A-90-20

ANSI/IEEE Std 315A-1986
24 December, 1986
(Supplement to
ANSI Y32.2-1975,
ANSI/IEEE Std 315-1975)

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THIS DOCUMENT CONTAINS 1 PAGES.

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(Supplement to ANSI Y32.2-1975,
ANSI/IEEE Std 315-1975)

American National Standard
IEEE Standard

Supplement to Graphic Symbols for Electrical and Electronics Diagrams

Published by
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American National Standard
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Supplement to Graphic Symbols for Electrical and Electronics Diagrams

Sponsor
IEEE Standards Coordinating Committee 11, Graphic Symbols
Institute of Electrical and Electronics Engineers

Approved September 19, 1985
Institute of Electrical and Electronics Engineers

Approved November 15, 1985
American National Standards Institute

The Institute of Electrical and Electronics Engineers, Inc
345 East 47th Street, New York, NY 10017, USA

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Foreword

(This Foreword is not a part of ANSI/IEEE Std 315A-1986, Supplement to Graphic Symbols for Electrical and Electronics Diagrams.)

This standard supplements ANSI/IEEE Std 315-1975 by providing symbols approved by the International Electrotechnical Commission since 1975, or for which there is now a greater need in the United States arising from international commerce. It is believed that immediate issue of this supplement is preferable to the inevitable delay that would occur if a complete and proper revision of ANSI/IEEE Std 315-1975 were undertaken.

Besides adding new symbols, some updating of the information in ANSI/IEEE Std 315-1975 has been undertaken. The updating includes references to other standards, IEC labels on symbols where a change has occured, and correction of errors.

This supplement is based on IEC Publication 617, Parts 2 through 11 and Part 13 as published in 1983. IEC Publication 617, Part 12 is included in full in ANSI/IEEE Std 91-1984, IEEE Standard Graphic Symbols for Logic Functions.

When this standard was approved SCC 11.1 had the following membership:

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Contents

SECTION PAGE

Section 25 Telecommunications Transmission

American National Standard
IEEE Standard

Supplement to Graphic Symbols for Electrical and Electronics Diagrams

AA1. Purpose

This supplement is intended to provide additional graphic symbols and information on internationally approved graphic symbols needed for use for electrical and electronics diagrams.

AA2. Scope

This supplement provides graphic symbols for use on all electrical or electronics diagrams except for those required for

(1) Logic circuit diagrams. See ANSI/IEEE Std 91-1984 [4][1].

(2) Architectural plans. See ANSI Y32.9-1972 [2] and IEC Publication 617 (1983) [22] Part 11, ch IV.

(3) Street maps and building system layouts for cable TV application. See ANSI/IEEE Std 623-1976 [8] and IEC Publication 617 (1983) [22], Part 11, ch III.

AA3. Organization

This supplement places the IEC Publication 617 new material in a practical sequence with related material in ANSI/IEEE Std 315-1975 [7]. Except where the nature of the revisions dictate otherwise (for reasons of clarity) existing ANSI/IEEE Std 315-1975 [7] text is not repeated.

[1] Numbers in brackets correspond to those of the references listed in Section AA4.

AA4. References

This standard shall be used in conjunction with the following publications:

[1] ANSI Y1.1-1972 (R 1984), Abbreviations for Use On Drawings and In Text.[2]

[2] ANSI Y32.9-1972, American National Standard Graphic Symbols for Electrical Wiring and Layout Diagrams Used in Architecture and Building Construction.

[3] ANSI/IEEE Std C37.2-1979, IEEE Standard Electrical Power System Device Function Numbers.[3]

[4] ANSI/IEEE Std 91-1984, IEEE Standard Graphic Symbols for Logic Functions.

[5] ANSI/IEEE Std 260-1978, IEEE Standard Letter Symbols for Units of Measurement.

[6] ANSI/IEEE Std 280-1985, IEEE Standard Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

[7] ANSI/IEEE Std 315-1975, Graphic Symbols for Electrical and Electronics Diagrams.

[8] ANSI/IEEE Std 623-1976, Graphic Symbols for Grid and Mapping Diagrams Used in Cable Television Systems.

[2] ANSI publications are available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

[3] IEEE publications are available from IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854.

[9] IEC Publication 27-1 (1971) Part 1: General. Letter Symbols to be Used in Electrical Technology.[4]

[10] IEC Publication 417 (1973), Graphic Symbols for Use on Equipment.

[11] IEC Publication 445 (1973), Identification of Apparatus Terminals and General Rules for a Uniform System of Terminal Marking, Using an Alphanumeric Notation.

[12] IEC Publication 617-1 (1985) Part 1: General Information, General Index. Cross-Reference Tables.

[13] IEC Publication 617-2 (1983) Part 2: Symbol Elements, Qualifying Symbols and Other Symbols Having General Application.

[14] IEC Publication 617-3 (1983) Part 3: Conductors and Connecting Devices.

[15] IEC Publication 617-4 (1983) Part 4: Passive Components.

[16] IEC Publication 617-5 (1983) Part 5: Semiconductors and Electron Tubes.

[17] IEC Publication 617-6 (1983) Part 6: Production and Conversion of Electrical Energy.

[18] IEC Publication 617-7 (1983) Part 7: Switchgear, Controlgear, and Protective Devices.

[19] IEC Publication 617-8 (1983) Part 8: Measuring Instruments, Lamps, and Signaling Devices.

[20] IEC Publication 617-9 (1983) Part 9: Telecommunications: Switching and Peripheral Equipment.

[21] IEC Publication 617-10 (1983) Part 10: Telecommunications: Transmission.

[22] IEC Publication 617-11 (1983) Part 11: Architectural and Topographical Installation Plans and Diagrams.

[23] IEC Publication 617-12 (1983) Part 12: Binary Logic Elements.

[24] IEC Publication 617-13 (1978) Part 13: Analog Elements.

[25] ISO 31, Parts 0-11 (1974-1980), Quantities, Units, Symbols, Conversion Factors, and Conversion Tables.[5]

[4] IEC Publications are available in the United States from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018, USA. The IEC publications are also available from International Electrotechnical Commission, 3, rue de varembé, Case postale 131, CH 1211—Geneva 20, Switzerland.

[5] ISO publications are available in the United States from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018, USA. ISO publications are also available from the International Organization for Standardization, 1, rue de Varembé, Case postale 56, CH 1211, Geneva 20, Switzerland.

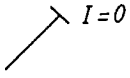
1.1.1.2 Preset, general

IEC 

Add:

Information on the conditions under which adjustment is permitted may be shown near the symbol.

1.1.1.2.1 Application: preset adjustment permitted only at zero current.

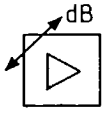
IEC 

After 1.1.4.2
Add:

1.1.5 Automatic (inherent) control
The controlled quantity may be indicated adjacent to the symbol.

IEC 

1.1.5.1 Application: Amplifier with automatic gain control

IEC 

1.2.1 Temperature dependence

IEC $t°$

Add:

OR

IEC θ

After 1.2.5
Add:

1.2.6 Thermal effect

IEC 

1.2.7 Electromagnetic effect

IEC 

1.2.8 Magnetostrictive effect

IEC 

After 1.3.1
Add:

1.3.1.1 Coherent radiation, nonionizing (for example coherent light)

IEC 

1.3.2 Radiation, ionizing

IEC 

Revise the NOTE to read as follows:

NOTE 1.3.2A: If it is necessary to show the specific type of ionizing radiation, the symbol may be augmented by the addition of symbols or letters such as the following:

Alpha particle	α
Beta particle	β
Gamma ray	γ
Deutron	d
Proton	p
Neutron	n
Pion	π
K-meson	K
Muon	μ
X ray	X

Add:

IEC Designations

α = alpha particle
β = beta particle
γ = gamma ray
δ = deuteron
ρ = proton
η = neutron
π = pion
κ = K meson
μ = muon
X = X ray

1.4.3 Solid

Add:

OR

IEC 

See NOTE 1.4A

After 1.4.5
Add:

1.4.6 Material, semiconducting

IEC 

1.4.7 Material, insulating

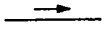
IEC 

1.7 Direction of Flow of Power, Signal, or Information

Avoid conflict with symbols 9.5, 9.5.2, and 9.5.4 if used on the same diagram

1.7.1 One-way

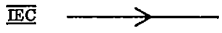
NOTE 1.7.1A: The lower symbol is used if it is necessary to conserve space. The arrowhead in the lower symbol shall be filled.



OR

Add:

OR

IEC 

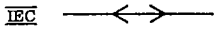
See NOTE 1.7.1A

1.7.2 Either way (but not simultaneously)

OR

Add:

OR

IEC 

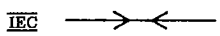
See NOTE 1.7.1A

1.7.3 Both ways, simultaneously

OR

Add:

OR

IEC 

See NOTE 1.7.1A

Avoid conflict with symbol 9.2 if used on the same diagram

After 1.7.5
Add:

1.7.6 Transmission

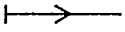
NOTE 1.7.6A: The dot may be omitted if the sense is unambiguously given by the arrowhead in combination with the symbol to which it is applied.

IEC

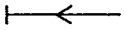
1.7.7 Reception
See NOTE 1.7.6A

IEC 

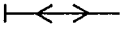
1.7.8 Energy flow from the busbars

IEC 

1.7.9 Energy flow towards the busbars

IEC 

1.7.10 Bidirectional energy flow

IEC 

1.8.1
Add:

The voltage may be indicated at the right of the symbol and the type of system at the left.

1.8.1.1 Application: Direct current, three conductors including midwire, 220 V (110 V between each outer conductor and midwire)

2M may be replaced by 2 + M

IEC 2M — 220/110 V

1.8.2 Alternating current

IEC ~

Add:

The numerical value of the frequency or the frequency range may be added at the right-hand side of the symbol.

The voltage may also be indicated to the right of the symbol.

The number of phases and the presence of a neutral may be indicated at the left-hand side of the symbol.

1.8.2.1 Application: Alternating current of 60 Hz

IEC ~ 60 Hz

1.8.2.2 Application: Alternating current frequency range 100 kHz to 600 kHz

IEC ~ 100...600 kHz

1.8.2.3 Application: Alternating current: three-phase with neutral, 60 Hz, 480 V (277 V between phase and neutral).

3N may be replaced by 3 + N

IEC 3N ~ 60 Hz 480/277 V

1.8.2.4 Neutral

This symbol for neutral is given in IEC Publication 445 (1973) [11].

IEC N

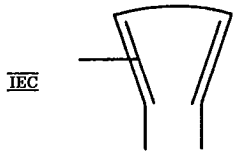
1.8.2.5 Midwire

This symbol for midwire is given in IEC Publication 445 (1973) [11].

IEC M

After 1.10.4
Add:

1.10.5 Conductive coating on internal surface of envelope

IEC 

Add:

1.14 Operational Dependence On a Characteristic Qauntity

1.14.1 Operating when the characteristic quantity is higher than the setting value

IEC >

1.14.2 Operating when the characteristic quantity is lower than the setting value

IEC <

1.14.3 Operating when the characteristic quantity is either higher than a given high setting or lower than a given low setting

IEC ≷

1.14.4 Operating when value of the characteristic quantity becomes zero

IEC = 0

1.14.5 Operating when the value of the characteristic quantity differs from zero by an amount which is very small compared with the normal value

IEC ≈ 0

1.15 Signal Identifiers

The symbol shall be used only when it is necessary to distinguish between analog and digital signals.

1.15.1 Identifier of analog signals

IEC ∩

1.15.2 Identifier of digital signals

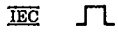
IEC #

A time-sequence number (m) of bits may be denoted m #.

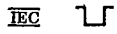
1.16 Signal Waveforms

Each symbol represents an idealized shape of the waveform.

1.16.1 Positive-going pulse

IEC 

1.16.2 Negative-going pulse

IEC 

1.16.3 Pulse of alternating current

IEC 

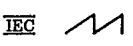
1.16.4 Positive-going step function

IEC 

1.16.5 Negative-going step function

IEC 

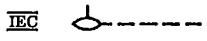
1.16.6 Sawtooth

IEC 

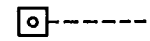
1.17 Control by Nonelectrical Quantities

Letter symbols from ANSI/IEEE Std 280-1985 [6], may be used to denote other operating quantities than those shown below (for example pressure or speed). They should be enclosed in a rectangle if ambiguity could otherwise arise.

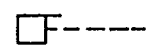
1.17.1 Control by fluid level

IEC 

1.17.2 Control by number of events
Control by a counter

IEC 

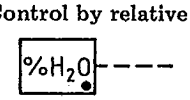
1.17.3 Control by flow

IEC 

1.17.3.1 Application: Control by gas flow

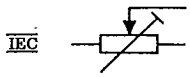
IEC

1.17.4 Control by relative humidity

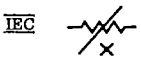
IEC 

After 2.1.4
Add:

2.1.4.1 Application: preset adjustable resistor

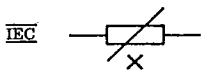


2.1.7 Magnetoresistor (intrinsic) (linear type shown)



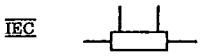
Add:

OR

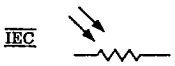


After 2.1.9
Add:

2.1.9.1 Shunt
Resistor with separate current and voltage terminals

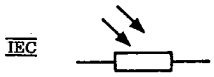


2.1.13 Symmetrical photoconductive transducer (resistive)



Add:

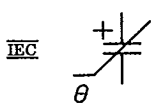
OR



After 2.2.2
Add:

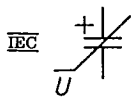
2.2.2.1 Temperature dependent polarized capacitor, where deliberate use is made of the temperature coefficient, for example, ceramic capacitor.

NOTE 2.2.2.1A: θ may be replaced by $t°$.



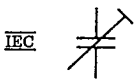
2.2.2.2 Voltage dependent polarized capacitor, where deliberate use is made of the voltage dependent characteristic, for example, semiconductor capacitor

NOTE 2.2.2.2A: *U* may be replaced by V.



After 2.2.4
Add:

2.2.4A Capacitor with preset adjustment

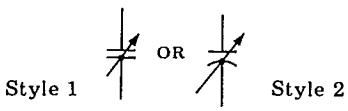


2.2.4.1 With moving element indicated

Revise NOTE 2.2.4.1A *to read as follows:*

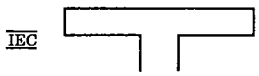
NOTE 2.2.4.1A: If it is desired to indicate the moving element, the common intersection of the moving element with the symbol for variability and the connecting line is marked with a dot.

See General Symbols 2.2.1 and NOTE 2.2B

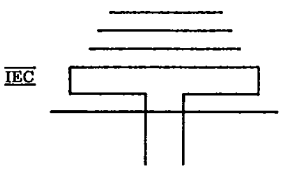


After 2.3.2
Add:

2.3.2.1 Folded dipole

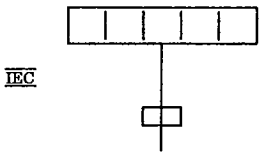


2.3.2.2 Folded dipole, shown with three directors and one reflector

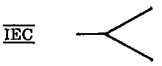


After 2.3.3
Add:

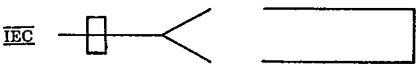
2.3.3.1 Slot antenna, shown with rectangular waveguide feeder



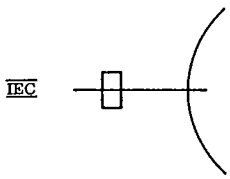
2.3.3.2 Horn antenna
Horn feed



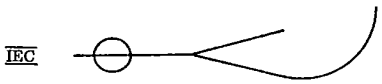
2.3.3.3 Cheese (box) reflector with horn feed, shown with rectangular waveguide feeder



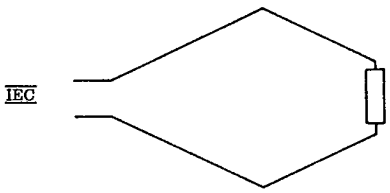
2.3.3.4 Paraboloidal antenna, shown with retangular waveguide feeder



2.3.3.5 Horn-reflector antenna, shown with circular waveguide feeder

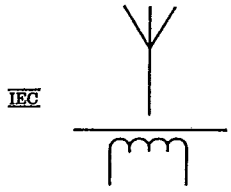


2.3.3.6 Rhombic antenna, shown terminated by a resistor



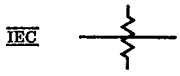
2.3.3.7 Magnetic rod antenna, for example ferrite.

If there is no risk of confusion, the general antenna symbol may be omitted.



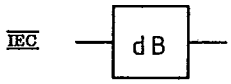
2.4 Attenuator

2.4.1 Fixed attenuator F ; pad (general)



Add:

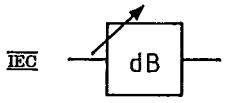
OR



2.4.4 Variable attenuator F (general)

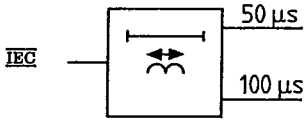
Add:

OR

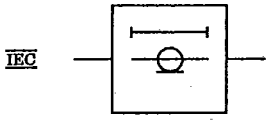


After **2.6.1**
Add:

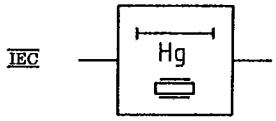
2.6.1.1 Magnetostrictive delay line shown with one input and two outputs giving delays of 50 μs and 100 μs



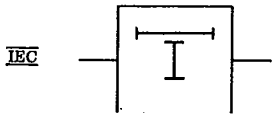
2.6.1.2 Coaxial delay line



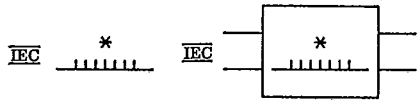
2.6.1.3 Mercury delay line with piezoelectric transducers



2.6.1.4 Delay line comprising an artificial line



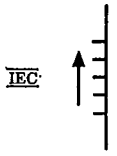
2.6.4 Slow-wave structure



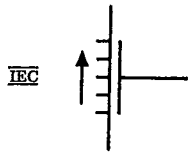
* See NOTE 2.6.1A

Add:

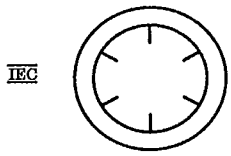
2.6.4.1 Open slow-wave structure (arrow indicates direction of energy flow)



2.6.4.2 Single electrode for electostatic focusing along open slow-wave structure



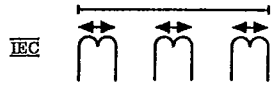
2.6.4.3 Closed slow-wave structure, shown with envelope



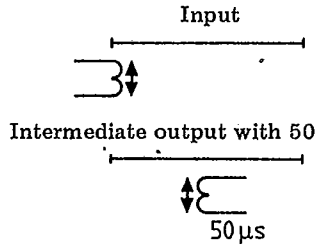
2.6.5 Delay Line Circuits

2.6.5.1 Magnetostrictive delay line with windings; three windings shown in assembled representation

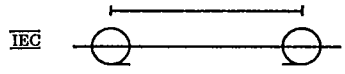
NOTE 2.6.5.1A: The winding symbols may be oriented as required



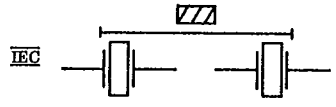
2.6.5.2 Magnetostrictive delay line with windings; one input and two outputs shown in detached representation



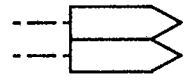
2.6.5.3 Coaxial delay line



2.6.5.4 Solid material delay line with piezoelectric transducers

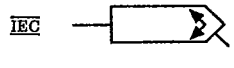


2.9.6‡ Stereo

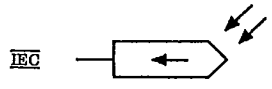


Add:

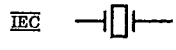
2.9.6.1 Stylus-operated stereophonic head



2.9.7 Light sensitive reproducing (reading, playback) head, monophonic

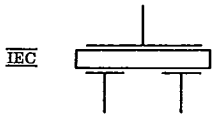


2.10 Piezoelectric Crystal Unit (including Crystal Unit, Quartz F)

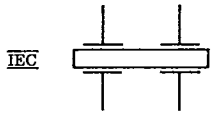


Add:

2.10.1 Piezoelectric crystal with three electrodes

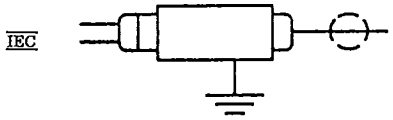


2.10.2 Piezoelectric crystal with two pairs of electrodes



Add:

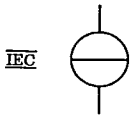
2.17.1 Ignition unit, high energy



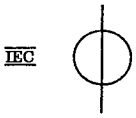
Add:

2.18 Ideal Circuit Elements

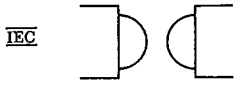
2.18.1 Ideal current source



2.18.2 Ideal voltage source



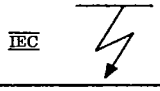
2.18.3 Ideal gyrator



2.19 Faults

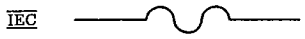
2.19.1 Fault
(indication of assumed fault location)

2.19.2 Flashover
Breakthrough



After 3.1.2.3
Add:

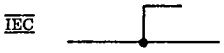
3.1.2.4 Flexible conductor



3.1.6 Junction of paths or conductors

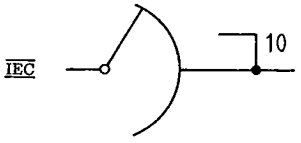
After 3.1.6.3
Add:

3.1.6.3A Connection common to a group of similar items



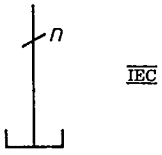
The total number of similar items may be indicated by a figure near the common connection symbol.

