EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 15194

March 2005

ICS

English version

Cycles - Electrically power assisted cycles - EPAC bicycle

Cycles - Vélos à assistance électrique - Bicyclette EPAC

Fahrräder - Elektromotorisch unterstützte Räder - EPAC Fahrräder

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 333.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. prEN 15194:2005: E

Contents

Page

Foreword 3
Introduction 4
1 Scope 5
2 Normative references 5
3 Terms and definitions 6
4 Requirements 8
5 Marking and labelling 12
6 Instructions for use 13
Annex A (informative) Battery charging - Temperature 14
Annex B (informative) Example of relation between speed/torque/current 15
Annex C (normative) Electromagnetic compatibility of two EPACs and electrical/electronic sub-assemblies 17
C.1 Conditions applying to vehicles and to electrical/electronic sub-assemblies (ESA) 17
C.2 Method of Measuring wide-band electromagnetic radiation from vehicles 19
C.3 Method of measuring narrow band electromagnetic radiation from vehicles 20
C.4 Methods of testing vehicle immunity to electromagnetic radiation 20
C.5 Method of measuring wide-band electromagnetic radiation from separate technical units (ESA) 24
C.6 Method of measuring narrow-band electromagnetic radiation from separate technical units (ESAs) 25
C.7 Methods of testing the ESA immunity to electromagnetic radiation 25

Foreword

This document (prEN 15194:2005) has been prepared by Technical Committee CEN/TC 333 “Bicycles”, the secretariat of which is held by UNI.

This document is currently submitted to the CEN Enquiry.

Introduction

This European Standard gives requirements for electric power assisted cycles (EPAC).

This standard has been developed in response to demand throughout Europe. Its aim is to provide a standard for the assessment of electrically powered cycles of a type which are excluded from type approval by Directive 2002/24/EC

Due to the limitation of the voltage to 48 Vdc, there are no special requirements applicable to the EPAC about protection against electrical hazards.

1 Scope

This European standard specifies safety requirements and test methods for the assessment of the design and assembly of electrically power assisted cycles and sub-assemblies for systems having voltage up to 48Vdc.

It is intended to cover electrically power assisted cycles of a type which have a maximum continuous rated power of 0,25 kW, of which the output is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h, or sooner, if the cyclist stops pedalling.

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.

EN 50272-3, S*afety requirements for secondary batteries and battery installations. Traction batteries*

EN 55011:1994, *Industrial, scientific and medical (ISM) radio-frequency equipment - Radio disturbance characteristics - Limits and methods of measurement*

prEN 14764:[1)] , City and trekking bicycles – Safety requirements and test methods

ISO 2575, *Road vehicles – Symbols for controls, indicators and tell tales*

ISO 11452-3, *Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 3: Transverse electromagnetic mode (TEM) cell*

ISO 11452-4, *Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 4: Bulk current injection (BCI)*

ISO 11452-5, *Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 5: Stripline*

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

IEC 60227-1: 1998, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V - Part 1: General requirements*

IEC 60245-1, *Rubber insulated cables - Rated voltages up to and including 450/750 V - Part 1: General requirements*

IEC 61000-3-2, *Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16A per phase)*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:1996, *Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:1995, *Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

---

1) To be published

IEC 61000-4-5:1995, *Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:1995, *Electromagnetic compatibility (EMC) –Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-11:1995, *Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61429, *Marking of secondary cells and batteries with the international recycling symbol ISO 7000-1135*

CISPR 12: 2001, *Vehicles, boats and internal combustion engine driven devices – Radio disturbance characteristics – Limits and methods of measurement for the protection of receivers except those installed in the vehicle/boat/device itself or in adjacent vehicles/boats/devices*

CISPR 16-2: 2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2: Methods of measurement of disturbances and immunity*

CISPR 25: 2002, *Radio disturbance characteristics for the protection of receivers used on board vehicles, boats and on devices – Limits and methods of measurement*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply:

3.1
cycle
any vehicle that has at least two wheels and is propelled solely or mainly by the muscular energy of the person in that vehicle, in particular by means of pedals

3.2
bicycle
two-wheels cycle

3.3
fully assembled bicycle
bicycle fitted with all the components necessary for its intended use

3.4
electrically power assisted cycle (EPAC)
cycle, equipped with pedals and an auxiliary electric motor, which cannot be propelled exclusively by means of this auxiliary electric motor

3.5
no load current point
current for which there is no torque on the driving wheel

3.6
full discharge of the battery
point in which the battery does not deliver any power/energy to the motor, according to the manufacturer's specifications

3.7
cut off speed
speed reached at the moment the current has dropped to zero or to the no load current value

3.8
maximum assistance speed by design
speed by design up to which assistance is provided

3.9
electromagnetic compatibility
ability of a vehicle or one of its electrical/electronic systems to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic diESArbances to anything in that environment

3.10
electromagnetic diESArbance
any electromagnetic phenomenon which may degrade the performance of a vehicle or one of its electronic/electrical systems. An electromagnetic diESArbance may be electromagnetic noise, an unwanted signal or a change in the propagation medium itself

