National Policing Improvement Agency

Automotive & Equipment Section

AUTOMOTIVE CONFORMANCE SPECIFICATION 5 (Issue 10) Revised December 2007

A specification relating to the electromagnetic compatibility (EMC) performance of vehicle mounted, electrically powered equipment, designed for use by the Police & Fire Services of England and Wales

NPIA Communications Directorate
Automotive & Equipment Section
8th Floor West, New King's Beam House
22 Upper Ground
London, SE1 9QY

AUTOMOTIVE CONFORMANCE SPECIFICATION 5 (Issue 10)

A specification relating to the Electro-Magnetic Compatibility (EMC) performance of vehicle mounted, electrically powered equipment designed for use by the Police & Fire Services of England and Wales.

CONTENTS

PART 1 (Issue 10): ROUTES TO SPEC 5 CERTIFICATION & COMPLIANCE WITH DIRECTIVE 2004/104/EC 3
1 INTRODUCTION 4
2 CONDITIONS FOR OBTAINING SPECIFICATION 5 CERTIFICATION 6
3 MARKED EQUIPMENT 6
4 TYPE APPROVAL AND AES SPECIFICATION 5 7
5 CONDITIONAL CERTIFICATES 7
6 REQUIRED DOCUMENTATION 7
6.1 Manufacturer's Documentation 8
6.2 Application Form 8
6.3 Test Plan 8
6.4 Test Report 9
7 CONTACT INFORMATION 10
8 APPENDIX A 11
PART 2 (Issue 10): TEST PROCEDURES 15
1 INTRODUCTION 19
2 TESTING PHILOSOPHY 20
2.1 Radiated Emissions 20
2.2 Radiated Immunity 20
2.3 Conducted Transient Emissions 20
2.4 Conducted Transient Immunity 20
2.5 Continuous Conducted Emissions (ripple voltage) 21
3 TESTING: GENERAL ASPECTS 22
3.1 Test Plan 22
3.2 CE Approved Equipment 22
4 PERFORMANCE LEVELS 23
4.1 Introduction 23
4.2 Frequency Bands 23
4.3 Radiated Emissions Limits 24
4.4 Immunity Test Frequencies 24
4.5 Radiated Immunity Limits 24
4.6 Conducted Transient Emissions Limits 25
4.7 Conducted Transient Immunity Limits 25
4.8 Continuous Conducted Emissions Limits 26
4.9 Overall Performance 26
5 APPENDIX 1: TEST PROCEDURES – GENERAL ASPECTS 27
5.1 Test Chamber 27
5.2 Device Under Test (DUT) Modes of Operation 27
5.3 Measuring Receiver Accuracy for Emission Testing 27
5.4 Measuring Receiver Bandwidth/Detector Function 27
5.5 Emission Sweep Speeds and Emission Plot Format 28
5.5.1 Automatic sweeping 28
5.5.2 Scan Rates and Dwell Times 29
5.5.3 Antenna Placement 29
6 APPENDIX 2: MEASUREMENT OF RADIATED EMISSIONS 30
6.1 Introduction 30

6.2 Test Method 30
7 APPENDIX 3: MEASUREMENT OF RADIATED IMMUNITY 33
7.1 Introduction 33
7.2 Test Method 33
8 APPENDIX 4: MEASUREMENT OF CONDUCTED EMISSIONS 36
8.1 Conducted Transient Emissions 36
8.1.1 Introduction 36
8.1.2 Test Method 36
8.2 Continuous Conducted Emissions (ripple voltage) 36
8.2.1 Introduction 36
8.2.2 Test Method 36
9 APPENDIX 5: MEASUREMENT OF CONDUCTED IMMUNITY 37
9.1 Conducted Transient Immunity 37
9.1.1 Introduction 37
9.1.2 Test Method 37
10 BIBLIOGRAPHY 38
11 REFERENCES 39

LIST OF FIGURES

Figure 1: Route to obtaining NPIA Certification 5
Figure 2: Generic Test Setup for Radiated Emission Testing (iaw CISPR 25) 31
Figure 3: Proposed dual modulation envelope 34
Figure 4: Generic Test Setup for Radiated Immunity Testing (IAW ISO11452-2) 35

LIST OF TABLES

Table 1: Radio Frequency Bands 23
Table 2: Radiated Emission limits 24
Table 3: Immunity Test Frequencies 24
Table 4: Radiated Immunity Test Limits 25
Table 5: Conducted immunity transient Limits [ISO 7637:-2:2004 ~ Supply Lines 26
Table 6: Measurement Bandwidths for Emission Tests 28

PART 1 (Issue 10): ROUTES TO SPEC 5 CERTIFICATION & COMPLIANCE WITH DIRECTIVE 2004/104/EC

1 INTRODUCTION

NPIA Automotive & Equipment Section has produced EMC Specifications to cover both vehicles (cars & m/cycles) and the operational electrical/electronic equipment being installed to ensure that:-

(a) The emissions from the vehicle or any installed electrical/electronic equipment do not interfere with the police mobile radio.

(b) The immunity of the vehicle and any installed electrical/electronic equipment will withstand the high RF levels generated by the installed police mobile radio transmitter.

This specification, which relates to equipment, is published in two parts:

- Specification 5, Part 1: Routes to Automotive & Equipment Section (AES) Certification & Required Supporting Documentation

- Specification 5, Part 2: Test Procedures

The specification states the EMC performance levels required for electrically powered equipment designed for use on Police and Fire service vehicles, together with the testing methods to be used to determine this performance.

Note: this specification is not for use with Traffic Law Enforcement Devices (TLEDs).

The test methods adopted give as close a correlation to the practical situation as possible and at a relatively low cost. The testing cost has been minimised by employing, where practical, those test methods specified in Directive 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 NPIA specification.

All testing should be accompanied by a “Test Plan” that has been reviewed by the testing laboratory and submitted to NPIA prior to the tests commencing.

This Test Plan will need to identify which frequency bands will be tested. This is important because whilst tests in the TETRA bands, covering spectrum from 380 MHz to 422 MHz, are compulsory for compliance with Spec 5, testing in the 'legacy' bands is dependant on the equipment application, and the intended customer. For example, if it is not intended to supply equipment to the UK Fire Service, then testing in low-band VHF frequencies may not be required. **This should be explained in the Test Plan and agreed with the NPIA AES Project Officer prior to commencement of testing.**

NPIA AES reserve the right to insist that all bands are addressed if considered necessary.

