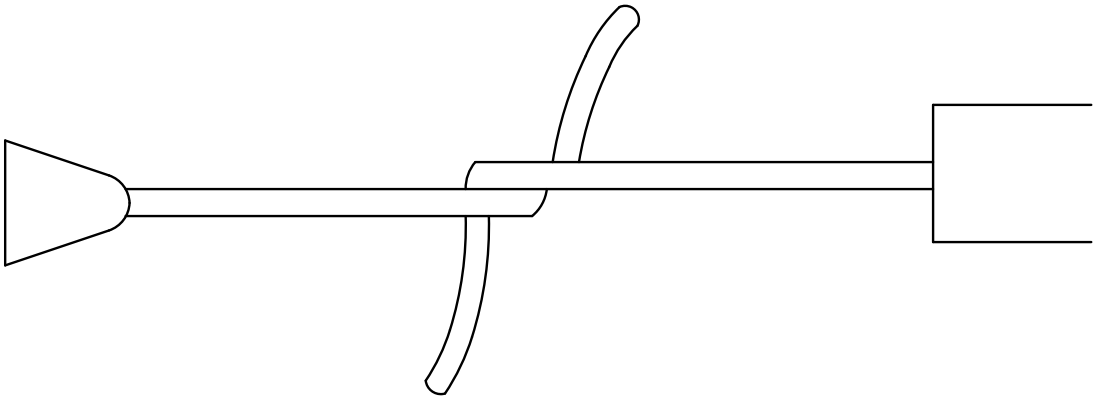
Figure 4.8

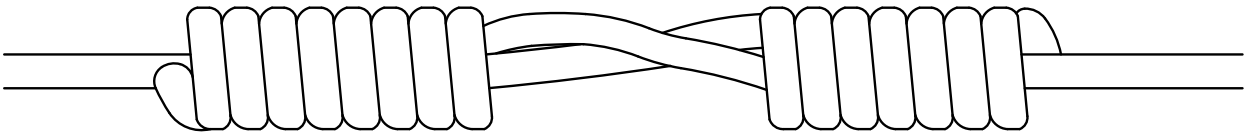
Over 1000 V GTO cable to electrode lead splice method

Twisted leads – option 2

Step 1



Step 2



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4.2.5.6.2.2 GTO-to-GTO connections shall be made using electrical devices that comply with the Standard for Electric Sign Components, UL 879.

4.2.5.6.3 Mechanical security and protection

4.2.5.6.3.1 GTO cable shall be protected by one of the following methods:

a) Mounted on insulators and run inside an enclosure or raceway;

b) Provided inside suitable conduit or tubing;

c) Provided with sleeving complying with the Standard for Electric Sign Components, UL 879; or

d) Identified as integrally sleeved GTO cable suitably rated for the voltage involved.

4.2.5.6.3.2 The insulation of a GTO cable shall extend beyond the end of an electrically conductive enclosure or raceway not less than the distance specified in Table 4.16.

Table 4.16
Minimum spacing from metal enclosure or raceway to end of GTO insulation (refer to 4.2.5.6.3.3)

Voltage rating of GTO	Minimum distance			
	Damp/wet location signs (e.g. skeleton neon tubing)		Dry location signs	
V	mm	(in)	mm	(in)
5,000	51	(2.00)	38	(1.50)
10,000	76	(3.00)	51	(2.00)
15,000	102	(4.00)	64	(2.50)

4.2.5.6.3.3 Not more than one GTO cable shall be routed in a single conduit or tubing. No other conductors, including grounding conductors are permitted to run in the same conduit or tubing with the GTO cable.

4.2.5.6.3.4 Where Flexible Metal Conduit is used to enclose GTO cable, it shall be at least trade size 1/2.

4.2.5.6.3.5 In raceways, other than conduit or tubing, where more than one GTO cable is routed, each cable shall be routed to comply with the minimum spacings in Table 4.16.

4.2.5.6.3.6 In conduit and tubing, the spacings between dead metal parts and insulated live parts greater than 1000 V specified in Table 4.16 do not apply.

