DRAFT International Standard

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Textiles — Smart Textiles — Test method for fabric interface with capacitive touchscreens

Textiles — Textiles intelligents — Méthode d'essai de l'interface étoffe avec les écrans tactiles capacitifs

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Contents

Page

Foreword ..... **iv**
Introduction ..... **v**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Principle **1**
5 Apparatus **1**
5.1 Test equipment 1
5.1.1 Reference screen 2
5.1.2 Cylindrical test bar 2
5.1.3 Force sensor 3
6 Atmosphere for conditioning and testing **3**
7 Test specimen **3**
8 Procedure **3**
8.1 Blank (Control) test 3
8.2 Single point test 3
8.3 Multi points test 4
8.4 Slide test 5
8.4.1 Slide test in line 5
8.4.2 Slide test in circle 5
9 Expression of results **6**
9.1 Single point test 6
9.2 Multi-points test 7
9.3 Slide test 7
9.3.1 Slide test in line 7
9.3.2 Slide test in circle 9
9.4 Deviation of the testing 10
10 Test report **10**
Annex A (informative) **Test equipment** **11**

Foreword

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This document was prepared by Technical Committee *[or Project Committee]* ISO/TC *38*, *textiles*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

With the improvement of consumers' living condition, wearable smart textiles came into being, and product types emerge one after another. There are more and more interactions between textiles and touch-screen electronic products, for example, touch-screen gloves, because of their novel functions, warmth and fashion, have considerable sales in all markets around the world, whether in stores or online sales platforms, for personal use or for workplace use.

a)

b)

Figure 1 — An example of touch-screen textile product
a) knitted gloves, b) coated gloves

The fabric with touch screen function uses conductive materials, such as conductive fibres, through which the human current is transmitted to the capacitive screen, so as to achieve the touch screen effect. As an emerging commodity, the market demand for the products is strong, and the market prospect is unanimously optimistic by investors. However, there are no corresponding test methods and relevant requirements within the global standards, and the quality of this touchscreen textile product is various.

The development of test methods for measuring the performance of textile touch screen is suitable for all types of fabrics with controllable capacitive screen, which meets the needs of the market at current stage of scientific and technological development. The formulation of this standard will provide evidence for the test and evaluation of the exchange effect between this type of textiles and touch screen electronic products which fills the blank in this area.

Textiles — Smart Textiles — Test method for fabric interface with capacitive touchscreens

1 Scope

This document specifies a test method for determining the screen touch property of the textiles. The method is applicable to all types of fabrics which are intended to be used for products that could handle the screen.

2 Normative references

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

ISO 139, *Textiles — Standard atmospheres for conditioning and testing*

IEC 62908-12-10, *Touch and interactive displays – Part 12-10: Measurement methods of touch displays – Touch and electrical performance*

IEC 62908-12-20, *Touch and interactive displays – Part 12-20: Measurement methods of touch displays – Multi-touch performance*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
screen touch property
property which is able to control the capacitive display through touch screen induction.

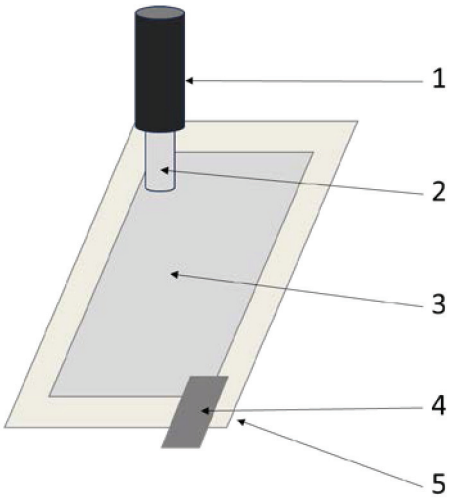
4 Principle

A test specimen is subjected to a testing head, and then tests are carried out by touching the capacitive display device through single point touch, multi-points and sliding touch under standard conditions. Deviation of precision and response ratio for single point touch, adjacent touch distance for multi-point touch, linearity for sliding touch will be stated.

