Introduction

Tips on Taking Tests

It is the author's experience that, for most electricians, knowing how to take a test is almost as important as knowing the technical information, as far as obtaining a passing grade is concerned. A great number of electricians fear tests more than they fear 480 volts.

Really, there is no good reason why this should be so. After all, if hundreds of thousands of men and women can pass these tests, anyone interested who gives a real effort and pays particular attention to some basic rules can succeed. Some basic rules for taking tests are these:

1. Know the material being covered.
2. Know the format of the test.
3. Be physically and mentally prepared on the exam day.
4. RELAX!
5. Work the test the smartest way you can.

The first point—knowing the material being covered—is a mandatory prerequisite. Most test failures come from violating this rule. No, it isn't always easy to learn all the material on a test. It requires hours, sometimes many hours, of studying when you'd rather be doing other things. It means that you have to make your brain work harder than it wants to, going over the material again and again. Sorry, but unless you have an exceptional aptitude for learning, there are no shortcuts for hard, intense study. A good study guide (like this book) is about as much help as you can get.

The second rule for taking tests is that you need to *know the format of the test*. Some of the things you need to know are:

How many questions are on the test?
How many questions are open-book?
How many are closed-book?
Do all questions count for the same number of points?
Is there a penalty for wrong answers?
How much time is allowed for each section of the test?
Who wrote the test?
How will the test be graded?

By knowing the answers to these questions, you can plan your efforts intelligently. For example, if certain questions will count for more points than others, you should be ready to spend more time and effort on those questions. By knowing the time limits, you can calculate how much time you have for each question, etc. Get answers to all of these questions and consider all of these facts as you prepare for the exam.

Now, as for *being physically and mentally prepared*, I think most readers are familiar with the way athletes prepare for an event. They make sure they eat the right kinds of food so that they have enough energy. They get plenty of sleep, and they come to the event planning on winning. The same thing should be done in preparation for a test.

The most important factor is what was mentioned above—planning on winning. Psychologists have found that the results one achieves are directly related to what one expects to receive. If you believe that you will do well, you are quite likely to do well; if you believe that you will do poorly, you probably will. Remember, it does not matter what you wish for; what matters is what you actually expect to happen. I'll pass on to you one of my favorite quotes along these lines. It comes from Robert J. Ringer: "The results you produce in life are inversely proportional to the degree to which you are intimidated."

If you want to improve your confidence (expectations) in your test-taking abilities, picture yourself as having aced the test. Refuse to imagine yourself failing, and spend as much time studying as is necessary for you to believe in yourself.

On the day of a test, you want to walk in well rested (but not still groggy), having been well fed (but not full), and with a subdued confidence. Generally, heavy studying the night before the test is not a good idea. Do a light review and leisurely go over a difficult part of the information if you like, but the night before is not the time to get intense. You should have been intense two weeks ago. The night before the test is a time to eat well and to go to bed early. Try not to eat within two or three hours of the test, as it tends to bog you down. It has been said that mental efficiency is highest on an empty stomach.

Confidence is built on a good knowledge of the material to be covered and the ability to pass with style.

Upon entering the test location, *relaxing* is very important. If you choke up during the test, you are automatically taking five points off your score, possibly more. You should have the same attitude as the

runner who shows up for a race he knows he will win. He is ready to run his fastest, but he is not nervous because he knows that his fastest is good enough.

Before taking the test, clear your mind, don't get involved with trivial conversations, and then, when it is time to answer the questions, dig into the test with your full strength.

During the test, first answer all of the easy questions; pass up the hard questions for now, and *do only the ones you know for sure*. Then, once you have answered these questions, don't go over them again; just move on to the next group of questions. Next, do the questions that will require some work, but don't do the most difficult questions; save them for last. It is silly to waste half of your time on one difficult question. Do the 47 easier questions, and then come back to the three especially difficult ones.

Work the test in the smartest possible way. Pay attention to time requirements, books allowed during open-book tests, etc. For your electrical exam, you should definitely put tabs on your Code book. Bring an electronic calculator with you and some scratch paper (as long as you are allowed to). Rather than buying a set of Code book tabs, I recommend that you do your own. Tab the index and the sections of the Code that you most commonly use. I generally put tabs on the following:

Tables 250.66 & 250.122 (Sizes of ground wires)
Table 310.16 (Wire ampacities)
Appendix C (Conduit fill tables)
Article 230 (Services)
Table 300.5 (Burial depths)
Table 370.6 (Number of wires in boxes)
Article 430 (Motors)
Article 450 (Transformers)
Article 490 (Over 600 volts)
Article 500 (Hazardous location wiring)
Article 700 (Emergency systems)

Remember

If hundreds of thousands of other people have passed these tests, you can too—if you prepare.

Business Competency Examinations

In recent years, many municipalities have added business competency examinations to their standard Master Electrician examinations. In reality, they didn't have much choice. Since 1980, the number of licensed electrical contractors has skyrocketed, causing a great number of problems. Most of these problems were the result not of a lack of technical knowledge but of bad business practices. After some study, the various State Departments of Professional Regulation found out that while the newly licensed electrical contractors were proficient at trade skills they were woefully inadequate in business skills.

In an effort to ensure that newly licensed contractors are knowledgeable in business, new sections have been added to many competency examinations. Typically, 25 percent of a Master Electrician exam is dedicated to business skills and knowledge. The following are the topics usually covered:

1. Taxes
2. Unemployment and worker's compensation
3. OSHA and safety
4. Lien laws
5. Business skills

To help familiarize you with the various requirements and reference sources, each of these topics will be briefly discussed and then followed with questions and answers.

The *Taxes* section of such tests covers withholding of employee taxes. The information needed to answer these questions can be found in various IRS publications. (The easiest way to obtain these publications is to download them from the IRS's web site—http://www.irs.ustreas.gov/businesses/index.html.) Knowing the proper rules for withholding federal income tax, social security, federal unemployment, and state taxes is critical, not only for your test but also in order to operate a business. Let me state this clearly: The IRS is neither understanding nor compassionate, and it won't cut you even a little bit of slack for an ignorant infraction of its rules. The business of the IRS is to collect as much of your money as it is entitled to. Learn the rules for the test, and if and when you open a business, engage the services of a good accountant.

Unemployment compensation is paid directly to the state by the employer. It is not deducted from the employee's wages. Rates vary, and there are a number of requirements for anyone receiving this

compensation. All of the required information can be found in a booklet called "Unemployment Compensation Handbook," which is available through various sources, including your public library.

Worker's compensation is handled on the state level, and the requirements vary from state to state; because of this, you will have to get local requirements from your state government. The people who administer your local test should be able to guide you to the right place.

OSHA (Occupational Safety and Health Administration) establishes rules to ensure that no employee is subjected to dangers to his or her safety or health. The OSHA regulations can be found in "OSHA Standard 2207, Part 1926." There are too many regulations to memorize, but one must be familiar enough with the book to be able to find the answer to any question easily.

Each state has its own *lien laws*. Copies of the regulations must be obtained through your own state government, although the testing agency administering your test can probably tell you exactly how to get them. Liens are very important in the construction business and have been developed primarily for the benefit of the contractor.

