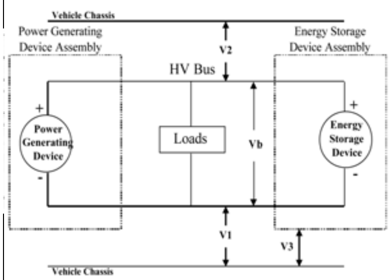
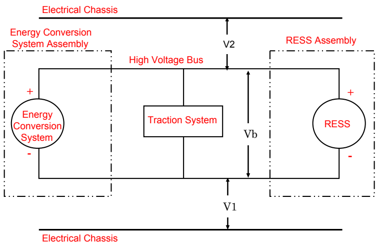
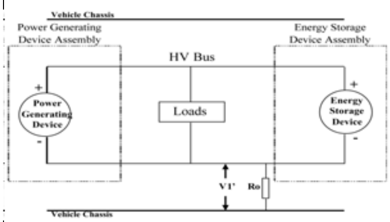
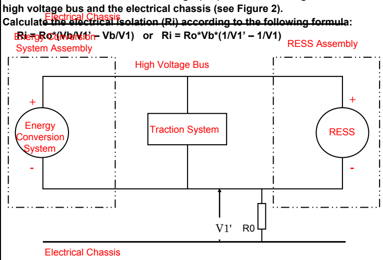
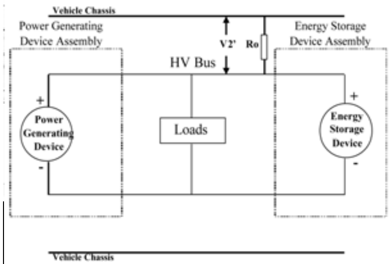
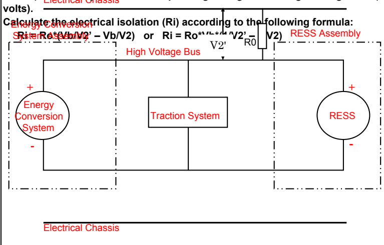
OICA proposal for Electrical Safety In-Use: comparison between previous and new proposal

Paragraph	ELSA Draft 080724		OICA proposal 20081012	OICA Comment
1.	1. ~~Scope~~ General	1	**General**	
	This module shall apply to the drive train of electric vehicles, hybrid vehicles and fuel cell vehicles high voltage components and systems which are galvanically connected to the high voltage bus of vehicles including the coupling system for connecting to the mains.		**This module shall apply to the electric power train of electric vehicles, hybrid vehicles and fuel cell vehicles, and the high voltage components and systems which are galvanically connected to the high voltage bus of the power train.**	- Revised to a term used in existing R100 - Included the coupling system for charging in the definition of "power train"
2.	Definitions	2	**Definitions**	
	For the purpose of this regulation the following definitions apply:		**For the purpose of this regulation the following definitions apply:**	
		2-1	**Electric powertrain** **The electrical circuit which may include the RESS, the energy conversion system, the electronic converters, the traction motors, the associated wiring harness and connectors and the coupling system for charging the RESS**	- Added the definitions based on existing R100. - Changed "traction battery" to "RESS". - Included the coupling system for charging in "power train"
[2–1	"Traction battery" the electrical power storage units which are electrically connected, and its assembly, the supply of energy of the power.	2-2	**RESS** **Rechargeable energy Storage System that provides the energy for electric propulsion.**	
2-1	"Rechargeable energy storage system RESS" system that stores energy for delivery of electric energy and which is rechargeable]			- Added the words "propulsion" to distinguish from other motors.
		2-3	**Energy conversion** **System that generates and provides electrical energy for propulsion**	- Added the definition.
		2-4	**Electronic converters** **a device capable of controlling or converting electric power,**	- Added the definition.
		2-5	**Coupling system for charging the RESS** **the electrical circuit used for charging the RESS from an external electric power supply, including the vehicle inlet.**	- Added the definition.
		2-6	**External electric power supply** **an AC or DC electric power supply outside of the vehicle.**	- Added the definition.
