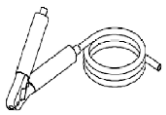

Welding Cables

INTRODUCTION

Cables deliver current from the welding power source to the welding or cutting arc. Welding cable size, length, connections, placement, and care are all important to welder safety. Know and understand the safe limits and proper use of welding cables to reduce potential hazards.

POTENTIAL WELDING CABLE HAZARDS

TRIPPING can cause falls and injuries.

- Relocate cables to prevent tripping.

ENTANGLEMENT can pull cables loose, and cause arcs and sparks.

- Keep cables out of the way. Protect them from damage.

ARCS and SPARKS can injure and start fires.

- Keep connections clean and tight.

INCORRECT CABLE SIZE can cause cables to overheat, damage insulation and cause burns and fires.

- Use the correct cable size/gauge. Follow the welding power source and cable manufacturers recommendations.
- Use proper connectors and splices.
- Use correct cable length for the job.
- Do not leave cables coiled while in use as this can cause spot overheating.
- Electromagnetic Fields - See AWS Safety & Health Fact Sheet No. 17, Electric and Magnetic Fields (EMF) in Welding.
- Examine before, during, and after use for damage.
- Repair or remove damaged cables.
- Do not use worn, damaged, undersized, or poorly spliced cables.

SOME CABLE FACTS

- To ensure the correct power is delivered to the arc, follow the welding power source and cable manufacturers recommendations. These recommendations maintain a 4 volt drop or less at a specific current and cable length. The maximum 4 volt drop helps maintain proper arc characteristics. It is not primarily meant to protect the cable, although longer cables will stay cooler with the same voltage drop.

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Recommended AWG Sizes of Copper Welding Cables

Amp	Distance in Feet from Welding Machine*											
	50	75	100	125	150	175	200	225	250	300	350	400
100	2	2	2	2	1	1/0	1/0	2/0	2/0	3/0	4/0	4/0
150	2	2	1	1/0	2/0	3/0	3/0	4/0	4/0			
200	2	1	1/0	2/0	3/0	4/0	4/0					
250	2	1/0	2/0	3/0	4/0							
300	1	2/0	3/0	4/0								
350	1/0	3/0	4/0									
400	1/0	3/0	4/0									
450	2/0	4/0										
500	2/0	4/0										
550	3/0											
600	3/0											
* Based on direct current and 4-v drop. Double the distance for total length												

- American Wire Gage (AWG) cable size numbers get smaller as the cable diameter gets bigger. For example, No.16 gage is about 0.05 inches in diameter, and No. 4 gage is about 0.20 inches in diameter.

- After No. 1 gage the next bigger cable is “one naught” (1/0 or 0) (sometimes called “one aught”). Bigger cables are 2/0, 3/0, and 4/0 (00, 000, 0000). AWG was formerly “Brown & Sharp Gage” and is sometimes referred to as “B & S Gage”.

- Metric wire gages are based on the actual diameter, in millimeters (mm) multiplied by 10. For example, a 5.00 mm diameter wire is a 50 gage metric wire.

- Metric cable sizes may not directly correspond to AWG cable sizes. Use a metric cable size at least as large as the recommended AWG cable size.

- With AWG cables a change of 3 number sizes doubles or halves the actual size. For example, if you go from 1/0 to 4/0, the cable has twice as much copper. Therefore, it will have half the resistance and half the voltage drop. You can then use cable twice as long before you a reach a 4 volt drop.

INFORMATION SOURCES

Manz, August. “How to Pick the Right-Sized Welding Cable” Welding Journal, March 2012, pages 91 and 92. Web site: www.aws.org. The article is included here in its entirety for your convenience.

American Welding Society (AWS). Safety Guidelines for Proper Selection of Welding Cables, AWS F4.2, available from the American Welding Society, 8669 36 Street, #139, Miami, FL 33166. Phone: 800-443-9353; Web site: www.aws.org.

How to Pick the Right-Sized Welding Cable

Here are a formula and tables that will help you to choose a safe-sized cable every time

BY AUGUST F. MANZ

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What size welding cable do you need to be safe when you are using XX amperes and are about YY feet from the power supply?

