

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Low-voltage switchgear and controlgear –
Part 4-3: Contactors and motor-starters – AC semiconductor controllers and
contactors for non-motor loads**

**Appareillage à basse tension –
Partie 4-3: Contacteurs et démarreurs de moteurs – Gradateurs et contacteurs à
semiconducteurs pour charges, autres que des moteurs, à courant alternatif**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

**Part 4-3: Contactors and motor-starters –
AC semiconductor controllers and contactors
for non-motor loads**

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This standard shall be used in conjunction with IEC 60947-1.

This consolidated version of IEC 60947-4-3 consists of the first edition (1999) [documents 17B/1000/FDIS and 17B/1013/RVD], its amendment 1 (2006) [documents 17B/1486/FDIS and 17B/1510/RVD], its amendment 2 (2011) [documents 17B/1727/FDIS and 17B/1735/RVD] and its corrigendum of May 2000.

The technical content is therefore identical to the base edition and its amendments and has been prepared for user convenience.

It bears the edition number 1.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

Annexes A, D and I form an integral part of this standard.

Annexes B, E, F, G, H and J are for information only.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This part of IEC 60947 covers low-voltage a.c. semiconductor controllers and contactors (solid-state contactors) intended for the use with non-motor loads. As controllers, they have many capabilities beyond the simple switching on and off of non-motor loads. As contactors, they perform the same functions as mechanical contactors, but utilize one or more semiconductor switching devices in their main poles.

The devices may be single-pole or multi-pole (see 2.3.1 of IEC 60947-1). This standard refers to complete devices rated as a unit incorporating all necessary heat-sinking material and terminals. It includes devices with all necessary terminals, which are supplied with or without heat-sink in knocked-down form for combination by the users, when the manufacturer gives with the device detailed information about choosing the heat-sink and mounting the device on the heat-sink.

The generic term, "controller", is used in this standard wherever the unique features of the power semiconductor switching elements are the most significant points of interest. The generic term "contactor" is used in this standard wherever the feature of simple switching on and off is the most significant point of interest. Specific designations (for example, form 4, form HxB, etc.) are used wherever the unique features of various configurations comprise significant points of interest.

The provisions of the general rules (IEC 60947-1) are applicable to this standard, where specifically called for. Clauses and subclauses thus applicable, as well as tables, figures, and annexes, are identified by reference to IEC 60947-1, for example 1.2.3, table 4 of IEC 60947-1 or annex A of IEC 60947-1.

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 4-3: Contactors and motor-starters – AC semiconductor controllers and contactors for non-motor loads

1 Scope and object

This part of IEC 60947 applies to a.c. semiconductor non-motor load controllers and contactors intended for performing electrical operations by changing the state of a.c. electric circuits between the ON-state and the OFF-state. Typical applications are given in table 2.

As controllers, they may be used to reduce the amplitude of the r.m.s. a.c. voltage on the load terminals from that of the applied voltage – either continuously or for a specified period of time. The half-wave period of the a.c. wave form remains unchanged from that of the applied voltage.

They may include a series mechanical switching device and are intended to be connected to circuits, the rated voltage of which does not exceed 1 000 V a.c.

This standard characterizes controllers and contactors for use with or without bypass switching devices.

The semiconductor controllers and contactors dealt with in this standard are not normally intended to interrupt short-circuit currents. Therefore, suitable short-circuit protection (see 8.2.5) should form part of the installation but not necessarily of the controller itself.

In this context, this standard gives requirements for semiconductor controllers and contactors associated with separate short-circuit protective devices.

This standard does not apply to

- operation of a.c. and d.c. motors;
- low-voltage a.c. semiconductor motor controllers and starters covered by IEC 60947-4-2;
- electronic a.c. power controllers covered by IEC 60146;
- all-or-nothing solid-state relays.

Contactors and control-circuit devices used in semiconductor controllers and contactors should comply with the requirements of their relevant product standard. Where mechanical switching devices are used, they should meet the requirements of their own IEC product standard and the additional requirements of this standard.

The object of this standard is to state

- a) the characteristics of semiconductor controllers and contactors and associated equipment;
- b) the conditions with which semiconductor controllers and contactors should comply with reference to
 - their operation and behaviour;
 - their dielectric properties;
 - the degrees of protection provided by their enclosures, where applicable;
 - their construction;
- c) the tests intended for confirming that these conditions have been met, and the methods to be adopted for these tests;
- d) the information to be given with the equipment or in the manufacturer's literature.

