

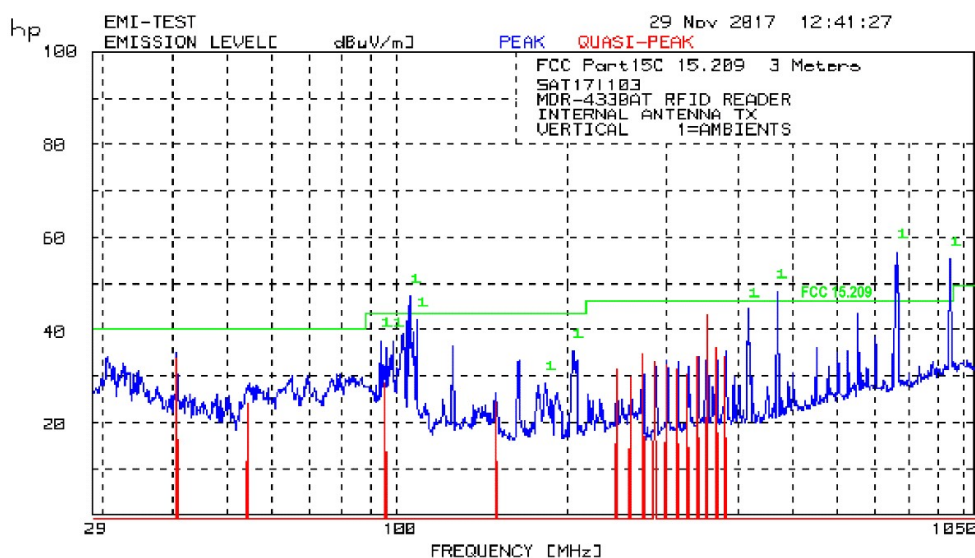
10.4.3 Radiated Emissions: 30MHz to 1000MHz at 3m distance

The highest measured Quasi-peak level was 0.8dB below the 15.209 limit at 352.7MHz. Emissions that were not attributed to the intentional radiation were not measured.

In accordance with section 15.33 (a) (4), intentional emissions up to 1GHz were measured as the highest internal frequency used by the EUT was a 50MHz clock.

Frequency MHz	Polarisation	Quasi-Peak $\mu\text{V/m}$	Quasi-Peak $\text{dB}\mu\text{V/m}$	Limit @ 3m $\mu\text{V/m}$	Limit @ 3m $\text{dB}\mu\text{V/m}$	Below Limit dB^*
352.7	Horizontal	182	45.2	200	46.0	0.8
311.9	Horizontal	166	44.4	200	46.0	1.6
352.7	Vertical	145	43.2	200	46.0	2.8
379.7	Horizontal	130	42.3	200	46.0	3.7
298.3	Horizontal	129	42.2	200	46.0	3.8
271.2	Horizontal	120	41.6	200	46.0	4.4

*Results were within the laboratories measurement uncertainties.

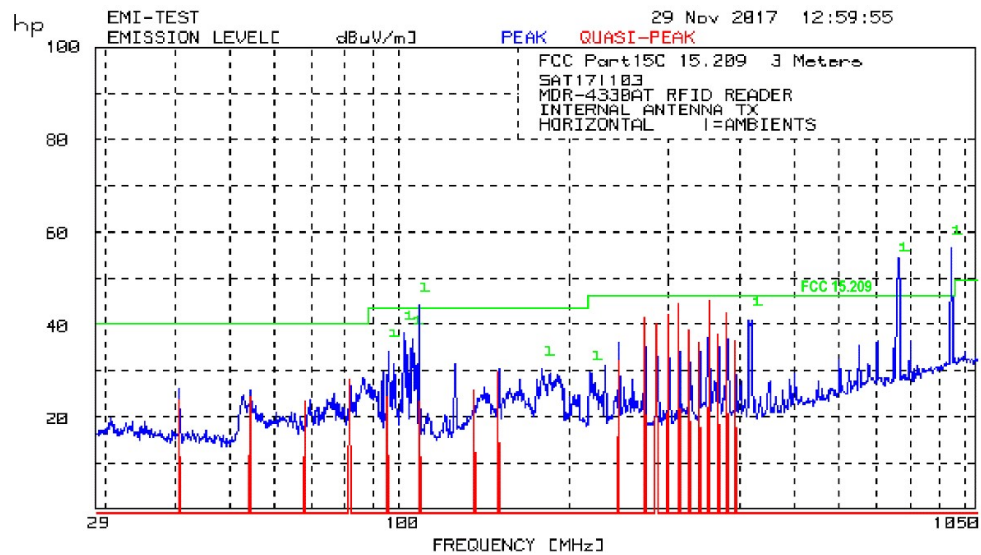


Radiated Emissions Plot 30MHz to 1000MHz (Vertical Polarisation)

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Radiated Emissions Plot 30MHz to 1000MHz (Horizontal Polarisation)

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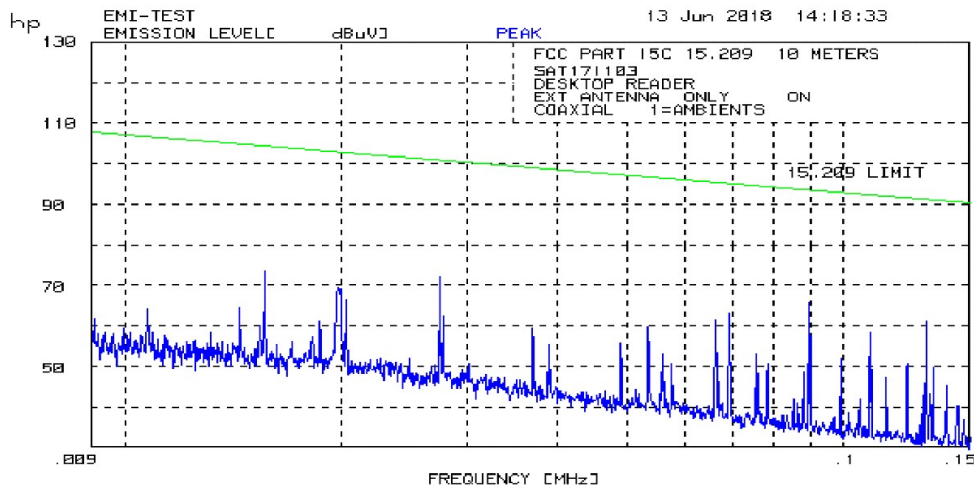
10.5 Test Results – Transmission from External Antenna

Since the external wand antenna was hand held, initial measurements were made with the antenna positioned in three orientations to determine worse case emission levels. Final measurement was made on the orientation that radiated the highest emission levels.

