IS/IEC 60034-8 (2002): Rotating electrical machines, Part 8: Terminal markings and direction of rotation [ETD 15: Rotating Machinery]

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भारतीय मानक

घूर्णी विद्युत मशीनें

भाग 8 टर्मिनल चिन्हांकन और घूर्णी की दिशा

(दूसरा पुनरीक्षण)

Indian Standard

ROTATING ELECTRICAL MACHINES

PART 8 TERMINAL MARKINGS AND DIRECTION OF ROTATION

(Second Revision)

ICS 29.160.01

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 10

NATIONAL FOREWORD

This Indian Standard (Part 8) (Second Revision) which is identical with IEC 60034-8 : 2002 'Rotating electrical machines — Part 8: Terminal markings and direction of rotation' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Rotating Machinery Sectional Committee and approval of the Electrotechnical Division Council.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminology and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to the following International Standard for which Indian Standard also exists. The corresponding Indian Standard, which is to be substituted in its respective place is listed below along with its degree of equivalence for the edition indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60050 (411) : 1973 International Electrotechnical Vocabulary (IEV) — Chapter 411 : Rotating machines	IS 1885 (Part 35) : 1993 Electrotechnical vocabulary: Part 35 Rotating machines *(first revision)*	Identical

The technical committee responsible for the preparation of this standard has reviewed the provisions of the following International Standards referred to in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
IEC 60034-1 : 2004	Rotating electrical machines — Part 1: Rating and performance
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 and of terminations of certain designated conductors, including general rules for an alphanumeric system

Only English language text has been retained while adopting it in this Indian Standard, and as such the page numbers given here are not the same as in the IEC Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ROTATING ELECTRICAL MACHINES

PART 8 TERMINAL MARKINGS AND DIRECTION OF ROTATION

(Second Revision)

1 Scope

This part of IEC 60034 applies to a.c. and d.c. 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.

Turbine type synchronous machines are excluded in this standard.

2 Normative references

The following referenced documents are indispensable for the application 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 60050(411), *International Electrotechnical Vocabulary (IEV) – Chapter 411: Rotating machines*

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 and of terminations of certain designated conductors including general rules for an alphanumeric system*

3 Terms and definitions

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

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

[IEV 411-37-01]

3.6
winding phase
one or more winding elements associated with a particular phase

3.7
winding element
a part of a winding, all the turns or coils in that part being 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
a motor which can be operated at any one of two or more definite speeds

3.10
constant power
when the change in speed of a multi-speed motor provides approximately constant power

3.11
constant torque
when the change in speed of a multi-speed motor provides approximately constant torque

3.12
variable torque
when output torque of a multi-speed motor is proportional to approximately the square of the speeds

3.13
phase sequence
the order in which the voltages successively reach their maximum positive values between supply conductors

3.14
D-end
that end of the machine which accommodates the shaft end

[IEV 411-43-36]

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.

4 Symbols

4.1 General

L	Supply conductor
PE	Protective earthing terminal
	User available terminal, marking mandatory
	Internal connection point
( )	Internal terminal marking, 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 commutators

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

NOTE The primary and secondary symbol allocations are irrespective of whether the primary winding is located in the stator or rotor.

4.4 Auxiliary devices

BA	AC brakes
BD	DC brakes
BW	Brushwear 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

5 Direction of rotation

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

Machines with terminal markings according to this standard shall have a clockwise direction of rotation

For other configurations, including unidirectional machines, the direction of rotation shall be shown by an arrow located on the enclosure

6 Rules for terminal markings

6.1 General

6.1.1 Application

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

NOTE External line connections and winding arrangements generally used for common applications are shown in annex A

6.1.2 Marking instructions

All three-phase a c 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 standard

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.14.

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 earth conductor shall be marked with the letters PE according to IEC 60445 (or marked with symbol IEC 60417-5019.) 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 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.18.

6.4 Winding identification for categories of machines

6.4.1 Three-phase machines

The letter symbols shall be U, V, and W for the first, 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.

6.4.2 Two-phase machines

The terminal markings of a two-phase machine are 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 auxiliary winding. See figure 12.

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 (e.g. 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.

6.5 Synchronous machines

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

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

6.6 DC machines

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

6.7 Relation between terminal markings and direction of rotation

6.7.1 Multi-phase machines

The terminal markings shall be so arranged that clockwise rotation is obtained when the alphabetical sequence of the letters (e.g. U1, V1, W1) corresponds to the time sequence of the system phase voltages.

For counter-clockwise rotation, the time sequence of the system phase voltages shall be reversed by rearrangement of the supply cables. (e.g. L2 and L3 in the case of 3-phase).