3.11
electromagnetic immunity
ability of a vehicle or one of its electronic/electrical systems to perform without degradation of quality in the presence of specific electromagnetic diESArbances

3.12
electromagnetic environment
all electromagnetic phenomena present in a given situation

3.13
reference limit
nominal level to which both the component type-approval of the vehicle type and the conformity-of-production limit value refer

3.14
reference antenna
balanced half-wave dipole tuned to the measured frequency

3.15
wide-band emission
any emission which has a bandwidth exceeding that of a specific receiver or measuring instrument

3.16
narrow-band emission
any emission which has a bandwidth less than that of a specific receiver or measuring instrument

3.17
electronic/electrical subassembly (ESA)
electronic and/or electrical component, or the set of components provided for installation in a vehicle, together with all electrical connections and associated wiring for the execution of several specific functions

3.18
ESA
the test carried out on one or more specific ESAs

3.19
vehicle type with regard to electromagnetic compatibility
given that there are no fundamental differences from one vehicle to another, means inter alia:

— the general layout of the electronic and/or electrical components;

— the overall size, layout and shape of the engine mounting and the disposition of the high-voltage wiring (where present);

— the raw material from which both the vehicle chassis and bodywork are constructed (e.g., a chassis or body made of glass fibre, aluminium or steel).

3.20
ESA type in relation to electromagnetic compatibility
separate technical unit that does not differ from other units in its essential aspects, e.g:

— the function performed by the ESA;

— the general layout of the electronic and/or electrical components;

— direct vehicle control the vehicle control performed by the rider acting on the steering, the brakes and the accelerator control.

4 Requirements

4.1 General

The electrically power assisted cycles, shall comply to clause 4, 5 and 6 of the European Standard prEN 14764, in addition to that follows applies.

4.2 EPAC specific additional requirements

4.2.1 Electric circuit

The electrical control system shall be designed so that, should it malfunction in a hazardous manner, it shall switch off power to the electric motor.

If symbols are used, their meaning shall be described in the instructions for use, their function is one described in ISO 2575, their design shall be according to that standard.

4.2.2 Batteries

Batteries shall comply with EN 50272-3, EN 61429:

Safety and compatibility of the combination battery/charger shall be ensured, according to the manufacturer's specifications shall be ensured.

The battery terminals shall be protected against hazardous contacts creating short circuit.

Care should be taken that the batteries are protected against overcharging. An appropriate overheating and short circuit protection device shall be fitted

NOTE indication and example of solution is given in informative Annex A

4.2.3 Electric cables and connections

The temperature shall be lower than the one specified for the cables and plugs and there shall not be corrosion on plug pins and no damage on cable insulation.

Discharge full charged battery to the discharging limit given by the battery manufacturer at the maximum current given by the electric motor and controller and record it. Measure cable and plug temperature and judge cable and plug by view.

4.2.3.1 Wiring

a) Wire ways shall be smooth and free from sharp edges.

b) Wires shall be protected so that they do not come into contact with burrs, cooling fins or similar edges which may cause damage to their insulation. Holes in metal through which insulated wires pass shall have smooth well-rounded surfaces or be provided with bushings.

c) Wiring shall be effectively prevented from coming into contact with moving parts.

Different parts of EPAC, which can move in normal use or during user maintenance relative to each other, shall not cause undue stress to electrical connections and internal conductors, including those providing earthing continuity.

Compliance with a), b), c) is checked by inspection.

d) If any open coil spring is used , it shall be correctly installed and insulated. Flexible metallic tubes shall not cause damage to the insulation of the conductors contained within them.

Compliance with d) is checked by inspection and by the following test. If flexing occurs in normal use, the appliance is placed in the normal position of use and is supplied at rated voltage under normal operation.

e) The movable part is moved backwards and forwards, so that the conductor is flexed through the largest angle permitted by the construction. The number of flexings for conductors flexed in normal use is 10 000 and the rate of flexing 30 per min; for conductors flexed during user maintenance the number is 100 with the same rate of flexing at (20 $\pm$ 10) °C.

The wiring and its connections shall withstand the electrical strength test. The test voltage expressed in V shall be equal to (500 + 2 x Vr) for 2 minutes and applied between live parts and other metal parts only.

f) The insulation of internal wiring shall withstand the electrical stress likely to occur in normal use.

Compliance is checked as follows:

— The basic insulation shall be electrically equivalent to the basic insulation of cords complying with IEC 60227-1 or IEC 60245-1.

— When slewing is used as supplementary insulation on internal wiring it shall be retained in position by positive means. A sleeve is considered to be fixed by positive means if it can only be removed by breaking or cutting or if it is clamped at both ends.

4.2.3.2 Cables and conduits

Conduit entries, cable entries and knock-outs shall be constructed or located so that the introduction of the conduit or cable does not reduce the protection measures adopted by the manufacturer.

