QRT

Quality
Reliability
Technology

Reliability Test
Failure Analysis
Material Analysis
FIB Solution

Five
Habits of QRT
Enjoy Support
Your Job Partner First
Do Steady Self-Learning
Keep Don't Waste
Principles Time on
& Useless
Rules Things

Contents

CEO Message

Young-Boo Kim

Chief Executive Officer &
Chairman QRT Inc.

Dear valued customers and partners,
Greetings, and welcome to QRT!

I am Young Boo Kim,
Chief Executive Officer and Chairman of QRT.

Over the past few decades, the world electronics industry has grown very rapidly, particularly technology in the semiconductor field, which is more widely applied for every new product.

In spite of this remarkable growth and development, the reliability test and failure analysis technology service field, which is needed for ensuring the quality of various components and parts including semiconductor, is so inadequate that many companies are currently experiencing a number of difficulties in several stages of business such as reliability of new products, mass production quality assurance and responding to customer claims.

Accordingly, QRT Inc. has contributed to reliability improvement and quality advancement of every electronic components including domestic and foreign mobile, display, automotive electric components and eco-friendly market based on the quality evaluation technology and professional technical personnel which has been developed as a specialized core field for over 30 years in SK Hynix Semiconductor, Korea's representative enterprise.

So far, QRT Inc. has provided reliability test and failure analysis services to numerous customers with state-of-the-art technology and equipment, fast service. These efforts have led to realizing customer satisfaction and opportunities for our company to also grow along, so we heartily thank our customers. These results could not have been achieved without our customers' constant interest and support.

We are building the diversified foundation of growth to jump up to be a valuable company giving consistently greater satisfaction, and a companion who can create a greater impression to customers by strengthening activities such as investing in new technology development and equipment, ensuring efficient management of the organization, procuring and cultivating outstanding talented personnel.

We, QRT Inc., will always do our best to achieve mutual progress through customers' development and business success with the world's highest quality and competitive service as an everlasting partner of our customers.

Our customers are at the center of QRT Inc.
A better future awaits based on our management philosophy of creating a community, with all our hearts, to pleasantly work with customers. Please keep an eye with encouragement and support on QRT Inc., making constant efforts to jump up to a new look.

Thank you.

History

Company History and Status of Accreditation (1983 ~ Present)

1983
Launch of QRT
QRT Quality Reliability Technology

2002
ISO 9001 Certification
ISO ISO9001

2004
Certified by the Korea Laboratory Accreditation Scheme (KOLAS)
→ JEDEC
(Standards for Industrial IC Evaluation)
KOLAS JEDEC

2009
Expanded Scope of Accreditation
→ AEC-Q100
(Standards for evaluating automotive semiconductors)
KOLAS

2010
Foundation of QRT Technology Research Center

2013
Built an automotive electronic components evaluation system
→ Test of Pb-free solders, etc.

2016
Certified as a Venture Business
KIBO

2017
Foundation of Wuxi Keertai Test Co. in China

2018
Built a Smart Lab. Expanded Scope of Accreditation
→ MIL-STD
Developed the SSD Evaluation System
→ Functional Testing
Certified as an Innovated Small and Medium-Sized Enterprise
INNOBIZ Innovation Association

2019
Certified by TÜV NORD
→ Awarded ISO 26262 FSCAE
(Functional Safety Certified Automotive Engineer)
ISO 26262 TÜV NORD

Foundation of Outermost-QRT JV in Silicon Valley, USA

Ensure Customers' Success with **technology** and **devotion**,
Path Our Future with **challenge** and **innovation**.

Business Parts

Service Items

Category	Item		Remarks
Reliability Test	Life Test	Early Life Failure Rate (ELFR)	Prediction of lifetime and verification of durability based on operating and environmental acceleration tests carried out in consideration of the user environment • Applicable Standards - International standards issued by IEC, ISO, etc. - Product standards issued by JEDEC, AEC, MIL-STD, etc. - Automotive OEM requirements specified by ES, GM, etc.
		High/Low Temperature Operating Life (HTOL/LTOL)	
		High Temperature (Humidity) Gate/Reverse Bias (HTGB/HTRB)	
		Write/Read/Endurance/Retention Memory	
	Environmental Test	Moisture Sensitivity Level (MSL)	
		Preconditioning	
		High/Low Temperature Storage (HTS/LTS)	
		Temperature Humidity Storage/Bias (THS/THB)	
		Temperature Cycle/Thermal Shock (TC/TS)	
		Power Temperature Cycle (PTC)	
		High Accelerated Stress Test (HAST) and Unbiased HAST (uHAST)	
		Pressure Cooker Test (PCT)	
		Battery Charging/Discharging Test	
		LED Luminous Flux	
Physical Test	Vibration/ Combined Environment	Vibration	Verification of durability in relation to vibration, combined environment (temperature, humidity vibration) and shock (drop) • Applicable Standards - International standards issued by IEC, ISO, etc. - Product standards issued by JEDEC, AEC, MIL-STD, etc. - Automotive OEM requirements specified by ES, GM, etc.
		Combined Environmental Reliability Test (CERT)	
		Highly Accelerated Life Test (HALT)	
	Shock/Drop	Mechanical Shock (MS)	
		Drop	
	Board Level	Board Level Drop/Bending/Temperature Cycle/ Vibration	Verification of characteristics and reliability of solder joints between materials and boards • Applicable Standards - IPC, JEDEC
	Tensile, Shear, Solder, etc.	Tensile/Shear	Use of the latest UTM system to simulate tensile, shear and compressive strength and stress • Applications - Die, wire bonding, etc. - PKG, body, lead, solder ball, etc. - PCB, module, etc.
		Torque/Twist/Bending	
		Solderability/Resistance to Solder Heat (SD/RSH)	
Electrical Stress Test	ESD/EOS/ IC-EMI/TLP	ESD Test (HBM/MM/CDM)	Verification of compatibility for various types of electrical stress (from IC to end-products of system) • Applicable Standards: - International standards issued by IEC, ISO, etc. - Product standards issued by JS, JEDEC, AEC, MIL-STD, etc. - Automotive OEM requirements specified by ES, GM, etc.
		Latch-up	
		Component/System Level Gun ESD	
		Electrical Over Stress (EOS)	
		IC level Electro-Magnetic Interference (IC-EMI)	
		Electrical Characteristics Verification Test on Electronic Parts	
		TLP (Transmission-Line Pulse)	

Category	Item		Remarks
Integrated Analysis	Non-Destructive Analysis	X-ray	Examination of delamination and crack in IC
		3D CT	
		Scanning Acoustic Tomography/Microscopy (SAT/SAM)	
		Electrical Characteristics Analysis (Curve Tracing)	
	Sample Preparation for Destructive Analysis	Decapsulation	Sample Preparation such as cross-section of ICs and PCBs
		Grinding/Polishing	
		Chip Delayering	
		Ion Milling	
	Failure Analysis	Scanning Electron Microscopy (SEM)	-
		Energy Dispersive X-Ray Spectrometry (EDS)	
		EMMI (PHEMOS/THEMOS)	
		OBIRCH	
		Dye & Pry	
		External Inspection (Optical Scope)	
		IC Counterfeit Analysis	
FIB Analysis	Circuit Modification		-
	TEM Lamella Preparation		
	Cross Section Analysis		
Material Analysis	Surface Analysis	X-ray Photoelectron Spectroscopy (XPS)	-
		Secondary Ion Mass Spectrometry (TOF-SIMS/D-SIMS)	
		Auger Electron Spectroscopy (AES)	
		Atomic Force Microscopy (AFM)	
	Micro-structure Analysis	Field Emission Scanning Electron Microscopy (FE-SEM)	-
		Dual Focused Ion Beam (Dual FIB)	
		Transmission Electron Microscopy (TEM)	
		Electron Energy Loss Spectroscopy (EELS)	
		EBSD/ASTAR	
		X-ray Diffraction (XRD)	
	Inorganic Analysis	Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	-
		Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)	
		X-Ray Fluorescence (XRF)	
		Ion Chromatography (IC)	
	Organic Analysis	Gas Chromatography Mass Spectrometry (GC-MS)	-
		Fourier Transform Infrared Spectroscopy (FT-IR)	
Education & Consulting	Technical Education Service		Production and process control Quality assurance and reliability establishment - Certification and diagnosis of quality - Internal audit/Leadership/Coaching
	ISO26262 Consulting		
	SEU Consulting		

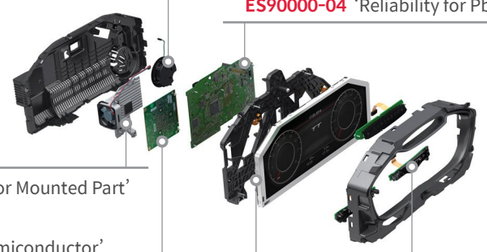
Company

Automotive Electronics Qualification

Sequence test and performance assessment required by AEC standards and various OEM standards

In order to determine the vehicle module or system level, it is necessary to perform a combined environmental reliability test (CERT) in which temperature and vibration among other conditions are applied simultaneously or a test that specifically examines an external environmental condition such as dust, water spray, ozone, and condensation. Sequence test, which involves sequentially performing various tests, is also a requirement, and a variety of extensive facilities that meet the latest standards is necessary to perform this test. At QRT, we provide all the services necessary from test design to improvement, in order to make it possible to carry out customized tests according to the requirements and products, in accordance with the OEM standards.

