# Test Report

For

**Product**：Electric Bicycle

**Trade Name**： N/A

**ModelNumber**： E2000RM-LS / e Folding RA-X9-LS

E2000RM-LS ECO / e Folding RS-X9-LS

**Prepared for**

DENVER S.R.L.

VIA PRIMO MAGGIO N.32, 12025 DRONERO-CN-ITALY

**Prepared by**

Shenzhen SCT-CERT Technology Co., Ltd.

F,C Bld,Tongan Logistics Information Center,NO.30,Hangkong Rd,Sanwei Village,Xixiang Street,Bao,an,Shenzhen

# TEST REPORT DECLARATION

| | |
|---|---|
| Applicant | :DENVER S.R.L. |
| Manufacturer | :DENVER S.R.L. |
| EUT Description | :Electric Bicycle |

(A) Model No. : E2000RM-LS / e Folding RA-X9-LS
E2000RM-LS ECO / e Folding RS-X9-LS

(B) Serial No. : N/A

(C) Power Supply : N/A

**Test Procedure Used:**

EN 15194:2017,EN ISO 13849-1:2015
EN 55014-1:2017, EN 61000-3-2:2014, EN61000-3-3: 2013
EN 55014-2:2015 (EN61000-4-2: 2009, EN61000-4-4: 2012, EN61000-4-5: 2014, EN61000-4-6: 2014, EN61000-4-11: 2004)

The devices described above have been tested by **Shenzhen SCT-CERT Technology Co., Ltd.** to determine the maximum emission levels emanating from the device, the severe levels that the device can endure and EUT'S performance criterion. The test results are contained in this test report. **Shenzhen SCT-CERT Technology Co., Ltd.** is assumed of full responsibility for the accuracy and completeness of these tests.

This report applies to above tested sample only and shall not be reproduced in part without written approval of **Shenzhen SCT-CERT Technology Co., Ltd.** .

Date of Test: Apr.27 — May.11.2020

Prepared by: Project Engineer Tony zhou

Reviewed by: Project Manager

Approved by: Technical Director

# EMC Test Report

## 1. TEST SUMMARY

Test procedures according to the technical standards:

| EPAC PART (EN 15194) | | | | |
|---|---|---|---|---|
| Standard | Test Item | Meets Limit / Performance Criteria | Judgment | Remark |
| CISPR 12:2007+A1:2009 | Radiated Emission | Table C.1 | PASS | |
| EN 61000-4-2: 2009 | Electrostatic Discharge | B | PASS | |
| ISO11451-1:2015 | RF Electromagnetic Field Immunity (20MHz to 2GHz) | A | PASS | |
| **ESA PART (EN 15194)** | | | | |
| Standard | Test Item | Meets Limit / Performance Criteria | Judgment | Remark |
| CISPR 12:2007+A1:2009 | Radiated Disturbance | Table C.1 | PASS | |
| ISO 11452-5:2002 | Stripline test | N/A | N/A | |
| ISO 11452-3:2001 | TEM cell | N/A | N/A | |
| ISO 11452-4:2011 | Bulk Current Injection | N/A | N/A | |
| ISO11452-2:2019 | Absorber lined Chamber test | A | PASS | |

| EMC Emission | | | | |
|---|---|---|---|---|
| Standard | Test Item | Limit | Judgment | Remark |
| EN 55014-1:2017 | Conducted Emission | Class B | PASS | |
| | Radiated Emission | Class B | PASS | |
| | Disturbance Power | ------ | PASS | |
| EN61000-3-2:2014 | Harmonic Current Emission | Class A or D | PASS | |
| EN 61000-3-3:2013 | Voltage Fluctuations & Flicker | ------ | PASS | |
| **EMC Immunity** | | | | |
| Section EN55014-2:2015 | Test Item | Performance Criteria | Judgment | Remark |
| EN 61000-4-2:2009 | Electrostatic Discharge | B | PASS | |
| EN 61000-4-3:2006+A1:2008+A2:2010 | RF electromagnetic field | A | PASS | |

| | | | | |
|---|---|---|---|---|
| EN61000-4-4:2012 | Fast transients | B | PASS | |
| EN61000-4-5:2014 | Surges | B | PASS | |
| EN61000-4-6:2014 | Injected Current | A | PASS | |
| EN61000-4-8:2010 | Power Frequency Magnetic Field | A | PASS | |
| EN61000-4-11:2004 | Volt. Interruptions Volt. Dips | C / C / C | PASS | |

NOTE:

(1)" N/A" denotes test is not applicable in this Test Report

(2)Voltage dip: 0% reduction – Performance Criteria **C**

Voltage dip: 30% reduction – Performance Criteria **C**

Voltage dip : 60% reduction – Performance Criteria **C**

(3) For client's request and manual description, the test will not be executed.

1.1 TEST FACILITY

Shenzhen SCT-CERT Technology Co., Ltd.

1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement **y ± U**，where expended uncertainty **U** is based on a standard uncertainty multiplied by a coverage factor of **k=2**，providing a level of confidence of approximately **95** %。

K- Conducted Measurement :

| Test Site | Method | Measurement Frequency Range | U，(Db) | NOTE |
|---|---|---|---|---|
| C | ANSI | 150 KHz ~ 30MHz | 3.2 | |

B. Radiated Measurement :

| Test Site | Method | Measurement Frequency Range | U，(Db) | NOTE |
|---|---|---|---|---|
| A | ANSI | 30MHz ~ 1000MHz | 4.7 | |
| | | 1GHz ~6GHz | 5.0 | |

# 2. GENERAL INFORMATION

## 2.1 GENERAL DESCRIPTION OF EUT

| | |
|---|---|
| Equipment | Electric Bicycle |
| Model Name | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS |
| Model Difference | See model list |
| Product Description | The EUT is a Electric Bicycle.<br>Operating frequency: N/A<br>Connecting I/O port: N/A |

## 2.2 DESCRIPTION OF TEST MODES

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

| Pretest Mode | Description |
|---|---|
| Mode 1 | Running |
| Mode 2 | Charging |

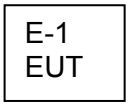
| **For Conducted Test** | |
|---|---|
| Final Test Mode | Description |
| Mode 2 | Charging |

| **For Radiated Test** | |
|---|---|
| Final Test Mode | Description |
| Mode 1 | Running |
| Mode 2 | Charging |

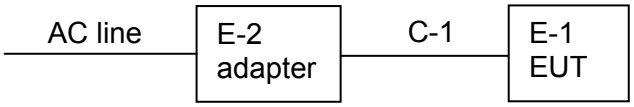
| **For EMS Test** | |
|---|---|
| Final Test Mode | Description |
| Mode 1 | Charging |

## 2.3 DESCRIPTION OF TEST SETUP

Mode 1:




Mode 2:



## 2.4 DESCRIPTION TEST PERIPHERAL AND EUT PERIPHERAL

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

| Item | Equipment | Model/Type No. | Series No. | Note |
|---|---|---|---|---|
| E-1 | Electric Bicycle | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | N/A | EUT |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| Item | Shielded Type | Ferrite Core | Length | Note |
|---|---|---|---|---|
| C-1 | NO | NO | 80cm | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Note:

(1) The support equipment was authorized by Declaration of Confirmation.
(2) For detachable type I/O cable should be specified the length in cm in 『Length』 column.
(3) “YES” is means “shielded” “with core”; “NO” is means “unshielded” “without core”.

## 2.5 MEASUREMENT INSTRUMENTS LIST

### 2.5.1 CONDUCTED TEST SITE

| Item | Kind of Equipment | Manufacturer | Type No. | Serial No. | Calibrated until |
|---|---|---|---|---|---|
| 1 | LISN | R&S | ENV216 | 101313 | Jun. 09, 2020 |
| 2 | LISN | EMCO | 3816/2 | 00042990 | Jun. 16, 2020 |
| 3 | 50Ω Switch | ANRITSU CORP | MP59B | 6200983704 | April. 23, 2021 |
| 4 | Test Cable | N/A | C01 | N/A | Jun. 06, 2020 |
| 5 | Test Cable | N/A | C02 | N/A | May. 14, 2020 |
| 6 | Test Cable | N/A | C03 | N/A | May. 23, 2020 |
| 7 | EMI Test Receiver | R&S | ESCI | 101160 | April. 06, 2021 |
| 8 | Passive Voltage Probe | ESH2-Z3 | R&S | 100196 | Jun. 12, 2020 |
| 9 | Triple-Loop Antenna | EVERFINE | LIA-2 | 11020003 | April. 06, 2021 |
| 10 | Absorbing Clamp | R&S | MDS-21 | 100423 | Jun. 11, 2020 |

### 2.5.2 RADIATED TEST SITE

| Item | Kind of Equipment | Manufacturer | Type No. | Serial No. | Calibrated until |
|---|---|---|---|---|---|
| 1 | Bilog Antenna | TESEQ | CBL6111D | 31216 | Jun. 30, 2020 |
| 2 | Test Cable | N/A | R-01 | N/A | May. 27, 2020 |
| 3 | Test Cable | N/A | R-02 | N/A | Jun. 21, 2020 |
| 4 | EMI Test Receiver | R&S | ESCI-7 | 101318 | April. 06, 2021 |
| 5 | Antenna Mast | EM | SC100_1 | N/A | N/A |
| 6 | Turn Table | EM | SC100 | 060531 | N/A |
| 7 | 50Ω Switch | Anritsu Corp | MP59B | 6200983705 | Jun. 06, 2020 |
| 8 | Spectrum Analyzer | Aglient | E4407B | MY45108040 | April. 07, 2021 |
| 9 | Horn Antenna | EM | EM-AH-10180 | 2011071402 | May. 09, 2020 |
| 10 | Amplifier | EM | EM-30180 | 060538 | Jun. 02, 2020 |

### 2.5.3 HARMONICS AND FILCK

| Item | Kind of Equipment | Manufacturer | Type No. | Serial No. | Calibrated until |
|---|---|---|---|---|---|
| 1 | Harmonic & Flicker | EM TEST | DPA500 | 0303-04 | Jun. 13, 2020 |
| 2 | AC Power Source | EM TEST | ACS500 | 0203-01 | Jun. 11, 2020 |

### 2.5.4 ESD

| Item | Kind of Equipment | Manufacturer | Type No. | Serial No. | Calibrated until |
|---|---|---|---|---|---|
| 1 | ESD TEST GENERATOR | EVERFINE | EMS61000-2A-V200 | 11040001T | Jun. 06, 2020 |

2.5.5 RS

| Item | Kind of Equipment | Manufacturer | Type No. | Serial No. | Calibrated until |
|---|---|---|---|---|---|
| 1 | Signal Generator | R&S | SMT 06 | 832080/007 | Jun. 12, 2020 |
| 2 | Log-Bicon Antenna | Schwarzbeck | VULB9161 | 4022 | April. 09, 2021 |
| 3 | Power Amplifier | AR | 150W1000M1 | 320946 | Jun. 05, 2020 |
| 4 | Microwave Horn Antenna | AR | AT4002A | 321467 | May. 26, 2020 |
| 5 | Power Amplifier | AR | 25S1G4A | 308598 | Jun. 28, 2020 |

2.5.6 SURGE, EFT/BURST, VOLTAGE INTERRUPTION/DIPS

| Item | Kind of Equipment | Manufacturer | Type No. | Serial No. | Calibrated until |
|---|---|---|---|---|---|
| 1 | Surge Generator | EVERFINE | EMS61000-5 A | 1101002 | Jun. 16, 2020 |
| 2 | DIPS Generator | EVERFINE | EMS61000-1 1K | 1011002 | April. 13, 2021 |
| | EFT/B Generator | EVERFINE | EMS61000-4 A-V2 | 1012005 | Jun. 07, 2020 |

2.5.7 INJECTION CURRENT

| Item | Kind of Equipment | Manufacturer | Type No. | Serial No. | Calibrated until |
|---|---|---|---|---|---|
| 1 | Signal Generator | IFR | 2023A | 202301/368 | April. 06, 2021 |
| 2 | Power Amplifier | AR | 75A250AM1 | 0320709 | Jun. 09, 2020 |
| 3 | CDN | FCC | FCC-801-M2 | 06043 | May. 08, 2020 |
| 4 | EM Clamp | FCC | F-203I-23MM | 504 | Jun. 19, 2020 |

2.4.8 MF

| Item | Kind of Equipment | Manufacturer | Type No. | Serial No. | Calibrated until |
|---|---|---|---|---|---|
| 1 | Generator | EVERFINE | EMS61000-8 K | 1007001 | Jun. 15, 2020 |

## 3. EMC EMISSION TEST

3.1 CONDUCTED EMISSION MEASUREMENT

3.1.1 POWER LINE CONDUCTED EMISSION (Frequency Range 150KHz-30MHz)

| Frequency Range (MHz) | At mains terminals | | At load terminals and additional terminals | |
|---|---|---|---|---|
| | Quasi-peak (dBuV) | Average (dBuV) | Quasi-peak (dBuV) | Average (dBuV) |
| 0.15 -0.5 | 66 - 56 * | 56 - 46 * | 80.00 | 70.00 |
| 0.50 -5.0 | 56.00 | 46.00 | 74.00 | 64.00 |
| 5.0 -30.0 | 60.00 | 50.00 | 74.00 | 64.00 |

3.1.2 MAINS TERMINALS OF TOOLS

| Frequency Range | Rated motor power not exceeding 700W | | Rated motor power above 700W and not exceeding 1 000 W | | Rated motor power above 1 000 W | |
|---|---|---|---|---|---|---|
| (MHz) | dB (uV) Quasi-peak | dB (uV) Average** | dB (uV) Quasi-peak | dB (uV) Average** | dB (uV) Quasi-peak | dB (uV) Average** |
| 0.15 -0.5 | 66.0 to 59.0* | 59.0 to 49.0* | 70.0 to 63.0* | 63.0 to 53.0* | 76.0 to 69.0* | 69.0 to 59.0* |
| 0.50 -5.0 | 59.0 | 49.0 | 63.0 | 53.0 | 69.0 | 59.0 |
| 5.0 -30.0 | 64.0 | 54.0 | 68.0 | 58.0 | 74.0 | 64.0 |

Note:

(1) The tighter limit applies at the band edges.

(2) The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

(3) "**" If the limit for the measurement with the average detector is met when using a receiver with a quasi-peak detector, the equipment under test shall be deemed to meet both limits and the measurement using the receiver with an average detector need not be carried out.

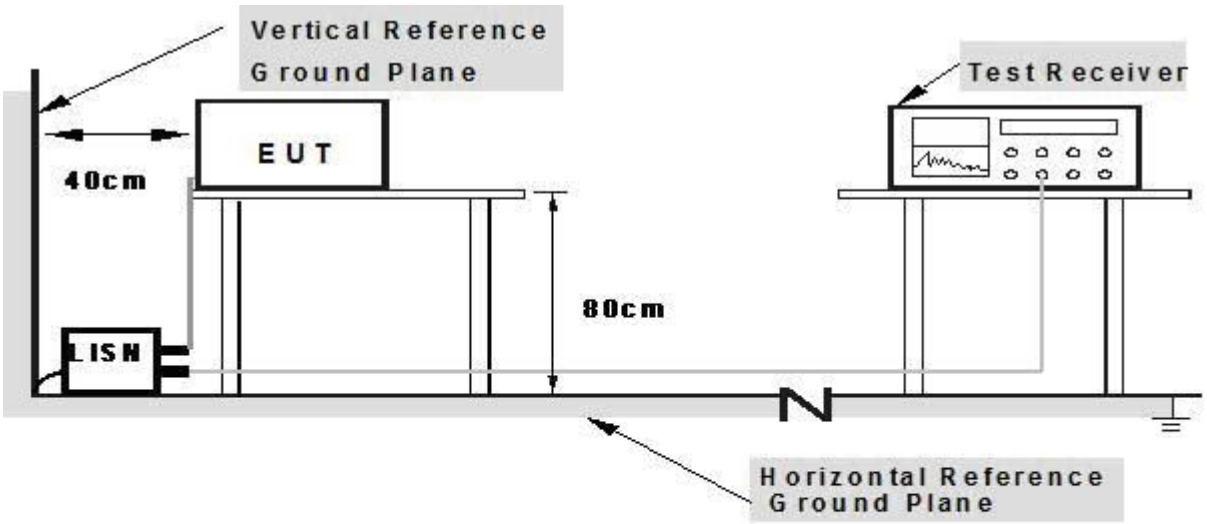
The following table is the setting of the receiver

| Receiver Parameters | Setting |
|---|---|
| Attenuation | 10 dB |
| Start Frequency | 0.15 MHz |
| Stop Frequency | 30 MHz |
| IF Bandwidth | 9 kHz |

3.1.3 TEST PROCEDURE

a. The EUT was placed 0.4 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
b. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
c. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
d. LISN at least 80 cm from nearest part of EUT chassis.
e. For the actual test configuration, please refer to the related Item –EUT Test Photos.

3.1.4 TEST SETUP




**Note: 1.Support units were connected to second LISN.**
**2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes**

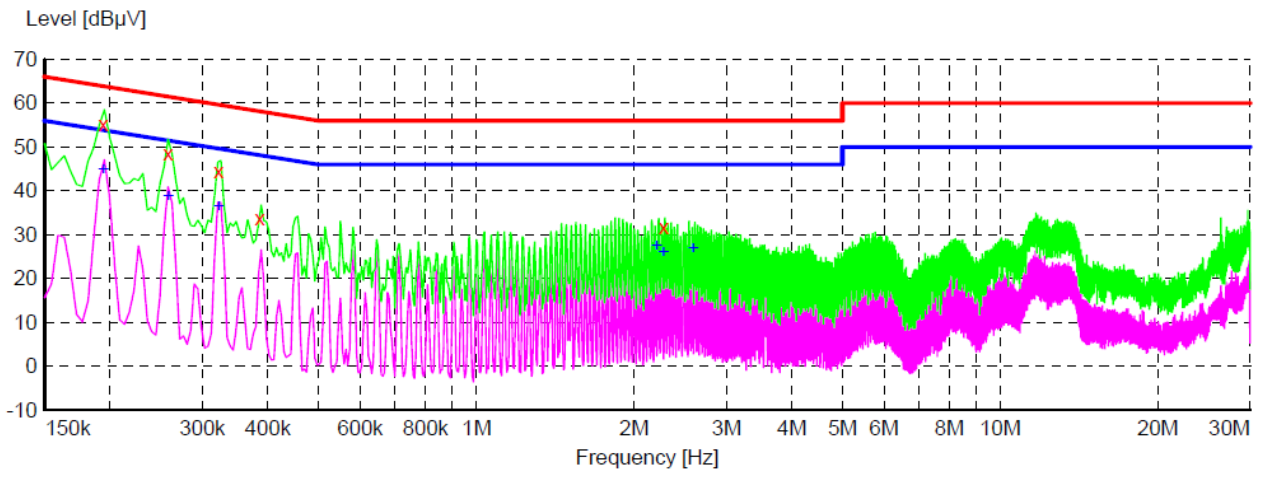
3.1.5 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of **2.3** Unless otherwise a special operating condition is specified in the follows during the testing.

3.1.6 TEST RESULTS

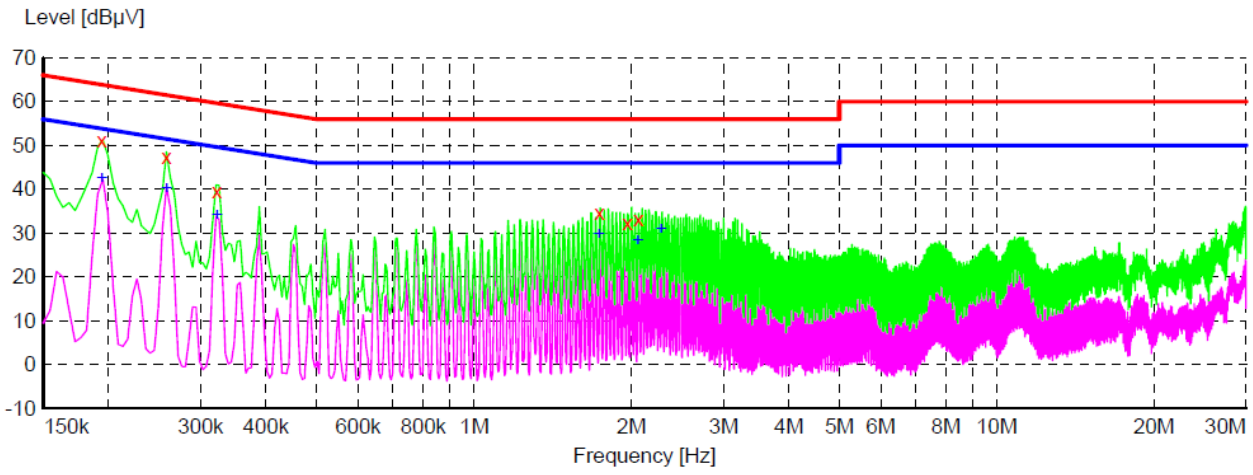
| | | | |
|---|---|---|---|
| EUT : | Electric Bicycle | Test Voltage : | Charging from adapter AC 230V/50Hz |
| Temperature : | 24 ℃ | Relative Humidity : | 46% |
| Pressure : | 1010hPa | Test Date : | 2020-04-29 |
| Test Mode : | Charging | Phase : | L |
| Model Name. : | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|---|---|---|---|---|---|---|---|
| 0.194000 | 55.30 | 10.2 | 64 | 8.6 | QP | L1 | GND |
| 0.258000 | 48.60 | 10.2 | 62 | 12.9 | QP | L1 | GND |
| 0.322000 | 44.40 | 10.2 | 60 | 15.3 | QP | L1 | GND |
| 0.386000 | 33.70 | 10.2 | 58 | 24.4 | QP | L1 | GND |
| 2.276000 | 31.60 | 10.4 | 56 | 24.4 | QP | L1 | GND |
| 0.194000 | 44.70 | 10.2 | 54 | 9.2 | AV | L1 | GND |
| 0.258000 | 38.60 | 10.2 | 52 | 12.9 | AV | L1 | GND |
| 0.322000 | 36.40 | 10.2 | 50 | 13.3 | AV | L1 | GND |
| 2.210000 | 27.40 | 10.4 | 46 | 18.6 | AV | L1 | GND |
| 2.276000 | 25.80 | 10.4 | 46 | 20.2 | AV | L1 | GND |
| 2.594000 | 26.90 | 10.4 | 46 | 19.1 | AV | L1 | GND |



| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | Charging from adapter AC 230V/50Hz |
| Temperature： | 24 ℃ | Relative Humidity： | 46% |
| Pressure： | 1010hPa | Test Date： | 2020-04-29 |
| Test Mode： | Charging | Phase： | N |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

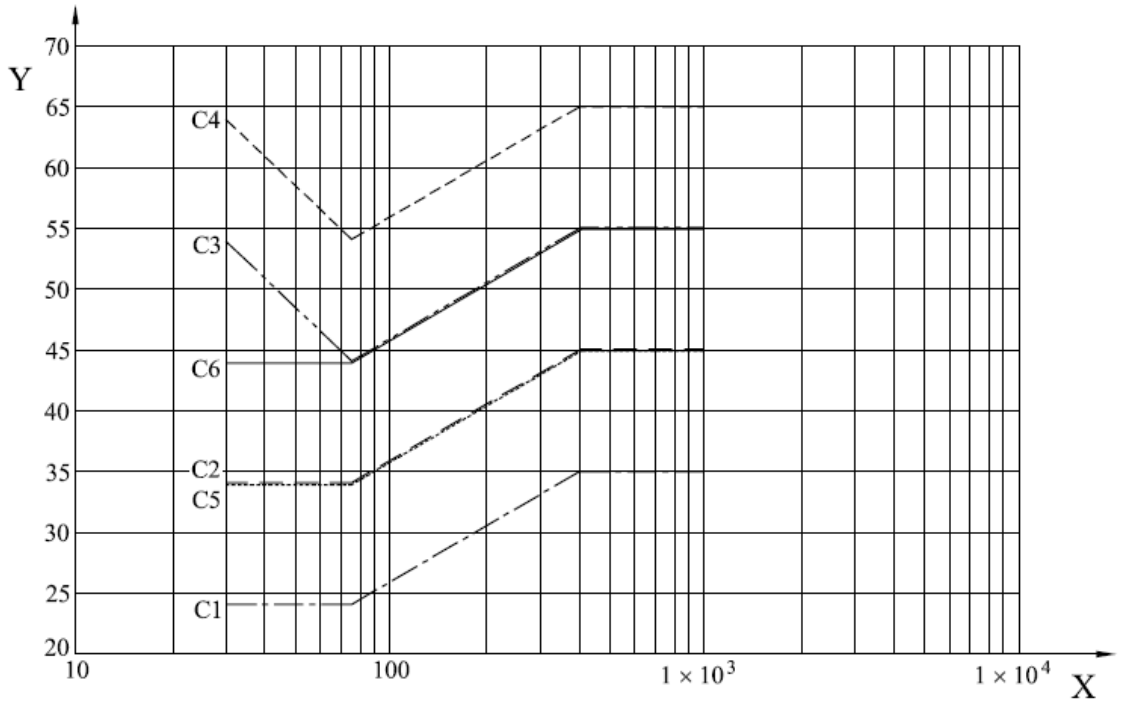
| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|---|---|---|---|---|---|---|---|
| 0.194000 | 51.20 | 10.2 | 64 | 12.7 | QP | L1 | GND |
| 0.258000 | 47.40 | 10.2 | 62 | 14.1 | QP | L1 | GND |
| 0.322000 | 39.50 | 10.2 | 60 | 20.2 | QP | L1 | GND |
| 1.736000 | 34.50 | 10.3 | 56 | 21.5 | QP | L1 | GND |
| 1.964000 | 32.20 | 10.3 | 56 | 23.8 | QP | L1 | GND |
| 2.060000 | 33.30 | 10.4 | 56 | 22.7 | QP | L1 | GND |
| 0.194000 | 42.50 | 10.2 | 54 | 11.4 | AV | L1 | GND |
| 0.258000 | 40.10 | 10.2 | 52 | 11.4 | AV | L1 | GND |
| 0.322000 | 34.10 | 10.2 | 50 | 15.6 | AV | L1 | GND |
| 1.736000 | 29.60 | 10.3 | 46 | 16.4 | AV | L1 | GND |
| 2.060000 | 28.30 | 10.4 | 46 | 17.7 | AV | L1 | GND |
| 2.282000 | 30.80 | 10.4 | 46 | 15.2 | AV | L1 | GND |



