

The Standards and Testing of Electronic Equipment for cars

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In the beginning the electrical equipment and electronics of cars were merely two headlights from batteries, but in the present various systems of cars have been developed greatly when compared to the starting age. Numerous electrical systems and electronics were contained in cars such as the ABS brake system, headlight ballasts, electrical mirror systems, electric chairs, crash prevention equipment, digital cameras for installation on cars, radio signal reception systems and image signal reception systems, wireless sensor equipment, and various kinds of telecommunications equipment. Additionally, there was also the use of digital cameras on cars to observe the interactions of drivers to detect sleepiness or drunkenness. All this was done for greater safety and to reduce accidents on roads. All of these various electrical equipment and electronics each work on different frequencies and may result in frequency interference from the DC area to many GHz and interference with other electronics systems that were originally installed on the cars to malfunction as well.

Electronics and Communications Systems outside of cars

In the present, many companies are progressing with the development of electronics communication systems for communication uses outside of cars with other cars and traffic networks on roads. This system was called the Intelligence Transportation System (ITS), where this aforementioned technology was applied in the present with a frequency as high as 5.8 GHz, or radar's frequency area for the ability to detect the movement of other cars on the road to order the engine's speed control system and brake system while moving too close to cars in front, or for use in investigating traffic routes as well.

Interfering Magnetic Signals on the inside and outside of cars

As the majority of a car's body was metallic, the important components of a car's structure are thus that of a conductor and an electromagnetic reflector. Thus, when a radio antenna or small satellite dish is installed onto a car body, radio signals will be reflected along the car body, which caused the interference signals of each equipment installed in cars will end up interfering with each other. At the same time, the car's structure, which is metal, that will create the emission of electromagnetic signals; it is the car's structure that will give the car the properties of a large antenna that can receive radio, television, telephone, or other signals into the car. Thus, various electronics equipment installed on cars and those sensitive to electromagnetic waves may receive highly interfering signals as well and may be the reason for malfunctions. For example, radio and television signal receivers may crackle, GPS systems may incorrectly pinpoint locations, all to the ECU system order wrong commands, etc. Sometimes, this could be a reason for decreased efficiencies in radio and image signal reception in the car.

Furthermore, the interfering electromagnetic wave signals that spread from the environment along typical roads may interfere with the function of various electronics equipment such as when cars run past areas with wind power substations, power transmission lines, radio transmission poles, television transmission poles, or telephone poles along the road, etc. If the electromagnetic fields that spread from this equipment while functioning were highly concentrated or have close frequencies with the functions of electronic circuits, they may interfere with the functions of electronics equipment in the car as well. Thus, all car producers will give importance with testing for the efficiency of resisting electromagnetic interference of various equipment in cars before distribution in the market to reduce risks in recalling products when sold in the market.

Standards for Automotive EMC Testing

For cars produced for distribution to be safe for use, control agencies in the United States of America such as the Society of Automotive Engineers (SAE) and the CISPR and ISO/IEC agencies of the European Union have appointed standards to test various properties of the car as well. The universal standards for automotive equipment testing were divided into several groups such as mechanical testing standards, reliability testing standards, EMC standards for vehicle and electronic sub-assemblies (ESA), etc. As for the comprised electronic equipment of cars, important testing standards exist as international standards down to manufacturers' standards. In these groups, each company inserted additional testing topics or higher testing intensity levels from the typical standards as the electronics equipment or the regulatory parts of each company were not alike. As for the classification of electronics equipment testing standards for each kind of car, they can be divided according to levels as follows.

- International standards, which are
 - The standards of the International Standards of Organization (ISO)
 - The standards of the International Electrotechnical commission (IEC/CISPR)
- Local standards, which are
 - The EU directive of 2004/104/EC or e-mark
 - The standards of the Society of Automotive Engineers (SAE)
- National standards, which are
 - The standards of the Japanese Automotive Standards Organization (JASO)
 - The standards of the Chinese national standards (GB/T) and
 - The standards of the Thai Industrial Standards Institute, etc.
- Manufacturer standards

