



Canada

# RF Test Report

As per

## RSS-247 Issue 2:2017 & FCC Part 15 Subpart 15.247

Unlicensed Intentional Radiators  
FHSS System  
on the

### EBERS42 Remote Sensor

Issued by: **TÜV SÜD Canada Inc.**  
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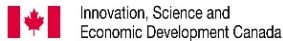
Testing produced for

ecobee

Prepared by:  
Amir Emami,  
Project Engineer

See Appendix A for full client &  
EUT details.

Reviewed by:  
Min Xie,  
Sr. Project Engineer



Registration #  
6844A-3




Testing Laboratory  
Certificate #2955.02



R-14023, G-20072  
C-14498, T-20060




Registration #  
CA6844

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

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Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Report Scope

This report addresses the EMC verification testing and test results of the **Remote Sensor**, Model: **EBERS42**, and is herein referred to as EUT (Equipment Under Test). The EUT was tested for compliance against the following standards:


RSS-247 Issue 2:2017

FCC Part 15 Subpart C 15.247

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

This report does not imply product endorsement by any government, accreditation agency, or TÜV SÜD Canada Inc.

Opinions or interpretations expressed in this report, if any, are outside the scope of TÜV SÜD Canada Inc. accreditations. Any opinions expressed do not necessarily reflect the opinions of TÜV SÜD Canada Inc., unless otherwise stated.


Client	<b>Ecobee Inc.</b>	
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Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Summary

The results contained in this report relate only to the item(s) tested.

EUT:	EBERS42 Remote Sensor
FCC Certification #, FCC ID:	WR91881541520
ISED Certification #, IC:	7981A-1881541520
EUT passed all tests performed	Yes
Tests conducted by	Amir Emami
Report reviewed by	Min Xie


For testing dates, see "Testing Environmental Conditions and Dates".

Client	<b>Ecobee Inc.</b>	
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Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203	Antenna Requirement	Unique	Pass See Justification
FCC 15.205 RSS-GEN (Table 6)	Restricted Bands for Intentional Operation	QuasiPeak Average	Pass
FCC 15.207 RSS-GEN (Table 3)	Power Line Conducted Emissions	QuasiPeak Average	N/A
FCC 15.209 RSS-GEN (Table 4)	Spurious Radiated Emissions	QuasiPeak Average	Pass
FCC 15.247(a)(1) RSS 247 5.1	Carrier Frequency Separation	> 25 kHz or 20 dB BW	Pass
FCC 15.247(a)(1)(i) RSS 247 5.1	Number of Hopping Frequencies	> 50	Pass
FCC 15.247(a)(1)(i) RSS 247 5.1 (3)	Time of Occupancy (FHSS)	< 0.4s in 20s period	Pass
FCC 15.247(b)(2) RSS-247 5.4(d)	Max Output Power (FHSS)	< 1 Watt	Pass
FCC 15.247(b)(4) RSS-247 5.4(d)	Antenna Gain	< 6 dBi	Pass See Justifications
FCC 15.247(d) RSS-247 5.5	Antenna Conducted Spurious (Hybrid)	< 30 dBc	Pass
FCC 15.247(f) RSS-247 5.3(a)	Time of Occupancy (Hybrid)	< 0.4sec	Pass
FCC 15.247(f) RSS-247 5.3(b)	Power Spectral Density (Hybrid)	< 8 dBm (3 kHz BW)	Pass
<b>Overall Result</b>			<b>Pass</b>

If the product as tested or otherwise complies with the specification, the EUT is deemed to comply with the requirement and is deemed a 'PASS' grade. If not 'FAIL' grade will be issued. Note that 'PASS' / 'FAIL' grade is independent of any measurement uncertainties. A 'PASS' / 'FAIL' grade within measurement uncertainty is marked with a '\*'.

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

### **Notes, Justifications, or Deviations**

The following notes, justifications for tests not performed or deviations from the above listed specifications apply:

For the Antenna requirement specified in FCC 15.203 (RSS-247 section 5.4(d)), the unit uses a permanently attached custom flexible antenna with 1.5dBi gain which is less than the 6 dBi gain limit.

For the Restricted Bands of operation, the EUT is designed to only operate between 920.00 – 927.35MHz.

For maximum permissible exposure, this device is designed to operate greater than 20 cm from any personnel during normal operation. No testing is required, however worst-case calculated exposure compliance was shown in the RF Exposure exhibits.

The Hybrid and FHSS have the same power setting.

### **Sample Calculation(s)**

#### **Radiated Emission Test**

E-Field Level = Received Signal + Antenna Factor + Cable Loss – Pre-Amp Gain


E-Field Level = 50dB $\mu$ V + 10dB/m + 2dB – 20dB

E-Field Level = 42dB $\mu$ V/m

Margin = Limit – E-Field Level


Margin = 50dB $\mu$ V/m – 42dB $\mu$ V/m

Margin = 8.0 dB (pass)

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Applicable Standards, Specifications and Methods


- ANSI C63.4:2014 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
- ANSI C63.10:2013 American National Standard For Testing Unlicensed Wireless Devices
- CFR 47 FCC 15 Subpart C Code of Federal Regulations – Radio Frequency Devices, Intentional Radiators
- FCC KDB 558074: 2019 FCC KDB 558074 Digital Transmission Systems, measurements and procedures
- FCC KDB 447498: 2015 RF exposure procedures and equipment authorization policies for mobile and portable devices
- ICES-003 Issue 7: 2020 Digital Apparatus - Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard
- RSS-GEN Issue 5: 2018+A1:2019+A2:2021 General Requirements and Information for the Certification of Radio Apparatus
- RSS-247 Issue 2: 2017 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
- ISO 17025:2017 General Requirements for the Competence of Testing and Calibration Laboratories

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Document Revision Status

Revision	Date	Description	Initials
000	February 28, 2022	Initial Release	AE
-	-	-	-



Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Definitions and Acronyms

The following definitions and acronyms are applicable in this report.  
See also ANSI C63.14.

**DTS** – Digital Transmission System  
**LISN** – Line Impedance Stabilization Network  
**NCR** – No Calibration Required  
**NSA** – Normalized Site Attenuation  
**N/A** – Not Applicable  
**RF** – Radio Frequency

**AE** – Auxiliary Equipment. A digital accessory that feeds data into or receives data from another device (host) that in turn, controls its operation.

**Antenna Port** – Port, other than a broadcast receiver tuner port, for connection of an antenna used for intentional transmission and/or reception of radiated RF energy.


**BW** – Bandwidth. Unless otherwise stated, this refers to the 6 dB bandwidth.

**EMC** – Electro-Magnetic Compatibility. The ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

**EMI** – Electro-Magnetic Immunity. The ability to maintain a specified performance when the equipment is subjected to disturbance (unwanted) signals of specified levels.

**EUT** – Equipment Under Test. A device or system being evaluated for compliance that is representative of a product to be marketed.

**ITE** – Information Technology Equipment. Has a primary function of entry, storage, display, retrieval, transmission, processing, switching, or control of data and/or telecommunication messages and which may be equipped with one or more ports typically for information transfer.


Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
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## Testing Facility

Testing for EMC on the EUT was carried out at TÜV SÜD Canada testing lab near Toronto, Ontario. The testing lab has calibrated 3m semi-anechoic chambers which allow measurements on a EUT that has a maximum width or length of up to 2m and a height of up to 3m. The testing lab also has a calibrated 10m Open Area Test Site (OATS). The chambers are equipped with a turntable that is capable of testing devices up to 5000lb in weight and are equipped with a mast that controls the polarization and height of the antenna. Control of the mast occurs in the control room adjoining the shielded chamber. This facility is capable of testing products that are rated for single phase or 3-phase AC input and DC capability is also available. Radiated emission measurements are performed using a BiLog antenna and a Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN and using the vertical ground plane if applicable.

### **Calibrations and Accreditations**


The 3m semi-anechoic chamber is registered with Federal Communications Commission (FCC, CA6844), Innovation, Science and Economic Development Canada (ISED, 6844A-3) and Voluntary Control Council for Interference (VCCI, R-14023, G-20072, C-14498, and T-20060). This chamber was calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. The NSA data is kept on file at TÜV SÜD Canada. For radiated susceptibility testing, a 16 point field calibration has been performed on the chamber. The field uniformity data is kept on file at TÜV SÜD Canada. TÜV SÜD Canada Inc. is accredited to ISO 17025 by A2LA with Testing Certificate #2955.02. The laboratory's current scope of accreditation listing can be found as listed on the A2LA website. All measuring equipment is calibrated on an annual or biennial basis as listed for each respective test.

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
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### ***Testing Environmental Conditions and Dates***

Following environmental conditions were recorded in the facility during time of testing

<b>Date</b>	<b>Test</b>	<b>Initials</b>	<b>Temperature (°C)</b>	<b>Humidity (%)</b>	<b>Pressure (kPa)</b>
November 25, 2021	Radiated Emissions	AE	22.3	31.1	101.1
November 25 to 30, 2021	Antenna Conducted Emissions	AE	21 – 23	22 – 31	100.5 – 101.5

Client	<b>Ecobee Inc.</b>	
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Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

**Detailed Test Results Section**

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Emission Bandwidth

### Purpose

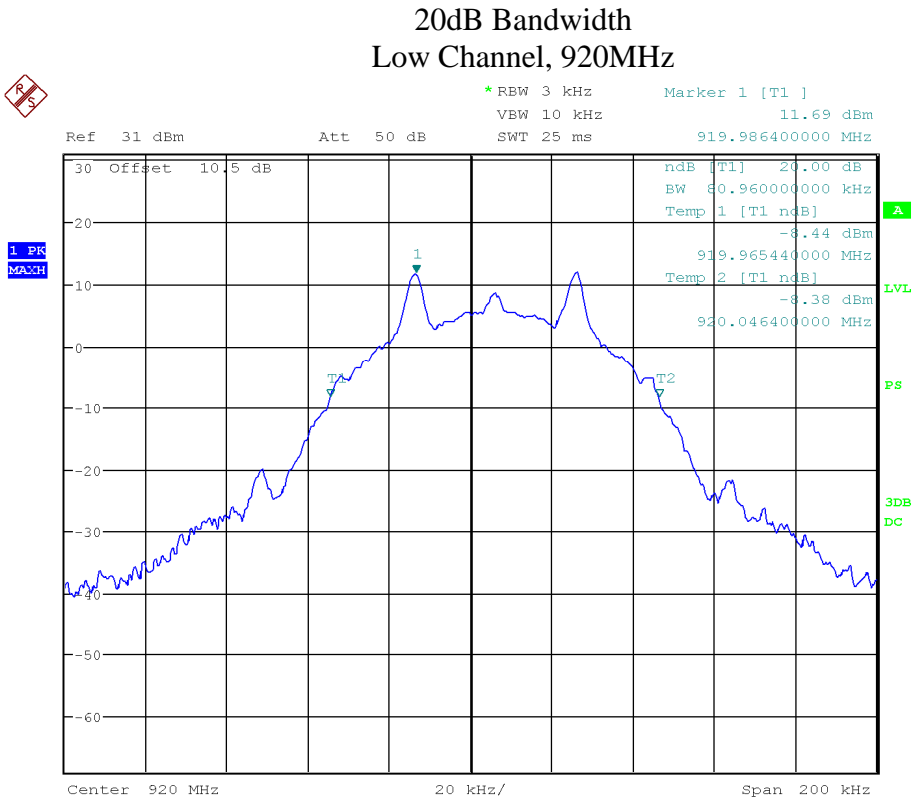
The purpose of this test is to ensure that the upper and lower frequency limits of the transmitter 99% emission power bandwidth remain within the operating frequency limits at all times.

### Limits and Method


The method is given in ANSI C63.10 Section 6.9.3 and RSS-GEN 6.7.

The 99% bandwidth shall remain within the operating frequency band at all times. This should be measured with a RBW in the range of 1% to 5% of the occupied bandwidth and a VBW of approximately three times RBW.