| Environmental Test/Examination Requirements for Each Type of Electronics |



ES90000-01 'Inspect of Solder Joint'

ES90000-04 'Reliability for Pb-free Soldering'

ES90000-02 'Delamination inspection for Mounted Part'
AEC-Q100 'Qualification for IC'
AEC-Q101 'Qualification for Discrete Semiconductor'
AEC-Q102 'Qualification for Discrete Optoelectronic Semiconductors'
AEC-Q103 'Qualification for Sensors'
AEC-Q104 'Qualification for MCM'
AEC-Q200 'Qualification for Passive Components'

ES90000-03 'Reliability Test for bare PCB'

ES90000-05 'Highly Accelerated Life Test'

ES95400-10 'Environmental Tests for Electronic Equipment'
ES95910-93 'Environmental Tests for Air Bag System'

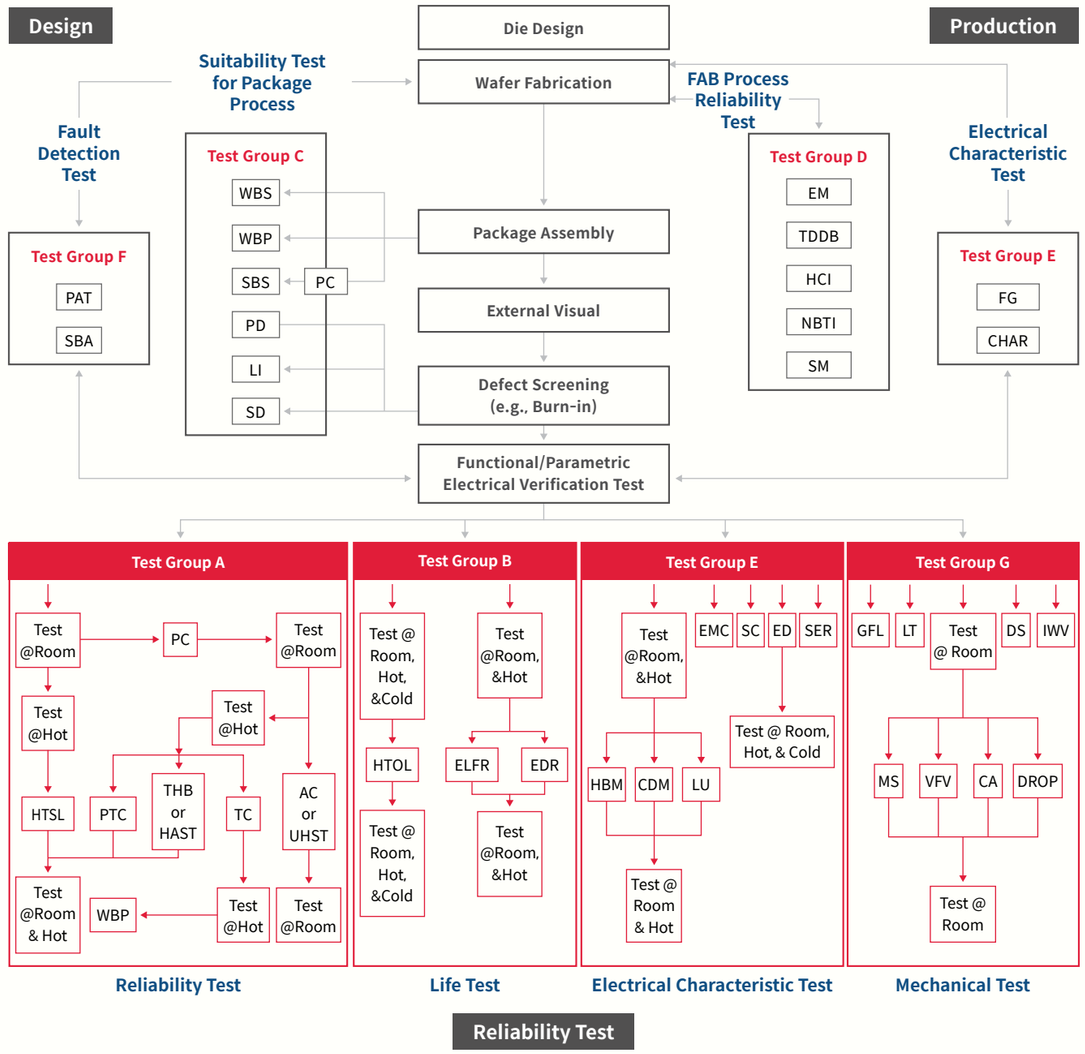
JEDEC AEC Q-100, 101, 102, 103, 104, 200 OEM in-house spec

AEC Q100

AEC-Q100 is a standard for testing the reliability of integrated circuits (ICs) that divides ICs into 4 grades according to their available temperature range. It is a standard concerning not only matters related to design and manufacturing but also to reliability test that targets major failure mechanisms. It is a suitable standard for evaluating automotive semiconductors that needs to be highly reliable.

Grade Level	Ambient Operating Temp. Range
Grade 0	-40°C to +150°C
Grade 1	-40°C to +125°C
Grade2	-40°C to +105°C
Grade 3	-40°C to +85°C

| Qualification Test Flow for Integrated Circuits |



Automotive Electronics Qualification

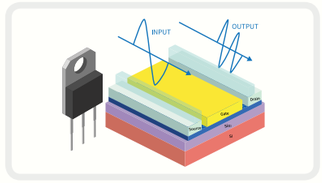
AEC Q101

AEC-Q101 is a standard for testing discrete components, each comprised of a single component such as a FET, Diode, IGBT, and Transistor. It consists of a test that can evaluate the physical durability and characteristics of high heat power semiconductors and devices.

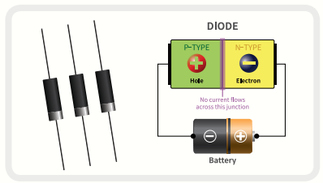
Temp. Range	Discrete Semiconductor Type
-40°C to +125°C	Discrete semiconductors except for LEDs

| Qualification Test Definitions for Discrete Semiconductors |

QUALIFICATION TEST DEFINITIONS									
	Stress	Abrv	Data type	Note	Sample Size per lot	Number of lots	Accept on # failed	Reference (current revision)	Additional Requirements
1	Pre- and Post-Stress Electrical Test	TEST	1	NG	All qualification parts tested per the requirements of the appropriate part specification.		0	User specification or supplier's standard specification	Test is performed as specified in the applicable stress reference at room temperature.
2	Pre-conditioning	PC	1	GS	SMD qualification parts before Test # 7, 8, 9 & 10.		0	JESD22 A-113	Performed on surface mount parts (SMDs) prior to Test # 7, 8, 9, & 10 only. TEST before and after PC. Any replacement of parts must be reported.
3	External Visual	EV	1	NG	All qualification parts submitted for testing		0	JESD22 B-101	Inspect part construction, marking and workmanship.
4	Parametric Verification	PV	1	N	25	3 Note A	0	Individual AEC user specification	Test all parameters according to user specification over the part temperature range to insure specification compliance.
5	High Temperature Reverse Bias	HTRB	1	CDGK UVPX	77	3 Note B	0	MIL-STD-750-1 M1038 Method A	1000 hours at the maximum DC Reverse Voltage rated junction temperature specified in the user/ supplier specification. The ambient temperature T_A is to be adjusted to compensate for current leakage. TEST before and after HTRB as a minimum. (See note X HTRB.) To be implemented on, or before, April 1, 2014.
27	Dielectric Integrity	DI	3	DM	5	1	0	AEC-Q101-004 Section 3	Pre- & Post-process change comparison to evaluate process change robustness. All parts must exceed gate breakdown voltage minimun (Power MOS & IGBT only).
28	Short Circuit Reliability Characterization	SCR	3	DP	10	3 Note B	0	AEC-Q101-006	For smart power parts only.
29	Lead Free	LF	3		-	-	-	AEC-Q005	For all related solderability, solder heat resistance and whisker requirements. To be implemented on, or before, April 1, 2014.



<FET>



< Diode >

AEC Q102

AEC-Q102 is a standard for testing discrete optoelectronic components for automobiles such as Light-emitting diodes, Photodiodes, and Laser components. It is suitable for testing the reliability of all kinds of optoelectronic components that are used in vehicle interior or exterior.