Compliance is checked by inspection.

Cables selection shall be made referring to comply IEC 60364-5-52 clauses 522.1.2, 523.1523.3 and table A 52-10.

4.2.3.3 Terminals for external conductors

Terminals which attachment of the conductor is such that it can easily be replaced shall allow the connection of conductors having nominal cross-sectional areas shown in the following table. However if a specially prepared cord is used, the terminals need only be suitable for the connection of that cord.

Table 1 — Nominal cross-sectional area

Maximum current (A)	Nominal cross-sectional area (mm^2)
≤ 3	0,5 and 0,75
> 3 and ≤ 6	0,75 and 1
> 10 and ≤ 16	1 and 1,5
> 6 and ≤ 10	1,5 and 2,5
> 16 and ≤ 25	2,5 and 4
> 25 and ≤ 32	4 and 6
> 32 and ≤ 40	6 and 10
> 40 and ≤ 63	10 and 16

4.2.4 Power management

4.2.4.1 General

The test may be performed either on a test track or on a test bench.

4.2.4.2 Requirements

Under all circumstances the braking efficiency shall comply with the bicycle standard pr EN 14764

When tested by the method described in 4.2.4.3 the recordings shall show that

a) Assistance is provided only when the cyclist pedals forward.

This requirement has to be checked according to the test methods described in 4.2.4.3.1

b) Assistance is cut off when the cyclist stops pedalling forward such that the cut off distance does not exceed 5 m with brake lever cut off switch or 2m without brake lever cut off switch. This requirement has to be checked according to the test methods described in 4.2.4.3.2

c) The output or assistance is progressively reduced and finally cut off as the vehicle reaches the maximum assistance speed as designed. This requirement has to be checked according to the test methods described in 4.2.6.2

4.2.4.3 Test procedure – Electric motor management test

4.2.4.3.1 Check that there is no electric motor assistance when pedalling backward. Test for checking that no electric motor assistance is provided when pedalling backward shall be adapted to the technology used. For example, pedal backward and check the no load current point or that no torque is delivered on the driving wheel (see Annex B).

4.2.4.3.2 Check the assistance cut off.

4.2.4.3.2.1 Test conditions

The test may be performed either on a test track or on a test bench or on a stand which keeps the motor driven wheel free of the ground.

The time-measuring device shall have the following characteristics:

— Accuracy: at least ± 2%;

— The ambient temperature shall be between 5°C and 35°C;

— The battery shall be fully charged according to the manufacturer instructions.

4.2.4.3.2.2 Test method

Worst case conditions of gearing and speed shall be applied.

Worst condition for speed is defined as 90 % of cut off speed.

Check the distance between stopping pedalling and actuating the switch brake simultaneously (if any) to no power corresponding to no load current point provided by the electric motor by using

— linear speed versus time measurement (an example is given in informative B);

— torque versus distance measurement,

— or any other appropriate method.

Carry out ten times and then average.

4.2.5 Electro Magnetic Compatibility

4.2.5.1 Emission

The EPAC shall conform with normative Annex C.

The EPAC shall conform to the limits of the harmonised standards under the generic EMC Directive 89/336/EC and its successive amendments for the domestic application when tested according to EN 55011: 1994 class B.

4.2.5.2 Immunity

The EPAC shall conform to normative Annex C.

The EPAC shall conform to the limits of the harmonised standards under the EMC Directive 89/336/EC for the industrial application when tested according to EN 61000-4-2: 1995 and EN 61000-4-3: 1996.

4.2.5.3 Battery charger

The battery charger shall comply with EN 55011: 1994, EN 61000-3-2: 1995, EN 61000-4-2: 1995, EN 61000-4-3: 1996, ENV 50204: 1995, EN 61000-4-4: 1995, EN 61000-4-5: 1995, EN 61000-4-6: 1996 and EN 61000-4-11: 1994.

4.2.6 Maximum speed for which the electric motor gives assistance

4.2.6.1 Requirements

The maximum speed for which the electric motor gives assistance may differ by ± 5% when determined according to the test method described in 5.1, from the values specified by the manufacturer.

During a production conformity check, the maximum speed may differ by ± 10% from the above-mentioned determined value.

4.2.6.2 Test method - Cut off speed measurement

4.2.6.2.1 Test conditions

The test may be performed either on a test track or on a test bench or on a stand which keeps the motor driven wheel free of the ground.

The speed-measuring device shall have the following characteristics:

— Accuracy: ± 2% ;

— Resolution: 0,1 km/h;

— The ambient temperature shall be between 5°C and 35°C;

— Maximum wind speed: 3m/s;

— The battery shall be fully charged according to the manufacturer instructions.

4.2.6.2.2 Test procedure

Pre-condition the EPAC by running 5 minutes at 80% of the maximum assistance speed as declared by the manufacturer.

Pedalling, go steadily to reach a speed equal to 1,25 times the maximum assistance speed as declared by the manufacturer.

Record continuously the current and note the speed at which the current drops to a value equal to or less than “no load current point”.

