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IEEE C37.2-1987)

IEEE Standard Electrical Power System Device Function Numbers

Sponsor

Substations Committee
of the
IEEE Power Engineering Society

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IEEE Standards Board

Abstract: The definition and application of function numbers for devices used in electrical substations and generating plants and in installations of power utilization and conversion apparatus are covered. The purpose of the numbers is discussed, and 94 numbers are assigned. The use of prefixes and suffixes to provide a more specific definition of the function is considered. Device contact designation is also covered.

Keywords: device functions, device function numbers, function numbers, switchgear

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Foreword

(This foreword is not a part of IEEE C37.2-1991, IEEE Standard Electrical Power System Device Function Numbers.)

This standard is an update of IEEE C37.2-1987, IEEE Standard Electrical Power System Device Function Numbers. Definitions of some device functions have been improved for present applications, and additional suggested suffix letters have been indicated. Previous revisions were approved as standards in 1987, 1979, 1962, 1956, 1945, and 1937. The original work on this subject was done by the American Institute of Electrical Engineers and published in 1928 as AIEE No. 26.

Preparation of this standard was done by a working group of the Data Acquisition, Processing, and Control Systems Subcommittee, Substations Committee. Membership of the working group during the preparation of this revision was:

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Contents

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IEEE Standard Electrical Power System Device Function Numbers

1. Scope and References

1.1 Scope. This standard applies to the definition and application of function numbers for devices used in electrical substations and generating plants and in installations of power utilization and conversion apparatus.

NOTE: Although the wording of this standard is directed specifically to equipment comprising conventional electromechanical devices, it also applies to equipment consisting totally, or in part, of electronic or solid-state devices.

1.2 References. This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.

[1] ASME Y1.1-1989, Abbreviations for Use on Drawings and in Text.[1]

[2] IEEE Std 315-1975, IEEE Standard Graphic Symbols for Electrical and Electronics Diagrams (ANSI).[2]

[3] IEEE C37.1-1987, IEEE Standard Definition, Specification, and Analysis of Systems Used for Supervisory Control, Data Acquisition, and Automatic Control.

[4] IEEE C37.20.1-1987, IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear (ANSI).

[5] IEEE C37.20.2-1987, IEEE Standard for Metal-Clad and Station-Type Cubicle Switchgear (ANSI).

2. Purpose of Device Function Numbers

A device function number, with an appropriate prefix and suffix where necessary, is used to identify the function of each device in all types of partial-automatic and automatic switchgear and in many types of manual switchgear. These numbers are to be used in drawings, elementary and connection diagrams, instruction books, publications, and specifications. In addition, for automatic switchgear, the number may be placed on, or adjacent to, each device on the assembled equipment so that the device may be readily identified.

NOTE: These device function designations, which have been developed as a result of usage over many years, may define the actual function the device performs in equipment, or they may refer to the electrical or other quantity to which the device is responsive. Hence, there may be in some instances a choice of the function number to be used for a given device. The preferable choice to be made in all cases should be the one that is recognized to have the narrowest interpretation so that it most specifically identifies the device in the minds of all individuals concerned with the design and operation of the equipment.

3. Standard Device Function Numbers

3.1 Standard Device Function Numbers. Each number with its corresponding function name and the general description of each function is listed below.

NOTE: When alternate names and descriptions are included under the function, only the name and description that applies to each specific case should be used. In general, only one name for each device, such as relay, contactor, circuit breaker, switch, or monitor, is included in each

[1] ASME publications are available from the American Society of Mechanical Engineers, 22 Law Drive, Fairfield, NJ, 07007, USA.

[2] IEEE publications are available from the Institute of Electrical and Electronics Engineers, Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

function designation. However, when the function is not inherently restricted to any specific type of device and where the type of device itself is thus merely incidental, any one of the above listed alternative names, as applicable, may be substituted. For example, if for device function 6 a contactor is used for the purpose in place of a circuit breaker, the function name should be specified as "starting contactor."

For every application of device function numbers, the originator should provide a brief definition for all device function numbers used in that application, including all combinations of prefixes, function numbers, and suffixes. Typical definitions are illustrated in Fig 3a. These definitions should be included in the drawing where the device function number is used, or in a separate drawing or list to which the other drawings refer. All instruction books and other documents shall also include the device function number definitions.

Numbers from 95 to 99 should be assigned only for those functions in specific cases where none of the assigned standard device function numbers are applicable. Numbers that are "reserved for future application" should not be used.

1. master element. The initiating device, such as a control switch, etc., that serves, either directly or through such permissive devices as protective and time-delay relays, to place equipment in or out of operation.

NOTE: This number is normally used for a hand-operated device, although it may also be used for an electrical or mechanical device for which no other function number is suitable.

2. time-delay starting or closing relay. A device that functions to give a desired amount of time delay before or after any point of operation in a switching sequence or protective relay system, except as specifically provided by device functions 48, 62, and 79.

3. checking or interlocking relay. A relay that operates in response to the position of a number of other devices (or to a number of predetermined conditions) in equipment to allow an operating sequence to proceed, stop, or provide a check of the position of these devices or conditions for any purpose.

4. master contactor. A device, generally controlled by device function 1 or the equivalent and the required permissive and protective devices, that serves to make and break the necessary control circuits to place equipment into operation under the desired conditions and to take it out of operation under abnormal conditions.

5. stopping device. A control device used primarily to shut down equipment and hold it out of operation. (This device may be manually or electrically actuated, but it excludes the function of electrical lockout [see device function 86] on abnormal conditions.)

6. starting circuit breaker. A device whose principal function is to connect a machine to its source of starting voltage.

7. rate-of-rise relay. A relay that functions on an excessive rate-of-rise of current.

8. control power disconnecting device. A disconnecting device, such as a knife switch, circuit breaker, or pull-out fuse block, used for the purpose of respectively connecting and disconnecting the source of control power to and from the control bus or equipment.

NOTE: Control power is considered to include auxiliary power that supplies such apparatus as small motors and heaters.

9. reversing device. A device that is used for the purpose of reversing a machine field or for performing any other reversing functions.

