BS EN 61822:2009

# BSI British Standards

# Electrical installations for lighting and beaconing of aerodromes — Constant current regulators



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BSI British Standards

## National foreword

This British Standard is the UK implementation of EN 61822:2009. It is identical to IEC 61822:2009. It supersedes BS EN 61822:2003 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/97, Aeronautical ground lighting.

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.



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**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 31 October 2009

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 61822

July 2009

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Supersedes EN 61822:2003

English version

# Electrical installations for lighting and beaconing of aerodromes - Constant current regulators

(IEC 61822:2009)

Installations électriques pour l'éclairage et le balisage des aérodromes - Régulateurs de courant constant (CEI 61822:2009)

Elektrische Anlagen für Beleuchtung und Befeuerung von Flugplätzen - Konstantstromregler (IEC 61822:2009)

This European Standard was approved by CENELEC on 2009-06-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

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

**Central Secretariat: Avenue Marnix 17, B - 1000 Brussels**



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## Foreword

The text of document 97/135/FDIS, future edition 2 of IEC 61822, prepared by IEC TC 97, Electrical installations for lighting and beaconing of aerodromes, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61822 on 2009-06-01.

This European Standard supersedes EN 61822:2003.

EN 61822:2009 includes the following significant technical changes with respect to EN 61822:2003:

– revision and update of terms and definitions;

– addition of new subclauses, such as "Nominal output current range and tolerances";

– modification of some subclauses, such as those related to "Local control" and "Remote control";

– deletion of some subclauses, in particular "Power transformers" and "Output current indicator".

The following dates were fixed:

| | | |
|---|---|---|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2010-03-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2012-06-01 |

Annex ZA has been added by CENELEC.

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## Endorsement notice

The text of the International Standard IEC 61822:2009 was approved by CENELEC as a European Standard without any modification.

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# 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 60038 (mod) | -[1)] | IEC standard voltages[2)] | HD 472 S1<br>+ corr. February<br>A1 | 1989[3)]<br>2002<br>1995 |
| IEC 60439-1 | 1999 | Low-voltage switchgear and controlgear assemblies -<br>Part 1: Type-tested and partially type-tested assemblies | EN 60439-1 | 1999 |
| IEC 60529 | -[1)] | Degrees of protection provided by enclosures (IP Code) | EN 60529<br>+ corr. May | 1991[3)]<br>1993 |
| IEC 61000-6-2 | -[1)] | Electromagnetic compatibility (EMC) -<br>Part 6-2: Generic standards - Immunity for industrial environments | EN 61000-6-2<br>+ corr. September | 2005[3)]<br>2005 |
| IEC 61000-6-4 | -[1)] | Electromagnetic compatibility (EMC) -<br>Part 6-4: Generic standards - Emission standard for industrial environments | EN 61000-6-4 | 2007[3)] |
| IEC/TS 61000-6-5 | -[1)] | Electromagnetic compatibilty (EMC) -<br>Part 6-5: Generic standards - Immunity for power station and substation environments | - | - |
| IEC 61024-1 | -[1)] | Protection of structures against lightning -<br>Part 1: General principles | - | - |
| IEC 61140 | -[1)] | Protection against electric shock - Common aspects for installation and equipment | EN 61140 | 2002[3)] |
| IEC 61439-1 | 2009 | Low-voltage switchgear and controlgear assemblies -<br>Part 1: General rules | - | - |
| IEC 62305-1 | -[1)] | Protection against lightning -<br>Part 1: General principles | EN 62305-1<br>+ corr. November | 2006[3)]<br>2006 |
| IEC 62305-3 (mod) | -[1)] | Protection against lightning -<br>Part 3: Physical damage to structures and life hazard | EN 62305-3<br>+ corr. September<br>+ A11 | 2006[3)]<br>2008<br>2009 |
| CISPR 11 (mod) | -[1)] | Industrial scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement | EN 55011 | 2007[3)] |

[1)] Undated reference.

[2)] The title of HD 472 S1 is: Nominal voltages for low-voltage public electricity supply systems.

[3)] Valid edition at date of issue.

| Publication | Year | Title | EN/HD | Year |
|---|---|---|---|---|
| CISPR 22 | -[1)] | Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement | - | - |

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

# ELECTRICAL INSTALLATIONS FOR LIGHTING AND BEACONING OF AERODROMES – CONSTANT CURRENT REGULATORS

## FOREWORD

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International Standard IEC 61822 has been prepared by IEC Technical Committee 97: Electrical installations for lighting and beaconing of aerodromes.

This second edition cancels and replaces the first edition published in 2002. It is a technical revision.

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

a) revision and update of terms and definitions;
b) addition of new paragraphs, such as "Nominal output current range and tolerances";
c) modification of some paragraphs, such as those related to "Local control" and "Remote control";
d) deletion of some paragraphs, in particular "Power transformers" and "Output current indicator".

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

| FDIS | Report on voting |
|---|---|
| 97/135/FDIS | 97/139/RVD |

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

# ELECTRICAL INSTALLATIONS FOR LIGHTING AND BEACONING OF AERODROMES – CONSTANT CURRENT REGULATORS

## 1 Scope

This International Standard specifies the requirements for a Constant Current Regulator (CCR) having a nominal output of 6,6 A for use in an aeronautical ground lighting constant current series circuit. However, CCRs may be manufactured which have a different power rating (kVA) and current steps than those specified in this standard in order to be used on existing circuits. This standard should be applied where appropriate for these CCRs.

