6.19 Least Interfered Channel, LIC

6.19.1 Standard Applicable: FCC 15.323(c) (5) same as RSS-213 4.3.4 (b)(5)

If access to spectrum is not available as determined by the above, and a minimum of 20 duplex system access channels are defined for the system, the time and spectrum windows with the lowest power level may be accessed. A device utilizing the provisions of this paragraph must have monitored all access channels defined for its system within the last 10 seconds and must verify, within the 20 milliseconds (40 milliseconds for devices designed to use a 20 milliseconds frame period) immediately preceding actual channel access that the detected power of the selected time and spectrum windows is no higher than the previously detected value. The power measurement resolution for this comparison must be accurate to within 6 dB. No device or group of co-operating devices located within 1 meter of each other shall during any frame period occupy more than 6 MHz of aggregate bandwidth, or alternatively, more than one third of the time and spectrum windows defined by the system.

6.19.2 Measurement procedure

Measurement method according to ANSI C63.17 2013 paragraph 4.3.3, 7.3.2, 7.3.3

6.19.3 Results: Complies

Measurement Data

Test Date : Oct. 22, 2014 Temperature : 24℃ Humidity : 58%

Calculation of monitoring threshold:
Monitoring threshold: $T_L = 15 \log B - 184 + 50 - P$ (dBm)
B = emission bandwidth (Hz)
P = peak transmit power (dBm)

Calculated thresholds:

T_L: Monitoring limit threshold (dBm)	-52.5

Used results	Emission bandwidth (MHz)	1.46
	Peak transmit power (dBm)	10.96
T_L+U_M = -52.5 + 6 = -46.5 (dBm)		

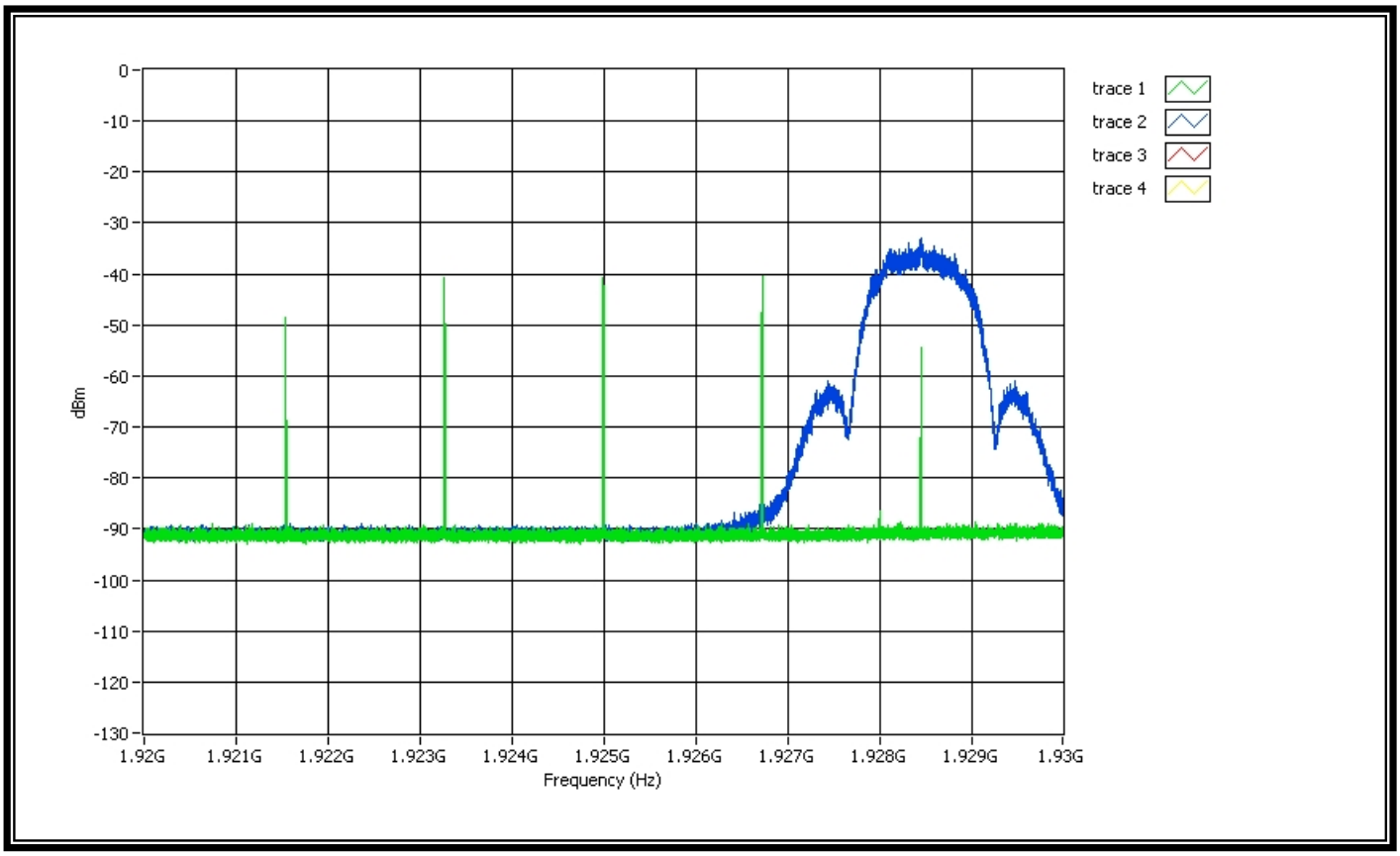
Result:

Least interfered channel	Pass

Note 1: The monitoring threshold is applicable for systems which have defined a minimum of 20 duplex system access channels.

