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桌面级电子电路打印设备通用技术规范

General technical specification for electronic circuit desktop printing equipment

2024-08-23 发布　　2024-08-24 实施

中关村标准化协会　　发布

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前　言

本文件按照 GB/T 1.1—2020《标准化工作导则 第 1 部分：标准化文件的结构和起草规则》的规定起草。

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本文件由中关村标准化协会技术委员会提出并归口。

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引　言

桌面级电子电路打印设备作为电子电路增材制造技术的转化实施载体，是全球范围内电子电路增材制造技术的最新技术成果，其基于直写式打印技术（接触或非接触），使用复合导电浆料，结合可控出墨技术和过孔工艺，快速地完成打孔、孔金属化、线路打印、裁边，还可以打印焊锡膏，实现桌面级回流焊接，可支持单面板、双面板的即时制作，满足电路板的快速打样、验证以及多品类电路板的小批量生产等需求，且整个过程安全环保。

为了保证及验证桌面级电子电路打印设备的各项性能，使其更好的满足客户需求，特制定该桌面级电子电路打印设备通用技术规范。

根据设备达到的制板工艺内容，对设备进行三个等级划分（A 类、B 类、C 类），其中 A 类设备支持打印多层板（双面或两层以上的线路板，含金属化孔），B 类设备支持打印单面板（含非金属化孔），C 类设备支持打印单面板（不含孔）。

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桌面级电子电路打印设备通用技术规范

1 范围

本文件规定了桌面级电子电路打印设备的要求、检验规则、标志、包装、运输和贮存，描述了对应的试验方法。

本文件适用于桌面级电子电路打印设备的研发、设计、生产、检测、验收。

2 规范性引用文件

下列文件中的内容通过文中的规范性引用而构成本文件必不可少的条款。其中，注日期的引用文件，仅该日期对应的版本适用于本文件；不注日期的引用文件，其最新版本（包括所有的修改单）适用于本文件。

GB/T 191-2008 包装储运图示标志

GB/T 2099.1-2021 家用和类似用途插头插座 第1部分：通用要求

GB/T 2423.1-2008 电工电子产品环境试验 第2部分：试验方法 试验A：低温

GB/T 2423.2-2008 电工电子产品环境试验 第2部分：试验方法 试验B：高温

GB/T 2423.3-2016 环境试验 第2部分：试验方法 试验Cab：恒定湿热试验

GB/T 2423.5-2019 环境试验 第2部分：试验方法 试验Ea和导则：冲击

GB/T 2423.10-2019 环境试验 第2部分：试验方法 试验Fc：振动（正弦）

GB/T 4677-2002 印制板测试方法

GB/T 4857.2-2005 包装 运输包装件基本试验 第2部分：温湿度调节处理

GB/T 4857.5-1992 包装 运输包装件 跌落试验方法

GB 4943.1-2022 音视频、信息技术和通信技术设备 第1部分：安全要求

GB/T 5271.14-2008 信息技术 词汇 第14部分 可靠性、可维护性与可用性

GB/T 9254.1-2021 信息技术设备、多媒体设备和接收机 电磁兼容 第1部分：发射要求

GB/T 9254.2-2021 信息技术设备、多媒体设备和接收机 电磁兼容 第2部分：抗扰度要求

GB/T 35351-2017 增材制造 术语

3 术语和定义

在 GB/T 35351-2017《增材制造 术语》中界定的以及下列术语和定义适用于本文件。

3.1

桌面级电子电路打印设备 electronic circuit desktop printing equipment

机身长、宽、高均不超过 1m 或重量不超过 50kg，可放置于普通桌面上进行电子电路打印的电子电路增材制造设备。

注：

桌面级电子电路打印设备不同于工业产线用大型电子电路打印设备，其采用的增材制造工艺主要包括材料挤出式、材料喷射式、印刷式或其他工艺。

3.2

位移精度 displacement accuracy

系统实际位移值与标称位移值的误差。

3.3

重复精度 repeat accuracy

系统重复操作后，初始状态和最终状态的误差。

3.4

钻孔孔径精度 accuracy of drilled hole diameter

钻孔孔径实际直径与标称孔径误差。

3.5

金属化孔 metalized hole

孔壁沉积有导电材料的孔。

注：金属化孔主要用于层间导电图形的电气连接。

3.6

非金属化孔 non-metallized holes

孔壁没有沉积导电材料的孔。

注：非金属化孔在层间导电图形间不起电气连接。

3.7

过孔孔径 Through-Hole Diameters

电子电路里用于连接层间导电图形的金属化孔。

注：常用孔径为 0.2mm~1.2mm。

3.8

元件孔孔径 Component Hole Diameters

电子电路里用于焊接固定插件式电子元器件以及接插件的金属化孔或非金属化孔。

注：通常也称插件孔，常用孔径为 0.6mm~1.8mm。

3.9

安装孔孔径 mounting hole diameters

电子电路里用于固定电路板到外壳等载体上直径较大的非金属化孔。

注：安装孔常用孔径为 2.0mm~5.0mm。

3.10

动轴系 dynamic axis system

设备的运动轴。

注：通常指 XYZ 轴。根据设备的实际运动轴系确定，可能包含多个 X 轴或多个 Y 轴或多个 Z 轴，也可能缺少 X 轴或 Y 轴或 Z 轴。对于多个 X 轴的，以 X1，X2……Xn 进行命名；对于多个 Y 轴的，以 Y1，Y2……Yn 进行命名；对于多个 Z 轴的，以 Z1，Z2……Zn 进行命名。

4 设备分类

桌面级电子电路打印设备（以下简称“设备”）按照不同的使用场景分为以下三类。

表 1 不同作用设备分类

设备分类	一般使用场景	设备定义
A类设备	复杂的电子电路个性化设计和快速制板及验证	支持打印多层板（双面或两层以上的线路板，含金属化孔）的桌面级电子电路打印设备
B类设备	低价、简单的电路板个性化制作和原理快速验证	支持打印单面板（含非金属化孔）的桌面级电子电路打印设备
C类设备	个性化柔性电路板制作	支持打印单面板（不含孔）的桌面级电子电路打印设备

5 技术要求

5.1 设备一般要求

5.1.1 设备外观应整洁，不应有锐边、锐角、凹痕、划伤、裂缝、变形、毛刺、霉斑及污染等，涂层应均匀、不应起泡、龟裂、脱落、磨损。
5.1.2 金属零件不应锈蚀和其他机械损伤。
5.1.3 上盖可以正常开启、关合到位，各个零部件应紧固无松动。
5.1.4 电源、工作指示灯应置于明显位置。
5.1.5 开关、按键、旋钮操作应方便、灵活、可靠，指示正确。
5.1.6 电源线应无破损、接插牢固，电源接通前，指示灯处于熄灭状态。
5.1.7 基材和墨盒或者墨管的安装应简单方便。
5.1.8 灌注物不应外溢。
5.1.9 使用说明应能指导用户正确使用和维护。
5.1.10 机身长、宽、高均不超过 1m 或重量不超过 50kg。

5.2 设备运动控制

5.2.1 一般功能

运动系统应运转平稳，无异常声响和自发性移动，无卡阻现象；机械动作协调准确、顺畅；安装限位开关，触发后响应保护逻辑，运动部件应停止动作。

5.3 钻孔质量

5.3.1 钻孔孔径

A 类和 B 类设备有钻孔孔径要求，C 类设备无钻孔孔径要求。在对应的孔径范围内有可支持尺寸的钻孔功能，且不同尺寸的孔径差异不小于 0.1mm，则满足钻孔孔径的要求。表 2 列出了 A 类和 B 类设备的孔径支持种类数量要求。

表 2 A 类和 B 类设备的孔径支持种类数量要求

设备类型	常见过孔孔径 （0.2mm~1.2mm）	常见元件孔孔径 （0.6mm~1.8mm）	安装孔孔径 （2.0mm~5.0mm）
A类	4种	4种	2种
B类	\	4种	2种
注:对于孔径范围为 0.6mm~1.2mm 的钻孔尺寸，能同时满足常见过孔孔径和常见元件孔孔径范围要求，可分别独立计算。			

