BS EN 61148:2012

BSI Standards Publication

Terminal markings for valve device stacks and assemblies and for power conversion equipment

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National foreword

This British Standard is the UK implementation of EN 61148:2012.
It is identical to IEC 61148:2011.

The UK participation in its preparation was entrusted to Technical Committee PEL/22, Power electronics.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

ISBN 978 0 580 68664 1

ICS 29.200

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 29 February 2012.

Amendments issued since publication

Amd. No.	Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61148

January 2012

ICS 29.200

English version

Terminal markings for valve device stacks and assemblies and for power conversion equipment
(IEC 61148:2011)

Marquage des bornes de blocs et d'ensembles d'éléments de valve et d'équipement de conversion de puissance (CEI 61148:2011)

Kennzeichnung der Anschlüsse von Ventilbauelement-Baugruppen und -sätzen sowie von Stromrichtergeräten (IEC 61148:2011)

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 61148:2012 E

Foreword

The text of document 22/185/FDIS, future edition 2 of IEC 61148, prepared by IEC/TC 22 "Power electronic systems and equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61148:2012.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-08-24
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2014-11-24

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61148:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60445	NOTE Harmonized as EN 60445.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050-551	-	International Electrotechnical Vocabulary (IEV) - Part 551: Power electronics	-	-
IEC 60146-1-1	-	Semiconductor converters - General requirements and line commutated converters - Part 1-1: Specification of basic requirements	EN 60146-1-1	-

CONTENTS

TERMINAL MARKINGS FOR VALVE DEVICE STACKS AND ASSEMBLIES AND FOR POWER CONVERSION EQUIPMENT

1 Scope

This International Standard is applicable to the terminal markings for the main circuits of valve device stacks and assemblies, and of integrated conversion equipment. The terminal markings refer to stacks, assemblies and equipment comprising semiconductor valve devices.

NOTE 1 Terminal markings for auxiliary circuits, including gate terminals and non-integrated conversion equipment with separate manufacturing of its components and their interconnection only after installation on site, are not considered in this standard.

For such equipment the relevant standards, if any, for the individual components apply.

Gate terminal markings are given in 6.3.

Terminal markings for other circuits such as protective conductor are not considered in this standard.

The object of this standard is to specify a logical alphanumeric marking system for the identification of the external main terminals of the main power circuits in a stack, valve device assembly or integrated conversion equipment, which is applicable for the purpose of reference in circuit diagrams, catalogues, descriptions, and information exchange and storage.

In the case of stacks and assemblies, alphanumeric terminal marking systems are indicated for those converter connections which are the most important and most commonly used ones.

Terminal marking systems making use of graphic symbols or identifying colours are not considered in this standard.

NOTE 2 The terminals of auxiliary circuits should be marked such that they may be clearly identified.

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 60050-551, *International Electrotechnical Vocabulary – Part 551: Power electronics*

IEC 60146-1-1, *Semiconductor converters – General requirements and line commutated converters – Part 1-1: Specification of basic requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-551, IEC 60146-1-1 and the following apply.

3.1
external main terminals
terminals of the main power circuit of the stack, assembly or equipment to which the external power supply or the load are connected

NOTE 1 In the following clauses this term is abbreviated to "terminals”.

NOTE 2 For stacks and assemblies the main power circuit is formed by the principal valve arms.

3.2
integrated conversion equipment
factory-built conversion equipment the components of which are assembled, interconnected and tested in the factory thus forming a complete equipment

NOTE 1 Equipment composing one or more semiconductor switches is considered to be conversion equipment.

NOTE 2 For transport purpose, the equipment can be divided in several cubicles that will have to be reassembled at the site.

3.3
anode
electrode capable of emitting positive charge carriers to and/or receiving negative charge carriers from the medium of lower conductivity

[IEC 60050-151: 2001, 151-13-02]

NOTE 1 The direction of electric current is from the external circuit, through the anode, to the medium of lower conductivity.

NOTE 2 In some cases (e.g. electrochemical cells), the term "anode" is applied to one or another electrode, depending on the electric operating condition of the device. In other cases (e.g. electronic tubes and semiconductor devices), the term "anode" is assigned to a specific electrode.

3.4
cathode
electrode capable of emitting negative charge carriers to and/or receiving positive charge carriers from the medium of lower conductivity

[IEC 60050-151:2001, 151-13-03]

NOTE 1 The direction of electric current is from the medium of lower conductivity, through the cathode, to the external circuit.

NOTE 2 In some cases (e.g. electrochemical cells), the term "cathode" is applied to one or another electrode, depending on the electric operating condition of the device. In other cases (e.g. electronic tubes and semiconductor devices), the term "cathode" is assigned to a specific electrode.

4 Method of identifying terminals

The use of alphanumeric notation should be preferred to any alternative marking, as in j).

a) The marking of the terminals should be based on alphanumeric notation employing capital (upper case) roman characters and Arabic numerals.

NOTE 1 It is recommended that the reference letters for d.c. terminals are chosen from the first part and reference letters for a.c. terminals from the second part of the alphabet.

NOTE 2 In those cases where difficulties could otherwise arise in correspondence, documents, etc., the use of small (lower case) letters, which have the same significance, is permitted.

b) Letters “I” and “O” shall not be used to prevent confusion with the numerals “1” and “0”.

c) For converter connections with unchangeable polarity, “+” or “pos” may be used to the positive terminal and “–” or “neg” may be used to the negative terminal.

NOTE 3 In this standard, if not otherwise stated, the term “polarity” is used with respect to the direction of current flow.

d) The complete notation is based on the use of combinations of alternate alphabetical and numerical character groups, each containing one or more letters and/or digits.

e) Terminals with identical basic markings according to Clause 5 and Clause 6 should be distinguished by a reference number in a naturally ascending sequence according to the sequence of operation or the direction of current flow starting with 1 and following the basic terminal markings, for example X1 – X2 – X3, Y1 – Y2 – Y3.

f) Terminals with identical basic markings according to Clause 5 and Clause 6 in two or more similar terminal groups should be distinguished by a reference number in a naturally ascending sequence starting with 1 and preceding the basic terminal markings, for example 1X – 1Y – 1Z, 2X –2Y – 2Z, etc.

g) If, for further differentiation of terminal groups, further letters or numbers are required in addition to the terminal marking in Clause 5 and Clause 6 and in f), such additional marking should be placed before this marking, separated from it by a full stop.

h) The marking shall be clearly legible and durable.

i) The marking of the main terminals according to Clause 5 to Clause 6 shall be shown clearly on the corresponding circuit diagram. This shall also be observed for main and auxiliary terminals not considered in this standard.

j) In cases where the construction mode or size of a stack or assembly prevents the application of the alphanumeric notation for terminal marking, the terminals shall be clearly identified by another applicable method, for example by identifying colours or graphic symbols which, however, are not the subject of this standard.

