Automotive & Equipment Section

SPECIFICATION 5 ISSUE 11
August 2013 Ver2.0

Specification relating to minimising electromagnetic interference and maximising compatibility between electronic equipment used in vehicles, as well as body worn, for use by emergency services in England and Wales

Spec 5 Issue 11 dated August 2013 Ver2.00
Section 6 – changed value and measurement unit for limit line, to a field strength unit (dBuV/m) and therefore also removed the need for a unity gain antenna

Spec 5 Issue 11 dated November 2012 Ver1.1
Removed references to former NPIA

Spec 5 Issue 11 dated July 2012 Ver1.0
Section 6 – correction: re-inserted reference to unity gain dipole antenna for emissions testing

Spec 5 Issue 11 dated June 2012 Ver1.3
Section 6 – added ripple and transient testing
Section 6 – removed reference to unity gain dipole antenna requirement
Sections 7.1 & 7.2 – radiated testing now in both vertical and horizontal planes
Section 7.2 – products using externally mounted antennas, should now be tested at the higher field strength

Spec 5 Issue 11 dated Jan 2012 Ver1.11
Removed all conducted tests
Added more guidance on test plans and re-testing criteria
Explained process and timeline
Introduced new Mutual Interference test
Removed some frequency bands and added others

1. INTRODUCTION

This specification ultimately aims to minimise radiated and conducted **interference** that could exist between electronic equipment and radio communication systems used in a typical emergency services environment. And, to ascertain the immunity of the vehicle and any installed electrical/electronic equipment to withstand the high RF levels generated by the installed radio transmitters. This includes body worn equipment and equipment fitted permanently or temporary into vehicles or motorcycles.

It is important to note that this specification does not replace the Home Office Centre for Applied Science and Technology (CAST) electromagnetic susceptibility requirements for Traffic Law Enforcement Devices (TLEDs). It does, however, apply to all TLEDs as an additional requirement to CAST's own requirements.

The test methods adopted in this specification employs those test methods specified in the e-Marking directive, known as 2004/104/EC. This means that when the equipment manufacturer submits a product for 'e' mark testing and certification, the testing can be extended fairly simply to incorporate testing to this specification.

More recently focus has also been on **compatibility** and **standardisation**. This involves the ability to install or interchange equipment from various manufacturers, with minimal reconfiguration and installation work required. To aid this requirement the One Box Single Vehicle Architecture (OBSVA) Criteria sets out the requirements and testing regime for an electronic infrastructure intended to be fitted to emergency service vehicles – whether as original equipment (OE) or aftermarket fit. This will be used to provide power, to control input, and to process any output from all specialised emergency service equipment fitted to these vehicles. This will be achieved by reusing and interfacing with existing vehicle electronic systems, wherever possible. It is therefore important that future equipment covered by the criteria be OBSVA compliant. AES Specification 5 is a mandated test under OBSVA.

OBSVA compliance will become mandatory for all relevant police vehicles and equipment by September 2012.

2. NOTABLE CHANGES FROM THE SPECIFICATION 5 ISSUE 10 dated December 2007

- Frequency bands for radiated emission and immunity testing, have changed to reflect the current Airwave band
- All TLEDs are now required to be Spec 5 compliant
- Mutual interference testing has been added to Spec 5 testing
- Conducted susceptibility tests have been removed

3. PROCESS, TIMELINE AND COST

The process starts with the equipment supplier [applicant] filling out an application form (Annex 2) and returning it to us [AES], who will then assist the applicant with the creation of a satisfactory test plan. This is done in collaboration with the applicant's preferred test laboratory (Annex 1). Once the test plan has been agreed a test date is arranged. In most cases one of our engineers will be present on the day of testing in order to witness the assessment and to conduct mutual interference tests using bespoke equipment. This will be decided once the test plan is agreed.

After testing is completed the test laboratory sends the results to us for assessment. Where the test results prove positive we will issue a report and certification to the applicant.

AES will also publish the product's certification status on the national government Online Knowledge Area (POLKA) system where it will not only be accessible to most emergency services users, but also to a growing number of other government departments. Having a certified product on POLKA is important as users use this information to assist in the making of procurement decisions and it supports the national framework agreements.

The entire process could take up to 2 months, but generally completes far sooner as it's mostly dependant on the time it takes the test laboratory to complete the testing and return the results to us.

Certification is valid for 2 years and provided that no changes have been made to the product, or our specification, or that no operational issues have arisen, no further testing should be required and no fees should be payable. Annex 3 explains more about re-testing, changes and issues.