The *business skills* part of the test deals mostly with banks, financing, and basic management skills. As a reference source for the exam, "Tax Guide for Small Business" is recommended. This book, published by the IRS Division of the Treasury Department, is available from your local office of the Small Business Administration (SBA). There are many, many other business books available (and I would hope that anyone going into business would read several), but this handbook addresses the material in the test more directly.

You should remember, however, that the business skills covered by these tests are not enough to ensure success in business. In addition to these skills, you will need skill in dealing with people, the ability to analyze a market, and the ability to make and follow through on decisions. This test covers only academic business skills; to actually make money, you will need other skills also.

I-1 If a certain employee spends less than half of his time during a pay period performing services that are subject to taxation, how much of his or her pay is taxable?

All employees are taxable.

I-2 If an employer fails to make federal income tax deposits when they are due, how large a penalty will they be assessed?

10 percent.

I-3 A self-employed person is considered an employee. True or false?

False.

I-4 What form must be used to correct errors in withholding taxes?

941C.

I-5 What would be the take-home pay of a worker who claims one deduction, is married, and who earns $500.00 per week (without state or local taxes)?

500.00	
(56.00)	Federal Income Tax Withholding
(31.00)	Social Security
(7.25)	Medicare
$405.75	

I-6 For unemployment taxation, the term "employer" includes any person or organization that paid _____ or more in wages in any quarter or had employees at any time in 20 weeks of the year.

$1,500.00.

I-7 If an employee is paid $325.00 per week, how much Social Security and Medicare tax should be deducted from his or her wages?

$325.00 \times 7.65\% = \$24.86$.

I-8 What form is used to get an Employer Identification Number?

SS-4.

I-9 What form must a new employee sign before beginning work?

W-4.

I-10 If an employer has _____ or more employees in 20 or more weeks, the employer must file a Form 940 Federal Unemployment Act.

1.

I-11 On what portion of his or her wages must an employee contribute for state unemployment compensation?

The first $9,000.00 of wages.

I-12 Casual labor is labor that is occasional, incidental, and not exceeding ___ working days in duration.
10.

I-13 Does a temporary light fixture with a reflector that deeply recesses its bulb require a guard?
No.

I-14 How long may double cleat ladders be?
15 feet.

I-15 What is the angle of repose for average soil?
45 degrees.

I-16 How many gallons of flammable liquid can be stored in a room outside of an approved storage cabinet?
25.

I-17 When an interior-hung scaffold is suspended from the beams of a ceiling, what percentage of the rated load must the suspending wire be capable of supporting?
600 percent (six times the rated load).

I-18 What is the proper maintenance procedure for an "ABC" dry-chemical stored-pressure fire extinguisher?
Check the pressure gauge and the condition of the chemical annually.

I-19 Workers should not be exposed to impulsive or impact noises louder than _____ decibels.
140.

I-20 What is the standard height for a guardrail?
42 inches.

I-21 What is the minimum size (OSHA requirement) of a conductor to a ground rod?
#2 AWG copper.

I-22 For a scaffold with a working load of 75 pounds per square feet, what is the maximum span for a 2″ × 12″ plank?
7 feet.

I-23 Loaded powder-activated tools may not be left _____.
Unattended.

I-24 What should be the predominant color of caution signs?
Yellow.

I-25 For 225 employees on a construction site, how many toilets must be provided?
Five toilet seats and five urinals.

I-26 When safety belts are used, the maximum distance of fall must be _____.
6 feet.

I-27 What is the minimum lighting level in a field construction office?
30 foot-candles.

I-28 Manually handled lumber cannot be stacked higher than _____.
16 feet.

I-29 What is the term for the claims of a creditor against the assets of a business?
Liabilities.

I-30 Small Business Administration loans can be guaranteed up to _____.
90 percent.

I-31 Would taxes be considered a liability?
Yes.

I-32 The assets of a business, minus its liabilities, are called its _____.
Equity.

I-33 Accounts receivable financing is normally based on receivables that are how old?
70 to 90 days.

I-34 If your company has gross sales of $210,000.00 and expenses of $198,500.00, what percentage of profit did it make?
5.5 percent.

I-35 An agreement by which you get exclusive use of a certain item for a stated period of time is called a _____.
Lease.

I-36 What is the minimum rate of return sought by most venture capitalists?

It is currently around 10 percent (or higher), but this figure can be modified by changes in interest rates, inflation, etc.

I-37 A one-year line of credit refers to a note that is renewable for one year at ___-day intervals.

90.

I-38 What is the term for a plan of cash receipts and expenditures for a certain period of time?

A cash budget.

I-39 What is the term for the money required to carry accounts receivable, cover payrolls, and buy products?

Working capital.

I-40 Is an 18-year-old boy, employed by his parents, exempt from Social Security tax?

Yes.

I-41 Is a wife, employed by her husband, subject to Social Security tax?

No.

I-42 What are the two primary account methods?

Cash accounting and accrual.

I-43 Are all types of business activities voluntary?

No, the payment of taxes is enforced. Almost every other type of business activity is voluntary between the parties involved.

I-44 What type of law covers the awarding of damages for accidental injuries and the like?

Torts.

I-45 Define "overhead."

"Overhead" is the money necessary to keep a company operating, even if there is no one working in the field. It includes everything except material, labor, and job expenses. Office expenses, office salaries, sales expenses, office equipment, vehicles, and similar expenses are considered to be overhead.

I-46 What does the term "Net 30" indicate?

"Net 30" indicates a payment procedure. In general, it means that if one party to a transaction presents a valid invoice, it will be paid by the other party within 30 days.

I-47 What is "cash flow," and why is it important?

"Cash flow" is a general term describing the flow of cash within a company. It is important because electrical construction work is almost always done on credit, sometimes leaving the contractor in a situation in which he or she is making a lot of money but hasn't collected it yet and therefore has no cash with which to pay bills. Insufficient cash has been the ruin of many construction firms.

I-48 What are the functions of profit in a company?

There are two. The first is to offset risks. Without some extra money in a contract, even a small difficulty would cause the project to go over budget. The second is to give the owners of the company a return on their investment. If the owners did not get a return on their money, they would have no reason to put it to use in the company.

I-49 What are job expenses?

Expenses—such as storage trailer rental, tool rentals, and job telephones—that are caused by the project and not by continuing operations.

