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TEST REPORT

RFI-148 250 Paging Transmitter

tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

STI Engineering Pty Ltd

This Test Report is issued with the authority of:

Andrew Cutler- General Manager

ACCREDITED IANZ TESTING LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

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1. COMPLIANCE STATEMENT

The **RFI-148 250 Paging Transmitter** complies with the limits defined in 47 CFR Part 90 and 47 CFR Part 2 when tested in-accordance with the test methods described in 47 CFR Part 2, ANSI / TIA-603-E: 2016 and ANSI C63.26: 2015.

2. RESULT SUMMARY

The results of testing carried out in March 2022 are summarised below.

Clause	Description	Result
90.203	Certification required	Noted. Product is certified with FCC ID: P5MRFI148 Applying for Class 2 permissive changes based on this test report.
2.1046 90.205	RF power output Power and antenna height limits	Noted Complies
2.1049 2.202 90.207 90.209 90.210	Occupied bandwidth Bandwidths Types of emissions Bandwidth limitations Emission masks	Noted Noted Complies Complies Complies
2.1051	Spurious emissions at antenna terminals	Complies
2.1053	Field strength of spurious radiation	Complies
2.1055 90.213	Frequency stability Frequency stability	Noted Complies
90.214	Transient frequency behaviour	Complies
1.1310	Radio frequency exposure limits	Complies

3. ATTESTATION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification with the following conditions:

The client selected the test sample.

The report relates only to the sample tested.

This report does not contain corrections or erasures.

Measurement uncertainties with statistical confidence intervals of 95% are shown below test results. Both Class A and Class B uncertainties have been accounted for, as well as influence uncertainties where appropriate.

In addition this equipment has been tested in accordance with the requirements contained in the appropriate Commission regulations.

All compliance statements have been made with respect of the specification limit with no reference to the measurement uncertainty.

To the best of my knowledge, these tests were performed using measurement procedures that are consistent with industry or Commission standards and demonstrate that the equipment complies with the appropriate standards.

I further certify that the necessary measurements were made by EMC Technologies NZ Ltd, 47 MacKelvie Street, Grey Lynn, Auckland, New Zealand.

Andrew Cutler
General Manager
EMC Technologies NZ Ltd

4. CLIENT INFORMATION

Company Name STI Engineering Pty Ltd

Postal Address 22 Boulder Rd Malaga
WA 6090

Country Australia

Contact Mr. Lahiru Raffel

5. TEST SAMPLE DESCRIPTION

Brand Name RFI-148 250 Paging Transmitter

Model Number RFI-148 250PCDAUNA03

Product VHF Transceiver

Manufacturer STI Engineering

Manufactured in Australia

Serial Number F00012K00891

FCC ID P5MRFI148

Configuration Application Cruise control configuration tool

Antenna connector N Type Female Connector

Rated Transmitter Output Power 250 Watts (+54.0 dBm)

Transmitter Certification Range

Part 90: 153.500 MHz to 159.500 MHz

Test frequencies

Frequency (MHz)	Power (Watts)	Channel Bandwidth (kHz)	Modulations Tested
153.500	250.0	6.25, 12.5	F2D 51 (51 bps FFSK) F2D100 (100 bps FFSK) F3D DTMF F3E VOICE-Analogue Audio
156.500	250.0	6.25, 12.5	
159.500	250.0	6.25, 12.5	

Standard Temperature and Humidity

Temperature: +15 °C to + 30 °C maintained.
Relative Humidity: 20% to 75% observed.

Standard Test Power Source

Standard Test Voltage: 120 Vac , 60 Hz

Extreme Temperature

High Temperature: + 50 °C maintained.
Low Temperature: - 30 °C maintained.

Extreme Test Voltages

+/- 15% of the input AC supply voltage.

Product Overview (from user manual):

The RFI-148 is a high power output paging transmitters operating in the VHF band.

Some of the products features are indicated as below:

- RFI-148 VHF band operation (138 MHz – 174 MHz) with 2.5 – 6 MHz switching bandwidth.
- 250 W (54 dBm) maximum transmit power
- The product is compatible with:
  - POCSAG 512, 1200, 2400 bps (2-level FSK).
  - FLEX 1600 (2-level FSK), 3200 (2- or 4-level FSK), 6400 bps (4-level FSK).
- Windows GUI for configuration and diagnostics over serial or network (Cruise Control).
- POCSAG encoder with in-built deployment test and modulation self-test feature
- Hardware alarm outputs.
- Front panel indicators for power output and diagnostics.

Test Setup

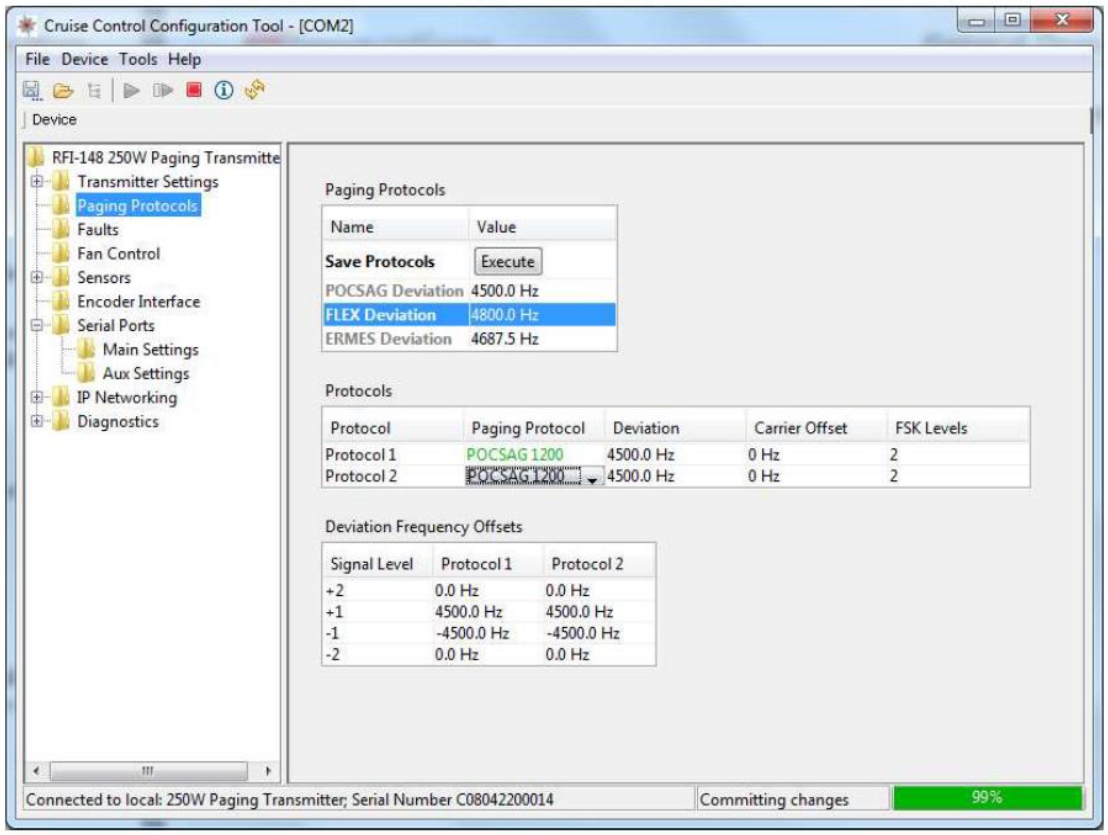
The client has supplied an auxiliary unit of STI make, model no: RFI-450 VF which was used as a signal generator to provide necessary modulated input to the device under test.

Client supplied instructions were followed to set the Transmitter to output a specific modulated output to facilitate testing.

For testing of product for F3E voice modulation, external calibrated signal generator was used to provide required audio tones from 100 Hz to 5 kHz of audio frequency testing range.

The product has RS 232 and Ethernet connections which were used to connect the product to the test laptop running cruise control software.

The frequencies, channel widths and test modulations were controlled via cruise control software.



Snapshot of Cruise control software used in product testing

6. TEST RESULTS

Certification required

Part 90.203(j)

4) Applications for part 90 certification of transmitters designed to operate on frequencies in the 150.8–162.0125 MHz, 173.2–173.4 MHz, and/or 421–512 MHz bands, received on or after January 1, 2011;

The product tested operates in the frequency range 153.5 MHz-159.5 MHz which falls within 150.8-173.4 MHz band and hence certification is required

(ii) 12.5 kHz for multi-bandwidth mode equipment with a maximum channel bandwidth of 12.5 kHz if it is capable of operating on channels of 6.25 kHz or less;

The multi bandwidth mode product tested is capable of operating using channel bandwidths of 12.5 kHz and 6.25 kHz.

(5), Applications for part 90 certification of transmitters designed to operate on frequencies in the 150.8–162.0125 MHz, 173.2–173.4 MHz, and/or 421–512 MHz bands, after January 1, 2011, must include a certification that the equipment meets a spectrum efficiency standard of one voice channel per 6.25 kHz of channel bandwidth;

The product tested is a digital and analogue voice modulated transceiver that has been shown to meet the spectrum efficiency standard of one voice channel per 6.25 kHz of channel bandwidth.

(7) Transmitters designed only for one-way paging operations may be certified with up to a 25 kHz bandwidth and are exempt from the spectrum efficiency requirements of paragraphs (j)(3) and (j)(5) of this section.

The RFI-148 250 is a transmitter designed for one-way paging operations.

Result: Complies.

RF power output

Measurements were carried out at the RF output terminals of the transmitter using a 60 dB power attenuator and a 50 Ω dummy load.

Measurements were carried out when the transmitter was not being modulated.

Testing was carried out at maximum power output.

Maximum transmitter power (CW) - Rated 250 Watts (+54.0 dBm)

Frequency (MHz)	Voltage (Vac)	Carrier Power (dBm)		
		+22˚ C	+50˚ C	-30˚ C
153.500	+15% of Vac	53.8	53.8	54.5
	Vac	53.8	53.8	54.5
	-15% of Vac	53.8	53.8	54.5
156.500	+15% of Vac	53.9	53.9	54.5
	Vac	53.9	53.9	54.5
	-15% of Vac	53.8	53.9	54.5
159.500	+15% of Vac	53.9	53.7	54.5
	Vac	54.0	53.7	54.5
	-15% of Vac	54.0	53.7	54.5

Limits:

Part 90 does not specify the transmitter output power

Result: Complies.

Measurement Uncertainty: ± 0.5 dB

Emission types and bandwidth limitations:

The following emission types are used: F2D, F3D and F3E, these have been elaborated as under:

F2D 51: 51 bps FFSK

F2D100: 100 bps FFSK

F3D DTMF: Alphanumeric characters encoded as Dual-Tone Multi-Frequency signalling sent at 4 characters/second.

F3E VOICE-Analogue Audio

Following emission designators been declared by the client:

11K2F2D, 11K2F3D and 11K2F3E for 12.5 kHz channel spacing.

6K00F2D, 6K00F3D and 6K00F3E for 6.25 kHz channel spacing.

The authorised bandwidth is taken to be the necessary bandwidth.

Measurements have been made to verify this declared bandwidth using the various modulation types and data rates that the device under test can support at each test frequency.

Measurements were made using a spectrum analyser that was operating in occupied bandwidth mode with the 99% power points being determined automatically.

The analyser was set up with a resolution bandwidth video bandwidth as per 47 CFR Part 2, ANSI / TIA-603-E-2016 and ANSI C63.26: 2015.

Attached to the input of the spectrum analyser was an external 60 dB attenuator.

All the measurements that have been tabulated were made but only the representative plots have been included in the test report in order to simplify the test report.

Result: Complies

Audio input to the product reasoning:

- To perform the F3E-Voice modulation tests, the level from the external signal generator from the test lab was set to 1 kHz frequency and the level was set to the output from client supplied modulation source (Crescendo) which is approximately 1.6 Vp-p.

- As per the user manual supplied by the client, without pre-emphasis, the audio response expected from the product is Flat (50Hz to 2800Hz; not referenced to 1kHz)

- The range of audio input that should be supplied to the product in typical operation should be between 0.035 to 2 Vp-p , which is corresponding to -25dBm to +10dBm based on 50 Ω.

- The audio level at which 60% frequency deviation of 1.5 kHz was noted for 12.5 kHz channel was found to be 570 mV (50 Ω).

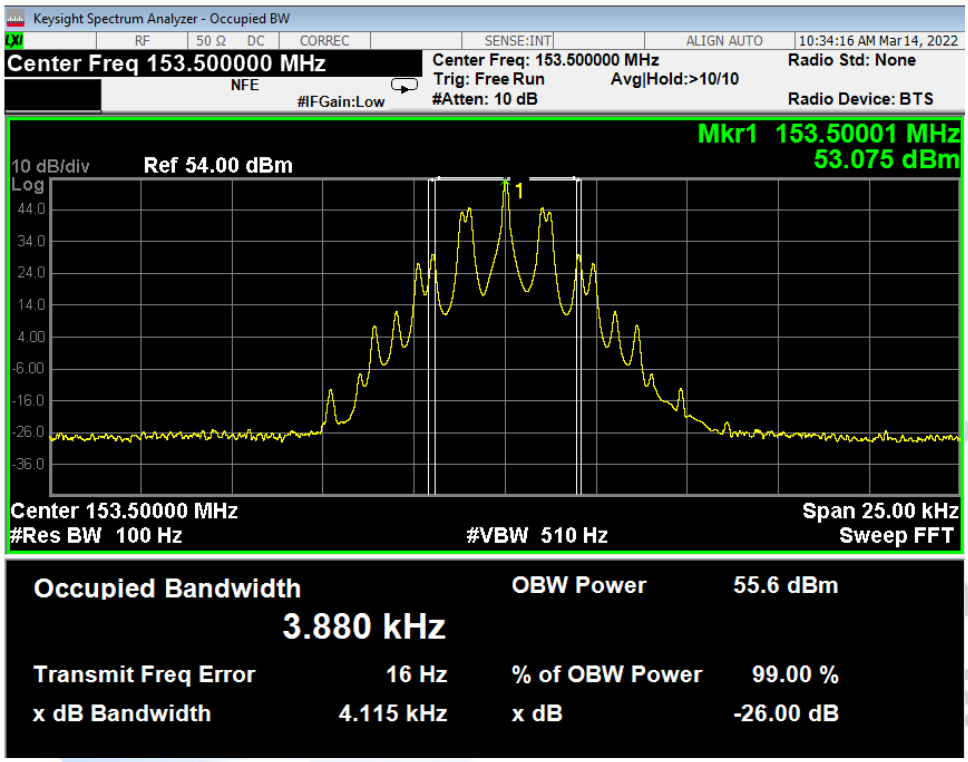
- The testing at a level 20 dB higher than this level at which 60% frequency deviation was obtained could not be done as this would exceed the audio level that is typical to the product operation which is 2 Vp-p.

- The testing was therefore performed at two audio levels, 2 Vp-p (0.7 Vrms) and at 5.7 Vp-p (2.0 Vrms) as worst case and the results have been provided in the test report.

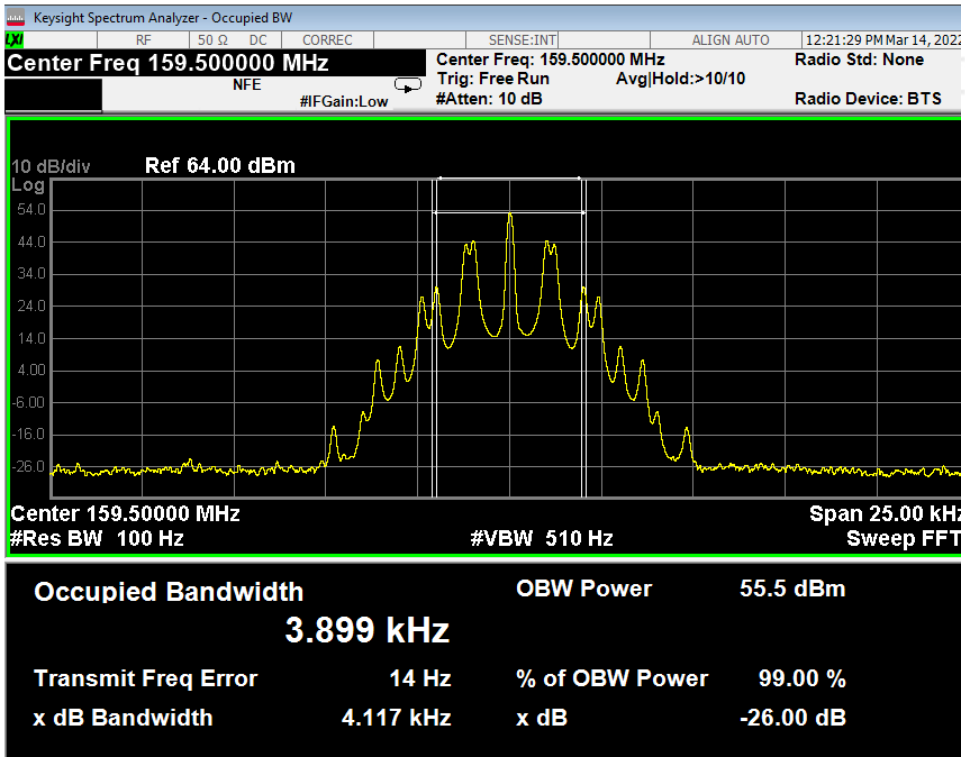
Emission- 6.25 kHz spacing.

