Experimental Aircraft Wiring

The Easy Way

There are three basic goals we should all have in mind when wiring our aircraft.

1) Desire to use wire no larger than required for a specific device/circuit
    a. Wire is expensive (and if it isn't – you shouldn't be using cheap stuff in your aircraft!)
    b. Wire is heavy
    c. Smaller wire is easier to route, easier to protect and easier to fit connections
2) Desire to use wire large enough to minimize voltage drop. We want whatever we are wiring to operate at top efficiency.
3) Desire to maintain adequate safety margin. Melting wires are never a good thing – especially at altitude enroute over terrain.

Begin by determining the current you must carry. For DC circuits, this is relatively easy. A lot of equipment is rated directly in current draw – Amps. Some equipment is rated in Watts – mostly lighting equipment. The power in Watts will be printed right on a bulb or stamped on the base. To derive amps use the basic formulas shown here.

$$\text{Amps} = \frac{\text{Watts}}{\text{Volts}}$$

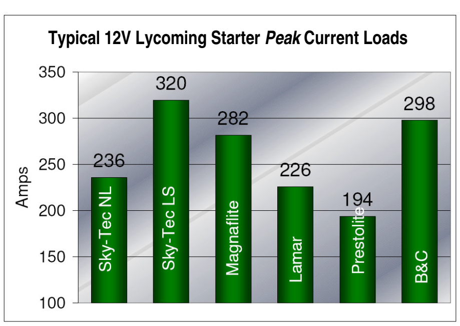
$$\text{Amps} = \frac{\text{Volts}}{\text{Ohms}}$$

$$\text{Amps} = \sqrt{\frac{\text{Watts}}{\text{Ohms}}}$$

Once the current load is determined, it is then just a matter of determining the proper gauge of wire required for any given length of wire run.

Given the context of this web site, let us consider a typical aircraft starter installation. Determining current load is much more difficult to determine. The amount of current required to start an engine depends on a number of variables that determine the force required to turn a given engine at a desirable RPM. This force varies depending on cylinder compression, temperature and other variables. So rather than calculating an *actual* current load, it is much more reasonable to start with a conservative *estimate*.

Testing at Sky-Tec has determined the following as reasonable *peak* current loads for the following 12V Lycoming starters.



Understand that these current ratings are estimated (by TEST) *peak* current figures. Most installations under typical conditions will fall well below these numbers. And even when all variables involved "stack-up" against us (cold day, high compression, etc.), these peak numbers are rarely reached for more than a brief period of time (initial inrush and/or first compression stroke before propeller/engine has acquired workload assisting momentum).

Now let's consider the total wire run from the battery to the starter. The chart below assumes a permissible ½ volt drop over the indicated length of cable, which is certainly acceptable for a starter application. An additional voltage loss of ½ volt should be anticipated through both the main and starter solenoids resulting in a little more than 11 volts being made available to the starter during cranking (typical 12+ volt static battery voltage).

Using the chart, we determine an aircraft utilizing a Sky-Tec LS starter requiring a ten-foot cable run to the battery located behind the baggage compartment should utilize a minimum of a 4 AWG cable. Compensating for realistic conditions (low battery, etc.), we go to the next size larger for a safety margin and we're at 2 AWG.

Now in reality, we have to balance the mathematical results with mechanical facts. Larger wire is only marginally heavier and allows for stronger/larger terminal connections. We would err on the side of caution and run 1 AWG if our routing installation allowed for it.

Remember, the starter is simply an appliance in the *middle* of the electrical circuit (not the "end") so you should use the same gauge wire to ground the circuit (starter/engine) as well. The circuit is only as efficient as its least efficient component. So it doesn't make any sense to run 1 AWG to the starter only to have a 4 AWG wire between the starter/engine and aircraft ground or between the battery and aircraft ground. **Your circuit is only a good as your ground** (or the weakest component in the total circuit). **DON'T FORGET TO ENGINEER THE GROUND CONNECTIONS TOO**.

Finally, remember that wire sizes for lighting are more critical than for other applications. Lighting is rated at 13.5 available volts, not 12. So a ½ volt drop results in 13.0 volts. At 95% of rated voltage, however, an incandescent light bulb produces 80% of the rated luminous intensity. Figure on the high side when sizing for incandescent lighting.

Wire Gauge AWG	Maximum length in feet for maximum ½ volt drop (12V system)											
	1	2	4	6	8	10	12	15	20	50	100	200
20	106	53	26	17	13							
18	150	75	37	25	18	15	12					
16	224	112	56	37	28	22	18	14				
14	362	181	90	60	45	36	30	24	18			
12	572	286	143	95	71	57	47	38	28			
10	908	454	227	151	113	90	75	60	45			
8	1452	726	363	241	181	145	120	96	72	29		
6	2342	1171	585	390	292	234	194	155	117	46	23	
4	3702	1851	925	616	462	370	307	246	185	76	37	
2	6060	3030	1515	1009	757	606	503	403	303	121	60	30
1	7692	3846	1923	1280	961	769	638	511	384	153	76	38
0	9708	4854	2427	1616	1213	970	805	645	485	194	97	48