## 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 60038, *IEC standard voltages*

IEC 60439-1:1999, *Low-voltage switchgear and control gear assemblies – Part 1: Type-tested and partially type-tested assemblies*

IEC 60529*, Degrees of protection provided by enclosures (IP Code)*

IEC 61000-6-2*, Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC/TS 61000-6-5, *Electromagnetic compatibility (EMC) – Part 6-5: Generic standards – Immunity for power station and substation environments*

IEC 61024-1, *Protection of structures against lightning – Part 1: General principles*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61439-1:2009, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 62305-1, *Protection against lightning – Part 1: General principles*

IEC 62305-3, *Protection against lightning – Part 3: Physical damage to structures and life hazard*

CISPR 11, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*

CISPR 22, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions developed to be included in international standards relating to airport/aerodrome visual aids apply

**3.1**
**aeronautical ground lighting (AGL) constant current series circuit**
apparatus configured as an electrical circuit designed to produce and operate with a constant current, independent of variations in the load, in order to provide a specified light output for aeronautical purposes

**3.2**
**constant current regulator (CCR)**
apparatus which produces a current output at a constant r.m.s. value independent of variations in the constant current series circuit load, input voltage and service conditions as specified

**3.3**
**open circuit**
AGL constant current series circuit with an unplanned interruption at any location of the primary current line that produces a hazardous high voltage between the interrupted circuit sections

**3.4**
**forced ventilation**
cooling system in which the air is moved by external power

**3.5**
**live**
electrically connected to a source of electricity or having acquired a charge by other means

## 4 Classification

### 4.1 Output current

The CCR shall produce a maximum rated r.m.s. current output of 6,6 A and a minimum rated r.m.s. current output of 1,8 A.

### 4.2 Current steps

CCRs shall be classified according to the number of output current steps available, as follows:

- style 1 : 3 current steps;
- style 2 : 5 current steps.

Each step shall have a single adjustment over the full range specified in 4.1.

NOTE An additional low current step(s) for non-illumination purposes may be offered as an option (see 5.7.6). Each style CCR can be configured to operate with a reduced number of current steps.

### 4.3 Ratings

CCRs shall be manufactured in the following output power ratings:

1 kVA; 2,5 kVA; 5 kVA; 7,5 kVA; 10 kVA; 15 kVA; 20 kVA; 25 kVA; and 30 kVA.

NOTE 1 There may be situations where greater power rating is required than that specified in this International Standard to meet existing circuit requirements. In this case, the CCR should meet the applicable performance, qualification and safety requirements contained in this International Standard.

The nominal input voltage to the CCR (see 5.3.6) shall be a single-phase or multiple phase value in accordance with IEC 60038.

The operating frequency shall be 50 Hz ± 7,5 % or 60 Hz ± 7,5 %.

NOTE 2 The CCR may be designed to operate from a d.c. power source.

## 5 Requirements

### 5.1 General

The following requirements are grouped into six categories: environmental, performance, EMC, design, protection against electric shock and optional accessories.

### 5.2 Environmental requirements

The equipment shall be designed for continuous indoor operation without derating, under the following conditions:

– temperature range from 0 °C to +50 °C;
– relative humidity from 10 % to 95 % without dewing;
– altitude from sea-level to 1 000 m;
– electromagnetic compatibility – as per IEC 61000-6-2.

### 5.3 Performance requirements

#### 5.3.1 Nominal output current range and tolerances

The nominal output current range is:

- Style 1: 4,8 A to 6,6 A;
- Style 2: 2,8 A to 6,6 A.

Table 1 gives the standard pre settings of the CCR. These settings may be varied according to the requirements of an airport.

**Table 1 – Standard CCR output current step pre-settings**

| Style | Current step | Nominal output current A (r.m.s.) |
|---|---|---|
| 1 | 3 | 6,60 |
| | 2 | 5,50 |
| | 1 | 4,80 |
| 2 | 5 | 6,60 |
| | 4 | 5,20 |
| | 3 | 4,10 |
| | 2 | 3,40 |
| | 1 | 2,80 |

Tolerance of ± 0,1 A for each current step setting within the nominal output current range.

#### 5.3.2 Regulation – resistive loading

While powering any resistive load between no load (short circuit) and full load, the CCR shall provide an output current within the specified tolerance for each current step setting within the nominal output current range.

CCRs shall provide regulation over the full range of environmental conditions specified in 5.2 and within the input voltage range of 90 % to 110 %.

#### 5.3.3 Regulation – reactive loading

The CCR shall maintain the current within the specified tolerance for each current step setting within the nominal output current range when the load has an inductive power factor of 0,60.

#### 5.3.4 Efficiency

At all current steps, the average efficiency of the CCR, operating at rated input voltage into a full nominal resistive load shall not be less than 80 %.

#### 5.3.5 Power factor

The power factor of the CCR, operating at rated input voltage into a full nominal resistive load shall not be less than 0,90.

#### 5.3.6 Input voltage

Input voltage shall be as stated in 4.3. The CCR shall operate as required in 5.3.1 when the input voltage is anywhere between 90 % and 110 % of the nominal input.

The CCR shall be designed to withstand momentary increases of voltage up to 120 % and momentary decreases of voltage down to 80 % of the nominal input voltage without being de-energized or damaged by such voltages. The CCR shall withstand such voltage excursions for up to 50 ms within a period of 1 min. The CCR shall automatically resume normal operation (Table 1) when the input voltage returns to 90 % to 110 % of the nominal value.

#### 5.3.7 Load matching

CCRs shall match connected loads from 50 % to 100 % of the rated load.

For resistive loads in the range of 50 % to 100 % of the rated load, at the rated input voltage, and with an output current at 100 %, the efficiency and power factor shall not be less than the values specified in 5.3.4 and 5.3.5. If required, additional output load taps may be provided to allow a more precise adjustment or lower load matching.

#### 5.3.8 Operation

The CCR shall stabilize the output current at any selected current step within 500 ms, and shall hold the output current stable within the specified tolerance of the nominal output current. There shall not be any interruption of output current to the series circuit when switching from one current step to another.

