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TEST REPORT

RFI-400 250 UHF 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-400 250 UHF 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 September 2023 are summarised below.

Clause	Description	Result
90.203	Certification required	Product is certified with FCC ID: P5MRFI400. Changes have been made with the Class 2 permissive change process being applied.
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

Report Revision Table.

Version	Change Made	Date
230905.1	Initial Issue	17/10/23
230905.1b	Software version changed (Client letter affixed to report)	17/11/23

4. CLIENT INFORMATION

Company Name	STI Engineering Pty Ltd
Postal Address	22 Boulder Rd Malaga WA 6090
Country	Australia
Contact(s)	Omid Targhagh, Johan Svean

5. TEST SAMPLE DESCRIPTION

Brand Name	STI
Model Number	RFI-400 250ECDAA01
Product	UHF Paging Transmitter
Manufacturer	STI Engineering
Manufactured in	Australia
Serial Number	M07112K02170
Software Version	4.8-E (Used in testing) 4.8-F (Firmware upgraded)
FCC ID	P5MRFI400
Configuration Application	Cruise control configuration tool
Antenna connector	N Type Female Connector
Rated Transmitter Output Power	250 Watts (+54.0 dBm)
Highest clock frequency	2.4 GHz VCO (voltage controlled oscillator)
Transmitter Certification Range	Part 90: 450.0 - 470.0 MHz

Test frequencies

Frequency (MHz)	Power (Watts)	Channel Bandwidth (kHz)	Modulations Tested
451.500	250.0	12.5, 25.0	F2D 51 (51 bps FFSK) F2D100 (100 bps FFSK) F3D DTMF F3E VOICE-Analogue Audio
453.000	250.0	12.5, 25.0	
454.900	250.0	12.5, 25.0	

Standard Temperature and Humidity

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

Standard Test Power Source

Standard Test Voltage: 48 VDC, 14 Amps (rated)

Extreme Temperature

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

Extreme Test Voltages

As per the user manual, the product is designed to operate as follows:

High Voltage: 51.5 VDC
Low Voltage: 45.0 VDC

Product Overview (from user manual):

The RFI-400 is a high power output paging transmitter operating in the UHF band.

Some of the products features are indicated as below:

- RFI-400: UHF band operation (450 MHz – 470 MHz) with 3 MHz switching bandwidth
- 250 W (54 dBm) maximum transmit power
- 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

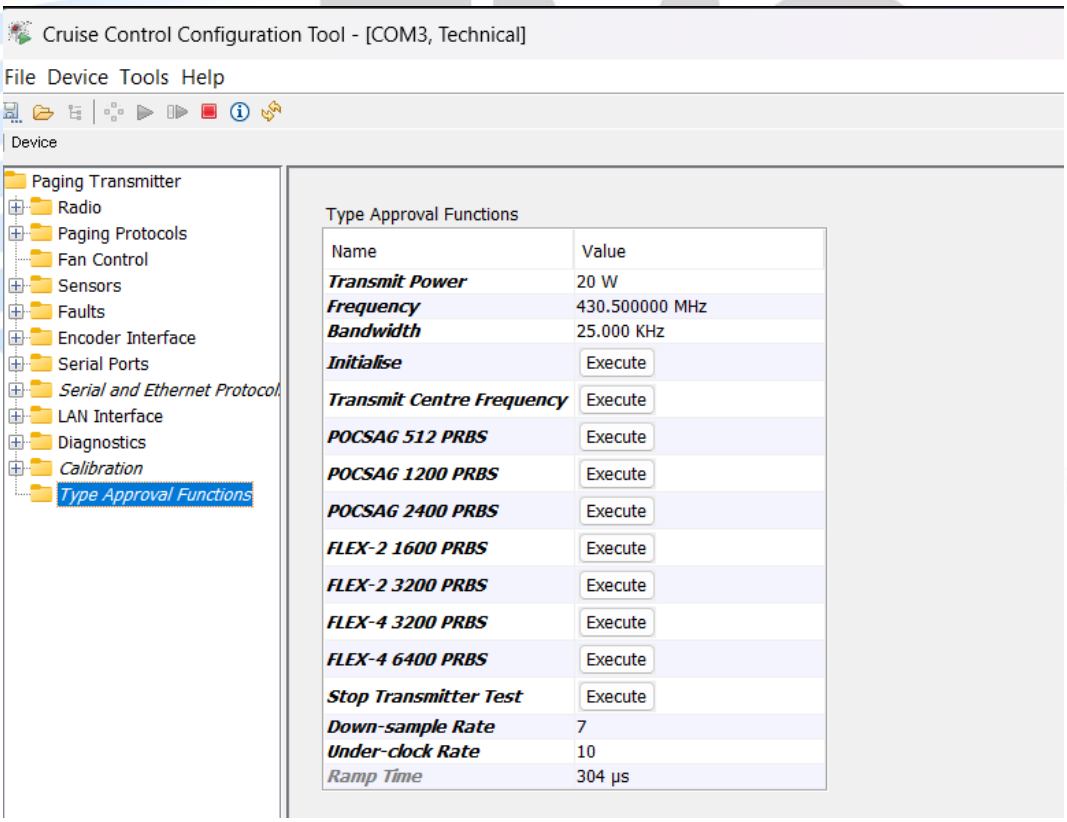
The client has supplied an auxiliary unit of STI make, model no: RFI-450 VF which was used as a signal generator to provide necessary modulated input to the device under test.

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)

Except where otherwise specially provided for, transmitters operating on frequencies in the 150-174 MHz and 406-512 MHz bands must comply with the following:

(1) Applications for certification of mobile and portable equipment designed to transmit voice on public safety frequencies in the 150-174 MHz or 450-470 MHz band will be granted only if the mobile/portable equipment is capable of operating in the analog FM mode on the nationwide public safety interoperability channels in the 150-174 MHz band or 450-470 MHz band, as appropriate. (See § 90.20(c), (d)(80) of this part.)

- The product is a base station transmitter. This clause is not applicable.

(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, except for hand-held transmitters with an output power of two watts or less, will only be granted for equipment with the following channel bandwidths:

- The product tested operates in the frequency range 451.0-455.0 MHz which falls within 421.0-512.0 MHz band and hence certification is required.

(i) 6.25 kHz or less for single bandwidth mode equipment;

(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;

(iii) 25 kHz for multi-bandwidth mode equipment with a maximum channel bandwidth of 25 kHz if it is capable of operating on channels of 6.25 kHz or less; and

(iv) Up to 25 kHz if the equipment meets the efficiency standard of paragraph (j)(5) of this section.

- The product is a paging base station transmitter which supports channel bandwidths of 12.5 kHz and 25.0 kHz.

Spectrum efficiency details have been provided in this test report.

(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, received on or 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.

Additionally, if the equipment is capable of transmitting data, has transmitter output power greater than 500 mW, and has a channel bandwidth of more than 6.25 kHz, the equipment must be capable of supporting a minimum data rate of 4800 bits per second per 6.25 kHz of channel bandwidth.

- See Part 90.203(j) (7)

(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 product is a transmitter designed for one-way paging operations.

(10) Except as provided in this paragraph, single-mode and multi-mode transmitters designed to operate in the 150-174 MHz and 421-512 MHz bands that operate with a maximum channel bandwidth greater than 12.5 kHz shall not be manufactured in, or imported into, the United States after January 1, 2011, except as follows:

(i) To the extent that the equipment meets the efficiency standard of paragraph (j)(3) of this section, or

(ii) Where operation with a bandwidth greater than 12.5 kHz is specified elsewhere.

- Noted and Applied. Spectrum efficiency details have been provided in this test report.

Result: Complies.

§2.1046, § 90.205 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 (Vdc)	Carrier Power (dBm)		
		+22˚ C	+50˚ C	-30˚ C
451.500	Vdc high	54.1	53.0	53.5
	Vdc nominal	54.1	53.0	53.6
	Vdc low	54.0	53.0	53.5
453.000	Vdc high	54.0	53.0	53.6
	Vdc nominal	54.0	53.0	53.6
	Vdc low	54.0	53.0	53.5
454.900	Vdc high	54.1	53.1	53.7
	Vdc nominal	54.1	53.1	53.7
	Vdc low	54.0	53.0	53.5

Limits:

Part 90 does not specify the transmitter output power

Result: Complies.

Measurement Uncertainty: ± 0.5 dB

§90.207 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.

20K0F2D, 20K0F3D and 20K0F3E for 25.0 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 1.0 Vp.

- 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 based on 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 4.0 Vp-p as worst case and the results have been provided in the test report.

Channel width			25kHz (Wideband) and 12.5kHz (Narrowband)
Frequency Response		Flat (50Hz to 2800Hz; not referenced to 1kHz)	+/-1dB (typical)
		Pre-emphasised (300Hz to 3000Hz, 3.3dB/octave)	+/-1.5dB (typical)
Audio input		Level	0.035 to 2 Vp-p (corresponding to -25dBm to +10dBm based on 50 Ω)
		Impedance with transformer	600Ω
		Configurations	Single-ended Pseudo-differential Fully-differential.
		DC Voltage for Pseudo-differential configuration	±1.5V

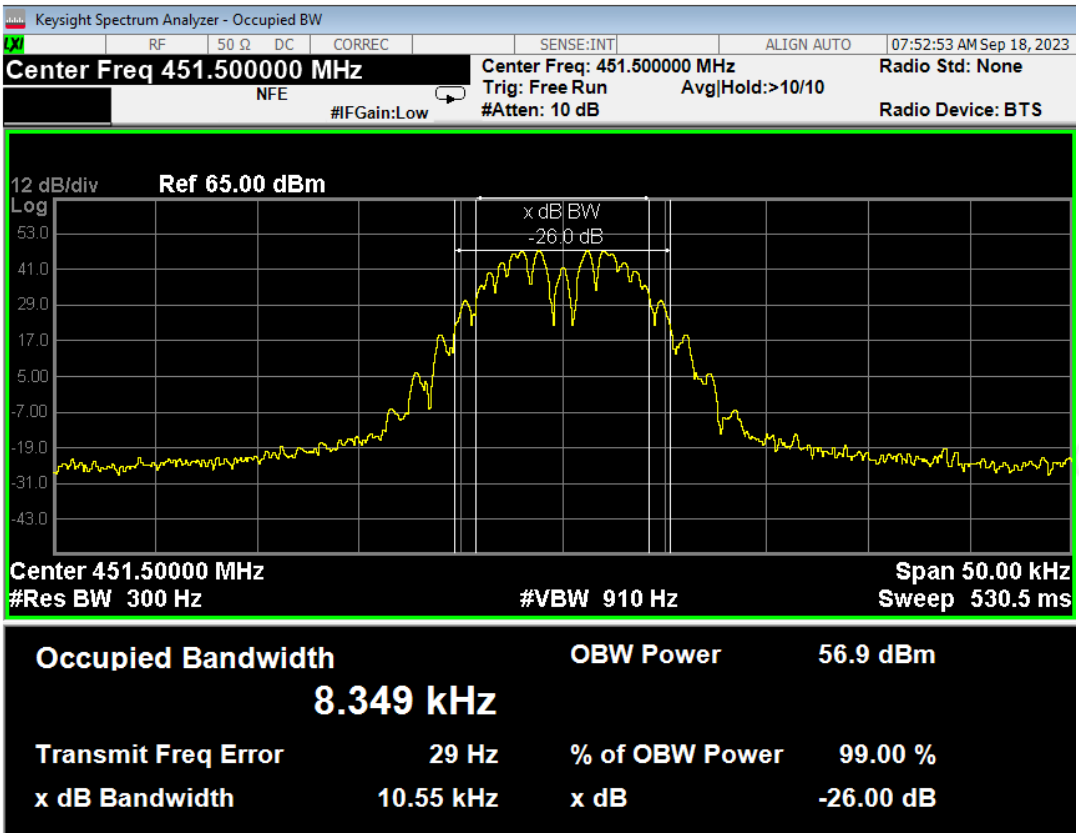
Information as per the user manual supplied by client

Emission- 12.5 kHz spacing.

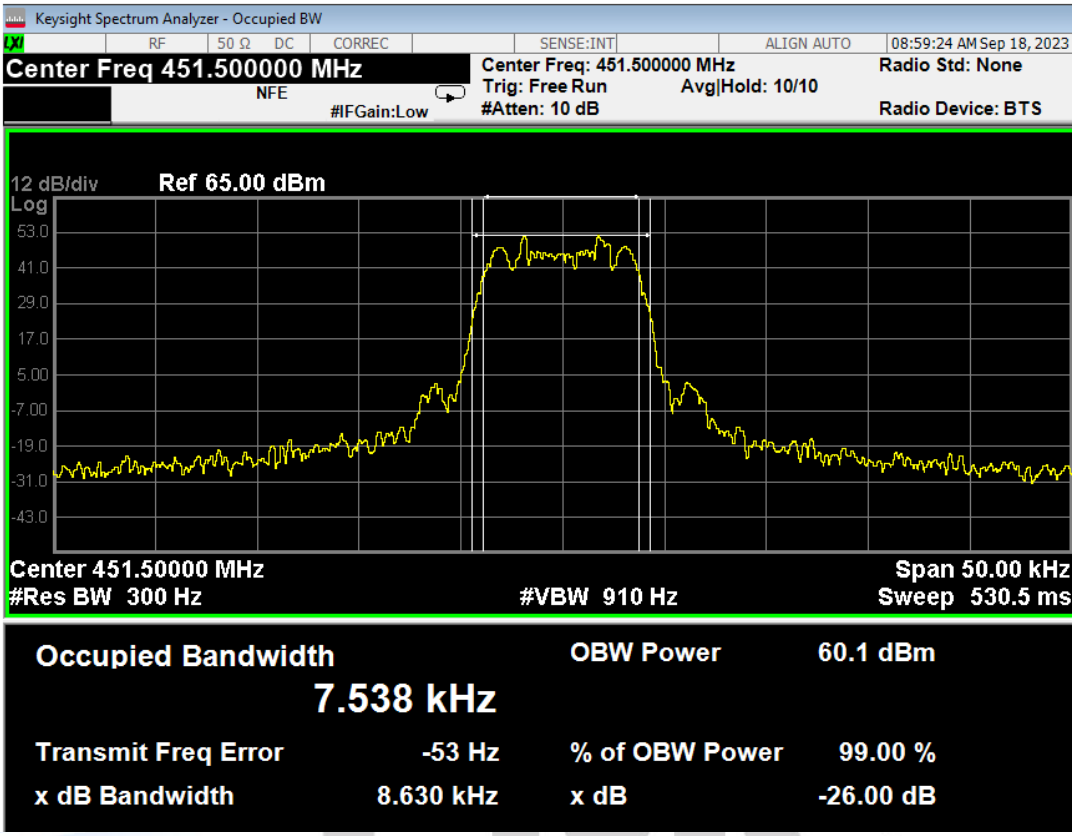
Emission Tested	Frequency (MHz)	Measured (kHz)	Authorised Bandwidth
F2D-51	451.500	8.349	11.2 kHz
F2D-51	454.900	8.376	
F2D-100	451.500	7.538	
F2D-100	454.900	7.491	
F3D-DTMF	453.000	7.582	
F3D-DTMF	454.900	7.639	
F3E-VOICE Audio input: 2.0 Vp-p	453.000	9.919	
F3E-VOICE Audio input: 4.0 Vp-p	453.000	10.077	

* Limited number of plots has been put in the test report for ease of readability.

