



IEC 60034-8

Edition 4.0 2026-06

INTERNATIONAL STANDARD

**Rotating electrical machines -
Part 8: Terminal markings and direction of rotation**



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CONTENTS

FOREWORD	4
INTRODUCTION	6
1 Scope	7
2 Normative references	7
3 Terms and definitions	7
4 Symbols	9
4.1 General	9
4.2 DC and single-phase commutator machines	9
4.3 AC machines without commutator	9
4.4 Auxiliary devices	10
5 Direction of rotation	10
6 Rules for terminal markings	10
6.1 General	10
6.1.1 Application	10
6.1.2 Marking instructions	11
6.1.3 Alphanumeric marking notation	11
6.1.4 Duplicate winding terminals	11
6.1.5 Shared terminals	11
6.1.6 Omissions	11
6.1.7 Earthing terminal	11
6.2 Suffixes	12
6.2.1 Winding elements	12
6.2.2 Internal connections	12
6.2.3 Tapping points	12
6.3 Prefixes	12
6.4 Winding identification for categories of Induction machines	13
6.4.1 Three-phase machines	13
6.4.2 Two-phase machines	13
6.4.3 Single-phase machines	13
6.4.4 Multiple three-phase group (for example, six-phase) machines	13
6.5 Synchronous machines	13
6.5.1 Primary windings of synchronous machines	13
6.5.2 Field winding of synchronous machines	13
6.5.3 Permanent magnet machines	13
6.6 DC machines	13
6.7 Relation between terminal markings and direction of rotation	14
6.7.1 Multi-phase machines not covered by IEC 60034-3 or IEC 60034-33	14
6.7.2 Multi-phase machines covered by IEC 60034-3 or IEC 60034-33	14
6.7.3 Multi-phase, multi-speed machines	14
6.7.4 Single-phase machines	14
6.7.5 Multiple three-phase group (for example, six-phase) machines	14
6.7.6 DC machines	15
6.7.7 Relation between direction of current and magnetic field (DC machines)	15
6.8 Terminal marking figures	15
6.8.1 General	15
6.8.2 Three-phase electrical machines	15

6.8.3	Single-phase induction machines.....	18
6.8.4	Multiple three-phase group (six-phase) machines	18
6.8.5	DC machines	18
7	Auxiliary terminal marking rules	20
7.1	General.....	20
7.2	Marking.....	20
7.2.1	Power-related devices	20
7.2.2	Thermal and measurement devices	21
7.2.3	Switches.....	22
Annex A	(normative) Connection diagrams for common applications.....	23
A.1	General.....	23
A.2	Three-phase machines.....	23
A.2.1	Single-speed stator windings	23
A.2.2	Multi-speed stator windings	26
A.3	Single-phase induction machines.....	31
A.4	DC machines	32
Bibliography		34
Figure 1	– Single three-phase winding, three elements, open connection, six terminals	15
Figure 2	– Single three-phase winding, delta connection, three terminals	15
Figure 3	– Single three-phase winding, internal star connection with neutral conductor, four terminals.....	15
Figure 4	– Single three-phase winding, two elements per phase, open connection, twelve terminals.....	16
Figure 5	– Single three-phase winding, four elements per phase, open connection, twenty-four terminals	16
Figure 6	– Single three-phase winding, two elements per phase with four tapping points per element, open connection, thirty-six terminals	16
Figure 7	– Two separate three-phase windings with two independent functions, two elements per phase, open connection, twenty-four terminals	17
Figure 8	– Two elements, internal connection, three terminals	17
Figure 9	– Single three-phase winding, star connection, duplicate terminals for alternate connection, six terminals	17
Figure 10	– Single three-phase winding, star connection, parallel terminals for shared current, six terminals	17
Figure 11	– Three-phase wound-rotor, star connections with neutral conductors, eight terminals.....	18
Figure 12	– Main and auxiliary winding, two elements.....	18
Figure 13	– Single-phase auxiliary winding, integrally connected capacitor, one element	18
Figure 14	– Single-phase main winding, integrally connected thermal protector, one element	18
Figure 15	– Six-phase winding, open connection, six elements	18
Figure 16	– Armature winding, one element	18
Figure 17	– Commutating winding, one and two elements	19
Figure 18	– Compensating winding, one and two elements	19
Figure 19	– Series winding, one element, two tappings.....	19
Figure 20	– Shunt excitation winding, one element	19

Figure 21 – Separately excited excitation winding, one and two elements	19
Figure 22 – Direct-axis auxiliary winding, one element.....	19
Figure 23 – Quadrature-axis auxiliary winding, one element	19
Figure 24 – Armature winding with commutating and compensating windings, one element	19
Figure 25 – Single-phase, single voltage	20
Figure 26 – Single-phase dual voltage	21
Figure 27 – Three-phase, single voltage	21
Figure 28 – Three-phase dual voltage	21
Figure 29 – Two-lead devices	22
Figure 30 – Three-lead devices of type R.....	22
Figure 31 – Four-lead devices of type R	22
Figure 32 – Switch connections	22
Figure A.1 – Delta connection	23
Figure A.2 – Star connection – with or without neutral	23
Figure A.3 – Dual voltage, six terminals ($U_{\text{Low}}: U_{\text{High}} = 1: \sqrt{3}$)	23
Figure A.4 – Star-connected, dual voltage, nine terminals ($U_{\text{Low}}: U_{\text{High}} = 1: 2$)	24
Figure A.5 – Delta-connected, dual voltage, nine terminals ($U_{\text{Low}}: U_{\text{High}} = 1: 2$)	24
Figure A.6 – Star-delta, single voltage, six terminals.....	24
Figure A.7 – Star-delta, dual voltage, twelve terminals ($U_{\text{Low}}: U_{\text{High}} = 1: 2$)	25
Figure A.8 – Part-winding, single voltage, six terminals	25
Figure A.9 – Part-winding, dual voltage, nine terminals ($U_{\text{Low}}: U_{\text{High}} = 1: 2$)	26
Figure A.10 – Variable-torque, six terminals	26
Figure A.11 – Variable-torque, dual-voltage ($U_{\text{Low}}: U_{\text{High}} = 1: \sqrt{3}$), nine terminals	27
Figure A.12 – Constant-torque, six terminals	28
Figure A.13 – Constant power, six terminals	28
Figure A.14 – Variable-torque, six terminals	29
Figure A.15 – Constant-torque, seven terminals.....	29
Figure A.16 – Constant-power, seven terminals	29
Figure A.17 – Example of three-speed, constant torque motor using two separate windings, ten terminals	30
Figure A.18 – Example of three-speed motor using three separate windings, ten terminals.....	30
Figure A.19 – Example of four-speed, variable-torque motor using two separate windings, twelve terminals	31
Figure A.20 – Split-phase or capacitor-start reversible motor	31
Figure A.21 – Reversible capacitor-start motor with four terminals with externally connected capacitor.....	32
Figure A.22 – Shunt motor or generator, four terminals.....	32
Figure A.23 – Compound-motor or generator with compensating and commutating windings, six terminals.....	32
Figure A.24 – Series-wound motor, two terminals	33

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Rotating electrical machines -
Part 8: Terminal markings and direction of rotation**

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IEC 60034-8 has been prepared by IEC technical committee 2: Rotating machinery. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2007 and Amendment 1:2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) The inclusion of turbine-type synchronous machines in the scope.

The text of this International Standard is based on the following documents:

Draft	Report on voting
2/2291/FDIS	2/2309/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

A list of all the parts of the IEC 60034 series, under the general title *Rotating electrical machines*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

The revision of this part of IEC 60034 provides worldwide uniformity in the electrical connections for rotating electrical machines and applies the recommendations of the basic safety publication IEC 60445 in specifying marking requirements.

These standardized connections will then enable the safe interchange of electric machines with their control and protective devices using standardized terminal markings.

NOTE Electrical connections of the machines are not the unique feature to be checked for safe interchange.