2–2	"Passenger compartment" the space for occupant accommodation, bounded by the roof, floor, side walls, doors, window glass, front bulkhead and rear bulkhead, or rear gate, as well as by the barriers and enclosures provided for protecting the power train from direct contact with live parts.	2–7	**(No change from ELSA draft)**	
2–3	"Luggage compartment" the space in the vehicle for luggage accommodation, bounded by the roof, hood, floor, side walls, as well as by the barrier and enclosure provided for protecting the power train from direct contact with live parts, being separated from the passenger compartment by the front bulkhead or the rear bulk head.	2–8	**(No change from ELSA draft)**	
2–4	"Direct contact" the contact of persons with live parts.	2–9	**(No change from ELSA draft)**	
2–5	"Live parts" ~~any~~ conductive part(s) intended to be electrically energized in normal use.	2–10	**(No change from ELSA draft)**	
2–6	"Indirect contact" the contact of persons with exposed conductive parts.	2–11	**(No change from ELSA draft)**	
2–7	"Protection degree IPXXB" and "Protection degree IPXXD" refer to those defined in ISO 20653 (2006??), Road vehicles - Degrees of protection (IP-Code) - Protection of electrical equipment against foreign objects, water and access	2–12	**"Protection degree"** **Protection provided by a barrier/enclosure related to the contact with live parts by a test probe, such as a test finger (IPXXB) or a test wire (IPXXD), as defined in Annex 3 of ECE 100**	Still needs to be looked at in detail because not all of the par. of annex 3 are relevant Alternatively also reference can be made to ISO 20653, par. 8.3.2.table 5 & table 6)
[2–8	"Exposed conductive part" conductive part which can be touched under the provisions of the applicable protection degree (see 2.7), and which is not normally alive, but which may become electrically energized under any failure conditions.	2-13	**Exposed conductive part** **conductive part which can be touched under the provisions of the applicable protection degree IPXXB but which only becomes electrically energized under failure conditions.**	- Clarified the definition. (IPXXB is used for judgment of "exposed conductive part" in ISO, too.)
2-8-2	"Non-exposed conductive part" Conductive part which cannot be touched under the provisions of the applicable protection degree (see 2.7)]		**delete**	- Deleted because this term is not used in this regulation.
2–9	"Electrical circuit" an assembly of connected live parts ~~through~~ which are ~~an electric current is~~ designated to electrically energized ~~pass~~ in normal operation conditions.	2–14	**Electrical circuit** **an assembly of connected live parts which is designed to be electrically energized in normal operation.**	
2–10	"Working voltage" the highest value of an electrical circuit voltage, specified by the manufacturer, which may occur between any conductive parts in open circuit conditions or under normal operation condition.	2–15	**(No change from ELSA draft)**	
2–11	"Electrical chassis" a set made of conductive parts electrically linked together, whose potential is taken as reference.	2–16	**(No change from ELSA draft)**	
2–12	"Solid insulator" insulating coating of wiring harnesses provided in order to cover and protect the live parts against direct contact from any direction of access; covers for insulating the live parts of connectors; and varnish or paint for the purpose of insulation.	2–17	**(No change from ELSA draft)**	
2–13	"Barrier" the part providing protection against direct contact to the live parts from any direction of access.	2–18	**(No change from ELSA draft)**	
2–14	"Enclosure" the part enclosing the internal units and providing protection against direct contact from any usual direction of access.	2–19	**(No change from ELSA draft)**	
2–15	"Service plug" the device for shutting off the electrical circuit when conducting checks and services of the traction battery, fuel cell stack, etc.	2–20	**(No change from ELSA draft)**	
		2-21	**On-board insulation resistance monitoring system** **the device which monitors the insulation resistance between the high voltage buses and the electrical chassis**	- Added the definition. - comment: isolation resistance is different from insulation material (appropriate use of these two terms needs to be double checked througout the whole text)
2 - 16	"High Voltage" classification of an electric component or circuit, if its maximum working voltage is > 60 V and ≤ [1500 V d.c.] or > 30 V and ≤ [1000 V a.c.] respectively	2-22	**(No change from ELSA draft)**	
2 - 17	"High Voltage Bus" electric circuit, including the vehicle coupling system, that operates on high voltage	2-23	**High voltage bus** **electrical circuit, including the coupling system for charging the RESS, that operates on high voltage**	
2 - 18	"Active driving possible mode" vehicle mode when application of pressure to the accelerator pedal (or activation of an equivalent control) will cause the drive train to move the vehicle.	2-24	**(No change from ELSA draft)**	
3.	Requirements for Protection against Electrical Shock - not connected	3.	**Requirements for Protection against Electrical Shock**	
	General		**General**	
	These electrical safety requirements apply to high voltage buses which are not galvanically connected to external high voltage power supplies.		These electrical safety requirements apply to high voltage buses under conditions where they are not connected to external high voltage electric power supplies.	
