Wire Sizing, Labels, and Lugs

Quick Reference Guide

1.1 Introduction

Wires must meet a wide range of applications. Therefore, wire charts used in the electronic industry vary in standards and content.

Wire design criteria includes

- conductor type (solid-core or stranded)
- conductor strands (size, quantity, coated, or tinned)
- insulating material and its dielectric strength, temperature rating, and fire resistance
- where the wire is used (internal or external to the product)
- whether the installation is factory- or field-wired

1.2 Inherent Voltage Drop

This phenomenon is due to the inherent resistance of the power cable to current flow. A voltage drop develops across the cable, lowering the actual voltage and power levels to the equipment. The longer the wire, the larger the drop. You may need to increase the circular mils or gauge of the wire to decrease the voltage drop, bringing it within the operating company's specification.

The voltage drop of the discharge bus loop, including the drop across the overcurrent protection devices between the battery terminals and the loads in the equipment frame, should be limited to a maximum of 2V at Class 2 amperage (typical). Most operating companies limit the power cable drop between the battery distribution fuse board (BDFB) and the distribution fuse/breaker alarm panel (DF/BAP) to 0.5V or less.

Check with the operating company for specific voltage drop information.

1.2.1 Formulas

When you know the allowable voltage drop, use the formulas that follow to calculate circular mils per conductor size; then use the accompanying table to select the size of wire and interruption device. (See Figure 1, “Typical Allowable Total Loop Voltage Drops for a –48V Plant DC Distribution System” on page 2 shows the typical voltage drops.) The first formula is based upon the equipment’s actual current draw. The second, preferred formula is based upon the maximum voltage drop, determined at the rating of the interruption device.

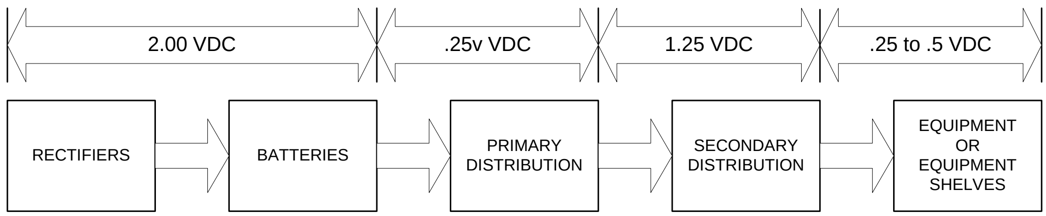

Figure 1 - Typical Allowable Total Loop Voltage Drops for a –48V Plant DC Distribution System

$$\text{Circular Mils of Wire} = \frac{11.1 \times \text{Load Amp} \times \text{Total Loop Length of Wire in ft}}{\text{Actual } V_{drop}}$$

$$\text{Circular Mils of Wire} = \frac{11.1 \times \text{Fuse/Breaker Size} \times \text{Total Loop Length of Wire in ft}}{\text{Max. } V_{drop}}$$

The following two tables for selecting AWG/metric wire sizes and interruption devices are compiled from several sources including the National Electric Code, Underwriters Laboratory, AMP, ALPHA, and OLFLEX.

Values in these tables are based on applications using **90-degree** stranded copper wire. The insulation temperature ratings determine the actual operating values of the different cables. The values in this chart are recommended values; actual values depend on the cables used in the application.

Fuse/ Breaker (Amps)	Wire Size[a] (AWG)	Metric Ref. Dia.[b] (mm)	Diameter Range		Wire Circular Area Range (Mils)
			U.S. (in.)	Metric (mm)	
0.6	26	0.50	0.018–0.021	0.400–0.533	202–440
1.3	24	0.50	0.023–0.024	0.511–0.610	384–576
2.0	22	0.75	0.030–0.031	0.643–0.787	640–961
2.7	20	1.00	0.035–0.040	0.813–1.016	1000–1600
14.0	18	1.00	0.047–0.052	1.020–1.320	1624–2700

