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Road vehicles — Test procedures for electric vehicles to determine charging performance

Véhicules routiers — Procédures d'essai des véhicules électriques pour déterminer les performances de charge

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Foreword

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This document was jointly prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 37, *Electrically propelled vehicles* and SAE Hybrid – EV Committee.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html. Alternatively, to provide feedback on this document, please visit http://standards.sae.org/PRODCODE.

Introduction

The test procedures were derived from typical use cases. Both test procedures and use cases were established based on the following premises:

— Comparability: the charging performance determined according to this document enables a comparison of the performance of different electrically propelled vehicles in realistic scenarios. The application of specific optimizing features to improve the charging performance (e.g. battery thermal preconditioning based on navigation systems) is taken into account.

— Imitability and plausibility: the possibility to retrace the determined charging performance in principle.

— Reproducibility: the specified test conditions, test methods and test processes ensure reproducibility within common measurement tolerances. It was important to leave as little space as possible for inadvertent deviations or manipulations.

The test results serve for information purposes, e.g. for vehicle operator interfaces or manufacturer specifications.

Road vehicles — Test procedures for electric vehicles to determine charging performance

1 Scope

This document specifies test procedures to determine the charging performance of electric vehicles. This document facilitates clear and consistent comparisons of realistic charging capabilities of electrically propelled vehicles (EVs) via commercially available electric vehicle supply equipment. It provides details about test conditions, test methods and test processes derived from typical use cases. Furthermore, it specifies requirements regarding the information for the vehicle operator.

This document is applicable to EVs, including plug-in hybrid EVs.

This document does not provide requirements for mopeds and motorcycles.

Unless specified otherwise, all test procedures can be applied to AC, DC or wireless charging methods.

NOTE Specifications for reverse power transfer are under consideration.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
applicable driving test
ADT
driving test provision including test procedure and requirements for homologation in the intended market

EXAMPLE Worldwide harmonized light vehicles test procedure; SAE J1634.

3.2
ADT schedule
collection of one or more driving cycle(s)

EXAMPLE Worldwide light-duty test cycle; urban dynamometer driving schedule.

3.3
DC electric energy consumption
EC_{DC}
$R_{EC,DC}$
energy withdrawn per unit of distance from the *RESS* (3.9) for operating the *EV* (3.5) as measured by the combined test procedure defined in the *ADT* (3.1)

Note 1 to entry: Charging losses due to AC charging are excluded.

Note 2 to entry: The unit of the distance referred to depends on the specification in the ADT.

Note 3 to entry: In the worldwide light-duty test cycle, the consumption of the combined test procedure is called $EC_{DC,WLTC}$.

3.4
discharged battery energy
DBE
E_{DBE}
energy removed from the *RESS* (3.9) during the *ADT schedule* (3.2)

Note 1 to entry: At the end of the ADT schedule the DBE equals the usable battery energy.

3.5
electrically propelled vehicle
EV
vehicle with one or more electric drive(s) for vehicle propulsion

[SOURCE: ISO 6469-3:2021, 3.15 — The abbreviated term “EV” has been added.]

3.6
EV supply equipment
EVSE
equipment or combination of equipment that provides dedicated functions to supply electric energy from a fixed electrical installation or supply network to an *electrically propelled vehicle* (3.5) for the purpose of charging

[SOURCE: IEC 61851-1:2017, 3.1.1, modified – Examples were deleted.]

3.7
indicated state of charge
indicated SOC
residual capacity of *rechargeable energy storage system* (3.9) available to be discharged as indicated to the vehicle operator

Note 1 to entry: Indicated state of charge is normally expressed as a percentage of full charge.

[SOURCE: ISO/TR 11954:2024, 3.11, modified — The term was originally RESS state of charge and “as indicated to the vehicle operator” has been added.]

3.8
optimizing features
all vehicle functions that positively impact the test results when activated either automatically or by the vehicle operator

EXAMPLE Battery thermal preconditioning functions activated by navigation systems, specific charging modes selected by the vehicle operator.

3.9
rechargeable energy storage system
RESS
rechargeable system that stores energy for delivery of electric energy for the electric drive

EXAMPLE Battery, capacitor.

[SOURCE: ISO 6469-1:2019, 3.22, modified — “Flywheel” has been deleted from the examples.]

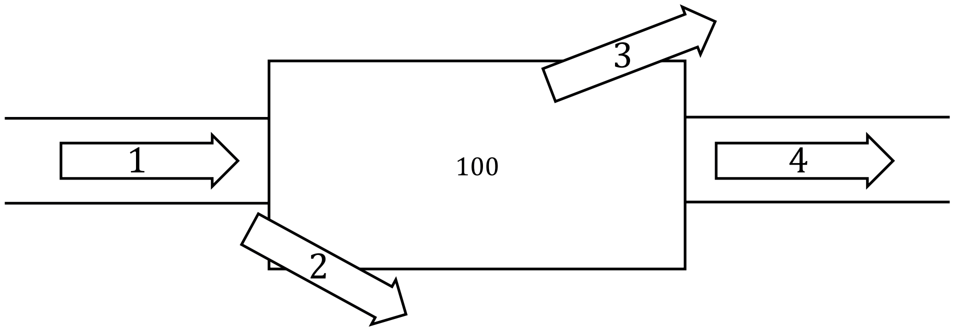
3.10
recharged usable battery energy
rUBE
E_{rUBE}
calculated share of *UBE* (3.13) that is recharged within a certain period

3.11
remaining electric range
range calculated based on the battery capacity remaining for driving and the EC_{DC} (3.3) of the *EV* (3.5) as determined in the *ADT* (3.1)

3.12
soaking
establishing a targeted steady state by exposing the *EV* (3.5) to defined environmental conditions

3.13
usable battery energy
UBE
usable *RESS* (3.9) energy determined according to *ADT* (3.1)

Note 1 to entry: See Figure 1.



