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TEST REPORT

4RF SQ400M131 Point to Multipoint Digital Radio

tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

4RF 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 **4RF SQ400M131 Point to Multipoint digital radio** 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-C.

2. RESULT SUMMARY

The results of testing, carried out between 6th and 14th May 2015, 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 4RF Limited

Address 26 Glover Street
Ngauranga,
Wellington.

Country New Zealand

Contact Mr Alan Turner

5. TEST SAMPLE DESCRIPTION

Brand Name 4RF

Model Number SQ400M131

Product Point to multipoint digital radio

Manufacturer 4RF Limited

Country of Origin New Zealand

Serial Number Not serialised.

FCC ID UIPSQ400M1311

The sample tested has the following specifications:

Rated Transmitter Output Power

5.0 Watts (37.0 dBm)

Transmitter FCC Frequency Bands

Part 90: 406.1 - 470 MHz

Test frequencies

Frequency (MHz)	Power (Watts)	Channel Bandwidth (kHz)
406.175	5.0	12.5 & 25.0
415.000	5.0	12.5 & 25.0
425.000	5.0	12.5 & 25.0
460.975	5.0	12.5 & 25.0

Emission Designators / Modes of operation

G1D (QPSK)
D1D (16QAM)
D1D (64QAM)

Power Supply

DC voltage supply typically 13.8 Vdc

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.

Extreme Test Voltages

High Voltage:	30.0 Vdc
Low Voltage:	10.0 Vdc

6. TEST RESULTS

Certification required

Certification of this device is sought for digital transmissions in accordance with section 90.203(j)(4)(ii)(iii) and 90.203(j)(5).

- certification has been sought after January 1, 2015.

- the equipment operates under FCC Part 90

- the equipment is designed to operate in various FCC Part 90 bands between 406.1 - 512 MHz

- the equipment can operate in multi bandwidth mode

- the equipment can operate in single bandwidth mode

- the equipment can operate with a data rate greater than 4.8 kbps per 6.25 kHz of channel bandwidth

- the equipment can operate with a data rate that is greater than 19200 bps when operating with a 25 kHz channel bandwidth

- the equipment can operate with a data rate that is greater than 9600 bps when operating with a 12.5 kHz 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 rated output power of 37 dBm.

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
406.175	13.8	37.0	36.4
425.000	10.0	37.0	36.4
425.000	13.8	37.0	36.4
425.000	30.0	37.0	36.4
460.975	13.8	37.0	36.6

Limits:

Part 90 does not specify the transmitter output power.

Result: Complies
Measurement Uncertainty: ±0.5 dB

Part 90.207 – Emission types:

The following emission types are used:

G1D: QPSK for the transmission of digital data and speech

D1D: QAM for the transmission of digital data

Part 90.209 – Bandwidth limitations:

For QPSK and QAM emissions the following designators have been declared by the client:

10k6D1D: 12.5 kHz QAM

10k6G1D: 12.5 kHz QPSK

19k5D1D: 25.0 kHz QAM

19k5G1D: 25.0 kHz QPSK

Measurements have been made to verify these declared bandwidths.

The occupied bandwidth has been measured and compared against the occupied bandwidth declared by the client.

Measurements have been made of each modulation type using a spectrum analyser operating in peak hold mode and a 30 dB attenuator.

Initially power measurements are made using a resolution bandwidth of 120 kHz.

This level is used as a reference level on the spectrum analyser.

The resolution bandwidth is then changed to 100 Hz and the reference level minus 23 dB (99%) absolute bandwidth points determined

406.175 MHz D1D – 12.5 kHz channel bandwidth

Emission	Channel	Measured	Designated
16QAM	12.5 kHz	10.275 kHz	10.600 kHz
64QAM	12.5 kHz	9.930 kHz	10.600 kHz

406.175 MHz G1D – 12.5 kHz channel bandwidth

Emission	Channel	Measured	Designated
QPSK	12.5 kHz	10.425 kHz	10.600 kHz

415.000 MHz D1D – 12.5 kHz channel bandwidth

Emission	Channel	Measured	Designated
16QAM	12.5 kHz	10.125 kHz	10.600 kHz
64QAM	12.5 kHz	9.900 kHz	10.600 kHz

415.000 MHz G1D – 12.5 kHz channel bandwidth

Emission	Channel	Measured	Designated
QPSK	12.5 kHz	10.415 kHz	10.600 kHz

425.000 MHz D1D – 12.5 kHz channel bandwidth

Emission	Channel	Measured	Designated
16QAM	12.5 kHz	10.125 kHz	10.600 kHz
64QAM	12.5 kHz	10.013 kHz	10.600 kHz

425.000 MHz G1D – 12.5 kHz channel bandwidth

Emission	Channel	Measured	Designated
QPSK	12.5 kHz	10.420 kHz	10.600 kHz

460.975 MHz D1D – 12.5 kHz channel bandwidth

Emission	Channel	Measured	Designated
16QAM	12.5 kHz	10.125 kHz	10.600 kHz
64QAM	12.5 kHz	9.900 kHz	10.600 kHz

460.975 MHz G1D – 12.5 kHz channel bandwidth

Emission	Channel	Measured	Designated
QPSK	12.5 kHz	10.425 kHz	10.600 kHz

406.175 MHz D1D – 25.0 kHz channel bandwidth

Emission	Channel	Measured	Designated
16QAM	25 kHz	18.900 kHz	19.500 kHz
64QAM	25 kHz	18.600 kHz	19.500 kHz

406.175 MHz G1D – 25 kHz channel bandwidth

Emission	Channel	Measured	Designated
QPSK	25 kHz	19.275 kHz	19.500 kHz

415.000 MHz D1D – 25.0 kHz channel bandwidth

Emission	Channel	Measured	Designated
16QAM	25 kHz	18.750 kHz	19.500 kHz
64QAM	25 kHz	18.575 kHz	19.500 kHz

415.000 MHz G1D – 25 kHz channel bandwidth

Emission	Channel	Measured	Designated
QPSK	25 kHz	19.350 kHz	19.500 kHz

425.000 MHz D1D – 25.0 kHz channel bandwidth

Emission	Channel	Measured	Designated
16QAM	25 kHz	18.780 kHz	19.500 kHz
64QAM	25 kHz	18.600 kHz	19.500 kHz

425.000 MHz G1D – 25 kHz channel bandwidth

Emission	Channel	Measured	Designated
QPSK	25 kHz	19.200 kHz	19.500 kHz

460.975 MHz D1D – 25.0 kHz channel bandwidth

Emission	Channel	Measured	Designated
16QAM	25 kHz	18.900 kHz	19.500 kHz
64QAM	25 kHz	18.600 kHz	19.500 kHz

460.975 MHz G1D – 25 kHz channel bandwidth

Emission	Channel	Measured	Designated
QPSK	25 kHz	19.275 kHz	19.500 kHz

Result: Complies.

Spectrum Masks

The spectrum masks are defined in:

Section 90.210(b) – Mask B has been applied as the transmitter can operate using a channel bandwidth of 25.0 kHz.

Section 90.210(d) – Mask D has been applied as the transmitter can operate using a channel bandwidth of 12.5 kHz.

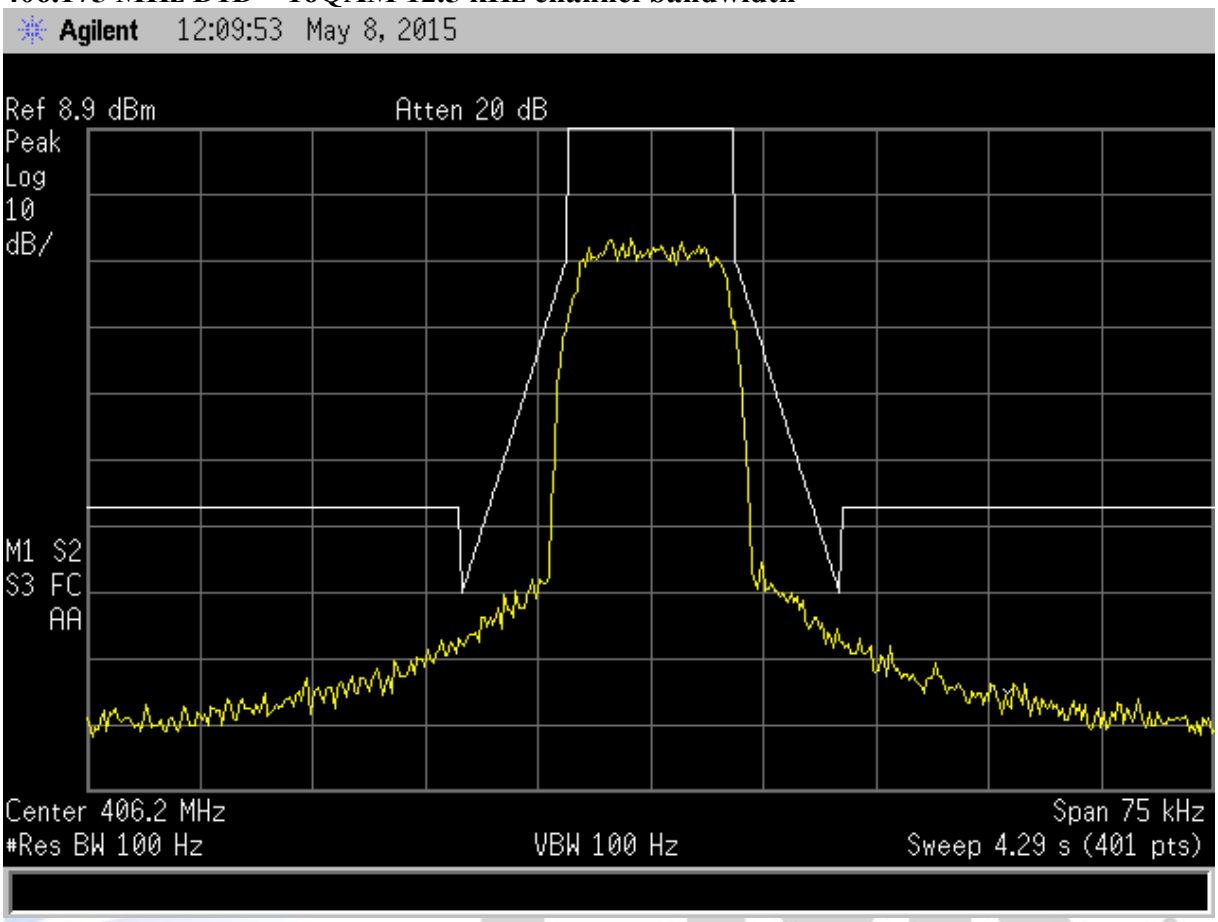
The reference level for the following emission mask measurements has been determined using a resolution bandwidth of 120 kHz with the transmitter modulated.

All measurements have been made with a 30 dB attenuator placed between the transmitter and the spectrum analyser which needs to be accounted for when the masks are reviewed.

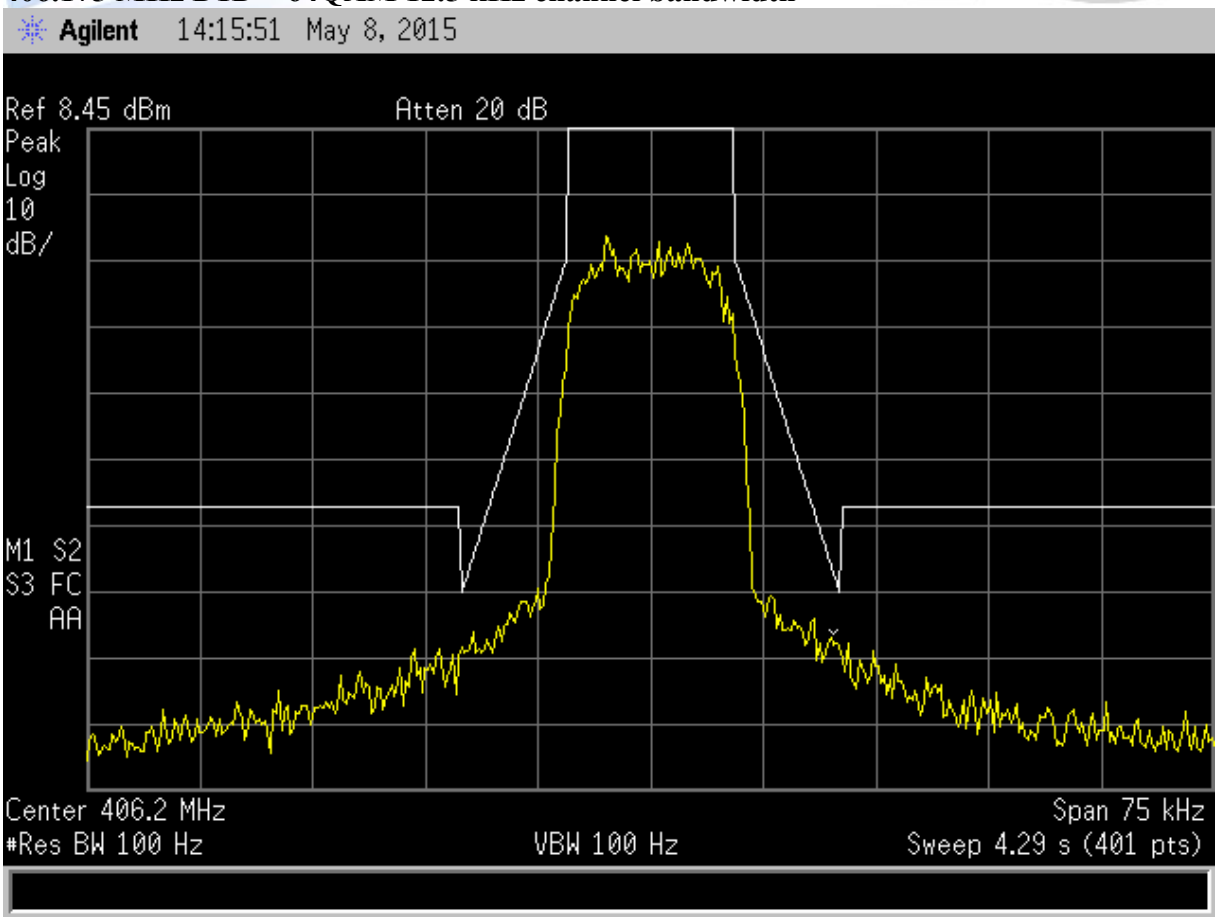
For the G1D and D1D modes the transmitter was modulated using the modulation sources internal to the transmitter as supplied by the client.

Result: Complies.