#### 5.3.9 Control/Monitoring System

##### 5.3.9.1 Functions

The CCR shall be capable of being controlled locally and from a remote location. Information on the selected current step and remote/local status shall be provided at the CCR regardless of whether the CCR is in local or remote control.

The local control system shall be integral to the CCR and shall not be supplied from a source located outside the CCR package. The CCR shall be capable of being controlled remotely for any current level by parallel wiring or serial interface. The design of the remote control interface shall provide, at least, the inputs and outputs described in Table 2.

**Table 2 – CCR remote control/monitoring functions**

| Remote control | | | Remote monitoring | | | |
|---|---|---|---|---|---|---|
| | Standard | Option | Standard | | Option | |
| a | On/Off selection | | a | CCR on | | |
| | | | b | Local/Remote | | |
| b | Current step selection | | c | Step 1 selected | c1 | Step 1 obtained |
| | | | d | Step 2 selected | d1 | Step 2 obtained |
| | | | e | Step 3 selected | e1 | Step 3 obtained |
| | | | f | Step 4 selected | f1 | Step 4 obtained |
| | | | g | Step 5 selected | g1 | Step 5 obtained |
| | | | | | h | CCR out of range |
| | | | I | Open circuit trip | | |
| | | | J | Over current trip | | |
| c | | CCR Non-illumination step | | | k | CCR non-illumination step |
| d | | Circuit Selector Switch | | | l | Circuit selector fault |
| | | | | | m | Lamp fault warning |
| | | | | | n | Lamp fault alarm |
| | | | | | o | Earth fault warning |
| | | | | | p | Earth fault alarm |
| NOTE For the monitoring section, if (c1) to (g1) is implemented, (c) to (g) can be omitted | | | | | | |

#### 5.3.9.2 Control interface

The standard source voltage for controlling and monitoring the CCR shall be +24 V d.c, +48 V d.c., or +60 V d.c. nominal, with the negative pole being common. Remote control power shall be provided from a source either external or internal to the CCR. If internal, a dedicated power supply shall be for remote control only.

Relays or other isolating devices shall be provided for switching on and setting the current steps of the CCR.

Monitoring of the CCR data output shall be provided by relay contacts or another isolating device rated at minimum 60 V d.c. and 50 mA. Where a common pole is used, it shall be negative.

Terminal blocks or connectors having a minimum voltage rating of 300 V shall be installed in the control cabinet for connection of external wiring associated with monitoring and remote control. Terminal blocks or connectors shall accommodate 0,250 $mm^2$ to 2,500 $mm^2$ cable with a minimum insulation rating of 300 V. Space for spare positions shall be provided to accommodate optional devices.

#### 5.3.9.3 Monitoring terminals

One terminal for each of the functions listed in 5.3.9.1 shall be provided.

#### 5.3.10 Output current surge limitation

The CCR shall be designed with a controlled feature, so that switching the CCR on and off, changing current steps, or shorting the load, shall not damage the CCR, trip a protective device, nor produce output current surges (transients) that will damage series circuit equipment. Changes of intensity due to switching of current steps in local or remote control shall occur without over-shoots exceeding 6,7 A r.m.s.

#### 5.3.11 Dynamic response

For sudden load variations exceeding 10 % of the load, the duration of the possible over current condition shall be limited to one half-cycle. If the peak current reaches twice the maximum peak current while in normal operation, (i.e. peak current in short circuit at maximum current and maximum input voltage) or the current reaches 125 % of the maximum r.m.s. value, the current shall be limited under 2,0 A r.m.s. after the half sine wave in progress. The suppression shall remain for one to four cycles and then the current limits of Table 1 shall be achieved in 500 ms or less.

#### 5.3.12 Output voltage limitation

With the open circuit protection disabled, the peak output voltage of an open-circuited CCR shall not exceed twice the rated r.m.s. output kVA divided by the rated r.m.s. output current.

#### 5.3.13 Protective devices

##### 5.3.13.1 Open circuit protection

The CCR shall include an open-circuit protective device to de-energize the CCR output within 1 s after an open circuit condition occurs in the primary series circuit. The protective device shall be reset manually from the local position only. The CCR shall not trip out due to the switching of load circuits or other transients.

##### 5.3.13.2 Overcurrent protection

The CCR shall include an overcurrent protective device to de-energize the CCR output between 3 s and 5 s when the output current exceeds 6,75 A r.m.s. The CCR shall de-energize the output within 300 ms when the output current exceeds 8,30 A r.m.s. The protective device shall be reset manually from the local position only.

##### 5.3.13.3 Primary switching

The CCR shall have an electro-mechanical isolating device that interrupts the input power before it reaches the main power transformer and shall not interrupt internal control power.

##### 5.3.13.4 Input power loss

In the event of an input power loss for up to 1 min, the CCR shall resume operation on the selected current setting within 500 ms after the restoration of input power.

NOTE It is not required to fulfil the 500 ms run up time for a power loss period longer than 1 min.

##### 5.3.13.5 Output series circuit switching

When the CCR is used with a circuit selector, the CCR shall not lock-out or produce surges that would damage the connected series circuits.

Means shall be provided for interlocking the CCR and circuit selector switch. A breaking switch in the circuit selector switch shall force the CCR output current to zero while the circuit selector switch is operating.

### 5.4 Electromagnetic compatibility (EMC)

#### 5.4.1 Limits for emission

CCRs shall comply with IEC 61000-6-4, the EMC generic emission standard for industrial environments. Radiated emission limits shall be in accordance with CISPR 11, class B.

#### 5.4.2 Output current waveform

The CCR shall provide an output current waveform with a crest factor of less than 3,2 at all current steps at the nominal input voltage and with 10 % resistive load.