The cost of testing is between the applicant and the test laboratory, and therefore your test laboratory will provide you with the necessary information. For its part AES charges only an assessment and certification fee. This could increase where additional time and travel is required – the applicant will be provided with a quotation prior to additional expenses being incurred.

The table below details the entire process along with the timelines involved:

Step	Activity	Duration	Cost	Responsibility
1	Applicant reads the AES specification and selects a test laboratory of his choice. Annex 1 offers a list of test laboratories frequently used for Spec 5 testing	Depends on applicant and test laboratory	Between applicant and test laboratory	Applicant
2	Applicant returns the completed Application Form (Annex 2), along with any product supporting documentation, to the AES Project Officer. AES will provide a quotation and the applicant should at this stage provide to AES a Purchase Order	Depends on applicant	AES charge dependant on complexity of test	Applicant
3	Applicant liaises with test laboratory to draft a test plan. The Project Officer can provide guidance with the drafting of the test plan. Brief test plan guidance can be found in Annex 4	Depend on applicant and test laboratory	NA	Applicant
4	Applicant arranges for completed test plan to be sent to the Project Officer for final agreement. Once agreed a mutually convenient test date is arranged	Allow 10 working days	NA	AES Project Officer
5	Testing is performed at the test laboratory. In most cases an AES engineer will attend to perform additional testing. Additional testing involves a blocking test (MI test) as described later in the document	Usually 1 working day	NA	Test laboratory and AES Engineer
6	Test laboratory sends the test results to the Project Officer for review.	Allow 10 working days	NA	Test laboratory
7	The Project Officer assesses the results and sends a report to the applicant. Where applicable a certificate is issued and the certified product added to the POLKA system for nationwide visibility	Allow 10 working days	NA	Project Officer

4. PRE-REQUISITES

Before any Spec 5 application can progress the applicant's product needs to comply with standard EU and UK safety requirements and legislation. Below is what is generally required, however, this is not a definitive list:

- Inline with UK legislation we require that any equipment intended for installation in a vehicle has appropriate and valid e- or CE marking evidence. When relying on CE marking a statement that it complies with section 3.2.9 of Directive 2004/104/EC (as amended) is required.
- A declaration stating that the product is representative of the final production model.

Your test laboratory will be able to advise you on the declarations and markings, while AES can brief you on OBSVA compliancy.

These documents will have to be provided to the Project Officer as part of Step 2 in the process table above, before any further progress can be made with Spec 5 certification.

5. TESTING PHILOSOPHY

As mentioned earlier Spec 5 testing is generally based on the test methods prescribed in the e-Marking directive. As test laboratories are familiar with this directive it will not be repeated here.

What is **important**, however, is that there are a few differences between Spec 5 and e-Mark testing methodology. These are the main differences:

- The testing **distance is nearer** in Specification 5
- The **field strength** during susceptibility testing is **higher** in Specification 5
- The emissions limit is **lower** in Specification 5

6. TESTING PERFORMANCE LEVELS

Radiated Emissions

Frequency Band (MHz)	Detector	Bandwidth (kHz)	Limit Line
163 – 165	Average & Peak	10 ±2	15dBuV/m
380 – 424	Average & Peak	10 ±2	15dBuV/m
450 – 470	Average & Peak	10 ±2	15dBuV/m

Radiated Susceptibility

Frequency Band (MHz)	Modulation	Max Step Size	Equipment Inside Vehicle	Equipment Outside Vehicle
380 – 424	TETRA or Pseudo-TETRA	500kHz	50V/m	75V/m
450 – 470	FM 1kHz sine wave at 10kHz deviation	500kHz	20V/m	40V/m

Depending on the equipment and its intended usage the equipment under test may be tested in other bands which are restricted. The Project Officer will provide more information at the time.

Ripple and Transients

Supply Voltage	Frequency Range	Ripple Limit
+12V	300 – 3400Hz	200mVp-p
+24V	300 – 3400Hz	200mVp-p

7. TESTING METHODS

7.1 Radiated Emissions

The test method is the same as used for 2004/104/EC for ESA tests, but with the following specific requirements:

