



R&D White Paper

WHP 100

November 2004

DAB Receiver Testing

M.R. Ellis, J.D. Rosser, P.N. Moss, A. Wiewiorka and M. Williams

DAB Receiver Testing

M.R. Ellis, J.D. Rosser, P.N. Moss, A. Wiewiorka and M. Williams

Abstract

BBC R&D has for some years carried out tests on DAB receivers, both prototypes and finished products. The aim of the testing programme was to help manufacturers - and hence the evolution of the DAB receiver industry - by providing an impartial testing regime including combinations of features that are not used on-air at present but may be used by broadcasters later. The programme also informed the BBC about the performance of DAB receivers actually on the market - an important consideration in the early days of the new service when there are not many receivers for the public to choose from. In 1999 the test procedures were standardised and described in a BBC internal document.

In 2004 BBC R&D decided that it was no longer appropriate for it to offer a DAB receiver testing service: DAB should now be a mature technology and a very wide range of receivers is available. However, there is still a need for manufacturers to check the functionality of their products in development and in particular the response to features that may come into use in the future. Accordingly, the 1999 document describing the tests is published in this White Paper, and suitable test streams will be published as an Annex. The complexity of modern digital broadcasting specifications is such that no reasonable testing procedure can exercise every possible combination of features. We believe the tests described below represent a reasonable test of a receiver, but passing them does not guarantee conformance with all aspects of the DAB specification.

Additional key words: radio broadcasting, digital radio, DAB

Contents

1.	Introduction	1
2.	RF Testing	2
2.1	<i>Maximum input power (P_{max})</i>	2
2.2	<i>Gaussian sensitivity (P_{min})</i>	2
2.3	<i>Rayleigh sensitivity</i>	2
2.4	<i>Selectivity</i>	2
2.5	<i>Acquisition time</i>	2
3.	Service Selection	3
3.1	<i>Access to programme service</i>	3
3.2	<i>Access all audio components of a programme service</i>	3
3.3	<i>Access data service</i>	3
3.4	<i>Access all audio components of a data service</i>	3
3.5	<i>Handling of non-sequential SCID values</i>	3
3.6	<i>Display ensemble label</i>	3
3.7	<i>Display programme service label</i>	3
3.8	<i>Display data service label</i>	3
3.9	<i>Display primary component label</i>	3
3.10	<i>Display secondary component label</i>	3
3.11	<i>Display unusual characters in labels</i>	4
3.12	<i>Link to equivalent RDS service</i>	4
3.13	<i>Return from RDS service</i>	4
3.14	<i>Link to equivalent AM/FM service</i>	4
3.15	<i>Return from equivalent AM/FM service</i>	4
3.16	<i>Link to equivalent DAB service in another ensemble</i>	4
3.17	<i>Return from equivalent DAB service in another ensemble</i>	4
4.	Announcements	5
4.1	<i>Announcement switching</i>	5
4.2	<i>Alarm switching</i>	5
4.3	<i>Interruption to secondary component</i>	5
4.4	<i>Interruption to tape/CD</i>	5
4.5	<i>Announcement support</i>	5
4.6	<i>User filtering</i>	6
4.7	<i>Cluster handling</i>	6
4.8	<i>Intra-service announcements</i>	6
4.9	<i>Multiple clusters</i>	6
4.10	<i>Regional filtering</i>	7
4.11	<i>Unknown TII codes</i>	7
5.	Programme Type	8
5.1	<i>Display of static international PTy</i>	8
5.2	<i>Display of static extended coarse PTy</i>	8
5.3	<i>Display of dynamic PTy</i>	8
5.4	<i>Downloadable PTy coarse code</i>	8
5.5	<i>PTy “Search” mode</i>	8
5.6	<i>PTy “Watch” mode</i>	8

6.	Dynamic Labels	9
6.1	<i>Display of dynamic labels</i>	9
6.2	<i>Display of dynamic headlines</i>	9
6.3	<i>Update of dynamic labels</i>	9
6.4	<i>Handling of “End of Headline” feature</i>	9
6.5	<i>Display of long headlines</i>	9
6.6	<i>Display of long labels</i>	9
6.7	<i>Display of non-alphabetic characters</i>	10
6.8	<i>Display of long words</i>	10
6.9	<i>Handling of “Preferred Word Break” feature</i>	10
6.10	<i>Handling of “Preferred Line Break” feature</i>	10
6.11	<i>Handling of “Clear Label” feature</i>	10
6.12	<i>Short format</i>	10
6.13	<i>Half-rate</i>	10
7.	Subchannel Coding	11
7.1	<i>Decoding audio below 192kbit/s</i>	11
7.2	<i>Decoding audio at 384kbit/s</i>	11
7.3	<i>Decoding first CU</i>	11
7.4	<i>Decoding second CU</i>	11
7.5	<i>Decoding last CU</i>	11
8.	Reconfiguration	12
8.1	<i>Service organisation</i>	12
8.2	<i>Subchannel sharing</i>	13
8.3	<i>Subchannel relocation (non-overlapping)</i>	13
8.4	<i>Subchannel relocation (overlapping)</i>	14
8.5	<i>Service and subchannel reconfiguration</i>	14
8.6	<i>Fallback to primary component when secondary removed</i>	14
8.7	<i>Changing SubChId</i>	15
8.8	<i>Changing bitrate</i>	15
8.9	<i>Changing protection level</i>	15
8.10	<i>Changing of programme service label</i>	15
8.11	<i>Changing of data service label</i>	15
8.12	<i>Changing of primary component label</i>	16
8.13	<i>Changing of secondary component label</i>	16
8.14	<i>Changing of ensemble label</i>	16
9.	Dynamic Range Control	17
9.1	<i>Dynamic Range Control supported</i>	17
9.2	<i>Timing accuracy of DRC application</i>	17
9.3	<i>DRC amplitude accuracy</i>	17
9.4	<i>DRC to non-DRC amplitude matching</i>	17
10.	Audio Conformance	18

11.	Date and time	19
11.1	<i>Decoding date</i>	19
11.2	<i>Decoding time</i>	19
11.3	<i>Decoding LTO</i>	19
12.	Whole System Testing	20
12.1	<i>Service-related Tests</i>	20
12.1.1	<i>Std C101: Stereo 128</i>	20
12.1.2	<i>Std C102: High / Low Quality</i>	20
12.1.3	<i>Std C103: Mono 80</i>	20
12.1.4	<i>Std C104: Combined / Split</i>	20
12.1.5	<i>Std C105: Part-Time A</i>	20
12.1.6	<i>Std C106: Part-Time B</i>	20
12.1.7	<i>Std C107: Sharing A / Separate A</i>	20
12.1.8	<i>Std C108: Sharing B / Separate B</i>	21
12.1.9	<i>Std C109: Half-Rate High / Low Quality</i>	21
12.2	<i>Other function tests</i>	21
12.2.1	<i>Dynamic labels</i>	21
12.2.2	<i>Service labels</i>	21
12.2.3	<i>Presets</i>	21
12.2.4	<i>Power-up</i>	21
12.2.5	<i>Tuning/Scanning</i>	21
12.3	<i>Checklist</i>	22
13.	FFT Window Positioning	23
Appendix A	Test Configurations	25
A.1	RxTest: Service Selection	25
A.2	RxTest: Announcements	27
A.3	RxTest: Subchannel Coding	29
A.4	RxTest: Reconfigurations	30
A.5	Whole System Testing	39
Appendix B	Character Mapping	41
Appendix C	Limitations of BBC DAB Receiver Testing	42
Appendix D	Results Recording Forms	43
D.1	RF Testing	43
D.2	Service Selection	44
D.3	Announcement Switching	45
D.4	Programme Type	45
D.5	Dynamic Labels	46
D.6	Subchannel Coding	47
D.7	Reconfiguration	48
D.8	Dynamic Range Control	48
D.9	Audio Conformance	49
D.10	Date and Time	49
D.11	Whole System Testing	49
D.12	FFT Window Positioning	52

White Papers are distributed freely on request.
Authorisation of the Chief Scientist is required for
publication.

© BBC 2004. All rights reserved. Except as provided below, no part of this document may be reproduced in any material form (including photocopying or storing it in any medium by electronic means) without the prior written permission of BBC Research & Development except in accordance with the provisions of the (UK) Copyright, Designs and Patents Act 1988.