3.2.	Protection against direct contact	3-1	**Protection against direct contact**	
	The protection against direct contact with live parts shall comply with paragraphs 3–2–1 and 3–2–2. These protections (solid insulator, barrier, enclosure, etc.) shall be reliably secured and sturdy, and they shall not be able to be opened, disassembled or removed without the use of tools. However, connectors of the high voltage bus may be separated without the use of tools, provided that they comply with the requirements of paragraphs 3–2–1 and 3–2–2 when separated. ~~under a condition that their connection is separated~~ This requirement is fulfilled if other components must be removed with the use of tools in order to separate the connector.		**The protection against direct contact with live parts shall comply with paragraphs 3–2–1 and 3–2–2. These protections (solid insulator, barrier, enclosure, etc.) shall be reliably secured and sturdy, and they shall not be able to be opened, disassembled or removed without the use of tools.** **Connectors (including vehicle inlet) are deemed to meet this requirement if:** **- they comply with 3–2–1 and 3–2–2 when separated without the use of tools or** **- they are located underneath the vehicle floor fulfill and provided with a locking mechanism or** **- they are provided with a locking mechanism and other components must be removed with the use of tools in order to separate the connector or.** **- the voltage of the live parts becomes equal or below 60 VDC or equal or below 30 VAC (r.m.s.) within one second after the connector is separated**	
3–2–1	For protection of live parts inside the passenger compartment or luggage compartment, the protection degree IPXXD shall be provided.	3-2-1	**(No change from ELSA draft)**	
3–2–2	For protection of live parts in areas other than the passenger compartment or luggage compartment, the protection degree IPXXB must be satisfied.	3-2-2	**(No change from ELSA draft)**	
3-2-3	Service plug For the service plug which can be opened, disassembled or removed without tools, it is acceptable if protection degree IPXXB is satisfied under a condition where it is opened, disassembled or removed without tools.	3-2-3	**(No change from ELSA draft)**	
[3-2-4	Vehicle inlet However, ~~this~~ the ~~provision~~ requirements of §§ 3-2-1 and 3-2-2 shall not apply to the vehicle inlet where the voltage of the live parts becomes equal or below DC 60V or equal or below AC 30V (r.m.s.) immediately after the connection to the external power supply is released.]		**deleted**	

3-2-4	Marking	3-2-4	**Marking**	
	The symbol shown in Figure 1 shall appear near high voltage electric energy sources as RESS and fuel cell stacks. The same symbol shall be visible on enclosures, which, when removed expose live parts of high voltage circuits and/or basic insulation. [Accessibility and removability of barriers / enclosures should be considered for the necessity of the symbol.] The symbol background shall be yellow, the bordering and the arrow shall be black. The outer covering of cables and harness for high voltage circuits, not within enclosures shall be identified by [orange] color. NOTE 1 High voltage connectors may be identified by the harnesses to which the connector is attached.		**The symbol shown in Figure 1 shall appear near the RESS** **The same symbol shall be visible on enclosures and barriers, which, when removed expose live parts of high voltage buses.** **However, this provision shall not apply to any of the following cases** **- where barriers or enclosures can not be disassembled, opened or removed unless other componenst are removed with the use of tools** **- where barriers or enclosures are located underneath teh vehicle floor** **- where double or more protections are provided by the barrier, enclosure or solid insulator** **The symbol background shall be yellow, the bordering and the arrow shall be black.** **The outer covering of cables and harness for high voltage buses, not within enclosures or not underneath the vehicle floor shall be orange or similar color.** **This provision shall not apply to any connectors for high voltage buses.**	Added an exemption for marking in the case that barriers or enclosures are underneath the floor where people don't access in normal use.