The requirement in this clause applies 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. This arrow needs not to be on the rating plate, but it shall be permanently attached and easily visible.

6.7.2 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 (e.g. 1U and 1W) shall be interchanged, when necessary, in order to obtain the same direction of rotation for both speeds.

6.7.3 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.

6.7.4 Multiple three-phase group (e.g. 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 correspond 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.

6.7.5 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 6.7.6.

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

6.7.6.1 Two excitation windings generate unidirectional fields 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.

6.7.6.2 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

Connection diagrams for common applications are shown in annex A.

6.8.1 Three-phase asynchronous machines

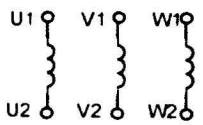


Figure 1 – Single three-phase winding, three elements, open connection, six terminals

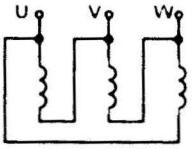


Figure 2 – Single three-phase winding, delta connection, three terminals

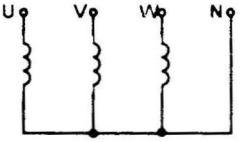


Figure 3 – Single three-phase winding, internal–star connection with neutral conductor, four terminals

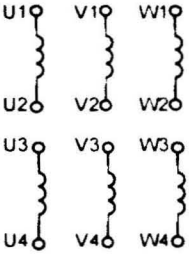


Figure 4 – Single three-phase winding, two elements per phase, open connection, twelve terminals

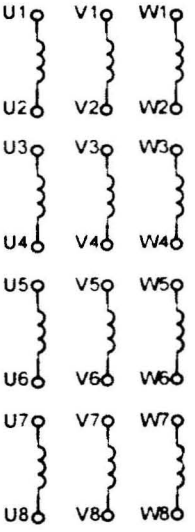


Figure 5 – Single three-phase winding, four elements per phase, open connection, twenty-four terminals

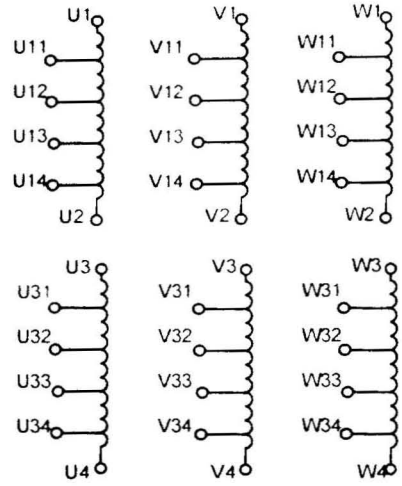


Figure 6 – Single three-phase winding, two elements per phase with four tapping points per element, open connection, thirty-six terminals

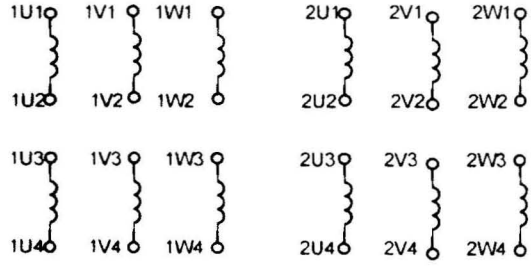


Figure 7 – Two separate three-phase windings with two independent functions, two elements per phase, open connection, twenty-four terminals

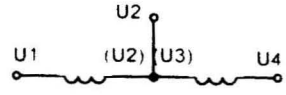


Figure 8 – Two elements, internal connection, three terminals

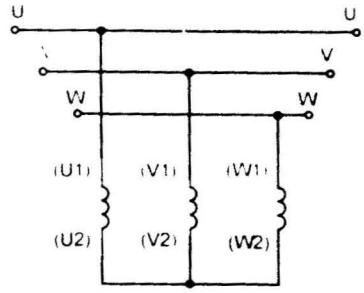


Figure 9 – Single three-phase winding, star connection, duplicate terminals for alternate connection, six terminals

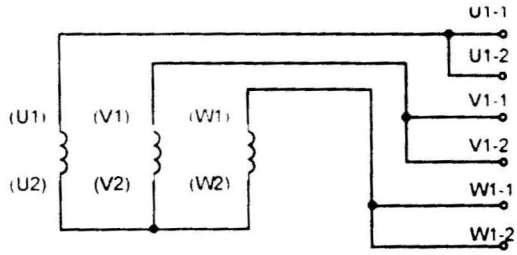


Figure 10 – Single three-phase winding, star connection, parallel terminals for shared current, six terminals

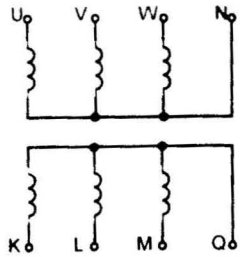


Figure 11 – Three-phase wound-rotor, star connections with neutral conductors, eight terminals