The BBC grants permission to individuals and organisations to make copies of the entire document (including this copyright notice) for their own internal use. No copies of this document may be published, distributed or made available to third parties whether by paper, electronic or other means without the BBC's prior written permission. Where necessary, third parties should be directed to the relevant page on BBC's website at <http://www.bbc.co.uk/rd/pubs/whp> for a copy of this document.

1. Introduction

BBC R&D has for some years carried out tests on DAB receivers, both prototypes and finished products. The aim of the testing programme was to help manufacturers - and hence the evolution of the DAB receiver industry - by providing an impartial testing regime including combinations of features that are not used on-air at present but may be used by broadcasters later. The programme also informed the BBC about the performance of DAB receivers actually on the market - an important consideration in the early days of the new service when there are not many receivers for the public to choose from. In 1999 the test procedures were standardised and described in a BBC internal document.

In 2004 BBC R&D decided that it was no longer appropriate for it to offer a DAB receiver testing service: DAB should now be a mature technology and a very wide range of receivers is available. However, there is still a need for manufacturers to check the functionality of their products in development and in particular the response to features that may come into use in the future. Accordingly, the 1999 document describing the tests is published in this White Paper, and suitable test streams will be published as an Annex.

The complexity of modern digital broadcasting specifications is such that no reasonable testing procedure can exercise every possible combination of features. We believe the tests described below represent a reasonable test of a receiver, but passing them does not guarantee conformance with all aspects of the DAB specification.

2. RF Testing

RF Testing is conducted in accordance with CENELEC document prEN50248, "Characteristics of DAB Receivers", March 1997. Additional tests are defined for alternate channel measurements at the request of BBC R&D Spectrum Planning Group to assist with their DAB SFN transmitter planning work.

The failure point for all tests is supposed to be a post-Viterbi BER of 1×10^{-4} . This can only accurately be determined using a receiver with a suitable RDI output to extract the post-Viterbi data. In the case where a suitable RDI output is not available, the failure point will be determined using a combination of any in-built BER measurement and an experienced operator listening to the audio received from a subchannel encoded using EEP-3A with stereo 192kbit/s audio.

2.1 Maximum input power (P_{\max})

Measured in accordance with prEN50248, §7.3.2.

2.2 Gaussian sensitivity (P_{\min})

Measured in accordance with prEN50248, §7.3.1.

2.3 Rayleigh sensitivity

Measured in accordance with prEN50248, §7.3.4.

2.4 Selectivity

Measured in accordance with prEN50248, §7.3.3.

2.5 Acquisition time

Measured in accordance with prEN50248, §7.3.5.

3. Service Selection

A Band-III DAB ensemble will be generated on channel 12A configured as described in “RxTest: Service Selection”, see Appendix A (Test Configurations) on page 25.

3.1 Access to programme service

A receiver will be deemed to have passed this test if the primary component of all 11 programme services can be heard on the audio output of the receiver.

3.2 Access all audio components of a programme service

A receiver will be deemed to have passed this test if it is possible to select (i.e. hear)

- a single secondary component for each of “Prog Service 7” to “Prog Service 10” inclusive
- 11 secondary components of “Prog Service 11”

3.3 Access data service

A receiver will be deemed to have passed this test if the primary component of all three data services can be selected.

3.4 Access all audio components of a data service

A receiver will be deemed to have passed this test if it is possible to select

- the audio component “Secondary D2”
- all 10 secondary audio components of “Data Service 3”

3.5 Handling of non-sequential SCIdS values

A receiver will be deemed to have passed this test if there is no unusual behaviour when accessing services containing components with non-sequential SCIdS values (i.e. c002, c003, c005, c006, c008 and c00a).

3.6 Display ensemble label

A receiver will be deemed to have passed this test if a recognisable ensemble label can be displayed.

3.7 Display programme service label

A receiver will be deemed to have passed this test if a recognisable service label for each the programme services is displayed.

3.8 Display data service label

A receiver will be deemed to have passed this test if the service labels for the data services are displayed correctly

3.9 Display primary component label

A receiver will be deemed to have passed this test if recognisable primary component labels are displayed.

3.10 Display secondary component label

A receiver will be deemed to have passed this test if the secondary component labels are displayed correctly.

3.11 Display unusual characters in labels

A receiver will be deemed to have passed this test if all of the non-ASCII characters present in the service and component labels are displayed correctly. A list of the correct characters can be found in Appendix B (Character Mapping) on page 41 together with their usual ASCII counterparts.

3.12 Link to equivalent RDS service

A receiver will be deemed to have passed this test if it re-tunes to an RDS service from the DAB service when the received RF signal strength of the DAB service is reduced. The test should be conducted for equivalent (same Sid/PI-code), hard and soft linked services. The RF signal level of the DAB service should be recorded at the point the receiver retunes.

3.13 Return from RDS service

A receiver will be deemed to have passed this test if it returns to the DAB service from the linked RDS service when the received RF signal strength of the DAB service is restored. The RF signal level of the DAB service should be recorded at the point the receiver retunes.

3.14 Link to equivalent AM/FM service

A receiver will be deemed to have passed this test if it re-tunes to an AM service from the DAB service when the received RF signal strength of the DAB service is reduced. The test should be conducted for equivalent (same Sid/dummy-PI-code), hard and soft linked services. The RF signal level of the DAB service should be recorded at the point the receiver retunes.

3.15 Return from equivalent AM/FM service

A receiver will be deemed to have passed this test if it returns to the DAB service from the linked AM service when the received RF signal strength of the DAB service is restored. The RF signal level of the DAB service should be recorded at the point the receiver retunes.

3.16 Link to equivalent DAB service in another ensemble

A receiver will be deemed to have passed this test if it re-tunes to an alternative DAB service when the received RF signal strength of the DAB service is reduced. The test should be conducted for an equivalent ensemble (same EId), equivalent service (same Sid), hard and soft linked services. The RF signal level of the DAB service should be recorded at the point the receiver retunes.

3.17 Return from equivalent DAB service in another ensemble

A receiver will be deemed to have passed this test if it returns to the DAB service from the linked DAB service when the received RF signal strength of the original DAB service is restored. The RF signal level of the DAB service should be recorded at the point the receiver retunes.

4. Announcements

A Band-III DAB ensemble will be generated on channel 12A configured as described in “RxTest: Announcements”, see Appendix A (Test Configurations) on page 25. The TII code 1/1 should be the only one present otherwise stated.

4.1 Announcement switching

While listening to “Test Service 1”, a series of announcement switches will be initiated as follows:

- i)* Cluster 1, subchannel 6, Traffic flash
- ii)* Cluster 1, subchannel 6, Transport flash
- iii)* Cluster 1, subchannel 6, Warning
- iv)* Cluster 1, subchannel 6, News flash
- v)* Cluster 1, subchannel 6, Weather flash
- vi)* Cluster 1, subchannel 6, Event flash
- vii)* Cluster 1, subchannel 6, Special event flash

A receiver will be deemed to have passed this test if it correctly selects the announcement, displays an appropriate message in each case, and returns to “Test Service 1” at the end of the announcement.

4.2 Alarm switching

While listening to each of the following audio strands in turn, an alarm will be signalled using cluster 0xFF for subchannel 6.

- i)* Test Service 1
- ii)* Secondary 1
- iii)* Test Service 3

The receiver will be deemed to have passed this test if it correctly switches and returns in each case.

4.3 Interruption to secondary component

While listening to “Secondary 1”, a news flash announcement on cluster 1, subchannel 6 will be signalled. The receiver will be deemed to have passed this test if it correctly switches and returns.

4.4 Interruption to tape/CD

After selecting “Test Service 1”, listen to a tape or CD. A news flash announcement on cluster 1, subchannel 6 will be signalled. The receiver will be deemed to have passed this test if it correctly switches and returns.

