



**CONSUMER
TECHNOLOGY**



WIRED FOR SUCCESS

**COMPREHENSIVE COMPLIANCE & PERFORMANCE
SOLUTIONS FOR PRINTED WIRING BOARDS**

UL CONSUMER TECHNOLOGY: SUPPORTING THE SUCCESS AND SAFETY OF PRINTED WIRING BOARDS (PWBS)

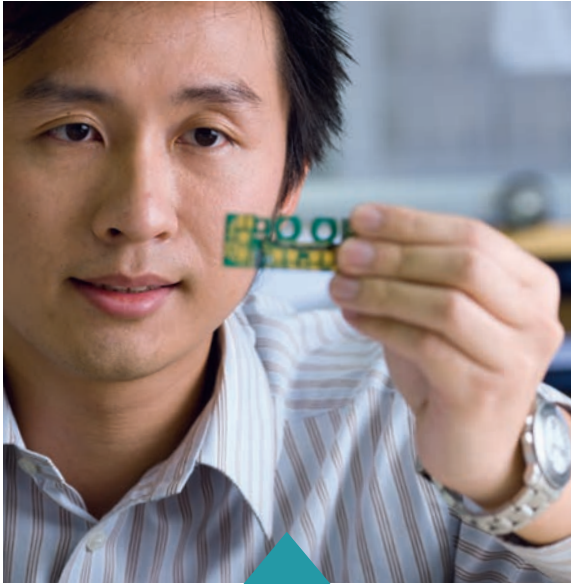
UL is one of the most recognized and trusted certification marks

for consumer technology. For more than 50 years, UL has been advancing safety science in support of PWB conformance assessments, now also covering extensive performance testing options which can help enhance your products' reputation for reliability.



THE COMPLETE SOLUTION FOR SAFETY, COMPLIANCE AND PERFORMANCE

UL is a symbol of trust in key markets around the world – with a solid reputation and unique set of values:

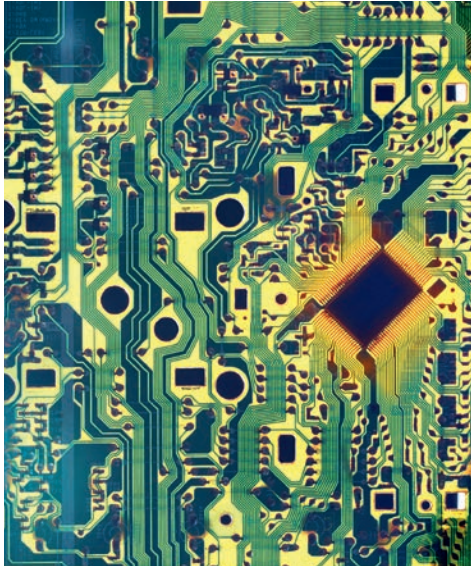


DRIVEN BY PURPOSE

Our sole purpose is to help ensure products are safe and compliant in order to help you get your product to market on time with minimal complications.

DEDICATED ENGINEERS

We attract and hire expert safety and compliance engineers who are committed to understanding your products and guiding you through the entire process.



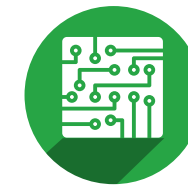
TRUSTED ADVICE

We offer practical advice and support to help ensure you get the test result you need to launch on time. This includes regulatory updates, specialist consultancy support, and a preliminary examination of your product to highlight any issues that may result in a test fail.

EFFECTIVE PLANNING

We are a single business who manages your project and gives you access to our comprehensive resources and facilities throughout the world. Our project kick-off sessions create a plan for your product launch and the project planning portal helps you stay up to date with access to all the updates, data and information you need.

TESTING SERVICES FOR PWBs



OPTIMIZED MARKET ACCESS

UL offers a full range of testing and certification services to UL Standards and many other international, national and regional requirements, including ASTM, IPC, and IEC.