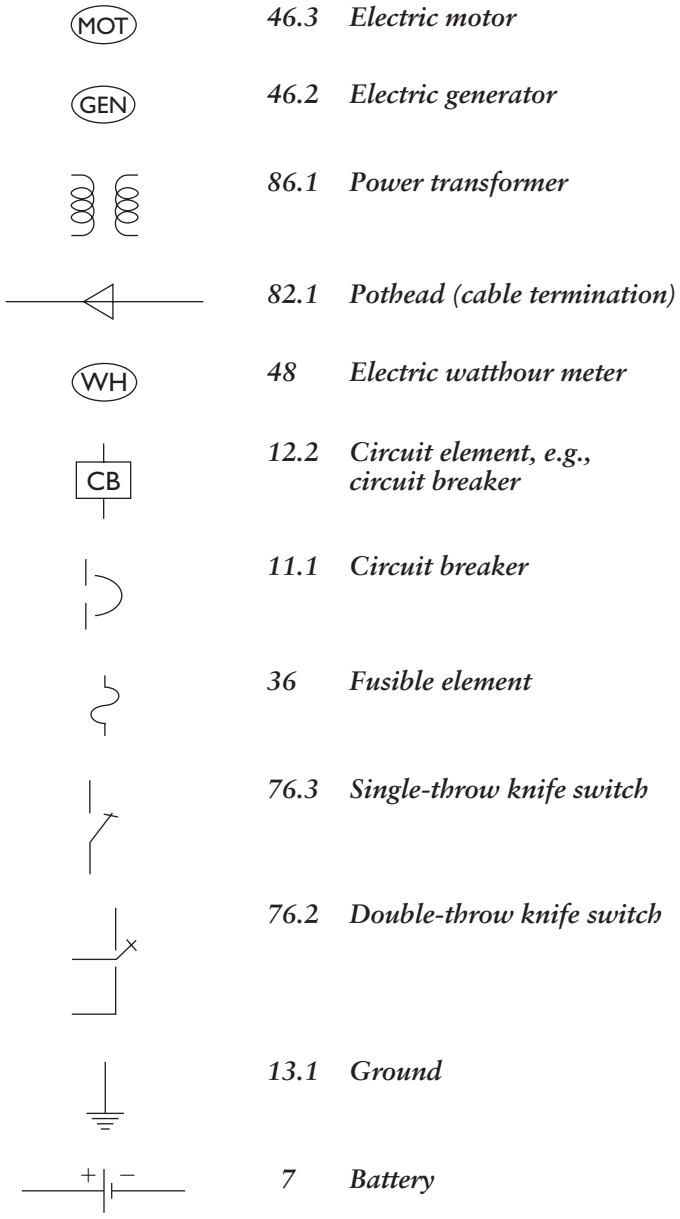
I-50 How does OSHA make sure that their rules are followed?

By imposing fines on companies that are judged to be in violation.

Electrical Symbols

To avoid confusion, ASA policy requires that the same symbol not be included in more than one Standard. If the same symbol were used in two or more Standards and one of these Standards were revised, changing the meaning of the symbol, considerable confusion could arise over which symbol was correct, the revised or unrevised.

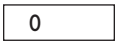
The symbols in this category include, but are not limited to, those listed below. The reference numbers are the American Standard Y32.2 item numbers.



Electrical Symbols.

List of Symbols

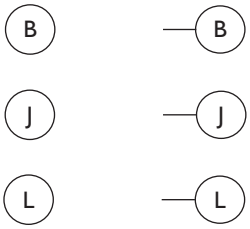
1.0 Lighting Outlets

Ceiling	Wall		
		*1.1*	*Surface or pendant incandescent, mercury vapor, or similar lamp fixture*
		*1.2*	*Recessed incandescent, mercury vapor, or similar lamp fixture*
		*1.3*	*Surface or pendant individual fluorescent fixture*
		*1.4*	*Recessed individual fluorescent fixture*
		*1.5*	*Surface or pendant continuous-row fluorescent fixture*
		*1.6*	*Recessed continuous-row fluorescent fixture**
		1.7	*Bare-lamp fluorescent strip***
		*1.8*	*Surface or pendant exit light*
		*1.9*	*Recessed exit light*

(*continued*)

*In the case of combination continuous-row fluorescent and incandescent spotlights, use combinations of the above Standard symbols.

**In the case of a continuous-row bare-lamp fluorescent strip above an area-wide diffusion means, show each fixture run, using the Standard symbol; indicate area of diffusing means and type of light shading and/or drawing notation.



1.10 Blanked outlet

1.11 Junction box

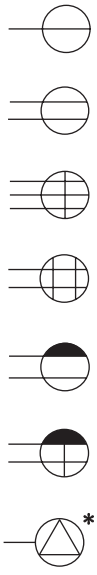
1.12 Outlet controlled by low-voltage switching when relay is installed in outlet box

Lighting Outlets.

2.0 Receptacle Outlets

Unless noted to the contrary, it should be assumed that every receptacle will be grounded and will have a separate grounding contact.

Use the uppercase subscript letters described under Section 2 item a-2 of this Standard when weatherproof, explosion-proof, or some other specific type of device will be required.



2.1 Single receptacle outlet

2.2 Duplex receptacle outlet

2.3 Triplex receptacle outlet

2.4 Quadruplex receptacle outlet

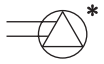
2.5 Duplex receptacle outlet—split wired

2.6 Triplex receptacle outlet—split wired

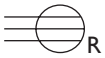
*2.7 Single special-purpose receptacle outlet**

(*continued*)

*Use numeral or letter, either within the symbol or as a subscript alongside the symbol keyed to explanation in the drawing list of symbols, to indicate type of receptacle or usage.

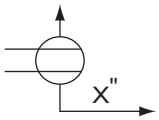


*2.8 Duplex special-purpose receptacle outlet**



2.9 Range outlet

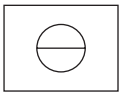
2.10 Special-purpose connection or provision for connection. Use subscript letters to indicate function (DW—dishwasher; CD—clothes dryer, etc.)



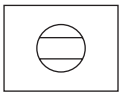
2.11 Multioutlet assembly. Extend arrows to limit of installation. Use appropriate symbol to indicate type of outlet. Also indicate spacing of outlets as x inches.

2.12 Clock Hanger Receptacle

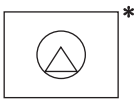
2.13 Fan Hanger Receptacle



2.14 Floor Single Receptacle Outlet



2.15 Floor Duplex Receptacle Outlet

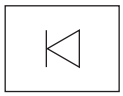


*2.16 Floor Special-Purpose Outlet**

(*continued*)

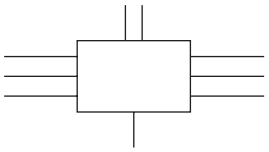
*Use numeral or letter, either within the symbol or as a subscript alongside the symbol keyed to explanation in the drawing list of symbols, to indicate type of receptacle or usage.

2.17 Floor Telephone Outlet—Public

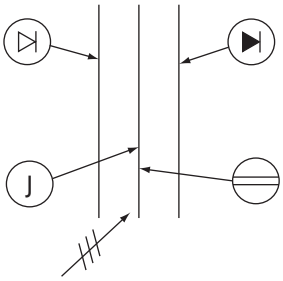


2.18 Floor Telephone Outlet—Private

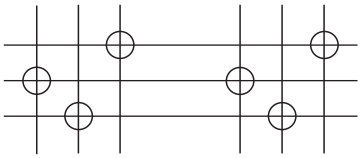
Not a part of the Standard: example of the use of several floor outlet symbols to identify a 2-, 3-, or more-gang floor outlet



2.19 Underfloor Duct and Junction Box for Triple, Double or Single Duct System as indicated by the number of parallel lines



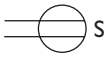
Not a part of the Standard: example of use of various symbols to identify location of different types of outlets or connections for underfloor duct or cellular floor systems



2.20 Cellular Floor Header Duct

Receptacle Outlets.

