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TEST REPORT

ELPRO E2-455-161 VHF Transceiver

tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

ELPRO Technologies Pty Ltd

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 **ELPRO E2-455-161 VHF Transceiver** 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 and ANSI / TIA-603-D-2010.

2. RESULT SUMMARY

The results of testing carried out between the 1st and 20th of November 2019 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	ELPRO Technologies Pty Ltd
Physical Address	29 Lathe Street Virginia QLD 4014
Country	Australia
Contact	Mr Andrew Sinclair

5. TEST SAMPLE DESCRIPTION

Brand Name	ELPRO
Model Number	E2-455-161
Brand Type	VHF Transceiver
Manufacturer	ELPRO Technologies Pty. Ltd
Serial Number(s)	Device under test: 30047511 Auxiliary device: 30047491
FCC ID	O9P-E2-455C1

Product Overview:

The E2-455 is a radio modem module that can be used as a base station radio for a number of ELPRO wireless products.

The modem module operates as a wireless network adapter for the transfer of 802.11 format data frames over lower speed wireless links.

The E2-455 consists of a host microcontroller, a RF transceiver section and a power supply section.

Band of operation

150 MHz to 174 MHz

Rated Transmitter Output Power

10 mW (+10.0 dBm) to 10 watts (+40.0 dBm)

Test frequencies

Frequency (MHz)	Channel Bandwidths (kHz)	Authorised Bandwidths (kHz)	Modulation Type
150.900	6.25, 12.5, 25.0	6.0, 11.25, 20.0	4FSK / 64QAM
160.000	6.25, 12.5, 25.0	6.0, 11.25, 20.0	4FSK / 64QAM
173.300	6.25, 12.5, 25.0	6.0, 11.25, 20.0	4FSK / 64QAM

Bottom and top frequencies of the switching range were selected for testing as per the FCC frequency allocation 47 C.F.R. § 2.106.

Transmitter Type

This equipment has been classed as mobile

Emission designators as declared by the client

4FSK: 11K0F1D, 19K0F1D

64QAM: 5K00D1D, 10K0D1D, 20K0D1D

Receiver Intermediate Frequency

Zero conversion receiver

Power Supply

External 12 Vdc power supply

Standard Temperature and Humidity

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

Standard Test Power Source

Standard Test Voltage: 13.8 Vdc

Extreme Temperature

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

Test Setup:

Programming of the device was performed by accessing the serial port of the laptop using a serial communication utility (Putty).

The baud rate for the communication was set to 115,200 bps.

The commands needed to change the device configuration for testing purposes were provided by the client.

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 band of 150 - 174 MHz 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;

(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.

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 10.0 W (+40.0 dBm)

Frequency (MHz)	Voltage (Vdc)	Carrier Power (dBm)		
		+22˚ C	+55˚ C	-30˚ C
150.900	9.0	39.3	39.4	39.1
	13.8	39.4	39.4	39.2
	30.0	39.3	39.5	39.3
173.300	9.0	39.4	39.0	38.9
	13.8	39.3	39.4	38.9
	30.0	39.4	39.5	39.0

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:

F1D and D1D: Frequency and Amplitude/Angle 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:

4FSK: 11K0F1D, 19K0F1D

64QAM: 5K00D1D, 10K0D1D, 20K0D1D

A 7.5 kHz channel spacing can be achieved, as per section 90.209(b)(s), as the frequency of may be set in 1 Hz increments.

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.

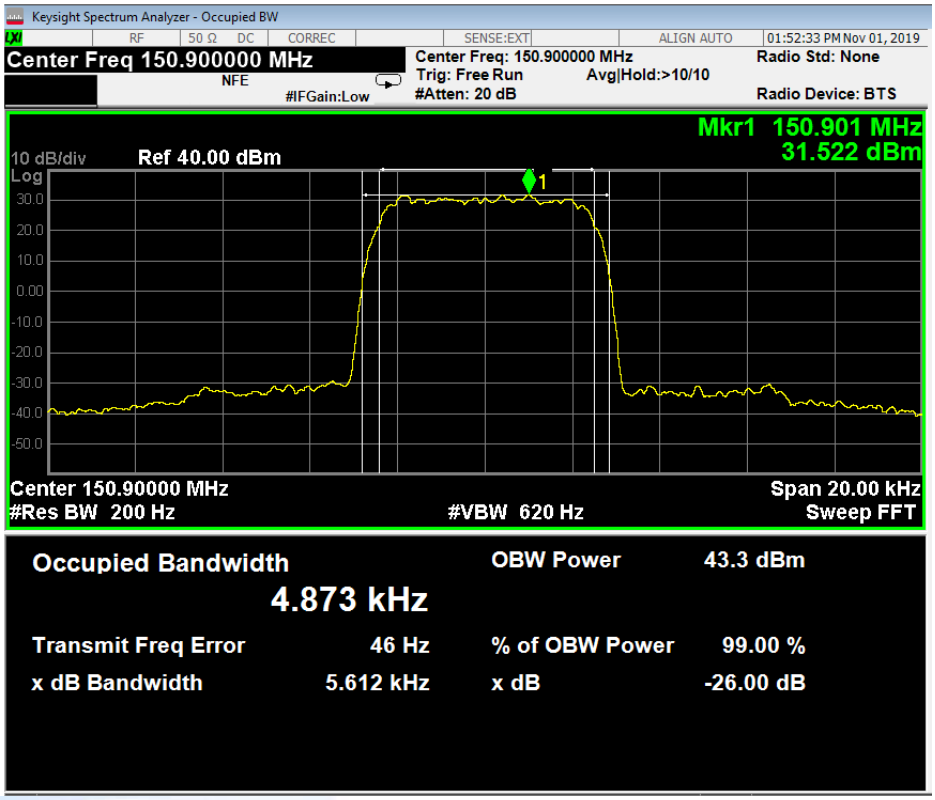
Attached to the input of the spectrum analyser was an external 30 dB attenuator.

Result: Complies

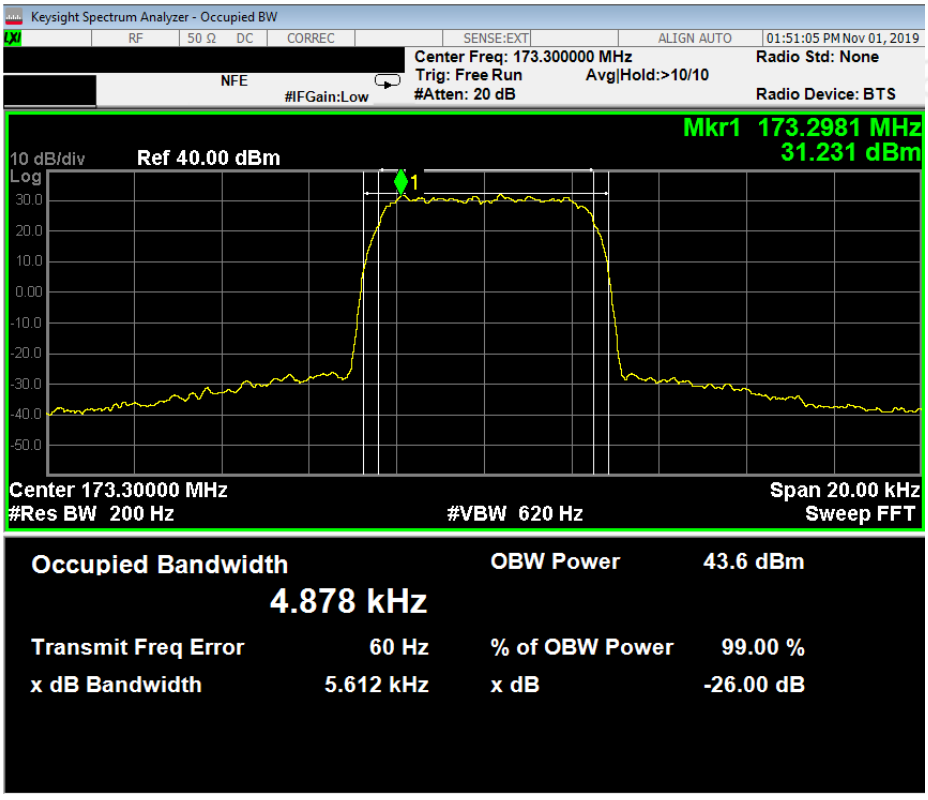
6.25 kHz channel bandwidth measurements with plots

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)
4QAM	150.900	4.873	6.000 kHz
4QAM	173.300	4.878	

6.25 kHz - 150.900 MHz - 4QAM



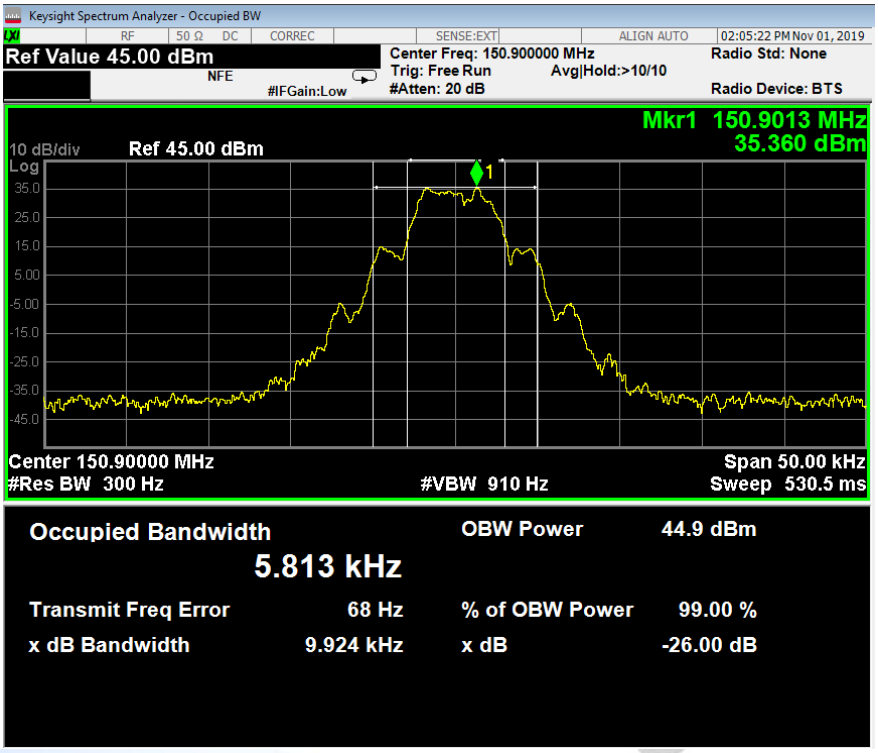
6.25 kHz – 173.300 MHz - 4QAM



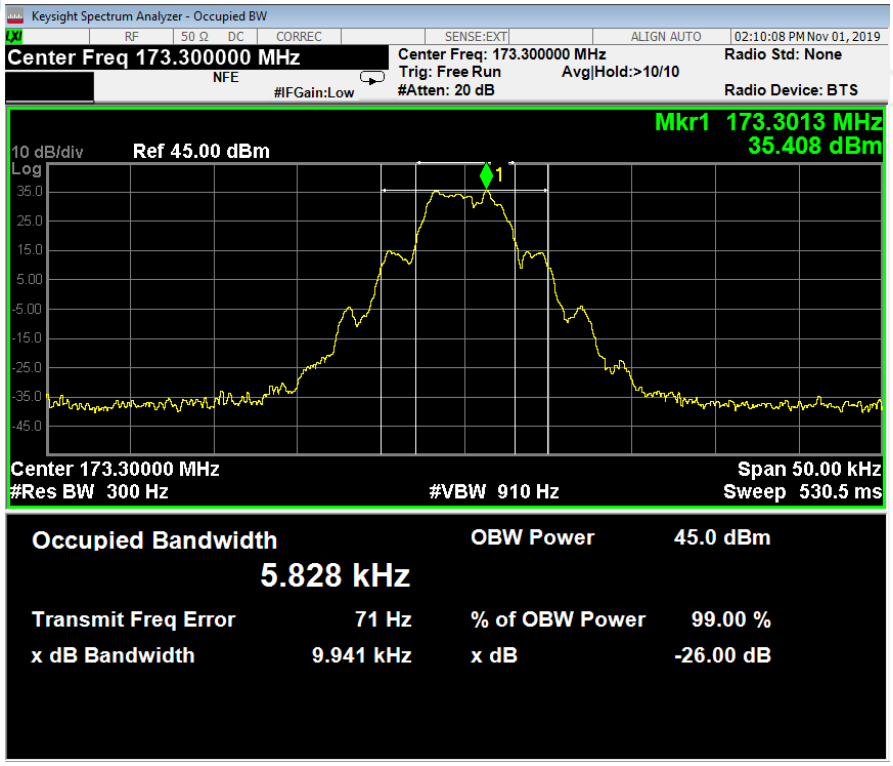
12.5 kHz channel bandwidth measurements with plots

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)
2FSK	150.900	5.813	11.250 kHz
	173.300	5.828	

12.5 kHz – 150.900 MHz - 2FSK



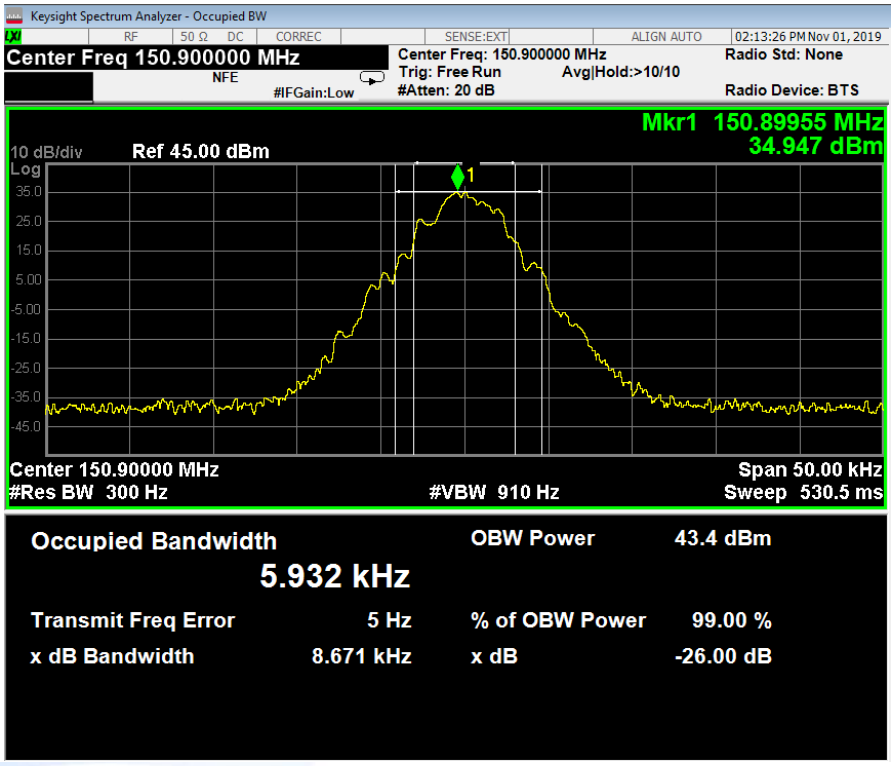
12.5 kHz – 173.300 MHz - 2FSK



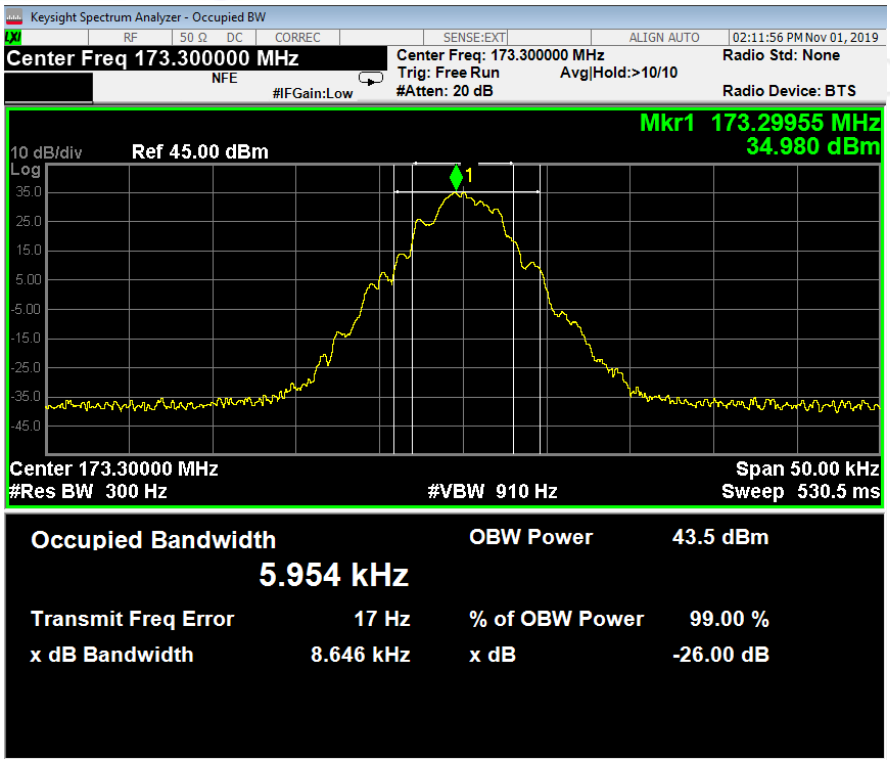
12.5 kHz channel bandwidth measurements with plots

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)
4FSK	150.900	5.932	11.250 kHz
	173.300	5.954	

