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# SURFACE VEHICLE STANDARD

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Submitted for recognition as an American National Standard

## (R) Road Vehicles—Alternators with Regulators—Test Methods and General Requirements



***1.*** ***Scope—***This SAE Standard specifies test methods and general requirements for the determination of the electrical characteristic data of alternators for road vehicles.

It applies to alternators, cooled according to manufacturer's instructions, mounted on internal combustion engines.

This document attempts to follow ISO 8854, dated 1988. ISO 8854 has been modified herein to reflect local market requirements and historical precedent.

***2.*** ***References***

**2.1** **Applicable Publication—**The following publication forms a part of this specification to the extent specified herein.

2.1.1 ISO PUBLICATION—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 8854—Road vehicles—Alternators with regulators—Test methods and general requirements

***3.*** ***Definitions—***For the purposes of this document, all currents defined are considered to be net output of the machine (gross output minus the field excitation) with the regulator connected to the output.

The following definitions apply.

**3.1** **Test Voltage, $V_t$—**Specified value, in volts, at which the current measurements shall be carried out.

**3.2** **ISO 8854 Cut-In Frequency, $n_A$—**(Copied from ISO 8854, FOR REFERENCE ONLY). Alternator rotational frequency (i.e., speed), which is the number of revolutions divided by time, in minutes to the power minus one, at which it begins to supply current when frequency is increased for the first time. This depends on pre-exciting power (input), frequency changing velocity, battery voltage, and the residual flux density of the rotor (speed when the charge indicator system indicates the commencement of battery charging.)

**3.3** **Cut-Out Speed, $n_0$—**Alternator rotational speed, in Revolutions per Minute (rpm), at specified test voltage, $V_t$, where output falls to zero amperes as the speed is decreased. Historically, in North America, this point is referred to as "cut-in," to remove the hysteresis from the alternator rating curve.



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**3.4** **Rated Low Application Speed, $n_L$—**Alternator rotational speed, in rpm, which corresponds approximately to the idling speed of the engine. This rotational speed is set at 1500 rpm for the purpose of this specification.

**3.5** **Low Speed Rated Current, $I_L$—**Current, in amperes, which is delivered by the alternator at test voltage, $V_t$, and at rated low application speed, $n_L$.

**3.6** **Rated Speed, $n_R$—**Alternator rotational speed, in rpm, at which it supplies its rated current, $I_R$, The rated speed is specified as $n_R$ = 6000 rpm for the purpose of this specification.

**3.7** **Rated Current $I_R$—**Minimum current, in amperes, which the alternator shall supply at test voltage, $V_t$, and rated speed, $n_R$.

**3.8** **Maximum Rated Speed, $n_{max}$—**Maximum continuous rotational speed for generating electric power, in rpm, as specified by the alternator manufacturer.

**3.9** **Current at Maximum Rated Speed, $I_{n(max)}$—**Current, in amperes, which the alternator supplies at test voltage, $V_t$ and maximum rated speed, $n_{max}$.

**3.10** **Shaft Input Power, $P_i$—**Power, in watts, required to turn alternator at required speed to generate measured current at specified $V_t$.

**3.11** **Maximum Drive Torque, $T_{max}$—**Maximum torque required to drive alternator, at a constant speed, under specified operating conditions. (Reference Only)

## *4. Test Conditions*

**4.1** The tests shall be carried out at an ambient temperature of 23 °C ± 5 °C. The actual test temperature shall be recorded on all published performance reports.

**4.2** The direction of alternator rotation shall be as indicated by the manufacturer.

**4.3** A battery and an adjustable resistor, R, shunted to the battery, are used in the measuring circuit, as shown in Figure 1.

**4.4** The tests shall be conducted using a fully charged lead-acid battery of the correct nominal voltage having a nominal capacity, expressed in ampere-hours, of not less than 50% of the rated alternator current, $I_R$ (i.e., 100-A alternator will have at least a 50 A-h battery in the test circuit.)

**4.5** The overall capability of the test equipment shall allow parameter measurements within the following tolerances:

a. Voltage: ±0.3%
b. Current: ±0.5%
c. Torque: ±2.0%
d. Rotational Speed: ±1.0%
e. Temperature: ±1.0 °C

**4.6** All measurements of current shall be carried out by adjusting the load resistor, R, to maintain a constant test voltage, $V_t$. Test voltages shall be recorded on all published performance reports.

**4.7** The measurements shall be carried out with the regulator operating normally, with its power coming from the output of the machine being tested.

