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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE STANDARD

SAE J180

REV. JAN2002

Issued 1970-06
Revised 2002-01

Superseding J180 MAY87

(R) Electrical Charging Systems for Off Highway Work Machines

1. ***Scope—***This SAE document describes alternator physical, performance and application requirements for heavy-duty electrical charging systems for on and off road applications including those defined in SAE J1116.

1.1 **Purpose—**The purpose of this SAE document is to provide information on which to base machine and component design and to establish minimum requirements which will result in the most satisfactory operation of charging systems in construction, agricultural, and industrial machinery environments.

2. ***References***

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

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-001.

SAE J56—Electrical Generating System (Alternator Type) Performance Curve and Test Procedure
SAE J551-4—Test Limits and Methods of Measurement of Radio Disturbance Characterisitics of Vehicles and Devices, Broadband and Narrowband, 150 kHz to 1000 MHz
SAE J1116—Categories of Off-Road Self-Propelled Work Machines

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

ASTM B 117—Salt Spray (Fog) Testing – NOV 85

2.2 **Related Publications—**The following publications are provided for information purposes only and are not a required part of this specification.

2.2.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-001.

SAEJ551-1—Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles and Devices
SAE J551-2—Test Limits and Methods of Measurement of Radio Disturbance Characterisitics of Vehicles, Motorboats, and Spark-Ignited Engine-Driven Devices

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3. Definitions

3.1 Flat Compensation—A regulator having flat compensation is one where the voltage setting remains near constant over the temperature range of operation.

3.2 Temperature Compensation—A regulator having temperature compensation is one where the voltage setting varies in relationship to temperature.

3.3 Batteryless Operation—Occurs in a machine application whenever the battery becomes disconnected from the alternator. The electrical load of the alternator is significantly different in this situation. The disconnection may be intentional or unintentional. In some applications, machines are shipped for export without batteries. In this situation, a slave battery may be used for jump starting the machine. After the machine is started, the battery is disconnected and the machine is moved. During movement the alternator is operating without the battery and expected to power such items as the transmission and engine fuel solenoids.

Batteryless operation can also occur during operational usage whenever there is:

a. A battery open cell failure
b. The battery becomes extremely sulfated
c. The connections to the battery become loose
d. The connections to the battery become corroded
e. A master disconnect switch becomes open or its connections become open.

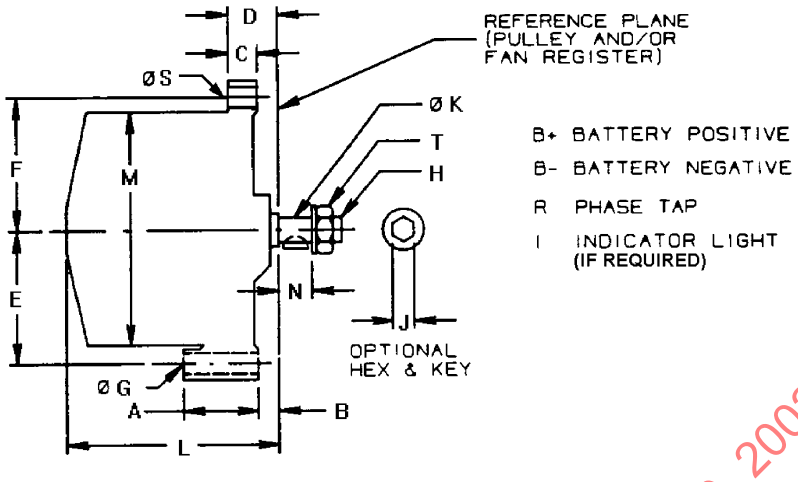
The effect of the alternator operating in a batteryless situation is typically a wider range of voltages in output than when loaded with a battery. Some alternators do not produce output without a battery.

3.4 Reverse Polarity—Reverse polarity occurs when the battery positive and negative cables are hooked up in reverse.

3.5 Load Dump—A sudden interruption of most electrical loads from the alternator during alternator operation causing a self-induced voltage surge. Load dump could be caused by such items as connections to the alternator B+ terminal becoming loose, connections to the alternator B+ terminal being corroded, defective alternator output cables, etc.

