Transport Canada
Motor Vehicle Safety

Transports Canada
Sécurité des véhicules automobiles

TECHNICAL STANDARDS DOCUMENT
No. 305, Revision 3R

Electrolyte Spillage and Electrical Shock Protection

The text of this document is based on Federal Motor Vehicle Safety Standard No. 305, Electric-powered vehicles: electrolyte spillage and electrical shock protection as published in the U.S. *Code of Federal Regulations,* Title 49, Part 571, revised as of October 1, 2010 as well as the Final Rules the *Federal Register* on July 29, 2011 (Vol. 76, No. 146, p. 45436).

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Introduction

As defined by section 12 of the *Motor Vehicle Safety Act*, a Technical Standards Document (TSD) is a document that reproduces an enactment of a foreign government (e.g. a Federal Motor Vehicle Safety Standard issued by the U.S. National Highway Traffic Safety Administration). According to the Act, the *Motor Vehicle Safety Regulations* may alter or override some provisions contained in a TSD or specify additional requirements; consequently, it is advisable to read a TSD in conjunction with the Act and the *Motor Vehicle Tire Safety Regulations*. As a guide, where the corresponding Regulation contains additional requirements, footnotes indicate the amending subsection number.

TSDs are revised from time to time in order to incorporate amendments made to the reference document, at which time a Notice of Revision is published in the *Canada Gazette*, Part I. All TSDs are assigned a revision number, with "Revision 0" designating the original version.

Identification of Changes

In order to facilitate the incorporation of a TSD, certain non-technical changes may be made to the foreign enactment. These may include the deletion of words, phrases, figures, or sections that do not apply under the Act or Regulations, the conversion of imperial to metric units, the deletion of superseded dates, and minor changes of an editorial nature. Additions are <u>underlined</u>, and provisions that do not apply are ~~stroked through~~. Where an entire section has been deleted, it is replaced by: "[CONTENT DELETED]". Changes are also made where there is a reporting requirement or reference in the foreign enactment that does not apply in Canada. For example, the name and address of the United States Department of Transportation are replaced by those of the Department of Transport.

Effective Date and Mandatory Compliance Date

The effective date of a TSD is the date of publication of its incorporating regulation or of the notice of revision in the *Canada Gazette*, and the date as of which voluntary compliance is permitted. The mandatory compliance date is the date upon which compliance with the requirements of the TSD is obligatory. If the effective date and mandatory compliance date are different, manufacturers may follow the requirements that were in force before the effective date, or those of this TSD, until the mandatory compliance date.

In the case of an initial TSD, or when a TSD is revised and incorporated by reference by an amendment to the Regulations, the mandatory compliance date is as specified in the Regulations, and it may be the same as the effective date. When a TSD is revised with no corresponding changes to the incorporating Regulations, the mandatory compliance date is six months after the effective date.

Official Version of Technical Standards Documents

The PDF version is a replica of the TSD as published by the Department and is to be used for the purposes of legal interpretation and application.

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S1. Scope

This Technical Standards Document (TSD) ~~standard~~ specifies requirements for limitation of electrolyte spillage, retention of electric energy storage/conversion devices, and protection from harmful electric shock during and after a crash.

S2. Purpose

The purpose of this TSD ~~standard~~ is to reduce deaths and injuries during and after a crash that occurs because of electrolyte spillage from electric energy storage devices, intrusion of electric energy storage/conversion devices into the occupant compartment, and electrical shock.

S3. Application

[CONTENT DELETED] For applicability, please see Schedule III and subsection 305(1) of Schedule IV to the *Motor Vehicle Safety Regulations*.

S4. Definitions

Automatic disconnect means a device that when triggered, conductively separates a high voltage source from the electric power train or the rest of the electric power train. *(Dispositif de débranchement automatique)*

Electric energy storage device means a high voltage source that stores energy for vehicle propulsion. This includes, but is not limited to, a high voltage battery or battery pack, rechargeable energy storage device, and capacitor module. *(Dispositif d'accumulation d'énergie électrique)*

Electric energy storage/conversion device means a high voltage source that stores or converts energy for vehicle propulsion. This includes, but is not limited to, a high voltage battery or battery pack, fuel cell stack, rechargeable energy storage device, and capacitor module. *(Dispositif d'accumulation/de conversion d'énergie électrique)*

Electric energy storage/conversion system means an assembly of electrical components that stores or converts electrical energy for vehicle propulsion. This includes, but is not limited to, high voltage batteries or battery packs, fuel cell stacks, rechargeable energy storage systems, capacitor modules, inverters, interconnects, and venting systems. *(Système d'accumulation/de conversion d'énergie électrique)*