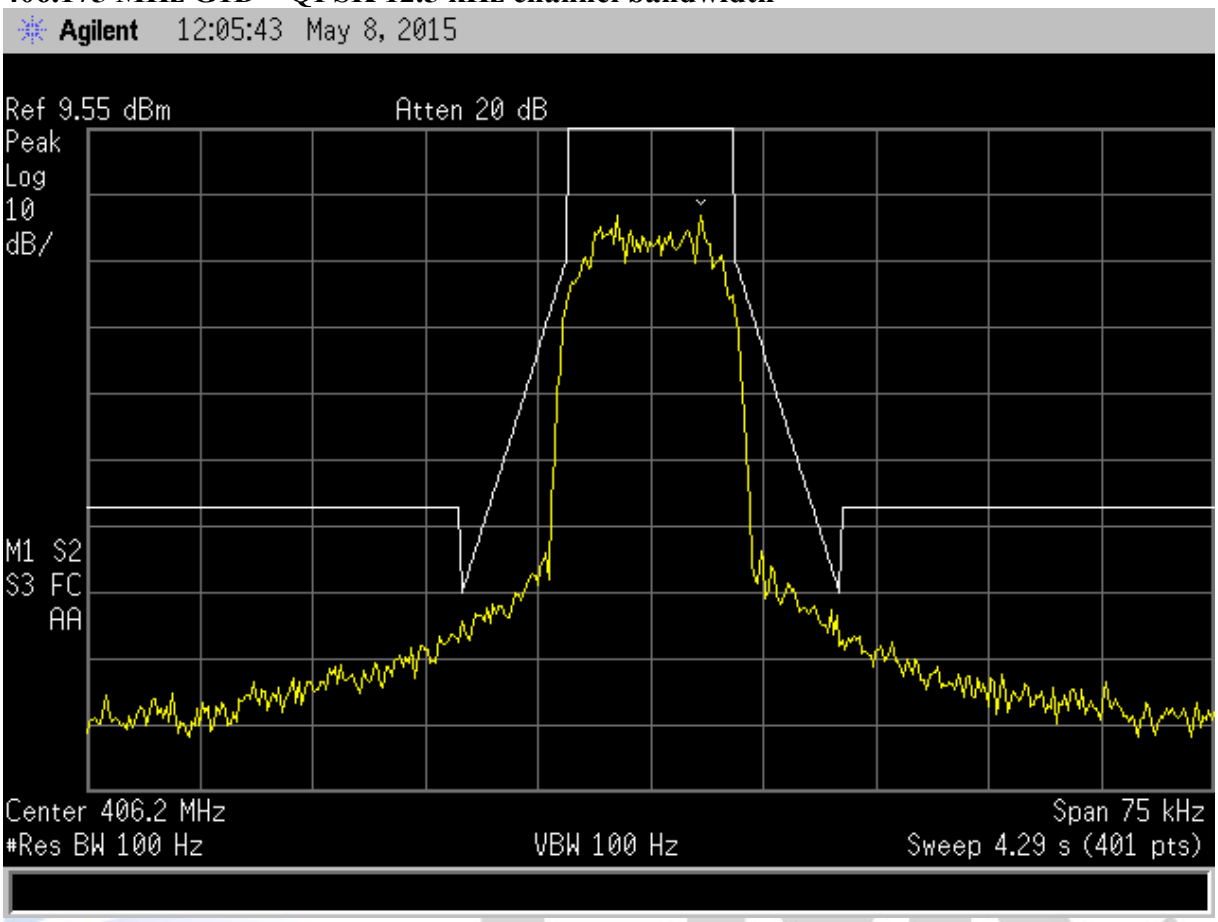
406.175 MHz D1D – 16QAM 12.5 kHz channel bandwidth



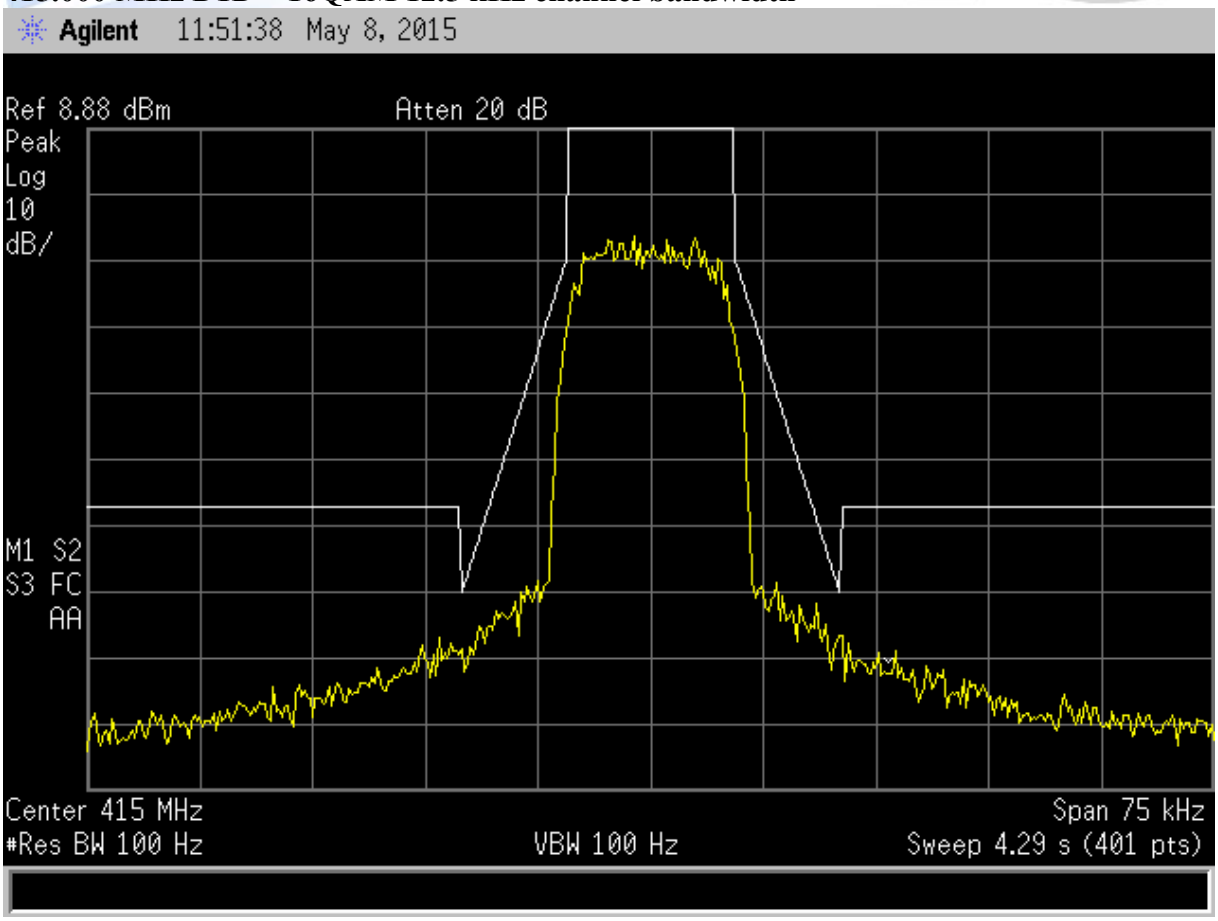
406.175 MHz D1D – 64QAM 12.5 kHz channel bandwidth



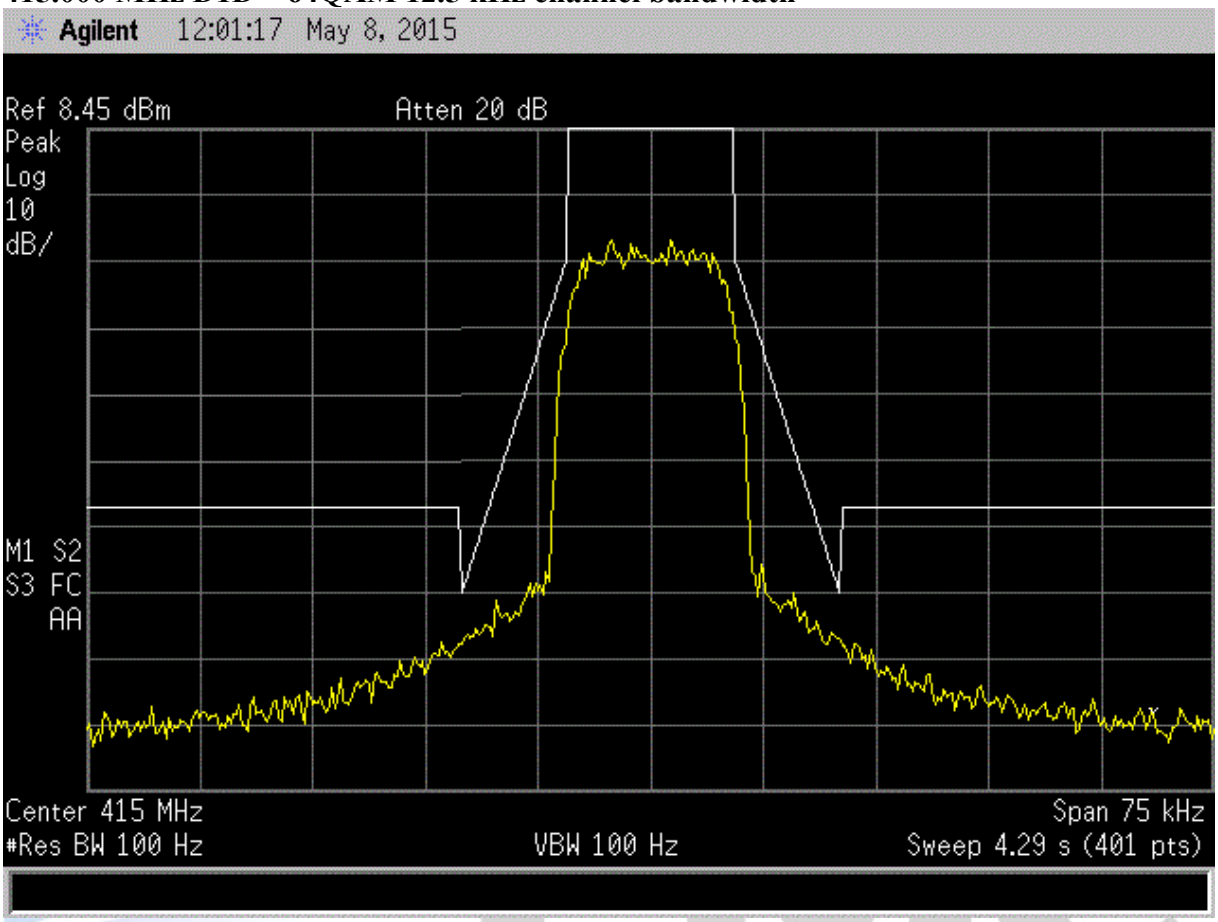
406.175 MHz G1D – QPSK 12.5 kHz channel bandwidth



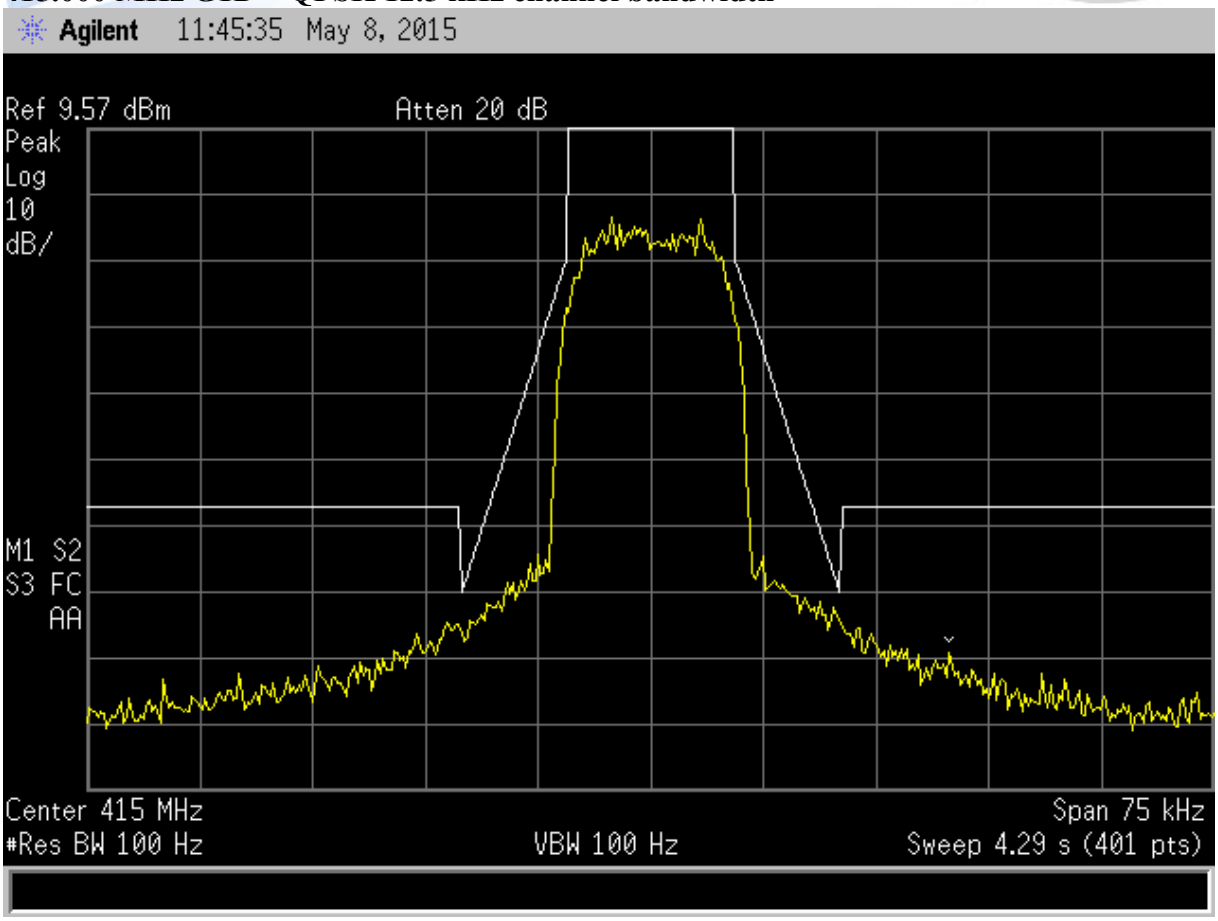
415.000 MHz D1D – 16QAM 12.5 kHz channel bandwidth



