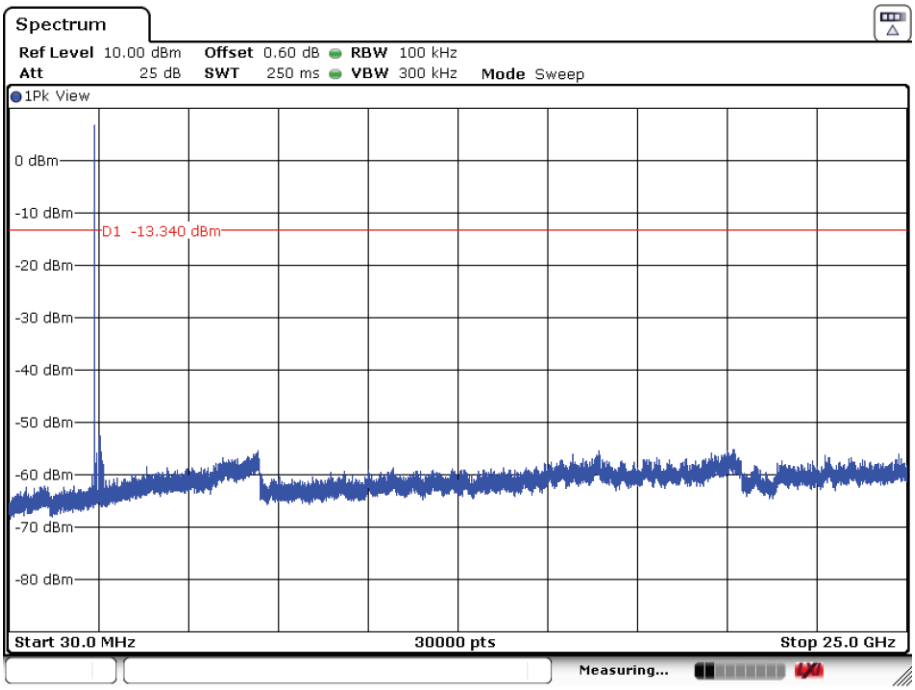
Modulation: GFSK

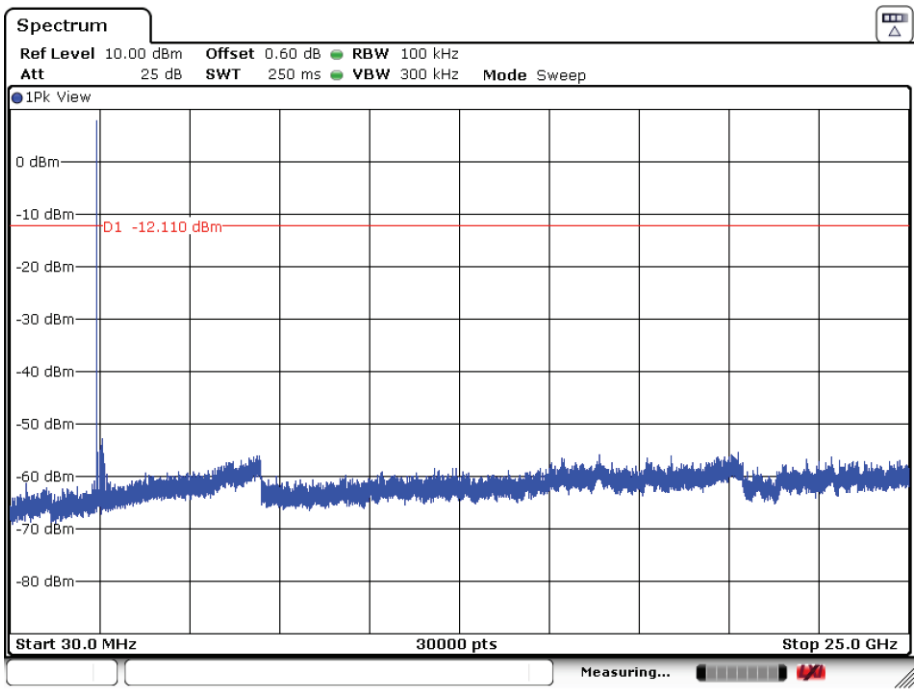
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limit is the carrier frequency.

Verdict: PASS

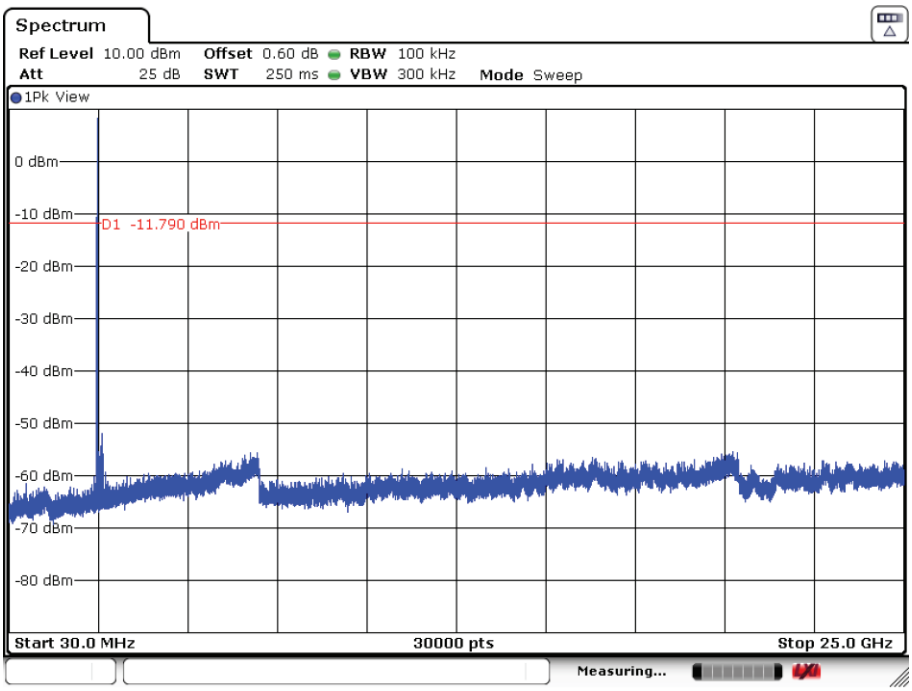
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limits is the carrier frequency.

Verdict: PASS

3. HIGHEST CHANNEL (2480 MHz): 30 MHz-25 GHz (see next plot).



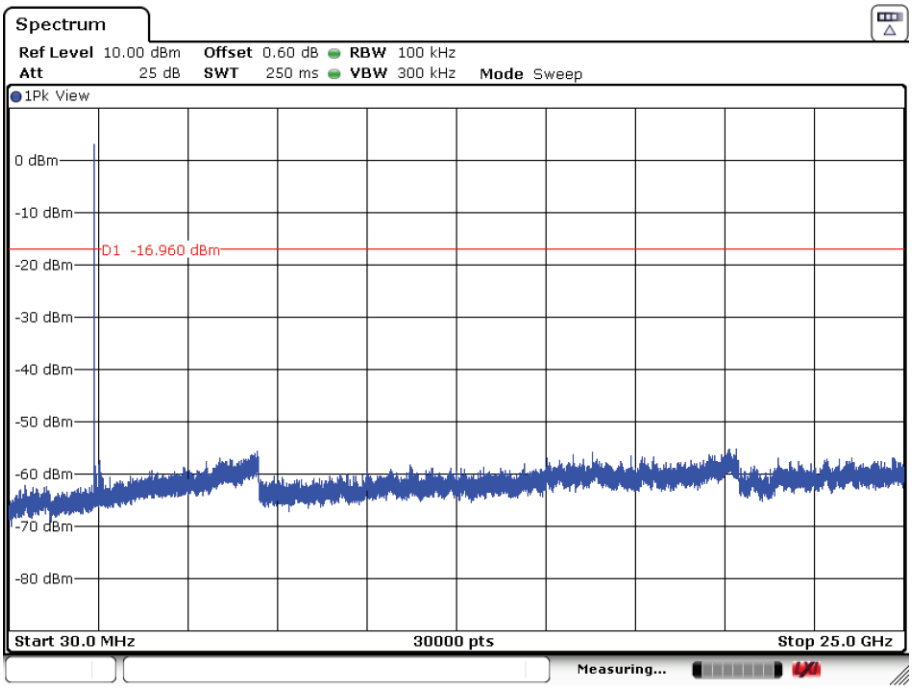
Note: The peak above the limits is the carrier frequency.

Verdict: PASS

Measurement uncertainty (dB)	<±1.20

Modulation: Π/4-DQPSK

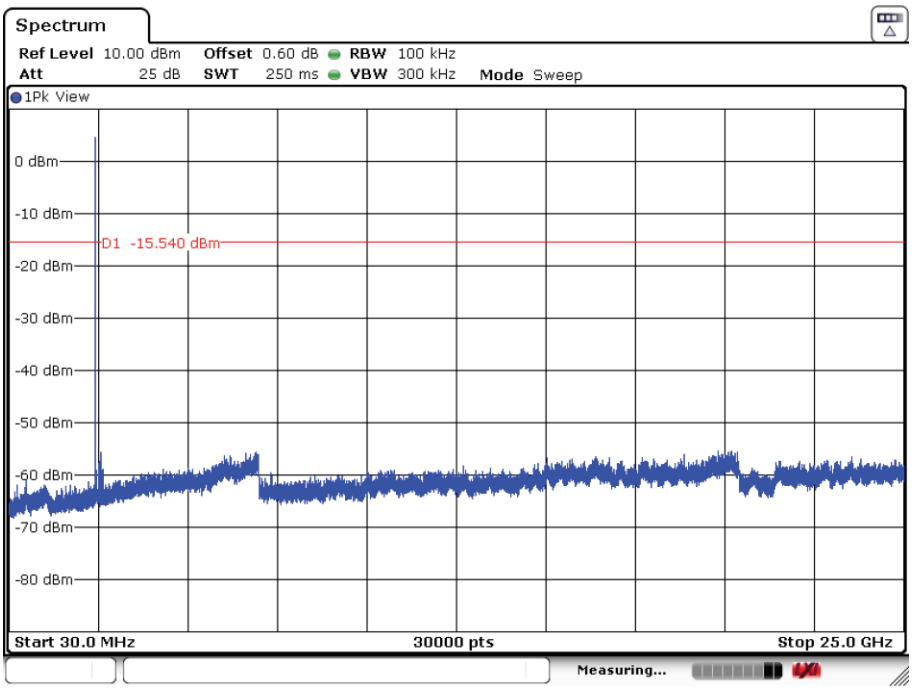
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limits is the carrier frequency.

Verdict: PASS

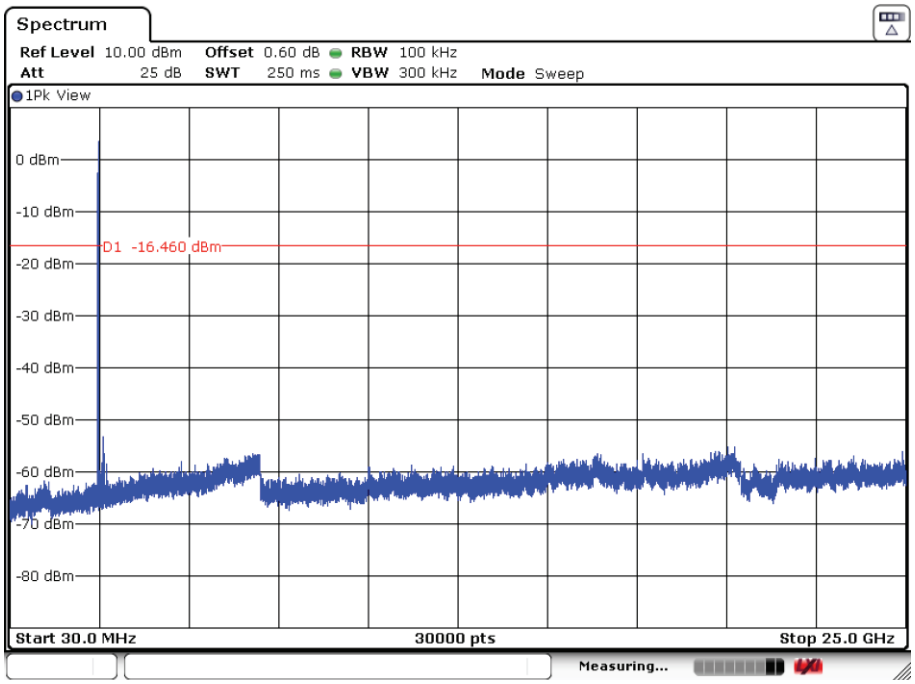
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



Note: The peaks above the limits are the carrier frequencies.

Verdict: PASS

3. HIGHEST CHANNEL (2480 MHz): 30 MHz-25 GHz (see next plot).



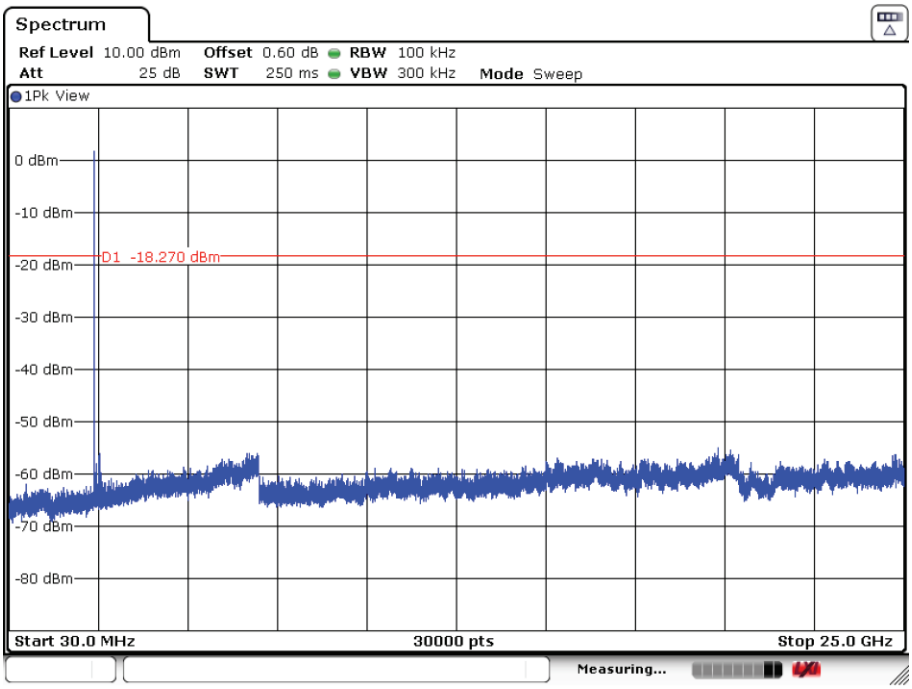
Note: The peak above the limit is the carrier frequency.

Verdict: PASS

Measurement uncertainty (dB)	<±1.20

Modulation: 8-DPSK

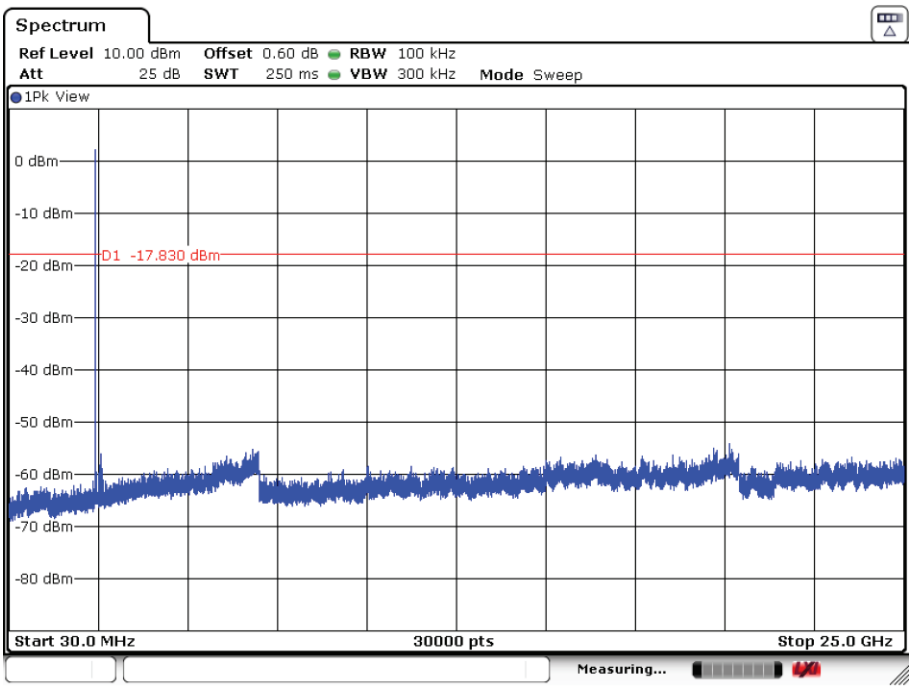
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limits is the carrier frequency.

Verdict: PASS

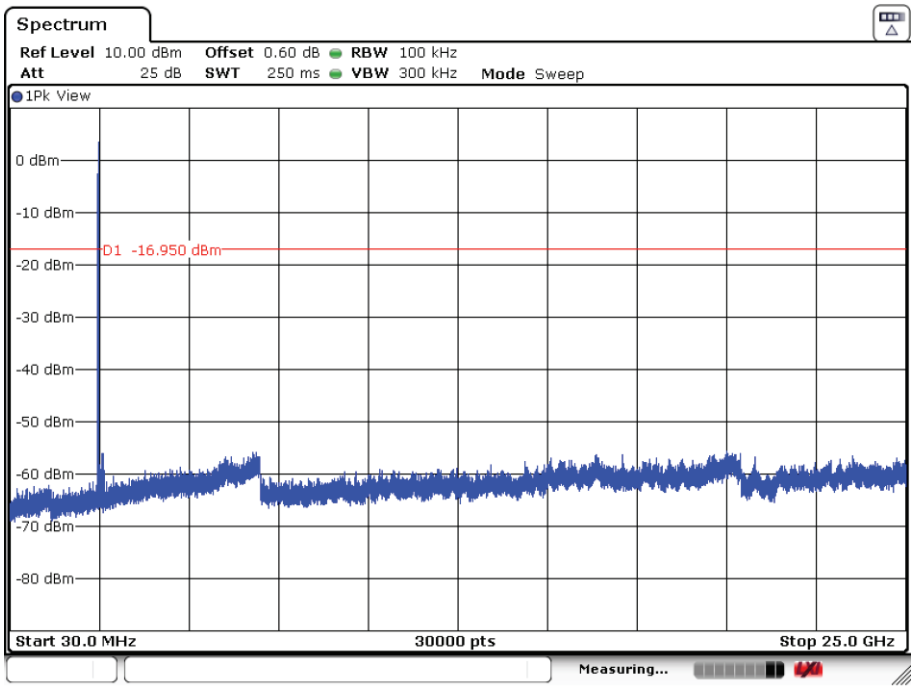
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



Note: The peaks above the limit are the carrier frequencies.

Verdict: PASS

3. HIGHEST CHANNEL (2480 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limit is the carrier frequency.

Verdict: PASS

Measurement uncertainty (dB)	<±1.20

FCC Section 15.247 Subclause (d) / RSS-247 Clause 5.5 Emission limitations radiated (Transmitter)

SPECIFICATION

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)/RSS-Gen):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RSS-247. Attenuation below the general field strength limits specified in RSS-Gen is not required.

RESULTS:

The situation and orientation were varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-1000 MHz and at distance of 1m for the frequency range 1 GHz-25 GHz.

The test was performed with the equipment transmitting first with only the 2.4 GHz BT-EDR radio and repeated with the WiFi 2.4GHz (WLAN0 CORE1), and WiFi 5 GHz (WLAN0 CORE0) radios transmitting simultaneously to check the impact of the co-location of the other radio interfaces. The results and plots below show the worst results obtained.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz-1000 MHz.

Note: The spurious emissions below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT.

Spurious levels operating (radiated) closest to limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
748.042	V	Quasi-Peak	27.00	± 3.88

Frequency range 1 GHz-25 GHz

The results in the next tables show the maximum measured levels in the 1-25 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz (see next plots).

