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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

Convertisseurs à semiconducteurs

Cinquième partie: Interrupteurs pour alimentations sans interruption (Interrupteurs d'ASI)

Semiconductor convertors

Part 5: Switches for uninterruptible power systems (UPS switches)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR CONVERTORS

Part 5: Switches for uninterruptible power systems (UPS switches)

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by Sub-Committee 22B: Semiconductor convertors, of IEC Technical Committee No. 22: Power electronics.

The text of this standard is based on the following documents:

Six Months' Rule	Report on Voting
22B(CO)51	22B(CO)52

Full information on the voting for the approval of this standard can be found in the Voting Report indicated in the above table.

The following IEC publications are quoted in this standard:

Publications Nos. 50(441) (1984): International Electrotechnical Vocabulary (IEV), Chapter 441: Switchgear, controlgear and fuses.

50(551) (1982): Chapter 551: Power electronics.

146-1-1 (under consideration): Semiconductor convertors, Part 1: General requirements and line-commutated convertors - Specification of basic requirements.

146-1-2 (under consideration): Part 2: General requirements and line-commutated convertors - Application guide.

146-4 (1986): Part 4: Method of specifying the performance and test requirements of uninterruptible power systems.

617-7 (1983): Graphical symbols for diagrams, Part 7: Switchgear, controlgear and protective devices.

SEMICONDUCTOR CONVERTORS

Part 5: Switches for uninterruptible power systems (UPS switches)

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1. Scope

This standard gives the method of specifying all power switches that form integral parts of a UPS and are associated with its output.

Included are interrupters, bypass switches, isolating switches, load transfer switches and tie switches. These switches interact with other functional units of the UPS to maintain continuity of load power.

This standard does not refer to conventional mains distribution boards, rectifier input switches or d.c. switches (e.g. for batteries, rectifier output or inverter input, etc.).

2. Object

This standard is intended to be used in conjunction with IEC Publication 146-4.

Refer to IEC Publication 146-4 for additional definitions and for information on UPS. Also refer to IEV Chapter 551 of the International Electrotechnical Vocabulary (IEV) [IEC Publication 50(551)].

3. Terms and definitions

3.1 *UPS switch*

Switch (quenched, line-commutated or self-commutated electronic or mechanical, depending on required continuity of load power) used to connect/isolate UPS or bypass to/from load.

3.2 *Electronic power switch*

Operative unit for electronic power switching comprising at least one electronic controllable valve device.

3.3 *Mechanical UPS power switch* (IEV 441-14-10, title modified)

A mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short-circuit.

Note.- A switch may be capable of making but not breaking short-circuit currents.

3.4 *Hybrid UPS power switch*

UPS power switch with mechanical separable contacts in combination with at least one electronic controllable valve device.

3.5 *Operation*

The transfer of a UPS switch from the on-state to the off-state (opening operation) or vice versa (closing operation).

Opening with interruption of load current is referred to as "breaking", closing with initiation of load current flow is referred to as "making".

Notes 1.- The terms "on-state" and "off-state" originate from semiconductor technology but are used in a generalized sense, to also cover the closed position and the open position, respectively, of a mechanical device.

2.- The terms "opening" and "closing" originate from mechanical switchgear technology but are used in a generalized sense to also cover removing or applying, respectively, of the control signal of a semiconductor switching device.

3.6 *Manual control* (IEV 441-16-04)

Control of an operation by human intervention.

3.7 *Automatic control* (IEV 441-16-05)

Control of an operation without human intervention, in response to the occurrence of predetermined conditions.

3.8 *Semi-automatic control*

Control of a switch where one of the operations (opening or closing) is automatically controlled (see Sub-clause 3.7), while the other is manually controlled (see Sub-clause 3.6).

3.9 *Synchronous transfer*

Transfer of the load power between two sources which are synchronized in frequency, voltage magnitude and voltage phase.

3.10 *Asynchronous transfer*

Transfer of the load power between two sources which are not synchronized.

n) isolation capability;

o) load power factor limits;

p) frequency and its tolerance band;

q) rate of rise of current at closing.

5.3 *Transfer switches*

For each set of input terminals the following rated values and characteristics shall be specified.

See Sub-clause 5.2 excluding Items *g)* and *h)*.

In addition, the maximum transfer times for both directions of the transfer switch shall be specified.

6. Testing of UPS switches

6.1 *General*

UPS switches which are regarded as integrated parts of a UPS unit and are matched to the requirements of the UPS are not tested separately, but according to the UPS document. It should be a matter of agreement between supplier and purchaser which of the tests should be performed in the factory and which on site.

Operational tests shall be performed in accordance with IEC Publications 146-1-1 and 146-1-2 as applicable.

a) insulation, according to IEC Publication 146-1-1;

b) checking of auxiliary devices, according to IEC Publication 146-1-2;

c) checking of protective devices, according to IEC Publication 146-1-1;

d) checking of supervising and remote signalling circuits;

e) checking of measuring devices;

f) light load transfer test.

In addition to the tests mentioned above, a type test programme will include tests to prove the rated values given in Clause 5 as far as those values are not proved by adequate calculation. If previous type tests have been performed, the original manufacturer's specifications shall be acceptable and no further tests will be required.

g) a complete functional test, e.g. switching of loads;

h) transfer time test;

i) load test, temperature rise, according to IEC Publication 146-1-2;

j) short-time overload, according to IEC Publication 146-1-2;

k) short-circuit capability, according to IEC Publication 146-1-2.

6.3.8 *Radio-frequency interference and conducted noise*

For radio-frequency interference and conducted noise, international and national regulations are applicable (e.g. C.I.S.P.R. standards).

6.3.9 *Audible noise*

Test procedure and limits shall be subject to agreement between purchaser and supplier.