6.8.2 Single-phase asynchronous machines

Figure 12 – Main and auxiliary winding, two elements

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

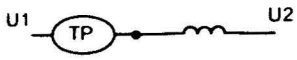


Figure 14 – Single-phase main winding, integrally connected thermal protector, one element

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

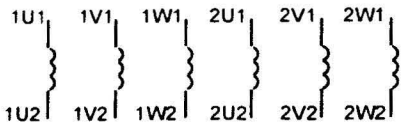


Figure 15 – Six-phase winding, open connection, six elements

6.8.4 DC machines

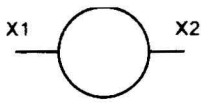


Figure 16 – Armature winding, one element

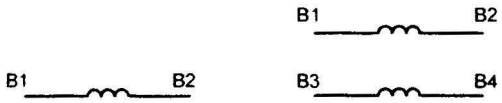


Figure 17 – Commutating winding, one and two elements

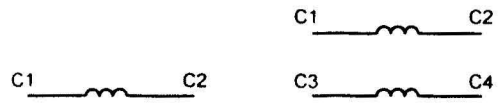


Figure 18 – Compensating winding, one and two elements

Figure 19 – Series winding, one element, two tappings

Figure 20 – Shunt excitation winding, one element

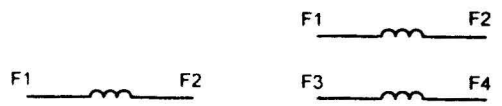


Figure 21 – Separately excited excitation winding, one and two elements

Figure 22 – Direct-axis auxiliary winding, one element

Figure 23 – Quadrature-axis auxiliary winding, one element

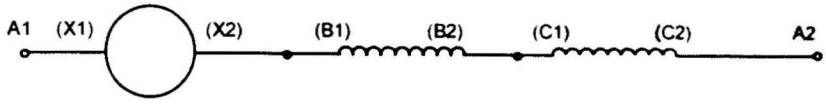


Figure 24 – Armature winding with commutating and compensating windings, one element

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 unit,
- 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 of this standard.

NOTE When there is a large number of terminals for a given type of device, 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).

7.2 Marking

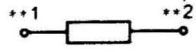
7.2.1 Power related devices

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

** indicates the device coding and ▭ represents the device.

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

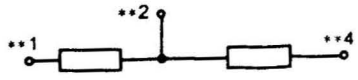
7.2.1.1 Single-phase, single voltage



L1	L2
**1	**2

Figure 25 – Single-phase, single voltage

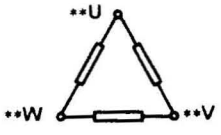
7.2.1.2 Single-phase, dual voltage



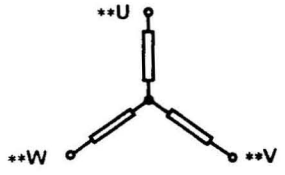
Voltage	L1	L2	Join	Isolate
High	**1	**4	-	**2
Low	**1	**2	[**1, **4]	-

Figure 26 – Single-phase dual voltage

7.2.1.3 Three-phase, single voltage



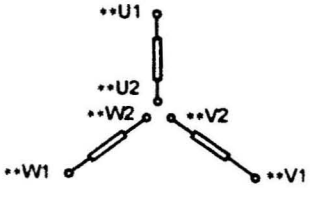
L1	L2	L3	Connection
**U	**V	**W	Delta

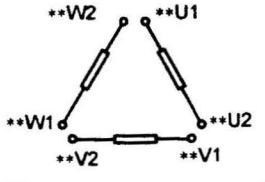


L1	L2	L3	Connection
**U	**V	**W	Star

Figure 27 – Three-phase, single voltage

7.2.1.4 Three-phase, dual voltage





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

Figure 28 – Three-phase dual voltage

7.2.2 Thermal and measurement devices

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

** indicates the device coding and ☐ represents the device.

The first character in the marking represents the device number.

NOTE 1 The manufacturer should identify the function of these devices in the written instructions.

NOTE 2 When only one circuit exists the initial character may be omitted.

NOTE 3 For TC devices, the leads are colour coded by the manufacturer to denote polarity.

NOTE 4 For resistance thermometers, the last character indicates the circuit number.

NOTE 5 This symbol should be changed according to IEC 60617 for schematic diagrams.