#### 5.4.3 Limits for immunity

CCRs shall comply with the generic immunity standards for industrial environments IEC 61000-6-2, supplemented by applicable parts of IEC/TS 61000-6-5 containing EMC immunity requirements for power station and substation environments (locations where apparatus for electricity utilities are installed). CCRs shall comply with requirements for apparatus installed in type G locations (power stations and medium voltage substations) as defined in IEC/TS 61000-6-5.

### 5.5 Design requirements

#### 5.5.1 Local control

The CCR shall be capable of being locally controlled to provide the following functions:

– on/off;
– local/remote control;
– current steps.

#### 5.5.2 Local indication

The CCR shall provide on the front of the unit an indication for the following:

– an open-circuit trip-out has occurred;
– an over current trip-out has occurred;
– input voltage is present;
– CCR is set to local or remote control;
– selected current step;
– output current is present (if no ammeter is installed according to 5.7.8).

#### 5.5.3 Wiring diagram

A wiring diagram showing all customer connection points shall be permanently readable, and located in a visible place in the CCR.

#### 5.5.4 Mechanical design

The CCR shall be constructed only of materials capable of withstanding the mechanical, electrical, and thermal stresses as well as the effects of humidity, which are likely to be encountered in normal service.

Protection against corrosion shall be ensured by the use of suitable materials or by the application of equivalent protective coatings to the exposed surface, taking account of the intended conditions of use and maintenance.

All enclosures and partitions shall be of a mechanical strength sufficient to withstand the stresses to which they may be subjected in normal service.

The CCR cabinet shall be designed for ease of installation movement of the unit (e.g. rollers, lifting rings, etc.).

If a CCR is designed as a distributed system where parts of the CCR are not in the same housing, the cabling used for interconnection between the separated parts has to be defined by the manufacturer.

The apparatus and circuits in the CCR shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

The CCR shall be designed and arranged in such a way that certain operations, according to agreement between manufacturer and user, can be performed when the CCR is connected to the mains.

Such operations may be:

a) visual inspection of
   - switching devices and other apparatus,
   - settings and indicators,
   - conductor connections and markings;

b) adjusting and resetting of relays, releases and electronic devices;

c) certain fault location operations.

Necessary measures shall be taken to enable maintenance of the CCR, with adjacent functional units or groups energized. Such measures may be:

– sufficient space between subassemblies;

– use of barrier protected sub-sections for each subassembly;

– use of compartments for each subassembly;

– insertion of additional protective means provided or specified by the manufacturer.

### 5.5.5 Electrical design

All components used in the design of the CCR shall be suitable for their function and shall not operate in excess of 80 % of the component manufacturer’s recommended rating. In order to maximize reliability, it is recommended that no forced ventilation be utilized. If either is used, it shall be monitored with an alarm given upon failure. Upon failure of the cooling or heating element, the CCR shall continue to operate normally for a period of time specified by the manufacturer.

All cabling and small wiring shall be securely placed in systematic runs and coded where terminated. Power cabling shall be terminated with lugs or eyes and terminals shall be clearly and appropriately coded. Wiring identification shall be in agreement with the indicators on wiring diagrams and drawings. Bushings, glands, or grommets shall protect cabling and wiring passing through metal work.

The protective earth conductor shall be readily distinguishable by twin coloured green and yellow markings. When the protective conductor is an insulated single core cable, this colour identification shall be used throughout the entire length.

Insulated conductors shall be rated for at least the maximum voltage of the circuit concerned.

Cables between two connecting devices shall have no intermediate splices or soldered joints. Connections shall be made at fixed terminals. The connection of two or more conductors to one terminal is permissible only in those cases where the terminals are designed for this purpose.

### 5.5.6 Nameplate

A permanently readable nameplate (Figure 1) with the information listed below shall be securely attached to a visible location on the exterior of the CCR enclosure. If the nameplate is attached to a readily removable surface, such as a cover, the serial number shall be duplicated in a permanent conspicuous place elsewhere on the CCR.

| |
|---|
| Constant current regulator |
| Manufacturer's name and part number: _____ |
| Number of current steps:__ |
| Input: V Hz |
| Remote control voltage: _____ V d.c. or serial physical layer: |
| Output: kVA at 6,6 A. Maximum output voltage: ____ V |
| Serial number: ___ |
| Year of manufacture:_____ |

**Figure 1 – Nameplate** *IEC 1609/02*

### 5.5.7 Instruction manual

The manufacturer shall specify in its instruction manuals the conditions for the installation, operation and maintenance of the CCR and the equipment contained herein.

The instructions for the transport, installation and operation of the CCR shall indicate the measures that are of particular importance for the proper and correct installation, commissioning and operation of the CCR.

The instruction manual shall include the following:

– theory of operation;
– wiring and control diagrams;
– general operation;
– installation instructions;
– preventive maintenance;
– spare parts list;
– troubleshooting;
– revision information including firmware (if applicable);
– options.

## 5.6 Protection against electric shock

CCRs shall be provided with protection against electric shock in accordance with the fundamental rules outlined in IEC 61140.

For provision of equipotential bonding and connection of protective conductors, refer to IEC 61439-1.

The degree of protection provided by the cabinet containing a CCR assembly against contact with live parts or ingress of solid bodies and liquid shall be indicated by the IP designation, according to IEC 60529.

For CCR assemblies for indoor use where there is no requirement for protection against ingress of water, the degree of protection shall be at least IP2X after installation in accordance with the manufacturer's instructions.

For CCR assemblies for outdoor use having no supplementary protection, the second numeral shall be at least 3.

High voltage equipment (1 000 V or greater), including the power transformer, shall be isolated from the low voltage equipment either by construction when they are in the same assembly, or by inclusion in a separate switchgear assembly.

The internal access plates shall be fitted with the appropriate IEC warning label.

### 5.7 Optional accessories

#### 5.7.1 Earth fault monitor

An earth fault indicator may be built into the CCR for monitoring its own output circuit and shall be designed in one of the following ways.