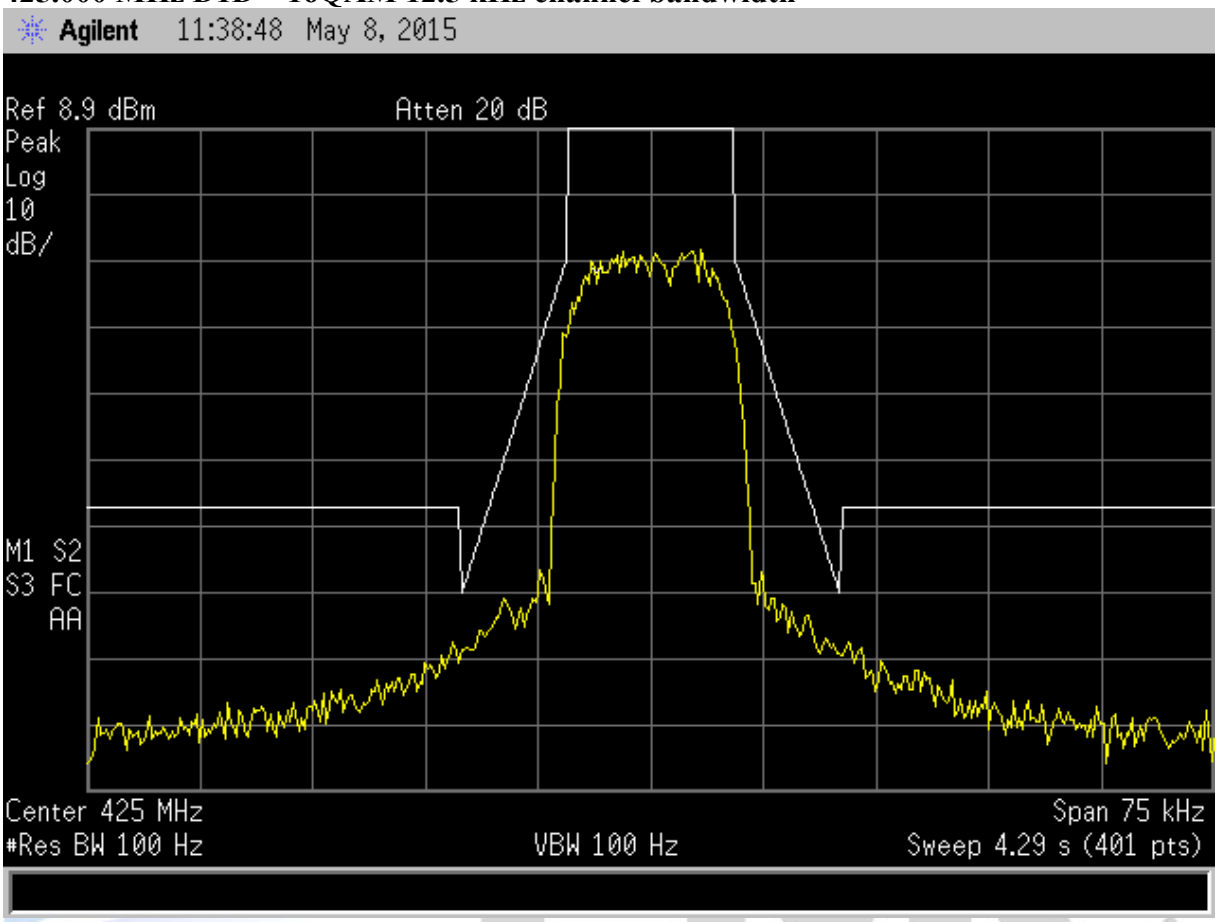
415.000 MHz D1D – 64QAM 12.5 kHz channel bandwidth



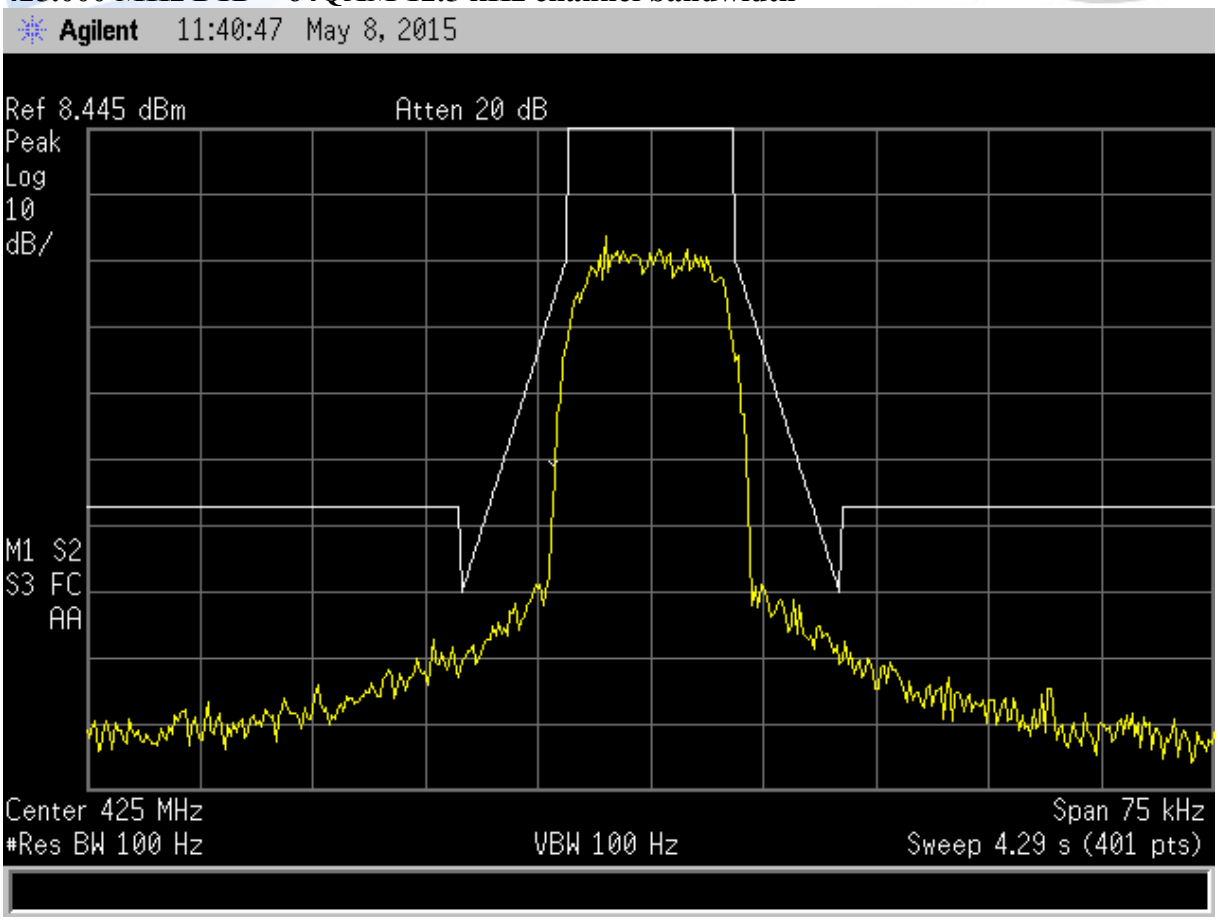
415.000 MHz G1D – QPSK 12.5 kHz channel bandwidth



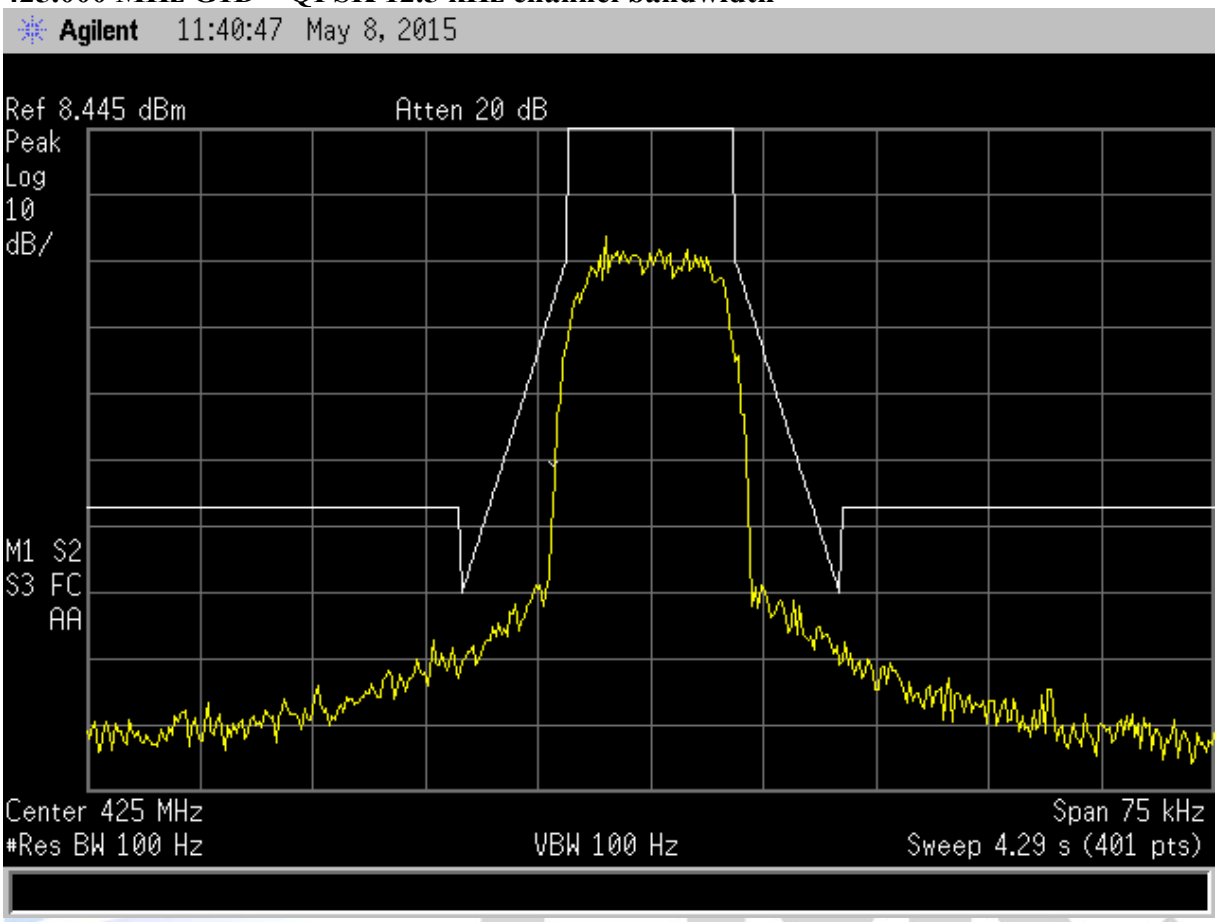
425.000 MHz D1D – 16QAM 12.5 kHz channel bandwidth



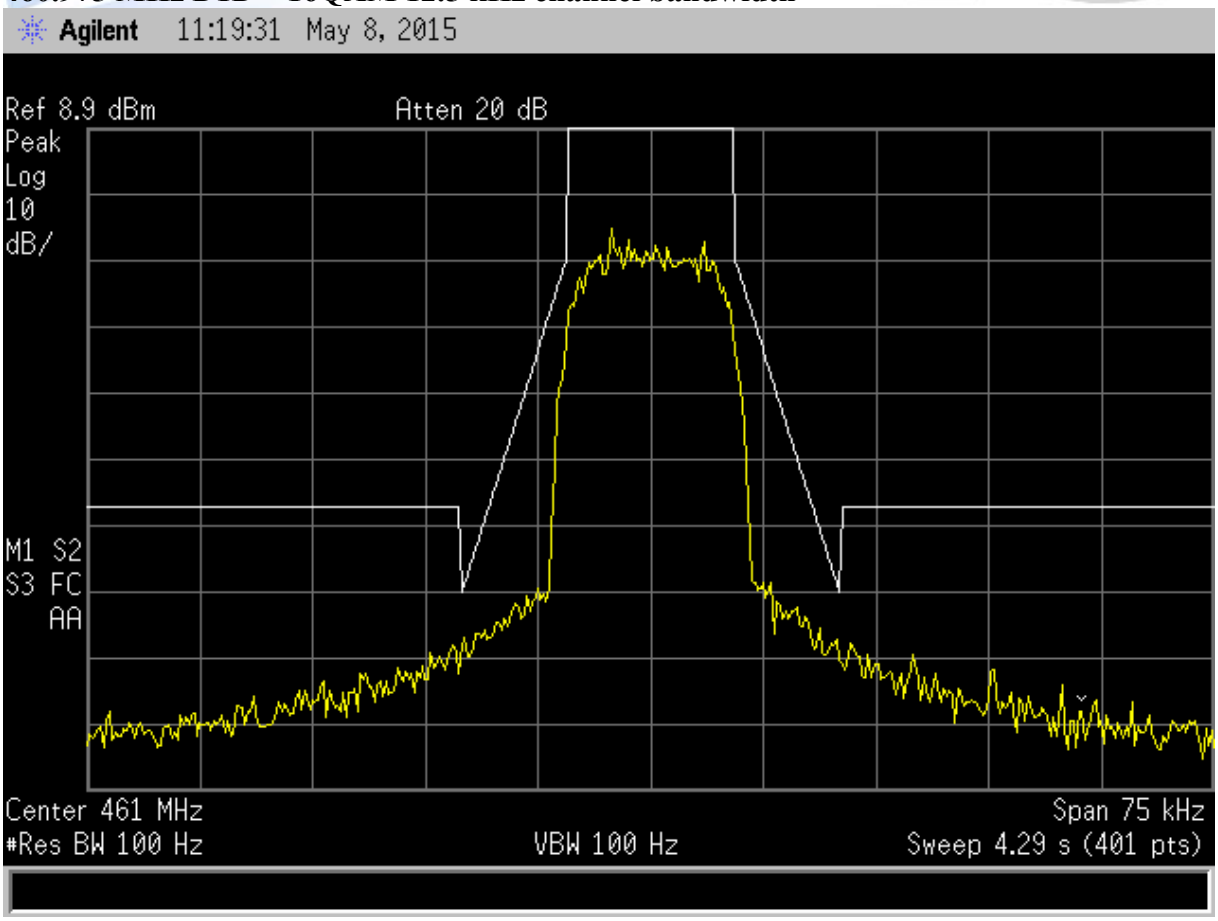
425.000 MHz D1D – 64QAM 12.5 kHz channel bandwidth



