

Electric Tachometer Specification

RATIONALE

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1. **Scope**—This SAE Recommended Practice establishes minimum requirements for electric tachometer systems with and without hourmeter or revolution counter, for general applications as follows:

Class 1-Passenger Car
Class 2-Bus and Truck
Class 3-Off-Road Vehicles

2. **References**

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

2.1.1 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B117-73

3. **Electric Tachometer System**—A typical electric tachometer system for engines using a Kettering ignition system or the newer electronic ignition systems, consists of an indicating unit that obtains a signal proportional to engine speed from the ignition system.

If the tachometer is intended for use on a diesel engine, a sender may be used to supply a signal proportional to engine speed. A signal may also be obtained from an a.c. tap on the alternator if the alternator is so equipped. If a sending unit is used, it will often be one of the following types: permanent magnet generator, magnetic switch, or magnetic sensor. The sender may be mounted on the engine outlet provided for mechanical tachometer cables, or it may be mounted so as to sense the number of teeth on the flywheel ring gear or some other location where a rotating element with teeth, slots, holes, or bosses may be sensed.

The indicating unit may contain an hourmeter. The hourmeter in an electric tachometer may be a true time indicator rather than an indication proportional to the number of engine revolutions. The latter indication is usually found in mechanical tachometers.

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4. **Factors Affecting Tachometer and Hourmeter Accuracy**—Changes in ambient temperature and voltage may affect the tachometer and/or the hourmeter indication.
5. **Tachometer and True Hourmeter Indication (Allowable System Variation)**
- 5.1 **Tachometers Driven by Signal from Ignition System or Alternator A.C. Tap**—The tachometer indication shall be within $\pm 2\%$ of full scale with nominal voltage applied at a temperature of 24 ± 3 °C when the tachometer is driven with a signal from an ignition system or from an alternator a.c. tap, as applicable. If a calibrator is used, it must supply a signal having the same characteristics as that supplied by an ignition system or an alternator a.c. tap. Calibration of tachometers shall be made with the instrument in approximately the same angular position that it will have when mounted in the vehicle. See Environmental Conditions for allowable variation within the instrument due to changes in ambient temperatures and voltage.
- 5.1.1 **SECONDARY LOSSES**—The effect of the tachometer on the ignition system should not reduce the available secondary voltage by more than 4%. Testing is to be done with the exact ignition system to be used in actual practice. The distributor is to be run with the coil input voltage held constant at 14.0 V and the coil secondary open circuited. The exact test procedure for measurements shall be established by the supplier and consumer.
- 5.2 **Sender Driven Units**—The tachometer indication shall be within $\pm 2\%$ of full scale with nominal voltage applied at a temperature of 24 ± 3 °C, when the tachometer is driven with a signal from a sender either rotated or excited in a fashion simulating actual operation. If a calibrator is used, it must supply a signal having the same characteristics as the sender. Calibration of tachometers shall be made with the instrument in approximately the same angular position that it will have when mounted in the vehicle. See Environmental Conditions for allowable variation within the instrument due to changes in ambient temperatures and voltage.
- 5.3 **True Hourmeter**—The hourmeter indication shall be within $\pm 2\%$ of elapsed time with nominal voltage applied at a temperature of 24 ± 3 °C.
- 5.4 **Hourmeter Proportional to Number of Engine Revolutions**—The time indication shall be within $\pm 0.3\%$ with nominal voltage applied, nominal input rpm required to indicate 1 h and at a temperature of 24 ± 3 °C.
6. **Effects of Environmental Conditions**
- 6.1 **Temperature (Allowable System Variation)**
- 6.1.1 **TACHOMETER INDICATION**—With nominal voltage applied, the tachometer indication shall not vary more than $\pm 2\%$ of full scale from the reading determined in Section 5, while the indicating unit is operating over the range of -7 to $+54$ °C and the sender (if required) is operating over the range of -40 to $+138$ °C. No permanent damage shall result from operating the indicating unit in a range of -40 to $+82$ °C.
- 6.1.2 **TRUE HOURMETER**—With nominal voltage applied, the time indication shall not vary more than $\pm 1\%$ from a reading obtained at 24 ± 3 °C while the instrument is operating over the range of -7 to $+54$ °C. No permanent damage shall result from operating the instrument in a range of -40 to $+82$ °C.
- 6.1.3 **HOURMETER PROPORTIONAL TO NUMBER OF ENGINE REVOLUTIONS**—With nominal voltage applied and nominal input rpm required to indicate 1 h, the time indication shall not vary more than $\pm 0.3\%$ from a reading obtained in Section 5 while the instrument is operating over the range of -7 to $+54$ °C. No permanent damage shall result from operating the instrument in a range of -40 to $+82$ °C.
- 6.2 **Temperature Extremes (Sender Only)**—It will be necessary to evaluate the specific application to specify the allowable temperature extremes.