3.1.6.3A.1 *EXAMPLE:* Multiple uniselector banks shown for 10 banks

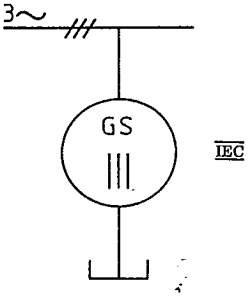


After 3.1.6.5
Add:

3.1.6.6 Neutral point in multiphase system, shown in single-line representation



3.1.6.6.1 *EXAMPLE:* Synchronous generator, three-phase; both leads of each phase brought out, shown with external neutral point

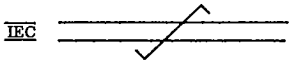


3.1.7.2 Twisted (shown with two twisted conductors)

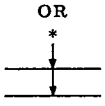
NOTE 3.1.7.2A: The asterisk is not part of the symbol. Always replace the asterisk by one of the following letters:
P = Pair
T = Triple

Add:

OR



OR



*See NOTE 3.1.7.2A

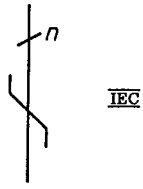
After 3.1.8.6
Add:

3.1.8.7

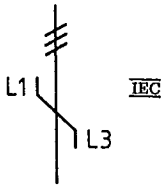
Interchange of conductors; change of phase sequence or inversion of polarity, shown for *n* conductors in single-line representation.

The interchanged conductors may be indicated.

For the identification of the conductors, IEC Publication 445 (1973) [11] applies.



3.1.8.7.1 *EXAMPLE:* Change of phase sequence

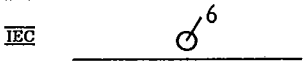


After 3.2.6.2
Add:

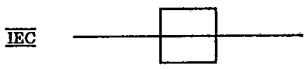
3.2.7 Duct or pipe

NOTE 3.2.7A: The number of ducts, the crosse-section dimensions or other particulars, such as duct occupancy, may be shown above the line representing the duct route.

3.2.7.1 *EXAMPLE:* Line of six-way duct

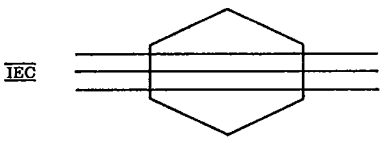


3.2.8 Line with manhole, giving access to jointing chamber

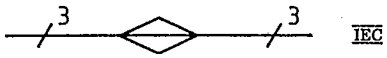


3.2.9 Straight-through joint box, shown with three conductors:

Multiline representation

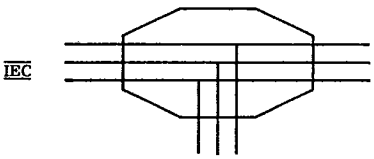


3.2.9.1 Single-line representation

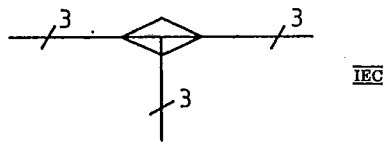


3.2.10 Junction box, shown with three conductors with T-connections:

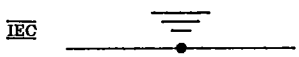
Multiline representation



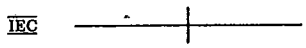
3.2.10.1 Single-line representation



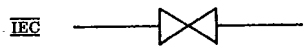
3.2.11 Line with buried jointing point



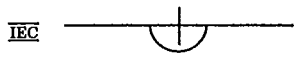
3.2.12 Line with gas or oil block



3.2.13 Line with gas or oil stop valve



3.2.14 Line with gas or oil block by-pass



3.2.15 Power feeding

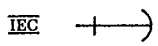
3.2.15.1 Power feeding (ac) on telecommunication lines

3.2.15.2 Power feeding (dc) on telecommunication lines

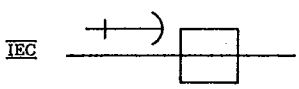
3.2.16 Anticreepage device

Anticreepage device for cable

NOTE 3.2.16A: The symbol should be shown on the *creepout* side of the manhole.

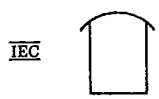


3.2.16.1 *EXAMPLE:* Manhole equipped with anticreepage device for cable (Creepage to the left is prevented)

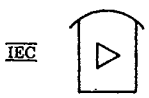


3.2.17 Overground, weatherproof enclosure, general symbol

NOTE 3.2.17A: Qualifying symbols or designations may be used to indicate the apparatus contained in the enclosure.



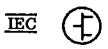
3.2.17.1 *EXAMPLE:* Amplifying point in a weatherproof enclosure



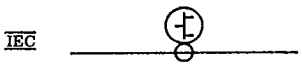
3.2.18 Crossconnection point

NOTE 3.2.18A: Inlets and outlets may be oriented as required.

3.2.19 Line concentrator
Automatic line connector

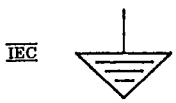


3.2.19.1 *EXAMPLE:* Line concentrator on a pole

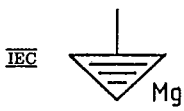


3.2.20 Protective anode

NOTE 3.2.20A: The type of anode material may be indicated by adding its chemical letter symbol.

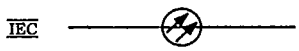


3.2.20.1 *EXAMPLE:* Magnesium protective anode



After 3.6.7
Add:

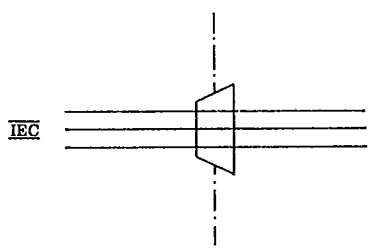
3.6.8 Optical fiber



After 3.10
Add:

3.10.1 Pressure-tight bulkhead cable gland; shown with three cables

NOTE 3.10.1A: The high-pressure side is the longer side of the trapezoid thus retaining gland in bulkhead.



4.1 Switching Function

NOTE 4.1A: Switching function symbols are suitable for use on *detached contact* diagrams, but may be used in other applications.

Add:

4.1A Qualifying Symbols for Contacts (IEC Publication 617-7 (1983) [18])

4.1A.1 Contactor function

IEC

4.1A.2 Circuit-breaker function

IEC ×

4.1A.3 Disconnector (isolator) function

IEC —

4.1A.4 Switch-disconnector (isolating-switch) function

IEC

4.1A.5 Automatic release function

IEC ■

4.1A.6 Position switch function
Limit switch function

NOTE 4.1A.6A: This qualifying symbol can be applied to simple contact symbols to indicate position or limit switches if there is no need to show the means of operating the contact. In complicated cases, where it is desirable to show the means of operation, symbols 14.4.16 to 14.4.16.3 should be used instead.

NOTE 4.1A.6B: This symbol is placed on both sides of the contact symbol when the contact is mechanically operated in both directions.

IEC

4.1A.7 Spring return function

NOTE 4.1A.7A: This symbol may be used to indicate spring return function. When this convention is invoked its use should be appropriately referenced.

NOTE 4.1A.7B: This symbol should not be used together with qualifying symbols 4.1A.1, 4.1A.2, 4.1A.3, and 4.1A.4. In many cases, symbol 14.5.1 may be used.

IEC

4.1A.8 Nonspring return (stay put) function

NOTE 4.1A.8A: This symbol may be used to indicate nonspring return function. When this convention is invoked, its use should be appropriately referenced.

NOTE 4.1A.8B: This symbol should not be used together with qualifying symbols 4.1A.1, 4.1A.2, 4.1A.3, and 4.1A.4. In many cases, symbol 14.5.2 may be used.

IEC

4.3 Basic Contact Assemblies

The standard method of showing a contact is by a symbol indicating the circuit condition it produces when the actuating device is in the de-energized or nonoperated position. The actuating device may be of a mechanical, electrical, or other nature, and a clarifying note may be necessary with the symbol to explain the proper point at which the contact functions; for example, the point where a contact closes or opens as a function of changing pressure, level, flow, voltage, current, etc. In cases where it is desirable to show contacts in the energized or operated condition and where confusion may result, a clarifying note shall be added to the drawing.

For designations of auxiliary switches or contacts for circuit breakers, etc, see ANSI/IEEE C37.2-1979 [3].

Add:

4.3A IEC Publication 617-7 (1983) [18] Coordinated System

This section provides preferred symbols for contact units and switchgear. Each symbol depicts the function of a contact or a switching device, without necessarily being related to the construction of the device it represents.

A small circle, open or filled in, representing the hinge-point may be added to most of the symbols for contacts, switches, and controlgear. See for example 4.3A.1.1.1.

For clarity this symbol must be shown on some symbols, see for example 4.3A.1.4.

4.3A.1 Contacts with two or three positions

4.3A.1.1 Make contact

NOTE 4.3A.1.1A: This symbol is also used as the general symbol for a switch.

IEC

Form 1

4.3A.1.1.1

IEC

Form 2

4.3A.1.2 Break contact

IEC

4.3A.1.3 Change-over break before make contact

IEC

4.3A.1.4 Two-way contact with center-off position

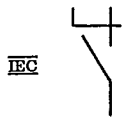
IEC

4.3A.1.5 Changeover make before break contact (bridging)

IEC

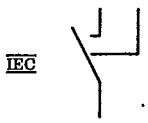
Form 1

4.3A.1.5.1

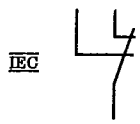


Form 2

4.3A.1.6 Contact with two makes



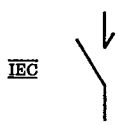
4.3A.1.7 Contact with two breaks



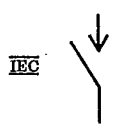
4.3A.2 Passing contacts with two positions

4.3A.2.1 Passing make contact closing momentarily when its operating device is actuated

4.3A.2.2 Passing make contact closing momentarily when its operating device is released



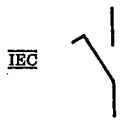
4.3A.2.3 Passing make contact closing momentarily when its operating device is actuated or released



4.3A.3 Early and late operating contacts

4.3A.3.1 Make contact (of a multiple contact assembly) which is early to close relative to the other contacts of the assembly

4.3A.3.2 Make contact (of a multiple contact assembly) which is late to close relative to the other contacts of the assembly

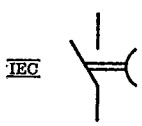


4.3A.3.3 Break contact (of a multiple contact assembly) which is late to open relative to the other contacts of the assembly

4.3A.3.4 Break contact (of a multiple contact assembly) which is early to open relative to the other contacts of the assembly

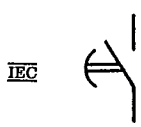
4.3A.4 Examples of contacts with intentional delay

4.3A.4.1 Make contact delayed when closing (operating device actuated)



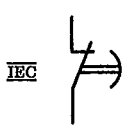
Form 1

4.3A.4.2



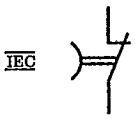
Form 2

4.3A.4.3 Break contact delayed when reclosing (operating device released)



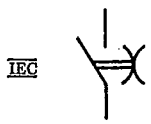
Form 1

4.3A.4.4

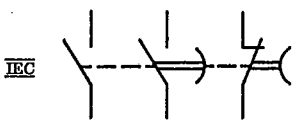


Form 2

4.3A.4.5 Make contact delayed when closing and opening

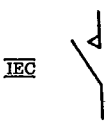


4.3A.4.6 Contact assembly with one make contact not delayed, one make contact delayed when reopening and one break contact delayed when opening

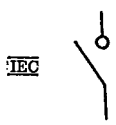


4.3A.5 Examples of spring return and nonspring return (stay put) contacts

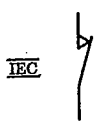
4.3A.5.1 Make contact with spring return



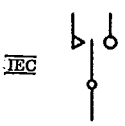
4.3A.5.2 Make contact without spring return (stay put)



4.3A.5.3 Break contact with spring return



4.3A.5.4 Two-way contact with center-off position with spring return from the left-hand position but not from the right-hand one (stay put)



Add:

4.3B ANSI/IEEE Std 315-1975 [7] System

4.3.1 Closed contact (break)

⋮ No change in existing symbols
4.3.8.3 but IEC approval will be withdrawn in the future.

Add:

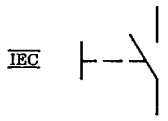
4.6.3 Indication of operating method

Former 4.6.3 *is now* 4.6.3.5

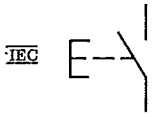
Devices with *push* or *pull* operation normally have spring return. It is therefore not necessary to show the automatic return symbol (14.5.1). On the other hand, a detent symbol (14.5.2) should be shown in the exceptional cases where locking exists.

Devices operated by turning do not usually have automatic return. It is therefore not necessary for the detent symbol (14.5.2) to be shown. On the other hand, the automatic return symbol (14.5.1) should be shown in those cases where an automatic return exists.

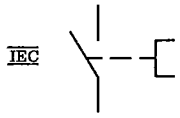
4.6.3.1 Manually operated switch; general symbol



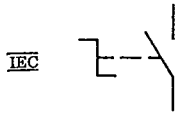
4.6.3.2 Push-button switch (nonlocking)



4.6.3.3 Pull-switch (nonlocking)



4.6.3.4 Turn-switch (locking)

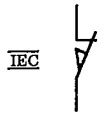


4.6.3.5 Knife switch F, general

4.14.5.3 Normally closed

Add:

OR



After 4.14.5.4
Add:

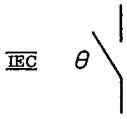
4.14.5.5 Position or limit switch mechanically operated in both directions with two separate circuits

4.21.1 Closes on rising temperature

See NOTE 4.21A

Add:

OR

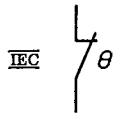


4.21.2 Opens on rising temperature

See NOTE 4.21A

Add:

OR



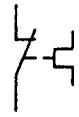
4.22 Flasher
Self-Interrupting Switch

OR

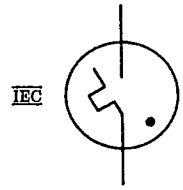
Add:

4.22.1 Self-operating thermal switch, break contact

NOTE 4.22.1A: It is important to distinguish between a contact as shown and a contact of a thermal relay, which in detached representation may be shown as follows:

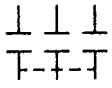


4.22.2 Gas discharge tube with thermal element
Starter for fluorescent lamp



Revise 4.29.1 *to read as follows:*

4.29.1 Manually operated 3-pole contactor

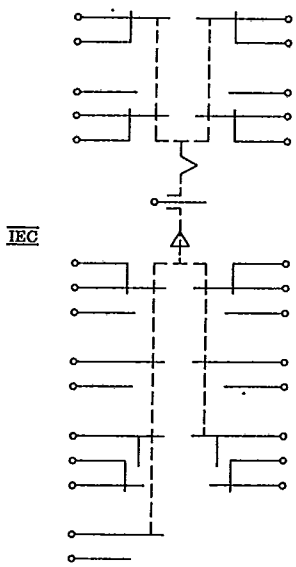


After 4.33
Add:

4.34 Multipole and Multiposition Switches (IEC Publication 617-7 (1983) [18]

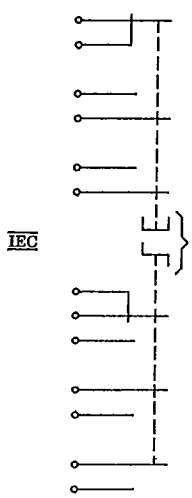
4.34.1 Key operated lever or turn switches (compare with 4.12 items)

4.34.1.1 Three position lever-operated switch, locking in the upper position and with spring return from the lower position to the middle one, shown with terminals

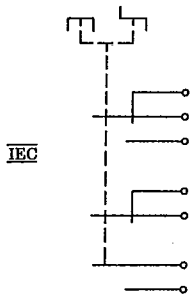


4.34.1.2 Button-operated switch in which one set of contacts is operated by pushing the button (nonlocking) and another set by turning it (locking), shown with terminals

The bracket indicates that there is only one actuator

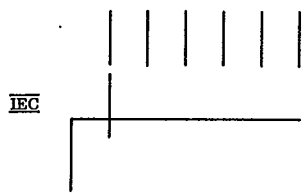


4.34.1.3 Button-operated switch in which the same set of contacts may be operated in two different ways; either by turning (with locking) or pushing (with spring return), shown with terminals

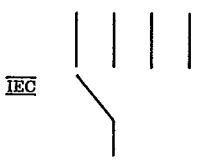


4.34.2 Multiposition Switches

4.34.2.1 Single-pole n-position switch, shown for $n = 6$

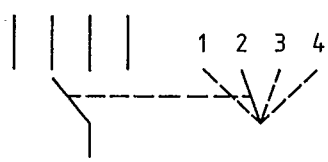


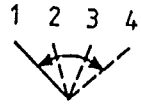
4.34.2.2 Single-pole n-position switch, alternative for use when n is small, shown for $n = 4$



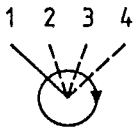
4.34.2.3 Example with position diagram

NOTE 4.34.2.3A: It is sometimes convenient to indicate the purpose of each switch position by adding text to the position diagram. It is also possible to indicate limitations of movement of the operating device as in the examples which follow:

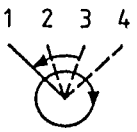




The operating device (for example handwheel) can be turned only from positions 1 to 4 and back.

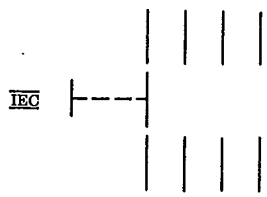


The operating device can be turned in the clockwise direction only.



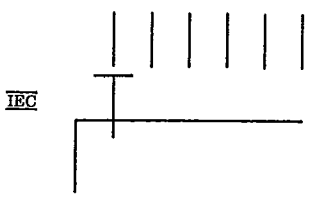
The operating device can be turned in the clockwise direction without limitation and may be turned in the counter-clockwise direction only between positions 3 and 1.

4.34.2.4 Four-position switch, manually operated, having four independent circuits

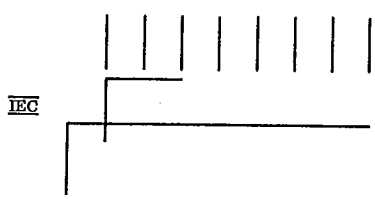


4.34.2.5 Single-pole, four-position switch in which position 2 cannot be connected

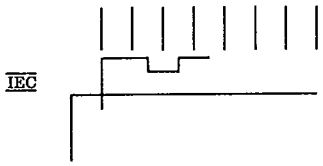
4.34.2.6 Single-pole, six-position switch with a wiper that bridges only while passing from one position to the next



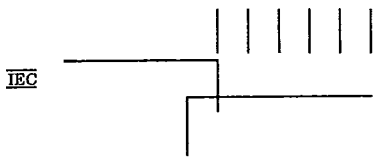
4.34.2.7 Single-pole multiposition switch with a wiper that bridges three consecutive terminals in each switch position



4.34.2.8 Single-pole multiposition switch with a wiper that bridges four terminals but omits one intermediate terminal in each switch position

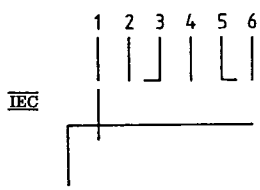


4.34.2.9 Single-pole multiposition switch for cumulative parallel switching



4.34.2.10 One pole of a six-position multipole switch

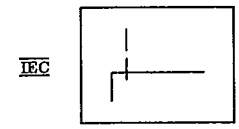
The pole shown makes earlier than the other poles when the wiper moves from position 2 to 3 and breaks later than the other poles when the wiper moves from position 5 to 6. When the wiper moves in the opposite direction the early make becomes a late break and vice versa



4.34.3 Block Symbols for Complex Switches

There are many ways in which complex switching functions can be achieved mechanically, for example by rotary wafer switches, slide switches, drum controllers, cam-operated contact assemblies, etc. There are also many ways in which the switching functions may be symbolized on circuit diagrams. Study has shown that there is no unique system of symbolization which is superior in every application. The system employed should be chosen with due regard to the purpose of the diagram and the degree of complexity of the switching device it is desired to symbolize. This section therefore presents one possible method of symbolizing complex switches. To facilitate understanding each example includes a constructional drawing of the device symbolized. The method shown here uses a general symbol for a complex switch which must be supplemented by a table of connections. Two examples are shown.

4.34.3.1 Complex switch, general symbol



4.34.3.2 *EXAMPLES:* 18-position rotary wafer switch with six terminals, here designated A to F, contructed as shown in the bottom diagram (switch shown in position 1)

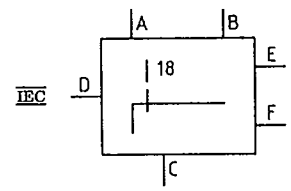
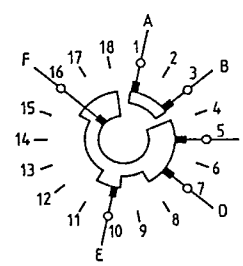


Table of connections

Position	Interconnections of terminals					
	A	B	C	D	E	F
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						



4.34.3.3 *EXAMPLE:* Six-position rotary drum switch with five terminals, constructed as shown in the bottom diagram

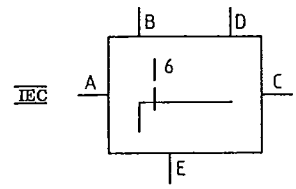
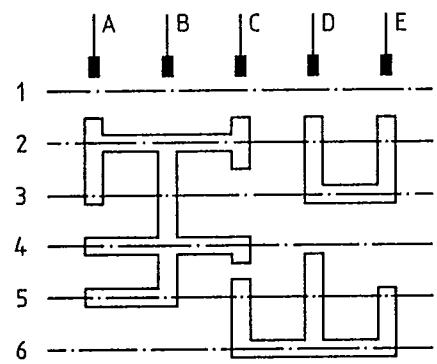


Table of connections

Position	Interconnections of terminals				
	A	B	C	D	E
1					
2	+		+	O	O
3	+	+	+	O	O
4	+	+	+	O	O
		+			
5	+	+	+ −	−	
6			−	−	−
			−	−	−

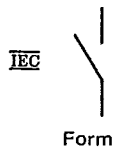


The symbols + − and O indicate the terminals that are connected together at any position (rest-position or intermediate position) of the switch, that is, terminals having the same indicating symbol for example, + are interconnected

NOTE 4.34.3.3A: Where additional symbols are required, the characters available on a typewriter should be used, for example, x, =.

