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TEST REPORT

RFI-400 250W 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 250W 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 May 2023 are summarised below.

Clause	Description	Result
90.203	Certification required	Noted.
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 Omid Targhagh, Johan Svean

5. TEST SAMPLE DESCRIPTION

Brand Name RFI-400 250W UHF Paging Transmitter

Model Number RFI-400 250PCDA01

Product UHF Transceiver

Manufacturer STI Engineering

Manufactured in Australia

Serial Number M07112K02128

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
452.100	250.0	12.5, 25.0	POCSAG:512/1200/2400 (2FSK) FLEX:1600/3200 (2FSK) & 3200/6400 (4FSK)
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: 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):

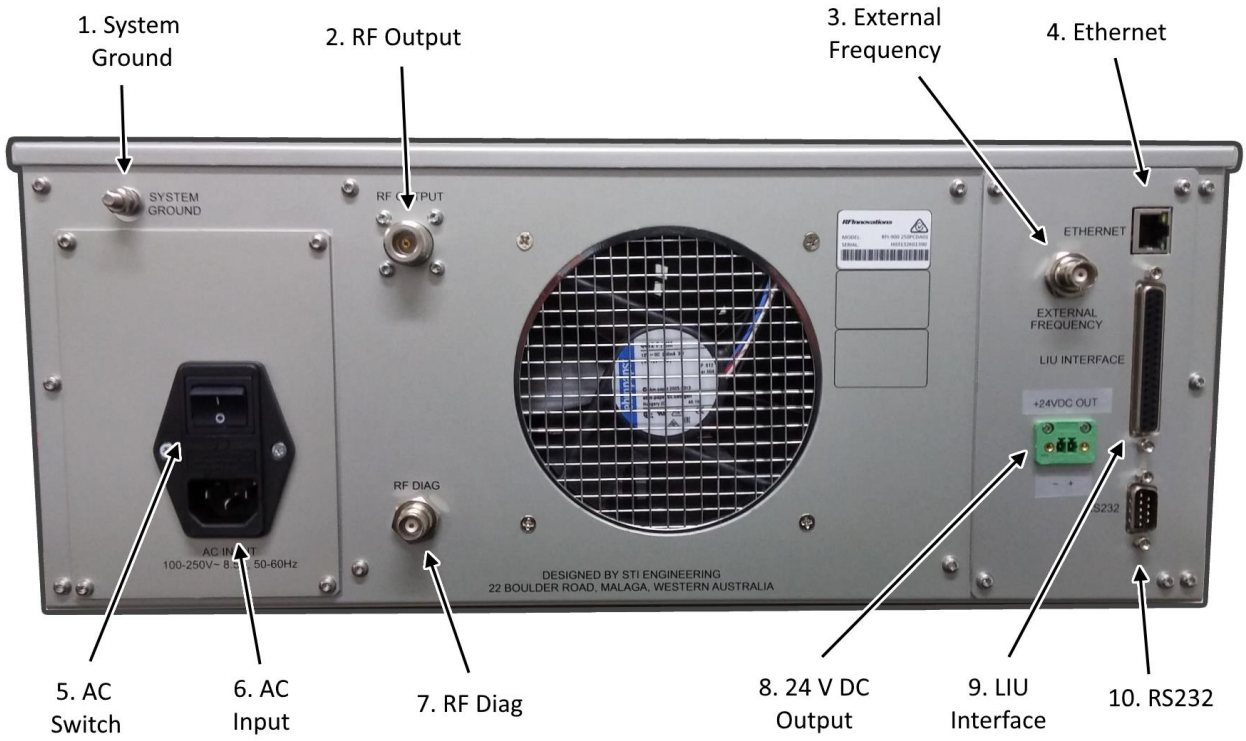
The RFI-400 is a high power output paging transmitters operating in the UHF band.

Some of the products features are indicated as below:

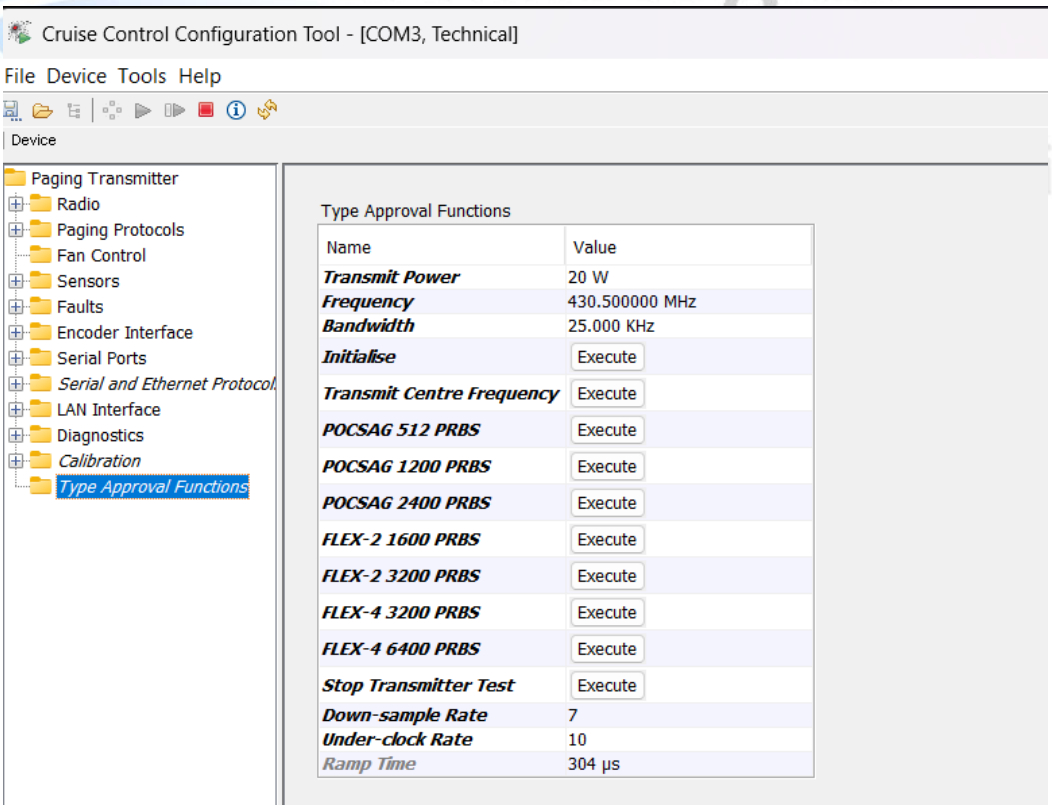
- RFI-400: UHF band operation (450 MHz – 470 MHz) with 3 MHz switching bandwidth
- 250 W (54 dBm) maximum transmit power
- Compatible with:
  POCSAG 512, 1200, 2400 bps (2-level FSK).

  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.



Paging Transmitter Back Panel (AC model shown)



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, the 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 452.0-455.0 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.

- The product does not support voice capability and 6.25 kHz channel bandwidth. Compliance to Part 90.203(j) (10) has been applied.

(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 (Vac)	Carrier Power (dBm)		
		+22˚ C	+50˚ C	-30˚ C
452.100	+15% of Vac	53.6	53.6	53.7
	Vac	53.5	53.6	53.7
	-15% of Vac	53.5	53.6	53.7
454.900	+15% of Vac	53.6	53.6	53.6
	Vac	53.5	53.6	53.6
	-15% of Vac	53.4	53.6	53.6

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: F1D, these have been elaborated as under:

POCSAG: 512/1200/2400 (2FSK)
FLEX: 1600/3200 (2FSK) & 3200/6400 (4FSK)

Following emission designators have been specified by the client:

Emission Type	Emission Designator for 12.5 kHz	Emission Designator for 25.0 kHz
POCSAG 512 bps	5K63F1D	10K7F1D
POCSAG 1200 bps	6K18F1D	11K0F1D
POCSAG 2400 bps	7K15F1D	11K9F1D
FLEX 1600 bps	6K72F1D	11K8F1D
FLEX 3200 bps	6K99F1D	12K9F1D
FLEX 3200 bps	6K42F1D	11K4F1D
FLEX 6400 bps	7K04F1D	12K6F1D

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

Measurement results:

Emission Type- 12.5 kHz spacing.

Modulation Type	Emission Tested	Frequency (MHz)	Measured (kHz)	Authorised Bandwidth
2-level FSK	POCSAG 512 bps	452.100	5.629	11.200 kHz
2-level FSK	POCSAG 1200 bps	452.100	6.178	
2-level FSK	POCSAG 2400 bps	452.100	7.154	
2-level FSK	FLEX 1600 bps	452.100	6.724	
2-level FSK	FLEX 3200 bps	452.100	6.994	
4-level FSK	FLEX 3200 bps	452.100	6.421	
4-level FSK	FLEX 6400 bps	452.100	7.041	

Emission Type- 25.0 kHz spacing.

Modulation Type	Emission Tested	Frequency (MHz)	Measured (kHz)	Authorised Bandwidth
2-level FSK	POCSAG 512 bps	452.100	10.712	20.000 kHz
2-level FSK	POCSAG 1200 bps	452.100	11.036	
2-level FSK	POCSAG 2400 bps	452.100	11.857	
2-level FSK	FLEX 1600 bps	452.100	11.795	
2-level FSK	FLEX 3200 bps	452.100	12.756	
4-level FSK	FLEX 3200 bps	452.100	11.423	
4-level FSK	FLEX 6400 bps	452.100	12.135	

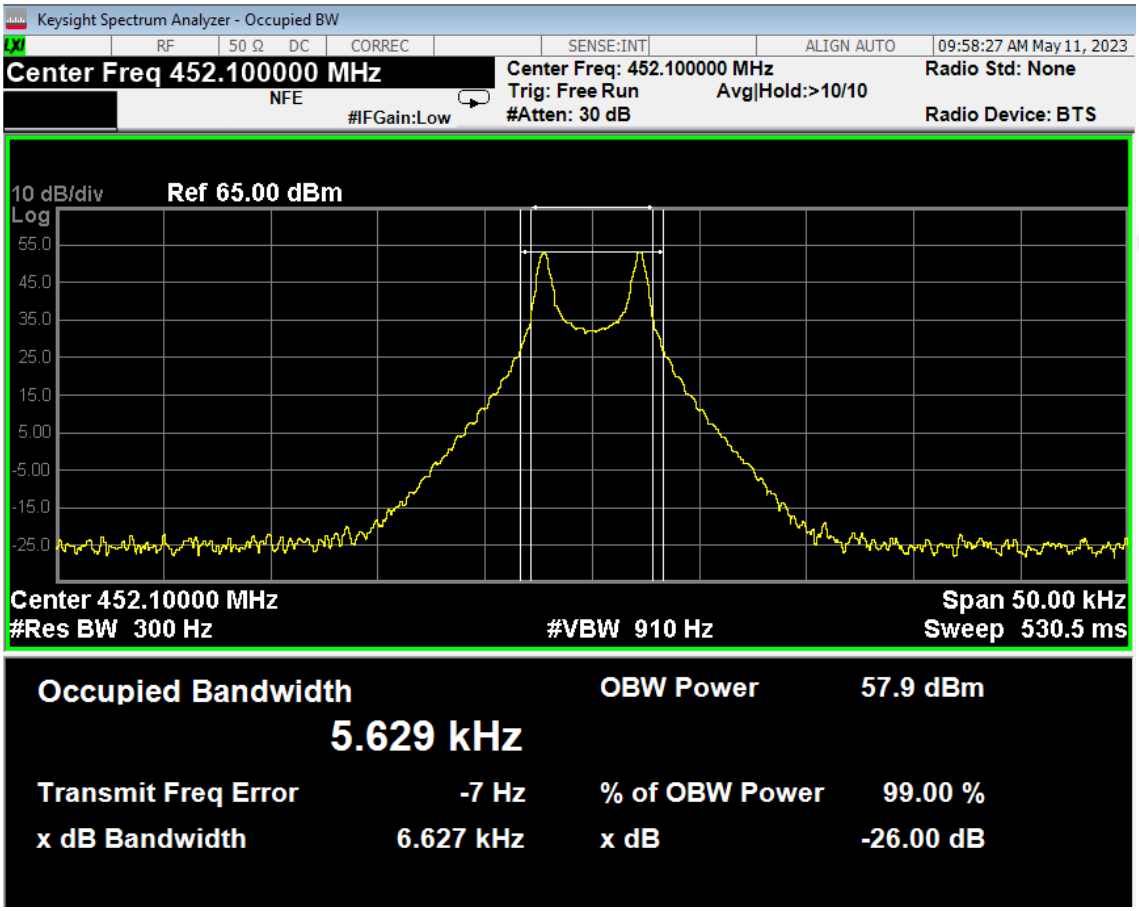
Emission Type- 25.0 kHz spacing.

Modulation Type	Emission Tested	Frequency (MHz)	Measured (kHz)	Authorised Bandwidth
2-level FSK	POCSAG 512 bps	454.900	10.694	20.000 kHz
2-level FSK	POCSAG 1200 bps	454.900	10.980	
2-level FSK	POCSAG 2400 bps	454.900	11.678	
2-level FSK	FLEX 1600 bps	454.900	11.795	
2-level FSK	FLEX 3200 bps	454.900	12.925	
4-level FSK	FLEX 3200 bps	454.900	11.404	
4-level FSK	FLEX 6400 bps	454.900	12.552	

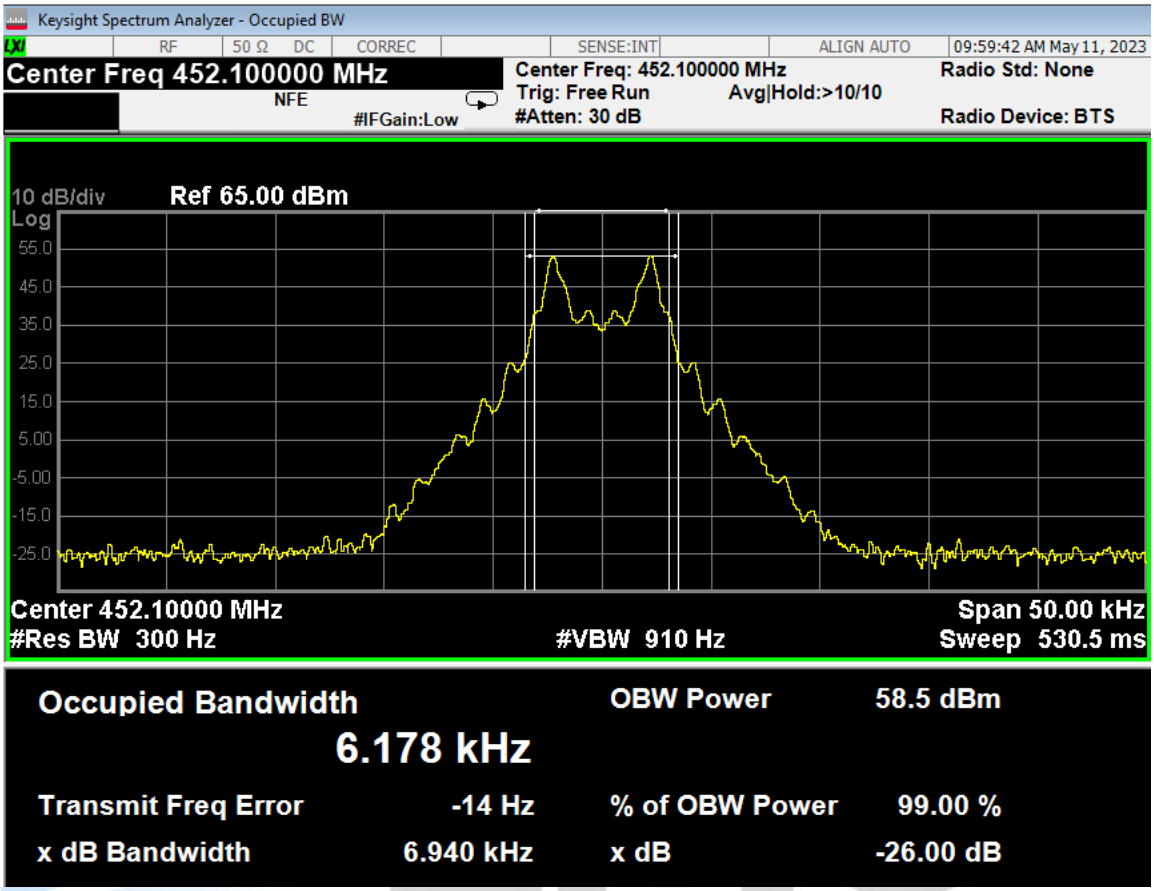
- Limited number of plots has been supplied in the test report for better readability.