6.3.10 *Earth fault test*

If the UPS switch is isolated from earth, then an earth fault can be applied to any terminal. UPS switch transients shall be measured.

6.3.11 *Additional tests*

Specifications and procedures for additional tests, e.g. vibration, shock, environmental and drift, shall be a matter of agreement between the purchaser and the supplier.

6.3.12 *Transfer test*

Transients will be measured during rated load transfer to an alternate source, caused by a simulated fault, and rated load retransfer after clearing of the fault.

APPENDIX A

ABBREVIATIONS AND SYMBOLS

A1. Abbreviations

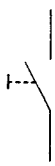
For convenience, the following abbreviations are used throughout this standard.

Abbreviations	Definitions, see Sub-clause
EPS - electronic power switch	3.2
MPS - mechanical UPS power switch	3.3
HYB - hybrid UPS power switch	3.4
INT - UPS interrupter	3.17
ISO - UPS isolation switch	3.18
TRA - transfer switch	3.19
TIE - tie switch	3.20
MBP - UPS maintenance bypass switch	3.21

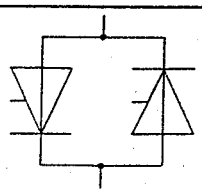
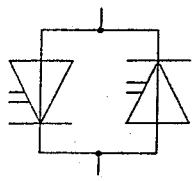
A2. Symbols

Throughout this standard, single line diagrams are used to represent both monophase and polyphase devices and circuits.

A2.1 *Mechanical UPS power switch*

Figure	Symbol	Description	Refer to IEC 617-7
A1		General switch	07-02-01
A2		Manually operated switch	07-07-01
A3		Circuit breaker	07-13-05
A4		Switch disconnector	07-13-08

A2.2 *Electronic power switch*

Figure	Symbol	Description
A5		Line-commutated
A6		Self-commutated

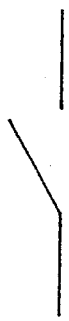


Figure A1

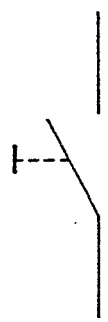


Figure A2

Figure A3

Figure A4

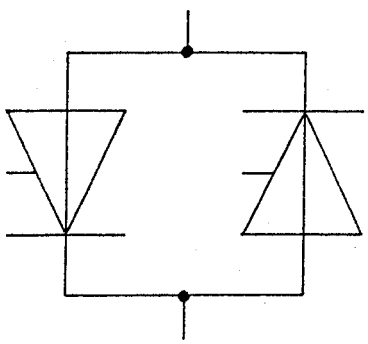


Figure A5

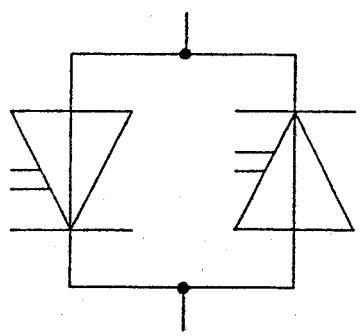


Figure A6

APPENDIX B

EXPLANATIONS OF UPS SWITCH DEFINITIONS

This appendix deals with some typical applications and arrangements of UPS switches and their functional characteristics. For convenience, the UPS switches are shown in the diagrams as separate from the UPS units. In some instances, the UPS switches are actually part of UPS units.

B1. UPS interrupters

UPS interrupters are "on-off" switches in series with UPS units. In addition, the term may be used to describe the device which connects or disconnects loads to or from a common output bus.

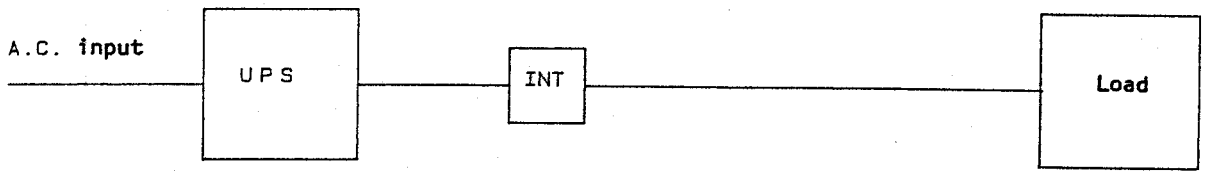


Figure B1.

Figure B2 shows UPS interrupters used in a parallel redundant UPS to connect or disconnect UPS units to or from a common bus.

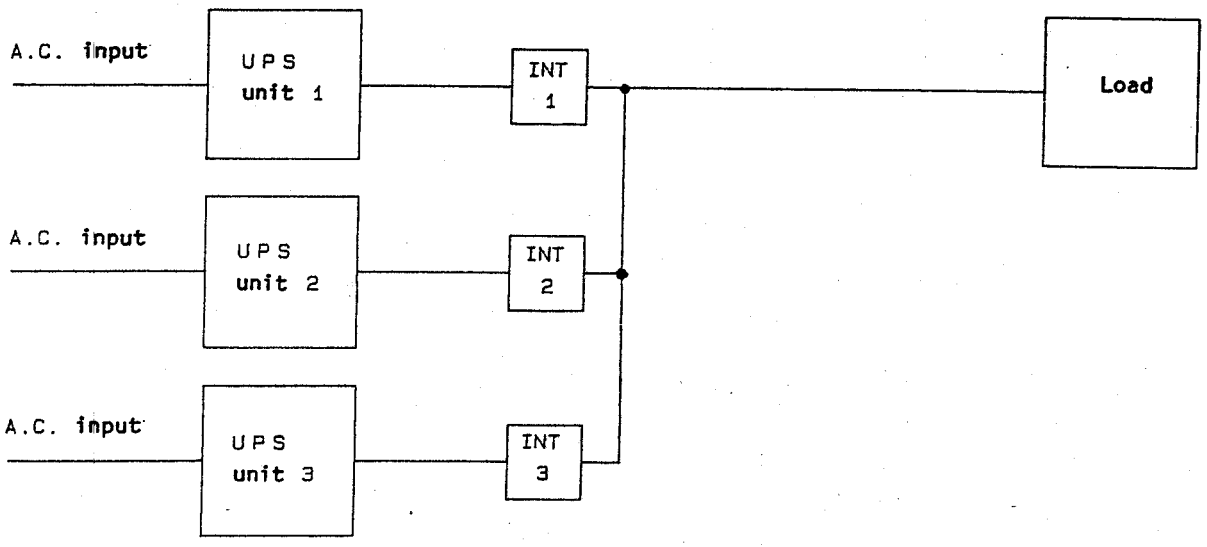


Figure B2.