3–3	Protection against indirect contact	3-3	**Protection against indirect contact**	
3–3–1	For protection against electrical shock which could arise from indirect contact, the exposed conductive parts, such as the conductive barrier and enclosure, shall be galvanically connected securely to the electrical chassis by connection with electrical wire or ground cable, or by welding, or by connection using bolts, etc. so that no dangerous potentials are produced.	3-3-1	**For protection against electrical shock which could arise from indirect contact, the exposed conductive parts, such as the conductive barrier and enclosure, shall be galvanically connected securely to the electrical chassis by connection with electrical wire or ground cable, or by welding, or by connection using bolts, etc. so that no dangerous potentials are produced.**	
3–3–2	The resistance between all exposed conductive parts and the electrical chassis shall be lower than 0.1 ohm when there is current flow of at least 0.2 amperes. The said resistance shall be regarded as lower than 0.1 ohm when it is clearly evident that the DC electrical connection has been established [adequately and securely by such means as] welding.	3-3-2	**The resistance between all exposed conductive parts and the electrical chassis shall be lower than 0.1 ohm when there is current flow of at least 0.2 amperes.** **This requirement is deemed to have been met if the galvanic connection has been established by welding.**	VDA comment for 25 A - it depends on the purpose of this requirement. If the equalisation device can only just withstand 0.2A it can not handle the high current that may be necessary to equalize the potential of two components. In this respect it would be necessary to check the effectiveness at higher Amps. This issue is also being disvussed at ISO but not yet concluded (ISO discusses about 25A for 5 seconds) JAMA comment: It is not necessary to have this 25A also in the regulation at this stage until ISO has finalised its discussion. For the time being OICA will stick to 0.2A
[3–3–3	In the case of motor vehicles which are connected to the external power supply through the conductive connection, a device for galvanical connection of the electrical chassis to the earth ground must be provided.]	3-3-3	**In the case of motor vehicles which are connected to the grounded external power supply through the conductive connection, a device to enable galvanical connection of the electrical chassis to the earth ground shall be provided.** **Note: The vehicle should enable that connection to the earth before exterior voltage is applied and retain the connection until after the exterior voltage is switched off.** or **The connection between the device and the earth terminal of the connector of the external power supply shall be established first when the connector is engaged to the vehicle, and retain the connection until the connector is disengaged** add **This requirement shall be demonstrated by using the connector specified by**	
3-4	Insulation resistance	3-4	**Isolation resistance**	
	Electrical isolation between the high voltage bus and the electrical ~~vehicle~~ chassis ~~conducting structure~~ shall be >[100] ohms/volt for DC buses, and >[500] ohms/volt for AC buses. The measurement shall be conducted according to Attached Sheet 1 "Insulation Resistance Measurement Method" or a method equivalent to it.	3-4-1	**Isolation resistance between the high voltage bus and the electrical chassis when the vehicle is not connected shall have a minimum value of 500 ohms/volt of the working voltage.** **However, if all AC high voltage buses are protected by the measures described in 3.4.1.1. or 3.4.1.2., insulation resistance between the high voltage bus and the electrical chassis shall have a minimum value of 100 ohms/volt of the working voltage.** **The insulation resistance of the entire vehicle may be demonstrated by calculation, measurement or a combination of both.** **The measurement shall be conducted according to Attached Sheet 1 "Insulation Resistance Measurement Method" or a method equivalent to it.**	- It is impossible to distinguish the insulation loss at AC circuit from that at DC circuit in the AC and DC combined (galvanically connected) electrical circuit. (Most AC circuits are galvanically connected to DC circuit in current HVs and EVs.) - Defined the requirement with referring the recent SAE and ISO discussion. - we can not ensure the isolation resistance from the external power supply
		3-4-1-1	**Double or more layers of solid insulators, barriers or enclosures that meet the requirement in paragraph 3.2. independently, for example wiring harness .**	- "Double layers" means physical layers. This is different from "double insulation" or "reinforced insulation". (Most AC harnesses has double layer insulation covers to insert the mesh metal for grounding to prevent the electrical magnetic noise.
