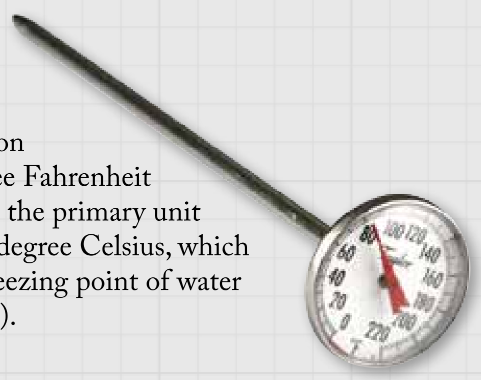
## Mass

Mass refers to the intrinsic property of material objects to resist changes in their momentum. Weight, on the other hand, refers to the downward force produced when a mass is in a gravitational field. In free fall, (no net gravitational forces) objects lack weight but retain their mass. The Imperial units of mass include the ounce, pound, and ton. The metric units gram and kilogram are units of mass.

One device for measuring weight or mass is called a weighing scale or, often, simply a scale. A spring scale measures force but not mass, a balance compares weight, both require a gravitational field to operate. Some of the most accurate instruments for measuring weight or mass are based on load cells with a digital read-out, but require a gravitational field to function and would not work in free fall.

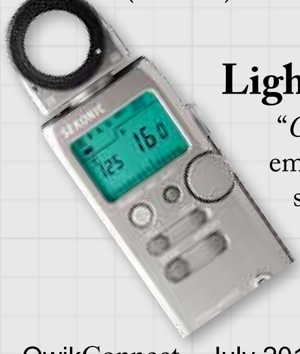

## Current

The ampere, often shortened to amp, is the SI unit of electric current. Named after French mathematician and physicist André-Marie Ampère (1775–1836), Ampère's Force Law states there is an attractive or repulsive force between two parallel wires carrying an electric current. This force is used in the formal definition of the ampere, which states that it is "the constant current that will produce an attractive force of $2 \times 10^{-7}$ newton per metre of length between two straight, parallel conductors of infinite length and negligible circular cross section placed one metre apart in a vacuum. The SI unit of charge, the "coulomb, " is the quantity of electricity carried in 1 second by a current of 1 ampere. Conversely, a current of one ampere is one coulomb of charge going past a given point per second.



## Temperature

The Kelvin scale, named after engineer and physicist William Thomson, 1st Baron Kelvin (1824–1907), establishes an "absolute thermometric scale." Unlike the degree Fahrenheit and degree Celsius, the kelvin is not referred to or typeset as a degree. The kelvin is the primary unit of measurement in the physical sciences, but is often used in conjunction with the degree Celsius, which has the same magnitude. Subtracting 273.16 K from the temperature of the freezing point of water (0.01 °C) makes absolute zero (0 K) equivalent to −273.15 °C (−459.67 °F).



## Light

"*Candela*," meaning "candle" in Latin, is the SI base unit of luminous intensity. It is the power emitted by a light source in a particular direction, weighted by the luminosity function—a standardized model of the sensitivity of the human eye to different wavelengths. A common candle emits light with a luminous intensity of roughly one candela. If emission in some directions is blocked by an opaque barrier, the emission would still be approximately one candela in the directions that are not obscured.

# International Standards IP Protection Classification

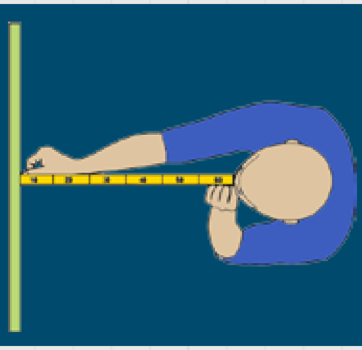
The IP Code, or Ingress Protection Rating, consists of the letters IP followed by two digits (or one digit and one letter and an optional letter.) As defined in international standard IEC 60529, IP Code classifies and rates the degrees of protection provided against the intrusion of solid objects (including body parts like hands and fingers), dust, accidental contact, and water in mechanical casings and with electrical enclosures.

| First Numeral | | | | Second Numeral | | |
|---|---|---|---|---|---|---|
| **IP** | | **Protection of Persons** | **Protection of Equipment** | **IP** | | **Protection of Equipment** |
| 0 | | No Protection | No Protection | 0 | | No Protection |
| 1 | | Protected against contact with large areas of the body (back of hand) | Protected against objects over 50 mm in diameter | 1 | | Protected against vertically falling drops of water, e.g. condensation |
| 2 | | Protected against contact with fingers | Protected against solid objects over 12 mm in diameter | 2 | | Protected against direct sprays of water up to 15° from vertical |
| 3 | | Protected against tools and wires over 2.5 mm in diameter | Protected against solid objects over 2.5 mm in diameter | 3 | | Protected against sprays to 60° from vertical |
| 4 | | Protected against tools and wires over 1 mm in diameter | Protected against objects over 1 mm in diameter | 4 | | Protected against water sprayed from all directions (limited ingress permitted) |
| 5 | | Protected against tools and wires over 1 mm in diameter | Protected against dust (limited ingress, no harmful deposit | 5 | | Protected against low pressure jets of water from all directions (limited ingress permitted) |
| 6 | | Protected against tools and wires over 1 mm in diameter | Totally protected against dust | 6 | | Protected against strong jets of water |
| | | | | 7 | | Protected against the effects of immersion between 15 cm and 1 m |
| | | | | 8 | | Protected against long periods of immersion under pressure |

**The MEASUREMENT DICTIONARY**

### Arm's-length

*In most cultures, the length of the human arm is, at least historically, a standardized unit of measure equal to approximately 28 inches (70 cm). The term "arm's-length" is also used figuratively to mean barely within reach, distant or detached. Examples of the former meaning include the Italian braccio, the Russian sadzhen, and the Turkish pik. An example from Shakespeare: "He took me by the wrist and held me hard. Then goes he to the length of all his arm, and, with his other hand thus o'er his brow, he falls to such perusal of my face as he would draw it. Long stayed he so." –Ophelia, Act 1, Scene 2, Hamlet.*



The digits indicate conformity with the conditions summarized in the tables below. Where there is no protection rating with regard to one of the criteria, the digit is replaced with the letter X. The first digit indicates the level of protection that the enclosure provides against access to hazardous parts (e.g., electrical conductors, moving parts) and the ingress of solid foreign objects. The second digit indicates the level of protection of the equipment inside the enclosure against harmful ingress of water
For example, an electrical socket rated IP22 is protected against insertion of fingers and will not be damaged or become unsafe during a specified test in which it is exposed to vertically or nearly vertically dripping water. IP22 or 2X are typical minimum requirements for the design of electrical accessories for indoor use.

**Levels of Sealing**

| Connector Type | Seal Rating | Sealing Method | Typical Shell Material | Contact Material |
|---|---|---|---|---|
| Dust Tight | IP 65 | Elastomer and/or epoxy | Aluminum or Plastic | Copper alloy/Brass/ others |
| Environmental | IP 66 | Elastomer and/or epoxy | Aluminum or Plastic | Copper alloy/Brass/ others |
| Environmental | IP 67 | Elastomer and/or epoxy | Aluminum or Plastic | Copper alloy/Brass/ others |
| Environmental | IP 68 | Elastomer and/or epoxy | Aluminum or Plastic | Copper alloy/Brass/ others |
| Semi-Hermetic (-491 Mod Code) | 1 X $10^{-4}$ Epoxy Special | Aluminum | Special | |
| Hermetic | 1 X $10^{-4}$* | Glass (soft) to Metal | Aluminum | Copper alloy/other |
| Hermetic | 1 X $10^{-6}$* | Glass to Metal | Cold Rolled Steel or Titanium | Alloy 52 or Kovar |
| Hermetic | 1 X $10^{-8}$* | Glass to Metal | Stainless Steel or Kovar | Alloy 52 or Kovar |
| Hermetic | 1 X $10^{-10}$* | Glass to Metal | Inconel or Stainless Steel | Inconel or Stainless Steel |
| Hermetic leak rate = CC He/Sec *Cubic centimeters of helium per second at 1 atmosphere pressure differential | | | | |

**International Standards IP Protection Classification**

| If the 1st IP number is… | and the 2nd IP number is… | Then the IP rating is |
|---|---|---|
| **2** | **3** | **IP 2 3** |
| (protection against solid objects) | (protection against liquids) | (Protection against touch with a finger and penetration of solid objects greater than 12 mm and against spraying water.) |

**The MEASUREMENT DICTIONARY**

## Avogadro's number ($N_A$)

*Also known as Avogadro's constant, it is the number of atoms present in 0.012 kilograms of isotopically pure Carbon-12, being 6.0221415 x $10^{23}$. By definition, the number of elementary entities (atoms or molecules) comprising one mole of a given substance. The atomic mass unit, in grams, is equal to one divided by this number. Italian chemist and physicist Amedeo Avogadro (1776–1856) was the first to conclude that equal volumes of gases (at the same temperature and pressure) must contain an equal number of molecules.*

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## Glenair Connector Material and Finish Options

This chart presents a selection of the broad range of base materials, plating options, specifications and codes available for Glenair-made connectors.

| Code | Material | Finish | Finish Specification | Hrs. Salt Spray (dynamic) | Electrical Conductivity | Operating Temp. Range | RoHS | Notes |
|---|---|---|---|---|---|---|---|---|
| AB | Marine Bronze | Unplated | AMS 4640 alloy, unplated | 1000 | Conductive | -65 to +200°C | ✓ | Marine and geo-physical applications |
| AL | Aluminum | AlumiPlate, Clear Chromate | MIL-DTL-83488, Class 2, Type II over electroless nickel | 500 | Conductive | -65 to +175°C | ✓ | Approved for MIL-DTL-38999L and MIL-DTL-83513G. |
| C | Aluminum | Anodize, Black | AMS-A-8625 Type II Class 2 | 336 | Non-Conductive | -65 to +175°C | ✓ | Glenair's standard black anodize finish. |
| E | Aluminum | Chem Film | MIL-DTL-5541 Type 1 Class 3 | 168 | Conductive | -65 to +175°C | | Glenair's standard chem film finish. |
| G | Aluminum | Anodize, Hardcoat | AMS-A-8625, Type III, Class 1, .001" thick | 336 | Non-Conductive | -65 to +200°C | ✓ | Glenair's preferred hardcoat finish. |
| JF | Aluminum | Cadmium, Gold | SAE-AMS-QQ-P-416 Type II, Class 2 over electroless nickel | 48 | Conductive | -65 to +175°C | | Glenair's preferred gold cadmium finish. |
| LF | Aluminum | Cadmium, Clear | SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel | 48 | Conductive | -65 to +175°C | | Glenair's preferred clear cadmium finish. |
| M | Aluminum | Electroless Nickel | AMS-C-26074 Class 4 Grade B; ASTM-B-733, SC 2, Type IV | 48 | Conductive | -65 to +200°C | ✓ | Glenair's standard electroless nickel finish. |
| MA | Aluminum | Electroless Nickel | AMS-C-26074 Class 4 Grade A | 96 | Conductive | -65 to +200°C | ✓ | Standard matte electroless nickel for space applications. |
| ME | Aluminum | Electroless Nickel | AMS-C-26074 Class 4 Grade A | 96 | Conductive | -65 to +200°C | ✓ | Electroless nickel with enhanced corrosion resistance. |
| MT | Aluminum | Nickel-PTFE | SAE AMS2454 | 500 | Conductive | -65 to +175°C | ✓ | Approved for MIL-DTL-38999L and MIL-DTL-83513G. |
| NC | Aluminum | Zinc-Cobalt, Olive Drab | ASTM B 840 Grade 6 Type D over electroless nickel | 350 | Conductive | -65 to +175°C | | Glenair's standard olive drab zinc-cobalt finish. |
| NF | Aluminum | Cadmium, Olive Drab | SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel | 500 | Conductive | -65 to +175°C | | Glenair's standard olive drab cadmium finish. |
| TP2 | Titanium | Electrodeposited Nickel | SAE-AMS-QQ-N-290 Class 1 Grade F | 96 | Conductive | -65 to +200°C | ✓ | Glenair's preferred finish for titanium connectors. |
| UC | Aluminum | Zinc-Cobalt, Black | ASTM B 840 Grade 6 Type D over electroless nickel | 240 | Conductive | -65 to +175°C | | Glenair's standard black zinc-cobalt finish. |
| UCR | Aluminum | Zinc-Cobalt, Black | ASTM B 840 Grade 6 Type D over electroless nickel | 240 | Conductive | -65 to +175°C | ✓ | RoHS version of UC. |
| UF | Aluminum | Cadmium, Black | SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel | 48 | Conductive | -65 to +175°C | | Glenair's preferred black cadmium finish. |
| XAL | Composite | AlumiPlate | MIL-DTL-86448, Class 2, Type II over electroless nickel | 2000 | Conductive | -65 to +175°C | ✓ | Approved for MIL-DTL-38999L. |
| XB | Composite | Unplated Black | | 2000 | Non-Conductive | -65 to +175°C | ✓ | Glenair's standard unplated composite. |
| XM | Composite | Electroless Nickel | AMS-C-26074 Class 4, Grade B | 2000 | Conductive | -65 to +200°C | ✓ | Glenair's standard electroless nickel finish over composite. |
| XMT | Composite | Nickel-PTFE | GMF-002 Type II Class 2 | 2000 | Conductive | -65 to +200°C | ✓ | Approved for MIL-DTL-38999L. |
| XW | Composite | Cadmium, Olive Drab | SAE-AMS-QQ-P-416 Type II Class 3 over electroless nickel | 2000 | Conductive | -65 to +175°C | | Glenair's standard olive drab cadmium finish over composite. |
| XZN | Composite | Zinc-Nickel, Black | ASTM B841 Grade 5 over electroless nickel | 2000 | Conductive | -65 to +175°C | | Glenair's standard black zinc-nickel finish over composite. |
| Z1 | Stainless Steel | Passivate | SAE AMS 2700 | 500 | Conductive | -65 to +200°C | ✓ | Glenair's standard passivated stainless steel. |
| Z16 | Aluminum | Electroless Nickel | AMS-C-26074 Class 4 Grade B | 48 | Conductive | -65 to +200°C | ✓ | Standard matte electroless nickel for space applications |
| Z2 | Aluminum | Gold | MIL-DTL-45204 Class 1 over electroless nickel | 48 | Conductive | -65 to +200°C | ✓ | Glenair's standard gold plating for space programs. |
| ZC | Stainless Steel | Zinc-Cobalt, Black | ASTM-B840, Grade 6 | 500 | Conductive | -65 to +175°C | | Glenair's standard zinc-cobalt over stainless steel. |
| ZCR | Stainless Steel | Zinc-Cobalt, Black | ASTM-B840, Grade 6 | 500 | Conductive | -65 to +175°C | ✓ | RoHS version of ZC. |
| ZL | Stainless Steel | Electrodeposited Nickel | SAE-AMS-QQ-N-290 Class 2 Grade F | 500 | Conductive | -65 to +200°C | ✓ | Glenair's preferred nickel-plated stainless steel. |
| ZM | Stainless Steel | Electroless Nickel | AMS-C-26074 Class 1 Grade A | 500 | Conductive | -65 to +200°C | ✓ | Glenair's preferred nickel-plated stainless steel. |
| ZMT | Stainless Steel | Nickel-PTFE | SAE AMS2454 | 1000 | Conductive | -65 to +175°C | ✓ | Glenair's new 1000 Hour Grey over stainless steel. |
| ZN | Aluminum | Zinc-Nickel, Olive Drab | ASTM B841 Grade 5 over electroless nickel | 500 | Conductive | -65 to +175°C | | Glenair's standard olive drab zinc-nickel finish. |
| ZNU | Aluminum | Zinc-Nickel, Black | ASTM B841 Grade 5 over electroless nickel | 500 | Conductive | -65 to +175°C | | Glenair's standard black zinc-nickel finish. |
| ZU | Stainless Steel | Cadmium, Black | SAE-AMS-QQ-P-416 Type II Class 2 | 500 | Conductive | -65 to +175°C | | Glenair's standard black cadmium over stainless steel. |
| ZW | Stainless Steel | Cadmium, Olive Drab | SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel | 500 | Conductive | -65 to +175°C | | Glenair's standard olive drab cadmium over stainless steel. |
| ZR | Aluminum | Zinc-Nickel, Black | ASTM B841 Grade 5 over electroless nickel | 500 | Conductive | -65 to +175°C | ✓ | Glenair's RoHS compliant black zinc-nickel |


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# Glenair Backshell and Accessory Material and Finish Options

Backshell and accessory base materials, plating options, specifications and codes