Key
1 energy entering the RESS (see MP3 in Figure 4)
2 Q_{loss} for recharging (e.g. loss due to cell chemistry, heating in RESS)
3 Q_{loss} for discharging (e.g. loss due to cell chemistry, heating in RESS)
4 UBE/rUBE (see MP4 in Figure 4)
100 RESS

Figure 1 — Relationship between energies and losses at the RESS

4 Abbreviated terms

AC	alternating current
DC	direct current
GPS	global positioning system
PER	pure electric range
RMS	root mean square
WLTC	worldwide light-duty test cycle
WLTP	worldwide harmonized light vehicles test procedure

5 General

The test procedures specified in this document serve to determine the charging performance of an EV.

NOTE It is not necessary to perform all test procedures.

This document does not address bundling or the classification of vehicle configurations. It therefore does not specify for which changes in vehicle configurations the test procedures shall be repeated. The manufacturer may apply test results to other vehicle configurations than the vehicle configuration tested. In this case, the vehicle manufacturer shall ensure that the values stated in the vehicle operator information (see Clause 7) are also possible with the corresponding vehicle configurations.

The vehicle manufacturer may specify values in the vehicle operator information that are worse than the test results achieved, e.g. to add some margin.

The vehicle manufacturer may specify a range of values in the vehicle operator information for bundling or the classification of vehicle configurations.

NOTE The vehicle operator can be, e.g. the owner or driver of the vehicle or a test engineer.

6 Test cases and general requirements

6.1 Overview of test cases

Table 1 gives an overview of the test cases to determine the charging performance. Implementation details on how to perform the corresponding test procedures are given in 6.3.

Table 1 — Overview of test cases

Test case	Charging power	Start condition	End condition	Test result
Normal Charge[d]	charging power applied in ADT[a]	start and end conditions apply according to the ADT		— charging duration — charging efficiency — max. charging power
		start conditions apply according to the ADT	60 min	— recharged electric range obtained within 60 min of Normal Charge
Fast Charge	charging power up to the max. charging power supported by the EV	15 km to 60 km remaining electric range[b]	10 min	— recharged electric range obtained within 10 min of Fast Charge
		10 % indicated SOC[c]	80 % indicated SOC	— charging duration — charging efficiency — max. charging power

[a] E.g. Europe 11 kW (16 A at 230 V 3-phase), US 9,6 kW (40 A at 240 V), China 7 kW (32 A at 220 V), Japan 6 kW (30 A at 200 V).

[b] See 6.3.2.5 for specifications related to the starting condition.

[c] See 6.2.4 for determination of indicated SOC.

[d] Typically AC unless unavailable on the EV.

The Fast Charge test case is only applicable to EVs that support a maximum charging power > 22 kW.

Annex A specifies the test procedure to determine the charging performance at low ambient temperatures. Annex B provides a test procedure for heavy duty vehicles.

6.2 General requirements

6.2.1 Vehicle manufacturer specifications

The vehicle manufacturer shall specify the required current and voltage ranges to be covered by the EVSE for each test procedure.

For AC charging, the vehicle manufacturer shall additionally specify the number of phases and the charging cable applied.

The vehicle manufacturer specifications should take region-specific availabilities (e.g. supply network connections) into account.

The EVSE applied in the testing shall support the specifications of the vehicle manufacturer to allow the maximum charging performance of the EV under test.

If applicable, the vehicle manufacturer shall explain how to activate optimizing features (e.g. specific charging modes, GPS navigation, activation via diagnostic function).

6.2.2 EV run-in

The EV under test shall have been run-in according to the specifications of the ADT. If the ADT does not specify run-in requirements, the EV shall have been run-in at least 300 km or one full charge distance, whichever is longer.

NOTE The EV run-in time can differ between battery electric vehicles and externally chargeable electric hybrid vehicles in the ADTs.

6.2.3 Measurement tolerances and accuracies

The vehicle manufacturer shall take measurement tolerances and accuracies into account in the determination of the test result. External measuring tools and/or on-board measurement data from the EV may be used in the tests.

Table 2 provides sample rate, accuracy and resolution for different parameters that shall be applied in the measurements described in this document.

Table 2 — Measurement sample rates, accuracies and resolutions

Measured parameter	Sample rate	Accuracy	Resolution
Time [s]	-	±1 s	≤ 1 s
Indicated SOC [%]	1 Hz	as provided by the EV	≤ 1 %
Energy [kWh] during discharge to measure the DBE (see 6.2.5)	20 Hz for the voltage and current measurements	±1 % of reading, or 0,3 % of full scale of measurement device, whichever is greater	≤ 1 Wh
Energy [kWh] to identify the charging efficiency (see 6.2.6)	Watt-hour meter, Class 1 in accordance with IEC 62053-21 or equivalent		
Electrical power [kW] (see 6.2.7)	1 Hz	±1 % of reading	≤ 10 W when charging power < 10 kW and ≤ 100 W when charging power ≥ 10 kW

The full scale of the measurement device should not exceed the maximum measured parameter to the extent that it significantly impacts the test result.

NOTE A wideband meter (power analyser) or wideband ampere-hour meter for pulsed power electronics can be used for the DBE measurement.

6.2.4 Determination of indicated SOC

The indicated SOC shall be obtained from the on-board measurement data of the EV or from the on-board indication.

NOTE The indicated SOC at any other interface available can be used for plausibility checks but can be subject to certain latencies.