3.0 Switch Outlets

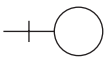
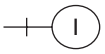
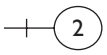
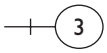
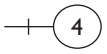
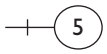
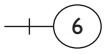
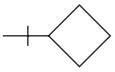
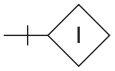
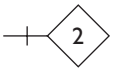
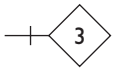
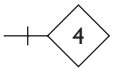
S	*3.1*	*Single-pole switch*
S_2	*3.2*	*Double-pole switch*
S_3	*3.3*	*Three-way switch*
S_4	*3.4*	*Four-way switch*
S_K	*3.5*	*Key-operated switch*
S_P	*3.6*	*Switch and pilot lamp*
S_L	*3.7*	*Switch for low-voltage switching system*
S_{LM}	*3.8*	*Master switch for low-voltage switching system*
	*3.9*	*Switch and single receptacle*
	*3.10*	*Switch and double receptacle*
S_D	*3.11*	*Door switch*
S_T	*3.12*	*Time switch*
S_{CB}	*3.13*	*Circuit-breaker switch*
S_{MC}	*3.14*	*Momentary contact switch or pushbutton for other than signaling system*

Switch Outlets.

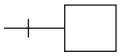
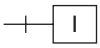
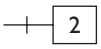
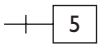
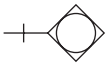
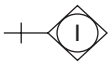
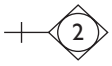
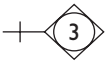
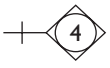
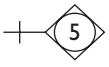
Signaling System Outlets

4.0 Institutional, Commercial, and Industrial Occupancies

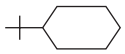
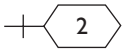
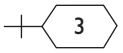
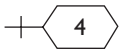
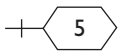
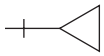
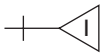
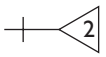
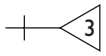
These symbols are recommended by the American Standards Association but are not used universally. The reader should remember not to assume that these symbols will be used on any certain plan and should always check the symbol list on the plans to verify whether these symbols are actually used.

Basic Symbol	Examples of Individual Item Identification (Not a part of the Standard)	
		**4.1 I. Nurse Call System Devices (and type)**
		*Nurses' Annunciator (can add a number after it as* **24** *to indicate number of lamps)*
		*Call station, single cord, pilot light*
		*Call station, double cord, microphone speaker*
		*Corridor dome light, 1 lamp*
		*Transformer*
		*Any other item on same system—use numbers as required.*
		**4.2 II. Paging System Devices (any type)**
		*Keyboard*
		*Flush annunciator*
		*2-face annunciator*
		*Any other item on same system—use numbers as required.*

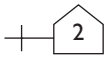
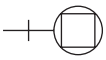
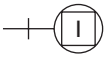
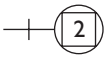
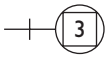
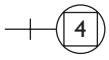
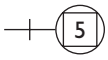
(*continued*)

Basic Symbol	Examples of Individual Item Identification (Not a part of the Standard)	
		**4.3 III. Fire Alarm System Devices (any type) including Smoke and Sprinkler Alarm Devices**
		***Control panel***
		***Station***
		***10″ Gong***
		***Pre-signal chime***
		***Any other item on same system—use numbers as required.***
		**4.4 IV. Staff Register System Devices (any type)**
		***Phone operators' register***
		***Entrance register—flush***
		***Staff room register***
		***Transformer***
		***Any other item on same system—use numbers as required.***

(*continued*)

Basic Symbol	Examples of Individual Item Identification (Not a part of the Standard)	
		**4.5 V. Electric Clock System Devices (any type)**
		*Master clock*
		*12" Secondary—flush*
		*12" Double dial—wall-mounted*
		*18" Skeleton dial*
		*Any other item on same system—use numbers as required.*
		**4.6 VI. Public Telephone System Devices**
		*Switchboard*
		*Desk phone*
		*Any other item on same system—use numbers as required.*
		**4.7 VII. Private Telephone System Devices (any type)**
		*Switchboard*
		*Wall phone*
		*Any other item on same system—use numbers as required.*

(*continued*)

Basic Symbol	Examples of Individual Item Identification (Not a part of the Standard)	
		**4.8 VIII. Watchman System Devices (any type)**
		*Central station*
		*Key station*
		*Any other item on same system—use numbers as required.*
		**4.9 IX. Sound System**
		*Amplifier*
		*Microphone*
		*Interior speaker*
		*Exterior speaker*
		*Any other item on same system—use numbers as required.*
		**4.10 X. Other Signal System Devices**
		*Buzzer*
		*Bell*
		*Pushbutton*
		*Annunciator*
		*Any other item on same system—use numbers as required.*

Signaling System Outlets

5.0 Residential Occupancies

When a descriptive symbol list is not employed, use the following signaling system symbols to identify standardized, residential-type, signal-system items on residential drawings. Use the basic symbols with a descriptive symbol list when other signal-system items are to be identified.

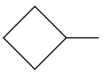
5.1 Pushbutton

5.2 Buzzer

5.3 Bell

5.4 Combination bell-buzzer

5.5 Chime



5.6 Annunciator

5.7 Electric door opener

5.8 Maid's signal plug

5.9 Interconnection box

5.10 Bell-ringing transformer

5.11 Outside telephone

5.12 Interconnecting telephone

5.13 Radio outlet

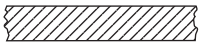
5.14 Television outlet

Residential Occupancies.

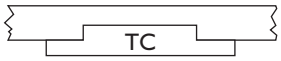
6.0 Panelboards, Switchboards, and Related Equipment

*6.1 Flush-mounted panelboard and cabinet**

*6.2 Surface-mounted panelboard and cabinet**



6.3 Switchboard, power control center, unit substations—should be drawn to scale*



6.4 Flush-mounted terminal cabinet. In small-scale drawings the TC may be indicated alongside the symbol.*

6.5 Surface-mounted terminal cabinet. In small-scale drawings the TC may be indicated alongside the symbol.*

6.6 Pull box (identify in relation to wiring section and sizes)

*6.7 Motor or other power controller**

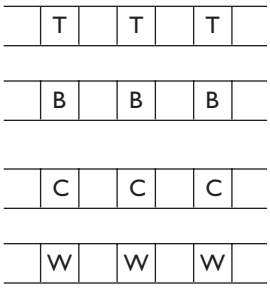
*6.8 Externally-operated disconnection switch**

*6.9 Combination controller and disconnection means**

Panelboards, Switchboards, and Related Equipment.

*Identify by notation or schedule.

7.0 Bus Ducts and Wireways



*7.1 Trolley duct**

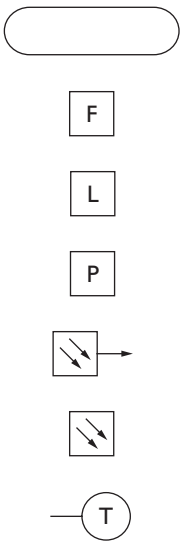
*7.2 Busway (service, feeder, or plug-in)**

*7.3 Cable trough ladder or channel**

*7.4 Wireway**

Bus Ducts and Wireways.

8.0 Remote Control Stations for Motors or Other Equipment*



8.1 Pushbutton station

8.2 Float switch—mechanical

8.3 Limit switch—mechanical

8.4 Pneumatic switch—mechanical

8.5 Electric eye—beam source

8.6 Electric eye—relay

8.7 Thermostat

Remote Control Stations for Motor or Other Equipment.

*Identify by notation or schedule.

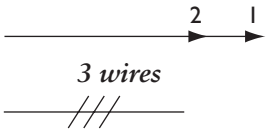
9.0 Circuiting
Wiring method identification by notation on drawing or in specification.

