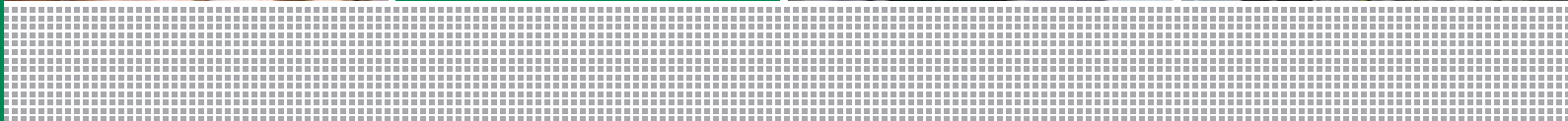




GLOBAL LAB
SERVICES AND
CAPABILITIES



Expertise Applied | Answers Delivered

Littelfuse global lab services

ability to test a wide variety of regulatory standards

confidential process for testing and sharing test results

expert staff available for design consultation

located globally to serve customers locally

our labs combine unique testing capabilities with expert consultation

We are keeping our leading edge in research and development with our network of global labs. Here, we design the products and solutions of the future and provide customer application support and testing.

The unique capabilities of our global labs include overcurrent, overvoltage, ESD and high-speed datacom and telecom testing, material analysis and specialized testing for new technologies, as well as application performance and regulatory compliance testing.



UPPER RIGHT: Wuxi lab team performing semiconductor failure analysis by preparing samples and examining with electron and optical microscopy.

RIGHT: Test engineer preparing polymer ESD (electrostatic discharge) suppressors for testing on automated test system.



rigid testing + technical expertise = best solution for safety and reliability

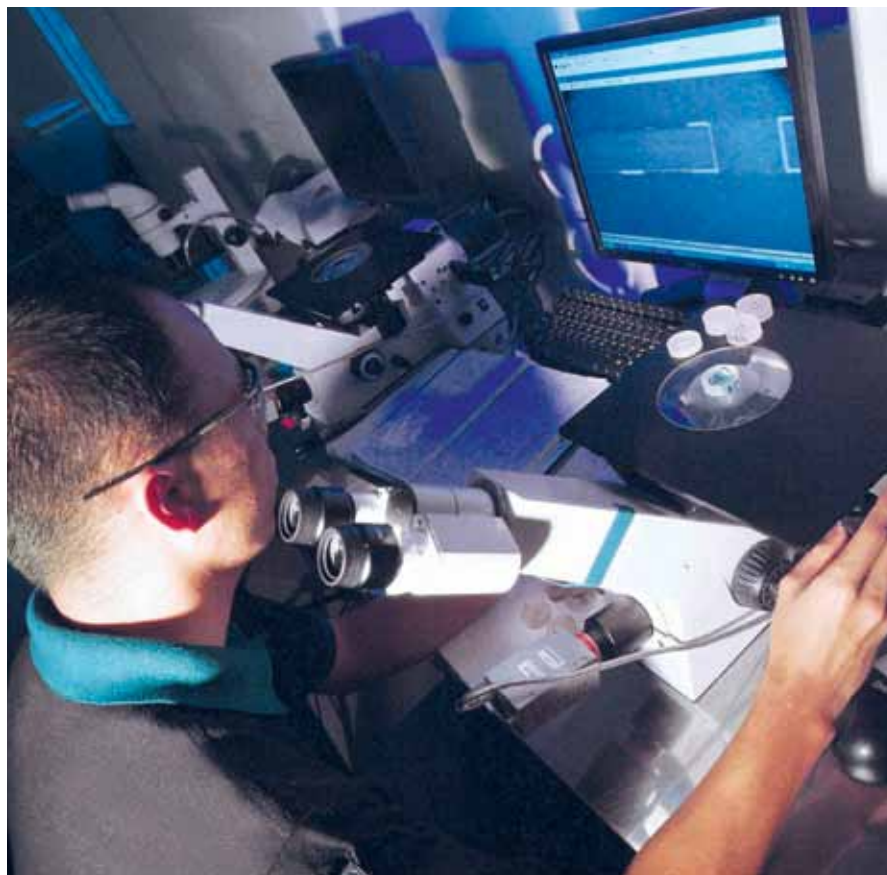
Our partnership-driven approach and technical expertise required to accurately conduct and analyze test results are the reasons why engineers around the world trust us to help them with their circuit protection needs. Because we offer the industry's broadest and deepest portfolio of products, we are not biased toward a particular technology and answer questions impartially to identify the right solution for each application.