4.5 Announcement support

While listening to “Test Service 2”, a series of announcement switches will be initiated as follows:

- i)* Cluster 2, subchannel 6, Traffic flash
- ii)* Cluster 2, subchannel 6, Transport flash
- iii)* Cluster 2, subchannel 6, Warning
- iv)* Cluster 2, subchannel 6, News flash
- v)* Cluster 2, subchannel 6, Weather flash
- vi)* Cluster 2, subchannel 6, Event flash
- vii)* Cluster 2, subchannel 6, Special event flash

A receiver will be deemed to have passed this test if it correctly selects the traffic flash announcement and ignores the other six announcements.

4.6 User filtering

While listening to “Test Service 1”, a series of announcement switches will be initiated as follows:

- i) Cluster 1, subchannel 6, Traffic flash
- ii) Cluster 1, subchannel 6, Transport flash
- iii) Cluster 1, subchannel 6, Warning
- iv) Cluster 1, subchannel 6, News flash
- v) Cluster 1, subchannel 6, Weather flash
- vi) Cluster 1, subchannel 6, Event flash
- vii) Cluster 1, subchannel 6, Special event flash
- viii) Cluster FF, subchannel 6, Alarm announcement

A receiver will be deemed to have passed this test if it provides a working facility to filter out each of the first seven announcements but should not be able to filter out the alarm announcement

4.7 Cluster handling

A receiver will be deemed to have passed this test if all four of the following are ignored by the receiver.

- i) Listening to “Test Service 1”, an announcement in cluster 3 will be signalled
- ii) Listening to “Test Service 3”, an announcement in cluster 3 will be signalled
- iii) Listening to “Test Service 2”, an announcement in cluster 1 will be signalled
- iv) Listening to “Test Service 3”, an announcement in cluster 1 will be signalled

4.8 Intra-service announcements

A receiver will be deemed to have passed this test if all of the following tests are successful.

Listen to	Announcement signalled for...		Correct result
	Cluster Id	Subchannel Id	
Test Service 1	0	2	Switch
Secondary 1	0	2	Switch
Test Service 2	0	2	Ignore
Test Service 3	0	2	Ignore
Test Service 1	0	63	Switch
Secondary 1	0	63	Switch
Test Service 1	0	6	Ignore
Test Service 3	0	5	Switch
Secondary 3	0	5	Switch
Test Service 3	0	4	Switch
Secondary 3	0	4	Switch
Test Service 3	0	63	Ignore

4.9 Multiple clusters

While listening to “Test Service 2”, a traffic announcement on cluster 4, subchannel 6 will be signalled. The receiver will be deemed to have passed this test if it correctly switches and returns.

4.10 Regional filtering

While listening to “Test Service 1”, a regional traffic announcement in region 1, cluster 1, subchannel 6 will be signalled. The receiver will be deemed to have passed this test if it ignores the announcement when the TII code is 1/2 or 2/1, but switches and returns when the TII code is 1/1.

4.11 Unknown TII codes

While listening to “Test Service 1”, a traffic announcement on cluster 1, subchannel 6 will be signalled. The receiver will be deemed to have passed this test if it ignores the announcement when the TII code is 2/2.

5. Programme Type

A Band-III DAB ensemble will be generated on channel 12A configured with two audio services at 192kbit/s joint stereo. PTy information will be produced for one or both of these services as described in the following sections.

5.1 Display of static international PTy

A receiver will be deemed to have passed this test if it displays a suitable label when the selected service is carrying

- a single international PTy coarse code
- two international PTy coarse codes

5.2 Display of static extended coarse PTy

A receiver will be deemed to have passed this test if it displays a suitable label when the selected service is carrying one international and one extended coarse code PTy.

5.3 Display of dynamic PTy

A receiver will be deemed to have passed this test if it displays a suitable label when the selected service is carrying

- a single dynamic international PTy coarse code
- two dynamic international PTy coarse code
- one international and one extended PTy coarse code

The receiver must also correctly follow changes to the dynamic PTy, and remove the label when the dynamic PTy is not signalled for a period longer than five seconds.

5.4 Downloadable PTy coarse code

A receiver will be deemed to have passed this test if it is able to correctly display a downloaded PTy coarse code.

5.5 PTy “Search” mode

A receiver will be deemed to have passed this test if it is possible to search for, and find, another station which is currently signalling a static or dynamic PTy which the user chooses.

5.6 PTy “Watch” mode

A receiver will be deemed to have passed this test if it is possible to set it in a mode where it will automatically select an alternate service when a dynamic PTy appears or disappears on that service.

6. Dynamic Labels

A Band-III DAB ensemble will be generated on channel 12A configured with a single audio component. Unless otherwise stated, this component will be encoded using 192kbit/s joint stereo. Dynamic labels will be encoded in this subchannel as described in the individual tests. Dynamic labels will be encoded using long format unless otherwise stated.

In describing these tests, the following symbols will be used to represent the special non-printing control characters permitted in the dynamic label:

- `<EOH>` - end of headline (0x0b)
- `<PLB>` - preferred line break (0x0a)
- `<PWB>` - preferred word break (0x1f)

6.1 Display of dynamic labels

A receiver will be deemed to have passed this test if it is able to display the following dynamic label

- Dynamic label

6.2 Display of dynamic headlines

A receiver will be deemed to have passed this test if it is able to display the following dynamic label

- Dynamic headline`<EOH>`

6.3 Update of dynamic labels

A receiver will be deemed to have passed this test if it displays each of the following two dynamic labels which will replace each other cyclically once every sixty seconds

- Test dynamic label
- Alternative test label

6.4 Handling of “End of Headline” feature

A receiver will be deemed to have passed this test if it displays the following dynamic label in a sensible manner - there should be NO space between the words “headline” and “and”.

- One headline`<EOH>`and some body test too

6.5 Display of long headlines

A receiver will be deemed to have passed this test if it displays both of the following dynamic labels in a sensible manner

- This headline is =31 characters`<EOH>`and then a few more
- This headline is ==32 characters`<EOH>`and then a few more

6.6 Display of long labels

A receiver will be deemed to have passed this test if it displays both of the following dynamic labels in a sensible manner

- This headline is ==32 characters`<EOH>`and has quite a lot of other characters following it so that the total length works out at 128.
- This is another very long dynamic label, up to the maximum 128 characters but it doesn't have a headline at all. Like or lump it

6.7 Display of non-alphabetic characters

A receiver will be deemed to have passed this test if it displays the following label correctly.

- `!"#%&'*+, - . / : ; <=>?@[\\]_`{|}~<EOH>`

6.8 Display of long words

A receiver will be deemed to have passed this test if it displays the following dynamic label in a sensible manner

- `ThisDynamicLabelAppearsToBeOneVeryLongWordWithNoLineBreaks`

6.9 Handling of “Preferred Word Break” feature

A receiver will be deemed to have passed this test if it displays the following dynamic label in a sensible manner

- `ThisDynamic<PWB>LabelAppears<PWB>ToBeOne<PWB>LongWord`

6.10 Handling of “Preferred Line Break” feature

A receiver will be deemed to have passed this test if it displays the following dynamic label in a sensible manner

- `This <PLB>label has many <PLB>short words<PLB> split in the most wierd<PLB> places`

6.11 Handling of “Clear Label” feature

A receiver will be deemed to have passed this test if it

- clears the dynamic label from the display on receipt of a “clear label” command.
- correctly displays the next dynamic label received

6.12 Short format

A receiver will be deemed to have passed this test if it is able to display either of the following dynamic labels when encoded using the short format

- `Dynamic headline<EOH>`
- `Dynamic label spanning multiple DLS segments to ensure that half-rate DLS concatenation works correctly`

6.13 Half-rate

A receiver will be deemed to have passed this test if it is able to display either of the following dynamic labels when the label is carried in a subchannel encoded using 96kbit/s joint stereo half-sampling-rate (LSF).

- `Dynamic headline<EOH>`
- `Dynamic label`

7. Subchannel Coding

A Band-III DAB ensemble will be generated on channel 12A configured as described in “RxTest: Subchannel Coding”, see Appendix A (Test Configurations) on page 25.

7.1 Decoding audio below 192kbit/s

A receiver will be deemed to have passed this test if it is able to decode identifiable audio from all thirteen programme services. Each of the thirteen tests should have the results recorded individually.

7.2 Decoding audio at 384kbit/s

An ensemble comprising a single subchannel encoded at 384kbit/s half-rate stereo using UEP-3 will be generated. A receiver will be deemed to have passed this test if it is able to decode identifiable audio from this subchannel.