7.2.2.1 Two-lead devices of types TB, TC, TM, TN and TP

Figure 29 – Two-lead devices (except type R)

L1 and L2 should be connected according to written instructions or lead colour identification

7.2.2.2 Two-lead devices of type R

Figure 30 – Two-lead devices of type R

7.2.2.3 Three-lead devices of type R

Figure 31 – Three-lead devices of type R

7.2.2.4 Four-lead devices of type R

Figure 32 – Four-lead devices of type R

7.2.3 Switches

Switches shall be marked and connected as shown in figure 33 where * denotes the switch number.

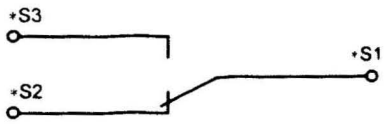


Figure 33 – Switch connections

Annex A
(normative)

Connection diagrams for common applications

A.1 General

Annex A provides connections for terminal markings that shall be used for common applications. The layout of figures is for information only and may take other forms.

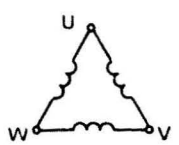
Applications not shown shall be derived from the rules of clause 6.

NOTE Additions of other common applications will be made to this annex upon request.

A.2 Three-phase machines

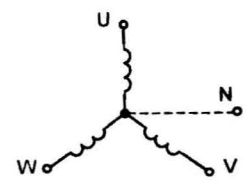
A.2.1 Single-speed stator windings

A.2.1.1 Single voltage



L1	L2	L3	Connection
U	V	W	Delta

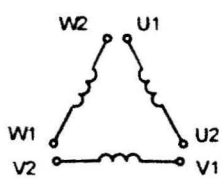
Figure A.1 – Delta connection

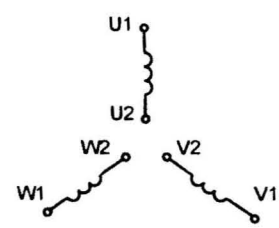


L1	L2	L3	Connection
U	V	W	Star

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

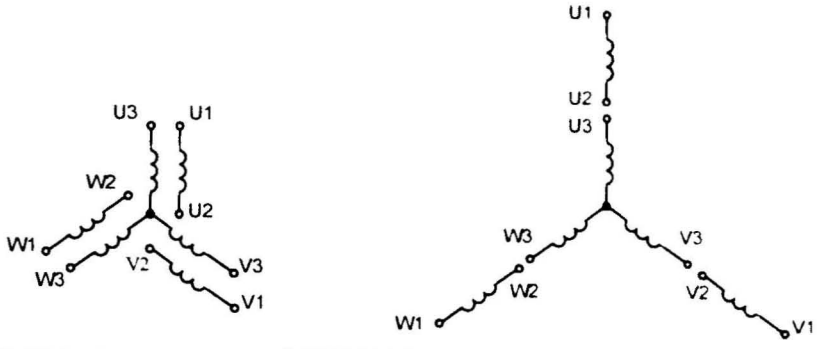
A.2.1.2 Dual voltage





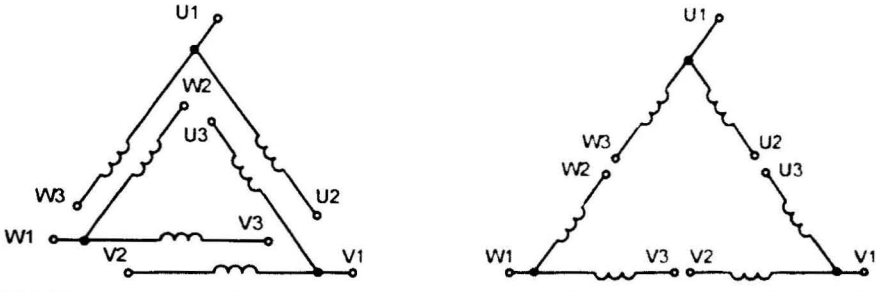
Voltage	L1	L2	L3	Join together	Winding connection
Low	U1	V1	W1	[U1.W2];[U2.V1];[V2.W1]	Delta
High	U1	V1	W1	[U2.V2.W2]	Star

Figure A.3 – Dual voltage, six terminals (1:√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 (1:2)



