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SOUTH AFRICAN NATIONAL STANDARD

Battery chargers — Industrial type

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Table of changes

Change No.	Date	Scope
Tech. corr. 1	1996	Changed to update a reference, to amend two terms, and to correct the values in column 1 of table 6.
Amdt 1	1997	Amended to change the requirement for radio frequency interference, and the references to SABS 0195 and SABS 173.
Amdt 2	2001	Amended to update referenced standards, and to correct table 3 and figure 4.
Amdt 3	2004	Amended to update referenced standards, and to change the definition of "acceptable".
Amdt 4	2008	Amended to update referenced standards and to add references for the requirements of radio frequency interference and protective devices.

Foreword

This South African standard was approved by National Committee SABS TC 69, *Power electronics and alternative energy conversion*, in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This document was originally prepared for a group of interested users for use when purchasing battery chargers for various mainly industrial applications, and was issued as NRS 026:1993.

This document was published in September 2008.

This document supersedes SANS 1652:2004 (edition 1.4).

A vertical line in the margin shows where the text has been technically modified by amendment No. 4.

Annexes A to C are for information only.

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Tables

Battery chargers — Industrial type

1 Scope

1.1 This standard specifies the characteristics of stabilized constant voltage, current-limited type battery chargers, for a.c. voltages up to and including 525 V, with filtered or unfiltered d.c. output. The battery chargers are designed to charge a battery and, if so required, simultaneously to power the connected d.c. system load. In such cases, the battery charger can be used as a d.c. uninterruptible power system.

1.2 This standard covers battery chargers designed to operate under the following normal service conditions:

a) ambient air temperature:

– not more than 40 °C and not less than 0 °C, and

– mean temperature, measured over a period of 24 h, not exceeding 35 °C;

b) altitude: up to 1 800 m above sea level;

c) atmospheric conditions: reasonably clean, with a relative humidity of not more than 85 %, but such that no condensation can occur; and

d) indoor use.

Any abnormal service conditions that the battery chargers need to tolerate will be specified in schedule A (see 4.7).

1.3 This standard also covers those battery chargers that are used to power a d.c. load direct, with the battery eliminated.

1.4 This standard also specifies the requirements for parallel operation of battery chargers.

1.5 This standard is not applicable to automotive, domestic and marine battery chargers.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

IEC 60127-1, *Miniature fuses – Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links*.

IEC 60695-2-10, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*. **Amdt 2**

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*. **Amdt 2**

IEC 61071, *Capacitors for power electronics.* **Amdt 4**

ISO 4014, *Hexagon head bolts – Product grades A and B*. **Amdt 2**

ISO 4015, *Hexagon head bolts – Product grade B – Reduced shank (shank diameter = pitch diameter)*. **Amdt 2**

ISO 4016, *Hexagon head bolts – Product grade C*. **Amdt 2**

ISO 4017, *Hexagon head screws – Product grades A and B*. **Amdt 2**

ISO 4018, *Hexagon head screws – Product grade C*. **Amdt 2**

ISO 4032, *Hexagon nuts, style 1 – Product grades A and B*. **Amdt 2**

ISO 4033, *Hexagon nuts, style 2 – Product grades A and B*. **Amdt 2**

ISO 4034, *Hexagon nuts – Product grade C*. **Amdt 2**

ISO 4035, *Hexagon thin nuts (chamfered) – Product grades A and B*. **Amdt 2**

SANS 211/CISPR 11, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement.* **Amdt 4**

SANS 556-1, *Low-voltage switchgear – Part 1: Circuit breakers* **Amdt 4**

SANS 1091, *National colour standard.*

SANS 1186-1, *Symbolic safety signs – Part 1: Standard signs and general requirements*. **Amdt 2**

SANS 1507-1, *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 1: General*.

SANS 1507-2, *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 2: Wiring cables*.

SANS 1507-3, *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 3: PVC Distribution cables*. **Amdt 3**

SANS 1507-4, *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 4: XLPE Distribution cables*.

SANS 1507-5, *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 5: Halogen-free distribution cables*.

SANS 1507-6 , *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 6: Service cables*. **Amdt 3**

SANS 3744/ISO 3744, *Acoustics – Determination of sound power levels of noise sources using sound pressure – Engineering method in an essentially free field over a reflecting plane*. **Tech. corr. 1**

SANS 7253/ISO 7253, *Paints and varnishes – Determination of resistance to neutral salt spray (fog)*. **Amdt 3**

SANS 9001/ISO 9001, *Quality management systems – Requirements*. **Amdt 2**

SANS 10064, *The preparation of steel surfaces for coating*.

SANS 60146-1-3/IEC 60146-1-3, *Semiconductor convertors – General requirements and line commutated convertors – Part 1-3:Transformers and reactors*.

SANS 60269-1/IEC 60269-1, *Low-voltage fuses – Part 1: General requirements*.

SANS 60269-2/IEC 60269-2, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Example of standardized systems of fases A to I.* **Amdt 3**

SANS 60269-4/IEC 60269-4, *Low-voltage fuses – Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices*.

SANS 60529/IEC 60529, *Degrees of protection provided by enclosures (IP Code)*. **Amdt 2**

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

SANS 60947-2/IEC 60947-2, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*.

SANS 60947-3/IEC 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*.

3 Definitions

For the purposes of this standard, the following definitions apply:

NOTE Definitions that have been extracted from the International Electrotechnical Vocabulary (IEV) (see annex C) have been indicated as such.

3.1
acceptable
acceptable to the authority administering this standard, or to the parties concluding the purchase contract, as relevant **Amdt 3; amdt 4**

3.2
battery (see also 3.17 (electrochemical) cell or battery)
two or more cells connected together to provide a specified voltage and a specified ampere-hour capacity

3.3
battery charger
a device capable of providing charging power to a battery

3.4
boost charge
a partial charge, generally at a high rate, for a short period. It is also known as a fast charge or a quick charge [IEV 486-04-04]

3.5
cable gland
a device to seal and secure the sheath and to secure the armour, where provided, of an electric cable to the terminal equipment, by means suitable for the type of the cable for which it is designed, including provision for making electrical connection to the sheath and to the armour

3.6
capacity
the quantity of electricity or electric charge which a fully charged battery can deliver under specified conditions [IEV 486-03-01]

NOTE The SI unit for electric charge is the coulomb (1 C = 1 A.s), but in practice, battery capacity is usually expressed in ampere-hours (A.h).

3.7
cell
an assembly of electrodes and electrolyte which constitutes the basic unit of a secondary battery [IEV 486-01-02]

3.8
charge (of a battery)
an operation during which a battery receives, from an external circuit, electrical energy which is converted into chemical energy [IEV 486-01-11]

3.9
charge rate
the current at which a battery is charged [IEV 486-03-06]

3.10
connector
a component that terminates conductors for the purpose of providing connection and disconnection to a suitable mating component

3.11
constant current charge
a charge during which the charging current is maintained at a constant value [IEV 486-04-01]

3.12
constant voltage charge
a charge during which the voltage across the battery terminals is maintained at a constant value [IEV 486-04-02]

3.13
clearance
the shortest distance between two conductive parts, usually measured through air

3.14
creepage distance
the shortest distance along the surface of the insulating material between two conductive parts [IEV 151-03-37]

3.15
disconnector
a mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements [IEV 441-14-05]

3.16
efficiency of a battery
the ratio of the output power of a battery to the input power required to restore the initial state of charge under specified conditions of current rate, final voltage and temperature. It can be expressed in two forms:

charge efficiency
the electrochemical efficiency expressed as the ratio of ampere-hours output to the ampere-hours input required to restore the initial state of charge; or **Tech. corr. 1**

energy efficiency
the electrochemical efficiency expressed as the ratio of watt-hours output to the watt-hours input required to restore the initial state of charge **Tech. corr. 1**

3.17
(electrochemical) cell or battery
an electrochemical device or system capable of storing electrical energy in chemical form from which it can be reconverted into electrical energy

3.18
end-of-charge rate
the current applied during the final stage of charging a battery

3.19
equalizing charge
an extended charge applied to correct relative density imbalance amongst the cells of a battery

3.20
filter (d.c.)
a resistance or capacitance or inductance network, or any combination of these, arranged to attenuate the residual a.c. component after rectification

3.21
float charge
a constant voltage charge ideally sufficient to maintain a cell or battery in a fully charged state

3.22
floating operation
the normal operation when the energy required by the external circuit is derived from both the battery and the charging circuit

3.23
fully charged state (of a cell or battery)
a state where all the available active material has been reconverted to its fully charged state [IEV 486-03-37]

3.24
gassing
the formation of gas produced by electrolysis of the electrolyte [IEV 486-03-24]

3.25
hazardous voltage
a peak a.c. voltage exceeding 42,4 V or a d.c. voltage exceeding 60 V, that exists in a circuit that does not comply with the requirements for a limited-current circuit

3.26
initial voltage (of a cell or battery)
the on-load voltage of a cell after closing the external circuit, as soon as the transient polarization effects have subsided [IEV 486-03-17]

3.27
isolation voltage
the maximum a.c. or d.c. voltage that may be continuously applied between input and chassis of equipment, or output and chassis of equipment, or both

3.28
lead-acid battery
a secondary battery in which the electrodes are made mainly from lead and the electrolyte is a sulfuric acid solution [IEV 486-01-04]

3.29
limited-current circuit
a circuit that is so designed and protected that, under both normal conditions and a possible fault condition, the current that can be drawn is not hazardous

NOTE For frequencies below 1 kHz, the current drawn through a non-inductive resistor of 2 000 Ω, connected between an accessible part and either pole of a limited-current a.c. circuit, does not exceed 0,7 mA or a d.c. current of 2 mA.

