

Converting Gauge To and From Linear Measures

Don Snyder

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The gauge of a wire, a rod or a sheet of precious metal is an alternative measure often used in place of its diameter or thickness; see [1] for examples of rods and sheets specified by their gauge. A brief history of the use of gauge as a measure is given in [2]. The unknown diameter of a wire or rod and the thickness of a sheet of metal can, of course, be measured using a caliper, but a caliper does not indicate the gauge directly. Simple devices to measure the gauge of a wire directly are available; for example circular devices like the one shown in Figure 1 are readily available; while some are marked with both gauge and diameter measures, many are not. There is more than one gauge measure. The American Wire Gauge (AWG) measure introduced in 1857 is prevalent, especially in the U.S. and Great Britain. It is the AWG measure that I will use. But, the SWG (Standard Wire Gauge, or British) measure introduced in 1883 is also used, but less frequently, and is different.



Figure 1. Device for measuring wire gauge

My motivation for thinking about gauge and conversions between this measure and linear measures in inches or millimeters arose from a reading of Jane Swanson's article [3] describing how she inlays silver wire and silver sheet as decorative elements in her projects made of wood. Her method is based on using a router and a pattern following guide to form a channel into which the wire is embedded. An end-mill type router bit is selected so that the channel width it cuts closely matches the size of the inlaid wire, which is then held snugly in place once set into the channel. However, end mills are usually specified by their cutting diameter and wires by their gauge. Swanson provides a small table of values giving wire diameters and their corresponding wire gauges. Selecting a desired wire gauge for

the inlay design and referring to her table for the corresponding wire diameter, a bit of the appropriate cutting diameter can be selected. Tables of this correspondence are readily available on-line for a wide range of gauges and diameters; see for example [4].

There are mathematical expressions that specify the linear dimension of a wire, a rod, or a sheet given its gauge and, also vice-versa, the gauge in terms of the linear dimension. If the (American AWG) gauge measure is G , the linear dimension (diameter, thickness) measure D , in the units of inches, is

$$D = 0.005(92)^{(36-G)/39} = 0.005e^{(36-G)(\ln 92)/39} . \quad (1)$$

Also, the linear dimension in the units of millimeters is $25.4D$ because there are 25.4 millimeters for each inch. Conversely, if the linear diameter or thickness, D , is given in the units of inches, the inverse expression of (1) for the gauge G is

$$G = 36 - \frac{39}{\ln 92} \ln [D / 0.005] . \quad (2)$$

Examples

1. A wire having gauge $G = 36$ has a diameter of 0.005 in. or 0.127 mm.
2. A wire having a gauge $G = 20$ has a diameter of 0.03196 in. or 0.8118 mm.
3. A number 67 drill bit has a diameter of 0.032 in. It can be used to drill a hole that will firmly hold a silver rod of gauge $G = 20$.
4. Equations (1) and (2) can be used to construct a table of gauges and corresponding diameters, such as the following table like Swanson's [3]. More complete tables are readily available on the internet.

gauge (AWG)	inch equivalent	millimeter equivalent
16	0.05085	1.292
18	0.04031	1.024
20	0.03196	0.8118
22	0.02534	0.6436
24	0.0201	0.5105
26	0.01594	0.4049
28	0.01264	0.3211
30	0.01003	0.2548

References

1. <http://www.riogrande.com/category/metals/Silver>
2. https://en.wikipedia.org/wiki/Wire_gauge
3. Jane Swanson, "Wire Inlay," *American Woodworker*, pp. 44-47, April 1996.
4. http://www.powerstream.com/Wire_Size.htm

FRINK Program to convert between gauge and diameter

Frink is the implementation by Alan Eliason of a java-based scientific programming language that runs on many platforms, including Windows, Mac, Linux and Android. The Android app can be downloaded from the Google Play Store and from the website <https://frinklang.org/>. Documentation for *Frink* is available on this website as are listings of many sample programs written in the *Frink* language.