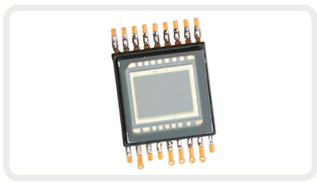
Temp. Range	Discrete Semiconductor Type
-40°C to the maximum operating temperature	Discrete optoelectronic semiconductors

| Qualification Test Definition for Discrete Optoelectronic Semiconductor |

QUALIFICATION TEST DEFINITIONS								
#	Stress	ABV	Note	Sample Size / lot	Number of lots	Accept Criteria	Test Method (current revision)	Additional Requirements
1	Pre- and Post-Stress Electrical Test and Photometric Test	TEST	N, G	All qualification parts tested per the requirements of the appropriate part specification.		0	User specification or supplier's standard specification	Test is performed as specified in the applicable stress reference. See also Section 2. 3. 7.
2	Pre-conditioning	PC	G, S	SMD qualification parts at least before Test #6, #7, & #8		0	JEDEC JESD22-A113	Performed on surface mount parts (SMDs) at least prior to Test #6, #7 & #8. Where applicable, preconditioning level and Peak Reflow Temperature must be reported when preconditioning and/or MSL is performed. Any replacement of parts must be reported. Test before and after PC.
3	External Visual	EV	N, G	All qualification parts submitted for testing except DPA and PD		0	JEDEC JESD22-B101	Inspect part construction, marking and workmanship.
4	Parametric Verification	PV	N	25	3 Note A	0	Individual AEC user specification	Test all parpmeters according to user spceification over the part temperature range to insure specification compliance.
5a	High Temperature Operating Life HTOL	HTOL1	D, G, X, Y	26	3 Note B	0	JEDEC JESD22-A108	Only for LED and Laser Component. Duration 1000h at maximum specified T solder. Choose corresponding drive current according to derating curve to achieve max Tj defined in the part specification. Test 5a is equivalent to 5b if no derating. For use within special application; a longer test duration may be needed to ensure reliability over application lifetime. For details. see Appendix 7a "Reliability Validation for LEDs". TEST before and after HTOL1.
5b	High Temperature Operating Life HTOL	HTOL2	D, G, X, Y	26	3 Note B	0	JEDEC JESD22-A108	Only for LED and Laser Component Duration 1000 h at maximum specified drive current. Choose corresponding T solder according to derating curve to achieve max Tj defined in the part specification. Test 5b is equivaient to 5a if no derating. For use within special application; a longer test duration may be needed to ensure reliability over application lifetime. For details, see Appendix 7a "Reliability Validation for LEDs". TEST before and after HTOL2.
26	Wire Bond Shear	WBS	D, G, W, E	10 bonds from min of 5 parts	3	0	AEC Q101-003	Pre- & Post-process change comparison to evaluate process change robustness. Data may be provided within PPAP (C_{pk} > 1.67).
27	Die Shear	DS	D, G	5	3	0	MIL-STD-750-2 Method 2017	Pre- & Post-process change comparison to evaluate process change robustness. Data may be prvided within PPAP (C_{pk} >1.67).
28	Whisker Growth	WG	G	see test method	see test method	see test method	AEC-Q005	Only for parts with Sn-based lead finishes. Test to be done on a family basis (plating metallization, lead configuration).

< LED >

< Laser Diode >



< Photodiode >

Automotive Electronics Qualification

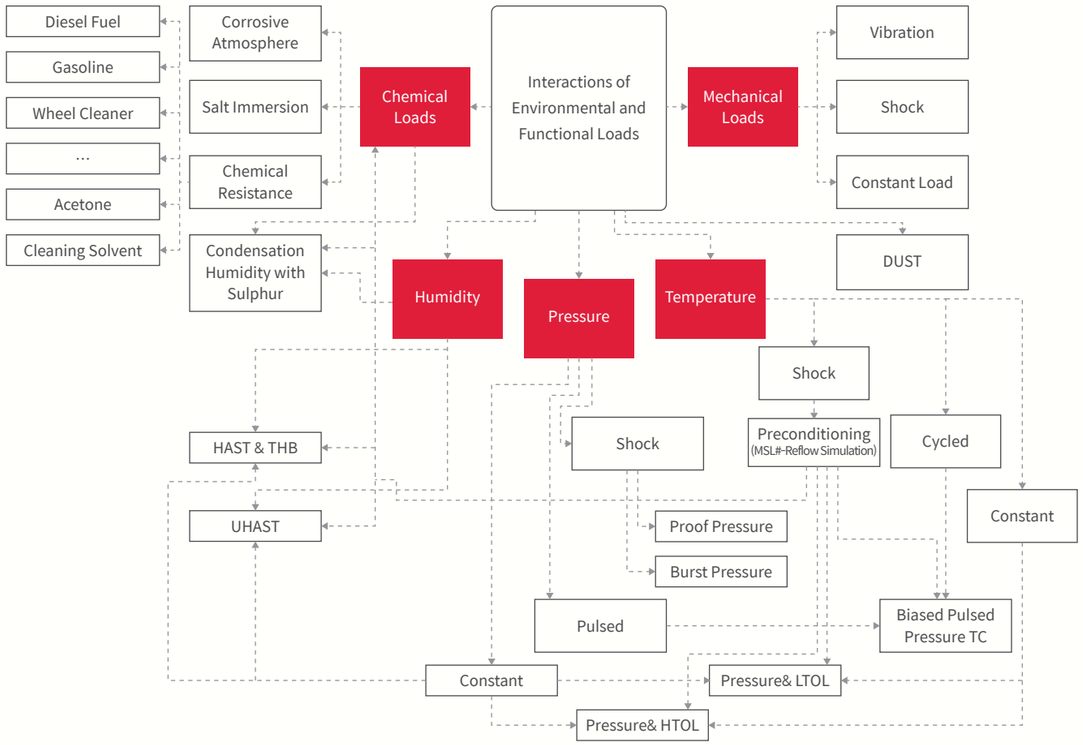
AEC Q103

AEC-Q103 specifies the reliability tests required for sensors. Compared to the tests required for general ICs, there is an additional reliability test required for the structure that detects external input. Standards defining requirements for microphone and MEMS have been established under subordinate document numbers.

Automotive sensors may be more vulnerable than general ICs, depending on the type of information that is detected and collected, as the input unit may have a mechanical structure and be exposed. Also, the data collected by sensors fall under the category of safety functions that affect ADAS or autonomous driving and thus require strict quality control. The operating situation in the user environment may be simulated to test the sensor product under various conditions such as physical stress (vibration, shock, etc.) and other stress factors such as chemicals, temperature, humidity, and pressure according to the scenario as a way to check its suitability as an automotive part.

Grade	Ambient Operating Temperature Range	
0A	-40°C to +165°C	0A and 0B are needed if ambient operating temperature range exceeds AEC-Q100 grade zero requirements
0B	-40°C to +175°C	

| Qualification Test Flow for MEMS(Micro Electro-Mechanical System) Pressure Sensor Devices |



< Microphone >

< TPMS >

< MEMS Mirror >

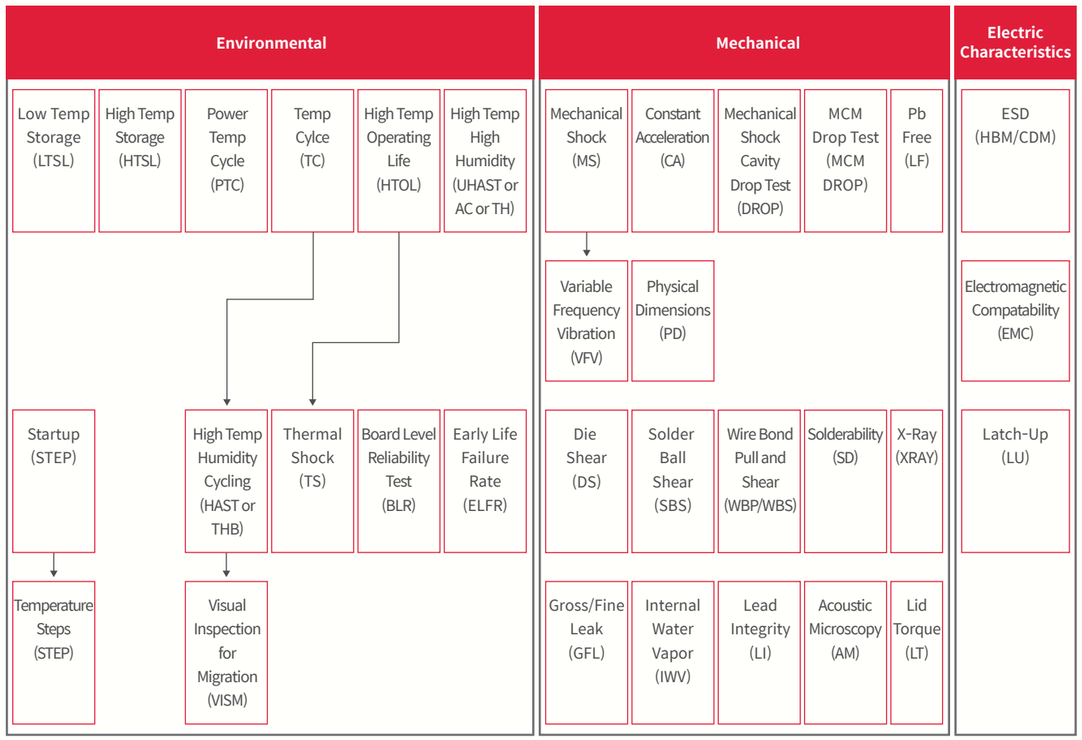
AEC Q104

AEC-Q104 is a standard for testing multi-chip module products such as MCP, SiP, and stack chip, which are highly complex. This standard, in particular, not only includes the requirements specified by AEC-Q100, AEC-Q101, and AEC-Q200 but also includes the BLR test for verification of solder joint on PCB boards, which is required for handheld products.

Qualification Test Method Options for the MCM

- **Case #1. If there are previous AEC qualification results,**
  - perform only the tests specified under Test Group H, provided that it is necessary to check the actual test items that are applicable to the package type (e.g., CAVITY package test items, etc.).
- **Case #2. If there are no previous AEC qualification results,**
  - perform all the tests required by AEC-104.

| Qualification Test Flow for Multi-Chip Modules (MCM) |



* Note: Pre-conditioning(PC) to simulate customer manufacturing and rework processes is required for the package accelerated environmental stress tests (test group A). See Tables 1&2 for applicability of each test.

