ICS 33.100
CCS L 06

NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 46130-2025

Guidance for statistical process control for EMC test laboratories

电磁兼容检测实验室统计过程控制指南

Issued on: August 29, 2025 **Implemented on: March 1, 2026**

Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC

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1 Scope

This document describes the method for implementing statistical process control (SPC) in electromagnetic compatibility (EMC) test laboratories.

This document is applicable to the planning and implementation of SPC in EMC test laboratories.

2 Normative References

GB/T 4365-2024

GB/T 17989.1-2020

GB/T 27025-2019

3.1 Terms and Definitions

The terms and definitions defined in GB/T 4365-2024 and GB/T 17989.1-2020 and the following are applicable to this document.

3.1.1 Statistical process control; SPC

A quality control method that uses statistical methods to monitor processes.

3.2 Abbreviations

The following abbreviations are applicable to this document. AM. Amplitude Modulation AN. Artificial Network BCI. Bulk Current Injection CDN. Coupling/Decoupling Network CE. Conducted Emissions CE(I). Conducted Current Emissions CE(V). Conducted Voltage Emissions CTE. Conducted Transient Emissions CW. Continuous Wave EFT/B. Electrical Fast Transient/Burst EMC. Electromagnetic Compatibility ESD. Electrostatic Discharge EUT. Equipment Under Test FM. Frequency Modulation LCL. Lower Control Limit MR. Moving Range RC. Resistor-Capacitor RE. Radiated Emissions RF. Radio Frequency RI. Radiated Immunity SPC. Statistical Process Control UCL. Upper Control Limit XmR. Individual moving Range

4 Overview

EMC test laboratories use SPC (Statistical Process Control) to record test data and examine data trends to evaluate the stability of the test system. Using SPC for laboratory quality audits can provide confidence to both the laboratory and its clients that their test results are accurate.

This document aims to provide recommended methods for implementing SPC in EMC test laboratories to meet the requirements of activities to ensure the validity of results in GB/T 27025-2019.This document provides relevant SPC calculations and recommendations on how to set control limits for test data analysis and establish SPC in the laboratory

environment, and provides SPC layouts for the following test methods.

- RE (see 6.3);

- CE (see 6.4);

- CTE (see 6.5);

- RI (see 6.6);

- BCI (see 6.7);

- Magnetic field immunity (see 6.8);

- Conducted transient immunity (see 6.9);

- ESD (see 6.10).

5.1 Measurement of Independent Variables

The recommended process for collecting SPC data is to individually measure independent variables within the test system.

EXAMPLE. in a BCI test, the independent variable is the forward power of the amplifier on the calibration fixture after reaching a pre-determined injection current, or the injection current on the calibration fixture after reaching a pre-determined forward power on the amplifier.

Data measured to track system stability are considered independent variables within the test system.

5.2 Number of Individual Measurement Values

For the test system, measurements should preferably be taken at no fewer than three frequency points per sub-frequency range. The measurement values at each frequency point shall be plotted on a control chart for that frequency to track the stability of the test system in the long term.

For RE tests, measurements should preferably be taken within the test bandwidth of each antenna as described above.

EXAMPLE. for a biconical antenna in the 30 MHz ~ 200 MHz range, measure the following five frequencies. 30 MHz, 75 MHz, 120 MHz, 160 MHz and 200 MHz.

If it is found that the number of measurement frequency points in each sub-frequency range is insufficient, the number of measurement frequency points should be increased.

5.3 XmR Plot for Individual Measurement Values

Based on the subgroup size of the collected data, select an appropriate control chart to plot

the SPC measurement values. When collecting one data point at each frequency point, an XmR plot for individual measurement values should be used. In this case, with a subgroup size of 1, plot the SPC data on the XmR plot shown in Figure 1.

NOTE 1.when the subgroup size is between 2 and 10, an R plot is typically used; when the subgroup size is greater than 10, an s plot is used. The definitions of R plot and s plot are found in GB/T 17989.1-2020.

The variation of individual measurement values plotted on the XmR plot is the most intuitive.

It is not advisable to calculate the arithmetic mean of individual SPC measurement values to obtain the standard deviation used in the control chart.

NOTE 2.the arithmetic mean will reduce the sensitivity of SPC verification and may mask variations in the test system.

In the XmR plot, X represents the measured data point, and mR is the MR between consecutive data points, which provides a discrete measure using the differences between consecutive values. This type of evaluation consists of a pair of plots. 1) indicates the data point plot of individual measurement values, and 2) indicates the MR plot of the differences between consecutive data points of the measurement values. Figure 1 gives an example of the XmR plot. .....