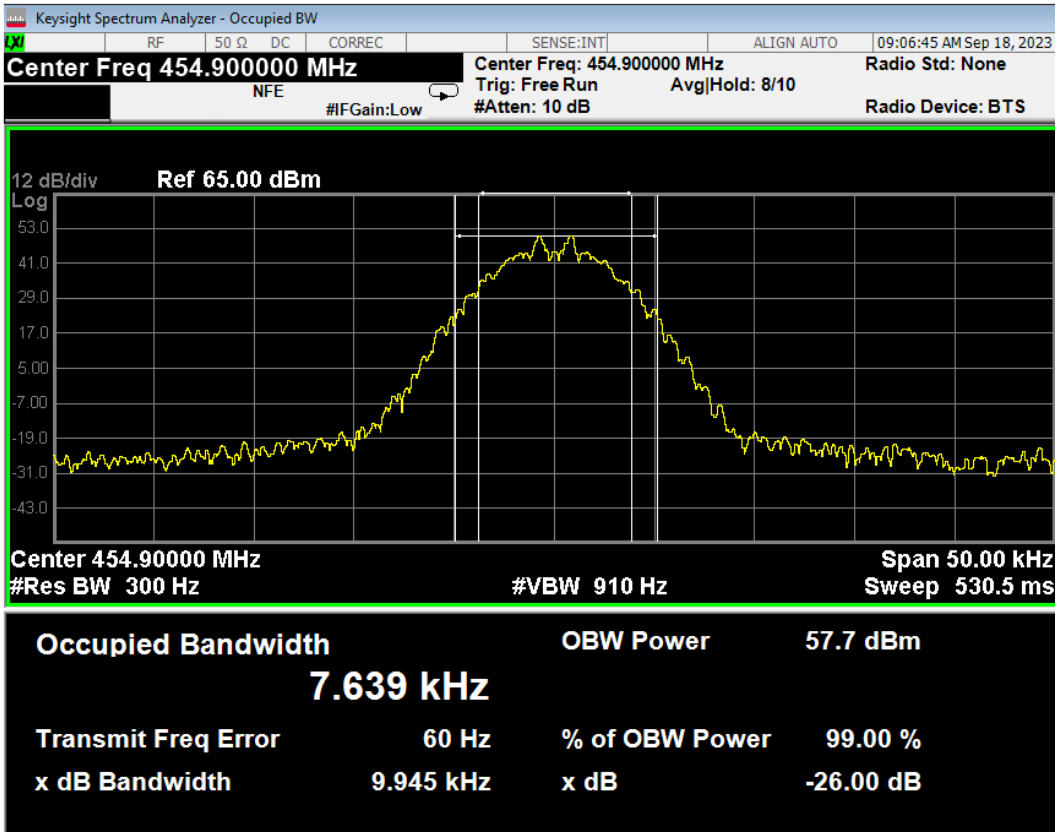
451.500 MHz/12.5 kHz channel/F2D-51 emission



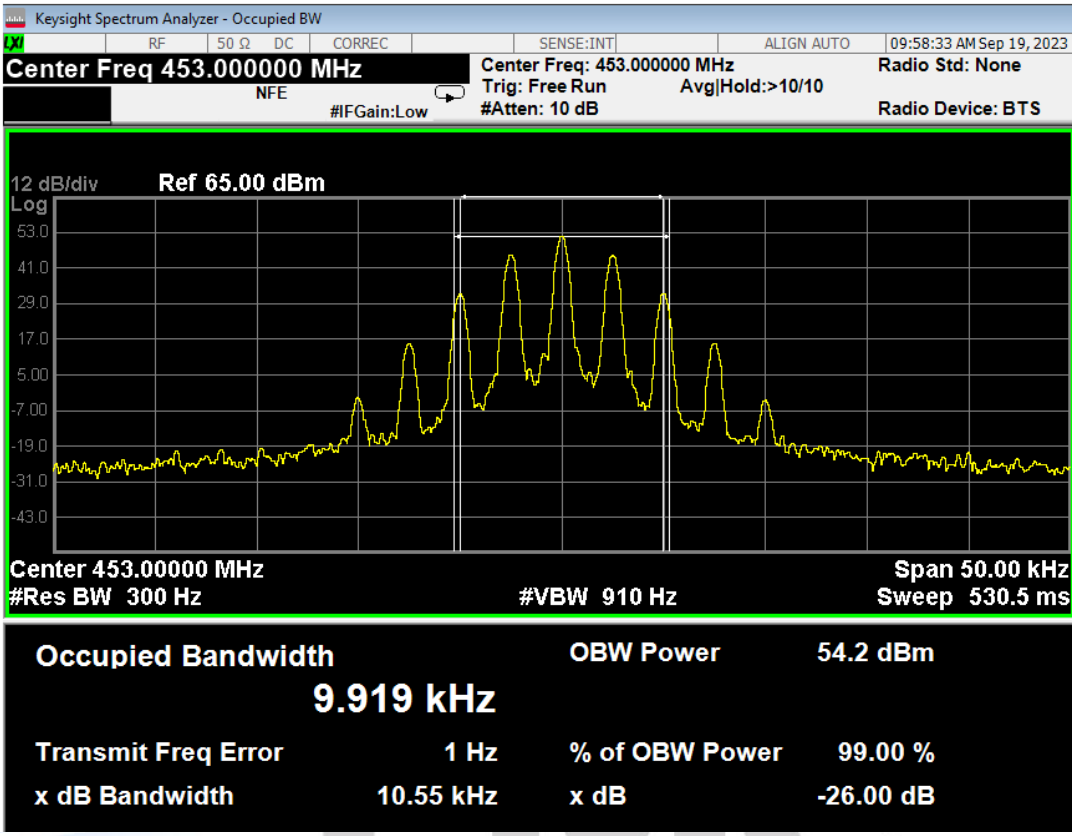
451.500 MHz/12.5 kHz channel/F2D-100 emission



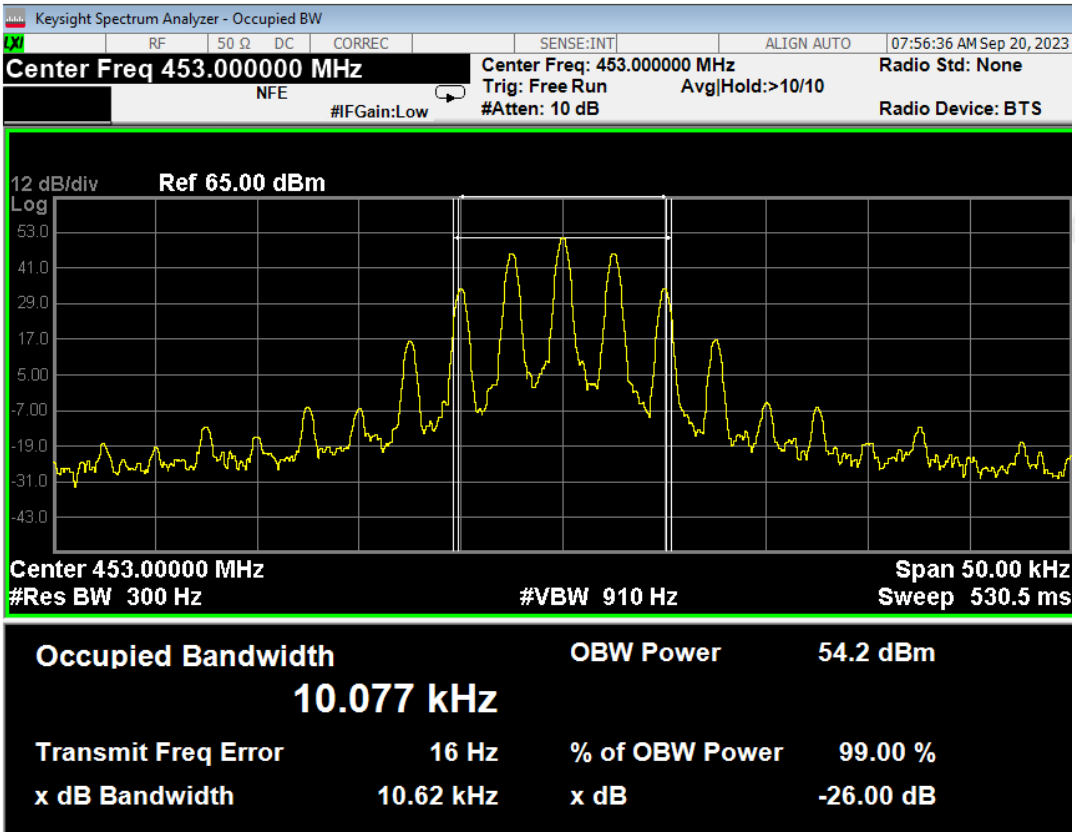
454.900 MHz/12.5 kHz channel/F3D-DTMF emission



453.000 MHz/12.5 kHz channel/F3D-Voice-2500 Hz, 2Vp-p emission



453.000 MHz/12.5 kHz channel/F3D-Voice-2500 Hz, 4Vp-p emission

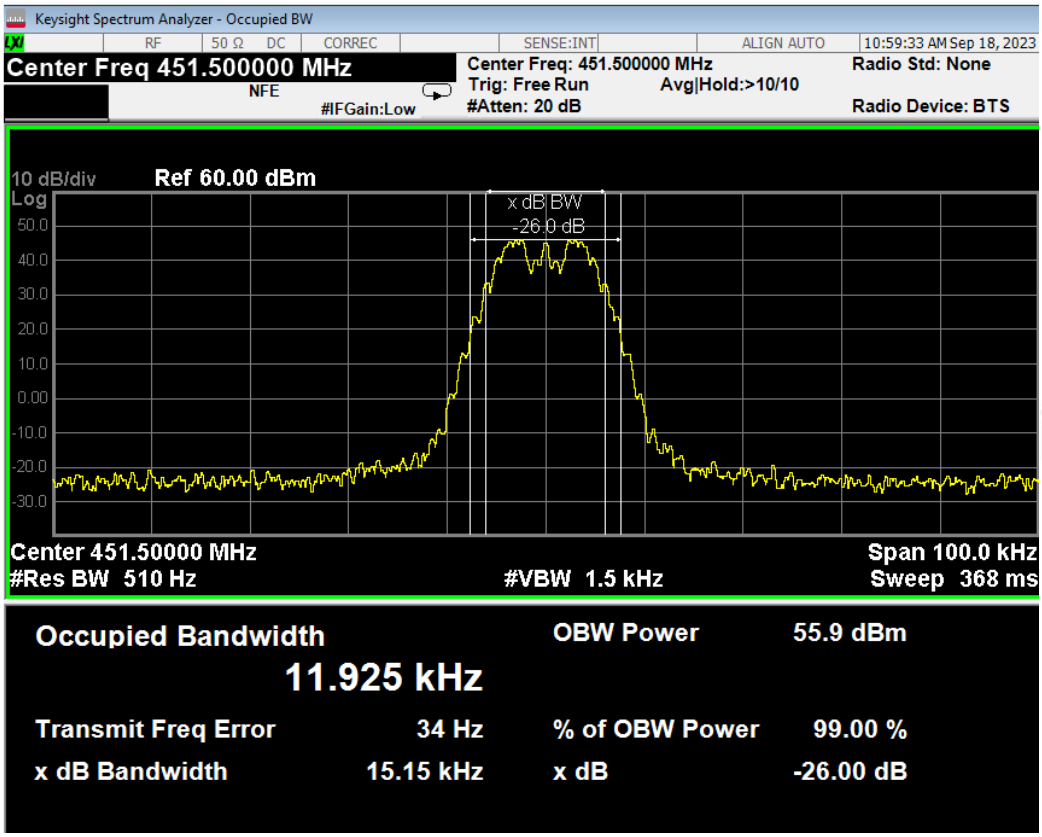


Emission Type- 25.0 kHz spacing.

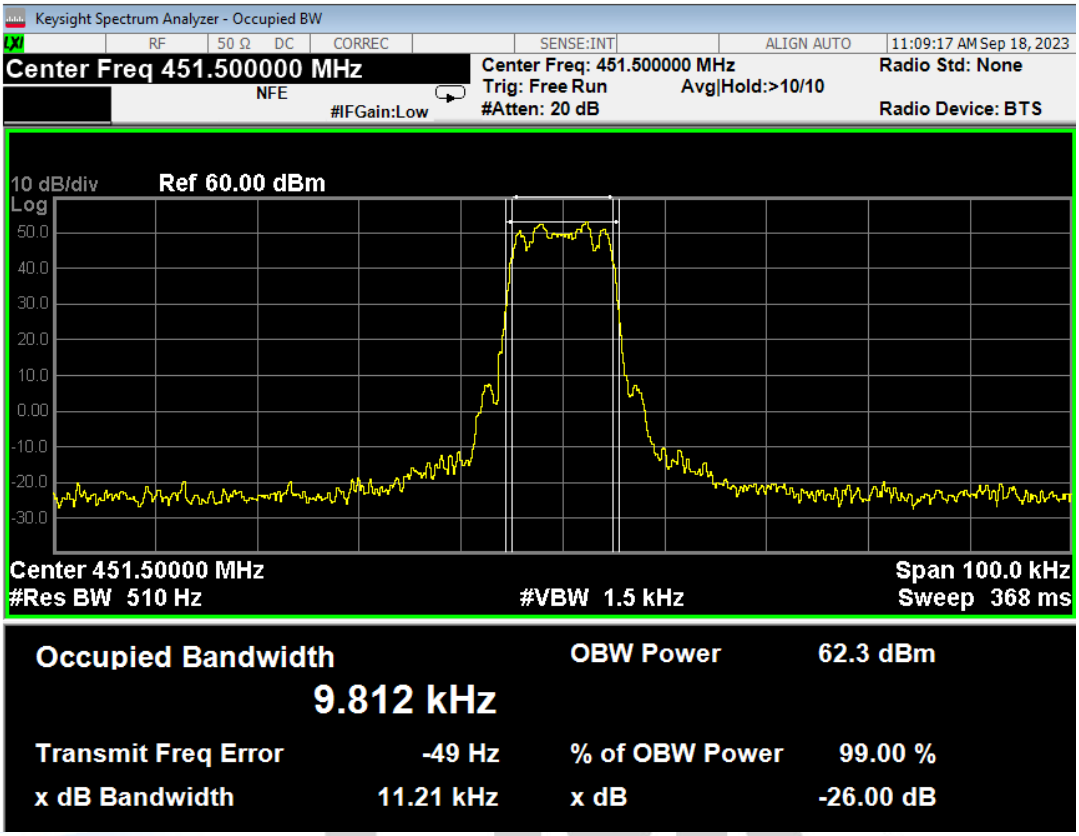
Emission Tested	Frequency (MHz)	Measured (kHz)	Authorised Bandwidth
F2D-51	451.500	11.925	20.000 kHz
F2D-51	454.900	11.890	
F2D-100	451.500	9.812	
F2D-100	454.900	9.779	
F3D-DTMF	453.000	10.563	
F3D-DTMF	454.900	10.573	
F3E-VOICE Audio input: 2.0 Vp-p	453.000	15.422	
F3E-VOICE Audio input: 4.0 Vp-p	453.000	15.635	

* Limited number of plots has been put in the test report for ease of readability.

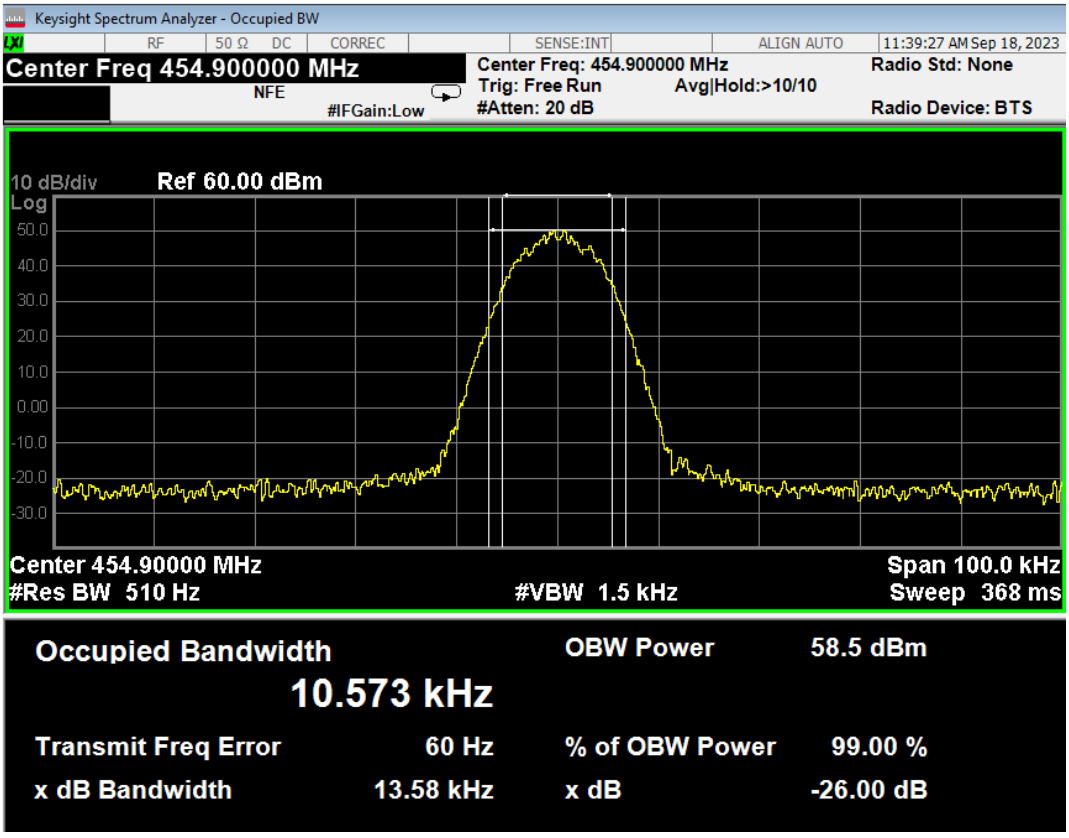
451.500 MHz/25.0 kHz channel/F2D-51 emission