ELECTRICAL

Pre and Post Stress Functional Tests (TEST)	Characterization (CHAR)	Short Circuit Characterization (SC)	Fault Grading (FG)	Electrical Distributions (ED)	Part Average Testing (PAT)	Statistical Bin Limits Statistical Yield Limits Analysis (SBA)	Soft Error Rate (SER)	NVM Endurance, Data Retention, and Operational Life (EDR)

Automotive Electronics Qualification

AEC Q200

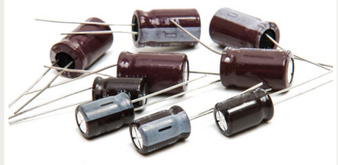
AEC-Q200 is a standard for testing passive devices such as the Capacitor, Inductor, and Resistor. The minimum temperature range required for each type of product is defined as shown in the following table. The required tests consist of those that take into consideration the characteristics of passive elements such as flammability and lead integrity.

Grade	Temp. Range	Discrete Semiconductor Type
0	-50°C to +150°C	Flat chip ceramic Resistors, X8R ceramic capcaitors
1	-40°C to +125°C	Capacitor Networks, Resistors, Inductors, Transformers, Thermistors, Resonators, Crystals and Varistors, all other ceramic and tantalum capacitors
2	-40°C to +105°C	Aluminum Electrolytic capacitors
3	-40°C to +85°C	Film capacitors, Ferrites, R/R-C Networks and Trimmer capacitors

| Qualification Test Definitions for Passive Components |

Qualification Sample Size Requirements					
Stress	No.	Note	Sample Size per lot	Number of lots	Accept on Number failed
Pre- and Post-Stress Electrical Test	1	G	All qualification parts submitted for testing		0
High Temperature Exposure	3	DG	77 Note B	1	0
Temperature Cycling	4	DG	77 Note B	1	0
Destructive Physical Analysis	5	DG	10 Note B	1	0
Shear Strength	31	DG	30	1	0
Short Circuit Fault Current Durability	32	DG	30	1	0
Fault Current Durability	33	DG	30	1	0
End-of-Life Mode Verification	34	DG	30	1	0
Jump Start Endurance	35	DG	30	1	0
Load Dump Endurance	36	DG	30	1	0

< Inductor >



< Capacitor >

< Resistor >

Strategic Test Service

Board Level Reliability Test (BLRT)

About BLRT

All electronic products contain countless solder joints between the IC component and PCB. A crack may form on the solder joint when it is exposed to various environmental stress factors such as torsion, vibration, high temperature, low temperature, and lead to electrical disconnection, which causes a severe failure. At QRT, we are capable of assessing the lifetime of joints under various environmental conditions such as temperature cycle, vibration, impact, high temperature, and high humidity. This means a more optimized solder composition can be examined, and the reliability in the user environment can be predicted based on the results.

QRT's BLRT Service

Temperature Cycling Test

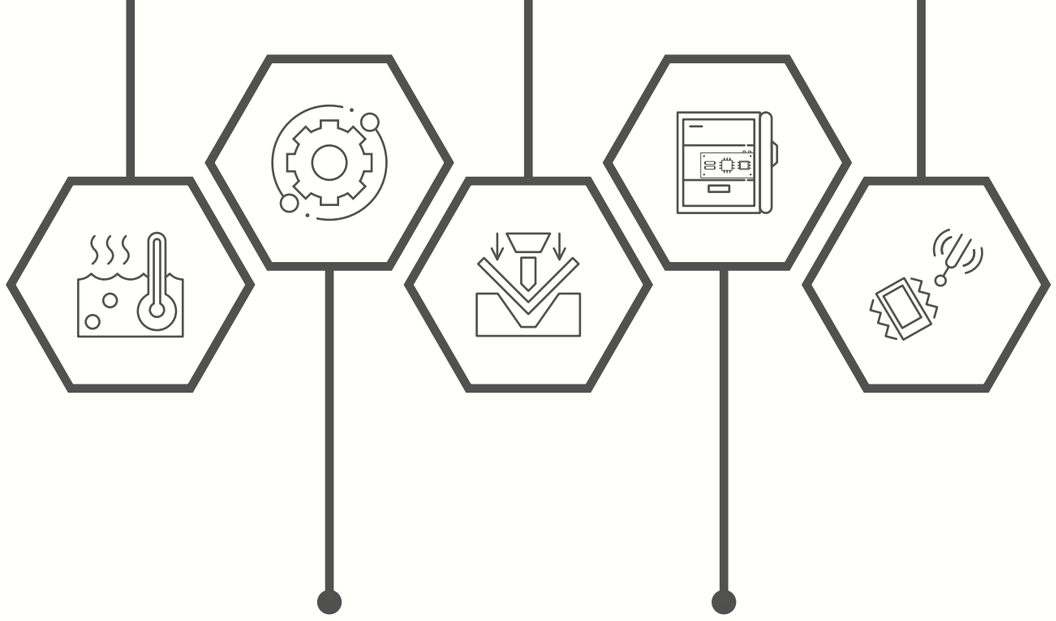
This test is performed to see whether the product can withstand repeated exposure to high/low temperatures. Cracking or delamination may occur as a result of an internal stress difference.

Cyclic Bending Test

PCB may bend during the manufacturing process or user environment. Repeated stress, in particular, is a major cause of solder joint cracks.

Vibration Test

The PCB is repeatedly shaken to test for solder joint detachment, according to the PCB characteristics and the package weight and shape.



Mechanical Shock Test

When a mobile phone is dropped to the ground, maximum acceleration gets transmitted to the board inside the phone when it hits the floor, thereby causing torsion and bending.

High-Temperature Storage Test

The IMC characteristic determines the reliability of solder joints. The growth of IMC over time can be examined at an accelerated rate through the high-temperature test.

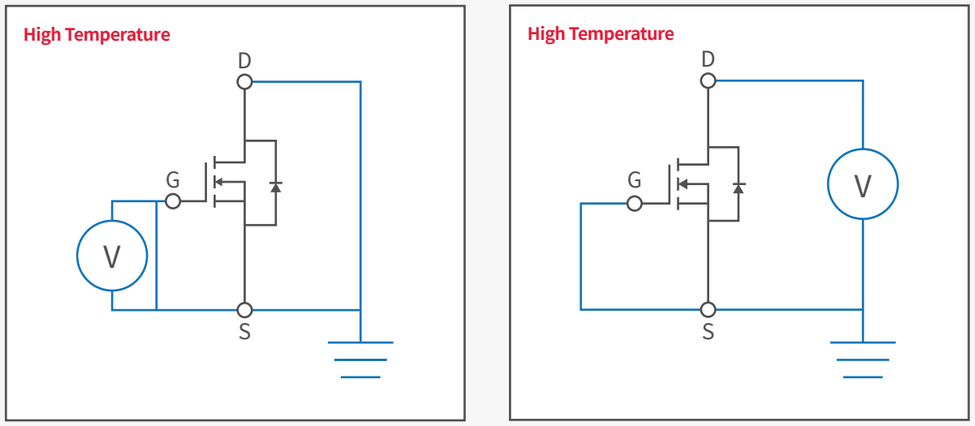
Power Device Reliability Test & Analysis

About Power Device Reliability Test & Analysis

The power device is a crucial component for the long-term stable operation of the system to which it is applied. The requirements for verifying the reliability of high-power, high-efficiency power devices used in not only commercial products but also automobiles are becoming increasingly more stringent.

Power devices are made using a wide range of materials in addition to Si, such as SiC and GaN, and reliability tests are being carried out extensively on these materials.

| Circuit Configuration for the Operating Test - (Left) HTGB, (Right) HTRB |



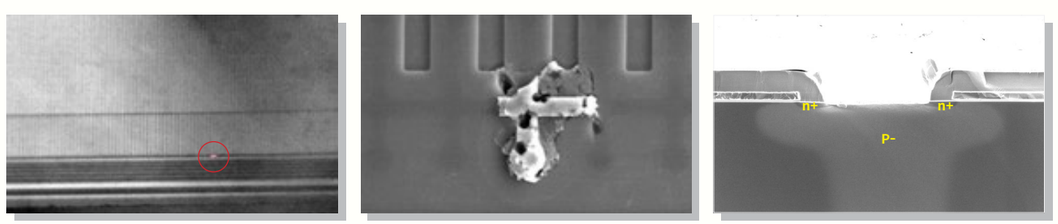
QRT's Power Device Reliability Test & Analysis Service

Armed with extensive experience and a long list of related testing and analytical equipment, we are capable of performing environmental, life, static electricity and physical tests on a wide variety of power devices such as diodes, transistors, and thyristors and products made from Si, SiC and GaN products.

We have recently built the necessary infrastructure to run various life tests on high-power power devices by setting up high-power power supplies, high-temperature chambers, and test boards for high-power devices.

With the growing diversity of the process structure and materials used in manufacturing power devices, it has become necessary to be equipped with a wealth of related know-how and analytical equipment to perform defect analysis.

QRT is staffed with analytical engineers with diverse analysis experiences and equipped with state-of-the-art analytical equipment. Not only that, but we also have specialized analysis capabilities specifically for analyzing field failure of materials and failure of materials after a reliability test.