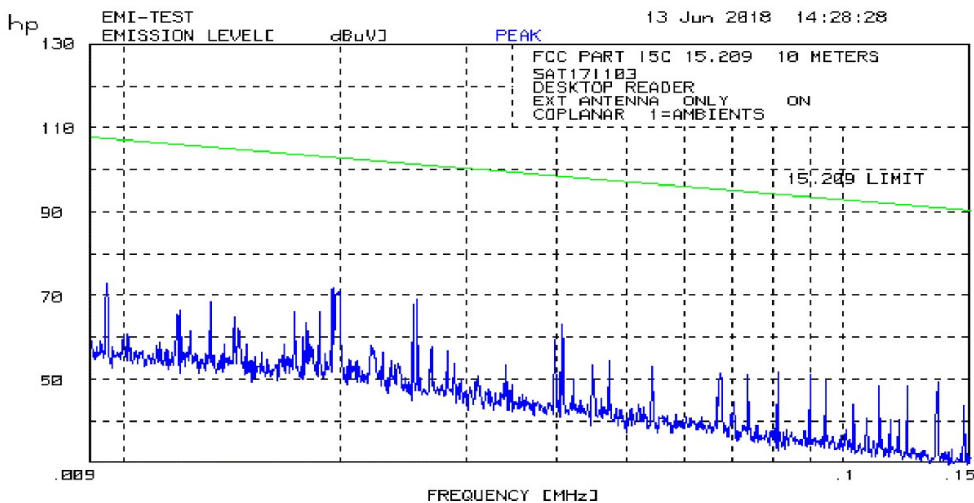
10.5.1 Radiated Emissions: 9kHz to 150kHz at 10m distance*

All measured emissions were greater than 10dB below the 15.209 limit.

*Measured at a 10m distance. In accordance with section 15.31 (e) (2), measured field strength values would be extrapolated to a 300m distance using an extrapolation factor of 40dB/decade.



Radiated Emissions Plot 9kHz to 150kHz (Coaxial Orientation)



Radiated Emissions Plot 9kHz to 150kHz (Coplanar Orientation)

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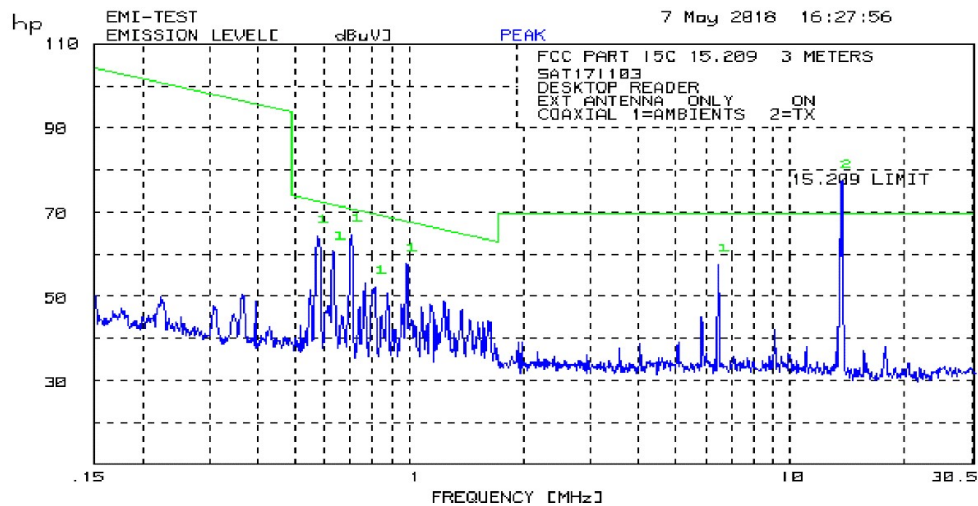
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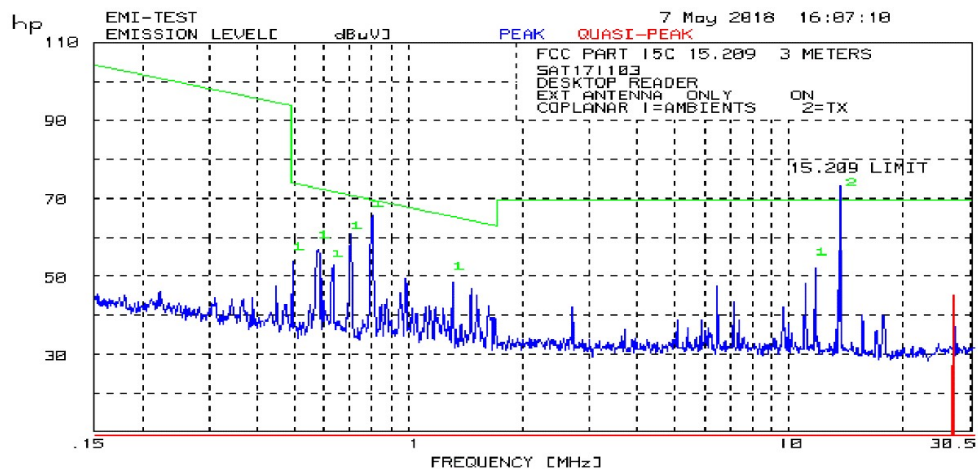
10.5.2 Radiated Emissions: 150kHz to 30MHz at 3m distance*

The highest measured emissions level was 7.0dB below the Quasi-peak limit a 12.94MHz, measured in both Coaxial and Coplanar orientations. Refer to section 11.1.7.2 of this report.

*Measured at a 3m distance. In accordance with section 15.31 (e) (2), measured field strength values would be extrapolated to a 30m distance using an extrapolation factor of 40dB/decade.