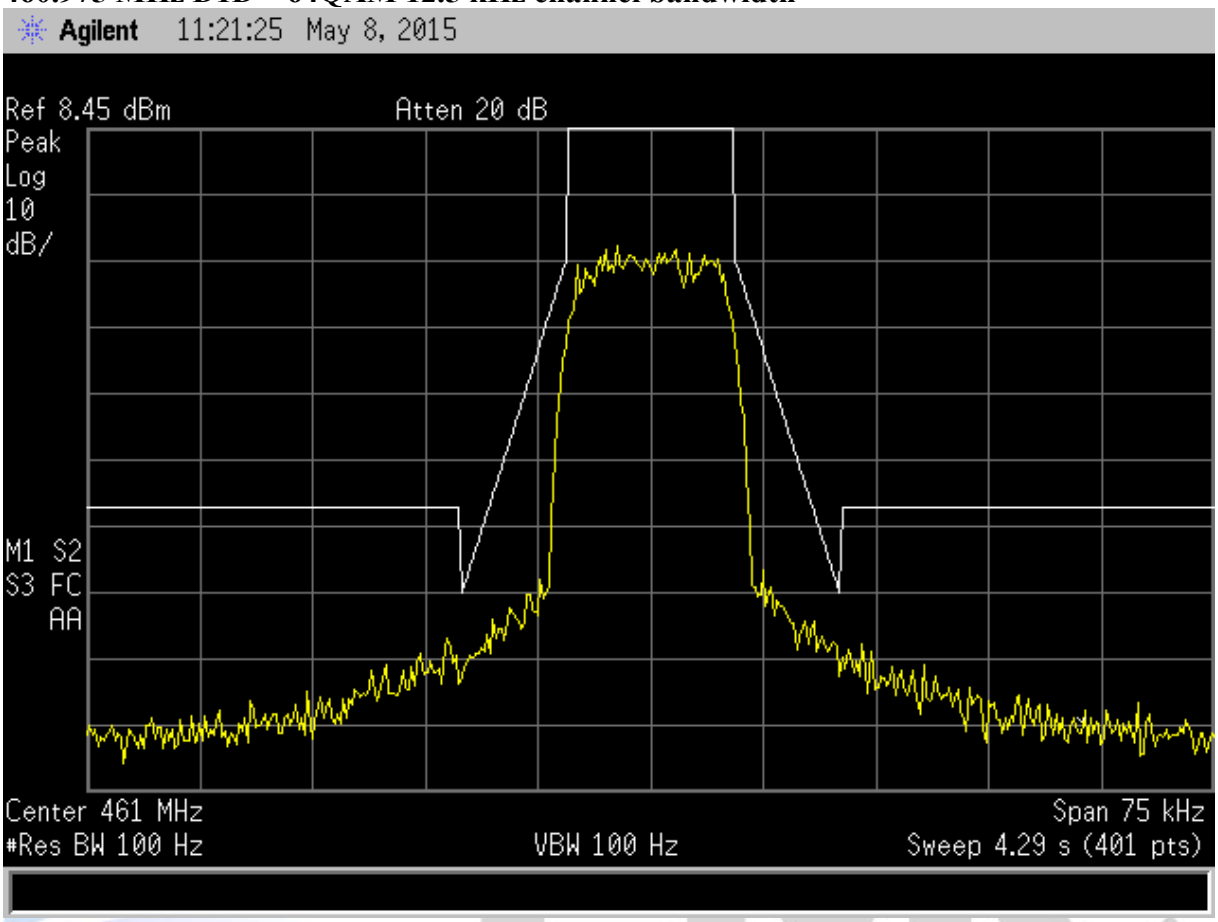
425.000 MHz G1D – QPSK 12.5 kHz channel bandwidth



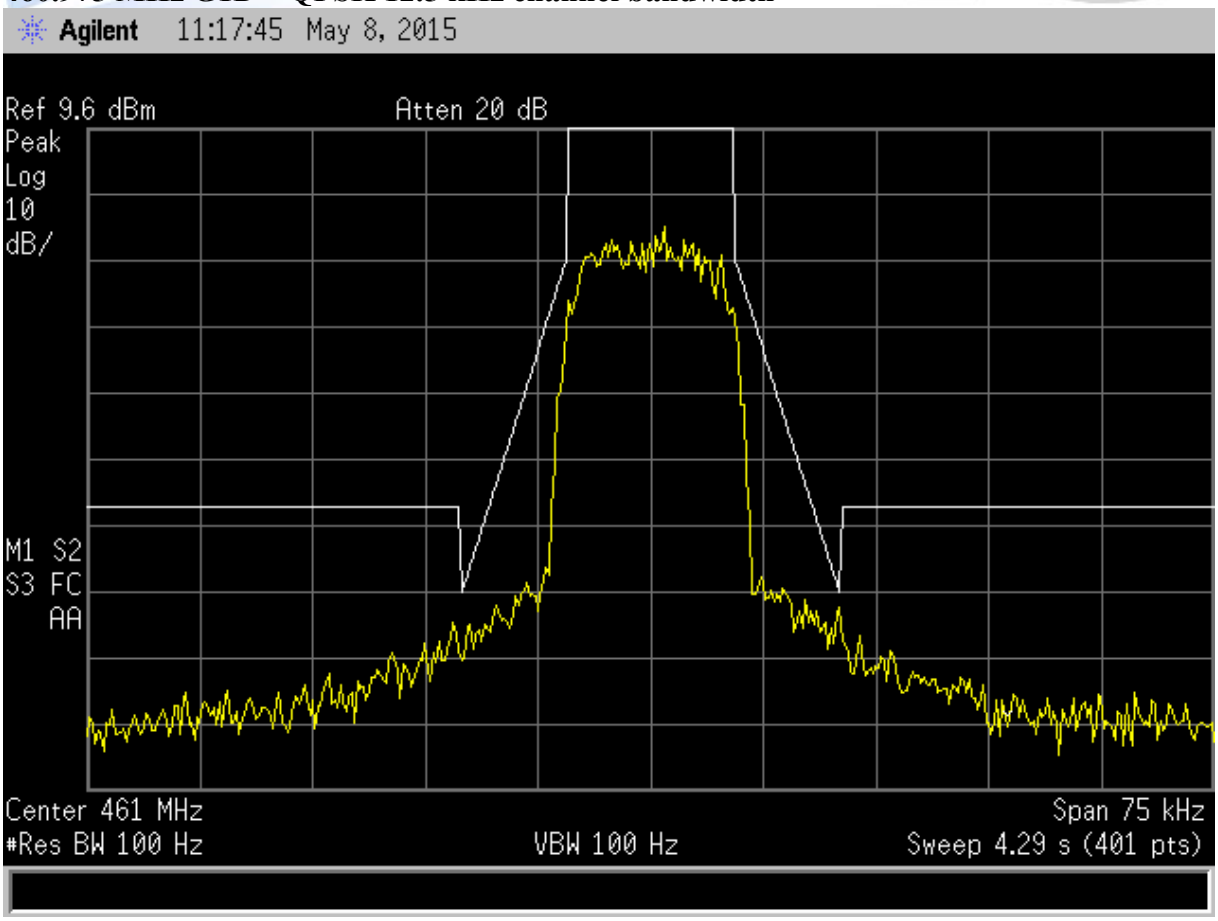
460.975 MHz D1D – 16QAM 12.5 kHz channel bandwidth



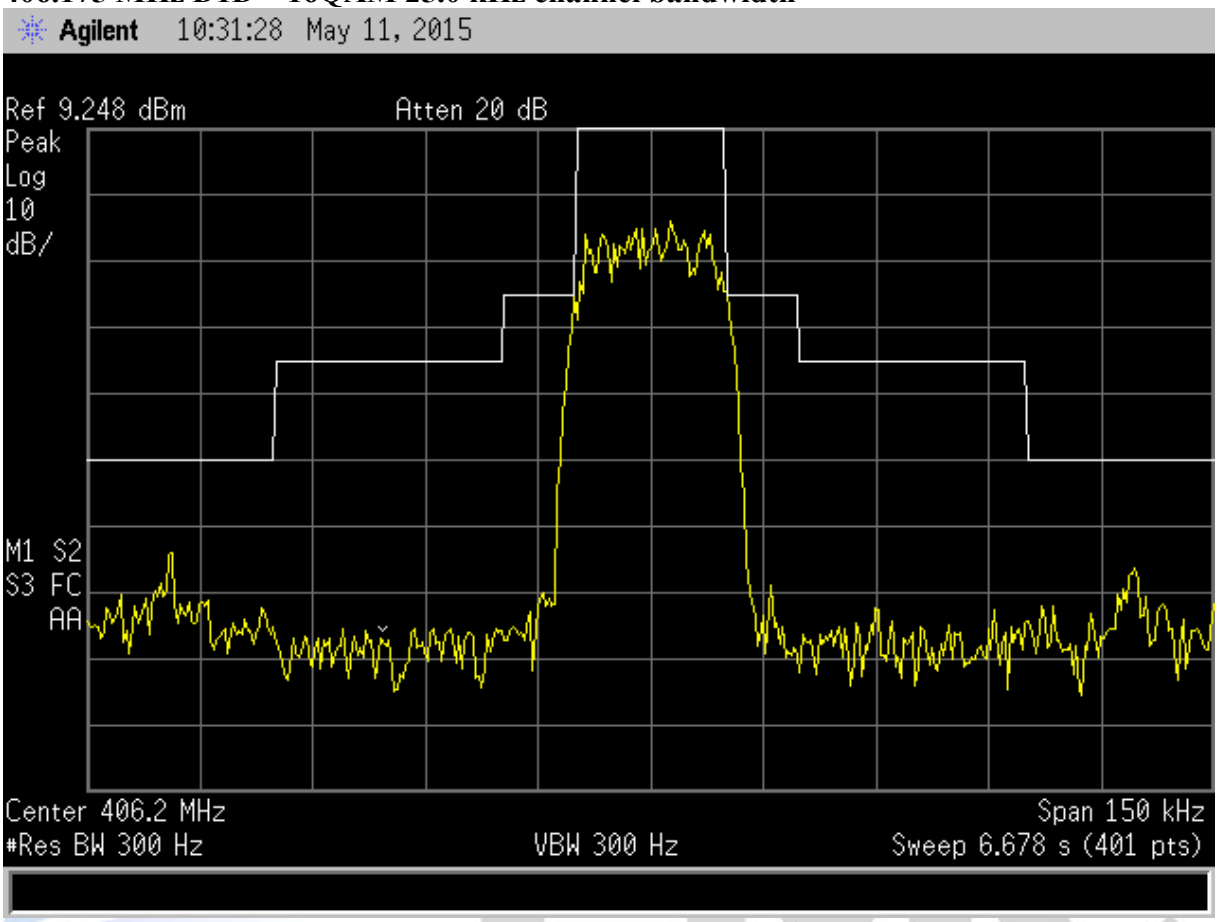
460.975 MHz D1D – 64QAM 12.5 kHz channel bandwidth



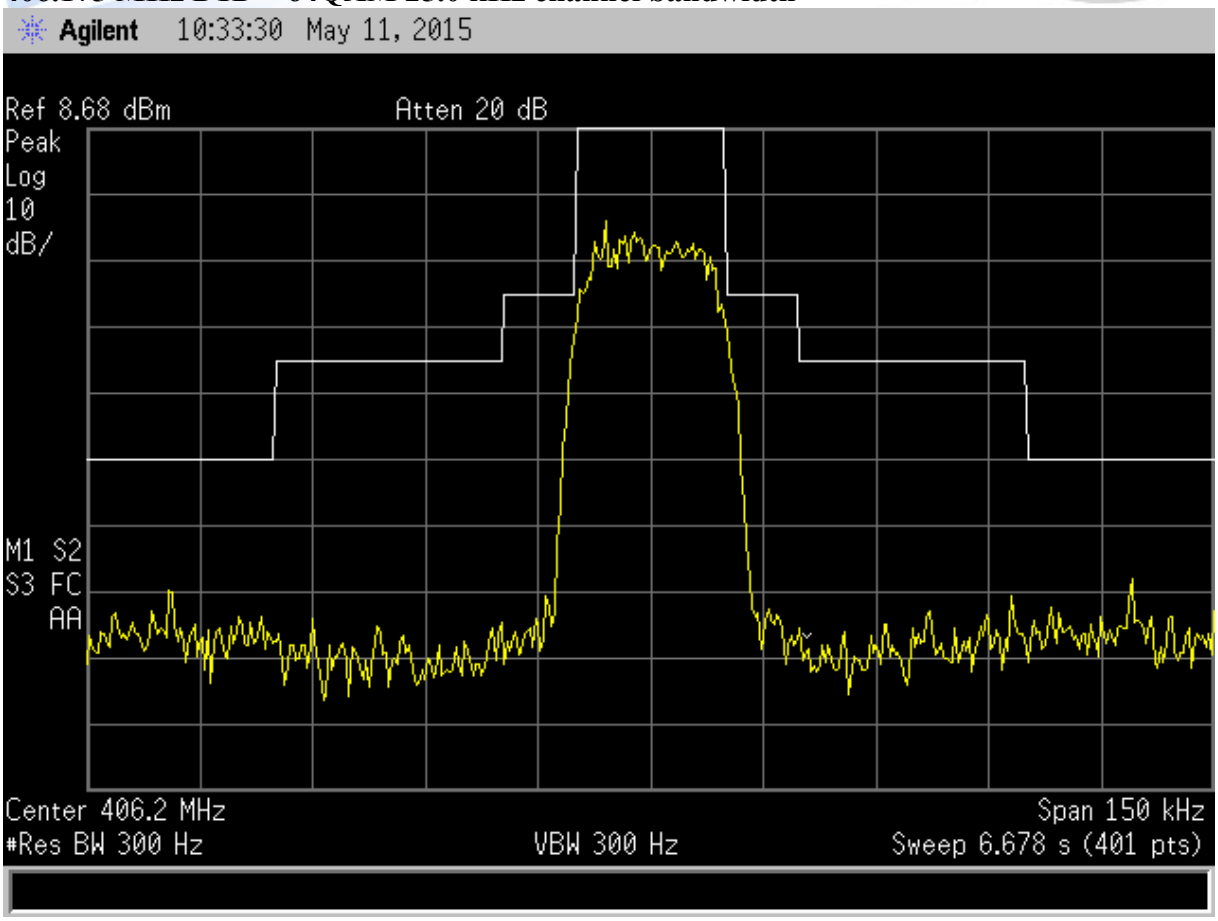
460.975 MHz G1D – QPSK 12.5 kHz channel bandwidth



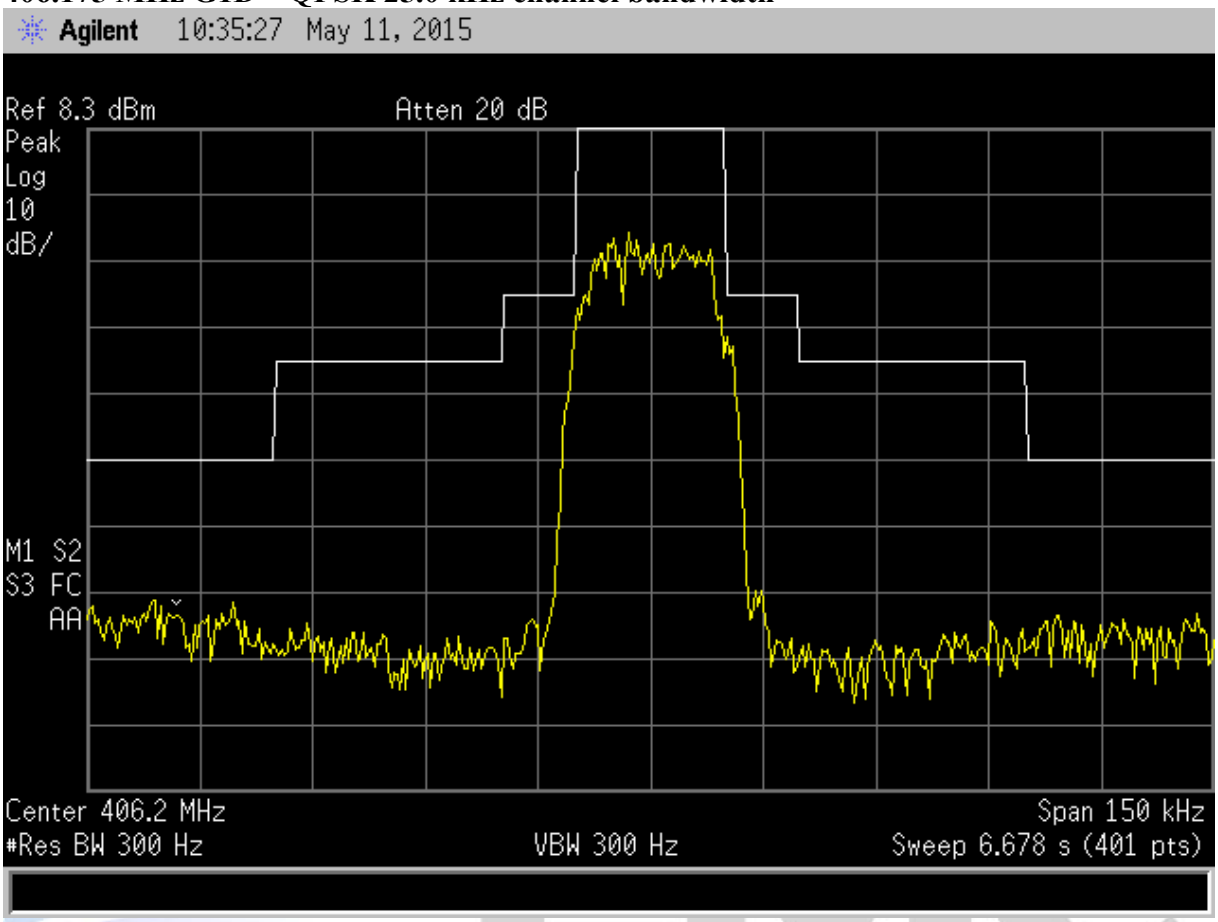
406.175 MHz D1D – 16QAM 25.0 kHz channel bandwidth