Record the speed at the no load current point which is the maximum assisted speed.

4.2.7 Maximum power measurement

The maximum continuous rated power shall be measured according to EN 60034-1 standard, clause 3.2.1 Duty type S1.

5 Marking and labelling

In addition to the requirements of Pr EN 14764, the EPAC shall be visibly and durably marked as follows:

EPAC

According to EN 15194

XX km/h[2)]

XX W[3)]

---

2) Cut off speed

6 Instructions for use

In addition to the instruction required by the bicycles standard EN 15194, each EPAC shall be provided with a set of instructions containing information on:

1) concept and description of electric assistance;

2) recommendation for washing;

3) maximum range as determined according to the EN 15194;

4) control and tell tales;

5) specific EPAC recommendations for use;

6) specific EPAC warnings;

7) recommendations about battery charging and charger use.

3) Electric motor maximum power

Annex A
(informative)

Battery charging - Temperature

Safety and quality of battery cherging can be improved by sensing the battery temperature during charging.

Most battery charger manufacturers set their chargers to have an optimal ambient temperature of 20 C to 25C. lower temperatures result in under charge, higher temperatures result in over charge.

Whilst it is normal when building battery packs from Ni-Cad, Ni-Mh and Li-ion battery cells, to include temperature sensing, this is not always the case with valve regulated lead acid (VRLA) batteries.

The main reason for including temperature sensing in VRLA batteries is to protect against one or more cells within the battery pack becoming short circuited. This lowers the terminal voltage and can allow the charger to supply more power than is required, which can lead to a dangerous thermal situation.

Temperature sensors should be fitted to each battery within the pack and this information fed back to the battery charger.

It is recommended that positive temperature coefficient (PTC) thermistors are used. All thermistors should be connected in series between the charger temperature pin (T) and the battery pack negative pin (-). Should any battery within the pack reach 60c the charger thermal detection circuitry should be adjusted to detect this condition and take suitable measures to stop any further increase in temperature.

Annex B
(informative)

Example of relation between speed/torque/current

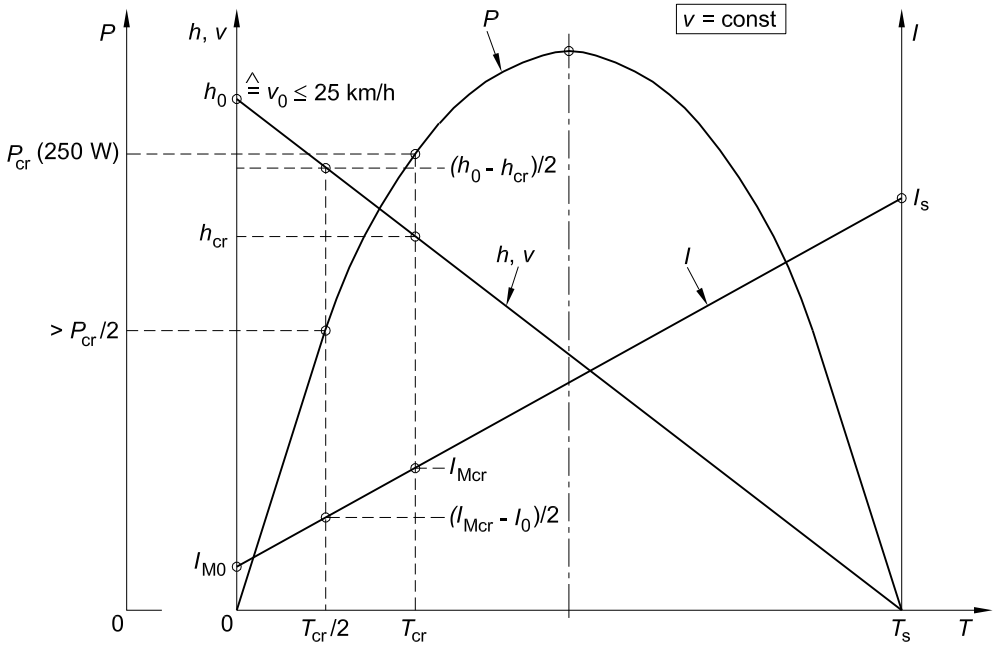

Figure B.1 — Example of relation between speed/torque/current

The relationship between motor-current I_M and torque T is linear according to

$T = k_T (I_M – I_{M0})$

with

I_{M0} : no load motor current at no load speed or $v_0 \leq 25$ km/h

T expressed in Nm

k_T expressed in Nm/A

I_M expressed in A

I_{M0} expressed in A

v_0 expressed in km/h

The relation of power is:

$P = 2\Pi \times T_n$

Because the natural speed-torque-diagram is a linear falling function (at constant voltage) the power-torque function is a parabolic one. Therefore, if the torque falls linear from T_{cr} (Torque at P_{cr} - continuous rated power) to zero the motor current falls linear to I_{MO} and the power P falls progressively from P_{CR} to zero.