Comprehensive Circuit Protection Testing Capabilities

Each Littelfuse lab is specially designed to comprehensively test our products, as well as our customers' products, against excessive conditions through to failure to ensure their safety and reliability.

Overcurrent Testing | Overvoltage Testing | ESD Testing | High Speed Datacom and Telecom Testing | Thyristor-Specific Testing | Failure and Material Analysis

A Littelfuse lab technician uses an optical microscope to examine cross-sectioned in-process fuse samples in the Philippines.



Specialty Area Testing Capabilities

Location	Testing Capabilities
Champaign, Illinois, USA	High Power Lab
Chicago, Illinois, USA	Silicon Lab, Materials Lab, Application Lab
Bremen, Germany	Product Evaluation, Reliability and Application Lab
Lipa City, Philippines	Materials Lab, Product Evaluation, Reliability and Application Lab
Piedras Negras, Mexico	Materials Lab
Dongguan, China	Product Evaluation, Reliability and Application Lab
Wuxi, China	Silicon Lab, Materials Lab
Yokohama, Japan	Materials Lab, Product Evaluation, Reliability and Application Lab



ABOVE: An engineer at our Champaign, Illinois facility performing High Power Lab resistor bank set up.

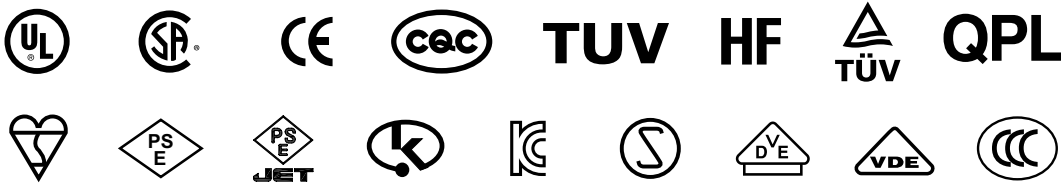


LEFT: At Littelfuse’s Materials lab, located in Piedras Negras, Mexico, a Lab Specialist inputs test parameters into the XRF machine to measure plating thickness.

our labs provide customers with invaluable services

Technical Expertise to Test to a Wide Variety of Regulatory Standards

With more than 80 years of industry experience and a global network of labs, Littelfuse has the expertise to make our customers' products safe and reliable and to help them meet regulatory standards. This saves customers the time and expense associated with achieving regulatory compliance for their products.



Representative Sample of Regulatory Standards to which products can be tested at Littelfuse global labs.

Dedicated, Expert Staff Available for Design Consultation

Littelfuse provides customers with dedicated application engineers who serve as partners offering design consultation, scheduling testing and presenting and evaluating all test results.

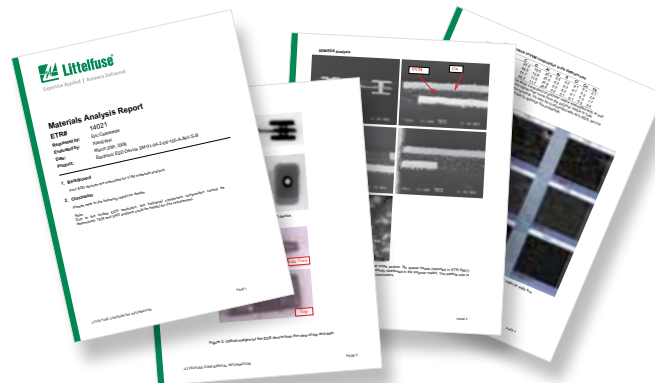
Confidential Process for Testing and Sharing Test Results

Our testing procedures are carefully designed to assure all customer product information remains private. Beginning with the testing environment through presenting test results, all information is held confidentially and released only to the customer.

Test Results are Available Quickly

Test results are captured on an advanced computerized system that delivers results immediately following a test, and application engineers are available to provide further evaluation of all data.

Example of an Evaluation Report, available immediately following testing.





