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CHARGE CONTROLLERS FOR PHOTOVOLTAIC SYSTEMS USING LEAD-ACID BATTERIES - Specification

ZAMBIA BUREAU OF STANDARDS

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This Zambian Standard was prepared by the Photovoltaic Systems Technical Committee (TC 5/6) upon which the following organisations were represented:

Chloride Zambia Ltd
Department Of Energy
Energy Regulation Board
Muhanya Solar Ltd
Rural Electrification Authority
Saro Agro Industries Ltd
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FOREWORD

This National Standard has been prepared by the Photovoltaic Systems Technical Committee (TC 5/6), in accordance with the procedures of ZABS. All users should ensure that they have the latest edition of this publication as standards are revised from time to time.

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The preparation of this Standard has been undertaken by the Photovoltaic Systems Technical Committee (TC 5/6). The revision of this standard was necessary to ensure that technological advancements are taken into consideration.

In the preparation of this standard, the following publications were consulted

- SAZS 524, Zimbabwe standard specification for charge controllers for photovoltaic systems using lead-acid batteries.
- NRS 052, South Africa Standard specification for photovoltaic systems for use in individual homes.
- "Universal technical standard for solar home systems" Thermie B SUP 995-96, EC-DGXVII,

ACKNOWLEDGEMENT

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ZAMBIA BUREAU OF STANDARDS

Zambian Standard

CHARGE CONTROLLERS FOR PHOTOVOLTAIC SYSTEMS USING LEAD-ACID BATTERIES - Specification

1 SCOPE

This Zambian Standard specifies the minimum requirements for Charge Controllers which shall be fitted on lead-acid battery- based Photovoltaic Systems.
This standard does not cover MPPT performance, but it is applicable to Battery Charge Controller (BCC) units that have this feature.

2 NORMATIVE REFERENCES

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

ZS IEC TS 61836 Solar photovoltaic energy systems – Terms and Symbols

ZS IEC 62509 Battery Charge Controllers for photovoltaic systems – Performance and functioning

3 DEFINITIONS

For the purpose of this standard, the terms and definitions given in ZS IEC 61836 and ZS IEC 62509 shall apply as well as the following:

3.1 Ampere
The unit of measure of the rate of flow of electrons in an electrical conductor.

3.2 Battery
A bank of cells connected together so as to produce and store useful electrical energy as defined in ZS 403

3.3 Battery Charge Controller
An electronic device/s that controls the charging and discharging of a device that can accept information from the battery, solar photovoltaic module and load and by predetermined instructions automatically carry out the correct sequence of regulation.

3.4 Circuit breaker
A device for making or breaking a circuit under normal or overload (over current) conditions either manually or automatically and electronically.

3.5 Current.
Refer to Clause 3.1.

3.6 Equalizing charge
A controlled overcharge of an already full battery to restore all the individual cells within the battery to the same state of charge.

3.7 Float Charge
A constant voltage charging state in which the battery is maintained at a voltage below the gassing point to complete the charging cycle and compensate for battery self-discharge.

3.8 Float Voltage
The minimum constant voltage necessary to offset the internal losses of the battery.

3.9 Fuse
A device for protecting an electric circuit which disconnects the circuit under faulty conditions with a current overload.
Note: the fuse may melt or not melt.

3.10 High/Over voltage array disconnect
The voltage set point of the Controller at which the array is disconnected from the battery.

3.11 Load
A power consuming device (e.g. light device or radio).

3.12 Polarity
A property with respect to the direction of flow of electrons in a conductor. It is characterized by the existence of opposite charges, positive and negative.

3.13 Photovoltaic Array
A mechanically integrated assembly of solar Photovoltaic (PV) Modules held together with support structure but exclusive of foundation, tracking, thermal control and other components, as required, to form an electric power producing unit.

3.14 Pulse-width modulation (PWM)
Pulse-Width Modulating (PWM) charge controllers use complex algorithms to determine the amount of charge going to a battery and slowly taper off charging as the battery becomes full.

