Zweirad-Industrie-Verband

Certification of a test bench for the determination of normalized range R_{200} for EPACs and S-EPACs (draft)

Date: November 24, 2020

1 Certification measurements

Note: In order to reduce the effort, the same tire is used for the certification measurements to determine the test bench losses $F_{B,comp}$ as for the actual R200 measurement.

1.1 Reproducibility

Carrying out three measurements of the R200 range on an EPAC, each with assembling and reassembling the EPAC on the test bench.

Documentation and evaluation according to the Excel template "Certification_Testbench_R200_template"

Calculation of the energy consumption

Requirement: Standard deviation of the 3 values for energy consumption <2%

1.2 Accuracy

Determination of the range R200 of a ZIV round robin Bike and comparison of the measured value with the ZIV reference result. If a ZIV round robin bike was used for the measurements under 1.1, then the first of the 3 measurements under 1.1 is used as the accuracy measurement.

Calculation of the energy consumption (*) and the range R200 based on 470 Wh Battery capacity.

Requirement: Standard deviation of the 2 values for energy consumption <2.5%

To (*): Energy consumption is independent of the actual battery capacity. The battery capacity changes over the life of the battery. Therefore, the energy consumption is more suitable for comparing measurements at different times.

2 Background information (extract from DIN SPEC 31064)

2.1 Test bench

Requirements for the test bench:

- Speed controlled brake roller under the driven wheel
- Torque controlled stimulation on the pedal axle, sinusoidal (supply of driver power)
- Possibility of determining the test bench losses (procedure: see below)
- Control of the test bench allows a stable operating point of (20 ± 1) km/h. The test bench does not oscillate in terms of speed.
- Reproducibility of the measurements on the test bench: scatter of the measured values of 3 measurements less than 2%, measurements in each case with disassembly and reassembly of the test object on the test bench. The reproducibility of the measurement of the braking torques (FB, FBcomp) is also required here. Especially when assembling the bike on the test bench, there must be no tension in the torque sensors that lead to offsets. Since FB and FBcomp are measured with different tires, offsets lead to incorrect results.

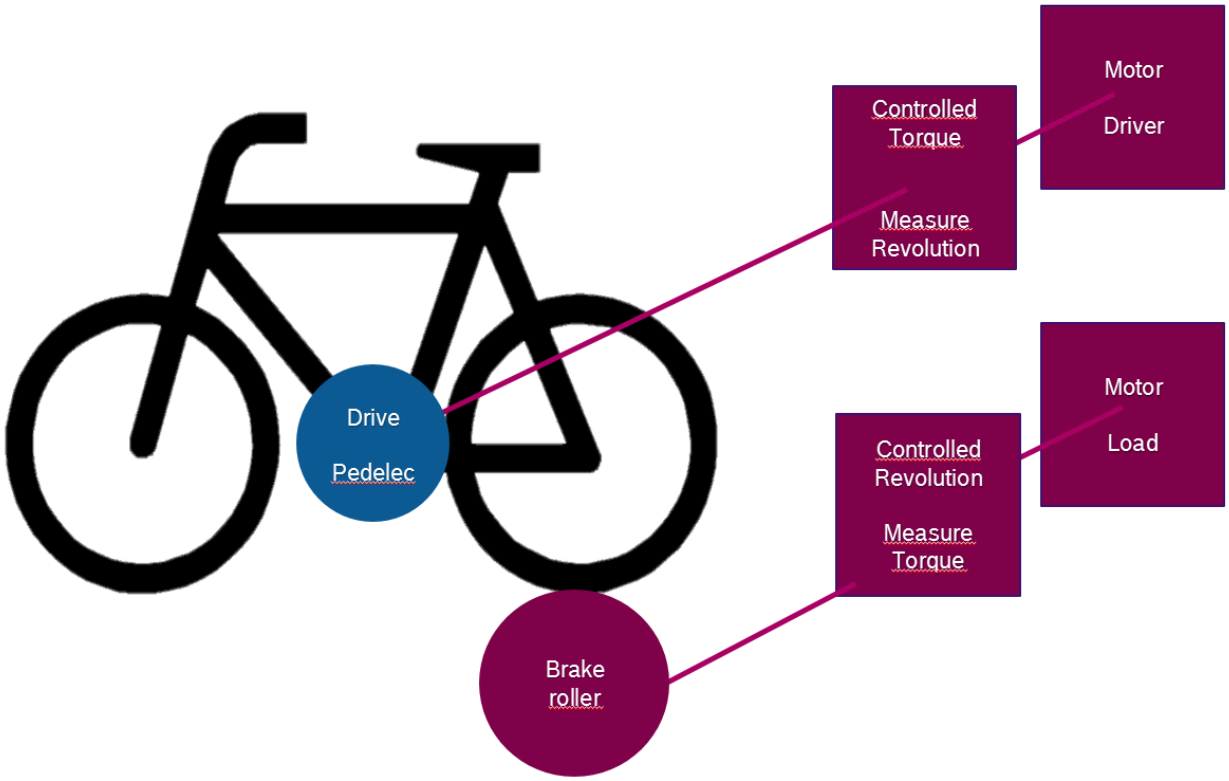

Figure 1: Measurement setup

2.2 Consideration of test bench losses

2.2.1 Determination of test bench losses

The losses are determined once with a reference bicycle with a reference tire (for example Schwalbe Kojak or Continental Grand Prix 4000 S2). The reference bicycle may be a bicycle without an electric drive system. The wheel on the brake roller must not have a dynamo, hub motor or similar, since these influences are not to be compensated.

2.2.2 Procedure

Bike assembly on the test bench, wheel vertical force: 500 N
The brake roller is actively driven. The powertrain (chain, belt) and eBike drive of the bicycle are not in motion. The power P_{comp} of the brake roller is determined at speeds of 15 km/h to 25 km/h in increments of 1 km/h. From this, the corresponding brake force $F_{B,\,comp}$ is calculated.

2.2.3 Formula braking force

$$F_{B,comp} = P_{comp}/(2\pi \cdot n \cdot r)$$

It is

$F_{B,comp}$	the brake force;
P_{comp}	the power;
n	the revolution speed;
r	the radius of the brake roller.

As with the measurement, a 30-minute warm-up phase of the test bench must be carried out immediately before the test bench losses are determined.

2.2.4 Compensation

To compensate the test bench losses, the brake force $F_{B,\,comp}$ is subtracted from the measured brake force $F_{B,\,measured}$:

$$\mathbf{F_B = F_{B,\,measured} - F_{B,\,comp}}$$

It is

F_B: the brake force on brake roller, compensated with the losses of the test bench;
$F_{B,\,comp}$ is negative, so F_B is greater than $F_{B,\,measured}$.

2.2.5 Frequency of the determination of the test bench losses

The reasonable frequency of determining the test bench losses depends on the measuring stability of the test bench. It is optimal if the compensation is determined before each measurement. If it can be assured that the test bench has a good measurement stability (variation of the losses <1% over time), the frequency of determining the test bench losses can be reduced.
After changes to the test bench (e.g. replacement of bearings, change of software), the test bench losses must be determined again.