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REPORT

on

COMPONENT - Wiring, Printed

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DESCRIPTION

PRODUCT COVERED:

USR - Single layer printed wiring boards. See Table IA for Type Designations.
CNR - Single layer printed wiring boards. See Table IA for Type Designations
JLC-3, **JLC-5**, **JLC-6**, **JLC-7**.

TECHNICAL CONSIDERATIONS (NOT FOR FIELD REPRESENTATIVE'S USE):

USR - United States Recognized.
CNR - Canadian Standards Recognized.

Use - The boards are for use only in electrical equipment where the acceptability of the combination has been determined by UL LLC.

CONDITIONS OF ACCEPTABILITY - The following are among the considerations to be made in judging the suitability of the boards in the end product.

1. Pattern Limits - Conductor pattern limits are specified in Table IA and IB. The edge conductor width and midboard conductor width specified in Table IA are the minimum acceptable widths. The maximum area diameter is the maximum unpierced conductor area of any pattern, typically a ground plane, on a printed wiring board and is determined by the largest circle that can be inscribed within the conductor. The minimum separation between silver conductors of different potential is specified in Table IB. Flame Only boards are not evaluated to determine the minimum acceptable conductor widths, maximum area conductor diameter, and the silver conductor limitations and shall be considered during the end product evaluation.
2. Surface Mount Technology - Printed wiring boards with circuitry using surface mount technology shall be Recognized with an assembly solder process. "Yes" is used in Table IA to indicate the printed wiring board types that may contain surface mount technology. "No" is used to indicate the printed wiring board types that cannot contain surface mount technology.

CONDITIONS OF ACCEPTABILITY (Continued) -

3. Assembly Solder Process and Solder Limits - Assembly solder process (ASP) and solder limits are a critical parameter for the printed wiring board and are used as preconditioning for the flammability classification and the maximum operating temperature (MOT). Assembly solder process and solder limits are profile(s), temperature(s) and time(s) representing the anticipated PWB production component assembly process(es). The component assembly solder process specified in Table IA shall not exceed the indicated peak temperature on the printed wiring board surface, dwell-time exposure and/or number of cycles during reflow, wave, dip or an equivalent soldering operation. Printed wiring boards with circuitry using surface mount technology shall be evaluated to the assembly solder process requirements. If the printed wiring board does not contain surface mount technology, either assembly solder process or solder limit requirements shall be evaluated. If Table IA indicates both ASP and solder limits for a single Type, then both ASP plus the solder limits have been evaluated.

The UL 796 standardized assembly soldering profiles are not prescriptive and may not represent the exact component assembly solder process. The board maximum surface temperature measured during the assembly solder process determines the peak temperature. The number of cycles for all soldering processes when the soldering is done in different steps shall not be exceeded. The cumulative time is not controlled if the number of soldering cycles is not exceeded. Assembly solder process Recognition may represent reflow, wave and/or selective soldering or other equivalent soldering techniques if the number of cycles is not exceeded. The solder limits represent wave or selective soldering techniques. The assembly solder process and solder limits do not apply to hand soldering.

4. Maximum Operating Temperature (MOT) - The maximum continuous use temperature the board is exposed to in the end product shall not exceed the value specified in Table IA with consideration to solder limits and ASP during the assembly soldering process. The maximum operating temperature is not evaluated for Flame Only boards and shall be considered during the end product evaluation.