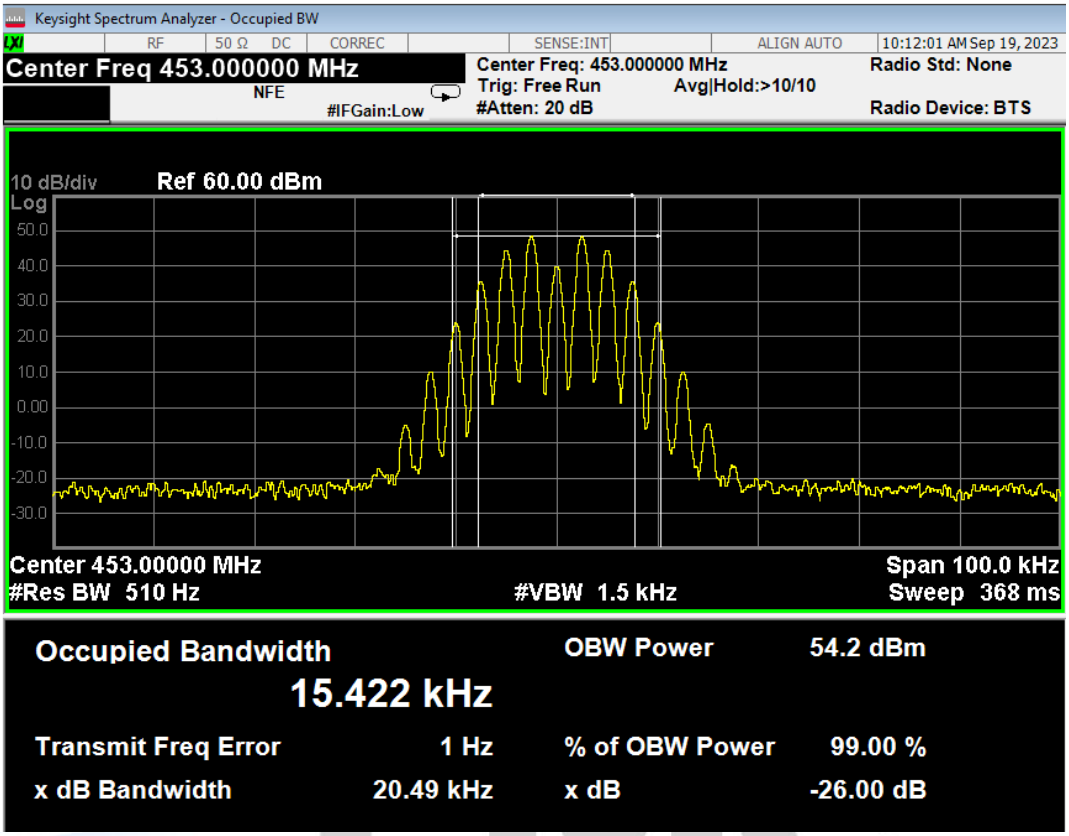
451.500 MHz/25.0 kHz channel/F2D-100 emission



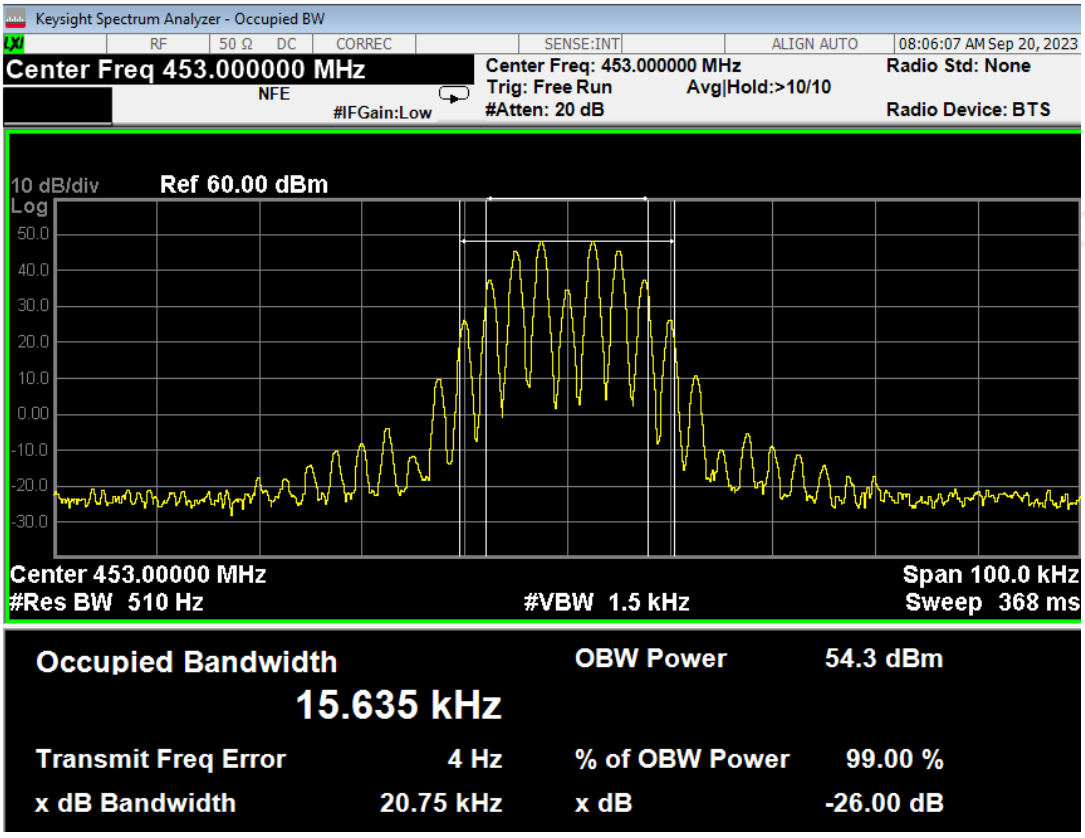
454.900 MHz/25.0 kHz channel/F3D-DTMF emission



453.000 MHz/25.0 kHz channel/F3D-Voice-2500 Hz, 2Vp-p emission



453.000 MHz/25.0 kHz channel/F3D-Voice-2500 Hz, 4Vp-p emission



§90.210 Spectrum Emission Masks

The spectrum masks are defined in:

As per the client, the product has audio filters, Section 90.210(d) – Mask D and B have been applied as the transmitter can operate in the band 450.000-470.000 MHz using an authorised bandwidth of 12.5 kHz and 25.0 kHz respectively as per Section 90.209(b)(5).

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

The yellow trace corresponds to unmodulated carrier only output. The blue trace corresponds to modulated output from the product.

All the measurements were performed when the product was operating at a high power setting (250 Watts)

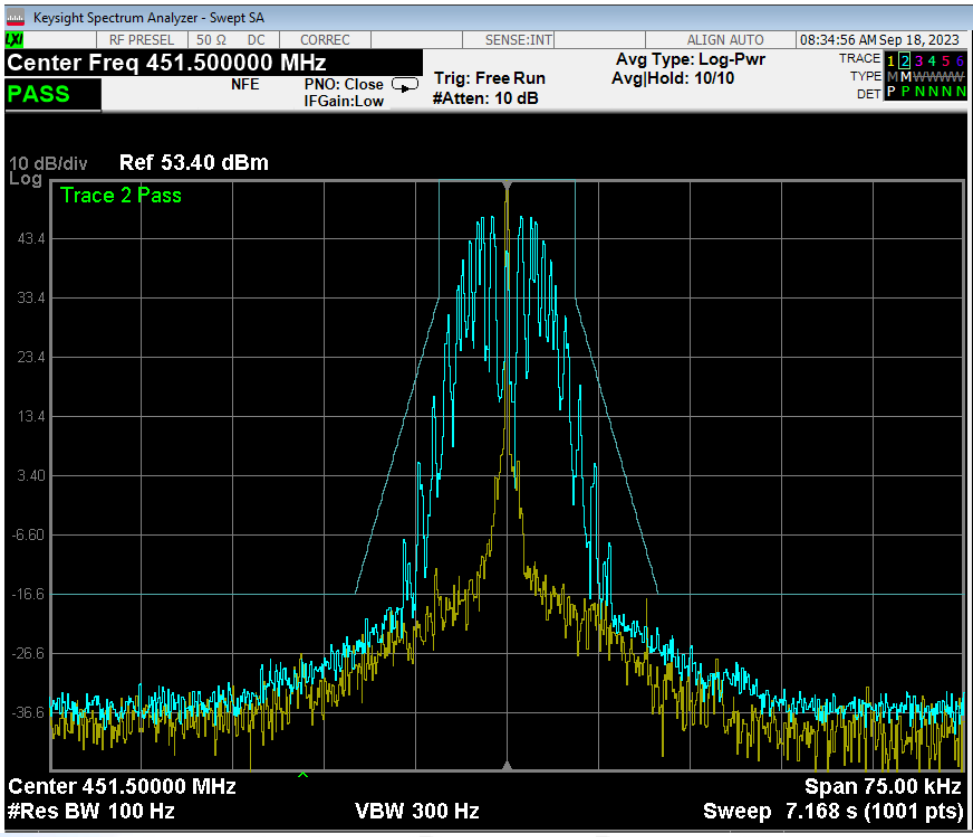
For the F2D and F3D mode the transmitter was modulated using the client supplied modulation source named Crescendo RFI-450VF external to the transmitter.

For F3E mode, the transmitter was modulated with a 2500 Hz tone at 4Vp-p audio level supplied from external calibrated audio signal generator from the test lab.

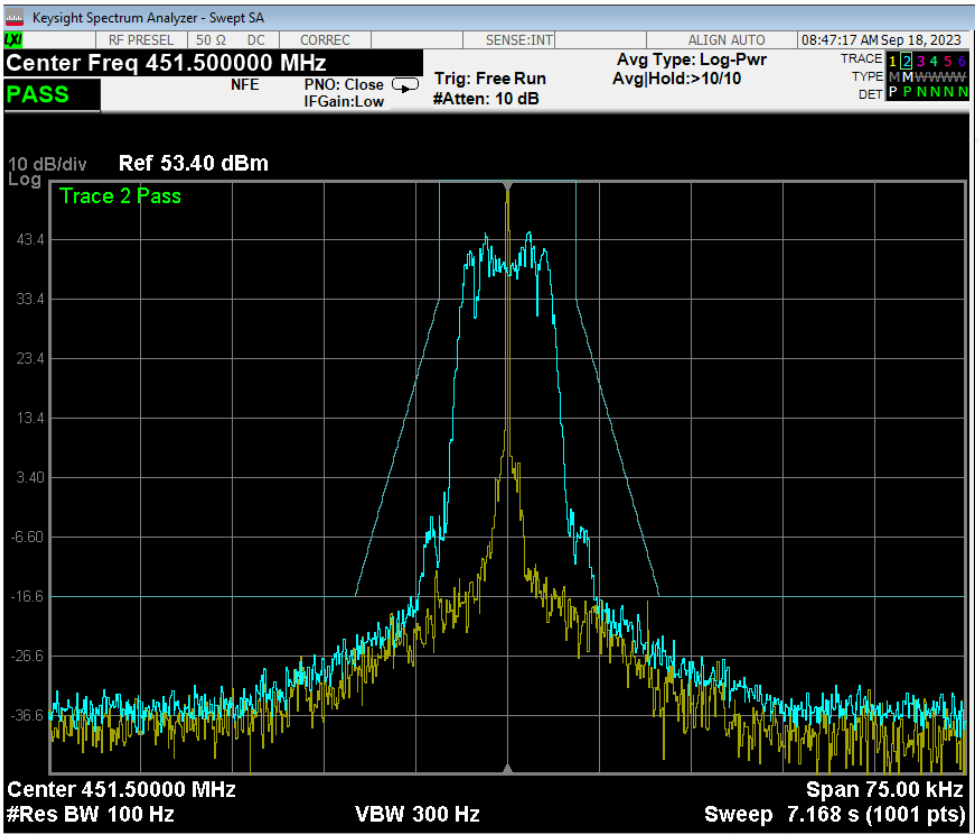
Result: Complies.

