

Seven Conductor Cable for ABS Power - Truck and Bus**RATIONALE**

The SAE J2394 document was reviewed and revised as part of the SAE five year review process. References to non specified ASTM Publications have been removed from Section 2.1.2 (ASTM Publications). The cable types (both stationary and flexing) referenced in Section 4.1 and 4.2 have been corrected to reflect the proper cable definition sections. Section 6.4.10 references a Figure 3 which is not contained within this document. The reference to Figure 3 has been removed from the Section 6.4.10 along with changes to the fluid resistance verbiage. SAE J1128 has also been added to this section for referencing the specific test fluids.

FOREWORD

This document, first published in 1998, superseded the traditional SAE J1067 standard that referred to the 1/8-1/10-5/12 gauge configuration used in non-ABS equipped tractor vehicles. The SAE J2394 standard was developed for a 1/8-2/10-4/12 construction where the blue circuit was upgraded to 10 gauge enabling power for ABS. The traditional seven conductor cable standard was often associated with the tractor-trailer interface cable while the lighter duty low tension primary cable standards became a common reference for the internal primary cables of the seven-conductor cable in truck, trailer and harness manufacturer specifications.

Studies prompted by increased safety awareness suggest that voltage losses in wiring and connectors had become of serious concern and both the SAE J1067 and SAE J2394 standards had been written to better address the demanding physical and electrical performance needs of seven conductor cable used throughout the entire truck and trailer electrical system. While SAE J1067 still exists as a standard to support those few users who still purchase it for older equipment, a switch to this SAE J2394 standard is strongly encouraged.

1. SCOPE

This SAE standard establishes the minimum construction and performance requirements for seven conductor 1/8-2/10-4/12 cable for use on trucks, trailers and converter dollies. Where appropriate, the standard refers to two types of cables, (Type F and S, described later in the standard), due to the variation in the performance demands of cables used in flexing and stationary applications. While the document's title refers to ABS Power to differentiate the document from the SAE J1067 standard that it supersedes, the scope applies to both the primary green cable for powering ABS and lighting and the yellow auxiliary cable of the same construction.

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on this Technical Report, please visit
http://www.sae.org/technical/standards/J2394_201302**

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. The latest issue of publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

- SAE J844 Nonmetallic Airbrake System Tubing
- SAE J1067 Seven Conductor Cable – Truck and Bus
- SAE J1128 Low Voltage Primary Cable

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org

- ASTM B 3 Specification for Soft or Annealed Copper Wire
- ASTM B 33 Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
- ASTM B 172 Specification for Rope Lay Stranded Copper Conductors having Bunch-Stranded Members for Electrical Conductors
- ASTM B 174 Specification for Bunch-Stranded Copper Conductors for Electrical Conductors
- ASTM B 189 Specification for Lead Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes
- ASTM B 263 Standard Test Method for Determination of Cross-Sectional Area of Standard Conductors
- ASTM B 117 Method of Salt Spray (Fog) Testing
- ASTM D 412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension

2.1.3 UL (Underwriters Laboratories) Publications

Available from Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096, Tel: 847-272-8800, www.ul.com.

- UL 1581 Reference Standard for Electrical Wires, Cables, and Flexible Cords - Section 593

2.2 Related Publications

The following publications are noted for information purposes only and are not a required part of this specification.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J560 Seven Conductor Electrical Connector for Truck-Trailer Jumper Cable

SAE J1067 Seven Conductor Cable – Truck and Bus

SAE J2222 Coiled Electrical Cable – Truck and Bus

SAE J2174 Heavy Duty Wiring for Trailers 2032 mm or More in Width

SAE J2202 Heavy Duty Wiring Systems for On-Highway Trucks

3. DEFINITIONS

3.1 FLEXING

Describes a condition where the cable is installed in an unsupported way over a distance of greater than 0.5 m (18 in) and/or where there is a reasonable likelihood that the cable will be subjected to bending, longitudinal extension, or significant movement. As an example all cables connecting the tractor to trailer or dolly to trailer are to be considered flexing cables.