12.5 kHz – 150.900 MHz - 4FSK



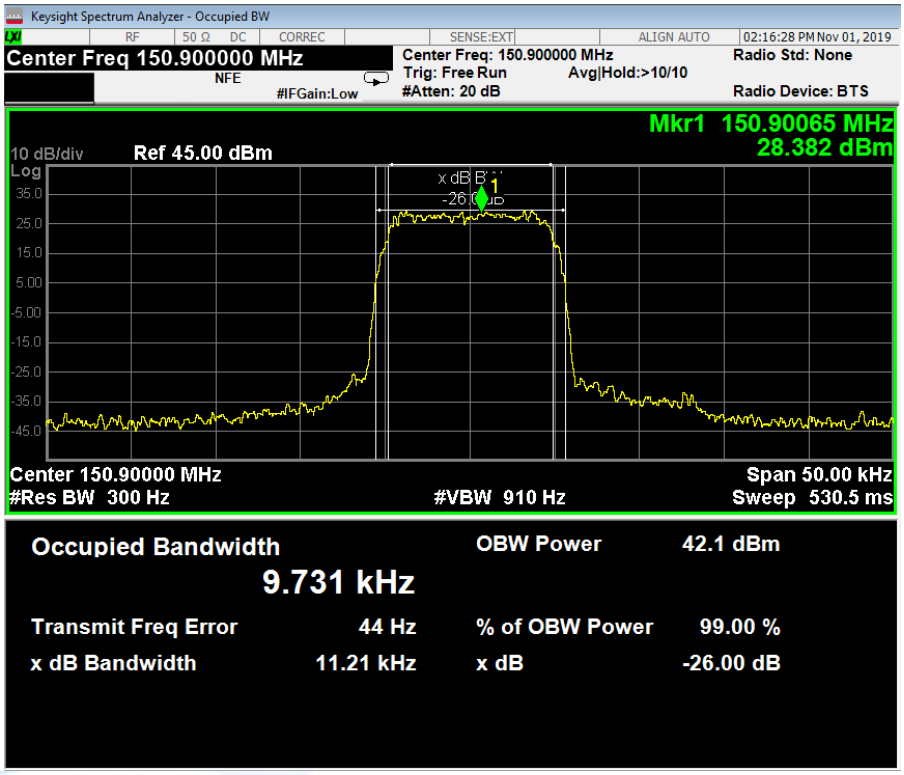
12.5 kHz – 173.300 MHz - 4FSK



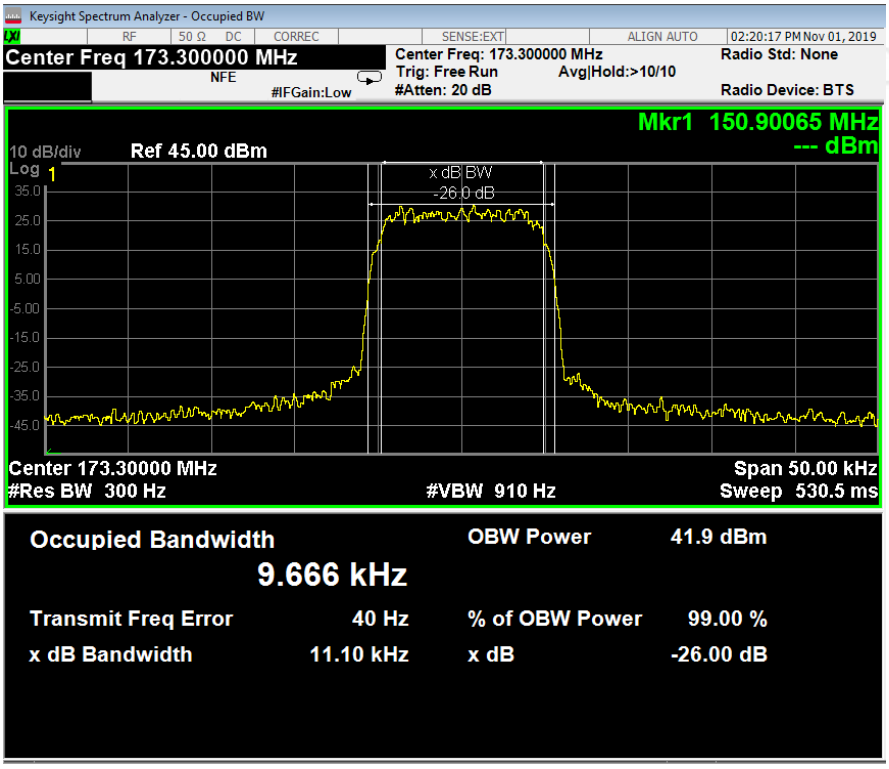
12.5 kHz channel bandwidth measurements with plots

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)
4QAM	150.900	9.731	11.250 kHz
	173.300	9.666	

12.5 kHz – 150.900 MHz - 4QAM



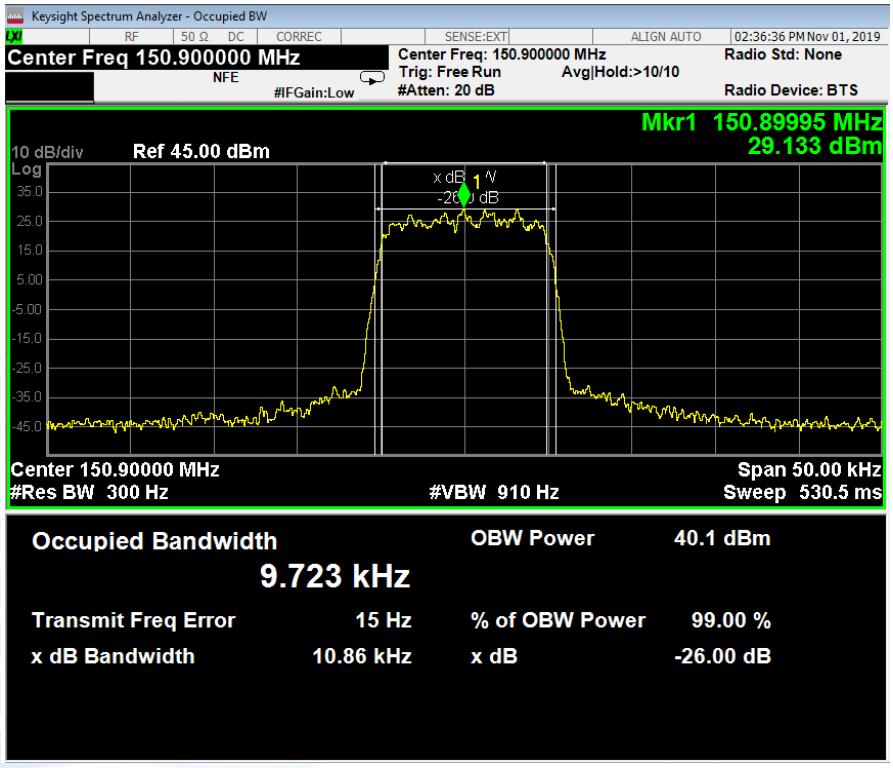
12.5 kHz – 173.300 MHz - 4QAM



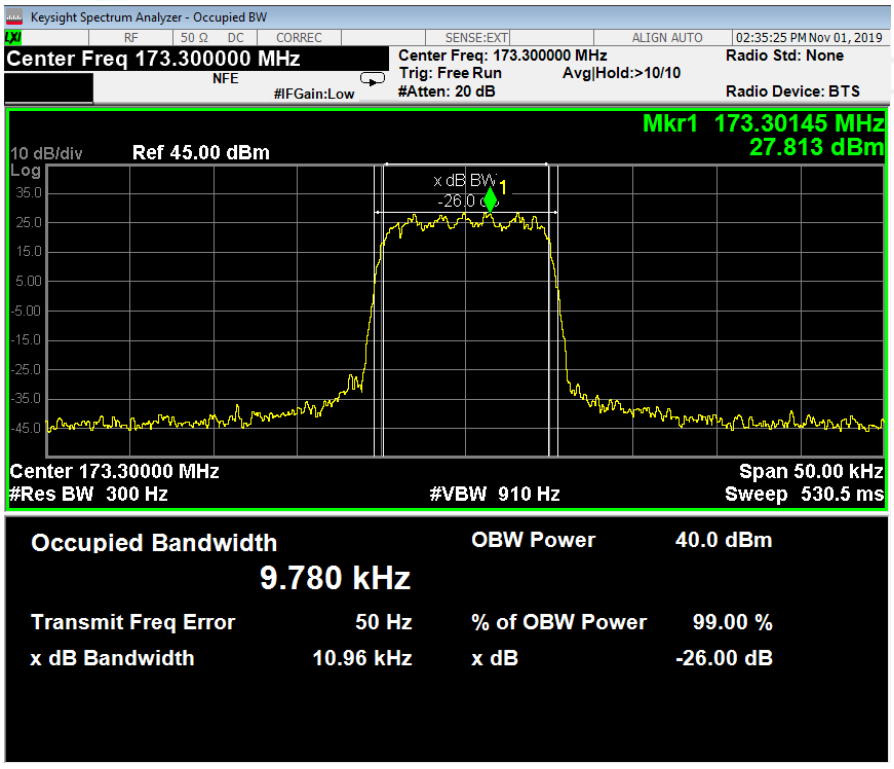
12.5 kHz channel bandwidth measurements with plots

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)
16QAM	150.900	9.723	11.250 kHz
	173.300	9.780	

12.5 kHz – 150.900 MHz - 16QAM



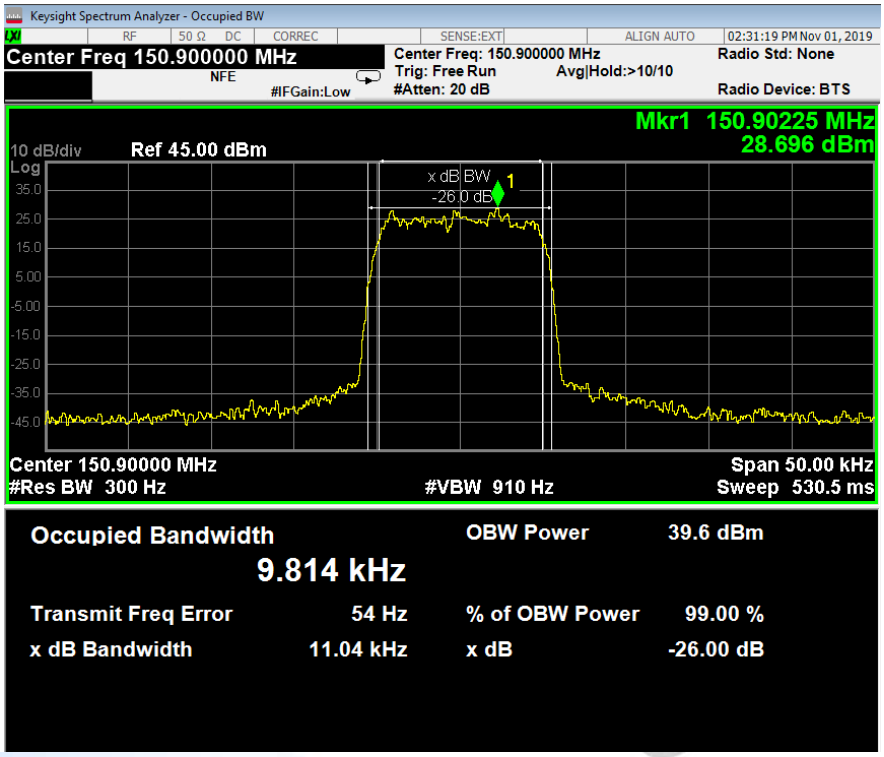
12.5 kHz – 173.300 MHz - 16QAM



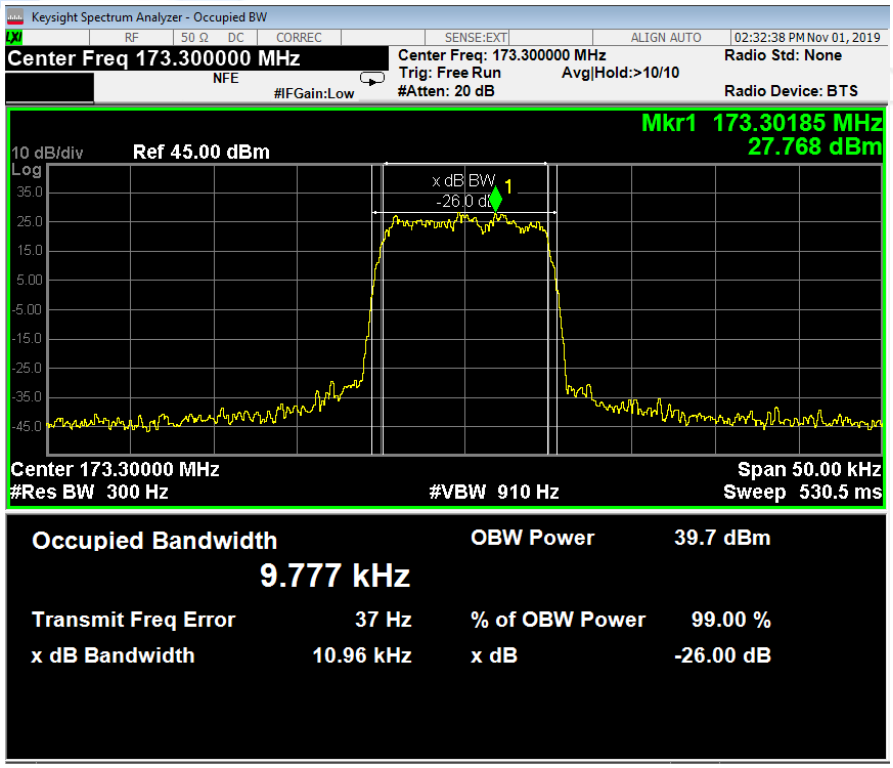
12.5 kHz channel bandwidth measurements with plots

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)
64QAM	150.900	9.814	11.250 kHz
	173.300	9.777	

12.5 kHz – 150.900 MHz - 64QAM



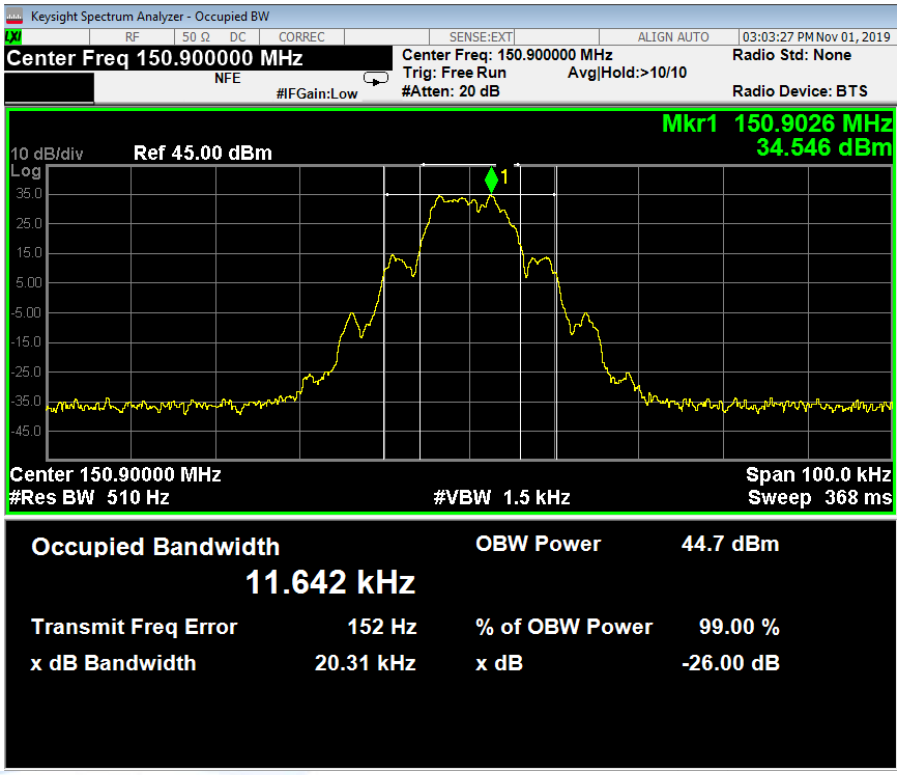
12.5 kHz – 173.300 MHz - 64QAM



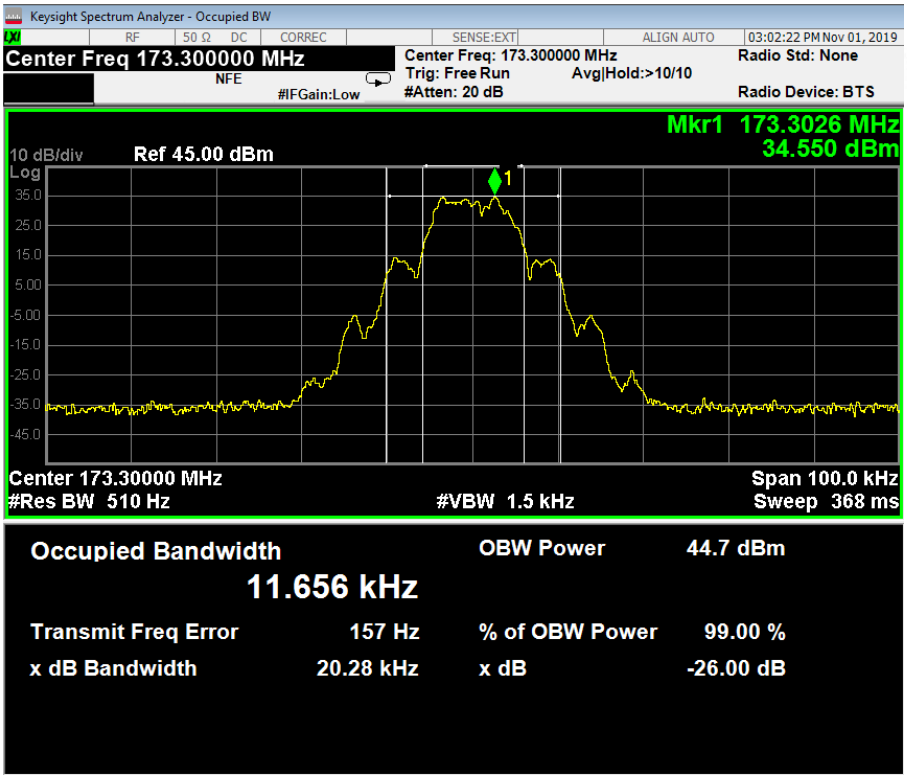
25.0 kHz channel bandwidth measurements with plots

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)
2FSK	150.900	11.642	20.0 kHz
	173.300	11.656	

