REGULATORY COMPLIANCE TEST REPORT

FCC CFR 47 15.407

Report No.: SONO01-U9_Master Rev A

Company: Sonos, Inc

Test of: S26

REGULATORY COMPLIANCE TEST REPORT

Test of: Sonos, Inc S26

To: FCC CFR 47 Part 15 Subpart E 15.407

Test Report Serial No.: SONO01-U9_Master Rev A

This report supersedes: NONE

Applicant: Sonos, Inc
614 Chapala St.
Santa Barbara, California 93101
USA

Issue Date: 13th April 2020

Generated Reports	Document Number
Master:	☒SONO01-U9_Master
Conducted:	☐ SONO01-U9_Conducted#1_Addendum
	☐ SONO01-U9_Conducted#2_Addendum
Radiated:	☐ SONO01-U9_Radiated_Addendum
DFS:	☐ SONO01-U9_DFS_Addendum

This Test Report is Issued Under the Authority of:

MiCOM Labs, Inc.
575 Boulder Court
Pleasanton California 94566
USA
Phone: +1 (925) 462-0304
Fax: +1 (925) 462-0306
www.micomlabs.com

ACCREDITED
TESTING CERT #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

Table of Contents

MiCOM Labs, 575 Boulder Court, Pleasanton, California 94566 USA, Phone: +1 (925) 462 0304, Fax: +1 (925) 462 0306, www.micomlabs.com

1. ACCREDITATION, LISTINGS & RECOGNITION

1.1. TESTING ACCREDITATION

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard ISO/IEC 17025:2017. 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

ilac-MRA A2LA

Accredited Laboratory

A2LA has accredited

MICOM LABS

Pleasanton, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 24th day of February 2020.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2021

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

1.2. RECOGNITION

MiCOM Labs, Inc has widely recognized wireless testing and certification capabilities. In addition to being recognized for Testing and Certification under Phase 2 agreements with Canada, Europe and Japan, our international recognition includes Conformity Assessment Body designation under Phase 1 agreements with APEC MRA countries. MiCOM Labs test reports are accepted globally.

Country	Recognition Body	Status	MRA Phase	Identification No.
USA	Federal Communications Commission (FCC)	TCB	-	US0159 Test Firm Designation#: US1084
Canada	Industry Canada (ISED)	FCB	APEC MRA 2	US0159 ISED#: 4143A
Japan	MIC (Ministry of Internal Affairs and Communication)	CAB	Japan MRA 2	RCB 210
	Japan Approvals Institute for Telecommunication Equipment (JATE)			
	VCCI	--	--	A-0012
Europe	European Commission	NB	EU MRA 2	NB 2280
Mexico	Instituto Federal de Telecomunicaciones (IFT)	CAB	Mexico MRA 1	US0159
Australia	Australian Communications and Media Authority (ACMA)	CAB	APEC MRA 1	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)			
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)			
Singapore	Infocomm Development Authority (IDA)			
Taiwan	National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI)			
Vietnam	Ministry of Communication (MIC)			

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.
MRA PhasePhase 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

Accredited Product Certification Body

A2LA has accredited

MiCOM LABS

Pleasanton, CA

This product certification body is accredited in accordance with the recognized International Standard ISO/IEC 17065:2012 *Requirements for bodies certifying products, processes and services*. This product certification body also meets the *A2LA R322 – Specific Requirements – Notified Body Accreditation Requirements* and *A2LA R308 - Specific Requirements - ISO-IEC 17065 - Telecommunication Certification Body Accreditation Program*. This accreditation demonstrates technical competence for a defined scope and the operation of a management system.

Presented this 24th day of February 2020

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2381.02
Valid to November 30, 2021

For the product certification schemes to which this accreditation applies, please refer to the organization's Product Certification Scope of Accreditation.

