Eskom	Standard	Technology

Title: **THYRISTOR AND SWITCH MODE CHARGERS, AC/DC TO DC/AC CONVERTERS AND INVERTER/UNINTERRUPTIBLE POWER SUPPLIES STANDARD**

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1. Introduction

This revision cancels and replaces all previous revisions of Specification or Standard No 36-815, 36-817, 474-104, 474-97, 474-99, 474-107, 240-53114248, 41-601.

2. Supporting Clauses

2.1 Scope

This standard describes Eskom's requirements for Thyristor and switch mode chargers, AC/DC to DC/AC converters and inverter/uninterruptible power supplies functions, mode settings, alarms, functional and monitoring functions. This standard covers the design, testing, quality assurance and commissioning of the charger/rectifier equipment.

2.1.1 Purpose

The purpose of this standard is to provide the operational and technical requirements for Thyristor and switch mode chargers, AC/DC to DC/AC converters and inverter/uninterruptible power supplies to be used within Eskom.

2.1.2 Applicability

This standard shall apply throughout Eskom Holdings Limited, its divisions, subsidiaries and entities wherein Eskom has a controlling interest.

2.2 References

2.2.1 Normative

The following documents contain provisions that, through reference in the text, constitute requirements of this document. At the time of publication the documents indicated were valid. These documents are subject to revision and users are responsible to ensure that the most recent edition of the documents listed below are used/referenced. Where specified values differ the most stringent specification will apply.

[1] CISPR 16-1-1:2003 Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring *apparatus*

[2] CISPR 16-1-2:2003 Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus - Ancillary equipment – Conducted disturbances

[3] CISPR 22:2005 Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement

[4] IEEE 142:1991 IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (The Green Book) (ANSI)

[5] IEC 60050-161:1990 International Electro technical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility

[6] IEC 60050-441:1984 International electro technical vocabulary Chapter 441: Switchgear, control gear and fuses

[7] IEC 61000-2-2:2002 Electromagnetic compatibility (EMC) – Part 2-2: Environment –Compatibility levels for low-frequency conducted disturbances and signalling in public low voltage *power supply systems*

[8] IEC 61000-3-2:2009 Electromagnetic compatibility (EMC) – Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)

[9] IEC 61000-3-4:1998 Electromagnetic compatibility (EMC) – Part 3-4: Limits – Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A

[10] IEC 61000-3-12:2011 Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and ≤175 A per phase

[11] IEC 61000-4-1:2007 Electromagnetic compatibility (EMC) – Part 4-1: Testing and measurement techniques - Overview of IEC 61000-4 series

[12] IEC 61000-4-2:2009 Electromagnetic compatibility (EMC) − Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test

[13] IEC 61000-4-3:2008 Electromagnetic compatibility (EMC) − Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test

[14] IEC 61000-4-4:2011 Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test

[15] IEC 61000-4-5:2006 Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test

[16] IEC 61000-4-6:2009 Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances induced by radio-frequency fields

[17] IEC 61000-4-8:2009 Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test

[18] IEC 61000-4-11:2005 Electromagnetic compatibility (EMC) Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests

[19] IEC 61000-4-34: Electromagnetic compatibility (EMC) Part 4-34: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests

[20] IEC 61850 Power utility automation

[21] IEC 61249-2 Base material for printed circuit boards part 2

[22] SANS 804 Unwrought tough pitch coppers: Electrolytic tough pitch high conductivity copper

[23] SANS 1091:2012 National colour standards for paint

[24] SANS 1195 Busbars

[25] SANS 1213 Mechanical cable glands

[26] SANS 1274: 2014 Coatings applied by the powder-coating process

[27] SANS 1411-1 Materials of insulated electric cables and flexible cords. Part 1: Conductors

[28] SANS 1507-1:2007 Electric cables with extruded solid dielectric insulation for fixed installations (300/500V 1900/3300V) Part 1: General

[29] SANS 1574-1:2012 Electric flexible cores, cords and cables with solid extruded dielectric insulation

[30] SANS 1632-2 2005 Batteries – Part 2: Vented type Stationary lead-cid cells and batteries

[31] SANS 1632-3 2005 Batteries – Part 3: Vented-type prismatic nickel-cadmium cells and batteries

[32] SANS 1652: 2013 Battery Chargers - Industrial Type

[33] SANS 10103:2008 The measurement and ratings of environmental noise with respect to annoyance and to speech communication

[34] SANS 10108:2014 Code of Practice for the Classification of Hazardous Locations and the selection of Apparatus for use in such areas – Latest Revision

[35] SANS 60076-1:2008 Power transformers Part 1: General

[36] SANS 60076-2:1993 Power transformers – Part 2: Temperature rise

[37] SANS 60076-3:2000 Power transformers – Part 3: Insulation levels and dielectric tests external clearances in air

[38] SANS 60076-4:2004 Power transformers - Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors

[39] SANS 60076-5:1976 Power transformers – Part 5: Ability to withstand short circuit

[40] SANS 60076-11:2005 Power transformers - Part 11: Dry-type transformers

[41] SANS 60146-1-1:1991 Semiconductor convertors; General requirements and line commutated convertors Part 1-1: Specifications of basic requirements

[42] SANS 60146-1-2:1991 Semiconductor convertors; General requirements and line commutated convertors Part 1-2: Application guide

[43] SANS 60146-1-1:1991 Semiconductor convertors; General requirements and line commutated convertors Part 1-3: Transformers and reactors

[44] SANS 60269 Low voltage fuses.

[45] SANS 60529:2001 Degree of protection provided by enclosures. (IP Code)

[46] SANS 60947-2:2009 Low-voltage switchgear and control gear Part 2: Circuit-breakers

[47] SANS 60947-3:2009 Low-voltage switchgear and control gear Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units

[48] SANS 60947-4-1:2004 Low-voltage switchgear and control gear Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters

[49] SANS 60439-1:2004 Low-voltage switchgear and control gear assemblies Part 1: Type-tested and partially type-tested assemblies

[50] SANS 60439-2:2006 Low-voltage switchgear and control gear assemblies Part 2: Particular requirements for busbar trunking systems (busways)

[51] SANS 60439-3:2007 Low-voltage switchgear and control gear assemblies Part 3: Particular requirements for low-voltage switchgear and control gear assemblies intended to be installed in places where unskilled persons have access for their use — Distribution boards

[52] SANS 60439-4:2005 Low-voltage switchgear and control gear assemblies Part 4: Particular requirements for assemblies for construction sites (ACS)

[53] SANS 60439-5:2006 Low-voltage switchgear and control gear assemblies Part 5: Particular requirements for assemblies for power distribution in public networks

[54] SANS 61238-1 Compression and mechanical connections for power cables for rated voltages up to 30 kV (Um = 36 kV) Part 1 Test methods and requirements.

[55] SANS 62040-1: 2013 Uninterruptible power systems (UPS)Part 1: General and safety requirements for UPS

[56] SANS 62040-2: 200 Uninterruptible power systems (UPS)Part 2: Electromagnetic compatibility (EMC) requirements

[57] SANS 62040-3: 2012 Uninterruptible power systems (UPS)Part 3: Method of specifying the performance and test requirements

[58] SCSSCAAP9 rev 3: Specification for Corrosion protection specification for new indoor and outdoor distribution equipment manufactured from steel

[59] CDA T22 busbars — Copper Development Association (CDA), Publication T22, Copper for

[60] ISO 898-1 screws and studs. — Mechanical properties of fasteners: bolts, screws and studs, Part 1: Bolts,

[61] 32-333 systems. — Standard for electronic protection and fault monitoring equipment for power

[62] 240-56356510 — Definitions of Terms Applicable to DC Emergency Supplies standard

[63] 240-56177186 — Acceptance and Commissioning of DC supply equipment

[64] 240-56176168 — DC systems setting standard

[65] 240-56360086 batteries — Specification for vented and semi-sealed Nickel-Cadmium cells and

[66] 240-70413291 — Specification for electrical terminal blocks

[67] 240-56360034 — Specification for vented lead acid cells

[68] 240-51999453 — Standard specification for valve-regulated Lead-acid cells

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
Battery charger	Consists of a sub rack, populated with the control and supervisory unit (CSU) and the appropriate number of switch mode rectifiers (SMRs).
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.
Cells out of step	The variation in the specific gravity and voltage readings of cells within a battery bank being greater than an acceptable level.
Converter system	A combination of two or more individual converters, connected in parallel, to collectively achieve the required rating.
dBA	"A" weighted sound pressure level. Sound meters are usually fitted with an “A” weighted filter whose response to frequency is a bit like that of the human ear which de-emphasizes both the low and high frequency portions of the audible spectrum.
DC system	Consists of a battery charger which is connected in parallel to a standby battery bank for the provision of the DC power to the required load equipment.
EMI	The interference of one piece of electronic equipment on the operation of another by means of electromagnetic energy transfer.
Equalizing charge	An extended charge applied to correct relative density imbalance amongst the cells of a battery
Float charge	A constant voltage charge ideally sufficient to maintain a cell or battery in a fully charged state.
Hot-pluggable	The ability to remove or insert a rectifier without first switching off disconnecting) the AC mains supply.

Definition	Description
Psophometric weighting	The application of a weighting curve to a signal used in the measurement of noise.
Rectifier	The power electronic equipment used to rectify the incoming AC into the required DC.
Remote	Remote means the ability to access the battery charger, at site, from the office environment (remote location).
Ripple voltage	The AC voltage component in the output of a rectifier that delivers direct current.
Short-circuit protection	A protective feature that limits the current under short-circuit conditions, to prevent the equipment from being damaged.
Soft start	A feature that limits the start-up switching currents of a switching supply and causes the output voltage to rise gradually.
Vented lead acid	Battery cell using lead and lead dioxide plates in a diluted sulphuric acid electrolyte open to atmosphere via vent caps.
Vented nickel cadmium	Battery cell using nickel hydroxide and cadmium hydroxide plates in a potassium hydroxide electrolyte open to atmosphere via vent caps.

2.3.2 Disclosure Classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary)

2.4 Abbreviations

Abbreviation	Description
°C	Degree Celsius
A	Ampere
AC	Alternating Current
Ah	Ampere per hour
C	Current
CFS	Combination fuse switch
CSU	Control and supervisory unit
dBA	A weighted decibel
DC	Direct current
Dx	Distribution Division
EMC	Electromagnetic Compatibility
ET	Eskom Telecomms
EUT	Equipment under test
Hz	Hertz
IEC	International Electrotechnical Commission
IED	Intelligent electronic device

Abbreviation	Description
In	Nominal Current
IP	Ingress protection
LA	Lead Acid
LED	Light emitting diodes
MCB	Miniature circuit breaker
MCCB	Moulded case circuit breaker
MTBF	Mean Time between Failures
mV	milli Volt
NiCd	Nickel Cadmium
PC	Personal Computer
Rev	Revision
RMS or rams	Root mean square
SANS	South African National Standards
SCADA	Supervisory Control and Data Acquisition
SNMP	Simple Network Management Protocol
TX	Transmission Division
UPS	Uninterruptable Power System
UV	Ultra Violet
V	Volt
VRLA	Valve Regulated Lead Acid

2.5 Roles and Responsibilities

Not applicable

2.6 Process for monitoring

Not applicable

2.7 Related/supporting documents

Not applicable

3. Requirements

3.1 General Operating Conditions

3.1.1 Site conditions

3.1.1.1 The equipment covered by this specification shall be suitable for operation under the following conditions:

3.1.1.1.1 Altitude : 2 000 metres maximum

3.1.1.1.2 Relative humidity : 20% to 90% non-condensing

3.1.1.1.3 Lightning : high lightning area

3.1.1.2 Outdoor air temperatures

3.1.1.2.1 Maximum : 60 °C

3.1.1.2.2 Daily average : 30 °C

3.1.1.2.3 Minimum : -15 °C

3.1.1.3 Equipment room and substation air temperature

3.1.1.3.1 Maximum : 50 °C

3.1.1.3.2 Daily average : 35 °C

3.1.1.3.3 Minimum : -5 °C

3.1.1.4 Controlled equipment room environment temperature

If the equipment room temperature is controlled the equipment shall be suitable for operation under the controlled environment.

3.1.1.4.1 Maximum : 27 °C

3.1.1.4.2 Minimum : 20 °C

3.1.2 Electrical input supply

3.1.2.1 The input supply to the converter or UPS including static bypass will be from a TN-S electricity supply configuration as stipulated in SANS 10142-1.

3.1.2.2 The nominal three phase input voltage is 400V ±25% as per GCR9

3.1.2.3 The nominal input frequency is 50Hz ±5% as per SANS 1652.

3.1.2.4 The nominal single phase to neutral voltage is 230V ±25%.

3.1.2.5 The equipment shall be tested to tolerate an input voltage deviation from the specified maximum to minimum voltage as short as 1 second.

3.1.2.6 The input voltage frequency can fluctuate between the minimum and maximum value within one to ten cycles.

3.1.2.7 Unbalance between phase voltages of not more than 3% negative phase sequence and/or the magnitude of one phase not lower than 5% than any of the other two for 6 hours as per GCR9 and NRS 048-2.

3.1.2.8 Input voltage total distortion factor <8% with the following maximum level of individual harmonic voltages according to table 1 of IEC 61000-2-2 for public low-voltage supplies, up to the 40th harmonic.

3.1.2.9 The minimum, maximum AC or DC input voltage of the converter/inverter shall be as above and listed in schedule A.

3.1.2.10 The minimum DC input voltage of the converter/inverter shall be determined by the smallest number of cells indicated at the lowest cell voltage indicated in battery standards.

3.1.2.11 The maximum DC input voltage of the converter/inverter shall be specified in Schedule A.

3.1.2.12 Typical nominal DC input voltages are: 12V, 24V, 32-36V, 50V, 110V and 220V.

3.1.2.13 Additional requirements shall be indicated in Schedule A.

3.2 Operational Requirements

The converters shall be fully compliant to IEC 60146-1-1: Semiconductor convertors; General requirements and line commutated converters and SANS 1652: Battery Chargers - Industrial Type.

The uninterruptible power supplies shall be fully compliant to IEC 60146-1-1: Semiconductor convertors; General requirements and line commutated converters and SANS 1652: Battery Chargers - Industrial Type and IEC 62040 - Uninterruptible power systems (UPS).

3.2.1 Thyristor and switch mode chargers

3.2.1.1 The Thyristor rectifier shall be 6 or12 pulse rectifier system as indicated in schedule A.

3.2.1.2 A double-wound transformer shall be provided on the AC input to the rectifier to isolate the rectifier from the AC supply.

3.2.1.3 All controls, rectifier functions, charging mode settings, alarms and monitoring functions shall be done via the micro-processor.

3.2.1.4 Overload protection shall be provided on all load circuits. Overload protection circuits shall be correctly graded for motor load circuits and the specific load profile of the application.

3.2.1.5 The DC output bus voltage shall be regulated during on-line boost. The voltage regulator shall be designed for the voltage range specified for boost charging. The dropping diode philosophy shall be failsafe, therefore not failing in-line and dropping the output voltage to below the minimum operating voltage. The control of the dropping diodes shall be done via voltage monitoring.

3.2.1.6 Monitoring of the rectifier for control purposes and evaluation operation, voltage and current before and after battery isolator and also battery loss, voltage and current before output circuit breaker/isolator and voltage after output circuit breaker/isolator. Temperature and operating status of each charger.

3.2.1.7 The charger shall be compatible and meet the required charging requirements for the following types of batteries:

3.2.1.7.1 Vented Lead Acid batteries in accordance to specification 240-56360034, Standard specification for Stationary Vented Lead Acid Batteries.

3.2.1.7.2 Vented and Semi-sealed Nickel Cadmium batteries in accordance to specification 240-56360086, Standard specification for Stationary Vented and Semi-sealed Nickel Cadmium Batteries for Power Stations.

3.2.1.7.3 Valve Regulated Lead Acid Batteries in accordance to specification 240-51999453, Standard specification for Valve-regulated Lead-acid Cells.

3.2.1.8 The standard charger operating voltage tolerances shall be indicated in Schedule A.

3.2.1.9 The charger/rectifier modules shall be of the constant voltage, current limiting type.

3.2.1.10 These charger/rectifier modules shall be capable of operation in parallel with any number of other modules and capable of charging the respective battery either in constant voltage or limited current mode depending on the battery requirements.

3.2.1.11 The charger/rectifier when installed in parallel with another charger/rectifier shall be capable to detect and share the total current to within 10% of each other.

3.2.1.12 Two 6 pulse Thyristor modules in parallel with a 30° phase shift to achieve the 12 pulse rectification is acceptable provided the load sharing between the two Thyristor modules is within 10% measured from 10% to 100% loading.

3.2.1.13 The modules shall be capable of operating into any type of load including a diode combiner when required.

3.2.1.14 The standard charger shall be capable of charging the batteries in float and boost with the load connected without supply interruptions to the load.

3.2.1.15 Initial charge mode is not required as a standard except if specified in Schedule A.

3.2.1.16 Power supply interruption to the load shall not occur when individual chargers and rectifier modules connected in parallel are switched off or on respectively.

3.2.1.17 The microprocessor control modules shall be interchangeable over the following range of chargers of the same manufacturer - 24V, 50V, 110V and 220V chargers.

3.2.1.18 Maintenance are to be done at any time without interrupting the supply from the battery to the load or where in parallel redundant configuration, one complete system are to be taken out for maintenance without interrupting the supply to the load. The general arrangement shall be to facilitate this requirement without jeopardising the IP2X rating of live circuitry.

3.2.1.19 During float and auto-boost, equalise or initial charge mode when subjected to an input voltage variation or +10 and -15% of nominal the charger shall be capable of maintaining the steady state output voltage measured at the charger load terminals to within ±0.5% tolerance for float and ±1% for the other charging modes, from 10 to 100% of the rectifier capability. This excludes the dropping diode circuitry.

3.2.1.20 During float and auto-boost, equalise or initial charge mode when subjected to an input voltage variation of ±25% of nominal, the charger shall be capable of maintaining the steady state output voltage produced at the rectifier output, to within ±1% tolerance for float and ±2% for the other charging modes.

3.2.1.21 At nominal the output voltage shall be within 2% after 1 second for a 10% to 90% step variation for rated rectifier current without the battery being connected. The control of the rectifier output voltage to within these tolerances shall be achieved without being influenced by environmental operating temperatures.

3.2.1.22 An interlock shall be provided that will prohibit initial or equalise charge if the load is not transferred.

3.2.1.23 Each single battery charger shall comprise of a suitable number of plug-in rectifier modules (at least two SMRs as a minimum in order to ensure redundancy against a single module failure), a controller shall have, as options, a separate load voltage regulator and / or load disconnect contactor.

3.2.1.24 As an option a load transfer switch capable of conducting the rated charger output current and overload protection (paralleling before interruption) will be indicated in the schedule as an integral function for a dual battery charger configuration.

3.2.1.25 The battery current limit must be adjustable from 0 to 100% of the rectifier capability.

3.2.1.26 Under abnormal AC supply voltage conditions, the battery charger shall revert to battery supply and back to the rectifier supply when the AC supply is within the operating limits. As a last resort safely shutdown the rectifier to prevent damage to the system.

3.2.1.27 Under rectifier module short circuit or failure conditions the faulty rectifier module shall be safely disconnected from the DC bus automatically.

3.2.1.28 In the event of the SMR controller failing or a loss in communication between the controller and rectifier modules, the rectifier modules shall revert to internal settings and maintain supply to the connected load equipment and battery.

3.2.1.29 The battery charger shall have a setting feature where the different charge modes can be enabled or disabled as required. An option shall be made available where a person can initiate a manual boost charge, this will be to facilitate manual boosting when required.

3.2.1.30 The SMR modules shall be hot-pluggable without interrupting or affecting the supply from the battery to the load or any other module on the bus.

3.2.1.31 The battery charger shall also be able to perform temperature compensation of the batteries, where the output voltage is controlled in relation to the battery temperature. The temperature compensation factor shall be settable in mV/°C. The temperature compensation shall be limited to the safe operating limits of the battery, and therefore being failsafe if the temperature monitoring fails.

3.2.1.32 Each rectifier module shall have its own AC supply circuit breaker from the AC supply distribution board to ensure that when the AC input to one rectifier module experiences an overload condition the other AC inputs are not affected.

3.2.1.33 The battery charger shall monitor the continuity of the battery circuit.

3.2.1.34 Active power factor correction (compulsory on SMR) or filtering shall be incorporated to reduce the harmonic currents on the mains to less than 10% total harmonic distortion and maintain the power factor at approximately unity (applicable to SMR). The specific harmonic order limits stated in IEC 61000-3-2,4 and 12 shall be applicable.

3.2.1.35 Only if requested as an option the DC port shall be equipped with an automatic disconnecting device when the battery reaches the minimum voltage. The voltage downstream of the disconnecting switch shall be monitored and the automatic disconnecting device shall close or be reset if the voltage at the battery terminal is above the minimum voltage. It is also required that the position of the disconnecting device must be monitored. The function of the disconnecting device is to protect against battery over discharge therefore disconnecting battery only at battery absolute minimum voltage. Battery automatic disconnecting devices shall not be used or installed as a standard.

3.2.1.36 The charger/rectifier shall be capable to power and/or accommodate a 4-20mA input signal from a hydrogen gas detector analyser. At a pre-set value of 0.8% hydrogen an high hydrogen alarm will be initiated via the charger/rectifier micro-processor, at a value of 1% hydrogen the auto-boost, equalise and initial charge shall be disabled with an high-high hydrogen alarm and the respective charging mode failure alarm. The input to the charger shall be able to detect power loss or broken wire status from the analyser.

3.2.1.37 When specified in technical schedule A it shall be possible to use different watt rating modules in parallel performing proportional load sharing as a percentage of capability, , this is not for redundancy but to increase capacity.

3.2.1.38 Additional hardwire over-voltage protection and current monitoring shall be provided on the DC port supplying the battery to protect against overvoltage during charging of semi-/sealed and valve regulated battery applications in order to ensure that an overvoltage will not occur and as a result hydrogen release above the designed ventilation values. The battery port may not be interrupted when an over voltage condition occurs on the battery. The manufacturer must provide the design philosophy to Eskom for approval.

3.2.2 AC/DC to DC/AC modular converters

3.2.2.1 When installed in parallel with another converter, the converter shall be capable to detect and share the total current to within 10% of each other.

3.2.2.2 Individual converters for modular converter application shall automatically synchronise.

3.2.2.3 Individual converters for the modular converter application shall be hot pluggable.

3.2.3 Inverter/uninterruptible power supplies

3.2.3.1 The rectifier on a UPS shall comply with the requirements stipulated in this document for charger/rectifier with the exclusion of a load voltage regulator provided the inverter is compatible with the minimum and maximum voltages that will occur to perform float, auto-boost and equalise charge.

3.2.3.2 The rectifier DC bus operating voltage as input supply to the inverter operating voltage will be between the battery minimum voltage to the maximum charging voltage ranging from 176V to 312V. The utilization of a DC to DC converter between the rectifier DC link and the battery to DC link is acceptable. The DC to DC converter shall be fully compliant to SANS 60146-1-1 Semiconductor convertors; General requirements and line commutated convertors Part 1-1: Specifications of basic requirements, SANS 1652: - Battery Chargers - Industrial Type.

3.2.3.3 If the application requires additional redundancy on the rectifier and inverter for a specific load, therefore a configuration of two parallel UPS units sharing a common battery bank, the rectifiers on each UPS unit will be rated double in order to supply both inverters at full load. The inverter of both UPS units will draw current from the main DC bus and not from the battery charging bus that will be limited, therefore one rectifier shall be capable to charge the battery and supply both inverters at full load. During float, auto-boost and equalise charging mode both the rectifiers will be synchronised and the specified charging limits shall be maintained. Load sharing between the two rectifiers shall be within 10%.

3.2.3.4 The UPS shall be a permanently connected UPS and readily accessible disconnect devices shall be incorporated in the fixed wiring, without requiring a key to open panel doors.

3.2.3.5 The UPS performance classification shall be VFI-SS-111 as specified in IEC 62040-3 “Uninterruptible power systems (UPS) Part 3: Method of specifying the performance and test requirements” at ±25% input voltage or as specified in Schedule A with the X in VFI-SS-XXX indicating the specific requirements. The input voltage is also applicable to the static by-pass supply and the output shall be as stated by performance curve 1 in IEC 62040-3 or specific requirement indicated by X. These parameters are reflected within the technical Schedule A.

3.2.3.6 Each individual UPS unit shall be equipped with a static and manual bypass facility.

3.2.3.7 When utilised in a dual redundant configuration:

3.2.3.7.1 Should a failure occur on one of the units then the second unit automatically assumes the full load without any power interruption to the load.

3.2.3.7.2 It shall be possible to disconnect and remove either of the two units without disruption of the output power to the load.

3.2.3.7.3 It shall also be possible to increase the UPS plant capacity or plant redundancy by adding another UPS unit in parallel.

3.2.3.8 The UPS shall have the capability to start-up the inverter with the static bypass supply unavailable and only rectifier supply available and battery drained or disconnected. The inverter output shall be systematically synchronised with the static bypass supply when available. If DC supply is available from the battery the inverter shall be able to manual start-up from the battery without the rectifier being available.

3.2.3.9 The inverter is not connected during initial mode of charging or automatically switches off when initial charge is performed.

3.2.3.10 The output frequency is controlled from within the inverter circuitry itself and is synchronised to the frequency of the mains and any other inverter operating in conjunction with it. Each inverter has its own frequency controlled from within its own circuits and not from a common control circuit. The output frequency deviation from the nominal values is kept within ±5% in response to a 100% step load application.

3.2.3.11 During normal operation, the output is kept in synchronism with the AC input supply to which the automatic bypass is connected. If the frequency of this AC supply deviates beyond the specified output tolerance, the UPS unit reverts to the internally generated frequency.

3.2.3.12 The inverter shall be suitably rated to carry the full load current as well as the load inrush current likely to occur without switching to static bypass. Load inrush current to be limited to within the overload capability of the inverter i.e. 125% for 10minutes and 150% for 1 minute.

3.2.3.13 The bypass switches shall either be of static type or of the hybrid type. The hybrid type is a combination of a static and an electromechanical switch. The static part of this hybrid type switch shall be used for the initial part of closing action and shall conduct the current until such time as the electromechanical part has closed and taken over the current.

3.2.3.14 An individual isolation transformer per bypass shall be supplied. The bypass isolation transformer shall be fully compliant and tested as per SANS 60076-11, Power transformers - Part 11: Dry-type transformers and all parts of SANS 60076 listed in this document. The necessary transformer component certification shall be submitted as part of the UPS component certification. The specified audible noise level of UPS is also applicable to the isolation transformer.

3.2.3.15 The specified input voltage tolerance shall be applicable to the by-pass to ensure a UPS performance characteristic as defined by VFI-SS-111 or specific requirements indicated by VFI-SS-XXX and detailed in Schedule A.

3.2.3.16 The automatic switches used for the connection of the UPS units to the load busbar and for the automatic bypass are protected against short circuit currents. Where semi-conductor devices are used as part of switches, they are protected by high speed HRC fuses. These switches are protected against exceeding the specified overload rating. This is done by automatic electronic shutdown or by fuses.

3.2.3.17 Circuitry is provided to continuously monitor the inverter AC output voltage. When this voltage deviates beyond the specified tolerances, the inverter automatically shuts down or is disconnected from the load busbar.

3.2.3.18 The inverter automatically shuts down when the input DC voltage deviates beyond the specified minimum or maximum levels. When the DC voltage returns to within the specified normal range the inverter performs a DC start. This includes DC voltage from the battery.

3.2.3.19 The inverter automatically shuts down when the input DC voltage deviates beyond the specified minimum or maximum levels. When the DC voltage returns to within the specified normal range the inverter performs a DC start. This includes DC voltage from the battery.

3.2.3.20 Monitoring of the rectifier, static by-pass input and inverter output voltage and current waveforms for event recording and analysis purposes is required. The data for 5 seconds, 2 seconds before the status change and 8 seconds following the incident shall be recorded. Sampling at 0.5ms. As an option a 1000 events register can be specified in schedule A.

3.2.4 Input supply

As per clause 3.1.2.

3.2.5 Output supply

As stipulated in schedule A.

3.2.6 Voltage ripple

The output DC voltage ripple expressed in RMS shall be less than or equal to the value specified in schedule A. A typical value shall be 1% of the nominal output voltage measured in millivolts RMS.

3.2.7 Current ripple

The maximum allowable RMS AC ripple current into the battery during charging modes shall be less than 5A per 100 Ah of the battery capacity during float for vented and VRLA cells and 20A per 100Ah for boost charging for vented cells.

3.2.8 Cooling requirements

3.2.8.1 It is preferred that the charger/rectifier, converter or UPS be convection cooled.

3.2.8.2 The following requirements will be applicable to all cooling methods:

a) Alarmed on over temperature conditions.

b) The method of ventilation shall be sufficient to enable the converter to continuously maintain the rated output for the equipment room condition specified.

c) Substantiated proof of long term life of the cooling fans.

d) 100% cooling fan redundancy shall be provided.

e) Detection and alarming of cooling system failure.

f) Protection such as rectifier shut-down or current reduction following early warning high and high-high temperature alarming, when the temperature inside the cabinet exceeds 50ºC maximum value.

g) Cooling fans should pressurise the equipment cabinet rather than extracting air from the cabinet.

h) The cooling should be sufficient to maintain the temperature inside the charger cabinet to below 50^{o}C. The temperature measuring position will provide a true reflection of the temperature inside the panel.

i) Provision shall be made to prevent dust ingress into the cabinet.

j) Removable/maintainable filters shall be provided on all ventilation grilles to prevent dust and dirt from entering the cabinet.

3.2.9 Abnormal output voltage

3.2.9.1 The output voltage of the converter shall continuously be monitored to ensure that it does not deviate from the specified tolerances. If such a condition exists, the converter shall automatically shutdown or disconnect from the load busbar.

3.2.10 Inrush current

3.2.10.1 The inrush current shall be determined as specified in IEC 62040-3 and declared in Schedule B.

3.2.11 No-load operation

3.2.11.1 The output voltage of the converter shall not exceed the value specified in schedule A. This value is a percentage of the nominal output voltage under no-load conditions and it shall not trigger any fault detection circuitry. If the converter is subsequently loaded within the required output current range, it shall begin to regulate and source current without triggering failures or causing control circuits to malfunction.

3.2.12 Step-load capability

3.2.12.1 Refer to 3.2.1.21.

3.2.13 Overload capability

3.2.13.1 The standard class for over-current capability of charger converters is class I and UPS converters within Eskom will be class II with the additional requirements stipulated below. Deviation from this classification of over-current capability shall be indicated in schedule A.

Table 1: Converter AC to DC, DC to DC or DC to AC efficiencies

Duty class	Rated currents for converters and test conditions for assemblies (relative values in per unit of I_{dN})
I	1.0 p.u. continuously
II	1.0 p.u. continuously 1.5 p.u. 1 min
III	1.0 p.u. continuously 1.5 p.u. 2 min 2 p.u. 10s
IV	1.0 p.u. continuously 1.25 p.u. 2 h 2 p.u. 10s
V	1.0 p.u. continuously 1.5 p.u. 2 h 2 p.u. 1min
VI	1.0 p.u. continuously 1.5 p.u. 2 h 3 p.u. 1min

3.2.13.2 The UPS Static bypass overload capability shall be 200% for 1minute.

3.2.13.3 The UPS inverter overload capability shall be 125% for 10 minutes.

3.2.14 Short-circuit and current limit capability

3.2.14.1 The equipment shall be able to limit its output current when a direct short-circuit is placed across its output terminals. The converter shall automatically restart, once the short-circuit has cleared. The short circuit capability shall meet the requirements stipulated in IEC 62040-3 and be capable to operate the downstream overload protection device.

3.2.15 Psophometric noise

3.2.15.1 Maximum Psophometric noise level to be limited to 2mV, weighted (CCITT Class A) for telecommunication applications indicated in schedule A.

3.2.16 Internal protection

3.2.16.1 The internal components of the converter shall be protected against internal failures and short-circuits. The protection devices shall be selected and employed in such a manner that failure of any component shall not result in damage to any remaining healthy component. Operation of this protection shall also cause automatic shutdown of the converter.

3.2.17 Hardwire/hardware independent protection

3.2.17.1 The following minimum hardwire/hardware protection shall be included to ensure that a single failure will not result in an overvoltage as an integral part of the converter and/or UPS:

- Over voltage protection on load.
- Additional hardwire over-voltage protection shall be provided on the DC port supplying the battery to protect against overvoltage during charging of semi-/sealed and valve regulated battery applications in order to ensure that an overvoltage will not occur and as a result hydrogen release above the designed ventilation values. The battery port may not be interrupted when an over voltage occur on the battery.

3.2.18 Active load sharing capability

3.2.18.1 The converter shall have load sharing capability for applications where more than one converter is connected in parallel. The imbalance between parallel connected converters shall be within 10%.

3.2.19 Efficiency

3.2.19.1 The efficiencies shall be reported as the AC to DC, DC to DC, DC to AC and AC to AC efficiency at 25, 50, 75 and 100% loading.

3.2.19.2 The efficiency tables listed in IEC 62040-3 will be applicable to a UPS with the inverter efficiency reported separately and the values in table 2 will be applicable.

3.2.19.3 Converter AC to DC, DC to DC or DC to AC efficiencies is listed below. A -7.5% efficiency allowance will be granted for converters smaller than 5kW.

Table 2: Converter AC to DC, DC to DC or DC to AC efficiencies

Efficiency	Percentage %
Efficiency for single stage converter or inverter	
a) @ 25% load	>87.5
b) @ 50% load	>90
c) @75% load	>92.5
d) @ 100% load	>95

3.2.20 Electromagnetic environment and immunity requirements

The requirements as specified in IEC 62040-2 for category C3 UPS will be applicable to all converters with the additional requirements stated for impulse withstand. Cables longer than 30m shall be considered.

3.2.20.1 Conducted and radiated emissions

3.2.20.1.1 The requirements as specified in IEC 62040-2 for category C3 UPS will be applicable.

3.2.20.1.2 Low-frequency emissions – Input current harmonics to be less than 10% as per test methodology stipulated in IEC 61000-3-2.

3.2.20.2 Immunity

3.2.20.2.1 The requirements as specified in IEC 62040-2 for category C3 UPS will be applicable to all converters.

3.2.21 Audible noise

3.3.20.1 Audible noise shall be less than 75 dBa absolute for industrial applications, 55dBa Computer rooms and 45dBa for general office applications as per SANS 10103 as indicated in schedule A with all doors and covers closed, as for normal operating conditions. This shall be achieved by correct design of components and not by cabinet silencing. Tests methodology as described by IEC and IEEE standards to the Eskom specific specified values will be accepted by Eskom as compliance with this specification.

3.2.22 Lightning protection

3.3.21.1 The AC input circuitry shall be protected against lightning induced voltage surges in accordance with the relevant clauses of SANS 1652. The impulse withstand values specified in Table G.1 – Correspondence between the nominal voltage of the supply system and the equipment rated impulse withstand voltage, in the case of overvoltage protection by surge-arresters according to IEC 60099-1 of IEC 61439 will be applicable. The DC port as well as output to load shall be tested to the levels indicated in Table G.1, DC port to 4kV and output to 2.5kV. Rectifier and AC/DC to DC/AC equipment not utilised as main supply equipment needs to meet the impulse withstand as per specific application.

3.3 Electrical Requirements

3.3.1 General

All major components used shall comply with the required standards as indicated in the normative references. Detailed IEC certification shall be submitted for evaluation as part of the product type testing. If required by Eskom the type testing reports shall made available.

3.3.1.1 Combination fused switches

Fuse combination unit complies with the requirements of IEC 60947-3 and it is a switch in series with fuses in separate carriers mounted within a single compartment. The required fuse combination units are of the air-break gang operated type with the number of poles specified in schedule A. Provision is made for the fitting of auxiliary contacts to the fuse combination unit for control and indication purposes.

Fuse combination units continuously carry the rated current specified in schedule A when mounted within their compartments and are capable of:

- Making and breaking the rated current in accordance with the utilization category
- Interrupting the rated fused short circuit current.

The fuse combination units fuse carriers and fuses are correctly rated to prevent the melting of fuse carriers.

Fuse combination units are fitted with a device indicating the position of the moving contacts. The position indicator is connected to the moving contacts in a reliable way. The operating handle of the unit forms part of the indicator, provided it cannot indicate the “OFF” position unless all moving contacts are in the open position. The indicating device is labelled as “ON” or “I” and “OFF” or “O”. The indication is clearly visible from the front of the panel.

Operation of the fuse-combination unit isolates all poles. The fuse combination units shall be accessible from the outside and be lockable in the open position.

3.3.1.2 Moulded case circuit breakers

Moulded case circuit breakers comply with IEC 60947-2.

All load circuit breakers are provided with auxiliary contacts for alarm purposes indicating position of breaker Circuit breakers are mounted inside the cubicle. Operation of the circuit breaker isolates all phases.

Only circuit breakers with the required IEC stated DC rating shall be used on DC circuits.

3.3.1.3 Transformer

All the transformers shall comply with SANS/IEC 60067 standard. The transformer type test reports shall be submitted for review.