In some UPS designs, the inverter itself is used as a UPS interrupter. In this type of configuration, the inverter may be designed to act as an impedance to power flow.

Figure B3 shows UPS interrupters used to connect or disconnect a load branch or branches to or from the common bus.

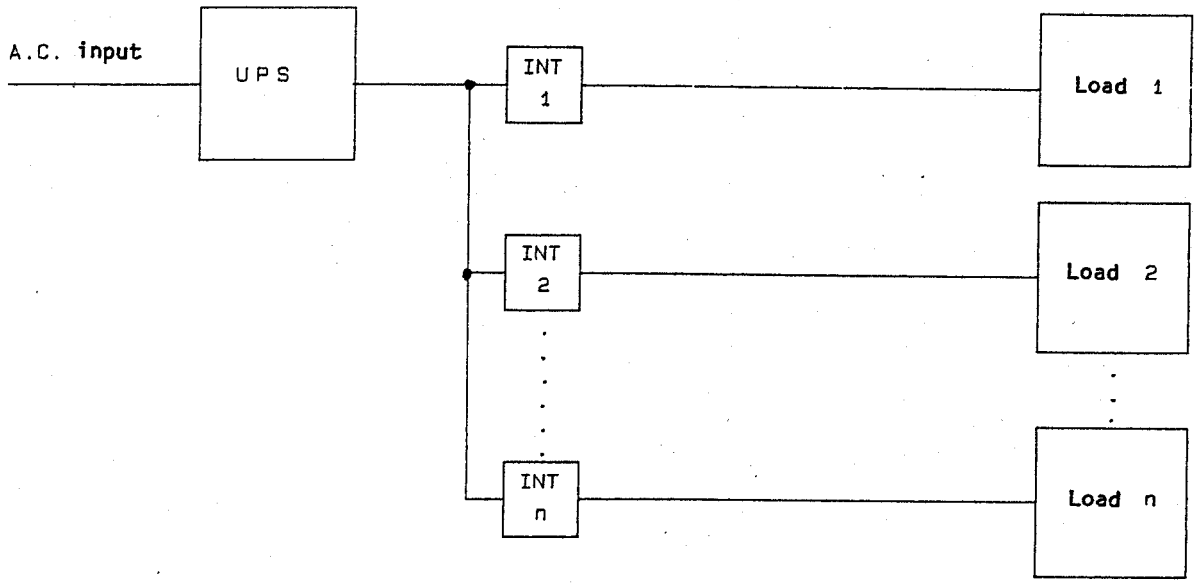


Figure B3.

B2. Transfer switches

Automatic or manual transfer switches are used in case of:

a) UPS failure;

b) maintenance;

c) load current transients (inrush currents or fault-clearing currents);

d) peak load.

These switches may be operated as synchronous or asynchronous transfer.

B2.1 *Types of transfer switches*

There are three types of transfer switches:

a) mechanical;

b) electronic;

c) hybrid.

Such characteristics as transfer time, overcurrent rating and isolation of input and output are different between these switches.

B2.1.1 *Mechanical transfer switches*

These transfer switches have advantages regarding isolation.

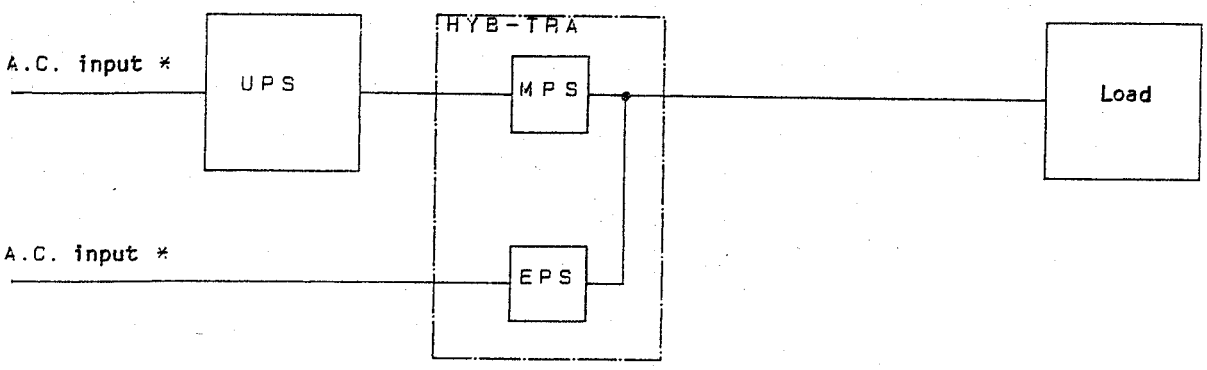


Figure B6.