| Code | Material | Finish | Finish Specification | Hrs. Salt Spray (static) | Electrical Conductivity | Operating Temp. Range | RoHS | Notes |
|---|---|---|---|---|---|---|---|---|
| A | Aluminum | Cadmium, No Chromate | SAE-AMS-QQ-P-416 Type I Class 3 | 48 | Conductive | -65 to +175°C | | Not recommended for new projects. LF is preferred. |
| AB | Marine Bronze | Unplated | | 1000 | Conductive | -65 to +200°C | ✓ | Marine and geophysical applications. |
| AL | Aluminum | AlumiPlate, Clear Chromate | MIL-DTL-83488, Class 2, Type II over electroless nickel | 1000 | Conductive | -65 to +175°C | ✓ | Approved for MIL-DTL-38999L and MIL-DTL-83513G. |
| B | Aluminum | Cadmium, Olive Drab | SAE-AMS-QQ-P-416 Type II Class 3 | 96 | Conductive | -65 to +175°C | | Not recommended for new projects. NF is preferred. |
| C | Aluminum | Anodize, Black | AMS-A-8625 Type II Class 2 | 336 | Non-Conductive | -65 to +175°C | ✓ | Glenair's standard black anodize finish. |
| E | Aluminum | Chem Film | MIL-DTL-5541 Type 1 Class 3 | 168 | Conductive | -65 to +175°C | | Glenair's standard chem film finish. |
| G | Aluminum | Anodize, Hardcoat | AMS-A-8625 Type III, Class 1, .001" thick | 336 | Non-Conductive | -65 to +200°C | ✓ | Glenair's preferred hardcoat finish. |
| J | Aluminum | Cadmium, Gold | SAE-AMS-QQ-P-416 Type II, Class 2 over electroless nickel | 500 | Conductive | -65 to +175°C | | Not recommended for new projects. JF is preferred. |
| JF | Aluminum | Cadmium, Gold | SAE-AMS-QQ-P-416 Type II, Class 2 over electroless nickel | 1000 | Conductive | -65 to +175°C | | Glenair's preferred gold cadmium finish. |
| LF | Aluminum | Cadmium, Clear | SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel | 1000 | Conductive | -65 to +175°C | | Glenair's preferred clear cadmium finish. |
| M | Aluminum | Electroless Nickel | AMS-C-26074 Class 4 Grade B; ASTM-B-733, SC 2, Type IV | 48 | Conductive | -65 to +200°C | ✓ | Glenair's standard electroless nickel finish. |
| MT | Aluminum | Nickel-PTFE | SAE AMS2454 | 1000 | Conductive | -65 to +175°C | ✓ | Approved for MIL-DTL-38999L and MIL-DTL-83513G. |
| N | Aluminum | Cadmium, Olive Drab | SAE-AMS-QQ-P-416 Type II Class 3 over electroless nickel | 500 | Conductive | -65 to +175°C | | Not recommended for new projects. NF is preferred. |
| NC | Aluminum | Zinc-Cobalt, Olive Drab | ASTM B 840 Grade 6 Type D over electroless nickel | 350 | Conductive | -65 to +175°C | | Glenair's standard olive drab zinc-cobalt finish. |
| NF | Aluminum | Cadmium, Olive Drab | SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel | 1000 | Conductive | -65 to +175°C | | Glenair's standard olive drab cadmium finish. |
| P | Stainless Steel | Electrodeposited Nickel | SAE-AMS-QQ-N-290 Class 1 Grade F | 500 | Conductive | -65 to +200°C | ✓ | Use ZM for electroless nickel alternative. |
| T | Aluminum | Cadmium, No Chromate | SAE-AMS-QQ-P-416 Type I Class 3 over electroless nickel | 96 | Conductive | -65 to +175°C | | Not recommended for new projects. LF is preferred. |
| TP2 | Titanium | Electrodeposited Nickel | SAE-AMS-QQ-N-290 Class 1 Grade F | 96 | Conductive | -65 to +200°C | ✓ | Glenair's preferred finish for titanium connectors. |
| U | Aluminum | Cadmium, Black | SAE-AMS-QQ-P-416 Type I Class 3 | 96 | Conductive | -65 to +175°C | | Not recommended for new projects. UF is preferred. |
| UC | Aluminum | Zinc-Cobalt, Black | ASTM B 840 Grade 6 Type D over electroless nickel | 350 | Conductive | -65 to +175°C | | Glenair's standard black zinc-cobalt finish. |
| UCR | Aluminum | Zinc-Cobalt, Black | ASTM B 840 Grade 6 Type D over electroless nickel | 350 | Conductive | -65 to +175°C | ✓ | RoHS version of UC. |
| UF | Aluminum | Cadmium, Black | SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel | 1000 | Conductive | -65 to +175°C | | Glenair's preferred black cadmium finish. |
| XAL | Composite | AlumiPlate | MIL-DTL-86448, Class 2, Type II over electroless nickel | 2000 | Conductive | -65 to +175°C | ✓ | Approved for MIL-DTL-38999L. |
| XB | Composite | Unplated Black | | 2000 | Non-Conductive | -65 to +175°C | ✓ | Glenair's standard unplated composite. |
| XM | Composite | Electroless Nickel | AMS-C-26074 | 2000 | Conductive | -65 to +175°C | ✓ | Glenair's standard electroless nickel finish over composite. |
| XMT | Composite | Nickel-PTFE | GMS-002 Class 2 Type II | 2000 | Conductive | -65 to +175°C | ✓ | Approved for MIL-DTL-38999L. |
| XO | Composite | Unplated Light Brown | | 2000 | Non-Conductive | -65 to +175°C | ✓ | Not recommended for new projects. Use XB. |
| XW | Composite | Cadmium, Olive Drab | SAE-AMS-QQ-P-416 Type II Class 3 over electroless nickel | 2000 | Conductive | -65 to +175°C | | Glenair's standard olive drab cadmium finish over composite. |
| XZN | Composite | Zinc-Nickel, Black | ASTM B841 Grade 5 over electroless nickel | 2000 | Conductive | -65 to +175°C | | Glenair's standard black zinc-nickel finish over composite. |
| Z1 | Stainless Steel | Passivate | SAE-AMS-SAE-AMS-QQ-P-35 Type VI | 1000 | Conductive | -65 to +200°C | ✓ | Glenair's standard passivated stainless steel. |
| Z2 | Aluminum | Gold | MIL-DTL-45204 Class 1 over electroless nickel | 48 | Conductive | -65 to +200°C | ✓ | Glenair's standard gold plating for space programs. |
| ZC | Stainless Steel | Zinc-Cobalt, Black | ASTM-B840, Grade 6 | 500 | Conductive | -65 to +175°C | | Glenair's standard zinc-cobalt over stainless steel. |
| ZCR | Stainless Steel | Zinc-Cobalt, Black | ASTM-B840, Grade 6 | 500 | Conductive | -65 to +175°C | ✓ | RoHS version of ZC. |
| ZL | Stainless Steel | Electrodeposited Nickel | SAE-AMS-QQ-N-290 Class 1 Grade F | 1000 | Conductive | -65 to +200°C | ✓ | Used on hermetic connectors. Use ZM for other applications. |
| ZM | Stainless Steel | Electroless Nickel | AMS-C-26074 Class 1 Grade A | 1000 | Conductive | -65 to +200°C | ✓ | Glenair's preferred nickel-plated stainless steel. |
| ZMT | Stainless Steel | Nickel-PTFE | SAE AMS2454 | 1000 | Conductive | -65 to +175°C | ✓ | Glenair's new 1000 Hour Grey over stainless steel. |
| ZN | Aluminum | Zinc-Nickel, Olive Drab | ASTM B841 Grade 5 over electroless nickel | 1000 | Conductive | -65 to +175°C | | Glenair's standard olive drab zinc-nickel finish. |
| ZNU | Aluminum | Zinc-Nickel, Black | ASTM B841 Grade 5 over electroless nickel | 1000 | Conductive | -65 to +175°C | | Glenair's standard black zinc-nickel finish. |
| ZR | Aluminum | Zinc-Nickel, Black | ASTM B841 Grade 5 over electroless nickel | 1000 | Conductive | -65 to +175°C | ✓ | Glenair's RoHs compliant black zinc-nickel. |
| ZU | Stainless Steel | Cadmium, Black | SAE-AMS-QQ-P-416 Type II Class 3 | 1000 | Conductive | -65 to +175°C | | Glenair's standard black cadmium over stainless steel. |
| ZW | Stainless Steel | Cadmium, Olive Drab | SAE-AMS-QQ-P-416 Type II Class 2 over electroless nickel | 2000 | Conductive | -65 to +175°C | | Glenair's standard olive drab cadmium over stainless steel. |



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## The MEASUREMENT DICTIONARY

### Baker's dozen

*From the archaic practice of bakers of adding a thirteenth loaf to a batch of twelve to avoid punishment for accidentally selling underweight bread. This custom dates from the thirteenth century, when the weights and prices of loaves of bread were strictly regulated, and bakers could be imprisoned for failure to deliver fair weight.*

### Bar

*The bar is a widely used metric unit of measurement for pressure. One bar equals 100,000 Pascals. Even though bar is not an SI unit, it has been adopted as one of the most popular pressure units, particularly in European countries.*

*The value of 1 bar is a close approximation to atmospheric pressure and is often used to represent atmospheric pressure rather than "standard atmosphere" (101,325 Pascals) which is the correct value used by the scientific and engineering community.*

# Glenair Connector Plating Code and Mil-Spec Connector Finish Code Cross-Reference

**MIL-DTL-38999 Series I and II**

| MIL-DTL-38999 Series I and II Finish Code | Material, Finish | Recommended Glenair Plating Code | Temperature Range |
|---|---|---|---|
| **A** | Aluminum, Cadmium Plated, Clear Chromate | **LF** | -65 to +175°C |
| **B** | Aluminum, Cadmium Plated, Olive Drab | **NF** | -65 to +175°C |
| **C** | Aluminum, Anodize, Hardcoat | **G2** | -65 to +200°C |
| **E** | Stainless Steel, Passivated | **Z1** | -65 to +200°C |
| **F** | Aluminum, Electroless Nickel Plated | **M** | -65 to +200°C |
| **N** | Stainless Steel, Electrodeposited Nickel (Hermetic) | **P** | -65 to +200°C |
| **P** | Aluminum, Pure Dense Aluminum (AlumiPlateSM) | **AL** | -65 to +175°C |
| **R** | Aluminum, Electroless Nickel Thick Matte Finish | **MA** | -65 to +200°C |
| **T** | Aluminum, Nickel-PTFE | **MT** | -65 to +175°C |
| **U** | Aluminum, Cadmium Plated, Clear Chromate | **LF** | -65 to +175°C |
| **X** | Aluminum, Cadmium Plated, Olive Drab | **NF** | -65 to +175°C |
| **Z** | Aluminum, Black Zinc-Nickel | **ZR** | -65 to +175°C |

**MIL-DTL-38999 Series III and IV**

| MIL-DTL-38999 Series III and IV Class Code | Material, Finish | Recommended Glenair Plating Code | Temperature Range |
|---|---|---|---|
| **C** | Aluminum, Anodize, Hardcoat | **G2** | -65 to +200°C |
| **F** | Aluminum, Electroless Nickel | **M** | -65 to +200°C |
| **G** | Aluminum, Electroless Nickel | **M** | -65 to +200°C |
| **H** | Stainless Steel, Passivated | **Z1** | -65 to +200°C |
| **J** | Composite, Cadmium Plated, Olive Drab | **XW** | -65 to +175°C |
| **K** | Stainless Steel, Passivated | **Z1** | -65 to +200°C |
| **L** | Stainless Steel, Electrodeposited Nickel | **ZL** | -65 to +200°C |
| **M** | Composite, Electroless Nickel Plated | **XM** | -65 to +200°C |
| **P** | Aluminum, Pure Dense Aluminum (AlumiPlate$^{SM}$) | **AL** | -65 to +175°C |
| **R** | Aluminum, Electroless Nickel Thick Matte Finish | **MA** | -65 to +200°C |
| **S** | Stainless Steel, Electrodeposited Nickel | **ZL** | -65 to +200°C |
| **T** | Aluminum, Nickel-PTFE | **MT** | -65 to +175°C |
| **W** | Aluminum, Cadmium Plated, Olive Drab | **NF** | -65 to +175°C |
| **X** | Aluminum, Cadmium Plated, Olive Drab | **NF** | -65 to +175°C |
| **Z** | Aluminum, Black Zinc-Nickel | **ZR** | -65 to +175°C |

| MIL-DTL-28840 | | | |
|---|---|---|---|
| **MIL-DTL-28840 Finish Code** | **Material, Finish** | **Recommended Glenair Plating Code** | **Temperature Range** |
| **A** | Aluminum, Cadmium Olive Drab over Nickel | **NF** | -65 to +175°C |
| **B** | Stainless Steel, Cadmium-Black over Nickel | **ZU** | -65 to +175°C |
| **L** | Aluminum, Nickel PTFE | **MT** | -65 to +175°C |
| **S** | Aluminum, Zinc Nickel, Non-Reflective | **ZR** | -65 to +175°C |

| SAE AS50151 | | | |
|---|---|---|---|
| **SAE AS50151 Class Code** | **Material, Finish** | **Recommended Glenair Accessory Code** | **Temperature Range** |
| **A, B, C, D, E, DJ, F, P, R, W** | Aluminum, Cadmium Plated, Olive Drab | **NF** | -65 to +175°C |
| **H, K** | Stainless Steel, Electroless Nickel | **ZM** | -65 to +200°C |
| **L,U** | Aluminum, Electroless Nickel | **M** | -65 to +200°C |

| MIL-DTL-26482 | | | |
|---|---|---|---|
| **MIL-DTL-26482** | **Material, Finish** | **Recommended Glenair Accessory Code** | **Temperature Range** |
| **Series I** | Aluminum, Cadmium Plated, Olive Drab | **NF** | -65 to +175°C |
| **Series 2 Class L** | Electroless Nickel | **M** | -65 to +200°C |
| **Series 2 Class W** | Aluminum, Cadmium Plated, Olive Drab | **NF** | -65 to +175°C |

| AS85049 | | | |
|---|---|---|---|
| **AS85049 Finish Code** | **Material, Finish** | **Recommended Glenair Accessory Code** | **Temperature Range** |
| **A** | Aluminum, Black Anodize | **C** | -65 to +175°C |
| **B** | Stainless Steel, Cadmium Plated, Black | **ZU** | -65 to +175°C |
| **G** | Aluminum, Electroless Nickel Plated (Space) | **M** | -65 to +200°C |
| **J** | Composite, Cadmium Plated, Olive Drab | **XW** | -65 to +175°C |
| **L** | Composite, Cadmium Plated, Olive Drab[1] | **XX** | -65 to +175°C |
| **M** | Composite, Electroless Nickel Plated | **XM** | -65 to +200°C |
| **N** | Aluminum, Electroless Nickel Plated | **M** | -65 to +200°C |
| **P** | Aluminum, Cadmium Plated, Olive Drab[1] | **NFP** | -65 to +200°C |
| **W** | Aluminum, Cadmium Plated, Olive Drab | **NF** | -65 to +175°C |
| **T** | Composite, Unplated | **XO** | -65 to +175°C |
| (1) Selective plated with polysulfide barrier | | | |

## The Measurement Dictionary

### Beat (music)

*The beat is the basic unit of time in music. In popular use, beat can refer to a variety of related concepts including: tempo, meter, rhythm and groove. The tempo of a piece of music is defined by the number of beats equal to a whole note and is communicated in sheet music through the use of a time-signature, such as ¾, the ever popular waltz tempo, in which each measure in the composition contains 3 beats. Rhythm in music is characterized by a repeating sequence of stressed and unstressed beats (often called "strong" and "weak"). Again using the ¾ waltz as an example, the beat is counted out with the stress on the one, like so:* ***one****, two, three;* ***one****, two, three.*

### Beat (theater)

*A theatrical (silent) pause in dialogue denoted in a script with a relative unit of time simply called a "beat." The exact length of a beat is undefined, rather it is interpreted by actors and directors according to the needs of the moment. Comedians are renowned for their use of the theatrical beat, or pregnant pause. Jack Benny was famous for his comedic timing that frequently employed a long beat or two followed by his signature exclamation, "well."*

# The Measurement Dictionary

**Bell**

*Strikes of a ship's bell are used to indicate the hour aboard a ship and thereby to regulate the sailors' duty watches. Unlike civil clock bells, the strikes of the bell do not accord to the number of the hour. Instead, there are eight bells, one for each half-hour of a four-hour watch. In the age of sailing, watches were timed with a 30-minute hourglass. Bells would be struck every time the glass was turned, and in a pattern of pairs for easier counting, with any odd bells at the end of the sequence. Six bells in the morning watch, 7:00 for you land lubbers, was the traditional time of day for the bosun to announce with his whistle and the cry of "up spirits" the daily distribution of rum or other spirits to the crew--a practice finally outlawed on British naval ships on Black Tot Day, July 31st, 1970.*

# Galvanic Corrosion and Anodic Index Reference Tables

**Galvanic Corrosion Table**

| | Metal | (V) |
|---|---|---|
| Most Noble/Cathodic | Gold, solid and plated, Gold-platinum alloy | 0.00 |
| | Rhodium plated on silver-plated copper | 0.05 |
| | Silver, solid or plated; monel metal. High nickel-copper alloys | 0.15 |
| | Nickel, solid or plated, titanium and special alloys such as Monel | 0.30 |
| | Copper, solid or plated; low brasses or bronzes; silver solder; German silvery high copper-nickel alloys; nickel-chromium alloys | 0.35 |
| | Brass and bronzes | 0.40 |
| | High brasses and bronzes | 0.45 |
| | 18% chromium type corrosion-resistant steels | 0.50 |
| | Chromium plated; tin plated; 12% chromium type corrosion-resistant steels | 0.60 |
| | Tin-plate; tin-lead solder | 0.65 |
| | Lead, solid or plated; high lead alloys | 0.70 |
| | Aluminum, wrought alloys of the 2000 Series | 0.75 |
| | Iron, wrought, gray or malleable, plain carbon and low alloy steels | 0.85 |
| | Aluminum, wrought alloys other than 2000 Series aluminum, cast alloys of the silicon type | 0.90 |
| | Aluminum, cast alloys other than silicon type, cadmium, plated and chromate | 0.95 |
| | Hot-dip-zinc plate; galvanized steel | 1.20 |
| | Zinc, wrought; zinc-base die-casting alloys; zinc plated | 1.25 |
| | Magnesium & magnesium-base alloys, cast or wrought | 1.75 |
| Least Noble/Anodic | Beryllium | 1.85 |

Galvanic corrosion occurs when dissimilar metals are in contact in the presence of an electrolyte. The corrosion of a metal, the anode, results from the positive current flowing from the anode to the less reactive (more noble) metal, the cathode, through the electrolyte. This form of corrosion has the potential to attack junctions of metals, or regions where one construction metal is changed to another. The critical point is the difference in potential of the two materials being considered as a joined pair.

The "anodic" or "less noble" metals such as magnesium, zinc and aluminium are more likely to be attacked than those at the "cathodic" or "noble" end of the series such as gold and silver.

| Environment | Examples | Acceptable Anodic Index Difference |
|---|---|---|
| Harsh Environments | Outdoors, high humidity, and salt environments | Not more than 0.15 V difference |
| Uncontrolled Environments | Storage in warehouses or non-temperature and humidity controlled environments | Not more than 0.25 V difference |
| Controlled Environments | Temperature and humidity controlled | Not more than 0.50 V difference |

# Wire Gauge Size and Composition Reference Table

| Wiring Information | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AWG wire sizes and other useful information. Reference fluoropolymer (ETFE) wire per MIL-W-22759/16 and solid wire per QQ-W-343, unless otherwise specified. | | | | | | | | | | | |
| Wire Gauge Size | Composition | Nominal Insulation Diameter | Maximum Conductor Diameter | Circular Mil Area | Wt Lbs/ 1000 ft Max | mm$^2$ Area | Ohms/ 1000 ft Max | TFE Insul (Amps) | | PVC Insul* (Amps) | |
| | | | | | | | | Bundle | Single | Bundle | Single |
| 30 | Solid | | .010 | 101.00 | .305 | .049 | | | | | |
| 30** | 7X38 | .036. | 012 | 112.00 | .314 | | | | | | |
| 28 | Solid | | .0126 | 160.00 | .484 | .080 | | | | | |
| 28** | 7X36 | .039 | .015 | 175.00 | .784 | | | | | | |
| 26 | Solid | | .0159 | 254.00 | .769 | .128 | | | | | |
| 26** | 19X38 | .043 | .020 | 304.00 | .784 | | | | | | |
| 24 | Solid | | .0201 | 404.00 | 1.22 | .205 | | | | | |
| 24 | 19X36 | .045 | .024 | 475.00 | 2.57 | | 26.20 | 2.0 | 3.3 | | |
| 22 | Solid | | .0254 | 642.00 | .94 | .325 | | | | | |
| 22 | 19X34 | .052 | .031 | 754.11 | 3.68 | | 16.20 | 2.5 | 4.5 | 5.0 | 9.0 |
| 20 | Solid | | .032 | 1,022.00 | 3.09 | .519 | | | | | |
| 20 | 19X32 | .060 | .039 | 1,216.00 | 5.36 | | 9.88 | 3.7 | 6.5 | 7.5 | 11.0 |
| 18 | Solid | | .0403 | 1,624.00 | 4.92 | .823 | | | | | |
| 18 | 19X30 | .071 | .049 | 1,900.00 | 7.89 | | 6.23 | 5.0 | 9.2 | 10.0 | 16.0 |
| 16 | Solid | | .0508 | 2,583.00 | 7.82 | 1.310 | | | | | |
| 16 | 19X29 | .079 | .055 | 2,426.30 | 9.95 | | 4.81 | 6.5 | 13.0 | 13.0 | 22.0 |
| 14 | Solid | | .0641 | 4,107.00 | 12.40 | 2.080 | | | | | |
| 14 | 19X27 | .093 | .069 | 3,830.40 | 14.90 | | 3.06 | 8.5 | 19.0 | 17.0 | 32.0 |
| 12 | Solid | | .080 | 6,530.00 | 19.70 | 3.310 | | | | | |
| 12 | 37X28 | .114 | .089 | 6,087.60 | 22.60 | | 2.02 | 11.5 | 25.0 | 23.0 | 41.0 |
| 10 | Solid | | .102 | 10,380.00 | 31.40 | 5.270 | | | | | |
| 10 | 37X26 | .139 | .112 | 9,353.00 | 35.10 | | 1.26 | 16.5 | 33.0 | 33.0 | 55.0 |
| 8 | Solid | | .1285 | 16,510.00 | 50.00 | 8.350 | | | | | |
| 8 | 133X29 | .199 | .169 | 16,984.10 | 63.50 | | .701 | 23.0 | 44.0 | 46.0 | 73.0 |
| 6 | Solid | | .162 | 26,250.00 | 79.40 | 13.300 | | | | | |
| 6 | 133X27 | .250 | .212 | 26,812.80 | 99.90 | | .445 | | | 60.0 | 101.0 |
| 4 | Solid | | .204 | 41,240.00 | 143.00 | 21.200 | | | | | |
| 4 | 133X25 | .312 | .268 | 42,613.00 | 157.00 | | .280 | | | 80.0 | 135.0 |
| 2 | Solid | | .258 | 66,370.00 | 200.00 | 33.600 | | | | | |
| 2 | 665X30 | .388 | .340 | 66,500.00 | 245.00 | | .183 | | | 100.0 | 181.0 |
| 1 | Solid | | .381 | 82,517.00 | 263.00 | 42.400 | | | | | |
| 1 | 817X30 | .431 | .380 | 81,700.00 | 314.00 | | .149 | | | | |
| 1/0 | Solid | | .3249 | 105,600.0 | 319.50 | 53.490 | | | | | |
| 1/0 | 045X30 | .479 | .425 | 104,500.0 | 391.00 | | .116 | | | | |
| 2/0 | Solid | | .3648 | 133,100.0 | 402.80 | 67.430 | | | | | |
| 2/0 | 330X30 | .546 | .475 | 133,000.0 | 504.00 | | .091 | | | | |

* Based On Mil-W-5088 Ratings.
** Ref Extruded Fluoropolymer Wire (Tfe) Per Mil-W-16878D, Type Ee.

