INTERNATIONAL STANDARD

**ISO 13064-2**

First edition
2012-09-15

# Battery-electric mopeds and motorcycles — Performance —

## Part 2: Road operating characteristics

*Cyclomoteurs et motocycles électriques — Performance —*

*Partie 2: Caractéristiques d'utilisation sur route*



Reference number
ISO 13064-2:2012(E)



ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

 

# Contents

Page

**Foreword** ... **iv**

**1 Scope** ... **1**

**2 Normative references** ... **1**

**3 Terms and definitions** ... **1**

**4 Principle** ... **2**

**5 Parameters, units and accuracy of measurements** ... **2**

**6 Test conditions** ... **3**
6.1 Vehicle conditions ... 3
6.2 Atmospheric conditions ... 3
6.3 Track conditions ... 3
6.4 Rider and riding position ... 4
6.5 Driving selection mode ... 5

**7 Preconditioning of the vehicle** ... **5**
7.1 Battery charge ... 5
7.2 Warm-up ... 5

**8 Test sequence** ... **5**

**9 Test procedures** ... **6**
9.1 Range at 80 % maximum speed ... 6
9.2 Complete battery discharge ... 6
9.3 Maximum speed ... 6
9.4 Partial battery discharge ... 7
9.5 Acceleration ability ... 8
9.6 Hill starting ability ... 8
9.7 Speed uphill ... 9

**10 Presentation of results** ... **9**

**Annex A** (informative) **Specimen format for test result sheet** ... **10**

# 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 13064-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 23, *Mopeds*.

ISO 13064 consists of the following parts, under the general title *Battery-electric mopeds and motorcycles — Performance*:

— *Part 1: Reference consumption and range*

— *Part 2: Road operating characteristics*



 

# Battery-electric mopeds and motorcycles — Performance —

# Part 2: Road operating characteristics

## 1 Scope

This International Standard specifies the procedures for measuring the road performance of electric motorcycles and mopeds with only a traction battery(ies) as power source for vehicle propulsion.

The road performance comprises road operating characteristics such as speed, acceleration and hill climbing ability.

## 2 Normative references

The following referenced documents are indispensable for the application 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 28981, *Mopeds — Methods for setting the running resistance on a chassis dynamometer*

ISO 13064-1:2012, *Battery-electric mopeds and motorcycles — Performance — Part 1: Reference energy consumption and range*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13064-1 and the following apply.

**3.1**
**complete battery-electric moped (motorcycle) kerb mass**
total unladen mass of the battery-electric moped (motorcycle), including traction batteries, cooling liquid, window-washer fluid, lubricating oil, tool kit, spare wheel (if mandatory) and on-board charger and portable charger or part of it, if provided as standard equipment by the manufacturer

**3.2**
**maximum design total mass**
maximum vehicle mass as specified by the battery-electric moped (motorcycle) manufacturer

**3.3**
**test mass of a battery-electric vehicle**
complete battery-electric vehicle kerb mass increased by a uniform figure of 75 kg, which represents the mass of a rider

**3.4**
**tyre rolling radius**
effective radius of a tyre when it is deformed by the mass of the vehicle loaded to its test mass

**3.5**
**range at 80 % maximum speed**
Total distance the vehicle can cover when running at 80 % maximum speed

NOTE For the relevant test procedure, see 9.1.

**3.6**
**maximum speed**
highest average speed which the vehicle can maintain twice over a distance of 200 m

NOTE For the relevant test procedure, see 9.3.

**3.7**
**acceleration ability**
shortest time required to accelerate the vehicle from standstill over a given distance

NOTE For the relevant test procedure, see 9.5.

**3.8**
**hill starting ability**
maximum slope on which the vehicle can start moving over a minimum distance of 10 m

NOTE For the relevant test procedure, see 9.6.

**3.9**
**speed uphill**
highest average speed which the vehicle can maintain on a given slope over a distance of 200 m

NOTE For the relevant test procedure, see 9.7.

## 4 Principle

All road operating characteristics (3.5 to 3.9) shall be tested in the test sequence according to Clause 8 with the charged states of the battery for each test resulting from the previous procedure.