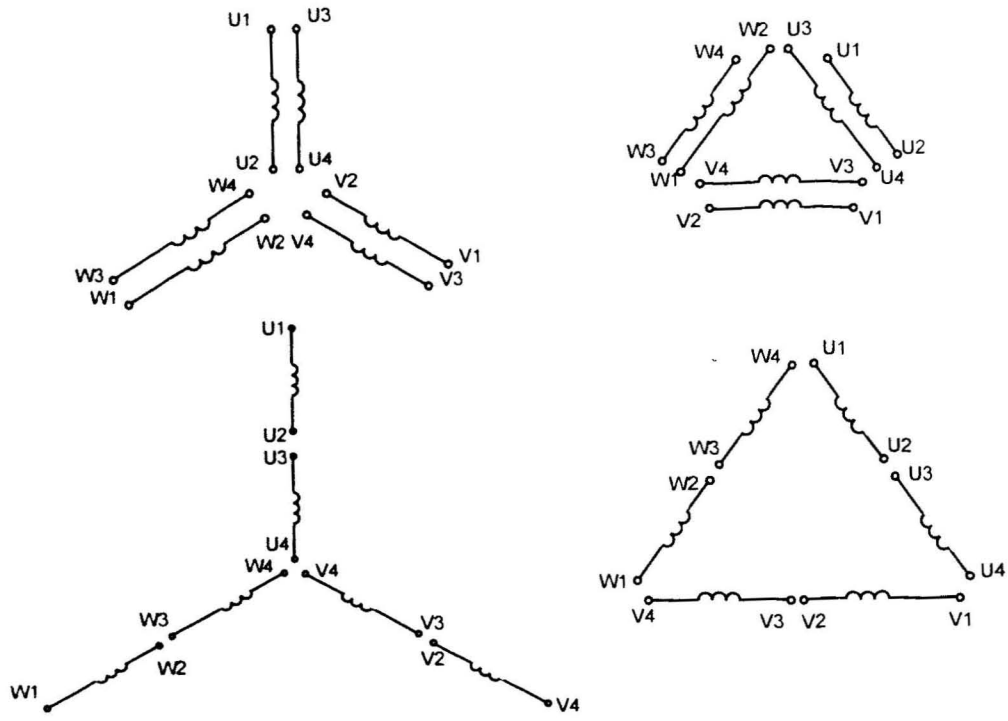
Voltage	L1	L2	L3	Join together	Winding connection
Low	U1	V1	W1	[U1.U3.W2]. [V1.V3.U2]. [W1.W3.V2]	Parallel delta
High	U1	V1	W1	[U2.U3].[V2.V3].[W2.W3]	Delta

Figure A.5 – Delta-connected, dual voltage, nine terminals (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

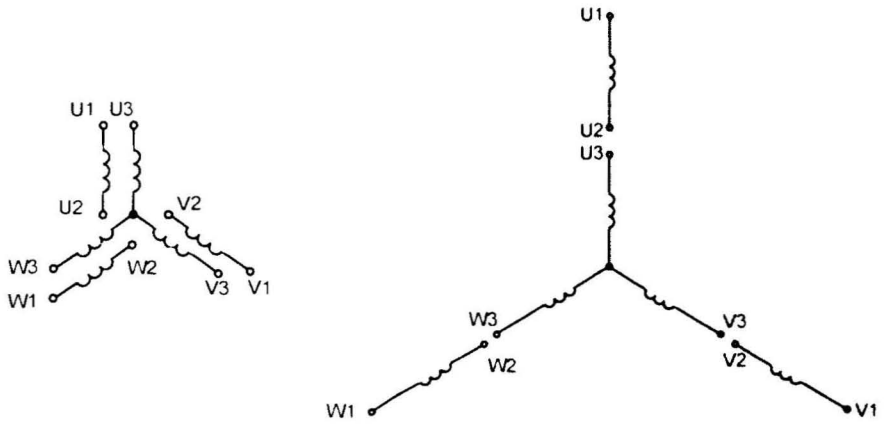


Voltage		L1	L2	L3	Join together	Winding connection
Low	Start	U1	V1	W1	[U1,U3];[V1,V3];[W1,W3]; [U2,V2,W2];[U4,V4,W4]	Parallel star
Low	Run	U1	V1	W1	[U1,W2,U3,W4]; [V1,U2,V3,U4]; [W1,V2,W3,V4]	Parallel delta
High	Start	U1	V1	W1	[U2,U3];[V2,V3]; [W2,W3];[U4,V4,W4]	Series star
High	Run	U1	V1	W1	[U1,W4];[V1,U4];[W1,V4];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

Figure A.7 – Star-delta, dual voltage, twelve terminals (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