One can verify this relation in two steps:

Firstly, reducing the torque to $T_{cr}/2$.

Secondly, reducing the torque from $T_{cr}/2$ to zero.

In the first step, the reduction of power is smaller than in the second one.

Annex C
(normative)

Electromagnetic compatibility of two EPACs and electrical/electronic sub-assemblies

C.1 Conditions applying to vehicles and to electrical/electronic sub-assemblies (ESA)

C.1.1 Marking

All ESAs, with the exception of cables shall bear the following and these marks shall be indelible and clearly legible.

C.1.1.1 the make or name of the manufacturer of the ESAs and their components;

C.1.1.2 the trade description.

C.1.2 Requirements

C.1.2.1 General requirements

All vehicles and ESAs shall be designed and constructed in such a way that, under normal conditions of use, they meet the conditions laid down in this Annex.

However, the measuring methods used in checking the immunity of vehicles and ESAs to electromagnetic radiation described in C4 and C7.

C.1.2.2 Requirements relating to wide-band radiation from vehicles

C.1.2.2.1 Measuring method

The electromagnetic radiation generated by the vehicle type submitted for testing are to be measured by the method described in C2.

C.1.2.2.2 Vehicle reference limits (wide-band)

C.1.2.2.2.1 If measurements are taken using the method described in C2, in respect of a vehicle-antenna distance of 10,0 ± 0,2 m, the radiation reference limit will be 34 dB microvolts/m (50 microvolts/m) in the 30-75 MHz frequency band and 34-45 dB microvolts/m (50-180 microvolts/m) in the 75-400 MHz frequency band. This limit will increase by the frequency logarithm for frequencies above 75 MHz. In the 400-1 000 MHz frequency band the limit remains constant at 45 dB (180 microvolts/m).

C.1.2.2.2.2 If measurements are taken using the method described in C2, in respect of a vehicle-antenna distance of 3,0 ± 0,05 m, 10 dB shall be added to the limit.

C.1.2.2.2.3 The measured values expressed in dB (microvolts/m) shall be at least 2,0 dB below the reference limit for the vehicle submitted for testing.

C.1.2.3 Requirements relating to narrow-band radiation emissions from vehicles

C.1.2.3.1 Measuring method

The electromagnetic radiation from the vehicle submitted for testing is to be measured by the method described in C3.

C.1.2.3.2 Vehicle Reference limits for vehicle narrow-band radiation

C.1.2.3.2.1 If measurements are taken using the method described in C3, in respect of a vehicle-antenna distance of 10,0 ± 0,2 m, the radiation reference limit will be 24 dB (16 microvolts/m) in the 30-75 MHz frequency band and 24-35 dB (16-56 microvolts/m) in the 75-400 MHz frequency band. This limit will increase by the frequency logarithm for frequencies above 75 MHz. In the 400-1 000 MHz frequency band the limit remains constant at 35 dB (56 microvolts/m).

C.1.2.3.2.2 If measurements are taken using the method described in C3, in respect of a vehicle-antenna distance of 3,0 ± 0,05 m, 10 dB shall be added to the limit.

C.1.2.3.2.3 The measured values for the vehicle type submitted for testing expressed in dB (microvolts/m), shall be at least 2,0 dB below the reference limit.

C.1.2.4 Requirements regarding vehicle immunity to electromagnetic radiation

C.1.2.4.1 Measuring method

Tests to determine the immunity of the vehicle type to electromagnetic radiation shall be conducted in accordance with the method described in C4.

C.1.2.4.2 Vehicle immunity reference limits

C.1.2.4.2.1 If measurements are taken using the method described in C4, the field strength reference level shall be 24 volts/m r.m.s. in over 90 % of the 20 MHz to 1 000 MHz frequency band and 20 volts/m r.m.s. over the whole 20 MHz to 1 000 MHz frequency band.

C.1.2.4.2.2 The vehicle representative of the type submitted for testing shall not display any deterioration in the direct control of the vehicle which might be observed by the driver or by any other road user when the vehicle in question is in the state defined in Annex C4, clause 4, and when it is subjected to the field strength expressed in volts/m, which shall be 25 % above the reference level.

C.1.2.5 Requirements concerning wide-band ESA radiation

C.1.2.5.1 Measuring method

The electromagnetic radiation generated by the ESA submitted for component type-approval shall be measured by the method described in C5.

C.1.2.5.2 ESA wide-band reference limits

C.1.2.5.2.1 If measurements are taken using the method described in C5, the radiation reference limit will be 64-54 dB (microvolts/m) within the 30-75 MHz frequency band, this limit decreasing by the frequency logarithm, and 54-65 dB microvolts/m) in the 75-400 MHz band, this limit increasing by the frequency logarithm.

In the 400-1 000 MHz frequency band the limit remains constant at 65 dB (1 800 microvolts/m).

C.1.2.5.2.2 The measured values for the ESA submitted for approval, expressed in dB (microvolts/m), shall be at least 2,0 dB below the reference limits.