5 Terminal marking for valve device stacks and assemblies

5.1 Single and double way connections

5.1.1 General

The external main terminals of an individual principal arm or of a number of inter-connected principal arms of the same polarity shall be marked by a capital letter corresponding to the polarity of the end of the arm(s) connected to the terminal to be identified, also in cases where the arms comprise, in addition to the valve devices, further components, for example fuses, reactors, capacitors, etc.

The terminal for a common connection point of arms ending with the same polarity shall be identified by the capital letter M placed behind the identification letter for its polarity.

– End terminal of a principal arm forming:
  - an anode: basic terminal marking A
  - a cathode: basic terminal marking K

NOTE Although other markings may be used for valve devices, e.g. C and B or D and S, A and K are used for arms.

– Terminal for interconnection point of the anode of a principal arm with the cathode of a second principal arm:
  - basic terminal marking AK

– Terminal for the interconnection point of two or more principal arms of the same polarity forming:
  - an anode: basic terminal marking AM
  - a cathode: basic terminal marking KM

– Terminal for an interconnection point of the same number of anodes and cathodes of principal arms:
  - basic terminal marking AKM

– If the valve device stack or assembly is used in a specific converter or semiconductor switch, and its terminals are connected to terminals of the converter or switch, the terminal marking of which may be used:
  - d.c. terminal: alternative terminal marking C, D
  - a.c. terminal: alternative terminal marking U, V, W

– For converter connections with unchangeable polarity of the d.c. terminals the following marking may be used alternatively:

- the sign + for the positive terminal
- the sign – for the negative terminal

If several identical principal arms are combined to a connection in a single stack or assembly, the end terminals with the same polarity shall be distinguished by natural reference numbers, for example 1, 2, 3... placed behind the basic terminal markings, i.e. A1 – A2 – A3, K1 – K2 – K3.

5.1.2 Single way connections

5.1.2.1 Single arm connection

Terminal marking:

– Anode side: A
– Cathode side: K

EXAMPLES: See Figure 1. Examples are shown for rectifier diode, P-gate reverse blocking triode thyristor, PNP bipolar transistor, NPN bipolar transistor, N-channel IGBT and N-channel Type C enhancement type MOSFET.

NOTE 1 The terminals of an individual principal arm which is intended to be part of a converter connection comprising several principal arms may be marked like those of a single arm connection.

NOTE 2 The marking of terminals connected to auxiliary arms only is not considered in this standard.

NOTE 3 The arm which consists of several valve devices connected series and/or parallel is considered to be one arm. The arm which consists of switched valve device and series diode for reverse blocking is also considered to be one arm.

NOTE 4 In some kinds of controllable valve devices, rectifier diodes connected anti-parallel may be integrated in common semiconductor chip or packaged in a common case. If the rectifier diodes are used, these arms are considered as half-controllable anti-parallel pairs. See 5.2.1.

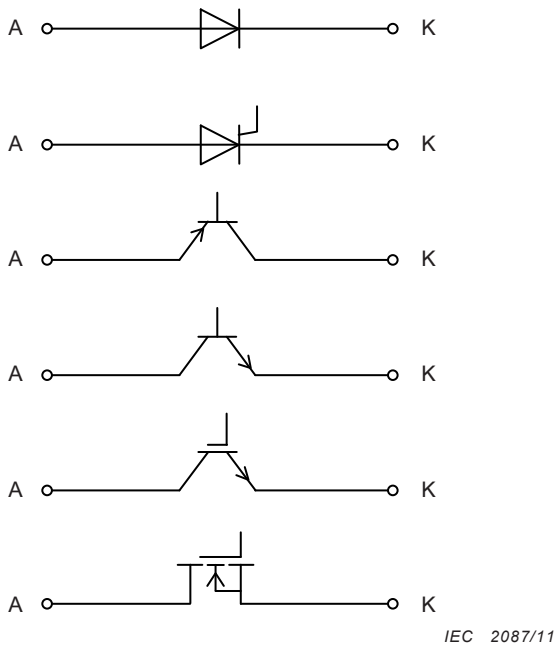


Figure 1 – Typical markings in single arm connections

5.1.2.2 Centre tap and star connection

The *m* principal arms with one and the same polarity connected to a common point, forming the d.c. terminal (*m* being a whole number equal to or greater than 2):

– Cathodes forming the d.c. terminal:
  - Marking of individual arm terminals: A1, A2 ... A*m*
  - Marking of common d.c. terminal: KM
  - For diode rectifiers admissible: +
– Anodes forming the d.c. terminal:
  - Marking of individual arm terminals: K1, K2 ... K*m*
  - Marking of common d.c. terminal: AM
  - For diode rectifiers admissible: –

EXAMPLES: See Figure 2 and Figure 3.

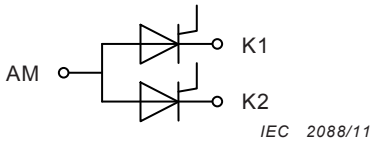


Figure 2 – Star connection with two arms

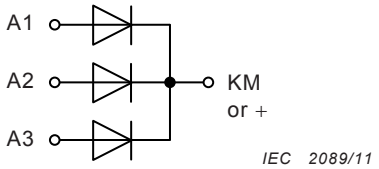


Figure 3 – Star connection with three arms

5.1.2.3 Several centre tap and star connections in a common assembly

A given number *n* of identical groups of *m* principal arms, all groups with the same polarity of the d.c. terminals, for example *n* commutating groups with pulse number *p*, isolated from each other, intended for interconnection via an external interphase transformer:

– Cathodes forming the d.c. terminal:
  - Marking of individual arm terminals: 1A1 – 1A2 to 1A*m*
    2A1 – 2A2 to 2A*m*
    *n*A1 – *n*A2 to *n*A*m*
  - Marking of common d.c. terminal: 1KM to *n*KM
– Anodes forming the d.c. terminal:
  - Marking of individual arm terminals: 1K1 – 1K2 to 1K*m*
    2K1 – 2K2 to 2K*m*
    *n*K1 – *n*K2 to *n*K*m*
  - Marking of common d.c. terminal: 1AM to *n*AM

EXAMPLES: See Figure 4 and Figure 5.