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(161):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*
Amendment 1 (1997)
Amendment 2 (1998)

IEC 60085:2007, *Electrical insulation – Thermal evaluation and designation*

IEC 60269-1:2006, *Low-voltage fuses – Part 1: General requirements*

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

IEC 60439-1:1999, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*
Amendment 1 (2004)

IEC 60664 (all parts), *Insulation coordination for equipment within low-voltage systems*

IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-4-2:1999, *Low-voltage switchgear and controlgear – Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers and starters*
Amendment 1 (2001)
Amendment 2 (2006)

IEC 61000-2-1:1990, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 1: Description of the environment – Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems*

IEC 61000-3-2:2005, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*
Amendment 1 (2008)
Amendment 2 (2009)

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3 : Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*
Amendment 1 (2007)
Amendment 2 (2010)

IEC 61000-4-4:2004, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*
Amendment 1 (2010)

IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2008, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

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CISPR 11:2009, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*
Amendment 1 (2010)

CISPR 14-1, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

3 Definitions, symbols and abbreviations

For the purposes of this part of IEC 60947, relevant definitions of clause 2 of IEC 60947-1 apply with the following additional definitions:

	Reference
A	
AC semiconductor controller	3.1.1.1
B	
Burst (of pulses or oscillations)	3.2.7
Bypassed controller	3.1.24
C	
Controlled operation	3.1.7
Current-limit function	3.1.3
D	
Defined-point switching (of a semiconductor controller)	3.1.14.4.1
E	
Electromagnetic compatibility, EMC (abbreviation)	3.2.1
Electromagnetic disturbance	3.2.3
(electromagnetic) Emission	3.2.2
F	
Full-on (state of controllers)	3.1.10
H	
Hybrid controllers or contactors, form HxA (where x = 4 or 5)	3.1.2.1
Hybrid controllers or contactors, form HxB	3.1.2.2
I	
Immunity (to a disturbance)	3.2.9
Instantaneous switching function	3.1.14.3
L	
Load control	3.1.4
M	
Minimum load current	3.1.11
Minimum load current detection	3.1.11.1
O	
OFF-state	3.1.12
OFF-state leakage current	3.1.13
OFF-time	3.1.23
ON-state	3.1.9
ON-time	3.1.22
OPEN position	3.1.2.3
Operating capability	3.1.16
Operating cycle (of a controller)	3.1.15
Operation (of a controller)	3.1.14
Overcurrent protective means OCPM	3.1.21
Overload current profile	3.1.17

R	
Radio (frequency) disturbance	3.2.4
Radio frequency interference, RFI (abbreviation)	3.2.5
Ramp-down	3.1.6
Ramp switching function	3.1.14.2
Ramp-up	3.1.5
Random point switching (of a semiconductor controller)	3.1.14.4.3
Rating index	3.1.18
S	
Semiconductor controller (form 4)	3.1.1.1.1
Semiconductor direct-on-line (DOL) controller (form 5)	3.1.1.1.3
Switching function	3.1.14.1
Switching point	3.1.14.4
T	
Transient (adjective and noun)	3.2.6
Trip-free controller	3.1.20
Tripping operation (of a controller)	3.1.19
V	
Voltage surge	3.2.8
Z	
Zero-point switching (of a semiconductor controller)	3.1.14.4.2

3.1 Definitions concerning a.c. semiconductor (non-motor-load) control devices

3.1.1 AC semiconductor controllers and contactors (solid-state contactors) (see figure 1)

3.1.1.1

a.c. semiconductor controller

semiconductor switching device (see 2.2.3 of IEC 60947-1) that provides a switching function for an a.c. electrical load (non-motor load) and an OFF-state

NOTE 1 Because dangerous levels of leakage currents (see 3.1.13) can exist in a semiconductor controller in the OFF-state, the load terminals should be considered to be live at all times.

NOTE 2 In a circuit where the current passes through zero (alternately or otherwise), the effect of "not making" the current following such a zero value is equivalent to breaking the current.

3.1.1.1.1

semiconductor controller (form 4)

a.c. semiconductor controller in which the switching function may comprise any method specified by the manufacturer. It provides control functions which may include any combination of ramp-up, load control or ramp-down. A FULL-ON state may also be provided