## The MEASUREMENT DICTIONARY

### Bore

*In firearms, the measure of the approximate internal diameter of the barrel in relation to the diameter of the projectile used in it. Also referred to as gauge in shotguns and caliber for other guns. In a rifled barrel, the distance is measured between opposing lands and grooves; groove measurements are common in cartridge designations originating in the United States, while land measurements are more common elsewhere. A bullet should closely match the groove diameter of a barrel to ensure a good seal.*

*When the barrel diameter is given in inches, the abbreviation "cal" is used in place of "inches." For example, a small bore rifle with a diameter of 0.22 inch is a .22 cal; however, the decimal point is generally dropped when spoken, making it "twenty-two caliber" or simply a "two-two". Calibers of firearms can be referred to in millimeters, as in a "caliber of eighty-eight millimeters" (88 mm) or "a hundred and five-millimeter caliber gun" (often abbreviated as "105 mm gun").*

# EMP Diode Waveform Specifications

When specifying transient voltage suppression for a given lightning strike waveform (or "shape") and level (or magnitude), diodes must be compatible with EMI filter dielectric withstanding voltage (DWV) rating, expressed in volts at a given frequency at ambient temperature defining the maximum voltage a dielectric material can withstand before failing.

**Diode Power Selection for Lightning Strike Waveform Threats**

| DO 160 Waveform | Level | Open Circuit Voltage/ Short Circuit Current (V/A) | Diode Peak Voltage (Vwm) | Diode Clamp Voltage (Vc) | Recomended Diode Power (Watts) |
|---|---|---|---|---|---|
| 1 MHz Damped Ringing Sine 3 | 1 | 100/4 | 5 to 60 | 9.2 to 96.8 | 600 |
| | 2 | 250/10 | 5 to 150 | 9.2 to 243 | 600 |
| | 3 | 600/24 | 5 to 170 | 9.2 to 275 | 600 |
| | 4 | 1500/60 | 5 to 54 | 9.2 to 87.1 | 600 |
| | | | 58 to 150 | 93.6 to 243 | 1500 |
| | | | 160 to 170 | 259 to 275 | 3000 |
| | 5 | 3200/128 | 5 to 22 | 9.2 to 38.9 | 600 |
| | | | 26 to 60 | 42.1 to 96.8 | 1500 |
| | | | 64 to 130 | 103 to 209 | 3000 |
| | | | 150 to 170 | 243 to 275 | 5000 |
| Double Exponential 6.4 x70 µsec 4 | 1 | 50/10 | 5 to 30 | 9.2 to 121 | 600 |
| | 2 | 125/25 | 5 to 75 | 9.2 to 121 | 600 |
| | 3 | 300/60 | 5 to 17 | 9.2 to 27.6 | 600 |
| | | | 18 to 26 | 29.2 to 42.1 | 3000 |
| | | | 28 to 110 | 45.4 to 177 | 5000 |
| | | | 120 to 170 | 193 to 275 | 15000 |
| | 4 | 750/150 | 5 to 11 | 9.2 to 18.2 | 3000 |
| | | | 12 to 60 | 19.9 to 96.8 | 5000 |
| | | | 64 to 170 | 104 to 275 | 15000 |
| | 5 | 1600/320 | 5.5 to 24 | 10.5 to 38.9 | 5000 |
| | | | 26 to 78 | 42.1 to 126 | 15000 |
| | | | 90 | 141 | 30000 |
| Double Exponential 40 x 120 µsec 5A | 1 | 50/50 | 5 to 30 | 9.2 to 48.4 | 1500 |
| | 2 | 125/25 | 5 to 75 | 9.2 to 121 | 3000 |
| | 3 | 300/300 | 5 to 15 | 9.2 to 24.4 | 3000 |
| | | | 17 to 170 | 26.7 to 291 | 15000 |
| | | | 180 | 291 | 30000 |
| | 4 | 750/750 | 17 to 28 | 26.7 to 45.4 | 15000 |
| | | | 30 to 48 | 55.2 to 77.4 | 30000 |
| | 5 | 1600/1600 | None | | |

**The Measurement Dictionary**

### Calorie (cal)

*A common name for the CGS unit of heat energy. This calorie (also called a gram calorie or small calorie) is the amount of heat required at a pressure of one atmosphere to raise the temperature of one gram of water by one degree Celsius. Unfortunately, this varies with the temperature of the water, so it is necessary to specify which degree Celsius is meant. A traditional choice was the degree from 14.5°C to 15.5°C; raising the temperature of water through this range requires 4.1858 joules, a quantity called the 15° calorie. Another choice produces the thermochemical calorie, equal to exactly 4.184 joules. More common today is the international steam table calorie, or IT calorie for short, defined by an international conference in 1956 to equal exactly 4.1868 joules, exactly 1.163 milliwatt hours, or about 0.00396832 British thermal units (Btu). The name of the unit comes from the Latin "calor," meaning "heat."*

## Choosing the Right Diode for EMP Suppression

**Tables for the selection of diodes and recommended DWV for a specified waveform voltage threat.**

1. Determine the specification threat waveform and level.
2. Determine the maximum clamping voltage that the system can tolerate (this may be a different value for each pin of the connector).
3. Move down the table to the waveform and Voc/Isc (Open Circuit Voltage/Short Circuit Current) that is covered in the specification.
4. Move across the table left to right and select the recommended diode power level.
5. If the application is a high frequency data line, a low capacitance diode will be needed. There is no difference in the power rating.
6. High speed data lines, Ethernet or USB, cannot tolerate much capacitance at all. These will need a special diode and no filter can be used.
7. If a filter is to be used in the application, consult EMI Filter Rating table (below) to determine the minimum DWV voltage needed to protect the selected filter capacitance.
8. The filter DWV rating applies with or without a diode.

**EMI Filter Rating in Dielectric Withstanding Voltage (DWV) For Compatibility with Transient Suppressing Diodes**

| DO 160 Waveform | Level | Waveform (Voc) | ▼ Recommended Dielectric Withstanding Voltage ▼ | *Capacitance pF Minimum* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **19000** | **16000** | **9000** | **4000** | **1650** | **400** | **200** |
| 1 MHz Damped Ringing Sine 3 | 1 | 100 | | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| | 2 | 250 | | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| | 3 | 600 | | 500 | 500 | 500 | 670 | 720 | 720 | 720 |
| | 4 | 1500 | | 740 | 840 | 1210 | 1660 | 1800 | 1800 | 1800 |
| | 5 | 3200 | | 1580 | 1790 | 2580 | 3530 | 3840 | 3840 | 3840 |
| Double Exponential 6.4 x70 µsec 4 | 1 | 50 | | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| | 2 | 125 | | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| | 3 | 300 | | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| | 4 | 750 | | 820 | 850 | 900 | 900 | 900 | 900 | 900 |
| | 5 | 1600 | | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |
| Double Exponential 40 x 120 µsec 5A | 1 | 50 | | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| | 2 | 125 | | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| | 3 | 300 | | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| | 4 | 750 | | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| | 5 | 1600 | | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 |

The MEASUREMENT DICTIONARY

**Calorie (kcal or Cal)**

*A common name for the MKS unit of heat energy. This unit is properly called the "kilocalorie;" it is also called the kilogram calorie or large calorie. It is often (but certainly not always!) distinguished from the small calorie by capitalizing its name and symbol. The large calorie, or rather kilocalorie, is the amount of heat required at a pressure of one atmosphere to raise the temperature of one kilogram of water by one degree Celsius. Since this is 1000 times as much water as mentioned in the definition of the small calorie, the kilocalorie equals 1000 small calories, 4.1868 kilojoules, 3.9683 Btu, or 1.163 watt hours. (These conversions assume the IT calorie is in use; see previous entry.) These are the "calories" that joggers are trying to get rid of, the ones we gain by eating. The use of the same term "calorie" for two different-size units is endlessly confusing, but we seem to be stuck with it.*

# The Measurement Dictionary

## Candlepower (cp)

*A unit formerly used for measuring the light-radiating capacity of a lamp or other light source. One candlepower represents the radiating capacity of a light with the intensity of one "international candle," or about 0.981 candela as now defined. Since 1948 the candela has been the official SI unit of light intensity, and the term "candlepower" now means a measurement of light intensity in candelas, just as "voltage" means a measurement of electric potential in volts.*

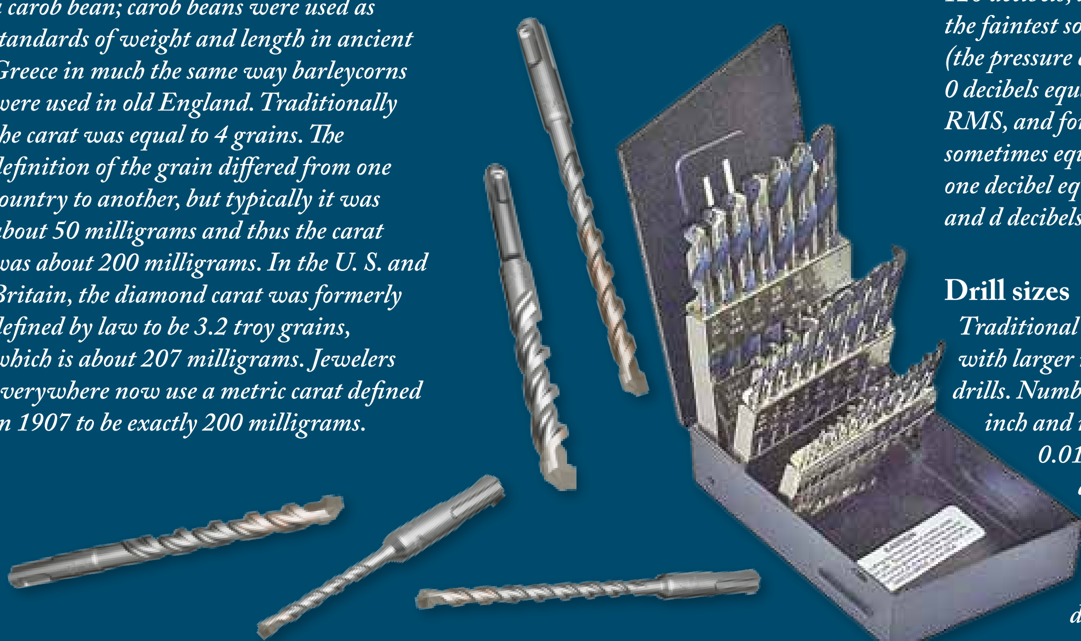
A dime is about the size of a 20 carat diamond

## Carat (ct or c)

*A unit of mass used for diamonds and other precious stones. Originally spelled karat, the word comes from the Greek "keration," a carob bean; carob beans were used as standards of weight and length in ancient Greece in much the same way barleycorns were used in old England. Traditionally the carat was equal to 4 grains. The definition of the grain differed from one country to another, but typically it was about 50 milligrams and thus the carat was about 200 milligrams. In the U. S. and Britain, the diamond carat was formerly defined by law to be 3.2 troy grains, which is about 207 milligrams. Jewelers everywhere now use a metric carat defined in 1907 to be exactly 200 milligrams.*

## Curie (Ci)

*A unit of radioactivity. One curie was originally defined as the radioactivity of one gram of pure radium. In 1953 scientists agreed that the curie would represent exactly 3.7 x $10^{10}$ atomic disintegrations per second, or 37 gigabecquerels (GBq), this being the best estimate of the activity of a gram of radium. The unit is named for Pierre and Marie Curie, discoverers of radium.*



## Decibel (dB)

*A customary logarithmic measure most commonly used (in various ways) for measuring sound. The human ear is capable of detecting an enormous range of sound intensities. Because of this great range, and because our perception of sound is not linear, it makes sense to measure sound on logarithmic scales. Informally, if one sound is 1 bel (10 decibels) "louder" than another, this means the louder sound is 10 times louder than the fainter one. A difference of 20 decibels corresponds to an increase of 10 x 10 or 100 times in intensity. The beginning of the scale, 0 decibels, can be set in different ways, depending on exactly which aspect of sound is being measured. For sound intensity (the power of the sound waves per unit of area) 0 decibels equals 1 picowatt per squareuare meter; this measure corresponds approximately to the faintest sound that can be detected by a person who has good hearing. A quiet room has a normal sound intensity of around 40 decibels, ten thousand times louder than the faintest perceptible sound, and a thunderclap may have an intensity of 120 decibels, a trillion times louder than the faintest sound. For sound pressure (the pressure exerted by the sound waves) 0 decibels equals 20 micropascals (µPa) RMS, and for sound power 0 decibels sometimes equals 1 picowatt. In all cases, one decibel equals about 0.115129 neper and d decibels equal d(ln 10)/20 nepers.*

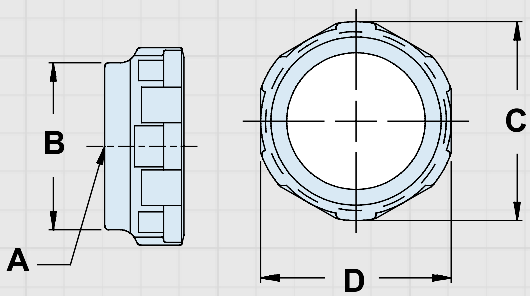
## Drill sizes

*Traditional drill sizes are numbers 1-80, with larger numbers indicating smaller drills. Number 1 has diameter 0.2280 inch and number 80 has diameter 0.0135 inch. Larger sizes are designated by letters or by specifying the diameter directly in 64ths of an inch. The metric drill size is the diameter in millimeters.*

# Connector-to-Backshell Interface Standards

See following two pages for connector designator codes.

| Circular Connector Front End Dimensional Details | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Shell Size for Connector Designator | | | | | A Thread Ref | B Dia Max | C Dia Max | D Flats Ref |
| A | F/L | G | H | U | | | | |
| - | 08 09 | - | - | - | 7/16-28 UNEF | .59 (15.0) | .86 (21.8) | .75 (19.1) |
| - | - | - | 09 A | - | M12 X 1 - 6H | .65 (16.5) | | |
| 08 | - | - | - | - | 1/2-20 UNF | .65 (16.5) | | |
| - | - | - | - | 08 9 A B | 1/2-28 UNEF | .65 (16.5) | .98 (24.9) | .88 (22.2) |
| 03 | 10 11 | - | - | - | 9/16-24 UNEF | .72 (18.3) | | |
| - | - | - | 11 B | - | M15 x 1 - 6H | .77 (19.6) | | |
| 10 | - | - | - | - | 5/8-24 UNEF | .77 (19.6) | | |
| - | - | - | - | 10 11 C D | 5/8-28 UN | .77 ( 19.6) | 1.16 (29.4) | 1.00 (25.4) |
| - | 12 13 | - | - | - | 11/16-24 UNEF | .84 (21.3) | | |
| - | - | - | 13 C | - | M18 x 1 - 6H | .89 (22.6) | | |
| 12 7 | - | 11 A | - | - | 3/4-20 UNEF | .91 (23.1) | | |
| - | - | - | - | 12 13 F | 3/4-28 UNS | 91 (23.1) | 1.28 (32.5) | 1.13 (28.6) |
| - | 14 15 | - | - | - | 13/16-20 UNEF | .97 (24.6) | | |
| - | - | - | - | - | M22 x 1 - 6H | 1.03 (26.2) | | |
| 14 12 | - | 13 B | 13 B | - | 7/8-20 UNEF | 1.03 (26.2) | | |
| - | - | - | - | 14 15 G H | 7/8-28 UN | 1.03 (26.2) | 1.41 (35.7) | 1.25 (31.8) |
| - | 16 17 | - | - | - | 15/16-20 UNEF | 1.09 (27.7) | | |
| - | - | - | 17 E | - | M25 x 1 - 6H | 1.15 (29.2) | | |
| 16 19 | - | 15 C | - | - | 1-20 UNEF | 1.15 (29.2) | | |
| - | - | - | - | 16 17 J K | 1-28 UN | 1.15 (29.2) | 1.52 (38.5) | 1.38 (35.1) |
| 18 27 | 18 19 | - | - | - | 1-1/16-18 UNEF | 1.22 (31.0) | | |
| - | - | - | 19 F | - | M28 x 1 - 6H | 1.28 (32.5) | | |
| - | - | 17 D | - | - | 1-1/8-18 UNEF | 1.28 (32.5) | | |
| - | - | - | - | 18 19 M N | 1-1/8-28 UN | 1.28 (32.5) | 1.64 (41.7) | 1.50 (38.1) |
| 20 37 | 20 21 | - | - | - | 1-3/16-18 UNEF | 1.34 (34.0) | | |
| - | - | - | 21 G | - | M31 x 1 - 6H | 1.41 (35.8) | | |
| - | - | 19 E | - | - | 1-1/4-18 UNEF | 1.41 (35.8) | | |
| - | - | - | - | 20 21 P R | 1-1/4-28 UN | 1.41 (35.8) | 1.77 (44.9) | 1.63 (41.3) |
| 22 | 22 23 | - | - | - | 1-5/16-18 UNEF | 1.47 (37.3) | | |
| - | - | - | 23 H | - | M34 x 1 - 6H | 1.53 (38.9) | | |
| - | - | - | - | 22 23 S T | 1-3/8-28 UN | 1.53 (38.9) | 1.89 (48.0) | 1.75 (44.5) |
| 24 | 24 25 | 23 F | - | - | 1-7/16-18 UNEF | 1.59 (40.4) | | |
| - | - | - | 25 J | - | M37 x 1 - 6H | 1.66 (42.2) | | |
| 61 | - | - | - | - | 1-1/2-18 UNEF | 1.66 (42.2) | | |
| - | - | - | - | 24 25 U M | 1-1/2-28 UN | 1.66 (42.2) | 2.02 (51.2) | 1.88 (47.6) |
| - | - | 25 G | - | | 1-9/16-18 UNEF | 1.66 (42.2) | | 2.00 (50.8) |
| 28 | - | - | - | - | 1-3/4-18 UNS | 1.97 (50.0) | 2.16 (54.8) | - |




***NOTES:***

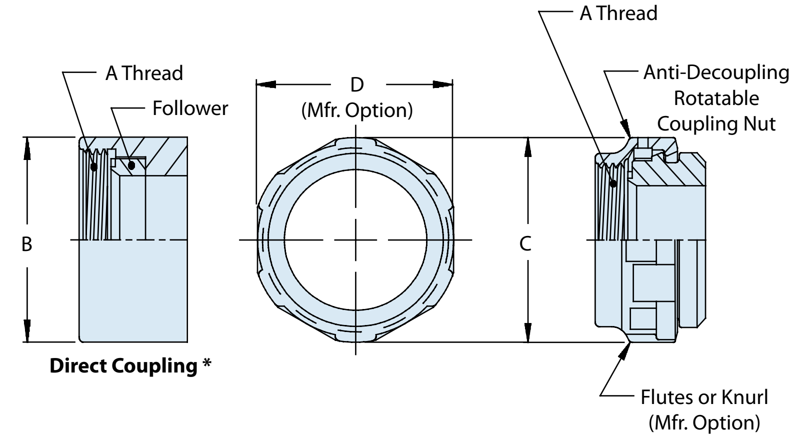
1. *Connector shell size designations in blue are for reference only; do not use in part numbers.*
2. *Metric dimensions (mm) are in parentheses and are for reference only. (1 inch = 25.4 mm)*
3. *Consult factory for accessory interface data not listed.*
4. *Use Glenair 600-091 or 600-157 tool to tighten coupling nut. Rubber jaw pliers or strap wrench may damage the parts.*

# Connector-to-Backshell Interface Standards (continued)

## Circular Connector Common Interface Standards

### Connector Designator A

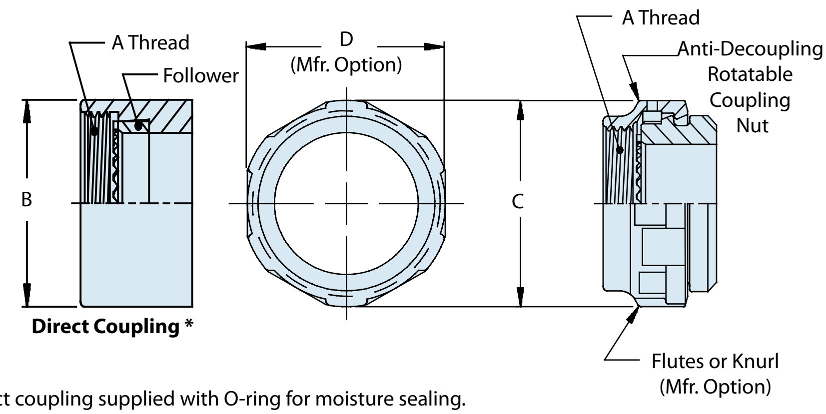
| SPECIFICATION | SERIES |
|---|---|
| MIL-DTL-5015 | MS34XX |
| MIL-DTL-26482 | 2 |
| MIL-C-81703 | 3 |
| MIL-DTL-83723 | 1 & 3 |
| 40M39569 | NB |
| DEF 5326-3 | |
| LN 29504 | |
| NFC 93422 | HE 302 |
| PAN 6432-1 | |
| PAN 6432-2 | |
| PATT 602 | |
| EN2997 | |




Note: Code A, rotatable coupling supplied without O-ring.
Environmental seal performed by interface geometry.
* Consult factory for direct coupling part numbers.