Emission Tested	Frequency (MHz)	Measured (kHz)	Authorised Bandwidth
F2D-51	153.500	3.880	6.0 kHz
	159.500	3.899	

153.5 MHz/6.25 kHz channel/F2D-51 emission



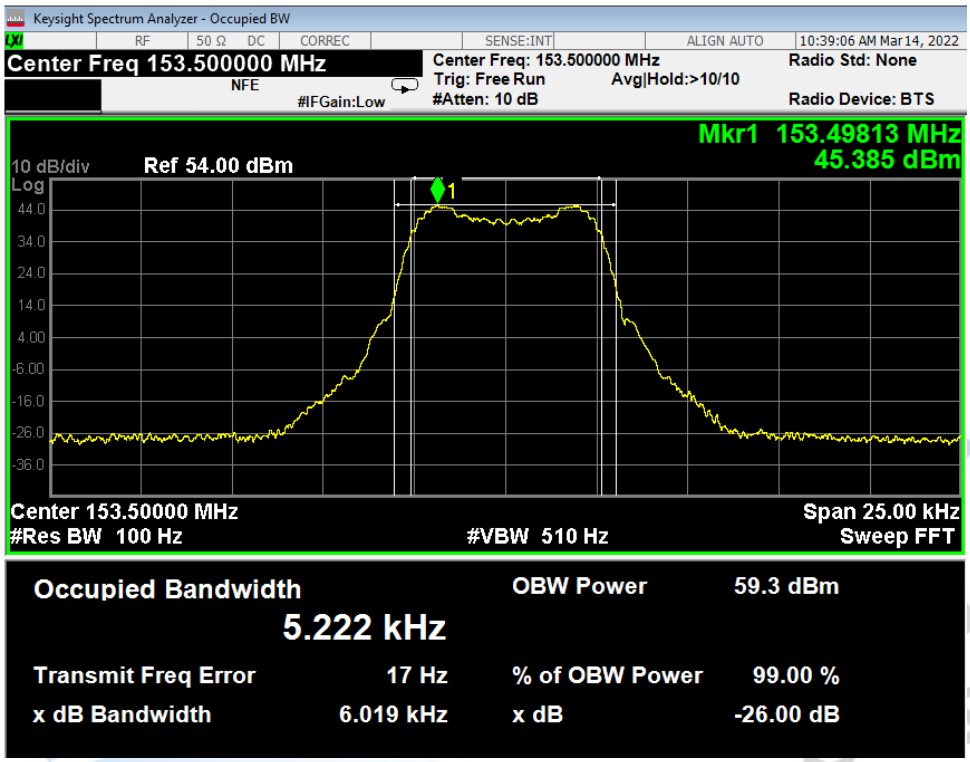
159.5 MHz/6.25 kHz channel/F2D-51 emission



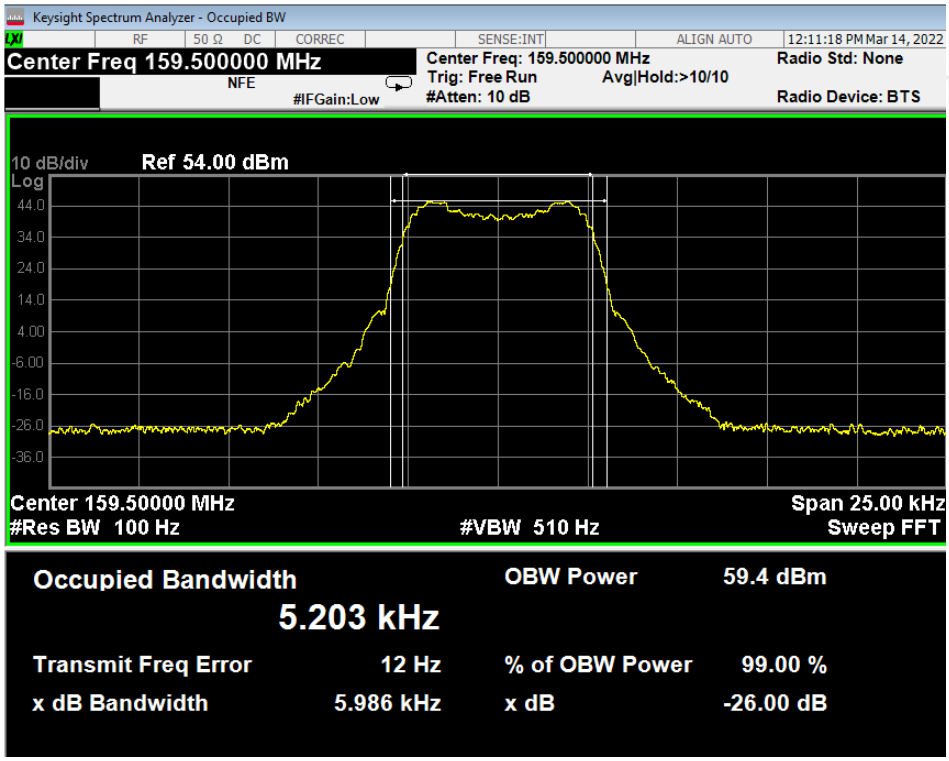
Emission- 6.25 kHz spacing.

Emission Tested	Frequency (MHz)	Measured (kHz)	Authorised Bandwidth
F2D-100	153.500	5.222	6.0 kHz
	159.500	5.203	

153.5 MHz/6.25 kHz channel/F2D-100 emission



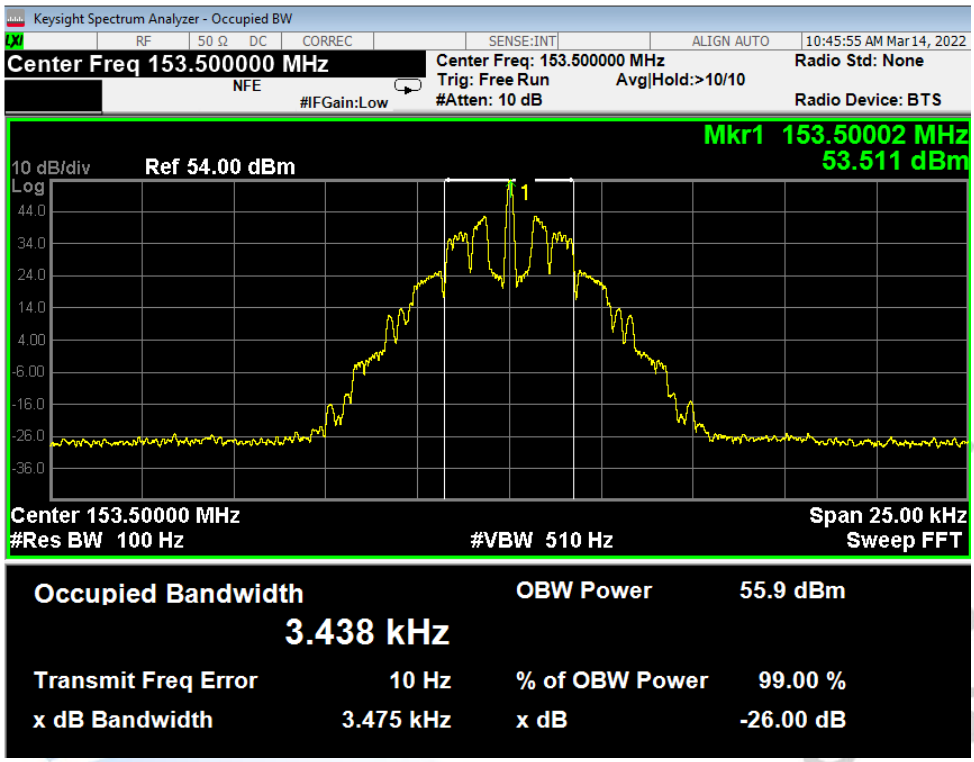
159.5 MHz/6.25 kHz channel/F2D-100 emission



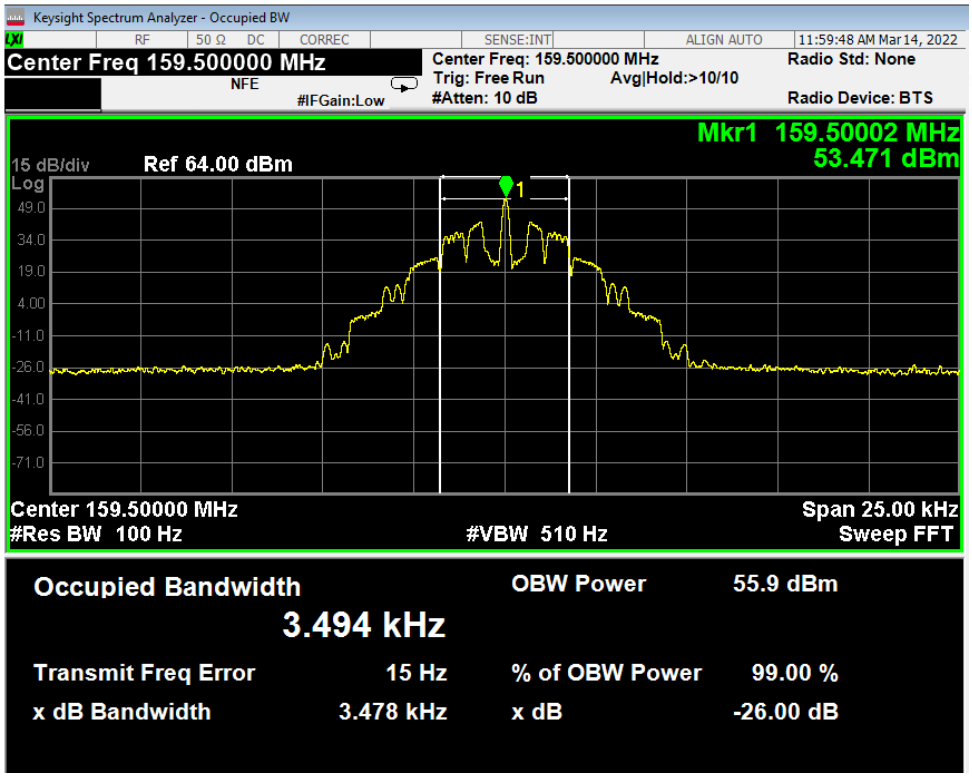
Emission- 6.25 kHz spacing.

Emission Tested	Frequency (MHz)	Measured (kHz)	Authorised Bandwidth
F3D-DTMF	153.500	3.438	6.0 kHz
	159.500	3.494	

153.5 MHz/6.25 kHz channel/F3D-DTMF emission



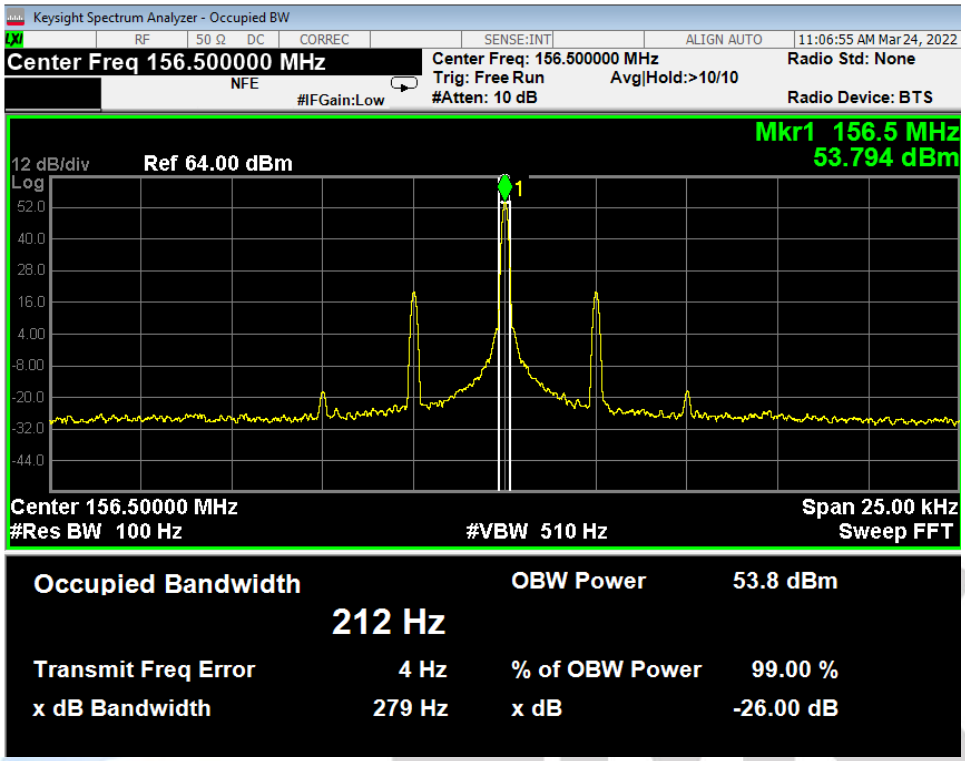
159.5 MHz/6.25 kHz channel/F3D-DTMF emission



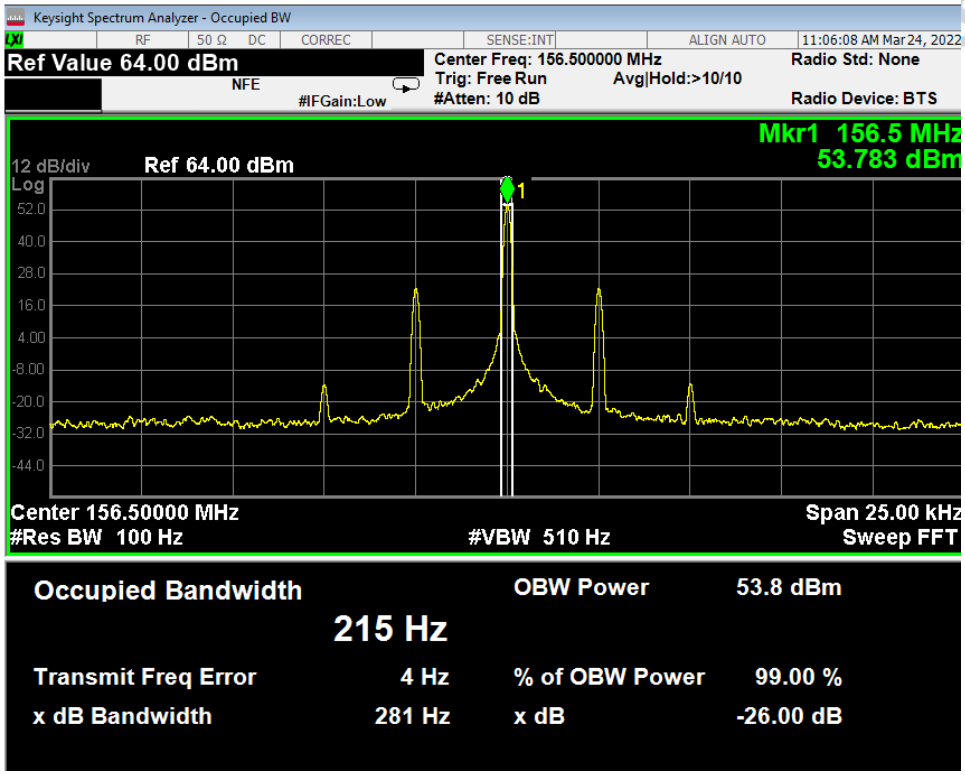
Emission- 6.25 kHz spacing.