4.2.5.6.3.7 A metal enclosure or metal raceway that is too small to comply with the required spacings of Table 4.16 and that houses one GTO cable connecting the neon supply and the first neon tube, shall not be longer than 6.10 m (20 ft).

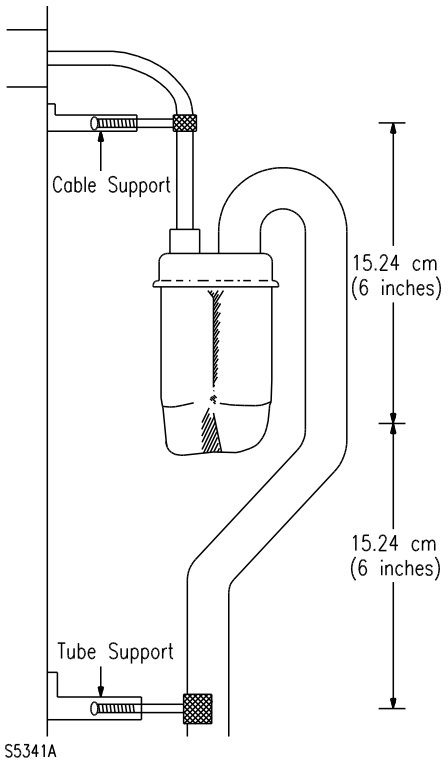
4.2.5.6.3.8 A metal raceway that complies with the required spacings of Table 4.16, and that houses the GTO cable connecting the neon supply and the first neon tube, does not have any length restriction.

4.2.5.6.3.9 A GTO cable support shall comply with the requirements of the Standard for Electric Sign Components, UL 879.

4.2.5.6.3.10 GTO cable supports and neon tube supports shall be located within 152 mm (6 in) of the neon tubing termination connections. See Figure 4.9. Where electrode receptacles are provided, neon tube supports shall be within 152 mm (6 in) from the point where the neon tubing exists the receptacle.