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	1st April 2020	Draft report for client review.
Rev A	13th April 2020	Initial Release

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

MiCOM Labs, 575 Boulder Court, Pleasanton, California 94566 USA, Phone: +1 (925) 462 0304, Fax: +1 (925) 462 0306, www.micomlabs.com

3. TEST RESULT CERTIFICATE

Manufacturer:	Sonos, Inc 614 Chapala St. Santa Barbara California 93101 USA	**Tested By:**	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California 94566 USA
Model:	S26	**Telephone:**	+1 925 462 0304
		Fax:	+1 925 462 0306
Equipment Type:	Home Audio Equipment		
S/N's:	Conducted #1 Radiated 54-2A-1B-20-02-04-E DFS Test		
Test Date(s):	24TH – 26TH March 2020	**Website:**	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC CFR 47 Part 15 Subpart E 15.407	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.

ACCREDITED
TESTING CERT #2381.01

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	October 2019	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	2020	Radio Frequency Devices; Subpart E –Unlicensed National Information Infrastructure Devices General Technical Requirements
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-Gen Issue 5	March 2019 Amendment 1	General Requirements for Compliance of Radio Apparatus
XIV	FCC 47 CFR Part 2.1033	2020	FCC requirements and rules regarding photographs and test setup diagrams.
XV	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.
XVI	KDB 789033 D02 V02r01	14th December, 2017	Guidelines For Compliance Testing Of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E
XVII	RSS-247 Issue 2	Feb 2017	Digital Transmission Systems (DTSs), Frequency Hopping System (FHSs) and Licence-Exempt Local Area Network (LE-LEN) Devices

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.

MiCOM Labs, 575 Boulder Court, Pleasanton, California 94566 USA, Phone: +1 (925) 462 0304, Fax: +1 (925) 462 0306, www.micomlabs.com

5. PRODUCT DETAILS AND TEST CONFIGURATIONS

5.1. Technical Details

Details	Description
Purpose:	Test of the Sonos, Inc S26 to **FCC CFR 47 Part 15 Subpart E 15.407,** Unlicensed National Information Infrastructure Devices General Technical Requirements.
Applicant:	Sonos, Inc 614 Chapala St. Santa Barbara California 93101 USA
Manufacturer:	Sonos, Inc
Laboratory performing the tests:	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California 94566 USA
Test report reference number:	SONO01-U9
Date EUT received:	20th March 2020
Standard(s) applied:	FCC CFR 47 Part 15 Subpart E 15.407
Dates of test (from - to):	24th – 26th March 2020
No of Units Tested:	3 (1 x conducted, 1 x radiated, 1 x DFS)
Product Family Name:	N/A
Model(s):	S26
Location for use:	Indoors
Declared Frequency Range(s):	5150 -5250 MHz; 5250 -5350 MHz; 5470 -5725 MHz; 5725 -5850 MHz
Type of Modulation:	OFDM
EUT Modes of Operation:	802.11a / nHT-20
Declared Nominal Output Power (dBm):	5150 - 5250 MHz: 23 dBm 5250 - 5350 MHz: 23 dBm 5470 - 5725 MHz: 23 dBm 5725 - 5850 MHz: 24 dBm
Number of antennas:	4
Transmit/Receive Operation:	4x4 transmit and receive antenna chains
Rated Input Voltage and Current:	115 Vac, 60 Hz, 2A
Operating Temperature Range:	0° to 40° C
ITU Emission Designator:	802.11a 18M4D1D 802.11n HT-20 19M0D1D
Hardware Rev:	A100
Software Rev:	59.0-75030-1-32

5.2. Scope Of Test Program

Sonos, Inc S26

The scope of the test program was to test the Sonos, Inc. S26 802.11a/n configurations in the frequency ranges 5150 - 5250 MHz; 5250 - 5350 MHz; 5470 - 5725 MHz and 5725 - 5850 MHz; for compliance against the following specifications:

FCC CFR 47 Part 15 Subpart E 15.407
Radio Frequency Devices; Subpart E –Unlicensed National Information Infrastructure Devices
General Technical Requirements

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

Type (EUT/ Support)	Equipment Description	Mfr	Model No.	Serial/Marking No.
EUT	Home Audio Equipment	SONOS Inc.	S26	54-2A-1B-20-02-04-E
EUT	Home Audio Equipment	SONOS Inc.	S26	Conducted #1
EUT	Home Audio Equipment	SONOS Inc.	S26	DFS Test
Support	Laptop	Lenovo	X230	SON-00002271

