COMPLIANCE TESTING REPORT
FCC TITLE 47 PART 15
SUBPARTS A & C

Client:	Seeley International Pty Ltd
Address:	112 O'Sullivan Beach Road, Lonsdale, SA 5160, Australia
Report Number:	0312SEELEY_MQWC(Controller)_FCC15C
Date of Testing:	9th March to 7th November 2018
File Number:	SEELEY161223
Equipment Name:	MagIQtouch Wireless Smart Controller
Equipment Model Number	MQWC
Equipment Serial Numbers	Not Supplied
Equipment FCC ID:	R2ESIA18
Equipment Description:	MagIQtouch Wireless Smart Controller
Result:	**COMPLIED**
Tested by:	Aaron Fan Test Engineer Joel Mulig Test Engineer Steve Garnham Test Engineer
Report compiled by:	Richard Turner Test Engineer
Approved by:	Colin Gan Assessment Engineer
Date of Issue:	12th March 2019

AUSTEST (NSW) FCC REGISTRATION NUMBER 520620

Results appearing herein relate only to the sample(s) tested.

This report is issued errors and omissions exempt and is subject to withdrawal at Austest Laboratories discretion.

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

ilac-MRA
A2LA ACCREDITED
TEST LABORATORY
CERT #2765.02

Table of Contents:

1 REPORT REVISION HISTORY

Date	Report Number	Changes
4th Dec. 2018	1204SEELEY_MQWC_FCCPT15C	Original report
8th Feb. 2019	0208SEELEY_MQWC(WallControl)_ FCC15C	Removed Gateway from report.
12th Mar. 2019	0312SEELEY_MQWC(Controller)_ FCC15C	Revised EUT name & description; corrections to EUT Description section; removed reference to professional install; incorrect reference in Section 11 amended; tabulated data added to Section 10; continuous transmission statement added to Section 10.1. Additional statement added under Section 10.3.2 Table.

2 REFERENCES

Document	Name	Issue/ Amendments
FCC Title 47 Part 15	FCC Title 47 Part 15 – Radio Frequency Devices	Current as of Nov. 2018
ANSI C63.10	Procedures for Compliance Testing of Unlicensed Wireless Devices - PDF (Personal Use)	2013
KDB 558074	Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules	24th Aug. 2018

3 TEST SUMMARY

Austest makes no claim regarding the consistency of production versions of the EUT.

The results in this report apply only to the tested EUT described in Section 5 of this report.

FCC Section	Test	Result	Notes
FCC Part 15, Subpart C – Intentional Radiators			
15.203	Antenna Requirement	COMPLIED	
15.205	Restricted Bands of Operation	COMPLIED	
15.207	Conducted Limits	NA	(ii)
15.209	Radiated Emission Limits, General Requirements	COMPLIED	(i)
15.215	Additional Provisions to the General Radiated Limitations	COMPLIED	
15.247	Operation within the Bands 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz	COMPLIED	

Notes:
(i) EUT complied (the measurement results were below the applicable limits), but some emissions were within the range of measurement uncertainty of the limits.
(ii) EUT is powered from internal batteries only.

4 MODIFICATIONS

No modifications were required to achieve compliance.

5 EQUIPMENT UNDER TEST (EUT) DESCRIPTION

EUT Name:	MagIQtouch Wireless Smart Controller
EUT Description:	MagIQtouch Wireless Smart Controller
EUT Model:	MQWC
EUT Serial Number:	Not Supplied
EUT FCC ID:	R2ESIA18
Manufacturer:	Seeley International Pty Ltd.
Power Supply & Rating:	4 x 1.5V AA batteries (internal)
Highest Clock/Operating Frequency:	Highest clock, specified by the client – 40MHz Highest possible operating frequency – 927.1MHz (FHSS high channel)
Lowest Internal Frequency source	32.768kHz (Y1) crystal
Transmit Frequency Range:	915.1MHz to 927.1MHz
Transmit Power:	12.4 dBm or 17mW
Modulation Technique:	50kb/s 2-GFSK
Number of Channels:	61
Antenna Specifications:	Permanently connected wire antenna, approx. 7.5cm long

The equipment under test (EUT) was a Wireless Smart Controller for use in the remote control of evaporative air coolers.
The Wireless Smart Controller utilised internal batteries for power.
915MHz to 928MHz FHSS transceiver, Texas Instruments CC125, used with permanently connected 7.5cm long wire antenna.

6 EUT TEST SETUP & CONFIGURATION

Refer to the photographs in APPENDIX C – EUT TEST SETUP PHOTOGRAPHS for the EUT test setup and physical configuration.

Several samples were supplied for testing:

1. Wireless Smart Controller unit with permanent wire antenna fitted. Configured with normal operating firmware for frequency hopping transmission. Note: Unit only transmitted in frequency hopping mode when transmission from the Wireless Receiver was detected.
2. Wireless Smart Controller unit with permanent wire antenna fitted. Configured with test firmware to enable constant transmission at selected low, middle and high channels.
3. Wireless Smart Controller unit with permanent wire antenna removed and replaced with 50Ω SMA coaxial cable connection at the transceiver output. Configured with test firmware to enable constant transmission at selected low, middle and high channels.

Transmitter power settings were as supplied by the client.

The following cables and auxiliary equipment as supplied by the client were used:

6.1 Supporting Equipment

No supporting equipment.

6.2 Cables

No ports for connection to external cabling.

7 TEST SPECIFICATIONS

7.1 Accreditations & Listings

Austest Laboratories (NSW)'s test facilities are accredited with the FCC under the ACMA-FCC APEC-TEL MRA. Designation Number AU0003 / Registration number 520620.

Austest Laboratories Castle Hill test facilities are accredited by A2LA for CFR 47 FCC Part 15 subparts B and C using ANSI C63.4.2014 and C63.10:2013. The tests reported herein have been performed in accordance with its terms of accreditation.

7.2 Deviations from Standards and/or Accreditations

None.

7.3 Test Facility

Testing was performed at Austest Laboratories, 2/9 Packard Avenue, Castle Hill, NSW 2154, Australia

7.4 Test Equipment

Calibration traceable to Australian National standards or international equivalents. Equipment performance verified prior to use.

Type	Model	Cal. Date	Cal. Due
Spectrum Analyser	Agilent E4440A	08/02/17	08/02/19
Biconical Array Antenna	EM6912	07/12/16	07/12/18
Log Periodic Array Antenna	EM3146	02/05/17	02/05/19
DRG Horn Antenna	AH Systems SAS-571	17/08/17	17/08/20
Preamp (30MHz – 1GHz)	Rall RE-1200A	07/11/17	07/11/19
Preamp (1GHz – 18.GHz)	Com-Power PAM-118A	21/11/17	21/11/19
High Pass Filter	WHKX1.3/15G-6SS	09/06/16	09/06/19
Semi-Anechoic Chamber	Frankonia SAC3	Verified	

Type	Model	Cal. Date	Cal. Due
6dB Attenuator	Weinschel Corp	08/09/15	08/09/18
10dB Attenuator	Mini Circuits BW-N10W5	Verified	
AC Source	California Inst. CSW 5500	31/08/17	31/08/19
Close-Field Probe	Com-Power	Verified	
EMI measurement software	Teseq Compliance 5	Verified	

7.5 Measurement Uncertainties

The following uncertainties are for a 95% level of confidence, based on a coverage factor, k=2.

Test	Measurement Uncertainty
RF Frequency	±5 part in 10^{10}
RF power conducted	±1.3dB
RF power radiated	±4.7dB
Humidity	±2%
Temperature	±0.8 ºC
Mains Port Conducted Emissions-AMN	±2.6dB

8 Section 15.203 – ANTENNA REQUIREMENT

The EUT complied with the requirement of this Section since integral wire antenna was used with no end-user accessible coaxial antenna port.

9 Section 15.205 – RESTRICTED BANDS OF OPERATION

The EUT complied with the requirements of this Section since it did not operate within the listed Restricted Bands of Operation. Out of band emissions falling within the Restricted Bands of Operation were found to be below limits specified in section 15.209.

10 Section 15.209 - RADIATED EMISSION LIMITS, GENERAL REQUIREMENTS

Test Dates:	09/03/18, 10/04/18, 17/04/18, 24/05/18, 05/07/18, 06/07/18, 24/10/18	Temperature:	20-26°C
Test Officers:	Joel Mulig / Aaron Fan / Steve Garnham	Humidity:	54-68%
Test Location:	Austest Laboratories (Castle Hill and Yarramalong)		

Measurements below 30MHz took place at the Austest OATS facility at Yarramalong.
Measurements above 30MHz took place at the Austest SAC facility at Castle Hill.

10.1 EUT Operating Mode

Refer to section 5.
Tests were performed on the Wireless Smart Controller unit with permanent wire antenna fitted. Configured with test firmware to enable constant transmission at selected low, middle and high channels. Transmission was continuous with >98% duty cycle.
The Wireless Smart Controller was powered by four fully charged 1.5V AA batteries.

10.2 Test Method

a. Measurements were performed in accordance with ANSI C63.10-2013.
b. The measuring receiver BW settings were:
   i. 9kHz (150kHz to 30MHz) EMI Receiver RBW.
   ii. 120kHz (30MHz to 1GHz) EMI Receiver RBW.
   iii. 1MHz (above 1GHz) RBW, 1MHz or more VBW, using a Spectrum Analyser for Peak measurements.
   iv. 1MHz (above 1GHz) RBW, 10Hz VBW with linear detection, using a Spectrum Analyser for Average measurements.
c. The EUT was positioned on a non-conductive turntable, 0.8m (for measurements up to 1GHz) and 1.5m (for measurements above 1GHz) above a conductive ground plane and at the indicated test distance away from the measuring antenna.
d. Emissions were maximised by rotating the EUT through 360° and varying the measuring antenna height between 1m to 4m in the following antenna orientations:
   i. Loop antenna (150kHz to 30MHz) – Coaxial and coplanar orientations.
   ii. Biconical and Log-Periodic antennas (30MHz to 1GHz) - Both vertical and horizontal polarizations.
   iii. Horn antenna (above 1GHz) - Both vertical and horizontal polarizations.

e. The maximised emission levels were measured and the above process repeated for all measurement frequencies.
f. Average level measurements were not made where the peak level did not exceed the average limit.
g. The linearity of the measuring system was checked, reducing gain when required.