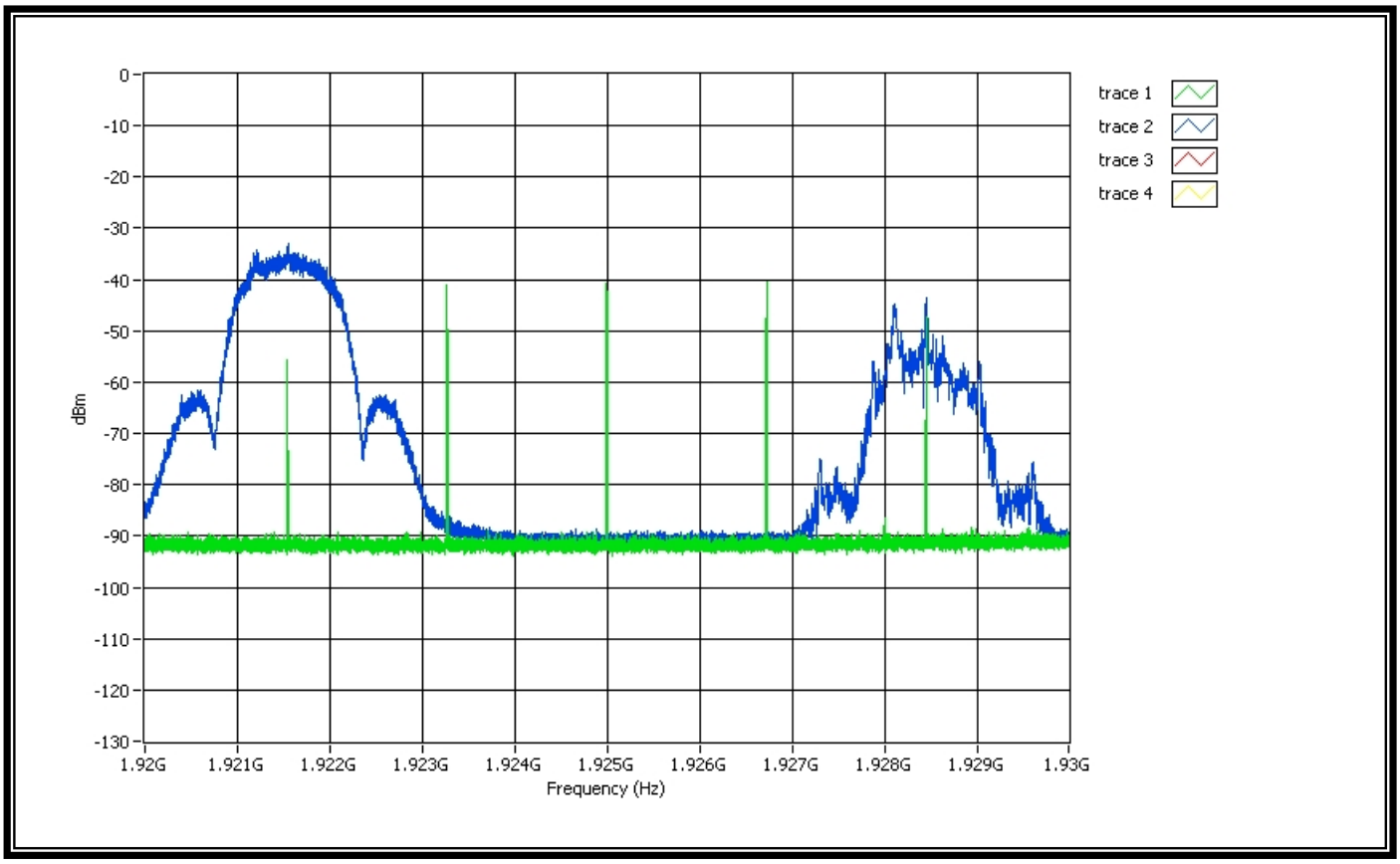
Note 2: f1=1921.536 MHz, f2=1928.448MHz

Comment: 7.3.2b



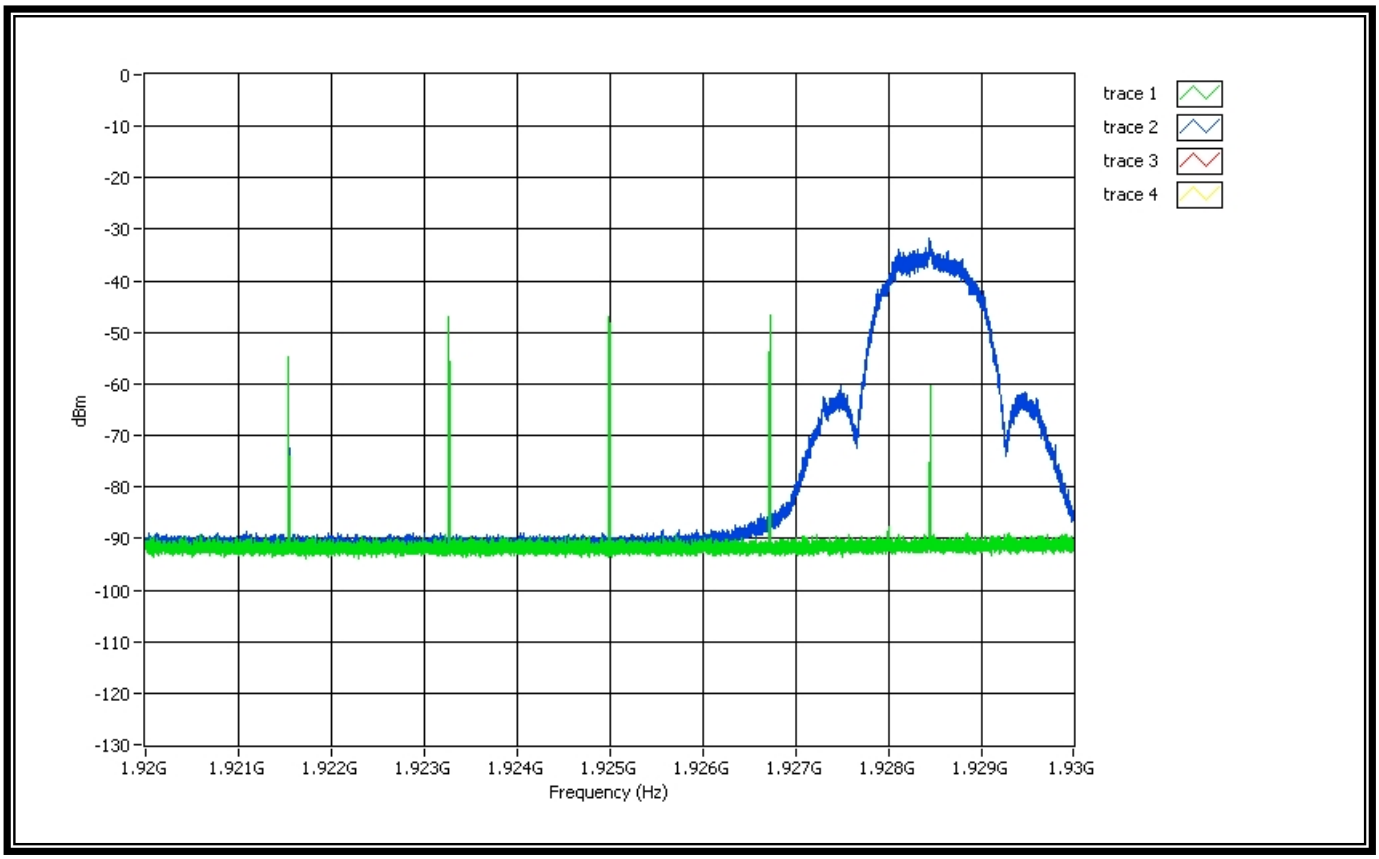
Comment1: Trace1 (green) shows the interference profile.
Comment2: Trace2 (blue) shows the EUT transmissions are occurring.
Comment3: The EUT always transmits on f2 (the carrier with the lower interference level) and so meets the requirement.

Comment: 7.3.2c



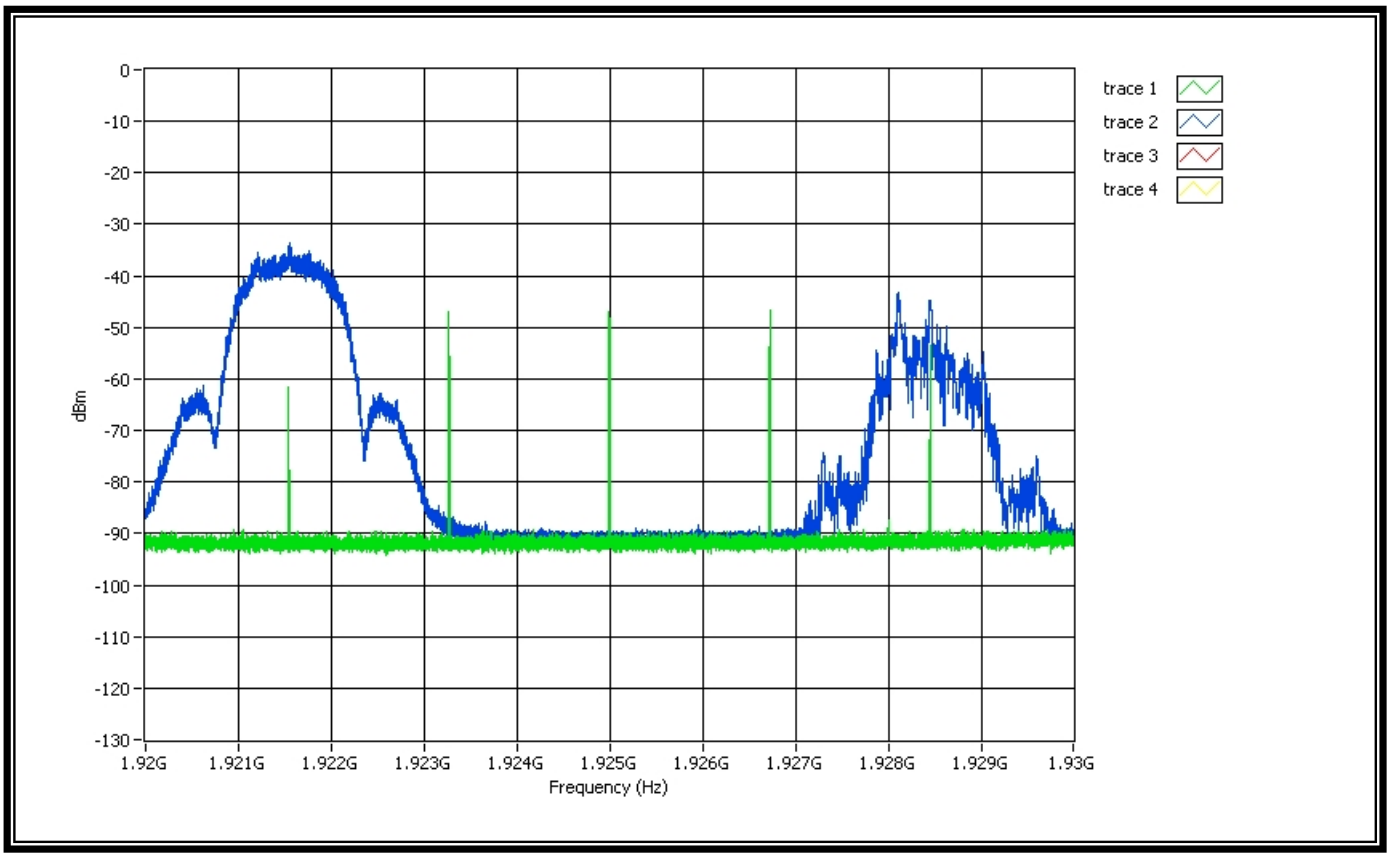
Comment1: Trace1 (green) shows the interference profile.
Comment2: Trace2 (blue) shows the EUT transmissions are occurring.
Comment3: The EUT always transmits on f1 (the carrier with the lower interference level) and so meets the requirement.