5 Apparatus

5.1 Test equipment

The testing equipment includes mobile arm, reference screen (5.1.1), test bar (5.1.2) and platform, as shown in Figure 2. Test equipment for touch performance measurement of touch displays was provided in IEC 62908-12-10 and IEC 62908-12-20. The frequently used equipment is showed in the Annex A. The force used for testing should be 0,1 N to 10,0 N.



Key

1	moving arm	4	electrical interface
2	test bar	5	stage
3	reference screen		

Figure 2 — Composition of the test equipment

5.1.1 Reference screen

A capacitive multi-touch reference screen (without screen protective membrane). Before testing, it shall be placed in the test atmosphere for at least 2 h.

The parameters for the reference screen shall comply with below:

a) Minimum force to stand: 50 N.

b) Dimension: meet the travel range of mechanical device.

c) Precision of single touch ≤ 0,50 mm; sensitivity shall be 100 % response for single point test using bare test bar (test at least 5 times).

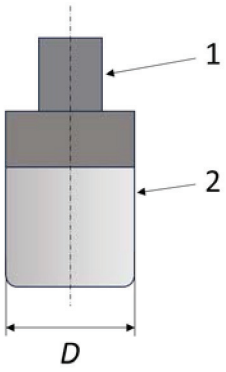
d) Linearity of slide touch ≤ 0,50 mm; sensitivity shall be no leakage point for slide test using bare test bar.

e) Least response distance of two touchpoints: not more than 10,0 mm.

NOTE Testing condition for above reference screen is carried out in atmosphere with the diameter of cylindrical test bar of 6 mm and 0,1 N to 10,0 N pressure or extra 0,2 mm in the direction vertical to the reference screen.

5.1.2 Cylindrical test bar

The diameter *D* of the cylindrical test bar, shown in Figure 3, shall be (6,0 ± 0,01) mm. The material used for the cylindrical test bar shall have a resistivity of 10^2 to 10^4 Ω · cm and a hardness greater than R119, meeting the requirements of IEC 62908-12-10. Examples of suitable materials are brass or a conductive polyamide resin. If both parties agree, test bars of other diameters or shapes can be used.



Key

1 connecting joint
2 test bar
D diameter of test bar

Figure 3 — Examples of test bars

5.1.3 Force sensor

The precision of the force sensor shall be not more than 1 %.

6 Atmosphere for conditioning and testing

Conditioning and testing shall be carried out according to ISO 139. The temperature shall be (20,0 ± 2,0) °C, and the relative humidity shall be (65,0 ± 4,0) %. If so agreed, conditioning and testing may be carried out in the ambient temperature and humidity.

7 Test specimen

After receipt, avoid folding it sharply and do not treat it in any way (e.g. by ironing it) other than by conditioning.

Take at least five test specimens from different places in the fabric or final product so that they do not contain the same yarns and represent the material as fully as possible. The dimension of test specimen shall be at least 2 cm; it shall be ensured that the testing area of test bar is covered completely.

Areas with deep creases or fold marks shall not be tested.

Lay the fabric flat and fix it on the test bar so that the test surface is as flat as possible without creases. Before the test, the test specimens shall be conditioned according to clause 6.

8 Procedure

8.1 Blank (Control) test

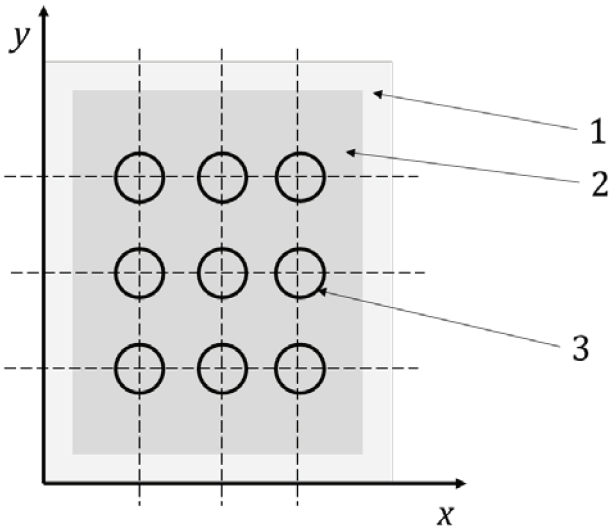
The blank test is to eliminate the effect of test equipment. The reference screen under test shall be attached to the stage and connected to the electrical interface. Test with no test specimen following clauses 8.2 to 8.4.