5.3.2 钻孔孔径精度

A 类和 B 类设备有钻孔孔径精度要求，C 类设备无钻孔孔径精度要求。钻孔孔径精度为±0.05mm。

5.4 金属化孔质量

5.4.1 金属化孔孔径

A 类设备有金属化孔孔径要求。B 类和 C 类设备无金属化孔孔径要求。在常见过孔孔径范围 0.2mm~1.2mm 内，应至少能支持 4 种不同尺寸的金属化过孔；在常见元件孔孔径范围 0.6mm~1.8mm 内，

应至少能支持 4 种不同尺寸的金属化元件孔。

5.4.2 金属化孔基本性能

A 类设备有金属化孔基本性能要求。B 类和 C 类设备无金属化孔基本性能要求。金属化孔基本性能满足以下要求：

——金属化孔要清洁，应没有任何能影响元件插入及可焊性能的杂质；

——孔内空洞的总面积不应超过孔壁总面积的 10%，在水平面内最大尺寸不应超过孔圆周的 25%，在垂直面内最大尺寸不应超过板厚度的 25%；

——金属化孔在孔壁与导电图形的界面处不应有空洞，此界面是指延伸到孔中并低于板表面一定距离，此距离为表面导电图形厚度的 1.5 倍；

——金属化孔中导电层应无环状裂纹或与孔壁的环状分离；

——有空洞的金属化孔不应超过金属化孔总数的 5%。

5.5 打印质量

5.5.1 打印线宽

设备有标称的最小线宽，则打印的线宽应达到最小线宽或以下；无标称的最小线宽，则打印的线宽应达到 0.2mm 或以下。

5.5.2 打印线距

设备有标称的最小线距，则打印的线距应达到最小线距或以下；无标称的最小线距，则打印的线距应达到 0.2mm 或以下。

5.6 裁切精度

A 类和 B 类设备有裁切精度要求。

裁切精度为±0.4mm。

5.7 安全

5.7.1 基本防护

设备外壳可能被人体触及到的边角，应无锐边锐角。

5.7.2 标记与说明

整机上的标记与说明应满足 GB 4943.1-2022 中附录 F 的相关要求。

5.7.3 抗电强度

抗电强度应满足 GB 4943.1-2022 5.4.9 中的要求。

5.7.4 接地性能

按照 GB 4943.1-2022 5.6.6 中的要求，保护连接系统的电阻不应超过 0.1Ω

5.7.5 保护导体电流

应符合 GB 4943.1-2022 5.7.5 的规定，保护导体电流不大于 3.5mA。

5.7.6 电源插头、插座或电线组件

应符合 GB/T 2099.1-2021 的要求。

5.7.7 接触温度

应符合 GB 4943.1-2022 9.3 的规定。

5.8 电源适应性

设备应能在 220×(1±15%)V～或 220×(1±15%)VAC、50Hz±1Hz 的条件下正常工作。

5.9 电磁兼容性

5.9.1 无线电干扰极限值

应符合 GB/T 9254.1-2021 中 A 级设备的要求。

5.9.2 抗扰度限值

应符合 GB/T 9254.2-2021 信息技术设备、多媒体设备和接收机 电磁兼容 第 2 部分：抗扰度要求规定的各项抗扰度测试的要求，性能判据要求至少为 C。

5.10 环境适应性

5.10.1 气候环境适应性

设备应在表 3 中的大气环境下，保证设备的正常运行。

表 3 气候环境适应性

大气条件	工作运行	贮存运输
温度	5℃~35℃	-10℃~45℃
相对湿度	20%RH ~80%RH	20%RH ~80%RH

5.10.2 机械环境适应性

设备应在表 4、表 5、表 6 中的机械环境下，保证设备的正常运行。

表 4 振动适应性要求

项目	分项	参数
初始和最后振动响应检查	频率范围/Hz	5~55
	扫频速率/oct/min	≤1
	位移幅值/mm	0.15
定频耐久试验	位移幅值/mm	0.15
	时间/min	30
扫频耐久试验	频率范围/Hz	5~55
	位移幅值/mm	0.15
	扫频速率/oct/min	≤1
	次数	2

表 5 冲击适应性要求

级别	峰值加速度/m/s^2	脉冲持续时间/ms	冲击波形

1	150	11	半正弦波形

表 6 跌落适应性要求

包装件质量/kg	跌落高度/mm
≤15	1000
＞15~30	800
＞30~40	600
＞40~45	500
＞45~50	400
＞50	300

5.11 运转稳定性

5.11.1 空运转稳定性

受试设备按照表 7 进行测试，保证设备的空运转稳定性。

表 7 空运转稳定性要求

序号	项目	要求
1	电气检查	设备在通电后各指示灯、显示器、继电器等工作状态正常。
2	各轴运动	各个轴运动平稳、功能可靠。
3	各轴限位	各轴限位在极限位置应自动停止，功能可靠。
4	噪声	设备的噪声声压级不大于75dB（A），且没有冲击声和异响声。

5.11.2 负载运转稳定性

设备在任意一种负载工作（打印线路、钻孔、裁切）条件下，机械零件、结构件元器件均正常工作，且受试设备完成规定的功能，且持续工作时间不低于 72h，保证设备的负载运转稳定性。

6 试验方法

6.1 设备一般检查

采用目视法和手动操作法进行检查。

6.2 设备运动控制

6.2.1 一般功能

采用目视法和手动操作法进行检查。

6.3 钻孔质量

6.3.1 钻孔孔径

将基材放置在设备平台上，根据要求在基材上完成钻孔的孔径种类选取，A 类设备共选取 10 种孔径，B 类设备共选取 6 种孔径，每种孔径至少完成 5 个，证明具备常用钻孔孔径的实现能力。

6.3.2 钻孔孔径精度

按 GB/T 4677—2002 中 5.2 的规定测量在基材上钻取的孔径(在 5.3.1 中选取的钻孔)，取正面和反面的孔径算数平均值作为实际尺寸。以实际尺寸和标称尺寸的差值作为钻孔孔径精度。