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



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

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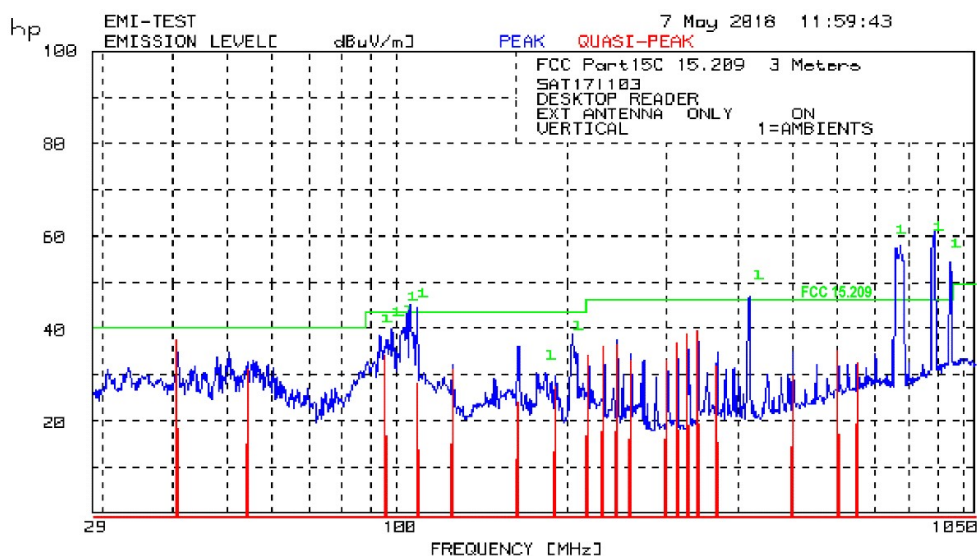
10.5.3 Radiated Emissions: 30MHz to 1000MHz at 3m distance

The highest measured Quasi-peak level was 2.6dB below the 15.209 limit at 40.7MHz. Emissions that were not attributed to the intentional radiation were not measured.

In accordance with section 15.33 (a) (4), intentional emissions up to 1GHz were measured as the highest internal frequency used by the EUT was a 50MHz clock.

Frequency MHz	Polarisation	Quasi-Peak $\mu\text{V/m}$	Quasi-Peak $\text{dB}\mu\text{V/m}$	Limit @ 3m $\mu\text{V/m}$	Limit @ 3m $\text{dB}\mu\text{V/m}$	Below Limit dB
40.7	Vertical	74	37.4	100	40.0	2.6*
339.0	Vertical	92	39.3	200	46.0	6.7
325.4	Vertical	88	38.9	200	46.0	7.1
339.0	Horizontal	85	38.6	200	46.0	7.4
366.1	Horizontal	79	37.9	200	46.0	8.1
54.2	Vertical	35	31.0	100	40.0	9.0

*Result was within the laboratories measurement uncertainties.

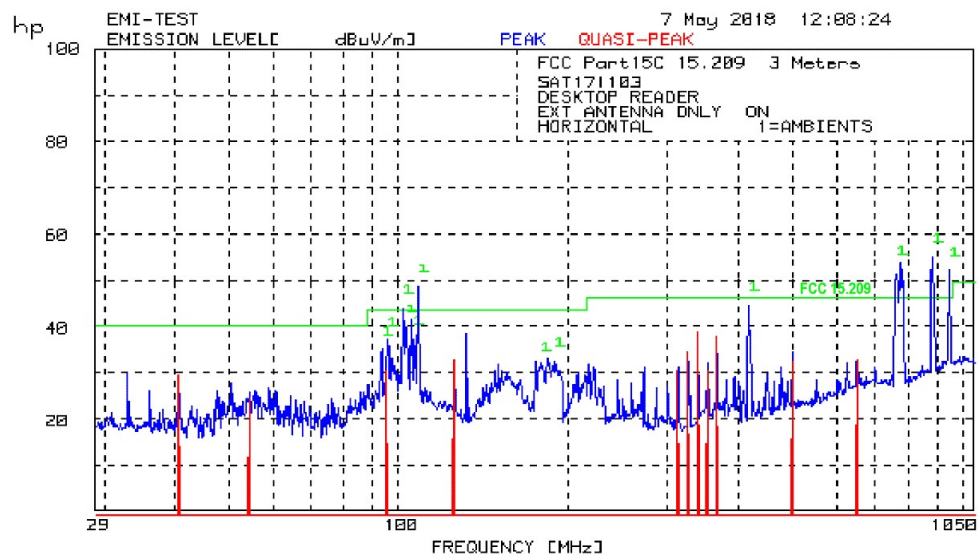


Radiated Emissions Plot 30MHz to 1000MHz (Vertical Polarisation)

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Radiated Emissions Plot 30MHz to 1000MHz (Horizontal Polarisation)

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11 FCC Part 15C, Section 15.225 – OPERATION WITHIN THE BAND 13.110-14.010MHz

11.1 Section 15.225(a)(b)(c)(d) – Field Strength Measurement

Test Date:	13 th , 21 st and 23 rd February 2018	Temperature:	22°C
Test Officer:	Richard Turner	Humidity:	56%
Test Location:	Austest Laboratories (Yarramalong, NSW)		

11.1.1 EUT Operating Mode

Refer to section 5.

The following two configurations were used in testing:

1. Constant transmission with internal antenna selected.
2. Constant transmission with external antenna selected.

Mains supply voltage set to 120VAC 60Hz.

11.1.2 Test Method

- a. Measurements were performed in accordance with ANSI C63.10-2013.
- b. Measuring receiver RBW was set to 9kHz.
- c. The EUT was setup on a non-conductive turntable, 0.8m above the OATS conductive ground plane, and at the indicated test distance away from the measuring antenna.
- d. To maximise emissions, the EUT was rotated through 360° and the measuring antenna height was varied between 1m to 4m in the following antenna orientations:
 - i. Loop antenna (150kHz to 30MHz) – Coaxial and coplanar orientations.
- e. The maximised emissions were measured and the above was repeated for all measurement frequencies.
- f. Peak detection was used for initial measurements. For emission levels close to the limit quasi-peak detection was used.
- g. Linearity of the measuring system was checked, reducing gain when required.

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11.1.3 Sample Calculation Example

The final radiated emission levels were obtained from the measurement equipment software which automatically applied all the stored calibration factors. The calibration / correction factors were applied as follows:

$$E = V + AF + L_{cbl} - G_{pre}$$

Where:

- E = Radiated Electric Field Strength in dB μ V/m at the specified distance.
- V = EMI Receiver measured signal input voltage in dB μ V.
- AF = Antenna Factor of the measuring antenna in dB/m.
- L_{cbl} = Total cable insertion loss in dB.
- G_{pre} = Preamplifier gain in dB.