**4.8** Measurements shall be made at the following test voltages:

a. 13.5 V ± 0.1 V for 12-V nominal systems
b. 27.0 V ± 0.2 V for 24-V nominal systems

If test voltages other than 13.5/27.0 are used, they must be recorded on all published performance reports.

NOTE—Existing ISO and JIS specifications use 13.5 and 27.0 V.

***5. Test Equipment Connection Diagram*—**For alternator tests, connections shall be made in accordance with Figure 1.

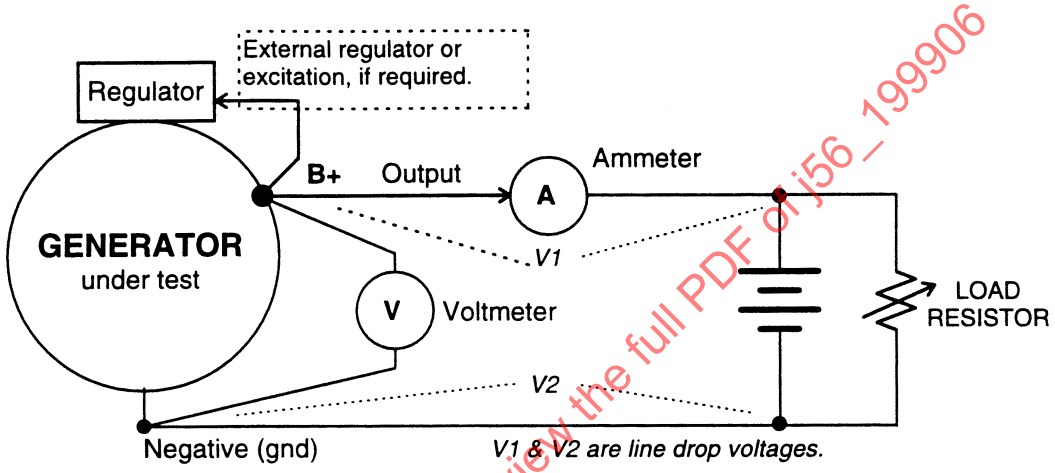



FIGURE 1—TEST CONNECTION DIAGRAM

The voltmeter shall be connected directly to the alternator power output terminals.

The voltage drop shall be 0.5 V or less for all test conditions. The voltage drop as shown in Figure 1, is defined as $V_1 + V_2$ which is the voltage from the alternator B+ to alternator ground, minus the load voltage drop.

***6. Measurement Procedure***

**6.1 Current/Rotational Speed Characteristics**

6.1.1 STABILIZED PERFORMANCE TESTS (REQUIRED FOR RATING)—Current measurement shall be taken at least at the following rotational speeds, in rpm. The current shall be allowed to reach equilibrium (within 2% of reading for 5 min) at each individual speed before current and torque values are recorded:

a. 2-A speed, 1500, 1800, 2000, 2500, 3000, 3500, 4000, 5000, 6000, $n_{max}$
b. Cut-Out Speed, $n_0$, (Indirect Measurement)—Reduce the alternator rotational speed until an alternator output current between 5% of $I_R$ and 2 A, but not less than 2 A, is reached. Record speed and current for graphic determination of the Cut-Out Speed: i.e., the Cut-Out Speed is determined by extension of the current/rotational speed characteristic until the abscissa is intersected. The graphic extrapolation shall be made after completing the measurements.

The shaft input power shall be determined for each measurement point.

6.1.2 SWEPT SPEED, TEMPERATURE STABILIZED TEST—The alternator under test shall be warmed up for 30 min at 3000 rpm. It is, however, permissible to reduce this time if it can be shown that the temperature which would be reached after 30 min has been attained in a shorter period. The voltage and load shall be constant and equal to the test voltage, $V_t$, and load during the warm up and measuring period.

After the warm up period, the rotational speed shall be reduced until the current is between 2 A and 0.05 $I_R$. Record the current and rotational speed.

Current measurements shall be taken while the speed is swept from $n_0$ to no less than $n_R$.

The test time shall not exceed 30 s, with constant rate of change of speed.

6.1.3 SWEPT SPEED, NON-TEMPERATURE STABILIZED TEST—Same procedure as 6.1.2, except that temperature stabilization is not required.

**6.2 Cold Temperature Stabilized Performance Test (Optional)—**Same procedure as 6.1.1, except at 0 °C ambient. Recording torque data during this procedure is optional.

