



REGULATORY COMPLIANCE TEST REPORT

FCC CFR 47 Part 15, Sub-Part 15.407
(Limited to DFS Bands)

Report No.: MIKO93-U2 Rev A

Company: Mikrotiks SIA (MikroTik)

Model Name: RB4011iGS+5HacQ2HnD-IN-US

REGULATORY COMPLIANCE TEST REPORT

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Model Name: RB4011iGS+5HacQ2HnD-IN-US

To: FCC CFR 47 Part 15 Subpart E 15.407 (Limited to DFS Bands)

Test Report Serial No.: MIKO93-U2 Draft

This report supersedes: NONE

Applicant: Mikrotikls SIA (MikroTik)
Brivibas gatve 214i
Riga, LV-1039
Latvia

Issue Date: 8th October 2019

Master Document Number	Addendum Reports
MIKO93-U2	MIKO93-U2_Conducted
	MIKO93-U2_Radiated
	MIKO93-U2_DFS

This Test Report is Issued Under the Authority of:

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MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

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1. ACCREDITATION, LISTINGS & RECOGNITION

1.1. TESTING ACCREDITATION

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard ISO/IEC 17025:2005. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; <http://www.a2la.org/scopepdf/2381-01.pdf>



1.2. RECOGNITION

MiCOM Labs, Inc has widely recognized wireless testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA countries. MiCOM Labs test reports are accepted globally.

Country	Recognition Body	Status	Phase	Identification No.
USA	Federal Communications Commission (FCC)	TCB	-	US0159 Listing #: 102167
Canada	Industry Canada (IC)	FCB	APEC MRA 2	US0159 Listing #: 4143A-2 4143A-3
Japan	MIC (Ministry of Internal Affairs and Communication)	CAB	APEC MRA 2	RCB 210
	VCCI	--	--	A-0012
Europe	European Commission	NB	EU MRA	NB 2280
Australia	Australian Communications and Media Authority (ACMA)	CAB	APEC MRA 1	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)	CAB	APEC MRA 1	
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)	CAB	APEC MRA 1	
Singapore	Infocomm Development Authority (IDA)	CAB	APEC MRA 1	
Taiwan	National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI)	CAB	APEC MRA 1	
Vietnam	Ministry of Communication (MIC)	CAB	APEC MRA 1	

EU MRA – European Union Mutual Recognition Agreement.

NB – Notified Body

APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement. Recognition agreement under which test lab is accredited to regulatory standards of the APEC member countries.

Phase I - recognition for product testing

Phase II – recognition for both product testing and certification

1.3. PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard ISO/IEC 17065:2012. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.02. MiCOM Labs test schedule is available at the following URL; <http://www.a2la.org/scopepdf/2381-02.pdf>



United States of America – Telecommunication Certification Body (TCB)
Industry Canada – Certification Body, CAB Identifier – US0159
Europe – Notified Body (NB), NB Identifier - 2280
Japan – Recognized Certification Body (RCB), RCB Identifier - 210

2. DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft	1 st October 2019	Draft for Comment - this test program adds DFS frequency bands (5250 – 5350 & 5470 – 5725 MHz) for the MikroTik RB4011iGS+5HacQ2HnD-IN-US
Rev A	8 th October 2019	Initial Release

In the above table the latest report revision will replace all earlier versions.

3. TEST RESULT CERTIFICATE

Manufacturer: Mikrotiks SIA (MikroTik) Brivibas gatve 214i Riga LV-1039 Latvia	Tested By: MiCOM Labs, Inc. 575 Boulder Court Pleasanton California 94566 USA
Model: RB4011iGS+5HacQ2HnD-IN-US	Telephone: +1 925 462 0304
Equipment Type: 802.11a/b/g/n/ac WLAN router	Fax: +1 925 462 0306
S/N's: 96890938EC6E/911, A2820977C749/848	
Test Date(s): 27 th August – 1 st October 2019	Website: www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC CFR 47 Part 15 Subpart E 15.407 (Limited to DFS Bands)	EQUIPMENT COMPLIES

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Notes:

1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

Approved & Released for MiCOM Labs, Inc. by:



Graeme Grieve
Quality Manager MiCOM Labs, Inc.