10. unit sequence switch. A switch that is used to change the sequence in which units may be placed in and out of service in multiple-unit equipment.

11. multifunction device. A device that performs three or more comparatively important functions that could only be designated by combining several of these device function numbers. All of the functions performed by device 11 shall be defined in the drawing legend or device function definition list.

NOTE: If only two relatively important functions are performed by the device, it is preferred that both function numbers be used, as described in 3.6.

12. overspeed device. Usually, a direct-connected speed switch that functions on machine overspeed.

13. synchronous-speed device. A device such as a centrifugal-speed switch, a slip-frequency relay, a voltage relay, an undercurrent relay, or any other type of device that operates at approximately the synchronous speed of a machine.

14. underspeed device. A device that functions when the speed of a machine falls below a predetermined value.

15. speed or frequency matching device. A device that functions to match and hold the speed or frequency of a machine or a system equal to, or approximately equal to, that of another machine, source, or system.

16. Reserved for future application.

17. shunting or discharge switch. A switch that serves to open or close a shunting circuit around any piece of apparatus (except a resistor), such as a machine field, a machine armature, a capacitor, or a reactor.

NOTE: This excludes devices that perform such shunting operations as may be necessary in the process of starting a machine by devices 6 or 42 (or their equivalent) and also excludes device function 73 that serves for the switching of resistors.

18. accelerating or decelerating device. A device that is used to close or cause the closing of circuits that are used to increase or decrease the speed of a machine.

19. starting-to-running transition contactor. A device that operates to initiate or cause the automatic transfer of a machine from the starting to the running power connection.

20. electrically operated valve. An electrically operated, controlled, or monitored valve used in a fluid, air, gas, or vacuum line.

NOTE: The function of the valve may be more completely indicated by the use of suffixes as discussed in 3.2.

21. distance relay. A relay that functions when the circuit admittance, impedance, or reactance increases or decreases beyond a predetermined value.

22. equalizer circuit breaker. A breaker that serves to control or make and break the equalizer or the current-balancing connections for a machine field, or for regulating equipment, in a multiple-unit installation.

23. temperature control device. A device that functions to raise or lower the temperature of a machine or other apparatus, or of any medium, when its temperature falls below or rises above a predetermined value.

NOTE: An example is a thermostat that switches on a space heater in a switchgear assembly when the temperature falls to a desired value. This should be distinguished from a device that is used to provide automatic temperature regulation between close limits and would be designated as device function 90T.

24. volts per hertz relay. A relay that functions when the ratio of voltage to frequency exceeds a preset value. The relay may have an instantaneous or a time characteristic.

25. synchronizing or synchronism-check device. A device that operates when two ac circuits are within the desired limits of frequency, phase angle, and voltage to permit or cause the paralleling of these two circuits.

26. apparatus thermal device. A device that functions when the temperature of the protected apparatus (other than the load-carrying windings of machines and transformers as covered by device function number 49) or of a liquid or other medium exceeds a predetermined value; or when the temperature of the protected apparatus or of any medium decreases below a predetermined value.

27. undervoltage relay. A relay that operates when its input voltage is less than a predetermined value.

28. flame detector. A device that monitors the presence of the pilot or main flame in such apparatus as a gas turbine or a steam boiler.

29. isolating contactor. A device that is used expressly for disconnecting one circuit from another for the purposes of emergency operation, maintenance, or test.

30. annunciator relay. A nonautomatically reset device that gives a number of separate visual indications upon the functioning of protective devices and that may also be arranged to perform a lockout function.

31. separate excitation device. A device that connects a circuit, such as the shunt field of a synchronous converter, to a source of separate excitation during the starting sequence.

32. directional power relay. A relay that operates on a predetermined value of power flow in a given direction or upon reverse power flow such as that resulting from the motoring of a generator upon loss of its prime mover.

33. position switch. A switch that makes or breaks contact when the main device or piece

of apparatus that has no device function number reaches a given position.

34. master sequence device. A device such as a motor-operated multicontact switch, or the equivalent, or a programming device, such as a computer, that establishes or determines the operating sequence of the major devices in equipment during starting and stopping or during other sequential switching operations.

35. brush-operating or slip-ring short-circuiting device. A device for raising, lowering, or shifting the brushes of a machine; short-circuiting its slip rings; or engaging or disengaging the contacts of a mechanical rectifier.

36. polarity or polarizing voltage device. A device that operates, or permits the operation of, another device on a predetermined polarity only or that verifies the presence of a polarizing voltage in equipment.

37. undercurrent or underpower relay. A relay that functions when the current or power flow decreases below a predetermined value.

38. bearing protective device. A device that functions on excessive bearing temperature or on other abnormal mechanical conditions associated with the bearing, such as undue wear, which may eventually result in excessive bearing temperature or failure.

39. mechanical condition monitor. A device that functions upon the occurrence of an abnormal mechanical condition (except that associated with bearings as covered under device function 38), such as excessive vibration, eccentricity, expansion, shock, tilting, or seal failure.

40. field relay. A relay that functions on a given or abnormally low value or failure of machine field current, or on an excessive value of the reactive component of armature current in an ac machine indicating abnormally low field excitation.

41. field circuit breaker. A device that functions to apply or remove the field excitation of a machine.

42. running circuit breaker. A device whose principal function is to connect a machine to its source of running or operating voltage. This function may also be used for a device, such as a contactor, that is used in series with a circuit breaker or other fault-protecting means, primarily for frequent opening and closing of the circuit.

43. manual transfer or selector device. A manually operated device that transfers the control circuits in order to modify the plan of operation of the switching equipment or of some of the devices.

44. unit sequence starting relay. A relay that functions to start the next available unit in multiple-unit equipment upon the failure or nonavailability of the normally preceding unit.

45. atmospheric condition monitor. A device that functions upon the occurrence of an abnormal atmospheric condition, such as damaging fumes, explosive mixtures, smoke, or fire.

46. reverse-phase or phase-balance current relay. A relay that functions when the polyphase currents are of reverse-phase sequence or when the polyphase currents are unbalanced or contain negative phase-sequence components above a given amount.

