EVE IWG 71th session
UBC, open items and pilot phase

May 27th

-online-

6.3.2. Verification procedure
6.3.3. Statistical Method for Pass/Fail decision for a sample of vehicles

6.3.2. Verification procedure

In order to verify the SOCE monitor, the value for the usable battery energy shall be measured at the time of the verification and the related value from the monitor shall be collected before the verification test procedure. To support future improvement of the GTR, indicator values shall be collected again after the verification test procedure. Those indicators read after the verification test procedure shall not be considered in the Part A verification.

The measured SOCE value shall be determined by dividing the measured value for the usable battery energy by the certified value for the usable battery energy, in accordance with the procedure defined in Annex 3 of this GTR, respectively, expressed in per cent.

$$SOCE_{measured} = \frac{UBE_{measured}}{UBE_{certified}} * 100$$

In cases where $UBE_{measured}$ is higher than the $UBE_{certified}$, the $SOCE_{measured}$ shall be set to 100 per cent.

6.3.3. Statistical Method for Pass/Fail decision for a sample of vehicles

An adequate number of vehicles (at least 3 and not more than 16) shall be selected from the same monitor family for testing following a vehicle survey (see Annex 1) which contains information designed to ensure that the vehicle has been properly used and maintained according to the specifications of the manufacturer. The following statistics shall be used to take a decision on the accuracy of the monitor.

For evaluating the SOCE monitor normalised values shall be calculated:

$$x_i = SOCE_{read,i} - SOCE_{measured,i}$$

Where

$SOCE_{read,i}$ is the on-board SOCE read from the vehicle i ; and

$SOCE_{measured,i}$ is the measured SOCE of the vehicle i.

For the total number of N tests and the normalised values of the tested vehicles, x_1, x_2, ... x_N, the average X_{tests} and the standard deviation s shall be determined:

$$X_{tests} = \frac{(x_1 + x_2 + x_3 + \cdots + x_N)}{N}$$

and

$$s = \sqrt{\frac{(x_1 - X_{tests})^2 + (x_2 - X_{tests})^2 + \ldots + (x_N - X_{tests})^2}{N-1}}$$

For each N tests $3 \leq N \leq 16$, one of the three following decisions can be reached, where the factor A shall be set at 5:

(a) Pass the family if $X_{tests} \leq A - (t_{P1,N} + t_{P2,N}) \cdot s$

Effect of „apparent battery aging/healing“ for energy based test procedures according to 6.3 Part A (5% criterion)

Certification measurement (day 1)		In-service measurement (day 2)		In-service measurement (day 1000)	
Actual battery SoH (capacity):	100 %	Actual battery SoH (capacity):	100 %	Actual battery SoH (capacity):	95 %
Displayed SoH:	100 %	Displayed SoH:	100 %	Displayed SoH:	95 %
Vehicle weight:	10t	Vehicle weight:	39t	Vehicle weight:	39t
Route topography:	flat	Route topography:	hilly	Route topography:	hilly
Discharge energy (cert):	**312 kWh**	Discharge energy (in-service):	**295 kWh**	Discharge energy (in-service):	280 kWh
SOCE (energy):	-	SOCE (energy):	94,5 %	SOCE (energy):	89,7 %
		→ Failed		→ Failed	

Certification measurement (day 1)		In-service measurement (day 2)		In-service measurement (day 1000)	
Actual battery SoH (capacity):	100 %	Actual battery SoH (capacity):	100 %	Actual battery SoH (capacity):	**95 %**
Displayed SoH:	100 %	Displayed SoH:	100 %	Displayed SoH:	95 %
Vehicle weight:	39t	Vehicle weight:	10t	Vehicle weight:	10t
Route topography:	hilly	Route topography:	flat	Route topography:	flat
Discharge energy (cert):	**295 kWh**	Discharge energy (in-service):	**312 kWh**	Discharge energy (in-service):	296,4 kWh
SOCE (energy):	-	SOCE (energy):	105,7 %	SOCE (energy):	**100,5 %**
		→ passed		→ passed	

The in-vehicle discharged energy is influenced by boundary conditions like topography, amount of recuperation, vehicle weight, actual temperature and more. A spread higher than 5% must be expected for the same vehicle used within is operation window. This makes the discharge energy for in-vehicle measurements an inappropiate parameter. False failed (case #1) and tampering would be possible (case #2).