Modulation: GFSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.0002	V	Peak	43.38	± 4.87

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.0002	V	Peak	43.32	± 4.87

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.0002	V	Peak	43.20	± 4.87

Verdict: PASS

Modulation: Π/4-DQPSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.0002	V	Peak	43.50	± 4.87

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.0002	V	Peak	43.77	± 4.87

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.0002	V	Peak	44.08	± 4.87

Verdict: PASS

Modulation: 8-DPSK

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.00002	V	Peak	43.54	± 4.87

2. CHANNEL: MIDDLE (2441 MHz).

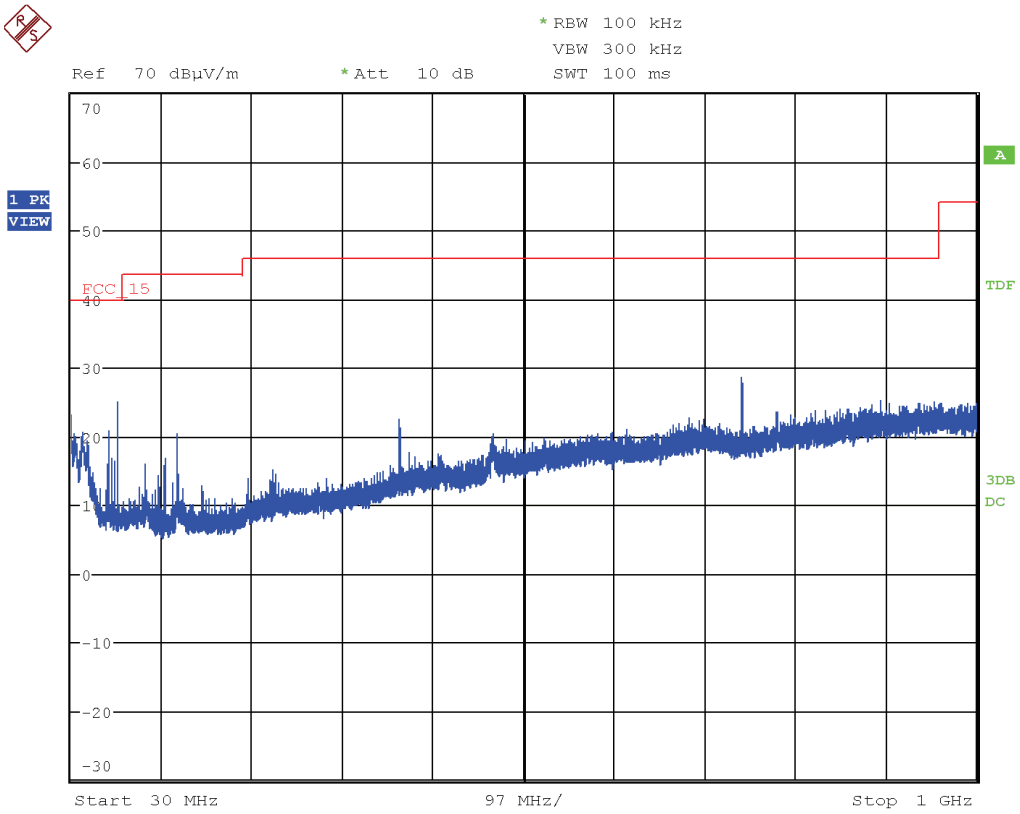
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.00002	V	Peak	43.47	± 4.87

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.00002	H	Peak	43.23	± 4.87

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

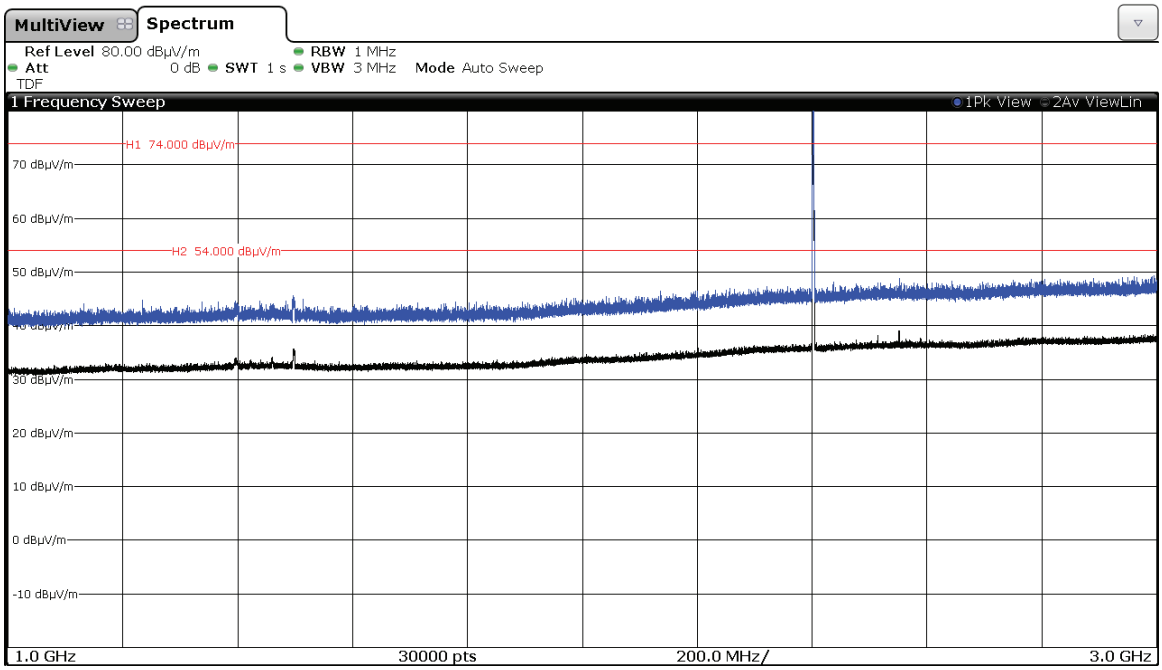


(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

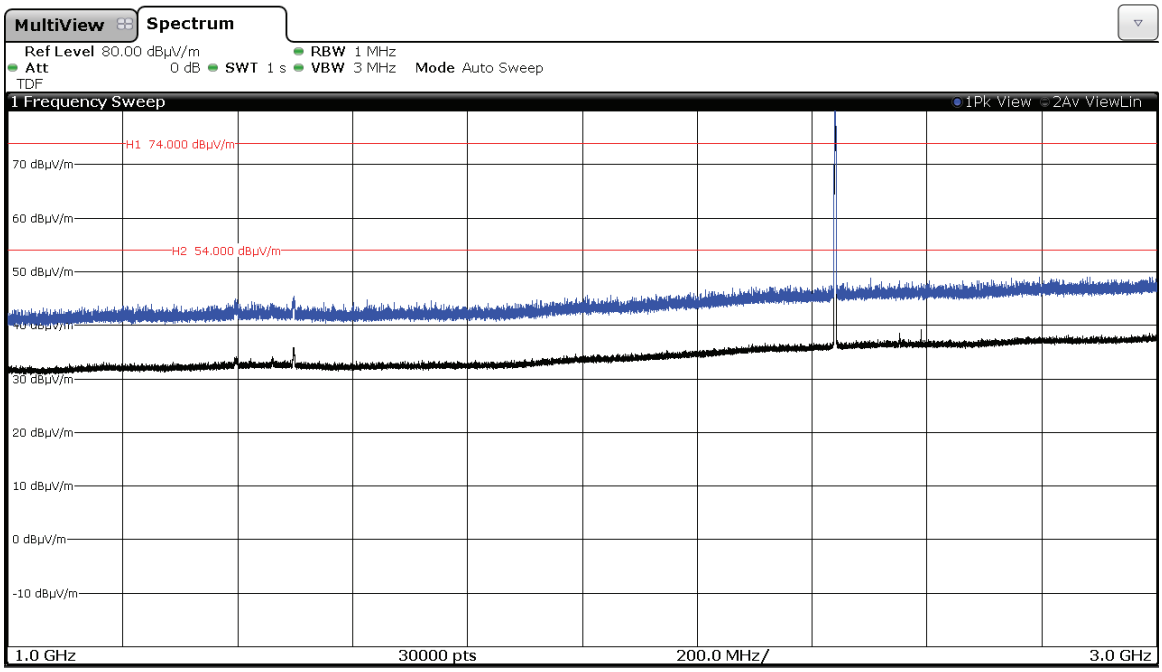
Modulation: GFSK

CHANNEL: Lowest (2402 MHz).



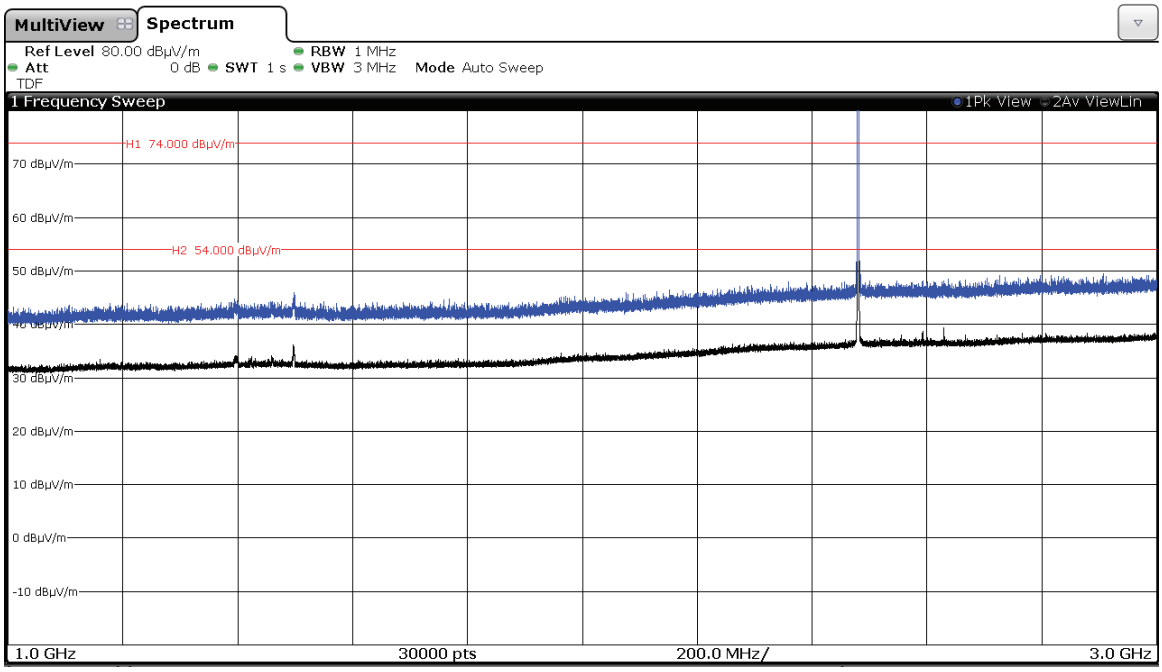
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



Note: The peak shown in the plot above the limits is the carrier frequency.

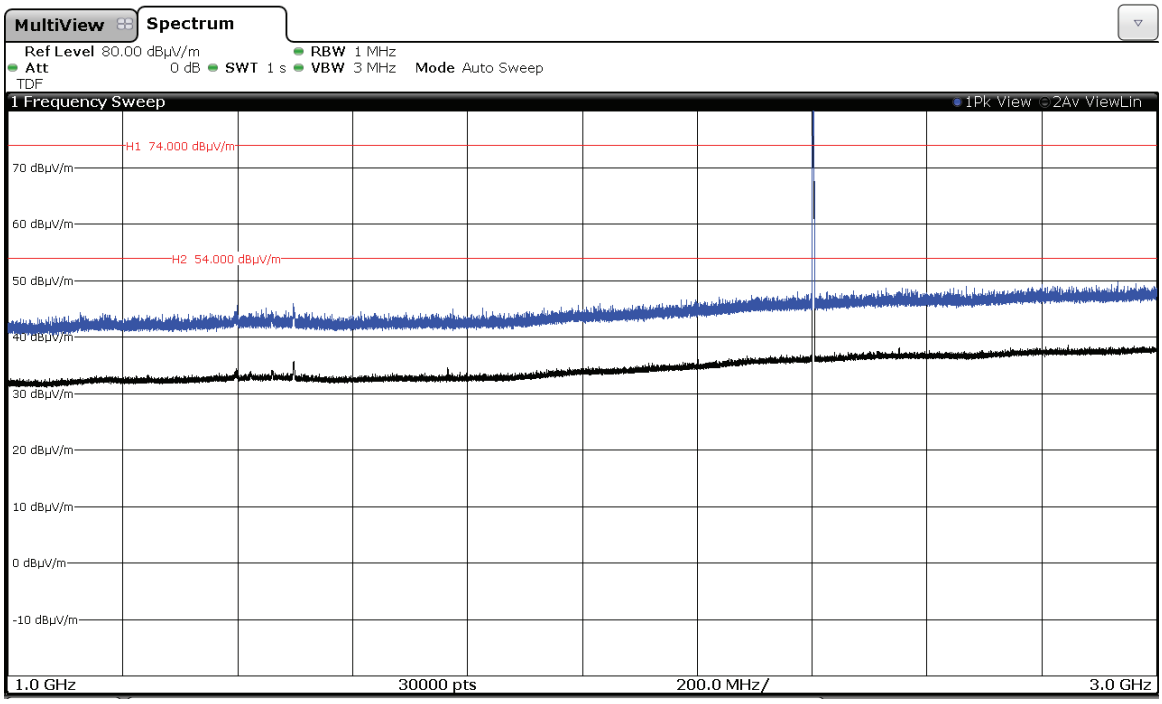
CHANNEL: Highest (2480 MHz).



Note: The peak shown in the plot above the limits is the carrier frequency.

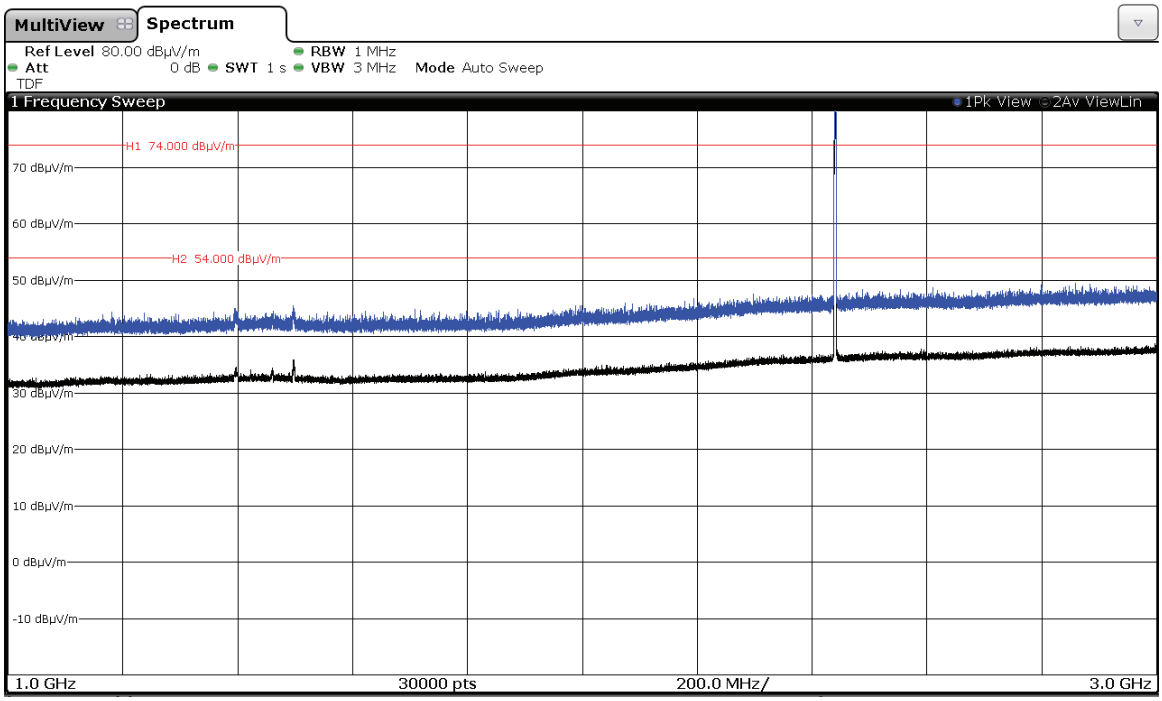
Modulation: Π/4-DQPSK

CHANNEL: Lowest (2402 MHz).



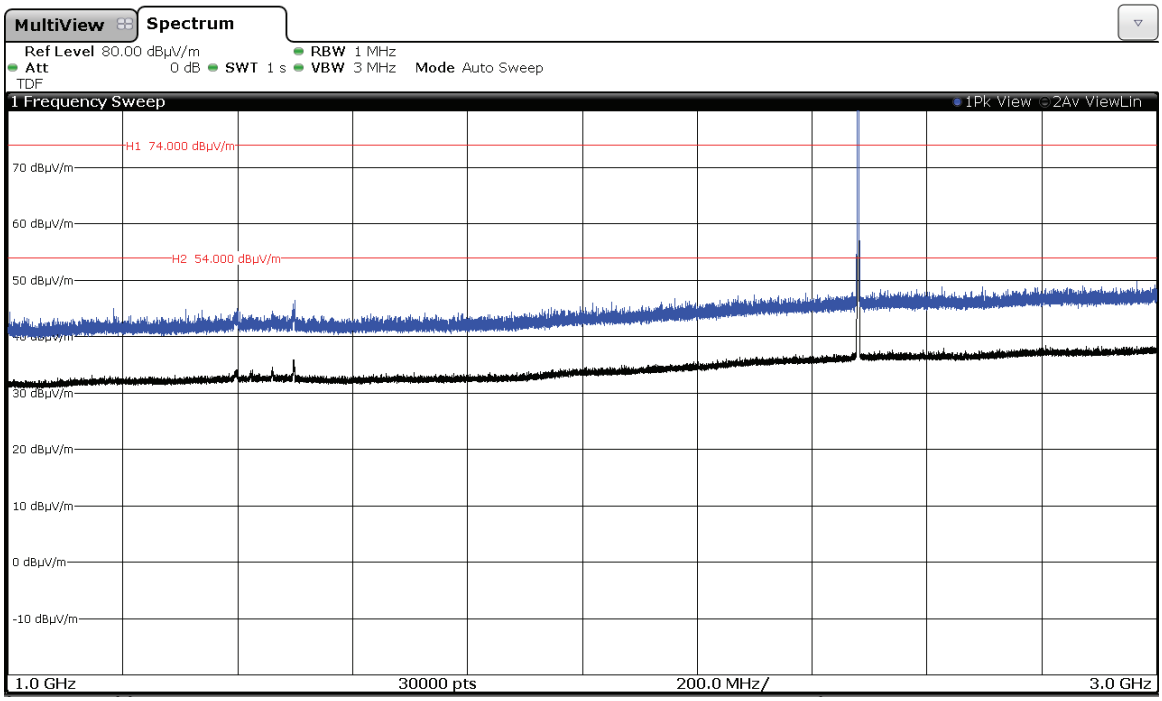
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



Note: The peak shown in the plot above the limits is the carrier frequency.

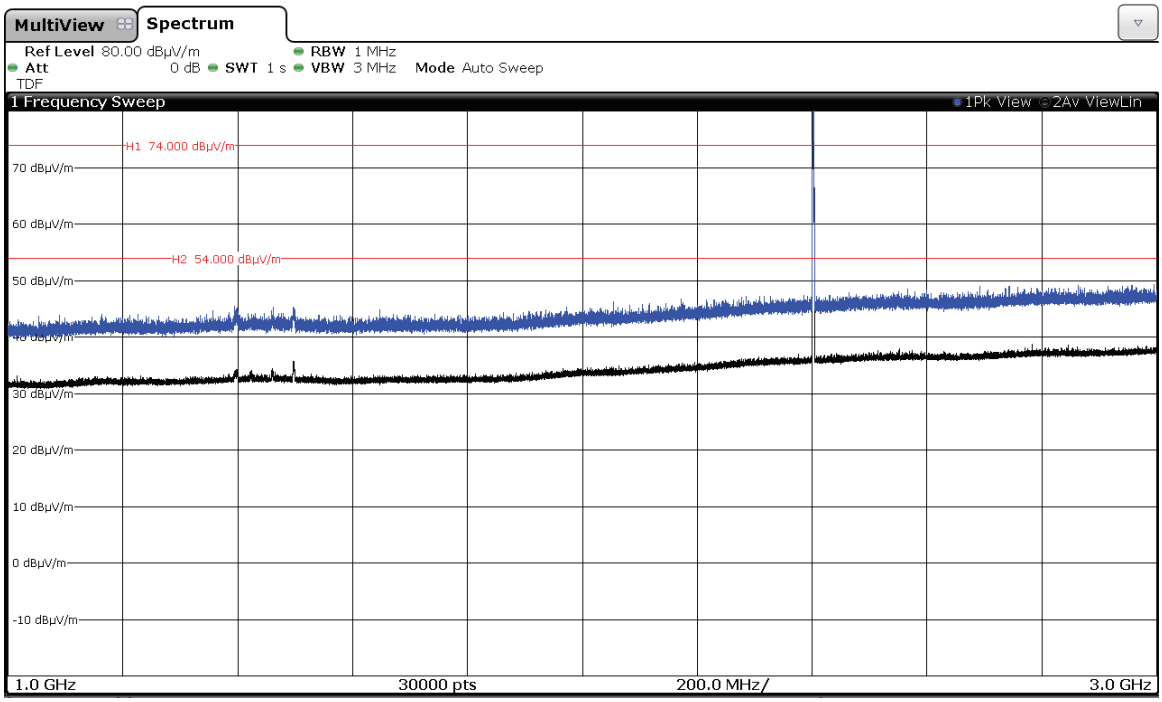
CHANNEL: Highest (2480 MHz).



Note: The peak shown in the plot above the limits is the carrier frequency.

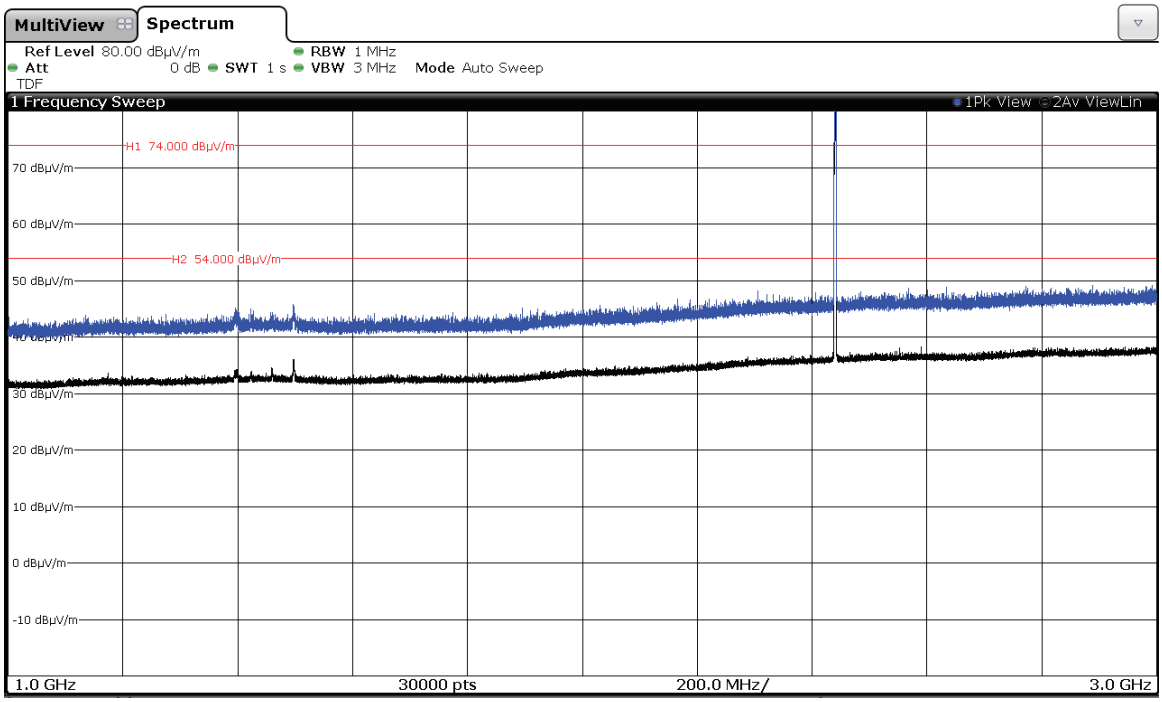
Modulation: 8-DPSK

CHANNEL: Lowest (2402 MHz).