25.0 kHz – 150.900 MHz - 2FSK



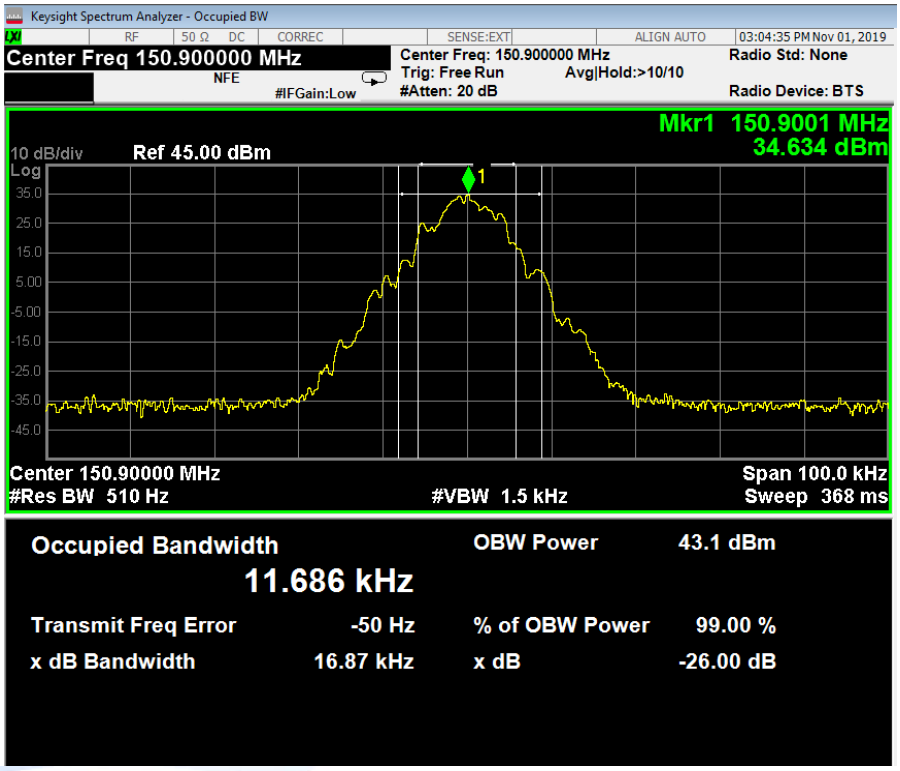
25.0 kHz – 173.300 MHz - 2FSK



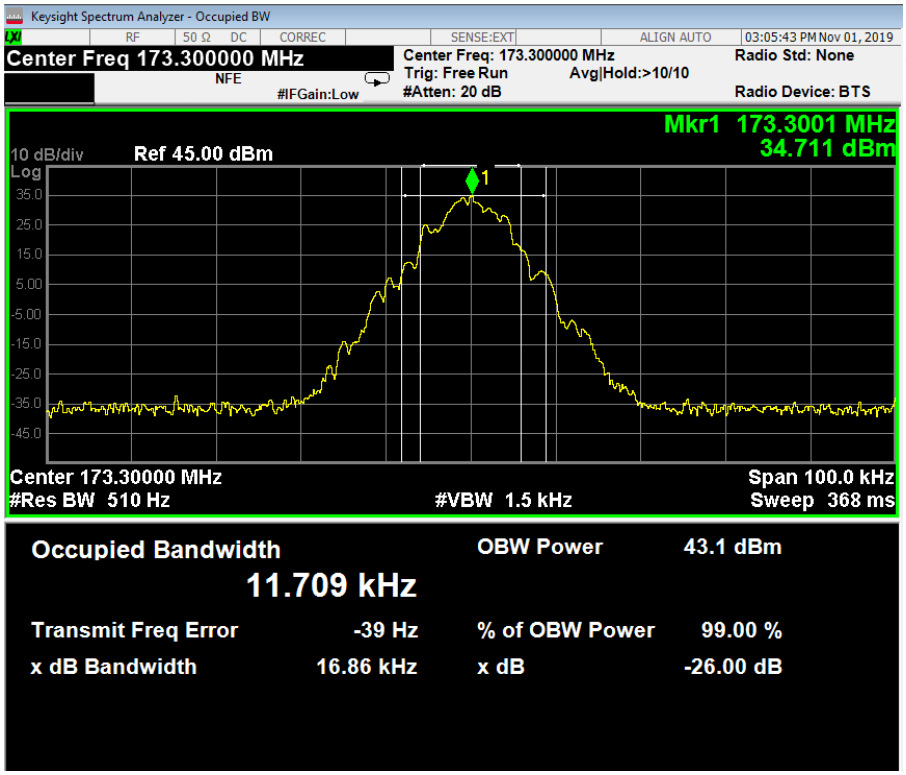
25.0 kHz channel bandwidth measurements with plots

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)
4FSK	150.900	11.686	20.0 kHz
	173.300	11.709	

25.0 kHz – 150.900 MHz - 4FSK



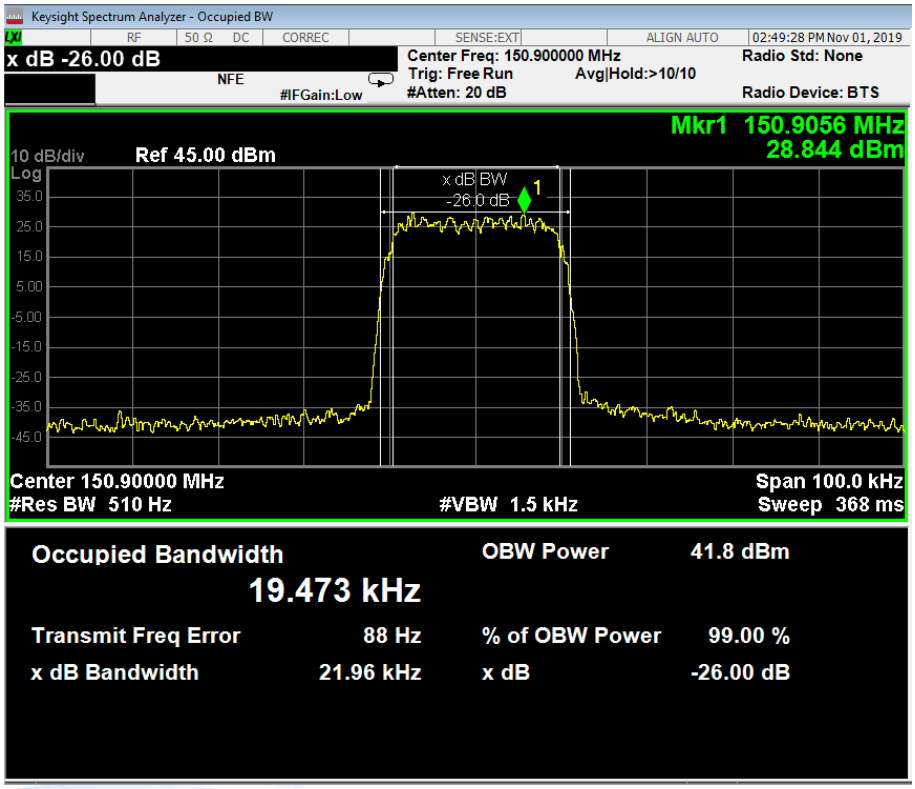
25.0 kHz – 173.300 MHz - 4FSK



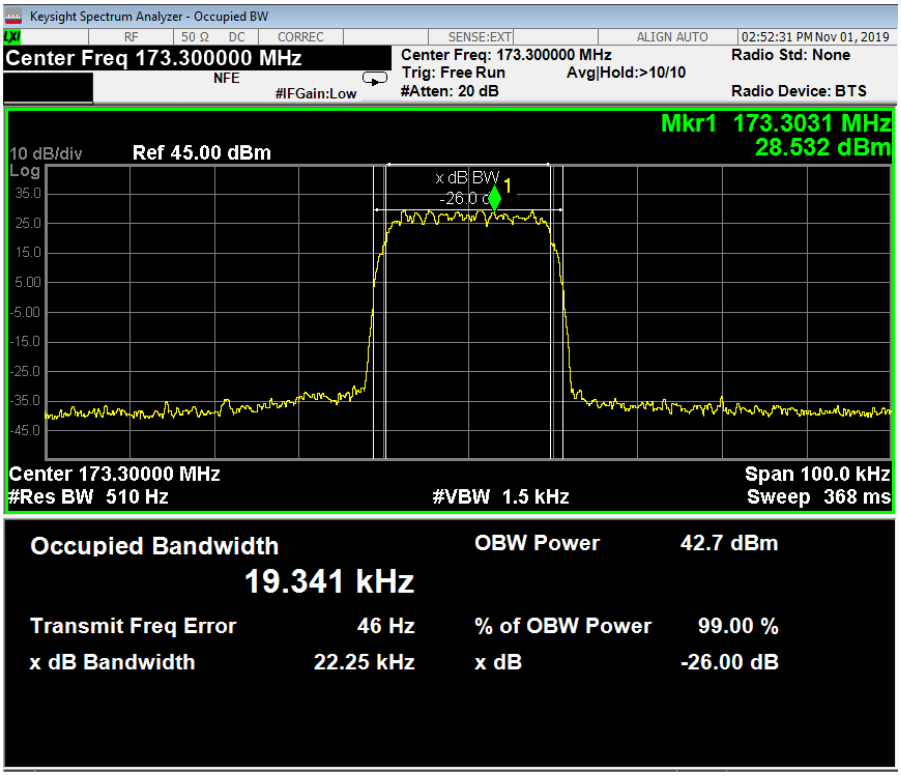
25.0 kHz channel bandwidth measurements with plots

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)
4QAM	150.900	19.473	20.0 kHz
	173.300	19.341	

25.0 kHz – 150.900 MHz - 4QAM



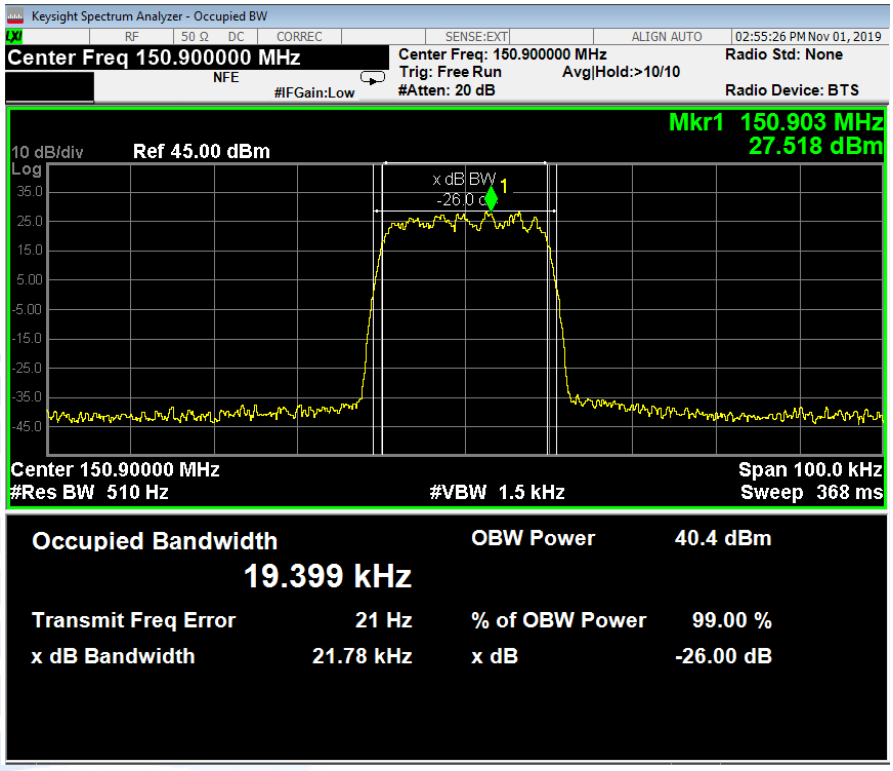
25.0 kHz – 173.300 MHz - 4QAM



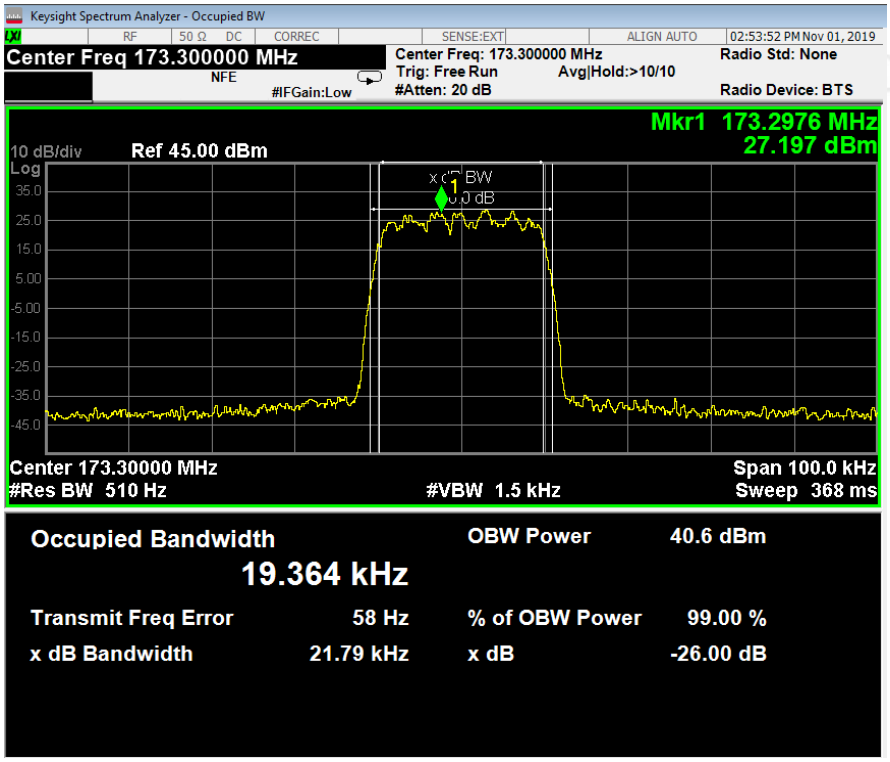
25.0 kHz channel bandwidth measurements with plots

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)
16QAM	150.900	19.399	20.0 kHz
	173.300	19.364	

25.0 kHz – 150.900 MHz - 16QAM



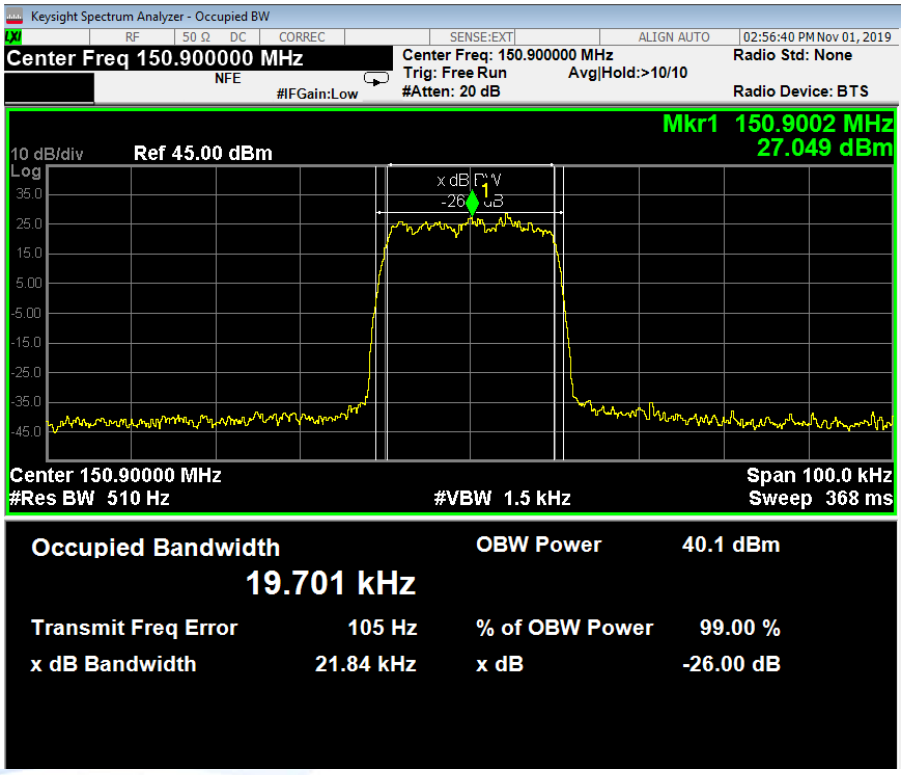
25.0 kHz – 173.300 MHz - 16QAM



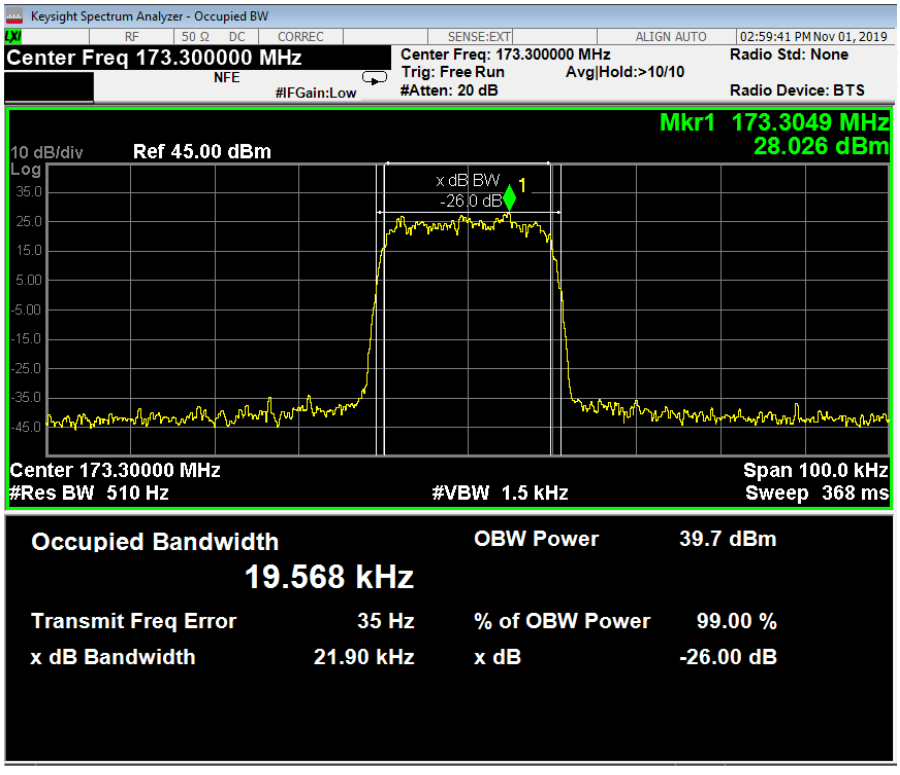
25.0 kHz channel bandwidth measurements with plots

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)
64QAM	150.900	19.701	20.0 kHz
	173.300	19.568	

25.0 kHz – 150.900 MHz - 64QAM



25.0 kHz – 173.300 MHz - 64QAM



Spectrum Masks

The spectrum masks are defined in:

Section 90.210(d) – Mask B & C, D and E have been applied as the transmitter can operate in the band 150.0-174.0 MHz using a channel bandwidth 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 mode using a peak detector.

The product was operated at the maximum transmit power.