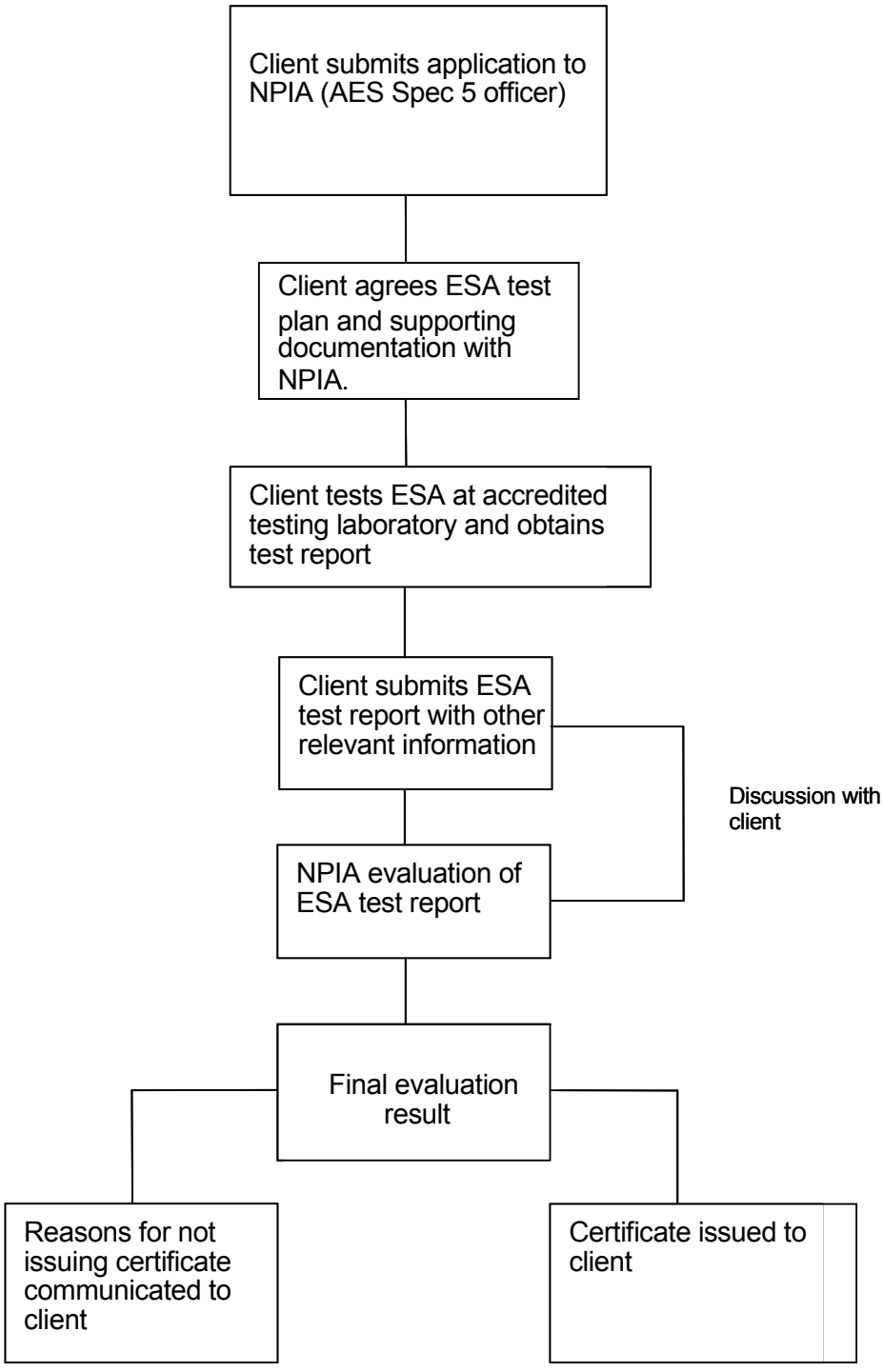


Figure 1: Route to obtaining NPIA (AES) Certification

2 CONDITIONS FOR OBTAINING SPECIFICATION 5 CERTIFICATION

Before a certificate of conformance to Specification 5 will be issued, any ESA submitted must be accompanied by documentary evidence of conformance with 2004/104/EC. This may be a Type Approval Certificate or, where the equipment in question is not immunity related, AES will accept CE marked equipment subject to the following section.

In the flowchart in Figure 1 above, where an application is made to NPIA, the applicant must either submit the Type Approval Certificate or other evidence as detailed below or specify that this testing will be combined with the AES Specification 5 testing and the documentation will be presented in one submission.

3 MARKED EQUIPMENT

Certain equipment, namely those that are for after market fitment and that do not affect the immunity related functions of the vehicle (and not connected to the vehicles CAN network) may have been CE marked through the application of 89/336/EEC or 2004/108/EC. These items are allowed to be fitted to vehicles without a full Type Approval and “e” mark process. Prior to CE marking, the manufacturer must obtain an Attestation from a Technical Service that the equipment is not “immunity related”.

The procedure for this is as follows:

- Contact Technical Service to request Annex IIIC attestation
- Submit product literature/other information explaining the functions of the equipment in full
- Pay the relevant fees
- Technical Service must issue attestation within three weeks of submission and payment

These systems will also require a specific “declaration” (defined in 2004/104/EC) as meeting certain requirements of 2004/104/EC. Where AES accept CE marked equipment to then be assessed against Spec 5, it must be accompanied by copies of the Annex IIIC Declaration, the correct Declaration of Conformity and the test reports for immunity and emissions that were performed at an ISO 17025 approved laboratory that show compliance with, as a minimum, the requirements of 2004/104/EC.

This evidence should form part of the Application, and Test Plan process which NPIA AES will then assess for suitability for testing. For example, some additional tests might be necessary to gain full Spec 5 compliance.

4 TYPE APPROVAL AND AES SPECIFICATION 5

The test methods in 2004/104/EC overlap to a great extent with those defined in AES Conformance Specification 5. As 2004/104/EC allows the Technical Service to use test results from an ISO 17025 accredited laboratory, it is possible to achieve compliance with 2004/104/EC and conformance to Specification 5 without testing the ESA twice.

Alternatively equipment already e-marked or “CE” marked may be submitted for Spec 5 testing in isolation.

5 CONDITIONAL CERTIFICATES

Specification 5 is primarily intended to minimise the risk of interference to and from the Airwave trunked radio service.

To achieve this, automotive equipment (ESAs) which is intended for use by the police service should not:

a) interfere with the correct operation of the trunked radio

b) exhibit susceptibility to Airwave transmissions which disturbs the correct operation of the equipment.

Accordingly measurements will be conducted to show that radiated emissions are within prescribed limits and tests conducted to ensure devices offer immunity to TETRA Airwave transmissions.

- Equipment demonstrating conformance over all of the Airwave TETRA and legacy frequency bands will be awarded a fully compliant Certificate.
- Equipment demonstrating compliance in the Airwave TETRA bands, but non-conformant radiated emissions over legacy frequency bands only will be awarded a conditional certificate.
- Equipment not able to achieve the necessary standards of performance non compliance with Airwave TETRA bands will not be awarded a certificate of conformance.

6 REQUIRED DOCUMENTATION

The required documentation as a minimum consists of the following items:

Prior to test:

- Manufacturer’s documentation
- Completed application Form
- Test Plan

Following Test:

- Test Report

These are described in more detail in the following Sections.

6.1 Manufacturer's Documentation

The manufacturer must supply Automotive & Equipment Section (AES) with relevant handbooks/brochures of the equipment being submitted for testing.

In addition certain equipment may have been CE marked through the application of 89/336/EEC (or 2004/108/EC from 2007 onwards). These items are allowed to be fitted to vehicles without a full Type Approval and "e" mark process. These systems will have been "Declared" as meeting certain requirements of 2004/104/EC. However for the purposes of NPIA Spec 5 the system must be accompanied by copies of test reports for their immunity and emissions that were performed at an ISO 17025 approved laboratory that show compliance with as a minimum the requirements of 2004/104/EC. These items would then be deemed suitable to be tested to the requirements of this Specification without an "e" mark.

