DEKRA Testing and Certification, S.A.U.
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C.I.F. A29 507 456

Test report No:

ISED CABid: ES1909

NIE: 66837RRF.004A1

Dynamic Frequency Selection (DFS) Test report

USA FCC Part 15.407, 15.209

CANADA RSS-247, RSS-Gen

Unlicensed National Information Infrastructure (U-NII) Devices. General technical requirements.
Radiated emission limits; general requirements.
Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.
General Requirements and Information for the Certification of Radio Apparatus.

(*) Identification of item tested	Nokia Industrial MulteFire Router 700H
(*) Trademark	Nokia
(*) Model and /or type reference	HWNDUSEB1006
Other identification of the product	HW version: A101 SW version: 20210121_01_UESW_MF_DEV_00540_12b1d3b_3f98503 IMEI TAC: 35999539 FCC ID: 2AVO2MFRTR700H1 ID: 661AF-MFRTR700H1
(*) Features	MulteFire 1.0
Applicant	Nokia Innovations US LLC 600-700 Mountain Ave Murray Hill, NJ, 07974 USA
Test method requested, standard	USA FCC Part 15.407 (10-1-19) Edition: Unlicensed National Information Infrastructure (U-NII) Devices. General technical requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 Amendment 1 (March 2019). ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.

	KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Rafael López Martín EMC Consumer & RF Lab. Manager  2021.08.12 11:42:12 +02'00'
Date of issue	2021-08-12
Report template No	FDT08_23 (*) “Data provided by the client”

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DEKRA Testing and Certification S.A.U. is an FCC-recognized accredited testing laboratory with the appropriate scope of accreditation that covers the performed test in this report.

DEKRA Testing and Certification S.A.U. is an ISED-recognized accredited testing laboratory, CABid: ES1909, with the appropriate scope of accreditation that covers the performed tests in this report.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification has a calibration and maintenance program for its measurement equipment.

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The results presented in this Test Report apply only to the particular item under test established in this document.

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1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
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Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification internal document PODT000.

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested"

2. The Nokia Industrial MulteFire Router 700H acts as a client device. When connected to an Access Point, it provides wireless data service.

Usage of samples

Samples undergoing test have been selected by: the client.

Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
66837/012	Nokia Industrial MulteFire Router 700H	HWNDUSEB1006	120200031720CPB0013	2020-12-01
66837/007	AC/DC Adapter	G0957B-120-200	---	2020-12-01
66837/010	Power Cable	---	---	2020-12-01

Auxiliary elements used with the sample S/01:

Control Nº	Description	Model	Serial Nº	Date of reception
64023/009	Flexi Zone MulteFire Outdoor Pico BTS	FW2RH-m	EB184990223	2020-06-10
64023/018	Ethernet Cable UTP Cat6 0,5m	---	---	2020-06-10
64023/003	Power Cable	---	---	2020-06-10

Sample S/01 has undergone the following test(s): All Conduted tests indicated in Appendixes A, B.

Test sample description

Ports…….. :	Port name and description	Cable			
		Specified max length [m]	Attached during test	Shielded	Coupled to patient (3)
	RJ45	100	☒	☒	☐
	USB2.0	4	☒	☒	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
Supplementary information to the ports…… :	N/A				

Rated power supply .....:	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐

	☒	DC: 10-30 V					
Rated Power .....:	12W max.						
Clock frequencies.....:	XO 12MHz/25MHz/125MHz, SoC 1000MHz/750MHz, DDR 800MHz						
Other parameters .....:							
Software version .....:	20210121_01_UESW_MF_DEV_00540_12b1d3b_3f98503						
Hardware version .....:	A101						
Dimensions in cm (W x H x D) :	10.5 x 16.2 x 2.5						
Mounting position .....:	☒	Wall/Ceiling mounted equipment					
	☒	Table top equipment					
	☒	Floor standing equipment					
	☐	Hand-held equipment					
	☒	Other: Industrial machine mounted equipment; pole					
Modules/parts.....:	Module/parts of test item		Type		Manufacturer		
	5150-5925MHz 3dBi Antenna x 2		Antenna		Shenzhen DongLi		
	12V DC Adapter		Power Supply		Shenzhen Gospell		
Accessories (not part of the test item).....:	Description		Type		Manufacturer		
Documents as provided by the applicant .....:	Description		File version		Issue date		
	TestMac User Guide for Regulatory Certification		N/A		Nov 20, 2020		