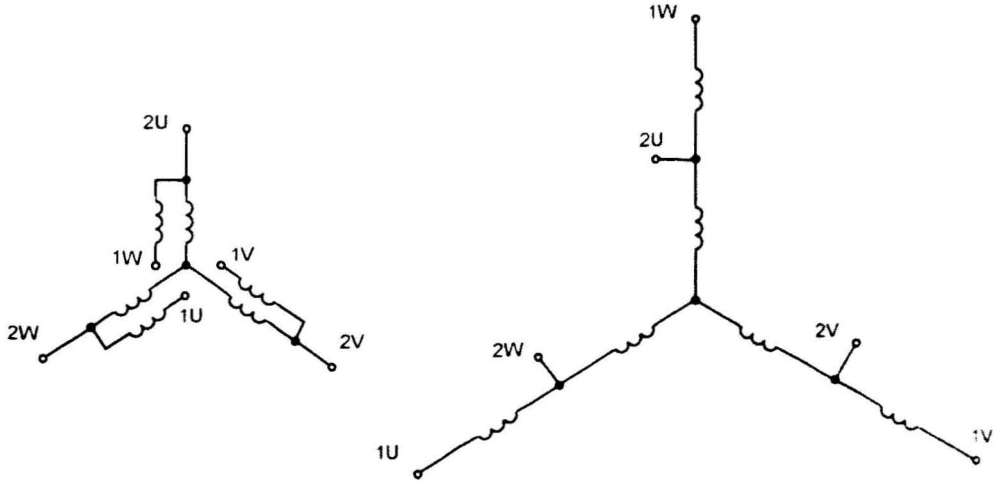


Voltage		L1	L2	L3	Isolate separately	Join together	Winding connection
Low	Start	U1	V1	W1	U3.V3.W3	[U2.V2.W2]	Star
Low	Run	U1	V1	W1		[U1.U3].[V1.V3].[W1.W3].[U2.V2.W2]	Parallel star
High	Run	U1	V1	W1		[U2.U3].[V2.V3].[W2.W3]	Series star

Figure A.9 – Part-winding, dual voltage, nine terminals (1:2)

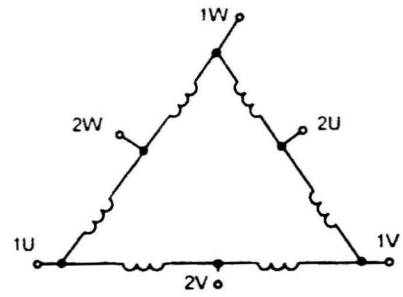
A.2.2 Multi-speed stator windings

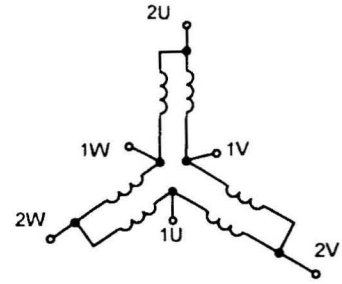
A.2.2.1 Two-speed, single-winding



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

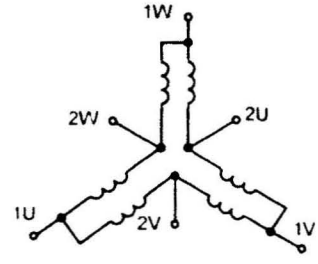
Figure A.10 – Variable-torque, six terminals

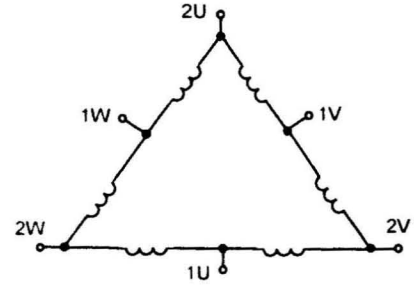




Speed	L1	L2	L3	Isolate separately	Join together	Winding connection
Low	1U	1V	1W	2U,2V,2W		Series delta
High	2U	2V	2W		[1U,1V,1W]	Parallel star

Figure A.11 – Constant-torque, six terminals





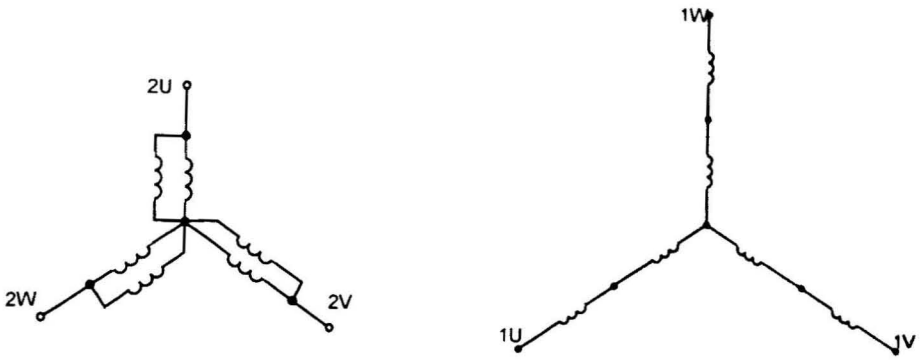
Speed	L1	L2	L3	Isolate separately	Join together	Winding connection
Low	1U	1V	1W		[2U,2V,2W]	Parallel star
High	2U	2V	2W	1U,1V,1W		Series delta