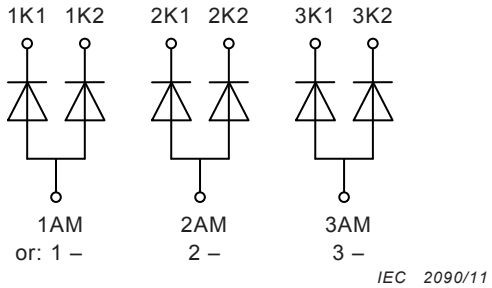


Figure 4 – Three groups with two arms

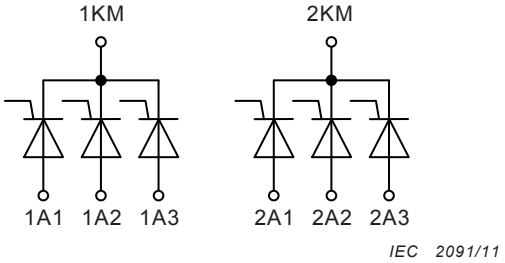


Figure 5 – Two groups with three arms

5.1.2.4 Switched valve device arm and series connected reverse-direction diode arm for d.c. chopper

This terminal marking is applied for choppers.

EXAMPLE: See Figure 6.

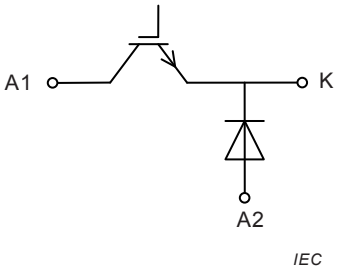


Figure 6a) – Regular terminal marking

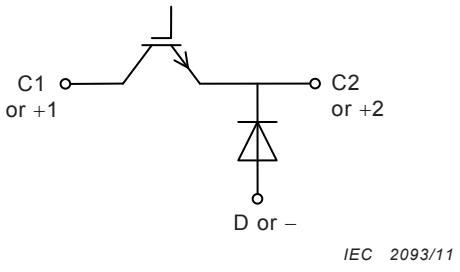


Figure 6b) – Alternative terminal marking

Figure 6 – Assembly for d.c. chopper

5.1.3 Double way connections

5.1.3.1 Pair of arms

Terminal marking:

- Central terminal: AK
- Anode side: A
- Cathode side: K

EXAMPLE: See Figure 7.

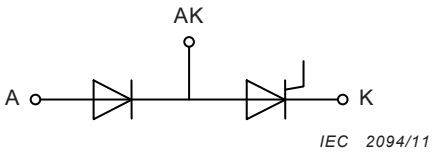


Figure 7 – Pair of arms

5.1.3.2 Bridge connection

m pairs of arms connected to a bridge connection.

Terminal marking:

- Central terminals: AK1 – AK3 to AK*m*
- Anode side d.c. terminal: AM
- Cathode side d.c. terminal: KM
- For diode rectifiers admissible: – for AM, + for KM

EXAMPLE: See Figure 8.

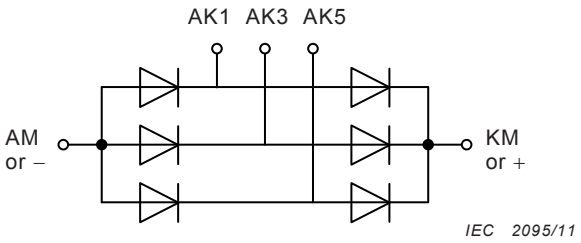


Figure 8 – Bridge connection

NOTE 1 According to the conduction sequence of six diodes, 1, 3 and 5 are used as reference numbers.

NOTE 2 An open bridge connection with the positive bridge section isolated from the negative bridge section, each section provided with separated a.c. terminals, can be considered as two centre tap or star connections. For this connection mode the terminals of the two sections should be marked according to 5.1.2.2, e.g. A1 – A3 – A5/KM and K4 – K6 – K2/AM.

5.1.3.3 Several bridge connections in a common assembly

The *n* bridge connections, isolated from each other.

Terminal marking:

- Central terminals: 1AK1 – 1AK3 to 1AK*m* to *n*AK1 – *n*AK3 to *n*AK*m*
- Anode side d.c. terminals: 1AM to *n*AM
- Cathode side d.c. terminals: 1KM to *n*KM

EXAMPLE: See Figure 9.

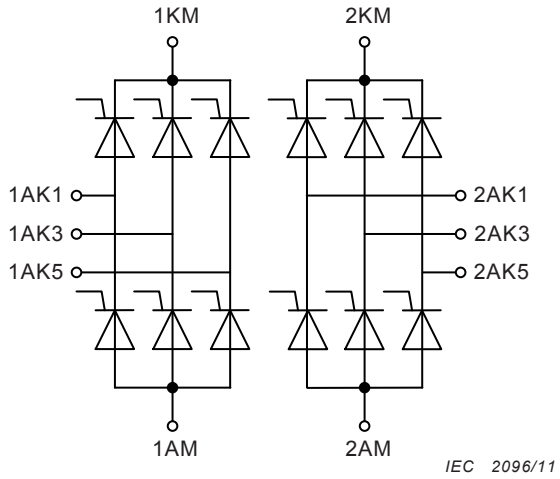


Figure 9 – Double bridge connection

5.1.4 Combination of connections

5.1.4.1 Anti-parallel single way and double way connections

Terminal marking:

– Centre tap and star connections:
  - Marking of common d.c. terminal: AKM
– Bridge connections:
  - Marking if common d.c. terminals: AKM1 and AKM2

EXAMPLE: See Figure 10.

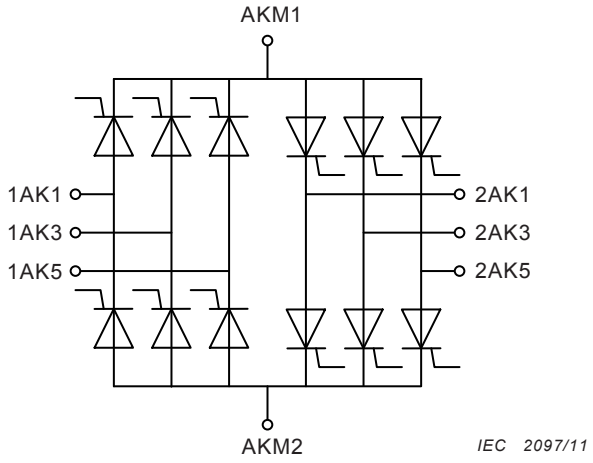


Figure 10 – Anti-parallel bridge connection

5.1.4.2 Series connection of bridges

Intermediate terminal, if any (between the two bridges): AKM

EXAMPLE: See Figure 11.

