Global Product Certification

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TEST REPORT

WTE MReX 460 UHF Transceiver

tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

WTE Limited

This Test Report is issued with the authority of:

Andrew Cutler- General Manager

IANZ ACCREDITED 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 **WTE MReX 460 UHF Transceiver** complies with the limits defined in 47 CFRPart 90 and 47 CFR Part 2 when tested in-accordance with the test methods described in 47 CFR Part 2 and ANSI/TIA-603-E-2016.

2. RESULT SUMMARY

The results of testing carried out between March 4th and March 23rd 2020 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	Not tested
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 contains following corrections:

1. ANSI/TIA-603-D-2010 has been corrected with ANSI/TIA-603-E-2016 on page 3 and page 9.
2. Emission designator for 9600 baud 4GFSK modulation/ 12.5 kHz channel spacing has been updated to 8K30F1D on page 9.

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.

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

All testing was carried out as per the standard in the worst-case configuration with no deviations being applied.

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

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	WTE Limited
Postal Address	1 Pukeko Place, Southshore Christchurch 8062
Physical Address	175 Lawford Road, RD6 West Melton, Christchurch 7676
Country	New Zealand
Contact	Mr Shannon Reardon

5. TEST SAMPLE DESCRIPTION

Brand Name	WTE
Model Number	MReX 460
Product	UHF Transceiver
Manufacturer	Wireless Technologies Ltd
Manufactured in	New Zealand
Serial Number	10125
FCC ID	2ASGC-MREX460
Transmitter Power	100 mW (+20 dBm)
Certification Range	421 – 480 MHz

Test frequencies

Frequency (MHz)	Power (Watts)	Emission
421.000	100 mW	FXD
451.000	100 mW	FXD
480.000	100 mW	FXD

12.5 kHz and 25 kHz offsets from the above mentioned frequencies have been used during testing and have been clearly mentioned in the test description and results.

Temperature and Humidity

Standard Temperature:	+15 °C to + 30 °C maintained.
Relative Humidity:	20% to 75% observed.
High Temperature:	+ 50 °C maintained.
Low Temperature:	- 30 °C maintained.

Test Power Source

Standard Test Voltage:	5.0 Vdc
High Voltage:	9.0 Vdc
Low Voltage:	n/a

Product Overview:

The MReX is a transceiver module for mobile paging and general telemetry use.

The product sends and receives POCSAG paging messages at 512, 1200 and 2400 baud

It also sends and receives Telemetry data between 512 baud up to 9600 baud using 4GFSK modulation.

The MReX is a USB capable transceiver.

It can be configured using serial commands sent via a WTE console.

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 421- 480 MHz which falls within 421-512 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 25 kHz, 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 modulated transceiver that has been shown to meet the 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 tested supports 4800 bits per second per 6.25 kHz of channel bandwidth.

Result: Complies.

RF power output

Measurements were carried out at the RF output terminals of the transmitter using a 30 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 100 mW (+20.0 dBm)

Frequency (MHz)	Voltage (Vdc)	Carrier Power (dBm)		
		+22˚ C	+50˚ C	-30˚ C
421.000	5.0	18.9	19.2	19.7
	9.0	18.9	19.2	19.7
451.000	5.0	18.8	19.3	19.7
	9.0	18.8	19.3	19.7
480.000	5.0	18.9	19.0	19.7
	9.0	18.9	19.0	19.7

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:

FXD: Digital Modulation using channel bandwidths of 6.25 kHz, 12.5 kHz and 25.0 kHz.

The following emission designators have been declared by the client:

6k00F1D for 6.25 kHz channel spacing

11k00F1D for 12.5 kHz channel spacing

8K30F1D for 9600 baud 4GFSK modulation/ 12.5 kHz channel spacing

20k00F1D for 25.0 kHz channel spacing

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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 this radio 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 and ANSI/TIA-603-E-2016.

Attached to the input of the spectrum analyser was an external 30 dB attenuator.

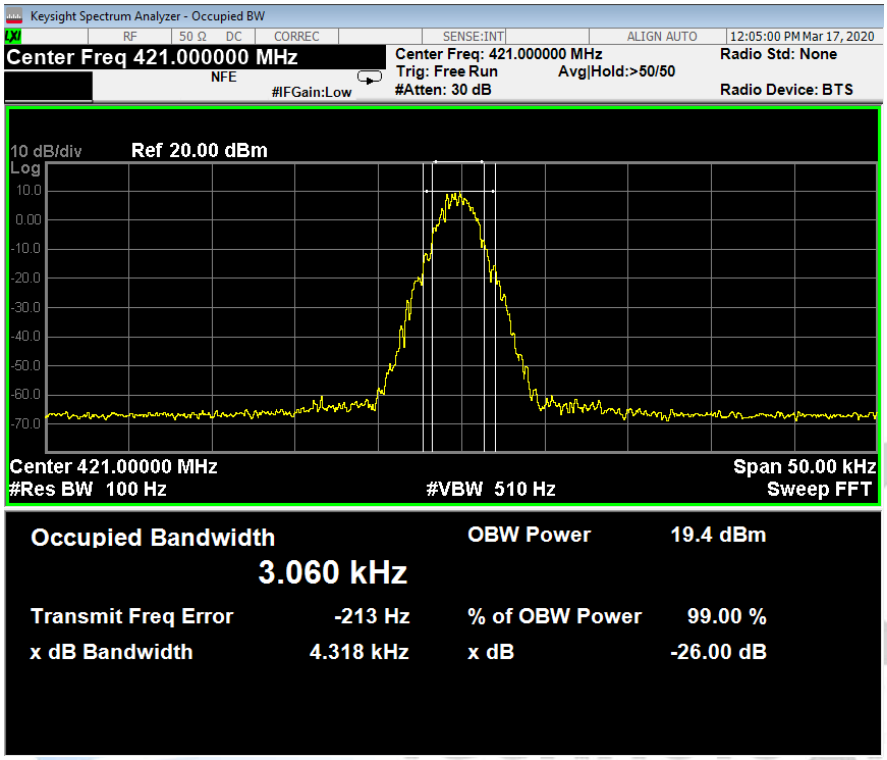
All the measurements that have been tabulated were made but only the representative plots have been included in the test report in order to simplify the test report.

Result: Complies

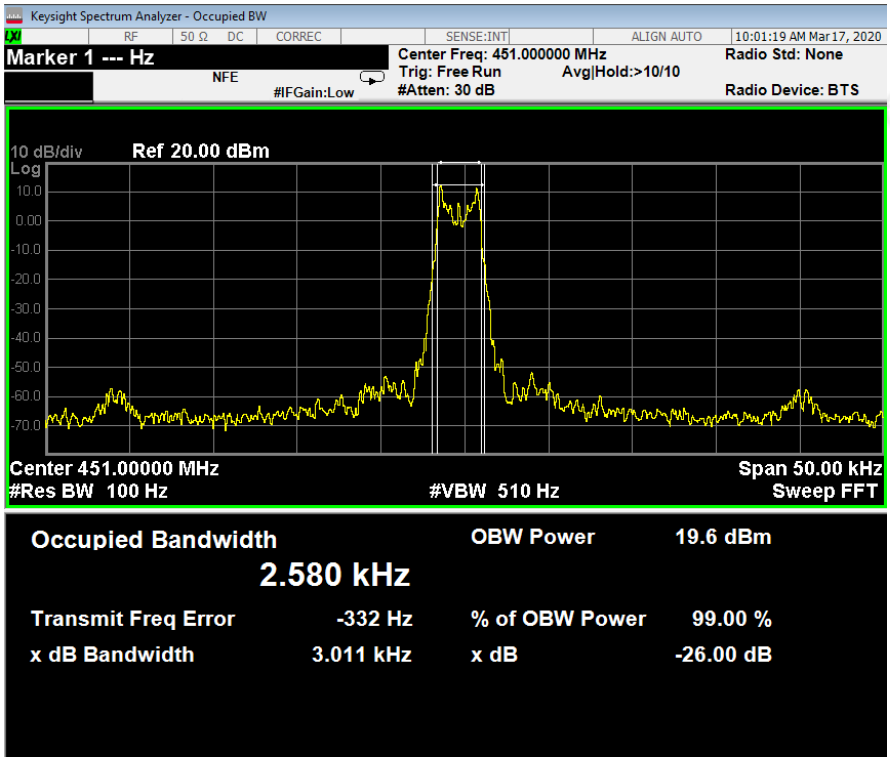
FXD – 6.25 kHz spacing.

Modulation	Data Rate	Frequency (MHz)	Measured (kHz)	Designated
4GFSK	4800	421.000	3.060	6.0 kHz
FSK	512	451.000	2.580	
4GFSK	4800	451.000	3.069	

421.000 MHz - 4GFSK modulation at 4800 bps



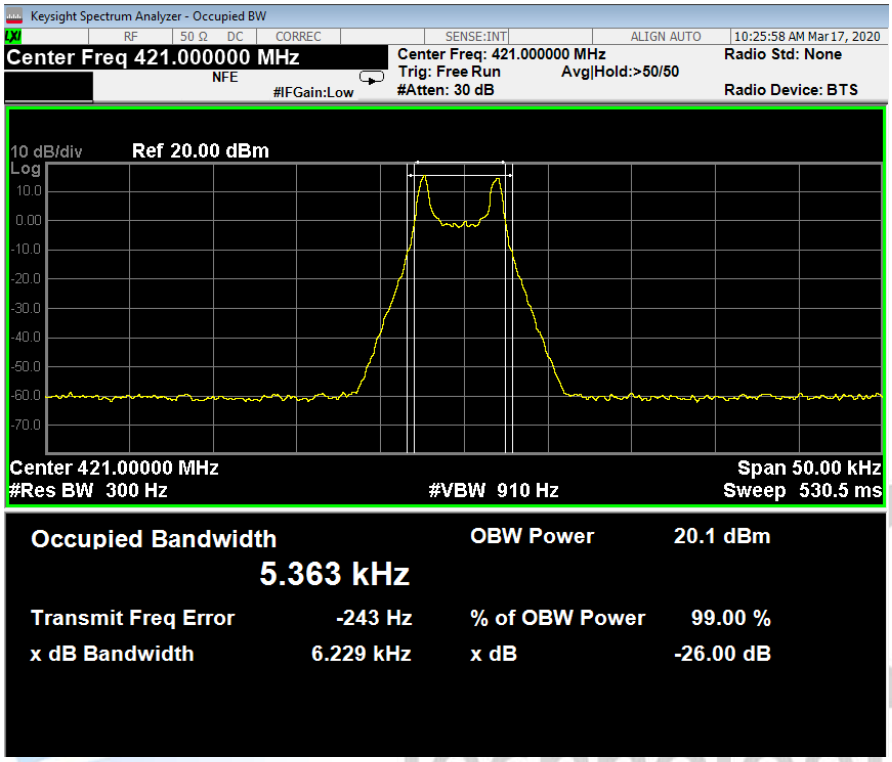
451.000 MHz – FSK modulation at 512 bps



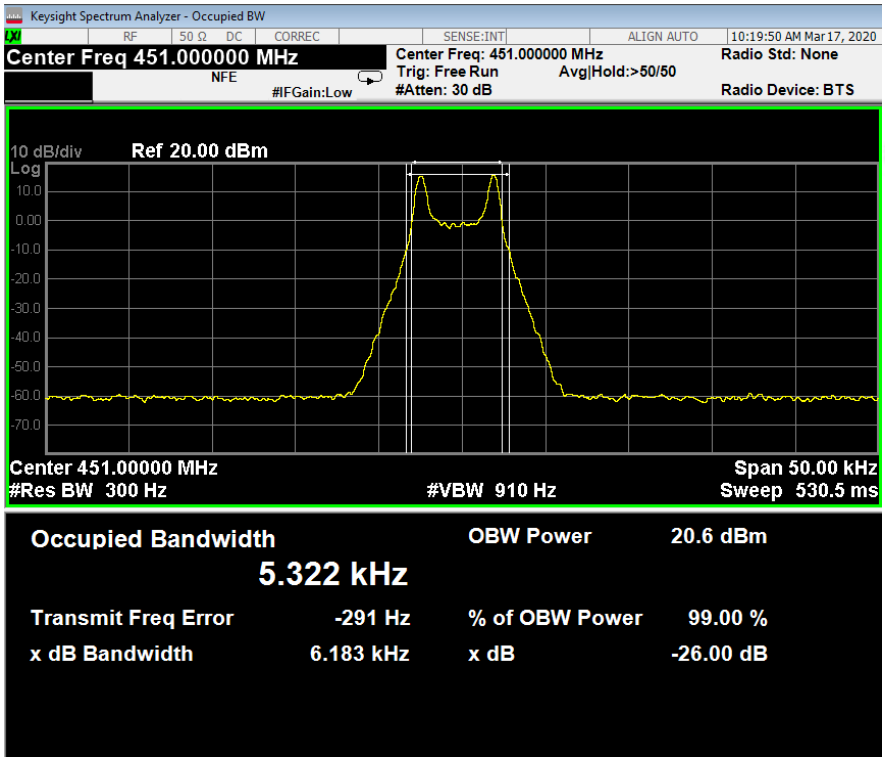
FXD – 12.5 kHz spacing.