### Connector Designator F

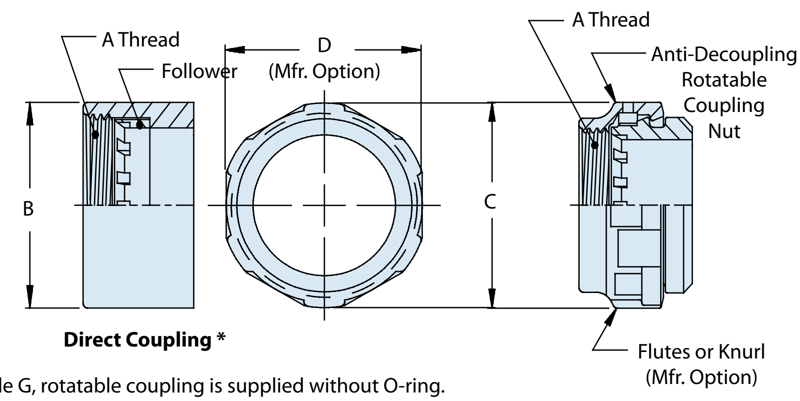
| SPECIFICATION | SERIES |
|---|---|
| MIL-DTL-38999 | I & II |
| 40M38277 | NLS |
| NFC 93422 | HE 309 |
| NFC93422 | HE 308 |
| PAN 6433-1 | |
| PATT 614 | |
| PATT 616 | |




Note: Direct coupling supplied with O-ring for moisture sealing.
Add modifier code 101A to end of part number for O-ring to be supplied on rotatable coupling.
* Consult factory for direct coupling part numbers.

### Connector Designator G

| SPECIFICATION |
|---|
| MIL-DTL-28840 |

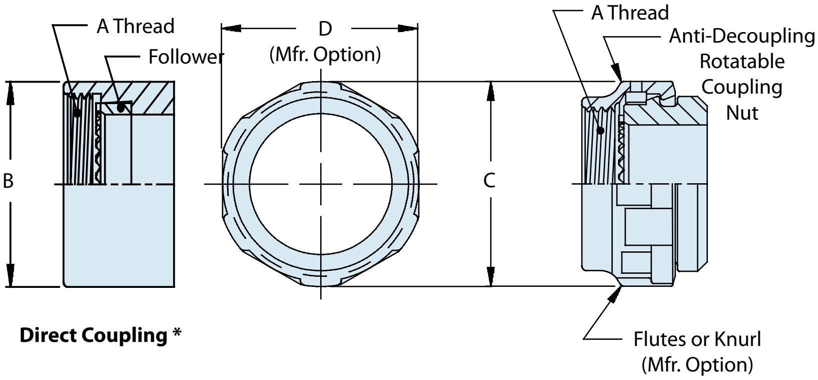



Note: Code G, rotatable coupling is supplied without O-ring.
Environmental seal performed by interface geometry.
* Consult factory for direct coupling part numbers.

## Circular Connector Common Interface Standards

### Connector Designator **H**

| SPECIFICATION | SERIES |
|---|---|
| MIL-DTL-38999<br>EN3645 | III & IV |




**Direct Coupling ***

Note: Direct coupling supplied with O-ring for moisture sealing. Add modifier code 101A to end of part number for O-ring to be supplied on rotatable coupling.
* Consult factory for direct coupling part numbers.

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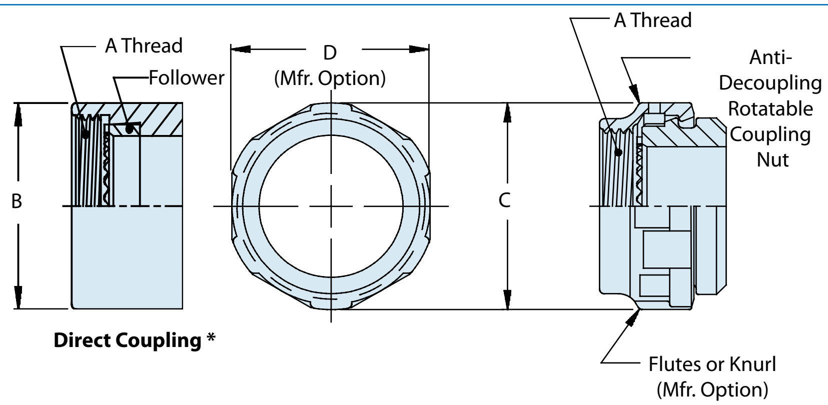
### Connector Designator **L**

| SPECIFICATION | SERIES |
|---|---|
| EN3372<br>JN1003<br>LN 29729<br>NFC93422<br>PAN 6433-2<br>PATT<br>615<br>VG 96912 | HE306 |




**Direct Coupling ***

Note: Direct coupling supplied with O-ring for moisture sealing.
Add modifier code 101A to end of part number for O-ring to be supplied on rotatable coupling.
* Consult factory for direct coupling part numbers.

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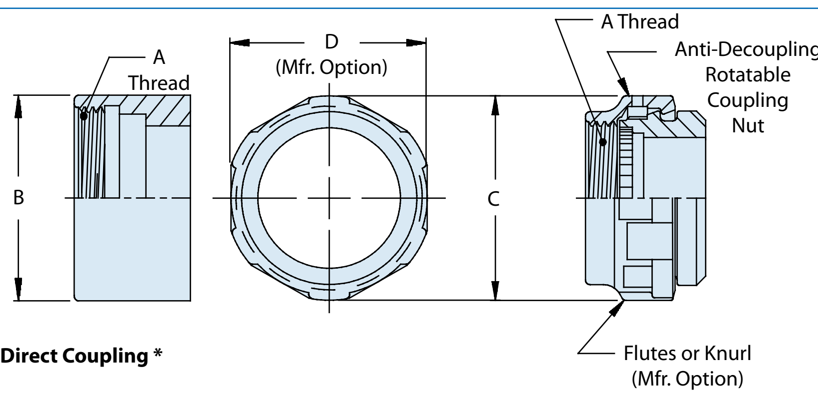
### Connector Designator **U**

**SPECIFICATION**

MIL-C-29600

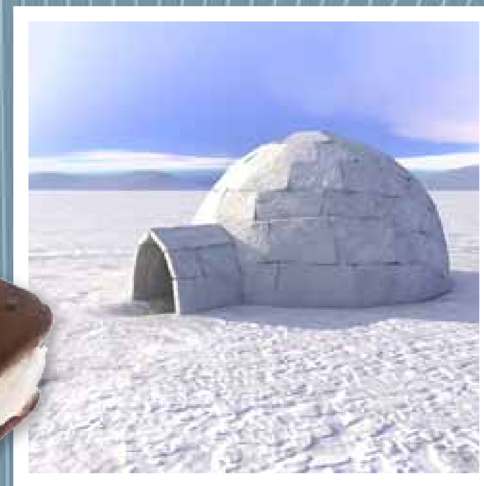



**Direct Coupling ***

Note: Direct coupling supplied with O-ring for moisture sealing. Add modifier code 101A to end of part number for O-ring to be supplied on rotatable coupling.
* Consult factory for direct coupling part numbers.

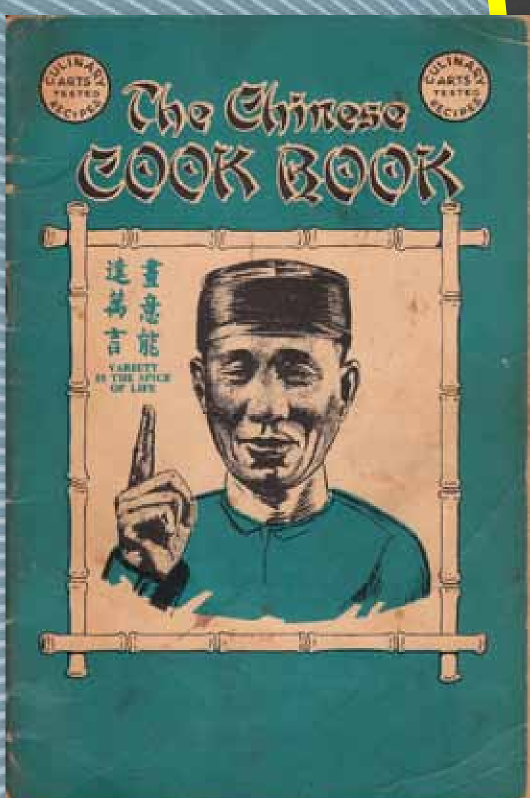
# Illustrated Conversion Units Quick Reference Guide


1000 aches = 1 megahurtz



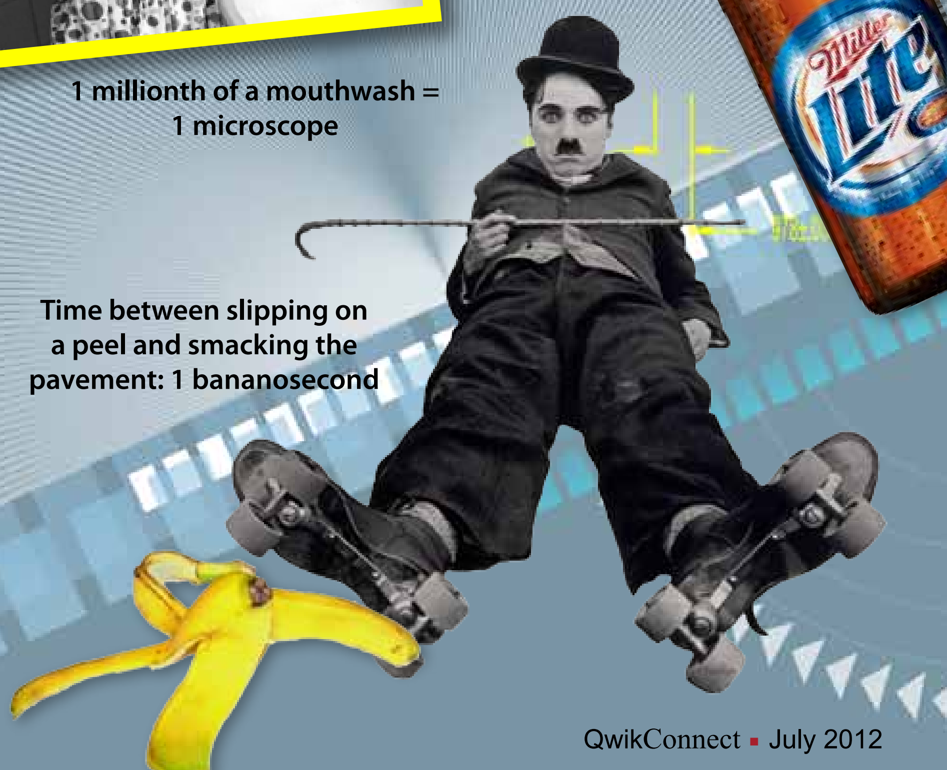
Ratio of an igloo's circumference to its diameter: Eskimo Pi

1 millionth of a mouthwash = 1 microscope




2000 pounds of Chinese soup = Won ton

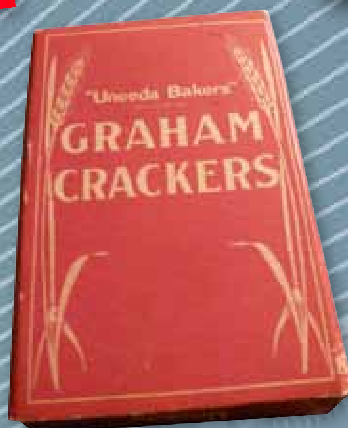

365 days of drinking low-calorie beer = 1 lite year



Time between slipping on a peel and smacking the pavement: 1 bananosecond


Weight an evangelist carries with God: 1 billigram

1/2 million bicycles = 1 megacycle



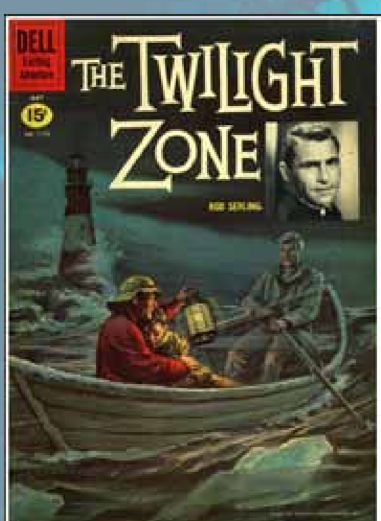

Basic unit of laryngitis: 1 hoarsepower

10 cards = 1 decacards

453.6 graham crackers = 1 pound cake


10 rations = 1 decoration

Shortest distance between two jokes: A straight line




16.5 feet in the Twilight Zone = 1 Rod Serling

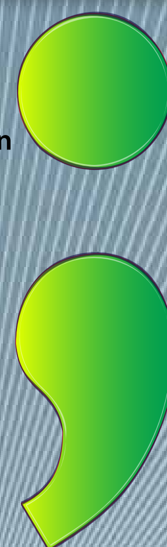
1 million-million microphones = 1 megaphone


Time it takes to sail 220 yards at 1 nautical mile per hour: Knot-furlong

2000 mockingbirds = two kilomockingbirds

1 trillion sins = 1 cardinal sin


2 monograms = 1 diagram



½ large intestine = one semicolon

1000 grams of wet socks = 1 literhosen

1 trillion pins = 1 terrapin

1 millionth of a fish = 1 microfiche

8 nickels =
2 paradigms

4 lawyers = 2 paralegals

A first-date kiss: 1 peck

2 untruths = 1 paralyze

1 kilogram of falling figs =
1 Fig Newton

A one mile stroll: 1 Milwaukee

# Contact Densities and Service Ratings

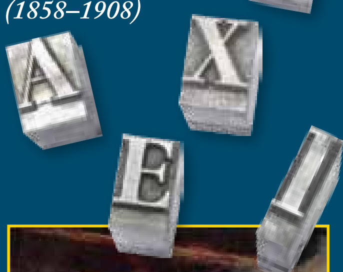
## The Measurement Dictionary

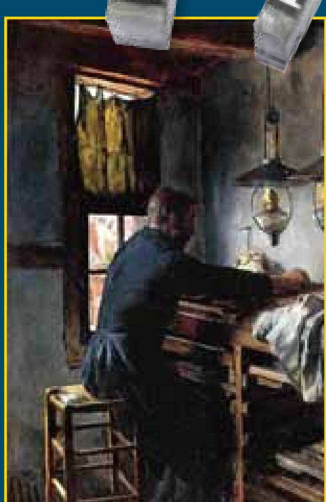
### Em

*A printer's unit of relative distance, from the era of movable type. One em is the height of the type size (in points) being used. If 12 point type is being set, then one em is 12 points, and so on. An "Em dash" is used in typography to separate a subordinate clause—or a parenthetical statement—inside or at the end of a longer sentence.*

### En

*A printer's unit of relative distance, equal to 1/2 em. If 12 point type is being set, then one en is 6 points, and so on. An "En dash" is used in typography to separate a range of numbers, as in the attribution for this picture, The Dutch Typesetter, Charles Frederic Ulrich (1858–1908)*

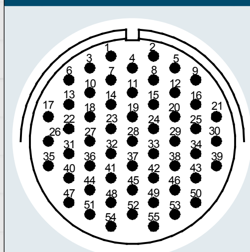




| Center-to-Center Contact Distances | | | | | | |
|---|---|---|---|---|---|---|
| Type | Connector Specification | Insert Arrangement Specification | Max Shell Size | Max Number of Contacts | Contact Size | Center-to-Center |
| Standard | MIL-DTL-5015 | MIL-STD-1651 | 48 | 85 | 16 | 0.241" (6.1 mm) |
| | MIL-DTL-22992 | MIL-STD-1651 | 44 | 104 | 16 | 0.193" (4.9 mm) |
| | VG95234 | MIL-STD-1651 | 26 | 52 | 16 | 0.203" (5.2 mm) |
| | MIL-DTL-28840 | MIL-STD-1698 | 33 | 155 | 20 | 0.114" (2.9 mm) |
| Miniature | MIL-DTL-26482 | MIL-STD-1669 | 24 | 61 | 20 | 0.135" (3.4 mm) |
| | MIL-DTL-26500 | MIL-STD-1554 | 24 | 61 | 20 | 0.131" (3.3 mm) |
| | MIL-DTL-83723 | MIL-STD-1554 | 24 | 61 | 20 | 0.131" 3.3 mm) |
| Subminiature | MIL-DTL-38999 | MIL-STD-1560 | 24 | 128 | 22D | 0.095" (2.4 mm) |
| Ultra-miniature | Series 80 "Mighty Mouse" | | 23 | 130 | 23 | 0.076" (1.9 mm) |
| Rectangular Nano | MIL-DTL-32139 | | | 51 | 30/32 | 0.025" (0.6 mm) |
| Rectangular Micro | MIL-DTL-83513 | | | 100 | 24/26 | 0.050" (1.3 mm) |
| D-Subminiature | M24308 | | | 104 | 20/22 | 0.109" (2.8 mm) |
| ARINC | | | | | | |

| Contact Service Ratings | | |
|---|---|---|
| Service Rating | Operating Voltages | |
| | DC | AC RMS |
| A | 700 | 500 |
| B | 2450 | 1750 |
| C | 4200 | 3000 |
| D | 1250 | 900 |
| E | 1750 | 1250 |
| M | 400 | 550 |
| Instrument | 250 | 200 |
| I | 850 | 600 |
| II | 1400 | 1000 |