5.4. Antenna Details

Type	Manufacturer	Model	Family	Gain (dBi)	BF Gain	Dir BW	X-Pol	Frequency Band (MHz)
integral	SAA	Chain0	PCB	2.1	-	360	-	5150 - 5250
integral	SAA	Chain0	PCB	1.1	-	360	-	5250 - 5350
integral	SAA	Chain0	PCB	0.5	-	360	-	5470 - 5725
integral	SAA	Chain0	PCB	0.2	-	360	-	5725 - 5850
integral	SAA	Chain1	PCB	2.8	-	360	Yes	5150 - 5250
integral	SAA	Chain1	PCB	3.6	-	360	Yes	5250 - 5350
integral	SAA	Chain1	PCB	2.4	-	360	Yes	5470 - 5725
integral	SAA	Chain1	PCB	0.6	-	360	Yes	5725 - 5850
integral	SAA	Chain2	PCB	0.7	-	360	-	5150 - 5250
integral	SAA	Chain2	PCB	2.7	-	360	-	5250 - 5350
integral	SAA	Chain2	PCB	1.3	-	360	-	5470 - 5725
integral	SAA	Chain2	PCB	1.8	-	360	-	5725 - 5850
integral	SAA	Chain3	PCB	1.7	-	360	-	5150 - 5250
integral	SAA	Chain3	PCB	1.7	-	360	-	5250 - 5350
integral	SAA	Chain3	PCB	1.3	-	360	-	5470 - 5725
integral	SAA	Chain3	PCB	1.3	-	360	-	5725 - 5850

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

NOTE: Chain 1 antenna is cross-polarized

5.5. Cabling and I/O Ports

Port Type	Max Cable Length	# of Ports	Screened	Conn Type	Data Type	Bit Rate
Ethernet	10-30m	1	n/a	RJ45	Packet Data	10/100/1000
AC Input	< 3M	1	Y	AC Jack	Analog	n/a

5.6. Test Configurations

Results for the following configurations are provided in this report:

Operational Mode(s) (802.11a/n)	Data Rate with Highest Power MBit/s	Channel Frequency (MHz)		
		Low	Mid	High
5150 - 5250 MHz				
a	6	5,180.00	5,200.00	5,240.00
HT-20	6.5	5,180.00	5,200.00	5,240.00
5250 - 5350 MHz				
a	6	5,260.00	5,300.00	5,320.00
HT-20	6.5	5,260.00	5,300.00	5,320.00
5470 - 5725 MHz				
a	6	5,500.00	5,580.00	5,700.00
HT-20	6.5	5,500.00	5,580.00	5,700.00
5725 - 5850 MHz				
a	6	5,745.00	5,785.00	5,825.00
HT-20	6.5	5,745.00	5,785.00	5,825.00

5.7. Equipment Modifications

The following modifications were required to bring the equipment into compliance:
1. NONE

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	Data Link
Maximum Conducted Output Power	Complies	-
26 dB & 99% Bandwidth	Complies	-
6 dB & 99% Bandwidth (Limited to 5.725 – 5.850 GHz Frequency Band)	Complies	-
Power Spectral Density	Complies	-
Frequency Stability	*Complies	-
Emissions	Complies	-
Radiated	Complies	-
TX Spurious & Restricted Band Emissions	Complies	-
Integral Antenna SAA Calculated	Complies	-
Restricted Edge & Band-Edge Emissions	Complies	-
Integral Antenna SAA Calculated	Complies	-
Digital Emissions	Complies	See Test Report SONO01-U2
AC Wireline	Complies	See Test Report SONO01-U2
Dynamic Frequency Selection (DFS)	Complies	-
Channel Close/Channel Shutdown	Complies	-
Non-Occupancy Period	Complies	-