Measurement Plots:

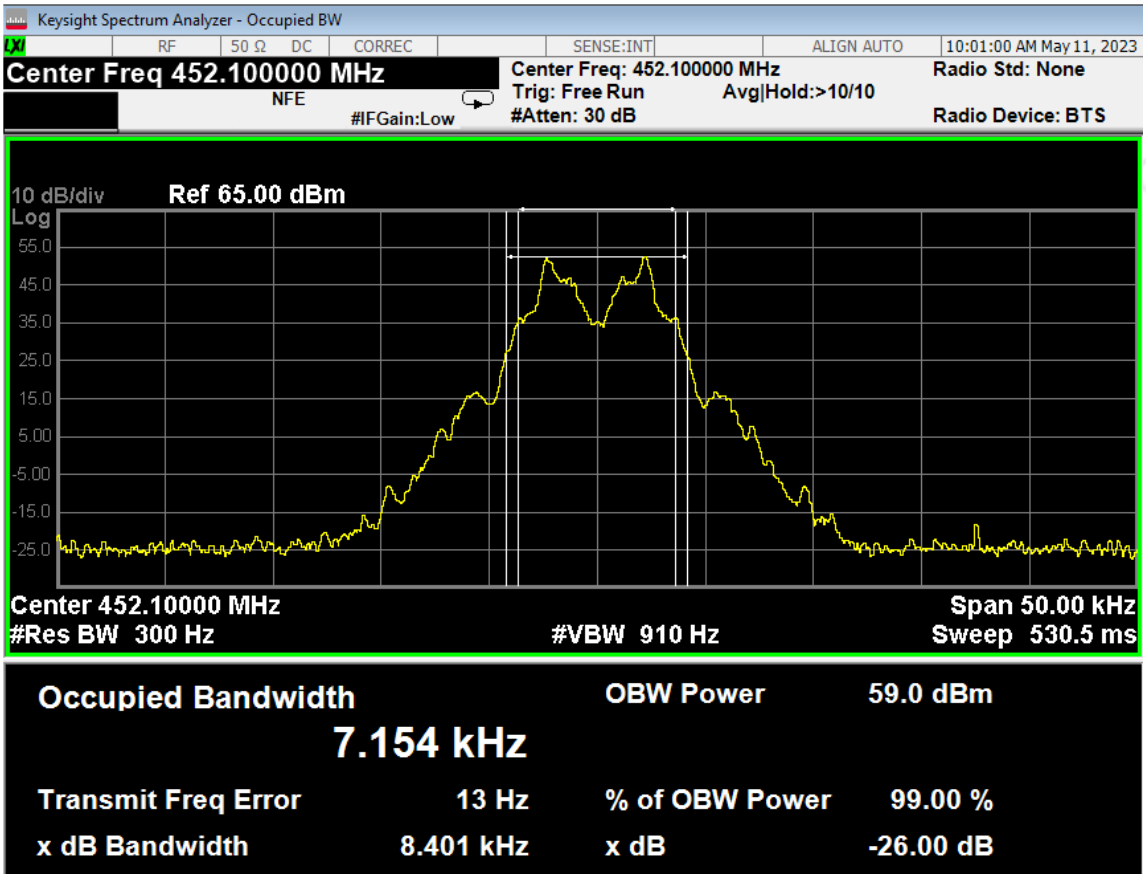
12.5 kHz Channel/2-level FSK/ POCSAG 512 bps/452.100 MHz



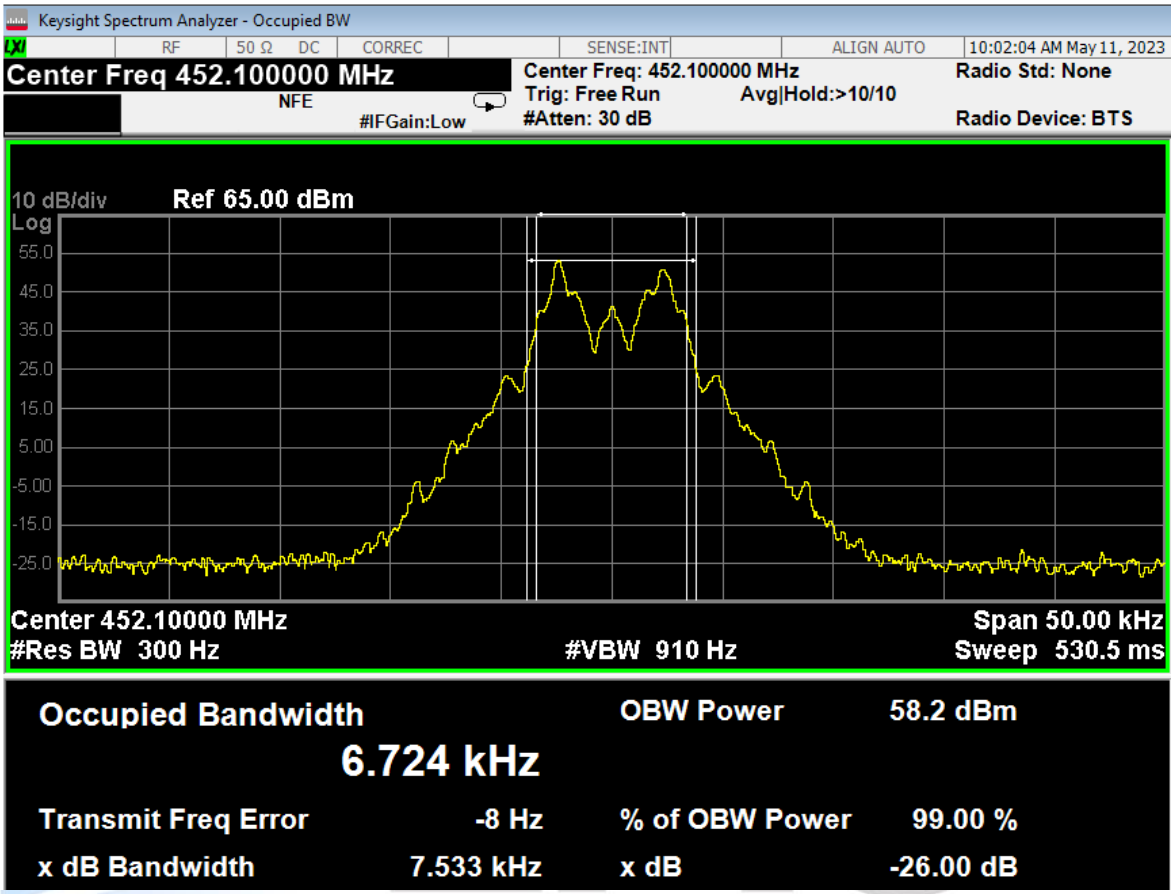
12.5 kHz Channel/2-level FSK/ POCSAG 1200 bps/452.100 MHz



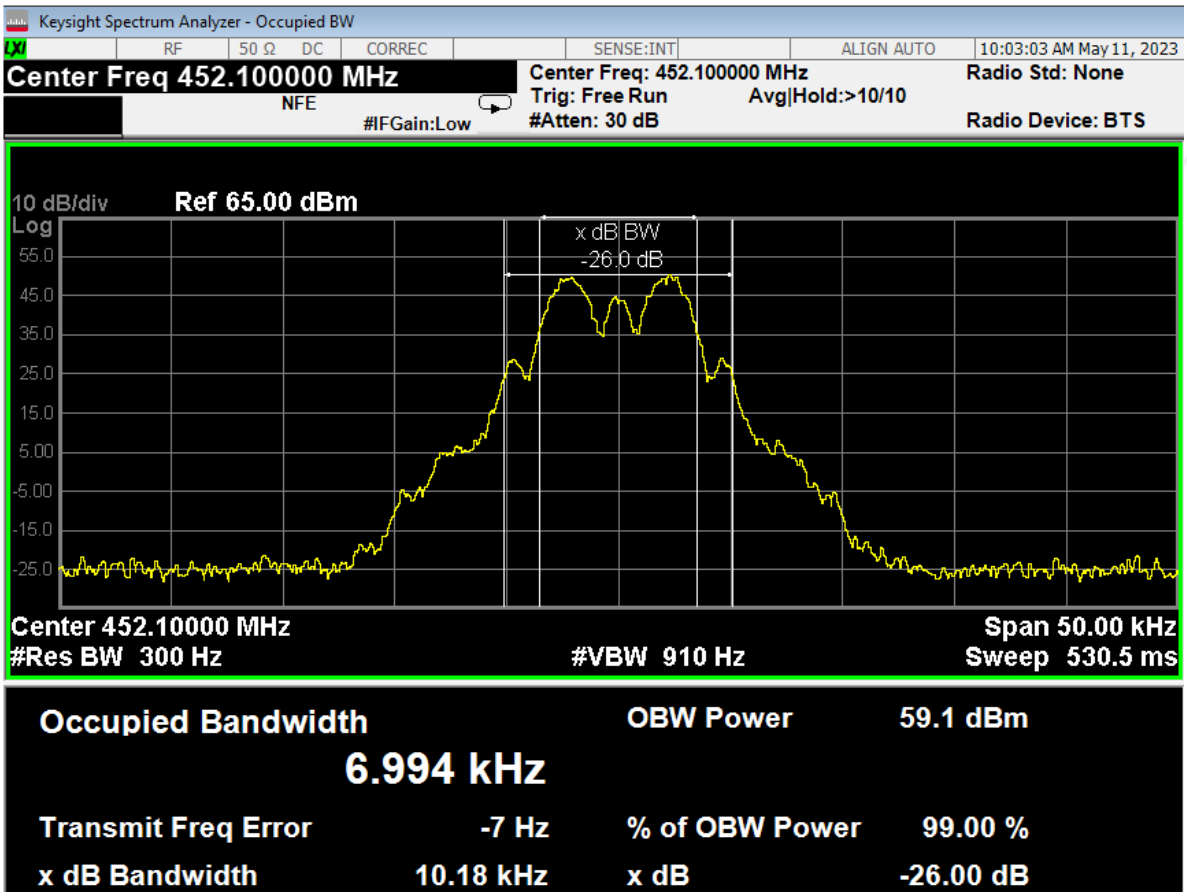
12.5 kHz Channel/2-level FSK/ POCSAG 2400 bps/452.100 MHz



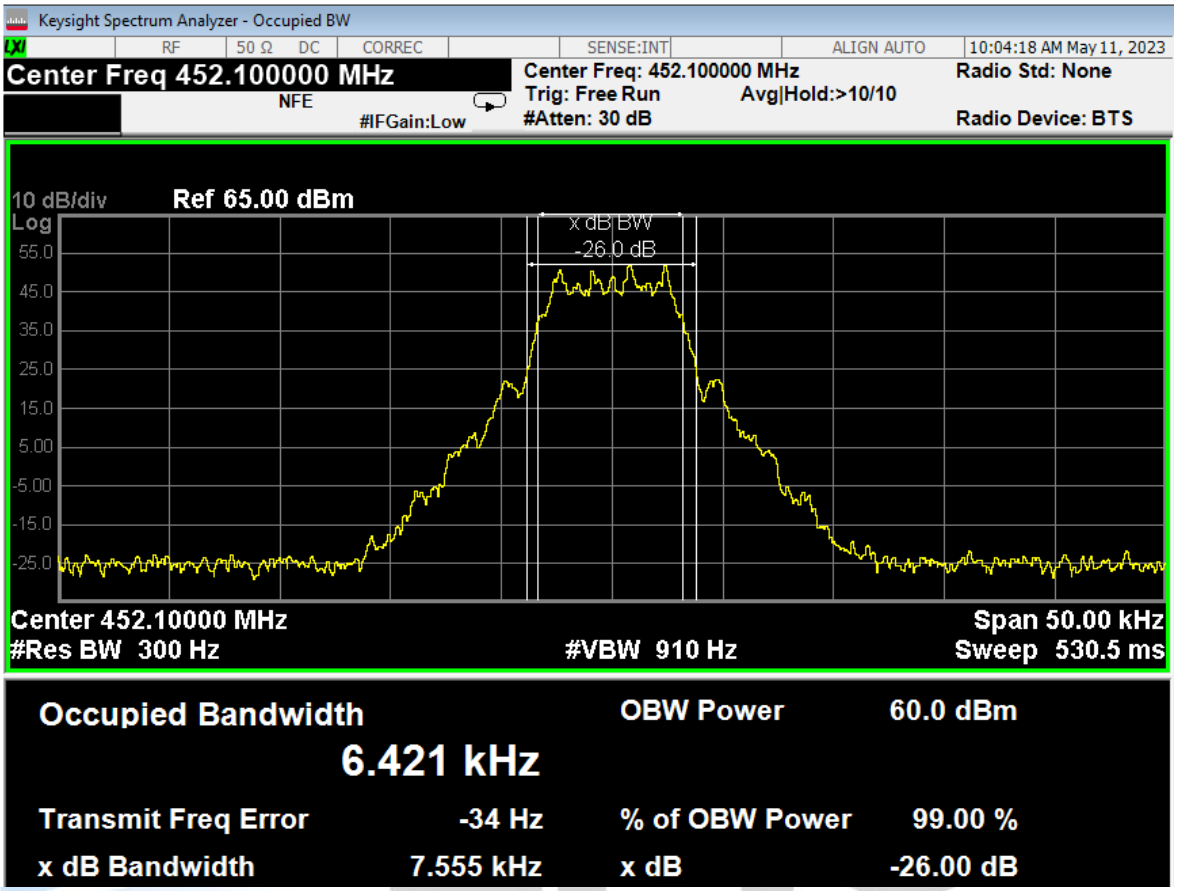
12.5 kHz Channel/2-level FSK/ FLEX 1600 bps/452.100 MHz



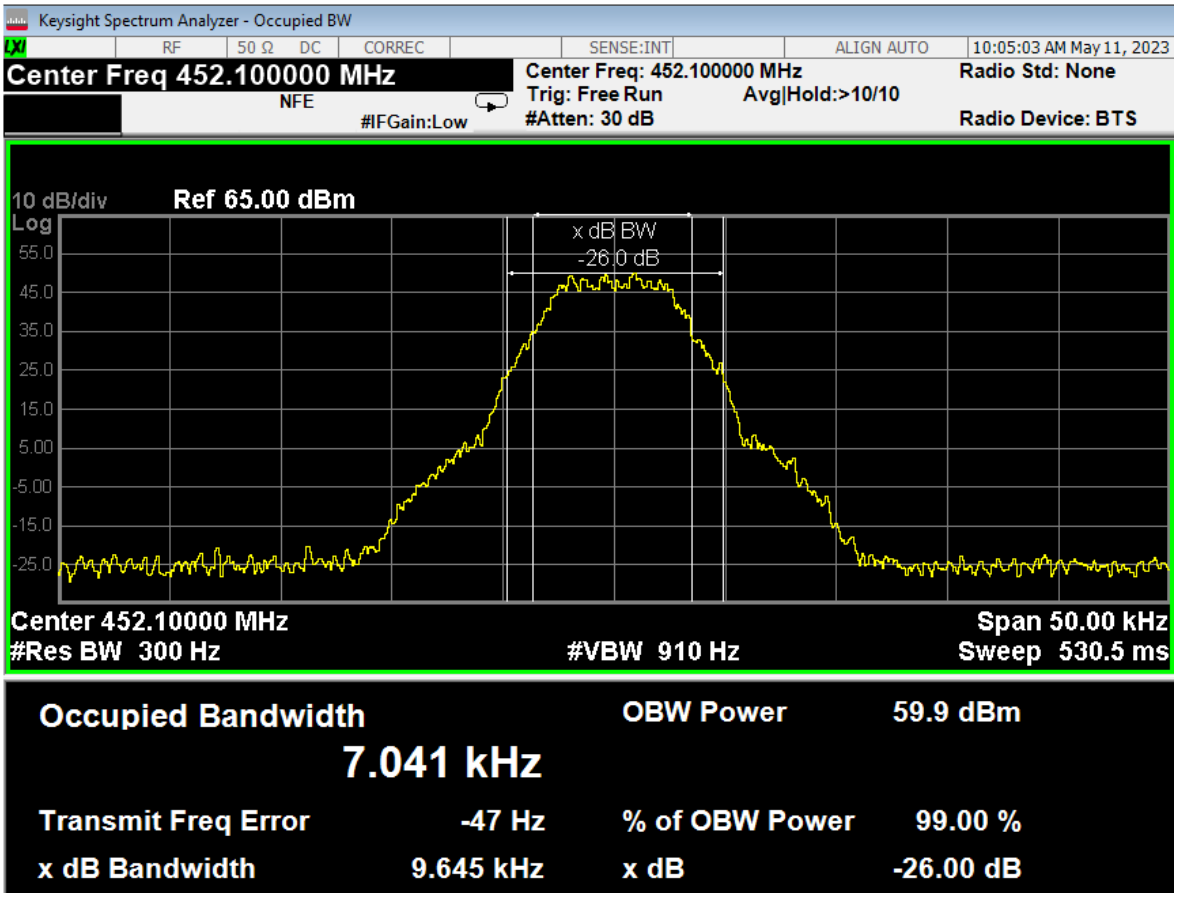
12.5 kHz Channel/2-level FSK/ FLEX 3200 bps/452.100 MHz