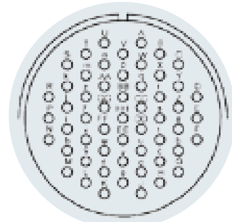
**Standard**



**MIL-DTL-5015**
**MIL-DTL-22992**
**VG95234 (ITS)**
**MIL-DTL-28840**

Insert arrangement shown: 24-A55 • 55 #20 Contacts

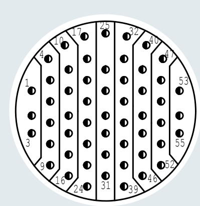
**Miniature**



**MIL-DTL-26482**

Insert arrangement shown: 22-55 • 55 #20 Contacts

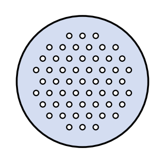
**Subminiature**



**MIL-DTL-38999**

Insert arrangement shown: E35 • 55 #22D Contacts

**Ultraminiature**



**Series 80 "Mighty Mouse"**

Insert arrangement shown: 16-55 • 55 #23 Contacts

# Wire Bundle Diameter Calculator

| Calculating Wire Bundle Diameter | |
|---|---|
| When calculating wire bundle diameters, note that the gauge of the wire describes only the diameter of the metal conductor, and not the overall diameter including insulation and/or braids. Refer to the appropriate wire specification for the actual diameter of the wire for use in the following calculations. | |
| **Steps** | **Calculations** |
| (1a) Determine average wire diameter when all wires are the same diameter; or | Given 30 Wires @ .045 DIA<br>**Avg. Wire DIA = .045** |
| (1b) Determine average wire diameter when wires are different diameters. | Given 15 Wires @ .045 **and** 15 Wires @ .135<br>15 x .045 = .68<br>15 x .135 = 2.03 + = 2.71<br>$\frac{2.71}{30}$ = **.090 Avg. Wire DIA** |
| (2) Multiply average wire diameter by factor from Table I below | (1a) .045 x 6.5 = **.2925 Core Wire Bundle DIA**<br>(1b) .090 x 6.5 = **.585 Core Wire Bundle DIA** |
| (3) Add thickness of any shielding or jacketing to core wire bundle diameter (for example, add .025 for braided sleeving | (1a) .2925 + .025 = **.3175 Wire Bundle Outside DIA**<br>(1b) .585 + .025 = **.61 Wire Bundle Outside DIA** |

**Table I**

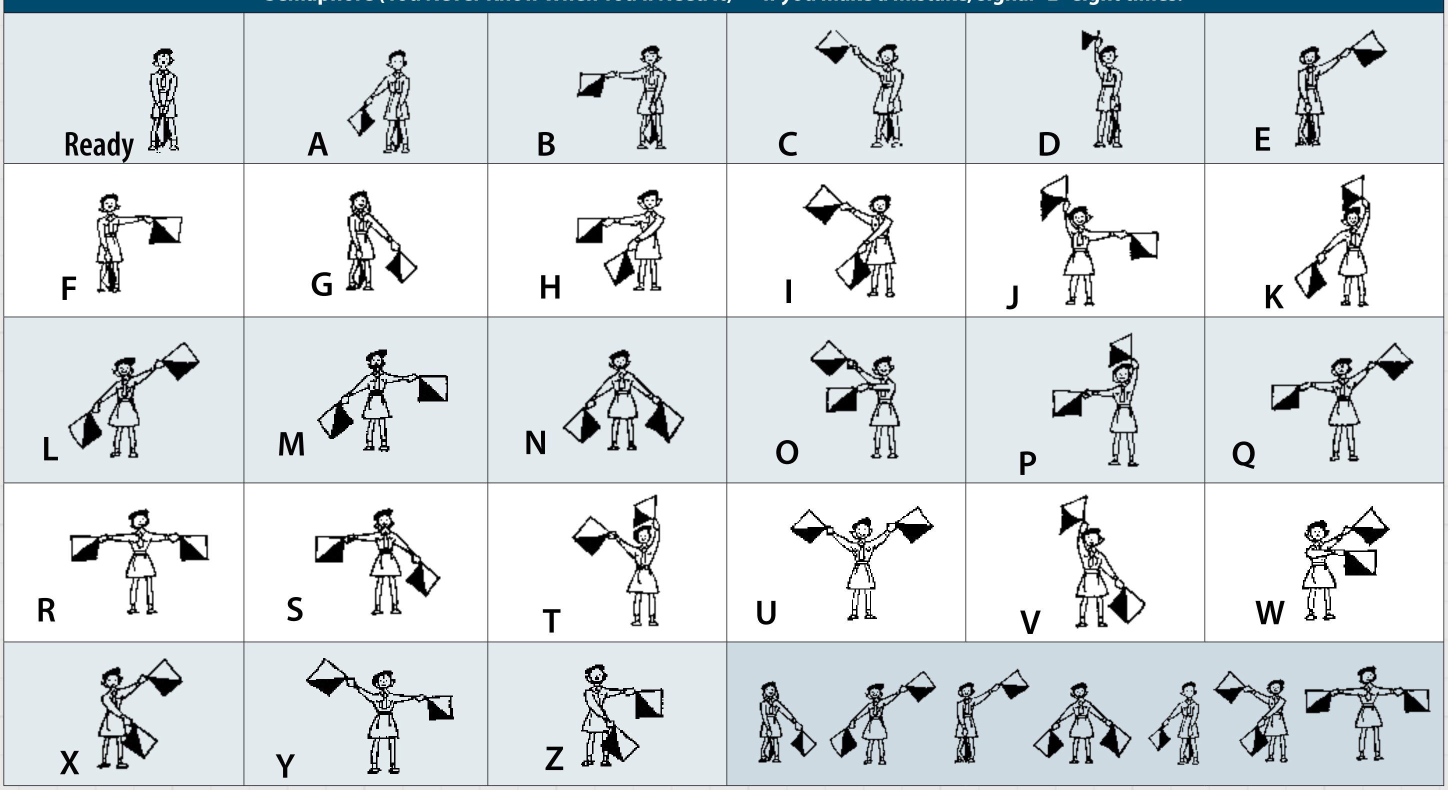
| **No. of Wires** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 14 | 16 | 18 | 20 | 24 | 28 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Factor** | 1.0 | 2.0 | 2.2 | 2.4 | 2.7 | 2.9 | 3.0 | 3.3 | 3.8 | 4.0 | 4.3 | 4.6 | 5.0 | 5.3 | 5.6 | 6.0 | 6.5 | 6.9 |
| **No. of Wires** | 36 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 90 | 100 | 125 | 150 | 175 | 200 | 250 | 300 |
| **Factor** | 7.4 | 7.7 | 8.1 | 8.5 | 8.9 | 9.3 | 9.7 | 10.1 | 10.5 | 10.9 | 11.6 | 12.2 | 13.7 | 15.0 | 16.1 | 17.2 | 19.3 | 21.0 |

## The MEASUREMENT DICTIONARY

**Farad (F)**

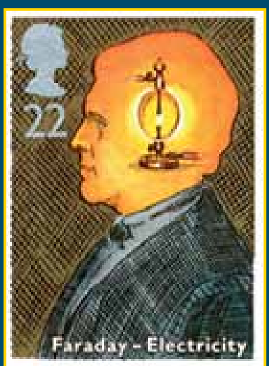
*The SI unit of electric capacitance. Very early in the study of electricity scientists discovered that a pair of conductors separated by an insulator can store a much larger charge than an isolated conductor can store. The better the insulator, the larger the charge that the conductors can hold. This property of a circuit is called capacitance, and it is measured in farads. One farad is defined as the ability to store one coulomb of charge per volt of potential difference between the two conductors. This is a natural definition, but the unit it defines is very large. (Continued, next page)*

**Semaphore (You Never Know When You'll Need It) — If you make a mistake, signal "E" eight times.**



The MEASUREMENT DICTIONARY

*In practical circuits, capacitance is often measured in microfarads, nanofarads, or picofarads ($10^{-12}$ farad, or trillionths of a farad). The unit is named for the British physicist Michael Faraday (1791–1867). The picofarad (pF) is commonly pronounced "puff."*




### Faraday (Fd)

*A unit of electric charge. In a process called "electrolysis," chemists separate the components of a dissolved chemical compound by passing an electric current through the compound. The components are deposited at the electrodes, where the current enters or leaves the solution. Michael Faraday determined that the same amount of charge is needed to deposit one mole of any element or ion of valence one (meaning that each molecule of the ion has either one too many or one too few electrons). This amount of charge, equal to about 96.4853 kilocoulombs or 26.8015 ampere hours, became known as Faraday's constant. Later, it was adopted as a convenient unit for measuring the charges used in electrolysis. One faraday is equal to the product of Avogadro's number and the charge (1 e) on a single electron.*

# AS39029, M29504 and Other High-Performance Contacts/Termini Reference Tables

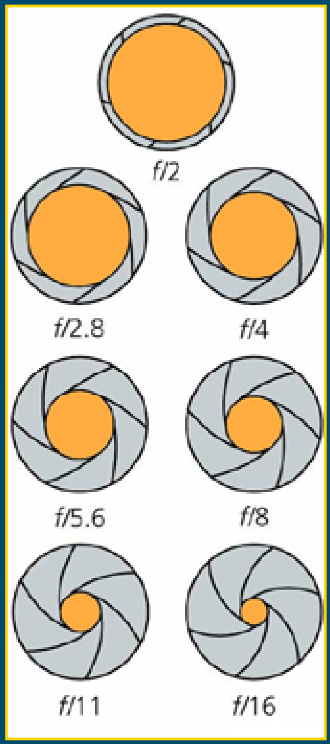
| Glenair Part Number | Part Description | Contact Size | Pin / Socket | Connector Series |
|---|---|---|---|---|
| **MIL-DTL-38999 Fiber Optic Contacts** | | | | |
| 181-001 | M29504/5 Socket Terminus | 16 | Socket | D38999 Series III |
| 181-002 | M29504/4 Pin Terminus | 16 | Pin | D38999 Series III |
| 181-035 | Socket, Large Core Fiber | 16 | Socket | D38999 Series III |
| 181-036 | Pin, Large Core Fiber | 16 | Pin | D38999 Series III |
| 181-052 | Jewel Pin Terminus | 16 | Pin | D38999 Series III |
| 181-053 | Jewel Socket Terminus | 16 | Socket | D38999 Series III |
| 181-048 | Sealing Plug | 16 | Pin | D38999 Series III |
| 181-065 | #20 Pin Terminus | 20 | Pin | D38999 Series III |
| 181-066 | #20 Socket Terminus | 20 | Socket | D38999 Series III |
| **MIL-PRF-28876 Fiber Optic Contacts** | | | | |
| 181-039 | M29504/14 Pin Terminus | 16 | Pin | M28876 |
| 181-040 | M29504/15 Socket Terminus | 16 | Socket | M28876 |
| 181-051 | M29504/3 Dummy Terminus | 16 | Dummy | M28876 |
| **Series 80 Mighty Mouse Fiber Optic Contacts** | | | | |
| 181-057 | Mighty Mouse Pin Terminus | 16 | Pin | Series 80 Mighty Mouse |
| 181-075 | Mighty Mouse Socket Terminus | 16 | Socket | Series 80 Mighty Mouse |
| **Special Fiber Optic COTS Contacts Size 16 Front Release** | | | | |
| 181-011 | Front Release Socket with Pressure Sealing O-Ring(s) | 16 | Socket | COTS |
| 181-012 | Front Release Pin | 16 | Pin | COTS |
| 181-051 | M29504/3 Dummy Terminus | 16 | Dummy | COTS |
| **ARINC Type Fiber Optic Contacts** | | | | |
| 181-076 | ARINC 801 Terminus | 16 | Genderless Pin | ARINC 801 |
| 187-079 | M29504/6 Pin Terminus | 16 | Pin | ARINC 404, 600 |
| 187-080 | M29504/7 Socket Terminus | 16 | Socket | ARINC 404, 600 |
| **Glenair High Density (GHD) Fiber Optic Contacts** | | | | |
| 181-056 | GHD Terminus, Non-keyed | 18 | Genderless Pin | GHD |
| 181-047 | GHD Terminus, Keyed | 18 | Genderless Pin | GHD |
| 181-058 | Dummy Terminus | 18 | Dummy | GHD |
| **Glenair GFOCA Fiber Optic Contacts** | | | | |
| 181-050 | GFOCA Terminus | | Genderless Pin | GFOCA |
| 181-059 | Dummy Terminus | | Dummy | GFOCA |
| **Next Generation Fiber Optic (NGCON) Contacts** | | | | |
| 181-043 | M29504/18 | 16 | Genderless Pin | M64266 |

| Glenair Part Number | Part Description | Contact Size | Type |
|---|---|---|---|
| 859-xxx | Grommet Sealing Plugs (MS27488 Type) | 0-23 | Sealing Plug |
| 809-001 | Series 80 Mighty Mouse Pin Contact | 23 | Crimp Contact |
| 809-002 | Series 80 Mighty Mouse Socket Contact | 23 | Crimp Contact |
| 857-010 | Pneumatic Socket Contact for Series 79 | 12 | Pneumatic |
| 857-011 | Pneumatic Pin Contact for Series 79 | 12 | Pneumatic |
| 850-010 | PCB Pin Contact to fit D38999/20 and /24 | 12-22 | PCB Pin |
| 850-011 | PCB Socket Contact to fit D38999/20 and /24 | 12-22 | PCB Socket |
| 850-013 | High Power Socket Contact | 8 | Power Socket |
| 850-014 | High Power Pin Contact | 8 | Power pin |
| 850-015 | M39029/56 Type Socket Contact with Solder Cup | 10-22 | Solder Cup |
| 850-016 | Pin Contact with Solder Cup | 10-22 | Solder Cup |
| 850-017 | M39029/58 Type Pin Contact with Solder Cup | 12-22 | Solder Cup |
| 850-018 | M39029/56-348 Type Socket Contact | 22 | Crimp Contact |
| 850-019 | M39029/58-360 Type Pin Contact | 22 | Crimp Contact |
| 850-020 | M39029/57 Type Socket Contact | 22 | Crimp Contact |
| 857-027 | M39029/58 Type High Power Pin with PC Tails | 8 | PCB Power |
| 857-028 | M39029/56 Type High Power Socket with PC Tails | 8 | PCB Power |
| 687-348 | Wire to Contact Crimp Adapter | | Crimp Adapter |
| 850-023 | M39029/87 Thermocouple Pin Contact | 16, 20, 22 | Thermocouple |
| 850-024 | M39029/88 Thermocouple Socket Contact; Series I, II, IV | 16, 20, 22 | Thermocouple |
| 850-025 | M39029/89 Thermocouple Socket Contact; Series II | 16, 20, 22 | Thermocouple |

The MEASUREMENT DICTIONARY

### f ratio or f number or f stop (f/ or f)

*A measure of the light-gathering power of camera and telescope lenses. The f ratio, for example "f/4" or "f4," is the aperture of the lens (the effective diameter of the lens, which may be reduced or "stopped down" for the exposure) expressed as a fraction of the focal length of the lens (the distance from the lens to the point where light is focused). Thus "f/4" indicates that the aperture is 1/4 the focal length. In cameras the f ratio is proportional to the squareuare root of the exposure time, so an f/8 setting requires a four times ((8/4)²) longer exposure than an f/4 setting. Because of this connection with exposure times, the f ratio is often said to express the "speed" of a lens.*



## SAE-AS39029 Crimp Contact Selection Guide

| Military Part Number | Glenair Part Number | Contact Size | Wire Accommodation | Pin / Socket | BIN Color Striping | | |
|---|---|---|---|---|---|---|---|
| M39029/56-348 | 850-001-22-348 | 22 | 22-28 AWG | Socket | Orange | Yellow | Grey |
| M39029/56-351 | 850-001-20-351 | 20 | 20-24 AWG | Socket | Orange | Green | Brown |
| M39029/56-352 | 850-001-16-352 | 16 | 16-20 AWG | Socket | Orange | Green | Red |
| M39029/56-353 | 850-001-12-353 | 12 | 12-14 AWG | Socket | Orange | Green | Orange |
| M39029/56-527 | 850-001-10-527 | 10 | 10 AWG | Socket | Green | Red | Violet |
| M39029/57-354 | 850-003-22-354 | 22 | 22-28 AWG | Socket | Orange | Green | Yellow |
| M39029/57-357 | 850-003-20-357 | 20 | 20-24 AWG | Socket | Orange | Green | Violet |
| M39029/57-358 | 850-003-16-358 | 16 | 16-20 AWG | Socket | Orange | Green | Grey |
| M39029/57-359 | 850-003-12-359 | 12 | 12-14 AWG | Socket | Orange | Green | White |
| M39029/58-360 | 850-002-22-360 | 22 | 22-28 AWG | Pin | Orange | Blue | Black |
| M39029/58-363 | 850-002-20-363 | 20 | 20-24 AWG | Pin | Orange | Blue | Orange |
| M39029/58-364 | 850-002-16-364 | 16 | 16-20 AWG | Pin | Orange | Blue | Yellow |
| M39029/58-365 | 850-002-12-365 | 12 | 12-14 AWG | Pin | Orange | Blue | Green |
| M39029/58-528 | 850-002-10-528 | 10 | 10 AWG | Pin | Green | Red | Grey |
| M39029/63-368 | 850-021-20-368 | 20 | 20-24 AWG | Socket | Orange | Blue | Grey |
| M39029/64-369 | 850-022-20-369 | 20 | 20-24 AWG | Pin | Orange | Blue | White |

| BIN Color Coding | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0<br>BLACK | 1<br>BROWN | 2<br>RED | 3<br>ORANGE | 4<br>YELLOW | 5<br>GREEN | 6<br>BLUE | 7<br>VIOLET | 8<br>GREY | 9<br>WHITE |

| Military Part Number | Glenair Part Number | Contact Size | Wire Accommodation | Pin / Socket | BIN Color Striping | | |
|---|---|---|---|---|---|---|---|
| M39029/83-450 | 850-004-20-450 | 20 | 22-26 AWG | Pin | Yellow | Green | Black |
| M39029/83-451 | 850-004-20-451 | 20 | 28-32 AWG | Pin | Yellow | Green | Brown |
| M39029/83-508 | 850-004-20-508 | 20 | 20-24 AWG | Pin | Green | Black | Grey |
| M39029/84-452 | 850-005-20-452 | 20 | 22-26 AWG | Socket | Yellow | Green | Red |
| M39029/84-453 | 850-005-20-453 | 20 | 28-32 AWG | Socket | Yellow | Green | Orange |
| M39029/84-509 | 850-005-20-509 | 20 | 20-24 AWG | Socket | Green | Black | White |
| M39029/106-614 | 850-006-22-614 | 22 | 22-28 AWG | Socket | Blue | Brown | Yellow |
| M39029/106-615 | 850-006-20-615 | 20 | 20-24 AWG | Socket | Blue | Brown | Green |
| M39029/106-616 | 850-006-16-616 | 16 | 16-20 AWG | Socket | Blue | Brown | Blue |
| M39029/106-617 | 850-006-12-617 | 12 | 12-14 AWG | Socket | Blue | Brown | Violet |
| M39029/106-618 | 850-006-10-618 | 10 | 10 AWG | Socket | Blue | Brown | Grey |
| M39029/107-620 | 850-007-22-620 | 22 | 22-28 AWG | Pin | Blue | Red | Black |
| M39029/107-621 | 850-007-20-621 | 20 | 20-24 AWG | Pin | Blue | Black | Brown |
| M39029/107-622 | 850-007-16-622 | 16 | 16-20 AWG | Pin | Blue | Red | Red |
| M39029/107-623 | 850-007-12-623 | 12 | 12-14 AWG | Pin | Blue | Red | Orange |
| M39029/107-624 | 850-007-10-624 | 10 | 10 AWG | Pin | Blue | Red | Yellow |

| BIN Color Coding | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0<br>BLACK | 1<br>BROWN | 2<br>RED | 3<br>ORANGE | 4<br>YELLOW | 5<br>GREEN | 6<br>BLUE | 7<br>VIOLET | 8<br>GREY | 9<br>WHITE |