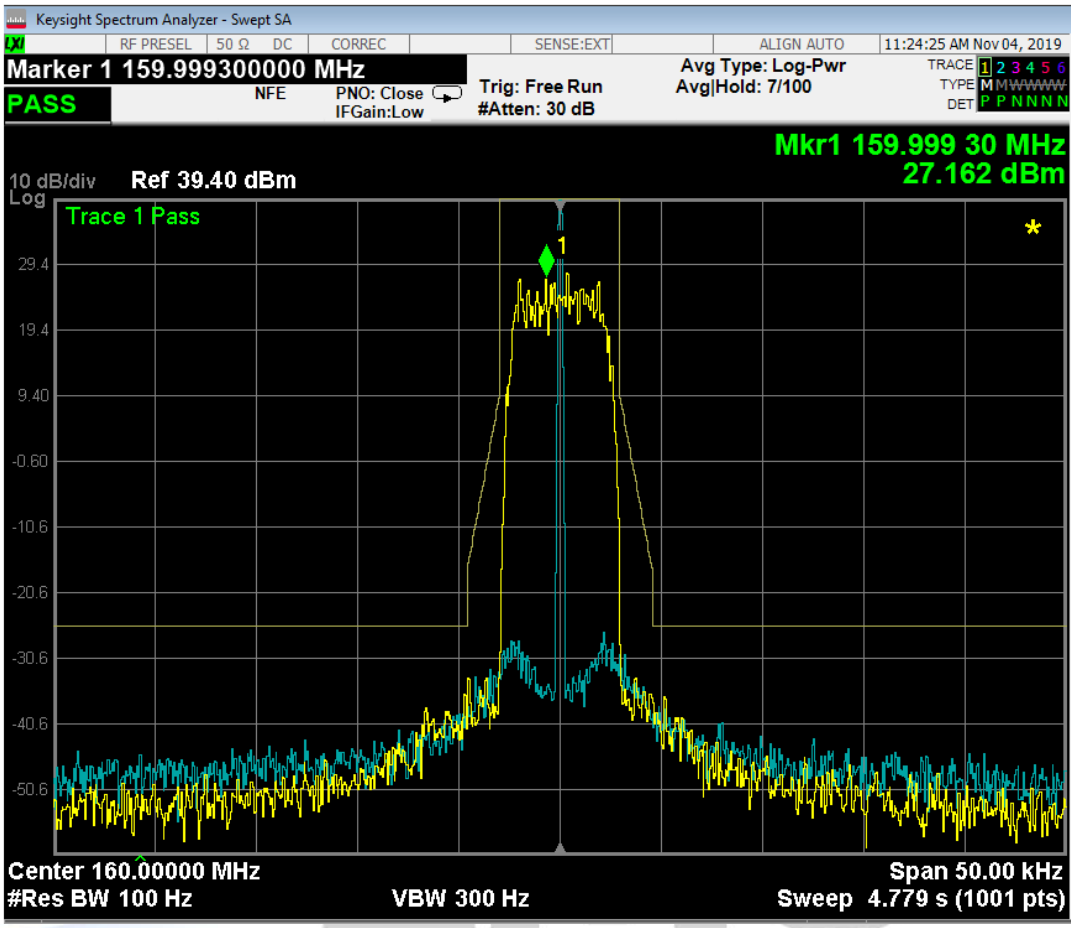
Before each measurement the true peak for each modulation was determined by using a bandwidth of 120 kHz.

The yellow trace corresponds to the modulated peak when the transmitter was modulated using the modulation sources internal to the transmitter as supplied by the client

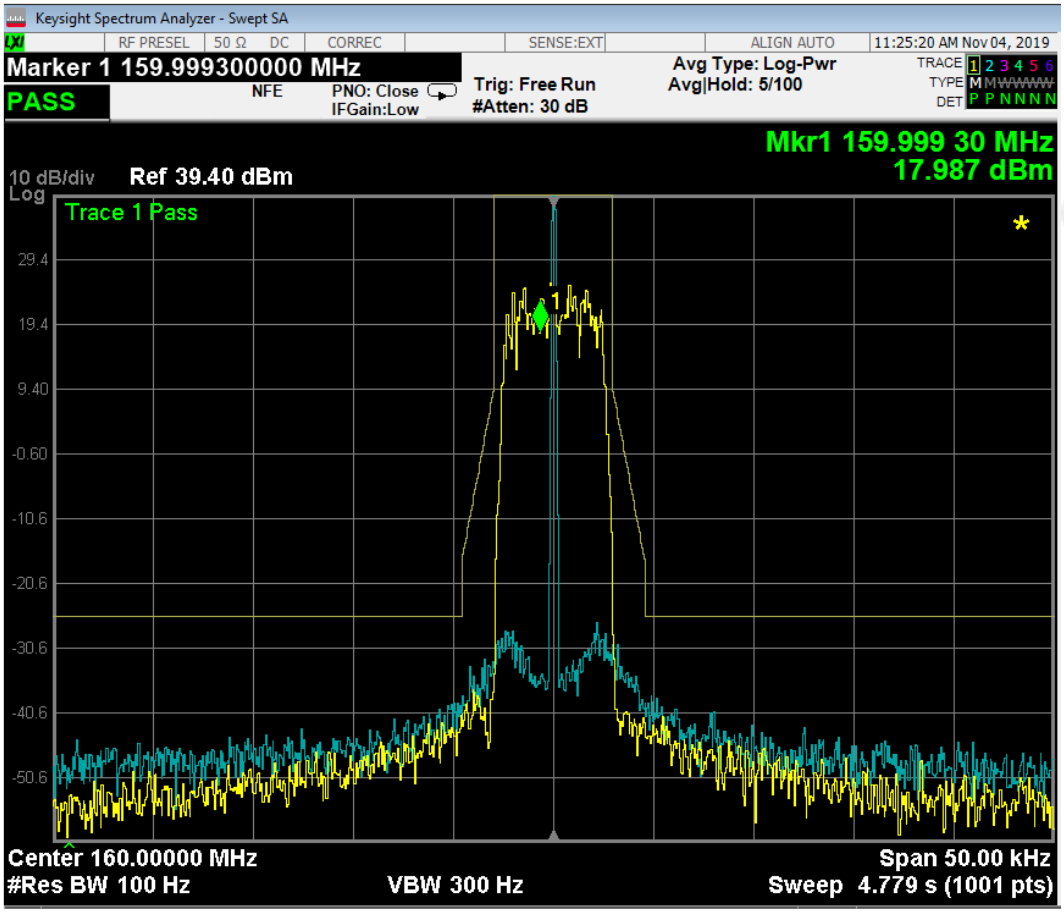
The blue trace corresponds to the unmodulated RF output has also been included in the plots.

Result: Complies.

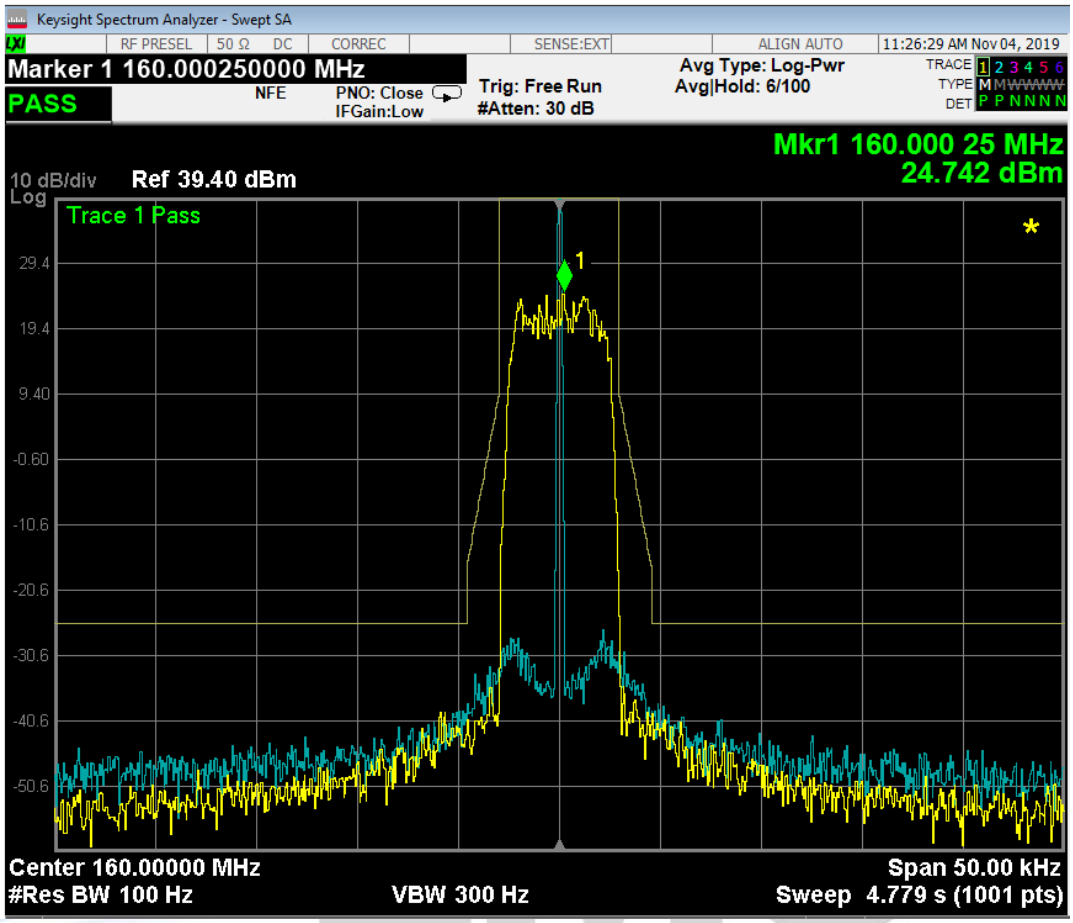
160.000 MHz, 6.250 kHz bandwidth, Mask E, 4QAM



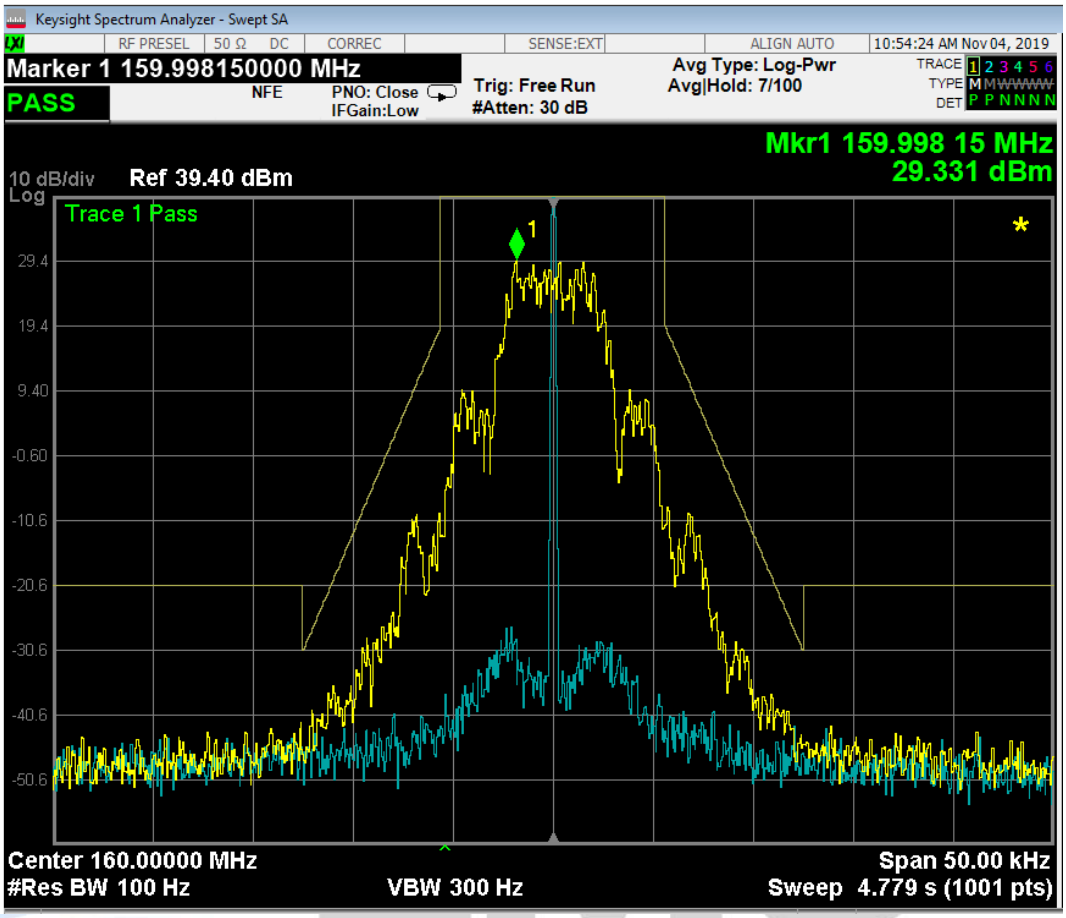
160.000 MHz, 6.250 kHz bandwidth, Mask E, 16QAM



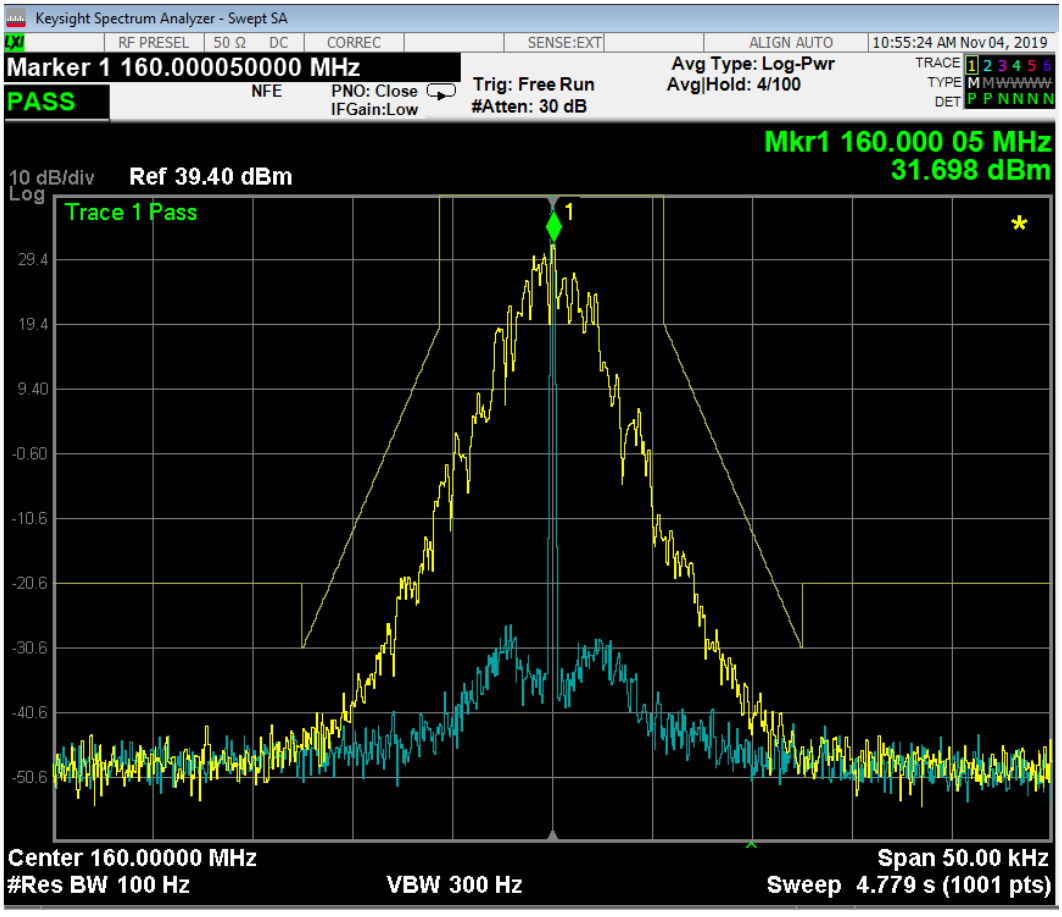
160.000 MHz, 6.250 kHz bandwidth, Mask E, 64QAM



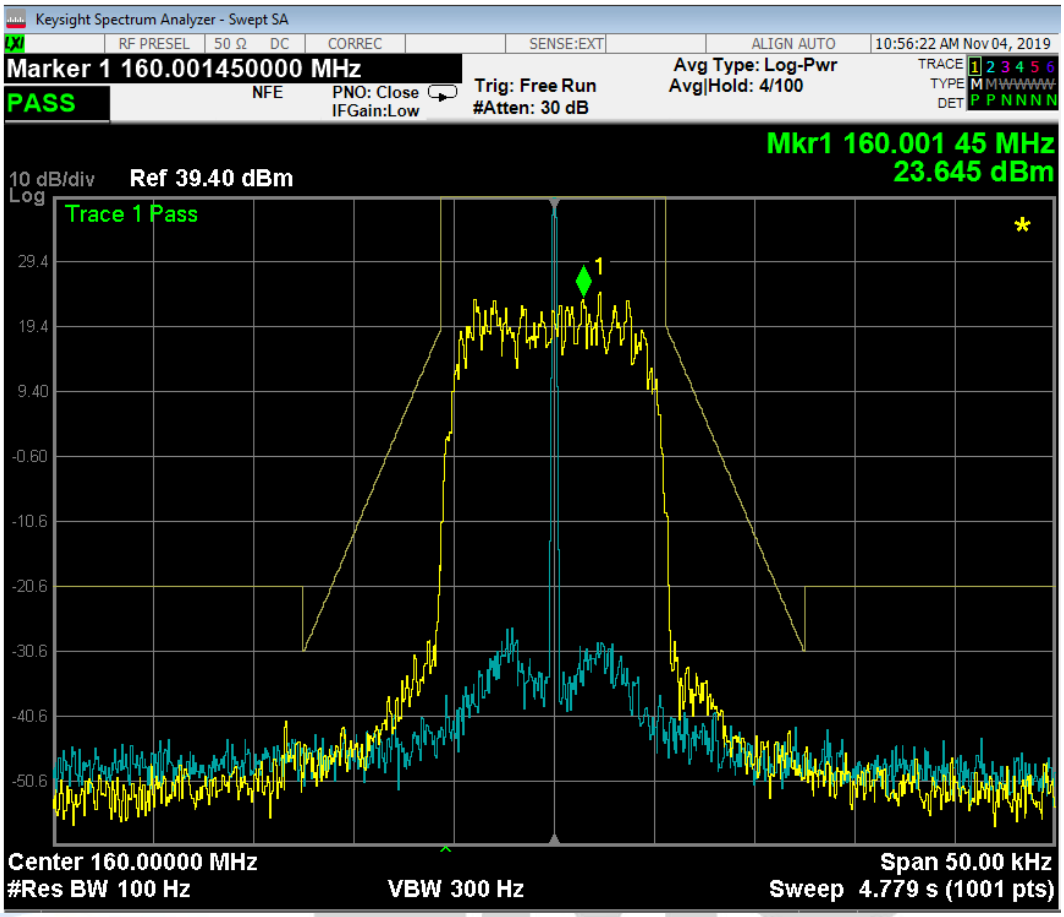
160.000 MHz, 12.5 kHz bandwidth, Mask D-2FSK