Comment: 7.3.2d



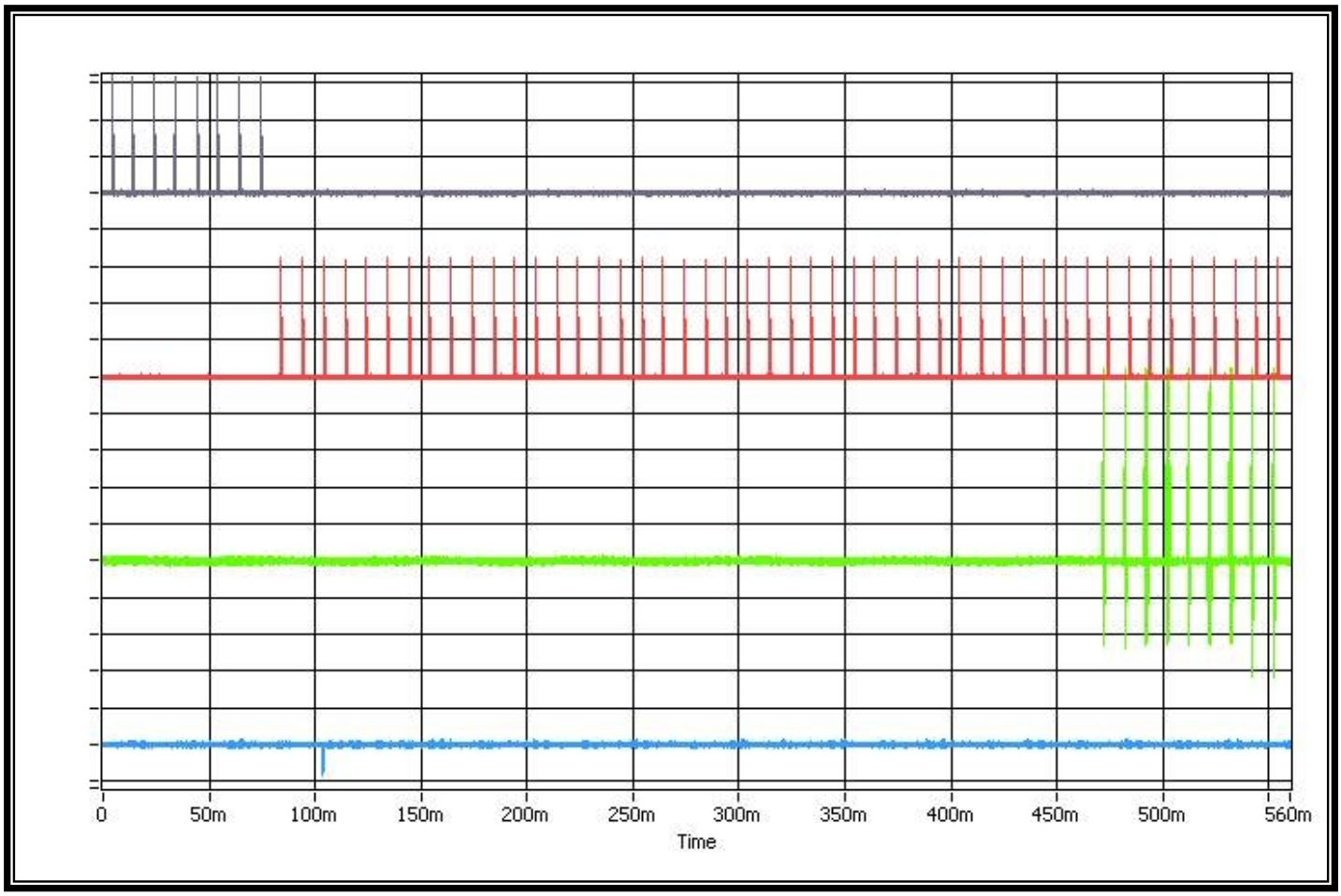
Comment1: Trace1 (green) shows the interference profile.
Comment2: Trace2 (blue) shows the EUT transmissions are occurring.
Comment3: The EUT always transmits on f2 (the carrier with the lower interference level) and so meets the requirement.

Comment: 7.3.2e



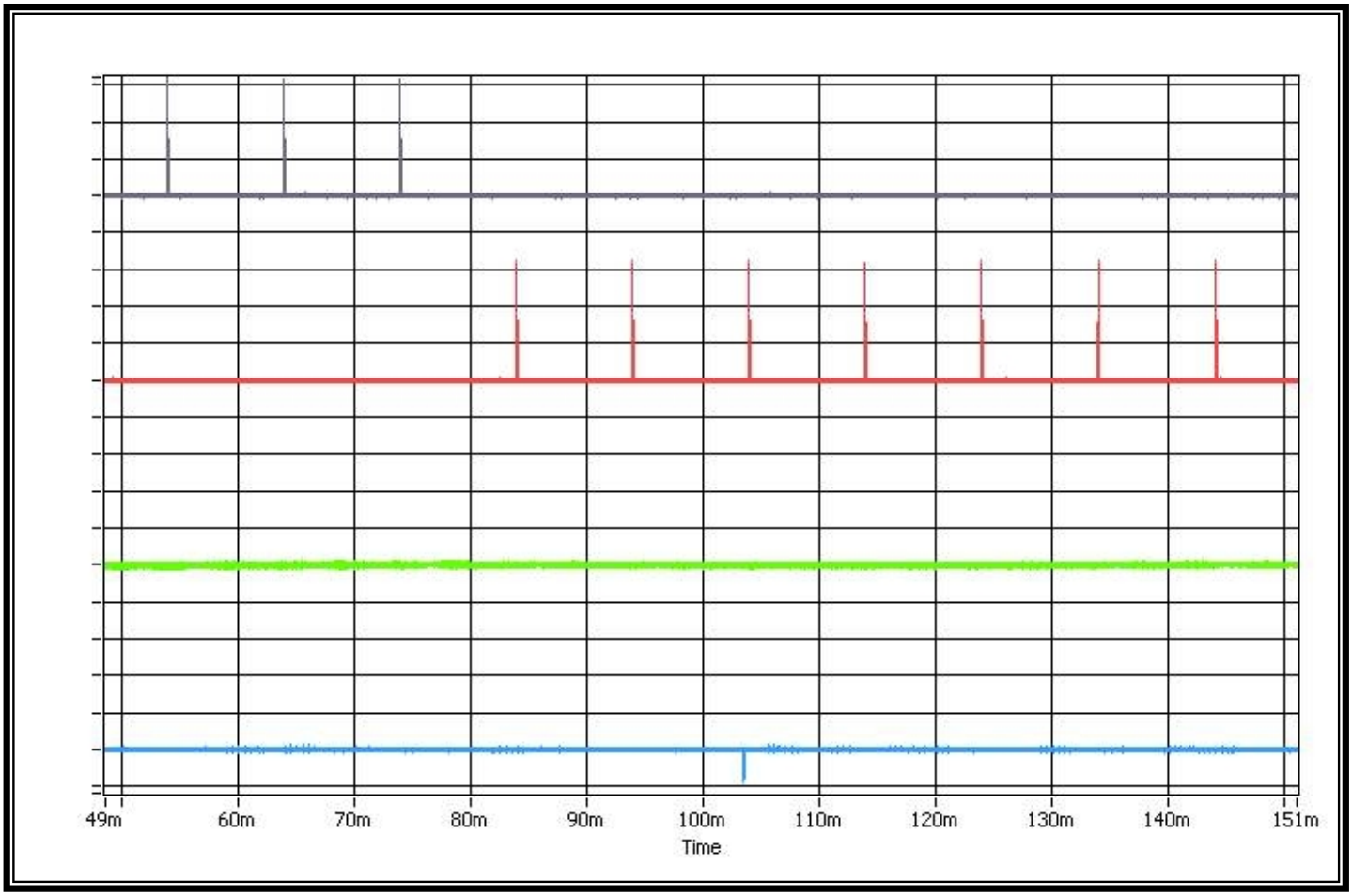
Comment1: Trace1 (green) shows the interference profile.
Comment2: Trace2 (blue) shows the EUT transmissions are occurring.
Comment3: The EUT always transmits on f1 (the carrier with the lower interference level) and so meets the requirement.

