INTERNATIONAL STANDARD

ISO 23280

First edition
2022-05

Electrically propelled mopeds and motorcycles — Test method for evaluation of energy performance using motor dynamometer

Motocycles et cyclomoteurs à propulsion électrique — Méthode d'essai pour l'évaluation de la performance énergétique à l'aide d'un dynamomètre

Reference number
ISO 23280:2022(E)

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 38, *Mopeds and Motorcycles*.

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.

Electrically propelled mopeds and motorcycles — Test method for evaluation of energy performance using motor dynamometer

1 Scope

This document specifies a test method to evaluate energy performance of electric motorcycles and mopeds by measuring performance of a test motor system (3.4) to be installed to an electric moped or motorcycle under consideration.

The test is carried out on a motor dynamometer test bench where the traction motor system is connected to a load motor system (3.3) that simulates resistance torque arising from running resistance of vehicle and drive train friction loss and inertia effect.

This method provides estimates of specific energy consumption and range of an electric moped or motorcycle to which the traction motor system is intended to be applied.

This document is only applicable to two-wheeled motorcycles and mopeds.

NOTE This test method is applicable to motorcycle or moped regardless of types of power transmission devices, such as chains, belts, gears, ratio controllable CVTs, shaft drives, direct drives, etc., once gear ratios (ratio of input to output speed) and transmission efficiencies (ratio of input to output torque) are provided.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11486, *Motorcycles — Methods for setting running resistance on a chassis dynamometer*

ISO 13064-1, *Battery-electric mopeds and motorcycles — Performance — Part 1: Reference energy consumption and range*

ISO 13064-2, *Battery-electric mopeds and motorcycles — Performance — Part 2: Road operating characteristics*

ISO 28981, *Mopeds - Methods for setting the running resistance on a chassis dynamometer*

IEC 60034-1, *Rotating electrical machines — Part 1: Rating and performance*

IEC 60034-2-1, *Rotating electrical machines — Part 2-1: Standard methods for determining losses and efficiency from test (excluding machines for traction vehicles)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13064-2, IEC 60034-1, IEC 60034-2-1 and the following 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
driving mode
test mode used for performance evaluation of mopeds and motorcycles such as UDC (urban driving cycle), EUDC (extra-urban driving cycle), WMTC (world motorcycle test cycle)

Note 1 to entry: For reference to UDC, see ISO 13064-1:2012, Annex A for mopeds and Annex B for motorcycles, and EUDC, see ISO 13064-1:2012, Annex B for mopeds, and WMTC, see UN-ECE GTR No.02.

3.2
load motor
electric motor that provides torque control function defined from running resistance, friction loss and inertia effect of the drive train when testing a traction motor system of electrically propelled mopeds and motorcycles

3.3
load motor system
combination of a *load motor* (3.2) and its pairing inverter

3.4
test motor system
combination of a traction motor and its pairing inverter under test that is used as a main traction motor for electric mopeds or motorcycles

3.5
speed-torque control mode
test mode performed in a *motor dynamometer* (3.6) where a *test motor system* (3.4) is speed controlled and *load motor system* (3.3) is torque controlled

3.6
motor dynamometer
test equipment for measuring *test motor system* (3.4) energy performance comprising test motor system, *load motor system* (3.3), DC power supply, transducers, data acquisition and analysing system

4 Principle

This test method specifies a test procedure to evaluate energy performance, such as consumed energy (7.1), travelled distance (7.2), motor system efficiency (7.3) and reference energy consumption (7.4) of electric motorcycles and mopeds with a traction motor system to be fitted to a vehicle under consideration. Instead of chassis dynamometer test that requires a full vehicle, this method is carried out with a traction motor system on a motor dynamometer and provides estimate of energy performance of vehicle with nominal information of the vehicle.

NOTE Reference energy consumption (7.4) defined in this document is different from those in other standards, such as ISO/TR 8713, ISO 8714 and ISO 13064-1, where reference energy consumption is defined as electric energy required to fully recharge the traction battery from the main electric supply network system after completion of a selected driving cycle. While in this document reference energy consumption is the ratio of consumed energy (7.1) to travelled distance (7.2).