6.4 金属化孔质量

6.4.1 金属化孔孔径

把基材放置在设备平台上，对基材上已经钻取常用过孔孔径和常用元件孔径共 8 种尺寸的孔进行孔金属化，每种孔径至少 5 个，证明具备常用金属化孔孔径的实现能力。

6.4.2 金属化孔基本性能

按 GB/T 4677—2002 中 5.1.1 的试验 1a 的规定进行。

6.5 打印质量

6.5.1 打印线宽

按图 1 所示图案要求，完成图案打印，重复 5 次。

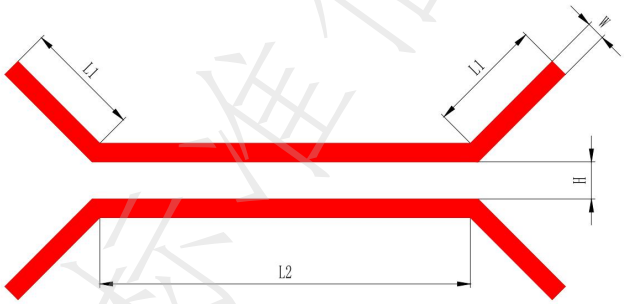

图 1 打印图案

标引序号说明：

L1, L2——打印线长（根据设备幅面要求进行设定）；W——打印线宽；H——打印线距。

打印完成后，在高精度测量仪器（比如数字显微镜）下测量 5 个图案共 10 个线宽值，线宽值的算数平均值作为实际打印线宽。

6.5.2 打印线距

按图 2 所示图案要求，完成图案打印，重复 5 次。

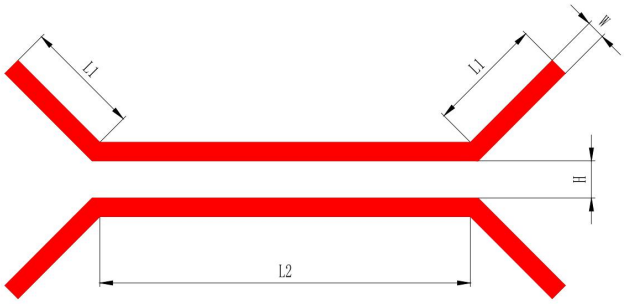

图 2 打印图案

标引序号说明：

L1, L2——打印线长（根据设备幅面要求进行设定）；W——打印线宽；H——打印线距。

打印完成后，在高精度测量仪器（比如数字显微镜）下测量 5 个图案共 5 个线距值，线距值的算数平均值作为实际打印线距。

6.6 裁切精度

按图 3 所示图案要求，完成图案裁切，重复 5 次。（单位：mm）

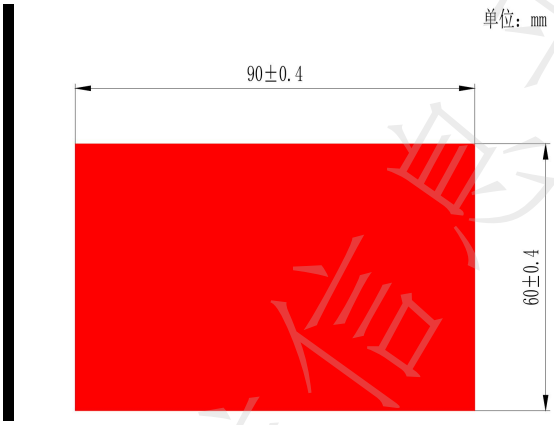

图 3 裁切用图案

裁切完成后，在高精度测量仪器（比如数字显微镜、游标卡尺）下测量 5 个图案共 5 组长宽数据，该长宽数据的算数平均值与对应的设计长宽值的差值为裁切精度。

若设备的工作幅面不足 90mm×60mm，则以设备的最大工作幅面确定裁切用的矩形图案。

6.7 安全试验

6.7.1 基本防护

目检设备外壳及相关结构。

6.7.2 标记与说明

按 GB 4943.1-2022 4.1.15 规定的方法进行试验，采用目视法检查标识与说明。

6.7.3 抗电强度

按 GB 4943.1-2022 5.4.9 抗电强度试验规定的方法进行试验，检验其绝缘是否击穿。

6.7.4 接地性能

按 GB 4943.1-2022 5.6.6 规定的方法进行试验。在整机不通电的状态下，测量机身上的保护接地端子与距离该端最远的整机外壳上的金属螺钉之间的接地电阻值。接地电阻值不超过 0.1Ω。

6.7.5 保护导体电流

按 GB 4943.1-2022 5.7 的规定的检验方法检验。测量时保护导体电流不大于 3.5mA。

6.7.6 电源插头、插座或电线组件

按 GB/T 2099.1-2021 规定的方法进行试验。

6.7.7 接触温度

按 GB 4943.1-2022 9.3 的规定的方法进行试验。

6.8 电源适应能力试验

电源适应能力应按表 8 的组合对受试设备进行试验，每种组合运行自检程序或其他指定标准程序一遍，受试设备工作应正常。

表 8 交流电源适应能力

组合	电压/V	频率/Hz
1	220	50
2	187	49
3	187	51
4	253	49
5	253	51

6.9 电磁兼容性试验

6.9.1 无线电干扰极限值的测试方法

按 GB/T 9254.1-2021 规定的方法和 A 级设备的要求进行。试验过程中运行自检程序或其他指定的标准程序，工作应正常。

6.9.2 抗扰度限值试验

按 GB/T 9254.2-2021 信息技术设备、多媒体设备和接收机 电磁兼容 第 2 部分：抗扰度要求规定的方法进行，对每个测试项应至少满足 C 性能要求。试验过程中运行自检程序或其他指定的标准程序，工作应正常。

6.10 环境试验

6.10.1 一般要求

在 6.10.2~6.10.7 的各项试验中，规定的初始检测和最后检测，统一按 6.1 进行外观和结构检查，并运行自检程序或其他指定标准程序一遍，工作应正常。

6.10.2 低温试验

低温试验按照以下步骤进行：

a) 运行试验

按 GB/T 2423.1-2008“试验 Ad”进行，受试设备先进行初始检测，在受试设备不工作的条件下，将箱内温度逐渐降到工作温度下限值，待温度稳定后，加电运行系统自检程序或其他指定标准程序 4h，受试设备工作应正常。试验完后，待箱内温度回到室温，取出设备，在正常大气压下恢复 2h。

b) 贮存试验

按 GB/T 2423.1-2008“试验 Ab”进行，将设备放入低温箱，使箱内温度降到运输温度下限值，在受试设备不工作的条件下存放 16h，取出设备回到室温，再恢复 2h，进行最后检测。为防止试验中受试设备结霜和凝露，允许将受试设备用聚乙烯薄膜密封后进行试验，必要时还可以在密封套内装吸潮剂。

6.10.3 高温试验

高温试验按照以下步骤进行：

a） 运行试验

按 GB/T 2423.2-2008“试验 Bd”进行试验，受试设备先进行初始检测，在受试设备不工作的条件下，将箱内温度逐渐升到工作温度上限值，待温度稳定后，加电运行系统自检程序或其他指定标准程序4h，受试设备工作应正常。试验完后，待箱内温度回到室温，取出设备，在正常大气压下恢复 2h。

b) 贮存试验

按 GB/T 2423.2-2008“试验 Bb”进行试验，将设备放入高温箱，使箱内温度升到运输温度上限值，在受试设备不工作的条件下存放 16h，取出设备回到室温，再恢复 2h，进行最后检测。

6.10.4 恒定湿热试验

恒温试验按照以下步骤进行：

a） 运行试验

按 GB/T 2423.3-2016“试验 Cab”进行，严酷程度取设备规定的工作温度、湿度上限值，受试设备要求进行初始检测。试验持续时间为 2h。在此期间加电运行自检程序或其他指定标准程序，工作应正常。恢复时间为 2h，进行最后检测。

b） 贮存试验

按 GB/T 2423.3-2016“试验 Cab”进行，严酷程度取设备规定的贮存温度、湿度上限值，受试设备要求进行初始检测。受试设备在不工作条件下存放 24h，恢复时间为 2h，进行最后检测。

6.10.5 振动试验

振动试验按照以下步骤进行：

a） 试验规定

按 GB/T 2423.10-2019“试验 Fc”进行，受试设备按工作位置固定在振动台上，进行初始检测。受试设备在不工作条件下，按规定值，分别对三个互相垂直的轴线方向进行振动。

试验工作条件下的振动试验，应加电运行自检程序或其他指定标准程序，工作应正常。试验结束后应进行外观结构检查。

如无特别要求，受试设备以包装件形式进行振动试验。

b） 初始振动响应检查

试验应在给定频率范围内，在一个扫频循环上完成。试验过程中应记录危险频率，包括共振频率和导致及影响性能的频率。

c） 定频耐久试验

用初始振动响应检查中记录的危险频率进行定频试验，如果发现两种及两种以上的危险频率同时存在，则对每一种危险频率进行定频耐久试验。

若在试验规定频率范围内无明显共振频率或无影响性能的频率，或危险频率超过 4 种，则直接做扫频耐久试验。

d） 扫频耐久试验

按给定的频率范围由低到高，再由高到低，做一次循环。按规定的循环次数进行扫频试验。

已做过定频耐久试验的设备不再做扫频耐久试验。

e） 最后振动响应检查

此项试验在不工作条件下进行，对于已做过定频耐久试验的设备要求做此项试验。对于做扫频耐久试验的设备，可将最后一次扫频试验作为最后振动响应检查。本试验应将记录的共振频率与初始振动响应检查记录的共振频率相比较，若有明显变化，应对受试设备进行修正，重新进行该项试验。试验后，进行最后检测。

