

FCC and ISED Test Report

Dyson Technology Limited
Adaptivity Jig, Model: RB03 HLP

In accordance with FCC 47 CFR Part 15E and
ISED RSS-247 (5 GHz WLAN)

Prepared for: Dyson Technology Limited
Tetbury Hill
Malmesbury
SN16 0RP
United Kingdom



Add value.
Inspire trust.

FCC ID: QVHRB03001

IC: 7986A-RB03001

COMMERCIAL-IN-CONFIDENCE

Document 75950804-03 Issue 02

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Matthew Russell	RF Team Leader	Authorised Signatory	19 May 2021

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15E, ISSED RSS-247. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	George Porter	19 May 2021	
Testing	Philip Harrison	19 May 2021	

FCC Accreditation

90987 Octagon House, Fareham Test Laboratory

ISED Accreditation

12669A Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15E: 2019 and ISSED RSS-247, Issue 2 (2017-02) for the tests detailed in section 1.3.



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is a trading name of TÜV SÜD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TÜV SÜD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuv-sud.co.uk

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom



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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	14 April 2021
2	Images replaced as some were not clear. Application form included. Addition of table 6. Added figure 4. Test channel included in table 8.	19 May 2021

Table 1

1.2 Introduction

Applicant	Dyson Technology Limited
Manufacturer	Dyson Technology Limited
Model Number(s)	RB03 HLP
Serial Number(s)	Not serialised (0075950804-TSR0001)
Hardware Version(s)	DVT
Software Version(s)	RB03ED.11.99.101.0266
Number of Samples Tested	1
Test Specification/Issue/Date	FCC 47 CFR Part 15E: 2019 ISED RSS-247: Issue 2 (2017-02)
Order Number	6000099213
Date	16-December-2020
Date of Receipt of EUT	26-January-2021
Start of Test	26-January-2021
Finish of Test	27-January-2021
Name of Engineer(s)	George Porter and Philip Harrison
Related Document(s)	KDB 905462 D02 v02



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15E and ISSED RSS-247 is shown below.

Section	Specification Clause		Test Description	Result	Comments/Base Standard
	FCC Part 15E	RSS-247			
Configuration and Mode: 5 GHz WLAN - 802.11ac 80 MHz Bandwidth					
2.1	15.407 (h)(2)(iii)(iv)	6.3.2(c)(d)(e)	Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period	Pass	

Table 2



1.4 Application Form

Equipment Description

Technical Description: <i>(Please provide a brief description of the intended use of the equipment including the technologies the product supports)</i>	Robotic vacuum cleaner with 2.4GHz, 5GHz Wi-Fi and Bluetooth Low Energy wireless technologies	
Manufacturer:	Dyson Technology Ltd	
Model:	RB03	
Part Number:	RB03	
Hardware Version:	DVT	
Software Version:	RB03ED.11.99.101.0266	
FCC ID of the product under test – see guidance here	QVHRB03001	
IC ID of the product under test – see guidance here	7986A-RB03001	

Type of Equipment

Master	☐
Client with Radar Detection	☐
Client without Radar Detection	☒
Wi-Fi Direct Support	☐

AC Power Source

AC supply frequency:	50/60	Hz
Voltage	110 - 240	V
Max current:	2	A
Single Phase ☒ Three Phase ☐		

DC Power Source

Nominal voltage:		V
Extreme upper voltage:		V
Extreme lower voltage:		V
Max current:		A

Battery Power Source

Voltage:	21.6	V
End-point voltage:	NA	V (Point at which the battery will terminate)
Alkaline ☐ Leclanche ☐ Lithium ☒ Nickel Cadmium ☐ Lead Acid* ☐ *(Vehicle regulated)		
Other ☐	Please detail:	



Transmitter Technical Characteristics – Frequency Characteristics

5.150 GHz to 5.250 GHz	☒
5.250 GHz to 5.350 GHz	☒
5.470 GHz to 5.725 GHz	☒
5.725 GHz to 5.825 GHz	☒
EUT can operate in the frequency band 5600 – 5650 MHz	☒
Note: DFS is not required in the ranges 5.15 – 5.25 GHz and 5.725 – 5.825 GHz	

Transmitter RF Power Characteristics

Maximum rated transmitter output power as stated by manufacturer		
Conducted Power	15dBm	dBm
Maximum Antenna Gain	7.1	dBi
EIRP	22.1	dBm
Minimum rated transmitter output power as stated by manufacturer (if applicable)		
Conducted Power		dBm
Maximum Antenna Gain		dBi
EIRP		dBm
Is TPC supported	Yes ☐ No ☒	
If Yes, provide a description of operation		

