

Dynamometer for E-Bikes According to new EPAC/EMC standard

Matur GmbH designed the new state-of-the-art dynamometer for EMC testing of E-Bikes according to new Standard EN 15194:2009-06 appendix C for EPACs (Electrically Power Assisted Cycles).

The market for E-Bikes has changed drastically with the implementation of the new standard in year 2009.

Pedelecs (all motorised bicycles) have to fulfil from now on the same EMC test requirements as ca, motorcycles and mopeds according to new safety standard EN 15194 EPAC appendix C.



Fig.: E-Bike Dynamometer in the field at VDE

Features:

- Three independently selectable drive units for front-/rear- and pedal-powered drive
- Speed up to 40 km/h, driving power up to 800 W
- Accurate readout and calculation of speed, torque, engine rating and level of efficiency
- Measurement of electromagnetic radiation with load of $75\% \pm 10\%$ according to CISPR 12
- Measurement of electromagnetic immunity with condition 90% of assistance speed

Information presented enclosed is subject to change as product enhancements are made regularly. Pictures included are for illustration purposes only and do not represent all possible configurations.

Brief description

The dynamometer for E-Bike allows the testing and inspection of bicycles with electromotive drive support (EPAC) in respect to the electromagnetic compatibility.

An EPAC (electrically power assisted cycles – EPAC Bicycles) remains a “bicycle“ without the necessity of a road traffic-legal approval, if:

- the motor-driven support speed does not exceed 25 km/h
- the motor-driven support is only activated, if there is also the pedal force / pedal movement activated
- the motor output is maximum 250 W
- the possible mode of a “starting support“ does not exceed a maximum of 6 km/h, also at the mode without pedal movement

The vehicle is liable to the European permission requirements for the road traffic (directives 2002/24/EG and 97/24/EG), if one of the above criteria is exceeding.