Modulation	Data Rate	Frequency (MHz)	Measured (kHz)	Designated
FSK	512	421.000	5.363	11.250 kHz
FSK	512	451.000	5.322	

421.000 MHz – FSK modulation at 512 bps



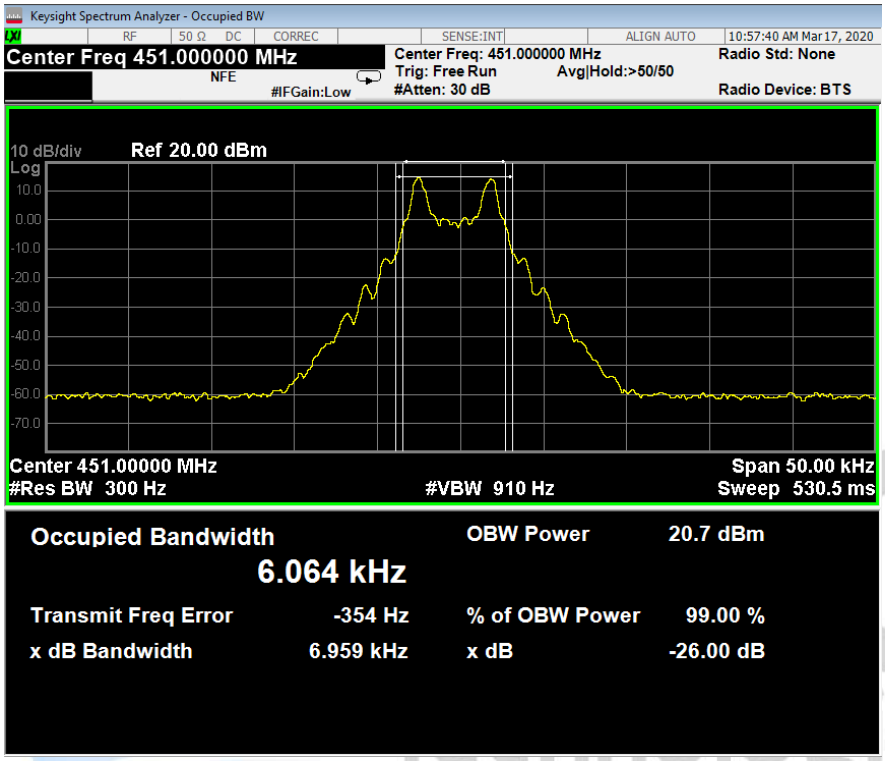
451.000 MHz – FSK modulation at 512 bps



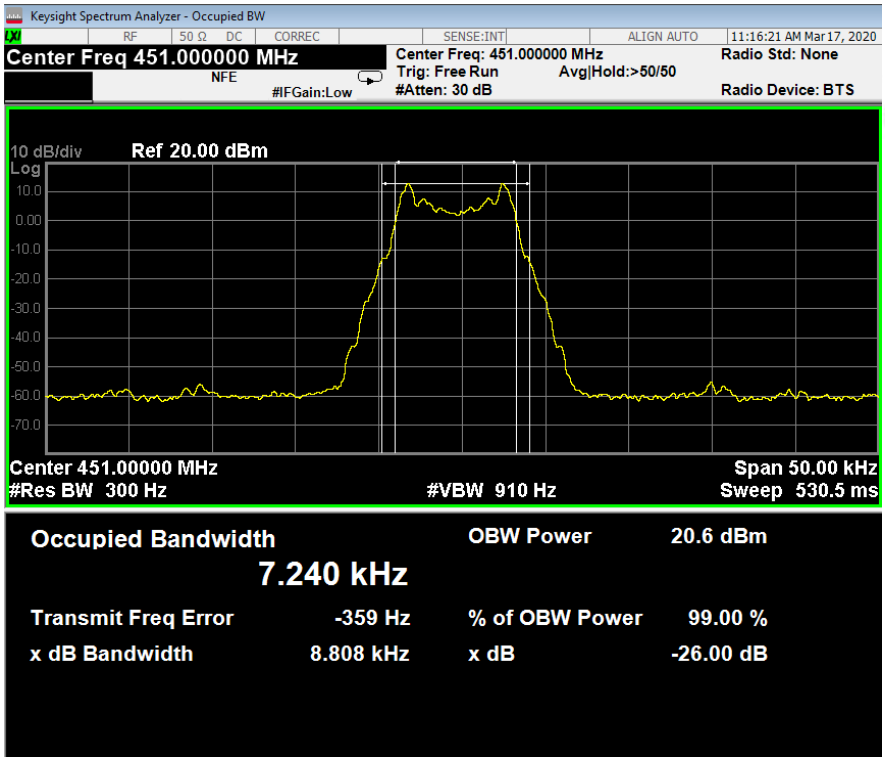
FXD – 12.5 kHz spacing (Cont...)

Modulation	Data Rate	Frequency (MHz)	Measured (kHz)	Designated
FSK	1200	451.000	6.064	11.250 kHz
GFSK	1800	451.000	7.240	

451.000 MHz 12.5 kHz FSK 1200



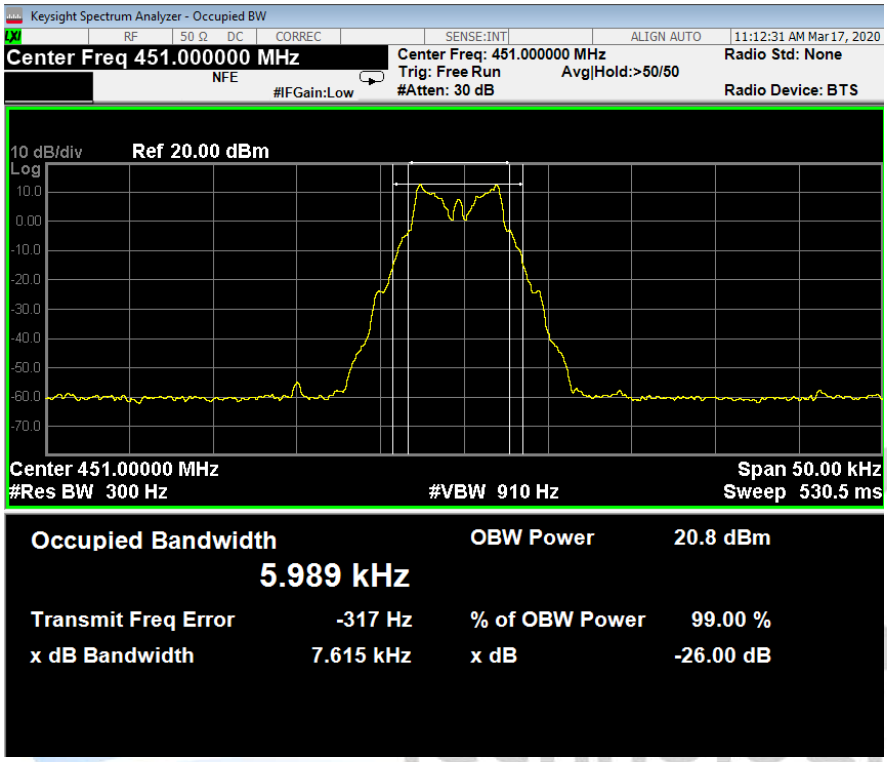
451.000 MHz 12.5 kHz GFSK 1800



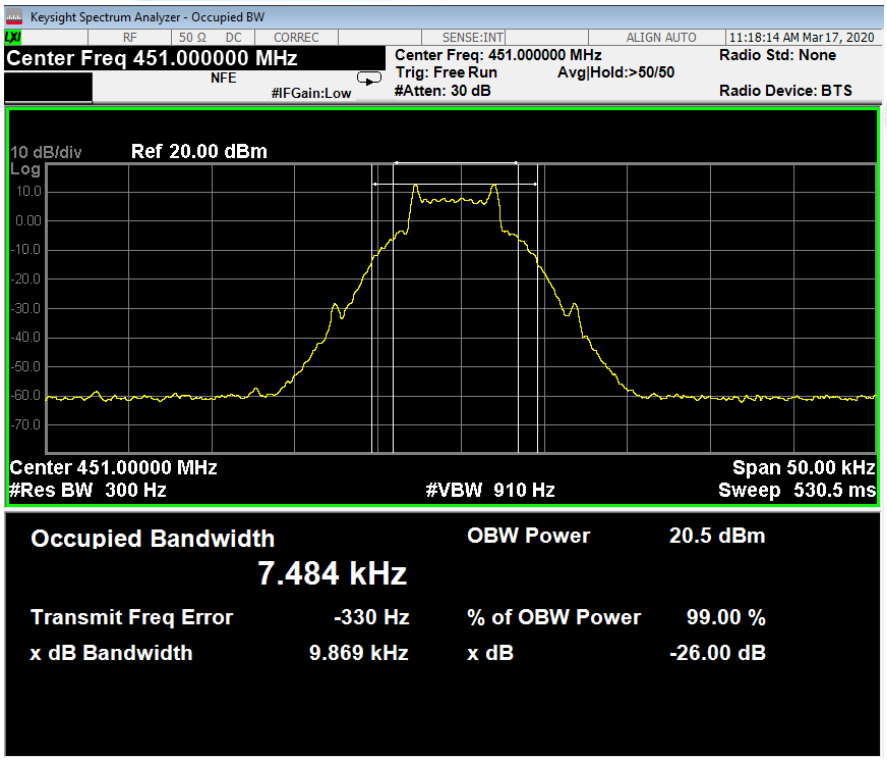
FXD – 12.5 kHz spacing (Cont...)

Modulation	Data Rate	Frequency (MHz)	Measured (kHz)	Designated
GFSK	2400	451.000	5.989	11.250 kHz
4GFSK	4800	451.000	7.484	
4GFSK	9600	451.000	6.182	8.300 kHz