8.2 Single point test

This method is a straightforward method to evaluate the distance between each target point and its corresponding reported point.

The active area is defined as the area where touch is recognized. The centre area is defined as the rest of the active area without the edge area. The target grid point distribution is shown in Figure 4, there are in total 9 points in the centre area.

At each target grid point (i, j), lift the test bar down and up 5 times, record the reported coordinates. Record the failure response times F_t.



Key

1 edge area (the area within specific length from the outer toward inner screen, approximately 10 % of the length of reference screen)

2 centre area (the rest of the edge area)

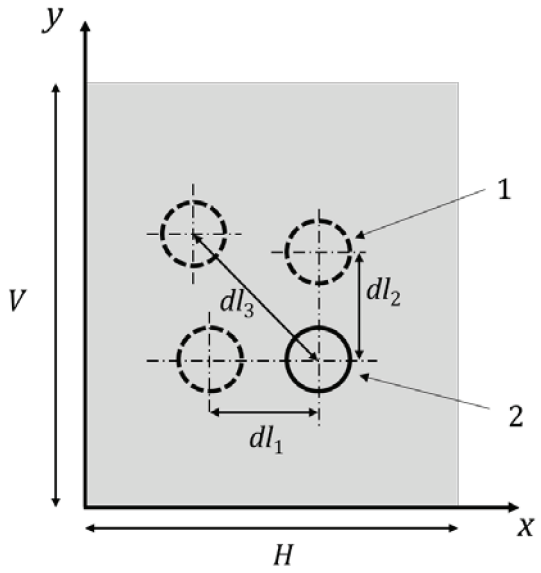
3 touch point (evenly distributed in the centre are of reference screen)

Figure 4 — Point grid distribution

8.3 Multi points test

The purpose of this test is to measure the smallest possible distance between two adjacent touch points that would allow the reference screen to report each coordinate separately.

Two test bars with the same properties should be fitted to the moving arm. The centre-to-centre distance between the two test bars is *dl*, and *dl* should be greater than the diameter of the test bar and less than or equal to min (*V*, *H*) / 3, where *V* and *H* are the length and the width of the reference screen, respectively (see Figure 5). One of the test bars is stationary while the other moves towards it until the test bars' coordinates cannot be reported separately; then record the distance between the last reported points. The measurement should be done in three directions (horizontal, vertical and 45° direction), as shown in Figure 5. The test bar's moving speed is 1 mm/s.



Key

1	moving test bar	dl_1	distance type 1 between two touch points
2	stationary test bar	dl_2	distance type 2 between two touch points
H	length of the active area of the reference screen	dl_3	distance type 3 between two touch points
V	width of the active area of the reference screen		

Figure 5 — Example of adjacent touch distance

8.4 Slide test

8.4.1 Slide test in line

The test bar of the selected diameter shall be attached to the moving arm. The test bar touches and drags from one edge of the panel to the opposite edge. The dragging speed is 10 mm/s. The path of the dragging operation is chosen to be horizontal, vertical or diagonal across the active area of reference screen for each 3 times, as shown in Figure 6. Record the reported coordinate.