3.3.1.4 Contactors

Contactors shall comply with IEC 60947-4.

All contactors are provided with auxiliary contacts for alarm purposes indicating position. The contactors operating voltage shall be considered in the design together with the Input voltage range specified.

3.3.1.5 Transfer switches

All transfer switches shall comply with IEC 60947-6.

3.3.1.6 Static Transfer switches

All static transfer switches shall comply with IEC 62310-1/2/3 for industrial application. The static transfer switch shall also be tested to the specified input voltage.

3.3.1.7 Terminal blocks

All terminal blocks shall comply with IEC 60947-7 and Eskom standard 240-70413291 “Specification for electrical terminal blocks”.

3.3.1.8 Control circuit devices and switching elements

All control circuit devices and switching elements shall comply with IEC 60947-5.

3.3.2 Input isolation and overload protection

3.3.2.1 The input to the individual equipment shall be provided with a suitably rated disconnecting switch, combination fuse switch, MCCB or MCB. The opening of this switch shall ensure that the input to the equipment is completely isolated from other sources of electrical supply and adequately protect against overload condition.

3.3.2.2 All input isolation and overload protection devices are provided with auxiliary contacts for alarm purposes indicating position of the device.

3.3.3 Output isolation and overload protection

3.3.3.1 The output of the individual equipment shall be provided with a suitably rated disconnecting switch combination fuse switch, MCCB or MCB. The opening of this switch shall ensure that the output is completely isolated from other sources of electrical supply.

3.3.3.2 Single phase applications on a three phase output UPS shall be fitted with additional single phase isolation devices graded to ensure only single phase isolation during overcurrent conditions. This is required to benefit from the unbalance load capability of the UPS.

3.3.3.3 The output isolation shall also be graded with the load profile.

3.3.3.4 All output isolation and overload protection devices are provided with auxiliary contacts for alarm purposes indicating position of the device.

3.3.4 Battery isolation and overload protection

3.3.4.1 The battery is connected to the main DC power port via a suitably rated double pole fused isolator or circuit breaker and stud terminals of sufficient current rating to accept the battery connection cables. The current rating of the fuses or circuit breaker is between 25% and 50% of the Ah capacity of the associated battery. This is to ensure that under all fault conditions other than a short circuit on the main DC power port, the battery to load connection is maintained.

3.3.4.2 The battery isolation shall also be graded with the load profile.

3.3.4.3 All battery isolation and overload protection devices are provided with auxiliary contacts for alarm purposes indicating position of the device.

3.3.4.4 The fault switching rating of the fused isolator shall be rated for the fault current rating of the battery supply.

3.3.5 Input-output isolation

3.3.5.1 The input-output of the rectifier and/or converter shall be galvanically isolated.

3.3.6 Earthing

3.3.6.1 All exposed non-current carrying parts are earthed onto the earth bar using standard green/yellow PVC insulated earthing conductors.

3.3.6.2 An earthing point shall be provided and clearly indicated on the external casing or cabinet.

3.3.6.3 The neutral (grounded circuit conductor) should be bonded to the equipment safety-earthing conductor and to the local earth which have a direct connection to the station earth.

3.3.6.4 The earthed conductor from neutral should be connected to the earthing conductor at the source and not at any other point to prevent the earth fault protection to be ineffective. The earthing standard as stipulated in IEEE 142:1991 shall be applicable.

3.3.6.5 Certain application will require that the 0V DC be earthed and will be indicated in schedule A.

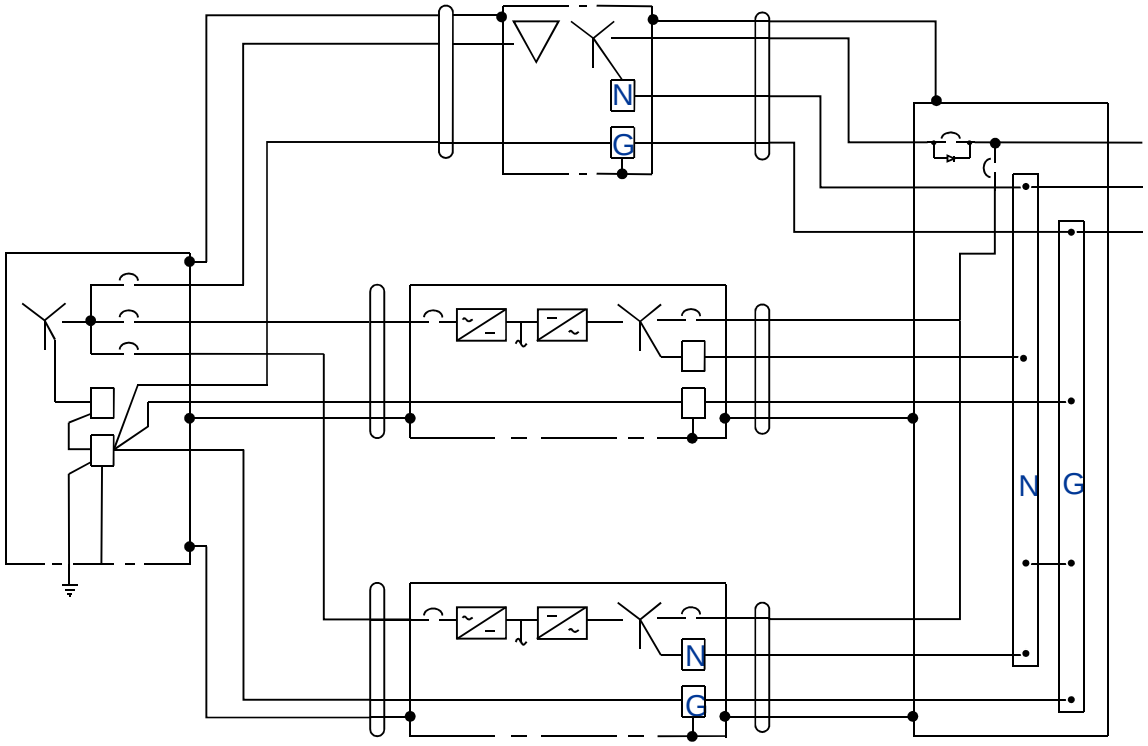

Figure 1: UPS earthing configuration

3.3.7 Dropping diode voltage regulator requirements

3.3.7.1 The maximum allowable volt-drop across the entire dropping diode will not cause the voltage to decay below the minimum operating voltage when the dropping diode is in-line and the AC supply to the charger is unavailable.

3.3.7.2 As a guideline the maximum voltage drop over a set of dropping diodes will not exceed the value between the open circuit voltage of the battery bank less the minimum load operating voltage.

3.3.7.3 The dropping diode normally may not be switched into the circuit during float charge; the amount of cells in a bank should be taken into account to ensure that the float voltage does not exceed the maximum load voltage.

3.3.7.4 During type testing the time delay shall be measured, when the dropping diode is in the circuit, between sensing a voltage drop below the OEM pre-set voltage to actual closing of the contactor.

3.3.7.5 The contactors and relays used in the circuits shall be normally closed.

3.3.8 Inverter synchronisation

3.3.8.1 Typical Settings:

3.3.8.1.1 Δf/Hz (Slip) = 0.1Hz

3.3.8.1.2 Maximum difference in voltage magnitude = <5% of nominal (Preferable =<2V)

3.3.8.1.3 Maximum difference in voltage phase angle = ±5° (Preferable < ±2.5°)

3.3.9 Charging Modes

3.3.9.1 Float charge mode

The float charge mode is the normal operating mode of the charger. In float mode, the charger shall keep the battery bank at a steady state voltage and at the same time provide current to the load. During float charge mode the current flowing into the battery shall be monitored, and limited to a pre-set float current limit. The table below indicates the ranges of the voltage and current settings required.

Table 3: Float voltage settings

	Float Voltage Settings per cell
Lead acid	2.15V/cell to 2.35V/cell
Vented NiCad	1.35V/cell to 1.50V/cell

The float current limit shall be adjustable from 1% to 100% of rated rectifier current.

3.3.9.2 Auto-boost mode including dropping diodes and load connected

Every 28 days, the charger automatically initiates a boost charge.

When a boost charge is initiated and the battery bank voltage is not at the float charge voltage, the charger will raise the battery bank voltage to the correct float voltage while monitoring and limit the current into the battery bank.

Once the battery bank voltage has reached the float voltage and the current is below the maximum current limit the voltage will be raised automatically to the pre-set boost voltage, the battery current shall be continuously monitored not to exceed the boost maximum current limit.

Once the battery bank has reached this voltage, the charger shall keep the battery bank at this voltage for a period of four (4) hours. This time shall be adjustable from 1 hour to 12 hours and will be specified.

After the boost charge cycle the charger shall revert to the normal float mode and the 28 day timer shall reset.

As a safeguard, the DC charger shall monitor and ensure that this entire sequence does not exceed a pre-set time period, typically twelve (12) hours could be increased to twenty four (24) hours if required, referred to the total auto boost period. If the charger is unable to raise the bank voltage to the Auto boost voltage, and keep it there for the full boost cycle, without exceeding the total auto boost period, the charger shall revert to float charge mode, and indicate an auto boost failure alarm.

The total auto boost period shall be pre-settable from 8 hours to 24 hours.

Table 4: Auto-boost voltage settings

	Auto boost Voltage Settings per cell
Lead acid	2.20V/cell to 2.40V/cell
Vented NiCad	1.45V/cell to 1.55V/cell

The battery auto boost current limit shall be adjustable from 1% to 100% of rated charger current. The set value of the battery manufactures specification will be taken into account and will be recommended setting except if otherwise specified.

A function to enable or disable auto-boost must be provided.

3.3.9.2.1 Auto boost Mode after 'MAINS FAIL'

If the AC supply to the charger was interrupted and the battery bank voltage was drained below the auto boost trigger voltage, specified as a voltage of 2 V/cell for vented lead acid cells and 1.2 V/cell for vented Nickel Cadmium cells, the DC charger will initiate an auto boost charging cycle when the AC supply is restored. The 28 day timer shall reset to zero after each auto boost cycle. If the battery bank voltage did not decrease below the auto boost trigger voltage the DC charger will continue in float charge mode when the AC supply is available.

Table 5: Auto-boost trigger voltage settings

	Auto boost Trigger Voltage Settings per cell
Lead acid	1.85V/cell to 2.0V/cell
Vented NiCad	1.0V/cell to 1.3V/cell

A function to enable or disable auto-boost must be provided.

3.3.9.3 Equalise mode

When the DC charger is set to the equalise mode, no operational load is attached to the load distribution bus.

When the charger is set to the equalise mode, it will raise the battery bank voltage to the equalise voltage and equalise current limit. Indication that the DC charger is in equalise mode shall be provided.

Table 6: Equalise charge voltage settings

	Equalise Voltage Settings per cell
Lead acid	2.30V/cell to 2.60V/cell
Vented NiCad	1.50V/cell to 1.70V/cell

The equalise current limit shall be adjustable from 1% to 50% of rated charger current.

3.3.9.4 Initial charge mode

Due to the infrequent usage of initial charge, as a standard initial charge is not required except if specified in Schedule A.

During initial charge, no operational load is attached to the load distribution bus. If required high voltage modules can be fitted and set to limit the current between 3% and 15% of the Ah, capacity of the battery capacity and the battery bank voltage is allowed to increase to any level up to a maximum of 3 V/cell and 1.8V/cell for NiCd.

During the initial charge all over- and under-voltage alarms shall be inhibited to prevent interference with normal operation i.e. over voltage shutdown.

During initial charge mode, the charger shall be capable of reaching the required final voltage of the battery bank, expressed in the table below in terms of voltage per cell.

Table 7: Initial charge voltage settings

	Initial Charge Voltage per cell
Lead Acid	>2.70V/cell
Vented NiCad	>1.75V/cell

This Initial Charge current limit shall be adjustable from 5% to 70% of total rated charger current. As an example for a 100A charger from 5A to 70A.

3.3.10 Measurements, controls, indications and alarms

3.3.10.1 Charger/Rectifier measurements

3.3.10.1.1 The following meter types shall be used:

- Panel meters;
- Liquid crystal display (LCD).

3.3.10.1.2 All meters shall be of class 1% accuracy.

3.3.10.1.3 Selection of the required measurements shall be by means of pushbutton and/or menu selection and shall be clearly labelled as specified in Schedule A. The following measurements shall be displayed:

- Input voltage and waveform recording
- Input current and waveform recording
- DC port voltage
- DC port current
- Output voltage
- Output current
- Hydrogen level input
- Temperature charging compensation measurement.

3.3.10.2 AC/DC to DC/AC converter measurement

3.3.10.2.1 The following meter types shall be used:

- Panel meters;
- Liquid crystal display (LCD).

3.3.10.2.2 All meters shall be of class 1% accuracy.

3.3.10.2.3 The following measurements shall be displayed:

- Input voltage
- Output voltage
- Output current

3.3.10.3 UPS measurements

3.3.10.3.1 A mimic display panel showing the various main components of the UPS is provided in the front panel of the UPS unit. This mimic display panel has digital indicators for panel monitoring and digital display is of the auto-ranging 3.5 digit type.

3.3.10.3.2 Selection of the required measurements shall be by means of labelled latching as specified in Schedule A. The following selections are provided:

- Rectifier input voltage and waveform recording
- Rectifier input current and waveform recording
- Battery DC voltage
- Battery DC current

- Inverter output voltage per phase
- Inverter output current per phase
- Inverter output frequency
- Static Bypass input voltage and waveform recording
- Static bypass input current and waveform recording

3.3.10.3.3 Hydrogen level high

3.3.10.3.4 Hydrogen level high-high

3.3.10.4 AC/DC to DC/AC converter controls

The following controls shall be available on the facia of each converter:

a) Alarm reset,

b) On-off switch,

c) Lamp test if not LCD display.

3.3.10.5 Charger/rectifier indications

3.3.10.5.1 The micro-processor shall be capable to store at least 100 events on a first in first out principle. As a minimum all the unhealthy conditions will be logged and stored as a single event log entry. A charger status change is also defined as an event.

3.3.10.5.2 All events shall be date and time stamped as well as the duration of the event or end time of the event. The Indications and Alarms shall be visible on the front of the equipment. The voltage, current and temperature indications should be at least 1% accurate over the full range.

3.3.10.5.3 All changes in charging mode as well as alarm conditions shall be treated as events and logged.

3.3.10.5.4 SMS facilities to indicate alarm conditions and system parameters shall be offered when called for in schedule A.

3.3.10.5.5 The alarms require remote indication by means of potential free contacts.

3.3.10.5.6 All relay contacts shall be wired to the alarm terminal strip. Remote contact relays all to be changeover contacts to be in the energised state and the normally closed (NC) contacts wired to the control centre. This means that all relays will be energised and contacts will remain open until an alarm occurs after which the relay will be de-energised and the contact closed causing an alarm at the remote side (control centre). The other advantage of this is that if the controller loses DC supply for whatever reason, all the remote contacts will close and this will send simultaneous alarms.

3.3.10.5.7 The following indications shall be available on the facia of each charger/rectifier:

a) IN FLOAT, AUTOBOOST, EQUALISE or INITIAL MODE indicates the charging mode in which the charger is operating.

b) EQUALISE INHIBITED indicates that equalise charge has been selected, but is inhibited or terminated due to the battery room fan has failed or hydrogen sensor.

c) SYSTEM PARALLELED indicates that the system paralleling switch has been closed so that the two charger/battery systems are in parallel.

d) LOAD TRANSFERRED indicates that all the loads have been transferred to one or other of the two charger/battery systems.

e) BATTERY ISOLATED indicates that the battery isolator has been opened.

f) CHARGER, BATTERY & LOAD VOLTAGES & CURRENTS are indicated by a suitable display.

g) AMBIENT TEMPERATURES of the charger and battery rooms are indicated on a suitable display.

h) HYDROGEN LEVEL display hydrogen level measured.

i) HYDROGEN ANALYSER HEALTHY indicates hydrogen analyser status.

3.3.10.5.8 A list of "INDICATIONS" that Eskom requires to be indicated locally is tabled below :

Table 8: of local indications

Local Indications	Equipment
Charger/Rectifier In Float Mode	Charger/Rectifier
Charger/ Rectifier In Auto boost Mode	
Equalise Charge Initiated	
Battery/Charger Voltage	
Battery Current	
Charger Current	
Load transferred	
System paralleled	
Load Voltage	
Load Current	
Ambient Temperature	DC Switchgear Room
Battery Room Temperature	Battery Room
Battery Room Fan Failure	
Hydrogen level	
Hydrogen analyser healthy	

Local Indication: Shall be indicating the charger status, on an indication panel on the front of the charger. It resets immediately and automatically when the initiating condition is removed.

Local Alarm: Shall be indicating the individual charger statuses that require action, on an indication panel on the front of the charger and a facility to relay to a remote position. An alarm shall be able to attract attention by flashing or other means until accepted. If the alarmed condition is not present the alarm status shall clear. Provision shall be made for external inputs.

Remote Indication: Shall be indicating the charger statuses that require action as individual alarms. Individual alarms will be grouped at the charger and grouped alarms relayed to a remote position. If the alarmed condition is not present the alarm status shall clear. Provision shall be made for external inputs.

Rectifier Trip: Is a protection operation to protect the equipment from being damaged due to a fault condition that is detected.

3.3.10.6 UPS controls

3.3.10.6.1 The following controls are provided on the mimic display panel:

a) Alarm acknowledge

b) Alarm reset

c) Equalise charge

d) Rectifier on/off switch; and

e) Inverter on/off switch.

3.3.10.7 AC/DC to DC/AC converter indications

3.3.10.7.1 The indications stipulated above will be the norm unless differently indicated in schedule A, The following indications shall be available on the facia of each converter as part of functional single line mimic:

1) Input healthy

2) Output healthy

3.3.10.7.2 Where LEDs are used, green LEDs shall indicate active or operational circuits, and red LEDs shall be used to indicate non-operational circuits.

3.3.10.7.3 All indications shall be clearly labelled.

3.3.10.8 UPS indications

3.3.10.8.1 The following indications shall be available on the facia of each inverter/static bypass as part of functional single line mimic :

a) Output healthy,

- Inverter on

b) Static bypass healthy,

- Mains supply to static bypass available and within limits

c) Manual bypass on

d) Battery Healthy

- Battery voltage
- Battery current
- Battery ripple voltage

e) Rectifier Healthy

- Mains supply available
- Rectifier voltage within limits
- Rectifier current

f) Where LEDs are used, green LEDs shall indicate active or operational circuits, and red LEDs shall be used to indicate non-operational circuits.

g) All indications shall be clearly labelled.

3.3.10.9 Charger/Rectifier alarms

3.3.10.9.1 Each unit is provided with a relay dedicated to each alarm for remote indication of the listed alarms. Each relay is equipped with two normally open and two normally closed potential free contacts to provide for two independent sets of remote alarms.

3.3.10.9.2 The following remote alarms shall be available and is described as functionality required within the charger/rectifier:

a) AC FAILURE alarms any fault appearing on the AC input to the charger. This covers individual phase failure, incorrect phase rotation if applicable and voltage excursions beyond the normal voltage limits.

b) RECTIFIER MODULE FAIL/SHUTDOWN alarms that one or more rectifier modules have failed or when the rectifier is tripped by battery or load over voltage. Rectifier module failure senses low output voltage simultaneously with low current, output ripple high, internal protection failure, failure of power electronics, failure of communication electronics etc.

c) RECTIFIER MODULE I/O MCB TRIP alarms when either the input or output circuit breaker trips.

d) LOAD VOLTAGE LOW alarms when the load voltage is lower than normal.

e) LOAD VOLTAGE HIGH alarms when the load voltage exceeds the normal safe limits and trips the rectifier module causing the over voltage by sensing the high voltage and simultaneously a high output current on that module.

f) BATTERY VOLTAGE LOW alarms when the battery voltage is lower than normal.

g) BATTERY VOLTAGE HIGH alarms when the battery voltage exceeds the normal safe limits and trips the rectifier module causing the over voltage by sensing the high voltage and simultaneously a high current output current on that module.

h) BATTERY VOLTAGE LOW (URGENT) alarms when the battery voltage has reached a pre-set value close to the minimum voltage of the system.

i) PROTECTIVE DEVICE FAIL alarms when the battery protective device operates.

j) RIPPLE HIGH alarms when voltage and current ripple exceeds pre-set value.

k) BATTERY LOSS ALARM alarms when the battery circuit is no longer continuous, i.e. the battery cable has been severed, a cell connector has become corroded, a cell casing has ruptured losing all the electrolyte or for whatever reason. Under these conditions the battery would be unable to provide load current if the charger were to fail. The battery loss sensing may be carried out in a variety of ways. The actual method used shall be approved by Eskom.

l) LOAD VOLTAGE LOW (URGENT) alarms when the load voltage is so low that the load is close to its operating minimum limit.

m) FAILURE OF AUTOBOOST CYCLE alarms when the auto boost cycle has not been completed within the allocated time as described.

n) BATTERY ROOM FAN FAILURE alarms when the extraction fan in the battery room fails. This also means that any equalise charging will be inhibited.

o) LOAD VOLTAGE REGULATOR FAILURE alarms when the load voltage regulator is not keeping the load voltage within prescribed limits and the backup protection has come into operation.

p) DC EARTH FAULT alarms when an earth fault is detected.

q) HYDROGEN LEVEL HIGH alarms when high hydrogen levels of 0.8% is detected.

r) HYDROGEN LEVEL HIGH-HIGH alarms when high hydrogen levels of >1% is detected and the auto-boost, equalise and initial charge shall be disabled with a high-high hydrogen alarm and the respective charging mode failure alarm.

s) HYDROGEN ANALYSER FAILURE alarms when power supply to the analyser is unavailable or broken wire status from the analyser or any other failure from the analyser is detected. The auto-boost, equalise and initial charge shall be disabled with a hydrogen analyser failure and the respective charging mode failure alarmed.

t) BATTERY SELF-TEST – FAILURE alarms when a battery self-test was performed and the voltage decayed below a pre-set value (determined by battery OEM)

3.3.10.9.3 A list of "ALARMS" that Eskom requires to be indicated locally and relayed to a central office is tabled below:

Table 9: of alarms

Local/Remote Charger Alarms	Rectifier Trip	Grouped Alarm
AC Phase Failure	No	Charger Fail (A charger fail alarm shall be re-initiated as a URGENT Charger fail after 50% of the battery standby time based on voltage level setting)
Rectifier Module Fail/Shutdown	No	
Rectifier Module I/O MCB Trip	No	
Ripple High	Yes	
Load Voltage Low	No	
Load Voltage High	Yes	
Battery Voltage Low	No	
Battery Voltage High	Yes	
Battery Voltage Low (Urgent)	No	DC System Fail (A DC Fail System Alarm shall be refreshed every 1 minute)
Battery Fuse Fail (or MCB Trip)	No	
Battery Loss Alarm	No	
Load Voltage Low (urgent)	No	
Failure of Auto-boost Cycle	No	Charger Facility Abnormal
Load Voltage Regulator Failure	No	
Battery Self- test Failure	No	
DC Earth Fault +ve leg	No	DC System Abnormal
DC Earth Fault -ve leg	No	
Spring Rewind Supply Tripped	No	
Hydrogen level high	No	
Hydrogen level high-high	No	
Hydrogen analyser failure	No	

3.3.10.9.4 Any additional alarms shall be specified in schedule A.

3.3.10.10 AC/DC to DC/AC converter alarms

3.3.10.10.1 Each unit is provided with a relay dedicated to each alarm for remote indication of the listed alarms. Each relay is equipped with two normally open and two normally closed potential free contacts to provide for two independent sets of remote alarms.

3.3.10.10.2 The following remote alarms shall be available:

a) OUTPUT FAILURE,

b) INPUT FAILURE,

- Mains failure to the rectifier
- Rectifier failure
- Rectifier voltage out of limits
- Ripple voltage out of limits

3.3.10.10.3 Any additional alarms shall be specified in schedule A

3.3.10.11 UPS alarms

3.3.10.11.1 Each unit is provided with a relay dedicated to each alarm for remote indication of the listed alarms. Each relay is equipped with two normally open and two normally closed potential free contacts to provide for two independent sets of remote alarms.

3.3.10.11.2 The following remote alarms shall be available:

a) CHARGER/RECTFIER FAILURE
- As per clause above.

b) DC SYSTEM FAILURE
- As per clause above.

c) CHARGER FACILITY ABNORMAL
- As per clause above.

d) DC SYSTEM ABNORMAL
- As per clause above.

e) OUTPUT FAILURE,
- Inverter –off, failure or stopped;
- Voltage or frequency out of limits; and
- Inverter overload

f) STATIC BYPASS INPUT FAILURE,
- Mains failure or out of limits to the static bypass
- Static bypass unavailable

3.3.10.11.3 Any additional alarms shall be specified.

3.3.11 Communication and control design requirements

3.3.11.1 General

3.3.11.1.1 The battery charger system shall be remotely accessible through a communications link; all details of the interface, including hardware, software, logical and protocol details shall be made available to Eskom to allow the equipment to be interfaced to a remote terminal unit (RTU) and/or communication equipment.

3.3.11.1.2 The communications protocol used shall also be specified.

3.3.11.1.3 The possibility of supporting the DNP 3.0 level 2 or level 3 protocols and IEC61850 over RS485/Ethernet/Fibre shall be specified.

3.3.11.1.4 The rectifier module shall have a built in micro-controller to control the current and voltage control loops and the default current and voltage limits in the event of loss of communication with the rest of the system.

3.3.11.1.5 In the event that external control is lost, the micro-controller shall automatically detect this and revert to the default settings, and operate effectively in a stand-alone mode.

3.3.11.1.6 The micro-controller shall also carry out internal diagnostics, monitor internal parameters for status and telemetry feedback where possible.

3.3.11.2 Real time clock and time synchronization

3.3.11.2.1 In order to get correct event reports, the converter system shall have a real time clock and built-in calendar, suitable for at least 30 years.

3.3.11.2.2 The real time clock shall not drift by more than 60s in one month.

3.3.11.2.3 It shall be possible to adjust the time and date without resetting any other parameters.

3.3.11.2.4 During any loss of supply, the time of the clock shall be maintained for at least 7 days, for example, a crystal oscillator circuit and a backup battery.

3.3.11.2.5 Where serial communication to the RTU is specified, it shall be possible to synchronise the IED's internal clock to that of the substation RTU via the DNP3 protocol or any other.

3.3.11.2.6 The synchronization shall be indicated in the event report if the period is longer or shorter to enable proper information recording.

3.3.11.3 Communication ports

3.3.11.3.1 The equipment shall be equipped with at least two RS-232 ports to facilitate local and remote communication. In addition to the RS-232 ports, RS-485 and Ethernet or Fiber-optic ports shall be provided as a standard.

3.3.11.4 Monitoring and control

3.3.11.4.1 The module input/output MCBs may also be fuses.

3.3.11.4.2 Interface to a local PC for programming shall be possible.

3.3.11.4.3 Interface to enable remote communications to the battery charger shall be possible.

3.3.11.4.4 The pre-programmed current / voltage / time duration as required by the different charging modes shall be maintained.

3.3.11.4.5 The battery charger system shall ensure optimal management during power outages.

3.3.11.4.6 Software and firmware shall be upgradeable to suit new control & monitoring requirements.

3.3.11.4.7 The battery charger settings and alarms display shall be via a front panel display and keypad.

3.3.11.4.8 Password controlled access to perform setting changes either by means of the keypad or a computer shall be possible.

3.3.11.4.9 Real time control of rectifier modules via a dedicated control bus shall be done.

3.3.11.4.10 The rectifier modules shall be initialised with default values for stand-alone operation in the event of loss of the master control and monitoring computer.

3.3.11.4.11 The individual rectifier module parameters shall be monitored and compared with system level parameters for fault diagnostics (voltage, current, temperature etc.).

3.3.11.4.12 Interfaces with an optional cell/battery monitor / test unit to check the integrity of the battery and accumulate and log battery data for retrieval at a later stage shall be possible when stipulated in schedule A.

3.3.11.4.13 Logging of all events with date, time, type and duration of event, voltage and current profiles etc. Note that date-timestamp of event clearing shall also be recorded.

3.3.11.4.14 Monitoring of the battery charger -, battery - and load currents to within 1% accuracy for front panel display and front-end software.

3.3.11.4.15 Monitoring of system internal and environmental parameters as defined, such as room and battery temperatures, cooling fans, generator operation etc. shall be possible.

3.3.11.4.16 Each controller shall be uniquely identifiable and addressable for security purposes during remote operation.

3.3.12 Software and firmware

3.3.12.1 General

3.3.12.1.1 Software for equipment equipped with serial and network interfaces whereby fault recordings, sequence of events, settings and marshalling can be accessed by a PC and are downloadable in an acceptable format (e.g. csv, xls, and txt), shall be made available as it is deemed to be an integral part of the required converter system functionality. This software shall be compatible with the current Eskom approved Microsoft Windows (e.g., 7 and 8) operating system. Software with DOS as the operating system will not be acceptable. Details of various operating systems supported shall be included in the tender documentation.

3.3.12.1.2 Any future software versions shall be backward compatible.

3.3.12.1.3 The cost of the software, including software manuals, disks and serial cable, shall be limited to a fair cost that shall be included in the tender documentation. A “fair cost” is deemed to be an amount sufficient to cover the material cost and overhead of such items and not the perceived intellectual value of the software. Eskom shall have the right to freely copy the software and reproduce the manuals for exclusive use within Eskom and the successful tenderer shall issue Eskom with a Corporate Software Licence. Preference will be given to on-board web based software which does not require additional software installation.

3.3.12.1.4 The supplier shall provide software support for the full, guaranteed, lifetime of the hardware.

3.3.12.1.5 The supplier shall, on request from Eskom, provide Eskom with the necessary software detail when this is required for the converter system interfacing with future or existing systems.

3.3.12.1.6 The supplier shall adhere to the software control standard, ESKPBAAH5, Rev 0: The control of new products and version changes in the technical software, firmware and hardware used in the technical field.

3.3.12.1.7 All settings and display features available on the front keypad / display of the converter system shall be available on the operating software for remote or local applications.

3.3.12.1.8 The alarm / event log page shall be able to be downloaded as a text (*.txt) or excel (*.xls) file to the host PC.

3.3.12.1.9 The software shall be able to save all alarm / charge mode settings as a file (settings sheet) which can be uploaded to the converter system. All the converter settings shall also be downloadable into the setting template format.

3.3.12.1.10 The software shall display the status of any modules connected to the converter system

3.3.12.1.11 During an AC mains failure condition or equipment system failure, the converter system shall record the discharge curve (battery bank voltage and current, as a minimum) of the battery until the converter system shut down due to low volts. The recording function shall be optimised to save memory space. This discharge information shall be downloaded when the converter system is back to normal for review purposes. This file shall also be able to be downloaded to the remote PC, for viewing with the front-end software. This data shall not be stored on or reduce the required memory allocated for normal event logging purposes.

3.3.12.2 Software verification and validation

3.3.12.2.1 To meet the requirements of future contracts based on this specification, if a microprocessor based converter is being offered, the contractor shall supply evidence on request in the form of reports from a mutually acceptable third party that:

a) An adequate formal specification for the software has been produced, based on a requirement document and comprehensive hazard analysis.

b) The software has been developed using tested tools, adequately trained staff and using an acceptable quality management system. In particular, all stages of design, development and testing process shall have been adequately planned and documented.

c) The software has been formally verified to ensure that it matches its specification.

3.3.12.3 System firmware

3.3.12.3.1 The equipment system firmware version shall be displayed on the rectifier and controller module display and on the operating software.

3.3.12.3.2 Any converter system based firmware (EPROM or Flash ROM) supplied to Eskom, shall not be changed unless Eskom requests the modification or Eskom gives written approval to the supplier to do the proposed modification. Any modification shall be subject to testing and verification and formal approval, in writing by Eskom, shall be required prior to the supplier placing the altered firmware into operation. The requirements of ESKPBAAH5, Rev 0: The control of new products and version changes in the technical software, firmware and hardware used in the technical field, shall be adhered to.

3.3.12.3.3 The estimated data retention time of EPROM or FLASH ROMs used in the converter systems shall be the design life of the equipment.

3.3.12.3.4 The equipment firmware shall be upgradeable via remote communication and security checks shall be in place to ensure that such remote upgrade has been successfully completed. In the event of the remote upgrade being unsuccessful, the converter shall resume normal operation on the older firmware version.

3.3.12.4 The equipment system software operational features

3.3.12.4.1 All settings and display features available on the front keypad / display of the converter system shall be available on the operating software for remote or local applications.

3.3.12.4.2 The alarm / event log page shall be able to be downloaded as a text (*.txt) or excel (*.xls) file to the host PC.

3.3.12.4.3 The software shall be able to save all alarm / charge mode settings as a file (settings sheet) which can be uploaded to the converter system. All the converter settings shall also be downloadable into the setting template format.

3.3.12.4.4 The software shall display the status of any modules connected to the converter system.

3.3.12.4.5 The software shall display the status of the remote communications connection.

3.3.12.4.6 During an AC mains failure condition or equipment system failure, the converter system shall record the discharge curve (battery bank voltage and current, as a minimum) of the battery until the converter system shut down due to low volts. The recording function shall be optimised to save memory space. This discharge information shall be downloaded when the converter system is back to normal for review purposes. This file shall also be able to be downloaded to the remote PC, for viewing with the front-end software. This data shall not be stored on or reduce the required memory allocated for normal event logging purposes.

3.4 Mechanical requirements

3.4.1 General

3.4.1.1 The converter and/or UPS ASSEMBLY shall comply with the fundamental safety requirements of Clause 5 of SANS 10142-1 and SANS 62040-1, Uninterruptible power systems (UPS) Part 1: General and safety requirements for UPS.

3.4.1.2 The converter and/or UPS ASSEMBLY shall as a minimum be designed, constructed and tested in accordance with the requirements of Clause 6.6 of SANS 10142-1.

3.4.1.3 All components and electric conductors fitted to the ASSEMBLY shall be certified as safe by means of a valid Regulatory Certificate of Compliance (RCC) in accordance with SANS 10142-1 Table 4.2 or an SABS Mark of approved performance.

3.4.2 Doors and covers

3.4.2.1 For easy access, each cable compartment and each fixed pattern functional unit sub-section shall be provided with individual hinged doors.

3.4.2.2 All removable covers shall require the use of a tool for their removal.

3.4.2.3 All opening doors shall be padlockable.

3.4.2.4 Doors shall have not less than the following points of hinging:

- up to 450mm - 2 hinges,
- up to 800mm - 3 hinges
- more than 800mm - 4 hinges.

3.4.2.5 All doors shall be secured by square key latches as follows:

- up to 450 mm - 2 latches,
- up to 800 mm - 3 latches and
- more than 800 mm - 4 latches

Any other proven design shall be submitted to Eskom for approval.

3.4.2.6 Door latches shall be of robust construction and be manufactured from steel. At least the center square key latch shall be padlockable.

3.4.2.7 Provision shall be made on the cable compartment door hinges to allow the doors to be lifted off. Metal hinges shall be of robust construction and shall ensure effective electrical bonding to the enclosure is maintained. Plastic and die cast material is not acceptable.

3.4.2.8 The method of fastening the latches and hinges shall be such that it will not wear loose due to vibration or rough handling of the door.

3.4.2.9 The door latches and hinges shall be able to withstand an internal severe fault.

3.4.2.10 Doors shall have stops to prevent over swing when opening and to avoid interference with adjacent compartments.

3.4.2.11 Doors of 800mm or longer shall be provided with webs or other methods to prevent wobbling when the door is operated.

3.4.3 Main, Distribution, Equalizing and Collection Busbars

3.4.3.1 Main busbars and distribution busbars shall be manufactured from electrolytic tough pitch high conductivity copper complying with SANS 804.

3.4.3.2 Conditions of temper for busbar copper shall comply with the designation H2 for half-hard cold working in accordance with SANS 1195.

3.4.3.3 Main and distribution busbar dimensions shall take into account the maximum allowed surface temperature-rise, the expected power losses per running metre, the ASSEMBLY form of separation, the external degree of protection IP and the ability of the ASSEMBLY to dissipate the power losses at the assigned rated current. For main busbars, the maximum permissible surface temperature-rise at rated current shall not exceed 65 K and for distribution busbars 55 K.

3.4.3.4 Unless stated otherwise, the neutral busbar shall not be rated at less than 50 % of the main and 100% the associated distribution busbars and shall be easily accessible.

3.4.3.5 In the case where the ASSEMBLY is fed directly from a transformer, the neutral busbar shall be connected to the protective conductor by means of a removable bolted link on the cable side of each incoming functional unit. The link shall be readily accessible for removal and testing. The link shall be long enough to allow the fitting of a dedicated ring-core current transformer.

3.4.3.6 Joints and tees in busbar connections shall comply with the recommendations of the Copper Development Association laid down in T 22 - "Copper for Busbars". High tensile bolts of 8,8 strength grade to ISO 898-1 shall be used. Bolts, nuts, washers etc. shall be zinc plated and chromate passivated.

