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IEEE Guide for Selecting, Charging, Testing, and Evaluating Lead-Acid Batteries Used in Stand-Alone Photovoltaic (PV) Systems

IEEE Standards Coordinating Committee 21

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IEEE Standards Coordinating Committee 21 (SCC21) on
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Abstract: This guide is applicable to all stand-alone photovoltaic (PV) systems where PV is the only charging source. Stand-alone PV system parameters and operating conditions are discussed in relation to battery characteristics and expected system performance. Charging parameters for PV systems are suggested to help in the selection of a battery for a specific application. Finally, a performance test to verify the battery selection and system parameters is provided, including discussions on how to interpret test results. Test results only provide information on initial battery performance. No cycle-life predictions are made.

Keywords: IEEE 1361™, lead-acid battery test procedure, lead-acid battery tutorial, photovoltaic (PV) battery characteristics, PV battery selection, PV battery test procedure, PV systems

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Introduction

This introduction is not part of IEEE Std 1361™-2014, IEEE Guide for Selecting, Charging, Testing, and Evaluating Lead-Acid Batteries Used in Stand-Alone Photovoltaic (PV) Systems.

The PV system designer depends on the capacity of a storage battery for reliable extended operation of the system load during hours of darkness and below average solar resource. Photovoltaic systems can subject batteries to harsh operational environments with minimal control of recharge profiles. The economics of photovoltaic modules limit the ability to charge the battery at more traditional motive power deep-cycle charge rates and times. Typical charge rates for small stand-alone PV systems are less than 6.5 amperes (A) and may be less than 2.0 A per 100 Ah of battery capacity. Relatively low rates, coupled with the unpredictability of the solar resource, result in limited recharge capabilities.

Stand-alone PV systems are typically utilized in remote locations with minimal power resources, which limits the amount of initial battery boost charging possible. In daily operation, the limited available PV charging source combined with relatively low charge regulation voltages may be insufficient to provide a full charge to the battery. In an effort to identify appropriate stand-alone PV system parameters together with appropriate battery technology, a repeatable test procedure is provided to verify PV system parameters based on laboratory battery performance testing. This test procedure is designed to be characteristic of the low charge/discharge rates, shallow cycle operation, and various charging methods used in PV systems.

This guide contains relevant information on PV system design considerations as related to lead-acid batteries and a recommended test plan for evaluating battery performance in a particular system design. Specific lead-acid battery topics include the following:

— PV battery selection,

— PV battery characteristics, and

— PV battery testing and evaluation.

The recommended test plan for evaluating PV batteries includes the following:

— Limitations and expectations,

— System parameter selection,

— PV battery cycle test, and

— Interpretation of test results.

This guide may be used separately, or in combination with IEEE Std 937™, IEEE Std 1013™, and IEEE Std 1562™. Together, these documents will provide the user with a general guide to sizing, designing, placing in service, maintaining, and testing lead-acid storage batteries for PV systems.

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IEEE Guide for Selecting, Charging, Testing, and Evaluating Lead-Acid Batteries Used in Stand-Alone Photovoltaic (PV) Systems

1. Overview

This guide was written to provide a relevant photovoltaic (PV) battery test procedure that can be used to evaluate battery performance and identify appropriate PV battery charging requirements. Use of this document by funding organizations, battery manufacturers, PV system integrators, and consumers should provide the means for improved battery selection and its subsequent charging specifications. It is intended that this document provide a means to identify more cost effective and reliable PV batteries.

1.1 Scope

This guide contains a tutorial on lead-acid battery technology, battery charging characteristics, and a laboratory test procedure to evaluate charge parameters and battery performance. The information on lead-acid battery designs and environmental characteristics is provided to help the PV system designer make appropriate battery decisions. Photovoltaic system parameters and operating conditions are discussed. Charging parameters related to PV systems are also suggested to help in the selection of appropriate test set points. Finally, a performance test to verify the battery's operating set points and performance is provided, including discussions on how to interpret test results.

This guide is applicable to all stand-alone PV systems where PV is the only charging source. This guide does not include PV hybrid systems.