6.2 Application Form

If the product is for "stand alone" Spec 5 testing, any reference to the Type Approval certification documentation or "CE" marking provisions shall be supplied. The equipment manufacturer shall also supply NPIA AES with a statement confirming that the equipment submitted is representative of series production and that any changes to the equipment specification or its components within two years of certificate issue will be communicated to AES.

Any Controller Area Network (CAN) communications to the vehicle are to be declared. A template for the mandatory Application Form is provided in Appendix A to Part 1.

After submission NPIA will allocate a specific reference number for your product and perform preliminary checks to ensure that:

- The product is suitable for Specification 5 assessment
- A suitable test laboratory is to be used
- The requirements and process is understood
- The product under test (ESA) can be identified

6.3 Test Plan

A Test Plan must be agreed between the ESA manufacturer, NPIA Automotive & Equipment Section and the test laboratory prior to commencement of the tests.

A test plan allows aspects of the testing, including which frequency bands will be covered, to be agreed by all parties prior to the testing commencing and therefore reduces time and costs during the tests. If a plan is being agreed as part of the Type Approval (e marking) process, then a section for testing to AES Specification 5 can easily be incorporated into the existing test plan. Otherwise stand alone plans must be formulated and agreed.

Whichever method is used the plan must be reviewed by NPIA and approved before testing commences. NPIA reserves the right to refuse test results arising from a plan which was not agreed with NPIA beforehand.

The plan must include:

- The product description and identification including part numbers etc.
- The facility where the test will be conducted and its location.
- Details of any external agencies used, including evidence of their competence to undertake the expected work.
- A clear and concise technical description of what tests are to be undertaken.
- A connectivity diagram showing all the equipments under test together with an explanation of how the operation environment is to be emulated. Any assumptions made and any pre-requisites necessary shall be defined. In addition, all tests that are required to have been run prior to the test being defined shall be identified. The ESA must be operated in the worst case EMC situation during the testing.

6.4 Test Report

When the tests have been completed by the test house, the manufacturer/test house shall supply the Automotive & Equipment Section (AES) with a detailed printed test report describing the tests that were carried out, the equipment used and the results.

In particular, the following are required:

- The details of the equipment tested, including build state and serial numbers
- The number of ESAs tested, and the number of times the tests were run.
- The details of the test equipment used, including model types and serial number.
- Plots of radiated emissions over the measurement spectrum showing full details.
- Tables clearly showing the frequency & level at which every emission exceeds the Limit Line for the band being tested.
- A soft copy of the test report in Microsoft® WORD or PDF with graphs in JPEG format.
- A set of good quality digital photographs of the equipment, and in particular as laid out for testing
- A summary of the results showing compliance pass or fail with each requirement of the Specification

7 CONTACT INFORMATION

In the first instance write to:

Head of Automotive & Equipment Section (AES)
NPIA COMMUNICATIONS DIRECTORATE
8th FLOOR WEST
NEW KINGS BEAM HOUSE
22 UPPER GROUND
LONDON
SE1 9QY

In the event of difficulties please email jim.mathieson@npia.pnn.police.uk
or phone 07887 821 392.

8 APPENDIX A

APPLICATION FORM – CERTIFICATION TO AES SPECIFICATION 5

1. CONTACT DETAILS - MANUFACTURER

Name of manufacturing company and postal address:

Contact name:

Telephone number:

e-mail contact:

2. CONTACT DETAILS - AGENT

Name of agents and postal address:

Acting in what capacity:

Contact name:

Telephone number:

e-mail contact:

Please provide contact details for any company acting as agents or consultants for or on behalf of the manufacturer. ***This will be the name of the company who will hold the certificate .***

3. EQUIPMENT

Description and role

Please give a brief overview of the role of the equipment within the authority if known. This may be a category such as specialist vehicles, general use, covert etc but should give NPIA an idea to the types of vehicles it is being fitted to and for what purpose.

4 . EQUIPMENT DESCRIPTION.

Please identify the items or system being submitted for testing. This identification should include a unique description of the product as follows:

System identification:

Hardware part numbers:

Software Levels:

PCB part numbers:

Electrical variations:

Notes:

Equipment variants included under the same tests should be provided with a justification as to why they may be accommodated by the tests on the selected (main) item. Certificates are issued against a specific system or equipment and as such cover that item including all variants described for the application. If variants are not described or tested they will not be included in the final certificate issue.

5. APPROVED TEST LABORATORY

Test laboratories that are ISO 17025, ISO 9001 or UKAS approved for this the test methods indicated in 2004/104/EC are accepted as being suitable for the performance of these tests.

Please provide their full postal address, contact name and telephone fax and email addresses below.

6. OTHER EMC APPROVALS (Current Approvals and EMC Tests)

Please list details of any other EMC testing that has been performed, approvals already attained or being sought at the same time as NPIA spec (5) testing.

Please attach to the application any evidence of compliance of these results for review by NPIA.

7. LIMITED TESTS

If you are intending to perform only specific tests then please indicate below together with any specific requirements.

Reference to NPIA Test Methods described in Spec 5

Radiated Emissions	Yes/No	Remarks:
Radiated Immunity	Yes/No	Remarks:
Conducted Transient Emissions	Yes/No	Remarks:
Conducted Continuous Emissions	Yes/No	Remarks:
Conducted Transient Immunity	Yes/No	Remarks:

8. SYSTEM DESCRIPTION

Please insert a complete description of the system in general terms, including what its purpose is, human interaction, position on vehicle, warning indications, basic principles:

9. FURTHER INFORMATION

One of the major issues surrounding equipment entry into service on Police and Fire vehicles is that of system emitting RF noise that interferes with communication systems fitted to the vehicle. Therefore please list all potential sources of narrow band and broadband noise and the fundamental frequencies at which they operate.

10. OTHER SUPPORTING DOCUMENTATION

Please make available to NPIA any documentation available covering:

System Installation
System Maintenance
Conformance of Production

PART 2 (Issue 10): TEST PROCEDURES

AUTOMOTIVE CONFORMANCE SPECIFICATION 5 (Issue 10)

A specification relating to the Electro-Magnetic Compatibility (EMC) performance of vehicle mounted, electrically powered equipment designed for use by the Police & Fire Services of England and Wales.

CONTENTS

PART 1 (Issue 10): ROUTES TO SPEC 5 CERTIFICATION & COMPLIANCE WITH DIRECTIVE 2004/104/EC 3
1 INTRODUCTION 4
2 CONDITIONS FOR OBTAINING SPECIFICATION 5 CERTIFICATION 6
3 MARKED EQUIPMENT 6
4 TYPE APPROVAL AND AES SPECIFICATION 5 7
5 CONDITIONAL CERTIFICATES 7
6 REQUIRED DOCUMENTATION 7
6.1 Manufacturer's Documentation 8
6.2 Application Form 8
6.3 Test Plan 8
6.4 Test Report 9
7 CONTACT INFORMATION 10
8 APPENDIX A 11
PART 2 (Issue 10): TEST PROCEDURES 15
1 INTRODUCTION 19
2 TESTING PHILOSOPHY 20
2.1 Radiated Emissions 20
2.2 Radiated Immunity 20
2.3 Conducted Transient Emissions 20
2.4 Conducted Transient Immunity 20
2.5 Continuous Conducted Emissions (ripple voltage) 21
3 TESTING: GENERAL ASPECTS 22
3.1 Test Plan 22
3.2 CE Approved Equipment 22
4 PERFORMANCE LEVELS 23
4.1 Introduction 23
4.2 Frequency Bands 23
4.3 Radiated Emissions Limits 24
4.4 Immunity Test Frequencies 24
4.5 Radiated Immunity Limits 24
4.6 Conducted Transient Emissions Limits 25
4.7 Conducted Transient Immunity Limits 25
4.8 Continuous Conducted Emissions Limits 26
4.9 Overall Performance 26
5 APPENDIX 1: TEST PROCEDURES – GENERAL ASPECTS 27
5.1 Test Chamber 27
5.2 Device Under Test (DUT) Modes of Operation 27
5.3 Measuring Receiver Accuracy for Emission Testing 27
5.4 Measuring Receiver Bandwidth/Detector Function 27
5.5 Emission Sweep Speeds and Emission Plot Format 28
5.5.1 Automatic sweeping 28
5.5.2 Scan Rates and Dwell Times 29
5.5.3 Antenna Placement 29