System Architecture

Frame Based		☐		
IP Based		☐		
Other		☒		
If other, please specify		Load Based		
802.11(a)	☒	Receiver Bandwidth:	20/40	MHz
802.11(n) – 20 MHz	☒	Receiver Bandwidth:	20	MHz
802.11(n) – 40 MHz	☒	Receiver Bandwidth:	40	MHz
802.11(ac) – 20 MHz	☒	Receiver Bandwidth:	20	MHz
802.11(ac) – 40 MHz	☒	Receiver Bandwidth:	40	MHz
802.11(ac) – 80 MHz	☒	Receiver Bandwidth:	80	MHz

Declaration

No parameter or information relating to the detected radar waveforms is available or accessible to the end user.
True ☒ False ☐

Miscellaneous (Master Device Only)

Power-on cycle time*	
* Time from switching on the UUT to the point at which Channel Availability Check (CAC) commences	

Uniform Spreading (Master Device Only)



Describe how the meter provides, on aggregate, uniform channel loading of the spectrum across all channels.

Antenna Options

Antenna 1			
Description:	PCB Patch Antenna	Model :	Proprietary
Maximum Gain:	6.7 dBi	Frequency Range:	2412 - 5825 MHz
Antenna 2			
Description:	PCB Patch Antenna	Model :	Proprietary
Maximum Gain:	7.1 dBi	Frequency Range:	2402 - 5825 MHz
Antenna 3			
Description:		Model :	
Maximum Gain:		Frequency Range:	
Antenna 4			
Description:		Model :	
Maximum Gain:		Frequency Range:	
Antenna 5			
Description:		Model :	
Maximum Gain:		Frequency Range:	

I hereby declare that the information supplied is correct and complete.

Name: Neil Taylor

Position held: Senior Radio Approvals Engineer

Date: 14 May 2021



1.5 Product Information

1.5.1 Technical Description

The equipment under test (EUT) was an RB03 HLP board with adaptivity enabled.

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.

The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Model: RB03 HLP, Serial Number: Not serialised (0075950804-TSR0001)			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 3

1.8 Test Location

TÜV SÜD conducted the following tests at our Fareham Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: 5 GHz WLAN - 802.11ac 80 MHz Bandwidth		
Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period	George Porter	UKAS

Table 4

Office Address:

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire
PO15 5RL
United Kingdom



2 Test Details

2.1 Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period

2.1.1 Specification Reference

FCC 47 CFR Part 15E, Clause 15.407 (h)(2)(iii)(iv)
ISED RSS-247, Clause 6.3.2(c)(d)(e)

2.1.2 Equipment Under Test and Modification State

Model: RB03 HLP, S/N: Not serialised (0075950804-TSR0001) - Modification State 0

2.1.3 Date of Test

26-January-2021 to 27-January-2021

2.1.4 Test Method

This test was performed in accordance with FCC KDB 905462 D02, clause 7.8.3.

The EUT was configured to run iPerf, transmitting UDP to the client laptop. The channel loading was set to >17% by adjusting the bandwidth specified in the iPerf UDP transfer.

Radar Pulse Type 0 was then transmitted, and the Spectrum monitored. The transmissions from the UUT were observed for a period of 12 seconds after the final injected Radar Pulse.

It was checked that all transmissions stopped within the 10 second period defined from the point of the end of the final Radar pulse + 10 seconds. In addition, the aggregate on time during the first 200ms and the following 9.8 seconds of the Channel Move Time was computed by the Aeroflex DFS Software.

The markers on the trace data correspond to the following time periods:

Red - End Of Radar Burst, (T0)
Purple - End Of 200ms Period, (T0 + 200 ms)
Orange - End Of Channel Move Time, (T0 + 10 seconds)

To verify the non-occupancy period, the PXI digitiser was replaced with a Spectrum Analyser. The external trigger from the Aeroflex DFS test system was used to trigger a 30-minute sweep from the moment the radar burst sequence was injected. It was verified that no transmissions occurred on the test channel during this time period.

2.1.5 Environmental Conditions

Ambient Temperature	20.1 - 21.7 °C
Relative Humidity	41.5 - 47.6 %

2.1.6 Test Results

5 GHz WLAN - 802.11ac 80 MHz Bandwidth - 802.11ac VHT80

The equipment was set up as shown in the diagram below.