Figure 4.9

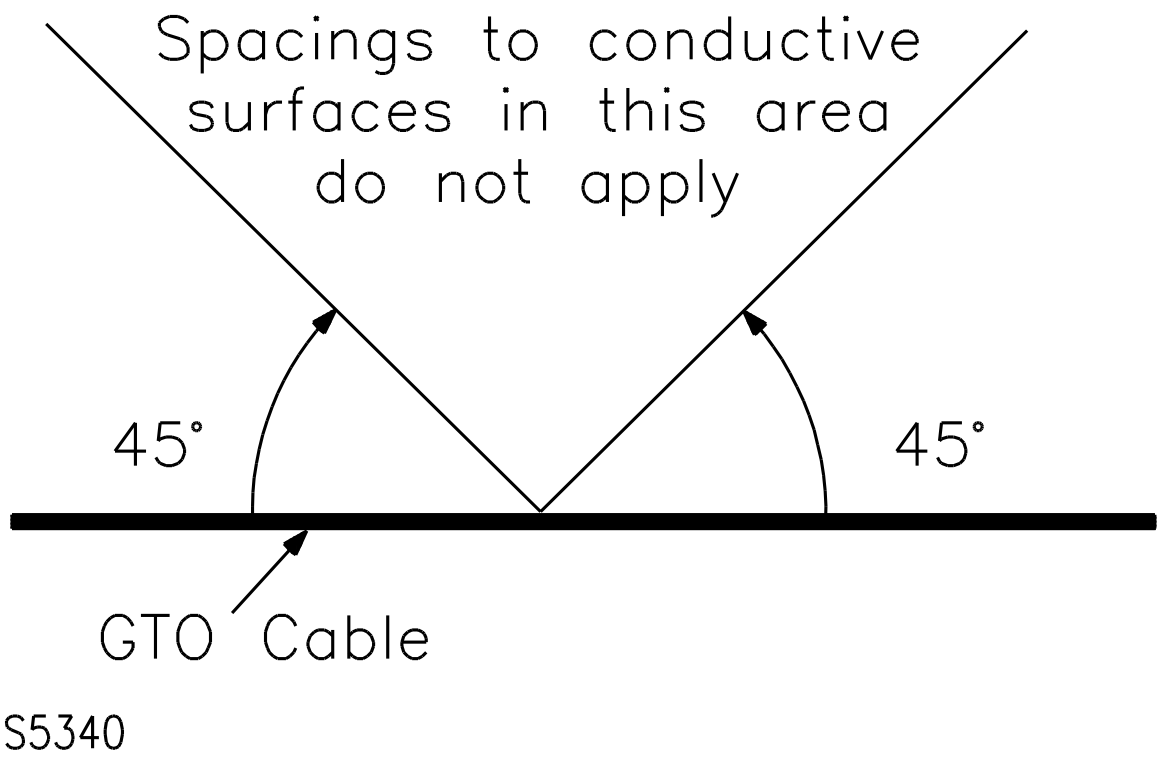
Cable and neon tube support



4.2.5.6.3.11 GTO cable supports and neon tube supports that support GTO cable shall be positioned so that spacings are maintained per 4.2.3.1. When a GTO cable is routed through or to a conductive surface, and the angle between the surface and the GTO is 45° – 90°, spacings to the surface do not apply. See Figure 4.10.

Figure 4.10

GTO cable positioning



4.2.6 Barriers and bushings

4.2.6.1 A barrier or bushing relied upon to comply with the Standard shall be mechanically secured in place. Adhesive shall not be used as the sole means to secure a barrier or bushing.

4.2.6.2 A barrier shall be rigid and self supporting.

4.2.6.3 Material that is not an integral part of a component and is within 0.8 mm (0.032 in) of uninsulated live parts shall be of non-absorptive, noncombustible material such as those indicated in Table 4.11, or another material that complies with the requirements of the Standard for Electric Sign Components, UL 879.

4.2.6.4 Ordinary vulcanized fiber may be used for insulating bushings, separators and barriers, but not as the sole support for uninsulated live parts.

4.2.6.5 A barrier or bushing spaced greater than 0.8 mm (0.032 in) from uninsulated live parts, and used in a circuit operating at 600 V or less, shall be one of those specified in Table 4.11 or Items 11 or 12 of Table 5.1. The material shall not exceed the temperature limit specified in Table 5.1 during Temperature Test.

4.2.6.6 A barrier or bushing is permitted to be in contact with insulated live parts and shall be one of those specified in Table 4.11 or Items 11 or 12 of Table 5.1. The material shall not exceed the temperature limit specified in Table 5.1 during the Temperature Test.

4.2.6.7 Electrically conductive barriers provided to limit accessibility to uninsulated live parts shall be spaced per 4.2.3.1.

4.2.6.8 Barriers also functioning as a water shield shall additionally comply with the requirements for use as such.

4.2.6.9 Polymeric barriers shall that function as an insulating barrier shall comply with the Standard for Electric Sign Components, UL 879.

4.2.6.10 Cable Bushings for use with GTO shall comply with the requirements of the Standard for Electric Sign Components, UL 879.

4.2.6.11 An insulating cap provided on an electrode receptacle shall be secured in place. Spacings are to be measured through the joint between the cap and the receptacle.

4.3 Devices and components

4.3.1 General

4.3.1.1 Signs that use devices and components specified in 4.3 shall comply with the applicable requirements in 4.3.

4.3.1.2 Electrical devices shall be securely mounted as specified in the manufacturer's instructions. When mounting options exist, a minimum of two mechanical means of attachment are required.

4.3.1.3 Devices that rotate during normal setting or operation shall be mounted to prevent rotation by means other than friction alone. A properly applied lock washer, keyed opening, or similar means is considered to comply with this requirement.

4.3.1.4 An electrical device or component shall not be mounted on a hinged, sliding, or removable door or cover is required for user-servicing operations such as the changing of advertising material or replacement of lamps or lamp starters.