6 APPENDIX 2: MEASUREMENT OF RADIATED EMISSIONS 30
6.1 Introduction 30
6.2 Test Method 30
7 APPENDIX 3: MEASUREMENT OF RADIATED IMMUNITY 33
7.1 Introduction 33
7.2 Test Method 33
8 APPENDIX 4: MEASUREMENT OF CONDUCTED EMISSIONS 36
8.1 Conducted Transient Emissions 36
8.1.1 Introduction 36
8.1.2 Test Method 36
8.2 Continuous Conducted Emissions (ripple voltage) 36
8.2.1 Introduction 36
8.2.2 Test Method 36
9 APPENDIX 5: MEASUREMENT OF CONDUCTED IMMUNITY 37
9.1 Conducted Transient Immunity 37
9.1.1 Introduction 37
9.1.2 Test Method 37
10 BIBLIOGRAPHY 38
11 REFERENCES 39

LIST OF FIGURES
Figure 1: Route to obtaining NPIA (AES) Certification 5
Figure 2: Generic Test Setup for Radiated Emission Testing (iaw CISPR 25) 31
Figure 3: Proposed dual modulation envelope 34
Figure 4: Generic Test Setup for Radiated Immunity Testing (IAW ISO11452-2) 35

LIST OF TABLES

Table 1: Radio Frequency Bands 23
Table 2: Radiated Emission limits 24
Table 3: Immunity Test Frequencies 24
Table 4: Radiated Immunity Test Limits 25
Table 5: Conducted immunity transient Limits [ISO 7637:-2:2004 ~ Supply Lines 26
Table 6: Measurement Bandwidths for Emission Tests 28

1 INTRODUCTION

This specification is split into two parts:

- Spec 5, Part 1: Routes to Spec 5 Certification and Compliance with 2004/104/EC
- Spec 5, Part 2: Test Procedures

The test procedures stated in this Part 2 of the specification will allow a manufacturer to:

a) design the equipment so that it has a high probability of working correctly on any service vehicle without being grossly over-engineered;
b) test his equipment using industry standard methods, principally those specified in 2004/104/EC; and
c) make preliminary measurements off-vehicle.

The test methods adopted give as close a correlation to the practical situation as possible and at a relatively low cost. The testing cost has been minimised by employing, where practical, those test methods specified in 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 NPIA specification.

This specification covers both 12 and 24 Volt systems. All testing should be accompanied by a "Test Plan" that has been reviewed by the testing laboratory and submitted to NPIA prior to the tests commencing. See Part 1 of this document for details on required documentation.

2 TESTING PHILOSOPHY

The chosen test procedures embrace the following EMC categories within the vehicle environment. Appendix 1 details general aspects of the test laboratory and procedures.

2.1 Radiated Emissions

Equipment may radiate energy that interferes with other installed systems, particularly the on-board Police/Fire service radio. These emissions will depend on the inherent energy radiated from the equipment as well as the vehicle body shape, wiring length, wiring/equipment location and measurement position.

Suitable broadband antennas are used in conjunction with a suitable measuring receiver. These tests need to be carried out in an absorber-lined shielded enclosure to prevent interference from ambient electromagnetic noise. These tests are described in Appendix 2 and are based on the 2004/104/EC test methods.

2.2 Radiated Immunity

Equipment may malfunction as a result of energy radiated from other installed systems; particularly energy radiated from the transmitting antenna (and co-located communication equipment).

For the **preliminary** off-vehicle tests, radiated field tests must be used. Details are given in Appendix 3; again, the tests are based on the 2004/104/EC test method.

2.3 Conducted Transient Emissions

Equipment may give rise to transients on its power leads, which are conducted, via the vehicle battery, to the power leads of other systems. Also the transients are conducted around the vehicle wiring harness and can be inductively or capacitively coupled into the signal/control leads of other installed systems. Transient emissions from operational equipment can cause other installed systems (including vehicle systems such as the ABS) to fail either momentarily or, in severe cases, permanently. It is a requirement of this specification that operational equipment is designed to a standard that keeps these transient emissions within acceptable limits. This test involves the use of an oscilloscope and an artificial harness network and is described in Appendix 4.

2.4 Conducted Transient Immunity

There are two elements that need to be considered in the case of the transient immunity performance of operational equipment. These two elements are: -

a) Voltage transients conducted along the power supply leads and directly into the equipment.

b) Voltage transients that flow along the vehicle wiring harness and become inductively or capacitively coupled into the signal or control leads of the operational equipment.

In the case of (b), this effect can be radically reduced or even eliminated by the adoption of good installation techniques. Such techniques are required to be used by contractors employed by the Police and Fire services of England and Wales. Consequently this specification does not set any pass requirements for this element of transient immunity performance. However, this does not completely remove the need for these tests to be carried out. This is performed by connecting a transient generator to the unit under test and injecting

transients that represent those which can be present on the vehicle wiring harness. These tests are described in Appendix 5**.**

Bench tests only, are used to determine the transient performance of equipment.

2.5 Continuous Conducted Emissions (ripple voltage)

As well as transient emissions, it is possible for operational equipment to emit continuous conducted emissions, on its power supply leads, that can give rise to a whining noise on the Police/Fire service radio. This test involves the use of an oscilloscope and an artificial harness network and is described in Appendix 5.

3 TESTING: GENERAL ASPECTS

3.1 Test Plan

It is a requirement that a full test plan be produced as part of this process. A test plan allows all aspects of the testing to be agreed by all parties prior to the testing commencing and therefore reduces time and costs during the tests. If part of the Type Approval process, this can easily be incorporated into the existing test plan otherwise stand alone plans must be formulated and agreed. The test plan is described in Part 1.

3.2 CE Approved Equipment

Certain equipment, namely those that are for after market fitment and that do not effect the immunity related functions of the vehicle (and not connected to the vehicles CAN network) may have been CE marked through the application of 89/336/EEC (and 2004/108/EC from 2007 onwards). These items are allowed to be fitted to vehicles without a full Type Approval and “e” mark process. These systems will have been “Declared” as meeting certain requirements of 2004/104/EC. However for the purposes of NPIA the system must be accompanied by copies of test reports for their immunity and emissions that were performed at an ISO 17025 approved laboratory that show compliance with as a minimum the requirements of 2004/104/EC. These items would then be deemed suitable to be tested to the requirements of this specification without an “e” mark.

Again, this process is explained in Part 1.