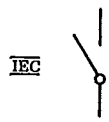
4.35 Switchgear and Controlgear

4.35.1 Switch (mechanical)



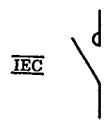
Form 1

OR



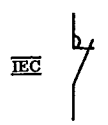
Form 2

4.35.2 Contactor (contact open in the unoperated position)

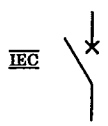


4.35.3 Contactor with automatic release

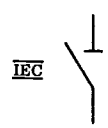
4.35.4 Contactor (contact closed in the unoperated position)



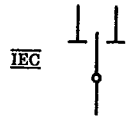
4.35.5 Circuit breaker



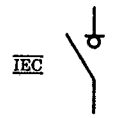
4.35.6 Disconnector (isolator)



4.35.7 Two-way disonnector (isolator) with center-off position

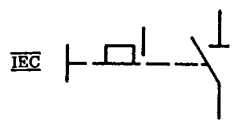


4.35.8 Switch-disconnector (on-load isolating switch)



4.35.9 Switch-disconnector with automatic release

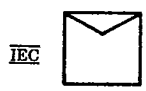
4.35.10 Disconnector (isolator) with blocking device, manually operated



4.36 Block Symbols for Motor Starters

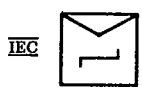
4.36.1 Motor starter, general symbol

NOTE 4.36.1A: Qualifying symbols may be shown inside the general symbol to indicate particular types of starters. See symbols 4.36.5, 4.36.7, and 4.36.8.

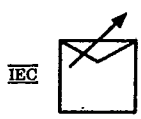


4.36.2 Starter operated in steps

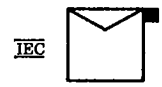
NOTE 4.36.2A: The number of steps may be indicated.



4.36.3 Starter-regulator



4.36.4 Starter with automatic release

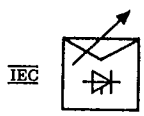


4.36.5 Direct on line contactor starter for reversing motor
Full voltage contactor starter for reversing motor

4.36.6 Star-delta starter

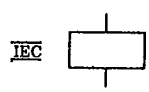
4.36.7 Autotransformer starter

4.36.8 Starter-regulator with thyristors



4.37 Operating Devices for Electromechanical (all or nothing) Relays

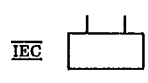
4.37.1 Operating device, general symbol



Form 1

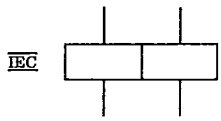
4.37.2

NOTE 4.37.2A: Operating devices with several windings may be indicated by inclusion of the appropriate number of inclined strokes or by repeating symbol 4.37.1 or 4.37.2.



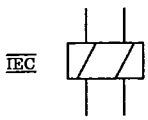
Form 2

4.37.3 *EXAMPLES:* Operating device with two separate windings, assembled representation



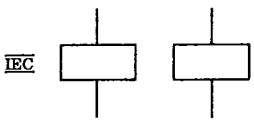
Form 1

4.37.4



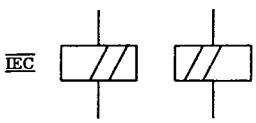
Form 2

4.37.5 Operating device with two separate windings, detached representation



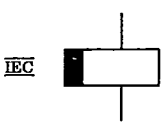
Form 1

4.37.6

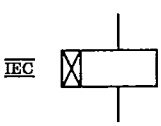


Form 2

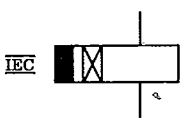
4.37.7 Relay coil of a slow-releasing relay



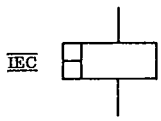
4.37.8 Relay coil of a slow-operating relay



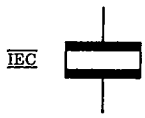
4.37.9 Relay coil of a slow-operating and slow-releasing relay



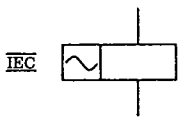
4.37.10 Relay coil of a high-speed relay (fast operating and fast releasing)



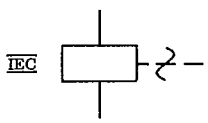
4.37.11 Relay coil of a relay unaffected by alternating current



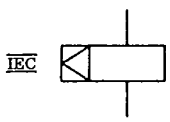
4.37.12 Relay coil of an alternating current relay



4.37.13 Relay coil of a mechanically resonant relay



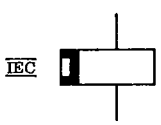
4.37.14 Relay coil of a mechanically latched relay



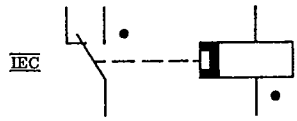
4.37.15 Relay coil of a polarized relay

NOTE 4.37.15A: Dots may be used to indicate the relationship between the direction of the current through the winding of a polarized relay and the movement of the contact arm.

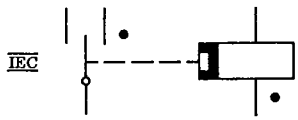
When the winding terminal identified by the polarity dot is positive with respect to the other winding terminals, the contact arm moves or tends to move towards the position marked with the dot.



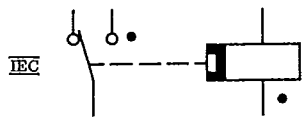
4.37.16 *EXAMPLES:* Polarized relay, self restoring, operating for only one direction of current in the winding



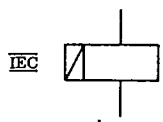
4.37.17 Polarized relay with neutral position, self restoring, operating for either direction of current in the winding



4.37.18 Polarized relay with two stable positions

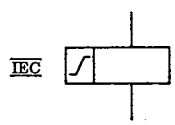


4.37.19 Relay coil of a remanent relay



Form 1

4.37.20

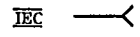


Form 2

5.3 Connector
Disconnecting Device
Jack F
Plug F

The contact symbol is not an arrowhead. It is larger and the lines are drawn at a 90° angle.

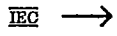
5.3.1 Female contact



Add:

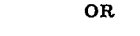
OR

5.3.2 Male contact



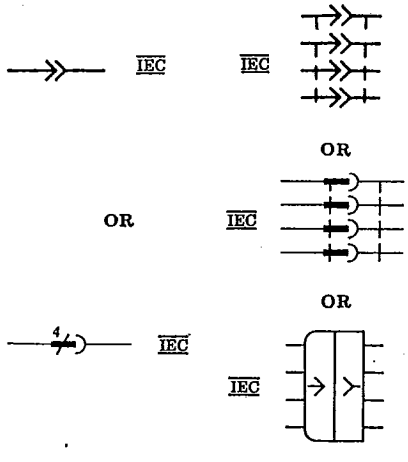
Add:

OR



Revise 5.3.4.1 *to read as follows:*

5.3.4.1 Application: engaged 4-conductors (male plug – female receptacle shown)



5.3.5.1 2-conductor (jack)

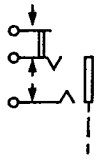
OR

5.3.5.2 2-conductor (plug)

Add:

OR

5.3.5.3‡ 3-conductor (jack) with 2 break contacts (normals) and 1 auxiliary make contact



Add:

OR

5.3.5.4 3-conductor (plug)

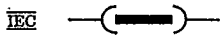
Add:

OR

5.3.5.5 Break or isolating jack, telephone type

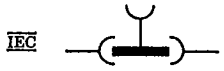
After 5.3.6.4
Add:

5.3.7 Adapter
5.3.7.1 Plug and socket-type connector, for example U-link: male-male.



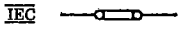
5.3.7.2 Male-female

5.3.7.3 Male-male with socket access



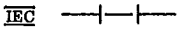
5.3.8 Butt-connector

5.3.9 Connecting link, closed



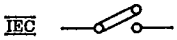
Form 1

5.3.9.1



Form 2

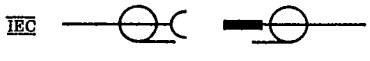
5.3.9.2 Connecting link, open



After 5.6.1
Add:

5.6.1A Coaxial plug and socket

NOTE 5.6.1A: If the coaxial plug or socket is connected to a coaxial pair, the tangential line(s) should be appropriately extended.



6.1.2 Magnetic core of inductor or transformer

Not to be used unless it is necessary to identify a magnetic core.

Add:

OR

IEC

Revise 6.2.1 *to read as follows:*

6.2.1 General

NOTE 6.2.1A: This symbol is deprecated and should not be used on new schematics.

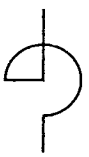
IEC 

OR

See NOTE 6.2.1A

Add:

6.2.1A Choke
Reactor

IEC 

See NOTE 6.4.1A

6.2.2 Magnetic-core inductor
Telephone loading coil

If necessary to show a magnetic core.

Add:

OR

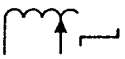
IEC 

6.2.2.1 Inductor with gap in magnetic core

IEC 

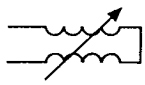
Add:

6.2.4.1 Inductor with moving contact, variable in steps

IEC 

After 6.2.5
Add:

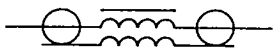
6.2.5A Variometer

IEC 

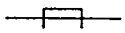
6.2.9 *See* new 11.3.3

After 6.2.9
Add:

6.2.10 Coaxial choke with magnetic core

IEC 

6.2.11 Ferrite bead, shown on a conductor

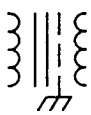
IEC 

See also 15.18.1

Revise NOTE 6.4.1A to read as follows:

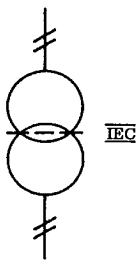
NOTE 6.4.1A: This symbol is the preferred single-line symbol in IEC Publication 617-6 (1983) [17]. It should be used on schematics for equipments having international usage, especially when the equipment will be marked using this symbol (in accordance with IEC Publication 417 (1973) [10].

6.4.2.3 Application: transformer with magnetic core shown and with an electrostatic shield between windings. The shield is shown connected to the frame.

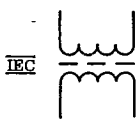


Add:

6.4.2.3A Single-phase transformer with two windings and screen.



IEC



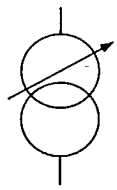
IEC

Revise 6.4.4 *to read as follows:*

6.4.4 One winding with adjustable inductance

IEC 

OR



IEC See NOTE 6.4.4A

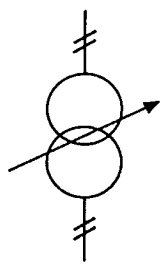
See NOTE 6.4.1A

NOTE 6.4.4A: The former right-hand ϴ symbol has been deleted. It is no longer recommended for use on complete diagrams.

6.4.6 Adjustable mutual inductor; constant-current transformer

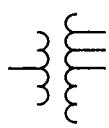
Add:

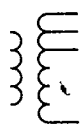
OR



IEC

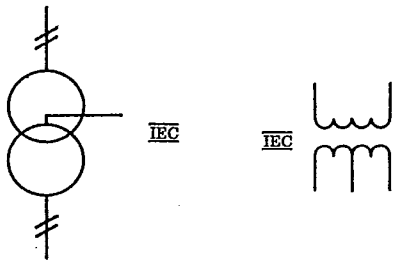
6.4.7 With taps, 1-phase





Add:

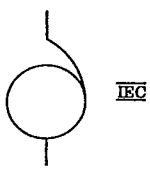
6.4.7A Transformer with center tapping on one winding



Revise **6.4.8** *to read as follows:*

6.4.8 Autotransformer, 1-phase

OR

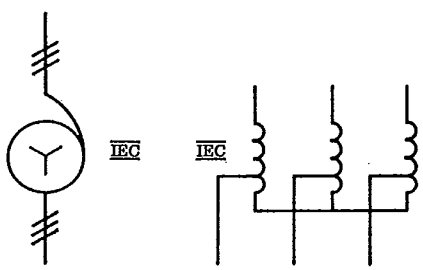


See NOTE 6.4.4A

See NOTE 6.4.1A

Add:

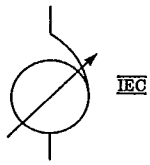
6.4.8A Autotransformer, three-phase, star connection



Revise **6.4.9** *to read as follows:*

6.4.9 Adjustable

OR



See NOTE 6.4.4A

See NOTE 6.4.1A

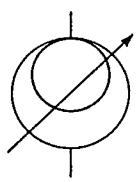
Revise **6.4.12** *to read as follows:*

6.4.12 1-phase induction voltage regulator(s)

Number of regulators may be written adjacent to the symbol.

OR

OR



See NOTE 6.4.4A

See NOTE 6.4.1A

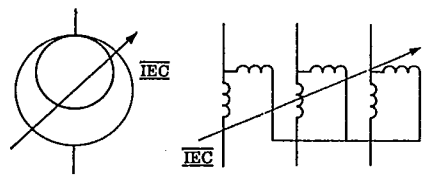
Revise **6.4.14** *to read as follows:*

6.4.14 3-phase induction voltage regulator

OR

OR

OR



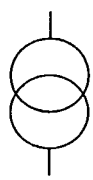
See NOTE 6.4.4A

See NOTE 6.4.1A

Revise **6.4.15** *to read as follows:*

6.4.15 1-phase, 2-winding transformer

OR

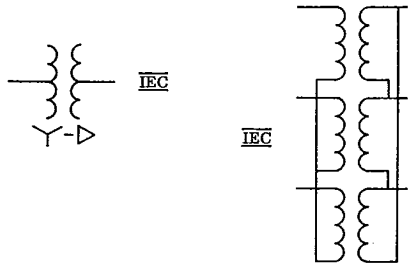


See NOTE 6.4.4A

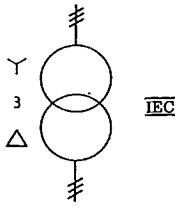
See NOTE 6.4.1A

Revise **6.4.15.1** *to read as follows:*

6.4.15.1 Application: 3-phase bank of 1-phase, 2-winding transformers with wye–delta connections



OR



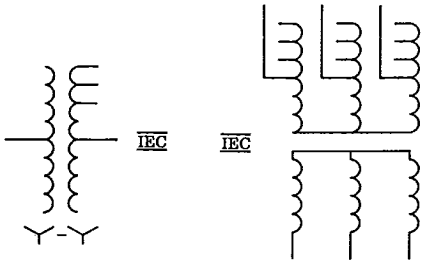
See NOTE 6.4.4A

See NOTE 6.4.1A

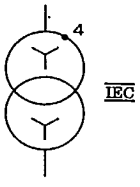
The alternate symbol has been corrected to conform to IEC Publication 617-6 (1983) [17]. Shown outside the symbol is Y. *Reason:* Three separate transformers.

Revise **6.4.15.2** *to read as follows:*

6.4.15.2 Three-phase transformer with 4 taps with wye–wye connections



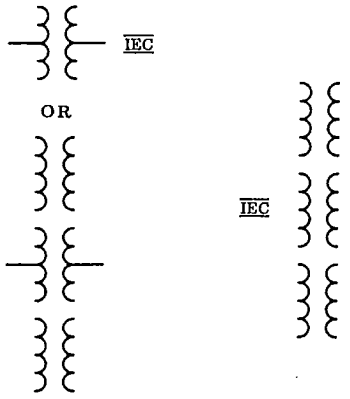
OR



See NOTE 6.4.4A

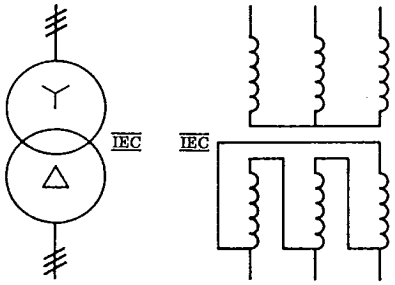
See NOTE 6.4.1A

6.4.16 Polyphase transformer



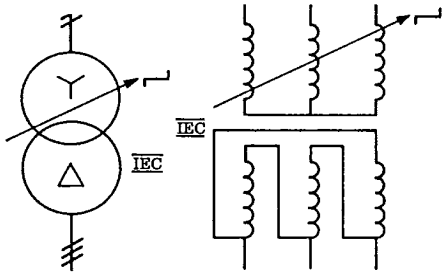
Add:

6.4.16A.1 Three-phase transformer, connection star-delta

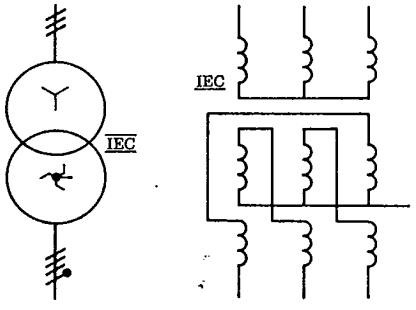


6.4.16A.2 *See* 6.4.15.2

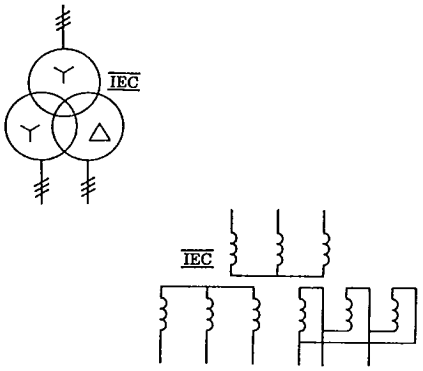
6.4.16A.3 Three-phase transformer with on-load tap changer, connection star-delta



6.4.16A.4 Three-phase transformer, connection star-zigzag

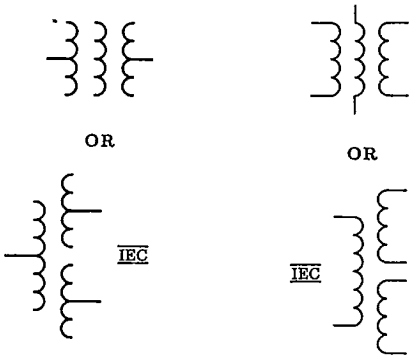


6.4.16A.5 Three-phase transformer, connection star-star-delta

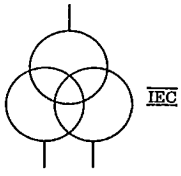


Revise **6.4.17** *to read as follows:*

6.4.17 1-phase, 3-winding transformer



OR

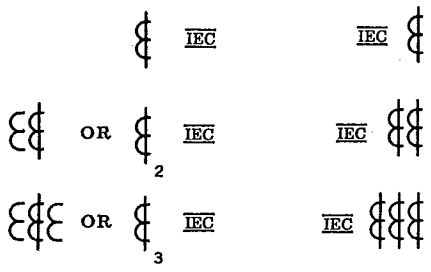


See NOTE 6.4.4A

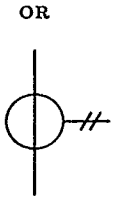
See NOTE 6.4.1A

6.4.18 Current transformer(s)

Avoid conflict with symbol 3.2.5 if used on the same diagram.



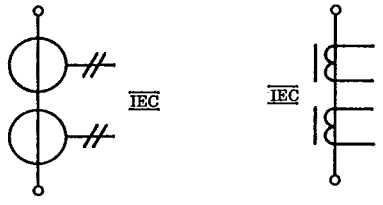
Add:



6.4.18.1 Current transformer with two cores and two secondary windings

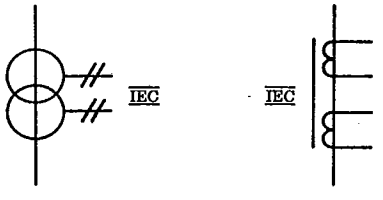
The terminal symbols shown at each end of the primary circuit indicate that only a single device is represented.

NOTE 6.4.18.1A: In the right-hand symbol core symbols my be omitted.

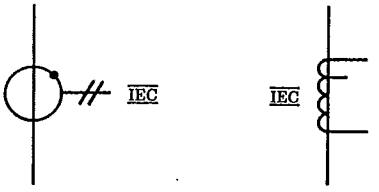


6.4.18.2 Current transformer with two secondary windings on one core.

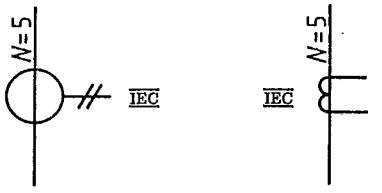
NOTE 6.4.18.2A: In the right-hand symbol the core symbol shall be drawn.



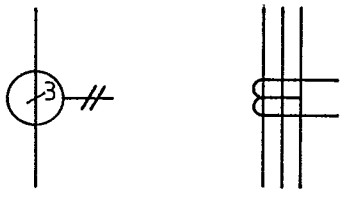
6.4.18.3 Current transformer with one secondary winding with three tappings



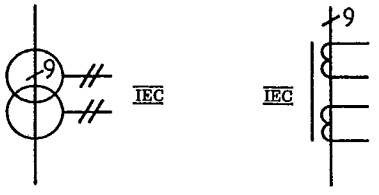
6.4.18.4 Current transformer where the primary conductor forms five winding turns



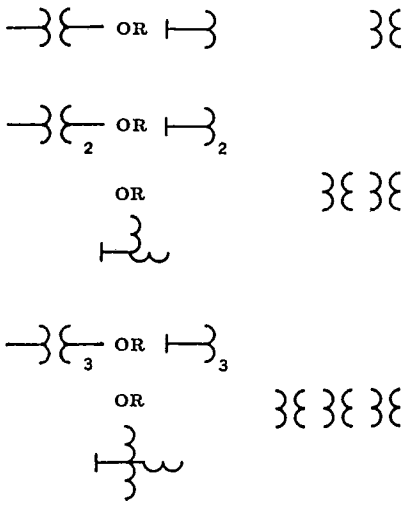
6.4.18.5 Pulse or current transformer with one permanent winding and three threaded windings



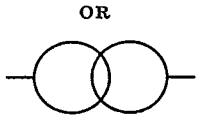
6.4.18.6 Pulse or current transformer with two permanent windings on the same core and with nine threaded windings



6.4.20 Potential transformer(s)



Add:



After 6.5
Add:

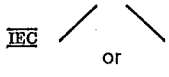
6.6 Ferrite Cores—Symbol Elements (IEC Publication 617-4 (1983) [15])

6.6.1 Ferrite core

6.6.2 Flux/current direction indicator

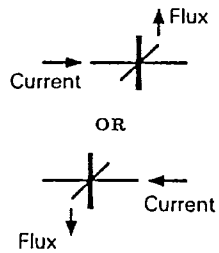
This symbol indicates that a horizontal line drawn at a right angle through a core symbol represents a core winding, and it also gives the relative directions of current and flux.