**6.3 High Temperature Stabilized Performance Test (Optional)—**Same procedure as 6.1.1, except at 100 °C ambient. Recording torque data during this procedure is optional.

**6.4 Testing of Functional Ability of Regulator—**The alternator shall be run at rated rotational speed and rated current until the temperature of the regulator becomes stable. The load shall then be reduced to 10% of $I_R$, but not less than 5 A, and a check made to determine that the voltage does not rise above the alternator voltage specified by the alternator manufacturer.

NOTE—The setting of the regulator is specific to the vehicle manufacturer.

***7. Presentation of Results—***Measurements of current, rotational speed, and torque characteristics shall be presented in accordance with Figure 2. Calculations of power and efficiency are optional on Figure 2.

The tests described in 6.1.1 and 6.1.2 will produce different characteristic curves and therefore different maximum current values. The manufacturer shall indicate which test method has been used.

**7.1 Displayed Rating Format—**Any references to performance marked on an alternator shall follow this format:

" $I_L$ / $I_R$ A $V_T$ V"

where:

$I_L$ = Low Speed Rated Current
$I_R$ = High Speed Rated Current
$V_T$ = Test Voltage

For example: "50/120A 13.5V"

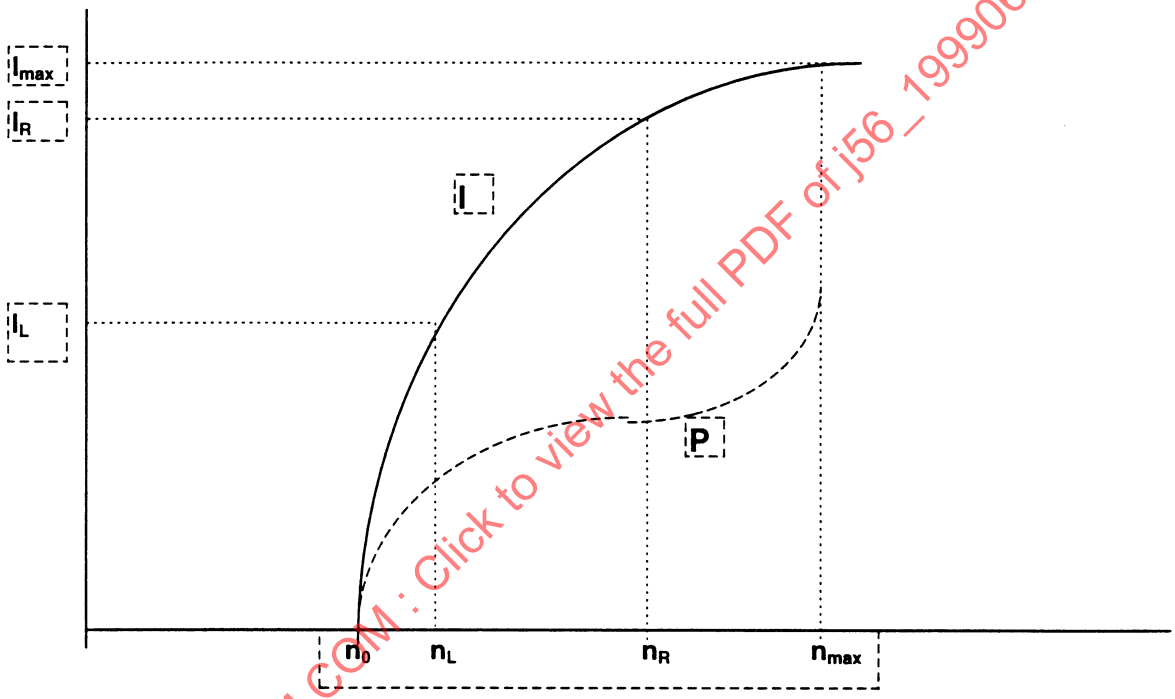
The sample size used to generate the curves in Figure 2 shall be reported on the curve.

$V_t$ = _____ volts

T = _____ °C

Test: STABILIZED SWEPT (circle one)

Sample Size _____




WHERE:

I max = Current at Maximum Rated Speed
$I_R$ = Rated Current
$I_L$ = Low Speed Rated Current

$n_0$ = Cut-In Speed
$n_L$ = Rated, Low Application Speed
$n_R$ = Rated Speed
$n_{max}$ = Maximum Rated Speed

I = Current Output Performance Curve
P = Power absorbed by alternator at full load (torque Measurement).

FIGURE 2—PRESENTATION OF RESULTS