47. phase-sequence or phase-balance voltage relay. A relay that functions upon a predetermined value of polyphase voltage in the desired phase sequence, when the polyphase voltages are unbalanced, or when the negative phase-sequence voltage exceeds a given amount.

48. incomplete sequence relay. A relay that generally returns the equipment to the normal, or off, position and locks it out if the normal starting, operating, or stopping sequence is not properly completed within a predetermined time.

49. machine or transformer thermal relay. A relay that functions when the temperature of a machine armature winding or other load-carrying winding or element of a machine or

power transformer exceeds a predetermined value.

50. instantaneous overcurrent relay. A relay that functions instantaneously on an excessive value of current.

51. ac time overcurrent relay. A relay that functions when the ac input current exceeds a predetermined value, and in which the input current and operating time are inversely related through a substantial portion of the performance range.

52. ac circuit breaker. A device that is used to close and interrupt an ac power circuit under normal conditions or to interrupt this circuit under fault or emergency conditions.

53. exciter or dc generator relay. A relay that forces the dc machine field excitation to build up during starting or that functions when the machine voltage has built up to a given value.

54. turning gear engaging device. An electrically operated, controlled, or monitored device that functions to cause the turning gear to engage (or disengage) the machine shaft.

55. power factor relay. A relay that operates when the power factor in an ac circuit rises above or falls below a predetermined value.

56. field application relay. A relay that automatically controls the application of the field excitation to an ac motor at some predetermined point in the slip cycle.

57. short-circuiting or grounding device. A primary circuit switching device that functions to short-circuit or ground a circuit in response to automatic or manual means.

58. rectification failure relay. A device that functions if a power rectifier fails to conduct or block properly.

59. overvoltage relay. A relay that operates when its input voltage is more than a predetermined value.

60. voltage or current balance relay. A relay that operates on a given difference in voltage, or current input or output, of two circuits.

61. density switch or sensor. A device that operates on a given value, or a given rate of change, of gas density.

62. time-delay stopping or opening relay. A time-delay relay that serves in conjunction with the device that initiates the shutdown, stopping, or opening operation in an automatic sequence or protective relay system.

63. pressure switch. A switch that operates on given values, or on a given rate of change, of pressure.

64. ground detector relay. A relay that operates upon failure of machine or other apparatus insulation to ground.

NOTE: This function is not applied to a device connected in the secondary circuit of current transformers in a normally grounded power system, where other device numbers with the suffix G or N should be used; that is, 51N for an ac time overcurrent relay connected in the secondary neutral of the current transformers.

65. governor. The assembly of fluid, electrical, or mechanical control equipment used for regulating the flow of water, steam, or other media to the prime mover for such purposes as starting, holding speed or load, or stopping.

66. notching or jogging device. A device that functions to allow only a specified number of operations of a given device or equipment, or a specified number of successive operations within a given time of each other. It is also a device that functions to energize a circuit periodically or for fractions of specified time intervals, or that is used to permit intermittent acceleration or jogging of a machine at low speeds for mechanical positioning.

67. ac directional overcurrent relay. A relay that functions on a desired value of ac overcurrent flowing in a predetermined direction.

68. blocking relay. A relay that initiates a pilot signal for blocking of tripping on external faults in a transmission line or in other apparatus under predetermined conditions, or that cooperates with other devices to block tripping or to block reclosing on an out-of-step condition or on power swings.

69. permissive control device. Generally, a two-position device that in one position permits

the closing of a circuit breaker, or the placing of an equipment into operation, and in the other position prevents the circuit breaker or the equipment from being operated.

70. rheostat. A variable resistance device used in an electric circuit when the device is electrically operated or has other electrical accessories, such as auxiliary, position, or limit switches.

71. level switch. A switch that operates on given values, or on a given rate of change, of level.

72. dc circuit breaker. A circuit breaker that is used to close and interrupt a dc power circuit under normal conditions or to interrupt this circuit under fault or emergency conditions.

73. load-resistor contactor. A contactor that is used to shunt or insert a step of load limiting, shifting, or indicating resistance in a power circuit; to switch a space heater in circuit; or to switch a light or regenerative load resistor of a power rectifier or other machine in and out of circuit.

74. alarm relay. A relay other than an annunciator, as covered under device function 30, that is used to operate, or that operates in connection with, a visual or audible alarm.

75. position changing mechanism. A mechanism that is used for moving a main device from one position to another in equipment; for example, shifting a removable circuit breaker unit to and from the connected, disconnected, and test positions.

76. dc overcurrent relay. A relay that functions when the current in a dc circuit exceeds a given value.

77. telemetering device. A transmitter used to generate and transmit to a remote location an electrical signal representing a measured quantity, or a receiver used to receive the electrical signal from a remote transmitter and convert the signal to represent the original measured quantity.

78. phase-angle measuring or out-of-step protective relay. A relay that functions at a predetermined phase angle between two voltages, between two currents, or between voltage and current.

79. ac reclosing relay. A relay that controls the automatic reclosing and locking out of an ac circuit interrupter.

80. flow switch. A switch that operates on given values, or on a given rate of change, of flow.

81. frequency relay. A relay that responds to the frequency of an electrical quantity, operating when the frequency or rate of change of frequency exceeds or is less than a predetermined value.

82. dc load-measuring reclosing relay. A relay that controls the automatic closing and reclosing of a dc circuit interrupter, generally in response to load circuit conditions.

83. automatic selective control or transfer relay. A relay that operates to select automatically between certain sources or conditions in equipment or that performs a transfer operation automatically.

84. operating mechanism. The complete electrical mechanism or servomechanism, including the operating motor, solenoids, position switches, etc., for a tap changer, induction regulator, or any similar piece of apparatus that otherwise has no device function number.

85. carrier or pilot-wire receiver relay. A relay that is operated or restrained by a signal used in connection with carrier-current or dc pilot-wire fault relaying.

86. lockout relay. A hand or electrically reset auxiliary relay that is operated upon the occurrence of abnormal conditions to maintain associated equipment or devices inoperative until it is reset.