4 PERFORMANCE LEVELS

4.1 Introduction

Any equipment item which, in accordance with its own published specification and operating parameters, fully meets the required standard of performance, as stated below, will be awarded a compliance certificate.

4.2 Frequency Bands

For the purposes of this specification, the VHF, UHF, TETRA frequency bands are as defined in Table 4 below:

Table 1: Radio Frequency Bands

Frequency Band	From (MHz)	To (MHz)
VHF	70.5	71.5
	80.0	84.0
	143	148
	152	158
	168	174
TETRA	380	422
UHF	450	470

4.3 Radiated Emissions Limits

Using the procedures stated in **Appendix 2** the following noise limits in *Table 2* apply:

Table 2: Radiated Emission limits

Analogue			**Digital (TETRA) (Peak Limit)**
VHF Low Band (QP limit)	**VHF High Band (QP limit)**	**UHF Band (QP limit)**	**UHF Band (Peak Limit)**
10kHz Impulse Bandwidth		**10kHz Impulse Bandwidth**	
70.5-84 MHz	143-174 MHz	450-470MHz	380-422MHz
0dB(μV/m)	6dB(μV/m)	15dB(μV/m)	15dB(μV/m)

4.4 Immunity Test Frequencies

The conducted and radiated immunity test procedures laid out within Specification 5 require a spot frequency plan to cover the frequency bands of concern. The following table contains the frequencies and step sizes required.

Table 3: Immunity Test Frequencies

All frequencies are in MHz				
VHF Low Band	**VHF High Band**		**UHF**	
			Analogue	**TETRA**
70.5	143	168	450.0MHz and then at 0.5MHz intervals up to and including 470.0MHz	380.0MHz and then at 0.5 MHz intervals up to and including 422.0MHz.
71	143.5	169		
71.5	144	170		
80	146	171		
80.5	146.5	172		
81	147	173		
81.5	147.5	174		
83.5	148			
84	152			
	152.5			
	153			

4.5 Radiated Immunity Limits

Using the procedures stated in **Appendix 3**, the equipment under test must not malfunction when the following test levels, in *Table 4* are applied.

Table 4: Radiated Immunity Test Limits

Radiated Field Test	Analogue		Digital
	VHF Bands	UHF Band	TETRA Band (Test Level is in terms of Peak RMS)
For equipment mounted external to the body	60V/m	40V/m	75V/m
For equipment mounted within the body shell	20V/m	20V/m	50V/m
Test modulation used	Carrier wave & AM 1kHz sine wave; 80% modulation depth	Carrier wave & FM 1kHz sine wave; deviation = 1.6kHz	TETRA signal complying with ETS 300 392[1] or pseudo-TETRA signal as per Appendix 5

4.6 Conducted Transient Emissions Limits

Using the procedure stated in **Appendix 4**, Section 8.1, the value of any transients observed and measured should not exceed 50V positive or negative with respect to ground. +100V or -300V for 24V systems. These levels are based on ISO 7637 Part 2:2004 (Annexe C) and correspond to Test Level II.

4.7 Conducted Transient Immunity Limits

The equipment must perform, in accordance with the functional status criteria given in *Table 5* when subjected to the test procedure stated in **Appendix 5,** Section 9.1. All memory functions must perform as designed during and after the exposure to the disturbance. *Table 5* is based on ISO 7637 Part 2:2004 and correspond to Test Level III.

Table 5: Conducted immunity transient Limits [ISO 7637:-2:2004 ~ Supply Lines

Test Pulse (ISO 7637-2:2004)	Test Level (III) 12 Volt Systems	Test Level (III) 24 Volt Systems	Number of pulses or test time	Functional Status (ISO 7637-2:2004 Annexe A)
1	-75	-450	5,000	B
2a	+37	+37	5,000	B
2b	+10	+20	10 Pulses	B
3a	-112	-150	1 hour	B
3b	+75	+150	1 hour	B
4	-6[1]	-12[2]	5	C
5	+65	+123	5 (1 minute recovery time between pulses)	C

4.8 Continuous Conducted Emissions Limits

Using the procedure stated in Appendix 4 Section 8.2, the value of any ripple superimposed on the d.c. supply must not exceed 0.2V peak-to-peak in the frequency band 300Hz – 3.4 kHz for all functional modes of the equipment. This relates to pulses with a repetition frequency between 294µs and 3.3ms only.

4.9 Overall Performance

All equipment that meets, or has a performance that is better than, the limits stated in this specification can be identified as such.

[1] This level refers to Va and Vs in the cranking waveform

5 APPENDIX 1: TEST PROCEDURES – GENERAL ASPECTS

5.1 Test Chamber

All testing must be performed in a suitable laboratory that meets the requirements of ISO 17025. Tests may be done in conjunction with Type Approval testing or as a stand alone test.

5.2 Device Under Test (DUT) Modes of Operation

During the "Worst Case Meeting" for the purposes of Type Approval, the modes of testing will be selected that represent the worst case in terms of expected emissions, immunity for both radiated and conducted mediums. These test modes must be reviewed and were necessary enhanced to ensure that other conditions that may produce higher emissions levels or cause areas for concern from an immunity point of view are addressed in the test plan. For example, in normal operating modes, many pumps are intermittent in there activation and as such may not be fully tested by the requirements of 2004/104/EC. In these cases it may be necessary to ensure that the pumps are continually activated to ensure intermittent operation does not effect communications equipments within the desired operating bands. Should testing be performed as part of a stand alone test program, the test laboratory and suppliers must meet to ensure that the requirements of this specification are contained within the test plan itself.

5.3 Measuring Receiver Accuracy for Emission Testing

The Automotive EMC Directive 2004/104/EC calls for use of a Measuring Receiver, although it is permitted to use a Spectrum Analyser for a "quick look" initial assessment

Measuring receivers shall comply with the requirements of CISPR 16 -1 and be calibrated by a UKAS accredited calibration laboratory or equivalent. The receivers shall be calibrated in terms of the rms value of a sine wave although fitted with peak detectors, i.e. one volt RMS sine wave will be recorded as one volt peak.

The limits set down in Specification 5 take into account the uncertainty of the measuring equipment provided that the following parameters are within the tolerances described:

5.4 Measuring Receiver Bandwidth/Detector Function

For all emission measurements, outside the TETRA UHF band, a quasi-peak detector shall be used. For the TETRA band 380-422MHz a peak detector shall be used. The bandwidths to be used when carrying out emission measurements are as detailed in Table 6 below. *Table 6*.

Table 6: Measurement Bandwidths for Emission Tests

Frequency Band	From (MHz)	To (MHz)	Impulse Bandwidth
VHF	70.5	71.5	10 kHz +/- 2 kHz
	80.0	84.0	10 kHz +/- 2 kHz
	143	148	10 kHz +/- 2 kHz
	152	158	10 kHz +/- 2 kHz
	168	174	10 kHz +/- 2 kHz
TETRA	380	422	10 kHz +/- 2 kHz
UHF	450	470	10 kHz +/- 2 kHz

5.5 Emission Sweep Speeds and Emission Plot Format

5.5.1 Automatic sweeping

When performing emission measurements, consideration shall be given to the rate at which the frequency is scanned with respect to receiver bandwidth. To avoid amplitude measurement errors, the minimum time, T, to scan for a linear frequency scan rate, is the frequency span divided by the bandwidth. Although this equation determines the minimum scan time which will allow the receiver detector to reach the peak value, in practice, a much longer scan time will generally be required to allow for data collection. A minimum sweep speed of 20s/MHz is recommended.

