

# SURFACE VEHICLE INFORMATION REPORT

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## GUIDE TO MANIFOLD ABSOLUTE PRESSURE TRANSDUCER REPRESENTATIVE TEST METHOD

**Foreword**—This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

This document is intended as a guide for technical personnel of both using and supplier firms whose duties include specifying, calibrating, testing, developing, or demonstrating the performance characteristics of Manifold Absolute Pressure (MAP) transducers. By basing users' specifications as well as supplier technical advertising and reference literature on this document, or by referencing portions thereof, as applicable, a clear understanding of the methods used for evaluating or proving performance will be provided. Adhering to the exemplary test method outline, terminology, and procedures shown will result in simple, complete test method documents; it will reduce design time, procurement lead time, labor, and materials costs. Of major importance will be the reduction of qualification test lead time and duration resulting from the use of commonly accepted test procedures.

The guide may also serve a useful purpose as a general example for test procedures on other types of transducers.

The MAP Transducer Representative Test Method has a companion dependent document, SAE J1347, Guide to Manifold Absolute Pressure Transducer Representative Specification, which is referenced to it.

**1. Scope**—This guide is intended to cover test procedures applicable to MAP transducers; it is also applicable to transducers such as Barometric (Ambient) Absolute Pressure transducers, Manifold Vacuum transducers, and similar pressure transducers used in automotive systems. Although oriented towards active devices (those using internal signal conditioning), it can be applied to passive devices with minor modifications.

**1.1 Values**—The guide is intended to be general in nature. Specific values for test data are not included in order to maintain generality. Exemplary values are contained in the Appendix in an attempt to clarify the text. *The SAE does not imply any recommendation regarding these values.*

## **2. References**

**2.1 Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

**2.1.1 SAE PUBLICATION**—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15006-0001.

SAE Recommended Practice J1113a, "Electromagnetic Susceptibility Procedures for Vehicle Components (Except Aircraft)", 1975

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2.1.2 ANSI PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI MC 6.1–1975 (ISA S37.1), Standard, "Electrical Transducer Nomenclature and Terminology", October 1975

ANSI MC 6.2–1975 (ISA S37.3), Standard, "Specifications and Tests for Strain Gage Pressure Transducers", January 1976

ANSI MC 6.5–1976 (ISA S37.6), Standard, "Specifications and Tests of Potentiometric Pressure Transducers", July 1976

ANSI B88.1–1972, Standard, "A Guide for the Dynamic Calibration of Pressure Transducers", August 1972

2.1.3 OTHER PUBLICATION

P. S. Lederer, "Methods for Performance-Testing of Electromechanical Pressure Transducers", NBS Technical Note 411 (February 1967)

### 3. Test Method—Manifold Absolute Pressure Transducer

#### 3.1 Qualification Tests

3.1.1 INSPECTION—The transducer shall be inspected visually for mechanical defects, poor finish, and improper identification markings. The electrical connector shall also be inspected.

3.1.2 STANDARD TEST CONDITIONS—Unless otherwise specified, all performance test procedures shall be conducted under the following standard test conditions:

- a. Laboratory Ambient Temperature:  $a \pm b \text{ }^{\circ}\text{C}^1$
- b. Relative Humidity:  $c \pm d\%$
- c. Excitation Voltage:  $e \pm f\text{V DC}$  (Source impedance  $< g \pm h\Omega$ )
- d. Output Load: As specified in J1347, paragraph 2.6

3.1.3 CALIBRATION EQUIPMENT—A variable pressure/vacuum source with a minimum range of pp–qq kPa (rr–ss torr), absolute, and a vacuum-pressure gage with an accuracy of  $\pm tt\%$  of the reading within this range, comprise the static pressure system. The transducer readout equipment shall have an accuracy of  $\pm uu\%$  of the reading. The traceability of these components must be known. A quick-opening-valve-type of dynamic step pressure calibrator is also required, with a rise time (10–90%) of kk ms or less and a range of at least 80% of the transducer range.