Frequency (MHz)	Receiver Level, V (dB μ V)	AF (dB/m)	Lcbl (dB)	Gpre (dB)	Corrected Level, E (dB μ V/m)
13.56	40.0	12.0	2.9	22.5	32.4

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11.1.4 Test Results – Section 15.225(a) 13.553–13.567MHz at 10m distance

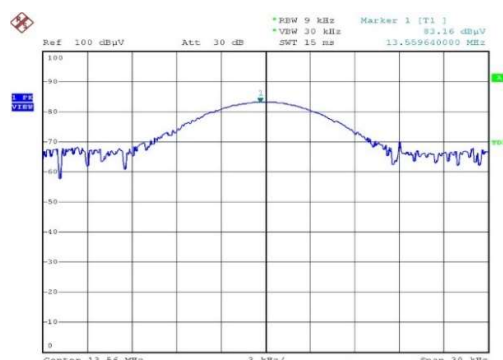
11.1.4.1 Internal Antenna

Measured field strengths shown below:

Frequency MHz	Antenna Orientation	Measured Quasi-Peak @ 10m dBμV/m	Equivalent Quasi-Peak @ 30m		Limit @ 30m		Below Limit dB
13.56*	Coaxial	79.9	1,096	60.8	15,848	84.0	23.2
13.56*	Coplanar	82.4	1,462	63.3	15848	84.0	20.7

*Measured at a 10m distance. In accordance with section 15.31 (e) (2), measured field strength values were extrapolated to a 30m distance using an extrapolation factor of 40dB/decade.

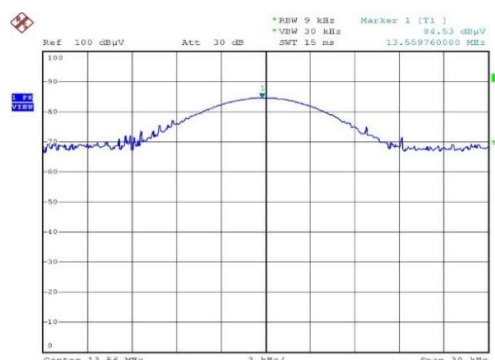
Section 15.31 (e) requires transmitted power at the fundamental to be measured with the supply voltage varied between 85% and 115% of the nominal voltage range. No change in transmit power at the fundamental was observed when the AC supply voltage was varied.



SAT171103

Date: 13.FEB.2010 12:10:12

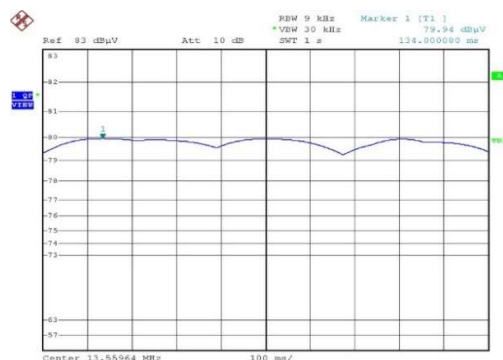
Coaxial Orientation – 13.56MHz – Peak



SAT171103

Date: 13.FEB.2010 12:21:55

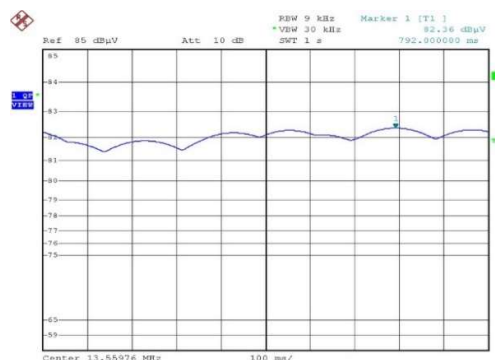
Coplanar Orientation – 13.56MHz Peak



SAT171103

Date: 13.FEB.2010 12:12:47

Coaxial Orientation – 13.56MHz – Quasi-Peak



SAT171103

Date: 13.FEB.2010 12:25:18

Coplanar Orientation – 13.56MHz Quasi-Peak

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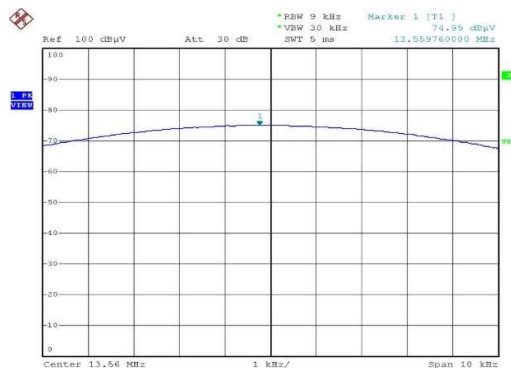
11.1.4.2 External Antenna

Measured field strengths shown below:

Frequency MHz	Antenna Orientation	Measured Quasi-Peak @ 10m dBμV/m	Equivalent Quasi-Peak @ 30m μV/m	Equivalent Quasi-Peak @ 30m dBμV/m	Limit @ 30m μV/m	Limit @ 30m dBμV/m	Below Limit dB
13.56*	Coaxial	74.5	589	55.4	15,848	84.0	28.6
13.56*	Coplanar	78.4	923	59.3	15848	84.0	24.7

*Measured at a 10m distance. In accordance with section 15.31 (e) (2), measured field strength values were extrapolated to a 30m distance using an extrapolation factor of 40dB/decade.

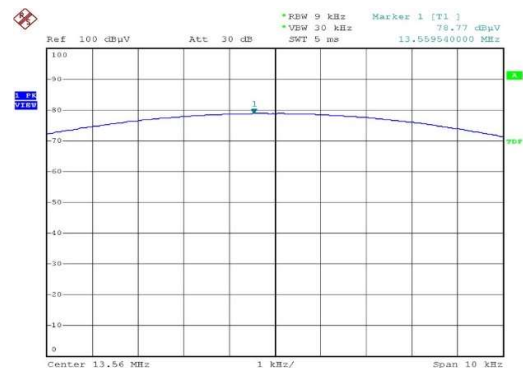
Section 15.31 (e) requires transmitted power at the fundamental to be measured with the supply voltage varied between 85% and 115% of the nominal voltage range. No change in transmit power at the fundamental was observed when the AC supply voltage was varied.