6.10.6 冲击试验

按 GB/T 2423.5-2019“试验 Ea”进行，受试设备要求进行初始检测。安装时要注意重力影响，按规定值，受试设备在不工作条件下，分别对三个互相垂直轴线方向进行冲击，冲击次数各为 3 次，试验后，进行最后检测。

如无特别要求，受试设备以包装件形式进行冲击试验。

6.10.7 包装件跌落试验

对受试设备进行初始检测，将运输包装件处于准备运输状态，按 GB/T 4857.2-2005 中的规定进行预处理 4h。

按 GB/T 4857.5-1992 中 5.6.2 的要求和本标准中的规定值进行跌落，一角三棱六面，各跌落一次。试验后检测包装件的损坏情况，并对受试设备进行最后检测。

6.11 运转稳定性试验

6.11.1 试验条件

本标准规定运转稳定性试验目的为确定设备在正常使用条件下的稳定性水平，试验条件按照设备正常使用的通常条件为准。

6.11.2 空运转稳定性试验方案

设备空运转试验按照表 9 进行。

表 9 空运转稳定性试验

序号	试验项目	试验方法
1	电气检查	按照使用说明书的规定操作程序，通电后检查各指示灯、显示器、继电器等的工作状态是否正常
2	各轴运动试验	分别控制各轴运动，试验其运动的平稳性和功能的可靠性
3	各轴限位试验	各轴分别以正、反方向进行运动至极限位置时是否能自动停止，验证其功能的可靠性
4	噪声试验	测试设备运行过程中的噪声声压，观察设备运行过程中是否有冲击声和异常声。

6.11.3 负载运转稳定性试验方案

受试设备在规定负载范围内（打印线路、钻孔、裁切）连续工作持续 72h，检查运行过程中是否出现了机械零件、结构件的损坏和卡死，或出现了元器件的失效或断裂，而使受试样品设备不能完成其规定的功能。

7 检验规则

7.1 检验分类

检验分定型（鉴定）检验、交收（逐批）检验、例行（周期）检验三种。

各类检验项目和顺序按表 10 进行。

表 10 检验分类

检验项目	要求	试验方法	定型检验	交收检验	例行检验
外观和结构	5.1	6.1	◎	◎	◎
设备运动控制	5.2	6.2	◎	◎	◎
钻孔质量	5.3	6.3	◎	—	—
金属化孔质量	5.4	6.4	◎	—	—
打印质量	5.5	6.5	◎	—	—
裁切精度	5.6	6.6	◎	—	—
安全	5.7	6.7	◎	—	—
电源适应能力	5.8	6.8	◎	—	—
电磁兼容	5.9	6.9	◎	—	—
环境适应性	5.10	6.10	◎	—	—
运转稳定性	5.11	6.11	◎	—	—
注：标“◎”表示进行检验的项目，标“—”表示不检验的项目。					

7.2 定型检验

7.2.1 检验内容

定型检验是对设备进行全面质量考核的试验，包括外观和结构、设备运动控制性能、钻孔质量、金属化孔质量、打印质量、裁切精度、安全性、电源适应能力、电磁兼容性、环境适应性和运转稳定性，设备在设计定型和生产定型时均应通过定型检验。

7.2.2 检验设备数量

定型检验中的设备数为2台。

7.3 交收检验

7.3.1 批量生产或连续生产的企业，在交收时，应全数进行交收检验。

7.3.2 交收检验包括开箱检查和常温条件下的性能检查。

7.3.3 检验中，出现一项不合格时，返修后应重新检验。若再次出现任一项不合格时，该台设备判为不合格设备。

7.4 例行检验

7.4.1 批量生产的设备，每批均应进行例行检验。连续生产的设备，每年至少进行一次例行检验。

7.4.2 例行检验设备应在交收检验合格设备中随机抽取，试验设备数为2台。

7.4.3 除可靠性鉴定一项外，其余项目均按以下规定进行。检验中出现故障或任一项不满足时，经修复后重新做该项检验。之后，再顺序做以下各项检验，若再次出现故障或某项不满足时，在查明故障原因，提出故障分析报告，再经修复后，则应重新进行各项例行试验。在重新进行检验中又出现某项不满足时，则判该设备不满足例行试验。

7.4.4 经例行检验中的环境试验的设备，应印有标记，检验后要提交例行试验报告。

8 标志、包装、运输、贮存

8.1 标志

包装箱外应有设备名称、设备型号、制造商名称和地址、生产日期、设备批号、本文件标准编号等

标志。包装箱外喷刷或贴有“易碎物品”、“怕雨”、“向上”及“堆码层数极限”等运输标志，所有标志应符合 GB/T 191-2008 中的有关规定。

包装箱外喷刷或粘贴的标志不因正常运输条件或储存条件而褪色、变色、脱落。

8.2 包装

包装箱应符合防潮、防尘、防振的要求，设备清理整洁后，装入纸箱内，并装入驱动光盘、设备明细表、备附件、设备说明书、合格证等随机文件。

8.3 运输

设备不应装在敞开的船舱和车厢中进行运输，中途转运不应存放在露天的仓库。在运输过程中，不准许和易燃易爆易腐蚀的物品同车装运，并且设备不准许经雨、雪或液体的淋袭雨机械损伤

8.4 贮存

设备贮存应放在原包装箱内，存放设备的仓库环境温度为常温。仓库内不准许有各种有害气体、易燃、易爆的设备及有腐蚀性的化学物品，并且应无强烈的机械振动、冲击和强磁场作用。包装箱应垫离地面至少 20cm，距离墙壁、冷源、热源、窗口或空气入口至少 50cm。若无其他规定时，贮存期一般不超过 6 个月，如超过 6 个月则应重新进行交收检验。

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General Technical Specification for Electronic Circuit Printing Equipment

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Preface

This document is drafted in accordance with the provisions of GB/T 1.1-2020 "Guidelines for Standardization Work Part 1: Structure and Drafting Rules of Standardization Documents".

Please note that some content in this document may involve patents. The publishing institution of this document does not assume responsibility for identifying patents.

This document is proposed and managed by the Technical Committee of Zhongguancun Standardization Association.

This document is drafted by: Beijing Mengzhimo Technology Co., Ltd., Tsinghua University, Institute of Physical and Chemical Technology of Chinese Academy of Sciences, Tianjin University, Beijing University of Aeronautics and Astronautics, Beijing University of Technology, China Academy of Printing Science and Technology Co., Ltd., and Zhongguancun Zhilian Software Service Industry Quality Innovation Alliance.

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Introduction

Desktop level electronic circuit printing equipment, as a carrier for the transformation and implementation of electronic circuit additive manufacturing technology, is the latest technological achievement in electronic circuit additive manufacturing technology worldwide. It is based on direct writing printing technology (contact or non-contact), uses composite conductive paste, combined with controllable ink printing technology and through-hole process, to quickly complete drilling, hole metallization, circuit printing, cutting, and can also print solder paste to achieve desktop level reflow soldering. It can support real-time production of single panel and double-sided boards, meet the needs of rapid prototyping, verification, and small batch production of multiple types of circuit boards, and the entire process is safe and environmentally friendly.

In order to ensure and verify the performance of desktop level electronic circuit printing equipment and better meet customer needs, a general technical specification for this desktop level electronic circuit printing equipment is formulated.

According to the board making process achieved by the equipment, it is divided into three levels (Class A, Class B, and Class C). Class A equipment supports printing multi-layer boards (double-sided or two or more layer circuit boards, including metalized holes), Class B equipment supports printing single panels (including non-metallic holes), and Class C equipment supports printing single panels (excluding holes).

The issuing organization of this document reminds that when declaring compliance with this document, it may involve the use of patents related to "through holes" in sections 5.3 and 5.4.

The publishing institution of this document has no position on the authenticity, validity, and scope of the relevant patents.