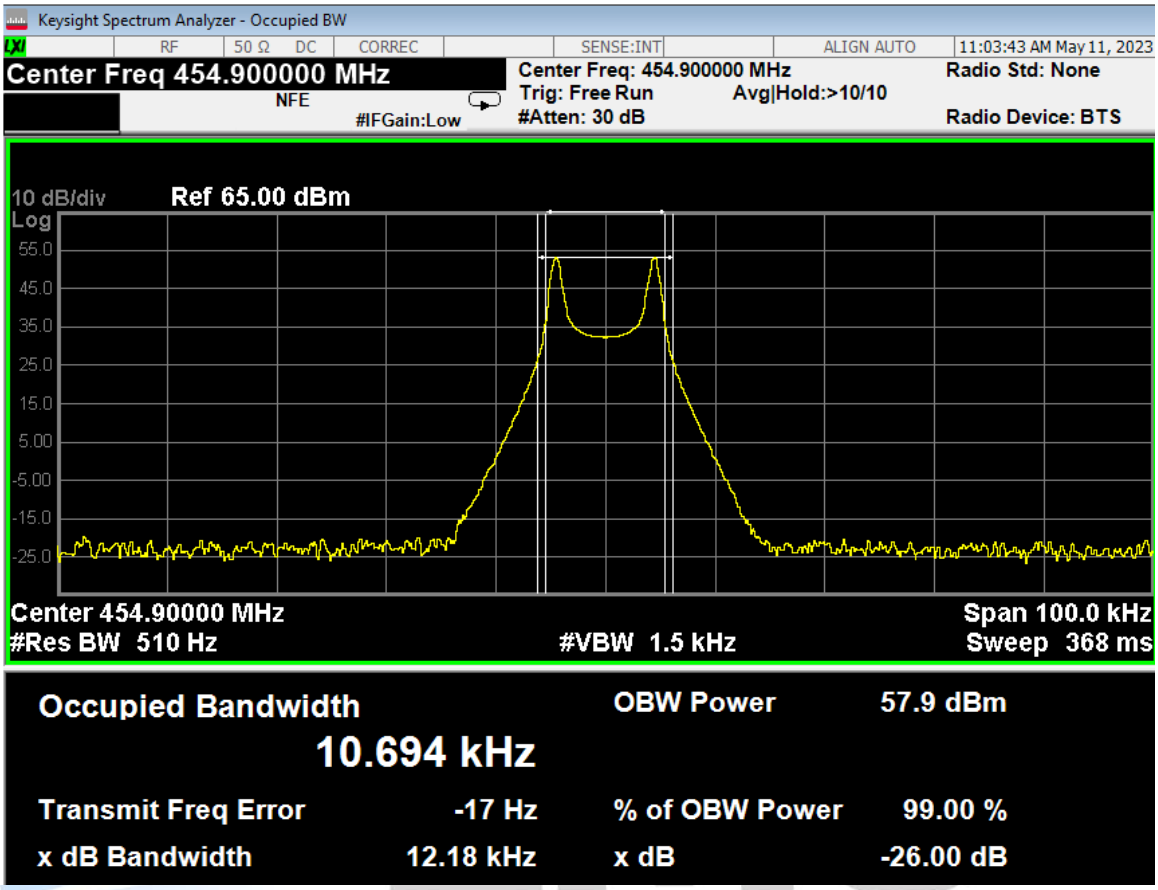
12.5 kHz Channel/4-level FSK/ FLEX 3200 bps/452.100 MHz



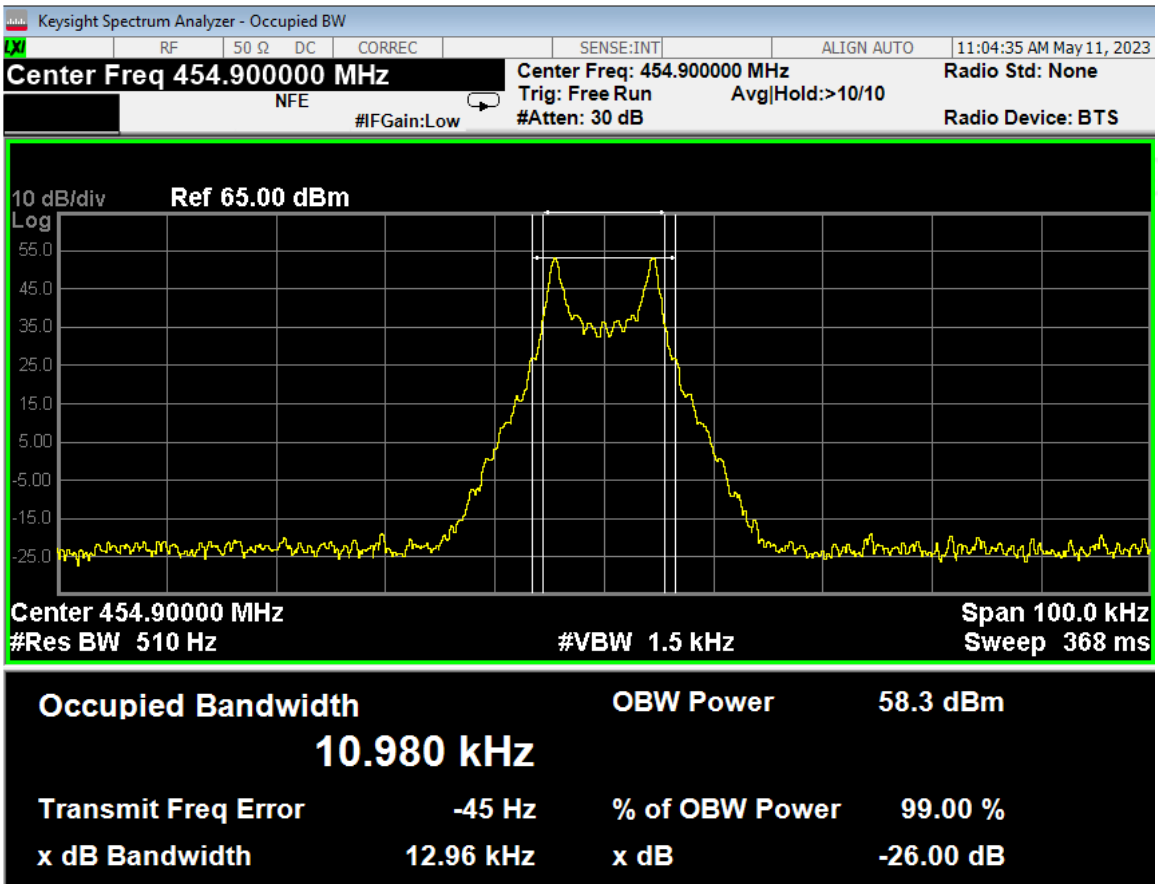
12.5 kHz Channel/4-level FSK/ FLEX 6400 bps/452.100 MHz



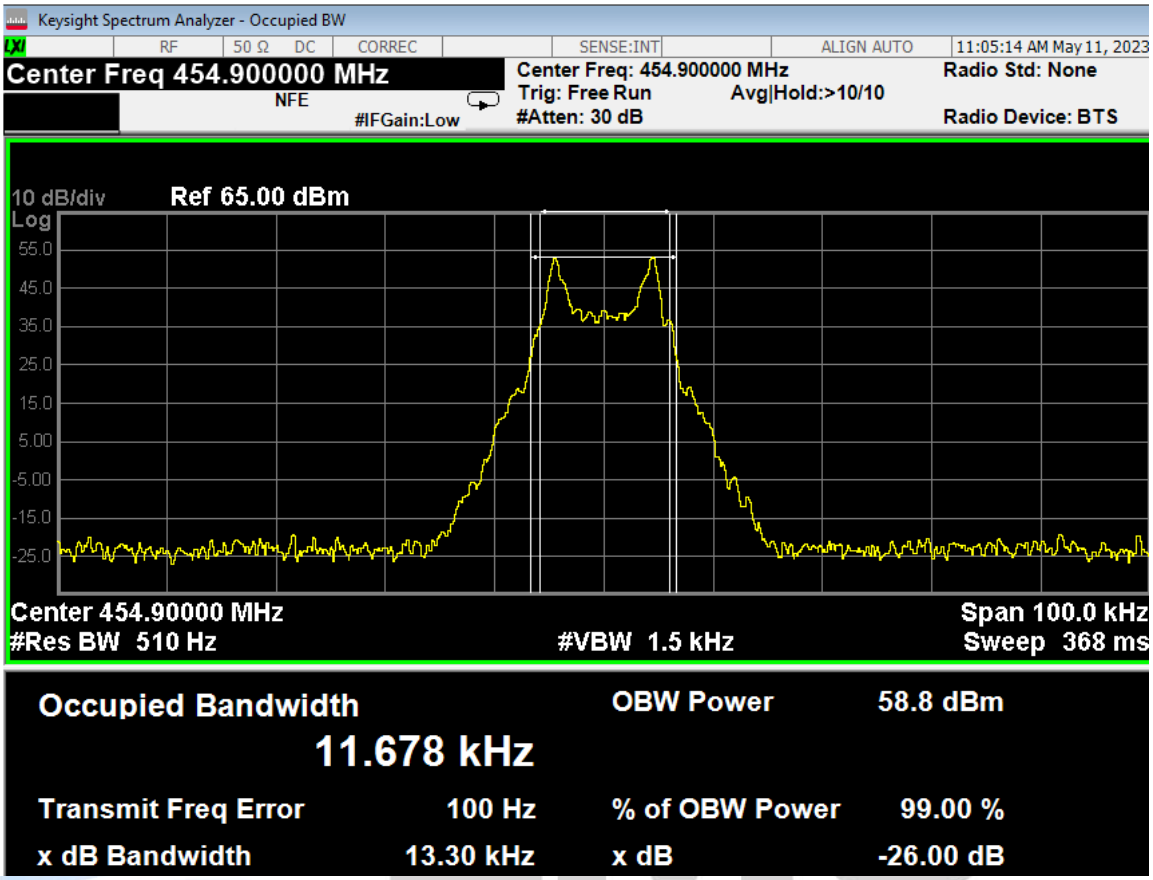
25.0 kHz Channel/2-level FSK/ POCSAG 512 bps/454.900 MHz



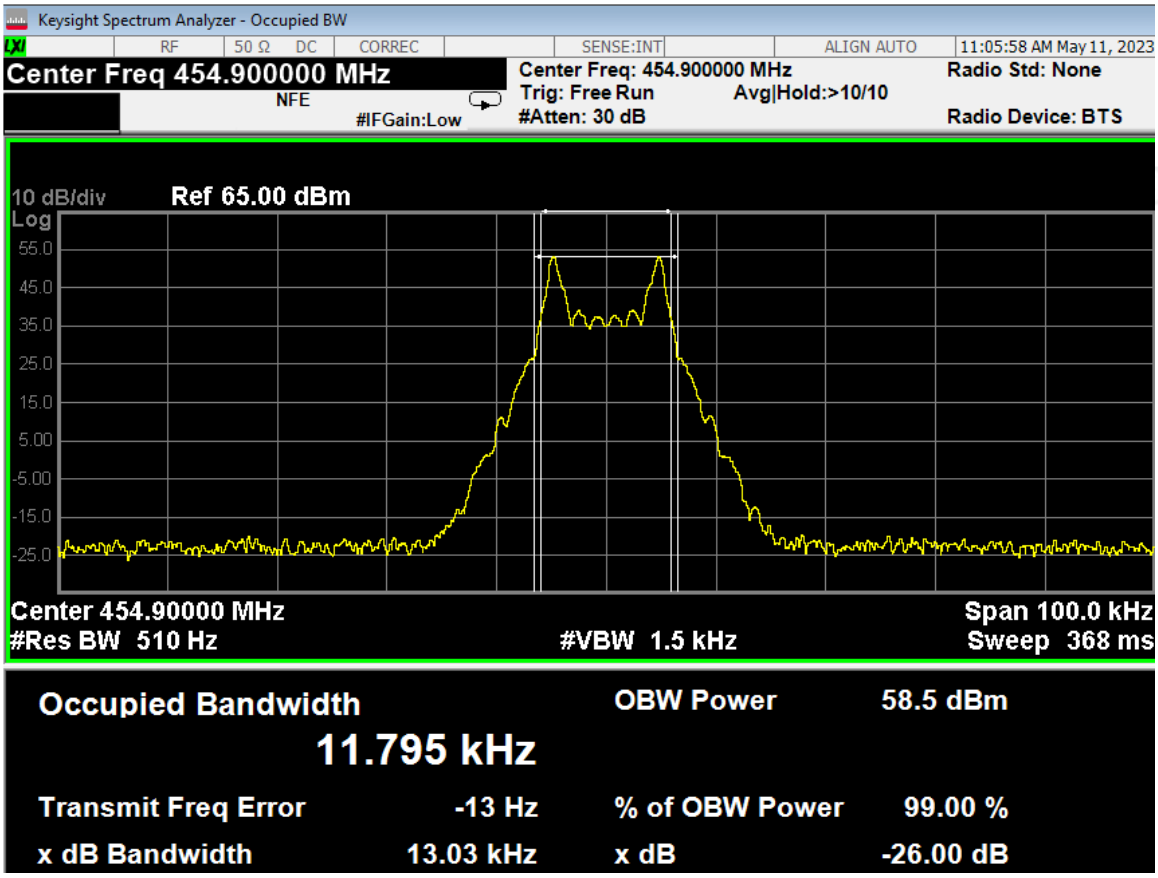
25.0 kHz Channel/2-level FSK/ POCSAG 1200 bps/454.900 MHz



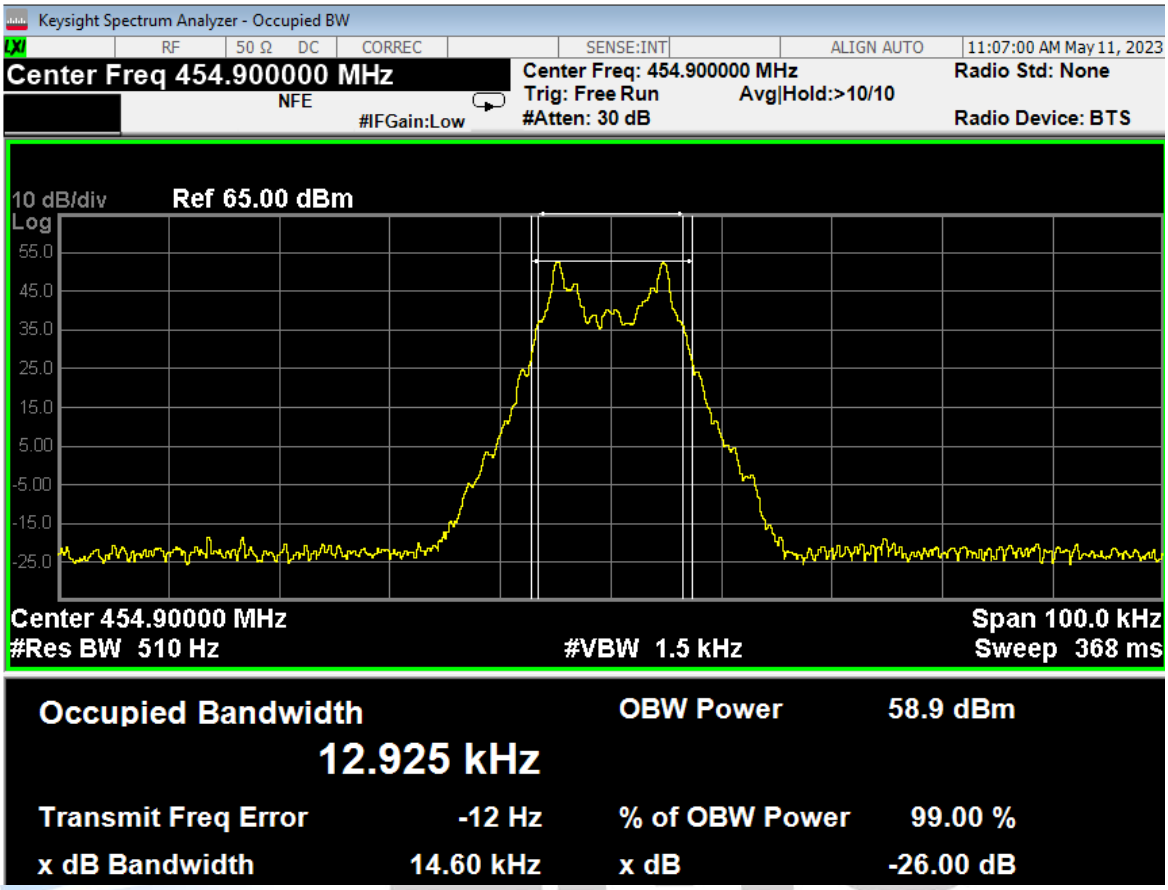
25.0 kHz Channel/2-level FSK/ POCSAG 2400 bps/454.900 MHz