4.3.1.5 An electrical device or component intended for mounting in a wet or damp location sign shall be mounted to provide a minimum 12.7 mm (1/2 in) spacing off the bottom of a sign unless:

a) The device or component is in a watertight enclosure, or

b) The device or component is marked for use in wet locations, or

c) The ballast, transformer, or neon supply is marked for wet location use, or

d) The device has been evaluated for use in a wet location, or

e) The sign is evaluated as watertight type enclosure.

4.3.1.6 For a vertically mounted circuit breaker, switch, or similar device with a marked on or off position, the up position shall be the on position.

4.3.1.7 No component shall use fiber or similar absorptive material.

4.3.1.8 Where exposed to the weather, a lampholder shall be rated as weatherproof.

4.3.1.9 Lampholders for use in damp or wet locations shall not employ an aluminum or aluminum alloy screw shell.

4.3.1.10 A porcelain or ceramic lampholder shall be glazed on all external surfaces.

4.3.1.11 If a general use snap switch is used for the sign disconnect, a switch boot that complies with the requirements of the Standard for Electric Sign Components, UL 879, shall be provided.

4.3.1.12 Ballasts used shall be marked Type 1 Outdoor, Type 2 Outdoor, Weatherproof, or WP.

4.3.1.13 Neon Supplies shall be marked "Outdoor", "Weatherproof", or "WP".

4.3.1.14 A lampholder used in a wet location sign that is not watertight shall employ insulation piercing or solder terminals. All exposed current-carrying parts of a soldered terminal shall be covered with an insulating compound (such as asphaltic paint or sealing compound), to reduce the risk of corrosion.

4.3.1.15 A neon tubing electrode enclosure system shall comply with the requirements of the Standard for Electric Sign Components, UL 879, for the intended use.

4.3.1.16 Electrical devices and components, including wiring, flexible cords and cables, shall not be painted or similarly coated with any material unless the components have been evaluated for use with the painting or coating used.

4.3.1.17 Flexible metal conduit may be painted if all of the following conditions are met:

a) The flexible metal conduit is inside the sign;

b) The flexible metal conduit is not relied upon for bonding or grounding; and

c) The flexible metal conduit is secured in place and not subject to movement or flexing during routine user servicing such as lamp replacement or replacement of advertising.

4.3.2 Overcurrent protective devices

4.3.2.1 A fuseholder shall comply with the requirements of the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1.

4.3.3 Switches and control devices

4.3.3.1 A switch, flasher, controller and the like, shall:

a) Have a current rating equal to or greater than total current of the load; and

b) When used for an inductive load, such as a ballast or transformer, be marked "L" or "AC General Use" for an AC circuit, or "T" for a DC circuit; and

c) When used for an incandescent lamp or tungsten load, be marked "L" or "AC General Use" for an AC circuit, or "T" for a DC circuit; or

d) Have a current rating exceeding the total current of the load multiplied times the factor in Table 4.17.

Table 4.17
Switch derating factors

Switching load	Switch type				
	AC general use ac only	"L" rated ac only	"T" rated ac/dc	AC ampere rated only	AC/DC ampere rated
Transformer and ballast	1	1	1	2	2
Tungsten filament	1	1	1	3	3
Receptacle	1	1	1	3	3

1) An ac general use switch is typically a wall type switch normally used in a building and mounted to outlet boxes. An ac general use switch is also of the through cord type used on power supply cord connected products.

A switch, other than the ac general use type, that has been investigated for the control of inductive loads is marked with the letter "L" in conjunction with the current rating at which the inductive rating applies; for example, "1 A, 125 V, L".

A switch that has been investigated for the control of tungsten loads, is marked with the letter "T" in conjunction with the dc current rating at which the tungsten rating applies. A tungsten load is primarily an incandescent light source.

Switches with an ac, ac and dc or dc current rating with no "L", "T" or "AC General Use " marking are typically special use switches intended for resistive loads.

4.3.3.2 A control device, other than an AC general-use snap switch, that controls a motor with a horsepower rating shall have a horsepower rating not less than that of the motor to be controlled.

4.3.3.3 An AC general-use snap switch (not an AC-DC general-use snap switch) may be used to control a motor load of two horsepower or less and shall be rated not less than 125% of the marked motor full load ampacity (FLA) at its rated voltage.