Electric power train means an assembly of electrically connected components which includes, but is not limited to, electric energy storage/conversion systems and propulsion systems. *(Système de propulsion électrique)*

Electrical chassis means conductive parts of the vehicle whose electrical potential is taken as reference and which are: (1) conductively linked together, and (2) not high voltage sources during normal vehicle operation. *(Châssis électrique)*

Electrical isolation of a high voltage source in the vehicle means the electrical resistance between the high voltage source and any of the vehicle's electrical chassis divided by the working voltage of the high voltage source. *(Isolation électrique)*

High voltage source means any electric component contained in the electric power train or conductively connected to the electric power train that has a working voltage greater than 30 VAC or 60 VDC. *(Source de haute tension)*

Propulsion system means an assembly of electric or electro-mechanical components or circuits that propel the vehicle using the energy that is supplied by a high voltage source. This includes, but is not limited to, electric motors, inverters/converters, electronic controllers, and associated wire harnesses and connectors, and coupling systems for charging rechargeable energy storage systems. *(Système de propulsion)*

Working voltage means the highest root mean square voltage of the voltage source, which may occur across its terminals or between its terminals and any conductive parts in open circuit conditions or under normal operating conditions. *(Tension de fonctionnement)*

VAC means volts of alternating current (AC). *(VCA)*

VDC means volts of direct current (DC). *(VCC)*

S5. General requirements

Each vehicle to which this TSD ~~standard~~ applies, must meet the requirements in S5.1, S5.2, and S5.3 when tested according to S6 under the conditions of S7.

S5.1 Electrolyte spillage from propulsion batteries[1]

Not more than 5.0 liters of electrolyte from propulsion batteries shall spill outside the passenger compartment, and no visible trace of electrolyte shall spill into the passenger compartment. Spillage is measured from the time the vehicle ceases motion after a barrier impact test until 30 minutes thereafter, and throughout any static rollover after a barrier impact test.

S5.2 Electric energy storage/conversion device retention[1]

During and after each test specified in S6 of this TSD ~~standard~~:

(a) Electric energy storage/conversion devices shall remain attached to the vehicle by at least one component anchorage, bracket, or any structure that transfers loads from the device to the vehicle structure, and
(b) Electric energy storage/conversion devices located outside the occupant compartment shall not enter the occupant compartment.

[1] Please see subsection 305(5) of Schedule IV to the *Motor Vehicle Safety Regulations* (MVSR) for an additional requirement.

S5.3 Electrical safety[1]

After each test specified in S6 of this TSD ~~standard~~, each high voltage source in a vehicle must meet the electrical isolation requirements of subparagraph (a) or the voltage level requirements of subparagraph (b).

(a) The electrical isolation of the high voltage source, determined in accordance with the procedure specified in S7.6, must be greater than or equal to one of the following:

(1) 500 ohms/volt for an AC high voltage source; or

(2) 500 ohms/volt for a DC high voltage source without electrical isolation monitoring during vehicle operation; or

(3) 100 ohms/volt for a DC high voltage source with electrical isolation monitoring, in accordance with the requirements of S5.4, during vehicle operation.

(b) The voltages V1, V2, and Vb of the high voltage source, measured according to the procedure specified in S7.7, must be less than or equal to 30 VAC for AC components or 60 VDC for DC components.

S5.4 Electrical isolation monitoring

Each DC high voltage source with electrical isolation monitoring during vehicle operation pursuant to S5.3(a)(3~~2~~) shall be monitored by an electrical isolation monitoring system that displays a warning for loss of isolation when tested according to S8. The system must monitor its own readiness and the warning display must be visible to the driver seated in the driver's designated seating position.

S6. Test requirements

Each vehicle to which this TSD ~~standard~~ applies, under the conditions of S7, must be capable of meeting the requirements of any applicable single barrier crash/static rollover test sequence, without alteration of the vehicle during the test sequence. A particular vehicle need not meet further test requirements after having been subjected to a single barrier crash/static rollover test sequence.

S6.1 Frontal barrier crash

The vehicle must meet the requirements of S5.1, S5.2, and S5.3 when it is traveling longitudinally forward at any speed, up to and including 48 km/h, and impacts a fixed collision barrier that is perpendicular to the line of travel of the vehicle, or at any angle up to 30 degrees in either direction from the perpendicular to the line of travel of the vehicle.

[1] Please see subsection 305(5) of Schedule IV to the *Motor Vehicle Safety Regulations* (MVSR) for an additional requirement.