In each market you are targeting, UL can help you gain the confidence you need to succeed there. The scope of UL services include:

PRE-CERTIFICATION SERVICES

- Consulting
- Planning
- Project optimization
- Quotation

SAFETY TESTING & CERTIFICATION

- PWB-specific compliance to UL Standards
- PWB-related compliance
- UL Recognized Components
- Production Board Testing

PERFORMANCE & RELIABILITY TESTING

- Interconnect Stress Testing
- Signal Integrity Testing
- Conductive Anodic Filament Growth
- Coating Testing – Conformal Coating & Solder Mask

OVERALL TESTING CAPABILITY

- Advanced Analytical
- Chemical
- Electrical
- Environmental
- Flammability
- Mechanical & Physical
- Coatings

UL SERVES MANUFACTURERS ACROSS THE ENTIRE PWB SUPPLY CHAIN:

INDUSTRIAL LAMINATES

- rigid
- ultra-thin
- flexible
- high density-interconnect
- metal-based
- metal-clad laminates

COATINGS & SOLDER MASKS

- solder resist
- conformal coating
- films
- liquids
- photo-imageable
- UV curable

PRINTED WIRING BOARDS

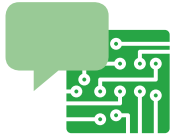
- single layer
- multilayer
- hybrid
- flexible
- flex-rigid
- metal-based