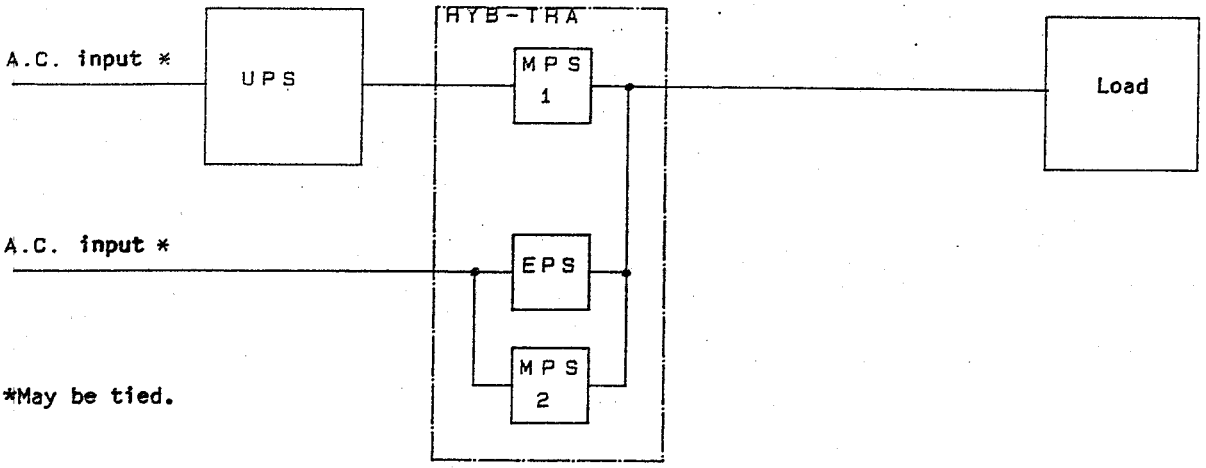


Figure B7.

Operation of the transfer switch in Figure B7 is almost the same as in Figure B6 except that another mechanical switch, MPS 2, also closes after the electronic switch closes. Therefore, the electronic switch only carries the load current for a short time. The advantage of the hybrid switches is that they possess the merits of both the electronic and mechanical switches.

B2.2 *Other examples of use of transfer switches*

B2.2.1 *Load transfer switches*

Switches used for switching of loads from one source to another are called "load transfer switches".

Figure B8 shows an example of mechanical load transfer switches and Figure B9 shows electronic load transfer switches.

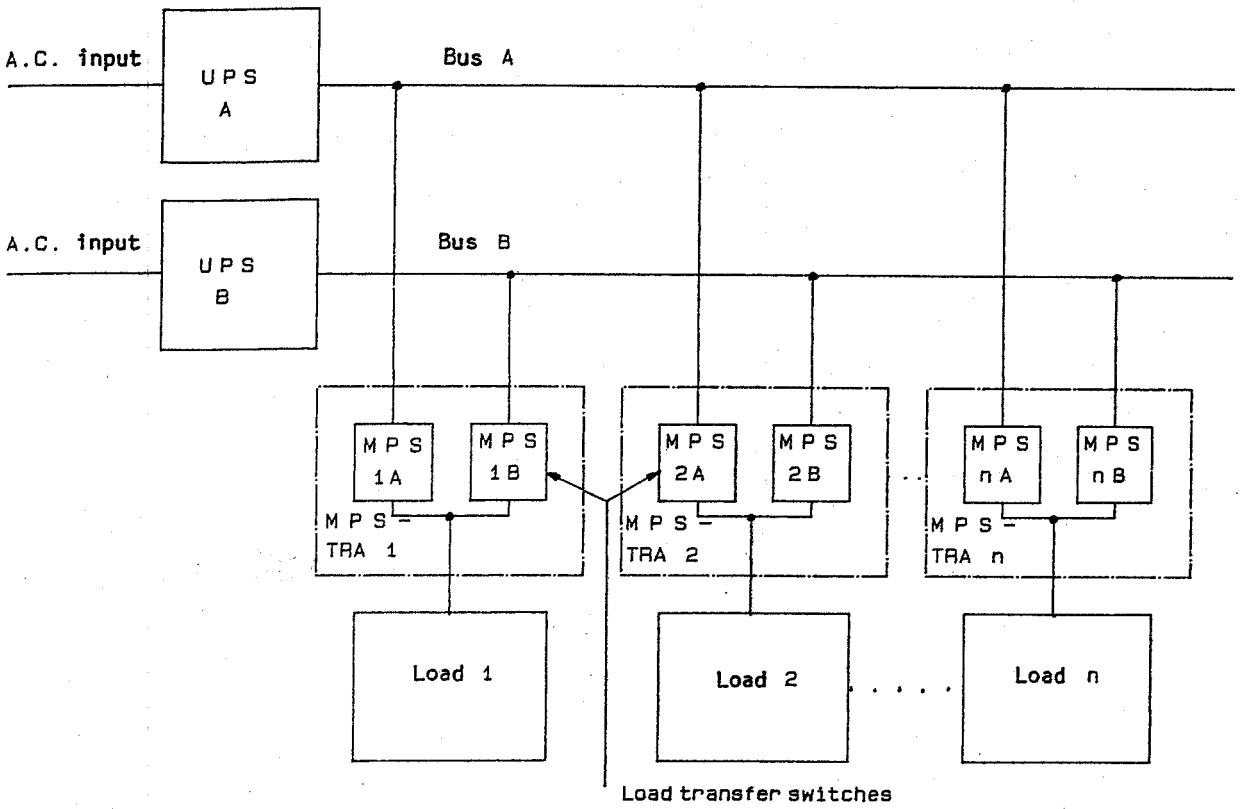


Figure B8.