The MEASUREMENT DICTIONARY

# Basic Unit Conversion Tables

**Gauge [Ga]**

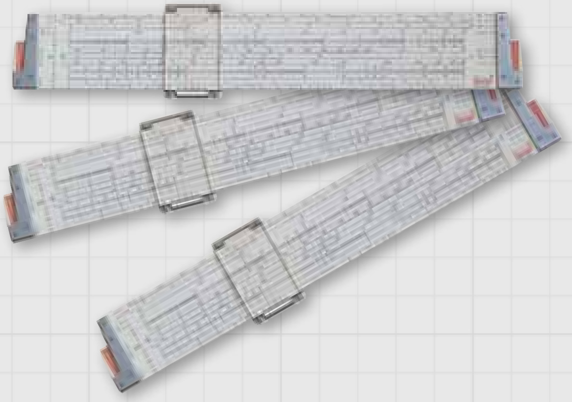
*A traditional unit measuring the diameter (or the cross-sectional area) of a wire. Various wire gauge scales have been used in the U.S. and Britain. In traditional scales, larger gauge numbers represent thinner wires. (For very thick wires, repeated zeros are used instead of negative numbers, so gauges 00, 000, and 0000 represent -1, -2, and -3, respectively.) In the American Wire Gauge (AWG) scale, 0000 gauge represents a wire having a diameter of 0.46 inch and 36 gauge represents a diameter of 0.005 inch (5 mils). Diameters for the other gauges are obtained by geometric interpolation, meaning that the ratio between successive diameters is a constant, except for necessary roundoff. Thus n gauge wire has a diameter of .005•92((36-n)/39) inch. The metric wire gauge number is equal to 10 times the diameter of the wire, in millimeters; thus a metric 8 gauge wire has diameter 0.8 millimeters. A table of wire gauge equivalents is provided on Page 31.*


**Weights and Measures Conversion Table**

| From | To | Multiply by |
|---|---|---|
| inches | millimeters | 25.4 |
| millimeters | inches | 0.0394 |
| inches | centimeters | 2.54 |
| centimeters | inches | 0.3937 |
| feet | meters | 0.3048 |
| meters | feet | 3.281 |
| yards | meters | 0.9144 |
| meters | yards | 1.094 |
| miles | kilometers | 1.609 |
| kilometers | miles | 0.6214 |
| square inches | square centimeters | 6.452 |
| square centimeters | square inches | 0.155 |
| square meters | square feet | 10.76 |
| square feet | square meters | 0.0929 |
| square yards | square meters | 0.8361 |
| square meters | square yards | 1.196 |
| square miles | square kilometers | 2.589 |
| square kilometers | square miles | 0.3861 |
| acres | hectares | 0.4047 |
| hectares | acres | 2.471 |
| cubic inches | cubic centimeters | 16.39 |
| cubic centimeters | cubic inches | 0.06102 |
| cubic feet | cubic meters | 0.02832 |
| cubic meters | cubic feet | 35.315 |
| cubic yards | cubic meters | 0.7646 |
| cubic meters | cubic yards | 1.308 |
| cubic inches | liters | 0.01639 |
| liters | cubic inches | 61.03 |
| pints | liters | 0.5682 |
| liters | pints | 1.76 |
| US pints | liters | 0.47311 |
| liters | US pints | 2.114 |
| US gallon | liters | 3.785 |
| gallons | liters | 4.546 |
| liters | US gallons | 0.2642 |
| liters | gallons | 0.22 |
| grains | grams | 0.0648 |
| grams | grains | 15.43 |
| ounces | grams | 28.35 |
| grams | ounces | 0.03527 |
| pounds | grams | 453.6 |
| grams | pounds | 0.002205 |
| pounds | kilograms | 0.4536 |
| kilograms | pounds | 2.205 |
| tons | kilograms | 1016.05 |
| kilograms | tons | 0.0009842 |

| Inches (Decimal) To Millimeters (mm) Conversion Table | | | |
|---|---|---|---|
| **Decimal** | **mm** | **Decimal** | **mm** |
| 0.001 | 0.0254 | 0.470 | 11.9380 |
| 0.002 | 0.0508 | 0.480 | 12.1920 |
| 0.003 | 0.0762 | 0.490 | 12.4460 |
| 0.004 | 0.1016 | 0.500 | 12.7000 |
| 0.005 | 0.1270 | 0.510 | 12.9540 |
| 0.006 | 0.1524 | 0.520 | 13.2080 |
| 0.007 | 0.1778 | 0.530 | 13.4620 |
| 0.008 | 0.2032 | 0.540 | 13.7160 |
| 0.009 | 0.2286 | 0.550 | 13.9700 |
| 0.010 | 0.2540 | 0.560 | 14.2240 |
| 0.020 | 0.5080 | 0.570 | 14.4780 |
| 0.030 | 0.7620 | 0.580 | 14.7320 |
| 0.040 | 1.0160 | 0.590 | 14.9860 |
| 0.050 | 1.2700 | 0.600 | 15.2400 |
| 0.060 | 1.5240 | 0.610 | 15.4940 |
| 0.070 | 1.7780 | 0.620 | 15.7480 |
| 0.080 | 2.0320 | 0.630 | 16.0020 |
| 0.090 | 2.2860 | 0.640 | 16.2560 |
| 0.100 | 2.5400 | 0.650 | 16.5100 |
| 0.110 | 2.7940 | 0.660 | 16.7640 |
| 0.120 | 3.0480 | 0.670 | 17.0180 |
| 0.130 | 3.3020 | 0.680 | 17.2720 |
| 0.140 | 3.5560 | 0.690 | 17.5260 |
| 0.150 | 3.8100 | 0.700 | 17.7800 |
| 0.160 | 4.0640 | 0.710 | 18.0340 |
| 0.170 | 4.3180 | 0.720 | 18.2880 |
| 0.180 | 4.5720 | 0.730 | 18.5420 |
| 0.190 | 4.8260 | 0.740 | 18.7960 |
| 0.200 | 5.0800 | 0.750 | 19.0500 |
| 0.210 | 5.3340 | 0.760 | 19.3040 |
| 0.220 | 5.5880 | 0.770 | 19.5580 |
| 0.230 | 5.8420 | 0.780 | 19.8120 |
| 0.240 | 6.0690 | 0.790 | 20.0660 |
| 0.250 | 6.3500 | 0.800 | 20.3200 |
| 0.260 | 6.6040 | 0.810 | 20.5740 |
| 0.270 | 6.8580 | 0.820 | 20.8280 |
| 0.280 | 7.1120 | 0.830 | 21.0820 |
| 0.290 | 7.3660 | 0.840 | 21.3360 |
| 0.300 | 7.6200 | 0.850 | 21.5900 |
| 0.310 | 7.8740 | 0.860 | 21.8440 |
| 0.320 | 8.1280 | 0.870 | 22.0980 |
| 0.330 | 8.3820 | 0.880 | 22.3520 |
| 0.340 | 8.6360 | 0.890 | 22.6060 |
| 0.350 | 8.8900 | 0.900 | 22.8600 |
| 0.360 | 9.1440 | 0.910 | 23.1140 |
| 0.370 | 9.3980 | 0.920 | 23.3680 |
| 0.380 | 9.6520 | 0.930 | 23.6220 |
| 0.390 | 9.9060 | 0.940 | 23.8760 |
| 0.400 | 10.1600 | 0.950 | 24.1300 |
| 0.410 | 10.4140 | 0.960 | 24.3840 |
| 0.420 | 10.6680 | 0.970 | 24.6380 |
| 0.430 | 10.9220 | 0.980 | 24.8920 |
| 0.440 | 11.1760 | 0.990 | 25.1460 |
| 0.450 | 11.4300 | 1.000 | 25.4000 |
| 0.460 | 11.6840 | | |

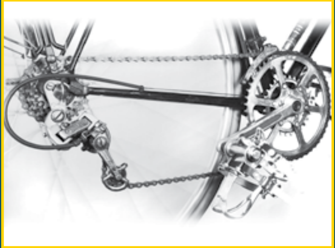
| Fractions to Decimals to Millimeters (mm) | | | | | |
|---|---|---|---|---|---|
| **Fraction** | **Decimal** | **mm** | **Fraction** | **Decimal** | **mm** |
| 1/64 | 0.0156 | 0.3969 | 33/64 | 0.5156 | 13.0969 |
| 1/32 | 0.0312 | 0.7938 | 17/32 | 0.5312 | 13.4938 |
| 3/64 | 0.0469 | 1.1906 | 35/64 | 0.5469 | 13.8906 |
| 1/16 | 0.0625 | 1.5875 | 9/16 | 0.5625 | 14.2875 |
| 5/64 | 0.0781 | 1.9844 | 37/64 | 0.5781 | 14.6844 |
| 3/32 | 0.0938 | 2.3812 | 19/32 | 0.5938 | 15.0812 |
| 7/64 | 0.1094 | 2.7781 | 39/64 | 0.6094 | 15.4781 |
| 1/8 | 0.1250 | 3.1750 | 5/8 | 0.6250 | 15.8750 |
| 9/64 | 0.1406 | 3.5719 | 41/64 | 0.6406 | 16.2719 |
| 5/32 | 0.1562 | 3.9688 | 21/32 | 0.6562 | 16.6688 |
| 11/64 | 0.1719 | 4.3656 | 43/64 | 0.6719 | 17.0656 |
| 3/16 | 0.1875 | 4.7625 | 11/16 | 0.6875 | 17.4625 |
| 13/64 | 0.2031 | 5.1594 | 45/64 | 0.7031 | 17.8594 |
| 7/32 | 0.2188 | 5.5562 | 23/32 | 0.7188 | 18.2562 |
| 15/64 | 0.2344 | 5.9531 | 47/64 | 0.7344 | 18.6531 |
| 1/4 | 0.2500 | 6.3500 | 3/4 | 0.7500 | 19.0500 |
| 17/64 | 0.2656 | 6.7469 | 49/64 | 0.7656 | 19.4469 |
| 9/32 | 0.2812 | 7.1438 | 25/32 | 0.7812 | 19.8438 |
| 19/64 | 0.2969 | 7.5406 | 51/64 | 0.7969 | 20.2406 |
| 5/16 | 0.3125 | 7.9375 | 13/16 | 0.8125 | 20.6375 |
| 21/64 | 0.3281 | 8.3344 | 53/64 | 0.8281 | 21.0344 |
| 11/32 | 0.3438 | 8.7312 | 27/32 | 0.8438 | 21.4312 |
| 23/64 | 0.3594 | 9.1281 | 55/64 | 0.8594 | 21.8281 |
| 3/8 | 0.3750 | 9.5250 | 7/8 | 0.8750 | 22.2250 |
| 25/64 | 0.3906 | 9.9219 | 57/64 | 0.8906 | 22.6219 |
| 13/32 | 0.4062 | 10.3188 | 29/32 | 0.9062 | 23.0188 |
| 27/64 | 0.4219 | 10.7156 | 59/64 | 0.9219 | 23.4156 |
| 7/16 | 0.4375 | 11.1125 | 15/16 | 0.9375 | 23.8125 |
| 29/64 | 0.4531 | 11.5094 | 61/64 | 0.9531 | 24.2094 |
| 15/32 | 0.4688 | 11.9062 | 31/32 | 0.9688 | 24.6062 |
| 31/64 | 0.4844 | 12.3031 | 63/64 | 0.9844 | 25.0031 |
| 1/2 | 0.5000 | 12.700 | 1 | 1.0000 | 25.4000 |



## The Measurement Dictionary

### Gear inch

*A traditional unit for measuring the gears of bicycles. In low gears, the pedals are easy to turn but have to be turned very fast to achieve any speed; in high gears the pedals are harder to turn but don't have to be turned fast to achieve high speed. The gear value is computed in gear inches as the diameter of the drive wheel times the size of the front sprocket divided by the size of the rear sprocket, all measurements being in inches.*

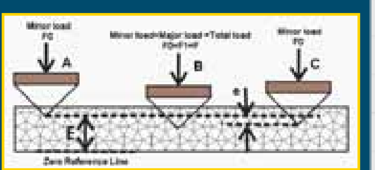


*(This is the same as the diameter of the drive wheel times the number of gear teeth on the front sprocket divided by the number of teeth on the rear sprocket.) This is the diameter that the drive wheel would need to have to give the same pedal effort as if the pedals were attached directly to the wheel, as on a child's tricycle. Values range from about 25 gear inches for the low gears on mountain bikes to more than 100 gear inches for the highest gears on road bikes.*

## The Measurement Dictionary

### Hardness

*A measure of the hardness of a metal or mineral. Hardness is a property easy to appreciate but difficult to quantify and measure. The Mohs hardness scale is used in geology to give a rough estimate of hardness by testing which minerals are able to scratch the sample. In metallurgy, samples are tested for hardness by machines which indent the surface under a controlled pressure; the resulting measurement is often computed as the force applied divided by the surface area of the indentation. The Brinell, Vickers, Rockwell, and Knoop tests are among the techniques used. Plastics, rubber, and similar materials are tested with instruments called durometers and the resulting readings are often designated duro.*



# Internal Thread: M Profile

An internal thread is formed in holes, or in nuts. The M profile threads of tolerance class 6H/6g are intended for metric applications where inch class 2A/2B have been used. At the minimum material limits, the 6H/6g results in a looser fit than the 2A/2B.

**Internal Thread — Limiting Dimensions M Profile**

| Basic Thread Designation | Tolerance Class | Minor Ø $D_1$ Min. | Minor Ø $D_1$ Max. | Pitch Ø $D_2$ Min. | Pitch Ø $D_2$ Max | Pitch Ø $D_2$ Tol. | Major Ø D Min. | Major Ø D Max* |
|---|---|---|---|---|---|---|---|---|
| M1.6 × 0.35 | 6H | 1.221 | 1.321 | 1.373 | 1.458 | 0.085 | 1.600 | 1.736 |
| M2 × 0.4 | 6H | 1.567 | 1.679 | 1.740 | 1.830 | 0.090 | 2.000 | 2.148 |
| M2.5 × 0.45 | 6H | 2.013 | 2.138 | 2.208 | 2.303 | 0.095 | 2.500 | 2.660 |
| M3 × 0.5 | 6H | 2.459 | 2.599 | 2.675 | 2.775 | 0.100 | 3.000 | 3.172 |
| M3.5 × 0.6 | 6H | 2.850 | 3.010 | 3.110 | 3.222 | 0.112 | 3.500 | 3.698 |
| M4 × 0.7 | 6H | 3.242 | 3.422 | 3.545 | 3.663 | 0.118 | 4.000 | 4.219 |
| M5 × 0.8 | 6H | 4.134 | 4.334 | 4.480 | 4.605 | 0.125 | 5.000 | 5.240 |
| M6 × 1 | 6H | 4.917 | 5.153 | 5.350 | 5.500 | 0.150 | 6.000 | 6.294 |
| M8 × 1.25 | 6H | 6.647 | 6.912 | 7.188 | 7.348 | 0.160 | 8.000 | 8.340 |
| M8 × 1 | 6H | 6.917 | 7.153 | 7.350 | 7.500 | 0.150 | 8.000 | 8.294 |
| M10 × 1.5 | 6H | 8.376 | 8.676 | 9.026 | 9.206 | 0.180 | 10.000 | 10.397 |
| M10 × 1.25 | 6H | 8.647 | 8.912 | 9.188 | 9.348 | 0.160 | 10.000 | 10.340 |
| M10 × 1 | 6H | 8.917 | 9.153 | 9.350 | 9.500 | 0.150 | 10.000 | 10.294 |
| M10 × 0.75 | 6H | 9.188 | 9.378 | 9.513 | 9.645 | 0.132 | 10.000 | 10.240 |
| M12 × 1.75 | 6H | 10.106 | 10.441 | 10.863 | 11.063 | 0.200 | 12.000 | 12.452 |
| M12 × 1.5 | 6H | 10.376 | 10.676 | 11.026 | 11.216 | 0.190 | 12.000 | 12.407 |
| M12 × 1.25 | 6H | 10.647 | 10.912 | 11.188 | 11.368 | 0.180 | 12.000 | 12.360 |
| M12 × 1 | 6H | 10.917 | 11.153 | 11.350 | 11.510 | 0.160 | 12.000 | 12.304 |
| M14 × 2 | 6H | 11.835 | 12.210 | 12.701 | 12.913 | 0.212 | 14.000 | 14.501 |
| M14 × 1.5 | 6H | 12.376 | 12.676 | 13.026 | 13.216 | 0.190 | 14.000 | 14.407 |
| M15 × 1 | 6H | 13.917 | 14.153 | 14.350 | 14.510 | 0.160 | 15.000 | 15.304 |
| M16 × 2 | 6H | 13.835 | 14.210 | 14.701 | 14.913 | 0.212 | 16.000 | 16.501 |
| M16 × 1.5 | 6H | 14.376 | 14.676 | 15.026 | 15.216 | 0.190 | 16.000 | 16.407 |
| M17 × 1 | 6H | 15.917 | 16.153 | 16.350 | 16.510 | 0.160 | 17.000 | 17.304 |
| M18 × 1.5 | 6H | 16.376 | 16.676 | 17.026 | 17.216 | 0.190 | 18.000 | 18.407 |
| M20 × 2.5 | 6H | 17.294 | 17.744 | 18.376 | 18.600 | 0.224 | 20.000 | 20.585 |
| M20 × 1.5 | 6H | 18.376 | 18.676 | 19.026 | 19.216 | 0.190 | 20.000 | 20.407 |
| M20 × 1 | 6H | 18.917 | 19.153 | 19.350 | 19.510 | 0.160 | 20.000 | 20.304 |
| M22 × 2.5 | 6H | 19.294 | 19.744 | 20.376 | 20.600 | 0.224 | 22.000 | 22.585 |
| M22 × 1.5 | 6H | 20.376 | 20.676 | 21.026 | 21.216 | 0.190 | 22.000 | 22.407 |
| M24 × 3 | 6H | 20.752 | 21.252 | 22.051 | 22.316 | 0.265 | 24.000 | 24.698 |
| M24 × 2 | 6H | 21.835 | 22.210 | 22.701 | 22.925 | 0.224 | 24.000 | 24.513 |
| M25 × 1.5 | 6H | 23.376 | 23.676 | 24.026 | 24.226 | 0.200 | 25.000 | 25.417 |
| M27 × 3 | 6H | 23.752 | 24.252 | 25.051 | 25.316 | 0.265 | 27.000 | 27.698 |
| M27 × 2 | 6H | 24.835 | 25.210 | 25.701 | 25.925 | 0.224 | 27.000 | 27.513 |
| M30 × 3.5 | 6H | 26.211 | 26.771 | 27.727 | 28.007 | 0.280 | 30.000 | 30.786 |
| M30 × 2 | 6H | 27.835 | 28.210 | 28.701 | 28.925 | 0.224 | 30.000 | 30.513 |
| M30 × 1.5 | 6H | 28.376 | 28.676 | 29.026 | 29.226 | 0.200 | 30.000 | 30.417 |
| M33 × 2 | 6H | 30.835 | 31.210 | 31.701 | 31.925 | 0.224 | 33.000 | 33.513 |
| M35 × 1.5 | 6H | 33.376 | 33.676 | 34.026 | 34.226 | 0.200 | 35.000 | 35.417 |