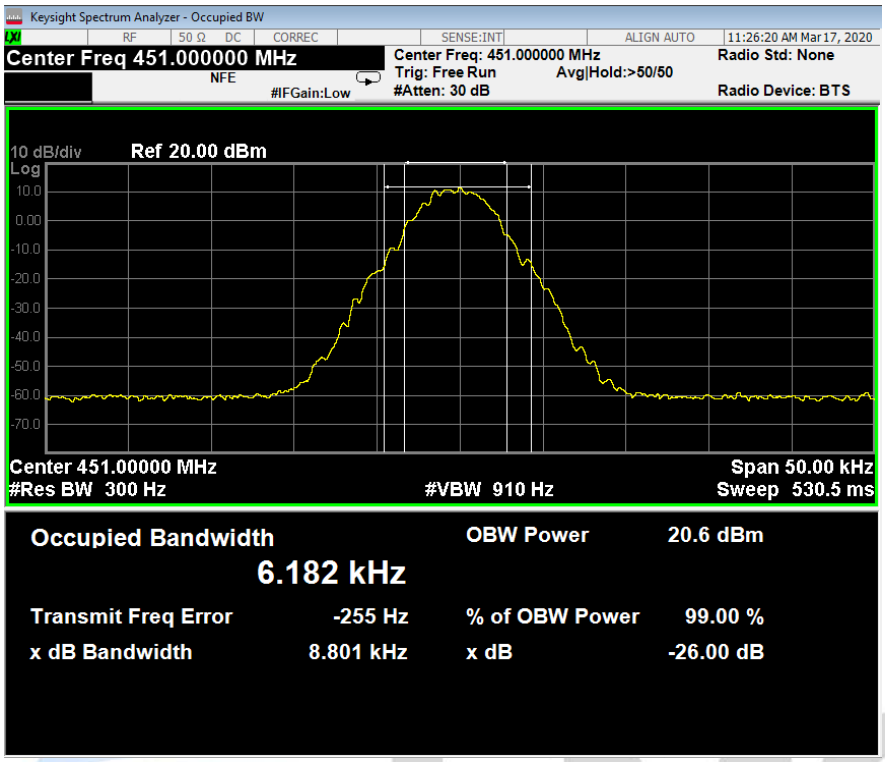
451.000 MHz 12.5 kHz GFSK 2400



451.000 MHz 12.5 kHz GFSK 4800



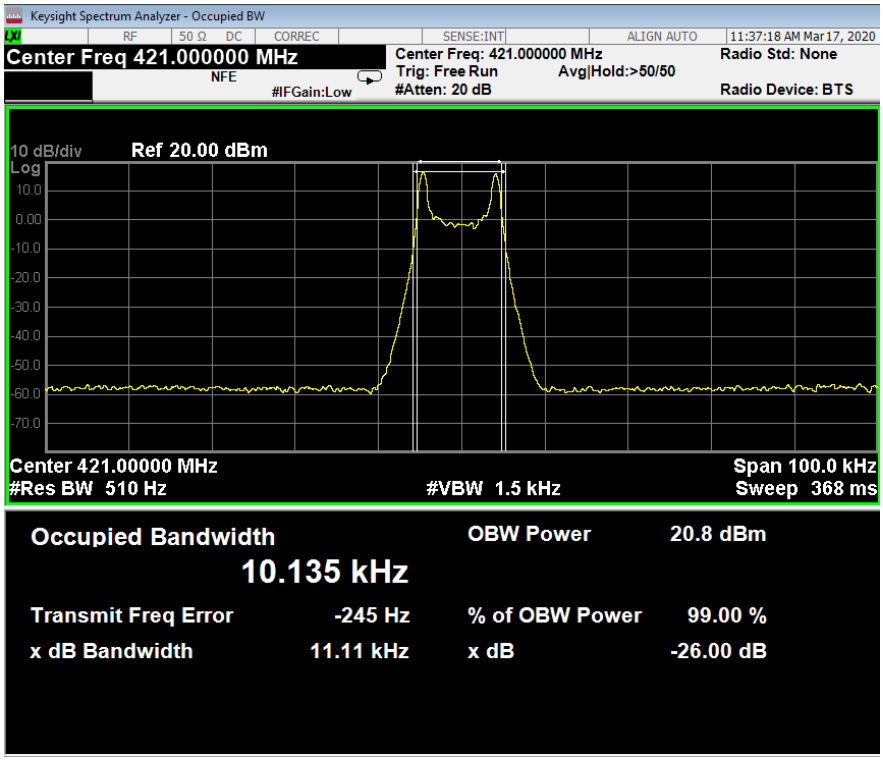
451.000 MHz 12.5 kHz GFSK 9600



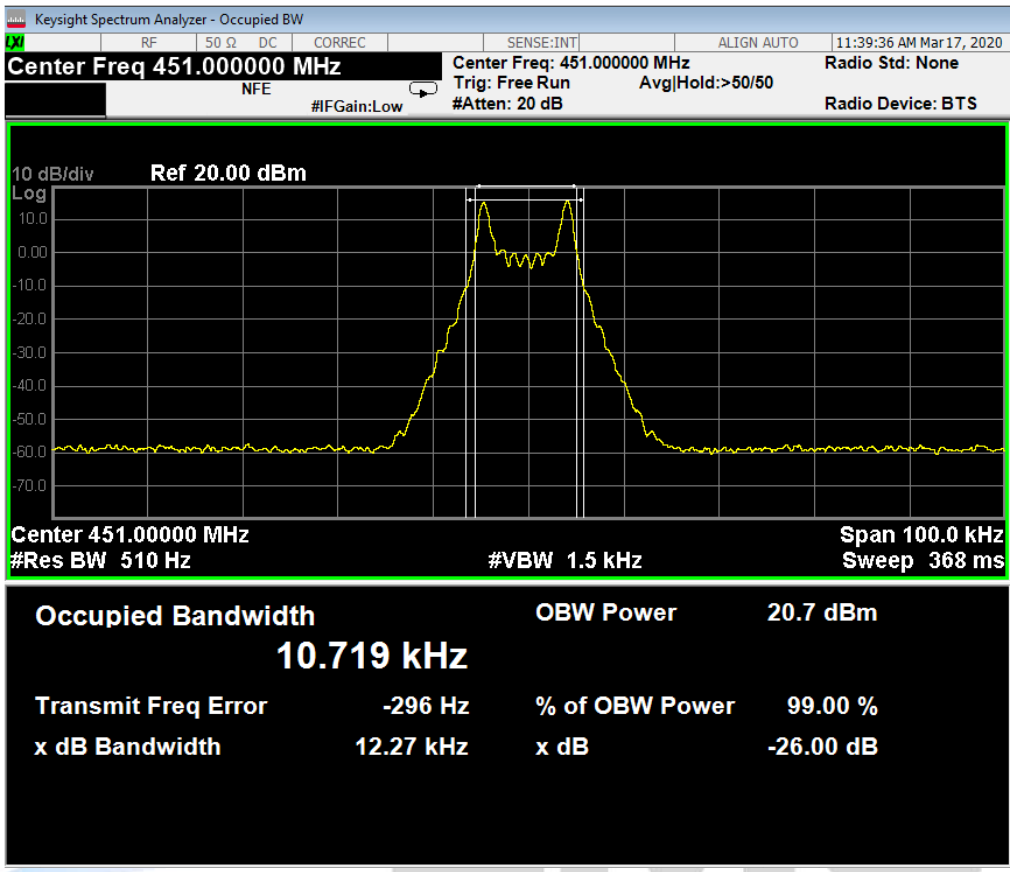
FXD – 25.0 kHz spacing

Modulation	Data Rate	Frequency (MHz)	Measured (kHz)	Designated
FSK	512	421.000	10.135	20.000 kHz
FSK	1200	421.000	10.700	
FSK	512	451.000	10.719	
FSK	1200	451.000	10.095	

421.000 MHz 25 kHz FSK 512



451.000 MHz 25 kHz FSK 1200



Spectrum Masks

The spectrum masks are defined in:

Section 90.210(d) – Mask C, D and E have been applied as the transmitter can operate in the band 421.000–512.000 MHz using authorised bandwidths of 25.0 kHz, 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 30 dB attenuator is placed between the transmitter and the spectrum analyser. Measurements were made in peak hold

The transmitter was modulated using the modulation source internal to the transmitter as supplied by the client.

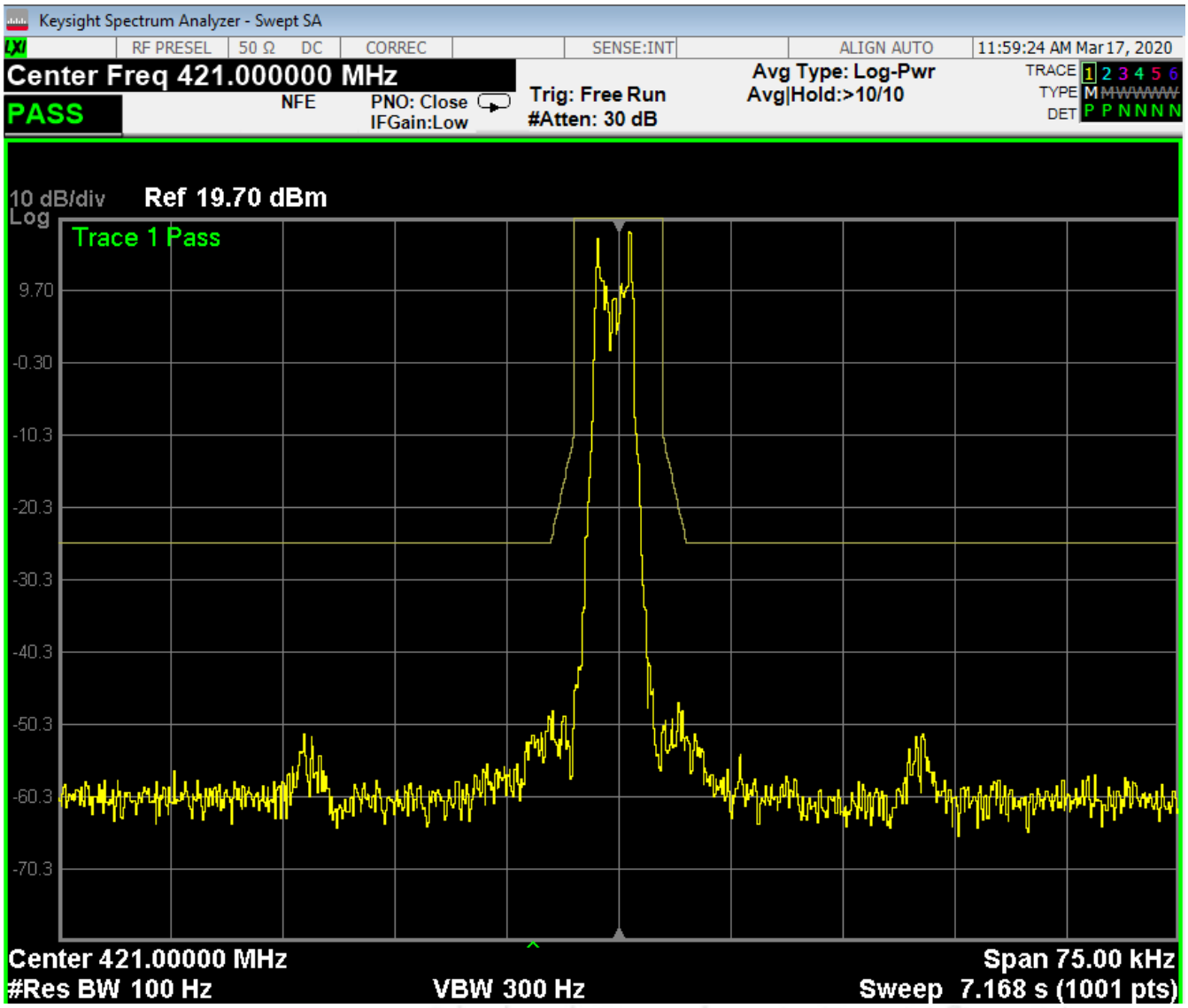
Initially testing was carried out at 421.000 MHz and 451.000 MHz.

The results were found comparable.

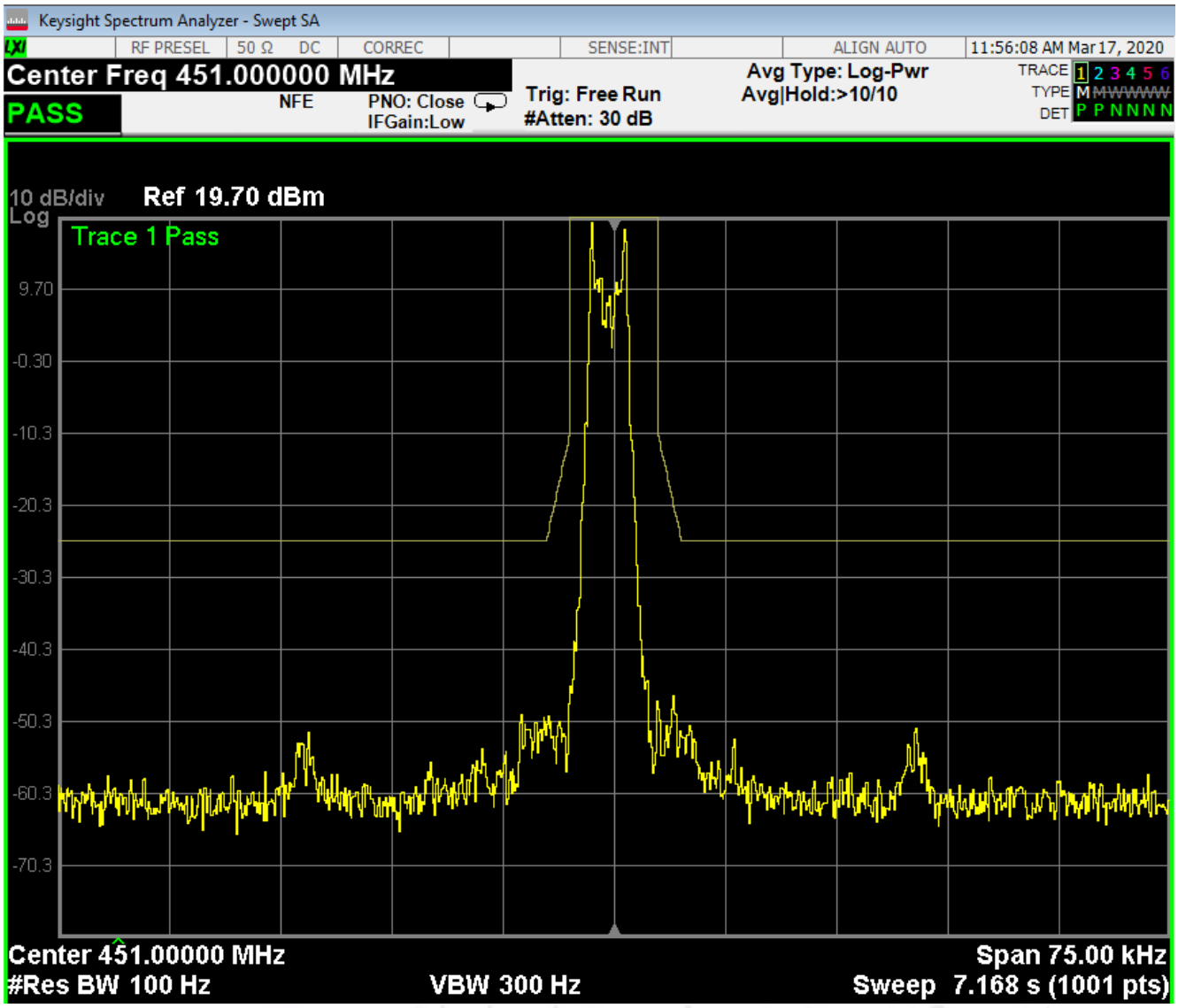
Therefore a complete set of masks has been provided for 451.000 MHz and only selected masks have been provided for 421.000 MHz.

Result: Complies.