Comment: 7.3.3



Comment1: Trace1 (deep blue, top) shows interference on f1.
Comment2: Trace2 (red, 2nd from top) shows the interference on f2.
Comment3: Trace3 (green, 3rd from top) shows EUT transmissions on f1.
Comment4: Trace4 (light blue, 4th from top) shows the signal to the handset to trigger the transmissions.
Comment5: Set interference on all system carriers except f2, at a level of T_L+U_M, in-band per carrier.
Comment6: Apply interference on f2 at a level of T_L+U_M+20, in-band, and immediately remove all interference from f1 and immediately (but not sooner than 20 ms after the interference on f2 is applied) cause the EUT to attempt transmission.
Comment7: The EUT transmits on f1 and so meets the requirement.

Comment: 7.3.4 (Zoom in)



Comment1: Trace1 (deep blue, top) shows interference on f1.
Comment2: Trace2 (red, 2nd from top) shows the interference on f2.
Comment3: Trace3 (green, 3rd from top) shows EUT transmissions on f1.
Comment4: Trace4 (light blue, 4th from top) shows the signal to the handset to trigger the transmissions. The signal is not sooner than 20 ms after the interference on f2 is applied.

6.20 Random waiting

6.20.1 Standard Applicable: FCC 15.323 (c)(6) same as RSS-213 4.3.4 (b)(6)

If the selected combined time and spectrum windows are unavailable, the device may either monitor and select different windows or seek to use the same window after waiting an amount of time, randomly chosen from a uniform random distribution between 10 and 150 milliseconds, commencing when the channel becomes available.

6.20.2 Measurement procedure

Measurement method according to ANSI C63.17 2013 paragraph 8.1.3

6.20.3 Results:

The manufacturer declares that this provision is not utilized by the EUT.

6.21 Monitoring bandwidth and reaction time

6.21.1 Standard Applicable: FCC 15.323(c)(7)

The monitoring system band width must be equal to or greater than the emission band width of the intended transmission and have a maximum reaction time less than 50 x SQRT (1.25/emission band width in MHz) microseconds for signals at the applicable threshold level but shall not be required to be less than 50 microsecond. If a signal is detected that is 6 dB or more above the applicable threshold level, the maximum reaction time shall be 35 x SQRT (1.25/emission band width in MHz) microseconds but shall not be required to be less than 35 microseconds.

RSS-213 4.3.4 (b)(7)
The monitoring system bandwidth must be equal to or greater than the occupied bandwidth of the intended transmission. **Note:** Testing of the monitoring system bandwidth is not required if the designed bandwidth from the manufacturer is available and given in the test report.
The monitor shall have a maximum reaction time less than 50√ (1.25/occupied bandwidth in MHz) microseconds for signals at the applicable threshold level but shall not be required to be less than 50 microseconds.
If a signal is detected that is 6 dB or more above the threshold level, the maximum reaction time shall be 35√ (1.25/occupied bandwidth in MHz) microseconds but shall not be required to be less than 35 microseconds.

6.21.2 Measurement procedure

Measurement method according to ANSI C63.17 2013 paragraph 7.5

6.21.3 Results: Meets the requirement

Measurement Data

Calculation of applied pulse eidth and maximum reaction time:

For emission bandwidth > 1.25MHz, the pulse width is always 35us and 50us.

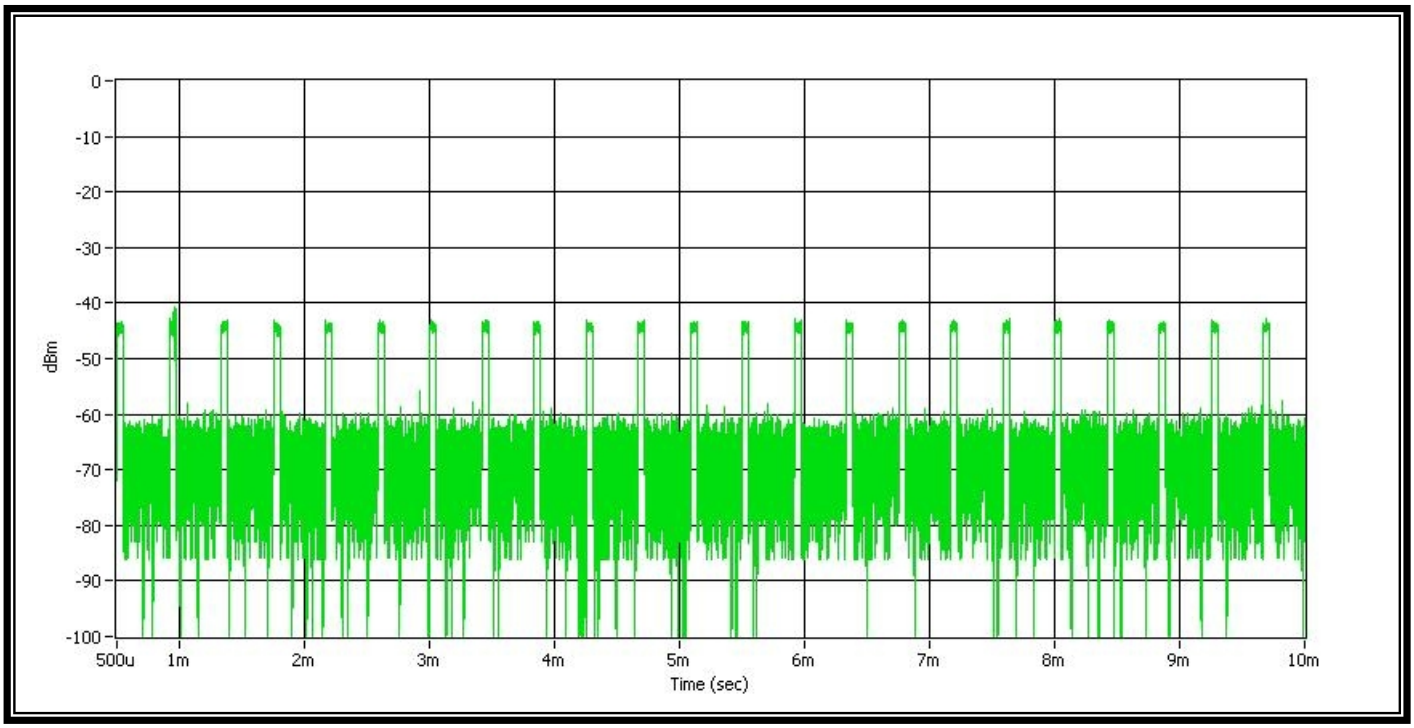
Used results	Emission bandwidth B (MHz)	1.46 MHz
Maximum reaction time and pulse width	$50\sqrt{1.25/B}$ (μs)	46.3 μs
	$35\sqrt{1.25/B}$ (μs)	32.4 μs

Result:

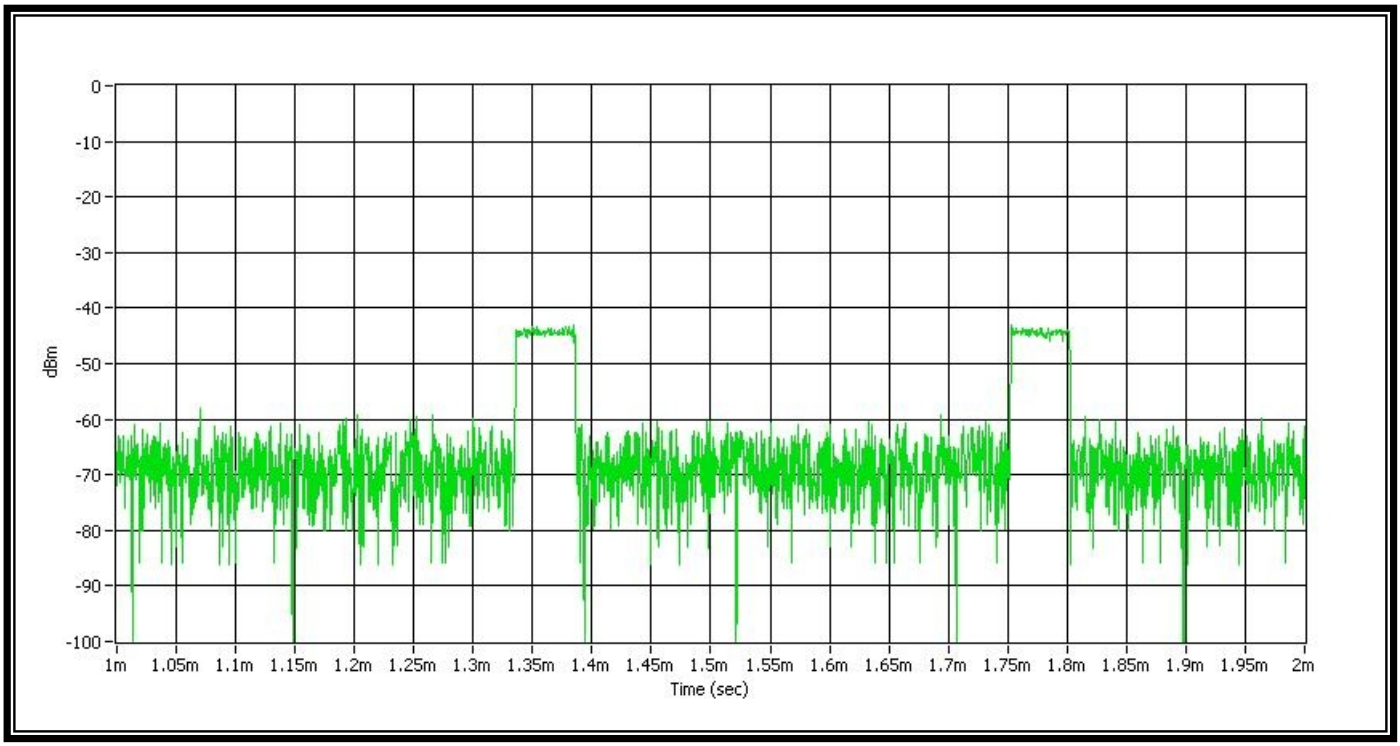
Test Date : Oct. 22, 2014 Temperature : 24℃ Humidity : 58%

Pulse width (μs)	**Connection**
50 μs or $50\sqrt{(1.25/B)}$	no
35 μs or $35\sqrt{(1.25/B)}$	no

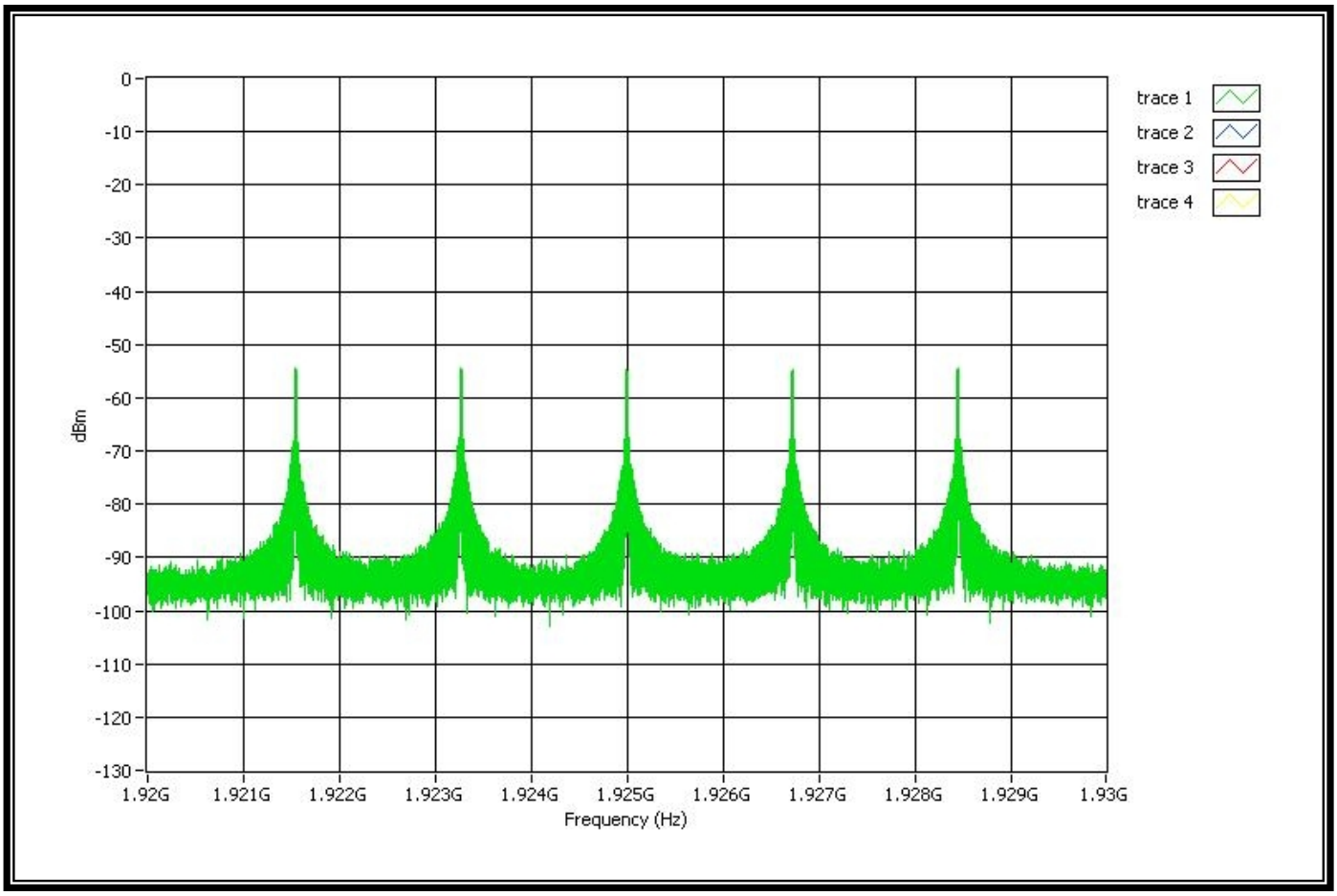
Comment: 50us



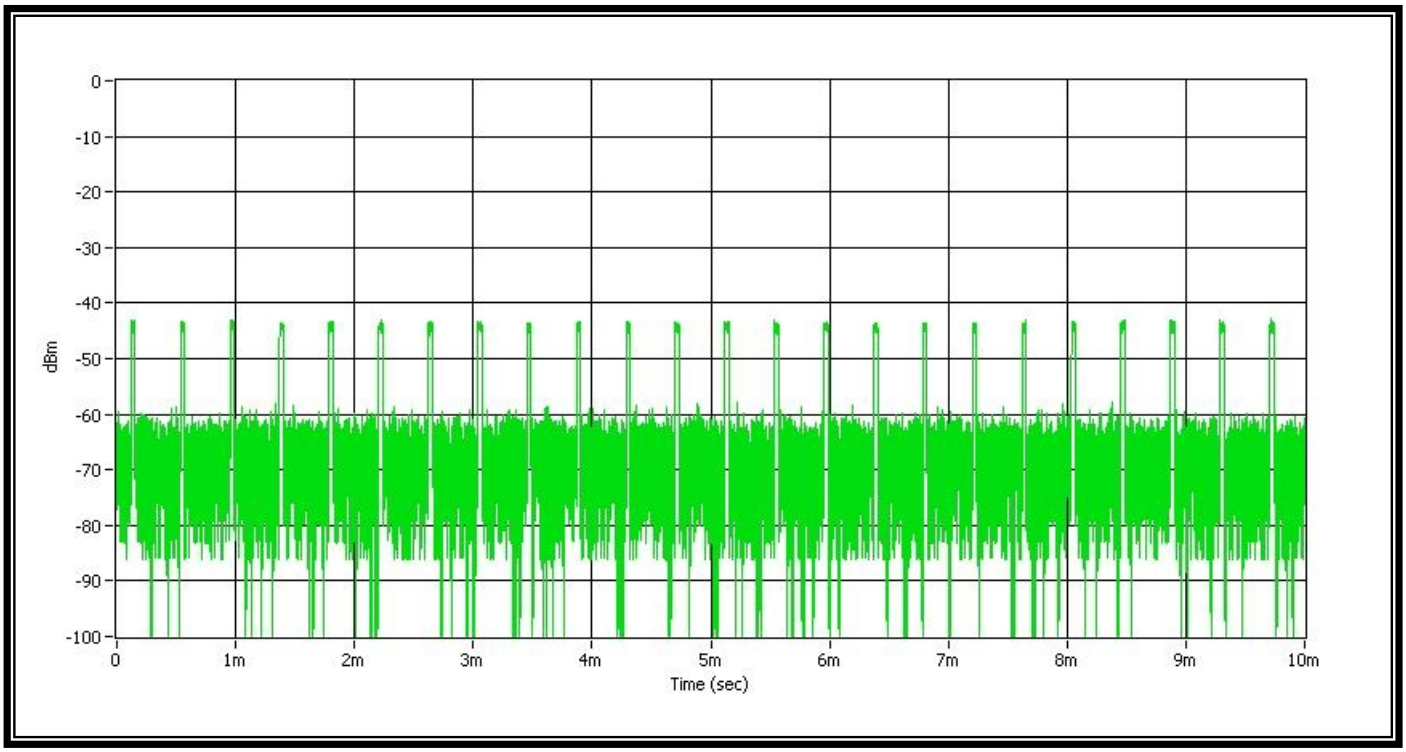
Comment: 50us (Zoom in)