SAT171103

Date: 23.FEB.2018 14:19:20

Coaxial Orientation – 13.56MHz – Peak



SAT171103

Date: 21.FEB.2018 13:57:52

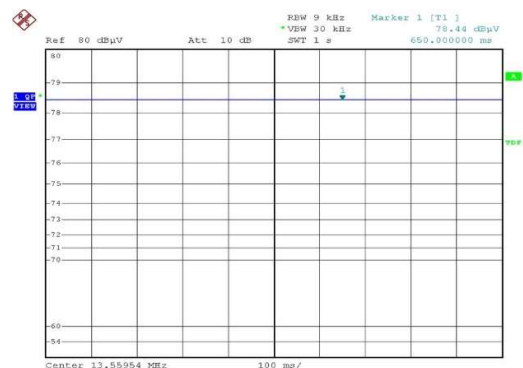
Coplanar Orientation – 13.56MHz Peak



SAT171103

Date: 23.FEB.2018 14:22:32

Coaxial Orientation – 13.56MHz Quasi-Peak



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Date: 21.FEB.2018 14:03:16

Coplanar Orientation – 13.56MHz Quasi-Peak

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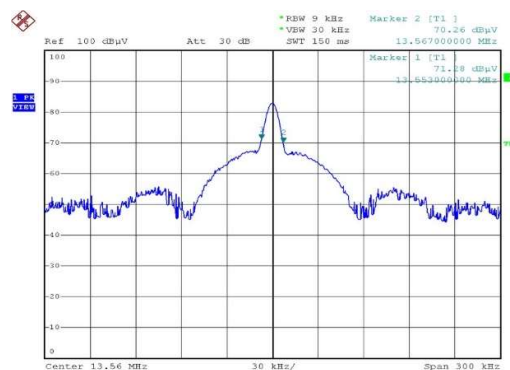
11.1.5 Test Results – Section 15.225(b) 13.410-13.553MHz and 13.567-13.710MHz at 10m distance

11.1.5.1 Internal Antenna Measured field strengths shown below:

Frequency MHz	Antenna Orientation	Measured Quasi-Peak @ 10m dBμV/m	Equivalent Quasi-Peak @ 30m		Limit @ 30m		Below Limit** dB
			μV/m	dBμV/m	μV/m	dBμV/m	
13.553*	Coaxial	66.2	226	47.1	334	50.5	3.4
13.553*	Coplanar	68.9	309	49.8	334	50.5	0.7
13.567*	Coaxial	64.9	195	45.8	334	50.5	4.7
13.567*	Coplanar	67.2	254	48.1	334	50.5	2,4

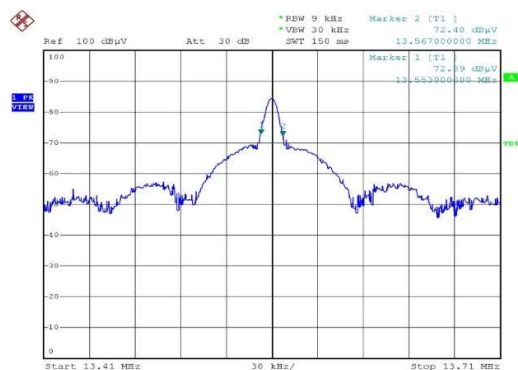
*Measured at a 10m distance. In accordance with section 15.31 (e) (2), measured field strength values were extrapolated to a 30m distance using an extrapolation factor of 40dB/decade.

**Results were within the laboratory's measurement uncertainty.



SAT171103

Date: 13.FEB.2018 13:52:19



SAT171103

Date: 13.FEB.2018 12:51:05

Coaxial Orientation – 13.410MHz to 13.710MHz Peak

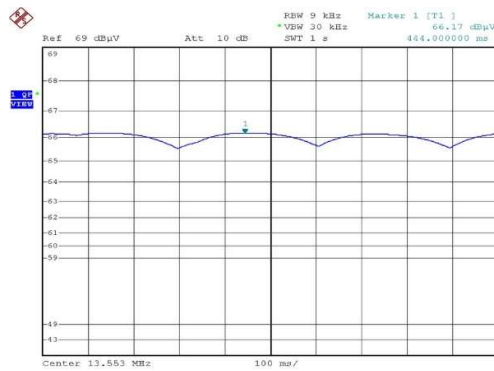
Coplanar Orientation – 13.410MHz to 13.710MHz Peak

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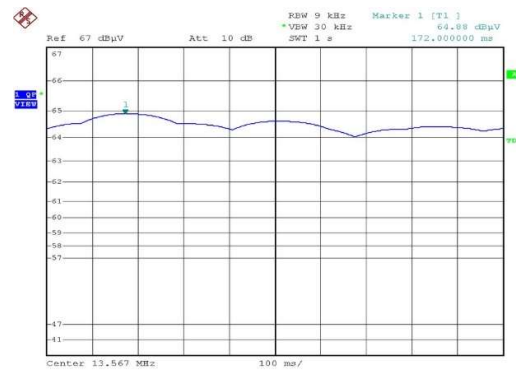




SAT171103

Date: 13.FEB.2018 13:37:23

Coaxial Orientation – 13.553MHz Quasi-Peak



SAT171103

Date: 13.FEB.2018 13:46:57

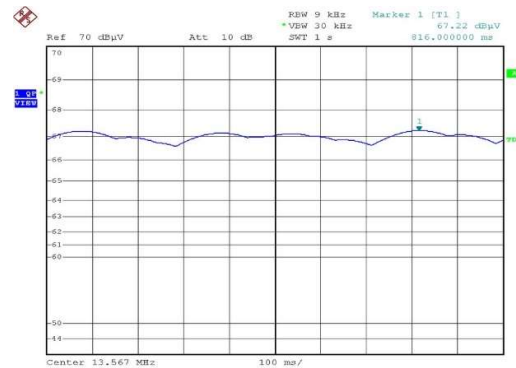
Coaxial Orientation – 13.567MHz Quasi-Peak