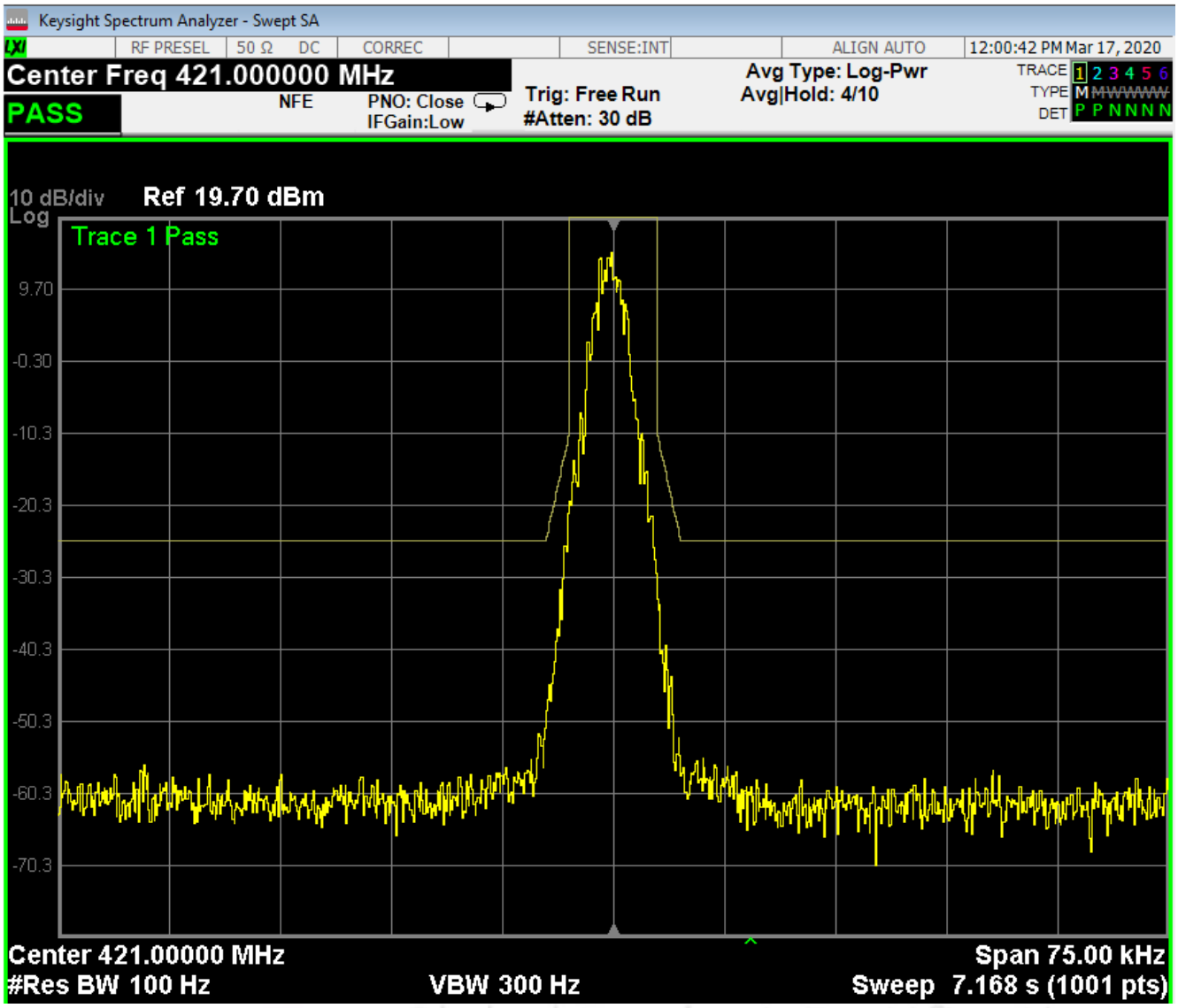
421.000 MHz, 6.25 kHz spacing, FSK 512



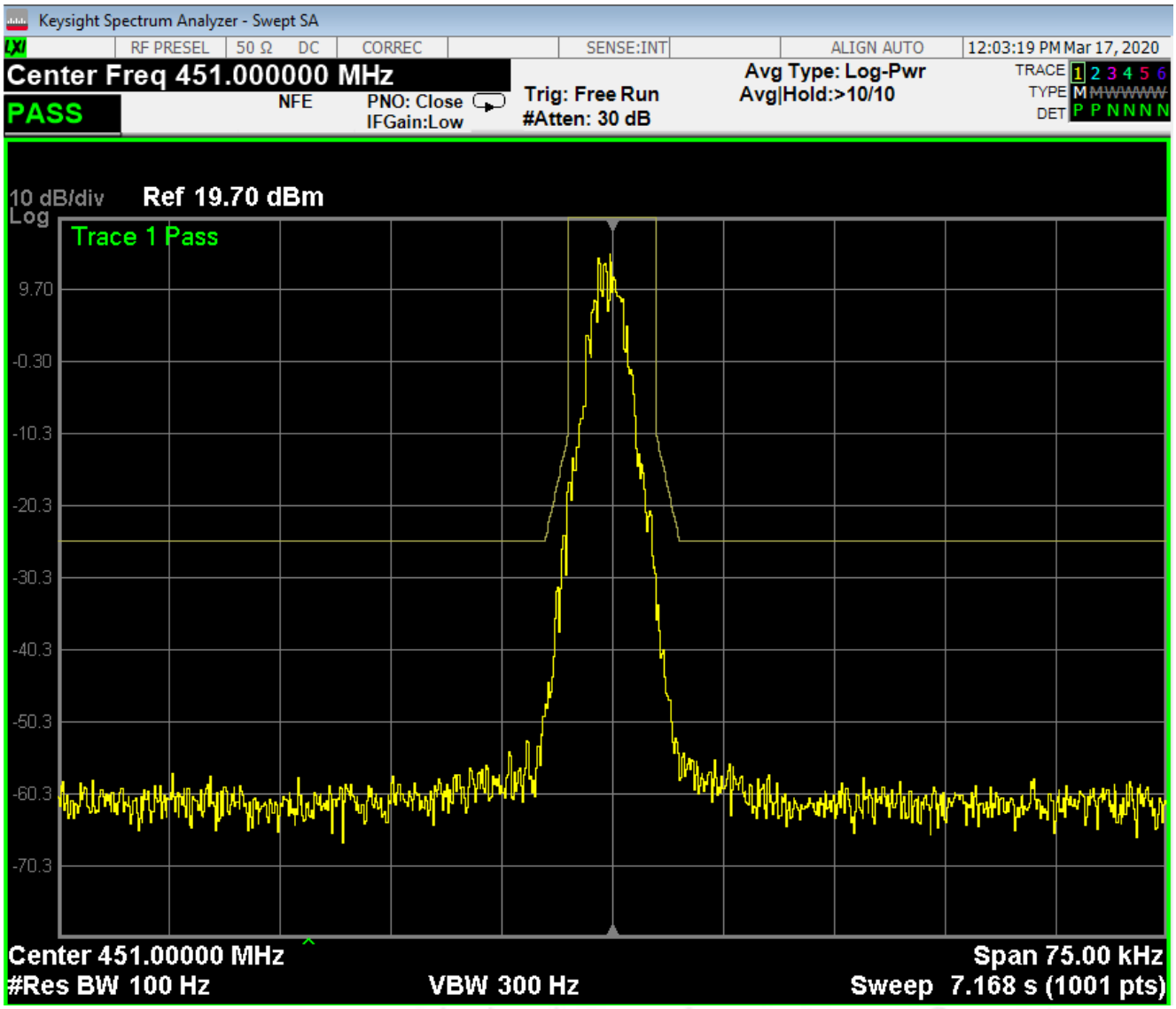
451.000 MHz, 6.25 kHz spacing, FSK 512



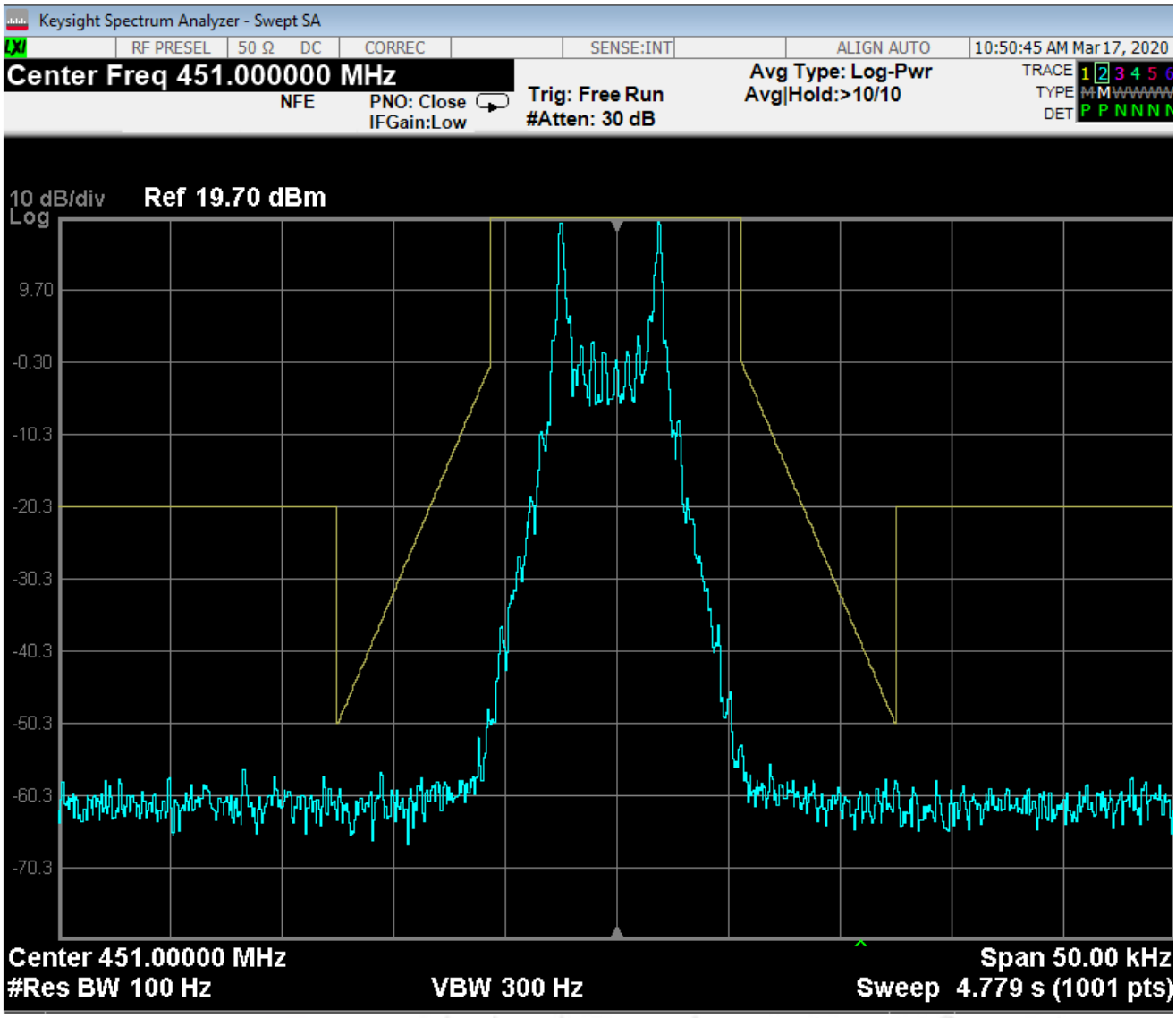
421.000 MHz, 6.25 kHz spacing, GFSK 4800



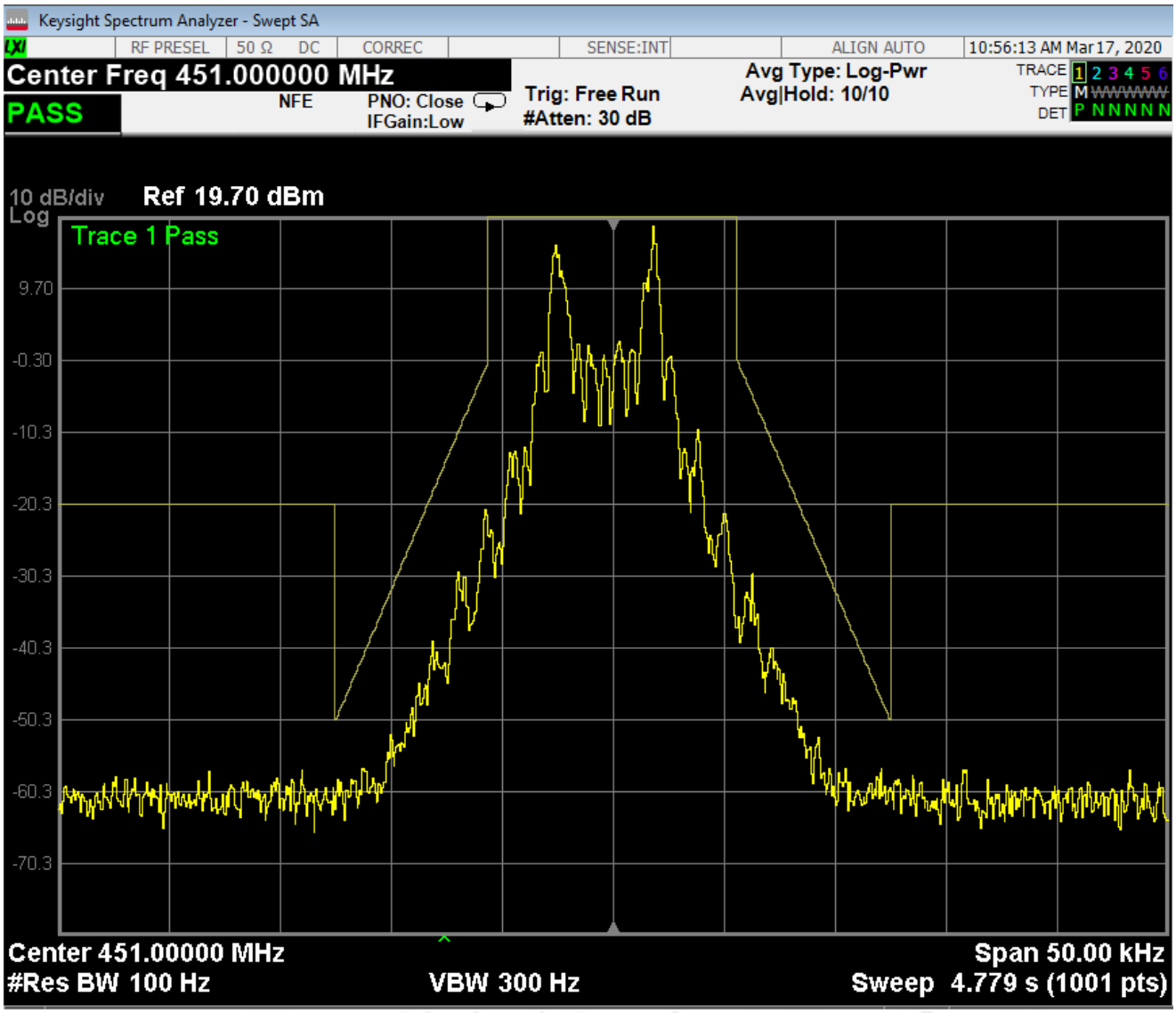
451.000 MHz, 6.25 kHz spacing, GFSK 4800