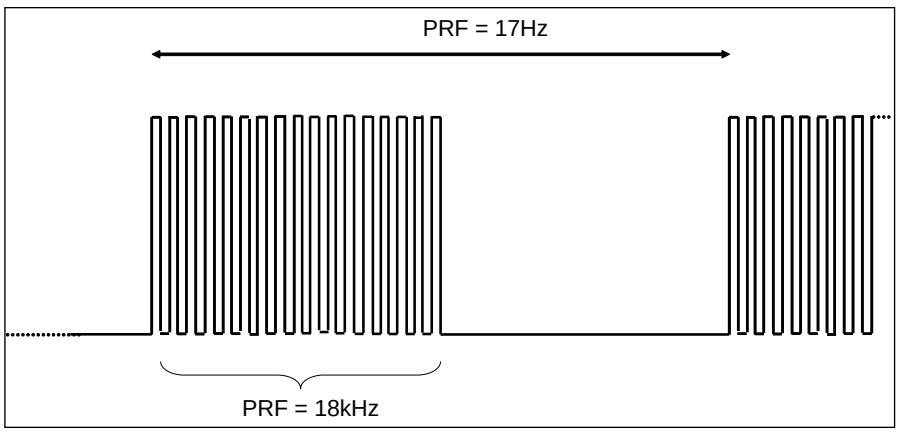
- The test antenna shall be **1 metre distance** from the EUT.
- Testing shall be done with both **vertical** and **horizontal** polarisation.
- The setup and mode of operation for the EUT shall be as described in the test plan guidance provided in ANNEX 4.

As an alternative, CISPR 25 may be used as the test method. If this test method is used then the above mentioned requirements again apply.

7.2 Radiated Susceptibility

The test method is the same as required by 2004/104/EC, but only using the anechoic chamber method defined in ISO11452-2. The following differences should be observed:

- The test antenna shall be **1 metre distance** from the EUT.
- Testing shall be done with both **vertical** and **horizontal** polarisation.
- **Different levels** are required for different product installations. Equipment fitted outside a vehicle, **or with an antenna mounted outside the vehicle**, should be tested at higher field strengths than equipment fitted inside a vehicle and with no outside antenna.
- Similar principle applies to body worn equipment, which will be tested at closer proximity than vehicle based equipment. The Project Officer will advise on this however.
- The TETRA signal should either comply with ETS300392, **or** should be a pseudo-TETRA signal comprising a 18kHz square wave modulation with a depth of greater than 98%, and gated ON and OFF at 17Hz with a 50% duty cycle. For this modulation the limit is in terms of the peak RMS value of the applied signal.
- The setup and mode of operation for the EUT shall be as described in the test plan guidance provided in ANNEX 4



7.3 Ripple

Using an oscilloscope connected across the supply lines, capture and report any ripple within the stated audio frequency range. Provide a screen shot clearly showing the ripple wave form.

7.4 Mutual Interference Test (MI)

This test is only required when excessive radiated emissions have been found during the radiated emissions test.

AES reserves the right to have an engineer present during testing, and on the basis of the radiated emissions results AES may decide if this test is needed. If present and the test is deemed necessary, AES will provide the equipment and expertise to perform the MI test.

This assessment uses the Minimum Wanted Signal (MWS) test procedure described below and the results should be summarised as per the table below.

During radiated emissions testing excessive emissions may be seen in the TETRA receive bands. The frequency and level of each of these emissions, or at least representative samples thereof, shall then noted.

A TETRA radio is then tuned to the corresponding ETSI channel nearest to the emissive frequency - usually the nearest channel either side of the emissive frequency.

With the EUT OFF a test generated TETRA signal is then audio modulated (to represent speech) and injected into the TETRA radio receiver. This is done in an environment with no other external signals present. The RF level at which the audio becomes decipherable over the TETRA radio's speaker, is then noted.

In the presence of the TETRA radio the EUT is then switched ON and exercised to the same degree as during radiated emissions testing. If at this stage the audio becomes undecipherable, due to interference from the EUT, the test generated signal is gradually increased until the audio become just decipherable again. The level at which this occurs is then also noted.

The difference in the signal level required (EUT OFF vs. EUT ON) to produce an acceptable audio output, is recorded as the amount of blocking that will be experienced by the radio in the presence of the EUT being ON.

This level corresponds to a reduction in operational performance and/or range when the received base station signals are equal or less than the received interference signal.

The above process is repeated and recorded for each of the emissive frequencies. Once the blocking level for each of the frequencies has been determined one more test remains, which is to find the "safe" distance between the radio and EUT. This involves separating the equipment to a distance at which the blocking becomes

negligible, and then recording such distance. This test should be done at the frequency (ETSI channel) that experienced the highest level of blocking.