(3) Only for Medical Equipment

Identification of the client

NOKIA INNOVATIONS US LLC
600-700 Mountain Ave
Murray Hill, NJ, 07974 USA

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2021-05-26
Date (finish)	2021-05-26

Document history

Report number	Date	Description
66837RRF.004	2021-07-28	First release
66837RRF.004A1	2021-08-12	Second release. First modification due to typo in antenna gain value. This modification test report cancels and replaces the test report 66837RRF.004

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

Remarks and comments

The tests have been performed by the technical personnel: Ignacio Cabra and Cristina Calle.

Used instrumentation:

Conducted Measurements

		Last Calibration	Due Calibration
1.	Shielded Room ETS LINDGREN S101	N.A.	N.A.
2.	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2019/09	2021/09
3.	DC Power Supply 40V/40A Rohde & Schwarz NGPE40	N.A.	N.A.
4.	Digital Multimeter FLUKE 179	2020/10	2021/10
5.	Vector Signal Generator 8 kHz-6GHz ROHDE AND SCHWARZ SMBV100B	2019/10	2021/10
6.	Signal Generator 8 KHz-6 GHz, ROHDE AND SCHWARZ SMB100B	2019/10	2021/10
7.	OPEN SWITCH UNIT OSP120 ROHDE AND SCHWARZ	2019/10	2021/10
8.	OPEN SWITCH UNIT UP TO 18 GHz OSP150 ROHDE AND SCHWARZ	2019/09	2021/09

Testing verdicts

Not applicable :	N/A
Pass :	P
Fail :	F
Not measured :	N/M

Summary

A. DFS for Slave Device Mode

FCC PART 15 PARAGRAPH / RSS-247 / KDB 905462			
Requirement – Test case		Verdict	Remark
RSS-247. 6.3.1/ KDB Sect. 7.8.1	Detection Threshold	P	
RSS-247. 6.3.1/ KDB Sect. 7.8.1	Detection Bandwidth	N/A	(2)
RSS-247. 6.3.2/ KDB Sect. 7.8.2	Performance Requirements Check	P	
RSS-247. 6.3.2 / KDB Sect. 7.8.3	In Service Monitoring	P	
RSS-247. 6.3.2 / KDB Sect. 7.8.4	Radar Statistic Performance Check	N/A	(2)
Supplementary information and remarks: 1) MulteFire only works with bandwidth of 20MHz. 2) Slave without Radar detection			

Appendix A: DFS for Slave Device Mode

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TEST CONDITIONS

Power supply (V):

Vnominal = 120 Vac

Type of power supply = AC voltage main supply.

Type of antenna = External antenna.

Declared Gain for antenna (maximum):

$G_{ANTENNA\ SISO1}$ = 3 dBi

$G_{ANTENNA\ SISO2}$ = 3 dBi

Technology Tested:	MulteFire 1.0	
Modes:	QPSK, 16QAM and 64QAM	
Beamforming:	No	
Frequency Range:	5250 MHz to 5350 MHz	
	5470 MHz to 5725 MHz	
Channel Spacing:	20 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	UNII-2A: 60	5300