ASSEMBLIES

- Traceability program

PAVING THE WAY FOR FUTURE COMPLIANCE

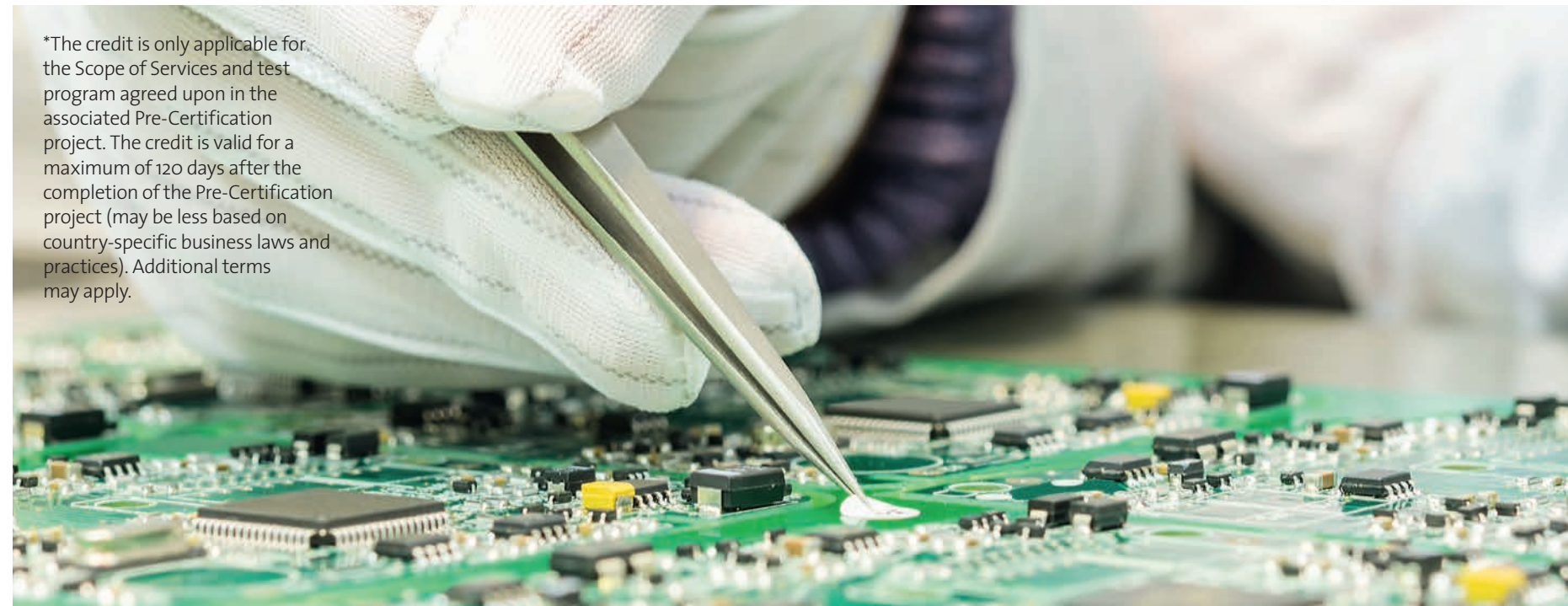
PRE-CERTIFICATION SERVICES



UL's pre-certification reviews are designed to shorten the path to certification. Through an advanced technical consultation with a UL engineer, we'll help make sure you fully understand the sample requirements and test program ahead of time, thus avoiding potential costly delays. Pre-certification reviews are also eligible for a 100% credit toward certification costs.*



PRE-CERTIFICATION PROCESS



*The credit is only applicable for the Scope of Services and test program agreed upon in the associated Pre-Certification project. The credit is valid for a maximum of 120 days after the completion of the Pre-Certification project (may be less based on country-specific business laws and practices). Additional terms may apply.

BENEFITS

ACCELERATED TIME TO MARKET

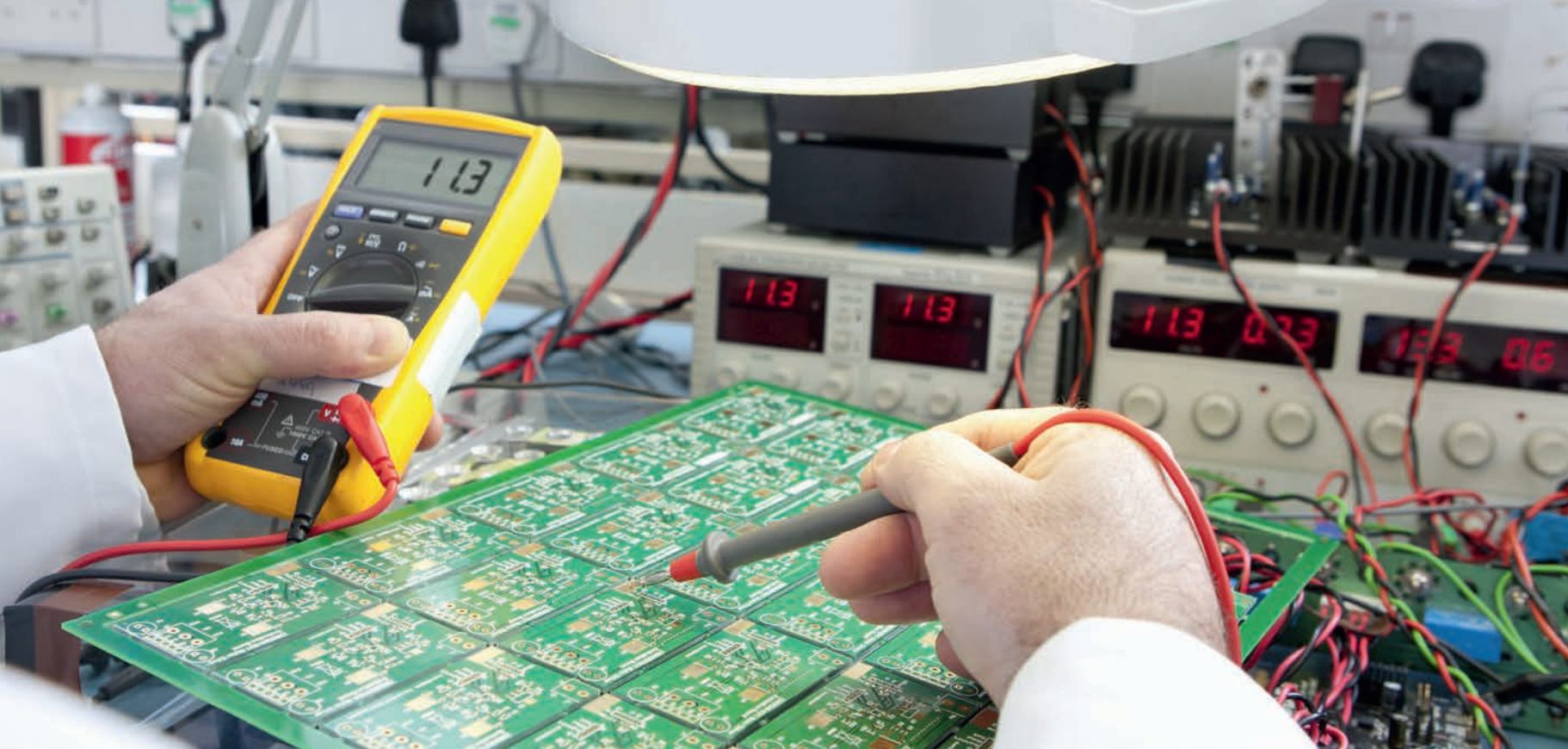
UL makes sure that you understand the test program and its requirements, enabling you to avoid obstacles and proactively build in efficiencies that accelerate certification. In addition, pre-certification identification of potential non-compliance issues allows you to correct them before they occur.