LED Reliability Test

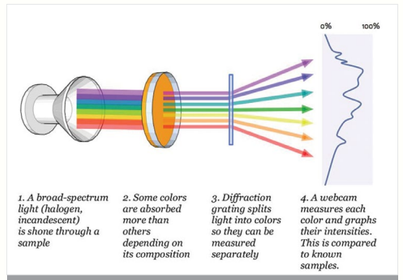
About LED Reliability Test

The LED reliability test is generally conducted according to the AEC or JEDEC Test Plan, with the key assessment items being operated at high temperatures. Effects of temperature and humidity, and external and internal damage caused by the temperature cycle are studied. For product performance assessment before and after the test, the main electrical characteristics and the product's performance as a light source are assessed.

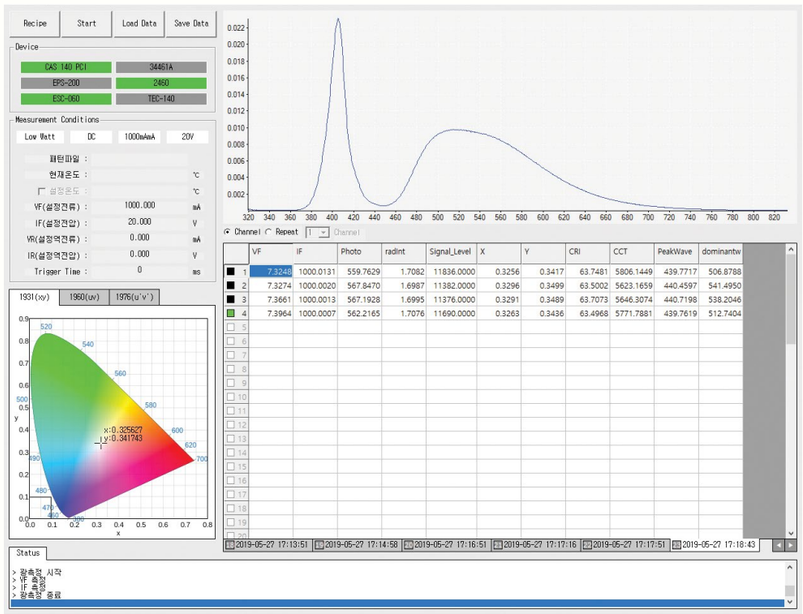
QRT's LED Service

We are equipped with an integrating sphere with a diameter of about 1m, making it possible to measure the light intensity of various LED products and lighting products. We also have test facilities where various mechanical and climatic environmental conditions can be created for testing the reliability of optical measurement systems as well as LEDs. As such, we are able to provide a one-stop service for full qualification testing required by international standards (USCAR-33, AEC-Q102).

Optical Measurement Test



Spectrometer: Principles of Operation



Optical Measurement Data (Example)

Strategic Test Service

SSD Reliability Test

About SSD RDT

The reliability demonstration test (RDT) is an aging test carried out to check whether the product demonstrates the intended level of reliability. Through this test, the device manufacturer can check the device performance and expected lifetime.

SSD Certification Test Items

SPOR (Sudden Power Off Recovery)		This test is carried out to verify the data storage reliability by simulating a situation in which the SSD's power is suddenly shut off while the data writing command is being executed
Cold RDT		The RDT carried out at low temperatures for at least 500 hours
Hot RDT		The RDT carried out at high temperatures for at least 500 hours
Data Retention	HTDR	This test is carried out at 40°C for 3 months or until the SSD dies
Environment	Temperature & Humidity	This test is carried out under temperature and humidity conditions that cause stress to the device
	Temperature Cycling	This test is carried out while varying the temperature condition periodically (-40°C to +85°C)
Mechanical		Mechanical Shock, Vibration, Bending, Torsion, Module Push, Magnetic Field, E-Field
Certification		RoHS, EMC, Safety

SSD Interface

2.5 SATA | NVMe | M.2 SATA | VBVBCVVmSATA

QRT's SSD Service

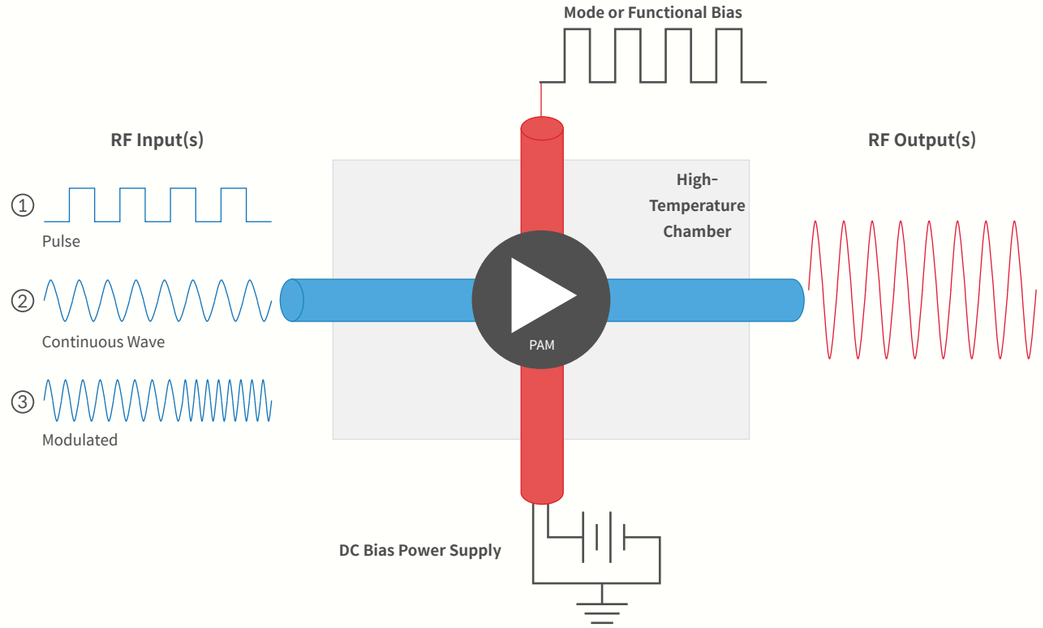
We are capable of performing an optimal RDT to demonstrate product reliability, based on the test script we have developed to apply stress to SSD, and we can also include additional stress factors according to the customer's needs. Based on the MB/sec, IOPS, and SMART information indicating SSD performance, it is possible to monitor the product condition during the RDT in real-time.

We have equipment that is compatible with both Gen3 and Gen4 interfaces and can perform optimized testing by not only testing the functions but also by combining various environmental conditions such as temperature and humidity.

RF Biased Life Test

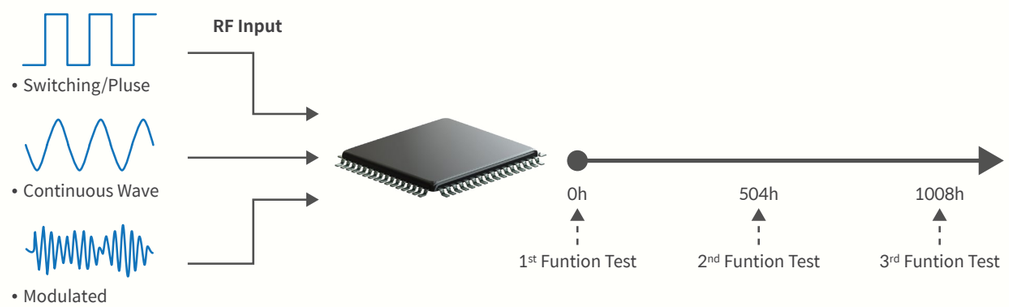
RF-Biased Life Test

With the expansion of the market for applications using the 5G network, the reliability of RF products is becoming increasingly important. RF-biased life (RFBL) test simulates the actual conditions under which RF products are used by creating an environment where it is possible to transmit RF signals, the key elements of the life test on RF semiconductors. The RF semiconductor is operated in an accelerated manner for device qualification, reliability monitoring, and lifetime assessment.



Time Zero Service

Time zero service is possible for RFBL. In order to minimize the duration of the test, we offer RF testing service at various frequencies. Power levels vary using a broadband high-power power amplifier. Moreover, we can quickly provide accurate RF data from the RF-biased semiconductor function test using ATE equipment. In addition to stress tests, key RF characteristics can be assessed to immediately check whether the product will pass or fail the qualification test.



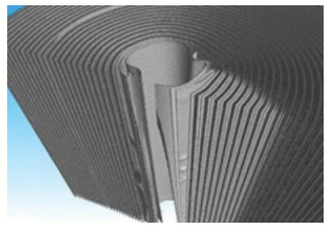
Battery Reliability Test & Analysis

About Battery Reliability Test & Analysis

With the widespread use of various small electronic devices such as smartphones, smartwatches, and electronic cigarettes, there has been a rapid shift to the use of secondary batteries as the primary power source. Lithium-ion batteries, in particular, are the most common type of secondary batteries used today because of their high energy density and their excellence in relation to the operating voltage. However, improper handling and the use of products without any built-in battery protection circuits may lead to serious personal safety issues such as ignition or explosion, and this is why their quality must be verified through a reliability test.