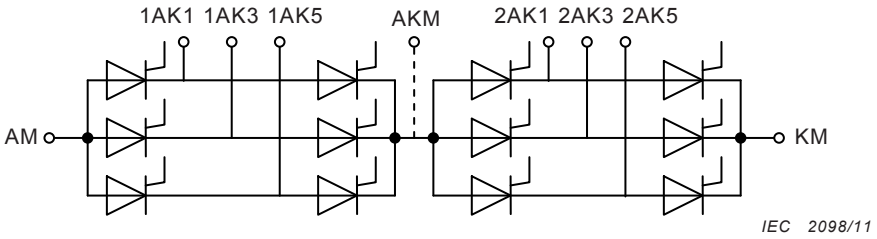


Figure 11 – Series connection of bridges

5.2 Bi-directional connections

5.2.1 Inseparable connections of pair of anti-parallel arms

Terminal marking:

– Fully controllable pairs:

End terminals marked by numbers 1 and 2 or AK1 and AK2.

EXAMPLE: See Figure 12.

NOTE Other connections having equivalent function are considered to be the pair of anti-parallel arms.

– Half-controllable pairs:

For a pair of controllable valve device and anti-parallel diode, end terminals marked by A and K according to the direction of the controllable valve device.

EXAMPLE: See Figure 13.

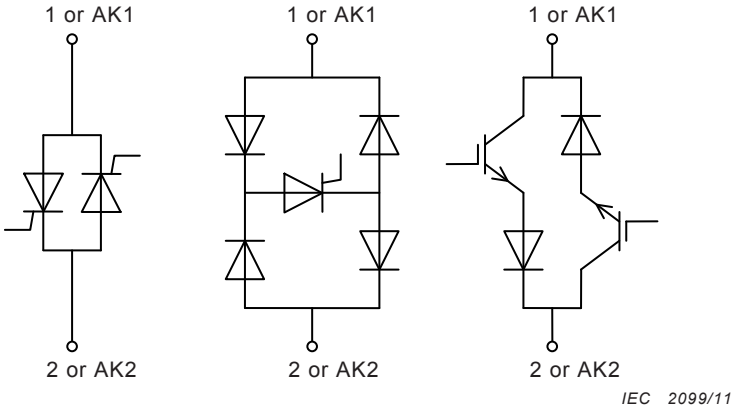


Figure 12 – Fully controllable anti-parallel pairs

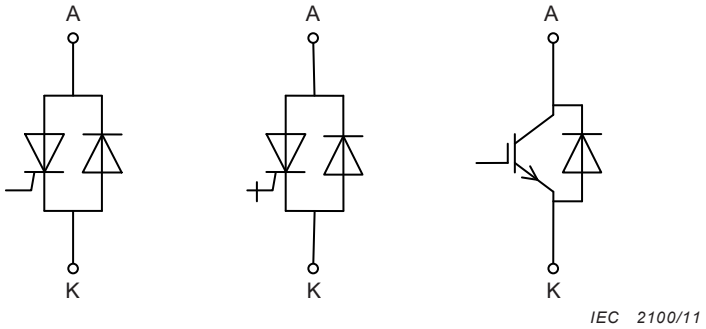


Figure 13 – Half-controllable anti-parallel pairs

5.2.2 Combinations of pairs of anti-parallel arms

The terminals of a combination of pairs of anti-parallel arms (in the following, abbreviated to pairs of arms) are distinguished by the reference number:

– 1.1 / 1.2 to *n*.1 / *n*.2 or 1AK1 / 1AK2 to *n*AK1 / *n*AK2 for fully controllable *n* pairs of arms

– 1A / 1K to *n*A / *n*K, for half-controllable *n* pairs of arms

Pairs of arms which are intended to be connected directly or indirectly (via the load) to the a.c. supply should basically be marked by the identifying letters:

– U, V, for two pairs of arms

– U, V, W, for three pairs of arms

and, if necessary, with the additional marking for the combinations of pairs of arms specified in 5.2.2.1 and 5.2.2.2.

For more than three phases in the supply system:

Subdivision in two or more groups, with the terminals of each group marked by a reference number preceding the basic terminal marking (see Clause 4, f)).

5.2.2.1 Isolated pairs of arms

Connected between the a.c. supply and the load.

– Marking of supply side terminals: U1 – V1 or U1 – V1 – W1

– Marking of load side terminals: U2 – V2 or U2 – V2 – W2

EXAMPLE: See Figure 14.

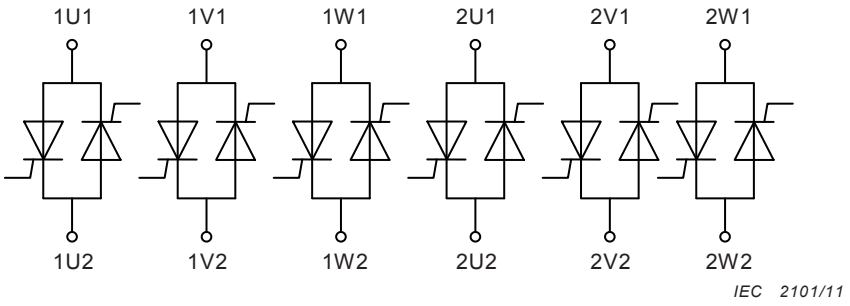


Figure 14 – Example for six-phase supply

5.2.2.2 Star connection

Marking of input terminals: U, V, W

More than three pairs of arms: Same method as recommended in 5.2.2.1.

For star connections without neutral:

– No further marking of neutral.

For star connections with neutral:

– Marking of neutral terminal: N

EXAMPLES: See Figure 15, Figure 16 and Figure 17.