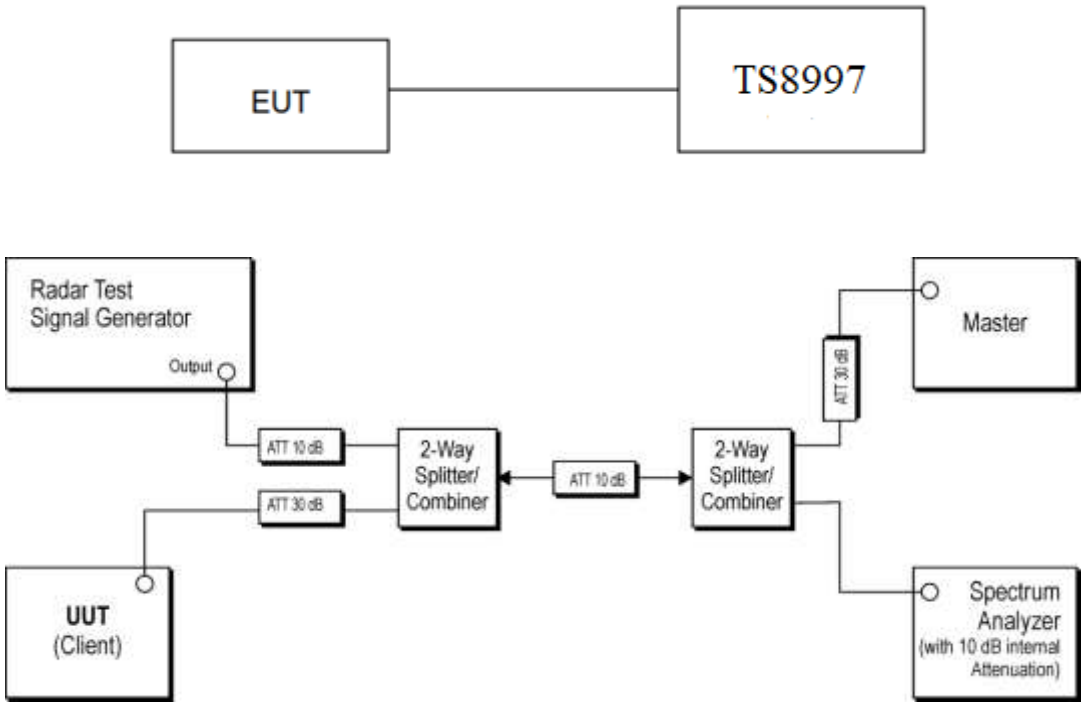
The test set-up was made in accordance to the general provisions of FCC Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017 and KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02

The EUT was tested in the following operating mode:

- Normal mode working as router slave without radar detection.

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it is connected to the TS8997 using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.



The AC supply voltage is applied using an external power supply.