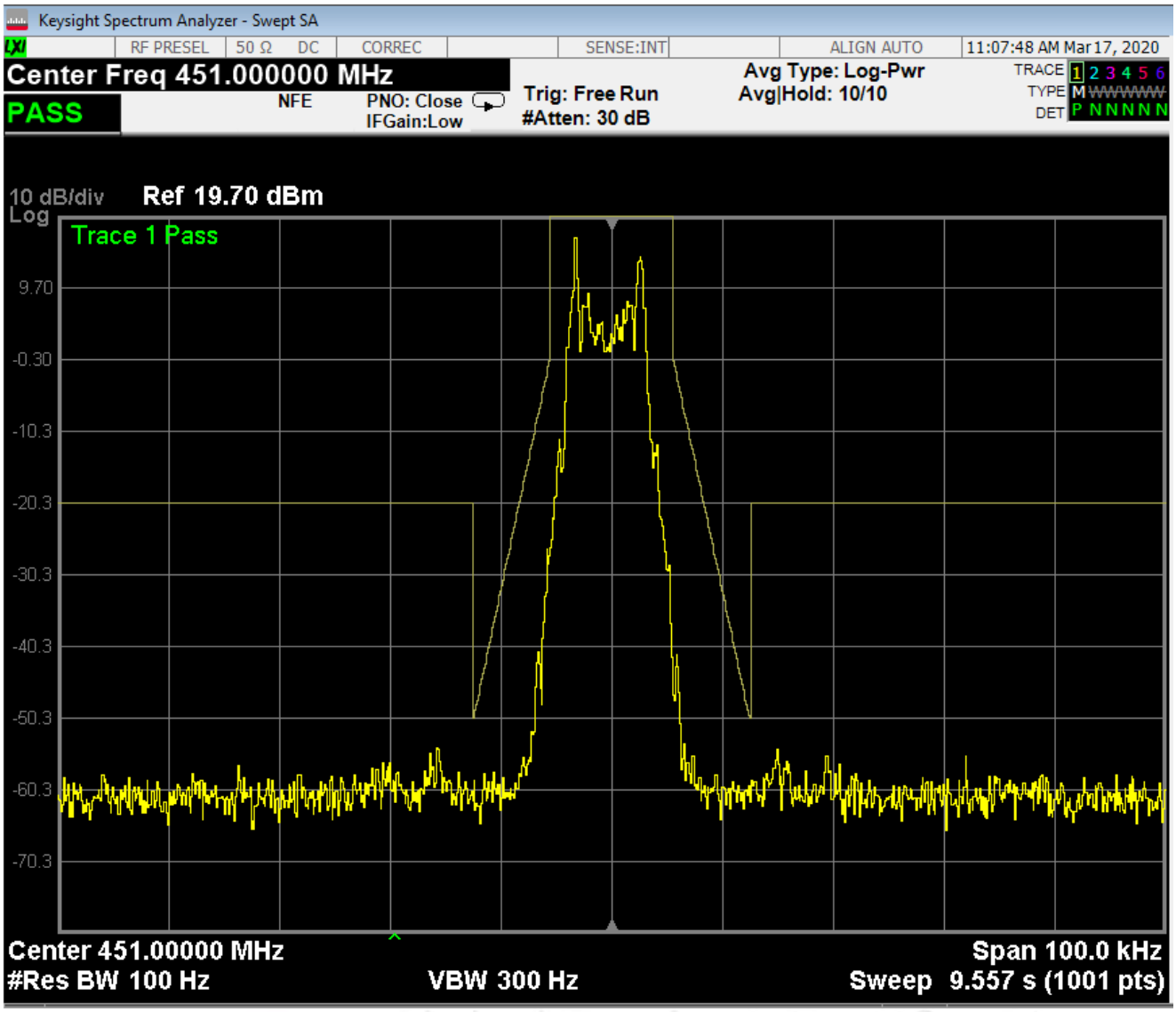
451.000 MHz, 12.5 kHz spacing, FSK 512



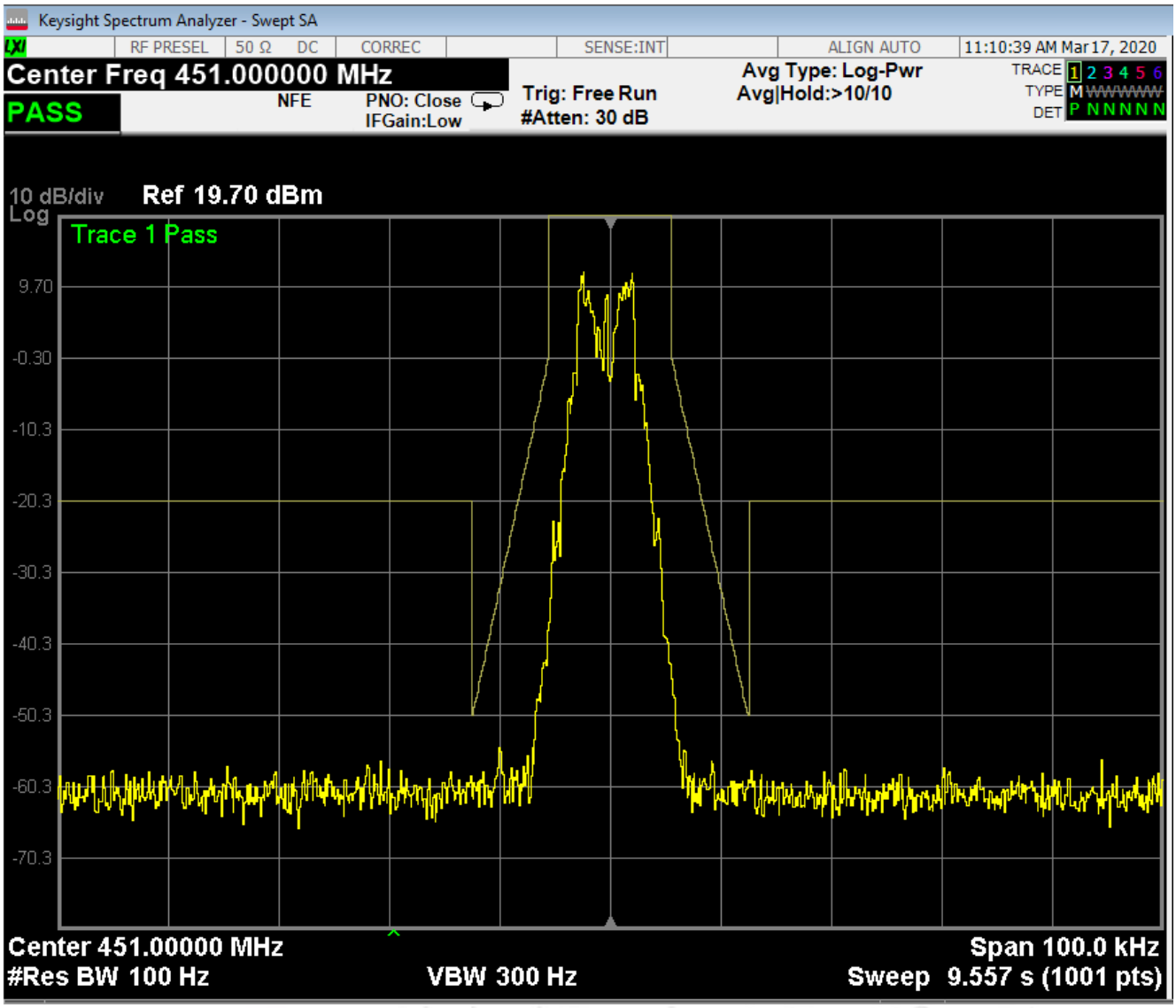
451.000 MHz, 12.5 kHz spacing, FSK 1200



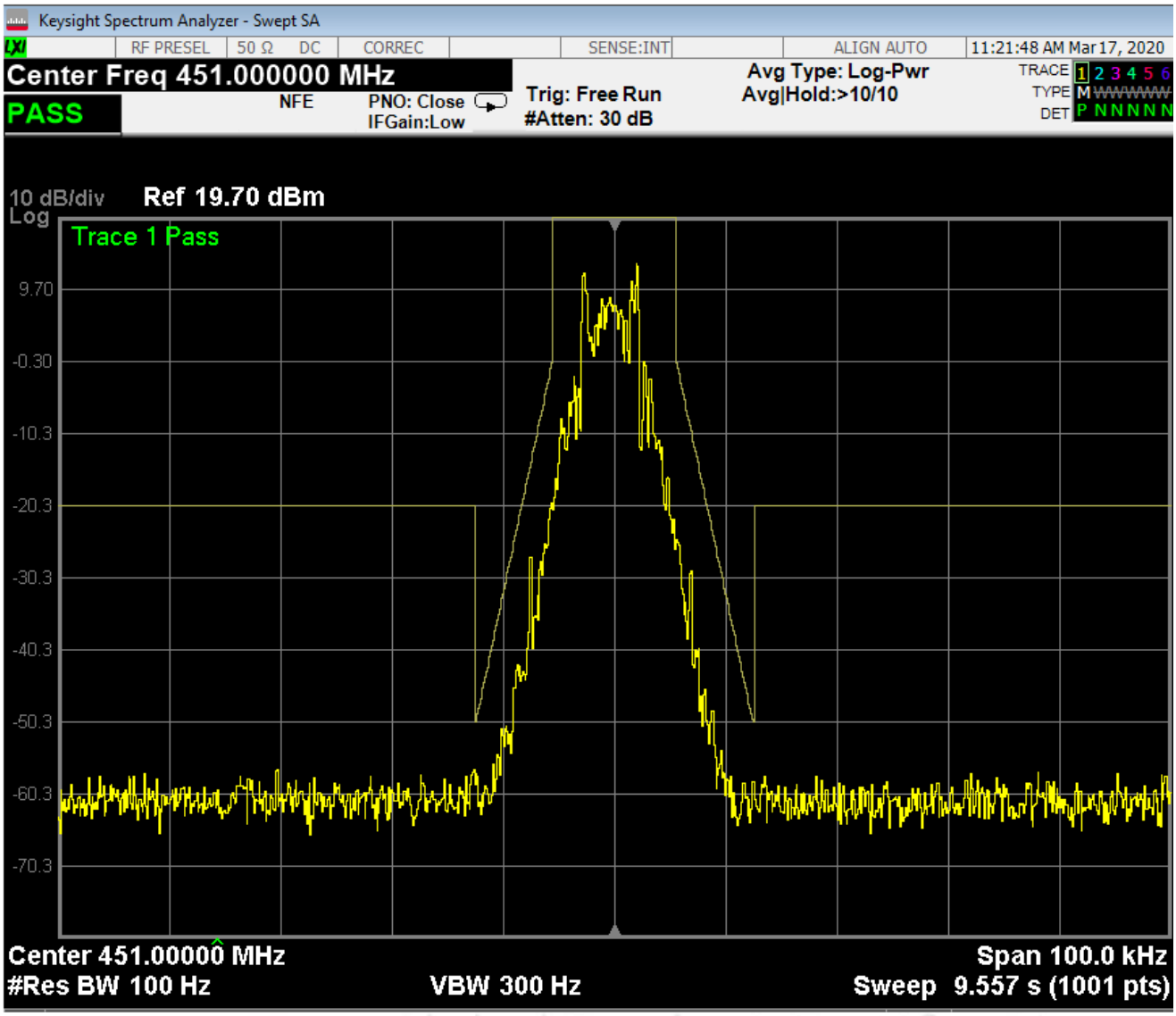
451.000 MHz, 12.5 kHz spacing, GFSK 1800