3.30
load
a device that absorbs power [IEV 151-03-08]

3.31
moulded-case circuit-breaker
MCCB
a circuit-breaker having a supporting housing of moulded insulating material forming an integral part of the circuit-breaker [IEV 441-14-24]

3.32
nickel-cadmium cell
an alkaline secondary cell in which the positive material is made mainly from nickel and the negative material is made mainly from cadmium with an electrolyte of diluted potassium hydroxide

3.33
noise
the aperiodic, random component on a power source output which is unrelated to the source and switching frequency. Unless otherwise stated, it is expressed in peak-to-peak units over a specified bandwidth

3.34
overcurrent protection
protection of the battery charger against excessive current, including short-circuit current

3.35
rated output current
the maximum current that a battery charger is designed to provide at a specified temperature

3.36
regulation
the variation of selected parameters expressed as a percentage of nominal value, resulting from changes in influencing quantities

3.37
relative ripple current
the ratio of the r.m.s. ripple current to the mean value of the direct current, expressed as a percentage

3.38
remote sensing
a means by which a battery charger maintains the stabilized value of output voltage at an external point (such as the battery or load) rather than at its output terminals

3.39
ripple current
the a.c. current component in the output of a rectifier that delivers direct current

3.40
ripple voltage
the a.c. voltage component in the output of a rectifier that delivers direct current

3.41
short-circuit protection
a protective feature that limits the current under short-circuit conditions, to prevent the equipment from being damaged

3.42
soft start
a feature that limits the start-up switching currents of a switching supply and causes the output voltage to rise gradually

3.43
stability
the capability of a device to regain a steady state of operation after a disturbance

3.44
stabilized battery charger
a battery charger that contains means to minimize the deviations in the output quantities which are caused by changes in the influencing quantities

3.45
two-step charge
two-rate charge
a charge which starts at a given current and, at a pre-determined point, continues at a lower current [IEV 486-04-07]

3.46
valve regulated sealed (secondary) cell
a secondary cell which is closed under normal conditions but which has an arrangement which allows the escape of gas if the internal pressure exceeds a predetermined value. The cell cannot normally receive addition to the electrolyte [IEV 486-01-20]

3.47
vented battery
a secondary cell or battery that has a cover which is provided with an opening through which gaseous products can escape

3.48
withstand voltage
the maximum voltage that can be applied between separate circuits without causing failure

4 Requirements

4.1 Alternating current (a.c.) input

4.1.1 Input characteristics

4.1.1.1 The a.c. input voltage shall be within 10 % of the nominal voltage specified in schedule A.

4.1.1.2 The a.c. input frequency shall be 50 Hz ± 2,5 Hz.

NOTE A decrease in frequency is assumed not to coincide with an increase in a.c. line voltage, and vice versa.

4.1.1.3 The maximum three-phase unbalance shall be such that the maximum input voltage on any phase is not more than 105 % of the minimum input voltage on any other phase. All voltages shall be within the limits given in 4.1.1.1.

4.1.1.4 The a.c. input system will be earthed as specified in schedule A.

4.1.2 Input protective devices

4.1.2.1 All protective devices that are not capable of breaking the prospective short-circuit fault current shall have appropriate short-circuit back-up protection at the point of installation. In the case of a battery charger that is not intended to be permanently connected to fixed wiring and relies on the electrical installation for protection of the internal wiring of the battery charger, the supplier shall state in schedule B whether or not protection is provided and, if it is not provided, shall state the necessary requirements for short-circuit protection at the point of installation.

4.1.2.2 The protective devices shall be one or more of the following, or equivalent means:

a) circuit-breakers that comply with SANS 60269-1 and SANS 60269-2 or with SANS 556-1 or SANS 60947-2; **Amdt 2; amdt 3; amdt 4**

b) high rupturing capacity fuse-links that comply with the requirements of SANS 60269-1 and SANS 60269-2; **Amdt 3**

c) fuse-links for the protection of semiconductor devices and that comply with the requirements of SANS 60269-4;

d) fuse-combination units that comply with the requirements of SANS 60947-3; and **Amdt 3**

e) in the case of a battery charger that is intended to be plugged into the normal supply mains, cartridge fuse-links for miniature fuses that comply with the requirements of IEC 60127-1.

4.1.3 Primary power isolation

4.1.3.1 For the purposes of servicing, a disconnect device or devices shall be provided to isolate the battery charger from the supply. Parts in the battery charger on the supply side of the disconnect device that remain energized when the disconnect device is switched off, shall be so guarded as to prevent accidental contact by personnel.

4.1.3.2 In the case of a single-phase battery charger, the disconnect device shall at least isolate the phase conductor of the supply.

4.1.3.3 In the case of a three-phase battery charger, the disconnect device shall isolate all the phase conductors of the supply simultaneously.

4.1.3.4 The disconnect device shall be one or more of the following, as specified in schedule A:

a) a switch or switch-disconnector that complies with SANS 60947-3, and is of a utilization category that is suitable for the particular application; or **Amdt 3**

b) a circuit-breaker that complies with 4.1.2.2(a) or with SANS 60947-2.

4.1.3.5 If so specified in schedule A, disconnect devices shall be provided with key-operated locks or other safety facility.

4.1.4 Protection against lightning surges (optional)

NOTE Because lightning ground flash density varies widely in South Africa, the need to protect a battery charger against lightning should be assessed in accordance with the procedure given in SANS 10313. **Amdt 2**

4.1.4.1 If so specified in schedule A, battery chargers shall be fitted with surge arresting devices to protect the battery charger against the effects of lightning surges. The devices shall be rated to withstand the voltage and current impulses given in table 1.

Table 1 — Standard lightning impulse voltage and lightning impulse current deemed to represent the indoor environment

1	2	3	4
Impulse		**Type of load circuit**	**Energy absorbed by an arrester with a maximum clamping voltage of 1 000 V** 1)
Waveform	**Amplitude**		
1,2/50 µs	6 kV	High impedance 2)	–
8/20 µs	3 kA	Low impedance 3)	80 J

1) Other arresters that have lower clamping voltages would absorb lower energy levels.

2) For high-impedance load circuits, the voltage shown represents the open-circuit surge voltage of the test generator.

3) For low-impedance load circuits, the current shown represents the discharge current of the surge (not the short-circuit currents of the power system).

4.1.4.2 When a battery charger is tested in accordance with 5.8, it shall:

a) withstand, without damage, ten successive 1,2/50 μs lightning voltage impulses of 6 kV, applied between each of the following pairs of input terminals:

1) live and earth;

2) live and neutral; and

3) neutral and earth; and

b) be capable of absorbing the energy of ten successive 8/20 μs lightning current impulses of 3 kA, applied between each of the following pairs of input terminals:

1) live and earth;

2) live and neutral; and

3) neutral and earth.

4.2 Direct current (d.c.) output

4.2.1 Output characteristics

4.2.1.1 The float, boost, equalize and initial charge voltage ranges per cell at the battery terminals and at an ambient battery temperature of 25 °C for a lead-acid cell, or 20 °C for a nickel-cadmium cell, shall be as specified in schedule A. Table 2 is given as a guide to the voltage setting ranges. Where an initial charge capability is required, it will be specified in schedule A.

4.2.1.2 The type of battery to be charged, the number of cells and the ampere-hour capacity will be specified in schedule A.

Table 2 — Float, boost, equalize and initial charge voltage ranges per cell

Voltages in volts

1	2	3	4	5	6
Battery type	**Nominal voltage**	**Float charge**	**Boost charge**	**Equalize charge**	**Initial charge**
Lead-acid Nickel-cadmium	2,0 1,2	2,15 to 2,33 1,35 to 1,45	2,25 to 2,40 1,50 to 1,60	2,50 to 2,70 1,70	2,25 to 2,70 1,90
NOTE The purchaser is advised to contact the battery manufacturer for float, boost and equalize voltages appropriate to the type of batteries being used and the service conditions under which the batteries will operate.					

4.2.1.3 All performance requirements shall be complied with when the battery charger is connected to the battery and to load.

4.2.1.4 The maximum and minimum voltage levels that the load can tolerate, and also the maximum and rated load current, will be specified in schedule A.

4.2.2 Output voltage adjustment controls

The output voltage adjustment controls shall be either manual or automatic, as specified in schedule A, to provide for the outputs specified in schedule A (see 4.2.1.1). The adjustment controls shall allow continuous adjustment over the given ranges. Compliance with this requirement shall be assessed in accordance with 5.4.

4.2.3 Output voltage regulation

4.2.3.1 When the battery charger is subjected to the a.c. input conditions specified in 4.1, the float voltage regulation from 0 % to 100 % of full load variation shall be not more than ± 0,5 %. The boost and equalize voltage regulation shall be within ± 1 % of the nominal input voltage. If the output voltage is automatically adjusted to meet the battery requirements at various temperatures, the above requirements need not be met.

4.2.3.2 For tests of output voltage regulation, see 5.5.

4.2.4 Parallel operation

If so specified in schedule A, the battery chargers shall be capable of operating in parallel.

4.2.5 Ripple voltage limits with resistive load

When a battery charger is tested in accordance with 5.10, the ripple voltage generated by the battery charger at the d.c. output terminals shall not exceed the values specified in schedule A. For this condition, the battery charger shall feed a resistive load of up to 100 % of the rated full load d.c. output current, with the battery disconnected.

4.2.6 Ripple current limits during charging of lead-acid batteries

4.2.6.1 When measured in accordance with 5.10, the maximum r.m.s. ripple current to the battery shall, in the case of valve-regulated cells, be as specified in schedule A.

4.2.6.2 In the case of vented cells, the maximum r.m.s. ripple current to the battery, when measured in accordance with 5.10, shall not exceed the following values:

a) 5 A per 100 A.h of the battery capacity during float charge; and

b) 20 A per 100 A.h of the battery capacity during boost and equalize charge.

4.2.7 Current-limiting facility

4.2.7.1 A battery charger shall have a current-limiting facility in order to enable it to limit its total output to the full load value, as specified in 4.2.8. The battery charger shall be capable of starting up or operating continuously at this value, without incurring any damage or causing the operation of any protective device.

4.2.7.2 The battery charging current shall be limited, automatically, to the preselected current values specified in schedule A, for all modes of operation.

4.2.7.3 The battery charger shall be capable of feeding into a short-circuit, without incurring any damage, until the protective device operates. This protection shall be tested in accordance with 5.9.