4. Physical Requirements

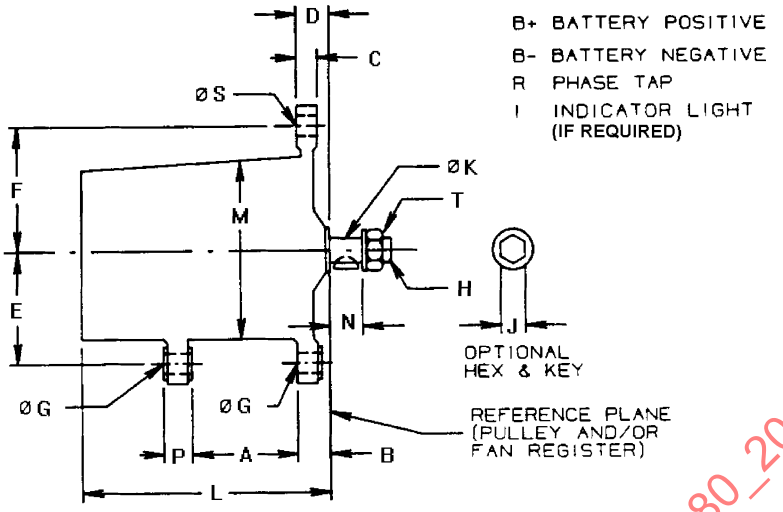
4.1 Dimensional—Figure 1 portrays a spool-mount alternator. Figure 2 portrays a hinge mount alternator. Included in both are the proper pulley hub dimensions for the alternators in both envelopes.



															Terminals			
A ◊	B ◊	C	D	E	F	G	H	J	K ◊	L	M	N	S	T Torque Max	B+	B-	R	I
51	21	16	32	105	105	10	5/8 or M16	8	17 or 22.2	170	180	20	10 or M8	65 Nm	5/16 or M10	1/4 or M6	#10 or M4	#10 or M4

Note: Unless indicated all dimensions are nominal.
◊ is a critical dimension

FIGURE 1—ALTERNATOR DIMENSIONS FOR SPOOL MOUNTING



A ◊	B ◊	C	D	E	F	G	H	J	K ◊	L	M	N	P	S	T Torque Max	Terminals B+	Terminals B-	Terminals R	Terminals I
100	30	14.5	30	120	115	13	5/8 or M16	8	22.2	280	205	40	20	1/2 or M12	108 Nm	7/16 or M12	1/4 or M6	3 mm Dia. Pin or M4	#10 or M4

Note: Unless indicated all dimensions are nominal.
◊ is a critical dimension

FIGURE 2—ALTERNATOR DIMENSIONS WITH HINGE MOUNTING

4.2 Mounting Recommendations

4.2.1 HINGE MOUNTING—Figure 3 shows a hardened split bushing in the alternator mounting lug opposite the drive end. The mounting bolt clamps the mounting bracket to this bushing. Tightening of the mounting bolts positions the bushing, easing strain on bracket and lugs.

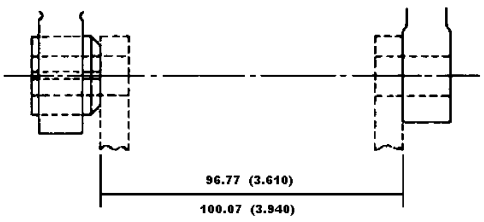


FIGURE 3—TYPICAL INSTALLATION OF SPLIT BUSHING IN HINGE MOUNTING LUG

4.2.2 SPOOL MOUNTING—Figure 4 shows the hardware and brackets for spool mounting. A hardened, split bushing is located in the mounting bracket.

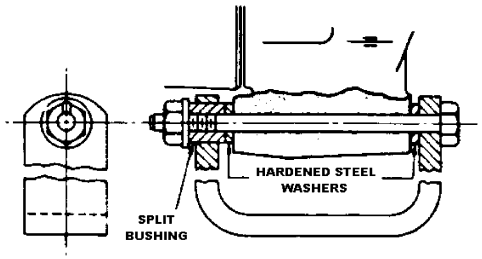


FIGURE 4—TYPICAL INSTALLATION OF SPLIT BUSHING IN BRACKET FOR SPOOL MOUNTING

4.3 Terminals—On all alternators, provisions shall be made for a negative ground connection, either by a terminal post or a threaded hole, to insure a sound electrical ground path from the alternator to the machine system ground.