Example Data

Tetra ETSI Channel	Test Frequency (MHZ)	Wanted Signal EUT Off (dBm)	Wanted Signal EUT On (dBm)	Blocking Level (dB)
3648	391.2125	-88	-75	13
3649	391.2375	-87	-73	14
3793	394.8375	-88	-76	12
3794	394.8625	-87	-77	10

8. TEST RESULTS

When the tests have been completed by the test laboratory the results should be sent to the AES Project Officer. The test results should contain all deviations from the test plan and test methods, any unintended observations, and all measurements obtained during testing.

9. CONTACT INFORMATION

Automotive & Equipment Section
AES Manager
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Tel: 07880 781 540

Specification 5 Project Officer
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Tel: 07876476093

ANNEX 1: TEST LABORATORIES

The following list is not exhaustive, but contains the test laboratories that AES has dealt with over the years and who are familiar with our requirements and possess the facilities to conduct the type of tests we require. Should a supplier wish to make use of a laboratory not on this list then please mention it to the project officer. This also applies to any test laboratory wishing to be added to this list. Our requirement is for the test laboratory to be ISO 17025 accredited.

3C Test Limited
Silverstone Technology Park, Silverstone Circuit, Northamptonshire, NN12 8GX
01327 857500, sales@3ctest.co.uk
www.3ctest.co.uk

Intertek (EMC Facility)
Unit D Imperial Park, Randalls Way, Leatherhead, Surrey, KT22 7TS
Ranjit Bhambra, ranjit.bhambra@intertek.com, 01372370900,
www.intertek.com

MIRA Ltd
Watling Street, Nuneaton, Warwickshire, CV10 0TU
Matthew Farmer, Business Development Manager, 02476355556,
matthew.farmer@mira.co.uk
www.mira.co.uk

QinetiQ
Cody Technology Park, Ively Road, Farnborough, Hampshire, GU14 0LX
01252 39 3437, emcfocus@QinetiQ.com
www.qinetiq.com/home/capabilities/emc.html

TRaC EMC & Safety Limited
100 Frobisher Business Park, Leigh Sinton Road, Malvern, WR14 1BX
01684 571 700, emc@tracglobal.com
www.tracglobal.com

RFI Global Services
Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH
Jared McGladdery, 01256 31 2043, jared.mcgladdery@rfi-global.com
www.rfi-global.com

SGS IEA Ltd
South Industrial Estate, Bowburn, Co. Durham, DH6 5AD
Geoff Hann, 0191 377 2000, geoff_hann@sgs.com
http://www.sgs.co.uk/

TÜV SÜD Product Service Ltd
Snitterfield Road, Bearley, Stratford upon Avon, Warwickshire, CV37 0EX
David West, 01789 731155, DWest@tuvps.co.uk
www.tuvps.co.uk

ANNEX 2: SPECIFICATION 5 APPLICATION FORM

SUPPLIER DETAILS:

The supplier refers to the company actually selling the product to the emergency services.

Name of company:
Postal address:
Contact person:
Acting in what capacity:
Telephone nr:
E-Mail address:

EQUIPMENT DETAILS:

The product name should match any accompanying certifications, as well as the brand name it's sold under.

Name of product to appear on certificate:
Product variations covered by this certification:
Description of product and its operation:

TEST LABORATORY DETAILS:

Name of test facility:
Physical address:
Contact person:
Telephone nr:
E-Mail address:

TEST DETAILS:

The test frequencies depend on who the end user is.

Who is this product aimed at? (i.e. police, fire, ambulance, covert, etc.)
What supply voltage does the product require? (12v/24v/both)
Does the product need to be earthed?

SUPPORTING DOCUMENTATION:

Does the product have e-Marking? (If so then attach a copy please)
Does the product have CE marking? (If so then attach a copy please)
Attach copies of installation/maintenance manuals.

OTHER DETAILS:

Which of the emergency services are already using this product?
Have any problems been reported by any users of this product?

ANNEX 3: RE-TESTING EXISTING PRODUCTS

AES takes a keen interest in any product that does not fulfil its function in the operational environment it was initially intended for. This includes affecting third party products.