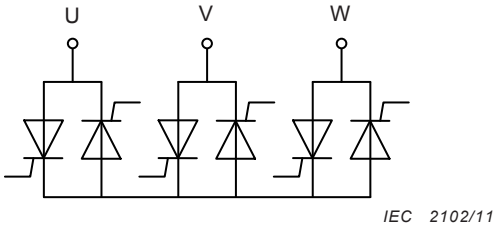


Figure 15 – Three-phase star connection

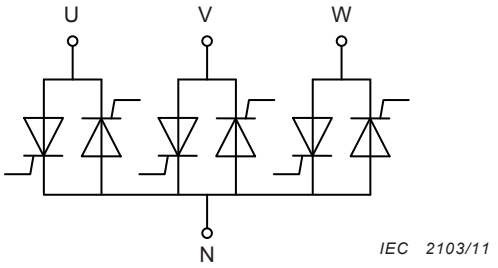


Figure 16 – Three-phase star connection with neutral

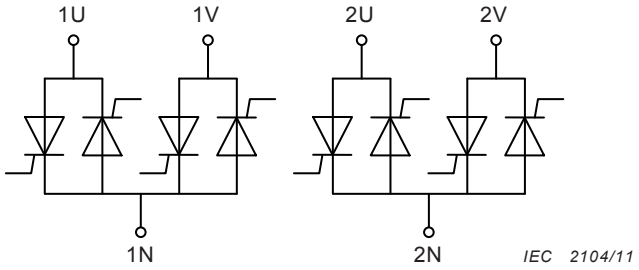


Figure 17 – Double two-phase star connection with neutral

5.2.2.3 Polygon connection with *m* arms for *m* phases

Marking of input terminals: U, V, W

with extension to 1U – 1V – 1W – 2U – 2V – 2W for example for six-phase polygon connection.

EXAMPLE: See Figure 18.

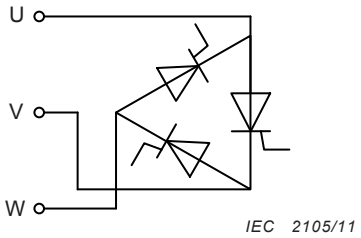


Figure 18 – Polygon connection

5.2.2.4 Legs for voltage stiff converters

Terminal marking:

– Central terminal: AK
– Anode side d.c. terminal of the controllable valve device: A or +
– Cathode side d.c. terminal of the controllable valve device: K or –

– D.C. mid-point terminal of three-level connection: M

NOTE C for anode and D for cathode are also admissible.

EXAMPLE: See Figure 19.

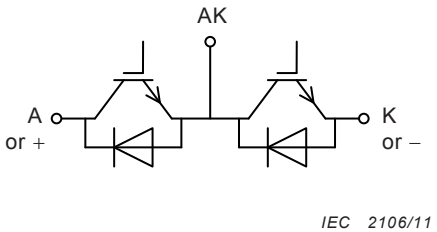


Figure 19a) – For two-level converter

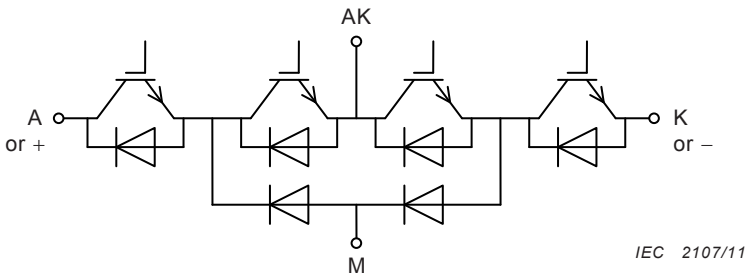


Figure 19b) – For three-level converter

Figure 19 – Legs for voltage stiff converters

5.2.2.5 Bridge connection for voltage stiff converter

Terminal marking:

– Central terminals: AK1 to AK*m*
– Anode side d.c. terminal of the controllable valve device: AM or +
– Cathode side d.c. terminal of the controllable valve device: KM or –
– D.C. mid-point terminal of three-level connection: M

NOTE 1 Relations between AM and + and between KM and – are opposite to 5.1.3.2.

EXAMPLE: See Figure 20.

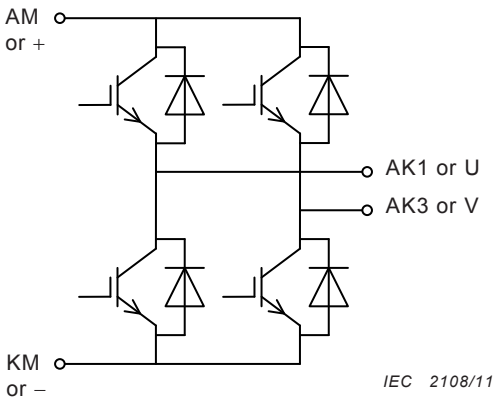


Figure 20a) – Single phase connection for inverter

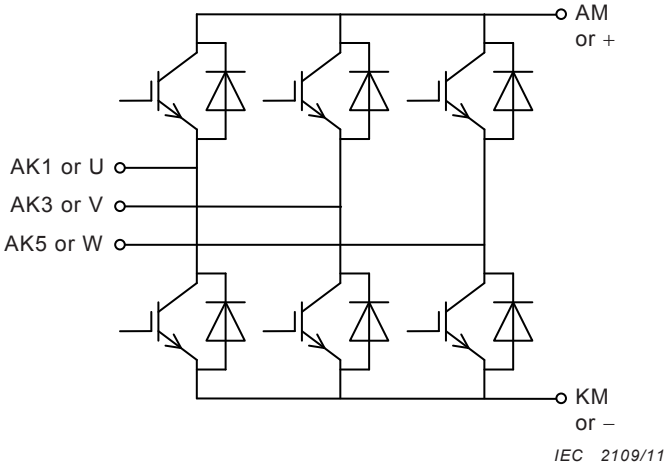


Figure 20b) – Three phase connection

Figure 20 – Bridge connection for voltage stiff converter (two-level)

NOTE 2 Terminal markings for d.c. and a.c. terminals are also admissible.

NOTE 3 When the single phase bridge connection is used as a four-quadrant chopper, terminal marking C1/D1 for input terminal and C2/D2 for output terminal is admissible.

5.2.2.6 Three-level converter connection

Terminal marling is the same as above.

EXAMPLE: See Figure 21. A terminal marking C/D is applied according to 6.2.