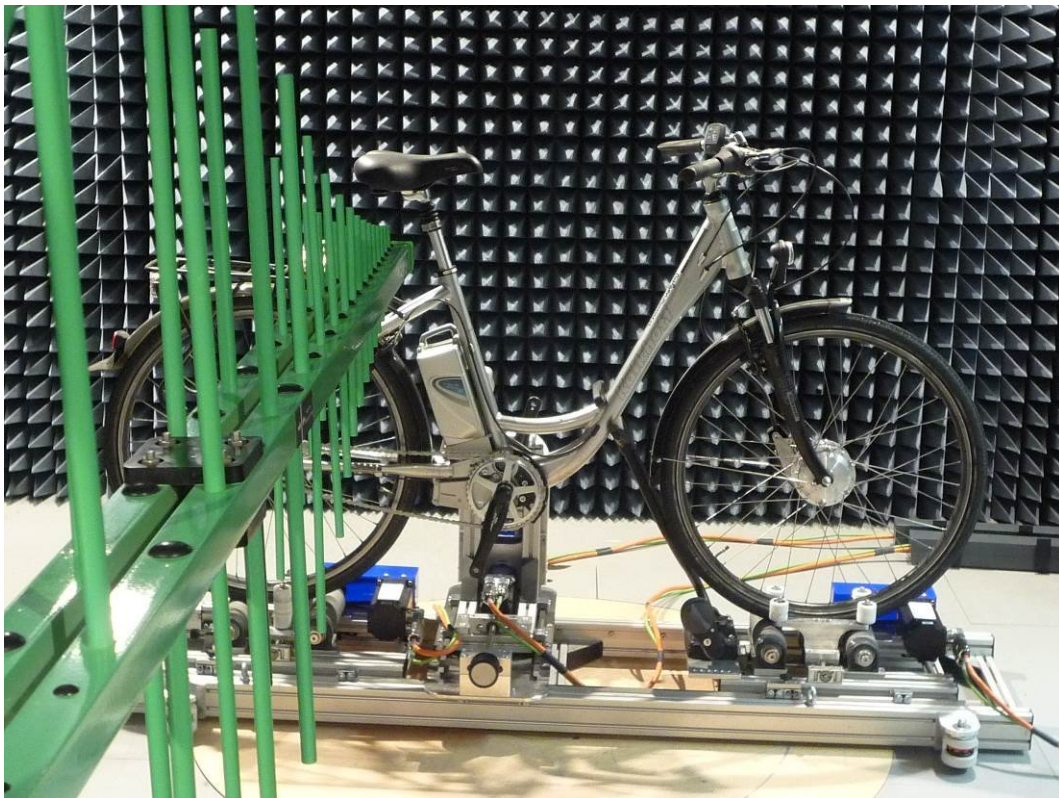


Fig.: E-Bike Dynamometer in the field at SLG Prüf- und Zertifizierungs GmbH

Emission of the system:

Less than 10 dB the limits of CISPR 12 and CISPR 25
Frequency range

150 kHz – 1 GHz

Immunity of the system:

Continuous field strength
Frequency range

200 V/m

10 kHz – 18 GHz

Technical Data

Permissible load		100 kg
Speed adjustable between		0 – 40 km/h
Speed accuracy and readout		+/- 0.1 km/h
Wheel base range from		0.7 – 1.7 m
Diameter of rollers		70 mm
Roller coating similar to road surface		Rz 50 – 60µm
Overall dimensions (L x W x H)		2380 x 1000 x 627 mm
Total weight	approx.	170 kg
Height of tyres above floor	approx.	150 mm
Adjustable frame holder for E-Bikes made of plastic		
Motors		Brushless synchronous servomotors
Rated power	each	800 W
Rated torque	each	6.0 Nm
Braking power adjustable	up to	800 W
Control cable		Fibre optic lines
Current consumption	max.	16 A
Voltage		380-400 VAC, 50/60 Hz, 3-phase
Temperature range		+10°C to +35°C
Accessories		Interface to NCD Controller 1.5 m power supply cable Service manual

Technical Requirements

The technical requirements are described in the standard EN 15194:2009 and also include the EMI requirements to EPAC's at attachment C as follows:

- Measurement of the electromagnetic radiation with load according to CISPR 12
- Testing of the electromagnetic immunity to HF-field (according to ISO 11451-1/-2) in the operation mode "standstill", without pedal movement at standstill with 0 km/h
- Testing of the electromagnetic immunity in mode "during operation" with movement of the motor at movement or pedal force
- Testing of the electromagnetic immunity in mode "starting support" for vehicles which this option.

The dynamometer itself must be interference-resistant up to field strength of 30 V/m for all operation modes above. No high frequency interference must be created by the dynamometer, which could affect the test result.

The dynamometer is portable for use in anechoic chambers. The system itself does not create any major influence of the test results, except due to the construction.

The new E-Bike dynamometer allows the input of a target speed for the tyres as well as the readout of the speed for each tyre. This function can be selected for each individual drive – front wheel drive, pedal drive and rear wheel drive.

An additional feature of the system is the input of torque for the simulation of uphill and downhill drives.

A third drive unit, with adaptation to the foot pedal of the EPAC, can be used for simulations of the pedal movement if required. This pedal movement is evaluated as an indication of the rotating movement at many E-Bikes.

The compliance of a constant speed, also by the influence of high frequent emission, is the main criteria for the test of the electromagnetic immunity. At the operation mode “standstill”, the E-Bike must not be activated; the speed therefore must remain a “0” km/h.

The Controller NCD of the dynamometer has an output function of a scalable value for the voltage. This function enables the automation of the test sequence in the EMI laboratory, where the possible reactions or speed fluctuations are recorded as a function of the test frequency.

Voltage output for documentation:



The analogue voltage can be output in relation to the operating mode and speed. The value can be measured with either a voltmeter or a test receiver.

