An Overview of European Union EMC Type Approval Regulations for Motor Vehicles

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The European Union type approval directives and UNECE regulations define the safety requirements for the design and operations of road vehicles as they relate to the vehicle driver, passengers, and pedestrians. These requirements are in a state of transition and soon the road vehicle requirements in Europe will be based only on the UNECE regulations. Vehicles and electronic subassemblies that have previously been EMC tested and type approved to the European Union directive 2004/104/EC will now be tested and type approved to UN Regulation 10. The EU and the UN regulations for EMC type approval are described in this paper.

Background and Overview

Motor vehicle regulations had existed for years in individual European countries. But having different requirements and separate certification schemes for each country created inefficient trade and market conditions. In the 1970s a number of early European Community (EC) members moved toward developing common requirements and a process for mutual recognition of vehicle safety standards. Today's versions of these common requirements have been developed through the European Union and are outlined in the EC vehicle framework Directive 2007/46/EC.

The EC framework directive 2007/46/EC provides the core objectives, structure, rules and procedures for vehicle type-approval certification. The framework directive identifies over sixty technical requirements that establish the minimum standards for safety features such as passenger restraints, anti-lock brakes, lights and turn signals, crash protection, and prevention of unauthorized use.

The requirements also include environmental regulations that limit tailpipe emissions, road noise, and set requirements for maximizing fuel economy and energy efficiency.

To promote fair trade the framework directive, related technical requirements, and conformity assessment scheme are adopted by each member state to remove technical barriers to trade and promote free and fair trade between EU members and with markets outside Europe. Once a product is type-approved through the EC process, it must be allowed free passage into other member countries.

Transition from e-Mark to E-Mark

The European Union vehicle and component regulations are a type approval certification process. Vehicles and electronic subassemblies that are type-approved are labeled with the "e-Mark" after being tested then certified by a third-party Notified Body. The directive 2004/104/EC is currently the vehicle and electronic subassembly EMC requirement in Europe.

In addition to the European Union "e-Marking" directives such as 2004/104/EC, a parallel set of regulations exist through the UN Economic Commission for Europe (UNECE) Revised 1958 Agreement. This Agreement, to which the EU is a signatory, provides a global legislative process to develop and adopt worldwide harmonized motor vehicle regulations with reciprocal recognitions country to country. The UNECE requirements and certification process applies an "E-Marking" (upper case "E" rather than the lower case "e") to type approved products.

The importance of the UNECE regulations is increasing as countries and markets around the world are adopting the UNECE motor vehicle homologation requirements as their own national laws. The signatories to the 1958 Agreement include a majority of the individual countries in the European Union as well as Japan, Australia, Ukraine, South Africa, New Zealand, Cyprus, Malta, Republic of Korea, Malaysia, Thailand, Montenegro, and Tunisia.

Recently the European Union acceded its EC Whole Vehicle Type Approval (WVTA) requirements to many of the UNECE regulations. A

complete list of the UNECE regulations to which the EC has acceded as of August 2013 can be found on the Europe website at: http://ec.europa.eu/enterprise/sectors/automotive/files/unece/status-table_en.pdf.

It is important to note that some of the UNECE regulations are not adopted in full by the European Union, and not all countries that have acceded to the 1958 agreement have signed on to all UNECE regulations. Vehicle manufacturers should carefully evaluate the applicable EU directives or UNECE regulations and apply the appropriate requirements for in their situation.

Presently UNECE Regulation 10 Revision 4 is the EMC technical document that is harmonized with the requirements of the European Union Directive 2004/104/EC. The type approval process for UNECE Regulation 10.4 follows the same basic structure as for the EC WVTA with both vehicles and electronic subassemblies (ESAs). Upon completion of the UNECE process a type approval certificate of conformance is issued and the device is labeled with an upper case "E"-mark as illustrated in Figure 1.

Figure 1. Example of UNECE "E-Mark"

Beginning in November of 2014 all European Union vehicle and electronic subassembly EMC type approvals will be issued through the UNECE Regulation 10 and related UNECE certification processes.

Products Requiring E-Marking

The E-Marking requirements apply to whole vehicles and trailers, along with components, separate technical units, and electronic subassemblies. Vehicles are defined as being one of three categories, M, N, or L, and trailers as category O.

- Category M vehicles are designed and constructed primarily for the carriage of persons and their luggage.
- Category N vehicles are designed and constructed primarily for the carriage of goods.
- Category L vehicles are motor vehicles with less than four wheels
- Category O trailers are designed and constructed for the carriage of goods or of persons as well as for the accommodation of persons.

Within each category, there are further classifications of vehicle types and functions. A vehicle is generally defined as being intended for road use, moved by its own means, being complete, completed or incomplete, and with a maximum design speed exceeding 25 km/h.