10.3 Test Results

10.3.1 Radiated Disturbances: 9kHz to 150kHz

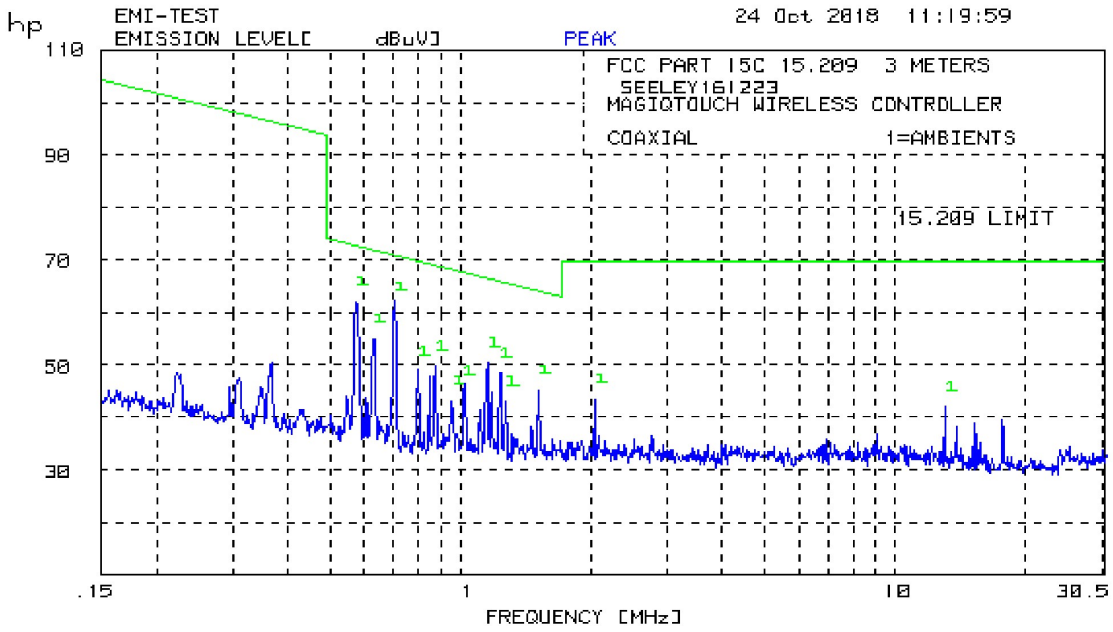
Preliminary measurements indicated no significant intentional emission levels below 150kHz. All intentional radiation emission levels were greater than 20dB below the limits specified in section 15.209.

10.3.2 Radiated Disturbances: 150kHz to 30MHz

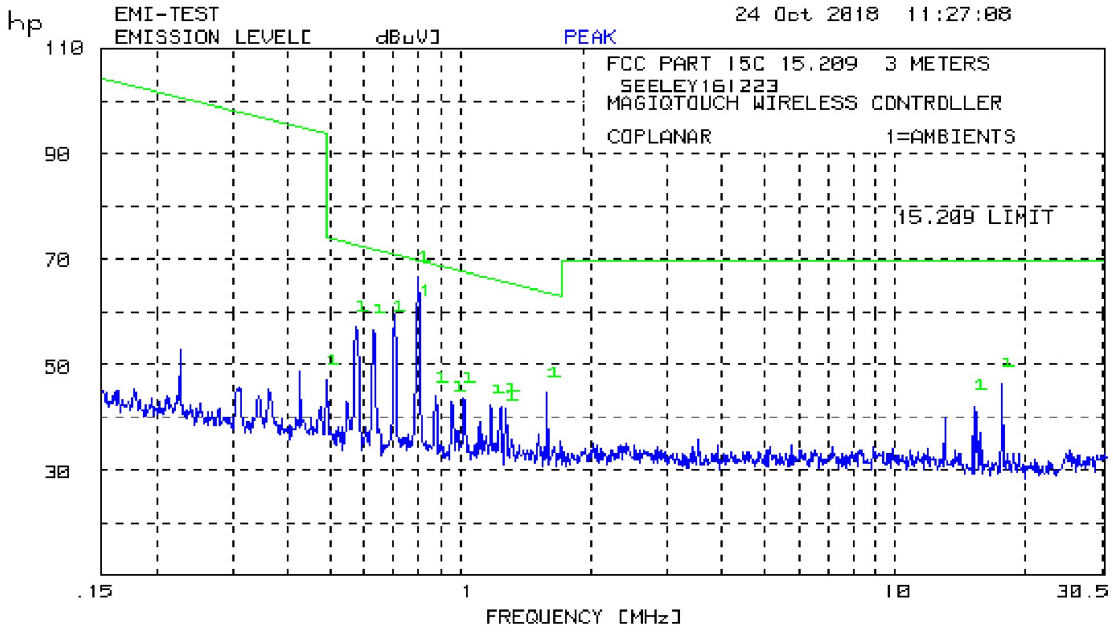
The Wireless Smart Controller was tested with a supporting Wireless Receiver with both being placed on the test table.
Measurement distance 3m.
Note: Limit lines on the following plots reflect use of a 40dB/decade correction, as per section 15.31 (f) (2).

Frequency (MHz)	Antenna Pol.	Measured QP Level @ 3m (dBµV/m)	QP Limit @ 30m (dBµV/m)	QP Pass Margin (dB)
All measured emission levels were greater than 20dB below limits specified in section 15.209.				

Since no emissions were found below 30MHz, comparison of Open Field Site (OFS) and OATS measurements yield noise floor profiles only, giving similar results when addressing comparison of OFS and OATS per KDB 414788.



Radiated Emissions Plot (Coaxial Orientation, 150kHz to 30MHz)



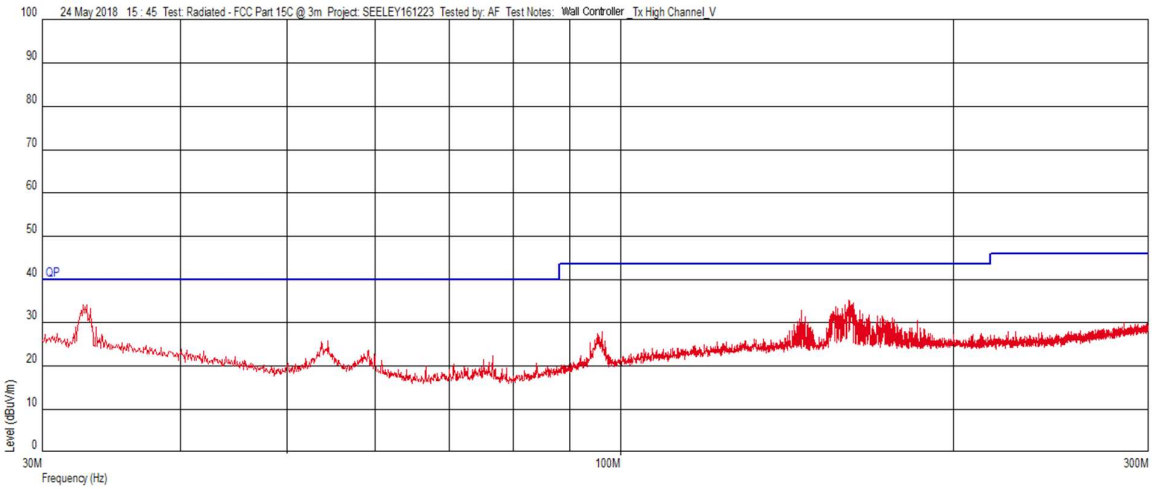
Radiated Emissions Plot (Coplanar Orientation, 150kHz to 30MHz)

10.3.3 Radiated Disturbances: 30MHz to 1000MHz

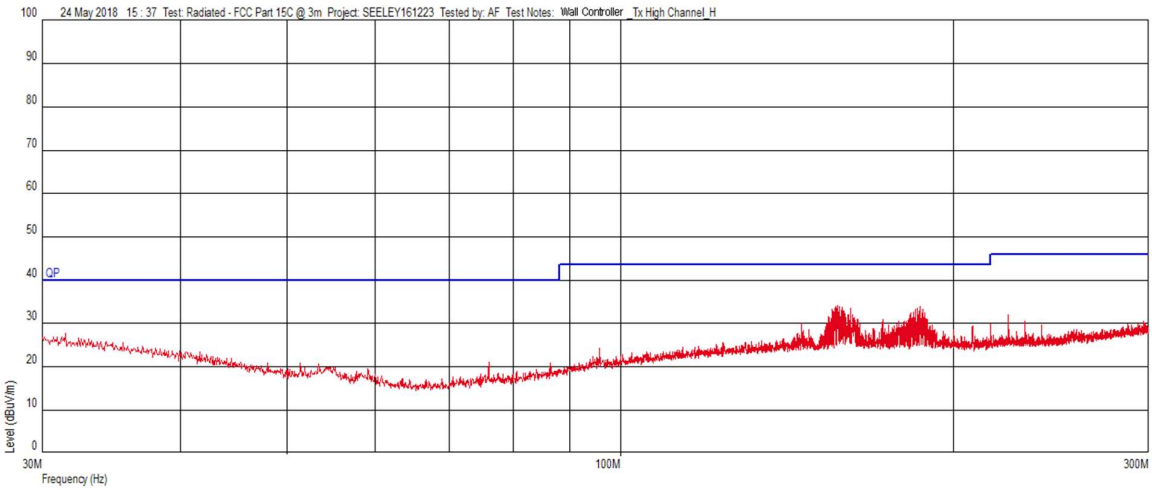
Measurement distance: 3m.

Frequency (MHz)	Antenna Pol.	Measured QP Level @ 3m (dBµV/m)	QP Limit @ 3m (dBµV/m)	QP Pass Margin (dB)
All measured emission levels within the restricted bands of operation (section 15.205) were greater than 20dB below limits specified in section 15.209.				
Measured emission levels outside the restricted bands of operation are addressed by compliance with section 15.247 (d) as follows:				
907.1250	H	45.61	63.09*	-17.48
911.0954	H	40.02	63.09*	-23.07
913.1269	H	45.38	63.09*	-17.71
923.1197	H	39.01	63.09*	-24.08
929.1174	H	41.97	63.09*	-21.12
935.0954	H	42.00	63.09*	-21.09

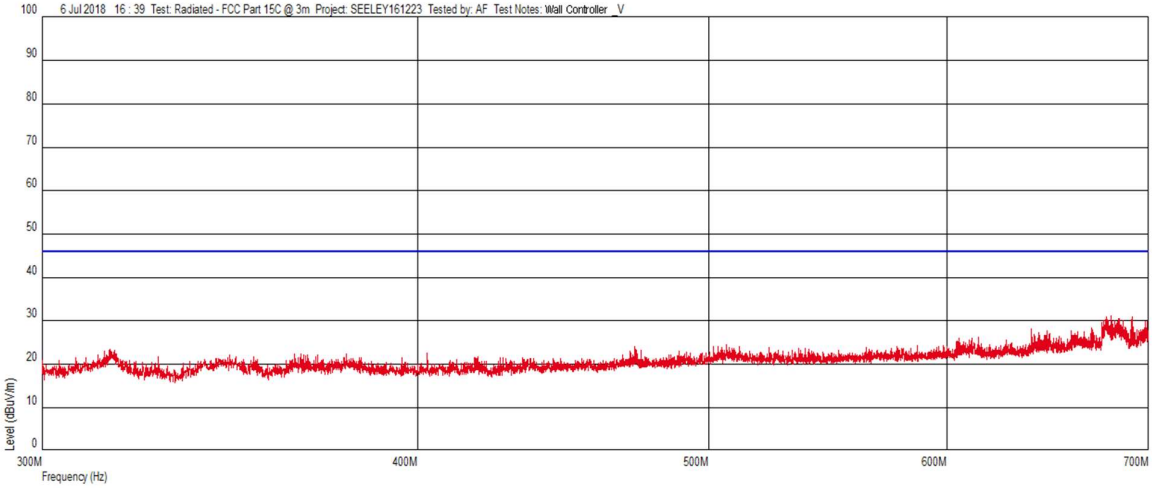
* The worst-case QP Limit @ 3m was determined by taking the minimum measured level of the intended signal @ 3m – 20dB, i.e. 83.09dBµV/m – 20dB = 63.09dBµV/m.