Features of the system:

- Adjustment of the wheelbase
- Adjustments to the tyre width / wheel rim
- Calibration to the tyre diameter
- Adaptation to the foot pedal at removed pedal arm
- Velocity control
- Torque Control
- Fastening device for the E-Bike to the dynamometer
- Movable by integrated casters

Operation by Controller NCD

For the operation for the E-Bike Dynamometer the Controller **NCD** is used. The Controller NCD is capable for the operation of up to 8 devices with multiple axis of motion.



Figure: NCD with option "tip-up handle"

Technical Data

Data interfaces	IEEE 488.2 (GPIB-Bus) and Ethernet
Transmission	Fibre optic cable (up to 2000 m distance)
Transfer rate	Real time 100 Mbit/s (fast Ethernet)
Display	5.7" TFT Touch screen-Display

Brief description of NCD

- **User-friendly, time-saving function keys**
The function keys F1 to F10 allows the implementation of individual, customer-specific sequence programs for user-friendly, times-saving handling and operation. The individual programs can be stored and accessed by one function key.
- **USB interface**
Updates easily implemented by USB stick
Possibility to plug in a computer mouse and keyboard
- **Easy operation with touch panel**
Fast and reliable operability based on touch panel technology
The layout of touch screen display can easily be modified to customers' request
- **Output of measured quantities**
The Controller has an analogue output of measured quantities function for the external documentation.

Operating Modes:

1) Determination of the E-Bike factor:

The transmission ratio of the bike has to be determined for each gear respectively for each different bike.

This process can be started with one button and is performed automatically.

2) Mode 1: 75% of the rated continuous power:

At this mode a counter-torque applies to the bike.

The current power at the driven wheel can be determined during activated auxiliary drive by the measured torque and the engine speed.

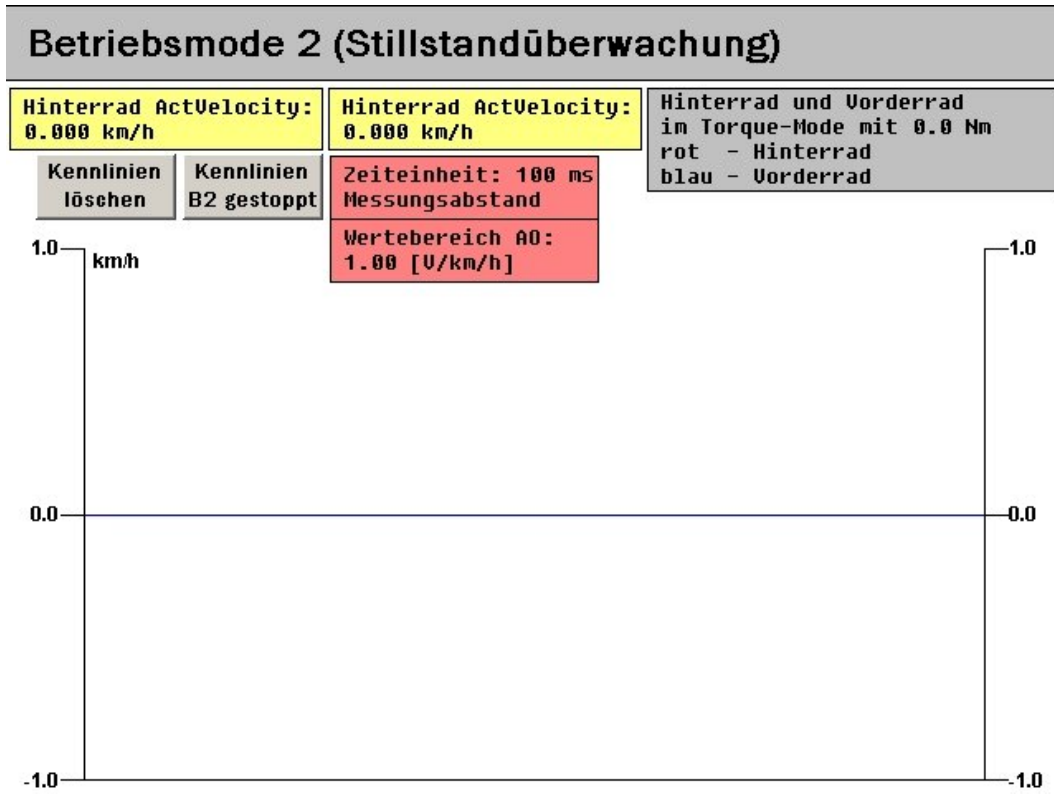
Betriebsmode 1 (75% Nenndauerleistung)			
Hinterrad M1			
Dif: 0.000 W	Torque +	Steps: 0.10 NM	Torque -
Differenz M3 zu M1	SetTorque: 0.00 NM - bergab + bergauf		ActTorque: 0.00 Nm
Wertebereich A0: 1.00 [U/km/h]			ActTorque: 0.00 Pro
			ActVelocity: 0.0 km/h
			ActVelocity: 0.00 U/min
			ActPower: 0.00 W
Vorderrad M2			
	Torque +	Steps: 0.10 NM	Torque -
	SetTorque: 0.00 NM - bergab + bergauf		ActTorque: 0.00 Nm
			ActTorque: 0.00 Pro
			ActVelocity: 0.0 km/h
			ActVelocity: 0.00 U/min
			ActPower: 0.00 W
Pedal M3			
	Velo +	Steps: 0.10 km/h	Velo -
	Velocity: 0.0 km/h		ActTorque: 0.00 Nm
	Acc: 2 U/min/s		ActTorque: 0.00 Pro
	Dec : 2 U/min/s		ActVelocity: 0.0 km/h
			ActVelocity: 0.00 U/min
			ActPower: 0.00 W