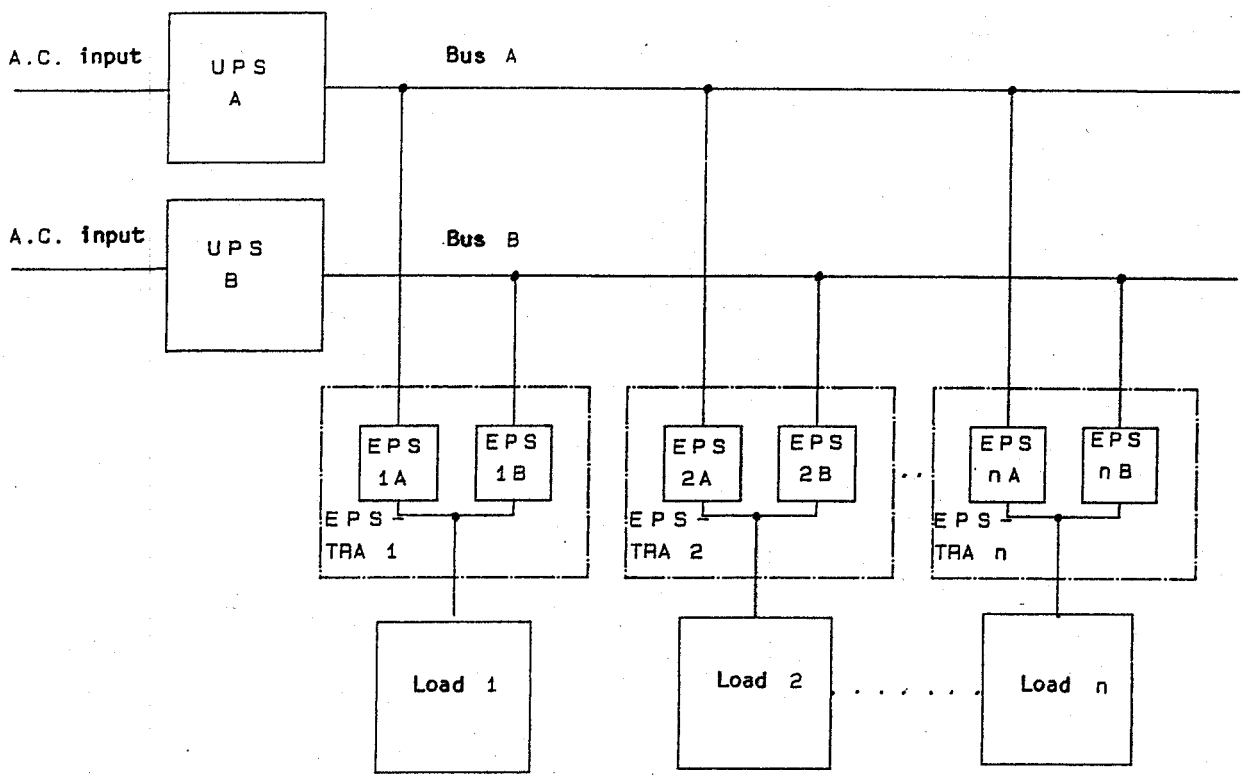


Figure B9.

B3. UPS isolation switches

UPS isolation switches are used as auxiliary parts of UPS switches.

A typical use of UPS isolation switches is to isolate electronic UPS switches from power sources for maintenance purposes. Figures B10 and B12 show examples of the use of UPS isolation switches with electronic power switches.

UPS isolation switches may also be used as UPS interrupters as shown in Figure B11.

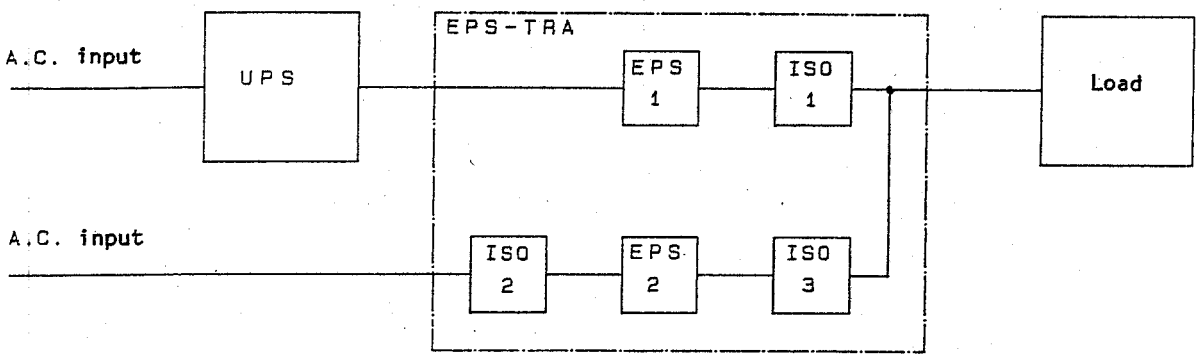


Figure B10.