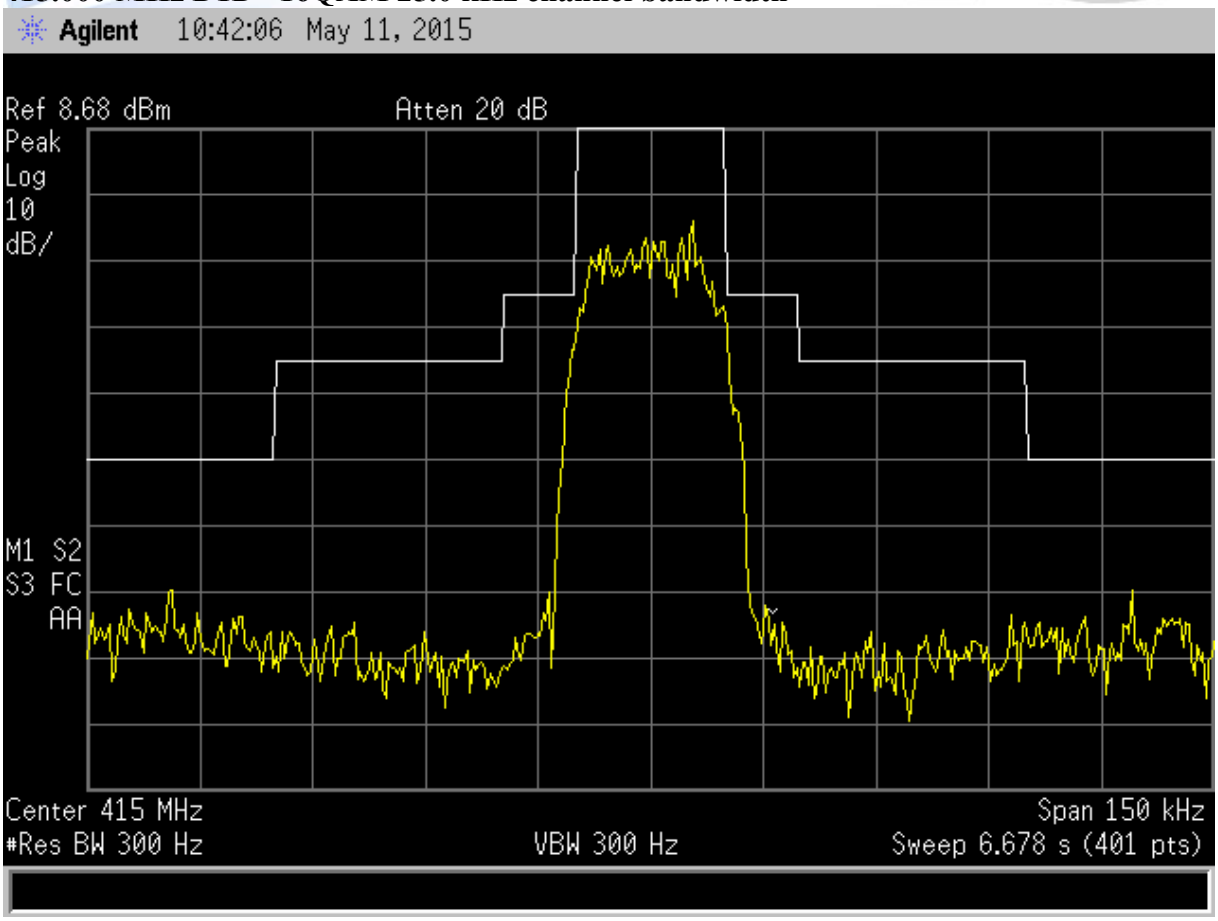
406.175 MHz D1D – 64QAM 25.0 kHz channel bandwidth



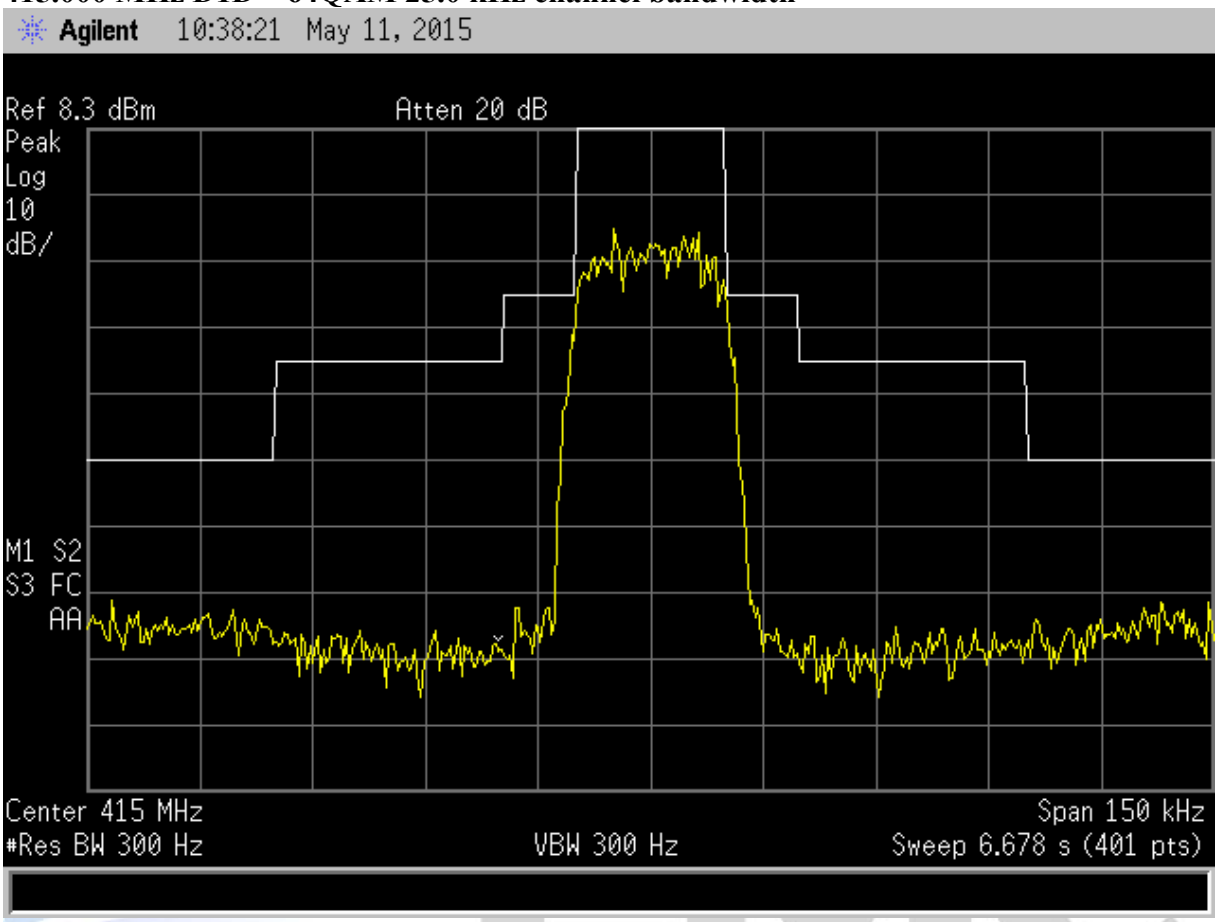
406.175 MHz G1D – QPSK 25.0 kHz channel bandwidth



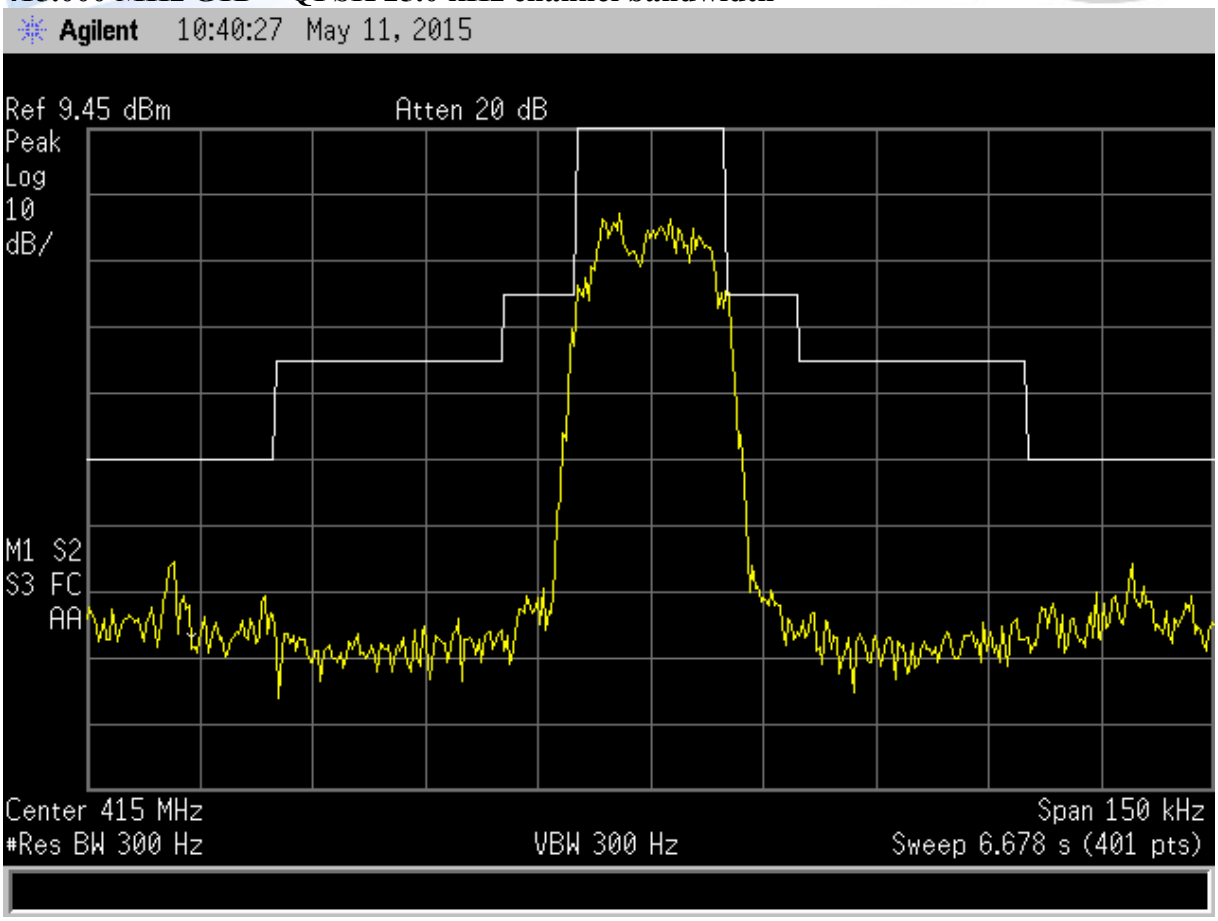
415.000 MHz D1D –16QAM 25.0 kHz channel bandwidth



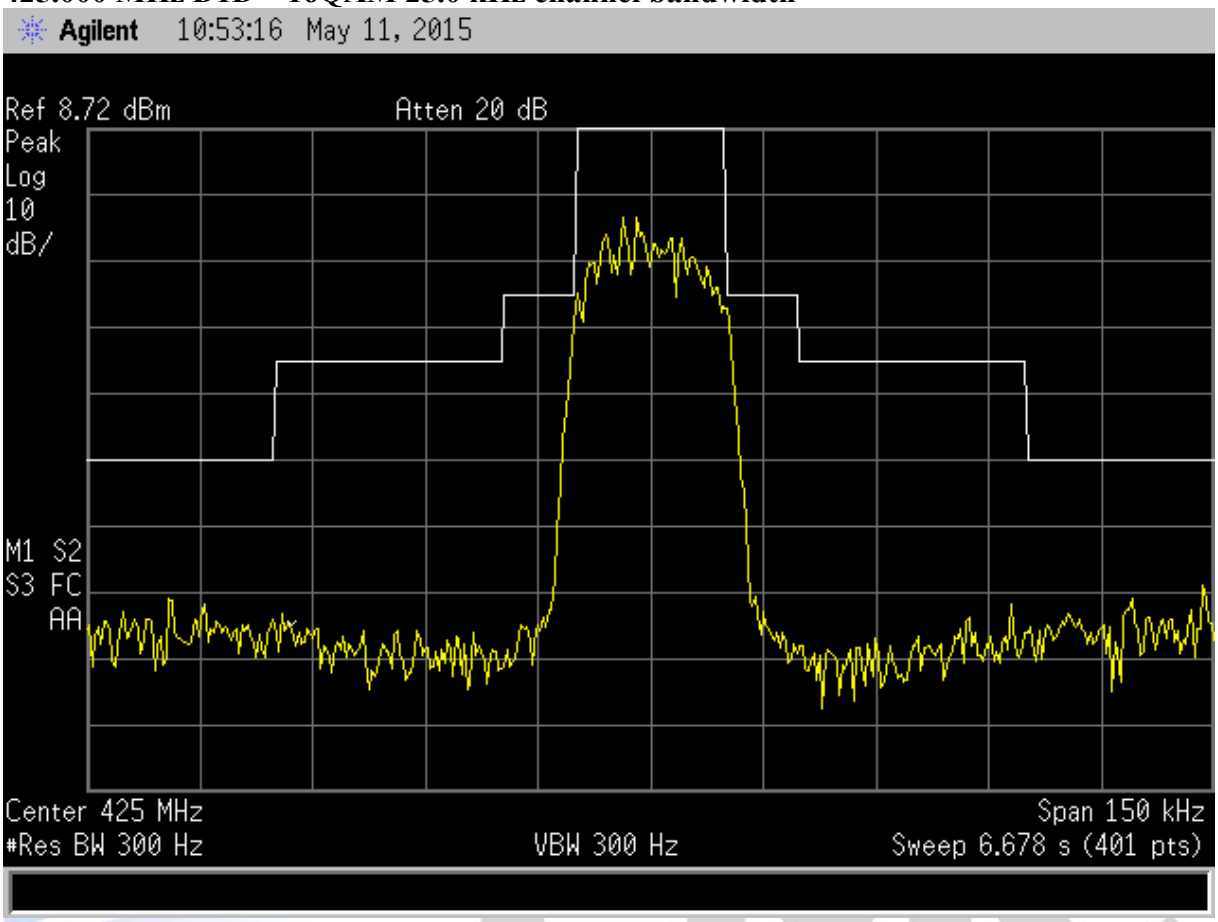
415.000 MHz D1D – 64QAM 25.0 kHz channel bandwidth