## 3.2 RADIATED EMISSION MEASUREMENT

### 3.2.1 LIMITS OF RADIATED EMISSION MEASUREMENT (Below 1000MHz)

A. EN 15194: 2017




**Key**

| | |
|---|---|
| X | frequency f in MHz |
| Y | reference limits L in dB [µV/m) |
| C1 | requirements relating to narrow-band radiation emission from vehicle, antenna at 10 m |
| C2 | requirements relating to broad-band radiation emission from vehicle, antenna at 10 m |
| C3 | requirements relating to narrow-band ESA radiation emission, antenna at 1m |
| C4 | requirements relating to broad-band ESA radiation emission, antenna at 1 m |
| C5 | requirements relating to narrow-band radiation emission from vehicle, antenna at 3 m |
| C6 | requirements relating to broad-band radiation emission from vehicle, antenna at 3 m |

**Figure C.1 — Overview of electromagnetic radiation emissions reference limits**

**Table C.1 — Overview of electromagnetic radiation emissions reference limits – Curves characteristics**

| Characteristic | Value | Band-width | Antenna distance [m] | Equation for L [dB(µV/m)] within f [MHz] | | |
|---|---|---|---|---|---|---|
| | | | | 30…75 | 75…400 | 400…1000 |
| C 1 | mean value | narrow-band | 10 ± 0,2 | 24=const. | 24+15,13·log(f/75) | 35=const. |
| C 2 | quasi-peak | broad-band | 10 ± 0,2 | 34=const. | 34+15,13·log(f/75) | 45=const. |
| C 3 | mean value | narrow-band | 1,0 ± 0,05 | 54-25,13·log(f/30) | 44+15,13·log(f/75) | 55=const. |
| C 4 | quasi-peak | broad-band | 1,0 ± 0,05 | 64-25,13·log(f/30) | 54+15,13·log(f/75) | 65=const. |
| C 5 | mean value | narrow-band | 3 ± 0,05 | 34=const. | 34+15,13·log(f/75) | 45=const. |
| C 6 | quasi-peak | broad-band | 3 ± 0,05 | 44=const. | 44+15,13·log(f/75) | 55=const. |

B. EN 55014-1

| FREQUENCY (MHz) | At 10m | At 3m |
|---|---|---|
| | dBuV/m | dBuV/m |
| 30 – 230 | 30 | 40 |
| 230 – 1000 | 37 | 47 |

3.2.2 LIMITS OF DISTURBANCE POWER MEASUREMENT (Below 1000MHz)

| | Household and similar appliances | | Tools | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frequency Range | | | Rated motor power not exceeding 700 W | | Rated motor power above 700 W and not exceeding 1 000 W | | Rated motor power above 1 000 W | |
| (MHz) | dB (pW) Quasi-peak | dB (pW) Averag* | dB (pW) Quasi-peak | dB (pW) Averag* | dB (pW) Quasi-peak | dB (pW) Averag* | dB (pW) Quasi-peak | dB (pW) Average * |
| 30-300 | 44-55 | 35-45 | 44-55 | 35-45 | 49-59 | 39-49 | 55-65 | 45-55 |
| * If the limit for the measurement with the average detector is met when using a receiver with a quasi-peak detector, the equipment under test shall be deemed to meet both limits and the measurement using the receiver with an average detector need not be carried out. | | | | | | | | |

Notes:

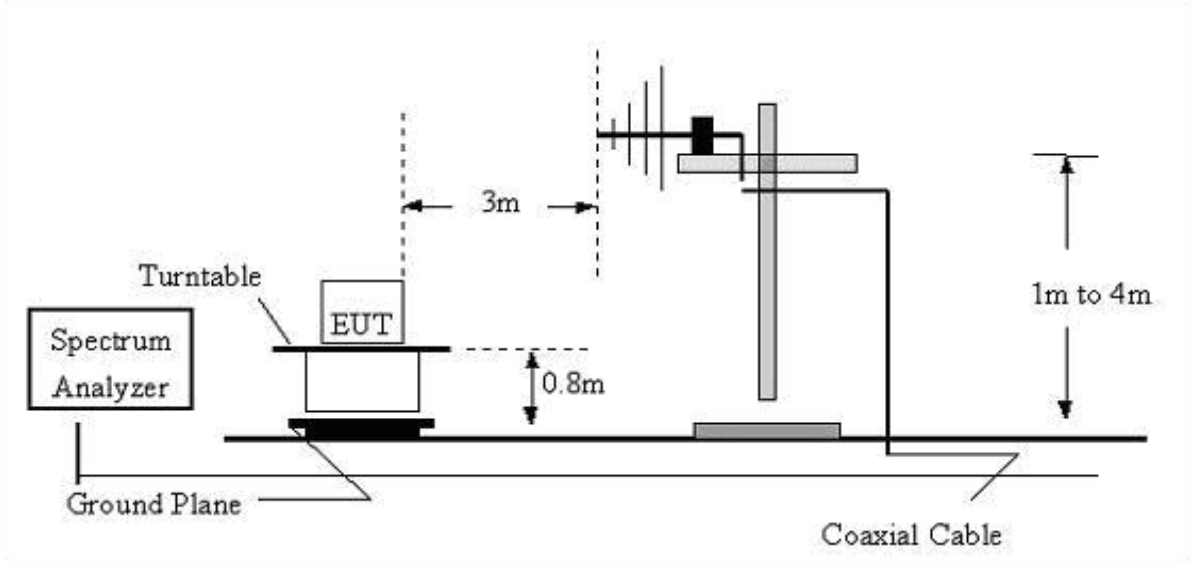
(1) The limit for radiated test was performed according to as following: CISPR 14/12.
(2) The tighter limit applies at the band edges.
(3) Emission level (dBuV/m)=20log Emission level (uV/m).

3.2.3 TEST PROCEDURE

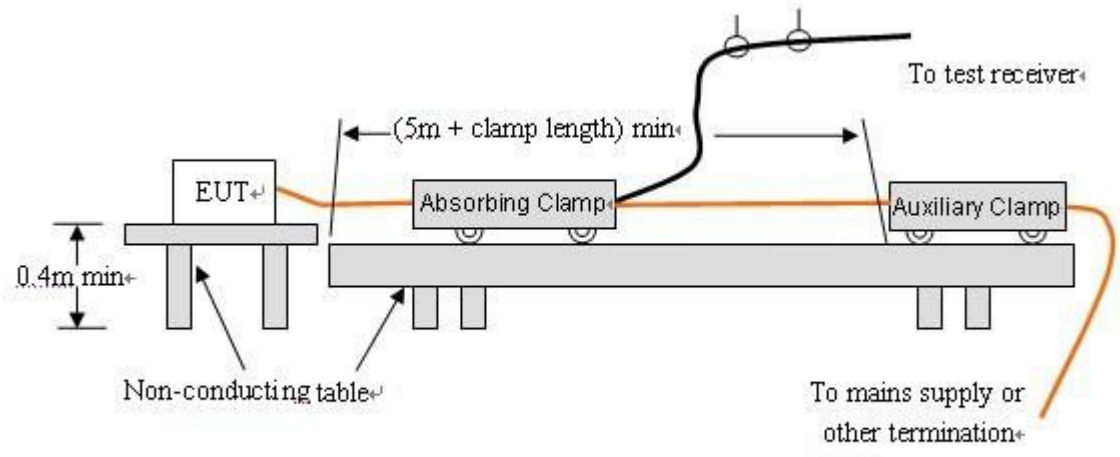
a. The measuring distance of at 10 m shall be used for measurements at frequency up to 1GHz. For frequencies above 1GHz, any suitable measuring distance may be used.
b. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 10 meter open area test site. The table was rotated 360 degrees to determine the position of the highest radiation.
c. The height of the equipment or of the substitution antenna shall be 0.8 m; the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured, above 1G Average detector mode will be instead.
e. If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP(AV) Limits and then no additional QP Mode measurement performed.
f. For the actual test configuration, please refer to the related Item –EUT Test Photos.

3.2.4 TEST SETUP

(A) Radiated Emission Test Set-Up Frequency Below 1 GHz




(B) Disturbance Power Test Set-UP Frequency Below 1GHz



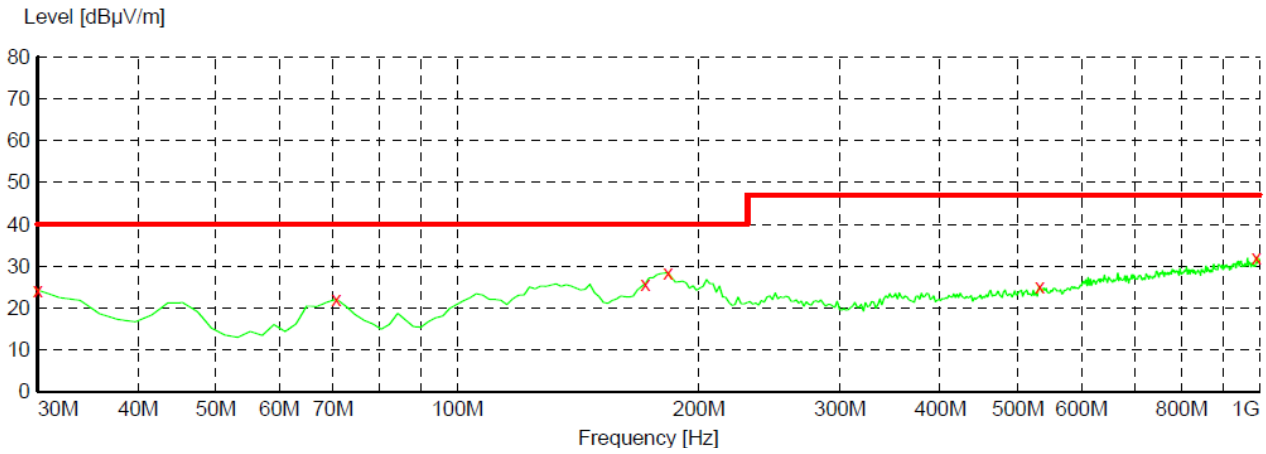

3.2.5 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of **2.3** Unless otherwise a special operating condition is specified in the follows during the testing.

3.2.6 TEST RESULTS(30MHz-1000MHz)

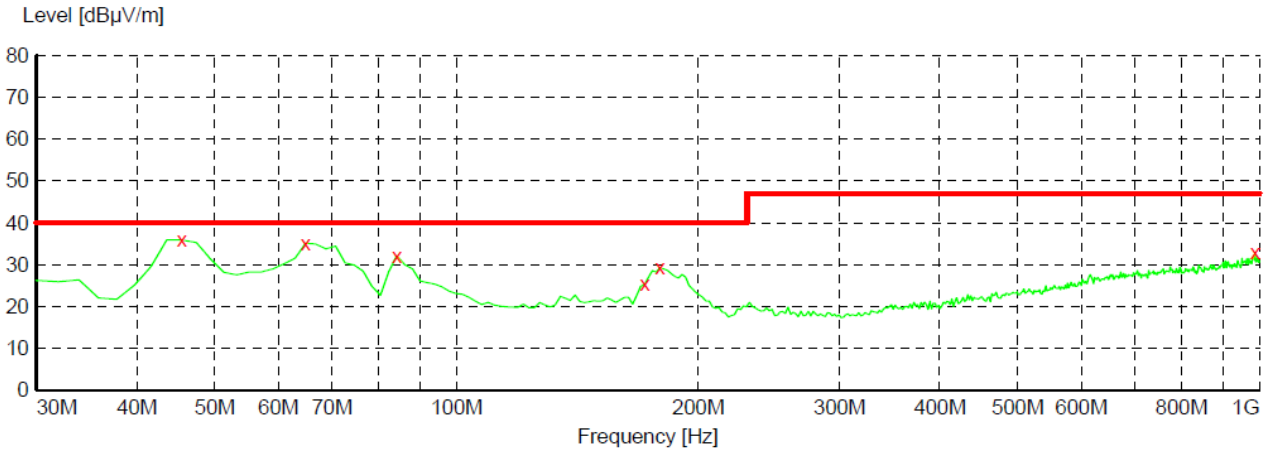
| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | Charging from adapter AC 230V/50Hz |
| Temperature： | 24 ℃ | Relative Humidity： | 46% |
| Pressure： | 1010hPa | Test Date： | 2020-04-29 |
| Test Mode： | Charging | Polarization： | Horizontal |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Frequency MHz | Level dBµV/m | Transd dB | Limit dBµV/m | Margin dB | Det. | Height cm | Azimuth deg | Polarization |
|---|---|---|---|---|---|---|---|---|
| 30.000000 | 24.30 | 21.1 | 40.0 | 15.7 | --- | 0.0 | 0.00 | HORIZONTAL |
| 70.740000 | 22.10 | 8.4 | 40.0 | 17.9 | --- | 0.0 | 0.00 | HORIZONTAL |
| 171.620000 | 25.80 | 13.4 | 40.0 | 14.2 | --- | 0.0 | 0.00 | HORIZONTAL |
| 183.260000 | 28.50 | 13.3 | 40.0 | 11.5 | --- | 0.0 | 0.00 | HORIZONTAL |
| 532.460000 | 25.20 | 20.6 | 47.0 | 21.8 | --- | 0.0 | 0.00 | HORIZONTAL |
| 992.240000 | 32.20 | 27.2 | 47.0 | 14.8 | --- | 0.0 | 0.00 | HORIZONTAL |



| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | Charging from adapter AC 230V/50Hz |
| Temperature： | 24 ℃ | Relative Humidity： | 46% |
| Pressure： | 1010hPa | Test Date： | 2020-04-29 |
| Test Mode： | Charging | Polarization： | Horizontal |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Frequency MHz | Level dBµV/m | Transd dB | Limit dBµV/m | Margin dB | Det. | Height cm | Azimuth deg | Polarization |
|---|---|---|---|---|---|---|---|---|
| 45.520000 | 35.90 | 10.0 | 40.0 | 4.1 | --- | 0.0 | 0.00 | VERTICAL |
| 64.920000 | 35.10 | 8.4 | 40.0 | 4.9 | --- | 0.0 | 0.00 | VERTICAL |
| 84.320000 | 32.10 | 9.2 | 40.0 | 7.9 | --- | 0.0 | 0.00 | VERTICAL |
| 171.620000 | 25.30 | 13.4 | 40.0 | 14.7 | --- | 0.0 | 0.00 | VERTICAL |
| 179.380000 | 29.30 | 13.3 | 40.0 | 10.7 | --- | 0.0 | 0.00 | VERTICAL |
| 988.360000 | 32.80 | 27.2 | 47.0 | 14.2 | --- | 0.0 | 0.00 | VERTICAL |



| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | DC 36V power by battery |
| Temperature： | 24 ℃ | Relative Humidity： | 46% |
| Pressure： | 1010hPa | Test Date： | 2020-04-29 |
| Test Mode： | Charging | Polarization： | Horizontal |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Freq. (MHz) | Reading (dBuV) | Factor (dBuV) | Measurement (dBuV) | Limit (dBuV) | Over (dB) | Detector |
|---|---|---|---|---|---|---|
| 31.28 | 33.18 | 17.56 | 51.94 | 70.74 | -10.7 | QP |
| 155.34 | 34.75 | 12.34 | 46.43 | 54.68 | -8.21 | QP |
| 182.32 | 34.87 | 9.8 | 42.27 | 55.21 | -101.33 | QP |
| 316.84 | 31.12 | 14.88 | 45.18 | 60.19 | -11.06 | QP |

Remark:
1. All readings are Quasi-Peak and Average values.
2. Factor = Antenna Factor + Cable Loss.
3. N/A means All Data have pass Limit

| Freq. (MHz) | Reading (dBuV) | Factor (dBuV) | Measurement (dBuV) | Limit (dBuV) | Over (dB) | Detector |
|---|---|---|---|---|---|---|
| 41.32 | 39.06 | 11.88 | 51.91 | 60.11 | -8.13 | QP |
| 143.45 | 32.41 | 11.96 | 44.39 | 53.48 | -9.31 | QP |
| 209.12 | 34.89 | 9.32 | 45.12 | 56.67 | -11.56 | QP |
| 378.89 | 30.41 | 15.72 | 46.17 | 60.12 | -16.68 | QP |

Remark:
1. All readings are Quasi-Peak and Average values.
2. Factor = Antenna Factor + Cable Loss.
3. N/A means All Data have pass Limit

3.2.7 TEST RESULTS (30MHz ~300MHz)

| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | Charging from adapter AC 230V/50Hz |
| Temperature： | 24 ℃ | Relative Humidity： | 46% |
| Pressure： | 1010hPa | Test Date： | 2020-04-29 |
| Test Mode： | AC Line | Polarization： | Horizontal |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Freq. (MHz) | Reading (dBuV) | Factor (dBuV) | Measurement (dBuV) | Limit (dBuV) | Over (dB) | Detector |
|---|---|---|---|---|---|---|
| 32.14 | 19.16 | 15.28 | 31.12 | 43.53 | -13.65 | QP |
| 32.54 | 12.73 | 17.32 | 24.47 | 31.61 | -11.85 | AVG |
| 58.18 | 21.85 | 19.71 | 31.26 | 43.16 | -16.74 | QP |
| 52.26 | 8.29 | 11.73 | 25.85 | 37.56 | -18.52 | AVG |
| 73.19 | 3.84 | 13.13 | 12.25 | 26.62 | -15.74 | AVG |
| 76.34 | 21.42 | 15.76 | 31.64 | 46.81 | -14.59 | QP |

Remark:
1. All readings are Quasi-Peak and Average values.
2. Factor = Antenna Factor + Cable Loss - Amplifier.
3. N/A means All Data have pass Limit

3.3 HARMONICS CURRENT

3.3.1 LIMITS OF HARMONICS CURRENT

| IEC 555-2 | | | | | |
|---|---|---|---|---|---|
| Table - I | | | Table - II | | |
| Equipment Category | Harmonic Order n | Max. Permissible Harmonic Current (in Ampers) | Equipment Category | Harmonic Order n | Max. Permissible Harmonic Current (in Ampers) |
| Non Portable Tools or TV Receivers | Odd Harmonics | | TV Receivers | Odd Harmonics | |
| | 3 | 2.30 | | 3 | 0.80 |
| | 5 | 1.14 | | 5 | 0.60 |
| | 7 | 0.77 | | 7 | 0.45 |
| | 9 | 0.40 | | 9 | 0.30 |
| | 11 | 0.33 | | 11 | 0.17 |
| | 13 | 0.21 | | 13 | 0.12 |
| | 15≤n≤39 | 0.15 · 15/n | | 15≤n≤39 | 0.10 · 15/n |
| | Even Harmonics | | | Even Harmonics | |
| | 2 | 1.08 | | 2 | 0.30 |
| | 4 | 0.43 | | 4 | 0.15 |
| | 8 | 0.30 | | | |
| | 8≤n≤40 | 0.23 · 8/n | | DC | 0.05 |

| EN 61000-3-2/IEC 61000-3-2 | | | | | |
|---|---|---|---|---|---|
| Equipment Category | Max. Permissible Harmonic Current (in Ampers) | Equipment Category | Harmonic Order n | Max. Permissible Harmonic Current (in A) | (mA/w) |
| Class A | Same as Limits Specified in 4-2.1, Table - I, but only odd harmonics required | Class D | 3 | 2.30 | 3.4 |
| | | | 5 | 1.14 | 1.9 |
| | | | 7 | 0.77 | 1.0 |
| | | | 9 | 0.40 | 0.5 |
| | | | 11 | 0.33 | 0.35 |
| | | | 13≤n≤39 | see Table I | 3.85/n |
| | | | only odd harmonics required | | |

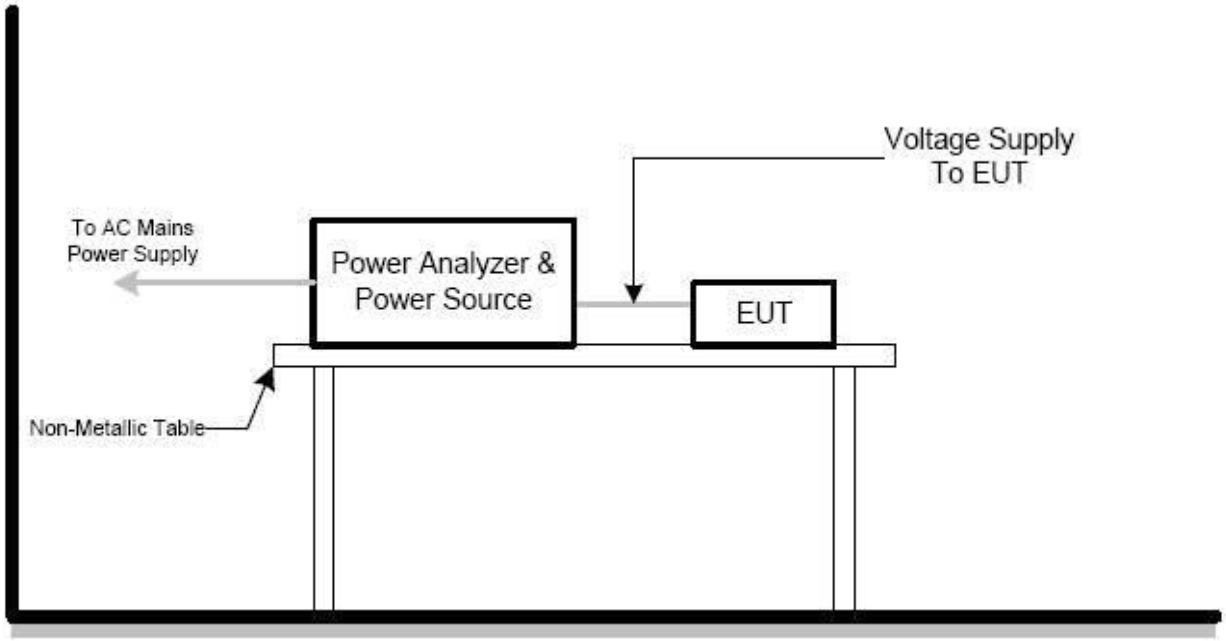
3.3.1.1 TEST PROCEDURE

a. The EUT was placed on the top of a wooden table 0.8 meters above the ground and operated to produce the maximum harmonic components under normal operating conditions.
b. The classification of EUT is according to section 5 of EN 61000-3-2. The EUT is classified as follows:
Class A: Balanced three-phase equipment, Household appliances excluding equipment as Class D, Tools excluding portable tools, Dimmers for incandescent lamps, audio equipment, equipment not specified in one of the three other classes.
Class B: Portable tools. Portable tools.; Arc welding equipment which is not professional equipment.
Class C: Lighting equipment.
Class D: Equipment having a specified power less than or equal to600 W of the following types: Personal computers and personal computer monitors and television receivers.
c. The correspondent test program of test instrument to measure the current harmonics emanated from EUT is chosen. The measure time shall be not less than the time necessary for the EUT to be exercised.

3.3.1.2 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of **2.3** Unless otherwise a special operating condition is specified in the follows during the testing.