TOP LEFT: Scanning electron microscope (SEM) and energy dispersive X-Ray (EDX) monitors showing sample image and elemental composition.

TOP RIGHT: Network analyzer measuring network parameters of silicon protection device on test board.

LEFT: Across the globe, Littelfuse application engineers work closely with customers, providing customized, confidential service.



our labs offer unique circuit protection tests and testing equipment

Silicon Application Labs

These labs are ideally suited for semiconductor product testing and provide new product and process validations, and customer application testing including regulatory compliance and failure analysis.

Tests and Capabilities

- Lightning Surge Testing
- Regulatory Compliance
- AC Power Cross Testing
- Environmental Testing
- Semiconductor Parametric Testing
- High Speed Device Characterization Testing
- Failure Analysis
- ESD Testing
- Power and Dynamic Testing
- Application Testing

The Littelfuse Silicon Applications Group uses the Surge Generator located in Chicago, USA, to test customer equipment to a wide variety of telecom standards.





The High Power Lab control room allows engineers to control and view the tests safely from behind bullet-proof glass. All tests are recorded by cameras and data acquisition equipment, providing test results and images immediately following the test.

High Power Lab

This full-service lab is ideally suited to testing products that require short circuit tests up to 50kA at various voltages and power factors. It is also fully rated at direct current for various time constants.

Located in the Research Park at the University of Illinois—ranked in the top five U.S. universities for electrical engineering—the Littelfuse High Power Lab is available to other organizations that wish to conduct their own testing.

Tests and Capabilities

AC Capabilities at 60Hz Nominal/Symmetrical			
AC Voltage	Three Phase (kA)	Single Phase (kA)	Power Factor (%)
120	40	35	30
250	50	50	20
480	40	40	20
600	30	30	30
1000	20	20	20

DC Capabilities		
DC Voltage	Max Current (kA)	Time Constant (ms)
125	30	10
250	40	10
300	50	10
600	30	10
1000	20	10

Impulse Testing Capability

The high power surge generator produces up to 60kV/100kA, 8x20μs impulse waveforms and is used to ensure customer applications pass regulatory standards.



ABOVE: The high power surge generator, located in the High Power Lab, has also been called the Lightning Generator because it generates 60kV, 100kA surges.



LEFT: The High Power Lab generator is an Allis Chalmers design, capable of producing 10MW of power.

Lab engineers conduct reliability tests in the Dongguan facility.



Product Evaluation, Reliability and Application Labs

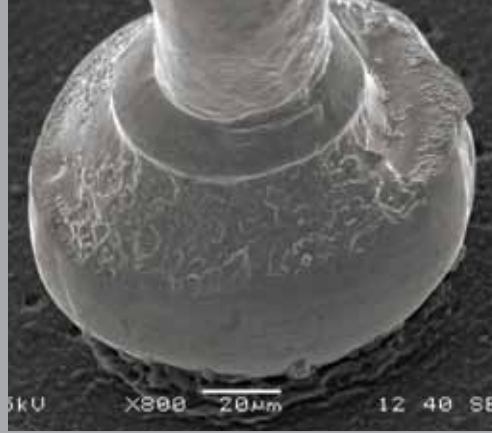
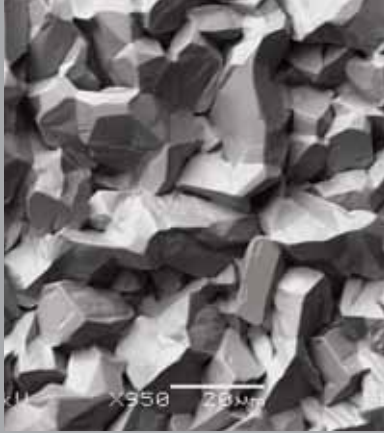
These labs are ideally suited for product evaluation and reliability tests. Other features accommodate product development/operations support validation, reliability, performance evaluation, high current DC testing (up to 3000A), environmental testing, regulatory compliance and failure analysis.

Tests and Capabilities

- Lightning Surge Testing
- Constant, Step, Cycle and Pulse Current up to 3000ADC
- Environmental Testing
- Mechanical Shock and Vibration Testing
- Thermal Cycle and Shock Testing
- Humidity Testing
- Salt Spray Testing
- Full Data Logging and Analysis

Current cycling and thermal analysis equipment used to evaluate performance of protective devices in customer applications.