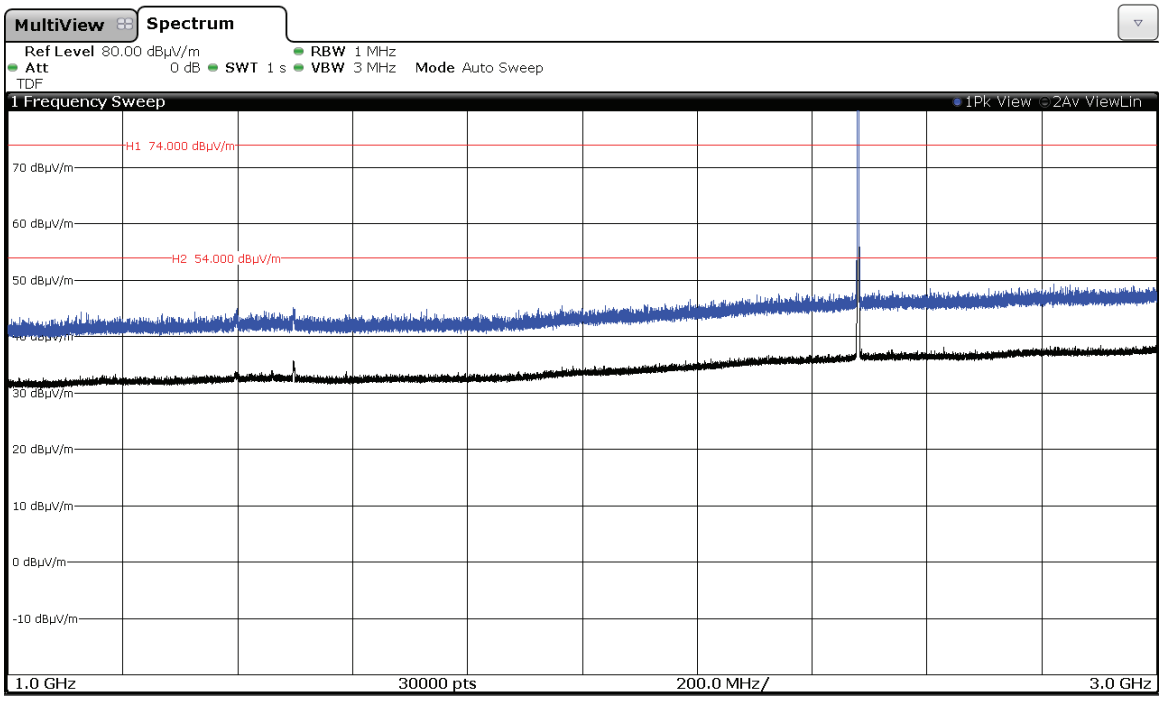
Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Middle (2441 MHz).



Note: The peak shown in the plot above the limits is the carrier frequency.

CHANNEL: Highest (2480 MHz).

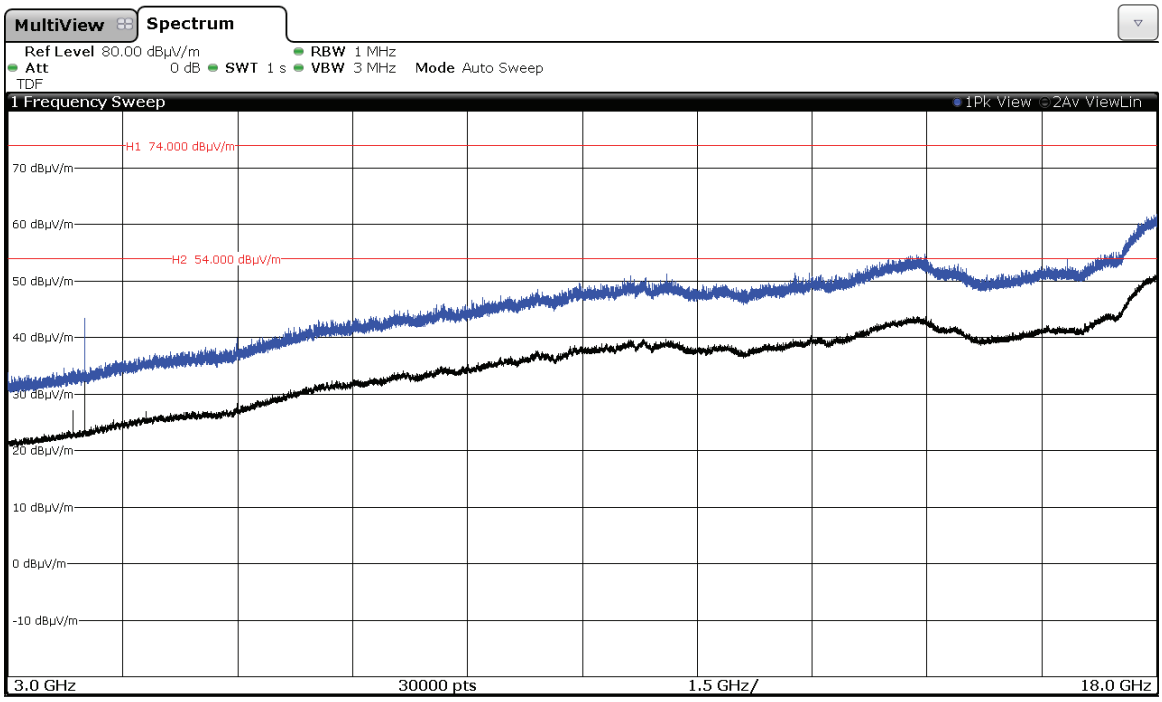


Note: The peak shown in the plot above the limits is the carrier frequency.

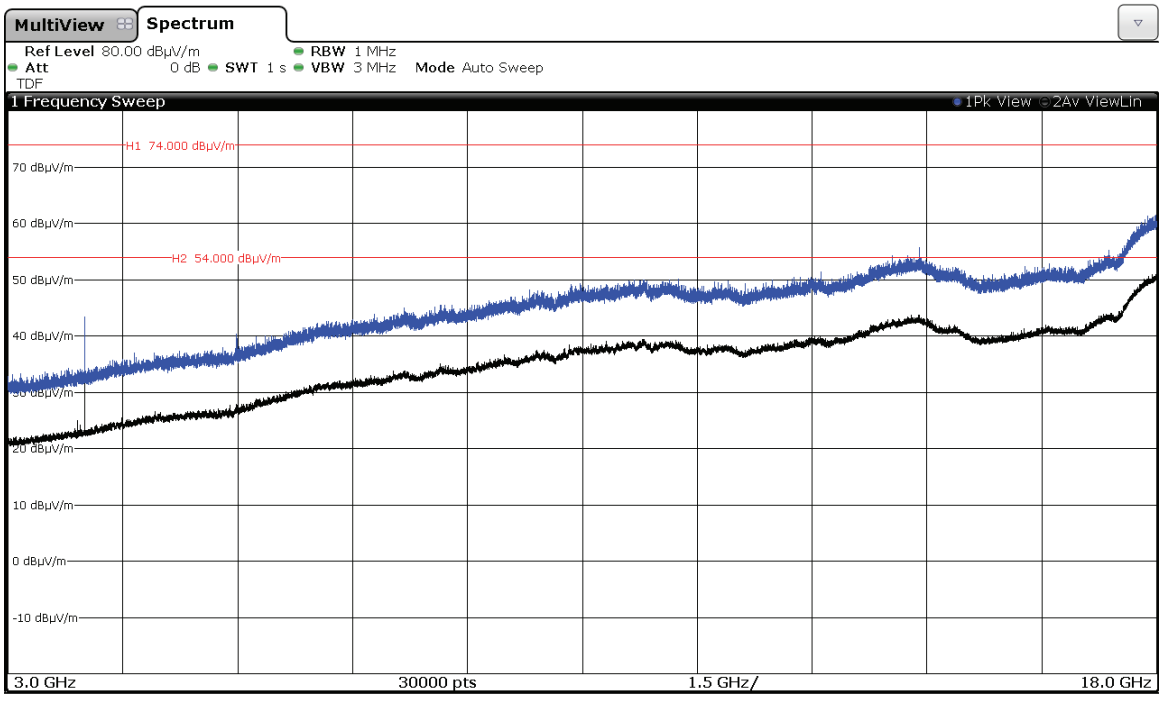
FREQUENCY RANGE 3 GHz to 18 GHz.

Modulation: GFSK

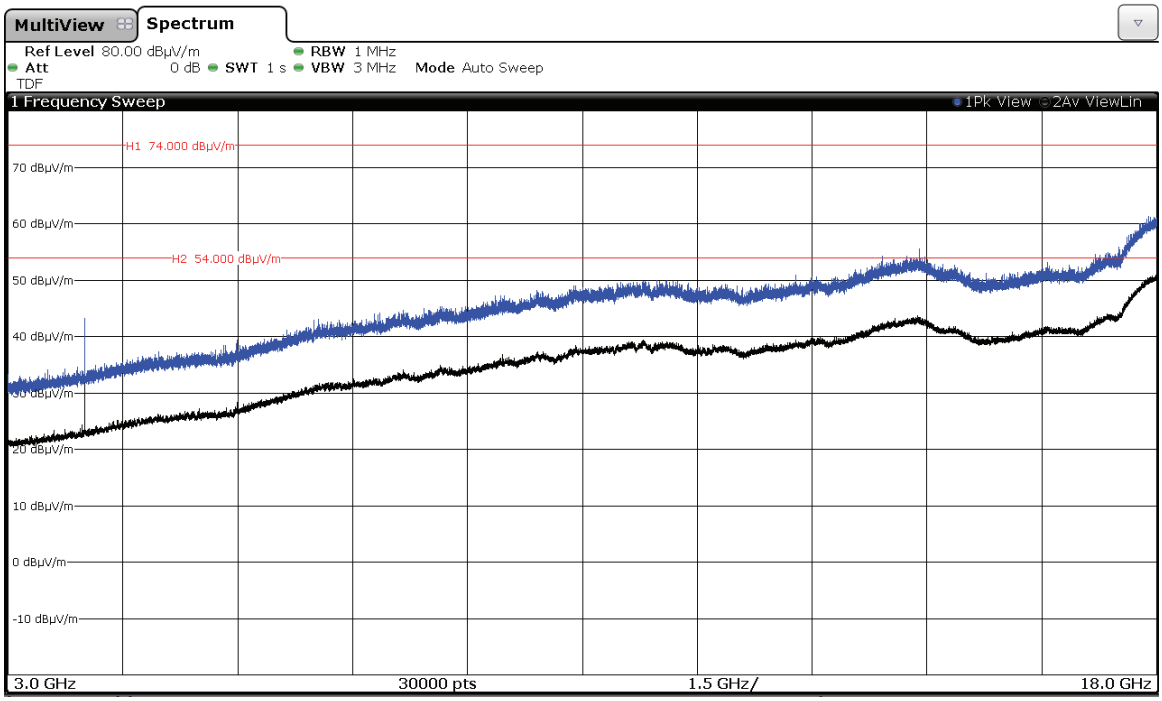
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

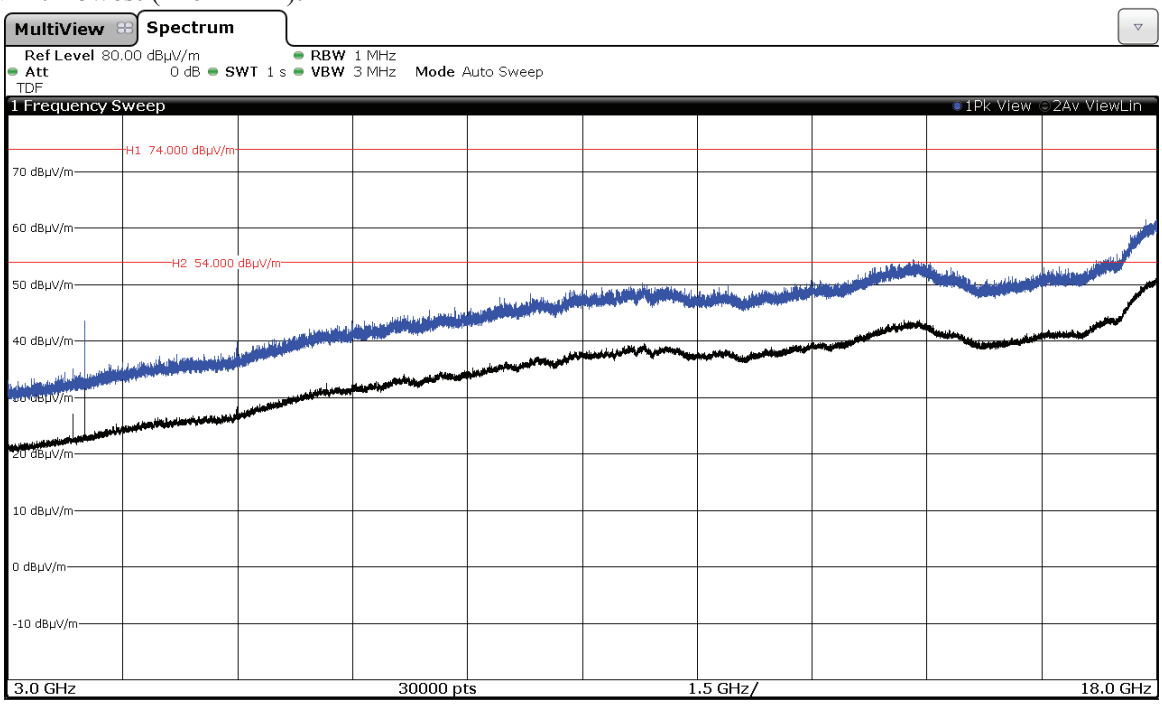


CHANNEL: Highest (2480 MHz).

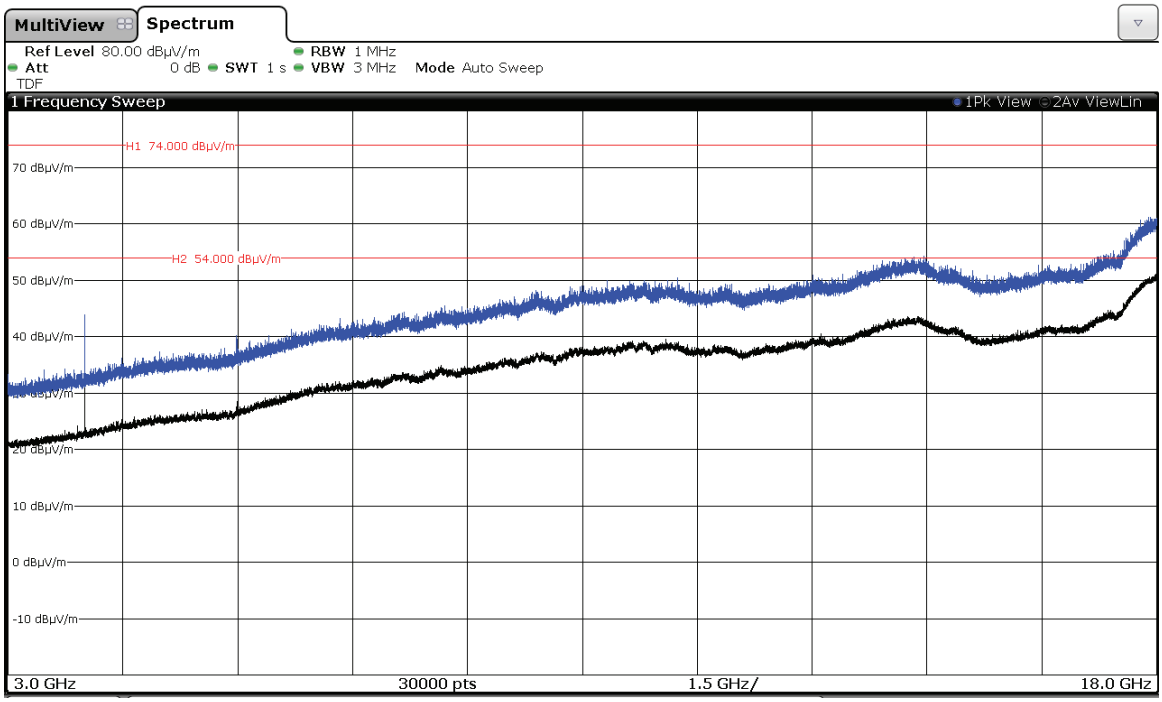


Modulation: Π/4-DQPSK

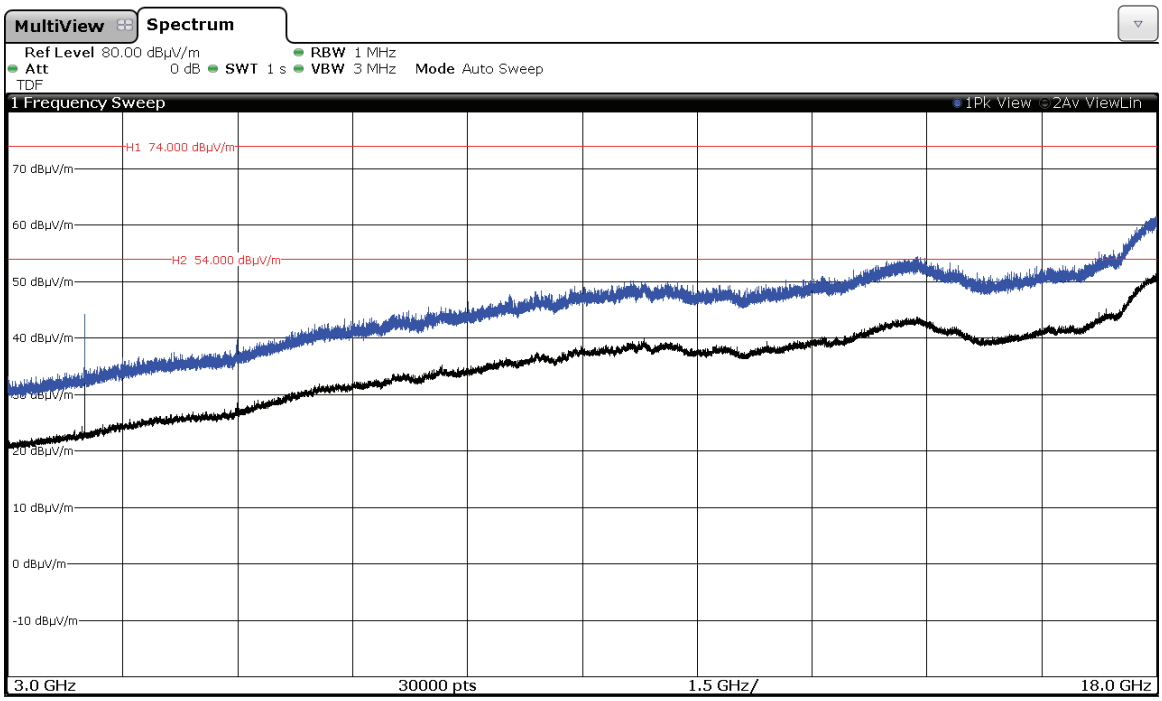
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

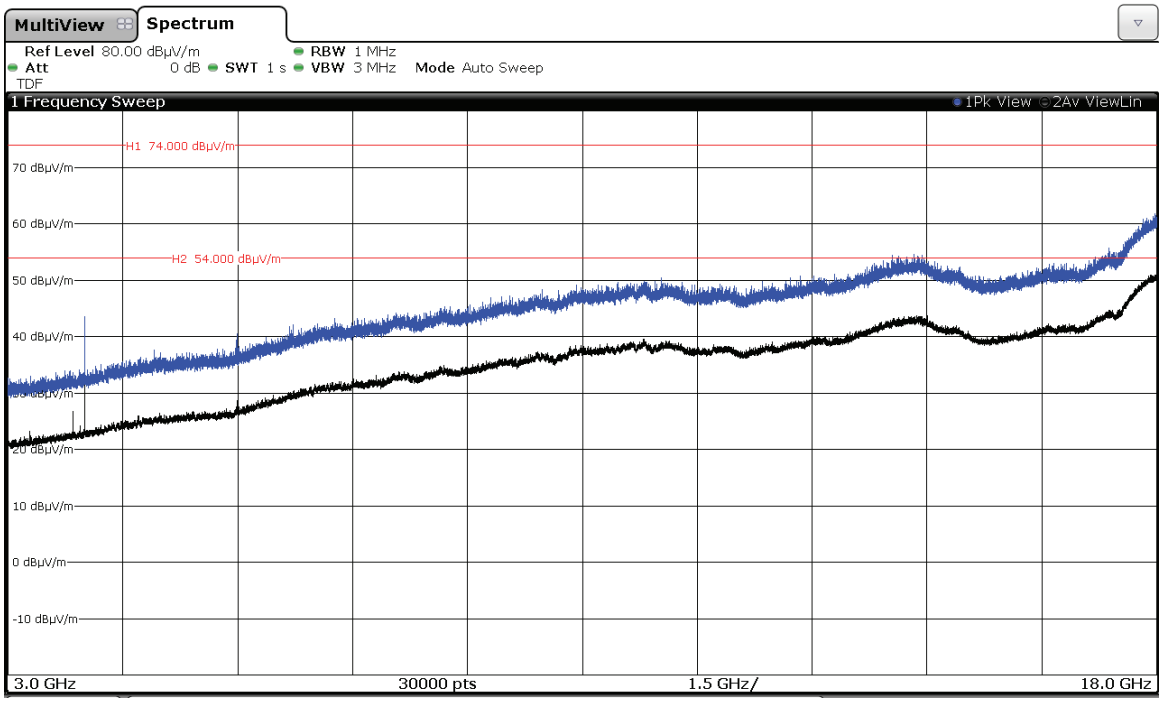


CHANNEL: Highest (2480 MHz).