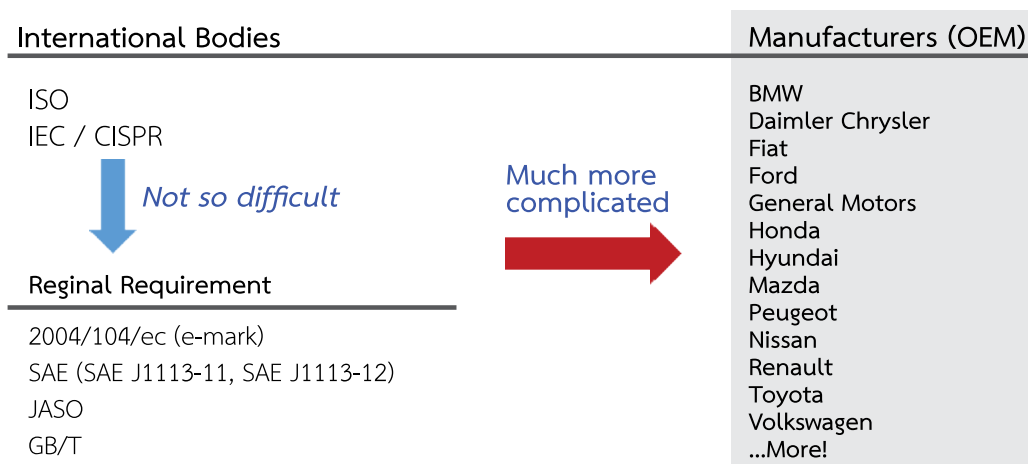


Figure 1 International, local, and national level automotive standards

Electromagnetic Compatibility Standards

Automotive EMC for automotive equipment testing can be divided into 2 parts, which are Electromagnetic Emission (EMI) testing and Electromagnetic Susceptibility (EMS) testing.

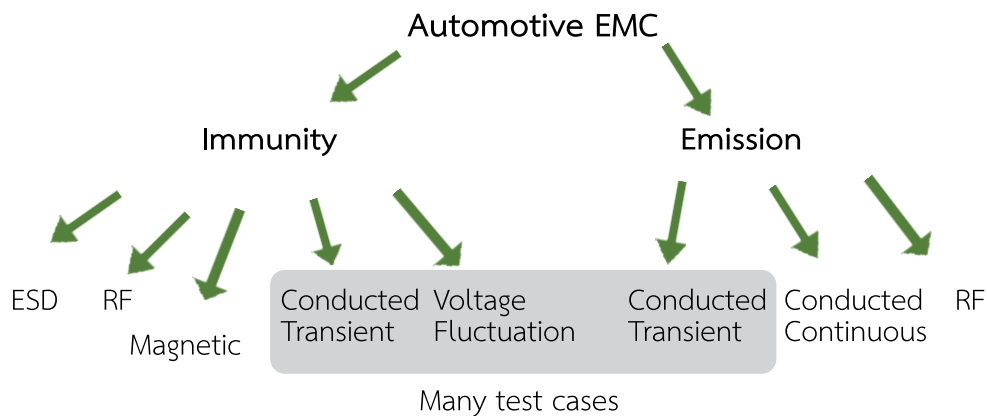


Figure 2 The classification of electromagnetic compatibility for electronics equipment in automotive

1. Electromagnetic Emission (EMI) Testing is the testing of interference signals that spread from electronics circuits to interfere with the function of other kinds of electronics devices installed in cars. EMI testing for electronics in cars can be divided into 3 types, which are

- Conducted Transient Testing is testing of the spread of electromagnetic signals that changed as a discontinuous time along conducting wires or electric wires in cars such as the opening and closing of various control relays in the car used in on and off switches of headlights, windshield wipers, etc.
- Conducted Continuous Testing is the testing of the spread of electromagnetic signals with continuous changes in signals and many frequency areas following conducting wires such as the spread of interfering radio signals in cars during function to interfere with the telephone system functions in cars, etc.
- Radiated Emission Testing is the testing of the spread of continuous electromagnetic signals and frequency areas through air such as the spread of interference signals from the function of radio signal reception systems or the television reception set outside of the functional frequency area to interfere with ECU function, etc.

2. Electromagnetic Susceptibility (EMS) Testing is the testing of immunities against interfering electromagnetic signals spread from other electronics circuits in cars to interfere with the functioning of electronics equipment that we are interested to test, of which EMS testing for electronics in cars can be divided into 5 types, which are

- Electromagnetic Static Discharge (ESD) testing is the testing of the ability to resist voltage created from accumulated static charges created from the functioning of electronic equipment in cars in low temperature, low moisture conditions from turning on air conditioning in

cars or from the grating of drivers' clothes with car seats made of rubber or polyester. Drivers may use fingers to touch radio and television buttons in cars. After that, static charges will interfere with or destroy electronic circuits inside those equipment, etc.