DECREASED COSTS

UL minimizes the possibility of expensive rework or redesign delays resulting from improper sample submissions and test failures.

INCREASED PEACE OF MIND

UL keeps you informed and up to date throughout the entire process, so you can feel confident that your product and your business needs are well cared for.



SETTING THE BENCHMARK

SAFETY TESTING AND CERTIFICATION



UL is the only organization that issues PWB safety standards. Make use of our technical expertise in safety testing and certification services to achieve regulatory compliance as well as communicate to customers that your product has been tested to the benchmark of product safety.

UL's extensive relationships across the entire printed wiring board supply chain have manufacturers turning to us when they are looking for reliable components from trustworthy sources. Your customers will also value how UL assists them to eliminate duplicate testing of the finished end products when they contain UL Recognized components.

All testing can be conducted in UL accredited laboratories or in your own qualified facilities.

UL Standards for PWBs

For UL recognition of PWB safety, the following standards apply:

- **UL 796** Printed Wiring Boards – for standard rigid, metal-based and HDI PWBs
- **UL 796F** Flexible Materials Interconnect Constructions – for flexible and flex-rigid PWBs
- **UL 746E** Polymeric Materials – for industrial laminates and materials used in PWBs
- **UL 746F** Polymeric Materials – for flexible dielectric film materials
- **UL 94** – for flammability of plastic materials

UL Standards related to PWBs

Certification is driven by end-product requirements. The actual PWB ratings required are dependent on the end-product application and how the PWB will be employed. Always check with the end-product manufacturer to determine what ratings they require. Many end-product standards, such as the following, require UL Recognized PWBs:

- **UL 60950** – Information Technology Equipment
- **UL 60065** – Audio & Video Equipment
- **UL 62368** – ITE and Audio/Video Equipment
- **UL 60601** – Medical Equipment
- **UL 60335** – Appliances
- **UL 61010** – Industrial Control Equipment
- **UL 8750** – LED Equipment

UL Recognized = enhanced market acceptance

PWB components and materials that are recognized by UL are known to have undergone the industry's most stringent safety testing and follow-up program. UL Recognized Components are listed in UL's Online Certifications Directory www.ul.com/database and the UL iQTM database iq.ul.com/pwb. This allows your customers to search and identify the components and materials they need to complete their subassemblies or end products.

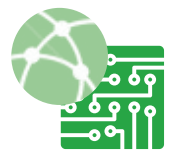
Quick-Turn Certification for rush orders

UL also offers Quick-Turn Certification of production boards to UL 796. This service allows for faster time to market by testing actual production boards instead of requiring specialized samples which first need to be created. The service is limited to the tested build of materials, construction stack-up, and trace layout.