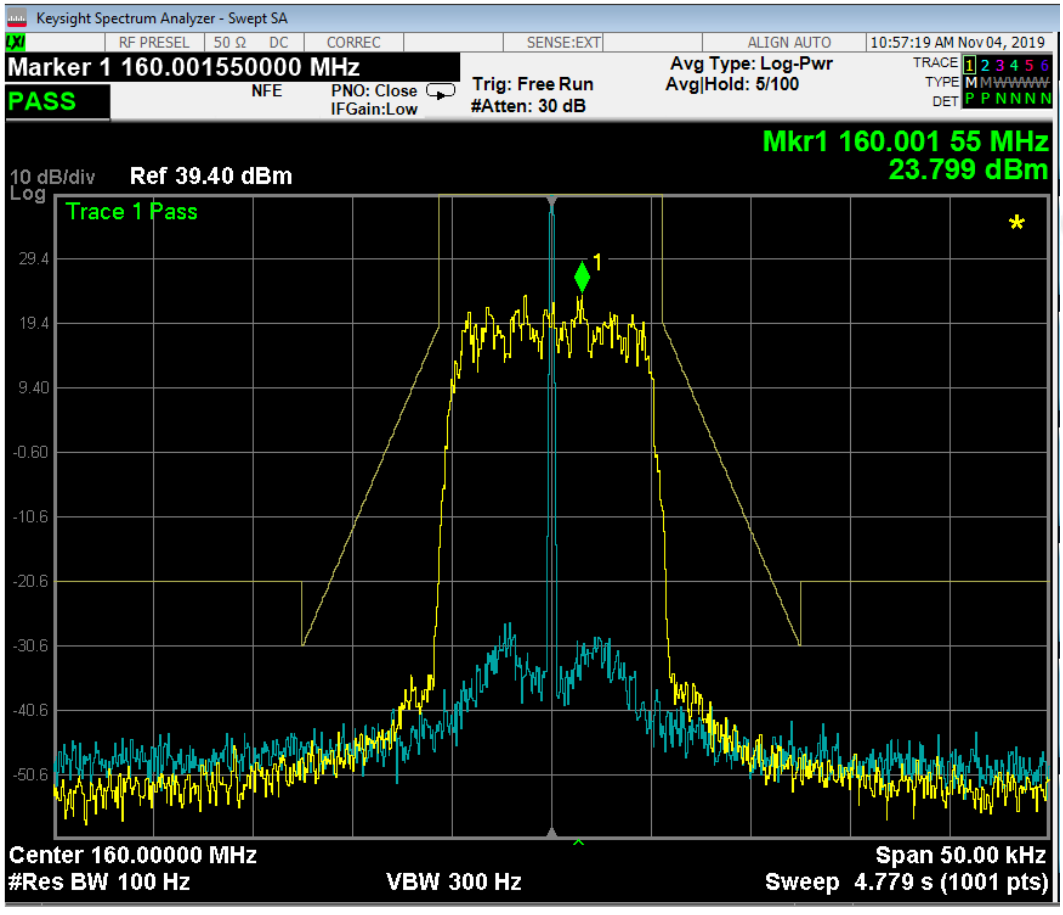
160.000 MHz, 12.5 kHz bandwidth, Mask D-4FSK



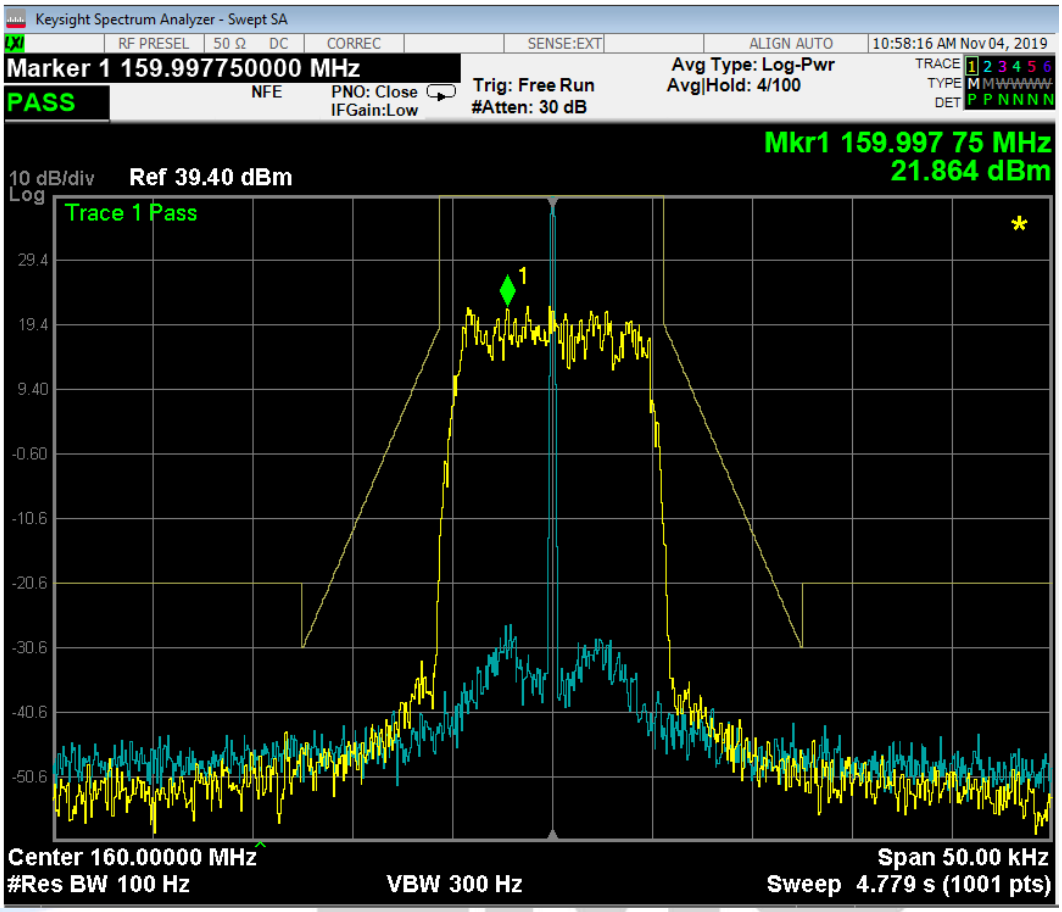
160.000 MHz, 12.5 kHz bandwidth, Mask D, 4QAM



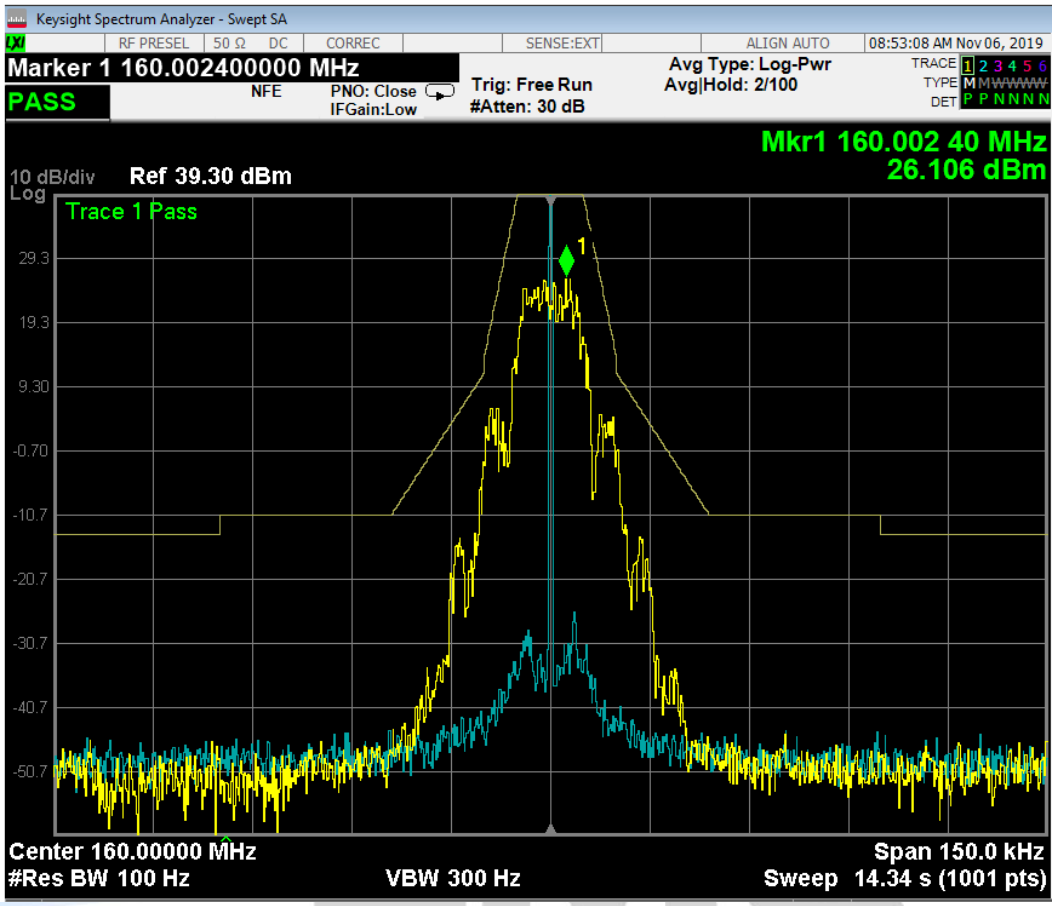
160.000 MHz, 12.5 kHz bandwidth, Mask D, 16QAM



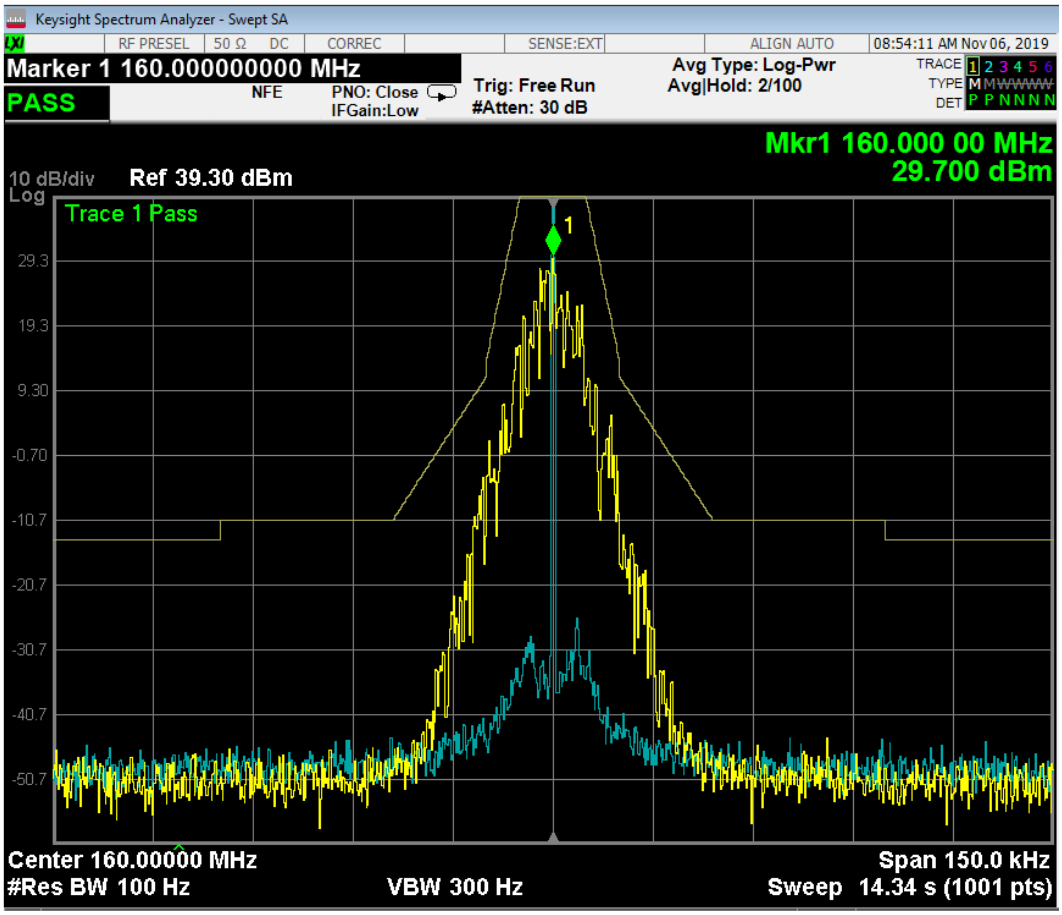
160.000 MHz, 12.5 kHz bandwidth, Mask D, 64QAM



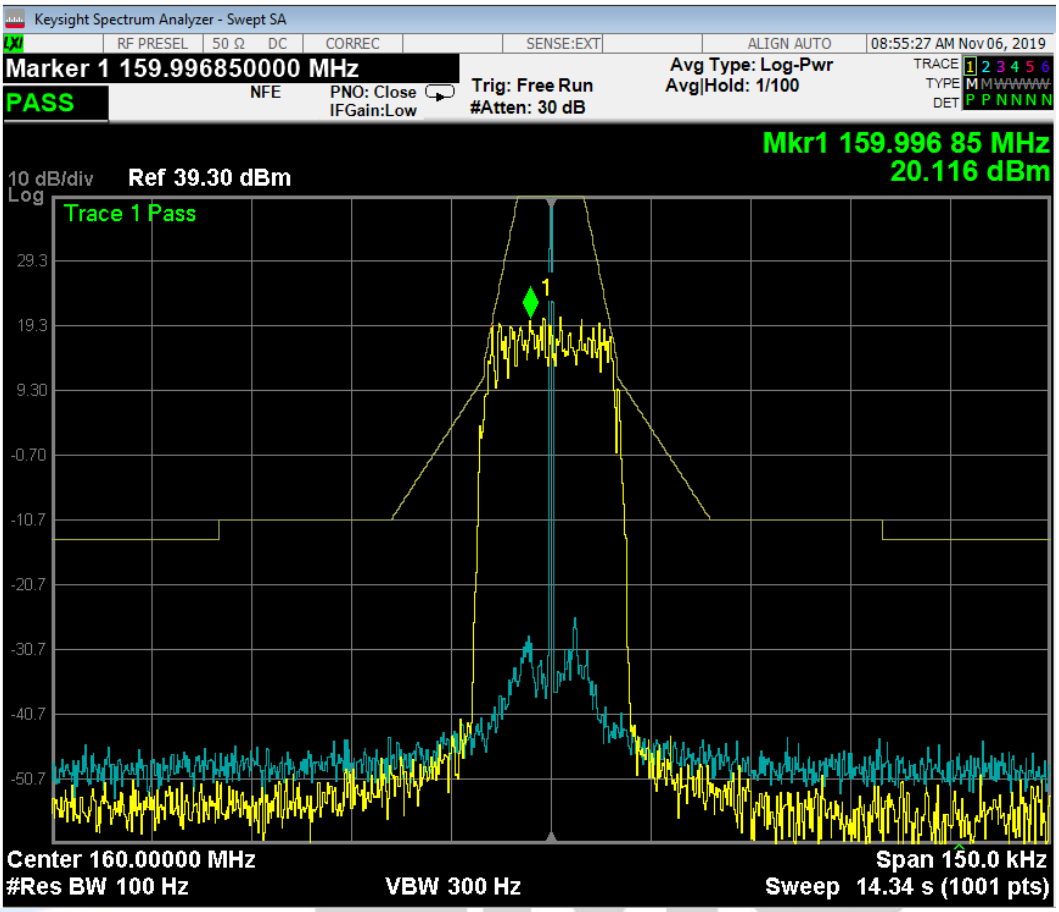
160.000 MHz, 25.0 kHz bandwidth, Mask C, 2FSK



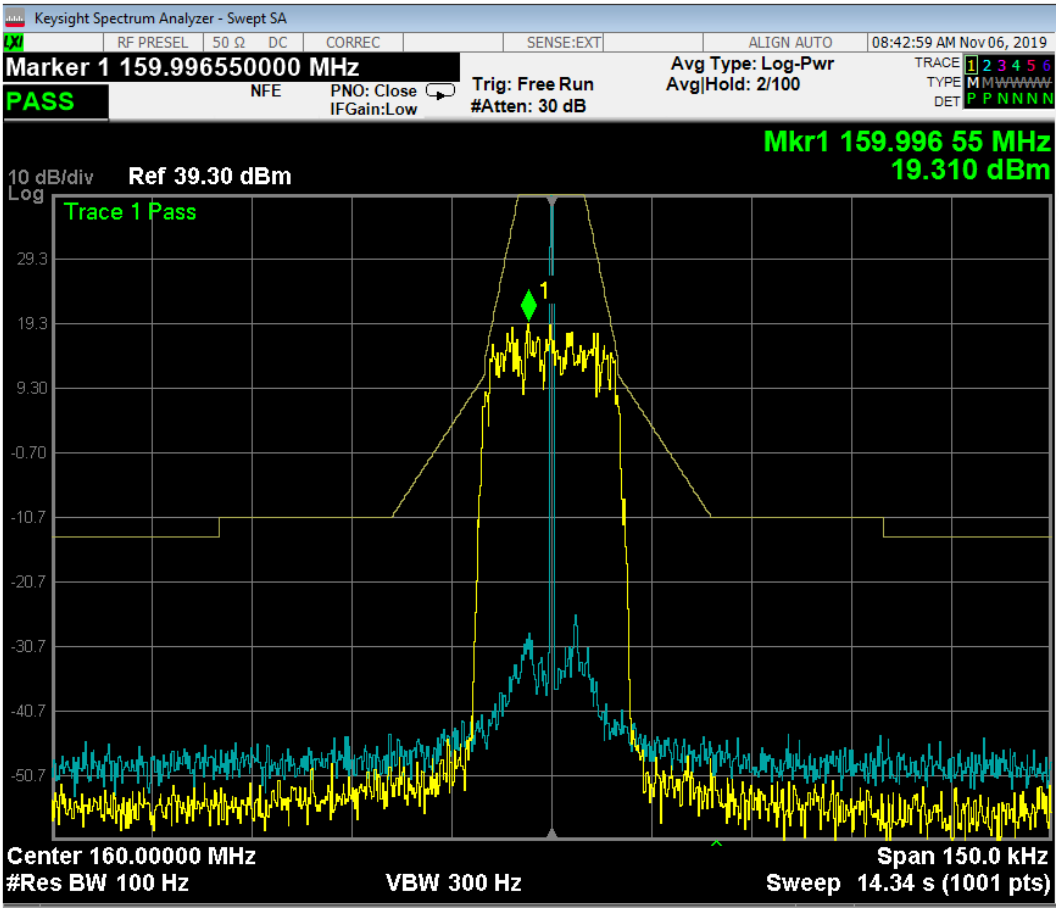
160.000 MHz, 25.0 kHz bandwidth, Mask C, 4FSK