| Internal Thread — Limiting Dimensions M Profile | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Minor Ø $D_1$ | | Pitch Ø $D_2$ | | | Major Ø D | |
| Basic Thread Designation | Tolerance Class | Min. | Max. | Min. | Max | Tol. | Min. | Max* |
| M36 × 4 | 6H | 31.670 | 32.270 | 33.402 | 33.702 | 0.300 | 36.000 | 36.877 |
| M36 × 2 | 6H | 33.835 | 34.210 | 34.701 | 34.925 | 0.224 | 36.000 | 36.513 |
| M39 × 2 | 6H | 36.835 | 37.210 | 37.701 | 37.925 | 0.224 | 39.000 | 39.513 |
| M40 × 1.5 | 6H | 38.376 | 38.676 | 39.026 | 39.226 | 0.200 | 40.000 | 40.417 |
| M42 × 4.5 | 6H | 37.129 | 37.799 | 39.077 | 39.392 | 0.315 | 42.000 | 42.964 |
| M42 × 2 | 6H | 39.835 | 40.210 | 40.701 | 40.925 | 0.224 | 42.000 | 42.513 |
| M45 × 1.5 | 6H | 43.376 | 43.676 | 44.026 | 44.226 | 0.200 | 45.000 | 45.417 |
| M48 × 5 | 6H | 42.587 | 43.297 | 44.752 | 45.087 | 0.335 | 48.000 | 49.056 |
| M48 × 2 | 6H | 45.835 | 46.210 | 46.701 | 46.937 | 0.236 | 48.000 | 48.525 |
| M50 × 1.5 | 6H | 48.376 | 48.676 | 49.026 | 49.238 | 0.212 | 50.000 | 50.429 |
| M55 × 1.5 | 6H | 53.376 | 53.676 | 54.026 | 54.238 | 0.212 | 55.000 | 55.429 |
| M56 × 5.5 | 6H | 50.046 | 50.796 | 52.428 | 52.783 | 0.355 | 56.000 | 57.149 |
| M56 × 2 | 6H | 53.835 | 54.210 | 54.701 | 54.937 | 0.236 | 56.000 | 56.525 |
| M60 × 1.5 | 6H | 58.376 | 58.676 | 59.026 | 59.238 | 0.212 | 60.000 | 60.429 |
| M64 × 6 | 6H | 57.505 | 58.305 | 60.103 | 60.478 | 0.375 | 64.000 | 65.241 |
| M64 × 2 | 6H | 61.835 | 62.210 | 62.701 | 62.937 | 0.236 | 64.000 | 64.525 |
| M65 × 1.5 | 6H | 63.376 | 63.676 | 64.026 | 64.238 | 0.212 | 65.000 | 65.429 |
| M70 × 1.5 | 6H | 68.376 | 68.676 | 69.026 | 69.238 | 0.212 | 70.000 | 70.429 |
| M72 × 6 | 6H | 65.505 | 66.305 | 68.103 | 68.478 | 0.375 | 72.000 | 73.241 |
| M72 × 2 | 6H | 69.835 | 70.210 | 70.701 | 70.937 | 0.236 | 72.000 | 72.525 |
| M75 × 1.5 | 6H | 73.376 | 73.676 | 74.026 | 74.238 | 0.212 | 75.000 | 75.429 |
| M80 × 6 | 6H | 73.505 | 74.305 | 76.103 | 76.478 | 0.375 | 80.000 | 81.241 |
| M80 × 2 | 6H | 77.835 | 78.210 | 78.701 | 78.937 | 0.236 | 80.000 | 80.525 |
| M80 × 1.5 | 6H | 78.376 | 78.676 | 79.026 | 79.238 | 0.212 | 80.000 | 80.429 |
| M85 × 2 | 6H | 82.835 | 83.210 | 83.701 | 83.937 | 0.236 | 85.000 | 85.525 |
| M90 × 6 | 6H | 83.505 | 84.305 | 86.103 | 86.478 | 0.375 | 90.000 | 91.241 |
| M90 × 2 | 6H | 87.835 | 88.210 | 88.701 | 88.937 | 0.236 | 90.000 | 90.525 |
| M95 × 2 | 6H | 92.835 | 93.210 | 93.701 | 93.951 | 0.250 | 95.000 | 95.539 |
| M100 × 6 | 6H | 93.505 | 94.305 | 96.103 | 96.503 | 0.400 | 100.000 | 101.266 |
| M100 × 2 | 6H | 97.835 | 98.210 | 98.701 | 98.951 | 0.250 | 100.000 | 100.539 |
| M105 × 2 | 6H | 102.835 | 103.210 | 103.701 | 103.951 | 0.250 | 105.000 | 105.539 |
| M110 × 2 | 6H | 107.835 | 108.210 | 108.701 | 108.951 | 0.250 | 110.000 | 110.539 |
| M120 × 2 | 6H | 117.835 | 118.210 | 118.701 | 118.951 | 0.250 | 120.000 | 120.539 |
| M130 × 2 | 6H | 127.835 | 128.210 | 128.701 | 128.951 | 0.250 | 130.000 | 130.539 |
| M140 × 2 | 6H | 137.835 | 138.210 | 138.701 | 138.951 | 0.250 | 140.000 | 140.539 |
| M150 × 2 | 6H | 147.835 | 148.210 | 148.701 | 148.951 | 0.250 | 150.000 | 150.539 |
| M160 × 3 | 6H | 156.752 | 157.252 | 158.051 | 158.351 | 0.300 | 160.000 | 160.733 |
| M170 × 3 | 6H | 166.752 | 167.252 | 168.051 | 168.351 | 0.300 | 170.000 | 170.733 |
| M180 × 3 | 6H | 176.752 | 177.252 | 178.051 | 178.351 | 0.300 | 180.000 | 180.733 |
| M190 × 3 | 6H | 186.752 | 187.252 | 188.051 | 188.386 | 0.335 | 190.000 | 190.768 |
| M200 × 3 | 6H | 196.752 | 197.252 | 198.051 | 198.386 | 0.335 | 200.000 | 200.768 |

NOTE: All dimensions are in millimeters.
*This Reference dimension is used in the design of tools, etc. In dimensioning internal threads it is not normally specified. Generally, major diameter acceptance is based on maximum material condition gaging.

The MEASUREMENT DICTIONARY

## Hertz (Hz)

*the SI unit of frequency, equal to one cycle per second. The hertz is used to measure the rates of events that happen periodically in a fixed and definite cycle; the becquerel, also equal to one "event" per second, is used to measure the rates of things which happen randomly or unpredictably. Multiples of the hertz are common: the frequencies of radio and television waves are measured in kilohertz (kHz), megahertz (MHz), or even gigahertz (GHz), and the frequencies of light waves in terahertz (THz).*

*The unit is named for the German physicist Heinrich Rudolf Hertz (1857–1894), who proved in 1887 that energy is transmitted through a vacuum by electromagnetic waves.*

# The Measurement Dictionary

## Inch of mercury (in Hg)

*a traditional unit of atmospheric pressure. In the United States, atmospheric pressure is customarily expressed as the height of a column of mercury exerting the same pressure as the atmosphere. When a traditional mercury barometer is used, this height is read directly as the height of the mercury column. These readings must be corrected for temperature since mercury, like most liquids, tends to expand as it warms. The conventional equivalent of one inch of mercury is 0.491153 pounds per squareuare inch or 3.38638 kilopascals (33.8638 millibars). In the symbol for the unit, Hg is the chemical symbol for mercury; it comes from the Latin word hydrargyrum ("water-silver") for the liquid metal.*


## International rubber hardness degree (IRHD)

*a unit used to measure the hardness of rubber and similar materials (technically known as elastomers). Measurements are made using an IRHD durometer, and the results are usually similar, but not identical, to readings made with the older Shore "A" durometer.*

| External Thread /Internal Thread | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Nominal Size, TPI, Series | Class | Allowance | Max A Major Max Minor | Min Major Min Minor | Min B | Max A Pitch | Min Pitch | UNR C Minor Dia Major Dia (Min) |
| Ext. | 0-80 UNF | 2A | 0.0005 | 0.0595 | 0.0563 | - | 0.0514 | 0.0496 | 0.0446 |
| Int. | | 2B | | 0.0514 | 0.0465 | | 0.0542 | 0.0519 | 0.0600 |
| Ext. | 0-80 UNF | 3A | 0.0000 | 0.0600 | 0.0568 | - | 0.0519 | 0.0506 | 0.0451 |
| Int. | | 3B | | 0.0514 | 0.0465 | | 0.0536 | 0.0519 | 0.0600 |
| Ext. | 1-64 UNC | 2A | 0.0006 | 0.0724 | 0.0686 | - | 0.0623 | 0.0603 | 0.0538 |
| Int. | | 2B | | 0.0623 | 0.0561 | | 0.0655 | 0.0629 | 0.0730 |
| Ext. | 1-64 UNC | 3A | 0.0000 | 0.0730 | 0.0692 | - | 0.0629 | 0.0614 | 0.0544 |
| Int. | | 3B | | 0.0623 | 0.0561 | | 0.0648 | 0.0629 | 0.0730 |
| Ext. | 1-72 UNF | 2A | 0.0006 | 0.0724 | 0.0689 | - | 0.0634 | 0.0615 | 0.0559 |
| Int. | | 2B | | 0.0635 | 0.0580 | | 0.0665 | 0.0640 | 0.0730 |
| Ext. | 1-72 UNF | 3A | 0.0000 | 0.0730 | 0.0695 | - | 0.0640 | 0.0626 | 0.0565 |
| Int. | | 3B | | 0.0635 | 0.0580 | | 0.0659 | 0.0640 | 0.0730 |
| Ext. | 2-56 UNC | 2A | 0.0006 | 0.0854 | 0.0813 | - | 0.0738 | 0.0717 | 0.0642 |
| Int. | | 2B | | 0.0737 | 0.0667 | | 0.0772 | 0.0744 | 0.0860 |
| Ext. | 2-56 UNC | 3A | 0.0000 | 0.0860 | 0.0819 | - | 0.0744 | 0.0728 | 0.0648 |
| Int. | | 3B | | 0.0737 | 0.0667 | | 0.0765 | 0.0744 | 0.0860 |
| Ext. | 2-64 UNF | 2A | 0.0006 | 0.0854 | 0.0816 | - | 0.0753 | 0.0733 | 0.0668 |
| Int. | | 2B | | 0.0753 | 0.0691 | | 0.0786 | 0.0759 | 0.0860 |
| Ext. | 2-64 UNF | 3A | 0.0000 | 0.0860 | 0.0822 | - | 0.0759 | 0.0744 | 0.0674 |
| Int. | | 3B | | 0.0753 | 0.0691 | | 0.0779 | 0.0759 | 0.0860 |
| Ext. | 3-48 UNC | 2A | 0.0007 | 0.0983 | 0.0938 | - | 0.0848 | 0.0825 | 0.0734 |
| Int. | | 2B | | 0.0845 | 0.0764 | | 0.0885 | 0.0855 | 0.0990 |
| Ext. | 3-48 UNC | 3A | 0.0000 | 0.0990 | 0.0945 | - | 0.0855 | 0.0838 | 0.0741 |
| Int. | | 3B | | 0.0845 | 0.0764 | | 0.0877 | 0.0855 | 0.0990 |
| Ext. | 3-56 UNF | 2A | 0.0007 | 0.0983 | 0.0942 | - | 0.0867 | 0.0845 | 0.0771 |
| Int. | | 2B | | 0.0865 | 0.0797 | | 0.0902 | 0.0874 | 0.0990 |
| Ext. | 3-56 UNF | 3A | 0.0000 | 0.0990 | 0.0949 | - | 0.0874 | 0.0858 | 0.0778 |
| Int. | | 3B | | 0.0865 | 0.0797 | | 0.0895 | 0.0874 | 0.0990 |
| Ext. | 4-40 UNC | 2A | 0.0008 | 0.1112 | 0.1061 | - | 0.0950 | 0.0925 | 0.0814 |
| Int. | | 2B | | 0.0939 | 0.0849 | | 0.0991 | 0.0958 | 0.1120 |
| Ext. | 4-40 UNC | 3A | 0.0000 | 0.1120 | 0.1069 | - | 0.0958 | 0.0939 | 0.0822 |
| Int. | | 3B | | 0.0939 | 0.0849 | | 0.0982 | 0.0958 | 0.1120 |
| Ext. | 4-48 UNF | 2A | 0.0007 | 0.1113 | 0.1068 | - | 0.0978 | 0.0954 | 0.0864 |
| Int. | | 2B | | 0.0968 | 0.0894 | | 0.1016 | 0.0985 | 0.1120 |
| Ext. | 4-48 UNF | 3A | 0.0000 | 0.1120 | 0.1075 | - | 0.0985 | 0.0967 | 0.0871 |
| Int. | | 3B | | 0.0968 | 0.0894 | | 0.1008 | 0.0985 | 0.1120 |
| Ext. | 5-40 UNC | 2A | 0.0008 | 0.1242 | 0.1191 | - | 0.1080 | 0.1054 | 0.0944 |
| Int. | | 2B | | 0.1062 | 0.0979 | | 0.1121 | 0.1088 | 0.1250 |
| Ext. | 5-40 UNC | 3A | 0.0000 | 0.1250 | 0.1199 | - | 0.1088 | 0.1069 | 0.0952 |
| Int. | | 3B | | 0.1062 | 0.0979 | | 0.1113 | 0.1088 | 0.1250 |
| Ext. | 5-44 UNF | 2A | 0.0007 | 0.1243 | 0.1195 | - | 0.1095 | 0.1070 | 0.0972 |
| Int. | | 2B | | 0.1079 | 0.1004 | | 0.1134 | 0.1102 | 0.1250 |
| Ext. | 5-44 UNF | 3A | 0.0000 | 0.1250 | 0.1202 | - | 0.1102 | 0.1083 | 0.0979 |
| Int. | | 3B | | 0.1079 | 0.1004 | | 0.1126 | 0.1102 | 0.1250 |
| Ext. | 6-32 UNC | 2A | 0.0008 | 0.1372 | 0.1312 | - | 0.1169 | 0.1141 | 0.1000 |
| Int. | | 2B | | 0.1140 | 0.1040 | | 0.1214 | 0.1177 | 0.1380 |
| Ext. | 6-32 UNC | 3A | 0.0000 | 0.1380 | 0.1320 | - | 0.1177 | 0.1156 | 0.1008 |
| Int. | | 3B | | 0.1140 | 0.1040 | | 0.1204 | 0.1177 | 0.1380 |

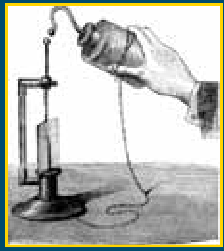
**External Thread /Internal Thread**

| | Nominal Size, TPI, Series | Class | Allowance | Max A Major Max Minor | Min Major Min Minor | Min B | Max A Pitch | Min Pitch | UNR C Minor Dia Major Dia (Min) |
|---|---|---|---|---|---|---|---|---|---|
| Ext. | 6-40 UNF | 2A | 0.0008 | 0.1372 | 0.1321 | - | 0.1210 | 0.1184 | 0.1074 |
| Int. | | 2B | | 0.1190 | 0.1110 | | 0.1252 | 0.1218 | 0.1380 |
| Ext. | 6-40 UNF | 3A | 0.0000 | 0.1380 | 0.1329 | - | 0.1218 | 0.1198 | 0.1082 |
| Int. | | 3B | | 0.1186 | 0.1110 | | 0.1243 | 0.1218 | 0.1380 |
| Ext. | 8-32 UNC | 2A | 0.0009 | 0.1631 | 0.1571 | - | 0.1428 | 0.1399 | 0.1259 |
| Int. | | 2B | | 0.1390 | 0.1300 | | 0.1475 | 0.1437 | 0.1640 |
| Ext. | 8-32 UNC | 3A | 0.0000 | 0.1640 | 0.1580 | - | 0.1437 | 0.1415 | 0.1268 |
| Int. | | 3B | | 0.1389 | 0.1300 | | 0.1465 | 0.1437 | 0.1640 |
| Ext. | 8-36 UNF | 2A | 0.0008 | 0.1632 | 0.1577 | - | 0.1452 | 0.1424 | 0.1301 |
| Int. | | 2B | | 0.1420 | 0.1340 | | 0.1496 | 0.1460 | 0.1640 |
| Ext. | 8-36 UNF | 3A | 0.0000 | 0.1640 | 0.1585 | - | 0.4600 | 0.1439 | 0.1309 |
| Int. | | 3B | | 0.1416 | 0.1340 | | 0.1487 | 0.1460 | 0.1640 |
| Ext. | 10-24 UNC | 2A | 0.0010 | 0.1890 | 0.1818 | - | 0.1619 | 0.1586 | 0.1394 |
| Int. | | 2B | | 0.1560 | 0.1450 | | 0.1672 | 0.1629 | 0.1900 |
| Ext. | 10-24 UNC | 3A | 0.0000 | 0.1900 | 0.1828 | - | 0.1629 | 0.1604 | 0.1404 |
| Int. | | 3B | | 0.1555 | 0.1450 | | 0.1661 | 0.1629 | 0.1900 |
| Ext. | 10-28 UNS | 2A | 0.0010 | 0.1890 | 0.1825 | - | 0.1658 | 0.1625 | 0.1464 |
| Int. | | 2B | | 0.1600 | 0.1510 | | 0.1711 | 0.1668 | 0.1900 |
| Ext. | 10-32UNF | 2A | 0.0009 | 0.1891 | 0.1831 | - | 0.1688 | 0.1658 | 0.1519 |
| Int. | | 2B | | 0.1640 | 0.1560 | | 0.1736 | 0.1697 | 0.1900 |
| Ext. | 10-32UNF | 3A | 0.0000 | 0.1900 | 0.1840 | - | 0.1697 | 0.1674 | 0.1528 |
| Int. | | 3B | | 0.1641 | 0.1560 | | 0.1726 | 0.1697 | 0.1900 |
| Ext. | 10-36 UNS | 2A | 0.0009 | 0.1891 | 0.1836 | - | 0.1711 | 0.1681 | 0.1560 |
| Int. | | 2B | | 0.1660 | 0.1600 | | 0.1759 | 0.1720 | 0.1900 |
| Ext. | 10-40 UNS | 2A | 0.0009 | 0.1891 | 0.1840 | - | 0.1729 | 0.1700 | 0.1592 |
| Int. | | 2B | | 0.1690 | 0.1630 | | 0.1775 | 0.1738 | 0.1900 |
| Ext. | 10-48 UNS | 2A | 0.0008 | 0.1892 | 0.1847 | - | 0.1757 | 0.1731 | 0.1644 |
| Int. | | 2B | | 0.1720 | 0.1670 | | 0.1799 | 0.1765 | 0.1900 |
| Ext. | 10-56 UNS | 2A | 0.0007 | 0.1893 | 0.1852 | - | 0.1777 | 0.1752 | 0.1681 |
| Int. | | 2B | | 0.1750 | 0.1710 | | 0.1816 | 0.1784 | 0.1900 |
| Ext. | 12-24 UNC | 2A | 0.0010 | 0.2150 | 0.2078 | - | 0.1879 | 0.1845 | 0.1654 |
| Int. | | 2B | | 0.1810 | 0.1710 | | 0.1933 | 0.1889 | 0.2160 |
| Ext. | 12-24 UNC | 3A | 0.0000 | 0.2160 | 0.2088 | - | 0.1889 | 0.1863 | 0.1664 |
| Int. | | 3B | | 0.1807 | 0.1710 | | 0.1922 | 0.1889 | 0.2160 |
| Ext. | 12-28 UNF | 2A | 0.0010 | 0.2150 | 0.2085 | - | 0.1918 | 0.1886 | 0.1724 |
| Int. | | 2B | | 0.1860 | 0.1770 | | 0.1970 | 0.1928 | 0.2160 |
| Ext. | 12-28 UNF | 3A | 0.0000 | 0.2160 | 0.2095 | - | 0.1928 | 0.1904 | 0.1734 |
| Int. | | 3B | | 0.1857 | 0.1770 | | 0.1959 | 0.1928 | 0.2160 |
| Ext. | 12-32 UNEF | 2A | 0.0009 | 0.2151 | 0.2091 | - | 0.1948 | 0.1917 | 0.1779 |
| Int. | | 2B | | 0.1900 | 0.1820 | | 0.1998 | 0.1957 | 0.2160 |
| Ext. | 12-32 UNEF | 3A | 0.0000 | 0.2160 | 0.2100 | - | 0.1957 | 0.1933 | 0.1788 |
| Int. | | 3B | | 0.1895 | 0.1820 | | 0.1988 | 0.1957 | 0.2160 |
| Ext. | 12-36 UNS | 2A | 0.0009 | 0.2151 | 0.2096 | - | 0.1971 | 0.1941 | 0.1821 |
| Int. | | 2B | | 0.1920 | 0.1860 | | 0.2019 | 0.1980 | 0.2160 |
| Ext. | 12-40 UNS | 2A | 0.0009 | 0.2151 | 0.2100 | - | 0.1989 | 0.1960 | 0.1835 |
| Int. | | 2B | | 0.1950 | 0.1890 | | 0.2035 | 0.1998 | 0.2160 |
| Ext. | 12-48 UNS | 2A | 0.0008 | 0.2152 | 0.2107 | - | 0.2017 | 0.1991 | 0.1904 |