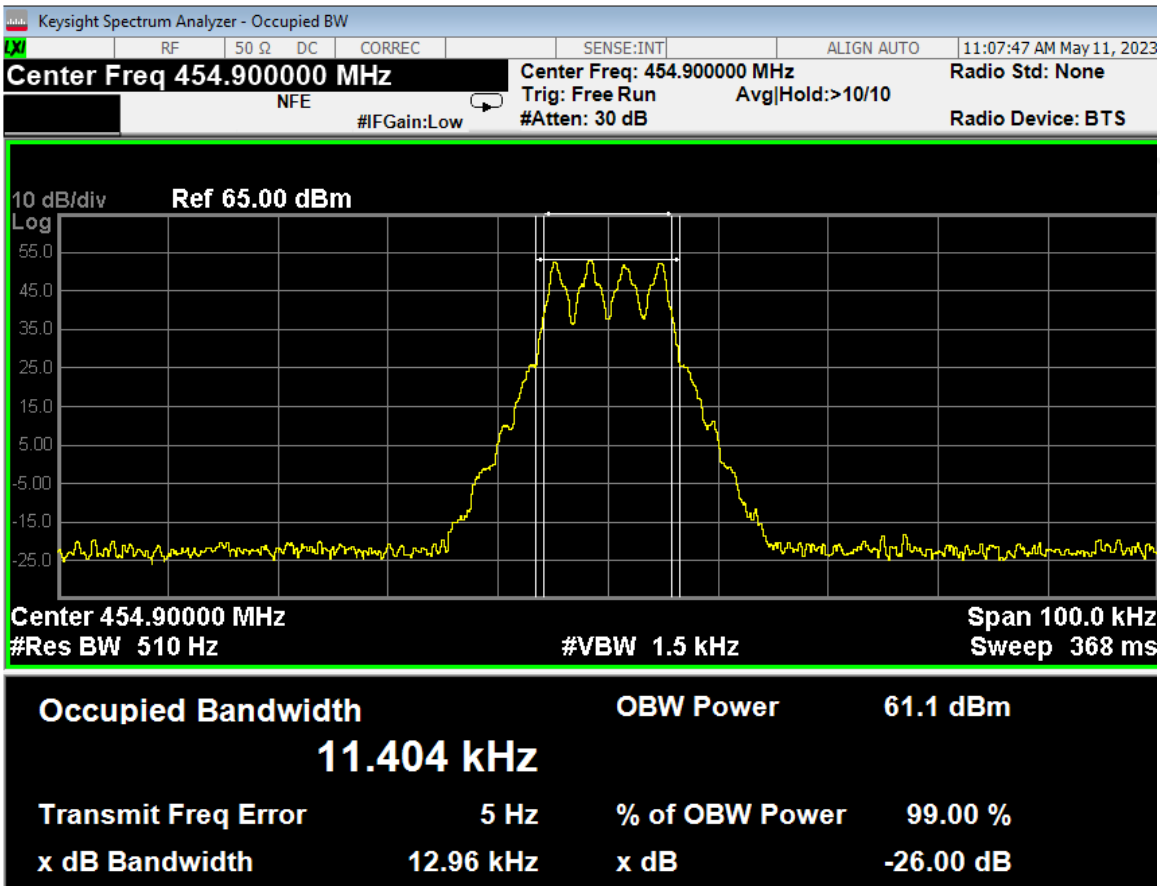
25.0 kHz Channel/2-level FSK/ FLEX 1600 bps/454.900 MHz



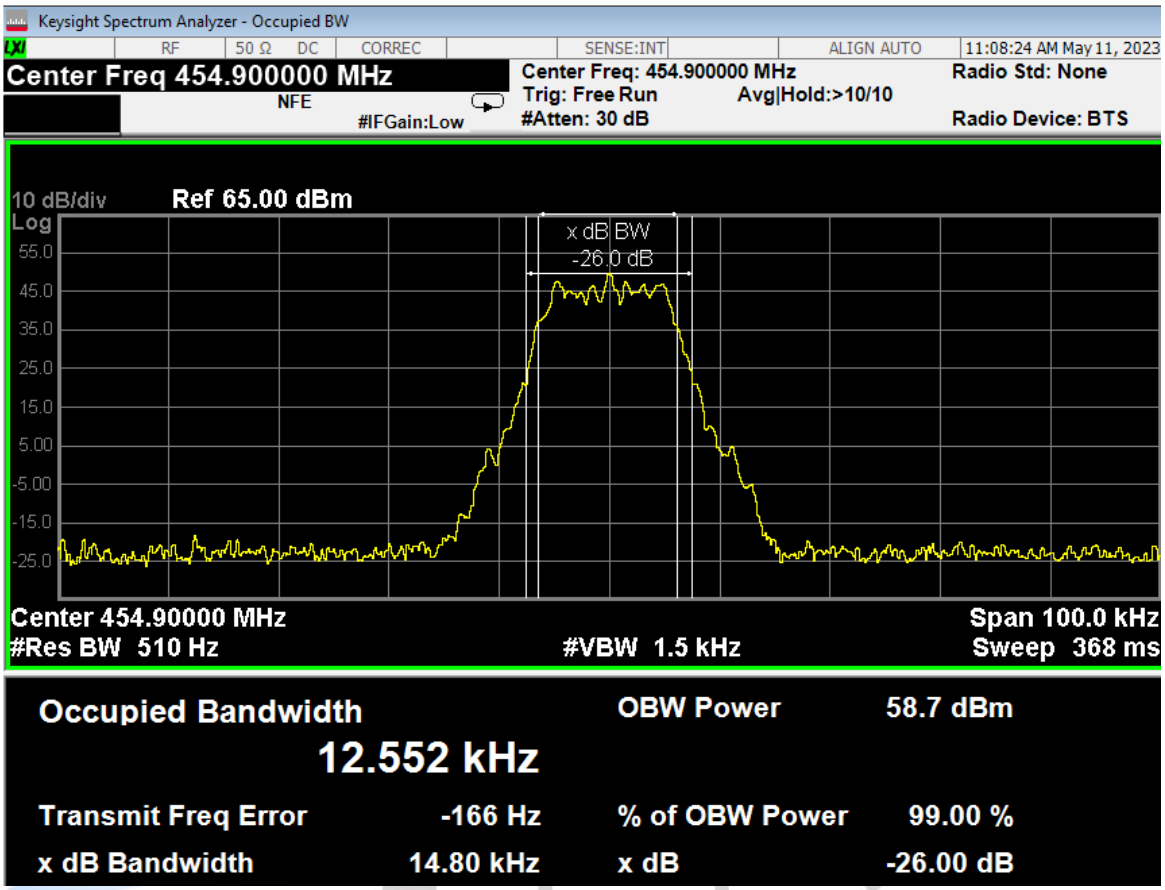
25.0 kHz Channel/2-level FSK/ FLEX 3200 bps/454.900 MHz



25.0 kHz Channel/4-level FSK/ FLEX 3200 bps/454.900 MHz



25.0 kHz Channel/4-level FSK/ FLEX 6400 bps/454.900 MHz



§90.210 Spectrum Emission Masks

The spectrum masks are defined in:

As per the client, the product does not have audio filters, Section 90.210(d) – Mask D and C 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).

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.

The product is specifically for the 452.000-455.000 MHz range and the client is seeking certification for that narrow band. For showing compliance of the product to emission masks plots at various modulation and channel bandwidths when the product was operating on 453.000 MHz have been presented in the test report.

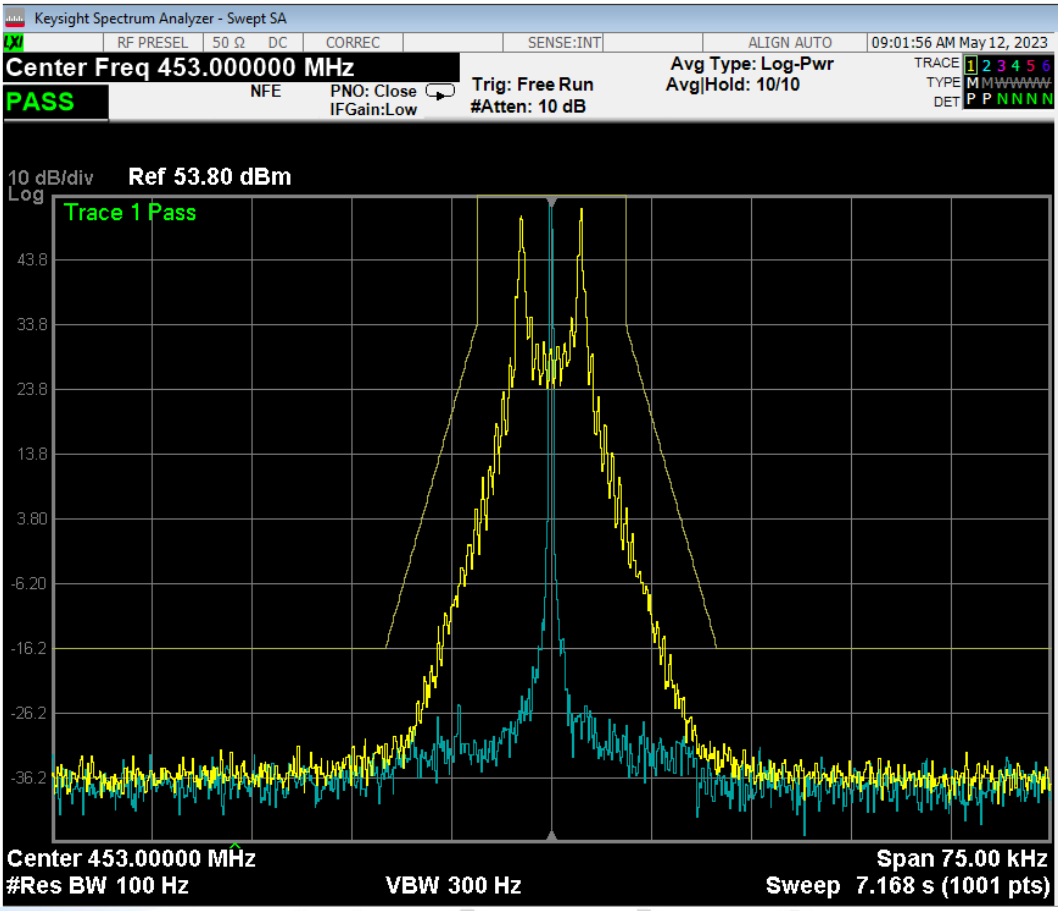
The blue trace corresponds to unmodulated carrier only output. The yellow trace corresponds to modulated output from the product.

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

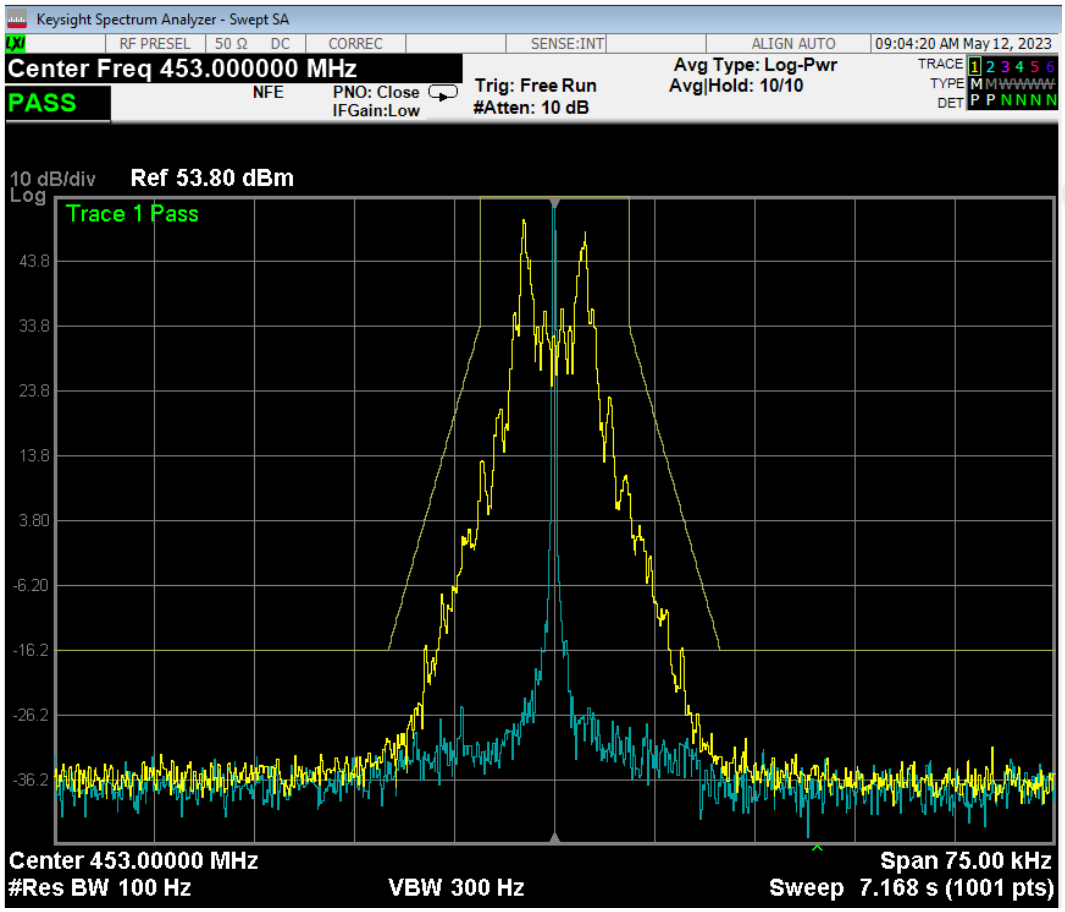
Result: Complies.

12.5 kHz Channel bandwidth emission mask-D

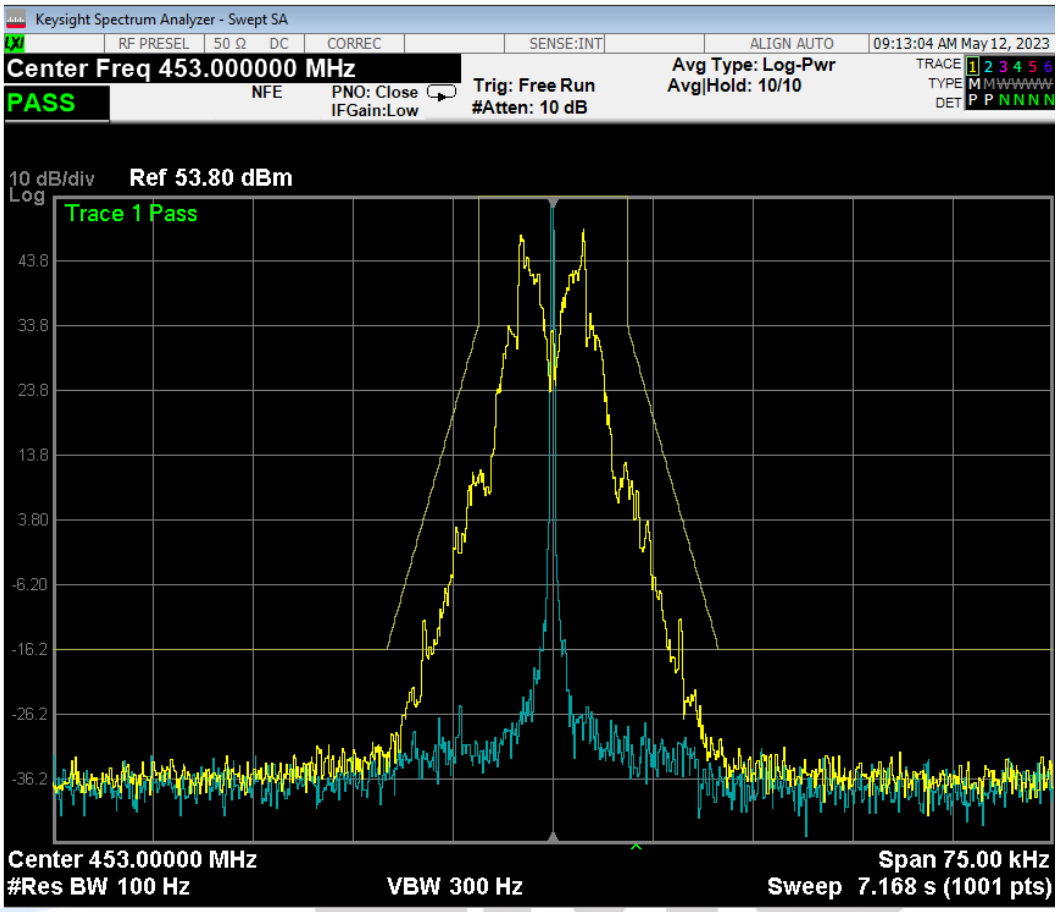
Mask-D/12.5 kHz Channel/2-level FSK/ POCSAG 512 bps/453.000 MHz