9.1 Wiring concealed in ceiling or wall

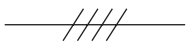
9.2 Wiring concealed in floor

9.3 Wiring exposed

Note: *Use heavyweight line to identify service and feeders. Indicate empty conduit by notation CO (conduit only).*



9.4 Branch-circuit home run to panel-board. Number of arrows indicates number of circuits. (A numeral at each arrow may be used to identify circuit number.) Note: Any circuit without further identification indicates two-wire circuit. For a greater number of wires, indicate with cross lines, e.g.:



Unless indicated otherwise, the wire size of the circuit is the minimum size required by the specification.

Identify different functions of wiring system, e.g., signaling system by notation or other means.

9.5 Wiring turned up

9.6 Wiring turned down

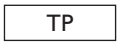
Circuiting.

10.0 Electric Distribution or Lighting System, Underground

*10.1 Manhole**

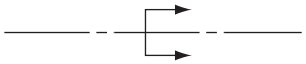
*10.2 Handhole**

*10.3 Transformer manhole or vault**



*10.4 Transformer pad**

10.5 Underground direct burial cable. Indicate type, size, and number of conductors by notation or schedule.



10.6 Underground duct line. Indicate type, size, and number of ducts by cross-section identification of each run by notation or schedule. Indicate type, size, and number of conductors by notation or schedule.

*10.7 Streetlight standard feed from underground circuit**

Electric Distribution or Lighting System, Underground.

*Identify by notation or schedule.

11.0 Electric Distribution or Lighting System, Aerial

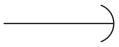
*11.1 Pole**

*11.2 Streetlight and bracket**

*11.3 Transformer**

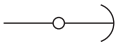
*11.4 Primary circuit**

*11.5 Secondary circuit**



11.6 Down guy

11.7 Head guy



11.8 Sidewalk guy

*11.9 Service weather head**

Electrical Distribution or Lighting System Aerial.

4 Arrester, Lighting Arrester (Electric surge, etc.) Gap

4.1 General

4.2 Carbon block

Block, telephone protector

The sides of the rectangle are to be approximately in the ratio of 1 to 2, and the space between rectangles shall be approximately equal to the width of a rectangle.

(*continued*)

*Identify by notation or schedule.

4.3 Electrolytic or aluminum cell
This symbol is not composed of arrowheads.

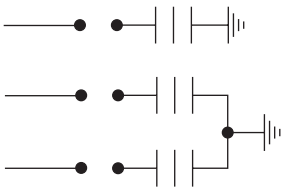
4.4 Horn gap

4.5 Protective gap
These triangles shall not be filled.

4.6 Sphere gap

4.7 Valve or film element

4.8 Multigap, general

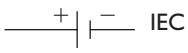


4.9 Application: gap plus valve plus ground, 2-pole4.9 Application: gap plus valve plus ground, 2-pole

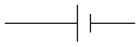
Arrester, Lighting Arrester (Electric surge etc.) Gap.

7 Battery

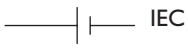
The long line is always positive, but polarity may be indicated in addition. Example:



7.1 Generalized direct-current source

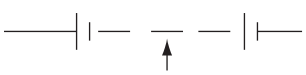


7.2 One cell



7.3 Multicell

7.3.1 Multicell battery with 3 taps



7.3.2 Multicell battery with adjustable tap

Battery.

11 Circuit Breakers

If it is desired to show the condition causing the breaker to trip, the relay-protective-function symbols in item 66.6 may be used alongside the break symbol.

11.1 General

11.2 Air circuit breaker, if distinction is needed; for alternating-current breakers rated at 1,500 volts or less and for all direct-current circuit breakers.

11.2.1 Network protector

11.3 Circuit breaker, other than covered by item 11.2. The symbol in the right column is for a 3-pole breaker.

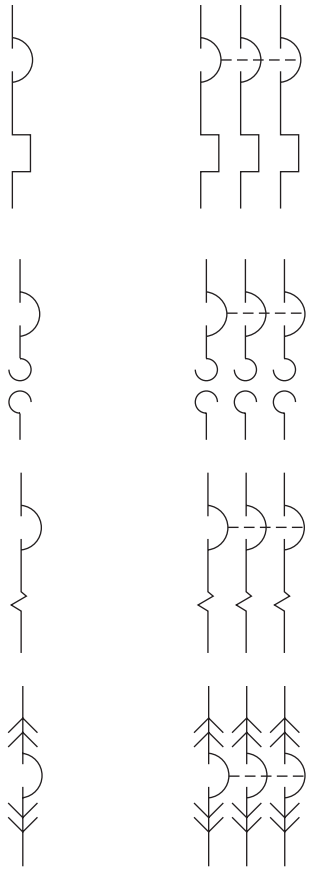
***See* Note 11.3A**

11.3.1 On a connection or wiring diagram, a 3-pole single-throw circuit breaker (with terminals shown) may be drawn as shown.

***See* Note 11.3A**

(*continued*)

Note 11.3A—On a power diagram, the symbol may be used without other identification. On a composite drawing where confusion with the general circuit element symbol (item 12) may result, add the identifying letters CB inside or adjacent to the square.



11.4 Applications

11.4.1 3-pole circuit breaker with thermal overload device in all 3 poles

11.4.2 3-pole circuit breaker with magnetic overload device in all 3 poles

11.4.3 3-pole circuit breaker, drawout type

Circuit Breakers.

13 Circuit Return

13.1 Ground

(A) A direct conducting connection to the earth or body of water that is a part thereof

(*continued*)

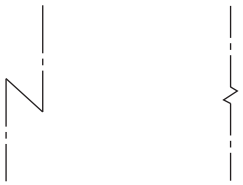
(B) A conducting connection to a structure that serves a function similar to that of an earth ground (that is, a structure such as a frame of an air, space, or land vehicle that is not conductively connected to earth)

13.2 Chassis or frame connection
A conducting connection to a chassis or frame of a unit. The chassis or frame may be at a substantial potential with respect to the earth or structure in which this chassis or frame is mounted.

13.3 Common connections
*Conducting connections made to one another. All like-designated points are connected. *The asterisk is not a part of the symbol. Identifying valves, letters, numbers, or marks shall replace the asterisk.*

Circuit Return.

15 Coil, Magnetic Blowout*

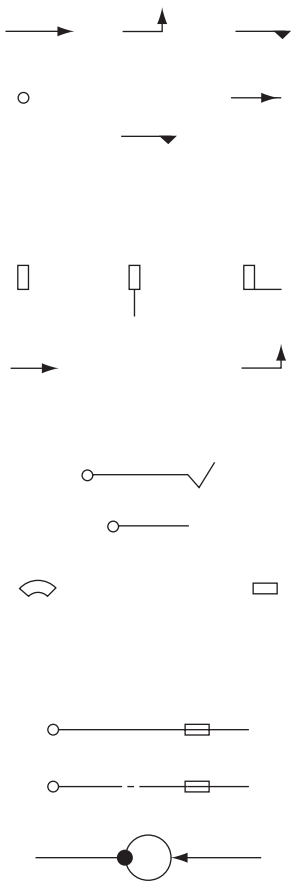


Coil, Magnetic Blowout.

*The broken line (— - —) indicates where line connection to a symbol is made and is not a part of the symbol.