1 Scope

This part of IEC 60034 applies to AC and DC machines and specifies

- a) rules for the identification of winding connection points;
- b) marking of winding terminals;
- c) direction of rotation;
- d) relationship between terminal markings and direction of rotation;
- e) terminal marking of auxiliary devices;
- f) connection diagrams of machines for common applications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034-1, *Rotating electrical machines - Part 1: Rating and performance*

IEC 60034-3, *Rotating electrical machines - Part 3: Specific requirements for synchronous generators driven by steam turbines or combustion gas turbines and for synchronous compensators*

IEC 60034-33, *Rotating electrical machines - Part 33: Synchronous hydrogenerators including motor-generators - Specific requirements*

IEC 60417-1, *Graphical symbols for use on equipment - Part 1: Overview and application*

IEC 60445, *Basic and safety principles for man-machine interface, marking and identification - Identification of equipment terminals, conductor terminations and conductors*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60034-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

terminal marking

permanent identification of the external termination of winding leads or auxiliary leads at the disposal of the user for connection of the machine to the supply or apparatus that indicates the function of the termination

3.2

connection points

all current transfer points that are used to permanently interconnect winding or winding element ends internally

3.3

tapping points

intermediate connections to a portion of a winding element

3.4

winding leads

insulated conductors that make the electrical connection between a winding and its termination

3.5

winding

assembly of turns or coils having a defined function in an electrical rotating machine

[SOURCE: IEC 60050-411:1996, 411-37-01]

3.6

winding phase

one or more winding elements associated with a particular phase

3.7

winding element

part of a winding in which all the turns or coils are permanently connected together

3.8

separate windings

two or more windings, each having a separate function, and not interconnected, used only separately, whether fully or in part

3.9

multi-speed motor

motor, which can be operated at any one of two or more definite speeds

3.10

constant power

when a multi-speed motor provides approximately constant power over the speed range

3.11

constant torque

when a multi-speed motor provides approximately constant torque over the speed range

3.12

phase sequence

order in which the voltages successively reach their maximum positive values between supply conductors

3.13

D-end

that end of the machine which accommodates the shaft end

Note 1 to entry: For machines having two shaft ends, the D-end is the end

a) having the larger diameter;

b) opposite the external fan when the shaft ends are of the same diameter.

[SOURCE: IEC 60050-411:1996, 411-43-36]

4 Symbols

4.1 General

L	Supply conductor
PE	Protective earthing terminal
 —	User available terminal, marking mandatory
	Internal connection point
(....)	Internal terminal marking (showing element symbol), optional
[.... ,]	Grouping of user joined terminals
;	Separation of terminals or groups of terminals

4.2 DC and single-phase commutator machines

A	Armature winding
B	Commutating winding
C	Compensating winding
D	Series excitation winding
E	Shunt excitation winding
F	Separately excited winding
H	Direct-axis auxiliary winding
J	Quadrature-axis auxiliary winding

4.3 AC machines without commutator

F	DC excitation winding
K	Secondary winding
L	Secondary winding
M	Secondary winding
N	Star point (neutral conductor) of the primary winding
Q	Star point (neutral conductor) of a secondary winding
U	Primary winding
V	Primary winding
W	Primary winding
Z	Auxiliary windings

The primary and secondary symbol allocations are irrespective of whether the primary winding is located in the stator or rotor. Different symbols may be used as agreed between the manufacturer and the purchaser with special attention to safety rules.

4.4 Auxiliary devices

BA	AC brakes
BD	DC brakes
BW	Brush-wear detector
CA	Capacitors
CT	Current transformer
HE	Heaters
LA	Lightning arrestor
PT	Potential transformer
R	Resistance thermometers
SC	Surge capacitor
SP	Surge protectors
S	Switches including plugging switches
TB	Thermostats opening on increase of temperature
TC	Thermocouples
TM	Thermostats closing on increase of temperature
TN	Thermistors, negative temperature coefficient
TP	Thermistors, positive temperature coefficient

The above list standardizes the most commonly used auxiliary devices. The designation of other devices may be chosen by the manufacturer. Different symbols may be used as agreed between the manufacturer and the purchaser.

5 Direction of rotation

The direction of rotation shall be that of the shaft observed when facing the D-end.

Synchronous generators and motor-generators in the scope of IEC 60034-3 or IEC 60034-33 shall have the direction of rotation as imposed by the prime mover being in turbine or motor mode. For synchronous compensators, the direction of rotation shall be agreed between manufacturer and purchaser. This direction of rotation shall be marked as per 6.7.

If not otherwise specified, all machines apart from synchronous and motor generators in the scope of IEC 60034-3 or IEC 60034-33 shall have a clockwise direction of rotation."

Unidirectional machines, apart for synchronous generators and motor-generators in the scope of IEC 60034-3 or IEC 60034-33 shall have an arrow located on the enclosure to show the direction of rotation.

6 Rules for terminal markings

6.1 General

6.1.1 Application

A terminal marking shall identify all winding leads and auxiliary device terminations accessible to the user.

NOTE External line connections and winding arrangements used for common applications are shown in Annex A.

6.1.2 Marking instructions

All three-phase AC machines with more than three terminals and all other machines (and auxiliary devices) with more than two terminals shall have connecting instructions consistent with this document.

The graphical symbols shall be in accordance with IEC 60417-1.

6.1.3 Alphanumeric marking notation

The terminal marking comprises upper-case Latin characters and Arabic numerals. The characters shall be arranged without spaces.

Each winding, winding phase or auxiliary circuit shall be assigned (a) letter symbol(s) in accordance with Clause 4.

To prevent confusion with the numerals 1 and 0, the letters “I” and “O” shall not be used.

6.1.4 Duplicate winding terminals

Several leads of a machine can have the same marking only if each of them is capable of completely fulfilling the same electrical function, so that either one of them can be used for the connection. See Figure 9.

6.1.5 Shared terminals

When several leads or conductors are provided to share the current, the terminal markings shall be identified by an additional numerical suffix separated by a hyphen. See Figure 10.

Some multi-speed motors having two or more independent windings may produce circulating currents in the de-energized winding. In this case, the terminal markings for the open delta connection shall be identified by an additional numerical suffix separated by a hyphen. See Figure A.15.

6.1.6 Omissions

Numerical suffixes and/or prefixes may be omitted if there is no risk of confusion. See Figure 2.

When two or more elements are connected to the same terminal, its marking shall be determined from one of the elements. The order of precedence shall be determined by the lower suffix. See Figure 8.

When two or more functionally different elements are connected internally, the combination of elements shall be considered a single element, and the terminal marking shall have the alpha notation of the primary element function. See Figure 24.

6.1.7 Earthing terminal

The termination for the protective earthing conductor shall be marked with the letters PE according to IEC 60445 (or marked with symbol IEC 60417-5019:2006-08). No other terminals shall be so marked.

6.2 Suffixes

6.2.1 Winding elements

The ends of each winding element are distinguished by a numerical suffix, in accordance with IEC 60445, as follows (see Figure 5):

- 1 and 2 for the first winding element (see Figure 1);
- 3 and 4 for the second winding element;
- 5 and 6 for the third winding element;
- 7 and 8 for the fourth winding element.

In all winding elements, the end closer to the supply connection shall be marked with the lower of the two numbers.

6.2.2 Internal connections

When several ends of winding elements are joined, the terminal marking for the connecting shall use the lower suffix; see Figure 8.

6.2.3 Tapping points

Tapping points of a winding element shall be marked in the sequence in which they occur in the winding element, as follows (see Figure 6):

- 11, 12, 13, etc. for the first winding element;
- 31, 32, 33, etc. for the second winding element;
- 51, 52, 53, etc. for the third winding element;
- 71, 72, 73, etc. for the fourth winding element.

The tap closest to the beginning of the winding shall be marked with the lowest suffix.

6.3 Prefixes

Winding elements that are separate (or belong to different current systems), but have a similar, but independent, function, shall be marked with the same letter, but distinguished by a numerical prefix.

Each of the terminals shall be marked with a numerical prefix corresponding to the separate winding (or current system) to which it belongs, as follows (see Figure 7):

- first winding 1
- second winding 2
- third winding 3
- fourth winding 4
- and so on...

With multi-speed machines, the sequence of the prefixes corresponds to the sequence of increasing speeds. See Figure A.19.

6.4 Winding identification for categories of Induction machines

6.4.1 Three-phase machines

The letter symbols shall be U, V, and W for the first (see Figure 1), second and third primary winding phase respectively and N when a neutral conductor is used (see Figure 3) and K, L, and M and Q when a secondary winding is used. See Figure 11.

Different symbols may be used as agreed between the manufacturer and the purchaser with special attention to safety rules.

6.4.2 Two-phase machines

The terminal markings of a two-phase machine shall be derived from the markings for three-phase machines, with the letter symbols W and M omitted.

6.4.3 Single-phase machines

The letter symbols assigned shall be U for the primary winding and Z for the auxiliary winding. See Figure 12, Figure 13, and Figure 14.

If the winding ends of a main and an auxiliary winding are connected to a common terminal, the terminal shall be marked according to the rule for the main phase.

6.4.4 Multiple three-phase group (for example, six-phase) machines

Each phase group shall be differentiated by a prefix according to 6.3. See Figure 15.

The numerical order of the prefix shall increase according to the order in which the U phase of each phase group reaches its maximum voltage value.

6.5 Synchronous machines

6.5.1 Primary windings of synchronous machines

The primary windings shall have terminal markings as derived for induction machines.

6.5.2 Field winding of synchronous machines

Terminal markings of the DC separately excited field windings shall be F1 and F2.

