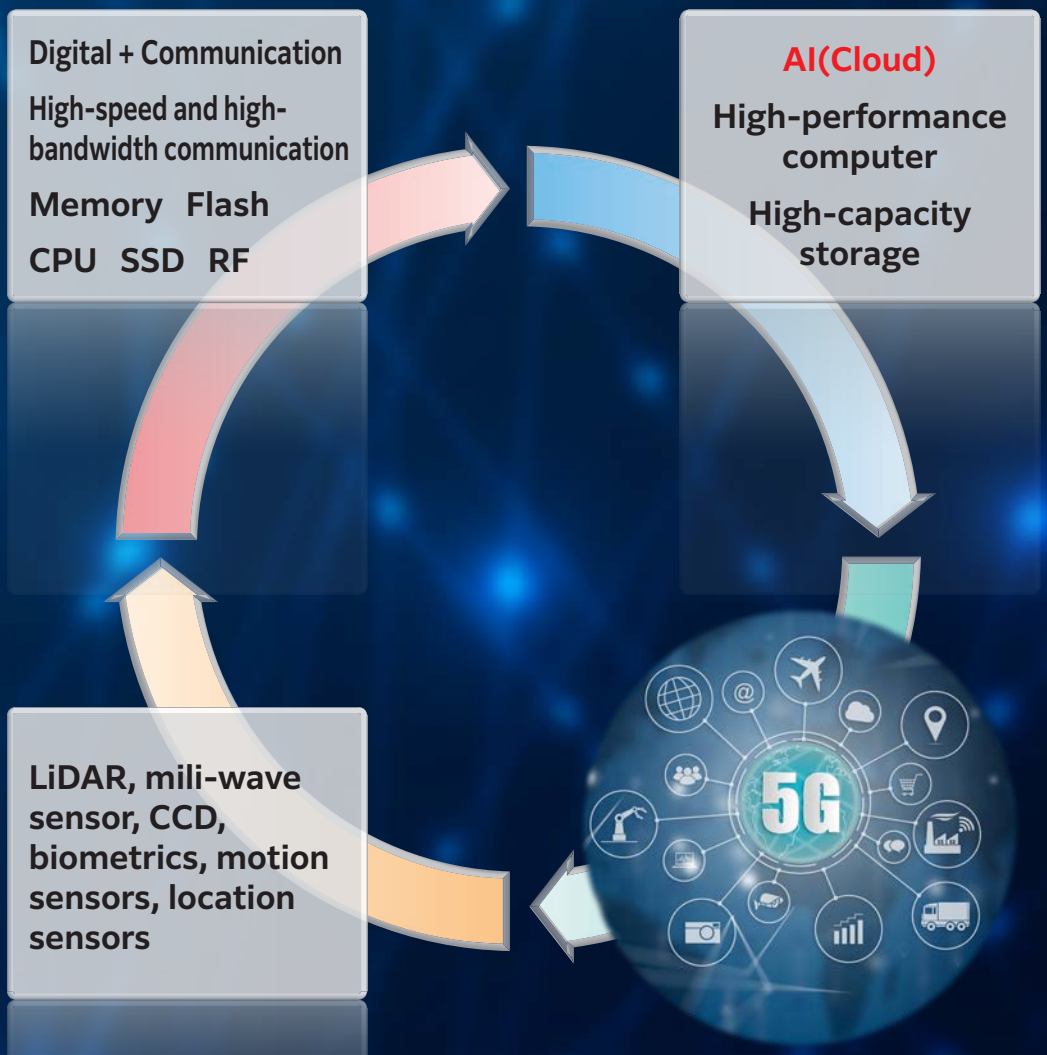
Quality is more than a word

ESPEC

Reliability Evaluation supporting the basis of IoT, 5G and the mobility field



Key devices

Semiconductors
(Memory device, flash memory and power device, FPGA and RF device)

Sensor
(CMOS, LiDAR, current sensor and G3)

Parts
(Capacitor, inductor and resistor)