Vehicles that fall outside the scope of the E-Marking requirements typically must comply with the CE Mark. Construction machinery, farm machinery, and general purpose non-road are such vehicles that fall into the scope of the CE Marking conformity assessment.

Components and separate technical units that are electronic subassemblies (ESAs) can be type approved separately from an individual vehicle certification. Any ESA mechanically fastened to the vehicle having digital or active circuitry which is operational while the vehicle is in motion is required to be type approved.

The separate type approval of component may be required when a manufacturer or integrator chooses to type approve a vehicle in multiple stages rather than as a single integrated vehicle having all electronics incorporated at the time of assessment. Separate ESA type approvals are also necessary when new or modified electronic equipment is added to an already type approved vehicle.

ESAs that are not permanently fastened to the vehicle but have a connection to the vehicle wiring

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harness must be type approved.

ESAs that are sold as aftermarket equipment and intended for installation in vehicles must be type approved if they have an immunity related function. ESAs which do not have an immunity related function are not type approved, rather they are CE Marked per the EMC Directive 2004/108/EC.

Immunity related functions are those:

- affecting the direct control of the vehicle,
- relating to driver, passenger, or other road users' protections,
- liable to cause confusion to the driver or other road users,
- for vehicle data bus functionality.
- affecting vehicle statutory data, or
- for vehicle RESS charging.

EMC Testing for Whole Vehicles and Components

The UN Regulation 10.4 defines the EMC test methods and requirements for both vehicle and ESAs.

For vehicle testing, broadband emissions are measured to the CISPR 12 methods over the frequency range of 30 to 1000MHz. The test is performed with the engine running along with all equipment capable of generating broadband interference, i.e. motors or fans are switched on.

Vehicle narrowband emissions are measured to CISPR 12 over the frequency range of 30 to 1000MHz. The test is performed with the ignition switch on but the engine not operating. All digital electronic systems with internal oscillators operating at clock frequencies greater than 9kHz and capable of being switched on by passengers are set to operate in their normal mode.

Vehicle radiated RF immunity testing is performed to ISO11451-2 over the range 20-2000MHz. Radiating antennas are positioned at locations where the electronics and vehicle harnesses are concentrated. These locations typically include facing the driver side door, front of the vehicle, or passenger side door. However, since each vehicle may be configured differently, the number and location of antenna radiating positions should be determined based on input from the vehicle manufacturer, the EMC laboratory, and Notified Body.

Vehicle radiated immunity testing is typically performed in a shielded anechoic chamber, since outdoor radiated immunity testing is restricted by national spectrum authorities. Bulk current injection immunity testing per ISO 11451-4 is an option, but it's limited to large vehicles. In addition, BCI immunity testing is inefficient at coupling RF energy at high frequencies. And since modern vehicles have many ESAs onboard, and most of them with immunity functions, performing a vehicle BCI immunity test to evaluate each module becomes a comprehensive and overly lengthy process.

A basic set of vehicle conditions and pass/fail criteria are listed in Annex 6 of UN Reg.10. Specific vehicle operating modes, pass/fail criteria, and other test conditions should be agreed upon between all parties then written into a test plan. Generally, immunity testing is performed to identify any un-commanded movements or any changes to the vehicle systems that may affect the direct control of the vehicle or otherwise affect the driver or passengers in an unsafe manner.

For ESA emissions testing, the requirements follow CISPR 25 for broadband and narrowband emissions over the range 30 to 1000MHz. The limits are expressed as quasi-peak and peak for broadband emissions and as average limits for narrowband emissions. There are no conducted RF emissions requirements.

For ESA immunity testing, UN Reg 10 provides a choice of different methods to cover the frequency range 20MHz to 2000MHz. They include TEM Cell, Strip Line, Bulk Current Injection, and free-field radiated immunity. Best practices suggest the use of BCI from 20MHz to 200MHz and free field radiated immunity from 200MHz to 2000MHz. The TEM Cell and Stripline are suitable alternatives to BCI testing over the range 20 to 200MHz. Above

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200MHz their coupling effectiveness decreases.

ESAs are also evaluated for their immunity to and emissions of conducted transients per ISO 7637-2. The immunity pulses include 1, 2a/b, 3a/b and 4. Conducted transients are applied only to the power leads. Similarly, transient emissions are measured only across power leads. ESAs that are not switched, contain no switches, or do not include inductive loads are not tested for conducted transient emissions.

There is no requirement for ESD testing for vehicles or components.

Similarly to vehicle level immunity testing, ESA test modes and pass/fail criteria should be discussed between the manufacturer, the EMC lab and Notified Body and written into a test plan. Any response noted during the test should be evaluated with the definition of immunity-related functions of UN Reg. 10 Section 2.12 in mind.