The patent holder has promised to the publishing institution of this document that he is willing to negotiate with any applicant on reasonable and non discriminatory terms and conditions regarding patent authorization and licensing. The statement of the patent holder has been filed with the publishing institution of this document. The patentee or patent applicant agrees to license any organization or individual to implement the Zhongguancun standard for a fee on a fair, reasonable, and non discriminatory basis. Relevant information can be obtained through the following contact methods:

Patent holder name: Beijing Mengzhimo Technology Co., Ltd

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Please note that in addition to the aforementioned patents, some content in this document may still involve patents. The publishing institution of this document does not assume responsibility for identifying patents.

General Technical Specification for Electronic Circuit Printing Equipment

1 Scope

This document specifies the requirements, inspection rules, labeling, packaging, transportation, and storage of desktop electronic circuit printing equipment, and describes the corresponding test methods.

This document is applicable to the research and development, design, production, testing, and acceptance of desktop electronic circuit printing equipment.

2 Normative References

The contents of the following documents constitute essential clauses of this document through normative references in the text. Among them, for referenced documents with dates, only the version corresponding to that date is applicable to this document; The latest version (including all modifications) of the referenced document without a date is applicable to this document.

GB/T 191-2008 Packaging, Storage and Transportation Symbols

GB/T 2099.1-2021 household and similar use plugs and sockets - Part 1: General requirements

GB/T 2423.1-2008 Environmental Testing for Electric and Electronic Products - Part 2: Test Methods - Test A: Low Temperature

GB/T 2423.2-2008 Environmental Testing for Electric and Electronic Products - Part 2: Test Methods - Test B: High Temperature

GB/T 2423.3-2016 Environmental Testing Part 2: Test Methods Test Cab: Constant Damp Heat Test

GB/T 2423.5-2019 Environmental Testing Part 2: Test Methods Test Ea and Guidelines: Impact

GB/T 2423.10-2019 Environmental Testing Part 2: Test Methods Test Fc: Vibration (Sinusoidal)

GB/T 4677-2002 Test Methods for Printed Boards

GB/T 4857.2-2005 Packaging - Basic tests for transport packages - Part 2: Temperature and humidity control treatment

GB/T 4857.5-1992 Packaging Transport Packaging Drop Test Method

GB 4943.1-2022 Audio and video, information technology and communication technology equipment Part 1: Security requirements

GB/T 5271.14-2008 Information Technology Vocabulary Part 14 Reliability, Maintainability and Availability

GB/T 9254.1-2021 Information technology equipment, multimedia equipment and receivers - Electromagnetic compatibility - Part 1: Emission requirements

GB/T 9254.2-2021 Information technology equipment, multimedia equipment and receivers - Electromagnetic compatibility - Part 2: Immunity requirements

GB/T 35351-2017 Additive Manufacturing Terminology

3 Terms and definitions

The terms defined in GB/T 35351-2017 "Additive Manufacturing Terminology" and the following terms and definitions are applicable to this document.

3.1

Desktop electronic circuit printing equipment

Electronic circuit additive manufacturing equipment with a body length, width, and height not exceeding 1m or a weight not exceeding 50kg, which can be placed on a regular desktop for electronic circuit printing.

Note:

Desktop electronic circuit printing equipment is different from large-scale electronic circuit printing equipment used in industrial production lines. Its additive manufacturing processes mainly include material extrusion, material spraying, printing, or other processes.

3.2

Displacement accuracy

The error between the actual displacement value and the nominal displacement value of the system.

3.3

Repeat accuracy

The error between the initial and final states after repeated system operations.

3.4

Accuracy of drilled hole diameter

The actual diameter of the drilling hole differs from the nominal diameter.

3.5

Metalized hole

A hole with conductive material deposited on its wall.

Note: Metallized holes are mainly used for electrical connections of interlayer conductive patterns.

3.6

Non metalized holes

Holes without deposited conductive materials on the wall.

Note: Non metalized holes do not establish electrical connections between interlayer conductive patterns.

3.7

Through Hole Diameters

Metallized holes used in electronic circuits to connect interlayer conductive patterns.

Note: The commonly used aperture is 0.2mm~1.2mm.

3.8

Component Hole Diameters

Metallic or non-metallic holes used in electronic circuits for soldering and fixing plug-in electronic components and connectors.

Note: Also known as plug-in hole, the commonly used aperture is 0.6mm~1.8mm.

3.9

Mounting hole diameters

Large diameter non-metallic holes used in electronic circuits to secure circuit boards to carriers such as casings.

Note: The commonly used aperture for installation holes is 2.0mm~5.0mm.

3.10

Dynamic axis system

The motion axis of the device.

Note: Usually refers to the XYZ axis. Based on the actual motion axis of the device, it may include multiple X axes, Y axes, Z axes, or may be missing X, Y, or Z axes. For multiple X axes, name them X1, X2... Xn; For multiple Y axes, name them Y1, Y2... Yn; For multiple Z-axis, name them Z1, Z2... Zn.

4 Equipment Classification

Desktop electronic circuit printing equipment (hereinafter referred to as "equipment") is divided into the following three categories according to different usage scenarios.

Table 1 Classification of Devices with Different Functions

Equipment classification	General usage scenarios	Equipment definition
Class A equipment	Personalized design and rapid board fabrication and verification of complex electronic circuits	Desktop electronic circuit printing equipment that supports printing multi-layer boards (double-sided or two or more layer circuit boards, including metalized holes)
Class B equipment	Low price, simple circuit board personalized production and rapid principle verification	Desktop electronic circuit printing equipment that supports printing single panels (including non-metallic holes)
Class C equipment	Personalized flexible circuit board production	Desktop electronic circuit printing equipment that supports printing single panels (without holes)

5 Technical Requirements

5.1 General Equipment Requirements

5.1.1 The appearance of the equipment should be clean, without sharp edges, sharp corners, dents, scratches, cracks, deformations, burrs, mold spots, and contamination. The coating should be uniform, without bubbles, cracks, peeling, or wear.

5.1.2 Metal parts should not rust or suffer other mechanical damage.

5.1.3 The upper cover can be opened and closed properly, and all components should be securely fastened without any looseness.

5.1.4 The power supply and work indicator lights should be placed in prominent positions.

5.1.5 Switches, buttons, and knobs should be easy, flexible, reliable, and indicate correctly.

5.1.6 The power cord should be undamaged, firmly plugged in, and the indicator light should be off before the power is turned on.

5.1.7 The installation of substrates and ink cartridges or ink tubes should be simple and convenient.

5.1.8 The infusion material should not overflow.

5.1.9 The instructions should be able to guide users in the correct use and maintenance.

5.1.10 The length, width, and height of the aircraft shall not exceed 1m or the weight shall not exceed 50kg.

5.2 Equipment motion control

5.2.1 General Functions

The motion system should run smoothly, without any abnormal sounds or spontaneous movements, and without any jamming phenomenon; Accurate and smooth coordination of mechanical actions; Install limit switches, trigger the response protection logic, and the moving parts should stop moving.

5.3 Drilling Quality

5.3.1 Borehole diameter

Class A and B equipment have drilling aperture requirements, while Class C equipment does not have drilling aperture requirements. If there are drilling functions that can support different sizes within the corresponding aperture range, and the difference in aperture between different sizes is not less than 0.1mm, then the requirements for drilling aperture are met. Table 2 lists the required number of aperture support types for Class A and Class B devices.

Table 2 Requirements for the number of aperture support types for Class A and Class B equipment

Equipment type	Common through-hole diameters （0.2mm~1.2mm）	Common component hole diameter （0.6mm~1.8mm）	Installation hole diameter （2.0mm~5.0mm）
Class A	4 types	4 types	2 types
Class B	\	4 types	2 types
Note: For drilling sizes ranging from 0.6mm to 1.2mm, they can simultaneously meet the requirements of common through-hole diameters and common component hole diameters, and can be calculated independently.			

5.3.2 Drilling aperture accuracy

Class A and B equipment have drilling aperture accuracy requirements, while Class C equipment does not have drilling aperture accuracy requirements. The precision of drilling hole diameter is ± 0.05mm.