Changes in environmental factors

DC high voltage and large current

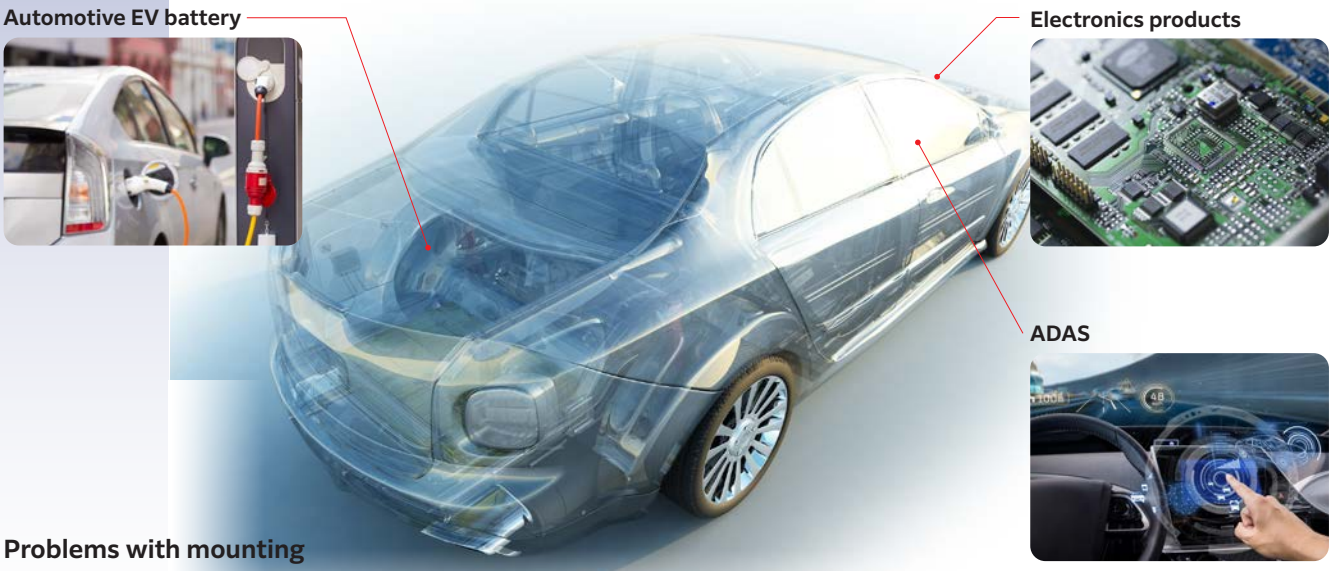
Increased self-heat generation
(Device miniaturization, FOWLP and 3D mounting)

Guaranteed device performance under a wide range of temperatures

Electronic devices and components used in vehicles

Increased power devices

While the demand for energy is growing worldwide, the climate crisis also became global attention. It has now become essential to not just to produce electricity efficiently, but also to use it safely, with long-term stability.
This trend led to the rise of alternative energy sources, such as wind and solar. On the application side, in the fields of hybrid and electric vehicles, and inverter-based appliances (such as air conditioners, refrigerators, and washing machines), the development of more energy-efficient products became a necessity to win the consumer's attention.



Problems with mounting in-vehicle devices and electronic components

In-vehicle devices should maintain reliability under a wide range of temperature/humidity environments.

EVs and electronic-based design require higher voltage.

*Electrification, including EV, ADAS (Advanced Driver-Assistance Systems), and internet connectivity, has contributed to a significant increase in the number of electronic components in a vehicle.
*Higher efficiency requires a higher voltage, which will lead to more evaluations in such conditions.

① Power cycle test (power device)	RBS-PST
② Reverse bias test (power device)	HTRB HTGB H3TRB AMI
③ High-voltage insulation evaluation	AMI
④ Capacitor leakage current evaluation test	AMI-C
⑤ Capacitor temperature characteristic evaluation test	AMQ
⑥ Electromigration/inductor evaluation test	AEM
⑦ Conductor resistance evaluation test (joint reliability test)	AMR

Issue 1: Measures against insulation and discharge under high voltage

It is important to provide measures against failures caused by discharges or short-circuits between substrates under different environments.

➡ **Insulation evaluation under high voltage**

Issue 2: Reliability under a wide range of temperature and humidity

➡ **Temperature characteristic evaluation and reliability under high temperature or constant temperature/humidity**

① Power cycle test (power device)

RBS-PST

The self-heat generation cycle that occurs when a power device is turned ON or OFF can cause disconnection of wiring and damage to heat dissipation circuits. Power cycle tests are conducted to improve the reliability of products.

■Major test modes

Continuous mode	Control the temperature and amount of cooling water to achieve the device temperature setting while Ice is constant.
Vf cycle mode	Repeat the control of turning Ice ON/OFF to make the device temperature reach the set temperature.
Cycle mode	Turn Ice ON/OFF repeatedly for the setting time.