3) Mode 2: "Standstill" monitoring:

Main criteria for testing of the electromagnetic immunity.

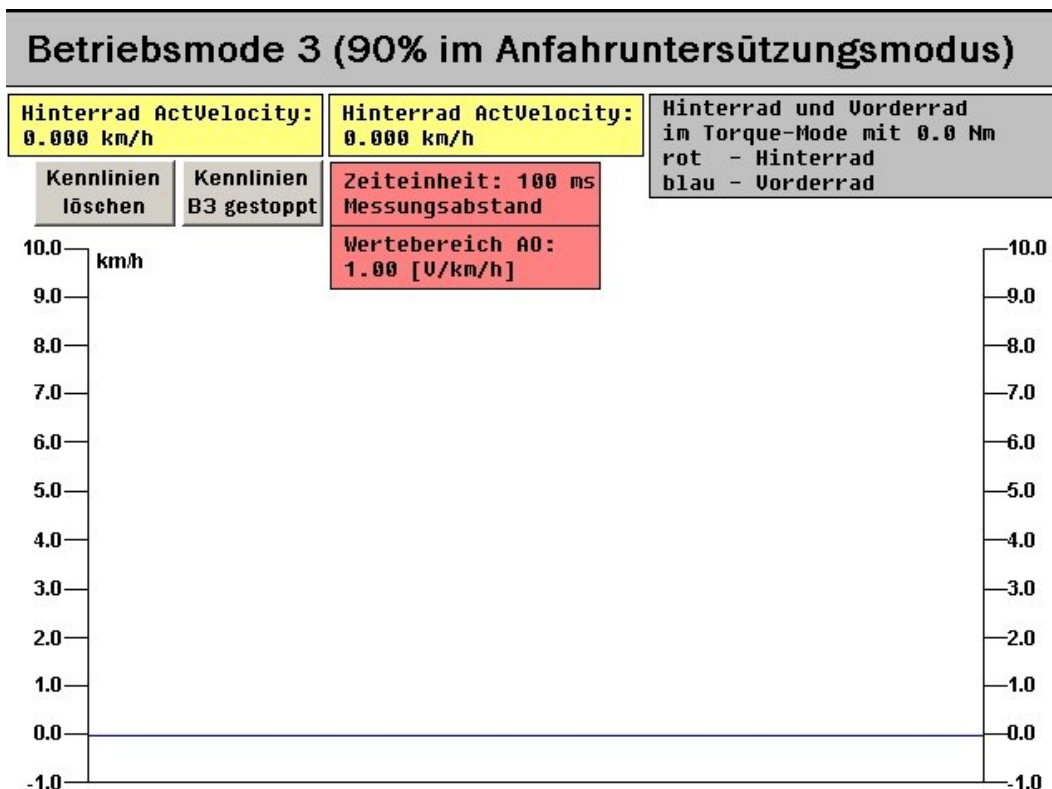
The speed of the driving wheel is monitored by the influence of high frequent emissions.