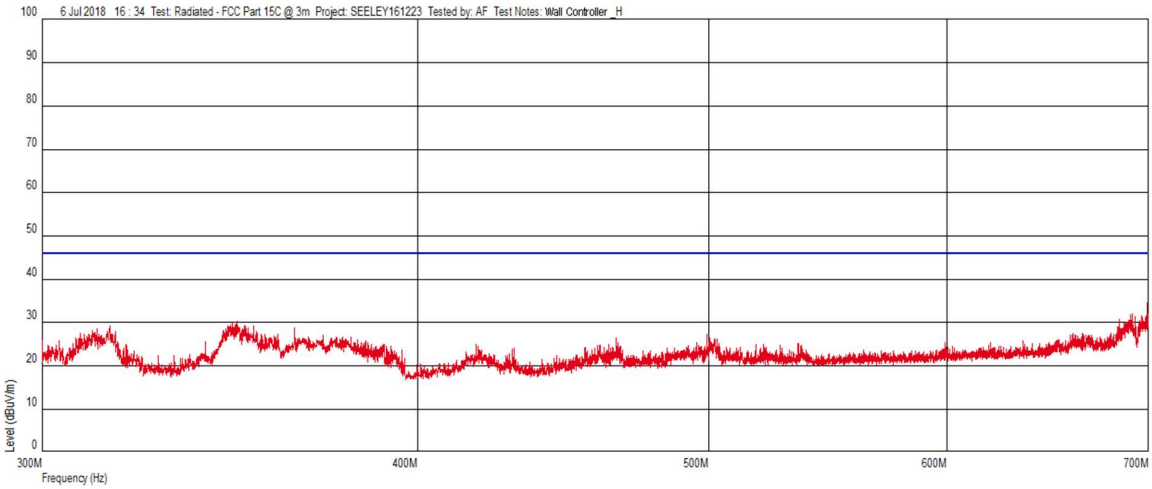
Radiated Emissions Plot (Vertical Polarisation, 30MHz to 300MHz)



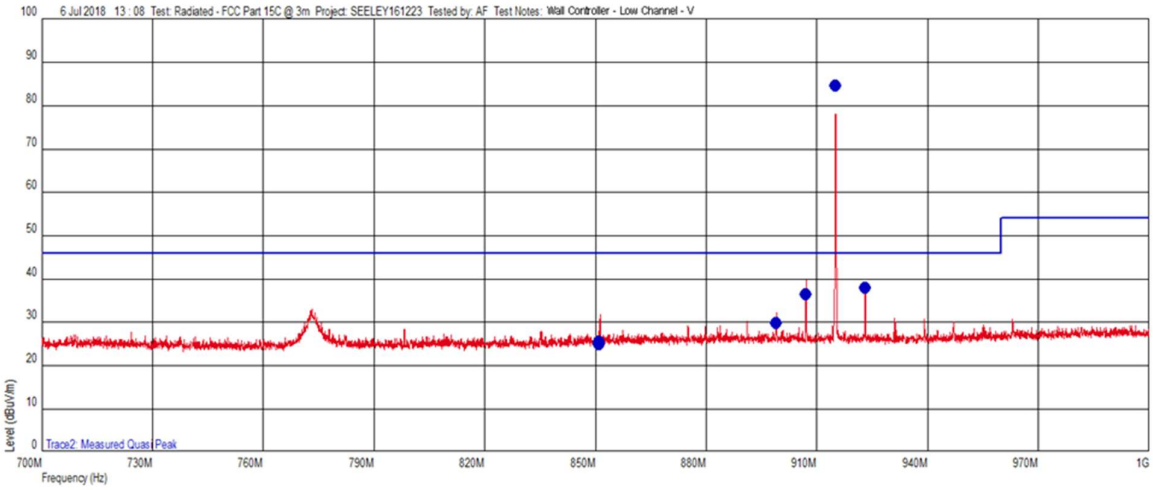
Radiated Emissions Plot (Horizontal Polarisation, 30MHz to 300MHz)



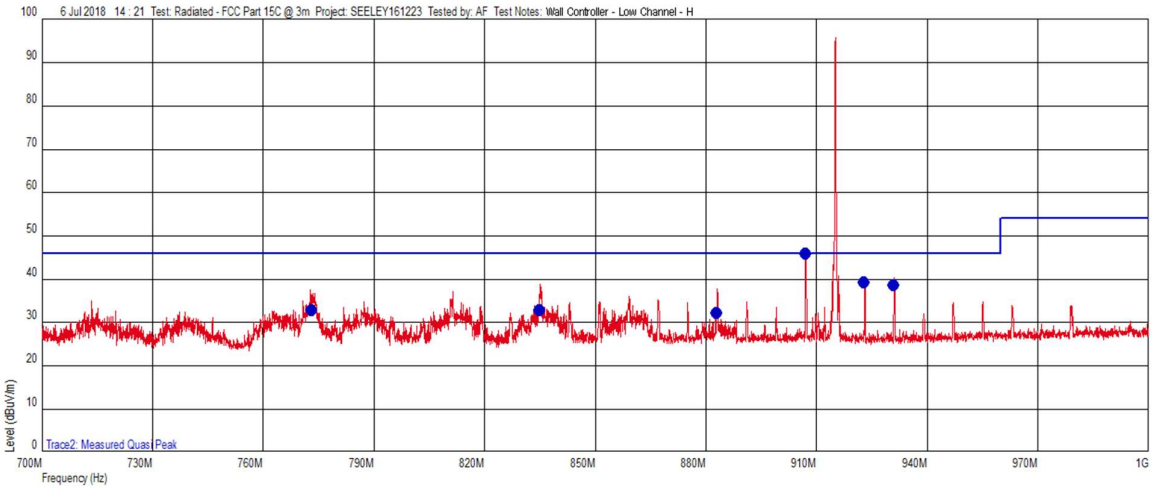
Radiated Emissions Plot (Vertical Polarisation, 300MHz to 700MHz)



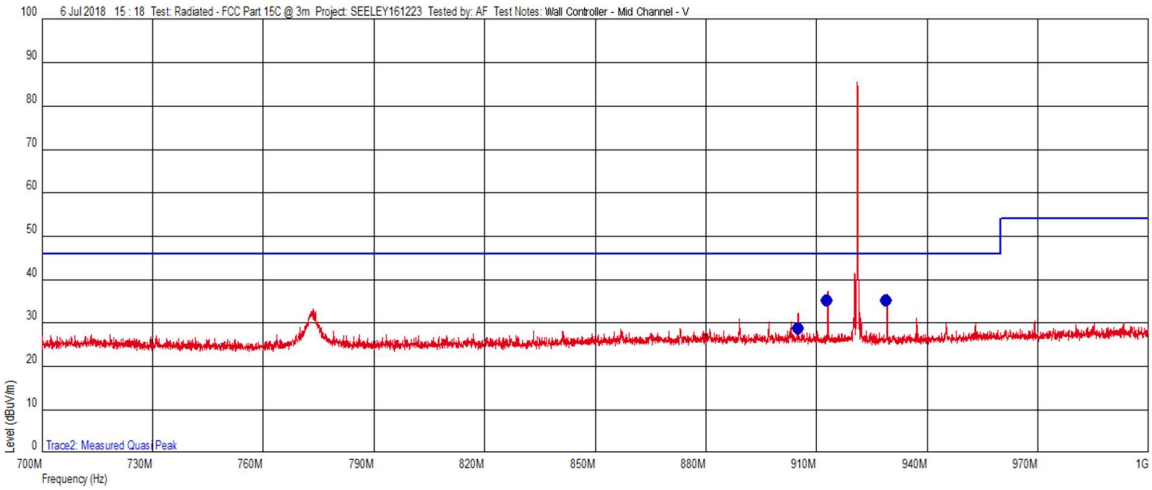
Radiated Emissions Plot (Horizontal Polarisation, 300MHz to 700MHz)



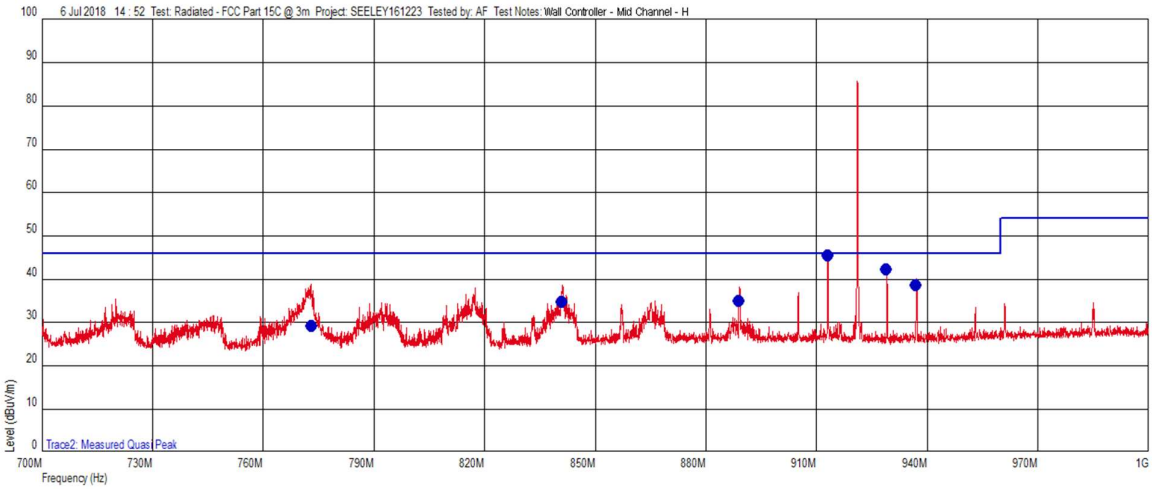
Radiated Emissions Plot (Vertical Polarisation, 700MHz to 1000MHz, Low Channel)



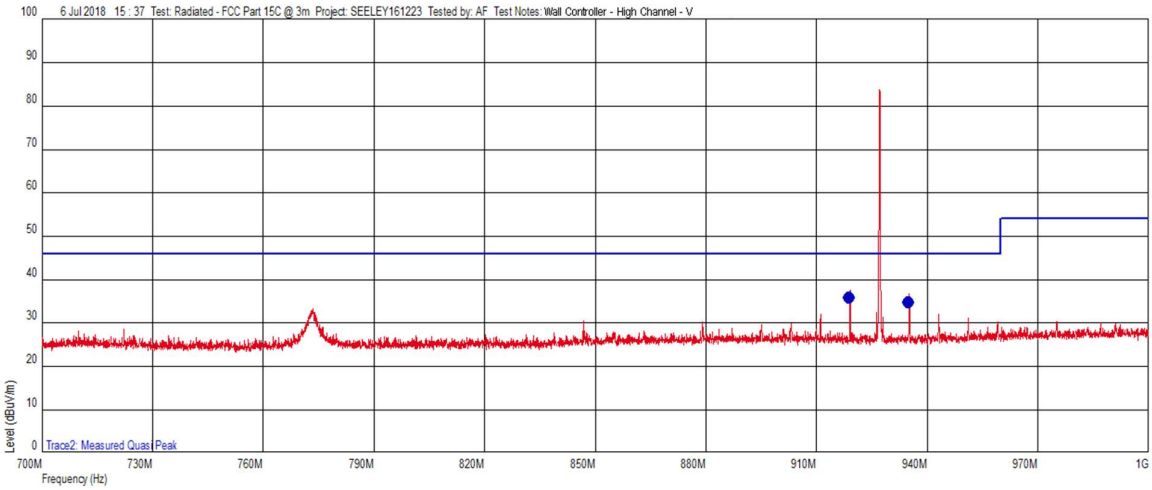
Radiated Emissions Plot (Horizontal Polarisation, 700MHz to 1000MHz, Low Channel)