3.3.1.3 TEST SETUP



3.3.2 TEST RESULTS

| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | DC 36V power by battery |
| Temperature： | 26 ℃ | Relative Humidity： | 48% |
| Pressure： | 1010hPa | Test Date： | 2020-04-30 |
| Test Mode： | Runnin | | |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

# E. U. T. Result

| | |
|---|---|
| **Harmonic(s) > 200%:** | |
| Order (n): | None |
| **Harmonic(s) with average > 90%:** | |
| Order (n): | None |
| **Harmonic(s) between 150% and 200% during more than 10% of the test time or max. 10min:** | |
| Order (n): | None |

## Power Source Result

| | |
|---|---|
| **First dataset out of limit:** | |
| DS (time): | None |
| **Harmonic(s) out of limit:** | |
| Order (n): | None |

## *Average harmonic current results*

| Hn | Ieff [A] | Ieff [%] | Limit [A] | Result |
|---|---|---|---|---|
| 1 | 383.267E-3 | 100.000 | | |
| 2 | 687.417E-6 | 0.179 | 972.00E-3 | PASS |
| 3 | 84.108E-3 | 21.945 | 2.07 | PASS |
| 4 | 1.825E-3 | 0.476 | 387.00E-3 | PASS |
| 5 | 7.213E-3 | 1.882 | 1.03 | PASS |
| 6 | 804.287E-6 | 0.210 | 270.00E-3 | PASS |
| 7 | 13.802E-3 | 3.601 | 693.00E-3 | PASS |
| 8 | 740.549E-6 | 0.193 | 207.00E-3 | PASS |
| 9 | 8.339E-3 | 2.176 | 360.00E-3 | PASS |
| 10 | 697.790E-6 | 0.182 | 165.60E-3 | PASS |
| 11 | 5.692E-3 | 1.485 | 297.00E-3 | PASS |
| 12 | 655.011E-6 | 0.171 | 138.00E-3 | PASS |
| 13 | 1.840E-3 | 0.480 | 189.00E-3 | PASS |
| 14 | 840.645E-6 | 0.219 | 118.29E-3 | PASS |
| 15 | 6.898E-3 | 1.800 | 135.00E-3 | PASS |
| 16 | 682.474E-6 | 0.178 | 103.50E-3 | PASS |
| 17 | 4.041E-3 | 1.054 | 119.11E-3 | PASS |
| 18 | 1.087E-3 | 0.284 | 92.00E-3 | PASS |
| 19 | 4.598E-3 | 1.200 | 106.58E-3 | PASS |
| 20 | 662.263E-6 | 0.173 | 82.80E-3 | PASS |
| 21 | 5.833E-3 | 1.522 | 96.43E-3 | PASS |
| 22 | 993.409E-6 | 0.259 | 75.28E-3 | PASS |
| 23 | 4.572E-3 | 1.193 | 88.05E-3 | PASS |
| 24 | 685.480E-6 | 0.179 | 68.99E-3 | PASS |
| 25 | 3.971E-3 | 1.036 | 81.00E-3 | PASS |
| 26 | 689.669E-6 | 0.180 | 63.69E-3 | PASS |
| 27 | 2.282E-3 | 0.595 | 75.00E-3 | PASS |
| 28 | 688.613E-6 | 0.180 | 59.14E-3 | PASS |
| 29 | 3.909E-3 | 1.020 | 69.83E-3 | PASS |
| 30 | 746.339E-6 | 0.195 | 55.20E-3 | PASS |
| 31 | 2.304E-3 | 0.601 | 65.32E-3 | PASS |
| 32 | 776.850E-6 | 0.203 | 51.75E-3 | PASS |
| 33 | 1.132E-3 | 0.295 | 61.36E-3 | PASS |
| 34 | 664.893E-6 | 0.173 | 48.71E-3 | PASS |
| 35 | 1.146E-3 | 0.299 | 57.86E-3 | PASS |
| 36 | 913.940E-6 | 0.238 | 46.00E-3 | PASS |
| 37 | 863.258E-6 | 0.225 | 54.73E-3 | PASS |
| 38 | 737.006E-6 | 0.192 | 43.58E-3 | PASS |
| 39 | 2.123E-3 | 0.554 | 51.92E-3 | PASS |
| 40 | 897.700E-6 | 0.234 | 41.40E-3 | PASS |

## *Maximum harmonic current results*

| Hn | Ieff [A] | Ieff [%] | Limit [A] | Result |
|---|---|---|---|---|
| 1 | 383.588E-3 | 100.000 | | |
| 2 | 783.998E-6 | 0.204 | 2.16 | PASS |
| 3 | 86.239E-3 | 22.482 | 4.60 | PASS |
| 4 | 2.219E-3 | 0.578 | 860.00E-3 | PASS |
| 5 | 7.987E-3 | 2.082 | 2.28 | PASS |
| 6 | 1.018E-3 | 0.265 | 600.00E-3 | PASS |
| 7 | 13.938E-3 | 3.634 | 1.54 | PASS |
| 8 | 916.500E-6 | 0.239 | 460.00E-3 | PASS |
| 9 | 9.030E-3 | 2.354 | 800.00E-3 | PASS |
| 10 | 867.639E-6 | 0.226 | 368.00E-3 | PASS |
| 11 | 5.913E-3 | 1.541 | 660.00E-3 | PASS |
| 12 | 788.346E-6 | 0.206 | 306.66E-3 | PASS |
| 13 | 2.095E-3 | 0.546 | 420.00E-3 | PASS |
| 14 | 1.056E-3 | 0.275 | 262.86E-3 | PASS |
| 15 | 7.282E-3 | 1.898 | 300.00E-3 | PASS |
| 16 | 792.309E-6 | 0.207 | 230.00E-3 | PASS |
| 17 | 4.364E-3 | 1.138 | 264.70E-3 | PASS |
| 18 | 1.222E-3 | 0.318 | 204.44E-3 | PASS |
| 19 | 5.101E-3 | 1.330 | 236.84E-3 | PASS |
| 20 | 842.518E-6 | 0.220 | 184.00E-3 | PASS |
| 21 | 6.309E-3 | 1.645 | 214.28E-3 | PASS |
| 22 | 1.160E-3 | 0.302 | 167.28E-3 | PASS |
| 23 | 4.814E-3 | 1.255 | 195.66E-3 | PASS |
| 24 | 846.935E-6 | 0.221 | 153.32E-3 | PASS |
| 25 | 4.289E-3 | 1.118 | 180.00E-3 | PASS |
| 26 | 807.828E-6 | 0.211 | 141.54E-3 | PASS |
| 27 | 2.629E-3 | 0.685 | 166.66E-3 | PASS |
| 28 | 892.861E-6 | 0.233 | 131.42E-3 | PASS |
| 29 | 4.198E-3 | 1.094 | 155.18E-3 | PASS |
| 30 | 898.240E-6 | 0.234 | 122.66E-3 | PASS |
| 31 | 2.564E-3 | 0.668 | 145.16E-3 | PASS |
| 32 | 979.854E-6 | 0.255 | 115.00E-3 | PASS |
| 33 | 1.432E-3 | 0.373 | 136.36E-3 | PASS |
| 34 | 776.398E-6 | 0.202 | 108.24E-3 | PASS |
| 35 | 1.514E-3 | 0.395 | 128.58E-3 | PASS |
| 36 | 1.036E-3 | 0.270 | 102.22E-3 | PASS |
| 37 | 1.391E-3 | 0.363 | 121.62E-3 | PASS |
| 38 | 866.143E-6 | 0.226 | 96.84E-3 | PASS |
| 39 | 2.350E-3 | 0.613 | 115.38E-3 | PASS |
| 40 | 1.027E-3 | 0.268 | 92.00E-3 | PASS |

## Maximum harmonic voltage results

| Hn | Ueff [V] | Ueff [%] | Limit [%] | Result |
|---|---|---|---|---|
| 1 | 231.31 | 100.570 | | |
| 2 | 81.30E-3 | 0.035 | 0.2 | PASS |
| 3 | 167.27E-3 | 0.073 | 0.9 | PASS |
| 4 | 23.16E-3 | 0.010 | 0.2 | PASS |
| 5 | 27.10E-3 | 0.012 | 0.4 | PASS |
| 6 | 15.60E-3 | 0.007 | 0.2 | PASS |
| 7 | 27.47E-3 | 0.012 | 0.3 | PASS |
| 8 | 12.08E-3 | 0.005 | 0.2 | PASS |
| 9 | 42.67E-3 | 0.019 | 0.2 | PASS |
| 10 | 11.67E-3 | 0.005 | 0.2 | PASS |
| 11 | 27.73E-3 | 0.012 | 0.1 | PASS |
| 12 | 14.02E-3 | 0.006 | 0.1 | PASS |
| 13 | 23.72E-3 | 0.010 | 0.1 | PASS |
| 14 | 15.58E-3 | 0.007 | 0.1 | PASS |
| 15 | 39.31E-3 | 0.017 | 0.1 | PASS |
| 16 | 16.64E-3 | 0.007 | 0.1 | PASS |
| 17 | 42.38E-3 | 0.018 | 0.1 | PASS |
| 18 | 14.81E-3 | 0.006 | 0.1 | PASS |
| 19 | 31.56E-3 | 0.014 | 0.1 | PASS |
| 20 | 20.46E-3 | 0.009 | 0.1 | PASS |
| 21 | 38.34E-3 | 0.017 | 0.1 | PASS |
| 22 | 15.26E-3 | 0.007 | 0.1 | PASS |
| 23 | 33.09E-3 | 0.014 | 0.1 | PASS |
| 24 | 15.41E-3 | 0.007 | 0.1 | PASS |
| 25 | 22.13E-3 | 0.010 | 0.1 | PASS |
| 26 | 14.11E-3 | 0.006 | 0.1 | PASS |
| 27 | 27.76E-3 | 0.012 | 0.1 | PASS |
| 28 | 15.86E-3 | 0.007 | 0.1 | PASS |
| 29 | 35.27E-3 | 0.015 | 0.1 | PASS |
| 30 | 16.01E-3 | 0.007 | 0.1 | PASS |
| 31 | 27.38E-3 | 0.012 | 0.1 | PASS |
| 32 | 16.01E-3 | 0.007 | 0.1 | PASS |
| 33 | 20.56E-3 | 0.009 | 0.1 | PASS |
| 34 | 11.20E-3 | 0.005 | 0.1 | PASS |
| 35 | 29.32E-3 | 0.013 | 0.1 | PASS |
| 36 | 11.04E-3 | 0.005 | 0.1 | PASS |
| 37 | 20.73E-3 | 0.009 | 0.1 | PASS |
| 38 | 10.30E-3 | 0.004 | 0.1 | PASS |
| 39 | 21.15E-3 | 0.009 | 0.1 | PASS |
| 40 | 10.89E-3 | 0.005 | 0.1 | PASS |

## Power and THD results - DS: 12

| | | | |
|---|---|---|---|
| True power P: | 131.7W | Apparent power S: | 159.6VA |
| Reactiv power Q: | 64.54var | Power factor: | 0.843 |
| THD (U): | 0.009 | THD (I): | 1.467 |
| Crest Factor (U): | 1.561 | Crest Factor (I): | 3.325 |

## 3.4 VOLTAGE FLUCTUATION AND FLICKERS

### 3.4.1 LIMITS OF VOLTAGE FLUCTUATION AND FLICKERS

| Tests | Limits | | Descriptions |
|---|---|---|---|
| | IEC555-3 | IEC/EN 61000-3-3 | |
| Pst | ≤ 1.0, Tp= 10 min. | ≤ 1.0, Tp= 10 min. | Short Term Flicker Indicator |
| Plt | N/A | ≤ 0.65, Tp=2 hr. | Long Term Flicker Indicator |
| dc | ≤ 3% | ≤ 3.3% | Relative Steady-State V-Chang |
| dmax | ≤ 4% | ≤ 4% | Maximum Relative V-change |
| d (t) | N/A | ≤ 3.3% for > 500 ms | Relative V-change characteristic |

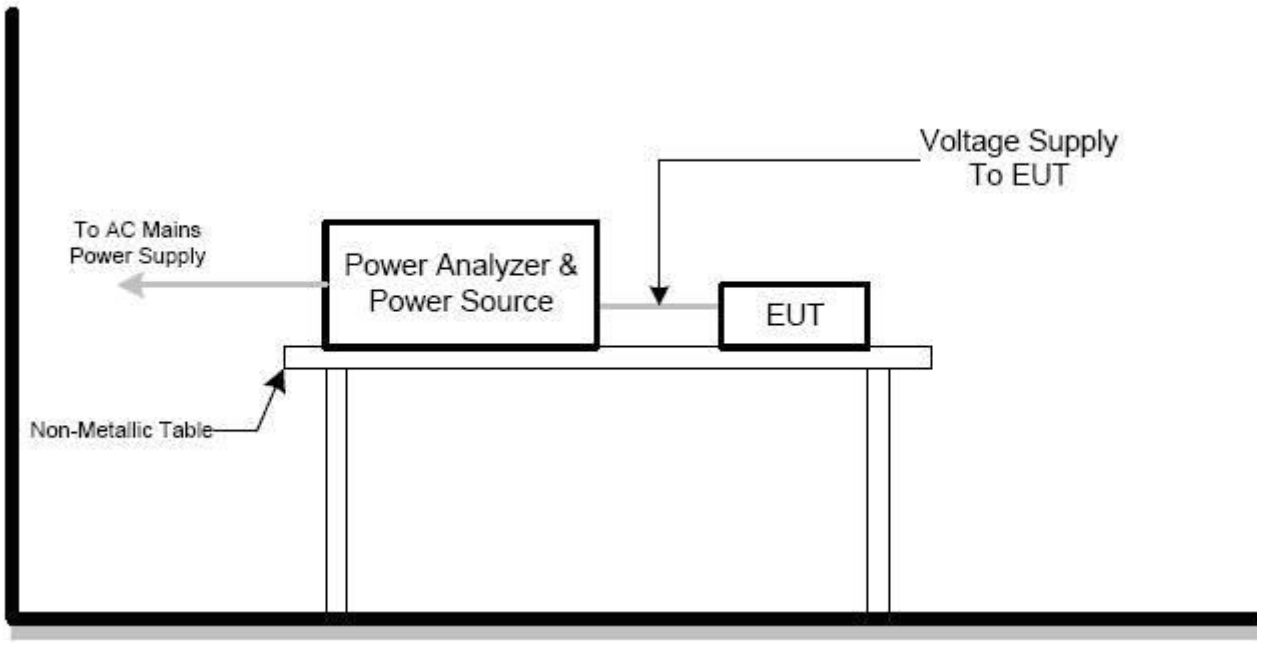
#### 3.4.1.1 TEST PROCEDURE

a. Harmonic Current Test:
Test was performed according to the procedures specified in Clause 5.0 of IEC555-2 and/or Sub-clause 6.2 of IEC/EN 61000-3-2 depend on which standard adopted for compliance measurement.
b. Fluctuation and Flickers Test:
Tests was performed according to the Test Conditions/Assessment of Voltage Fluctuations specified in Clause 5.0/6.0 of IEC555-3 and/or Clause 6.0/4.0 of IEC/EN 61000-3-3 depend on which standard adopted for compliance measurement.
c. All types of harmonic current and/or voltage fluctuation in this report are assessed by direct measurement using flicker-meter.

#### 3.4.1.2 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of **2.3** Unless otherwise a special operating condition is specified in the follows during the testing.

#### 3.4.1.3 TEST SETUP



3.4.2 TEST RESULTS

| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | DC 36V power by battery |
| Temperature： | 26 ℃ | Relative Humidity： | 48% |
| Pressure： | 1010hPa | Test Date： | 2020-04-30 |
| Test Mode： | Running | | |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

# Maximum Flicker results

| | EUT values | Limit | Result |
|---|---|---|---|
| Pst | 0.028 | 1.00 | PASS |
| Plt | 0.028 | 0.65 | PASS |
| dc [%] | 0.014 | 3.30 | PASS |
| dmax [%] | 0.158 | 4.00 | PASS |
| dt [s] | 0.000 | 0.50 | PASS |

## 4. **EMC IMMUNITY TEST**

4.1 STANDARD COMPLIANCE/SERVRITY LEVEL/CRITERIA

| Tests<br>Standard No. | TEST SPECIFICATION | Test Mode<br>Test Ports | Perform.<br>Criteria |
|---|---|---|---|
| 1. ESD<br>IEC/EN 61000-4-2 | 8KV air discharge<br>4KV contact discharge | Direct Mode | B |
| | 4KV HCP discharge<br>4KV VCP discharge | Indirect Mode | B |
| 2. RS<br>IEC/EN 61000-4-3 | 80 MHz to 1000 MHz,<br>1000Hz, 80%,<br>AM modulated | Enclosure | A |
| 3. EFT/Burst<br>IEC/EN 61000-4-4 | 5/50ns Tr/Th<br>5KHz Repetition Freq. | Power Supply<br>Port | B |
| | 5/50ns Tr/Th<br>5KHz Repetition Freq. | CTL/Signal<br>Data Line<br>Port | B |
| 4. Surges<br>IEC/EN 61000-4-5 | 1.2/50(8/20) Tr/Th us | L-N | B |
| | 1.2/50(8/20) Tr/Th us | L-PE<br>N-PE | B |
| | 0.15 MHz to 80 MHz,<br>1000Hz 80 %,<br>AM Modulated<br>150Ω source impedance | CTL/Signal Port | A |
| 5 Injected Current<br>IEC/EN 61000-4-6 | 0.15 MHz to 80 MHz,<br>1000Hz 80 %,<br>AM Modulated<br>150Ω source impedance | AC Power Port | A |
| | 0.15 MHz to 80 MHz,<br>1000Hz 80 %,<br>AM Modulated<br>150Ω source impedance | DC Power Port | A |
| 6. Power Frequency<br>Magnetic Field<br>IEC/EN 61000-4-8 | 50 Hz, | Enclosure | A |
| 7. Volt. Interruptions<br>Volt. Dips<br>IEC/EN 61000-4-11 | Voltage dip 0%<br>Voltage dip 30%<br>Voltage dip 60% | AC Power Port | C<br>C<br>C |

4.2 GENERAL PERFORMANCE CRITERIA

According to **EN 55014-2** standard, the general performance criteria as following:

| | |
|---|---|
| **Criterion A** | The equipment shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer when the equipment is used as intended.<br>The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the equipment if used as intended. |
| **Criterion B** | After the test, the equipment shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed, after the application of the phenomena below a performance level specified by the manufacturer, when the equipment is used as intended.<br>The<br>performance level may be replaced by a permissible loss of performance.<br>During the test, degradation of performance is allowed. However, no change of operating state or stored data is allowed to persist after the test. |
| **Criterion C** | Loss of function is allowed, provided the function is self-recoverable, or can be restored by the operation of the controls by the user in accordance with the manufacturer's instructions.<br>Functions, and/or information stored in non-volatile memory, or protected by a battery backup, shall not be lost. |

4.3 GENERAL PERFORMANCE CRITERIA TEST SETUP

The EUT tested system was configured as the statements of **2.3** Unless otherwise a special operating condition is specified in the follows during the testing.

## 4.4 ESD TESTING

### 4.4.1 TEST SPECIFICATION

| | |
|---|---|
| Basic Standard: | IEC/EN 61000-4-2 |
| Discharge Impedance: | 330 ohm / 150 pF |
| Required Performance | B |
| Discharge Voltage: | Air Discharge：2kV/4kV/8kV(Direct)<br>Contact Discharge：2kV/4kV(Direct/Indirect) |
| Polarity: | Positive & Negative |
| Number of Discharge: | Air Discharge: min. 20 times at each test point<br>Contact Discharge: min. 20 at each test point |
| Discharge Mode: | Single Discharge |
| Discharge Period: | 1 second minimum |

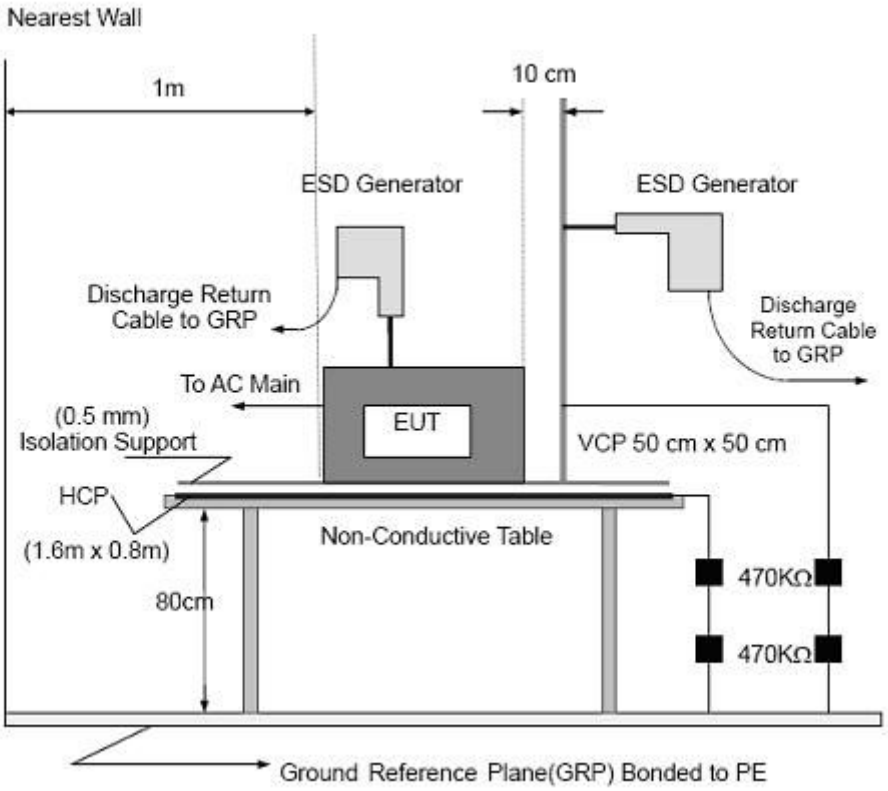
### 4.4.2 TEST PROCEDURE

The test generator necessary to perform direct and indirect application of discharges to the EUT in the following manner:

a. Contact discharge was applied to conductive surfaces and coupling planes of the EUT.
During the test, it was performed with single discharges. For the single discharge time between successive single discharges was at least 1 second. The EUT shall be exposed to at least 200 discharges, 100 each at negative and positive polarity, at a minimum of four test points. One of the test points shall be subjected to at least 50 indirect discharges to the center of the front edge of the horizontal coupling plane. The remaining three test points shall each receive at least 50 direct contact discharges.
If no direct contact test points are available, then at least 200 indirect discharges shall be applied in the indirect mode. Test shall be performed at a maximum repetition rate of one discharge per second.
Vertical Coupling Plane (VCP):
The coupling plane, of dimensions 0.5m x 0.5m, is placed parallel to, and positioned at a distance 0.1m from, the EUT, with the Discharge Electrode touching the coupling plane.
The four faces of the EUT will be performed with electrostatic discharge.
Horizontal Coupling Plane (HCP):
The coupling plane is placed under to the EUT. The generator shall be positioned vertically at a distance of 0.1m from the EUT, with the Discharge Electrode touching the coupling plane.
The four faces of the EUT will be performed with electrostatic discharge.

b. Air discharges at insulation surfaces of the EUT.
It was at least ten single discharges with positive and negative at the same selected point.

4.4.3 TEST SETUP




Note:

TABLE-TOP EQUIPMENT

The configuration consisted of a wooden table 0.8 meters high standing on the Ground Reference Plane. The GRP consisted of a sheet of aluminum at least 0.25mm thick, and 2.5 meters square connected to the protective grounding system. A Horizontal Coupling Plane (1.6m x 0.8m) was placed on the table and attached to the GRP by means of a cable with 940k total impedance. The equipment under test, was installed in a representative system as described in section 7 of IEC /EN 61000-4-2, and its cables were placed on the HCP and isolated by an insulating support of 0.5mm thickness. A distance of1-meter minimum was provided between the EUT and the walls of the laboratory and any other metallic structure.

FLOOR-STANDING EQUIPMENT

The equipment under test was installed in a representative system as described in section 7 of IEC/EN 61000-4-2, and its cables were isolated from the Ground Reference Plane by an insulating support of0.1-meter thickness. The GRP consisted of a sheet of aluminum that is at least 0.25mm thick, and 2.5meters square connected to the protective grounding system and extended at least 0.5 meters from the EUT on all sides.