5.4 Quality of metalized holes

5.4.1 Metallic pore size

A-class equipment has requirements for the size of metalized holes. There is no requirement for the size of metalized holes in Class B and Class C equipment. Within the common through-hole aperture range of 0.2mm~1.2mm, it should be able to support at least 4 different sizes of metalized vias; Within the common component hole diameter range of 0.6mm~1.8mm, it should be able to support at least 4 different sizes of metalized component holes.

5.4.2 Basic properties of metalized pores

Class A equipment has basic performance requirements for metalized holes. Basic performance requirements for Class B and Class C equipment without metalized holes. The basic performance of metalized pores meets the following requirements:

——The metalized holes should be clean and free of any impurities that may affect the insertion and solderability of the components;

——The total area of the cavity inside the hole should not exceed 10% of the total area of the hole wall, the maximum size in the horizontal plane should not exceed 25% of the circumference of the hole, and the maximum size in the vertical plane should not exceed 25% of the plate thickness;

——Metallized holes should not have voids at the interface between the hole wall and the conductive pattern. This interface refers to extending into the hole and being a certain distance below the surface of the plate, which is 1.5 times the thickness of the surface conductive pattern;

——The conductive layer in the metalized hole should have no annular cracks or annular separation from the hole wall;

——The number of metalized holes with voids should not exceed 5% of the total number of metalized holes.

5.5 Printing Quality

5.5.1 Printing Line Width

If the device has a nominal minimum line width, the printed line width should be at or below the minimum line width; If there is no nominal minimum line width, the printed line width should be 0.2mm or less.

5.5.2 Printing line spacing

If the device has a nominal minimum line spacing, the printed line spacing should be at or below the minimum line spacing; If there is no nominal minimum line spacing, the printed line spacing should be 0.2mm or less.

5.6 Cutting accuracy

Class A and B equipment have cutting accuracy requirements.

The cutting accuracy is ± 0.4mm.

5.7 Safety

5.7.1 Basic Protection

The edges and corners of the device casing that may be touched by the human body should have no sharp edges or corners.

5.7.2 Marking and Explanation

The markings and instructions on the entire machine should meet the relevant requirements of Appendix F of GB 4943.1-2022.

5.7.3 Electrical Strength

The electrical strength should meet the requirements of GB 4943.1-2022 5.4.9.

5.7.4 Grounding Performance

According to the requirements of GB 4943.1-2022 5.6.6, the resistance of the protective connection system should not exceed 0.1 Ω

5.7.5 Protection of conductor current

It should comply with the provisions of GB 4943.1-2022 5.7.5, and the protective conductor current should not exceed 3.5mA.

5.7.6 Power plugs, sockets or wire components

It should comply with the requirements of GB/T 2099.1-2021.

5.7.7 Contact temperature

It should comply with the provisions of GB 4943.1-2022 9.3.

5.8 Power adaptability

The equipment should be able to operate normally under the conditions of 220 × (1 ± 15%) V~or 220 × (1 ± 15%) VAC, 50Hz ± 1Hz.

5.9 Electromagnetic compatibility

5.9.1 Radio interference limit value

It should meet the requirements of Class A equipment in GB/T 9254.1-2021.

5.9.2 Immunity limit

It should comply with the requirements of various immunity tests specified in GB/T 9254.2-2021, and the performance criterion should be at least C.

5.10 Environmental adaptability

5.10.1 Climate and Environmental Adaptability

The equipment should operate normally in the atmospheric environment listed in Table 3.

Table 3 Climate and Environmental Adaptability

Atmospheric conditions	Work operation	Storage and transportation
temperature	5℃~35℃	-10℃~45℃
relative humidity	20%RH ~80%RH	20%RH ~80%RH

5.10.2 Mechanical Environment Adaptability

The equipment should operate normally in the mechanical environment specified in Tables 4, 5, and 6.

Table 4 Vibration Adaptability Requirements

project	Sub item	parameter
Initial and final vibration response checks	Frequency range/Hz	5~55
	Sweep rate/oct/min	≤1
	Displacement amplitude/mm	zero point one five
Constant frequency durability test	Displacement amplitude/mm	zero point one five
	Time/min	thirty
Frequency endurance test	Frequency range/Hz	5~55
	Displacement amplitude/mm	zero point one five
	Sweep rate/oct/min	≤1
	frequency	two

Table 5 Requirements for Impact Adaptability

level	Peak acceleration/$m/^{s2}$	Pulse duration/2s	Shock waveform
one	one hundred and fifty	eleven	Half sine waveform

Table 6 Requirements for Fall Adaptability

Packaging quality/kg	Drop height/mm
≤15	one thousand
＞15~30	eight hundred
＞30~40	six hundred
＞40~45	five hundred
＞45~50	four hundred
＞50	three hundred

5.11 Operational Stability

5.11.1 Stability of Air Freight Conversion

The test equipment shall be tested according to Table 7 to ensure the stability of the equipment during idle operation.

Table 7 Stability Requirements for Air Freight Conversion

Serial number	project	requirement
one	Electrical inspection	After the device is powered on, all indicator lights, displays, relays, and other devices are working normally.
two	Movement of each axis	Each axis moves smoothly and functions reliably.
three	Limit of each axis	Each axis limit should automatically stop at the limit position, with reliable functionality.
four	Noise	The noise pressure level of the equipment shall not exceed 75dB (A), and there shall be no impact sound or abnormal noise.

5.11.2 Load Operation Stability

Under any load working condition (printing lines, drilling, cutting), the mechanical and structural components of the equipment work normally, and the tested equipment completes the specified functions for a continuous working time of not less than 72 hours, ensuring the stability of the equipment's load operation.

6 Test Methods

6.1 General Inspection of Equipment

Inspect using visual and manual methods.

6.2 Equipment motion control

6.2.1 General Functions

Inspect using visual and manual methods.

6.3 Drilling Quality

6.3.1 Borehole diameter

Place the substrate on the equipment platform and select the type of hole diameter for drilling on the substrate according to the requirements. A total of 10 hole diameters are selected for Class A equipment, and 6 hole diameters are selected for Class B equipment, with at least 5 holes completed for each hole diameter, proving the ability to achieve commonly used drilling hole diameters.

6.3.2 Drilling aperture accuracy

According to the provisions of 5.2 in GB/T 4677-2002, measure the hole diameter drilled on the substrate (selected in 5.3.1), and take the arithmetic mean of the hole diameters on the front and back sides as the actual size. Use the difference between the actual size and the nominal size as the accuracy of the drilling hole diameter.

6.4 Quality of metalized holes

6.4.1 Metallic pore size

Place the substrate on the equipment platform and perform metalization on holes with a total of 8 sizes, including commonly used via holes and commonly used component holes, with at least 5 holes of each size. This demonstrates the ability to achieve commonly used metalized hole sizes.

6.4.2 Basic properties of metalized pores

According to the provisions of Test 1a in 5.1.1 of GB/T 4677-2002.

6.5 Printing Quality

6.5.1 Printing Line Width

According to the pattern requirements shown in Figure 1, complete the pattern printing and repeat 5 times.

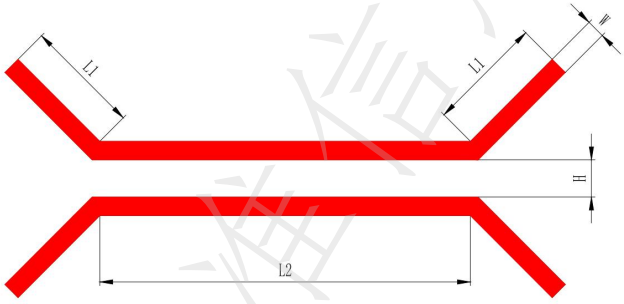

Figure 1 Printing Pattern

Index number description:

L1, L2- Printing line length (set according to device format requirements); W - Print line width; H - Printing line spacing.