To calibrate the level of the radar at the input to the companion device, the companion device was replaced by the spectrum analyser and the output of the PXI RF generator adjusted to give -62 dBm.

Radar Type	Pulse Width (μ s)	PRI (μ s)	Number of Pulses
0	1	1428	18

Table 5 - Radar Pulse Type 0 Characteristics

Manufacturer	Model	Serial Number	FCC ID
Asus	RT-AC68U	GAIUOH002628	MSQ-RTACHN00

Table 6 - Details of Master Device used to support testing

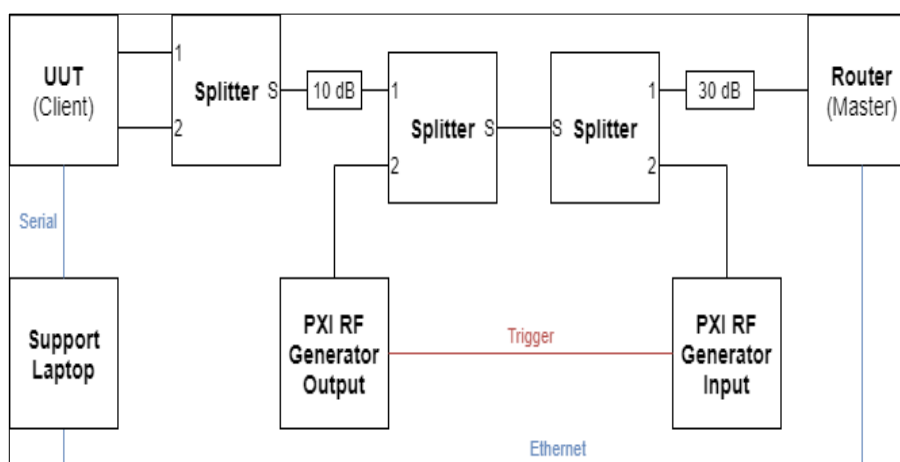


Figure 1 - Test Equipment Setup Diagram for Client without Radar Detection with Injection at the Master