4.3.3.4 A single-pole device shall be connected in the ungrounded (line) conductor, or both the ungrounded and grounded (neutral) conductors if it simultaneously opens both conductors.

4.3.4 Disconnect switch

4.3.4.1 Unless marked in accordance with 7.1.7, a switch provided with the sign that is actuated external to the sign will be considered the sign disconnect switch and shall comply with 4.3.4.2 to 4.3.4.4 in accordance with the National Electrical Code, NFPA 70.

4.3.4.2 A disconnect switch shall have a marked "Off" position and shall disconnect the supply source by causing an air gap between opposing contacts in a circuit. When the switch is operated vertically rather than horizontally, the down position shall be the off position. The live terminal of the disconnect switch should be insulated or enclosed to prevent contact by service personnel.

4.3.4.3 If the disconnect is out of the line of sight from any section of the sign that is energized, the disconnect shall be capable of being locked in the off (open) position.

4.3.4.4 If the sign is operated by a controller, such as a time clock, external to the sign, the disconnect shall be located within sight of the controller or in the same enclosure as the controller, shall disconnect the sign and the controller at the same time, and shall be capable of being locked in the off (open) position.

4.3.5 Receptacles

4.3.5.0 General

4.3.5.0.1 A receptacle provided in or on a sign shall be in accordance with 4.3.5.1, 4.3.5.2 or 4.3.5.3.

4.3.5.0.2 A receptacle with or without a USB slot shall comply with the requirements in the Standard for Attachment Plugs and Receptacles, UL 498. An independent Class 2 output low-voltage connector (i.e. USB) slot shall comply with the requirements in the Standard for Class 2 Power Units, UL 1310.

4.3.5.1 Dedicated Receptacles

4.3.5.1.1 A sign is capable of being provided with receptacles that are dedicated for the connection of a specific product on or within the sign enclosure. The product that is intended for connection to the dedicated receptacle shall comply with the appropriate requirements for its product class.

4.3.5.1.2 A sign circuit supplying a dedicated receptacle shall have the circuit protected by supplementary overcurrent protection, such as a fuse, circuit breaker, or similar device, having a current rating not exceeding the applicable value specified in Table 4.18.

Table 4.18
Supplementary overcurrent protective device current rating

Maximum supplementary overcurrent protective device rating	Minimum cord conductor size rating		Minimum internal conductor size	
A	AWG	(mm^2)	AWG	(mm^2)
10	18	(0.82)	18[a]	(0.82)
13	16	(1.3)	18[a]	(0.82)
15	14	(2.1)	14	(2.1)
18	14	(2.1)	12	(3.3)
20	12	(3.3)	12	(3.3)

[a] Rated 90°C or 6 A maximum.

4.3.5.1.3 A marking identifying the product to be used with the dedicated receptacle shall be provided adjacent to each dedicated receptacle per 7.2.10.

4.3.5.2 Convenience Receptacles

4.3.5.2.1 A permanently connected sign is capable of being provided with one or more convenience receptacles.

4.3.5.2.2 Convenience receptacles are intended to supply independent products such as service and repair equipment only.

4.3.5.2.3 A maximum of 1 duplex convenience receptacle may be provided every 3.66 m (12 ft).

4.3.5.2.4 A convenience receptacle shall:

a) For a dry location sign, be a 3-wire grounding-type receptacle, rated 15 or 20 A only, 125 V and compatible with (c) below;

b) For a damp/wet location sign, be a 2-pole, 3-wire grounding-type Class A ground-fault circuit interrupter receptacle, rated 15 or 20 A only, 125 V with a weatherproof cover plate and compatible with (c) below;

c) Provided with means for connection in the field to a 15 or 20 A maximum, 125 V branch circuit with no conductors common with other sign circuits;

d) Be mounted on, or inside, the sign within a rated enclosure;

e) Be mounted such that uninsulated live parts are inaccessible during sign servicing; and

f) Be marked in accordance with 7.2.11 in a location immediately adjacent to the receptacle.