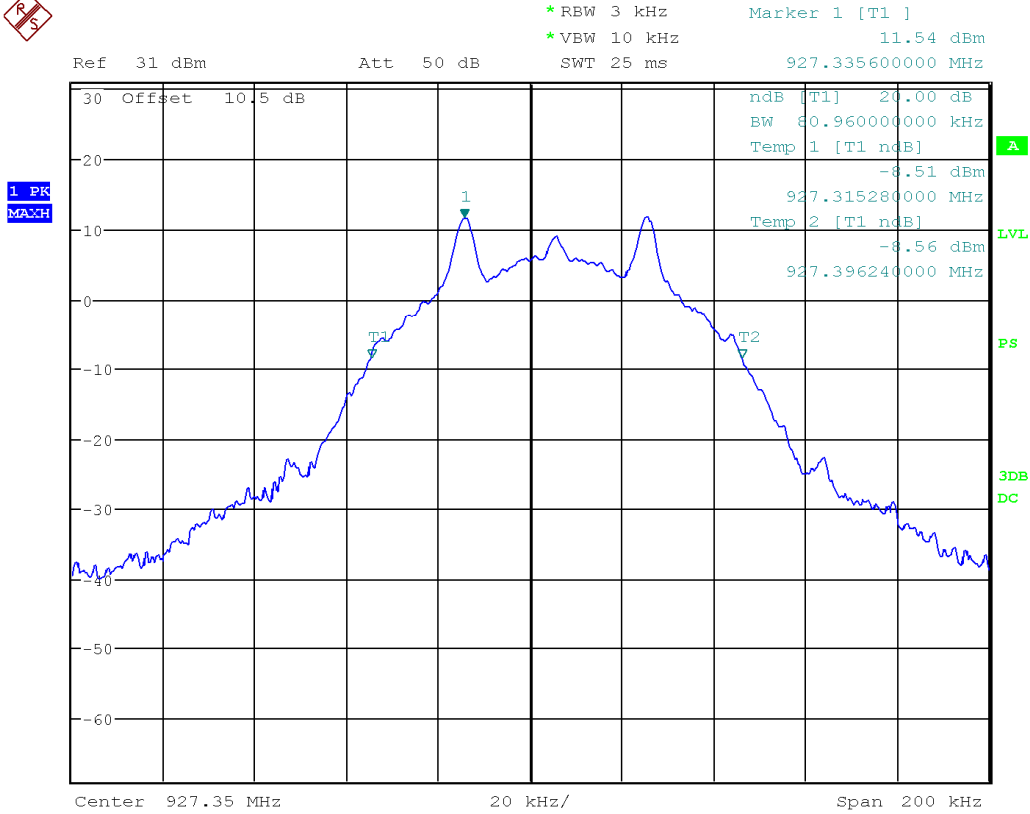
### Graphs




Date: 25.NOV.2021 17:12:25

Client	<b>Ecobee Inc.</b>	 Canada
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

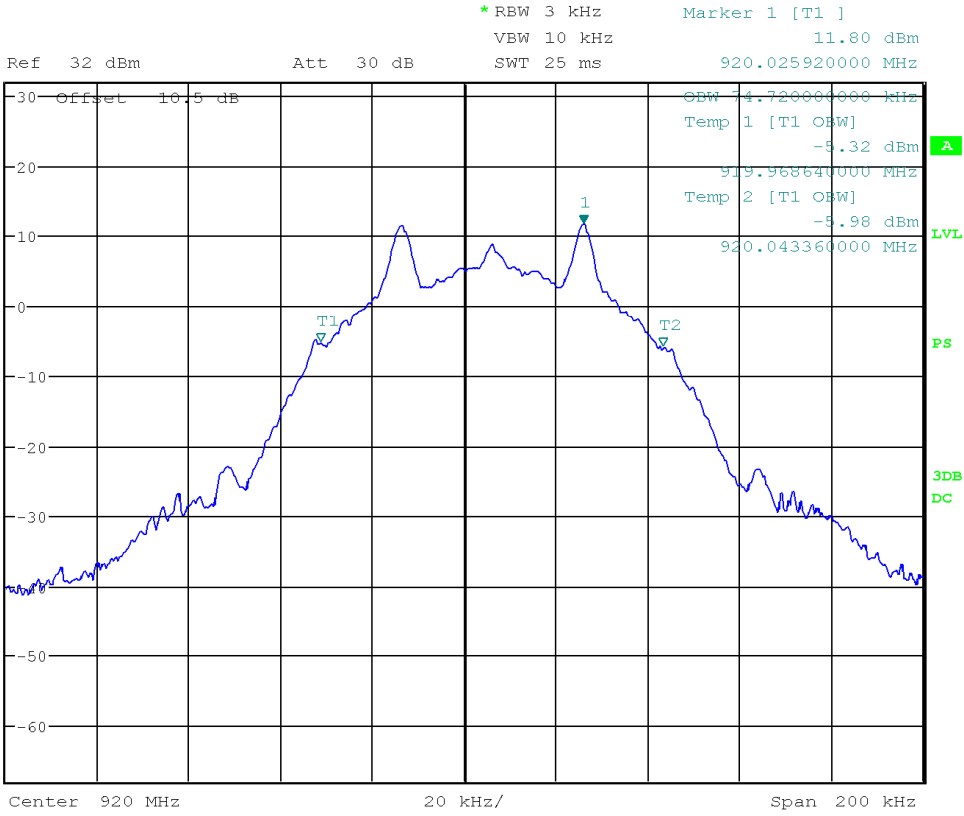
**20dB Bandwidth  
High Channel, 927.35MHz**




Date: 25.NOV.2021 16:33:45

Client	<b>Ecobee Inc.</b>	 Canada
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

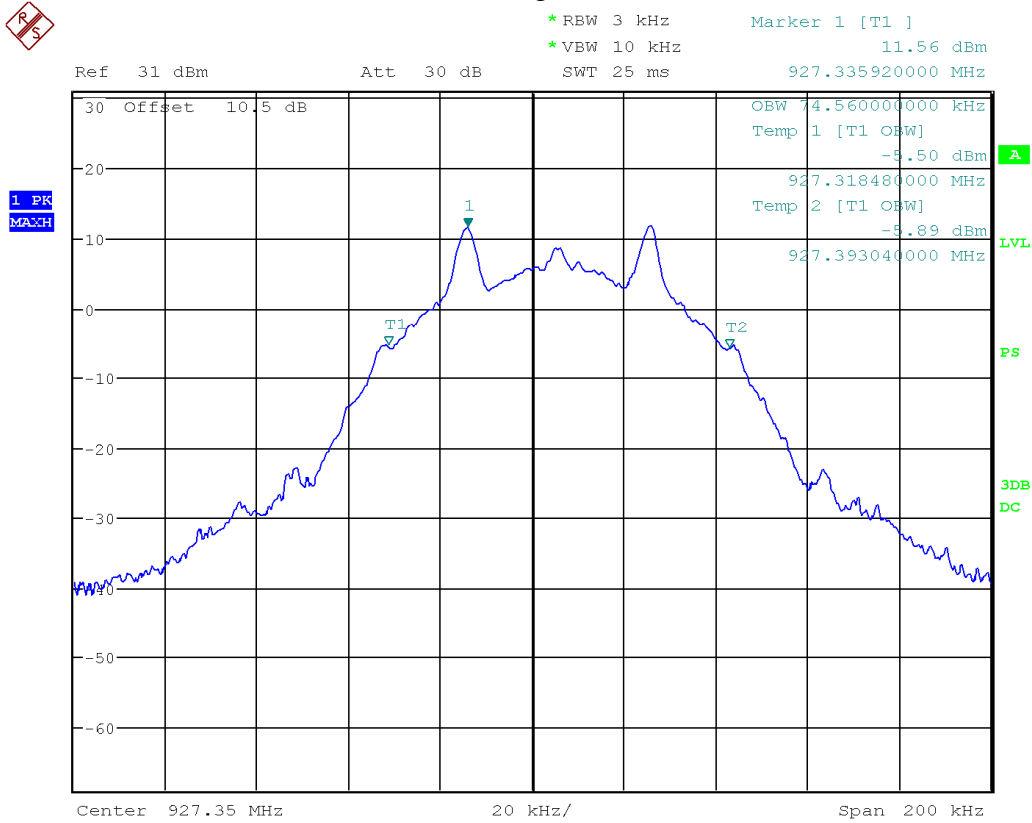
### 99% Bandwidth Low Channel



Date: 25.NOV.2021 15:56:18

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	


### 99% Bandwidth High Channel



Date: 25.NOV.2021 16:36:28

Note: See 'Appendix B – EUT & Test Setup Photos' for photos showing the test set-up.



Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	


## Results

The EUT passed. The 99% bandwidth was measured using the 99% bandwidth function of the spectrum analyzer.

Frequency (MHz)	99% Occupied Bandwidth (kHz)	20dB Bandwidth (kHz)	Result
920.00	74.72	80.96	Pass
927.35	74.56	80.96	Pass

## Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 15, 2020	Jan. 15, 2022	GEMC 233
Attenuator 10 dB	8493B	Agilent	Oct 4, 2021	Oct 4, 2022	GEMC133

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Carrier Frequency Separation

### Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is sufficiently spread over a spectrum and that the radio energy is not overly dense. This limit helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information.

### Limits and method


The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1) and RSS 247 Section 5.1. The test method is a defined in ANSI C63.10 Sections 7.8.2 and 7.8.7.

902 to 928 MHz	$P_{\max\text{-pk}} \leq 1 \text{ W}$ $\Delta f \geq \text{MAX} \{25 \text{ kHz}, BW_{20\text{dB}}\}$ $BW_{20\text{dB}} \leq 250 \text{ kHz}$	$P_{\max\text{-pk}} \leq 0.25 \text{ W}$ $\Delta f \geq \text{MAX} \{25 \text{ kHz}, BW_{20\text{dB}}\}$ $250 \text{ kHz} \leq BW_{20\text{dB}} \leq 500 \text{ kHz}$
2400 to 2483.5 MHz	$P_{\max\text{-pk}} \leq 1 \text{ W}$ $\Delta f \geq \text{MAX} \{25 \text{ kHz}, BW_{20\text{dB}}\}$ Max. $BW_{20\text{dB}}$ not specified	$P_{\max\text{-pk}} \leq 0.125 \text{ W}$ $\Delta f \geq [\text{MAX} \{25 \text{ kHz}, \frac{2}{3}BW_{20\text{dB}}\}]$ OR $\text{MAX} \{25 \text{ kHz}, BW_{20\text{dB}}\}$ Max. $BW_{20\text{dB}}$ not specified
5275 to 5850 MHz	$P_{\max\text{-pk}} \leq 1 \text{ W}$ $\Delta f \geq \text{MAX} \{25 \text{ kHz}, BW_{20\text{dB}}\}$ $BW_{20\text{dB}} \leq 1 \text{ MHz}$	

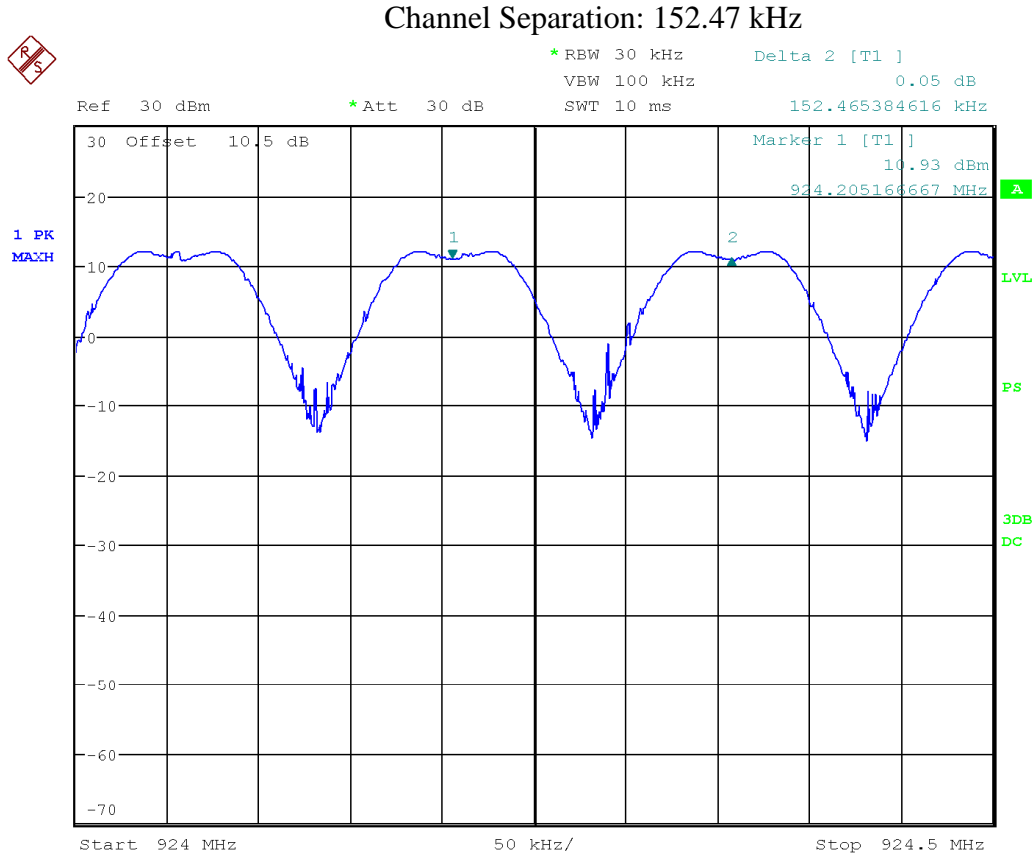
Note 1: The greater of the 20 dB BW or 25 kHz. The 20 dB BW of the system was measured to be 80.96 kHz, so a limit of 80.96 kHz applies.