SAT171103

Date: 13.FEB.2018 12:34:44

Coplanar Orientation – 13.553MHz Quasi-Peak



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Date: 13.FEB.2018 12:42:43

Coplanar Orientation – 13.567MHz Quasi-Peak

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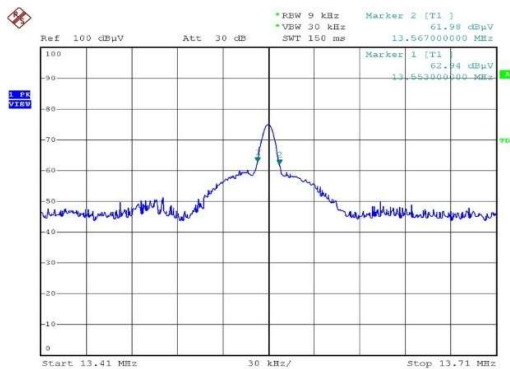


11.1.5.2 External Antenna

Measured field strengths shown below:

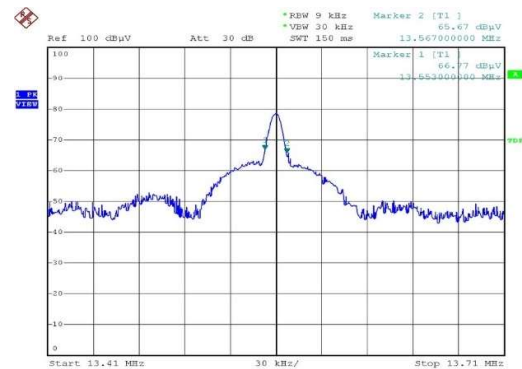
Frequency MHz	Antenna Orientation	Measured Quasi-Peak @ 10m dBμV/m	Equivalent Quasi-Peak @ 30m		Limit @ 30m		Below Limit dB
			μV/m	dBμV/m	μV/m	dBμV/m	
13.553*	Coaxial	60.7	120	41.6	334	50.5	8.9
13.553*	Coplanar	64.6	188	45.5	334	50.5	5.0
13.567*	Coaxial	59.5	105	40.4	334	50.5	10.1
13.567*	Coplanar	63.3	162	44.2	334	50.5	6.3

*Measured at a 10m distance. In accordance with section 15.31 (e) (2), measured field strength values were extrapolated to a 30m distance using an extrapolation factor of 40dB/decade.



SAT171103

Date: 23.FEB.2018 15:31:17



SAT171103

Date: 23.FEB.2018 13:30:40

Coaxial Orientation–13.410MHz to 13.710MHz Peak

Coplanar Orientation–13.410MHz to 13.710mHz Peak



SAT171103

Date: 23.FEB.2018 14:30:44

Coaxial Orientation – 13.553MHz Quasi-Peak



SAT171103

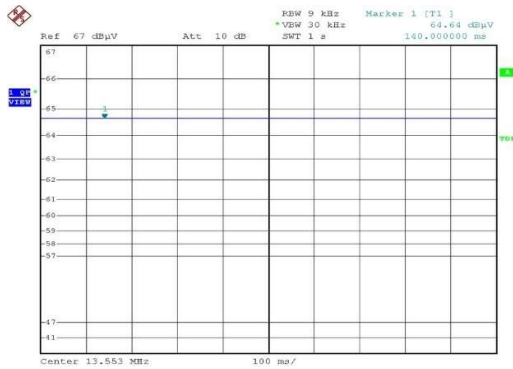
Date: 23.FEB.2018 14:39:05

Coaxial Orientation – 13.567MHz Quasi-Peak

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Date: 21.FEB.2018 16:15:12

Coplanar Orientation – 13.553MHz Quasi-Peak



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Date: 21.FEB.2018 16:21:48

Coplanar Orientation – 13.567MHz Quasi-Peak

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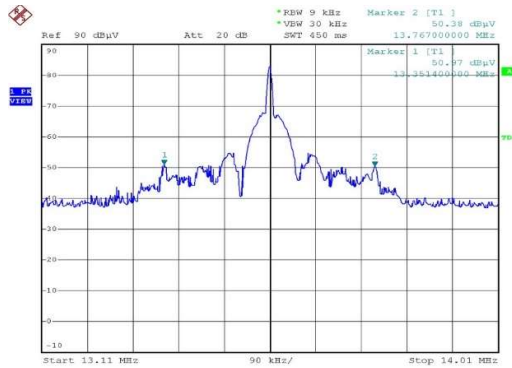
11.1.6 Test Results – Section 15.225(c) 13.110-13.410MHz and 13.710-14.010MHz at 10m distance

11.1.6.1 Internal Antenna

Measured field strengths shown below:

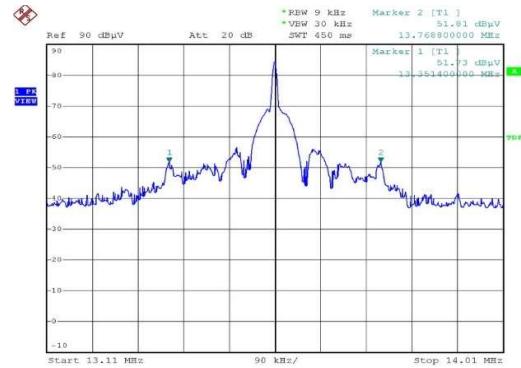
Frequency MHz	Antenna Orientation	Measured Quasi-Peak @ 10m dBμV/m	Equivalent Quasi-Peak @ 30m		Limit @ 30m		Below Limit dB
			μV/m	dBμV/m	μV/m	dBμV/m	
13.35*	Coaxial	51.0	39	31.9	106	40.5	8.6
13.35*	Coplanar	51.7	43	32.6	106	40.5	7.9
13.77*	Coaxial	50.4	37	31.3	106	40.5	9.2
13.77*	Coplanar	51.8	43	32.7	106	40.5	7.8

*Measured at a 10m distance. In accordance with section 15.31 (e) (2), measured field strength values were extrapolated to a 30m distance using an extrapolation factor of 40dB/decade.