4.4.4 TEST RESULTS

| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | DC 36V power by battery |
| Temperature： | 26 ℃ | Relative Humidity： | 48% |
| Pressure： | 1010hPa | Test Date： | 2020-04-30 |
| Test Mode： | Running/Charging | | |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Mode | Air Discharge | | | | | | | | Contact Discharge | | | | | | | | Criterion | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Test level (kV) | 4 | | 8 | | 10 | | 15 | | 2 | | 4 | | 6 | | 8 | | | |
| Test Location | + | - | + | - | + | - | + | - | + | - | + | - | + | - | + | - | | |
| HCP | | | | | | | | | A | A | A | A | | | | | | **PASS** |
| VCP | | | | | | | | | A | A | A | A | | | | | | **PASS** |
| enclosure | A | A | A | A | | | | | | | | | | | | | | **PASS** |
| screw | | | | | | | | | A | A | A | A | | | | | | **PASS** |
| | | | | | | | | | | | | | | | | | **B** | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |

Note:

1) +/- denotes the Positive/Negative polarity of the output voltage.
2) Test condition:
   Direct / Indirect (HCP/VCP) discharges: Minimum 50 times (Positive/Negative) at each point. Air discharges: Minimum 10 times (Positive/Negative) at each point.
3) Test location(s) in which discharge (Air and contact discharge) to be applied illustrated by photos shown in next page(s)
4) The Indirect (HCP/VCP) discharges description of test point as following:
   1.left side 2.right side 3.front side 4.rear side
5) N/A - denotes test is not applicable in this test report

## 4.5 RS TESTING

### 4.5.1 TEST SPECIFICATION

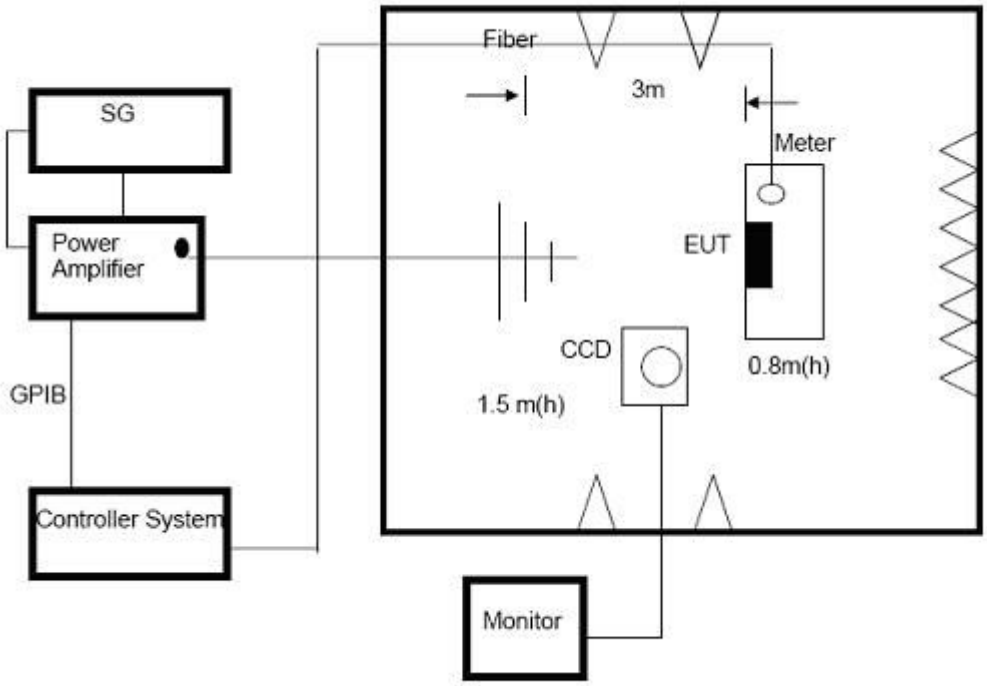
| | |
|---|---|
| Basic Standard: | IEC/EN 61000-4-3 |
| Required Performance | A |
| Frequency Range: | 80 MHz - 1000 MHz |
| Field Strength: | 3 V/m |
| Modulation: | 1kHz Sine Wave, 80%, AM Modulation |
| Frequency Step: | 1 % of fundamental |
| Polarity of Antenna: | Horizontal and Vertical |
| Test Distance: | 3 m |
| Antenna Height: | 1.5 m |
| Dwell Time: | at least 3 seconds |

### 4.5.2 TEST PROCEDURE

The EUT and support equipment, which are placed on a table that is 0.8 meter above ground and the testing was performed in a fully-anechoic chamber.
The testing distance from antenna to the EUT was 3 meters.
The other condition as following manner:

a. The frequency range is swept from 80 MHz to 1000 MHz, & 1400MHz - 2700MHz with the signal 80%amplitude modulated with a 1kHz sine wave. The rate of sweep did not exceed 1.5x 10-3 decade/s. Where the frequency range is swept incrementally, the step size was 1% of fundamental.
b. Sweep Frequency 900 MHz, with the Duty Cycle:1/8 and Modulation: Pulse 217 Hz(if applicable)
c. The dwell time at each frequency shall be not less than the time necessary for the EUT to be able to respond.
d. The test was performed with the EUT exposed to both vertically and horizontally polarized fields on each of the four sides.

4.5.3 TEST SETU




Note:

TABLE-TOP EQUIPMENT

The EUT installed in a representative system as described in section 7 of IEC/EN 61000-4-3 was placed on a non-conductive table 0.8 meters in height. The system under test was connected to the power and signal wire according to relevant installation instructions.

FLOOR-STANDING EQUIPMENT

The EUT installed in a representative system as described in section 7 of IEC/EN 61000-4-3 was placed on a non-conductive wood support 0.1 meters in height. The system under test was connected to the power and signal wire according to relevant installation instructions.

4.5.4 TEST RESULTS

| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | DC 36V power by battery |
| Temperature： | 26 ℃ | Relative Humidity： | 48% |
| Pressure： | 1010hPa | Test Date： | 2020-04-30 |
| Test Mode： | Running/Charging | | |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Frequency Range (MHz) | RF Field Position | R.F. Field Strength | Azimuth | Perform. Criteria | Results | Judgment |
|---|---|---|---|---|---|---|
| 80MHz - 1000MHz<br>1000MHz-2700MHz | H / V | 3 V/m (rms)<br>AM Modulated<br>1000Hz, 80% | Front | **A** | **A** | **PASS** |
| | | | Rear | | | |
| | | | Left | | | |
| | | | Right | | | |

Note:

1) N/A - denotes test is not applicable in this test report.
2) Criteria A: There was no change operated with initial operating during the test.
3) Criteria B: The EUT function loss during the test, but self-recoverable after the test.
4) Criteria C: The system shut down during the test.

## 4.6 EFT/BURSTTESTING

### 4.6.1 TESTSPECIFICATION

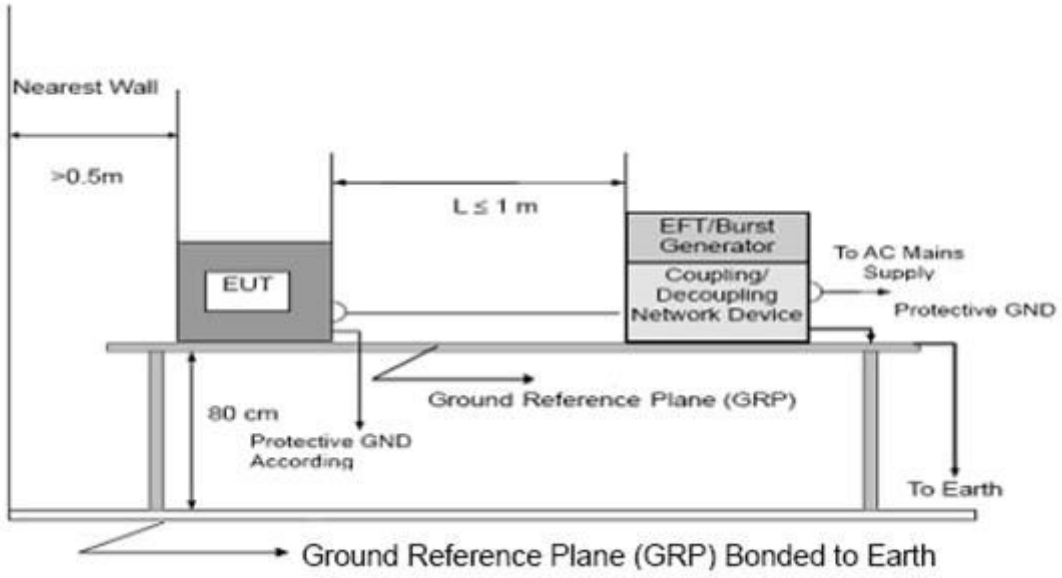
| | |
|---|---|
| Basic Standard: | IEC/EN61000-4-4 |
| RequiredPerformance | B |
| Test Voltage: | Power Line：1 kV<br>Signal/Control Line：0.5 KV |
| Polarity: | Positive & Negative |
| Impulse Frequency: | 5 kHz |
| Impulse Wave shape : | 5/50 ns |
| Burst Duration: | 15 ms |
| Burst Period: | 300 ms |
| Test Duration: | Not less than 1 min. |

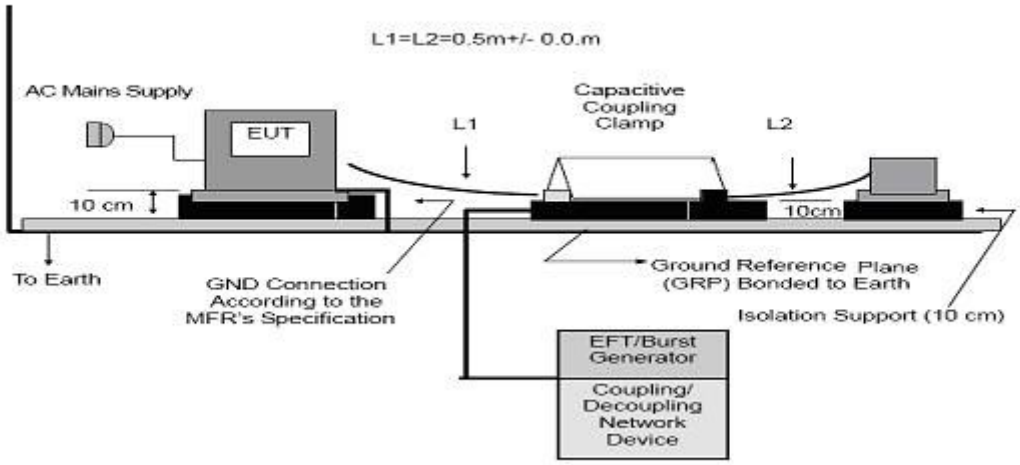
### 4.6.2 TESTPROCEDURE

The EUT and support equipment, are placed on a table that is 0.8 meter above a metal ground plane measured 1m*1m min. and 0.65mm thick min.
The other condition as following manner:

a. The length of power cord between the coupling device and the EUT should not exceed 1 meter.
b. Both positive and negative polarity discharges were applied.
c. The duration time of each test sequential was 1 minute

4.6.3 TEST SETUP




Note:

TABLE-TOP EQUIPMENT

The configuration consisted of a wooden table (0.8m high) standing on the Ground Reference Plane. The GRP consisted of a sheet of aluminum (at least 0.25mm thick and 2.5m square) connected to the protective grounding system. A minimum distance of 0.5m was provided between the EUT and the walls of the laboratory or any other metallic structure.

FLOOR-STANDING EQUIPMENT

The EUT installed in a representative system as described in section 7 of IEC/EN 61000-4-4 and its cables, were isolated from the Ground Reference Plane by an insulating support that is 0.1-meter thick. The GRP consisted of a sheet of aluminum (at least 0.25mm thick and 2.5m square) connected to the protective grounding system.

4.6.4 TEST RESULTS

| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | Charging from adapter AC 230V/50Hz |
| Temperature： | 26 ℃ | Relative Humidity： | 48% |
| Pressure： | 1010hPa | Test Date： | 2020-04-30 |
| Test Mode： | Running/Charging | | |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Coupling Line | | Test level (kV) | | | | | | | | Criterion | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.5 | | 1 | | 2 | | 4 | | | |
| | | + | - | + | - | + | - | + | - | | |
| AC line | L | A | A | A | A | | | | | B | **PASS** |
| | N | A | A | A | A | | | | | | **PASS** |
| | PE | A | A | A | A | | | | | | **PASS** |
| | L+N | A | A | A | A | | | | | | **PASS** |
| | L+PE | A | A | A | A | | | | | | **PASS** |
| | N+PE | A | A | A | A | | | | | | **PASS** |
| | L+N+PE | A | A | A | A | | | | | | **PASS** |
| DC Line | | | | | | | | | | | |
| Signal Line | | | | | | | | | | | |

Note:

1) +/- denotes the Positive/Negative polarity of the output voltage.

2) N/A - denotes test is not applicable in this test report

3) Criteria A: There was no change operated with initial operating during the test.

4) Criteria B: The EUT function loss during the test, but self-recoverable after the test.

5) Criteria C: The system shut down during the test.

## 4.7 SURGE TESTING

### 4.7.1 TEST SPECIFICATION

| | |
|---|---|
| Basic Standard: | IEC/EN 61000-4-5 |
| Required Performance | B |
| Wave-Shape: | Combination Wave<br>1.2/50 us Open Circuit Voltage<br>8 /20 us Short Circuit Current |
| Test Voltage: | Power Line ：0.5 kV, 1 kV, 2 kV |
| Surge Input/Output: | L-N, L-PE, N-PE |
| Generator Source: | 2 ohm between networks |
| Impedance: | 12 ohm between network and ground |
| Polarity: | Positive/Negative |
| Phase Angle: | 0 /90/180/270° |
| Pulse Repetition Rate: | 1 time / min. (maximum) |
| Number of Tests: | 5 positive and 5 negative at selected points |

### 4.7.2 TEST PROCEDURE

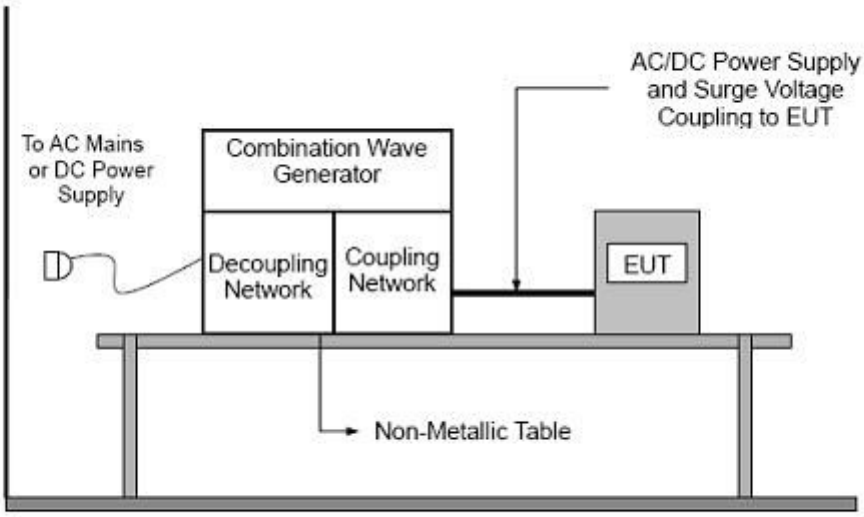
a. For EUT power supply:
The surge is to be applied to the EUT power supply terminals via the capacitive coupling network. Decoupling networks are required in order to avoid possible adverse effects on equipment not under test that may be powered by the same lines, and to provide sufficient decoupling impedance to the surge wave. The power cord between the EUT and the coupling/decoupling networks shall be 2meters in length (or shorter).

b. For test applied to unshielded unsymmetrically operated interconnection lines of EUT:
The surge is applied to the lines via the capacitive coupling. The coupling /decoupling networks shall not influence the specified functional conditions of the EUT. The interconnection line between the EUT and the coupling/decoupling networks shall be 2 meters in length (or shorter).

c. For test applied to unshielded symmetrically operated interconnection /telecommunication lines of EUT:

d. The surge is applied to the lines via gas arrestors coupling. Test levels below the ignition point of the coupling arrestor cannot be specified. The interconnection line between the EUT and the coupling/decoupling networks shall be 2 meters in length (or shorter).

4.7.3 TEST SETUP



4.7.4 TEST RESULTS

| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | Charging from adapter AC 230V/50Hz |
| Temperature： | 26 ℃ | Relative Humidity： | 48% |
| Pressure： | 1010hPa | Test Date： | 2020-04-30 |
| Test Mode： | Charging | | |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Coupling Line | | | Test level | | | | | | | | Criterion | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0.5 kV | | 1 kV | | 2 kV | | 4 kV | | | |
| | | | + | - | + | - | + | - | + | - | | |
| AC line | L-N | 0° | A | A | B | B | | | | | B | PASS |
| | | 90° | A | A | B | B | | | | | | |
| | | 180° | A | A | B | B | | | | | | |
| | | 270° | A | A | B | B | | | | | | |
| | L-PE | 0° | A | A | B | B | B | B | | | | PASS |
| | | 90° | A | A | B | B | B | B | | | | |
| | | 180° | A | A | B | B | B | B | | | | |
| | | 270° | A | A | B | B | B | B | | | | |
| | N-PE | 0° | A | A | B | B | B | B | | | | PASS |
| | | 90° | A | A | B | B | B | B | | | | |
| | | 180° | A | A | B | B | B | B | | | | |
| | | 270° | A | A | B | B | B | B | | | | |
| DC Line | | | | | | | | | | | | |
| Signal Line | | | | | | | | | | | | |

Note:

1) Polarity and Numbers of Impulses：5 Pst / Ngt at each tested mode
2) N/A - denotes test is not applicable in this Test Report
3) Criteria A: There was no change operated with initial operating during the test.
4) Criteria B: The EUT function loss during the test, but self-recoverable after the test.
5) Criteria C: The system shut down during the test.

## 4.8 INJECTION CURRENT TESTING

### 4.8.1 TEST SPECIFICATION

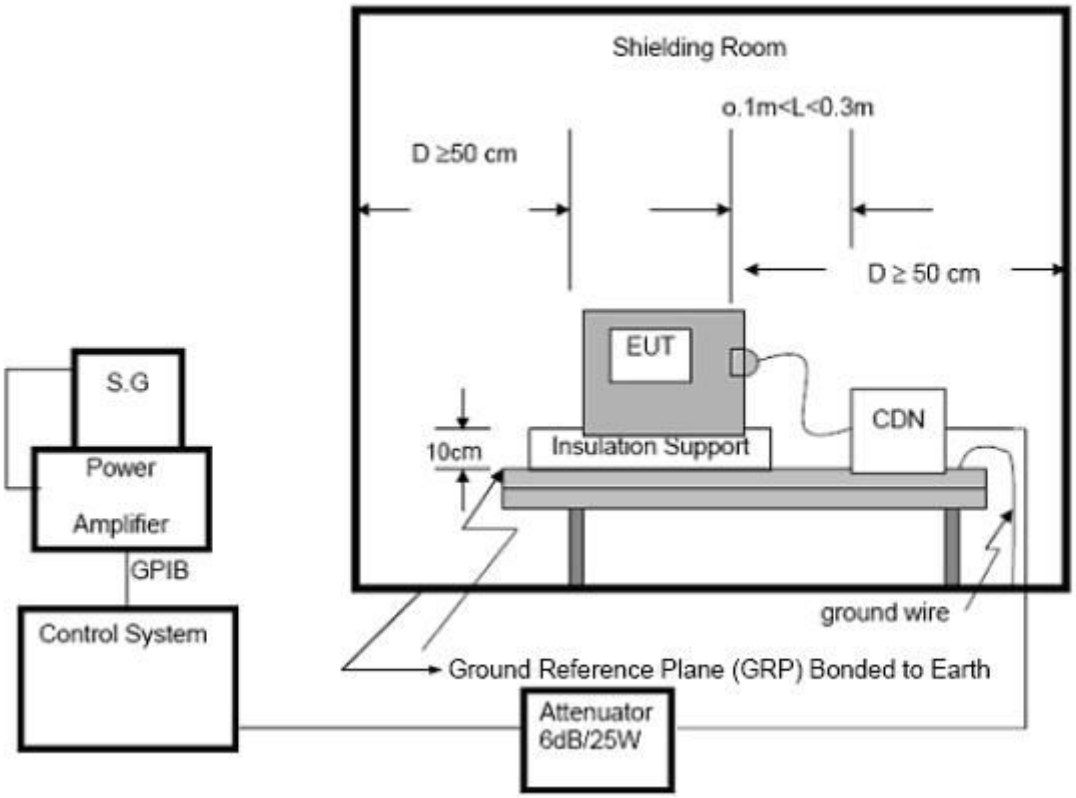
| | |
|---|---|
| Basic Standard: | IEC/EN 61000-4-6 |
| Required Performance | A |
| Frequency Range: | 0.15 MHz - 80 MHz |
| Field Strength: | 3 Vr.m.s. |
| Modulation: | 1kHz Sine Wave, 80%, AM Modulation |
| Frequency Step: | 1 % of fundamental |
| Dwell Time: | at least 3 seconds |

### 4.8.2 TEST PROCEDURE

The EUT and support equipment, are placed on a table that is 0.8 meter above a metal ground plane measured 1m*1m min. and 0.65mm thick min.
The other condition as following manner:

a. The frequency range is swept from 150 KHz to 80 MHz, with the signal 80%amplitude modulated with a 1kHz sine wave. The rate of sweep did not exceed 1.5x 10-3 decade/s. Where the frequency range is swept incrementally, the step size was 1% of fundamental.
b. The dwell time at each frequency shall be not less than the time necessary for the EUT to be able to respond.

4.8.3 TEST SETUP




NOTE:

FLOOR-STANDING EQUIPMENT

The equipment to be tested is placed on an insulating support of 0.1 meters height above a ground reference plane. All relevant cables shall be provided with the appropriate coupling and decoupling devices at a distance between 0.1 meters and 0.3 meters from the projected geometry of the EUT on the ground reference plane.

4.8.4 TEST RESULTS

| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | Charging from adapter AC 230V/50Hz |
| Temperature： | 26 ℃ | Relative Humidity： | 48% |
| Pressure： | 1010hPa | Test Date： | 2020-04-30 |
| Test Mode： | Running/Charging | | |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Test Ports (Mode) | Freq. Range MHz) | Field Strength | Perform. Criteria | Results | Judgment |
|---|---|---|---|---|---|
| Input/ Output AC. Power Port | 0.15 ---80 | 3V(rms) AM Modulated 1000Hz, 80% | **A** | **A** | **PASS** |
| Input/ Output DC. Power Port | 0.15 --- 80 | | **A** | **N/A** | **N/A** |
| Signal Line | 0.15 --- 80 | | **A** | **N/A** | **N/A** |

Note:

1) N/A - denotes test is not applicable in this Test Report.
2) Criteria A: There was no change operated with initial operating during the test.
3) Criteria B: The EUT function loss during the test, but self-recoverable after the test.
4) Criteria C: The system shut down during the test.

## 4.9 POWER FREQUENCY MAGNETIC FIELD TESTING

### 4.9.1 TEST SPECIFICATION

| | |
|---|---|
| Basic Standard: | IEC/EN 61000-4-8 |
| Required Performance | A |
| Frequency Range: | 50Hz |
| Field Strength: | 1 A/m |
| Observation Time: | 1 minute |
| Inductance Coil: | Rectangular type, 1mx1m |

### 4.9.2 TEST PROCEDURE

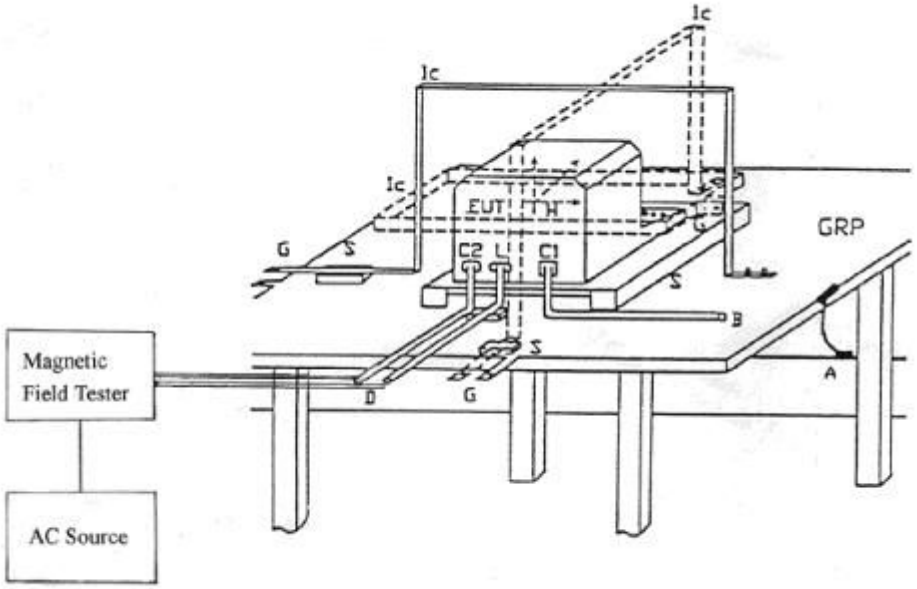
The EUT and support equipment, are placed on a table that is 0.8 meter above a metal ground plane measured 1m*1m min. and 0.65mm thick min.

The other condition as following manner:

a. The equipment cabinets shall be connected to the safety earth directly on the GRP via the earth terminal of the EUT.

b. The cables supplied or recommended by the equipment manufacturer shall be used. 1 meter of all cables used shall be exposed to the magnetic field.

4.9.3 TEST SETUP




Note:

TABLE-TOP EQUIPMENT

The equipment shall be subjected to the test magnetic field by using the induction coil of standard dimension (1 m x 1 m). The induction coil shall then be rotated by 90 degrees in order to expose the EUT to the test field with different orientations.

FLOOR-STANDING EQUIPMENT

The equipment shall be subjected to the test magnetic field by using induction coils of suitable dimensions. The test shall be repeated by moving and shifting the induction coils, in order to test the whole volume of the EUT for each orthogonal direction. The test shall be repeated with the coil shifted to different positions along the side of the EUT, in steps corresponding to 50 % of the shortest side of the coil. The induction coil shall then be rotated by 90 degrees in order to expose the EUT to the test field with different orientations.