CONDITIONS OF ACCEPTABILITY (Continued) -

5. Flammability - The flammability classification, with consideration to solder limits and ASP during the assembly soldering process, for the board is indicated in Table IA. The classification is based on samples tested in accordance with UL 94 and CAN/CSA-C22.2 No. 0.17 test methods with and without nonmetallic permanent coatings (such as solder resist). Only Permanent Coatings (ex: solder resist, hole plugging material, decorative coating, overcoat and/or undercoat) specified in the Permanent Coatings Table IIIA and Table IIIB may be employed. Unless specified in Table IIIA, multiple layers of permanent coatings may not be employed. If the board assembler or end product manufacturer applies any permanent coating, the effect on the flammability of the board is to be determined in the end product evaluation. Marking ink and flux are not considered a permanent coating. Non-flame and HB rated Types may be coated with any permanent coating.
6. Silver Conductors - The minimum clearance and creepage distance between any two silver conductors of different potential must not be less than that indicated in Table IB. The silver conductors have been found suitable only for circuits that do not require a dielectric strength potential greater than that indicated between adjacent parts and conductors. The maximum voltage applied between any two silver conductors of different potential shall not exceed that listed in Table IB. Reference to silver conductors includes silver, electroless or electroplated silver plating, or silver paste, for purposes of this report, unless otherwise indicated. Immersion Silver, Tin-Silver-Copper [Sn-Ag-Cu(SAC)] alloy, other silver containing tertiary alloys, and Tin-Silver (SnAg) alloy coated conductors do not require a silver migration evaluation. Flame Only boards are not evaluated to determine if silver conductors are present on the board, and the effect of silver conductors on the board shall be considered during the end product evaluation.
7. Direct Support of Current-Carrying Parts - Printed wiring boards used as a dielectric barrier and/or substrate for conductors of opposite polarity are identified to meet direct support requirements (DSR) for current carrying parts at 120 Vrms or less and 15 A or less. Boards evaluated to determine the dielectric material(s) meets the UL 796 minimum levels for direct-support of current carrying parts are identified in Base Materials Table IIA to enable the OEM to select appropriate printed wiring boards for the end use application. Flame Only boards are not evaluated to determine direct support and shall be considered during the end product evaluation.

CONDITIONS OF ACCEPTABILITY (Continued) -

8. Comparative Tracking Index (CTI) - The CTI is expressed as that voltage, which causes tracking on a printed wiring board base material after 50 drops of 0.1 percent ammonium chloride solution has fallen on the material. Results of testing the nominal 3 mm (1/8 in.) thickness are considered representative of the material's performance in any thickness. Boards shall be assigned a performance level category (PLC) for CTI based on the PLC assigned to the base material. The CTI is identified in Table IIA and shall be used by the OEM in selection of PWBs for applications in which the CTI rating is significant, such as for decreased clearance and creepage distances. Flame Only boards are not evaluated to determine CTI and shall be considered during the end product evaluation. For CNR, the actual CTI values are indicated in Table IIA.

CTI Range Tracking Index (TI in Volts)	Assigned PLC
600 and greater	0
400 and up to 600	1
250 and up to 400	2
175 and up to 250	3
100 and up to 175	4
Less than 100	5

9. Voltage Rating - No voltage rating is assigned. The suitability of the dielectric base material(s) as insulation between different potential conductors and between these conductors and dead-metal parts shall be determined in the end product evaluation. See Table IB for silver voltage limitations and Table IIA for base material identification.
10. Mechanical Strength - The adequacy of the board for the support and replacement of components shall be considered in the end product evaluation and shall be considered in the end product evaluation.
11. EMI Shielding Films - The adequacy of EMI shielding has not been evaluated for shielding properties.
12. Embedded Components - The function of the embedded component shall be considered during the end product evaluation.

CONDITIONS OF ACCEPTABILITY (Continued) -

13. Flammability Only Boards - Printed wiring boards investigated for flammability characteristics only. The bond strength of conductors, delamination and blistering of base materials, direct support, CTI and/or the silver conductor limitations shall be considered during the end product evaluation.
14. Printed Wiring Board construction modification - For any changes in the construction, such as addition, deletion, or change in material, the requirements for printed wiring boards in UL 796 shall be followed.
15. Other Considerations - The following items shall be considered for insertion into the end product report:
 - A. Minimum required spacing between conductors of different potential and between these conductors and dead-metal parts. Cupping, twisting, bowing and/or warping of the board has not been evaluated.
 - B. Minimum Creepage Spacing between conductors on opposite sides and closest to the printed wiring board edge shall not be less than the minimum creepage spacing between conductors on the same side/plane. If the printed wiring board edge creepage spacing is less than the surface creepage spacing, the function shall be considered during the end product investigation.
 - C. Minimum required dielectric/insulation thickness (distance through) between conductor layers has not been evaluated regarding dielectric strength requirements in the end product design.
 - D. Pattern Limits. The narrowest conductor width shall not be less than the indicated minimum width mid-board or edge conductor depending upon operating temperature and/or ampacity conditions, as indicated in the end product report. Flame Only boards, the minimum width conductors have not been established.
 - E. Thickness or weight of conductors.
 - F. Assembly Solder Process (ASP) and/or Solder limits.
 - G. The overall board dimensions.
 - H. Identification marking.
 - I. For flammability classification, identification of coatings applied by the assembler, end product, or user.

GENERAL CHARACTERISTICS:

The printed wiring boards must meet the pattern limits, solder limits and/or assembly solder process given by Engineering Considerations and Table IA and IB.