Gordon Hurst
President & CEO MiCOM Labs, Inc.

4. REFERENCES AND MEASUREMENT UNCERTAINTY

4.1. Normative References

REF.	PUBLICATION	YEAR	TITLE
I	KDB 662911 D01 & D02	Oct 31 2013	Guidance for measurement of output emission of devices that employ single transmitter with multiple outputs or systems with multiple transmitters operating simultaneously in the same frequency band
II	KDB 905462 D07 v02	22nd August 2016	Test guidance to demonstrate compliance for U-NII devices subject to DFS requirements.
III	KDB 926956 D01 v02	22nd August 2016	U-NII Device Transition Plan
IV	A2LA	August 2018	R105 - Requirement's When Making Reference to A2LA Accreditation Status
V	ANSI C63.10	2013	American National Standard for Testing Unlicensed Wireless Devices
VI	ANSI C63.4	2014	American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
VII	CISPR 32	2015	Electromagnetic compatibility of multimedia equipment - Emission requirements
VIII	ETSI TR 100 028	2001-12	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
IX	FCC 06-96	Jun 30 2006	Memorandum Opinion and Order
X	FCC 47 CFR Part 15.407	2016	Radio Frequency Devices; Subpart E –Unlicensed National Information Infrastructure Devices
XI	ICES-003	Issue 6 Jan 2016; Updated April 2019	Information Technology Equipment (Including Digital Apparatus) – Limits and methods of measurement.
XII	M 3003	Edition 3 Nov.2012	Expression of Uncertainty and Confidence in Measurements
XIII	RSS-247 Issue 2	Feb 2017	Digital Transmission Systems (DTSS), Frequency Hopping System (FHSs) and Licence-Exempt Local Area Network (LE-LEN) Devices
XIV	RSS-Gen Issue 5	March 2019 Amendment 1	General Requirements for Compliance of Radio Apparatus
XV	FCC 47 CFR Part 2.1033	2016	FCC requirements and rules regarding photographs and test setup diagrams.
XVI	KDB 905462 D02 v02	April 8 2016	Compliance Measurement Procedures for Unlicensed National Information Infrastructure devices operating in the 5250 to 5350 MHz and 5470 to 5725 MHz bands incorporating Dynamic Frequency Selection.
XVII	KDB 789033 D02 V02r01	14th December, 2017	Guidelines For Compliance Testing Of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E

4.2. Test and Uncertainty Procedure

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

5. PRODUCT DETAILS AND TEST CONFIGURATIONS

5.1. Technical Details

Details	Description
Purpose:	Test of the Mikrotikls SIA (MikroTik) RB4011iGS+5HacQ2HnD-IN-US to FCC CFR 47 Part 15 Subpart E 15.407. Compliance Measurement Procedures for Unlicensed National Information Infrastructure devices operating in the 5250 to 5350 MHz and 5470 to 5725 MHz bands incorporating Dynamic Frequency Selection.
Applicant:	Mikrotikls SIA (MikroTik) Brivibas gatve 214i Riga LV-1039 Latvia
Manufacturer:	Mikrotikls SIA (MikroTik)
Laboratory performing the tests:	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California 94566 USA
Test report reference number:	MIKO93-U2
Date EUT received:	18 th July 2019
Standard(s) applied:	FCC CFR 47 Part 15 Subpart E 15.407
Dates of test (from - to):	27 th August – 1 st October 2019
No of Units Tested:	2
Product Family Name:	RouterBoard 4011i
Model(s):	RB4011iGS+5HacQ2HnD-IN-US
Location for use:	Indoors
Declared Frequency Range(s):	5150 - 5250 MHz; 5250 - 5350 MHz; 5470 - 5725 MHz;
Type of Modulation:	OFDM
EUT Modes of Operation:	802.11a; 802.11ac-20/40/80/160; 802.11n-HT-20/n-HT-40;
Declared Nominal Output Power (dBm):	+27
Transmit/Receive Operation:	2
Rated Input Voltage and Current:	+24 Vdc, 2.5 A
Operating Temperature Range:	-30°C to +40°C
ITU Emission Designator:	802.11a: 16M4D1D 802.11ac-80: 75M9D1D 802.11ac-160: 154M8D1D 802.11n HT-20: 17M6D1D 802.11n HT-40: 36M0D1D
Equipment Dimensions:	142 / 30 / 228 mm
Weight:	0.7 Kg
Software Rev:	6.46Beta46