In order to determine resistance torque to the traction motor system, running resistance acting on the driving wheel of a vehicle, in accordance with ISO 11486 for motorcycles and ISO 28981 for mopeds, shall be converted to the resistance torque to the traction motor system, and additionally the inertia effects and friction losses of the drive train of vehicle shall be accounted for.

5 Determination of resistance torque to traction motor system

5.1 Running resistance of vehicle

Running resistance of motorcycle and moped, respectively according to ISO 11486 and ISO 28981, is given as Formula (1):

$$F_w = m_i A + a + b\,v^2 \tag{1}$$

where

F_w is the running resistance acting on the driving wheel;

m_i is the equivalent mass;

A is the acceleration of vehicle;

a is the rolling resistance of the front and rear wheel;

b is the aero dynamic drag coefficient;

v is the velocity of the vehicle.

While values for m_i and b can be adopted from ISO 11486 and ISO 28981, rolling resistance a shall account for both front and rear wheels for motor dynamometer test. In this document, a is determined by assuming 50:50 weight distribution between front and rear wheels and the same rolling resistance coefficients. Care should be taken for the application of this method to mopeds and motorcycles having extraordinary weight distribution characteristics. Values m_i, a, and b for motorcycles and mopeds are given in Annex A and Annex B, respectively.

The accuracy and resolution of associated parameters, such as time, distance, temperature, speed, mass and energy, is in accordance with ISO 13064-1, which is given in Table 1.

Table 1 — Accuracy and resolution of parameters

Parameter	Unit	Accuracy	Resolution
Time	s	±0,1 s	0,1 s
Distance	m	±0,1 %	1,0 m
Temperature	°C	±1,0 K	1,0 K
Speed	km/h	±1,0 %	0,2 km/h
Mass	kg	±0,5 %	1,0 kg
Energy	Wh	class 0,2 S[a]	class 0,2 S[a]

[a] According to IEC 62053-22.

5.2 Resistance torque for central drive system

A typical configuration for a central drive system is shown in Figure 1, where a chassis mounted traction motor is connected to driving sprocket via gears, and power is transmitted to driven sprocket with a chain or belt. Besides chain, belt and sprocket, other types of transmission devices, such as CVT, gear, shaft drive, direct drive, etc. Resistance torque T_m [N-m] that shall be applied to the traction motor system on a motor dynamometer test setup can be given as (see Annex C for derivation) Formula (2):

$$T_m = \left(\frac{r}{\eta N}\right) F_w \quad (2)$$

where r is the rear wheel radius, η is overall torque transmission efficiency between traction motor and wheel, and N is overall gear ratio between traction motor and wheel.

NOTE 1 In case of drive configuration given in Figure 1, η is given as $\eta = \eta_g \times \eta_c$, where η_g is the transmission efficiency of gear between traction motor and driving sprocket, and η_c is the transmission efficiency of the chain drive system connected with driving sprocket and driven sprocket (see Annex C).

If a traction motor system is combined with internal transmission gears to form a single assembly, then the whole assembly is regarded as a traction motor unit. If this is the case, transmission efficiency η_g shall not be taken into consideration, thus, the overall torque transmission efficiency is $\eta = \eta_c$, and the overall gear ratio becomes $N = N_w$.