### Results

The EUT passed the requirements of channel carrier spacing exceeding the measured 20 dB BW of the EUT. The 20 dB bandwidth measured was 80.96 kHz and the device had a channel spacing of 152.47kHz.


Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Graphs




Date: 30.NOV.2021 10:15:51

Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

### Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 15, 2020	Jan. 15, 2022	GEMC 233
Attenuator 10 dB	8493B	Agilent	Oct 4, 2021	Oct 4, 2022	GEMC133

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## **Number of Hopping Frequencies**

### **Purpose**

The purpose of this test is to ensure that the RF energy of frequency hopping systems is sufficiently spread over a spectrum and that the radio energy is not overly dense. This limit helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information.


### **Limits and method**

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1) and RSS 247 Section 5.1. The test method is a defined in ANSI C63.10 Section 7.8.3.

902 to 928 MHz	$P_{\max\text{-pk}} \leq 1 \text{ W}$ $N_{\text{ch}} \geq 50$	$P_{\max\text{-pk}} \leq 0.25 \text{ W}$ $25 \leq N_{\text{ch}} \leq 50$
2400 to 2483.5 MHz	$P_{\max\text{-pk}} \leq 1 \text{ W}$ $N_{\text{ch}} \geq 75$	$P_{\max\text{-pk}} \leq 0.125 \text{ W}$ $N_{\text{ch}} \geq 15$
5275 to 5850 MHz	$P_{\max\text{-pk}} \leq 1 \text{ W}$ $N_{\text{ch}} \geq 75$	

### **Results**

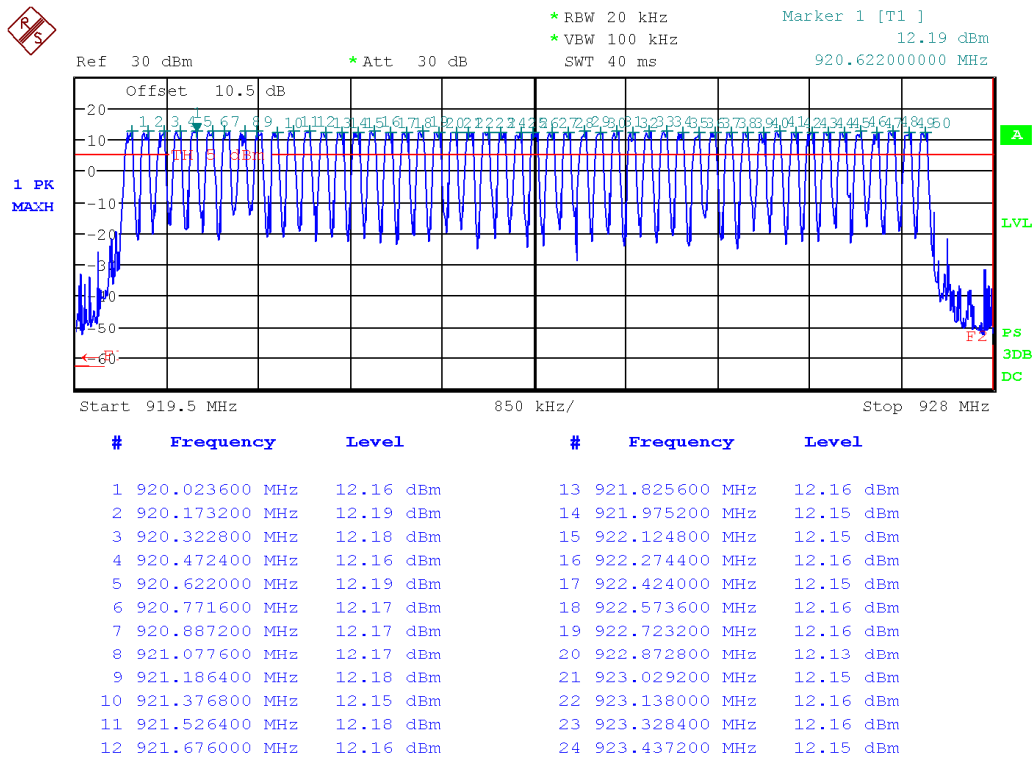
The EUT passed the requirements of the number of channels. The number of channels the device occupies is 50 in the allocation band of 920 to 927.35 GHz.

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	


## Graphs

The graphs shown below shows the number of occupied channels during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the channel spacing of the signal being measured. This measurement is a peak measurement. Max hold is performed for a duration sufficient to capture all the channels occupied.

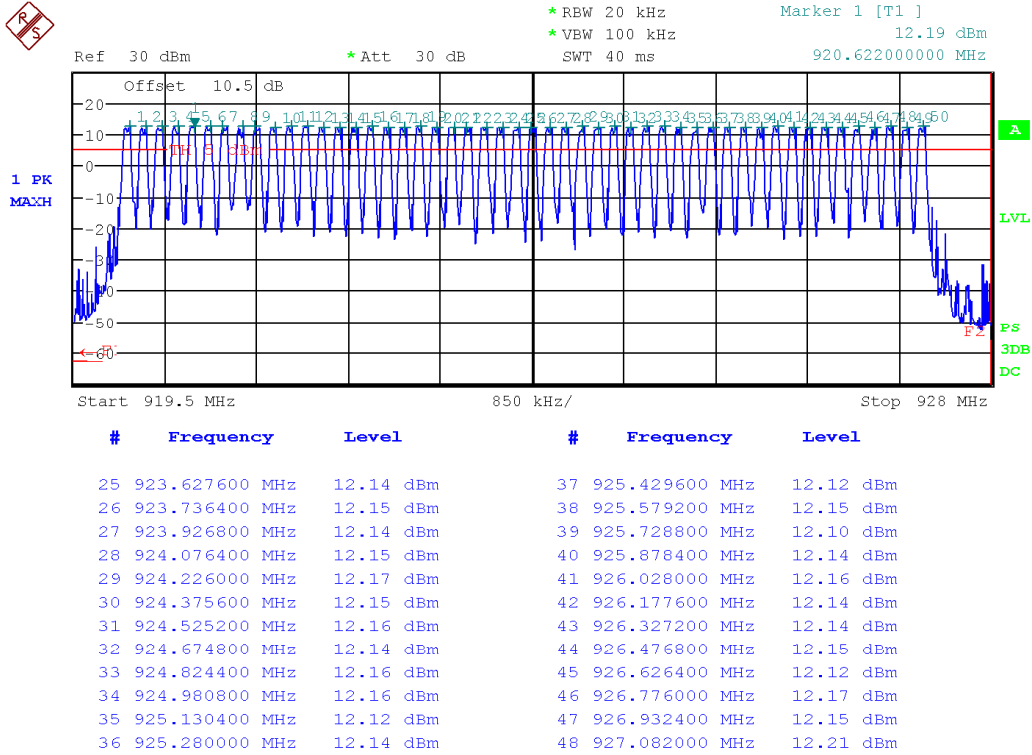
Graph 1 of 3




Date: 26.NOV.2021 11:05:57

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

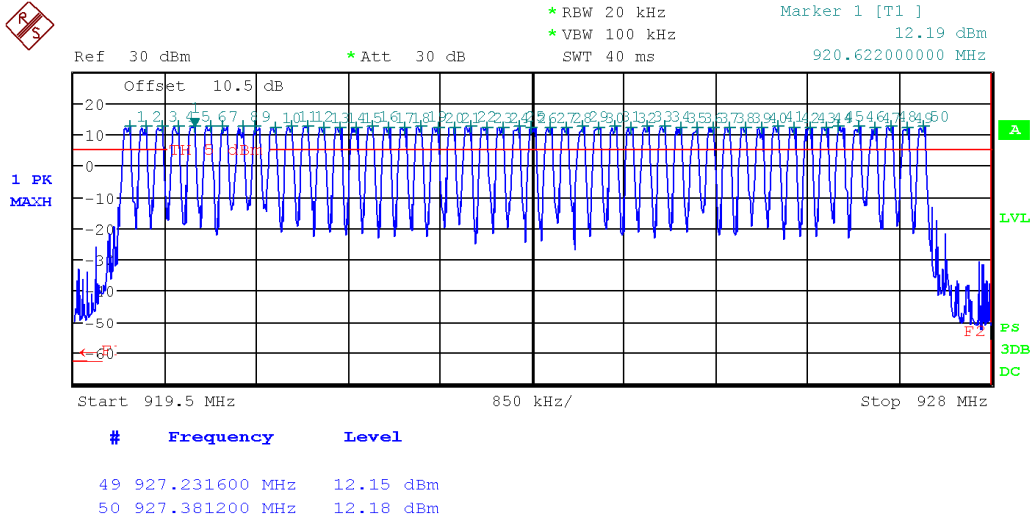
Graph 2 of 3



Date: 26.NOV.2021 11:06:22

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	


Graph 3 of 3



Date: 26.NOV.2021 11:06:46


Note: See ‘Appendix B – EUT & Test Setup Photographs’ for photos showing the test set-up.



Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

### Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 15, 2020	Jan. 15, 2022	GEMC 233
Attenuator 10 dB	8493B	Agilent	Oct 4, 2021	Oct 4, 2022	GEMC133

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Time of Occupancy

### Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is hopping at a minimum defined rate. This helps ensure sufficient time off to enable other frequency hopping devices to co-operate within this allocated band.

### Limits


The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1)(i) and (f) and RSS 247 Section 5.1 and 5.3(a). The test method is defined in ANSI C63.10 Section 7.8.4.

#### Frequency Hopping System

902 to 928 MHz	$P_{\max\text{-pk}} \leq 1 \text{ W}$ $BW_{20\text{dB}} \leq 250 \text{ kHz}$  $t_{\text{ch}} \leq 0.4 \text{ s for } T = 20 \text{ s}$	$P_{\max\text{-pk}} \leq 0.25 \text{ W}$ $250 \text{ kHz} \leq BW_{20\text{dB}} \leq 500 \text{ kHz}$  $t_{\text{ch}} \leq 0.4 \text{ s for } T = 10 \text{ s}$
2400 to 2483.5 MHz	$P_{\max\text{-pk}} \leq 1 \text{ W}$ $N_{\text{ch}} \geq 75$  $t_{\text{ch}} \leq 0.4 \text{ s for } T = 0.4 N_{\text{ch}} \text{ s}$	$P_{\max\text{-pk}} \leq 0.125 \text{ W}$ $N_{\text{ch}} \geq 15$  $t_{\text{ch}} \leq 0.4 \text{ s for } T = 0.4 N_{\text{ch}} \text{ s}$
5275 to 5850 MHz	$P_{\max\text{-pk}} \leq 1 \text{ W}$  $t_{\text{ch}} \leq 0.4 \text{ s for } T = 30 \text{ s}$	

#### Hybrid System

902 to 928 MHz, 2400 to 2483.5 MHz, 5275 to 5850 MHz	$t_{\text{ch}} \leq 0.4 \text{ s for } T = 0.4 N_{\text{ch}} \text{ s}$
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Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Results

The EUT passed the requirements. Worst case results are shown.

### FHSS:

<b>Number of Channels</b>	50
<b>Dwell Time</b>	12.43ms
<b>Number of hops within 20s (0.4s x 50 Channels Used)</b>	8

$$\begin{aligned}
 \text{Time of Occupancy} &= (\text{Dwell Time}) \times (\# \text{ of hops within } 20\text{s}) \\
 &= 12.43\text{ms} \times 8 \\
 &= 99.44\text{ms or } 0.0994\text{s}
 \end{aligned}$$


The EUT has an average occupancy of 99.44ms within a 20s period. This is under the 0.4s limit.