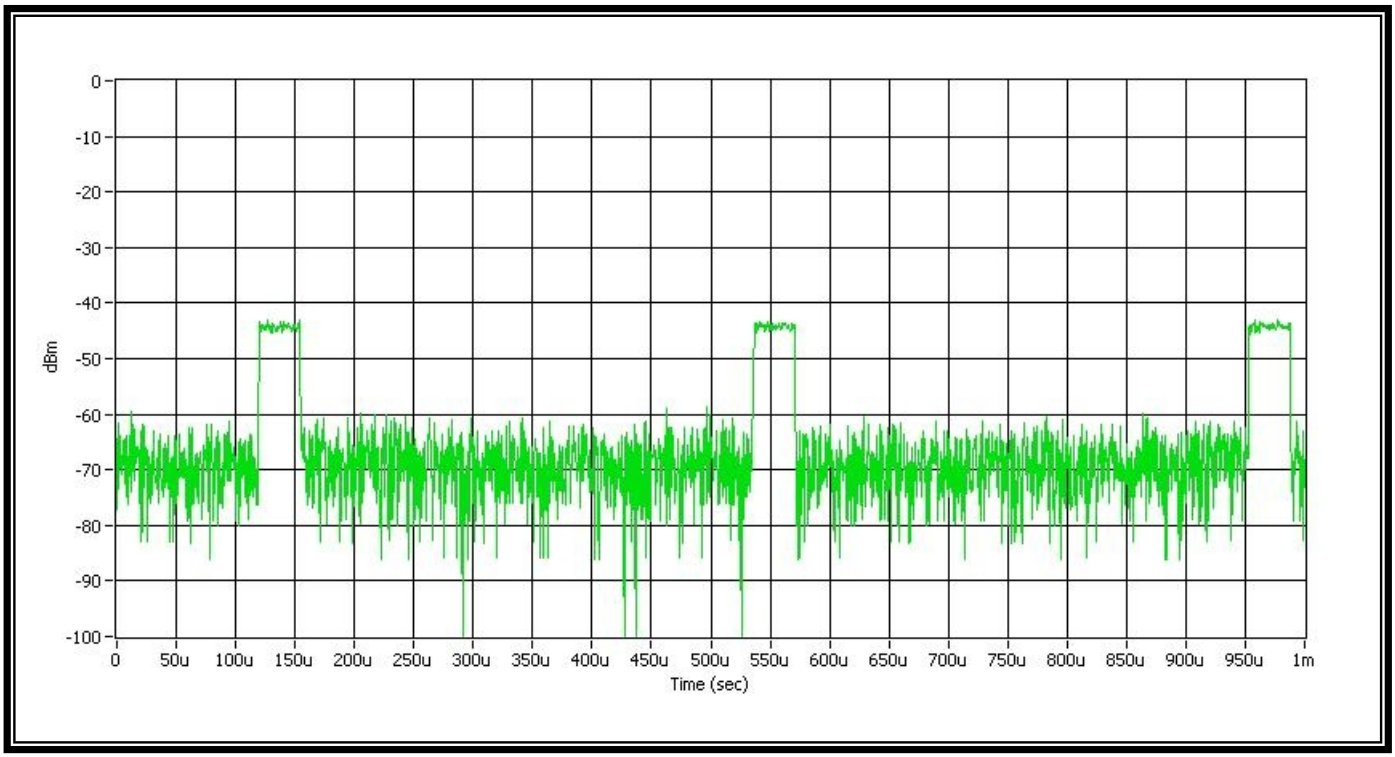
Comment: 50us (5 carriers)



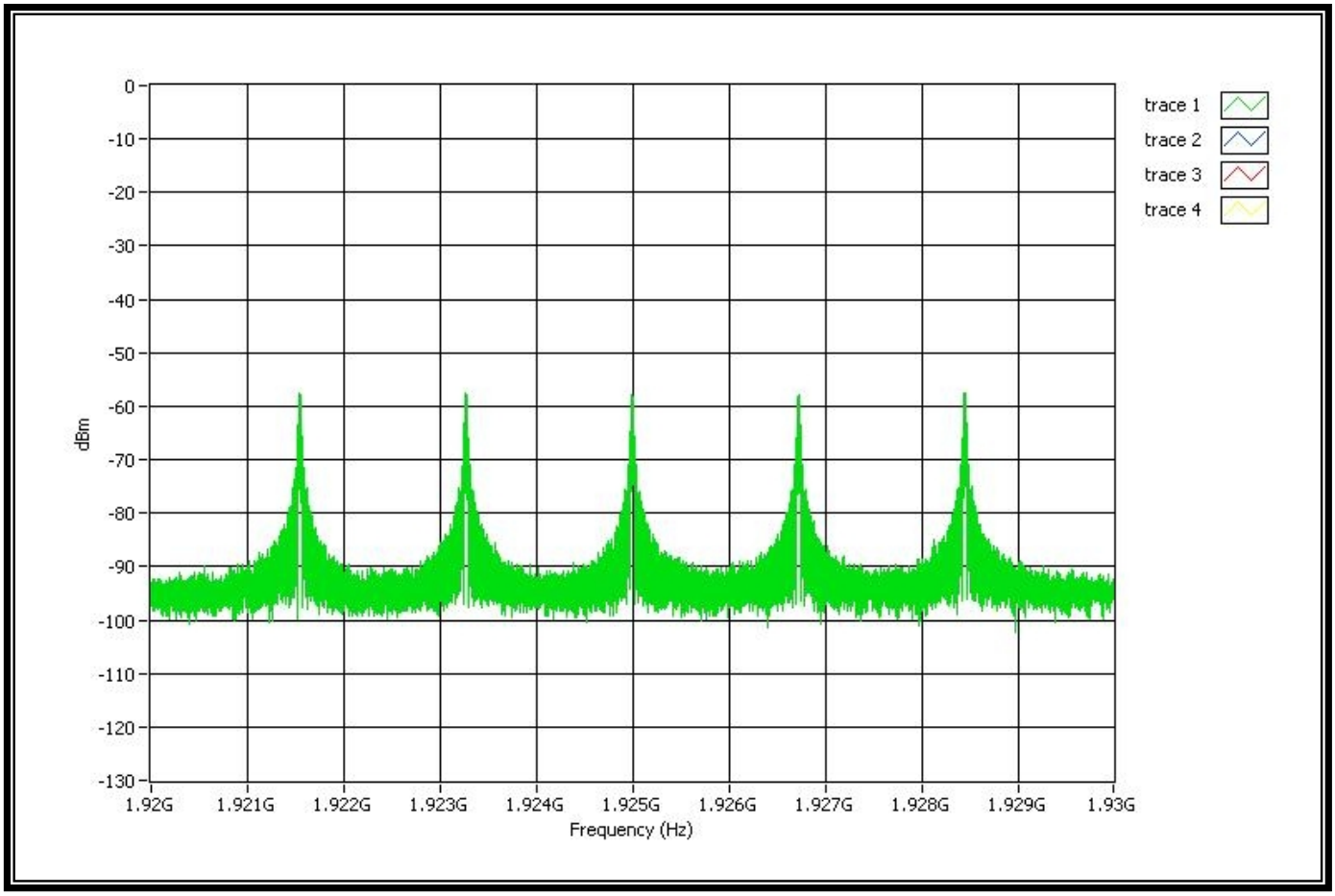
Comment: 35us



Comment: 35us (Zoom in)



Comment: 35us (5 carriers)



6.22 Monitoring antenna

6.22.1 Standard Applicable: FCC 15.323(c) (8)

The monitoring system shall use the same antenna used for transmission, or an antenna that yields equivalent reception at that location.