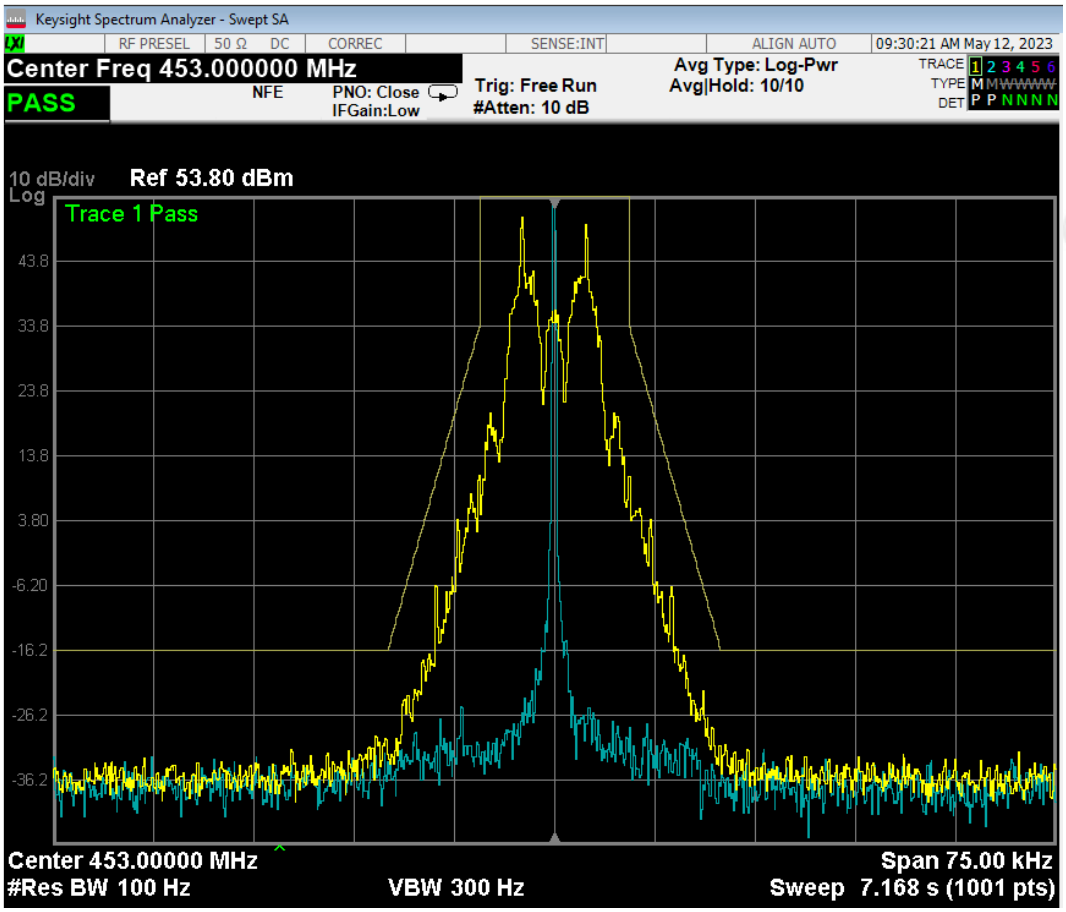
Mask-D/12.5 kHz Channel/2-level FSK/ POCSAG 1200 bps /453.000 MHz



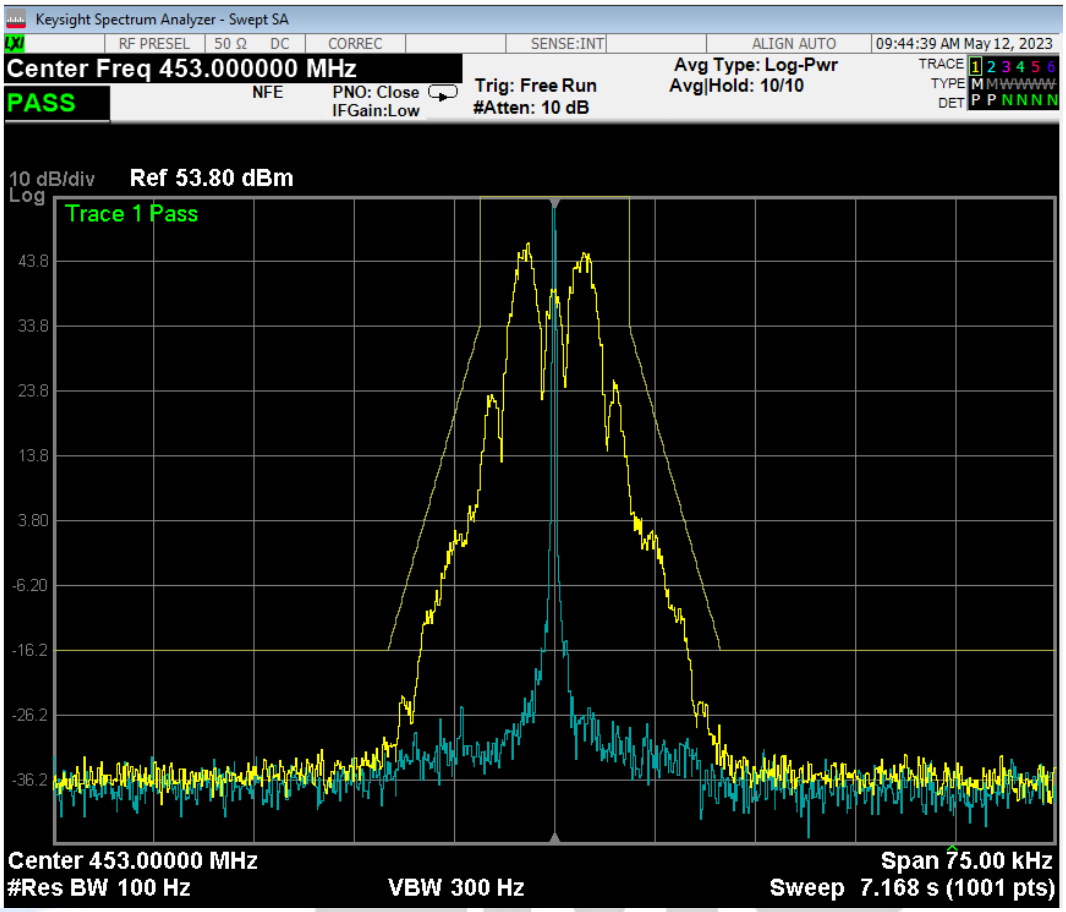
Mask-D/12.5 kHz Channel/2-level FSK/ POCSAG 2400 bps /453.000 MHz



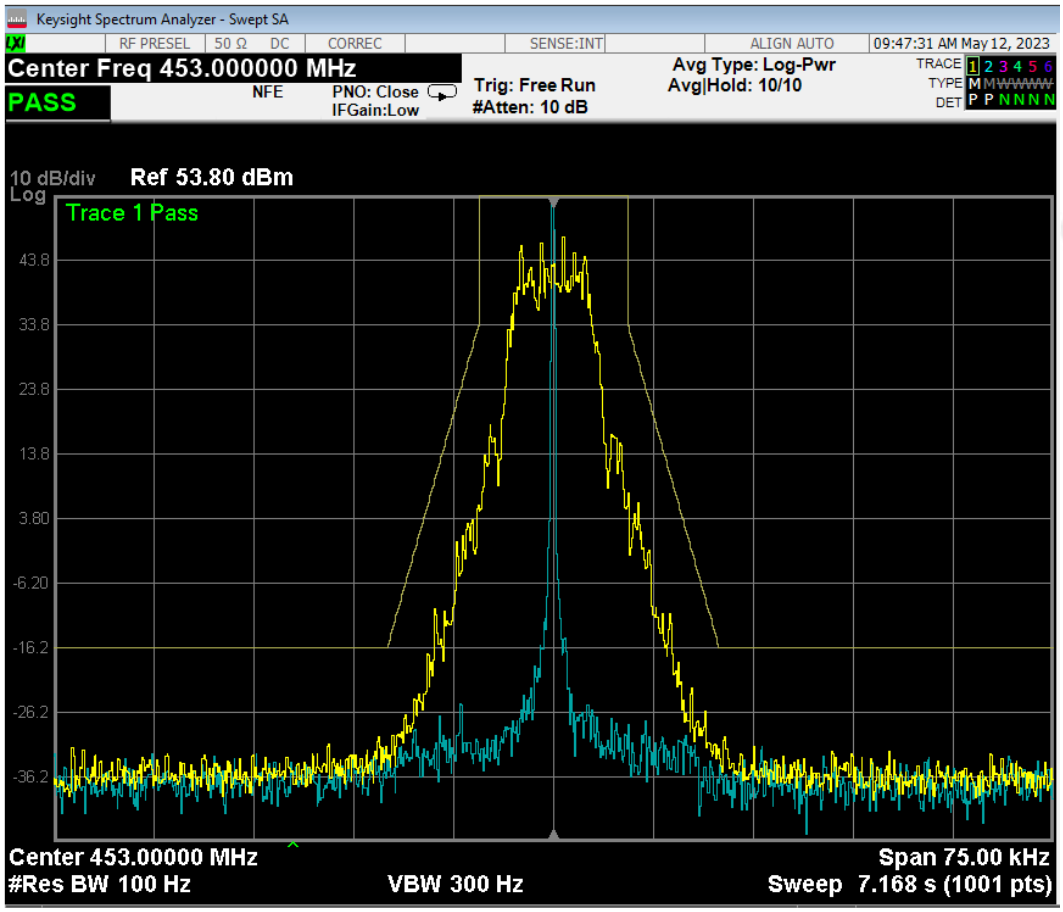
Mask-D/12.5 kHz Channel/2-level FSK/ FLEX 1600 bps/453.000 MHz



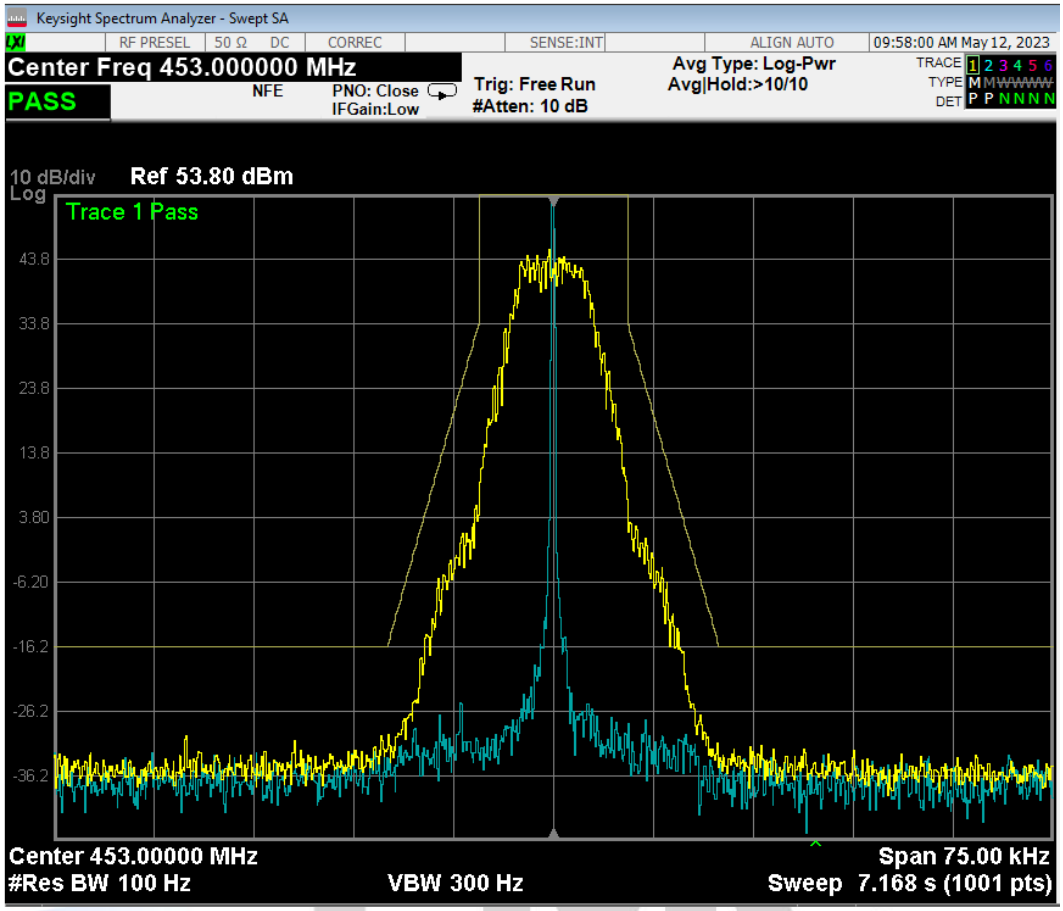
Mask-D/12.5 kHz Channel/2-level FSK/ FLEX 3200 bps/453.000 MHz