4.3.5.2.5 The circuit conductors for a convenience receptacle shall be sized in accordance with the ampere rating (15 or 20 A) of the receptacle and Table 4.18.

4.3.5.3 Auxiliary Receptacles

4.3.5.3.1 Receptacles embedded in a sign to provide a supplementary or stand-alone function such as charging stations shall be accessible external to the sign enclosure.

4.3.5.3.2 Receptacles that derive power from within the sign electrical enclosure shall comply with:

a) The supplementary circuit protection requirements in 4.3.5.1.2, and

b) The marking requirement of 7.2.19.

4.3.5.3.3 Receptacles that are powered separate from all sign circuits and that are installed in a separate electrical enclosure attached to the sign shall comply with:

a) The requirements in 4.3.5.2.4 sub-clauses a through e, and 4.3.5.2.5, and

b) The marking requirements of 7.2.19 and 7.2.20.

4.3.6 Sign rotors/animators

4.3.6.1 Sign rotators and animators shall comply with the Standard for Electric Sign Components, UL 879.

4.3.7 Motor operated clocks

4.3.7.1 The motor of a motor operated clock shall comply with the requirements of either:

a) The Standard for Time-Indicating and -Recording Appliances, UL 863, or

b) The Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, plus the applicable requirements from the Standard for Impedance Protected Motors, UL 1004-2, the Standard for Thermally Protected Motors, UL 1004-3, and the Standard for Electronically Protected Motors, UL 1004-7.

4.3.7.2 Clock mechanisms shall comply with the requirements in this Standard, and may additionally comply with the Standard for Electric Sign Components, UL 879.

4.3.8 Ballasts, transformers and power supplies

4.3.8.1 A transformer, ballast, or power supply shall be mounted on sheet steel that is minimum 0.66-mm (0.026-in) thick in compliance with Table 4.2, or aluminum, brass, or copper that is minimum 0.76-mm (0.030-in) thick in compliance with Table 4.3.

4.3.8.2 The mounting surface shall not deform under the weight of the device.

4.3.8.3 A ballast, transformer or power supply shall be installed so that it is accessible, unless constructed in accordance with 5.3, when the sign is intended for use in dwellings.

4.3.8.4 A ballast, transformer, or power supply shall be installed so that the secondary connections are as short as possible. This shall be indicated in the installation instructions if they are to be mounted remotely.

4.3.9 Fans

4.3.9.1 Fans shall comply with the requirements of the Standard for Electric Fans, UL 507.

4.3.10 Heaters, air conditioners and controllers

4.3.10.1 Heaters shall comply with the requirements of the Standard for Electric Heating Appliances, UL 499.

4.3.10.2 Thermostats shall comply with the requirements of the Standard for Temperature-Indicating and -Regulating Equipment, UL 873 or the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1.

4.3.10.3 Air Conditioners shall comply with the requirements of the Standard for Heating and Cooling Equipment, UL 1995 or the Standard for Room Air Conditioners, UL 484.

4.3.11 Changing message controllers

4.3.11.1 Changing message sign controllers shall comply with the requirements of the Standard for Electric Sign Components, UL 879.

4.3.12 GFCI

4.3.12.1 Portable, Mobile, and Stationary signs intended for damp or wet locations shall be provided with factory installed a GFCI. The GFCI shall be an integral part of the attachment plug or shall be located in the cord assembly within 30.5 cm (12 in) of the attachment plug.

4.3.12.2 A sign required to have a GFCI shall be provided with a Class A GFCI that complies with the Standard for Ground-Fault Circuit-Interrupters, UL 943.

4.3.13 Incandescent components

4.3.13.1 Lampholders

4.3.13.1.1 Lampholders shall comply with the Standard for Lampholders, UL 496.

4.3.13.1.2 Lampholders for use in other than a dry location sign application shall be marked for use in the intended environmental application. For example a lampholder for use inside an enclosed outdoor or wet location sign shall be marked for use in a damp location or for use in damp and/or wet location. Lampholders exposed directly to an outdoor or wet location environment shall be marked for use in a wet location.