3.15 Maximum Power Point Tracking (MPPT)
A Maximum Power Point Tracker (MPPT), or is an electronic DC to DC converter that optimizes the match between the solar array (PV panels), and the battery bank or utility grid. It converts a higher voltage DC output from solar panels down to the lower voltage needed to charge batteries.

3.16 Switch
A device for opening or closing an electrical circuit.

3.17 Volt

The potential difference which, when applied to a resistance of one ohm produces a current of one ampere.

4 FUNCTIONS OF CHARGE CONTROLLERS

4.1 General

Charge Controllers shall include the following functions:

4.1.1 Safely Control the flow of current from the photovoltaic Photovoltaic Module to the battery;

4.1.2 Safely Control the flow of current from the battery to the load; and

4.1.3 Indicate the state of charge of the battery.

4.1.4 controller must have a minimum of three stages of charging (Bulk, absorption and float charging)

4.1.5 adjustable charging set points

4.1.6 temperature compensated charging set points

4.1.7 voltage drop compensation for set point measurement

4.1.8 set point security

Where the charge Controller produces a float charge function, the float voltage shall be as specified by the manufacturer of the battery used in the system. In the absence of these specifications, the following float charge voltages shall apply:

a. Lead-antimony-calcium batteries, a float voltage of 2.35 V per cell $\pm$ 1 % at 25ºC.

b. Lead-antimony batteries, a float voltage of 2.30 V per cell $\pm$ 1 % at 25ºC.

4.2 Overcharge protection

Where the charge Controller is of the switching type, the High Voltage Array Disconnect point (HVD) shall be set in accordance with the specifications laid down by the manufacturer of the battery used in the system. In the absence of this information, the HVD points shall be:

4.2.1 Lead-antimony-calcium batteries, 2.35 V per cell at 25ºC. Lead-antimony batteries, 2.35 V per cell at 25ºC.

4.2.2 As specified by the client where appropriate otherwise by the installer, if other types of batteries are used.

4.2.3 The charge voltage disconnect point shall be maintained within one percent over an ambient temperature range of 10 to 40ºC.

4.2.4 The charge reconnect voltage shall be set so as to avoid rapid switching between charge and disconnect modes. A voltage of 2.1 V $\pm$ 1 % per cell is recommended for lead-acid batteries.

4.3 Over-discharge protection

The Charge Controller shall be used to protect the battery against over-discharge. The disconnect point shall be set in accordance with the specifications set down by the manufacturer of the battery used in the system. In the absence of this information, the load disconnect point shall be set at 90% of its rated voltage.

The load should be reconnected at a battery voltage of 2.0V per cell or as recommended by the battery manufacturers.

4.4 Boost Charge

Boost charging involves a high current for short period of time to charge the battery. It is generally done when the battery has been discharged heavily. Boost charge enables the quick charging of depleted batteries.

Note: this may not be applicable to all batteries such as non-aqueous systems e.g lithium-ion

4.5 Equalising

The charge Controller shall be capable of providing equalising charge.

Note: Only applies to vented batteries

4.6 Battery state of charge indication

The following visual indicators/alarms shall be provided on the front of the Controller and where the Controller is mounted inside the battery enclosure these shall be visible to the user without necessarily having to open the box:

4.6.1 battery fully charged;

4.6.2 battery one quarter to half charged as a low voltage warning before load disconnect point; and c) load disconnect point.

Note 1: In systems where the photovoltaic output or load current is greater than 20 A, separate accurate battery voltage sensor terminals may be provided which sense the battery terminal voltage independently of the battery/load power circuit.

Note 2: In a DC system the controller should have a load disconnect point and the controller should be able to show the battery charge levels.

Note 3: A system that uses only AC loads does not require a load disconnect function

4.7 Electrical protection features

The following protection features shall be provided:

4.7.1 protection against polarity reversal at the battery terminals;

4.7.2 protection against polarity reversal at the PV array terminals;

4.7.3 over-current protection; and

4.7.4 protection against short-circuits in the load circuits whilst a battery is connected to the Controller.

Note 1: Suitable discrimination between the protection provided for the load circuits and the battery fuse may be provided.