### Hybrid:

<b>Number of Channels</b>	2
<b>Dwell Time</b>	12.48ms
<b>Number of hops within 0.8s (0.4s x 2 Channels Used)</b>	8

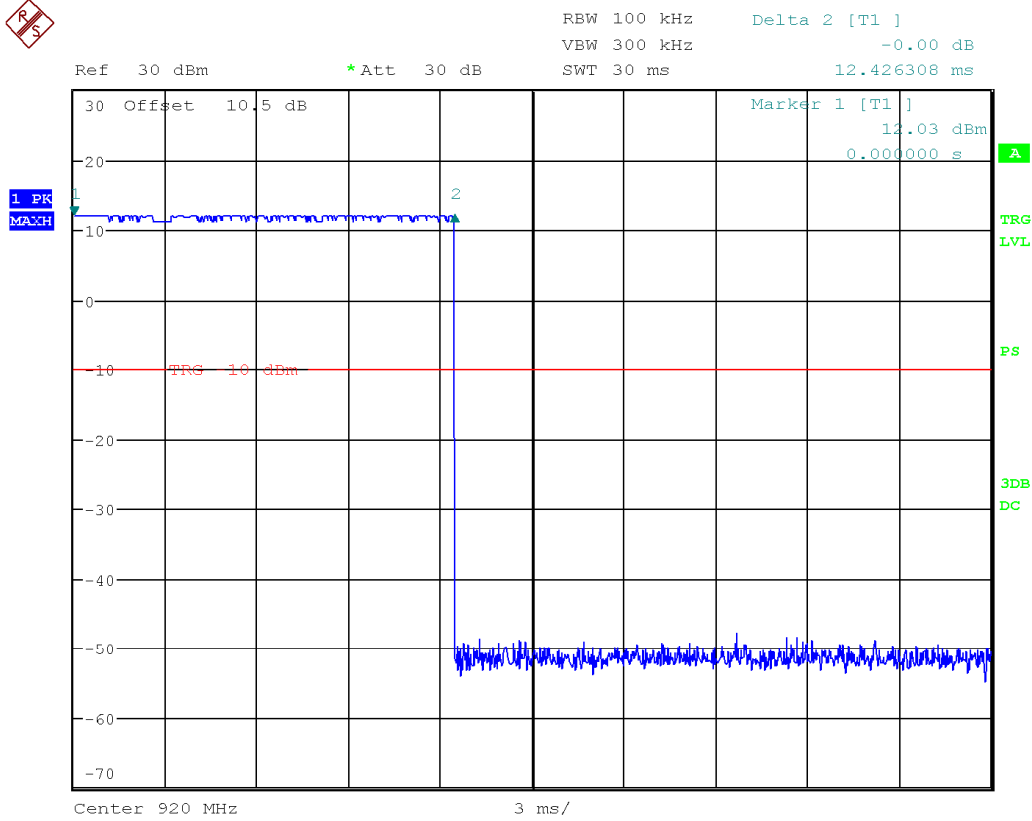
$$\begin{aligned}
 \text{Time of Occupancy} &= (\text{Dwell Time}) \times (\# \text{ of hops within } 0.8\text{s}) \\
 &= 12.48\text{ms} \times 8 \\
 &= 99.84\text{ms or } 0.0998\text{s}
 \end{aligned}$$

The EUT has an average occupancy of 99.84ms within an 800ms period. This is under the 400 msec limit


Client	<b>Ecobee Inc.</b>	 Canada
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Graphs

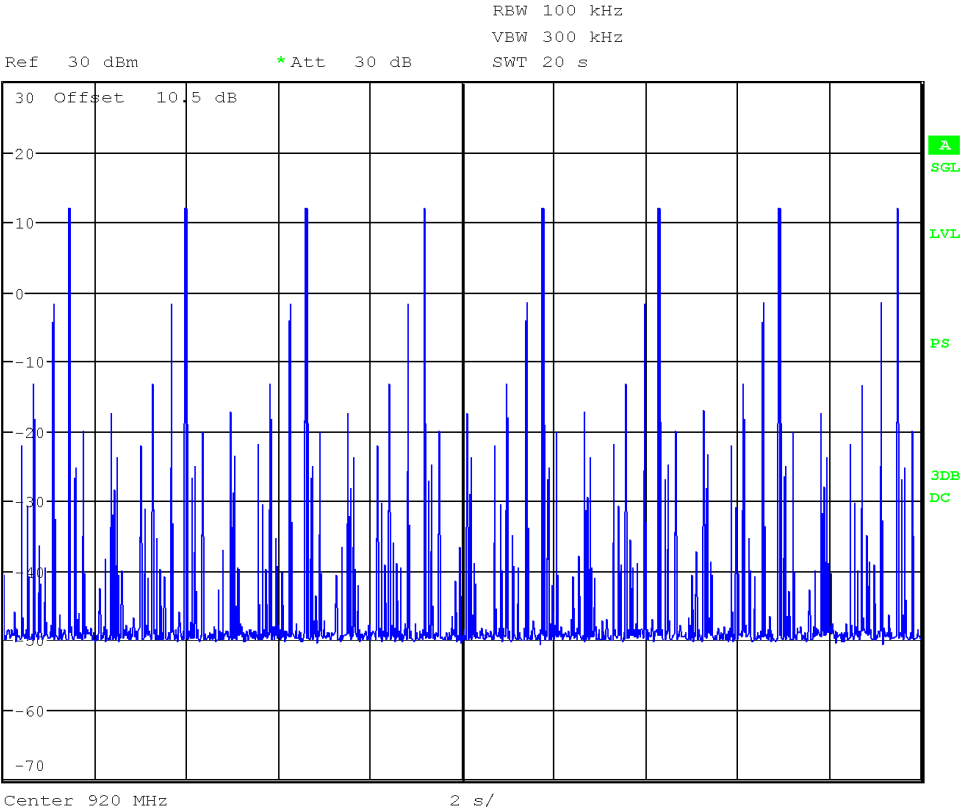
### FHSS – Dwell Time



Date: 30.NOV.2021 10:06:45


Client	<b>Ecobee Inc.</b>	 Canada
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

FHSS – Number of Hops within 20s Period

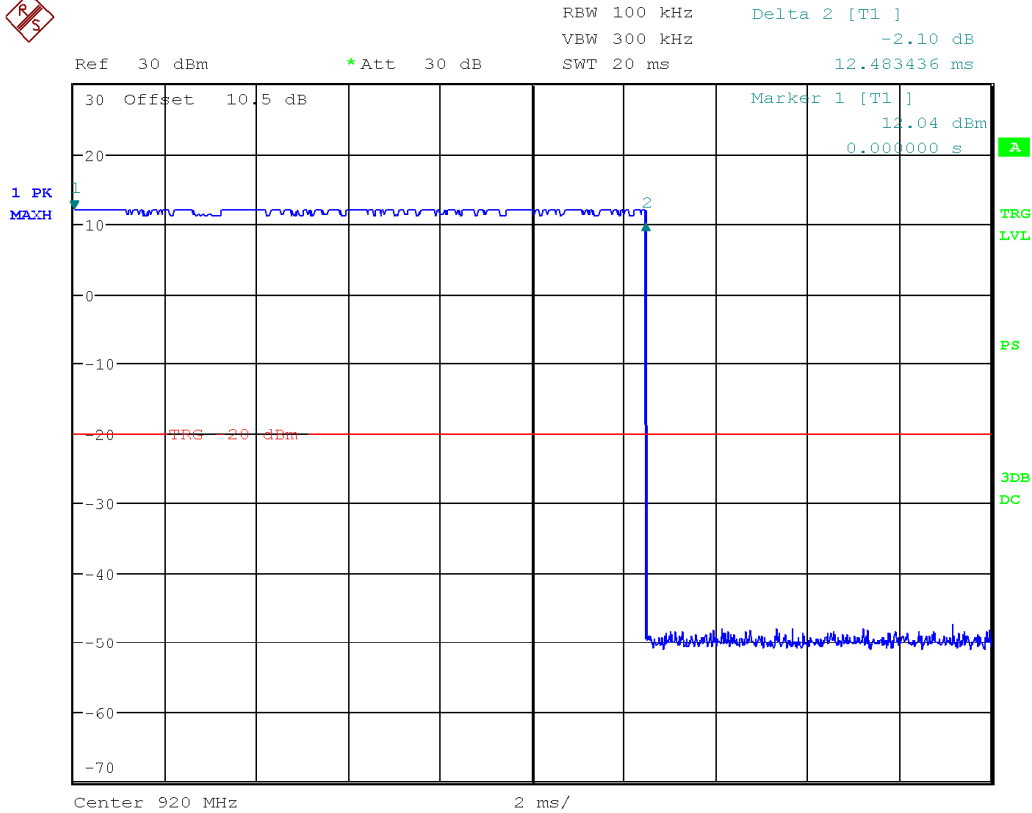


Date: 30.NOV.2021 10:10:42


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Client	<b>Ecobee Inc.</b>	 Canada
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

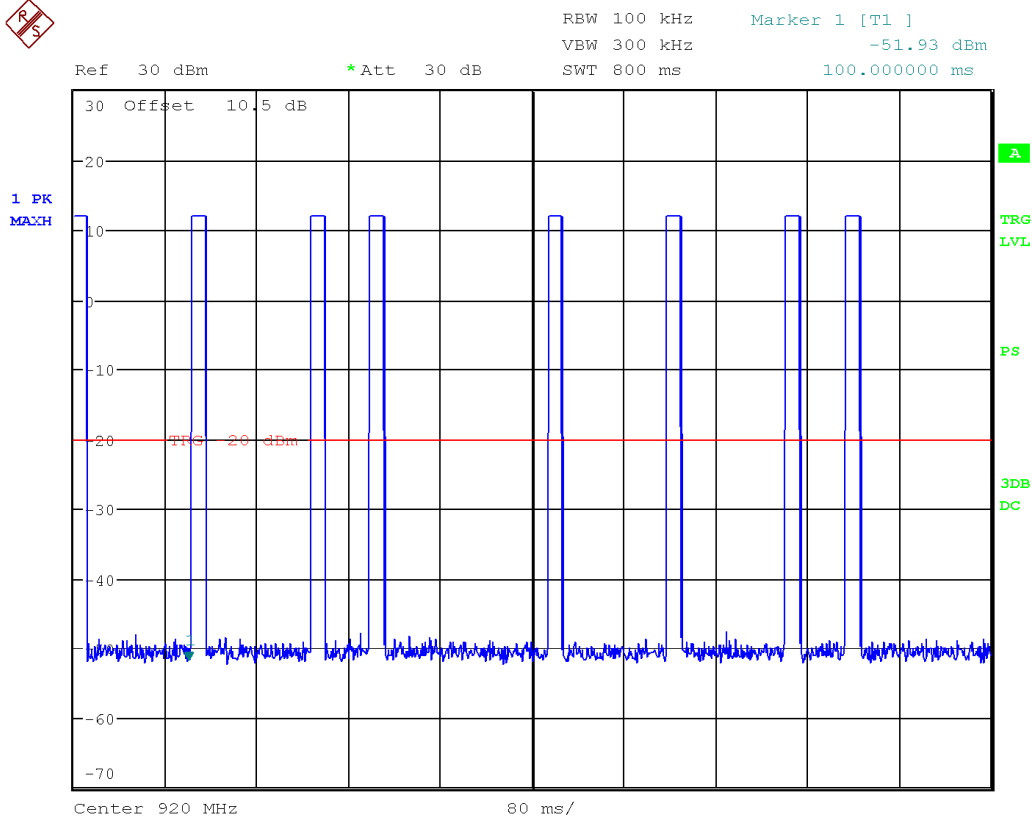
### Hybrid – Dwell Time



Date: 30.NOV.2021 09:46:53

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

### Hybrid – Number of Hops within 800ms Period




Date: 30.NOV.2021 09:51:40

Note: See ‘Appendix B – EUT & Test Setup Photographs’ for photos showing the test set-up.

### Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 15, 2020	Jan. 15, 2022	GEMC 233
Attenuator 10 dB	8493B	Agilent	Oct 4, 2021	Oct 4, 2022	GEMC133

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Maximum Conducted Output Power

### Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified.

### Limits

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(b) and RSS 247 Section 5.4. The test method is defined in ANSI C63.10 Section 11.12.2.5.1 and 11.9.2.2.2.

902 to 928 MHz	$N_{ch} \geq 50$ $P_{max-pk} \leq 1 \text{ W}$	$25 \leq N_{ch} \leq 50$ $P_{max-pk} \leq 0.25 \text{ W}$
2400 to 2483.5 MHz	$N_{ch} \geq 75$ $P_{max-pk} \leq 1 \text{ W}$	$N_{ch} \geq 15$ $P_{max-pk} \leq 0.125 \text{ W}$
5275 to 5850 MHz	$N_{ch} \geq 75$ $P_{max-pk} \leq 1 \text{ W}$	


### Results

The EUT passed. The FHSS average power measured was 10.75 dBm (11.89 mW).