3.1.3.1 When two instruments are required to make measurements, the systematic individual instrument tolerances shall be considered additive. (That is, if resistance is measured by measuring current and voltage, a 1% measurement requires  $\pm 0.5\%$  systematic accuracy in each instrument.) If instrument tolerances are statistically independent, a root-mean-square overall value may be computed as the square root of the sum of the squares of the individual values.

3.1.3.2 A variable pressure/vacuum source shall be used that has a range extending above and below the range of the transducer to be measured, and not less than 110% of that range.

3.1.4 INSTALLATION CHECKS—The transducer shall be connected to the pressure source (manifold) and secured with the recommended force or torque. The excitation source, signal conditioner, and read-out instrument shall also be connected to the transducer and turned on.

A warm-up time of 1/2 h shall be allowed for the test equipment, prior to energizing the transducer under test.

1. The letters referenced in place of numeric values are keyed to the Appendix.

The pressure source, connecting tubing, and transducer system shall pass a leak test: the transducer system shall be pressurized to  $i \pm j$  kPa (absolute) after which the system shall be sealed off from the pressure source. During the next 30 min, the system pressure shall not change by more than  $\pm k$  kPa. Alternative leak tests may be specified.

- 3.1.5 INITIAL STATIC CALIBRATIONS—The transducer shall be energized for  $vv$  min, after which the initial calibration shall be performed.

The transducer output shall be recorded at standard test conditions and eleven input pressures representing 20% increments of the range of the transducer in ascending and descending directions (or as otherwise specified) approaching each pressure slowly in a monotonic manner to avoid overshoot. In the case of overshoot, the pressure shall be backed up by approximately a 10% increment and the step repeated. Three complete calibration cycles shall be performed consecutively to establish sensitivity, linearity (least squares line of regression is recommended), hysteresis, output noise, and repeatability.

- 3.1.6 EXCITATION-VOLTAGE EFFECTS—A complete calibration cycle (as specified in 3.1.5) shall be performed at laboratory standard conditions but with excitation voltages of these percentages of nominal: 70%, 85%, 100%, or as otherwise specified.

- 3.1.7 WARM-UP CHARACTERISTICS—The transducer shall be subjected to abbreviated calibration cycles. The transducer output shall be recorded at standard test conditions and four input pressures of 0%, 50%, 100%, and 0% of the range of the transducer. These abbreviated calibration cycles shall be performed at specified time intervals, starting  $ww$  min after the transducer is energized, and continuing for approximately  $xx$  min.

- 3.1.8 ENVIRONMENTAL EFFECTS

- 3.1.8.1 *Temperature*—A complete calibration cycle (as specified in 3.1.5) shall be performed at standard test conditions, but at the following temperatures and in this sequence: from laboratory ambient to specified minimum, up through laboratory ambient to maximum and returning to laboratory ambient. Readings shall not be taken until the output value at constant pressure input has stabilized to within  $\pm 1\%$  of the value of  $m$  min.

- 3.1.8.2 *Temperature Cycling*—The transducer shall be subjected to 200 temperature cycles at standard test conditions, but with the following temperature-time conditions:

Increase temperature from ambient to maximum specified, hold for 1 h, then decrease to the minimum specified, hold for 1 h, then increase to maximum again and hold for 1 h, then decrease the laboratory ambient standard temperature and hold for 2 h. At the end of this time a complete calibration cycle shall be performed.

NOTE—See 3.1.8.1.

- 3.1.8.3 *Shock*—The transducer shall be subjected to shock stimuli of  $n \pm o g_n$  peak amplitude, half sine wave with duration of  $p \pm q$  ms in three mutually perpendicular directions. Following this, one complete calibration cycle shall be performed.

- 3.1.8.4 *Vibration*—The transducer shall be subjected to sinusoidal vibration in each of three mutually perpendicular directions for a duration of  $r$  min in each direction at the frequencies and amplitudes listed (within  $\pm 10\%$ ). The transducer shall be powered with a fixed pressure input of  $aaa \pm bbb$  kPa, and its output shall be monitored. In lieu of continuous monitoring, the output may be sampled periodically.