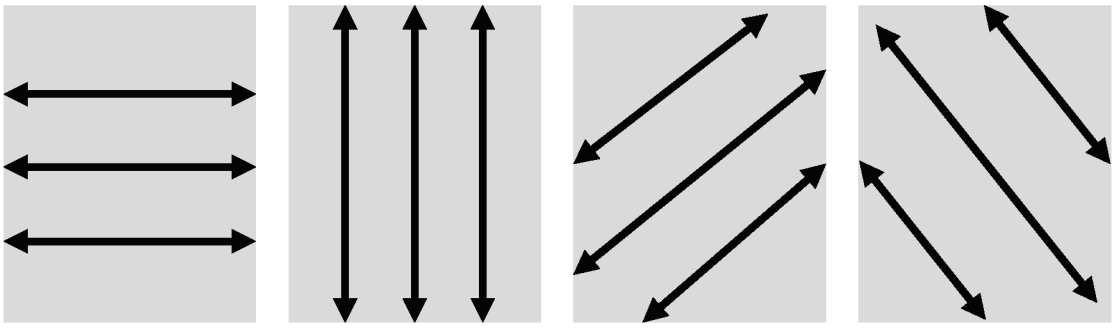
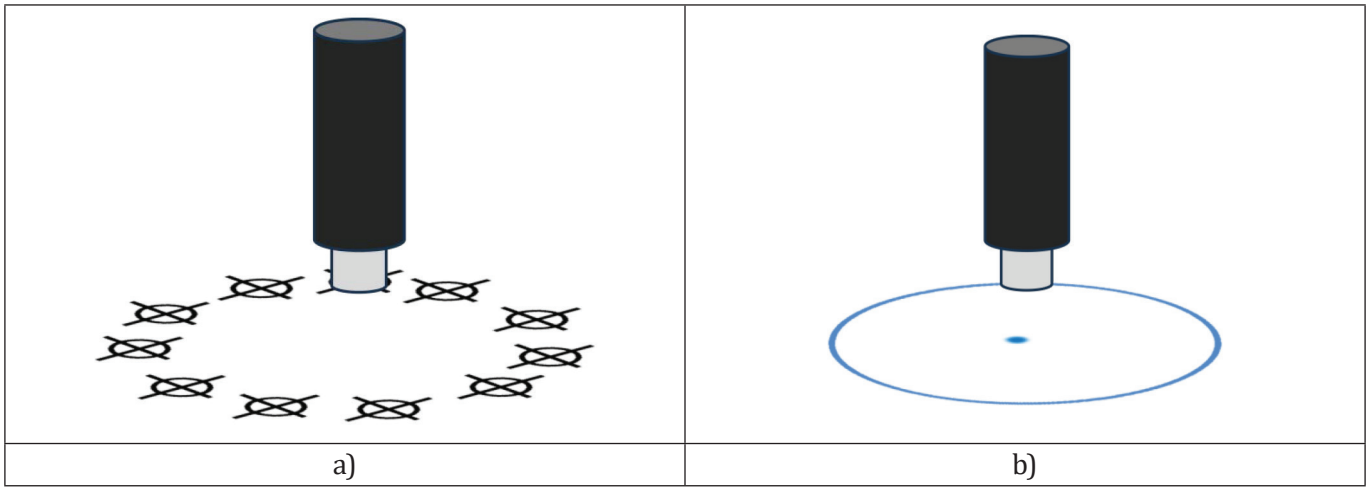


Figure 6 — Examples of dragging lines for slide test

8.4.2 Slide test in circle

An arm capable of moving the test bar in a circular trajectory with variable radius and velocity is required to move in a circle with specific radius, see Figure 7. A minimum radius is typically half of the sensor channel pitch under test and a typical angular velocity is 1 080° / s. Collect the touch report data at equally spaced

target points on a reference circle by using the arm. Collect the reported touch coordinates $(x_i,y_i)(i=1,\ldots,m)$ while rotating 30 times.



a) b)