Radar Waveform Calibration Plot

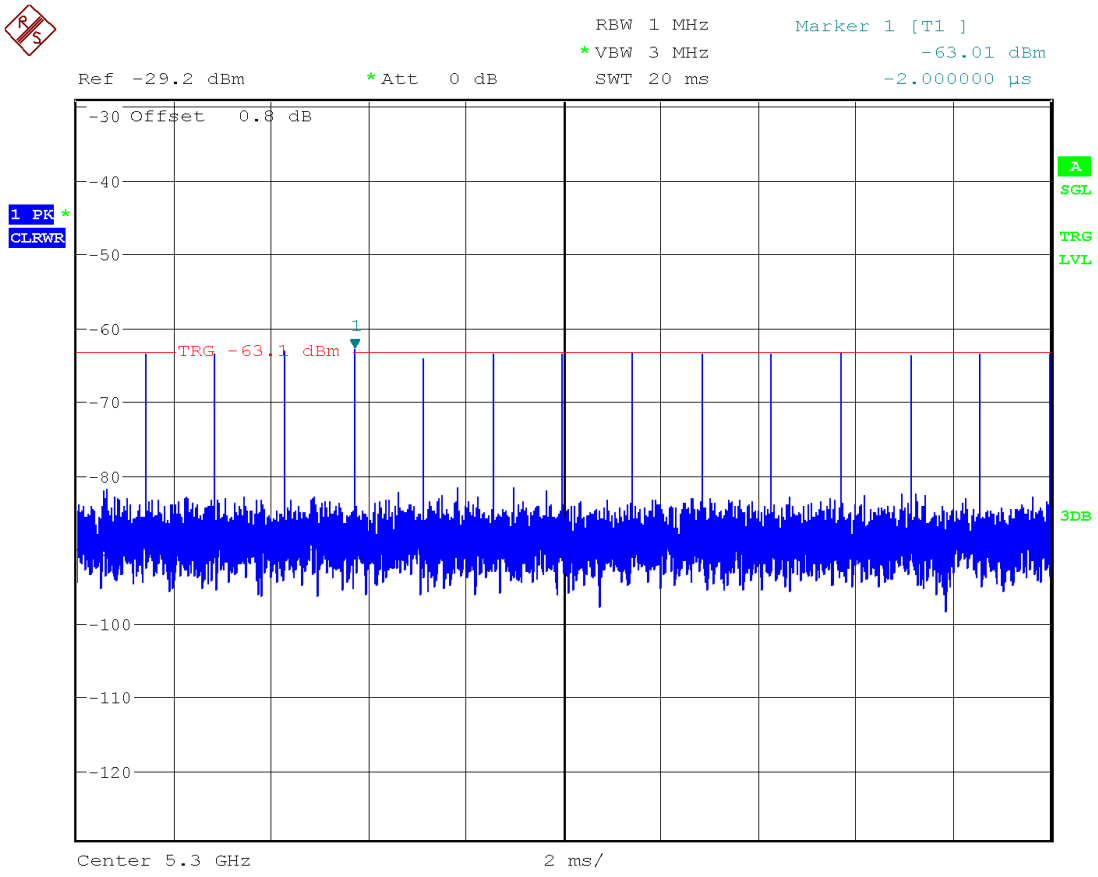
SPECIFICATION

All radar waveforms were verified at the 5300MHz center frequency using conducted method. Wareforms type 0, type 1, type 2, type 3, type 4, type 5 and type 6 were compensated for the cable loss as offset on spectrum analyser.

Radar signals level were calibrated to be less than -63dBm for EUT Detection Threshold.

RESULTS:

Radar Type 0 DFS Detection Threshold



Radar Type 1 DFS Detection Threshold.

Not applicable for only test requested In Service Monitoring.

Radar Type 2 DFS Detection Threshold

Not applicable for only test requested In Service Monitoring.

Radar Type 3 DFS Detection Threshold

Not applicable for only test requested In Service Monitoring.

Radar Type 4 DFS Detection Threshold

Not applicable for only test requested In Service Monitoring.

Radar Type 5 DFS Detection Threshold

Not applicable for only test requested In Service Monitoring.

Radar Type 6 DFS Detection Threshold

Not applicable for only test requested In Service Monitoring.

Verdict: PASS

Channel Loading

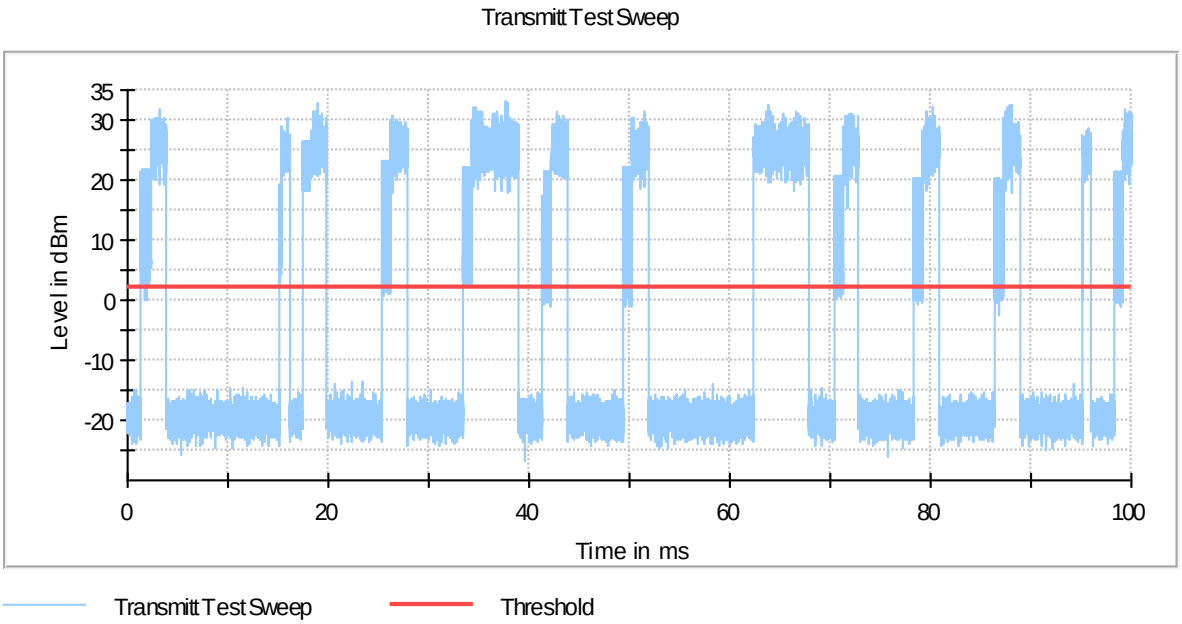
SPECIFICATION

The minimum channel loading requirement is approximately 17% or greater. The operating channel on 5300 MHz was selected for 20 MHz bandwidth.