3.2 STATIONARY

Describes a condition where the cable is installed in a fashion where its weight is supported within a distance of 0.5 m (19.7 in) or less, and where there is little likelihood of flexing as described above. An example of a stationary application is cable that is connected with clamps to a vehicle chassis.

3.3 CONDUCTOR

The current carrying element(s) in a cable comprised of a series of copper strands twisted together.

3.4 STRAND

The solid component members of a conductor.

3.5 LAY

The measure along a single plane, between an individual strand or series of copper strands or insulated conductor's starting and ending points in a complete spiral wrap around the grouping of which it is a part.

3.6 INSULATION

The material applied to the conductor to provide electrical insulation and a level of mechanical protection.

3.7 CABLE CORE

The grouping of insulated conductors twisted together.

3.8 JACKET

The outer sheath applied to the cable core to maintain inner conductor positioning and to enhance the mechanical strength and durability of the cable.

4. TYPES

Due to the variation in the performance demands of cables used in different applications within the truck-trailer system, this document addresses two types of cables, determined by their mode of installation.

4.1 Type F - Flexing

Pertains to cables that are subjected to flexing as defined in Section 3.1.

4.2 Type S - Stationary

Pertains to cables that are stationary as defined in Section 3.2.

5. IDENTIFICATION CODE DESIGNATION

Cable conforming to this document shall be identified with the manufacturer's identification, and shall be identified with SAE J2394 and the revision (month and year) of this document along with the cable type as described in this document.

For example: XYZ Corp. SAE J2394 (mo/yr) - Type S (or F)

6. TECHNICAL REQUIREMENTS

6.1 Conductors

6.1.1 Material

All conductors shall be of stranded, soft-annealed copper, complying with ASTM B 3, and ASTM B 174-Class K or ASTM B 172-Class K. Strands may be uncoated or may be coated in a tin complying with ASTM B 33 or a tin/lead coating complying with ASTM B 189.

6.1.2 Cross-Sectional Area

The cross-sectional area of stranded conductors shall not be less than the values specified in Table 1. The cross-sectional area may be verified by measuring actual strand sizes or by using the weight method in ASTM B 263 with a calculated factor to allow for the twist loss.

6.1.3 Stranding

The individual strands contained within a conductor shall be of the same nominal diameter. The minimum number of strands per wire size for the two types of cable covered by this document are as shown in Table 1.

6.1.4 Strand Lay

The maximum acceptable lay of strands for each wire size, regardless of the number of strands in the conductor, is as shown in Table 1.

6.1.5 Conductor Splicing

When agreed between the supplier and purchaser, splices may be used for the individual strands or for the conductor as a whole, provided that they are made in a workmanlike manner as described in ASTM B 172/174, and that they fulfill the following criteria:

- 6.1.5.1 The break strength shall not be reduced by more than 20%.
- 6.1.5.2 The resistance shall not be increased.
- 6.1.5.3 The diameter of the splice must not exceed the diameter of the uninsulated strand or conductor being spliced by more than 20%.
- 6.1.5.4 Single strand splices are not to be closer together than two lay lengths in a bunched or concentric stranded conductor and twenty lay lengths in a rope-lay construction and there shall be no more than three single strand splices per 3 m of conductor.
- 6.1.5.5 Whole conductor splices are not to be closer together than twenty conductor lay lengths in the cable core and there shall be no more than three whole conductor splices per 100 m of cable.

TABLE 1 - CONDUCTORS

SAE Wire Size mm ²	METRIC		Type F (Flexing) Min. Strands	Type S (Stationary) Min. Strands	SAE Wire Size No.	ENGLISH	
	Min. Cond. Area mm ²	Max. Strand Lay Length mm				Min. Cond. Area cir mils	Max. Strand Lay Length Inches
3	3.24	70	65	19	12	6334	2.75
5	5.16	64	104	19	10	10069	2.50
8	8.20	76	133	19	8	16104	3.00

NOTE 1: English units are not direct conversions from metric.

NOTE 2: The metric wire size is the approximate nominal area of the conductor.

NOTE 3: The SAE wire size number indicates that the cross-sectional area of the conductor approximates the area of the American Wire Gauge for the equivalent size.