Record emissions from the Device Under Test (DUT) and include in a report, ensuring all of the criteria shown below are contained:-

- Calibrated frequency graduations (MHz).
- Calibrated amplitude graduations (at least every 10 dB).
- Specification limit or equivalent specification limit (dBµV/m).
- Receiver bandwidth (kHz).
- Receiver scan rate.
- Detector function (Peak and/or Quasi-peak).
- Transducer type with Correction Factor.
- Attenuator settings (dB).
- DUT mode of operation and lead under test, as applicable.
- Date of test.
- Title of DUT.
- Test method.
- Test point.

5.5.2 Scan Rates and Dwell Times

Test Receiver scan rates and detector peak hold time shall be selected to be compatible with each other and the type of electromagnetic signals being measured. The detector hold or dwell time shall be adequate (a minimum of 10ms) to record the peak amplitude of the interference but not so long in relation to the scan time such that the interference profile is not accurately captured.

When sweeping with digital EMI receivers, the receiver step size shall be no more than half of the selected receiver bandwidth, i.e. for:-

- emission searches at 10 kHz b/width, the step size shall be no more than 5 kHz

When performing emission measurements enough information must be gathered to describe accurately the distribution of interference with frequency. When making spot frequency measurements (non-preferred); for a distribution which changes slowly with frequency at least 3 readings per octave must be recorded, for quicker changes extra readings will be required, for example to indicate the presence of narrowband signals within a broadband spectrum, e.g. presence of clock frequencies.

5.5.3 Antenna Placement

For both radiated emission and immunity testing when measuring a large DUT more than one antenna position and hence frequency sweep may be required to ensure that all of the DUT is covered within the 3dB beam width of the antenna.

6 APPENDIX 2: MEASUREMENT OF RADIATED EMISSIONS

6.1 Introduction

This appendix describes the means of measuring the radiated emissions from operational equipment in isolation (i.e. without the need for a vehicle). However, because many factors influence the level of emissions received at the vehicle antenna, variations of at least 20dB are possible in the levels measured using this technique compared with those measured on the vehicle. For example, the level of disturbance measured on the vehicle will be very dependent on the position of the vehicle antenna with respect to the other operational equipment. Nevertheless, it provides a method for the manufacturers and suppliers of operational equipment to determine, with reasonable accuracy, whether or not their apparatus is likely to cause interference to other electronic equipment, in particular the police/fire service radio, fitted to a motor vehicle.

6.2 Test Method

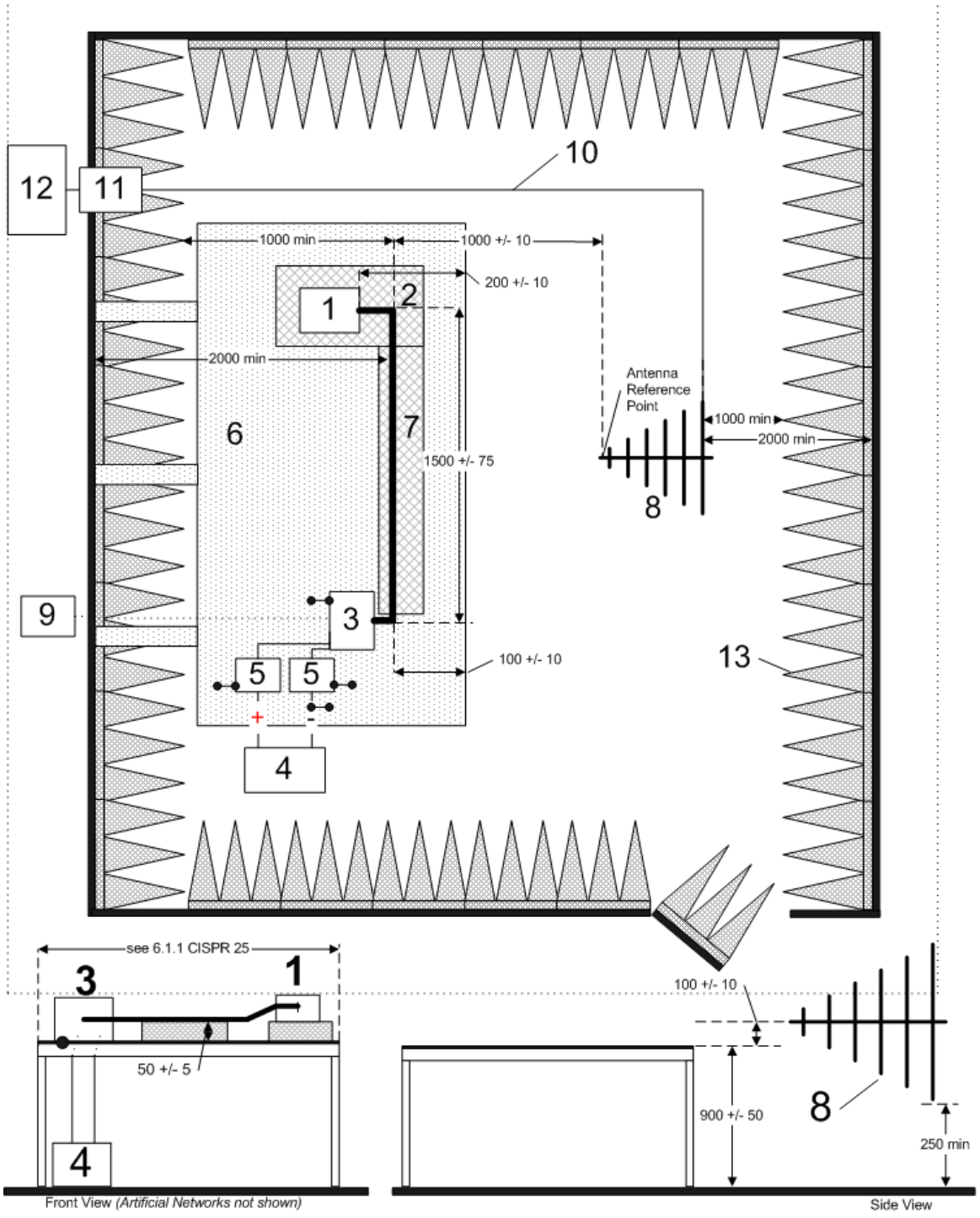
An absorber-lined shielded enclosure will be required to carry out these tests to prevent measurement errors due to both extraneous ambient noise and reflections from the walls within the shielded enclosure. The test method is the same as used for 2004/104/EC for ESA (electrical/electronic sub-assembly) tests but with the following specific requirements:

- An absorber-lined shielded enclosure must be used (the ambients encountered on an open area test site would be too high for the sensitive measurements required for this specification)
- A quasi-peak detector must be used for the emission measurements in the non-Tetra frequency band. In the TETRA band 380-422MHz a peak detector must be used.
- The bandwidth of the detector shall be as defined in Section 5.4.
- The equipment must be operating in its most emitting mode e.g. for a lightbar, the lights must be flashing and for a wailer system, the sounder must be ‘on’
- A ground plane bench must be used (not just a wooden table)
- The antenna shall be 1 metre from the DUT as shown in Figure 2.