Most welders know that the use of the wrong cable size can lead to cable overheating, insulation failure, electric shock, and even fires. The wrong size can even affect the welding condition.

Picking a Safe Cable Size

To answer the question above, you need to know the welding current and the distance from the power supply. The safe American Wire Gauge (AWG) size is based on a 4-V cable loss, due to the welding current flowing through the cable resistance. (Note: Years ago, it was agreed that a 4-V cable loss, due to welding current, would be acceptable. A 4-V drop does not have too much effect on the arc system or the system efficiency.) Table 1 shows that at 250 A and 150 ft from the power supply, the correct size is a 4/0 AWG cable, which is the same as the #0000 AWG in Table 2.

Another Method

You can also pick a safe cable size by using the formula below, and Table 2, for copper cables. First, calculate the safe circular mil size needed. Circular mil (CM) is engineering measure of the cable cross-section area.

CM = 10.37 A (total cable length, ft)/4 V

Now, use the calculated CM value and the AWG sizes in Table 2 to select a cable (the 10.37 value is only good for copper cables). Always pick an AWG cable size with a CM value larger than the calculated value. Do not pick an AWG size smaller than #2 because of needed mechanical strength. The following is an example CM calculation: To determine the safe AWG size cable needed for 250 A and a total cable length of 300 ft [150 ft · 2 (from the power supply to the arc and return)], you use the following formula:

CM = 10.37 (250)(300)/4 = 194,438 cm

In Table 2, the next larger CM is 211,600 cm, for #0000 AWG cable. This is the same 4/0 size you found in Table 1. The actual voltage drop in the cable can be calculated as follows: From Table 2, for #0000 AWG, at 20°C (the estimated room temperature) there are 0.04901 ohms per 1000 ft. Using Ohm's Law as follows:

$$\begin{aligned}\text{Volts} &= (\text{ohms})\,(\text{amperes})\\ &= (0.04901 \text{ ohms}/1000 \text{ ft})(300\text{ft})(250 \text{ A})\\ &= 3.68 \text{ V}\end{aligned}$$

The calculated 3.68-V loss is smaller than the acceptable 4-V loss agreed upon, and is okay. Calculations like this were used to generate the data in Table 1.

The Bottom Line

With the tables and information in this article, you can choose a safe cable size every time.

Table 1 — Recommended Sizes of Copper Welding Leads *

Amps	Distance in Feet from Welding Machine											
	50	75	100	125	150	175	200	225	250	300	350	400
100	2	2	2	2	1	1/0	1/0	2/0	2/0	3/0	4/0	4/0
150	2	2	1	1/0	2/0	3/0	3/0	4/0	4/0			
200	2	1	1/0	2/0	3/0	4/0	4/0					
250	2	1/0	2/0	3/0	4/0							
300	1	2/0	3/0	4/0								
350	1/0	3/0	4/0									
400	1/0	3/0	4/0									
450	2/0	4/0										
550	3/0	4/0										
600	3/0											

*Based on direct current and 4-V drop. Double the distance for total length.

Table 2 — Wire Table, Standard Annealed Copper American Wire Gauge

Gauge No.	Dia. in Mils at 20°C	Cross Section 20°C Circular Mils	Cross Section 20°C Square Inch	Pounds 1000 ft	Ohms per 1000 ft 0°C (32°F)	Ohms per 1000 ft 20°C (68°F)	Ohms per 1000 ft 50°C (122°F)
0000	460.0	211,600	0.1662	640.5	0.04516	0.04901	0.05479
000	409.6	167,800	0.1318	507.9	0.05695	0.06180	0.06909
00	364.8	133,100	0.1045	402.8	0.07181	0.07793	0.08712
0	324.9	105,500	0.08289	319.5	0.09055	0.09827	0.1099
1	289.3	83,690	0.06573	253.3	0.1142	0.1239	0.1385
2	257.6	66,370	0.05213	200.9	0.1440	0.1563	0.1747
3	229.4	52,640	0.04134	159.3	0.1816	0.1970	0.2203
4	204.3	41,740	0.03278	126.4	0.2289	0.2485	0.2778

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