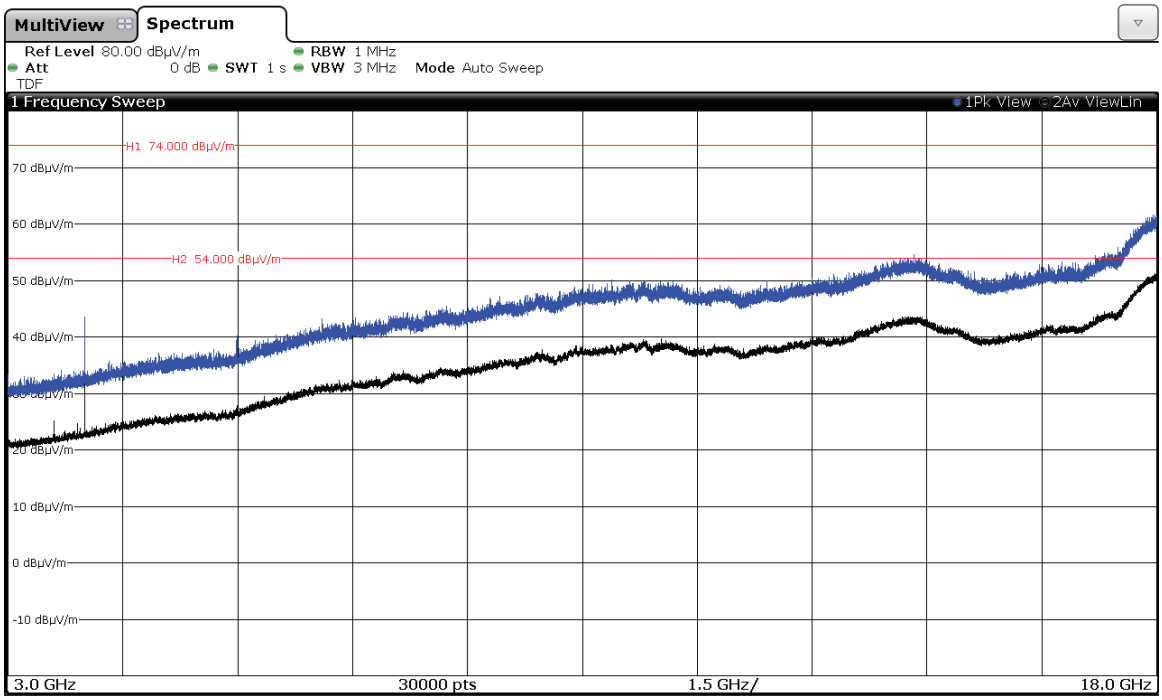


Modulation: 8-DPSK

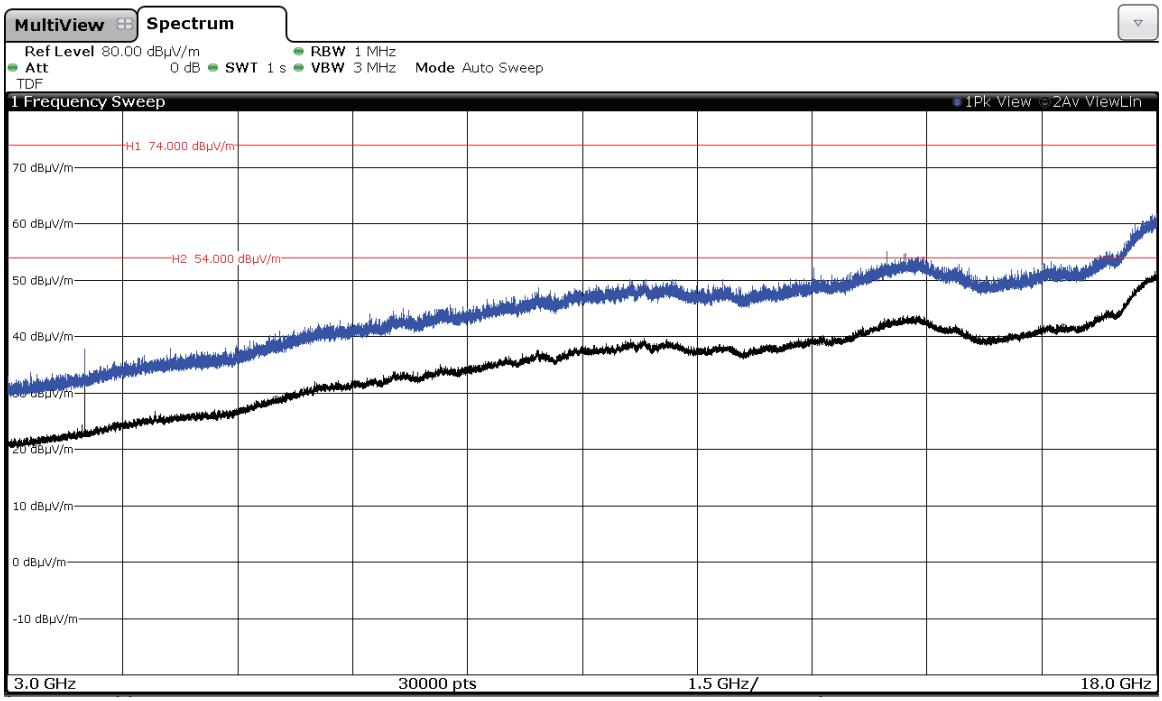
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).



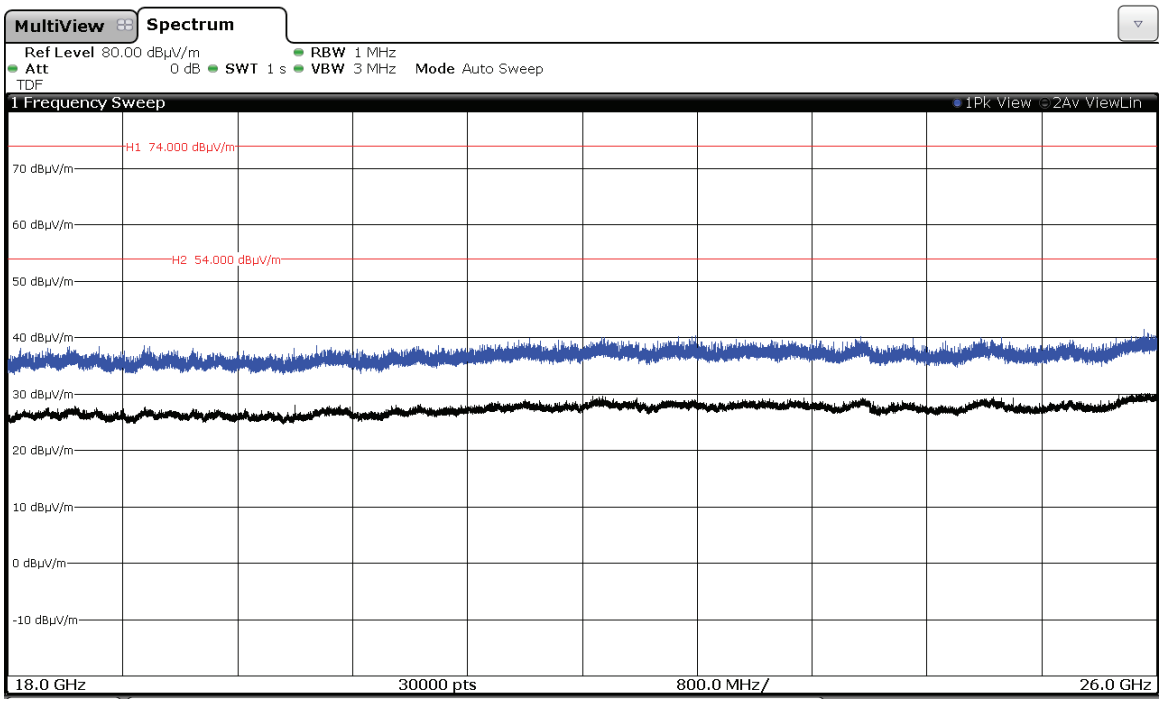
CHANNEL: Highest (2480 MHz).



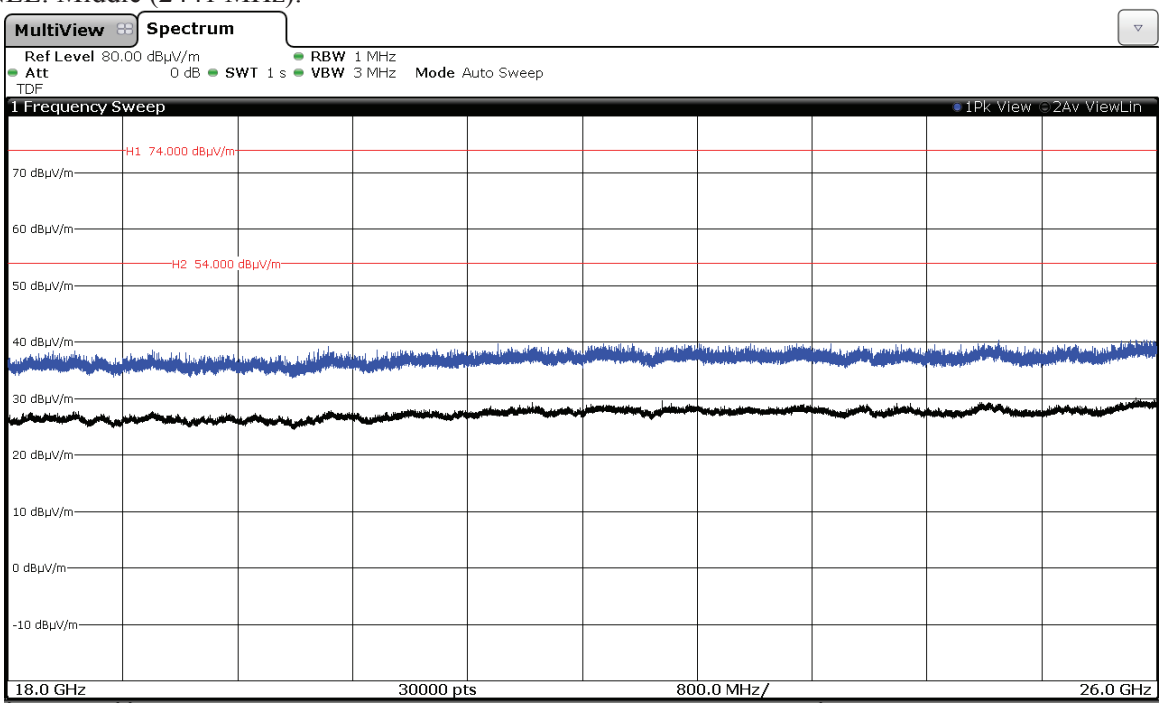
FREQUENCY RANGE 18 GHz to 26 GHz.

Modulation: GFSK

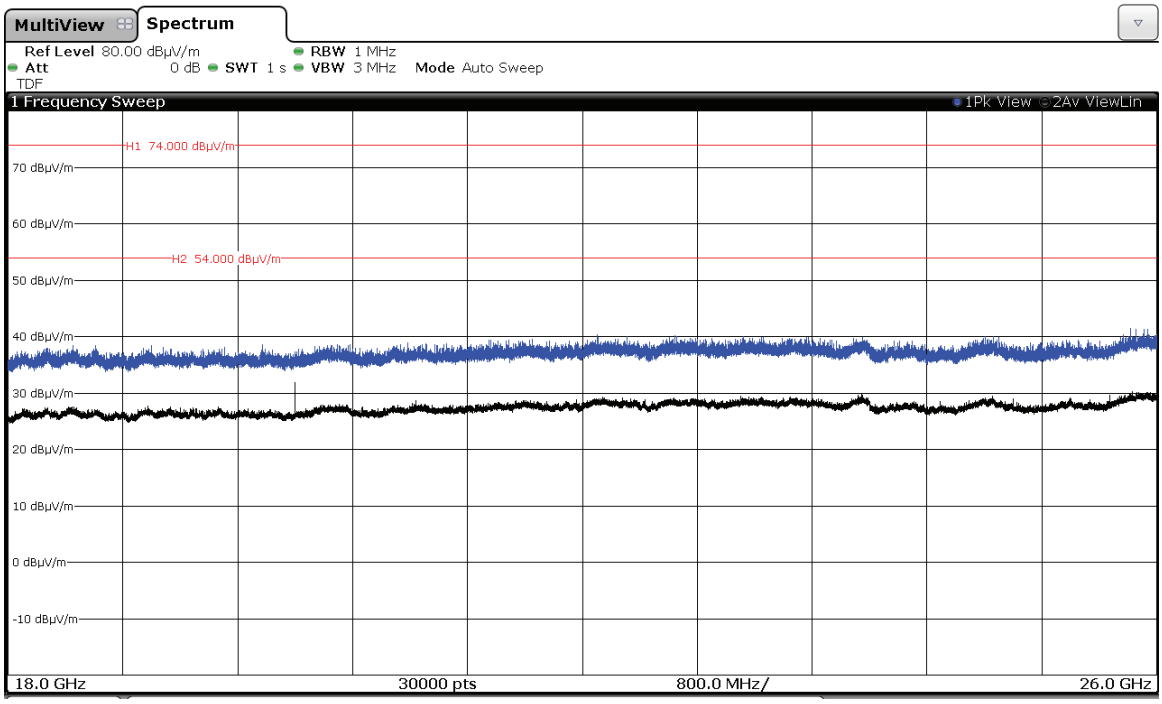
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

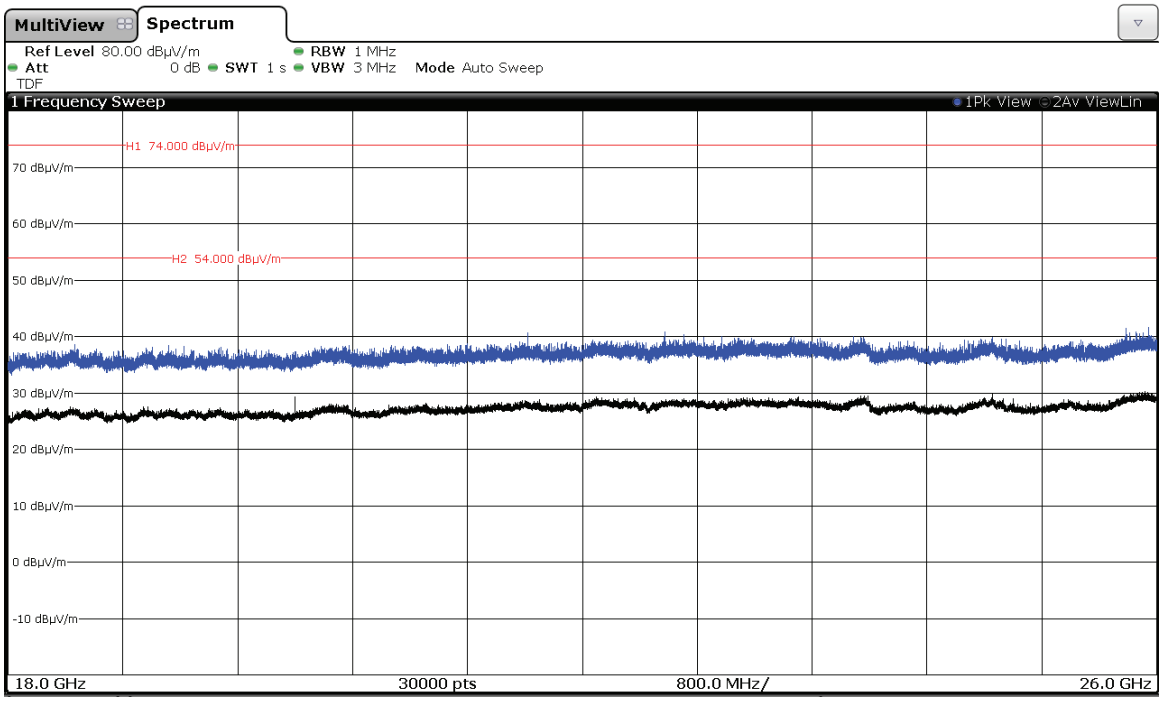


CHANNEL: Highest (2480 MHz).

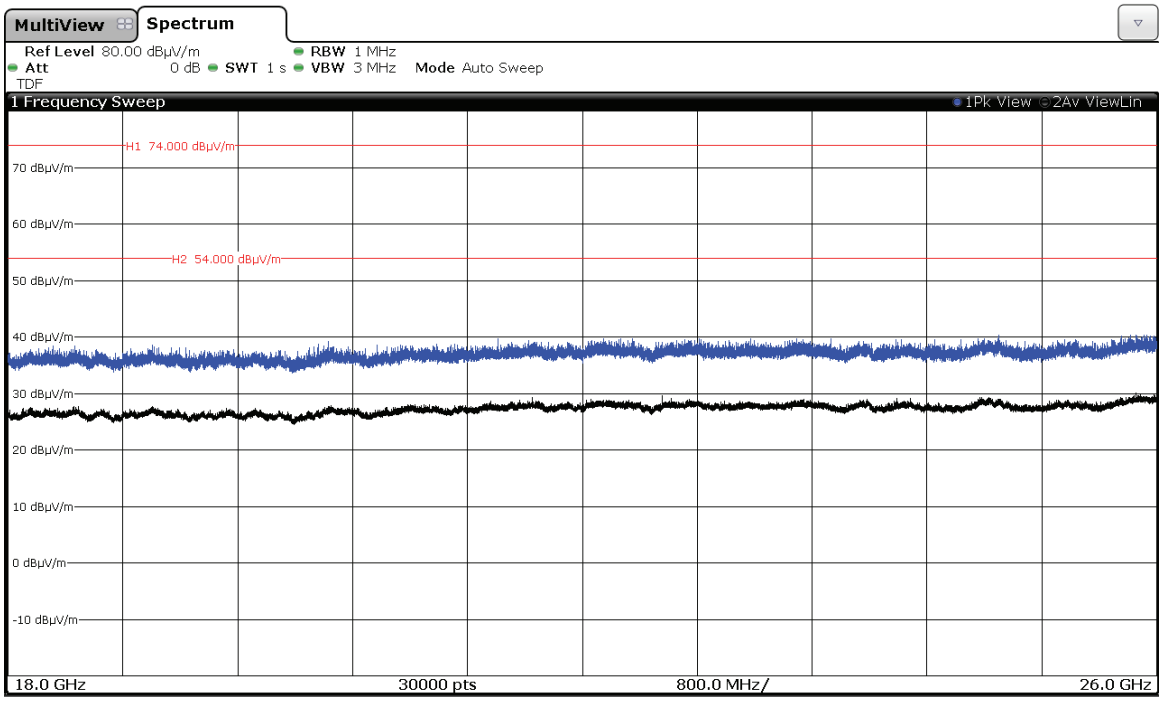


Modulation: Π/4-DQPSK

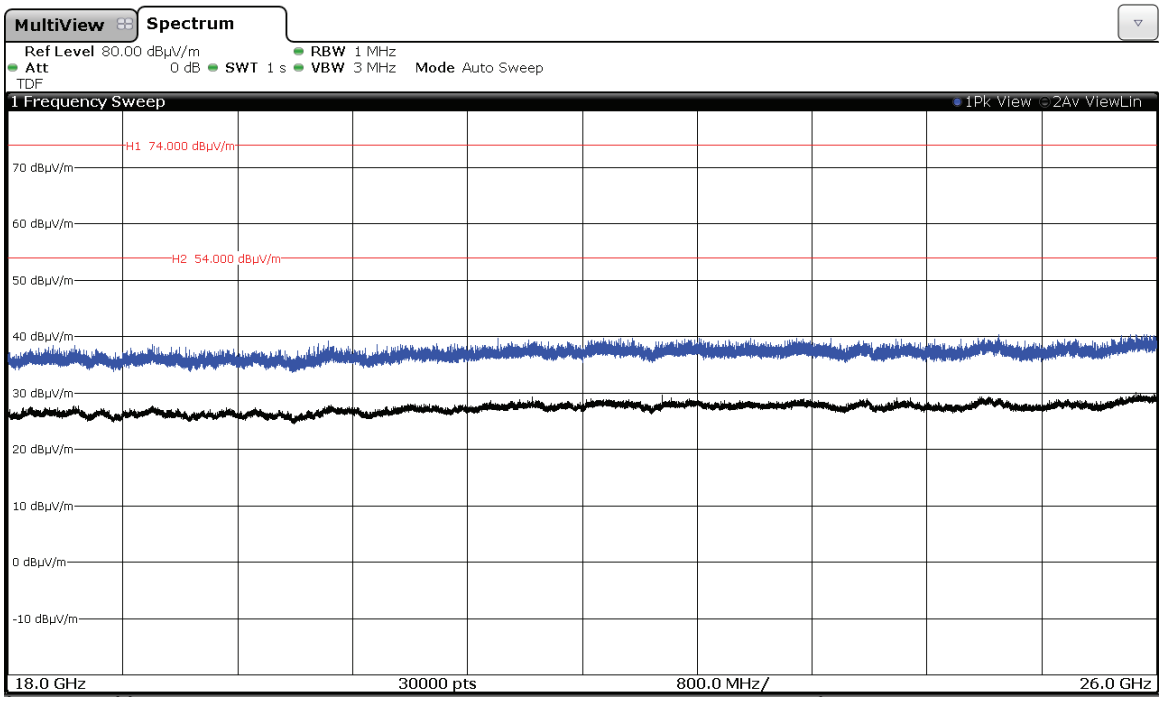
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).

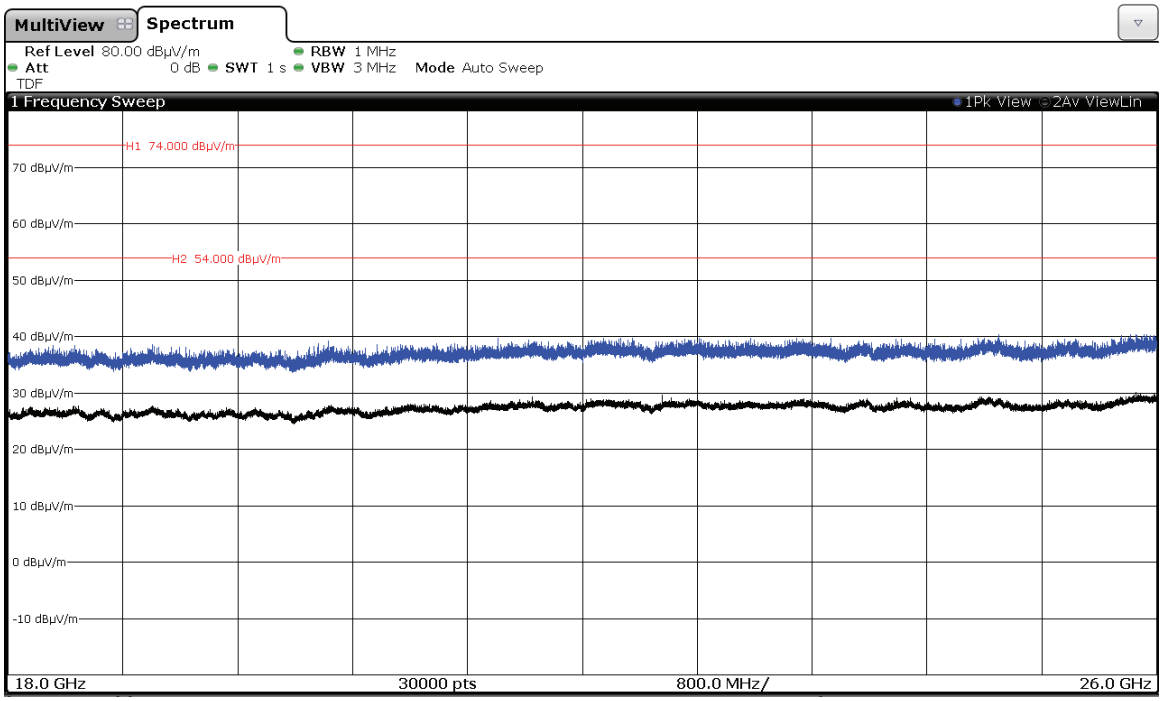


CHANNEL: Highest (2480 MHz).