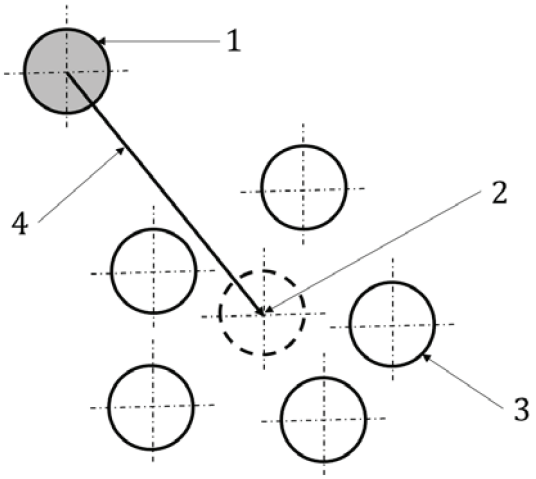
Figure 7 — Estimation of a reference circle,
a) individual touch points, b) circle on which the touch points are situated

Then determine the radius R_{ref} and the centre of the reference circle from the reported touch data by calculating the best fitted circle $x^2 + y^2 + Ax + By + C = 0$ with the following formulae, where $(x_i,y_i)(i=1,\ldots,m)$ are the reported touch coordinates.

9 Expression of results

9.1 Single point test

As shown in Figure 8, the accuracy is defined as the distance between the target coordinate and the mean reported coordinate.



Key

1 target coordinate $(xt, yt)_{i,j}$

2 mean reported coordinate $(\overline{xr}, \overline{yr})_{i,j}$

3 reported coordinate $(xr, yr)_{i,j}$

4 distance between the target coordinate and the mean reported coordinate $A_{cci,j}$

Figure 8 — Accuracy definition

Calculate the maximum of accuracy and response ratio using below formulae:

$$A_{cc\max} = \max\left(A_{cci,j}\right) \tag{1}$$

$$A_{cci,j} = \sqrt{\left(\overline{xr}_{i,j} - xt_{i,j}\right)^2 + \left(\overline{yr}_{i,j} - yt_{i,j}\right)^2} \tag{2}$$

$$\overline{xr}_{i,j} = \frac{\sum_{k=1}^{p} xr_{i,j,k}}{p},\ \overline{yr}_{i,j} = \frac{\sum_{k=1}^{p} yr_{i,j,k}}{p} \tag{3}$$

$$S_{\text{res}} = \left(1 - \frac{F_{\text{t}}}{p}\right) \times 100\ \% \tag{4}$$

where

p is the number of reports at a target point (1, 2, ...);

i, j, k is the k^{th} data in number of reports (p) at a target point (i, j);

$A_{cci,j}$ is the distance between the target coordinate and the mean reported coordinate;

$A_{cc\max}$ is the maximum of accuracy;

S_{res} is the response rate of device;

F_{t} is the failed response times of device.

9.2 Multi-points test

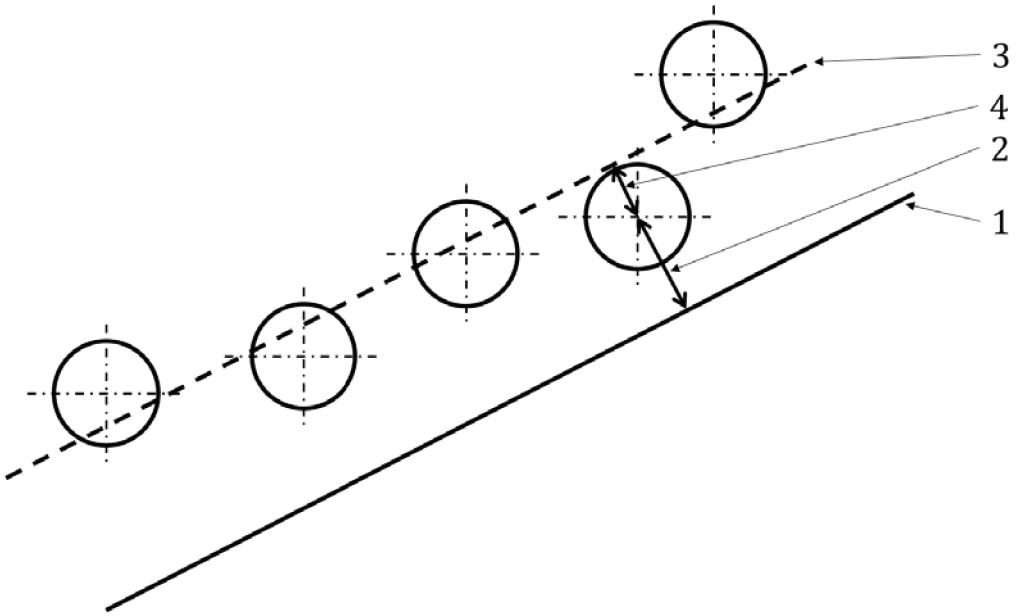
The adjacent touch distance is the maximum recorded distance *dl* among the three directions.