Fuse/ Breaker (Amps)	Wire Size[a] (AWG)	Metric Ref. Dia.[b] (mm)	Diameter Range		Wire Circular Area Range (Mils)
			U.S. (in.)	Metric (mm)	
18.0	16	1.50	0.058–0.060	1.473–1.524	2580–3600
25.0	14[b]	1.75	0.068–0.073	1.727–1.854	3830–5329
30.0	12[b]	2.00	0.083–0.096	2.369–2.438	5180–9216
40.0	10[b]	3.00	0.115–0.116	2.921–2.946	9353–13456
55.0	8	3.75	0.128–0.147	3.264–3.734	16625–21609
75.0	6	4.75	0.162–0.184	4.115–4.674	25900–33856
95.0	4	6.00	0.192–0.232	5.000–5.898	41650–53824
130.0	2	7.00	0.250–0.276	6.400–6.543	65475–76176
150.0	1	8.00	0.289–0.328	7.348–8.250	81700–107584
170.0	1/0	9.00	0.330–0.363	8.350–9.250	104636–131769
195.0	2/0	10.50	0.364–0.414	9.260–10.52	132297–171396
225.0	3/0	11.75	0.415–0.470	10.40–11.68	163195–220900
260.0	4/0	13.00	0.480–0.530	11.69–13.26	210386–280900

a. The recommended AWG/metric size is based on an ambient temperature of 26-30°C (79-86°F). Multiply these size values by the factors in the following table to determine the optimum wire for other ambient temperature conditions.

b. NEC 240-3 requires that the overcurrent protection shall not exceed 15A for No. 14, 20A for a No. 12, and 30A for No. 10 copper.

For Ambient Temp. (°C) —	Multiply AWG/Metric Size In Preceding Table By —	For Ambient Temp. (°C) —	Multiply AWG/Metric Size In Preceding Table By —
21–25	1.04	41–45	0.82
26–30	1	46–50	0.75
31–35	0.96	51–55[a]	0.67
36–40	0.88		

NOTE: a) All Telect power distribution products are designed and built to meet the maximum operation temperature (55°C).

1.3 GMT Fuse Duration

GMT fuses have a small inherent electrical resistance resulting in a small inherent power loss. For this reason, the GMT fuse manufacturer recommends that the load for GMT fuses up to and including 7.5A not exceed 80% of the fuse rating and that the load for GMT fuse sizes between 10A and 20A not exceed 70% of the fuse rating. For example, the load for a 15A GMT fuse should not exceed 10.5A (15A x .70 = 10.5A).

The following table lists GMT fuse values, their inherent resistance, and the derated current and power.

Table 1 - GMT Fuse Values

Ampere Rating (A)	Ohms	Max. Power (W)	Deration Factor	Derated Current (A)	Derated Power (W)
0.18	6.25	0.2025	80%	0.144	0.1296
0.2	5.7	0.2280	80%	0.16	0.1459
0.25	4.2	0.2625	80%	0.2	0.1680
0.375	2	0.2813	80%	0.3	0.1800
0.5	1.52	0.3800	80%	0.4	0.2432
0.65	1.25	0.5281	80%	0.52	0.3380
0.75	0.98	0.5513	80%	0.6	0.3528
1	0.665	0.6650	80%	0.8	0.4256
1.33	0.48	0.8491	80%	1.064	0.5434
1.5	0.385	0.8663	80%	1.2	0.5544
2	0.12	0.4800	80%	1.6	0.3072
2.5	0.0904	0.5650	80%	2	0.3616
3	0.067	0.6030	80%	2.4	0.3859
3.5	0.0415	0.5084	80%	2.8	0.3254
4	0.035	0.5600	80%	3.2	0.3584
5	0.0285	0.7125	80%	4	0.4560
7.5	0.0113	0.6356	80%	6	0.4068
10	0.0084	0.8400	70%	7	0.4116
12	0.0066	0.9504	70%	8.4	0.4657
15	0.0058	1.3050	70%	10.5	0.6395
20	0.00394	1.5760	70%	14	0.7722

1.4 Wire Selection

Select wire and cable to meet the worst-case conditions for your application. When making your selection, consider the

- types of cables required
- amount of cables in a bundle
- total loop length
- high ambient or operating temperatures

Also, refer to the operating company's requirements for amperage, wire lengths, and flammability. Calculate wire size using Class 2 operating amperage.