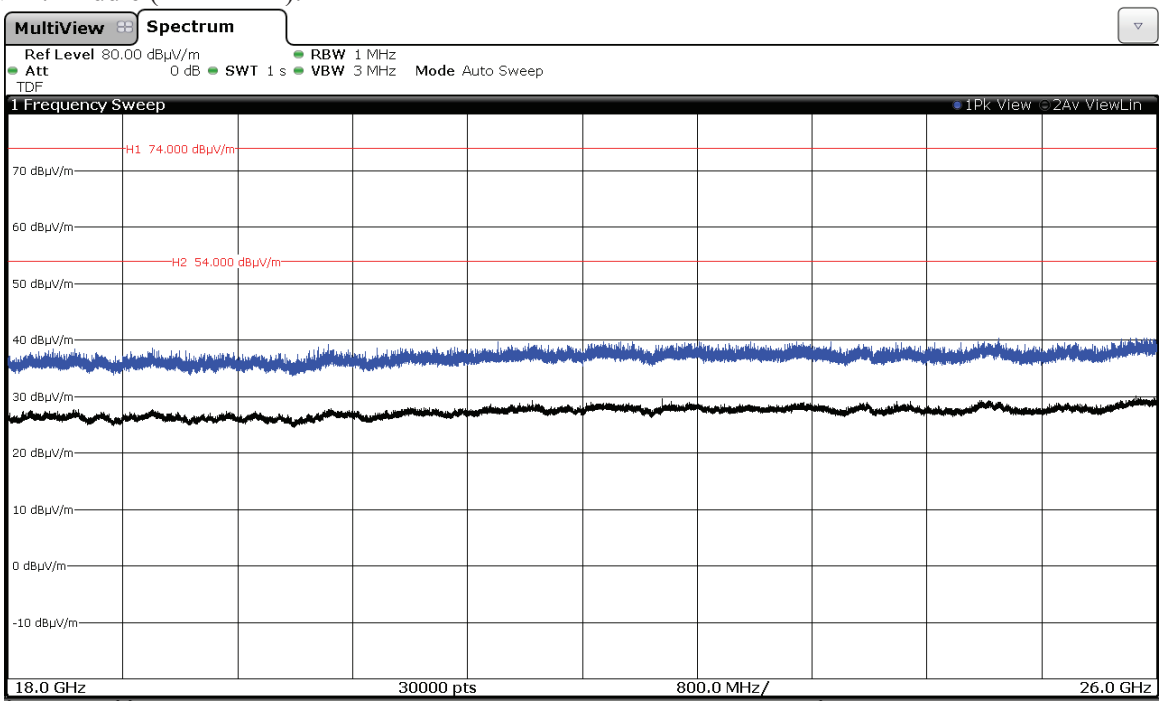


Modulation: 8-DPSK

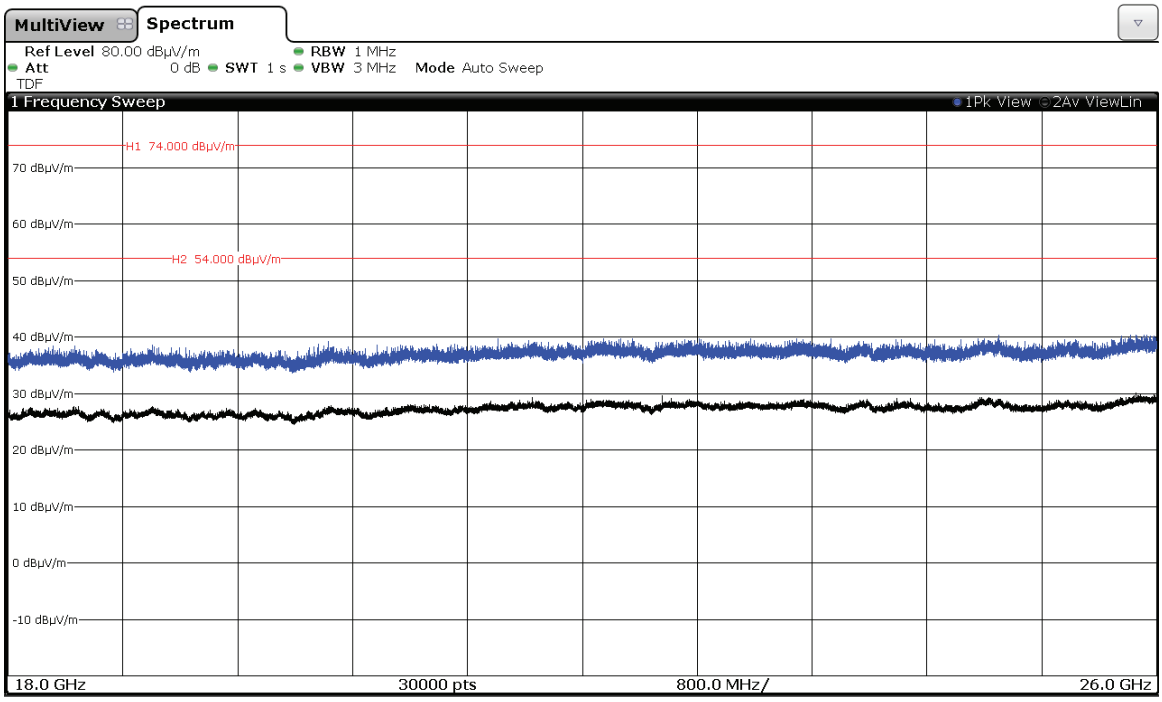
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2441 MHz).



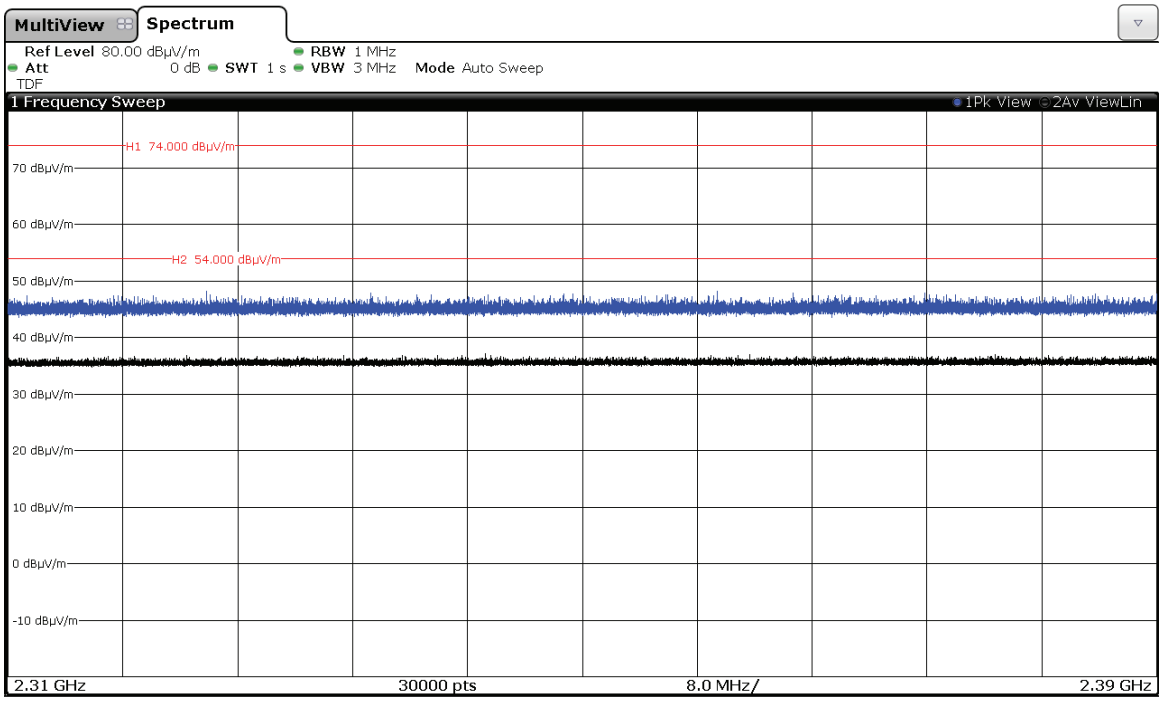
CHANNEL: Highest (2480 MHz).



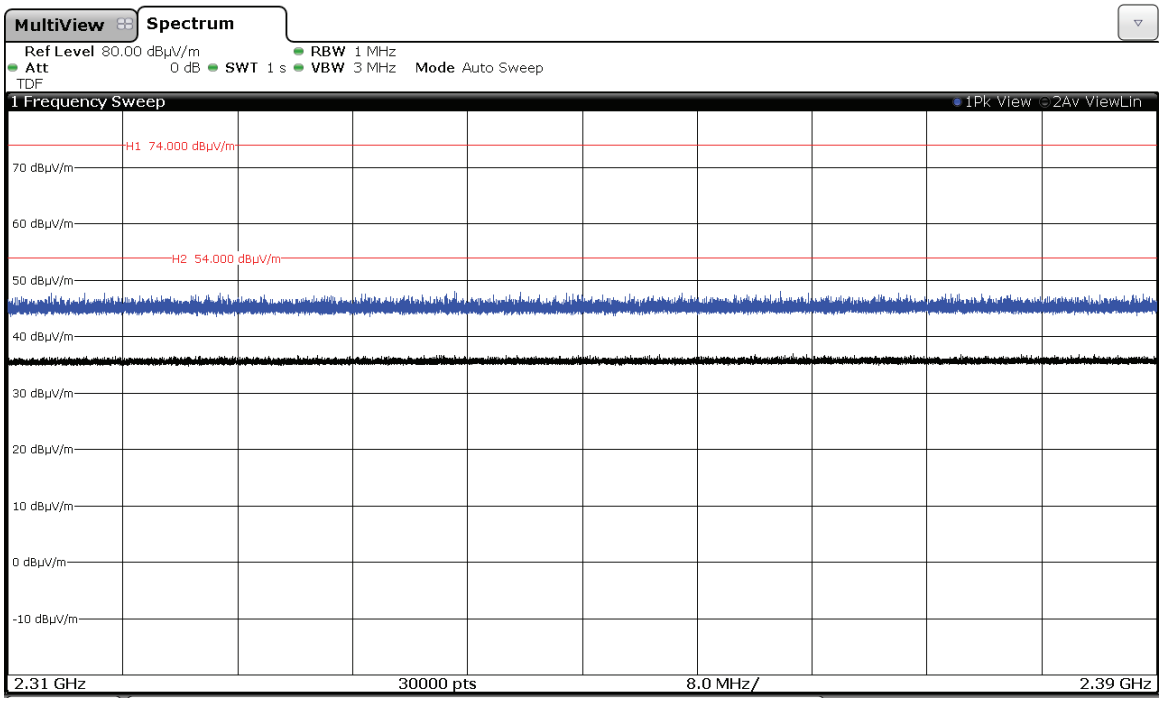
FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