Note 2: Fuses and/or circuit breakers shall have ratings of not more than 1.25 times the maximum rated load current.

4.8 Full array voltage tolerance

With the Controller battery terminals disconnected including battery sense terminals if provided, the Controller shall not be damaged when twice the nominal system voltage is applied to the Controller solar array terminals for a period of five minutes.

4.9 Efficiency

The voltage drop across the Controller between the input of the Controller from the PV array and the output of the Controller to the battery, including blocking diode, if applicable, shall not exceed 2% of the nominal voltage under any load condition.

The voltage drop across the Controller between the input of the Controller from the battery and the output of the Controller to the load shall not exceed 2% of the nominal voltage under any load condition.

4.10 Electromagnetic interference

The Controller shall not cause conducted or radiated electromagnetic interference (e.m.i.) with typical loads in a home at a distance of greater than 1m from the Controller. Typically for a spectrum of 1.1KHz to 10MHz, the field strength shall be less than 100μV/m at 1m from the Controller.

4.11 Electrical Parameters

The following state the recommended criteria of operation for charge controllers from the manufacturer:

4.11.1 Battery voltage – the recommended design operating voltages for the charge controller should be clearly specified and in the event where voltages need to be changed manually made mention of maximum array current- the maximum recommended design operating current for the charge controller should be clearly specified.

4.11.2 Maximum load current- the maximum recommended design operating load current for the charge controller should be clearly specified.

Note: the manufacturer shall state the above in the operations/user manual and on the exterior of the charge controller.

4.12 User interface requirements

4.12.1 Operational information

4.12.1.1 General

The level of information provided to the user is determined by the intended application and its specific requirements. The user interface of the charge controller should provide information such as detailed in Clause 4.12.1.2

4.12.1.2 Recommended operational information

a. An indication of charging status (i.e. charging or not charging)
b. An indication of load-disconnect state (over discharge protection status)
c. An indication of the state-of-charge of the connected battery.

Other additional operational information displayed by the unit may include but is not limited to:

a. Charging set-points.
b. Battery voltage.
c. Charging current.
d. Energy input/output

4.12.2 Alarms

The following conditions should be signaled by the user interface:

a. Low battery state of charge / Low battery voltage/ Low availability.

b. Load disconnect.

c. BCC trip (e.g. by over temperature)

Visible and/or audible alarms, clearly identifiable by the system user, shall be triggered within the unit in case of any of the above conditions occurring. Audible alarms shall be time limited and revert to a visible alarm or be pulsed.

Compliance shall be determined by tests in Clauses 5.2.2 and 5.2.3 of ZS IEC 62509.

5 TESTING

All testing shall be done in accordance with Clause 5 of ZS IEC 62509.

6 HOUSING

The charge Controller housing shall provide protection to at least IP32, according to IEC 60529.

7 TERMINAL CONNECTIONS

All electrical terminal connections shall be fully shrouded so as to protect against accidental short circuit.

8 MARKING

Each charge Controller shall be clearly and permanently marked in English or any other language alongside English with the following information:

a. Name of manufacturer or supplier;

b. Model name or number;

c. Serial number;

d. Maximum continuous photovoltaic array current;

e. Maximum continuous load current;

f. Maximum input array voltage

g. Function and state of switches and indicator lights;

h. Polarity and function of each terminal; and

i. Nominal system voltage.

j. The Zambia Bureau of Standards certification mark, when used.

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Note: All the above shall also be stated in the operations/user manual with the necessary illustrations should they apply.

ANNEX A
(Normative)
Information to Be Provided By the Manufacturer or Supplier

The following information shall be provided on an information sheet supplied with each charge Controller:

a. The country and year of manufacture;

b. The maximum photovoltaic array current;

c. The maximum load current;

d. High voltage disconnect for solar Photo Voltaic Module;

e. Solar array reconnect voltage;

f. Low voltage disconnect for load;

g. The load reconnect voltage;

h. Reverse polarity protection;

i. Fuse type e.g. size;

j. Current consumption under quiescent (night-time) conditions;

k. Installation diagram and instructions; and

l. General Safety Information

m. Warranty period