6.2 Insulation

6.2.1 Material Physical Properties

The unaged physical properties of insulation material, tested in accordance with the method identified in ASTM D 412 at room temperature, (23 °C ± 5 °C) shall be a minimum of the following values:

- 6.2.1.1 Minimum tensile strength of 10 MPa (1500 psi).
- 6.2.1.2 Minimum elongation of 150%.

An accelerated aging test involving heat aging for 168 hours at 110 °C shall be conducted in accordance with SAE J1128.

6.2.2 Application

Insulation shall be homogeneous and shall be placed concentrically within commercial tolerances about the conductor. Insulation shall adhere closely to, but strip readily from the conductor leaving it reasonably clean and in suitable condition for termination.

6.2.3 Insulated Conductor Outside Diameter

The outside diameter of each insulated conductor shall be measured in accordance with SAE J1128. The mean of the diameter readings shall determine the finished insulated conductor diameter and shall be no greater than the maximum values shown in Table 2.

6.2.4 Wall Thickness

The minimum wall thickness shall be measured using the method outlined in SAE J1128. All individual wall thickness values must be in accordance with those listed in Table 2.

6.2.5 Dielectric Voltage Withstand Test

This test is only practical for use by manufacturers of the wire or cable. Refer to 6.2.6 for an alternate test for use by those wishing to test cable before installation or use in harness assemblies. Unless otherwise specified, all specimens shall be the entire length of wire conductors subjected to continuous spark testing with voltage set at 1500 volts, AC.

6.2.5.1 Apparatus

6.2.5.1.1 Spark Tester

A transformer of sufficient capacity to maintain the test voltage specified in the detailed specification under all normal conditions of leakage current shall be used. The core of the transformer and one end of the secondary winding shall be connected to ground. A voltmeter shall be so located in the circuit that it will indicate at all times the actual test voltage applied. The spark tester shall not be simultaneously connected to more than one electrode.

6.2.5.1.2 Electrode

An electrode which makes direct mechanical contact with the surface of the insulation of the wire or cable undergoing test shall be used. A pipe, coiled spring or the like shall not be acceptable. If the link bead-chain type of electrode is used, the bottom of the metal electrode enclosure shall be "V"-shaped. The chains shall have a length appreciably greater than the depth of the enclosure. The width of the trough shall be approximately 38 mm (1.5 in) greater than the diameter of the largest wire or cable to be tested. If a bead-chain type of electrode is used, the beads shall have a diameter of 5 mm (3/16 in). The longitudinal spacing of the chains shall not be more than 13 mm (1/2 in). The transverse spacing of the chains shall not be more than 9.5 mm (3/8 in), except that the spacing may be 13 mm (1/2 in) if the transverse rows of chain are staggered. The electrode shall be provided with a grounded metallic screen or the equivalent as a guard against contact by personnel. The length of the electrode shall be sufficient to meet the requirements in 6.2.5.2.

6.2.5.1.3 Fault Signaling Device

A fault signaling device or system shall include a visible signal, a defect recording device, and/or an automatic stop device. The arrangement shall operate in such a way that when the fault signal is given, it will be maintained until manually reset.

6.2.5.2 Procedure

The spark test shall be conducted as near to the end of the manufacturing process as is practicable. The test voltage shall be as specified in the detailed specification. The specimen shall be attached to the electrode and the electrode connected to one lead of the transformer secondary. Both ends of the conductor of the specimen, the other secondary lead and the transformer core shall be grounded. A direct connection shall be made between the ground of the conductor at the take-up end of the transformer secondary ground. The voltmeter located in the circuit shall indicate the test potential at all times during the test. The speed of the specimen through the electrode shall be adjusted so that contact between the electrode and any point on the insulation of the specimen will be maintained for at least 0.15 seconds. This rate limits the speed of the specimen travel to a maximum of 10 m (33 ft) per minute per 25 mm (1 in) of electrode length. Unless otherwise specified in the detailed specification, the entire delivery of the wire shall be tested.