S6.2 Rear moving barrier impact[2, 3]

The vehicle must meet the requirements of S5.1, S5.2, and S5.3, when it is impacted from the rear by a barrier that conforms to S7.3(b) of the U.S. *Code of Federal Regulations* (CFR), Title 49, Part 571, Standard No. 301 (hereinafter referred to as 49 CFR 571.301) ~~of this chapter~~ and that is moving at any speed up to and including 80 km/h (50 mph) with dummies in accordance with S6.2 of 49 CFR 571.301 ~~of this chapter~~.

S6.3 Side moving deformable barrier impact[2]

The vehicle must meet the requirements of S5.1, S5.2, and S5.3 when it is impacted from the side by a barrier that conforms to 49 CFR part 587 ~~of this chapter~~ that is moving at any speed up to and including 54 km/h, with the appropriate 49 CFR part 572 test dummies specified in 49 CFR 571.214 ~~of this chapter~~.

S6.4 Post-impact test static rollover

The vehicle must meet the requirements of S5.1, S5.2, and S5.3, after being rotated on its longitudinal axis to each successive increment of 90 degrees after each impact test specified in S6.1, S6.2, and S6.3.

S7. Test conditions

When the vehicle is tested according to S6, the requirements of S5.1 through S5.3 must be met under the conditions specified in S7.1 through S7.7. All measurements for calculating voltage(s) and electrical isolation are made after a minimum of 5 seconds after the vehicle comes to rest in tests specified in S6. Where a range is specified, the vehicle must be capable of meeting the requirements at all points within the range.

S7.1 Electric energy storage device state-of-charge

The electric energy storage device shall be at the state-of-charge specified in either subparagraph (a), (b), or (c):

(a) At the maximum state-of-charge in accordance with the vehicle manufacturer's recommended charging procedures, as stated in the vehicle owner's manual or on a label that is permanently affixed to the vehicle; or

(b) If the manufacturer has made no recommendation for charging procedures in the owner's manual or on a label permanently affixed to the vehicle, at a state-of-charge

[2] Please see subsection 305(2) of Schedule IV to the *Motor Vehicle Safety Regulations* (MVSR) for an additional requirement.

[3] Please see subsection 305(4) of Schedule IV to the *Motor Vehicle Safety Regulations* (MVSR) for an additional requirement.

of not less than 95 percent of the maximum capacity of the electric energy storage device; or

(c) If the electric energy storage device(s) is/are rechargeable only by an energy source on the vehicle, at any state-of-charge within the normal operating voltage defined by the vehicle manufacturer.

S7.2 Vehicle conditions

The switch or device that provides power from the electric energy storage/conversion system to the propulsion system is in the activated position or the ready-to-drive position.

S7.2.1 The parking brake is disengaged and the transmission, if any, is in the neutral position. In a test conducted under S6.3, the parking brake is set.

S7.2.2 Tires are inflated to the manufacturer's specifications.

S7.2.3 The vehicle, including test devices and instrumentation, is loaded as follows[4]:

(a) A passenger car is loaded to its unloaded vehicle ~~weight~~ mass plus its rated cargo and luggage capacity ~~weight~~ mass, secured in the luggage area, plus the necessary test dummies as specified in S6, restrained only by means that are installed in the vehicle for protection at its seating position.

(b) A multipurpose passenger vehicle, truck, or bus with a GVWR of 4 536 kg or less is loaded to its unloaded vehicle ~~weight~~ mass plus the necessary dummies, as specified in S6, plus 136 kg or its rated cargo and luggage capacity ~~weight~~ mass, whichever is less. Each dummy is restrained only by means that are installed in the vehicle for protection at its seating position.

S7.3 Static rollover test conditions

In addition to the conditions of S7.1 and S7.2, the conditions of S7.4 of Sec. 49 CFR 571.301 ~~of this chapter~~ apply to the conduct of static rollover tests specified in S6.4.

S7.4 Rear moving barrier impact test conditions[5]

In addition to the conditions of S7.1 and S7.2, the conditions of S7.3(b) and S7.6 of 49 CFR 571.301 ~~of this chapter~~ apply to the conducting of the rear moving deformable barrier impact test specified in S6.2.

[4] Please see subsection 305(3) of Schedule IV to the *Motor Vehicle Safety Regulations* (MVSR) for an additional requirement.

[5] Please see subsection 305(2) of Schedule IV to the *Motor Vehicle Safety Regulations* (MVSR) for an additional requirement.

S7.5 Side moving deformable barrier impact test conditions[5]

In addition to the conditions of S7.1 and S7.2, the conditions of S8.9, S8.10, and S8.11 of 49 CFR 571.214 ~~of this chapter~~ apply to the conduct of the side moving deformable barrier impact test specified in S6.3.