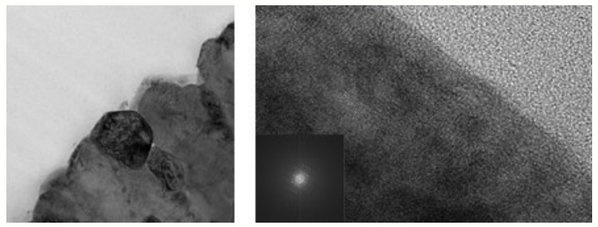
Test on the intended purpose of uses	• Battery charging/discharging	• High-temperature deformation test [battery]
Reasonable misuse test	• External short circuit test [battery] • Overcharging test	• Free fall test • Vibration/mechanical shock test

Battery Defect Analysis



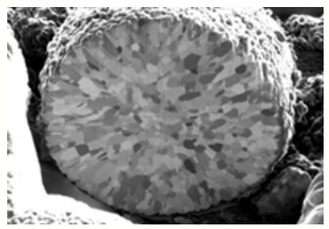
3D CT

- Winding defect inside the battery
- Crack formation caused by aging of the active material



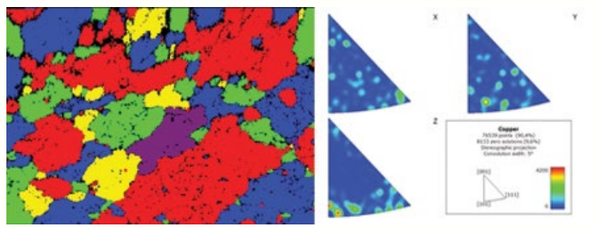
HR-TEM

- High resolution and crystal structure on the surface of cathode material
- TEM/EDS mapping for each element



FIB

- Core and shell grain orientation structure of the cathode material
- Observation of the internal void of the cathode material



EBSD

- Cu foil crystal structure analysis: Grain size and orientation

QRT's Battery Reliability Test & Analysis Service

We are equipped with various types of equipment needed to test diverse lithium-ion batteries that are supplied with electronic devices and analyze materials and products to check the battery characteristics. Of particular note, we are staffed with analytical engineers with specialized know-how in battery analysis.

SMT (Solder Mount Technology)

About SMT Reliability Test

In the case of most semiconductor chips, reliability and life test is performed using sockets and test boards for electrical signal transmission. However, packages such as a wafer level chip scale package (WLCSP) are without any external protection functions such as EMC, and thus, SMT is directly applied to the test board, in case a socket cannot be used, for electrical signal transmission.

QRT's SMT Service

We offer test board production and SMT services in parallel to enable reliability test at the board level as well as diverse types of packages requiring SMT such as WLCSP. To ensure improved SMT quality, we conduct solder paste volume ratio inspections, void inspections using X-ray and audiovisual inspections, and also provide special soldering services such as selective soldering.

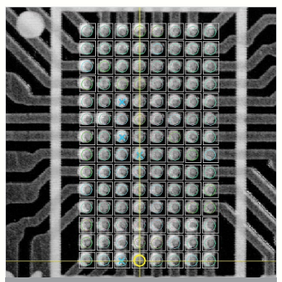
Solder Paste Inspection

Auto Visual Inspection

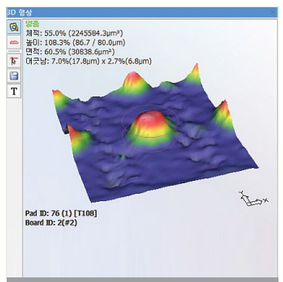
X-Ray M/C

Reflow System

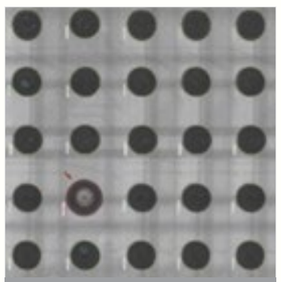
Selective Soldering M/C



Solder Paste Inspection



Auto Visual Inspection



X-Ray M/C

Transmission Line Pulse (TLP) Test

About TLP

The TLP test provides data based on which it becomes possible to determine the operating characteristics of the built-in ESD protection circuit of the semiconductor chip and judge the possibility of static electricity protection.

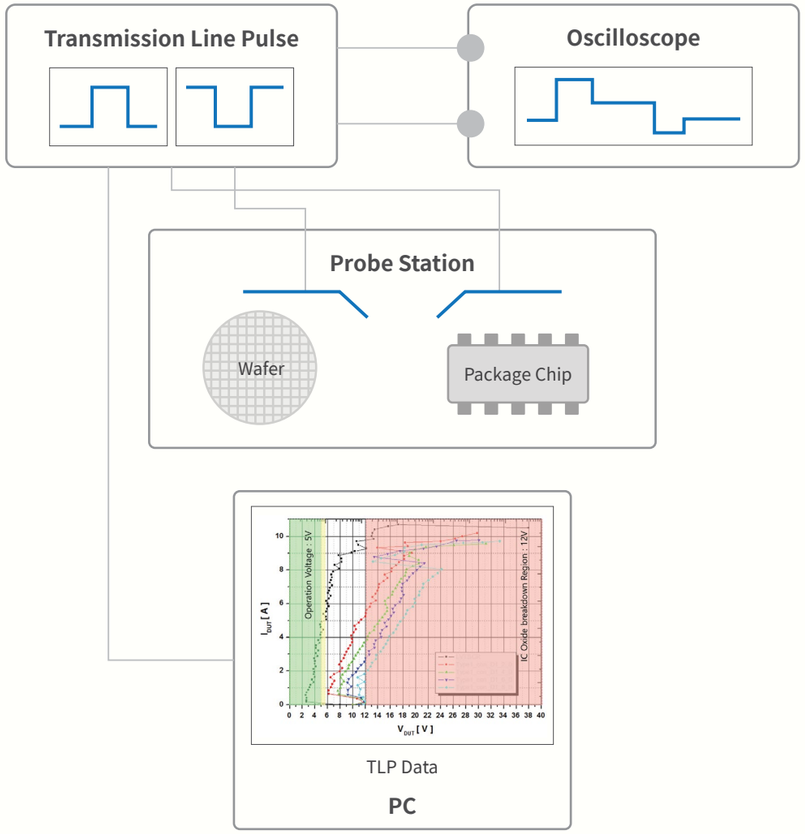
QRT's TLP Test Service

In recent years, a growing number of companies have been demanding TLP test results to enhance the quality of their semiconductor chips. We provide a TLP test service that meets the TLP waveform requirements of the relevant international standards to meet customer needs.

With the results of the ESD tests such as HBM and CDM, it is only possible to judge whether the product has passed or failed, but more data can be provided through the TLP test.

Generally speaking, one of the biggest reasons that companies stop their product development process and return to the starting point is a reliability issue concerning ESD. The TLP test can lead to the discovery of ESD-related reliability issues much earlier. When testing a prototype, the TLP test can provide data that provide critical information on whether the static electricity protection circuit is working correctly. Such data can help prevent ESD-related reliability issues.

| Conceptual Diagram of the TLP Test |



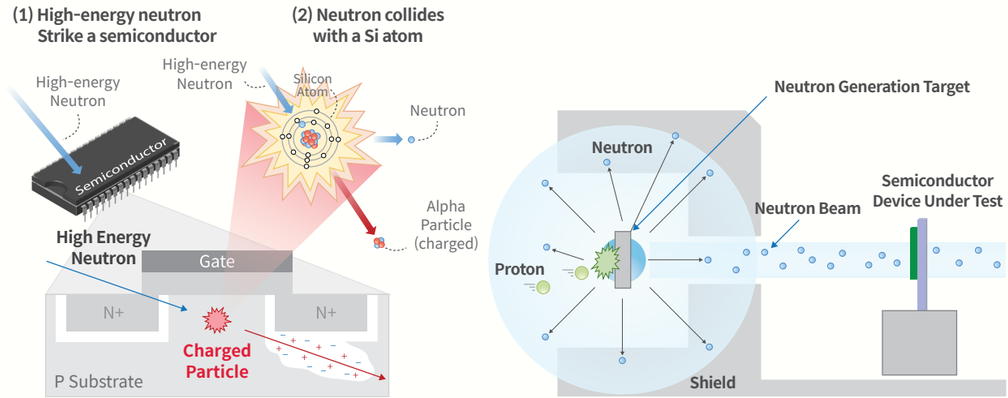
Soft Error & Radiation test

Soft Error Test and Analysis of Semiconductor and Electronic Parts & Components

Need for Soft Error Test of Semiconductor and Electronic Parts & Components

A soft error in a semiconductor device refers to a phenomenon in which the state of the memory cell or circuit has been temporarily changed due to a charge created when the radiation from alpha particles in the semiconductor and/or neutrons and protons present in space and the Earth passes through the semiconductor.

Electronic components are constantly exposed to the risk of soft errors, and this is why international standards for functional safety including ISO 26262 (Road vehicles - Functional safety) and ITU-K.130 (Neutron irradiation test methods for telecommunication equipment; requirements for assessing soft error in communication equipment) have made it mandatory for next-generation industries such as manufacturers of self-driving cars, flying cars, and drones to obtain the necessary certifications and ensure robust designs.



World-Class Radiation effects capabilities. QRT's All in One Service

Based on years of testing experience and expertise, we provide comprehensive solutions for assessing soft errors in semiconductors and electronic parts and components.

Radiation Test

- Thermal Neutron & Neutron
- Protons
- Heavy Ions
- Muons & Alpha Particles
- Gamma

SEU Analysis

- Alpha Particle Counting
- Total Ionizing Does Effect
- Soft Error Rate
- Single Event Latch-up
- SEFI Test & Analysis

Design & Test Consulting

We have optimized our soft error test and are capable of deriving product improvement measures, based on preliminary simulations of the product and environment and our wealth of experience.