4.2.8 Rated output current

4.2.8.1 The rated output current of a battery charger shall be as specified in schedule A.

4.2.8.2 The load current or the duty cycle detailing maximum currents will be specified in schedule A. The maximum charge current to the battery for each of the ranges in 4.2.1.1 will be specified in schedule A. The number of output circuits required from the charger will be specified in schedule A.

When the battery charger is operating in the constant current mode, the current variation shall not exceed ± 5 %.

4.2.9 Radio frequency interference

The battery charger shall comply with the limits of radio frequency interference, as given in SANS 211. The test shall be conducted with the battery charger feeding into a resistive load under the most onerous condition. **Amdt 1; amdt 4**

4.2.10 Direct current (d.c.) system earthing

The type of d.c. system earthing will be specified in schedule A.

4.3 Controls, alarms and instruments

4.3.1 If so specified in schedule A, an interlock shall be provided on the equalize control switch, to prevent equalize charging if the battery ventilation fan (if fitted) is not operating, or if the load is still connected.

4.3.2 To prevent damage to the battery, a timer with a setting range of 24 h shall be provided to switch off the equalize charge.

4.3.3 A boost override facility shall be provided to maintain the charger in the float-only mode when the charger is used with valve-regulated cells.

4.3.4 Whether or not the load is to remain connected when the battery is on equalize charge, will be specified in schedule A. In a case where the load cannot operate at the equalize voltage, the load shall be connected through a suitable voltage dropping device to ensure that the rated d.c. output voltage at the load is not exceeded. The maximum and minimum voltage that the load can tolerate will be specified in schedule A.

4.3.5 Status indications and abnormal operating (alarm) conditions shall be indicated by means of visual or audible signals or both, as specified in schedule A.

4.3.6 Light-emitting diode type (LED) indicators shall be used for visual alarms. The colour shall be as follows:

a) a separate, clearly labelled, red LED, for each fault condition and each condition that requires immediate attention;

b) a separate, clearly labelled, amber LED, for each fault condition that does not require immediate attention;

c) a separate, clearly labelled, green LED, for a normal operating condition; and

d) a separate, clearly labelled, amber LED for a status indication.

4.3.7 If so specified in schedule A, a test facility shall be provided for the LEDs.

4.3.8 If so specified in schedule A, alarm indications shall remain until they are reset, even if the alarm initiating condition disappears.

4.3.9 Audible alarm requirements will be specified in schedule A, and shall have a facility for cancellation.

4.3.10 Other forms of visual alarm, such as liquid crystal display (LCD), video display units (VDUs) or print-outs, may be specified in schedule A, or proposed by the supplier in schedule B.

4.3.11 Each alarm or status indication condition shall energize the number of potential-free, changeover contacts, or isolated solid state device circuits, specified in schedule A. The type and rating of the contacts will be specified in schedule A.

4.3.12 Alarm and status indication contacts shall be so selected that failure of the sensing relays causes the alarm or indication condition to be displayed.

4.3.13 The required alarms and indicators will be specified in schedule A, and will be selected from the following:

a) **charger output failure alarm (red)**: an alarm to indicate loss of battery charger d.c. output for any reason, such as transformer failure, blown fuse(s), rectifier failure or any other shutdown;

b) **low d.c. voltage alarm (red)**: an alarm to indicate that the d.c. output voltage has decreased below a preset, adjustable level;

c) **high d.c. voltage alarm (amber)**: an alarm to indicate that the d.c. output voltage has increased above a preset, adjustable level;

d) **high d.c. voltage shutdown alarm (red)**: an alarm to indicate high d.c. voltage shutdown and a facility to shut down the battery charger if the output voltage exceeds a preset value. If a lock-out facility is required, the time delay and voltage requirements will be specified in schedule A;

e) **output voltage ripple alarm (amber)**: an alarm to indicate when the output voltage ripple exceeds a predetermined level specified in schedule A;

f) **a.c. power alarm (red)**: an alarm to indicate the loss of a.c. power, the loss of one or more phases of the a.c. input, incorrect phase sequence, or the a.c. input voltage exceeding the limits in 4.1;

g) **d.c. earth fault alarm (amber/red)**: an alarm to indicate an earth fault condition on either the positive or the negative side, for batteries with floating positive or negative poles or for batteries with an artificial mid-point earth;

h) **load disconnected alarm (red)**: an alarm to indicate that the load has been disconnected from the battery charger output terminals;

j) **battery loss alarm (red)**: an alarm to indicate that the battery has been disconnected from the battery charger output terminals;

k) **ventilation fan (if fitted) failure alarm (red)**: an alarm to indicate when a forced ventilation fan has failed;

l) **rectifier fuse fail alarm (red)**: an alarm to indicate the operation of a rectifier fuse;

m) **charger on equalize indicator (amber)**: an indication when the charger is operating under equalize conditions; and

n) **charger on float indicator (green)**: an indication when the charger is operating on float.

Other alarms or indications required, together with their colours, will be specified in schedule A.

4.3.14 Analogue or digital indicating instruments, such as voltmeters and ammeters, shall be of the type and accuracy as specified in schedule A.

4.3.15 Where remote instruments are required, full details will be specified in schedule A. The instruments shall be driven by transducers suitable for the required application, as stated in schedule B.

4.4 Components

4.4.1 Transformers and reactors

4.4.1.1 Transformers shall be of the double-wound dry type, with the primary winding galvanically isolated from the secondary winding(s).

4.4.1.2 If so specified in schedule A, an electrostatic screen that is connected to the earthing conductor direct shall be placed between the primary and secondary windings.

4.4.1.3 Windings of power transformers and smoothing reactors shall be treated to exclude moisture.

4.4.1.4 The insulation systems used for power transformers and smoothing reactors shall be suitable for use within the temperature limits specified in SANS 60146-1-3 and shall not break down when tested in accordance with 5.2.

4.4.2 Semiconductors

4.4.2.1 Semiconductor rectifying elements used in the convertor stage shall be adequately rated for their particular applications and to withstand the surge conditions on the a.c. input and the effects of a short-circuit on the output.

4.4.2.2 Rectifier diodes and thyristors used in the a.c./d.c. convertor stage shall be protected either by high-speed, high-rupturing capacity (HRC) fuses in accordance with the requirements of SANS 60269-4 or by current-limiting circuit-breakers.

4.4.3 Printed circuit boards

4.4.3.1 The printed circuit boards shall be made of material similar to epoxy fibreglass laminate, or better.

4.4.3.2 The printed circuit boards shall be suitably protected from the effects of moisture and dust.

4.4.3.3 All printed circuit boards shall be marked to allow the board type, and each individual component, to be readily identified.

4.4.3.4 Printed circuit boards shall be easily replaceable. Where boards are secured by screws or bolts, access to these screws or bolts shall not be obstructed, except by the enclosure.

4.4.3.5 Each plug-in board shall be polarized by means of a mechanical key, to prevent a card from being plugged into the wrong socket and to prevent a card from being inserted upside down.

4.4.3.6 Printed circuit boards shall be provided with rigid and positive support.

4.4.4 Electrolytic capacitors

Electrolytic capacitors shall be of the industrial grade that complies at least with the requirements of IEC 61071 or a similar, acceptable standard. **Amdt 4**

4.4.5 Electronic components

All electronic components shall be of an industrial grade, or as specified in schedule A.

4.4.6 Audible noise level

4.4.6.1 The A-weighted sound power level, in decibels (dB(A)), emitted by a battery charger shall be as specified in schedule A.

NOTE The attention of the manufacturer and the user is drawn to table 1 of SANS 10103, in which recommended sound and noise levels for different areas of occupancy/activity in non-residential indoor spaces are given.

4.4.6.2 When a battery charger is tested in accordance with 5.11, the A-weighted sound power level emitted by the battery shall not exceed the value specified in schedule A.

4.5 Construction requirements

4.5.1 Enclosure

4.5.1.1 A battery charger shall be housed in an enclosure, as specified in schedule A. Non-metallic enclosures shall be tested in accordance with 5.13, and shall show no signs of flammability or melting.

4.5.1.2 The material used for the enclosure and for parts of the enclosure (doors, casings, lids, covers and similar components) shall be of such a thickness as to provide strength and rigidity to prevent distortion.

4.5.1.3 Provision shall be made for opening the enclosure or parts of the enclosure, to facilitate cabling and to allow service access to all components that could require maintenance or replacement, without having to dismantle any other part of the circuitry. Access requirements will be specified in schedule A.

4.5.1.4 It shall not be possible to remove or withdraw any casing, lid, cover or similar component without the use of a key or tool. If so specified in schedule A, the enclosure shall be lockable.

4.5.1.5 All parts that carry hazardous voltages shall:

a) be shrouded or screened to prevent contact by service personnel; or

b) have warning labels, as specified in 6.4.3.

4.5.1.6 The enclosure shall have openings to allow natural or forced ventilation. If so specified in schedule A, forced ventilation is acceptable. Any opening in an enclosure shall be such that it affords a degree of protection of at least IP2X, in accordance with SANS 60529, or as specified in schedule A. **Amdt 2**

4.5.1.7 Facilities shall be provided for easy handling and transporting of the battery charger, such as removable lifting devices, or facilities for forklift handling, or other acceptable methods. The handling facilities offered and the gross mass of the heaviest item to be lifted shall be detailed in schedule B.

4.5.2 Protective earthing

4.5.2.1 The battery charger shall be provided with an earthing terminal which is clearly identified, in accordance with 6.2.4. The non-current-carrying metal parts shall be electrically connected to this terminal.

4.5.2.2 The earthing terminal shall be placed next to the a.c. input terminals. The current rating of the earthing terminal shall be at least that of the earth fault rating of the input or output cables connected to the battery charger.

4.5.2.3 Protective earthing conductors may be bare or insulated. If they are insulated, the insulation shall be green/yellow, except in the case of braided earthing straps, which may have transparent insulation.

4.5.2.4 The clamping means of a protective earthing terminal shall be locked against accidental loosening. It shall not be possible to loosen the clamping means without the use of a tool.