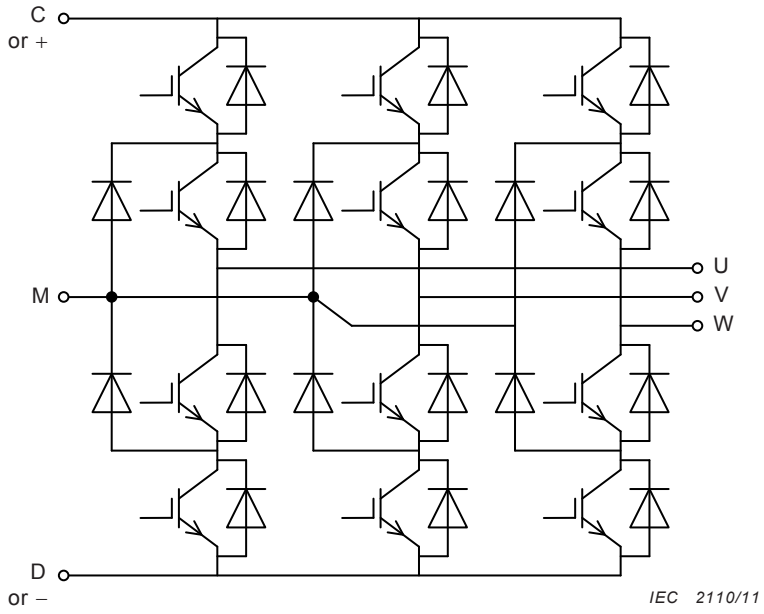


Figure 21 – Three-level connection for inverter

6 Marking of external main terminals of integrated conversion equipment

6.1 A.C. terminals

6.1.1 Single-phase a.c. system

Terminal marking:

– without particular need to connect one terminal to the neutral conductor: U – V
– with one terminal to be connected to the neutral conductor: U – N

L1 – L2 or L1 – N may be applied instead of U – V or U – N.

NOTE These markings such as L1 or N are specified for line or neutral conductors by IEC 60445, and the same terminal markings facilitate the connection to correct line conductors.

6.1.2 Three-phase a.c. system

Terminal marking:

– without neutral terminal: U – V – W
– neutral terminal: N

L1 – L2 – L3 may be applied instead of U – V – W.

6.1.3 A.C. conversion equipment with a.c. terminals on supply and load side, for three-phase systems

Terminal marking:

– supply side terminals: U1 – V1 – W1 and N1 if any

– load side terminals: U2 – V2 – W2 and N2 if any

L1 – L2 – L3 may be applied for supply side instead of U1 – V1 – W1. In this case, U – V – W for load side may be applied instead of U2 – V2 – W2.

In conversion equipment in which one and the same terminal set may form the supply (input) side for one operation mode, or the load (output) side for a second operation mode, the manufacturer should assign the preferred operation mode for the determination of the supply and the load side, and should mark for this operation mode the corresponding terminal sets.

The corresponding marking method is equally applicable to single-phase a.c. systems and to conversion equipment for single-phase a.c. systems.

6.2 D.C. terminals

6.2.1 General

Basic terminal marking: C and D

For converter connections with unchangeable polarity of the d.c. terminals the following marking may be used alternatively:

– the sign + for the positive terminal

– the sign – for the negative terminal

6.2.2 A.C./D.C. conversion equipment

Terminal marking:

– positive terminal in rectifier operation: C or +

– negative terminal in rectifier operation: D or –

6.2.3 Double conversion equipment with reversible polarity of d.c. terminals

Terminal marking: C(D) and D(C)

The first letter corresponds to the polarity of the forward section, as assigned by the manufacturer.

6.2.4 D.C. conversion equipment with d.c. terminals on the supply and load sides

Terminal marking:

– supply side terminal set: C1 – D1 or +1 – –1

– load side terminal set: C2 – D2 or +2 – –2

where C: positive terminals

D: negative terminals

In conversion equipment in which one and the same terminal set may form the supply (input) side for one operation mode, or the load (output) side for a second operation mode, the manufacturer should assign the preferred operation mode for the determination of the supply and the load side, and should mark for this operation mode the corresponding terminal sets.

If the polarity is freely reversible such as in four-quadrant d.c. chopper, it is recommended to use U and V in place of C(D) and D(C).

6.2.5 Terminal for connection to mid-wire conductor

Terminal marking: M

6.2.6 Conversion equipment with more than one converter section with separate terminal sets on supply and load side

Differentiation of identical basic terminal markings in the different groups by a reference number preceding the basic terminal marking (see Clause 4 f)).

6.2.7 Conversion equipment in which the external main terminals are formed by the main terminals of the assembly(ies) incorporated in the equipment

The terminal markings for the assembly(ies) according to Clause 5 may be used in place of those specified in Clause 6.

EXAMPLES: See Figure 22, Figure 23, Figure 24, Figure 25 and Figure 26.

