SAE International

SURFACE VEHICLE STANDARD

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Electrical Grounding Practice

RATIONALE

The technology in this standard is mature and no longer in need of frequent updating.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE CTTC C2, Electrical Components and Systems Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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1. ***Scope***—This SAE Standard outlines general procedures for the grounding of electrical components in 12- and 24-V systems, intended for light and heavy-duty on-highway trucks and their trailers; and off-road machinery applications as described in SAE J1116.

1.1 **General—**The voltage drops specified throughout this document are for a 12-V system. For 24-V systems, the allowable voltage drops may be doubled. These voltage drops are nominal at room temperature (25 °C ± 5 °C), and may not be sufficient to guarantee proper operation of voltage sensitive devices, such as gauges, alternators, and electronic devices. Manufacturer's recommendations for the grounding of components must be followed whenever provided.

2. ***Reference***

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

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1116—Categories of Off-Road Self-Propelled Work Machines

3. ***Definitions***

3.1 **Common Ground—**The machine member to which all wire grounds are connected. Typically, this is either the frame or the engine block.

3.2 **Low Current Ground—**A ground path in which the current in any one segment is limited to 3 A.

3.3 **Medium Current Ground—**A ground path in which the current in any one segment is limited to 30 A.

3.4 **High Current Ground—**A ground path in which the allowable current in any segment may exceed 30 A.

3.5 **Primary Ground Path—**The intended lowest resistance electrical path which interconnects the cranking motor and the battery.

3.6 **Secondary Ground—**A connection node which is the terminating point for one or more medium current grounds and which is, in turn, connected to common ground.

4. ***Low Current Grounds—***Used primarily for instrumentation systems.

4.1 The voltage differential between any point along the low current ground path and the common ground shall not exceed 150 mV.

4.2 Low current ground connections shall be made directly from an electrical part(s) to the common ground via a dedicated wire(s) in the harness. Although no secondary grounds should be included in a low current ground path, it is permissible to loop ground conductors between several components if the user adheres to the voltage drop provision of 4.1.

5. ***Medium Current Grounds—***Includes, but is not restricted to, grounds for lights, blower motors, solenoids, warning flashers, etc.

5.1 Medium current grounds may be made either directly to the common ground or to a secondary grounding point.

5.2 The voltage differential between any point along the medium current ground path and common ground shall not exceed 500 mV.

6. ***High Current Grounds—***May include, but is not restricted to, alternator grounds, cranking motor grounds, and cab to frame grounds.

6.1 High current grounds shall be made directly to the common ground. Connecting a high current ground to the common ground via a secondary ground is not recommended.

6.2 A wire sized to carry the full alternator output current shall connect directly from the alternator negative output terminal to the engine block or cranking motor ground terminal, if provided.

6.3 The maximum voltage differential between any point along a high current ground path and the negative battery terminal shall not exceed 500 mV under any combination of loads and conditions.

6.4 To ensure acceptable battery charging characteristics, the total voltage difference between the battery terminal voltage and the alternator output voltage shall not exceed 500 mV at maximum alternator output current. The voltage drop in the ground circuit between the alternator and the battery shall not exceed 250 mV under the same conditions. Consult alternator and battery suppliers for specific application information.

7. ***Primary Grounds—***Includes cranking motor, common ground, battery cable, disconnect switch, and any other component in the ground path between the cranking motor and the battery.

7.1 Primary ground paths shall not pass through any bolted metal surfaces or structures. Exceptions can be made for cranking motors and other similar devices which, by design, complete the ground path through mounting hardware.

7.2 The maximum voltage differential between any two points on the primary ground path shall not exceed 100 mV under any conditions except during engine cranking.

8. ***Secondary Grounds—***Any sheet metal part, cast part, buss bar, rollover protection structure, etc., which is a continuous metal part not broken by any bolted joints, can be used as a grounding point for one or more electrical devices. It is, in turn, connected to the common ground using either wire or cable. It is preferred, however, that all grounds have a wire or cable connection to the common ground.

8.1 The voltage difference from any point on the secondary ground and the common ground shall not exceed 300 mV under conditions of maximum load.

8.2 Each secondary ground shall have a wire or cable connected directly to common ground.

8.3 For noncritical functions, several grounds may be made to a single connection node, which is then connected to a secondary ground through a single conductor. An example is a dash panel which is connected to the cab structure (secondary ground), which is in turn connected to the common ground. Instrument lights and cigar lighter grounds may then be connected to the dash ground.

8.3.1 The connection node shall be provided with a dedicated wire or cable connection to the secondary ground. Bolted joints, hinges, latches, etc., are not acceptable. The maximum current in this conductor shall be limited to 30 A or less.

8.3.2 The maximum voltage differential between any device grounded in this manner and common ground shall not exceed 1.25 V.

9. ***Ground Connections—***Ground connections made to metal surfaces shall maintain contact integrity with the normal effects of aging, temperature cycling, moisture, splash, spray washing, fatigue, and other environmental conditions.

9.1 Metal surfaces shall be free of primer, paint, rust, and corrosion. The surface shall have a bright, polished appearance immediately before the ground terminal is connected.

9.2 The terminal cross section shall be equal to or greater than the wire cross section. The mating surfaces shall be sufficiently flat to ensure that the total contact area is equal to or greater than the sum of the cross-sectional areas of all wires connected to a common grounding point.

9.2.1 A steel flat washer (with an OD approximately equal to the ring terminal diameter) shall be placed between the bolt head and the terminal.

9.2.2 For punched holes, care shall be taken to ensure that the edge distortion on the breakout side does not inhibit contact between mating surfaces.

9.2.3 Star washers have not been proven to be effective as a means of ensuring long-term connection integrity with the effects of aging and environmental extremes. The use of star washers is not recommended.

9.3 Stacking of up to three ring terminals of the same size in medium current, low current, and signal ground applications is acceptable.

9.3.1 It is good practice to place the terminal carrying the highest current closest to the grounding surface.

9.3.2 It is desirable that all ring terminals in a stack have the same OD. However, if ring terminals of dissimilar ODs are used, the largest terminal shall be placed closest to the grounding surface.

9.4 Grounding studs and joints shall be dedicated, and shall not also be used as structural joints. Mixing softer terminal material with stress-bearing joints can lead to loss of electrical and structural integrity.

9.5 All grounding locations shall be accessible for maintenance.