9.3 Slide test

9.3.1 Slide test in line

The linearity is defined as the centre of the distance between the reported point and target straight line. Diagonal, horizontal and vertical directions shall be tested.

The centre of the distance between the reported point and target straight line is calculated as shown in Figure 9.



Key

1 target straight line $a_t x + b_t y + 1 = 0$

2 distance between reported point and target straight line, $d_{(t(i,j))}$

3 approximate straight line $a_r x + b_r y + 1 = 0$

4 distance between reported point and approximate straight line, $d_{(r(i,j))}$

Figure 9 — Linearity definition

The distance between the target straight line and each reported point is measured and determines the linearity of the reference screen. The maximum of linearity of all points in each measurement area is then calculated using below formulae:

$$d_{r(i,j)} = \frac{\left|a_r x_{r(i,j)} + b_r y_{r(i.j)} + 1\right|}{\sqrt{a_r^2 + b_r^2}} \tag{5}$$

$$d_{t(i,j)} = \frac{\left|a_t x_{r(i,j)} + b_t y_{r(i.j)} + 1\right|}{\sqrt{a_t^2 + b_t^2}} \tag{6}$$

$$L_r = \max\left(d_{r(i,j)}\right) \tag{7}$$

$$L_t = \max\left(d_{t(i,j)}\right) \tag{8}$$

where

a_r, b_r is the coefficient of the approximate straight line;

a_t, b_t is the coefficient of the target straight line;

i, j is *the data for* coordinate of reported point;

L_r is the maximum of distance between reported point and approximate straight line;

L_t is the maximum of distance between reported point and target straight line.

9.3.2 Slide test in circle

The reproducibility is defined with the following formulae. The items R_{ref}, R_{min} and R_{max} is defined as shown in Figure 10.