3.4.3.7 Joints shall be made with at least two bolts and the overlap shall be sufficient to ensure ample mechanical strength and joint conductivity. The busbar overlap shall be not less than six times the thickness or shall equal the width of the busbar material whichever is the greater. For busbar connections, conical washers will be preferred above spring washers.

3.4.3.8 The distribution busbar compartment shall be rigid and supported all the way from the main busbar section down to the gland plate below the bottom end of the distribution busbars. Standard approved busbar supports with a minimum fault current rating in line with that of the main busbar support shall be used as supports for distribution busbars.

3.4.3.9 The span of the distribution busbar shall not interfere with the ASSEMBLY cable entry zone, allowing for easy cabling of even the lowest functional unit. Provision shall be made for easy inspection of all functional unit connections to the distribution busbars.

3.4.3.10 All busbars shall be marked in such a way that it is easy to identify to which supply phase or pole they are connected to when any covers are removed.

3.4.3.11 Busbars shall be colour coded as follows:

3.4.3.11.1 AC busbars are colour coded RED, WHITE & BLUE for the phases and BLACK for neutral busbar.

3.4.3.11.2 DC busbars rated at 220 V shall be colour coded RED, for the positive conductor and BLACK for the negative.

3.4.3.11.3 DC busbars rated at 24 V shall be colour coded RED, for the positive conductor and BLUE for the negative, and the zero bar shall be colour coded BLACK (where required)

3.4.3.12 Collection busbars need to be constructed where SCPD's and mcb's need to be connected in cascaded circuits. Collection busbars shall be rated for the full prospective short-circuit rating and equal to the derated current rating of the supply SCPD.

3.4.3.13 In cases where it is found necessary to connect single phase cables to incoming or outgoing circuit-breakers, it may be necessary to install equalizing busbars. Additional fixed supports to the OEM's

prescriptions shall be installed to prevent the equalizing busbars to show any signs of deformation when subjected to a short-circuit condition.

3.4.4 Protective earth conductor and the screened earth busbar

3.4.4.1 A separate protective earth (PE) conductor, to which all metal parts are galvanically connected, shall be installed on the inside rear of each ASSEMBLY along the entire length. The bar shall be in an accessible position to allow for the earthing of conductors within a closest distance from the cable entry points and have a provision for connection to the system earth on both ends.

3.4.4.2 Non-current carrying conductive parts, including relays, meters etc., shall be electrically connected to the protective earth conductor by means of their mounting arrangement on the ASSEMBLY or by a separate earthing conductor connected to the protective conductor. This shall include gland plates and earth terminals provided on equipment.

3.4.4.3 Earthing or bonding to the PE conductor shall be applied to all doors by means of at least 6 mm2 cross-sectional area multistring conductors.

3.4.4.4 The PE conductor shall be dimensioned in accordance with SANS 10142-1 with respect to the thermal stresses due to duration of short-circuit at 60 % of the ASSEMBLY prospective short-circuit rating kA.

3.4.4.5 All parts of the protective circuit within the ASSEMBLY shall be designed to withstand the highest dynamic stresses that may occur during fault conditions.

3.4.4.6 Where specified, a screened earth busbar made of copper material shall be installed in the inside rear of the ASSEMBLY along its entire length. The screened earth busbar shall be completely insulated from all metal parts and shall be located in an accessible position to allow for the connection of cable screens.

3.4.4.7 The PE conductor shall be colour coded GREEN with a YELLOW stripe and the screened earth bar shall be left uncoloured.

3.4.5 Power and control wiring

3.4.5.1 Power circuit wiring and connections in the ASSEMBLY shall be rated according to the de-rated operating current of the associated protective gear and not the load current.

3.4.5.2 All control wiring connected to a source of fault energy shall be capable of carrying continuously a current equal to 1,5 times the rating of the fuse protecting it and withstanding the total I2t let-through current of the fuse under any fault condition from overload to short circuit without suffering perceptible damage.

3.4.5.3 Each individual functional unit control circuit shall be connected directly to the control busbars as far as it is practically possible. Looping of control wires is not preferred. However, if looping is necessary, the wiring shall present neat appearance and the conductors shall be adequately braced, clipped and or laced to avoid loose connections during vibrations.

3.4.5.4 Connections to equipment on swing doors shall be arranged so as to give a twisting motion and not a bending motion to the conductor.

3.4.5.5 Only stranded conductor cable shall be used. Single or solid conductor shall not be used. Aluminium conductors shall also not be used.

3.4.5.6 Multistrand cable with conductors of 1.5 mm2 cross sectional area shall be used for control circuits.

3.4.5.7 Wiring of the current and voltage transformer circuits shall be done by multistring conductor at least 2.5 mm2 cross-sectional area. The circuits and shall be colour coded according to the phases to which it is connected.

3.4.5.8 Joints or splices in any circuit as well as the termination of more than one conductor in one lug will not be acceptable.

3.4.5.9 ASSEMBLY and equipment terminals, labels, etc., shall be accessible after the circuits have been completed. Terminals, which are on the live side of fuses and isolating switches, shall be completely shrouded.

3.4.5.10 In order as to minimize the effect of electrolytic corrosion, coils shall be placed in the circuit so that they are not connected to the positive pole of a battery except through normally open contacts.

3.4.5.11 Compressed lugs shall match the conductor size and all compression joints shall be made with the correct crimping tool for the type of lug used. Compression joints shall be made to successfully pass the test as specified in BS EN 61238.

3.4.5.12 Conductors passing through holes in compartments shall be protected by means of robust neoprene grommets. Bevelling of steel sheet as a substitute is not acceptable.

3.4.5.13 Conductors carrying currents in excess of 100 A and passing through metal shall either be all three phases (both poles of DC conductors) or the metal barrier shall be split.

3.4.5.14 AC and DC conductors shall not be routed in the same wire way.

3.4.5.15 Power circuit cable sizing shall be based on SANS 1973-1 Annex H.2.

3.4.5.16 Stripping of insulation shall not result in damage to the conductors, shall result in 90 degrees clean cut and insulation is not damaged. The stripping tools used shall be of the type which permits the length of strip to be pre-set and the "force" applied to be pre-set.

3.4.5.17 Crimping tools shall be of the type which will not release the termination during normal operation until the conductor crimp has been correctly formed.

3.4.5.18 Correct torque shall be applied when any bolt or screw is tightened.

3.4.6 Conductor identification

3.4.6.1 Conductors for power conductors shall bear the face colour along the entire length of the phase to which they are connected or may be used in a common colour provided they are phase colour coded at each end of the conductor and at every connection point.

3.4.6.2 Control conductor sheath shall be coloured as follows:

3.4.6.2.1 BLACK for AC circuits

3.4.6.2.2 GREY for DC circuits

3.4.6.3 Control bus wiring shall be coloured as follows:

3.4.6.3.1 DC - RED for positive and BLACK for negative

3.4.6.3.2 AC - BROWN and BLUE

3.4.6.4 Conductors of CT and VT circuits shall bear the phase colours. The neutral conductor shall be coloured BLACK.

3.4.6.5 Control conductors shall be marked at both ends with an interlocking type of ferrule with permanent black letters impressed on a white or yellow background. The numbered ferrule shall not fall off when disconnecting the cable. Ferrules shall read in a consistent manner in both vertical and horizontal planes.

3.4.7 Enclosure and Assembly

3.4.7.1 If isolators and MCB or MCCBs are fitted behind the panel door EMC testing shall be conducted with the panel door open.

3.4.7.2 The input, DC port, output and static bypass isolation devices shall be individually segregated. Segregated cable ways shall be provided for different input, DC port, output, signal and control cabling. Deviations need to be approved by Eskom.

3.4.7.3 The SMR charger and AC/DC to DC/AC convertor sub-rack assemblies shall be able to be installed in swing frame and fixed frame 19" cabinets.

3.4.7.4 The following shall be required where swing frame cabinets are used:

3.4.7.4.1 19" swing frame cabinets shall be 800mm wide, 600mm, deep and 2400mm high and comply with DSP_34-464: Rev 0, Distribution specification for a swing frame panel (19 inch rack) and blanking plates

- Only front access via the door is required.

3.4.7.4.2 The following shall be required where fixed frame cabinets are used:

1) Standard 19" fixed frame cabinets (600mmx600mmx1200 to 2400mm).

- Front and rear access is required.

3.4.7.5 Facilities shall be provided for easy lifting and transporting of the equipment, such as removable lifting devices, or facilities for forklift handling, or other acceptable methods. The handling facilities offered shall be detailed in Schedule B.

3.4.7.6 The dimensions for UPS and rectifiers shall be indicated in schedule B preference will be given to smaller footprints per kVA rating the maximum height will be limited to 2200mm. The maximum allowable height for displays, MCBs and isolators etc. shall be 1700mm.

3.4.8 Sub-rack assemblies and input / output power distribution modules

3.4.8.1 The sub-rack assemblies shall consist of the controller sub-assembly which is installed in the front of the cabinet and the terminal plate sub-assembly which is installed at the back of the cabinet. A suitable segregated wire loom shall connect these sub-assemblies.

3.4.8.2 The input / output power modules consist of a front distribution module and rear terminal plate connected by a segregated wire loom.

3.4.8.3 In the case of sub-rack assemblies, it shall be possible to increase the power output of the overall system by the simple addition of more rectifier modules up to a maximum for the sub-rack beyond which additional sub-racks shall be required.

3.4.8.4 In the situations where the sub-rack is not fully populated, the spare module positions shall be already pre-wired for AC, and DC power and control, with the necessary protection devices already fitted. The current capability shall be designed for the maximum current capability determined by the total number of specific size modules able to be used in the rack and should be indicated on the nameplate.

3.4.8.5 Any unused module positions shall be covered with blanking plates which are removed and discarded when additional rectifier modules are fitted.

3.4.8.6 All parts that carry hazardous voltages shall be shrouded or screened to prevent contact by service personnel or have warning labels and meets minimum IP2X rating.

3.4.8.7 All MCB modules shall have a metal flip cover for individual MCB locking facility with a 8mm hole and a clear flip covering the entire MCB module to prevent accidental switching.

3.4.8.8 Terminal plates and top drawer assemblies shall be manufactured from mild steel of 1.6mm thickness.

3.4.8.9 Each sub-rack terminal plate shall be 482.6mm from edge to edge.

3.4.8.10 The mounting holes shall be slotted and shall be 10.30mm wide and 6.80mm high. The horizontal distance between the hole centres shall be 465.10mm. The spacing and size of the holes, similar to all other dimensions and tolerances, shall conform to the latest version of the IEC 60297-1 specification and shall be for the closed hole/slot type. The IEC specification is the only source for manufacturing dimensions.

3.4.8.11 The bends at the edges shall be done in such a way that the gap between butting plates is minimised. Special care shall be taken on the portion that overlaps the door mounting edges with a view to producing a cabinet fitted with blanking plates with an overall aesthetically pleasing appearance.

3.4.8.11.1 Each terminal plate shall have an earthing stud fitted on the rear, right hand side, i.e. closest to the door hinge, internal to the cabinet. The stud shall be fitted with a spring or a serrated washer, plain washer and the fastening nut.

3.4.8.11.2 All non-current carrying metal parts shall be electrically connected (bonded) to a clearly identified earth terminal as stipulated by SANS 10142.

3.4.8.11.3 The clamping means of the 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.

3.4.9 Ingress protection

3.4.9.1 The system assembly shall comply to IP31 with the panel doors closed and a minimum IP2X rating with the panel doors open. The general arrangement shall be such that an IP2X rating shall be maintained between live parts when the rectifier is isolated for maintenance purposes and battery supply is feeding the load.

3.4.9.2 If the application requires a unique ingress protection it shall be indicated in schedule A and the relevant type testing shall be repeated for example temperature rise.

3.4.10 Cable entry

3.4.10.1 Cable entry shall be possible from the top or the bottom of any enclosure. Installations may require all top entry, all bottom entry or both top and bottom.

3.4.11 Gland plate

3.4.11.1 Cable gland plates of a uniform design shall be provided at a minimum height of 300 mm above the point of entry. In case of cables entering from above, the cable gland plate shall be mounted at the point of entry.

3.4.11.2 Adequate access shall be provided beneath the gland plate to ensure that, once the cables have been installed, the floor slot can be sealed from above using fire retardant material. The arrangement shall be such that once this slot is sealed level with the floor, each base frame sub-section shall be sealed from the adjacent base frame sub-section.

3.4.11.3 Undrilled removable and corrosion protected gland plates shall be provided as per SANS 1652.

3.4.11.4 The gland plates shall be supported to prevent movement of the cables.

3.4.11.5 Non-magnetic gland plates shall be specified for single core cables and indicated in Schedule A.

3.4.11.6 Where cables of 95mm2 and larger are required, they shall be provided with robust, individual, un-drilled, removable gland plates.

3.4.11.7 Metal gland plates shall be bonded to the PE conductor by means of a bonding conductor whose cross-section is selected in accordance with SANS 10142-1.

3.4.12 Corrosion protection

3.4.12.1 All surface preparation, the application of the primer coat and finishing coat shall be in accordance with the requirements of SCSSCAAP9: Rev 3, Specification for Corrosion protection specification for new indoor and outdoor distribution equipment manufactured from steel.

3.4.12.2 The terminal plates and cabinet of AC assemblies shall be texture powder coated to colour “Light Grey”, code G29. All colours shall be according to SANS 1091, except for mounting plates and other support structures, which can be galvanized, or alloy cold rolled zinc steel.

3.4.12.3 The finished external colour of the DC assemblies shall be shall be texture powder coated to colour “Signal Red”, code A11 to SANS 1091, except for mounting plates and other support structures, which can be galvanized, or alloy cold rolled zinc steel.

3.4.13 Terminations

3.4.13.1 All terminals shall comply with the requirements of 240-70413291, Specification for electrical terminal blocks.

3.4.13.2 Terminals shall be provided for all input and output power cables as well as all external (remote) alarms.

3.4.13.3 Not more than two cable cores may be connected to a single terminal stud.

3.4.13.4 As a standard main supply terminals shall be rated for the rated input current at the minimum voltage and DC port terminals shall be supplied for 95mm2 cable terminations or as specified in schedule A.

3.4.14 Internal wiring

3.4.14.1 Wire ways and trunking shall be smooth and free from sharp edges. Conductors shall be so routed that it will not be damaged under normal operating conditions.

3.4.14.2 Trunking shall be able to withstand temperatures up to 90°C inside the cabinet without losing rigidness.

3.4.14.3 All wiring shall be neat and placed in trunking and / or wire looms where applicable. They shall also be clipped or laced to prevent vibration and deformation during through-fault conditions.

3.4.14.4 In the case of the swing frame cabinet with the swing door, the wire loom shall be so arranged as to give a twisting motion and not a bending motion.

3.4.14.5 Bare conductors shall be so rigid that under normal and through-fault operating conditions, creepage distances and clearances cannot be reduced below safe values.

3.4.14.6 Minimum creepage distances shall be for Pollution Degree 3, material group 111a with the specified insulation voltage.

3.4.14.7 It shall be verified that clearances and creepage distances comply with SANS 60439-1 Clause 7.1.2.

3.4.14.8 Clearances and creepage distances that depends on the degree of pollution shall not be lower than the values given in SANS 60439-1, Tables 14 and 16 respectively.

3.4.15 Conformal coating

3.4.15.1 Conformal coating shall be selectively applied in order not to degrade the required thermal performance of the whole system and prevent accumulated dust or other conductive particles from causing short-circuit.

3.4.15.2 The printed circuit boards, control circuitry, semiconductor leads and all other exposed leads shall be coated with an effective conformal coating whereas magnetic devices, which are already varnished, and other encapsulated semiconductor components are not required to be coated.

3.4.15.3 During application of the conformal coating, the components not to be coated shall be covered with masking materials. The use of an UV indicator in the coating material is advised to make quality control with an UV light possible which will aid in ensuring a correct uniform application of the coating material.

3.4.16 Accessibility

3.4.16.1 The enclosure shall allow easy access for terminating load and supply cables, and ease of maintenance.

3.4.16.2 The equipment shall be installed in such a manner that it shall be possible to access all components from the access point indicated required for normal maintenance.

3.4.16.3 The SMR and converter can be front accessible and rear accessible.

3.4.17 Minimum clearances

3.4.17.1 The pole-to-pole and pole-to-earth clearances shall not be less than indicated in SANS 10142-1 and IEC 61439-1.

3.4.17.2 The terminals for input, DC port, output and static by-pass are segregated from each other or clear barriers provided when installed on the same rail.

3.4.17.3 Minimum creepage distances shall be for Pollution Degree 3, material group 111a with the specified insulation voltage.

3.4.17.4 It shall be verified that clearances and creepage distances comply with SANS 60439-1 Clause 7.1.2.

3.4.17.5 Clearances and creepage distances that depends on the degree of pollution shall not be lower than the values given in SANS 60439-1, Tables 14 and 16 respectively.

3.4.18 Nameplate/Rating plate/Declared Electrical Performance

Each cubicle shall have a stainless steel or anodized aluminium plate on which the electrical performance of the product is declared. The following information as a minimum is engraved:

- As per IEC requirements
- Manufacturer
- Month/year of manufacture
- Type/model of unit
- Serial number
- UPS classification acc. to IEC 62040-3
- RECTIFIER as per SANS 1652
- Rectifier input voltage and tolerance

- Electrical supply configuration
- Nominal input current of rectifier
- Input frequency
- Input frequency tolerance
- Nominal DC output voltage
- Output voltage range.
- Rectifier output range
- Maximum rectifier output current
- INVERTER
- Inverter input supply voltage and tolerance
- Nominal input current of inverter
- Nominal AC output voltage
- Electrical output supply configuration
- Nominal AC output current
- Output frequency
- Power factor output
- Rated output active power
- Rated output apparent power
- BYPASS SUPPLY
- Bypass input supply voltage and tolerance.
- Electrical supply configuration
- Bypass supply nominal input current
- Input frequency and tolerance
- Nominal output voltage
- Nominal input power

3.5 Settings and Commissioning

3.5.1 Settings

3.5.1.1 The charger/rectifier shall be set up as per 240-56176168 DC systems setting standard for the specific type of battery technology to be used with the product.

3.5.1.2 A specific settings document in hard and soft copy shall be compiled for the specific product and incorporated in the manual.

3.5.1.3 The above mentioned setting values shall be programmed into the micro-processor and will not alter when supply to the micro-processor is lost.

3.5.1.4 The applicable software revision containing the specific settings shall be indicated on the settings document.

3.5.1.5 The settings document will also stipulate the required SCPD to be used as per the applicable load profile.

3.5.2 Commissioning

3.5.2.1 The charger/rectifier, converter and uninterruptible power supplies shall be commissioned as per 240-56177186 Acceptance and Commissioning of DC supply equipment.

3.5.2.2 As part of commissioning specific tests as listed as routine, operational and/or functional test in the IEC standards shall be executed.

3.6 Upgrading/Modifications

1) All proposed upgrades and modifications to any of the offered equipment shall be accompanied by a full technical report and shall only be implemented once it has been accepted and approved in writing by Eskom.

2) Any hardware upgrades affected to equipment shall be identifiable by some means of identification, affixed to the equipment.

3.7 Equipment Performance

3.7.1 Warranty

All equipment supplied shall be accompanied by a full 36 month warranty from date of commissioning.

3.7.2 Reliability, security, dependability, maintainability and life expectancy

3.7.2.1 The supplier / tenderer shall submit a full track record which shall include the following:

3.7.2.1.1 Equipment hours of installed units per voltage or model / type.

3.7.2.1.2 Customers indicating the number of units employed per model / type.

3.7.2.1.3 Environmental conditions where such equipment is installed.

3.7.2.2 All chargers/rectifiers, converters and UPSs to be used shall have:

3.7.2.2.1 A proven service record of at least two years and one hundred equipment years.

3.7.2.2.2 All tendered equipment shall be designed for a minimum working lifetime of 10 years for electronic equipment and 20 years for the balance as indicated in schedule A.

3.7.2.2.3 Written guarantees to this effect shall be made available as part of the tender.

3.7.2.2.4 The supplier shall make a statement regarding re-calibration of the equipment to keep it in perfect working order or any other required intervention by the supplier, subsequent to the sale of equipment that will have a financial impact on Eskom.

3.7.2.3 Any internal battery requirements for converters/ controllers, i.e., battery lifetime, type of battery etc. shall be stated during tender and on a label attached to the front of the equipment.

4. Tests

4.1 Applicability

One of each type and size charger, converter, UPS inverter and rectifier shall be fully type tested as per the requirements stipulated in this document based on the Eskom specifications and the relevant international standards. Thereafter, tests will be conducted and verified against the type and routine tests.

Redundant and dual redundant applications shall be routine tested (FAT) as a system. Each type and size product shall be type tested once and comprehensive routine test conducted on every product produced in the factory. Therefore, on a 10kVA UPS with a rectifier sized for 1 hour standby and a 10kVA UPS with a rectifier sized for 4 hours standby both are subjected to type testing once.

Tests will be conducted as per the latest revision of standards. Test reports of previous revisions shall only be accepted if the contractor can prove that the previous revision of the standard is similar to the latest revision.

Every size and model UPS is comprehensively type tested for UPS performance characteristics as stipulated in SANS (IEC) 62040-03 and factory witnessed tests/on-site tests as stipulated.. Less extensive routine and operational tests as per SANS (IEC) 62040-3 with actual batteries and load are conducted on site. The final test on site ensures correct connection between units, ventilation, cooperation between units, function of battery, etc. The required parameters shall be measured to be compared with the type and factory type test results.

4.2 Type testing

As per IEC 60146-1-1 “Semiconductor convertors; General requirements and line commutated convertors Part 1-1: Specifications of basic requirements” and IEC 62040 -3 “Uninterruptible power systems (UPS) Part 3: Method of specifying the performance and test requirements”. The detailed schematics and parts list and firmware versions of the type tested product shall be submitted with the type test reports. The type tests of the major components as indicated shall be submitted as part of the type test report. The type test report shall indicate the applicable test as per the clause indicated in the SANS and IEC standard as well as the applicable limits.

All type testing shall be done for configurations where the DC port, signal and control cables exceed 3m.

NOTE: Test results in which the environmental interference is masking the equipment under test performance will be rejected.

4.2.1 Converter tests

Rectifier tests shall be performed in accordance with 4.1.3 to 4.2, where applicable, of IEC 60146-1-1. Routine tests will cover insulation test and light load test and a checking of auxiliary protection devices and control systems. Type tests will include additional load tests, determination of losses, temperature rise, etc.

Table 10: Summary of tests

Test	Type Test	Routine Test	IEC 60146—1-1 Sub-clause.
Insulation test	X	X	4.2.1
Light load test	X	X	4.2.2.
Functional test	X	X	4.2.2.
Rated current test	X		4.2.3
Power loss determination for assemblies and equipment	X		4.2.4
Temperature rise test	X		4.2.5
Power factor measurement	X		4.2.6
Checking of auxiliary devices	X	X	4.2.7
Measurement of inherent voltage regulation	X		4.2.8
Checking the properties of the control equipment	X	X	4.2.9

Test	Type Test	Routine Test	IEC 60146—1-1 Sub-clause.
Checking the protective devices	X	X	4.2.10
Immunity test	X		4.2.11
Overcurrent capability test	X		4.2.12
Radio frequency generated interference and conducted noise	X		4.2.13
Audible noise	X		4.2.14
Measurement of ripple voltage and current	X	X	4.2.15
Additional tests	X		4.2.16

Table 11: of tests as per SANS 1652: "Battery Chargers – Industrial Type"

Test	Type Test	Routine Test	SANS 1652 Sub-clause.
Dielectric strength test	X	X	5.2
Insulation resistance test	X	X	5.3
DC output voltage adjustment range test	X	X	5.4
DC output voltage regulation tests	X		5.5
Temperature rise test	X		5.6
Power efficiency test	X		5.7
Test for protection against lightning surges	X		5.8
Short-circuit test on output terminals	X		5.9
Ripple voltage limits and ripple current test	X		5.10
Audible noise level test	X		5.11
Salt fog test	(X)		5.12
Glow-wire test on non-metallic enclosures	X		5.13
Lightning surge test	X		4.1.4
Parallel operation test	X		4.2.4

4.2.2 Rectifier functional tests

- Cooling requirements
- Load sharing within between rectifiers including two 6 pulse rectifiers
- Charging modes
- Dropping diode operating philosophy.
- Dropping diode voltage drop from 10 to 100% output capability.
- Alarming.

- Serial port communication
- Battery loss monitoring functionality.
- Reverse polarity protection.
- On a secondary delta star transformer configuration to achieve 12 pulse the load sharing between the two rectifiers needs to be measures at 10%, 25%, 50%, 75% and 100% load.
- Current limiting operation.
- Protection device operation.
- Voltage regulation sizing and load test verification.
- Diode failure operating philosophy test.

4.2.3 UPS tests

Complete tests shall be performed in accordance with IEC 62040-3 including additional requirements on impulse withstand test. The schedule of routine tests and type tests is given in IEC 62040-3.

Table 12: SANS (IEC) 62040-3 Type tests for UPS performance characteristics

Test description	Routine test	Type test	Sub clause
Cable and interconnection check	X	X	6.2.2.2
Control device(s)	X	X	6.2.2.3.a
Protective device(s)	X	X	6.2.2.3.b
Auxiliary device(s)	X	X	6.2.2.3.c
Supervisory, monitoring, signalling device(s)	X	X	6.2.2.3.d
Auto transfer to stored energy mode and back to normal	X	X	6.2.2.3.e
Auto transfer to bypass / isolation mode and back to normal	X	X	6.2.2.3.f
Manual transfer to bypass/isolation mode and back to normal	X	X	6.2.2.3.g
No load	X	X	6.2.2.4
Full load	X	X	6.2.2.5
Frequency slew-rate		X	6.2.2.6
AC input failure	X	X	6.2.2.7
AC input return	X	X	6.2.2.8
Parallel redundant UPS fault		X	6.4.2.12
Transfer test to bypass	X	X	6.2.2.9
Input supply compatibility			
Steady-state input voltage tolerance		X	6.4.1.1
Input frequency variation		X	6.4.1.2
Input inrush current		X	6.4.1.3
Harmonic distortion of input current		X	6.4.1.4
Power factor		X	6.4.1.5
Efficiency		X	6.4.1.6
Stand-by generator compatibility		X	6.4.1.9
Output – Linear load			
Normal mode – No load		X	6.4.2.1

Test description	Routine test	Type test	Sub clause
Normal mode – Full load		X	6.4.2.2
Stored energy mode – No load		X	6.4.2.3
Stored energy mode – Full load		X	6.4.2.4
3-phase voltage unbalance test		X	6.4.2.5
DC components in the output		X	6.4.2.6
Current division across paralleled UPS		X	6.4.2.7
Output overvoltage test		X	6.4.2.8
Periodic output voltage variation test (modulation)		X	6.4.2.9
Normal mode – Overload		X	6.4.2.10.1
Stored energy mode – Overload		X	6.4.2.10.2
UPS rated output fault clearing capability – Normal mode		X	6.4.2.10.3
UPS rated output fault clearing capability – Stored energy mode		X	6.4.2.10.4
UPS output dynamic performance tests			
Dynamic performance – Normal to stored energy mode		X	6.4.2.11.1
Dynamic performance – Stored energy to normal mode		X	6.4.2.11.2
Dynamic performance – Normal to bypass mode – overload		X	6.4.2.11.3
Dynamic performance – Step load – Normal mode		X	6.4.2.11.4
Dynamic performance – Step load – Stored energy mode		X	6.4.2.11.5
Output – Non-linear load			
Normal mode – Full load		X	6.4.3.1
Stored energy mode – Full load		X	6.4.3.2
Dynamic performance – Normal to stored energy mode		X	6.4.3.3.1
Dynamic performance – Stored energy to normal mode		X	6.4.3.3.2
Dynamic performance – Step load – Normal mode		X	6.4.3.3.3
Dynamic performance – Step load – Stored energy mode		X	6.4.3.3.4
Stored and restored energy times			
Stored energy time		X	6.4.4.1
Restored energy time		X	6.4.4.2
Battery ripple current		X	6.4.4.3
Restart test		X	6.4.4.4
Environmental			
Repetitive shock during transportation		X	6.5.2.1
Free-fall during transportation		X	6.5.2.2
Storage in dry heat, damp heat and cold environments		X	6.5.3
Operation in dry heat, damp heat and cold environments		X	6.5.4
Acoustic noise		X	6.5.5
Safety		X	Refer to IEC 62040-1
EMC test		X	IEC 62040-2

5. Marking, labelling and packaging

5.1 Labelling

a) Product labelling is done in accordance with ESKOM drawing number 0.54/3695 sheet 1 and 2 MV, LV and DC switchgear labels and nameplate details or 240-62629353 Specification for panel labelling standard whichever is required by the specific Eskom division. All outgoing circuit breakers are provided with blank labels, fixed by means that will allow easy removal for future engraving.

b) The package shall be clearly labelled with the station name, full delivery address, Eskom and supplier order number, dispatch date and the contents of the package.

5.2 Packaging

a) The products shall be packed in high specification impact resistant corrugated cardboard with a waterproof outer plastic covering. This shall ensure that the equipment is protected from damage in the event of a light drizzle as well as protected from bumps and scratches that could occur from normal handling and transport.

b) The packaging shall be suitable to protect the equipment from transport damage over long distance by road.

c) Two additional packaging options can be indicated in Schedule A:

1) Installation of the equipment system into a cabinet and crating of the cabinet / equipment. In this case the cabinet does not have to be crated into a solid crate. It should merely be crated in such a fashion that no damage occurs to any switches or other components on the battery charger when two crates are placed face-to-face next to each other.

2) Crating of the equipment.

6. Spares

6.1 General

a) Development of the converters shall not be considered complete until the supplier has provided a comprehensive list of spares to be held in stock that shall, at minimum, include one of each of the different rectifier and controller modules, auxiliary relays, MCBs, switches, lamps as well as empty sub-racks, plugs and sockets and consumable items, if any.

b) A list of spares recommended necessary for the proper maintenance of the converter shall be submitted as part of the converter documentation.

c) The spares items shall be priced individually in the price schedule and the lists shall include a description of the item, a reference number and the pricing details.

d) All spares shall be delivered in approved packaging suitable for storing such parts over a period of ten (10) years without damage or deterioration.

e) Spares shall be available at the supplier or agent at the local works for the duration of the warranty period in accordance with the following numbers of schemes in the field:

1) 1 to 20 modular converters, chargers or UPSs : 1 spare modular converter or set of cards ; and

2) 21 to 40 modular converters, chargers or UPSs : 3 spares of each module or 3 sets of cards and doubling of these quantities for above 40.

f) The delivery time for these spares shall not exceed 24 h ex-works from the receipt of an authorised written order from Eskom.

g) The supplier's responsibility to keep spares at his premises shall end when the warranty period expires on the last unit supplied to Eskom.

h) Converter spares and controllers shall be available for a period of at least 10 years subsequent to the delivery of the last unit to Eskom.

7. Documentation

7.1 General

a) Three hard copies and one soft copy of the documentation as described in SANS 1652 shall be submitted with every product delivered applicable to all converters and UPS.

b) Reproducible drawings shall be provided in an English language. All drawing shall be in at least A3 size. All detail drawings are drawn and prepared on software .dgn format.

7.2 Drawings

7.2.1 General arrangement drawings

7.2.1.1 General arrangement drawings shall be completely dimensioned, showing:

7.2.1.1.1 Arrangement of equipment

7.2.1.1.2 Top, front, and side views and cross-sections of the ASSEMBLY.

7.2.1.1.3 Position of each functional unit and their compartments.

7.2.1.1.4 Clearances for opening doors.

7.2.1.1.5 Locations of busbars and distributions.

7.2.1.1.6 Details on the required openings for the power cables.

7.2.1.1.7 Incoming and outgoing cable termination positions and details.

7.2.1.1.8 Cable slot positions.

7.2.1.1.9 The height of all cable glands above floor level.

7.2.1.1.10 Instrument transformers (i.e. VT's and CT's) physical positions.

7.2.1.1.11 Terminal block locations.

7.2.1.1.12 Earthing or bonding connections.

7.2.1.1.13 Mass of transportable sections of equipment.

7.2.1.1.14 Details and position of the holding down bolts.

7.2.1.1.15 Magnitude and disposition of all loads imposed on foundations.

7.2.2 Single line diagram

7.2.2.1 Single line diagram shall show the following:

7.2.2.1.1 Configuration of the circuits (i.e. incomers and feeders) on the ASSEMBLY.

7.2.2.1.2 Electrical connection of VT's and CT's

7.2.2.1.3 Section or sub-section numbers of the different functional units.

7.2.3 Schematic Drawing

7.2.3.1 Schematic wiring diagrams shall show the following:

7.2.3.1.1 All protection and control devices and their contacts, each of which shall be labelled with its correct ANSI device function number (i.e. protection and control scheme).

7.2.3.1.2 Device terminal numbers, terminal block numbers and terminal numbers.

7.2.3.1.3 All wiring within each functional unit.

7.2.3.1.4 All internal interconnections, bus wiring, inter ASSEMBLY wiring and connections to external equipment.

7.2.3.1.5 All control and protection switches.

7.2.3.1.6 Power supply connections.

7.2.3.1.7 Component schedule (Detail parts list indicating the type number, item description, electronic cards including card revision etc.).

7.2.4 Installation, Operating and Maintenance Instruction Manuals

7.2.4.1 Instruction manuals shall comply with the requirements laid down in the tender enquiry. The number of copies is as specified in Schedule A.

7.2.4.2 The manuals that cover all equipment forming part of the ASSEMBLY shall be complete with:

7.2.4.2.1 Power station name, Transmission, Distribution or Telecoms Division details and order number;

a) Content list;

b) List of reference drawings;

c) Details of all components.

7.2.4.2.2 The manuals to be submitted shall be in loose-leaf binders to ISO format (or equivalent) and nominally A4 size. The use of oversize pages shall be kept to minimum and shall not exceed page height unfolded. Fixings shall preferably be D-ring and be of the snap close type. Post binders or other fixings will not be accepted. Binders shall not exceed 80 mm in overall thickness. The document identity shall appear on both the front cover and on the spine.

7.2.4.2.3 Manuals shall contain general arrangements drawings, installation drawings and instructions, operating and maintenance instructions for all components, detailed parts lists which shall be accompanied by exploded view type drawings clearly detailing the part and uniquely identifying it, technical descriptions of the equipment and components parts, spare part ordering instructions and instructions and type test certificates.

7.2.4.2.4 Any special instructions pertaining to the storage of spare parts or to their shelf life shall be included in the manual. All drawings required for component locations, dismantling and re-assembly for maintenance shall be included in the manual.

7.2.4.2.5 All special tools required for maintaining and operating the equipment shall be identified in a schedule to be included in the manual.

7.2.5 Engineering Design System (EDS)

7.2.5.1 The EDS is the source document of design, type-testing, manufacturing, routine testing and commissioning of the converter and/or UPS assembly. The engineering design system shall as a minimum cover stated deviations, proven by test, and shall include, where relevant, information on the following:

7.2.5.1.1 the modularity of the complete ASSEMBLY, the sections and the subsections;

7.2.5.1.2 the method of future extension;

7.2.5.1.3 design requirements applied in the case of the chassis, doors, covers, hinges, handles, locking mechanisms, and the ability of each alternative selection to withstand a short-circuit;

7.2.5.1.4 The method of changing internal partitions to suit the required form of separation;

7.2.5.1.5 Entries or exits of cables and busbars;

7.2.5.1.6 Conditions for applying ventilation;

7.2.5.1.7 Descriptions of different designs of ASSEMBLIES for specific industrial environments;

7.2.5.1.8 The degree of protection (IP rating);

7.2.5.1.9 Protection against corrosion of the ASSEMBLY and the busbar system;

7.2.5.1.10 Design and selection requirements of main busbars and supports;

7.2.5.1.11 Design and selection requirements of distribution busbars and supports;

7.2.5.1.12 Design requirements for protective and neutral busbars and supports;

7.2.5.1.13 The method of establishing the maximum distance between supports by calculation of short-circuit forces acting on the respective busbar systems;

7.2.5.1.14 A specification of support material for each short-time rating of the range of ASSEMBLIES;

7.2.5.1.15 The method of calculation of maximum allowable power losses of functional units per section and subsection;

7.2.5.1.16 The maximum temperature ratings of internal conductors, wiring and functional units;

7.2.5.1.17 The range of ASSEMBLY sections, subsections, cable sections and busbar chambers;

7.2.5.1.18 The properties of all materials used in the ASSEMBLIES;

7.2.5.1.19 The method of connecting busbars and the torque values for connection bolts for each current rating;

7.2.5.1.20 Foundations and fixing mechanisms;

7.2.5.1.21 The suitability of terminals in the case of copper or aluminium connections;

7.2.5.1.22 Insulation design requirements with specific reference to minimum creepage distances and connections between busbar systems and functional units in the fault free zone.

7.2.5.1.23 The engineering design system shall specify stated deviations from the following:

a) limits of operation;

b) service conditions;

c) rated current of circuits and current densities;

d) rated voltage;

e) rated short-circuit withstand strength (magnitude and duration);

f) rated conditional short-circuit current (magnitude at rated voltage);

g) temperature-rise limits at specific IP rating and forms of separation;

h) change of system earthing;

i) degree of protection; and

j) forms of separation.