		3-4-1-2	**Mechanically robust protections that have sufficient durability over vehicle service life such as motor housings, electronic convertor cases or connectors.**	- AC circuits are mostly protected by sufficiently durable protection in current EVs and HVs.
		3-4-2	**If the minimum isolation resistance can not be maintained then protection shall be achieved by any of the following:** **- Double or more layers of solid insulators, barriers or enclosures that meet the requirement in paragraph 3.1. independently** **- onboard isolation resistance monitoring system together with a warning to the driver when the insulation resistance drops to the minimum required value.**	OICA proposes this text because the ELSA proposal is design restrictive. This text is based on ISO 6963
[5.	Requirements for traction batteries	4.	**Requirements for RESS**	
		4.1	**Protection against excessive current**	
	The battery shall be equipped with a protective device (such as fuses or circuit breakers) in order to prevent excessive current. However, this provision shall not apply to cases where there is no likelihood of dangerous effects resulting from excessive currents in the wires and the traction battery. This shall be demonstrated by calculation.]		**The RESS shall be equipped with a protective device (such as fuses or circuit breakers) in order to prevent excessive current. However, this provision shall not apply to cases where there is no likelihood of dangerous effects resulting from excessive currents in the wires and the traction battery. This shall be demonstrated by calculation.**	
		4.2	**Accumulation of gas** **Places for containing open type traction battery that may produce hydrogen gas shall be provided with a ventilation fan or a ventilation duct to prevent the accumulation of hydrogen gas. No hydrogen gas shall enter the passenger compartment.**	(Originated from ECE100)
6.	Requirements for Functional Safety	5.	**Requirements for Functional Safety**	
	At least a momentary indication must be given to the driver either : (a) when the vehicle is in "active driving possible mode" or, (b) when one further action is required to place the vehicle in "active driving possible mode". However, this provision does not apply under conditions where an internal combustion engine provides directly or indirectly the vehicle´s propulsion power.		**At least a momentary indication must be given to the driver either :** **(a) when the vehicle is in "active driving possible mode" or,** **(b) when one further action is required to place the vehicle in "active driving possible mode".** **However, this provision does not apply under conditions where an internal combustion engine provides directly or indirectly the vehicle´s propulsion power.** **When leaving the vehicle, the driver shall be informed by an obvious signal (e.g. optical or audible signal) if the drive train is still in the active driving possible mode.** **If the on-board RESS can be externally charged by the user, vehicle movement by its own propulsion system shall be impossible as long as the RESS is physically connected to the offboard electric power supply (e.g. mains, off-board charger).** **This requirement shall be demonstrated by using the connector specified by**	OICA agreed to include only part of the ECE 100 functional requirements par. 5.2 - 5.2.2.1: vehicle active driving mode - 5.2.2.2: low battery: not include this unless low fuel level indicator would also be mandatory for conventional vehicles - 5.2.2.3: unintentional accelleration, decelleration, .. - 5.2.2.4: signal when leaving the vehicle while in active driving mode - 5.2.3. reversing: will not be included - 5.2.4. emergency power reduction: will not be included
	Attached Sheet 1 **Insulation Resistance Measurement Method**		**Attached Sheet 1** **Insulation Resistance Measurement Method**	
1	General	1	**General**	
	The insulation resistance for each high voltage bus of the vehicle shall be measured or shall be determined by calculation using measurement values from each part or component unit of a high voltage bus (hereinafter referred to as the "divided measurement")..		**(No change from ELSA draft)**	
2	Measurement Method	2	**Measurement Method**	
	The insulation resistance measurement shall be conducted by selecting an appropriate measurement method from among those listed in Paragraphs 2–1 through 2–3, depending on the electrical charge of the live parts or the insulation resistance, etc.		**(No change from ELSA draft)**	