12.5 kHz, Spectrum Masks

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

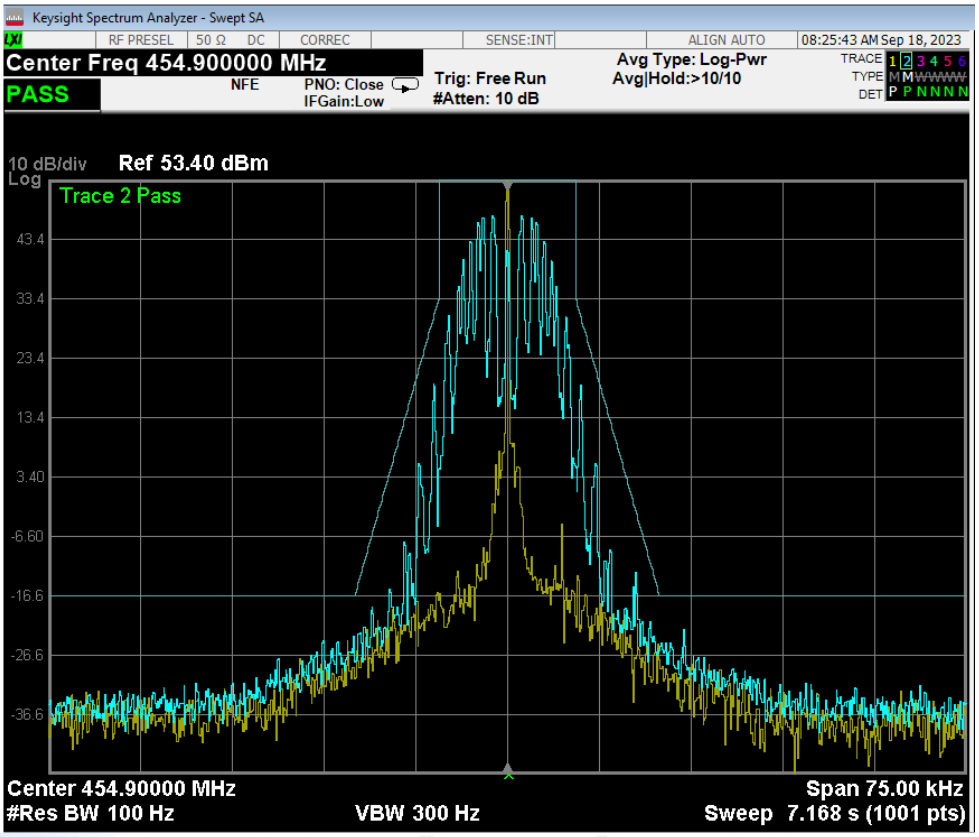


451.500 MHz/12.5 kHz channel/F2D-51/Mask D emission

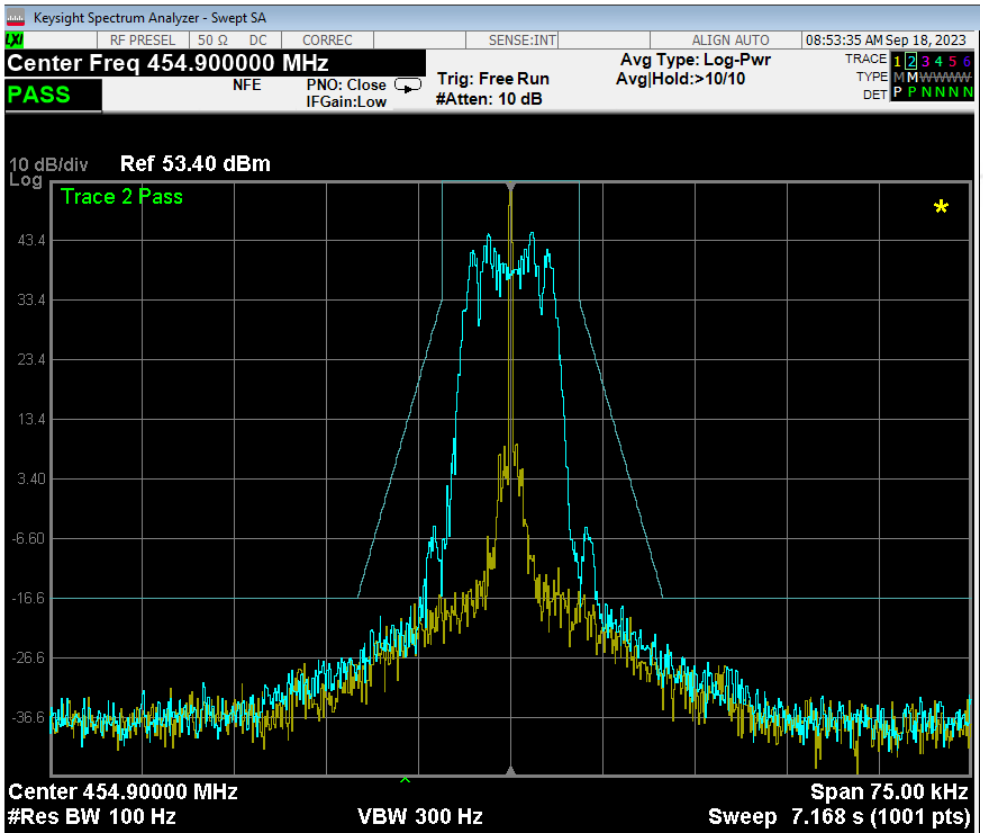


12.5 kHz, Spectrum Masks

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

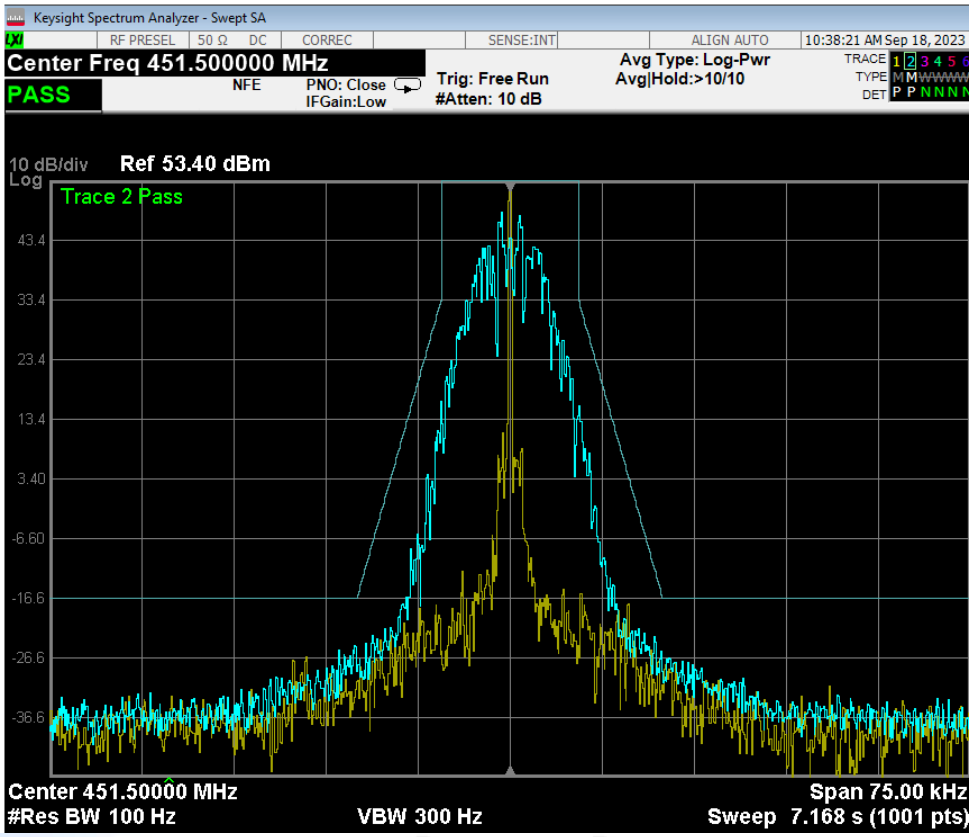


454.900 MHz/12.5 kHz channel/F2D-100/Mask D emission

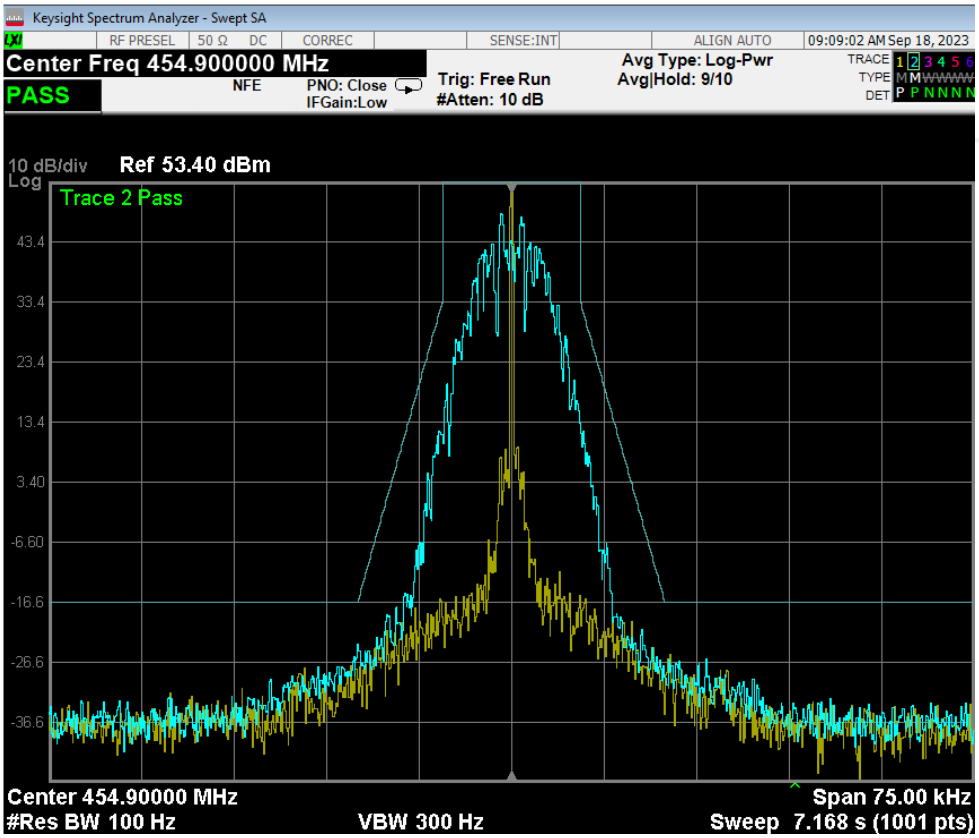


12.5 kHz, Spectrum Masks

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

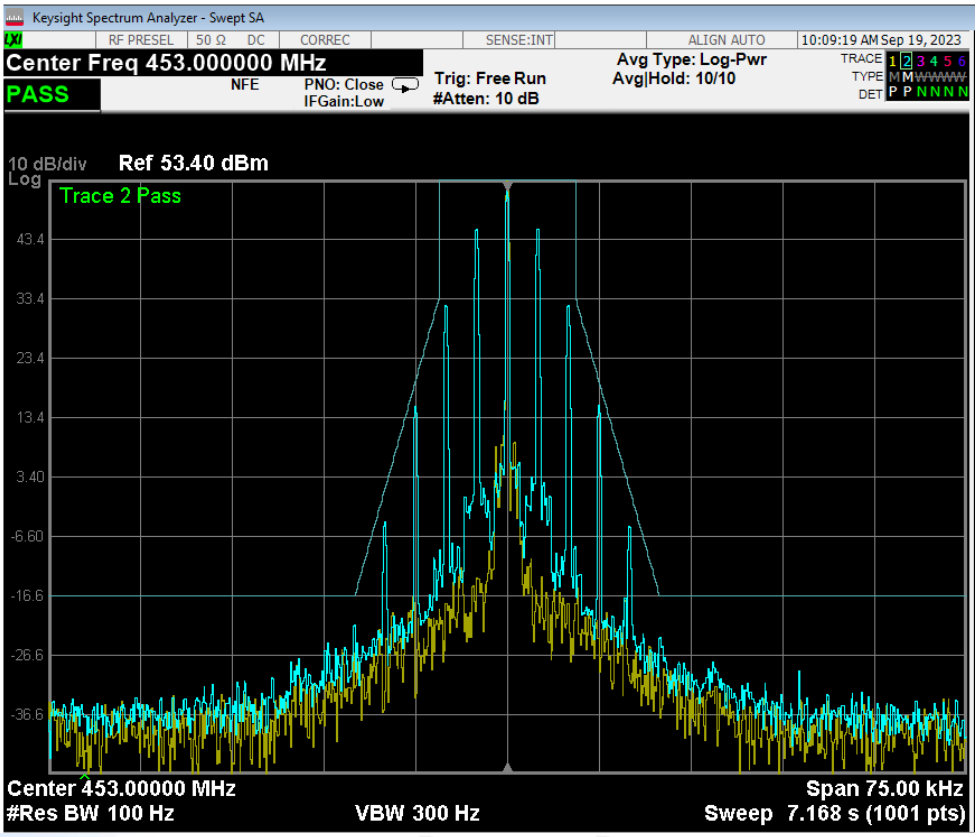


454.900 MHz/12.5 kHz channel/F3D-DTMF/Mask D emission

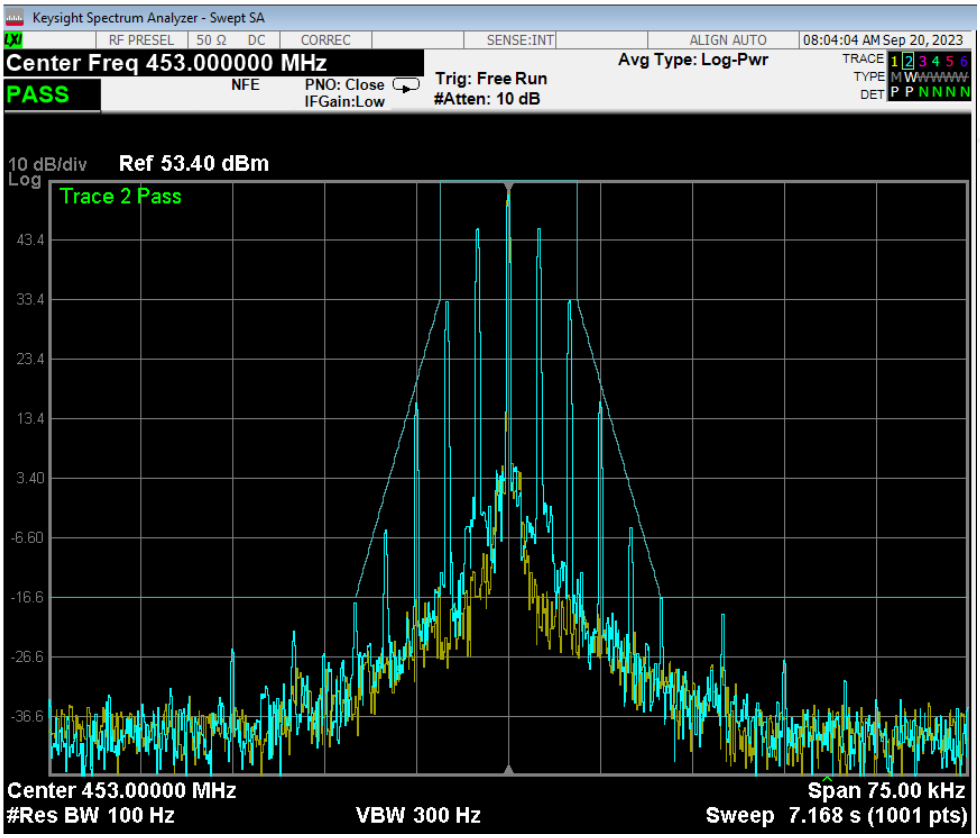


12.5 kHz, Spectrum Masks

453.000 MHz/12.5 kHz channel/F3E-Voice-2500 Hz, 2Vp-p/Mask D emission

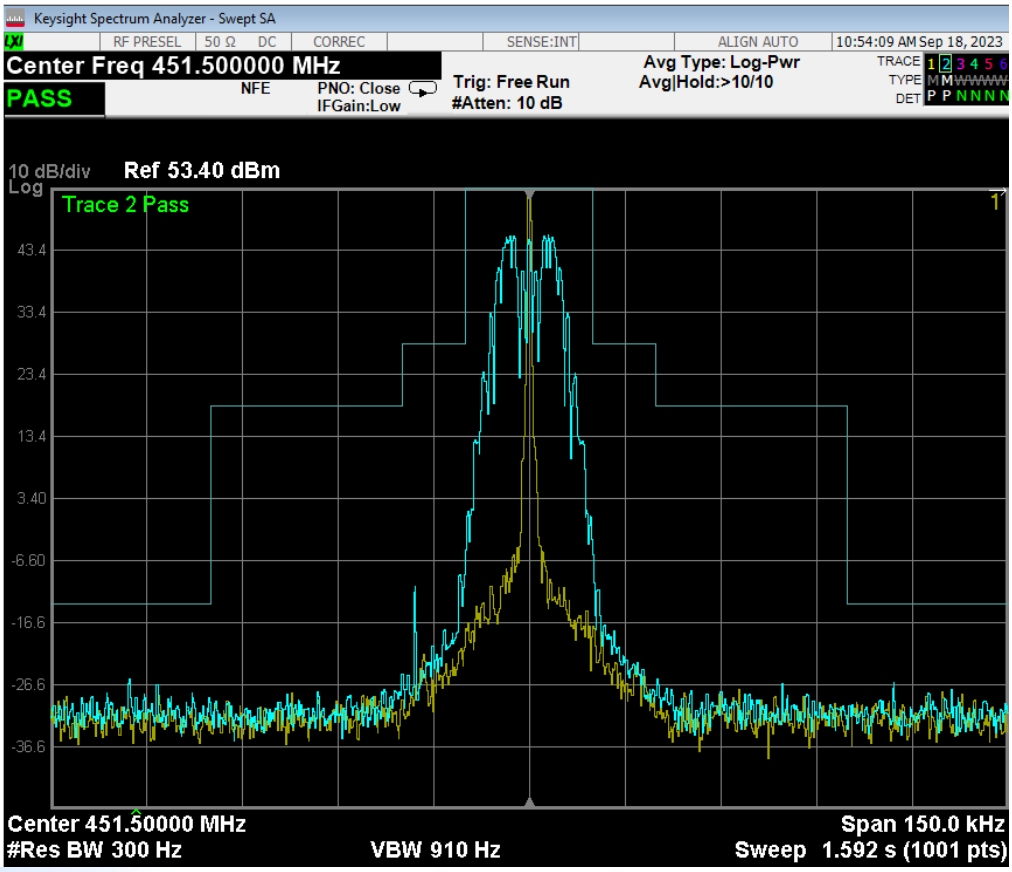


453.000 MHz/12.5 kHz channel/F3E-Voice-2500 Hz, 4Vp-p/Mask D emission

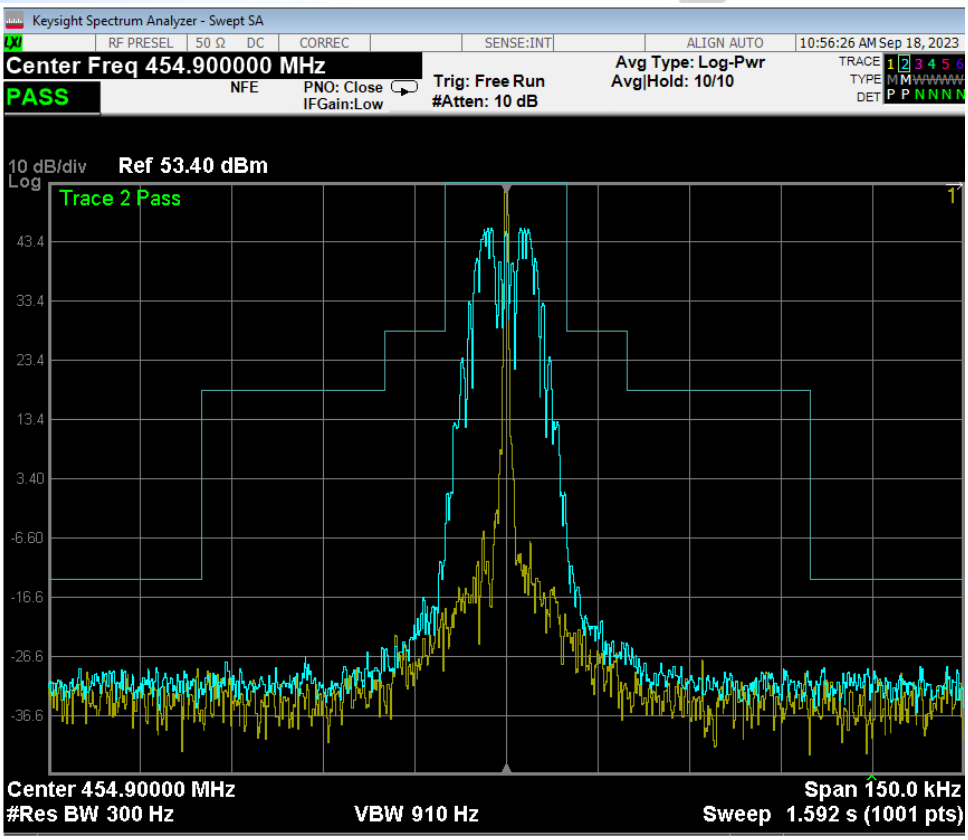


25.0 kHz, Spectrum Masks

451.500 MHz/25.0 kHz channel/F2D-51/Mask B emission

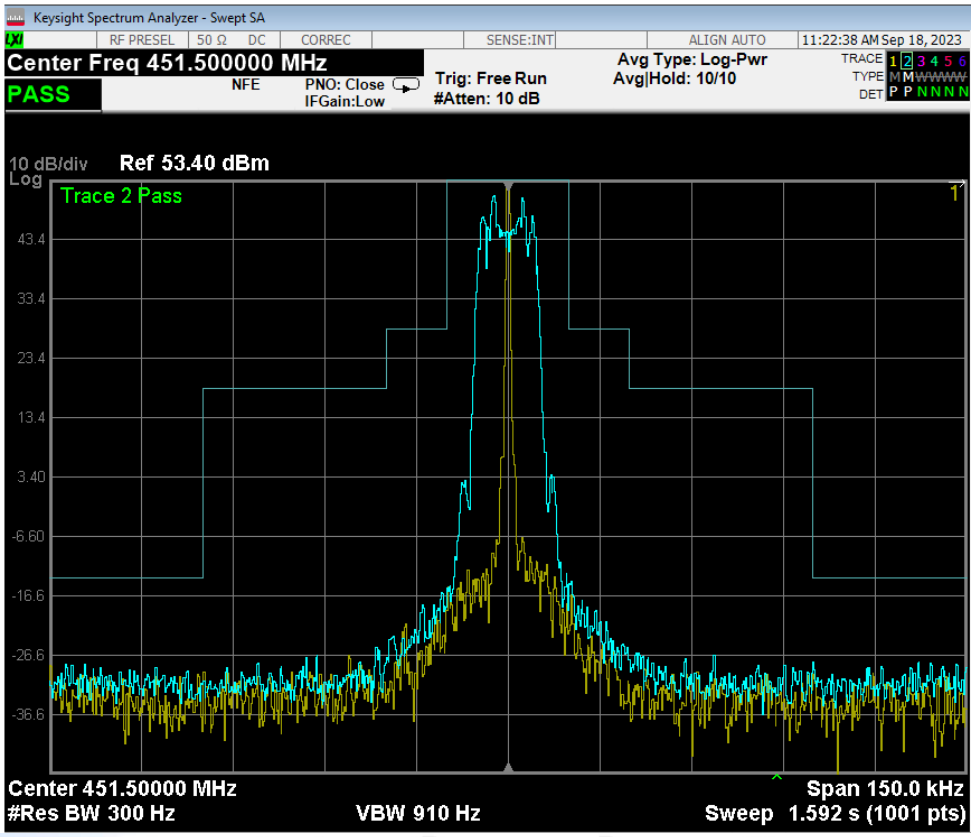


454.900 MHz/25.0 kHz channel/F2D-51/Mask B emission

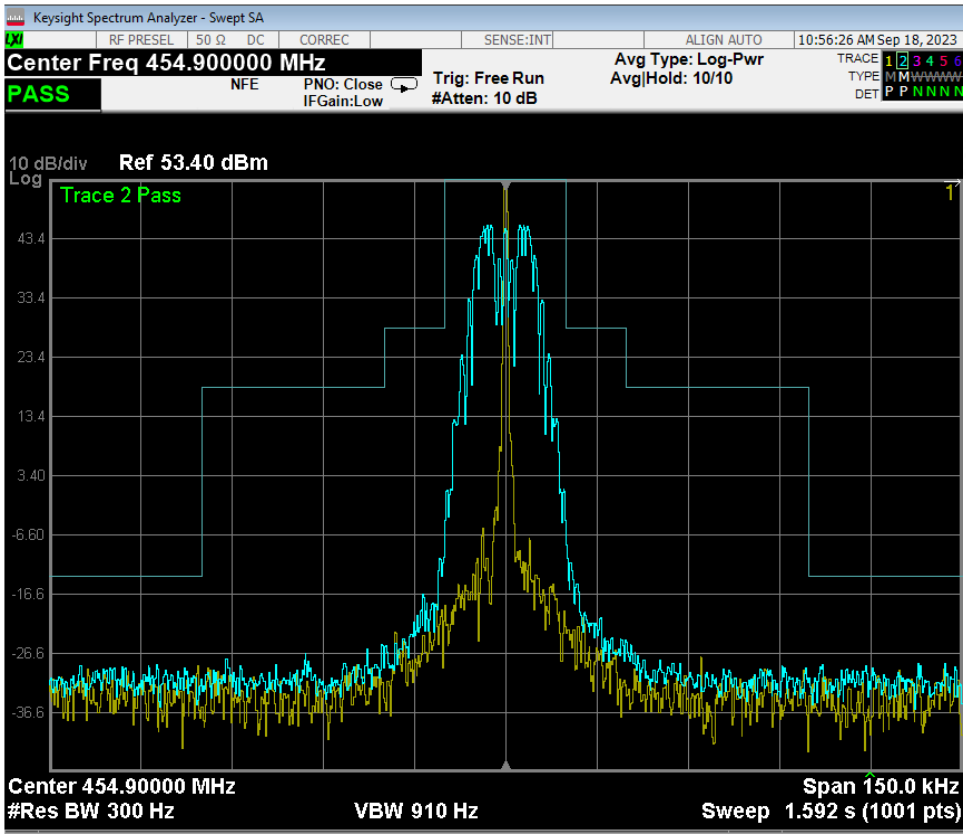


25.0 kHz, Spectrum Masks

451.500 MHz/25.0 kHz channel/F2D-100/Mask B emission

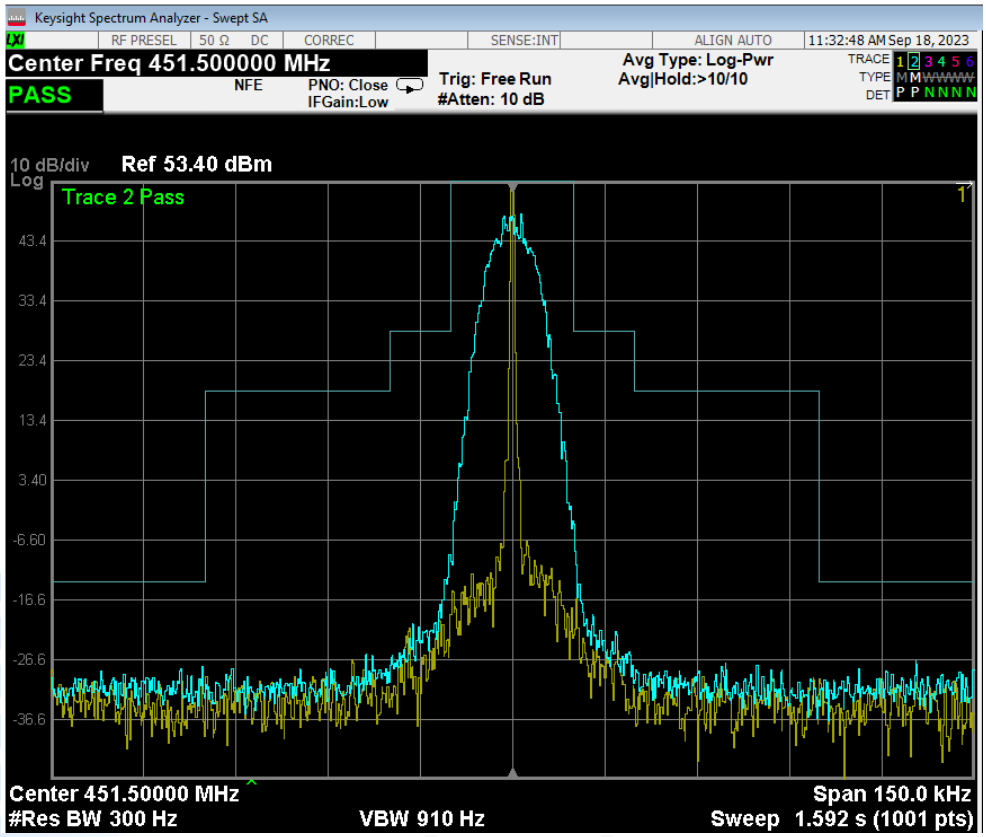


454.900 MHz/25.0 kHz channel/F2D-100/Mask B emission