8. Language

The language on the display, drawings, documentation and software shall be US or UK English.

9. Authorisation

This document has been seen and accepted by:

Name and surname	Designation
Richard McCurrach	Senior Manager PTM&C
Willy Majola	Senior General Manager
Thomas Jacobs	SC Chairperson

10. Revisions

This revision cancels and replaces Revision No. all previous revisions of Specification or Standard No 36-815, 36-817, 474-104, 474-97, 474-99, 474-107, 240-53114248.

Date	Rev	Compiler	Remarks
June 2015	2	HJ Van Staden Senior Electrical Consultant	Revision of 240-53114248
Feb 2013	1	HJ Van Staden Senior Electrical Consultant	Draft Document for review created from 36-815, 36-817, 474-104, 474-97, 474-99, 474-107, 240-53114248.

11. Development team

The following people were involved in the development of this document:

- Bathathu Jonga
- Hamus Lourens
- Trevor Pope
- Jonathan Magano
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12. Acknowledgements

Not applicable.

Annex A – Charger/Rectifier

240-53114248

SCHEDULE A & B Chargers/Rectifiers

DESCRIPTION

Schedule A: The Engineer's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

NOTES REGARDING THE COMPLETION OF SCHEDULE A & B:

General

The requirements of this section specified under "Schedule A & B" form part of the Works Information. Schedule B shall be completed by the Contractor and submitted with his tender.

Filling in Instructions

● Where the Contractor does not fully comply with the Engineering requirement, any deviations shall be clearly indicated in Schedule B and listed in the Deviation Schedule, with the cost of the deviation.

● Where there is a need to substantiate or further describe an item in Schedule B, especially in instances of non-compliance with Schedule A, particulars are furnished on a separate sheet clearly marked with the notation of the Schedule A item referred to.

● If a blank space is left in Schedule B next to certain requirements specified in Schedule A, this constitutes as confirmation that the tenderer does not comply with that specific requirement.

● Where xxxxx is indicated for an item in Schedule A, the Contractor is required to fill in the appropriate information in Schedule B, for the equipment offered.

● Where t.b.c. (to be confirmed) is indicated for an item in Schedule A, the Engineer will fill in the appropriate information in Schedule A, when confirmed.

Evidence Reference

● Each evidence reference shall be filled in with a reference to the delivery documentation where the word "REQUIRED" is stated. The evidence reference section will refer to the documentation that backs-up the statement made in Schedule B. If no evidence is received or it is not referenced to correctly, it shall be taken as non-compliance with regard to Schedule A.

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
1.0	3.1.	General Requirements					
1.1	3.1.1	Site conditions					
1.2	3.1.1.1.1	Altitude	m	2000			
1.4	3.1.1.1.2	Relative humidity	%	10-90 non condensing			
1.5	3.1.1.1.3	Lighting		High lighting area as SANS 1652 and SANS 61439 -1 Table G1			
1.6	3.1.1.2	Outdoor air temperature					
1.6.1	3.1.1.2.1	Maximum	°C	60			
1.6.2	3.1.1.2.2	Daily average	°C	30			
1.6.3	3.1.1.2.4	Minimum	°C	-15			
1.7	3.1.1.3	Equipment room air temperature					
1.7.1	3.1.1.3.1	Maximum	°C	50			
1.7.2	3.1.1.3.2	Daily average	°C	35			
1.7.3	3.1.1.3.4	Minimum	°C	-5			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
1.8	3.1.1.4	Controlled equipment room environment temperature	Yes/No	No (equipment room air temperature conditions will be applicable)			
1.8.1	3.1.1.4.1	Maximum	°C	27			
1.8.2	3.1.1.4.2	Minimum	°C	20			
2.0	3.1.2	Electrical input supply					
2.1	3.1.2.1	Input supply configuration	Configuration as per SANS 10142-1	TN-S			
2.2	3.1.2.2	Input voltage fluctuations as percentage of nominal voltage	%	400V±25			
2.3	3.1.2.3	Input frequency fluctuations as percentage of nominal frequency	%	50Hz±5			
2.4	3.1.2.5	Input voltage deviation from specified voltage maximum to minimum within 1 second.	Yes/No	Yes			
2.5	3.1.2.6	Input voltage fluctuation between specified minimum to maximum value within one to ten cycles	Yes/No	Yes			
2.6	3.1.2.7	Unbalance between phase	%	≤3 negative phase sequence and/or the magnitude of one phase not			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
				lower than 5% than any of the other two for 6 hours			
2.7	3.1.2.8	Input voltage total distortion		Table 1 IEC 61000-2-2			
2.8	3.1.2.9	The minimum, maximum DC input voltage	Minimum and maximum				
2.9	3.1.2.12	Additional input supply requirements	Yes/No Dual input supplies to be accommodated with electrical chop-over system inside charger/rectifier. 1 kW heater element circuit breakers on the input supply (number to be indicated).	Yes. Dual input supplies to be accommodated with electrical chop-over system inside charger/rectifier.			
3.0	3.2	Operational requirements					
3.1	3.2.1	Thyristor and switch mode chargers					
3.1.1	3.2.1.1	Number of pulses	Number 6/12	12			
3.1.2	3.2.1.2	Double wound transformer on the input	Yes/No	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.1.3	3.2.1.3	Controls, rectifier functions, charging mode settings, alarms and monitoring functions done via micro-processor	Yes/No	Yes			
3.1.4	3.2.1.4	Overload protection on all circuits	Yes/No	Yes			
3.1.5	3.2.1.5	DC output bus voltage to be regulated.	Yes/No	Yes			
3.1.6	3.2.1.6	Monitoring requirements: Rectifier voltage and current before and after battery isolator Battery loss Voltage and current before output circuit breaker/isolator Voltage after output circuit breaker Temperature and operating status of each charger	Yes/No	 Yes Yes Yes Yes Yes			
3.1.7	3.2.1.7	Charger compatible with and meets the required charging requirements for all types of batteries specified.	Yes/No	Yes			
3.1.8	3.2.1.8	Standard output operating voltage tolerance Minimum output voltage Maximum output voltage	V_{nom} V_{min} V_{max}	V_{nom} V_{min} V_{max}			
3.1.9	3.2.1.9	Charger/rectifier modules shall be constant voltage, current limiting	Yes/No	Yes			
3.1.10	3.2.1.10	Number of parallel modules/units	Number	xxxxx			
3.1.11	3.2.1.11	Load sharing requirement of parallel modules/units	%	≤10			
3.1.12	3.2.1.14	Boost charge at maximum boost charge voltage with load connected	Yes/No	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.1.13	3.2.1.15	Initial charge capability	Yes/No	No			
3.1.14	3.2.1.16	Output power is maintained when parallel/modules units are switched on or off	Yes/No	Yes			
3.1.15	3.2.1.17	Microprocessor control module compatibility over the OEM product range	Yes/No	Yes			
3.1.16	3.2.1.18	Maintainability of parallel modules/units without output supply interruption and jeopardizing IP2X	Yes/No	Yes			
3.1.17	3.2.1.19	Output voltage regulation at +10 and -15% input voltage; Float Other charging modes	 % %	 ±0.5 ±1			
3.1.18	3.2.1.20	Output voltage regulation at +25 and -25% input voltage; Float Other charging modes	 % %	 ±1 ±2			
3.1.19	3.2.1.21	Voltage regulation during 10 to 90% step variation	% after 1 second	2			
3.1.20	3.2.1.22	Initial and equalize charge interlock when load is connected	Yes/No	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.1.21	3.2.1.23	Single SMR module redundancy; Controller load voltage regulator capability Controller load disconnect capability	Yes/No Yes/No Yes/No	Yes Yes Yes			
3.1.22	3.2.1.24	Load transfer switch required as an option	Yes/No	Yes			
3.1.23	3.2.1.25	Battery charging current limit adjustability	% of rectifier capability	0-100			
3.1.24	3.2.1.26	Rectifier auto-start when input voltage recovers within ±25%input voltage limit	Yes/No	Yes			
3.1.25	3.2.1.27	Faulty module isolation without output supply interruption parallel configuration	Yes/No	Yes			
3.1.26	3.2.1.28	Maintain output supply during SMR controller/communication failure	Yes/No	Yes			
3.1.27	3.2.1.29	Individual charging mode enable/disable function; Manual boost charge function	Yes/No Yes/No	Yes Yes			
3.1.28	3.2.1.30	SMR module hot-pluggable	Yes/No	Yes			
3.1.29	3.2.1.31	Temperature compensation charging capability	Yes/No	Yes			
3.1.30	3.2.1.32	Individual module overload protection	Yes/No	Yes			
3.1.31	3.2.1.33	Battery circuit continuity monitoring	Yes/No	Yes			
3.1.32	3.2.1.34	Active power factor correction on SMR	Yes/No	Yes			
3.1.33	3.2.1.35	THD	%	≤10			
3.1.34	3.2.1.36	Battery circuit disconnect	Yes/No	No			
3.1.35	3.2.1.37	4-20mA Hydrogen analyser input with functionality	Yes/No	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.1.36	3.2.1.38	Different power rating module compatibility	Yes/No	xxxx			
3.1.37	3.2.1.39	Additional hardwire over voltage protection	Yes/No	Yes			
3.2.1	3.2.4	Input requirements	As per clause 3.1.2				
3.2.2	3.2.3	Output requirements					
3.2.2.1	3.2.3	Standard output operating voltage tolerance Minimum output voltage Maximum output voltage	V_{nom} V_{min} V_{max}	V_{nom} V_{min} V_{max}			
3.2.3	3.2.6	Voltage ripple	%	0.1			
3.2.4	3.2.7	Current ripple	5A per 100Ah of battery capacity	5A per 100Ah of battery capacity			
3.2.5	3.2.8	Cooling requirements					
3.2.5.1	3.2.8.1	Natural	Yes/No				
3.2.5.2	3.2.8.2	Forced cooling as per a) to j)		xxxx			
3.2.6	3.2.9	Abnormal DC output voltage					
3.2.6.1	3.2.9.1	Abnormal DC output voltage protection as specified	Yes/No				
3.2.7	3.2.10	Inrush current					
3.2.7.1	3.2.10.1	Inrush current determined as specified in IEC 62040-3		xxxx			
3.2.8	3.2.11	No-load operation					
3.2.8.1	3.2.11.1	No-load operation maximum voltage	%	+10			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.2.9	3.2.12	Step load capability					
3.2.9.1	3.2.12.1	Voltage regulation during 10 to 90% step variation	% after 1 second	2			
3.2.10	3.2.13	Overload capability					
3.2.10.1	3.2.13.1	Overload capability	Duty class	II			
3.2.11	3.2.14	Short-circuit and current limit capability					
3.2.11.1	3.2.14.1	Short circuit capability as stipulated in IEC 62040-3	Yes/No	Yes			
3.2.12	3.2.15	Psophometric noise					
3.2.12.1	3.2.15.1	Maximum Psophometric noise CCITT Class A	mV%	2			
3.2.13	3.2.16	Internal protection					
3.2.13.1	3.2.16.1	Internal protection	Yes	Yes			
3.2.14	3.2.17	Hardwire/hardware independent protection					
3.2.14.1	3.2.17.1	Hardwire/hardware independent protection: Overvoltage protection on rectifier output Overvoltage protection on load Over temperature monitoring Additional hardwire overvoltage protection on DC port	 Yes/No Yes/No Yes/No Yes/No	 Yes Yes Yes Yes			
3.2.15	3.2.18	Active load sharing					
3.2.15.1	3.2.18.1	Active load sharing	%	≤10			
3.2.16	3.2.19	Efficiency					
3.2.16.1	3.2.19.3	a) @ 25% load	%	>87.5			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.2.16.2		b) @ 50% load	%	>90			
3.2.16.3		c) @75% load	%	>92.5			
3.2.16.4		d) @ 100% load	%	>95			
3.2.17	3.2.20	Electromagnetic environment and immunity requirements					
3.2.17.1	3.2.20.1	Conducted and radiated emissions					
3.2.17.1.1	3.2.20.1.1	Conducted and radiated emissions as specified in IEC 62040-2 for category C3	Yes	Yes			
3.2.17.1.2	3.2.20.1.2	Low frequency emissions THDI as per IEC 6100-3-2	%	≤10			
3.2.18	3.2.21	Immunity					
3.2.18.1	3.2.21.1	Immunity as specified in IEC 62040-2 for category C3	Yes	Yes			
3.2.19	3.2.22	Audible noise	dB				
3.2.19.1	3.2.22.1	Audible noise	dB	<65			
3.2.20	3.2.23	Lightning protection					
3.2.20.1		Input	kV	6			
3.2.20.2		DC port	kV	4			
3.2.20.3		Output	kV	4			
3.3	3.3	Electrical Requirements					
3.3.1	3.3.1	General					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.1.1	3.3.1.1	Combined fused switches	as per IEC 60947-3	as per IEC 60947-3			
3.3.1.2	3.3.1.2	Moulded case circuit breakers	as per IEC 60947-2	as per IEC 60947-2			
3.3.1.3	3.3.1.3	Transformers	as per IEC 60067	as per IEC 60067			
3.3.1.4	3.3.1.4	Contactors	as per IEC 60947-4	as per IEC 60947-4			
3.3.1.5	3.3.1.5	Transfer switches	as per IEC 60947-6	as per IEC 60947-6			
3.3.1.6	3.3.1.6	Terminal blocks	as per IEC 60947-7 and Eskom standard 240-70413291	as per IEC 60947-7 and Eskom standard 240-70413291			
3.3.1.7	3.3.1.7.	Control circuit devices and switching elements	as per IEC 60947-5	as per IEC 60947-5			
3.3.2	3.3.2	Input isolation and overload protection	CFS/MCCB/MCB		xxxx		
3.3.2.1	3.3.2.1	Input isolation and overload protection provided	Yes/No	Yes			
3.3.2.2	3.3.2.2	Aux contacts provided	Yes/No	Yes			
3.3.3	3.3.3	Output isolation and overload protection	CFS/MCCB/MCB		xxxx		
3.3.3.1	3.3.3.1	Output isolation and overload protection provided	Yes/No	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.3.3	3.3.3.3	Load profile grading required	Yes/No	Yes			
3.3.3.4	3.3.3.4	Aux contacts provided	Yes/No	Yes			
3.3.4	3.3.4	Battery isolation and overload protection	CFS/MCCB/MCB		xxxx		
3.3.4.1	3.3.4.1	Battery isolation and overload protection provided	Yes/No	Yes			
3.3.4.2	3.3.4.2	Load profile grading required	Yes/No	Yes			
3.3.4.3	3.3.4.3	Aux contacts provided	Yes/No	Yes			
3.3.4.4	3.3.4.4	Fault switching rating graded with battery fault current	Yes/No	Yes			
3.3.5	3.3.5	Input – output isolation	Yes				
3.3.5.1	3.3.5.1	Input – output isolation galvanically	Yes	Yes			
3.3.6	3.3.6	Earthing					
3.3.6.1	3.3.6.1	Exposed non-current carrying parts earthed onto earth bar	Yes	Yes			
3.3.6.2	3.3.6.2	External earthing point	Yes	Yes			
3.3.6.3	3.3.6.3	Neutral (grounded circuit conductor) bonded to safety-earthing	Yes	Yes			
3.3.6.4	3.3.6.4	Earthing compliant with IEEE142:1991	Yes	Yes			
3.3.6.5	3.3.6.5	Earthing (0V DC earthed)	Yes/No	The specific application shall indicate the requirement			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.7	3.3.7	Dropping diode voltage regulator	Yes/No	Indicated as an option			
3.3.7.1	3.3.7.1	Maximum volt drop	V	Charging mode limits to be used. Application specific design will determine the setting and volt-drop			
3.3.7.4	3.3.7.4	Time delay	Ms				
3.3.7.2	3.3.7.2	Maximum dropping diode voltage guideline	$V_{ocv} - V_{min(load)}$				
3.3.9	3.3.9	Charging Modes					
3.3.9.1	3.3.9.1	Float Charging					
3.3.9.1.1		Float charge mode functionality	Yes/No	Yes			
3.3.9.1.2		Float voltage 2.15 to 2.35 (Flooded Lead Acid). 1.35 to 1.5 (Flooded Nickel Cadmium)	V/cell	2.15 to 2.35 (Flooded Lead Acid). 1.35 to 1.5 (Flooded Nickel Cadmium)			
3.3.9.1.3		Float current limit pre-settable between (1% to 100%) of rated rectifier current	(1% to 100%)	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.9.2	3.3.9.2	Auto-boost Charging (with load connected)					
3.3.9.2.1		Auto-boost mode functionality	Yes/No	Yes			
3.3.9.2.2		28 day automatic auto-boost mode operation	Yes/No	Yes			
3.3.9.2.3		Auto-boost voltage 2.20 to 2.4 (Flooded Lead Acid). 1.45 to 1.55 (Flooded Nickel Cadmium	V/cell	2.20 to 2.4 (Flooded Lead Acid). 1.45 to 1.55 (Flooded Nickel Cadmium)			
3.3.9.2.4		Auto-boost current limit pre-settable between (1% to 100%) of rated charger current	(1% to 100%)	Yes			
3.3.9.2.5		Auto-boost time (adjustable)	Hours	(1-12) hours			
3.3.9.2.6	3.3.9.2	Auto-boost failure Indication	Yes/No	Yes			
3.3.9.2.7		Auto-boost mode after “Mains Fail” functionality	Yes/No	Yes			
3.3.9.2.8		Auto-boost Trigger Voltage (Set @ 2,0 V per Cell)	V/cell	1.85 – 2.0			
3.3.9.2.9	3.3.9.1	Auto-boost enable/disable function available from display	Yes/No	Yes			
3.3.9.3	3.3.9.3	Equalize Charging					
3.3.9.3.1		Equalize voltage functionality and Indication	Yes/No	Yes			
3.3.9.3.2		Equalize charge load interlock	Yes/No	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.9.3.3		Equalize voltage 2.3 to 2.6 (Flooded Lead Acid) 1.50 to 1.70 (Flooded Nickel Cadmium	V/cell	2.3 to 2.6 (Flooded Lead Acid) 1.50 to 1.70 (Flooded Nickel Cadmium)			
3.3.9.3.4		Equalize current limit pre-settable between (1% to 50%) of rated charger current	(1% to 50%)	Yes			
3.3.9.4	3.3.9.4	Initial Charging					
3.3.9.4.1		Initial charge functionality	Yes/No				
3.3.9.4.2		Initial charge load interlock	Yes	Yes			
3.3.9.4.3		Initial charge >2.7 to 3 (Flooded Lead Acid). Adjusted to >1.75 (Flooded Nickel Cadmium)	V/cell	2.7 to 3 (Flooded Lead Acid). Adjusted to 1.75 (Flooded Nickel Cadmium)			
3.3.9.4.4		Initial current limit pre-settable between (5% to 70%) of rated charger current	(1% to 70%)	Yes			
3.3.10	3.3.10	Measurements, controls, indications and alarms					
3.3.10.1	3.3.10.1	Charger/Rectifier measurement					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.10.1.1	3.3.10.1.1	Meter types	Panel meters/ LCD	LCD			
3.3.10.1.2	3.3.10.1.2	Meter accuracy	%	1			
3.3.10.1.3	3.3.10.1.3	Input voltage measurement and waveform	Yes/No	Yes			
3.3.9.4.1		Input current measurement and waveform	Yes/No	Yes			
3.3.9.4.2		DC port voltage measurement	Yes/No	Yes			
3.3.9.4.3		DC port current measurement	Yes/No	Yes			
3.3.9.4.4		Output voltage measurement	Yes/No	Yes			
3.3.9.4.5		Output current measurement	Yes/No	Yes			
3.3.9.4.6		External hydrogen analyzer (located in battery cabinet or battery room)	Battery cabinet/Battery room input 4-20mA	Battery cabinet			
3.3.9.4.7		Temperature charging compensation measurement	Yes/No	Yes			
3.3.10.5	3.3.10.5	Charger/rectifier indications					
3.3.10.5.1	3.3.10.5.1/3	Data logging capability	Yes/No	Yes			
3.3.10.5.2	3.3.10.5.2	All events date and time stamped	Yes/No	Yes			
3.3.10.5.3	3.3.10.5.4	SMS facility	Yes/No				
3.3.10.5.4	3.3.10.5.5/6	Alarm remote indication via potential free contacts	Yes/No	Yes			
3.3.10.5.5	3.3.10.5.7	Local indications					

Item	Sub-Clause	Description		Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.10.5.1		Charging mode float, auto-boost, equalize or initial charge		Yes				
3.3.10.5.2		Equalise inhibited		Yes				
3.3.10.5.3		System paralleled		Yes				
3.3.10.5.4		Load transferred		Yes				
3.3.10.5.5		Battery isolated		Yes				
3.3.10.5.6		Charger, battery & load voltage and currents		Yes				
3.3.10.5.7		Ambient temperatures		Yes				
3.3.10.5.8		Battery room/cabinet forced ventilation failure		Yes				
3.3.10.5.9		Hydrogen level		Yes				
3.3.10.5.10		Hydrogen analyser healthy		Yes				
3.3.10.6	3.3.10.9.2	Local Alarms	Rectifier Trip	Remote Alarm				
3.3.10.6.1		AC Phase Failure	No	Charger Fail	Yes			
3.3.10.6.2		Rectifier Module Fail/Shutdown	No	Charger Fail	Yes			
3.3.10.6.3		Rectifier Module I/O MCB Trip	No	Charger Fail	Yes			
3.3.10.6.4		Load Voltage Low	No	Charger Fail	Yes			
3.3.10.6.5		Load Voltage High	Yes	Charger Fail	Yes			
3.3.10.6.6		Battery Voltage Low	No	Charger Fail	Yes			
3.3.10.6.7		Battery Voltage High	Yes	Charger Fail	Yes			
3.3.10.6.8		Battery Voltage Low (Urgent)	No	DC System Fail	Yes			

Item	Sub-Clause	Description		Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.10.6.9		Protective Device Fail	No	DC System Fail	Yes			
3.3.10.6.10		Ripple High	Yes	Charger Fail	Yes			
3.3.10.6.11		Battery Loss Alarm	No	DC System Fail	Yes			
3.3.10.6.12		Load Voltage Low (Urgent)	No	DC System Fail	Yes			
3.3.10.6.13		Failure of Auto-boost Cycle	No	Charger Facility Abnormal	Yes			
3.3.10.6.14		Battery Room/Cabinet Forced Ventilation Failure	No	DC System Fail	Yes			
3.3.10.6.15		Load Voltage Regulator Failure	No	Charger Facility Abnormal	Yes			
3.3.10.6.16		DC Earth Fault +ve leg	No	DC System Abnormal	Yes			
		DC Earth Fault -ve leg	No	DC System Abnormal	Yes			
3.3.10.6.17		Hydrogen level high >0.8%	No	DC System Abnormal	Yes			
3.3.10.6.18		Hydrogen level High-High	No	DC System Abnormal	Yes			
3.3.10.6.19		Hydrogen analyzer failure	No	DC System Abnormal	Yes			
3.3.10.6.20		Battery Self-Test: Failure	No	Charger Facility Abnormal	Yes			
3.3.11	3.3.11	Communication and control design requirements						
3.3.11.1	3.3.11.1	General						

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.11.2	3.3.11.1.1	Remote communication link	Yes/no	Yes			
3.3.11.3	3.3.11.1.2	Communication protocol		xxxx			
3.3.11.4	3.3.11.1.3	Supporting DNP 3.0 level 2 or 3 protocols and IEC 61850	Yes/no				
3.3.11.5	3.3.11.1.4	Micro-processor controlled	Yes/no	Yes			
3.3.11.6	3.3.11.1.5	Internal rectifier module micro-processor controlled as back-up	Yes/no	Yes			
3.3.11.7	3.3.11.1.6	Diagnostic and telemetry capability	Yes/no	Yes			
3.3.11.8	3.3.11.2	Real time clock and time synchronization					
3.3.11.8.1	3.3.11.2.1	Real time clock and time synchronization for 30 years	Yes/no	Yes			
3.3.11.8.2	3.3.11.2.2	Real time clock drift	Seconds/month	<60			
3.3.11.8.3	3.3.11.2.3	Resettable clock with resetting other parameters	Yes/no	Yes			
3.3.11.8.4	3.3.11.2.4	Maintain time of clock for 7 days during loss of supply	Yes/no	Yes			
3.3.11.8.5	3.3.11.2.5	Synchronization of IEDs	Yes/no	Yes			
3.3.11.8.6	3.3.11.2.6	Synchronization indicated in event log	Yes/no	Yes			
3.3.11.3	3.3.11.3	Communication ports					
3.3.11.3.1	3.3.11.3	Communication ports	2 x Rs-232 1x Rs485 1 x Ethernet or Fibre optic	Yes Yes Yes			
3.3.11.4	3.3.11.4	Monitoring and control					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.11.4.1	3.3.11.4.1	Interface to local PC	Yes/no	Yes			
3.3.11.4.2	3.3.11.4.2	Remote interface with charger/rectifier	Yes/no	Yes			
3.3.11.4.3	3.3.11.4.3	Pre-programmed current/voltage/time durations	Yes/no	Yes			
3.3.11.4.4	3.3.11.4.4	Optimal management during normal supply unavailability	Yes	Yes			
3.3.11.4.5	3.3.11.4.5	Software and firmware upgradeable	Yes	Yes			
3.3.11.4.6	3.3.11.4.6	Settings, indications and alarm display via front panel	Yes	Yes			
3.3.11.4.7	3.3.11.4.7	Password controlled	Yes	Yes			
3.3.11.4.8	3.3.11.4.8	Real time control	Yes	Yes			
3.3.11.4.9	3.3.11.4.9	Default values for stand-alone opera tion	Yes	Yes			
3.3.11.4.10	3.3.11.4.10	Individual rectifier module parameter monitoring and comparison.	Yes/no	Yes			
3.3.11.4.11	3.3.11.4.11	Interface with optional unit	Yes/no	Optional			
3.3.11.4.12	3.3.11.4.12	Unique remote controller identification	Yes	Yes			
3.3.12	3.3.12	Software and firmware					
3.3.12.1	3.3.12.1	General					
3.3.12.1.1	3.3.12.1.1	Software to access equipment	Yes	Yes			
3.3.12.1.2	3.3.12.1.2	Software updates compatible with supplied systems	Yes	Yes			
3.3.12.1.3	3.3.12.1.3	Software license and documentation copyright	Yes	Yes			
3.3.12.1.4	3.3.12.1.4	Software support	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.12.1.5	3.3.12.1.5	Software detail to be supplied	Yes	Yes			
3.3.12.1.6	3.3.12.1.6	Adhere to software control standard	Yes	Yes			
3.3.12.1.7	3.3.12.1.7	Settings and display features available from front panel display	Yes	Yes			
3.3.12.1.8	3.3.12.1.8	Alarm/event lock downloadable	Yes	Yes			
3.3.12.1.9	3.3.12.1.9	Software capable to upload and download alarm/ event log or settings	Yes	Yes			
3.3.12.1.10	3.3.12.1.10	Software display the status of any modules connected	Yes	Yes			
3.3.12.1.11	3.3.12.1.11	Software to display the status of remote communication connections	Yes	Yes			
3.3.12.1.12	3.3.12.1.12	Record battery discharge curve	Yes	Yes			
3.3.12.2	3.3.12.2	Software verification and validation	Yes	Yes			
3.3.12.3	3.3.12.3	System firmware					
3.3.12.3.1		Equipment system firmware displayed on the equipment					
3.3.12.3.2		Firmware alterations to be controlled					
3.3.12.3.3		Data retention for the expected life of the equipment					
3.3.12.3.4		Firmware upgradeable					
4.0	3.4	Mechanical Requirements					
4.1	3.4.1	General					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.1.1	3.4.1.1	Compliance to clause 5 of SANS 10142-1 and SANS 62040-1	Yes	Yes			
4.1.2	3.4.1.2	Designed, constructed and tested in accordance to clause 6.6 of SANS 10142-1	Yes	Yes			
4.1.3	3.4.1.3	RCC as per SANS 10142-1 table 4.2	Yes	Yes			
4.2	3.4.2	Doors and covers					
4.2.1	3.4.2.1	Individual hinged doors for each cable compartment and each fix patter functional unit sub-section.	Yes	Yes			
4.2.2	3.4.2.2	All removable covers shall require the use of a tool	Yes	Yes			
4.2.3	3.4.2.3	All opening doors shall be padlockable	Yes	Yes			
4.2.4	3.4.2.4	Hinging as specified up to 450mm- 2 hinges, up to 800mm - 3 hinges more than 800mm - 4 hinges	 Yes Yes Yes	 Yes Yes Yes			
4.2.5	3.4.2.5	Square key latches as specified up to 450 mm - 2 latches, up to 800 mm - 3 latches and more than 800 mm - 4 latches	 Yes Yes Yes	 Yes Yes Yes			
4.2.6	3.4.2.6	As a minimum the center square key latch shall be padlockable with hole > 8mm	Yes	Yes			
4.2.7	3.4.2.7	Cable compartment hinges to allow lifting off	Yes	Yes			
4.2.8	3.4.2.8	Durable hinge and latch fastening	Yes	Yes			
4.2.9	3.4.2.9	Doors stops required	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
5.2.10	3.4.2.10	Door latches and hinges to withstand internal faults	Yes	Yes			
5.2.11	3.4.2.11	Doors >800mm to be fitted with webs	Yes	Yes			
4.3	3.4.3	Main, Distribution, Equalising and Collection Busbars					
4.3.1	3.4.3.1	Main and distribution busbars manufactured from electrolytic tough pitch high conductivity copper as per SANS 804	Yes	Yes			
4.3.2	3.4.3.2	Condition of temper for busbar copper designation H2 for half-hard cold working as per SANS 1195	Yes	Yes			
4.3.3	3.4.3.3	Main busbar design maximum permissible surface temperature rise at rated current, Distribution busbar	K K	65 55			
4.3.4	3.4.3.4	Neutral busbar sizing relative to main busbar rating on input and relative to the associated distribution busbars	% of main busbar % of distribution busbar	≥50 100			
4.3.5	3.4.3.5	Neutral busbar connected to protective earth via removable bolted link	Yes	Yes			
4.3.6	3.4.3.6	Joints and tees in busbar compliance Bolts high tensile	T-22 8.8 to ISO 898-1	T-22 8.8 (ISO 898-1)			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.3.7	3.4.3.7	Joints: Minimum number of bolts Busbar overlap Washers	 # Multiple of thickness or relative to width Conical or spring	 ≥2 ≥6 or equal Conical			
4.3.8	3.4.3.8	All busbar supports with minimum rating of the respective fault current rating	Yes	Yes			
4.3.9	3.4.3.9	Span of distribution busbar shall not interfere with cable entry zone.	Yes	Yes			
4.3.10	3.5.3.10	Busbar identification marking: AC Busbars DC Busbars 220 and 110V DC DC Busbars 24DC	Yes/No Red, White & Blue and Black -Neutral Red - positive and Black - Negative Red – positive and Blue – negative and Black - zero bar	Yes Red, White & Blue and Black - Neutral Red - positive and Black - Negative Red – positive and Blue – negative and Black - zero bar			
4.3.11	3.4.3.11	Collection busbars need to be constructed where SCPD's and mcb's need to be connected in cascaded circuits	Yes/no	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.3.12	3.4.3.12	Sufficient supports for equalizing busbars to withstand fault current	Yes/no	Yes			
4.4	3.4.4	Protective earth conductor and screened earth busbar					
4.4.1	3.4.4.1	A separate protective earth connected	Yes/no	Yes			
4.4.2	3.4.4.2	Non-current carrying conductive parts connected to PE	Yes/no	Yes			
4.4.3	3.4.4.3	Earth conductor size connected to doors	mm^2	6			
4.4.4	3.4.4.4	PE rating	As per SANS 10142-1	As per SANS 10142-1			
4.4.5	3.4.4.5	Protective circuit parts rated for the highest fault condition	Yes/no	Yes			
4.4.6	3.4.4.6	Screened earth busbar		xxxx			
4.4.7	3.4.4.7	PE conductor colour	Green with yellow stripes	Green with yellow stripes			
4.5	3.4.5	Power and control cabling					
4.5.1	3.4.5.1	Power circuit wiring and connections rated according to the de-rated operating current of the associated protective gear	Yes	Yes			
4.5.2	3.4.5.2	Control wiring connected to source of fault energy rating	1.5 times fuse rating and withstanding I^2t fuse rating	1.5 times fuse rating and withstanding I^2t fuse rating			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.5.3	3.4.5.3	Individual function unit connection to the control busbar		xxxx			
4.5.4	3.4.5.4	Connections to equipment mounted on swing doors		xxxx			
4.5.5	3.4.5.5	Type of conductor cable	Stranded, single or solid	Stranded			
4.5.6	3.4.5.6	Multistrand cable conductor diameter	mm^2	1.5			
4.5.7	3.4.5.7	Multistrand cable conductor diameter for current and voltage transformers	mm^2	2.5			
4.5.8	3.4.5.8	Joints and splices in any circuit, more than one conductor in one lug.	Not allowed Not allowed	Not allowed Not allowed			
4.5.9	3.4.5.9	Terminals and labels shall be accessible after assembly		xxxx			
4.5.10	3.4.5.10	Terminals which are on the live side of fuses and isolating switches shall be completely shrouded	Yes	Yes			
4.5.11	3.4.5.11	Coils in-line with normally open contacts connected to positive	Yes/no	Yes			
4.5.12	3.4.5.12	Compression joints standard	BS EN 61238	BS EN 61238			
4.5.13	3.4.5.13	Grommets installed on all holes through which cables are passing	Yes	Yes			
4.5.14	3.4.5.14	Conductors >100A and passing through metal	Conductor all three phases (both poles of DC conductors) or metal barrier split	xxxx			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.5.15	3.4.5.15	AC and DC conductors allowed in same wireway	Yes/no	No			
4.5.16	3.4.5.16	Power circuit cable sizing standard for the specified volt-drop	SANS 1973-1	SANS 1973-1			
4.5.17	3.4.5.17	Stripping of insulation standard		xxxx			
4.5.18	3.4.5.18	Crimping standard		xxxx			
4.5.19	3.4.5.19	Correct torque standard		xxxx			
4.6	3.4.6	Conductor identification					
4.6.1	3.4.6.1	Conductor identification	Yes	Yes			
4.6.2	3.4.6.2	Control conductor identification AC circuits DC circuits	 Black Grey	 Black Grey			
4.6.3	3.4.6.3	Control bus wiring identification DC AC	 Red – positive Black – negative Brown and Blue	 Red positive Black negative Brown and Blue			
4.6.4	3.4.6.4	Conductor of CT and VT circuits identification	Phase colours	Phase colours			
4.6.5	3.4.6.5	Control conductor wiring		xxxx			
4.7	3.4.7	Enclosure and Assembly					
4.7.1	3.4.7.1	EMC testing required with door open when MCB and MCCB are fitted behind the door	Yes/no	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.7.2	3.4.7.2	Individual segregation for input, DC port, output, signal and control cabling	Yes/no	Yes			
4.7.3	3.4.7.3	Converter modules and controller sub rack assemblies	Swing/fix frame assembly	Swing/fix frame assembly options			
4.7.4	3.4.7.4	Handling and lifting facilities	Removable lifting facility. Forklift handling	Removable lifting facility. Forklift handling			
4.7.5	3.4.7.5	Dimensions		To be supplied for product range			
4.7.5.1		Height	Mm	xxxx			
4.7.5.2		Width	Mm	xxxx			
4.7.5.3		Depth	Mm	xxxx			
4.7.5.4		Weight	Kg	xxxx			
4.8	3.5.8	Sub-rack assemblies and input/output power distribution modules					
4.8.1	3.4.8.1	Sub-rack inclusions Controller sub-assembly infront Terminal plate sub-assembly rear Segregated wire loom	 Yes/no Yes/no Yes/no	 Yes Yes Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.8.2	3.4.8.2	Input/output power modules – front distribution modules Terminal plate sub assembly rear Segregated wire loom	Yes/no Yes/no Yes/no	Yes Yes Yes			
4.8.3	3.4.8.3	Sub-rack expandable to maximum modules power rating	Yes/no	Yes			
4.8.4	3.4.8.4	Sub-rack pre wired for expansion	Yes/no	Yes			
4.8.5	3.4.8.5	Blanking plates installed on unused module positions	Yes/no	Yes			
4.8.6	3.4.8.6	Ingress protection	IP	IP2X			
4.8.7	3.4.8.7	Individual MCB module locking facility	Yes/no	Yes			
4.8.8	3.4.8.8	Terminal plate and top drawer plate thickness	Mm	1.6			
4.8.9	3.4.8.9	Terminal plate width	Mm	482.6			
4.8.10	3.4.8.10	Slotted mounting hole dimensions as per IEC 60297-1 Width Height Horizontal distance between hole centers	IEC 60297-1 mm mm mm	IEC 60197-1 10.3 6.80 465.1			
4.8.11	3.4.8.11	Overall aesthetically pleasing appearance	Yes	Yes			
4.8.12	3.4.8.12	Earthing stud fitted on terminal plate	Yes	Yes			
4.9	3.4.9	Ingress protection					
4.9.1	3.4.9.1	IP rating Panel doors closed Panel doors open	 IP IP	 31 2X			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.9.2	3.4.9.2	Additional IP rating requirements	IP	As options IP45 IP55 IP65			
4.10	3.4.10	Cable entry					
4.10.1	3.4.10.1	Cable entry	Top/bottom	Top and bottom			
4.11	3.4.11	Gland plate					
4.11.1	3.4.11.1	Gland plate height	Mm	300mm above point of bottom entry and at point of top entry.	300mm above point of bottom entry and at point of top entry		
4.11.2	3.4.11.2	Fire retardant and sealing of floor slot	Yes	Yes required as part of installation			
4.11.3	3.4.11.3	Undrilled gland-plate, corrosion protected as per SANS 1652	Yes	Yes			
4.11.4	3.4.11.4	Adequate gland plate support	Yes	Yes			
4.11.5	3.4.11.5	Non-magnetic gland plates	Yes/no	Yes			
4.11.6	3.4.11.6	95mm^2 cabling gland plate requirements	Yes/no	Yes as an option			
4.11.7	3.4.11.7	Bonding of gland plate to PE conductor	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.12	3.4.12	Corrosion protection					
4.12.1	3.4.12.1	Corrosion protection standard	SCSSCAAP9	SCSSCAAP 9			
4.12.2	3.4.12.2	AC input supply assembly colour	G29	G29			
4.12.3	3.4.12.3	DC input supply assembly colour	A11	A11			
4.13	3.4.13	Terminations					
4.13.1	3.4.13.1	Termination standard	240-70413291	240-70413291			
4.13.2	3.4.13.2	Terminations for all input output and alarming	Yes/no	Yes			
4.13.3	3.4.13.3	Maximum number of cable cores per termination point	#	2			
4.13.4	3.4.13.4	Input terminal rating at input minimum voltage	Yes/no	Yes, alternatives can be specified as an option			
4.13.5	3.4.13.5	DC port terminal size	mm^2	95 Alternatives can be specified as an option			
4.14	3.4.14	Internal wiring					
4.14.1	3.4.14.1	Wire ways and trunking shall be smooth and free of sharp edges	Yes	Yes			
4.14.2	3.4.14.2	Trunking temperature rating	ºC	90			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.14.3	3.4.14.3	All wiring in trunking or wire looms clipped or laced	Yes	Yes			
4.15	3.4.15	Conformal coatings					
4.15.1	3.4.15.1/2/3	Conformal coatings required	Yes/no				
4.16	3.4.16	Accessibility					
4.16.1	3.4.16.1	Accessibility for cable termination	Yes	Yes			
4.16.2	3.4.16.2	Normal maintenance accessibility following installation	Yes	Yes			
4.16.3	3.4.16.3	Accessibility	Front/rear	Front and rear			
4.17	3.4.17	Minimum clearances					
4.17.1	3.4.17.1	Pole-to-pole and pole-to-earth clearance standard	SANS 10142-1	SANS 10142-1			
4.17.2	3.4.17.2	Terminals for input, DC port and output	Segregated/ barriers	Segregated /barriers			
4.17.3	3.4.17.3	Minimum creepage distance rating as per SANS 60439-1 clause 7.1.2	Pollution Degree 3, material group 111a with the specified insulation voltage	Pollution Degree 3, material group 111a with the specified insulation voltage			
4.17.4	3.4.17.4	Clearance and creepage distances	SANS 60439-1 Table 14 and 16	SANS 60439-1 Table 14 and 16			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.18	3.4.18	Nameplate/rating plate/declared electrical performance					
4.18.1	3.4.18	Nameplate material	Stainless steel/ anodized aluminium	Stainless steel/ anodized aluminium			
4.18.2	3.4.18	Nameplate information	Clause 3.5.18	Clause 3.5.18			
5.0	3.5	Settings and Commissioning					
5.1	3.5.1	Settings					
5.1.1	3.5.1.1	Settings standard	240-56176168	240-56176168			
5.1.2	3.5.1.2	Settings document for each piece of equipment required based on specific application	Yes	Yes To be compiled by OEM based on application.			
5.1.3	3.5.1.3	Microprocessor shall be programmed with these settings as default	Yes	Yes			
5.1.4	3.5.1.4	Revision indicated on document	Yes	Yes			
5.1.5	3.5.1.5	SCPD indicated on settings document	Yes	Yes			
5.2	3.5.2	Commissioning					
5.2.1	3.5.2.1	Commissioning standard	240-56177186	240-56177186			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
5.2.2	3.5.2.2	As commissioning routine, operational and functional tests shall be performed	Yes	Yes			
5.3	3.6	Upgrading/modifications					
5.3.1	3.6.1	Upgrade/modification report required	Yes	Yes			
5.3.2	3.6.2	Hardware upgrade identification	Yes	Yes			
5.4	3.7	Equipment performance					
5.4.1	3.7.1	Warranty					
5.4.1.1	3.7.1.1	Warranty period	36 months from date of commissioning	36 months from date of commissioning			
5.4.2	3.7.2	Reliability, security, dependability, maintainability and life expectancy					
5.4.2.1	3.7.2.1.1	Equipment hours of installed units per voltage or model/type	Yes	Yes			
5.4.2.2	3.7.2.1.2	Customers indicating the number of units employed per model/type	Yes	Yes			
5.4.2.3	3.7.2.1.3	Environmental conditions where such equipment is installed	Yes	Yes			
5.4.2.4	3.7.2.2.1	Equipment proven record	>2 years and one hundred equipment years	>2 years and one hundred equipment years			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
5.4.2.5	3.7.2.2.2	Life expectancy Electronic equipment Other hardware	 ≥10 years ≥20 years				
5.4.2.6	3.7.2.2.3	Written guarantee to meet life expectancy	Yes	Yes			
5.4.2.7	3.7.2.2.4	Supplier product health statement	Yes	Yes			
5.4.2.8	3.7.2.3	Internal battery specification		xxxx			
6.0	4.2	Type testing					
6.1	IEC 60146-1-1	Converter tests	Type Tests Required as per IEC 60146-1-1				
6.1.1	4.2.1	Insulation test	Yes	Yes			
6.1.2	4.2.2.	Light load functional test.	Yes	Yes			
6.1.3	4.2.2.	Functional test	Yes	Yes			
6.1.4	4.2.3	Rated current test	Yes	Yes			
6.1.5	4.2.4	Power loss determination for assemblies and equipment	Yes	Yes			
6.1.6	4.2.5	Temperature rise test	Yes	Yes			
6.1.7	4.2.6	Power factor measurement	Yes	Yes			
6.1.8	4.2.7	Checking of auxiliary devices	Yes	Yes			
6.1.9	4.2.8	Measurement of inherent voltage regulation	Yes	Yes			
6.1.10	4.2.9	Checking the properties of the control equipment	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
6.1.11	4.2.10	Checking the protective devices	Yes	Yes			
6.1.12	4.2.11	Immunity test	Yes	Yes			
6.1.13	4.2.12	Overcurrent capability test	Yes	Yes			
6.1.14	4.2.13	Radio frequency generated interference and conducted noise	Yes	Yes			
6.1.15	4.2.14	Audible noise	Yes	Yes			
6.1.16	4.2.15	Measurement of ripple voltage and current	Yes	Yes			
6.1.17	4.2.16	Additional tests	Yes	Yes			
6.2	SANS 1652	Type Tests Required as per SANS 1652	Yes/No	Yes			
6.2.1	5.2	Dielectric strength test	Yes	Yes			
6.2.2	5.3	Insulation resistance test	Yes	Yes			
6.2.3	5.4	DC output voltage adjustment range test	Yes	Yes			
6.2.4	5.5	DC output voltage regulation tests	Yes	Yes			
6.2.5	5.6	Temperature rise test	Yes	Yes			
6.2.6	5.7	Power efficiency test	Yes	Yes			
6.2.7	5.8	Test for protection against lightning surges	Yes	Yes			
6.2.8	5.9	Short-circuit test on output terminals	Yes	Yes			
6.2.9	5.10	Ripple voltage limits and ripple current test	Yes	Yes			
6.2.10	5.11	Audible noise level test	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
6.2.11	5.12	Salt fog test	Yes	Yes			
6.2.12	5.13	Glow-wire test on non-metallic enclosures	Yes	Yes			
6.2.13	4.1.4	Lightning surge test	Yes	Yes			
6.2.14	4.2.4	Parallel operation test	Yes	Yes			
7.0	5.0	Marking, labeling and packaging					
7.1	5.1	Labelling					
7.1.1	5.1.1	Labeling	0.54/3695 sheet 1 & 2 or 240-62629353	0.54/3695 sheet 1 & 2 or 240-62629353			
7.1.2	5.1.2	Package labelling	Yes	Yes			
7.2	5.2	Packaging					
7.2.1	5.2.1	Packaging	High specification impact resistant corrugated cardboard with waterproof outer plastic covering	High specification impact resistant corrugated cardboard with waterproof outer plastic covering			
7.2.2	5.2.2	Additional packaging requirements	Crating	Crating as an option			
8.0	6.0	Spares					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
8.1	6.1	General					
8.1.1	6.1.1	Spares list	Yes	Yes			
8.1.2	6.1.2	Maintenance spares list	Yes	Yes			
8.1.3	6.1.3	Spares pricing	Yes	Yes			
8.1.4	6.1.4	Spares life expectancy within packaging	Years	10			
8.1.5	6.1.5	Spares available for warranty period	Yes	Yes			
8.1.6	6.1.5.1	Spares holding for 1 to 20 modular type/units	#/set of cards	1			
8.1.7	6.1.5.2	Spares holding for 21 to 40 modular types	#/set of cards	3			
8.1.8	6.1.6	Delivery	hr ex-works	24			
8.1.9	6.1.8	Spares availability	years	10			
9.0	7.0	Documentation					
9.1	7.1	General					
9.1.1	7.1.1	Sets of hard copies	#	3			
9.1.2	7.1.2	Drawings format Drawings size	.dgn A3	.dgn A3			
9.2	7.2	Drawings					
9.2.1	7.2.1	General arrangement drawings	Yes	Yes			
9.2.2	7.2.2	Single line diagrams	Yes	Yes			
9.2.3	7.2.3	Schematic drawings	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
9.2.3	7.2.4	Installation, operating and maintenance instruction manuals					
9.2.3.1	7.2.4.1	All instruction manuals shall be comprehensively detailed	Number of copies including .pdf software copy	3			
9.2.3.2	7.2.4.2	The manuals shall cover all equipment forming part of the assembly including: Content list List of reference drawings Detail of all components	 Yes Yes Yes	 Yes Yes Yes			
9.2.3.3	7.2.4.3	Manual in loose leaf binder to ISO standard in A4 size	Yes	Yes			
9.2.3.4	7.2.4.4	Manual content	General arrangement drawings, installation drawings and instructions, operating and maintenance instructions for all components, detailed parts list, spare parts ordering instructions etc	General arrangement drawings, installation drawings and instructions, operating and maintenance instructions for all components, detailed parts list, spare parts ordering instructions etc			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
9.2.3.5	7.2.4.5	Additional content	Special instructions pertaining to spares storage, drawings for component locations, dismantling and re-assembly.	Special instructions pertaining to spares storage, drawings for component locations, dismantling and re-assembly.			
9.2.3.6	7.2.4.6	Special tool requirements		xxxx			
9.2.4	7.2.5	Engineering design system					
9.2.4.1	7.2.5.1	EDS source document of design	Yes	Yes			
10.0	8.0	Language					
10.1	8.1	Language on display, drawings, documentation and software	US or UK English				