– When the CCR is in a brightness step, it shall be designed to apply a d.c. voltage of 500 V maximum on the output series circuit relative to ground or earth potential.
– When the CCR is disconnected, it shall be designed to apply a d.c. voltage of 1 000 V maximum on the output series circuit relative to ground or earth potential.

The earth fault indicator shall be able to detect an insulation resistance with a minimum range of 10 kΩ to 50 MΩ.

The insulation resistance reading shall be independent of the current step setting, and of the location of the fault. The fault shall be measured permanently as soon as the local switch is on "remote control" position or on a current step setting. If operated at voltages exceeding 70 V d.c., when the CCR is in local-off, this control device shall be automatically switched off.

At least two thresholds (warning and alarm), determined in relation to the local operational requirement of the airport, shall be offered with information available locally and remotely.

#### 5.7.2 Load indicator

A load indicator may be installed in the CCR in order to indicate the amount of load on the CCR.

#### 5.7.3 Lamp fault indicator

A lamp fault detector may be installed in the CCR to detect a pre-determined number of burnt out lamps on the series circuit.

**Table 3 – Lamp failure indicator**

| Range of burnt out lamps in % of total installed lamps | Required accuracy of the lamp failure indicator in % of total installed lamps |
|---|---|
| ≤ 10 % | 1 % |
| >10 % to ≤30 % | 2 % |

Detection shall operate, at a minimum, the top two steps of both CCR types and for all loads between 25 % and 100 % of the nominal load.

The tolerances are valid for the basic conditions:

- all lamp transformers of same type;
- all loads of same wattage;
- all loads of lamp load;
- the fault occurred by broken filament.

At least two thresholds (warning and alarm) for the number of lamps out of service shall be available. These thresholds shall be adjustable from two times the actual accuracy. Local visual indication shall be provided, as well as remote indication when a lamp out warning or alarm has occurred.

#### 5.7.4 Output lightning arrestors

The CCR may be fitted with output surge protective devices (SPD).

Where fitted, SPD shall meet the lightning protection requirements of IEC 62305-1 and IEC 62305-3.

Where fitted, SPD of the size necessary to protect the CCR shall be installed across the CCR output terminals. The ground side of the SPD shall be connected to the earth terminal of the enclosure or other suitable earth ground location. The SPD shall have the capability to withstand a pulse on the output circuit consisting of a 10 μs by 20 μs current surge of 15 000 A with a subsequent power-follow current and a voltage surge of 10 000 V/μs minimum without damaging the CCR.

#### 5.7.5 Field circuit isolator

The CCR may contain an integral isolating device to allow the isolation of the outgoing field cables for the purpose of load disconnection, cable insulation resistance testing, and ground search capability. When operated, the device shall short out the CCR output terminals and provide access for instrument connection to both of the load side terminals. A facility shall be provided for earthing the primary series circuit.

#### 5.7.6 Non-illumination current step

A non-illumination current step may be offered to allow the use of accessory devices on the series circuit. The minimum nominal current value shall be 1,8 A r.m.s. The accuracy of this option shall be ± 0,1 A.

#### 5.7.7 Out of range indicator

The CCR may contain an out of range indicator for the series circuit. This indicator shall be installed on the CCR front panel that displays a warning when the current measured for the selected current step is not within the required limits.

#### 5.7.8 Output ammeter

An r.m.s. reading ammeter may be installed on the front panel of the CCR to indicate output current. The accuracy shall be better than or equal to ±1 % of the full range (i.e. 6,6 A).

#### 5.7.9 Short circuit protection

The CCR may have short-circuit protection on the primary side of the power transformer appropriate to the fault current level.

### 5.7.10 Serial wiring

All controls and output functions may be optionally available using a serial interface. Output functions exclusively may be made optionally available via a serial interface.

## 6 Qualification and test requirements

### 6.1 Type tests

The type tests shown in Table 4 aim to ensure that the design of the CCR is able to comply with this standard. Any certification report shall mention compliance to this standard and to any other applicable standard.

Each CCR design type shall be tested with the largest power rating for each enclosure size. All tests shall be performed with all optional accessories offered by the manufacturer, which are defined in 5.7.

The ambient temperature shall be measured during the last quarter of the test period by means of at least two thermometers or thermocouples equally distributed around the CCR assembly. The ambient temperature shall be in the range from +10 °C to +40 °C.

In case the CCR is made of several subassemblies, the type test shall be run on a complete assembly containing subassemblies wired as per the manufacturer's instruction manual. The test results for the CCR and each subassembly shall be recorded.

### 6.2 Routine tests

The following tests, shown in Table 4, shall be carried out at the factory on every CCR assembly when it is assembled in accordance with a previously accepted type or through the exclusive use of parts and accessories specified or supplied by the manufacturer for this purpose and already approved.

The following minimum routine tests shall be undertaken at an ambient temperature in the range from +10 °C to +40 °C. Additionally, the CCR shall be checked for compliance with the particular requirements of the purchase order/contract. This check shall at least comprise, but not be limited to, specific controls, signalling and/or marking.

The results of the routine tests shall be recorded in the test protocol. A copy of these results shall be included with each CCR.

NOTE The performance of the routine tests at the factory does not relieve the CCR installer from the duty of checking it after transport and installation.