5.2. Scope Of Test Program

Mikrotikls SIA (MikroTik) RB4011iGS+5HacQ2HnD-IN-US

The scope of the test program was to test the Mikrotikls SIA (MikroTik) RB4011iGS+5HacQ2HnD-IN-US, configurations in the frequency ranges 5250 - 5350 MHz; 5470 - 5725 MHz for compliance against the following specification:

FCC CFR 47 Part 15 Subpart E 15.407

Compliance Measurement Procedures for Unlicensed National Information Infrastructure devices operating in the 5250 to 5350 MHz and 5470 to 5725 MHz bands incorporating Dynamic Frequency Selection.

Mikrotikls SIA (MikroTik) RB4011iGS+5HacQ2HnD-IN-US



Top View

5.3. Equipment Model(s) and Serial Number(s)

Type (EUT/Support)	Equipment Description	Manufacturer	Model No.	Serial No.
EUT Radiated	802.11ac Phase 2 WLAN	MikroTikls	RB4011iGS+5HacQ2HnD-IN-US	96890938EC6E/911
EUT Conducted	802.11ac Phase 2 WLAN	MikroTikls	RB4011iGS+5HacQ2HnD-IN-US	A2820977C749/848

5.4. Antenna Details

Type	Manufacturer	Model	Family	Gain (dBi)	BF Gain	Dir BW	X-Pol	Frequency Band (MHz)
external	Mikrotik	RF21C02478A	OMNI	4.0	-	360	-	5250 – 5350 5470 – 5725
external	Mikrotik	RF21C02478A	OMNI	4.0	-	360	-	5250 – 5350 5470 – 5725
external	Mikrotik	RF21C02480A	OMNI	4.0	-	360	-	5250 – 5350 5470 – 5725
external	Mikrotik	RF21C02480A	OMNI	4.0	-	360	-	5250 – 5350 5470 – 5725

BF Gain - Beamforming Gain
Dir BW - Directional BeamWidth
X-Pol - Cross Polarization

5.5. Cabling and I/O Ports

Port Type	Max Cable Length	# of Ports	Screened	Connector Type	Data Type	Data Rate(s)
Ethernet PoE Out	>30m	1	No	RJ45	Packet	10,100,1000
Ethernet PoE IN	>30m	1	No	RJ45	Packet	10,100,1000
Ethernet	>30m	8	No	RJ45	Packet	10,100,1000
Management Port	>30m	1	No	RJ45	Packet	10,100,1000
DC Jack	5m	1	No	DC Jack	None	None
SFP+	>30m	1	No	SFP+	Packet	10,100,1000,10000

5.6. Test Configurations

Results for the following configurations are provided in this report:

Operational Mode(s) (802.11a/b/g/n/ac)	Data Rate with Highest Power MBit/s	Channel Frequency (MHz)		
		Low	Mid	High
5250 - 5350 MHz				
a	6	5,260.00	5,300.00	5,320.00
ac-160	58.6	5,250.00	--	--
ac-80	29.3	--	--	5,290.00
HT-20	6.5	5,260.00	5,300.00	5,320.00
HT-40	13.5	5,270.00	--	5,310.00
5470 - 5725 MHz				
a	6	5,500.00	5,580.00	5,720.00
ac-160	58.6	5,570.00	--	--
ac-80	29.3	5,530.00	5,610.00	5,690.00
HT-20	6.5	5,500.00	5,580.00	5,720.00
HT-40	13.5	5,510.00	5,550.00	5,710.00

5.7. Equipment Modifications

The following modifications were required to bring the equipment into compliance:

1. Software was updated from 6.46Beta35 to 6.46Beta46 to enable ac160 channel 50.

5.8. Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:

1. NONE

6. TEST SUMMARY

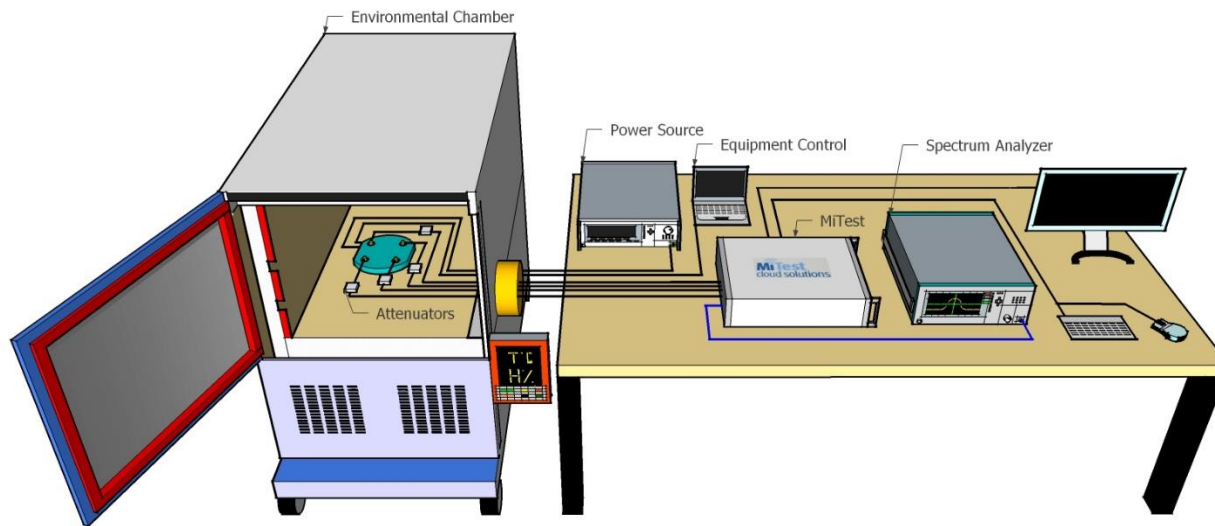
List of Measurements

Test Header	Result	Comments
Peak Transmit Power	Complies	See MiCOM Labs Test Report MIKO93-U2_Conducted
26 dB & 99% Bandwidth	Complies	
6 dB & 99% Bandwidth	Complies	
Power Spectral Density	Complies	
Frequency Stability	Complies	
Dynamic Frequency Selection (DFS)	Complies	See MiCOM Labs Test Report MIKO93-U2_DFS
Channel Availability Check	Complies	
Initial CAC	Complies	
Beginning CAC	Complies	
End CAC	Complies	
Channel Close / Transmission Time	Complies	
Non-Occupancy Period	Complies	
Probability of Detection	Complies	
Detection Bandwidth	Complies	
Radiated	Complies	See MiCOM Labs Test Report MIKO93-U2_Radiated
TX Spurious & Restricted Band Emissions	Complies	
Restricted Edge & Band-Edge Emissions	Complies	
Digital Emissions (0.03 – 1 GHz)	Complies	See Rogers Labs, Inc. Test Report #:180515 Date: 31 st July 2018
AC Wireline	Complies	
RF Unique Connector	Complies	

7. TEST EQUIPMENT CONFIGURATION(S)

7.1. Conducted Test Setup

MiTest Automated Test System



A full system calibration was performed on the test station and any resulting system losses (or gains) were considered in the production of all final measurement data.