4.5.3 Terminations

The position, size and arrangement of input and output terminations shall be subject to an agreement between the purchaser and the supplier.

4.5.4 Terminals

4.5.4.1 The dimensions of mounting rails shall be to DIN standards or equivalent.

4.5.4.2 Terminals shall be provided for all external alarms specified in schedule A (see 4.3.13).

4.5.4.3 Plug-in type edge connectors or connection plugs used for terminals for printed circuit cards (PCCs) shall be such as to be acceptable. Details shall be stated in schedule B by the supplier.

4.5.4.4 The required conductor sizes for the a.c. input cable and d.c. output cable will be specified in schedule A.

4.5.5 Internal wiring

4.5.5.1 Where voltage drops are critical, the purchaser will specify his requirements in schedule A. Internal conductors between battery charger terminals and the charger load terminals shall comply with the requirements of the relevant parts of SANS 1507. The nominal cross-sectional area of internal conductors shall be such that the maximum permitted temperature rise of the conductor insulation is not exceeded. **Amdt 3**

4.5.5.2 Wireways or trunking shall be smooth and free from sharp edges. Conductors shall be so protected that they do not come into contact with parts such as burrs, cooling fins and moving parts that can damage conductor insulation. Holes in metal, through which insulated conductors pass, shall have smooth, well-rounded surfaces and shall have bushings or grommets.

NOTE In electronic assemblies, conductors are allowed to be in contact with wire wrapping posts if the breakdown of insulation will not result in a hazard, or if adequate mechanical protection is provided by the insulation system employed.

4.5.5.3 Wiring shall be neat and shall be braced, placed in trunking, and clipped or laced (or both) to prevent vibration and to ensure that the wiring does not deform under through-fault conditions. Connections to equipment on swing doors shall be so arranged as to give the conductor a twisting motion and not a bending motion.

4.5.5.4 Bare conductors shall be either so rigid and so fixed or so arranged that, under normal operating conditions, creepage distances and clearances cannot be reduced below the values specified in 4.6.1.

4.5.6 Protection of internal wiring and electronic equipment

4.5.6.1 In a battery charger, all internal wiring, including busbars, interconnecting cables, rectifiers and transformers, shall be protected against excess current and short-circuit by adequately rated overload protective devices that form an integral part of the battery charger.

4.5.6.2 Short runs of wiring not involved in the distribution path direct are exempt from the above requirement where it can be shown that no safety hazard is involved (for example, indicating circuits).

NOTE Devices for overload protection of components can also provide protection of associated wiring. Internal branch circuits might require individual protection, depending on reduced wire size and length of conductors.

4.5.7 Cable gland plates

4.5.7.1 Enclosures shall be designed for ease of access for the purposes of terminating and connecting cables.

4.5.7.2 Where so specified in schedule A, provision shall be made for insulated gland plates to allow cable screens to be separately earthed. In this case, the earthing terminal shall have provision for cable armouring to be galvanically connected.

4.5.7.3 Cable gland plates shall be removable and shall be made of corrosion-protected steel; they shall be left undrilled or, if so specified in schedule A, shall be drilled.

NOTE Among acceptable methods of treatment against corrosion are phosphating, galvanizing, sherardizing, zinc impregnation, and plating or spraying with copper, nickel, cadmium, silver, tin or zinc.

4.5.7.4 A drawing of the gland plate shall be provided before installation. The number of the drawing shall be stated in schedule B.

4.5.8 Bolts, nuts, screws and washers

4.5.8.1 All bolts, nuts, screws and washers used in the construction of a battery charger shall comply with the requirements of ISO 4014, ISO 4015, ISO 4016, ISO 4017, ISO 4018, ISO 4032, ISO 4033, ISO 4034 and ISO 4035, and shall be of an intrinsically corrosion-resistant metal or shall have been so treated as to render them resistant to corrosion. **Amdt 2**

4.5.8.2 Spaced-thread (sheet metal) or thread-cutting (self-tapping) screws shall not be used.

4.5.9 Workmanship and finish

4.5.9.1 If the purchaser has documented standards such as for workmanship and finish, these should be stated in detail in schedule A and should be included in the enquiry documents.

4.5.9.2 If the supplier is registered as working to SANS 9001, this should be stated in schedule B.
Amdt 2

4.6 Safety requirements

4.6.1 Clearance and creepage distances

4.6.1.1 All apparatus that forms part of a battery charger shall have clearances and creepage distances that comply with those given in a relevant SANS or IEC standard. These distances shall be maintained during normal service conditions. The apparatus within a battery charger shall be so arranged that the specified clearances and creepage distances are complied with, taking into account the relevant service conditions.

4.6.1.2 For bare, live conductors and terminations (e.g. busbars, interconnections between components, cable lugs), the clearances and creepage distances shall at least comply with those specified for the apparatus with which they are immediately associated.

NOTE Recommendations regarding the measurement of clearances and creepage distances are given in appendix D of SANS 1474.

4.6.2 Fault ratings

4.6.2.1 Busbars and conductors between busbars and the supply side of a single functional unit shall be rated to withstand the combined fault currents of both the charger and the battery for the time required by the protective device to clear the fault. The fault levels of the input circuit and the battery shall be as specified in schedule A.

4.6.2.2 All components and interconnections shall be protected by moulded-case circuit-breakers (MCCBs), fuses or similar devices, against fault currents within their circuits or in the a.c. input or d.c. output circuits.

4.6.2.3 When so specified in schedule A, the battery charger shall be protected against a reversed battery connection. This shall include protection of all the auxiliary circuits within the battery charger. The methods of protection shall be stated in schedule B.

4.7 Abnormal service conditions

Where a battery charger is to be used under conditions different from those specified in the scope, the manufacturer shall be consulted. This applies in cases of installations under unusual service conditions, as listed below. The design and manner of use of a battery charger intended to be used under these circumstances should be subject to an agreement between the purchaser and the supplier. The purchaser will specify, in schedule A, which, if any, of these or of the following other conditions apply:

a) exposure to damaging fumes;

b) exposure to vapours of oil or other substances;

c) exposure to excessive moisture;

d) exposure to steam;

e) exposure to weather or high humidity;

f) exposure to salt air;

g) exposure to excessive dust;

h) exposure to abrasive dust;

j) exposure to abnormal vibration, shocks, or tilting during transportation or operation;

k) exposure to unusual transportation or storage conditions;

l) exposure to unusual electromagnetic fields;

m) operation at ambient temperature below 0 °C or above 40 °C;

n) operation at altitudes that exceed 1 800 m above sea level;

p) exposure to abnormal radiation;

q) exposure to insects, vermin or fungi;

r) operation with switching or negative resistance loads;

s) limits of input supply voltage exceeding ± 10 %;

t) phase voltage imbalance, if exceeding 5 % of rated voltage.

4.8 Harmonics

The question of harmonic suppression and measurement has been left for future consideration.

4.9 Protection against corrosion

4.9.1 General

All surfaces of the battery charger and other non-current-carrying parts, including screws, nuts, bolts and washers, that are not of a material that is inherently corrosion resistant, shall be protected from corrosion by application of a suitable paint or coating system that satisfies the requirements of the test given in 5.12, whether or not this test is specified.

4.9.2 Surface preparation

All holes shall have been punched, drilled or tapped prior to the coating of the surfaces. Surfaces shall be free from burrs and sharp edges and shall have been prepared in accordance with SANS 10064. **Amdt 4**

NOTE The above is not applicable to prototype and one-off orders.

4.9.3 Paint/coating

The paint/coating processes adopted shall comply with the paint/coating manufacturer's recommendations and shall take account of the intended conditions of use, the environment and the maintenance of the battery charger.

4.9.4 Method(s) of painting and coating

It is recommended that the purchaser discuss the method(s) of painting and coating with the battery charger manufacturer as well as with the paint/coating manufacturer, especially when the service conditions are abnormal (see 4.7).

The paint/coating finish shall be smooth, uniformly applied and free from visible defects. The method of applying and finishing shall be stated in schedule B.

4.9.5 Colour

4.9.5.1 All external surfaces of the enclosure shall be finished in the colour specified in schedule A in accordance with SANS 1091.

4.9.5.2 The colour of internal surfaces of the enclosure shall be as specified in schedule A and may be the same colour as the external surfaces. If the colour of the external surfaces is dark, a white interior is preferred.

4.10 Spares

4.10.1 A comprehensive, individually priced spare parts list shall be provided by the supplier before delivery, to allow the purchaser to request any spares to be delivered with the equipment.

4.10.2 The supplier shall maintain spare parts for the battery charger for a period of ten years from the date of delivery and shall guarantee this in schedule B.

5 Inspection and methods of test

5.1 Inspection

Visually examine each battery charger for compliance with all the requirements of the standard, for which tests to assess compliance are not given in 5.2 to 5.13 (inclusive).

5.2 Dielectric strength test

5.2.1 Requirements

When tested in accordance with 5.2.2 to 5.2.4, the insulation of a battery charger shall withstand, for 1 min, without breakdown or flashover, the appropriate of the following test voltages:

a) **main circuit and auxiliary circuits that are so rated as to be suitable for connection to the main circuit**: the test voltage given in column 2 of table 3, appropriate to the rated voltage of the battery charger given in column 1.

Table 3 — Dielectric test voltage (main circuit)

1	2
Rated voltage *U* V	**Dielectric test voltage** r.m.s., V
60 < $U \leq$ 300 300 < $U \leq$ 660	2 000 2 500

Amdt 2

b) **auxiliary circuits that are so rated as to be unsuitable for connection to the main circuit**: the test voltage given in column 2 of table 4, appropriate to the rated voltage of the auxiliary circuit given in column 1.