87. differential protective relay. A protective relay that functions on a percentage, phase angle, or other quantitative difference between two currents or some other electrical quantities.

88. auxiliary motor or motor generator. A device used for operating auxiliary equipment, such as pumps, blowers, exciters, rotating magnetic amplifiers, etc.

89. line switch. A switch used as a disconnecting, load-interrupter, or isolating switch in an ac or dc power circuit. (This device function number is normally not necessary unless the switch is electrically operated or has electrical accessories, such as an auxiliary switch, a magnetic lock, etc.)

90. regulating device. A device that functions to regulate a quantity or quantities, such as voltage, current, power, speed, frequency, temperature, and load, at a certain value or between certain (generally close) limits for machines, tie lines, or other apparatus.

91. voltage directional relay. A relay that operates when the voltage across an open circuit breaker or contactor exceeds a given value in a given direction.

92. voltage and power directional relay. A relay that permits or causes the connection of two circuits when the voltage difference between them exceeds a given value in a predetermined direction and causes these two circuits to be disconnected from each other when the power flowing between them exceeds a given value in the opposite direction.

93. field-changing contactor. A contactor that functions to increase or decrease, in one step, the value of field excitation on a machine.

94. tripping or trip-free relay. A relay that functions to trip a circuit breaker, contactor, or equipment; to permit immediate tripping by other devices; or to prevent immediate reclosing of a circuit interrupter if it should open automatically, even though its closing circuit is maintained closed.

95–99. Used only for specific applications in individual installations if none of the functions assigned to the numbers from 1 to 94 is suitable.

3.2 Addition of Prefixes and Suffixes. Letters and numbers may be used as prefixes or suffixes to device function numbers to provide a more specific definition of the function, as discussed below. They permit a manifold multiplication of available function designations for the large number and variety of devices used in the many types of equipment covered by this standard. They may also serve to denote individual or specific parts or auxiliary contacts of these devices or certain distinguishing features, characteristics, or conditions that describe the use of the device or its contacts in the equipment.

Prefixes and suffixes should, however, be used only when they accomplish a useful purpose. For example, when all of the devices in a piece of equipment are associated with only one kind of apparatus, such as a feeder, motor, or generator, it is common practice, in order to retain maximum simplicity in device function identification, not to add the respective suffix letters F, M, or G to any of the device function numbers.

3.2.1 Defining Letter Suffixes. In order to prevent any possible conflict or confusion, each letter suffix should preferably have only one meaning in individual pieces of equipment. To accomplish this, short, distinctive abbreviations, such as those contained in ASME Y1.1-1989 [1][3], or any appropriate combination of letters may also be used as letter suffixes where necessary. However, each suffix should not consist of more than three (and preferably not more than two) letters, in order to keep the complete function designation as short and simple as possible.

The meaning of each suffix should be designated in the drawings or the publications with which they are used, similar to: TC-trip coil, V-voltage, X-auxiliary relay.

In cases where the same suffix (consisting of one letter or a combination of letters) has different meanings in the same equipment depending upon the device function number with which it is used, then the complete device function number with its suffix letter or letters and its corresponding function definition should be listed in the legend in each case, as follows: 63V-vacuum relay, 70R-raising relay for device 70, 90V-voltage regulator.

[3]The numbers in brackets correspond to those of the references in 1.2.

3.3 Suggested Prefixes. A similar series of numbers, prefixed by the letters RE (for "remote") may be used for the interposing relays performing functions that are controlled directly from the supervisory system. Typical examples of such functions are RE1, RE5, and RE94.

In multiple-unit installations, it may be desirable to use a prefix number to distinguish between device functions associated with individual units. For example, in pipeline pump stations, the numbers 1–99 are applied to device functions that are associated with the overall station operation. A similar series of numbers, starting with 101 instead of 1, are used for those device functions that are associated with unit 1; a similar series starting with 201 for device functions that are associated with unit 2; and so on, for each unit in these installations.

3.4 Suggested Suffix Letters. Sections 3.4.1 through 3.4.6 describe letters that are commonly used and are recommended for use when required and as appropriate.

3.4.1 Auxiliary Devices. These letters denote separate auxiliary devices, such as

C Closing relay/contactor
CL Auxiliary relay, closed (energized when main device is in closed position)
CS Control switch
D "Down" position switch relay
L Lowering relay
O Opening relay/contactor
OP Auxiliary relay, open (energized when main device is in open position)
PB Push button
R Raising relay
U "UP" position switch relay
X Auxiliary relay
Y Auxiliary relay
Z Auxiliary relay

NOTE: In the control of a circuit breaker with a so-called X-Y relay control scheme, the X relay is the device whose main contacts are used to energize the closing coil or the device that in some other manner, such as by the release of stored energy, causes the breaker to close. The contacts of the Y relay provide the antipump feature of the circuit breaker.

3.4.2 Actuating Quantities. These letters indicate the condition or electrical quantity to which the device responds, or the medium in which it is located, such as

A Air/amperes/alternating
C Current
D Direct/discharge
E Electrolyte
F Frequency/flow/fault
H Explosive
J Differential
L Level/liquid
P Power/pressure
PF Power factor
Q Oil
S Speed/suction/smoke
T Temperature
V Voltage/volts/vacuum
VAR Reactive power
VB Vibration
W Water/watts

3.4.3 Main Device. These letters denote the main device to which the numbered device is applied or is related:

A Alarm/auxiliary power
AN Anode
B Battery/blower/bus
BK Brake
BL Block (valve)
BP Bypass
BT Bus tie
C Capacitor/condenser/compensator/carrier current/case/compressor
CA Cathode
CH Check (valve)
D Discharge (valve)
DC Direct current
E Exciter
F Feeder/field/filament/filter/fan
G Generator/ground[4]
H Heater/housing
L Line/logic
M Motor/metering
MOC Mechanism operated contact[5]
N Network/neutral[6]
P Pump/phase comparison

[4]The suffix N is generally used in preference to G for devices connected in the secondary neutral of current transformers or in the secondary of a current transformer whose primary winding is located in the neutral of a machine or power transformer, except in the case of transmission line relaying, where the sufiix G is more commonly used for those relays that operate on ground faults.