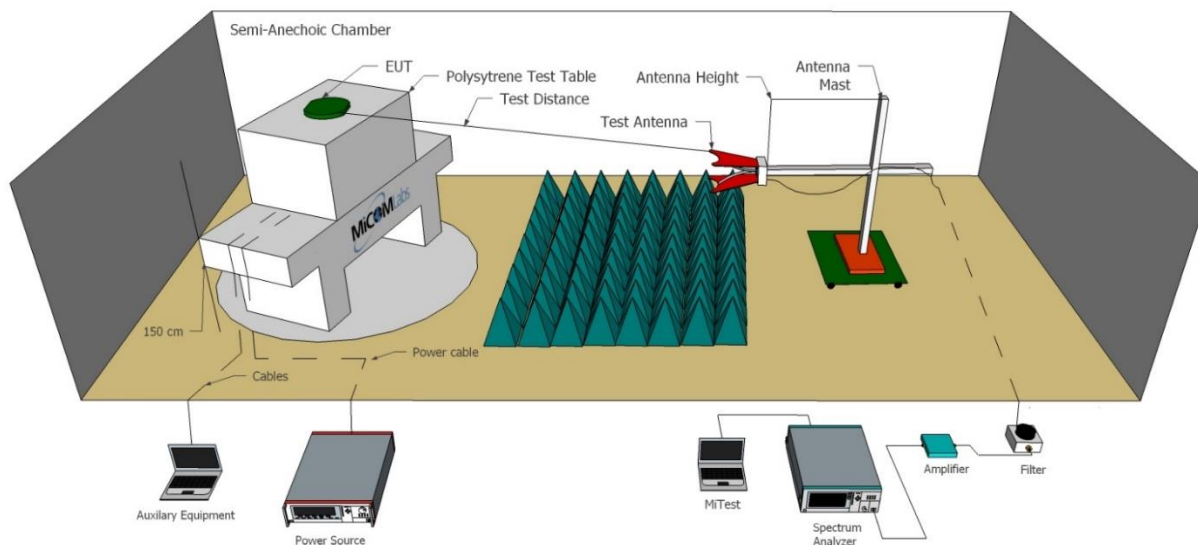
Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
127	Power Supply	HP	6674A	US36370530	Cal when used
248	Resistance Thermometer	Thermotronics	GR2105-02	9340 #1	30 Oct 2020
378	Rohde & Schwarz 40 GHz Receiver with Generator	Rhode & Schwarz	ESIB40	100107/040	12 Oct 2020
398	MiTest RF Conducted Test Software	MiCOM	MiTest ATS	Version 4.1	Not Required
419	Laptop with Labview Software	Lenova	W520	TS02	Not Required
420	USB to GPIB Interface	National Instruments	GPIB-USB HS	1346738	Not Required
445	PoE Injector	D-Link	DPE-101GL	QTAH1E2000625	Not Required
460	Dell Computer with installation of MiTest executable.	Dell	Optiplex330	BC944G1	Not Required
461	Spectrum Analyzer	Agilent	E4440A	MY46185537	20 Oct 2020
493	USB Wideband Power Sensor	Boonton	55006	9634	10 Oct 2020

494	USB Wideband Power Sensor	Boonton	55006	9726	19 Sep 2020
510	Barometer/Thermometer	Control Company	68000-49	170871375	20 Dec 2019
512	MiTest Cloud Solutions RF Test Box	MiCOM	2nd Gen with DFS	512	27 Mar 2020
516	USB Wideband Power Sensor	Boonton	RTP5006	10511	12 Jun 2020
517	USB Wideband Power Sensor	Boonton	RTP5006	10510	12 Jun 2020
74	Environmental Chamber Chamber 3	Tenney	TTC	12808-1	Not Required
RF#2 GPIB#1	GPIB cable to Power Supply	HP	GPIB	None	Not Required
RF#2 SMA#1	EUT to Mitest box port 1	Flexco	SMA Cable port1	None	27 Mar 2020
RF#2 SMA#2	EUT to Mitest box port 2	Flexco	SMA Cable port2	None	27 Mar 2020
RF#2 SMA#3	EUT to Mitest box port 3	Flexco	SMA Cable port3	None	27 Mar 2020
RF#2 SMA#4	EUT to Mitest box port 4	Flexco	SMA Cable port4	None	27 Mar 2020
RF#2 SMA#SA	Mitest box to SA	Flexco	SMA Cable SA	None	27 Mar 2020
RF#2 USB#1	USB Cable to Mitest Box	Dynex	USB Cable	None	Not Required