4.9.4 TEST RESULTS

| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | Charging from adapter AC 230V/50Hz |
| Temperature： | 26 ℃ | Relative Humidity： | 48% |
| Pressure： | 1010hPa | Test Date： | 2020-04-30 |
| Test Mode： | Charging | | |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Test Mode | Test Level | Antenna aspect | Duration (minute) | Perform Criteria | Results | Judgment |
|---|---|---|---|---|---|---|
| Enclosure | 1 A/m | X | 5 | **A** | **A** | **Pass** |
| Enclosure | 1 A/m | Y | 5 | **A** | **A** | **Pass** |
| Enclosure | 1 A/m | Z | 5 | **A** | **A** | **Pass** |

Note:

1) N/A - denotes test is not applicable in this test report
2) Criteria A: There was no change operated with initial operating during the test.
3) Criteria B: The EUT function loss during the test, but self-recoverable after the test.
4) Criteria C: The system shut down during the test.

## 4.10 VOLTAGE INTERRUPTION/DIPS TESTING

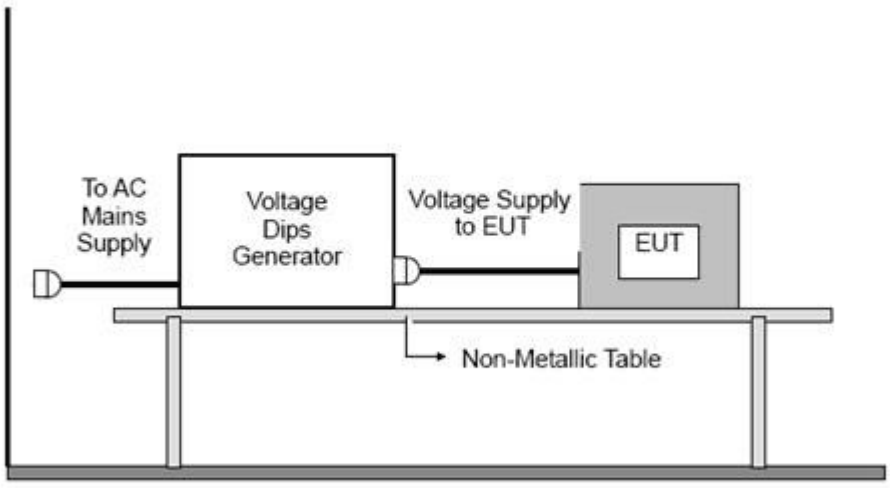
### 4.10.1 TEST SPECIFICATION

| | |
|---|---|
| Basic Standard: | IEC/EN 61000-4-11 |
| Required Performance | C (For 0% Voltage Dips)<br>C (For 30% Voltage Dips)<br>C (For 60% Voltage Dips) |
| Test Duration Time: | Minimum three test events in sequence |
| Interval between Event: | Minimum ten seconds |
| Phase Angle: | 0°/45°/90°/135°/180°/225°/270°/315°/360° |
| Test Cycle: | 3 times |

### 4.10.2 TEST PROCEDURE

The EUT shall be tested for each selected combination of test levels and duration with a sequence of three dips/interruptions with intervals of 10 s minimum (between each test event). Each representative mode of operation shall be tested. Abrupt changes in supply voltage shall occur at zero crossings of the voltage waveform.

### 4.10.3 TEST SETUP



4.10.4 TEST RESULTS

| | | | |
|---|---|---|---|
| EUT： | Electric Bicycle | Test Voltage ： | Charging from adapter AC 230V/50Hz |
| Temperature： | 26 ℃ | Relative Humidity： | 48% |
| Pressure： | 1010hPa | Test Date： | 2020-04-30 |
| Test Mode： | Charging | | |
| Model Name. ： | E2000RM-LS / e Folding RA-X9-LS<br>E2000RM-LS ECO / e Folding RS-X9-LS | | |

| Interruption & Dips | Duration (T) | Perform Criteria | Results | Judgment |
|---|---|---|---|---|
| Voltage dip 0% | 0.5 | C | B | PASS |
| Voltage dip 60% | 10 | C | B | PASS |
| Voltage dip 30% | 50 | C | B | PASS |

Note:

1). N/A - denotes test is not applicable in this test report.

2) Criteria A: There was no change operated with initial operating during the test.

3) Criteria B: The EUT function loss during the test, but self-recoverable after the test.

4) Criteria C: The system shut down during the test.

# *EN 15194:2017 TEST REPORT*

| Clause | Requirement | Result | Verdict |
|---|---|---|---|
| 4 | Requirement | | |
| 4.1 | General | | |
| | EPAC shall be designed according to the principles of EN ISO 12100 for relevant but not significant hazards, which are not dealt with by this document. It includes evaluation of such risks for all relevant components. Means shall be provided to the user to prevent an unauthorized use of the EPAC e.g. key, locks, | Complied | p |
| 4.2 | Electrical 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 without causing a hazardous situation and it requires user interaction to switch on again. | Compiled | p |
| 4.2.2 | Controls and symbols | | |
| | If symbols are used, their meaning shall be described in the instructions for use. “On” “Off” symbols, lightings symbols, start-up assistance symbols, audible warning device symbols design shall be in accordance with those described in Annex I and Annex J. | Compiled | p |
| | A master control device shall be fitted to switch on and shut off the assistance, which shall be apparent, easy to reach and unmistakable. | Compiled | p |
| | This master control device shall be activated by voluntary action to enable all assistance modes (start up and pedalling) before use of the EPAC. | Compiled | p |
| 4.2.3 | Batteries | | |
| 4.2.3.1 | Requirements | | |
| | The EPAC and batteries pack shall be designed in order to avoid risk of fire and mechanical deterioration resulting from abnormal use. Compliance is checked by the test described in 4.2.3.2. | Compiled | p |
| | During the test the EPAC and the batteries shall not emit flames, molten metal or poisonous ignitable gas in hazardous amounts and any enclosure shall show no damage that could impair compliance with this European Standard. Safety and compatibility of the battery/charger combination shall be ensured, according to the manufacturer's specifications. | Compiled | p |

| | | | |
|---|---|---|---|
| | The battery terminals shall be protected against creating an accidental short circuit. | Compiled | p |
| | An appropriate care shall be taken to ensure that the batteries are protected against overcharging.<br>An appropriate overheating and short circuit protection device shall be fitted. | Compiled | p |
| | Batteries and the charger unit shall be labelled in order to be able to check their compatibility. | Compiled | p |
| 4.2.3.2 | Test | | |
| | Battery terminals are short-circuited with the batteries in a fully charged condition. | Protection operated,<br>No hazard | p |
| | Motor terminals are short-circuited; all commands are in “ON” position, while the batteries are fully charged. | Protection operated,<br>No hazard | p |
| | The EPAC is operated with the electric motor or drive system blocked until the motor torque stops | Protection operated,<br>No hazard | p |
| | The battery is charged for double the recommended charging period or for 24 h whichever is greater. | Test for 24h<br>No hazard | p |
| 4.2.4 | Battery charger | | |
| | Chargers for EPAC are considered to be operated in a residential (household) environment. | Complied | p |
| 4.2.5 | Electric cables and connections | | |
| | Cable and plug temperature shall be lower than that specified by the manufacturer of the cables and plugs. Damage to cable and plug insulation shall be prevente | Complied | p |
| | Test | | |
| | At an ambient room temperature (20±5)° C, discharge the fully charged EPAC battery to the discharging limit specified by the EPAC or ESA manufacturer at the maximum current allowable by the system and record it. Measure the cable and pl ug temperatures and ensure, by examination, that there is no deterioration of the insulation on either assembly. The increase of outer surface temperature of parts that can be touched shall be ≤ 60 K while in use on | Complied | p |
| 4.2.6 | Wiring | | |
| | Wire ways shall be smooth and free from sharp edges. | Complied | p |

| | | | |
|---|---|---|---|
| | Wires shall be protected so that they do not come into contact with burrs, cooling fins or similar sharp edges that 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. | Complied | p |
| | Wiring shall be effectively prevented from coming into contact with moving parts. | Complied | p |
| | Separate parts of the EPAC that 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 ground continuity. | Complied | p |
| | If an open coil spring is used to protect wire, it shall be correctly installed and insulated. Flexible metallic tubes shall not cause damage to the insulation of the conductors contained within them. | | N/A |
| | The movable part is moved backwards and forwards through the largest angle permitted by its construction, | Complied | p |
| | For conductors that are flexed in normal use, flex movable part for 10000 cycles at a test frequency of 0,5 Hz. For conductors that are flexed during user maintenance, flex the movable part for 100 cycles at the same frequency. | Complied | p |
| 4.2.7 | Power cables and conduits | | |
| | Conduit entries, cable entries and knockouts 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. | Complied | p |
| | The insulation of internal wiring shall withstand the electrical stress likely to occur in normal use. | Complied | p |
| | The wiring and its connections shall withstand the electrical strength test. The test voltage expressed in V shall be equal to+(500+2xUr) for 2 min and applied between live parts and other metal parts only. | 572V | p |
| 4.2.8 | External and internal electrical connections | | |
| | Electrical connection shall comply with HD 60364-5-52:2011, 526.1 and 526.2. | Complied | p |
| 4.2.9 | Moisture resistance | | |
| | The electrical components of a fully assembled EPAC shall be tested and shall comply with IPX4 requirements according to EN 60529:1991. | IP44 | p |
| 4.2.10 | Mechanical strength test | | |

| | | | |
|---|---|---|---|
| | The electrical components including the battery shall have adequate mechanical strength and be constructed to withstand such rough handling that may be expected in normal use. Compliance is checked by: | | |
| | Applying impacts to the battery pack mounted on the EPAC by means of the spring hammer as specified in EN 60068-2-75. The battery pack is rigidly supported and three impacts are applied to every point of the enclosure that is likely to be weak with an impact energy of (0,7 ± 0,05) J. After the test the battery pack shall show no damage that could impair compliance with this European Standard; | Complied | p |
| | — Detachable batteries are submitted to free fall on a rigid surface as specified in EN 22248 at a height of 0.90 m in three different positions. The positions shall be one surface, one edge and one corner of the enclosure that is likely to be weak. | Complied<br>No damage | p |
| 4.2.11 | Maximum speed for which the electric motor gives assistance | | |
| | The electrical motor assistance shall stop when the EPAC reaches a speed of 25 km/h or lower speed if limited by design. | Complied | p |
| | The maximum speed of the EPAC for which the electric motor gives assistance shall not differ by more than +10 % from the maximum assistance speed indicated in the marking required by Clause 5 when determined according to the test method described in 4.2.11.2. 4.2.11.2 | Complied | p |
| | Test | | |
| | Test conditions | | |
| | a) The test shall be performed either on a test track, a test bench or on a stand that keeps the motor | Test bench | p |
| | The speed-measuring device used for the test shall have the following characteristics: | | |
| | 1)Accuracy: ± 2 %;<br>2) Resolution: 0.1 km/h. | Complied | p |
| | The ambient temperature shall be between 5 ° C and 35 ° C. | 25° C | p |
| | Maximum wind speed: 3 m/s. | 2.7m/s | p |
| | The battery shall be fully charged according to the manufacturer instructions. | Complied | p |
| | The cut-off speed can be measured by measuring either the motor torque output or the motor current. | Complied | p |

| | | | |
|---|---|---|---|
| | Pre-condition the EPAC by running it for 5 min at 80 % of the maximum assistance speed as declared by the manufacturer. | Complied | p |
| | b) 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” | Complied | p |
| | While pedalling, ride steadily to reach a speed equal to 1,25 times (if possible by design) the maximum assistance speed as declared by the manufacturer | Complied | p |
| | d) Verify that the noted value in b) is the no load cur | Complied | p |
| 4.2.12 | Start-up assistance mode | | |
| | An EPAC can be equipped with a start-up assistance mode that operates up to a maximum speed of 6 km/h. | Complied | p |
| | This mode shall be activated by the voluntary and maintained action of the user either when riding without pedalling or when the user is pushing the cycle. | Complied | p |
| 4.2.13 | Power management | | |
| | When tested by the method described in 4.2.13.2 the recordings shall show that assistance shall be provided only when the cyclist pedals forward. This requirement shall be checked according to the test methods described in 4.2.13.2.3; | Complied | p |
| | b) assistance shall be cut off when the cyclist stops pedalling forward and the cut-off distance shall not exceed 2 m; | Complied | p |
| | c) If all braking devices (e.g. levers, back pedal) are equipped with cut-off switches, the cut off distance shall not exceed 5 m; | Complied | p |
| | the power output or assistance shall be progressively reduced (see Annex B) and finally cut off as the EPAC reaches the maximum assistance speed as designed. This requirement shall be checked according to the test methods described in 4.2.13.2; | Complied | p |
| | e) the assistance shall be progressively and smoothly managed (e.g. no hunting); | Complied | p |
| | f) two independent applying actions shall be required to start the electrical assistance mode (e.g. power switch and forward pedalling activation); a traffic caused stop (e.g. traffic lights) is not subject to this requirement; | Complied | p |
| | after a deactivation of the electrical assistance mode due to any hazardous electric drive malfunction, the electric drive shall not start automatically without rider intervention (pedalling is not considered as rider intervention). | Complied | p |

| | | | |
|---|---|---|---|
| 4.2.13.2 | Electric motor management | | |
| | the worst case conditions of gear ratio and speed shall be applied. The worst condition for speed is defined as 90 % of cut off speed | Complied | p |
| 4.2.13.2.2 | Test track | | |
| | The gradient of the track shall not exceed 0,5 %. If the gradient is less than 0,2 % carry out all runs in the same direction. If the gradient lies between 0,2 % and 0,5 % carry out alternate runs in opposite directions. | Complied | p |
| | The surface shall be hard, of concrete or fine asphalt free from loose dirt or gravel. The minimum coefficient of friction between the dry surface and the bicycle tyre shall be 0,75. | Complied | p |
| 4.2.14 | Maximum power measurement — Measurement at the engine shaft | | |
| | The maximum continuous rated power shall be measured according to EN 60034-1 when the motor reaches its thermal equilibrium as specified by the manufacturer. | 230 w | p |
| | In circumstance where the power is measured directly at the shaft of the electronic motor, the result of the measurement shall be divided by 1,10 to consider the measurement uncertainty and then divided by 1,05 to include for example the transmission losses, unless the real values of these losses are determined. | 220 w | p |
| 4.2.15 | Electro Magnetic Compatibility | | |
| 4.2.15.1 | Emission | | |
| | The EPAC and ESA shall fulfil the requirements of Annex C. | Complied | p |
| 4.2.15.3 | Battery charger | | |
| | As an EPAC is not intended to be used while charging on the electric network, for integrated charger the whole EPAC plus integrated charger shall be tested for EMC according to the applicable standards based on the European EMC directive. | EN55014－1, EN55014－2, EN61000 -3-2,EN 61000－3-3 | p |
| 4.2.16 | Failure mode | | |
| | It shall be possible to ride the EPAC by pedalling even if the assistance failed. | Complied | p |
| | Test | | |

| | | | |
|---|---|---|---|
| | Remove or disconnect the battery pack. | Complied Remove the battery pack | p |
| | Ride the bicycle up to 10 km/h. | Complied Ride the bicycle up to 9.5 km/h | p |
| 4.2.17 | Anti-tampering measure | | |
| | Anti-tampering measures apply to tampering or modifications that general consumers carry out concerning the control unit, drive unit or other parts of power assisting system by using commercially available tools, equipment or parts. | Complied | p |
| 4.2.17.2 | Prevention of tampering of the motor | | |
| | Anti-tampering relevant parameters indicated below shall only be accessible to the manufacturer or authorized persons and changes of software configuration parameters require programming tools that are not commercially available or security protected: | Complied | p |
| | maximum speed with motor assistance (all systems), | Complied | p |
| | parameters affecting the maximum vehicle speed limited by design, | Complied | p |
| | maximum gear ratio (system with middle motors), | Complied | p |
| | maximum motor power (all systems), | Complied | p |
| | maximum speed of starting up assistance; | Complied | p |
| | Assumable manipulations on the approval relevant configuration shall be prevented or compensated by effective counter measures, i.e. plausibility logics to detect manipulations on sensors; | Complied | p |
| | Closed set of components (i.e. operation only with released battery); | Complied | p |
| | Protection against opening of relevant components without traces (sealing). | Complied | p |
| 4.3 | Mechanical requirements | | |
| 4.3.1 | Definition of brake tests | | |
| | Brake tests to which accuracy requirements apply, as in 4.3.1.4, are those specified in 4.3.5.3 to 4.3.5.6 inclusive. | Complied | p |

| | | | |
|---|---|---|---|
| 4.3.1.3 | Numbers and condition of specimens for the strength tests | | |
| | In general, for static, impact and fatigue tests, each test shall be conducted on a new test sample, but if only one sample is available, it is permissible to conduct all of these tests on the same sample with the sequence of testing being fatigue, static and impact. When more than one test is conducted on the same sample, the test sequence shall be clearly recorded in the test report or record of testing. | Complied | p |
| 4.3.1.4 | Accuracy tolerances of test conditions for brake tests and strength tests | Complied | p |
| 4.3.1.5 | Fatigue test | | |
| | The force for fatigue tests shall be applied and released progressively, not to exceed 10 Hz. The tightness of fasteners according to manufacturer's recommended torque can be re-checked not later than 1 000 test cycles to allow for the initial settling of the component assembly. (This is considered applicable to all components, where fasteners are present for clamping.) The test bench shall be qualified to meet dynamic requirements of 4.3.1.4. | Complied | p |
| 4.3.1.6 | Fatigue test for composite components | | |
| | For fatigue test for composite components, the initial value of displacement (peak-to-peak value) is taken after 1 000 cycles and before 2 000 cycles. | Complied | p |
| 4.3.1.7 | Plastic material test ambient temperature | | |
| | All strength tests involving any plastic materials shall be pre-conditioned for two hours and tested at an ambient temperature of 23 ° C ± 5 ° C. | Complied 23 ° C. | p |
| 4.3.1.8 | Crack detection methods | | |
| | Standardized methods should be used to emphasize the presence of cracks where visible cracks are specified as criteria of failure in tests specified in this standard. | Compiled | p |
| 4.3.2 | Sharp edges | | |
| | Exposed edges that could come into contact with the rider's hands, legs, etc., during normal riding or normal handling and normal maintenance shall not be sharp, e.g. deburred, broken, rolled or processed with comparable techniques. | Compiled | p |
| 4.3.3 | Security and strength of safety-related fasteners | | |

| | | | |
|---|---|---|---|
| 4.3.3.1 | Security of screws | | |
| | Any screws used in the assembly of suspension systems or screws used to attach bracket attached electric generators, brake-mechanisms and mud-guards to the frame or fork, and the saddle to the seat-post shall be provided with suitable locking devices, e.g. lock-washers, lock-nuts, thread locking compound or stiff nuts. | Compiled | p |
| 4.3.3.2 | Minimum failure torque | | |
| | The minimum failure torque of bolted joints for the fastening of handle bars, handlebar-stems, bar-ends, saddle and seat-posts shall be at least 50 % greater than the manufacturer's recommended tightening torque | Compiled | p |
| 4.3.3.3 | Folding bicycles mechanism | | |
| | If provided, folding bicycle mechanism shall be designed so that EPAC can be locked for use in a simple, stable, safe way and when folded no damage shall occur to any cables. No locking mechanism shall contact the wheels or tyres during riding, and it shall be impossible to unintentionally loosen or unlock the folding mechanisms during riding. | Compiled | p |
| 4.3.4 | Protrusions | | |
| | These requirements are intended to address the hazards associated with the users of EPACs falling on projections or rigid components (e.g. handlebars, levers) on EPAC possibly causing internal injury or skin puncture. Tubes and rigid components in the form of projections which constitute a puncture hazard to the rider should be protected. The size and shape of the end protection has not been stipulated, but an adequate shape shall be given to avoid puncturing of the body. Screw threads which constitute a puncture hazard shall be limited to a protrusion length of one major diameter of the screw beyond the internally threaded mating part. | Compiled | p |
| 4.3.5 | Brakes | | |
| 4.3.5.1 | Braking-systems | | |
| | EPAC shall be equipped with at least two independently actuated braking-systems. At least one shall operate on the front wheel and one on the rear wheel. The braking-systems shall operate without binding and shall be capable of meeting the braking-performance requirements of 4.3.5.9. No hand shall need to be taken from the handlebar to operate the brake levers. | Compiled | p |

| | | | |
|---|---|---|---|
| | If additional braking-systems are implemented, they shall meet the brake requirements of 4.3.5. | | |
| 4.3.5.2 | Hand-operated brakes | | |
| 4.3.5.2.1 | Brake-lever position | | |
| | The brake levers for front and rear brakes shall be positioned according to the legislation or custom and practice of the country in which EPAC is to be sold, and EPAC manufacturer shall state in the manufacturer’ s instructions which levers operate the front and rear brakes (see also Clause 6 i)). | Compiled | p |
| 4.3.5.2.2 | Brake-lever grip dimensions | | |
| | The dimension, d, measured between the outer surfaces of the brake-lever in the region intended for contact with the rider's fingers and the handlebar or any other covering present shall over a distance of not less than 40 mm as shown in Figure 1 not exceed 90 mm. Conformance shall be established by the method detailed in 4.3.5.2.2.2. The range of adjustment on the brake-lever ought to permit these dimensions to be obtained. | Compiled | p |
| 4.3.5.2.2.2 | Test for the brake-lever similar | | |
| 4.3.5.3 | Attachment of brake assembly and cable requirements | | |
| | Cable pinch-bolts shall not sever any of the cable strands when assembled to the manufacturer's instructions. In the event of a cable failing, no part of the brake mechanism shall inadvertently inhibit the rotation of the wheel. | Compiled | p |
| | The cable end shall either be protected with a cap that shall withstand a removal force of not less than 20 N or be otherwise treated to prevent unravelling. | compiled | p |
| 4.3.5.4 | Brake-levers – Position of applied force | | |
| | For the purposes of braking test in this standard, for brake-levers similar to Type A, the test force shall be applied at a distance, b, which is equal to either dimension a as determined in 4.3.5.2.2.2 or 25 mm from the free end of the brake-lever, whichever is the greater | Compiled | p |
| 4.3.5.5 | Brake-block and brake-pad assemblies – Safety test | | |
| | The friction material shall be securely attached to the holder, backing-plate, or shoe and there shall be no failure of the braking system or any component thereof when tested by the method specified in 4.3.5.5.2. | Compiled | p |

| | | | |
|---|---|---|---|
| 4.3.5.6 | Brake adjustment | | |
| | Each brake shall be equipped with an adjustment mechanism either manual or automatic. | Compiled | p |
| | Each brake shall be capable of adjustment with or without the use of a tool to an efficient operating position until the friction material has worn to the point of requiring replacement as recommended in the manufacturer's instructions. Also, when correctly adjusted, the friction material shall not contact anything other than the intended braking surface. | Compiled | p |
| | The brake blocks of a bicycle with rod brakes shall not come into contact with the rim of the wheels when the steering angle of the handlebars is set at 60° , nor shall the rods be bent, or be twisted after the handlebars are reset to the central position. | Compiled | p |
| 4.3.5.7 | Hand-operated braking-system – Strength test | | |
| | When tested by the method described in 4.3.5.7.2, there shall be no failure of the braking-system or of any component thereof | Compiled | p |
| 4.3.5.8 | Back-pedal braking system – Strength test | | N/A |
| 4.3.5.9 | Braking performance | | |
| | Where EPAC is fitted with secondary brake-levers attached to brake-levers, bar-ends or aerodynamic extensions, separate tests shall be conducted for the operation of the secondary brake-levers in additionto tests with the normal levers. | Compiled | p |
| 4.3.5.9.4 | Ratio between wet and dry braking performance requirements | | |
| | In order to ensure safety for both wet and dry braking, the ratio of braking performance wet: dry shall be greater than 4:10. | Compiled | p |
| 4.3.5.9.5.5 | Vertical force on the tested wheel | | |
| | The wheel to be tested shall be forced vertically downwards so that no skidding of the wheel occurs when tested according to 4.3.5.9.5.6 c) 1) and 2). It is permitted that the necessary force be applied anywhere on the bicycle (wheel-axle, bottom bracket, seat-post, etc.) provided that it is exerted vertically downwards | Compiled | p |
| 4.3.5.10 | Brakes – Heat-resistance test | | |

| | | | |
|---|---|---|---|
| | Throughout the test described in 4.3.5.10.3, the brake-lever shall not touch the handlebar-grip, the operating force shall not exceed 180 N, and the braking force shall not deviate outside the range 60 N to 115 N. Immediately after having been subjected to the test described in 4.3.5.10.3, the brakes shall achieve at least 60 % of the braking performance which was recorded at the highest operating force used during the performance tests 4.3.5.9.5.6 c) 1) and 2). | Compiled | p |
| 4.3.5.11 | Back-pedal brake linearity test | | |
| | This test shall be conducted on a fully assembled EPAC. The output force for a back-pedal brake shall be measured tangentially to the circumference of the rear tyre, when the wheel is rotated in the direction of forward movement, while a force of between 90 N and 300 N is being applied to the pedal at right angles to the crank and in the direction of braking. The braking force reading shall be taken during a steady pull and after one revolution of the wheel. A minimum of five results, each at a different pedal force level, shall be taken. Each result shall be the average of three individual readings at the same load level. | compiled | p |
| 4.3.6 | Steering | | |
| 4.3.6.1 | Handlebar – Dimensions | | |
| | Adjust the handlebar height to its highest normal riding position and the saddle to its lowest normal riding position as specified by the manufacturer , Measure the vertical distance from the centre and top of the handlebar grips to a point where the saddle surface is intersected by the seat post axis This dimension shall not exceed 400 mm. | compiled | p |
| 4.3.6.2 | Handlebar grips and plugs | | |
| | The ends of the handlebar shall be fitted with handgrips or end plugs. When tested by the method described in 4.3.6.2.2 and 4.3.6.2.3, the handgrips or plugs shall withstand the specified removal forces. | compiled | p |
| 4.3.6.2.2 | Freezing test | | |