Following is a Frink program that implements (1) and (2) for conversions between gauge and linear dimensions. I have it installed on my Android smart phone.

```
-----start Frink program-----

// Calculates wire diameter from American Wire Gauge
// and American Wire Gauge from wire diameter
//
// Created By: D. L. Snyder 25 June 2015
//
// Parameters
// AWG American Wire Gauge
// D_in wire diameter in inches (decimal)
// D_mm wire diameter in millimeters
//
// Formulas: ref. https://en.wikipedia.org/wiki/American_wire_gauge
//  $D_{in} = 0.005 * (92)^{((36 - AWG)/39)} = 0.005 * e^{[(\ln[92]) * ((36 - AWG)/39)]}$ 
//diameter, inches
//  $AWG = 36 - (39/\ln[92]) * \ln[D_{in}/0.005]$  //American Wire Gauge,
diameter (D) in inches
//
// Functions
  setPrecision[4]
  D[AWG] := 0.005*exp[(ln[92])*((36 - AWG)/39)] //diameter, inches from
AWG
  G[D] := 36 - (39/ln[92])*ln[D/0.005] //American Wire Gauge from
diameter (D) in inches
//
// Display Setup
g = new graphics
g.backgroundColor[0,0,0] //black background
g.font["SansSerif","bold",3.5]
g.color[1,1,0] //yellow box fill
g.fillRectCenter[20, 15, 60, 15]
g.color[0,0,1] //blue text
```

```

//
//start.....
//user input
Conversion_Choice = input["Enter a, b, c or d:" + "\n" +
+ "a -from wire diameter (inches) to AWG," + "\n" +
+ "b -from wire diameter (millimeters) to AWG," + "\n" +
+ "c -from AWG to wire diameter (inches)," + "\n" +
+ "d -from AWG to wire diameter (millimeters)"]
//

if Conversion_Choice == "a"
{
    D_in = input["Enter wire diameter in inches"] //diameter as a string
    D_IN = eval[D_in] //diameter as a numeric, inches
    AWG = G[D_IN]
    g.text[" Wire Diameter = " + D_IN + " inches" + "\n" +
+ " American Wire Gauge = " + AWG, 20, 15]
    g.show[]
} else
if Conversion_Choice == "b"
{
    D_mm = input["Enter wire diameter in millimeters"] //diameter as a string
    D_MM = eval[D_mm] //diameter as a numeric,
millimeters
    D_IN = D_MM/25.4 //diameter, inches
    AWG = G[D_IN]
    g.text[" Wire Diameter = " + D_MM + " millimeters" + "\n" +
+ " American Wire Gauge = " + AWG, 20, 15]
    g.show[]
} else
if Conversion_Choice == "c"
{
    guage = input["Enter American Wire Guage = "] //gauge as a string
    AWG = eval[guage] //gauge as a numeric
    D_IN = D[AWG] //diameter, inches
    g.text[" American Wire Gauge = " + AWG + "\n" +
+ " Wire Diameter = " + D_IN + " inches", 20, 15]
    g.show[]
} else
if Conversion_Choice == "d"
{
    guage = input["Enter American Wire Guage = "]; //gauge as a string
    AWG = eval[guage] //gauge as a numeric

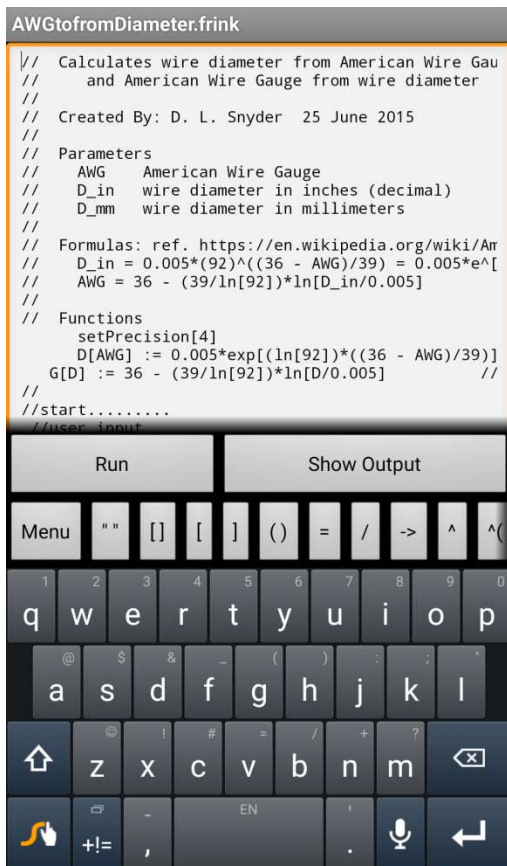
```

```

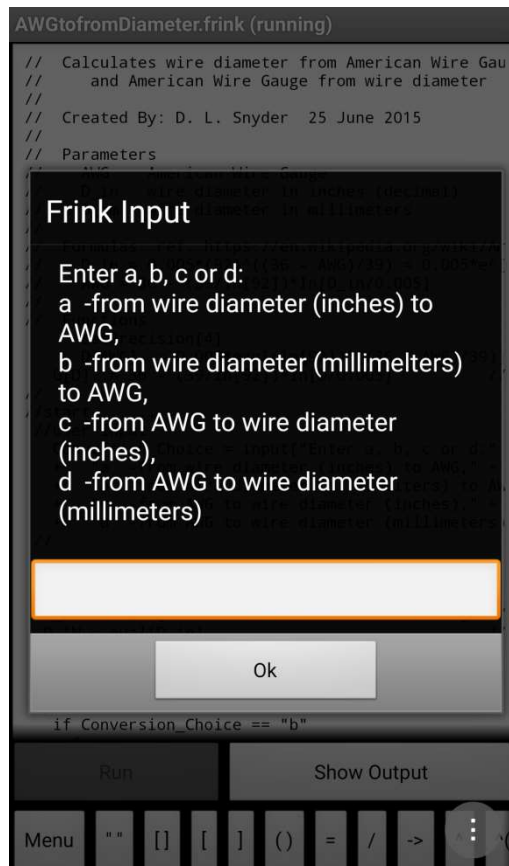
        D_IN = D[AWG]                                //diameter, inches
    D_MM = 25.4*D_IN                                //diameter, millimeters
    g.text[" American Wire Gauge = " + AWG + "\n" +
        + " Wire Diameter = " + D_MM + " millimeters", 20, 15]
    g.show[]
} else
if true      //there is an invalid entry
{
    println[" Invalid Entry.  Enter a, b, c, or d and run again."]
}
//.....end
-----end FRINK program-----