[5]MOC denotes a circuit breaker mechanism-operated auxiliary switch that is mounted on the stationary housing of a removable circuit breaker.

[6]See foonote 4.

R	Reactor/rectifier/room
S	Synchronizing/secondary/strainer/ sump/suction (valve)
T	Transformer/thyratron
TH	Transformer (high-voltage side)
TL	Transformer (low-voltage side)
TM	Telemeter
TOC	Truck-operated contacts[7]
TT	Transformer (tertiary-voltage side)
U	Unit

3.4.4 Main Device Parts. These letters denote parts of the main device, except auxiliary contacts, position switches, limit switches, and torque limit switches, which are covered in Section 4.

BK	Brake
C	Coil/condenser/capacitor
CC	Closing coil
HC	Holding coil
M	Operating motor
MF	Fly-ball motor
ML	Load-limit motor
MS	Speed adjusting or synchronizing motor
S	Solenoid
SI	Seal-in
TC	Trip coil
V	Valve

3.4.5 Other Suffix Letters. The following letters cover all other distinguishing features, characteristics, or conditions not specifically described in 3.4.1 to 3.4.4, which serve to describe the use of the device in the equipment, such as

A	Accelerating/automatic
B	Blocking/backup
C	Close/cold
D	Decelerating/detonate/down/ disengaged
E	Emergency/engaged
F	Failure/forward
GP	General purpose
H	Hot/high
HR	Hand reset
HS	High speed
L	Left/local/low/lower/leading
M	Manual
O	Open/over
OFF	Off
ON	On
P	Polarizing
R	Right/raise/reclosing/receiving/ remote/reverse
S	Sending/swing
SHS	Semihigh speed
T	Test/trip/trailing
TDC	Time-delay closing
TDO	Time-delay opening
U	Up/under

3.4.6 Use of Suffix Letters. Lowercase (small) letters are used in practically all instances on electrical diagrams for the auxiliary, position, and limit switches, as shown in 4.1. Capital letters are generally used for all suffix letters in 3.4.

The letters in 3.4.1 to 3.4.3, since they should generally form part of the device function designation, are usually written directly after the device function number, for example, 52CS, 71W, or 49D. When it is necessary to use two types of suffix letters in connection with one function number, it is often desirable for clarity to separate them by a slanted line or dash, as, for example, 20D/CS or 20D-CS.

The suffix letters in 3.4.4, which denote parts of the main device, and those in 3.4.5, which cannot or need not form part of the device function designation, are generally written directly below the device function number on the drawings, for example:

$\frac{52}{CC}$ or $\frac{43}{A}$ (see Fig 3)

3.5 Suffix Numbers. If two or more devices with the same function number and suffix letter (if used) are present in the same piece of equipment, they may be distinguished by numbered suffixes, as, for example, 4X-1, 4X-2, and 4X-3, when necessary.

3.6 Devices Performing More Than One Function. If one device performs two relatively important functions in a piece of equipment so that it is desirable to identify both of these functions, a double function number and name, such as 50/51 instantaneous and time overcurrent relay, may be used.

[7]TOC denotes a circuit breaker truck-operated auxiliary switch that is mounted on the stationary housing of a removable circuit breaker.

4. Device Contacts

4.1 Auxiliary, Position, and Limit Switch Contacts. The letters *a* and *b* shall be used for all auxiliary, position, and limit switch contacts for such devices and equipment as circuit breakers, contactors, valves and rheostats, and contacts of relays:

a Contact that is open when the main device is in the standard reference position, commonly referred to as the nonoperated or de-energized position, and that closes when the device assumes the opposite position

b Contact that is closed when the main device is in the standard reference position, commonly referred to as the nonoperated or de-energized position, and that opens when the device assumes the opposite position

The simple designation *a* or *b* is used in all cases where there is no need to adjust the contacts to change position at any particular point in the travel of the main device or where the part of the travel where the contacts change position is of no significance in the control or operating scheme. Hence the *a* and *b* designations usually are sufficient for circuit breaker auxiliary switches.

Standard reference positions of some typical devices are given in Table 1.

4.1.1 Auxiliary Switches With Defined Operating Position. When it is desired to have the auxiliary, position, or limit switch designation indicate at what point of travel the contacts change position, as is sometimes necessary in the case of valves and for other main devices, then an additional letter (or a percentage figure, if required) is added (as a suffix to the *a* or *b* designation) for this purpose.

For a valve, the method of designating such position switches is shown in the diagram and legend in Fig 1. There are thus two points to consider in visualizing or describing the operation of these position switches. The first is whether the contact is *a* or *b* as indicated by the first letter. The second is where the contact changes position, either at or near:

(1) The closed position of the valve *c*,

(2) The open position of the valve *o*, or

(3) A specified percentage such as 25% of the full open position, for example, *a25*.

When applied to devices other than valves, gates, circuit breakers, and switches for which the letters *o* and *c* are used for *open* and *closed*, respectively, it will be necessary to use other applicable letters. For example, for such devices as a clutch, turning gear, rheostat, electrode, and adjusting device, the letters *d*, *e*, *h*, *l*, *u*, and *d*, meaning *disengaged*, *engaged*, *high*, *low*, *up*, and *down*, respectively, are applicable. Also, other appropriate suffix letters may be used for special *a* or *b* position switches, when these are considered more appropriate

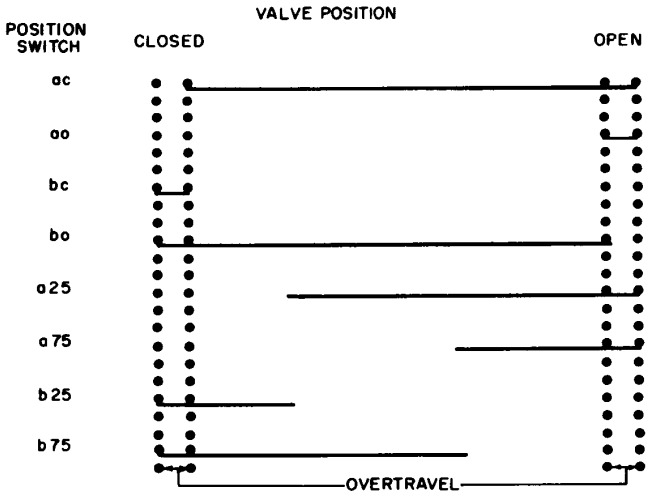
Table 1
Standard Reference Positions of Devices