After printing is completed, measure a total of 10 line width values for 5 patterns using high-precision measuring instruments such as digital microscopes. The arithmetic mean of the line width values is taken as the actual printed line width.

6.5.2 Printing line spacing

According to the pattern requirements shown in Figure 2, complete the pattern printing and repeat 5 times.

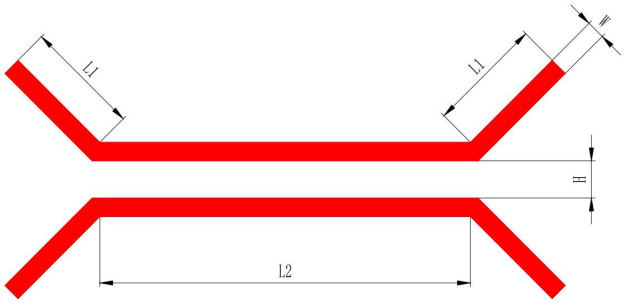

Figure 2 Printing Pattern

Index number description:

L1, L2- Printing line length (set according to device format requirements); W - Print line width; H - Printing line spacing.

After printing is completed, measure a total of 5 line spacing values for 5 patterns under a high-precision measuring instrument (such as a digital microscope), and the arithmetic mean of the line spacing values is taken as the actual printing line spacing.

6.6 Cutting accuracy

According to the pattern requirements shown in Figure 3, complete the pattern cutting and repeat 5 times. (Unit: mm)

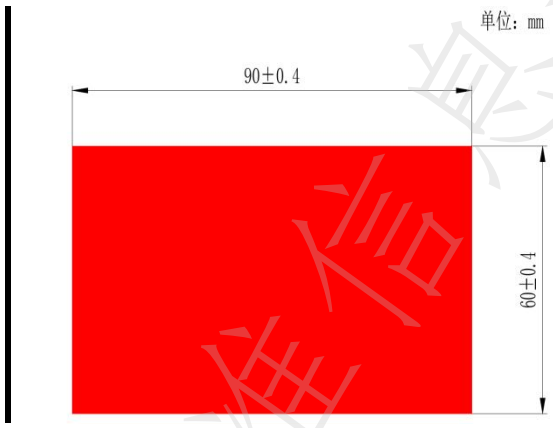

Figure 3 Pattern for Cutting

After cutting, measure the length and width data of 5 patterns in total using high-precision measuring instruments such as digital microscopes and vernier calipers. The difference between the arithmetic mean of the length and width data and the corresponding design length and width values is the cutting accuracy.

If the working area of the equipment is less than 90mm × 60mm, the rectangular pattern for cutting shall be determined based on the maximum working area of the equipment.

6.7 Safety Test

6.7.1 Basic Protection

Visually inspect the casing and related structures of the equipment.

6.7.2 Marking and Explanation

Conduct the test according to the method specified in GB 4943.1-2022 4.1.15, and visually inspect the markings and instructions.

6.7.3 Electrical Strength

Conduct the test according to the method specified in GB 4943.1-2022 5.4.9 Electrical Strength Test to check whether the insulation is broken down.

6.7.4 Grounding Performance

Conduct the test according to the method specified in GB 4943.1-2022 5.6.6. Measure the grounding resistance between the protective grounding terminal on the machine body and the metal screw on the machine

shell farthest from that end when the whole machine is not powered on. The grounding resistance value shall not exceed 0.1 Ω.

6.7.5 Protection of conductor current

Inspect according to the inspection method specified in GB 4943.1-2022 5.7. During measurement, the protective conductor current should not exceed 3.5mA.

6.7.6 Power plugs, sockets or wire components

Conduct the test according to the method specified in GB/T 2099.1-2021.

6.7.7 Contact temperature

Conduct the test according to the method specified in GB 4943.1-2022 9.3.

6.8 Power supply adaptability test

The adaptability of the power supply should be tested on the tested equipment according to the combination in Table 8. Each combination should run a self check program or other specified standard program once, and the tested equipment should work normally.

Table 8 Adaptability of AC Power Supply

combination	Voltage/V	Frequency/Hz
one	two hundred and twenty	fifty
two	one hundred and eighty-seven	forty-nine
three	one hundred and eighty-seven	fifty-one
four	two hundred and fifty-three	forty-nine
five	two hundred and fifty-three	fifty-one

6.9 Electromagnetic compatibility test

6.9.1 Testing method for radio interference limit value

According to the methods specified in GB/T 9254.1-2021 and the requirements of Class A equipment. During the experiment, the self check program or other designated standard program should run normally.

6.9.2 Immunity limit test

According to the method specified in GB/T 9254.2-2021, each test item should meet at least the C performance requirements. During the experiment, the self check program or other designated standard program should run normally.

6.10 Environmental Testing

6.10.1 General Requirements

In the various tests from 6.10.2 to 6.10.7, the specified initial and final tests shall be uniformly inspected for appearance and structure according to 6.1, and the self inspection program or other designated standard program shall be run once, and the work shall be normal.

6.10.2 Low temperature test

The low-temperature test shall be conducted according to the following steps:

a) Operation test

According to GB/T 2423.1-2008 "Test Ad", the test equipment is first subjected to initial testing. Under the condition that the test equipment is not working, the temperature inside the box is gradually reduced to the lower limit of the working temperature. After the temperature stabilizes, the system self check program or other specified standard program is powered on and operated for 4 hours. The test equipment should work normally. After the experiment is completed, wait for the temperature inside the box to return to room temperature, remove the equipment, and restore it to normal atmospheric pressure for 2 hours.

b) Storage test

According to GB/T 2423.1-2008 "Test Ab", place the equipment in a low-temperature chamber to lower the temperature inside the chamber to the lower limit of the transport temperature. Store the tested equipment under non working conditions for 16 hours, remove the equipment and return it to room temperature, and then restore it for 2 hours for final testing. To prevent frosting and condensation of the test equipment during the experiment, it is allowed to seal the test equipment with polyethylene film before conducting the test. If necessary, a moisture absorbing agent can also be installed inside the sealing sleeve.

6.10.3 High temperature test

The high temperature test shall be conducted according to the following steps:

a) Operation test

According to GB/T 2423.2-2008 "Test Bd", the test equipment is first subjected to initial testing. Under the condition that the test equipment is not working, the temperature inside the box is gradually raised to the upper limit of the working temperature. After the temperature stabilizes, the system self check program or other specified standard program is powered on and operated for 4 hours. The test equipment should work normally. After the experiment is completed, wait for the temperature inside the box to return to room temperature, remove the equipment, and restore it to normal atmospheric pressure for 2 hours.

b) Storage test

Conduct the test according to GB/T 2423.2-2008 "Test Bb", place the equipment in a high-temperature box, raise the temperature inside the box to the upper limit of the transport temperature, store it for 16 hours without the tested equipment working, take out the equipment and return it to room temperature, then restore it for 2 hours, and perform the final test.

6.10.4 Constant Damp Heat Test

The constant temperature test shall be conducted according to the following steps:

a) Operation test

According to GB/T 2423.3-2016 "Test Cab", the severity is taken as the upper limit of the operating temperature and humidity specified by the equipment, and the tested equipment is required to undergo initial testing. The duration of the experiment is 2 hours. During this period, power on and run the self-test program or other designated standard program, and the work should be normal. The recovery time is 2 hours, and the final test will be conducted.

b) Storage test

According to GB/T 2423.3-2016 "Test Cab", the severity is taken as the upper limit of storage temperature and humidity specified by the equipment, and the tested equipment is required to undergo initial testing. The test equipment is stored under non working conditions for 24 hours, with a recovery time of 2 hours, for final testing.

6.10.5 Vibration Test

The vibration test shall be conducted according to the following steps:

a) Test regulations

According to GB/T 2423.10-2019 "Test Fc", the test equipment is fixed in its working position on the vibration table for initial testing. Under non working conditions, the test equipment vibrates in three mutually perpendicular axis directions according to the specified values.