6.5.3 Permanent magnet machines

Since these machines do not have a separate excitation, the windings shall have terminal markings as established for induction machines. This is valid for both machines operating with a frequency converter with permanent magnets located in or on the rotor and for machines suitable for across the line start, with permanent magnets inserted in or on the rotor with or without a squirrel cage rotor for starting.

6.6 DC machines

The letter symbols assigned to winding elements shall be as listed in 4.2 with terminal markings as shown in Figure 16 to Figure 24.

6.7 Relation between terminal markings and direction of rotation

6.7.1 Multi-phase machines not covered by IEC 60034-3 or IEC 60034-33

The terminal markings shall be so arranged that clockwise rotation is obtained when the alphabetical sequence of the letters (for example, U1, V1, W1) corresponds to the time sequence of the system phase voltages. The phase sequence of a secondary winding (for example, K, L, M) shall correspond to the phase sequence of the primary winding (for example, U, V, W).

For counterclockwise rotation, the time sequence of the system phase voltages shall be reversed by rearrangement of the supply cables (for example, L2 and L3 in the case of 3-phase).

These requirements apply to machines of any rated output and voltage even if clockwise rotation is impracticable.

When machines are suitable for operation in only one direction of rotation, an arrow shall indicate the direction of rotation. It is not necessary for this arrow to be on the rating plate, but it shall be permanently attached and easily visible.

6.7.2 Multi-phase machines covered by IEC 60034-3 or IEC 60034-33

The time-phase sequence of the stator voltage shall be indicated by marking the terminals in the sequence in which their voltages reach maximum, for example, U1, V1, W1 when rotating in the direction defined by the application. The phase sequence of a secondary winding if any (for example, K, L, M) shall correspond to the phase sequence of the primary winding (for example, U, V, W).

When machines are suitable for operation in only one direction of rotation, the direction of rotation, indicated either by indicating cw (clockwise) or ccw (counterclockwise) on the rating plate or by an arrow. It is not required for this arrow to be in the rating plate, but it shall be easily visible.

6.7.3 Multi-phase, multi-speed machines

With multi-speed machines incorporating a pole-changing winding, such as a Dahlander or PAM (pole-amplitude-modulated) winding, the markings of the terminals for the lower speed of these winding(s), which are to be connected to the supply (for example, 1U and 1W) shall be interchanged, when necessary, in order to obtain the same direction of rotation for both speeds.

6.7.4 Single-phase machines

Clockwise rotation shall be obtained when the supply is connected to U1 and U2 and the auxiliary winding is connected as Z1 with U1 and Z2 with U2. To reverse the direction of rotation, terminals Z1 shall be connected to U2 and Z2 to U1.

6.7.5 Multiple three-phase group (for example, six-phase) machines

The terminal markings shall be so arranged that clockwise rotation is obtained when the alphabetical sequence of the letters in each phase group corresponds to the time sequence of the system phase voltages connected to this group. The order of prefixes of the groups corresponds to the sequence in which the first phase of each phase group reaches its maximum value.

For counter-clockwise rotation, the time sequence of the system phase voltages shall be reversed by the rearrangement of the supply cables within each group and by reversing the order of connecting the groups of the supply voltages to the phase groups of the windings.

6.7.6 DC machines

The terminal markings shall be so arranged that clockwise rotation is obtained when the line polarities L+ and L– correspond to the polarities of the terminals A1 and A2. When the machine is provided with a separately-excited field winding, the terminal markings shall be so arranged that clockwise rotation is obtained when the line polarities L+ and L– correspond to the polarities of both the terminals A1 and A2 and the terminals F1 and F2.

For counter-clockwise rotation, the polarity of the supply connection to either the armature or the field shall be reversed taking into account the requirements of this 6.7.6.

6.7.7 Relation between direction of current and magnetic field (DC machines)

6.7.7.1 Two excitation windings generate fields having the same direction if the excitation current in both windings flows from the terminal with the lower (higher) numerical suffix to the terminal with the higher (lower) suffix.

6.7.7.2 The magnetic fields of commutating and compensating windings shall be of correct polarity with respect to each other and to the magnetic field of the armature winding if, in all the windings, current flows from the terminal with the lower (higher) numerical suffix to the terminal with the higher (lower) suffix.

6.8 Terminal marking figures

6.8.1 General

The normative connection diagrams for common applications are shown in Annex A.

6.8.2 Three-phase electrical machines

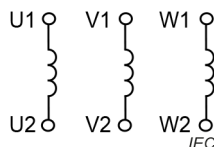


Figure 1 – Single three-phase winding, three elements, open connection, six terminals

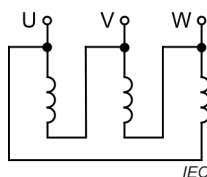


Figure 2 – Single three-phase winding, delta connection, three terminals

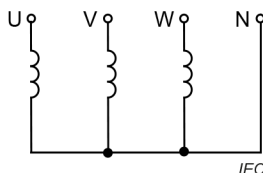


Figure 3 – Single three-phase winding, internal star connection with neutral conductor, four terminals

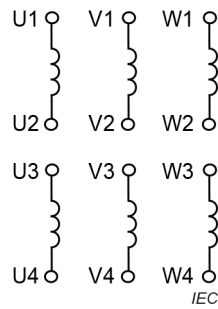


Figure 4 – Single three-phase winding, two elements per phase, open connection, twelve terminals

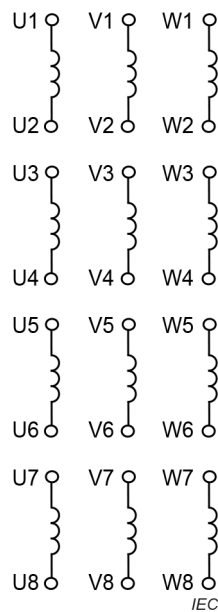


Figure 5 – Single three-phase winding, four elements per phase, open connection, twenty-four terminals

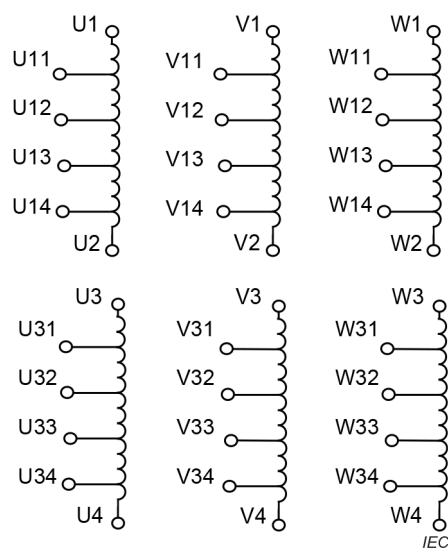


Figure 6 – Single three-phase winding, two elements per phase with four tapping points per element, open connection, thirty-six terminals

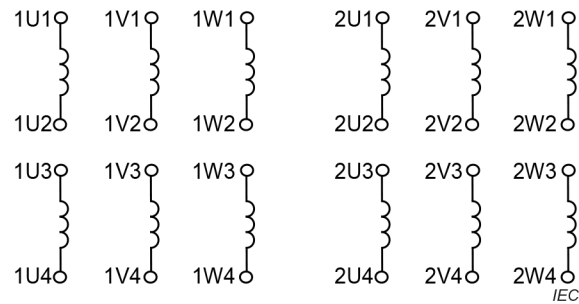


Figure 7 – Two separate three-phase windings with two independent functions, two elements per phase, open connection, twenty-four terminals

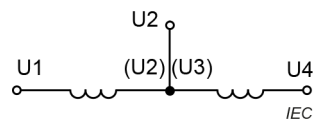


Figure 8 – Two elements, internal connection, three terminals

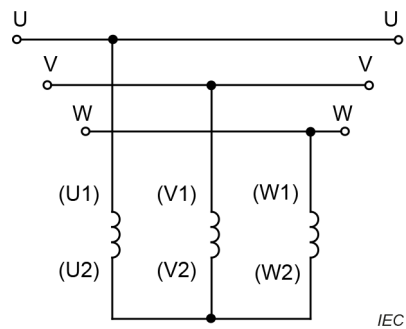


Figure 9 – Single three-phase winding, star connection, duplicate terminals for alternate connection, six terminals

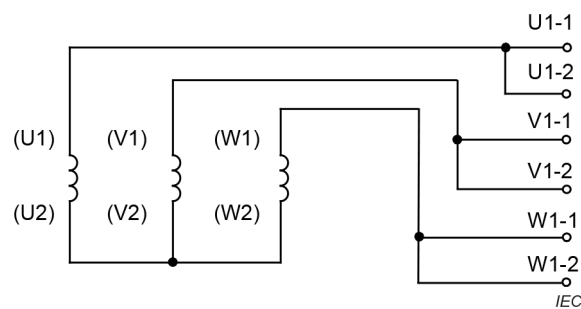


Figure 10 – Single three-phase winding, star connection, parallel terminals for shared current, six terminals