**Table 4 – Type and routine tests**

| Test | Type test | Routine test | reference |
|---|---|---|---|
| Visual inspection | X | X | 7.1 |
| Safety | X | X | 7.2 |
| Power frequency | X | | 7.3.1 |
| Enclosure temperature | X | | 7.4 |
| Open circuit | X | X | 7.5.1 |
| Overcurrent | X | X | 7.5.2 |
| Operation | X | X | 7.6 |
| Regulation (resistive load) | X | X | 7.7.1.1 |
| Regulation (reactive load) | X | | 7.7.1.2 |
| Efficiency | X | | 7.7.2 |
| Power factor | X | | 7.7.3 |
| Output current surge | X | | 7.7.4 |
| Dynamic response | X | | 7.7.5 |
| Power supply interruptions | X | | 7.7.6 |
| Output waveforms | X | | 5.4.2 |
| Mechanical operation | X | X | 7.7.7 |
| EMC | X | | 7.7.8 |
| BIL | X | | 7.3.2 |
| Lightning arrestors | X | | 7.7.9 |
| Low temperature | X | | 7.8.1 |
| High temperature | X | | 7.8.2 |

## 7 Tests description for tests

Calibrated r.m.s. measuring equipment with an accuracy class at least twice the specified accuracy for the parameter to be measured shall be used. Calibration shall be traceable. When a variation from a following test description is applicable in the corresponding re-qualification or routine production tests, the variation is explicitly recorded.

### 7.1 Visual inspection

The equipment shall be visually inspected for compliance with:

– manufacturer's data sheet;
– manufacturer's drawings;
– manufacturer's instruction manual;
– this standard regarding name plate position and content;
– presence of the safety warnings;
– presence and size of power, earthing and control terminals;
– presence of equipment (rolling castors, lifting rings, etc.) specified in this International Standard.

### 7.2 Protection against electric shock

#### 7.2.1 Verification of protection by enclosures

The specified degree of protection provided by enclosures shall be verified in accordance with procedures specified in IEC 60529.

#### 7.2.2 Verification of clearances and creepage distances

It shall be verified that the clearances and creepage distances which comply with values are consistent with the rated insulation voltages. Tables 1 and 2 included in IEC 61439-1 contain minimum values for clearances and creepage distances for low voltage circuits. If necessary, the clearances and creepage distances have to be verified by measurements, taking account of possible deformation of parts of the enclosure or of the internal screens, including possible changes in the event of a short-circuit.

NOTE The rated insulation voltage is a voltage value to which dielectric test voltages and creepage distances are referred. It is assumed that the maximum rated operational voltage of any circuit of the CCR will not, even temporarily, exceed 110 % of its rated insulation voltage.

### 7.3 Dielectric test

#### 7.3.1 Dielectric strength

The dielectric strength shall be checked as follows:

a) between output terminals and earth in accordance with 10.9.2 of IEC 61439-1, with the test voltage being twice the rated insulation voltage plus 2 500 V r.m.s., with the rated insulation voltage being 1,1 times the maximum operating voltage (when the CCR is operating at maximum rated output current). During this test, the control terminals and low voltage circuitry shall be bonded to earth;

b) low voltage input terminals and earth (output and control terminals bonded to earth) in accordance with 10.9.2 of IEC 61439-1.

#### 7.3.2 Basic impulse insulation level (BIL) test for power transformer

Basic lightning impulse insulation level (BIL) testing of the CCR's power transformer shall be performed on both the primary and secondary windings. The terminals of each winding shall be connected together to the high impulse generator. All other terminals and the core shall be grounded. Testing shall be performed with a 1,2 μs rise time × 50 μs fall time wave shape at the nominal peak levels shown below (Table 5) with a negative polarity. One reduced, two chopped and one full impulse wave shall be applied.

**Table 5 – BIL test**

| Transformer size | Primary BIL | | | Secondary BIL | | |
|---|---|---|---|---|---|---|
| | Reduced wave | Chopped wave | Full wave | Reduced wave | Chopped wave | Full wave |
| | kV Peak | kV Peak | kV Peak | kV Peak | kV Peak | kV Peak |
| Under 10 kVA | 7 | 10 | 10 | 7 | 10 | 10 |
| 10 kVA and 15 kVA | 7 | 10 | 10 | 12 | 20 | 20 |
| 20 kVA, 25 kVA and 30 kVA | 7 | 10 | 10 | 18 | 30 | 30 |

### 7.4 Enclosure temperature test

The CCR shall be installed and wired per manufacturer's instruction manual. The clearances around the CCR shall be at the minimum specified by the instruction manual.

The enclosure temperature test shall be carried out as follows.

a) Connect the CCR to a nominal power source and a nominal resistive load.

b) Adjust the CCR for supplying a nominal output current until the temperature has stabilized (no variation in excess of 1 °C for a period of 1 h). Record the highest temperature spot on the enclosure. Verify that the temperature on the enclosure does not exceed 15 °C above the ambient temperature. Record the temperature.

### 7.5 Test of protective devices

#### 7.5.1 Open circuit test

An open circuit test (see 5.3.13.1) shall be carried out as follows.

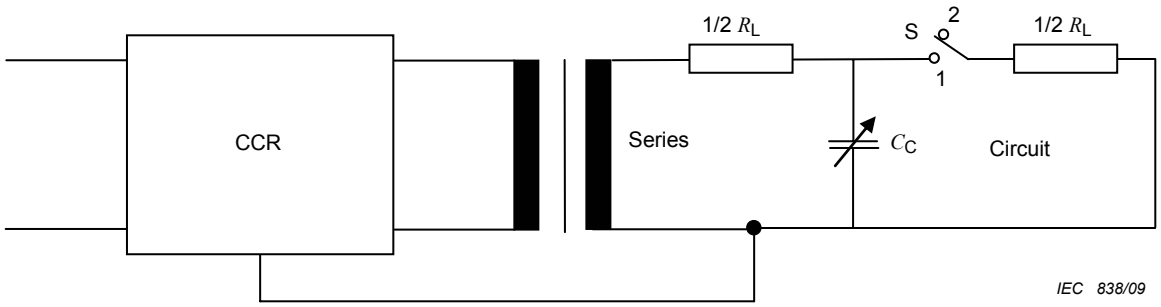
The open circuit maximum r.m.s voltage before operation of the protective circuitry should not exceed twice the nominal r.m.s. output voltage (rated r.m.s. output kVA divided by the r.m.s. output current).

a) Force or adjust the CCR output current to between 1,30 A and 1,50 A ($I_0$). Check that the power to the output transformer is switched off within 1 s.

b) De-energize the CCR. Remove the load circuit from the output of the CCR.

c) Re-energize the CCR into the highest current step. Check that the power to the output transformer is switched off within 1 s and record the maximum output voltage.

d) Test for cap load.