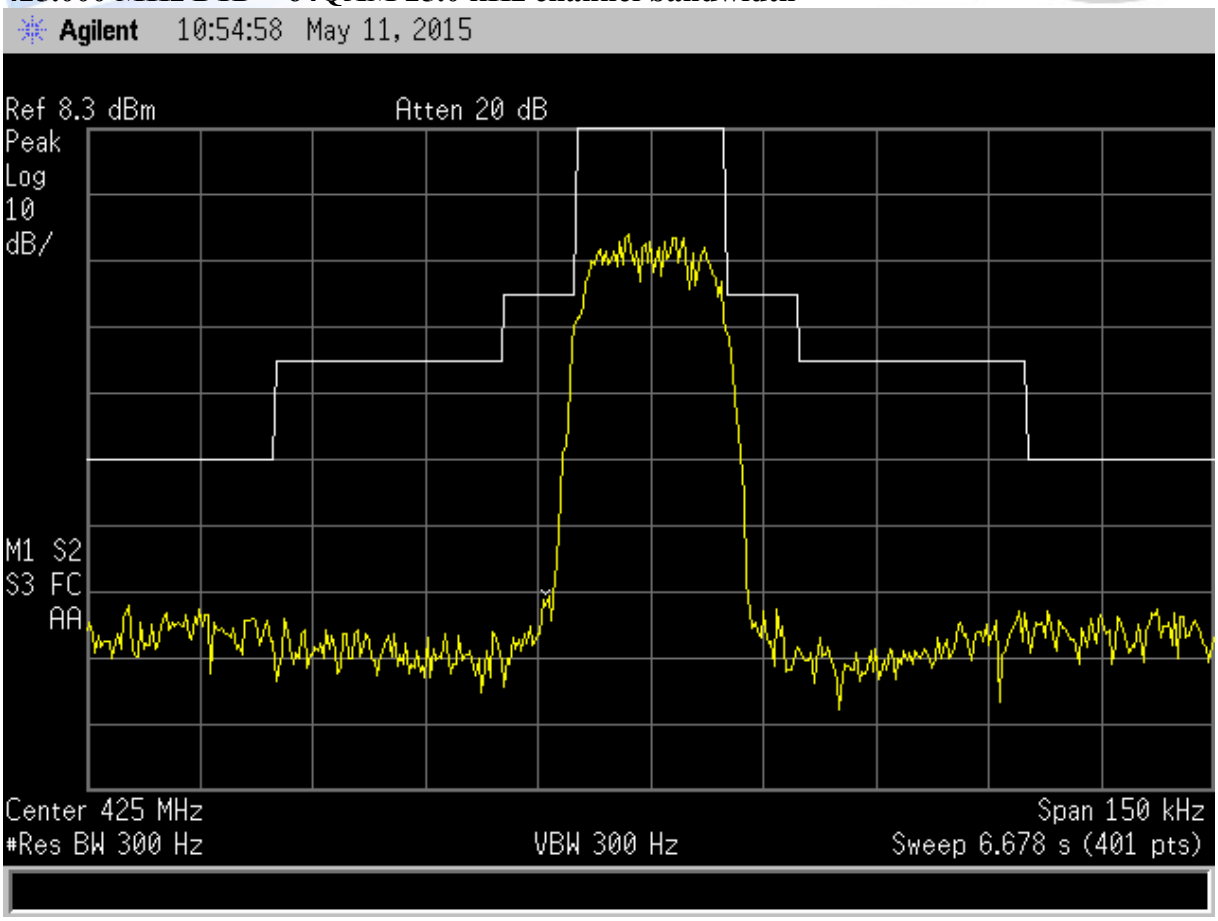
415.000 MHz G1D – QPSK 25.0 kHz channel bandwidth



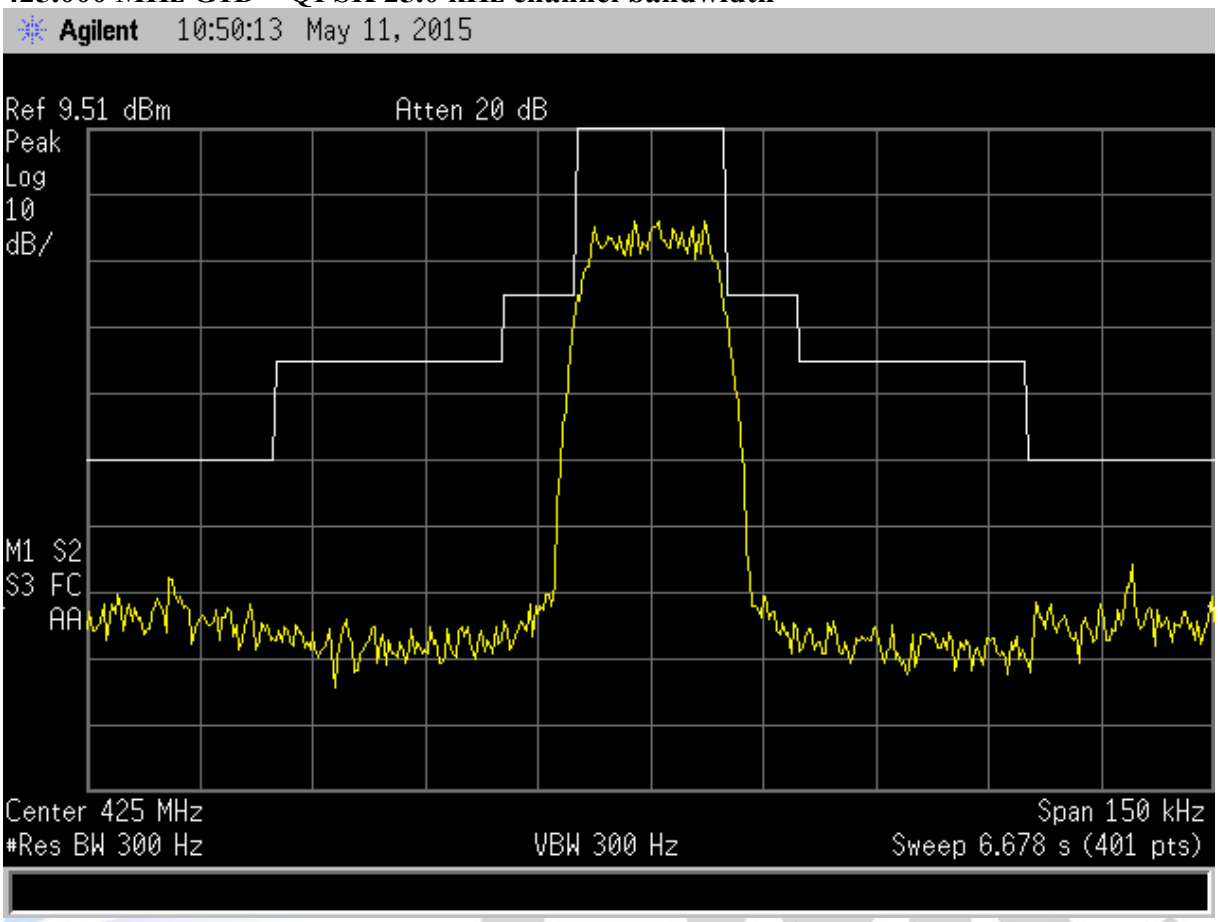
425.000 MHz D1D – 16QAM 25.0 kHz channel bandwidth



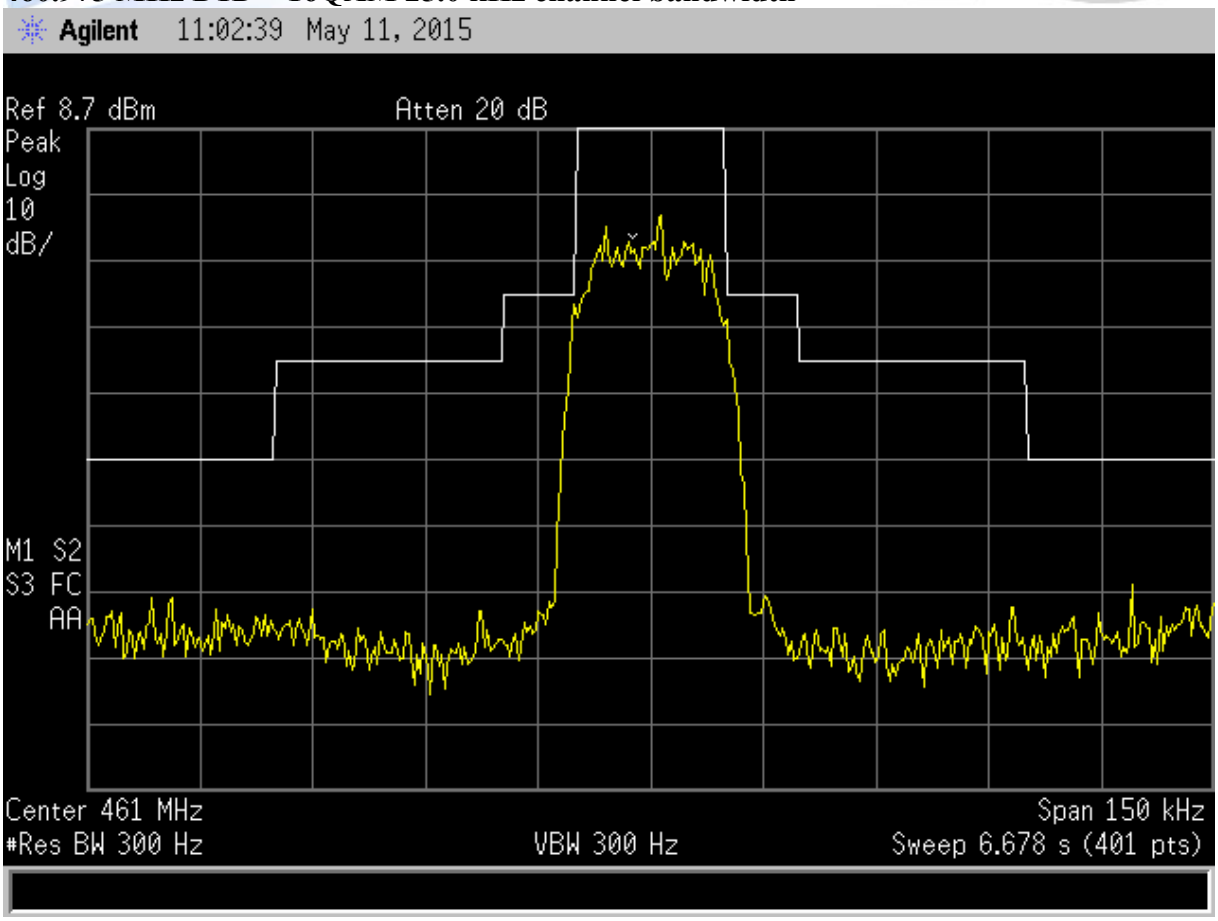
425.000 MHz D1D – 64QAM 25.0 kHz channel bandwidth



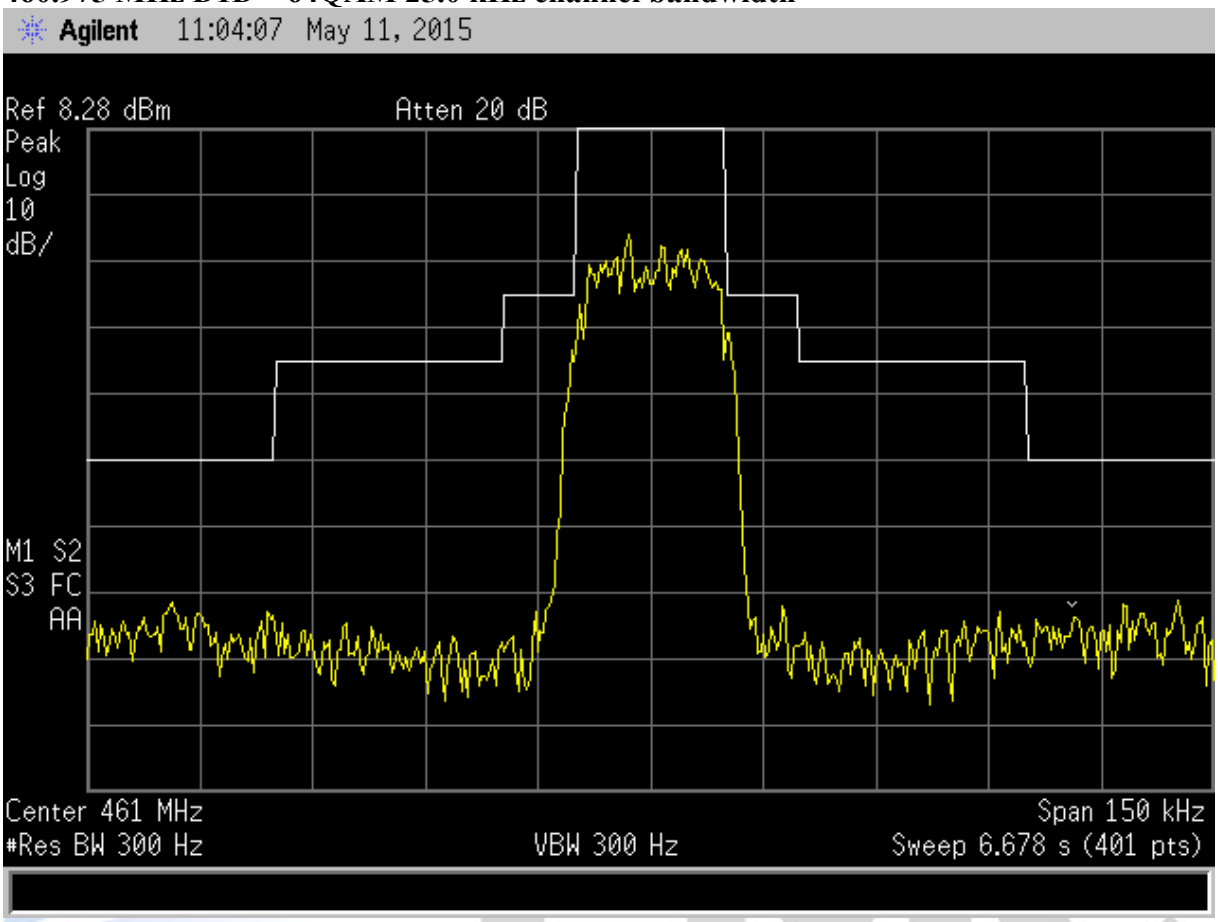
425.000 MHz G1D – QPSK 25.0 kHz channel bandwidth