To insure correct electrical connection between the alternator and the mating wiring harness, and to standardize on terminals between the various alternator manufacturers, terminal sizes are recommended in Figures 1 and 2.

Blade type external terminations are not recommended to be used on alternators that are covered by this SAE document.

4.4 Shaft Size—See Figures 1 and 2.

4.5 Alternator Identification—Each alternator shall be identified with the following characteristics:

Manufacturer's Identification, Part Number, Voltage Rating, Current Rating, Manufacturing Plant, and Manufacturing Date Code (and/or Serial Number).

5. Performance Requirements

5.1 Performance—Refer to SAE J56 for performance and test procedure.

5.2 Regulation—When engines run continuously for hours on end, battery charging systems require special voltage regulation considerations to maintain correct battery charging voltage. Possible regulation systems are:

a. Flat compensated (see Figure 5): Nominal voltage ranges of 13.5 V to 14.5 V and 27.0 V to 29.0 V. If a direct relationship between battery temperature and regulator temperature is not known or applied, the regulator shall have flat compensation. Figure 5 depicts typical flat temperature compensation with respect to the regulated voltage. The curve shows a regulated voltage of 14.0 V is given for a specific operating condition, and operating to limiting conditions permits excursion of the voltage to between 13.5 V and 14.5 V.

b. Temperature compensated regulator (see Figure 6) when regulator and battery are in same ambient. Voltage ranges 13.0 V to 15.5 V; 26.0 V to 31.0 V. If there exists a known relationship between the battery temperature and the regulator temperature, then temperature compensation may be applied to the regulated voltage. Figure 6 depicts a typical temperature compensation curve with respect to the regulated voltage that confines the voltage to between 13.0 V and 15.5 V throughout the operating range. Such temperature compensation curves are specific to type of battery used and battery charge characteristics and are designed for specific applications.