Annex B – Uninterruptible Power Suppliers

240-53114248

SCHEDULE A & B - Uninterruptible Power Supplies

DESCRIPTION

Schedule A: The Engineer's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

All Standards quoted will be the Latest revision

NOTES REGARDING THE COMPLETION OF SCHEDULE A & B:

NOTE: The schedules A&B of the Battery Charger shall also be completed and submitted as part of these schedules.

General

The requirements of this section specified under "Schedule A & B" form part of the Works Information. Schedule B shall be completed by the Contractor and submitted with his tender.

Filling in Instructions

● Where the Contractor does not fully comply with the Engineering requirement, any deviations shall be clearly indicated in Schedule B and listed in the Deviation Schedule, with the cost of the deviation.

● Where there is a need to substantiate or further describe an item in Schedule B, especially in instances of non-compliance with Schedule A, particulars are furnished on a separate sheet clearly marked with the notation of the Schedule A item referred to.

● If a blank space is left in Schedule B next to certain requirements specified in Schedule A, this constitutes a confirmation that the tender does not comply with that specific requirement.

● Where xxxxx is indicated for an item in Schedule A, the Contractor is required to fill in the appropriate information in Schedule B, for the equipment offered.

● Where t.b.c. (to be confirmed) is indicated for an item in Schedule A, the Engineer will fill in the appropriate information in Schedule A, when confirmed.

Evidence Reference

● Each evidence reference shall be filled in with a reference to the delivery documentation where the word "REQUIRED" is stated. The evidence reference section will refer to the documentation that backs-up the statement made in Schedule B. If no evidence is received or it is not referenced to correctly, it shall be taken as non-compliance with regard to Schedule A.

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
1.0	3.1.	General Requirements					
1.1	3.1.1	Site conditions					
1.2	3.1.1.1.1	Altitude	M	2000			
1.4	3.1.1.1.2	Relative humidity	%	10-90 non condensing			
1.5	3.1.1.1.3	Lighting		High lighting area as SANS 1652 and SANS 61439 -1 Table G1			
1.6	3.1.1.2	Outdoor air temperature					
1.6.1	3.1.1.2.1	Maximum	°C	60			
1.6.2	3.1.1.2.2	Daily average	°C	30			
1.6.3	3.1.1.2.3	Minimum	°C	-15			
1.7	3.1.1.3	Equipment room air temperature					
1.7.1	3.1.1.3.1	Maximum	°C	50			
1.7.2	3.1.1.3.2	Daily average	°C	35			
1.7.3	3.1.1.3.3	Minimum	°C	-5			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
1.8	3.1.1.4	Controlled equipment room environment temperature	Yes/No	No (equipment room air temperature conditions will be applicable)			
1.8.1	3.1.1.4.1	Maximum	°C	27			
1.8.2	3.1.1.4.2	Minimum	°C	20			
2.0	3.1.2	Electrical input supply					
2.1	3.1.2.1	Input supply configuration	Configuration as per SANS 10142-1	TN-S			
2.2	3.1.2.2	Input voltage fluctuations as percentage of nominal voltage	%	400V±25			
2.3	3.1.2.3	Input frequency fluctuations as percentage of nominal frequency	%	50Hz±5			
2.4	3.1.2.5	Input voltage deviation from specified voltage maximum to minimum within 1 second.	Yes/No	Yes			
2.5	3.1.2.6	Input voltage fluctuation between specified minimum to maximum value within one to ten cycles	Yes/No	Yes			
2.6	3.1.2.7	Unbalance between phase	%	≤3 negative phase sequence and/or the magnitude of one phase not			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
				lower than 5% than any of the other two for 6 hours			
2.7	3.1.2.8	Input voltage total distortion		Table 1 IEC 61000-2-2			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
2.8	3.1.2.14	Additional input supply requirements	Yes/No Dual input supplies to be accommodated with electrical chop-over system inside charger/rectifier. 1 kW heater element circuit breakers on the input supply (number to be indicated).	Yes. Dual input supplies to be accommodated with electrical chop-over system inside charger/rectifier.			
3.0	3.2	Operational requirements					
3.1	3.2.3	Inverter/uninterruptable power supplies					
3.1.1	3.2.3.1	UPS rectifier shall meet the requirements for a rectifier/charger	Yes, excluding voltage regulator	Yes, excluding voltage regulator			
3.1.2	3.2.3.2	Standard output operating voltage tolerance Minimum output voltage (inverter minimum voltage) Maximum output voltage (inverter maximum input voltage)	V_{nom} V_{min} V_{max}	220V DC 176 V DC 312V DC			
3.1.3	3.2.3.2	DC to DC converter between the rectifier DC link and the battery	Yes/no				
3.1.4	3.2.3.3	Common battery configuration	Yes/no	As an option			
3.1.5	3.2.3.4	Accessible disconnect devices	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.1.6	3.2.3.5	UPS performance classification	VFI-SS-III or VFI-SS-XXX	VFI-SS-III as an option (VFI-SS-XXX – X indicating maximum tolerance of +10 and -15% constant used for control supply)			
3.1.7	3.2.3.5	Input voltage tolerance of ±25% shall be also applicable to the static bypass to provide specified performance classification	YES	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.1.8	3.32.3.6	Static bypass required Manual bypass required	Yes/no Yes/no	Yes Yes			
3.1.9	3.2.3.7	Dual redundant configuration requirements:	Yes/no	Yes			
3.1.9.1	3.2.3.7.1	Automatic 100% load capability of redundant UPS	Yes	Yes			
3.1.9.2	3.2.3.7.2	Disconnection and replacement of redundant unit without supply interruption					
3.1.9.3	3.2.3.7.3	Possibility to increase UPS capability by adding another UPS in parallel					
3.1.10	3.2.3.8	UPS start-up capability from rectifier supply and static by-pass unavailable					
3.1.11	3.2.3.9	Initial charge enabled when inverter is switched on					
3.1.12	3.2.3.10	Internal frequency control	Yes				
3.1.13	3.2.3.11	Input voltage	%	±25%			
3.1.14	3.2.3.12	UPS synchronizes with static by-pass	Yes				
3.1.15	3.2.3.13	Bypass switch	Static switch or Hybrid type	xxxx			
3.1.16	3.2.3.14	Isolation transformer on static bypass	Yes/no	Yes			
3.1.17	3.2.3.15	Specified output performance at input voltage tolerance	Yes	Yes			
3.1.18	3.2.3.16	Short circuit and overload protection	Yes	Yes			
3.1.19	3.2.3.17	Monitoring of UPS output to be within performance characteristic	Yes	Yes			
3.1.20	3.2.3.18	DC start capability	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.1.21	3.2.3.19	Monitoring of input, output and static by-pass voltage and current waveforms 1000 event register	Yes/no Yes/no	As options			
3.1.22	3.2.3.20	UPS autonomy per inverter size	Hr	1 2 4 6			
3.2	3.3.2	UPS rectifier/charger					
3.2.1	3.2.1.1	Number of pulses	Number 6/12	12			
3.2.2	3.2.1.2	Double wound transformer on the input	Yes/No	Yes			
3.2.3	3.2.1.3	Controls, rectifier functions, charging mode settings, alarms and monitoring functions done via micro-processor	Yes/No	Yes			
3.2.4	3.2.1.4	Overload protection on all circuits	Yes/No	Yes			
3..2.5	3.2.1.5	DC output bus voltage to be regulated.	Yes/No	No			
3.2.6	3.2.1.6	Monitoring requirements: Rectifier voltage and current before and after battery isolator Battery loss Voltage and current before output circuit breaker/isolator Voltage after output circuit breaker Temperature and operating status of each charger	Yes/No	 Yes Yes Yes Yes Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.2.7	3.2.1.7	Charger compatible with and meets the required charging requirements for all types of batteries specified.	Yes/No	Yes			
3.2.8	3.2.1.8	Standard output operating voltage tolerance Minimum output voltage (inverter minimum voltage) Maximum output voltage (inverter maximum input voltage)	V_{nom} V_{min} V_{max}	220V DC 176 V DC 312V DC			
3.2.9	3.2.1.9	Charger/rectifier modules shall be constant voltage, current limiting	Yes/No	Yes			
3.2.10	3.2.1.10	Number of parallel modules/units	Number	xxxxx			
3.2.11	3.2.1.11	Load sharing requirement of parallel modules/units	%	≤10			
3.2.12	3.2.1.14	Boost charge at maximum boost charge voltage with load connected	Yes/No	Yes			
3.2.13	3.2.1.15	Initial charge capability	Yes/No	No			
3.2.14	3.2.1.16	Output power is maintained when parallel/modules units are switched on or off	Yes/No	Yes			
3.2.15	3.2.1.17	Microprocessor control module compatibility over the OEM product range	Yes/No	Yes			
3.2.16	3.2.1.18	Maintainability of parallel modules/units without output supply interruption and jeopardizing IP2X	Yes/No	Yes			
3.2.17	3.2.1.19	Output voltage regulation at +10 and -15% input voltage; Float Other charging modes	 % %	 ±0.5 ±1			
3.2.18	3.2.1.20	Output voltage regulation at +25 and -25% input					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
		voltage; Float Other charging modes	% %	±1 ±2			
3.2.19	3.2.1.21	Voltage regulation during 10 to 90% step variation	% after 1 second	2			
3.2.20	3.2.1.22	Initial and equalize charge interlock when load is connected	Yes/No	Yes			
3.2.21	3.2.1.23	Single SMR module redundancy; Controller load voltage regulator capability Controller load disconnect capability	Yes/No Yes/No Yes/No	Yes Yes Yes			
3.2.22	3.2.1.24	Load transfer switch required as an option	Yes/No	No			
3.2.23	3.2.1.25	Battery charging current limit adjustability	% of rectifier capability	0-100			
3.2.24	3.2.1.26	Rectifier auto-start when input voltage recovers within ±25%input voltage limit	Yes/No	Yes			
3.2.25	3.2.1.27	Faulty module isolation without output supply interruption parallel configuration	Yes/No	Yes			
3.2.26	3.2.1.28	Maintain output supply during SMR controller/communication failure	Yes/No	Yes			
3.2.27	3.2.1.29	Individual charging mode enable/disable function; Manual boost charge function	Yes/No Yes/No	Yes Yes			
3.2.28	3.2.1.30	SMR module hot-pluggable	Yes/No	Yes			
3.2.29	3.2.1.31	Temperature compensation charging capability	Yes/No	Yes			
3.2.30	3.2.1.32	Individual module overload protection	Yes/No	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.2.31	3.2.1.33	Battery circuit continuity monitoring	Yes/No	Yes			
3.2.32	3.2.1.34	Active power factor correction on SMR	Yes/No	Yes			
3.2.33	3.2.1.34	THD	%	≤10			
3.2.34	3.2.1.35	Battery circuit disconnect	Yes/No	No			
3.2.35	3.2.1.36	4-20mA Hydrogen analyser input with functionality	Yes/No	Yes			
3.2.36	3.2.1.37	Different power rating module compatibility	Yes/No	xxxx			
3.2.37	3.2.1.38	Additional hardwire over voltage protection	Yes/No	Yes			
3.3.1	3.2.4	Input requirements	Refer to clause 3.1.2	Refer to clause 3.1.2			
3.3.2	3.2.5	Output requirements					
3.3.2.1	3.2.5.1	Standard output operating voltage tolerance Minimum output voltage Maximum output voltage	V_{nom} V_{min} V_{max}	V_{nom} V_{min} V_{max}			
3.3.3	3.2.6	Voltage ripple	%	0.1			
3.3.4	3.2.7	Current ripple	5A per 100Ah of battery capacity	5A per 100Ah of battery capacity			
3.3.5	3.2.8	Cooling requirements					
3.3.5.1	3.2.8.1	Natural	Yes/No				
3.3.5.2	3.2.8.2	Forced cooling as per a) to j)		xxxx			
3.3.6	3.2.9	Abnormal DC output voltage					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.6.1	3.2.9.1	Abnormal DC output voltage protection as specified	Yes/No				
3.3.7	3.2.10	Inrush current					
3.3.7.1	3.2.10.1	Inrush current determined as specified in IEC 62040-3		xxxx			
3.3.8	3.2.11	No-load operation					
3.3.8.1	3.2.11.1	No-load operation maximum voltage	%	+10			
3.3.9	3.2.12	Step load capability					
3.3.9.1	3.2.12.1	Voltage regulation during 10 to 90% step variation	% after 1 second	2			
3.3.10	3.2.13	Overload capability					
3.3.10.1	3.2.13.1	Overload capability rectifier and inverter	Duty class	II			
3.3.10.2	3.2.13.2	UPS static bypass overload capability	% for 1 min	200			
3.3.10.3	3.2.13.3	Inverter overload capability	% for 10 minutes	125			
3.3.11	3.2.14	Short-circuit and current limit capability					
3.3.11.1	3.2.14.1	Short circuit capability as stipulated in IEC 62040-3	Yes/No	Yes			
3.3.12	3.2.15	Psophometric noise					
3.3.12.1	3.2.15.1	Maximum Psophometric noise CCITT Class A	mV%	N/A			
3.3.13	3.2.16	Internal protection					
3.3.13.1	3.2.16.1	Internal protection	Yes	Yes			
3.3.14	3.2.17	Hardwire/hardware independent protection					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.14.1	3.2.17.1	Hardwire/hardware independent protection: Overvoltage protection on rectifier output Overvoltage protection on load Over temperature monitoring Additional hardwire overvoltage protection on DC port	 Yes/No Yes/No Yes/No Yes/No	 Yes Yes Yes Yes			
3.3.15	3.2.18	Active load sharing					
3.3.15.1	3.3.17.1	Active load sharing	%	≤10			
3.3.16	3.2.19	Efficiency					
3.3.16.1	3.2.19.1/2/3	a)AC to DC @ 25% load	%	>87.5			
3.3.16.2		b)AC to DC @ 50% load	%	>90			
3.3.16.3		c)AC to DC @75% load	%	>92.5			
3.3.16.4		d) AC to DC @ 100% load	%	>95			
3.3.16.5		a)DC to DC @ 25% load	%	>87.5			
3.3.16.6		b)DC to DC @ 50% load	%	>90			
3.3.16.7		c)DC to DC @75% load	%	>92.5			
3.3.16.8		d)DC to DC @ 100% load	%	>95			
3.3.16.9		a)DC to AC @ 25% load	%	>87.5			
3.3.16.10		b)DC to AC @ 50% load	%	>90			
3.3.16.11		c)DC to AC @75% load	%	>92.5			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.6.12		d) DC to AC @ 100% load	%	>95			
3.3.6.13		a)AC to DC @ 25% load	%	As per IEC 62040-3			
3.3.6.14		b)AC to DC @ 50% load	%	As per IEC 62040-3			
3.3.6.15		c)AC to DC @75% load	%	As per IEC 62040-3			
3.3.6.16		d) AC to DC @ 100% load	%	As per IEC 62040-3			
3.3.17	3.2.20	Electromagnetic environment and immunity requirements					
3.3.17.1	3.2.20.1	Conducted and radiated emissions					
3.3.17.1.1	3.2.20.1.1	Conducted and radiated emissions as specified in IEC 62040-2 for category C3	Yes	Yes			
3.3.17.1.2	3.2.20.1.2	Low frequency emissions THDI as per IEC 6100-3-2	%	<10			
3.3.18	3.2.20.2	Immunity					
3.3.18.1	3.2.20.2.1	Immunity as specified in IEC 62040-2 for category C3	Yes	Yes			
3.3.19	3.2.21	Audible noise	dB				
3.3.19.1	3.2.21.1	Audible noise	dB	<65			
3.3.20	3.2.22	Lightning protection					
3.3.20.1		Input	kV	6			
3.3.20.2		DC port	kV	4			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.3.20.3		Output	kV	4			
3.4	3.3	Electrical Requirements					
3.4.1	3.3.1	General					
3.4.1.1	3.3.1.1	Combined fused switches	as per IEC 60947-3	as per IEC 60947-3			
3.4.1.2	3.3.1.2	Moulded case circuit breakers	as per IEC 60947-2	as per IEC 60947-2			
3.4.1.3	3.3.1.3	Transformers	as per IEC 60067	as per IEC 60067			
3.4.1.4	3.3.1.4	Contactors	as per IEC 60947-4	as per IEC 60947-4			
3.4.1.5	3.3.1.5	Transfer switches	as per IEC 60947-6	as per IEC 60947-6			
3.4.1.6	3.3.1.6	Static transfer switches	As per IEC 62310-1/2/3	As per IEC 62310-1/2/3			
3.4.1.7	3.3.1.7	Terminal blocks	as per IEC 60947-7 and Eskom standard 240-70413291	as per IEC 60947-7 and Eskom standard 240-70413291			
3.4.1.8	3.3.1.8	Control circuit devices and switching elements	as per IEC 60947-5	as per IEC 60947-5			
3.4.2	3.3.2	Input isolation and overload protection	CFS/MCCB/MCB		xxxx		

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.2.1	3.3.2.1	Input isolation and overload protection provided	Yes/No	Yes			
3.4.2.2	3.3.2.2	Aux contacts provided	Yes/No	Yes			
3.4.3	3.3.3	Output isolation and overload protection	CFS/MCCB/MCB		xxxx		
3.4.3.1	3.3.3.1	Output isolation and overload protection provided	Yes/No	Yes			
3.4.3.2	3.3.3.2	Single phase isolation devices required on three phase output UPS	Yes	Yes			
3.4.3.3	3.3.3.3	Load profile grading required	Yes/No	Yes			
3.4.3.4	3.3.3.4	Aux contacts provided	Yes/No	Yes			
3.4.4	3.3.4	Battery isolation and overload protection	CFS/MCCB/MCB		xxxx		
3.4.4.1	3.3.4.1	Battery isolation and overload protection provided	Yes/No	Yes			
3.4.4.2	3.3.4.2	Load profile grading required	Yes/No	Yes			
3.4.4.3	3.3.4.3	Aux contacts provided	Yes/No	Yes			
3.4.4.4	3.3.4.4	Fault switching rating graded with battery fault current	Yes/No	Yes			
3.4.5	3.3.5	Input – output isolation	Yes				
3.4.5.1	3.3.5.1	Input – output isolation galvanically	Yes	Yes			
3.4.6	3.3.6	Earthing					
3.4.6.1	3.3.6.1	Exposed non-current carrying parts earthed onto earth bar	Yes	Yes			
3.4.6.2	3.3.6.2	External earthing point	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.6.3	3.3.6.3	Neutral (grounded circuit conductor) bonded to safety-earthing	Yes	Yes			
3.4.6.4	3.3.6.4	Earthing compliant with IEEE142:1991	Yes	Yes			
3.4.6.5	3.3.6.5	Earthing (0V DC earthed)	Yes/No	No			
3.4.7	3.3.7	Dropping diode voltage regulator	Yes/No	N/A			
3.4.7.1	3.3.7.1	Maximum volt drop	V	N/A			
3.4.7.2	3.3.7.4	Time delay	ms	N/A			
3.4.7.3	3.3.7.2	Maximum dropping diode voltage guideline	$V_{ocv} - V_{min(load)}$	N/A			
3.4.8	3.3.8	Inverter synchronization					
3.4.8.1	3.3.8.1	Settings	**Δ**f/Hz (Slip) = 0.1Hz Maximum difference in voltage magnitude = <5% of nominal (Preferable =<2V) Maximum difference in voltage phase angle = ±5° (Preferable <	**Δ**f/Hz (Slip) = 0.1Hz Maximum difference in voltage magnitude = <5% of nominal (Preferable =<2V) Maximum difference in voltage phase angle = ±5°			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
			±2.5°)	(Preferable < ±2.5°)			
3.4.9	3.3.9	Charging Modes					
3.4.9.1	3.3.9.1	Float Charging					
3.4.9.2		Float charge mode functionality	Yes/No	Yes			
3.4.9.3		Float voltage 2.15 to 2.35 (Flooded Lead Acid). 1.35 to 1.5 (Flooded Nickel Cadmium)	V/cell	2.15 to 2.35 (Flooded Lead Acid). 1.35 to 1.5 (Flooded Nickel Cadmium)			
3.4.9.4		Float current limit pre-settable between (1% to 100%) of rated rectifier current	(1% to 100%)	Yes			
3.4.10	3.3.9.2	Auto-boost Charging (with load connected)					
3.4.10.1		Auto-boost mode functionality	Yes/No	Yes			
3.4.10.2		28 day automatic auto-boost mode operation	Yes/No	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.10.3		Auto-boost voltage 2.20 to 2.4 (Flooded Lead Acid). 1.45 to 1.55 (Flooded Nickel Cadmium	V/cell	2.20 to 2.4 (Flooded Lead Acid). 1.45 to 1.55 (Flooded Nickel Cadmium)			
3.4.10.4		Auto-boost current limit pre-settable between (1% to 100%) of rated charger current	(1% to 100%)	Yes			
3.4.10.5		Auto-boost time (adjustable)	Hours	(1-12) hours			
3.4.10.6	3.3.9.2	Auto-boost failure Indication	Yes/No	Yes			
3.4.10.7		Auto-boost mode after “Mains Fail” functionality	Yes/No	Yes			
3.4.10.8		Auto-boost Trigger Voltage (Set @ 2,0 V per Cell)	V/cell	1.85 – 2.0			
3.4.10.9	3.3.9.1	Auto-boost enable/disable function available from display	Yes/No	Yes			
3.4.11	3.3.9.3	Equalize Charging					
3.4.11.1		Equalize voltage functionality and Indication	Yes/No	Yes			
3.4.11.2		Equalize charge load interlock	Yes/No	Yes			
3.4.11.3		Equalize voltage 2.3 to 2.6 (Flooded Lead Acid) 1.50 to 1.70 (Flooded Nickel Cadmium	V/cell	2.3 to 2.6 (Flooded Lead Acid) 1.50 to 1.70 (Flooded Nickel Cadmium)			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.11.4		Equalize current limit pre-settable between (1% to 50%) of rated charger current	(1% to 50%)	Yes			
3.4.12	3.3.9.4	Initial Charging					
3.4.12.1		Initial charge functionality	Yes/No				
3.4.12.2		Initial charge load interlock	Yes	Yes			
3.4.12.3		Initial charge >2.7 to 3 (Flooded Lead Acid). Adjusted to >1.75 (Flooded Nickel Cadmium)	V/cell	2.7 to 3 (Flooded Lead Acid). Adjusted to 1.75 (Flooded Nickel Cadmium)			
3.4.12.4		Initial current limit pre-settable between (5% to 70%) of rated charger current	(1% to 70%)	Yes			
3.4.13	3.3.10	Measurements, controls, indications and alarms					
3.4.13.1	3.3.10.1	Charger/Rectifier measurement					
3.4.13.1.1	3.3.10.1.1	Meter types	Panel meters/ LCD	LCD			
3.4.13.1.2	3.3.10.1.2	Meter accuracy	%	1			
3.4.13.1.3	3.3.10.1.3	Input voltage measurement and waveform	Yes/No	Yes			
3.4.13.1.4		Input current measurement and waveform	Yes/No	Yes			
3.4.13.1.5		DC port voltage measurement	Yes/No	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.13.1.6		DC port current measurement	Yes/No	Yes			
3.4.13.1.7		Output voltage measurement	Yes/No	Yes			
3.4.13.1.8		Output current measurement	Yes/No	Yes			
3.4.13.1.9		External hydrogen analyzer (located in battery cabinet or battery room)	Battery cabinet/Battery room input 4-20mA	Battery cabinet			
3.4.13.1.10		Temperature charging compensation measurement	Yes/No	Yes			
3.4.14	3.3.10.3	UPS measurements					
3.4.14.1	3.3.10.3.1	Mimic display indicating main components and status	Yes/no	Yes			
3.4.14.2	3.3.10.3.2	Selection of individual measurements by means of pushbuttons or menu selection	Pushbutton or menu selection	xxxx			
3.4.14.3		Rectifier input voltage and waveform recording	Yes	Yes			
3.4.14.4		Rectifier input current and waveform recording	Yes	Yes			
3.4.14.5		Battery DC voltage	Yes	Yes			
3.4.14.6		Battery DC current	Yes	Yes			
3.4.14.7		Inverter output voltage per phase	Yes	Yes			
3.4.14.8		Inverter output current per phase	Yes	Yes			
3.4.14.9		Inverter output frequency	Yes	Yes			
3.4.14.10		Static by-pass input voltage and waveform	Yes	Yes			
3.4.14.11		Static by-pass input current and waveform	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.14.12		Hydrogen level high	Yes	Yes			
3.4.14.13		Hydrogen level high-high	Yes	Yes			
3.4.15	3.3.10.5	Charger/rectifier indications					
3.4.15.1	3.3.10.5.1/3	Data logging capability	Yes/No	Yes			
3.4.15.2	3.3.10.5.2	All events date and time stamped	Yes/No	Yes			
3.4.15.3	3.3.10.5.4	SMS facility	Yes/No				
3.4.15.4	3.3.10.5.5/6	Alarm remote indication via potential free contacts	Yes/No	Yes			
3.4.15.5	3.3.10.5.7	Local indications					
3.4.15.5.1		Charging mode float, auto-boost, equalize or initial charge	Yes				
3.4.15.5.2		Equalise inhibited	Yes				
3.4.15.5.3		System paralleled	Yes				
3.4.15.5.4		Load transferred	N/A				
3.4.15.5.5		Battery isolated	Yes				
3.4.15.5.6		Charger, battery & load voltage and currents	Yes				
3.4.15.5.7		Ambient temperatures	Yes				
3.4.15.5.8		Battery room/cabinet forced ventilation failure	Yes				
3.4.15.5.9		Hydrogen level	Yes				
3.4.15.5.10		Hydrogen analyser healthy	Yes				