We will withdraw or suspend certification and insist on a re-test of any product that, in our opinion, poses a liability to any of the emergency service users or the public. Furthermore we will immediately inform all emergency service users of this withdrawal or suspension in order to mitigate any risk as soon as possible. The following will constitute such a liability. AES becomes aware of:

- **changes** made to a product or its components that could give rise to increased emissions or susceptibility
- any operational or safety **issues**
- any incorrectly or **uncertified** products being used

With **changes** we refer to any change that could affect the emissions and susceptibility of a product or its components. It is usually best to consult a test laboratory on their opinion of whether a particular change is likely to affect a product's emission and susceptibility properties. From our experience we have identified the following changes as candidates for changes in a product's emissions and susceptibility characteristics:

- changes to the dimensions or openings of a metal enclosure or any screening
- changes to connectors, plugs, wiring and cable types, or earthing
- changes to the PC board layout or internally mounted metal enclosures
- changes to oscillator frequencies, switching speeds, or data transfer rates
- increases in switching currents and voltages

With operational and safety **issues** we refer to any unintended product behaviour, either experienced by itself or caused to another product, that affects day-to-day operational use. We ask that should a manufacturer become aware, at any stage from its user base, of any issues that result in the product not functioning as initially intended, or causing interference with any 3rd party products, that we be informed as soon as possible. This will allow us to take mitigating measures as soon as possible and hopefully prevent any serious consequences.

AES will be monitoring the new national POLKA system as it contains numerous forums in which emergency service users discuss product performance and after sales service. This gives us first hand knowledge of users' experiences with various products and constructively allows us to feed information back to suppliers in order to improve their service.

If during a product's two year validity period (Spec 5 certified) a change is made, we must be notified in writing of the exact changes. If no changes have been made during this period then at the end of the two year validity period AES will in any event expect the supplier to declare in writing two things:

- that no changes have been made to the product or its components
- that they are not aware of any operational issues experienced or caused by their product

Any such declaration can be made via email to us at aes@homeoffice.gsi.gov.uk and we will then place this on the product file.

Lastly; from experience AES has become aware of a multitude of products in use by emergency services, many of which have never been tested for Spec 5 compliancy. With new platforms like POLKA allowing emergency services, the Home Office, and many other government departments, to collaborate and share knowledge more closely, it is unlikely that non-compliant products will be tolerated for much longer.

ANNEX 4: TEST PLAN GUIDANCE

Test laboratories are familiar with drafting test plans and in many cases applicants leave the entire test plan to them to finalise. However, below is a summary of what the Project Officer expects from a typical test plan. Feel free to ask for input from the Project Officer at any stage during the drafting of the test plan.

- Provide a **labelled diagram** of how the system components are interconnected. This should include interconnecting cables, power cables and antenna cables. The purpose of this is to help the Project Officer understand how the system works. If the product documentation demonstrates all this in a reasonably simple way then this would suffice.

- Provide a **photo** of each component and its connectors and ports. The purpose of this is to assist the Project Officer in getting an idea of what the various components look like and what type of input and output ports each component possesses.

- Remember that the equipment need to be setup and configured as it would be in a **typical emergency service environment**. This includes cable lengths of at least a metre. Where cables are likely to be left un-terminated in a vehicle, this needs to be represented also. An example of this is where users have a USB port extended to the front of the vehicle in order to easily insert a memory stick. Also, where the equipment is capable of functionality like 2G, 3G, Bluetooth, GPS, etc. this should form part of your testing regime, even if the user is unlikely to make use of that functionality in the near future.

- For **emissions** testing explain how you will exercise your equipment in order to be as representative of the worst case scenario as possible. You can decide on what the "worst case" is, but please explain your reasons for such.

- For **susceptibility** testing state what your failure criteria will be during immunity testing and how this will be monitored. If your product allows for a variety of supply voltages then explain why you decided to use a particular supply voltage, ie 12V as opposed to 24V for susceptibility testing, due to lower switching thresholds, etc.

ABBREVIATIONS & TERMINOLOGY

AES	-	Automotive & Equipment Section
CAST	-	Centre for Applied Science & Technology
CE Marking	-	Generic EMC Directive
		(formerly known as 89/336/EEC)
e-Marking	-	Automotive EMC Directive
		(formerly known as 72/245/EEC or 95/54/EC or 2004/104/EC)
EM	-	Electromagnetic
EMC	-	Electromagnetic Compatibility
ESA	-	Electronic Sub-Assembly
ETSI	-	European Telecommunications Standards Institute
EUT	-	Equipment Under Test
HOSDB	-	Home Office Scientific Development Branch
NAPFM	-	National Association of Police Fleet Managers
OBSVA	-	One Box Single Vehicle Architecture
OE	-	Original Equipment
POLKA	-	Police OnLine Knowledge Area
RF	-	Radio Frequency
RX	-	Receive
TETRA	-	Terrestrial Trunked Radio
TLED	-	Traffic Law Enforcement Device
TX	-	Transmit

REFERENCES

One Box: Single Vehicle Architecture Criteria
http://www.homeoffice.gov.uk/publications/science/cast/cast3911