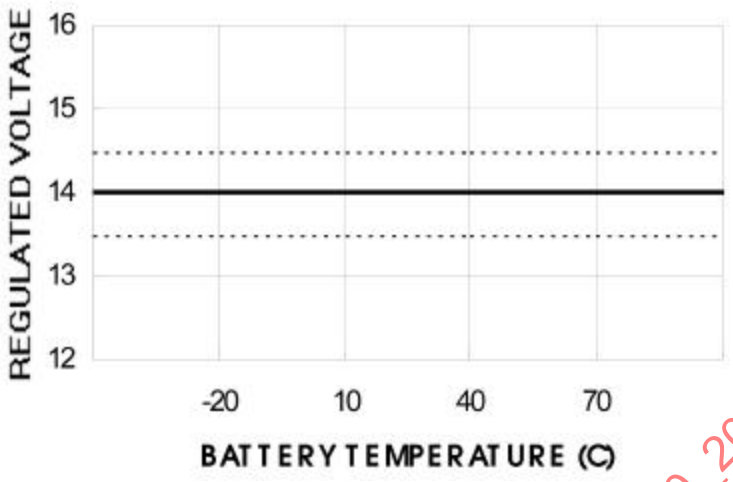


FIGURE 5—FLAT COMPENSATION CURVE

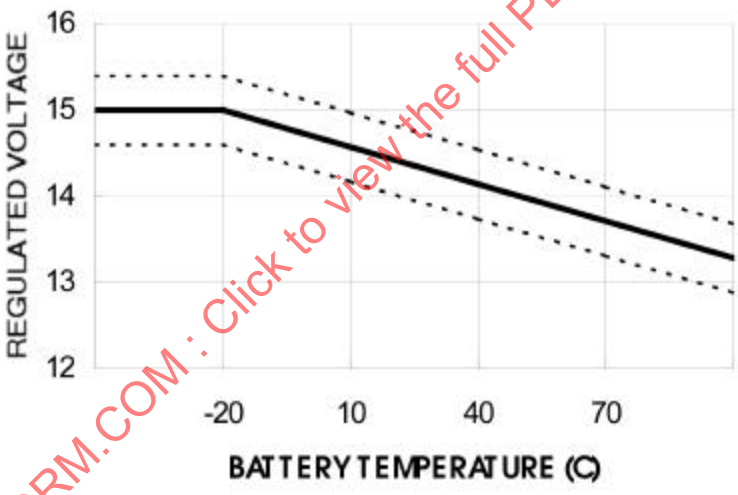


FIGURE 6—TEMPERATURE COMPENSATION CURVE

5.3 Batteryless Application—The machine designer shall consider the probability of open-circuit operation and accidentally induced high transient voltage. The designer shall define the conditions (maximum speed, maximum load change, repetition rate) to the alternator manufacturer and specify the maximum voltage (peak and duration) tolerable to the load components of the electrical system.

The average steady-state alternator system output terminal voltage, with battery disconnected and a minimum resistive load of 60 Ω, shall not rise by more than 10% when compared to the allowable voltage with the battery connected.

5.4 Load Dump—The alternator system, including all associated rectifying, regulating, and filtering devices, shall withstand the self-induced voltage surge resulting from the sudden disconnection (not longer than 20 ms to complete break) of the output current (including battery) at 6000 rpm and maximum possible output at that speed. This test shall be conducted a minimum of five (5) consecutive times.

6. *Application Requirements*

6.1 Dust—The alternator shall be capable of operating in severe dust environments with no detrimental effects on performance. This unit shall be tested by operating the complete unit for 1500 h at 5000 rpm ± 500 rpm in an enclosure where dust is available to be circulated. This test shall be performed with a minimum of 80% of the rated alternator output. The alternator inlet air temperature shall be 93 °C ± 5 °C. Some typical dusts:

a. AC coarse dust
b. Phoenix dust
c. Fly Ash / Portland Cement dust

Specific requirements for dust and density shall be established per agreement with the manufacturer and machine designer.

6.2 Vibration—Alternators shall be designed to withstand the vibration environment of the application. Guidelines for acceptable vibration tolerance should be developed by the alternator manufacturer based on industry application requirements.

Guidelines may resemble the individual speed plots and total vibration envelope shown in Figure 7. These guidelines will not be exact due to resonant mode shape differences between mounting bracket systems. Alternator mounting systems shall be designed to have a minimum resonance four times the normal engine firing frequencies.

Mounting bolt strength and mounting surface hardness are important in retaining initial tightness and vibration resistant performance. Mountings of types shown in Figures 3 and 4 have been effective in adjusting differences between the alternator lug and the mounting bracket dimensions, thus providing the necessary clamping without excessive strain on the alternator lug or a requirement for close tolerances on either part.

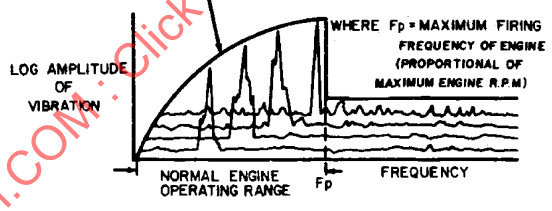


FIGURE 7—ENGINE VIBRATION ENVELOPE

6.3 Temperature Range—Alternators shall be designed to withstand the temperature environment of the chosen application. The alternator shall operate with an air inlet temperature of –40 °C to 93 °C.

The alternator manufacturer and machine manufacturer shall jointly review the application and develop a procedure to measure the critical temperatures during actual operating conditions. Attachments that will be used on the alternator, such as debris screens, guards, etc. shall be included in these tests.

Consideration shall be given to external heat sources when designing and locating the alternator mounting. External sources of heat include engine items such as exhaust manifolds, turbochargers and mufflers.

6.4 Belt Loading—Belt load and pulley distance from the drive-end bearing are the most severe cause of excessive bearing loads. To attain acceptable bearing life, the machine designer must keep within the limits provided by the alternator manufacturer. See Figure 8 for typical shaft load versus distance between bearing and load centerlines. For the alternators shown in Figure 2, which normally use a medium-duty 25 mm bearing, the curves present information based on 10 000 h B-10 life. In other combinations of shaft and bearing size, the limitation may be set by shaft fretting or shaft fatigue.