Device	Standard Reference Position
Power circuit breaker	Main contacts open
Disconnecting switch	Main contacts open
Load-break switch	Main contacts open
Valve	Closed position
Gate	Closed position
Clutch	Disengaged position
Turning gear	Disengaged position
Power electrodes	Maximum gap position
Rheostat	Maximum resistance position
Adjusting means[8]	Low or down position
Relay [9]	De-energized position
Contactor[9]	De-energized position
Relay (latched-in type)	See 4.5.3
Contactor (latched-in type)	Main contacts open
Temperature relay[10]	Lowest temperature
Level detector[10]	Lowest level
Flow detector[10]	Lowest flow
Speed switch[10]	Lowest speed
Vibration detector[10]	Minimum vibration
Pressure switch[10]	Lowest pressure
Vacuum switch[10]	Lowest pressure, that is, highest vacuum

[8]These may be speed, voltage, current, load, or similar adjusting devices comprising rheostats, springs, levers, or other components for the purpose.

[9]These electrically operated devices are of the nonlatched-in type, whose contact position is dependent only upon the degree of energization of the operating, restraining, or holding coil or coils that may or may not be suitable for continuous energization. The de-energized position of the device is that with all coils de-energized.

[10]The energizing influences for these devices are considered to be, respectively, rising temperature, rising level, increasing flow, rising speed, increasing vibration, and increasing pressure.



Each of the eight valve positions can be described as follows:

ac, *a* contact that changes position at or near the closed position of the valve, that is, open only when the valve is fully closed

ao, *a* contact that changes position at or near the open position of the valve, that is, closed only when the valve is fully open

bc, *b* contact that changes position at or near the closed position of the valve, that is, closed only when the valve is fully closed

bo, *b* contact that changes position at or near the open position of the valve, that is, open only when the valve is fully open

a25, *a* contact that changes position when the valve is 25% open, that is, closed only when the valve is open 25% or more

a75, *a* contact that changes position when the valve is 75% open, that is, closed only when the valve is open 75% or more

b25, *b* contact that changes position when the valve is 25% open, that is, closed only when the valve is open less than 25%

b75, *b* contact that changes position when the valve is 75% open, that is, closed only when the valve is open less than 75%

Example:

$\frac{20\,BL}{ac}$ designates an auxiliary switch, on a block valve, that is open only when the valve is fully closed

$\frac{20\,D}{a\,10}$ designates an auxiliary switch, on a discharge valve, that is open except when the valve is 10% or more open

Fig 1
Valve

and if their meaning is clearly indicated. For example, in the case of an early-opening auxiliary switch on a power circuit breaker, adjusted to open when the breaker is tripped before the main contacts part, it may be thus described and then designated as an *ae* auxiliary switch.

4.1.2 Auxiliary Switches for Devices Without a Standard Reference Position. In designating position switches for such a special device as, for example, a fuel transfer device, which has no standard reference or nonoperated position and may be placed in either extreme or any intermediate position for normal operation, *a* and *b* designations are still applicable. However, a percentage figure of the "full open" or "on" position should always be used, and, for the sake of consistency, this percentage should always be in terms of the position that is 50% or more of the "full open" or "on" position, as shown in Fig 2.

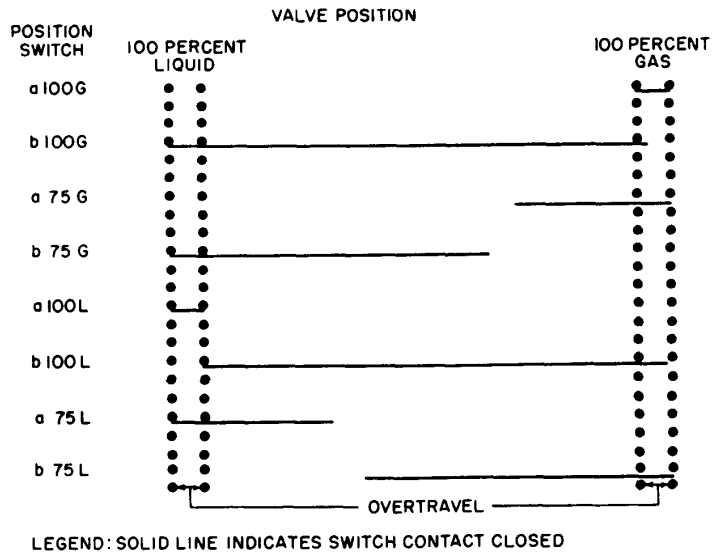
4.1.3 Auxiliary Switches for Circuit Breaker Operating Mechanisms. For the mechanically trip-free mechanism of a circuit breaker:

aa Contact that is open when the operating mechanism of the main device is in the nonoperated position and that closes when the operating mechanism assumes the opposite position

bb Contact that is closed when the operating mechanism of the main device is in the nonoperated position and that opens when the operating mechanism assumes the opposite position

The part of the stroke at which the auxiliary switch changes position should, if necessary, be specified in the description. LC is used to designate the latch-checking switch of such a mechanism, which is closed when the mechanism linkage is relatched after an opening operation of the circuit breaker.