Table 4 — Dielectric test voltage (auxiliary circuits)

1	2
Rated voltage *U* V	**Dielectric test voltage** r.m.s., V
$U \leq 60$	500
$60 < U \leq 125$	1 000
$125 < U \leq 250$	1 500
$250 < U \leq 500$	2 000

5.2.2 Apparatus

High voltage test transformer, that

a) has a rating of at least 500 VA,

b) operates at a frequency of 50 Hz,

c) is capable of supplying a waveform as nearly sinusoidal as is practicable,

d) has an output current of at least 40 mA at the appropriate of the test voltages given in tables 3 and 4, and

e) has limits of error of the high voltage indicating voltmeter not exceeding 3 %.

5.2.3 Preparation of battery charger

NOTE Plug-in printed circuit boards and modules that have multi-point connectors may be withdrawn, disconnected or replaced by dummies during this test.

WARNING: When a battery charger is being prepared for test, it is vital to ensure that good contact is made at all electrical connections.

5.2.3.1 Connect together the main terminals of the battery charger assemblies, as well as the anode, cathode and gate terminals of all semiconductor devices used in the assemblies.

5.2.3.2 Do not disconnect auxiliaries (auxiliary transformers, measuring equipment, pulse transformers and instrument transformers) through which, in the case of an insulation fault, voltage could be impressed onto accessible parts not connected to the enclosure, or the voltage could be impressed from the higher voltage side to the lower voltage.

5.2.3.3 Connect to the enclosure those auxiliaries not connected by means of metal parts to the main circuits (for example, system control equipment, motors of fans).

5.2.3.4 Close or bridge switchgear and controlgear in the main circuits.

5.2.3.5 In the main circuits, disconnect all voltage surge arresting devices and components of radio frequency interference (RFI) filters liable to be damaged during the test.

5.2.3.6 Ensure that the battery charger is at an ambient temperature of 10 °C to 40 °C and measure and record the actual ambient temperature in accordance with 5.6.4.

5.2.4 Procedure

5.2.4.1 Apply the test voltage between each electrically separate circuit of the battery charger (in turn) and the metal enclosure connected to the terminals of all the other electrically separate circuits.

5.2.4.2 Start the test at a voltage not exceeding one-third of the appropriate test voltage given in column 1 of table 3 or in column 1 of table 4. Increase the voltage to the full test voltage within 3 s, as rapidly as is consistent with its value being indicated truly by the measuring instrument. Maintain the test voltage for 1 min and then reduce it to not more than one-third of this value before switching off. Check for compliance with 5.2.1. One minute after this test, measure the insulation resistance in accordance with 5.3.

5.3 Insulation resistance test

5.3.1 Requirements

When measured in accordance with 5.3.2 to 5.3.4, the insulation resistance between input terminals connected together and the earthing terminal, and between the output terminals connected together and the earthing terminal shall be at least 2 MΩ.

5.3.2 Apparatus

Insulation tester (an ohmmeter), capable of measuring insulation resistance at a d.c. voltage of at least 100 V but not exceeding 500 V, with limits of error not exceeding 5 %.

5.3.3 Preparation of battery charger

5.3.3.1 Connect the main circuits as in 5.2.3.

5.3.3.2 Disconnect any intentional grounding resistors.

5.3.4 Procedure

Measure the insulation resistance between the input terminals connected together and the earthing terminal, and between the output terminals connected together and the earthing terminal. Record the d.c. voltage at which the insulation resistance was measured and check for compliance with 5.3.1.

5.4 DC output voltage adjustment range test

Ensure that the controls enable continuous adjustment of the level of d.c. output voltage over the following ranges:

a) **Floating voltage adjustment range**: the range for this control at nominal a.c. input voltage and half-load shall be as shown in column 3 of table 2, multiplied by the number of series-connected cells for which the charger is intended. Follow the battery manufacturer's instructions for the proper voltage setting (see the note to table 2).

b) **Equalizing voltage adjustment range**: when provided, the range of this control, at rated a.c. input voltage and hold load, shall be as shown in column 5 of table 2, multiplied by the number of cells for which the charger is intended. Follow the battery manufacturer's instructions for the proper voltage setting (see the note to table 2).

c) Check for compliance with 4.2.2.

5.5 DC output voltage regulation tests

Carry out the d.c. output voltage regulation test at 110 % of the rated input voltage and also at 90 % of the rated input voltage of the battery charger as follows:

While the battery charger is being subjected to the a.c. input conditions of 110 % of the rated input voltage and also at 90 % of the rated input voltage at 50 Hz ± 5 %, and the load variations of 0 % to 100 %, ensure that the d.c. output voltage is maintained as follows:

a) **Floating voltage regulation test**: when a battery is being float charged at a voltage shown in column 3 of table 2, multiplied by the number of cells for which the battery charger is intended, the regulation shall not exceed ± 0,5 % (see 4.2.3).

b) **Equalizing voltage regulation test**: when a battery is being equalize charged at a voltage shown in column 5 of table 2, multiplied by the number of cells for which the battery charger is intended, the regulation shall not exceed ± 1 % (see 4.2.3).

5.6 Temperature rise test

5.6.1 Requirements

When determined in accordance with 5.6.2 to 5.6.5, the temperature rise of parts of a battery charger listed in column 1 of table 5 shall not exceed the appropriate value given in column 2.

5.6.2 Test circuit

The test circuit comprises

a) an a.c. power supply that has

   1) a frequency of 50 Hz,

   2) low impedance (as seen from the input side of the battery charger),

   3) a prospective short-circuit current of at least 30 times the rated input current of the battery charger,

   4) the same number of phases as that of the battery charger under test,

   5) adjustability within the range of at least ± 10 % of the rated input voltage of the battery charger, and

   6) an a.c. voltmeter that is capable of measuring the r.m.s. value of the input voltage of the battery charger to an accuracy within 1 %;

b) an adjustable resistor;

c) a d.c. voltmeter and a d.c. ammeter, both capable of reading to an accuracy within 1 %;

d) PVC-insulated copper conductors of cross-sectional area as given in table 6, appropriate to the rated current of the battery charger; and

e) the battery charger under test.

5.6.3 Preparation of battery charger

5.6.3.1 Mount the battery charger as for normal service (in accordance with the manufacturer's instructions) and ensure that the battery charger is protected from undue external heating or cooling.

5.6.3.2 Make the connections to the input and output terminals (in the case of a battery charger that has input and output terminals) by means of single-core PVC-insulated copper conductors of cross-sectional area as given in table 6, appropriate to the rated current of the battery charger. Ensure that the length of each temporary connection (from terminal to terminal) is at least 1 m for cross-sections not exceeding 10 mm^2 and at least 2 m for cross-sections exceeding 10 mm^2. Space the temporary connections at a distance not exceeding the distance between the terminals. Connect the resistor to the output, and so adjust the resistor as to obtain the rated full load d.c. output current at the rated d.c. output voltage.

5.6.3.3 Connect thermocouples to the relevant parts of the battery charger listed in table 5. Ensure good heat conductivity between each thermocouple and the surface of the part under test, protect thermocouples from external cooling, and ensure that the protected area forms a negligible portion of the cooling area of the part under test.

In the case of a power transformer (rectifier transformer), connect at least three thermocouples to the top of the transformer windings and space them evenly along the radius of the windings at a position that has been determined by any acceptable method (e.g. a hand-held temperature measuring probe) as the most onerous condition.

In the case of smoothing chokes, so connect at least three thermocouples to the top of the choke winding (as for power transformers) as to represent the most onerous condition of testing.

5.6.4 Measurement of ambient temperature

Measure the ambient temperature by means of at least two thermometers or thermocouples equally distributed about the battery charger, at points about half-way between the top and bottom of the battery charger, and at a distance of 1 m to 2 m away from it, and protected from stray air currents and heat radiations by being placed in suitable containers filled with approximately 250 mL of transformer oil.

5.6.5 Procedure

5.6.5.1 Energize the battery charger at the maximum rated input voltage as stated by the manufacturer. Maintain the d.c. output current within 2 % of the rated value (at the rated d.c. output voltage) for a period sufficient for the temperature (as indicated by the thermocouple connected to the semi-conductor device) to reach a steady value, but not exceeding 8 h. Deem steady temperature to have been reached when the temperature variation does not exceed 1 °C over a period of 1 h.

5.6.5.2 Record and report the air temperature at the air outlet opening(s) of the battery charger. During the last quarter of the test period, note the temperature indicated by each of the thermocouples and subtract the ambient temperature (measured in accordance with 5.6.4) from these temperatures, to obtain the temperature rises of the relevant parts of the battery charger. Check for compliance with 5.6.1.

5.6.5.3 As soon as possible after completion of the temperature rise test, carry out the power efficiency test (see 5.7) with the battery charger at its normal operating temperature.

Table 5 — Temperature rise limits of battery charger parts

1	2
Part of battery charger	**Temperature rise above an ambient temperature of 40 °C** K
Built-in components[1)]	In accordance with the relevant requirements for the individual components, if any, or in accordance with the manufacturer's instructions, taking into consideration the temperature in the battery charger
Terminals for external insulated conductors	70[2)]
Busbars and conductors	Limited by: – mechanical strength of conducting material – possible effect on adjacent equipment – permissible temperature limit of the insulating materials in contact with the conductor – the effect of the temperature of the conductor on the apparatus connected to it
Manual operating means: – of metal – of insulating material	 15[3)] 25[3)]
Accessible external enclosures and covers: – metal surfaces – insulating surfaces	 30[4)] 40[4)]
Insulated windings of dry-type power transformers and smoothing chokes that have insulation of class: F H	Measured by means of thermocouple applied direct to the insulation of the winding: 85[5)] 105[5)]

1) The term "built-in components" means: conventional switchgear and controlgear; electronic subassemblies (e.g. rectifier bridge, printed circuit); and parts of the equipment (e.g. regulator, stabilized power supply unit, operational amplifier).

2) The temperature rise limit of 70 K is a value based on the conventional test given in 5.6. A battery charger used or tested under installation conditions could have connections, the type, nature and disposition of which will not be the same as those adopted for the test, and a different temperature rise of terminals could result and might be required or accepted.

3) Manual operating means within a battery charger, which are only accessible after the battery charger has been opened.

4) Unless otherwise specified in the case of covers and enclosures that are accessible but need not be touched during normal operation, an increase of 10 K in the temperature rise limits is permissible.