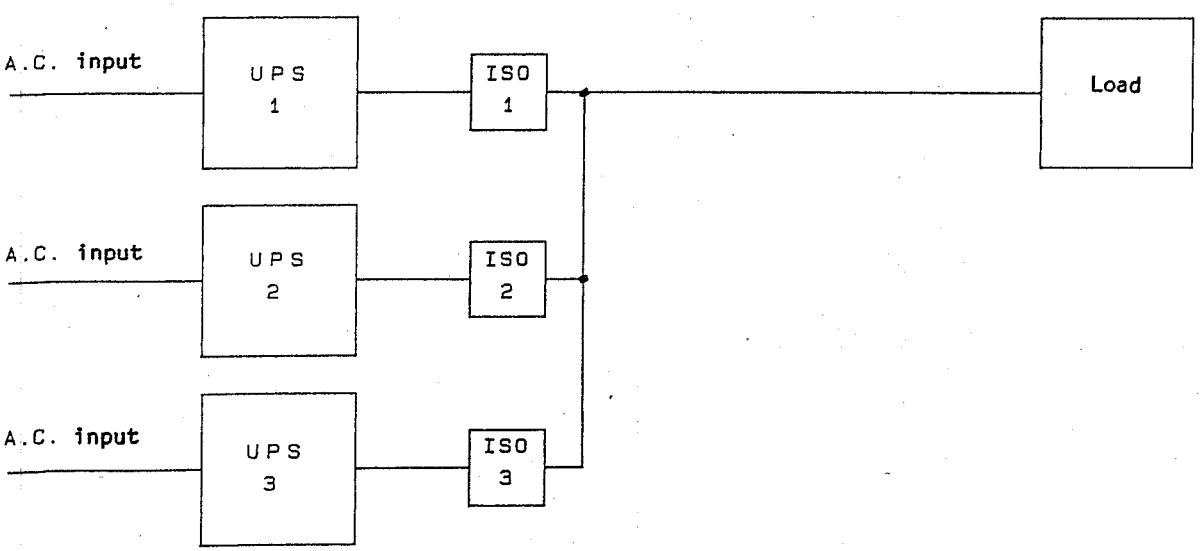


Figure B11.

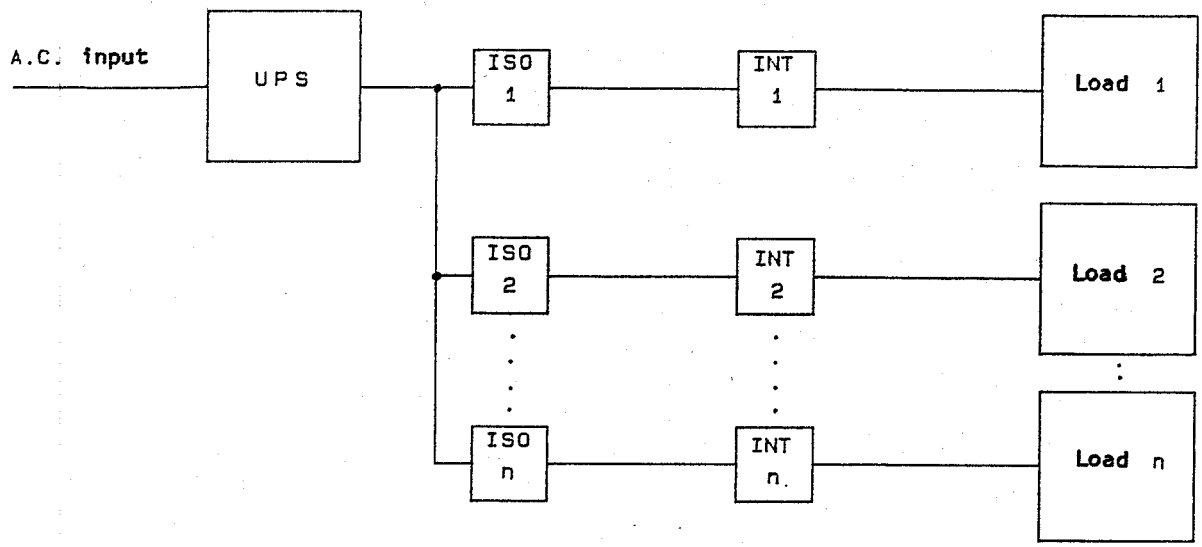


Figure B12.

B4. UPS maintenance bypass switches

UPS maintenance bypass switches are used to bypass the transfer switch and ensure the continuity of load power. Figures B13 and B14 show examples of UPS maintenance bypass switches.

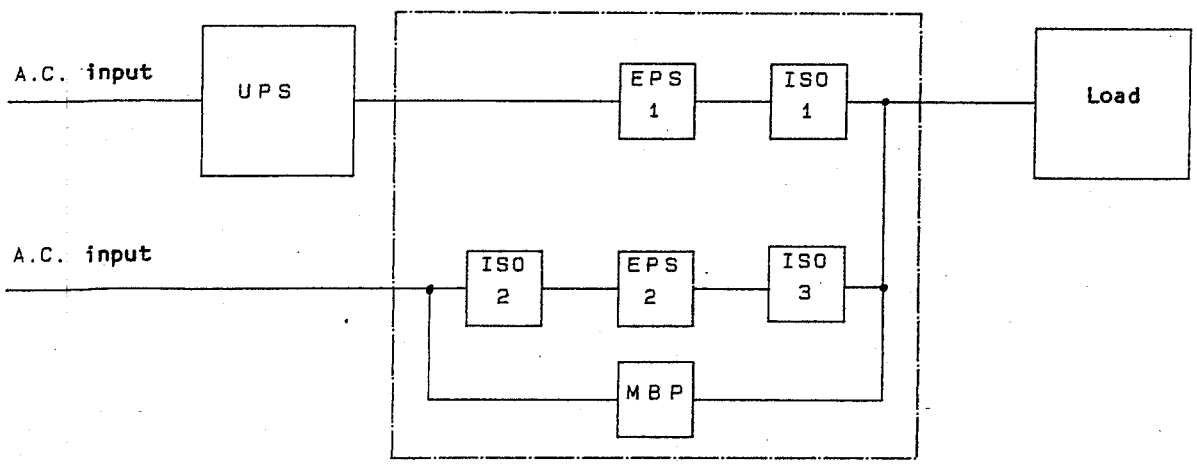


Figure B13.