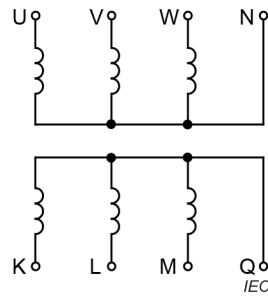


Figure 11 – Three-phase wound-rotor, star connections with neutral conductors, eight terminals

6.8.3 Single-phase induction machines

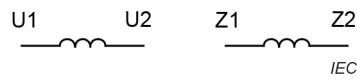


Figure 12 – Main and auxiliary winding, two elements

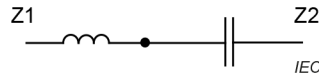


Figure 13 – Single-phase auxiliary winding, integrally connected capacitor, one element

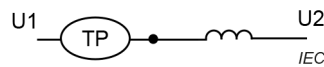


Figure 14 – Single-phase main winding, integrally connected thermal protector, one element

6.8.4 Multiple three-phase group (six-phase) machines

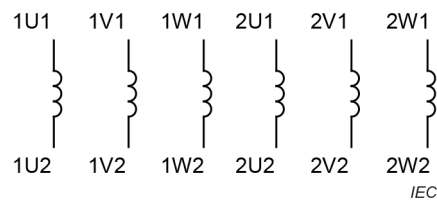


Figure 15 – Six-phase winding, open connection, six elements

6.8.5 DC machines

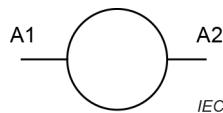


Figure 16 – Armature winding, one element

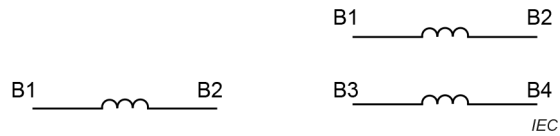


Figure 17 – Commutating winding, one and two elements

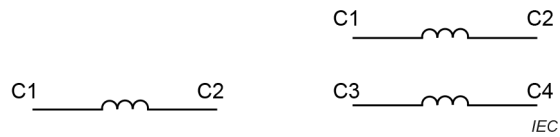


Figure 18 – Compensating winding, one and two elements

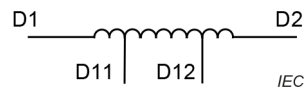


Figure 19 – Series winding, one element, two tapplings



Figure 20 – Shunt excitation winding, one element

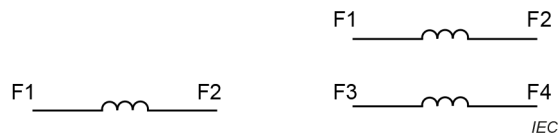


Figure 21 – Separately excited excitation winding, one and two elements



Figure 22 – Direct-axis auxiliary winding, one element



Figure 23 – Quadrature-axis auxiliary winding, one element

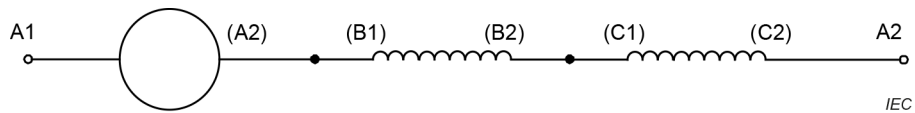


Figure 24 – Armature winding with commutating and compensating windings, one element

7 Auxiliary terminal marking rules

7.1 General

The marking of auxiliary terminals shall be according to 6.1.3, with 4.4 identifying the type of auxiliary device together with:

- a numerical prefix identifying the individual circuit or device;
- a numerical suffix identifying the lead function.

The addition of letters and/or numbers to the auxiliary symbol shall, wherever possible, be based on the rules given in Clause 6.

When there is a large number of terminals for a given type of device (for example, thermocouples), the leads may be grouped by device code and the terminals identified by a prefix (1-99) and followed by a single digit suffix (1-9).

The manufacturer should identify the function of these devices in the written instructions.

When only one device of a certain type exists, the prefix may be omitted.

Other identification systems can be agreed between the manufacturer and the purchaser. Different symbols may be used as agreed between the manufacturer and the purchaser with special attention to safety rules.

7.2 Marking

7.2.1 Power-related devices

7.2.1.1 General

Devices BA, BD, BW, CA, HE, LA, SC and SP shall be marked and connected in accordance with Figure 25, Figure 26, Figure 27 and Figure 28 in 7.2.1.1 to 7.2.1.4 where:

** indicates the device coding and  represents the device.

This symbol should be changed according to IEC 60617 for schematic diagrams.

7.2.1.2 Single-phase, single voltage

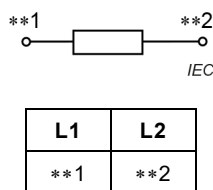


Figure 25 – Single-phase, single voltage

7.2.1.3 Single-phase, dual voltage

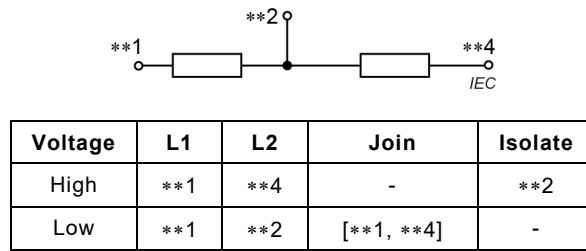


Figure 26 – Single-phase dual voltage

7.2.1.4 Three-phase, single voltage

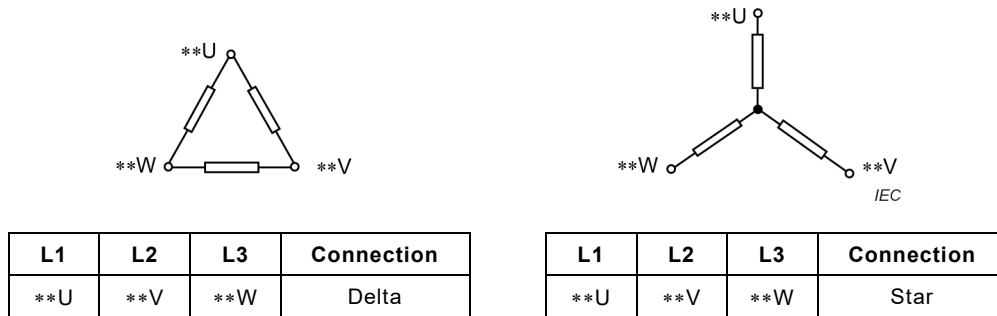


Figure 27 – Three-phase, single voltage

7.2.1.5 Three-phase, dual voltage

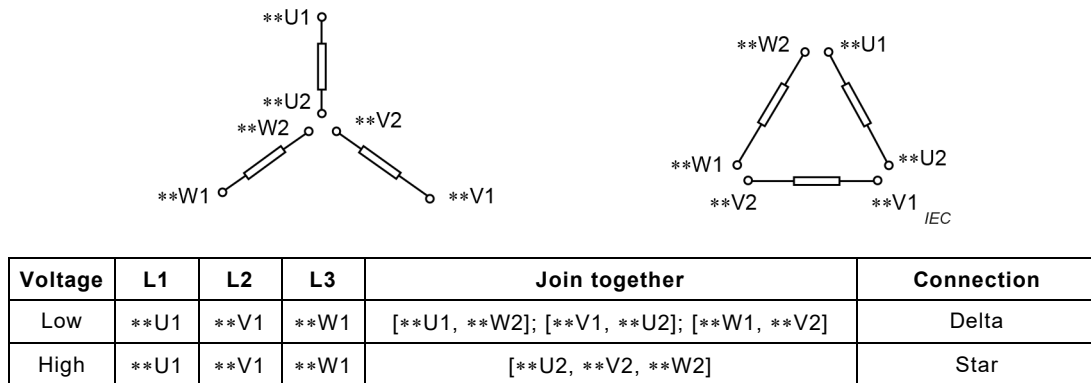


Figure 28 – Three-phase dual voltage

7.2.2 Thermal and measurement devices

7.2.2.1 General

Devices CT, PT, R, TB, TC, TN, TM and TP shall be marked and connected in accordance with the Figure 29, Figure 30 and Figure 31 in 7.2.2.1 to 7.2.2.4 where:

This symbol should be changed according to IEC 60617 for schematic diagrams.

** indicates the device coding and  represents the device.

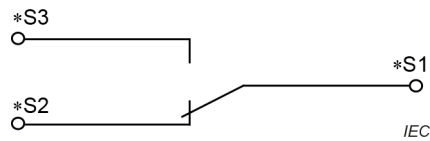
NOTE 1 For TC devices, the leads are colour coded by the manufacturer to denote polarity.