5) Because of the possibility of a contact having been made at a "hot spot" (an isolated hot position not indicative of the general temperature of the transformer or the choke), the temperature rise measured by means of a thermocouple could exceed the appropriate value. In such a case, provided that the appropriate value has not been exceeded by more than 20 °C by any one out of three or more thermocouples, the temperature rise shall be deemed satisfactory.

Table 6 —Size of copper conductors for temperature rise test

1	2
Rated current of battery charger unit *I* A	**Cross-sectional area of single-core copper conductors** mm^2
< *I* ≤ 6	1
6 < *I* ≤ 12,5	1,5
12,5 < *I* ≤ 20	2,5
20 < *I* ≤ 25	4
25 < *I* ≤ 32	6
32 < *I* ≤ 50	10
50 < *I* ≤ 63	16
63 < *I* ≤ 80	25
80 < *I* ≤ 100	35
100 < *I* ≤ 125	50
125 < *I* ≤ 160	70
160 < *I* ≤ 200	95
NOTE For a rated d.c. output current that exceeds 200 A, use copper conductors specified for the temperature rise test as given in SANS 60947-3 or SANS 60269-1.	

Tech. corr. 1; amdt 3

5.7 Power efficiency test

5.7.1 Requirements

The power efficiency (the ratio of active power output to the active power input) expressed as a percentage shall be not less than the guaranteed value stated in schedule B. The guaranteed efficiency shall not exceed the actual power efficiency of the battery charger, determined in accordance with 5.7.2 to 5.7.4, by the greater of the appropriate of the following percentages and 0,7 %:

Output of battery charger kVa	Difference %
Not exceeding 50	0,15 (100 % – η)
Exceeding 50	0,10 (100 % – η)

where η is the guaranteed efficiency, expressed as a percentage.

5.7.2 Test circuit

As in 5.6.2, and including wattmeters that are capable of measuring power, with harmonic components of voltage and current (for example, r.m.s. reading digital wattmeters) within the range of the battery charger under test, to within 1 %.

5.7.3 Preparation of battery charger

As in 5.6.3.

5.7.4 Procedure

5.7.4.1 With the rated input voltage applied to the battery charger, use the wattmeter(s) to measure the active input power (i.e. the sum of the power of fundamental frequency components of voltage and current and the power of the harmonic components). Measure the d.c. output power of the battery charger, using the d.c. ammeter and the d.c. voltmeter both at the full rated load and at half the rated load.

5.7.4.2 Take the power efficiency *P*, as a percentage, of the battery charger to be as follows:

$$P = \frac{I_2\, V_2}{W_1} \times 100$$

where

W_1 is the active input power, in watts;

I_2 is the rated d.c. output current, in amperes; and

V_2 is the rated d.c. output voltage, in volts.

5.7.4.3 Check for compliance with 5.7.1.

5.8 Test for protection against lightning surges (optional)

5.8.1 Test circuit of voltage impulse generator

The schematic diagram of a suitable voltage impulse generator is shown in figure 1. Other test circuits capable of producing the specified waveform may also be used, provided that the energy of the impulse does not exceed 0,5 J at 6 kV.

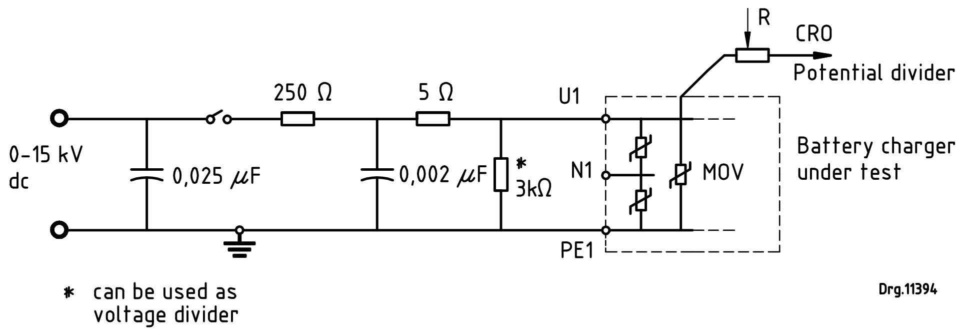
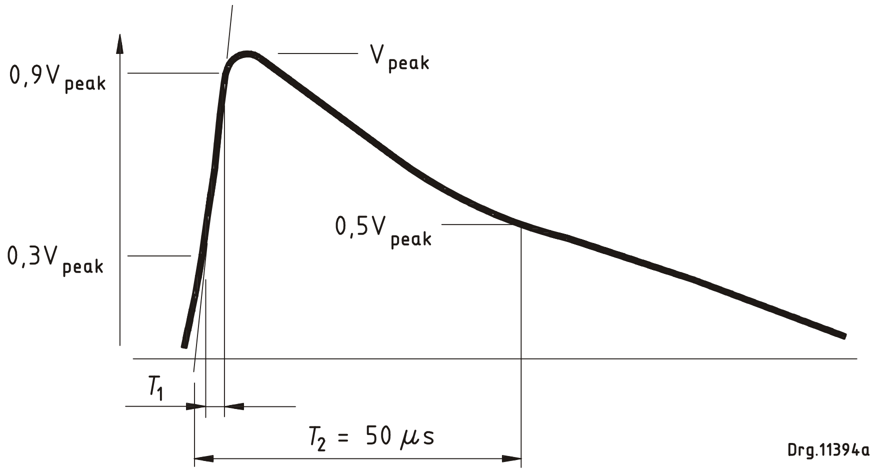


Figure 1 — Voltage impulse generator

5.8.2 Waveform of voltage impulse

The open-circuit waveform of the voltage impulse is shown in figure 2.



$T_1 \times 1{,}67 = 1{,}2\ \mu s$

Figure 2 — Open-circuit voltage impulse waveform

5.8.3 Test circuit of current impulse generator

The schematic diagram of a suitable current impulse generator is shown in figure 3. Other test circuits capable of producing the specified waveform may also be used.

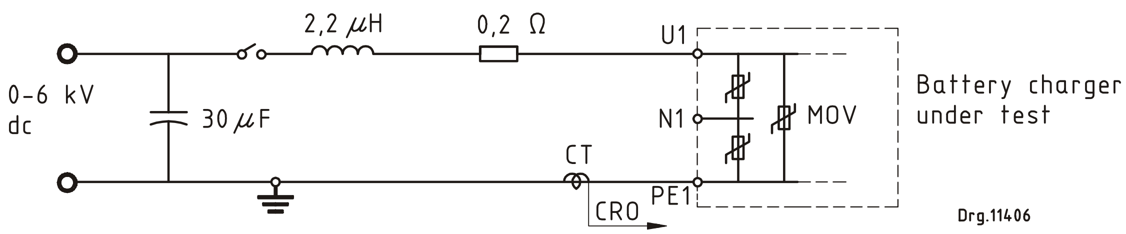


Figure 3 — Current impulse generator

5.8.4 Waveform of current impulse

The current impulse discharge waveform is shown in figure 4. Ensure that a current impulse whose virtual time T_1 is 1,25 times the interval between the instance when the impulse is 10 % and 90 % of its peak value, does not differ from its specified value by more than the following tolerances:

a) virtual front time T_1 ± 1 µs;

b) time to half value of wavetail T_2 ± 2 µs; and

c) peak value ± 10 %.

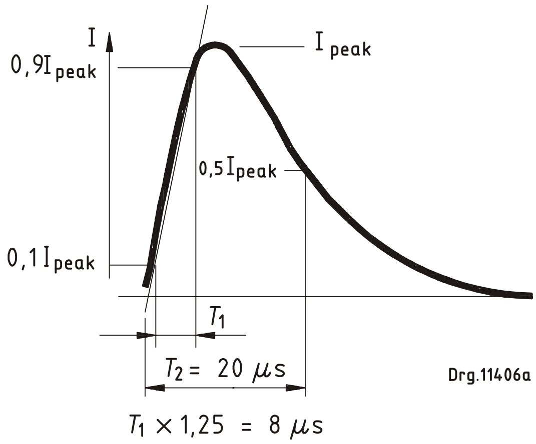


Figure 4 — Current impulse discharge waveform

Amdt 2

5.8.5 Procedure

5.8.5.1 1,2/50 µs voltage impulse

5.8.5.1.1 Adjust the voltage impulse generator to produce an open-circuit impulse of waveform and amplitude as shown in figure 2.

5.8.5.1.2 Disconnect the battery charger from the a.c. power supply and apply 10 successive voltage impulses, at approximately 10 s intervals, between the battery charger input live terminal and the input earthing terminal. Use an oscilloscope to record the clamping voltage of each impulse and take the average value as the clamping voltage recorded between the input live terminal and the earthing terminal of the battery charger. In the case of a three-phase battery charger, apply 10 impulses between each input live terminal and the input earthing terminal. Check for compliance with the relevant requirements of 4.1.4.

5.8.5.1.3 Apply 10 successive voltage impulses, at approximately 10 s intervals, between the battery charger input live terminal and the input neutral terminal, and also 10 successive voltage impulses between the battery charger input neutral terminal and the input earthing terminal. Calculate the average clamping voltage recorded in each case (as in 5.8.5.1.2). Check for compliance with the relevant requirements of 4.1.4.

5.8.5.2 8/20 µs current impulse

5.8.5.2.1 Connect the current impulse generator to the battery charger as shown in figure 3.

5.8.5.2.2 Apply a calibrating 8/20 µs current impulse with a peak current not exceeding 1 500 A, by suitably adjusting and noting the value of the d.c. voltage to the capacitor. Preferably do not apply more than three current impulses to the battery charger during the calibration.

5.8.5.2.3 After establishing the d.c. voltage necessary to achieve the specified amplitude of the peak current impulse, apply 10 successive current impulses at approximately 30 s intervals. Use an oscilloscope to record the peak current impulse and the resulting clamping voltage during each impulse. Calculate the energy absorbed by the surge arresting device of the battery charger as follows:

$$E = V_c I_p \tau$$

where

E is the energy absorbed, in joules;

V_c is the average clamping voltage, in volts;

I_p is the peak current impulse, in amperes; and

τ is the pulse width, in seconds.