EMPOWERING THE PWB INDUSTRY

PERFORMANCE & RELIABILITY TESTING



Advances in today's electronic applications depend upon sophisticated PWB technology. If it doesn't work, the whole product will be compromised. Increase your customers' confidence by demonstrating the PWB is not only compliant to regulatory safety requirements but also tested to perform reliably.

Our performance testing and certification programs apply to a comprehensive range of PWB components and materials. Every program can be customized to match the PWB application and meet your business needs.

INTERCONNECT STRESS TESTING

Interconnect Stress Testing (IST) speeds up temperature cycling to detect susceptibility to early failure, and thereby increases product reliability. It is twelve times faster than in an air-to-air thermal oven, creating the opportunity for greater testing output.

SIGNAL INTEGRITY TESTING

Signal Integrity Testing (SIT) determines the amount of signal propagation caused by the characteristics of the materials, conductors and accompanying structures on the PWB. Losses in the signal will result in frequency-dependent attenuation. UL performs five methods* of SIT testing, such as the particularly beneficial Single-ended TDR method and Differential Insertion Loss (SET2DIL).

* Method A: Effective Bandwidth (EBW) method
 Method B: Root Impulse Energy (RIE) method
 Method C: Short Pulse Propagation (SPP) method
 Method D: Single-Ended TDR to Differential Insertion Loss (SET2DIL) method
 Method E: Frequency Domain (FD) method

CONDUCTIVE ANODIC FILAMENT GROWTH

Conductive anodic filament failure involves the growth or "electro-migration" of copper in a PWB. This unintentional growth typically bridges two oppositely biased copper conductors resulting in a short circuit. Catching and correcting this potential failure can substantially lengthen product lifespans.

CONFORMAL COATING & SOLDER MASK TESTING

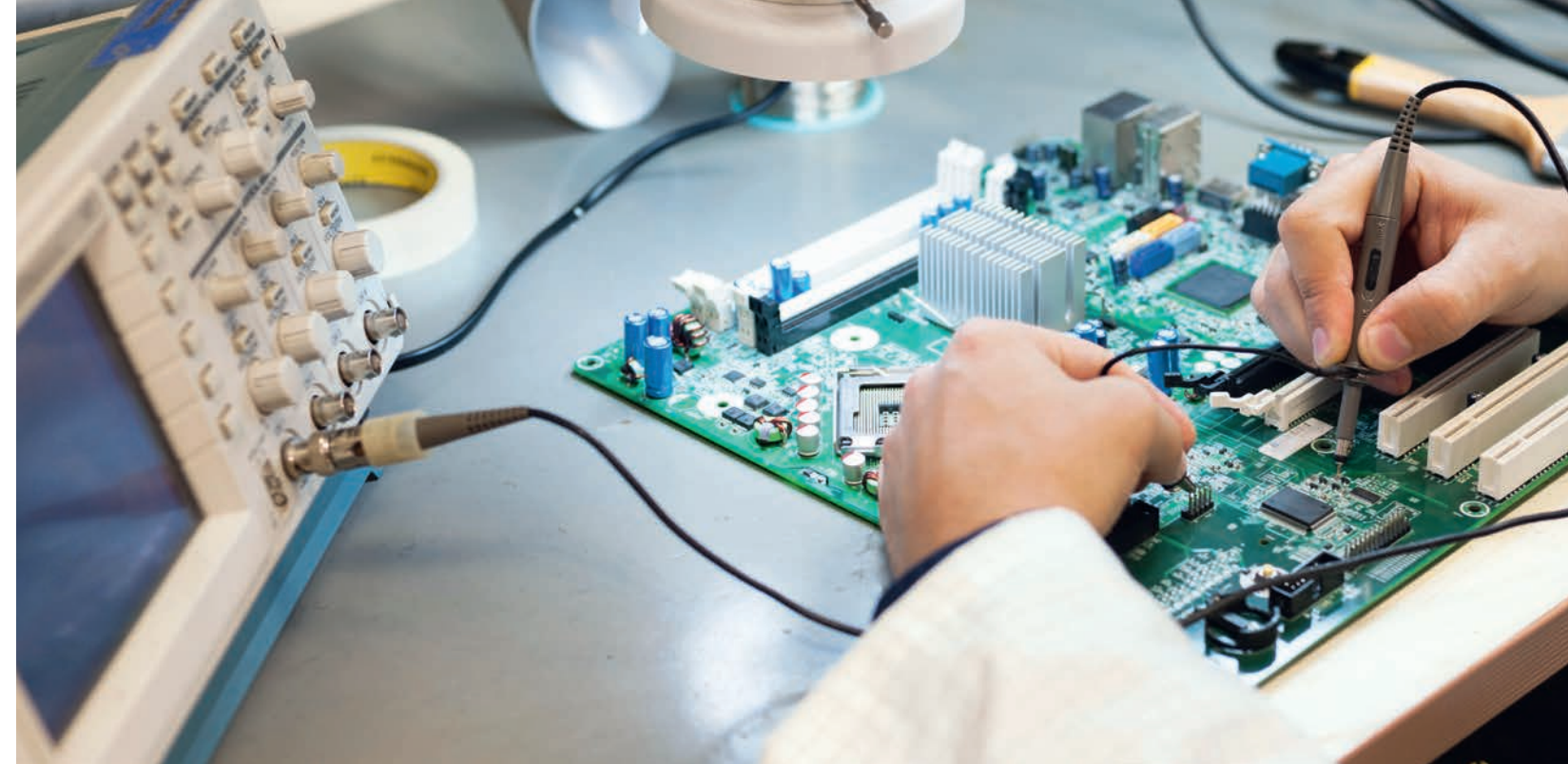
Conformal coatings are applied to electronic circuits to provide a barrier to moisture and contamination and to provide electrical insulation. UL offers a full suite of coating testing services, including:

- UL 746E evaluations
- IPC-CC-830: Qualification and performance testing of electrical insulating compounds for printed wiring assemblies
- IPC-SM-840: Qualification and performance specification of permanent solder mask and flexible cover materials
- IEC-60664-3: Insulation coordination for equipment within low-voltage systems, via the use of coatings to achieve insulation coordination of printed board Performance & assemblies



OVERVIEW OF SAFETY, PERFORMANCE, AND RELIABILITY TESTING

Explore our range of testing services. The following list includes commonly requested tests, such as flammability, ignition, long-term thermal aging and micro-sectioning analysis. We also perform many other tests that are not listed. Please contact us about custom testing and designing a test plan to fit your unique needs.



ADVANCED ANALYTICAL TECHNIQUES

- Atomic Absorption Spectroscopy (AAS)
- Ash Content
- Differential Scanning Calorimetry (DSC), Glass Transition Temperature
- Dynamic X-Ray (2D or 3D X-Ray)
- Dynamic Mechanical Analysis (DMA)
- Energy Dispersive X-Ray Spectroscopy (EDS)
- Extractions
- Failure Analysis (F/A)
- Fourier Transform Infrared Spectroscopy (FTIR)
- Gas Chromatography / Mass Spectroscopy (GC/MS)
- Gel Content
- Ignition Loss
- Inductively Coupled Plasma Spectroscopy/ Optical Emission Spectroscopy (ICP/OES)
- Ion Chromatography (IC)
- Microwave Digestion
- Scanning Electron Microscopy (SEM)
- Thermogravimetric Analysis (TGA)
- Thermomechanical Analysis (TMA)
- X-Ray (Live-time, non-destructive inspection of package)
- X-Ray Fluorescence (XRF)