156.5 MHz/6.25 kHz channel/F3E-VOICE

Tested with Audio input at 2500 Hz and a level of 0.7 Vrms



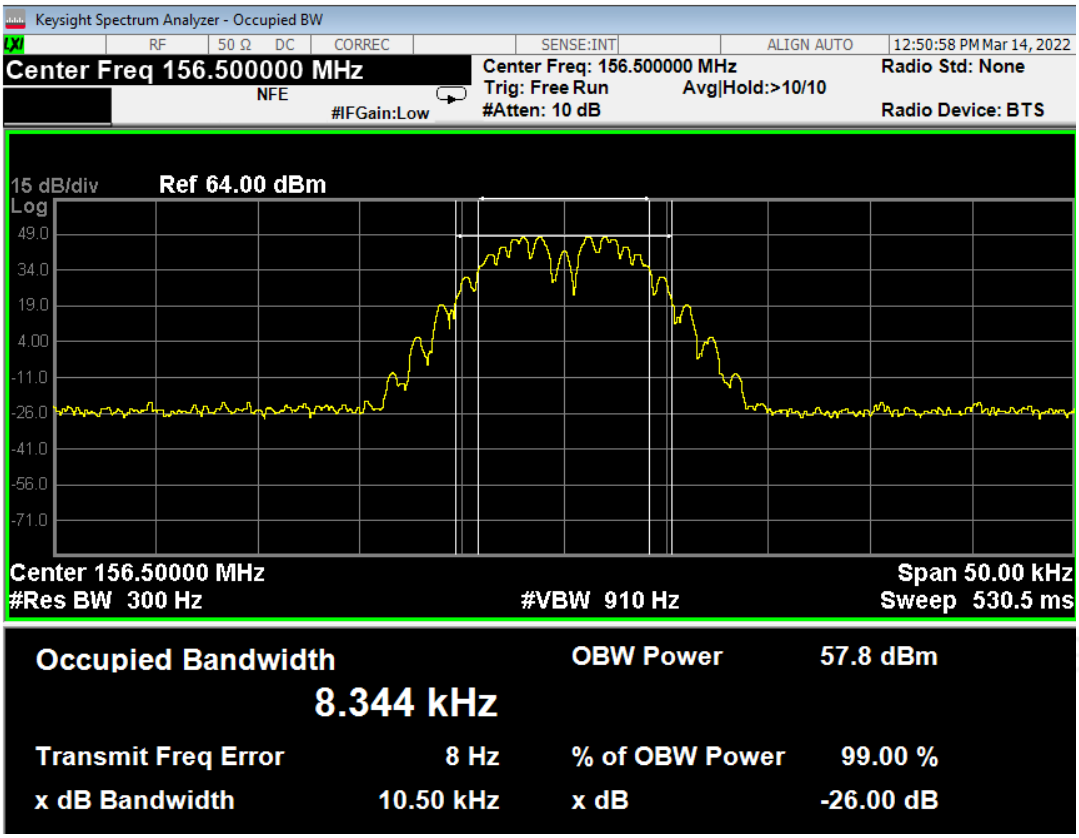
Tested with Audio input at 2500 Hz and a level of 2 Vrms



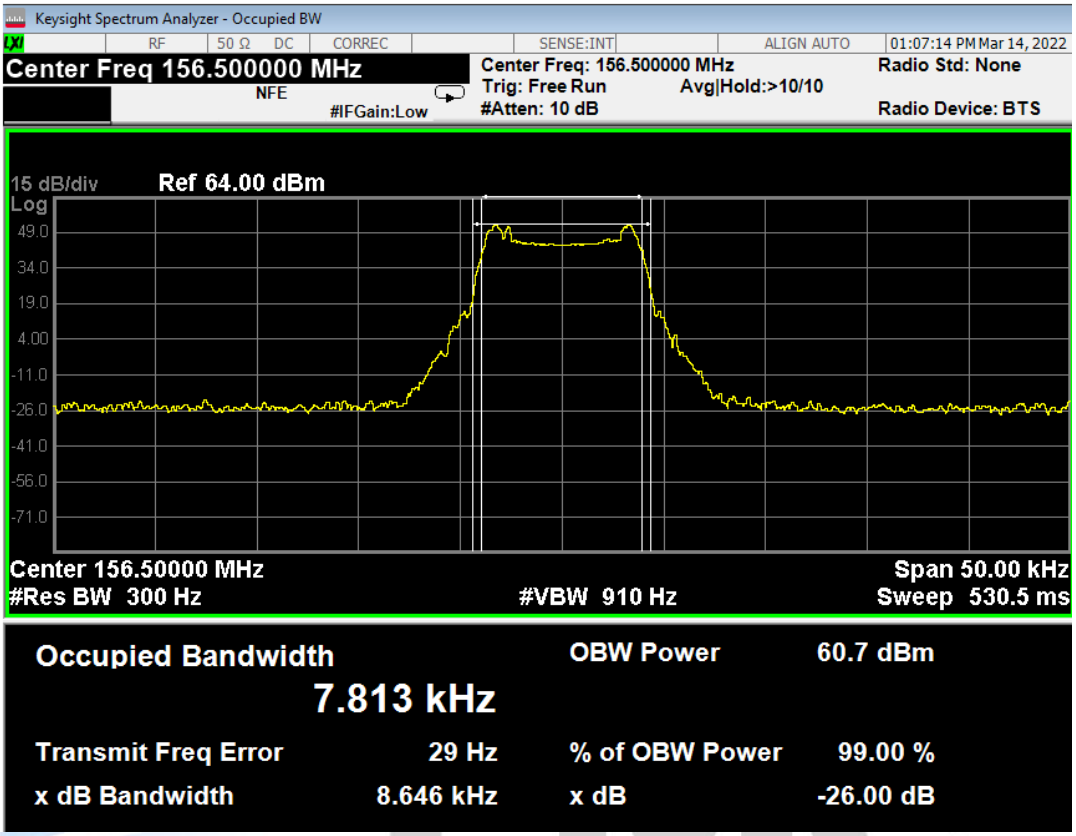
Emission- 12.5 kHz spacing.

Emission Tested	Frequency (MHz)	Measured (kHz)	Authorised Bandwidth
F2D-51	156.500	8.344	11.2 kHz
F2D-100	156.500	7.813	
F3D-DTMF	156.500	0.795	
F3E-VOICE Audio input: 0.7 Vrms	156.500	5.876	
F3E-VOICE Audio input: 2.0 Vrms	156.500	10.076	

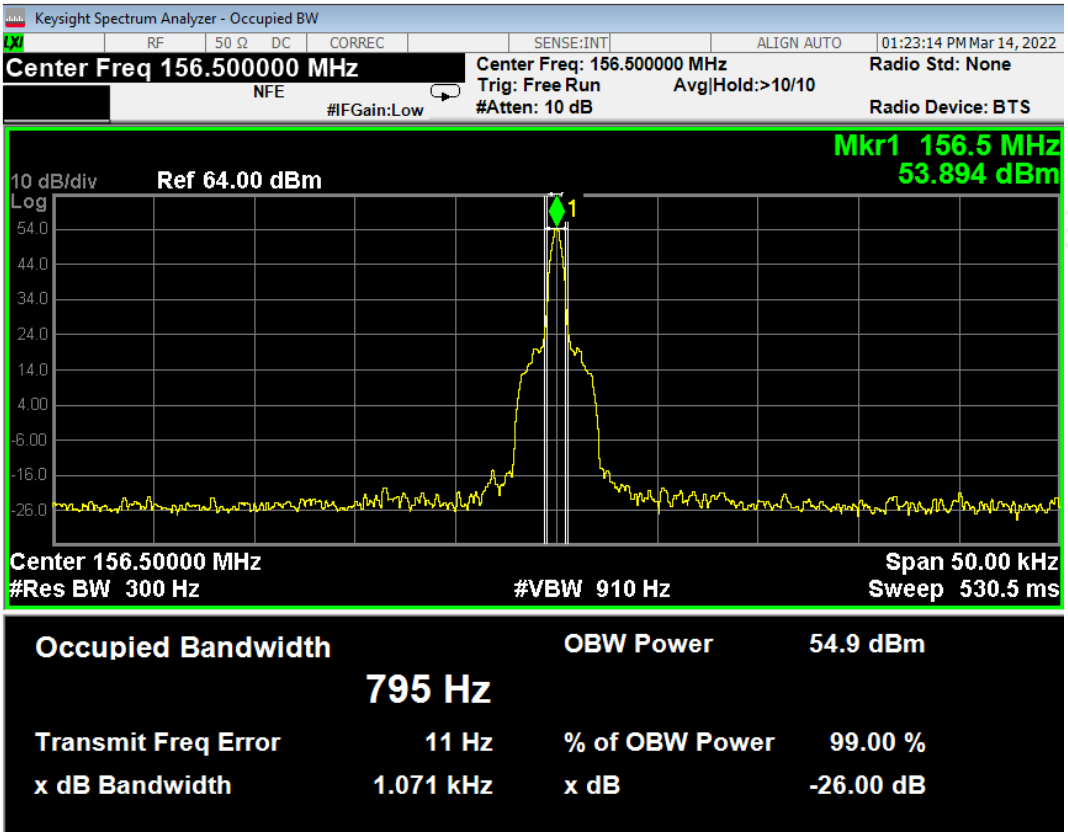
156.5 MHz/12.5 kHz channel/F2D-51 emission



156.5 MHz/12.5 kHz channel/F2D-100 emission

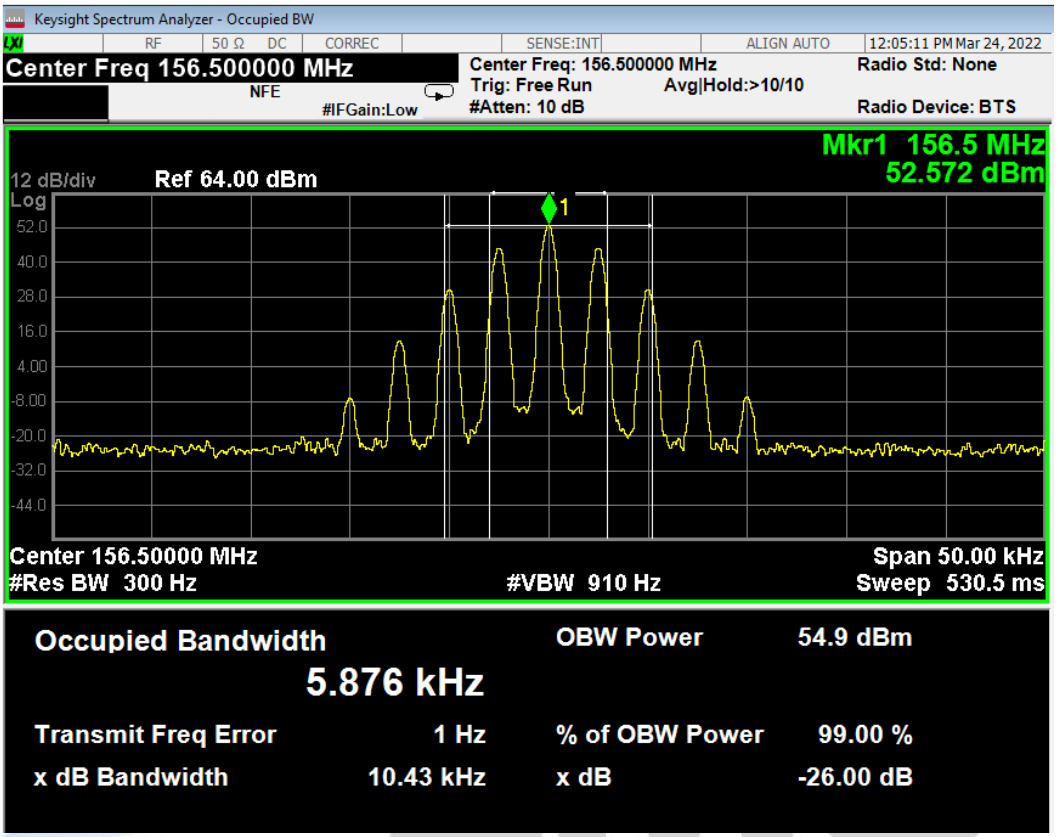


156.5 MHz/12.5 kHz channel/F3D-DTMF emission



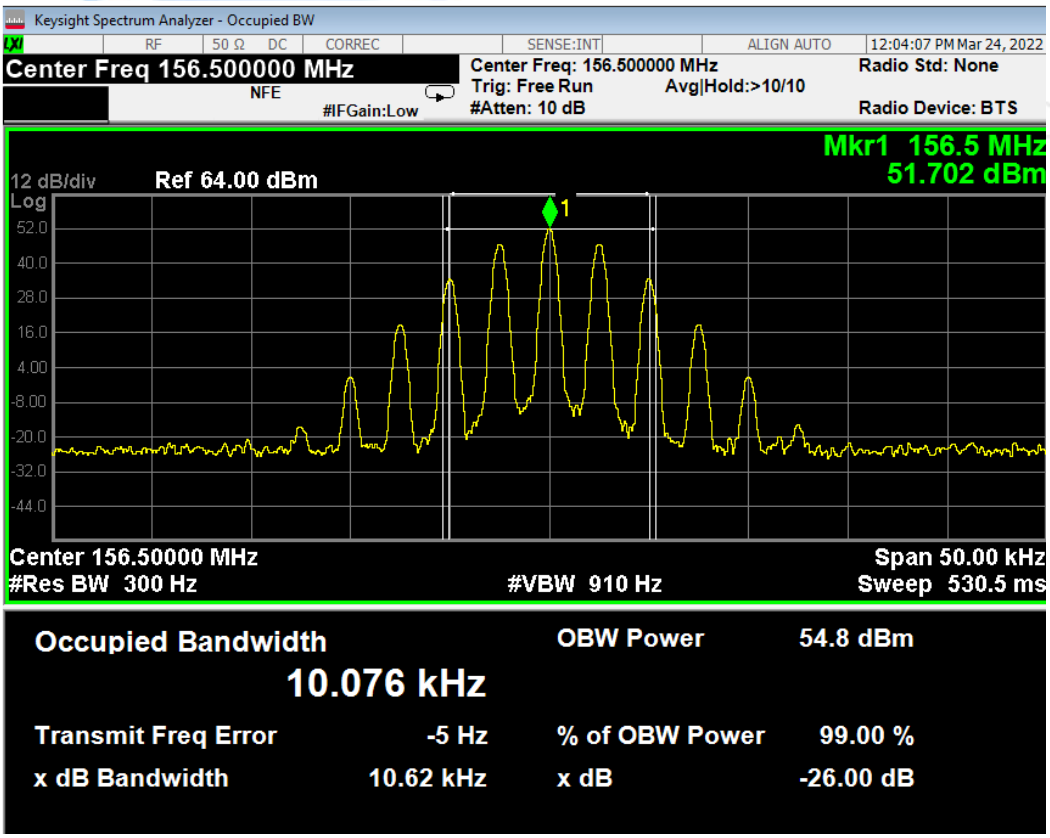
156.5 MHz/12.5 kHz channel/F3E-VOICE emission

Tested with Audio input at 2500 Hz and a level of 0.7 Vrms



156.5 MHz/12.5 kHz channel/F3E-VOICE emission

Tested with Audio input at 2500 Hz and a level of 2.0 Vrms



Spectrum Masks

The spectrum masks are defined in:

Section 90.210(d) – Mask D and E have been applied as the transmitter can operate in the band 150.800-173.400 MHz using an authorised bandwidth of 12.5 kHz and 6.25 kHz respectively as per Section 90.209(b)(5).

The reference level for the following emission mask measurements has been determined using a resolution bandwidth of 120 kHz with the transmitter modulated.

For all measurements a 60 dB attenuator is placed between the transmitter and the spectrum analyser. Measurements were made in peak hold

For the F2D and F3D mode the transmitter was modulated using the client supplied modulation source named Crescendo RFI-450VF external to the transmitter.

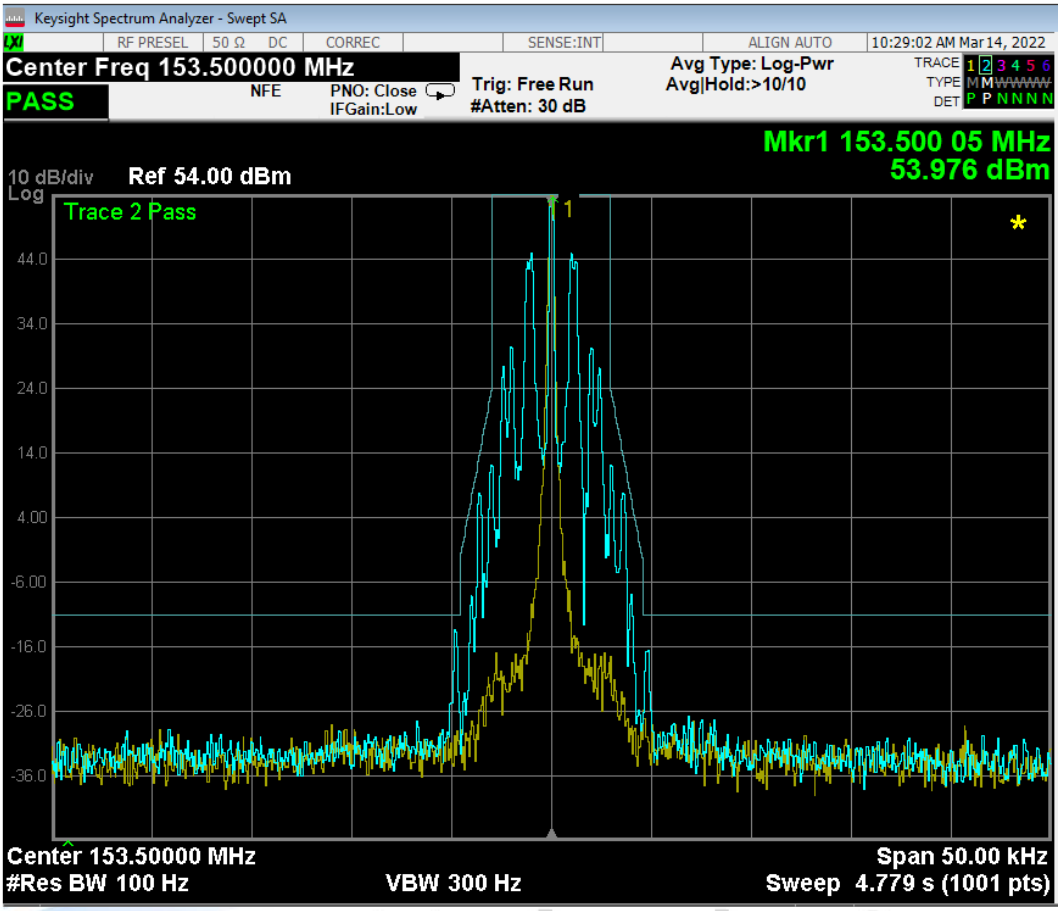
For F3E mode, the transmitter was modulated with a 2500 Hz tone at 2 Vrms audio level supplied from external calibrated audio signal generator from the test lab.

The test was carried out at 153.500 MHz and 159.500 MHz.