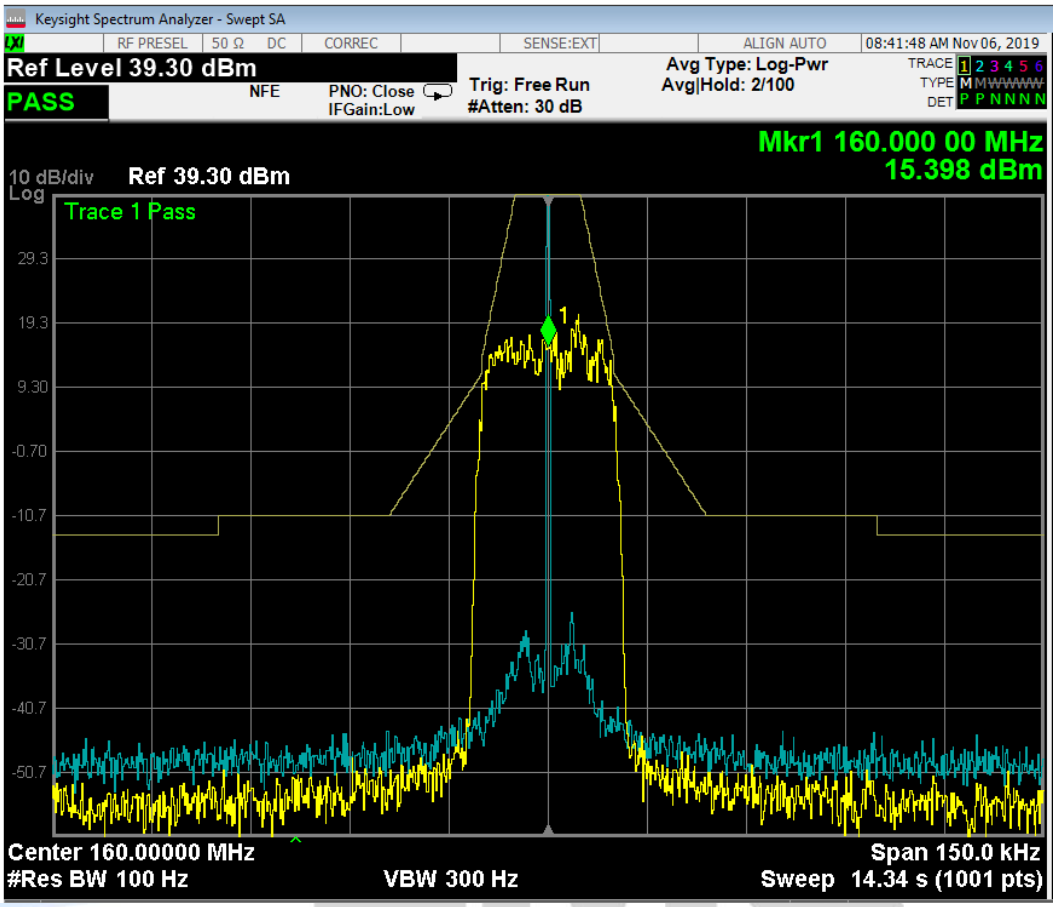
160.000 MHz, 25.0 kHz bandwidth, Mask C, 4QAM



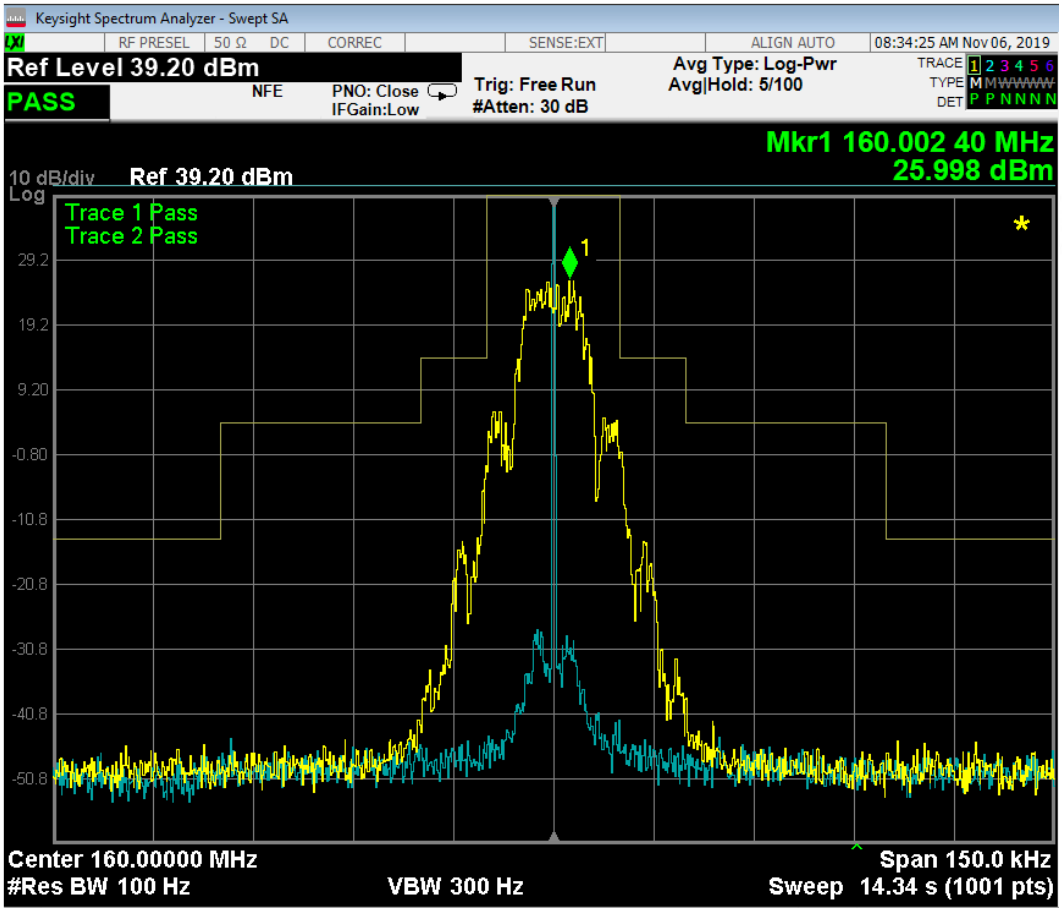
160.000 MHz, 25.0 kHz bandwidth, Mask C, 16QAM



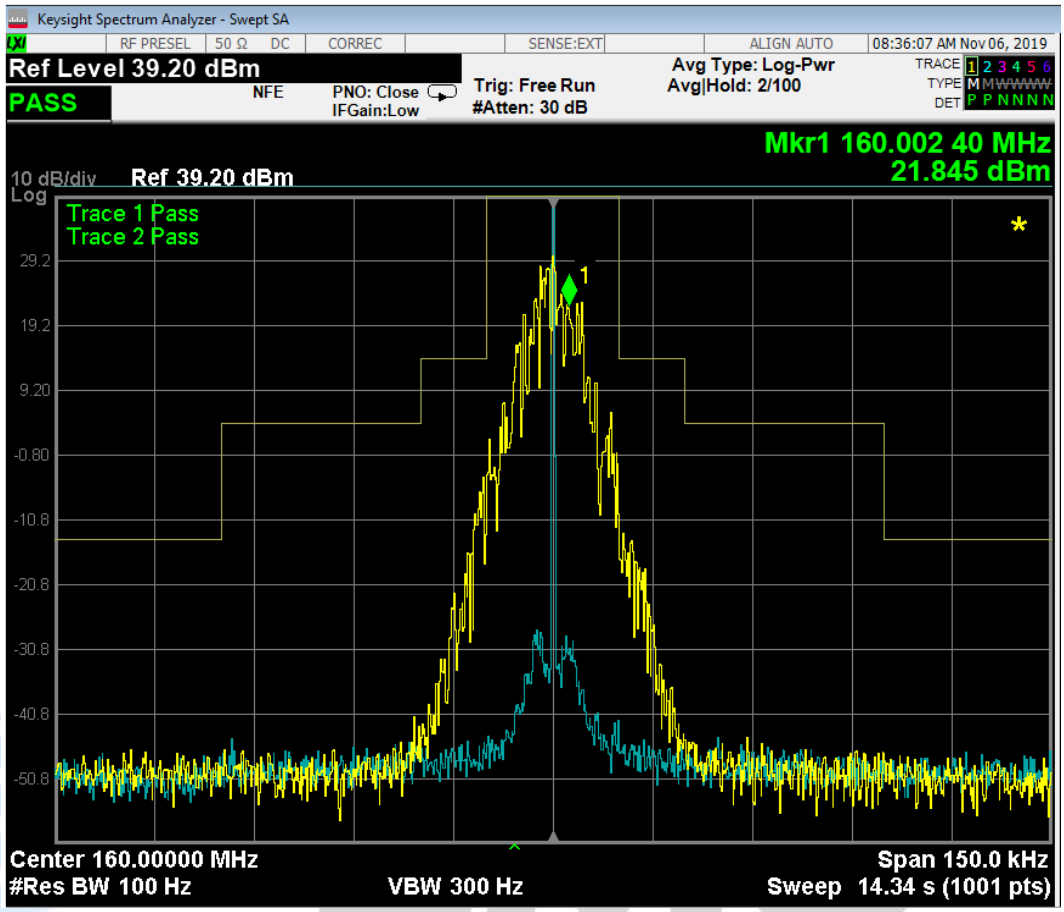
160.000 MHz, 25.0 kHz bandwidth, Mask C, 64QAM



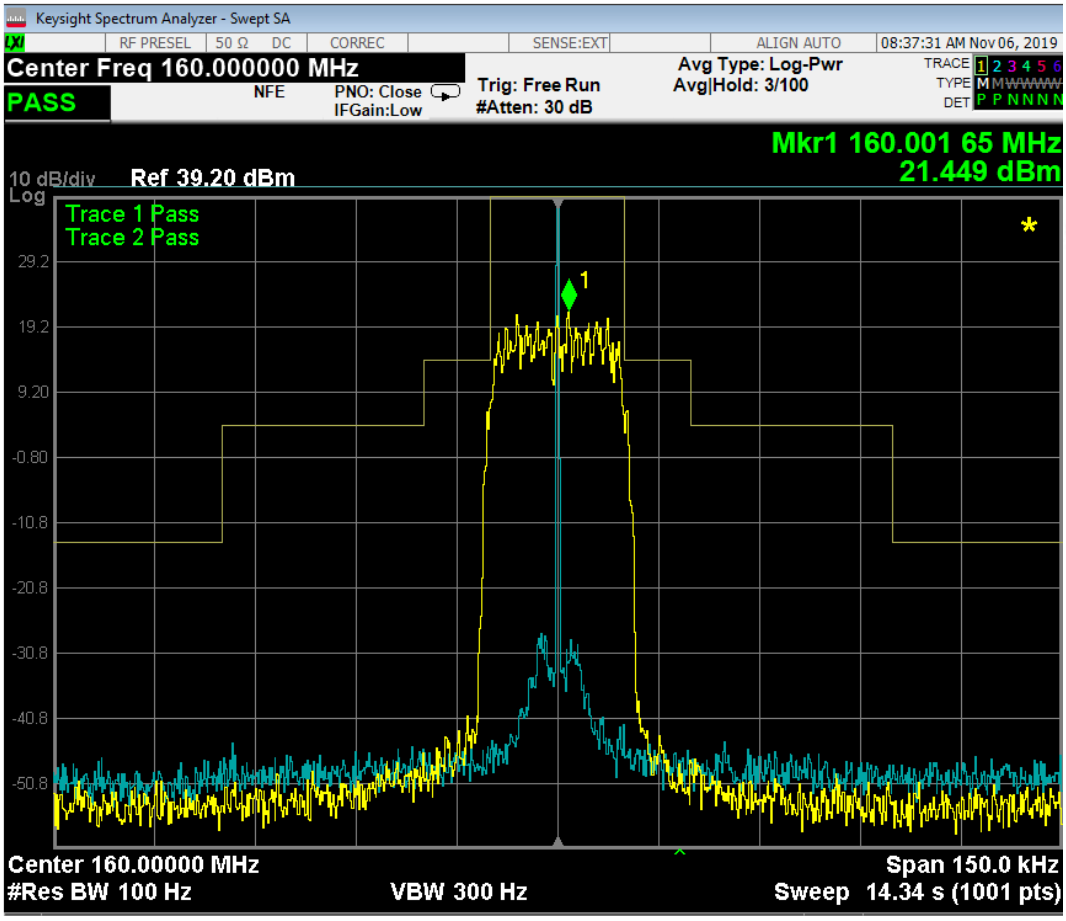
160.000 MHz, 25.0 kHz bandwidth, Mask B, 2FSK



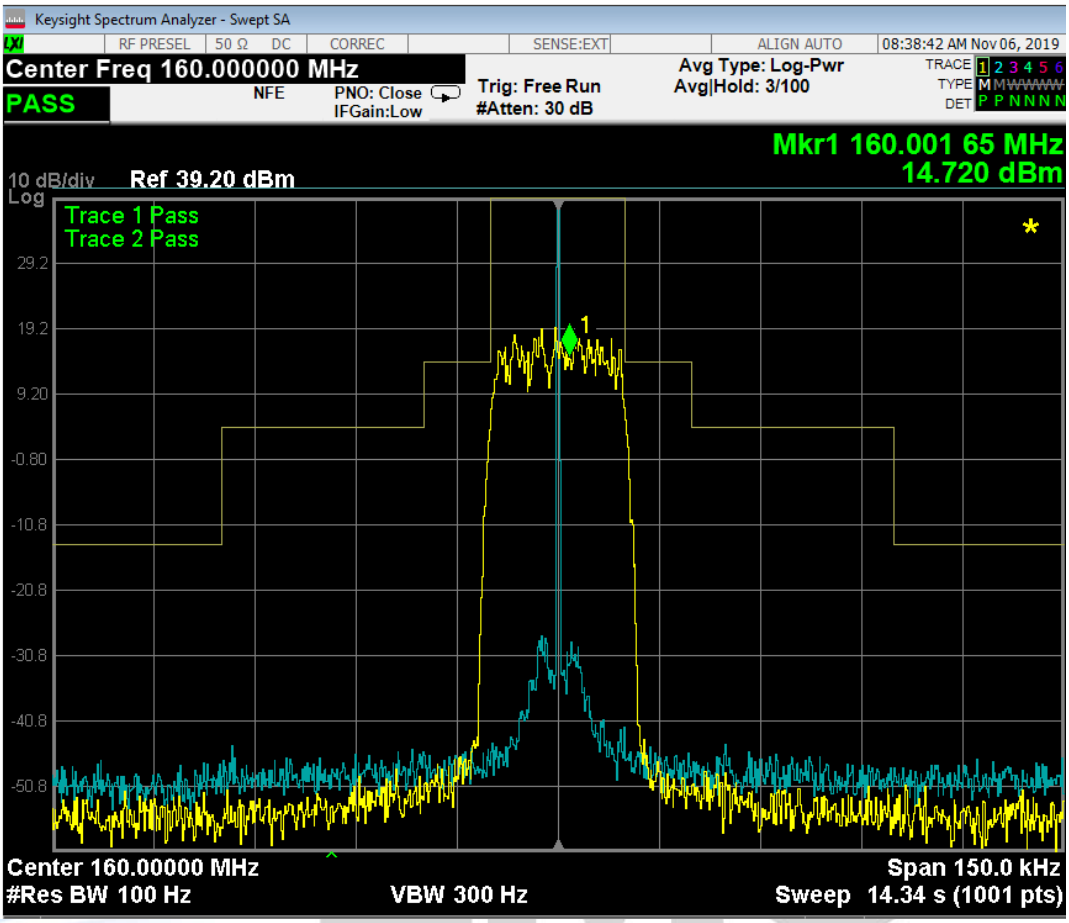
160.000 MHz, 25.0 kHz bandwidth, Mask B, 4FSK



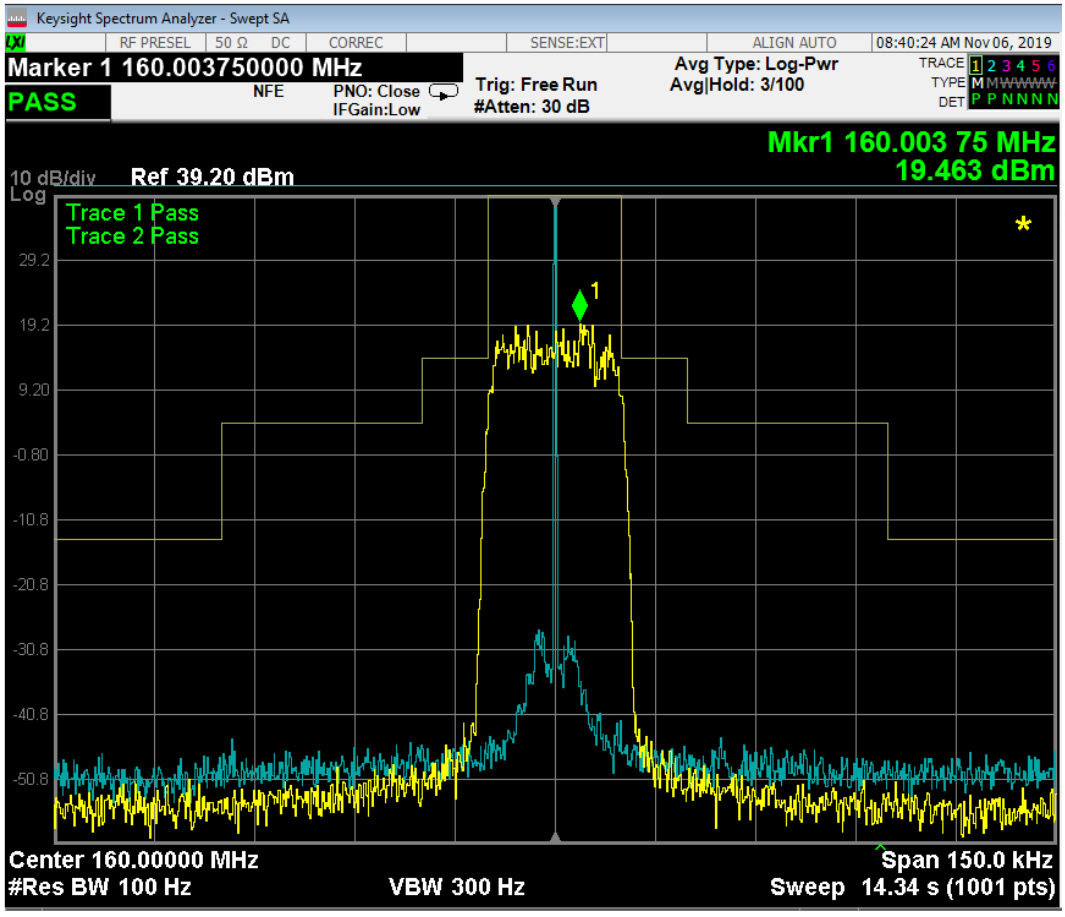
160.000 MHz, 25.0 kHz bandwidth, Mask B, 4QAM



160.000 MHz, 25.0 kHz bandwidth, Mask B, 16QAM



160.000 MHz, 25.0 kHz bandwidth, Mask B, 64QAM



Transmitter spurious emissions at the antenna terminals

The test was carried out using the unmodulated output which was identified to produce the worst case results.