- Electromagnetic Radiate Immunity (RI) Testing is the testing of the ability to resist electromagnetic signals that spread through air from the functioning of other electronic circuits in the cars that interfered with electronics equipment of interest for testing such as the spread of electromagnetic waves from Bluetooth systems to interfere with the functioning of radio reception devices in cars or television reception devices in cars and creating crackling sounds, etc.
- Magnetic Field Testing of magnetic fields from electrical and electronics equipment installed in cars to interfere with the functioning of electronic circuits of interest for testing such as magnetic fields from the alternator or di-start in cars to interfere with the functioning of radios in cars and create crackling signals, etc.
- Conducted Transient testing of continuous transient signals spread in conducting wires to interfere with the functioning of electronic circuits of interest for testing, such as the spread of interference signals of radios installed on cars that interfere with ECU functioning, etc.
- Voltage Fluctuation testing is the modelling of the alternator's or battery charger's functioning conditions, which normally would cause ripples in voltage that supply various electronic circuit while functioning. This voltage would be sent to supply other electronic circuits if that equipment are unable to resist this rippling voltage and malfunction such as the turning on and off of radios during function, etc.

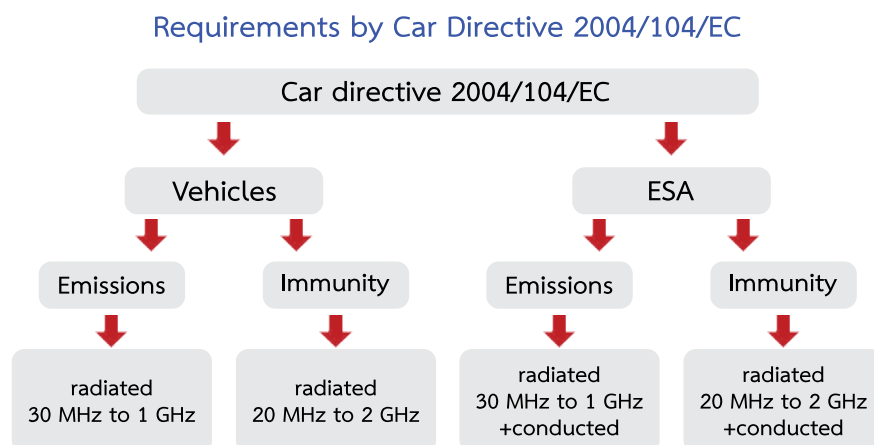


Figure 3 The classification of electromagnetic compatibility testing for automotive equipment according to the standards of the European Union, or E-mark

For electromagnetic compatibility testing, aside from being divided according to the past topics, they are also divided into testing for whole vehicles and for electronic sub-assemblies (ESA), which has different details. With this, electronics part manufacturers should obtain an understanding and study important tests, which are

1. Conducted Transients Emission testing according to ISO 7637-2 standards
2. Conducted Continuous Emission testing according to CISPR25 standards
3. Radiated Emissions Standards for ESA testing according to CISPR25 standards
4. Conducted Immunity Standards for ESA testing according to ISO 11452-4, CISPR25, and SAE J1113 standards
5. Car Electronics Equipment Electric Field Immunity testing to ISO 11452-5 CISPR25, and SAE J1113 standards
6. Radiated Immunity testing according to CISPR25, 2004/140/EC (e-mark), ISO 11452-2, and SAE J1113 standards
7. Concentrated radiated Immunity testing according to CISPR25, 2004/140/EC (e-mark), ISO 11452-3, and SAE J1113 standards
8. Static Discharge testing according to ISO 10605 standards
9. Conducted Transients Immunity of ESA Testing according to ISO 7637-2 standards

Electromagnetic compatibility testing for ESA according to universal standards such as CISPR 12, ISO 7637, ISO 10605, and others can be used as guidelines for research and development

to raise the standards of automotive products in the country to comply with further universal, local, or national automotive standards. For OEMs, the use of knowledge from these standards for the design of standardized products will enable the delivery of products to leading car producers. This is to increase Thailand's competitive potential and help support state policies that push for Thailand to continue to be the center of car production in this region, especially with the official opening of the free market of the AEC in 2018, in which there will be inevitable competition in aspects of skilled labor, design engineers, researchers and developers, production factories, and other sectors.

References

1. ISO 11451-2 Standards: Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy -- Part 2: Off-vehicle radiation sources
2. SAE J551-11 Standards: Vehicle Electromagnetic Immunity -- Off-Vehicle Source
3. 95/54 EC Annex VI Directive: Electromagnetic Compatibility (EMC) in Vehicles directive Annex VI
4. ISO 7637 Standards: Road vehicles - Electrical disturbances from conduction and coupling -- Part 2: Electrical transient conduction along supply lines only
5. CISPR12 Standards: Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of off-board receivers
6. CISPR25 Standards: Radio disturbance characteristics for the protection of receivers used on board vehicles, boats,
7. and on devices - Limits and methods of measurement
8. ISO 10605 Standards: Road vehicles - Test methods for electrical disturbances from electrostatic discharge
9. SAE J1113 Standards: Electromagnetic Compatibility Measurement Procedures and Limits for Components of Vehicles,
10. Boats (up to 15 m), and Machines (Except Aircraft) (16.6 Hz to 18 GHz)