NOTE 2 For resistance thermometers, the last character indicates the circuit number.

7.2.2.2 Two-lead devices of types TB, TC, TM, TN, TP and R**Figure 29 – Two-lead devices****7.2.2.3 Three-lead devices of type R****Figure 30 – Three-lead devices of type R****7.2.2.4 Four-lead devices of type R****Figure 31 – Four-lead devices of type R****7.2.3 Switches**

Switches shall be marked and connected as shown in Figure 32 where:

* denotes the switch number.

**Figure 32 – Switch connections**

Annex A
(normative)

Connection diagrams for common applications

A.1 General

Annex A provides connections for terminal markings in Figure A.1 to Figure A.24, that shall be used for common applications. The layout of figures is for information and may take other forms.

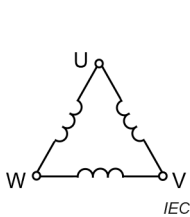
Applications not shown shall be derived from the rules of Clause 6.

Additions of other common applications may be made to this Annex A upon request.

A.2 Three-phase machines

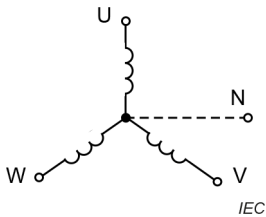
A.2.1 Single-speed stator windings

A.2.1.1 Single voltage



L1	L2	L3	Connection
U	V	W	Delta

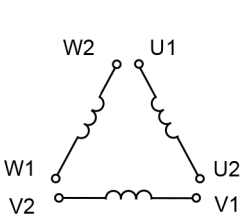
Figure A.1 – Delta connection



L1	L2	L3	Connection
U	V	W	Star

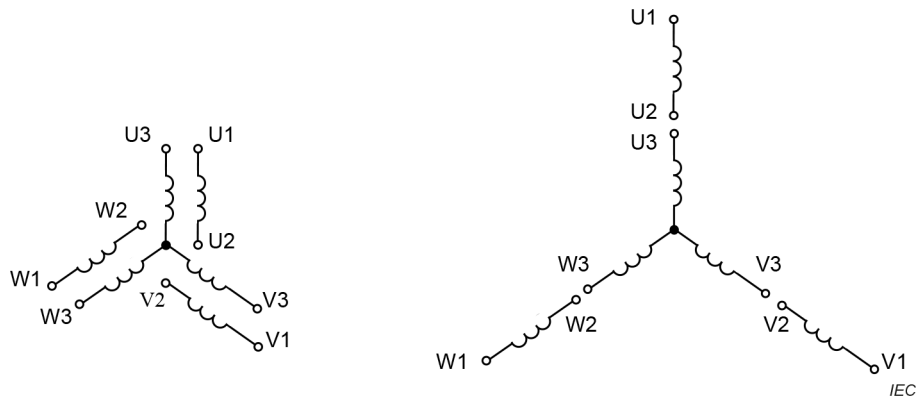
**Figure A.2 – Star connection –
with or without neutral**

A.2.1.2 Dual voltage



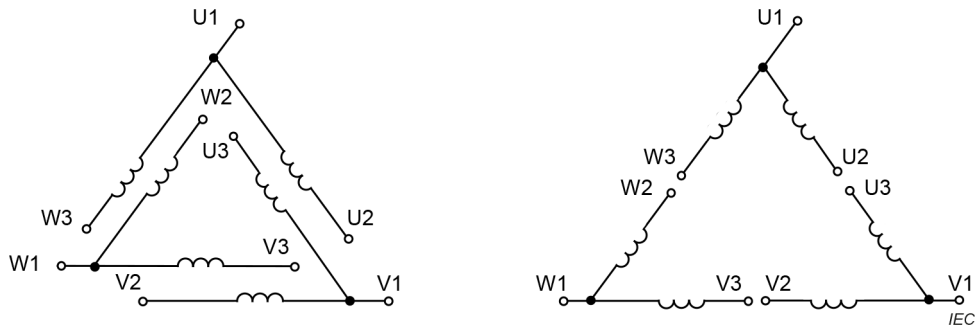
Voltage	L1	L2	L3	Join together	Winding connection
Low	U1	V1	W1	[U1, W2]; [U2, V1]; [V2, W1]	Delta
High	U1	V1	W1	[U2, V2, W2]	Star

Figure A.3 – Dual voltage, six terminals ($U_{\text{Low}}: U_{\text{High}} = 1: \sqrt{3}$)



Voltage	L1	L2	L3	Join together	Winding connection
Low	U1	V1	W1	[U1, U3]; [V1, V3]; [W1, W3]; [U2, V2, W2]	Parallel star
High	U1	V1	W1	[U2, U3]; [V2, V3]; [W2, W3]	Series star

Figure A.4 – Star-connected, dual voltage, nine terminals ($U_{\text{Low}}: U_{\text{High}} = 1: 2$)



Voltage	L1	L2	L3	Join together	Winding connection
Low	U1	V1	W1	[U1, U3, W2]; [V1, V3, U2]; [W1, W3, V2]	Parallel delta
High	U1	V1	W1	[U2, U3]; [V2, V3]; [W2, W3]	Series delta

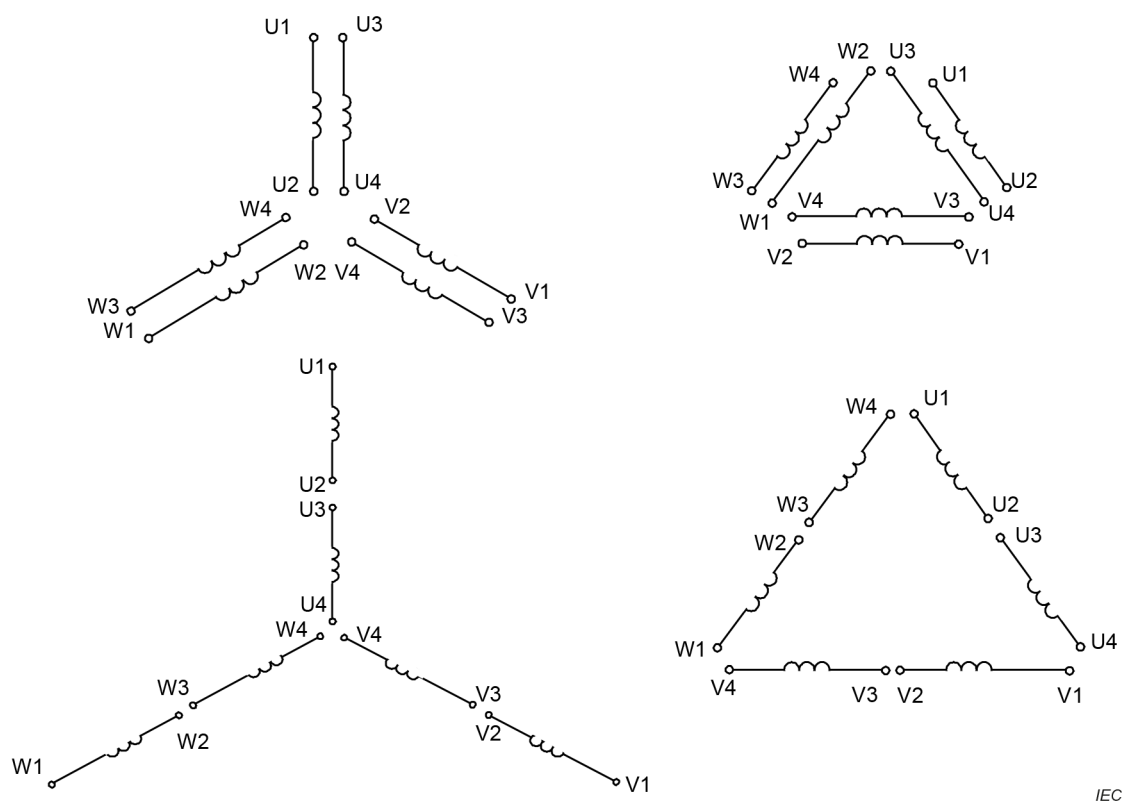
Figure A.5 – Delta-connected, dual voltage, nine terminals ($U_{\text{Low}}: U_{\text{High}} = 1: 2$)

A.2.1.3 Starting windings



	L1	L2	L3	Join together	Winding connection
Start	U1	V1	W1	[U2, V2, W2]	Star
Run	U1	V1	W1	[U1, W2]; [V1, U2]; [W1, V2]	Delta

