



Designation: **G100–89 (Reapproved 2010)^{ε1} G100 – 89 (Reapproved 2015)**

Standard Test Method for Conducting Cyclic Galvanostaircase Polarization¹

This standard is issued under the fixed designation G100; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

^{ε1} NOTE—Clarified the SI unit statement editorially in May 2010.

1. Scope

1.1 This test method covers a procedure for conducting cyclic galvanostaircase polarization (GSCP) to determine relative susceptibility to localized corrosion (pitting and crevice corrosion) for aluminum alloy 3003-H14 (UNS A93003) (**1**).² It may serve as guide for examination of other alloys (**2-5**). This test method also describes a procedure that can be used as a check for one's experimental technique and instrumentation.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*³

[D1193 Specification for Reagent Water](#)

[G1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens](#)

[G5 Reference Test Method for Making Potentiodynamic Anodic Polarization Measurements](#)

[G59 Test Method for Conducting Potentiodynamic Polarization Resistance Measurements](#)

[G69 Test Method for Measurement of Corrosion Potentials of Aluminum Alloys](#)

3. Significance and Use

3.1 In this test method, susceptibility to localized corrosion of aluminum is indicated by a protection potential (E_{prot}) determined by cyclic galvanostaircase polarization (**1**). The more noble this potential, the less susceptible is the alloy to initiation of localized corrosion. The results of this test method are not intended to correlate in a quantitative manner with the rate of propagation of localized corrosion that one might observe in service.

3.2 The breakdown (E_b), and protection potentials (E_{prot}) determined by the cyclic GSCP method correlate with the constant potential corrosion test (immersion-glassware) result for aluminum (**1, 6, 7**). When the applied potential was more negative than the GSCP E_{prot} , no pit initiation was observed. When the applied potential was more positive than the GSCP E_{prot} , pitting occurred even when the applied potential was less negative than E_b .

3.2.1 Severe crevice corrosion occurred when the separation of E_b and E_{prot} was 500 mV or greater and E_{prot} was less than -400 mV Vs. SCE (in 100 ppm NaCl) (**1, 6, 8**). For aluminum, E_{prot} determined by cyclic GSCP agrees with the repassivation potential determined by the scratch potentiostatic method (**1, 9**). Both the scratch potentiostatic method and the constant potential technique for determination of E_{prot} require much longer test times and are more involved techniques than the GSCP method.

3.3 DeBerry and Viebeck (**3-5**) found that the breakdown potentials (E_b) (galvanodynamic polarization, similar to GSCP but no kinetic information) had a good correlation with the inhibition of localized corrosion of 304L stainless steel by surface active compounds. They attained accuracy and precision by avoiding the strong induction effect which they observed by the potentiodynamic technique.

¹ This test method is under the jurisdiction of ASTM Committee G01 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.11 on Electrochemical Measurements in Corrosion Testing.

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² The boldface numbers in parentheses refer to a list of references at the end of this standard.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

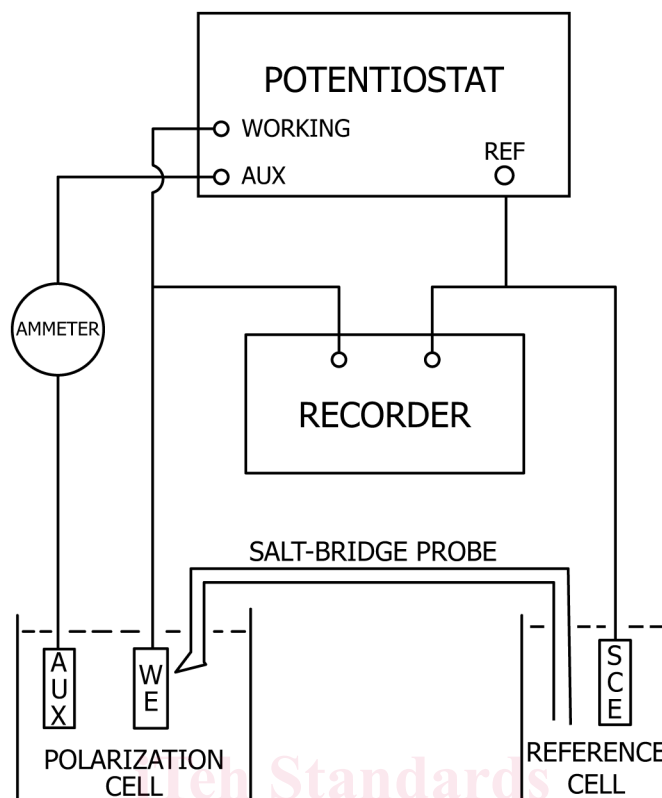


FIG. 1 Schematic Wiring Diagram for Galvanostaircase Polarization

3.4 If this test method is followed using the specific alloy discussed it will provide (GSCP) measurements that will reproduce data developed at other times in other laboratories.

3.5 E_b and E_{prot} obtained are based on the results from eight different laboratories that followed the standard procedure using aluminum alloy 3003-H14 (UNS A93003). E_b and E_{prot} are included with statistical analysis to indicate the acceptable range.

4. Apparatus

4.1 *Cell*—The cell should be constructed of inert materials such as borosilicate glass and PTFE fluorocarbon. It should have ports for the insertion of a working electrode (1 cm² flat specimen holder (Note 1) is very convenient), two auxiliary electrodes, salt bridge for reference electrode, and a thermometer or a thermostat probe for temperature control. The figure in Test Method G5 would be satisfactory, but a flat bottom cell is also satisfactory provided that all of the essential ports are provided. (See Ref (10) for details.)

NOTE 1—These specific recommendations and conditions were followed to improve the interlaboratory precision during the round robin for galvanostaircase polarization.

4.2 *Current Staircase Generator and Recorder*—The schematic diagram of the apparatus is given in Fig. 1. The recorder may be replaced by a plotter if the current staircase signal is generated with the aid of a computer. The current staircase may be generated manually (Note 2) but this is not recommended. The most convenient current staircase generators are found in recent commercial potentiostats where the software is available. The electrical equipment may be checked in accordance with the procedure in Practice G59.

NOTE 2—The current staircase signal was generated manually in the round robin because automated system or software was not available when this project was started.

4.3 Electrodes:

4.3.1 *Working Electrode*—For generating data to be compared to the reference data included herein, use type 3003-H14 (UNS A93003) A1 in sheet form. Cut 1.55 cm diameter circles and prepare in accordance with Practice G1 using 600-grit diamond slurry on a flat lapping machine. Install in flat specimen holder using PTFE gasket (no crevice type) (Note 1) so that 1 cm² is exposed to the test solution. Apply 29 m-g of torque.

4.3.2 *Auxiliary Electrodes*—Graphite, (ultrafine grade) (Note 3).

NOTE 3—Coarse grades of graphite should be avoided because they absorb solute impurities. Ultrafine grades are available from spectrographic supply companies.