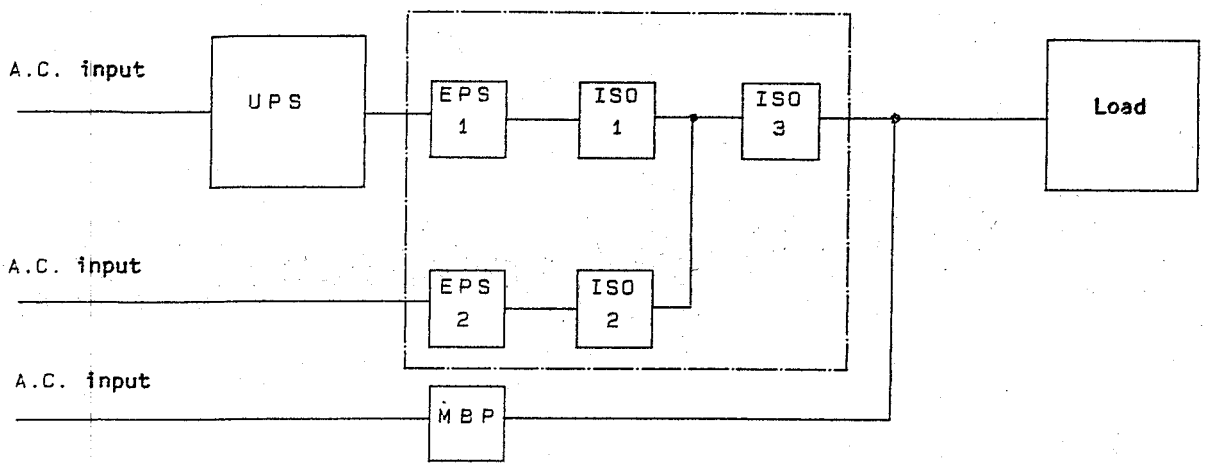


Figure B14.

B5. Tie switches

Figures B15 and B16 illustrate examples of tie switches.

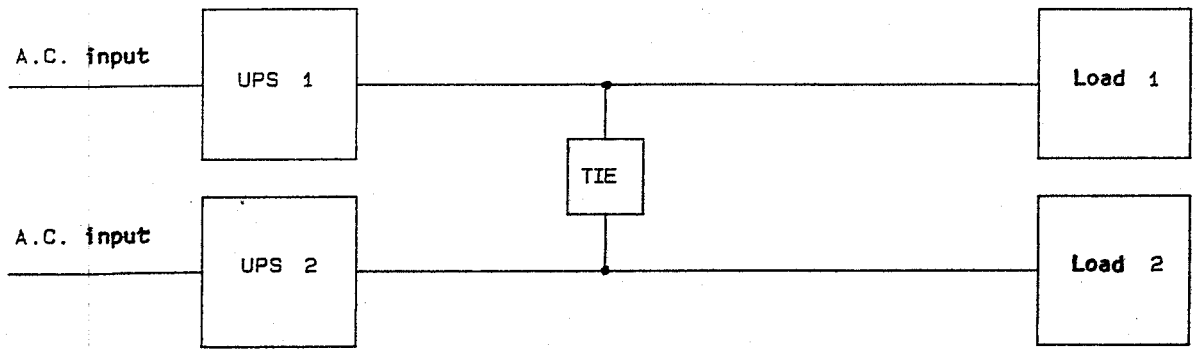


Figure B15.

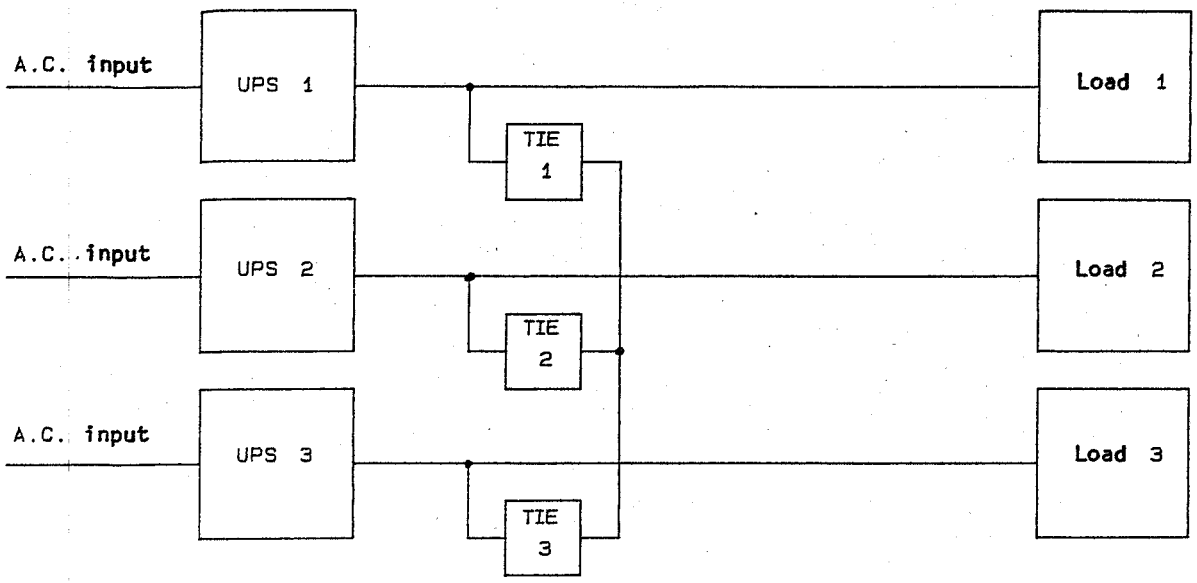


Figure B16.

B6. Multiple function UPS switches

UPS switches can be combined in different ways. In such cases, each UPS switch can perform multiple functions and it is therefore not necessary to cascade separate functions.

For example, Figure B17 illustrates a parallel redundant UPS with the capability of UPS unit interruption and UPS transfer to bypass. If the UPS interrupters are capable of isolation, then they perform the isolation functions for the UPS units. In the transfer switch operation, the UPS interrupters operate in unison.