C.1.2.6 Requirements concerning narrow-band ESA radiation

C.1.2.6.1 Method of measurement

The electromagnetic radiation generated by the ESA submitted for component type-approval is to be measured in accordance with the method described in C6.

C.1.2.6.2 ESA narrow-band reference limits

C.1.2.6.2.1 If measurements are taken using the method described in C6, the radiation reference limit will be 54-44 dB (microvolts/m) in the 30-75 MHz frequency band, this limit decreasing by the frequency logarithm, and 44-55 dB (microvolts/m) in the 75-400 MHz band, this limit increasing by the frequency logarithm.

In the 400-1 000 MHz frequency band the limit remains constant at 55 dB (560 microvolts/m).

C.1.2.6.2.2 The measured values for the ESA submitted for competent type-approval, expressed in dB (microvolts/m), shall be at least 2,0 dB below the reference limits.

C.1.2.7 Requirements concerning ESA immunity to electromagnetic radiation

C.1.2.7.1 Method of measurement

The immunity to electromagnetic radiation of the ESA submitted for component type approval will be tested by means of one of the methods described in C7.

C.1.2.7.2 ESA immunity reference limits

C.1.2.7.2.1 If measurements are taken using the methods described in C7, the immunity test reference levels will be 48 volts/m for the 150 mm stripline testing method, 12 volts/m for the 800 mm stripline testing method, 60 volts/m for the TEM cell testing method, 48 mA for the Bulk Current Injection (BCI) testing method and 24 volts/m for the Absorberlined Chamber testing method.

C.1.2.7.2.2 The ESAs representative of the type submitted for testing may not exhibit any malfunction which is able to cause any degradation on the direct control of the vehicle perceptible to the driver or other road user if the vehicle is in the state defined in Annex C, clause 4 at a field strength or current expressed in appropriate linear units 25 % above the reference limit.

C.2 Method of Measuring wide-band electromagnetic radiation from vehicles

C.2.1 General

C.2.1.1 Measuring equipment

The measuring equipment shall meet the conditions laid down in Publication No 16, Edition 2, of the International Special Committee on Radio Interference (CISPR).

A quasi-peak detector shall be used to measure wide-band electromagnetic radiation.

C.2.1.2 Test method

According CISPR 12

C.2.2 Test conditions

According CISPR 12

C.2.3 State of the vehicle during the test

C.2.4 Antenna type, position and orientation

According CISPR 12

C.3 Method of measuring narrow band electromagnetic radiation from vehicles

C.3.1 General

C.3.1.1 Measuring equipment

The measuring equipment shall comply with the conditions laid down in Publication No 16, Edition 2, of the International Special Committee on Radio Interference (CISPR).

A mean-value detector is used to measure narrow-band electromagnetic radiation.

C.3.1.2 Test method

According CISPR 12

C.3.2 Test conditions

According CISPR 12

C.3.3 State of the vehicle during the tests

C.3.4 Antenna type, position and orientation

According CISPR 12

C.4 Methods of testing vehicle immunity to electromagnetic radiation

C.4.1 General

C.4.1.1 Test methods

These tests are designed to demonstrate the insensitivity of the vehicle to any factor which may alter the quality of its direct control. The vehicle shall be exposed to the electromagnetic fields, described in this Annex, and shall be monitored during the tests.

C.4.2 Expression of results

The field strengths shall be expressed in volts/m for all the tests described in this Annex.

C.4.3 Test conditions

The test equipment shall be capable of generating the field strengths in the range of frequencies defined in this Annex, and shall meet the (national) legal requirements regarding electromagnetic signal. The control and monitoring equipment shall not be susceptible to radiation fields whereby the tests could be invalidated.

C.4.4 State of the vehicle during the tests

C.4.4.1 The mass of the vehicle shall be equal to the mass in running order.

C.4.4.1.1 The engine shall turn the driving wheels at a constant speed predetermined by the testing authority in agreement with the vehicle manufacturer. The vehicle shall be placed on a suitably loaded dynamometer or, if no dynamometer is available, shall rest on electronically insulated axle supports at a minimum distance from the ground.

C.4.4.1.2 The dipped-beam headlamps shall be switched on.

C.4.4.1.3 The left or right direction indicators shall be on.

C.4.4.1.4 All other vehicle systems shall be operating normally.

C.4.4.1.5 There shall be no electrical connection between the vehicle and the test surface and no connections between the vehicle and the equipment, save where so required by C.4.1.1.1 or C.4.4.2.

Contact between the wheels and the test surface is not regarded as an electrical connection.

C.4.4.2 Where ESAs are involved in the direct control of the vehicle and where these systems do not operate under the conditions described in C.4.1.1.1, the testing authority may carry out separate tests on the systems in question under conditions agreed with the vehicle manufacturer.

C.4.4.3 During the tests on the vehicle, only non-interference-generating equipment may be used.

C.4.4.4 Under normal conditions, the vehicle shall be facing the antenna.