- Impact analysis of parts and systems
- Optimized test conditions and environmental design

Test Board/System Development

We develop and provide test boards and detection systems that apply algorithms for detecting soft errors and performing functional operations in consideration of diverse product characteristics.

- Target products: All electronic parts and components such as memory semiconductors, system semiconductors, and solutions/system products
- Detection algorithms: SEU, MBU, SET, SEL, SEB, SEFI, SEGR, etc.

Preliminary Conformity Verification

We provide preliminary conformity verification service for customers to review the robustness against radiation in the early stages of development and determine the product level before the evaluation for certification.

- Tests carried out using domestic accelerators (P, N, HI)
- Femto laser testing and analysis

International Standard Certification Evaluation

We perform evaluations for certification in compliance with the international standards using an internationally certified radiation accelerator and testing site.

- ISO 26262, JEDEC and AEC standards for industrial and automotive parts
- MIL-STD-883, 750, etc. standards for military parts
- Standards from NASA, ESA, etc. for spacecraft parts
- OEM In-house Standards

Strategy

Reliability Test

What is reliability of electronics?

Electronics are used in a variety of ways, from mobile phones with diverse user environments to fully autonomous vehicles as a supportive function to active control. Moreover, with the increasing importance of electronics, its reliability is under market pressure more than ever. Typically, strong reliability follows technological development but needs from the market can be an element of acceleration of the technology.

The reliability of an electronic product is defined by

> **1) the probability that the function of the product**
> **2) to be maintained without failure during the required time**
> **3) within the user environment.**

It is a concept that can be applied to a single electronic component, system, or person.

Notably, the importance of reliability in the parts market has become even more significant, because, in the case of electronic devices made of various electronic components, failure of an individual components lead to system-wide failures.

Recently, methods to simulate the environment under various combined stresses such as high temperature, high humidity, vibration, etc., have been developed to test the reliability of software.

Based on the reliability technology and failure analysis expertise accumulated for more than 35 years, QRT Inc. has satisfied the reliability demands of domestic and foreign components level manufacturers, and as an institution certified as KOLAS, serves as an essential partner that can appeal to large OEMs by providing certified test result.


High/Low Temperature


Operation Instruction


Static Friction


Humidity


Mechanical Shock

How do we test for reliability in electronic products?

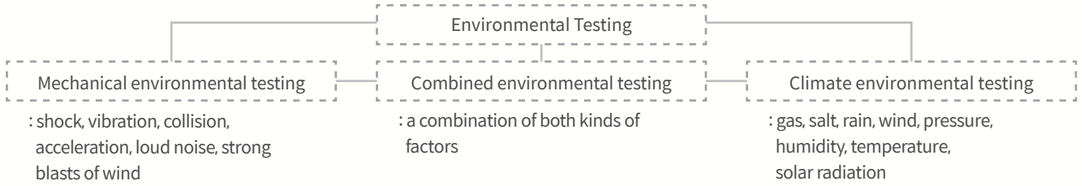
Reliability test is literally done by applying specific stress to a product and checking whether it works normally. In particular, in the case of electronic products, when tested at high temperatures, defects occur more quickly than at room temperature.

For example, ***defects that occur when operating at 55°C for 800 hours occur in 10 hours when tested at 125°C.***

A method for evaluating products in a relatively short time by raising stresses has been developed, and such testing is called the accelerated test. Semiconductors, mobile phones, and automotive electronics are all introduced in markets after testing reliability in this way.

If a product is destroyed by exposure to a specific environment (high temperature, high humidity, electrical stress, etc. as described above, a statistical method can be used to predict the time and the amount of product failure during real life usage. Most manufacturers have set their reliability standards and been managing the reliability in the manner that "the product pass the test if no problem occurs after 1000 hours of test".

| Categorization of Reliability Test |



How is reliability data used?

Product developers can gain a key basis for determining whether a product can be launched with the current design and current process. Or, when selecting a component, the user can make sure that the component can withstand the user's environment where the component will be used in the future.

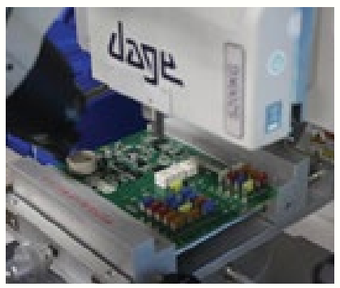
When companies compare different products of the same function, it is possible to evaluate which product is suitable (or excellent) by comparing price, service, and reliability. When the series of processes in which the reliability data is collected and utilized is continuously accumulated in this way, reliable reliability data can be formed and affect the quality/reliability of the entire related industry beyond one company.

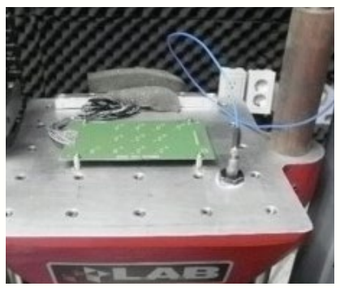
> **Even if we leave a computer on for an extended business trip,**
> **few people are worried about malfunctions caused by the long-term operation.**
> **Even if we drop the phone on the floor, we do not expect it to break down right away.**

As such, "reliability testing and data" in electronic products play "an important role in providing and improving many benefits in our lives."







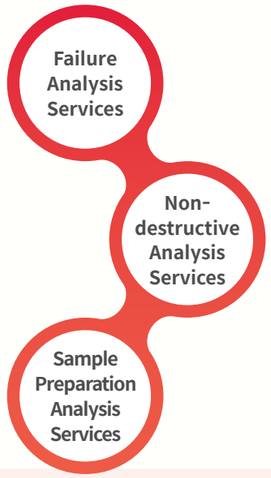
Service

Failure & FIB Analysis

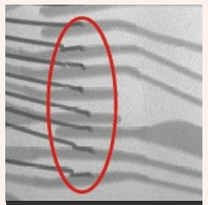
Failure Analysis

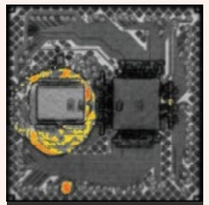
To understand the problems that may occur in the manufacturing or application of products, extensive analysis methods, and technologies are required. QRT Inc. has been providing prompt failure analysis services for a variety of electronic components, from Semiconductor ICs to active devices, passive devices, and PCBs through our latest analysis equipment, failure analysis processes, and FA engineers with analysis knowledge and skills.

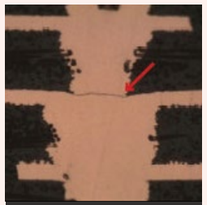
We find evidence of electrical and physical failures, clearly identify the cause of failures, and identify failure mechanisms through our failure analysis services. We serve as an important partner that can provide feedback on various information so that failure that may occur in manufacturing processes and on the field or recurrence of such failure can be prevented through the identification of the root causes.

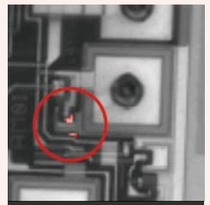


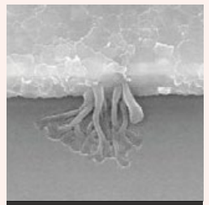
Electronic Device/Component Failure Analysis Case Studies


Wire Open(X-ray)


Microscope (SEM) Inspection of Discrete Semiconductor Devices (Peeling)

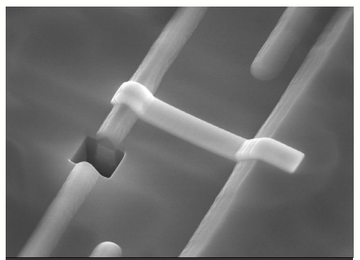

Laser Via Crack


EMMI Hot Spot

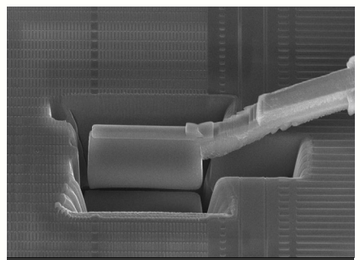

Poly Filament of IC Gate Layer

Focused Ion Beam (FIB) Analysis

QRT Inc. has many types of FIBs and a great deal of experience in analyzing products used in various fields, including semiconductors, electronic components and materials. In particular, we have excellent equipment and analysis know-how for failure analysis of a cross-sectional IC semiconductor devices, TEM Lamella, and modification of IC circuits.


Circuit Modification

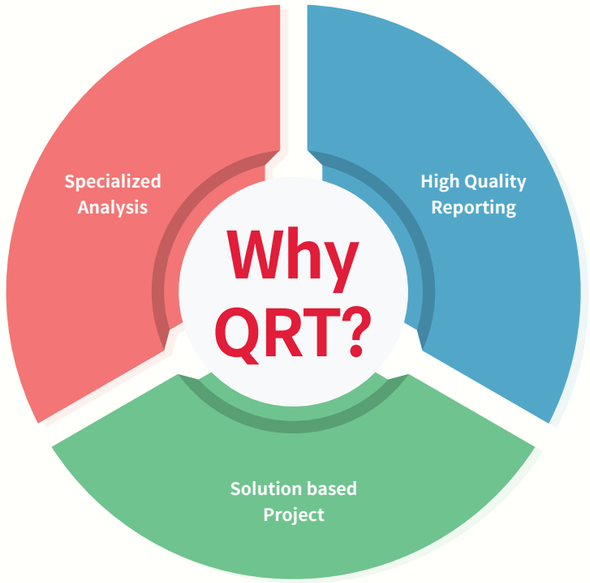

Cross Section Analysis


TEM Lamella Preparation

Material Analysis

Material Analysis

Through specialized analysis engineers for electronic materials used in various applications, we provide a wide range of material analysis services for raw materials needed in product development processes such as surface analysis, microstructure analysis, and organic and inorganic analysis.