	The range of the electrical circuit to be measured shall be clarified in advance, using electrical circuit diagrams, etc.		**(No change from ELSA draft)**	
	Moreover, modification necessary for measuring the insulation resistance may be carried out, such as removal of the cover in order to reach the live parts, drawing of measurement lines, change in software, etc.		**(No change from ELSA draft)**	
	In cases where the measured values are not stable due to the operation of the on-boa insulation resistance monitoring system, etc., necessary modification for conducting the measurement may be carried out, such as stopping of the operation of the device concerned or removing it. Furthermore, when the device is removed, it must be proven, using drawings, etc., that it will not change the insulation resistance between the live parts and the electrical chassis.		**(No change from ELSA draft)**	

	Utmost care must be exercised as to short circuit, electric shock, etc., for this confirmation might require direct operations of the high-voltage circuit.		**(No change from ELSA draft)**	
2–1	Measurement method using DC voltage from off-vehicle sources	2–1	**Measurement method using DC voltage from off-vehicle sources**	
2–1–1	Measurement instrument	2–1–1	**Measurement instrument**	
	An insulation resistance test instrument capable of applying a DC voltage higher than the maximum working voltage of the high voltage bus shall be used.		**(No change from ELSA draft)**	
2–1–2	Measurement method	2–1–2	**Measurement method**	
	2–1–2–1 An insulator resistance test instrument shall be connected between the live parts and the electrical chassis. Then, the insulation resistance shall be measured by applying a DC voltage higher than the maximum working voltage of the high voltage b and coupling system for charging, respectively.		**An insulator resistance test instrument shall be connected between the live parts and the electrical chassis. Then, the insulation resistance shall be measured by applying a DC voltage higher than the maximum working voltage of the high voltage bus and coupling system for charging, respectively.** **However, in cases where there is a likelihood that parts are damaged by excessive voltage during the measurement no appropriate application voltage is obtained due to the characteristics of the insulation resistance test instrument, it shall be permissible to perform the measurement with the next lower voltage level of the test instrument.**	- Some HVs have electrical parts whose withstand voltage is not high enough between the high voltage bus and the electrical chassis. - Insulation resistance test equipment (mega Ohm meter) e.g. can only be set at 500V or 1000V. If our operating voltage is 650V, we have to select 1000V which may damage certain parts
2–2	Measurement method using the vehicle's own RESS as DC voltage source	2–2	**Measurement method using the vehicle's own RESS as DC voltage source**	
2–2–1	Test vehicle conditions	2–2–1	**Test vehicle conditions**	
	The HV-bus shall be energized by the vehicle's own RESS and the voltage level throughout the test shall be at least the nominal operating voltage as specified by the vehicle manufacturer..		**The high voltage bus shall be energized by the vehicle's own RESS and/or energy conversion system, and the voltage level throughout the test shall be at least the nominal operating voltage as specified by the vehicle manufacturer.**	
2–2–2	Measurement instrument	2–2–2	**Measurement instrument**	
	The voltmeter used in this test shall measure DC values and shall have an internal resistance of at least 10 MΩ.		**(No change from ELSA draft)**	
2–2–3	Measurement method	2–2–3	**Measurement method**	
2–2–3–1	First step	2–2–3–1	**First step**	
	The voltage is measured as shown in Figure 1 and the HV Bus voltage (Vb) is recorded. Vb shall be must be equal to or greater than the nominal operating voltage specified by the vehicle manufacturer. 		**The voltage is measured as shown in Figure 1 and the high voltage bus voltage (Vb) is recorded. Vb shall be must be equal to or greater than the nominal operating voltage as specified by the vehicle manufacturer.**  Figure 1: Measurement of Vb, V1, V2	- Changed the words to those used in the main body.