The printed wiring boards are fabricated from the base materials shown in Table IIA, having a solid external copper sheet in the minimum thickness shown bonded to one or both sides of the external laminate, unless otherwise indicated. The maximum external board conductor thickness of 102 microns may be used unless otherwise indicated.

The overall thickness of the finished board must be equal to or greater than the minimum indicated in the "Min Thk" column in Table IIA, excluding conductors.

The printed wiring boards are fabricated with permanent coatings (solder resist and/or decorative coating) applied to the external surface as indicated in Table IIIA and IIIB. Hole plugging materials are used to fill the board vias as described in the manufacturing process and Table IIIA and IIIB.

There shall be no changes, additions or substitutions made by the manufacturer in the printed wiring board production as described without prior written clearance from UL LLC.

MARKING - See Section General.

TABLE IA - PARAMETER PROFILE INDICES

Type	Pattern Limits			Surface Mount Technology Yes/No	ASP Conditions	Assembly Solder Process (ASP)		Solder Limits		Max Oper Temp (C)	Flame Class	USR/CNR
	Min Cond Width (mm)	Min Edge Cond Width (mm)	Max Area Diam (mm)			Temp (C)	Cycles	Max Temp (C)	Max Time (sec)			
JLC-3	0.1@	0.3@	25.4	Yes	ASP 1	260	2	288	20	130	V-0	USR/CNR
JLC-5	0.15	0.30	25.4	Yes	ASP 1	260	2	288	20	115	V-0	USR/CNR
JLC-6	0.10	0.30	25.4	Yes	ASP 1	260	2	288	20	130	V-0	USR/CNR
JLC-7	0.10	0.30	25.4	Yes	ASP 1	260	2	288	20	130	V-0	USR/CNR

Notes:	
ASP 1 -	Assembly solder process evaluated to IPC-TM-650, 2.6.27 Thermal Stress Assembly Simulation
USR -	United States Recognized
CNR -	Canadian Standards Recognized
@ -	When the external copper thk range from 102mic to 140mic, the Min Width and Min edge Width is 0.30mm

TABLE IB - SILVER CONDUCTOR LIMITATIONS

Type	Silver Conductor Materials Present (Yes/No)	Min. Spacing Between Adjacent Silver Conductors of Different Potential (mm)	Maximum Voltage Withstood Between Silver Conductors (V dc)
JLC-3	No	Not determined	Not determined
JLC-5	No	Not determined	Not determined
JLC-6	No	Not determined	Not determined
JLC-7	No	Not determined	Not determined

Note: See Conditions of Acceptability for types of silver conductors that do not require silver migration evaluation.

TABLE IIA - BASE MATERIALS

Type	Base Material & Individual Laminate Matl			Min Thk (mm)	SS/ DS@	Min Cond Thk# (mic)	Max Cond Thk# (mic)	Mfg Proc	Meets DSR	CTI V (PLC/V)
	UL/ ANSI Grade	+ UL File	Grade							
JLC-3	FR-4.0	E123995	KB-6160, KB-6164	0.38	DS	E:12	E:140	A	YES	3/175
	FR-4.0	E359866	HY-8101, HY-8102	0.38	DS	E:12	E:140	A	YES	0/600
	FR-4.0	E136069	H140A, H140A M	0.38	DS	E:12	E:140	A	YES	3/175
	FR-4.0	E213990	NY2140, SN- L2 (NY1140), SN- L4 (NY1140), NY2140H, NY2140L, NY-A0	0.38	DS	E:12	E:140	A	YES	3/175
	FR-4.0	E109769	Q100, Q100A, Q100B, Q100C, Q100D, Q100E, Q100F, Q100G	0.38	DS	E:12	E:140	A	YES	3/175

- & - Recognized Component, (QMTS2)
- # - E: External copper thickness
- @ - SS: Single Sided; DS: Double Sided or Single Sided
- + - See Table IIB for UL File and Manufacturer Name

TABLE IIB - Base Material File Number and Manufacturers (Refer to TABLE IIA)

UL File	Manufacturer
E123995	Kingboard
E359866	Jiangxi Hangyu
E136069	Zhejiang Wazam
E213990	Nanya New
E109769	Shengyi

TABLE IIA - BASE MATERIALS

Type	Base Material &			Min Thk (mm)	SS/ DS@	Min Cond Thk# (mic)	Max Cond Thk# (mic)	Mfg Proc	Meets DSR	CTI V (PLC/V)
	Individual Laminate Matl									
	UL/ ANSI Grade	+ UL File	Grade							
JLC-5	NO ANSI	E102763	RO4350B™, RO4350B2™, RO4350B3™, RO4350D™	0.51	DS	E:17	E:102	A	YES	0/600
JLC-6	NO ANSI	E109769	SCGA-500 GF255	0.76	DS	E:17	E:102	A	YES	0/600
JLC-7	NO ANSI	E109769	SCGA-500-GF300	0.76	DS	E:17	E:102	A	YES	0/600

