



# Standard Practice for Verification of Algorithm and Equipment for Electrochemical Impedance Measurements<sup>1</sup>

This standard is issued under the fixed designation G106; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers an experimental procedure which can be used to check one's instrumentation and technique for collecting and presenting electrochemical impedance data. If followed, this practice provides a standard material, electrolyte, and procedure for collecting electrochemical impedance data at the open circuit or corrosion potential that should reproduce data determined by others at different times and in different laboratories. This practice may not be appropriate for collecting impedance information for all materials or in all environments.

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:<sup>2</sup>

[D1193 Specification for Reagent Water](#)

[G3 Practice for Conventions Applicable to Electrochemical Measurements in Corrosion Testing](#)

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

[G15 Terminology Relating to Corrosion and Corrosion Testing \(Withdrawn 2010\)<sup>3</sup>](#)

<sup>1</sup> This practice 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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

## 3. Terminology

3.1 *Definitions*—For definitions of corrosion related terms, see Terminology [G15](#).

### 3.2 Symbols:

|          |                                                                                                                                                            |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $C$      | = capacitance (farad-cm <sup>-2</sup> )                                                                                                                    |
| $E'$     | = real component of voltage (volts)                                                                                                                        |
| $E''$    | = imaginary component of voltage (volts)                                                                                                                   |
| $E$      | = complex voltage (volts)                                                                                                                                  |
| $f$      | = frequency (s <sup>-1</sup> )                                                                                                                             |
| $I'$     | = real component of current (amp-cm <sup>-2</sup> )                                                                                                        |
| $I''$    | = imaginary component of current (amp-cm <sup>-2</sup> )                                                                                                   |
| $I$      | = complex current (amp-cm <sup>-2</sup> )                                                                                                                  |
| $j$      | = $\sqrt{-1}$                                                                                                                                              |
| $L$      | = inductance (henry – cm <sup>2</sup> )                                                                                                                    |
| $R_s$    | = solution resistance (ohm-cm <sup>2</sup> )                                                                                                               |
| $R_p$    | = polarization resistance (ohm-cm <sup>2</sup> )                                                                                                           |
| $R_t$    | = charge transfer resistance (ohm-cm <sup>2</sup> )                                                                                                        |
| $Z'$     | = real component of impedance (ohm-cm <sup>2</sup> )                                                                                                       |
| $Z''$    | = imaginary component of impedance (ohm-cm <sup>2</sup> )                                                                                                  |
| $Z$      | = complex impedance (ohm-cm <sup>2</sup> )                                                                                                                 |
| $\alpha$ | = phenomenological coefficients caused by depression of the Nyquist plot below the real axis, $\alpha$ is the exponent and $\tau$ is the time constant(s). |
| $\theta$ | = phase angle (deg)                                                                                                                                        |
| $\omega$ | = frequency (radians-s <sup>-1</sup> )                                                                                                                     |

### 3.3 Subscripts:

|     |                          |
|-----|--------------------------|
| $x$ | = in-phase component     |
| $y$ | = out-of-phase component |

## 4. Summary of Practice

4.1 Reference impedance plots in both Nyquist and Bode format are included. These reference plots are derived from the results from nine different laboratories that used a standard dummy cell and followed the standard procedure using a