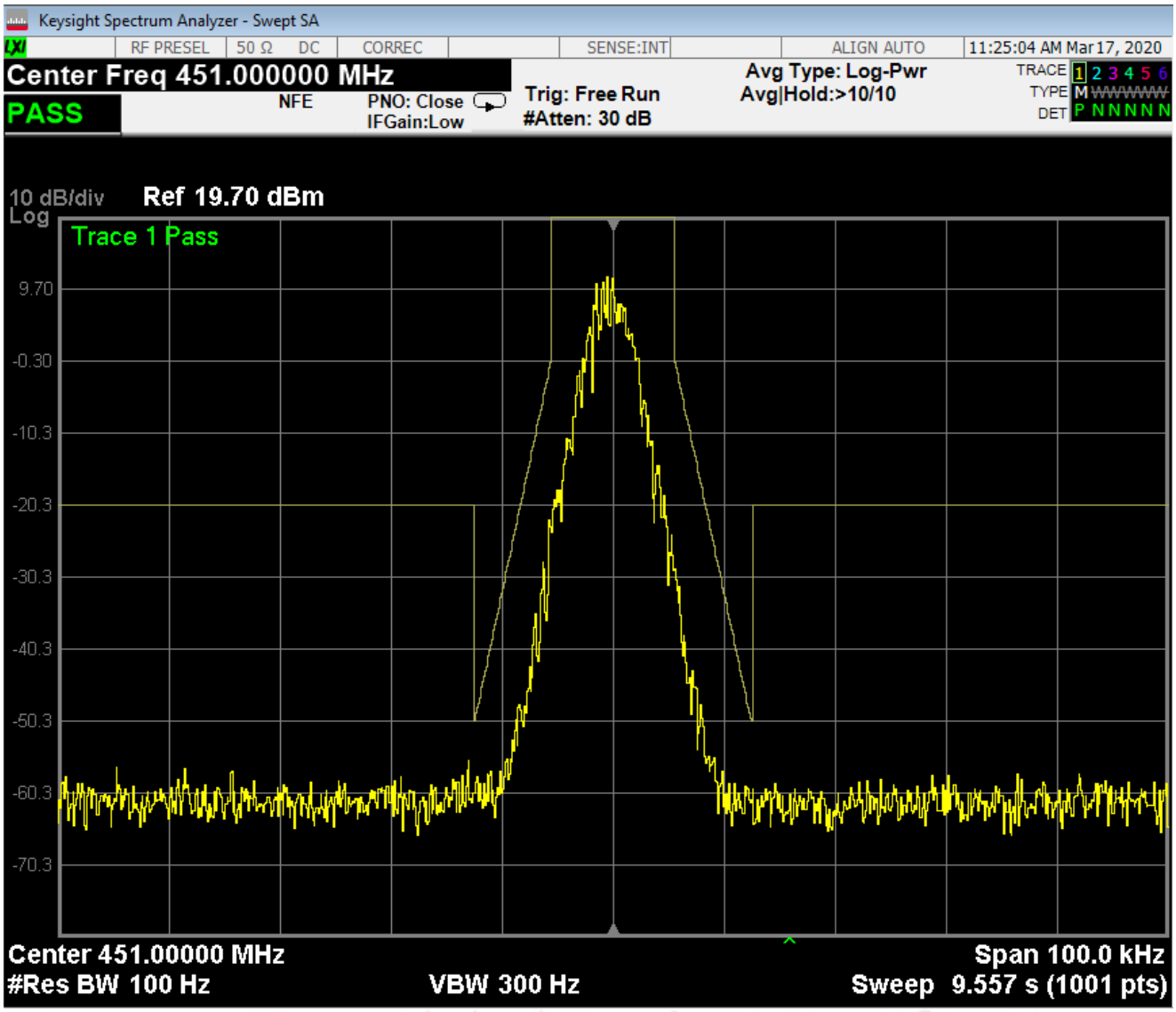
451.000 MHz, 12.5 kHz spacing, GFSK 2400



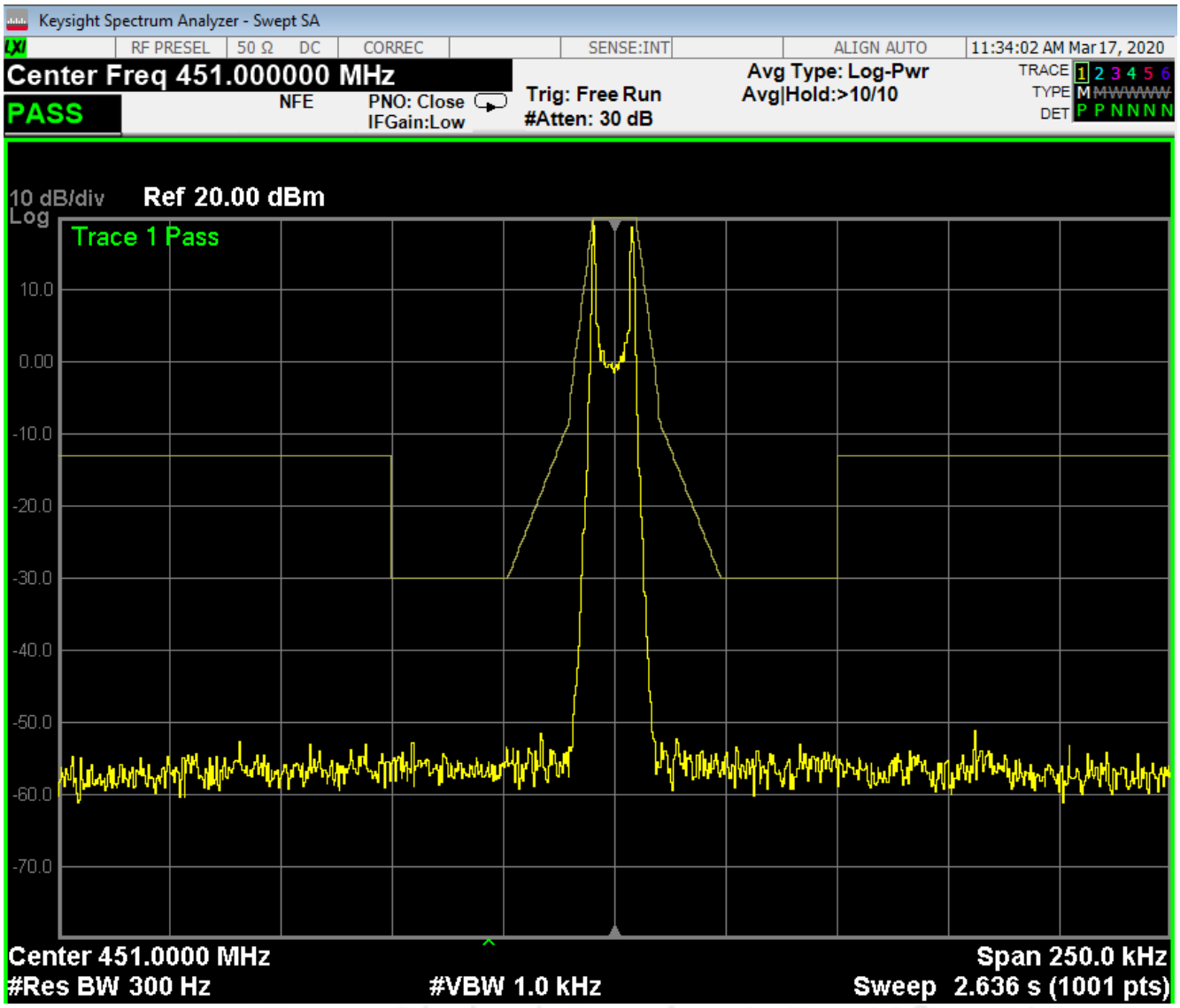
451.000 MHz, 12.5 kHz spacing, GFSK 4800



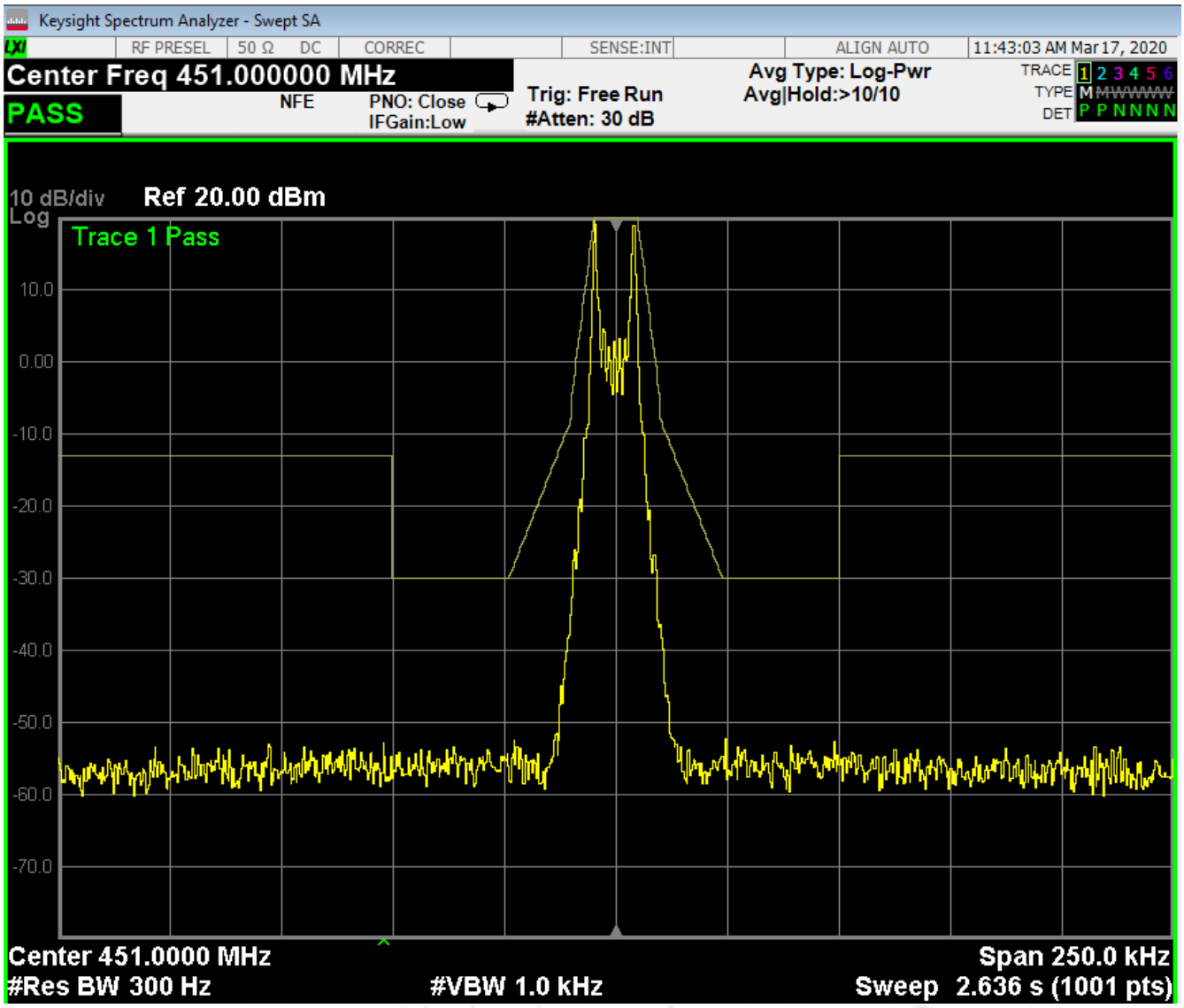
451.000 MHz, 12.5 kHz spacing, GFSK 9600



451.000 MHz, 25.0 kHz spacing, FSK 512



451.000 MHz, 25.0 kHz spacing, FSK 1200



Transmitter spurious emissions at the antenna terminals

Frequency: 421.0000 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
842.000	-65.0	-20.0
1263.000	-65.1	-20.0
2105.000	-50.0	-20.0
2526.000	-49.8	-20.0

Frequency: 470.000 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
940.000	-52.0	-20.0
1410.000	-53.0	-20.0
2350.000	-38.0	-20.0

Limit:

Part 90.210(d) Mask D, (3) on any frequency removed from the centre of the authorised bandwidth by a displacement frequency of more than 12.5 kHz shall be attenuated by at least 50 + 10 log (P) or 70 dB whichever is the lesser attenuation.

The spurious emission limit defined by Mask D has been applied as this transmitter can operate using channel spacing of 12.5 kHz.

Part 2.1051 states that emissions greater than 20 dB below the limit need not be specified.

Part 2.1057 states that the spectrum should be investigated up to the 10th harmonic if the transmitter operates below 10 GHz.

A rated power of 100 mW gives a limit of –20.0 dBm.

No measurements were made above the 10th harmonic.