```

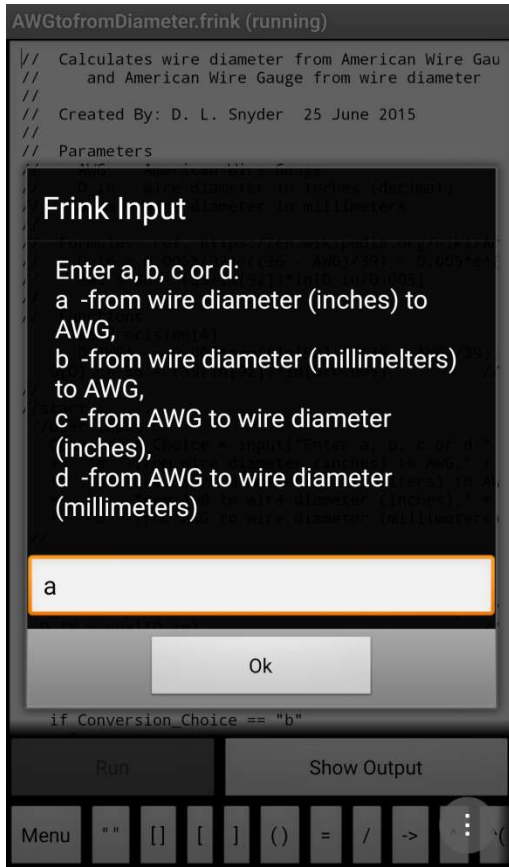
Following is a series of screen shots from my Android smart phone when this Frink program is used.