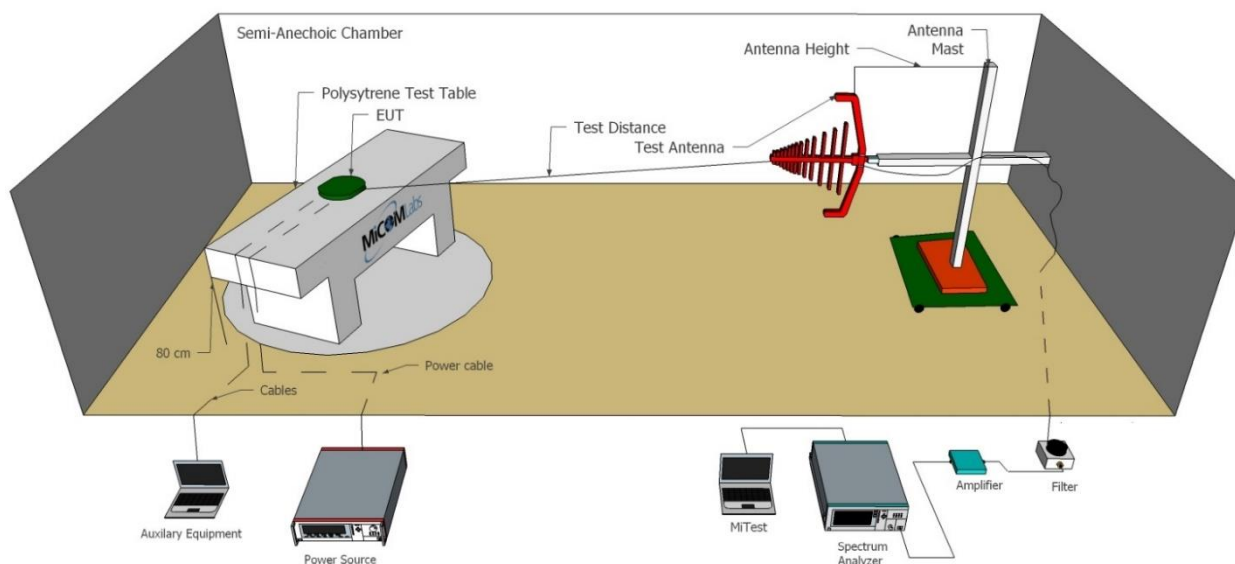
7.2. Radiated Emissions

The following tests were performed using the radiated test set-up shown in the diagram below. Radiated emissions above and below 1GHz.

Radiated Emissions Above 1GHz Test Setup



Radiated Emissions Below 1GHz Test Setup

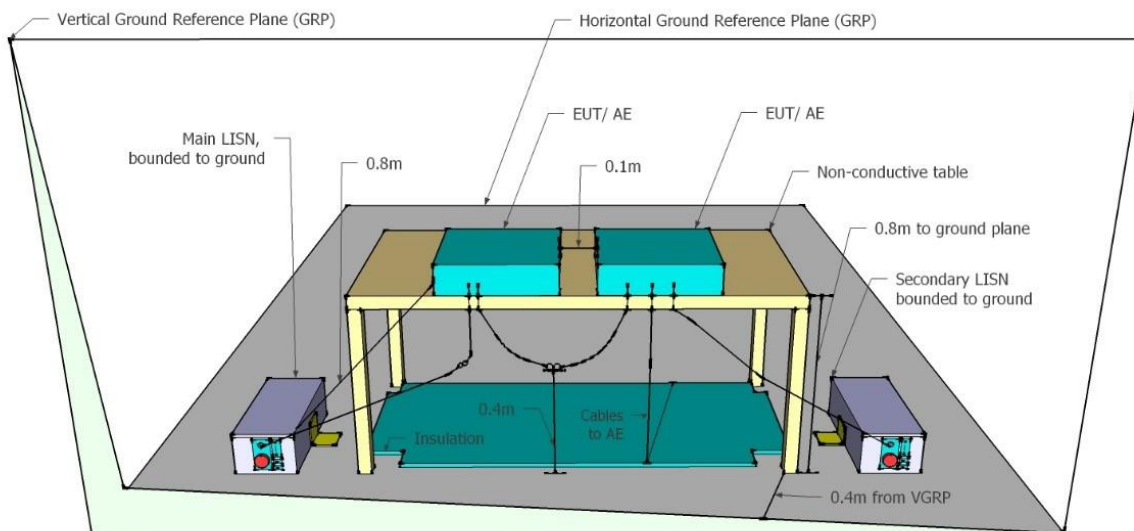


A full system calibration was performed on the test station and any resulting system losses (or gains) were considered in the production of all final measurement data.