NOTE 6.6.2A: This symbol is not applicable for topographical representation.



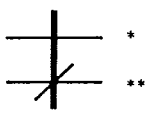
6.6.3 Ferrite core with one winding

The oblique line may be regarded as a reflector that relates the directions of current and flux as shown below.



For drawing convenience, lines representing conductors are often shown crossing core symbols even though there is no winding on the magnetic circuit. Except in topographical representation the use of the oblique stroke is mandatory in all cases where a line through the core symbol represents a winding.

EXAMPLE:

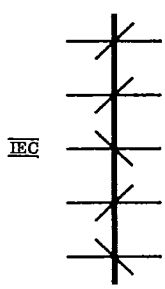


* Conductor crossing the core symbol
** Winding on the core

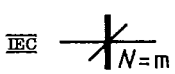
6.7 Ferrite Cores (IEC Publication 617-4 (1983) [15])

6.7.1 Ferrite core with five windings

NOTE 6.7.1A: Information on the direction of current, its relative amplitude and the logic conditions imposed by the state of the magnetic remanence may be added.

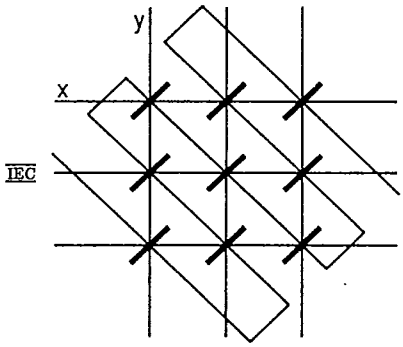


6.7.2 Ferrite core with one winding of m turns

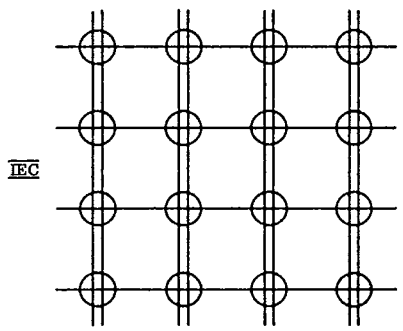


6.8 Magnetic Storage Matrices (Topographical Representation)

6.8.1 Ferrite core matrix with x and y windings and a readout winding. The symbol of a ferrite core, 6.6.1, is shown at 45° to the horizontal.



6.8.2 Matrix arrangement comprising thin sheet magnetic stores, located between thin sheet wiring layers.



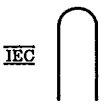
7.1.1.1 Directly heated (filamentary) cathode

NOTE 7.1.1.1A: Leads may be connected in any convenient manner to ends of the ^ provided the identity of the ^ is retained.

See NOTE 7.1.1.1A

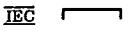
Add:

OR



7.1.1.2 Indirectly heated cathode

Lead may be connected to either extreme end of the ⌐¬ or, if required, to both ends, in any convenient manner.

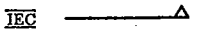


Add:

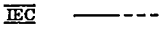
OR

After 7.1.1.6
Add:

7.1.1.7 Photoemissive electrode

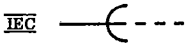


7.1.2.1 Grid
Beam-confining or beam-forming electrodes



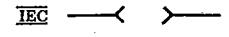
Add:

7.1.2.1.1 Grid with secondary emission

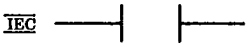


Revise 7.1.2.2 *to read as follows:*

7.1.2.2 Deflecting electrodes (used in pairs)



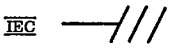
OR



7.1.2.2A Radial deflecting electrodes, one pair of electrodes shown

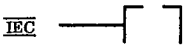
After 7.1.2.4
Add:

7.1.2.5 Ion diffusion barrier



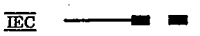
7.1.2.6 Intensity modulating electrode

NOTE 7.1.2.6A: Symbol 7.1.2.1 may be used if no confusion will arise.



7.1.2.7 Focusing electrode with aperture
Beam-forming plate

See NOTE 7.1.2.6A



7.1.2.8 Beam-splitting electrode internally connected to the final focusing electrode of the electron gun

7.1.2.9 Cylindrical focusing electrode
Drift space electrode

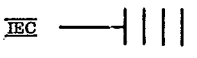
Electronic lens element

See NOTE 7.1.2.6A

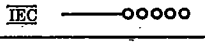
7.1.2.10 Cylindrical focusing electrode with grid

7.1.2.11 Multiaperture electrode

See NOTE 7.1.2.6A



7.1.2.12 Quantizing electrode
Sampling electrode

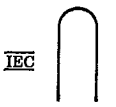


7.1.5 Heater

See NOTE 7.1.1.1A

Add:

OR

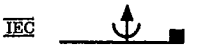


After 7.1.8
Add:

7.1.9 Storage electrodes
7.1.9.1 Storage electrode

7.1.9.2 Photoemissive storage electrode

7.1.9.3 Storage electrode with secondary emission in the direction of the arrow



7.1.9.4 Photoconductive storage electrode

7.1.10 Symbol elements for microwave tubes
7.1.10.1 Electron gun assembly, shown with envelope

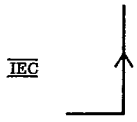
Simplified Form

7.1.10.2 Reflector
Repelling electrode (used in velocity modulated tubes)

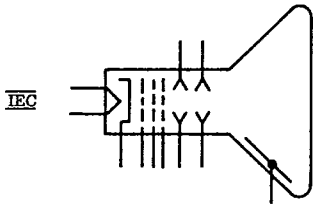
7.1.10.3 Nonemitting sole for open slow-wave structure

7.1.10.4 Nonemitting sole for closed slow-wave structure

7.1.10.5 Emitting sole (arrow indicates direction of electron flow)

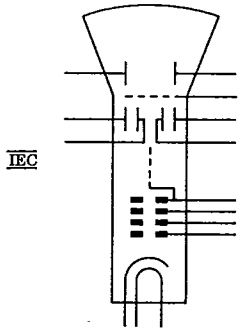


7.3.6.1 With electric-field (electrostatic) deflection



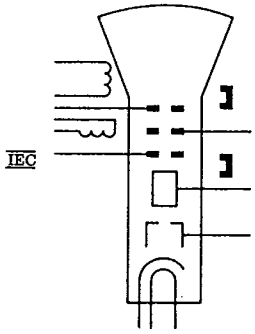
Add:

7.3.6.1.1 Double-beam cathode-ray tube, split-beam type with:
Electrostatic deflection
Indirectly heated cathode



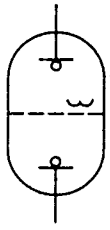
Add:

7.3.6.2.3 Cathode-ray tube with electromagnetic deviation, with:
— Permanent magnet focusing and ion trap
— Intensity modulating electrode
— Indirectly heated cathode
For example, television picture tube



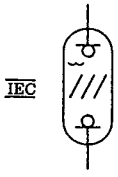
7.4 Solion
Ion-Diffusion Device

7.4.1 Diode solion



Add:

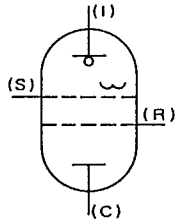
OR



7.4.2 Tetrode solion

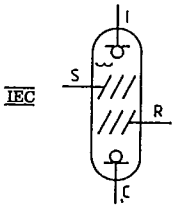
NOTE 7.4.2A: Letters in parentheses are not part of the symbol.

I Input
S Shield
R Readout
C Common



Add:

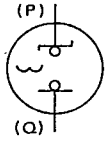
OR



See NOTE 7.4.2A

7.5 Coulomb Accumulator
Electrochemical Step-Function Device

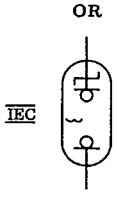
NOTE 7.5A: Letters in parentheses are not part of the symbol, but are for explanation only. For a precharged cell, with + polarity applied to P, the cell internal resistance and voltage drop will remain low until the designed coulomb quantity has passed; then the internal resistance will rise to its high value.



See NOTE 7.5A

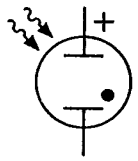
Add:

OR



Revise **7.7.1** *to read as follows:*

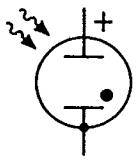
7.7.1 General



See NOTE 7.7A

Revise **7.7.2** *to read as follows:*

7.7.2 Application: metal enclosure, having one collector connected to the enclosure

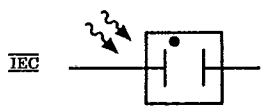


See NOTE 7.7A

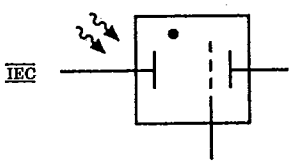
After **7.7.2**
Add:

7.7.3 Ionizing radiation detectors

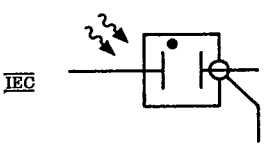
7.7.3.1 Ionization chamber



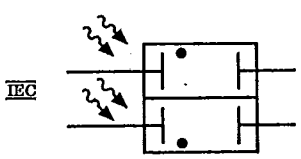
7.7.3.2 Ionization chamber with grid



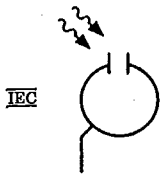
7.7.3.3 Ionization chamber with guard ring



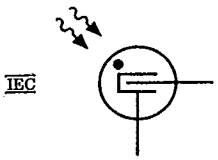
7.7.3.4 Ionization chamber, compensated type



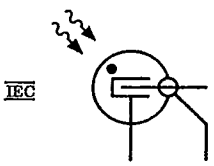
7.7.3.5 Faraday cup



7.7.3.6 Counter tube



7.7.3.7 Counter tube with guard ring



Revise 8.2.2 *to read as follows:*

8.2.2 Rectifying junction or junction which influences a depletion layer

Arrowheads (⟶|) shall be half the length of the arrow away from the semiconductor base region.

See item 8.6

The equilateral (⟶▶) triangle shall be filled and shall touch the semiconductor base-region symbol.

NOTE 8.2.2A: The triangle points in the direction of the forward (easy) current as indicated by a direct-current ammeter, unless otherwise noted adjacent to the symbol. Electron flow is in the opposite direction.

Add:

8.2.2A Rectifying junction

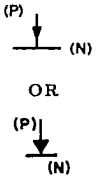
IEC

OR

IEC

Revise:

8.2.2.1 P region on N region



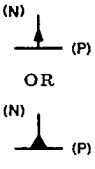
Add:

OR

IEC 

Revise:

8.2.2.2 N region on P region

IEC 

Add:

OR

IEC 

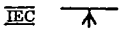
8.2.3 Enhancement-type semiconductor region with plurality of ohmic connections and a rectifying junction

Portions of the interrupted channel line having ohmic contacts shall be of equal length and drawn significantly longer than the center-channel section. Channel gaps shall be of equal length and approximately equal to the center-channel length.

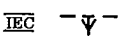
Add:

8.2.3A Indication of the conductivity type of the channel for insulated gate field effect transistors (IGFET)

8.2.3A.1 N-type channel on P-type substrate, shown for a depletion type IGFET

IEC 

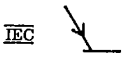
8.2.3A.2 P-type channel on an N-type substrate, shown for an enhancement type IGFET

IEC 

8.2.4.1 P emitter on N region

Add:

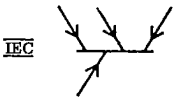
OR

IEC 

8.2.4.1.1 Plurality of P emitters on N region

Add:

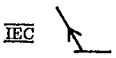
OR

IEC 

8.2.4.2 N emitter on P region

Add:

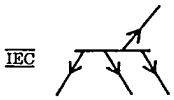
OR

IEC 

8.2.4.2.1 Plurality of N emitters on P region

Add:

OR

IEC 

CORRECTION: *Symbol was omitted in some printings.*

8.2.9.2 Gate (no external connection)

For application, see symbol 8.5.9

Because there is no external connection to the gate, this lead shall not extend to the envelope symbol, if any.

Style 3 

See NOTE 8.2.9A

8.3.1 Breakdown

Do not rotate or show in mirror-image form.

Style 1 IEC

Add:

8.3.1A Bidirectional breakdown effect

IEC

8.3.3 Backward

Style 1 IEC

Add:

OR

IEC

After 8.3.4
Add:

8.3.5 Schottky effect

IEC 

8.5.1 Semiconductor diode; semiconductor rectifier diode; metallic rectifier

IEC 

Add:

OR

IEC 

8.5.2 Capacitive diode (varactor)

Style 1 IEC 

Add:

OR

IEC 

Style 2 

8.5.3 Temperature-dependent diode

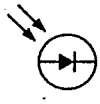
IEC 

Add:

OR

IEC 

8.5.4.1 Photosensitive type

IEC 

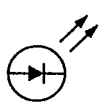
Add:

OR

IEC 

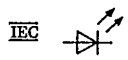
8.5.4.2 Photoemissive type

See also item 11.1.1



Add:

OR

IEC 

8.5.6.1 Unidirectional diode; voltage regulator

Style 1 

OR

*Style 2 

Add:

*Note conflict with 8.3.1A

OR

IEC 

8.5.6.2 Bidirectional diode

Style 1 

Style 2 IEC 

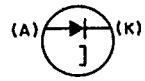
Add:

OR

IEC 

8.5.7 Tunnel and backward diodes
8.5.7.1 Tunnel diode

For this application, NOTE 8.2.2A does not apply.

Style 1 

OR

Style 2 

Add:

OR

IEC 

8.5.7.2 Backward diode; tunnel rectifier

For this application, NOTE 8.2.2A does not apply.

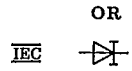
Style 1 

OR

Style 2 

Add:

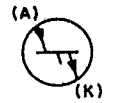
OR

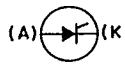
IEC 

8.5.8 Thyristor, reverse-blocking diode-type
8.5.8.1 General

Style 1 

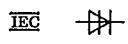
OR



Style 3 

Add:

OR

IEC 

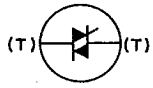
After 8.5.8.2
Add:

8.5.8.3 Reverse conducting diode thyristor

IEC 

8.5.9 Thyristor, bidirectional diode type; bi-switch

See also symbol 8.6.15



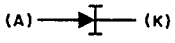
Add:

OR

IEC 

Add:

8.5.11 Current regulator

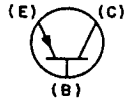
* 

*Note conflict with 8.3.3

8.6 Typical Applications, Three- (or more) Terminal Devices

8.6.1 PNP transistor (also PNIP transistor, if omitting the intrinsic region will not result in ambiguity)

NOTE 8.6.1A: See ANSI/IEEE Std 315-1975 [7], paragraph A4.11 of the Introduction.



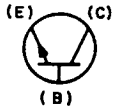
Add:

OR

IEC 

8.6.2 NPN transistor (also NPIN transistor, if omitting the intrinsic region will not result in ambiguity)

See NOTE 8.6.1A



Add:

8.6.2A NPN transistor with collector connected to the envelope

IEC 

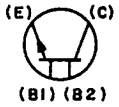
After 8.6.2.1
Add:

8.6.2.2 NPN avalanche transistor

IEC 

8.6.3 NPN transistor with transverse-biased base

See NOTE 8.6.1A



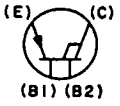
Add:

OR

IEC 

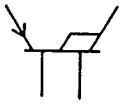
8.6.4 PNIP transistor with ohmic connection to the intrinsic region

See NOTE 8.6.1A



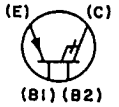
Add:

OR

IEC 

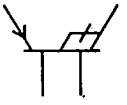
8.6.6 PNIN transistor with ohmic connection to the intrinsic region

See NOTE 8.6.1A



Add:

OR

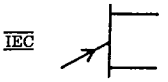
IEC 

8.6.8 Unijunction transistor with N-type base

See NOTE 8.6.1A

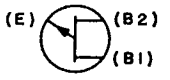
Add:

OR

IEC 

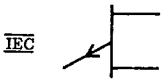
8.6.9 Unijunction transistor with P-type base

See NOTE 8.6.1A



Add:

OR

IEC 

8.6.10 Field-effect transistor with N-channel (junction gate and insulated gate)

8.6.10.1 N-channel junction gate

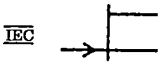
If desired, the junction-gate symbol element may be drawn opposite the preferred source.

See NOTE 8.6.1A

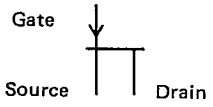
OR

Add:

OR

IEC 

NOTE 8.6.10.1A: The gate and source connections shall be drawn in line.

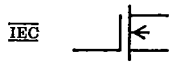


8.6.10.2 N-channel insulated-gate, depletion-type, single-gate, passive-bulk (substrate), three-terminal device

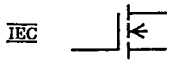
IEC 

Add:

OR

IEC 

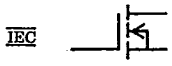
8.6.10.2A IGFET enhancement-type, single-gate, N-type channel without substrate connection

IEC 

8.3.10.3 N-channel insulated-gate, depletion-type, single-gate, active-bulk (substrate) internally terminated to source, three-terminal device

Add:

8.6.10.3A IGFET enhancement-type, single-gate, N-type channel with substrate internally connected to source

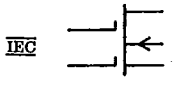
IEC 

8.6.10.4 N-channel insulated-gate, depletion-type, single-gate, active-bulk (substrate) externally terminated, four-terminal device

8.6.10.4.1 Application: N-channel insulated-gate, depletion-type, two-gate, five-terminal device

Add:

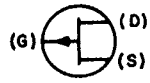
OR

IEC 

8.6.11 Field-effect transistor with P-channel (junction gate and insulated gate)

8.6.11.1 P-channel junction gate

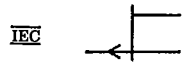
See NOTE 8.6.1A



OR

Add:

OR

IEC 

8.6.11.2 P-channel insulated-gate, depletion-type, single-gate, passive-bulk (substrate), three-terminal device

Add:

OR

IEC 

8.6.11.2A Insulated-gate field-effect transistor (abridged IGFET) enhancement type, single gate. P-type channel without substrate connection

NOTE 8.6.11.2A: For an example with multiple gates, see symbol 8.6.10.4.1.

IEC 

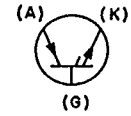
8.6.11.5 P-channel insulated-gate, enhancement-type, single-gate, active-bulk (substrate) externally terminated, four-terminal device

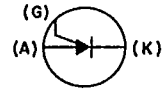
Add:

OR

IEC 

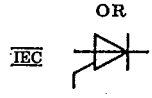
8.6.12.1 General

Style 1 

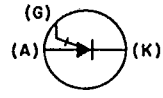
Style 3 

Add:

OR

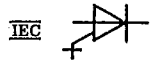
IEC 

8.6.12.2 Gate turn-off type

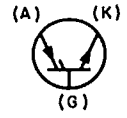
Style 3 

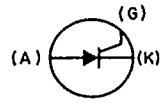
Add:

OR

IEC 

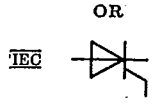
8.6.13.1 General

Style 1 

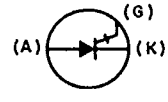
Style 3 

Add:

OR

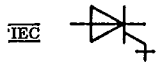
IEC 

8.6.13.2 Gate turn-off type

Style 3 

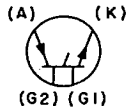
Add:

OR

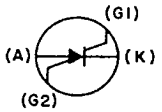
IEC 

8.6.14 Thyristor, reverse-blocking tetrode-type; semiconductor controlled switch

Style 1



Style 3



Add:

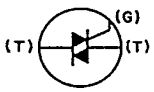
OR

IEC

8.6.15 Thyristor, bidirectional triode-type; triac; gated switch

See also symbol 8.5.9

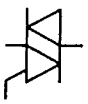
Style 3



Add:

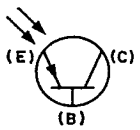
OR

IEC



8.6.16 Phototransistor (PNP-type)

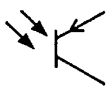
See also symbol 8.5.10, for 2-terminal device



Add:

OR

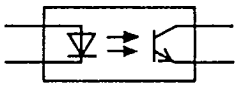
IEC



After 8.10.4
Add:

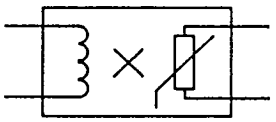
8.10.5 Optical coupling device
Opto isolator
Shown with light emitting diode and phototransistor

IEC



8.10.6 Magnetic coupling device
Magnetic isolator

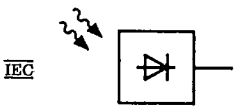
IEC



After 8.11.2
Add:

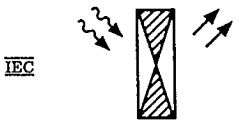
8.12 Ionizing Radiation Detectors
8.12.1 Detector, semiconductor type

IEC



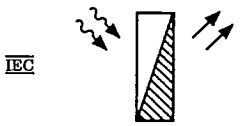
8.12.2 Scintillator detector

IEC



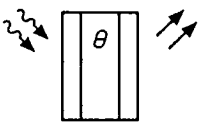
8.12.3 Cerenkov detector

IEC



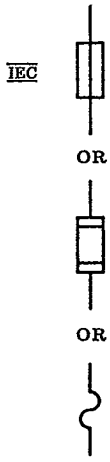
8.12.4 Thermoluminescence detector

IEC



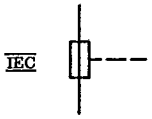
9.1 Fuse (one-time thermal current-overload device)

9.1.1 General



Add:

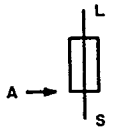
9.1.1A Fuse with mechanical linkage (striker fuse)



Revise:

9.1.2 Fuse with alarm contact

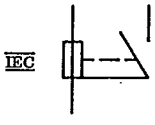
NOTE 9.1.2A: When fuse blows, alarm bus A is connected to power supply bus S. The letters S (supply), L (load), and A (alarm circuit) are for explanation only, and are not part of the symbol.