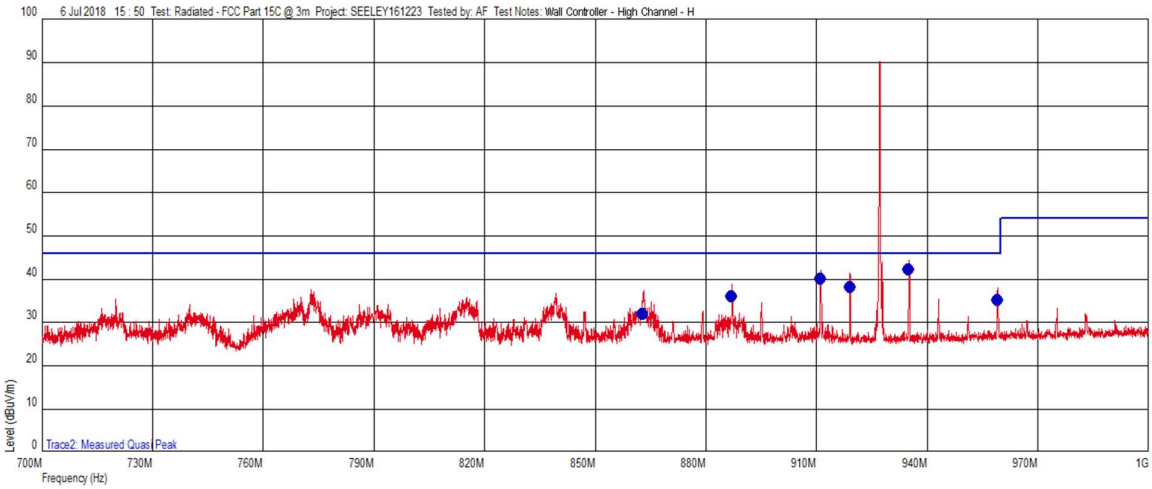
Radiated Emissions Plot (Vertical Polarisation, 700MHz to 1000MHz, Middle Channel)



Radiated Emissions Plot (Horizontal Polarisation, 700MHz to 1000MHz, Middle Channel)



Radiated Emissions Plot (Vertical Polarisation, 700MHz to 1000MHz, High Channel)



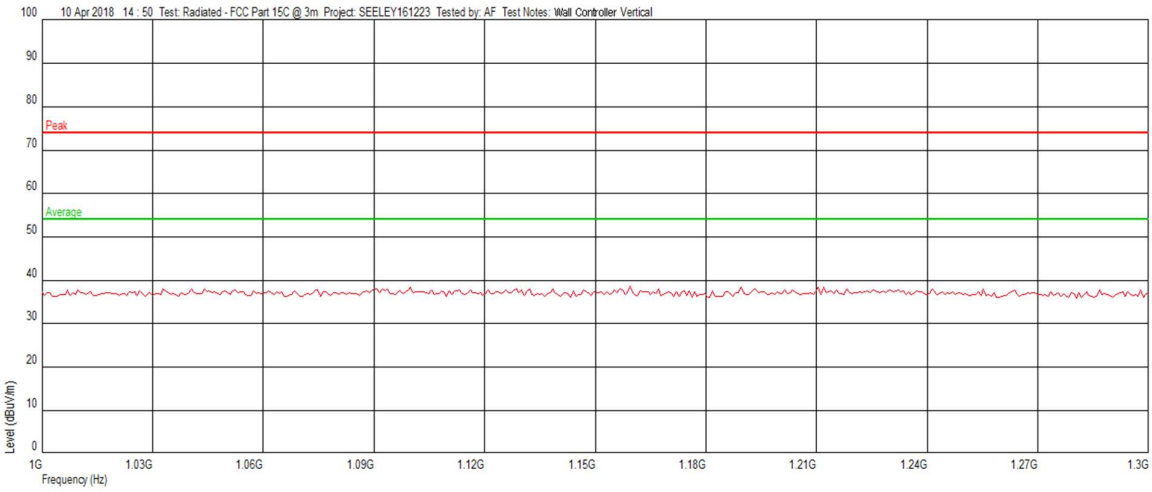
Radiated Emissions Plot (Horizontal Polarisation, 700MHz to 1000MHz, High Channel)

10.3.4 Radiated Disturbances: 1000MHz to 9300MHz

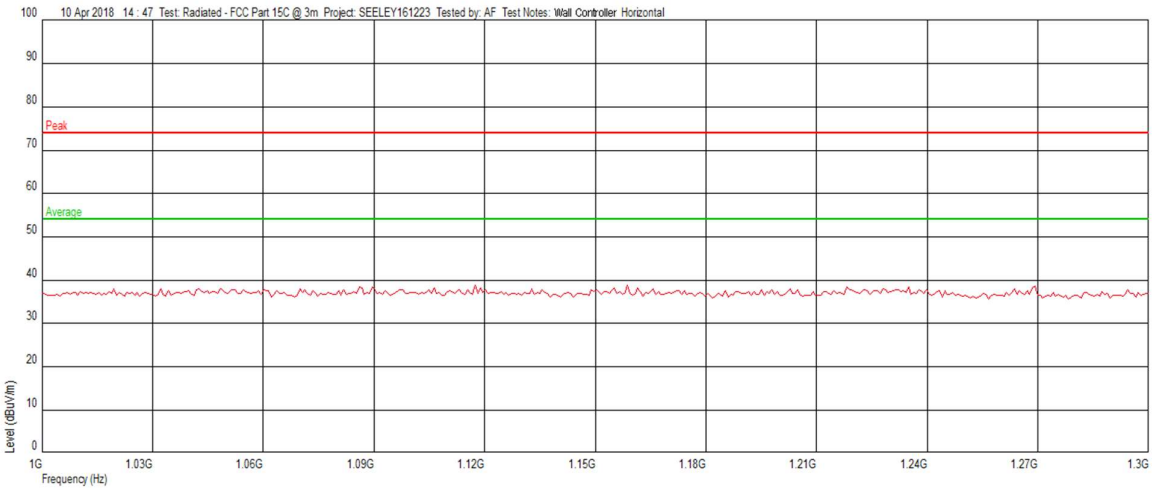
Measurement distance: 3m.

Frequency (GHz)	Antenna Pol.	Measured AV Level @ 3m (dBµV/m)	AV Limit @ 3m (dBµV/m)	AV Pass Margin (dB)
Measured emission levels within the restricted bands of operation against limit specified in section 15.209 as follows:				
3.7083	H	50.50	54	-3.50**
3.6844	H	48.80	54	-5.20
3.7086	V	47.90	54	-6.10
3.6603	V	47.70	54	-6.30
3.6607	H	45.50	54	-8.50
Measured emission levels outside the restricted bands of operation are addressed by compliance with section 15.247 (d) as follows:				
1.8541	H	45.70	63.09*	-17.39

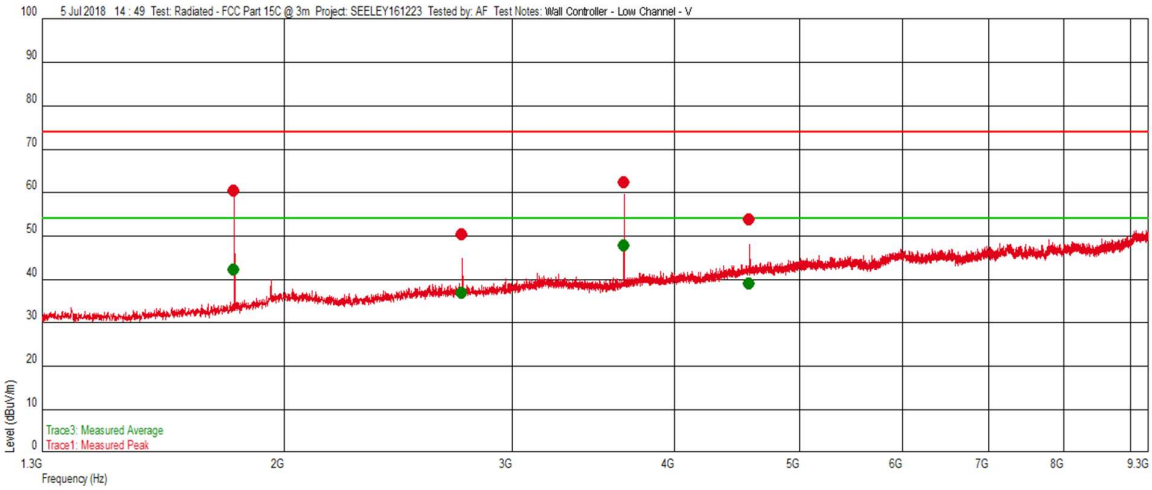
* The worst-case QP Limit @ 3m was determined by taking the minimum measured level of the intended signal @ 3m – 20dB, i.e. 83.09dBµV/m – 20dB = 63.09dBµV/m.
** Result was within the laboratory's measurement uncertainty.



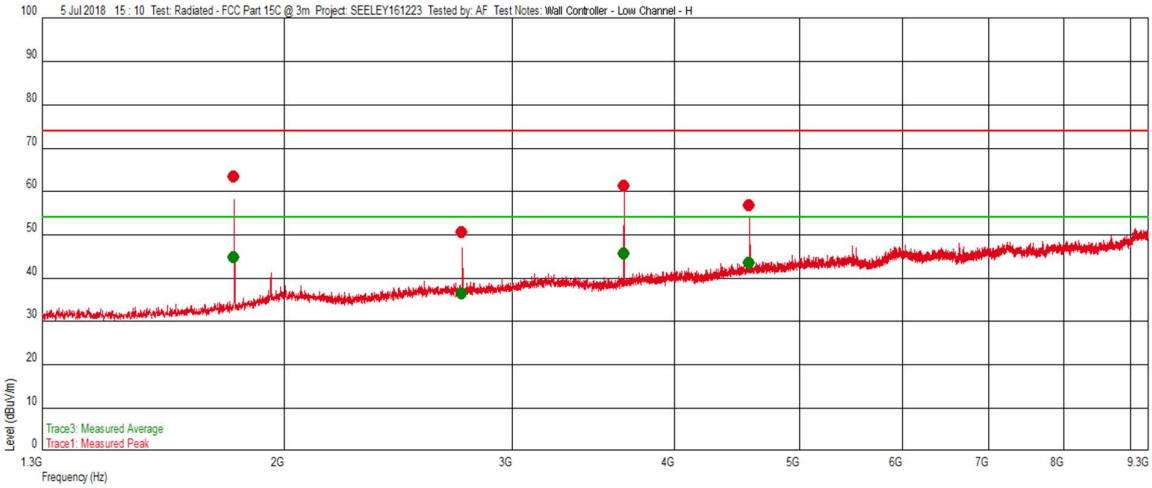
Radiated Emissions Plot (Vertical Polarisation, 1000MHz to 1300MHz)