C.4.5 Type, position and orientation of the field generator

C.4.5.1 Type of field generator

C.4.5.1.1 The criterion for the selection of the field generator type is the capacity of the latter to attain the prescribed field strength at the reference point (see C.4.5.4) and at the appropriate frequencies.

C.4.5.1.2 Either the antenna(s) or a transmission line system (TLS) may be used as the field generating device(s).

C.4.5.1.3 The design and orientation of the field generator shall be such that the field is polarised both horizontally and vertically at frequencies between 20 and 1 000 MHz.

C.4.5.2 Measurement height and distance

C.4.5.2.1 Height

C.4.5.2.1.1 The phase mid-point of all antennas shall not be less than 1,5 m above the vehicle plane.

C.4.5.2.1.2 No part of the antenna radiator elements shall be less than 0,25 m from the vehicle plane.

C.4.5.2.2 Measuring distance

C.4.5.2.2.1 Greater homogeneity of the field may be obtained by placing the field generator as far as technically possible from the vehicle. This distance will normally be in the range 1 to 5 m.

C.4.5.2.2.2 If the test is carried out in a closed installation, the radiator elements of the field generator shall not be less than 0,5 m from any type of radio frequency absorption material and not less than 1,5 m from the wall of the installation in question. There shall be no absorption material between the transmitting antenna and the vehicle under test.

C.4.5.3 Position of the antenna in relation to the vehicle

C.4.5.3.1 The field generator shall be positioned in the median longitudinal plane of the vehicle.

C.4.5.3.2 No part of the TLS, except the vehicle plane, may be less than 0,5 m from any part of the vehicle.

C.4.5.3.3 Any field generator placed above the vehicle shall cover at least 75 % of the length of the vehicle.

C.4.5.4 Reference point

C.4.5.4.1 The reference point is the point at which the field strengths are established and is defined as follows:

C.4.5.4.1.1 Horizontally, at least two metres from the antenna phase mid-point or, vertically, at least one metre from the TLS radiator elements;

C.4.5.4.1.2 In the median longitudinal plane of the vehicle;

C.4.5.4.1.3 At a height of 1,0 ± 0,05 m above the vehicle plane;

C.4.5.4.1.4 or:

at 1,0 ± 0,2 m behind the vertical centre line of the vehicle's front wheel in the case of tricycles;

or

at 0,2 ± 0,2 m behind the vertical centre line of the vehicle's front wheel in the case of motorcycles.

C.4.5.5 If it is chosen to subject the rear part of the vehicle to radiation, the reference point shall be established as stated in C.4.5.4. In this case the vehicle will be positioned with its front part facing in the opposite direction to the antenna and as if it had been rotated horizontally through 180 degrees about its central point. The distance between the antenna and the nearest part of the outer surface of the vehicle shall remain the same.

C.4.6 Requisite test and condition

C.4.6.1 Range of frequencies, duration of the tests, polarisation

The vehicle shall be exposed to electromagnetic radiation in the 20-1 000 MHz frequency range.

C.4.6.1.1 **T**ests are to be carried out at the following 12 frequencies: 27, 45, 65, 90, 150, 180, 220, 300, 450, 600, 750 and 900 MHz ± 10 % for 2 s at ± 10 % in each frequency.

C.4.6.1.2 One of the polarisation modes described in C.4.5.1.3 shall be selected by common agreement between manufacturer and testing body.

C.4.6.1.3 All other test parameters are as defined in this clause.

C.4.6.2 Tests to check deterioration in direct control

C.4.6.2.1 A vehicle is deemed to fulfil the requisite immunity conditions if, during the tests carried out in the manner required by this clause, there are no abnormal changes in the speed of the vehicle's drive wheels, there are no signs of operational deterioration which might mislead other road users and there are no other noticeable phenomena which could result in a deterioration in the direct control of the vehicle.

C.4.6.2.2 For vehicle observation purposes, only the monitoring equipment described in section 8 may be used.

C.4.6.2.3 If a vehicle does not meet the requirements of the tests defined in C.4.6.2, steps shall be taken to verify that the faults occurred under normal conditions and are not attributable to spurious fields.

C.4.7 Generation of the requisite field strength

C.4.7.1 Test method

C.4.7.1.1 The 'substitution method` is to be used for the purpose of creating the field test conditions.

C.4.7.1.2 Substitution method: For each test frequency required, the RF power level of the field generator shall be set so as to produce the required test field strength at the reference point of the test area without the vehicle being present. This RF power level, as well as all other relevant settings on the field generator shall be recorded in the test report (calibration curve). The recorded information is to be used for type-approval purposes. Should any alterations be made to the equipment at the test location, the substitution method shall be repeated.

C.4.7.1.3 The vehicle is then brought to the test installation and positioned in accordance with the conditions laid down in C.4.5. The power required by C.4.7.1.2 is then applied to the field generator for each of the frequencies indicated in 6.1.1.