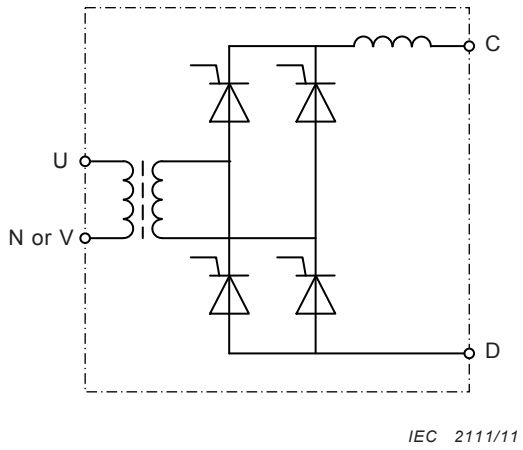


Figure 22a) – Line commutated converter

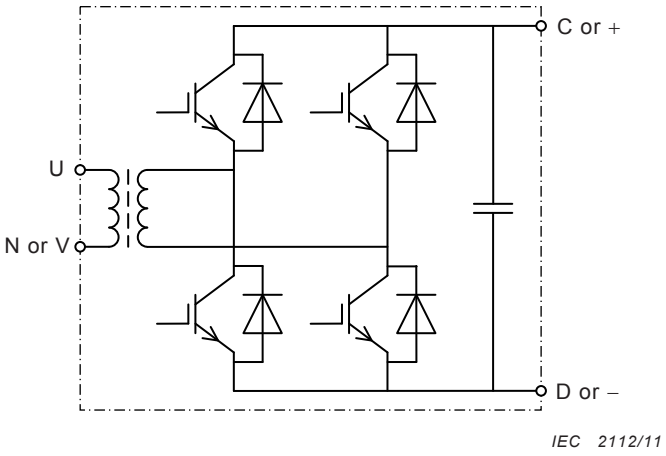


Figure 22b) – Voltage stiff self-commutated converter

Figure 22 – Single-phase a.c./d.c. converter

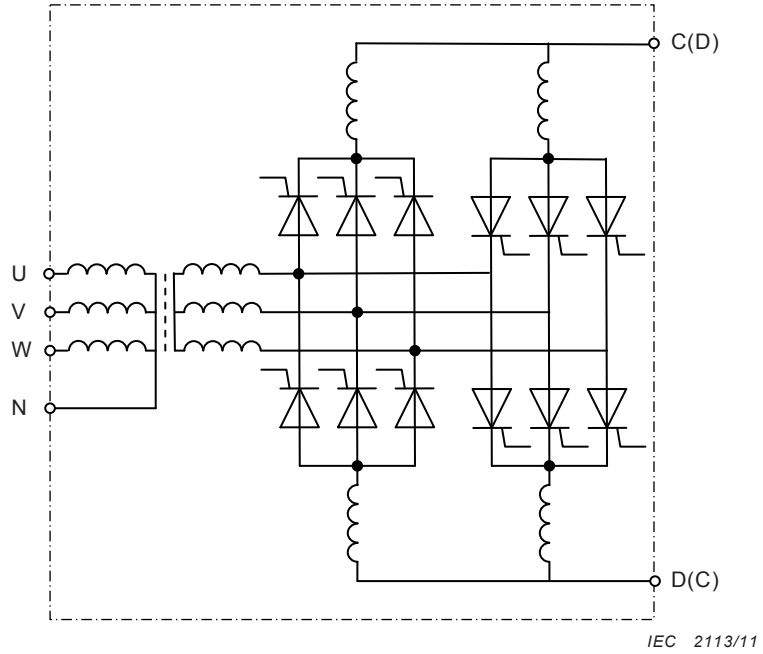


Figure 23 – Double converter

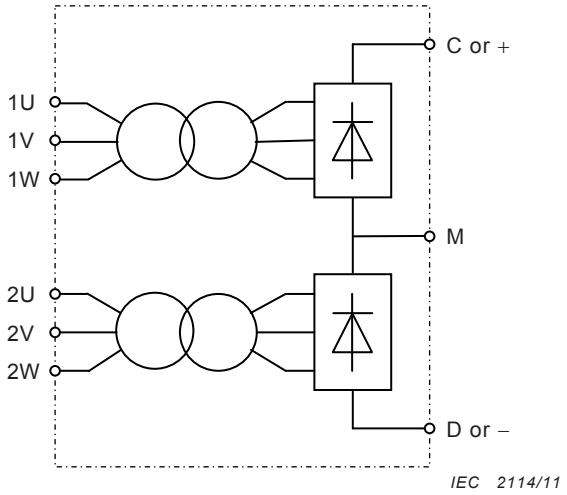


Figure 24 – Three-phase rectifier with two sections and d.c. side centre tap for connection to a mid-wire conductor

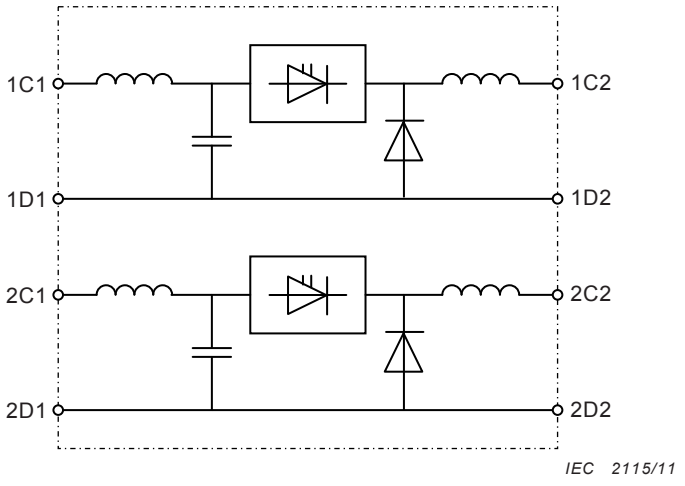


Figure 25 – Direct (or indirect) d.c. converter with two independent sections

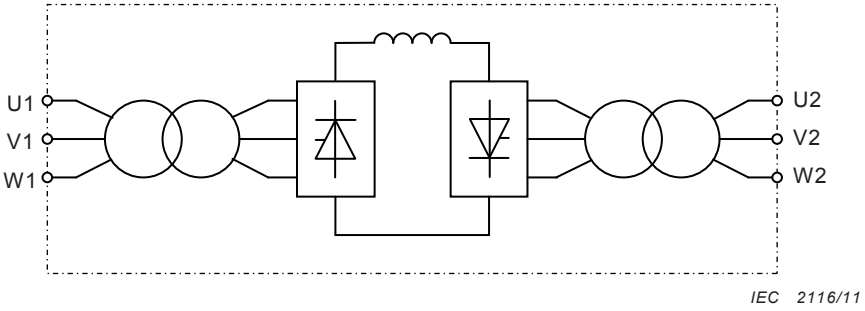


Figure 26a) – Regular terminal marking

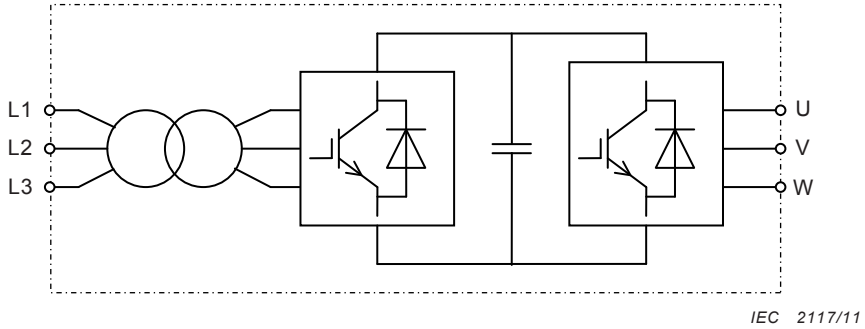


Figure 26b) – Alternative terminal marking

Figure 26 – Indirect (or direct) a.c. converter

6.3 Marking of gate terminals

6.3.1 General

If terminal markings for control terminals are necessary, next are applied.

– control terminals of valve devices:
  - a gate terminal : basic terminal marking G
  - the pair to the gate terminal : basic terminal marking H

NOTE Although markings B may be used for valve devices, G is used for valve device stacks and so on.