European Union Type Approval by "E-Mark"

A successful type approval requires a Notified Body and an EMC test laboratory with demonstrated expertise in automotive EMC testing.

An automotive EMC lab can provide the initial assessment and advise whether the appropriate conformity evaluation is through an E-Mark type approval or CE Mark manufacturer's self-declaration.

For example, an ESA such as a car stereo which integrates to the vehicle through its CAN bus and includes a Bluetooth transceiver will require a vehicle type approval and an assessment for the R&TTE Directive 1999/5/EC. This product will be labeled with both the E-Mark and the CE Mark.

Similarly, a vehicle such as a garbage truck incorporating moving machinery will be evaluated and labeled with the E-Mark for those aspects of the machine safety associated with its road operation, but also a CE Mark to note compliance with the Machine Safety Directive 2006/42/EC for the hydraulics and moving assemblies of the trash can lifts.

In a parallel effort with EMC testing, the manufacturer works with the Notified Body to gather information and documents to support the product manufacturing quality system. A conformity of production (CoP) evaluation is completed between the manufacturer and the Notified Body to assure the appropriate quality controls are in place and that the manufacturer continues to produce products that match the specification, performance and marking requirements outlined in the type approval documentation. In most cases, the majority of the CoP is deemed to be achieved if the manufacturer demonstrates compliance with a registered quality management systems based on ISO 9001. Depending on the findings of the Notified Body, continued quality compliance may be verified through control programs and or the CoP process may be extended to the actual surveillance testing of selected production samples.

Testing is performed according to the requirements identified in UN Reg.10. During EMC testing, the Notified Body is present to witness the testing, and along with the test laboratory and manufacturer, evaluate the test outcome and interpret the results. When the testing is complete the lab issues a detailed formal test report with a statement of compliance for the tests performed. The test report is delivered by the lab to the client, who in turn formally submits the report to the Notified Body for review and approval.

Once the Notified Body has received, reviewed, and approved all required documentation from the applicant, and has granted conformity of production for the manufacturing process, the certificate of conformity (CoC) is generated. The CoC is, in effect, a statement by the manufacturer that the vehicle conforms to the relevant EC WVTA and/or UN Reg requirements. Access to the European market must be permitted if products are accompanied by a valid CoC. Lastly, the manufacturer must apply the E-Mark to the product with the appropriate Notified Body designations.

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The Notified Body is required to provide a list of the vehicle type-approval certificate for each vehicle type which it has approved, refused to approve or withdrawn with all Community Member States. For systems, components and separate technical units, only a list of approvals granted is published quarterly.

The E-Mark 9-Step Process to Market

The following steps summarize the general sequence of steps for E-Marking type approval.

1. Contact the EMC laboratory and/or Notified Body at the early phases of development to conduct an initial review of the product and its range of applications. Determine if the device falls within the scope of the vehicle EMC regulations of UNECE Reg 10. At this phase it will also be important to determine if other directives and requirements apply.

2. Contact the EMC laboratory to request a proposal and for scheduling a test start date. The test laboratory will coordinate the start date with the Notified Body. Typically, anticipate 4-6 weeks advance notice to schedule component tests and witness services. For vehicle testing, plan for 8-10 weeks for test scheduling.

3. Contact the Notified Body to request a proposal for test witnessing, conformity of production, and certification services.

4. Prepare a test plan manufacturer with guidance from the EMC lab and Notified Body to outline the scope of testing, test conditions, mode(s) of operation, and pass/fail criteria.

5. Complete a formal application for certification with the Notified Body. The manufacturer shall submit the completed type approval application along with product descriptions, quality control information, and related documents as identified by the Notified Body. The information required shall be of the detail necessary for the Notified Body to complete a document review to assess the compliance of the device with the requirements.

6. Complete the compliance testing in accordance with the requirements. During the test a representative of the Notified Body will be present to witness the equipment setup, testing, and evaluate the test outcome.

7. The Notified Body will conduct a conformity of production (CoP) review of the manufacturer's quality management system. This review may include an audit of the manufacturing facility.

8. All revised and completed documents including the test report shall be submitted to the Notified Body for final review and approval.

9. The Notified Body shall issue a type approval report and issue the Certificate of Compliance (CoC).

As part of the CoP process, the manufacturer is obligated to communicate any changes in design or production processes that may impact the continued compliance of the type approved device with the regulations.

Conclusion

Vehicle type approval can be a challenging process. From start to finish, a vehicle certification can take from several months or up to a year to complete, and ESA type approval can run up to several months. But through careful planning and by working with an experienced EMC lab and Notified Body a more timely and successful type approval certification can be assured.

For more information on Elite's vehicle and ESA type approval services contact Elite Electronic Engineering, Inc.

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