Check for compliance with the relevant requirements of 4.1.4.

5.8.5.2.4 With the current impulse generator connected in turn to the battery charger between

a) the input live terminal and the input neutral terminal,

b) the input live terminal and the input earthing terminal,

c) the input neutral terminal and the input earthing terminal,

proceed as in 5.8.5.2.2 and 5.8.5.2.3 and calculate the energy absorbed by the surge arresting device of the battery charger in each case.

Check for compliance with the relevant requirements of 4.1.4.

5.9 Short-circuit test on output terminals

5.9.1 Requirements

When a battery charger is tested in accordance with 5.9.2, it shall be capable of withstanding the short-circuit condition by means of either a current limit feature, or operation of an output circuit-breaker or a fuse. Upon removal of the short-circuit across the output terminals, the output voltage shall return to normal value without any immediate or future degradation in the performance of the battery charger. (See also 4.2.7.)

5.9.2 Procedure

5.9.2.1 Disconnect the battery from the battery charger.

5.9.2.2 Disconnect the battery charger from the supply mains.

5.9.2.3 Use a suitable size of copper wire to short-circuit the output terminals of the battery charger.

5.9.2.4 Connect the battery charger to the supply mains at the rated voltage, and energize the battery charger for a period of at least 60 s.

5.9.2.5 Remove the short-circuit from the output terminals and measure the output voltage after switching on the output circuit-breaker, or after replacing the fuse.

5.9.2.6 Examine the battery charger for any visible signs of damage to the relevant components of the battery charger.

5.9.2.7 Check the performance of the battery charger by charging the battery at the maximum load current and at the rated load current.

5.9.2.8 Check for compliance with 5.9.1 above.

5.10 Ripple voltage limits and ripple current limits test

5.10.1 Test circuit

As in 5.6.2, and including an oscilloscope, an adequately rated current shunt and the battery for which the battery charger is intended.

5.10.2 Preparation of battery charger

As in 5.6.3.1 and 5.6.3.2 in the case of the ripple voltage limits test, but for the ripple current limits test, replace the load resistor by the battery connected in series with the current shunt.

5.10.3 Procedure

5.10.3.1 Ripple voltage limits

With the load resistor drawing (from the battery charger) the rated full load current at the rated output voltage, measure, by using the oscilloscope or other equivalent means, the r.m.s. value of ripple voltage. Check for compliance with 4.2.5.

5.10.3.2 Ripple current limits

Using the oscilloscope and the adequately rated current shunt or other equivalent means, measure the r.m.s. value of ripple current flowing into the battery during the float charge and also during the boost charge or equalize charge. Also record, in each case, the corresponding mean value of the pulsating direct current flowing to the battery, using the d.c. ammeter. In each case, take the ratio of the r.m.s. ripple current to the mean value of the direct current as the relative ripple current content, and express the ratio as a percentage by multiplying by 100 %. Alternatively, express the r.m.s. ripple current per 100 A.h of the battery capacity.

Check for compliance with 4.2.6.

5.11 Audible noise level test

With the battery charger operating at a resistive load of approximately 100 % of the rated full load current, use the method given in SANS 3744 to determine the A-weighted sound power level of the battery charger. Check for compliance with 4.4.6. **Amdt 1**

5.12 Salt fog test (optional)

5.12.1 Requirements

After the test panels have been exposed in the salt fog chamber for 168 h, the underlying metal shall show no visible signs of corrosion.

5.12.2 Procedure

Refer to SANS 7253, except that the three coated test panels shall be representative of the typical coating of the enclosure of the battery charger, and shall be supplied by the manufacturer of the battery charger. **Amdt 3**

5.13 Glow-wire test on non-metallic enclosures

5.13.1 Apparatus

As in IEC 60695-2-10.

5.13.2 Procedure

Carry out the test on a non-metallic enclosure of the battery charger, in accordance with IEC 60695-2-11. The temperature of the glow-wire tip shall be 550 °C and the duration of the application of the hot-wire tip to the enclosure shall be 30 s ± 1 s.

5.13.3 Results

Assess and report the results of the test in accordance with IEC 60695-2-11 and check for compliance with 4.5.1.1.

6 Marking/labelling/documentation

6.1 Rating plates

6.1.1 Rating plates of the battery charger shall be of intrinsically corrosion-resistant material, and shall bear the following in legible and indelible marking:

a) the manufacturer's name or logo;

b) the manufacturer's type number;

c) the date of manufacture;

d) the manufacturer's serial number;

e) the rated a.c. input voltage and tolerance band;

f) the rated a.c. input current;

g) the number of phases;

h) the rated frequency (i.e. 50 Hz);

j) the rated d.c. output voltage, or number and type of cells, or both; and

k) the rated d.c. output current.

6.1.2 Rating plates shall be permanently affixed in a prominent position on the battery charger.

6.2 Function labels

6.2.1 All instruments, meters, fuses, control switches and luminous indicators, the functions of which are not identified by signs or pictograms, shall be clearly labelled to indicate their functions. All labels shall be permanently and securely attached, as detailed in schedule B.

6.2.2 Fuse labels shall include the fuse rating and class designation.

6.2.3 Operating switch positions shall be clearly marked on all switching devices.

6.2.4 Earthing terminals shall be permanently and indelibly marked with the symbol ⏚ (SANS 60947-1) with black lines on a yellow background, or with the letters PE placed next to the terminal.

6.2.5 Operation labels shall be clearly visible to the operator when he is standing in the normal operating position.

6.3 Identification of external terminals

6.3.1 Alternating current (a.c.) input supply terminals

The preferred terminal markings are given below, but the actual terminal markings used may be otherwise specified in schedule A:

a) terminals for a single-phase system: U, N; and

b) terminals for a three-phase system: U, V, W, N.

6.3.2 Direct current (d.c.) output terminals

The d.c. output terminals shall be marked as follows:

a) the plus sign (+) for the positive terminal; and

b) the minus sign (–) for the negative terminal.

6.4 Other labels

6.4.1 When so specified in schedule A, instruction labels in at least English or Afrikaans or in pictogram form, shall be provided on the front of the battery charger, to indicate to the operator the operating function of the battery charger.

6.4.2 When so specified in schedule A, each battery charger shall bear a label with the purchaser's identification number.

6.4.3 The standard danger notice (type WW of SANS 1186-1) shall be prominently displayed outside and inside the enclosure and shall be readily visible when the battery charger is installed for normal service.
Amdt 2

6.5 Documentation

The supplier shall provide the following documentation and shall supply the number of copies specified in schedule A:

a) a final schematic diagram, with all parts suitably identified;

b) a wiring diagram, showing the "as installed" connections;

c) installation instructions;

d) an instruction manual containing comprehensive instructions for the operation of the battery charger, fault tracing guide and maintenance instructions. The manual shall also contain a complete set of drawings for the battery charger;

e) a detailed list of parts and equipment incorporated in the battery charger, together with their ratings, part number, type and manufacturer; and

f) a dimensional outline drawing.

Annex A
(informative)

Guide to purchasers on preparing an enquiry

A.1 General

A model form is given in annex B to provide the purchaser with a convenient aid to purchasing. The use of this form is intended to obviate the need for preparing a detailed technical specification.

The purchaser need only specify compliance with this standard, provide the tenderers with details of his particular requirements, and set out the information he requires the tenderer to provide, as indicated below.

NOTE It is assumed that tenderers are in possession of this standard.

A.2 Schedules

The model form in annex B provides the purchaser with examples of a schedule A and a schedule B. In his enquiry, the purchaser should provide his own schedule A and schedule B, based on these examples.

A.2.1 Schedule A

Schedule A lists the requirements to be specified by the purchaser in enquiries and orders. These requirements include references to the relevant subclauses of this standard, to assist in compiling the schedules.

Where the text of any referenced standards stipulates that the purchaser shall indicate his requirements, these requirements should also be specified in schedule A.

The purchaser should set out his particular requirements and choices in his own schedule A.

A.2.2 Schedule B

The purchaser should draw up his own schedule B (based on the schedule B in the model form), and require the tenderer to fill in this schedule. By doing this, the tenderer will be stating compliance with this standard and will provide the information the purchaser has requested.

NOTES

1 Where this standard allows the purchaser to make a choice, the example of schedule A (in the model form in annex B) lists the preferred items/values/quantities. In the interests of standardization, purchasers are encouraged not to deviate from these preferences.

2 When preparing his own schedule A and schedule B from the examples in the model form in annex B, the purchaser need only include the items he considers to be relevant or necessary.

3 These schedules, when completed, become normative annexes to the enquiry specification.

A.3 Commercial conditions

A purchaser will furthermore need to indicate the commercial conditions applicable and draw up a price schedule. Requirements for delivery, storage, packing and marking should be attended to in this part of the enquiry.

A.4 Quality assurance

The specification does not cover the purchaser's possible requirements in respect of quality assurance, quality control, inspections, etc., since each purchaser needs to consider the criticality of the application of each component, his own policy towards these matters, etc. The purchaser is referred to SANS 9001 for guidance. **Amdt 2**

A.5 Testing

Attention should be paid to the subject of tests, and their related costs. Tests should be carried out by a competent party and tenderers should be requested to provide assurances on this point. Price schedules should be drawn up and covering letters so worded that the costs of all services such as tests, delivery and spares are declared and allowed for in the tender.

When samples are being tested for routine tests, the number of samples used and the frequency of sample testing should be agreed upon with the supplier.

A.6 Revision of standards used as normative references

This standard, as has been indicated, is based on a set of defined standards which may have been revised or amended. It may be expected that most purchasers would in principle wish to employ the latest standards. It is recommended that an approach to this question be to secure an undertaking from a supplier to review the latest versions and amendments and to incorporate these where possible and agreeable to both parties. A blanket commitment to work to the "latest" versions of standards creates risks for both parties and should be properly assessed. This invariably cannot be done in the time available. A blanket commitment to use the "latest" versions of standards creates legal difficulties of interpretation.