However, if any test is conducted individually, start the test procedure for range and maximum speed (9.1 and 9.3) with a battery state between 100 % and 90 % of fully charged.

For acceleration (9.5), hill starting ability (9.6) and speed uphill (9.7), the test procedure shall be started with a battery state between 65 % and 50 % of fully charged.

## 5 Parameters, units and accuracy of measurements

Table 1 specifies parameters and their units, accuracy and resolution.

**Table 1 — Parameters, units and accuracy of measurements**

| Parameter | Unit | Accuracy | Resolution |
|---|---|---|---|
| Time | s | ±0,1 s | 0,1 s |
| Distance | m | ±0,1 % | 0,1 m |
| Temperature | °C | ±1 K | 1 K |
| Air pressure | kPa | ±1 kPa | 1 kPa |
| Speed, constant | km/h | ±1 % or ± 0,1 km/h [a] | 0,2 km/h |
| Mass | kg | ±0,5 % | 1 kg |
| [a] Whichever is the greater. | | | |

# 6 Test conditions

## 6.1 Vehicle conditions

The vehicle shall be loaded according to the specification for each test.

The vehicle tyres shall be inflated to the pressure specified by the vehicle manufacturer when the tyres are at ambient temperature.

The viscosity of oils for the mechanical moving parts shall conform to the specification of the vehicle manufacturer.

The lighting, signalling and auxiliary devices shall be off, except those required for testing and usual day-time operation of the vehicle.

All energy storage systems available for other than traction purposes (electric, hydraulic, pneumatic, etc.) shall be charged up to their maximum level specified by the vehicle manufacturer.

The vehicle shall be clean, and the windows and air entries, not needed for the correct operation of the vehicle and the drive system, shall be closed by the normal operating controls.

If batteries are to be operated at temperatures above ambient temperature, the driver shall follow the procedure recommended by the vehicle manufacturer to keep the battery temperature within its operating range.

The vehicle shall be run in properly in accordance with the manufacturer's requirements, and in any case not less than 100 km before the test with those batteries that are installed in the test vehicle.

The mass of the vehicle used in the test shall be the test mass of an electric vehicle in accordance with 3.1 and 3.3.

The traction battery shall be in the state of charge required for the test to be performed.

## 6.2 Atmospheric conditions

Outdoor test steps shall be performed at an ambient temperature between 5 °C and 35 °C. Indoor test steps shall be performed at a room temperature between 20 °C and 30°C. The atmospheric pressure shall be between 91 kPa and 104 kPa. The relative humidity shall be less than 95 %. The tests shall be performed in the absence of rain and fog.

The wind speed and the direction of the wind shall be measured continuously or with adequate frequency at a location where the wind force during the measurement is representative. The wind conditions shall be within the following limits:

a) average wind speed: 3 m/s;

b) maximum wind speed for gusts: 5 m/s.

## 6.3 Track conditions

### 6.3.1 General conditions

The measurements shall be taken on a track, which may be either a straight track (see 6.3.2) or a loop track (see 6.3.3). The surface of the track shall be flat, level, and smoothly paved. The road surface shall be dry and free of obstacles or wind barriers that might impede the measurements.

### 6.3.2 Straight track

The test track shall be long enough to allow the vehicle to attain its maximum speed.

The test track shall have not more than 0,5 % longitudinal slope and not more than 3 % transverse slope.

The length of the launching track shall be long enough to achieve a stable speed ahead of the measuring zone.

In order to reduce the influence of factors such as road slope and wind direction/speed, the acceleration and the speed tests shall be executed in both directions of the test track in direct sequence, taking care to use the same stretch of the track.

When conditions preclude performing the test in both directions, a single direction test shall be carried out as in 6.3.4.

### 6.3.3 Loop track

The test track shall have not more than 0,5 % longitudinal slope and not more than 3 % transverse slope.

The loop track may vary from a perfect circle to straight sections linked by approximately circular sections.

The measuring zone shall be located on the straight part of loop track. The straight track length before the measuring zone shall be long enough to allow the vehicle to reach the maximum speed before the measuring zone.