Figure 2 - Verification of Radar Type 0

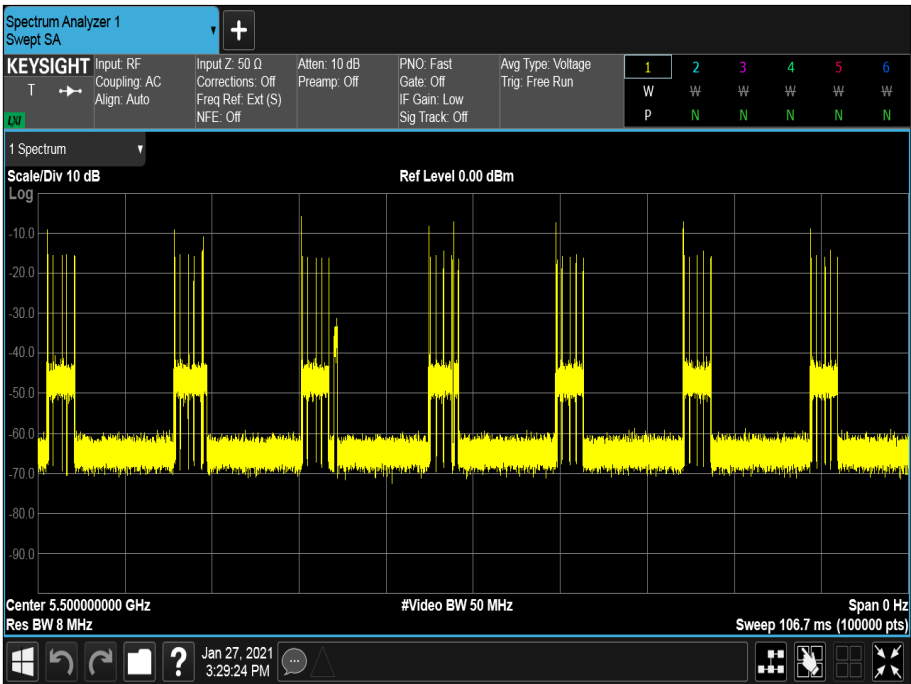


Figure 3 - Channel Loading

The channel loading was 22.49 %

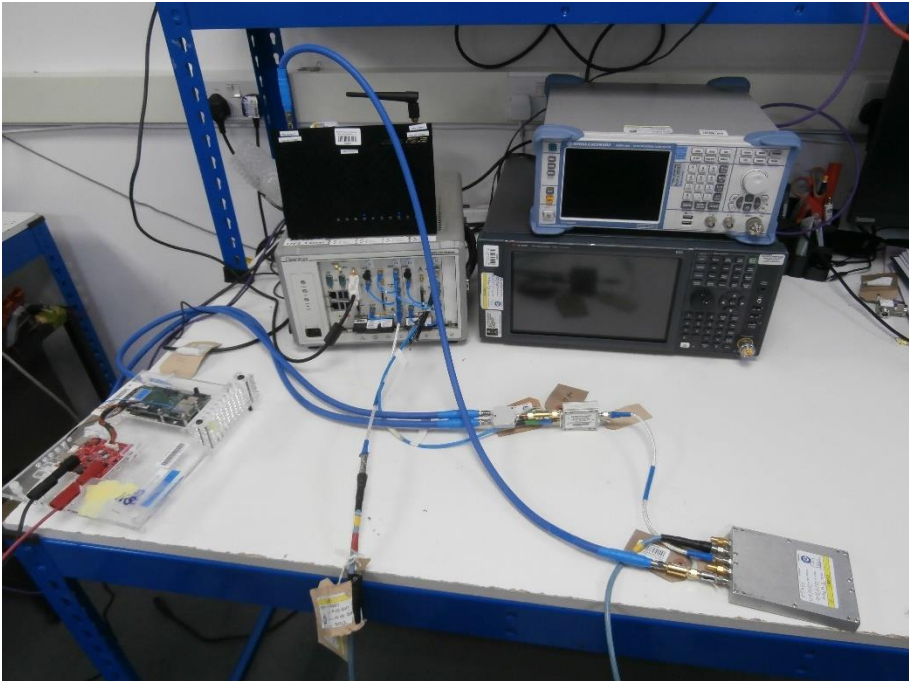


Figure 4 - Test Setup Photograph

Maximum Transmit Power	Value (Notes 1 and 2)
≥ 200 milliwatt	-64 dBm
< 200 milliwatt	-62 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna.	
Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.	

Table 7 - DFS Detection Thresholds for Master Devices and Client Devices with Radar Detection

Test Parameter	Result
Test Channel	CH106 (5530 MHz), Control CH36 (5500 MHz)
Channel Move Time	1.993 s
Channel Closing Time (Aggregate Time During 200 ms)	1.620 ms
Channel Closing Time (Aggregate Time During 200 ms to 10 s)	0.091 ms
Channel Closing Time (Aggregate Time During 10 s)	1.711 ms
Transmission Observed During Non-Occupancy Period	No