| | | | |
|---|---|---|---|
| | Immerse the handlebar, with handlebar grips or plugs fitted, in water at room temperature for one hour and then place the handlebar in a freezer until the handlebar is at a temperature lower than −5 ° C. Remove the handlebar from the freezer and allow the temperature of the handlebar to reach −5 ° C, and then apply a force of 70 N to the grip or plug in the loosening direction as shown in Figure 10. Maintain the force until the temperature of the handlebar has reached +5 ° C. It shall be permitted to create a hole in the plug to allow for the testing fixture to be fitted so long as the hole does not affect the seat of the plug in the handlebar and the fixture does not contact the handlebar during the test. | compiled | p |
| 4.3.6.2.3 | Hot water test method | | |
| | Immerse the handlebar, with handlebar grips fitted, in hot water of +60 ° C ± 2 ° C for one hour. Remove the handlebar from the hot water, allow the handlebar to stabilize at ambient temperature for 30 min, apply a force of 100 N to the grip in the loosening direction . Maintain this force for 1 min. | Compiled | p |
| 4.3.6.3 | Handlebar stem – Insertion-depth mark or positive stop | | |
| | The handlebar-stem shall be provided with one of the two following alternative means of ensuring a safe insertion depth into the fork steerer: | | |
| | it shall contain a permanent, transverse mark, of length not less than the external diameter of the stem, that clearly indicates the minimum insertion depth of the handlebar-stem into the fork steerer. The insertion mark shall be located at a position not less than 2,5 times the external diameter of the handlebar-stem from the bottom of the stem, and there shall be at least one stem diameter's length of contiguous, circumferential stem material below the mark; | compiled | p |
| | it shall incorporates a permanent stop to prevent it from being drawn out of the fork steerer such as to leave the insertion less than the amount specified in a) above. | compiled | p |
| 4.3.6.4 | Handlebar stem to fork steerer – Clamping requirements | | |
| | The distance , between the top of the handlebar stem and the top of the fork steerer to which the handlebar stem is clamped shall not be greater than 5 mm. | compiled | p |
| | The upper part of the fork steerer to which the handlebar stem is clamped shall not be threaded. | compiled | p |
| | The dimension g shall also ensure that the proper adjustment of the steering system can be achieved. | compiled | p |

| | | | |
|---|---|---|---|
| | For aluminium and composite fork steerer any internal device that couthe fork steerer shall be avoided.ld damage the internal surface of the fork steerer shall be avoided. | compiled | p |
| 4.3.6.5 | Steering stability | | |
| | The steering shall be free to turn through at least 60 ° either side of the straight-ahead position and shall exhibit no tight spots, stiffness or slackness in the bearings when correctly adjusted. | compiled | p |
| | A minimum of 25 % of the total mass of EPAC and rider shall act on the front wheel when the rider is holding the handlebar grips and sitting on the saddle, with the saddle and rider in their most rearwa positions | compiled | p |
| 4.3.6.6 | Steering assembly – Static strength and safety tests | | |
| 4.3.6.6.1 | Handlebar and stem assembly – Lateral bending test | | |
| | there shall be no cracking or fracture of the handlebar, stem or clamp-bolt and the permanent deformation measured at the point of application of the test force shall not exceed 15 mm. | Compiled no cracking or fracture | p |
| 4.3.6.6.2 | Handlebar-stem – Forward bending test | | |
| | there shall be no visible cracks or fractures and the permanent deformation measured at the point of application of the test force and in the direction of the test force shall not exceed 10 mm | compiled | p |
| 4.3.6.6.3 | Handlebar to handlebar-stem – Torsional safety test | | |
| | there shall be no movement of the handlebar relative to the handlebar-stem. | compiled | p |
| 4.3.6.6.4 | Handlebar-stem to fork steerer – Torsional safety test | | |
| | there shall be no movement of the handlebar-stem relative to the fork steerer. | compiled | p |
| 4.3.6.6.5 | Bar-end to handlebar – Torsional safety test | | |
| | there shall be no movement of the bar-end in relation to the handlebar | Compiled | p |
| 4.3.6.7 | Handlebar and stem assembly – Fatigue test | | |
| | there shall be no visible cracks or fractures in any part of the handlebar and stem assembly or any bolt failure | Compiled | p |
| | For composite handlebars or stems, the running displacements (peak-to-peak value) at the points where the test forces are applied shall not increase by more than 20 % of the initial values. | Compiled | p |
| 4.3.7 | Frames | | |
| 4.3.7.1 | Suspension-frames | | |
| 4.3.7.2 | Frame – Impact test Requirements | | |

| | | | |
|---|---|---|---|
| | The permanent deformation measured between the axes of the wheel axles shall not exceed the following values: | | |
| | a) 30 mm where a fork is fitted;. | compiled | p |
| | b) where a dummy fork is fitted in place of a fork, the values are given in Table 9 | Compiled | p |
| 4.3.7.3 | Frame and front fork assembly – Impact test (falling frame) | | |
| | there shall be no visible cracks or fractures in the assembly and after the second impact there shall be no separation of any parts of any suspension system. The permanent deformation measured between the axes of the wheel axles shall not exceed the values specified permanent deformation 60 mm | compiled | p |
| 4.3.7.4 | Frame – Fatigue test with pedalling forces | | |
| | there shall be no visible cracks or fractures in any part of the frame, and there shall be no separation of any parts of the suspension system. For composite frames, the running displacements (peak-to-peak values) at the points where the test forces are applied shall not increase by more than 20 % of the initial values | compiled | p |
| 4.3.7.5 | Frame – Fatigue test with horizontal forces | | |
| | there shall be no visible cracks or fractures in the frame and there shall be no separation of any parts of any suspension system. For composite frames, the running displacement (peak-to-peak value) at the point where the test forces are applied shall not increase by more than 20 % of the initial values | compiled | p |
| 4.3.7.6 | Frame – Fatigue test with a vertical force | | |
| | there shall be no visible cracks or fractures in the frame and there shall be no separation of any parts of the suspension system. For composite frames, the running displacement (peak-to-peak value) at the point where the test forces are applied shall not increase by more than 20 % of the initial value | compiled | p |
| 4.3.8 | Front fork | | |
| | Means of location of the axle and wheel retention | | |
| | The slots or other means of location for the wheel-axle within the front fork shall be such that when the axle or cones are firmly abutting the top face of the slots, the front wheel remains central within the fork. | compiled | p |
| 4.3.8.3.2 | Tensile test Requirement | | |
| | there shall be no detachment or loosening of any parts of the assembly and the tubular, telescopic components of any fork-leg shall not separate under the test force. | compiled | p |
| 4.3.8.4 | Front fork – Static bending test | | |

| | | | |
|---|---|---|---|
| | there shall be no fractures or visible cracks in any part of the fork, and the permanent deformation, measured as the displacement of the axis of the wheel-axle or simulated axle in relation to the axis of the fork steerer, shall not exceed 10 mm. | compiled | p |
| 4.3.8.5 | Front fork – Rearward impact test | | |
| 4.3.8.5.1 | Forks made entirely of metal | | |
| 4.3.8.5.1.1 | Crown/steerer joint assembled by welding or brazing | | |
| | there shall be no fractures or visible cracks in any part of the fork, and the permanent deformation, measured as the displacement of the axis of the wheel-axle or simulated axle in relation to the axis of the fork steerer, shall not exceed 45 mm. | compiled | p |
| 4.3.8.5.2 | Forks which have composite parts | | |
| | there shall be no fractures in any part of a fork and the permanent deformation, measured as the displacement of the axis of the wheel-axle or simulated axle in relation to the axis of the fork steerer, shall not exceed 45 mm. After which, it shall exhibit no fractures, then it shall be subjected to a second test Torque on fork, irrespective of the amount of permanent deformation, there shall be no relative movement between the steerer and the crown. | compiled | p |
| 4.3.8.6 | Front fork – Bending fatigue test plus rearward impact test | | |
| | there shall be no fractures in any part of the fork, and the permanent deformation, measured as the displacement of the axis of the wheel-axle or simulated axle in relation to the axis of the fork steerer, shall not exceed 45 mm. For composite forks, the running displacement (peak-to-peak value) at the points where the test forces are applied shall not increase by more than 20 % of the initial values | compiled | p |
| 4.3.8.7 | Forks intended for use with hub- or disc-brakes | | |
| 4.3.9 | Wheels/tyre assembly – Concentricity tolerance and lateral tolerance | | |
| | the run-out shall not exceed the values | compiled | P |
| | Intended for rim-brakes (1)<br>Not intended for rim-brakes （2） | compiled | P |
| 4.3.9.2 | Wheel/tyre assembly – Clearance | | |
| | Alignment of the wheel assembly in EPAC shall allow not less than the clearance values given in between the tyre and any frame or fork element or a front mudguard and its attachment bolts. | compiled | P |
| 4.3.9.3 | Wheel/tyre assembly – Static strength test Requirement | | |

| | | | |
|---|---|---|---|
| | When a fully assembled wheel fitted with a tyre inflated to the maximum inflation pressure is tested by the method described in 4.3.9.3.2, there shall be no failure of any of the components of the wheel, and the permanent deformation, measured at the point of application of the force on the rim, shall not exceed the values which are given in Table 24 | Compiled | p |
| 4.3.9.4 | Wheels – Wheel retention | | |
| 4.3.9.4.2 | Wheel retention – Retention devices secured Requirement | | |
| | there shall be no relative motion between the axle and the front fork/frame. | compiled | p |
| 4.3.9.4.3 | Front wheel retention – Retention devices unsecured | | |
| | EPAC shall be equipped with secondary retention system that retains the front wheel in the dropouts when the primary retention system is in the open (unlocked) position and wheel off the ground. | compiled | p |
| 4.3.9.5 | Wheels – Quick-release devices – Operating features | | |
| | a) it shall be adjustable to allow setting for tightness; | compiled | p |
| | b) its form and marking shall clearly indicate whether the device is in the open or locked position; | compiled | p |
| | c) if adjustable by a lever, the force required to close a properly set lever shall not exceed 200 N and, at this closing force there shall be no permanent deformation of the quick-release device; | compiled | p |
| | d) the releasing force of the clamping device when closed shall not be less than 50 N; | compiled | p |
| | e) if operated by a lever, the quick-release device shall withstand without fracture or permanent deformation a closing force of not less than 250 N applied with the adjustment set to prevent closure at this force; | compiled | p |
| | f) the wheel retention with the quick-release device in the clamped position shall be in accordance with 4.3.9.4.2, 4.3.9.4.3; | compiled | p |
| | g) the front wheel retention with the quick-release device in the open position shall be in accordance with 4.3.9.4.3. If applied to a lever, the forces specified in c), d), and e) shall be applied 5 mm from the tip end of the lever. | compiled | p |
| 4.3.10 | Rims, tyres and tubes | | |
| 4.3.10.2 | Tyre inflation pressure | | |

| | | | |
|---|---|---|---|
| | Tyres that comply with the requirements of ISO 5775-1 and rims that comply with the requirements of ISO 5775-2 are compatible. The tyre, tube and tape shall be compatible with the rim design. When inflated to 110 % of the maximum inflation pressure, determined by the lower value between maximum inflation pressures recommended on the rim or the tyre, for a period of not less than 5 min, the tyre shall remain intact on the rim. | compiled | p |
| 4.3.10.4 | Rim-wear | | |
| | In the case where the rim forms part of a braking system and there is a danger of failure due to wear, the manufacturer shall make the rider aware of this danger by durable and legible marking on the rim, in an area not obscured by the tyre, | compiled | p |
| 4.3.10.5 | Greenhouse effect test for composite wheels | | |
| | This requirement is to ensure wheels made from composite materials that are subjected to high temperature conditions (i.e. such as car storage in direct sunlight) do not suffer concealed damage that could subsequently affect the safety performance of the wheel during normal use. | compiled | p |
| 4.3.11 | Front mudguard Requirements | | |
| | If front mudguard is fitted, when tested by the method described in the two-stage tests in 4.3.11.2 (for mudguard with stays) or 4.3.11.3 (for mudguard without stays), the front mudguard shall not prevent rotation of the wheel or obstruct steering. | compiled | p |
| 4.3.12 | Pedals and pedal/crank drive system | | |
| 4.3.12.1.1 | Tread surface | | |
| | The tread surface of a pedal shall be secured against movement within the pedal assembly. | compiled | p |
| 4.3.12.1.2 | Toe Clips | | |
| | Pedals intended to be used without toe-clips, or for optional use with toe-clips, shall have: a) tread surfaces on the top and bottom surfaces of the pedal; or | compiled | p |
| | b) a definite preferred position that automatically presents the tread surface to the rider's foot. Pedals designed to be used only with toe-clips or shoe-retention devices shall have toe-clips or shoe-retention devices securely attached and need not comply with the requirements of 4.3.12.1.2 a) and b). | compiled | p |
| 4.3.12.2 | Pedal clearance | | |
| 4.3.12.2.1 | Ground clearance | | |

| | | | |
|---|---|---|---|
| | With EPAC un-laden, the pedal at its lowest point and the tread surface of the pedal parallel to the ground and uppermost where it has only one tread surface, EPAC shall be capable of being leaned over at an angle of θ from the vertical before any part of the pedal touches the ground. The values are given in Table 26 | Compiled | p |
| | When EPAC is equipped with a suspension system, this measurement shall be taken with the suspension adjusted to the softest condition and with EPAC depressed into a position such as would be caused by a rider weighing 90 kg | Compiled | p |
| 4.3.12.2.2 | Toe clearance | | |
| | EPACs shall have at least C clearance between the pedal and front tyre or mudguard (when turned to any position). The clearance shall be measured forward and parallel to the longitudinal axis of EPAC from the centre of either pedal-axle to the arc swept by the tyre or mudguard, whichever results in the least clearance (see Figure 37). The values are given in Table 27. | compiled | p |
| 4.3.12.3 | Pedal – Static strength test | | |
| | there shall be no fractures, visible cracks, or distortion of the pedal or spindle that could affect the operation of the pedal and pedal-spindle. | compiled | p |
| 4.3.12.4 | Pedal – Impact test Requirement | | |
| | there shall be no fractures of any part of the pedal body, the pedal-spindle or any failure of the bearing system. | compiled | p |
| 4.3.12.5 | Pedal – Dynamic durability test Requirement | | |
| | there shall be no fractures or visible cracking of any part of the pedal, the pedal-spindle nor any failure of the bearing system | compiled | p |
| 4.3.12.6 | Drive-system – Static strength test | | |
| | a) Drive-system with chain When tested by the method described in 4.3.12.6.2, there shall be no fracture of any component of the drive system, and drive capability shall not be lost. | compield | p |
| | b) Drive-system with belt When tested by the method described in 4.3.12.6.3, there shall be no fracture of any component of the drive system, and the belt shall not slip/skip, fracture or cause any loss in drive capability. Smooth sliding between pulleys and belt is allowed at a rate not exceeding 1 ° /s at the drive axis. | compield | p |
| 4.3.12.6.2.2 | Single-speed system | | |
| | With the left-hand crank in the forward position, apply a force, F15, increasing gradually to 1 500 N vertically downwards to the centre of the left-hand pedal. Maintain this force for 1 min. | compiled | p |

| | | | |
|---|---|---|---|
| | Should the system slip or the drive-sprockets tighten such that the crank rotates while under load to a position more than 30 ° below the horizontal, remove the test force, return the crank to the horizontal position or some appropriate position above the horizontal to take account of yield or movement and repeat the test. | compiled | p |
| | On completion of the test on the left-hand crank repeat the test with the right-hand crank in the forward position and with the force applied to the right-hand pedal. | compiled | p |
| 4.3.12.7 | Crank assembly – Fatigue test Requirement | | |
| | there shall be no fractures or visible cracks in the cranks, the bottom-bracket spindle or any of the attachment features, or loosening or detachment of the chain-wheel from the crank. | compiled | p |
| | For composite cranks, the running displacements (peak -to-peak values) of either crank at the point where the test forces are applied shall not increase by more than 20 % of the initial value | compiled | p |
| 4.3.13 | Drive-chain | | |
| | Where a chain-drive is used as a means of transmitting the motive force, the chain shall operate over the front and rear sprockets without binding.<br>The chain shall conform to the tensile strength and push-out force requirements of ISO 9633. | compiled | p |
| 4.3.14 | Chain-wheel and belt-drive protective device | | |
| | EPAC shall be equipped with one of the following; | | |
| | a) a chain wheel disc or drive pulley disk which conforms to 4.3.14.2; or | compiled | p |
| | b) a chain and drive belt protective device which conforms to 4.3.14.3; or | compiled | p |
| | c) where fitted with positive foot-retention devices on the pedals, a combined front gear-change guide which conforms to 4.3.14.4 shall be used. | compiled | p |
| 4.3.14.2 | Chain-wheel disc and drive pulley disc diameter | | |
| | A chain-wheel disc shall exceed the diameter of the outer chain-wheel, when measured across the tips of the teeth by not less than 10 mm (see Figure 44). | compiled | p |
| | A drive pulley disc shall exceed the diameter of the front pulley, when measured across the tips of the teeth by not less than 10 mm (see Figure 45). Where the design is such that the pedal-crank and chain-wheel are too close together to accommodate a full disc, a partial disc may be fitted which closely abuts the pedal-crank. | compiled | p |
| 4.3.14.3 | Chain and drive belt protective device | | |

| | | | |
|---|---|---|---|
| | A chain protective device shall, as a minimum, shield the side-plates and top surface of the chain and the chain-wheel for a distance of at least 25 mm rearwards along the chain from the point where the chain-wheel teeth first pass between the side-plates of the chain and forwards round the outer chain-wheel to a horizontal line passing through the bottom-bracket axle centre (see Figure 46 a)). | compiled | p |
| | A drive belt protective device shall, as a minimum, shield the side and top surface of the drive belt and the front pulley for a distance of at least 25 mm rearwards along the drive belt from the point where the tip circle of the pulley is intersected by the tip line of the belt (line C in Figure 46 b)) and forwards round the front pulley to a horizontal line passing through the bottom-bracket axle centre (see Figure 46 b)) | compiled | p |
| 4.3.14.4 | Combined front gear-change guide | | |
| | When the chain is located in the outer gear position, some portion of the combined front gear change guide shall be above the chain in the region 25 mm from the point where the chain wheel first passes between the side plates of the chain, parallel to the chain side plates in the direction towards the rear wheel of the bicycle (see Figure 47). | compiled | p |
| | In addition some portion of the combined front gear change guide shall be present below the chain in the region beyond 25 mm from the point where the chain wheel first passes between the side plates of the chain, parallel to the chain side plates in the direction towards the rear wheel of the bicycle (see Figure 47). | compiled | p |
| | It is recommended that the gap between front-gear and front gear-change guide specified by the manufacturer is properly set. | compiled | p |
| 4.3.15 | Saddles and seat-posts | | |
| 4.3.15.1 | Limiting dimensions | | |
| | No part of the saddle, saddle supports, or accessories to the saddle shall be more than 125 mm above the top saddle surface at the point where the saddle surface is intersected by the seat-post axis | compiled | p |
| 4.3.15.2 | Seat-post – Insertion-depth mark or positive stop | | |

| | | | |
|---|---|---|---|
| | a) it shall contain a permanent, transverse mark of length not less than the external diameter or the major dimension of the cross-section of the seat-post that clearly indicates the minimum insertion-depth of the seat-post into the frame. For a circular cross-section, the mark shall be located not less than two diameters of the seat-post from the bottom of the seat-post (i.e. where the diameter is the external diameter). For a non-circular cross-section, the insertion-depth mark shall be located not less than 65 mm from the bottom of the seat-post (i.e. where seat-post has its full cross-section); | Compiled | p |
| | b) it shall incorporate a permanent stop to prevent it from being drawn out of the frame such as to leave the insertion less than the amount specified in a) above. | Compiled | p |
| 4.3.15.3 | Saddle/seat-post – Safety test | | |
| | If a suspension seat-post is involved, the test may be conducted with the suspension-system either free to operate or locked. If it is locked, the pillar shall be at its maximum length | Compiled | p |
| 4.3.15.3.2 | Saddles with adjustment-clamps | | |
| | When tested by the method described in 4.3.15.3.4, there shall be no movement of the saddle adjustment clamp in any direction with respect to the seat-post, or of the seat-post with respect to the frame, nor any failure of saddle, adjustment clamp or seat-post. If the saddle design is such that it cannot accurately test the saddle/seat-post clamp, it shall be possible to use a fixture which is representative of the saddle dimensions. | Compiled | p |
| 4.3.15.3.3 | Saddles without adjustment-clamps | | |
| 4.3.15.4 | Saddle – Static strength test | | |
| | the saddle cover and/or plastic moulding shall not disengage from the chassis of the saddle, and there shall be no cracking or permanent distortion of the saddle assembly | Compiled | p |
| 4.3.15.5 | Saddle and seat-post clamp – Fatigue test | | |
| | Seat-posts can influence test failures of saddles: for this reason, a saddle shall be tested in combination with a seat-post as recommended by the saddle manufacturer. | Compiled | p |
| 4.3.15.6 | Seat-post – Fatigue test | | |
| | In the following test, if a suspension seat-post is involved, the test shall be conducted with the suspension system adjusted to give maximum resistance. | | |
| 4.3.15.6.2.1 | Seat-post without suspension system | | |
| 4.3.15.6.2.2 | Seat-post with suspension system | | |

| | | | |
|---|---|---|---|
| | When tested by the method described in 4.3.15.6.3, there shall be no visible cracks or fractures in the seat-post, nor any bolt failure. The design shall be such that in the event of failure of the suspension system, the two main parts do not separate nor does the upper part (i.e. the part to which the saddle would be attached) become free to swivel in the lower part. | Compiled | p |
| 4.3.16 | Spoke protector | | |
| | EPAC bicycles with multiple free-wheel/cassette sprockets shall be fitted with a spoke-protector guard to prevent the chain interfering with or stopping rotation of the wheel through improper adjustment or damage | Compiled | p |
| 4.3.17 | Luggage carriers | | |
| | If luggage carriers are fitted or provided they shall comply with EN ISO 11243. | Compiled | p |
| 4.3.18 | Road-test of a fully-assembled EPAC | | |
| | The EPAC shall with or without assistance exhibit stable handling in braking, turning and steering, and it shall be possible to ride with one hand removed from the handlebar (as when giving hand signals), without difficulty of operation or hazard to the rider. | Compiled | p |
| 4.3.19 | Lighting systems and reflectors | | |
| | EPAC shall be equipped with reflectors at the front, rear and side. EPAC shall be equipped with lighting systems and reflectors in conformity with the national regulations in the country in which EPAC is marketed, because national regulations for lighting systems and reflectors differ from country to country | Compiled | p |
| 4.3.19.2 | Wiring harness | | |
| | When a wiring harness is fitted, it shall be positioned to avoid any damage by contact with moving parts or sharp edges. All connections shall withstand a tensile force in any direction of 10 N. | Compiled | p |
| 4.3.19.3 | Lighting systems | | |
| | The lighting system consists of a front and a rear light. These devices shall comply with the provisions in force in the country in which the product is marketed. If there are no forced provisions of these devices, the lighting system shall comply with the requirements of ISO 6742-1. | Compiled | p |
| 4.3.19.4 | Reflectors | | |
| | These devices shall comply with the provisions in force in the country in which the product is marketed. If there are no forced provisions of these devices, the retro-reflective devices shall comply with the requirements of ISO 6742-2. | Compiled | p |

| | | | |
|---|---|---|---|
| 4.3.19.4.2 | Rear reflectors | | |
| | Rear reflectors shall be red in colour. | Compiled | p |
| 4.3.19.4.3 | Side reflectors | | |
| | The retro reflective device(s) shall be either | | |
| | a reflectors fitted on the front half and on the rear half of EPAC. At least one of these shall be mounted on the spokes of the wheel. Where EPAC incorporates features at the rear wheel other than the frame and mudguard stays, the moving reflector shall be mounted on the front wheel; or | Compiled | p |
| | b) a continuous circle of reflective material applied to both sides of each wheel within 10cm of the outer diameter of the tyre. | Compiled | p |
| | All side reflectors shall be of the same colour, either white (clear) or yellow. | Compiled | p |
| 4.3.19.4.4 | Front reflectors | | |
| | Front reflectors shall be white (clear) in colour. | Compiled | p |
| 4.3.19.4.5 | Pedal reflectors | | |
| | Each pedal shall have reflectors, located on the front and rear surfaces of the pedal. The reflector elements shall be either integral with the construction of the pedal or mechanically attached, but shall be recessed from the edge of the pedal, or of the reflector housing, to prevent contact of the reflector element with a flat edge placed in contact with the edge of the pedal. | Compiled | p |
| 4.3.20 | Warning device | | |
| | Where a bell or other suitable device is fitted, it shall comply with the provisions in force in the country in which the product is marketed. | Compiled | p |
| 4.3.21 | Thermal hazards | | |
| | A warning shall be placed on the surface if the temperature of the hot accessible surface could be above 60 ° C (see EN ISO 7010:2012, symbol W017). Brake systems are excluded from this requirement. | Compiled | p |
| 4.3.22 | Performance levels (PLrs) for control system of EPACs | | |
| | The safety related parts of the control systems of the EPAC shall comply with the required performance level (PLr) given in Table 34 in accordance with EN ISO 13849-1. | Compiled | p |
| | Should risk assessment indicate that additional or different PLr are required for a particular application, these should be determined in accordance with EN ISO 13849 (all parts). Such PLr will be outside the scope of this standard. | Compiled | p |