SAT171103

Date: 13.FEB.2018 13:59:42



SAT171103

Date: 13.FEB.2018 14:05:29

Coaxial Orientation – 13.110MHz to 14.010MHz Peak

Coplanar Orientation – 13.110MHz to 14.010MHz Peak

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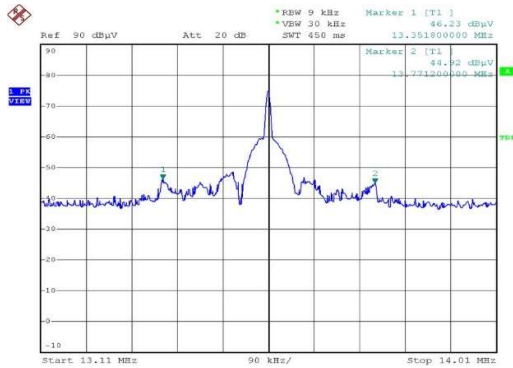


11.1.6.2 External Antenna

Measured field strengths shown below:

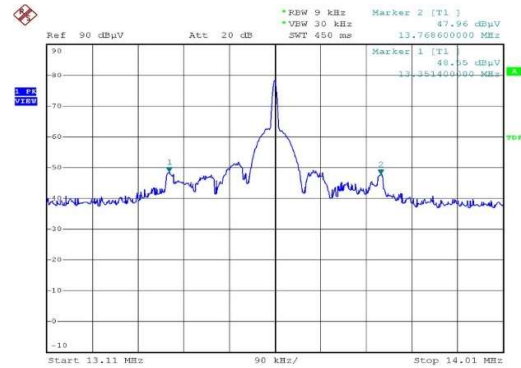
Frequency MHz	Antenna Orientation	Measured Quasi-Peak @ 10m dBμV/m	Equivalent Quasi-Peak @ 30m		Limit @ 30m		Below Limit dB
			μV/m	dBμV/m	μV/m	dBμV/m	
13.35*	Coaxial	46.2	23	27.1	106	40.5	13.4
13.35*	Coplanar	48.6	30	29.5	106	40.5	11.0
13.77*	Coaxial	44.9	19	25.8	106	40.5	14.7
13.77*	Coplanar	48.0	28	28.9	106	40.5	11.6

*Measured at a 10m distance. In accordance with section 15.31 (e) (2), measured field strength values were extrapolated to a 30m distance using an extrapolation factor of 40dB/decade.



SAT171103

Date: 23.FEB.2018 15:40:06



SAT171103

Date: 23.FEB.2018 13:35:37

Coaxial Orientation – 13.110MHz to 14.010MHz Peak

Coplanar Orientation – 13.110MHz to 14.010MHz Peak

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11.1.7 Test Results – Section 15.225(d) outside the band 13.110-14.010MHz at 10/3m distance

Measured field strength levels did not exceed the general radiated emission limits in section 15.209. Refer to section 12 of this report.

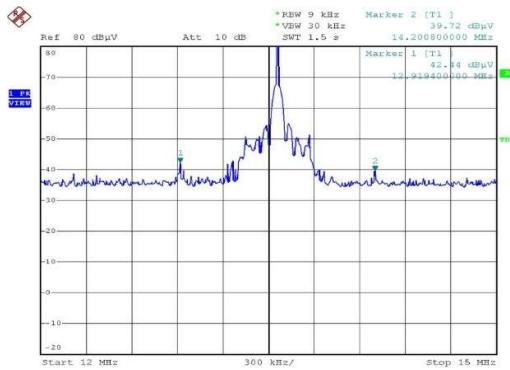
Additional measurements were performed between 12MHz and 15MHz to determine emissions levels which lie just outside the allowed band 13.110-14.010MHz.

11.1.7.1 Internal Antenna

Measured field strengths shown below:

Frequency MHz	Antenna Orientation	Measured Quasi-Peak @ 10m dBμV/m	Equivalent Quasi-Peak @ 30m μV/m	Equivalent Quasi-Peak @ 30m dBμV/m	Limit @ 30m μV/m	Limit @ 30m dBμV/m	Below Limit dB
12.92*	Coaxial	42.4	15	23.3	30	29.5	6.2
12.92*	Coplanar	42.4	15	23.3	30	29.5	6.2
14.20*	Coaxial	39.7	11	20.6	30	29.5	8.9
14.19*	Coplanar	41.6	13	22.5	30	29.5	7.0

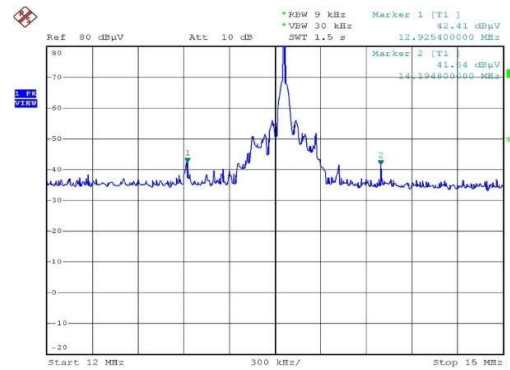
*Measured at a 10m distance. In accordance with section 15.31 (e) (2), measured field strength values were extrapolated to a 30m distance using an extrapolation factor of 40dB/decade.



SAT171103

Date: 13.FEB.2018 14:17:59

Coaxial Orientation – 12MHz to 15MHz Peak



SAT171103

Date: 13.FEB.2018 14:10:25

Coplanar Orientation – 12MHz to 15MHz Peak

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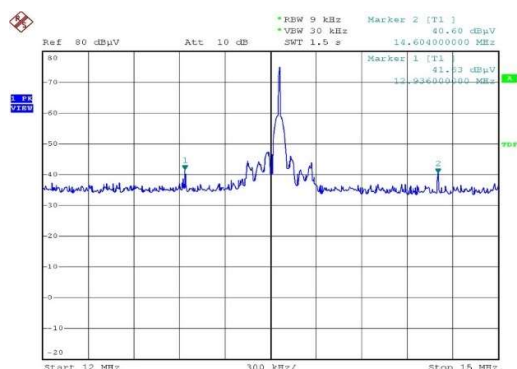


11.1.7.2 External Antenna

Measured field strengths shown below:

Frequency MHz	Antenna Orientation	Measured Quasi-Peak @ 10m dBμV/m	Equivalent Quasi-Peak @ 30m		Limit @ 30m		Below Limit dB
			μV/m	dBμV/m	μV/m	dBμV/m	
12.94	Coaxial	41.6	13	22.5	30	29.5	7.0
12.94	Coplanar	40.6	12	21.5	30	29.5	8.0
14.60	Coaxial	40.6	12	21.5	30	29.5	8.0
14.22	Coplanar	37.9	9	18.8	30	29.5	10.7

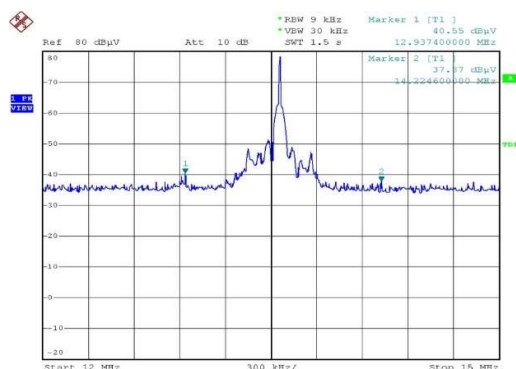
*Measured at a 10m distance. In accordance with section 15.31 (e) (2), measured field strength values were extrapolated to a 30m distance using an extrapolation factor of 40dB/decade.