Annex B
(informative)

Model form for schedules A and B

This model form is provided as a convenient aid to purchasing. Guidance in preparing an enquiry using this form is given in annex A.

SCHEDULE A: Purchaser's particular requirements

SCHEDULE B: Guarantees and technical particulars of equipment offered

1	2	3	4	5
Item	**Clause**	**Description**	**Schedule A**	**Schedule B**
B.1	1.2	Service conditions a) ambient air temperature Max. °C Min. °C b) altitude up to m c) relative humidity Max. %	 40/_____ 0/_____ 1 800 85/_____	 xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx
B.2		High lightning area	YES/NO	xxxxxxxxxx
B.3	4.1.1	Details of a.c. input supply a) nominal frequency b) nominal voltage V c) full load current A d) number of wires	 50 Hz ± 2,5 Hz __________ xxxxxxxxxx __________	 xxxxxxxxxx xxxxxxxxxx __________ xxxxxxxxxx
B.4	4.1.1.4	details of earthing a.c. input system	__________ __________ __________	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx
B.5	4.1.2.1	Is overload and earth fault protection provided? a) if NO, requirements for short-circuit protection b) if YES, details of protective devices provided	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx	YES/NO __________ __________ __________ __________ __________ __________
B.6	4.1.3.4	a) type of disconnect device	__________	xxxxxxxxxx
B.7	4.1.3.5	b) are key-operated locks on disconnect devices required? If NO, other method required	YES/NO __________	xxxxxxxxxx xxxxxxxxxx
B.8	4.1.4.1	Are surge arresting devices required?	YES/NO	xxxxxxxxxx

1	2	3	4	5
Item	**Clause**	**Description**	**Schedule A**	**Schedule B**
B.9	4.2.1.1	Battery requirements a) nominal d.c. voltage V b) battery float voltage V c) battery boost voltage V d) battery equalize voltage V e) battery initial charge voltage V f) is initial charge capability required?	 __________ __________ __________ __________ __________ YES/NO	 __________ __________ __________ __________ __________ __________
B.10	4.2.1.2	a) type of battery b) number of cells c) ampere-hour capacity A.h	__________ __________ __________	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx
B.11	4.2.1.4	DC load a) maximum load voltage permissible V b) minimum load voltage permissible V c) maximum load current permissible A d) rated load current A	 __________ __________ __________ __________	 xxxxxxxxxx xxxxxxxxxx __________ __________
B.12	4.2.2	Type of output voltage adjustment	manual/auto	xxxxxxxxxx
B.13	4.2.4	Are chargers to operate in parallel?	YES/NO	xxxxxxxxxx
B.14	4.2.5	Maximum r.m.s. ripple voltage on d.c. output %	__________	__________
B.15	4.2.6.1	Maximum r.m.s. ripple current mA	__________	__________
B.16	4.2.7.2	a) limit of battery charging current A b) battery float current A c) battery boost current A d) battery equalize current A	__________ __________ __________ __________	__________ __________ __________ __________
B.17	4.2.8.1	Rated output current of battery charger A	__________	__________
B.18	4.2.8.2	Maximum load current A Duty cycle Maximum currents for: a) float charge A b) boost charge A c) equalize charge A d) initial charge A Number of output circuits	__________ __________ __________ __________ __________ __________ __________	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx
B.19	4.2.10	Type of d.c. system earthing	__________	xxxxxxxxxx
B.20	4.3.1	Is an interlock on the equalize control switch required?	YES/NO	xxxxxxxxxx

1	2	3	4	5
Item	**Clause**	**Description**	**Schedule A**	**Schedule B**
B.21	4.3.4	Is the load to remain connected on equalize charge? a) maximum load voltage V b) minimum load voltage V	YES/NO __________ __________	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx
B.22	4.3.5	Method of indicating abnormal operating conditions	visual/audible/ both methods	xxxxxxxxxx xxxxxxxxxx
B.23	4.3.7	Is a test facility for LEDs required?	YES/NO	xxxxxxxxxx
B.24	4.3.8	Are alarm indications to remain until manually reset?	YES/NO	xxxxxxxxxx
B.25	4.3.9	Audible alarm requirements	__________ __________ __________ __________	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx
B.26	4.3.10	Type of alarm display required or proposed by the supplier, e.g. LCD, VDUs, print-outs	__________ __________	__________ __________
B.27	4.3.11	a) number of alarm changeover contacts required b) type of contacts c) rating of contacts	__________ __________ __________	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx
B.28	4.3.13	Supervisory alarms and indicators required (Listed as (a), (b), (c), etc., of 4.3.13)	__________ __________ __________	__________ __________ __________
B.29	4.3.13	Is a lock-out facility for item (d) of 4.3.13 required? a) time delay s b) pull-in voltage V c) dropout voltage V d) output voltage ripple alarm level V	YES/NO __________ __________ __________ __________	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx
B.30	4.3.13	Are any other alarms or indications (including their colours) required?	__________ __________ __________	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx

1	2	3	4	5
Item	**Clause**	**Description**	**Schedule A**	**Schedule B**
B.31	4.3.14	Type of instruments required a) analogue or digital b) input a.c. voltmeter(s) V accuracy % c) input a.c. ammeter(s) A accuracy % d) output d.c. voltmeter(s) V accuracy % e) output d.c. ammeter(s) A accuracy % (indicated as type/L or R or B where L = local, R = remote, B = both local and remote)	__________ __________ __________ __________ __________ __________ __________ __________ __________ xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx
B.32	4.3.15	Details of remote instruments to be used Details of transducers to be supplied	__________ xxxxxxxxxx xxxxxxxxxx	__________ __________ __________
B.33	4.4.1.2	Transformers Is an electrostatic screen required?	YES/NO	xxxxxxxxxx
B.34	4.4.5	Electronic components Grade of electronic components required, if other than industrial	__________	__________
B.35	4.4.6	Maximum noise level dB(A)	__________	xxxxxxxxxx
B.36	4.5.1.1	Enclosure type and details a) floor mounting or b) wall mounting	__________ __________	__________ __________
	4.5.1.3	Access for cabling Top, bottom or side	__________	__________
	4.5.1.3	Access for maintenance Front, rear, side or all	__________	__________
	4.5.1.4	Is enclosure to be lockable?	YES/NO	xxxxxxxxxx
B.37	4.5.1.6	Is forced ventilation acceptable?	YES/NO	xxxxxxxxxx
B.38	4.5.1.6	Degree of protection of enclosure required if other than IP2X	__________	xxxxxxxxxx
B.39	4.5.1.7	Method of handling Gross mass of heaviest item kg	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx	__________ __________ __________
B.40	4.5.3	Position, size and arrangement of input and output terminations to be agreed upon	__________	__________
B.41	4.5.4.3	Type of connectors offered	xxxxxxxxxx	__________

1	2	3	4	5
Item	**Clause**	**Description**	**Schedule A**	**Schedule B**
	4.5.4.4	a) conductor size of a.c. input cable b) conductor size of d.c. output cable	__________ __________	xxxxxxxxxx xxxxxxxxxx
B.42	4.5.5.1	Maximum voltage drop between charger battery terminals and the charger load busbars V	__________	xxxxxxxxxx
B.43	4.5.7.2	Are insulated gland plates required?	YES/NO	xxxxxxxxxx
B.44	4.5.7.3	Are gland plates to be drilled? If YES, details of drilling in drawing number ... Method of corrosion protection	YES/NO __________ xxxxxxxxxx	xxxxxxxxxx xxxxxxxxxx __________
B.45	4.5.7.4	Details of gland plates on drawing number ...	xxxxxxxxxx	__________
B.46	4.5.9	Are details of quality workmanship standards provided? Supplier's, SANS, standards	YES/NO xxxxxxxxxx	xxxxxxxxxx __________
B.47	4.6.2.1	Fault level of: input circuit kA battery kA	__________ __________	xxxxxxxxxx xxxxxxxxxx
B.48	4.6.2.3	Is reversed battery connection protection required? If YES, details of protection method	YES/NO xxxxxxxxxx	xxxxxxxxxx __________
B.49	4.7	Which abnormal service conditions apply (listed as (a), (b), (c), etc., of 4.7)?	__________ __________ __________ __________	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx
B.50	4.9.4	Type of paint/coating offered a) method of applying b) method of finishing	xxxxxxxxxx xxxxxxxxxx	__________ __________
B.51	4.9.5.1	Colour of external surfaces	__________	xxxxxxxxxx
B.52	4.9.5.2	Colour of internal surfaces	__________	__________
B.53	4.10.1	Comprehensive spare parts list to be provided, with prices before delivery	YES	xxxxxxxxxx
	4.10.2	All spares guaranteed to be available for ten years from date of delivery	xxxxxxxxxx	YES
B.54	5.7.1	Guaranteed power efficiency %	__________	__________

1	2	3	4	5
Item	**Clause**	**Description**	**Schedule A**	**Schedule B**
B.55	6.2.1	Method of attaching function labels	xxxxxxxxxx	__________ __________
B.56	6.3.1	Details of terminal markings if other than the preferred markings	__________ __________ __________ __________	xxxxxxxxxx xxxxxxxxxx
B.57	6.4.1	a) are instruction labels required? b) if YES, language(s) or method(s) to be used	YES/NO __________ __________	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx
B.58	6.4.2	a) is/are the purchaser's identification number(s) required? b) if YES, see attached list for details	YES/NO xxxxxxxxxx	xxxxxxxxxx xxxxxxxxxx
B.59	6.5	Required number of copies of the following: a) final schematic diagram b) wiring diagram c) installation instructions d) instruction manual e) detailed parts list f) dimensional outline drawing	__________ __________ __________ __________ __________ __________	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx

Annex C
(informative)

Bibliography

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SANS 1632-3, *Batteries – Part 3: Vented-type prismatic nickel-cadmium cells and batteries*. **Amdt 2**

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SANS 10313, *Protection against lightning – Physical damage to structures and life hazard.* **Amdt 2**

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