– input terminals of gate transformers or gate drivers:
  - control signal input terminal: E
  - control signal reference terminal: F
  - shield terminal of the gate transformer (if any): S

6.3.2 For thyristors

The same as 6.3.1.

EXAMPLES: See Figure 27, Figure 28 and Figure 29.

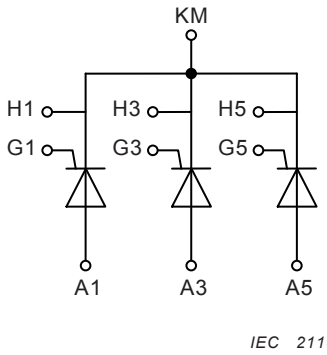


Figure 27a) – With common cathod

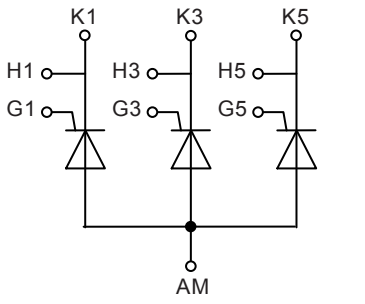
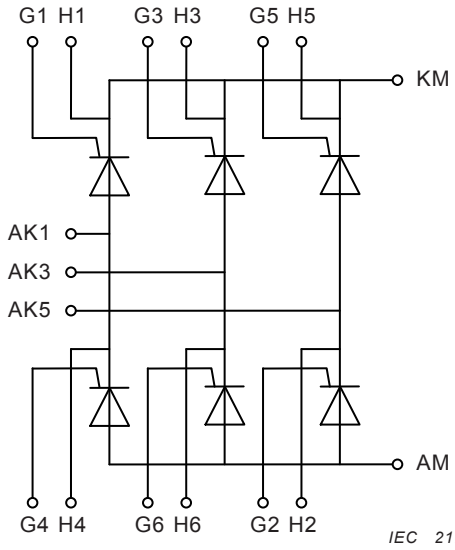


Figure 27b) – With common anode

NOTE Other reference numbers such as A1, A2 and A3 according to 5.1.2.2 or G4-H4, G6-H6 and G2-H2 are permitted.

Figure 27 – Three-phase star connection with neutral



NOTE Reference number G4-H4, G6-H6 and G2-H2 for KM side and G1-H1, G3-H3 and G5-H5 for AM side is permitted.

Figure 28 – Bridge connection

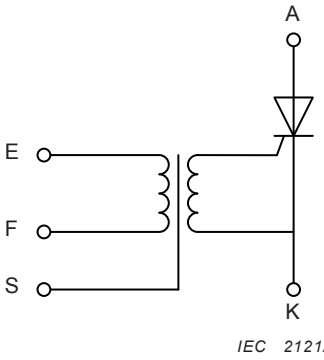


Figure 29a) – With gate transformer

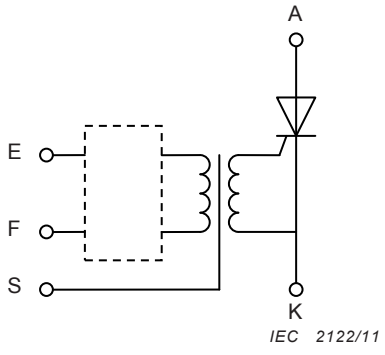


Figure 29b) – With gate driver

NOTE In case of changing of a gate transformer the winding polarity shall be maintained.

Figure 29 – Thyristor with gate unit

6.3.3 For power transistors

The same as above.

EXAMPLES: See Figure 30, Figure 31 and Figure 32.

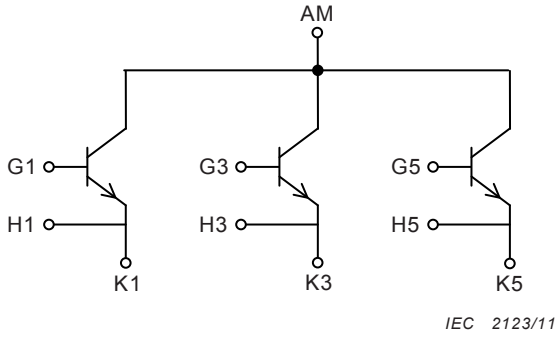


Figure 30a) – Bipolar transistors with common anode

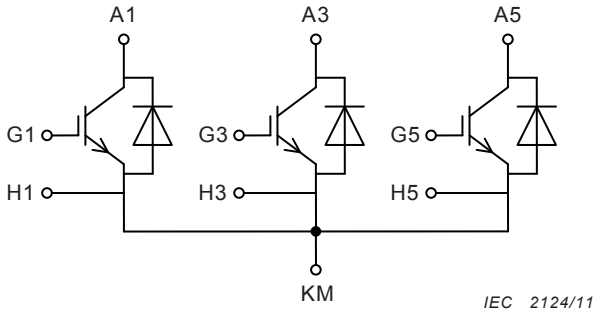


Figure 30b) – IGBTs with anti-parallel diodes and common cathode

NOTE Other reference numbers such as K1, K2 and K3 according to 5.1.2.2 or G4-H4, G6-H6 and G2-H2 are permitted.

Figure 30 – Three-phase star connection with power transistors

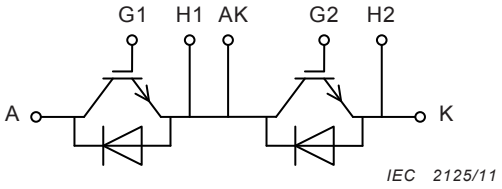


Figure 31 – Pair of power transistors with anti-parallel diodes

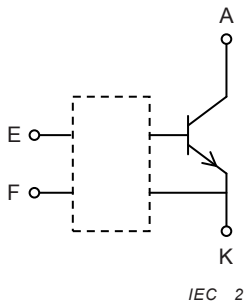


Figure 32a) – Bipolar transistor

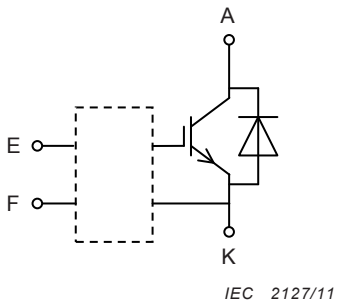


Figure 32b) – IGBT with anti-parallel diode

Figure 32 – Power transistor with gate driver

Bibliography

IEC 60050-151:2001, *International Electrotechnical Vocabulary – Part 151: Electrical and magnetic devices*

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

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