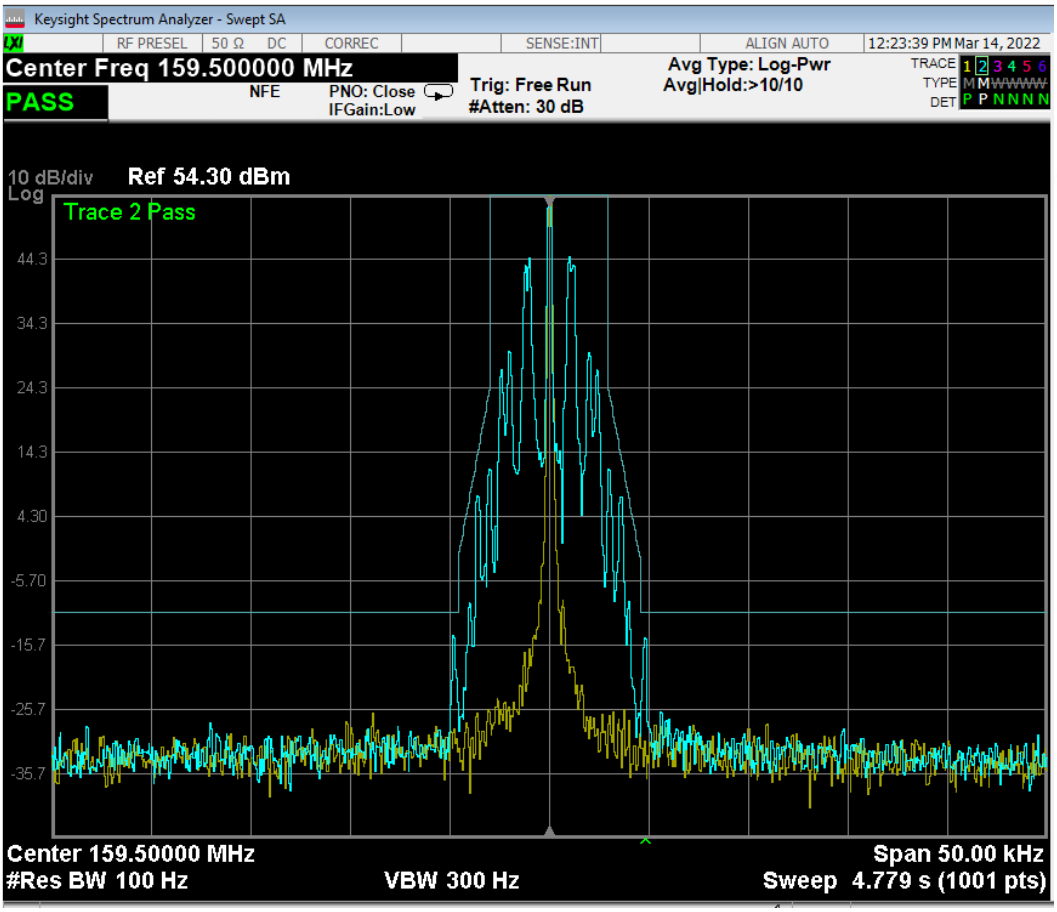
Result: Complies.

