Designation: ~~E1237 – 93 (Reapproved 2009)~~ E1237 – 93 (Reapproved 2014)

Standard Guide for Installing Bonded Resistance Strain Gages[1]

This standard is issued under the fixed designation E1237; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This guide provides guidelines for installing bonded resistance strain gages. It is *not* intended to be used for bulk or diffused semiconductor gages. This document pertains only to adhesively bonded strain gages.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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:*[2]

E251 Test Methods for Performance Characteristics of Metallic Bonded Resistance Strain Gages

2.2 *Other Standards:*

ANSI/SEM 1-1984; Standard for Portable Strain-Indicating Instruments—Designation of Strain Gage Bridge and Color Code of Terminal Connections; August 16, 1984.[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *lead wire*—an electrical conductor used to connect a sensor to its instrumentation.

3.1.2 *resistance strain gage bridge*—a common Wheatsone bridge made up of strain gages used for the measurement of small changes of resistance produced by a strain gage, where the gages may be wired in the following configuration (see also Fig. 1 and Fig. 2):

~~Arm 1 between + excitation and – signal~~
~~Arm 2 between – excitation and – signal~~
~~Arm 3 between + signal and – excitation~~
~~Arm 4 between + signal and + excitation~~

Arm 1 between + excitation and – signal
Arm 2 between – excitation and – signal
Arm 3 between + signal and – excitation
Arm 4 between + signal and + excitation

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bonded resistance strain gage*—a resistive element with a carrier that is attached by bonding to the base material so that the resistance of the element will vary as the surface of the base material to which it is attached is deformed. ~~(For a complete definition of this term see Test Methods E251.)~~

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[2] 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.

[3] Available from American National Standards ~~Institute, 11 W. 42nd St., 13th floor,~~Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY ~~10036.~~10036, http://www.ansi.org.

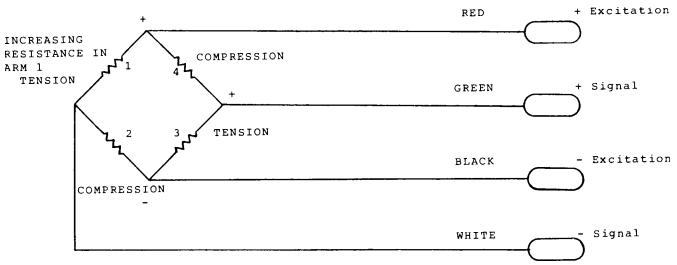

FIG. 1 Designation of Strain Gage Bridge and Color Code of Lead Wires (Full Bridge)

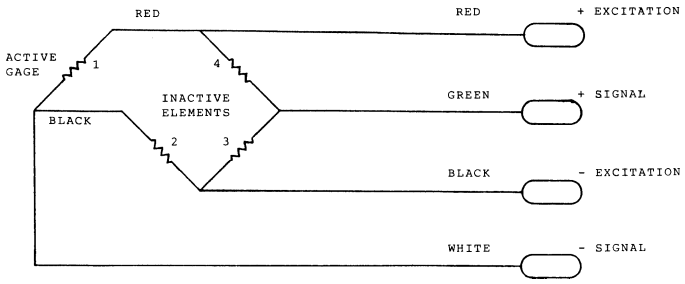

FIG. 2 Designations of Strain Gage Bridge and Color Code of Lead Wires (¼ Bridge)

3.2.1.1 *Discussion*—

For a complete explanation of this term see Test Methods E251.

4. Significance and Use

4.1 Methods and procedures used in installing bonded resistance strain gages can have significant effects upon the performance of those sensors. Optimum and reproducible detection of surface deformation requires appropriate and consistent surface preparation, mounting procedures, and verification techniques.

5. Gage Selection

5.1 Careful consideration must be given to the intended use when selecting an appropriate gage. Installation and operating characteristics of a gage are affected by many factors such as resistive element alloy, carrier material, gage length, gage and resistive element pattern, solder tab type and configuration, temperature compensation characteristics, resistance of active elements, gage factor, and options desired.

5.2 Factors that should also be considered include type of test or application, operating temperature range, environmental conditions, accuracy requirements, stability, maximum elongation, test conditions (static or dynamic) and duration, and simplicity and ease of installation. Dissipation of self-generated heat to the carrier should be considered in selecting gage resistance and size of grid.

5.3 To minimize errors due to strain gradients over the gage area, gage size should normally be small with respect to the dimensions of an immediately adjacent geometric irregularity (hole, fillet, etc.). However, the gage size should generally be large relative to the underlying material structure (grain size, fabric-reinforced composite weave pattern, etc.).

5.4 A two- or three-element rosette gage should be used unless the strain state is unquestionably uniaxial. A ~~single element~~ single-element gage may be selected to measure the strain due to a uniaxial strain state if the principal directions are known.

5.5 Temperature compensation of the gage should be selected to match the thermal coefficient of expansion of the base material, where possible. As a note of caution, for extreme temperature changes, nominal or handbook data on the thermal expansion characteristics of the base material may not be sufficiently accurate, and actual calibration may be required.

5.6 Strain gage manufacturers provide detailed critiques of the various factors ~~which~~that affect gage selection (**1**).[4]

5.7 For nonroutine applications, the advice of experienced users and of strain gage manufacturers should be sought. Specific verification tests may be required to ensure accurate results.

6. Bonding Technique Selection

6.1 Selection of the proper bonding technique and agent is important. Because the bonding agent becomes part of the strain gage system, many of the gage selection factors should be considered in bonding technique or agent selection.

6.2 Additional selection factors include compatibility of the bonding materials used in the selected gage construction with the material under test, environmental conditions, and available installation time.

6.3 Strain gages from different manufacturers may differ. Generally, each manufacturer will supply instructions and recommendations for bonding. These instructions should be considered when making a selection.

7. Surface Preparation

7.1 The surface must be properly prepared to ensure good bonding. Surface preparation includes solvent degreasing, cleaning, mechanical preparation, and chemical preparation. The surface should be smooth, but not highly polished. Preparation of this surface must be compatible with the gage, bonding method, and base material.

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.