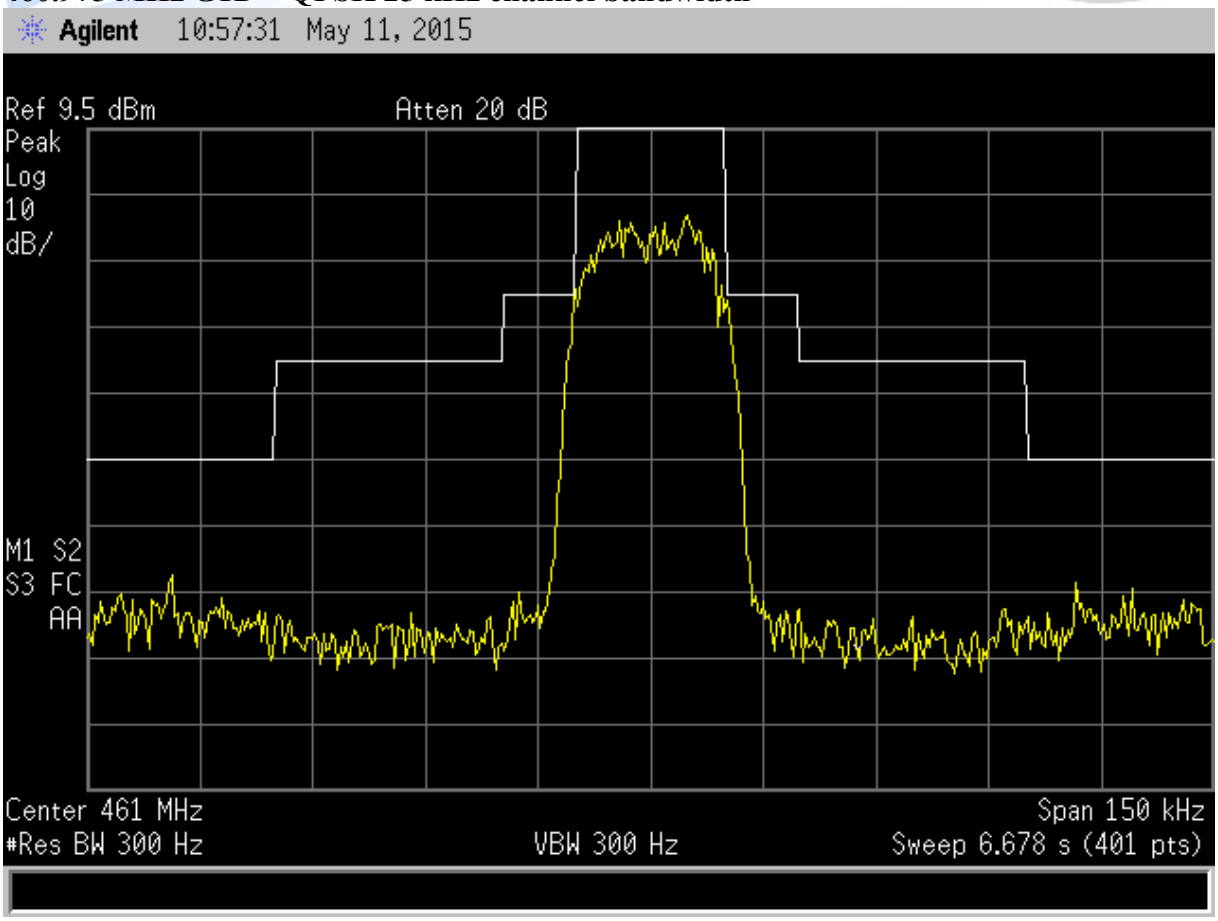
460.975 MHz D1D – 16QAM 25.0 kHz channel bandwidth



460.975 MHz D1D – 64QAM 25.0 kHz channel bandwidth



460.975 MHz G1D – QPSK 25 kHz channel bandwidth



Transmitter spurious emissions at the antenna terminals

Frequency: 406.175 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
812.350	-67.4	-20.0
1218.525	<-70.0	-20.0
1624.700	<-70.0	-20.0
2030.875	<-70.0	-20.0
2437.050	<-70.0	-20.0
2843.225	<-70.0	-20.0
3249.400	<-70.0	-20.0
3655.575	<-70.0	-20.0
4061.750	<-70.0	-20.0

Frequency: 460.975 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
921.950	-66.7	-20.0
1382.925	<-70.0	-20.0
1843.850	<-70.0	-20.0
2304.825	<-70.0	-20.0
2765.800	<-70.0	-20.0
3226.775	<-70.0	-20.0
3687.750	<-70.0	-20.0
4148.725	<-70.0	-20.0
4609.750	<-70.0	-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 a 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.

A rated power of 5.0 watts 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

Frequency: 406.175 MHz

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
812.350	36.1	-61.3	-20.0	Vertical	41.3
812.350	34.6	-62.8	-20.0	Horizontal	42.8
1218.525	55.1	-42.3	-20.0	Vertical	22.3
1218.525	55.1	-42.3	-20.0	Horizontal	22.3
1624.700	60.1	-37.3	-20.0	Vertical	17.3
1624.700	60.1	-37.3	-20.0	Horizontal	17.3
2030.875	62.6	-34.8	-20.0	Vertical	14.8
2030.875	62.5	-34.9	-20.0	Horizontal	14.9
2437.050	67.0	-30.4	-20.0	Vertical	10.4
2437.050	67.0	-30.4	-20.0	Horizontal	10.4
2843.225	54.1	-43.3	-20.0	Vertical	23.3
2843.225	54.1	-43.3	-20.0	Horizontal	23.3
3249.400	54.5	-42.9	-20.0	Vertical	22.9
3249.400	54.5	-42.9	-20.0	Horizontal	22.9
3655.575	57.0	-40.4	-20.0	Vertical	20.4
3655.575	57.0	-40.4	-20.0	Horizontal	20.4
4061.750	58.5	-38.9	-20.0	Vertical	18.9
4061.750	58.5	-38.9	-20.0	Horizontal	18.9

Frequency: 415.000 MHz

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
830.000	36.8	-60.6	-20.0	Vertical	40.6
830.000	35.0	-62.4	-20.0	Horizontal	42.4
1245.000	55.9	-41.5	-20.0	Vertical	21.5
1245.000	56.0	-41.4	-20.0	Horizontal	21.4
1660.000	60.1	-37.3	-20.0	Vertical	17.3
1660.000	60.0	-37.4	-20.0	Horizontal	17.4
2075.000	64.0	-33.4	-20.0	Vertical	13.4
2075.000	64.0	-33.4	-20.0	Horizontal	13.4
2490.000	67.0	-30.4	-20.0	Vertical	10.4
2490.000	67.0	-30.4	-20.0	Horizontal	10.4
2905.000	54.5	-42.9	-20.0	Vertical	22.9
2905.000	54.5	-42.9	-20.0	Horizontal	22.9
3320.000	55.0	-42.4	-20.0	Vertical	22.4
3320.000	55.0	-42.4	-20.0	Horizontal	22.4
3735.000	57.0	-40.4	-20.0	Vertical	20.4
3735.000	57.0	-40.4	-20.0	Horizontal	20.4
4150.000	59.0	-38.4	-20.0	Vertical	18.4
4150.000	59.0	-38.4	-20.0	Horizontal	18.4

Field strength of the transmitter spurious emissions

Frequency: 425.000 MHz

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
850.000	38.4	-59.0	-20.0	Vertical	39.0
850.000	35.5	-61.9	-20.0	Horizontal	41.9
1275.000	57.3	-40.1	-20.0	Vertical	20.1
1275.000	57.0	-40.4	-20.0	Horizontal	20.4
1700.000	60.0	-37.4	-20.0	Vertical	17.4
1700.000	60.0	-37.4	-20.0	Horizontal	17.4
2125.000	64.0	-33.4	-20.0	Vertical	13.4
2125.000	63.8	-33.6	-20.0	Horizontal	13.6
2550.000	68.0	-29.4	-20.0	Vertical	9.4
2550.000	68.0	-29.4	-20.0	Horizontal	9.4
2975.000	55.0	-42.4	-20.0	Vertical	22.4
2975.000	55.0	-42.4	-20.0	Horizontal	22.4
3400.000	57.0	-40.4	-20.0	Vertical	20.4
3400.000	57.0	-40.4	-20.0	Horizontal	20.4
3825.000	58.0	-39.4	-20.0	Vertical	19.4
3825.000	58.0	-39.4	-20.0	Horizontal	19.4
4250.000	59.0	-38.4	-20.0	Vertical	18.4
4250.000	59.0	-38.4	-20.0	Horizontal	18.4

Frequency: 460.975 MHz

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
921.950	36.6	-60.8	-20.0	Vertical	40.8
921.950	36.5	-60.9	-20.0	Horizontal	40.9
1382.925	56.3	-41.1	-20.0	Vertical	21.1
1382.925	56.5	-40.9	-20.0	Horizontal	20.9
1843.850	61.0	-36.4	-20.0	Vertical	16.4
1843.850	61.0	-36.4	-20.0	Horizontal	16.4
2304.825	65.2	-32.2	-20.0	Vertical	12.2
2304.825	65.0	-32.4	-20.0	Horizontal	12.4
2765.800	67.0	-30.4	-20.0	Vertical	10.4
2765.800	67.0	-30.4	-20.0	Horizontal	10.4
3226.775	54.0	-43.4	-20.0	Vertical	23.4
3226.775	54.0	-43.4	-20.0	Horizontal	23.4
3687.750	57.0	-40.4	-20.0	Vertical	20.4
3687.750	57.0	-40.4	-20.0	Horizontal	20.4
4148.725	59.0	-38.4	-20.0	Vertical	18.4
4148.725	59.0	-38.4	-20.0	Horizontal	18.4
4609.750	61.0	-36.4	-20.0	Vertical	16.4
4609.750	61.0	-36.4	-20.0	Horizontal	16.4

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). The rated power of 5 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: 425.000 MHz

Temperature (°C)	Voltage 10.0 Vdc	Voltage 13.8 Vdc	Voltage 30.0 Vdc
+50	+31.0	+35.0	+19.0
+40	+37.0	+34.0	+30.0
+30	+75.0	+48.0	+58.0
+20	+114.0	+127.0	+112.0
+10	+54.0	+46.0	+50.0
0	+82.0	+89.0	+86.0
-10	+62.0	+45.0	+67.0
-20	+43.0	+36.0	+44.0
-30	+73.0	+59.0	+56.0

Limit:

Part 90.213 states that mobile station transmitters operating between 421 – 512 MHz with 12.5 kHz channel bandwidth are required to have a frequency tolerance of 2.5 ppm.

A worst case frequency stability of 127.0 Hz or 0.30 ppm was observed.

Result: Complies
Measurement Uncertainty: ±30 Hz

Transient frequency behaviour

Transient frequency behaviour measurements are applicable to wide band and narrow band transmitters

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

In summary this method calls for the use of an external signal generator tuned to transmitter frequency of 460.975 MHz with an output level 0.1 % (-30 dB) of the level from the transmitter with a 1 kHz tone with a frequency deviation of 12.5 kHz being applied to the input of a modulation analyser along with the output from the transmitter.

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:

Spacing	Period t_1 (kHz)	Period t_2 (kHz)	Period t_3 (kHz)
12.5 kHz	Nil	Nil	Nil
25.0 kHz	Nil	Nil	Nil

Limits:

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

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

12.5 kHz transmitter turn on (425.000 MHz)

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

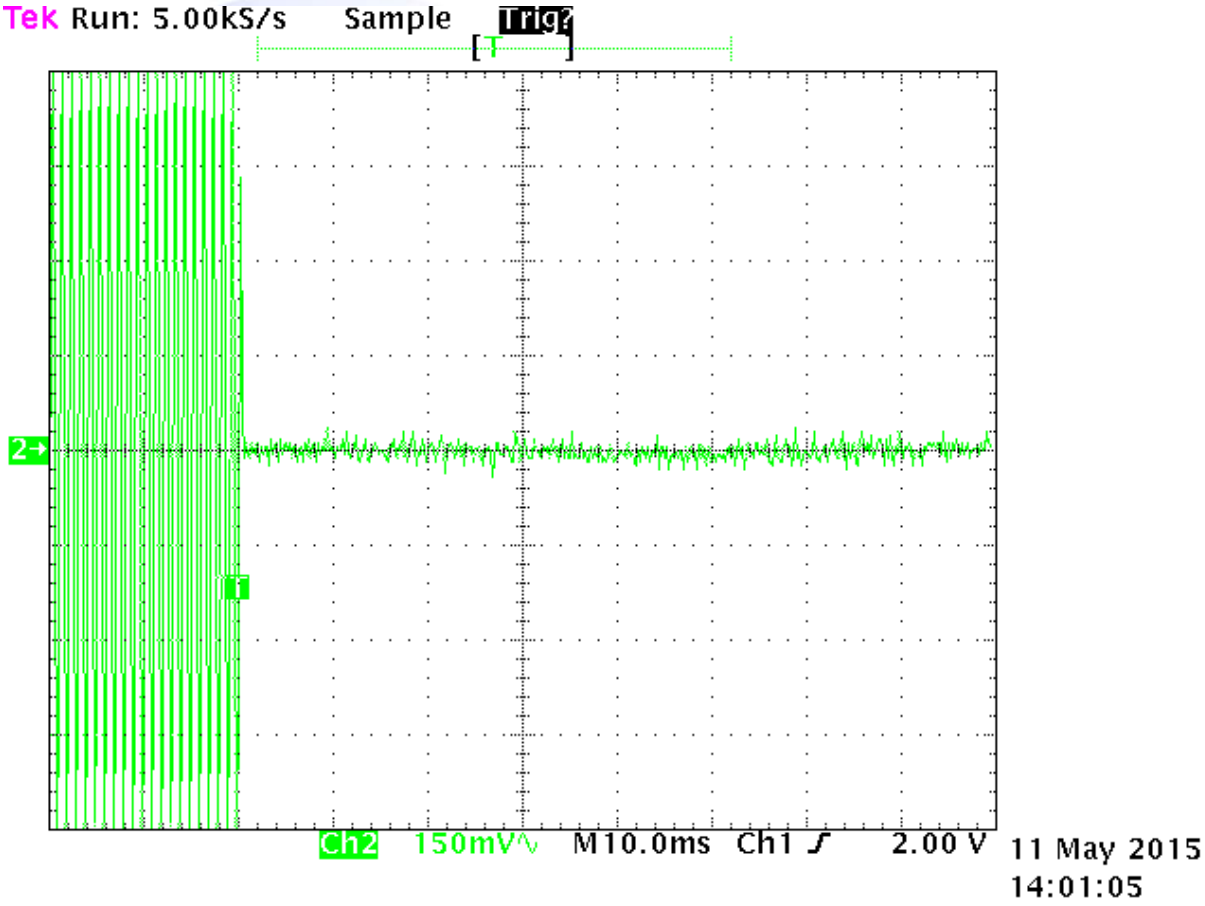
Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division.