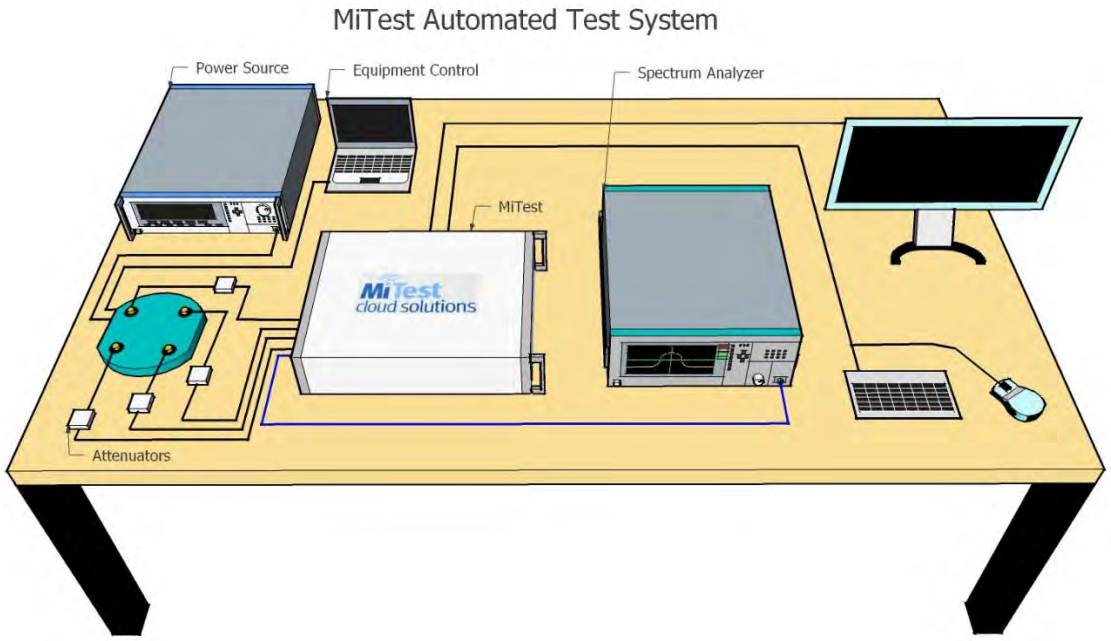
*Frequency Stability – Manufacturer Declaration

NOTE: In this report antenna chains are reported as chains ‘a’ through ‘d’. This is equivalent to CH0-CH3 on all Sonos documentation.

7. TEST EQUIPMENT CONFIGURATION(S)

7.1. Conducted

Conducted RF Emission Test Set-up(s) The following tests were performed using the conducted test set-up shown in the diagram below.

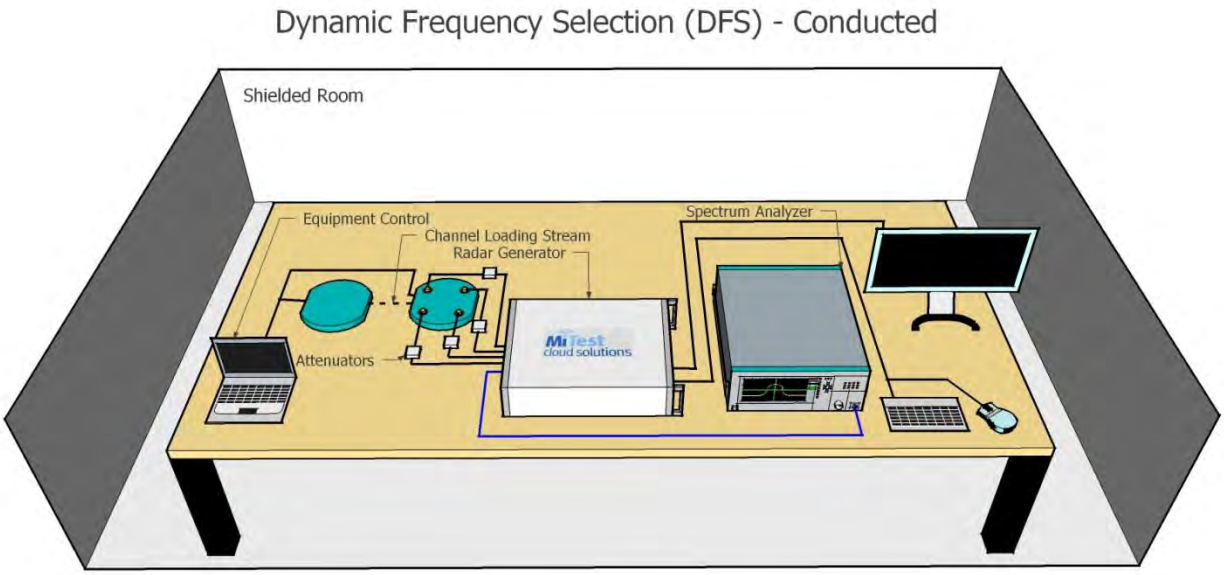


A full system calibration was performed on the test station and any resulting system losses (or gains) were accounted for in the production of all final measurement data.