S7.6 Electrical isolation test procedure

In addition to the conditions of S7.1 and S7.2, the conditions in S7.6.1 through S7.6.7 apply to the measuring of electrical isolation specified in S5.3(a).

S7.6.1 Prior to any barrier impact test, the energy storage/conversion system is connected to the vehicle's propulsion system, and the vehicle ignition is in the ''on'' (propulsion system energized) position. Bypass any devices or systems that do not allow the propulsion system to be energized at the time of impact when the vehicle ignition is on and the vehicle is in neutral. For a high voltage source that has an automatic disconnect that is physically contained within itself, the electrical isolation measurement after the test is made from the side of the automatic disconnect connected to the electric power train or to the rest of the electric power train if the high voltage source is a component contained in the power train. For a high voltage source that has an automatic disconnect that is not physically contained within itself, the electrical isolation measurement after the test is made from both the high voltage source side of the automatic disconnect and from the side of the automatic disconnect connected to the electric power train or to the rest of the electric power train if the high voltage source is a component contained in the power train.

S7.6.2 The voltmeter used in this test has an internal resistance of at least 10 MΩ.

S7.6.3 The voltage(s) is/are measured as shown in Figure 1 and the high voltage source voltage(s) (Vb) is/are recorded. Before any vehicle impact test, Vb is equal to or greater than the nominal operating voltage as specified by the vehicle manufacturer.

S7.6.4 The voltage(s) is/are measured as shown in Figure 2, and the voltage(s) (V1) between the negative side of the high voltage source and the electrical chassis is/are recorded.

S7.6.5 The voltage(s) is/are measured as shown in Figure 3, and the voltage(s) (V2) between the positive side of the high voltage source and the electrical chassis is/are recorded.

S7.6.6 If V1 is greater than or equal to V2, insert a known resistance (Ro) between the negative side of the high voltage source and the electrical chassis. With the Ro installed, measure the voltage (V1′) as shown in Figure 4 between the negative side of the high voltage source and the electrical chassis. Calculate the electrical isolation resistance (Ri) according to the formula shown. Divide Ri (in ohms) by the working voltage of the high voltage source (in volts) to obtain the electrical isolation (in ohms/volt).

S7.6.7 If V2 is greater than V1, insert a known resistance (Ro) between the positive side of the high voltage source and the electrical chassis. With the Ro installed, measure the voltage (V2′) as shown in Figure 5 between the positive side of the high voltage source and the electrical chassis. Calculate the electrical isolation resistance (Ri) according to the formula shown. Divide Ri (in ohms) by the working voltage of the high voltage source (in volts) to obtain the electrical isolation (in ohms/volt).

S7.7 Voltage measurement.

For the purpose of determining the voltage level of the high voltage source specified in S5.3(b), voltage is measured as shown in Figure 1. Voltage Vb is measured across the two terminals of the voltage source. Voltages V1 and V2 are measured between the source and the electrical chassis. For a high voltage source that has an automatic disconnect that is physically contained within itself, the electrical isolation measurement after the test is made from the side of the automatic disconnect connected to the electric power train or to the rest of the electric power train if the high voltage source is a component contained in the power train. For a high voltage source that has an automatic disconnect that is not physically contained within itself, the electrical isolation measurement after the test is made from both the high voltage source side of the automatic disconnect and from the side of the automatic disconnect connected to the electric power train or to the rest of the electric power train if the high voltage source is a component contained in the power train.

S8 Test procedure for on-board electrical isolation monitoring system.

Prior to any impact test, the requirements of S5.4 for the on-board electrical isolation monitoring system shall be tested using the following procedure.

(1) The electric energy storage device is at the state-of-charge specified in S7.1.

(2) The switch or device that provides power from the high voltage system to the propulsion motor(s) is in the activated position or the ready-to-drive position.

(3) Determine the isolation resistance, Ri, of the high voltage source with the electrical isolation monitoring system using the procedure outlined in S7.6.2 through S7.6.7.

(4) Insert a resistor with resistance Ro equal to or greater than 1/(1/(95 times the working voltage of the high voltage source)-1/Ri) and less than 1/(1/(100 times the working voltage of the high voltage source)-1/Ri) between the positive terminal of the high voltage source and the electrical chassis.

(5) The electrical isolation monitoring system indicator shall display a warning visible to the driver seated in the driver's designated seating position.