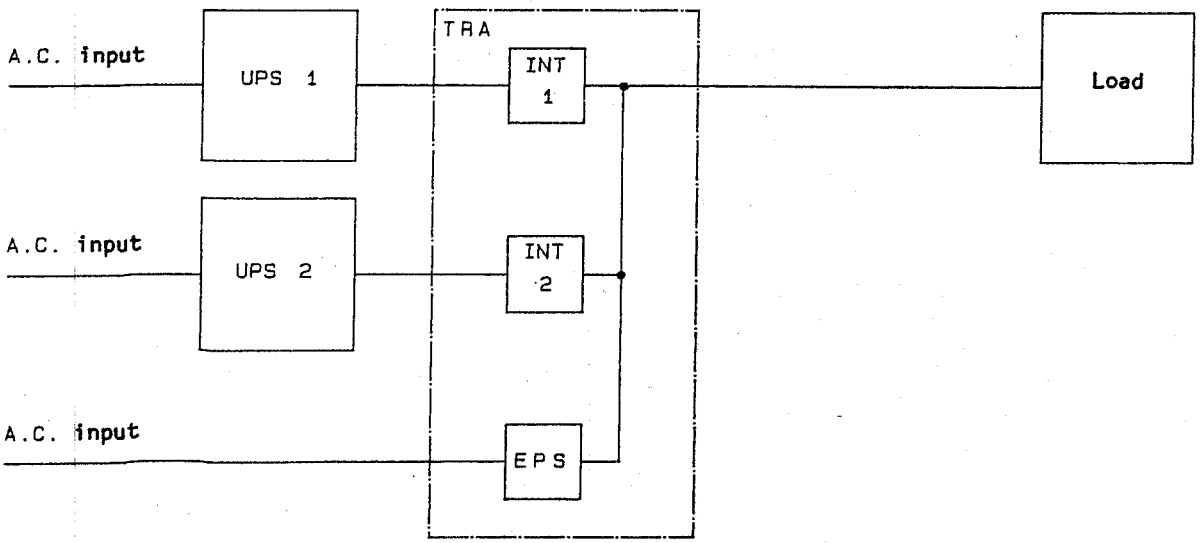


Figure B17.

Publications de la C E I préparées par le Comité d'Etudes n° 22

84 (1957) Recommandations pour les convertisseurs à vapeur de mercure.

84A (1966) Premier complément: Onduleurs à vapeur de mercure.

84B (1967) Deuxième complément: Convertisseurs à vapeur de mercure à puissance réversible.

119 (1960) Recommandations pour les cellules, éléments redresseurs et groupes redresseurs à semiconducteurs polycristallins.

146: — Convertisseurs à semiconducteurs.

146 (1973) Convertisseurs à semiconducteurs. Modification n° 1 (1975).

146-A (1974) Premier complément: Chapitre VII: Marques et indications sur les groupes convertisseurs et sur les blocs.

146-2 (1974) Deuxième partie: Convertisseurs autocommutés à semiconducteurs.

146-3 (1977) Troisième partie: Convertisseurs à courant continu directs à semiconducteurs (hacheurs).

146-4 (1986) Quatrième partie: Méthode de spécification des performances et procédures d'essais des alimentations sans interruption.

146-5 (1988) Cinquième partie: Interrupteurs pour alimentations sans interruption (Interrupteurs d'ASI).

237 (1967) Ignitrons utilisés pour la commande des machines à souder.

411: — Convertisseurs de puissance pour la traction.

411 (1973) Convertisseurs statiques monophasés de puissance pour la traction.

411-1 (1975) Première partie. Convertisseurs monophasés de puissance à thyristors.

411-2 (1978) Deuxième partie: Informations techniques supplémentaires.

411-3 (1982) Troisième partie: Convertisseurs autocommutés pour la traction monophasée.

478: — Alimentations stabilisées à sortie en courant continu.

478-1 (1974) Première partie: Termes et définitions.

478-2 (1986) Deuxième partie: Caractéristiques et performances.

478-3 (1976) Troisième partie: Essais concernant les perturbations radioélectriques.

478-4 (1976) Quatrième partie: Essais autres que ceux concernant les perturbations radioélectriques.

633 (1978) Terminologie pour le transport d'énergie en courant continu à haute tension.

686 (1980) Alimentations stabilisées à sortie en courant alternatif.

700 (1981) Essais des valves à semiconducteurs pour le transport d'énergie en courant continu à haute tension.

I E C publications prepared by Technical Committee No. 22

84 (1957) Recommendations for mercury-arc convertors.

84A (1966) First supplement: Mercury-arc inverters.

84B (1967) Second supplement: Mercury-arc convertors for reversible power.

119 (1960) Recommendations for polycrystalline semiconductor rectifier stacks and equipment.

146: — Semiconductor convertors.

146 (1973) Semiconductor convertors. Amendment No. 1 (1975).

146-A (1974) First supplement: Chapter VII: Markings on convertor equipments and assemblies.

146-2 (1974) Part 2: Semiconductor self-commutated convertors.

146-3 (1977) Part 3: Semiconductor direct d.c. convertors (d.c. chopper convertors).

146-4 (1986) Part 4: Method of specifying the performance and test requirements of uninterruptible power systems.

146-5 (1988) Part 5: Switches for uninterruptible power systems (UPS switches).

237 (1967) Ignitrons to be used in welding machine control.

411: — Power convertors for electric traction.

411 (1973) Single-phase traction power convertors.

411-1 (1975) Part 1: Single-phase power convertors using thyristors.

411-2 (1978) Part 2: Additional technical information.

411-3 (1982) Part 3: Self-commutated convertors for single-phase traction.

478: — Stabilized power supplies, d.c. output.

478-1 (1974) Part 1: Terms and definitions.

478-2 (1986) Part 2: Rating and performance.

478-3 (1976) Par 3: Radio-frequency interference tests.

478-4 (1976) Part 4: Tests other than radio-frequency interference.

633 (1978) Terminology for high-voltage direct current transmission.

686 (1980) Stabilized power supplies, a.c. output.

700 (1981) Testing of semiconductor valves for high-voltage d.c. power transmission.

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