CHANNEL: Lowest

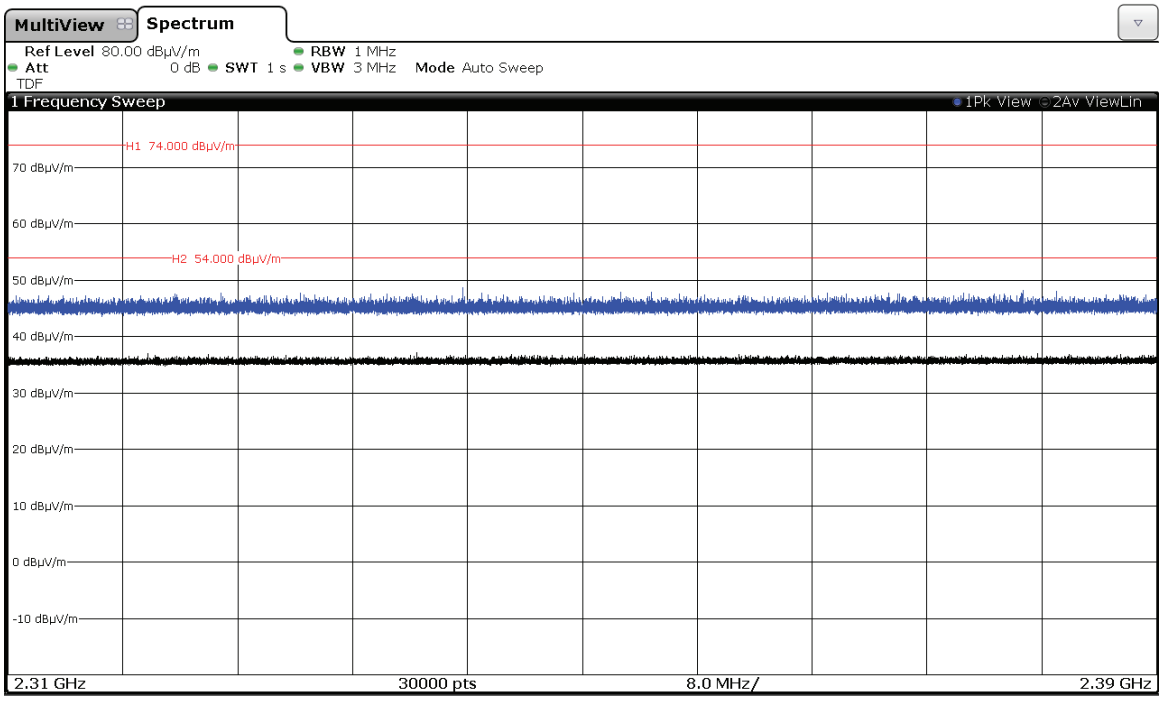
Modulation: GFSK



Modulation: Π/4-DQPSK

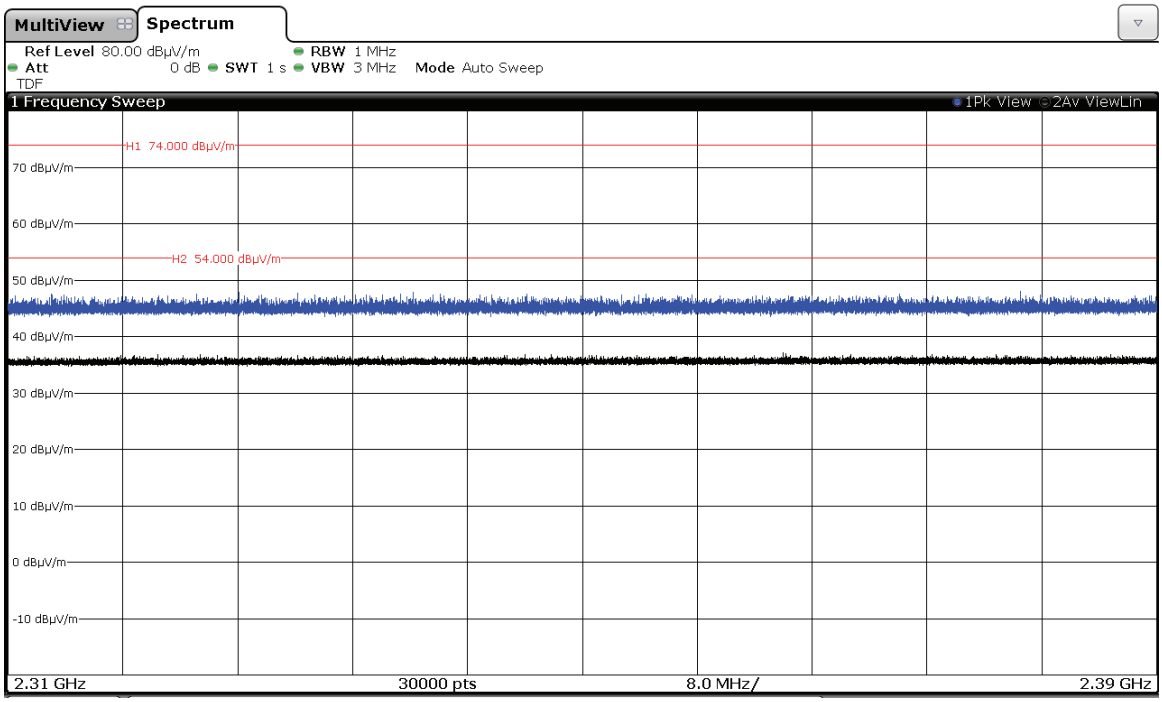


Modulation: 8-DPSK

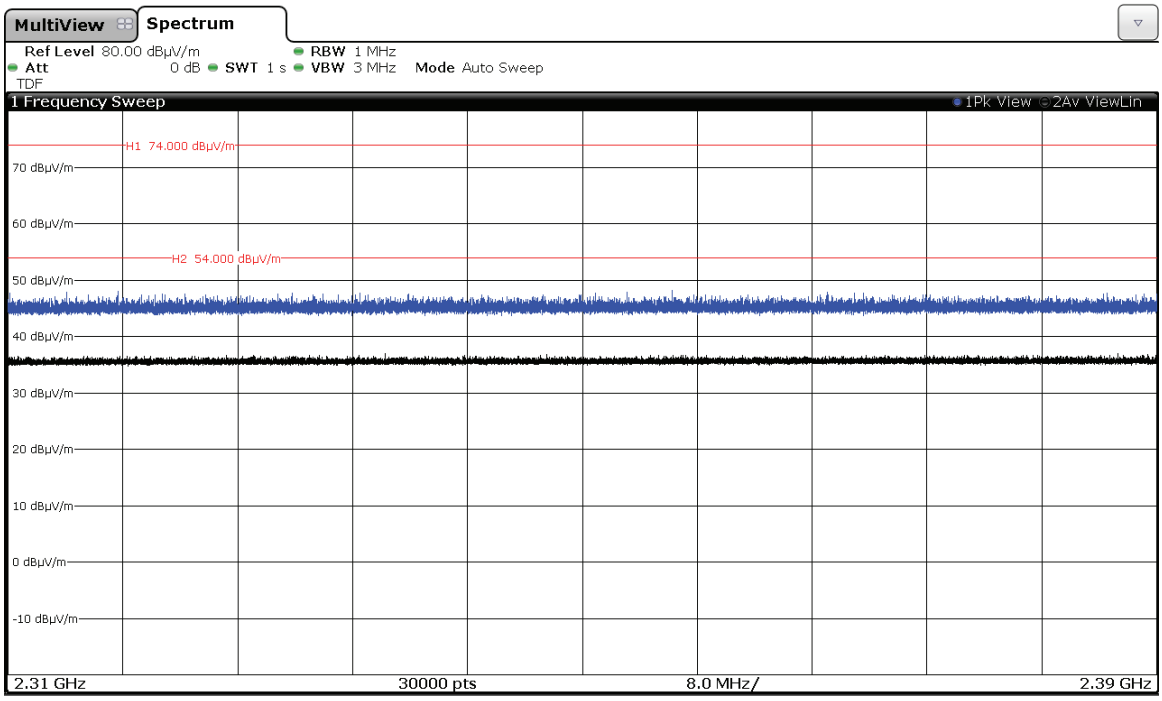


CHANNEL: Middle

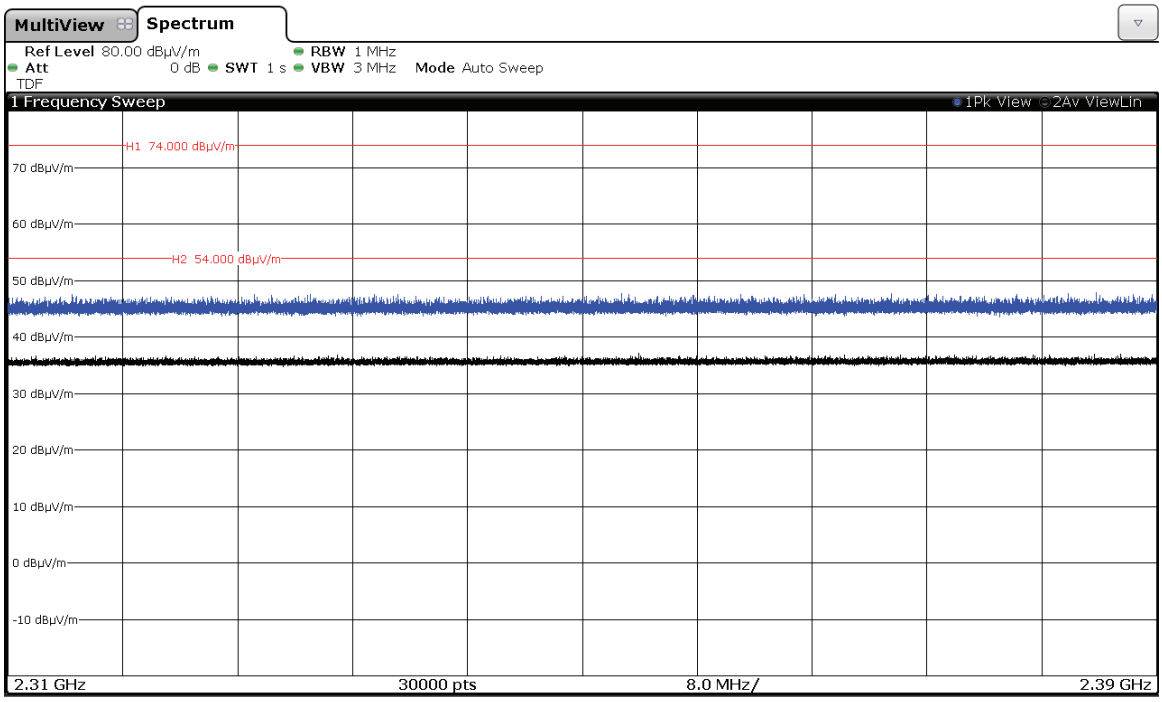
Modulation: GFSK



Modulation: Π/4-DQPSK

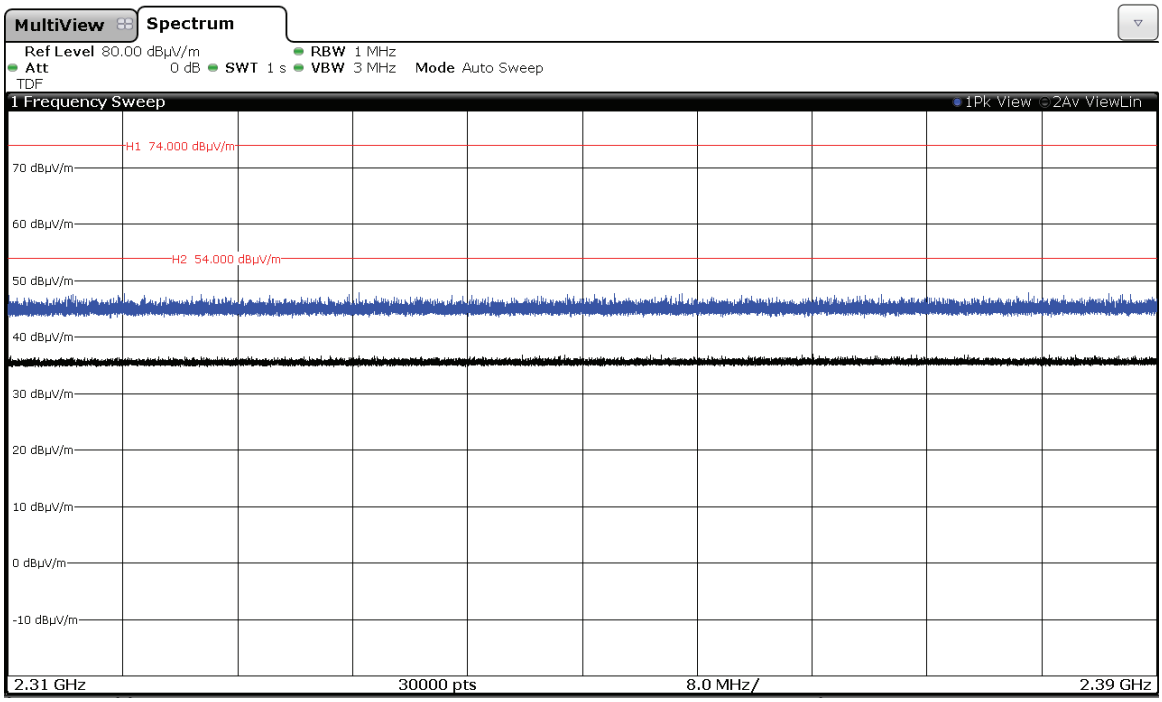


Modulation: 8-DPSK

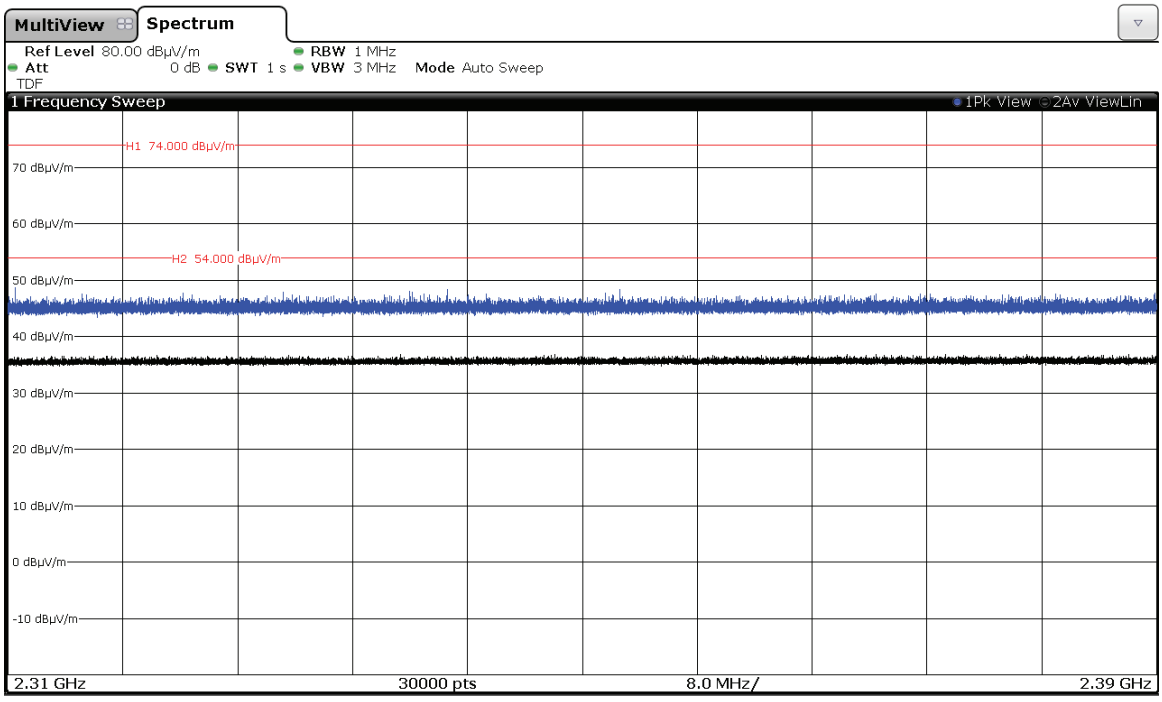


CHANNEL: Highest

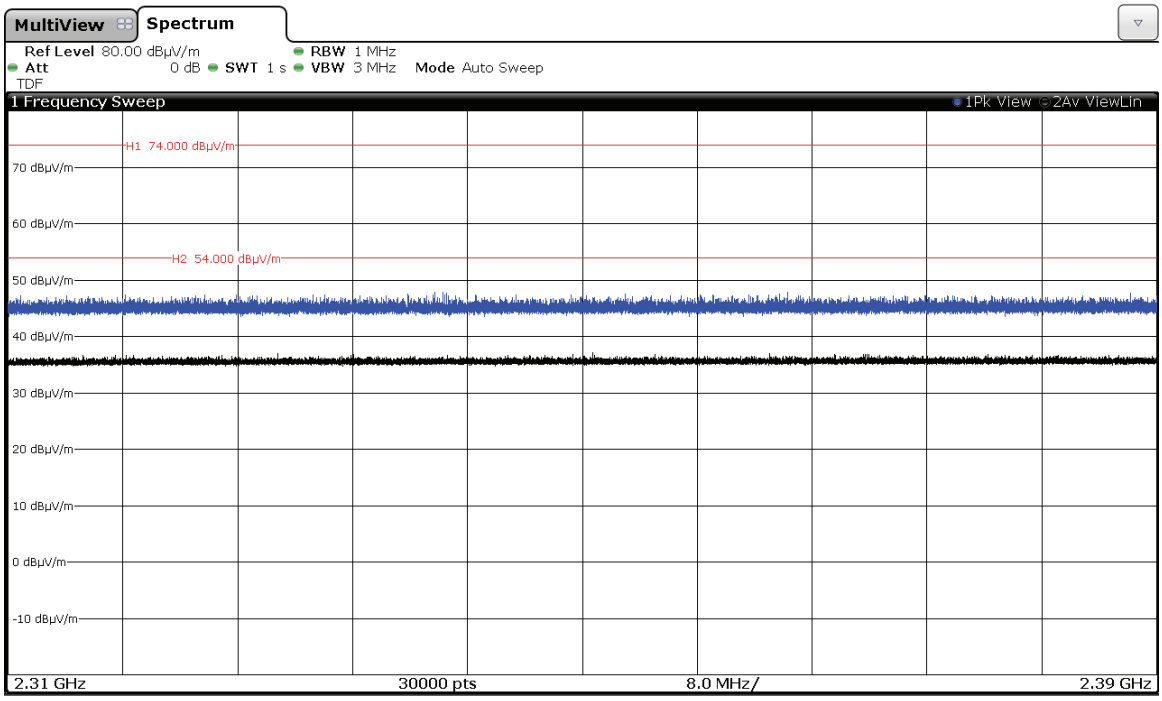
Modulation: GFSK



Modulation: Π/4-DQPSK



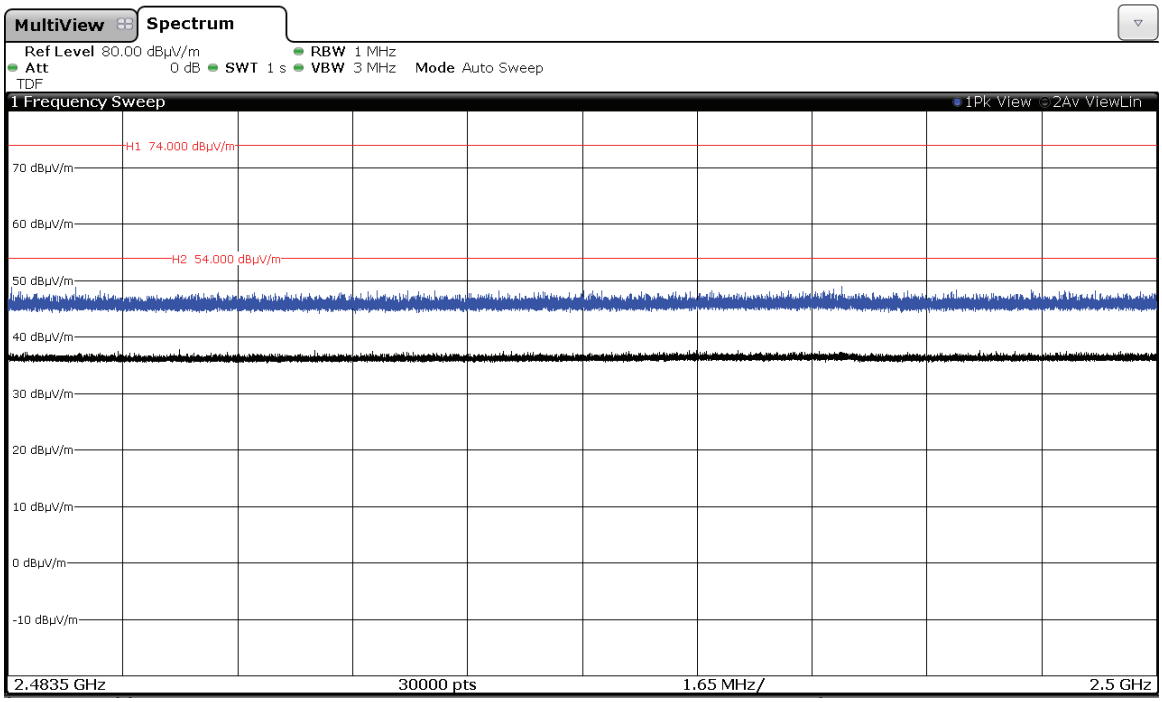
Modulation: 8-DPSK



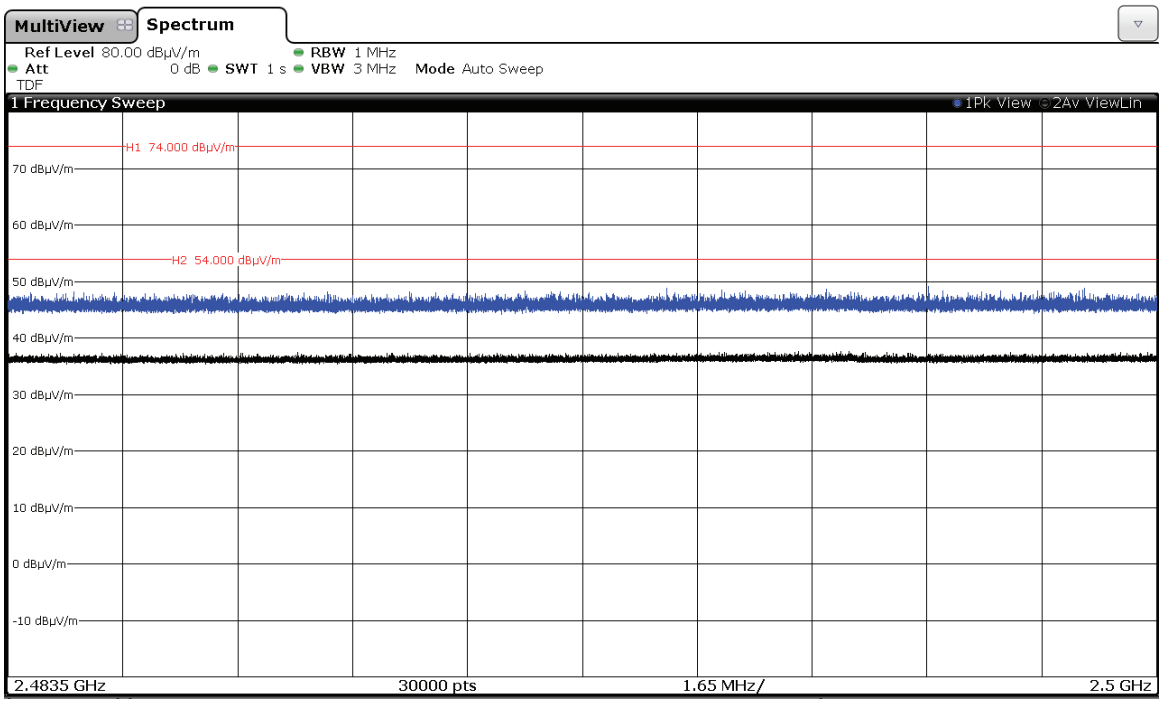
FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