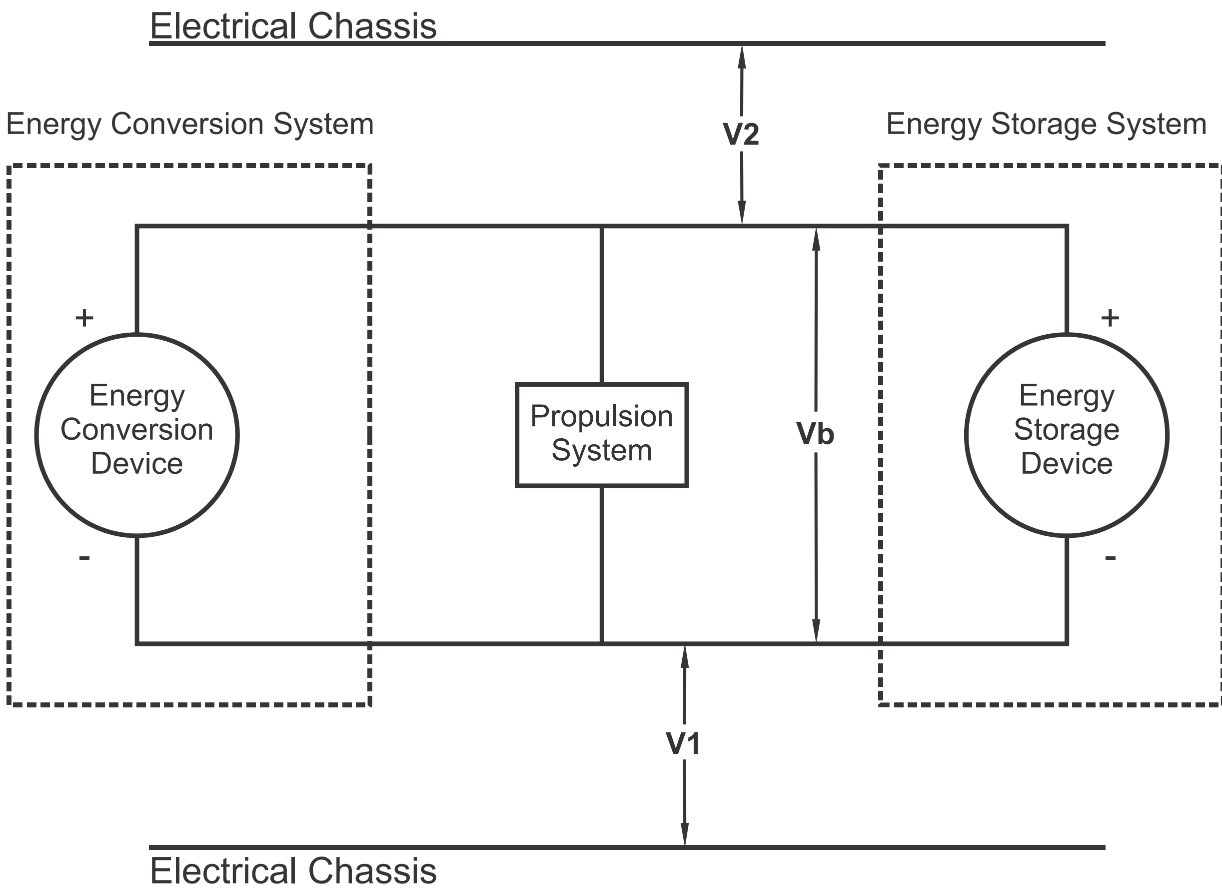


Figure 1 — S7.6.3 and S7.7 Voltage Measurements of the High Voltage Source

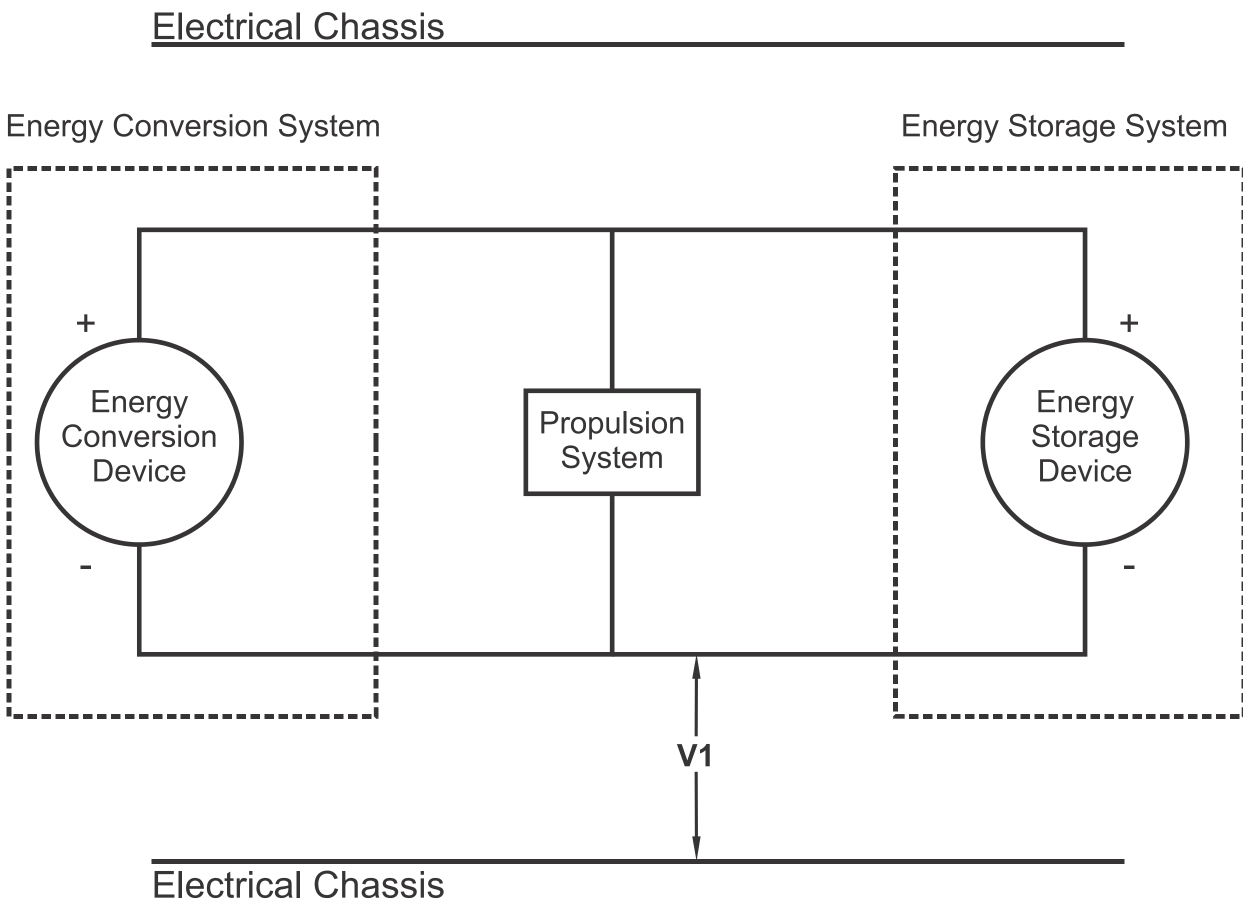


Figure 2 — S7.6.4 Measurement for V1 Voltage between the Negative Side of the High Voltage Source and the Electrical Chassis