Channel loading calculation: Time On / (Time On + Off Time)

RESULTS:

Transmitting Test



Tx-Test Tx OnTime (µs)	Tx-Test Tx OnTime Limit	Tx-Test No. of Pulses found
33286.667	>0.000 s	274

Channel loading calculation = (33286.667 us / 100000us) * 100 % = 0.3328 us * 100% = 33.28%

Verdict: PASS

DFS Detection Threshold. RSS-247. 6.3.1/ KDB Sect. 7.8.1

SPECIFICATION

KDB 905462 D02:
Table 3 below provides the DFS Detection Thresholds for Master Devices as well as Client Devices incorporating In-Service Monitoring.

Table 3: DFS Detection Thresholds for Master Devices and Client Devices with Radar Detection

Maximum Transmit Power	Value (See Notes 1, 2, and 3)
EIRP ≥ 200 milliwatt	-64 dBm
EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-64 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. **Note3:** EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.	

RSS-247: Devices shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems. The device must detect radar signals within its entire emission bandwidth. The minimum DFS radar signal detection threshold is described below in Table 1.

Table 1: DFS Detection threshold for master devices and slave devices with radar detection

Devices	DFS Threshold
Devices with an e.i.r.p. < 200 mW AND a Power Spectral Density < 10 dBm/MHz	-62 dBm
Devices with 200 mW ≤ e.i.r.p. ≤ 1 W	-64 dBm
Note: The detection threshold power is the received power, averaged over a 1-microsecond reference to a 0 dBi antenna.	

RESULTS:

The required threshold level is -64 dBm due to EIRP power is greater than 200 mW. It is calculated by adding correction factor. This correction factor includes cable loss and connection loss.

Radar Injection Level = -64.0 dBm + 1dB = -63.0 dBm

Note: The above threshold level was used to verify all Waveforms Type 0 to 6.

Measurement uncertainty: 0.01 %

Verdict: PASS

DFS In Service Monitoring RSS-247. 6.3.2 / KDB Sect. 7.8.3

SPECIFICATION

Channel Closing Transmission Time, Channel Move Time and Non-occupancy period.

One frequency will be chosen from the Operating Channels of the UUT within the 5250-5350 MHz or 5470-5725 MHz bands.

Table 4: DFS Response Requirement Values

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds See Note 1.
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
Note 1: *Channel Move Time* and the *Channel Closing Transmission Time* should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst. **Note 2:** The *Channel Closing Transmission Time* is comprised of 200 milliseconds 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 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.	

RESULTS:

The EUT was used as Client Device and configured to operate at 5300 MHz for 20 MHz bandwidth.

Radar type 0.

Radar Burst with a level equal to the DFS Detection Threshold + 1dB is generated.

Detection Threshold: -63dBm

Operation Mode: data transfer continuously with Iperf UDP protocol.

Channel Move Time

DUT Frequency (MHz)	Radar Type No.	CMT Tx Time (s)	CMT Limit (s)
5300.0000	0	0.000	10.000