CHANNEL: Lowest

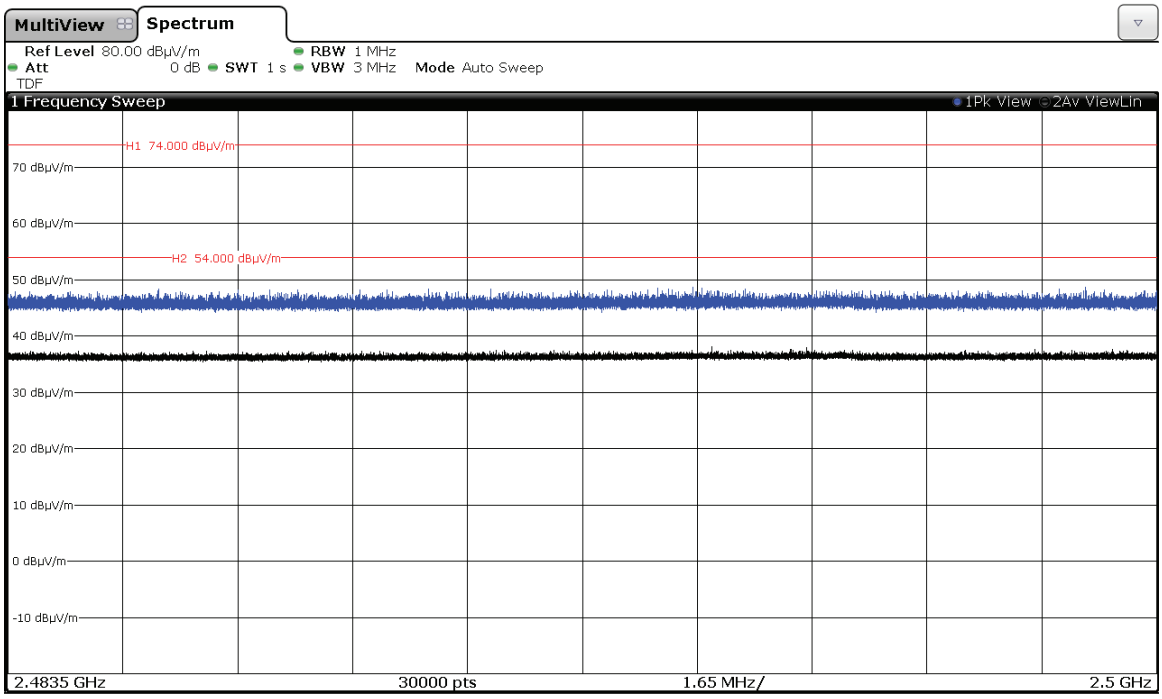
Modulation: GFSK



Modulation: Π/4-DQPSK

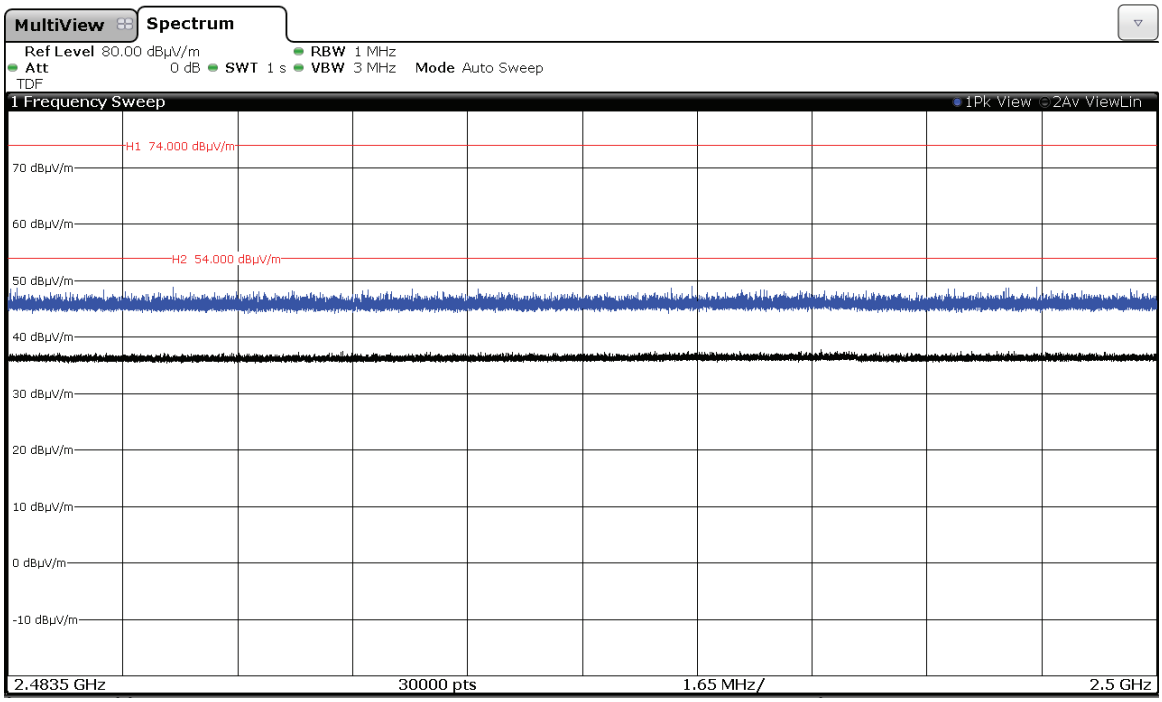


Modulation: 8-DPSK

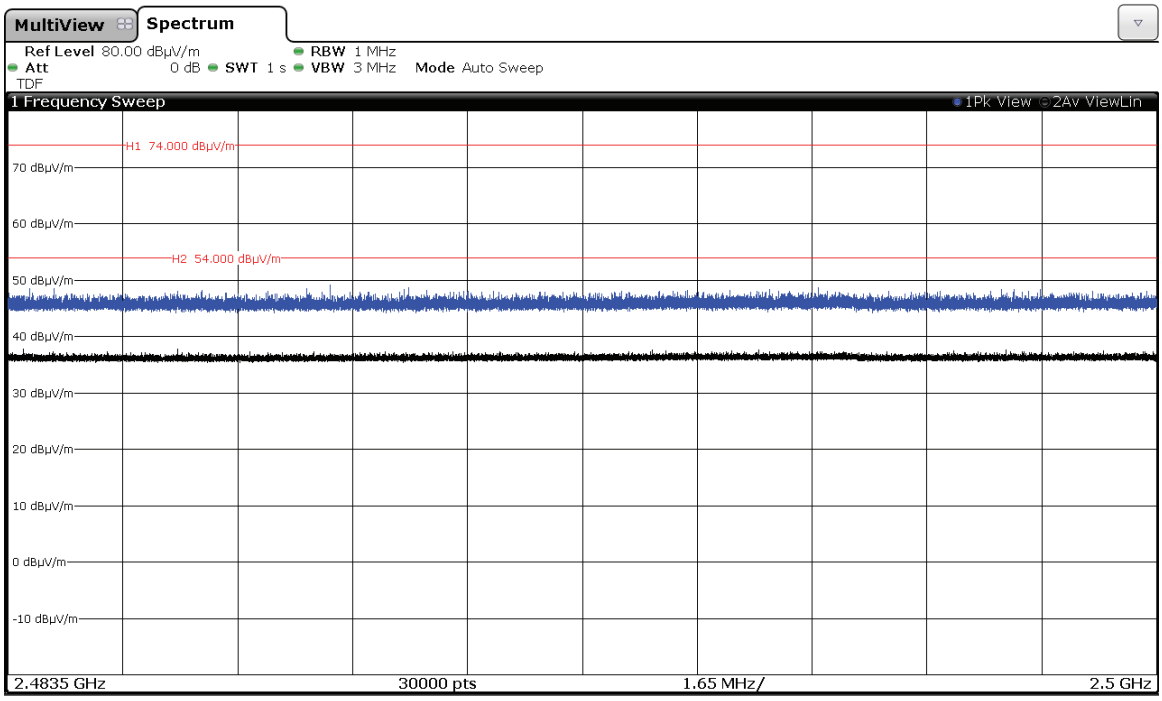


CHANNEL: Middle

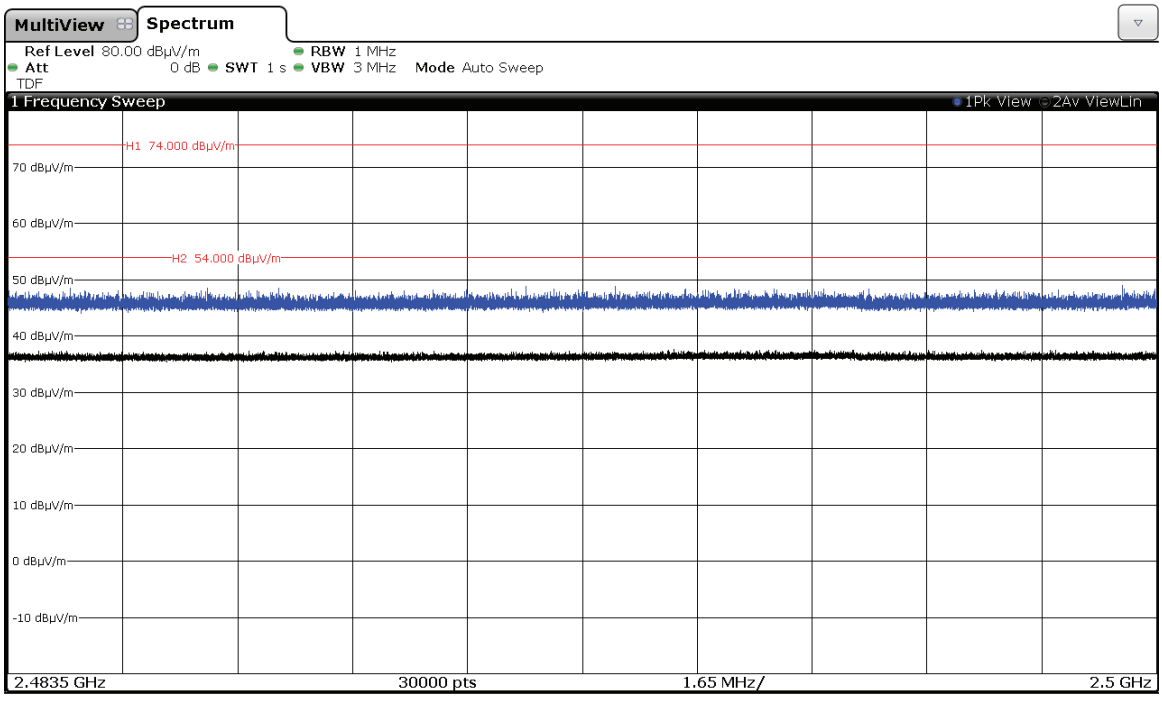
Modulation: GFSK



Modulation: Π/4-DQPSK

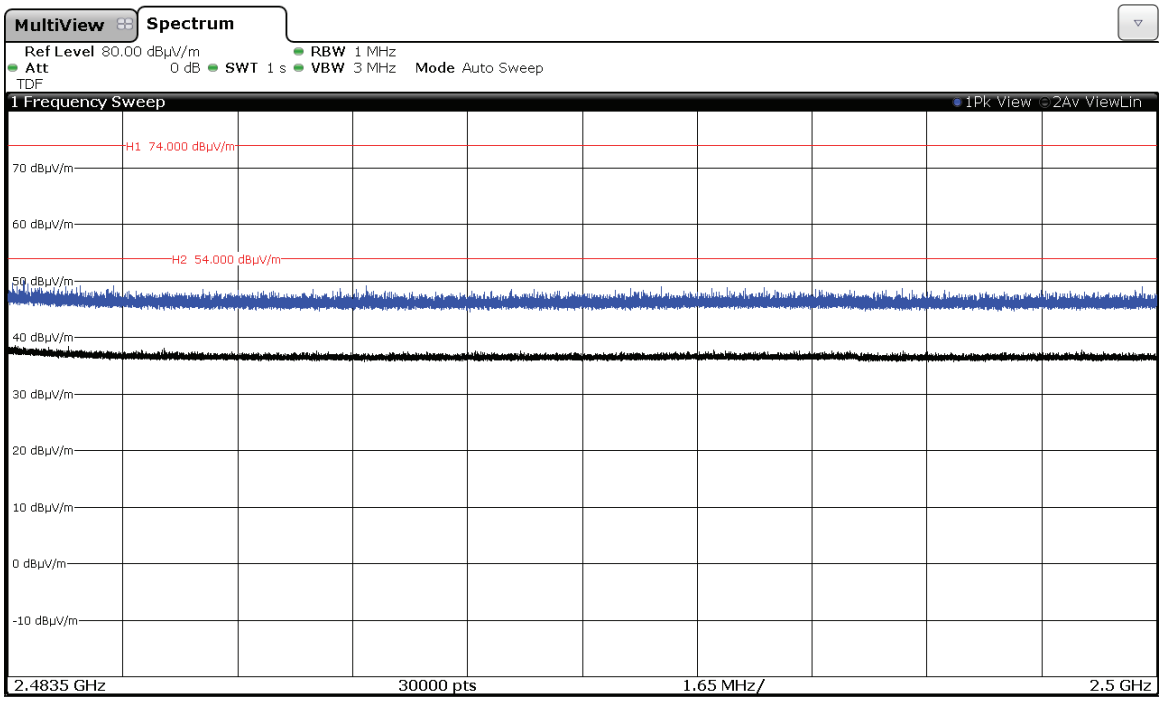


Modulation: 8-DPSK

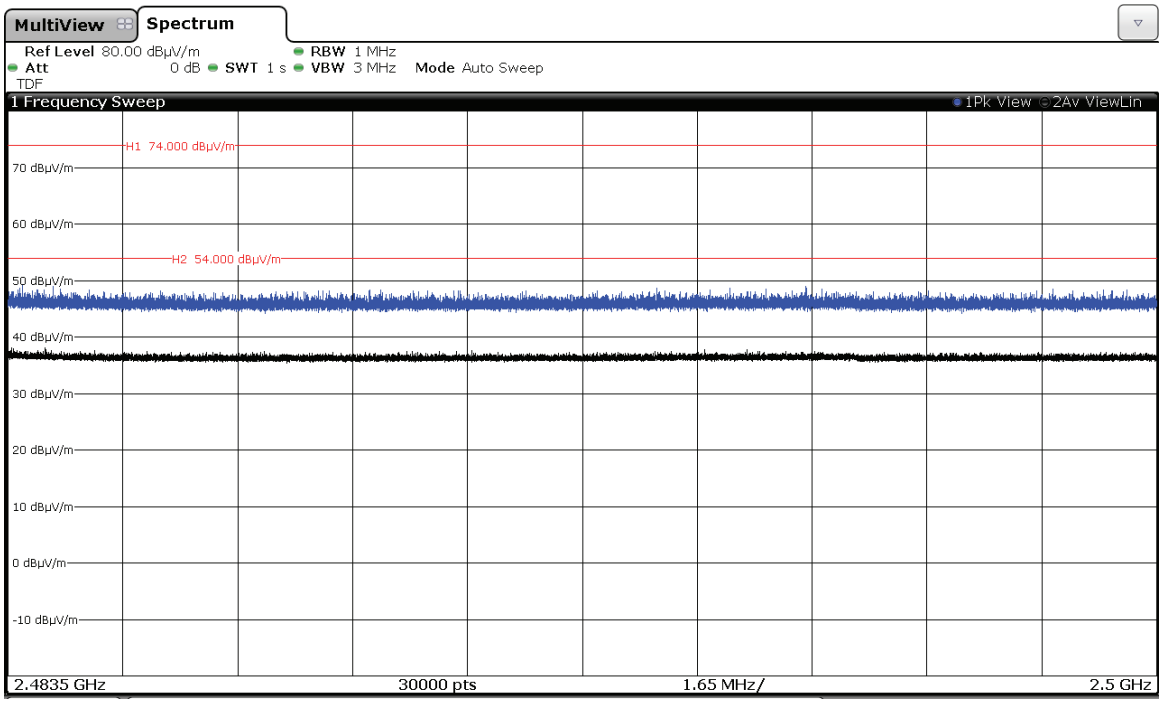


CHANNEL: Highest

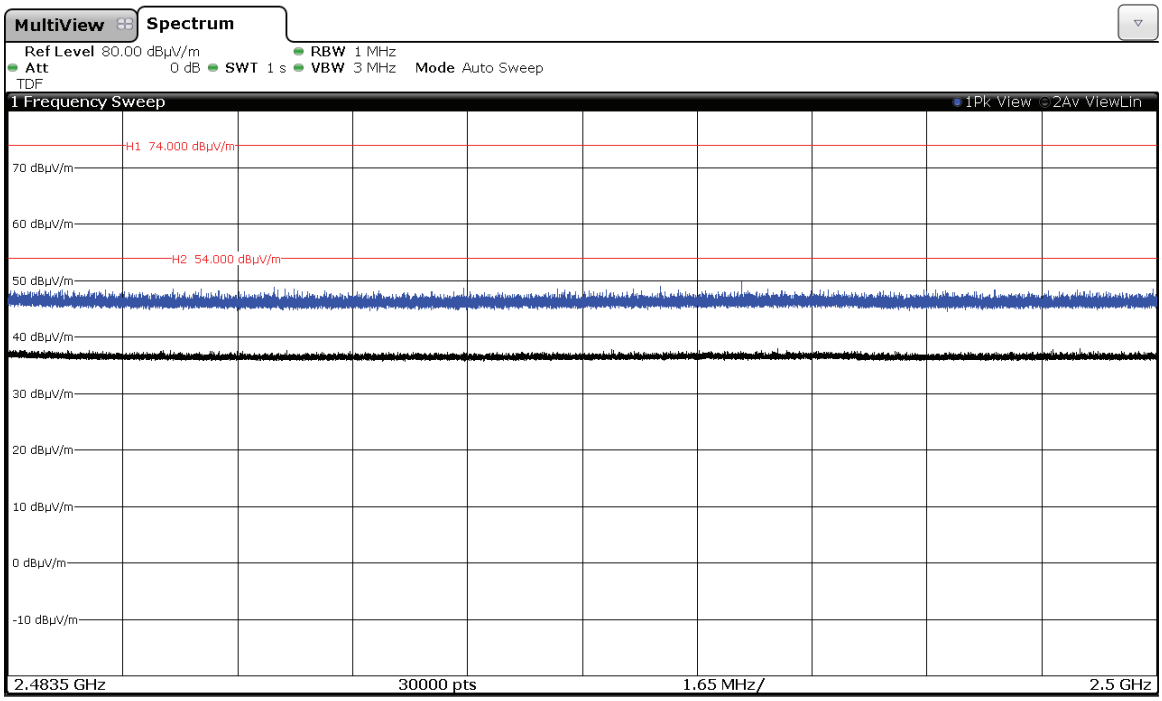
Modulation: GFSK



Modulation: Π/4-DQPSK



Modulation: 8-DPSK



Appendix B – Test result "WiFi 2.4 GHz (802.11b/g/n20/n40)"

INDEX

TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 13.2 Vdc

Type of power supply = External power supply (Battery).

Type of antenna: External antenna.

Declared Gain for antenna RF WIFI/Bluetooth (maximum): -6.2 dBi.

TEST FREQUENCIES:

For WiFi 802.11b/g/n20:

Lowest channel (1): 2412 MHz

Middle channel (6): 2437 MHz

Highest channel (11): 2462 MHz

For WiFi 802.11n40:

Lowest channel (3): 2422 MHz

Middle channel (6): 2437 MHz

Highest channel (9): 2452 MHz

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v04 dated 04/05/2017.

The sample was used to configure the EUT to continuously transmit at a specified output power in all channels with different modes and modulation schemes.

It was necessary to change between WLAN 0 CORE 1.
WIFI FCC:
tx_test.sh -a wlan0 stop

B
tx_test.sh -a wlan0 1 1 -d x -r 1 20
tx_test.sh -a wlan0 6 1 -d x -r 1 20
tx_test.sh -a wlan0 11 1 -d x -r 1 20

G
tx_test.sh -a wlan0 1 1 -d x -r 6 20
tx_test.sh -a wlan0 6 1 -d x -r 6 20
tx_test.sh -a wlan0 11 1 -d x -r 6 20

N20
tx_test.sh -a wlan0 1 1 -d x -h 0 20
tx_test.sh -a wlan0 6 1 -d x -h 0 20
tx_test.sh -a wlan0 11 1 -d x -h 0 20

N40
tx_test.sh -a wlan0 5 1 -d x -h 0 40
tx_test.sh -a wlan0 8 1 -d x -h 0 40
tx_test.sh -a wlan0 11 1 -d x -h 0 40

The field strength at the band edges was evaluated for each mode for the channel under test.
During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes.

The data rates of 1Mb/s for 802.11b, 6.5Mb/s for 802.11g, MSC0 for 802.11n20, MSC0 for 802.11n40 were selected based on preliminary testing that identified those rates corresponding to the worst cases for output power and band edge levels at restricted bands.

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is directly connected to the spectrum analyzer.

RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

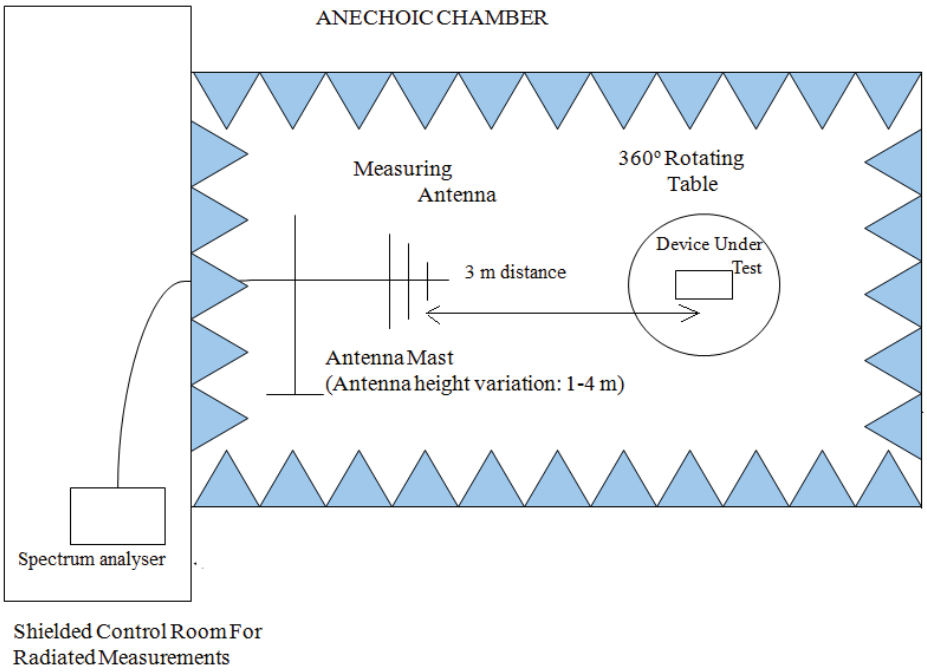
For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission.

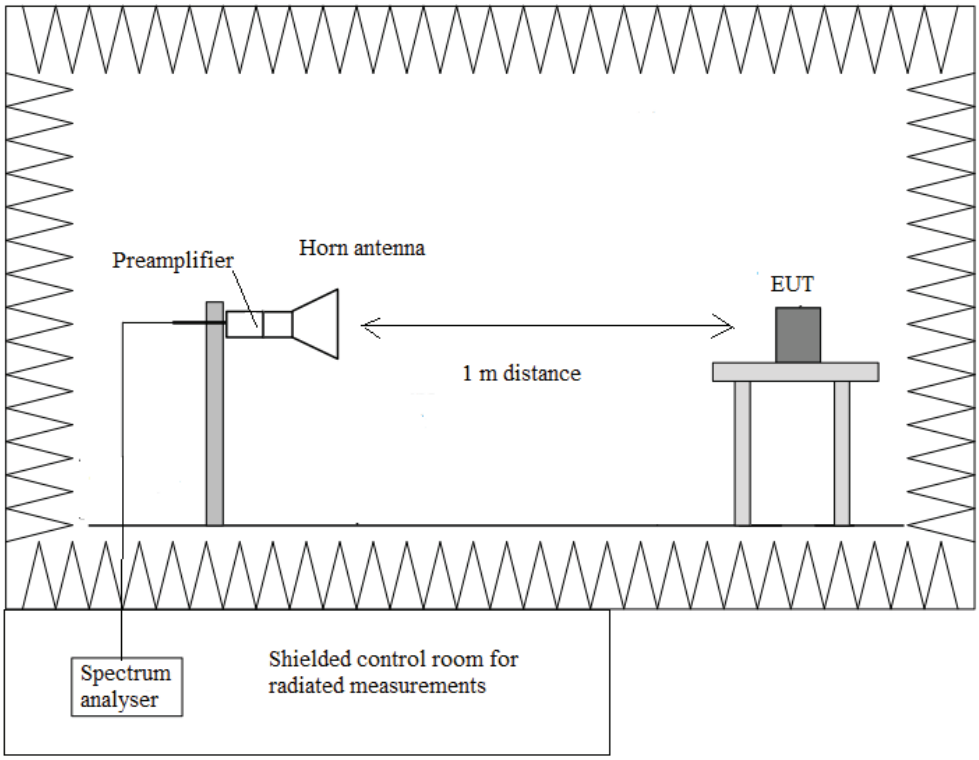
It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



Occupied Bandwidth

RESULTS

(see next plots)

Mode B

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	10.746	10.698	10.602
-26 dBc bandwidth (MHz)	14.280	14.254	14.221
Measurement uncertainty (kHz)	<±13.01		

Mode G

	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	16.842	16.896	16.902
-26 dBc bandwidth (MHz)	21.249	21.257	21.322
Measurement uncertainty (kHz)	<±18.02		

Mode N20

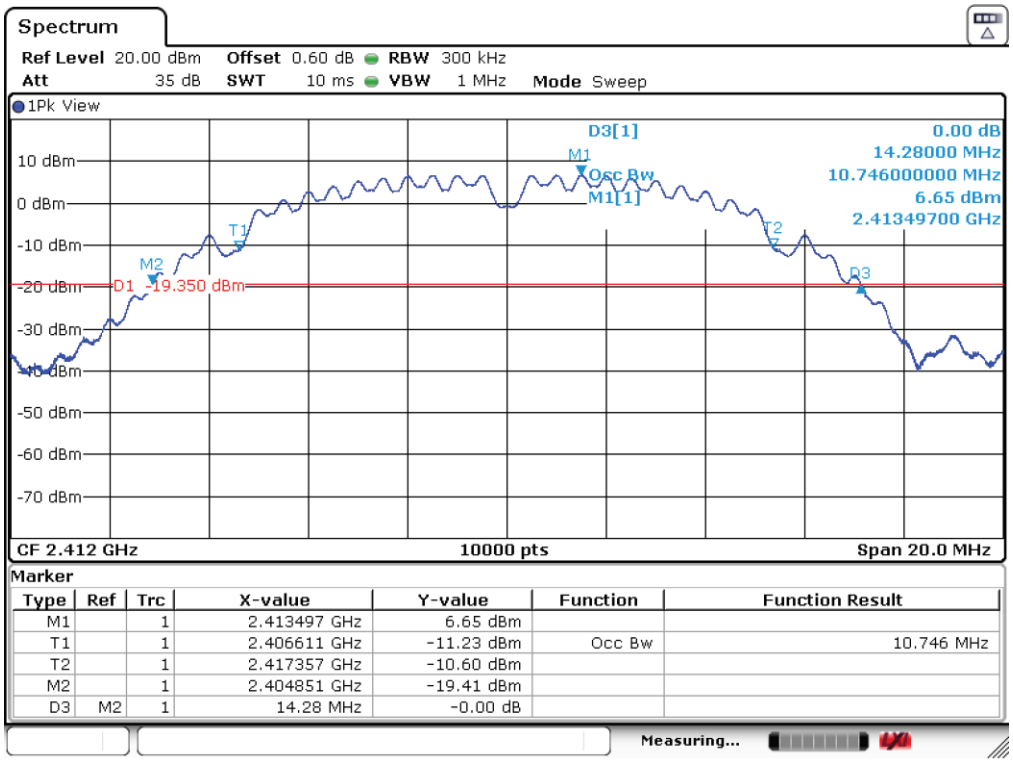
	Lowest frequency 2412 MHz	Middle frequency 2437 MHz	Highest frequency 2462 MHz
99% bandwidth (MHz)	18.012	18.015	18.039
-26 dBc bandwidth (MHz)	22.062	22.103	21.760
Measurement uncertainty (kHz)	<±18.02		

Mode N40

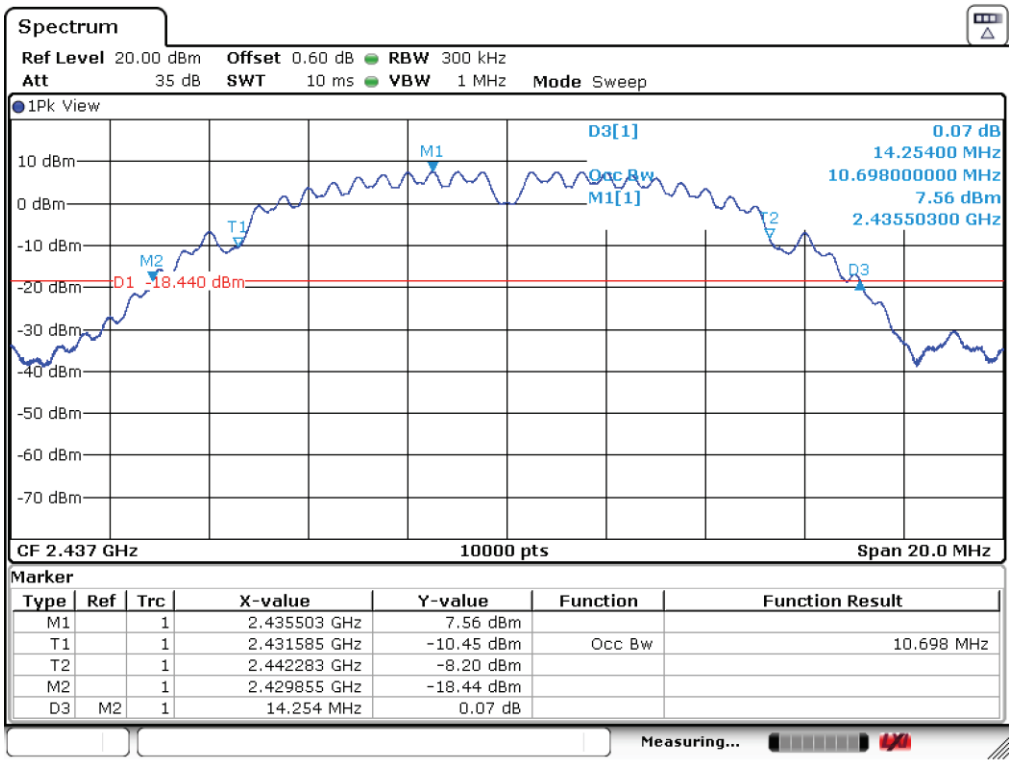
	Lowest frequency 2422 MHz	Middle frequency 2437 MHz	Highest frequency 2452 MHz
99% bandwidth (MHz)	36.012	36.024	36.030
-26 dBc bandwidth (MHz)	39.804	39.666	39.816
Measurement uncertainty (kHz)	<±35.03		

