A typical proficiency testing programmes sample design for electrical and electronic product

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Abstract. Creepage distance and clearance testing are the basic testing items in the safety standards for almost all electrical and electronic products. A typical sample group is designed in this paper for the purpose of proficiency testing programmes. The sample group is composed of two kinds of circuit board. The length of the creepage distance of the two circuit boards in pollution degree 2 and 3 are the same but with different paths. This sample group includes three testing points. This sample group is designed beneficial for numerical statistics and avoiding the data complicity in the laboratory. It can be used for effective laboratory monitoring.

1 Introduction
Creepage distance is the shortest distance along the surface of a solid insulating material between two conductive parts. Clearance is the shortest distance in air between two conductive parts. A creepage distance cannot be less than the associated clearance so that the shortest creepage distance possible is equal to the required clearance. However, there is no physical relationship, other than this dimensional limitation, between the minimum clearance in air and the minimum acceptable creepage distance [1].

Creepage distance and clearance is two key test items of electrical and electronic products, which is related to the working voltage, insulation type and environment. It is put forward as a safety requirement in kinds of standards [2-7]. If it is too small, the dis-match creepage distance and clearance will cause the equipment breakdown and the electric shock to user. This is a very serious product safety issue and will damage people's life and property safety. Therefore, the test items are always as the focus of the products monitor.

In this paper, a typical proficiency testing programmes sample is designed here. It can be used to control the quality of the testing lab.

2 Sample design
The sample is designed as a printed circuit board. The appearance figure of the sample is in figure 1.
A hollow out triangular is in the middle of the sample. Rectangular slot and the conductive metal pieces are designed in the sample. The appearance figure of the sample is in figure 1.

**Design points**

This designing scheme includes two sets of samples made of printed circuit board called sample A and sample B. The production precision is 0.01 mm. The difference between two kinds of samples lies in the vertex angle. The vertex angle of sample A is 75 degrees and sample B is 85 degrees. According to our designing scheme, the length of the creepage distance of two pieces of samples in pollution degree 2 and degree 3 are the same. However, the paths are different.

The most critical part of the creepage distance and clearance testing is how to choose the testing path, which is the key to get the correct results. In this designing scheme, three testing points is included.

- Point one-Groove.

Condition 1: Path under consideration includes a parallel- or converging-sided groove of any depth with a width less than X mm.

Rule: Creepage distance and clearance are measured directly across the groove as shown.

The dimension X, specified in the examples, has a minimum value depending on the pollution degree as follows.

| Pollution degree | Dimension X minimum value |
|------------------|---------------------------|
| 1                | 0.25mm                    |
| 2                | 1.0mm                     |
| 3                | 1.5mm                     |

*Figure 1. The sample for proficiency testing programmes.*

*Figure 2. Point one-Groove (condition 1).*
Figure 3. Point one-Groove(condition 2).

Condition 2: Path under consideration includes a parallel-sided groove of any depth and equal to or more than $X$ mm.

Rule: Creepage is the “line of sign” distance. Clearance path follows the contour of the groove.

- Point two- V-shaped groove.

Figure 4. Point two- V-shaped groove.

Condition: Path under consideration includes a V-shaped groove with a width greater than $X$ mm.

Rule: Creepage is the “line of sign” distance. Clearance path follows the contour of the groove but “short-circuits” the bottom of the groove by $X$ mm link.

- Point three- Conductive floating part.

Figure 5. Point three-Conductive floating part.

Condition: $C$ is the conductive floating part.

Rule: Clearance is the distance=$d+D$. Creepage distance is also=$d+D$.

Statistical methods

Using robust statistical methods to evaluate the laboratory’s testing result. A calculated value $Z$ is used to represent the satisfaction of the laboratory’s test result, which is

$$Z = \frac{x - X}{\sigma}$$

(1)

Where, $x$ is the testing result of the laboratory. $X$ is the specified value. $\sigma$ is the standard deviation. Here, the specified value is the median value and the standard deviation is the standardized interquartile range (NIQR).

When $|Z| \leq 2$, the result is satisfied. When $2 < |Z| < 3$, the result is suspicious. When $|Z| \geq 3$, the result is not satisfied.
3 The result analysis

3.1 The correct path
In this part, the correct path of the creepage distance and clearance for sample A and sample B in pollution degree 2 and 3 is given here. Draw the path in the red line.

- Sample A (vertex angle is 75 degrees):
The creepage distance and clearance for sample A in pollution degree 2 and 3 are shown in figure 6 to figure 8.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure6.png}
\caption{The creepage distance for sample A in pollution degree 2.}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure7.png}
\caption{The creepage distance for sample A in pollution degree 3.}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure8.png}
\caption{The clearance for sample A in pollution degree 2 and 3.}
\end{figure}

- Sample B (vertex angle is 85 degrees):
The creepage distance and clearance for sample B in pollution degree 2 and 3 are shown in figure 9 to figure 12.
Figure 9. The creepage distance for sample B in pollution degree 2.

Figure 10. The creepage distance for sample B in pollution degree 3.

Figure 11. The clearance for sample B in pollution degree 2.

Figure 12. The clearance for sample B in pollution degree 3.

3.2 Typical error path
In this part, several typical error paths are presented here.

- Error path one: The groove leads to an error path of the creepage distance in pollution degree 2. Figure 13 is an example for sample A.

Figure 13. The error creepage distance for sample A in pollution degree 2.
• Error path two: The continuous conduction leads to an error path of the creepage distance or clearance in pollution degree 3. Figure 14 and figure 15 are the examples.

![Image](image1.png)  
**Figure 14.** The error creepage distance for sample B in pollution degree 3.

![Image](image2.png)  
**Figure 15.** The error clearance for sample B in pollution degree 3.

4 Conclusion

Creepage distance and clearance testing are the basic testing items in the safety standards for almost all electrical and electronic products. A typical sample group is designed in this paper for the purpose of proficiency testing programmes. The sample group is composed of two kinds of circuit board. The length of the creepage distance of the two circuit boards in pollution degree 2 and 3 are the same but with different paths. This sample group includes three testing points. This sample group is designed beneficial for numerical statistics and avoiding the data complicity in the laboratory. It can be used for effective laboratory monitoring.

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