Wire size selection for Aircraft Electrical Systems

Many homebuilders wonder what size wire is appropriate for the various circuits in their aircraft. We will provide you with guidelines condensed from the FAA's AC-43.13b in this document. Wires are sized according the wire "gauge", abbreviated AWG. The larger the gauge, the smaller the wire diameter.

Maximum current capacity

All wire sizes have a maximum continuous current rating as given in AC43.13. This is the greatest amount of current that should be drawn through the wire for an extended length of time. Most circuits in the aircraft are continuous duty, only the starter and perhaps the gear and flap motors might also be considered intermittent duty. The figures given below are for wires bundled into harnesses, and are based on 150 degree C wire insulation ratings. This is typical of the wire most builders will use in their projects.

Wire size (AWG)	Maximum Current (amps)	Resistance (ohms/ft)
24	4	0.03 ohm/ft
22	5	0.016 ohm/ft
20	7	0.01 ohm/ft
18	9	0.006 ohm/ft
16	11	0.005 ohm/ft
14	14	0.003 ohm/ft
12	19	0.002 ohm/ft
10	26	0.0012 ohm/ft
8	57	0.0007 ohm/ft
6	76	0.0004 ohm/ft

Wire sizes for short wires

The maximum current of each wire will dictate the size of most wires in the aircraft. On longer wires, the wire resistance may require using a larger size of wire. The purpose of the fuse is to prevent electrical fires by protecting the wire from overheating in the event of a short. **The wire should be sized based on the fuse value of the circuit**, not on the expected current draw of the device to be powered. A 3 amp output from the EXP bus could use any wire size 24 AWG or larger. The 9 amp landing light outputs should be wired with a wire of 18AWG or greater. You should not use a wire size of 20AWG on a 9 amp output, as the wire may burn up before the fuse blows. Since the wire sizes are determined by the amperage of the fuse, if you are using one fuse output to power several small accessories, remember to size the wire for each accessory based on the fuse size, and not the small load by the accessory. The AC also states that wire sizes of 24 AWG and 26 AWG should NOT be used as single wires, although they could be used as part of a wire bundle. Any wires of smaller than 20 AWG should be carefully supported, as such small wires are very fragile and more prone to failure by vibration and mechanical stress.

Wire sizing for longer wires

AC-43.13 also specifies a maximum allowable VOLTAGE DROP across a wire. The maximum allowable voltage drop according to the FAA for 14V systems is 0.5 volts. All wires have some resistance, and when current is drawn through a wire, there will be some voltage drop across the wire. It is this voltage drop that causes the wire to heat up, since power is equal to voltage drop times current flow (P = V * I). If the wire is long enough, the voltage drop across the wire will exceed 0.5V long before the maximum current capacity of the wire is exceeded. This voltage drop will at some point cause the equipment being powered to quit working reliably, just as though the battery voltage were too low. The formula for voltage drop on a wire is known as *ohm's law*

$$V_{drop} = I * R.$$

I is normally used to symbolize current flow (in AMPS), and R is the resistance (in OHMS). The resistance of the wire depends on the diameter and the length of the wire. Each wire size in the above table shows the typical resistance per foot. We will call this value $R_{PF.}$ The formula for the Voltage drop for a wire of length L feet is:

$$V_{drop} = I * R_{pf} * L$$

Since the FAA has told us not to exceed 0.5 volts of drop across the wire, we can write a formula for the maximum allowable wire length, if we know the R_{pf} value from the above table, and the current load (I) that will be on the wire.

$$L = \frac{1}{2 * I * R_{pf}}$$

Using the value from the table above, let's calculate the maximum length of the 18AWG landing light wire above. The current is 9 amps, and the R_{pf} of this wire is 0.006 ohms/ft from the above table. Therefore the maximum length of this wire would be:

$$L = \frac{1}{2 * 9 * 0.006} = 9.25 \text{ feet.}$$

If the distance from the switch to the landing light (allowing for wire routing) exceeds 9 feet, 3 inches, then we should use a larger wire, probably 16 AWG. In fact 16AWG wire would allow a maximum length of 11 feet, while 14 AWG wire would run a maximum of 18.5 feet. Generally the only place where these will be of any concern is in the NAV lights on the wing tips, and maybe the battery cable and landing light cable.