Table 8 - In-Service Monitoring Test Results

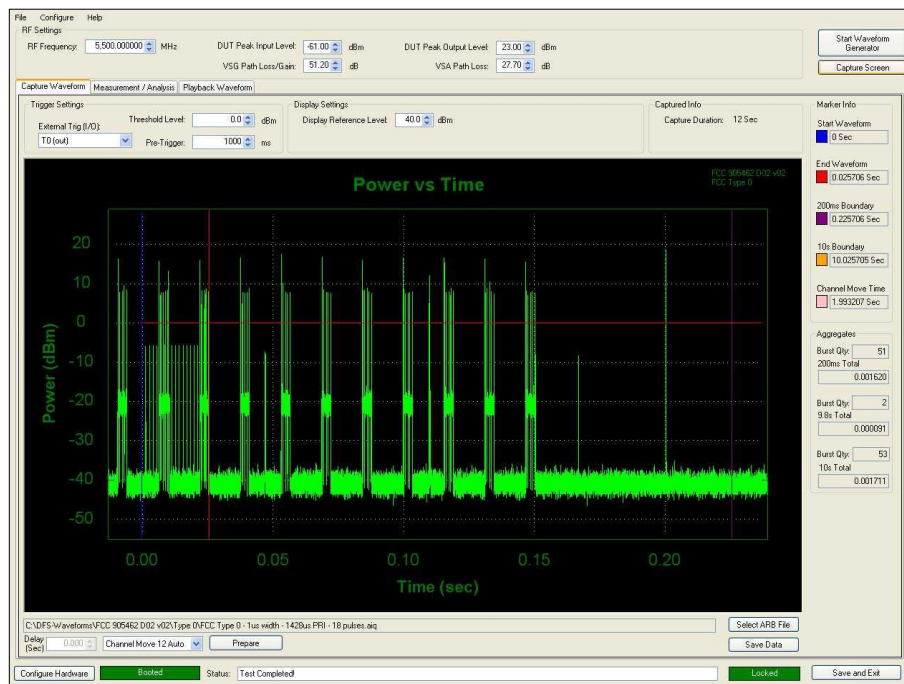


Figure 5 - First 200 ms of Channel Shutdown Period

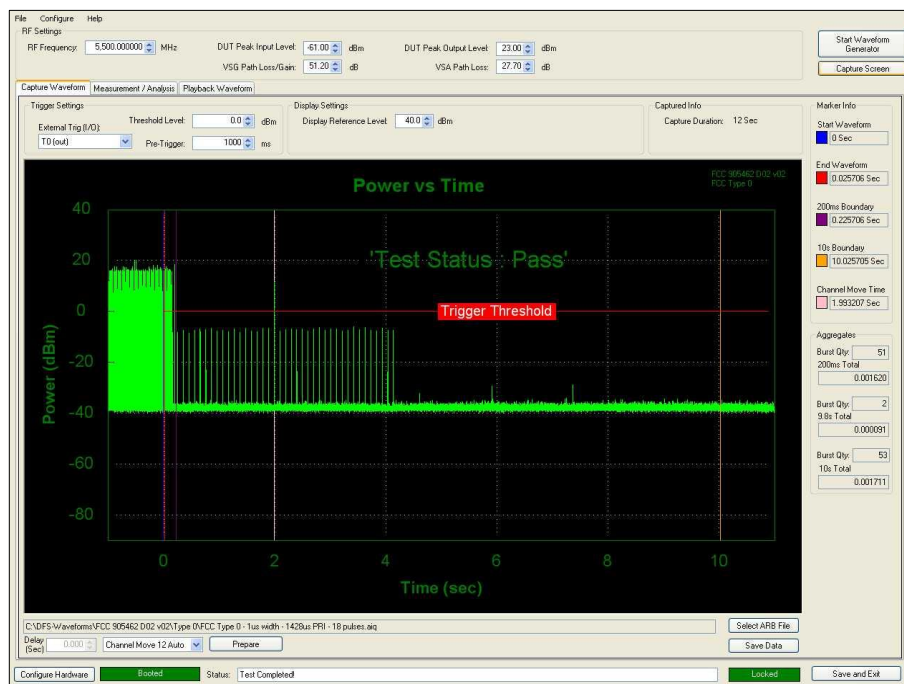


Figure 6 - First 12 s of Channel Shutdown Period

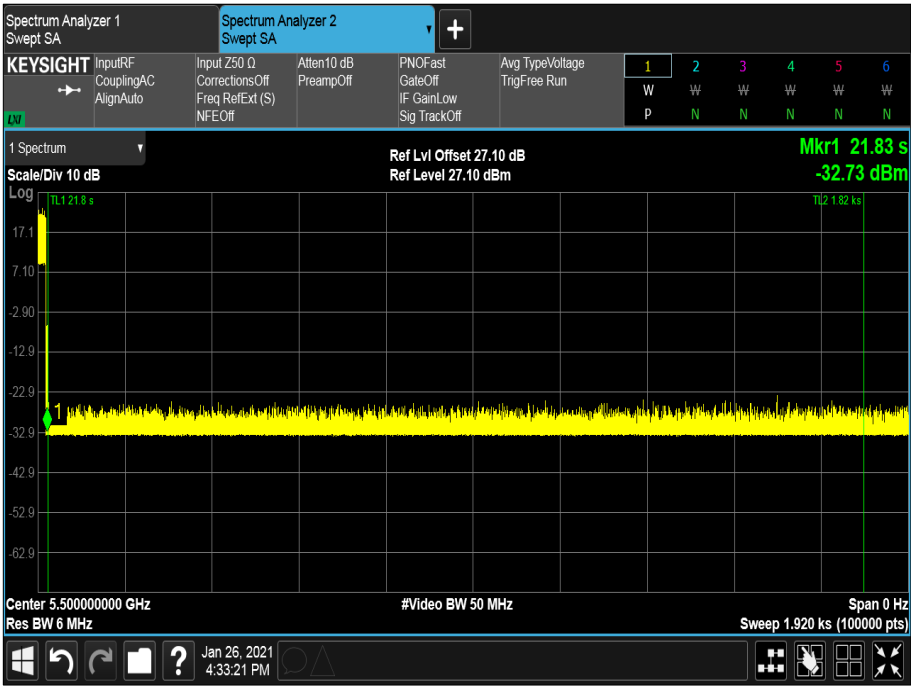


Figure 7 - 30 minute Non-Occupancy Period



FCC 47 CFR Part 15, Limit Clause 15.407 (h)(2)(iii)