Figure A.12 – Constant power, six terminals

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

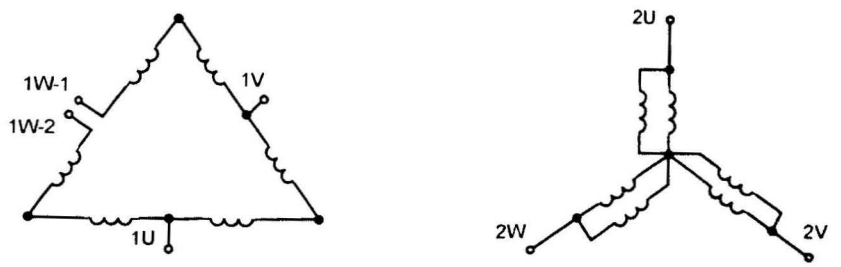
Figures A.10, A.11 and A.12 are generally utilized as one of the windings in a three or four speed motor.

Some motor designs do not produce circulating currents. In these cases, terminals (1W-1, 1W-2) and (2W-1, 2W-2) in figures A.14 and A.15 respectively will be permanently joined by the motor manufacturer and the -1 and -2 suffixes deleted.



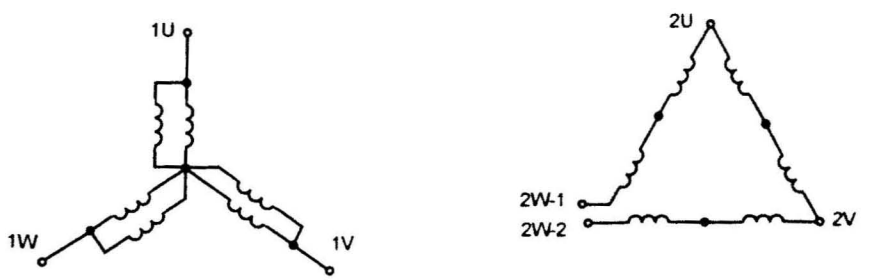
Speed	L1	L2	L3	Isolate separately	Winding connection
Low	1U	1V	1W	2U, 2V, 2W	Series star
High	2U	2V	2W	1U, 1V, 1W	Parallel star

Figure A.13 – Variable-torque, six terminals



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

Figure A.14 – Constant-torque,seven terminals

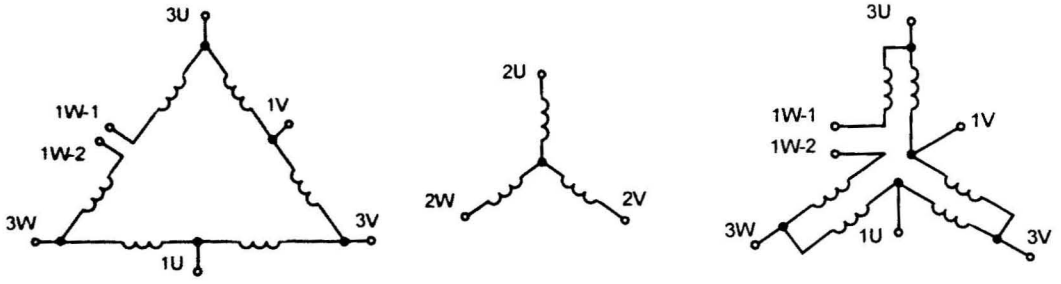


Speed	L1	L2	L3	Isolate separately	Winding connection
Low	1U	1V	1W	2U, 2V, 2W-1, 2W-2,	Parallel star
High	2U	2V	[2W-1, 2W-2]	1U, 1V, 1W	Open series delta

Figure A.15 – Constant-power, seven terminals

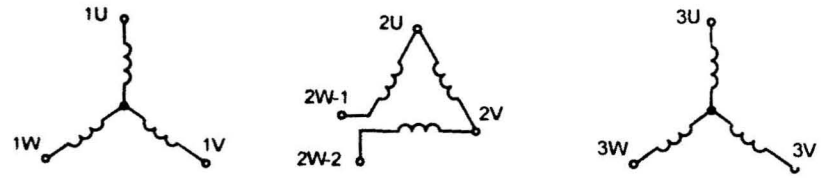
A.2.2.3 Three-speed

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



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

Figure A.16 – Example of three-speed, constant torque motor using two separate windings, ten terminals