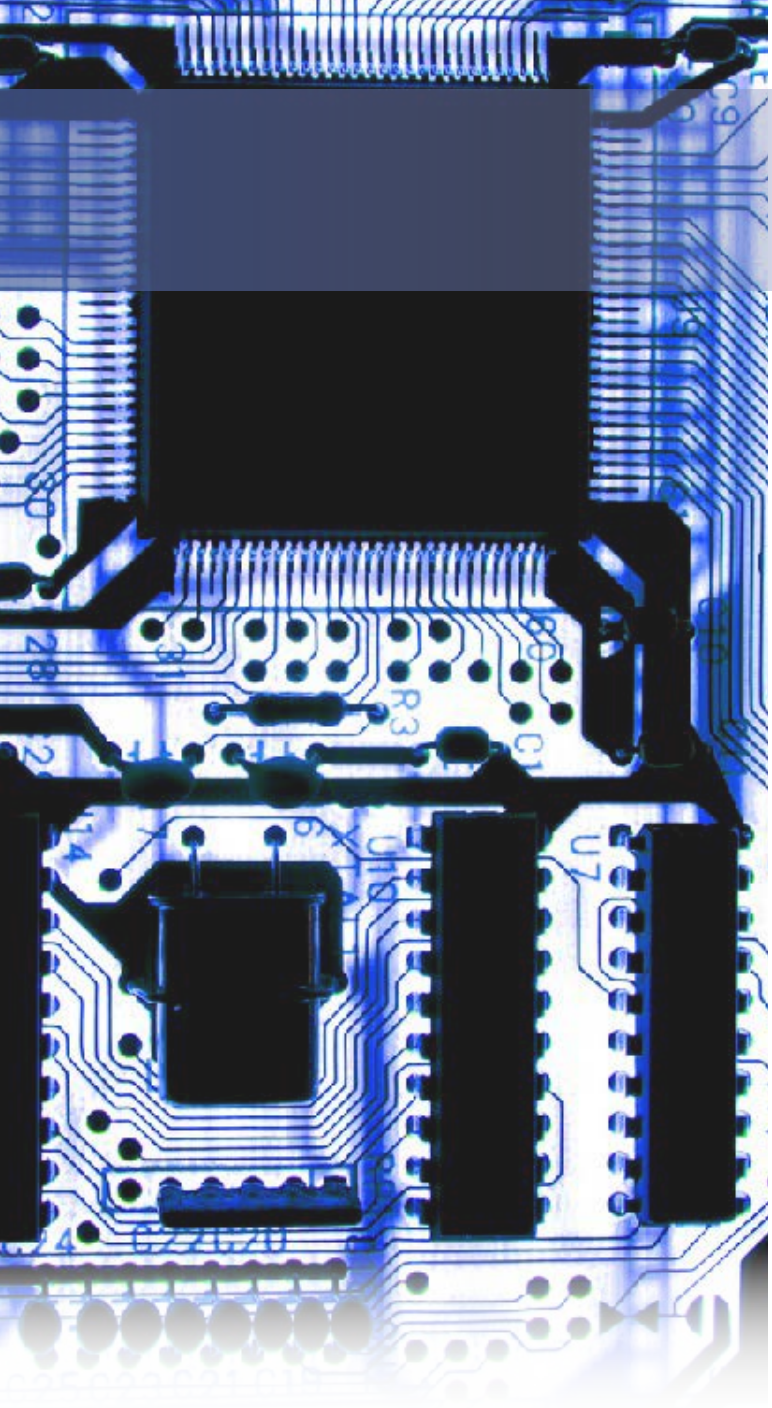
② Reverse bias test (power device)

HTRB HTGB H3TRB AMI

When the voltage of a power device is shut off, the inductors in the circuit generate surge voltage, which may damage the device. A reverse bias test is conducted to improve the reliability of the product.

Drain power supply	0 to 2 kV or 0 to 3 kV
Gate power supply	0 to ±30 V or 0 to ±35 V
Temperature control	In-chamber DUT board connection type: 200°C or 350°C

* Temperature/humidity type is also available.



Communication PCBs and electronic components

Reliability evaluation of IoT/5G devices

IoT/5G will increase the amount of data to allow remote operation, multi-communication, and ADAS (Advanced driver-assistance systems) for vehicles.
5G base stations require higher voltage, therefore devices generate more heat. From a safety standpoint, it is critical to have stable and reliable operations under such conditions, which will require more evaluation tests.