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 *t*1 which does not exceed 12.5 kHz.



12.5 kHz transmitter turn off (425.000 MHz)

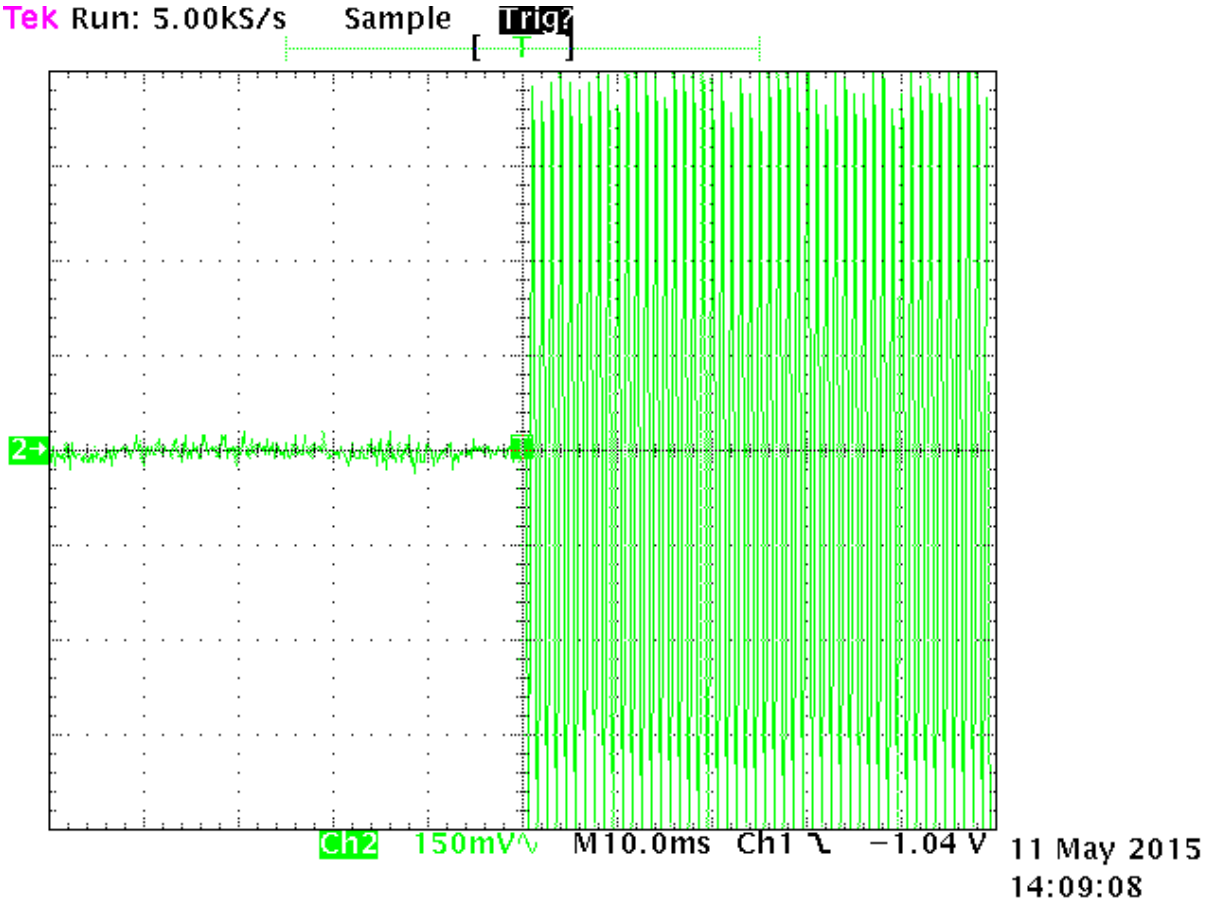
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz.

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

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 (425.000 MHz)

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

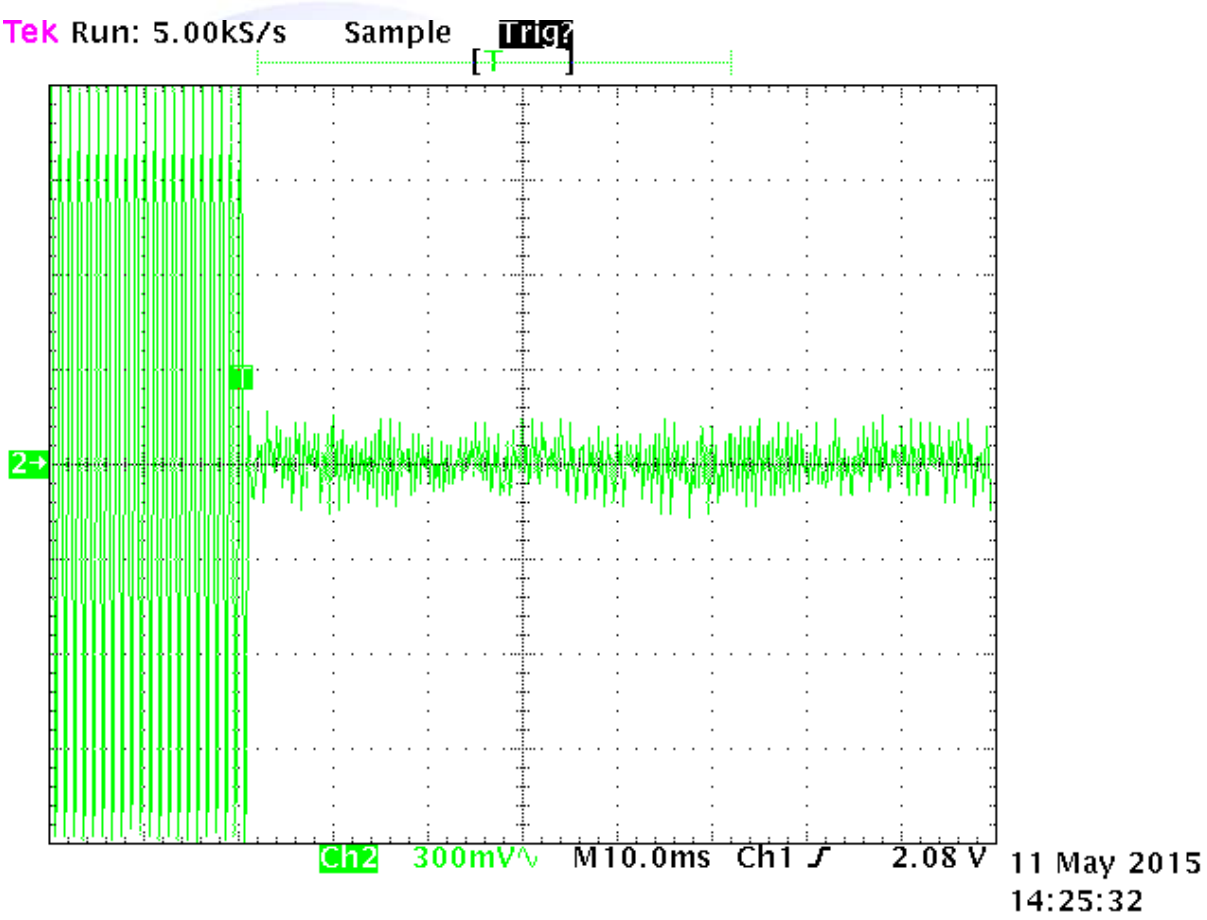
Green trace has been maximised to give full screen indication of +/- 25.0 kHz.
Therefore each Y axis division = 6.25 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division.

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 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 *t*1 which does not exceed 25.0 kHz.



25.0 kHz transmitter turn off (425.000 MHz)

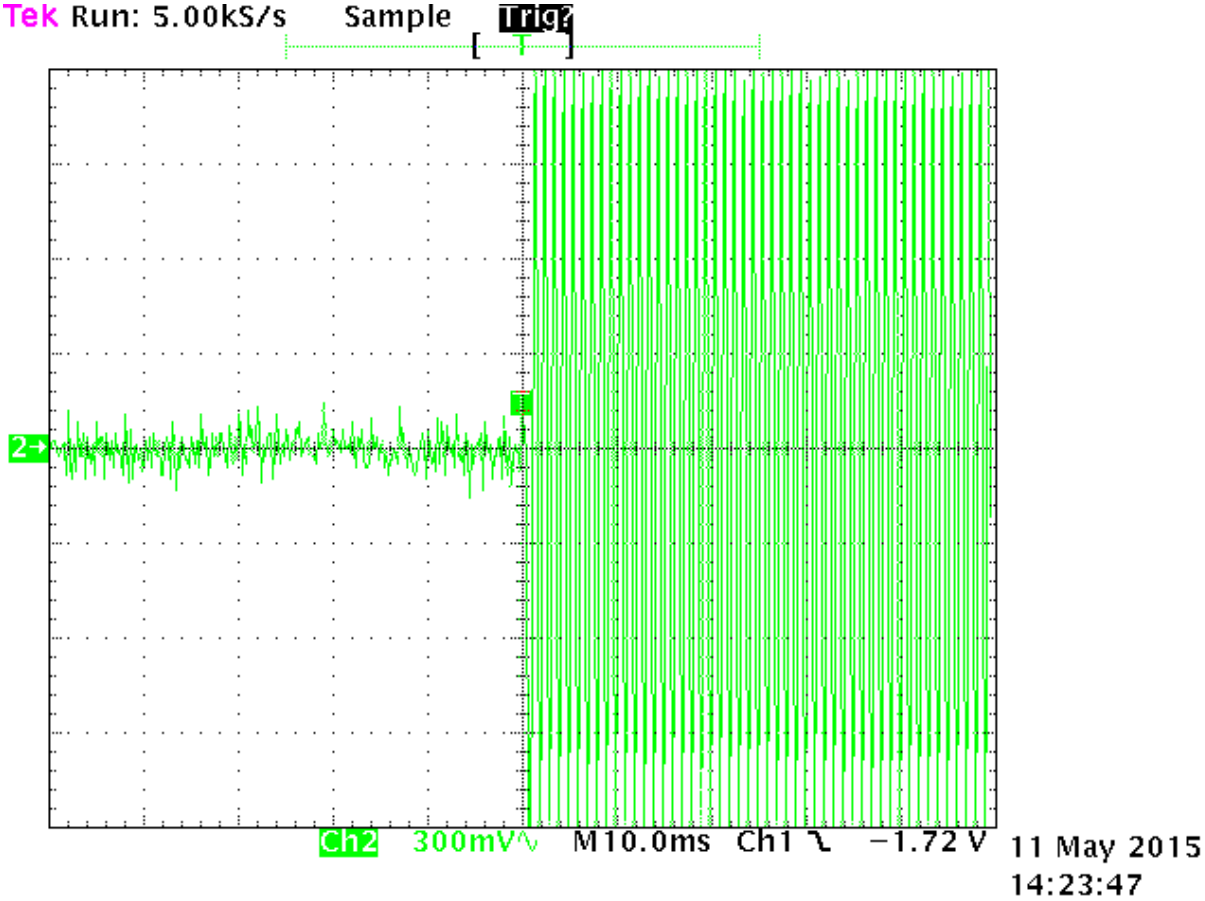
Green Trace = 1 kHz tone with FM deviation of 25.0 kHz.

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 4.0 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 Section 1.1310 mobile transmitters are required to be operated in a manner that ensures the public is not exposed to RF energy levels in accordance with OST/OET Bulletin Number 65.

Calculations have been made using the General Public/Uncontrolled Exposure limits.

Minimum safe distances have been calculated below.

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

- General Population / Uncontrolled exposure limit will be 0.27 mW/m^2
(f/1500 = 406.1 MHz/1500)

As 406.1 MHz is the lowest frequency of operation in USA, this frequency has been used to give a worst case result.

The minimum distance from the antenna at which the MPE is met is calculated from the equation relating field strength in V/m, transmit power in watts, transmit antenna gain, transmitter duty cycle and separation distance in metres:

E, V/m = (√ (30 * P * G)) / d

Uncontrolled

$E = 0.27\ mW/m^2 = E^2/3770$
$E = \sqrt{0.27*3770}$
E = 31.6 V/m

The rated maximum transmitter power = 5 watts.

This transmitter can used with a variety of antennas with gains of up to 15 dBi (31.6).

A duty cycle of 100% as the transmitter is a base station could possibly be operated for long periods of time.

Uncontrolled

d = √ (30 * P * G*DC) / E

d = √ (30 *5 * 31.6 * 1.0) / 31.6

d = 2.18 metres or 218 cm

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

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset	Cal Due	Interval
Aerial Controller	EMCO	1090	9112-1062	3710	N/a	N/a
Aerial Mast	EMCO	1070-1	9203-1661	3708	N/a	N/a
Biconical Antenna	Schwarzbeck	BBA 9106	-	3612	03/02/2018	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	04/06/2017	3 years
Level generator	Anritsu	MG443B	M61689	E1143	21/05/2016	2 years
Log Periodic Antenna	Schwarzbeck	VUSLP 91111	9111-228	3785	17/12/2017	3 years
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	E1552	15/06/2015	2 years
Modulation Analyzer	Hewlett Packard	8901B	2608A00782	E1090	15/10/2016	2 years
Oscilloscope	Tektronics	745A	B010643	E1569	15/06/2015	2 years
Power Attenuator	JFW	50FH-030-100	-	-	N/a	N/a
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069	N/a	N/a
Receiver	Rohde & Schwarz	ESIB-40	100171	4003	16/04/2016	1 year
Selective Level Meter	Anritsu	ML422C	M35386	E1140	03/07/2015	2 years
Signal Generator	Rohde & Schwarz	SMHU	838923/028	E1493	22/06/2015	2 years
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	3776	26/06/2015	1 year
Thermal chamber	Contherm	M180F	86025	E1129	01/06/2015	N/a
Thermometer	DSIR	RT200	035	E1049	01/06/2015	N/a
Turntable	EMCO	1080-1-2.1	9109-1578	3709	N/a	N/a
VHF Balun	Schwarzbeck	VHA9103	-	3603	03/02/2018	3 years

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

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies Ltd registration with the Federal Communications Commission as a listed facility, registration number: 90838, which was updated in June 2014.

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

Radiated emissions set up