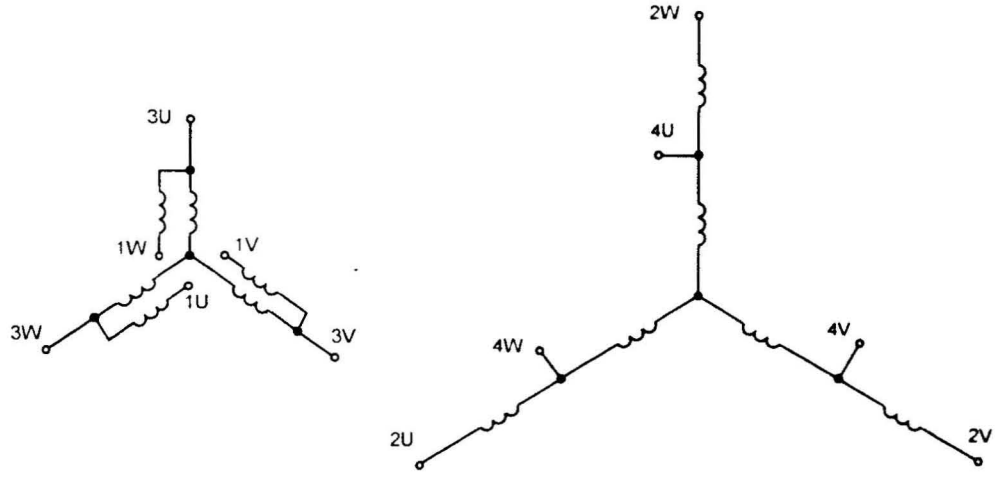


Speed	L1	L2	L3	Isolate separately	Join together	Winding connection
Low	1U	1V	1W	2U, 2V, 2W-1, 2W-2, 3U, 3V, 3W	---	Star
Middle	2U	2V	2W-1	1U, 1V, 1W, 3U, 3V, 3W	[2W-1, 2W-2]	Open delta
High	3U	3V	3W	1U, 1V, 1W, 2U, 2V, 2W-1, 2W-2	---	Star

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

A.2.2.4 Four-speed

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

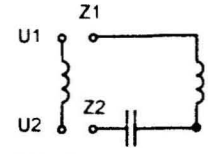


Speed	L1	L2	L3	Isolate separately	Join together	Winding connection
Low	1U	1V	1W	2U, 2V, 2W, 3U, 3V, 3W, 4U, 4V, 4W	---	Series star
Second	2U	2V	2W	1U, 1V, 1W, 3U, 3V, 3W, 4U, 4V, 4W	---	Series star
Third	3U	3V	3W	2U, 2V, 2W, 4U, 4V, 4W	[1U, 1V, 1W]	Parallel star
High	4U	4V	4W	1U, 1V, 1W, 3U, 3V, 3W	[2U, 2V, 2W]	Parallel star

Figure A.18 – Example of four-speed, variable-torque motor using two separate windings, twelve terminals

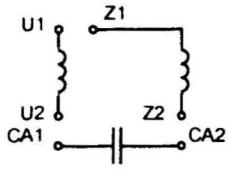
A.3 Single-phase asynchronous machines

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



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

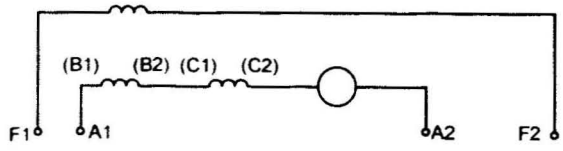
Figure A.19 – Split-phase or capacitor-start reversible motor



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

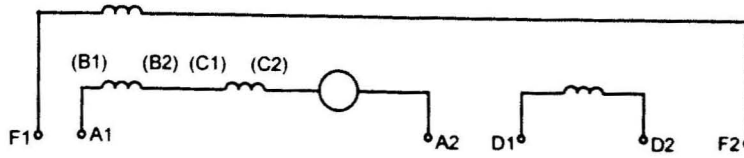
Figure A.20 – Reversible capacitor-start motor with four terminals with externally connected capacitor

A.4 DC machines



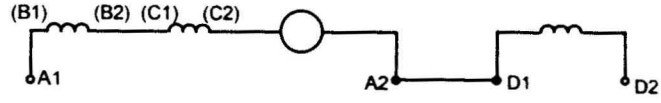
Rotation	L+	L–
Clockwise	[F1, A1]	[F2, A2]
Counter-clockwise	[F1, A2]	[F2, A1]

Figure A.21 – Shunt motor or generator, four terminals



Rotation	L+	L–
Clockwise	[F1, A1, D1]	[F2, A2, D2]
Counter-clockwise	[F1, A2, D2]	[F2, A1, D1]

Figure A.22 – Shunt-motor or compound generator with cumulative series and commutating windings, six terminals



Rotation	L+	L–
Clockwise	A1	A2, (D2)
Counter-clockwise (see below)	A1	A2, (D1)

Figure A.23 – Series-wound motor, two terminals

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.

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

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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