The following are requirements that differ from those in 2004/104/EC:

- The emissions limits are those given in Section 4.3 above

As an alternative, CISPR 25[2] may be used as the test method. If this test method is used then the above mentioned two sets of requirements again apply. Note that some of the requirements are already included in CISPR 25, for example the use of a ground plane bench. Figure 2 is an example of the test setup defined in CISPR 25.



Key

1	EUT (grounded locally if required in test plan)	8	Receiving antenna
2	Test harness	9	Support equipment
3	Load simulator (placement and ground connection according to CISPR 25 6.4.2.5)	10	High quality double shielded coaxial cable (50 Ohm)
4	Power Supply (Location Optional)	11	Bulkhead connector
5	Artificial Network (AN)	12	Measuring instrument
6	Ground plane (bonded to shielded enclosure)	13	RF absorber material
7	Low releative permitivity support (er <= 1.4)		

Figure 2: Generic Test Setup for Radiated Emission Testing (iaw CISPR 25)

The interference is recorded for all frequency bands covered by this specification, in accordance with the Test Frequency Plan shown in Section 4.3. It is important to pause at each frequency to allow the CISPR detector to settle and to ensure the reading is steady. Where a 'sweep mode' programme is being used, the sweep time should be set for the rate of 20s/MHz or greater (Part 2, Section 5.5). Measurements are made with the test antenna vertically polarised only and all results are recorded in the test report.

7 APPENDIX 3: MEASUREMENT OF RADIATED IMMUNITY

7.1 Introduction

The tests described in this appendix provide a method for the manufacturers and suppliers of operational equipment to determine, with reasonable accuracy, whether or not their apparatus will malfunction due to the radiated fields encountered under service conditions. These tests represent the worst-case situation, e.g. when the transmitting antenna is located one metre from the equipment being tested, as in the case of some light-bar installations.

7.2 Test Method

An absorber-lined shielded enclosure, with the appropriate monitoring facilities [audio and visual], will be required to carry out these tests.

The test method is the same as required by 2004/104/EC but only using the anechoic chamber method defined in ISO11452-2, with the following specific requirements:

- The test system must be capable of generating an RF field, at the reference point, in excess of 75V/m across the frequency ranges identified
- The equipment must be operating in its most susceptible mode e.g. for a lightbar, the lights must be flashing and for a wailer system, the sounder must be ‘on’

The following are requirements that differ from those in 2004/104/EC:

- In addition to carrier wave testing, amplitude modulation, frequency modulation and TETRA or pseudo-TETRA modulation must be used as detailed in Section 4.5 above
- For the VHF bands, tests are required with the carrier amplitude modulated by a 1kHz sine wave signal adjusted to give a modulation depth of 80%
- For amplitude modulation, the field strength limits are expressed as carrier wave levels. Applying amplitude modulation will therefore increase the peak field by around 5dB. In other words, the signal generator output is set to give the required output using a carrier wave and is not reduced on application of amplitude modulation.
- For the 450-470MHz UHF band, the carrier wave shall be frequency modulated by a 1kHz sine wave at a deviation of 1.6kHz
- For the UHF TETRA band, tests are required with a TETRA signal complying with ETS 300 392 or with a pseudo-TETRA signal as described in Appendix 5. This pseudo-TETRA signal comprises a 18kHz square wave modulation with a depth >98% additionally gated on and off at 17Hz) with a 50% duty cycle (Figure 3). For this modulation the limit is in terms of the peak RMS value of the applied signal.

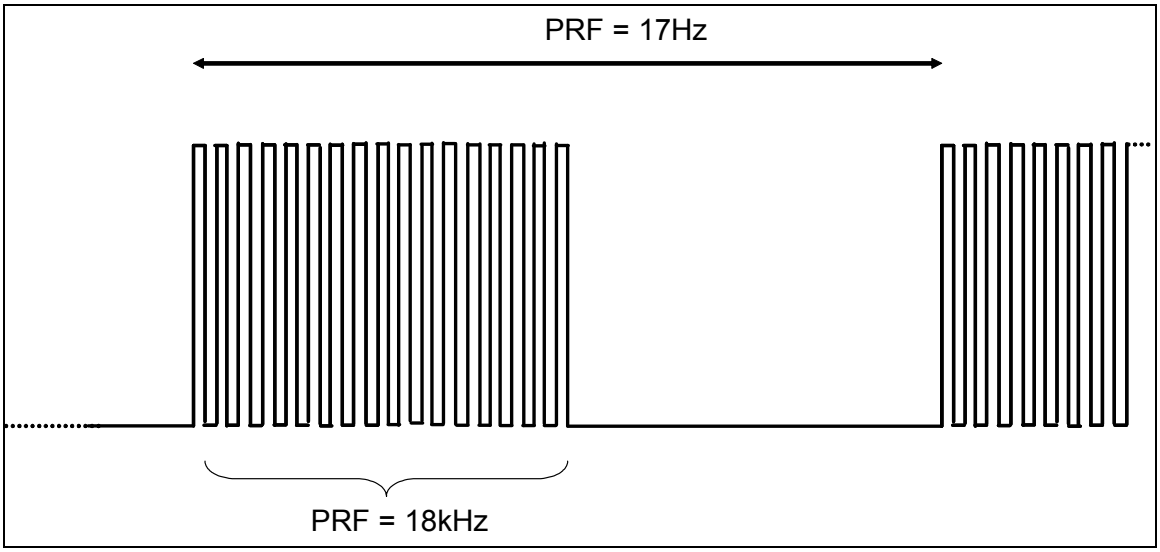
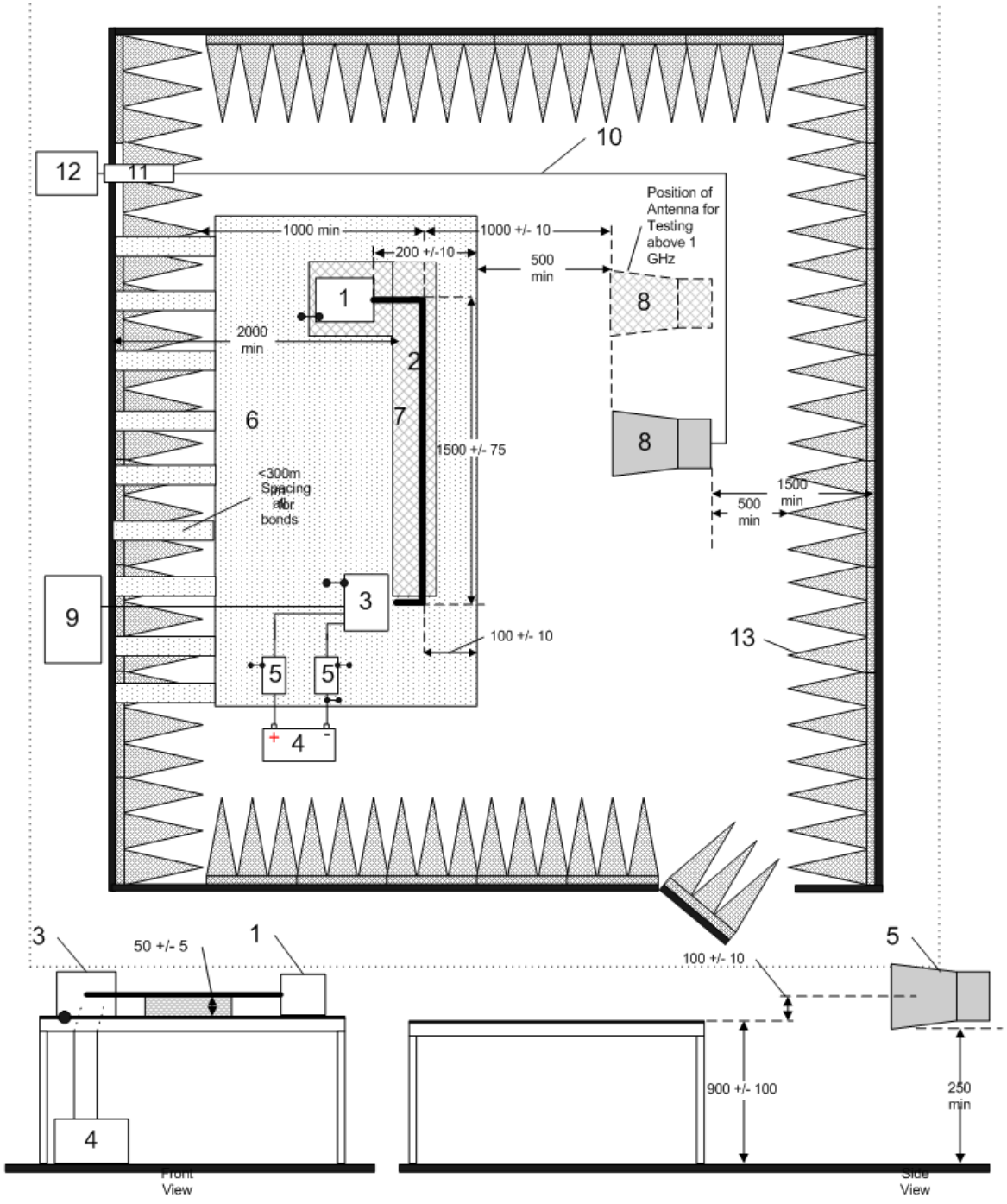