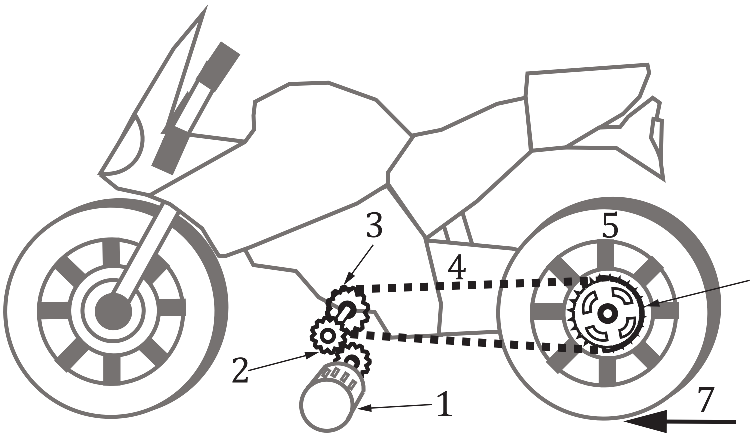
If the traction motor system and gear between traction motor and driving sprocket is combined to form a single assembly, and tested as a one unit, which is the case when a traction motor system assembly has integrated internal gears whose gear ratio may be varying (see NOTE 2), then, both transmission efficiency η_g and gear ratio N_g between traction motor and driving sprocket need not be considered and set to 1. In this case all energy performance results are valid for the assembly, and not for a traction motor. When traction motor system assembly has varying gear ratios, then gear shifting shall be implemented in the test according to the test motor gear shifting map (see NOTE 3).

NOTE 2 Gear ratios can change stepwise or continuously like CVT.

NOTE 3 Gear ratios are determined depending on acceleration throttle angle (desired speed), traction motor speed and torque, traction motor efficiency etc., and gear shifting strategy is expressed as so called “gear shifting map” in conjunction with acceleration throttle angle and traction motor current relations (map), and traction motor speed–torque–current relations (map).

Typical values for η_g and η_c are $\eta_c = \eta_g = 0{,}9$. However, other efficiency values or non-constant values that depend on load, speed, etc., can be used by agreement between parties involved. The adopted values for each power transmission devices shall be reported.

In case of Figure 1, N is given as $N = N_g \times N_w$, where N_g is the gear ratio between traction motor and driving sprocket, and N_w is the gear ratio between driving sprocket and driven sprocket (see Annex C). The adopted values for N_g and N_w shall be reported.



Key

1 traction motor
2 gear between traction motor and driving sprocket
3 driving sprocket
4 chain
5 wheel
6 driven sprocket
7 running resistance applied to wheel

Figure 1 — Configuration of a central drive system

5.3 Resistance torque for in-wheel drive system

A typical configuration for in-wheel drive system is shown in Figure 2, where a traction motor is connected to a wheel with gears.

Resistance torque to traction motor system can be given as (see Annex D for derivation) Formula (3):

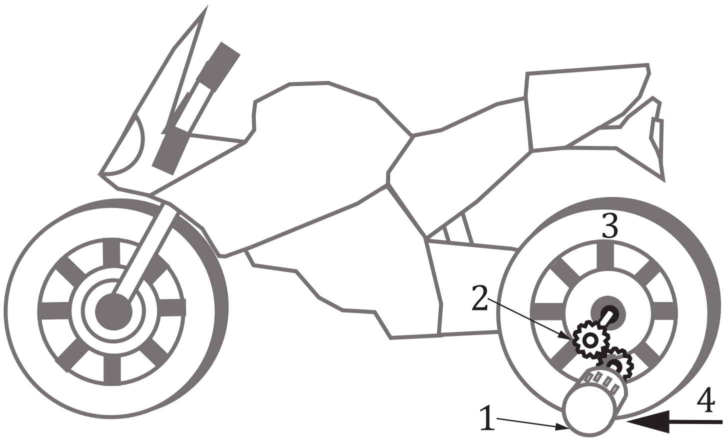
$$T_m = \left(\frac{r}{\eta N}\right) F_w \quad (3)$$

where η is torque transmission efficiency between traction motor and wheel, and N is the gear ratio between traction motor and wheel.

If a traction motor system is combined with internal transmission gears to form a single assembly, then the whole assembly is regarded as a traction motor unit. If this is the case, the overall torque transmission efficiency is $\eta = 1$, and the gear ratio is $N = 1$.

Typical values for $\eta = 0,9$, or other value can be adopted by agreement between parties involved. If this is the case, then the adopted values shall be reported.

The adopted values for N shall be reported.