C.4.7.1.4 Whatever field-definition parameter in chosen in accordance with the conditions laid down in C.4.7.1.2, the same parameter shall be used in order to determine the strength of that field throughout the test.

C.4.7.1.5 For the purposes of this test, the same field generating equipment and the same equipment configuration shall be used as in the operations conducted in pursuance of C.4.7.1.2.

C.4.7.1.6 Field strength measuring device:

Under the substitution method, the device used to determine the field strength during the calibration stage should take the form either of a compact isotropic probe for measuring field strength or of a calibrated receiving antenna.

C.4.7.1.7 During the calibration phase of the substitution method, the phase mid-point of the field-strength measuring device shall coincide with the reference point.

C.4.7.1.8 If a calibrated receiving antenna is used as the field strength measuring device, readings will be obtained in three directions at right angles to each other. The equivalent isotropic value corresponding to these measurements is to be regarded as the field strength.

C.4.7.1.9 In order to take account of differences in vehicle geometry, a number of reference points shall be established for the relevant test installation.

C.4.7.2 Field strength contour

C.4.7.2.1 During the calibration phase (before the vehicle is positioned on the test surface) the field strength shall not be less than 50 % of the nominal field strength at the following locations:

i) for all field-generating devices, 1,0 ± 0,02 m on either side of the reference point on a line passing through this point, and perpendicular to the median longitudinal plane of the vehicle;

ii) in the case of a TLS, 1,5 ± 0,02 m on a line passing through the reference point, and situated in the median longitudinal plane of the vehicle.

C.4.7.3 Characteristics of the test signal to be generated

C.4.7.3.1 Peak value of the modulated test field strength

The peak value of the modulated test field strength shall correspond to that of the unmodulated test field strength, the actual value in volts/m of which is defined in C.1.3.4.2.

C.4.7.3.2 Test signal waveform

The test signal shall be a radio-frequency sinusoidal wave, amplitude-modulated by a sinusoidal 1 kHz wave at a modulation rate m of 0,8 ± 0,04 m.

C.4.7.3.3 Modulation rate

The modulation rate m is defined as follows:

m = >NUM>peak envelope value - minimum envelope value >DEN>peak envelope value + minimum envelope value

The envelope describes the curve formed by the edges of the modulated carrier as seen on an oscillograph.

C.4.8 Inspection and monitoring equipment

For the purposes of monitoring the external part of the vehicle and the passenger compartment and of determining whether the conditions laid down in 6.4.6.2 have been met, use will be made of a video camera or cameras.

C.5 Method of measuring wide-band electromagnetic radiation from separate technical units (ESA)

C.5.1 General

C.5.1.1 Measuring equipment

The measuring equipment shall meet the conditions laid down in Publication No 16, Edition 2, of the International Special Committee on Radio Interference (CISPR).

A quasi-peak detector shall be used to measure wide-band electromagnetic emissions.

C.5.1.2 Test method

According CISPR 25 Absorberlined Chamber

C.5.2 Test conditions

According CISPR 25 Absorberlined Chamber

C.5.3 State of the ESA during the test

According CISPR 25 Absorberlined Chamber

C.5.4 Antenna type, position and orientation

According CISPR 25 Absorberlined Chamber

C.6 Method of measuring narrow-band electromagnetic radiation from separate technical units (ESAs)

C.6.1 General

C.6.1.1 Measuring equipment

The measuring equipment shall meet the conditions laid down in publication No 16, edition 2 by the International Special Committee on Radio Interference (CISPR).

A mean-value detector is used to measure the narrow-band electromagnetic radiation.

C.6.1.2 Test method

According CISPR 25 Absorberlined Chamber

C.6.2 Test conditions

According CISPR 25 Absorberlined Chamber

C.6.3 State of the ESA during the tests

According CISPR 25 Absorberlined Chamber

C.6.4 Antenna type, position and orientation

According CISPR 25 Absorberlined Chamber

C.7 Methods of testing the ESA immunity to electromagnetic radiation

C.7.1 General

C.7.1.1 Test methods

ESAs shall comply with the limits (C.1.3.7.2.1) for one of the following test methods, at their manufacturers discretion, within the range of 20-1 000 MHz:

— stripline test;

— Bulk current injection test;

— TEM-cell test;

— Absorberlined Chambert.

NOTE To avoid radiation from electromagnetic fields during tests, they shall be carried out in a shielded area.

C.7.2 Test conditions

C.7.2.1 The test equipment shall be capable of generating the test signal required for the frequency ranges defined in this clause. The location of the tests shall meet the (national) legal requirements regarding electromagnetic signal emissions.

C.7.2.2 The control and monitoring equipment may not be affected by any radiation fields which could invalidate the tests.

C.7.3 Stripline test

C.7.3.1 Test method

According ISO 11452-5

C.7.4 Bulk current injection test

C.7.4.1 Test method

According ISO 11452-4

C.7.5 Tem-cell test

C.7.5.1 Test method

According ISO 11452-3

TEM cell.