Channel	Frequency (MHz)	Average Power (dBm)	Average Power (mW)
Low	920.00	10.71	11.78
High	927.35	10.75	11.89

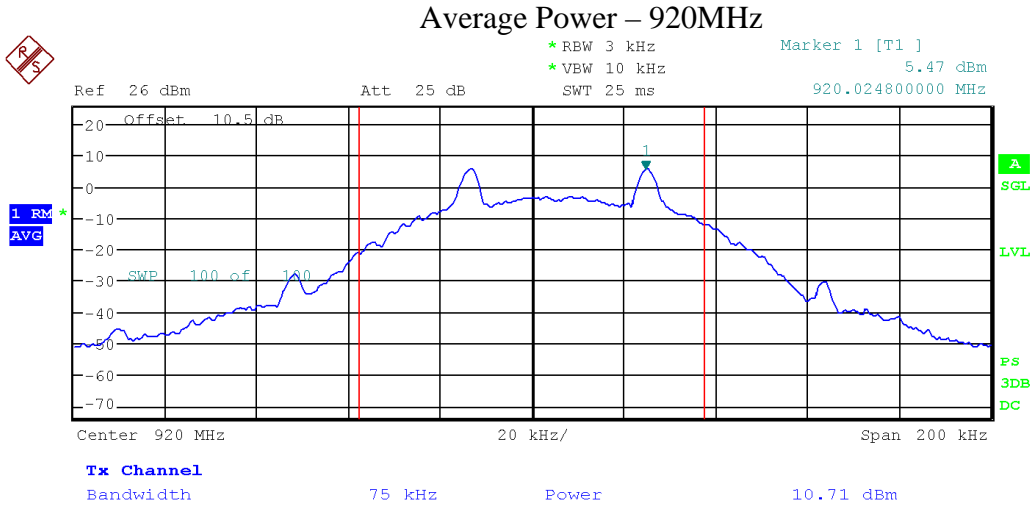
Note: The external attenuator and cable loss are accounted for as reference offset in the spectrum analyzer




Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

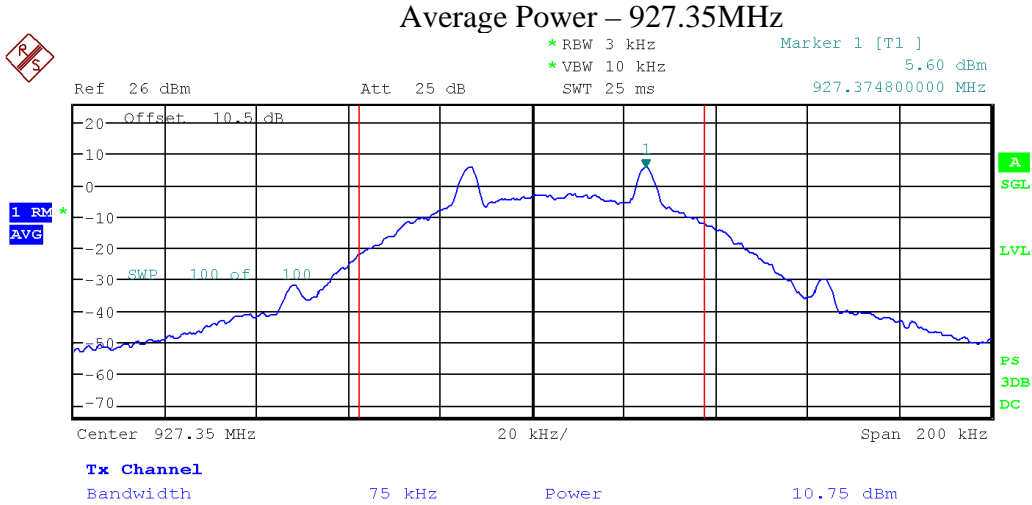
## Graphs

The graphs shown below show the average power output of the device during the conducted measurement operation of the EUT. The integrated band power measurement method was used.



Date: 25.NOV.2021 16:18:29


Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	



Date: 25.NOV.2021 16:27:33

### Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 15, 2020	Jan. 15, 2022	GEMC 233
Attenuator 10 dB	8493B	Agilent	Oct 4, 2021	Oct 4, 2022	GEMC133

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## ***Antenna Spurious Conducted Emissions (30dBc)***

### **Purpose**

The purpose of this test is to ensure that the maximum power conducted to the radiating element at frequencies outside of the authorized spectrum does not exceed the limits specified. This ensures that the only the intended signal is delivered to the radiating element.

### **Limits and Method**

The limits are defined in 15.247(d) and RSS-247 5.5. In any 100 kHz band, the peak spurious harmonics emissions must be at least 30 dB below the fundamental instead of 20dB when average output power is used. Spurious conducted emissions are to be evaluated up to the 10<sup>th</sup> harmonic. This -30 dBc requirement also applies at the ‘band edge’.

The method is given in ANSI C63.10 Section 11.11.

### **Results**

The EUT passed. Low, and high bands were measured. The -30 dBc requirement is shown for the lower band edge at 902MHz in the low band and for the higher band edge at 928MHz in the high band. Band edge testing was performed with the transmitter in hopping mode and with hopping mode turned off.






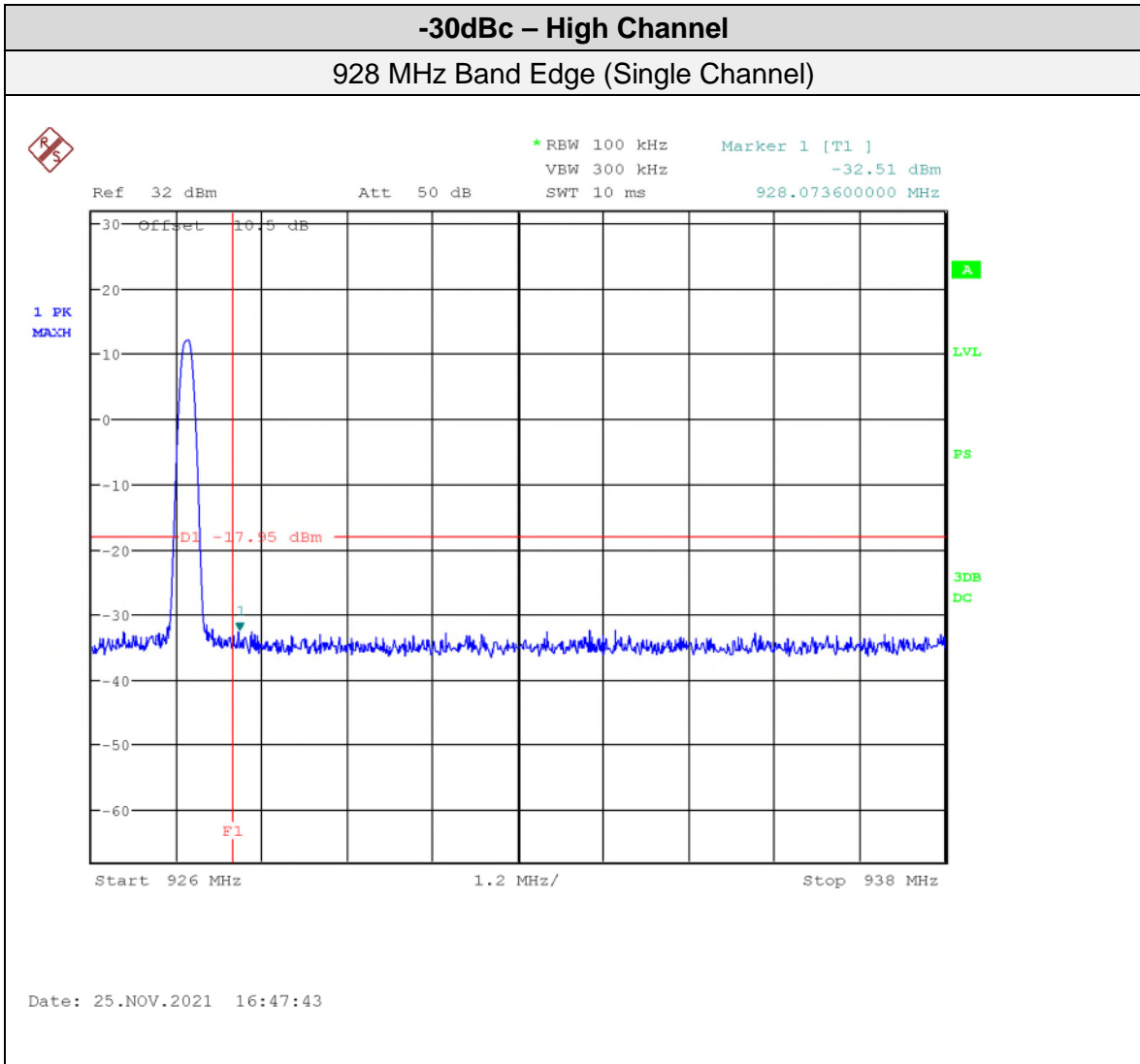









Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	








Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 15, 2020	Jan. 15, 2022	GEMC 233
Attenuator 10 dB	8493B	Agilent	Oct 4, 2021	Oct 4, 2022	GEMC133

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## ***Transmitter Spurious Radiated Emissions***

### **Purpose**

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

### **Limits and Method**

The limits, as defined in 15.247(d) for unintentional radiated emissions, apply for those emissions that fall in the restricted bands, as defined in Section 15.205(a). These emissions must comply with the radiated emission limits specified in Section 15.209(a).

The method is as defined in ANSI C63.10 Section 7.8.6.

All unintentional emissions must also meet the ‘Spurious Conducted Emissions’ requirements of -30 dBc or greater. See also ‘Antenna Spurious Conducted Emissions’ for further details.


<b>Frequency</b>	<b>Field Strength Limit (<math>\mu\text{V}/\text{m}</math>)</b>	<b>Field Strength at 3m (dB<math>\mu\text{V}/\text{m}</math>)</b>
0.009 MHz – 0.490 MHz	2400/F(kHz) <sup>a</sup> (at 300m)	128.5 to 93.8 <sup>a</sup>
0.490 MHz – 1.705 MHz	24000/F(kHz) <sup>a</sup> (at 30m)	73.8 to 63.0 <sup>a</sup>
1.705 MHz – 30 MHz	30 <sup>a</sup> (at 30m)	69.5 <sup>a</sup>
30 MHz – 88 MHz	100 <sup>a</sup> (at 3m)	40.0 <sup>a</sup>
88 MHz – 216 MHz	150 <sup>a</sup> (at 3m)	43.5 <sup>a</sup>
216 MHz – 960 MHz	200 <sup>a</sup> (at 3m)	46.0 <sup>a</sup>
Above 960 MHz	500 <sup>a</sup> (at 3m)	54.0 <sup>a</sup>
Above 1000 MHz	500 <sup>b</sup> (at 3m)	54.0 <sup>b</sup>
Above 1000 MHz	5 mV/m <sup>c</sup> (at 3m)	74.0 <sup>c</sup>

<sup>a</sup>Limit is with Quasi Peak detector with bandwidths as defined in CISPR-16-1-1

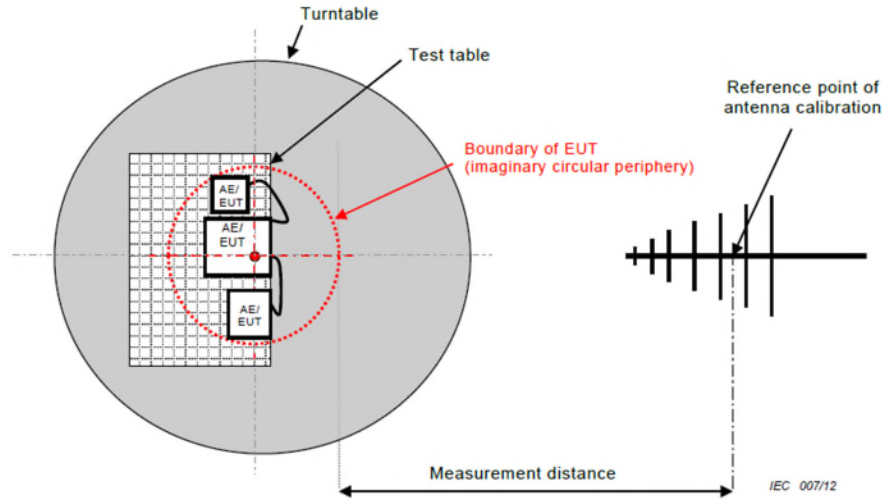
<sup>b</sup>Limit is with 1 MHz measurement bandwidth and using an Average detector

<sup>c</sup>Limit is with 1 MHz measurement bandwidth and using a Peak detector

Based on ANSI C63.4 Section 4.2, if the Peak detector measurements do not exceed the Quasi-Peak limits, where defined, then the EUT is deemed to have passed the requirements.

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

### Typical Radiated Emissions Setup



### Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is  $\pm 5.67\text{dB}$  for 30MHz – 1GHz and  $\pm 4.58\text{dB}$  for 1GHz – 18GHz with a 'k=2' coverage factor and a 95% confidence level.


### Preliminary Graphs

The graphs shown below are maximized peak measurement graphs measured with a resolution bandwidth greater than or equal to the final required detector over a full 0-360°. This peaking process is done as a worst-case measurement and enables the detection of frequencies of concern for final measurement. For final measurements with the appropriate detector, where applicable, please refer to the tables under Final Measurements.

In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to the 10<sup>th</sup> harmonic (a minimum of 9280 MHz).