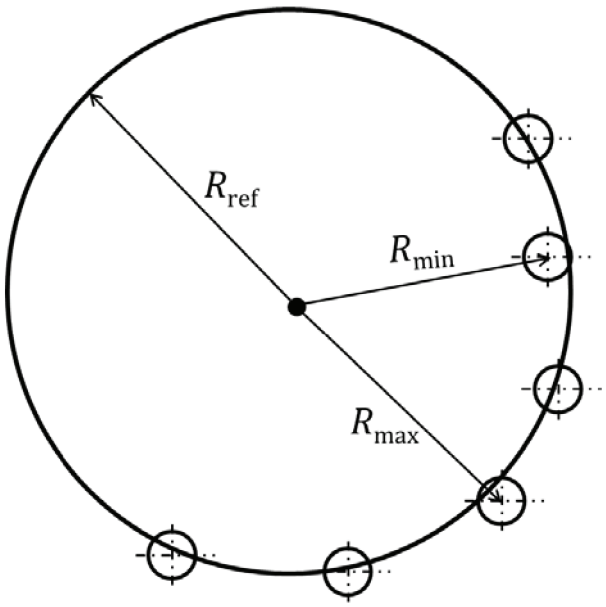


Figure 10 — Reproducibility definition

$$\begin{bmatrix} A \\ B \\ C \end{bmatrix} = \begin{bmatrix} \sum_{i=1} x_i^2 & \sum_{i=1} x_i y_i & \sum_{i=1} x_i \\ \sum_{i=1} x_i y_i & \sum_{i=1} y_i^2 & \sum_{i=1} y_i \\ \sum_{i=1} x_i & \sum_{i=1} y_i & \sum_{i=1} 1 \end{bmatrix}^{-1} \begin{bmatrix} -\sum_{i=1} \left(x_i^3 + x_i y_i^2 \right) \\ -\sum_{i=1} \left(x_i^2 y_i + y_i^3 \right) \\ -\sum_{i=1} \left(x_i^2 + y_i^2 \right) \end{bmatrix} \tag{9}$$

$$R_{ref} = \sqrt{\frac{\boldsymbol{A}^2 + \boldsymbol{B}^2}{4} - \boldsymbol{C}} \tag{10}$$

$$P_{centre} = \left(\frac{-\boldsymbol{A}}{2}, \frac{-\boldsymbol{B}}{2} \right) \tag{11}$$

$$R_d = \frac{|R_{max} - R_{ref}| + |R_{min} - R_{ref}|}{R_{ref}} \times 100 \tag{12}$$

where

A, B, C is the coefficient of the fitted circle;

i, j is the data for coordinate of reported touch point;

R_{ref} is the radius of the reference circle;

R_{max} is the farthest points from the centre of the reference circle;

R_{min} is the nearest points from the centre of the reference circle;

R_d is the calculated reproducibility.

9.4 Deviation of the testing

The deviation of the testing with test specimen and the control testing is calculated with below formula.

$$Dev = |CI_t - CI_0| \quad (13)$$

where

CI_t is the average of calculated items for testing with five test specimens such as maximum of accuracy (A_{ccmax}), response ratio (S_{res}), maximum of adjacent touch distance (dl), maximum of linearity (L_r, L_t), reproducibility (R_d);

CI_0 is the calculated items for control testing such as maximum of accuracy (A_{ccmax}), response ratio (S_{res}), maximum of adjacent touch distance (dl), maximum of linearity (L_r, L_t), reproducibility (R_d);

Dev is the deviation of the testing with test specimen and control testing.

10 Test report

The test report shall include the following information:

a) reference to this document;

b) the atmosphere used (standard temperate or standard tropical or other atmosphere);

c) the type of test bar used;

d) any variation in size or shape of the test specimen;

e) the maximum of accuracy (A_{ccmax}) and the response ratio (S_{res}) for single point test for control testing, the average of A_{ccmax} and S_{res} of testing with test specimens and the deviation (Dev) of testing with test specimen and control testing;

f) the maximum of adjacent touch distance (dl) for multi-point test for control testing, dl and average of dl of testing with test specimens, and deviation (Dev) of average of testing with test specimen and control testing;

g) the maximum of linearity (L_r, L_t) of slide test in line, and the reproducibility (R_d) of slide test in circle for control testing, L_r, L_t, R_d and the average results respectively of testing with test specimens and deviation (Dev) of average of testing with test specimen and control testing;

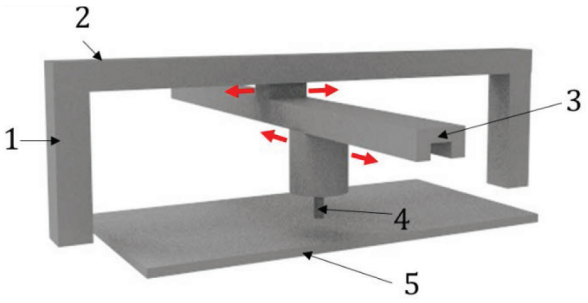
h) any deviations from the given procedure;

i) date of the test.