6.25 kHz, Spectrum Masks

153.500 MHz/6.25 kHz channel/F2D-51/Mask E emission

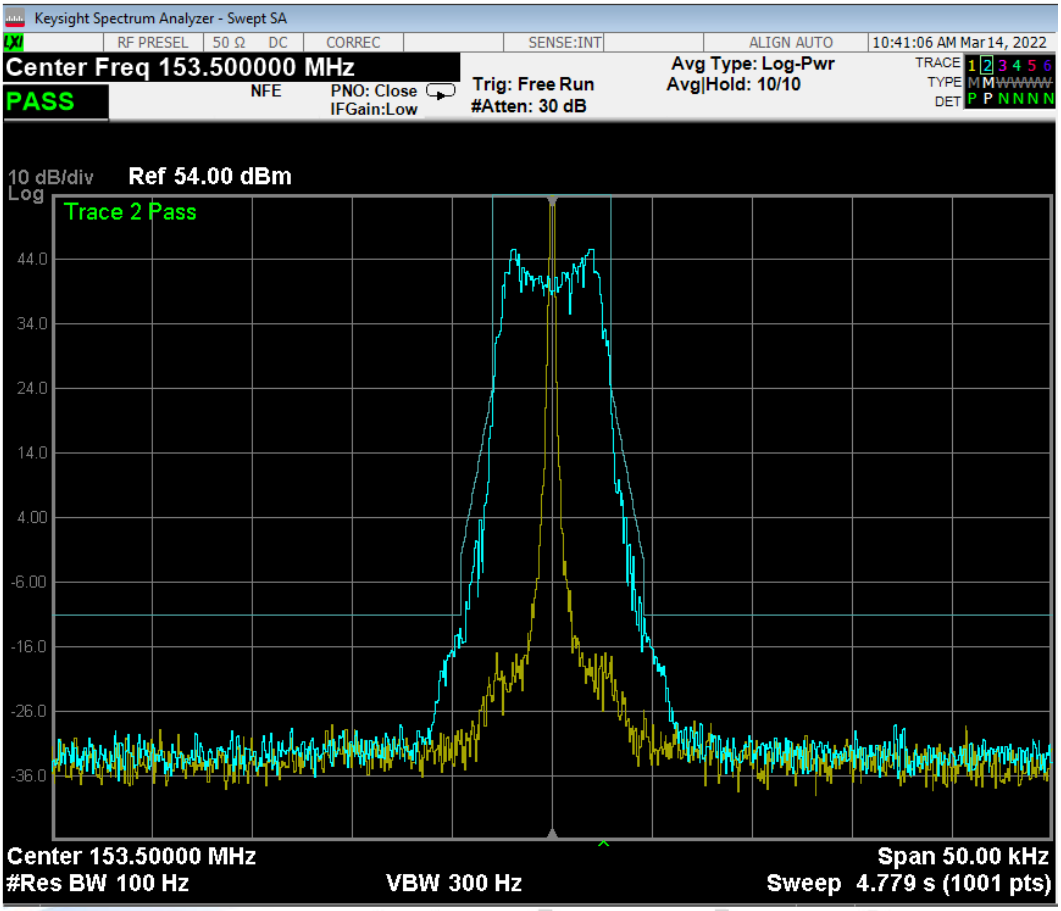


159.500 MHz/6.25 kHz channel/F2D-51/Mask E emission

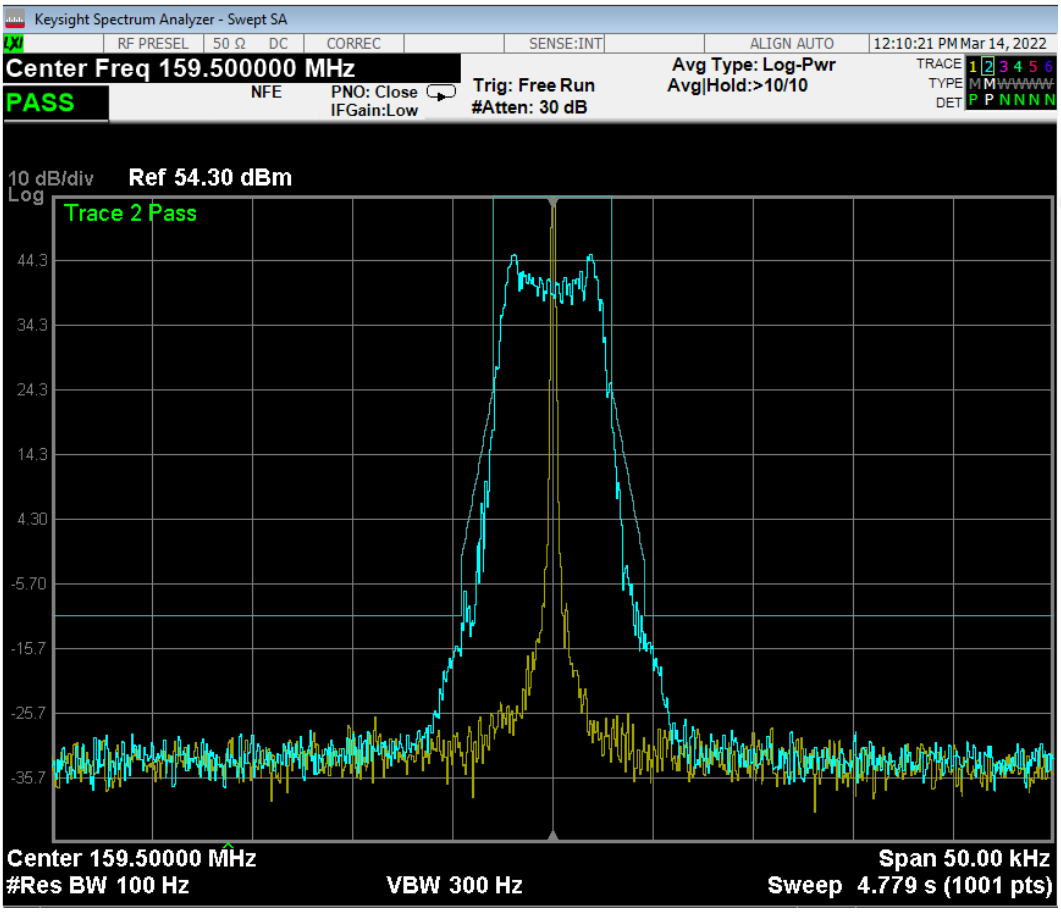


6.25 kHz, Spectrum Masks

153.500 MHz/6.25 kHz channel/F2D-100/Mask E emission

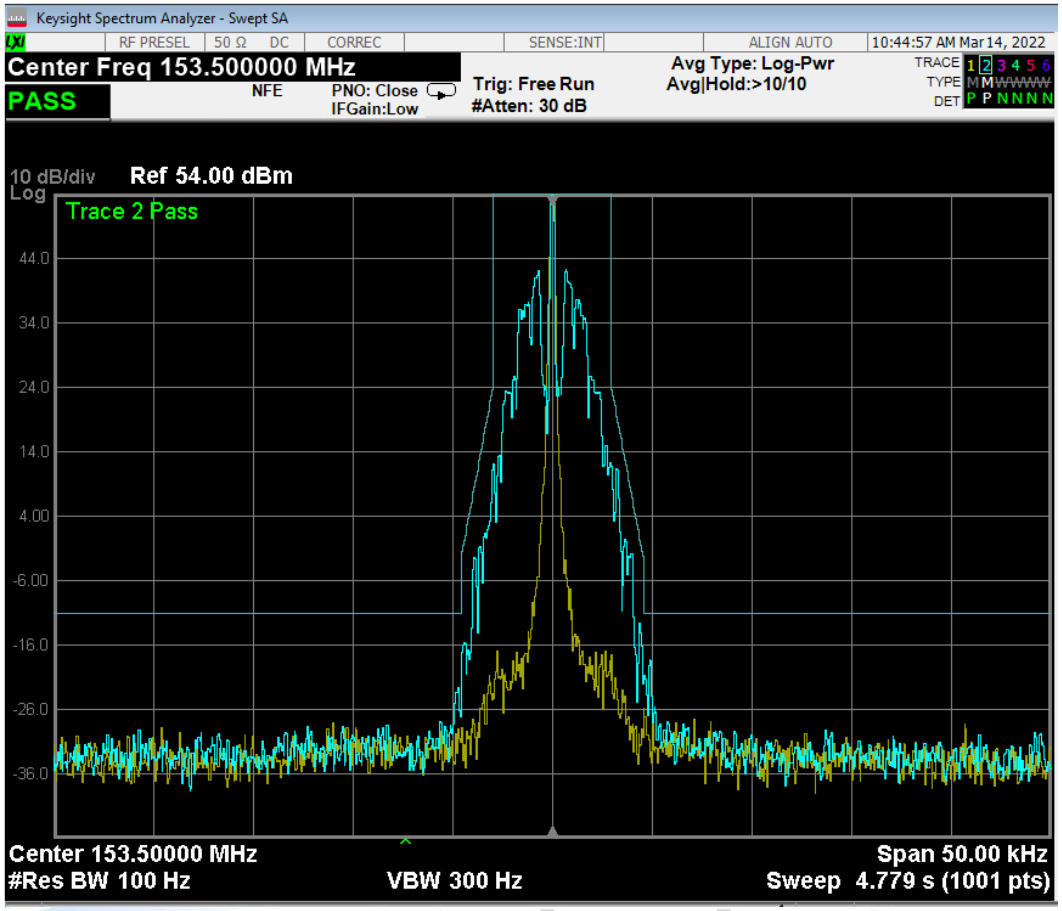


159.500 MHz/6.25 kHz channel/F2D-100/Mask E emission

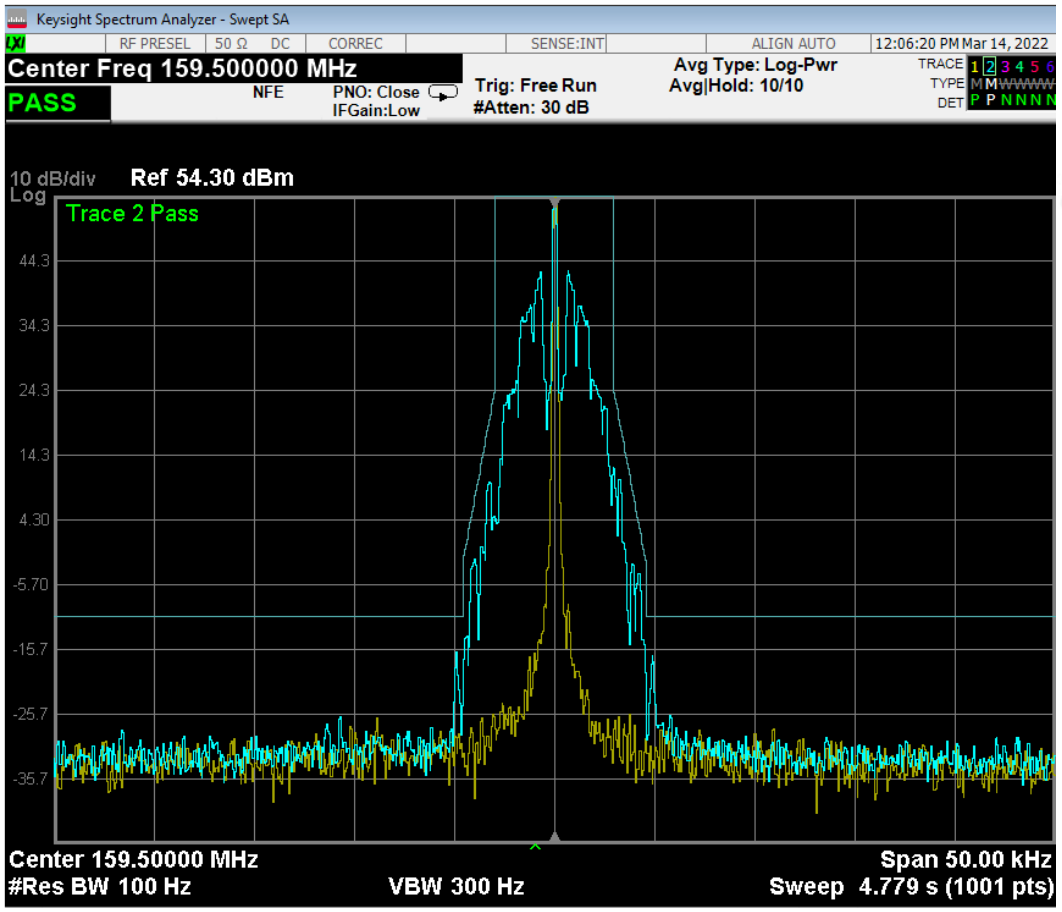


6.25 kHz, Spectrum Masks

153.500 MHz/6.25 kHz channel/F3D-DTMF/Mask E emission

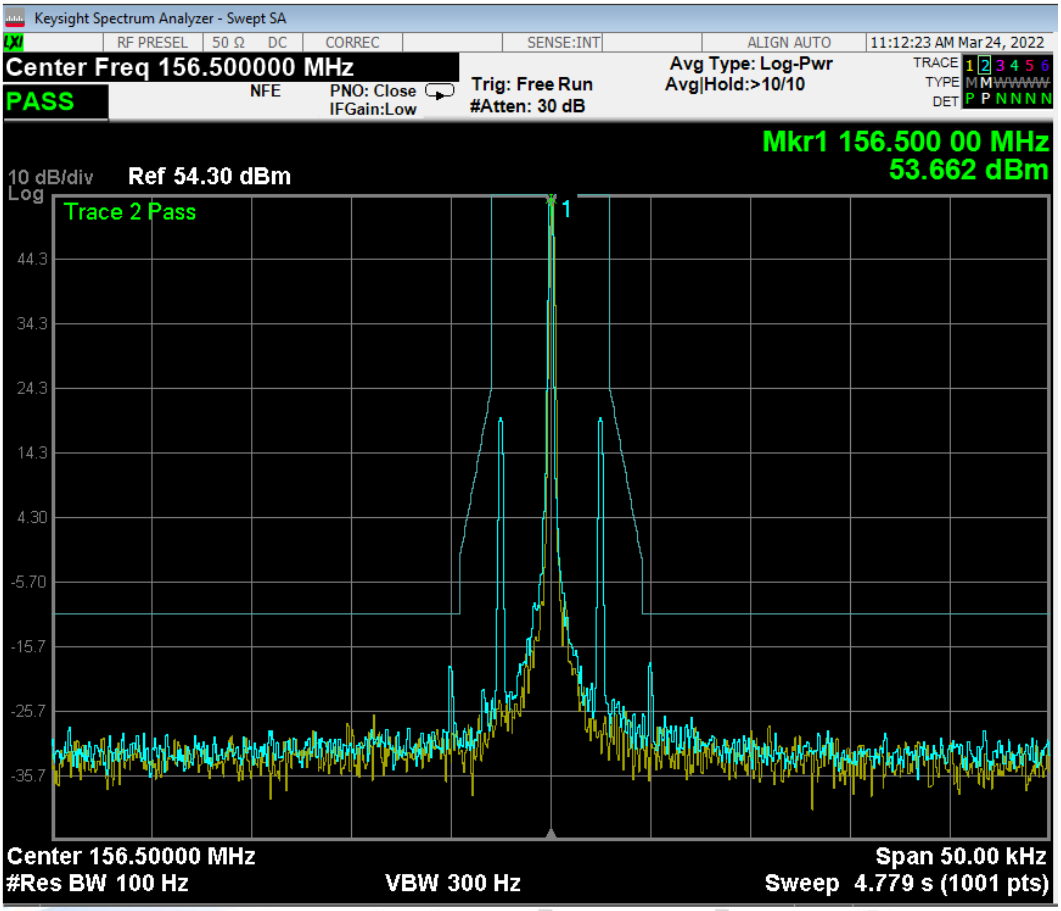


159.500 MHz/6.25 kHz channel/F3D-DTMF/Mask E emission

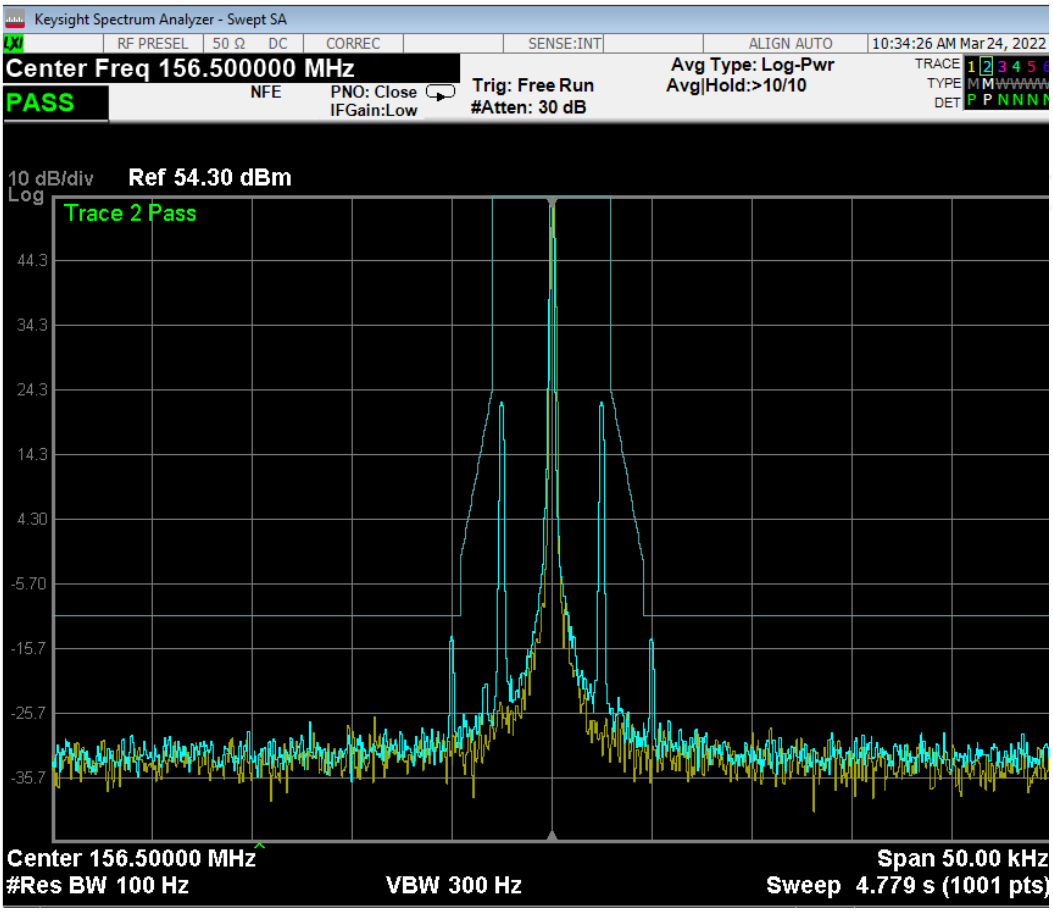


156.500 MHz/6.25 kHz channel/F3E-VOICE/Mask E emission

Tested with Audio input at 2500 Hz and a level of 0.7 Vrms

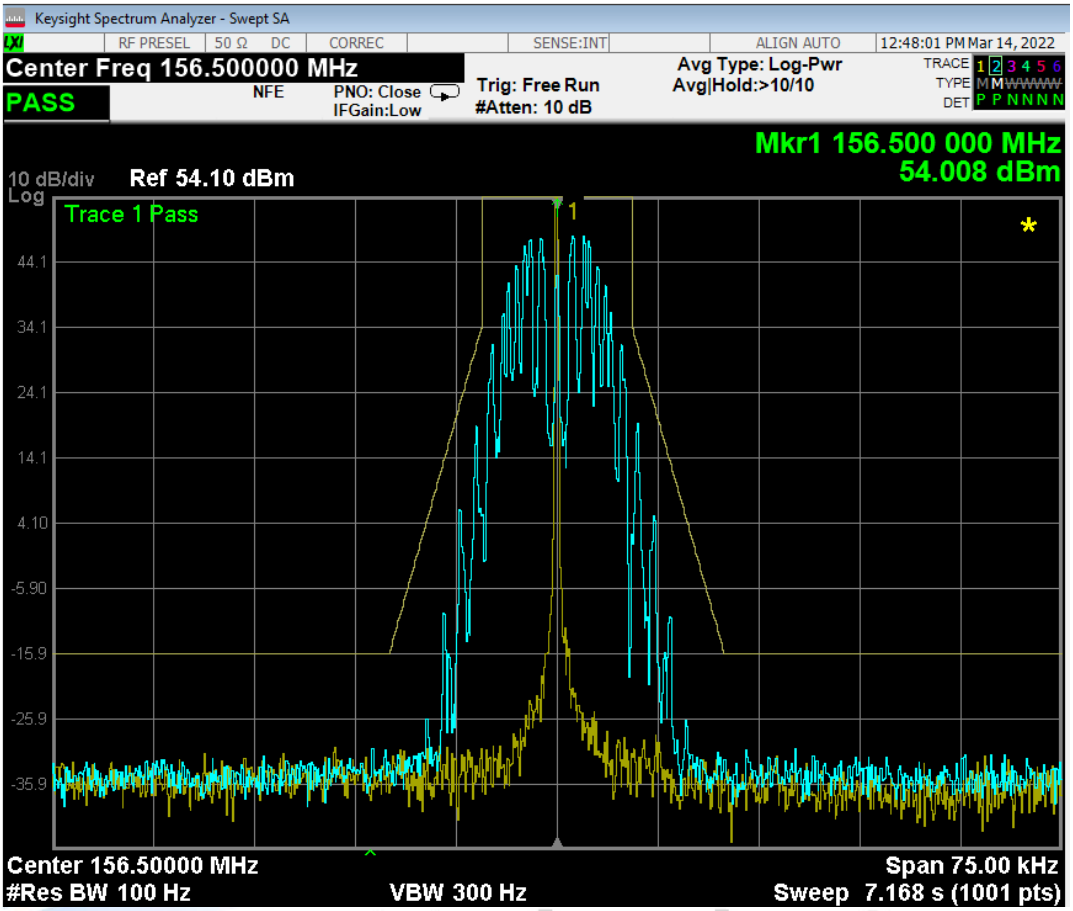


Tested with Audio input at 2500 Hz and a level of 2.0 Vrms

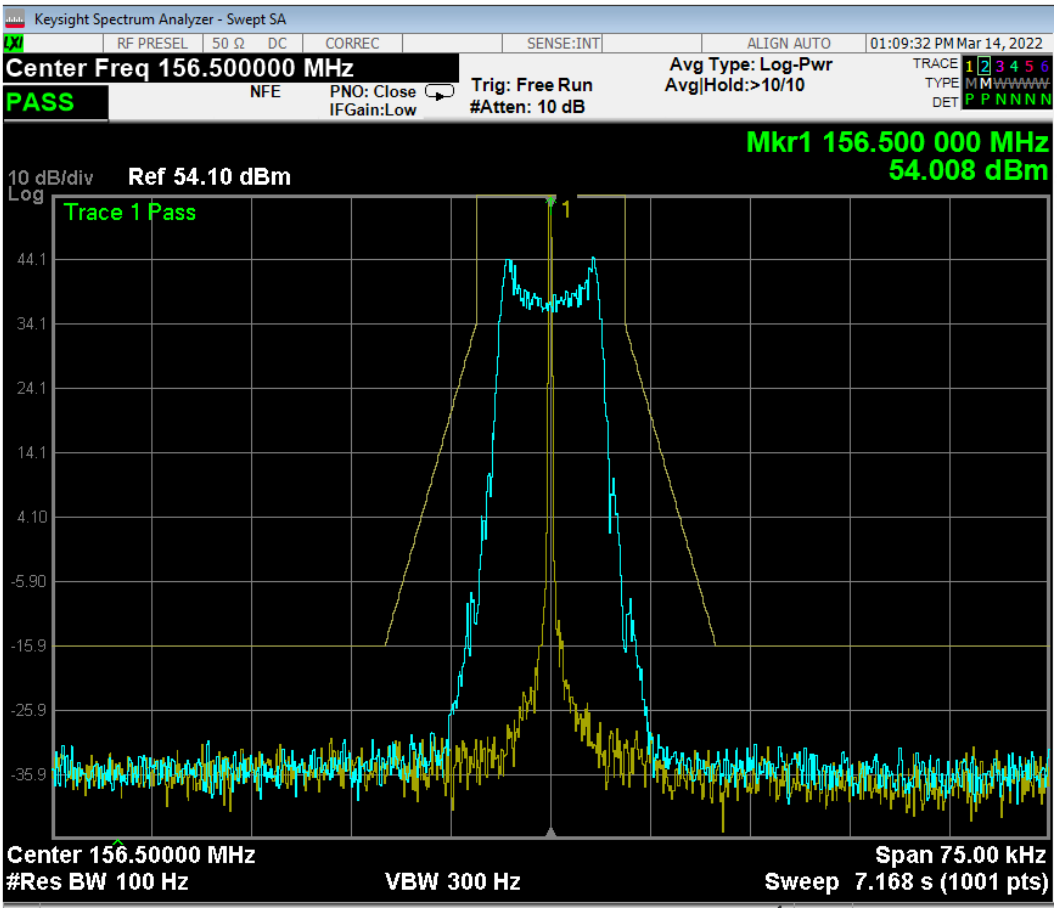


12.5 kHz, Spectrum Masks

156.500 MHz/12.5 kHz channel/F2D-51/ Mask D emission

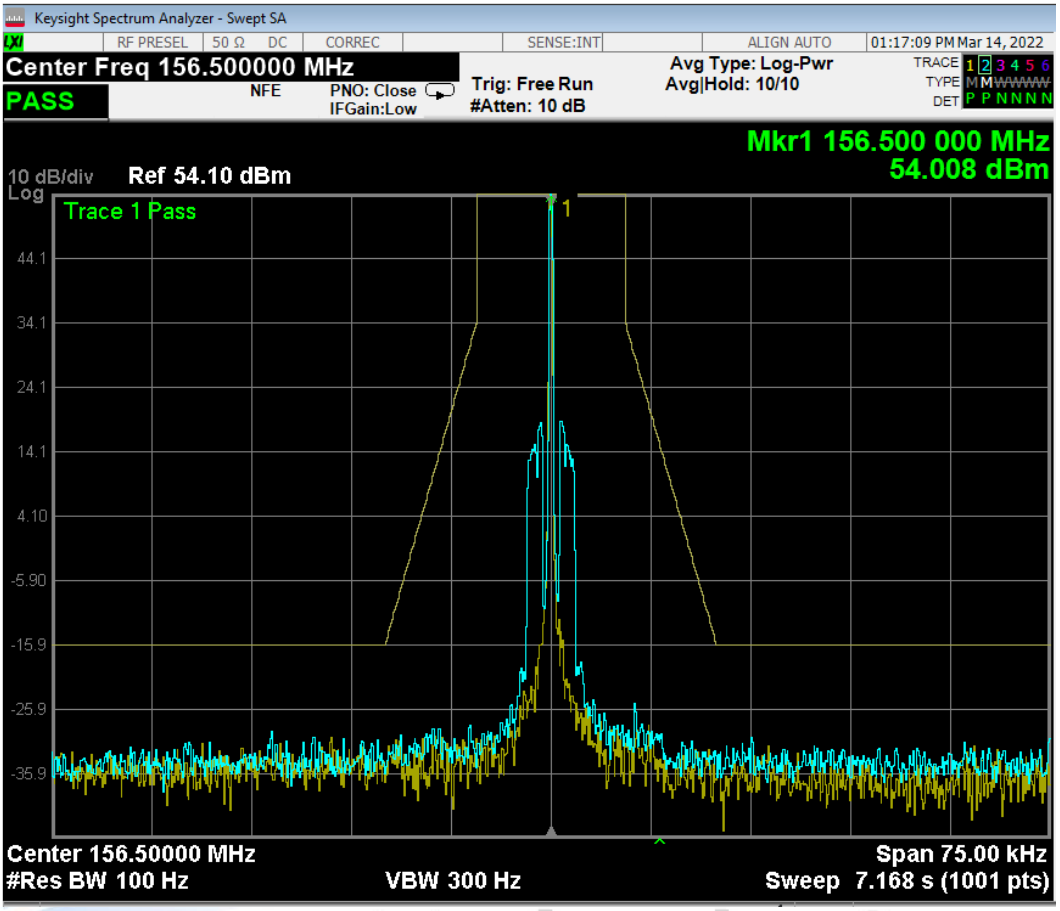


156.500 MHz/12.5 kHz channel/F2D-100/ Mask D emission

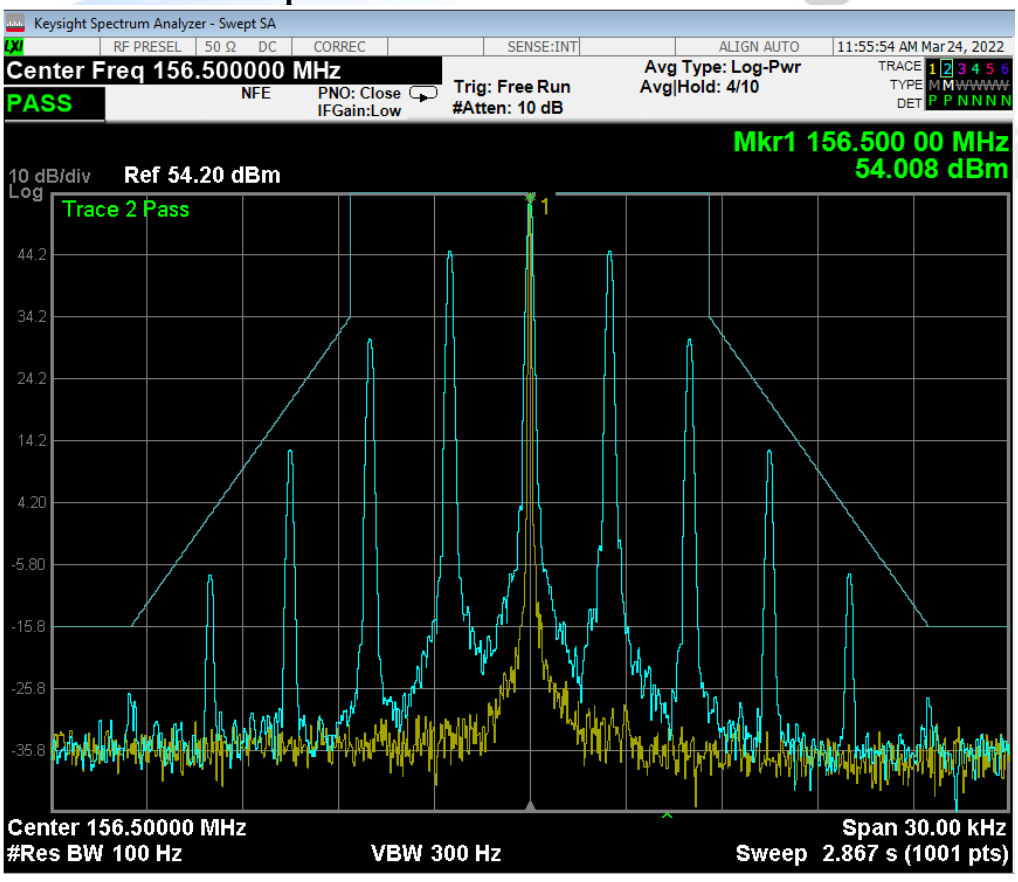


12.5 kHz, Spectrum Masks

156.500 MHz/12.5 kHz channel/F3D-DTMF/ Mask D emission

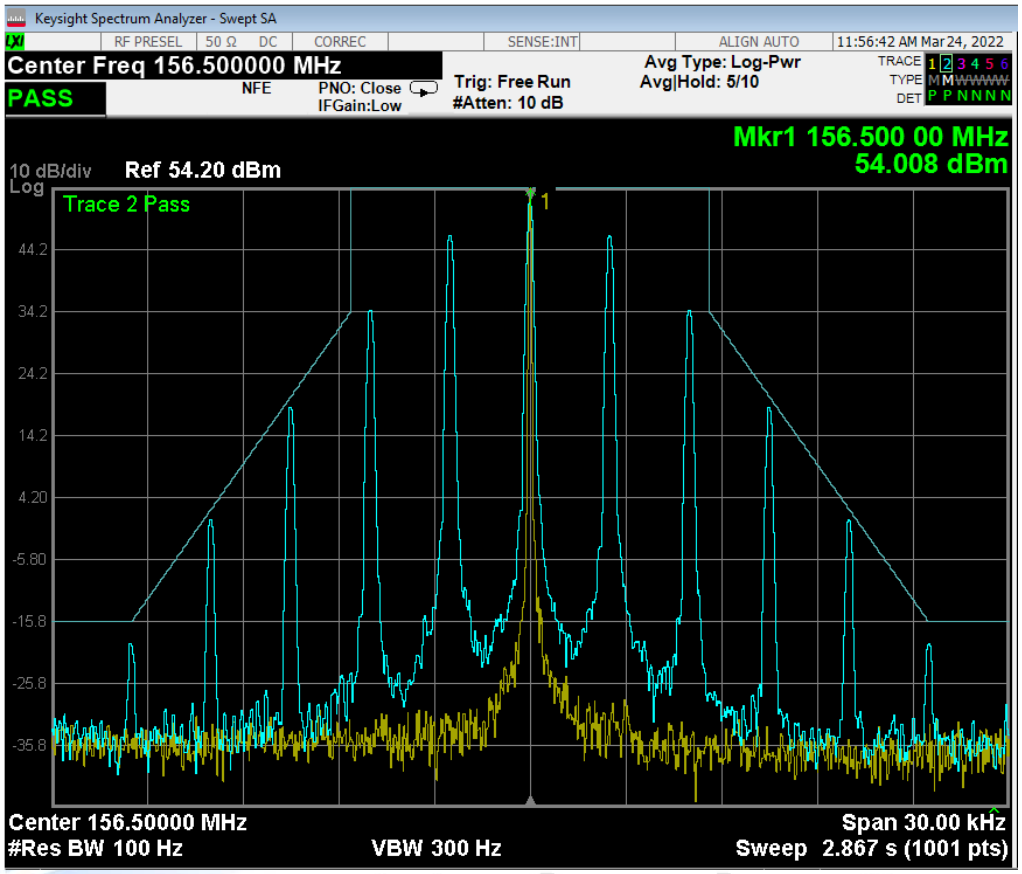


156.500 MHz/12.5 kHz channel/F3E-VOICE/ Mask D emission
Tested with Audio input at 2500 Hz and a level of 0.7 Vrms



156.500 MHz/12.5 kHz channel/F3E-VOICE/ Mask D emission

Tested with Audio input at 2500 Hz and a level of 2.0 Vrms



Transmitter spurious emissions at the antenna terminals

The test was conducted at standard and extreme test conditions and the worst case has been tabulated as below:

Frequency: 153.500 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
307.00	-31.6	-20.0
460.50	<-32.0	-20.0
614.00	<-32.0	-20.0
767.50	<-32.0	-20.0
921.00	<-28.0	-20.0
1074.50	<-28.0	-20.0

Frequency: 159.500 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
319.00	<-32.0	-20.0
478.50	<-30.0	-20.0
638.00	<-30.0	-20.0
797.50	<-30.0	-20.0
957.00	<-28.0	-20.0
1116.50	<-28.0	-20.0

Limit:
The limit of -20 dBm has been applied to the measurements.