4.2 Limit Switches. LS designates a limit switch. This is a position switch that is actuated by a main device, such as a rheostat or valve, at or near its extreme end of travel. Its usual function is to open the circuit of the operating device, but it may also serve to give an indication that the main device has reached an extreme position of travel. The designations *ac*, *ao*, *bc*, and *bo*, given in Fig 1, are actually more descriptive for valve limit



Each of the eight positions can be described as follows:

a100G, closed only when 100% of the fuel being supplied is gas

b100G, closed only when less than 100% of the fuel being supplied is gas

a75G, closed only when 75% or more of the fuel being supplied is gas

b75G, closed only when less than 75% of the fuel being supplied is gas

a100L, closed only when 100% of the fuel being supplied is liquid

b100L, closed only when less than 100% of the fuel being supplied is liquid

a75L, closed only when 75% or more of the fuel being supplied is liquid

b75L, closed only when less than 75% of the fuel being supplied is liquid

Fig 2
Fuel Transfer Device

switches than such designations as LSC or LSO. Also, in the case of a fuel transfer device as covered in 4.1.2, designations such as a100G, b100G, a100L, and b100L are more descriptive than LS designations. In both cases they indicate whether the specific contact is an *a* contact or a *b* contact.

4.3 Torque Limit Switches. This is a switch that is used to open an operating motor circuit at a desired torque limit at the extreme end of travel of a main device, such as a valve. It should be designated as follows:

tqc Torque limit switch, opened by a torque-responsive mechanism, that stops valve closing

tqo Torque limit switch, opened by a torque-responsive mechanism, that stops valve opening

4.4 Other Switches. If several similar auxiliary, position, and limit switches are present on the same device, they should be designated with such supplementary numerical suffixes as 1, 2, 3, etc., when necessary.

4.5 Representation of Device Contacts on Electrical Diagrams

4.5.1 Contacts With Defined Reference Position. On electrical diagrams, the *b* contacts of all devices as described in 4.1 to 4.1.3, including those of relays and those with suffix letters or percentage figures, should be shown as closed contacts, and all *a* contacts should be shown as open contacts. The use of the single letters *a* and *b* with the contact representation is generally superfluous on the diagrams. However, these letters are a convenient means of reference in the text of instruction books, articles, and other publications (see Fig 3 and IEEE Std 315-1975 [2] for representation of closed and open contacts on electrical diagrams).

4.5.2 Contact Opening and Closing Settings. The opening and closing settings of the contacts and auxiliary, position, and limit switches, covered in 4.1 to 4.3 should, when necessary for the ready understanding of the operation of the devices in the equipment, be indicated on the elementary diagram for each such contact. In the case of relay contacts, this indication would consist of the numerical settings; in the case of the switches, this indication would consist of a chart similar to those shown in Figs 1 and 2, respectively.

4.5.3 Devices Without a Standard Reference Position. For those devices that have no de-energized or nonoperated position, such as manually-operated transfer or control switches (including those of the spring-return type) or auxiliary position indicating contacts on the housings or enclosures of a removable circuit breaker unit, the preferred method of representing these contacts is normally open. Each contact should, however, be identified on the elementary diagram as to when it closes.[11] For example, the contacts of the manual-automatic transfer switch, device 43, which are closed in the automatic position, would be identified with the letter A, and those that are closed in the manual position would be identified with the letter M; and the auxiliary position switches on the housing 52 TOC of a removable circuit breaker unit, which are open when the unit is not in the connected position, may be identified by

$$\frac{52\ \text{TOC}}{\text{a}}$$

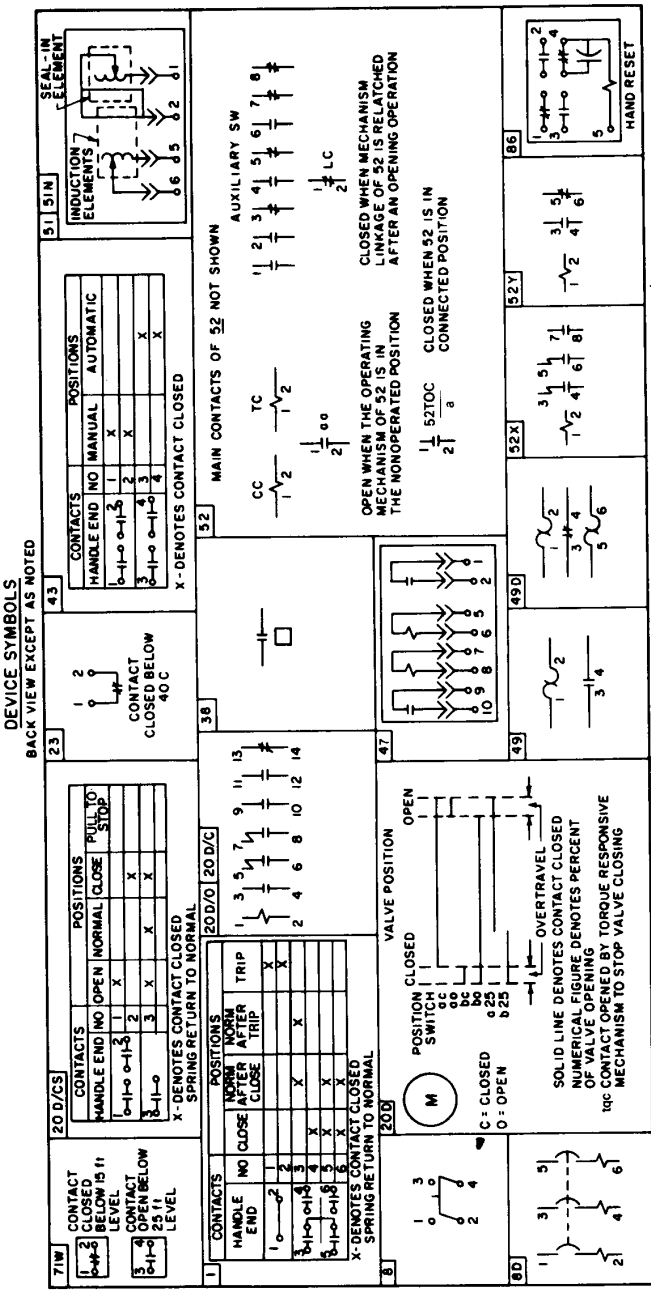
and those that are closed when the unit is not in the connected position may be identified by

$$\frac{52\ \text{TOC}}{\text{b}}$$

as shown in IEEE C37.20.1-1987 [4] and IEEE C37.20.2-1987 [5].