23 Contact, Electrical

For buildups or forms using electrical contacts, see applications under CONNECTOR (item 19), RELAY (item 66), and SWITCH (item 76). See DRAFTING PRACTICES (item 0.4.6).



23.1.1 Fixed contact for jack, key, relay, etc.

23.1.2 Fixed contact for switch

23.1.3 Fixed contact for momentary switch
See SWITCH (item 76.8 and 76.10).

23.1.4 Sleeve

23.2.1. Adjustable or sliding contact for resistor, inductor, etc.

23.2.2 Locking

23.2.3 Segment; bridging contact

23.2.4 Nonlocking
See SWITCH (items 76.12.3 and 76.12.4).

23.2.5 Vibrator reed

23.2.6 Vibrator split reed

23.2.7 Rotating contact (slip ring) and brush

A. Contact, Electrical.

It is standard procedure to show a contact by a symbol that indicates the circuit condition produced when the actuating device is in the nonoperated, or deenergized, position. It may be necessary to add a clarifying note explaining the proper point at which the contact functions—the point where the actuating device (mechanical, electrical, etc.) opens or closes due to changes in pressure, level,

flow, voltage, current, etc. When it is necessary to show contacts in the operated, or energized, condition—and where confusion would otherwise result—a clarifying note shall be added to the drawing. Contacts for circuit breakers, auxiliary switches, etc., may be designated as shown below:

(a) Closed when device is in energized or operated position.

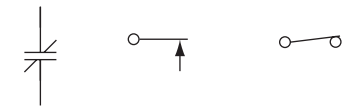
(b) Closed when device is in deenergized or nonoperated position.

(aa) Closed when operating mechanism of main device is in energized or operated position.

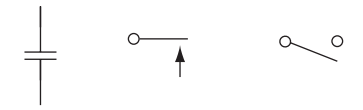
(bb) Closed when operating mechanism of main device is in deenergized or nonoperated position.

[See American Standard C37.2-1962 for details.]

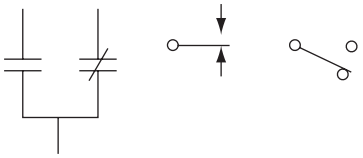
In the parallel-line contact, symbols showing the length of the parallel lines shall be approximately 1¼ times the width of the gap (except for item 23.6).



23.3.1 Closed contact (break)
See also SWITCHING FUNCTION (item 77).



23.3.2 Open contact (make)
See also SWITCHING FUNCTION (item 77).

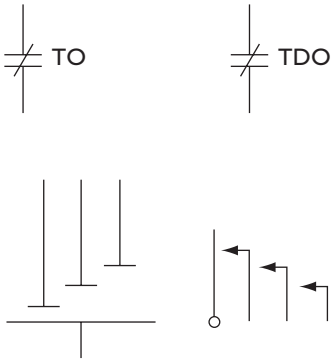


23.3.3 Transfer
See also SWITCHING FUNCTION (item 77).

23.3.4 Make-before-break

23.4 Application: open contact with time closing (TC) or time delay closing (TDC) feature

(*continued*)



23.5 Application: closed contact with time opening (TO) or time delay opening (TDO) feature

23.6 Time sequential closing

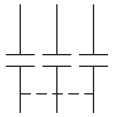
B. Contact, Electrical.

24 Contactor

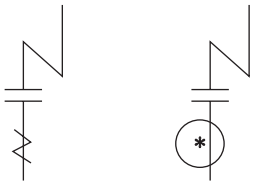
See also RELAY (item 66).

Contactor symbols are derived from fundamental contact, coil, and mechanical connection symbols and should be employed to show contactors on complete diagrams. A complete diagram of the actual contactor device is constructed by combining the abovementioned fundamental symbols for mechanical connections, control circuits, etc.

Mechanical interlocking should be indicated by notes.



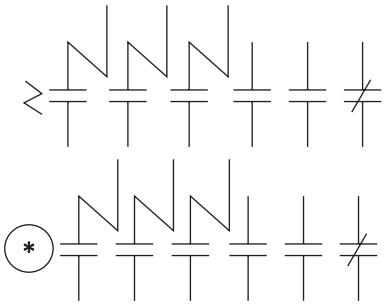
24.1 Manually operated 3-pole contactor



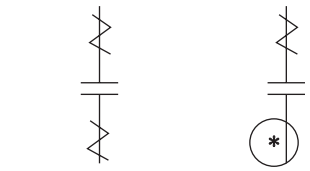
24.2 Electrically operated 1-pole contact or with series blowout coil See Note 24.2A.

(*continued*)

Note 24.2A—The asterisk is not a part of the symbol. Always replace the asterisk by a device designation.



24.3 Electrically operated 3-pole contactor with series blowout coils; 2 open and 1 closed auxiliary contacts (shown smaller than the main contacts)



24.4 Electrically operated 1-pole contactor with shunt blowout coil

Contactor.

46 Machine, Rotating

46.1 Basic

46.2 Generator (general)

46.3 Motor (general)

46.4 Motor, multispeed

USE BASIC MOTOR SYMBOL AND NOTE SPEEDS

*46.5 Rotating armature with commutator and brushes**

(*continued*)

*The broken line (– – –) indicates where line connection to a symbol is made and is not a part of the symbol.

46.6 Field, generator or motor
Either symbol of item 42.1 may be used in the following items.

46.6.1 Compensating or commutating

46.6.2 Series

46.6.3 Shunt, or separately excited

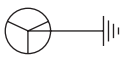
46.6.4 Magnet, permanent
See item 47.

46.7 Winding symbols
Motor and generator winding symbols may be shown in the basic circle using the following representation.

46.7.1 1-phase

46.7.2 2-phase

46.7.3 3-phase wye (ungrounded)



46.7.4 3-phase wye (grounded)

46.7.5 3-phase delta

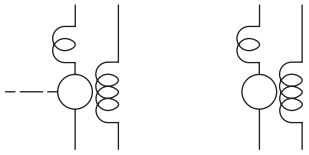
46.7.6 6-phase diametrical

46.7.7 6-phase double-delta

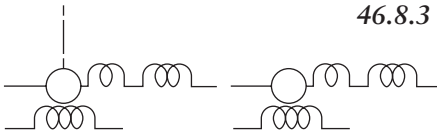
46.8 Direct-current machines; applications

(*continued*)

*46.8.1 Separately excited direct-current generator or motor**

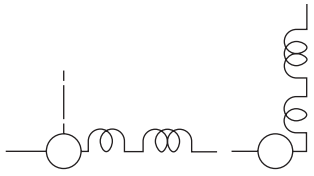


*46.8.2 Separately excited direct-current generator or motor; with commutating or compensating field winding or both**

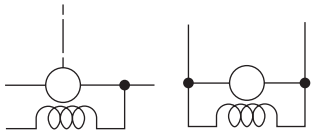


*46.8.3 Compositely excited direct-current generator or motor; with commutating or compensating field winding or both**

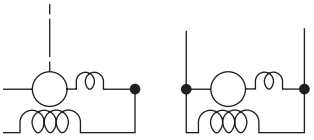
*46.8.4 Direct-current series motor or 2-wire generator**



*46.8.5 Direct-current series motor or 2-wire generator; with commutating or compensating field winding or both**



*46.8.6 Direct-current shunt motor or 2-wire generator**

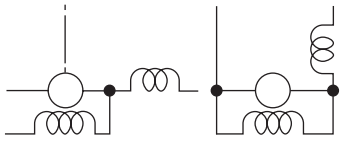


*46.8.7 Direct-current shunt motor or 2-wire generator; with commutating or compensating field winding or both**

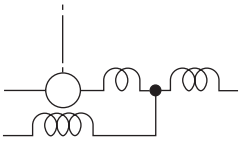
(*continued*)

*The broken line (- — -) indicates where line connection to a symbol is made and is not a part of the symbol.