Item	Sub-Clause	Description		Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.16	3.3.10.6	UPS controls						
3.4.16.1	3.3.10.6.1	UPS controls required						
3.4.16.2		Alarm acknowledge		Yes	Yes			
3.4.16.3		Alarm reset		Yes	Yes			
3.4.16.4		Rectifier on/off selection		Yes	Yes			
3.4.16.5		Inverter on/off selection		Yes	Yes			
3.4.17	3.3.10.8	UPS indications						
3.4.17.1	3.3.10.8.1	Output healthy		Yes	Yes			
3.4.17.2		Static by-pass healthy		Yes	Yes			
3.4.17.3		Manual by-pass on		Yes	Yes			
3.4.17.4		Battery healthy		Yes	Yes			
3.4.17.5		Rectifier healthy		Yes	Yes			
3.4.18	3.3.10.9.2	Local Alarms	Rectifier Trip	Remote Alarm				
3.4.18.1		AC Phase Failure	No	Charger Fail	Yes			
3.4.18.2		Rectifier Module Fail/Shutdown	No	Charger Fail	Yes			
3.4.18.3		Rectifier Module I/O MCB Trip	No	Charger Fail	Yes			

Item	Sub-Clause	Description		Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.18.4		Load Voltage Low	No	Charger Fail	Yes			
3.4.18.5		Load Voltage High	Yes	Charger Fail	Yes			
3.4.18.6		Battery Voltage Low	No	Charger Fail	Yes			
3.4.18.7		Battery Voltage High	Yes	Charger Fail	Yes			
3.4.18.8		Battery Voltage Low (Urgent)	No	DC System Fail	Yes			
3.4.18.9		Protective Device Fail	No	DC System Fail	Yes			
3.4.18.10		Ripple High	Yes	Charger Fail	Yes			
3.4.18.11		Battery Loss Alarm	No	DC System Fail	Yes			
3.4.18.12		Load Voltage Low (Urgent)	No	DC System Fail	Yes			
3.4.18.13		Failure of Auto-boost Cycle	No	Charger Facility Abnormal	Yes			
3.4.18.14		Battery Room/Cabinet Forced Ventilation Failure	No	DC System Fail	Yes			
3.4.18.15		Load Voltage Regulator Failure	No	Charger Facility Abnormal	Yes			

Item	Sub-Clause	Description		Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.18.16		DC Earth Fault +ve leg	No	DC System Abnormal	Yes			
		DC Earth Fault -ve leg	No	DC System Abnormal	Yes			
3.4.18.17		Hydrogen level high >0.8%	No	DC System Abnormal	Yes			
3.4.18.18		Hydrogen level High-High	No	DC System Abnormal	Yes			
3.4.18.19		Hydrogen analyzer failure	No	DC System Abnormal	Yes			
3.4.18.20		Battery Self-Test: Failure	No	Charger Facility Abnormal	Yes			
3.4.18..21	3.3.10.11.2	Output failure		UPS failure				
3.4.18.22	3.3.10.11.2	Static by-pass input failure		UPS System Abnormal				
3.4.19	3.3.11	Communication and control design requirements						
3.4.19.1	3.3.11.1	General						
3.4.19.2	3.3.11.1.1	Remote communication link		Yes/no	Yes			
3.4.19.3	3.3.11.1.2	Communication protocol			xxxx			
3.4.19.4	3.3.11.1.3	Supporting DNP 3.0 level 2 or 3 protocols and IEC 61850		Yes/no				
3.4.19.5	3.3.11.1.4	Micro-processor controlled		Yes/no	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.19.6	3.3.11.1.5	Internal rectifier module micro-processor controlled as back-up	Yes/no	Yes			
3.4.19.7	3.3.11.1.6	Diagnostic and telemetry capability	Yes/no	Yes			
3.4.20	3.3.11.2	Real time clock and time synchronization					
3.4.20.1	3.3.11.2.1	Real time clock and time synchronization for 30 years	Yes/no	Yes			
3.4.20.2	3.3.11.2.2	Real time clock drift	Seconds/month	<60			
3.4.20.3	3.3.11.2.3	Resettable clock with resetting other parameters	Yes/no	Yes			
3.4.20.4	3.3.11.2.4	Maintain time of clock for 7 days during loss of supply	Yes/no	Yes			
3.4.20.5	3.3.11.2.5	Synchronization of IEDs	Yes/no	Yes			
3.4.20.6	3.3.11.2.6	Synchronization indicated in event log	Yes/no	Yes			
3.4.21	3.3.11.3	Communication ports					
3.4.21.1	3.3.11.3.1	Communication ports	2 x Rs-232 1x Rs485 1 x Ethernet or Fibre optic	Yes Yes Yes			
3.4.22	3.3.11.4	Monitoring and control					
3.4.22.1	3.3.11.4.1	Interface to local PC	Yes/no	Yes			
3.4.22.2	3.3.11.4.2	Remote interface with charger/rectifier	Yes/no	Yes			
3.4.22.3	3.3.11.4.3	Pre-programmed current/voltage/time durations	Yes/no	Yes			
3.4.22.4	3.3.11.4.4	Optimal management during normal supply unavailability	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.22.5	3.3.11.4.5	Software and firmware upgradeable	Yes	Yes			
3.4.22.6	3.3.11.4.6	Settings, indications and alarm display via front panel	Yes	Yes			
3.4.22.7	3.3.11.4.7	Password controlled	Yes	Yes			
3.4.22.8	3.3.11.4.8	Real time control	Yes	Yes			
3.4.22.9	3.3.11.4.9	Default values for stand-alone opera tion	Yes	Yes			
3.4.22.10	3.3.11.4.10	Individual rectifier module parameter monitoring and comparison.	Yes/no	Yes			
3.4.22.11	3.3.11.4.11	Interface with optional unit	Yes/no	Optional			
3.4.22.12	3.3.11.4.12	Unique remote controller identification	Yes	Yes			
3.4.23	3.3.12	Software and firmware					
3.4.23.1	3.3.12.1	General					
3.4.23.1.1	3.3.12.1.1	Software to access equipment	Yes	Yes			
3.4.23.1.2	3.3.12.1.2	Software updates compatible with supplied systems	Yes	Yes			
3.4.23.1.3	3.3.12.1.3	Software license and documentation copyright	Yes	Yes			
3.4.23.1.4	3.3.12.1.4	Software support	Yes	Yes			
3.4.23.1.5	3.3.12.1.5	Software detail to be supplied	Yes	Yes			
3.4.23.1.6	3.3.12.1.6	Adhere to software control standard	Yes	Yes			
3.4.23.1.7	3.3.12.1.7	Settings and display features available from front panel display	Yes	Yes			
3.4.23.1.8	3.3.12.1.8	Alarm/event lock downloadable	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.4.23.1.9	3.3.12.1.9	Software capable to upload and download alarm/ event log or settings	Yes	Yes			
3.4.23.1.10	3.3.12.1.10	Software display the status of any modules connected	Yes	Yes			
3.4.23.1.11	3.3.12.1.11	Software to display the status of remote communication connections	Yes	Yes			
3.4.23.1.12	3.3.12.1.12	Record battery discharge curve	Yes	Yes			
3.4.23.2	3.3.12.2	Software verification and validation	Yes	Yes			
3.4.24	3.3.12.3	System firmware					
3.4.24.1		Equipment system firmware displayed on the equipment					
3.4.24.2		Firmware alterations to be controlled					
3.4.24.3		Data retention for the expected life of the equipment					
3.4.24.4		Firmware upgradeable					
4. 0	3.4	Mechanical Requirements					
4.1	3.4.1	General					
4.1.1	3.4.1.1	Compliance to clause 5 of SANS 10142-1 and SANS 62040-1	Yes	Yes			
4.1.2	3.4.1.2	Designed, constructed and tested in accordance to clause 6.6 of SANS 10142-1	Yes	Yes			
4.1.3	3.4.1.3	RCC as per SANS 10142-1 table 4.2	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.2	34.2	Doors and covers					
4.2.1	3.4.2.1	Individual hinged doors for each cable compartment and each fix patter functional unit sub-section.	Yes	Yes			
4.2.2	3.4.2.2	All removable covers shall require the use of a tool	Yes	Yes			
4.2.3	3.4.2.3	All opening doors shall be padlockable	Yes	Yes			
4.2.4	3.4.2.4	Hinging as specified up to 450mm- 2 hinges, up to 800mm - 3 hinges more than 800mm - 4 hinges	 Yes Yes Yes	 Yes Yes Yes			
4.2.5	3.4.2.5	Square key latches as specified up to 450 mm - 2 latches, up to 800 mm - 3 latches and more than 800 mm - 4 latches	 Yes Yes Yes	 Yes Yes Yes			
4.2.6	3.4.2.6	As a minimum the center square key latch shall be padlockable with hole > 8mm	Yes	Yes			
4.2.7	3.4.2.7	Cable compartment hinges to allow lifting off	Yes	Yes			
4.2.8	3.4.2.8	Durable hinge and latch fastening	Yes	Yes			
4.2.9	3.4.2.9	Doors stops required	Yes	Yes			
4.2.10	3.4.2.10	Door latches and hinges to withstand internal faults	Yes	Yes			
4.2.11	3.4.2.11	Doors >800mm to be fitted with webs	Yes	Yes			
4.3	3.4.3	Main, Distribution, Equalising and Collection Busbars					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.3.1	3.4.3.1	Main and distribution busbars manufactured from electrolytic tough pitch high conductivity copper as per SANS 804	Yes	Yes			
4.3.2	3.4.3.2	Condition of temper for busbar copper designation H2 for half-hard cold working as per SANS 1195	Yes	Yes			
4.3.3	3.4.3.3	Main busbar design maximum permissible surface temperature rise at rated current, Distribution busbar	K K	65 55			
4.3.4	3.4.3.4	Neutral busbar sizing relative to main busbar rating on input and relative to the associated distribution busbars	% of main busbar % of distribution busbar	≥50 100			
4.3.5	3.4.3.5	Neutral busbar connected to protective earth via removable bolted link	Yes	Yes			
4.3.6	3.4.3.6	Joints and tees in busbar compliance Bolts high tensile	T-22 8.8 to ISO 898-1	T-22 8.8 (ISO 898-1)			
4.3.7	3.4.3.7	Joints: Minimum number of bolts Busbar overlap Washers	 # Multiple of thickness or relative to width Conical or spring	 ≥2 ≥6 or equal Conical			
4.3.8	3.4.3.8	All busbar supports with minimum rating of the respective fault current rating	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.3.9	3.4.3.9	Span of distribution busbar shall not interfere with cable entry zone.	Yes	Yes			
4.3.10	3.4.3.10	Busbar identification marking: AC Busbars DC Busbars 220 and 110V DC DC Busbars 24DC	Yes/No Red, White & Blue and Black -Neutral Red - positive and Black - Negative Red – positive and Blue – negative and Black - zero bar	Yes Red, White & Blue and Black - Neutral Red - positive and Black - Negative Red – positive and Blue – negative and Black - zero bar			
4.3.11	3.4.3.11	Collection busbars need to be constructed where SCPD's and mcb's need to be connected in cascaded circuits	Yes/no	Yes			
4.3.12	3.4.3.12	Sufficient supports for equalizing busbars to withstand fault current	Yes/no	Yes			
4.4	3.4.4	Protective earth conductor and screened earth busbar					
4.4.1	3.4.4.1	A separate protective earth connected	Yes/no	Yes			
4.4.2	3.4.4.2	Non-current carrying conductive parts connected to PE	Yes/no	Yes			
4.4.3	3.4.4.3	Earth conductor size connected to doors	mm^2	6			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.4.4	3.4.4.4	PE rating	As per SANS 10142-1	As per SANS 10142-1			
4.4.5	3.4.4.5	Protective circuit parts rated for the highest fault condition	Yes/no	Yes			
4.4.6	3.4.4.6	Screened earth busbar		xxxx			
4.4.7	3.4.4.7	PE conductor colour	Green with yellow stripes	Green with yellow stripes			
4.5	3.4.5	Power and control cabling					
4.5.1	3.4.5.1	Power circuit wiring and connections rated according to the de-rated operating current of the associated protective gear	Yes	Yes			
4.5.2	3.4.5.2	Control wiring connected to source of fault energy rating	1.5 times fuse rating and withstanding I^2t fuse rating	1.5 times fuse rating and withstanding I^2t fuse rating			
4.5.3	3.4.5.3	Individual function unit connection to the control busbar		xxxx			
4.5.4	3.4.5.4	Connections to equipment mounted on swing doors		xxxx			
4.5.5	3.4.5.5	Type of conductor cable	Stranded, single or solid	Stranded			
4.5.6	3.4.5.6	Multistrand cable conductor diameter	mm^2	1.5			
4.5.7	3.4.5.7	Multistrand cable conductor diameter for current and voltage transformers	mm^2	2.5			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.5.8	3.4.5.8	Joints and splices in any circuit, more than one conductor in one lug.	Not allowed Not allowed	Not allowed Not allowed			
4.5.9	3.4.5.9	Terminals and labels shall be accessible after assembly		xxxx			
4.5.10	3.4.5.10	Terminals which are on the live side of fuses and isolating switches shall be completely shrouded	Yes	Yes			
4.5.11	3.4.5.11	Coils in-line with normally open contacts connected to positive	Yes/no	Yes			
4.5.12	3.4.5.12	Compression joints standard	BS EN 61238	BS EN 61238			
4.5.13	3.4.5.13	Grommets installed on all holes through which cables are passing	Yes	Yes			
4.5.14	3.4.5.14	Conductors >100A and passing through metal	Conductor all three phases (both poles of DC conductors) or metal barrier split	xxxx			
4.5.15	3.4.5.15	AC and DC conductors allowed in same wireway	Yes/no	No			
4.5.16	3.4.5.16	Power circuit cable sizing standard for the specified volt-drop	SANS 1973-1	SANS 1973-1			
4.5.17	3.4.5.17	Stripping of insulation standard		xxxx			
4.5.18	3.4.5.18	Crimping standard		xxxx			
4.5.19	3.4.5.19	Correct torque standard		xxxx			
4.6	3.4.6	Conductor identification					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.6.1	3.4.6.1	Conductor identification	Yes	Yes			
4.6.2	3.4.6.2	Control conductor identification AC circuits DC circuits	 Black Grey	 Black Grey			
4.6.3	3.4.6.3	Control bus wiring identification DC AC	 Red – positive Black – negative Brown and Blue	 Red positive Black negative Brown and Blue			
4.6.4	3.4.6.4	Conductor of CT and VT circuits identification	Phase colours	Phase colours			
4.6.5	3.4.6.5	Control conductor wiring		xxxx			
4.7	3.4.7	Enclosure and Assembly					
4.7.1	3.4.7.1	EMC testing required with door open when MCB and MCCB are fitted behind the door	Yes/no	Yes			
4.7.2	3.4.7.2	Individual segregation for input, DC port, output, signal and control cabling	Yes/no	Yes			
4.7.3	3.4.7.3	Converter modules and controller sub rack assemblies	Swing/fix frame assembly	Swing/fix frame assembly options			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.7.4	3.4.7.4	Handling and lifting facilities	Removable lifting facility. Forklift handling	Removable lifting facility. Forklift handling			
4.7.5	3.4.7.5	Dimensions		To be supplied for product range			
4.7.5.1		Height	mm	xxxx			
4.7.5.2		Width	mm	xxxx			
4.7.5.3		Depth	mm	xxxx			
4.7.5.4		Weight	kg	xxxx			
4.8	3.4.8	Sub-rack assemblies and input/output power distribution modules					
.8.1	3.4.8.1	Sub-rack inclusions Controller sub-assembly infront Terminal plate sub-assembly rear Segregated wire loom	 Yes/no Yes/no Yes/no	 Yes Yes Yes			
4.8.2	3.4.8.2	Input/output power modules – front distribution modules Terminal plate sub assembly rear Segregated wire loom	Yes/no Yes/no Yes/no	Yes Yes Yes			
4.8.3	3.4.8.3	Sub-rack expandable to maximum modules power rating	Yes/no	Yes			
4.8.4	3.4.8.4	Sub-rack pre wired for expansion	Yes/no	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.8.5	3.4.8.5	Blanking plates installed on unused module positions	Yes/no	Yes			
4.8.6	3.4.8.6	Ingress protection	IP	IP2X			
4.8.7	3.4.8.7	Individual MCB module locking facility	Yes/no	Yes			
4.8.8	3.4.8.8	Terminal plate and top drawer plate thickness	mm	1.6			
4.8.9	3.4.8.9	Terminal plate width	mm	482.6			
4.8.10	3.4.8.10	Slotted mounting hole dimensions as per IEC 60297-1 Width Height Horizontal distance between hole centers	IEC 60297-1 mm mm mm	IEC 60197-1 10.3 6.80 465.1			
4.8.11	3.4.8.11	Overall aesthetically pleasing appearance	Yes	Yes			
4.8.12	3.4.8.12	Earthing stud fitted on terminal plate	Yes	Yes			
4.9	3.4.9	Ingress protection					
4.9.1	3.4.9.1	IP rating Panel doors closed Panel doors open	 IP IP	 31 2X			
4.9.2	3.4.9.2	Additional IP rating requirements	IP	As options IP45 IP55 IP65			
4.10	3.4.10	Cable entry					
4.10.1	3.4.10.1	Cable entry	Top/bottom	Top and bottom			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.11	3.4.11	Gland plate					
4.11.1	3.4.11.1	Gland plate height	mm	300mm above point of bottom entry and at point of top entry.	300mm above point of bottom entry and at point of top entry		
4.11.2	3.4.11.2	Fire retardant and sealing of floor slot	Yes	Yes required as part of installation			
4.11.3	3.4.11.3	Undrilled gland-plate, corrosion protected as per SANS 1652	Yes	Yes			
4.11.4	3.4.11.4	Adequate gland plate support	Yes	Yes			
4.11.5	3.4.11.5	Non-magnetic gland plates	Yes/no	Yes			
4.11.6	3.4.11.6	95mm^2 cabling gland plate requirements	Yes/no	Yes as an option			
4.11.7	3.4.11.7	Bonding of gland plate to PE conductor	Yes	Yes			
4.12	3.4.12	Corrosion protection					
4.12.1	3.4.12.1	Corrosion protection standard	SCSSCAAP9	SCSSCAAP 9			
4.12.2	3.4.12.2	AC input supply assembly colour	G29	G29			
4.12.3	3.4.12.3	DC input supply assembly colour	A11	A11			
4.13	3.4.13	Terminations					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.13.1	3.4.13.1	Termination standard	240-70413291	240-70413291			
4.13.2	3.4.13.2	Terminations for all input output and alarming	Yes/no	Yes			
4.13.3	3.4.13.3	Maximum number of cable cores per termination point	#	2			
4.13.4	3.4.13.4	Input terminal rating at input minimum voltage	Yes/no	Yes, alternatives can be specified as an option			
4.13.5	3.4.13.5	DC port terminal size	mm^2	95 Alternatives can be specified as an option			
4.14	3.4.14	Internal wiring					
4.14.1	3.4.14.1	Wire ways and trunking shall be smooth and free of sharp edges	Yes	Yes			
4.14.2	3.4.14.2	Trunking temperature rating	ºC	90			
4.14.3	3.4.14.3	All wiring in trunking or wire looms clipped or laced	Yes	Yes			
4.15	3.4.15	Conformal coatings					
4.15.1	3.4.15.1/2/3	Conformal coatings required	Yes/no				
4.16	3.4.16	Accessibility					
4.16.1	3.4.16.1	Accessibility for cable termination	Yes	Yes			
4.16.2	3.4.16.2	Normal maintenance accessibility following installation	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.16.3	3.4.16.3	Accessibility	Front/rear	Front and rear			
4.17	3.4.17	Minimum clearances					
4.17.1	3.4.17.1	Pole-to-pole and pole-to-earth clearance standard	SANS 10142-1	SANS 10142-1			
4.17.2	3.4.17.2	Terminals for input, DC port and output	Segregated/ barriers	Segregated /barriers			
4.17.3	3.4.17.3	Minimum creepage distance rating as per SANS 60439-1 clause 7.1.2	Pollution Degree 3, material group 111a with the specified insulation voltage	Pollution Degree 3, material group 111a with the specified insulation voltage			
4.17.4	3.4.17.4	Clearance and creepage distances	SANS 60439-1 Table 14 and 16	SANS 60439-1 Table 14 and 16			
4.18	3.4.18	Nameplate/rating plate/declared electrical performance					
4.18.1	3.4.18	Nameplate material	Stainless steel/ anodized aluminium	Stainless steel/ anodized aluminium			
4.18.2	3.4.18	Nameplate information	Clause 3.5.18	Clause 3.5.18			
5.0	3.5	Settings and Commissioning					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
5.1	3.5.1	Settings					
5.1.1	3.5.1.1	Settings standard	240-56176168	240-56176168			
5.1.2	3.5.1.2	Settings document for each piece of equipment required based on specific application	Yes	Yes To be compiled by OEM based on application.			
5.1.3	3.5.1.3	Micro-processor shall be programmed with these settings as default	Yes	Yes			
5.1.4	3.5.1.4	Revision indicated on document	Yes	Yes			
5.1.5	3.5.1.5	SCPD indicated on settings document	Yes	Yes			
5.2	3.5.2	Commissioning					
5.2.1	3.5.2.1	Commissioning standard	240-56177186	240-56177186			
5.2.2	3.5.2.2	As commissioning routine, operational and functional tests shall be performed	Yes	Yes			
5.3	3.6	Upgrading/modifications					
5.3.1	3.6.1	Upgrade/modification report required	Yes	Yes			
5.3.2	3.6.2	Hardware upgrade identification	Yes	Yes			
5.4	3.7	Equipment performance					
5.4.1	3.7.1	Warranty					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
5.4.1.1	3.7.1.1	Warranty period	36 months from date of commissioning	36 months from date of commissioning			
5.4.2	3.7.2	Reliability, security, dependability, maintainability and life expectancy					
5.4.2.1	3.7.2.1.1	Equipment hours of installed units per voltage or model/type	Yes	Yes			
5.4.2.2	3.7.2.1.2	Customers indicating the number of units employed per model/type	Yes	Yes			
5.4.2.3	3.7.2.1.3	Environmental conditions where such equipment is installed	Yes	Yes			
5.4.2.4	3.7.2.2.1	Equipment proven record	>2 years and one hundred equipment years	>2 years and one hundred equipment years			
5.4.2.5	3.7.2.2.2	Life expectancy Electronic equipment Other hardware	 ≥10 years ≥20 years				
5.4.2.6	3.7.2.2.3	Written guarantee to meet life expectancy	Yes	Yes			
5.4.2.7	3.7.2.2.4	Supplier product health statement	Yes	Yes			
5.4.2.8	3.7.2.3	Internal battery specification		xxxx			
6.0	4.2	Type testing					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
6.1	IEC 60146-1-1	Converter tests	Type Tests Required as per IEC 60146-1-1				
6.1.1	4.2.1	Insulation test	Yes	Yes			
6.1.2	4.2.2.	Light load functional test.	Yes	Yes			
6.1.3	4.2.2.	Functional test	Yes	Yes			
6.1.4	4.2.3	Rated current test	Yes	Yes			
6.1.5	4.2.4	Power loss determination for assemblies and equipment	Yes	Yes			
6.1.6	4.2.5	Temperature rise test	Yes	Yes			
6.1.7	4.2.6	Power factor measurement	Yes	Yes			
6.1.8	4.2.7	Checking of auxiliary devices	Yes	Yes			
6.1.9	4.2.8	Measurement of inherent voltage regulation	Yes	Yes			
6.1.10	4.2.9	Checking the properties of the control equipment	Yes	Yes			
6.1.11	4.2.10	Checking the protective devices	Yes	Yes			
6.1.12	4.2.11	Immunity test	Yes	Yes			
6.1.13	4.2.12	Overcurrent capability test	Yes	Yes			
6.1.14	4.2.13	Radio frequency generated interference and conducted noise	Yes	Yes			
6.1.15	4.2.14	Audible noise	Yes	Yes			
6.1.16	4.2.15	Measurement of ripple voltage and current	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
6.1.17	4.2.16	Additional tests	Yes	Yes			
6.2	SANS 1652	Type Tests Required as per SANS 1652	Yes/No	Yes			
6.2.1	5.2	Dielectric strength test	Yes	Yes			
6.2.2	5.3	Insulation resistance test	Yes	Yes			
6.2.3	5.4	DC output voltage adjustment range test	Yes	Yes			
6.2.4	5.5	DC output voltage regulation tests	Yes	Yes			
6.2.5	5.6	Temperature rise test	Yes	Yes			
6.2.6	5.7	Power efficiency test	Yes	Yes			
6.2.7	5.8	Test for protection against lightning surges	Yes	Yes			
6.2.8	5.9	Short-circuit test on output terminals	Yes	Yes			
6.2.9	5.10	Ripple voltage limits and ripple current test	Yes	Yes			
6.2.10	5.11	Audible noise level test	Yes	Yes			
6.2.11	5.12	Salt fog test	Yes	Yes			
6.2.12	5.13	Glow-wire test on non-metallic enclosures	Yes	Yes			
6.2.13	4.1.4	Lightning surge test	Yes	Yes			
6.2.14	4.2.4	Parallel operation test	Yes	Yes			
6.3	SANS 62040-3	Type Tests Required as per SANS 62040-3	Yes/No	Yes			
6.3.1	6.2.2.2	Cable and interconnection check	Yes	Yes			
6.3.2	6.2.2.3.a	Control device(s)	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
6.3.3	6.2.2.3.b	Protective device(s)	Yes	Yes			
6.3.4	6.2.2.3.c	Auxiliary device(s)	Yes	Yes			
6.3.5	6.2.2.3.d	Supervisory, monitoring, signalling device(s)	Yes	Yes			
6.3.6	6.2.2.3.e	Auto transfer to stored energy mode and back to normal	Yes	Yes			
6.3.7	6.2.2.3.f	Auto transfer to bypass / isolation mode and back to normal	Yes	Yes			
6.3.8	6.2.2.3.g	Manual transfer to bypass/isolation mode and back to normal	Yes	Yes			
6.3.9	6.2.2.4	No load	Yes	Yes			
6.3.10	6.2.2.5	Full load	Yes	Yes			
6.3.11	6.2.2.6	Frequency slew-rate	Yes	Yes			
6.3.12	6.2.2.7	AC input failure	Yes	Yes			
6.3.13	6.2.2.8	AC input return	Yes	Yes			
6.3.14	6.4.2.12	Parallel redundant UPS fault	Yes	Yes			
6.3.15	6.2.2.9	Transfer test to bypass	Yes	Yes			
		Input supply compatibility					
6.3.16	6.4.1.1	Steady-state input voltage tolerance	Yes	Yes			
6.3.17	6.4.1.2	Input frequency variation	Yes	Yes			
6.3.18	6.4.1.3	Input inrush current	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
6.3.19	6.4.1.4	Harmonic distortion of input current	Yes	Yes			
6.3.20	6.4.1.5	Power factor	Yes	Yes			
6.3.21	6.4.1.6	Efficiency	Yes	Yes			
6.3.22	6.4.1.9	Stand-by generator compatibility	Yes	Yes			
		Output – Linear load					
6.3.23	6.4.2.1	Normal mode – No load	Yes	Yes			
6.3.24	6.4.2.2	Normal mode – Full load	Yes	Yes			
6.3.25	6.4.2.3	Stored energy mode – No load	Yes	Yes			
6.3.26	6.4.2.4	Stored energy mode – Full load	Yes	Yes			
6.3.27	6.4.2.5	3-phase voltage unbalance test	Yes	Yes			
6.3.28	6.4.2.6	DC components in the output	Yes	Yes			
6.3.29	6.4.2.7	Current division across paralleled UPS	Yes	Yes			
6.3.30	6.4.2.8	Output overvoltage test	Yes	Yes			
6.3.31	6.4.2.9	Periodic output voltage variation test (modulation)	Yes	Yes			
6.3.32	6.4.2.10.1	Normal mode – Overload	Yes	Yes			
6.3.33	6.4.2.10.2	Stored energy mode – Overload	Yes	Yes			
6.3.34	6.4.2.10.3	UPS rated output fault clearing capability – Normal mode	Yes	Yes			
6.3.35	6.4.2.10.4	UPS rated output fault clearing capability – Stored energy mode	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
		UPS output dynamic performance tests					
6.3.36	6.4.2.11.1	Dynamic performance – Normal to stored energy mode	Yes	Yes			
6.3.37	6.4.2.11.2	Dynamic performance – Stored energy to normal mode	Yes	Yes			
6.3.38	6.4.2.11.3	Dynamic performance – Normal to bypass mode – overload	Yes	Yes			
6.3.39	6.4.2.11.4	Dynamic performance – Step load – Normal mode	Yes	Yes			
6.3.40	6.4.2.11.5	Dynamic performance – Step load – Stored energy mode	Yes	Yes			
		Output – Non-linear load					
6.3.41	6.4.3.1	Normal mode – Full load	Yes	Yes			
6.3.42	6.4.3.2	Stored energy mode – Full load	Yes	Yes			
6.3.43	6.4.3.3.1	Dynamic performance – Normal to stored energy mode	Yes	Yes			
6.3.44	6.4.3.3.2	Dynamic performance – Stored energy to normal mode	Yes	Yes			
6.3.45	6.4.3.3.3	Dynamic performance – Step load – Normal mode	Yes	Yes			
6.3.46	6.4.3.3.4	Dynamic performance – Step load – Stored energy mode	Yes	Yes			
		Stored and restored energy times					
6.3.47	6.4.4.1	Stored energy time	Yes	Yes			
6.3.48	6.4.4.2	Restored energy time	Yes	Yes			
6.3.49	6.4.4.3	Battery ripple current	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
6.3.50	6.4.4.4	Restart test	Yes	Yes			
		Environmental					
6.3.51	6.5.2.1	Repetitive shock during transportation	Yes	Yes			
6.3.52	6.5.2.2	Free-fall during transportation	Yes	Yes			
6.3.53	6.5.3	Storage in dry heat, damp heat and cold environments	Yes	Yes			
6.3.54	6.5.4	Operation in dry heat, damp heat and cold environments	Yes	Yes			
6.3.55	6.5.5	Acoustic noise	Yes	Yes			
6.3.56	Refer to IEC 62040-1	Safety	Yes	Yes			
6.3.57	IEC 62040-2	EMC test	Yes	Yes			
7.0	5.0	Marking, labeling and packaging					
7.1	5.1	Labelling					
7.1.1	5.1.1	Labeling	0.54/3695 sheet 1 & 2 or 240-62629353	0.54/3695 sheet 1 & 2 or 240-62629353			
7.1.2	5.1.2	Package labelling	Yes	Yes			
7.2	5.2	Packaging					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
7.2.1	5.2.1	Packaging	High specification impact resistant corrugated cardboard with waterproof outer plastic covering	High specification impact resistant corrugated cardboard with waterproof outer plastic covering			
7.2.2	5.2.2	Additional packaging requirements	Crating	Crating as an option			
8.0	6.0	Spares					
8.1	6.1	General					
8.1.1	6.1.1	Spares list	Yes	Yes			
8.1.2	6.1.2	Maintenance spares list	Yes	Yes			
8.1.3	6.1.3	Spares pricing	Yes	Yes			
8.1.4	6.1.4	Spares life expectancy within packaging	Years	10			
8.1.5	6.1.5	Spares available for warranty period	Yes	Yes			
8.1.6	6.1.5.1	Spares holding for 1 to 20 modular type/units	#/set of cards	1			
8.1.7	6.1.5.2	Spares holding for 21 to 40 modular types	#/set of cards	3			
8.1.8	6.1.6	Delivery	hr ex-works	24			
8.1.9	6.1.8	Spares availability	years	10			
9.0	7.0	Documentation					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
9.1	7.1	General					
9.1.1	7.1.1	Sets of hard copies	#	3			
9.1.2	7.1.2	Drawings format Drawings size	.dgn A3	.dgn A3			
9.2	7.2	Drawings					
9.2.1	7.2.1	General arrangement drawings	Yes	Yes			
9.2.2	7.2.2	Single line diagrams	Yes	Yes			
9.2.3	7.2.3	Schematic drawings	Yes	Yes			
9.2.3	7.2.4	Installation, operating and maintenance instruction manuals					
9.2.3.1	7.2.4.1	All instruction manuals shall be comprehensively detailed	Number of copies including .pdf software copy	3			
9.2.3.2	7.2.4.2	The manuals shall cover all equipment forming part of the assembly including: Content list List of reference drawings Detail of all components	 Yes Yes Yes Yes	 Yes Yes Yes Yes			
9.2.3.3	7.2.4.3	Manual in loose leaf binder to ISO standard in A4 size	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
9.2.3.4	7.2.4.4	Manual content	General arrangement drawings, installation drawings and instructions, operating and maintenance instructions for all components, detailed parts list, spare parts ordering instructions etc	General arrangement drawings, installation drawings and instructions, operating and maintenance instructions for all components, detailed parts list, spare parts ordering instructions etc			
9.2.3.5	7.2.4.5	Additional content	Special instructions pertaining to spares storage, drawings for component locations, dismantling and re-assembly.	Special instructions pertaining to spares storage, drawings for component locations, dismantling and re-assembly.			
9.2.3.6	7.2.4.6	Special tool requirements		xxxx			
9.2.4	7.2.5	Engineering design system					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
9.2.4.1	7.2.5.1	EDS source document of design	Yes	Yes			
10.0	8.0	Language					
10.1	8.1	Language on display, drawings, documentation and software	US or UK English				

Annex C – AC/DC to AC/DC Convertors

240-53114248

SCHEDULE A & B – AC/DC to AC/DC convertors

DESCRIPTION

Schedule A: The Engineer's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

All Standards quoted will be the Latest revision

NOTES REGARDING THE COMPLETION OF SCHEDULE A & B:

NOTE: The schedules A&B of the Battery Charger Specification 36-815 shall also be completed and submitted as part of these schedules.

General

The requirements of this section specified under "Schedule A & B" form part of the Works Information. Schedule B shall be completed by the Contractor and submitted with his tender.

Filling in Instructions

● Where the Contractor does not fully comply with the Engineering requirement, any deviations shall be clearly indicated in Schedule B and listed in the Deviation Schedule, with the cost of the deviation.

● Where there is a need to substantiate or further describe an item in Schedule B, especially in instances of non-compliance with Schedule A, particulars are furnished on a separate sheet clearly marked with the notation of the Schedule A item referred to.

● If a blank space is left in Schedule B next to certain requirements specified in Schedule A, this constitutes a confirmation that the tender does not comply with that specific requirement.

● Where xxxxx is indicated for an item in Schedule A, the Contractor is required to fill in the appropriate information in Schedule B, for the equipment offered.

● Where t.b.c. (to be confirmed) is indicated for an item in Schedule A, the Engineer will fill in the appropriate information in Schedule A, when confirmed.

Evidence Reference

● Each evidence reference shall be filled in with a reference to the delivery documentation where the word "REQUIRED" is stated. The evidence reference section will refer to the documentation that backs-up the statement made in Schedule B. If no evidence is received or it is not referenced to correctly, it shall be taken as non-compliance with regard to Schedule A.