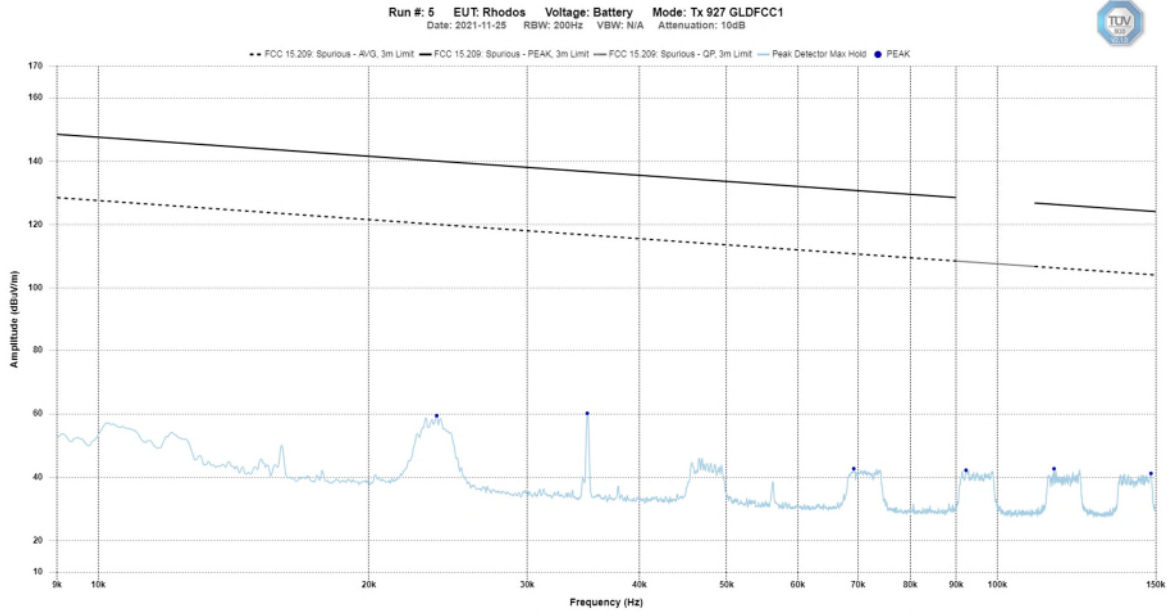
Devices scanned may be scanned at alternate test distances and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above 30 MHz and 40 dB/decade below 30 MHz. For example, for 1 meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m / 3m) is applied.


Peak output power for low and high channels were checked. The worst case was used for the spurious emissions.

Client	<b>Ecobee Inc.</b>	 Canada
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

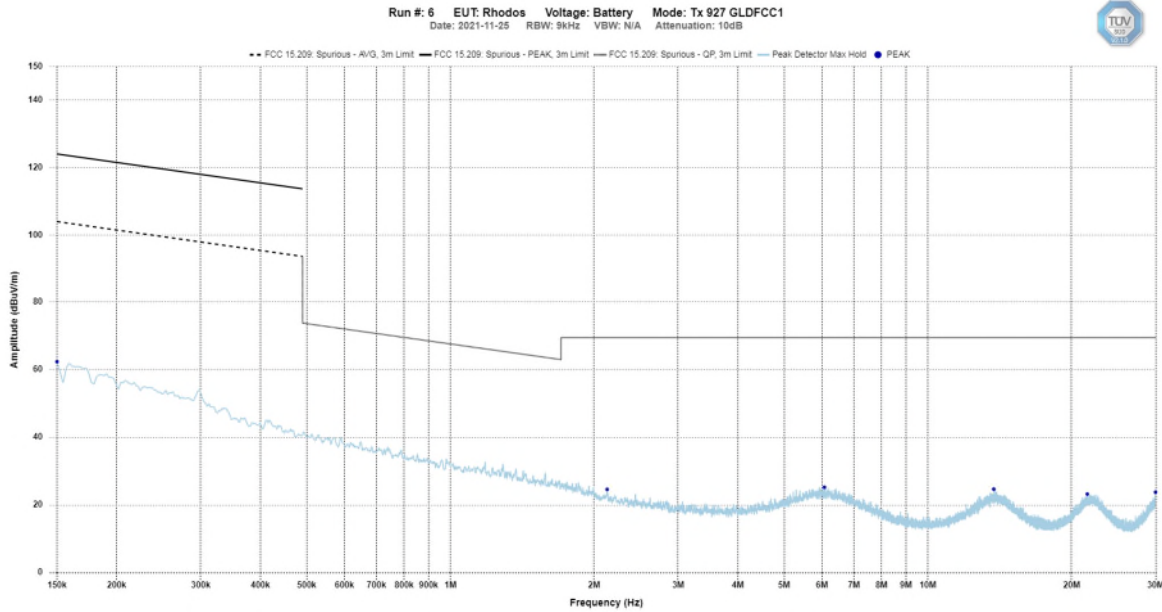
### Spurious Emissions

#### High Channel 9 kHz – 150 kHz Peak Emission Graph

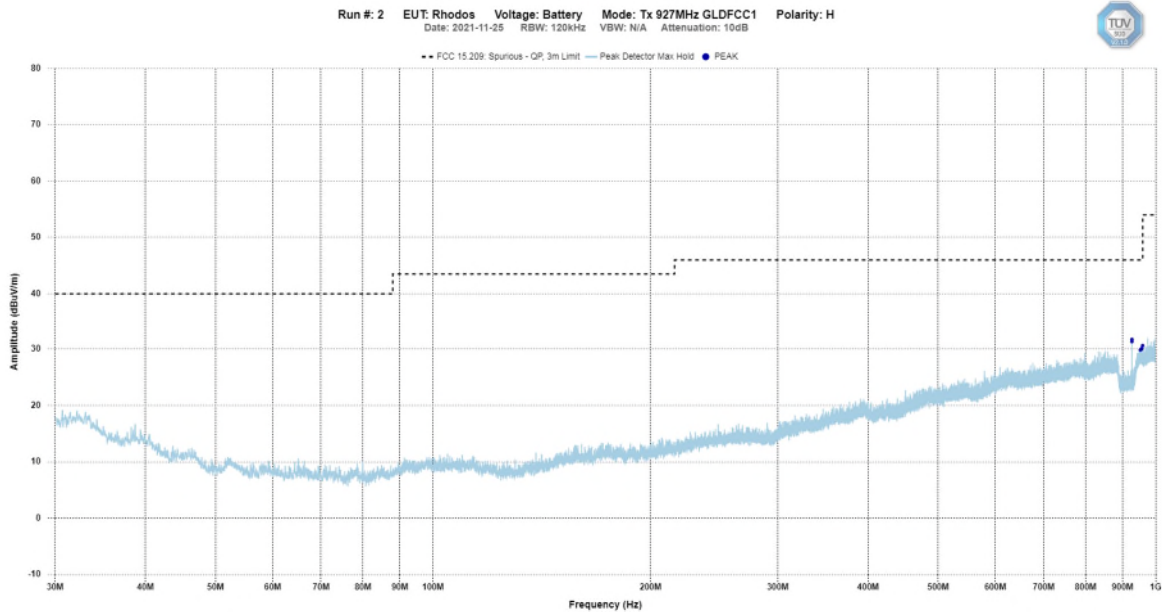


Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	


### High Channel 150 kHz – 30 MHz Peak Emission Graph



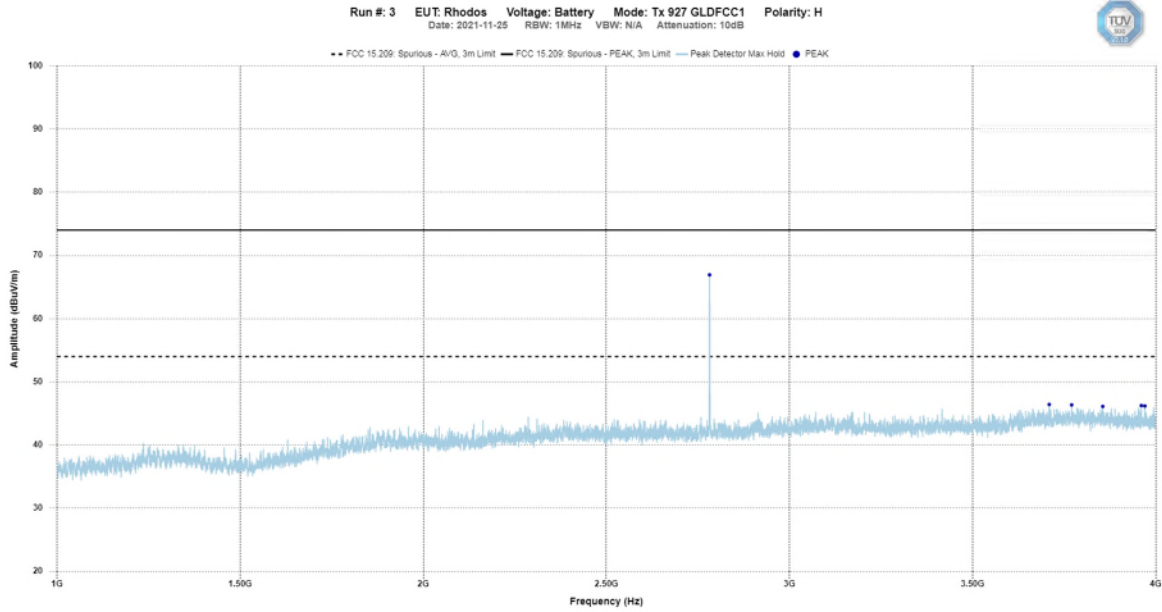
### High Channel – 30 MHz – 1 GHz Horizontal - Peak Emission Graph