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
398	MiTest RF Conducted Test Software	MiCOM	MiTest ATS	Version 4.1	Not Required
420	USB to GPIB Interface	National Instruments	GPIB-USB HS	1346738	Not Required
461	Spectrum Analyzer	Agilent	E4440A	MY46185537	20 Sep 2020
441	USB Wideband Power Sensor	Boonton	55006	9179	19 Sep 2020
510	Barometer/Thermometer	Control Company	68000-49	170871375	20 Dec 2020
512	MiTest Cloud Solutions RF Test Box	MiCOM	2nd Gen with DFS	512	27 Sep 2020
516	USB Wideband Power Sensor	Boonton	RTP5006	10511	12 Jun 2020

517	USB Wideband Power Sensor	Boonton	RTP5006	10510	12 Jun 2020
436	USB Wideband Power Sensor	Boonton	55006	8731	19 Sep 2020
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 Sep 2020
RF#2 SMA#2	EUT to Mitest box port 2	Flexco	SMA Cable port2	None	27 Sep 2020
RF#2 SMA#3	EUT to Mitest box port 3	Flexco	SMA Cable port3	None	27 Sep 2020
RF#2 SMA#4	EUT to Mitest box port 4	Flexco	SMA Cable port4	None	27 Sep 2020
RF#2 SMA#SA	Mitest box to SA	Flexco	SMA Cable SA	None	27 Sep 2020
RF#2 USB#1	USB Cable to Mitest Box	Dynex	USB Cable	None	Not Required

7.2. DFS - Conducted



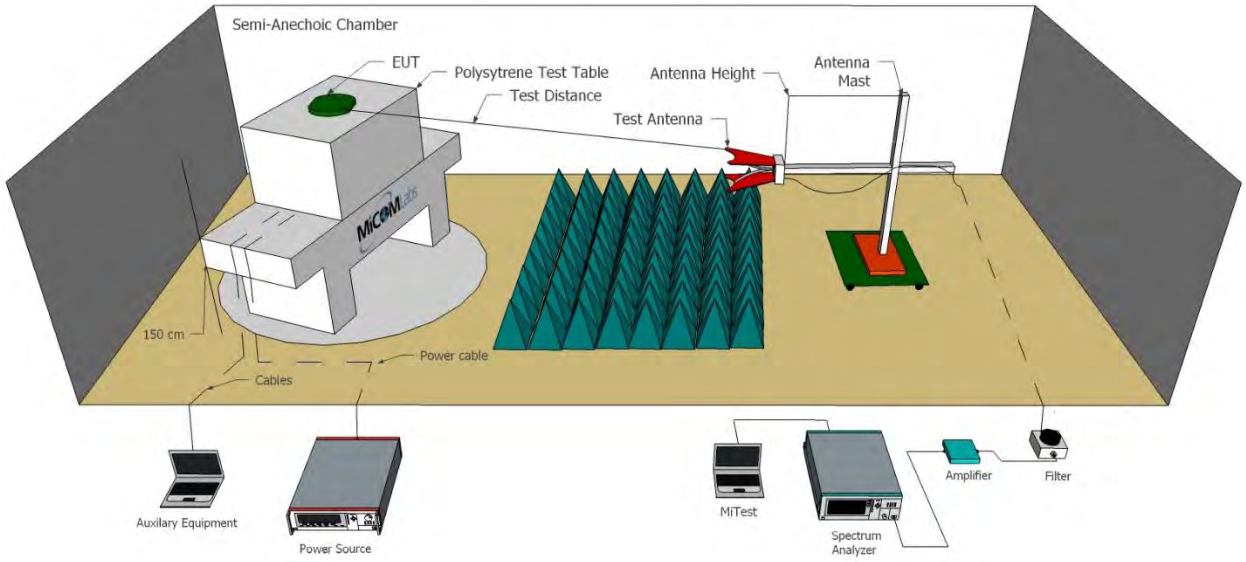
A full system calibration was performed on the test station and any resulting system losses (or gains) were taken into account in the production of all final measurement data.