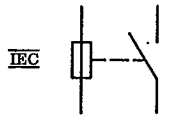
See NOTE 9.1.2A

Add:

9.1.2.1 Fuse with alarm contact, three terminals



9.1.2.2 Fuse with separate alarm circuit



Add:

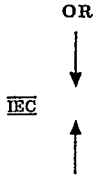
9.1.3.1 Fuse-switch

9.3 Lightning Arrester F
Arrester (electric surge, etc)
Gap

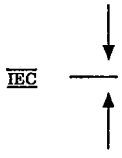
See also symbol 8.5.6

9.3.1 General

Add:

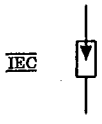


9.3.1.1 Double spark-gap

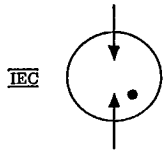


After 9.3.9
Add:

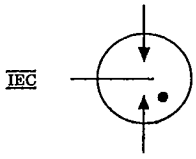
9.3.10 Surge arrester
(Lightning arrester)



9.3.11 Protective gas discharge tube



9.3.12 Symmetric protective gas discharge tube

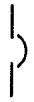


Revise 9.4 *to read as follows:*

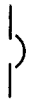
9.4 Circuit Breaker F

If it is desired to show the condition causing the breaker to trip, the relay protective-function symbols in item 9.5.1 may be used alongside the breaker symbol.

9.4.1 General



9.4.2 Air circuit breaker, if distinction is needed; for alternating-current circuit breakers rated at 1500 volts or less and for all direct-current circuit breakers.



9.4.3 Network protector

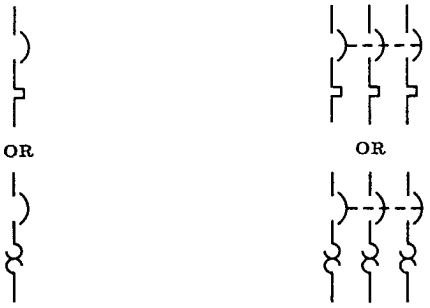
9.4.4 Circuit breaker, other than covered by symbol 9.4.1

The symbol in the right column is for a 3-pole breaker.

NOTE 9.4.4A: 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 16.1) may result, add the identifying letters CB inside or adjacent to the square.

See NOTE 9.4.4A

9.4.5 Application: 3-pole circuit breaker with thermal-overload device in all 3 poles



9.4.6 Application: 3-pole circuit breaker with magnetic-overload device in all 3 poles

9.4.7 Application: 3-pole circuit breaker, drawout type

After 9.5.12.20
Add:

9.6 Protective Relays (IEC Publication 617-7 (1983 [18]) Block Symbol and Qualifying Symbol

9.6.1 Measuring relay or related device

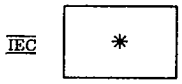
The asterisk must be replaced by one or more letters or qualifying symbols indicating the parameters of the device, in the following order; characteristic quantity and its mode of variation; direction of energy flow; setting range; resetting ratio; delayed action; value of time delay

NOTE 9.6.1A: Letter symbols for characteristic quantities should be in accordance with established standards, for example ISO 31, 0-11 (1974-1980) [25], IEC Publication 27 [9], ANSI/IEEE Std 260-1978 [5], and ANSI/IEEE Std 280-1985 [6].

Symbols 9.6.2, 9.6.4, and 9.6.7 show how letter and qualifying symbols may be combined.

NOTE 9.6.1B: A figure giving the number of similar measuring elements may be included in the symbol as shown in example 9.7.5.

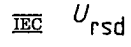
NOTE 9.6.1C: The symbol may be used as a functional symbol representing the whole of the device, or as a symbol representing only the actuating element of the device.



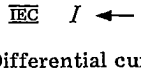
9.6.2 Voltage failure to frame (frame potential in case of fault)

NOTE 9.6.2A: *U* may be replaced by V.

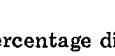
9.6.3 Residual voltage
The NOTE with symbol 9.6.2 is applicable



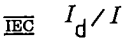
9.6.4 Reverse current



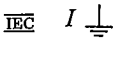
9.6.5 Differential current



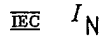
9.6.6 Percentage differential current



9.6.7 Earth fault current

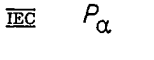


9.6.8 Current in the neutral conductor

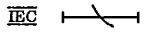


9.6.9 Current between neutrals of two polyphase systems

9.6.10 Power at phase angle α

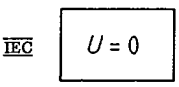


9.6.11 Inverse time-lag characteristic

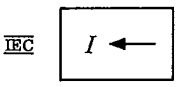


9.7 Examples of Protective Relays (IEC Publication 617-7 (1983) [18])

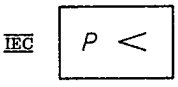
9.7.1 No voltage relay



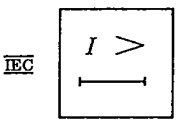
9.7.2 Reverse current relay



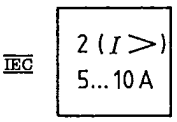
9.7.3 Underpower relay



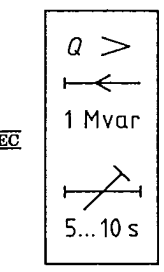
9.7.4 Delayed overcurrent relay



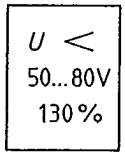
9.7.5 Overcurrent relay with two current elements and a setting range from 5 A to 10 A



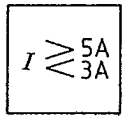
9.7.6 Maximum reactive power relay:
- Energy-flow towards the busbars
- Operating value 1 Mvar
- Time-lag adjustable from 5 s to 10 s



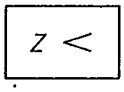
9.7.7 Undervoltage relay:
— Setting range from 50 V to 80 V
— Resetting ratio 130%

IEC 

9.7.8 Current relay operating above 5 A and below 3 A

IEC 

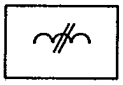
9.7.9 Under-impedance relay

IEC 

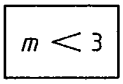
9.7.10 Relay detecting interturn short-circuits

IEC 

9.7.11 Divided-conductor detection relay

IEC 

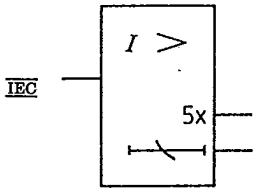
9.7.12 Phase-failure detection relay in a three-phase system

IEC 

9.7.13 Locked-rotor detection relay operating by current sensing

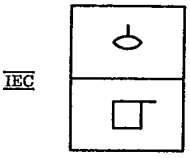
IEC 

9.7.14 Overcurrent relay with two outputs, one active at current above five times the setting value, the other with inverse time-lag characteristic

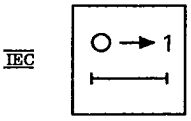
IEC 

9.8 Other Relay Devices

9.8.1 Buchholz protective device (gas relay)

IEC 

9.8.2 Auto-reclose device

IEC 

Section 10

Graphic Symbols for Acoustic Devices

10.1.2 Buzzer F

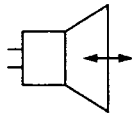
Add:

OR OR

See NOTE 10.1.1A

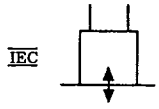
Revise:

10.1.3.3 Loudspeaker-microphone IEC Underwater sound transducer, two-way

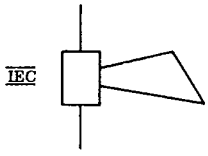


After 10.1.4
Add:

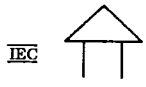
10.1.5 Hydrophone (supersonic transmitter-receiver)



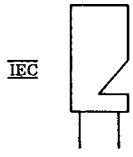
10.1.6 Horn



10.1.7 Siren



10.1.8 Whistle, electrically operated

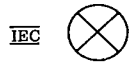


Section 11

Graphic Symbols for Lamps and Visual-Signaling Devices

After NOTE 11.1.1C
Add:

11.1.1A Lamp (IEC Publication 617-8 (1983) [19])
11.1.1A.1 Lamp, general symbol
Signal lamp, general symbol



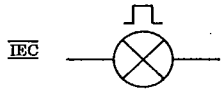
If it is desired to indicate the color, a notation according to the following code is placed adjacent to the symbol:

RD = red
YE = yellow
GN = green
BU = blue
WH = white

If it is desired to indicate the type of lamp, a notation according to the following code is placed adjacent to the symbol:

Nc = neon
Xe = xenon
Na = sodium vapor
Hg = mercury
I = iodine
IN = incandescent
EL = electroluminescent
ARC = arc
FL = fluorescent
IR = infrared
UV = ultraviolet
LED = light-emitting diode

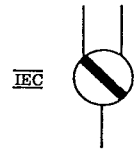
11.1.1A.2 Signal lamp, flashing type



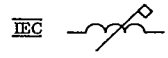
After 11.2.8
Add:

11.3 Electromechanical Signal
11.3.1 Indicator, electromechanical
Annunciator, element

11.3.2 Electromechanical position indicator with one de-energized (shown) and two operated positions



11.3.3 Coil operated flag indicator



(Relocated from 6.2.9)

12.1 Meter
Instrument

Add:

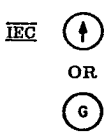
Note that IEC Publication 617-8 (1983) [19]
- Distinguishes symbolwise between indicating, recording, and integrating instruments (see 12.3)
- Carefully follows the lettering style (uppercase, lowercase) specified for the SI system of measurement (see 12.4 through 12.6)

NOTE 12.1A: The asterisk is not part of the symbol. Always replace the asterisk by one of the following letter combinations, depending on the function of the meter or instrument, unless some other identification is provided in the circle and explained on the diagram.

See NOTE 12.1A

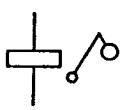
12.1.1 Galvanometer [F]

Avoid conflict with symbols 4.5 and 13.1.2 if used on the same diagram.

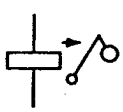


12.2 Electromagnetically Operated Counter
Message Register
See also 12.7

12.2.1 General



12.2.2 With make contact



Add:

12.3 Indicating, Recording and Integrating Instruments, General Symbols (IEC Publication 617-8 (1983) [19]

NOTE 12.3A: The asterisk within the symbols of this section shall be replaced with one of the following:
- The letter symbol for the *unit* of the quantity measured, or a multiple or submultiple thereof (see examples 12.4.1 and 12.4.7)
- The letter symbol for the *quantity* measured (see examples 12.4.5 and 12.4.6)
- A chemical formula (see example 12.4.13)
- A graphic symbol (see example 12.4.8)

The symbol or formula used should be related to the information displayed by the instrument regardless of the means used to obtain the information.

NOTE 12.3B: Letter symbols for *units* and for *quantities* shall be selected from one of the parts of IEC Publication 27 [9], ANSI/IEEE Std 260-1978 [5], and ANSI/IEEE Std 280-1985 [6].

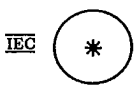
Provided IEC Publication 27 [9], ANSI/IEEE Std 260-1978 [5], ANSI/IEEE Std 280-1985 [6], or the letter symbols for chemical elements, do not apply, other letter symbols may be used, if they are explained on the diagram or in referenced documents.

NOTE 12.3C: If the letter symbol for the *unit* of the quantity measured is used, it may be necessary to show the letter symbol for the *quantity* as supplementary information. It should be placed below the unit letter symbol (see example 12.4.2).

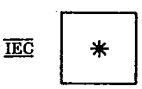
Supplementary information concerning the quantity measured, and any necessary qualifying symbol may be shown below the quantity letter symbol.

NOTE 12.3D: If more than one quantity is indicated or recorded by an instrument, the appropriate symbol outlines shall be placed attached in line, horizontally or vertically (see examples 12.5.2 and 12.6.14).

12.3.1 Indicating instrument
The asterisk shall be replaced in accordance with the rules given in NOTE 12.3A



12.3.2 Recording instrument
The asterisk shall be replaced in accordance with the rules given in NOTE 12.3A



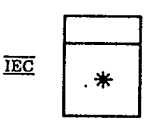
12.3.3 Integrating instrument
Energy meter
The asterisk shall be replaced in accordance with the rules given in NOTE 12.3A

NOTE 12.3.3A: The symbol may also be used for a remote instrument which repeats a reading transmitted from an integrating meter. For example, see symbol 12.6.11.

NOTE 12.3.3B: The outline may be combined with that for a recording instrument to represent a combined instrument. For example, see symbol 12.6.14.

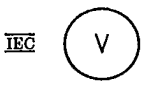
NOTE 12.3.3C: Symbols from 1.7 may be used to specify the direction of energy flow. For examples, see symbols 12.6.4 to 12.6.7.

NOTE 12.3.3D: The number of rectangles at the top of the symbol indicates the number of different summations by a multirate meter. For example, see symbol 12.4.8.

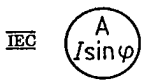


12.4 Examples of Indicating Instruments (IEC Publication 617-8 (1983) [19])

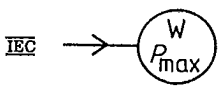
12.4.1 Voltmeter



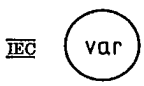
12.4.2 Reactive current ammeter



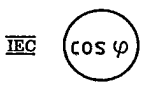
12.4.3 Maximum demand indicator actuated by an integrating meter



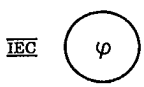
12.4.4 Varmeter



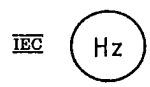
12.4.5 Power-factor meter



12.4.6 Phase meter

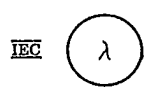


12.4.7 Frequency meter

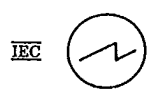


12.4.8 Synchronoscope

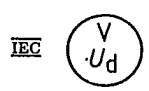
12.4.9 Wavemeter



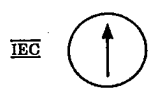
12.4.10 Oscilloscope



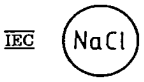
12.4.11 Differential voltmeter



12.4.12 Galvanometer

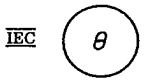


12.4.13 Salinity meter

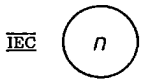


12.4.14 Thermometer
Pyrometer

NOTE 12.4.14A: θ may be replaced by $t°$.

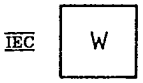


12.4.15 Tachometer

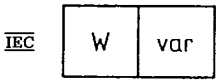


12.5 Examples of Recording Instruments (IEC Publication 617-8 (1983) [19]

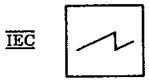
12.5.1 Recording wattmeter



12.5.2 Combined recording wattmeter and varmeter

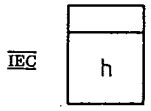


12.5.3 Oscillograph

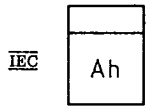


12.6 Examples of Integrating Instruments (IEC Publication 617-8 (1983) [19])

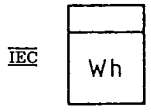
12.6.1 Hour meter



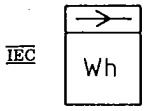
12.6.2 Ampere-hour meter



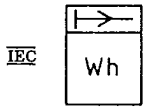
12.6.3 Watthour meter



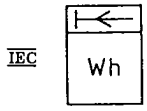
12.6.4 Watthour meter, measuring energy transmitted in one direction only



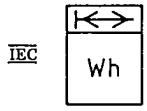
12.6.5 Watthour meter, measuring the energy flow from the busbars



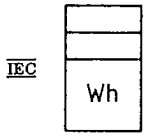
12.6.6 Watthour meter, measuring the energy flow towards the busbars



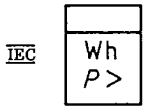
12.6.7 Import-export watthour meter



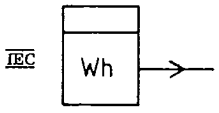
12.6.8 Multirate watthour meter, two-rate shown



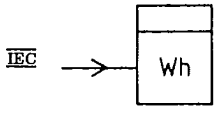
12.6.9 Excess watthour meter



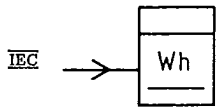
12.6.10 Watthour meter with transmitter



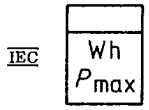
12.6.11 Remote meter (repeater) actuated by a watthour meter



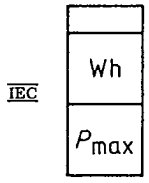
12.6.12 Remote meter (repeater) with printing device, actuated by a watthour meter



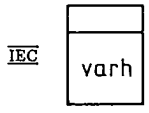
12.6.13 Watthour meter with maximum demand indicator



12.6.14 Watthour meter with maximum demand recorder

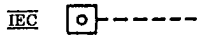


12.6.15 Varhour meter

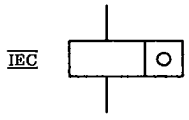


12.7 Counting Devices (IEC Publication 617-8 (1983) [19])

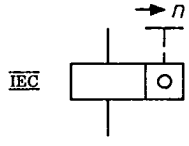
12.7.1 Counting function of a number of events, qualifying symbol



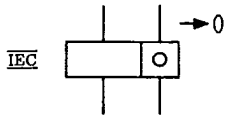
12.7.2 Pulse meter (electrically-operated counting device)



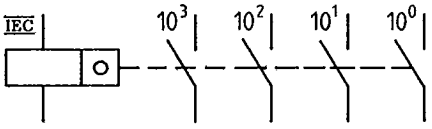
12.7.3 Pulse meter manually preset to n (reset if $n = 0$)



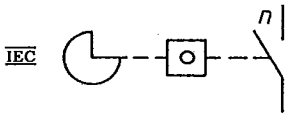
12.7.4 Pulse meter electrically reset to 0



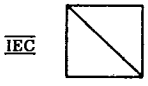
12.7.5 Pulse meter with multiple contacts
Respective contacts close once at every unit (10^0), ten (10^1), hundred (10^2), thousand (10^3) events registered by the counter



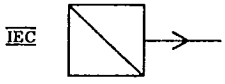
12.7.6 Counting device, cam driven and closing a contact for each *n* events



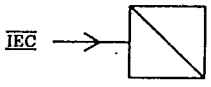
12.8 Telemetering Devices
12.8.1 Signal translator, general symbol



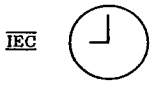
12.8.2 Telemetering transmitter



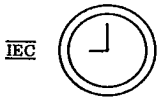
12.8.3 Telemetering receiver



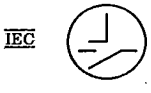
12.9 Electric Clocks
12.9.1 Clock, general symbol
Secondary clock



12.9.2 Master clock



12.9.3 Clock with switch



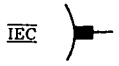
Section 13

Graphic Symbols for Rotating Machinery

Add:

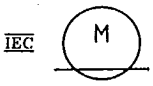
13.1.5A Brush (on slip-ring or commutator)

NOTE 13.1.5A: Brushes are shown only if necessary.

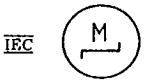


Add:

13.1.7 Linear motor, general symbol

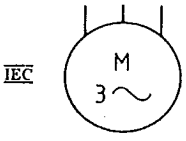


13.1.8 Stepping motor, general symbol

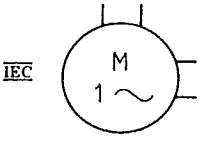


Add:

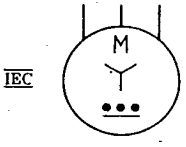
13.5.1.1 Induction motor, three-phase, squirrel cage



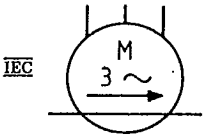
13.5.1.2 Induction motor, single-phase, squirrel cage, leads of split phase brought out



13.5.1.3 Induction motor, three-phase, star-connected, with automatic starter in the rotor

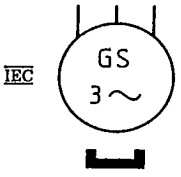


13.5.1.4 Linear induction motor, three-phase, movement limited to one direction



Add:

13.6.1.1 Synchronous generator, three-phase, permanent magnet



14.2 Mechanical Motion

14.2.1 Translation, one direction

Add:

14.2.1A Rectilinear force or motion in the direction of the arrow

IEC

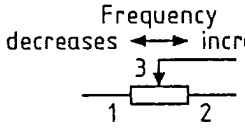
14.2.2 Translation, both directions

Add:

14.2.2A Bidirectional rectilinear forces or motion

IEC

EXAMPLE: Frequency is increased when wiper 3 is moved towards terminal 2



After 14.2.4
Add:

14.2.4A Bidirectional rotation, limited in both directions

14.2.4.1 Alternating or reciprocating
For application see symbol 2.3.7.7

IEC 

Add:

OR

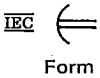
IEC 

After 14.2.6
Add:

14.2.7 Delayed action

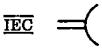
14.2.7.1 Delayed action

NOTE 14.2.7.1A: Delayed action in the direction of movement from the arc towards its center.

IEC 

Form 1

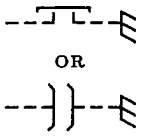
14.2.7.2

IEC 

Form 2

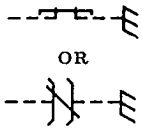
Revise 14.3.3 *to read as follows:*

14.3.3 Brake applied when operating means (not shown) is energized



Revise 14.3.4 *to read as follows:*

14.3.4 Brake released when operating means (not shown) is energized

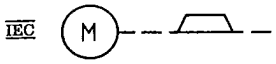


Add:

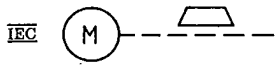
14.3.5 Brake (IEC Publication 617 (1983) [13])

IEC 

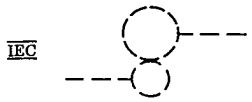
14.3.5.1 EXAMPLE: Electric motor with brake applied.

IEC 

14.3.5.2 EXAMPLE: Electric motor with brake released.

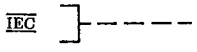
IEC 

14.3.6 Gearing

IEC 

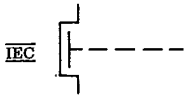
After 14.4.2
Add:

14.4.2A Operating by pulling.