| | | | |
|---|---|---|---|
| | The manufacturer of the EPAC shall record the process adopted for verification of compliance with PLr for each relevant safety function. | Compiled | p |
| 4.4 | List of significant hazards | | |
| | a) Mechanical hazards: high deceleration, high acceleration, Protrusion, instability; kinetic energy; rotating elements and moving elements, rough, slippery surface, sharp edges; | Compiled | p |
| | b) Electrical hazards: electromagnetic phenomena; electrostatic phenomena; overload; short-circuit; thermal radiation; | Compiled | p |
| | c) Thermal hazards: explosion; flame; radiation from heat sources; | Compiled | p |
| | d) Ergonomic hazards: effort; lighting; posture; | Compiled | p |
| | e) Hazards associated with the environment in which the machine is used: water (rain and projection); | Compiled | p |
| | f) Combination of hazards: braking under wet and dry condition, handgrips, motor management system, engine power management, installed braking power. | Compiled | p |
| 5 | Marking, labelling | | |
| | The EPAC shall be marked visibly, legibly and indelibly with the following minimum particulars: | Compiled | p |
| | contact and address of the manufacturer or authorized representative; | Compiled | p |
| | EPAC according to EN 15194; | Compiled | p |
| | appropriate marking required by legislation (CE); | Compiled | p |
| | year of construction, that is the year in which the manufacturing was completed (it is not possible to use a code) | Compiled | p |
| | — cut off speed XX km/h; | Compiled | p |
| | maximum continuous rated power XX kW; | Compiled | p |
| | designation of series or type; | Compiled | p |
| | individual serial number if any; | Compiled | p |
| | mass if EPAC mass is more than 25 kg; | Compiled | p |
| | mass of the EPAC in the most usual configuration. | Compiled | p |
| | The frame shall be | | |
| | a) visibly and permanently marked with a successive frame number at a readily visible location such as near the pedal-crank, the seat-post, or the handlebar; | Compiled | p |

| | | | |
|---|---|---|---|
| | b) visibly and durably marked, with the name of the manufacturer of complete EPAC or the manufacturer's representative and the number of this document, i.e. EN 15194.; the method of testing for durability is specified in 5.2. | Compiled | p |
| | Where appropriate, if EPAC is equipped with a coupling device for a trailer the following values shall be given: | Compiled | p |
| | c) total weight of the trailer; | Compiled | p |
| | d) vertical load on the coupling system. | Compiled | p |
| | For components, currently there are no specific requirements, but it is recommended that the following safety critical components be clearly and permanently marked with traceable identification, such as a manufacturer's name and a part number: | Compiled | p |
| | e) front fork; | Compiled | p |
| | f) handlebar and handlebar-stem; | Compiled | p |
| | g) seat-post; | Compiled | p |
| | h) brake-levers, brake blocks and/or brake-block holders; | Compiled | p |
| | i) outer brake-cable casing; | Compiled | p |
| | j) hydraulic-brake tubing; | Compiled | p |
| | k) disc-brake callipers, brake-discs, and brake pads; | Compiled | p |
| | l) chain; | Compiled | p |
| | m) pedals and cranks; | Compiled | p |
| | n) bottom-bracket spindle; | Compiled | p |
| | o) wheel-rims. | Compiled | p |
| 5.2 | Durability test | | |
| | Rub the marking by hand for 15 s with a piece of cloth soaked in water and again for 15 s with a piece of cloth soaked in petroleum spirit. It shall not be easily possible to remove any label nor shall any label show any sign of curling. | Compiled | p |
| 6 | Instruction for use | | |

| | | | |
|---|---|---|---|
| | Each EPAC shall be provided with a set of instructions in the language of the country to which EPAC will be supplied. Different countries may have local requirements regarding this type of information (see EN 82079-1). Instructions for use shall be delivered obligatory in paper form. For more detailed information and enabling an access for vulnerable people instructions for use should be available additionally in electronic form on demand. Instructions for use shall contain the following information on: | | |
| | a) Concept and description of electric assistance including varying levels of motor assistance; | Compiled | p |
| | b) Recommendation for cleaning and the use of high pressure cleaners; | Compiled | p |
| | c) Control and tell tales; | Compiled | p |
| | d) Specific EPAC recommendation for use (e.g. removal of the battery, temperature range for the use of the bicycle including battery, use of start-up assistance mode); | Compiled | p |
| | e) Specific EPAC warnings (e.g. always remove the battery during maintenance, inappropriate use including manipulation of the electric management system); | Compiled | p |
| | f) Recommendations about battery charging and charger use (e.g. temperature range for the battery storage, indoor or outdoor charging) as well as the importance of following the instruction contained on the label of the battery charger; | Compiled | p |
| | g) The meaning of symbol and tell tales used shall be explained in the instruction for use. Warning about contact with hot surfaces as for example disc brakes after heavy use; | Compiled | p |
| | h) The type of use for which EPAC has been designed (i.e. the type of terrain for which it is suitable) with a warning about the hazards of incorrect use; | Compiled | p |
| | i) Preparation for riding - how to measure and adjust the saddle height to suit the rider with an explanation of the insertion-depth warning marks on the seat-post and handlebar-stem. Clear information on which lever operates the front brake, which lever operates the rear brake, the presence of any brake-power modulators with an explanation of their function and adjustment, and the correct method of using a back-pedal brake if fitted; | Compiled | p |
| | j) Indication of minimum saddle height and the way to measure it; | Compiled | p |
| | k) The recommended method for adjusting any adjustable suspension system fitted; | Compiled | p |

| | | | |
|---|---|---|---|
| | l) Recommendations for safe riding, the use of a bicycle helmet, regular checks on brakes, tyre pressure, steering, rims and caution concerning possible increased braking distances in wet weather; | Compiled | p |
| | m) The safe use and adjustment of foot-securing devices if fitted (i.e. quick-release pedals and toe-clips); | Compiled | p |
| | n) The permissible total payload (rider plus luggage) and the empty weight of the EPAC; | Compiled | p |
| | o) Recommendation about usage for bicycle trailer or trailer bicycle if allowed by EPAC manufacturer; | Compiled | p |
| | p) An advisory note to draw attention to the rider concerning possible national legal requirements when EPAC is to be ridden on public roads (e.g. lighting and reflectors); | Compiled | p |
| | q) Recommended tightening of fasteners related to the handlebar, handlebar-stem, saddle, seat-post, wheels, and aerodynamic extension if fitted with torque values for threaded fasteners; | Compiled | p |
| | r) The method for determining the correct adjustment of quick-release devices, such as “the mechanism should emboss the fork-ends when closed to the locked position”; | Compiled | p |
| | s) The correct method of assembling any parts supplied unassembled; | Compiled | p |
| | t) Lubrication - where and how often to lubricate, and the recommended lubricants; | Compiled | p |
| | u) The correct chain tension and how to adjust it (if appropriate); | Compiled | p |
| | v) Adjustments of gears and their operation (if appropriate); | Compiled | p |
| | w) Adjustment of brakes and recommendations for the replacement of the friction components; | Compiled | p |
| | x) Recommendations on general maintenance; | Compiled | p |
| | y) The importance of using only genuine replacement parts for safety-critical components; | Compiled | p |
| | z) Care of the wheel-rims and a clear explanation of any danger of rim-wear (see also 4.3.10.4 and 5.1) | Compiled | p |
| | For composite rims wear damage may be invisible to the user, the manufacturer shall explain the consequences of rim wear and how the cyclist can assess the degree of wear or should recommend returning the composite rim to the manufacturer for inspection. | Compiled | p |
| | aa) The correct gluing technique for wheels equipped with tubular tyres if fitted; | Compiled | p |
| | bb) Appropriate spares, i.e. tyres, tubes, and brake friction-components; | Compiled | p |

| | | | |
|---|---|---|---|
| | cc) Accessories - where these are offered as fitted, details should be included such as operation, maintenance required (if any) and any relevant spares (e.g. light bulbs); | Compiled | p |
| | dd) An advisory note to draw attention of the rider to possible damage due to intensive use and to recommend periodic inspections of the frame, fork, suspensions joints (if any), and composite components (if any). The wording of the advice may be as follows; | Compiled | p |
| | ee) For composite components, an advisory note to draw attention to the influence of high temperature (heat radiations) in confined environment on composite materials (if appropriate); | Compiled | p |
| | ff) importance of possible suitably covering any coil springs under the saddle if a child-seat is fitted to prevent trapping of fingers; | Compiled | p |
| | gg) The handlebar, the rider's response to steering and braking can be adversely affected; | Compiled | p |
| | hh) The maximum inflation pressure for a conventional or tubular tyre, according to the lowest value between maximum inflation pressure recommended on the rim or the tyre | Compiled | p |
| | ii) Recommendation on the installation of bicycle carriers as well as child seats (max. load, mounting,) It is permitted to include any other relevant information at the discretion of the manufacturer. | Compiled | p |
| | kk) Recommendations and users responsibility in case of tampering; | Compiled | p |
| | ll) The following statement: The A-weighted emission sound pressure level at the driver ears is less than 70 dB(A). | Compiled | p |
| | | | |
| | | | |

# *EN ISO 13849 TEST REPORT*

| | | | |
|---|---|---|---|
| 4 | Design considerations | | |
| 4.1 | Safety objectives in design | | |
| | The SRP/CS shall be designed and constructed so that the principles of ISO 12100 are fully taken into account (see Figures 1 and 3). All intended use and reasonable foreseeable misuse shall be considered. | Compiled | p |
| 4.2 | Strategy for risk reduction | | |
| | The strategy for risk reduction at the machine is given in ISO 12100:2010, 6.1, and further guidance is given in ISO 12100:2010, 6.2 (inherent design measures) and 6.3 (safeguarding and complementary protective measures). This strategy covers the whole life cycle of the machine. | Compiled | p |
| | The hazard analysis and risk reduction process for a machine requires that hazards are eliminated or reduced through a hierarchy of measures:— | Compiled | p |
| | hazard elimination or risk reduction by design (see ISO 12100:2010, 6.2); | Compiled | p |
| | — risk reduction by safeguarding and possibly complementary protective measures (see ISO 12100:2010, 6.3); | Compiled | p |
| | — risk reduction by the provision of information for use about the residual risk (see ISO 12100:2010, 6.4). | Compiled | p |
| 4.2.2 | Contribution to the risk reduction by the control system | | |
| | The purpose in following the overall design procedure for the machine is to achieve the safety objectives (see 4.1). The design of the SRP/CS to provide the required risk reduction is an integral subset of the overall design procedure for the machine. The SRP/CS provides safety function(s) at a PL which achieves the required risk reduction. In providing safety function(s), either as an inherently safe part of the design or as a control for an interlocking guard or protective device, the design of the SRP/CS is a part of the strategy for risk reduction. This is an iterative process and is illustrated in Figures 1 and 3. | Compiled | p |
| | In this part of ISO 13849 the performance levels are defined in terms of probability of dangerous failure per hour. Five performance levels are set out, from the lowest PL a to the highest PL e with defined ranges of probability of a dangerous failure per hour | Compiled | p |

| | | | |
|---|---|---|---|
| | From the risk assessment (see ISO 12100) at the machine, the designer shall decide the contribution to the reduction of risk which needs to be provided by each relevant safety function which is carried out by the SRP/CS(s). This contribution does not cover the overall risk of the machinery under control, e.g. not the overall risk of a mechanical press, or washing machine is considered, but that part of risk reduced by the application of particular safety functions. Examples of such functions are the stopping function initiated by using an electro-sensitive protective device on a press or the door-locking function of a washing machine. | Compiled | p |
| 4.3 | Determination of required performance level (PLr) | | |
| | For each selected safety function to be carried out by a SRP/CS, a required performance level (PLr) shall be determined and documented (see Annex A for guidance on determining PLr). The determination of the required performance level is the result of the risk assessment and refer to the amount of the risk reduction to be carried out by the safety-related parts of the control system | Compiled | p |
| 4.4 | Design of SRP/CS | | |
| | Part of the risk reduction process is to determine the safety functions of the machine. This will include the safety functions of the control system, e.g. prevention of unexpected start-up. | Compiled | p |
| | A safety function may be implemented by one or more SRP/CS, and several safety functions may share one or more SRP/CS [e.g. a logic unit, power control element(s)]. It is also possible that one SRP/CS implements safety functions and standard control functions. The designer may use any of the technologies available, singly or in combination. SRP/CS may also provide an operational function (e.g. an AOPD as a means of cycle initiation). | Compiled | p |
| | A typical safety function diagrammatic presentation is given in Figure 4 showing a combination of safety-related parts of control systems (SRP/CS) for<br>— input (SRP/CSa),<br>— logic/processing (SRP/CSb),<br>— output/power control elements (SRP/CSc),<br>— interconnecting means (iab, ibc) (e.g. electrical, optical). | Compiled | p |
| 4.5 | Evaluation of the achieved performance level PL and relationship with SIL | | |
| 4.5.1 | Performance level PL | | |

| | | | |
|---|---|---|---|
| | For the purposes of this part of ISO 13849, the ability of safety-related parts to perform a safety function is expressed through the determination of the performance level. | Compiled | p |
| | For each selected SRP/CS and/or for the combination of SRP/CS that performs a safety function the estimation of PL shall be done. | Compiled | p |
| | The PL of the SRP/CS shall be determined by the estimation of the following aspects: | | |
| | — the MTTFD value for single components (see Annex C and Annex D);<br>— the DC (see Annex E);<br>— the CCF (see Annex F);<br>— the structure (see Clause 6);<br>— the behaviour of the safety function under fault condition(s) (see Clause 6);<br>— safety-related software (see 4.6 and Annex J);<br>— systematic failure (see Annex G);<br>— the ability to perform a safety function under expected environmental conditions. | Compiled | p |
| | These aspects can be grouped under two approaches in relation to the evaluation process: | | |
| | a) quantifiable aspects (MTTFD value for single components, DC, CCF, structure); | Compiled | p |
| | b) non-quantifiable, qualitative aspects which affect the behaviour of the SRP/CS (behaviour of the safety function under fault conditions, safety-related software, systematic failure and environmental conditions). | Compiled | p |
| | Among the quantifiable aspects, the contribution of reliability (e.g. MTTFD, structure) can vary with the technology used. For example, it is possible (within certain limits) for a single channel of safety-related parts of high reliability in one technology to provide the same or higher PL as a fault-tolerant structure of lower reliability in another technology. | Compiled | p |
| | To make the assessment of the quantifiable aspects of the PL easier, this part of ISO 13849 provides a simplified method based on the definition of five designated architectures that fulfil specific design criteria and behaviour under a fault condition (see 4.5.4). | Compiled | p |
| | For a SRP/CS or combination of SRP/CS designed according to the requirements given in Clause 6, the average probability of a dangerous failure could be estimated by means of Figure 5 and the procedure given in Annexes A to H, J and K. | Compiled | p |
| | For a SRP/CS which deviates from the designated architectures, a detailed calculation shall be provided to demonstrate the achievement of the required performance level (PLr). | Compiled | p |

| | | | |
|---|---|---|---|
| 4.5.2 | Mean time to dangerous failure of each channel (MTTFD) | | |
| | The value of the MTTFD of each channel is given in three levels (see Table 4) and shall be taken into account for each channel (e.g. single channel, each channel of a redundant system) individually.For each SRP/CS (subsystem) according to Table 5, the maximum value of MTTFD for each channel is 100 years. For Category 4 SRP/CS (subsystems) the maximum value of MTTFD for each channel is increased to 2500 years. | Compiled | p |
| 4.5.3 | Diagnostic coverage (DC) | | |
| | The value of the DC is given in four levels (see Table 5).For the estimation of DC, in most cases, failure mode and effects analysis (FMEA, see IEC 60812) or similar methods can be used. In this case, all relevant faults and/or failure modes should be considered. For a simplified approach to estimating DC, see Annex E. | Compiled | p |
| 4.5.4 | Simplified procedure for estimating the quantifiable aspects of PL | | |
| | The PL may be estimated by taking into account all relevant parameters and the appropriate methods for calculation (see 4.5.1). | Compiled | p |
| | This clause describes a simplified procedure for estimating the quantifiable aspects of PL of a SRP/CS based on designated architectures. Some other architectures with similar structure may be transformed to these designated architectures in order to obtain an estimation of the PL. | Compiled | p |
| | The designated architectures are represented as block diagrams, and are listed in the context of each category in 6.2. Information about the block method and the safety-related block diagrams are given in 6.2 and Annex B. | Compiled | p |
| | The designated architectures show a logical representation of the system structure for each category. The technical realization or, for example, the functional circuit diagram, may look completely different. | Compiled | p |
| | The designated architectures are drawn for the combined SRP/CS, starting at the points where the safety-related signals are initiated and ending at the output of the power control elements (see also ISO 12100:2010, Annex A). The designated architectures can also be used to describe a part or subpart of a control system that responds to input signals and generates safety-related output signals. Thus the “input” element can represent, for example, a light curtain (AOPD) as well as input circuits of control logic elements or input switches. “Output” can also represent, for example, an output signal switching device (OSSD) or outputs of laser-scanners. | Compiled | p |

| | | | |
|---|---|---|---|
| | For the designated architectures, the following typical assumptions are made: | | |
| | — mission time, 20 years (see Clause 10);<br>— constant failure rates within the mission time;<br>— for category 2, demand rate ⩽ 1/100 test rate (see also Note in Annex K); or testing occurs immediately upon demand of the safety function and the overall time to detect the fault and to bring the machine to a non-hazardous condition (usually to stop the machine) is shorter than the time to reach the hazard (see also ISO 13855);<br>— for category 2, MTTFD of the testing channel is greater than one half of MTTFD of the functional channel. | Compiled | p |
| | The methodology considers the categories as architectures with defined DCavg. The PL of each SRP/CS depends on the architecture, the mean time to dangerous failure (MTTFD) in each channel and the DCavg Common cause failures (CCF) should also be taken into account (for guidance, see Annex F). | Compiled | p |
| | If quantitative data are not available or not used (e.g. low complexity systems), the worst case of all relevant parameters should be chosen.A combination of SRP/CS or a single SRP/CS may have a PL. The combination of several SRP/CS with different PL is considered in 6.3.In the case of applications with PLr a to c, measures to avoid faults can be sufficient; for higher risk applications, PLr d to e, the structure of the SRP/CS can provide measures for avoiding, detecting or tolerating faults. Practical measures include redundancy, diversity, monitoring (see also ISO 12100:2010, Clause 3 and IEC 60204-1:2005). | Compiled | p |
| | Figure 5 shows the procedure for the selection of categories in combination with the MTTFD of each channel and DCavg to achieve the required PL of the safety function.<br>For the estimation of the PL, Figure 5 gives the different possible combinations of category with DCavg (horizontal axis) and the MTTFD of each channel (bars). The bars in the diagram represent the three MTTFD ranges of each channel (low, medium and high) which can be selected to achieve the required PL.<br>Before using this simplified approach with Figure 5 (which represents results of different Markov models based on designated architectures of Clause 6), the category of the SRP/CS as well as DCavg and the MTTFD of each channel shall be determined (see Clause 6 and Annexes C to E). | Compiled | p |

| | | | |
|---|---|---|---|
| | For categories 2, 3 and 4, sufficient measures against common cause failure shall be carried out (for guidance, see Annex F). Taking these parameters into account, Figure 5 provides a graphical method for determining the PL, achieved by the SRP/CS. The combination of category (including common cause failure) and DCavg determines which column of Figure 5 is to be chosen. According to the MTTFD of each channel, one of the three different shaded areas of the relevant column shall be chosen.The vertical position of this area determines the achieved PL which can be read off the vertical axis. If the area covers two or three possible PLs, the PL achieved is given in Table 6. For a more precise numerical selection of PL depending on the precise value of MTTFD of each channel, see Annex K. | Compiled | p |
| 4.5.5 | Description of the output part of the SRP/CS by category | | |
| | If for mechanical, hydraulic or pneumatic components (or components comprising a mixture of technologies) no application – specific reliability data are available, the machine manufacturer may evaluate the quantifiable aspects of the PL without any MTTFD-calculation. | Compiled | p |
| | For such cases, the safety-related performance level (PL) is implemented by the architecture, the diagnostic and the measures against CCF.<br>Table 7 shows the relationship between achievable PL (corresponding to Figure 5) and categories. PL a and<br>PL b can be implemented with Cat. B. PL c can be implemented with Cat. 1 or Cat. 2, if well-tried components and well-tried safety principles are used. | Compiled | p |
| | When implementing an PL c safety function with Cat.1, the T10d values of safety-relevant components that are not monitored in the process, are determined. This T10d values can be determined based on proven in use data by machine manufacturer.The MTTFD of the test channel in Cat. 2 shall at least be 10 years.PL d can be implemented with Cat. 3, if well-tried components and well-tried safety principles are used. | Compiled | p |
| | Basically: In the implementation of the safety function with Cat. 2, Cat. 3 or Cat. 4 common-cause failures (CCF) and a sufficient diagnostic coverage (DC) have to be considered (low, medium for Cat. 2 and 3, high for Cat. 4).In this case the calculation of the DCavg is reduced to the arithmetic mean value of all components individuals DCs in the functional channel. | Compiled | p |
| 4.6 | Software safety requirements | | |

| | | | |
|---|---|---|---|
| | All lifecycle activities of safety-related embedded or application software shall primarily consider the avoidance of faults introduced during the software lifecycle (see Figure 6). The main objective of the following requirements is to have readable, understandable, testable and maintainable software. | Compiled | p |
| 4.6.2 | Safety-related embedded software(SRESW) | | |
| | For SRESW for components with PLr a to d, the following basic measures shall be applied:<br>— software safety lifecycle with verification and validation activities, see Figure 6;<br>— documentation of specification and design;<br>— modular and structured design and coding;<br>— control of systematic failures (see G.2);<br>— where using software-based measures for control of random hardware failures, verification of correct implementation;<br>— functional testing, e.g. black box testing;<br>— appropriate software safety lifecycle activities after modifications. | Compiled | p |
| | For SRESW for components with PLr c or d, the following additional measures shall be applied:<br>— project management and quality management system comparable to, e.g. IEC 61508 or ISO 9001;<br>— documentation of all relevant activities during software safety lifecycle;<br>— configuration management to identify all configuration items and documents related to a SRESW release;<br>— structured specification with safety requirements and design;<br>— use of suitable programming languages and computer-based tools with confidence from use;<br>— modular and structured programming, separation from non-safety-related software, limited module sizes with fully defined interfaces, use of design and coding standards;<br>— coding verification by walk-through/review with control flow analysis;<br>— extended functional testing, e.g. grey box testing, performance testing or simulation;<br>— impact analysis and appropriate software safety lifecycle activities after modifications. | Compiled | p |

| | | | |
|---|---|---|---|
| | SRESW for components with PLr = e shall comply with IEC 61508-3:1998, Clause 7, appropriate for SIL 3. When using diversity in specification, design and coding, for the two channels used in SRP/CS with category 3 or 4, PLr = e can be achieved with the above-mentioned measures for PLr of c or d. | Compiled | p |
| | For components for which SRESW requirements are not fulfilled, e.g. PLCs without safety rating by the manufacturer, these components may be used under the following alternative conditions:<br>— the SRP/CS is limited to PL a or b and uses category B, 2 or 3;<br>— the SRP/CS is limited to PL c or d and may use multiple components for two channels in category 2 or 3. The components of these two channels use diverse technologies. | Compiled | p |
| 4.6.3 | Safety-related application software(SRASW) | | |
| | The software safety lifecycle (see Figure 6) applies also to SRASW (see Annex J).<br>SRASW written in LVL and complying with the following requirements can achieve a PL a to e. If SRASW is written in FVL, the requirements for SRESW shall apply and PL a to e is achievable. If a part of the SRASW within one component has any impact (e.g. due to its modification) on several safety functions with different PL, then the requirements related to the highest PL shall apply. For SRASW for components with PLr from a to e, the following basic measures shall be applied: | Compiled | p |
| | —development lifecycle with verification and validation activities, see Figure 6;<br>— documentation of specification and design;<br>— modular and structured programming;<br>— functional testing;<br>—appropriate development activities after modifications. | Compiled | p |
| | For SRASW for components with PLr from c to e, the following additional measures with increasing efficiency (lower effectiveness for PLr of c, medium effectiveness for PLr of d, higher effectiveness for PLr of e) are required or recommended. | | |