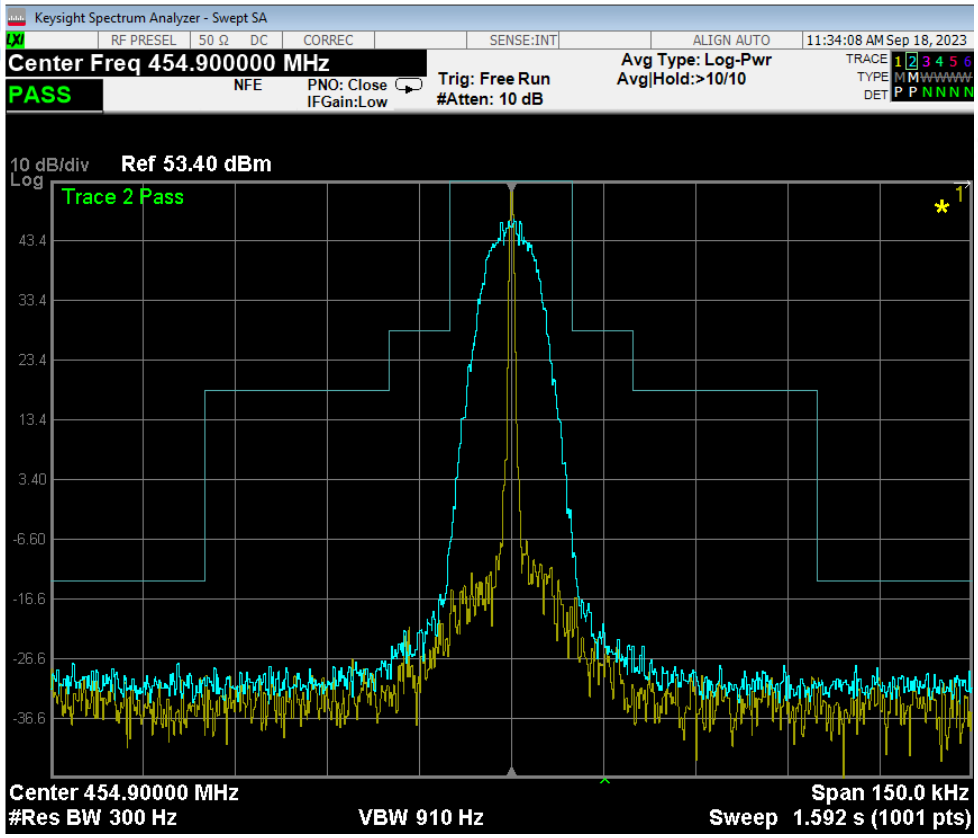


25.0 kHz, Spectrum Masks

451.500 MHz/25.0 kHz channel/F3D-DTMF/Mask B emission

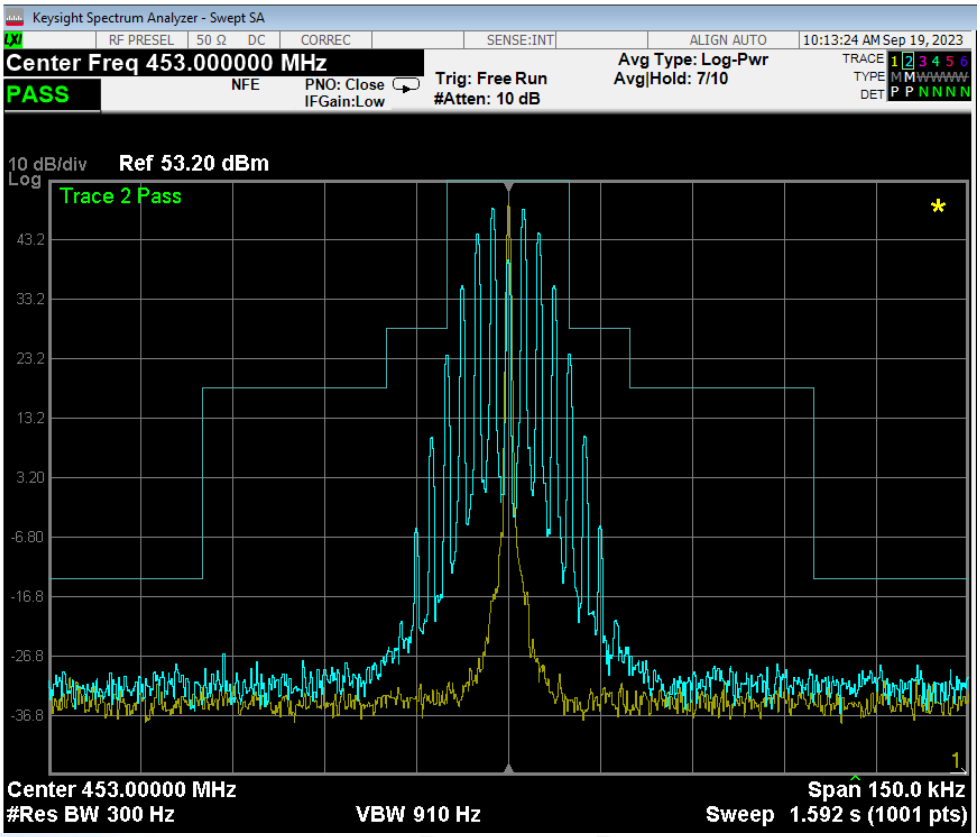


454.900 MHz/25.0 kHz channel/F3D-DTMF/Mask B emission

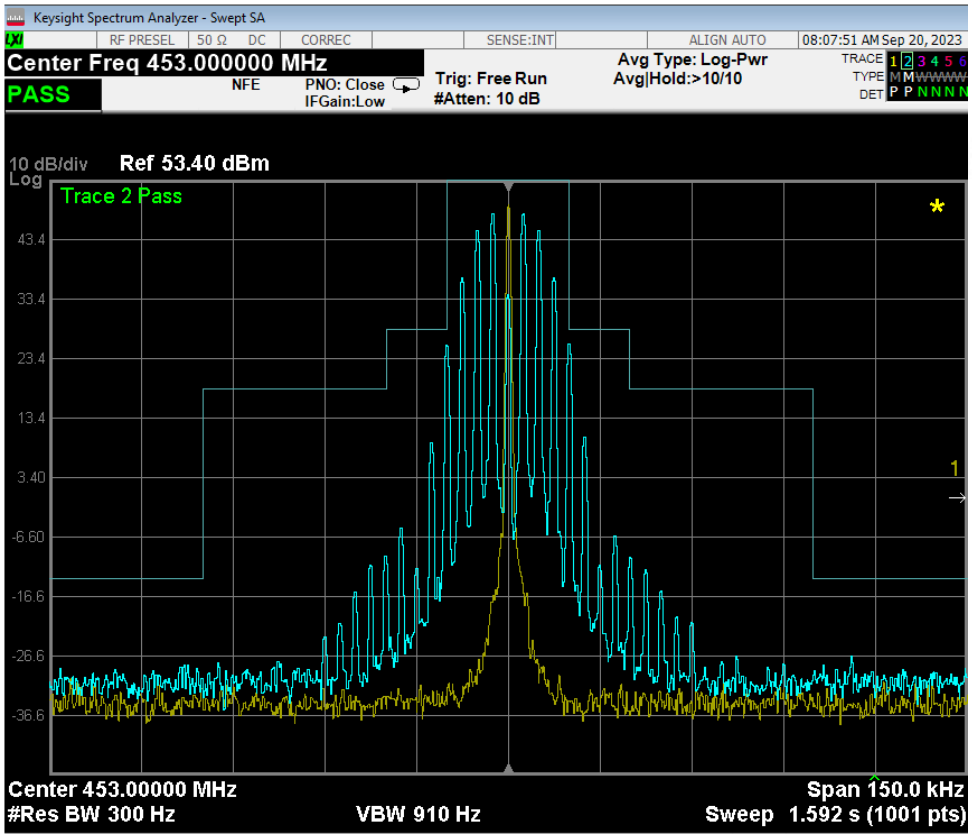


25.0 kHz, Spectrum Masks

453.000 MHz/25.0 kHz channel/F3E-Voice-2500 Hz, 2Vp-p/Mask B emission



453.000 MHz/25.0 kHz channel/F3E-Voice-2500 Hz, 4Vp-p/Mask B emission



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: 451.500 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
903.000	-30.3	-20.0
1354.500	-45.1	-20.0
1806.000	<-40.0	-20.0
2257.500	<-40.0	-20.0
2709.000	<-40.0	-20.0
3160.500	<-40.0	-20.0
3612.000	<-40.0	-20.0
4063.500	<-40.0	-20.0

Frequency: 454.900 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
909.800	-32.6	-20.0
1364.700	-45.5	-20.0
1819.600	<-40.0	-20.0
2274.500	<-40.0	-20.0
2729.400	<-40.0	-20.0
3184.300	<-40.0	-20.0
3639.200	<-40.0	-20.0
4094.100	<-40.0	-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: ± 1.0 dB

Field strength of the transmitter spurious emissions

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

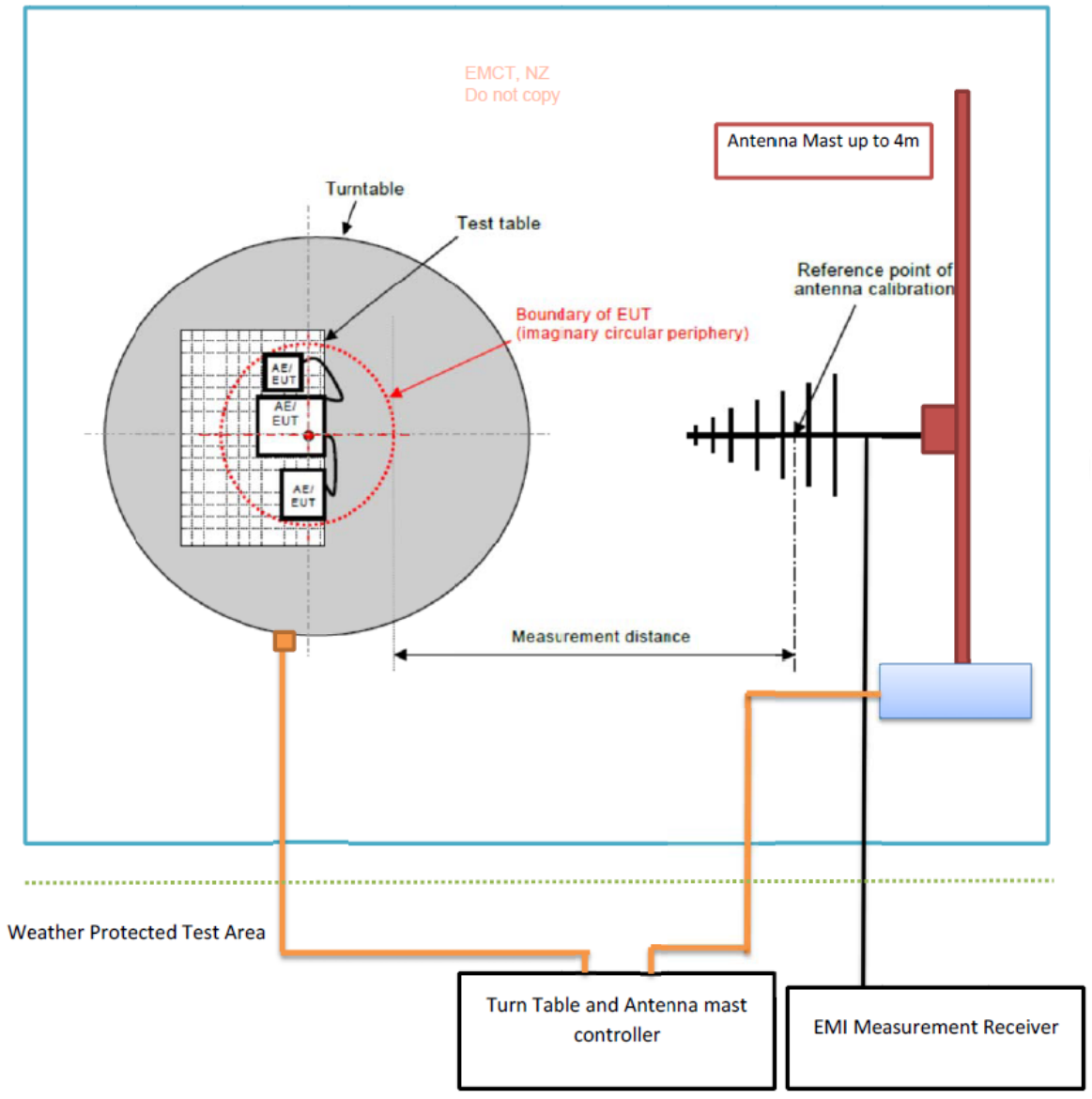
When operating in transmit mode no significant emissions were found between the harmonic emissions.