6.3 Storage Temperature (Indication Unit Only)

- 6.3.1 TACHOMETER—A 4 h exposure of the indicating unit to a temperature of -40 to $+85$ °C shall result in no more than $\pm 1\%$ of full scale permanent calibration change from the reading obtained in Section 5. The rate of temperature change during this test shall not exceed 2 °C/min.
- 6.3.2 HOURMETERS—A 4 h exposure of the indicating unit to a temperature of -40 to $+85$ °C shall result in no more than $\pm 1\%$ permanent calibration change from the reading obtained in Section 5. The rate of temperature change during this test shall not exceed 2 °C/min.

6.4 Voltage Variation (Indicating Unit)

- 6.4.1 TACHOMETER—The indication shall not change more than $\pm 1\%$ of full scale from the reading obtained in Section 5, within the following voltage ranges.

TABLE 1—

12 Volt System	24 Volt System
12–16 VDC	24–32 VDC

Twelve and twenty-four volt tachometers shall not change more than $\pm 3\%$ of full scale, from the reading obtained in Section 5, at 11 and 22 V respectively.

- 6.4.2 TRUE HOURMETER—The indication shall not change more than $\pm 1\%$ from the reading obtained in Section 5, within the following voltage ranges.

TABLE 2—

12 Volt System	24 Volt System
12–16 VDC	24–32 VDC

Twelve and twenty-four volt hourmeters shall not change more than $\pm 3\%$ from the reading obtained in Section 5, at 11 and 22 V respectively.

- 6.4.3 HOURMETER PROPORTIONAL TO NUMBER OF ENGINE REVOLUTIONS—At 24 ± 3 °C and with nominal input rpm required to indicate 1 h the time indication shall not vary more than $\pm 0.3\%$ from a reading obtained in Section 5 when operating within the voltage ranges given in paragraph 6.4.2.

6.5 Abnormal Voltage Conditions—Tachometer and True Hourmeter

- 6.5.1 TRANSIENT VOLTAGE PROTECTION—The indicating unit shall be capable of withstanding supply voltage transients without permanent damage and shall remain within the calibration specification of Section 5 at the conclusion of this test. The instrument shall be connected and operated for a total of 1 h with a means provided to impress upon the nominal battery voltage a repetitive rectangular voltage pulse of plus and minus six times nominal battery voltage with a duration of 300 μ s and 1% duty cycle with a current of no more than 1.0 A.
- 6.5.2 OVERVOLTAGE AND REVERSE POLARITY—Provisions for protection against booster starts with double battery voltage and/or reversed polarity must be negotiated between the user and the manufacturer.

6.6 Moisture Resistance

- 6.6.1 HUMIDITY (INDICATING UNIT)—Indicating unit shall withstand exposure to 95% relative humidity at 38 °C for 48 h
- 6.6.2 SALT SPRAY (SENDER UNIT)—Sender units shall be corrosion resistant and shall withstand a salt spray (fog) test of 48 h duration with 5% salt solution (Reference ASTM B 117-73).

- 6.7 **Vibration Test (Indicating Unit)**—The indicating unit shall be capable of withstanding without mechanical or electrical failure, 3 h of vibration, 1 h along each of the three mutually perpendicular axes. One of said axes is to be parallel to the indicator shaft. The vibration test shall be run at a double amplitude as specified in the table below with the frequency varying as shown in the table at intervals of 1 min. After completion of test, the calibration shall remain within tolerances as specified in Sections 5 and 6.

TABLE 3—

Class	Amplitude, DA (mm)	Frequency Range (Hz)	Max. Acceleration (g)
1	0.75	10–30–10	1.4 at 30 Hz
2	1.52	10–55–10	10 at 55 Hz
3	1.52	10–80–10	20 at 80 Hz

6.8 Vibration Test (Sender Only)

- 6.8.1 ENGINE MOUNTED—The sender shall be capable of withstanding 6 h of vibration without mechanical or electrical failure, 2 h along each of the three mutually perpendicular axes. One of said axes is to be parallel to the input shaft. The vibration test shall be run at a double amplitude of 0.50 mm with the frequency varying from 10-120-10 Hz at intervals of 1 min.

- 6.9 **Shock Test (Indicating Unit Only)**—The indicating unit shall be capable of withstanding without mechanical or electrical failure, the following series of shocks and still maintain the calibration tolerances specified in Sections 5 and 6. The indicating unit shall be subjected to an equal number of shocks in each direction along each of three mutually perpendicular axes. One of said axes is to be parallel to the indicator shaft. Each shock shall be half sine of 9–13 ms duration, the acceleration and total number of shocks per table below.

TABLE 4—

Class	Peak Acceleration (g)	Total Number
1	23–27	6
2	23–27	72
3	44–55	72

- 6.10 **Shock Test (All Senders)**—The sender shall be capable of withstanding, without mechanical or electrical failure, six shocks of 44–55 g, half sine of 9–13 ms duration in each direction along each of three mutually perpendicular axes. One of said axes is to be perpendicular to the mounting plane.

6.11 Design Detail Recommendations (Indicating Unit Only)

- 6.11.1 When analog displays are used, the display shall be accomplished by a pointer or other indicator traversing in a clockwise or left to right direction as applicable, to register increasing revolutions per minute over a suitable scale on the indicating unit dial.
- 6.11.2 Graduations shall be designed for the best practical legibility and accuracy of reading.