7.3 Decoding first CU

With the configuration set to start on CU0, a receiver will be deemed to have passed this test if it correctly decodes an audio subchannel starting on CU0.

7.4 Decoding second CU

With the configuration changed to start on CU1, a receiver will be deemed to have passed this test if it correctly decodes an audio subchannel starting on CU1.

7.5 Decoding last CU

With the configuration set to use CU863, a receiver will be deemed to have passed this test if it correctly decodes an audio subchannel ending on CU863.

8. Reconfiguration

A Band-III DAB ensemble will be generated on channel 12A. The configuration will be varied between the configuration described in “RxTest: Reconfigurations”, see Appendix A (Test Configurations) on page 25 as instructed in the tests below. Wherever possible, the sequence of tests will be continuous. Where this is not possible, the appropriate entry in the table is highlighted.

8.1 Service organisation

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
2	1	Service 1	Remove service - subchannel remains	No change
1	3	Service 1	Add component - existing subchannel	No change
3	1	Service 1	Remove component - subchannel remains	No change
1	2	Service 1	Add service - existing subchannel	No change
2	1	Service 2	Remove service - subchannel remains	Mute, or select “Service 1”

8.2 Subchannel sharing

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
4	2	Service 1	Share services - remove subchannel	No change
2	4	Service 1	Split services - new subchannel	No change
4	2	Service 2	Share services - remove subchannel	Butt join in audio, no change to service selection
2	7	Service 1	Split services - existing subchannel	No change
7	2	Service 1	Share services - subchannel remains	No change
2	7	Service 2	Share services - subchannel remains	Butt join in audio, no change to service selection
6	5	Secondary 1	Share components - remove subchannel	No change
5	6	Secondary 1	Split components - new subchannel	No change
6	5	Secondary 2	Share components - remove subchannel	Butt join in audio, no change to service selection
5	8	Secondary 1	Split components - existing subchannel	No change
8	5	Secondary 1	Share components - subchannel remains	No change
5	8	Secondary 2	Share components - subchannel remains	Butt join in audio, no change to service selection

8.3 Subchannel relocation (non-overlapping)

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
1	9	Service 1	Single subchannel moved up	No change
9	1	Service 1	Single subchannel moved down	No change
1	10	Service 1	Subchannels swap	No change

8.4 Subchannel relocation (overlapping)

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
1	11	Service 1	Single subchannel moved up	No change
11	1	Service 1	Single subchannel moved down	No change
12	13	Service 1	Three subchannels moved up	No change
13	12	Service 1	Three subchannels moved down	No change

8.5 Service and subchannel reconfiguration

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
14	1	Service 1	Remove service - subchannel removed	No change
1	14	Service 1	Add service - new subchannel	No change
14	1	Service 2	Remove service - subchannel removed	Mute or select alternate service
1	15	Service 1	Add component - new subchannel	No change
15	1	Service 1	Remove component - subchannel removed	No change

8.6 Fallback to primary component when secondary removed

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
15	1	Secondary 1	Secondary removed	Switch to service 1 (audio & label)
1	15	do not alter from previous test	Secondary added	No disturbance - secondary should not be selected

8.7 Changing SubChId

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
1	16	Service 1	Subchannel Id	Short audio mute followed by restoration of the same service

8.8 Changing bitrate

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
1	17	Service 1	Bitrate increased - no overlap	No change
17	1	Service 1	Bitrate decreased - no overlap	No change

8.9 Changing protection level

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
1	18	Service 1	Protection level increased	No change
18	1	Service 1	Protection level decreased	No change

8.10 Changing of programme service label

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
19	20	Service 1	Service label changed	Label should change to "New programme"

8.11 Changing of data service label

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
20	19	Service 2	Service label changed	Label should change to "New data"

8.12 Changing of primary component label

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
19	20	Primary	Component label changed	Label should change to "New Primary"

8.13 Changing of secondary component label

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
20	19	Secondary	Component label changed	Label should change to "New Secondary"

8.14 Changing of ensemble label

The receiver will be deemed to have passed this test if the following behaviour is observed:

Configuration		Service to monitor	What changes	Expected result
Before	After			
19	20	Any	Ensemble label changed	Ensemble label should change from "First ELabel" to "Second ELabel"

9. Dynamic Range Control

A Band-III DAB ensemble will be generated on channel 12A configured with a single audio services at 192kbit/s stereo. A short pre-coded MPEG test file will be looped into this service as described in Annex A of the Eureka 147 WG-A document "Conformance Testing for DAB Audio" version 2.0.

9.1 Dynamic Range Control supported

A receiver will be deemed to have passed this test if it is possible to select a mode where DRC information is applied to the audio.

9.2 Timing accuracy of DRC application

A receiver will be deemed to have passed this test if the decoded audio shows that the DRC has been applied at the correct instant. In the event of a near-miss, the approximate timing error, and direction of the error, should be recorded.

9.3 DRC amplitude accuracy

A receiver will be deemed to have passed this test if the decoded audio shows that the amplitude of the DRC adjustment is correct. For receivers offering several "levels" of DRC, the receiver will be deemed to have passed if any of the levels offers the correct response. In the event of a near-miss, the approximate value of the error (in dB) should be recorded.

9.4 DRC to non-DRC amplitude matching

A receiver will be deemed to have passed this test if the subjective maximum volume is near-constant as the DRC feature is switched on and off.

10. Audio Conformance

The tests will be performed in accordance with V2.0 of the Eureka WG-A paper “Conformance Testing for DAB Audio”, February 1998. The results will be recorded in the form of the equivalent bit-accuracy of the decoder. Individual results which are widely at variance to the median of all of the results indicate a failure of the test.

11. Date and time

A Band-III DAB ensemble will be generated on channel 12A. The configuration will contain a single joint-stereo audio subchannel at 192kbit/s. Date and time information added as instructed in the tests below.

11.1 Decoding date

With the LTO value set to zero, a receiver will be deemed to have passed this test if it is able to display the following dates correctly:

- 31st December 1999
- 1st January 2000
- 28th February 2000
- 29th February 2000
- 1st March 2000
- 1st January 2001
- 28th February 2003
- 1st March 2003
- 28th February 2004
- 29th February 2004
- 1st March 2004
- 28th February 2005
- 1st March 2005

11.2 Decoding time

With the LTO value set to zero, a receiver will be deemed to have passed this test if it is able to display the following times correctly:

- 00:00:00
- 23:59:59

11.3 Decoding LTO

A receiver will be deemed to have passed this test if it is able to display the following dates and times correctly:

- Today, now, +01:00
- Today, now, -01:00
- Today, now, +12:00
- Today, now, -12:00
- 31st December 1999, 12:00:00 UTC +12:00 (should display as midnight, 1st January 2000)
- 28th February 2000, 23:30:00 UTC +03:30 (should display as 03:00, 29th February 2000)

12. Whole System Testing

A multiplex will be generated comprising a number of simultaneous services and which will reconfigure once per minute. The testers will listen to each service in turn and record the behaviour of the receiver both between reconfigurations and at the moment of reconfiguration. Each tests will be repeated at least three times as it has been known for some receivers to behave differently even when the test itself is identical – this is believed to be due to the phasing of the information in the FIC.

12.1 Service-related Tests

A series of tests have been defined which require the receiver to correctly acquire and track a single service in a multiplex during a reconfiguration. Each service has been designed to closely resemble the behaviour of a service in the proposed BBC National DAB multiplex.

12.1.1 Sld C101: Stereo 128

This service is largely a control channel for these tests. It does not alter in terms of CU allocation or bitrate A dynamic label and the music/speech flag are carried in short X-PAD. The dynamic label is updated once per minute. This is typical of a service such as Radio 1.

12.1.2 Sld C102: High / Low Quality

This service changes between 192kbit/s and 128kbit/s, starting at the same CU. A dynamic label and the music/speech flag are carried in variable X-PAD. The dynamic label is added and removed for alternate minutes. This is typical of a service such as Radios 3.

12.1.3 Sld C103: Mono 80

This service does not change bitrate but does move CUs in the multiplex. This is typically what might happen when “shuffling” services to create a large gap to fit a new service into.