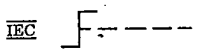
IEC 

Add:

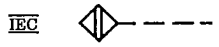
14.4.4 Manually operated control with restricted access

IEC 

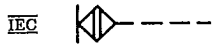
14.4.5 Operated by turning

IEC 

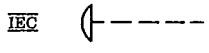
14.4.6 Operated by proximity effect

IEC 

14.4.7 Operated by touching

IEC 

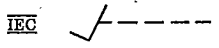
14.4.8 Emergency switch (mushroom-head safety feature)

IEC 

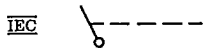
14.4.9 Operated by handwheel

IEC 

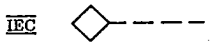
14.4.10 Operated by pedal

IEC 

14.4.11 Operated by lever

IEC 

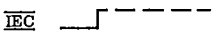
14.4.12 Operated by removable handle

IEC 

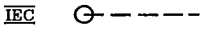
14.4.13 Operated by key

IEC 

14.4.14 Operated by crank

IEC 

14.4.15 Operated by roller

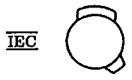
IEC 

14.4.16 Operated by cam

NOTE 14.4.16A: If desired, a more detailed drawing of the cam may be shown. This applies also to a profile plate.

IEC 

14.4.16.1 EXAMPLE: Cam profile

IEC 

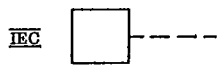
14.4.16.2 Profile plate
Cam profile (developed representation)

IEC 

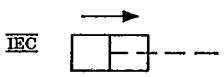
14.4.16.3 Operated by cam and roller

14.4.17 Operated by stored mechanical energy

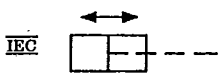
NOTE 14.4.17A: Information showing the form of stored energy may be added in the square.



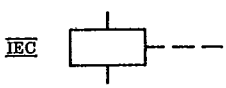
14.4.18 Operated by pneumatic or hydraulic control, single acting



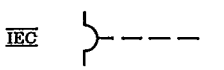
14.4.19 Operated by pneumatic or hydraulic control, double acting



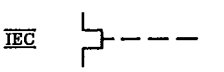
14.4.20 Operated by electromagnetic actuator



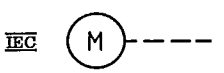
14.4.21 Operated by electromagnetic overcurrent protection



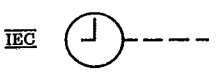
14.4.22 Operated by thermal actuator, for example thermal relay, thermal overcurrent protection



14.4.23 Operated by electric motor



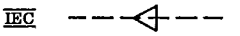
14.4.24 Operated by electric clock



14.5 Detents, Latching, and Blocking

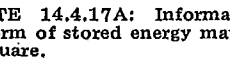
14.5.1 Automatic return

NOTE 14.5.1A: The triangle is pointed in the return direction.

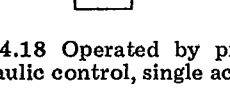


14.5.2 Detent
Nonautomatic return
Device for maintaining a given position

14.5.3 Detent, disengaged



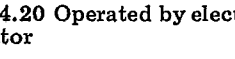
14.5.4 Detent, engaged



14.5.5 Mechanical interlock between two devices

14.5.6 Latching device, disengaged

14.5.7 Latching device, engaged



14.5.8 Blocking device

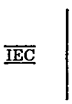
14.5.9 Blocking device engaged, movement to the left is blocked

15.2 Coupling

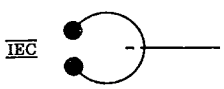
Commonly used in coaxial and waveguide diagrams.

Add:

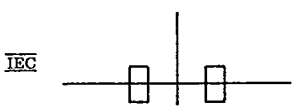
15.2A Coupler (or feed) type unspecified, general symbol



15.2A.1 EXAMPLE: Coupler to a cavity resonator

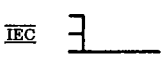


15.2A.2 EXAMPLE: Coupler to a rectangular waveguide

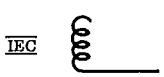


After 15.2.7
Add:

15.2.8 Slow-wave coupler

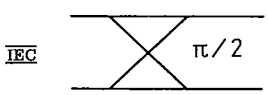


15.2.9 Helical coupler



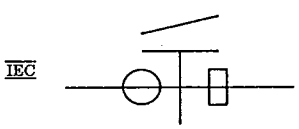
After 15.4.4.2
Add:

15.4.4.3 Quadrature hybrid junction



After 15.5.3
Add:

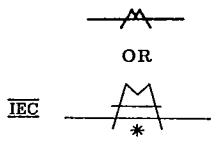
15.5.4 Taper transition from circular to rectangular waveguide



15.6 Mode Suppressor

Commonly used in coaxial and waveguide transmission.

15.6.1 General

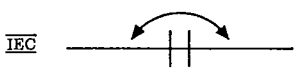


The asterisk shall be replaced by the indication of the mode suppressed

15.7 Rotary Joint (radio-frequency rotary coupler F)

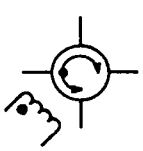
Add:

15.7A Rotatable joint, with symmetrical connectors

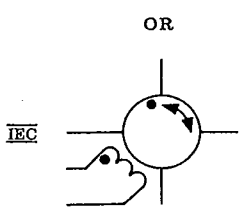


15.8.4.1 Reversible direction

Current entering the coil at the end marked with the dot causes the energy in the circulator to flow in the direction of the arrowhead marked with the dot.

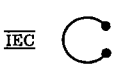


Add:



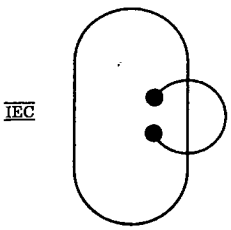
15.9.1 General

Commonly used for coaxial and waveguide transmission.

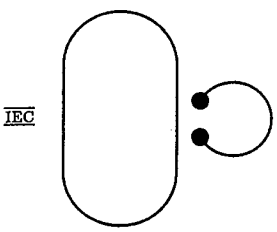


Add:

15.9.1.1 Cavity resonator forming an integral part of tube

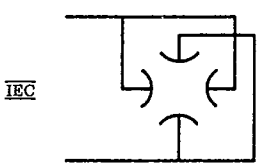


15.9.1.2 Cavity resonator, partly or wholly external to tube



After 15.9.4
Add:

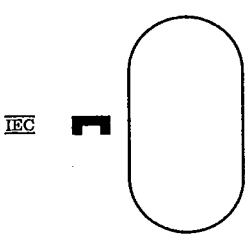
15.9.5 Tetrapole



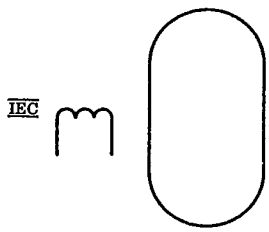
15.9.5.1 Tetrapole with loop coupler

After 5.10.3
Add:

15.10.4 Permanent magnet producing a transverse field (in a crossed field or magnetron type tube)

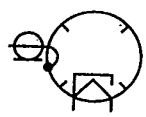


15.10.5 Electromagnet producing a transverse field (in a crossed field or magnetron type tube)



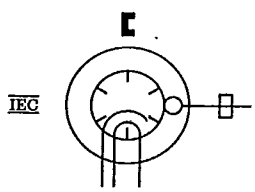
15.11 Magnetron

15.11.1 Resonant type with coaxial output

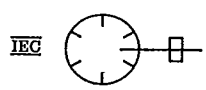


Add:

15.11.1A Magnetron oscillator tube with:
- — Indirectly heated cathode
- — Closed slow-wave structure with dc connection by way of a waveguide
- — Permanent field magnet
- — Window-coupler to rectangular waveguide



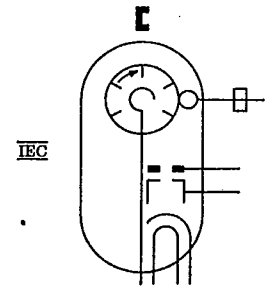
15.11.1A.1



Simplified form

After 15.11.3
Add:

15.11.4 Backward (traveling) wave oscillator tube (voltage tunable magnetron) with:
- — Indirectly heated cathode
- — Intensity modulating electrode
- — Beam-forming plate
- — Closed slow-wave structure with dc connection by way of waveguide
- — Nonemitting sole
- — Permanent field magnet
- — Window-coupler to rectangular waveguide

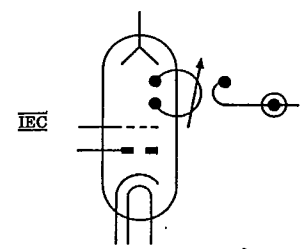


15.11.4.1

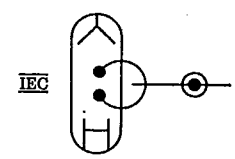
Simplified form

After 15.12.1
Add:

15.12.1A Reflex klystron with:
- — Indirectly heated cathode
- — Beam-forming plate
- — Grid
- — Tunable integral cavity resonator
- — Reflector
- — Loop coupler to coaxial output



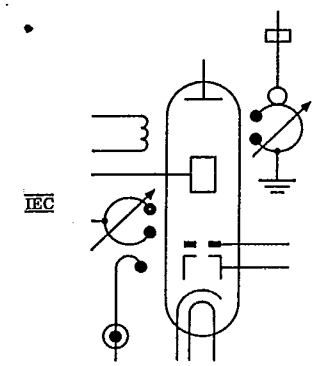
15.12.1A.1



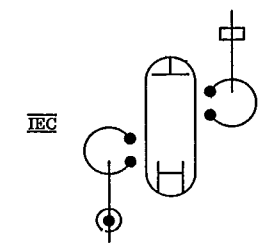
Simplified form

After 15.12.2
Add:

15.12.3 Klystron with:
- — Indirectly heated cathode
- — Intensity modulating electrode
- — Beam-forming plate
- — External tunable input cavity resonator
- — Drift space electrode
- — External tunable output cavity resonator with dc connection
- — Collector
- — Focusing coil
- — Input loop coupler to coaxial waveguide
- — Output window coupler to rectangular waveguide



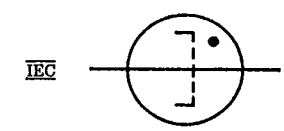
15.12.3.1



Simplified form

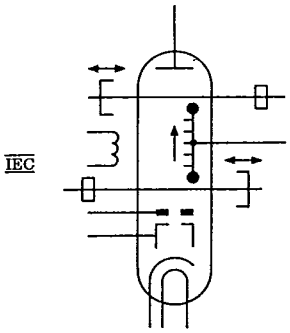
After 15.13
Add:

15.13.1 T-R tube



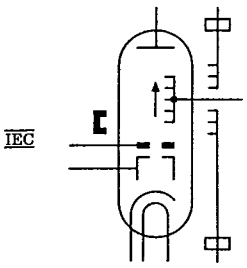
After **15.14.8**
Add:

15.14.9 O-type forward traveling wave amplifier tube with:
- Indirectly heated cathode
- Intensity modulating electrode
- Beam-forming plate
- Slow-wave structure with dc connection
- Collector
- Focusing coil
- Probe-couplers to rectangular waveguides each with sliding short



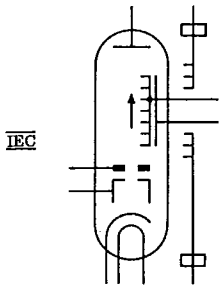
For a simplified form see symbol 15.14.11.1.

15.14.10 O-type forward traveling wave amplifier tube with:
- Indirectly heated cathode
- Intensity modulating electrode
- Beam-forming plate
- Slow-wave structure with dc connection
- Collector
- Permanent focusing-magnet
- Slow-wave couplers to rectangular waveguides



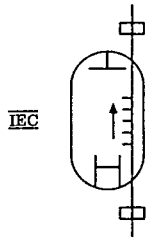
For a simplified form see symbol 15.14.11.1.

15.14.11 O-type forward traveling wave amplifier tube with:
- Indirectly heated cathode
- Intensity modulation electrode
- Beam-forming plate
- Slow-wave structure with dc connection
- Electrostatic focusing electrode
- Collector
- Slow-wave couplers to rectangular waveguides



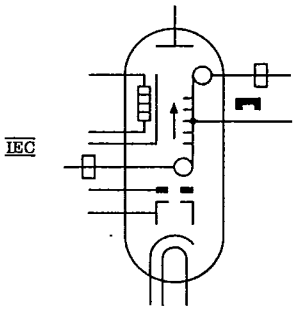
For a simplified form see symbol 15.14.11.1.

15.14.11.1 O-type forward traveling wave amplifier tube, simplified representation (simplified form for symbols 15.14.9, 15.14.10, and 15.14.11)

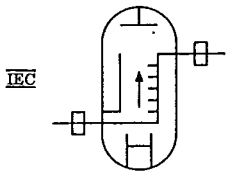


Simplified Form

15.14.12 M-type forward traveling wave amplifier tube with:
- Indirectly heated cathode
- Intensity modulating electrode
- Beam-forming plate
- Preheated nonemitting sole
- Slow-wave structure with dc connection
- Collector
- Permanent transverse field magnet
- Window couplers to rectangular waveguides

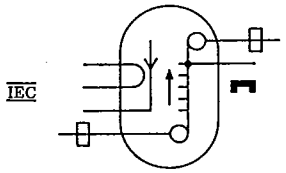


15.14.12.1

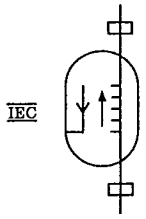


Simplified form

15.14.13 M-type backward (traveling) wave amplifier tube with:
- Filament-heated emitting sole
- Slow-wave structure with dc connection
- Permanent transverse field magnet
- Window-couplers to rectangular waveguides

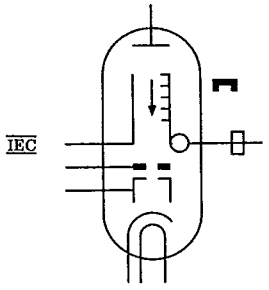


15.14.13.1

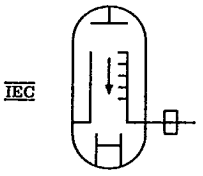


Simplified form

15.14.14 M-type backward (traveling) wave oscillator tube with:
- Indirectly heated cathode
- Intensity modulating electrode
- Beam-forming plate
- Nonemitting sole
- Slow-wave structure with dc connection by way of waveguide
- Collector
- Permanent transverse field magnet
- Window-coupler to rectangular waveguide

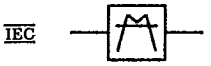


15.14.14.1



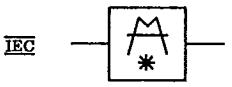
Simplified form

15.16 Filter
15.16.1 Mode filter



Add:

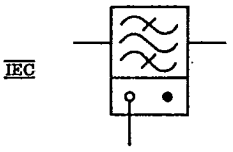
OR



The asterisk shall be replaced by the indication of the mode suppressed.

After **15.16.2**
Add:

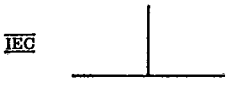
15.16.3 Bandpass filter switched by gas discharge



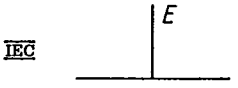
After **15.19**
Add:

15.20 Multiport Devices
15.20.1 Three-port junction

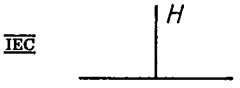
NOTE 15.20.1A: The type of coupling, power division proportions, reflection coefficients, etc, may be indicated as shown below. The angles between the ports may be drawn as convenient.



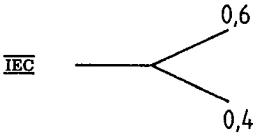
15.20.1.1 EXAMPLE: Series T, *E*-plane T



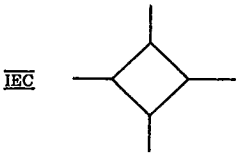
15.20.1.2 EXAMPLE: Shunt T, *H*-plane T



15.20.1.3 EXAMPLE: Power divider:
Power divided into ratio 6:4



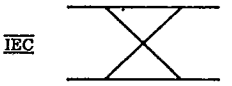
15.20.2 Four-port junction



Form 1

15.20.2.1

NOTE 15.20.2.1A: The convention is that the power entering at one port is conveyed only to the two directly connected ports and thence away from the device.

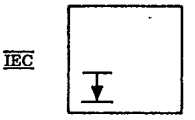


Form 2

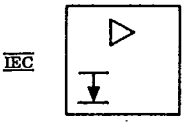
15.21 Lasers and Masers
15.21.1 Maser, general symbol

NOTE 15.21.1A: The symbol I represents the transition from one energy level to a lower one. It is drawn preferably in the lower left-hand quarter of the square.
NOTE 15.21.1B: Pumping by light may be shown by placing symbol 1.3.1 ( ) above
(a) An appropriate symbol chosen from 1.4, or
(b) The chemical symbol for the material

For example of application, see symbol 15.21.2.2

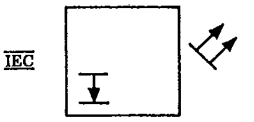


15.21.1.1 EXAMPLE: Maser used as an amplifier

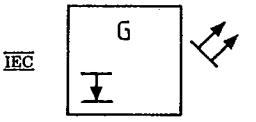


15.21.2 Laser (optical maser), general symbol

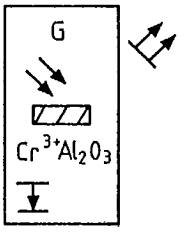
The NOTES with symbol 15.21.1 apply.



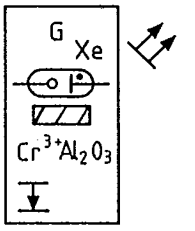
15.21.2.1 EXAMPLES: Laser used as a generator



15.21.2.2 Ruby laser generator



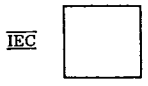
15.21.2.3 Ruby laser generator, shown with xenon lamp as pumping source



After 16.1.1
Add:

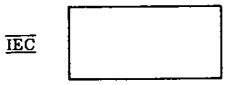
16.1.1A Item
Equipment
Functional unit

NOTE 16.1.1A: Suitable symbols or legends shall be inserted in or added to the symbol outline to indicate the item, equipment, or function.



Form 1

OR



Form 2

OR

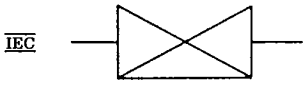
Form 3

Revise 16.1.1.1 *to read as follows:*

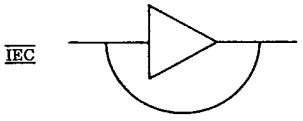
16.1.1.1 Accepted abbreviations from ANSI Y1.1-1972 (R 1984) [1] may be used in the rectangle.

After 16.2.8
Add:

16.2.9 Negative impedance both-way amplifier



16.2.10 Amplifier with bypass used for signaling or power feeding, or both



16.2.11 Amplifier with external direct-current control

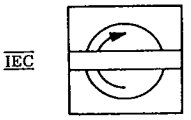
NOTE 16.2.11A: The controlled quantity may be indicated beside the arrowhead.

Revise 16.9 *to read as follows:*

16.9 Gyro
Gyroscope
Gyrocompass

Add:

16.9.1 Gyro



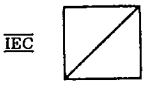
Add:

16.13 Changer, General Symbol
Converter, General Symbol

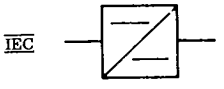
If the direction of change is not obvious, it may be indicated by an arrowhead on the outline of the symbol.

A symbol or legend indicating the input or output quantity, waveform, etc may be inserted in each half of the general symbol to show the nature of the change.
See IEC Publication 617-6 (1983) [17], Production and Conversion of Electrical Energy, and IEC Publication 617-10 (1983) [21], Telecommunications: Transmission.

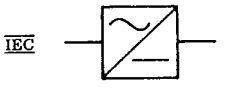
The diagonal line from this symbol is used in the form of a solidus to show a converting function.



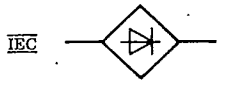
16.13.1 DC converter



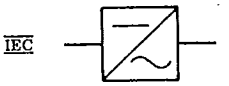
16.13.2 Rectifier



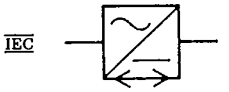
16.13.3 Rectifier in full wave (bridge) connection



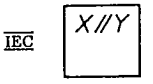
16.13.4 Inverter



16.13.5 Rectifier/inverter



16.14 Galvanic Separator



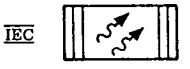
NOTE 16.14A: If necessary, indication of the way of separation may be given below the qualifying symbol.

For example: X///Y

Galvanic separation by opto-coupler

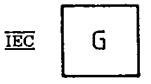
16.15 Heat Source, General Symbol

16.15.1 Radioisotope heat source



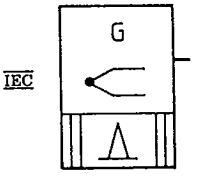
16.15.2 Combustion heat source

16.16 Generator, General Symbol

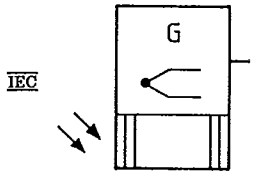


NOTE 16.16A: For a rotating generator, use symbol Ⓖ
See 13.1

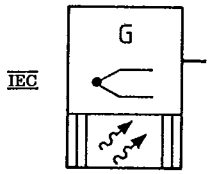
16.16.1 Thermoelectric generator, with combustion heat source



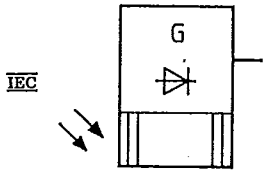
16.16.2 Thermoelectric generator with nonionizing radiation heat source



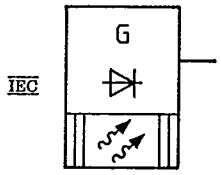
16.16.3 Thermoelectric generator wih radioisotope heat source



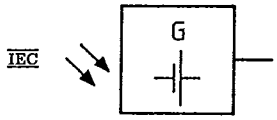
16.16.4 Thermionic diode generator with nonionizing radiation heat source



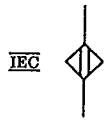
16.16.5 Thermionic diode generator with radioisotope heat source



16.16.6 Photovoltaic generator

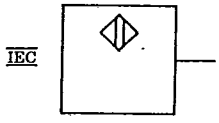


16.17 Sensors and Detectors
16.17.1 Proximity sensor

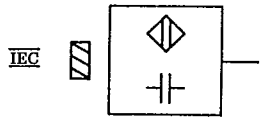


16.17.2 Proximity sensing device, block symbol

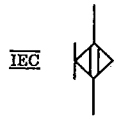
NOTE 16.17.2A: The method of operating may be indicated.



