ELECTROMAGNETIC INTERFERENCE

Peter Dorey *navigates the complexity of the electromagnetic compatibility of defence systems*

Obtaining evidence of EMC compliance is one of the major challenges of risk assessment

One of the difficulties with integrating military off-the-shelf (MOTS) and commercial off-the-shelf (COTS) products into complex military systems is achieving electromagnetic compatibility (EMC). Almost all electronic devices generate or are susceptible to electromagnetic interference, and for this reason regulatory authorities across the world have strict test and certification requirements for consumer and business products. For example, the EU has EMC Directive 2014/30/EU and a corresponding mandatory CE mark for all manufacturers of such products.

In the non-military world, this means that a product is permitted to generate only a limited level of electromagnetic interference such that the operation of other devices – for example: radio, television or mobile phones – is not impaired; and should not itself be prone to upset from interference or transmissions from wireless devices in the vicinity. However, what may be a straightforward procedure for small, simple devices requires in-depth knowledge when it comes to more complex apparatus.

MOTS equipment is qualified to a non-UK military EMC standard, such as MIL-STD-461, that may be more or less onerous than the UK standard, Def Stan 59-411. Although both are military standards, the severity of electromagnetic environment requirements differs due to the different military systems that are utilised by each nation.

THE CRITICAL DIFFERENCE

In the military domain, the issue is critical since electromagnetic interference may impair radio comms and the functioning of other devices, and so be an enormous source of potential risk. The incorporation of MOTS and COTS equipment into defence systems often requires electromagnetic barriers, such as shielded racks and filters. This reduces equipment susceptibility to harsh defence electromagnetic environments and enhances compatibility with sensitive systems such as military radio.

The UK EMC Defence Standard 59-411 provides guidance on a risk assessment process for successfully achieving EMC for both MOTS and COTS equipment that is used in military systems. However, when integrating MOTS and COTS into complex defence systems, correctly understanding and performing the assessment requirements is a complex challenge. The risk assessment process of Def Stan 59-411 contains four key steps to assess if any protection is needed, the first of which is defining the electromagnetic environment.

Once this environment definition is known, the adequacy of the MOTS/COTS EMC performance can be evaluated. The target electromagnetic environment is usually specified in the User Requirement Document (URD) or System Requirement Document (SRD), and is likely to be one of the default electromagnetic environments within Def Stan 59-411 (eg a ship below-decks environment). However, it may also be specified for a unique purpose, to ensure compatibility with specified systems, or tailored to a specific environment.

Next, it is important to evaluate the EMC compliance. Obtaining the evidence of EMC compliance is one of the major challenges of the risk assessment process. All MOTS/COTS equipment must carry the CE marking to European Directives, but its presence alone is not enough to identify levels of EMC performance. This must be identified from the manufacturer's EU Declaration of Conformity, test report, certificate or specifications.

Under the current EMC Directive 2014/30/EU, the manufacturer or supplier must maintain technical documentation containing an EMC assessment. This will include the equipment's test report and related design information. It is best practice that a copy of the EMC test report or certificate is obtained to confirm the limits applied during testing, in order to ensure the equipment's suitability for military use.

Using the guidance in Def Stan 59-411, a 'gap analysis' process can be used to determine whether the MOTS/COTS EMC compliance evidence is more or less stringent than the Def Stan 59-411 test limit. Any shortfalls identified also help to specify the degree of additional protection that is required, such as shielding or filter attenuation.

> **DEFENCE CONTRACTORS MUST ENSURE THAT ANY SUPPLIERS THEY USE UNDERSTAND THE RULES**

During this process, it is imperative that you identify the test methods and account for them as part of the comparison. These include ports tested, frequency range, limit levels, emission test detector type, test bandwidth, test distance, susceptibility test modulation and coupling method. Due to the multitude of commercial standards used today, it is likely that a range of comparisons will be required. This can be a time consuming, costly and complex exercise, so the use of specifically designed gap analysis tools is highly recommended.

Thirdly comes functional criticality. The risks identified during the gap analysis process must now be compared with the criticality of the equipment and platform environment impact in which the COTS/MOTS equipment will be used. If any unacceptable risks are identified, they must then be mitigated. For example, if the equipment has a critical function itself, adequate immunity is required. Secondly, if the equipment is co-located with other sensitive critical equipment, adequate emission control is required. Once the functional criticality process has determined the unacceptable risks, they must then be mitigated. There are two options here: firstly, retesting the MOTS/COTS equipment to determine compliance with Def Stan 59-411. This is technically a good approach, as any additional protection can be properly specified and over protection will be avoided. However, the disadvantage is the cost of the additional required testing. Secondly, remedial re-design can be achieved by adding the appropriate protection 'barriers' to reduce the coupled RF fields or interference that the equipment could be exposed to – or could emit – to below the levels of the target electromagnetic environment.