Slight differences of the speed, even at long cycles, are monitored and can be read out by a diagram.



4) Mode 3: 90% of Starting Assistance Speed:

Similar to mode 2 but only in the range of 90% of the assistance speed.
 Note: Not every E-Bike has the function of assistance speed.



5) Mode 4: 90% of Assistance Speed:

The auxiliary speed may only assist up to a certain speed. This mode is similar to mode 2 but only to monitor the influence to the assistance speed.
 The speed of the assistance speed is monitored by the influence of high frequent emissions. The assistance speed must not increase respectively must not be more than the maximum allowed assistance speed.

Betriebsmode 4 (90% Unterstützungsgeschwindigkeit)			
Hinterrad M1			
Torque +	Steps: 0.10 NM	Torque -	ActTorque: 0.00 Nm
SetTorque: 0.00 NM - bergab + bergauf			ActTorque: 0.00 ''
Wertebereich A0: 1.00 [U/km/h]			ActVelocity: 0.0 km/h
			ActVelocity: 0.00 U/min
			ActPower: 0.00 W
Vorderrad M2			
Torque +	Steps: 0.10 NM	Torque -	ActTorque: 0.00 Nm
SetTorque: 0.00 NM - bergab + bergauf			ActTorque: 0.00 ''
			ActVelocity: 0.0 km/h
			ActVelocity: 0.00 U/min
			ActPower: 0.00 W
Pedal M3			
Velo +	Steps: 0.10 NM	Velo -	ActTorque: 0.00 Nm
Velocity: 0.0 km/h			ActTorque: 0.00 ''
Acc: 2 U/min/s			ActVelocity: 0.0 km/h
Dec : 2 U/min/s			ActVelocity: 0.00 U/min
			ActPower: 0.00 W

Data Recording:

The data recording is available and can be started at every operating mode.

It is possible to store maximum 6000 pairs of value – this means that all current values can be stored 6000 times.

The time period of the recording can be selected between 100 ms up to 1000 ms.

After successful measurement the measurement results can be stored at an USB-Stick as XML-file.

The file name consists of date, time and operating mode.

This current values of the dynamometer can be recorded as follows:

- Torque Front	[Nm]
- Torque Rear	[Nm]
- Torque Pedal	[Nm]
- Velocity Front	[km/h]
- Velocity Rear	[km/h]
- Velocity Pedal	[km/h]
- Power Front	[W]
- Power Rear	[W]
- Power Pedal	[W]
- RPM Pedal	[rpm]
- Time	[ms]

1) Settings Data Recording

In the menu “System Settings” at “Setting data recording” the record-rate at the “Data Recording” can be changed.



E.g. every 100 ms all current values will be stored.

2) Operate Data Recording

The data recording can be started at every operating mode.



The data recording can be stopped any time, regardless how long it lasted.



If the puffer of the data storage is full or was stopped, the stored values can be stored with "Copy xxx to USB" on an USB-Stick.
With the button "Delete" the values can be deleted.



Optionally the above data recording is also possible with the function keys F9 or F10 at the NCD Controller panel.



Notes