In case of circular tracks, the radius of test track shall be large enough to allow the vehicle to attain the maximum speed.

The effects of centrifugal forces may be compensated by the transverse profile of the curves in such a way that the vehicle holds a normal line without any action on the handlebar and without extra weight shift effort by the rider.

When conditions preclude performing the test in both directions, a single direction test shall be carried out as in 6.3.4.

### 6.3.4 Single direction test

Testing in one direction only shall be permitted if, because of the characteristics of the test track layout, it is not possible for the vehicle to reach its maximum speed in both directions.

The following conditions shall be fulfilled:

a) the track shall conform to the requirements of 6.3.1 or 6.3.2;

b) the variation in altitude shall not exceed 1 m between any two points;

c) the run shall be repeated twice in immediate succession;

d) the average wind speed components parallel to the track shall not exceed 2 m/s.

## 6.4 Rider and riding position

**6.4.1** The rider shall wear a close-fitting suit (one-piece) or similar clothing, a protective helmet, eye protection, boots and gloves.

**6.4.2** The rider in the conditions given in 6.4.1 shall have a mass of 75 kg ± 2 kg, including the weight of any additional testing equipment. It is recommended the rider to be 1,75 m ± 0,02 m tall.

**6.4.3** The rider shall take the normal and safe riding position which is appropriate for attaining the maximum speed of the moped (motorcycle) to be tested. The position shall allow the rider at all the times to have proper control of the moped (motorcycle) during the test. The position of the rider should remain as stable as possible in order to avoid any influences on the test results.

### 6.5 Driving selection mode

In case of two or more manually selectable driving modes, tests shall be conducted for each single mode, and at least the worst case shall be mentioned in the test report. If the manufacturer can provide evidence that proves what is the worst case mode, it is allowed to only test such mode.

## 7 Preconditioning of the vehicle

### 7.1 Battery charge

#### 7.1.1 General

The battery shall be charged according to charging method recommended by the vehicle manufacturer. In case this is not available, or upon the request by the vehicle manufacturer, the battery shall be charged according to the following procedure. Upon the request by the vehicle manufacturer, the preconditioning may also include a complete battery discharge, according to 9.2, to be performed before the normal overnight charging procedure (7.1.2).

#### 7.1.2 Normal overnight charging procedure

The charging of the battery shall be carried out at an ambient temperature between 20 °C and 30 °C using the on-board charger, if fitted, or an external charger as recommended by the vehicle manufacturer.

The electrical connection with the public network shall be made with a plug as recommended by the vehicle manufacturer (e.g. plug used for domestic appliances, dedicated plug).

The procedure excludes all types of special charging, for example battery refreshing or service charging.

The vehicle manufacturer shall be in the position to attest that during the test no special charging has been performed.

#### 7.1.3 End-of-charge criteria

The end of charge criteria correspond to the indication that the battery is fully charged given by the standard instrumentation recommended by the vehicle manufacturer. The charging time shall not exceed 12 h.

#### 7.1.4 Fully charged battery

A battery is fully charged when charged according to the overnight charging procedure and the end of charge criteria.

### 7.2 Warm-up

The vehicle shall be driven according to the manufacturer's specifications in order to warm up the motor and transmission gears.

## 8 Test sequence

The test sequence is arranged such that all road performances can be performed within two days. It shall be performed according to the following sequences.

a) First part:

preconditioning (see Clause 7);

test: range at 80 % of the maximum design speed (see 9.1);

complete battery discharge (see 9.2).

b) Second part:

preconditioning (see Clause 7);

test: maximum speed (see 9.3);

preconditioning (see Clause 7);

partial battery discharge (see 9.4);

test: acceleration ability (see 9.5);

test: hill starting ability (see 9.6);

test: speed uphill at slopes of 6 % and 12 % (see 9.7).

c) Third part (optional):

preconditioning (see Clause 7);

test: acceleration ability (see 9.5);

test: hill starting ability (see 9.6);

test: speed uphill at slopes of 6 % and 12 % (see 9.7).