$R_L$ load resistance

$C_C$ simulation of cable capacitance

S switch for simulation of a circuit interrupt

**Figure 2 – Open circuit test schematic diagram**

1) Preparation
   - Size $R_L$ suitable to the nominal load of the CCR (e.g. CCR 15 kVA, $R_L$= ca. 300 Ω)
   - Deactivate capacitive switch off circuitry "$I_C$– switch off" of the CCR
   - Open switch S (position 2) and switch on CCR in step 1

     Adjust $C_C$ in a way that a current of 1,1 × $I_0$ will flow ($I_0$ = open circuit protection current)
   - Afterwards switch off CCR and close switch S again (position 1)
   - Activate capacitive switch off circuitry of the CCR
   - Switch on CCR in all current steps → CCR shall not switch off due to capacitive switch off circuitry

2) "$I_C$- switch off" Test

a) Test "$I_C$– switch off" when CCR is on

- Switch on CCR in lowest step
- Open switch S (switch in position 2) → CCR shall switch off ($I_C$-tripping) within 1 s after switching S in position 2 and generating open circuit-alarm
- Afterwards de-energise CCR manually and close switch S (position 1)

Test "$I_C$– switch off" for all other current steps accordingly.

Notice: In higher steps it may be that the series circuit current with open switch S is less than $I_0$ due to a different form factor of the current. In this case the CCR shall trip by the open circuit switch off circuitry ($I_0$-tripping).

b) Test "$I_C$– switch off" during CCR switching on

- Switch off CCR
- Open switch S (set to position 2)
- Switch on CCR in lowest step → CCR shall switch off ($I_C$–tripping) within 1 s after CCR switching on

Test ""$I_C$ – switch off" for all other current steps accordingly

3) Test "$I_C$– switch off" with $2 \times C_C$ and $3 \times C_C$

- Capacitor value $C_C$ found under 1)
  - double $C_C$ for rated nominal loads up to 20 kVA
  - triple $C_C$ for rated nominal loads for more than 20 kVA
- Afterwards switch off CCR and close again switch S (position 1)
- Switch on CCR in all current steps → CCR shall not switch off (no $I_C$–tripping)

Execute tests according to 2) with $2 \times C_C$ and $3 \times C_C$

### 7.5.2 Overcurrent test

An overcurrent test (see 5.3.13.2) shall be carried out as follows.

a) Force or adjust the CCR output current to more than 6,75 A and check that the power to the output transformer is cut off within 3 s to 5 s.

b) Force or adjust the CCR output current to more than 8,30 A. Check that the power to the output transformer is cut off within 300 ms.

## 7.6 Operation test

By applying a nominal supply voltage and control signals insulated from earth, check that the CCR is fully responding to the signals and that local and remote signalling follows the actual operation (see 5.3.8).

In order of precedence, reference shall be made to this standard, then to the CCR data sheet, then to the instruction manual.

The following procedures shall be carried out.

a) Circuit breakers, fuses, safety switches, etc. shall be checked.

b) Local ON/OFF and current step selection shall be checked.

c) Remote ON/OFF and current step selection of the CCR shall be verified at all current steps by inserting a 215 Ω resistor in series with all lines of the remote control circuitry (+48 V d.c. control), except for the common lead of the control power line. Operate the CCR remotely on all current steps at the rated output load to verify compliance.

d) Verify that when the control switch is in the local position, changes in the remote control status have no effect.

### 7.7 Performance test

#### 7.7.1 Regulation test

##### 7.7.1.1 Resistive loading

This test (see 5.3.2) shall be carried out as follows.

a) Operate the CCR at the nominal input voltage and full load until thermal stabilization (less than 1 °C temperature variation in 1 h).

b) Proceed to measure in accordance with 5.3.1 the output current at each current step at the given input voltage and load conditions shown in Table 6.

c) Verify the output current is in compliance with Table 1.

**Table 6 – Resistive loading test**

| Input voltage | Short circuit load | Full load |
|---|---|---|
| 90 % | X | X |
| Nominal | X | X |
| 110 % | X | X |

##### 7.7.1.2 Reactive loading

This test (see 5.3.3) shall be carried out as follows.

a) Operate the CCR at the nominal input voltage and full load until thermal stabilization (less than 1 °C temperature variation in 1 h).

b) Proceed to measure in accordance with 5.3.3 the output current at each current step at the given input voltage and load conditions shown in Table 7.

c) Verify that the output current is in compliance with Table 1.

**Table 7 – Reactive loading test**

| Input voltage | Half load having inductive power factor of 0,60[a] |
|---|---|
| 90 % | X |
| Nominal | X |
| 110 % | X |
| [a] The inductive load may be achieved by including the appropriate number of series circuit transformers with open secondary or an equivalent load as part of the test circuit. | |

#### 7.7.2 Efficiency testing

After the test described in 7.7.1.1, the efficiency at each current step (see 5.3.4) shall be computed as follows:

$$\eta = \frac{P_2}{P_1}$$

where

$\eta$ is the efficiency,

$P_2$ is the active output power, and

$P_1$ is the active input power.

The average efficiency shall be calculated at each nominal current step for resistive load of 100 % at the nominal input voltage. The sum of the efficiencies shall be divided by the number of current steps at each load. Verify that the average efficiency at each load is not less than 80 %.