Mask-D/12.5 kHz Channel/4-level FSK/ FLEX 3200 bps/453.000 MHz

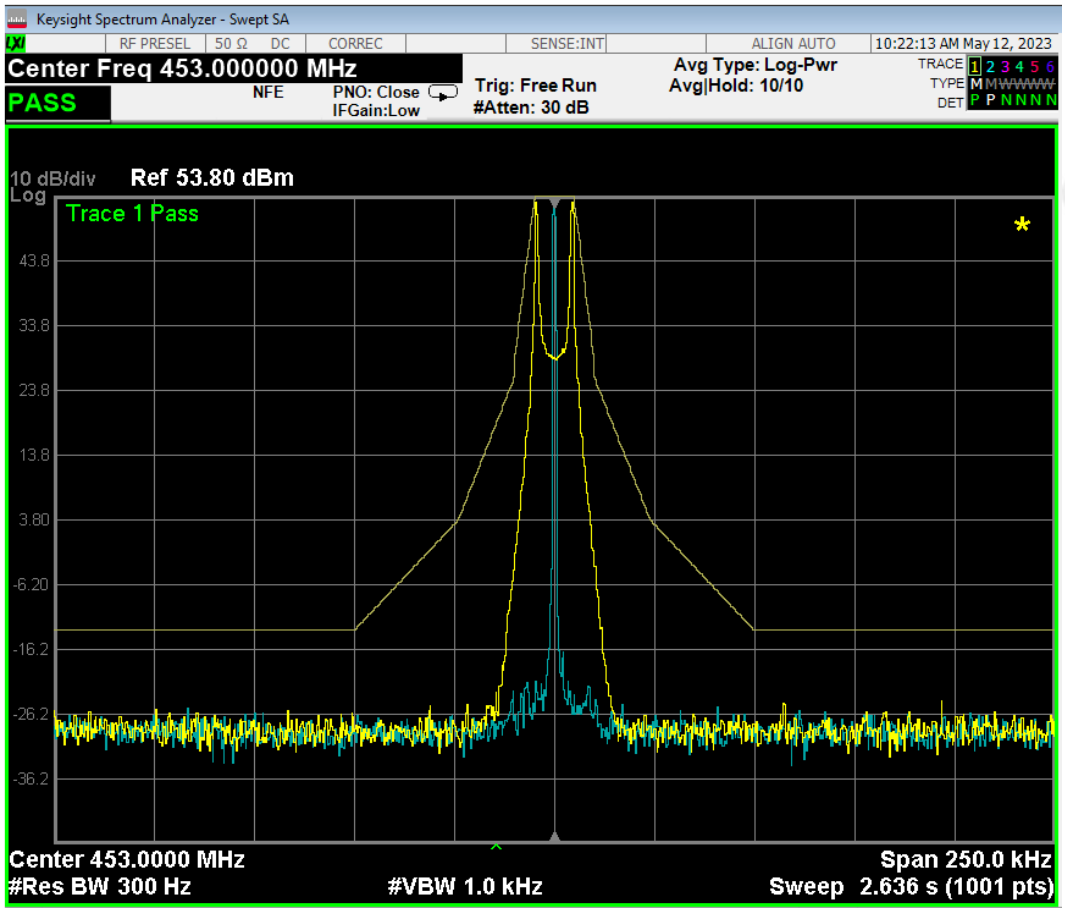


Mask-D/12.5 kHz Channel/4-level FSK/ FLEX 6400 bps/453.000 MHz

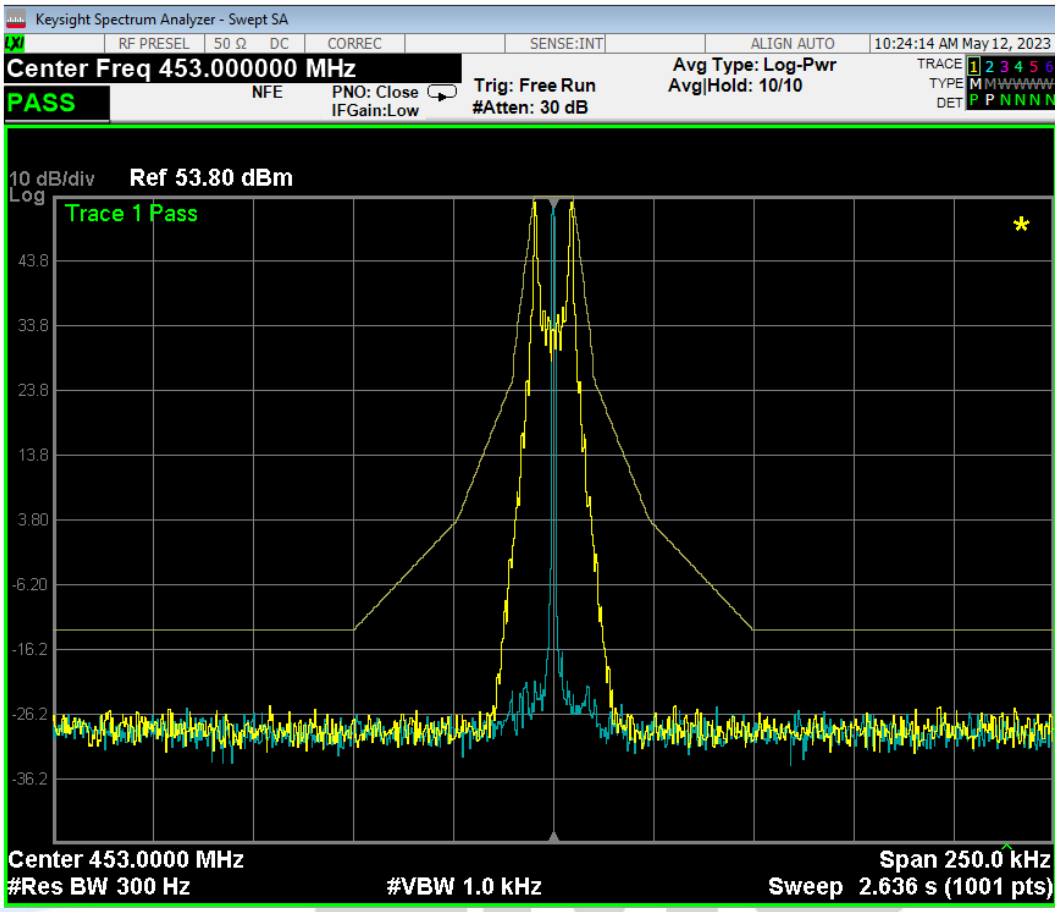


25.0 kHz Channel bandwidth emission mask-C

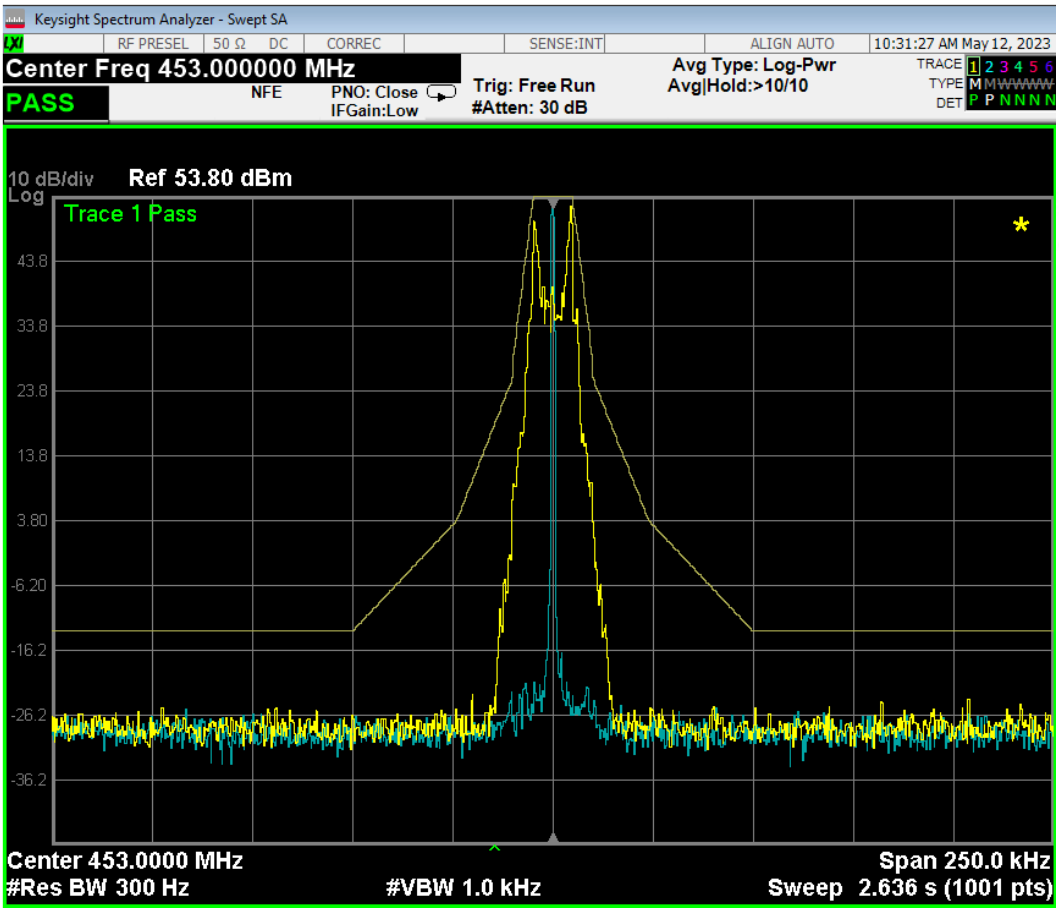
Mask-C/25.0 kHz Channel/2-level FSK/ POCSAG 512 bps/453.000 MHz



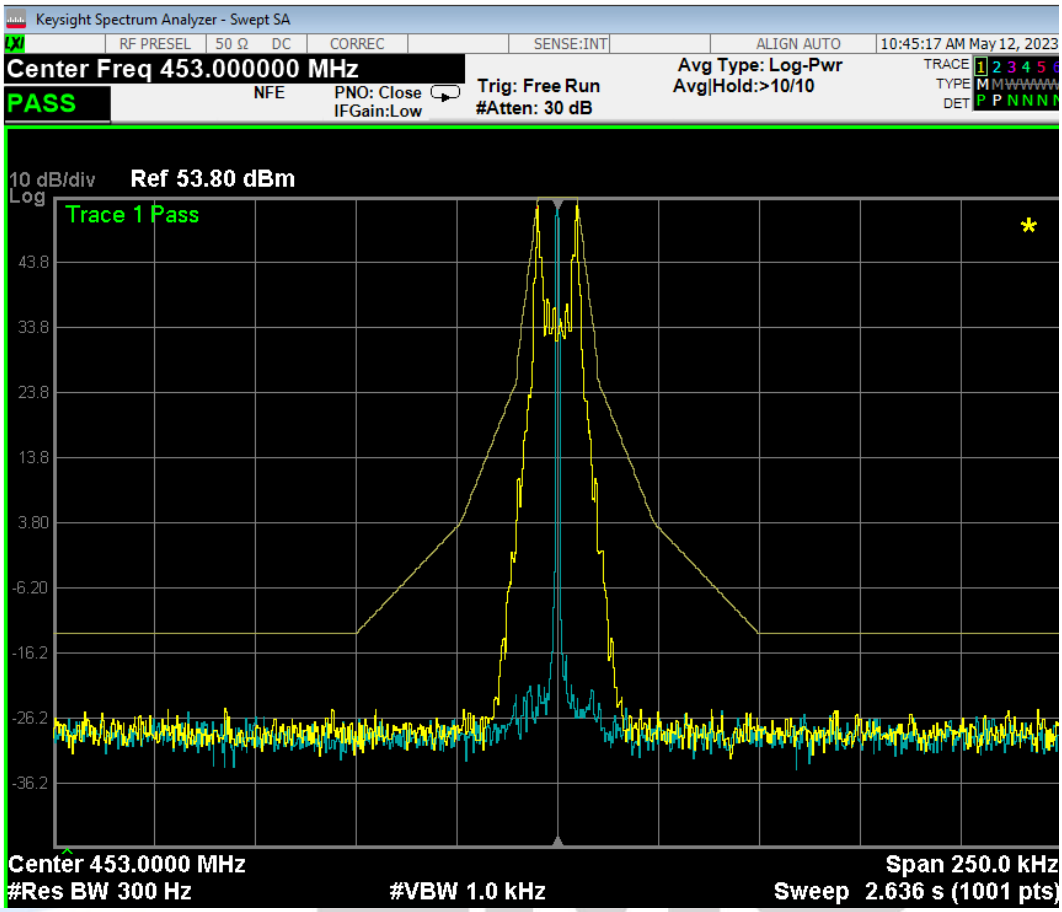
Mask-C/25.0 kHz Channel/2-level FSK/ POCSAG 1200 bps /453.000 MHz



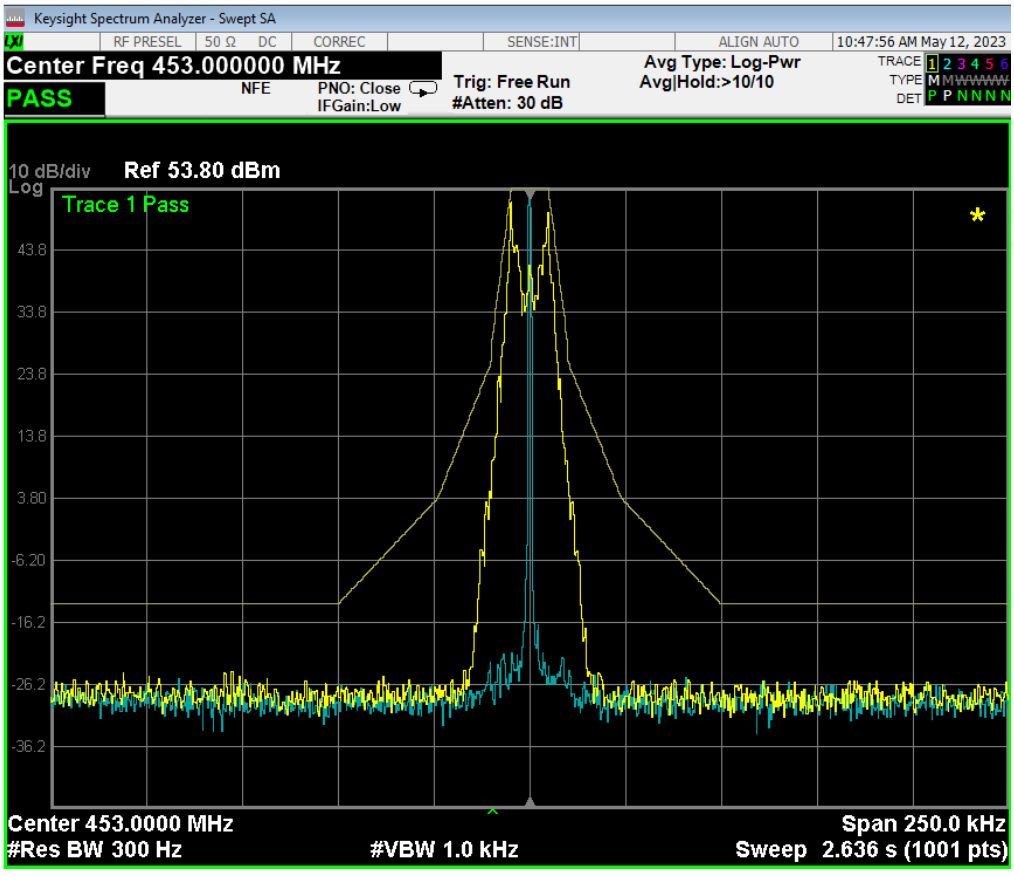
Mask-C/25.0 kHz Channel/2-level FSK/ POCSAG 2400 bps /453.000 MHz



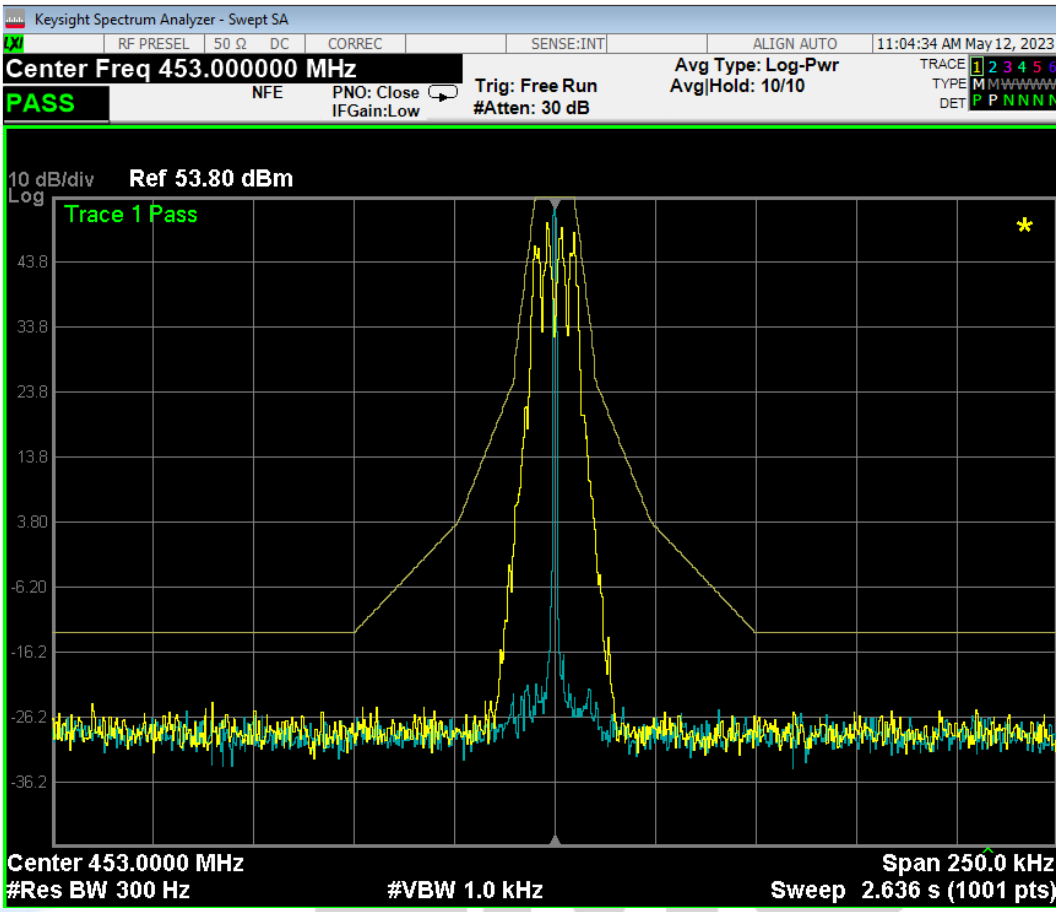
Mask-C/25.0 kHz Channel/2-level FSK/ FLEX 1600 bps/453.000 MHz



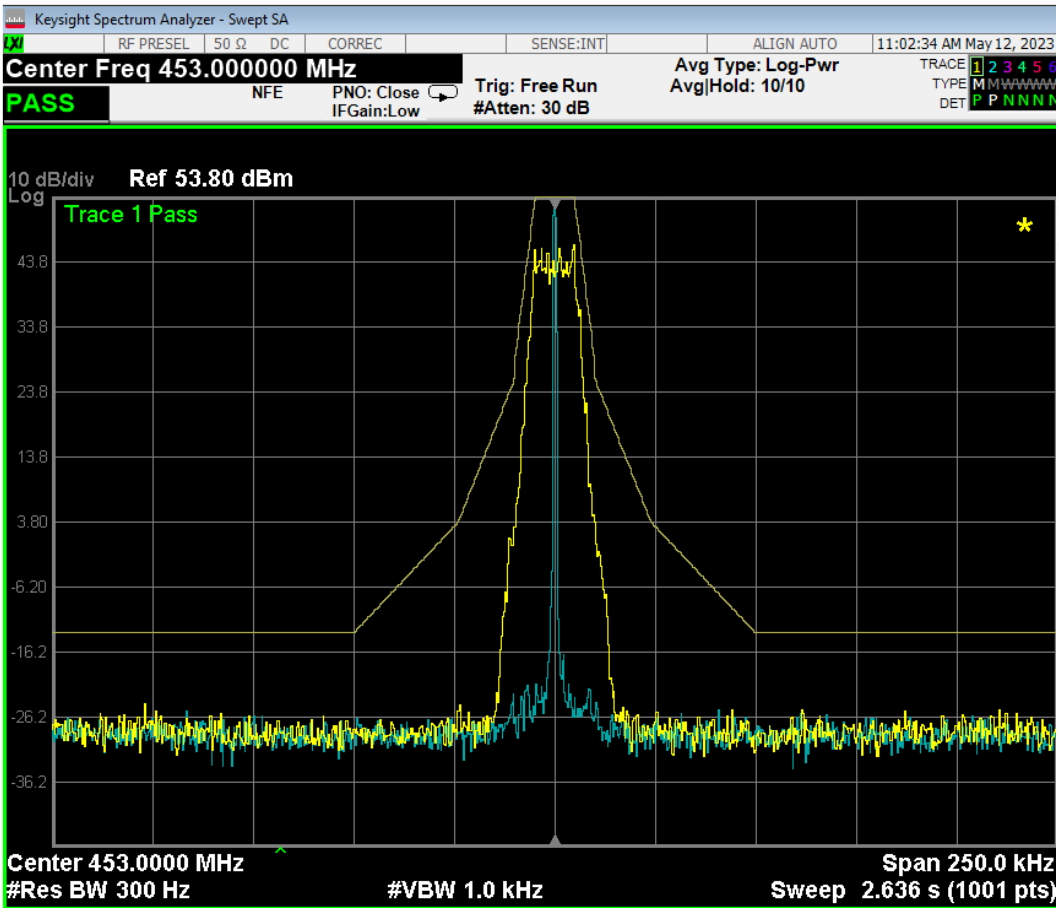
Mask-C/25.0 kHz Channel/2-level FSK/ FLEX 3200 bps/453.000 MHz



Mask-C/25.0 kHz Channel/4-level FSK/ FLEX 3200 bps/453.000 MHz



Mask-C/25.0 kHz Channel/4-level FSK/ FLEX 6400 bps/453.000 MHz



§2.1051 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: 452.100 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
904.200	-26.1	-20.0
1356.300	<-25.0	-20.0
1808.400	<-25.0	-20.0
2260.500	<-25.0	-20.0
2712.600	<-25.0	-20.0
3164.700	<-25.0	-20.0
3616.800	<-25.0	-20.0
4068.900	<-25.0	-20.0
4521.000	<-25.0	-20.0
4973.100	<-25.0	-20.0