The resolution bandwidth of the instrument was set to 100 kHz for frequencies below 1 GHz and to 1 MHz for harmonics measured above 1 GHz.

The transmitter output power is rated at 10 Watt (high power) and was sufficiently attenuated using an external power attenuator and internal attenuator in the spectrum analyser.

Frequency: 150.900 MHz / 10 Watts

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
301.8	-44.8	-20.0
452.7	-38.6	-20.0
603.6	<-45.0	-20.0
754.5	<-45.0	-20.0
905.4	<-45.0	-20.0
1056.3	<-45.0	-20.0
1207.2	<-45.0	-20.0
1358.1	<-45.0	-20.0

Frequency: 173.300 MHz / 10 Watts

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
346.6	-39.4	-20.0
519.9	-40.4	-20.0
693.2	<-45.0	-20.0
866.5	<-45.0	-20.0
1039.8	<-45.0	-20.0
1213.1	<-45.0	-20.0
1386.4	<-45.0	-20.0
1559.7	<-45.0	-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 bandwidth 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.

Result: Complies.
Measurement Uncertainty: ± 3.3 dB

Field strength of the transmitter spurious emissions

Nominal Frequency: 150.900 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
301.8000	34.3	-63.1	-20.0	Vertical	43.1	Pass
	39.7	-57.6	-20.0	Horizontal	37.6	Pass
452.7000	36.6	-60.8	-20.0	Vertical	40.8	Pass
	30.4	-67.0	-20.0	Horizontal	47.0	Pass
603.6000	36.5	-60.9	-20.0	Vertical	40.9	Pass
	32.0	-65.4	-20.0	Horizontal	45.4	Pass
754.5000	29.9	-67.5	-20.0	Vertical	47.5	Pass
	32.2	-65.2	-20.0	Horizontal	45.2	Pass
905.4000	34.1	-63.3	-20.0	Vertical	43.3	Pass
	35.5	-61.9	-20.0	Horizontal	41.9	Pass
1056.3000	43.3	-54.1	-20.0	Vertical	34.1	Pass
	42.6	-54.8	-20.0	Horizontal	34.8	Pass
1207.2000	45.0	-52.4	-20.0	Vertical	32.4	Pass
	44.5	-52.9	-20.0	Horizontal	32.9	Pass
1358.1000	46.0	-51.4	-20.0	Vertical	31.4	Pass
	46.3	-51.1	-20.0	Horizontal	31.1	Pass
1509.0000	48.0	-49.4	-20.0	Vertical	29.4	Pass
	47.4	-50.0	-20.0	Horizontal	30.0	Pass

Nominal Frequency: 173.300 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
346.6000	43.0	-54.4	-20.0	Vertical	34.4	Pass
	48.5	-48.9	-20.0	Horizontal	28.9	Pass
519.9000	31.5	-65.9	-20.0	Vertical	45.9	Pass
	36.7	-60.7	-20.0	Horizontal	40.7	Pass
693.2000	32.6	-64.8	-20.0	Vertical	44.8	Pass
	30.4	-67.0	-20.0	Horizontal	47.0	Pass
866.5000	32.6	-64.8	-20.0	Vertical	44.8	Pass
	32.2	-65.2	-20.0	Horizontal	45.2	Pass
1039.8000	43.0	-54.4	-20.0	Vertical	34.4	Pass
	49.3	-48.1	-20.0	Horizontal	28.1	Pass
1213.1000	45.0	-52.4	-20.0	Vertical	32.4	Pass
	48.0	-49.4	-20.0	Horizontal	29.4	Pass
1386.4000	45.0	-52.4	-20.0	Vertical	32.4	Pass
	48.0	-49.4	-20.0	Horizontal	29.4	Pass
1559.7000	47.0	-50.4	-20.0	Vertical	30.4	Pass
	48.0	-49.4	-20.0	Horizontal	29.4	Pass

The transmitter was tested while transmitting continuously on high power (10 watts) while attached to a dummy load.

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

The 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 60 dB from below the mean power of the transmitter.

The maximum rated power of 10.0 watts gives a limit of –20 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.

Frequency: 150.900 MHz

Temperature (°C)	9.0 Vdc (Hz)	13.8 Vdc (Hz)	30.0 Vdc (Hz)
+50	-55	-150	-80
+40	-120	-130	-100
+30	-10	-10	-10
+20	+50	+50	+50
+10	+10	+10	+20
0	+20	+20	+20
-10	+20	+10	+10
-20	+10	+10	+10
-30	-10	-10	-10

Frequency: 173.300 MHz

Temperature (°C)	9.0 Vdc (Hz)	13.8 Vdc (Hz)	30.0 Vdc (Hz)
+50	-30	-160	+10
+40	-50	-60	-40
+30	-60	-60	-60
+20	+60	+50	+60
+10	+20	+20	+30
0	+20	+10	+20
-10	+20	+20	+20
-20	+10	+10	+10
-30	-10	-10	-10

Limits:

Part 90.213 states that fixed station transmitters operating between 150.0 - 174.0 MHz with 12.5 kHz channelling are required to have a frequency tolerance of 1.5 ppm and fixed/base stations with 6.25 kHz channel bandwidth are required to have a frequency tolerance of 1.0 ppm.

A worst case error of 0.99 ppm (150 Hz / 150.900 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.

Results:

Channel Bandwidth (kHz)	Period t_1 Deviation (kHz)	Period t_2 Deviation (kHz)	Period t_3 Deviation (kHz)
6.25	Nil	Nil	Nil
12.5	Nil	Nil	Nil
25.0	Nil	Nil	Nil

Limits:

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

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

6.25 kHz Transmitter

Transmitter turn on

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

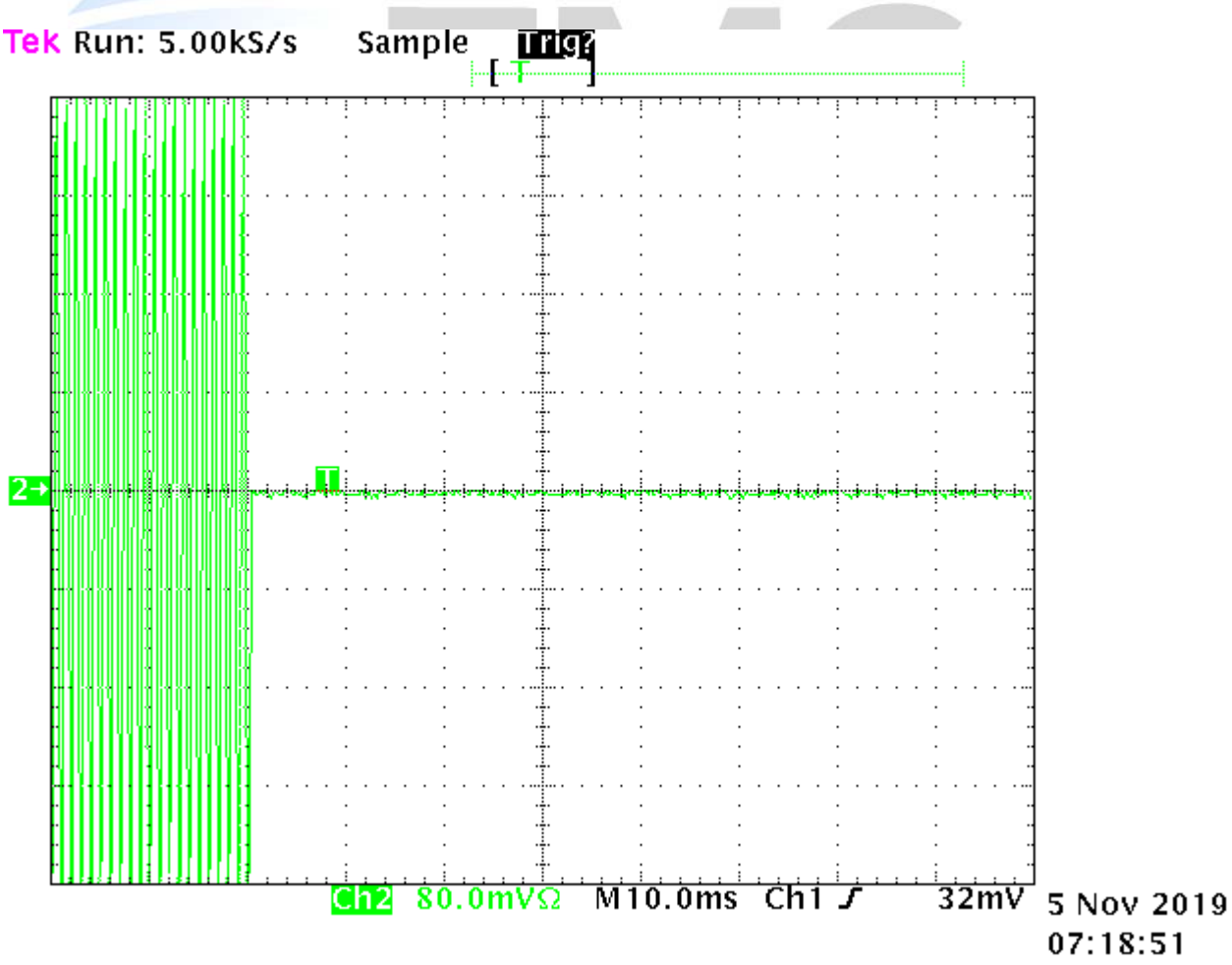
Green trace has been maximised to give full screen indication of +/- 6.25 kHz.
Therefore each Y axis division = 1.5 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division.

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 was observed during *t*1 and t2.



Transmitter turn off

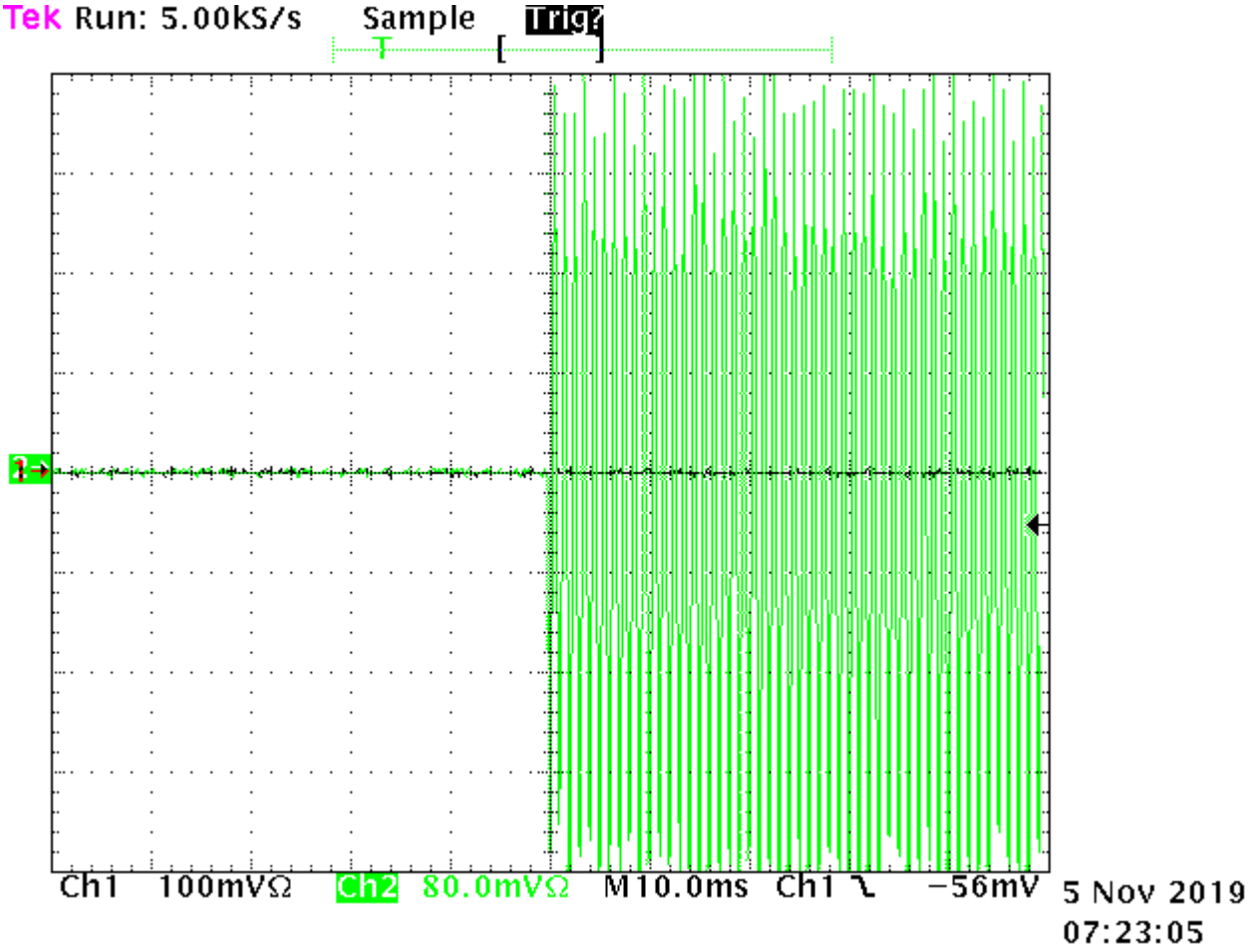
Green Trace = 1 kHz tone with FM deviation of 6.25 kHz.

Green trace has been maximised to give full screen indication of +/- 6.25 kHz.
Therefore each Y axis division = 1.5 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 was observed before *t*off.



12.5 kHz Transmitter

Transmitter turn on

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

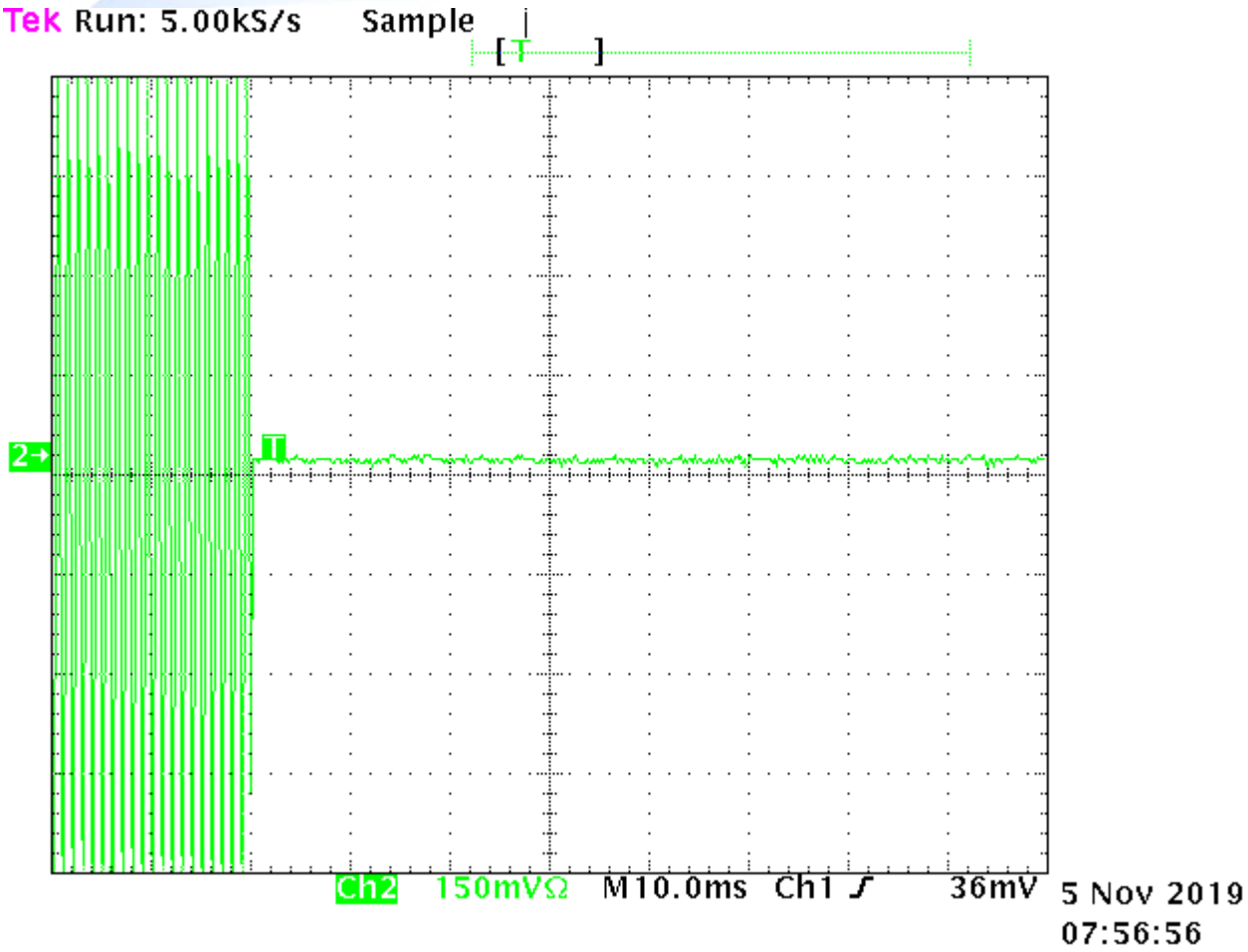
Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division.

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 was observed during *t*1 and t2.