Effect of „apparent battery aging/healing“ for capacity based test procedures

Certification measurent (day 1)			In-service measurent (day 2)			In-service measurent (day 1000)		
Actual battery SoH (capacity):		100 %	Actual battery SoH (capacity):		**100 %**	Actual battery SoH (capacity):		**95 %**
Displayed SoH:		100 %	Displayed SoH:		100 %	Displayed SoH:		95 %
Vehicle weight:		10t	Vehicle weight:		39t	Vehicle weight:		39t
Route topography:	flat		Route topography:	hilly		Route topography:	hilly	
Discharge capacity:	779 Ah		Discharge energy:	777 Ah		Discharge energy:	738 Ah	
Calculated SoH (energy):	-		Calculated SoH (energy):	**99,7 %**		Calculated SoH (energy):	94,7 %	
			→ passed			**→ passed**		

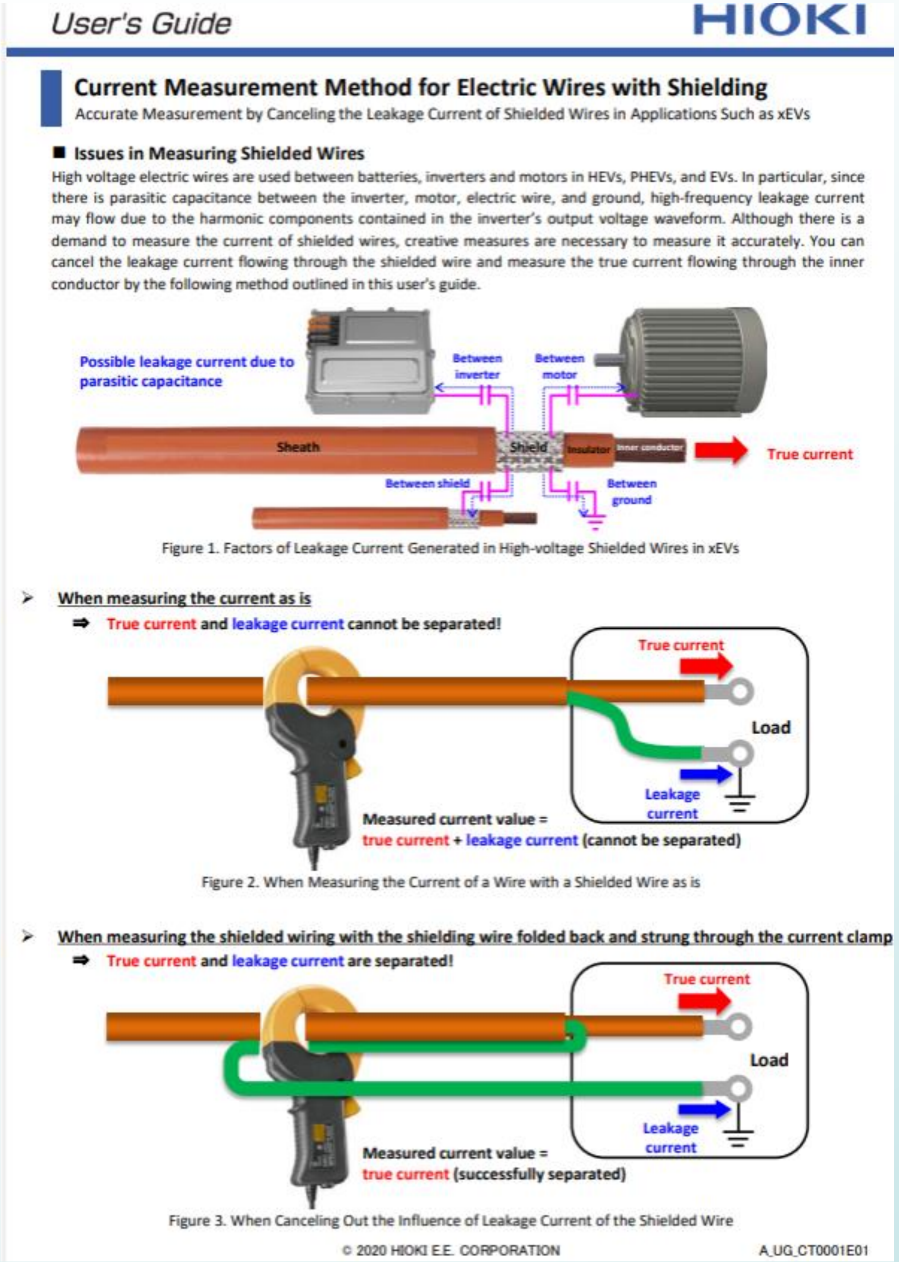
Certification measurent (day 1)			In-service measurent (day 2)			In-service measurent (day 1000)		
Actual battery SoH (capacity):		100 %	Actual battery SoH (capacity):		**100 %**	Actual battery SoH (capacity):		**95 %**
Displayed SoH:		100 %	Displayed SoH:		100 %	Displayed SoH:		95 %
Vehicle weight:		39t	Vehicle weight:		10t	Vehicle weight:		10t
Route topography:	hilly		Route topography:	flat		Route topography:	flat	
Discharge energy:	777 Ah		Discharge energy:	779 Ah		Discharge energy:	738 Ah	
Calculated SoH (energy):	-		Calculated SoH (energy):	**100,3 %**		Calculated SoH (energy):	**94,9 %**	
			→ passed			**→ passed**		

Charge/discharged based capacity is very robust against boundary conditions of vehicle usage. No tampering possible.