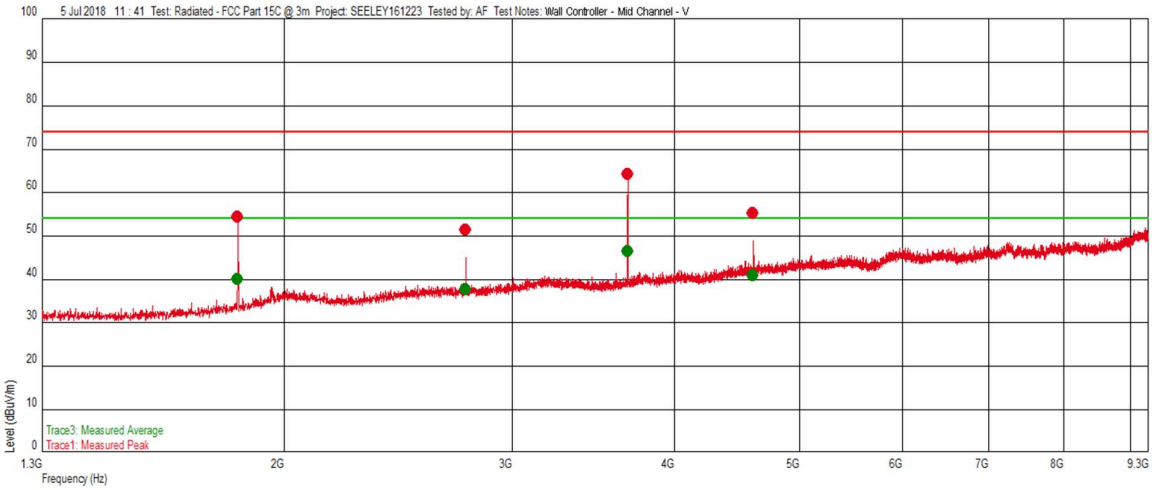
Radiated Emissions Plot (Horizontal Polarisation, 1000MHz to 1300MHz)



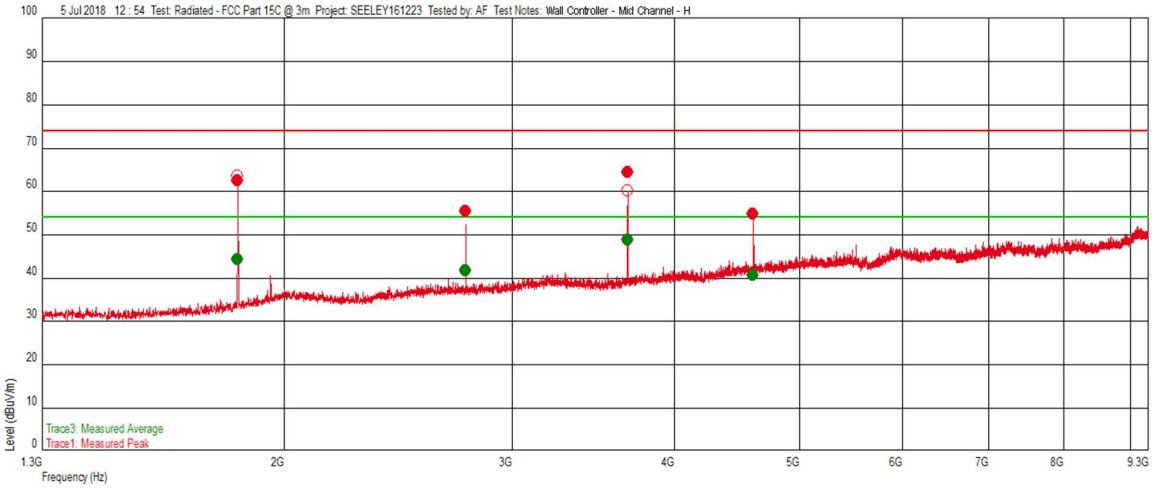
Radiated Emissions Plot (Vertical Polarisation, 1300MHz to 9300MHz, Low Channel)



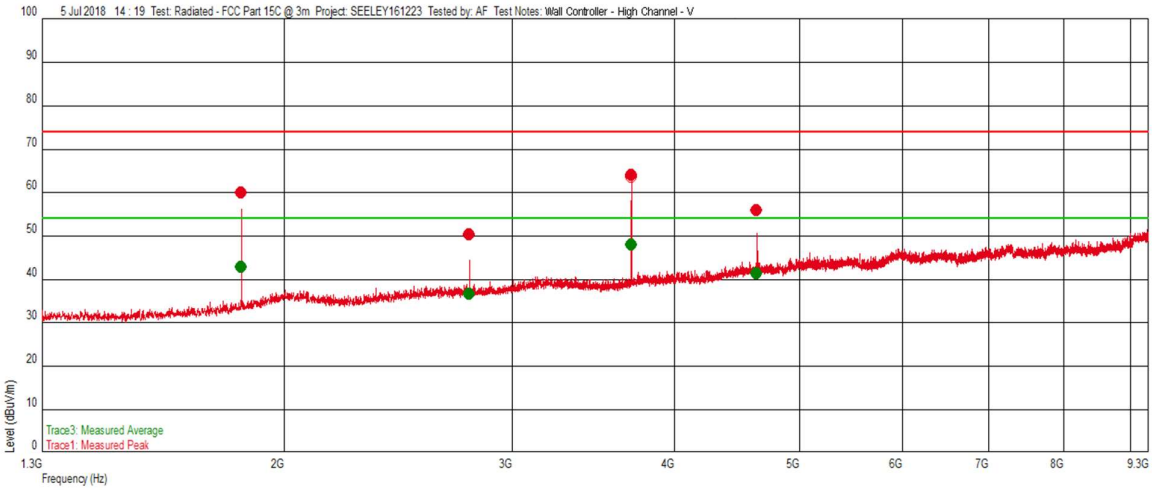
Radiated Emissions Plot (Horizontal Polarisation, 1300MHz to 9300MHz, Low Channel)



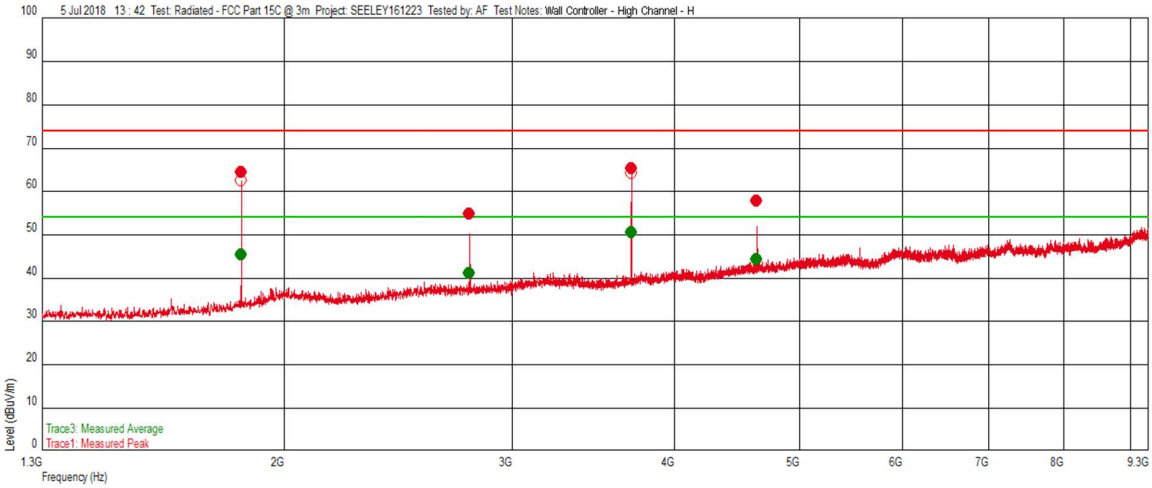
Radiated Emissions Plot (Vertical Polarisation, 1300MHz to 9300MHz, Middle Channel)



Radiated Emissions Plot (Horizontal Polarisation, 1300MHz to 9300MHz, Middle Channel)



Radiated Emissions Plot (Vertical Polarisation, 1300MHz to 9300MHz, High Channel)



Radiated Emissions Plot (Horizontal Polarisation, 1300MHz to 9300MHz, High Channel)

11 FCC Part 15C, Section 15.215 – ADDITIONAL PROVISIONS TO THE GENERAL RADIATED EMISSION LIMITATIONS.

20dB Bandwidth

The 20dB bandwidth was within the allowed band of operation between 902MHz and 928MHz. Refer to measurement results indicated in section 12.1.3 of this report.

F_{LOW} = 915.051MHz (low channel)
F_{HIGH} = 927.144MHz (high channel)

EUT COMPLIED.

12 FCC Part 15C, Section 15.247 – OPERATION WITHIN THE BANDS 902-928MHz, 2400-2483.5MHz, AND 5725-5850MHz

12.1 20dB Bandwidth - Section 15.247(a)(1)(i)

Test Date:	11/07/18, 03/10/18	Temperature:	18-20ºC
Test Officer:	Aaron Fan	Humidity:	47%-53%,
Test Location:	Austest Laboratories (Castle Hill)		

12.1.1 EUT Operating Mode

Refer to section 5.
Tests were performed on the Wireless Smart Controller unit with permanent wire antenna removed and replaced with 50Ω SMA coaxial cable connection at the transceiver output. Configured with test firmware to enable constant transmission at selected low, middle and high channels.
The Wireless Smart Controller was powered by four fully charged 1.5V AA batteries.

12.1.2 Test Method

a. Measurements were performed in accordance with ANSI C63.10 clause 6.9.2.
b. Using a modified sample with antenna disconnected and coaxial cable connected at the transceiver output, the EUT transceiver output was connected to a spectrum analyser via a low loss RF cable, and attenuator (as necessary).
c. Spectrum analyser RBW was set to 3kHz, VBW 10kHz.
d. The spectrum analyser automated xdB bandwidth measurement function was employed. xdB set to -20.0.
e. Measurements were repeated for the low, middle and high channels.

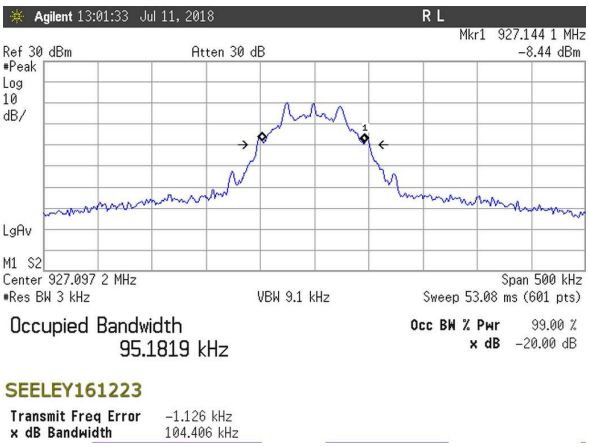
12.1.3 Test Results

Limit: The maximum allowed 20 dB bandwidth of the hopping channel was 500 kHz.

Channel	20dB Bandwidth (kHz)	Result
Low	102.841	COMPLIED
Middle	104.036	COMPLIED
High	104.406	COMPLIED

20dB BW - Low Channel

20dB BW – Middle Channel



20dB BW – High Channel

12.2 Channel Separation - Section 15.247(a)(1)(i)

Test Date:	11/07/18, 25/07/18	Temperature:	20ºC, 26ºC
Test Officer:	Aaron Fan	Humidity:	53%, 67%
Test Location:	Austest Laboratories (Castle Hill)		

12.2.1 EUT Operating Mode

Refer to section 5.
Tests were performed on the Wireless Smart Controller unit with permanent wire antenna fitted. Configured with normal operating firmware for frequency hopping transmission.
The Wireless Smart Controller was powered by four fully charged 1.5V AA batteries.