CHEMICAL TESTING

- Alloy Composition
- Bisphenol A Content
- Chemical Resistance / Solder Resistance
- Density/ Specific Gravity
- Flammability
- Hazardous Substance Analysis
- Heavy Metals/Lead Content
- Ion Chromatography (IC)
- Organotin Content
- pH
- Phthalate Content
- RoHS
- Solder Paste - Slump Test
- Spitting of Flux-Cored Wire Solder
- Viscosity

ELECTRICAL TESTING

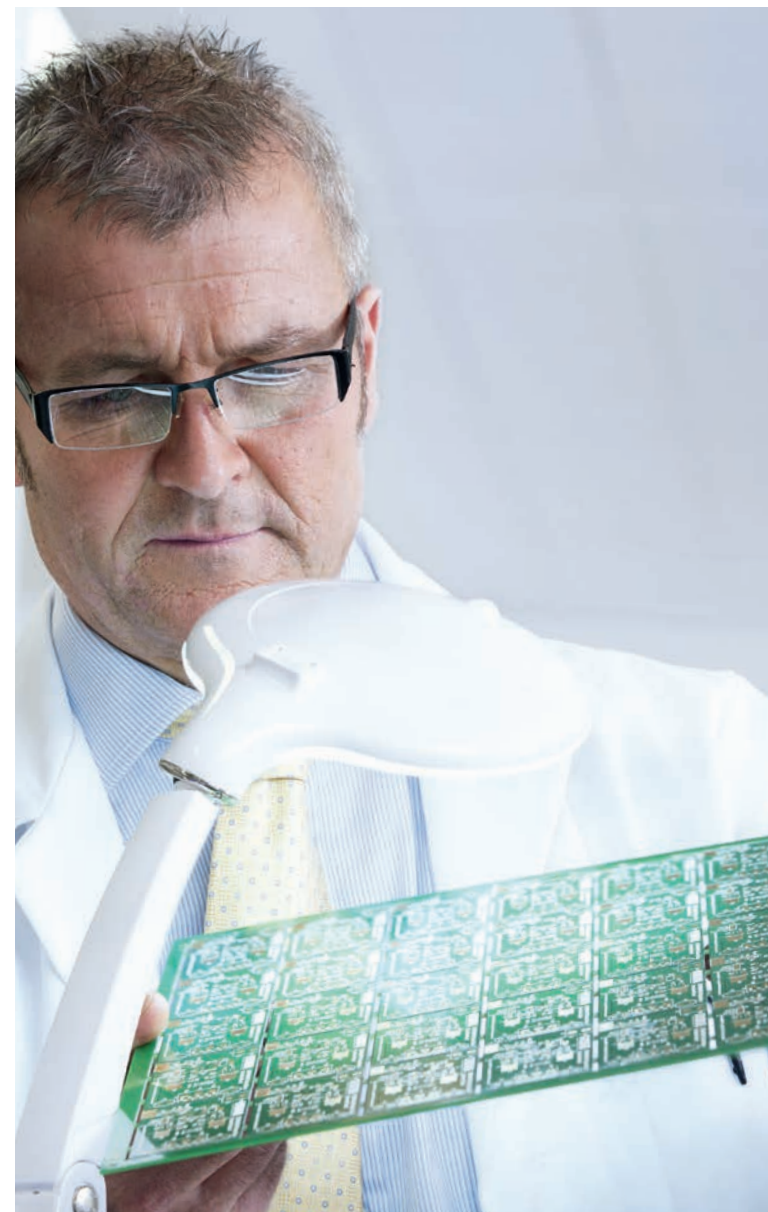
- Arc Resistance
- Capacitance
- Comparative Tracking Index (CTI)
- Conductive Anodic Filament Growth (CAF)
- Conductivity
- Dielectric Breakdown
- Dielectric Constant / Permittivity
- Dielectric Strength
- Dielectric Withstanding Voltage (DWV)
- Dissipation Factor / Loss Tangent
- Electromigration / Electrochemical Migration (ECM)
- High-Current Arc Ignition (HAI)
- High Voltage Arc Tracking
- Hot Wire Ignition
- Inclined Plane Tracking
- Interconnect Stress Test
- Resistance
- Signal Integrity Testing (SIT) / SET2DIL / TDR
- Surface Insulation Resistance (SIR) / Insulation Resistance
- Volume and Surface Resistivity