### 7.7.3 Power factor

After the test described in 7.7.1.2, the power factor (see 5.3.5) shall be computed as follows:

$$PF = \frac{P}{S}$$

where

$PF$ is the power factor,

$P$ is the total input active power in W, and

$S$ is the apparent input power in VA.

The measurement and calculation shall be made at the highest nominal current step for resistive load of 100 % at the nominal input voltage. Verify that the power factor is not less than 0,90.

### 7.7.4 Output current surge limitation

This test shall be carried out as follows.

a) Test the settling time of the output current at nominal voltage when switching from short circuit to full load or vice versa.

b) Verify that the output current reaches the specifications given in 5.3.10. The new value shall be stabilized within the limits of Table 1 in 500 ms or less of the start of the initiating event.

### 7.7.5 Dynamic response

This test shall be carried out in the following way:

a) Test the CCR's response time with 0,60 lag power factor inductive full load to sudden dynamic load variations.

b) For each current step, verify that the output current does not exceed the specifications given in 5.3.11 when 25 % of the load is suddenly short-circuited. Repeat the test by suddenly short-circuiting 50 % of the load for each current step.

### 7.7.6 Power supply interruptions and voltage dips

This test shall be carried out as follows.

After a power interruption or low voltage condition (see 5.3.6) occurs, verify that when the power supply is restored, the CCR resumes operation at the correct current step as indicated in Table 1 within 500 ms. For this test, interruptions of the power supply shall be in the following intervals: 10 ms, 50 ms, 200 ms, 500 ms and 1 s.

### 7.7.7 Mechanical operation test

This test shall be carried out as follows.

a) Check for the correct operation of all controls of the CCR.

b) Check for the effective interlocks per instruction manual.

c) Check for effective operation of the safety devices when opening doors/panels giving access to compartments containing dangerous voltages.

d) Check for effective operation of the door/panel locks and that the keys can be removed in the locked position.

#### 7.7.8 Electromagnetic compatibility (EMC)

CCRs shall be tested in accordance with 5.4. A copy of the manufacturer's certificate of compliance shall be included in the instruction manual delivered with the equipment. The test reports shall be kept by the manufacturer and presented on request to the buyer. Any significant engineering change shall be cause for type retesting.

##### 7.7.8.1 Emission tests

A CCR of each construction type, and for the lowest and highest power output rating per construction type shall be tested according to IEC 61000-6-4. The limits for emission on the power and enclosure ports shall be measured according to CISPR 11 for signal ports corresponding to information technology signals; they shall be measured according to CISPR 22.

##### 7.7.8.2 Output waveform

To ensure compatibility between CCRs and auxiliary equipment which may be powered by the CCR output, the manufacturer shall supply with the qualification documentation, oscilloscope photographs, printouts, or digital file of the output current and voltage waveform at nominal line voltage for all current steps in short circuit, half-load, and full-load. They shall be taken with a reactive load and then repeated with 30 % of the series circuit isolation transformers open-circuited. Tests shall be performed indicating a crest factor less than 3,2 at all current steps at nominal input voltage and with 10 % resistive load.

These output waveforms will be used by the auxiliary equipment manufacturers to ensure compatibility with all approved CCRs. These waveforms shall also be available in a manual to any interested auxiliary equipment manufacturers for a nominal fee.

##### 7.7.8.3 Immunity tests

A CCR of each construction type, and for the lowest and highest power output rating per construction type shall be tested according to IEC 61000-6-2 and applicable parts of IEC/TS 61000-6-5.

#### 7.7.9 Lightning arrestors

If provided, verify that the CCR's lightning arrestor has been tested to the requirements of 5.7.4.

### 7.8 Environmental tests

#### 7.8.1 Low temperature

This test shall be carried out as follows.

a) The CCR (or, in the case where the CCR is mounted in several racks with all power and control components combined together as an assembly in identical enclosures as they will be installed in the field) shall be installed in a low temperature chamber in which the temperature shall be adjusted to 0 °C ± 1 °C and left there for a period not less than 4 h after temperature stabilization. The CCR shall be left de-energized.

b) The CCR is then energized, with its output terminals connected to a resistive load external to the test chamber.

c) Repeat the resistive loading test as detailed in 7.7.1.1, waiting 5 min before recording data for each current step.

d) After this check, the CCR is allowed to warm up to ambient temperature.

e) After having returned to ambient conditions, the CCR is visually inspected in detail, inside and outside for

- any trace of blister, crack, deformation of any component or part of the enclosure;
- compliance to 7.7.7.

f) Any failure to meet the above shall be a cause for rejection.

### 7.8.2 High temperature

This test shall be carried out as follows.

a) The CCR (or in the case where the CCR is mounted in several racks: all power and control components combined together as an assembly in identical enclosures as they will be installed in the field) shall be installed in a high temperature room in which the ambient temperature is stabilized at +50 °C ± 1 °C. The CCR shall remain de-energized in the chamber for a period of 4 h.

b) During the duration of the test, the nature of air movement in the test chamber shall ensure uniform temperature without cooling the CCR under test.

c) The CCR is then energized, with its output terminals connected to a full load external to the test chamber for a period of 4 h.

d) Repeat the resistive loading test as detailed in 7.7.1.1 before recording data for each current step.

e) After this check, the CCR is allowed to cool down to ambient temperature.

f) After having cooled down, the CCR is visually inspected in detail, inside and outside for

- any component (part showing a trace of overheating);
- any trace of blister, crack, deformation of any component or part of the enclosure;
- any discoloration, fading or true change visible with the naked eye;
- compliance with 7.7.7;
- legibility of all markings, warnings, labels.

g) Any failure to meet the above shall be a cause for rejection.

## 7.9 Optional accessories

All options shall be tested to verify compliance with the requirements of 5.7.

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