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
1.0	3.1.	General Requirements					
1.1	3.1.1	Site conditions					
1.2	3.1.1.1.1	Altitude	m	2000			
1.4	3.1.1.1.2	Relative humidity	%	10-90 non condensing			
1.5	3.1.1.1.3	Lighting		High lighting area as SANS 1652 and SANS 61439 -1 Table G1			
1.6	3.1.1.2	Outdoor air temperature					
1.6.1	3.1.1.2.1	Maximum	°C	60			
1.6.2	3.1.1.2.2	Daily average	°C	30			
1.6.3	3.1.1.2.4	Minimum	°C	-15			
1.7	3.1.1.3	Equipment room air temperature					
1.7.1	3.1.1.3.1	Maximum	°C	50			
1.7.2	3.1.1.3.2	Daily average	°C	35			
1.7.3	3.1.1.3.4	Minimum	°C	-5			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
1.8	3.1.1.4	Controlled equipment room environment temperature	Yes/No	No (equipment room air temperature conditions will be applicable)			
1.8.1	3.1.1.4.1	Maximum	°C	27			
1.8.2	3.1.1.4.2	Minimum	°C	20			
2.0	3.1.2	Electrical input supply					
2.1	3.1.2.1	Input supply configuration	Configuration as per SANS 10142-1 or as specified below	TN-S or as specified below			
2.2	3.1.2.2	Input voltage fluctuations as percentage of nominal voltage	%	400V±25			
2.3	3.1.2.3	Input frequency fluctuations as percentage of nominal frequency	%	50Hz±5			
2.4	3.1.2.5	Input voltage deviation from specified voltage maximum to minimum within 1 second.	Yes/No	Yes			
2.5	3.1.2.6	Input voltage fluctuation between specified minimum to maximum value within one to ten cycles	Yes/No	Yes			
2.6	3.1.2.7	Unbalance between phase	%	≤3 negative phase sequence and/or the magnitude of one			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
				phase not lower than 5% than any of the other two for 6 hours			
2.7	3.1.2.8	Input voltage total distortion		Table 1 IEC 61000-2-2			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
2.8	3.1.2.14	Additional input supply requirements	Yes/No Dual input supplies to be accommodated with electrical chop-over system inside charger/rectifier. 1 kW heater element circuit breakers on the input supply (number to be indicated).	Yes. Dual input supplies to be accommodated with electrical chop-over system inside charger/rectifier.			
3.0	3.2.	Operational requirements					
3.1	3.2.2	AC/DC to DC/AC modular converters					
3.1.1.	3.2.2.1	Load sharing requirement of parallel modules/units	%	≤10			
3.1.2	3.2.2.2	Individual converters for modular converter applications shall synchronize automatically	Yes/No	Yes			
3.1.3	3.2.2.3	Individual converters for modular application shall be hot plugable	Yes/No	Yes			
3.1.4	3.2.2.3	Number of parallel modules/units	Number	Xxxxx			
3.2	3.2.4	Input requirements	As per clause 3.1.2 or And performance characteristic of UPS VFI-SS-III or specified DC	AC inputs as per clause 3.1.2 and performance characteristic of UPS			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
			input voltage and tolerance	VFI-SS-III DC input ±20%			
3.3	3.2.5	Output requirements					
3.3.1	3.2.5	Standard output operating voltage tolerance Minimum output voltage Maximum output voltage	V_{nom} V_{min} V_{max}	V_{nom} 10% 10%			
3.4	3.2.6	Voltage ripple	%	0.1			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3..4.1	3.2.7	Current ripple	5A per 100Ah of battery capacity	5A per 100Ah of battery capacity			
3.5	3.2.8	Cooling requirements					
3.5.1	3.2.8.1	Natural	Yes/No				
3.5.2	3.2.8.2	Forced cooling as per a) to j)		Xxxx			
3.6	3.2.9	Abnormal output voltage					
3.6.1	3.2.9.1	Abnormal DC output voltage protection as specified	Yes/No				
3.7	3.2.10	Inrush current					
3.7.1	3.2.10.1	Inrush current determined as specified in IEC 62040-3		Xxxx			
3.8	3.2.11	No-load operation					
3.8.1	3.2.11.1	No-load operation maximum voltage	%	+10			
3.9	3.2.12	Step load capability					
3.9.1	3.2.12.1	Voltage regulation during 10 to 90% step variation	% after 1 second	2			
3.10	3.2.13	Overload capability					
3.10.1	3.3.13.1	Overload capability	Duty class	II			
3.11	3.2.14	Short-circuit and current limit capability					
3.11.1	3.3214.1	Short circuit capability as stipulated in IEC 62040-3	Yes/No	Yes			
3.12	3.2.15	Psophometric noise					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.12.1	3.2.15.1	Maximum Psophometric noise CCITT Class A	mV%	2			
3.13	3.2.16	Internal protection					
3.13.1	3.2.16.1	Internal protection	Yes	Yes			
3.14	3.2.17	Hardwire/hardware independent protection					
3.14.1	3.2.17.1	Hardwire/hardware independent protection: Overvoltage protection on rectifier output Overvoltage protection on load Over temperature monitoring Additional hardwire overvoltage protection on DC port	 Yes/No Yes/No Yes/No Yes/No	 No Yes Yes No			
3.15	3.2.18	Active load sharing					
3.15.1	3.2.18.1	Active load sharing	%	≤10			
3.16	3.2.19	Efficiency					
3.16.1	3.2.19.3	a) @ 25% load	%	>87.5			
3.16.2		b) @ 50% load	%	>90			
3.16.3		c) @75% load	%	>92.5			
3.16.4		d) @ 100% load	%	>95			
3.17	3.2.20	Electromagnetic environment and immunity requirements					
3.17.1	3.2.20.1	Conducted and radiated emissions					
3.17.1.1	3.2.20.1.1	Conducted and radiated emissions as specified in IEC 62040-2 for category C3	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.17.1.2	3.2.20.1.2	Low frequency emissions THDI as per IEC 6100-3-2	%	≤10			
3.18	3.2.20.2	Immunity					
3.18.1	3.2.20.2.1	Immunity as specified in IEC 62040-2 for category C3	Yes	Yes			
3.19	3.2.21	Audible noise	dB				
3.19.1	3.2.21.1	Audible noise	dB	<65			
3.20	3.2.22	Lightning protection					
3.20.1		Input	kV	6			
3.20.2		DC port	kV	4			
3.20.3		Output	kV	4			
3.21	3.3	Electrical Requirements					
3.21.1	3.3.1	General					
3.21.1.1	3.3.1.1	Combined fused switches	as per IEC 60947-3	as per IEC 60947-3			
3.21.1.2	3.3.1.2	Moulded case circuit breakers	as per IEC 60947-2	as per IEC 60947-2			
3.21.1.3	3.3.1.3	Transformers	as per IEC 60067	as per IEC 60067			
3.21.1.4	3.3.1.4	Contactors	as per IEC 60947-4	as per IEC 60947-4			
3.21.1.5	3.3.1.5	Transfer switches	as per IEC 60947-6	as per IEC 60947-6			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.21.1.6	3.3.1.7	Terminal blocks	as per IEC 60947-7 and Eskom standard 240-70413291	as per IEC 60947-7 and Eskom standard 240-70413291			
3.21.1.7	3.3.1.8.	Control circuit devices and switching elements	as per IEC 60947-5	as per IEC 60947-5			
3.22	3.3.2	Input isolation and overload protection	CFS/MCCB/MCB		xxxx		
3.22.1	3.3.2.1	Input isolation and overload protection provided	Yes/No	Yes			
3.22.2	3.3.2.2	Aux contacts provided	Yes/No	Yes			
3.23	3.3.3	Output isolation and overload protection	CFS/MCCB/MCB		xxxx		
3.23.1	3.3.3.1	Output isolation and overload protection provided	Yes/No	Yes			
3.23.2	3.3.3.3	Load profile grading required	Yes/No	Yes			
3.23.3	3.3.3.4	Aux contacts provided	Yes/No	Yes			
3.24	3.3.5	Input – output isolation	Yes				
3.24.1		Input – output isolation galvanically	Yes	Yes			
3.25	3.3.6	Earthing					
3.25.1	3.3.6.1	Exposed non-current carrying parts earthed onto earth bar	Yes	Yes			
3.25.2	3.3.6.2	External earthing point	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.25.3	3.4.6.3	Neutral (grounded circuit conductor) bonded to safety-earthing	Yes	Yes			
3.25.4	3.3.6.4	Earthing compliant with IEEE142:1991	Yes	Yes			
3.26	3.3.10	Measurements, controls, indications and alarms					
3.26.1	3.3.10.2	AC/DC to DC/AC converter measurement					
3.26.1.1	3.3.10.2.1	Meter types	Panel meters/ LCD	LCD			
3.26.1.2	3.3.10.2.2	Meter accuracy	%	1			
3.26.1.3	3.3.10.2.3	Input voltage measurement	Yes/No	Yes			
3.26.1.4	3.3.10.2.4	Output voltage measurement	Yes/No	Yes			
3.26.1.5	3.3.10.2.5	Output current measurement	Yes/No	Yes			
3.27	3.3.10.4	AC/DC to DC/AC converter controls					
3.27.1		Alarm reset	Yes/no	Yes			
3.27.2		On-off switch	Yes/no	Yes			
3.27.3		Lamp test if not LCD	Yes/no	Yes			
3.28	3.3.10.7	AC/DC to DC/AC converter indications					
3.28.1	3.3.10.7.1	Input healthy	Yes				
3.28.2		Output healthy	Yes				
3.29	3.3.10.10	Local Alarms	Remote Alarm				
3.29.1		Output failure	Output Failure	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.29.2		Mains failure	Input Failure	Yes			
3.29.3		Rectifier failure	Input Failure	Yes			
3.29.4		Rectifier voltage out of limits	Input Failure	Yes			
3.29.5		Ripple voltage out of limits	Input Failure	Yes			
3.29.6		Additional alarms	Specify				
3.30	3.3.11	Communication and control design requirements					
3.30.1	3.3.11.1	General					
3.30.2	3.3.11.1.1	Remote communication link	Yes/no	Yes			
3.30.3	3.3.11.1.2	Communication protocol		xxxx			
3.30.4	3.3.11.1.3	Supporting DNP 3.0 level 2 or 3 protocols and IEC 61850	Yes/no				
3.30.5	3.3.11.1.4	Micro-processor controlled	Yes/no	Yes			
3.30.6	3.3.11.1.5	Internal rectifier module micro-processor controlled as back-up	Yes/no	Yes			
3.30.7	3.3.11.1.6	Diagnostic and telemetry capability	Yes/no	Yes			
3.31	3.3.11.2	Real time clock and time synchronization					
3.31.1	3.3.11.2.1	Real time clock and time synchronization for 30 years	Yes/no	Yes			
3.31.2	3.3.11.2.2	Real time clock drift	Seconds/month	<60			
3.31.3	3.3.11.2.3	Resettable clock with resetting other parameters	Yes/no	Yes			
3.31.4	3.3.11.2.4	Maintain time of clock for 7 days during loss of supply	Yes/no	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.31.5	3.3.11.2.5	Synchronization of IEDs	Yes/no	Yes			
3.31.6	3.3.11.2.6	Synchronization indicated in event log	Yes/no	Yes			
3.32	3.3.11.3	Communication ports					
3.32.1	3.3.11.3.1	Communication ports	2 x Rs-232 1x Rs485 1 x Ethernet or Fibre optic	Yes Yes Yes			
3.33	3.3.11.4	Monitoring and control					
3.33.1	3.3.11.4.1	Interface to local PC	Yes/no	Yes			
3.33.2	3.3.11.4.2	Remote interface with charger/rectifier	Yes/no	Yes			
3.33.3	3.3.11.4.3	Pre-programmed current/voltage/time durations	Yes/no	Yes			
3.33.4	3.3.11.4.4	Optimal management during normal supply unavailability	Yes	Yes			
3.33.5	3.3.11.4.5	Software and firmware upgradeable	Yes	Yes			
3.33.6	3.3.11.4.6	Settings, indications and alarm display via front panel	Yes	Yes			
3.33.7	3.3.11.4.7	Password controlled	Yes	Yes			
3.33.8	3.3.11.4.8	Real time control	Yes	Yes			
3.33.9	3.3.11.4.9	Default values for stand-alone opera tion	Yes	Yes			
3.33.10	3.3.11.4.10	Individual rectifier module parameter monitoring and comparison.	Yes/no	Yes			
3.33.11	3.3.11.4.11	Interface with optional unit	Yes/no	Optional			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.33.12	3.3.11.4.12	Unique remote controller identification	Yes	Yes			
3.34	3.3.12	Software and firmware					
3.34.1	3.3.12.1	General					
3.34.1.1	3.3.12.1.1	Software to access equipment	Yes	Yes			
3.34.1.2	3.3.12.1.2	Software updates compatible with supplied systems	Yes	Yes			
3.34.1.3	3.3.12.1.3	Software license and documentation copyright	Yes	Yes			
3.34.1.4	3.3.12.1.4	Software support	Yes	Yes			
3.34.1.5	3.3.12.1.5	Software detail to be supplied	Yes	Yes			
3.34.1.6	3.3.12.1.6	Adhere to software control standard	Yes	Yes			
3.34.1.7	3.3.12.1.7	Settings and display features available from front panel display	Yes	Yes			
3.34.1.8	3.3.12.1.8	Alarm/event lock downloadable	Yes	Yes			
3.34.1.9	3.3.12.1.9	Software capable to upload and download alarm/ event log or settings	Yes	Yes			
3.34.1.10	3.3.12.1.10	Software display the status of any modules connected	Yes	Yes			
3.34.1.11	3.3.12.1.11	Software to display the status of remote communication connections	Yes	Yes			
3.34.1.12	3.3.12.1.12	Record battery discharge curve	Yes	Yes			
3.35.2	3.3.12.2	Software verification and validation	Yes	Yes			
3.35.3	3.3.12.3	System firmware					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.35.3.1		Equipment system firmware displayed on the equipment					
3.35.3.2		Firmware alterations to be controlled					
3.35.3.4		Data retention for the expected life of the equipment					
3.35.3.5		Firmware upgradeable					
4.0	3.4	Mechanical Requirements					
4.1	3.4.1	General					
4.1.1	3.4.1.1	Compliance to clause 5 of SANS 10142-1 and SANS 62040-1	Yes	Yes			
4.1.2	3.4.1.2	Designed, constructed and tested in accordance to clause 6.6 of SANS 10142-1	Yes	Yes			
4.1.3	3.4.1.3	RCC as per SANS 10142-1 table 4.2	Yes	Yes			
4.2	3.4.2	Doors and covers					
4.2.1	3.4.2.1	Individual hinged doors for each cable compartment and each fix patter functional unit sub-section.	Yes	Yes			
4.2.2	3.4.2.2	All removable covers shall require the use of a tool	Yes	Yes			
4.2.3	3.4.2.3	All opening doors shall be padlockable	Yes	Yes			
4.2.4	3.4.2.4	Hinging as specified up to 450mm- 2 hinges, up to 800mm - 3 hinges more than 800mm - 4 hinges	 Yes Yes Yes	 Yes Yes Yes			
4.2.5	3.4.2.5	Square key latches as specified					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
		up to 450 mm - 2 latches, up to 800 mm - 3 latches and more than 800 mm - 4 latches	Yes Yes Yes	Yes Yes Yes			
4.2.6	3.4.2.6	As a minimum the center square key latch shall be padlockable with hole > 8mm	Yes	Yes			
4.2.7	3.4.2.7	Cable compartment hinges to allow lifting off	Yes	Yes			
4.2.8	3.4.2.8	Durable hinge and latch fastening	Yes	Yes			
4.2.9	3.4.2.9	Doors stops required	Yes	Yes			
4.2.10	3.4.2.10	Door latches and hinges to withstand internal faults	Yes	Yes			
4.2.11	3.4.2.11	Doors >800mm to be fitted with webs	Yes	Yes			
4.3	3.4.3	Main, Distribution, Equalising and Collection Busbars					
4.3.1	3.4.3.1	Main and distribution busbars manufactured from electrolytic tough pitch high conductivity copper as per SANS 804	Yes	Yes			
4.3.2	3.4.3.2	Condition of temper for busbar copper designation H2 for half-hard cold working as per SANS 1195	Yes	Yes			
4.3.3	3.4.3.3	Main busbar design maximum permissible surface temperature rise at rated current, Distribution busbar	K K	65 55			
4.3.4	3.4.3.4	Neutral busbar sizing relative to main busbar rating on input and relative to the associated distribution busbars	% of main busbar % of distribution busbar	≥50 100			
4.3.5	3.4.3.5	Neutral busbar connected to protective earth via	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
		removable bolted link					
4.3.6	3.4.3.6	Joints and tees in busbar compliance Bolts high tensile	T-22 8.8 to ISO 898-1	T-22 8.8 (ISO 898-1)			
4.3.7	3.4.3.7	Joints: Minimum number of bolts Busbar overlap Washers	 # Multiple of thickness or relative to width Conical or spring	 ≥2 ≥6 or equal Conical			
4.3.8	3.4.3.8	All busbar supports with minimum rating of the respective fault current rating	Yes	Yes			
4.3.9	3.4.3.9	Span of distribution busbar shall not interfere with cable entry zone.	Yes	Yes			
4.3.10	3.4.3.10	Busbar identification marking: AC Busbars DC Busbars 220 and 110V DC DC Busbars 24DC	Yes/No Red, White & Blue and Black -Neutral Red - positive and Black - Negative Red – positive and Blue – negative and Black - zero bar	Yes Red, White & Blue and Black - Neutral Red - positive and Black - Negative Red – positive and Blue – negative and Black - zero bar			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.3.11	3.4.3.11	Collection busbars need to be constructed where SCPD's and mcb's need to be connected in cascaded circuits	Yes/no	Yes			
4.3.12	3.4.3.12	Sufficient supports for equalizing busbars to withstand fault current	Yes/no	Yes			
4.4	3.4.4	Protective earth conductor and screened earth busbar					
4.4.1	3.4.4.1	A separate protective earth connected	Yes/no	Yes			
4.4.2	3.4.4.2	Non-current carrying conductive parts connected to PE	Yes/no	Yes			
4.4.3	3.4.4.3	Earth conductor size connected to doors	mm^2	6			
4.4.4	3.4.4.4	PE rating	As per SANS 10142-1	As per SANS 10142-1			
4.4.5	3.4.4.5	Protective circuit parts rated for the highest fault condition	Yes/no	Yes			
4.4.6	3.4.4.6	Screened earth busbar		xxxx			
4.4.7	3.4.4.7	PE conductor colour	Green with yellow stripes	Green with yellow stripes			
4.5	3.4.5	Power and control cabling					
4.5.1	3.4.5.1	Power circuit wiring and connections rated according to the de-rated operating current of the associated protective gear	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.5.2	3.4.5.2	Control wiring connected to source of fault energy rating	1.5 times fuse rating and withstanding I^2t fuse rating	1.5 times fuse rating and withstanding I^2t fuse rating			
4.5.3	3.4.5.3	Individual function unit connection to the control busbar		xxxx			
4.5.4	3.4.5.4	Connections to equipment mounted on swing doors		xxxx			
4.5.5	3.4.5.5	Type of conductor cable	Stranded, single or solid	Stranded			
4.5.6	3.4.5.6	Multistrand cable conductor diameter	mm^2	1.5			
4.5.7	3.4.5.7	Multistrand cable conductor diameter for current and voltage transformers	mm^2	2.5			
4.5.8	3.4.5.8	Joints and splices in any circuit, more than one conductor in one lug.	Not allowed Not allowed	Not allowed Not allowed			
4.5.9	3.4.5.9	Terminals and labels shall be accessible after assembly		xxxx			
4.5.10	3.4.5.10	Terminals which are on the live side of fuses and isolating switches shall be completely shrouded	Yes	Yes			
4.5.11	3.4.5.11	Coils in-line with normally open contacts connected to positive	Yes/no	Yes			
4.5.12	3.4.5.12	Compression joints standard	BS EN 61238	BS EN 61238			
4.5.13	3.4.5.13	Grommets installed on all holes through which cables are passing	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.5.14	3.4.5.14	Conductors >100A and passing through metal	Conductor all three phases (both poles of DC conductors) or metal barrier split	xxxx			
4.5.15	3.4.5.15	AC and DC conductors allowed in same wireway	Yes/no	No			
4.5.16	3.4.5.16	Power circuit cable sizing standard for the specified volt-drop	SANS 1973-1	SANS 1973-1			
4.5.17	3.4.5.17	Stripping of insulation standard		xxxx			
4.5.18	3.4.5.18	Crimping standard		xxxx			
4.5.19	3.4.5.19	Correct torque standard		xxxx			
4.6	3.4.6	Conductor identification					
4.6.1	3.4.6.1	Conductor identification	Yes	Yes			
4.6.2	3.4.6.2	Control conductor identification AC circuits DC circuits	 Black Grey	 Black Grey			
4.6.3	3.4.6.3	Control bus wiring identification DC AC	 Red – positive Black – negative Brown and Blue	 Red positive Black negative Brown and Blue			
4.6.4	3.4.6.4	Conductor of CT and VT circuits identification	Phase colours	Phase colours			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.6.5	3.4.6.5	Control conductor wiring		xxxx			
4.7	3.4.7	Enclosure and Assembly					
4.7.1	3.4.7.1	EMC testing required with door open when MCB and MCCB are fitted behind the door	Yes/no	Yes			
4.7.2	3.4.7.2	Individual segregation for input, DC port, output, signal and control cabling	Yes/no	Yes			
4.7.3	3.4.7.3	Converter modules and controller sub rack assemblies	Swing/fix frame assembly	Swing/fix frame assembly options			
4.7.4	3.4.7.4	Handling and lifting facilities	Removable lifting facility. Forklift handling	Removable lifting facility. Forklift handling			
4.7.5	3.4.7.5	Dimensions		To be supplied for product range			
4.5.7.1		Height	mm	xxxx			
4.5.7.2		Width	mm	xxxx			
4.5,7.3		Depth	mm	xxxx			
4.5.7.4		Weight	kg	xxxx			
4.8	3.4.8	Sub-rack assemblies and input/output power distribution modules					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.8.1	3.4.8.1	Sub-rack inclusions Controller sub-assembly infront Terminal plate sub-assembly rear Segregated wire loom	 Yes/no Yes/no Yes/no	 Yes Yes Yes			
4.8.2	3.4.8.2	Input/output power modules – front distribution modules Terminal plate sub assembly rear Segregated wire loom	Yes/no Yes/no Yes/no	Yes Yes Yes			
4.8.3	3.4.8.3	Sub-rack expandable to maximum modules power rating	Yes/no	Yes			
4.8.4	3.4.8.4	Sub-rack pre wired for expansion	Yes/no	Yes			
4.8.5	3.4.8.5	Blanking plates installed on unused module positions	Yes/no	Yes			
4.8.6	3.4.8.6	Ingress protection	IP	IP2X			
4.8.7	3.4.8.7	Individual MCB module locking facility	Yes/no	Yes			
4.8.8	3.4.8.8	Terminal plate and top drawer plate thickness	mm	1.6			
4.8.9	3.4.8.9	Terminal plate width	mm	482.6			
4.8.10	3.4.8.10	Slotted mounting hole dimensions as per IEC 60297-1 Width Height Horizontal distance between hole centers	IEC 60297-1 mm mm mm	IEC 60197-1 10.3 6.80 465.1			
4.8.11	3.4.8.11	Overall aesthetically pleasing appearance	Yes	Yes			
4.8.12	3.4.8.12	Earthing stud fitted on terminal plate	Yes	Yes			
4.9	3.4.9	Ingress protection					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.9.1	3.4.9.1	IP rating Panel doors closed Panel doors open	 IP IP	 31 2X			
4.9.2	3.4.9.2	Additional IP rating requirements	IP	As options IP45 IP55 IP65			
4.10	3.4.10	Cable entry					
4.10.1	3.4.10.1	Cable entry	Top/bottom	Top and bottom			
4.11	3.4.11	Gland plate					
4.11.1	3.4.11.1	Gland plate height	mm	300mm above point of bottom entry and at point of top entry.	300mm above point of bottom entry and at point of top entry		
4.11.2	3.4.11.2	Fire retardant and sealing of floor slot	Yes	Yes required as part of installation			
4.11.3	3.4.11.3	Undrilled gland-plate, corrosion protected as per SANS 1652	Yes	Yes			
4.11.4	3.4.11.4	Adequate gland plate support	Yes	Yes			
4.11.5	3.4.11.5	Non-magnetic gland plates	Yes/no	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.11.6	3.4.11.6	95mm^2 cabling gland plate requirements	Yes/no	Yes as an option			
4.11.7	3.4.11.7	Bonding of gland plate to PE conductor	Yes	Yes			
4.12	3.4.12	Corrosion protection					
4.12.1	3.4.12.1	Corrosion protection standard	SCSSCAAP9	SCSSCAAP 9			
4.12.2	3.4.12.2	AC input supply assembly colour	G29	G29			
4.12.3	3.4.12.3	DC input supply assembly colour	A11	A11			
4.13	3.4.13	Terminations					
4.13.1	3.4.13.1	Termination standard	240-70413291	240-70413291			
4.13.2	3.4.13.2	Terminations for all input output and alarming	Yes/no	Yes			
4.13.3	3.4.13.3	Maximum number of cable cores per termination point	#	2			
4.13.4	3.4.13.4	Input terminal rating at input minimum voltage	Yes/no	Yes, alternatives can be specified as an option			
4.13.5	3.4.13.5	DC port terminal size	mm^2	95 Alternatives can be specified as an option			
4.14	3.4.14	Internal wiring					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.14.1	3.4.14.1	Wire ways and trunking shall be smooth and free of sharp edges	Yes	Yes			
4.14.2	3.4.14.2	Trunking temperature rating	ºC	90			
4.14.3	3.4.14.3	All wiring in trunking or wire looms clipped or laced	Yes	Yes			
4.15	3.4.15	Conformal coatings					
4.15.1	3.4.15.1/2/3	Conformal coatings required	Yes/no				
4.16	3.4.16	Accessibility					
4.16.1	3.4.16.1	Accessibility for cable termination	Yes	Yes			
4.16.2	3.4.16.2	Normal maintenance accessibility following installation	Yes	Yes			
4.16.3	3.4.16.3	Accessibility	Front/rear	Front and rear			
4.17	3.4.17	Minimum clearances					
4.17.1	3.4.17.1	Pole-to-pole and pole-to-earth clearance standard	SANS 10142-1	SANS 10142-1			
4.17.2	3.4.17.2	Terminals for input, DC port and output	Segregated/ barriers	Segregated /barriers			
4.17.3	3.4.17.3	Minimum creepage distance rating as per SANS 60439-1 clause 7.1.2	Pollution Degree 3, material group 111a with the specified insulation voltage	Pollution Degree 3, material group 111a with the specified insulation voltage			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.17.4	3.4.17.4	Clearance and creepage distances	SANS 60439-1 Table 14 and 16	SANS 60439-1 Table 14 and 16			
4.18	3.4.18	Nameplate/rating plate/declared electrical performance					
4.18.1	3.4.18	Nameplate material	Stainless steel/ anodized aluminium	Stainless steel/ anodized aluminium			
4.18.2	3.4.18	Nameplate information	Clause 3.4.18	Clause 3.4.18			
5.0	3.5	Settings and Commissioning					
5.1	3.5.1	Settings					
5.1.1	3.5.1.1	Settings standard	240-56176168	240-56176168			
5.1.2	3.5.1.2	Settings document for each piece of equipment required based on specific application	Yes	Yes To be compiled by OEM based on application.			
5.1.3	3.5.1.3	Microprocessor shall be programmed with these settings as default	Yes	Yes			
5.1.4	3.5.1.4	Revision indicated on document	Yes	Yes			
5.1.5	3.5.1.5	SCPD indicated on settings document	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
5.2	3.5.2	Commissioning					
5.2.1	3.5.2.1	Commissioning standard	240-56177186	240-56177186			
5.2.2	3.5.2.2	As commissioning routine, operational and functional tests shall be performed	Yes	Yes			
5.3	3.6	Upgrading/modifications					
5.3.1	3.6.1	Upgrade/modification report required	Yes	Yes			
5.3.2	3.6.2	Hardware upgrade identification	Yes	Yes			
5.4	3.7	Equipment performance					
5.4.1	3.7.1	Warranty					
5.4.1.1	3.7.1.1	Warranty period	36 months from date of commissioning	36 months from date of commissioning			
5.4.2	3.7.2	Reliability, security, dependability, maintainability and life expectancy					
5.4.2.1	3.7.2.1.1	Equipment hours of installed units per voltage or model/type	Yes	Yes			
5.4.2.2	3.7.2.1.2	Customers indicating the number of units employed per model/type	Yes	Yes			
5.4.2.3	3.7.2.1.3	Environmental conditions where such equipment is installed	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
5.4.2.4	3.7.2.2.1	Equipment proven record	>2 years and one hundred equipment years	>2 years and one hundred equipment years			
5.4.2.5	3.7.2.2.2	Life expectancy Electronic equipment Other hardware	 ≥10 years ≥20 years				
5.4.2.6	3.7.2.2.3	Written guarantee to meet life expectancy	Yes	Yes			
5.4.2.7	3.7.2.2.4	Supplier product health statement	Yes	Yes			
5.4.2.8	3.7.2.3	Internal battery specification		xxxx			
6.0	4.2	Type testing					
6.1	IEC 60146-1-1	Converter tests	Type Tests Required as per IEC 60146-1-1				
6.1.1	4.2.1	Insulation test	Yes	Yes			
6.1.2	4.2.2.	Light load functional test.	Yes	Yes			
6.1.3	4.2.2.	Functional test	Yes	Yes			
6.1.4	4.2.3	Rated current test	Yes	Yes			
6.1.5	4.2.4	Power loss determination for assemblies and equipment	Yes	Yes			
6.1.6	4.2.5	Temperature rise test	Yes	Yes			
6.1.7	4.2.6	Power factor measurement	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
6.1.8	4.2.7	Checking of auxiliary devices	Yes	Yes			
6.1.9	4.2.8	Measurement of inherent voltage regulation	Yes	Yes			
6.1.10	4.2.9	Checking the properties of the control equipment	Yes	Yes			
6.1.11	4.2.10	Checking the protective devices	Yes	Yes			
6.1.12	4.2.11	Immunity test	Yes	Yes			
6.1.13	4.2.12	Overcurrent capability test	Yes	Yes			
6.1.14	4.2.13	Radio frequency generated interference and conducted noise	Yes	Yes			
6.1.15	4.2.14	Audible noise	Yes	Yes			
6.1.16	4.2.15	Measurement of ripple voltage and current	Yes	Yes			
6.1.17	4.2.16	Additional tests	Yes	Yes			
6.2		Type Tests Required as per SANS 1652	Yes/No	Yes			
6.2.1	5.2	Dielectric strength test	Yes	Yes			
6.2.2	5.3	Insulation resistance test	Yes	Yes			
6.2.3	5.4	DC output voltage adjustment range test	Yes	Yes			
6.2.4	5.5	DC output voltage regulation tests	Yes	Yes			
6.2.5	5.6	Temperature rise test	Yes	Yes			
6.2.6	5.7	Power efficiency test	Yes	Yes			
6.2.7	5.8	Test for protection against lightning surges	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
6.2.8	5.9	Short-circuit test on output terminals	Yes	Yes			
6.2.9	5.10	Ripple voltage limits and ripple current test	Yes	Yes			
6.2.10	5.11	Audible noise level test	Yes	Yes			
6.2.11	5.12	Salt fog test	Yes	Yes			
6.2.12	5.13	Glow-wire test on non-metallic enclosures	Yes	Yes			
6.2.13	4.1.4	Lightning surge test	Yes	Yes			
6.2.14	4.2.4	Parallel operation test	Yes	Yes			
7.0	5.0	Marking, labeling and packaging					
7.1	5.1	Labelling					
7.1.1	5.1.1	Labeling	0.54/3695 sheet 1 & 2 or 240-62629353	0.54/3695 sheet 1 & 2 or 240-62629353			
7.1.2	5.1.2	Package labelling	Yes	Yes			
7.2	5.2	Packaging					
7.2.1	5.2.1	Packaging	High specification impact resistant corrugated cardboard with waterproof outer plastic covering	High specification impact resistant corrugated cardboard with waterproof outer plastic covering			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
7.2.2	5.2.2	Additional packaging requirements	Crating	Crating as an option			
8.0	6.0	Spares					
8.1	6.1	General					
8.1.1	6.1.1	Spares list	Yes	Yes			
8.1.2	6.1.2	Maintenance spares list	Yes	Yes			
8.1.3	6.1.3	Spares pricing	Yes	Yes			
8.1.4	6.1.4	Spares life expectancy within packaging	Years	10			
8.1.5	6.1.5	Spares available for warranty period	Yes	Yes			
8.1.6	6.1.5.1	Spares holding for 1 to 20 modular type/units	#/set of cards	1			
8.1.7	6.1.5.2	Spares holding for 21 to 40 modular types	#/set of cards	3			
8.1.8	6.1.6	Delivery	hr ex-works	24			
8.1.9	6.1.8	Spares availability	years	10			
9.0	7.0	Documentation					
9.1	7.1	General					
9.1.1	7.1.1	Sets of hard copies	#	3			
9.1.2	7.1.2	Drawings format Drawings size	.dgn A3	.dgn A3			
9.2	7.2	Drawings					
9.2.1	7.2.1	General arrangement drawings	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
9.2.2	7.2.2	Single line diagrams	Yes	Yes			
9.2.3	7.2.3	Schematic drawings	Yes	Yes			
9.2.3	7.2.4	Installation, operating and maintenance instruction manuals					
9.2.3.1	7.2.4.1	All instruction manuals shall be comprehensively detailed	Number of copies including .pdf software copy	3			
9.2.3.2	7.2.4.2	The manuals shall cover all equipment forming part of the assembly including: Content list List of reference drawings Detail of all components	 Yes Yes Yes Yes	 Yes Yes Yes Yes			
9.2.3.3	7.2.4.3	Manual in loose leaf binder to ISO standard in A4 size	Yes	Yes			

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
9.2.3.4	7.2.4.4	Manual content	General arrangement drawings, installation drawings and instructions, operating and maintenance instructions for all components, detailed parts list, spare parts ordering instructions etc	General arrangement drawings, installation drawings and instructions, operating and maintenance instructions for all components, detailed parts list, spare parts ordering instructions etc			
9.2.3.5	7.2.4.5	Additional content	Special instructions pertaining to spares storage, drawings for component locations, dismantling and re-assembly.	Special instructions pertaining to spares storage, drawings for component locations, dismantling and re-assembly.			
9.2.3.6	7.2.4.6	Special tool requirements		xxxx			
9.2.4	7.2.5	Engineering design system					

Item	Sub-Clause	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
9.2.4.1	7.2.5.1	EDS source document of design	Yes	Yes			
10.0	8.0	Language					
10.1	8.1	Language on display, drawings, documentation and software	US or UK English				

Annex D – Deviation Schedule

DEVIATION SCHEDULE

Any deviations from the Works Information and Specifications, or alternatives offered, are listed below with reasons and estimated cost for departure from the specification. If no deviations or alternatives are offered, this schedule shall be marked (N/A).

Specification or Schedule Number	Specification or Clause Number	Proposed Deviation or Alternative	Cost of Deviation or Alternative

Annex E – E UPS Configuration

The required UPS configuration will be stipulated in the technical Schedule A. The types of Uninterruptible Power Systems (UPS) configurations are described in Annex A of IEC 62040 -3 “Uninterruptible power systems (UPS) Part 3: Method of specifying the performance and test requirements”.

Types of Uninterruptible Power Systems (UPS) configurations

A.1 Single UPS

A.1.1 Single UPS without bypass

A.1.2 Single UPS with a common rectifier for inverter and battery

A.1.4 Single UPS with DC and AC outputs

A.1.5 Single UPS (A.1.2) with bypass

A.1.5.1 Double conversion

A.1.5.2 Line interactive operation

A.1.5.3 Passive stand-by operation

A.2 Parallel UPS

A.2.1 Parallel UPS without bypass

A.2.2 Parallel UPS with bypass

A.3 Redundant UPS

A.3.1 Stand-by redundant UPS

A.3.1.1 Stand-by redundant UPS without bypass

A.3.1.2 Stand-by redundant UPS with bypass

A.3.2 Parallel redundant UPS

A.3.2.1 Parallel redundant UPS without bypass

A.3.2.2 Parallel redundant UPS with bypass

Uninterruptible Power System (UPS) operation

B.1 UPS double conversion

B.2 UPS double conversion with bypass

B.3 UPS line interactive operation

B.4 UPS line interactive operation with bypass

B.5 UPS passive stand-by operation

Single UPS with bypass A1.5 and two single UPS systems in parallel A2.2 or synchronised on the same output bus are the most common applications within Eskom. Uninterruptible Power System (UPS) operation is according to B.4 UPS line interactive operation with bypass.

With a parallel redundant configuration, two identical UPS units, each equipped with an automatic and manual bypass are in parallel, sharing the load current. The output rating of each UPS unit is equal to the total load requirement and an additional 20%.

With the parallel redundant UPS configuration, the failure of a component, system, subsystem does not lead the failure of both UPS units.

The output of each UPS unit is connected to a common load busbar via separate automatic switches. Each UPS unit in the parallel redundant configuration operates in an exact manner as a single configuration.

During normal operation, the load is shared equally between the UPS units. Adequate monitoring and control is provided via the microprocessor to ensure this. The output of the UPS units are synchronised with each other during normal operation.

Upon failure of a UPS unit, the failed UPS unit is automatically disconnected from the load busbar while the healthy UPS unit remains in service and provides the additional load current. Each UPS unit is therefore capable handling a step load of at least 50% of full load rating, at any point of load, from no load to 50% load. During the shutdown and disconnection of a faulty UPS unit, no disturbance outside the specified output tolerances occurs on the output busbar. The changeover will occur without switching to static bypass by any of the two UPSs.

An UPS unit does not shutdown or be disconnected from the load busbar for a main ac supply failure or a shutdown of its rectifier.

After repairs or restoration of a disconnected faulty UPS unit, it is possible to manually initiate automatic synchronisation of this UPS unit with the other UPS unit in operation and subsequent reconnection of the UPS unit to the load busbar. Automatic reconnection of an UPS unit does not occur if the outputs are not synchronised. The process of synchronisation and reconnection occurs without disconnecting the load and without any disturbance, outside the specified tolerances, occurring on the output busbar.

Transfer of the load to automatic bypass supply occurs under the following abnormal conditions, assuming the quality of the ac supply is within the tolerances specified for the load:

- Output failure of both units.
- Where loads require high in-rush currents or starting currents on switching, the automatic bypass supplies the load for the duration of these peak currents. Supply will revert to UPS power when the load current is within the rating of the UPS. Loads that require automatic bypass are detailed in Schedule A so that the automatic bypass is sized accordingly.

