

Automotive Wiring - The Way It's Really Done

All of us are concerned about wiring our car properly. So much in fact, that I'll bet most of you engineer to overkill. What are the issues you need to be concerned about?

- Use the smallest possible wire for the required current.
 - Wire is expensive and the larger you go, the more expensive it is.
 - Wire is heavy and the larger you go, the heavier it gets.
 - Mechanically, smaller wire is easier to route, easier to protect, easier to fit connectors on and therefore, more reliable mechanically (There are limits - see below).
- Use a large enough wire so there is no voltage drop. We want whatever it is we are wiring to operate at top efficiency.
- Maintain an adequate safety margin. We don't want to melt any wires do we?

The first thing you have to do is determine the current you have to carry. For DC circuits, that's relatively easy. Some equipment on a car is rated directly in current draw. Auxiliary fans, fuel pumps and things like that are rated in current draw - Amps. Some equipment is rated in Watts - mostly the lighting equipment. The power requirement in Watts will be printed right on the bulb or stamped in the base. To come up with amps use one of the formulas shown here.

Let's calculate for a typical 100 Watt Driving Light - the power required is 100 Watts and the voltage is 12 Volts - so the current requirement is $100 \text{ Watts} / 12 \text{ Volts} = 8.33 \text{ Amps}$. Let's assume you have to run a wire 6 feet from a relay to the lamp and look at the chart on the next page. Using the 10 Amp column you'll find that you can run 10 Amps on 15 feet of 18 AWG with only $\frac{1}{2}$ Volt drop. Go to the next size larger for safety margin and you're at 16 AWG (See the note below on lighting). Now in reality, you have to balance the mathematical results with mechanical reliability. Me, I'd go to 14 AWG as the wire and connectors are physically stronger — plus I only buy three sizes — 14, 12 and 10 AWG. Those three and crimp-on connectors are readily available just about anywhere. And except for primary circuits, those three sizes will cover just about anything you want to wire in a car with an adequate safety margin.

Wire sizes for lighting is more critical than for other applications — The rated output of any lamp is figured at 13.5 volts, not 12 volts as you might expect. So with a $\frac{1}{2}$ volt drop you are at 13.0 volts. And at 95% of the rated voltage, you are only putting out 80% of the rated luminous intensity - for a 100 watt lamp that's only 80 watts!! Get what you pay for and figure to the high side when you are sizing wire for lighting.

So how much current are you drawing in your car total? Is your Alternator big enough? Let's say you have four 100 Watt Driving Lights and you've upgraded your OEM Lights to 100 Watts each for another 200 Watts. Now you're at 600 Watts, or 50 Amps, just in forward lighting! Got an electric cooling fan? Another 8-12 Amps, the same as your heater fan. Dual Horn - 12 to 20 Amps. Stop Lights - 2 Amps each. Marker Lights - 0.5 Amps each. Ignition - 8 to 12 Amps. Fuel Pump - 4 to 8 Amps. Add 'em all up and see what you've got. If your equipment is sucking up more amps than your alternator is putting out, the balance is being made up by your battery. Eventually your battery will no longer be able to supply that additional current and your lights will start to get dimmer and dimmer. Eventually, your car will roll to a stop as the electronic ignition quits for lack of adequate power.

Wire Gauge AWG	Maximum length in feet for car wiring											
	Current load in Amps @ 12 Volts DC											
	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	74	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

1. Calculate the current load and find the next highest on the top row. Go down that column until you find the length you need to run. The wire gauge required is shown in the far left column.
2. The maximum lengths are based on a ½ volt drop over the indicated length.
3. To be safe, always choose one wire size larger than you need for the required current carrying capacity and length.

For example: You've calculated 10 amps load, over a length of 15 feet. The chart shows that 18 AWG is suitable. Choose 16 or 14 AWG to allow an adequate margin for safety.