Channel Move Time	<10 seconds
Channel Closing Time (Aggregate Time During 200ms)	<200 ms
Channel Closing Time (Aggregate Time During +200ms to 10s)	<60 ms

Table 9 - Channel Move Time and Channel Closing Transmission Time Limit

FCC 47 CFR Part 15, Limit Clause 15.407 (h)(2)(iv)

Non-occupancy Period	> 30 minutes
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Table 10 - Non-Occupancy Limit

ISED RSS-247, Limit Clause 6.3.2

Devices shall comply with the following requirements, however, the requirement for in-service monitoring does not apply to slave devices without radar detection.

In-service monitoring: an LE-LAN device shall be able to monitor the operating channel to check that a co-channel radar has not moved or started operation within range of the LE-LAN device. During in-service monitoring, the LE-LAN radar detection function continuously searches for radar signals between normal LE-LAN transmissions.

Channel availability check time: the device shall check whether there is a radar system already operating on the channel before it initiates a transmission on a channel and when it moves to a channel. The device may start using the channel if no radar signal with a power level greater than the interference threshold value specified in Section 6.3.1 above is detected within 60 seconds. This requirement only applies in the master operational mode.

Channel move time: after a radar signal is detected, the device shall cease all transmissions on the operating channel within 10 seconds.

Channel closing transmission time: is comprised of 200 ms starting at the beginning of the channel move time plus any additional intermittent control signals required to facilitate a channel move (an aggregate of 60 ms) over the remaining 10-second period of the channel move time.

Non-occupancy period: a channel that has been flagged as containing a radar signal, either by a channel availability check or in-service monitoring, is subject to a 30-minute non-occupancy period where the channel cannot be used by the LE-LAN device. The non-occupancy period starts from the time that the radar signal is detected



2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Dual Power Supply Unit	Hewlett Packard	6253A	271	-	O/P Mon
Attenuator (20dB, 1W)	Sealectro	60-674-1020-89	1520	-	O/P Mon
Multimeter	Fluke	79 Series II	3057	12	21-Aug-2021
PXI RF Digitizer	Aeroflex	3035	4012	24	12-Nov-2022
PXI RF Synthesizer	Aeroflex	3010	4013	24	12-Nov-2022
PXI RF Synthesizer	Aeroflex	3011	4014	24	12-Nov-2022
PXI Digital RF Signal Generator	Aeroflex	3025	4015	24	12-Nov-2022
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4517	12	22-Jun-2021
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4742	12	15-Jan-2022
Power splitter - 4 port	Mini-Circuits	ZN4PD1-63-S+	4744	12	22-Oct-2021
Wireless Cable & Fibre Router - AC 1900, Dual-band	Asus	RT-AC68U	4881	-	TU
EXA	Keysight Technologies	N9010B	4968	24	23-Dec-2021
Cable 2.92m	Junkosha	MWX241-01000KMS	5412	12	22-Jun-2021
Cable 2.92m	Junkosha	MWX241-01000KMS	5413	12	22-Jun-2021
2.92mm 1m cable	Junkosha	MWX211/B	5415	12	22-Jun-2021
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5480	-	18-Mar-2021
Attenuator 2W 10dB DC-10GHz	Telegartner	J01156A0031	5576	-	O/P Mon
Attenuator 2W 10dB DC-10GHz	Telegartner	J01156A0031	5578	-	O/P Mon
Power Divider	Aaren	AT30A-TE0208-2-AF	5684	12	18-Dec-2021
Cable	Junkosha	MWX221/B	S/N: 1810S 002	-	O/P Mon

Table 11

TU - Traceability Unscheduled

O/P Mon – Output Monitored using calibrated equipment



3 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
Channel Move Time, Channel Closing Transmission Time and Non-Occupancy Period	Time: $\pm 0.47 \%$ Power: $\pm 1.29 \text{ dB}$

Table 12

Measurement Uncertainty Decision Rule

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2007, clause 4.4.3 and 4.5.1.