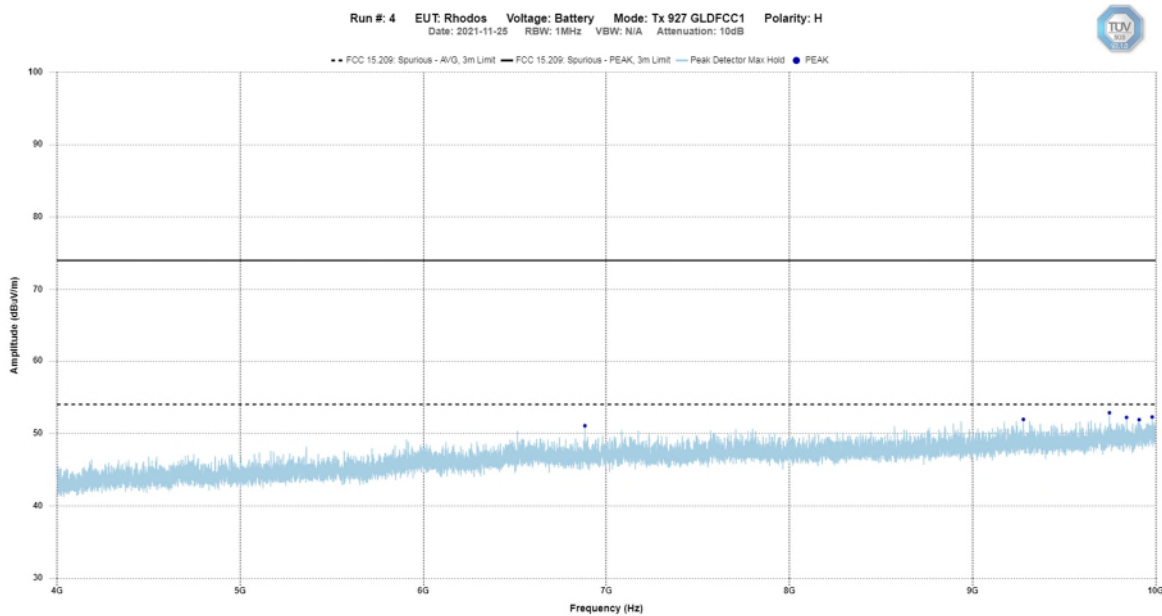



Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

### High Channel – 1 GHz – 4 GHz Horizontal - Peak Emission Graph

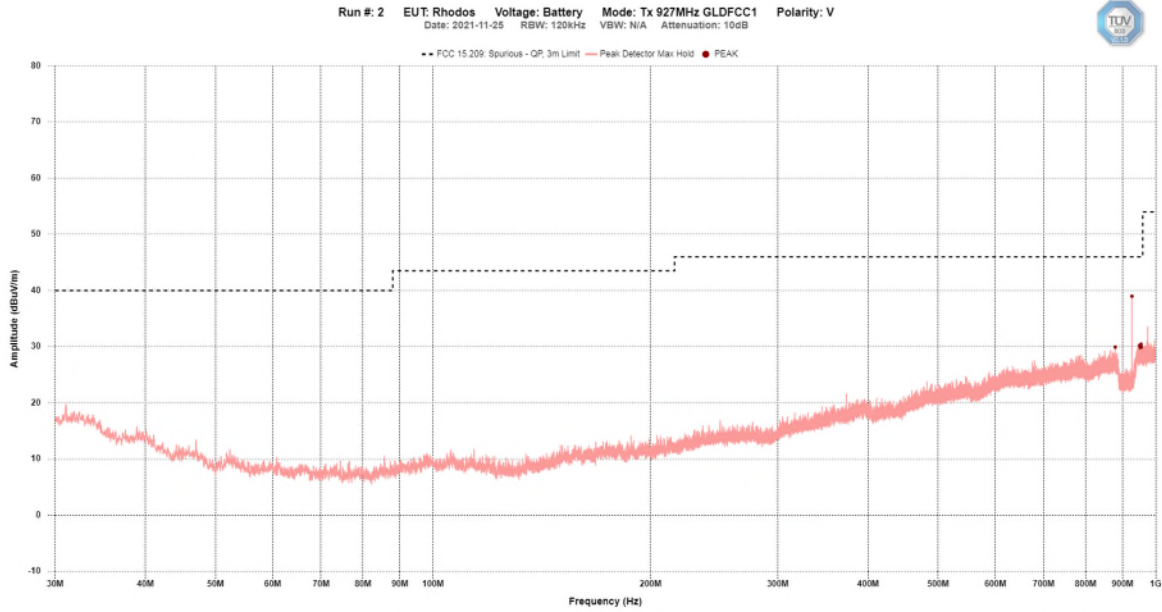



### High Channel – 4 GHz – 10 GHz Horizontal - Peak Emission Graph



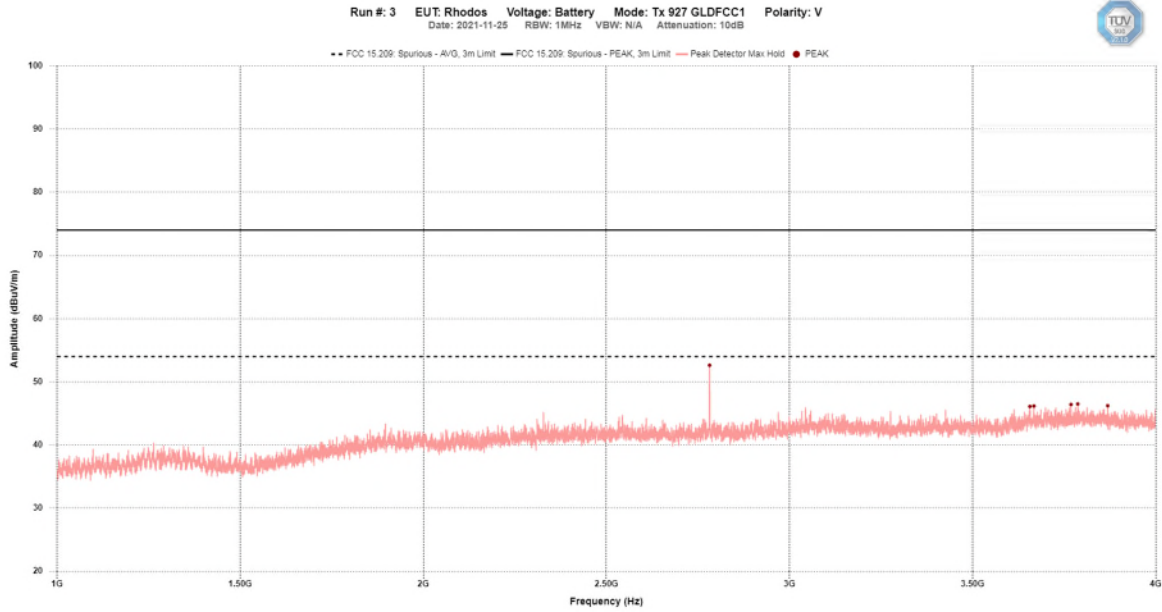
Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

**High Channel – 30 MHz – 1 GHz  
Vertical - Peak Emission Graph**

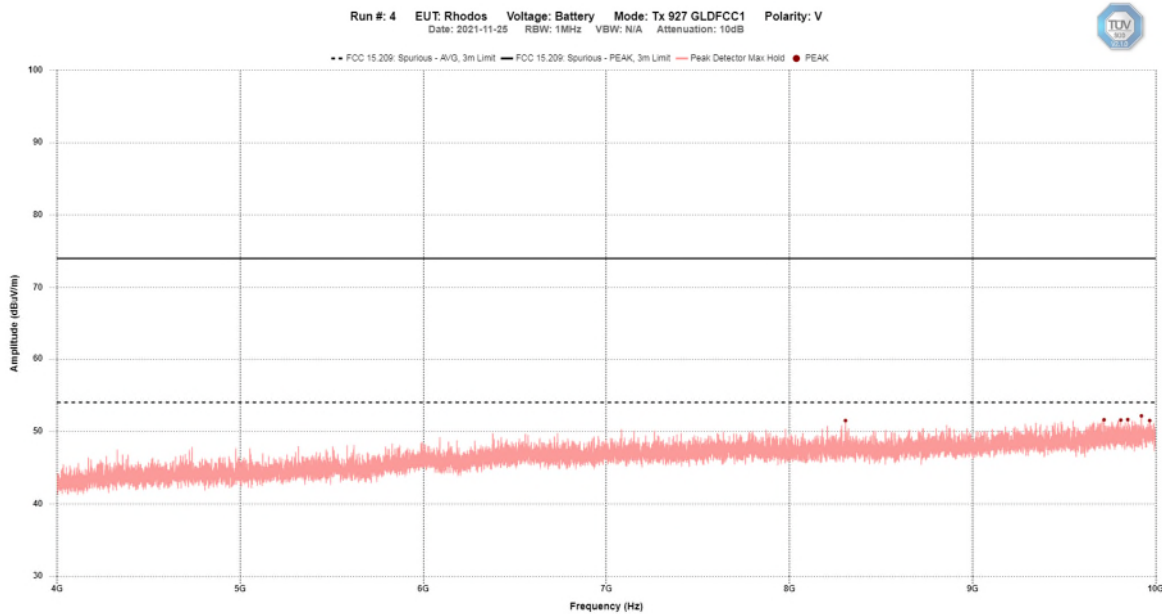



Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

### High Channel – 1 GHz – 4 GHz Vertical - Peak Emission Graph



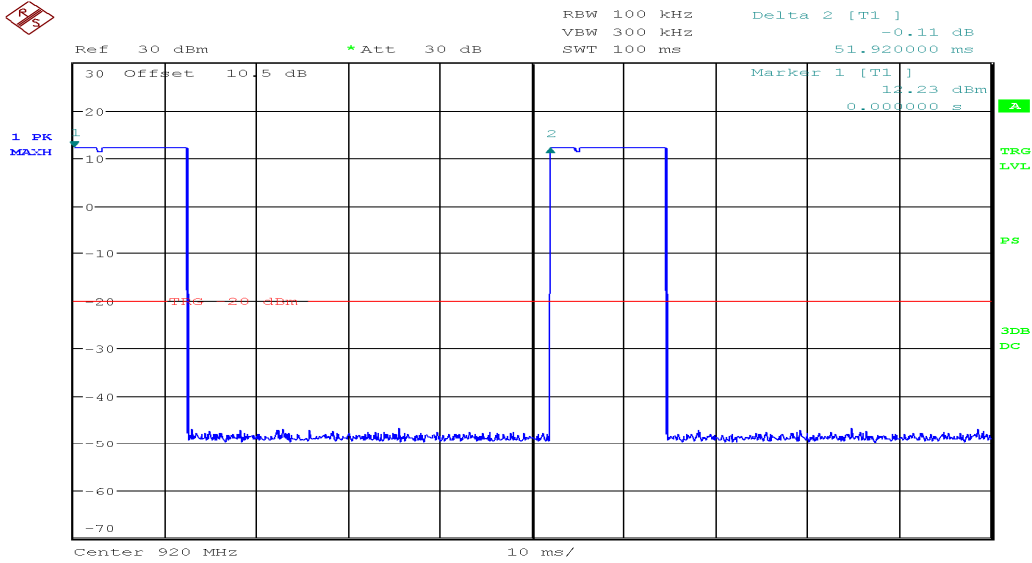
### High Channel – 4 GHz – 10 GHz Vertical - Peak Emission Graph



Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

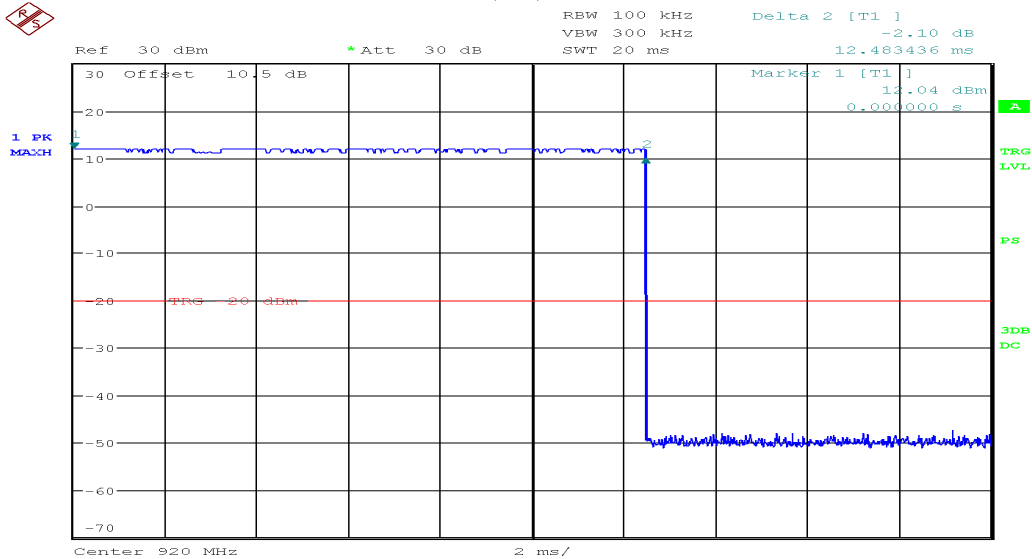
### Duty Cycle

Pulse Train in 100ms [Period, T = 100ms]




Date: 30.NOV.2021 09:43:54

Pulse ON Time ( $t_{ON}$ ) = [2 x 12.48ms] = 24.96ms



Date: 30.NOV.2021 09:46:53

Duty Cycle Correction Factor =  $20 \log (24.94\text{ms} / 100\text{ms}) = -12.06 \text{ dB}$

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	


## Final Measurements and Results

The EUT passed. Average measurement was obtained using duty cycle correction of -12.06dB applied to the peak measurement.

In accordance with 15.247(d), only frequencies exceeding the 15.209 limit that occur within the bands listed in 15.205 need to be verified with a final detector.


The measurements were maximized by rotating the turn table over a full 0-360 rotation and the antenna height was varied from 1 m to 4 m.

Test Frequency (MHz)	Detection Mode	Antenna Polarity (Horz/Vert)	Received Signal (dBµV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-Amp Gain (dB)	Level (dBµV/m)	Emission Limit (dBµV/m)	Margin (dB)	Result
Low Channel										
920	Peak	Horz	63.5	29.8	3.4	0.0	96.6	--	--	--
920	Peak	Vert	74.4	29.8	3.4	0.0	107.5	--	--	--
High Channel										
927.35	Peak	Horz	65.3	29.9	3.4	0.0	98.6	--	--	--
927.35	Peak	Vert	75.3	29.9	3.4	0.0	108.6	--	--	--
1854.7	Peak	Horz	48.7	30.5	3.4	-36.8	45.8	74.0	28.2	PASS
1854.7	Avg	Horz	37.7	30.5	3.4	-36.8	34.8	54.0	19.2	PASS
1854.7	Peak	Vert	48.7	30.5	3.4	-36.8	45.8	74.0	28.2	PASS
1854.7	Avg	Vert	35.6	30.5	3.4	-36.8	32.7	54.0	21.3	PASS
2782.05	Peak	Horz	66.6	32.3	4.2	-36.4	66.6	74.0	7.4	PASS
2782.05	Avg	Horz	53.7	32.3	4.2	-36.4	53.8	54.0	0.2	PASS
2782.05	Peak	Vert	52.6	32.3	4.2	-36.4	52.7	74.0	21.3	PASS
2782.05	Avg	Vert	48.8	32.3	4.2	-36.4	48.9	54.0	5.1	PASS
3709.4	Peak	Horz	46.4	33.1	5.1	-35.6	49.0	74.0	25.0	PASS
3709.4	Avg	Horz	33.0	33.1	5.1	-35.6	35.6	54.0	18.4	PASS
3709.4	Peak	Vert	46.0	33.1	5.1	-35.6	48.5	74.0	25.5	PASS
3709.4	Avg	Vert	31.7	33.1	5.1	-35.6	34.3	54.0	19.7	PASS
4636.75	Peak	Horz	46.4	34.3	5.3	-35.3	50.7	74.0	23.3	PASS
4636.75	Avg	Horz	34.8	34.3	5.3	-35.3	39.1	54.0	14.9	PASS
4636.75	Peak	Vert	45.6	34.3	5.3	-35.3	49.9	74.0	24.1	PASS
4636.75	Avg	Vert	32.2	34.3	5.3	-35.3	36.5	54.0	17.5	PASS
5564.1	Peak	Horz	50.2	34.7	5.9	-35.0	55.7	74.0	18.3	PASS
5564.1	Avg	Horz	35.0	34.7	5.9	-35.0	40.5	54.0	13.5	PASS
5564.1	Peak	Vert	49.7	34.7	5.9	-35.0	55.2	74.0	18.8	PASS
5564.1	Avg	Vert	35.0	34.7	5.9	-35.0	40.5	54.0	13.5	PASS
6491.45	Peak	Horz	52.1	35.7	6.9	-35.2	59.5	74.0	14.5	PASS
6491.45	Avg	Horz	39.9	35.7	6.9	-35.2	47.3	54.0	6.7	PASS
6491.45	Peak	Vert	50.5	35.7	6.9	-35.2	57.9	74.0	16.1	PASS
6491.45	Avg	Vert	37.5	35.7	6.9	-35.2	44.9	54.0	9.1	PASS