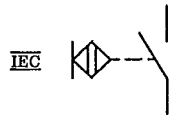
16.17.2.1 EXAMPLE: Capacitive proximity detector operating on the approach of solid material



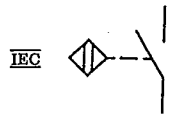
16.17.3 Touch sensor



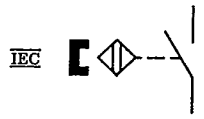
16.18 Applications of Sensors
16.18.1 Touch sensitive switch, make contact



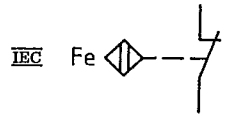
16.18.2 Proximity switch, make contact



16.18.3 Proximity switch, operated on the approach of a magnet, make contact



16.18.4 Proximity switch, operated on the approach of iron, break contact



NOTE 17A: The existing Section 17, symbols 17.1 through 17.9 (inclusive) filled a need for programming operations using general purpose computers equipped with removable programming (patch) panels. IEC Publication 617-13 (1978) [24] provides a more sophisticated system.

17.10 Analog Elements (IEC Publication 617-13 (1978) [24]) for Computation and Control

17.10.1 General Rules

(1) In many figures lowercase letters appear that are not part of the symbols and are added only for the purpose of identification of inputs and outputs as referenced in the description.

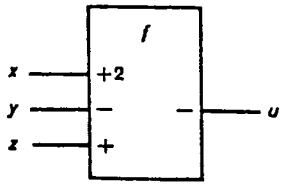
(2) The symbols for sign indication are + and −. They are placed inside the outline of the symbol adjacent to each relevant input and output.

(3) Weighting factors applied to the input signals are each indicated by a sign indicator in combination with a numerical value placed inside the outline of the symbol adjacent to the relevant input.

In this standard w_1, w_2, ... w_n which are understood to include the proper sign, will be used to denote the values of the weighting factors. When the weighting factor is +1 or −1, the number 1 may be omitted.

(4) The symbol f is used to denote the function of an anolog element. f may be replaced by a symbol or a graph denoting the actual function.

(5) *EXAMPLE:*



Element in which:

$u = -f(2x, -y, z)$

17.10.2 Qualifying symbols for signal identification

See 1.15

17.10.3 Qualifying symbols for amplifiers

(1) When an element performs a specific function in addition to amplification, f may be replaced by the appropriate qualifying symbol (see symbols 17.10.3.1 to 17.10.3.4) or may be omitted if no confusion can arise.

(2) In particualar cases, for example integrating amplifiers, special purpose inputs may be defined using symbols 17.10.3.5 to 17.10.3.11. If these symbols are not sufficient, controlling inputs should be labelled C_1, C_2 ... etc, and the effects of these should be defined in an associated table.

17.10.3.1 Summing

IEC $\sum$

17.10.3.2 Integrating

IEC $\int$

17.10.3.3 Differentiating

IEC $\frac{d}{dt}$

17.10.3.4 Logarithmic

IEC log

17.10.3.5 Frequency compensation

IEC F

17.10.3.6 Initial condition, analog value of integration

IEC I

17.10.3.7 Control: the defined 1-state allows integration

IEC C

17.10.3.8 Hold: the defined 1-state holds last value

IEC H

17.10.3.9 Reset: the defined 1-state resets the output condition to zero

IEC R

17.10.3.10 Set: the defined 1-state sets to initial condition

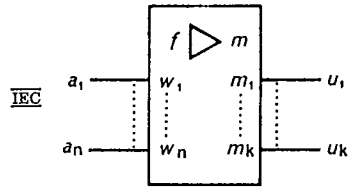
IEC S

17.10.3.11 Supply voltage (to be used if special requirements exist). Any necessary identification of the supply (numeric) or polarity (+ or −) follows the letter U

IEC U

17.10.4 Amplifiers

17.10.4.1 Amplifier for analog computation. General symbol.



w_1 ... w_n repersent the signed values of the weighting factors.

m_1 ... m_k represent the signed values of the amplification factors.

$u_1 = m \cdot m_1 \cdot f(w_1 \cdot a_1, w_2 \cdot a_2, \ldots, w_n \cdot a_n)$

where:

$i = 1, 2, \ldots, k$

The sign of the amplification factor is to be maintained at each of the outputs, except for those being digital in nature.

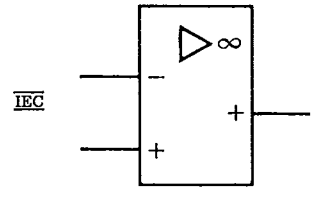
When there is only one amplification factor for the whole element, or there is a common factor resulting from weighting factors and amplification factors, the m in the qualifying symbol may be replaced by the absolute value.

When $m = 1$, the number 1 may be omitted. Signs should always be maintained at analog outputs.

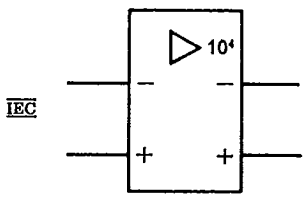
The use of the sign ∞ as an amplification factor is recommended where the nominal open loop gain is very high and the knowledge of its exact value is not of particular concern.

EXAMPLES:

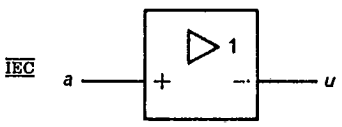
17.10.4.2 High gain differential amplifier (operational amplifier)



17.10.4.3 High gain amplifier with a nominal amplification of 10 000 and two complementary outputs

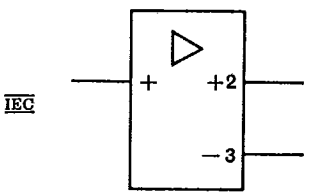


17.10.4.4 Inverting amplifier with an amplification of 1

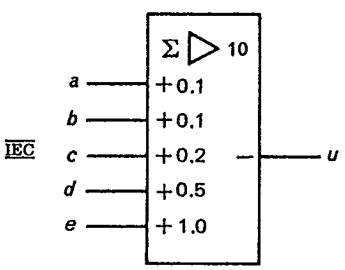


$u = -1 \cdot a$

17.10.4.5 Amplifier with two outputs, the upper, noninverting, has an amplification of 2, the lower, inverting output, has an amplification of 3



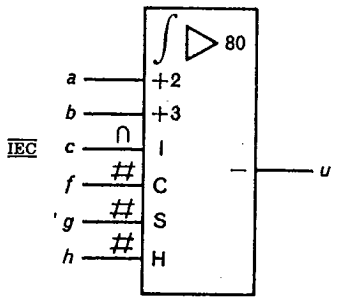
17.10.4.6



Summing amplifier

$u = -10\,(0.1a + 0.1b + 0.2c + 0.5d + 1.0c)$
$= -\,(a + b + 2c + 5d + 10e)$

17.10.4.7 Integrating amplifier (integrator)

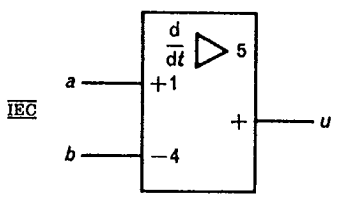


If $f = 1$, $g = 0$, and $h = 0$.
then

$$u = -80\left[c_{(t=0)} + \int_0^t (2a + 3b)\,dt\right]$$

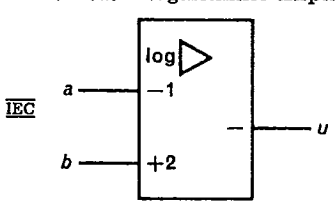
NOTE: The symbols for signal identification (∩ and #) may be omitted if no ambiguity arises.

17.10.4.8 Differentiating amplifier (differentiator)



$$u = 5\,\frac{d}{dt}\,(a - 4b)$$

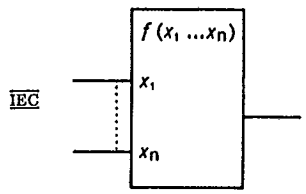
17.10.4.9 Logarithmic amplifier



$u = -\log\,(-a + 2b)$

17.10.5 Function generators

17.10.5.1 Function generator, general symbol



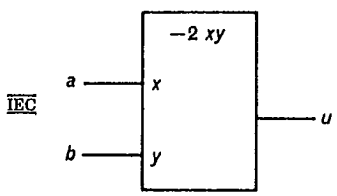
x_1 ... x_n represent the arguments of the function and may each be replaced by an appropriate indication, provided that no ambiguity can arise. All weighting factors are assigned the value +1 and are therefore omitted.

$f(x_1$ ... $x_n)$ shall be replaced by an appropriate indication of, or reference to, the function (see for example, IEC Publication 27-1 (1971) [9]).

NOTE 17.10.5.1A: the graphic "/" shall not be used for the indication of the division because of ambiguity with the symbols for the level converter and the code converter.

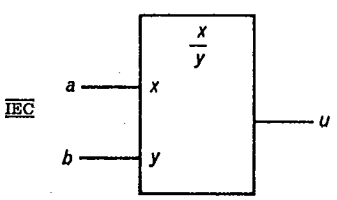
EXAMPLES:

17.10.5.2 Multiplier with weighting factor of -2



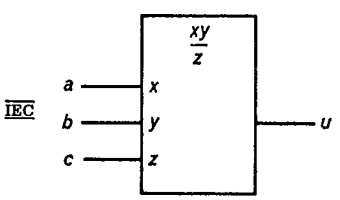
$u = -2ab$

17.10.5.3 Divider



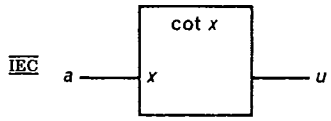
$$u = \frac{a}{b}$$

17.10.5.4 Multiplier-divider



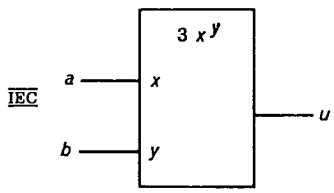
$$u = \frac{ab}{c}$$

17.10.5.5 Cotangent function



$u = \cot a$

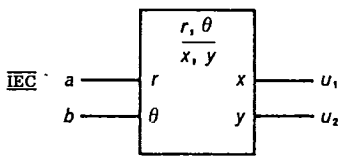
17.10.5.6 Exponential function



$u = 3a^b$

17.10.6 Coordinate converters

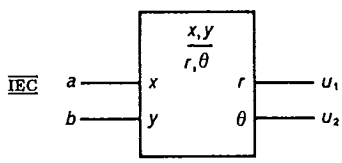
17.10.6.1 Coordinate converter, polar to rectangular



$u_1 = a \cdot \cos b$

$u_2 = a \cdot \sin b$

17.10.6.2 Coordinate converter, rectangular to polar



$u_1 = \sqrt{a^2 + b^2}$

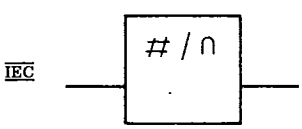
$u_2 = \arctan \frac{b}{a}$

17.10.7 Signal convertors

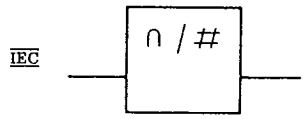
(1) The indication of the specific relation between inputs and outputs may be shown inside the outline.

(2) If the digital information is serial, the most significant bit is presented first unless otherwise indicated.

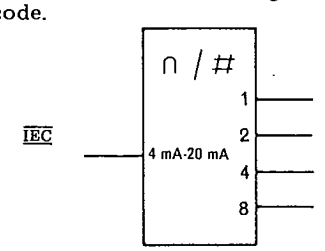
17.10.7.1 Digital to analog converter. General symbol.



17.10.7.2 Analog to digital converter. General symbol.



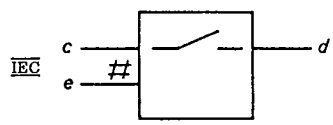
17.10.7.3 Analog to digital converter that converts the input range 4 mA-20 mA into a 4-bit weighted binary code.



17.10.8 Electronic switches

NOTE: Electronic switches are being considered in connection with binary logic elements. The results of this work may be published as a supplement to IEC Publciation 617-12 (1983) [23]. See ANSI/IEEE Std 91-1984 [4].

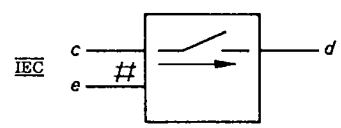
17.10.8.1 Bidirectional switch (make), general symbol



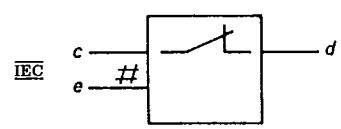
The analog signal can pass in either direction between *c* and *d* as long as the digital input *e* stands at its defined 1-state.

NOTE 17.10.8.1A: An arrow may be added to indicate an unidirectional switch (make).

17.10.8.2 *EXAMPLE:* The analog signal can pass only in the direction indicated by the arrow as long as the digital input *e* stands at its defined 1-state.



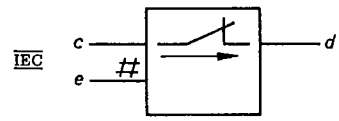
17.10.8.3 Bidirectional switch (break), general symbol



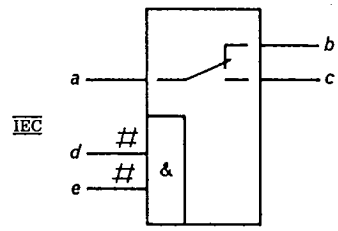
The analog signal can pass in either direction between *c* and *d* as long as the digital input *e* stands at its defined 0-state.

NOTE 17.10.8.3A: An arrow may be added to indicate an unidirectional switch (break).

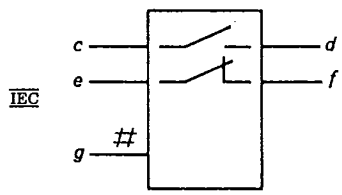
17.10.8.4 *EXAMPLE:* The analog signal can pass only in the direction indicated by the arrow as long as the digital input *e* stands at its defined 0-state.



17.10.8.5 Bidirectional transfer switch operated by the AND function of two digital inputs.

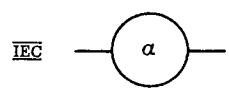


17.10.8.6 Two independent bidirectional switches (one make and one break), both operated by the same binary input.



17.10.9 Coefficient scaler

NOTE 17.10.9A: The value of the coefficient may be shown adjacent to and outside the outline of the symbol.



Section 20

Communications Equipment

Relocate:

20.3.2 *Relocate to* 24.2.1

20.3.3.*Relocate to* 24.2.2

21.1 Generating Station

NOTE 21.1A: Symbols for "planned" applications appear at the left; symbols for "in service" applications appear at the right.

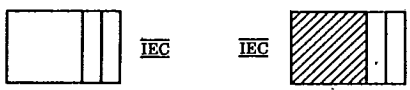
NOTE 21.1B: The preferred symbol is the square, but if necessary, a rectangle may be used.

NOTE 21.1C: Relative sizes of symbols are shown. Symbol size may be reduced for small-size diagrams. See also paragraph A4.5 of the Introduction.

21.1.1 General
See NOTE 21.1A

Add:

21.1.2 Combined electric and heat generating station



Revise to read as follows:

21.2 Hydroelectric Generating Station
See NOTE 21.1A

21.2.1 General

21.2.2 Run of river

21.2.3 With storage

21.2.4 With pumped storage

21.3 Thermoelectric Generating Station
See NOTE 21.1A

21.3.1 General

21.3.2 Coal or lignite fueled

21.3.3 Oil or gas fueled

21.3.4 Nuclear-energy fueled

21.3.5 Geothermic

Add:

21.3.6 Solar generating station

Revise to read as follows:

21.4 Prime Mover (qualifying symbols)
Use if essential to show the type of prime mover in a generating station.
See NOTE 21.1A

21.4.1 Gas turbine

21.4.1.1 Application: shown for oil- or gas-fueled generating station

21.4.2 Reciprocating engine

21.4.2.1 Application: shown for oil- or gas-fueled generation station

21.5 Substation
See NOTE 21.1A

21.5.1 General
Avoid conflict with symbol 13.1.1 if used on the same diagram.

21.5.2 Rectifier substation
Use if essential to show type of equipment.

Add:

21.5.3 Converting substation, dc to ac shown

21.6 Wind Generating Station

21.7 Plasma Generating Station
MHD (magneto-hydrodynamic)

24.1 Switching Systems

The symbols in this section may be used to represent switching systems without regard to the type of equipment used as shown in the examples of trunking diagrams in the Appendix to this section.

The following terms are used in this section with the meaning as given below.

Connecting stage:
An arrangement of inlets and outlets so that only one switching point is used to connect one inlet to an outlet. A number of connections may exist at any time in one connecting stage.

Marking stage:
In a common-control system, that sequence of connecting stages that is controlled by one marking process. A marking stage may consist of one or more connecting stages.

Switching stage:
A sequence of connecting stages that jointly perform a specified switching function, for example preselection or route selection.

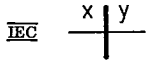
Highway-group:
The maximum number of circuits that have access to one highway.

24.1.1 Connecting stage

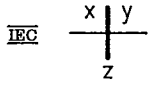
24.1.1.1 Connecting stage, shown with inlets and outlets, general symbol

Circuits on one side can be connected individually to circuits on the other side

24.1.1.2 Connecting stage with x inlets and y outlets

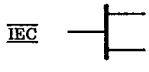


24.1.1.3 Connecting stage composed of z grading groups, each consisting of x inlets and y outlets

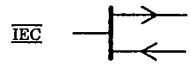


24.1.1.4 Connecting stage with one group of inlets and two groups of outlets

NOTE 24.1.1.4A: The number of inlets or outlets in each group may be indicated by a figure on the relevant line.



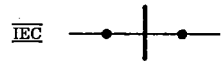
24.1.1.5 Connecting stage interconnecting one group of bothway trunks with two groups of unidirectional trunks of opposite sense



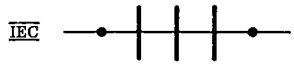
24.1.2 Marking stage

24.1.2.1 Marking stage consisting of only one connecting stage

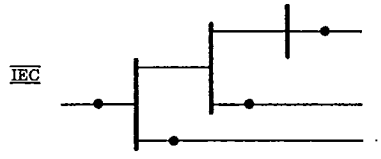
NOTE 24.1.2.1A: The qualifying symbol indicating a marking stage is a dot. It should be added to the inlets of the first connecting stage and to the outlets of the last connecting stage of that marking stage.



24.1.2.2 *EXAMPLES:* Marking stage consisting of three connecting stages



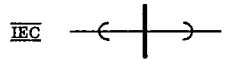
24.1.2.3 Mixed marking stage consisting of one, two, and three connecting stages



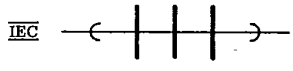
24.1.3 Switching stage

24.1.3.1 Switching stage consisting of one connecting stage

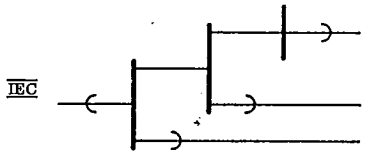
NOTE 24.1.3.1A: The qualifying symbol indicating a switching stage is an arc. It should be added to the inlets of the first connecting stage and to the outlets of the last connecting stage of that switching stage.