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
296	DFS Test Room	MiCOM	DFS Test Room	296	6 Jun 2020
504	MiTest Cloud Solutions RF Test Box	MiCOM	2nd Gen	504	5 Sep 2020
510	Barometer/Thermometer	Control Company	68000-49	170871375	20 Dec 2020
533	MiTest DFS Test Software	MiCOM	MiTest DFS Test software Version 2.8	533	Not Required
71	Spectrum Analyser 9KHz-50GHz	HP	8565E	3425A00181	Not Required
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

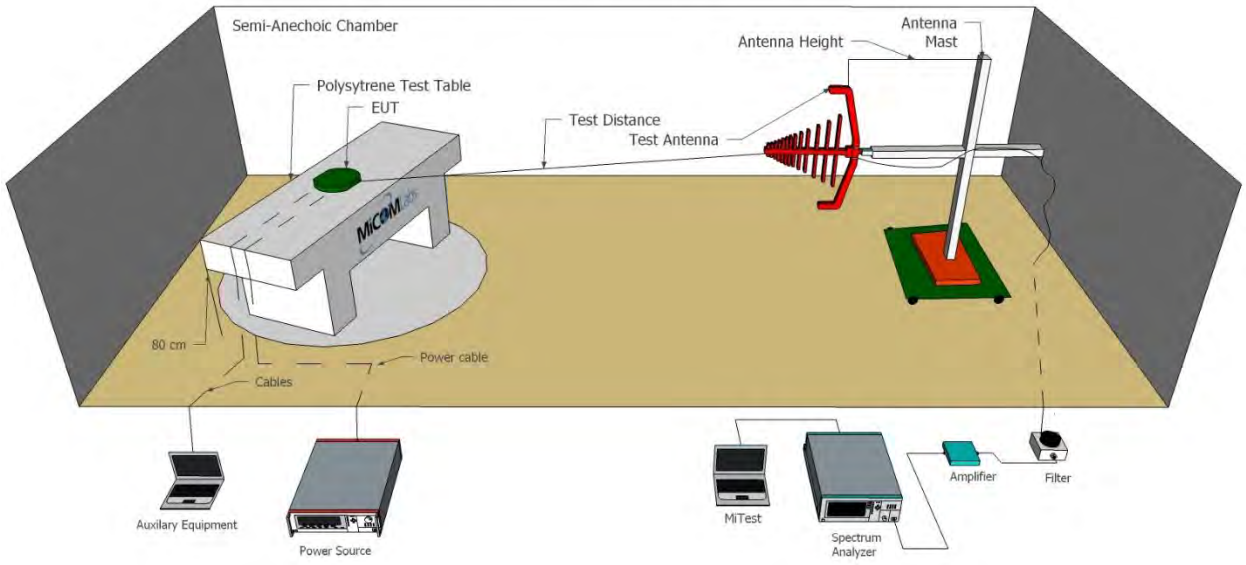
7.3. Radiated Emissions - 3m Chamber

The following tests were performed using the radiated test set-up shown in the diagram below. Radiated emissions below 1GHz radiated emissions above 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 taken into account 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
298	3M Radiated Emissions Chamber Maintenance Check	MiCOM	3M Chamber	298	26 Nov 2020
378	Rohde & Schwarz 40 GHz Receiver with Generator	Rhode & Schwarz	ESIB40	100107/040	12 Oct 2020
396	2.4 GHz Notch Filter	Microtronics	BRM50701	001	3 Sep 2020
399	ETS 1-18 GHz Horn Antenna	ETS	3117	00154575	12 Oct 2020
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
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 Version 1.0	447	Not Required
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 2020
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
CC05	Confidence Check	MiCOM	CC05	None	4 Oct 2020

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)

575 Boulder Court
Pleasanton, California 94566, USA
Tel: +1 (925) 462 0304
Fax: +1 (925) 462 0306
www.micomlabs.com