12.1.4 Sld C104: Combined / Split

This service is used to test the receiver’s handling of part-time secondary service components. For one minute in every two, the service contains two components, for the other minute it is a single, higher quality service strand. This is typical of the way an extra channel may be allocated to Sports Extra to cover multiple matches simultaneously.

12.1.5 Sld C105: Part-Time A

This service is used to test the receiver’s handling of part-time services which share a subchannel (very roughly equivalent to an audio coder) with another service. The service only exists for one minute in every two. When the service is not present, the receiver should indicate this fact to the user. Since the subchannel is shared with another service, some receivers may incorrectly “hold on to” the subchannel. This is unlikely to occur for real on the BBC National multiplex with the current service propositions, but may occur in the future.

12.1.6 Sld C106: Part-Time B

This service is used to test the receiver’s handling of part-time services which have a dedicated subchannel (very roughly equivalent to an audio coder) with another service. The service only exists for one minute in every two, but unlike Part-time A, the subchannel is also removed from the multiplex. When the service is not present, the receiver should indicate this fact to the user. This is likely to be the way in which any part-time services in the BBC National multiplex are provided, for example Sports Extra.

12.1.7 Sld C107: Sharing A / Separate A

This service is used to test the receiver’s handling of a “core” service from which other services switch away to a second strand of programming at certain times of the day. This is typically the way the Radio 4FM strand is handled.

12.1.8 Sld C108: Sharing B / Separate B

This service is used to test the receiver's handling of services which split away from a common core to form the second of two separate strands of programming at certain times of the day. This is typically the way the Radio 4LW strand is handled.

12.1.9 Sld C109: Half-Rate High / Low Quality

This service is used to test how the receiver handles services using half-rate audio which change their bitrate. This is especially hard for receivers since half-rate frames are double the length of full-rate frames, and the reconfiguration may occur part-way through an audio frame.

12.2 Other function tests

A second set of tests have been defined using the same changing multiplex as a source. These tests aim to determine the support offered by the receiver for certain key functions, such as the ability to turn it off and back on again without having to re-tune, and the ability to see all the services present in the multiplex.

12.2.1 Dynamic labels

Two of the services in the multiplex include dynamic labels, short pieces of text which can be displayed to add value to the core audio content. The receiver should be able to display, update and hide these labels in response to commands sent by the broadcaster.

12.2.2 Service labels

Each DAB service has a name to identify it. These names can be displayed to confirm the station you are listening to, and can be combined into a list to allow the user to re-tune the receiver. The broadcaster can update these labels at any time, and the receiver should track these changes, replacing any previously known name for the service with the new name. As services are added to and removed from the multiplex, the receiver should be able to build up a complete list of the services available in a given multiplex.

12.2.3 Presets

The addition of presets to store favourite stations greatly improves the usability of a radio. The handling of presets with part-time services and secondary service components can be tricky, however, and a quick check of how they are handled is included in these tests.

12.2.4 Power-up

The majority of radio listening is of a single station: traditionally people have been scared to tune away from their favourite station for fear of not being able to find it again. Although this fear should be a thing of the past now that DAB and RDS are available, many people still stick with a single station and expect a receiver to return to the same station if it is turned off and on again.

12.2.5 Tuning/Scanning

Traditionally radios have been hard to tune, a thing of the past thanks to the extra features in a DAB multiplex. However, in order for the user to benefit from these advances, the receiver must correctly compile a list of all the services available. Typically this is done by "scanning" the receiver during installation, after which the receiver should be able to track most changes automatically, the only exception being when a completely new multiplex is made available.

12.3 Checklist

The following table describes what should be checked while monitoring each service. The services are identified by their service label.

Service	Behaviour during reconfiguration
Stereo 128	<ul style="list-style-type: none"> No change
High Quality	<ul style="list-style-type: none"> Slight reduction in audio quality. No pops, splats or mutes. Displayed service label should change to "Low Quality" Service label for tuning should change to "Low Quality"
Low Quality	<ul style="list-style-type: none"> Slight improvement in audio quality. No pops, splats or mutes. Displayed service label should change to "High Quality" Service label for tuning should change to "High Quality"
Mono 80	<ul style="list-style-type: none"> No change
Combined	<ul style="list-style-type: none"> Slight reduction in audio quality. No pops, splats or mutes. "Secondary service component available" display should be activated. Displayed service label should change to "Split Service" Service label for tuning should change to "Split Service"
Split/Primary	<ul style="list-style-type: none"> Slight improvement in audio quality. No pops, splats or mutes. "Secondary service component available" display should be deactivated. Displayed service label should change to "Combined" Service label for tuning should change to "Combined"
Split/Secondary	<ul style="list-style-type: none"> Slight improvement in audio quality Audio content changes (butt-join, no pops, splats or mutes). "Secondary service component available" display should be deactivated. Displayed service label should change to "Combined" When the component returns, the receiver should not automatically re-select it
Part-time A	<ul style="list-style-type: none"> Either: "Service ended" display Or: Tune to and display service label for "Split Service / Secondary" Service label for tuning should remain in tuning list as "Part-time A" When the service resumes, the receiver should reselect it if "Service End" is displayed
Part-time B	<ul style="list-style-type: none"> Either: "Service ended" display Or: Tune to and display service label for another service Service label for tuning should remain in tuning list as "Part-time B" When the service resumes, the receiver should reselect it if "Service End" is displayed
Separate A	<ul style="list-style-type: none"> Slight reduction in audio quality. No pops, splats or mutes. Displayed service label should change to "Shared A" Service label for tuning should change to "Shared A"
Separate B	<ul style="list-style-type: none"> Slight reduction in audio quality Audio content changes (butt-join, no pops, splats or mutes) Displayed service label should change to "Shared B" Service label for tuning should change to "Shared B"
Shared A	<ul style="list-style-type: none"> Slight improvement in audio quality. No pops, splats or mutes. Displayed service label should change to "Separate A" Service label for tuning should change to "Separate A"
Shared B	<ul style="list-style-type: none"> Slight improvement in audio quality Audio content changes (butt-join, no pops, splats or mutes) Displayed service label should change to "Separate B" Service label for tuning should change to "Separate B"
HalfRate High Quality	<ul style="list-style-type: none"> Slight reduction in audio quality. No pops, splats or mutes. Displayed service label should change to "HalfRate LowQual" Service label for tuning should change to "HalfRate LowQual"
HalfRate Low Quality	<ul style="list-style-type: none"> Slight improvement in audio quality. No pops, splats or mutes. Displayed service label should change to "HalfRate HighQ" Service label for tuning should change to "HalfRate HighQ"

13. FFT Window Positioning

The key to correctly decoding a DAB signal is to position the FFT Window in such a place that both Inter-Symbol-Interference (ISI) and Inter-Carrier-Interference (ICI) is minimised. Once correctly positioned, the window should then automatically be adjusted on a frame-by-frame basis to ensure optimum reception. This test is designed to stress this “tracking” functionality.

Two COFDM modulators are used to generate the same ensemble with a precise time offset equivalent to the guard interval in the DAB mode in use. Initially only one COFDM is connected to the receiver, and the receiver is allowed to acquire the signal. The second COFDM is then turned on instantaneously (to simulate a direct path being unmasked by a building, for example) at a random point in the DAB frame. This new path may be either earlier or later than the initial path, and may be at +10dB, 0dB, -10dB or -20dB relative to the initial path. The receiver should continue to produce audio with no observable defects - the duration of any “bubbling” will be recorded. Once a steady-state has again been achieved, the second COFDM is instantaneously turned off and the receiver should again produce uninterrupted audio.

Appendix A Test Configurations

A.1 RxTest: Service Selection

A.1.1 Service Linkage

DAB Service	Linkage Set Number	ILS	Soft/Hard	Type	Linked Id
c001	0	National	Hard	RDS	c444
c002	1	National	Soft	RDS	c444
c003	2	National	Hard	AM/FM	cff
c004	3	National	Soft	AM/FM	cff
c005	4	National	Hard	DAB	c007
c006	5	National	Soft	DAB	c008
c444	-	-	-	-	-
cff	-	-	-	-	-

Two multiplexes will be required for the linkage tests. The EId of one of these will have to be changed (to test equivalent ensemble and equivalent service linkage).