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: 453.000 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
906.0000	56.5	-40.9	-20.0	Vertical	20.9	Pass
906.0000	55.3	-42.1	-20.0	Horizontal	22.1	Pass
1359.0000	50.0	-47.4	-20.0	Vertical	27.4	Pass
1359.0000	48.3	-49.1	-20.0	Horizontal	29.1	Pass
1812.0000	50.0	-47.4	-20.0	Vertical	27.4	Pass
1812.0000	53.6	-43.8	-20.0	Horizontal	23.8	Pass
2265.0000	48.0	-49.4	-20.0	Vertical	>29.4*	Pass
2265.0000	48.0	-49.4	-20.0	Horizontal	>29.4*	Pass
2718.0000	48.0	-49.4	-20.0	Vertical	>29.4*	Pass
2718.0000	48.0	-49.4	-20.0	Horizontal	>29.4*	Pass
3171.0000	52.0	-45.4	-20.0	Vertical	>25.4*	Pass
3171.0000	52.0	-45.4	-20.0	Horizontal	>25.4*	Pass
3624.0000	52.0	-45.4	-20.0	Vertical	>25.4*	Pass
3624.0000	52.0	-45.4	-20.0	Horizontal	>25.4*	Pass
4077.0000	53.0	-44.4	-20.0	Vertical	>24.4*	Pass
4077.0000	53.0	-44.4	-20.0	Horizontal	>24.4*	Pass
4530.0000	54.0	-43.4	-20.0	Vertical	>23.4*	Pass
4530.0000	54.0	-43.4	-20.0	Horizontal	>23.4*	Pass

* Noise floor measurement.

All other emissions observed from the product in transmit mode had a 20 dB margin from the limit line.

Limit:

A 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

Product emissions in standby state (Information Only):

Frequency (MHz)	Vertical (dBµV/m)	Horizontal (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Polarisation	Result
32.960	33.3	23.5	40.0	6.7	Vertical	Pass
48.000	35.2	23.7	40.0	4.8	Vertical	Pass
51.920	23.9	20.0	40.0	16.1	Vertical	Pass
64.280	28.5	20.8	40.0	11.5	Vertical	Pass
70.440	32.3	-	40.0	7.7	Vertical	Pass
72.000	40.0	34.8	40.0	0.0	Vertical	Pass
75.960	30.4	22.0	40.0	9.6	Vertical	Pass
83.920	30.4	24.3	40.0	9.6	Vertical	Pass
86.200	30.7	23.0	43.5	12.8	Vertical	Pass
118.680	32.5	30.0	43.5	11.0	Vertical	Pass
123.880	30.9	-	43.5	12.6	Vertical	Pass
134.760	32.5	28.0	43.5	11.0	Vertical	Pass
143.200	34.1	25.0	43.5	9.4	Vertical	Pass
151.280	31.6	26.0	43.5	11.9	Vertical	Pass
203.400	35.8	34.8	43.5	7.7	Vertical	Pass
217.840	28.1	33.6	43.5	9.9	Horizontal	Pass
255.520	30.4	33.2	43.5	10.3	Horizontal	Pass
322.600	32.3	36.7	46.0	9.3	Horizontal	Pass
330.480	33.6	41.2	46.0	4.8	Horizontal	Pass
342.000	32.1	40.0	46.0	6.0	Horizontal	Pass
364.760	29.6	33.0	46.0	13.0	Horizontal	Pass
403.000	30.9	30.1	46.0	15.1	Vertical	Pass
433.840	30.0	25.0	46.0	16.0	Vertical	Pass
725.600	34.3	33.0	46.0	11.7	Vertical	Pass

For completeness standby emission measurements were made.

The FCC part 15 section 15.109 Class B limits have been applied as measurements were made at a distance of 3 metres.

All other emissions were observed to have a margin to the limit that exceeds at least 15 dB of the limit when the measurements were carried out between 30 - 10000 MHz using both vertical and horizontal polarisations.

Result: Complies.
Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (30 - 10000 MHz) ± 4.1 dB

§90.213 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: 453.000 MHz

Temperature (°C)	Low Vac Error (Hz)	Nominal Vac Error (Hz)	High Vac Error (Hz)
+50	-60	-60	-60
+40	-20	-20	-20
+30	-30	-30	-30
+20	-10	-10	-10
+10	+40	+40	+40
0	+30	+30	+30
-10	+10	+10	+10
-20	-20	-20	-20
-30	-30	-30	-30

Limits:

Part 90.213 states that fixed station transmitters operating between 421.000-512.000 MHz are required to have a frequency tolerance of 1.5 ppm, note 7, 11 and 14 have been applied.

Note 7: In the 421-512 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 1.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 0.5 ppm.

Note 11: Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150-174 MHz band and 2.5 ppm in the 421-512 MHz band.

Note 14: Control stations may operate with the frequency tolerance specified for associated mobile frequencies.

A worst case error of 0.13 ppm (-60 Hz / 453.000 MHz) was observed.

Result: Complies.
Measurement Uncertainty: ± 30 Hz

§90.214 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: For 421.000 to 512.000 MHz Band, the limits are

Time Interval	Period (ms) UHF	VHF	6.25 kHz Deviation (kHz)	12.5 kHz Deviation (kHz)	25 kHz Deviation (kHz)
t_1	10	5	± 6.25	± 12.5	± 25.0
t_2	25	20	± 3.125	± 6.25	± 12.5
t_3	10	5	± 6.25	± 12.5	± 25.0

Result: Complies.

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

12.5 kHz transmitter turn on (453.000 MHz)

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

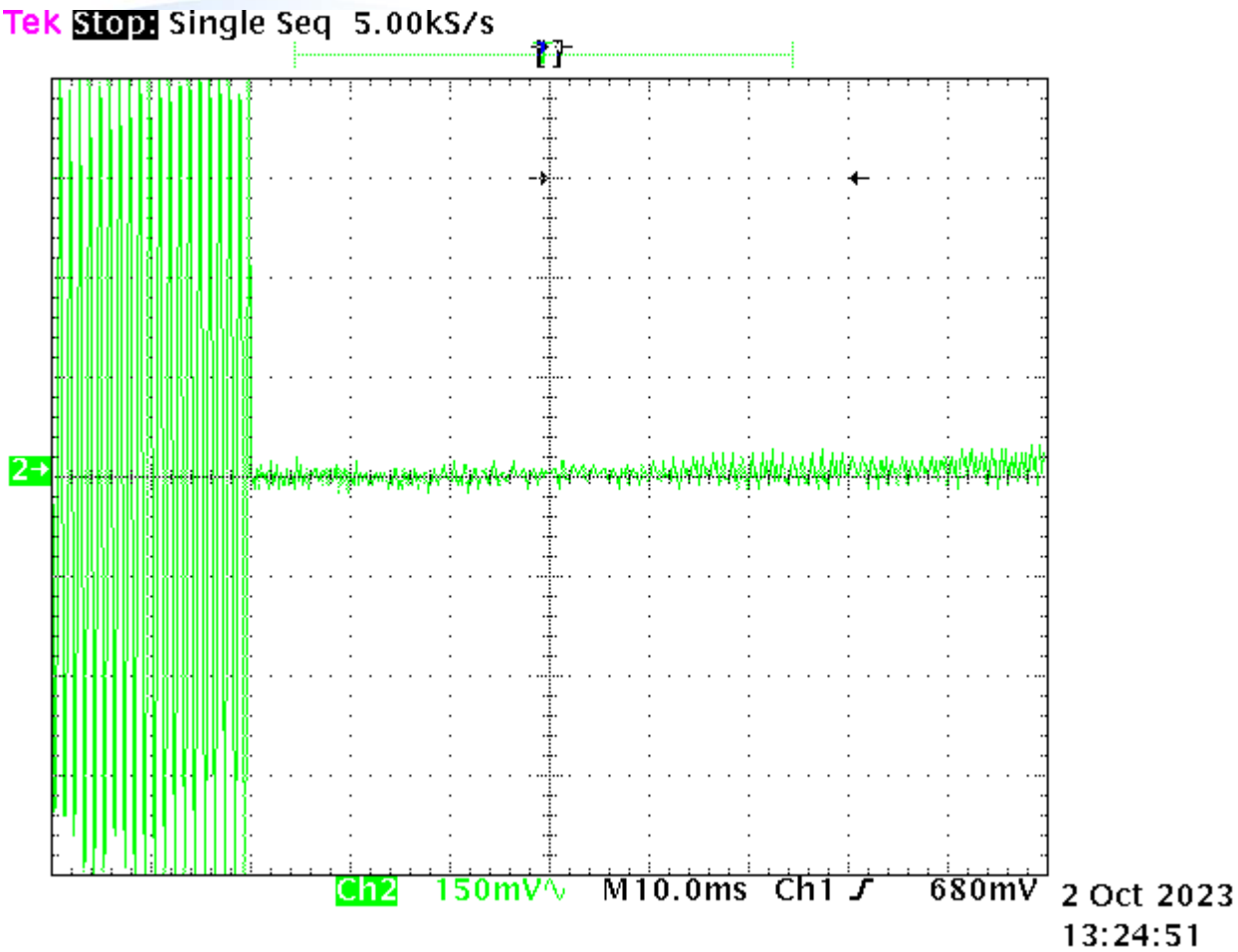
Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
The X axis has been set to a sweep rate of 10 ms/division.

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.

Transient response can be observed during t1 and t2.



12.5 kHz transmitter turn off (453.000 MHz)

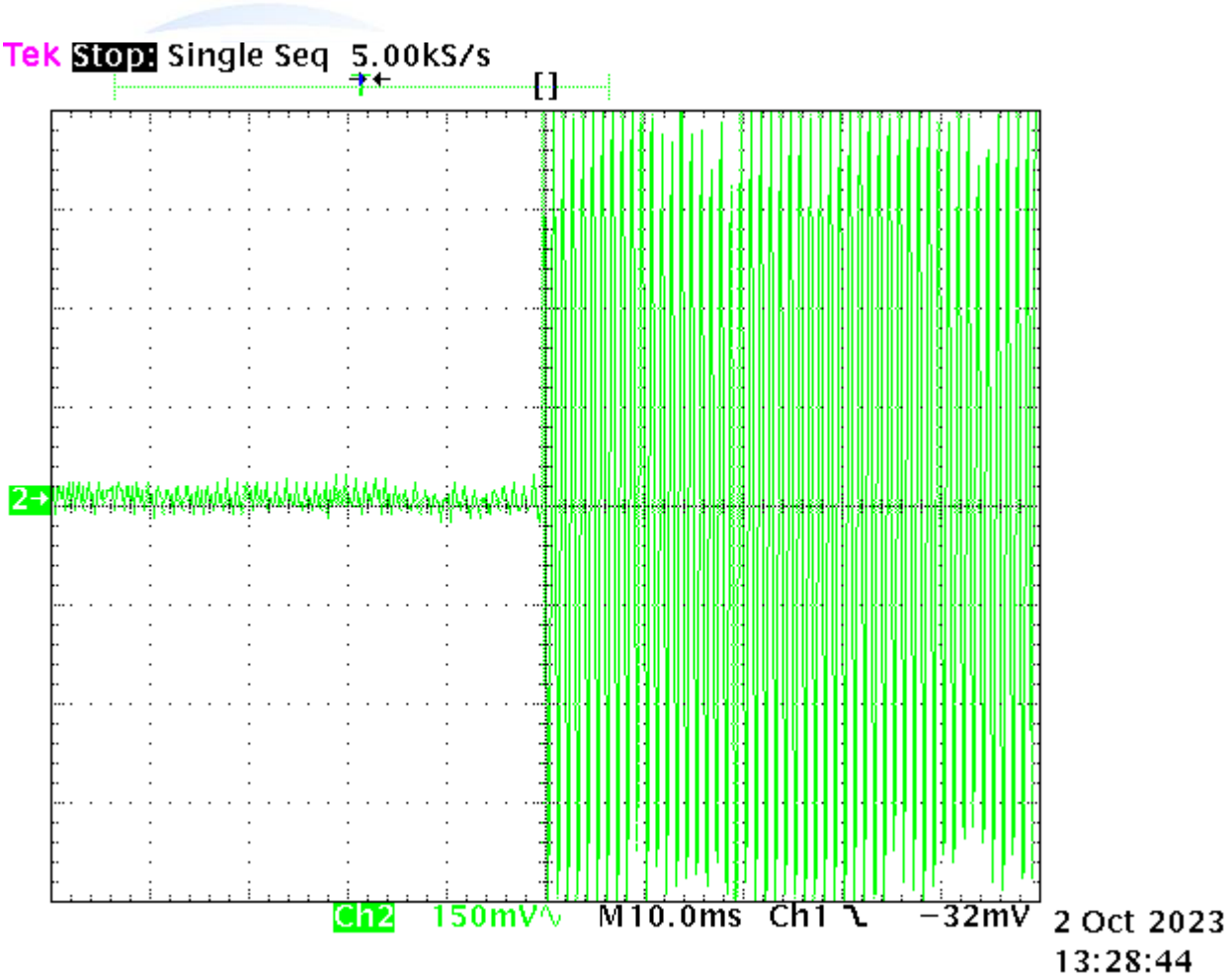
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz.

Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
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.

Transient response can be observed before *t*off.



25.0 kHz Transmitter turn on (453.000 MHz)

Green Trace = 1 kHz tone with FM deviation of 25.0 kHz.

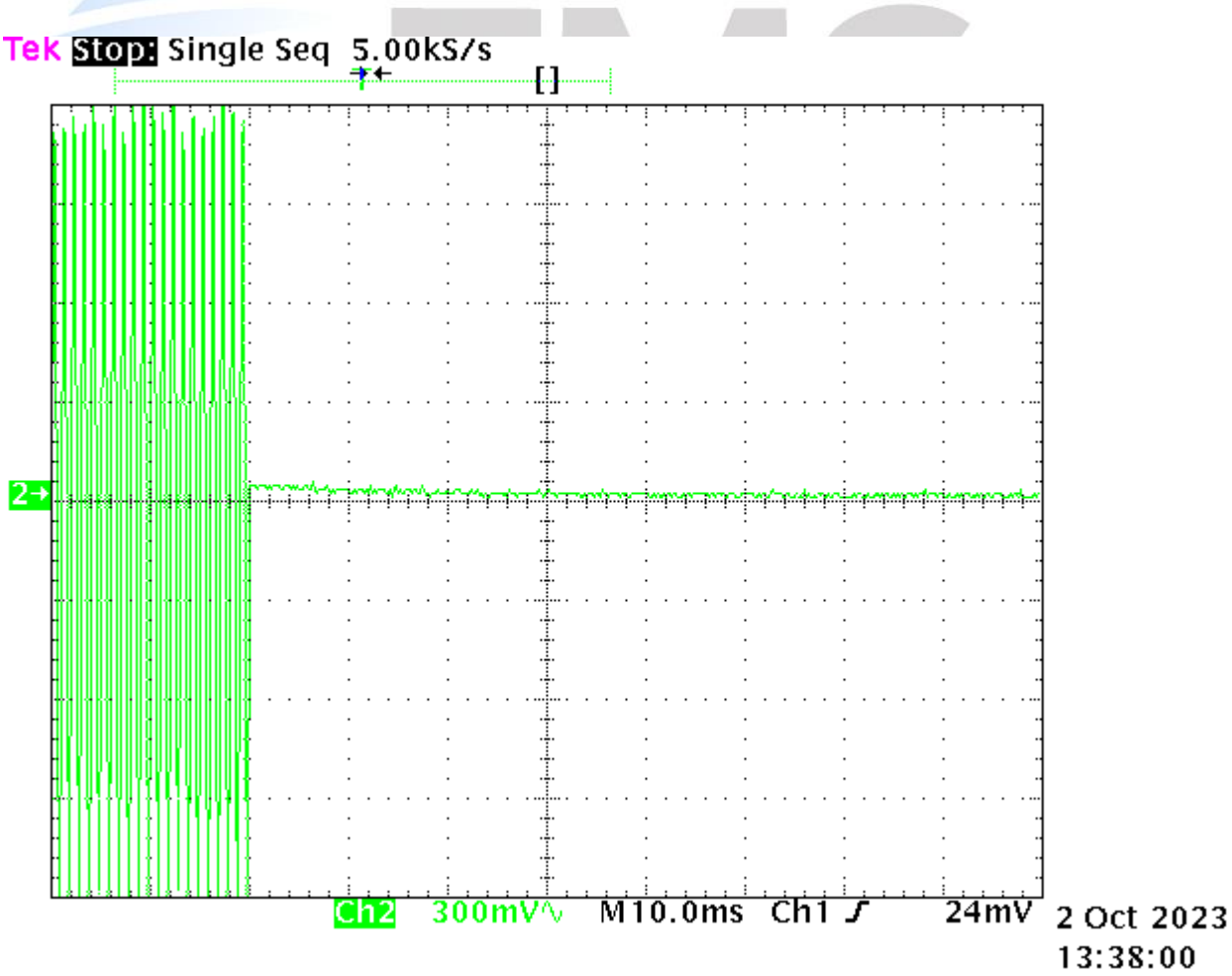
Green trace has been maximised to give full screen indication of +/- 25.0 kHz.
The X axis has been set to a sweep rate of 10 ms/division.