LEFT: Magnified SEM image of tin plated terminal.

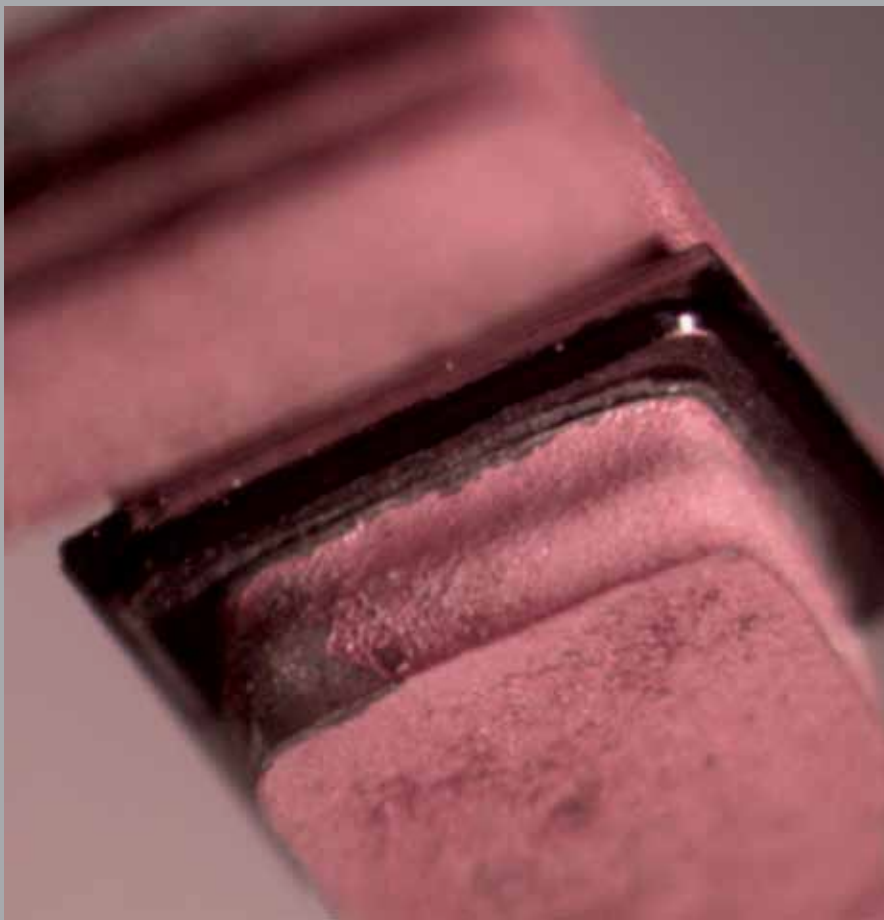
RIGHT: Magnified SEM image of gold ball-bonded wire to silicon die.

Materials Labs

These labs are ideally suited for material characterization and selection, incoming inspection, in-process evaluation and failure analysis for all Littelfuse products.

Testing and Capabilities

- Scanning Electron Microscopy
- Energy Dispersive Spectroscopy
- Optical Microscopy
- Fourier Transform Infrared Spectroscopy
- Differential Scanning Calorimetry
- Thermogravimetric Analysis
- Hardness Testing
- Real-Time X-Ray Microscopy



Magnified Optical Microscopy view of silicon diode soldered to copper lead frame.

located globally to serve our customers locally

With eight locations across the globe, Littelfuse provides customers with convenient access to our lab services anywhere they do business. Expert staff at each facility understands local regulatory standards, customs and the local language to better serve our customers.

CHINA

Dongguan
Wuxi

GERMANY

Bremen

JAPAN

Yokohama

MEXICO

Piedras Negras

PHILIPPINES

Lipa City

USA

Champaign
Chicago

For more information or to schedule an appointment, please contact your local Littelfuse sales representative.

Littelfuse labs across the globe, such as this one located in the Research Park on the campus of the University of Illinois in Champaign, Illinois, provide customers with a full range of valuable services and testing capabilities.





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