The vibration test under experimental working conditions should be operated with a self check program or other designated standard program powered on, and the work should be normal. After the experiment, a visual structural inspection should be conducted.

Unless otherwise specified, the tested equipment shall undergo vibration testing in the form of packaging.

b) Initial vibration response check

The experiment should be completed within a given frequency range on one sweep cycle. During the experiment, hazardous frequencies should be recorded, including resonance frequencies and frequencies that cause and affect performance.

c) Constant frequency durability test

Perform a fixed frequency test using the hazardous frequencies recorded in the initial vibration response check. If two or more hazardous frequencies are found to exist simultaneously, perform a fixed frequency durability test on each hazardous frequency.

If there are no obvious resonance frequencies or frequencies that do not affect performance within the specified frequency range of the test, or if there are more than four hazardous frequencies, the sweep frequency durability test shall be conducted directly.

d) Frequency endurance test

Repeat the cycle from low to high and then from high to low within the given frequency range. Perform frequency sweep test according to the prescribed number of cycles.

Equipment that has undergone fixed frequency durability testing will no longer undergo sweep frequency durability testing.

e) Final vibration response check

This experiment is conducted under non working conditions, and it is required for equipment that has already undergone fixed frequency durability testing to undergo this experiment. For equipment undergoing frequency sweep durability testing, the last frequency sweep test can be used as the final vibration response check. The resonance frequency recorded in this experiment should be compared with the resonance frequency recorded in the initial vibration response check. If there is a significant change, the tested equipment should be corrected and the experiment should be repeated. After the experiment, conduct the final inspection.

6.10.6 Impact Test

According to GB/T 2423.5-2019 "Test Ea", the test equipment is required to undergo initial testing. During installation, attention should be paid to the influence of gravity. According to the specified values, the tested equipment should be impacted three times in the direction of three mutually perpendicular axes under non working conditions. After the test, the final inspection should be carried out.

Unless otherwise specified, the tested equipment shall undergo impact testing in the form of packaging.

6.10.7 Packaging Drop Test

Perform initial testing on the test equipment, prepare the transport packaging for transportation, and

perform a 4-hour pre-treatment according to the provisions of GB/T 4857.2-2005.

According to the requirements of 5.6.2 in GB/T 4857.5-1992 and the specified values in this standard, drop one corner, three edges, and six faces, each drop once. After the experiment, check the damage of the packaging and conduct a final inspection of the tested equipment.

6.11 Operational Stability Test

6.11.1 Test conditions

This standard specifies that the purpose of the operational stability test is to determine the stability level of the equipment under normal use conditions, and the test conditions are based on the usual conditions of normal equipment use.

6.11.2 Airlift Stability Test Plan

The equipment air transportation test shall be conducted according to Table 9.

Table 9: Stability Test for Air Transport Operation

Serial number	Experimental project	test method
one	Electrical inspection	According to the operating procedures specified in the user manual, after powering on, check whether the working status of each indicator light, display, relay, etc. is normal
two	Axial motion test	Control the motion of each axis separately, test the smoothness of its motion and the reliability of its function
three	Limit test for each axis	Can each axis automatically stop when moving in the forward and reverse directions to the limit position, and verify the reliability of its function
four	Noise test	Test the noise pressure during the operation of the equipment and observe whether there is any impact sound or abnormal sound during the operation of the equipment.

6.11.3 Load Operation Stability Test Plan

The test equipment shall work continuously for 72 hours within the specified load range (printing lines, drilling, cutting), and check whether there is any damage or jamming of mechanical or structural components, or failure or fracture of electronic components during operation, which prevents the test sample equipment from completing its specified functions.

7 Inspection Rules

7.1 Classification of Inspection

There are three types of inspections: formal (identification) inspection, delivery (batch by batch) inspection, and routine (periodic) inspection.

All types of inspection items and sequences shall be carried out according to Table 10.

Table 10 Inspection Classification

Inspection items	requirement	test method	Type inspection	Delivery inspection	Routine inspection
Appearance and	five point one	six point one	◎	◎	◎

structure					
Equipment motion control	five point two	six point two	◎	◎	◎
Drilling quality	five point three	six point three	◎	—	—
Quality of metalized holes	five point four	six point four	◎	—	—
Print quality	five point five	six point five	◎	—	—
Cutting accuracy	five point six	six point six	◎	—	—
security	five point seven	six point seven	◎	—	—
Power adaptability	five point eight	six point eight	◎	—	—
electromagnetic compatibility	five point nine	six point nine	◎	—	—
Environmental adaptability	five point one zero	six point one zero	◎	—	—
Operational stability	five point one one	six point one one	◎	—	—
Note: The symbol "◎" indicates the items to be inspected, while the symbol "-" indicates the items not to be inspected.					

7.2 Type inspection

7.2.1 Inspection content

Type inspection is a comprehensive quality assessment test for equipment, including appearance and structure, equipment motion control performance, drilling quality, metalized hole quality, printing quality, cutting accuracy, safety, power supply adaptability, electromagnetic compatibility, environmental adaptability, and operational stability. Equipment should pass type inspection during design and production.

7.2.2 Quantity of Inspection Equipment

The number of equipment in the final inspection is 2.

7.3 Delivery Inspection

7.3.1 Enterprises engaged in mass production or continuous production shall conduct a full acceptance inspection upon delivery.

7.3.2 Delivery inspection includes unboxing inspection and performance inspection under normal temperature conditions.

During the inspection, if one item is found to be unqualified, it should be re inspected after repair. If any of the items fails again, the equipment will be judged as unqualified.

7.4 Routine Inspection

7.4.1 Equipment produced in batches should undergo routine inspections for each batch. Continuous production equipment shall undergo routine inspection at least once a year.

7.4.2 Routine inspection equipment should be randomly selected from the qualified equipment for delivery inspection, and the number of test equipment should be 2.

7.4.3 Except for reliability assessment, all other items shall be carried out in accordance with the following regulations. When there is a malfunction or any item does not meet the requirements during the inspection, the inspection shall be redone after repair. Afterwards, perform the following inspections in sequence. If a fault occurs again or a certain item is not met, identify the cause of the fault, submit a fault analysis report, and after repair, conduct routine tests again. When a certain item is found to be unsatisfactory during the re inspection, it is judged that the equipment does not meet the routine test.

Equipment that has undergone environmental testing during routine inspection should be marked and a routine

test report should be submitted after inspection.

8. Marking, packaging, transportation, and storage

8.1 Logo

The packaging box should have markings such as equipment name, equipment model, manufacturer name and address, production date, equipment batch number, and standard number in this document. The packaging box shall be spray painted or affixed with transportation signs such as "Fragile Items", "Rain Afraid", "Upward" and "Stacking Layer Limit", and all signs shall comply with the relevant provisions of GB/T 191-2008.

The markings sprayed or pasted on the outside of the packaging box shall not fade, discolor, or fall off due to normal transportation or storage conditions.

8.2 Packaging

The packaging box should meet the requirements of moisture-proof, dust-proof, and vibration proof. After the equipment is cleaned and tidy, it should be packed into a cardboard box and included with random documents such as driver CDs, equipment lists, spare accessories, equipment manuals, and certificates of conformity.

8.3 Transportation

Equipment should not be transported in open cabins and carriages, and should not be stored in open-air warehouses during transit. During transportation, it is not allowed to ship flammable, explosive, or corrosive items in the same vehicle, and the equipment is not allowed to be damaged by rain, snow, or liquid exposure to rain or mechanical damage

8.4 Storage

The equipment should be stored in its original packaging box, and the warehouse environment temperature for storing the equipment should be at room temperature. Various harmful gases, flammable and explosive equipment, and corrosive chemicals are not allowed in the warehouse, and there should be no strong mechanical vibration, impact, or strong magnetic field effects. The packaging box should be placed at least 20cm off the ground and at least 50cm away from walls, cold sources, heat sources, windows, or air inlets. If there are no other regulations, the storage period generally does not exceed 6 months. If it exceeds 6 months, a new delivery inspection should be conducted.