# 9 Test procedures

## 9.1 Range at 80 % maximum speed

The test of the range at 80 % maximum speed shall be performed either on a loop track or on a chassis dynamometer, as follows:

a) load the vehicle to the test mass (see 3.3);

b) define the target speed: $V_t$ = 80 % of the maximum design speed declared by the manufacturer or 90km/h whichever is the smaller;

c) Measure the total distance, $D_t$, covered during the test.

The test shall be performed according to the prescriptions and test sequence as given in Annex C to ISO 13064-1:2012.

## 9.2 Complete battery discharge

After performing the range test, the vehicle shall rest for 15 min. Driving shall then be resumed at 70 % of the range test target speed until the speed has decreased with throttle fully open to 50 % of target speed or to 15 km/h whichever is the greater, or until an indication is given to the driver to stop driving by the standard on-board instrumentation.

The total distance, $S_{tot}$, covered during the preconditioning plus the range test plus the complete discharge shall be recorded.

## 9.3 Maximum speed

### 9.3.1 Instrumentation

For time measurements it is recommended to use an automatic time trigger. When this is not possible, the use of a manual time trigger is allowed. This information shall be recorded in the test report.



 

### 9.3.2 Standard test procedure

Perform the following test procedure:

a) load the vehicle to the test mass (see 3.3);

b) Accelerate the vehicle to its maximum speed on the straight or loop track and maintain it over a distance $D_{vm}$ of 100 m for mopeds or 200 m for motorcycles;

c) Measure the time $T_{vm}$ to run the distance $D_{vm}$ and calculate the maximum speed as follows:

$$v = \frac{D_{vm}}{T_{vm}} \quad (1)$$

d) Immediately perform the same test in the opposite track direction.

The test shall be repeated until two measured speeds (one for each direction) are within ± 2 km/h of the arithmetical average of the same two measured speeds.

The reported maximum speed value in kilometres per hour (km/h), is the arithmetical average between the two valid speed values, rounded to the nearest integer.

### 9.3.3 Single direction test procedure

When a single direction test is carried out using a test track as in 6.3.4, the results of the two runs shall be calculated as follows, where the maximum speed $v$ is the arithmetical average of the two values of $v_i$.

The maximum speed shall be corrected according to the following formula which considers the wind speed and where the plus sign is used if the axial wind component is in the opposite direction to the vehicle driving direction and the minus sign is used if the axial wind component is in the same direction as the driving direction:

$$v_i = v_r \pm v_v \times f \quad (2)$$

where

$v_r$ is the maximum speed measured for each run in kilometres per hour (km/h);

$v_v$ is the axial wind component in metres per second (m/s);

$f$ is the correction factor and is equal to 0,6.

The maximum speed measured for each run, $v_r$, is calculated using the following formula:

$$v_r = 3{,}6 \times \frac{L}{t} \quad (3)$$

where

$L$ is the measured length in metres (m);

$t$ is the measured time in seconds (s).

## 9.4 Partial battery discharge

The battery shall then be discharged by running the vehicle over the test track or on a dynamometer, at the target speed defined in 9.3, over a distance of 35 % of the distance, $D_t$, measured during the range test [9.1 c)].

If the test is applied on a chassis dynamometer, the determination of vehicle road load and the reproduction on the chassis dynamometer shall be applied in accordance with ISO 11486 for motorcycles and ISO 28981 for mopeds.

## 9.5 Acceleration ability

### 9.5.1 Instrumentation

For time measurements it is recommended to use an automatic time trigger. When this is not possible, the use of a manual time trigger is allowed. This information shall be recorded in the test report.

### 9.5.2 Test procedure

Perform the following test procedure:

a) load the vehicle to the test mass (see 3.3);

b) stop the vehicle on the test track in the start position;

c) accelerate the vehicle by fully opening the throttle;

d) record the time elapsed from opening the throttle to achieving the target distance of 100 m ± 0,1 m for mopeds and 200 m ± 0,2 m for motorcycles;

e) immediately perform the same test in the opposite direction.

If one measurement deviates more than ± 5 % from the arithmetical average of the two measured time periods, that test shall be repeated until a valid value is measured.