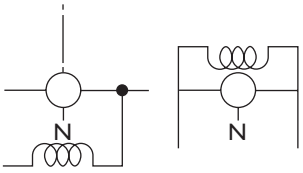
*46.8.8 Direct-current, permanent-magnet field generator or motor**



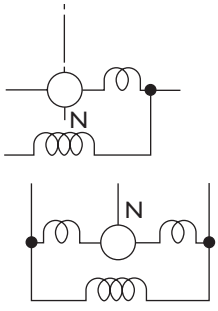
*46.8.9 Direct-current, compound motor or 2-wire generator or stabilized shunt motor**



*46.8.10 Direct-current compound motor or 2-wire generator or stabilized shunt motor; with commutating or compensating field winding or both**



*46.8.11 Direct-current, 3-wire shunt generator**

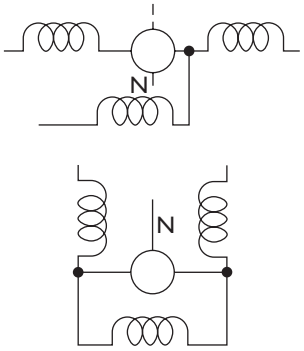


*46.8.12 Direct-current, 3-wire shunt generator; with commutating or compensating field winding or both**

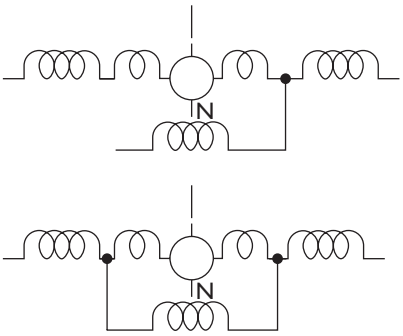
(continued)

*The broken line (- — -) indicates where line connection to a symbol is made and is not a part of the symbol.

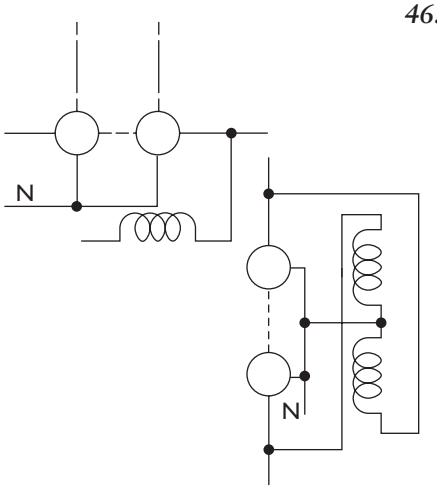
*46.8.13 Direct-current, 3-wire compound generator**



*46.8.14 Direct-current, 3-wire compound generator; with commutating or compensating field winding or both**

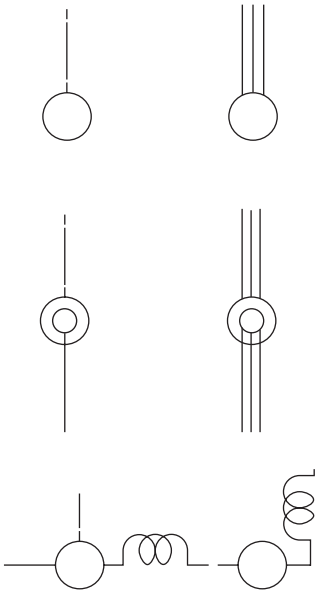


*46.8.15 Direct-current balancer, shunt wound**



(*continued*)

*The broken line (- — -) indicates where line connection to a symbol is made and is not a part of the symbol.



46.9 Alternating-current machines; application

46.9.1 Squirrel-cage induction motor or generator, split-phase induction motor or generator, rotary phase converter or repulsion motor.*

*46.9.2 Wound-rotor induction motor, synchronous induction motor, induction generator, or induction frequency converter**

*46.9.3 Alternating-current series motor**

Machine, Rotating.

48 Meter Instrument

As indicated in Note 48A, the asterisk is not part of the symbol and should always be replaced with one of the letter combinations listed below, according to the meter's function. This is not necessary if some other identification is provided in the circle and described in the diagram.

A *Ammeter*

AH *Ampere-hour*

CMA *Contact-making (or breaking) ammeter*

(*continued*)

*The broken line (- — -) indicates where line connection to a symbol is made and is not a part of the symbol.

CMC	*Contact-making (or breaking) clock*
CMV	*Contact-making (or breaking) voltmeter*
CRO	*Oscilloscope or cathode-ray oscillograph*
DB	*DB (decibel) meter*
DBM	*DBM (decibels referred to 1 milliwatt) meter*
DM	*Demand meter*
DTR	*Demand-totalizing relay*
F	*Frequency meter*
G	*Galvanometer*
GD	*Ground detector*
I	*Indicating*
INT	*Integrating*
μA or UA	*Microammeter*
MA	*Milliammeter*
NM	*Noise meter*
OHM	*Ohmmeter*
OP	*Oil pressure*
OSCG	*Oscillograph string*

(*continued*)

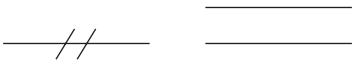
PH	*Phasemeter*
PI	*Position indicator*
PF	*Power factor*
RD	*Recording demand meter*
REC	*Recording*
RF	*Reaction factor*
SY	*Synchroscope*
TLM	*Telemeter*
T	*Temperature meter*
THC	*Thermal converter*
TT	*Total time*
V	*Voltmeter*
VA	*Volt-ammeter*
VAR	*Varmeter*
VARH	*Varhour meter*
VI	*Volume indicator; meter, audio level*
VU	*Standard volume indicator; meter, audio level*
W	*Wattmeter*
WH	*Watthour meter*

Meter Instrument.

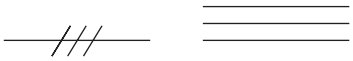
58 Path, Transmission, Conductor, Cable, Wiring

58.1 Guided path, general
The entire group of conductors, or the transmission path required to guide the power or symbol, is shown by a single line. In coaxial and waveguide work, the recognition symbol is employed at the beginning and end of each type of transmission path as well as at intermediate points to clarify a potentially confusing diagram. For waveguide work, the mode may be indicated as well.

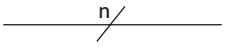
58.2 Conductive path or conductor; wire



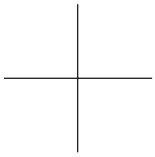
58.2.1 Two conductors or conductive paths of wires



58.2.2 Three conductors or conductive paths of wires



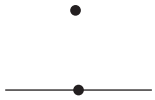
58.2.3 "n" conductors or conductive paths of wires



58.5 Crossing of paths or conductors not connected
The crossing is not necessarily at a 90-degree angle.

(continued)

58.6 Junction of paths or conductors

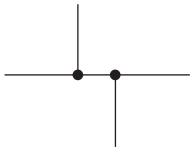


58.6.1 Junction of paths or conductors

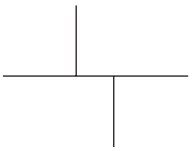
58.6.1.1 Application: junction of paths, conductor, or cable. If desired, indicate path type or size.