Annex F – Converter/Charger Configurations

The input AC supply and DC output supply shall be segregated. Two rectifiers to provide redundancy shall be hosted in separate panel compartments and the cable ways for the two segregated. If a voltgage regulator is shared between two rectifiers the voltage regulator shall be hosted in a separate panel compartment. The output supply and distribution shall be hosted in a segregated compartment.

1) Converter/Charger Configurations

2) Single systems

Many Distribution substations and telecommunications sites utilise non redundant (i.e. single) DC systems. The need for load voltage regulation equipment depends on the input voltage window of the load equipment. The single line diagram for a single battery charger system with DC distribution board is shown in Figure 3.

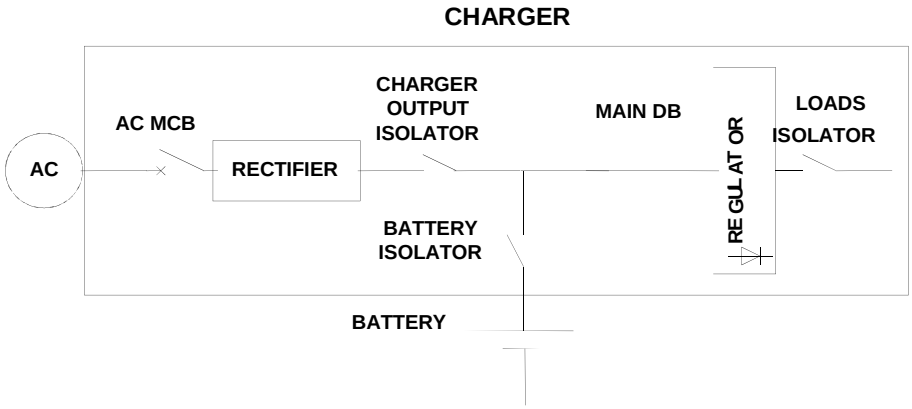


Figure F.1: 24V Single Battery Charger and DC Distribution Board Single Line Diagram

The single battery charger configuration could be in a single panel or dual panels. The different single battery charger system lay out drawings are shown in Figure 3 to Figure 11. Table 16 indicates the different single battery charger systems and indicates which Eskom Divisions normally utilizes them.

Table F.1: Caption Different single battery charger systems

Drawing	Description	Tx	Dx	ET	Gx
Figure 3	24V Single Charger Single Line Diagram (Separate Distribution Board)				✓
Figure 4	50/110/220V Single Battery Charger and DC Distribution Board Single Line Diagram				
Figure 5	50V Single Battery Charger and DC Distribution Board Layout	✓		✓	
Figure 6	110/220V Single Battery Charger and DC Distribution Board Layout	✓			✓
Figure 7	50V Single Battery Charger and DC Distribution Board Layout – VRLA Batteries			✓	
Figure 8	50V Single Battery Charger and DC Distribution Board Layout – Vented Batteries			✓	
Figure 9	50V Integrated Single Battery Charger and Distribution Modules Layout		✓		
Figure 10	110V Integrated Single Battery Charger and Distribution Modules Layout		✓		
Figure 11	50/110V Top Drawer Battery Charger with Distribution Layout		✓		
Legend: ✓ Indicates which division are most likely to make use of the battery chargers					

Many Distribution substations and telecommunications sites utilise non redundant (i.e. single) DC systems. The need for load voltage regulation equipment depends on the input voltage window of the load equipment. The single line diagram for a single battery charger system with DC distribution board is shown in Figure 4.

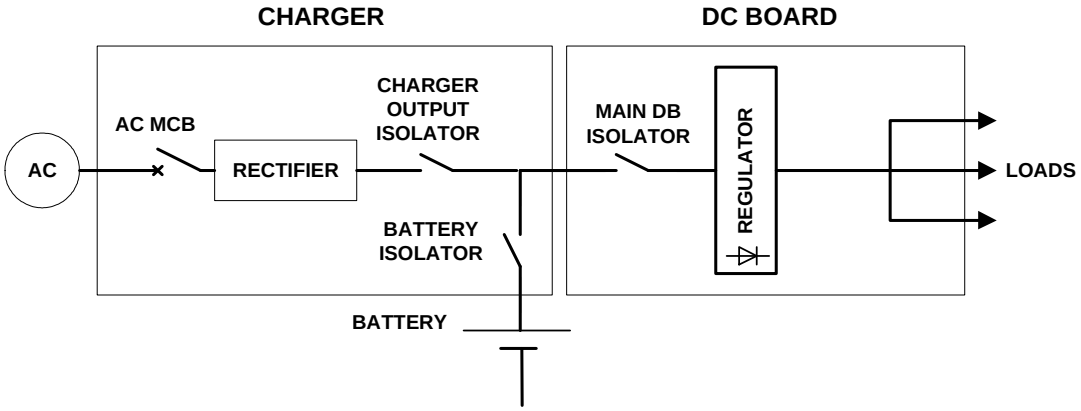


Figure F.2: 50/110/220V Single Battery Charger and DC Distribution Board Single Line Diagram

NOTE:

1) Fixed frame 600x600x2400 mm 19” cabinet

2) Front and rear access

3) Top and / or bottom cable entry

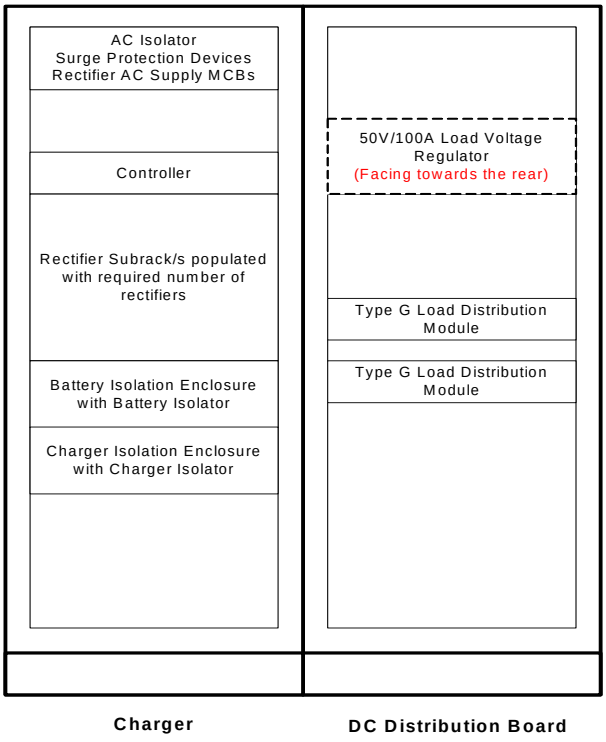


Figure F.3: 50V Single Battery Charger and DC Distribution Board Layout

NOTE:

1) Fixed frame 600x600x2400 mm 19” cabinet

2) Front and rear access

3) Top and / or bottom cable entry

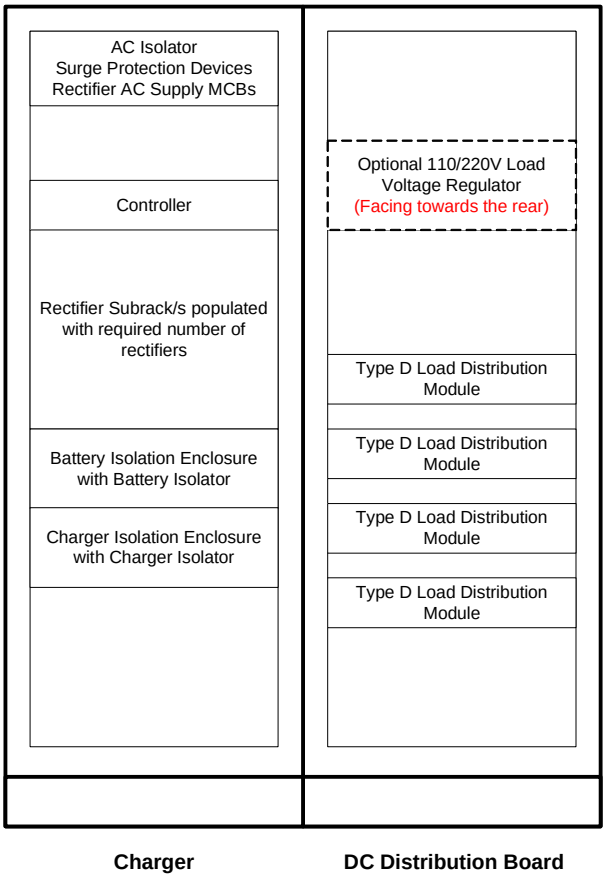


Figure F.4: 110/220V Single Battery Charger and DC Distribution Board Layout

NOTE:

1) Used with VRLA batteries
2) Top entry only
3) Front, rear and side access
4) 600x600x1500 fixed frame cabinet
5) Optional door for battery compartment

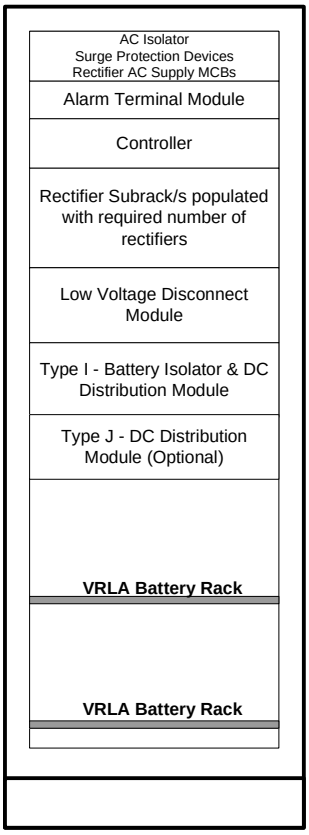


Figure F.5: 50V Single Battery Charger and DC Distribution Board Layout – VRLA Batteries

NOTE:

1) Used with VRLA batteries

2) Top entry only

3) Front, rear and side access

4) 600x600x1500 fixed frame cabinet

5) Optional door for battery compartment

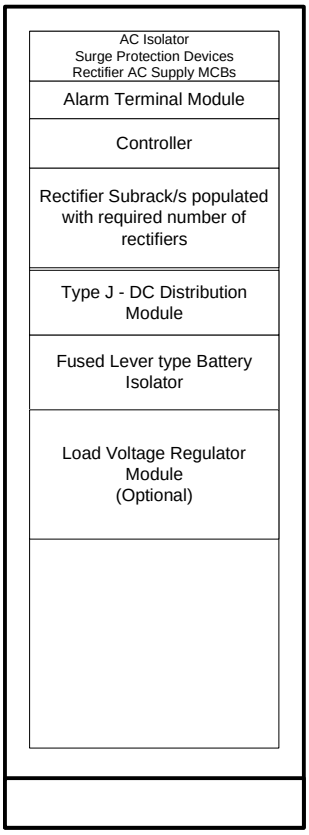


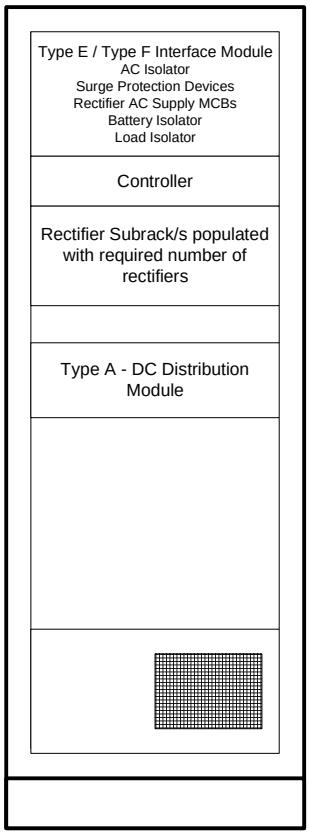
Figure F.6: 50V Single Battery Charger and DC Distribution Board Layout – Vented Batteries

NOTE:

1) Top or bottom entry

2) Front access only

3) 800(W)x600(D)x2400(H) swing frame cabinet



50V Integrated Charger

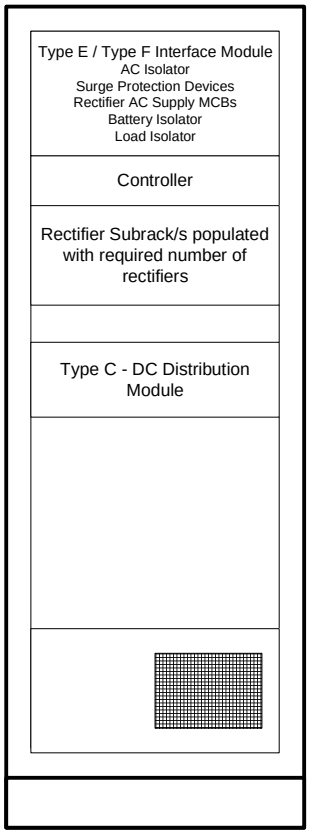
Figure F.7: 50V Integrated Single Battery Charger and Distribution Modules Layout

NOTE:

1) Top or bottom entry

2) Front access only

3) 800(W)x600(D)x2400(H) swing frame cabinet



110V Integrated Charger

Figure F.8: 110V Integrated Single Battery Charger and Distribution Modules Layout

NOTE:

1) Top drawer battery charger to fit into top compartment of the battery cabinet.

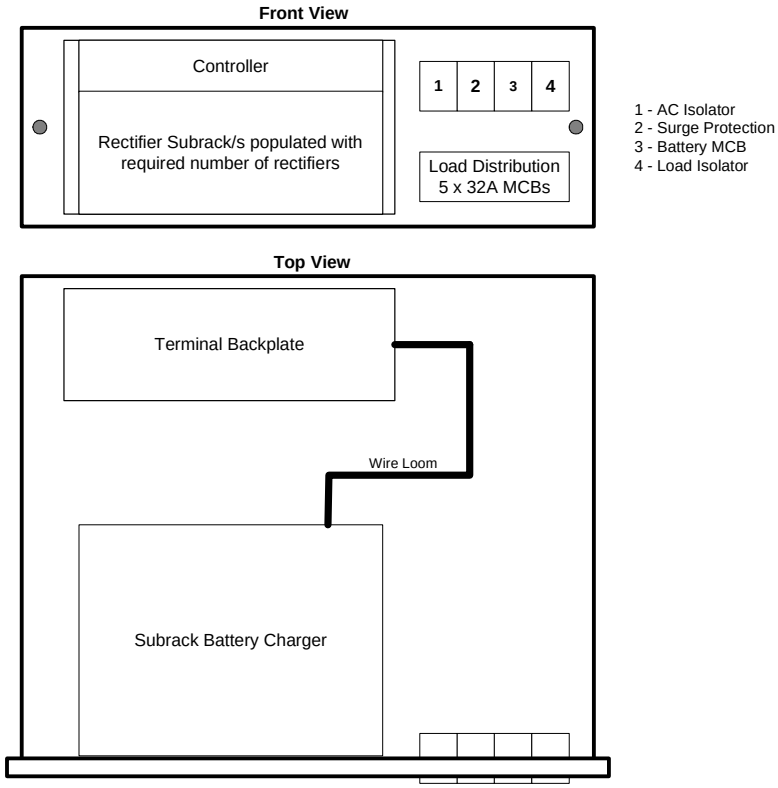


Figure F.9: 50/110V Top Drawer Battery Charger with Distribution Layout

3) Dual systems

The requirement for a dual system is that the two systems shall be electrically segregated. A combination of dual redundant and single supplies can be specified.

The latest technology 50V equipment being installed is designed with power supplies that have a greater voltage tolerance which removes the requirement for load voltage regulation equipment in chargers used in some of the divisions. Battery chargers supplied to Transmission division will continue to have voltage regulation equipment as some of the loads cannot take input voltage higher than 55V.

With dual systems, the equalize mode is entered into manually, and the load is transferred from the battery being equalized, to the second battery which is kept in float mode. If the trend towards the newer technology cells, e.g. VRLA batteries, increases then the requirement for load voltage regulation will become less used because of the lower charging voltages. However, a disconnect system will be required which will totally disconnects all loads from the battery to prevent deep discharge and subsequent irreversible damage to the VRLA battery.

The single line diagram for a dual battery charger system with dual DC distribution boards is shown in Figure 12,15 and 16. The different dual battery charger system with dual distribution boards lay out drawings are shown in Figure 13, 14 and 17. Figure 16 and 17 shows respectively the single line diagram and lay out drawing for a dual battery charger with single distribution board. Table 17 indicates the different dual battery charger systems and indicates which Eskom Divisions normally utilizes the respective configuration.

Table F.2: – Different Dual battery charger systems

Drawing	Description	Tx	Dx	ET	Gx
Figure 12	50V Dual Battery Charger and Dual DC Distribution Single Line Diagram	✓		✓	
Figure 13	50V Dual Battery Charger and Dual DC Distribution Boards Layout	✓			
Figure 14	110/220V Dual Battery Charger and Dual DC Distribution Boards Layout				
Figure 15	24V Dual Battery Charger – Combination of 2 Single Chargers) and Individual Load Combining diodes Single Line Diagram				✓
Figure 16	50V Dual Battery Charger and Single DC Distribution Board Single Line Diagram			✓	
Figure 17	50V Dual Battery Charger and Single DC Distribution Board Layout			✓	
Legend: ✓Indicates which division are most likely to make use of the battery chargers					

NOTE:

1) Fused, lever type battery isolator

2) 50V systems are (+) earthed

3) Load voltage regulator only applicable to 50V systems

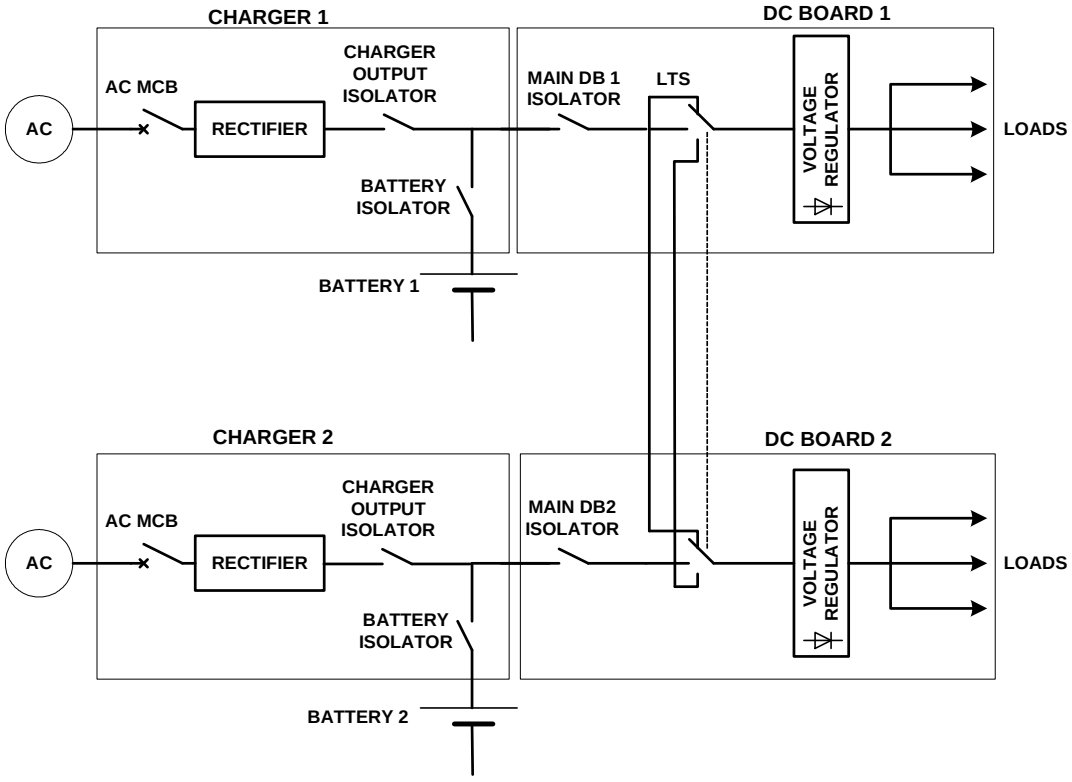


Figure F.10: 50/110/220V Dual Battery Charger and Dual DC Distribution Boards Single Line Diagram

NOTE:

1) Fixed frame 600x600x2400 mm 19” cabinet

2) Front and rear access

3) Top and / or bottom cable entry

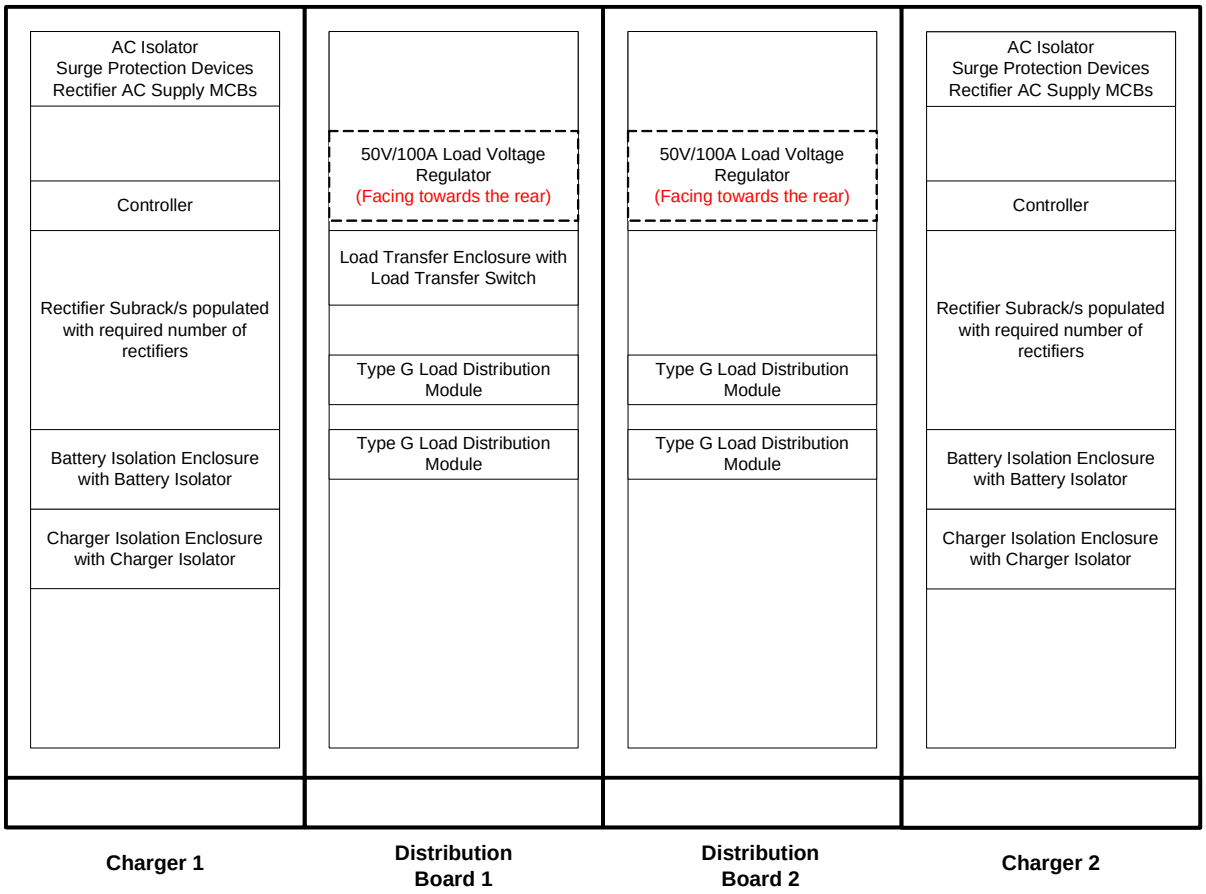


Figure F.11: 50V Dual Battery Charger and Dual DC Distribution Boards Layout

NOTE:

1) Fixed frame 600x600x2400 mm 19” cabinet

2) Front and rear access

3) Top and / or bottom cable entry

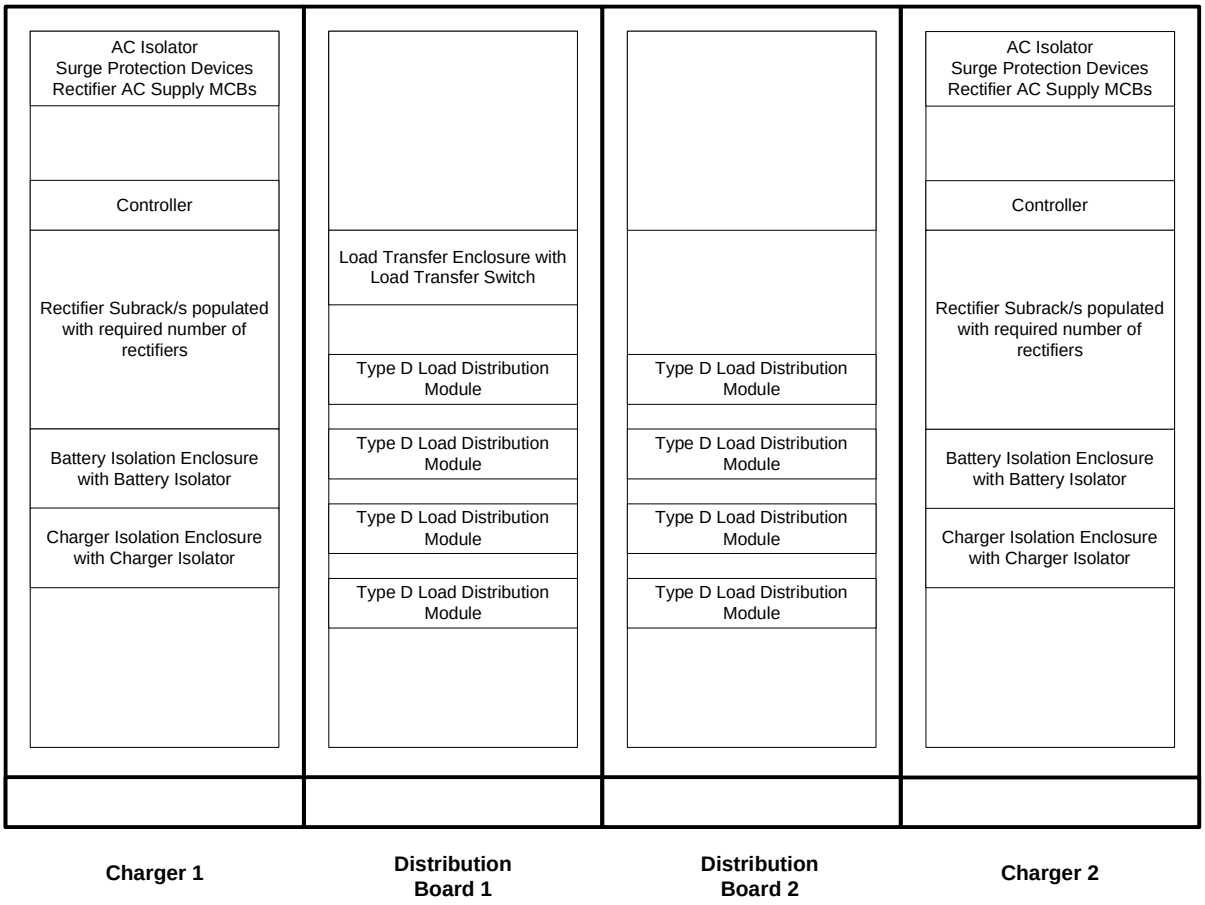


Figure F.12: 110V/220V Dual Battery Charger and Dual DC Distribution Boards Layout

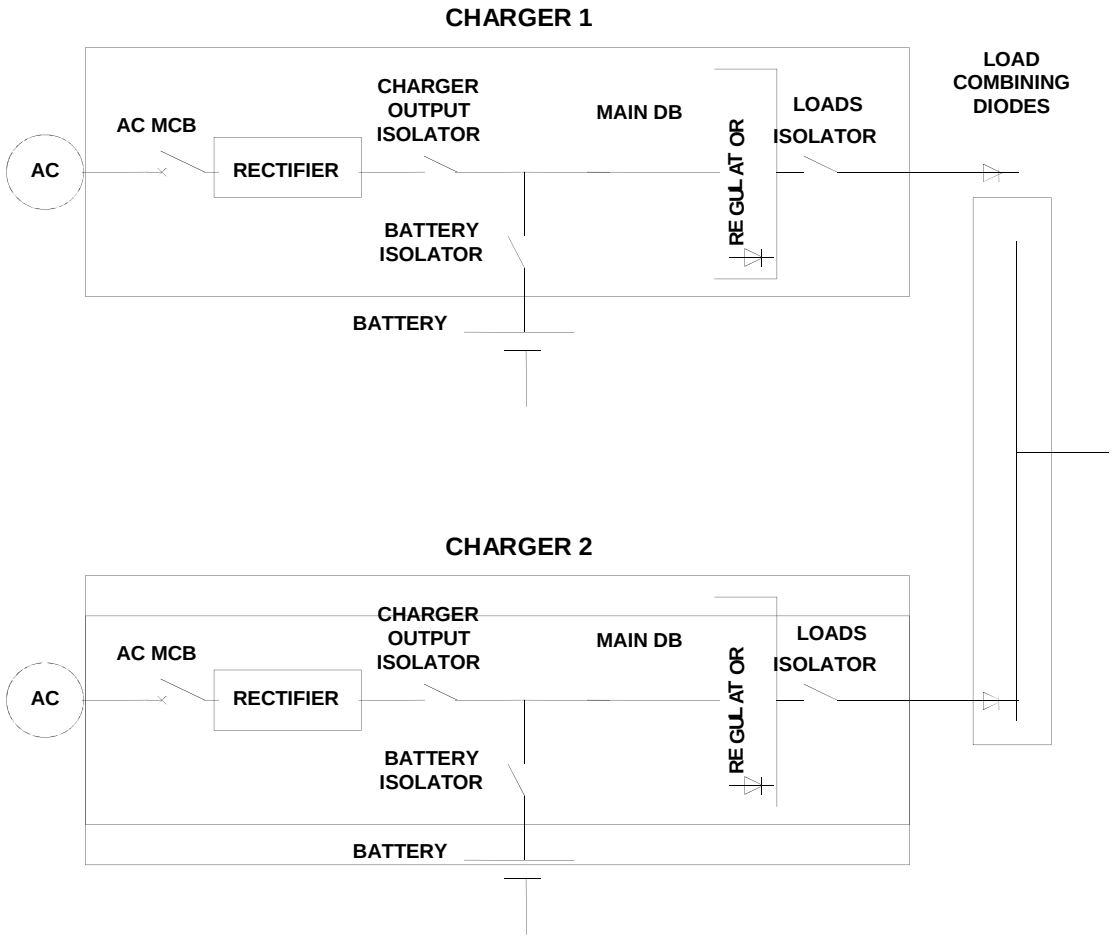


Figure F.13: 24V Dual Battery Charger – (Combination of 2 Single Chargers) and Individual Load Combining Diodes

NOTE:

1) Fused, lever type battery isolator

2) 50V systems are (+) earthed

3) Optional load voltage regulator

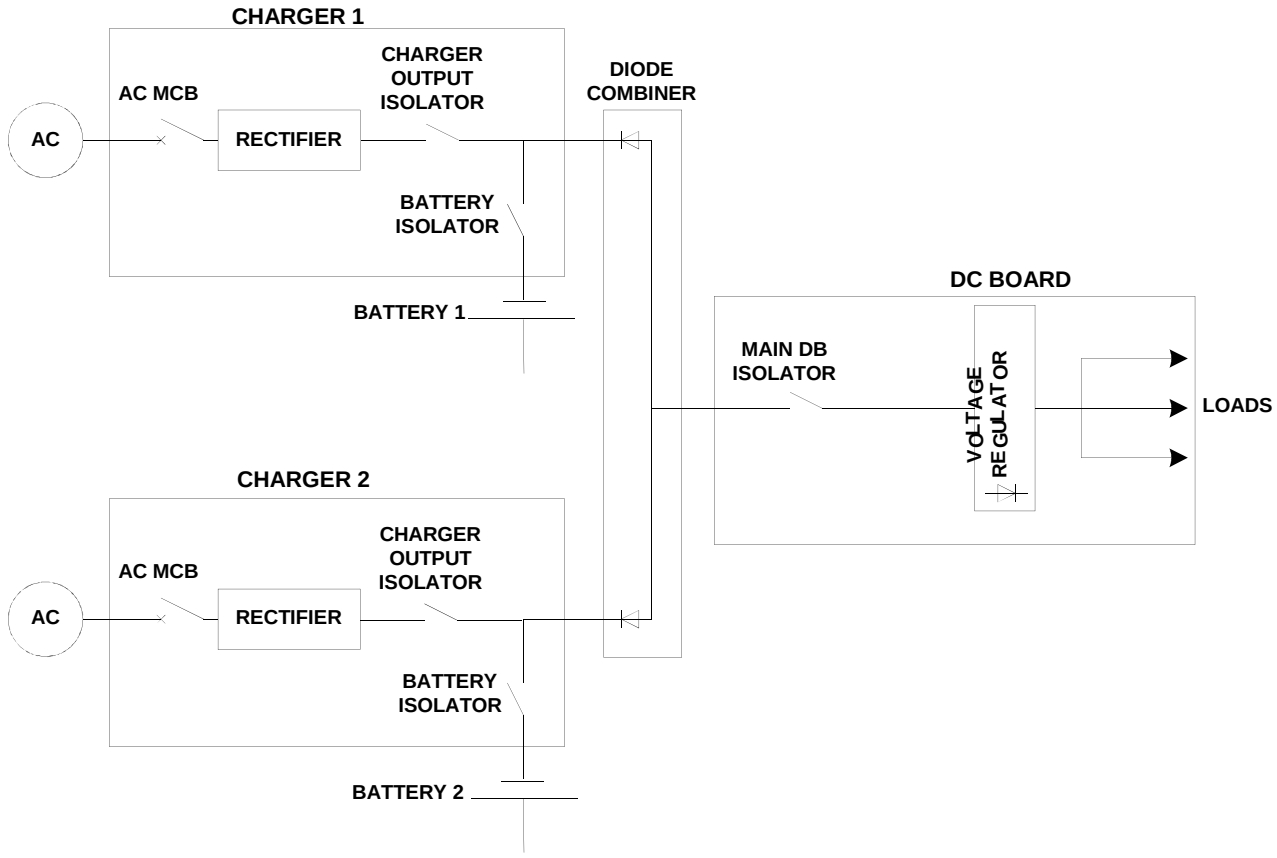


Figure F.14: 50V Dual Battery Charger and Single DC Distribution Board Single Line Diagram

NOTE:

1) Fused, lever type battery isolator

2) 50V systems are (+) earthed

3) Load voltage regulator only applicable to 50V systems

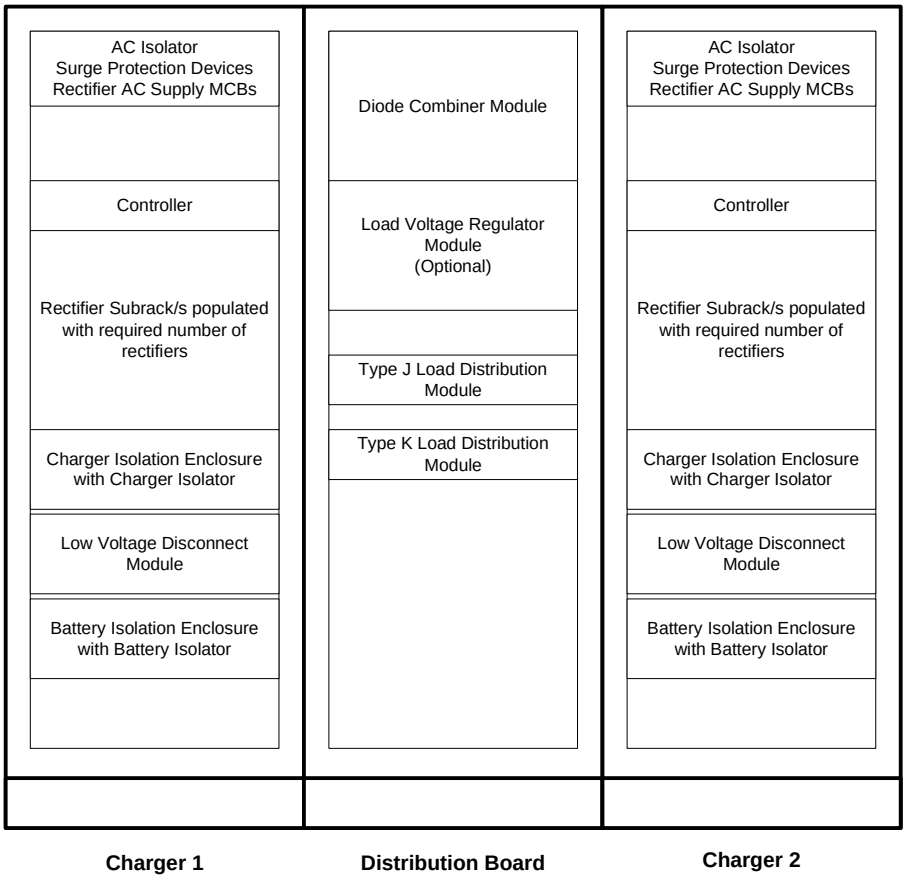


Figure F.15: 50V Dual Battery Charger and Single DC Distribution Board Layout