| | | | |
|---|---|---|---|
| | a) The safety-related software specification shall be reviewed (see also Annex J), made available to every person involved in the lifecycle and shall contain the description of:<br>1) safety functions with required PL and associated operating modes,<br>2) performance criteria, e.g. reaction times,<br>3) hardware architecture with external signal interfaces, and<br>4) detection and control of external failure. | Compiled | p |
| | b) Selection of tools, libraries, languages:<br>1) Suitable tools with confidence from use: for PL = e achieved with one component and its tool, the tool shall comply with the appropriate safety standard; if two diverse components with diverse tools are used, confidence from use may be sufficient. Technical features which detect conditions that could cause systematic error (such as data type mismatch, ambiguous dynamic memory allocation, incomplete called interfaces, recursion, pointer arithmetic) shall be used. Checks should mainly be carried out during compile time and not only at runtime. Tools should enforce language subsets and coding guidelines or at least supervise or guide the developer using them.<br>2) Whenever reasonable and practicable, validated function block (FB) libraries should be used — either safety-related FB libraries provided by the tool manufacturer (highly recommended for PL = e) or validated application specific FB libraries and in conformity with this part of ISO 13849.<br>3) A justified LVL-subset suitable for a modular approach should be used, e.g. accepted subset of IEC 61131-3 languages. Graphical languages (e.g. function block diagram, ladder diagram) are highly recommended. | Compiled | p |
| | c) Software design shall feature: | | |
| | 1) semi-formal methods to describe data and control flow, e.g. state diagram or program flow chart,<br>2) modular and structured programming predominantly realized by function blocks deriving from safety-related validated function block libraries,<br>3) function blocks of limited size of coding,<br>4) code execution inside function block which should have one entry and one exit point,<br>5) architecture model of three stages, Inputs ⇒ Processing ⇒ Outputs (see Figure 7 and Annex J<br>,6) assignment of a safety output at only one program location, and<br>7) use of techniques for detection of external failure and for defensive programming within input, processing and output blocks which lead to safe state. | Compiled | p |

| | | | |
|---|---|---|---|
| | c) Where SRASW and non-SRASW are combined in one component:<br>1) SRASW and non-SRASW shall be coded in different function blocks with well-defined data links;<br>2) there shall be no logical combination of non-safety -related and safety-related data which could lead to downgrading of the integrity of safety-related signals, for example, combining safety-related and non-safety-related signals by a logical "OR" where the result controls safety-related signals. | Compiled | p |
| | d) Software implementation/coding:<br>1) code shall be readable, understandable and testable and, because of this symbolic variables (instead of explicit hardware addresses) should be used;<br>2) justified or accepted coding guidelines shall be used (see also Annex J);<br>3) data integrity and plausibility checks (e.g. range checks.) available on application layer (defensive programming) should be used;<br>4) code should be tested by simulation;5) verification should be by control and data flow analysis for PL = d or e. | Compiled | p |
| | e) Testing:<br>1) the appropriate validation method is black-box testing of functional behaviour and performance criteria (e.g. timing performance);<br>2) for PL = d or e, test case execution from boundary value analysis is recommended;<br>3) test planning is recommended and should include test cases with completion criteria and required tools;<br>4) I/O testing shall ensure that safety-related signals are correctly used within SRASW. | Compiled | p |
| | f) Documentation:<br>1) all lifecycle and modification activities shall be documented;<br>2) documentation shall be complete, available, readable and understandable;<br>3) code documentation within source text shall contain module headers with legal entity, functional and I/O description, version and version of used library function blocks, and sufficient comments of networks/statement and declaration lines. | Compiled | p |
| | g) Verification1)<br>Review, inspection, walkthrough or other appropriate activities. | Compiled | p |
| | i) Configuration managementIt is highly recommended that procedures and data backup be established to identify and archive documents, software modules, verification/validation results and tool configuration related to a specific SRASW version. | Compiled | p |

| | | | |
|---|---|---|---|
| | j) Modifications<br>After modifications of SRASW, impact analysis shall be performed to ensure specification. Appropriate lifecycle activities shall be performed after modifications. Access rights to modifications shall be controlled and modification history shall be documented. | Compiled | p |
| 4.6.4 | Software-based parameterization | | |
| | Software-based parameterization of safety-related parameters shall be considered as a safety-related aspect of SRP/CS design to be described in the software safety requirements specification. Parameterization shall be carried out using a dedicated software tool provided by the supplier of the SRP/CS. This tool shall have its own identification (name, version, etc.) and shall prevent unauthorized modification, for example, by use of a password. | Compiled | p |
| | The integrity of all data used for parameterization shall be maintained. This shall be achieved by applying measures to<br>— control the range of valid inputs,<br>— control data corruption before transmission,<br>— control the effects of errors from the parameter transmission process,<br>— control the effects of incomplete parameter transmission, and<br>— control the effects of faults and failures of hardware and software of the tool used for parameterization. | Compiled | p |
| | The parameterization tool shall fulfil all requirements for SRP/CS according to this part of ISO13849. Alternatively, a special procedure shall be used for setting the safety-related parameters. This procedure shall include confirmation of input parameters to the SRP/CS by either<br>— retransmission of the modified parameters to the parameterization tool, or<br>— other suitable means of confirming the integrity of the parameters,as well as subsequent confirmation, e.g. by a suitably skilled person and by means of an automatic check by a parameterization tool. | Compiled | p |
| | The software modules used for encoding/decoding within the transmission/retransmission process and software modules used for visualization of the safety-related parameters to the user shall, as a minimum, use diversity in function(s) to avoid systematic failures. | Compiled | p |

| | | | |
|---|---|---|---|
| | Documentation of software-based parameterization shall indicate data used (e.g. pre-defined parameter sets) and information necessary to identify the parameters associated with the SRP/CS, the person(s) carrying out the parameterization together with other relevant information such as date of parameterization. | Compiled | p |
| | The following verification activities shall be applied for software based parameterization:<br>— verification of the correct setting for each safety-related parameter (minimum, maximum and representative values);<br>— verification that the safety-related parameters are checked for plausibility, for example by use of invalid values, etc.;<br>— verification that unauthorized modification of safety-related parameters is prevented;<br>— verification that the data/signals for parameterization are generated and processed in such a way that faults cannot lead to a loss of the safety function. | Compiled | p |
| 4.7 | Verification that achieved PL meets PLr | | |
| | For each individual safety function the PL of the related SRP/CS shall match the required performance level (PLr) determined according to 4.3 (see Figure 3). If this is not the case, an iteration in the process described in Figure 3 is necessary.The PL of the different SRP/CS which are part of a safety function shall be greater than or equal to the required performance level (PLr) of this safety function. | Compiled | p |
| 4.8 | Ergonomic aspects of design | | |
| | The interface between operators and the SRP/CS shall be designed and realized such that no person is endangered during all intended use and reasonable foreseeable misuse of the machine [see also ISO 12100, EN 614-1, ISO 9355-1, ISO 9355-2, ISO 9355-3, EN 1005-3, IEC 60204-1:2005, Clause 10, IEC 60447 and IEC 61310].Ergonomic principles shall be used so that the machine and the control system, including the safety-related parts, are easy to use, and so that the operator is not tempted to act in a hazardous manner.<br>The safety requirements for observing ergonomic principles given in ISO 12100:2010, 6.2.8, apply. | Compiled | p |
| 5 | Safety functions | | |
| | This clause provides a list and details of safety functions which can be provided by the SRP/CS. The designer (or type-C standard maker) shall include those neces sary to achieve the measures of safety required of the control system for the specific application. | Compiled | p |

| | | | |
|---|---|---|---|
| | Tables 8 and 9 list some typical safety functions and, respectively, certain of their characteristics and safety-related parameters, while making reference to other International Standards whose requirements relate to the safety function, characteristic or parameter. The designer (or type-C standard maker) shall ensure that all applicable requirements are satisfied for the relevant safety functions listed in the tables.<br>Additional requirements are set out in this clause for certain of the safety function characteristics .Where necessary, the requirements for characteristics and safety functions shall be adapted for use with different energy sources.As most of the references in Tables 8 and 9 relate to electrical standards, the applicable requirements will need to be adapted in the case of other technologies (e.g. hydraulic, pneumatic). | Compiled | p |
| | When identifying and specifying the safety function(s), the following shall at least be considered: | | |
| | a) results of the risk assessment for each specific hazard or hazardous situation; | Compiled | p |
| | b) machine operating characteristics, including<br>— intended use of the machine (including reasonable foreseeable misuse),<br>— modes of operation (e.g. local mode, automatic mode, modes related to a zone or part of the machine),<br>— cycle time, and | Compiled | p |
| | c) emergency operation; | Compiled | p |
| | d) description of the interaction of different working processes and manual activities (repairing, setting, cleaning, trouble shooting, etc.); | Compiled | p |
| | e) the behaviour of the machine that a safety function is intended to achieve or to prevent; | Compiled | p |
| | f) the behaviour of the machine on the loss of power (see also 5.2.8); | Compiled | p |
| | g) condition(s) (e.g. operating mode) of the machine in which it is to be active or disabled; | Compiled | p |
| | h) the frequency of operation; | Compiled | p |
| | i) priority of those functions that can be simultaneously active and that can cause conflicting action. | Compiled | p |
| 5.2 | Details of safety functions | | |
| 5.2.1 | Safety-related stop function | | |
| | The following applies in addition to the requirements of Table 8. | | |

| | | | |
|---|---|---|---|
| | A safety-related stop function (e.g. initiated by a safeguard) shall, as soon as necessary after actuation, put the machine in a safe state. Such a stop shall have priority over a stop for operational reasons.When a group of machines are working together in a coordinated manner, provision shall be made for signalling the supervisory control and/or the other machines that such a stop condition exists. | Compiled | p |
| 5.2.2 | Manual reset function | | |
| | he following applies in addition to the requirements of Table 8.After a stop command has been initiated by a safeguard, the stop condition shall be maintained until safe conditions for restarting exist.The re-establishment of the safety function by resetting of the safeguard cancels the stop command. If indicated by the risk assessment, this cancellation of the stop command shall be confirmed by a manual, | Compiled | p |
| | The manual reset function shall— be provided through a separate and manually operated device within the SRP/CS,— only be achieved if all safety functions and safeguards are operative, — not initiate motion or a hazardous situation by itself,— be by deliberate action, — enable the control system for accepting a separate start command,— only be accepted by disengaging the actuator from its energized (on) position. | Compiled | p |
| | The performance level of safety-related parts providing the manual reset function shall be selected so that the inclusion of the manual reset function does not diminish the safety required of the relevant safety function.<br>The reset actuator shall be situated outside the danger zone and in a safe position from which there is good visibility for checking that no person is within the danger zone.<br>Where the visibility of the danger zone is not complete, a special reset procedure is required. | Compiled | p |
| 5.2.3 | Start/restart function | | |
| | The following applies in addition to the requirements of Table 8.A restart shall take place automatically only if a hazardous situation cannot exist. In particular, for interlocking guards with a start function, ISO 12100:2010, 6.3.3.2.5, applies.<br>These requirements for start and restart shall also apply to machines which can be controlled remotely. | Compiled | p |
| 5.2.4 | Local control function | | |
| | The following applies in addition to the requirements of Table 8. | | |

| | | | |
|---|---|---|---|
| | When a machine is controlled locally, e.g. by a portable control device or pendant, the follow inrequirements shall apply: | | |
| | —the means for selecting local control shall be situated outside the danger zone;<br>— it shall only be possible to initiate hazardous conditions by a local control in a zone defined by the risk assessment;<br>— switching between local and main control shall not create a hazardous situation. | Compiled | p |
| 5.2.5 | Muting function | | |
| | The following applies in addition to the requirements of Table 8.Muting shall not result in any person being exposed to hazardous situations. During muting, safe conditions shall be provided by other means.<br>At the end of muting, all safety functions of the SRP/CS shall be reinstated.<br>The performance level of safety-related parts providing the muting function shall be selected so that the inclusion of the muting function does not diminish the safety required of the relevant safety function. | Compiled | p |
| 5.2.6 | Response time | | |
| | The following applies in addition to the requirements of Table 9.The response time of the SRP/CS shall be determined when the risk assessment of the SRP/CS indicates that this is necessary (see also Clause 11). | Compiled | p |
| 5.2.7 | Safety‑related parameters | | |
| | The following applies in addition to the requirements of Table 9.When safety-related parameters, e.g. position, speed, temperature or pressure, deviate from present limits the control system shall initiate appropriate measures (e.g. actuation of stopping, warning signal, alarm).If errors in manual inputting of safety-related data in programmable electronic systems can lead to a hazardous situation, then a data checking system within the safety-related control system shall be provided, e.g. check of limits, format and/or logic input values. | Compiled | p |
| 5.2.8 | Fluctuations, loss and restoration of power sources | | |
| | When fluctuations in energy levels outside the design operating range occur, including loss of energy supply, the SRP/CS shall continue to provide or initiate output signal(s) which will enable other parts of the machine system to maintain a safe state. | Compiled | p |
| 6 | Categories and their relation to MTTFD of each channel, DCavg and CCF | | |

| | | | |
|---|---|---|---|
| | The SRP/CS shall be in accordance with the requirements of one or more of the five categories specified in 6.2. | | |
| | Categories are the basic parameters used to achieve a specific PL. They state the required behaviour of the SRP/CS in respect of its resistance to faults based on the design considerations described in Clause 4.Category B is the basic category. The occurrence of a fault can lead to the loss of the safety function. In category 1 improved resistance to faults is achieved predominantly by selection and application of components. In categories 2, 3 and 4, improved performance in respect of a specified safety function is achieved predominantly by improving the structure of the SRP/CS. In category 2 this is provided by periodically checking that the specified safety function is being performed. In categories 3 and 4 this is provided by ensuring that the single fault will not lead to the loss of the safety function. In category 4, and whenever reasonably practicable in category 3, such faults will be detected. In category 4 the resistance to the accumulation of faults will be specified. | Compiled | p |
| | When considering the causes of failures in some components it is possible to exclude certain faults (see Clause 7).<br>The selection of a category for a particular SRP/CS depends mainly upon<br>— the reduction in risk to be achieved by the safety function to which the part contributes,<br>— the required performance level (PLr),<br>— the technologies used,<br>— the risk arising in the case of a fault(s) in that part,— the possibilities of avoiding a fault(s) in that part (systematic faults),<br>— the probability of occurrence of a fault(s) in that part and relevant parameters,<br>— the mean time to dangerous failure (MTTFD),<br>— the diagnostic coverage (DC), and<br>— the common cause failure (CCF) in the case of categories 2, 3 and 4. | Compiled | p |
| 6.2 | Specifications of categories | | |

| | | | |
|---|---|---|---|
| | Each SRP/CS shall comply with the requirements of the relevant category, see 6.2.3 to 6.2.7.The following architectures typically meet the requirements of the respective category.The following figures show not examples but general architectures. A deviation from these architectures is always possible, but any deviation shall be justified, by means of appropriate analytical tools (e.g. Markov modelling, fault tree analysis), such that the system meets the required performance level (PLr).The designated architectures cannot be considered only as circuit diagrams but also as logical diagrams. For categories 3 and 4, this means that not all parts are necessarily physically redundant but that there are redundant means of assuring that a fault cannot lead to the loss of the safety function.The lines and arrows in Figures 8 to 12 represent logical interconnecting means and logical possible diagnostic means. | Compiled | p |
| 6.2.2 | Designated architectures | | |
| | The structure of a SRP/CS is a key characteristic having great influence on the PL. Even if the variety of possible structures is high, the basic concepts are often similar. Thus, most structures which are present in the machinery field can be mapped to one of the categories. For each category, a typical representation as a safety-related block diagram can be made. These typical realizations are called designated architectures and are listed in the context of each of the following categories. | Compiled | p |
| | It is important that the PL shown in Figure 5, depending on the category, MTTFD of each channel and DCavg, is based on the designated architectures. If Figure 5 is used to estimate the PL the architecture of the SRP/CS should be demonstrated to be equivalent to the designated architecture of the claimed category. Designs fulfilling the characteristics of the respective category in general are equivalent to | Compiled | p |
| 6.2.3 | Category B | | |

| | | | |
|---|---|---|---|
| | The SRP/CS shall, as a minimum, be designed, constructed, selected, assembled and combined in accordance with the relevant standards and use basic safety principles for the specific application to withstand<br>— the expected operating stresses, e.g. the reliability with respect to breaking capacity and frequency,<br>— the influence of the processed material, e.g. detergents in a washing machine, and<br>— other relevant external influences, e.g. mechanical vibration, electromagnetic interference, power supply interruptions or disturbances.<br>There is no diagnostic coverage (DCavg = none) within category B systems and the MTTFD of each channel can be low to medium. In such structures (normally single-channel systems), the consideration of CCF is not relevant.The maximum PL achievable with category B is PL = b. | Compiled | p |
| 6.2.4 | Category 1 | | |
| | For category 1, the same requirements as those according to 6.2.3 for category B shall apply. In addition, the following applies.SRP/CS of category 1 shall be designed and constructed using well-tried components and well-tried safety principles (see ISO 13849-2).<br>A “ well-tried component ” for a safety-related application is a component which has been either<br>a) widely used in the past with successful results in similar applications, or<br>b) made and verified using principles which demonstrate its suitability and reliability for safety-related applications.<br>Newly developed components and safety principles may be considered as equivalent to “well-tried” if they fulfil the conditions of b).The decision to accept a particular component as being “ well-tried ” depends on the application. | Compiled | p |
| | The MTTFD of each channel shall be high.<br>The maximum PL achievable with category 1 is PL = c. | | |

| | | | |
|---|---|---|---|
| | It is important that a clear distinction between “well-tried component” and “fault exclusion” (see Clause 7) be made. The qualification of a component as being well-tried depends on its application. For example, a position switch with positive opening contacts could be considered as being well-tried for a machine tool, while at the same time as being inappropriate for application in a food industry — in the milk industry, for instance, this switch would be destroyed by the milk acid after a few months. A fault exclusion can lead to a very high PL, but the appropriate measures to allow this fault exclusion should be applied during the whole lifetime of the device. In order to ensure this, additional measures outside the control system may be necessary. In the case of a position switch, some examples of these kinds of measures are<br>— means to secure the fixing of the switch after its adjustment,<br>— means to secure the fixing of the cam,<br>— means to ensure the transverse stability of the cam,<br>— means to avoid overtravel of the position switch, e.g. adequate mounting strength of the shock absorber and any alignment devices, and<br>— means to protect it against damage from outside. | Compiled | p |
| 6.2.6 | Category 3 | | |
| | For category 3, the same requirements as those according to 6.2.3 for category B shall apply. “Well-tried safety principles” according to 6.2.4 shall also be followed. In addition, the following applies.<br>SRP/CS of category 3 shall be designed so that a single fault in any of these parts does not lead to the loss of the safety function. Whenever reasonably practicable, the single fault shall be detected at or before the next demand upon the safety function.<br>The diagnostic coverage (DCavg) of the total SRP/CS shall be at least low. The MTTFD of each of the redundant channels shall be low-to-high, depending on the PLr. Measures against CCF shall be applied (see Annex F). | Compiled | p |
| 6.3 | Combination of SRP/CS to achieve overall PL | | |

| | | | |
|---|---|---|---|
| | A safety function can be realized by a combination of several SRP/CS: input system, signal processing unit, output system. These SRP/CS may be assigned to one and/or different categories. For each SRP/CS used, a category according to 6.2 shall be selected. For the overall combination of these SRP/CS, an overall PL may be identified using the methods described in this clause. In this case, the validation of the combination of SRP/CS is required (see Figure 3). | Compiled | p |
| | According to 6.2, the combined safety-related parts of a control system start at the points where the safety-related signals are initiated and end at the output of the power control elements. But the combined SRP/CS could consist of several parts connected in a linear (series alignment) or redundant (parallel alignment) way. To avoid a new complex estimation of the performance level (PL) achieved by the combined SRP/CS where the separate PLs of all parts are already calculated, the following estimations are presented for a series combination of SRP/CS.It is assumed that there are N separate SRP/CSi in a series combination, which as a whole performs a safety function. For each SRP/CSi, a PLi has already been evaluated. This situation is illustrated in Figure 13 (see also Figure 4 and Figure H.2).If the PFHD values of all SRP/CSi are known, then the PFHD of the combined SRP/CS is the sum of all PFHD values of the N individual SRP/CSi. The PL of the combined SRP/CS is limited by:— the lowest PL of any individual SRP/CSi involved in performing the safety function (because the PL is determined also by non-quantifiable aspects) and— the PL corresponding to the PFHD of the combined SRP/CS according to Table 2. | Compiled | p |
| 7 | Fault consideration, fault exclusion | | |
| | In accordance with the category selected, safety-related parts shall be designed to achieve the required performance level (PLr). The ability to resist faults shall be assessed. | Compiled | p |
| 7.2 | Fault consideration | | |

| | | | |
|---|---|---|---|
| | ISO 13849-2 lists the important faults and failures for the various technologies. The lists of faults are not exhaustive and, if necessary, additional faults shall be considered and listed. In such cases, the method of evaluation should also be clearly elaborated. For new components not mentioned in ISO 13849-2, a failure mode and effects analysis (FMEA, see IEC 60812) shall be carried out to establish the faults that are to be considered for those components.In general, the following fault criteria shall be taken into account:— if, as a consequence of a fault, further components fail, the first fault together with all following faults shall be considered as a single fault; — two or more separate faults having a common cause shall be considered as a single fault (known as a CCF); — the simultaneous occurrence of two or more faults having separate causes is considered highly unlikely and therefore need not be considered. | Compiled | p |
| 7.3 | Fault exclusion | | |
| | It is not always possible to evaluate SRP/CS without assuming that certain faults can be excluded. For detailed information on fault exclusions, see ISO 13849-2.Fault exclusion is a compromise between technical safety requirements and the theoretical possibility of occurrence of a fault.Fault exclusion can be based on<br>— the technical improbability of occurrence of some faults,<br>— generally accepted technical experience, independent of the considered application, and<br>— technical requirements related to the application and the specific hazard.If faults are excluded, a detailed justification shall be given in the technical documentation. | Compiled | p |
| 8 | Validation | | |
| | The design of the SRP/CS shall be validated (see Figure 3). The validation shall demonstrate that the combination of SRP/CS providing each safety function meets all relevant requirements of this part of ISO 13849. | Compiled | p |
| 9 | Maintenance | | |
| | Preventive or corrective maintenance can be necessary to maintain the specified performance of the safety-related parts. Deviations with time from the specified performance can lead to a deterioration in safety or even to a hazardous situation. The information for use of the SRP/CS shall include instructions for the maintenance (including periodic inspection) of the SRP/CS. | Compiled | p |
| | | | |

| | | | |
|---|---|---|---|
| 10 | Technical documentation | | |
| | When designing a SRP/CS, its designer shall document at least the following information relevant to the safety-related part:<br>— safety function(s) provided by the SRP/CS;<br>— the characteristics of each safety function;<br>— the exact points at which the safety-related part(s) start and end;<br>— environmental conditions;<br>— the performance level (PL);<br>— the category or categories selected;<br>— the parameters relevant to the reliability (MTTFD, DC, CCF and mission time);<br>— measures against systematic failure;<br>— the technology or technologies used;<br>— all safety-relevant faults considered;<br>— justification for fault exclusions (see ISO 13849-2);<br>— the design rationale (e.g. faults considered, faults excluded);<br>— software documentation;<br>— measures against reasonably foreseeable misuse. | Compiled | p |
| 11 | Information for use | | |
| | The principles of ISO 12100:2010, 6.4.5.2, and the applicable sections of other relevant documents (e.g. IEC 60204-1:2005, Clause 17), shall be applied. In particular, that information which is important for the safe use of the SRP/CS shall be given to the user. This shall include, but is not limited to the following:<br>— the limits of the safety-related parts to the category(ies) selected and any fault exclusions;<br>— the limits of the SRP/CS and any fault exclusions (see 7.3), for which, when essential for maintaining the selected category or categories and safety performance, appropriate information (e.g. for modification, maintenance and repair) shall be given to ensure the continued justification of the fault exclusion(s);<br>— the effects of deviations from the specified performance on the safety function(s);<br>— clear descriptions of the interfaces to the SRP/CS and protective devices;<br>— response time;<br>— operating limits (including environmental conditions);<br>— indications and alarms; | Compiled | p |

| | | | |
|---|---|---|---|
| | — muting and suspension of safety functions;<br>— control modes;<br>— maintenance (see Clause 9);<br>— maintenance check lists;<br>— ease of accessibility and replacing of internal parts;<br>— means for easy and safe trouble shooting;<br>— information explaining the applications for use relevant to the category to which reference is made | Compiled | p |
| | Specific information shall be provided on the category or categories and performance level of the SRP/CS, as follows:<br>— dated reference to this part of ISO 13849 (i.e. “ISO 13849-1:2006”);the Category, B, 1, 2, 3, or 4;<br>— the performance level, a, b, c, d or e. | Compiled | p |

Photo E2000RM-LS / e Folding RA-X9-LS

Photo E2000RM-LS ECO / e Folding RS-X9-LS

**********End of this report**********