Result: Complies.
Measurement Uncertainty: ± 3.3 dB

Field strength of the transmitter spurious emissions

Nominal Frequency: 451.000 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
902.0000	43.3	-54.1	-20.0	Vertical	34.1	Pass
	43.0	-54.4	-20.0	Horizontal	34.4	Pass
1353.0000	40.0	-57.4	-20.0	Vertical	37.4	Pass
	50.9	-46.5	-20.0	Horizontal	26.5	Pass
1804.0000	43.0	-54.4	-20.0	Vertical	34.4	Pass
	50.6	-46.8	-20.0	Horizontal	26.8	Pass
2255.0000	55.0	-42.4	-20.0	Vertical	22.4	Pass
	55.0	-42.4	-20.0	Horizontal	22.4	Pass
2706.0000	55.0	-42.4	-20.0	Vertical	22.4	Pass
	55.0	-42.4	-20.0	Horizontal	22.4	Pass
3157.0000	55.0	-42.4	-20.0	Vertical	22.4	Pass
	55.0	-42.4	-20.0	Horizontal	22.4	Pass
3608.0000	55.0	-42.4	-20.0	Vertical	22.4	Pass

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

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

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.

Limit:

All spurious emissions are to be attenuated by at least 50 + 10 log (P) from below the mean power of the transmitter. The rated power of 100 mW gives a limit of -20.0 dBm.

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.

The test was done at normal and extreme voltage and worst case has been tabulated as under:

Temperature (°C)	421.000 MHz Error (Hz)	451.000 MHz Error (Hz)	480.000 MHz Error (Hz)
+50	-250	-290	-280
+40	-180	-230	-230
+30	-190	-240	-240
+20	-230	-290	-290
+10	-260	-320	-300
0	-270	-330	-320
-10	-230	-280	-280
-20	-70	-90	-100
-30	-110	-200	-150

Limits:

Part 90.213 states that mobile transmitters operating between 421.000-512.000 MHz with 6.25 kHz channelling are required to have a frequency tolerance of 1.0 ppm.

A worst case error of 0.73 ppm (330 Hz / 451.000 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.

Frequency deviation for each transient period in kHz

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

Limits:

Time Interval	Period (ms)	Channel Spacing 6.25 kHz	Channel Spacing 12.5 kHz	Channel Spacing 25 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.

12.5 kHz transmitter turn on (451.000 MHz)

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

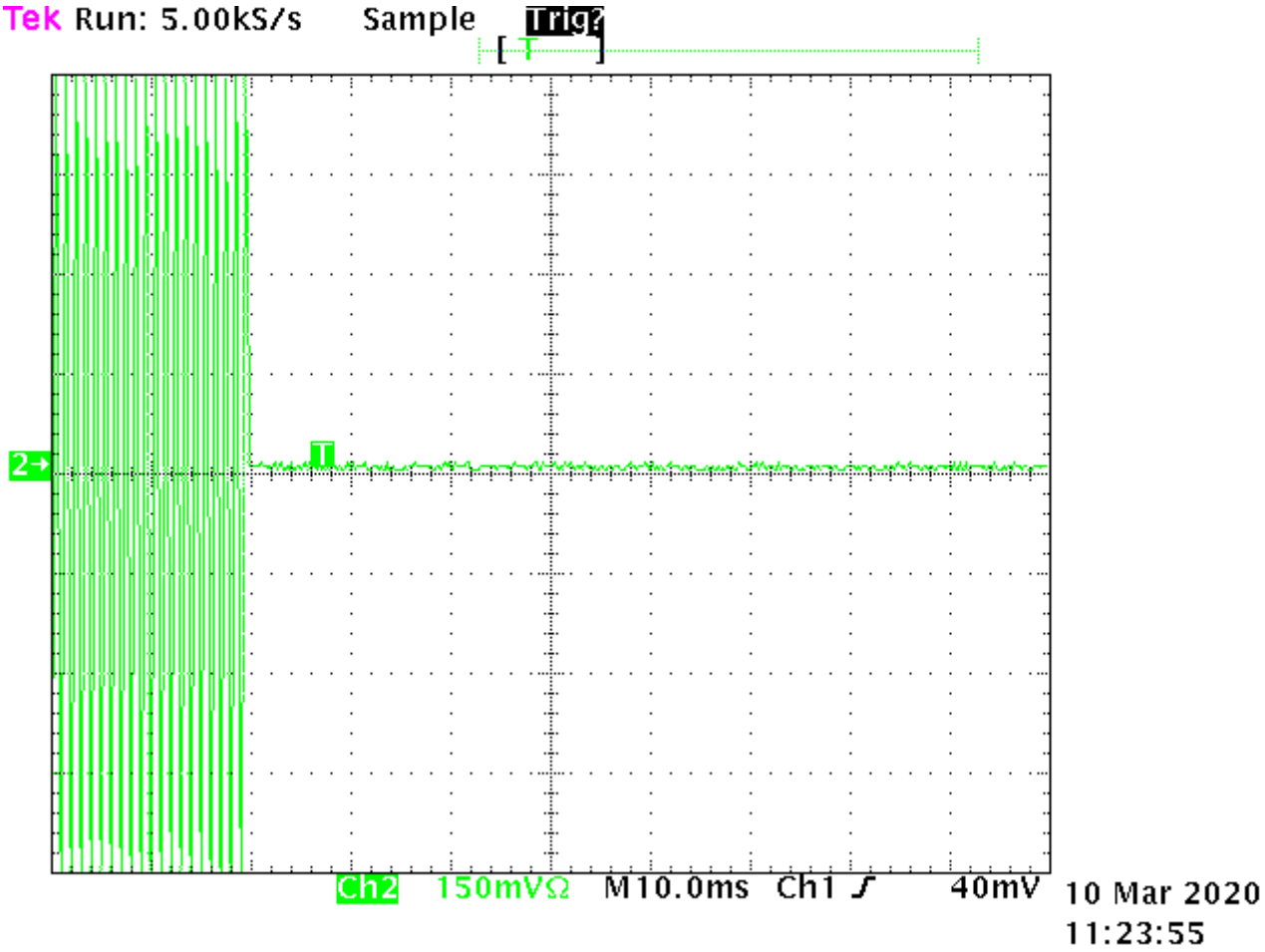
Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division.

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 (451.000 MHz)

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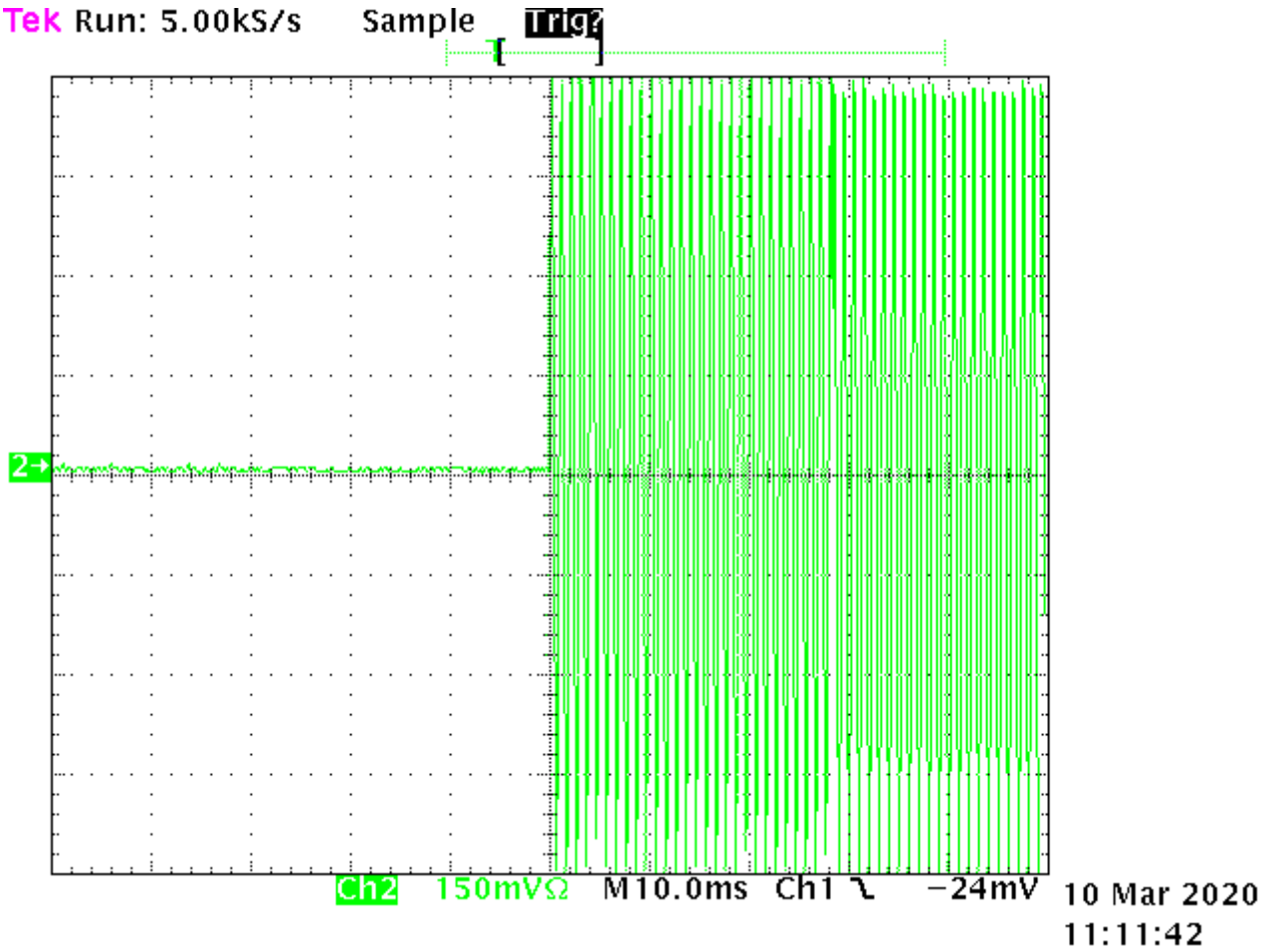
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division

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.



25.0 kHz Transmitter turn on (451.000 MHz)

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

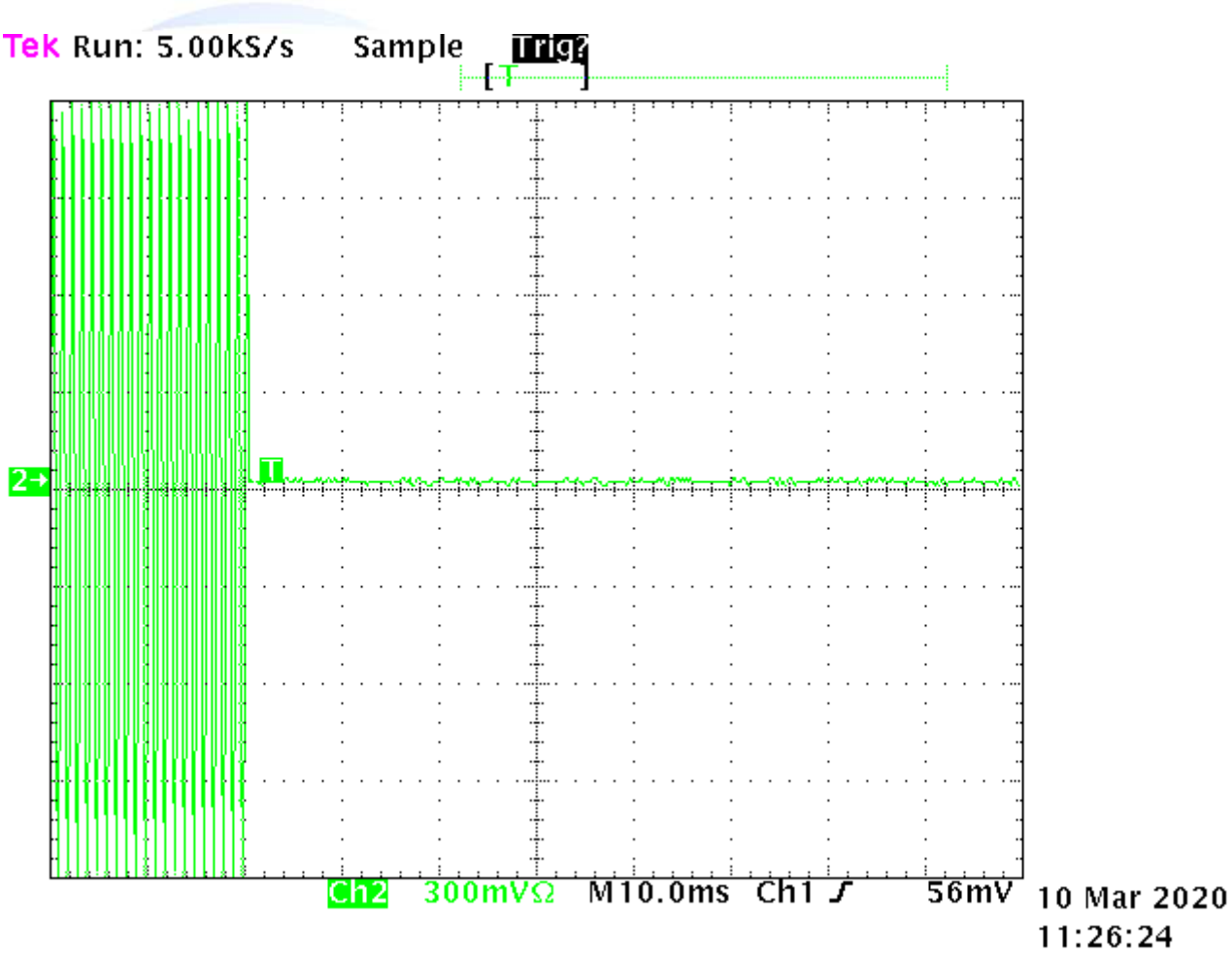
Green trace has been maximised to give full screen indication of +/- 25.0 kHz.
Therefore each Y axis division = 6.25 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division.