ACCOMMODATING FILTERS

As this is a common issue, many manufacturers now offer suitable RF shielded racks and enclosures for this purpose, which allow the MOTS/COTS equipment to be housed without modification, therefore preserving the validity of its CE marking. Additional filters and transient protection can also be accommodated within the enclosure. If the equipment itself is modified to achieve EMC, it is considered to have become a new type of equipment and needs to meet the EMC Directive with CE marking as a 'new apparatus' in its own right.

Something that has the potential to be overlooked is that the manufacturer or supplier of military equipment – whether bespoke, MOTS or COTS – needs to comply with those applicable UK regulations that implement EU Directives. This includes the EU EMC Directive, which would then lead to CE Marking. With regard to EMC, the current UK EMC regulations (SI 2016 No.1091), implementing the EMC Directive 2014/30/EU, do not have a specific exemption for defence equipment.

In the EU, military equipment is defined in a '1958 list' (Council Decision 255/58) and includes a category for military electronic equipment. Article 346 of the Treaty on the Functioning of the European Union (TFEU) provides a route to legal exemption from the internal market rules on a case-by-case basis, for the protection of essential national security interests. If Member States deem that a defence contract falls within the scope of Article 346, they can withhold information if they believe that its disclosure will negatively impact national security.

This has led to some confusion among designers and manufacturers, with some presuming that a 'blanket'

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exemption applies to military equipment. Even if a product is declared exempt under Article 346, in the UK the Ministry of Defence (MoD) requires evidence to show that it is at least compliant with equivalent standards to the relevant directives or harmonised standards.

MULTIPLE DIRECTIVES

There are some 25 non-military directives that require CE marking, with some specifying exclusions for military equipment and some not. For example, the Low Voltage Directive (LVD) (2014/35/EU) ensures that electrical equipment is safe and has no exclusions for military equipment whereas the Radio Equipment Directive 2014/53/EU applicable to radio transmitting or receiving equipment has an exclusion for public security, defence and State security equipment.

Even if military equipment is not within the scope of a particular directive, other directives may still apply. For example, while military radio equipment is not subject to the Radio Equipment Directive, it is subject to the Low Voltage and EMC Directives.

The applicability of CE marking to military equipment was also clarified by the European Commission in April 2012 with the statement: "Equipment which falls within the scope of the Radio & Telecommunications Terminal Equipment Directive, EMC Directive or Low Voltage Directive, shall be compliant with the applicable Directive(s) and bear CE marking."

Defence contractors must therefore ensure that any manufacturers or suppliers they use understand and comply with these rules.

In order to identify the relevant harmonised standards for compliance with the EMC Directive, a manufacturer should consider: the intended use – how is the equipment going to be used; interfaces – where does the equipment interface to public users; and the environment – what environment will it be operated in? Further guidance on the compliance of military equipment with the EMC Directive was published by CENELEC in report TR50538 back in 2010.

Integrating MOTS and COTS equipment into military projects and applying the EMC Directive to defence equipment requires careful management to avoid unnecessary duplication of compliance testing – once for Def Stan 59-411 and once for CE marking, which will of course incur additional costs. However, testing can be minimised by using the gap analysis process to establish within the technical documentation the equivalence between Def Stan 59-411 and the MOTS/COTS standards. This in itself can be a time consuming and costly exercise and often takes the user away from their core expertise or comfort zone.

However, testing can be minimised by establishing within the Technical Documentation the equivalence between Def Stan 59-411 and commercial harmonised standards using the gap analysis process previously mentioned. The can be used in either direction; to show equivalence of commercial standards to Def Stan 59-411, or equivalence of Def Stan 59-411 to commercial standards. The gap analysis process is simplified using tools developed by the UK MoD and made available to industry via the EMC Test Laboratory Association.

Due to the complexity of performing gap analysis, an EMC test laboratory partner could offer a low risk, and low-cost solution to successfully deal with defence EMC requirements, ensuring that the resulting products are legally placed on the market and acceptable for delivery, particularly for high-value projects ●

IN THE MILITARY DOMAIN ELECTROMAGNETIC INTERFERENCE CAN IMPAIR RADIO COMMS

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Using commercial off the shelf products in the military domain carries many risks

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