Transmitter turn off

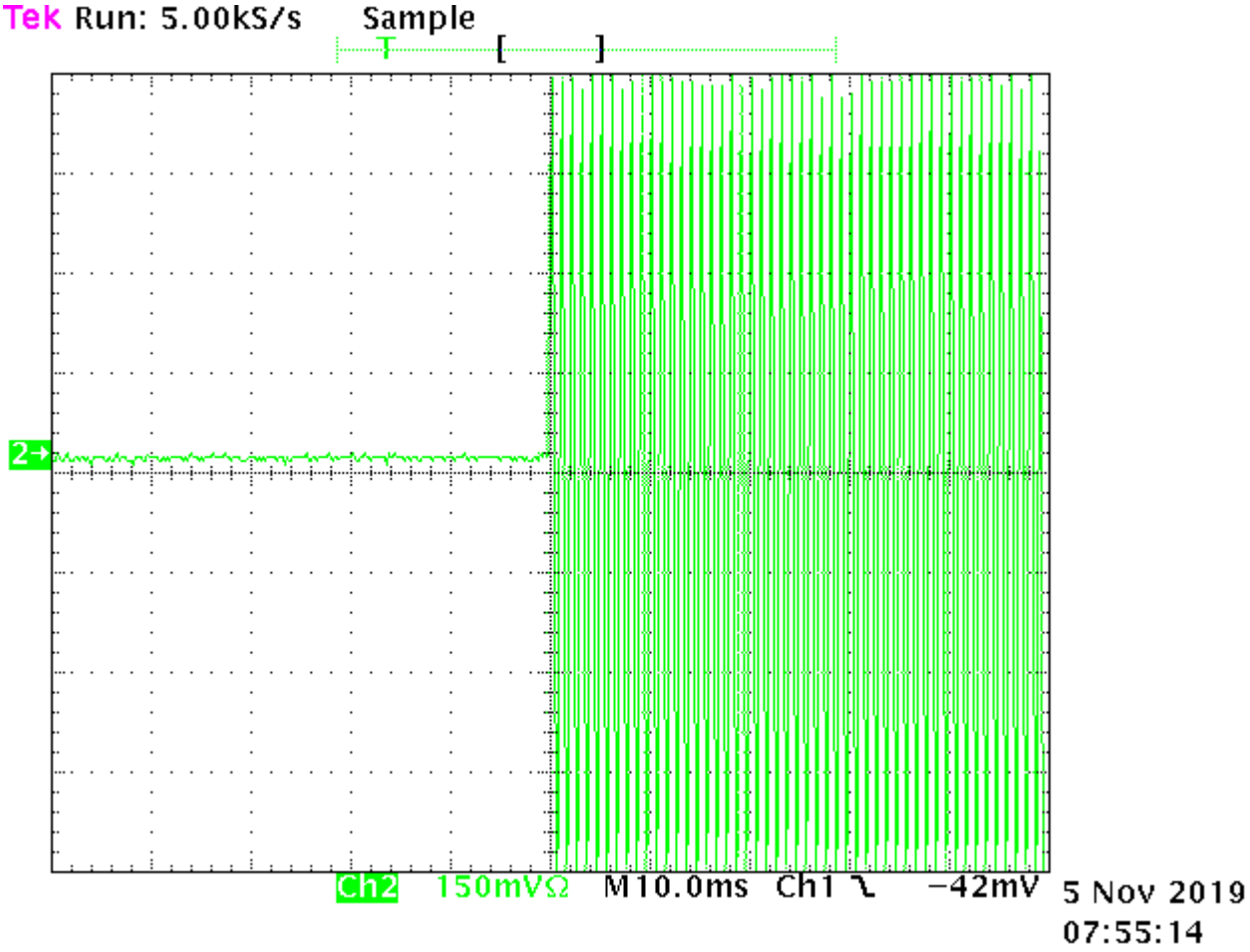
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz.

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

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

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

No transient response was observed before *t*off.



25.0 kHz Transmitter

Transmitter turn on

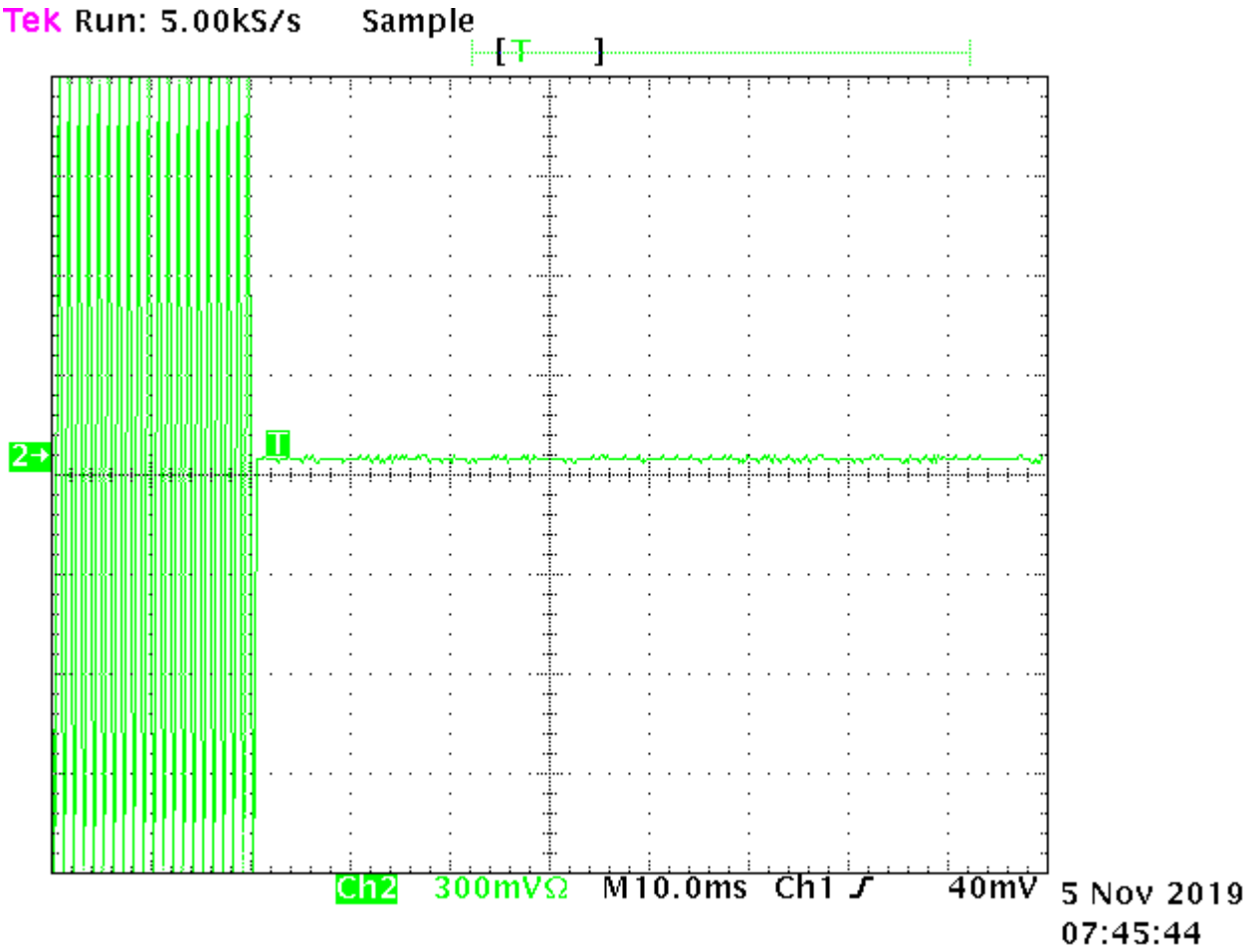
Green Trace = 1 kHz tone with FM deviation of 25 kHz.

Green trace has been maximised to give full screen indication of +/- 25 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 3 divisions from the left hand edge (30 mS).

*t*on occurs 2 divisions from the left of the display (20 mS).

No transient response can be observed during *t*on.



Transmitter turn off

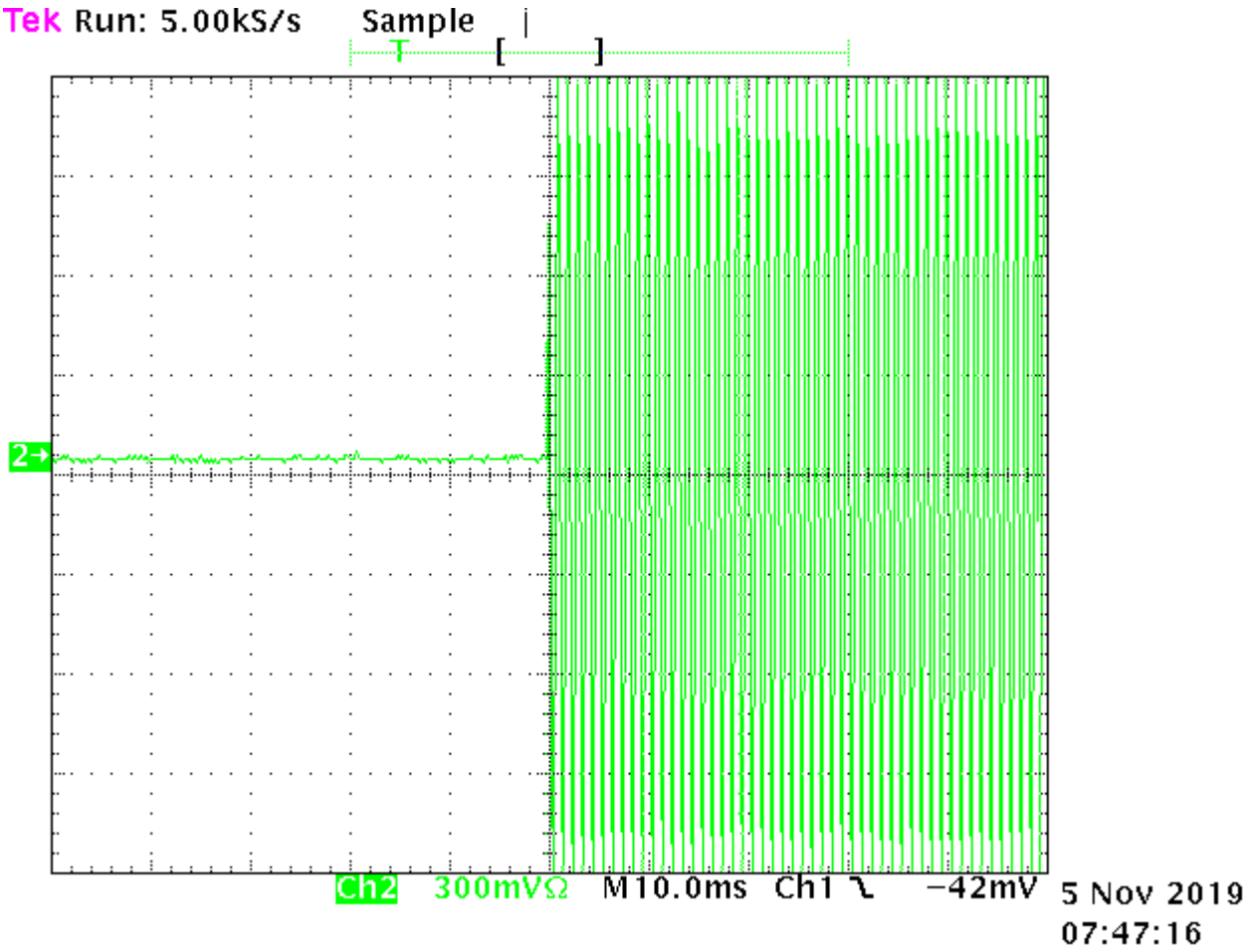
Green Trace = 1 kHz tone with FM deviation of 25 kHz.

Green trace has been maximised to give full screen indication of +/- 25 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.

No transient response can be observed during *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.

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

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

- General Population / Uncontrolled exposure is (f/1500) mW/cm^2

As this radio can operate over the range of 148.0 to 174.0 MHz the lowest frequency of operation in the USA, which will give the worst case result, would be 150.0 MHz.

The power density at 150.0 MHz comes out to be 0.2 mW/cm^2.

For an Uncontrolled Environment

Power Density = 0.20 $mW/cm^2 = E^2/3770$

$E = \sqrt{0.20*3770}$

E = 27.5 V/m

The rated output power for FSK modulation is up to +40 dBm (10 W) transmit power.

For QAM modulation the rated power is up to +36 dBm (4 W) average transmit power.

The rated power of 10 Watts (+40 dBm) has been used in the safe distance calculations to give the worst case results.

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

The client has stated that the device can be connected to the antenna models listed below.

Antenna Models:

Model Number	Coax Kit	Net Gain in dB	Numeric gain
UDP150-C	none	2.0 dB	1.59
BU-3/150	none	5.0 dB	3.16
BU-3/150	CC3	4.5 dB	2.82
YU3/150	none	6.0 dB	3.98
YU3/150	CC3	5.5 dB	3.55
YU6/150	None	9.0 dB	7.94
YU6/150	CC3	8.5 dB	7.08

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:

$FS = (\sqrt{}(30 * P * G * DC)) / D$

Net Gain in dB	Numeric gain	Minimum safe distance (d) (cm)
2.0 dB	1.59	79.4
5.0 dB	3.16	112.0
4.5 dB	2.82	105.8
6.0 dB	3.98	125.7
5.5 dB	3.55	118.7
9.0 dB	7.94	177.5
8.5 dB	7.08	167.6

Sample calculation is given below

$D = (\sqrt{}(30 * P * G * DC)) / FS$

$D = (\sqrt{}(30 * 10 * 1.59 * 1)) / 27.5$

D = 0.794 m or 79.4 cm

Result: Complies if the safe distances defined for this environment is applied.

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
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
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	11/01/2020	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.

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.

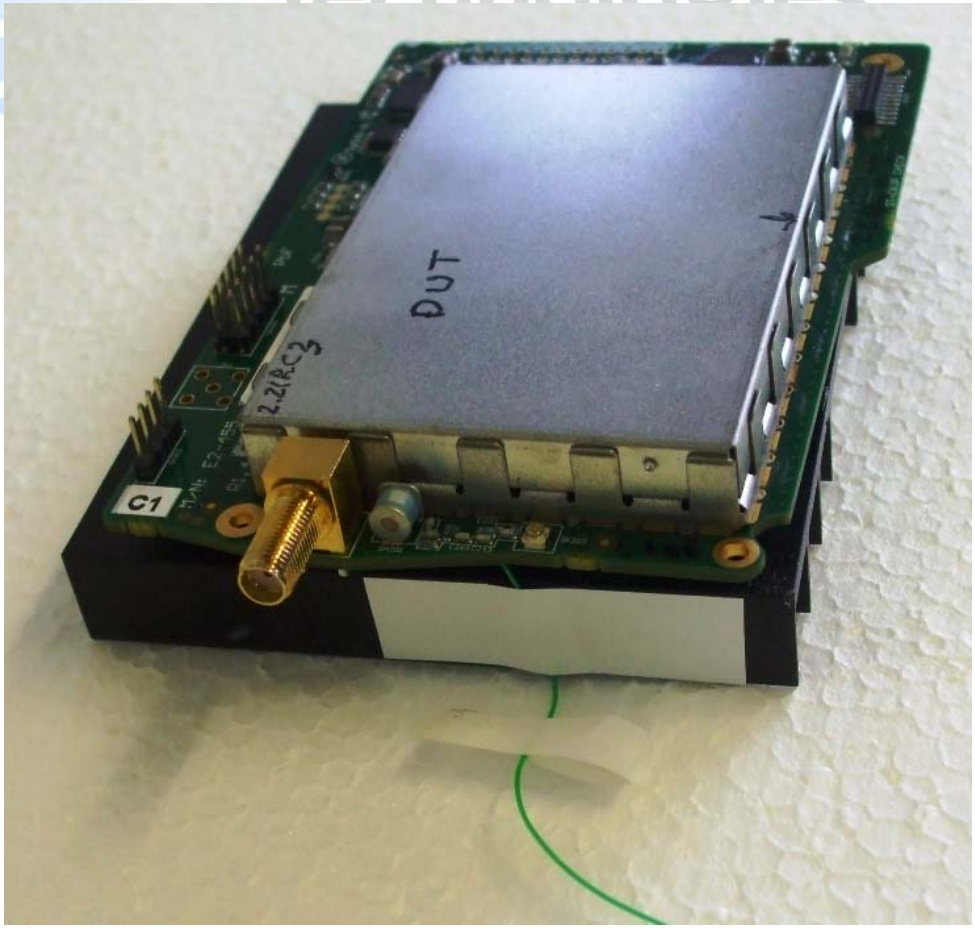
All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

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

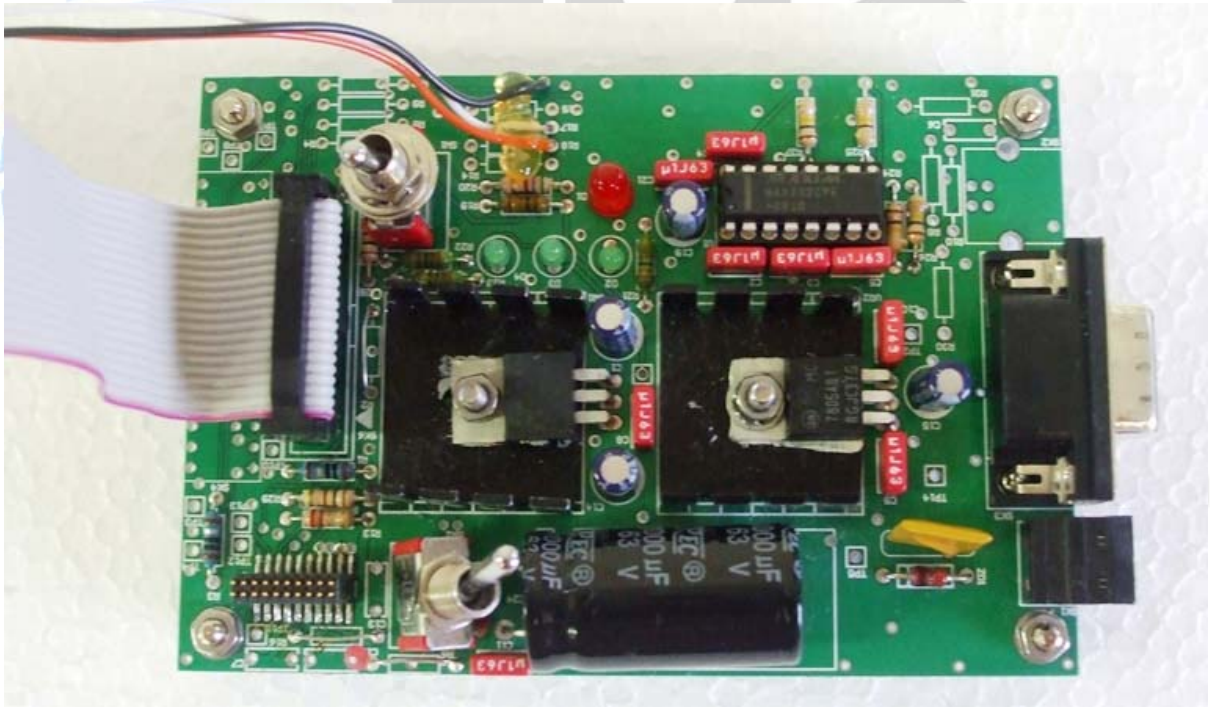
Device under test (Top Face)

Back Face



Label

Card to provide DC and RS232 connections to the DUT



Radiated emissions test setup