A.1.2 Multiplex configuration

Service		Component		Subchannel				
SIId	Name	SCIDs	Name	SubChId	Contents			
					Bitrate	Sample rate	Stereo mode	Protection
c001	Prog Svc !"#%&1	0	-	1	192kbit/s	48kHz	Stereo	UEP-3
c002	Prog Svc '()*+,-2	1	-	2	192kbit/s	48kHz	Stereo	UEP-3
c003	Prog Svc ./:;<=>3	6	-	3	192kbit/s	48kHz	Stereo	UEP-3
c004	Prog Svc ?@[_4	0	Test Component 4	4	192kbit/s	48kHz	Stereo	UEP-3
c005	Prog Svc {}~5	1	Test Component 5	1				
c006	Prog Service 6	6	Test Component 6	2				
c007	Prog Service 7	0	-	3				
		1	Test Component 7	4				
c008	Prog Service 8	6	-	1				
		15	Test Component 8	2				
c009	Prog Service 9	0	Primary 9	3				
		1	Secondary 9	4				
c444	Prog Service 10	6	Primary 10	1				
		15	Secondary 10	2				
cfff	Prog Service 11	0	-	1				
		1	Secondary 11-1	2				
		2	Secondary 11-2	3				
		3	Secondary 11-3	4				
		4	Secondary 11-4	5				
		5	Secondary 11-5	6	32kbit/s	24kHz	Mono	UEP-3
		6	Secondary 11-6	7	32kbit/s	24kHz	Mono	UEP-3
		7	Secondary 11-7	8	32kbit/s	24kHz	Mono	UEP-3
		8	Secondary 11-8	9	32kbit/s	24kHz	Mono	UEP-3
		9	Secondary 11-9	10	32kbit/s	24kHz	Mono	UEP-3
		10	Secondary 11-10	11	32kbit/s	24kHz	Mono	UEP-3
11	Secondary 11-11	12	32kbit/s	24kHz	Mono	UEP-3		
e1c00001	Data Service 1	0	-	13	8bit/s	n/a	n/a	EEP-A3
e1c00002	Data Service 2	0	-	13				
		1	Secondary D2	1				
e1c00003	Data Service 3	0	Primary D3	13				
		1	Secondary D3-1	2				
		2	Secondary D3-2	3				
		3	Secondary D3-3	4				
		4	Secondary D3-4	5				
		5	Secondary D3-5	6				
		6	Secondary D3-6	7				
		7	Secondary D3-7	8				
		8	Secondary D3-8	9				
		9	Secondary D3-9	10				
10	Secondary D3-10	11						

A.2 RxTest: Announcements

A.2.1 Announcement support

Service	Announcement types	Cluster(s)
c001	All	1
c002	Traffic	2, 4

A.2.2 Regions

Region Id	Name	TII Code(s)
1	Here	1/1
2	Nearby	1/2
3	FarAway	2/1

A.2.3 Multiplex configuration

Service		Component		Subchannel				
SId	Name	SCIdS	Name	SubChId	Contents			
					Bitrate	Sample rate	Stereo mode	Protection
c001	Test Service 1	0	-	63	192kbit/s	48kHz	Stereo	UEP-3
		1	Secondary 1	2	192kbit/s	48kHz	Stereo	UEP-3
c002	Test Service 2	0	-	3	192kbit/s	48kHz	Stereo	UEP-3
c003	Test Service 3	0	-	4	192kbit/s	48kHz	Stereo	UEP-3
		1	Secondary 3	5	192kbit/s	48kHz	Stereo	UEP-3
c004	Test Service 4	0	-	6	192kbit/s	48kHz	Stereo	UEP-3
c005	Test Service 5	0	-	2	192kbit/s	48kHz	Stereo	UEP-3

A.3 RxTest: Subchannel Coding

Service		Component		Subchannel				
SIId	Name	SCIDS	Name	SubChId	Contents			
					Bitrate	Sample rate	Stereo mode	Protection
c001	Test Service 1	0	-	1	64kbit/s	48kHz	Stereo	UEP-3
c002	Test Service 2	0	-	2	64kbit/s	24kHz	Dual	UEP-1
c003	Test Service 3	0	-	3	192kbit/s	48kHz	Stereo	EEP-A4
c004	Test Service 4	0	-	4	160kbit/s	48kHz	Stereo	EEP-B4
c005	Test Service 5	0	-	8	144kbit/s	24kHz	Dual	EEP-A3
c006	Test Service 6	0	-	15	128kbit/s	24kHz	Joint stereo	UEP-5
c007	Test Service 7	0	-	31	112kbit/s	48kHz	Joint stereo	EEP-A2
c008	Test Service 8	0	-	16	96kbit/s	24kHz	Dual	EEP-B3
c009	Test Service 9	0	-	32	64kbit/s	48kHz	Joint stereo	EEP-B2
c00a	Test Service 10	0	-	40	80kbit/s	48kHz	Mono	UEP-4
c00b	Test Service 11	0	-	61	56kbit/s	24kHz	Mono	UEP-2
c00c	Test Service 12	0	-	62	40kbit/s	24kHz	Mono	EEP-B1
c00d	Test Service 13	0	-	63	32kbit/s	48kHz	Mono	EEP-A1

A.4 RxTest: Reconfigurations

A.4.1 Configuration 1

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-3
cff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.2 Configuration 2

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-3
c002	Service 2	0	-	1					
cff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.3 Configuration 3

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-3
		1	Secondary	9	724	192kbit/s	48kHz	Stereo	UEP-3
cff	Placeholder	0	-	9					

A.4.4 Configuration 4

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-3
c002	Service 2	0	-	2	140	192kbit/s	48kHz	Stereo	UEP-3
cff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.5 Configuration 5

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-3
		1	Secondary 1	2	140	192kbit/s	48kHz	Stereo	UEP-3
c002	Service 2	0	-	1					
		1	Secondary 2	2					
cff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.6 Configuration 6

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-3
		1	Secondary 1	2	140	192kbit/s	48kHz	Stereo	UEP-3
c002	Service 2	0	-	1					
		1	Secondary 2	3					
cff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.7 Configuration 7

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-3
c002	Service 2	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3
cfff	Placeholder	0	-	9					

A.4.8 Configuration 8

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-3
		1	Secondary 1	2	140	192kbit/s	48kHz	Stereo	UEP-3
c002	Service 2	0	-	1					
		1	Secondary 2	9	724	192kbit/s	48kHz	Stereo	UEP-3
cfff	Placeholder	0	-	9					

A.4.9 Configuration 9

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	300	192kbit/s	48kHz	Stereo	UEP-3
cfff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.10 Configuration 10

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	724	192kbit/s	48kHz	Stereo	UEP-3
cfff	Placeholder	0	-	9	0	192kbit/s	48kHz	Stereo	UEP-3

A.4.11 Configuration 11

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	75	192kbit/s	48kHz	Stereo	UEP-3
cfff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.12 Configuration 12

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c000	Lower	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-3
c001	Service 1	0	-	2	140	192kbit/s	48kHz	Stereo	UEP-3
c002	Upper	0	-	3	280	192kbit/s	48kHz	Stereo	UEP-3

A.4.13 Configuration 13

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c000	Lower	0	-	1	139	192kbit/s	48kHz	Stereo	UEP-3
c001	Service 1	0	-	2	279	192kbit/s	48kHz	Stereo	UEP-3
c002	Upper	0	-	3	419	192kbit/s	48kHz	Stereo	UEP-3

A.4.14 Configuration 14

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-3
c002	Service 2	0	-	2	140	192kbit/s	48kHz	Stereo	UEP-3
cfff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.15 Configuration 15

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-3
		1	Secondary	2	140	192kbit/s	48kHz	Stereo	UEP-3
cfff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.16 Configuration 16

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	2	0	192kbit/s	48kHz	Stereo	UEP-3
cfff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.17 Configuration 17

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	224kbit/s	48kHz	Stereo	UEP-3
cfff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.18 Configuration 18

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	-	1	0	192kbit/s	48kHz	Stereo	UEP-5
cfff	Placeholder	0	-	9	724	192kbit/s	48kHz	Stereo	UEP-3

A.4.19 Configuration 19

The ensemble label should be "First ELabel"

Service		Component		Subchannel					
SId	Name	SCIDS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	Service 1	0	Primary	1	0	192kbit/s	48kHz	Stereo	UEP-3
		1	New secondary	2	140	192kbit/s	48kHz	Stereo	UEP-3
e1c00002	New data	0	-	3	280	192kbit/s	-	-	EEP-3A

A.4.20 Configuration 20

The ensemble label should be "Second ELabel"

Service		Component		Subchannel					
SId	Name	SCIDS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c001	New programme	0	New primary	1	0	192kbit/s	48kHz	Stereo	UEP-3
		1	Secondary	2	140	192kbit/s	48kHz	Stereo	UEP-3
e1c00002	Service 2	0	-	3	280	192kbit/s	-	-	EEP-3A

A.5 Whole System Testing

Two different configurations will be used, reconfiguring approximately once per minute.