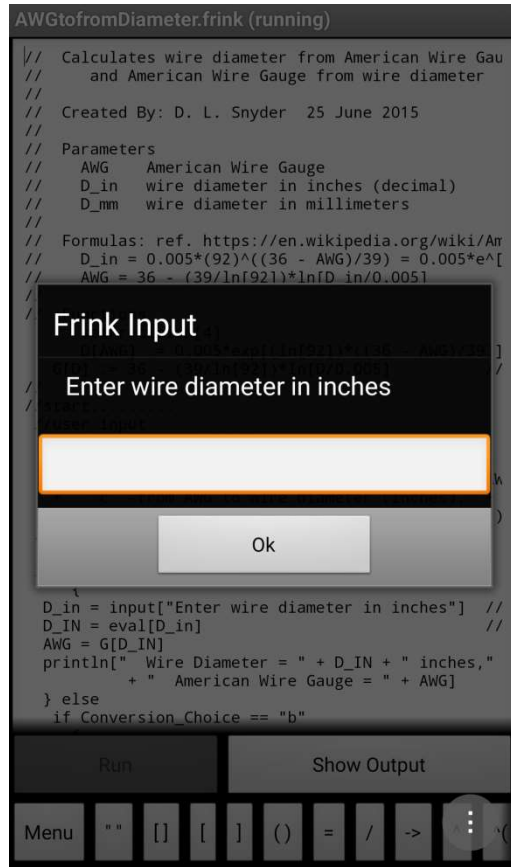
a. select Run, then



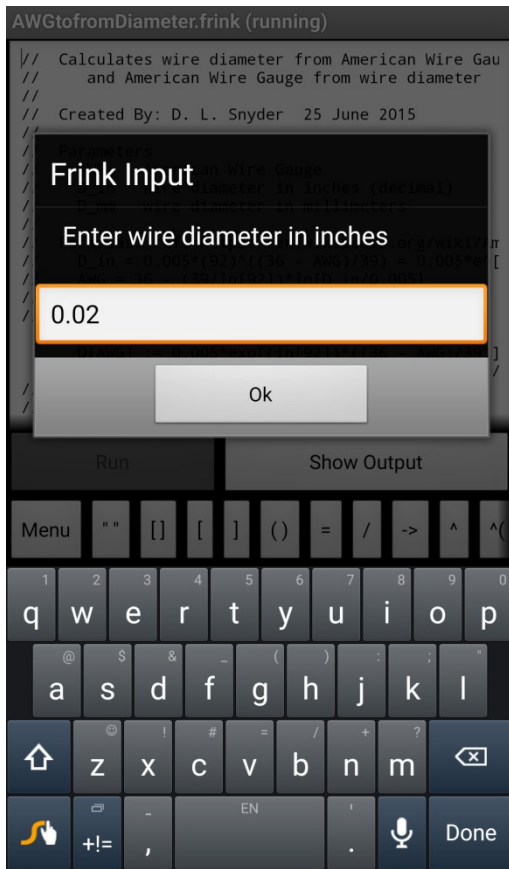
b. enter choice (a,b,c or d), then



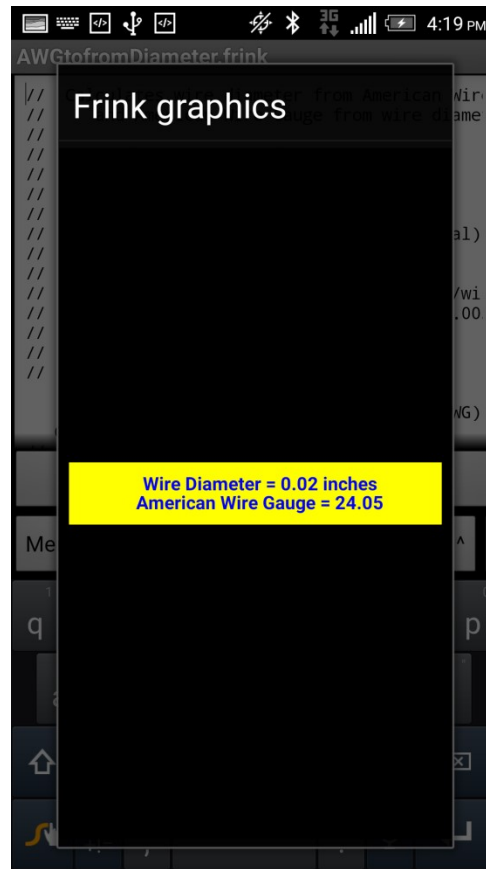
c. select Ok, then



d. enter diameter, then



e. Select Ok



f. read result, select Close to rerun