1.4.1 Formulas

The circular mil area of a conductor is equal to its diameter in mils squared (1 inch = 1000 mils).

Example: The circular mil area for an 8 AWG solid conductor that has a 0.1285-inch diameter is calculated as follows:

0.1285 in X 1000 = 128.5 mils
128.5 X 128.5 = 16,512.25 circular mils or
16,512 circular mils (rounded off)

This rounded value represents the circular mil area for a solid-core conductor. For stranded conductors, the circular mil area of each strand must be multiplied by the number of strands to determine the circular mil area of the conductor.

1.5 Ground Cables

Reference NEC (National Electric Code), Table 250-122.

Input Fuse/Breaker Rating (Amps)	Copper Wire Size (AWG)	Input Fuse/Breaker Rating (Amps)	Copper Wire Size (AWG)
15.0	14	100.0	8
20.0	12	200.0	6
30.0	10	300.0	4
40.0	10	400.0	3
60.0	10	400.0 +	2[a]

a. NEC 25-122 1999 requires a minimum #2 AWG for ground cables with fuse breaker ratings above 400A.

1.6 Fuse/Breaker Panel Labels

These sticky-backed labels are included with configurable Telect fuse and circuit breaker panels.

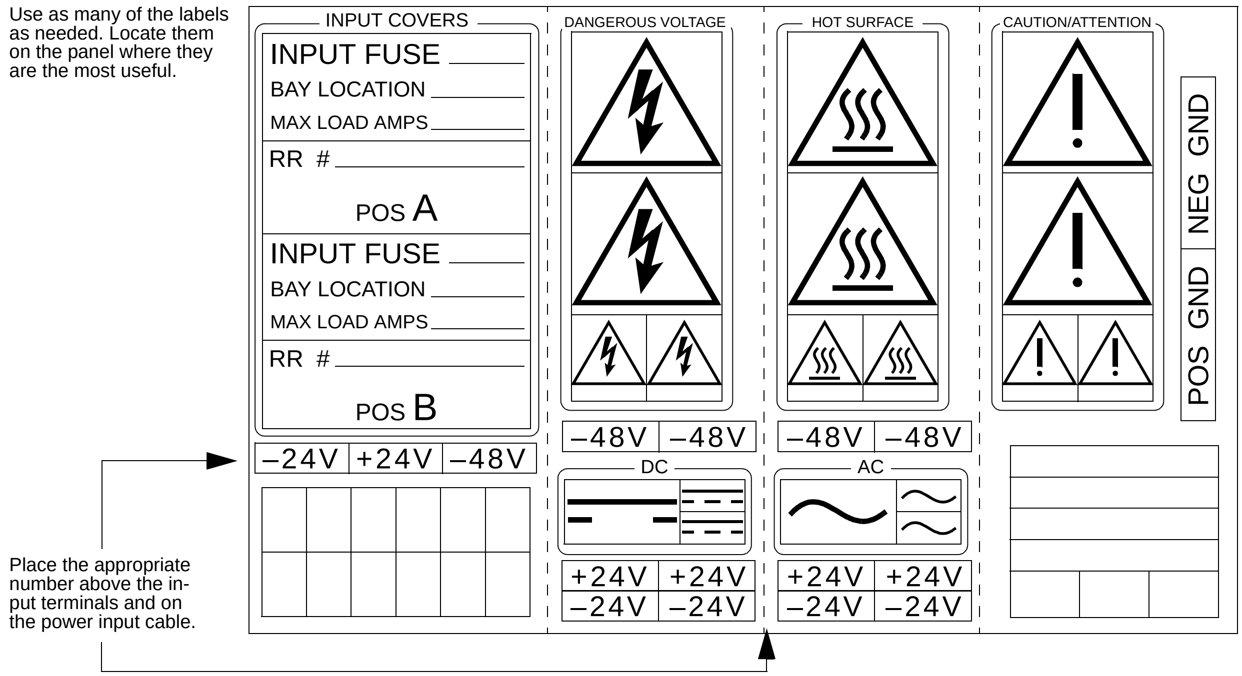

Figure 2 - Labels