Increased self-heat generation due to the use of higher voltages and high-capacity data transfer in communication base stations

- Increase in capacity to transfer tera or even peta level of data throughout the net requires high energy.
- Data processing in high-speed communication age means increase in self-heat generation from devices.
- With improved noise immunity, devices are now used in wider range of environments.

① Power cycle test (power device)	RBS-PST
② Reverse bias test (power device)	HTRB HTGB H3TRB AMI
③ High-voltage insulation evaluation	AMI
④ Capacitor leakage current evaluation test	AMI-C
⑤ Capacitor temperature characteristic evaluation test	AMQ
⑥ Electromigration/inductor evaluation test	AEM
⑦ Conductor resistance evaluation test (joint reliability test)	AMR

Issue 1: Need for better insulation and anti-discharge measures under high-voltage environments.
➡ **Insulation evaluation under high voltage**

Issue 2: Evaluation of deterioration caused by thermal stress from increased self-heat generation
➡ **Joint reliability in thermal cycle test**

Issue 3: Improved noise immunity due to higher switching frequencies
➡ **Temperature characteristic evaluation and reliability under high temperature**

③ High-voltage insulation evaluation

AMI

Since in-vehicle devices and 5 G base stations use high voltage, insulation deterioration caused by changes in the ambient environments will greatly affect the reliability of products. Insulation reliability evaluation is critically important.

Channel configuration	Standard 25 channels (maximum 150 channels per rack)
Test control unit	5ch 25ch
Resistance measurement range	2×10^5 Ω to 1×10^{13} Ω (when applying 100 V) 2×10^3 Ω to 1×10^{11} Ω (when applying 1 V)
Voltage application range	100V/ 500V /1000V /2500V

* Contact us for the test voltage.

④ Capacitor leakage current evaluation test

AMI-C

Capacitors and other electronic components are mounted in control circuits for IoT, 5G and in-vehicle devices. Capacitors are used in communication circuits and control boards. Reliability evaluation under high temperature is especially important for in-vehicle applications.

Channel configuration	Standard 25 channels (maximum 150 channels per rack)
Test control unit	5ch 25ch
Resistance measurement range	2×10^5 Ω to 1×10^{13} Ω (when applying 100 V) 2×10^3 Ω to 1×10^{11} Ω (when applying 1 V)
Voltage application range	100V/ 500V /1000V /2500V

* Contact us for the test voltage.

⑤ Capacitor temperature characteristic evaluation test

AMQ

IoT, 5G and automotive electronics carry many electronic components such as capacitors and resistors. These device performances are temperature-dependent, which makes temperature reliability test a must.

Measurement method	AC four-terminal pair measurement (end of measurement cable)
Measurement interval	Min. 1 minute to 1500 minutes (Variable in 1 minute increments)
Measurement range	Measured frequency 20Hz～1MHz Dielectric loss angle 0.0001～10.0000 tanδ Impedance 10mΩ～100M

⑦ Conductor resistance evaluation test (joint reliability test)

AMR

This system improves reliability of products by measuring the disconnection caused by the deformation in substrates due to changes in the ambient environment or by the strain between self-heat generation and the ambient environment.

Application system	Direct electric current measurement system
Channel configuration	Standard 40 channels (maximum 280 channels per rack)
Resistance measurement range	1×10^{-3}～$1\times10^{6}\Omega$

⑥ Electromigration/Inductor evaluation

AEM

Multi-layer chip inductors used for IoT, 5G and in-vehicle applications are subject to damage due to disconnection caused by electric currents and heat generated over long-term use. Supplying a constant current to the conductor coil at a high temperature allows service life evaluation.

Output current (10 A system)

Number of ranges	3 ranges		
	100 mA range	1,000 mA range	10,000 mA range
Setting range	0～100.000mA	0～1,000.000mA	0～10,000mA
Setting resolution	0.001mA		1mA
Accuracy-guaranteed output range	10～100mA	100～1,000mA	1,000～10,000mA
Output accuracy	±0.1% F.S (F.S=100mA)	±0.1% F.S (F.S=1,000mA)	±0.1% F.S (F.S=10,000mA)

ESPEC CORP. https://www.espec.co.jp/english
3-5-6, Tenjinbashi, Kita-ku, Osaka 530-8550, Japan
Tel : 81-6-6358-4759 Fax : 81-6-6358-1453

LEAF No.20200205 Ke3B02L00 (The contents of this page are current as of March, 2020.)