Key

1 traction motor
2 gear between traction motor and wheel
3 wheel
4 running resistance applied to wheel

Figure 2 — Configuration of in-wheel drive system

6 Test conditions

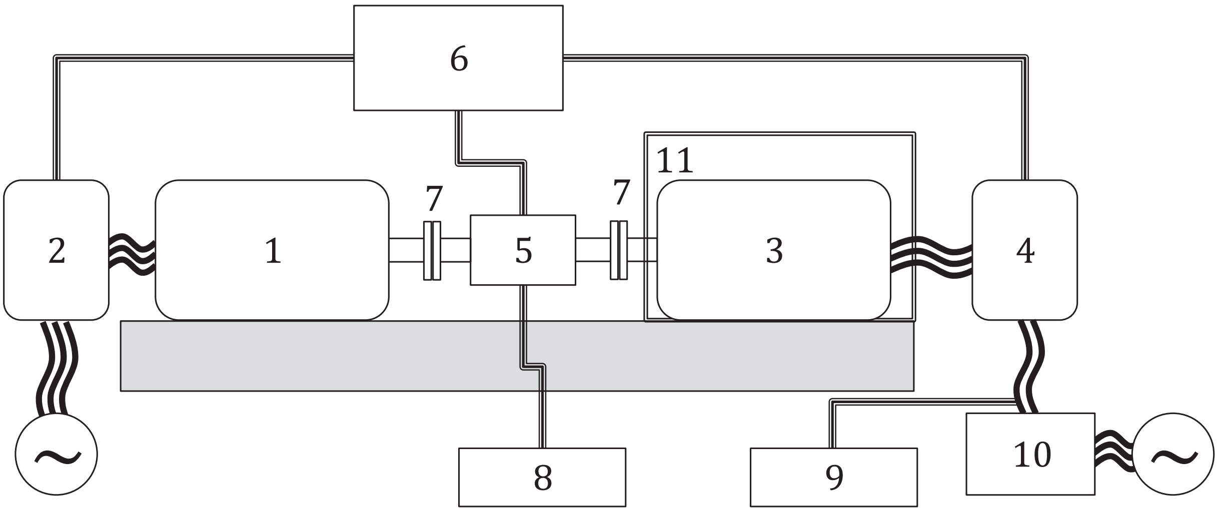
6.1 Motor dynamometer

Figure 3 shows a motor dynamometer test bench consisting of a load motor system and a test motor system that are mechanically connected by a coaxial mechanical coupling, power supply, torque and speed sensors, power meter, and data acquisition and processing equipment.

When the test motor is driven in a selected driving mode, the load motor shall be able to generate running resistance torque given in Formulae (2) or (3) as a function of rotational speed and acceleration. When the traction motor is operating as a generator in regenerative braking mode, the load motor shall be able to generate braking torque defined in a selected driving mode.

A temperature chamber should be used to control the temperature of the test motor. Temperature shall be maintained between 20 °C and 30 °C in accordance with ISO 13064-1.

Sampling rate for load, velocity, voltage and current shall be at least 10,0 Hz.



Key

1 load motor
2 load inverter
3 test motor
4 test inverter
5 torque sensor
6 main controller
7 coupling
8 torque/speed meter
9 power meter
10 DC power supply
11 temperature chamber

Figure 3 — Schematic diagram of the test system

6.2 Driving mode

The test motor system shall be able to perform any driving mode such as UDC, EUDC and WMTC.

The load motor system shall be controlled to emulate any driving mode, where WMTC driving mode is given in Figure C.1 as an example.

Tolerances on speed and time in the test sequence shall subject to ISO 8714:2002, Clause 5/Figure 1 and ISO 13064-1.

6.3 Operation for the motor dynamometer

The speed-torque control mode (3.5) shall be used, since test motor shall be driven in accordance with a selected driving mode, and load motor shall be able to generate corresponding running resistance torque.

Traction motor system shall be driven with the rotational speed(ω_m) given as Formula (4):

$$\omega_m = \frac{Nv}{r} \quad (4)$$

where v is the vehicle velocity specified in a selected driving cycle.

Any driving cycle can be adopted, however tolerances on speed and time for a selected driving cycle shall be satisfied in accordance with the specification given in the original document for the driving cycle.