Frequency: 454.900 MHz

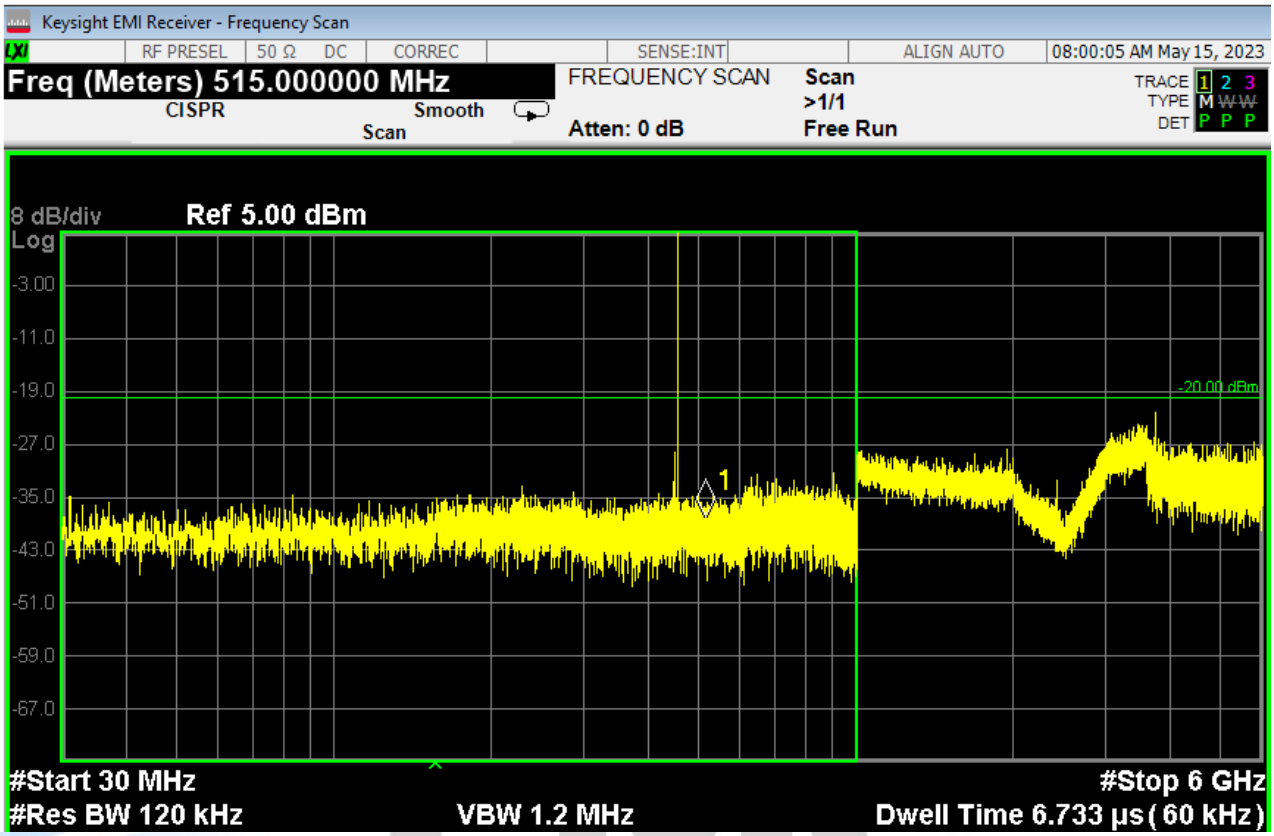
Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
909.800	-29.0	-20.0
1364.700	<-25.0	-20.0
1819.600	<-25.0	-20.0
2274.500	<-25.0	-20.0
2729.400	<-25.0	-20.0
3184.300	<-25.0	-20.0
3639.200	<-25.0	-20.0
4094.100	<-25.0	-20.0
4549.000	<-25.0	-20.0

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

Transmitter spurious emission plot using notch filter at centre frequency:



Standby emission plot:

§2.1053 Field strength of the transmitter spurious emissions

Radiated emission testing was carried out over the frequency range of 30 MHz to 10000 MHz.

The highest frequency in use is 2.4 GHz from VCO (Voltage controlled oscillator)

The measurements were carried out in transmit and standby mode.

Testing was carried out at the laboratory's open area test site - located at Driving Creek Orere Point, RD5, Papakura, New Zealand.

Before testing was carried out a receiver self-calibration was undertaken along with a check of all cables and programmed antenna factors was carried out.

The device tested when placed in the centre of the test table flat 0.8 m above the test site ground plane.

All interconnecting cables were bundled in 40 cm long bundles.

The Device was powered at 120 Vac, 60 Hz supply during the tests.

- A resistive dummy load that was attached to the antenna port via a 3 metre long coaxial cable.

- The device was operated at maximum output power.

- Attached to the device under test was a test laptop using a 2 meter long Ethernet cable and RS232 cable to facilitate product control using test software.

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

Between 30 - 1000 MHz the emission is measured in both vertical and horizontal antenna polarisations at a distance of 3 metres using a Quasi Peak detector with a 120 kHz bandwidth is used.

Between 1000 - 10000 MHz the emission is measured in both vertical and horizontal antenna polarisations at a distance of 3 metres using an Average detector and a Peak detector with bandwidths of 1 MHz.

The emission level was determined in field strength by taking the following into consideration:

Level (dBµV/m) = Receiver Reading (dBµV) + Antenna Factor (dB/m) + Coax Loss (dB)

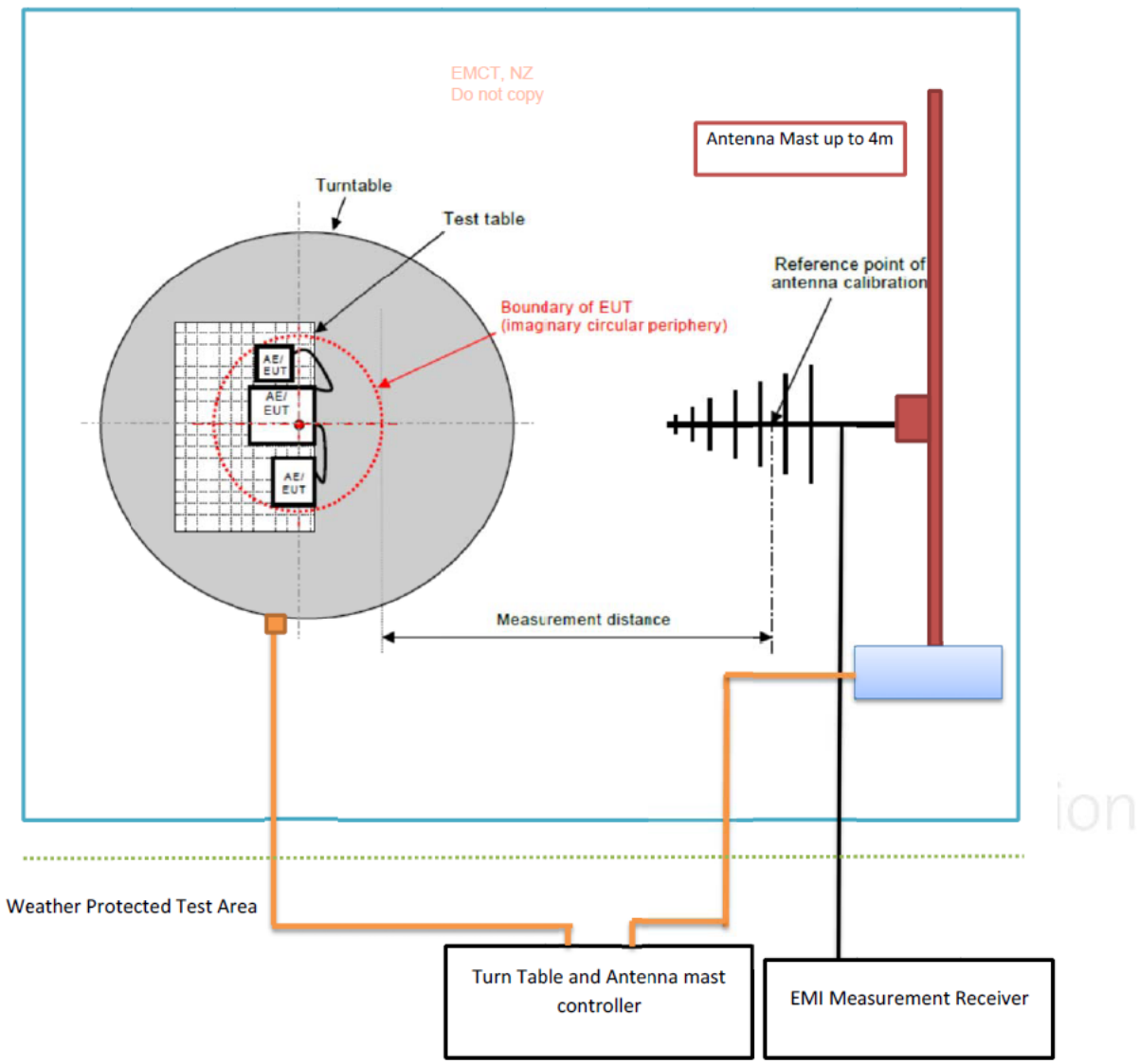
For example, if an emission of 30 dBµV was observed at 30 MHz.

45.5 dBµV/m = 30.0 dBµV + 14 dB/m + 1.5 dB

Result: Complies.

Measurement Uncertainty: ± 4.1 dB

Radiated Emissions Test setup at Open area test site



Below 30 MHz: Loop Antenna; Measurement distance: 10 m

30 MHz-300 MHz: Bi conical Antenna; Measurement distance: 3 m

300 MHz- 1000 MHz: Log Periodic Antenna; Measurement distance: 3 m

Above 1 GHz: Horn Antenna; Measurement distance: 3 m

EMI Receiver Used: ESIB40

Transmitter spurious emissions results:

Nominal Frequency: 453.000 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
906.000	54.0	-43.4	-20.0	Vertical	23.4	Pass
906.000	57.2	-40.2	-20.0	Horizontal	20.2	Pass
1359.000	41.0	-56.4	-20.0	Vertical	36.4	Pass
1359.000	42.2	-55.2	-20.0	Horizontal	35.2	Pass
1812.000	58.3	-39.1	-20.0	Vertical	19.1	Pass
1812.000	55.1	-42.3	-20.0	Horizontal	22.3	Pass
2265.000	46.1	-51.3	-20.0	Vertical	31.3	*Pass
2265.000	45.4	-52.0	-20.0	Horizontal	32.0	*Pass
2718.000	48.0	-49.4	-20.0	Vertical	29.4	*Pass
2718.000	48.0	-49.4	-20.0	Horizontal	29.4	*Pass
3171.000	55.0	-42.4	-20.0	Vertical	22.4	*Pass
3171.000	55.0	-42.4	-20.0	Horizontal	22.4	*Pass
3624.000	55.0	-42.4	-20.0	Vertical	22.4	*Pass
3624.000	55.0	-42.4	-20.0	Horizontal	22.4	*Pass
4077.000	55.0	-42.4	-20.0	Vertical	22.4	*Pass
4077.000	55.0	-42.4	-20.0	Horizontal	22.4	*Pass
4530.000	55.0	-42.4	-20.0	Vertical	22.4	*Pass
4530.000	55.0	-42.4	-20.0	Horizontal	22.4	*Pass
4983.000	55.0	-42.4	-20.0	Vertical	22.4	*Pass
4983.000	55.0	-42.4	-20.0	Horizontal	22.4	*Pass
5436.000	60.0	-37.4	-20.0	Vertical	17.4	*Pass
5436.000	60.0	-37.4	-20.0	Horizontal	17.4	*Pass

* Noise floor measurement.

FCC General Emissions with product transmitting:

Product Transmitting at 453.000 MHz:

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
30.640	47.9	-49.5	-20.0	Vertical	29.5	Pass
32.600	44.8	-52.5	-20.0	Vertical	32.5	Pass
34.640	42.3	-55.1	-20.0	Vertical	35.1	Pass
38.920	42.1	-55.3	-20.0	Vertical	35.3	Pass
253.360	30.0	-67.4	-20.0	Vertical	47.4	Pass
7200.000	57.7	-39.7	-20.0	Vertical	19.7	Pass
7200.000	57.2	-40.2	-20.0	Horizontal	20.2	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

§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	-40	-40	-40
+40	-40	-40	-40
+30	-40	-40	-40
+20	-60	-60	-60
+10	-60	-60	-60
0	-100	-100	-100
-10	-130	-130	-130
-20	-180	-180	-180
-30	-230	-230	-230

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 0.50 ppm (-230 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)		6.25 kHz Deviation (kHz)	12.5 kHz Deviation (kHz)	25 kHz Deviation (kHz)
	UHF	VHF			
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.

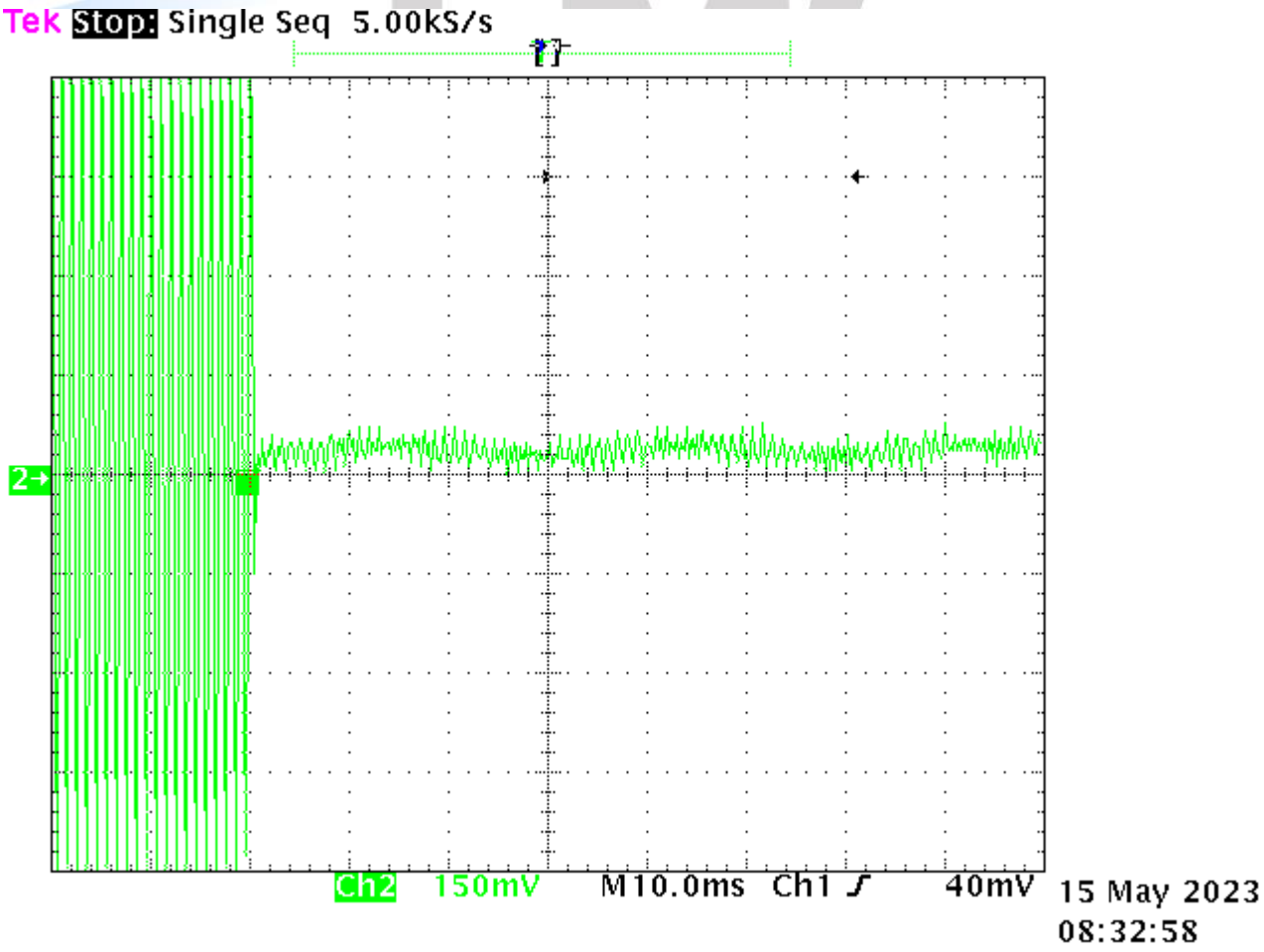
Triggering has been set to occur 2 divisions from the left hand edge (20 ms).

*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.