2–2–3–2	Second step	2–2–3–2	**Second step**	
	Measure and record the voltage (V1) between the negative side of the high voltage bus and the vehicle chassis (see Figure 1):		**Measure and record the voltage (V1) between the negative side of the high voltage bus and the electrical chassis (see Figure 1):**	- Changed the words to those used in the main body.
2–2–3–3	Third step	2–2–3–3	**Third step**	
	Measure and record the voltage (V2) between the positive side of the high voltage bus and the vehicle chassis (see Figure 1):		**Measure and record the voltage (V2) between the positive side of the high voltage bus and the electrical chassis (see Figure 1):**	- Changed the words to those used in the main body.
2–2–3–4	Fourth step	2–2–3–4	**Fourth step**	
	If V1 is greater than or equal to V2, insert a standard known resistance (Ro) between the negative side of the high voltage bus and the vehicle chassis. With Ro installed, measure the voltage (V1') between the negative side of the high voltage bus and the vehicle chassis (see Figure 2). Calculate the electrical isolation (Ri) according to the following formula: *Ri = Ro*(Vb/V1' – Vb/V1) or Ri = Ro*Vb*(1/V1' – 1/V1)* 		**If V1 is greater than or equal to V2, insert a standard known resistance (Ro) between the negative side of the high voltage bus and the electrical chassis. With Ro installed, measure the voltage (V1') between the negative side of the high voltage bus and the electrical chassis (see Figure 2).** **Calculate the electrical isolation (Ri) according to the following formula:** **Ri = Ro*(Vb/V1' – Vb/V1) or Ri = Ro*Vb*(1/V1' – 1/V1)**  Figure 2: Measurement of V1'	- Changed the words to those used in the main body.
	If V2 is greater than V1, insert a standard known resistance (Ro) between the positive side of the high voltage bus and the vehicle chassis. With Ro installed, measure the voltage (V2') between the positive side of the high voltage bus and the vehicle chassis. (See Figure 3).Calculate the electrical isolation (Ri) according to the formula shown. Divide this electrical isolation value (in ohms) by the nominal operating voltage of the high voltage bus (in volts). Calculate the electrical isolation (Ri) according to the following formula: *Ri = Ro*(Vb/V2' – Vb/V2) or Ri = Ro*Vb*(1/V2' – 1/V2)* 		**If V2 is greater than V1, insert a standard known resistance (Ro) between the positive side of the high voltage bus and the electrical chassis. With Ro installed, measure the voltage (V2') between the positive side of the high voltage bus and the electrical chassis. (See Figure 3).Calculate the electrical isolation (Ri) according to the formula shown. Divide this electrical isolation value (in ohms) by the nominal operating voltage of the high voltage bus (in volts).** **Calculate the electrical isolation (Ri) according to the following formula:** **Ri = Ro*(Vb/V2' – Vb/V2) or Ri = Ro*Vb*(1/V2' – 1/V2)**  Figure 3: Measurement of V2'	- Changed the words to those used in the main body.
2–2–3–5	Fifth step	2–2–3–5	**Fifth step**	
	The electrical isolation value Ri (in ohms) divided by the maximum operating voltage of the high voltage bus (in volts) shall be equal to or greater than 100 Ω/V for high voltage d.c. electric circuits or 500 Ω/V for high voltage a.c. electric circuits.		**The electrical isolation value Ri (in ohms) divided by the maximum operating working voltage of the high voltage bus (in volts) results in the isolation resistance (Ω/V)**	- Changed the words to those used in the main body.