& -	Recognized Component, (QMTS2)
# -	E: External copper thickness
@ -	SS: Single Sided; DS: Double Sided or Single Sided
+ -	See Table IIB for UL File and Manufacturer Name

TABLE IIB - Base Material File Number and Manufacturers (Refer to TABLE IIA)

UL File	Manufacturer
E102763	Rogers
E109769	Shengyi

TABLE IIIA - PERMANENT COATINGS (RECOGNIZED COMPONENT - QMJU2)

Types	Process	Solder Resists +
JLC-3	A	1, 2, 3
JLC-5	A	1, 2
JLC-6	A	1, 2
JLC-7	A	1, 2

+ - See Table IIIB for Permanent Coating Grade, UL File, and Manufacturer

TABLE IIIB - PERMANENT COATINGS GRADE, UL FILE and MANUFACTURERS

No.	Solder Resist		
	Grade	UL File	Manufacturer
1.	KSM-S6189/KSM-19 (ALL)	E189612	Guangzhou Kuangshun
2.	H-9100/H-9100B (GN)	E203293	Shenzhen Rongda
3.	SR-500/CA-66 (ALL)	E466073	China S.M

MANUFACTURING PROCESS:

1. Machining, cleaning, rinsing, air-drying and similar operations may be performed by the manufacturer but are not required to be listed in the following process description(s).
2. If not listed in the process description(s), temperatures equal to or above 100C or above the MOT of the board Type, whichever is greater, shall not be used in the following process description(s).
3. Conductive coatings and/or platings used in the production of the printed wiring board Type(s) shall be specified in the manufacturing process description(s).
4. Any of the steps in the following process description(s) may be omitted from the manufacturing process at the manufacturer's option unless the process step is noted as a MUST step.
5. There shall be no changes, additions or substitutions by the manufacturer to the following manufacturing process(es) without prior written clearance from UL LLC.
6. Process steps can be performed by an outside facility (subcontractor, multisite processor or alternate manufacturing location). Documentation is to be provided by the original manufacturing location to the outside facility (see Appendix D for the service/work (traveler) instructions). This documentation and the finished boards shall be returned only to the original manufacturer.

Critical steps (including, but not limited to, temperatures equal to or above 100C or the MOT, whichever is greater) performed by an outside facility (subcontractor) shall be indicated in the Process description by the footnote "++". The subcontractor shall be indicated in the Section General. The alternate manufacturing location shall be indicated in the Authorization Page or Addendum.

Non-critical steps (including, but not limited to, temperatures below the MOT or 100C) may be performed by any outside facility (multisite processor).

If the outside facility is procuring materials directly from the material vendor, the outside facility shall be documented as a subcontractor.

PROCESS A:

1	May cut boards.
2	May bake board at 160°C maximum for 120 minutes maximum.
3	May drill and debur boards.
4	May scrub boards.
5	May electroless plate copper over through holes or entire board.
6	May plug hole using hole plugging material, and then Boards may be dried at 190°C maximum for 6 hours maximum. Hole plugging materials used in this step must be encapsulated by copper.
7	May electroless copper plate or electroplate copper plate.
8	May print pattern by silk screening or laminate dry film at 120°C maximum for 30 mins maximum.
9	May electroplate copper, then electroplate tin-lead.
10	May strip plating resist.
11	May etch using any etchant except chromic/sulfuric.
12	May strip tin-lead.
13	Non-flame and HB rated types may be coated or hole plugged with any solder resists. V rated types may be coated or hole plugged with the resists indicated in the following pages. Boards may then be dried at 180°C maximum for 120 minutes maximum and solder resist and hole plugging material are applied in one single step with the same material.
14	May apply marking ink, and cure at 160°C maximum for 240 minutes maximum.
15	May apply solder using hot air solder level at 288°C maximum for 20 seconds maximum.
16	May electroplate nickel and then gold on contact fingers or entire pattern.
17	May immersion Ni/Au.
18	May perform punching or routing.
19	May wash boards and dry at 100°C maximum for 30 minutes maximum.
20	May apply flux or ENIG.
21	No other plating operations performed and no other temperature greater than 100°C encountered.