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
170	Video System Controller for Semi Anechoic Chamber	Panasonic	WV-CU101	04R08507	Not Required
338	Sunol 30 to 3000 MHz Antenna	Sunol	JB3	A052907	4 Apr 2020
377	Band Rejection Filter 5150 to 5880MHz	Microtronics	BRM50716	034	3 Sep 2020
378	Rohde & Schwarz 40 GHz Receiver with Generator	Rhode & Schwarz	ESIB40	100107/040	12 Oct 2019
396	2.4 GHz Notch Filter	Microtronics	BRM50701	001	3 Mar 2020
397	Amp 10 - 2500MHz	MiCOM Labs	Amp 10 - 2500 MHz	NA	6 Sep 2020
399	ETS 1-18 GHz Horn Antenna	ETS	3117	00154575	12 Oct 2019
406	Amplifier for Radiated Emissions	MiCOM Labs	40dB 1 to 18GHz Amp	0406	9 Sep 2020
410	Desktop Computer	Dell	Inspiron 620	WS38	Not Required
411	Mast/Turntable Controller	Sunol Sciences	SC98V	060199-1D	Not Required
412	USB to GPIB Interface	National Instruments	GPIB-USB HS	11B8DC2	Not Required
413	Mast Controller	Sunol Science	TWR95-4	030801-3	Not Required
414	DC Power Supply 0-60V	HP	6274	1029A01285	Cal when used
415	Turntable Controller	Sunol Sciences	Turntable Controller	None	Not Required
416	Gigabit ethernet filter	ETS-Lingren	Gigafoil 260366	None	Not Required
447	MiTest Rad Emissions Test Software	MiCOM	Rad Emissions Test Software	447	Not Required
462	Schwarzbeck cable from Antenna to Amplifier.	Schwarzbeck	AK 9513	462	5 Sep 2020
463	Schwarzbeck cable from Amplifier to Bulkhead.	Schwarzbeck	AK 9513	463	5 Sep 2020
464	Schwarzbeck cable from Bulkhead to Receiver	Schwarzbeck	AK 9513	464	9 Sep 2020
480	Cable - Bulkhead to Amp	SRC Haverhill	157-3050360	480	9 Sep 2020
481	Cable - Bulkhead to Receiver	SRC Haverhill	151-3050787	481	9 Sep 2020
510	Barometer/Thermometer	Control Company	68000-49	170871375	20 Dec 2019
518	Cable - Amp to Antenna	SRC Haverhill	157-3051574	518	9 Sep 2020
87	Uninterruptible Power Supply	Falcon Electric	ED2000-1/2LC	F3471 02/01	Cal when used