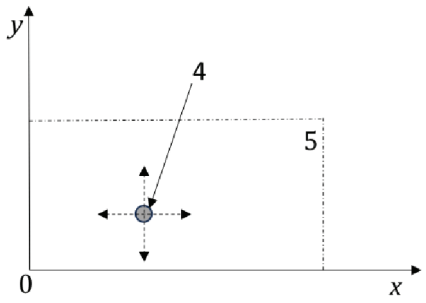
Annex A
(informative)

Test equipment

For the frequently test equipment for touch performance measurement of touch displays, there are three typical mechanical types showed as below only for the reference, in Figure A.1 to Figure A.3.



a)

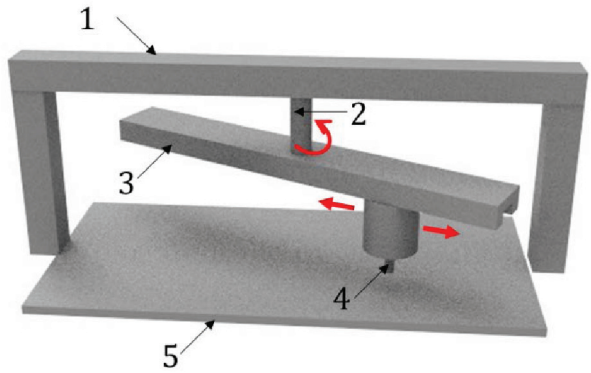


b)

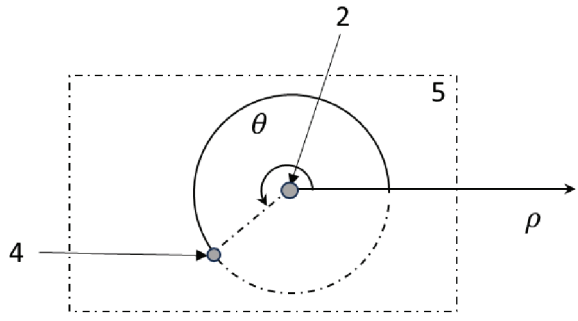
Key

1 fixed bracket
2 sliding track (y direction)
3 sliding track (x direction)
4 test bar (movable, up and down)
5 reference screen

Figure A.1 — Typical mechanical type A: Cartesian coordinates (*x*, *y*)
a) test set-up view, b) cartesian coordinates view



a)



b)

Key

1 fixed bracket
2 rotatable shaft
3 sliding track
4 test bar
5 reference screen

NOTE ρ, θ are Polar coordinates.

Figure A.2 — Typical mechanical type B: polar coordinate system (θ, ρ)
a) test setup view, b) polar coordinates view

Both cartesian coordinate system and polar coordinate system can be used to draw straight lines, circles and arbitrary curves. They can be mutually converted using the following formulae:

$$x = \rho\cos\theta \tag{A.1}$$

$$y = \rho\sin\theta \tag{A.2}$$

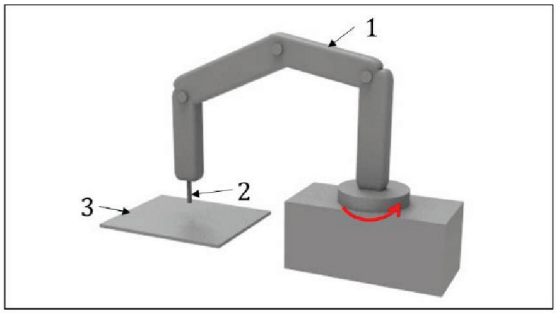
$$\theta = \arctan\left(\frac{y}{x}\right)(x \neq 0) \tag{A.3}$$

$$\rho = \sqrt{x^2 + y^2} \tag{A.4}$$

where

x, y are Cartesian coordinates;

ρ, θ are Polar coordinates.



Key

1 robotic arm

2 test bar

3 reference screen

NOTE Mechanical arm is a kind of intelligent robot that simulates the movement of human arm. It can move freely in a certain space. When the test bar is installed on the mechanical arm, it can click, move and slide operations in any direction and position within the range of motion.

Figure A.3 — Typical mechanical type C: intelligent manipulator