A.5.1 Configuration 1

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c101	Stereo 128	0		1	0	128kbit/s	48kHz	Stereo	UEP-3
c102	Low Quality	1		2	96	128kbit/s	48kHz	Joint Stereo	UEP-3
c103	Mono 80	6		3	192	80kbit/s	48kHz	Mono	UEP-3
c104	Split Service	2	Primary	4	250	80kbit/s	48kHz	Mono	UEP-3
		3	Secondary	5	308	80kbit/s	48kHz	Mono	UEP-3
c106	Part-time B	15		6	366	80kbit/s	48kHz	Mono	UEP-3
c107	Sharing A	1		7	424	160kbit/s	48kHz	Stereo	UEP-3
c108	Sharing B	2							
c109	Half-Rate Low	3		9	816	64kbit/s	24kHz	Mono	UEP-3

A.5.2 Configuration 2

Service		Component		Subchannel					
SId	Name	SCIdS	Name	SubChId	Start CU	Contents			
						Bitrate	Sample rate	Stereo mode	Protection
c101	Stereo 128	0		1	0	128kbit/s	48kHz	Stereo	UEP-3
c102	Low Quality	1		2	96	192kbit/s	48kHz	Stereo	UEP-3
c103	Mono 80	6		3	236	80kbit/s	48kHz	Mono	UEP-3
c104	Combined	2		4	294	128kbit/s	48kHz	Joint Stereo	UEP-3
c105	Part-time A	15							
c107	Separate A	1		6	390	128kbit/s	48kHz	Joint Stereo	UEP-3
c108	Separate B	2		7	486	192kbit/s	48kHz	Stereo	UEP-3
c109	Half-Rate High	3		9	626	80kbit/s	24kHz	Mono	UEP-3

Appendix B Character Mapping

The following table describes the character mapping between ASCII and the DAB character set where, in the code range 32-126 (decimal), they differ. For all other characters in this range, the ASCII symbol and the DAB symbol are the same. It should be noted that many commercially available dot-matrix displays include a character generator which implements the ASCII symbols and is thus not suitable for use in a DAB receiver without special encoding.

Code	ASCII Character		DAB Character	
	Symbol	Name	Symbol	Name
36	\$	Dollar	¤	Currency
94	^	Caret	—	Mid-line
95	_	Underscore	—	Bottom line
96	`	Backtick		Double VLine
126	~	Tilde	—	Top line

Appendix C Limitations of BBC DAB Receiver Testing

The existing DAB Receiver Testing equipment, set up in A034, is not currently able to perform all of the tests indicated in this document. Where differences exist, they are noted below.

Section	Severity ^[1]	Limitation
§2.3	5	Rayleigh channel tests require a fading channel simulator. The FADICS is currently unserviceable.
§3.	1	The service selection tests require too many components in the multiplex for the equipment in A034 to handle. A suitable multiplex can be generated using the ICS in A222, however even this lacks sufficient channels of audio coding. As a result, these tests require some manual intervention in A222 as well as A034.
§3.	1	The service selection tests require too many components for the current CD4/31-A multiplexer (V2.4X) to handle at the suggested repetition rates. If this is shown to cause problems, the configuration can be split into a pair of smaller configurations which are transmitted with all the FIGs repeated at or exceeding the suggested rates.
§3.12 & §3.13	4	The facilities for generating RDS data are very limited in A034.
§4.	4	It is not possible to generate a configuration containing both secondary service components and announcement switching/support. A reduced set of tests is possible using only primary service components with the equipment in A034. In particular, §4.8 cannot be completed.
§5.4	5	The current software does not allow downloadable PTy's to be sent.
§10.	5	The audio conformance testing software has not yet been written, so formal testing cannot be undertaken at this time. In addition, the Eureka 147 WG-A paper used as the basis for these tests does not define what is to be measured for most of the tests, and so a record of the calculated precision is made.

1. Severity is rated as one of:

- 1: minor – tests can be conducted in full but awkward and error prone
- 2: modified test can be conducted but should give the same results
- 3: modified test can be conducted but may give slightly different results
- 4: reduced range of tests can be conducted
- 5: major – test cannot be conducted

Appendix D Results Recording Forms

D.1 RF Testing

Details of test(s)		Target value	Result	
			Band-III	L-Band
§2.1	Maximum input (P_{\max})	> 0dBm		
§2.2	Gaussian sensitivity (P_{\min})	≤ -91 dBm		
§2.3	Rayleigh sensitivity	Urban	–	
		Rural	–	
		SFN Profile	–	
§2.4	Selectivity, $P_{\text{wanted}} = -60$ dBm DAB interferer	Lower alternate	–	
		Lower adjacent	30dB	
		Upper adjacent		
		Upper alternate	–	
	Selectivity, $P_{\text{wanted}} = -40$ dBm DAB interferer	Lower alternate	–	
		Lower adjacent	–	
		Upper adjacent	–	
		Upper alternate	–	
Far off selectivity	$P_{\text{wanted}} = P_{\min} + 3$ dB, FM interferer	>45dB Mobile >55dB		
	$P_{\text{wanted}} = -60$ dBm, FM interferer			
§2.5	Acquisition time	–		

D.1.1 Test parameters

RF Parameters	Value
Wanted frequency (sensitivity & far-off measurements only)	MHz
Interferer frequency (DAB interferer only)	225-648 MHz
Receiver IF frequency	MHz
Input mixer high-side or low-side	High/Low
Interferer frequency (far-off FM interferer only)	MHz
Receiver category	Mobile/ Stationary/ Portable

D.2 Service Selection

Details of test(s)		Pass (✓) Fail (✗) Not tested (—)
§3.1	Access programme service	
§3.2	Access all audio components of a programme service	
§3.3	Access data service	
§3.4	Access all audio components of a data service	
§3.5	Access components of a service with non-sequential SCIDS values	
§3.7	Display of ensemble label	
§3.8	Display of programme service label	
§3.9	Display of data service label	
§3.10	Display of primary service component label (if present)	
§3.11	Display of secondary service component label	
§3.11	Display of unusual characters in labels	
§3.12	Linking to equivalent RDS service	
	Linking to hard-linked RDS service	
	Linking to soft-linked RDS service	
§3.13	Return from linked RDS service	
§3.14	Linking to equivalent AM/FM service	
	Linking to hard-linked AM/FM service	
	Linking to soft-linked AM/FM service	
§3.15	Return from linked AM/FM service	
§3.16	Linking to equivalent DAB ensemble	
	Linking to equivalent DAB service	
	Linking to hard-linked DAB service	
	Linking to soft-linked DAB service	
§3.17	Return from linked DAB service	

D.3 Announcement Switching

Details of test(s)		Pass (✓) Fail (✗) Not tested (—)
§4.1	Announcement switching	
§4.2	Alarm switching	
§4.3	Interruption to secondary service component	
§4.4	Interruption to tape/CD	
§4.5	Announcement support	
§4.6	User filtering	
§4.7	Cluster handling	
§4.8	Intra-service announcements	
§4.9	Multiple clusters	
§4.10	Regional filtering by TII	
§4.11	Unknown TII codes	

D.4 Programme Type

Details of test(s)		Pass (✓) Fail (✗) Not tested (—)
§5.1	Display of static international PTy coarse code	
§5.2	Display of static PTy extended coarse code	
§5.3	Display of dynamic PTy coarse code	
§5.4	Downloadable PTy coarse code	
§5.5	PTy “Search”	
§5.6	PTy “Watch” mode	