Key messages UBC vs. UBE

- Differences in test method operating points inpacting and leading to artificial „aging“
- Additionally to that, Voltage measurement comes always with added inaccuracies:
  - BMS ↓
  - CAN-BUS ↓↓
  - External equipment ↓↓↓
- Positioning, packaging and different sizing adding to error propagation, too
- Usable energy is much more sensitive to test boundary conditions (slope, speed, acceleration, recuperation) – with capacity those impacts are neglectable – but the real battery aging is in both cases the same

HIOKI Manual: invasive measurement


User's Guide HIOKI

Current Measurement Method for Electric Wires with Shielding

Accurate Measurement by Canceling the Leakage Current of Shielded Wires in Applications Such as xEVs

■ Issues in Measuring Shielded Wires

High voltage electric wires are used between batteries, inverters and motors in HEVs, PHEVs, and EVs. In particular, since there is parasitic capacitance between the inverter, motor, electric wire, and ground, high-frequency leakage current may flow due to the harmonic components contained in the inverter's output voltage waveform. Although there is a demand to measure the current of shielded wires, creative measures are necessary to measure it accurately. You can cancel the leakage current flowing through the shielded wire and measure the true current flowing through the inner conductor by the following method outlined in this user's guide.

Figure 1. Factors of Leakage Current Generated in High-voltage Shielded Wires in xEVs

➢ When measuring the current as is

⇒ True current and leakage current cannot be separated!

Figure 2. When Measuring the Current of a Wire with a Shielded Wire as is

➢ When measuring the shielded wiring with the shielding wire folded back and strung through the current clamp

⇒ True current and leakage current are separated!

Figure 3. When Canceling Out the Influence of Leakage Current of the Shielded Wire

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Comments

- *"Although there is a demand to measure the current of shielded wires, creative measures are necessary to measure it accurately."*
- **Solution advise cancel the leakage current flowing through the shielded wire and measure the true current flowing through the inner conductor**
- **During pilot phase we might be able to show, if that is feasible and the value of deviations against on-board equipment and/or sensors**
- In general, thinking on in-service measurements with customer vehicles, non-invasive procedures must be the key priority considering:
    - Complex battery packaging (positions & sizes)
    - Complicated body superstructure (Rigids)
    - Customer vehicle availability (invasive → time, effort)

Annex 3, Part A, 1.2 Measurement requirements

Table A3/1
Measurement items and required accuracy

Item	*Units*	*Accuracy*	*Remarks*
Electrical voltage	V	±0.3 % FSD or ±1 % of reading	Whichever is greater. Resolution 0.1 V.
Electrical current	A	±0.3 % FSD or ±1 % of reading	Whichever is greater. Resolution 0.1 A.
Room/ambient temperature	K	±1 °C, with a measurement frequency of at least 0.033 Hz	
Time	s	± 10 ms; min. precision and resolution: 10 ms	

Item	*Units*	*Accuracy*	*Remarks*
Electrical power	W	[…]	Charging discharging electrical power ~~of the bidirectional charger/ bidirectional power supply~~, [i.e. accuracy, calibration]
Discharge rate		[…]	
Bidirectional charger/ bidirectional power supply/…		[…]	AC, DC …

Annex 3, Part A, 2.1.1.1.5. Measurement frequency

2.1.1.1 5. Measurement frequency

All the items in Table A3/1 of paragraph 1.2 of this annex, unless specified otherwise in the table, shall be measured and recorded at a frequency equal to 20 Hz for discharging and 0.033Hz for charging.

Pilot Phase – alignment within OICA

Guidelines agreed to have in common:

- 1a or 1b or 2 based on v17-update text
- Tests to be done at OEMs premises
- No other OEM will participate at other pilot phase tests
- Technical Service or authority is witnessing the tests as applicable in the short notice
- Details as:
  - road gradient, break-off criteria, pass/fail tolerance, repeatability, reproducability,
  - Accuracy requirements, frequncy requirements
  - Testing devices, battery construction/geometry impact on testing devices/locations
- Participation during tests:
  - 1-3 days
  - Whole day
  - Part day
  - Result evaluation
- External verification of voltage and current: OEMs try to organize measurement clamps (preferrably HIOKI as mutual industry standard)
  - At least break-out boxes will be used