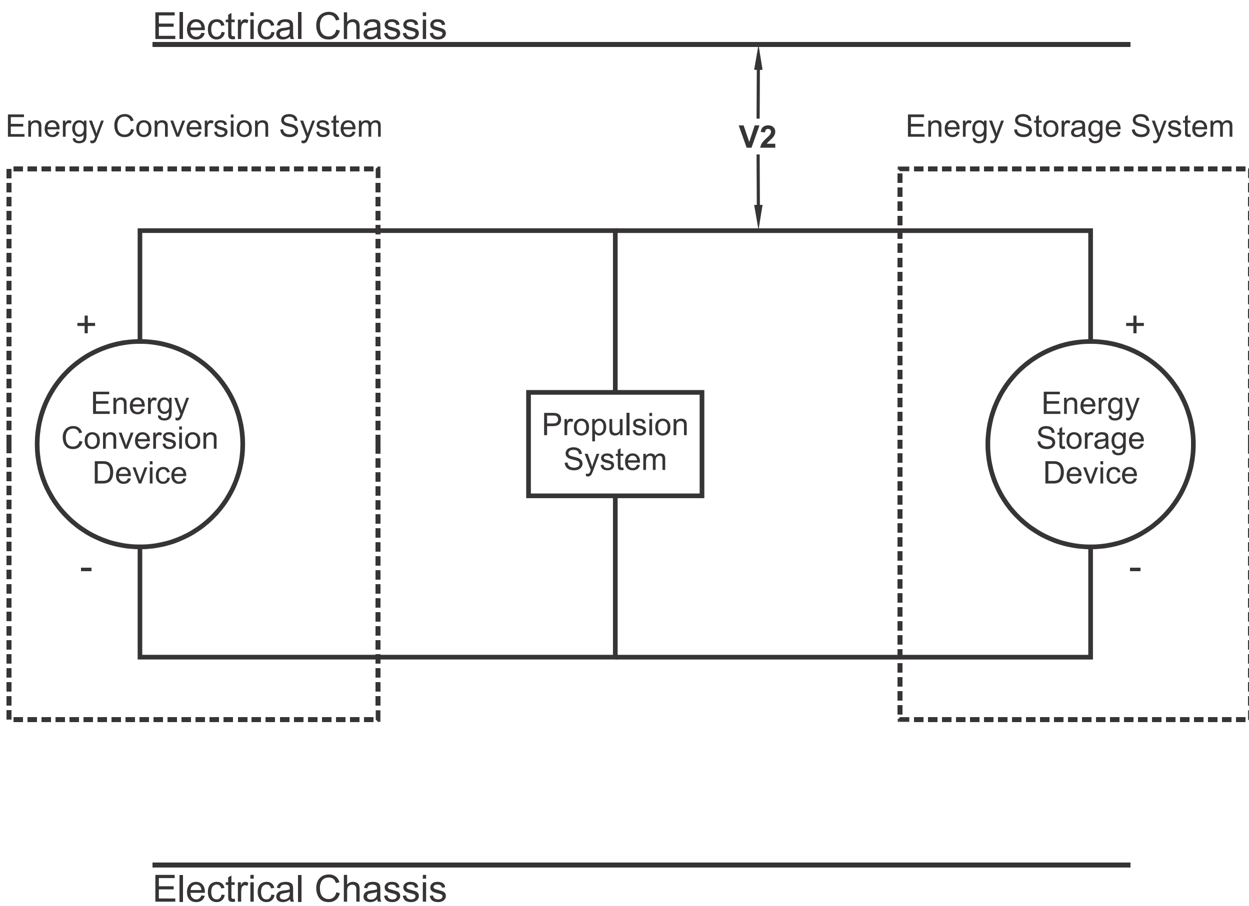


Figure 3 — S7.6.5 Measurement for V2 Voltage between the Positive Side of the High Voltage Source and the Electrical Chassis