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 2.5 divisions from the left hand edge.
t2 occurs between 2.5 and 4.5 divisions from the left hand edge.

No transient response can be observed during *t*1 and *t*2.



25.0 kHz transmitter turn off (451.000 MHz)

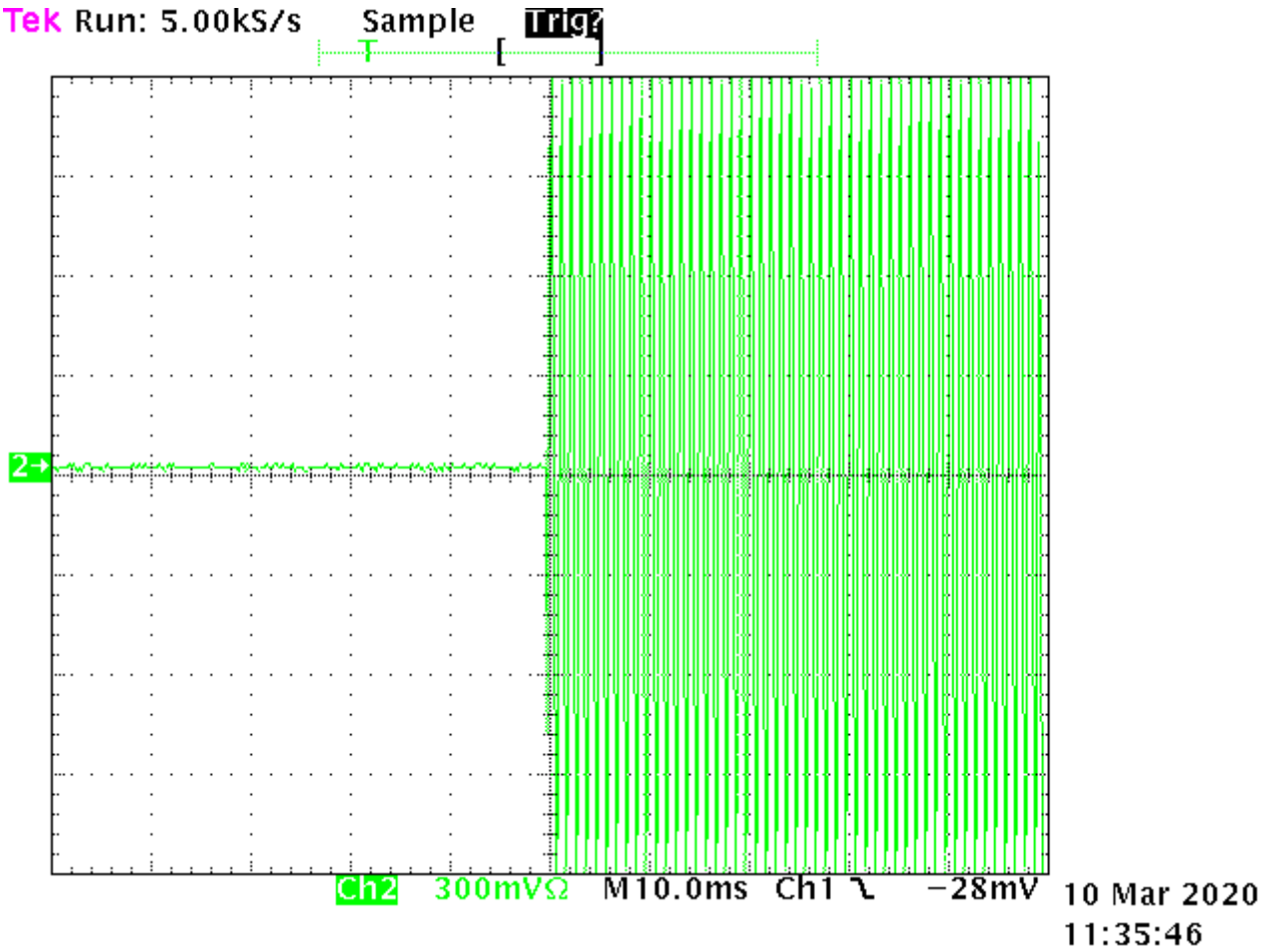
Green Trace = 1 kHz tone with FM deviation of 25.0 kHz.

Green trace has been maximised to give full screen indication of +/- 25.0 kHz.
Therefore each Y axis division = 6.25 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 4.5 and 5.0 divisions from the left hand edge..

No 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.

Minimum safe distances have been calculated below.

The formula for Power Density is given by: $E^2/3770 = mW/cm^2$

Between 300 – 1500 MHz the General Population / Uncontrolled exposure limit is f/1500 mW/cm^2 .

As this radio can operate over the range of 421.0 to 480.0 MHz the lowest frequency of operation in the USA, which will give the worst case result, would be 421.0 MHz.

The power density at 421.0 MHz will be 0.281 mW/cm^2.

For an Uncontrolled Environment

Power Density = 0.281 $mW/cm^2 = E^2/3770$

$E = \sqrt{0.281*3770}$

E = 32.5 V/m

The rated maximum transmitter power = 100 mW (+20 dBm).

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

The client has declared that this transmitter would typically be operated using quarter wave whip or a dipole antennas which typically have a gain of 2.15 dBi or a numeric gain of 1.64.

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

D = (√ (30 * P * G * DC)) / FS

D = (√ (30 * 0.1 * 1.64 * 1)) / 32.5

d= 0.068 m or 6.8 cm

Result: Complies if a safe distance of at least 20 cm is applied to this device when it is used in an uncontrolled environment.

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Last Cal	Cal Due	Interval
Aerial Controller	EMCO	1090	9112-1062	N/a	N/a	N/a
Aerial Mast	EMCO	1070-1	9203-1661	N/a	N/a	N/a
Biconical Antenna	Schwarzbeck	BBA 9106	-	28/09/2017	28/09/2020	3 years
Horn Antenna	EMCO	3115	9511-4629	08/08/2017	08/08/2020	3 years
Log Periodic Antenna	Schwarzbeck	VUSLP 91111	9111-112	24/09/2017	24/09/2020	3 years
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	08/05/2018	08/05/2021	3 years
Power Attenuator	JFW	50FH-030-100	-	N/a	N/a	N/a
Power Supply	Hewlett Packard	6032A	2743A-02859	N/a	N/a	N/a
Oscilloscope	Tektronics	745A	B010643	-	-	-
Receiver	Rohde & Schwarz	ESIB-40	100295	12/09/18	11/09/2020	2 years
Selective Level Meter	Anritsu	ML422C	M35386	22/05/2018	22/05/2020	2 years
Signal Generator	Rohde & Schwarz	SMHU	838923/028	21/05/2019	20/05/2021	2 years
Spectrum Analyzer	Keysight	N9038A	MY57290153	11/01/2019	11/04/2020	1 year
Thermal chamber	Contherm	M180F	86025	N/a	N/a	N/a
Thermometer	DSIR	RT200	35	10/10/2016	10/10/2021	5 years
Turntable	EMCO	1080-1-2.1	9109-1578	N/a	N/a	N/a
VHF Balun	Schwarzbeck	VHA9103	-	N/a	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.

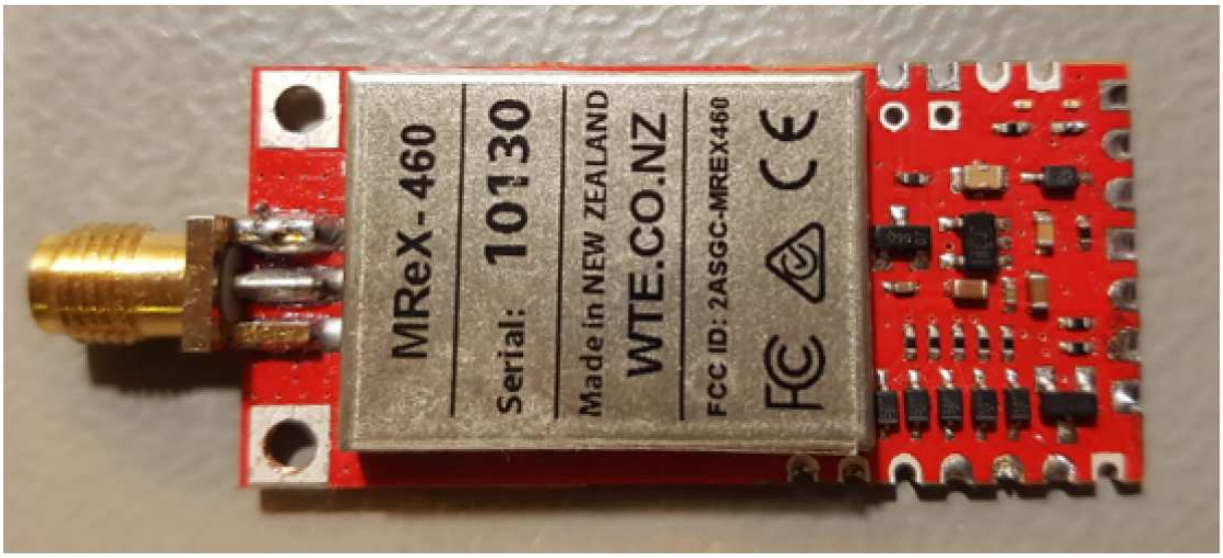
All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

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.

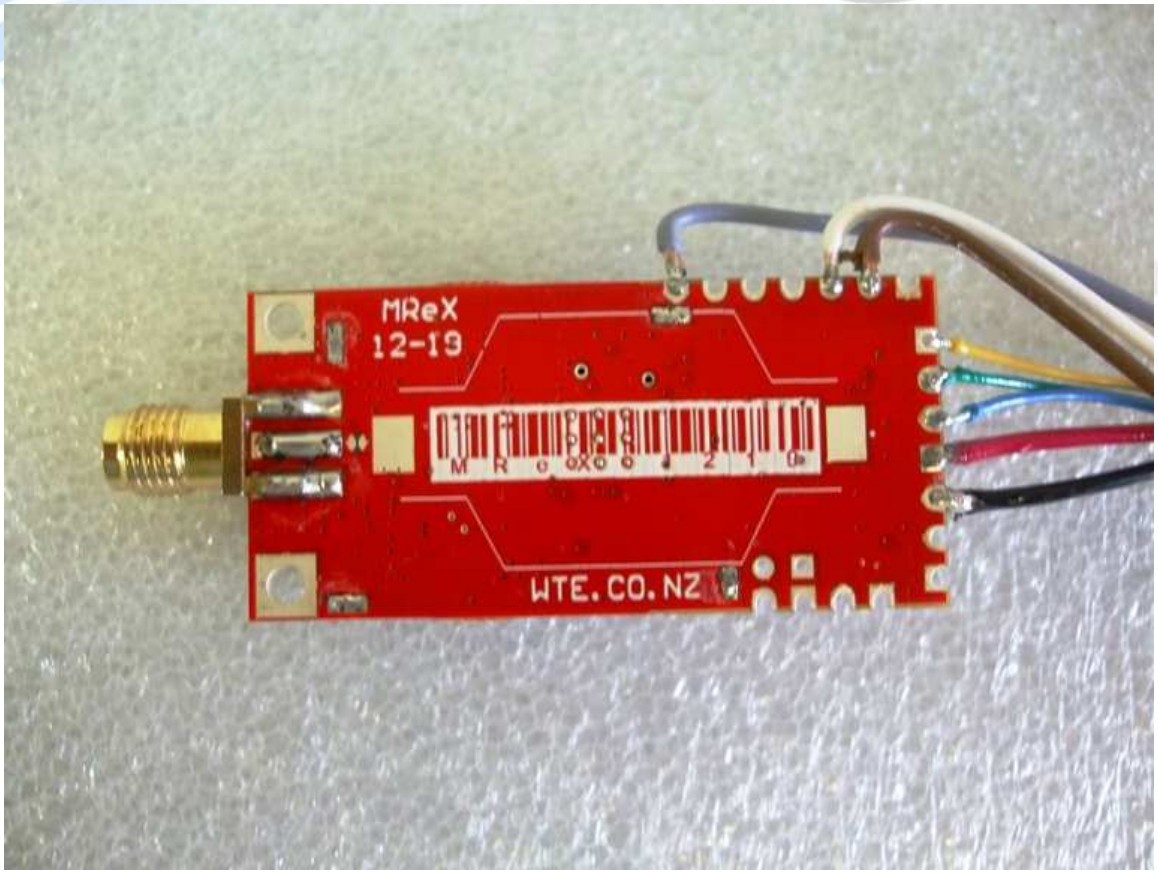
9. PHOTOGRAPHS

FCC ID 2ASGC-MREX460

Unit Top Face



Back face



Radiated Emission test setup