Figure 3: Proposed dual modulation envelope

- Tests shall be carried out using both horizontal and vertical polarisations
- The test frequencies used are those given in Section 4.4 above
- The immunity limits are those given in Section 4.5 above

Figure 4 shows the generic test setup for the radiated immunity test.



Key

1	DUT (grounded locally if required in test plan)	8	Antenna
2	Test Harness	9	Stimulation and Monitoring System
3	Load Simulator (Placement and ground see 7.5)	10	High Quality Double Shield Coax Cable (50 Ohm)
4	Power Supply (Location Optional)	11	Bulkhead Connector
5	Artificial Network	12	RF Sig Gen and Amplifier
6	Ground Plane (Bonded to SE)	13	RF Absorber Material
7	Insulated support (er <= 1.4)		

Figure 4: Generic Test Setup for Radiated Immunity Testing (IAW ISO11452-2)

8 APPENDIX 4: MEASUREMENT OF CONDUCTED EMISSIONS

8.1 Conducted Transient Emissions

8.1.1 Introduction

The test method for conducted transient emissions is a simple procedure using an artificial network to represent the impedance of the vehicle wiring harness and an oscilloscope to measure the transient emissions produced by the operational equipment. These tests provide a method for the manufacturers and suppliers of operational equipment to be confident, with reasonable accuracy, that their apparatus will not cause malfunction of other equipment fitted to the vehicle (including vehicle systems such as the ABS) under service conditions due to emission of conducted transients on their power supply leads.

8.1.2 Test Method

Testing is carried out in accordance with the voltage transient emissions tests of ISO 7637 Part 2. With reference to the device under test, switch on and then off each function in turn, using the dedicated switch (es) supplied for use with the operational equipment, for five operations. The tests should be repeated with the switch 'S' in ISO 7637 (effectively the vehicle ignition switch) being operated for five times whilst all of the operational equipment switches are in the on state to give worst-case emissions. The magnitudes of both the maximum positive and maximum negative transients are noted in the test report, together with the state of the equipment required to generate them. The limits are given in Part 2, Section 4.6.

8.2 Continuous Conducted Emissions (ripple voltage)

8.2.1 Introduction

This test provides a method for the manufacturers and suppliers of operational equipment to determine, with reasonable accuracy, whether or not their apparatus is likely to cause interference, as a result of ripple voltage on its supply leads, to other electronic equipment, in particular the police/fire service radio, fitted to a motor vehicle. The test method is a simple procedure using an artificial network to represent the impedance of the vehicle wiring harness and an oscilloscope to measure the ripple voltage produced by the operational equipment.

8.2.2 Test Method

Using the test set up as shown in Figure 1 of ISO 7637 Part 2 (i.e. the same set-up as for measuring conducted transient emissions) with the device under test set to its operational mode(s), the peak-to-peak value of the ripple superimposed on the d.c. supply is recorded in the test report. The limits are given in Section 4.8.

9 APPENDIX 5: MEASUREMENT OF CONDUCTED IMMUNITY

9.1 Conducted Transient Immunity

9.1.1 Introduction

These tests provide a method for the manufacturers and suppliers of operational equipment to determine, with reasonable accuracy, whether or not their apparatus will malfunction under service conditions due to conducted transients on the power supply. The test method involves using a commercially available transient generator to inject transients into the power supply leads of the operational equipment. Although conducted transient immunity testing is not yet a mandatory requirement, the equipment must still have sufficient transient immunity to work correctly in the host vehicle.

9.1.2 Test Method

The test is carried out in accordance with ISO 7637-2:2004, using the test levels shown in Table 4 of this specification (Section 4.7), and is repeated for all functions of the equipment under test specified in the test plan. Any malfunctions are noted in the test report.

10 BIBLIOGRAPHY

CISPR 12: 2001 + A1:2005. Vehicles, motor-boats and spark-ignited engine-driven devices. Radio disturbance characteristics. Limits and methods of measurement.

CISPR 16-1: 2002 Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus.

ISO 11451 Road vehicles - Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy.
Part 1:2005 General and definitions
Part 2:2005 Off-vehicle radiation source
Part 3:1994 On-board transmitter simulation
Part 4:1995 Bulk current injection (BCI)

ISO 11452 Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy
Part 1:2005. General and definitions
Part 2:2004 Absorber-lined chamber
Part 3:2001 Transverse electromagnetic mode (TEM) cell
Part 4:2005 Bulk current injection (BCI)
Part 5:2002 Stripline
Part 7:2003 Direct Signal Injection.
Part 8: Immunity to Magnetic Fields
Part 9: Portable Transmitters
Part 10: Conducted Immunity in the Extended Audio Range

ISO 10605:2001 Road vehicles – Test methods for electrical disturbances from electrostatic discharge.

ISO 7637 Road Vehicles – Electrical disturbances from conduction and coupling.
Part 1:2002. Definitions and general considerations.
Part 2:2004. Electrical transient conduction along supply lines only.

Police Vehicle EMC and Equipment Installation Handbook.

Police Vehicle Installation Code of Practice (National Association of Police Fleet Managers).

11 REFERENCES

[1] ETS 300 392 Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D)

[2] CISPR 25 Edition 2.0:2002 Radio disturbance characteristics for the protection of receivers used on board vehicles, boats and on devices - Limits and methods of measurement

[3] EN61000-4-3:2002 testing and Measurement techniques – radiated, radio frequency, Electromagnetic Field Immunity Test