No measurements were made above the 10th harmonic.

Result: Complies. **Measurement Uncertainty**: ± 0.5 dB

Field strength of the transmitter spurious emissions

The transmitter was tested while transmitting continuously while attached to a dummy load.

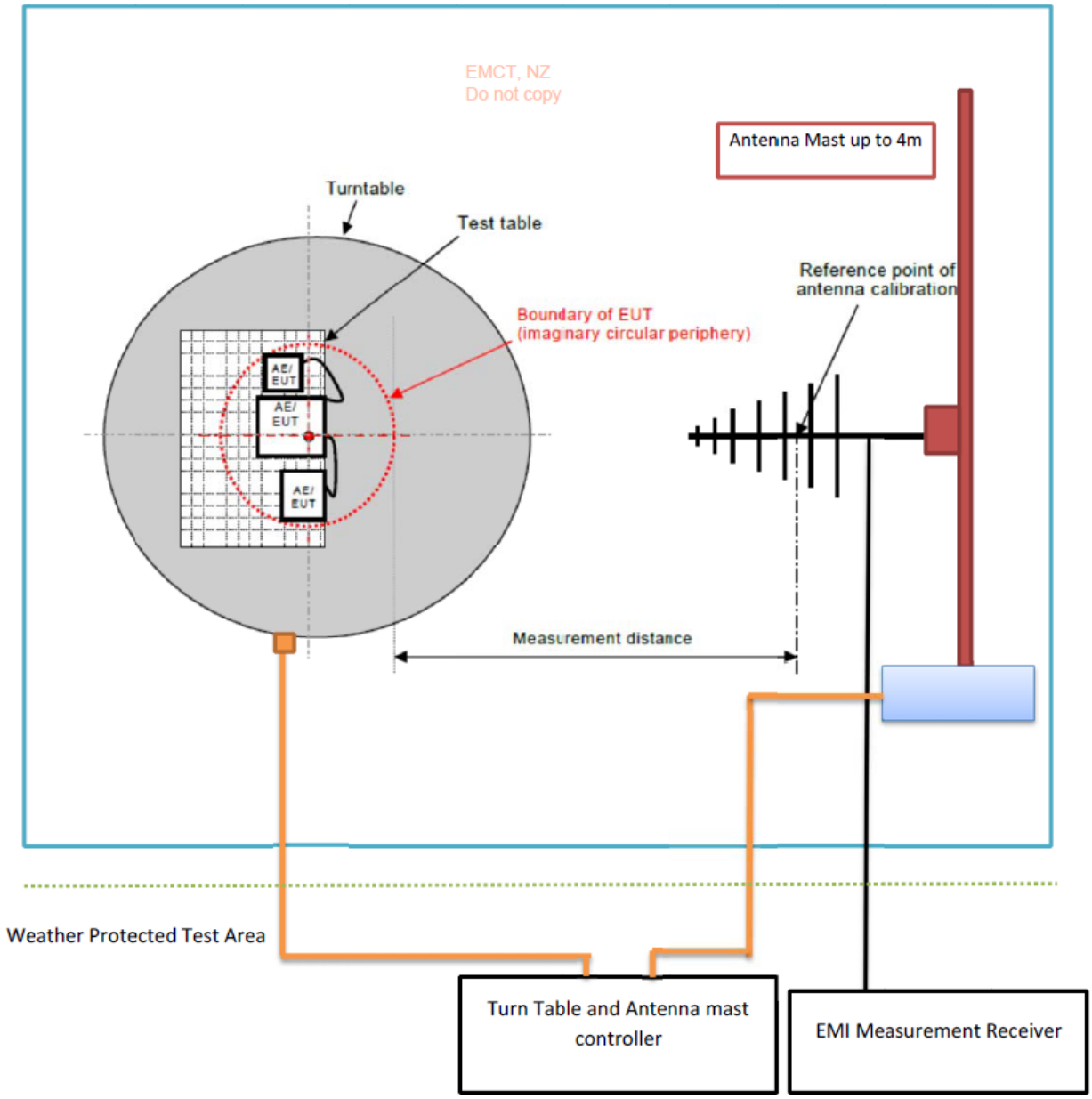
When operating in transmit mode no significant emissions were found between the harmonic emissions.

Device was tested on an open area test site at a distance of 3 metres.

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Driving Creek, Orere Point, Auckland.

The level recorded is the signal generator output level in dBm less any gains / losses due to the coax cable and the dipole antenna.

Radiated Emissions Test setup at Open area test site



Transmitter spurious emissions results:

Nominal Frequency: 153.500 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
307.000	31.2	-66.2	-20.0	Vertical	46.2	Pass
	35.1	-62.3	-20.0	Horizontal	42.3	Pass
460.500	35.1	-62.3	-20.0	Vertical	42.3	Pass
	35.2	-62.2	-20.0	Horizontal	42.2	Pass
614.000	38.3	-59.1	-20.0	Vertical	39.1	Pass
	39.6	-57.8	-20.0	Horizontal	37.8	Pass
767.500	41.2	-56.2	-20.0	Vertical	36.2	Pass
	40.4	-57.0	-20.0	Horizontal	37.0	Pass
921.000	42.8	-54.6	-20.0	Vertical	34.6	Pass
	42.4	-55.0	-20.0	Horizontal	35.0	Pass
1074.500	<48.0	<-49.4	-20.0	Vertical	>29.4*	Pass
	<48.0	<-49.4	-20.0	Horizontal	>29.4*	Pass
1228.000	<48.0	<-49.4	-20.0	Vertical	>29.4*	Pass
	<48.0	<-49.4	-20.0	Horizontal	>29.4*	Pass
1381.500	<48.0	<-49.4	-20.0	Vertical	>29.4*	Pass
	<48.0	<-49.4	-20.0	Horizontal	>29.4*	Pass
1535.000	<48.0	<-49.4	-20.0	Vertical	>29.4*	Pass
	<48.0	<-49.4	-20.0	Horizontal	>29.4*	Pass

* Noise floor measurement.

Nominal Frequency: 159.500 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
319.0000	34.1	-63.3	-20.0	Vertical	43.3	Pass
	36.0	-61.4	-20.0	Horizontal	41.4	Pass
478.5000	36.2	-61.2	-20.0	Vertical	41.2	Pass
	36.0	-61.3	-20.0	Horizontal	41.3	Pass
638.0000	42.2	-55.2	-20.0	Vertical	35.2	Pass
	44.4	-53.0	-20.0	Horizontal	33.0	Pass
797.5000	42.0	-55.4	-20.0	Vertical	35.4	Pass
	42.3	-55.1	-20.0	Horizontal	35.1	Pass
957.0000	44.5	-52.9	-20.0	Vertical	32.9	Pass
	45.5	-51.9	-20.0	Horizontal	31.9	Pass
1116.5000	44.9	-52.5	-20.0	Vertical	32.5	Pass
	47.4	-50.0	-20.0	Horizontal	30.0	Pass
1276.0000	<49.0	<-48.4	-20.0	Vertical	>28.4*	Pass
	<49.0	<-48.4	-20.0	Horizontal	>28.4*	Pass
1435.5000	<49.0	<-48.4	-20.0	Vertical	>28.4*	Pass
	<49.0	<-48.4	-20.0	Horizontal	>28.4*	Pass

* Noise floor measurement.

FCC General Emissions with product transmitting:

Product Transmitting at 153.500 MHz:

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
231.6000	48.0	-49.4	-20.0	Vertical	29.4	Pass
242.5600	42.8	-54.6	-20.0	Vertical	34.6	Pass
455.7200	40.0	-57.4	-20.0	Vertical	37.4	Pass
249.9600	36.2	-61.2	-20.0	Horizontal	41.2	Pass
293.0000	38.8	-58.6	-20.0	Horizontal	38.6	Pass

Product Transmitting at 159.500 MHz:

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
208.5200	38.1	-59.3	-20.0	Horizontal	39.3	Pass
218.4400	37.8	-59.6	-20.0	Horizontal	39.6	Pass
249.9600	36.0	-61.4	-20.0	Horizontal	41.4	Pass
290.3600	37.9	-59.5	-20.0	Horizontal	39.5	Pass

Limit:

The limit of -20 dBm has been applied to the measurements.

No measurements were made above the 10th harmonic.

Result: Complies.

Measurement Uncertainty: ± 4.1 dB

Frequency Stability

Frequency stability measurements were between - 30 °C and + 50°C in 10°C increments.

At each temperature the transmitter was given a period of 30 minutes to stabilise.

The transmitter was then turned on and the frequency error measured after a period of 1 minute.

Test Frequency: 153.500 MHz

Temperature (°C)	Low Vac Error (Hz)	Nominal Vac Error (Hz)	High Vac Error (Hz)
+50	-34	-34	-34
+40	-5	-5	-5
+30	+10	+10	+10
+20	+15	+15	+15
+10	+10	+10	+10
0	+20	+20	+20
-10	+16	+16	+16
-20	-6	-6	-6
-30	-19	-19	-19

Test Frequency: 159.500 MHz

Temperature (°C)	Low Vac Error (Hz)	Nominal Vac Error (Hz)	High Vac Error (Hz)
+50	-35	-35	-35
+40	-6	-6	-6
+30	+11	+11	+11
+20	+14	+14	+14
+10	+11	+11	+11
0	+21	+21	+21
-10	+17	+17	+17
-20	-5	-5	-5
-30	-18	-18	-18

Limits:

Part 90.213 states that fixed station transmitters operating between 150.800-173.400 MHz with 6.25 kHz channelling are required to have a frequency tolerance of 1.0 ppm.

A worst case error of 0.219 ppm (-35 Hz / 159.500 MHz) was observed.

Result: Complies.
Measurement Uncertainty: ± 30 Hz

Transient frequency behaviour

Measurements were carried out using the method described in TIA-603 and EN 300-086.

The modulation analyser produces an amplitude difference signal and a frequency difference signal, which are applied to the input of a storage oscilloscope.

The unmodulated transmitter is then keyed which produces a trigger pulse that is AC coupled to the oscilloscope that produces a display on the screen.

The result of the change in the ratio of power between the test signal from the signal generator and the transmitter output will produce 2 separate sides on the oscilloscope picture. One will show the 1000 Hz test modulation and the other will be the frequency difference of the transmitter versus time.

Channel Spacing (kHz)	Transient Period t_1	Frequency Period t_2	Deviation (kHz) Period t_3
6.25	Nil	Nil	Nil
12.5	Nil	Nil	Nil
25.0	Nil	Nil	Nil

Limits:

Time Interval	Period (ms)	6.25 kHz Deviation (kHz)	12.5 kHz Deviation (kHz)	25 kHz Deviation (kHz)
t_1	10	± 6.25	± 12.5	± 25.0
t_2	25	± 3.125	± 6.25	± 12.5
t_3	10	± 6.25	± 12.5	± 25.0

Result: Complies.
Measurement Uncertainty: Frequency difference ± 1.6 kHz, Time period ±1 ms.

6.25 kHz transmitter turn on (156.500 MHz)

Green Trace = 1 kHz tone with FM deviation of 12.5 kHz.

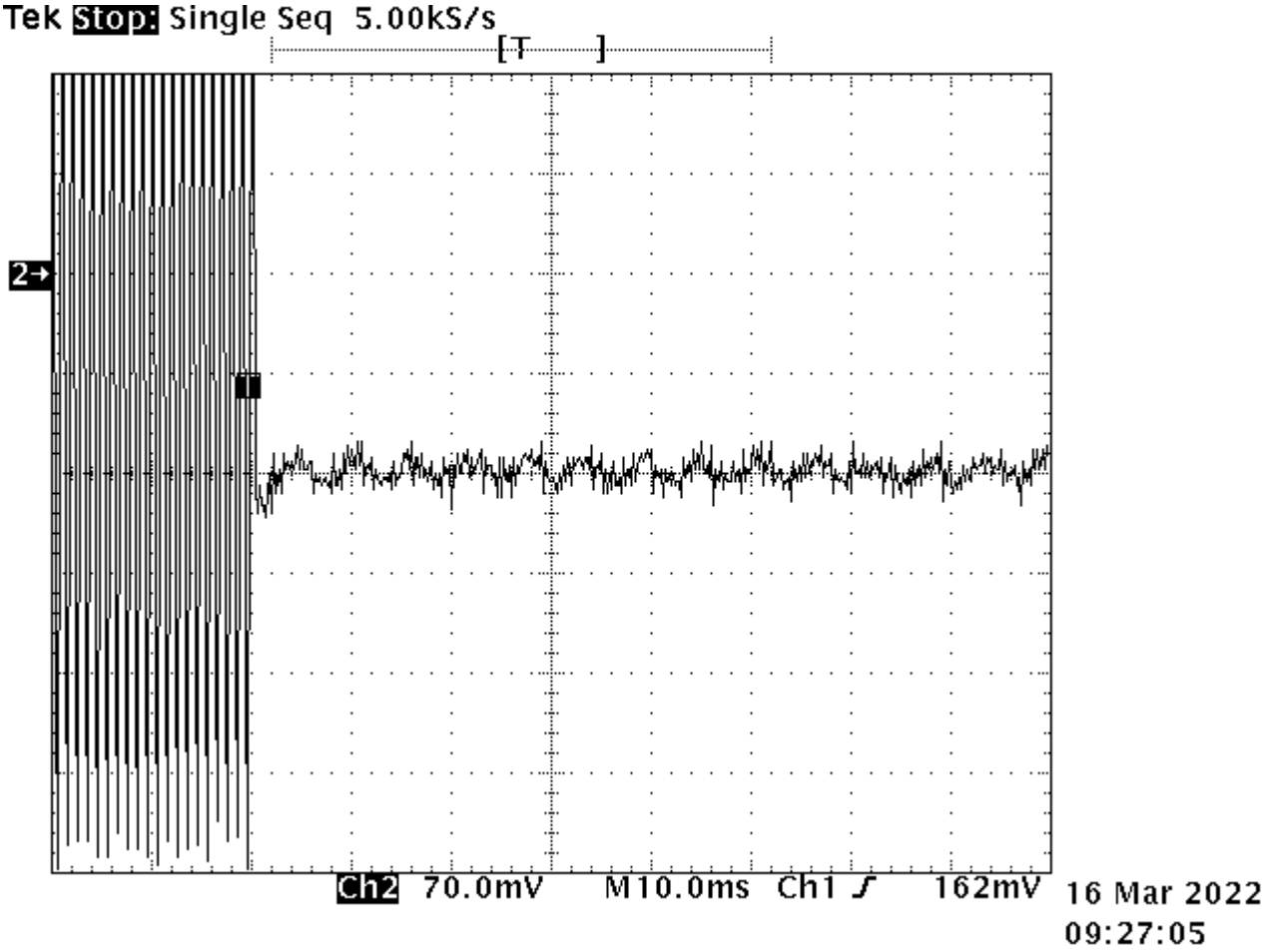
Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
Therefore each Y axis division = 1.565 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division.

Triggering has been set to occur 2 divisions from the left hand edge (20 ms).

*t*on occurs at 20 ms.

*t*1 occurs between 2.0 and 3.0 divisions from the left hand edge.
t2 occurs between 3.0 and 5.5 divisions from the left hand edge.

No transient response can be observed during t1 and t2.