## The MEASUREMENT DICTIONARY

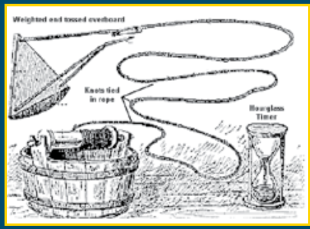
### Jar

*A traditional unit of electric capacitance, approximately equal to the capacitance of one of the Leiden jars used in electrical experiments as long ago as the eighteenth century. Benjamin Franklin is said to have measured the storage power of his electrical equipment in jars. There are 9 x $10^8$ jars in a farad, so 1 jar is approximately 1.1 nanofarad.*



### Knot (kn or kt)

*A unit of velocity equal to one nautical mile per hour. Knots are customarily used to express speeds at sea, including the speed of the ship as well as the speeds of the wind and of the current. The word comes from the former method of measuring a ship's speed, which involved use of a knotted cord called the log line. One knot equals about 1.1508 miles per hour, exactly 1.852 kilometers per hour, or 0.5143 meters per second. Since kt is the established symbol for the kilotonne, kn is the best choice as a symbol for the knot.*



## The MEASUREMENT DICTIONARY

### Mach or mach (M or Ma)

*A measure of relative velocity, used to express the speed of an aircraft relative to the speed of sound. The name of the unit is often placed before the measurement. Thus "Mach 1.0" is the speed of sound, "Mach 2.0" is twice the speed of sound, and so on. (The actual speed of sound varies, depending on the density and temperature of the atmosphere. At 0 °C and a pressure of 1 atmosphere the speed of sound is about 1088 ft/s, 331.6 m/s, or 741.8 mi/h). The mach speed is important to the control of an aircraft, especially at speeds close to or exceeding Mach 1.0. The unit is named for the Austrian physicist Ernst Mach (1838–1916).*

### Megahertz (MHz)

*A common unit of frequency equal to one million per second. Frequencies of radio waves are commonly stated in megahertz.*

| External Thread /Internal Thread | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Nominal Size, TPI, Series | Class | Allowance | Max A Major Max Minor | Min Major Min Minor | Min B | Max A Pitch | Min Pitch | UNR C Minor Dia Major Dia (Min) |
| Int. | | 2B | | 0.1980 | 0.1930 | | 0.2059 | 0.2025 | 0.2160 |
| Ext. | 12-56 UNS | 2A | 0.0007 | 0.2153 | 0.2112 | - | 0.2037 | 0.2012 | 0.1941 |
| Int. | | 2B | | 0.2010 | 0.1970 | | 0.2076 | 0.2044 | 0.2160 |
| Ext. | 1/4-20 UNC | 1A | 0.0011 | 0.2489 | 0.2367 | - | 0.2164 | 0.2108 | 0.1894 |
| Int. | | 1B | | 0.2070 | 0.1960 | | 0.2248 | 0.2175 | 0.2500 |
| Ext. | 1/4-20 UNC | 2A | 0.0011 | 0.2489 | 0.2408 | 0.2367 | 0.2164 | 0.2127 | 0.1894 |
| Int. | | 2B | | 0.2070 | 0.1960 | | 0.2224 | 0.2175 | 0.2500 |
| Ext. | 1/4-20 UNC | 3A | 0.0000 | 0.2500 | 0.2419 | - | 0.2175 | 0.2147 | 0.1905 |
| Int. | | 3B | | 0.2067 | 0.1960 | | 0.2211 | 0.2175 | 0.2500 |
| Ext. | 1/4-24 UNS | 2A | 0.0011 | 0.2489 | 0.2417 | - | 0.2218 | 0.2181 | 0.1993 |
| Int. | | 2B | | 0.2150 | 0.2050 | | 0.2277 | 0.2229 | 0.2500 |
| Ext. | 1/4-27 UNS | 2A | 0.0010 | 0.2490 | 0.2423 | - | 0.2249 | 0.2214 | 0.2049 |
| Int. | | 2B | | 0.2190 | 0.2100 | | 0.2304 | 0.2259 | 0.2500 |
| Ext. | 1/4-28 UNF | 1A | 0.0010 | 0.2490 | 0.2392 | - | 0.2258 | 0.2208 | 0.2064 |
| Int. | | 1B | | 0.2200 | 0.2110 | | 0.2333 | 0.2268 | 0.2500 |
| Ext. | 1/4-28 UNF | 2A | 0.0010 | 0.2490 | 0.2425 | - | 0.2258 | 0.2225 | 0.2064 |
| Int. | | 2B | | 0.2200 | 0.2110 | | 0.2311 | 0.2268 | 0.2500 |
| Ext. | 1/4-28 UNF | 3A | 0.0000 | 0.2500 | 0.2435 | - | 0.2268 | 0.2243 | 0.2074 |
| Int. | | 3B | | 0.2190 | 0.2110 | | 0.2300 | 0.2268 | 0.2500 |
| Ext. | 1/4-32 UNEF | 2A | 0.0010 | 0.2490 | 0.2430 | - | 0.2287 | 0.2255 | 0.2118 |
| Int. | | 2B | | 0.2240 | 0.2160 | | 0.2339 | 0.2297 | 0.2500 |
| Ext. | 1/4-32 UNEF | 3A | 0.0000 | 0.2500 | 0.2440 | - | 0.2297 | 0.2273 | 0.2128 |
| Int. | | 3B | | 0.2229 | 0.2160 | | 0.2328 | 0.2297 | 0.2500 |
| Ext. | 1/4-36 UNS | 2A | 0.0009 | 0.2491 | 0.2436 | - | 0.2311 | 0.2280 | 0.2161 |
| Int. | | 2B | | 0.2260 | 0.2200 | | 0.2360 | 0.2320 | 0.2500 |
| Ext. | 1/4-40 UNS | 2A | 0.0009 | 0.2491 | 0.2440 | - | 0.2329 | 0.2300 | 0.2193 |
| Int. | | 2B | | 0.2290 | 0.2230 | | 0.2376 | 0.2338 | 0.2500 |
| Ext. | 1/4-48 UNS | 2A | 0.0008 | 0.2492 | 0.2447 | - | 0.2357 | 0.2330 | 0.2243 |
| Int. | | 2B | | 0.2320 | 0.2270 | | 0.2401 | 0.2365 | 0.2500 |
| Ext. | 1/4-56 UNS | 2A | 0.0008 | 0.2492 | 0.2451 | - | 0.2376 | 0.2350 | 0.2280 |
| Int. | | 2B | | 0.2350 | 0.2310 | | 0.2417 | 0.2384 | 0.2500 |

Notes:

[a] For Class 2A threads with coating (plating) the max. is increased by the allowance, to the basic size. This is the same value as Class 3A.

[b] For uncoated hot-rolled, but not standard fasteners with cold rolled threads

[c] UN series external thread, Max.Diameter = Basic - Allowance, for Class 1A and 2A
= Basic for Class 3A

| Morse Code and Phonetic Alphabet | | | |
|---|---|---|---|
| Character | Morse Code | Telephony | Pionic (Pronunciation) |
| A | • — | Alfa | (Al-Fah) |
| B | — • • • | Bravo | (Brah-Voh) |
| C | — • — • | Charlie | (Char-Lee) or (Shar-Lee) |
| D | — • • | Delta | (Dell-Tah) |
| E | • | Echo | (Eck-Oh) |
| F | • • — • | Foxtrot | (Foks-Trot) |
| G | — — • | Golf | (Golf) |
| H | • • • • | Hotel | Hoh-Tel) |
| I | • • | India | (In-Dee-Ah) |
| J | • — — — | Juliet | (Jew-Lee-Ett) |
| K | — • — | Kilo | (Key-Loh) |
| L | • — • • | Lima | (Lee-Mah) |
| M | — — | Mike | (Mike) |
| N | — • | November | (No-Vem-Ber) |
| O | — — — | Oscar | (Oss-Cah) |
| P | • — — • | Papa | (Pah-Pah) |
| Q | — — • — | Quebec | (Keh-Beck) |
| R | • — • | Romeo | (Row-Me-Oh) |
| S | • • • | Sierra | (See-Air-Rah) |
| T | — | Tango | (Tang-Go) |
| U | • • — | Uniform | (You-Nee-Form) or (Oo-Nee-Form) |
| V | • • • — | Victor | (Vik-Tah) |
| W | • — — | Whiskey | (Wiss-Key) |
| X | — • • — | Xray | (Ecks-Ray) |
| Y | — • — — | Yankee | (Yang-Key) |
| Z | — — • • | Zulu | (Zoo-Loo) |
| 1 | • — — — — | One | (Wun) |
| 2 | • • — — — | Two | (Too) |
| 3 | • • • — — | Three | (Tree) |
| 4 | • • • • — | Four | (Fow-Er) |
| 5 | • • • • • | Five | (Fife) |
| 6 | — • • • • | Six | (Six) |
| 7 | — — • • • | Seven | (Sev-en) |
| 8 | — — — • • | Eight | (Ait) |
| 9 | — — — — • | Nine | (Nin-Er) |
| 0 | — — — — — | Zero | (Zee-Ro) |

## The Measurement Dictionary

### Ohm

*The SI unit of electric resistance, reactance, and impedance. If a conductor connects two locations having different electric potentials, then a current flows through the conductor. The amount of the current depends on the potential difference and also on the extent to which the conductor resists the flow of current. For direct current circuits, this property of opposition to current flow is called the resistance. In alternating current circuits, the current flow is also affected by components, capacitors or inductors, that react to the change in the current over time. This opposition is called reactance; impedance measures the combined effect of resistance and reactance. All three quantities are measured in ohms. One ohm is the resistance, reactance, or impedance that requires a potential difference of one volt per ampere of current. The unit honors the German physicist Georg Simon Ohm (1787–1854). The capital Greek letter omega is used as the symbol for the ohm, since "O" would be easily misinterpreted as a zero.*

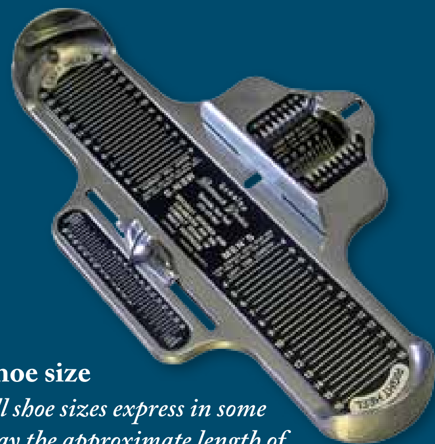
### Pencil hardness

*A traditional measure of the hardness of the "leads" (actually made of graphite) in pencils. The hardness scale, from softer to harder, takes the form ..., 3B, 2B, B, HB, F, H, 2H, 3H, 4H, .... The letters stand for Black, Hard, and Firm. (There is no industry standard defining the scale, so there is some variation between manufacturers in how it is applied). In the U.S., many manufacturers use a numerical scale in which the grades B, HB, F, H, 2H correspond approximately to numbers 1, 2, 2-1/2, 3, and 4, respectively. The pencil hardness scales are not just used for pencils, however. They are used widely to state the durability of paints and other semi-soft coatings. The hardness rating of a coating is the hardness of the hardest pencil that does not penetrate and gouge the coating. This "scratch" hardness scale is analogous to the Mohs hardness scale used in geology to measure the hardness of minerals.*

# The Measurement Dictionary

## Ring size

*A measure of the inside diameter or inside circumference of a ring (the kind worn on a finger). A variety of ring sizing systems are used in various countries. In the U.S., a ring of size n has an inside circumference of $1.43 + 0.102 \cdot n$ inches, or about $36.3 + 2.60 \cdot n$ millimeters. (There is some variation, because U.S. ring sizes have never been standardized). In Britain, traditional ring sizes are stated as letters A, B, etc.; if we replace the letters by numbers n (A = 1, B = 2, etc.), then a ring of British size n has an inside circumference of $36.25 + 1.25 \cdot n$ millimeters, or about $1.43 + 0.049 \cdot n$ inches. A difference of 1 U.S. size thus corresponds rather closely to two letters in the British system. In Japan, sizing is by the inside diameter in increments of 1/3 millimeter; a ring of Japanese size n has an inside diameter of $(n + 38)/3$ millimeters and an inside circumference of $39.8 + 1.047 \cdot n$ millimeters. There is an international standard (ISO 8653) defining the ring size to be the inside circumference in millimeters, minus 40. Rings are now sized by this standard in most of Europe, so a ring of European size n has an inside circumference of exactly 40 + n millimeters. (The British scale is aligned with the European scale, with British size C corresponding to European size 0 and a difference of four British letters corresponding to 5 European sizes.)*



## Shoe size

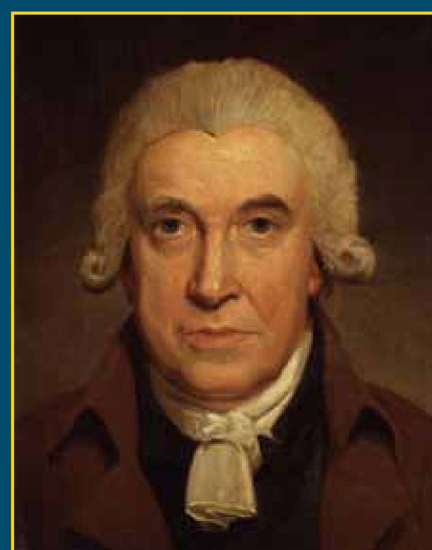
*All shoe sizes express in some way the approximate length of the shoe, or at least the length of the "last," the form on which the shoe is made. In the U.S., a difference of one full shoe size represents a length difference of 1/3 inch (8.47 mm), so shoe size n represents a length of $Z + n/3$, where Z is the length of a size 0 shoe (if there were such a thing). The value of Z is 3-11/12 inches (99.5 mm) for infants' and boys' shoes, 3-7/12 inches (91.0 mm) for girls' shoes, 7-11/12 inches (201.1 mm) for women's shoes, and 8-1/4 inches (209.6 mm) for men's shoes. The size number for a woman's shoe is 1 larger than for a man's shoe of the same length (for example, a man's 7-1/2 is the same length as a woman's 8-1/2). In Europe, shoe sizes are measured in Paris points, a unit equal to 2/3 centimeter. Ski boots and hiking boots worldwide are measured in mondo points, which are simply millimeters.*

## Volt (V)

*The SI unit of electric potential. Separating electric charges creates potential energy, which can be measured in energy units such as joules. Electric potential is defined as the amount of potential energy present per unit of charge. Electric potential is measured in volts, with one volt representing a potential of one joule per coulomb of charge. The name of the unit honors the Italian scientist Count Alessandro Volta (1745-1827), the inventor of the first battery.*

## Watt (W)

*The SI unit of power. Power is the rate at which work is done, or (equivalently) the rate at which energy is expended. One watt is equal to a power rate of one joule of work per second of time. This unit is used both in mechanics and in electricity, so it links the mechanical and electrical units to one another. In mechanical terms, one watt equals about 0.00134102 horsepower (hp) or 0.737562 foot-pound per second (lbf/s). In electrical terms, one watt is the power produced by a current of one ampere flowing through an electric potential of one volt. The name of the unit honors James Watt (1736–1819), the British engineer whose improvements to the steam engine are often credited with igniting the Industrial Revolution.*



# Fastener Screw Head and Drive Styles

| Screw Head Styles | | | | |
|---|---|---|---|---|
| Binding Head | Button Head | Fillister Head | Flange Hex Head | Flat Head |
| Flat Fillister Head | Hex Washer head | Indented Hex Head | Round Head | Pan Head |
| Truss Head | Oval Head | Washer Head | Trimmed Head | Anchor Head |

| Drive Styles | | | | | | |
|---|---|---|---|---|---|---|
| Torx © External (6-lobe) | Torx © Internal (6-lobe) | Torx - Internal Tamper Proof Pin (6-lobe) | Frearson | Clutch | Fluted Socket 4 flutes | Fluted Socket 6 flutes |
| Mortorq © | Tri-Wing © | Squareuare Socket (Robertson) | Hex Socket Allen Head Internal | Hexagon External | Hexagaon Internal Tamper Proof | Slotted 6 Lobe Combo |
| Quadrex © | Phillips | Phillips II © | Phillips/Slot Combination (Combo) | Post Drive © Phillips 1a | Phillips Squareuare Supa Drive © | Slotted |
| Squareuare Slot Combination | Slotted Tamper Proof (One Way) | Spanner Drilled Tamper Proof | Spanner Slotted Tamper Proof | Phillips © Hex Head | 5 Node Security | 7 Node Security |

Outlook

# Aircraft on Ground

I had a great phone call from a Glenair customer that—without revealing any company names or other clues that you sharpies will pick up on—I wanted to share with the Glenair family. My main motivation for telling this story is to highlight an important benefit of our same-day shipment inventory that may not always be readily apparent.

The gist of the call was our order fulfillment crew picked and shipped a somewhat obscure component overnight to a big regional aircraft maintenance facility enabling their mechanics to get a commercial aircraft back in service in record time. Over cocktails, the airline President remarked to the CEO of the OEM that manufactured the bird how pleased they were that spares were so readily available for their equipment. With a little research, the aircraft CEO determined Glenair had saved the day and called to thank us for a job well done. Bottom line, when his customers are happy, he's happy.

Now, we originally conceived our high-availability business model—with its ample inventory of ready-to-ship products—as a way to service the small quantity and just-in-time orders that are such a big part of our business. In fact, we usually tell customers, when they tour our facility and see the depth and breadth of our stockroom, our inventory program addresses a critical need found in literally every industry. That is, someone in the supply chain has to have product on hand when and where needed. It's just not possible to anticipate every requirement in advance. Someone (the user, a distributor, or the maker) has to have inventory, or manufacturing grinds to a halt.

But in this case, the value of our inventory program wasn't at the manufacturing stage, but at the repair and maintenance stage. An available inventory of spares—and in this case, a pretty obscure part number—was the difference between an idle aircraft stuck on the ground, and one back in service making money for its owner. Sure, the costs and benefits of inventory is a complex issue in business. But just imagine if the conversation at that cocktail party was about how difficult it was to get critical repair parts for the aircraft in question—instead of how easy. I think the phone call would have gone in quite a different direction. Anyway, kudos to everyone on the team for making an important customer's day. There is nothing more important in our business.

Chris Toomey

QwikConnect

GLENAIR ▪ VOLUME 16 ▪ NUMBER 3

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QwikConnect is published quarterly by Glenair, Inc. and printed in the U.S.A.

A complete archive of past issues of QwikConnect is available on the Internet at www.glenair.com/qwikconnect

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