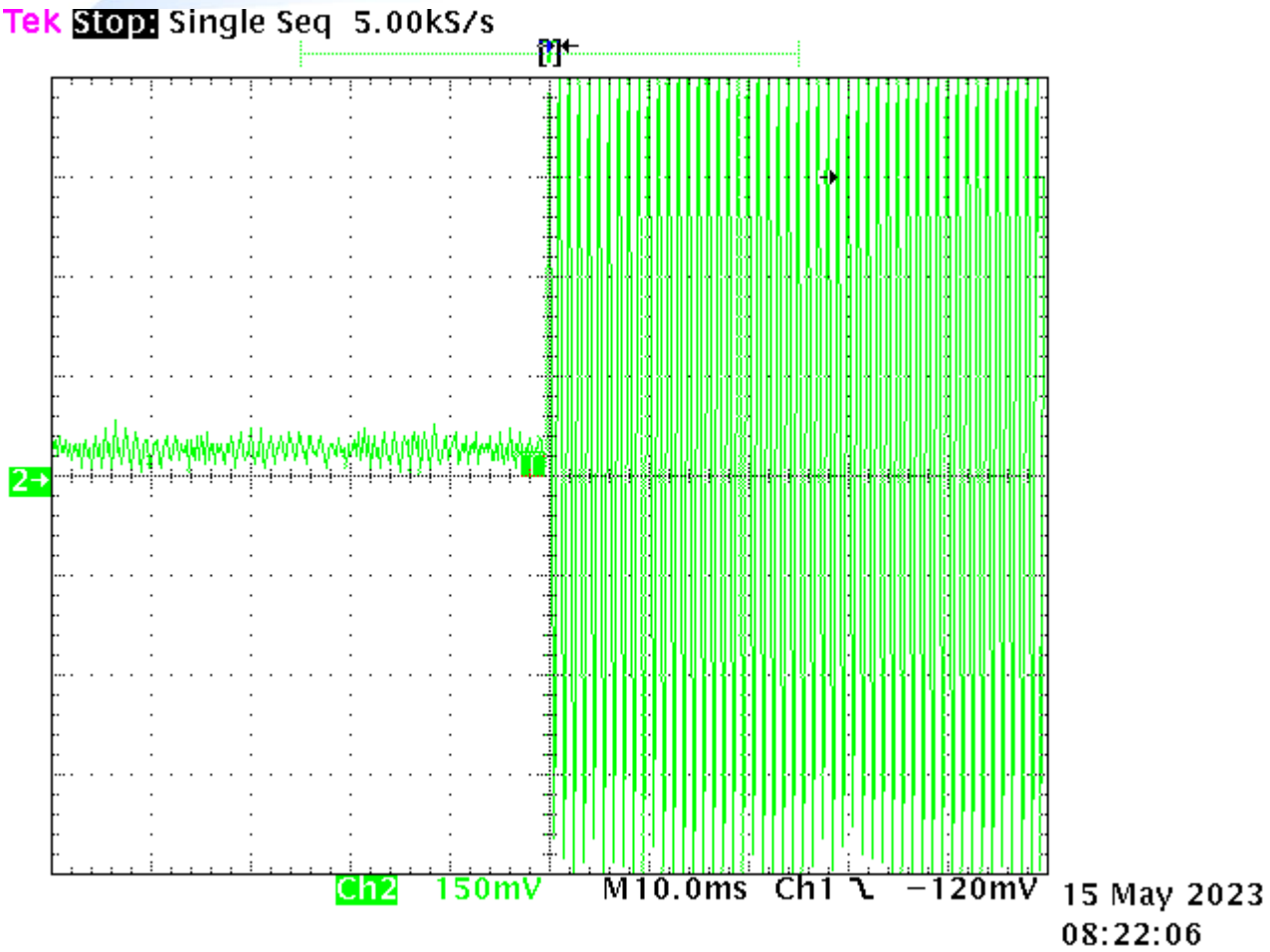
Green trace has been maximised to give full screen indication of +/- 12.5 kHz.

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.

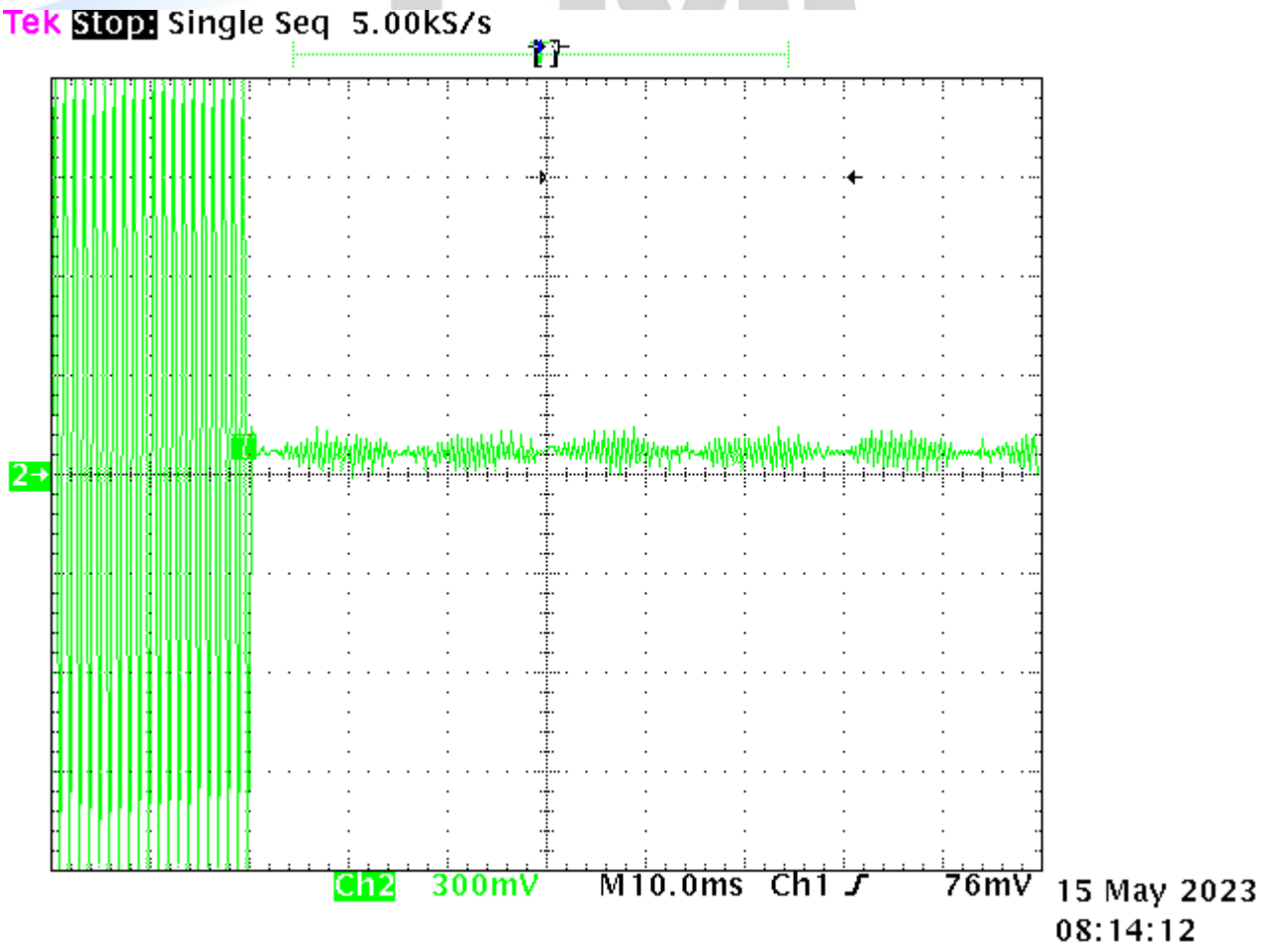
Green trace has been maximised to give full screen indication of +/- 25.0 kHz.
The X axis has been set to a sweep rate of 10 ms/division.

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.
t2 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)

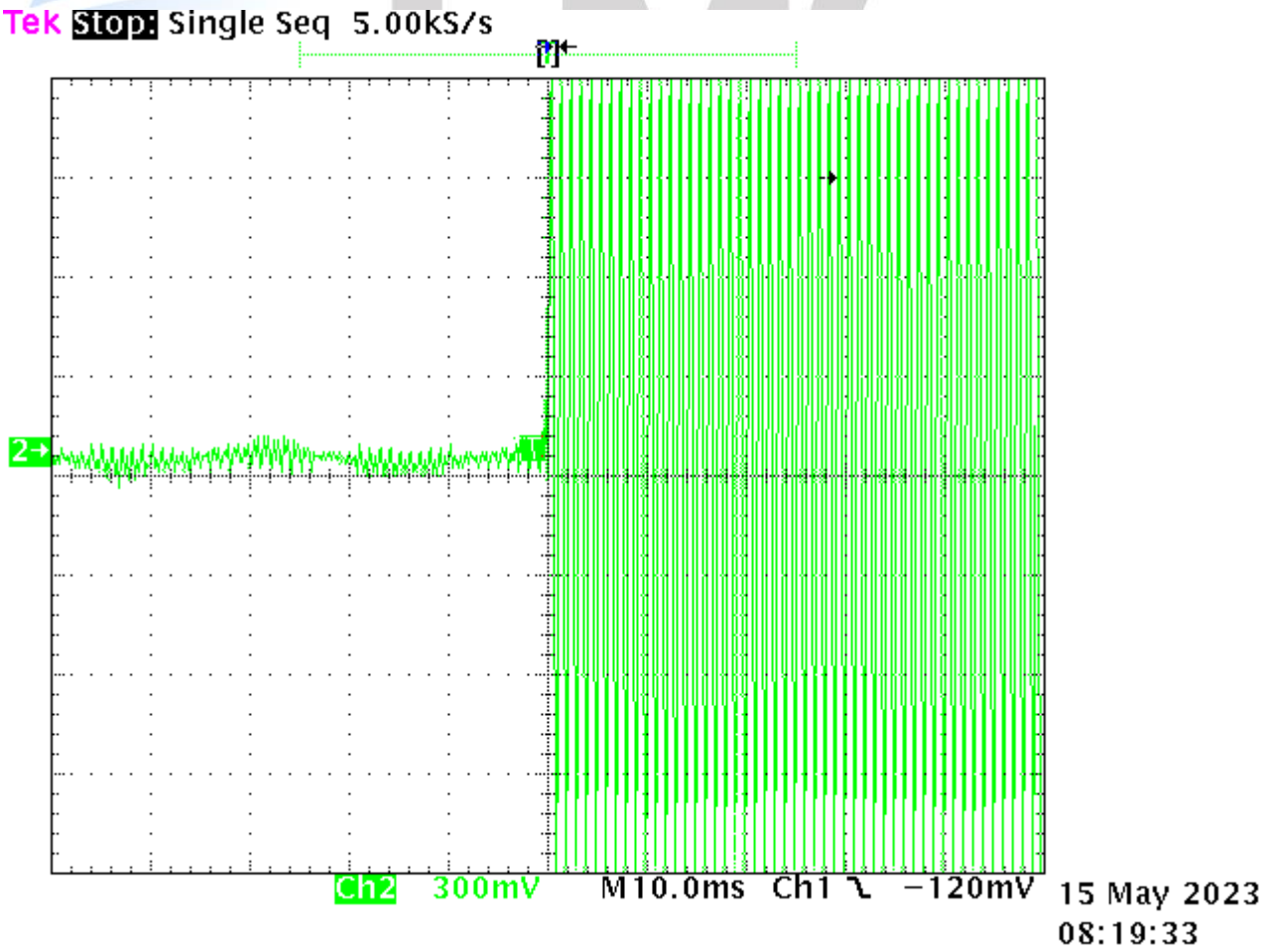
Green Trace = 1 kHz tone with FM deviation of 25.0 kHz.

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.



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 452.000 MHz to 455.000 MHz. For worst case MPE calculations, 452.000 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/cm^2

- Occupational /Controlled exposure is f/300. At 452.0 MHz, the calculated limit is 1.5mW/cm^2

Minimum safe distances have been calculated below.

For Uncontrolled Environment

At 452.0 MHz, Power Density = (452.0/1500)=0.30 mW/cm^2 = $E^2/3770$

E= √ 0.3*3770

E = 33.6 V/m

For Controlled Environment

At 452.0 MHz, Power Density = (452.0/300)=1.50 mW/cm^2 = E^2/3770

E= √ 1.50*3770

E = 75.4 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. 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 #	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	01/06/23	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
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
Heliax Cable	L6PNM-RPD	OATS	22869	23/12/23	1.0 Years
Receiver	Rohde & Schwarz	ESIB-40	100295	03/06/23	2.0 years
Spectrum Analyzer	Keysight	N9038A	MY57290153	29/07/23	2.0 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 View

Side and Top View

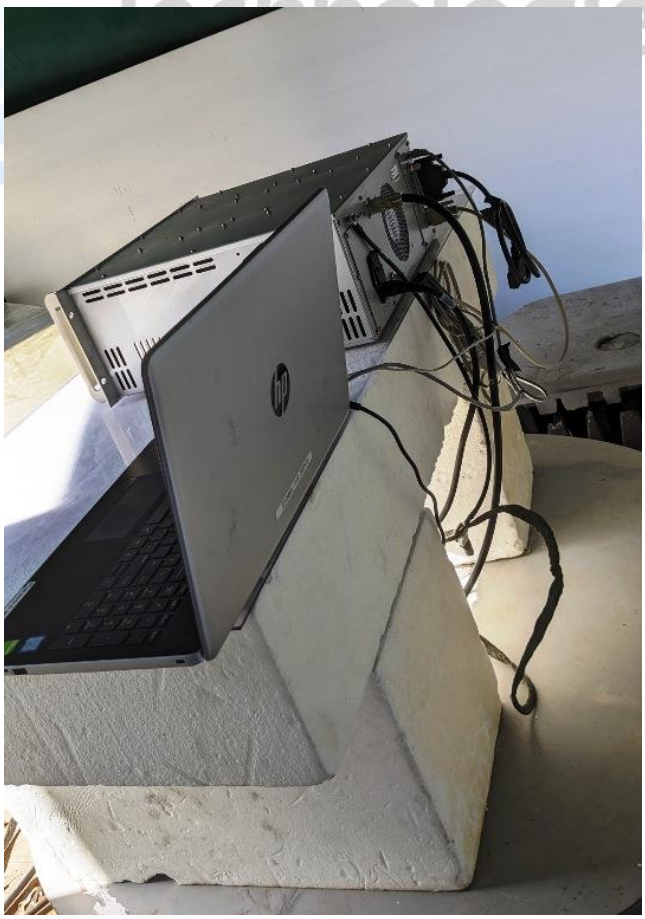
Rear View

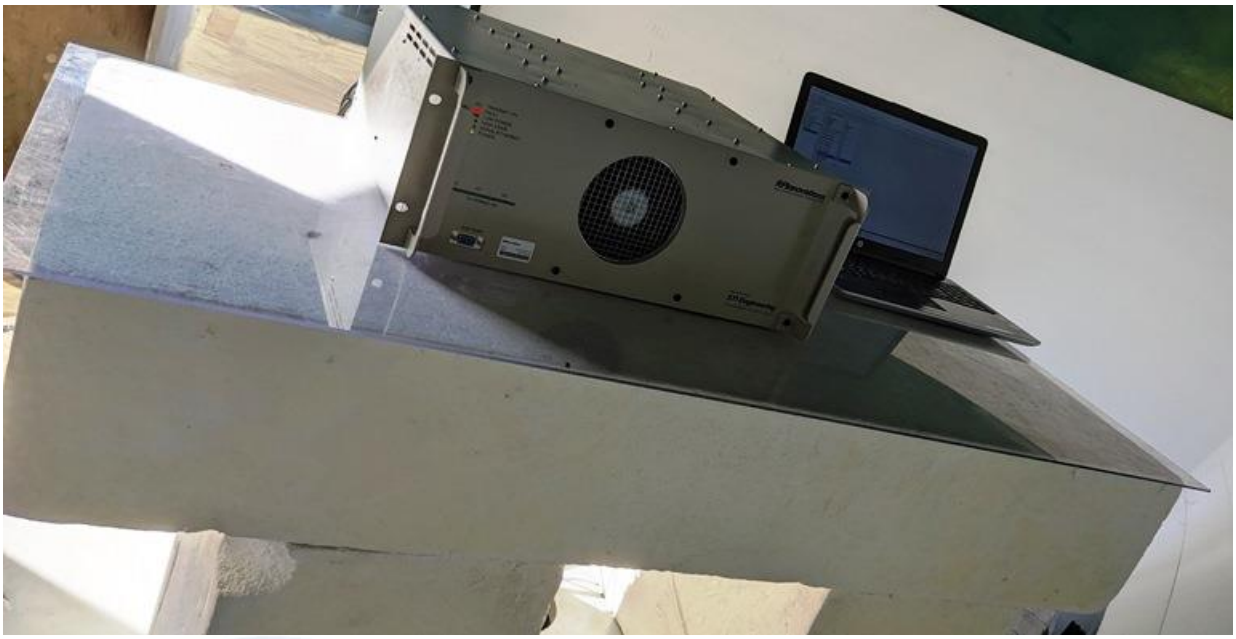
Side View

Label

Radiated emissions test setup

Radiated emissions test setup (Cont…)





Test Shed showing the use of a Biconical Antenna

Test Shed showing the use of a Log periodic Antenna

Test Antennas Used – Horn Antenna