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 2.5 divisions from the left hand edge.
*t*2 occurs between 2.5 and 4.5 divisions from the left hand edge.

Transient response can be observed during *t*1 and *t*2.



25.0 kHz transmitter turn off (453.000 MHz)

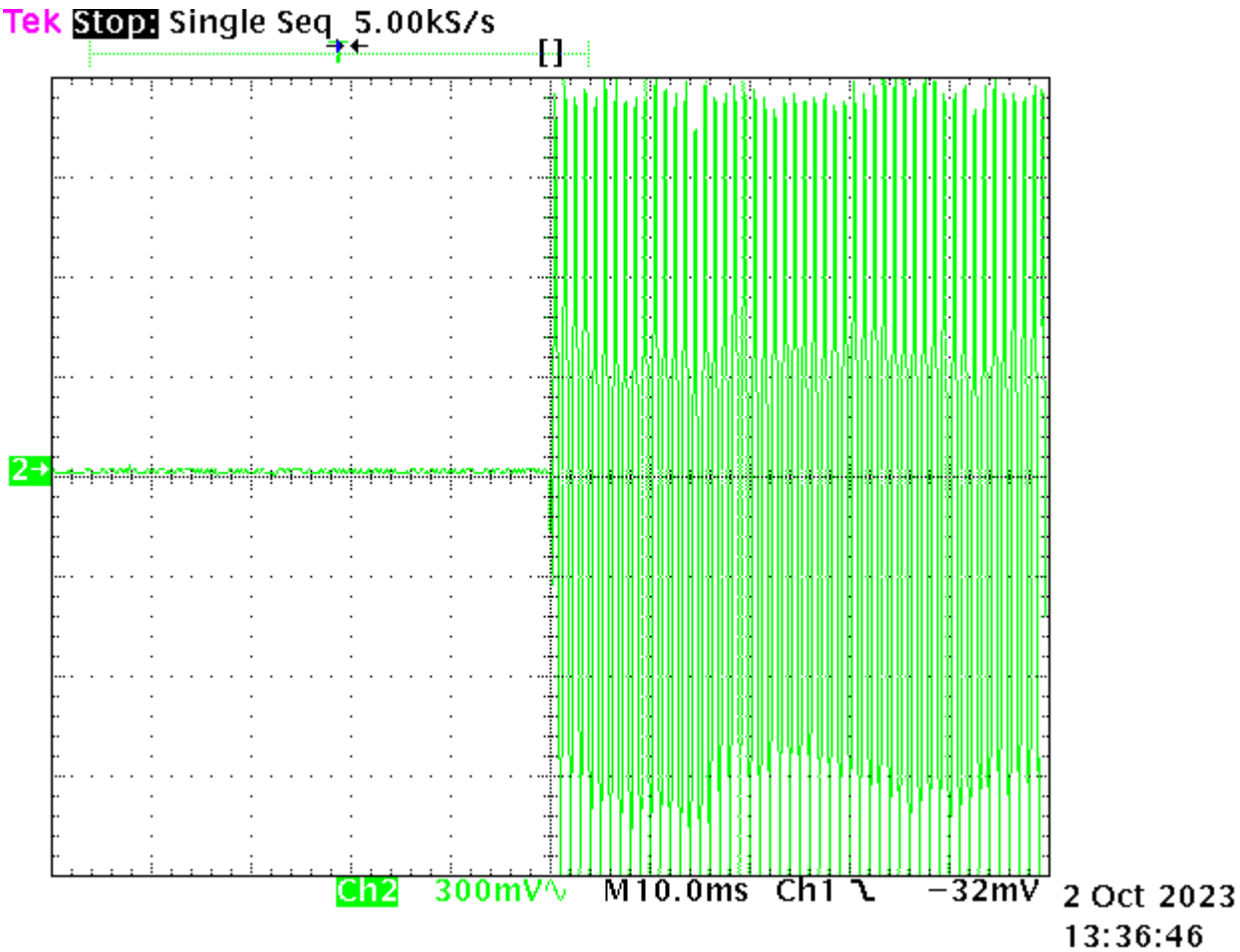
Green Trace = 1 kHz tone with FM deviation of 25.0 kHz.

Green trace has been maximised to give full screen indication of +/- 25.0 kHz.
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 4.5 and 5.0 divisions from the left hand edge..

A 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.

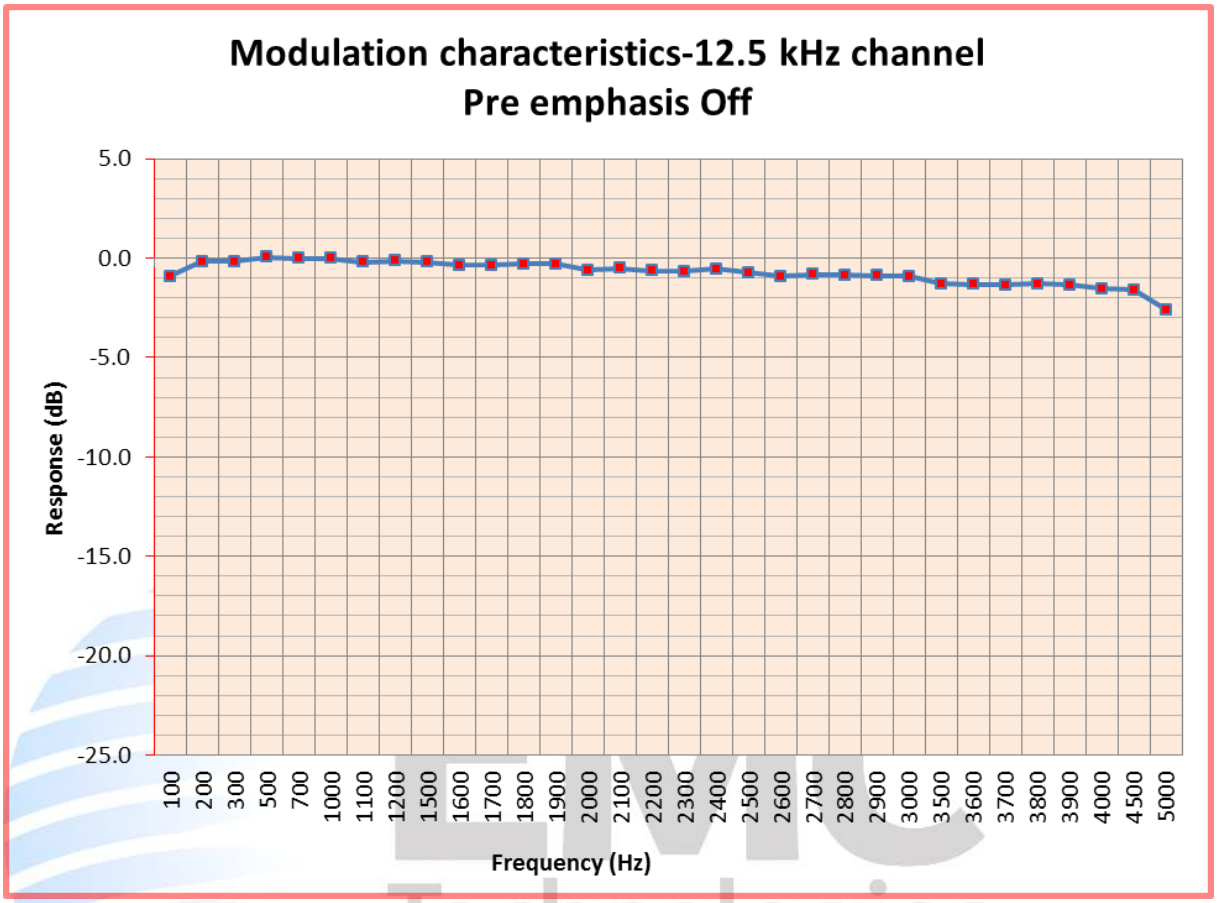
At each frequency the input voltage was slowly increased with the resulting frequency deviation of the transmitter being recorded.

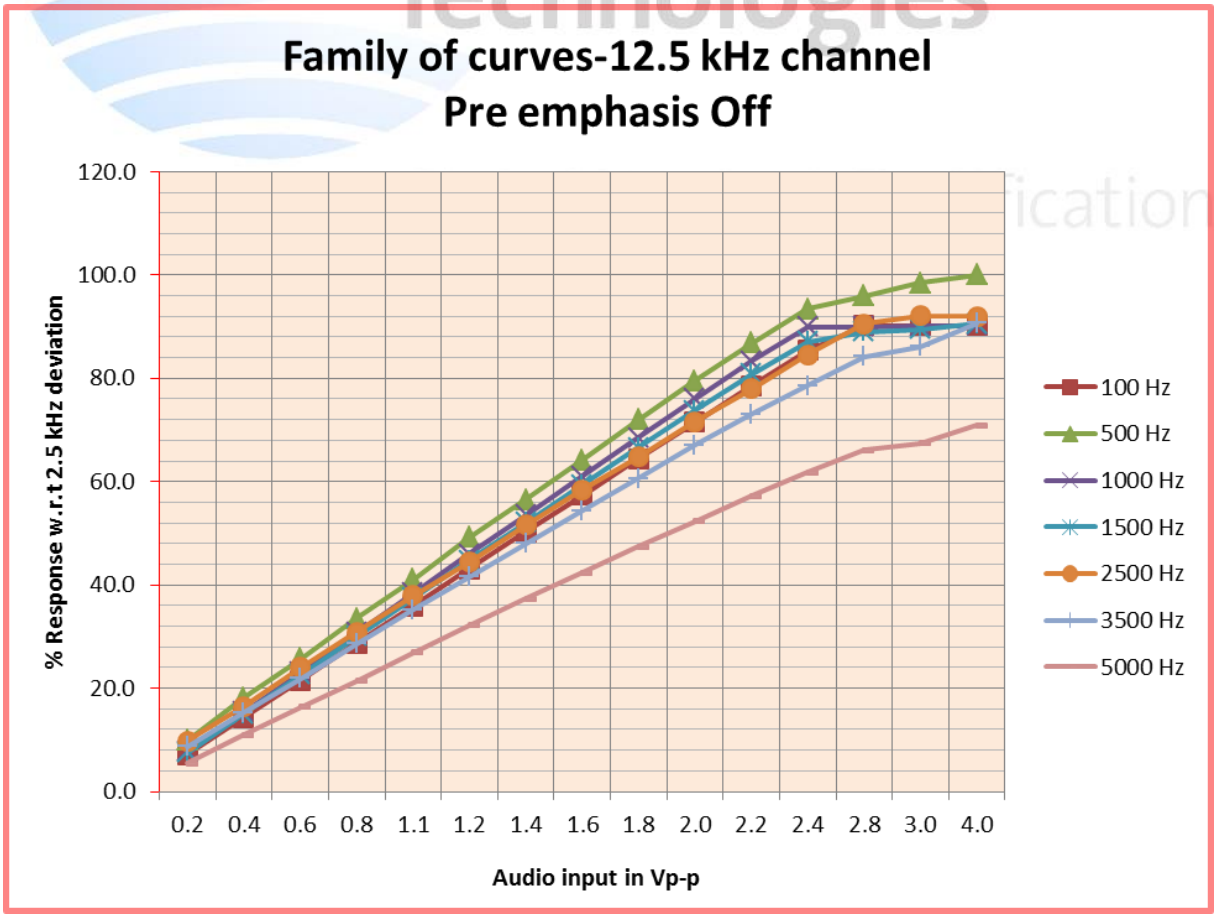
- The testing was carried out with and without pre emphasis filter active inside the product which could be selected by the test software supplied by the client.

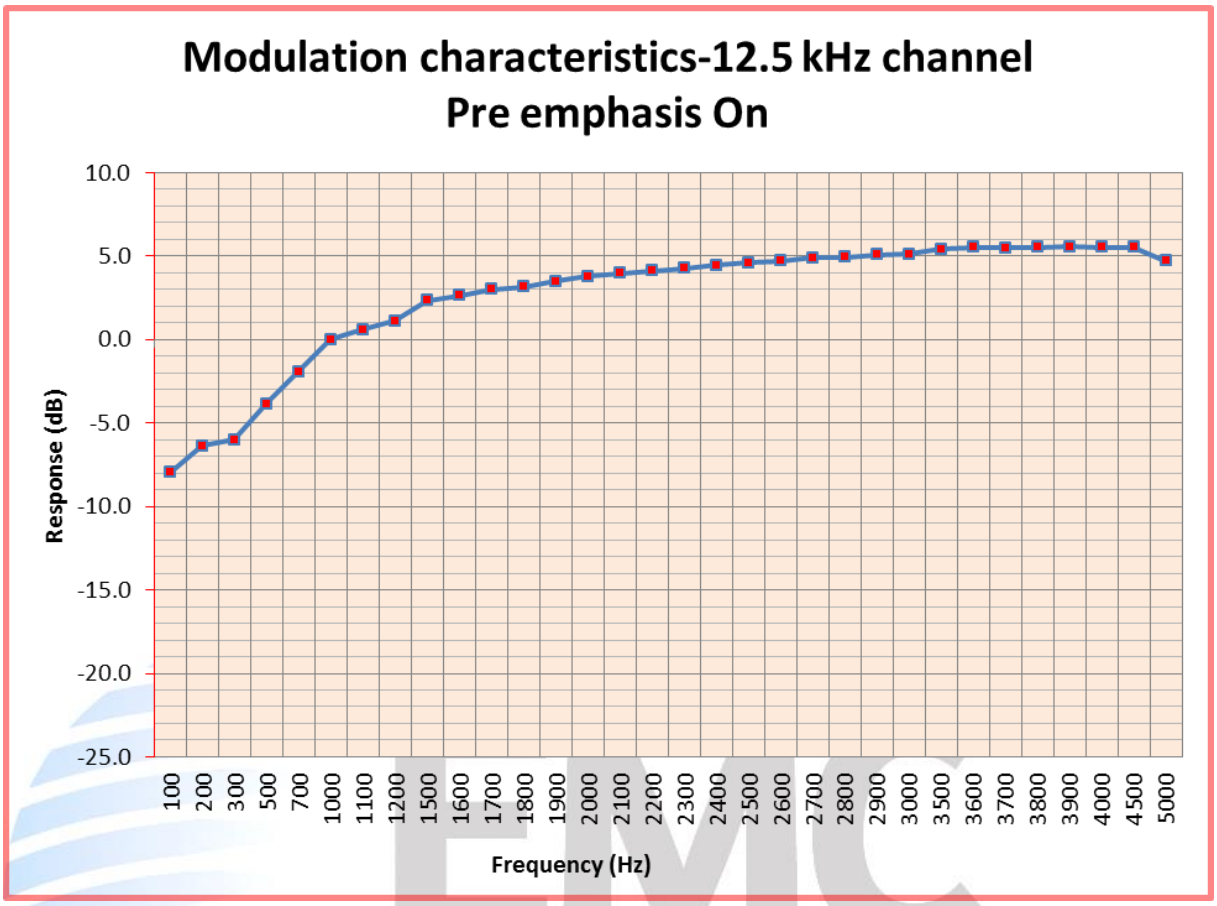
- The user manual instructs the user to limit the Audio input level to 2 Vp-p. This should allow the software to prevent the deviation limiter from being engaged unless the user provides an audio input from a source they cannot measure, e.g. speaking into a microphone.