Channel Closing Transmission Time

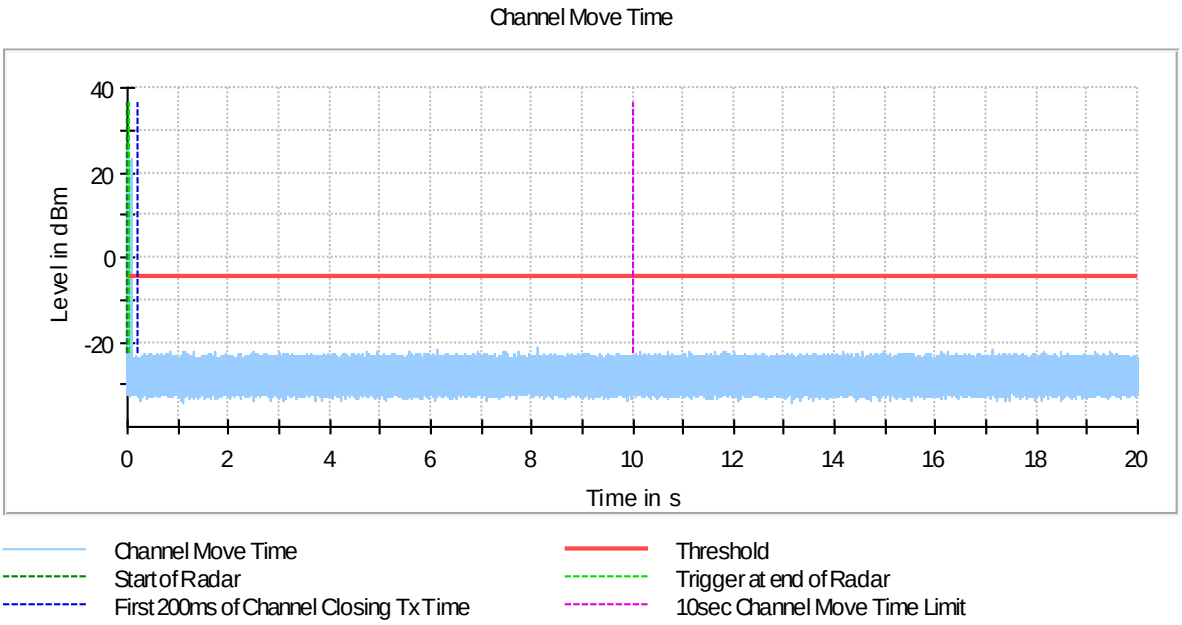
Radar Type No.	CCTT Type of Value	CCTT No. of Pulses found	CCTT Tx Time (ms)	CCTT Tx Time Limit (ms)
0	first 200 ms	134	19.672	200.000
0	remaining 10.0 second(s) period	0	0.000	60.000

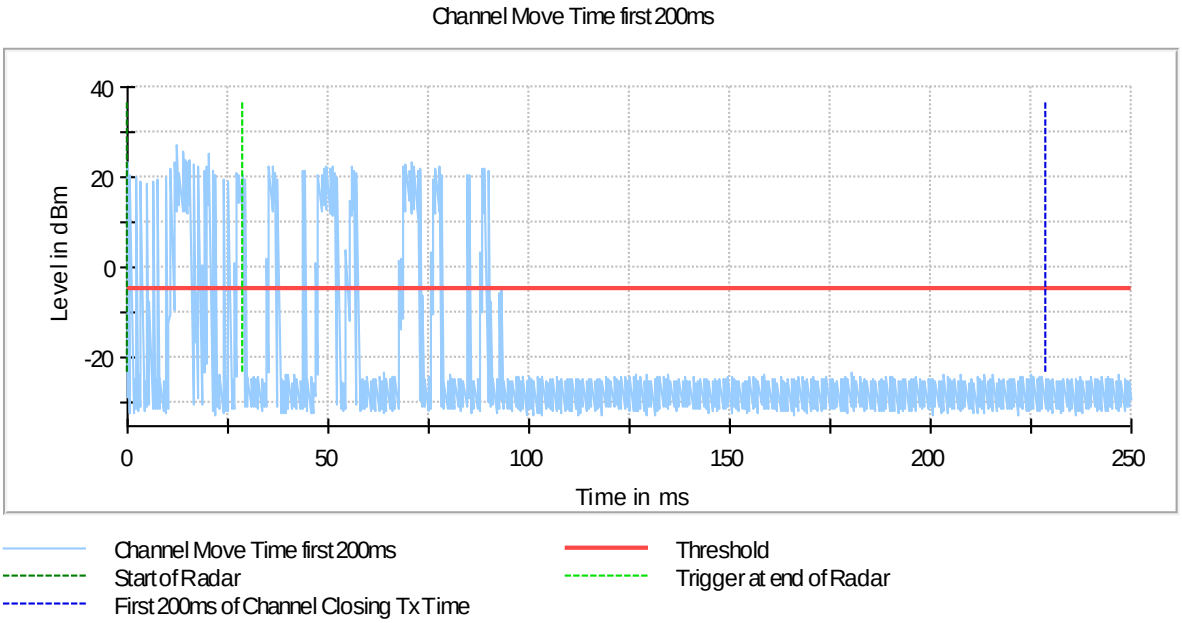
Non-occupancy period

Radar Type No.	NOP No. of Pulses found	NOP No. of Pulses Limit	NOP Tx Time (s)	NOP Tx Time Limit (s)
0	0	0	0.000	0.000

Verdict: PASS

Channel MoveTime:





Non occupancy period: