
Range of electric vehicles

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Version	4
Design group	00.10 Complete vehicle, technical data, tests required by law
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Validity	451ev3 (smart electric drive 3rd generation)
Reason for change	Range/reset >80% SOC added
Reason for block	

Complaint:

Range does not meet customer's expectations. Customers usually differentiate as follows:

1. Total of distance driven + indicated range remaining with one HV battery charge too low
2. Actual range until the drive system shuts down too low

Notes:

- When the HV battery has been fully charged (100% SOC) the instrument cluster (IC) displays the expected range. The calculation is based on the individual driving style during the last trip(s).
- During a journey the progress of the range can change, e.g. if a different driving style is used (primarily in shared vehicles) or if there are idle periods with active electrical consumers. This means that the total of the distance driven + indicated range remaining can vary from the reality, especially initially, because the actual consumption values are calculated on the basis of recent trips.
- At 20% SOC the message "HV Battery Reserve" is displayed in the IC. This message can be canceled.
- At 10% SOC the message "HV Battery Reserve" is displayed in the IC. When this message is canceled, the display "Low Battery" remains in the IC status line.

The available power of the vehicle is then reduced in stages relative to the HV battery temperature and the SOC (this can be seen on the kW power bar in the bottom right-hand corner of the IC)

- At 0% SOC the drive system is shut off. After this, the engine may be started one last time with very short range unless there are any other conditions preventing a restart.
- When the message "Charge HV Battery Now" or "Battery Power Too Low" appears on the IC, it is no longer possible to start the vehicle and the red battery lamp in the IC lights up.
- The Eco display in the IC generally expresses how well an environmentally aware driving style can be achieved in terms of acceleration, steady driving and coasting in relation to the customer's requirements.

100% Eco does not necessarily mean that the full range will be achieved (see variables under "Cause").

Cause:

The indicated range is always the certified value according to the applicable procedures (e.g. NEDC for Europe).

Particularly in cold and very hot temperatures the ranges of electric vehicles may be reduced. While at moderate temperatures (approx. 20°C) only approx. 10% of the total power consumption is required for electrical accessories, the percentage of the total consumption used by additional consumers increases to 20-30% in very cold or very hot temperatures. The following influencing variables play a particularly large role:

- Electric vehicles are heated via electric heater boosters/PTC, while in vehicles with combustion engine the waste heat of the engine can be utilized. Electric vehicles have the advantage that warm air is available immediate-

ly. This also means that vehicles with combustion engine profit in terms of heating from the poorer efficiency of the engine as the waste heat is utilized, while electric motors are more efficient.

The electric heater booster/PTC initially requires up to 4 kW peak power, or approx. 3 kW at -15°C or 2 kW at 0°C. As soon as the interior compartment has reached the desired temperature and the temperature only needs to be maintained, the power is approx. 1.5-2 kW.

- Additional consumers (12V electrical system) in the electric vehicle are supplied by the HV battery and not via the alternator as in vehicles with combustion engine

(Guideline values: Lights: approx. 130W / Heated rear window: approx. 150W / Seat heater: approx. 100-150W per seat / Blower: up to 500W)

- Increased rolling resistance: When the snow cover is closed, the rolling resistance rises, and so does the power consumption of the vehicle.
- Physical limits/HV battery: At low temperatures the internal resistance of the HV battery is higher.
- Idle times: When 12V consumers and e.g. the heating are activated while stationary, the above variables play a substantial role, since the HV battery is discharged yet no distance is covered, i.e. the energy ratio between driving and electrical accessories shifts (approx. 2 kW power requirement from the heating means e.g. that the HV battery will lose approx. 50% of its charge after 4 hours).

Attachments	
File	Designation
de_smart_electric drive 3 Gen_Reichweitemspektrum.pdf	DEUTSCH - Reichweitemspektrum
en_smart_electric drive 3rd gen_vehicle range.pdf	ENGLISH - range spectrum

Remedy:

1. Explain the relationships in a customer interview. For this purpose we are currently preparing a so-called "range spectrum" as information for customers. We will notify you as soon as this is available.

Use this interview to explain possible courses of action and useful vehicle functions to the customer. Consistently following the instructions below can help to increase the range of the vehicle:

- Use the pre-air conditioning function (with departure time) while the vehicle is connected to the charging infrastructure:

In this way the interior will be acclimatized and the HV battery kept at 100% SOC (vehicle plugged into the mains), i.e. PTC/air conditioner compressor only have to maintain the temperature after the charging cable is unplugged and while driving.

Alternatively it helps to park in garages or in the shade (in summer) if pre-air conditioning is not possible.

- Increase use of the seat heater instead of the interior heating:

Interior temperature setting can be reduced by using the seat heaters. Less energy is therefore required for the PTC/heater booster and the seat heaters operate more efficiently compared to the interior heating.

- Driving style/recuperation:

Power consumption can be reduced considerably by the consistent use of recuperation (energy recovery) and a preventive driving style. The effects of recuperation can be seen in the "Power" dial. In this way about 30% of the energy can be recovered when driving in mountains.

In addition, driving at high speeds should be avoided if the maximum range is desired.

2. If necessary, perform a consumption measuring drive as follows:

2.1 Acclimatize the vehicle (charge the HV battery to 100% SOC, leave the vehicle parked overnight in the workshop at approx. 20°C or program the pre-air conditioning function for the planned departure time)

2.2 Reset all consumption indicators (trip counter + consumption after start + consumption after reset)

Important: The SOC must be >80% SOC; the IC then indicates a range of approx. 135-145 km.

2.3 Set heater/blower to speed 1 and 22°C

2.4 Drive the vehicle mainly on urban/intercity routes (max. 90 km/h), and without stopping for long periods, until approx. 10% SOC remains (see IC displays under "Complaint")

2.5 Note down the values displayed in the IC for "range" + "distance driven" at 100% SOC, 75% SOC, 50% SOC, 25% SOC and 10% SOC

Guideline values:

- In very poor conditions (below -10°C, increased rolling resistance due to snow, heating activated) a range of approx. 70 km should be possible (without traffic jams)
- In temperatures above freezing and on cleared roads, approx. 85-95 km should be possible without traffic jams

Note:

- When the above instructions on driving style etc. are observed, then the effects of quick acceleration, urban traffic and topology are even less significant for electric vehicles than they are for vehicles with combustion engine.

Symptoms
Overall vehicle / Complete vehicle / Modified to
Power generation / Engine management / Boost effect / Nonfunctional
Power generation / Engine management / Electric drive / Nonfunctional
Power generation / Engine management / Regenerative braking / Nonfunctional
Overall vehicle / Power supply / High-voltage on-board electrical system battery / Nonfunctional
Overall vehicle / Power supply / High-voltage on-board electrical system battery / Display message

Work units				
Op. no.	Operation text	Time	Damage code	Note
00-9151	PERFORM CONSUMPTION MEASURING DRIVE			

Validity		
Vehicle	Engine	Transmission
451.390	*	*
451.392	*	*
451.490	*	*
451.492	*	*