Figure A.6 – Star-delta, single voltage, six terminals



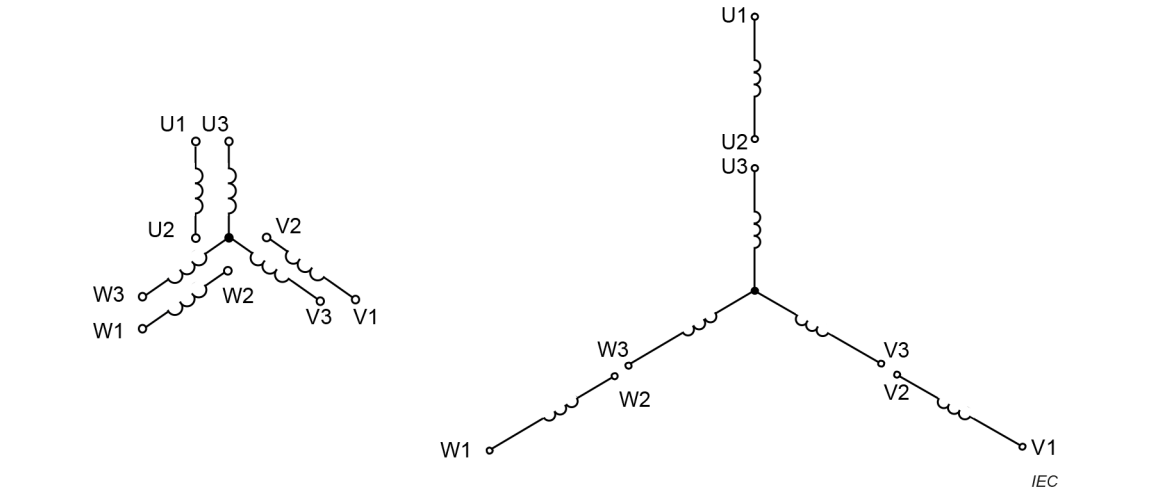
Voltage		L1	L2	L3	Join together	Winding connection
Low	Start	U1	V1	W1	[U1, U3]; [V1, V3]; [W1, W3]; [U2, V2, W2]; [U4, V4, W4]	Parallel star
Low	Run	U1	V1	W1	[U1, W2, U3, W4]; [V1, U2, V3, U4]; [W1, V2, W3, V4]	Parallel delta
High	Start	U1	V1	W1	[U2, U3]; [V2, V3]; [W2, W3]; [U4, V4, W4]	Series star
High	Run	U1	V1	W1	[U1, W4]; [V1, U4]; [W1, V4]; [U2, U3]; [V2, V3]; [W2, W3]	Series delta

Figure A.7 – Star-delta, dual voltage, twelve terminals ($U_{\text{Low}}: U_{\text{High}} = 1: 2$)



	L1	L2	L3	Isolate separately	Join together	Winding connection
Start	U1	V1	W1	U3; V3; W3		Star
Run	U1	V1	W1		[U1, U3]; [V1, V3]; [W1, W3]	Parallel star

Figure A.8 – Part-winding, single voltage, six terminals

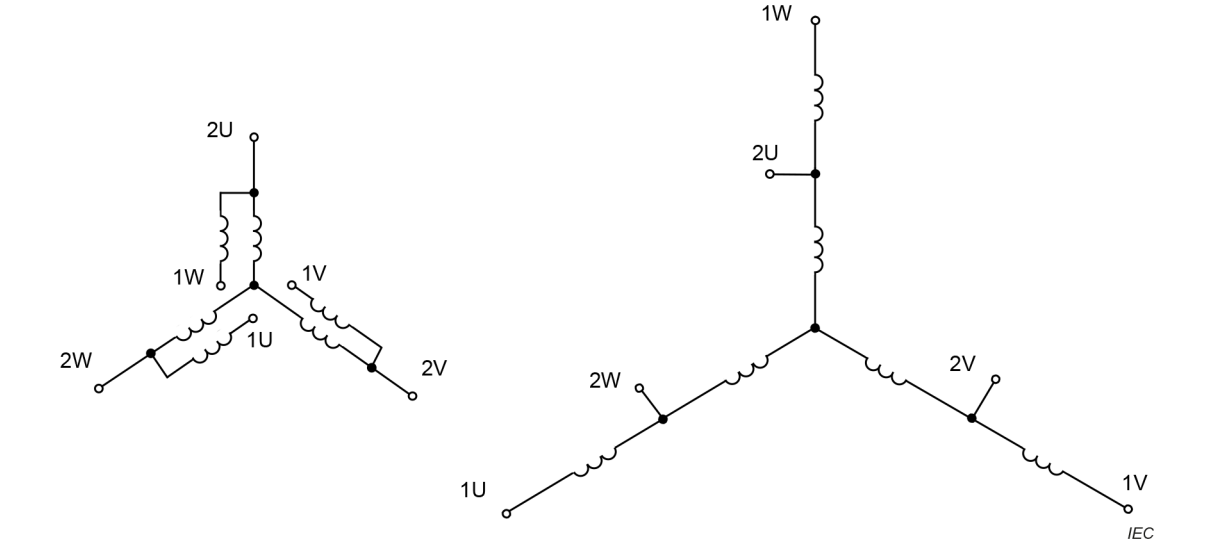


Voltage		L1	L2	L3	Isolate separately	Join together	Winding connection
Low	Start	U1	V1	W1	U3; V3; W3	[U2, V2, W2]	Star
Low	Run	U1	V1	W1		[U1, U3]; [V1, V3]; [W1, W3]; [U2, V2, W2]	Parallel star
High	Run	U1	V1	W1		[U2, U3]; [V2, V3]; [W2, W3]	Series star

Figure A.9 – Part-winding, dual voltage, nine terminals (U_{Low} : U_{High} = 1: 2)

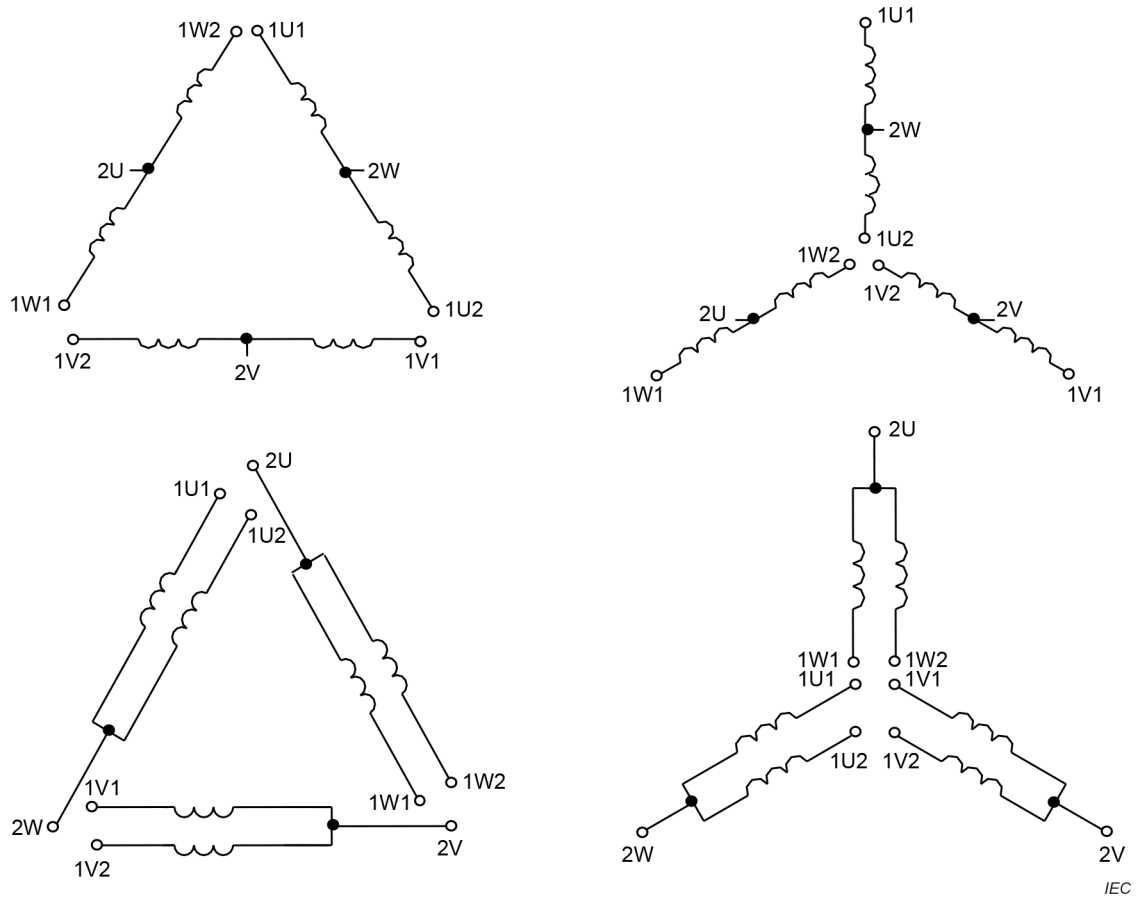
A.2.2 Multi-speed stator windings

A.2.2.1 Two-speed (1:2), single-winding



Speed	L1	L2	L3	Isolate separately	Join together	Winding connection
Low	1U	1V	1W	2U; 2V; 2W		Series star
High	2U	2V	2W		[1U, 1V, 1W]	Parallel star