Mode B

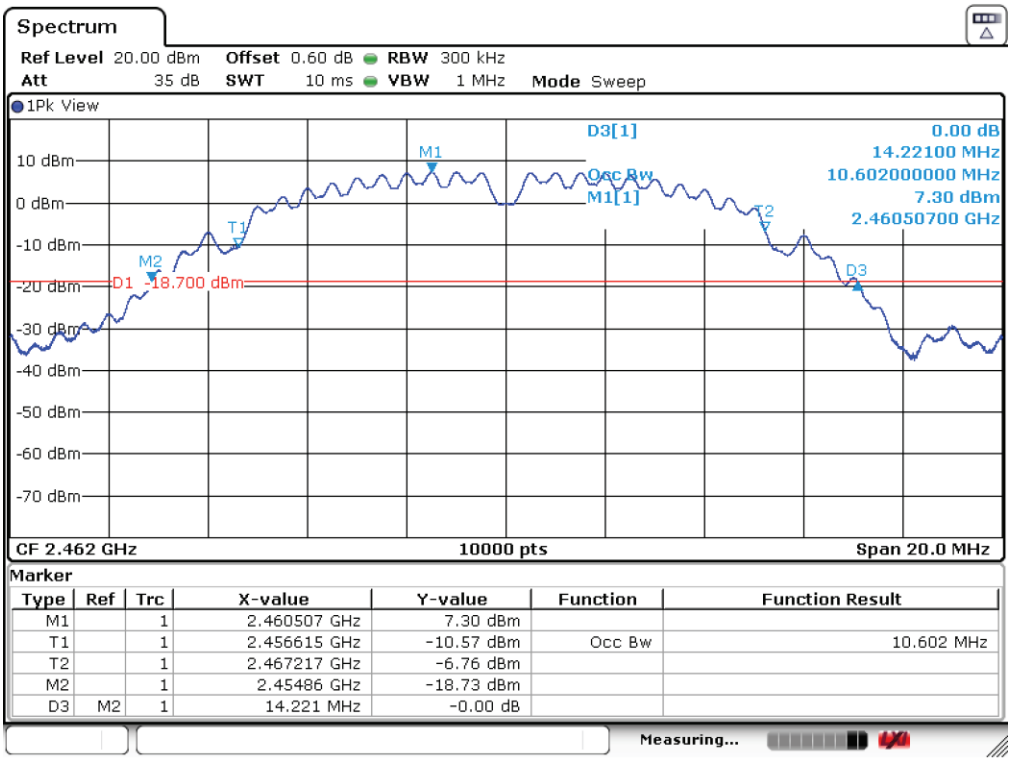
Lowest Channel



Middle Channel

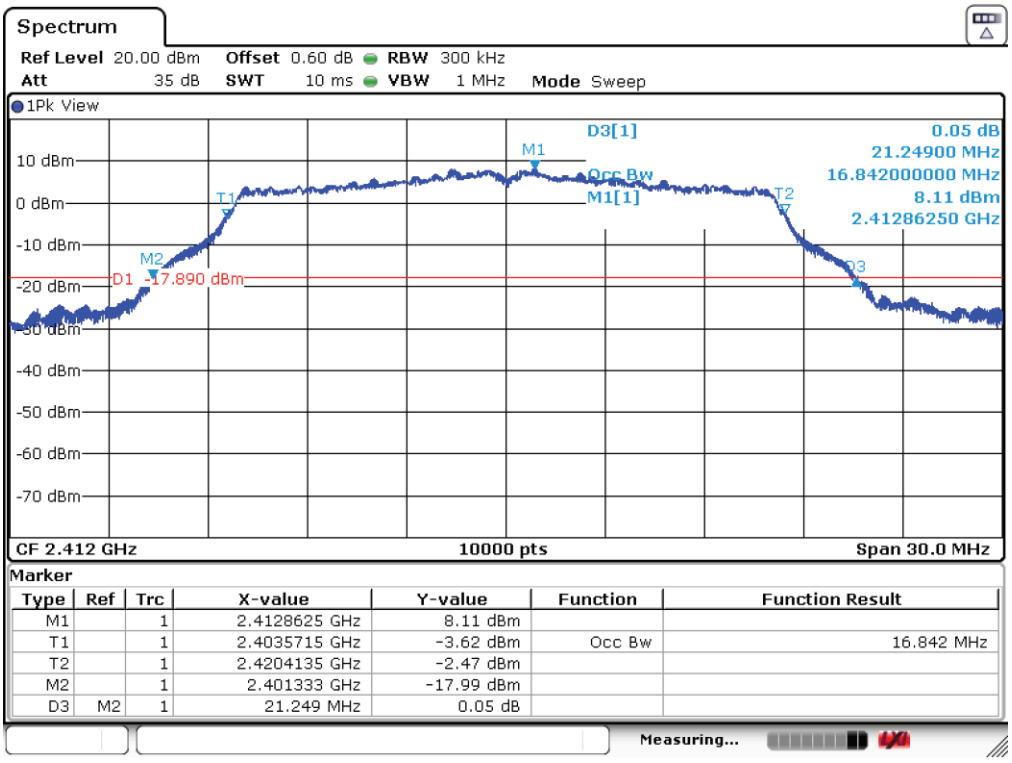


Highest channel

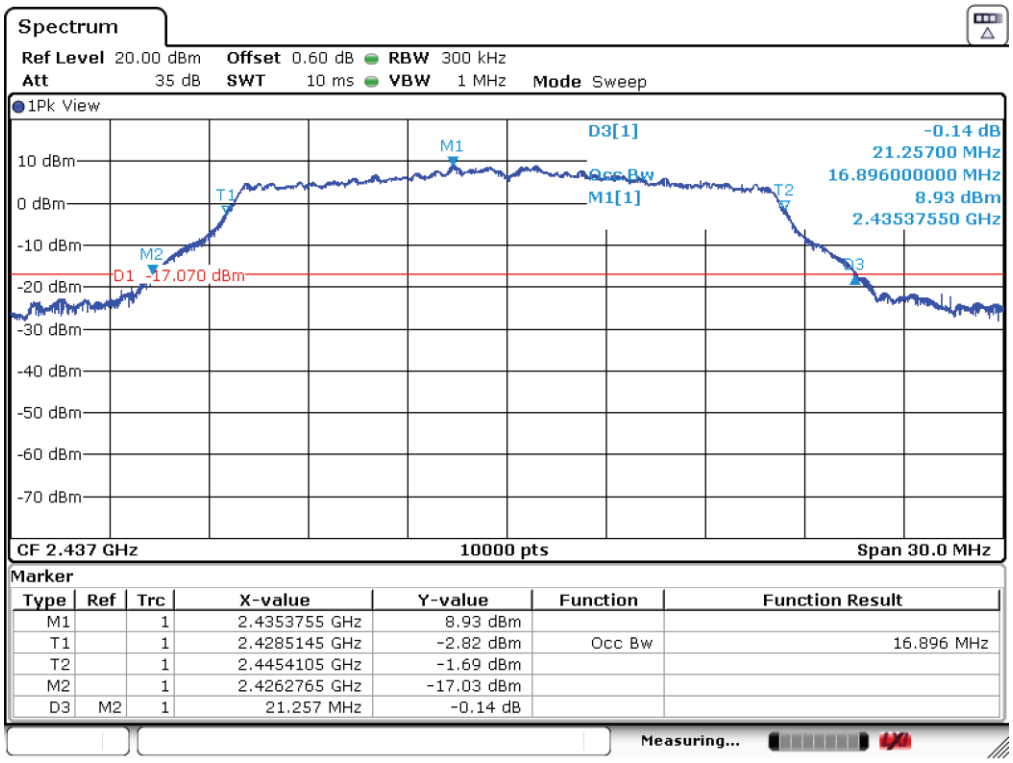


Mode G

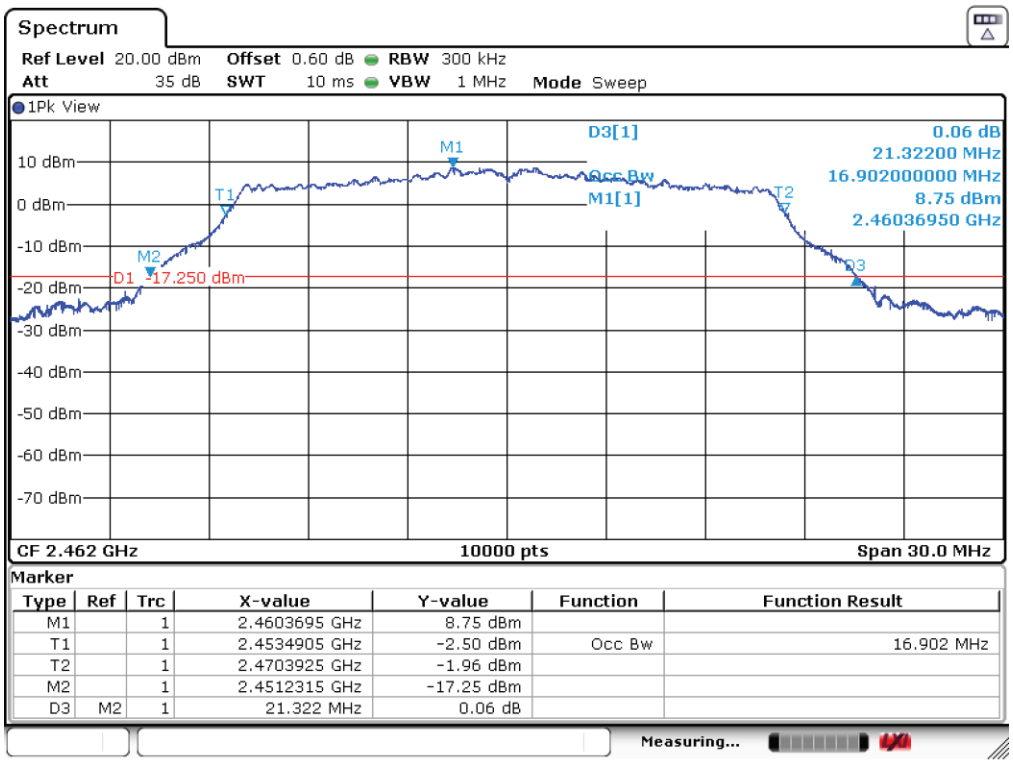
Lowest Channel



Middle Channel

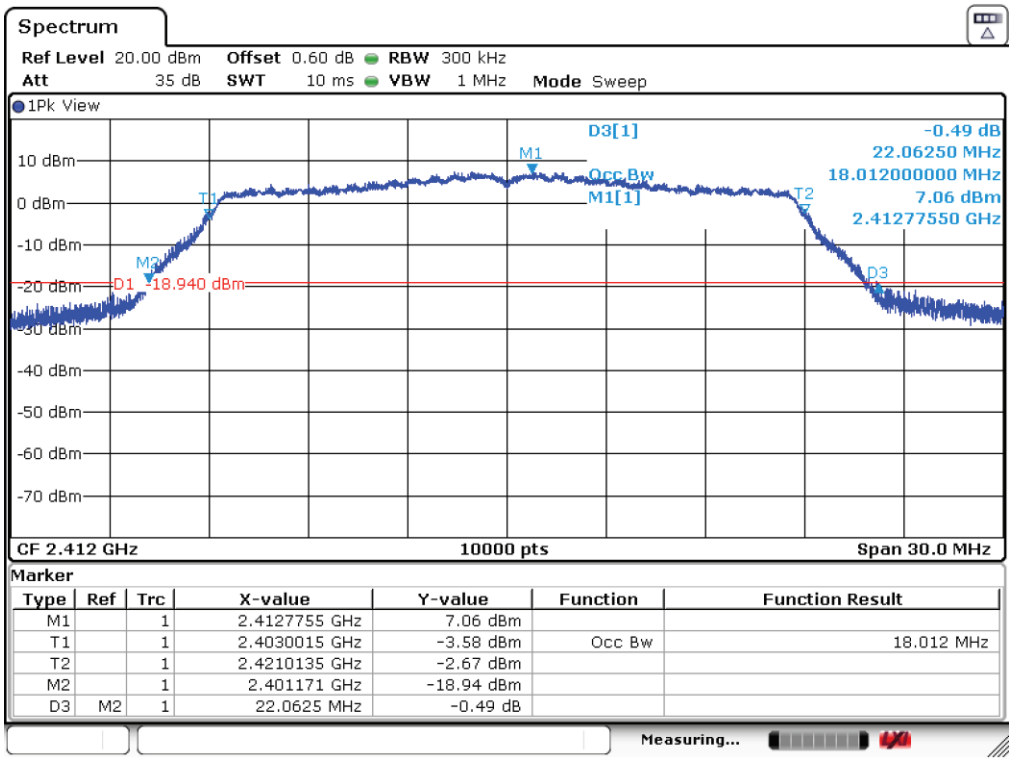


Highest channel

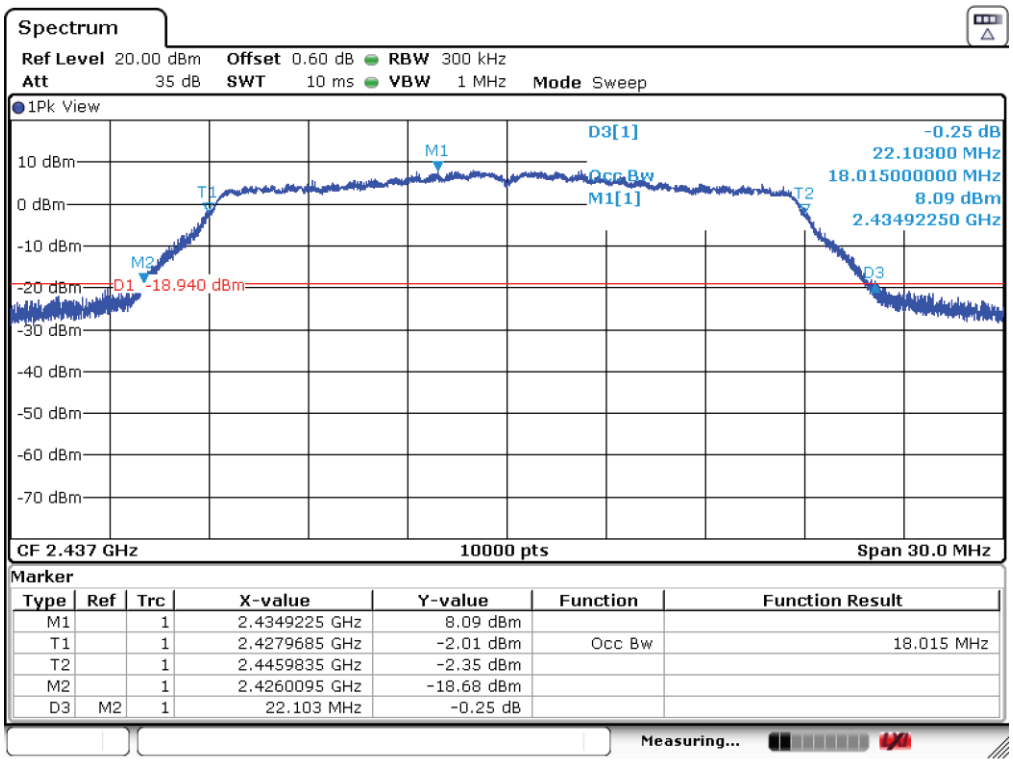


Mode N20

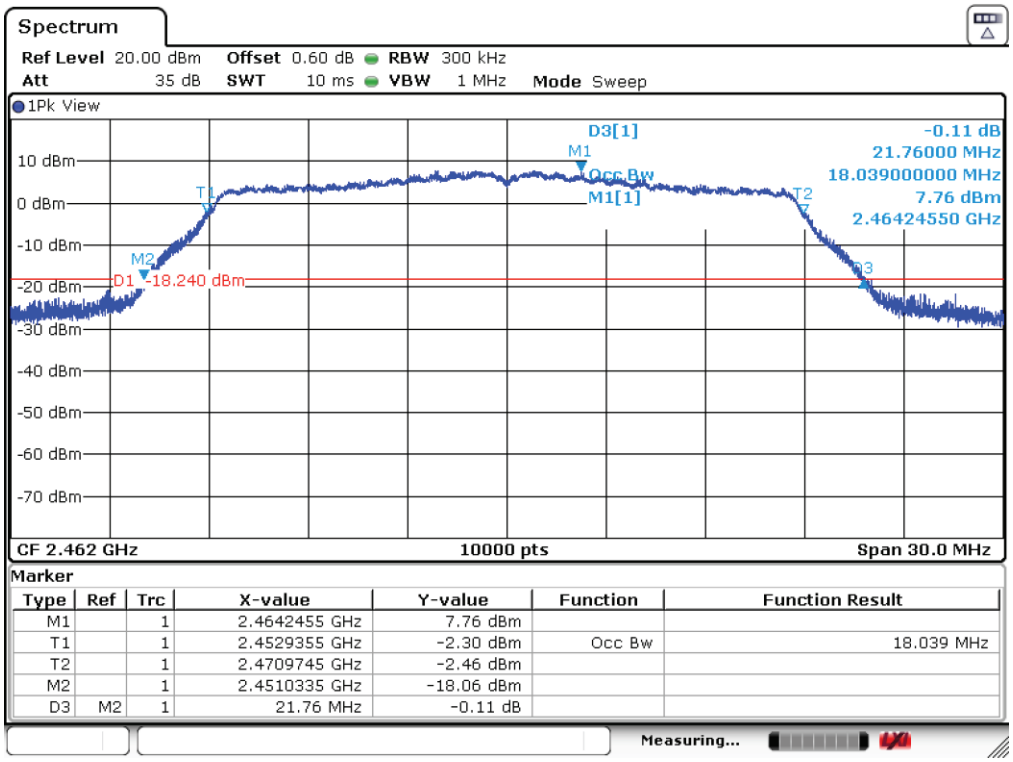
Lowest Channel



Middle Channel

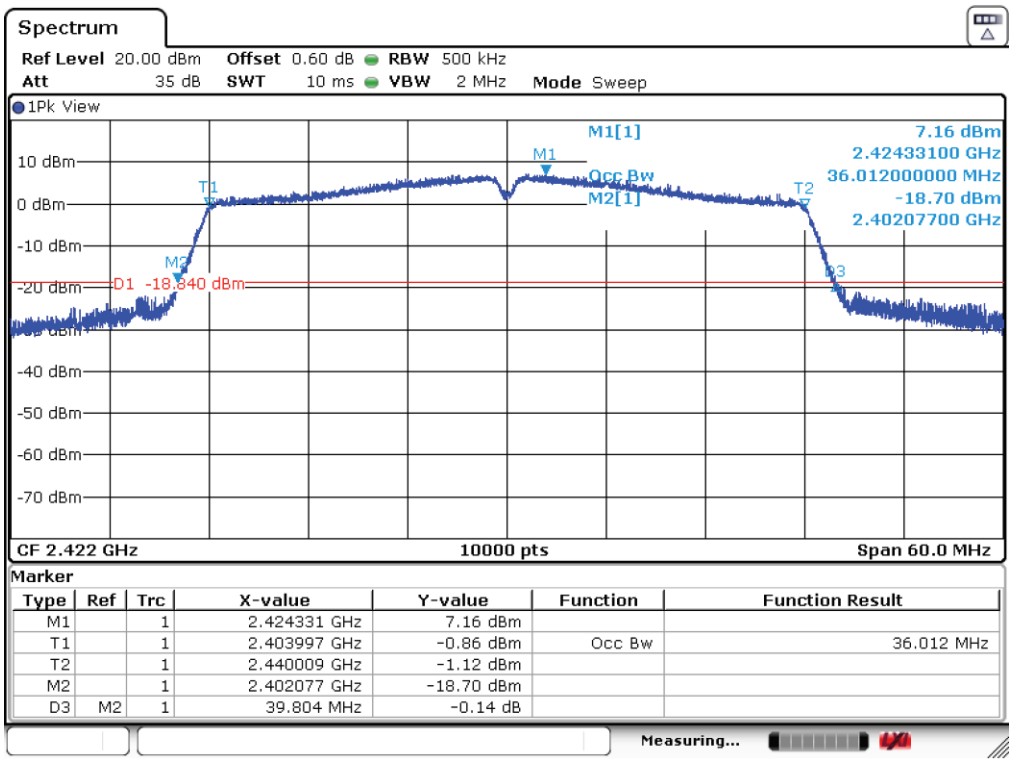


Highest channel

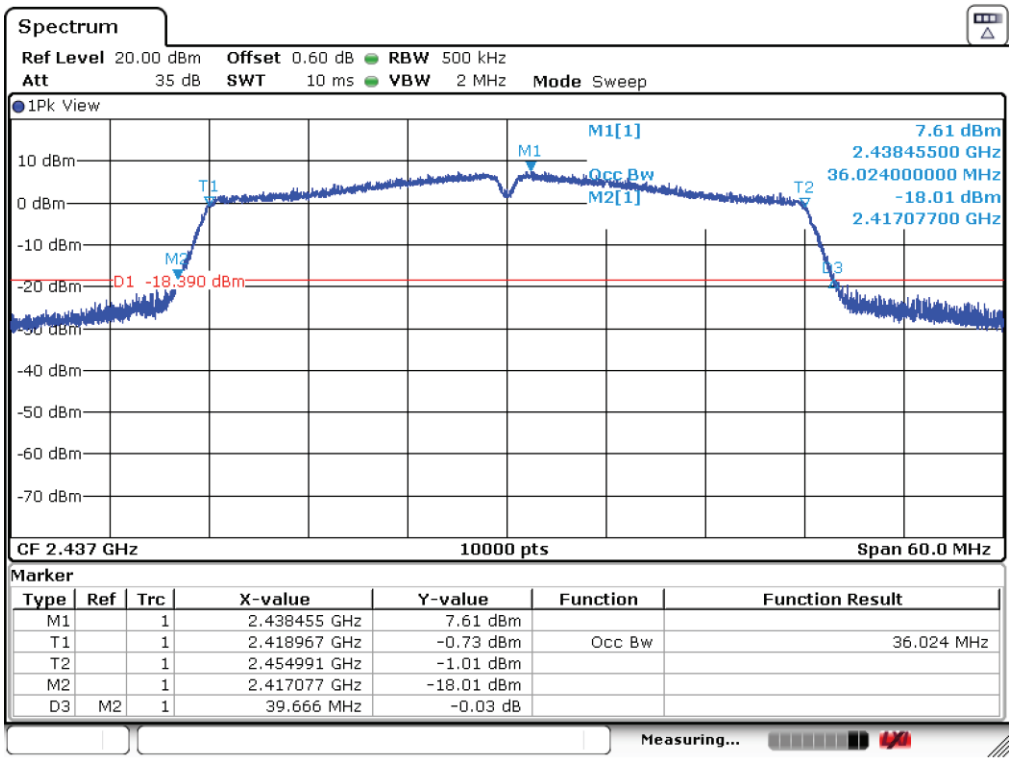


Mode N40

Lowest Channel



Middle Channel



Highest channel