3.1.1.1.2

Vacant

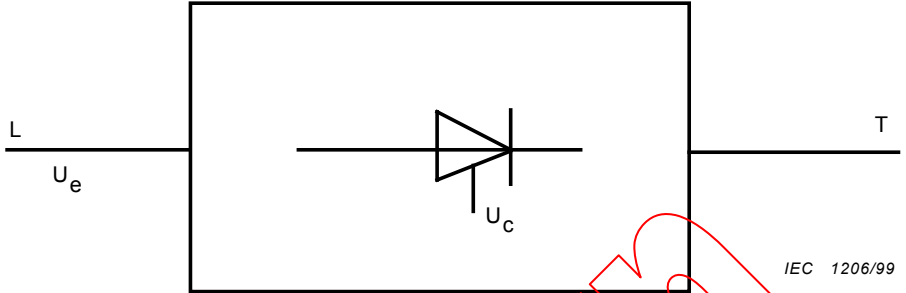
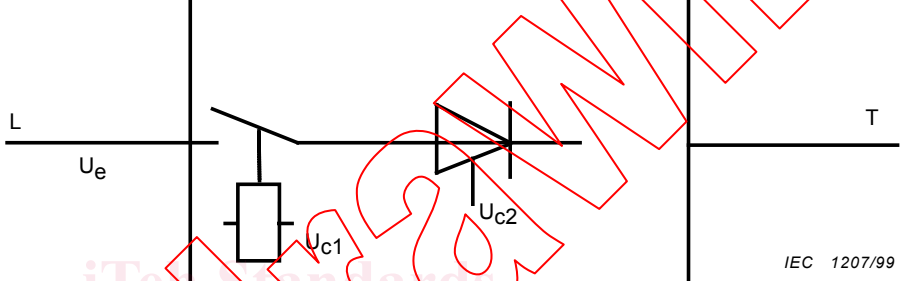
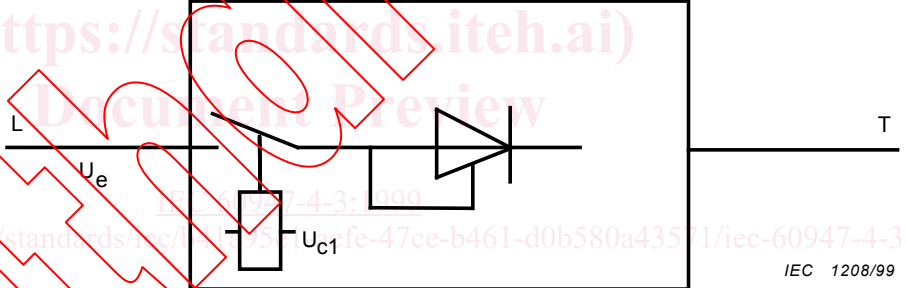
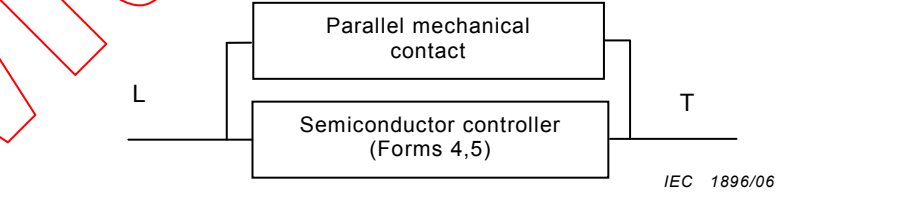
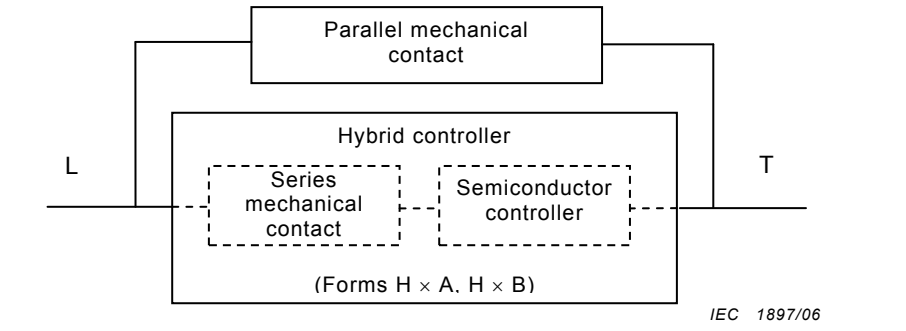
3.1.1.1.3

semiconductor direct-on-line (DOL) controller (form 5)

special form of a.c. semiconductor controller in which the switching function is limited to the full-voltage, unramped method only and where the additional control function is limited to providing FULL-ON (also known as a semiconductor contactor or solid-state contactor).

It is a device (see 2.2.13 of IEC 60947-1) which performs the function of a contactor by utilizing a semiconductor switching device (see 2.2.3 of IEC 60947-1). It has only one position of rest (OFF-state or Open state in the case of an HxB hybrid controller) and is operated by the application of a control signal. It is capable of carrying load currents as well as changing the state of the said load (electrical circuit) between the FULL-ON and the OFF-states (Open) under normal circuit conditions including operating overload conditions.

3.1.1.2
Vacant

Device	
Controller (all forms)	 <p style="text-align: right;">IEC 1206/99</p>
Hybrid controller HxA* where x = 4 or 5	 <p style="text-align: right;">IEC 1207/99</p>
Hybrid controller HxB** where x = 4 or 5	 <p style="text-align: right;">IEC 1208/99</p>
Bypassed controller	 <p style="text-align: right;">IEC 1896/06</p>
Bypassed hybrid controller ^c	 <p style="text-align: right;">IEC 1897/06</p>

* Two separate controls for the controller and the series mechanical switching device respectively.

** One control only for the series mechanical switching device.

^c For other configurations, tests may be suitably adapted by agreement between the user and the manufacturer.

Figure 1 – Graphical possibilities of controllers