Figure A.10 – Variable-torque, six terminals



Speed	L1	L2	L3	Isolate separately	Join together	Winding connection
Low	1U1	1V1	1W1	2U; 2V; 2W	[1U1, 1W2]; [1V1, 1U2]; [1W1, 1V2]	Series delta
Low	1U1	1V1	1W1	2U; 2V; 2W	[1U2, 1V2, 1W2]	Series star
High	2U	2V	2W		[2U, 1U1, 1U2]; [2V, 1W1, 1W2]; [2W, 1V1, 1V2]	Parallel delta
High	2U	2V	2W		[1U1, 1V1, 1W1, 1U2, 1V2, 1W2]	Parallel star

Figure A.11 – Variable-torque, dual-voltage ($U_{\text{Low}} : U_{\text{High}} = 1 : \sqrt{3}$), nine terminals

This connection diagram is also applicable for star-delta starting on the low speed by omitting the high-speed, parallel-delta connection.

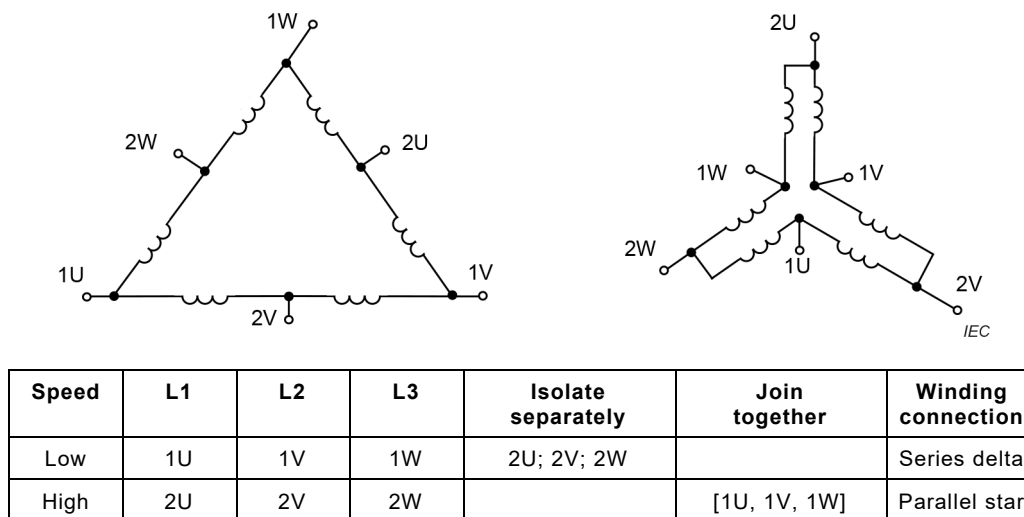


Figure A.12 – Constant-torque, six terminals

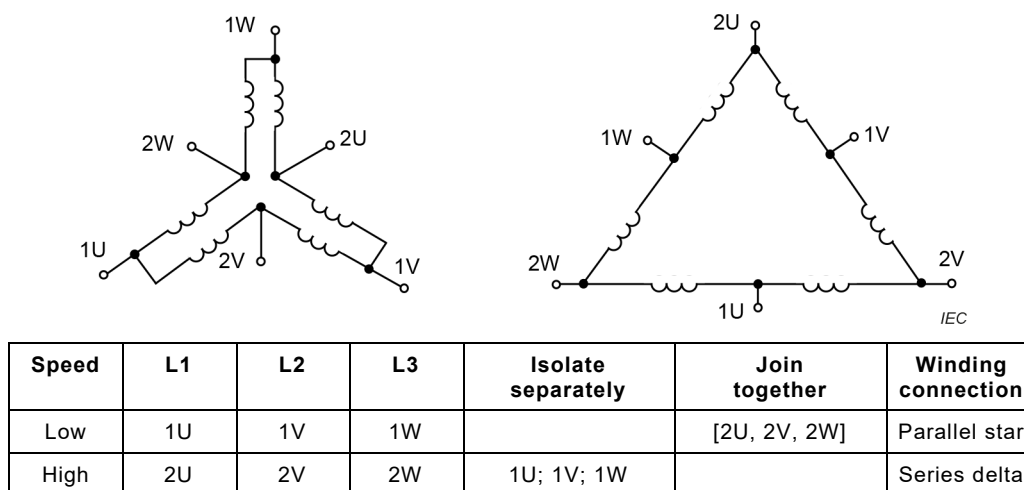


Figure A.13 – Constant power, six terminals

A.2.2.2 Multi-speed, with two or more independent windings

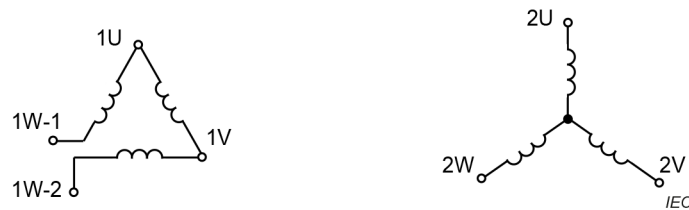
Figure A.10, Figure A.11, Figure A.12 and Figure A.13 are generally utilized as one of the windings in a three or four speed motor.

Many motor designs do not produce circulating currents. In these cases, the motor manufacturer will permanently join terminals (1W-1, 1W-2) and (2W-1, 2W-2) in Figure A.15 and Figure A.16, respectively, and delete the -1 and -2 suffixes.



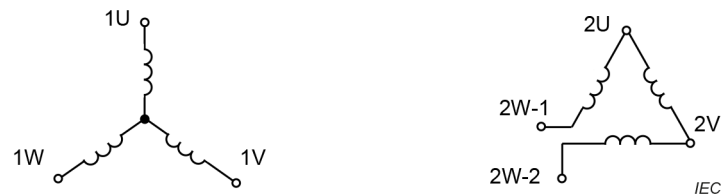
Speed	L1	L2	L3	Isolate separately	Winding connection
Low	1U	1V	1W	2U; 2V; 2W	Star
High	2U	2V	2W	1U; 1V; 1W	Star

Figure A.14 – Variable-torque, six terminals



Speed	L1	L2	L3	Isolate separately	Winding connection
Low	1U	1V	[1W-1, 1W-2]	2U; 2V; 2W	Open delta
High	2U	2V	2W	1U; 1V; 1W-1; 1W-2	Star

Figure A.15 – Constant-torque, seven terminals

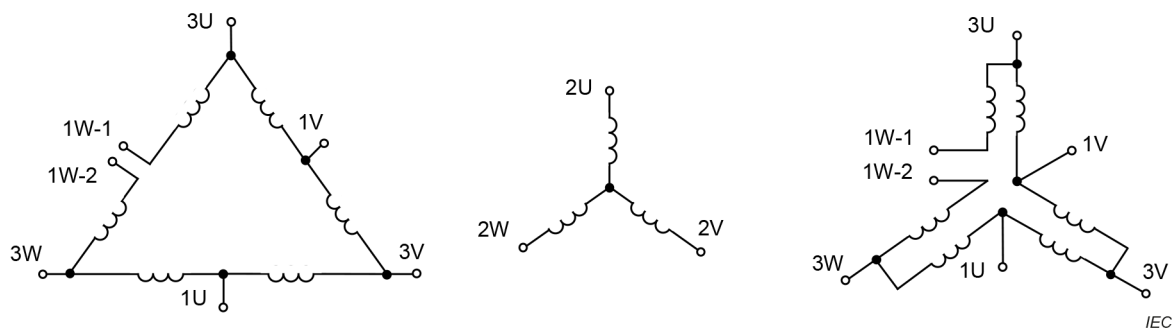


Speed	L1	L2	L3	Isolate separately	Winding connection
Low	1U	1V	1W	2U; 2V; 2W-1; 2W-2	Star
High	2U	2V	[2W-1, 2W-2]	1U; 1V; 1W	Open delta

Figure A.16 – Constant-power, seven terminals

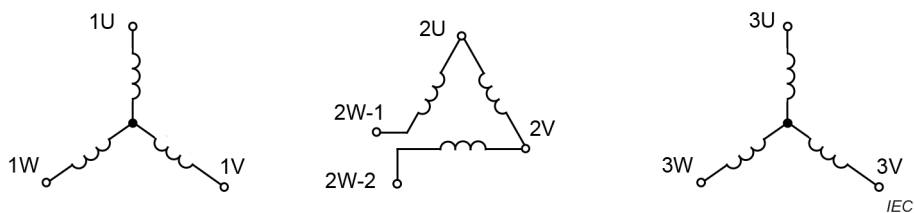
A.2.2.3 Three-speed

Combinations of windings shall be selected from Figure A.1, Figure A.2, Figure A.10, Figure A.11, Figure A.12 and Figure A.13 and the prefixes then adjusted.