7.3. ac Wireline Emissions

Test Setup – Power Input / Output Port

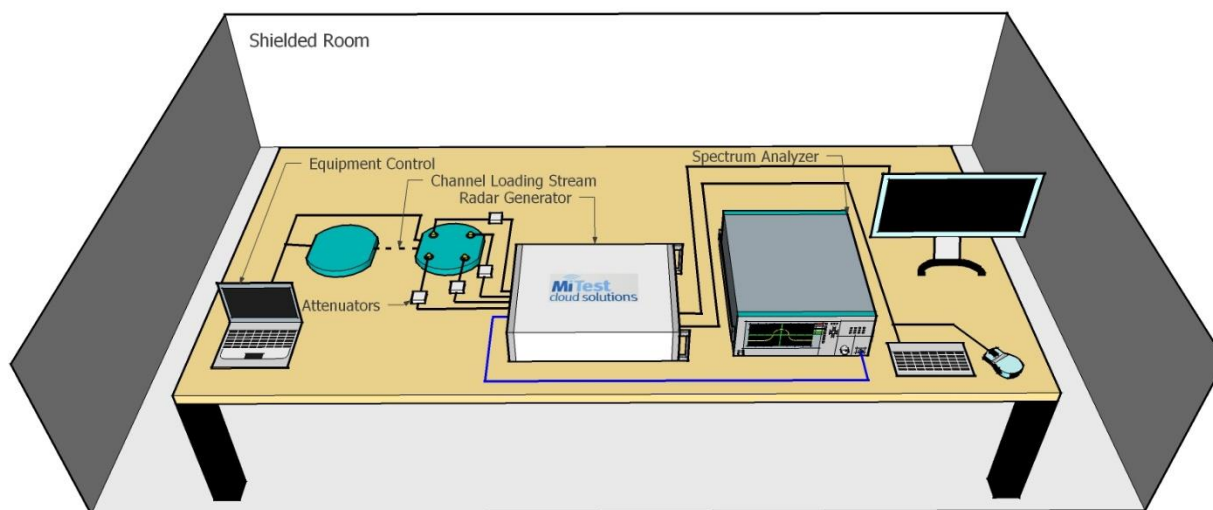


A full system calibration was performed on the test station and any resulting system losses (or gains) were taken into account in the production of all final measurement data.

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
184	Pulse Limiter	Rhode & Schwarz	ESH3Z2	357.8810.52	6 Oct 2019
190	LISN (two-line V-network)	Rhode & Schwarz	ESH3Z5	836679/006	18 Oct 2019
378	Rohde & Schwarz 40 GHz Receiver	Rhode & Schwarz	ESIB40	100107/040	12 Oct 2019
295	Conducted Emissions Chamber Maintenance Check	MiCOM	Conducted Emissions Chamber	295	18 Sep 2019
316	Dell desktop computer workstation	Dell	Desktop	WS04	Not Required
372	AC Variable PS	California Instruments	1251P	L06951	Cal when used
388	LISN (3 Phase) 9kHz - 30MHz	Rohde & Schwarz	ESH2-Z5	892107/022	20 Oct 2019
510	Barometer/Thermometer	Control Company	68000-49	170871375	11 Dec 2019

7.4. Dynamic Frequency Selection (DFS)

Dynamic Frequency Selection (DFS) - Conducted



A full system calibration was performed on the test station and any resulting system losses (or gains) were taken into account in the production of all final measurement data.

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
0507	Power Meter EPM Series	Agilent	E4418B	MY40511221	20 Oct 2019
296	DFS Test Room	MiCOM	DFS Test Room	296	28 Mar 2020
510	Barometer/Thermometer	Control Company	68000-49	170871375	11 Dec 2020
71	Spectrum Analyser 9KHz-50GHz	HP	8565E	3425A00181	6 Aug 2020
512	MiTest DFS Test System	MiCOM Labs Inc.	MiTest	3C:FD:FE:9F:B4:58	15 Jul 2020
DFS SMA#1	SMA Cable for DFS	Megaphase	SMA Cable	None	Cal when used
DFS SMA#2	SMA Cable for DFS	Megaphase	SMA Cable	None	Cal when used
DFS SMA#3	SMA Cable for DFS	Megaphase	SMA Cable	None	Cal when used
DFS SMA#4	SMA Cable for DFS	Megaphase	SMA Cable	None	Cal when used

8. MEASUREMENT AND PRESENTATION OF TEST DATA

The measurement and graphical data presented in this test report was generated automatically using state-of-the-art technology creating an easy to read report structure. Numerical measurement data is separated from supporting graphical data (plots) through hyperlinks. Numerical measurement data can be reviewed without scrolling through numerous graphical pages to arrive at the next data matrix.

Plots have been relegated into the Appendix 'Graphical Data'.

Test and report automation was performed by [MiTest](#). [MiTest](#) is an automated test system developed by MiCOM Labs. [MiTest](#) is the first cloud based modular test system enabling end-to-end automation of regulatory compliance testing for conducted RF testing.



The MiCOM Labs "[MiTest](#)" Automated Test System" (Patent Pending)

9. TEST RESULTS – see Conducted, Radiated & DFS Addendum Files



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