6.25 kHz transmitter turn off (156.500 MHz)

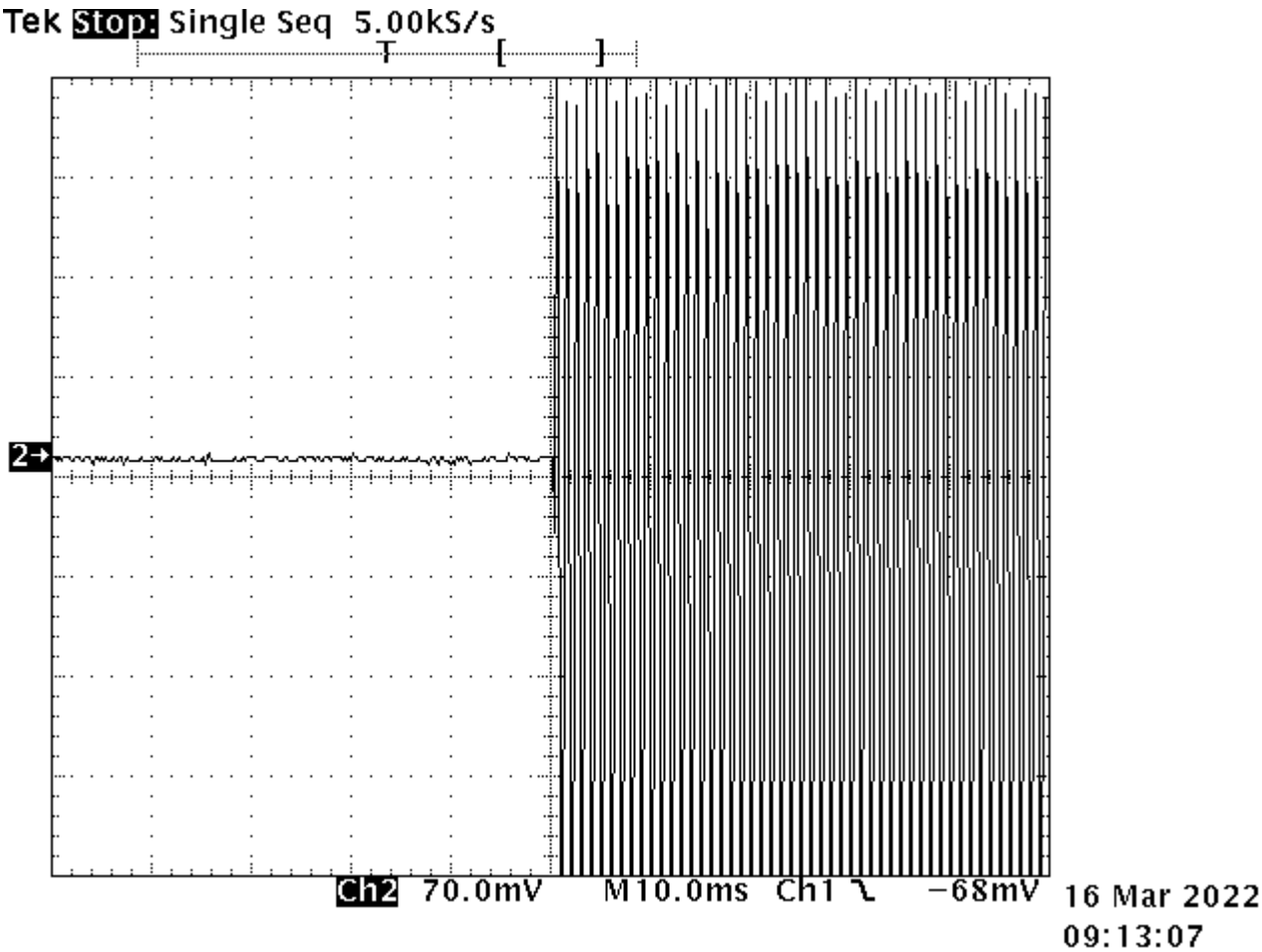
Green Trace = 1 kHz tone with FM deviation of 6.25 kHz.

Green trace has been maximised to give full screen indication of +/- 6.25 kHz.
Therefore each Y axis division = 1.565 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division

The display of the 1 kHz signal rising has been positioned 5 divisions from the left hand edge (50 ms). This is position *t*off.

*t*3 occurs between 4.0 and 5.0 divisions from the left hand edge.

No transient response can be observed before *t*off.



12.5 kHz transmitter turn on (156.500 MHz)
Green Trace = 1 kHz tone with FM deviation of 6.25 kHz.

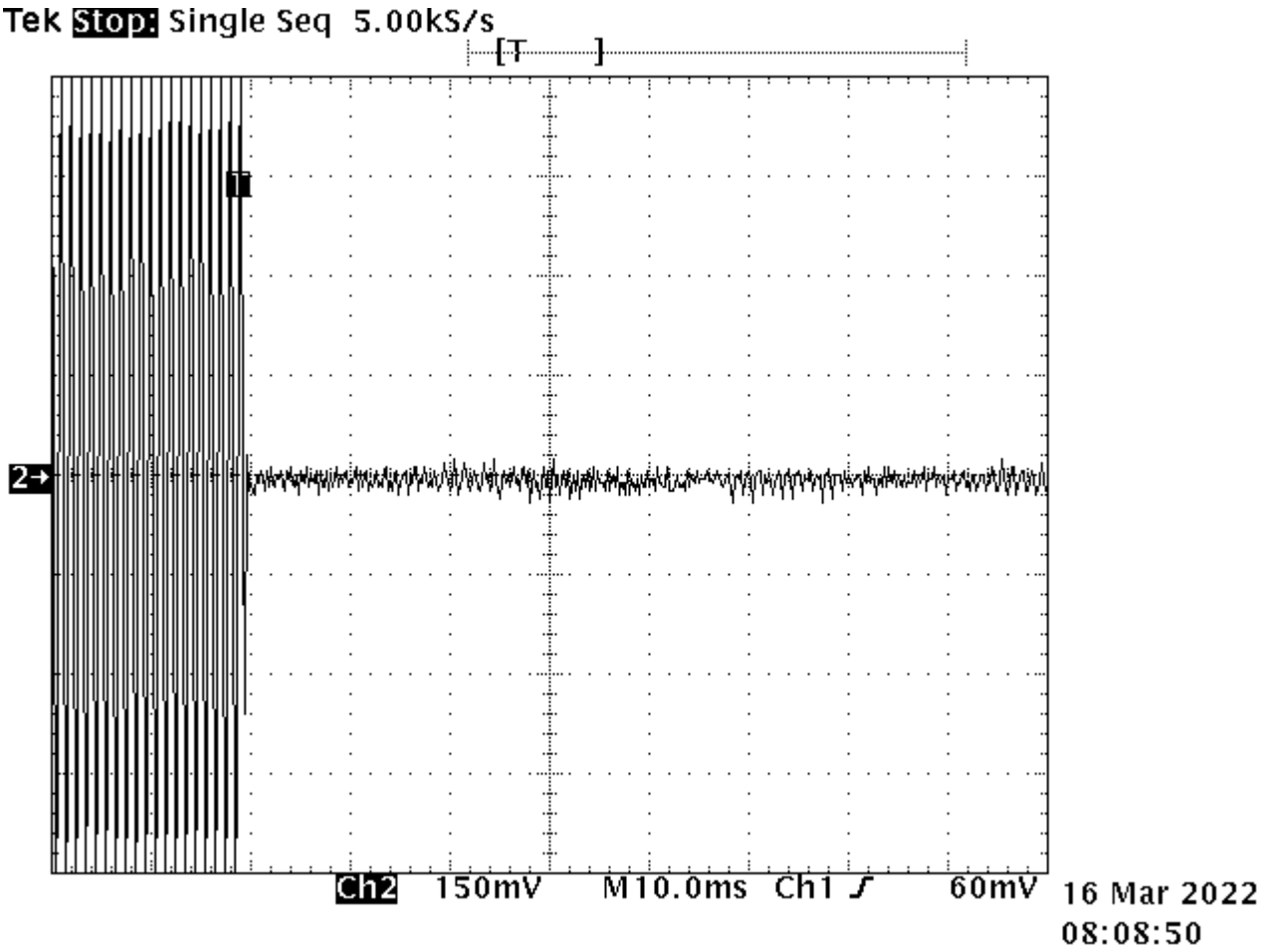
Green trace has been maximised to give full screen indication of +/- 6.25 kHz.
Therefore each Y axis division = 1.565 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division

Triggering has been set to occur 2 divisions from the left hand edge (20 ms).

*t*on occurs at 20 ms.

*t*1 occurs between 2.0 and 3.0 divisions from the left hand edge.
t2 occurs between 3.0 and 5.5 divisions from the left hand edge.

No transient response can be observed during t1 and t2.



12.5 kHz transmitter turn off (156.500 MHz)

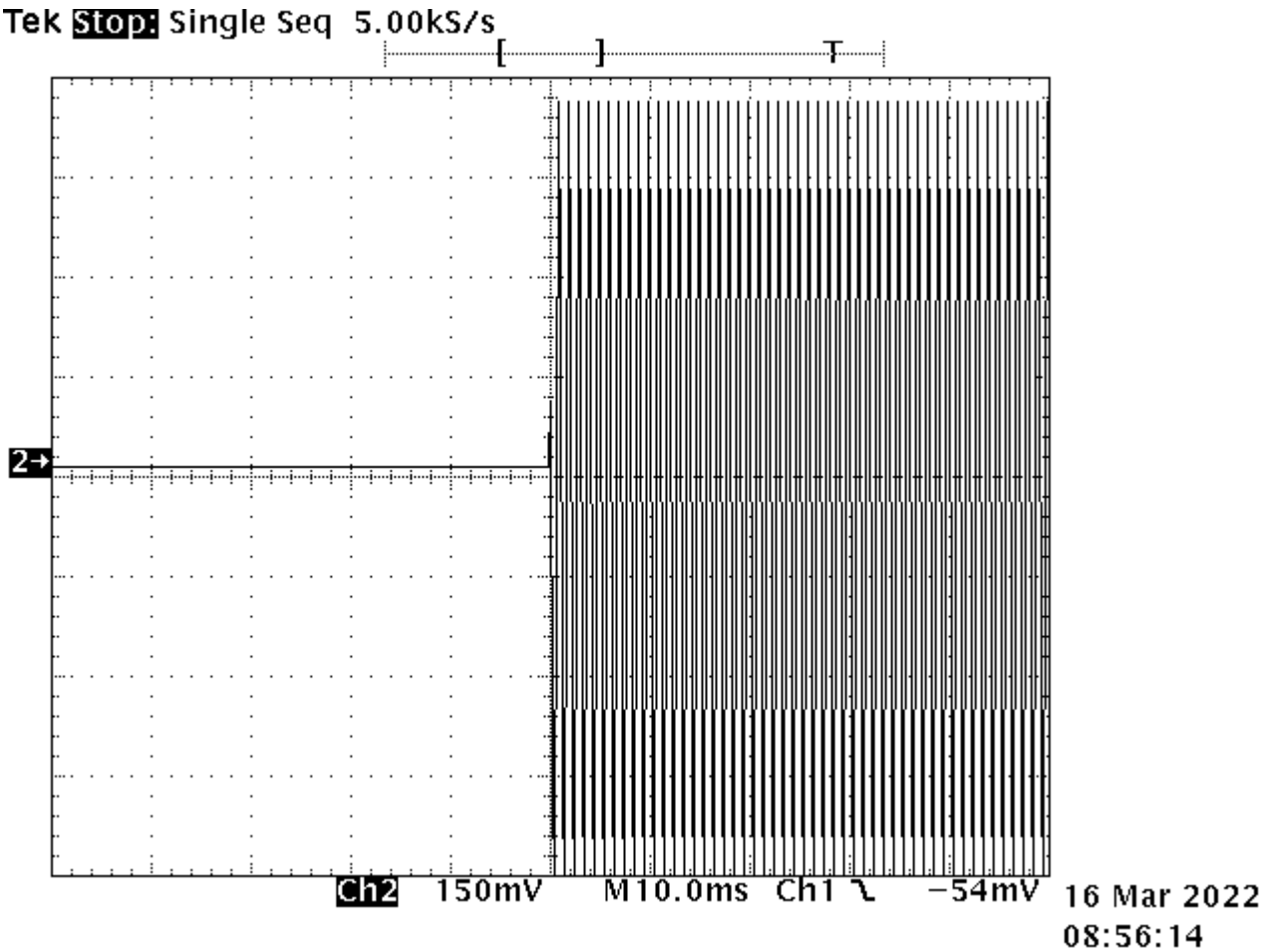
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz.

Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division

The display of the 1 kHz signal rising has been positioned 5 divisions from the left hand edge (50 ms). This is position *t*off.

*t*3 occurs between 4.0 and 5.0 divisions from the left hand edge.

No transient response can be observed before *t*off.



Modulation Characteristics

a) This transmitter is capable of producing analogue speech modulation.

Frequency response of the audio frequency low pass filter between 100 Hz and 15 kHz.

This measurement was carried out using an audio signal generator and an audio modulation analyser.

At 1 kHz an audio signal was applied which was used as a 0 dB response reference.

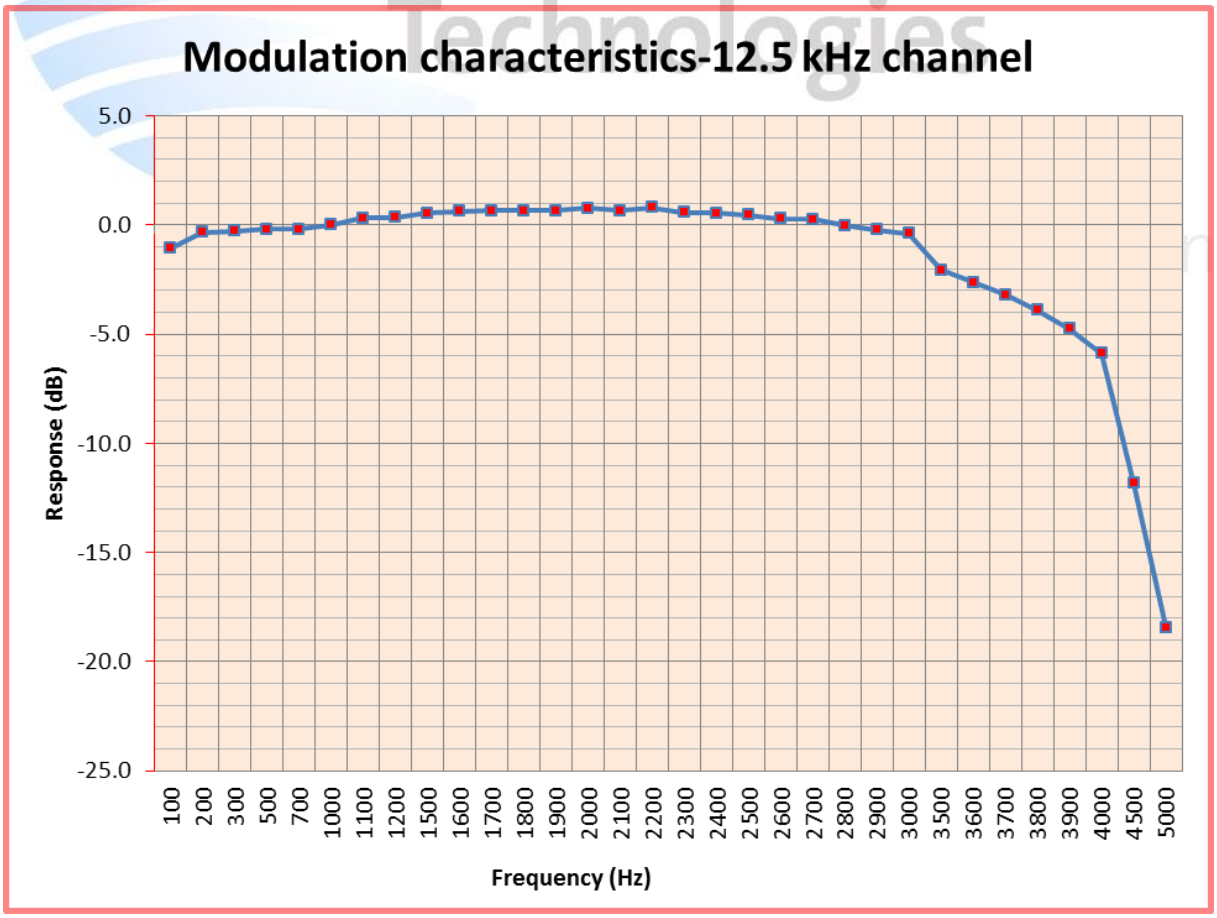
The frequency of the input signal was then varied and the output response noted.