To help determine the belt specifications and to help calculate the belt loading, the alternator manufacturer shall furnish curves showing the full-load horsepower and torque required to drive the alternator. For calculating loads on the drive components due to accelerations, the moment of inertia of the rotor is required.

For avoiding one cause of shaft wear and bearing failure, the pulley hub dimensions shall be consistent with shaft dimensional requirements according to Figures 1 and 2. The hub must have a free fit over the shaft so that all of the nut torque will be available for providing clamping force against bearing inner race.

Consideration shall be given to requirements specific to various drive belt systems, e.g.: "V" belts, poly "V" belts, cog belts.

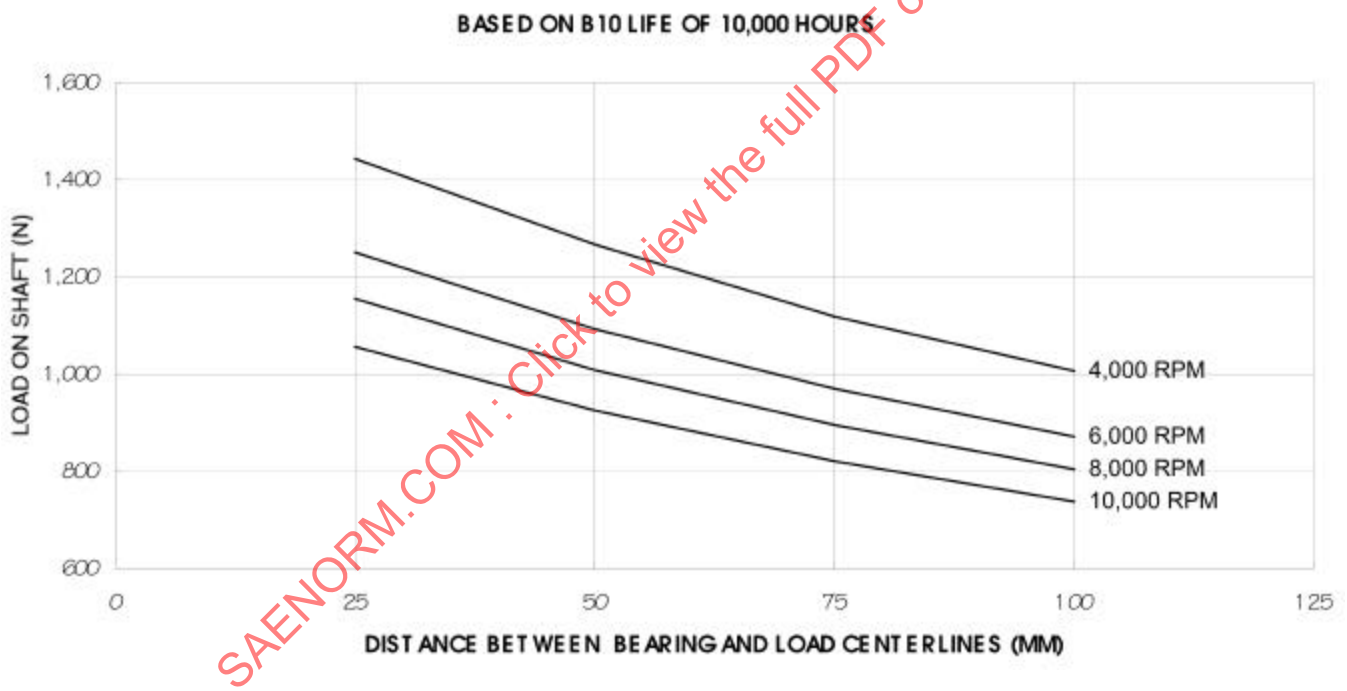


FIGURE 8—TYPICAL PARAMETERS EFFECTING BEARING LIFE

6.5 Corrosion—The alternator shall be placed in salt spray (fog) condition, per ASTM B 117 (except the temperature shall be held to 35 °C ± 5 °C) for 192 hours. It shall be electrically energized (battery connected to the output terminals), rotating at least once every 24 hours. At the end of this test, the unit shall be capable of rated output and show no significant deterioration of the alternator as agreed to between machine and alternator manufacturers.

6.6 Electromagnetic Interference—The alternator, when installed on the application, shall not prevent the application from passing the requirements of SAE J551-4.