24.1.3.2 *EXAMPLES:* Switching stage consisting of three connecting stages



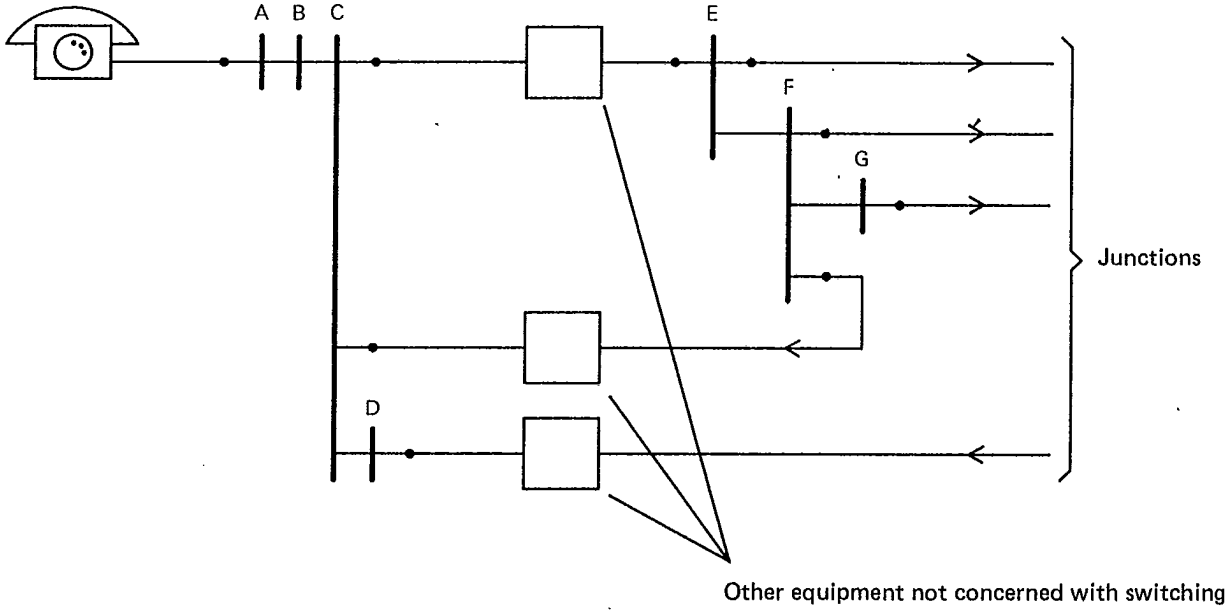
24.1.3.3 Mixed switching stage consisting of one, two, and three connecting stages



24.1.4 Examples of trunking diagrams

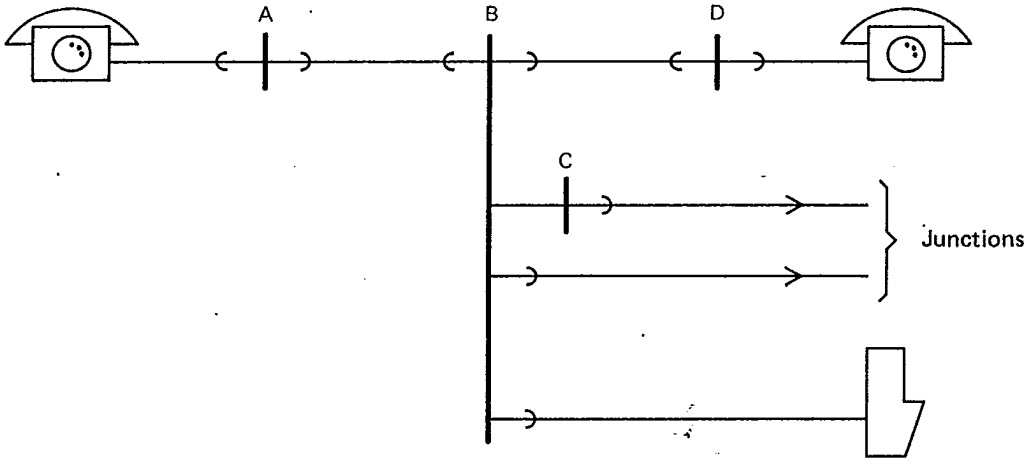
24.1.4.1 Trunking diagram for a switching system that consists of two marking stages, ABC or ABCD and E, EF or EFG, interconnected by other equipment represented by the squares. Calls are routed as follows:

(1) Incoming calls by way of DCBA
(2) Calls between subscribers connected to the same exchange by way of ABC, EF, and CBA
(3) Outgoing calls by way of ABC and either E, EF, or EFG



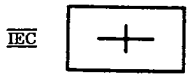
24.1.4.2 Trunking diagram of a switching system showing three switching stages

(1) Preselection stage A
(2) Route selection stage B or BC
(3) Final selection stage D



24.2 Block Symbols for Switching Equipment

24.2.1 Automatic switching*



*Relocated from 20.3.2

24.2.2 Manual switchboard*

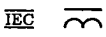
*Relocated from 20.3.3

24.3 Qualifying Symbols for Transducers, Recorders, and Reproducers

24.3.1 Magnetic type

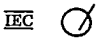
24.3.2 Moving coil or ribbon type

24.3.3 Moving iron type



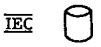
24.3.4 Stereo type

24.3.5 Disc type



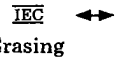
24.3.6 Tape or film type

24.3.7 Drum type

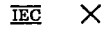


24.3.8 Recording or reproducing (the arrow points in the direction of energy transfer)

24.3.9 Recording and reproducing



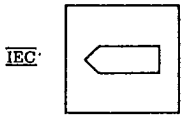
24.3.10 Erasing



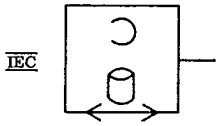
24.4 Recorders and Reproducers

24.4.1 Recorder or reproducer, or both, general symbol

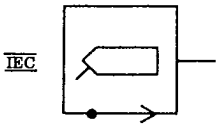
NOTE 24.4.1A: The qualifying symbol depicting a transducer head may be replaced by other qualifying symbols.



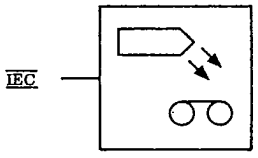
24.4.1.1 *EXAMPLE:* Recorder and reproducer, magnetic drum type



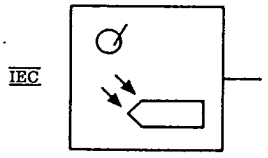
24.4.2 Reproducer with a stylus operated head



24.4.3 Recorder, film-type, with a head producing modulated light

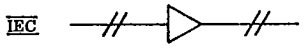


24.4.4 Reproducer, disc-type, with a light-operated head

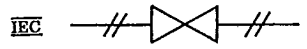


25.1 Amplified Circuits

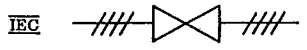
25.1.1 Two-wire line with unidirectional amplification



25.1.2 Two-wire line with both-way amplification

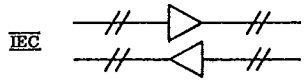


25.1.3 Four-wire circuit with both-way amplification



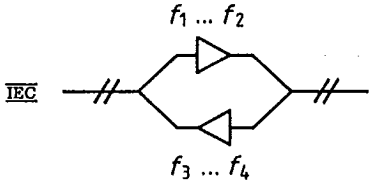
Form 1

OR

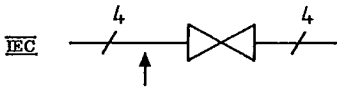


Form 2

25.1.4 Four-wire type circuit with frequency separation

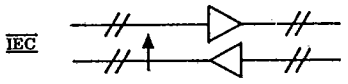


25.1.5 Four-wire circuit with both-way terminal amplification with echo suppression



Form 1

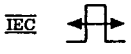
OR



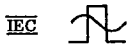
Form 2

25.2 Qualifying Symbols for Pulse Modulation

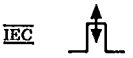
25.2.1 Pulse-position or pulse-phase modulation



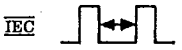
25.2.2 Pulse-frequency modulation



25.2.3 Pulse-amplitude modulation



25.2.4 Pulse-interval modulation



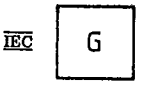
25.2.5 Pulse-duration modulation

25.2.6 Pulse-code modulation

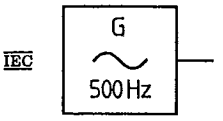
NOTE 25.2.6A: The * must be replaced by details of the code.

25.2.6.1 *EXAMPLE:* 3-out-of-7 code

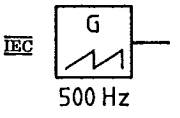
25.3 Signal Generator
Waveform Generator



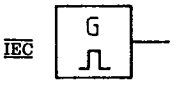
25.3.1 Sine-wave generator, 500 Hz



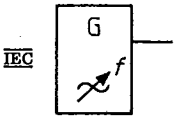
25.3.2 Sawtooth generator, 500 Hz



25.3.3 Pulse generator

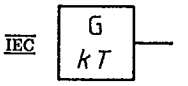


25.3.4 Variable frequency sine-wave generator

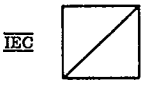


25.3.5 Noise generator

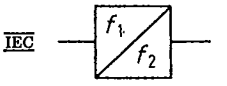
k = Boltzmann's constant
T = absolute temperature



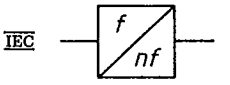
25.4 Changers
Converter, General Symbol



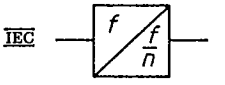
25.4.1 Frequency changer, changing from f_1 to f_2



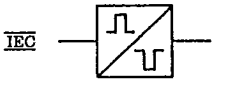
25.4.2 Frequency multiplier



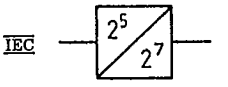
25.4.3 Frequency divider



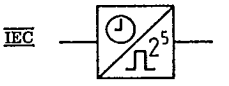
25.4.4 Pulse inverter



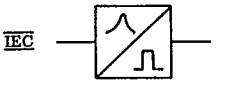
25.4.5 Code converter, five-unit binary code to seven-unit binary code



25.4.6 Changer giving clock-time indication in five-unit binary code

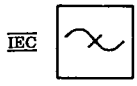


25.4.7 Pulse regenerator

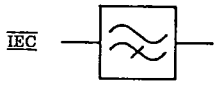


25.5 Filters

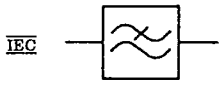
25.5.1 Filter, general symbol



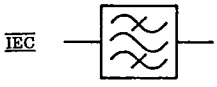
25.5.2 High-pass filter



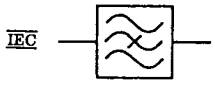
25.5.3 Low-pass filter



25.5.4 Band-pass filter

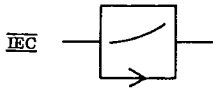


25.5.5 Band-stop filter

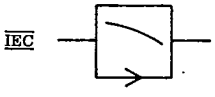


25.6 Networks

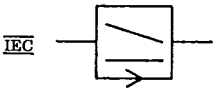
25.6.1 Device for pre-emphasis of higher frequencies



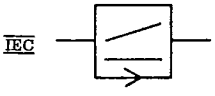
25.6.2 Device for de-emphasis of higher frequencies



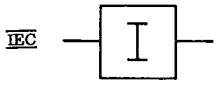
25.6.3 Compressor



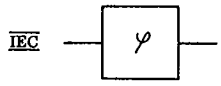
25.6.4 Expander



25.6.5 Artificial line



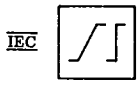
25.6.6 Phase-changing network



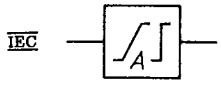
NOTE: φ may be replaced by B if no confusion arises

*Coordinate with symbol 15.17

25.6.7 Distortion corrector, general symbol

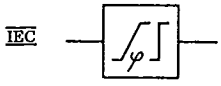


25.6.8 Amplitude/frequency distortion corrector, for example, equalizer

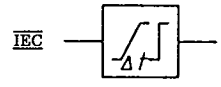


25.6.9 Phase/frequency distortion corrector

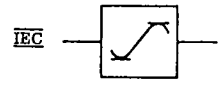
NOTE 25.6.9A: If it is desirable to indicate that the equalization refers to the time derivative of φ, φ may be replaced by Φ.



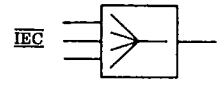
25.6.10 Delay/frequency distortion corrector



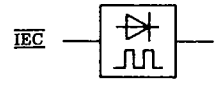
25.6.11 Nondistorting amplitude controller



25.6.12 Mixing network



25.7 Electronic Chopping Device

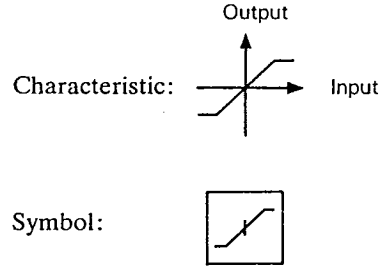


25.8 Threshold Devices

There are two ways of showing details of the operation carried out by a threshold device. The first is the use of the symbol 25.8.1 supplemented by appropriate waveform symbols on the input and output lines. The second is the use of a specific symbol consisting of a rectangle containing a figure derived from the input/output characteristic in the following manner:

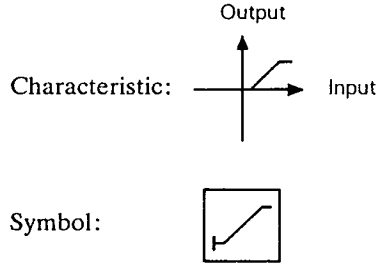
The axes are deleted, but the origin is indicated by a short vertical stroke representing the y-axis

EXAMPLE:

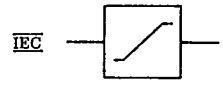


The origin may be located in the rectangle in such a position that the characteristic makes the maximum use of the available space

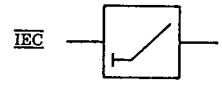
EXAMPLE:



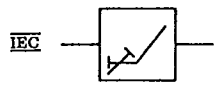
25.8.1 Threshold device, type unspecified (for example clipper)



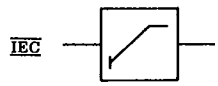
25.8.2 Device having a linear input/output characteristic for all signals that exceed a given threshold value and which has no output for input signals having an instantaneous amplitude between zero and that threshold



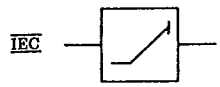
25.8.3 Device having a linear input/output characteristic for all signals that exceed a preset threshold value and that has no output for input signals having an instantaneous amplitude between zero and that threshold



25.8.4 Positive peak clipper

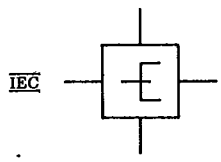


25.8.5 Negative peak clipper

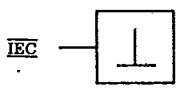


25.9 Terminating Sets

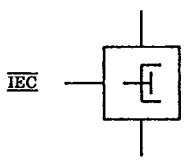
25.9.1 Terminating set



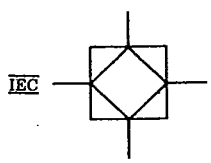
25.9.2 Balancing network



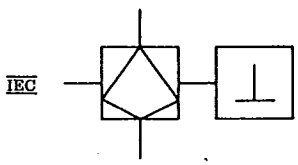
25.9.3 Terminating set with balancing network



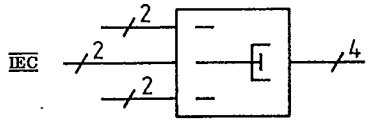
25.9.4 Hybrid transformer



25.9.5 Asymmetric (skew) hybrid transformer, shown with balancing network

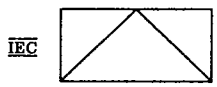


25.9.6 Equipment for connecting a four-wire circuit to either a two-wire circuit or a four-wire circuit depending upon the reception of a control signal

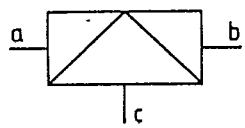


25.10 Modulator
Demodulator
Discriminator

25.10.1 General symbol



NOTE 25.10.1A: This symbol is used as follows: (Letters and input and output lines have been added in the figure for the purpose of explanation.)



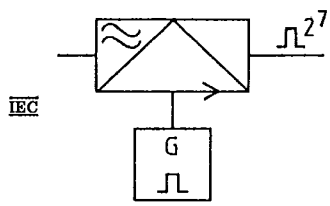
a and b represent the modulating or modulated signal input and the modulated or demodulated signal output

c represents the input of the carrier-wave if required

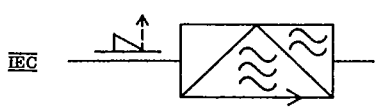
Qualifying symbols may be placed inside or outside the symbol as shown below

25.10.1.1 Modulator, double sideband output

25.10.1.2 Pulse code modulator (seven-unit binary code output)



25.10.2 Demodulator, single sideband with suppressed carrier to audio

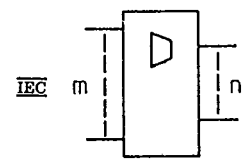


25.11 Concentrators
Multiplexers

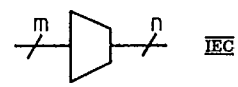
25.11.1 Concentrating switching function from left to right, qualifying symbol

25.11.2 Expanding switching function from left to right, qualifying symbol

25.11.3 *EXAMPLES:* Concentrator with m input circuits and n output circuits



Form 1



Form 2

25.11.4 Multiplexing function, qualifying symbol

IEC MUX

25.11.5 Demultiplexing function, qualifying symbol

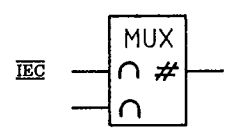
NOTE 25.11.5A: If confusion can arise, DX may be replaced by DMUX.

IEC DX

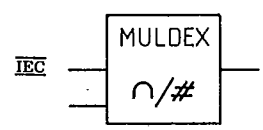
25.11.6 Multiplexing and demultiplexing function, qualifying symbol

IEC MULDEX

25.11.7 Multiplexer with analog/digital conversion



25.11.8 Multiplexer/demultiplexer with analog/digital conversion



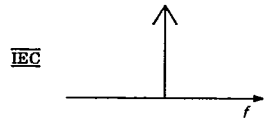
25.12 Frequency Spectrum Diagram Symbol Elements

A frequency spectrum is represented on a diagram by means of symbols on a horizontal frequency axis. The symbols show the functions of the various frequencies and frequency bands used in the transmission system as well as their relative positions in the spectrum.

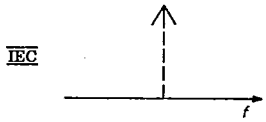
25.12.1 Carrier frequency

NOTE 25.12.1A: When this symbol is used to represent a carrier that is modulated in frequency or phase the f or φ is added. See, for example, symbol 25.13.2.

NOTE 25.12.1B: The arrowhead on the vertical line representing the carrier (and the arrowhead on the frequency axis) may be omitted if no confusion will result.



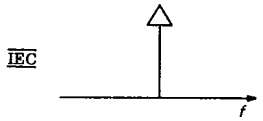
25.12.1.1 Suppressed-carrier frequency



25.12.1.2 Reduced-carrier frequency

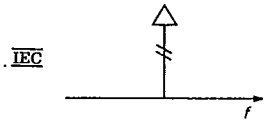
25.12.2 Pilot frequency

NOTE 25.12.2A: For FDM transmission systems the order of the group to which the pilot refers, that is, group, supergroup, mastergroup, or supermastergroup may be indicated by adding the respective number 1, 2, 3, or 4 of oblique strokes.

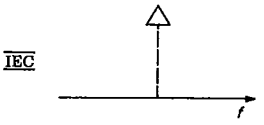


EXAMPLE: Supergroup pilot frequency

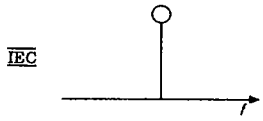
25.12.2.1



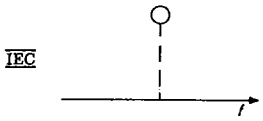
25.12.2.2 Suppressed pilot frequency



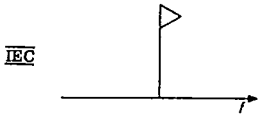
25.12.3 Additional measuring frequency



25.12.3.1 Additional measuring frequency, transmitted or measured on request



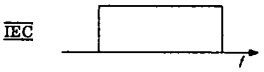
25.12.4 Signaling frequency



25.12.5 Frequency band

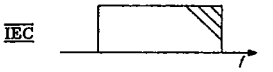
NOTE 25.12.5A: If it is desired to show whether a particular band of frequencies is erect or inverted, symbol 25.12.6 or 25.12.7 should be used.

NOTE 25.12.5B: The order of a band of frequencies forming part of a transmission system may be indicated by adding oblique strokes according to NOTE 25.12.2A of symbol 25.12.2.

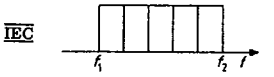


25.12.5.1 *EXAMPLE:* Mastergroup

NOTE 25.12.5.1A: The division of a band into channels, groups, etc, may be shown by adding vertical lines.



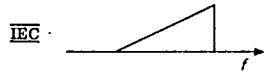
25.12.5.2 *EXAMPLE:* Band of frequencies from f_1 to f_2 divided into five channels, groups, etc.



25.12.6 Erect band of frequencies

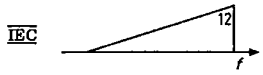
NOTE 25.12.6A: There is no indication of how much of the bandwidth shown by the symbol is actually used.

NOTE 25.12.6B: This symbol may be used to represent a single channel, group, etc, or a number of channels, groups, etc, providing they are all erect.



25.12.6.1 *EXAMPLE:* Band of frequencies consisting of a group of 12 erect channels

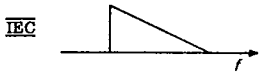
25.12.6.2



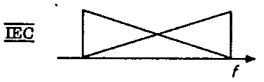
Simplified form

25.12.7 Inverted band of frequencies

NOTES 25.12.6A and 25.12.6B apply.

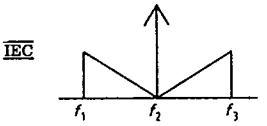


25.12.8 Band of mixed channels, groups, etc, some erect, remainder inverted



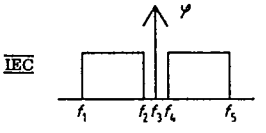
25.13 Examples of Frequency Spectrum Diagrams

25.13.1 Amplitude-modulated carrier with both sidebands

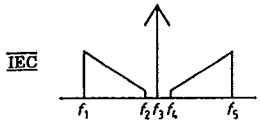


25.13.2 Phase modulated carrier with both sidebands

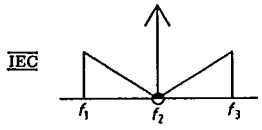
NOTE 25.13.2A: For frequency modulation, replace φ with f.



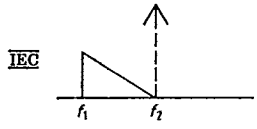
25.13.3 Amplitude-modulated carrier with both sidebands, lower modulating frequencies not being transmitted



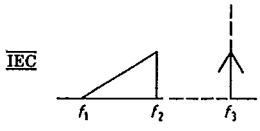
25.13.4 Amplitude-modulated carrier with both sidebands, modulating frequencies down to zero being transmitted



25.13.5 Single-sideband suppressed carrier

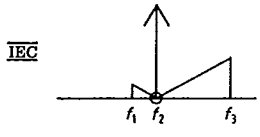


25.13.6 Reduced-carrier with single, lower, erect sideband



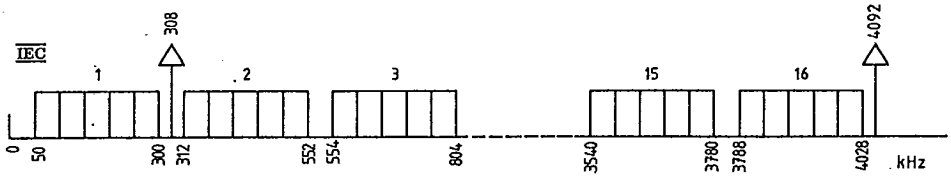
25.13.7 Suppressed-carrier with single-sideband scrambled for secrecy

25.13.8 Amplitude-modulated carrier with upper sideband and lower vestigial sideband, modulating frequencies down to zero being transmitted



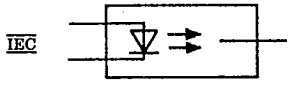
25.13.9 Band of five channels, groups, etc, four of which are inverted and one erect

25.13.10 4 MHz transmission system showing supergroups and pilot frequencies



25.14 Fiber Optic Devices

25.14.1 Guided light transmitter



25.14.2 Guided light receiver