In the case of latched-in or hand-reset relays, which operate from protective devices to perform the shutdown of a piece of equipment and hold it out of service, the contacts should preferably be shown in the normal, nonlockout position. In general, any devices, such as electrically operated latched-in relays, that have no de-energized or nonoperated position and have not been specifically covered in the above paragraphs or under 4.1, should have their contacts shown in the position most suitable for the ready understanding of the operation of the devices in the equipment. Sufficient description should be present, as necessary, on

[11]This information should be included on that part of the elementary diagram, either with the device symbol or with the contacts in the circuit diagram itself, where most convenient for the ready understanding of the operation of the devices and equipment.



Device Function Numbers

1	Master element (control switch)
8	Control power switch
8D	Control power circuit breaker for 20D
20D	Discharge valve
20D/CS	Control switch for 20D
20D/C	Closing contactor for 20D
20D/O	Opening contactor for 20D
23	Temperature control device
38	Bearing protective device
43	Manual transfer switch
47	Phase sequence voltage relay
49	Machine thermal relay
49D	Thermal relay for 20D motor
51	AC time overcurrent relay
51N	AC time overcurrent relay (neutral)
52	AC circuit breaker
52TOC	Housing auxiliary position switch
52X	Auxiliary relay for 52 (closing)
52Y	Auxiliary relay for 52 (antipump)
71W	Water level switch
86	Locking-out relay

Abbreviations

A	Automatic
AM	Ammeter
AMP	Ampere
CC	Closing coil
CT	Current transformer
HR	Hand reset
M	Manual
MOT	Motor
SI	Seal in
SW	Switch
TC	Trip coil
V	Volt
VT	Voltage transformer
W	Watt

Fig 3a
Typical Elementary Diagram

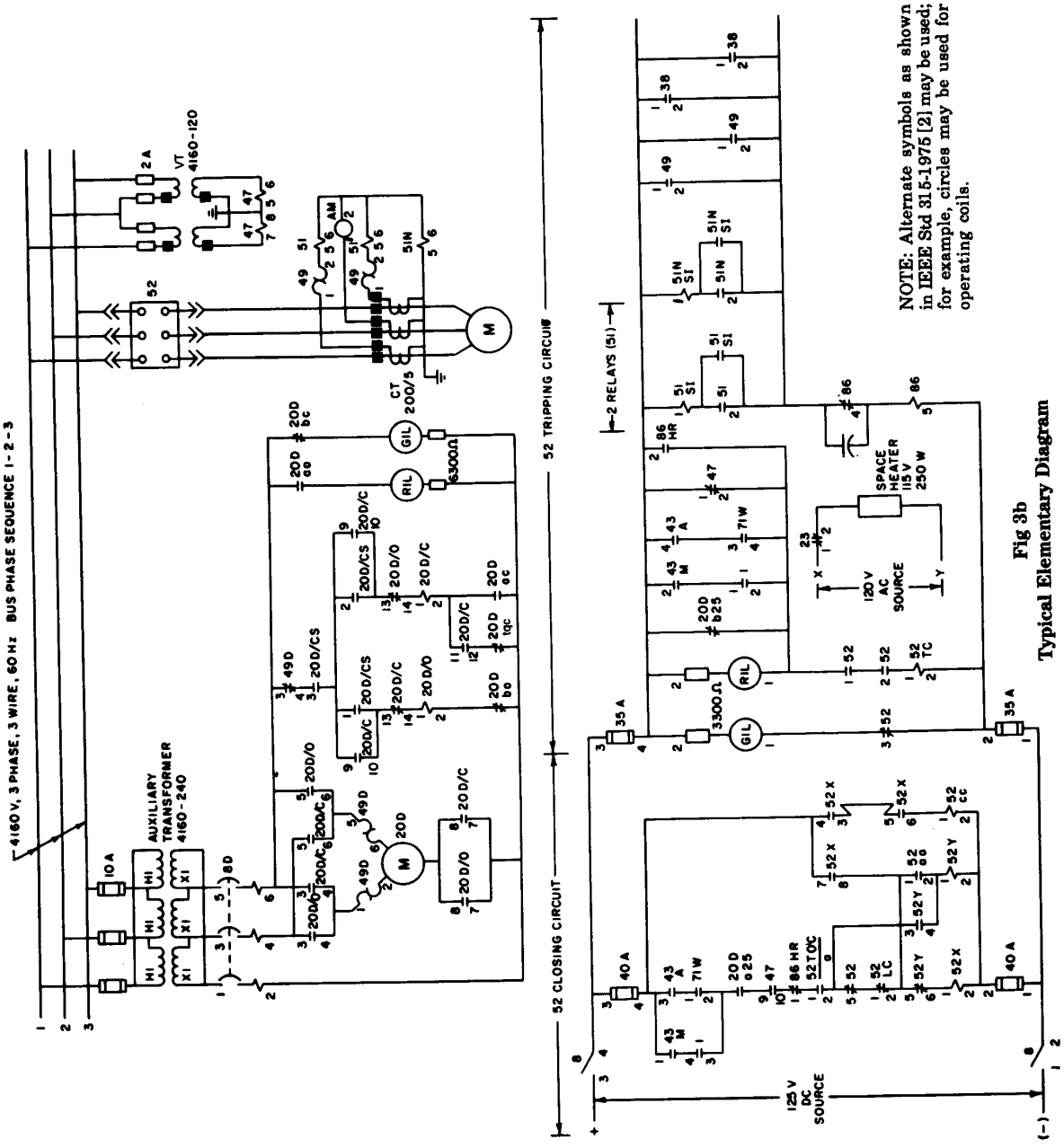


Fig 3b
Typical Elementary Diagram

the elementary diagram to indicate the contact operation.[12]

4.5.4 Recommended Representation of Device Functions and Contacts on Drawings. The typical elementary diagrams in Figs 3a and 3b illustrate the recommended method of representing the contacts of typical devices on an elementary diagram. All other representations and features, except those specifically covered in other standards, are illustrative only and are not necessarily generally accepted practice.

[12]See footnote 11.