The acceleration ability, $A$, in seconds (s) is the arithmetical average of the two measured time periods, rounded to the second decimal figure.

## 9.6 Hill starting ability

### 9.6.1 Principle

The measurement of hill starting ability shall be performed by starting on a slope featuring an angle, $\alpha_1$, as near as possible to the vehicle manufacturer's claimed hill starting ability, $\alpha_0$.

The difference between the real angle, $\alpha_1$, and the claimed angle, $\alpha_0$, shall be compensated for by an additional or a reduced mass, $\Delta m$, uniformly distributed on the moped (motorcycle).

In the case where the angle $\alpha_0$ is unknown, it can be evaluated using the formulae given in 9.6.3.

### 9.6.2 Procedure

Perform the following test procedure:

a) load the vehicle to its maximum design total mass (3.2);

b) arrange the vehicle on a test gradient slope, $\alpha_1$, selected as near as possible to $\alpha_0$, facing up the slope;

c) add the mass $\Delta m$ or reduce the load by $\Delta m$, calculated using the following formula:

$$\Delta m = m \times \frac{\sin\alpha_0 - \sin\alpha_1}{\sin\alpha_1 + R} \quad (4)$$

where



 

$m$ is the mass of the vehicle under test, in kilograms (kg);

$R$ is the rolling resistance, conventionally equal to 0,01.

d) run the vehicle over a distance of at least 10 m.

### 9.6.3 Evaluation of $\alpha_0$

With known peak motor shaft torque, calculate the wheel torque using the following formula:

$$C_r = C_a \times T \times \eta_t \quad (5)$$

where

$C_r$ is the wheel torque, in newton metres (Nm);

$C_a$ is the maximum peak motor shaft torque, in newton metres (Nm);

$T$ is the total gear ratio;

$\eta_t$ is the gear efficiency.

Then, with known tyre rolling radius, calculate the balance of forces as follows:

$$F_t = \frac{C_r}{r} = m \times g \times (\sin\alpha_0 + R) \quad (6)$$

where

$F_t$ is the total traction force necessary to balance the load, in newtons (N);

$r$ is the tyre dynamic loaded radius, in metres (m);

$g$ is the acceleration of gravity, in metres per second squared (m/s$^2$).

From Formulae (5) and (6), the hill starting ability, $\alpha_0$, can be calculated.

## 9.7 Speed uphill

Perform the following test procedure:

a) load the vehicle to its maximum design total mass;

b) position the vehicle on the dynamometer and make any necessary adjustment;

NOTE The test can also be performed using a dynamometer trailer.

c) set up the bench with an additional load corresponding to a 6 % slope;

d) accelerate by fully opening the throttle;

e) determine the maximum stabilized speed value that the vehicle can reach and run at over a distance of 100 m for mopeds or 200 m for motorcycles;

f) repeat the test starting with the bench set up with an additional load corresponding to a 12 % slope.

# 10 Presentation of results

The resulting road operating characteristics shall be reported in a test report. An example is given in Annex A.

# Annex A
(informative)

# Specimen format for test result sheet

## A.1 Test vehicle

Type (strike out the one that does not apply): moped / motorcycle

Category (strike out the one that does not apply): two-wheeler / three-wheeler

Manufacturer: .....

Model: ..... Year: .....

Electric motor type:

Gearbox (strike out the one that does not apply): manual / automatic

Number of gear ratios:

Drive ratios: ..... primary .....final

Maximum design speed [1]): ..... km/h

Maximum continuous rated power [2]): ..... kW at $min^{-1}$

Mileage accumulated at test: .....km

Others (alterations, if any):

## A.2 Tyre details

| | Front | Rear |
|---|---|---|
| Manufacturer: | ..... | ..... |
| Size: | ..... | ..... |
| Static radius: | ..... mm | ..... mm |

## A.3 Test masses

Vehicle mass: Kerb: ..... kg; Maximum: ..... kg; Test: ..... kg

Test rider: ..... kg

Instrumentation mass: ..... kg

1) Maximum design speed of the vehicle as stated by the manufacturer.

2) Maximum continuous rated power of the electric motor as stated by the manufacturer.