Speed	L1	L2	L3	Isolate separately	Join together	Winding connection
Low	1U	1V	1W-1	2U; 2V; 2W; 3U; 3V; 3W	[1W-1, 1W-2]	Open series delta
Middle	2U	2V	2W	1W-1; 1W-2; 1V; 1U; 3U; 3V; 3W		Star
High	3U	3V	3W	2U; 2V; 2W	[1W-1, 1W-2, 1V, 1U]	Open parallel star

Figure A.17 – Example of three-speed, constant torque motor using two separate windings, ten terminals



Speed	L1	L2	L3	Isolate separately	Join together	Winding connection
Low	1U	1V	1W	2U; 2V; 2W-1; 2W-2; 3U; 3V; 3W	---	Star
Middle	2U	2V	2W-1	1U; 1V; 1W; 3U; 3V; 3W	[2W-1, 2W-2]	Open delta
High	3U	3V	3W	1U; 1V; 1W; 2U; 2V; 2W-1; 2W-2	---	Star

Figure A.18 – Example of three-speed motor using three separate windings, ten terminals

A.2.2.4 Four-speed

Combinations of windings shall be selected from Figure A.1, Figure A.2, Figure A.10, Figure A.11, Figure A.12 and Figure A.13 and the prefixes adjusted.

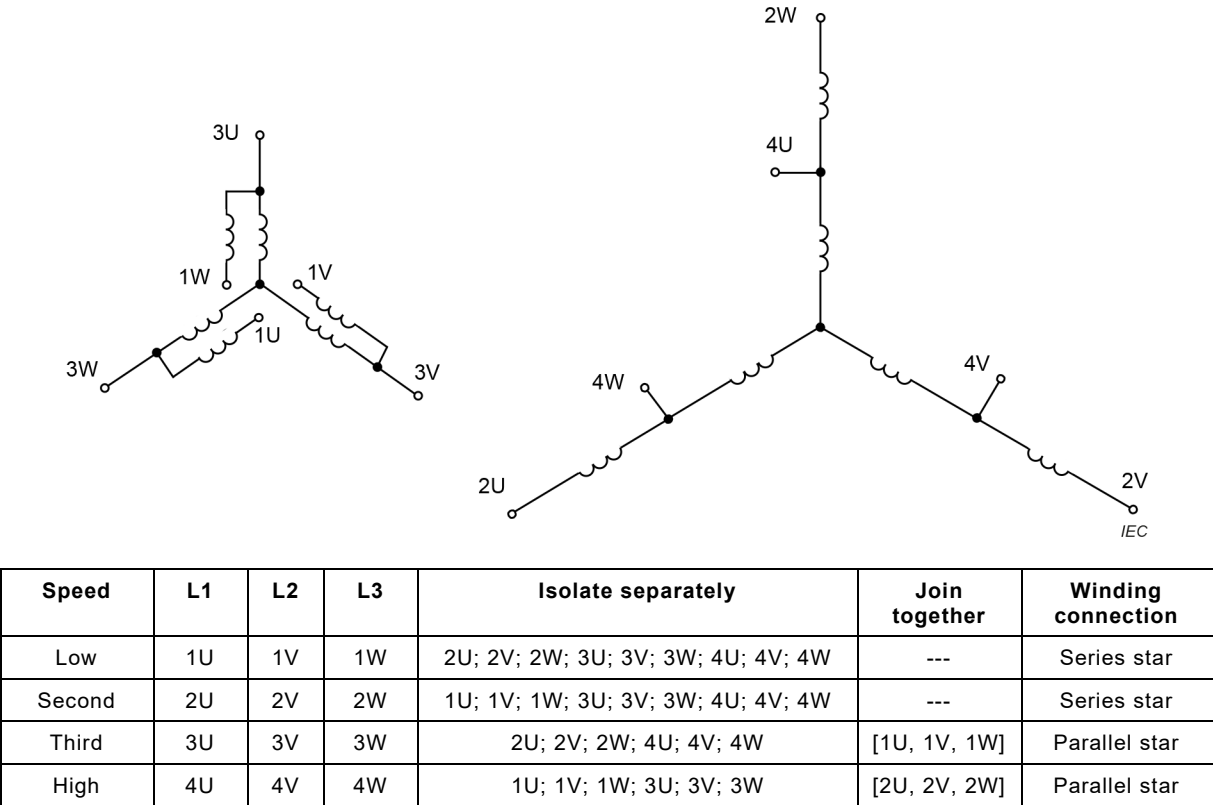
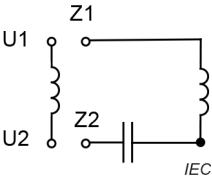


Figure A.19 – Example of four-speed, variable-torque motor using two separate windings, twelve terminals

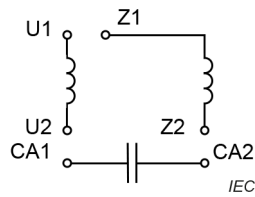
A.3 Single-phase induction machines

The terminal markings of single-phase, single voltage motor windings shall be as follows.



Direction of rotation	L1	L2	Join together
Clockwise	U1	U2	[U1, Z1]; [U2, Z2]
Counter-clockwise	U1	U2	[U1, Z2]; [U2, Z1]

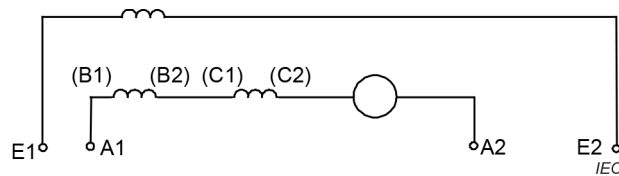
Figure A.20 – Split-phase or capacitor-start reversible motor



Direction of rotation	L1	L2	Join together
Clockwise	U1	U2	[U1, Z1]; [U2, CA1]; [CA2, Z2]
Counter-clockwise	U1	U2	[U2, Z1]; [U1, CA1]; [CA2, Z2]

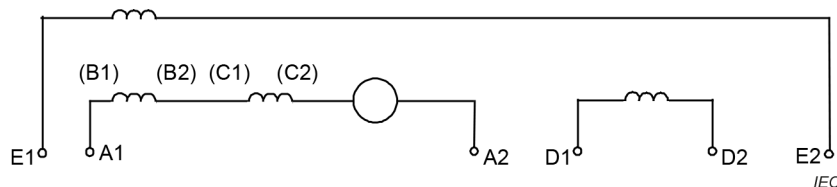
Figure A.21 – Reversible capacitor-start motor with four terminals with externally connected capacitor

A.4 DC machines



Direction of rotation	L+	L–
Clockwise	[E1, A1]	[E2, A2]
Counter-clockwise	[E1, A2]	[E2, A1]

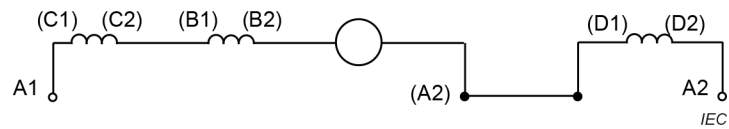
Figure A.22 – Shunt motor or generator, four terminals



Direction of rotation	L+	L–	Join together
Clockwise	[E1, A1]	[E2, D2]	[A2, D1]
Counter-clockwise	[E1, A2]	[E2, D2]	[A1, D1]

Figure A.23 – Compound motor or generator with compensating and commutating windings, six terminals

The proposed connection results in a compounding condition which will strengthen the magnetic field during motor operation and will weaken it during generator operation. If the opposite effect is desired, the connection of terminals D1 and D2 should change their positions.



Direction of rotation	L+	L-
Clockwise	A1	A2
Clockwise	A2	A1

Figure A.24 – Series-wound motor, two terminals

In Figure A.24, the direction of rotation is independent of the polarity of A1 and A2. An arrow on the enclosure shall always be used to indicate the direction of rotation.

NOTE Clockwise rotation is shown in Figure A.24. Counter-clockwise rotation can only be achieved by the motor manufacturer changing the internal connection (that is, by reversing the series-winding connecting points (D1) and (D2) and then marking (D1) as A2).

Bibliography

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