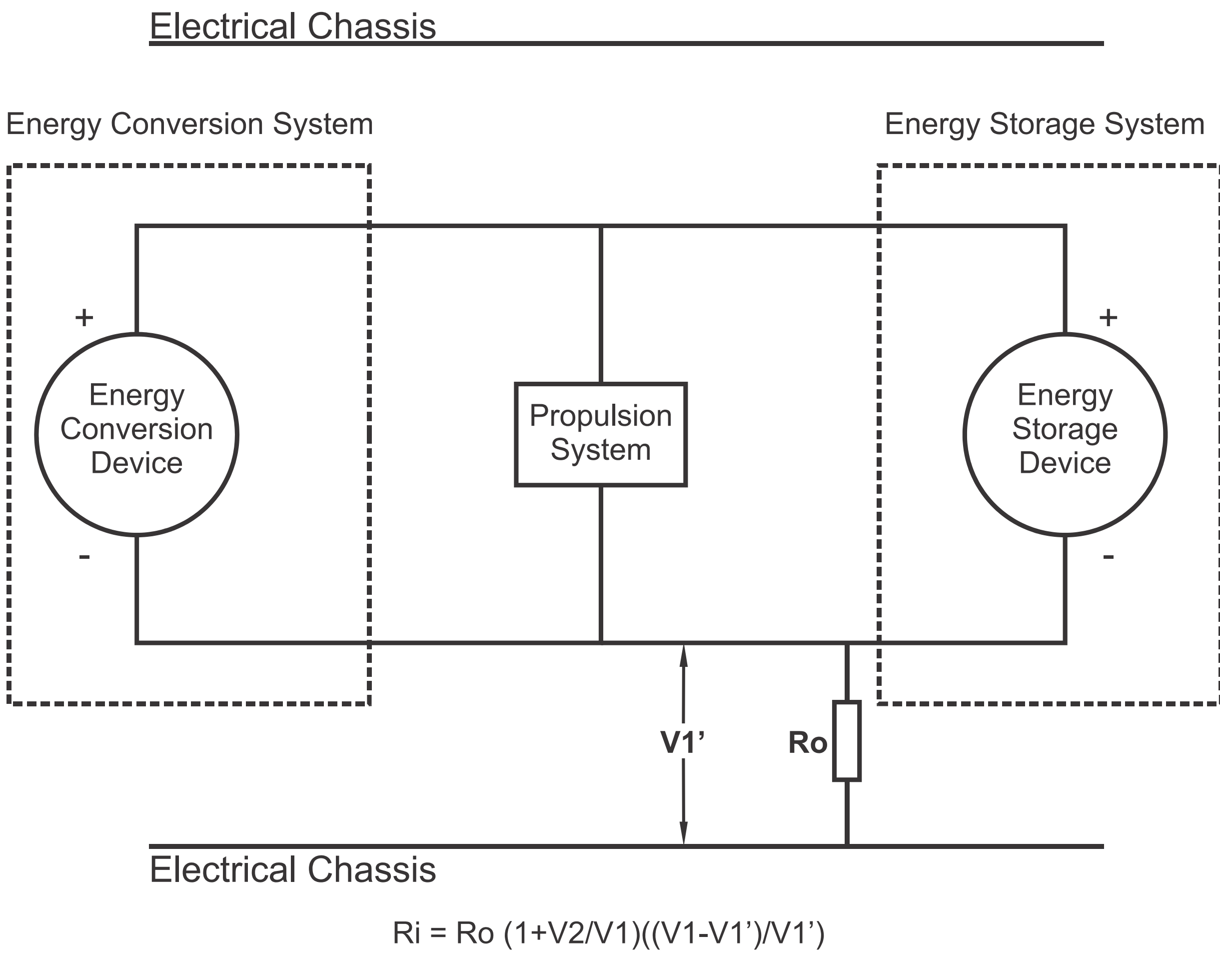
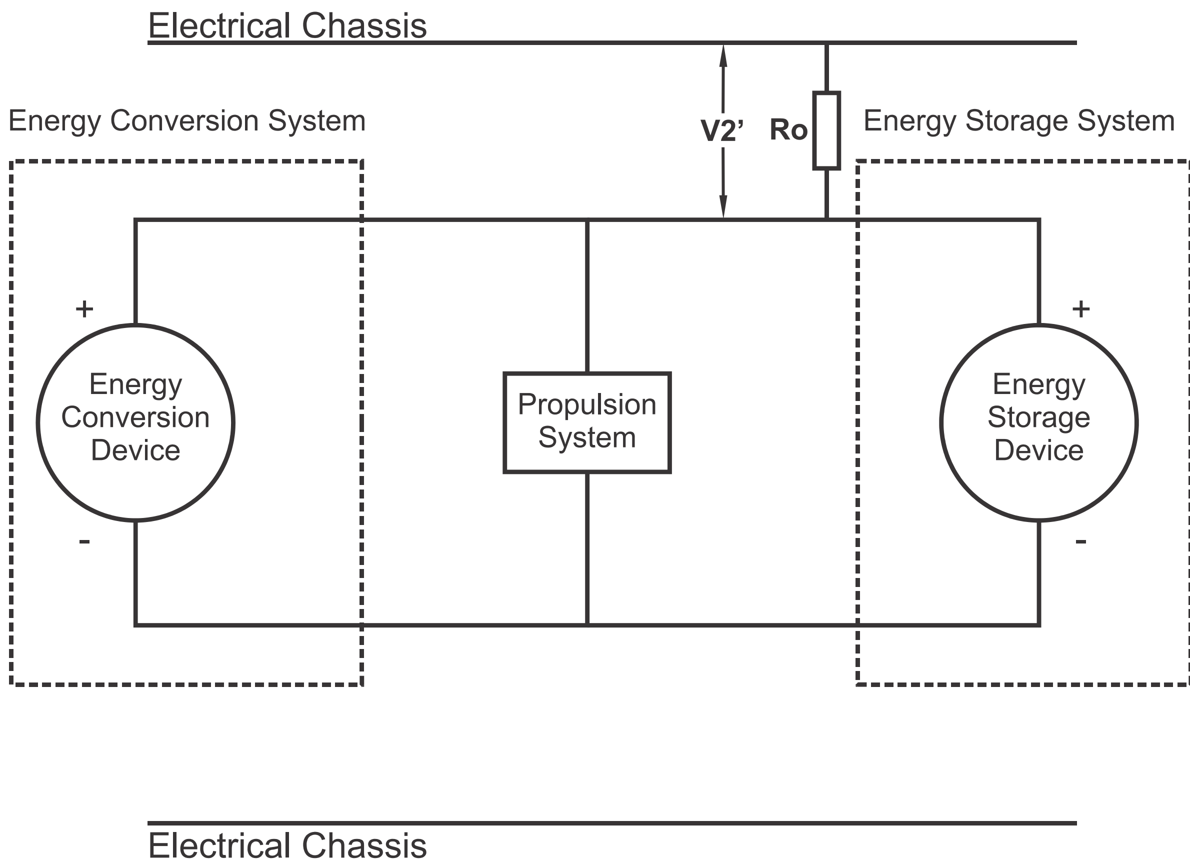


Figure 4 — S7.6.6 Measurement for V1' Voltage across Resistor between Negative Side of the High Voltage Source and Electrical Chassis



$$Ri = Ro\,(1+V1/V2)((V2-V2')/V2')$$

Figure 5 — S7.6.7 Measurement for V2’ Voltage across Resistor between Positive Side of High Voltage Source and Electrical Chassis