Splice

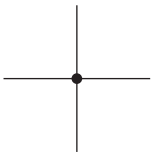
58.6.1.2 Application: splice (if desired) of same size cables. Junction of conductors of same size or different size cables. If desired, indicate sizes of conductors.



58.6.2 Junction of connected paths, conductors, or wires



OR ONLY IF REQUIRED BY SPACE LIMITATION



Path, Transmission, Conductor, Cable, Wiring.

63 Polarity Symbol

\+ *63.1 Positive*

– *63.2 Negative*

Polarity Symbol.

76 Switch

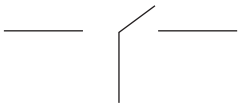
See also FUSE (item 36); CONTACT, ELECTRIC (item 23); and DRAFTING PRACTICES (items 0.4.6 and 0.4.7).

Switch symbols may be constructed using the fundamental symbols for mechanical connections, contacts, etc.

In standard procedure, a switch is represented in the nonoperating, or deenergized, position. In the case of switches that have two or more positions in which no operating force is applied and for those switches (air-pressure, liquid-level, rate-of-flow, etc.) that may be actuated by a mechanical force, the point at which the switch functions should be described in a clarifying note.

In cases where the basic switch symbols (items 76.1–76.4) are used in a diagram in the closed position, the terminals must be included for clarity.

76.1 Single throw, general



76.2 Double throw, general

76.2.1 Application: 2-pole double-throw switch with terminals shown

76.3 Knife switch, general

76.6 Pushbutton, momentary or spring return

76.6.1 Circuit closing (make)

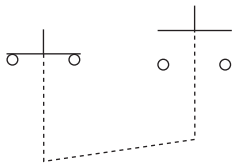
76.6.2 Circuit opening (break)

76.6.3 Two-circuit

(*continued*)

76.7 Pushbutton, maintained or not spring return

76.7.1 Two-circuit



Switch.

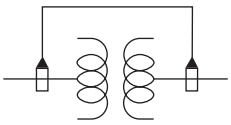
86 Transformer

86.1 General

Either winding symbol may be used. In the following items, the left symbol is used. Additional windings may be shown or indicated by a note. For power transformers use polarity markingH_1, X_1, etc., from American Standard C6.1-1956.

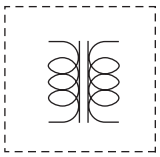
For polarity markings on current and potential transformers, see items 86.16.1 and 86.17.1

In coaxial and waveguide circuits , this symbol will represent a taper or step transformer without mode change



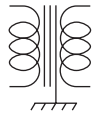
86.1.1 Application: transformer with direct-current connections and mode suppression between two rectangular waveguides

86.2 If it is desired especially to distinguish a magnetic-core transformer

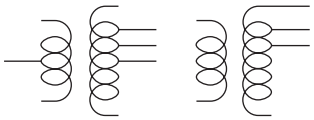


86.2.1 Application: shielded transformer with magnetic core shown

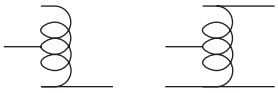
(*continued*)



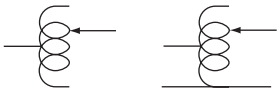
86.2.2 Application: transformer with magnetic core shown and with a shield between windings. The shield is shown connected to the frame.



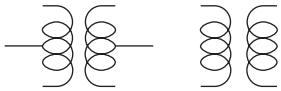
86.6 With taps, 1-phase



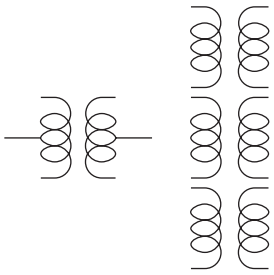
86.7 Autotransformer, 1-phase



86.7.1 Adjustable

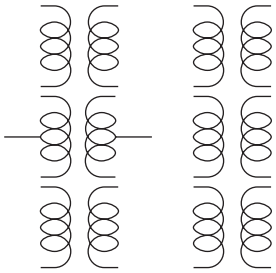


86.13 1-phase, 2-winding transformer



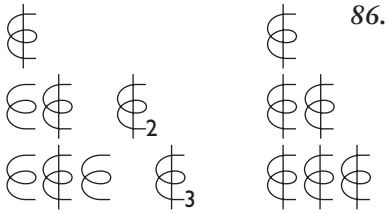
86.13.1 3-phase bank of 1-phase, 2-winding transformer

See American Standard C6.1-1965 for interconnections for complete symbol.



86.14 Polyphase transformer

(*continued*)



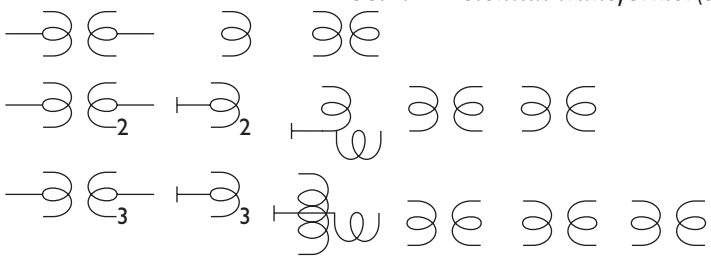
86.16 Current transformer(s)

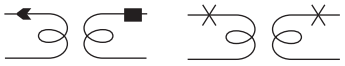
86.16.1 Current transformer with polarity marking. Instantaneous direction of current into one polarity mark corresponds to current out of the other polarity mark.

Symbol used shall not conflict with item 77 when used on same drawing.

*86.16.2 Bushing-type current transformer**

86.17 Potential transformer(s)



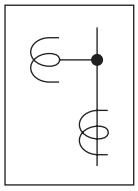


86.17.1 Potential transformer with polarity mark. Instantaneous direction of current into one polarity mark corresponds to current out of the other polarity mark.

(*continued*)

*The broken line (- — -) indicates where line connection to a symbol is made and is not a part of the symbol.

Symbol used shall not conflict with item 77 when used on same drawing.



86.18 Outdoor metering device

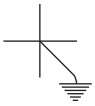
86.19 Transformer winding connection symbols

For use adjacent to the symbols for the transformer windings.

86.19.1 2-phase 3-wire, grounded

86.19.1.1 2-phase 3-wire, grounded

86.19.2 2-phase 4-wire



86.19.2.1 2-phase 5-wire, grounded

86.19.3 3-phase 3-wire, delta or mesh

86.19.3.1 3-phase 3-wire, delta, grounded

86.19.4 3-phase 4-wire, delta, ungrounded

(*continued*)

86.19.4.1 3-phase 4-wire, delta, grounded

86.19.5 3-phase, open-delta

86.19.5.1 3-phase, open-delta, grounded at common point

86.19.5.2 3-phase, open-delta, grounded at middle point of one transformer

86.19.6 3-phase, broken-delta

86.19.7 3-phase, wye or star, ungrounded

86.19.7.1 3-phase, wye, grounded neutral

The direction of the stroke representing the neutral can be arbitrarily chosen.

86.19.8 3-phase 4-wire, ungrounded

Transformer.