SAT171103

Date: 23.FEB.2018 15:49:01

Coaxial Orientation – 12MHz to 15MHz Peak



SAT171103

Date: 23.FEB.2018 13:40:36

Coplanar Orientation – 12MHz to 15MHz Peak

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11.2 Section 15.225(e) – Frequency Tolerance

Test Date:	16 th May 2018	Temperature:	50°C to -20°C
Test Officer:	Steve Garnham	Humidity:	59%
Test Location:	Austest Laboratories (Yarramalong, NSW)		

11.2.1 EUT Operating Mode

The EUT was configured so that there was constant transmission from the internal antenna port.

Transmit power was set to Level 3 by the client.

Mains supply voltage set to 120VAC 60Hz.

11.2.2 Test Method – Frequency stability with respect to ambient temperature

- a. Measurements were performed in accordance with ANSI C63.10:2013 clause 6.8.1
- b. The EUT was placed in a temperature chamber.
- c. A close field probe was fixed into position close to the EUT.
- d. The EUT was connected to the AC source, output set to 120VAC 60Hz. The EUT was then switched on.
- e. Spectrum analyser settings were adjusted to facilitate accurate measuring of the transmission frequency. Final setting: RBW 100Hz, VBW100Hz, span 1kHz centred on 13.559986MHz.
- f. The EUT was then switched off. The temperature chamber was set to +50°C and allowed to stabilised.
- g. The EUT was switched on and initiated transmission. The operating frequency was recorded at start up, two, five and ten minutes after transmission was initiated.
- h. The EUT was then switched off and the temperature in the chamber reduced by 10°C.
- i. After the temperature had stabilised step g was repeated.
- j. Steps g to i were repeated until the lower temperature of -20°C was reached.

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11.2.3 Test Method – Frequency stability with respect to supply voltage

- a. Measurements were performed in accordance with ANSI C63.10:2013 clause 6.8.2
- b. The EUT was placed in a temperature chamber.
- c. Temperature chamber was set to +20°C (ambient room temperature).
- d. A close field probe was fixed into position close to the EUT.
- e. The EUT was connected to the AC source, output set to 120VAC 60Hz. The EUT was then switched on.
- f. Spectrum analyser settings were adjusted to facilitate accurate measuring of the transmission frequency. Final setting: RBW 100Hz, VBW100Hz, span 1kHz was centred on 13.559986MHz.
- g. The EUT was switched on and the operating frequency was recorded.
- h. Step g was repeated with the AC supply voltage set to 85% and 115% of the nominal AC voltage.

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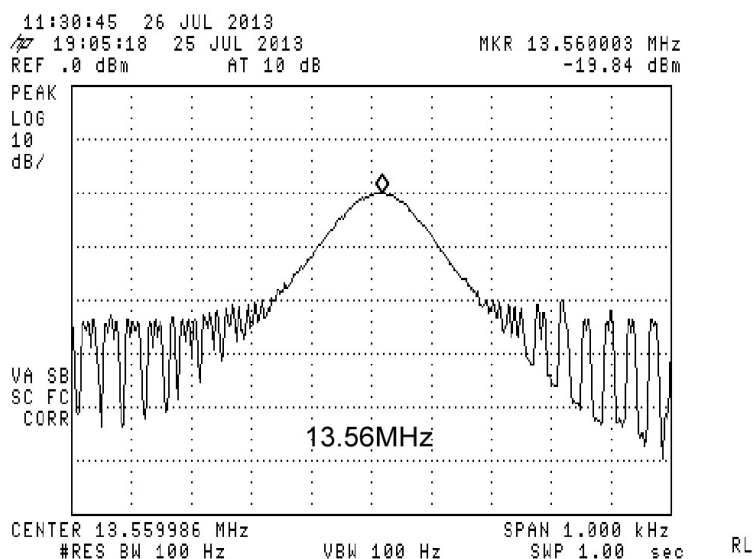
11.2.4 Test Results – Frequency stability with respect to ambient temperature

Operating frequency: 13.56MHz.

The maximum deviation from the operating frequency was -0.182kHz.

The frequency tolerance of the carrier signal kept within $\pm 0.01\%$ of the operating frequency, $\pm 1.356\text{kHz}$.

Temperature °C	Start up MHz	After 2mins MHz	After 5 mins MHz	After 10 mins MHz	Max. Δf kHz
50	13.559818	13.559829	13.559824	13.559820	-0.182
40	13.559819	13.559818	13.559822	13.559827	-0.182
30	13.559852	13.559841	13.559834	13.559829	-0.171
20	13.559875	13.559867	13.559862	13.559861	-0.139
10	13.559907	13.559899	13.559896	13.559896	-0.104
0	13.559944	13.559936	13.559935	13.559936	-0.065
-10	13.559975	13.559969	13.559968	13.559971	-0.032
-20	13.560000	13.559999	13.559998	13.559998	-0.002



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11.2.5 Test Results – Frequency stability with respect to supply voltage

Operating frequency: 13.56MHz.

Ambient temperature: 20°C.

The maximum deviation from the operating frequency was +0.013kHz.

The frequency tolerance of the carrier signal kept within $\pm 0.01\%$ of the operating frequency, $\pm 1.356\text{kHz}$.

120VAC 60Hz (nominal ac voltage).

Measured frequency: 13.559856MHz Deviation: -0.144kHz.

138VAC 60Hz (115% of nominal AC voltage).

Measured frequency: 13.559856MHz Deviation: -0.144kHz.

102VAC 60Hz (85% of nominal AC voltage).

Measured frequency: 13.559856MHz Deviation: -0.144kHz.

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