12.2.2 Test Method

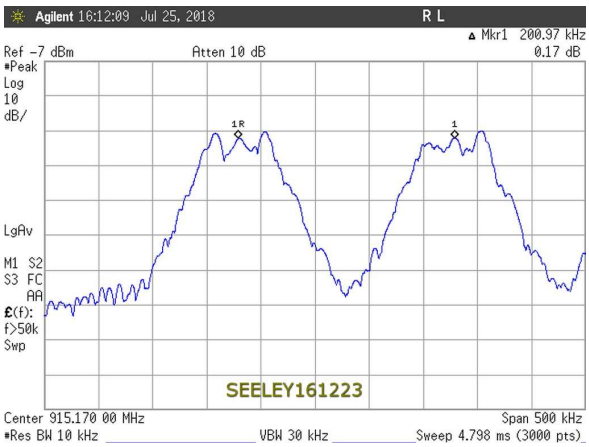
Note that measurements were made on units with permanent wire antenna fitted configured for normal frequency hopping transmission.
For the Wireless Smart Controller, normal hopping function could only be initiated when transmission from a supporting Wireless Receiver was detected. Communication was established with the Wireless Receiver. A near field probe, positioned close to the controller and connected to a spectrum analyser, was used to capture the transmission.

a. Measurements were performed in accordance with ANSI C63.10 clause 7.8.2.
b. Spectrum analyser RBW was set to 3kHz, VBW 10kHz.
c. Peak frequencies of adjacent channels were marked and frequency separation compared to the limit.
d. Measurements were repeated for the low, middle and high channels.

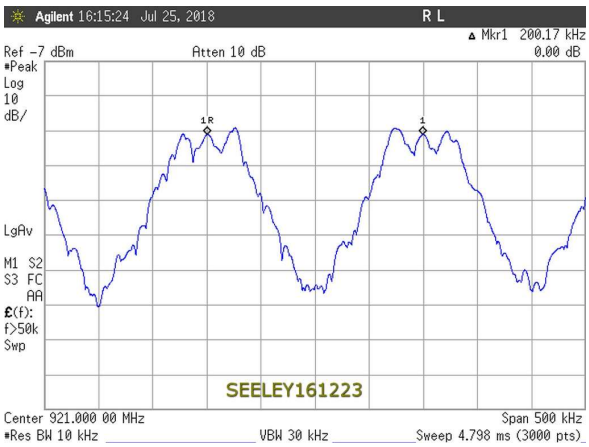
12.2.3 Test Results

Limit: Channel separation to be greater than 25kHz or the 20dB bandwidth of the hopping channel.

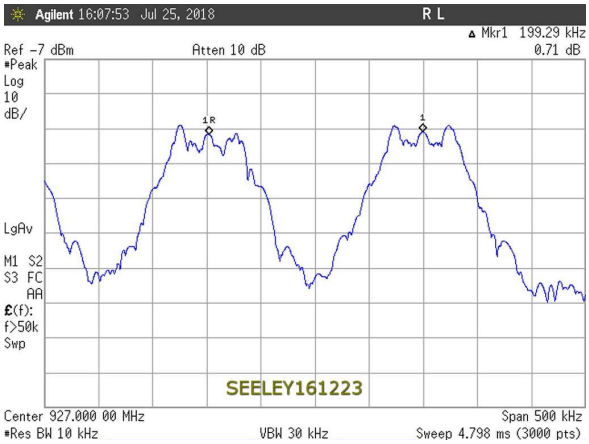
Channels	Separation (kHz)	20dB bandwidth (kHz)	Result
Low	201.0	102.8	COMPLIED
Medium	200.2	104.0	COMPLIED
High	199.3	104.4	COMPLIED



Ch Separation - Low Channel



Ch Separation – Middle Channel



Ch Separation – High Channel

12.3 Pseudorandom Frequency Hopping Sequence - Section 15.247(a)(1)

The client provided the following description:

There are 61 frequencies used.
A table is created that has each frequency in it once.
A polynomial random number generator is seeded with the Unique ID of the installation. No two networks have the same 32 but Unique ID.
Each entry in the table is swapped with another entry chosen at random. So finally, there is a list which has each frequency in it exactly 1 time and that pattern is nearly unique among all possible Unique ID's. The jumbled table of frequencies is used sequentially. Each new TX session starts on the next frequency and only exists on the one frequency (short burst). This ensures the equal use of frequencies is satisfied. The table entry swapping ensures the short term distribution of frequencies is met.
Code Snippet

```
static void setseed(unsigned long s)
{   seed = s;}
static unsigned long random32()
{  seed ^= seed << 13;
  seed ^= seed >> 17;
  seed ^= seed << 5;
  return seed;}
…
//  Setup the sequence of frequencies
setseed(pair_information.receiver_radio_link);
for (i = 0 ; i < NUM_FREQUENCIES ; i++)
    rf_link_freq_table_index[i] = i;
for (i = 1 ; i < NUM_FREQUENCIES ; i++)
{   k = rf_link_freq_table_index[i];
    j = (random32() % (NUM_FREQUENCIES-1)) + 1;
    rf_link_freq_table_index[i] = rf_link_freq_table_index[j];
    rf_link_freq_table_index[j] = k;}
```

pair_information.receiver_radio_link is the Unique ID

12.4 Equal Hopping Frequency Use- Section 15.247(a)(1)

Refer to client's description in section 12.3 of this report.

12.5 System Receiver Input Bandwidth- Section 15.247(a)(1)

The client provided the following statement:

Receiver Bandwidth is 125KHz which after the spectral spread caused by the 2-GFSK modulation and allowing 25KHz for frequency error is the bandwidth that matches the transmitted signal.

12.6 System Receiver Hopping Capability- Section 15.247(a)(1)

The client provided the following statement:

The receiver knows the Unique ID as it is in the message and does not change. The receiver knows the time since the last received message. The receiver knows the frequency of the last received message. The receiver calculates the same jumbled table of frequencies of the transmitter. By knowing the time difference, it knows how many steps have progressed and knows the frequency to receive on. Part of the protocol ensures that time is synchronized across devices in the system.

12.7 Number of Hopping Frequencies - Section 15.247(a)(1)(i)

Test Date:	11/07/18, 25/07/18	Temperature:	26°C
Test Officer:	Aaron Fan	Humidity:	67%
Test Location:	Austest Laboratories (Castle Hill)		

12.7.1 EUT Operating Mode

Refer to section 5.
Tests were performed on the Wireless Smart Controller unit with permanent wire antenna fitted. Configured with normal operating firmware for frequency hopping transmission.
The Wireless Smart Controller was powered by four fully charged 1.5V AA batteries.

12.7.2 Test Method

Note that measurements were made on units with permanent wire antenna fitted configured for normal frequency hopping transmission.
For the Wireless Smart Controller, normal hopping function could only be initiated when transmission from a supporting Wireless Receiver was detected. Communication was established with the Wireless Receiver. A near field probe, positioned close to the controller and connected to a spectrum analyser, was used to capture the transmission.

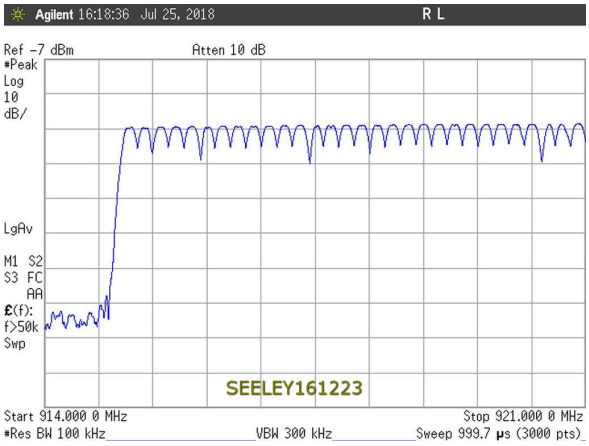
a. Measurements were performed in accordance with ANSI C63.10 clause 7.8.3.
b. Spectrum analyser RBW was set to 100kHz, VBW to 300kHz.
c. Spectrum analyser trace was set to max hold to enable capture of all hopping channels.
d. Number of hopping channels were then counted.
e. Multiple trace captures maybe required to facilitate easier counting of channels.

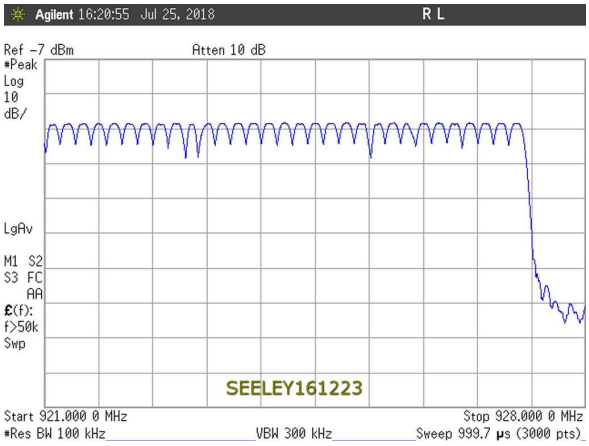
12.7.3 Test Results

Limit: If the 20dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.

20dB bandwidth <250kHz
Total number of channels counted: 61

EUT COMPLIED.





Number of Channels

12.8 Time of Occupancy (Dwell Time) - Section 15.247(a)(1)(iii)

Test Date:	07/11/2018	Temperature:	26°C
Test Officer:	Aaron Fan	Humidity:	67%
Test Location:	Austest Laboratories (NSW)		

12.8.1 EUT Operating Mode

Refer to section 5.
Tests were performed on the Wireless Smart Controller unit with permanent wire antenna fitted. Configured with normal operating firmware for frequency hopping transmission.
The Wireless Smart Controller was powered by four fully charged 1.5V AA batteries.

12.8.2 Test Method

Note that measurements were made on units with permanent wire antenna fitted configured for normal frequency hopping transmission.
For the Wireless Smart Controller, normal hopping function could only be initiated when transmission from a supporting Wireless Receiver was detected. Communication was established with the Wireless Receiver. A near field probe, positioned close to the controller and connected to a spectrum analyser, was used to capture the transmission.

a. Measurements were performed in accordance with ANSI C63.10 clause 7.8.4.
b. Spectrum analyser RBW was set to 100kHz, < channel spacing, VBW to 300kHz.
c. The spectrum analyser display was centered on one channel frequency, using zero span.
d. Sweep time was adjusted so that a single transmit pulse was captured and transmit duration measured.
e. Sweep time was then extended to 20 seconds and the number of transmit pulses counted.
f. Time of occupancy over a 20 second period was then calculated.
g. Measurements were repeated for the low, middle and high channels.

12.8.3 Test Results

Limit: The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 20 seconds.