	NOTE 1: The standard known resistance Ro (in ohms) should be approximately 500 times the nominal operating voltage of the vehicle (in volts). Ro is not required to be precisely this value since the equations are valid for any Ro; however, an Ro value in this range should provide good resolution for the voltage measurements.		**NOTE 1: The standard known resistance Ro (in ohms) should be approximately 500 times the nominal operating voltage of the vehicle (in volts). Ro is not required to be precisely this value since the equations are valid for any Ro; however, an Ro value in this range should provide good resolution for the voltage measurements.**	
2–3	Measurement method by an on-board insulation resistance monitoring system	2–3	**Confirmation method for functions of on-board insulation resistance monitoring system**	
2–3–2	Measurement method		**The function of the on-board insulation resistance monitoring system shall be confirmed by the following method or a method equivalent to it** **When a resistor is inserted which causes the isolation resistance between the terminal being monitored and the electrical chassis to drop below the minimum required isolation resistance value, the warning shall be activated.**	

2–3	Measurement method by an on-board insulation resistance monitoring system			moved into par. 2-3 of attachment 1
2–3–1	Measurement instrument			
	The on-board insulation resistance monitoring system shall be capable of monitoring the insulation resistance between the live parts and the electrical chassis and of giving a warning before it drops to 100 Ω/V for high voltage d.c. electric circuits or 500 Ω/V for high voltage a.c. electric circuits. Its function shall be confirmed by the method indicated in Paragraphs 2–3–1–1 through 2–3–1–2 or a method equivalent to it.			
2–3–1–1	Example of confirmation method in which a resistor is inserted in parallel in the high-voltage circuit			
	Warning of the driver shall be given when a resistor is inserted which makes the combined insulation resistance between the terminal being monitored and the electric chassis 100 Ω/V for high voltage d.c. electric circuits or 500 Ω/V for high voltage a.c. electric circuits.			
2–3–1–2	Example of confirmation method in which a pseudo signal is inputted			
	In cases where the relationship between the input value and output voltage of the sensor is clear warning shall be given when a pseudo voltage corresponding to the output voltage equivalent to 100 Ω/V for high voltage d.c. electric circuits or 500 Ω/V for high voltage a.c. electric circuits is applied instead of the output of the sensor concerned.			
2–3–2	Measurement method			
	Confirm that no warning is given under a condition that the on-board insulation resistance monitoring system is operating. In this case, confirmation as to whether or not the insulation resistance drop monitor is operating may be performed by means of the initial check function of the warning lamp when the motor vehicle is started.			
	If no warning is given, the insulation resistance shall be regarded as more than 100 Ω/V for high voltage d.c. electric circuits or 500 Ω/V for high voltage a.c. electric circuits.]			
	[Attached Sheet 2 (for information) **FUNCTION CONFIRMATION METHOD OF POWER SUPPLY SHUT-OFF AT TIME OF ELECTRIC LEAKAGE**			Combined into attached sheet 1
	The following shall prescribe the function confirmation method and requirements of power supply shut-off at time of electric leakage.			
1.	Confirmation method for functions of power supply shut-off at time of electric leakage			
	Paragraph 1-1 shows an example of the confirmation method in which leakage of electric current is caused by the resistor. Paragraph 1–2 gives an example of the confirmation method in which pseudo signal is added.			
	This confirmation requires the operation of the high-voltage circuit directly. Therefore, utmost care must be exercised as to short circuit, electrical shock, etc.			
1–1	Example of confirmation method in which leakage of electric current is caused by resistor			
	An appropriate resistor shall be inserted between the terminal for which the leaking electric current is monitored and the electrical chassis. At this time, the relationship between the electric current flowing in the resistor and the time elapsed until the shutting-off, shall be measured. The measurement shall be conducted with various electric currents by changing the resistance of the resistor connected.			
1–2	Example of confirmation method using a pseudo signal			
	In cases where the relationship between the input value and output voltage of the sensor is clear through the submitted data of characteristics of the sensor being used, etc., the relationship between the pseudo voltage being applied and the time elapsed until the shutting-off shall be measured when a pseudo voltage corresponding to the output voltage equivalent to the shutting-off limitation is applied instead of the output of the sensor concerned.			
2.	Requirements of power supply shut-off at time of electric leakage			
	The shut-off requirements shall be prescribed according to the leaking electric current and continuation time. Shutting-off shall take place below 200 mA when the continuation time is 10 msec or less; below the electric current determined from the following formula according to the continuation time when the continuation time is between 10 msec and 2 seconds; and below 26 mA when the continuation time is 2 seconds or more. $I=10^{-0.38507 \log10 t+2.6861}$ where: I : Leaking electric current (mA) t : Continuation time (msec) Leaking electric current I (mA)]			