D.5 Dynamic Labels

Details of test(s)		Pass (✓) Fail (✗) Not tested (—)
§6.1	Display of dynamic labels	
§6.2	Display of dynamic headlines	
§6.3	Update of dynamic labels	
§6.4	Handling of “End of Headline” feature	
§6.5	Display of long headlines	
§6.6	Display of long labels	
§6.7	Display of non-alphabetic characters	
§6.8	Display of long words	
§6.9	Handling of “Preferred Line Break” feature	
§6.10	Handling of “Preferred Word Break” feature	
§6.11	Handling of “Clear Label” feature	
§6.12	Short and long format	
§6.13	Low sampling frequency (LSF/half-rate) dynamic labels	

D.6 Subchannel Coding

Details of test(s)		Pass (✓) Fail (✗) Not tested (—)
§7.1	Decoding audio at 64kbit/s stereo half-rate, UEP-3	
	Decoding audio at 64kbit/s dual-channel half-rate, UEP-1	
	Decoding audio at 192kbit/s stereo full-rate, EEP-A4	
	Decoding audio at 160kbit/s stereo full-rate, EEP-B4	
	Decoding audio at 144kbit/s dual-channel half-rate, EEP-A3	
	Decoding audio at 128kbit/s joint-stereo half-rate, UEP-5	
	Decoding audio at 112kbit/s joint-stereo full-rate, EEP-A2	
	Decoding audio at 96kbit/s dual-channel half-rate, EEP-B3	
	Decoding audio at 64kbit/s joint-stereo full-rate, EEP-B2	
	Decoding audio at 80kbit/s mono full-rate, UEP-4	
	Decoding audio at 56kbit/s mono half-rate, UEP-2	
	Decoding audio at 40kbit/s mono half-rate, EEP-A1	
	Decoding audio at 32kbit/s mono half-rate, EEP-B1	
§7.2	Decoding audio at 384kbit/s stereo full-rate, UEP-3	
§7.3	Decoding first CU	
§7.4	Decoding second CU	
§7.5	Decoding last CU	

D.7 Reconfiguration

Details of test(s)		Pass (✓) Fail (✗) Not tested (—)
§8.1	Service organisation	
§8.2	Subchannel sharing	
§8.3	Subchannel relocation (non-overlapping)	
§8.4	Subchannel relocation (overlapping)	
§8.5	Service and subchannel reconfiguration	
§8.6	Fallback to primary component	
§8.7	Changing SubChId	
§8.8	Changing bitrate	
§8.9	Changing protection level	
§8.10	Changing programme service label	
§8.11	Changing data service label	
§8.12	Changing primary component label	
§8.13	Changing secondary component label	
§8.14	Changing ensemble label	

D.8 Dynamic Range Control

Details of test(s)		Pass (✓) Fail (✗) Not tested (—)
§9.1	DRC supported	
§9.2	Timing accuracy of DRC application	ms
§9.3	Amplitude accuracy of DRC application	dB
§9.4	Amplitude match between DRC and non-DRC	

D.9 Audio Conformance

Details of test(s)		Calculated accuracy (bits)	
		Left	Right
Audio output used for tests		SPDIF/analogue/AES-EBU	
Test 1 (Mode switching)	DRC off		
	DRC on		
Test 2 (Dual channel mode)			
Test 3 (Bit allocation)			
Test 4 (Scalefactor)			
Test 5 (Low bitrate table)			
Test 6 (Low bitrate table)			
Test 7 (Half-rate mode switching)	DRC off		
	DRC on		
Test 8 (Half-rate dual channel mode)			
Test 9 (Half-rate bit allocation)			
Test 10 (Half-rate scalefactors)			

D.10 Date and Time

Details of test(s)		Pass (✓) Fail (✗) Not tested (—)
§11.1	Decoding dates	
§11.2	Decoding times	
§11.3	Decoding LTO	

D.11 Whole System Testing

<i>Service / Test</i>		<i>Result</i>	<i>Notes</i>
Stereo 128	Correct audio decoded		
	Audio during reconfigurations		
	Dynamic label displayed		
	Dynamic label updated		
High Quality	Correct audio decoded		
	Audio during reconfigurations		
	Dynamic label displayed		
	Dynamic label hidden		

<i>Service / Test</i>		<i>Result</i>	<i>Notes</i>
Low Quality	Correct audio decoded		
	Audio during reconfigurations		
	Dynamic label displayed		
	Dynamic label hidden		
Mono 80	Correct audio decoded		
	Turning receiver on when tuned		
	Turn on when recalled from preset		
	Audio during reconfigurations		
Combined	Correct audio decoded		
	Audio during reconfigurations		
	“Secondary available” appears		
Split Service, Primary Component	Correct audio decoded		
	Audio during reconfigurations		
	Component label displayed		
	“Secondary available” disappears		
Split Service 2 nd ary Component	Correct audio decoded		
	Audio during reconfigurations		
	Correct audio after reconfiguration		
	Component label displayed		
	“Secondary available” disappears		
	Storing in preset stores primary		
	Turning receiver on while off-air		
	No automatic reselection on return		
Part-time A	Correct audio decoded		
	Audio during reconfigurations		
	Display updated sensibly		
	Service label remains in tuning list		
	Recalling preset while off-air		
	Service decoded on return		
Part-time B	Correct audio decoded		
	Audio during reconfigurations		
	Display updated sensibly		
	Service label remains in tuning list		
	Recalling preset while off-air		
	Service decoded on return		
Separate A	Correct audio decoded		
	Audio during reconfigurations		
	Correct audio after reconfiguration		
Separate B	Correct audio decoded		
	Audio during reconfigurations		
	Correct audio after reconfiguration.		

<i>Service / Test</i>		<i>Result</i>	<i>Notes</i>
Shared A	Correct audio decoded		
	Audio during reconfigurations		
	Correct audio after reconfiguration		
Shared B	Correct audio decoded		
	Audio during reconfigurations		
	Correct audio after reconfiguration.		
HalfRate High Quality	Correct audio decoded		
	Audio during reconfigurations		
HalfRate Low Quality	Correct audio decoded		
	Audio during reconfigurations		
Service labels and Tuning list	Updated service label displayed		
	Tuning list updated correctly		
	New services added to tuning list		
	Part-time services remain in list		
	Components removed from list		
Tuning type	Single list of services		
	Channel then service		
Multiplex scan time	Not applicable		
	UK-only		
	World-wide		

D.12 FFT Window Positioning

<i>Details of test(s)</i>		<i>Results</i>		
		<i>Adding echo</i>	<i>Steady state</i>	<i>Removing echo</i>
Mode I $T_{\text{echo}} = 246\mu\text{s}$ $P_{\text{main}} = -50\text{dBm}$	$P_{\text{echo}} = -40\text{dBm}$			
	$P_{\text{echo}} = -50\text{dBm}$			
	$P_{\text{echo}} = -60\text{dBm}$			
	$P_{\text{echo}} = -70\text{dBm}$			
Mode I $T_{\text{echo}} = -246\mu\text{s}$ (pre-echo) $P_{\text{main}} = -50\text{dBm}$	$P_{\text{echo}} = -40\text{dBm}$			
	$P_{\text{echo}} = -50\text{dBm}$			
	$P_{\text{echo}} = -60\text{dBm}$			
	$P_{\text{echo}} = -70\text{dBm}$			
Mode III $T_{\text{echo}} = 31\mu\text{s}$ $P_{\text{main}} = -50\text{dBm}$	$P_{\text{echo}} = -40\text{dBm}$			
	$P_{\text{echo}} = -50\text{dBm}$			
	$P_{\text{echo}} = -60\text{dBm}$			
	$P_{\text{echo}} = -70\text{dBm}$			
Mode III $T_{\text{echo}} = -31\mu\text{s}$ (pre-echo) $P_{\text{main}} = -50\text{dBm}$	$P_{\text{echo}} = -40\text{dBm}$			
	$P_{\text{echo}} = -50\text{dBm}$			
	$P_{\text{echo}} = -60\text{dBm}$			
	$P_{\text{echo}} = -70\text{dBm}$			