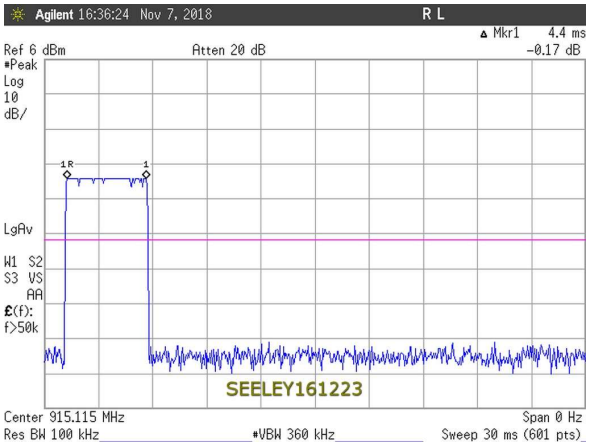
Transmit duration for one hop on a low channel: 4.4ms
Transmit duration for one hop on a middle channel: 4.4ms
Transmit duration for one hop on a high channel: 4.5ms

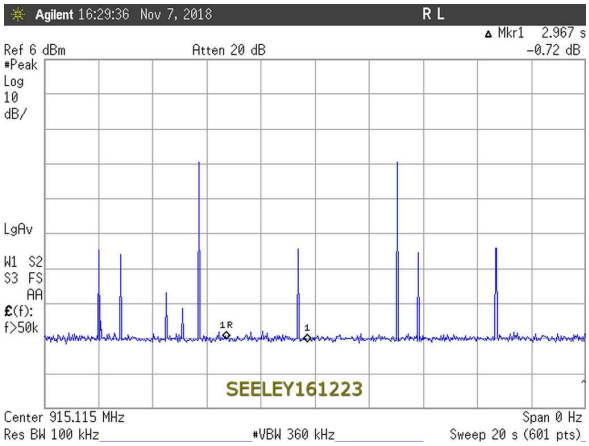
Number of hops over a 20 second period:
Low channel: 2
Middle channel: 2
High channel: 2

Time of occupancy over a 20 second period:
Low channel: 8.8ms
Middle channel: 8.8ms
High channel: 9.0ms

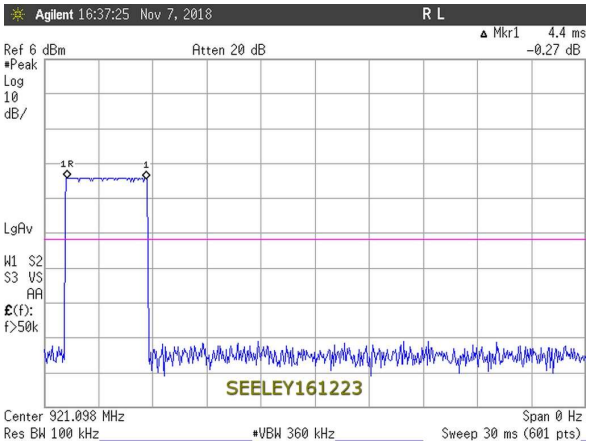
It should be noted that the number of hops over a 20 second period was significantly different to that of the Wireless Receiver.
The client advised that if no data is being sent by the Wireless Smart Controller it will default to a lower hopping rate to preserve battery use. When the Wireless Smart Controller does send data then hopping rate would increase to match that of the Wireless Receiver and therefore time of occupancy will be similar to the Wireless Receiver.

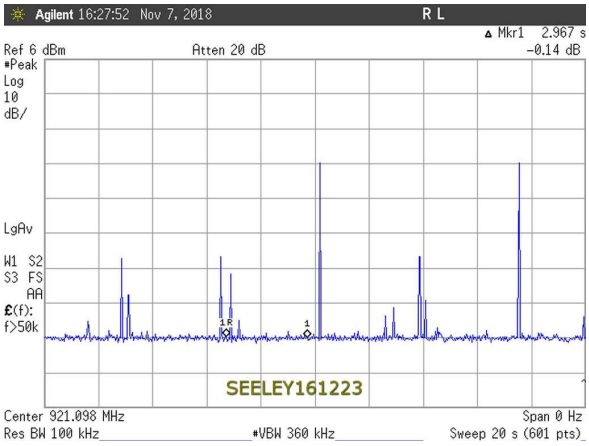
EUT COMPLIED



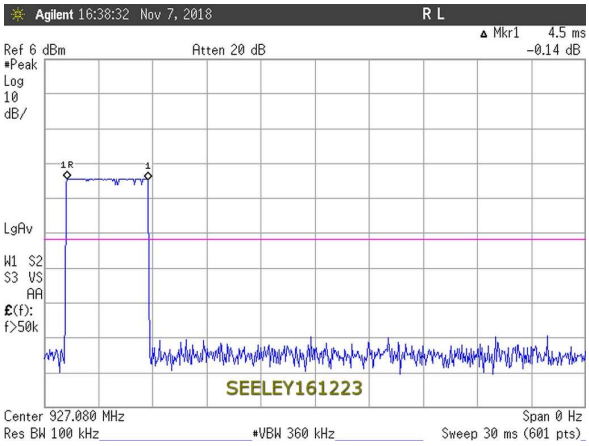


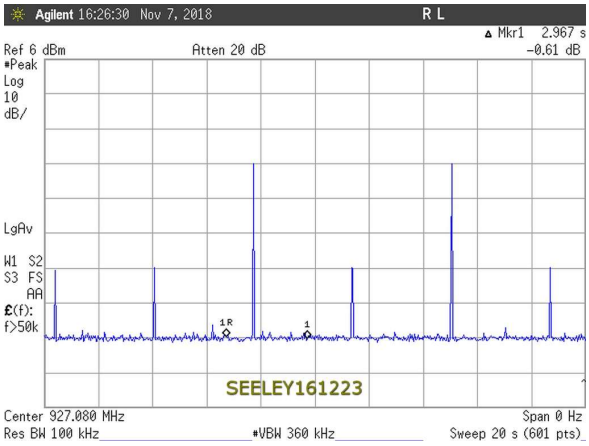
Time of Occupancy - Low Channel





Time of Occupancy – Middle Channel





Time of Occupancy – High Channel

12.9 Peak Conducted Output Power - Section 15.247(b)(2)

Test Date:	11/07/18	Temperature:	20ºC
Test Officer:	Aaron Fan	Humidity:	53%
Test Location:	Austest Laboratories (Castle Hill)		

12.9.1 EUT Operating Mode

Refer to section 5.
Tests were performed on the Wireless Smart Controller unit with permanent wire antenna removed and replaced with 50Ω SMA coaxial cable connection at the transceiver output.
Configured with test firmware to enable constant transmission at selected low, middle and high channels.
The Wireless Smart Controller was powered by four fully charged 1.5V AA batteries.

12.9.2 Test Method

a. Measurements were performed in accordance with ANSI C63.10 clause 7.8.5.
b. Spectrum analyser RBW was set to 1MHz, VBW to 3MHz.
c. The analyser display was centred on the channel frequency to be measured.
d. The spectrum analyser trace was set to max hold and the trace to stabilised.
e. The marker was positioned at the peak level (peak search).
f. The level was recorded and compared to the limit.
g. Measurements were repeated for the low, middle and high channels.

12.9.3 Directional antenna gain

The Wireless Smart Controller uses a permanently fitted wire antenna, approximately 7.5cm long.
The client estimated the gain of the Wireless Smart Controller antenna to be between -5dB and -10dB.
It is unlikely that such an antenna would have a gain that exceeds 6dBi for the band 915MHz to 928MHz.

Section 15.247 (b) (4) indicates that the specified limit of 1W for conducted output power is based on the use of an antenna with a directional gain not exceeding 6dBi.

12.9.4 Test Results

Limit: 1 watt for systems employing at least 50 hopping channels.

Frequency MHz	Output Power dBm	Output Power mW	Limit dBm	Limit mW	Δ Limit dB
915.1 (Low Ch)	12.4	17.4	30.0	1000	-17.6
921.1 (Mid Ch)	12.2	16.6	30.0	1000	-17.8
927.1 (High Ch)	12.1	16.2	30.0	1000	-17.9

Tx Power – Low Channel

Tx Power – Middle Channel

Tx Power – High Channel

12.9.5 Transmit Power – Supply Voltage Variation

The Wireless Smart Controller was powered from four 1.5V AA alkaline batteries. In accordance with section 15.31 (e) tests were performed with fully charged batteries.

12.10 Out of band emissions – Section 15.247(d)

Test Date:	15/07/18, 25/07/18, 01/08/18	Temperature:	20 - 26ºC
Test Officer:	Aaron Fan	Humidity:	53 - 74%
Test Location:	Austest Laboratories (Castle Hill)		

12.10.1 EUT Operating Mode

Refer to section 5.
Tests were performed on the Wireless Smart Controller unit with permanent wire antenna removed and replaced with 50Ω SMA coaxial cable connection at the transceiver output. Configured with test firmware to enable constant transmission at selected low, middle and high channels.

For measurement at the band-edges whilst frequency hopping was active, the Wireless Smart Controller unit was tested with permanent wire antenna fitted. Configured with normal operating firmware for frequency hopping transmission.

The Wireless Smart Controller was powered by four fully charged 1.5V AA batteries.

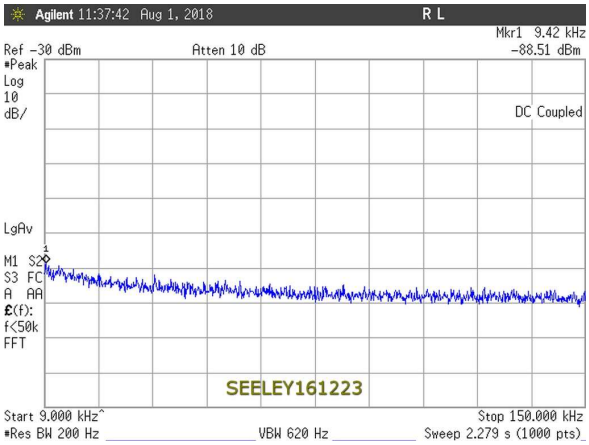
12.10.2 Test Method

a. Measurements were performed in accordance with ANSI C63.10 clauses 7.8.6 (band-edge) and 7.8.8.
b. Spectrum analyser RBW was set to 100kHz, VBW to 300kHz, except below 30MHz were RBW had to be reduced to reduce influence of the analysers zero marker.
c. Highest in-band level was recorded for each channel measured.
d. The frequency range 9kHz up to the 10^{th} harmonic of the intentional transmission was swept to locate the highest out of band emissions.
e. Ensured that any out of band emissions were greater than 20dB below the recorded in band level.
f. Ensured that any emissions that fall within the restricted bands specified in section 15.205 also meet the radiated emission limits specified in section 15.209.
g. Repeat the above for the low, middle and high channel and across all transmit modes.
h. For FHSS, remeasure at the band-edges with frequency hopping enabled. Due to the test samples provided, this was performed as a radiated emission measurement (see section 10 of this report for test method).

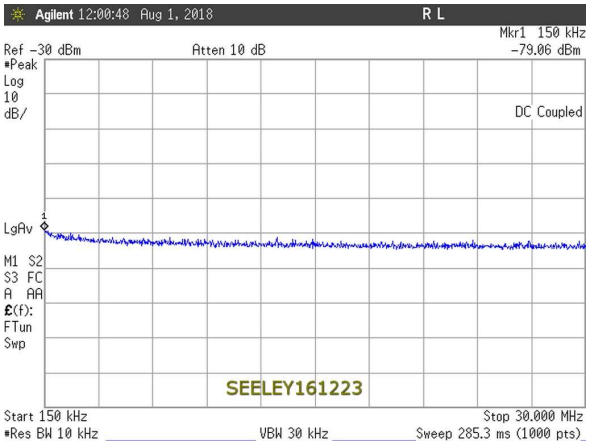
12.10.3 Test Results

12.10.3.1 Frequency Range: 9kHz to 25000MHz

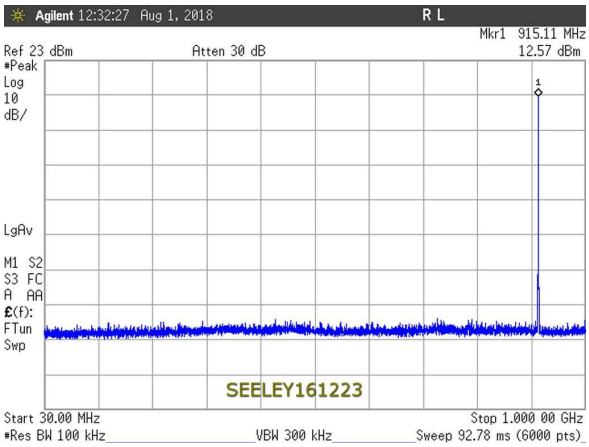
All measured out-of- band emissions were greater than 20dB below the highest in-band level.
Highest measured out of band emission level was -33.9dBm at 1842.2MHz with transmission on the middle channel.