ENVIRONMENTAL TESTING

- Accelerated Aging
- Altitude
- Autoclave (Pressure Vessel)
- Conductive Anodic Filament (CAF)
- Chemical Resistance
- Cold Impact
- Corrosion Resistance
- Drop/Impact
- Drop Resistance
- Electromigration / Electrochemical Migration (ECM)
- Flammability
- Fluid Resistance
- Fungus Resistance
- Humidity (Cycling or Steady State)
- Hydrolytic Stability
- Immersion
- Interconnect Stress Test
- IP (Ingress Protection)
- Moisture and Insulation Resistance (MIR)
- Moisture Absorption
- Moisture Resistance
- Oxygen Index
- Salt Spray/Fog
- Solvent Resistance
- Temperature/Humidity
- Thermal Aging (UL)
- Thermal Cycling
- Thermal Shock
- Thermal Stress
- Time to Delamination
- UV Exposure
- Vicat Softening Point
- Water Spray
- Water Vapor Transmission / Water Absorption
- Weathering

FLAMMABILITY TESTING

- Burning Rate ASTM D 229, Sections 61-66 (Method I/Vertical)
- Burning Rate ASTM D 635 (Horizontal)
- Burning Rate FAA 25.853b5 (Horizontal)
- Burning Rate FMVSS 302 (49CFR571) (Horizontal)
- Burning Rate ISO 3795 (Horizontal)
- Burning Rate UL 94 HB (Horizontal)
- Burning Rate UL 94 HBF (Horizontal)
- Burning Rate UL 94 5V (Vertical)
- Burning Rate UL 94 V (Vertical)
- Burning Rate UL 94 VTM (Vertical)
- Flammability, Small Component, UL 1694
- Oxygen Index ASTM D 2863 (Procedure A/Test Method A)



MECHANICAL & PHYSICAL PROPERTY TESTING

- Abrasion
- Adhesion
- Bend Testing
- Bond Strength
- Bow and Twist
- Breaking Strength
- Brittleness
- Coating Thickness
- Coefficient of Friction
- Coefficient of Thermal Expansion (CTE)
- Compression Set
- Compression Properties
- Compressive Strength
- Cross-section Analysis
- Cure
- Deflection Under Load
- Deformation Temperature
- Dimensional Stability
- Dynamic Mechanical Analysis (DMA)
- Elongation
- Flexural Strength and Modulus
- Glass Transition Temperature by TMA
- Hardness
- Impact Strength
- Impact Resistance
- Lap Shear Strength
- Mechanical Cycling
- Mechanical Strength
- Microsectioning
- Peel Strength
- Plating Thickness
- Rework Simulation
- Shear Properties
- Shear Strength
- Softening Point
- Specific Gravity / Density
- Tear Resistance
- Tensile Impact
- Tensile Strength
- Tensile Properties
- Tension and Compression
- Young's Modulus

COATINGS – CONFORMAL COATING AND SOLDER MASKS

- Abrasion (Taber)
- Adhesion
- Appearance
- Coating Thickness
- Cure Time & Temperature
- Dielectric Strength
- Dielectric Withstanding Voltage (DWV)
- Electrochemical Migration
- Flammability
- Flexibility
- Fluorescence
- Fourier Transform Infrared Spectroscopy (FTIR)
- Fungus Resistance
- Hardness
- Hydrolytic Stability
- Insulation Resistance
- Lap Shear
- Moisture Insulation Resistance
- Peel Strength
- Q-Resonance
- Resistance to Chemicals, Solvents and Cleaning Agents
- Shelf Life
- Tensile Strength
- Thermal Shock
- Thermal Stress
- Viscosity
- Visual Requirements

STAY CONNECTED

Learn more at www.ul.com/pwb



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