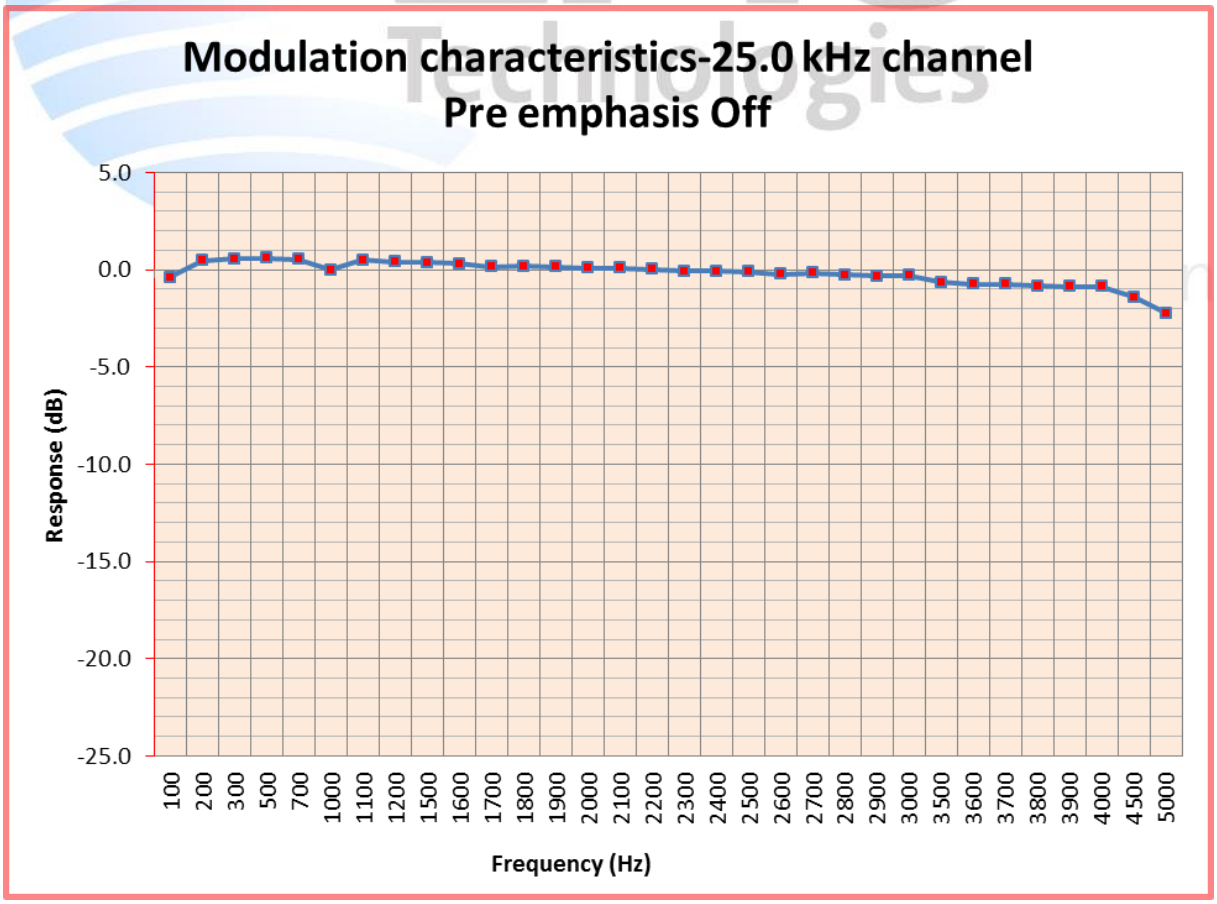
- For the purpose of testing the test was carried out up to 4 Vp-p and curves with the deviation limiter set to 4800 Hz and 4500 Hz has been presented in the test report.

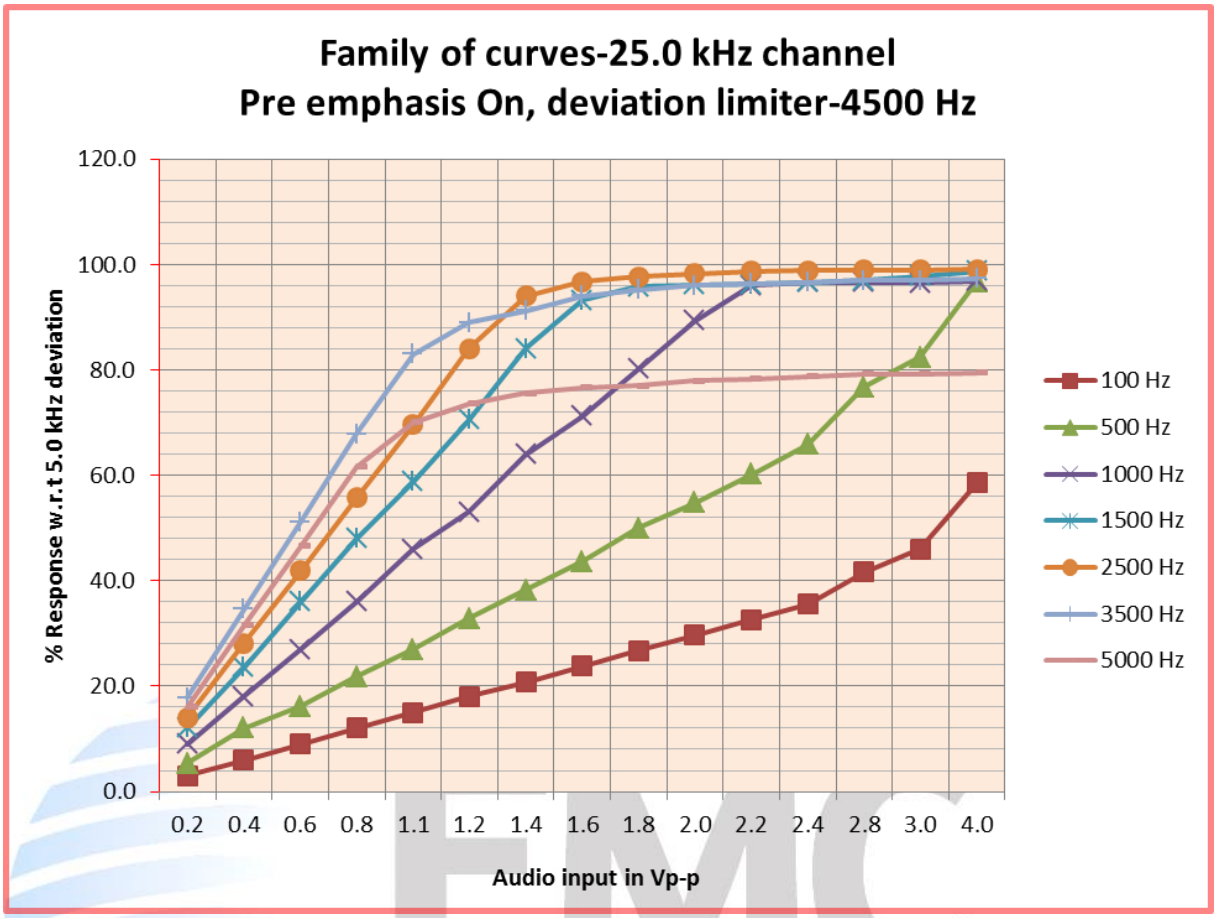
- The curves have been names accordingly to show the test condition.

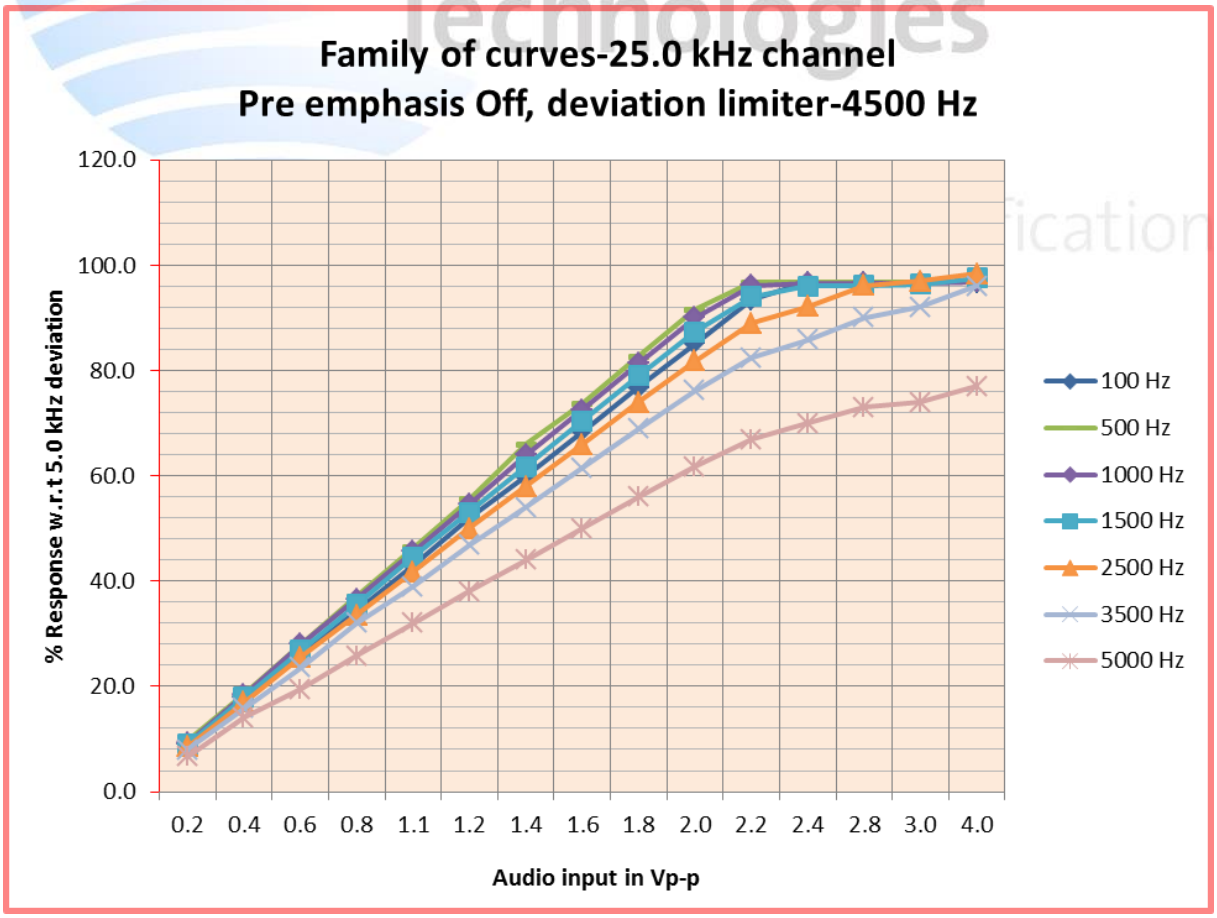












Exposure of humans to RF fields

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.

The product operates in the frequency band 451.000 MHz to 455.000 MHz. For worst case MPE calculations, 451.000 MHz has been selected.

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3–3.0	614	1.63	*100	6
3.0–30	1842/f	4.89/f	*900/f^2	6
30–300	61.4	0.163	1.0	6
300–1,500			f/300	6
1,500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*100	30
1.34–30	824/f	2.19/f	*180/f^2	30
30–300	27.5	0.073	0.2	30
300–1,500			f/1500	30
1,500–100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

Limits for maximum permissible exposure (MPE)

- General Population / Uncontrolled exposure is f/1500. At 452.0 MHz, the calculated limit is 0.3 mW/cm2

- Occupational /Controlled exposure is f/300. At 452.0 MHz, the calculated limit is 1.5mW/cm2

Minimum safe distances have been calculated below.

For Uncontrolled Environment

At 452.0 MHz,
Power Density = (451.0/1500) = 0.30 mW/cm2 = E2/3770

E= √ 0.3*3770

E = 33.6 V/m

For Controlled Environment

At 452.0 MHz,
Power Density = (451.0/300)=1.50 mW/cm2 = E2/3770

E= √ 1.50*3770

E = 75.4 V/m

Exposure of humans to RF fields cont.

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.

Unity gain has been used to make the assessment.

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)

The calculation is as follows:

FS = (√ (30 * P * G * DC)) / D

Therefore

a) For Uncontrolled environments, the minimum distance is:

D = (√ (30 * P * G * DC)) / FS

D = (√ (30 * 250 * 1.0 * 1.0)) / 33.6

D = 2.6 metres

a) For Controlled environments, the minimum distance is:

D = (√ (30 * P * G * DC)) / FS

D = (√ (30 * 250 * 1.0 * 1.0)) / 75.4

D = 1.15 metres

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

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial/ID #	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	9594	23/11/23	2.0 years
Log Periodic Antenna	Schwarzbeck	VUSLP 91111	9111-112	16/11/23	2.0 years
Horn Antenna	EMCO	3115	9511-4629	03/03/25	3.0 years
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	13/04/25	3.0 year
Power Attenuator	Tenuline	8322	-	N/a	N/a
Power Attenuator	DTS	-	-	N/a	N/a
Modulation Analyser	Hewlett Packard	8901B	SN2608A00782	30/04/25	2.0 years
Level Generator	Anritsu	MG443B	M61689	7/08/2025	2.0 years
Power meter	Hewlett Packard	436A	2512A22439	19/04/25	2.0 years
Power Sensor	Hewlett Packard	8482A	2237A07036	19/04/25	2.0 years
Oscilloscope	Tektronics	745A	B010643	4/10/24	2.0 Years
Signal Generator	Agilent	E4433B	ESG-D	28/02/24	2.0 Years
Signal Generator	Rohde & Schwarz	SMHU	E1493	27/05/24	2.0 Years
Heliax Cable	L6PNM-RPD	OATS	22869	23/12/23	1.0 Years
Receiver	Rohde & Schwarz	ESIB-40	100295	06/10/24	2.0 years
Spectrum Analyzer	Keysight	N9038A	MY57290153	29/01/2024	3.0 year
Thermal chamber	Contherm	M180F	86025	N/a	N/a
Thermometer	DSIR	RT200	35	11/04/27	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.

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 International Laboratory Accreditation Council (ILAC) 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.

9. PHOTOGRAPHS

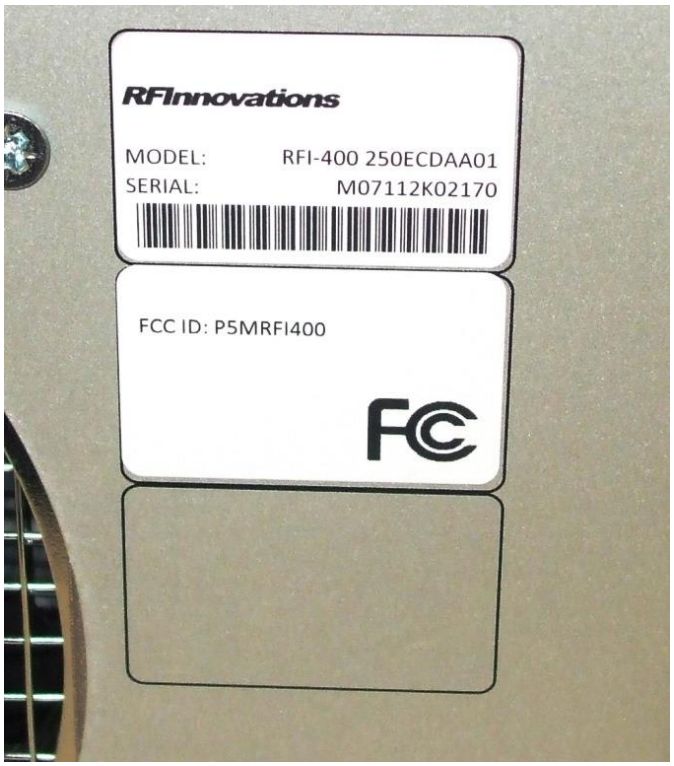
Front Face

Side Face

Side Face

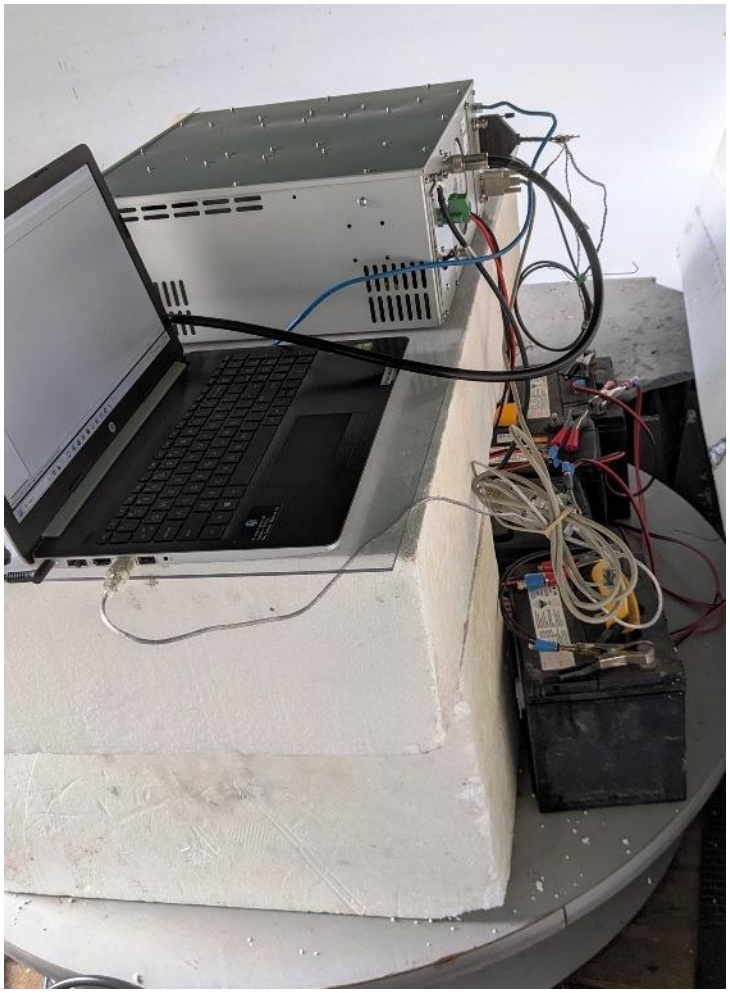
Rear Face

Label



Radiated Emissions Test Setup

Radiated Emissions Test Setup



Ancillary equipment

Test Shed showing the use of a Biconical Antenna

Test Shed showing the use of a Biconical Antenna

Test Shed showing the use of a Log Periodic Antenna

Test Shed showing the use of a Log Periodic Antenna

Test Shed showing the use of a Horn Antenna

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Dear Andrew

This letter formally acknowledges that the new Firmware with version number 4.8-F that has been supplied as part of the submission for the RFI-400 250 UHF Paging Transmitter reduces the upper limit for the Deviation Limiter for the 25KHz channels to 4500Hz. No other changes have been made to the Firmware that was originally supplied to you with the test device and its performance will be unchanged for all of the testing you have already done.

Kind Regards

Johan Svean
Managing Director

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