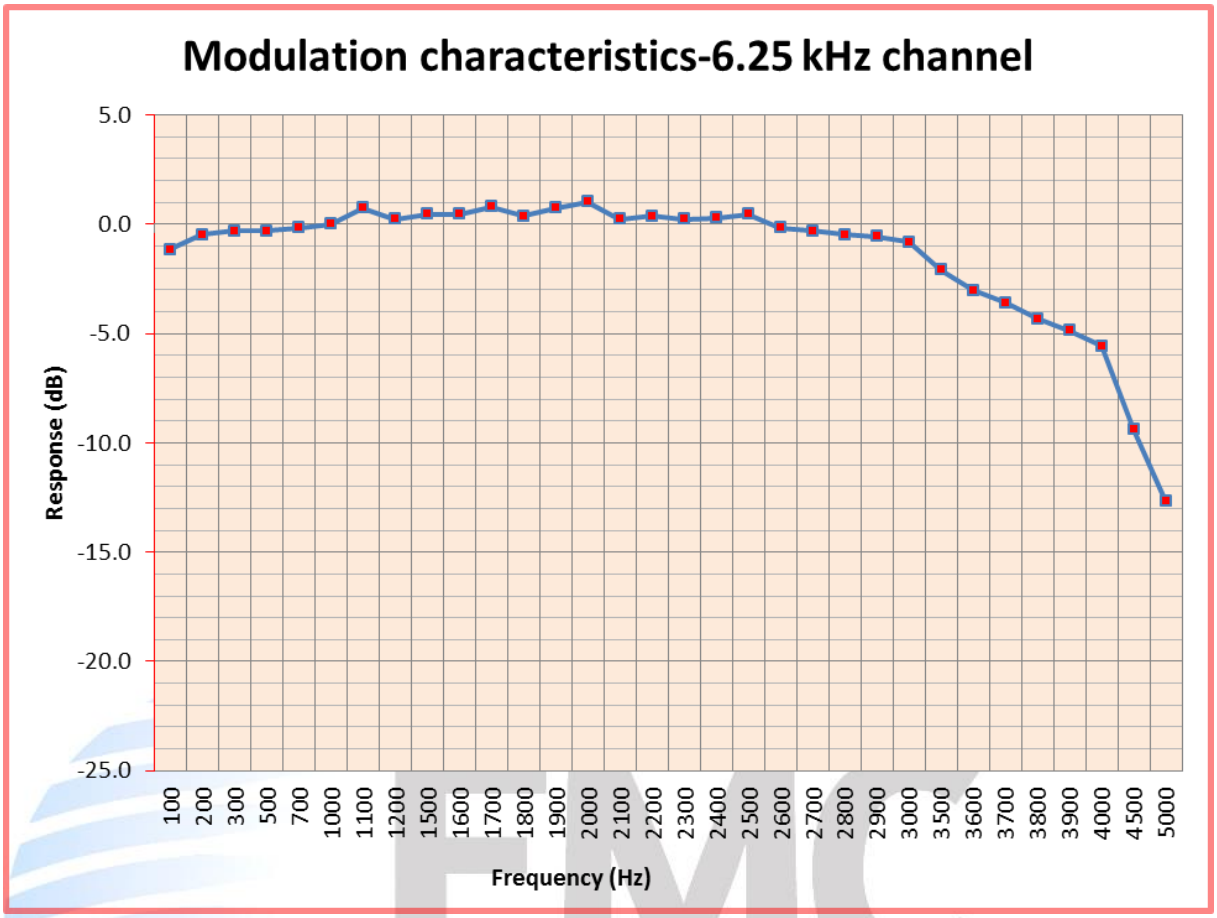
This measurement was carried out from 100 Hz to 5000 Hz as required by Part 2 with further measurements carried out in order to show the full range of this filter.

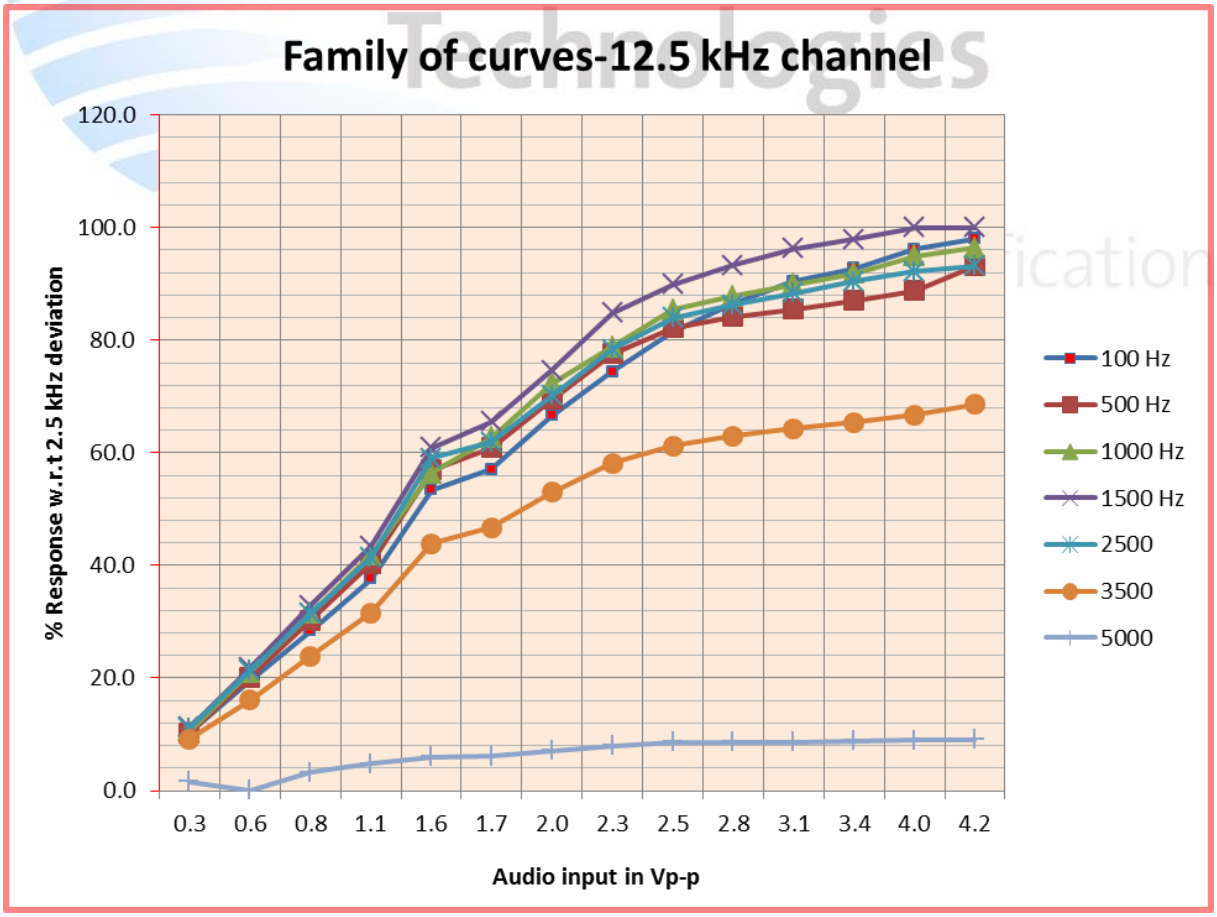
b) A family of curves showing the percentage of modulation versus the modulation input voltage.

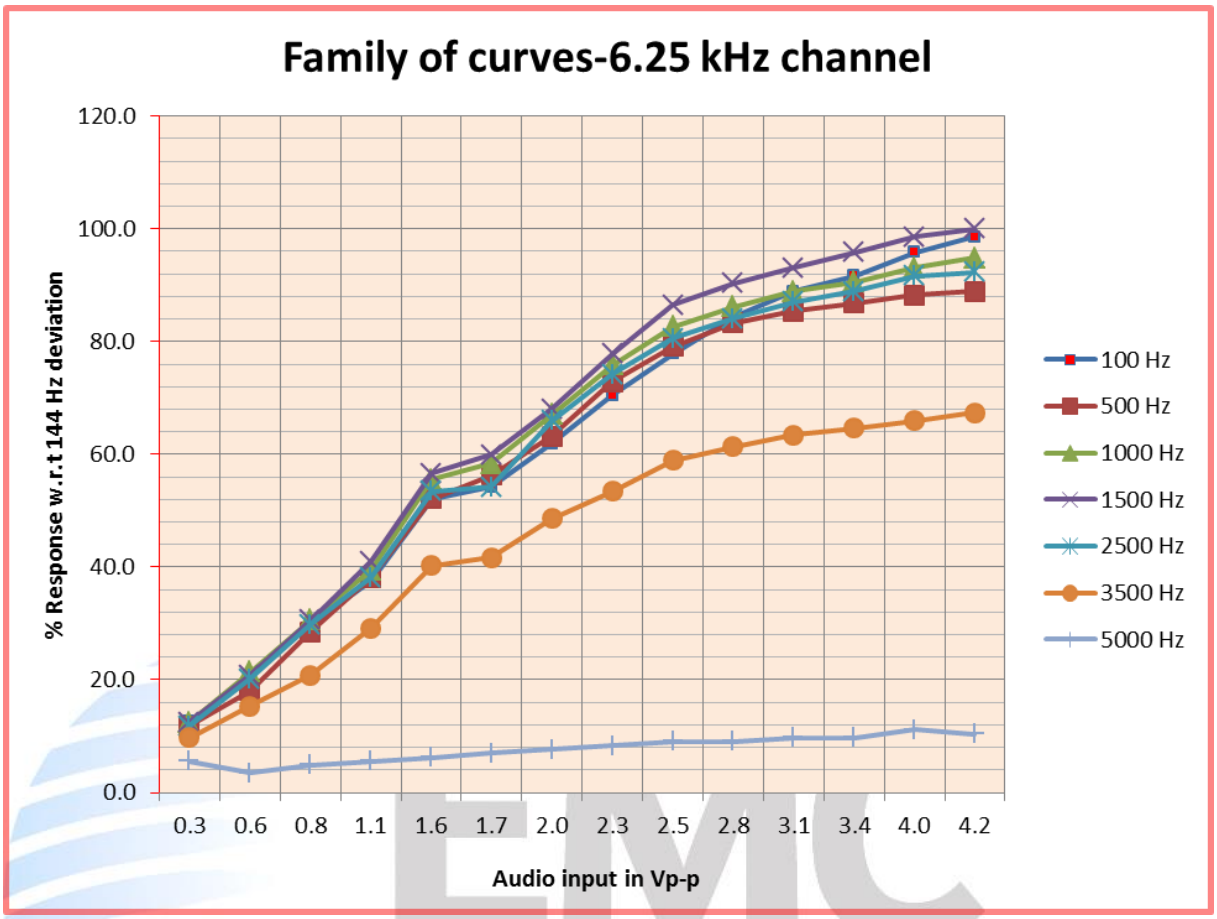
Measurements were made between 100 Hz to 5 kHz.

At each frequency the input voltage was slowly increased with the resulting frequency deviation of the transmitter being recorded.









Exposure of humans to RF fields

As per FCC KDB 447498 D01 and Section 2.1091 radio frequency transmitters are required to be operated in a manner that ensures the public is not exposed to RF energy levels.

Calculations have been made using the General Public/Uncontrolled Exposure limits that are defined in Section 1.1310.

Minimum safe distances have been calculated below.

Power density, $mW/cm^2 = E^2/3770$

Limits for General Population / Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (E) (V/m)**	**Magnetic Field Strength (H) (A/m)**	**Power Density (S) (mW/ cm²)**	**Averaging Time |E|²,|H|² or S (minutes)**
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30
Note 1: f = frequency in MHz ; *Plane-wave equivalent power density Note 2: For the applicable limit, see FCC 1.1310				

- General Population / Uncontrolled exposure is 0.2mW/cm^2

For Uncontrolled Environment

Power Density = 0.2 mW/cm^2 = E^2/3770

E= √ 0.2*3770

E = 27.4 V/m

The rated maximum transmitter power = 250 Watts (+54 dBm).

A worst case scenario duty cycle of 100% has been used for the calculations.

The client has declared that the antenna is chosen by the customer depending on the required coverage.

The available suitable antennas for this product can vary in gain from 2 dBi to 14 dBi. Which translates to antenna numeric gain between 1.6 to 25.1

The minimum distance from the antenna at which the MPE is met is calculated from the following

Field strength in V/m (FS),
Transmit power in watts (P)
Transmit antenna gain (G)
Transmitter duty cycle (DC)
Separation distance in metres (D)

(Continued…)

The calculation is as follows:

FS = (√ (30 * P * G * DC)) / D

Therefore

a) For Antenna Numeric gain of 1.6, the minimum distance is:

D = (√ (30 * P * G * DC)) / FS

D = (√ (30 * 250 * 1.6 * 1)) / 27.4

D = 4 metres

b) For Antenna Numeric gain of 25.1, the minimum distance is:

D = (√ (30 * P * G * DC)) / FS

D = (√ (30 * 250 * 25.1 * 1)) / 27.4

D = 15.8 metres

Result: Complies if a safe distance shown in the calculations above is followed.

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Cal Due	Interval
Aerial Controller	EMCO	1090	9112-1062	N/a	N/a
Aerial Mast	EMCO	1070-1	9203-1661	N/a	N/a
Biconical Antenna	Schwarzbeck	BBA 9106	-	29/03/2022	4.5 years
Log Periodic Antenna	Schwarzbeck	VUSLP 91111	9111-112	25/03/2022	4.5 years
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	13/04/2023	1.0 year
Loop Antenna	EMCO	6502	9003-2485	12 Feb 2022	4.5 years
Power Attenuator	Tenuline	8322	-	N/a	N/a
Power Attenuator	DTS	-	-	N/a	N/a
Modulation Analyser	Hewlett Packard	8901B	SN2608A00782	13/01/2023	3.0 years
Signal Generator	Rohde & Schwarz	SMHU	E1493	28/05/2023	2.0 years
Power meter	Hewlett Packard	436A	2512A22439	17/06/2022	2.5 years
Oscilloscope	Tektronics	745A	B010643	-	-
Receiver	Rohde & Schwarz	ESIB-40	100295	03/06/2023	2.0 years
Spectrum Analyzer	Keysight	N9038A	MY57290153	29/07/2022	1.0 year
Thermal chamber	Contherm	M180F	86025	N/a	N/a
Thermometer	DSIR	RT200	35	11/04/2027	5.0 years
Turntable	EMCO	1080-1-2.1	9109-1578	N/a	N/a
VHF Balun	Schwarzbeck	VHA9103	-	N/a	N/a

At the time of testing all test equipment was within calibration.

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies NZ Ltd designation as a FCC Accredited Laboratory by International Accreditation New Zealand, designation number: NZ0002 under the APEC TEL MRA, which expires on the 02/12/2022.

All testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied on request.

11. PHOTOGRAPHS

Front View

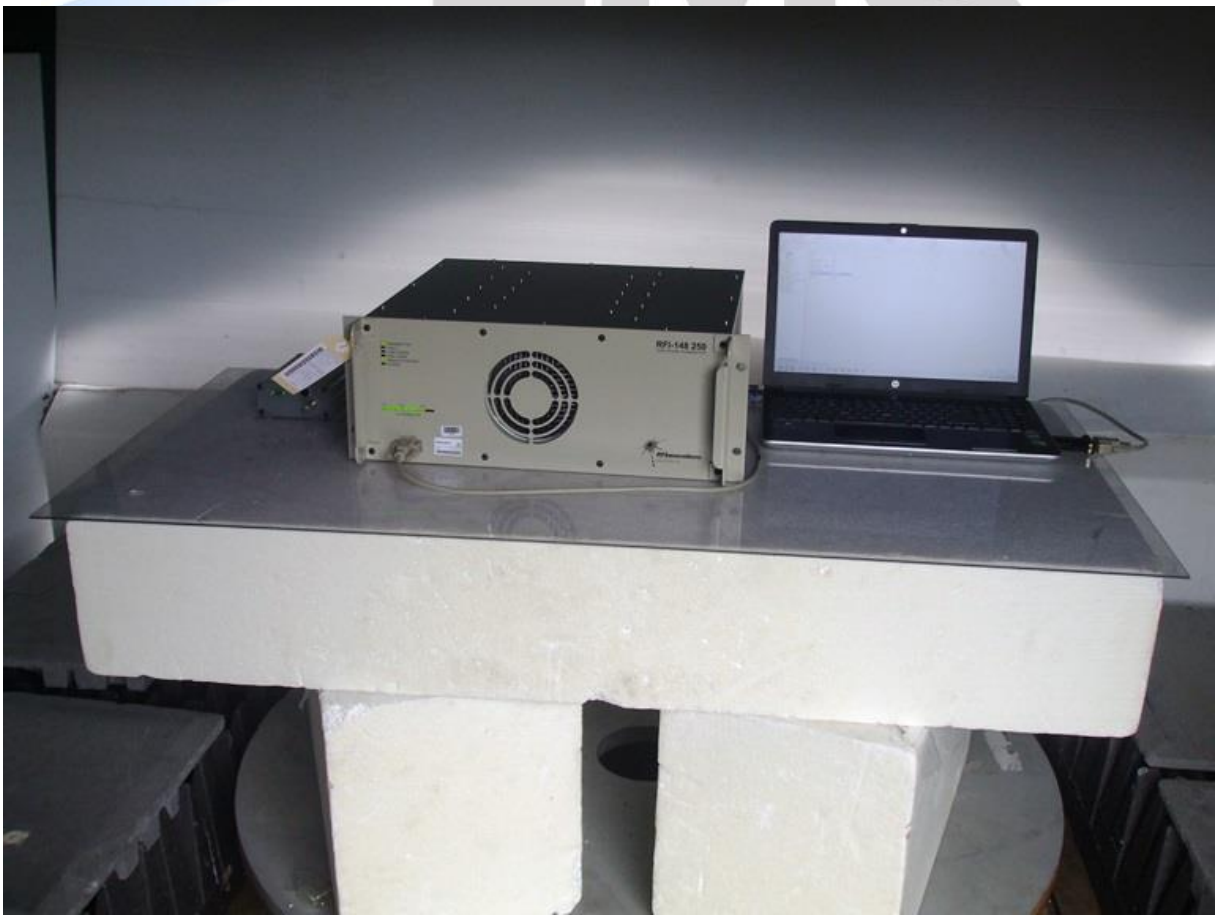
Side View

Rear View

Side View

Auxiliary unit supplied by the client to facilitate testing.

Radiated emissions test setup



Radiated emissions test setup (Cont…)