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 15, 2020	Jan. 15, 2022	GEMC 233
Loop Antenna	EM 6871	Electro-Metrics	Feb 26, 2021	Feb 26, 2023	GEMC 70
Loop Antenna	EM 6872	Electro-Metrics	Feb 26, 2021	Feb 26, 2023	GEMC 71
BiLog Antenna	3142-C	ETS-Lindgren	Mar. 26, 2021	Mar. 26, 2023	GEMC 137
Horn Antenna 1 – 10 GHz	3117	ETS-Lindgren	Feb. 17, 2020	Feb. 17, 2022	GEMC 340
Attenuator 6 dB	6N5W-06	Inmet	NCR	NCR	GEMC 346
Pre-Amp 9 kHz – 1 GHz	CPA9230	Chase	May 22, 2020	May 22, 2022	GEMC 301
Pre-Amp 1 – 26.5 GHz	HP 8449B	HP	Aug. 4, 2020	Aug. 4, 2022	GEMC 312
902-928MHz Notch Filter	BRC50722	Micro-Tronics	NCR	NCR	GEMC 186
0.98GHz HPF	8IH40-980	K & L Microwave	NCR	NCR	GEMC 4256
4GHz HPF	11SH10- 4000/T12000	K & L Microwave	NCR	NCR	GEMC 119
RF Cable <1GHz	LMR-400	LexTec	NCR	NCR	GEMC 27
RF Cable <1GHz	HP305S	Semflex	NCR	NCR	GEMC 310
RF Cable >1GHz	EMC2	MegaPhase	NCR	NCR	GEMC 370
Emissions Software	V2.1.0	TUV SUD Canada, Inc.	NCR	NCR	GEMC 361

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## **Power Spectral Density**

### **Purpose**

The purpose of this test is to ensure that the maximum power spectral density to the radiating element does not exceed the limits specified. This ensures that the modulation is significantly wide enough, or low enough in power that it will allow for co-operation of other wireless devices operating within this frequency allocation.

### **Limits and Method**

The limits are defined in 15.247(f) and RSS-247 5.3(b).

For hybrid systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

The method is given in FCC KDB 558074 Section 8.4 and ANSI C63.10 Section 11.10.3 (AVGPSD-1).


### **Results**

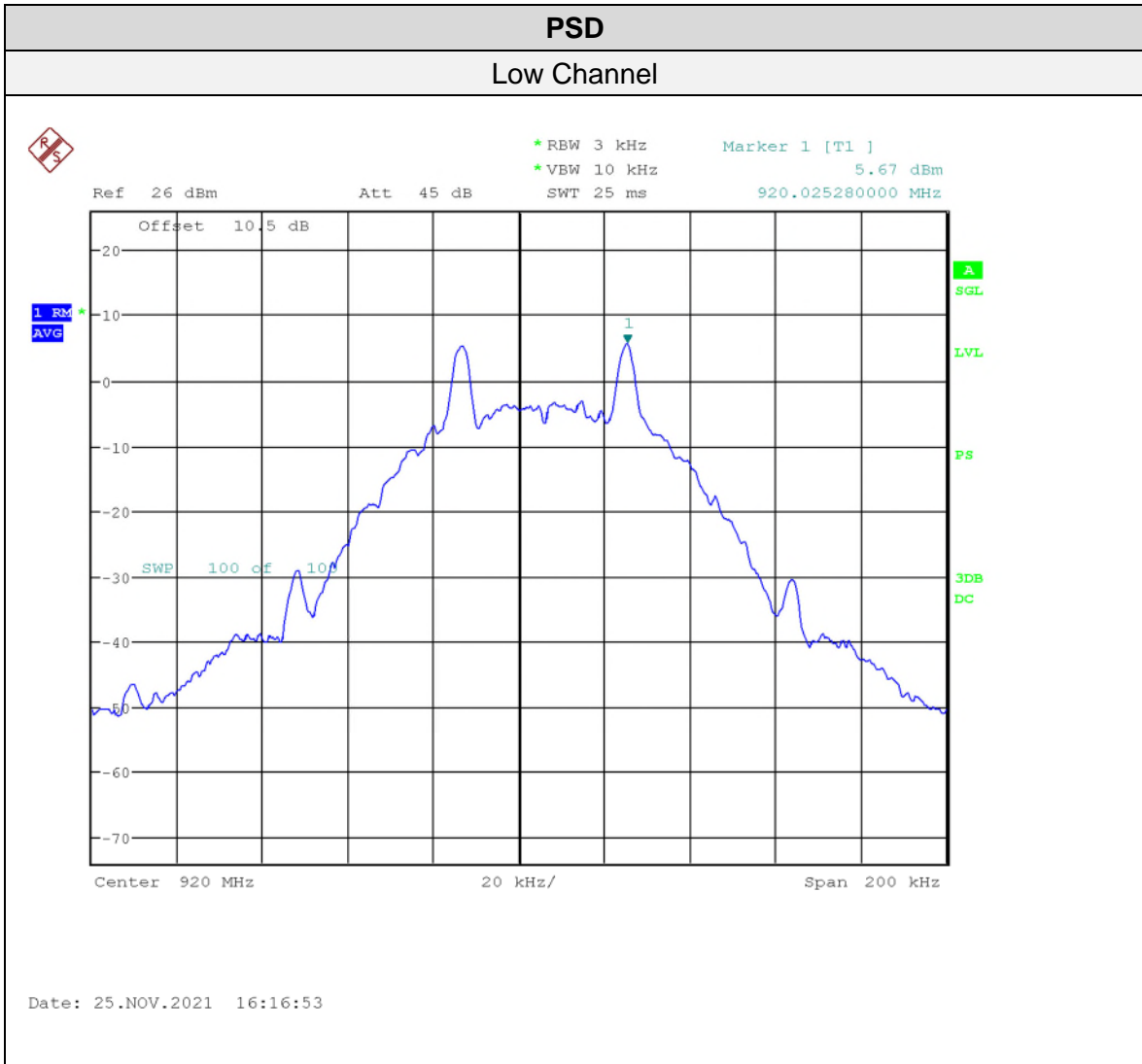
The EUT passed. Low and high bands were measured.

<b>Channel</b>	<b>Frequency (MHz)</b>	<b>PSD (dBm)</b>	<b>Limit (dBm)</b>	<b>Margin (dBm)</b>
Low	920.00	5.67	8	2.33
High	927.35	5.73	8	2.27


### **Graphs**

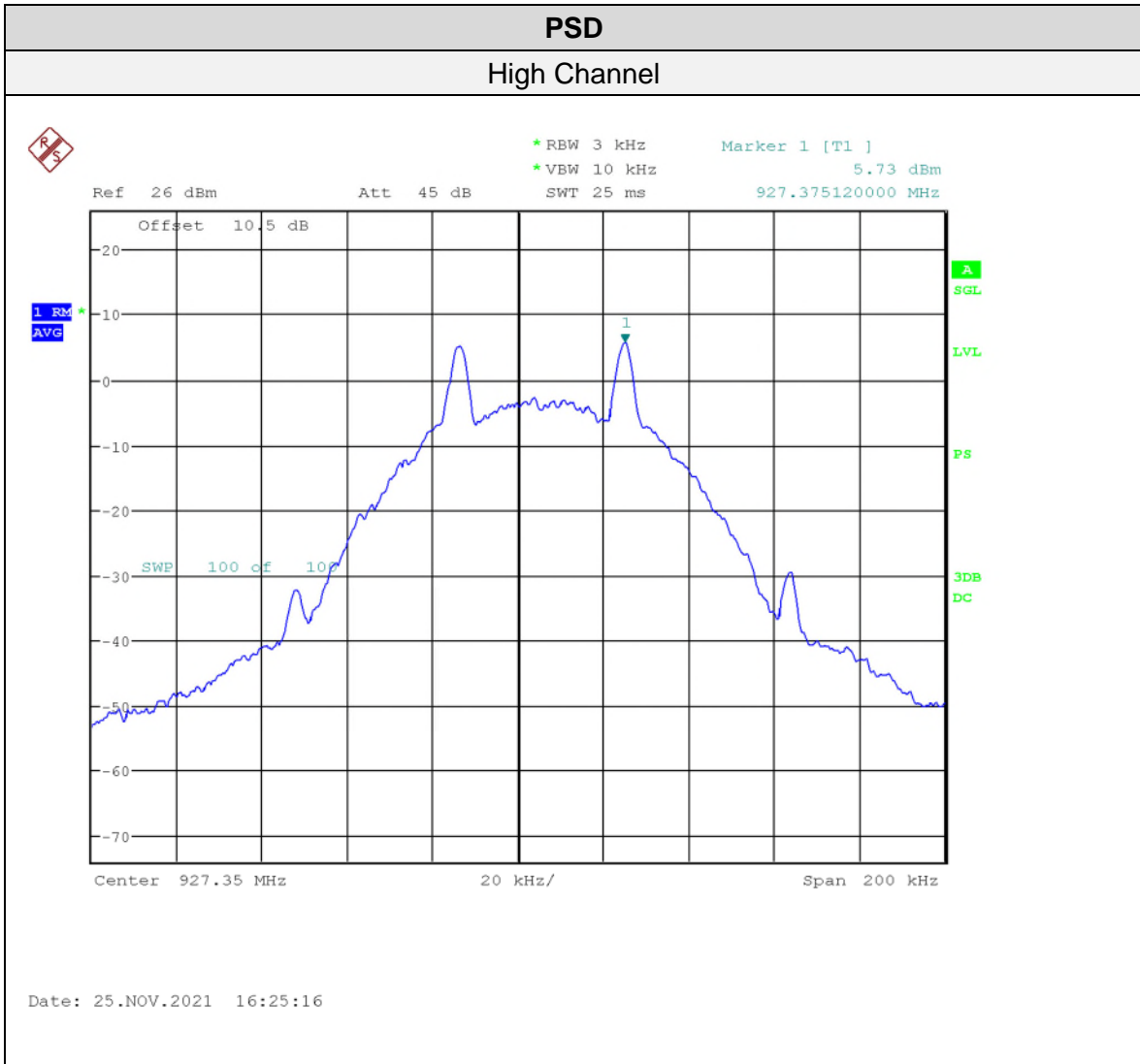
The graphs shown below show the power spectral density of the device during the conducted measurement operation of the EUT. The external attenuator and cable loss are accounted for as reference offset in the spectrum analyzer.

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	






Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	




See 'Appendix B – EUT and Test Setup Photos' for photos showing the test set-up.


Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

### Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 15, 2020	Jan. 15, 2022	GEMC 233
Attenuator 10 dB	8493B	Agilent	Oct 4, 2021	Oct 4, 2022	GEMC133

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Appendix A – EUT Summary


Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

For further details for filing purposes, refer to filing package.

### General EUT Description

<b>Client</b>	
Organization / Address	Ecobee Inc. 25 Dockside Drive. Suite 700 Toronto, ON. M5A 0B5, Canada
Contact	John Russomanno
Phone	416-987-1058
Email	johnr@ecobee.com
<b>EUT Details</b>	
EUT Name	EBERS42 Remote Sensor
FCC ID	WR91881541520
IC	7981A-1881541520
Equipment Category	Unlicensed transmitter
Basic EUT Functionality	Provide room temperature and occupancy sensing to Ecobee smart thermostat
Input Voltage and Frequency	3.0 VDC via CR2477 Lithium cell battery
Connectors available on EUT	None
Peripherals Required for Test	None
Release type	Final
Intentional Radiator Frequency Range	920.00 – 927.35 MHz
Antenna	Custom flex ribbon
Type of Transmitter	Hybrid, Frequency Hopping and Digitally Modulated
Modulation	FSK
EUT Configuration	Test software was configured to transmit continuously at 100% duty cycle and to control hopping through its pseudo random sequence or single channel. Channels tested: Lowest and Highest Power Setting: +12dBm

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated. For a close-up picture of the EUT, see ‘Appendix B – EUT and Test Setup Photos’.

Client	<b>Ecobee Inc.</b>	
Product	<b>EBERS42 Remote Sensor</b>	
Standard(s)	RSS 247 Issue 2:2017 FCC Part 15 Subpart 15.247	

## Appendix B – EUT and Test Setup Photos

Refer to the files separate from this test report