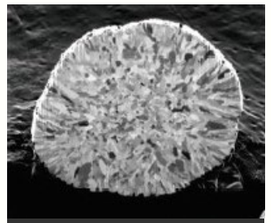


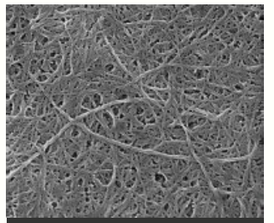
- QRT's Specilized Anlaysis
  TEM, EBSD, ASTAR, FT-IR, XPS, XRF, SIMS,
  Imaging IR, micro XRD, nano SIMS, micro XRF
- Global Network Service
  Radiation Test
  SEU Analysis

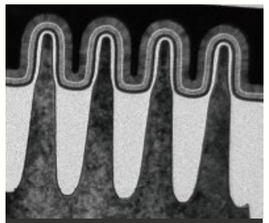
- Customer-Specific Analysis Services
- Problem-solving Projects
- "Material Analysis Recipe Setup" Services for Quality Control

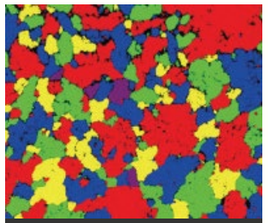
- Analytical Engineers with Various Experiences and Careers
- Advanced Analysis Services through Tech-mapping
- Test Result Data Analysis and Technical Consulting
- Analysis Method Summary Services

Surface and Surface Chemical Analysis	Nano Structure Analysis	Inorganic Analysis
D-SIMS, TOF-SIMS, XPS, AES, AFM, FT-IR	TEM, EELS, EBSD, ASTAR, XRD	ICP-MS, ICP-OES, XRF, IC
• Surface Contamination	• Crystal Structure, Defect, Size	• ppm, ppt Analysis
• Depth Profiling	• Orientation	
• Surface Morphology	**Organic Analysis**	**Global Network Service**
• Surface Elements	GC-MS, LC-MS, HPLC, FT-IR	• Radiation Test
• Chemical State of Surface Elements	• Organic materical analysis	• SEU Analysis


Battery Cathode Active Material Cross -Section (FIB)


Nano Cellulose(SEM)


FinFET Cross-Section (TEM)


Cu Foil Surface Grain (EBSD)

National Support Project

Reliability Voucher/Research-Based Utilization Projects

Category	Reliability Voucher Project		Research-Based Utilization Project	
Project Purpose	- A support project promoted by the Ministry of Trade, Industry, and Energy (MOTIE) and the Korea Institute for Advancement of Technology (KAIT) - Support for material development and reliability improvement for companies by utilizing the existing infrastructure of materials and reliability centers to ensure global competitiveness in materials and components		- A support project promoted by the Ministry of SMEs and Startups (MSS) and the Korea Association of University, Research Institute, and Industry (AURI) - Increasing the technological competitiveness and strengthening the research base of SMEs by utilizing research equipment possessed by university research institutes and collaborating with equipment experts	
Project Period	Applications are accepted from early April to December 31 of each year.		Applications are accepted from early March to December 31 of each year.	
Eligibility Requirements for the Support	Domestic SMEs and Middle-Standing Enterprises Specialized in Materials/Components		Domestic SMEs	
Main Content of the Support	QRT's test and analysis of tests for obtaining consulting certification/training/technical services		QRT's equipment support fee, test & analysis, reliability test, failure analysis/cause analysis, technical services	
Support Scale	About KRW 18 ~ 19 billion every year		About KRW 12 ~ 15 billion every year	
Corporate Contributions	13.29% by SMEs and 25% by Middle-Standing Enterprises (cash)		30 ~ 40% (cash)	
Support Category	Win-Win Type	Standalone Type 1st and 2nd	Shared-Diffusion Type	Research-Focused Type
Government Subsidies	KRW 70 million ~ 200 million	KRW 5 million ~ 70 million	Up to KRW 5 million	Up to KRW 70 million
Application Period	Once a year (April)	Twice a year (May/July)		
Website to Apply	http://www.신뢰성바우처.org		https:// rss.auri.go.kr	

※ The project period may change.

※ Eligibility Requirements for the Support: Companies according to the scope of the [Basic Act on Small and Medium Enterprises, Act on Middle-Standing Enterprises, and Act on Enterprises Specialized in Materialsor Components]

Contact Information - QRT Inc.

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※ Please contact us for additional information.

ISO26262 Consulting

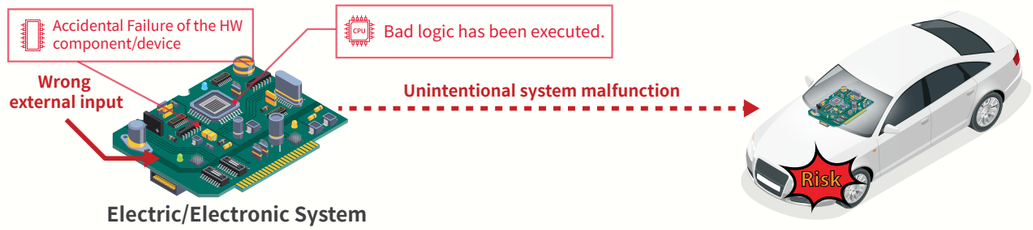
ISO 26262 (Functional Safety) Consulting

Functional Safety Concept

As an international development standard that presents process and development requirements to achieve functional safety of electric/electronic systems mounted on vehicles, vehicle manufacturers (OEM) require suppliers to comply with ISO26262 standard. In particular, as autonomous driving technology develops, compliance with the standard becomes more important.

Functional Safety Activities

Functional safety activities are activities that minimize the risk of accidents that may occur due to the malfunction of the electric/electronic system of the vehicle and to an acceptable level. Here, the criteria for accident risk is not the vehicle, but the degree of injury to drivers, passengers, and pedestrians.



Functional Safety Consulting Services

We provide practical guidance for ensuring processes and deliverables that semiconductor/system manufacturers must follow to reach functional safety requirements following ISO 26262.

Management and Procsee Optimization

- Safety gap analysis based on the latest safety standards
- Optimization of processes and work procedures
- Safety, manufacturing and maintenance planning
- Safety product development plan
- Guiding the Development Interface Agreement (DIA)

Functional Safety Goals and Requirements

- Realization of a hardware/software safety architecture
- Model-based development process optimization
- Creating/revision of internal safety standards
- Proposing a plan for the control/development of safe products

Product Verification and Validation

- Work tools, output templates, and validation/feasibility checklist
- Hardware/software integration verification and validation checking
- System and hardware/software evaluation

Education

Education Services (Regular Education)

To improve the reliability and quality of products, we provide comprehensive and essential core programs, not only fundamental theories but also case studies and practice-oriented on-site training. We conduct various monthly on-the-job training programs regularly.

Semiconductor Manufacturing Technology Studies

Understanding of Overall Semiconductor Industry and Various Standards and Processes

- International Standards for Reliability test of semiconductor devices
- Semiconductror Failure Analysis
- Understanding Chronic Quality Problem Analysis and Preparation for the Problem Analysis Report (8D Report)

Automotive Industry

Understanding Functional Safety of Automotive Applications such as Smart Cars and Self-Driving Technology

- Automotive Industry Quality Management System
- Automotive Functional Safety : ISO26262
- Core tools : APQP, PPAP, SPC, MSA, FMEA
- AIAG-VDA FMEA

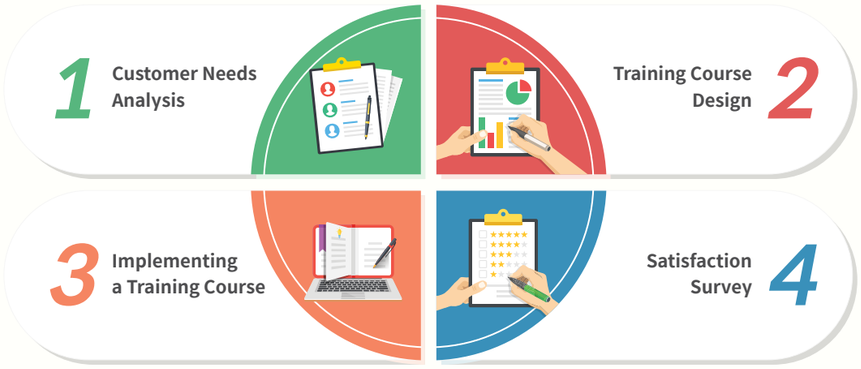
Quality Management System (QMS) and Quality Control

Presenting Proposals for Production Innovation and Improving Product Quality and Reliability

- Quality Management System : ISO9001
- Environmental Management System : ISO14001
- Safety and Health Management System : ISO45001
- Business Continuity Management System : ISO22301
- Aerospace Quality Management System : AS9100

Customized Training

Our customized training services are conducted by professional instructors in each field choosen in accordance with the requirements of skills, objectives, and targets required by the learner and our customers' business needs.



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Tel.	043-280-3504

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无锡科尔泰检测技术有限公司

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Tel.	+86-510-8115-9285

Gwanggyo Analysis Open Lab

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Gumi Branch Office

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