6.2.6 Alternate Dielectric Test

This test is an alternative to the dielectric voltage withstand test of 6.2.5, for users of cable who wish to perform such a test prior to installation or use in harness assemblies. A 25 mm (1 in) length of insulation shall be removed from each end of a 600 mm (24 in) sample of each size of finished insulated conductor and the two ends twisted together. The loop thus formed shall be immersed in water containing 5% salt by weight at room temperature so that not more than 150 mm (6 in) of each end of the sample protrudes above the solution. After being immersed for 5 hours and while still immersed, the sample shall withstand the application of 1000 V rms at 50 to 60 Hz between the conductor and the solution for 1 minute without failure of the insulation.

6.2.7 Cold Bend Test

Using a specimen of each of the insulated conductor sizes employed in the cable and a mandrel size as identified in Table 2, condition and test the specimen at -40°C according to the method outlined in SAE J1128. A visual inspection shall reveal no cracks or splits. The sample is to be returned to room temperature and then subjected to the dielectric test specified in 6.2.5 or 6.2.6.

6.2.8 Deformation (Pinch) Test

Insulated conductors shall pass the pinch test outlined in SAE J1128. Note that while this test does not specify elevated temperature in the way that a UL deformation test would, the heat aging requirement contained in the above physical properties section is considered fully adequate for the application.

6.2.9 Abrasion Resistance

The cable jacket shall be subjected to the sandpaper abrasion resistance test outlined in SAE J1128. The resistance shall meet or exceed the minimum abrasion requirement of 0.7 N (3 lb).

6.2.10 Fluid Resistance

Insulated conductors shall pass the fluid compatibility requirements as outlined in SAE J1128.

6.2.11 Color-Coding

The conductor color-coding by wire size for this construction is as follows:

- 3 mm² (12 AWG)—Black, Yellow, Green, Brown (4 conductors)
- 5 mm² (10 AWG)—Red, Blue (2 conductors)
- 8 mm² (8 AWG)—White (1 conductor)

The color of the insulated conductors shall match as closely as possible the central colors specified in SAE J1128.

TABLE 2 - INSULATION

METRIC				
SAE Wire Size mm ²	Max. OD mm	Minimum Wall Thickness mm	Mandrel Diameter mm	Abrasion Resistance Newtons
3	3.80	0.46	12.7	0.7
5	4.70	0.56	12.7	0.7
8	6.00	0.46	12.7	0.7
ENGLISH				
SAE Wire Size No.	Max. OD in	Minimum Wall Thickness in	Mandrel Diameter in	Abrasion Resistance Lbs
12	0.150	0.018	0.5	3.0
10	0.185	0.022	0.5	3.0
8	0.235	0.018	0.5	3.0

NOTE 1: English units are not direct conversions from metric.

NOTE 2: The metric wire size is the approximate nominal area of the conductor.

NOTE 3: The SAE wire size number indicates that the cross-sectional area of the conductor approximates the area of the American Wire Gauge.

6.3 Cable Core

6.3.1 Insulated Conductor Lay

The maximum lay of the individual insulated conductors in the cable core shall be 14 times the cable core diameter. Fillers may be used to improve the roundness of the cable core.

6.4 Cable Jacket

6.4.1 Material Physical Properties

The unaged physical properties of the jacket material, tested in accordance with the method identified in ASTM D 412 at room temperature, (23 °C ± 5 °C), shall be a minimum of the following values:

6.4.1.1 Minimum tensile strength of 10 MPa (1500 psi).

6.4.1.2 Minimum elongation of 150%.

An accelerated aging test involving heat aging for 168 hours at 110 °C shall be conducted in accordance with SAE J1128.

6.4.2 Application

The cable jacket shall be homogeneous and shall be placed concentrically within commercial tolerances about the cable core. The jacket shall be readily strippable from the core for purposes of termination.

6.4.3 Overall Cable Diameter

Due to the internal diameter restrictions of the SAE J560 connectors, the overall cable diameter must not exceed 18 mm (0.710 in)

6.4.4 Wall Thickness

The minimum jacket thickness at any point shall be measured in the method described in SAE J1128. The minimum wall thickness at any point of shall be 1.00 mm (0.040 in)