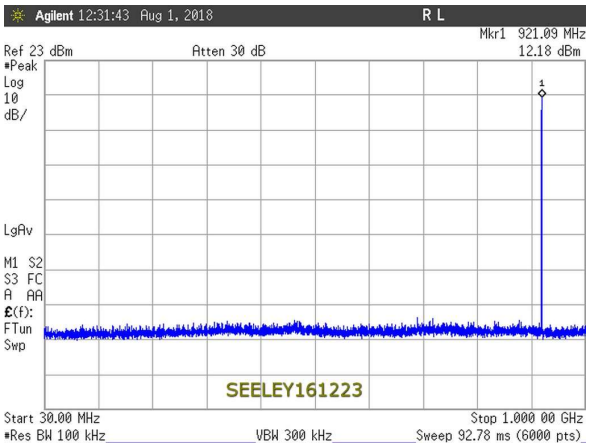
9kHz to 150kHz



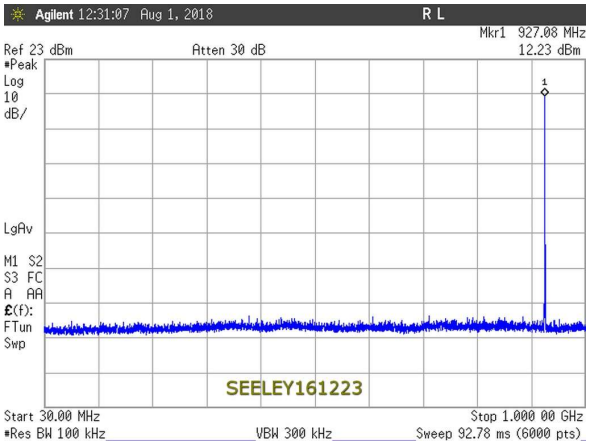
150kHz to 30MHz



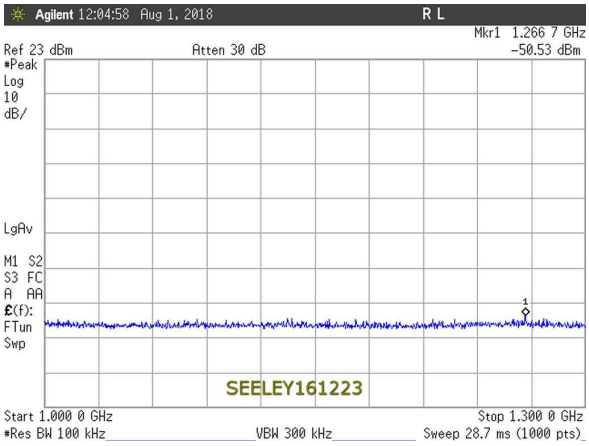
30MHz to 1000MHz – Low Channel



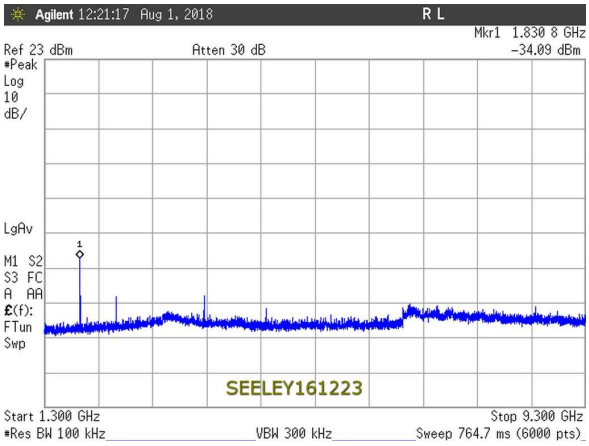
30MHz to 1000MHz – Middle Channel



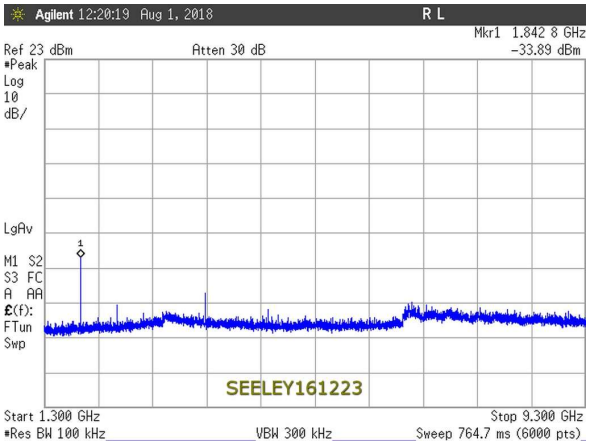
30MHz to 1000MHz – High Channel



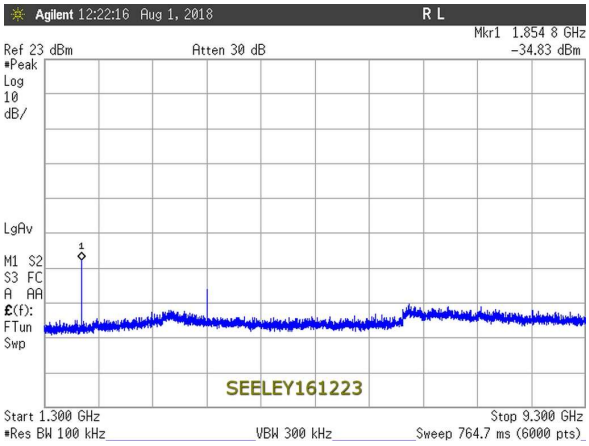
1000MHz to 1300MHz



1300MHz to 9300MHz – Low Channel



1300MHz to 9300MHz – Middle Channel

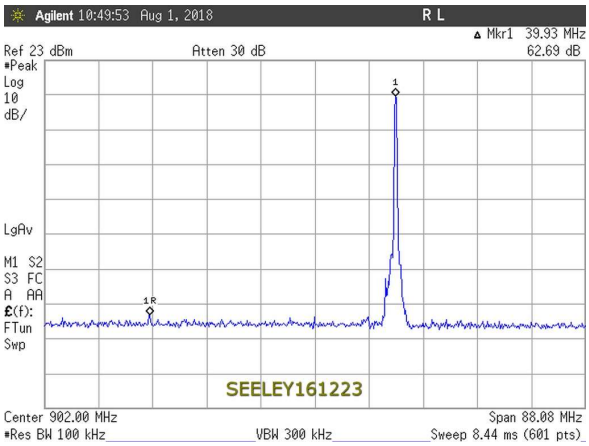


1300MHz to 9300MHz – High Channel

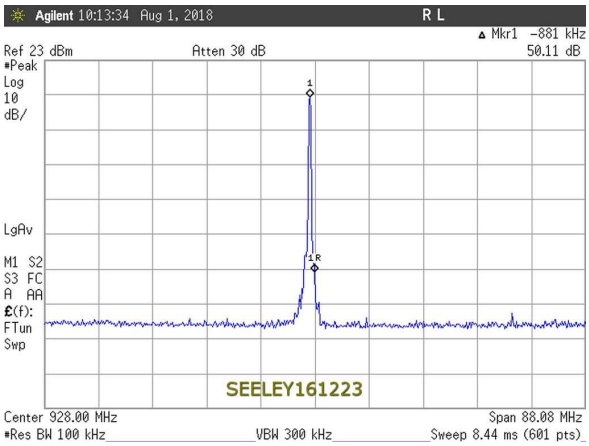
12.10.3.2 Authorised Band-Edges: 902MHz and 928MHz

At the authorised band-edges, measured out-of-band emissions were greater than 20dB below the highest in-band level.

Frequency Hopping Disabled

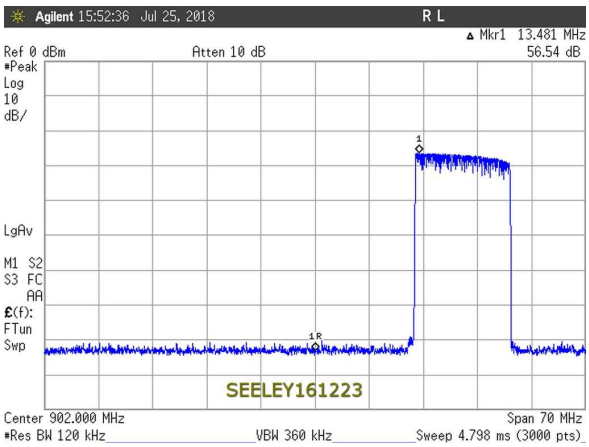


902MHz – Low Channel

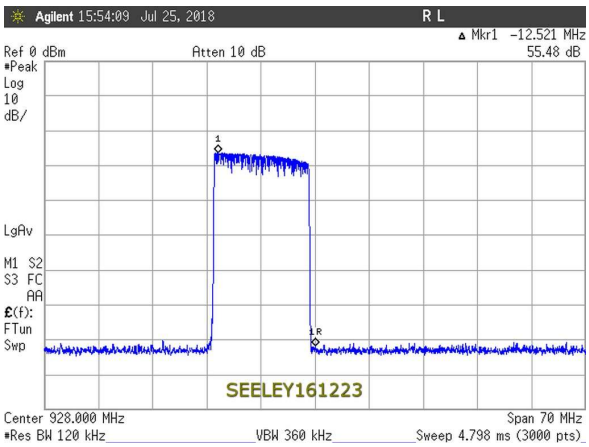


928MHz – High Channel

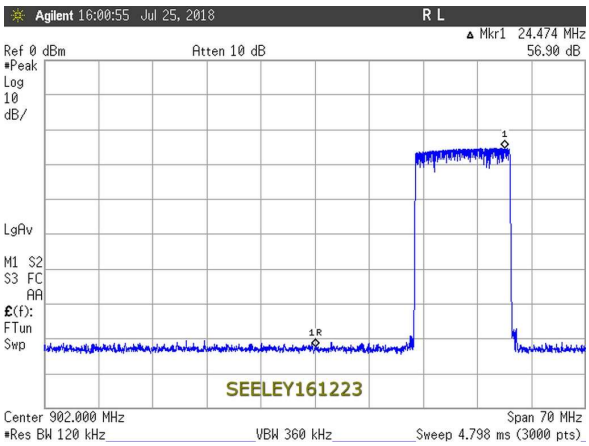
Frequency Hopping Enabled



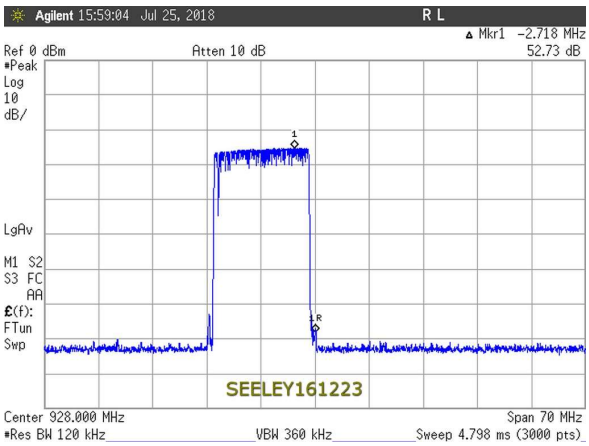
902MHz – Vertical Polarisation



928MHz – Vertical Polarisation



902MHz – Horizontal Polarisation



928MHz – Horizontal Polarisation

12.11 Co-existence with other FHSS systems- Section 15.247(h)

The client provided the following statement:

The transmit frequency is determined by 'network' time and each network has its own sequence of frequencies. The system does not adjust the next frequency or the timing of the next frequency based on the presence or otherwise of a message or the presence or otherwise of a clear channel.