RSS-213 4.3.4 (b)(8)

The monitoring system shall use the same antenna used for transmission, or an antenna that yields equivalent reception at that location. Note: A monitoring antenna of the same model (and manufacturer) as the transmitting antenna is considered equivalent. An antenna not of the same model but of the same type (e.g. both are horn antennas of different manufacturers) is considered equivalent if the main beam antenna gains are within 3 dB of each other. Both antennas are to be installed to point at the same general coverage area.

6.22.2 Measurement procedure

Measurement method according to ANSI C63.17 2013 paragraph 4

6.22.3 Results: Complies

The EUT uses the same antennas for transmission and reception as for monitoring.

6.23 Monitoring threshold relaxation

6.23.1 Standard Applicable: FCC 15.323(c)(9)

Devices that have a power output lower than the maximum permitted under the rules can increase their monitoring detection threshold by one decibel for each one decibel that the transmitter power is below the maximum permitted.

RSS-213 4.3.4 (b)(9)

Devices that have a power output lower than the maximum permitted under this standard may increase their detection threshold by 1 dB for each 1 dB that the transmitter power is below the maximum permitted.

6.23.2 Measurement procedure

Measurement method according to ANSI C63.17 2013 paragraph 4

6.23.3 Results: Complies

Measurement Data:

This requirement is covered by results of Least Interfered Channel (LIC) test according to FCC 15.323(c) (5)	☒

6.24 Duplex system LBT

6.24.1 Standard Applicable: FCC 15.323(c) (10)

An initiating device may attempt to establish a duplex connection by monitoring both its intended transmit and receive time and spectrum windows. If both the intended transmit and receive time and spectrum windows meet the access criteria, then the initiating device can initiate a transmission in the intended transmit time and spectrum window. If the power detected by the responding device can be decoded as a duplex connection signal from the initiating device, then the responding device may immediately begin transmitting on the receive time and spectrum window monitored by the initiating device.

RSS-213 4.3.4 (b)(10)

A device initiating a communication (hereafter called an initiating device) may attempt to establish a duplex connection by monitoring both its intended transmit and receive time and spectrum windows.
If both the intended transmit and receive time and spectrum windows meet the access criteria, then the initiating device can initiate a transmission in the intended transmit time and spectrum window.
If the power detected by the responding device can be decoded as a duplex connection signal from the initiating device, then the responding device may immediately begin transmitting on the receive time and spectrum window monitored by the initiating device.s

6.24.2 Measurement procedure

Measurement method according to ANSI C63.17, clause 8.3
This test is required for equipment that uses the access criteria in FCC 15.323(c)(10).

6.24.3 Test Results:

The manufacturer declares that this provision is not utilized by the EUT.

6.25 Co-located device LBT

6.25.1 Standard Applicable: FCC 15.323 (c)(11) same as RSS-213 4.3.4 (b)(11)

An initiating device that is prevented from monitoring during its intended transmit window due to monitoring system blocking from the transmissions of a co-located (within one meter) transmitter of the same system, may monitor the portions of the time and spectrum windows in which they intend to receive over a period of at least 10 milliseconds. The monitored time and spectrum window must total at least 50 percent of the 10 millisecond frame interval and the monitored spectrum must be within 1.25 MHz of the center frequency of channel(s) already occupied by that device or co-located co-operating device. If the access criteria is met for the intended receive time and spectrum window under the above conditions, then transmission in the intended transmit window by the initiating device may commence.

6.25.2 Measurement procedure

Measurement method according to ANSI C63.17 2013 paragraph 8.4

6.25.3 Results:

The manufacturer declares that this provision is not utilized by the EUT.

6.26 Fair Access

6.26.1 Standard Applicable: FCC 15.323 (c)(12) same as RSS-213 (b)(12)

The provisions of (c) (10) or (c) (11) shall not be used to extend the range of spectrum occupied over space or time for the purpose of denying fair access to spectrum for other devices.

6.26.2 Results:

The manufacturer declares that EUT does not work in a mode which denies fair access to spectrum for other devices.

6.27 Emissions inside and outside the subband

6.27.1 Standard Applicable: FCC 15.323(d)

Emissions inside the subband same as RSS-213 6.7.2
$B < f \leq 2B$: less than or equal to 30 dB below the maximum permitted peak power level
$2B < f \leq 3B$: less than or equal to 50 dB below the maximum permitted peak power level
$3B < f \leq$ UPCS Band Edge: less than or equal to 60 dB below the maximum permitted peak power level

Where B is the occupied bandwidth in hertz.

Emissions outside the subband same as RSS-213 6.7.1

$f \leq$ 1.25MHz outside UPCS band :	$\leq$ -9.5dBm
1.25MHz $\leq f \leq$ 2.5MHz outside UPCS band :	$\leq$ -29.5 dBm
$f \geq$ 2.5MHz outside UPCS band:	$\leq$ -39.5 dBm

6.27.2 Measurement procedure

Measurement method according to ANSI C63.17 2013 paragraph 6.1.6

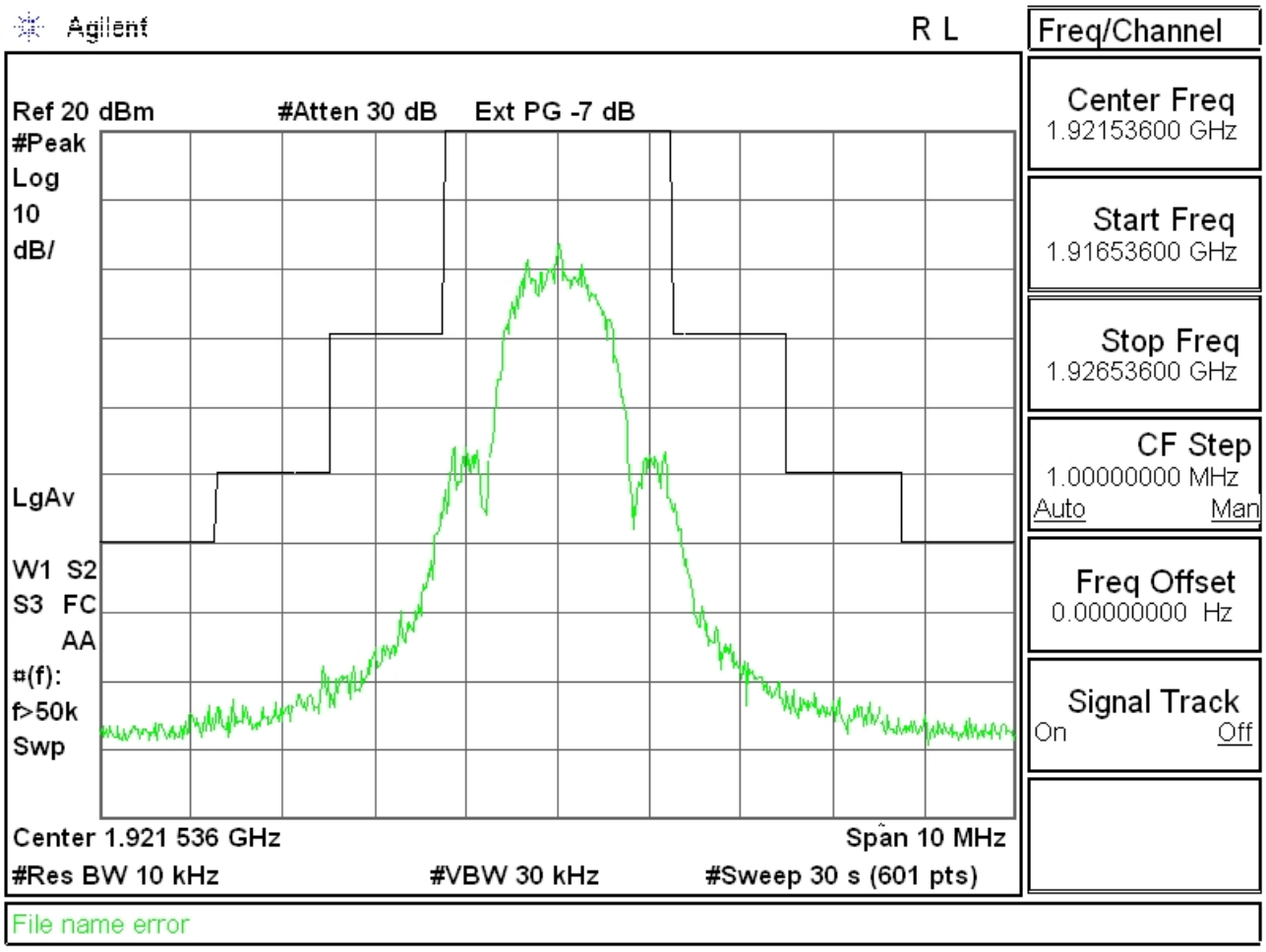
6.27.3 Results: Complies

Measurement Data:

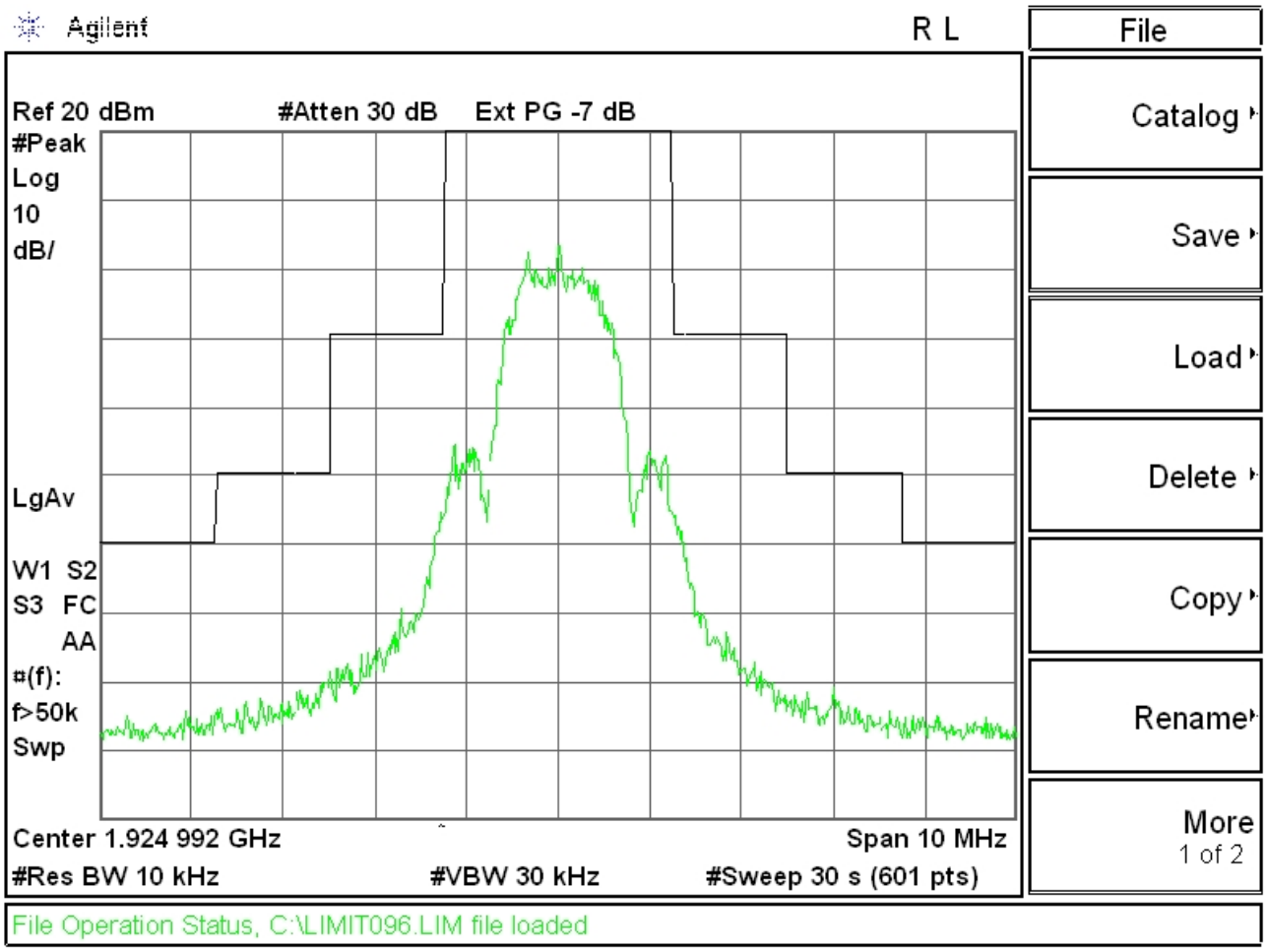
See plots.

Note: Photos of worst-case display follow:

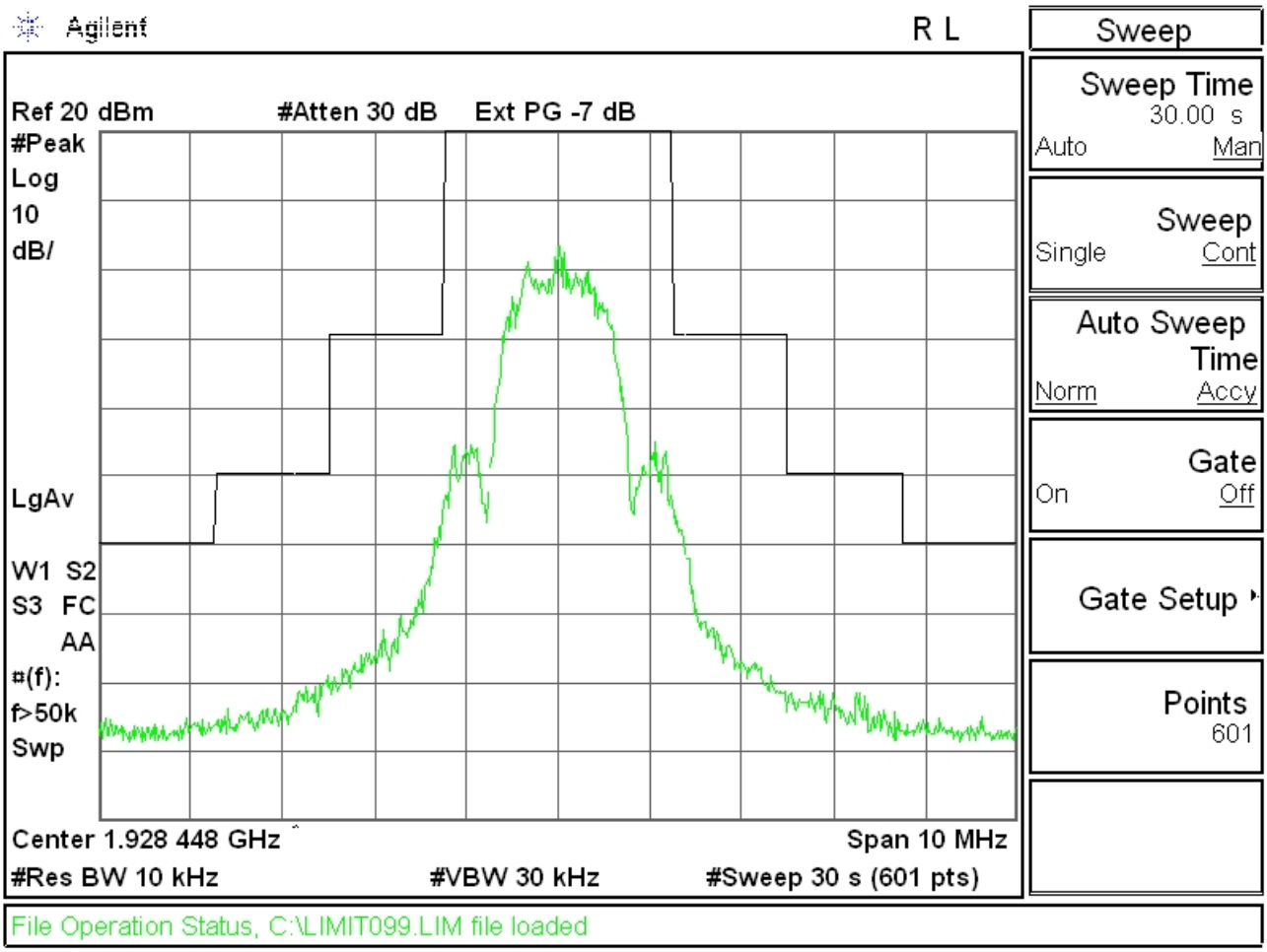
In-band Unwanted Emissions: CH F_L



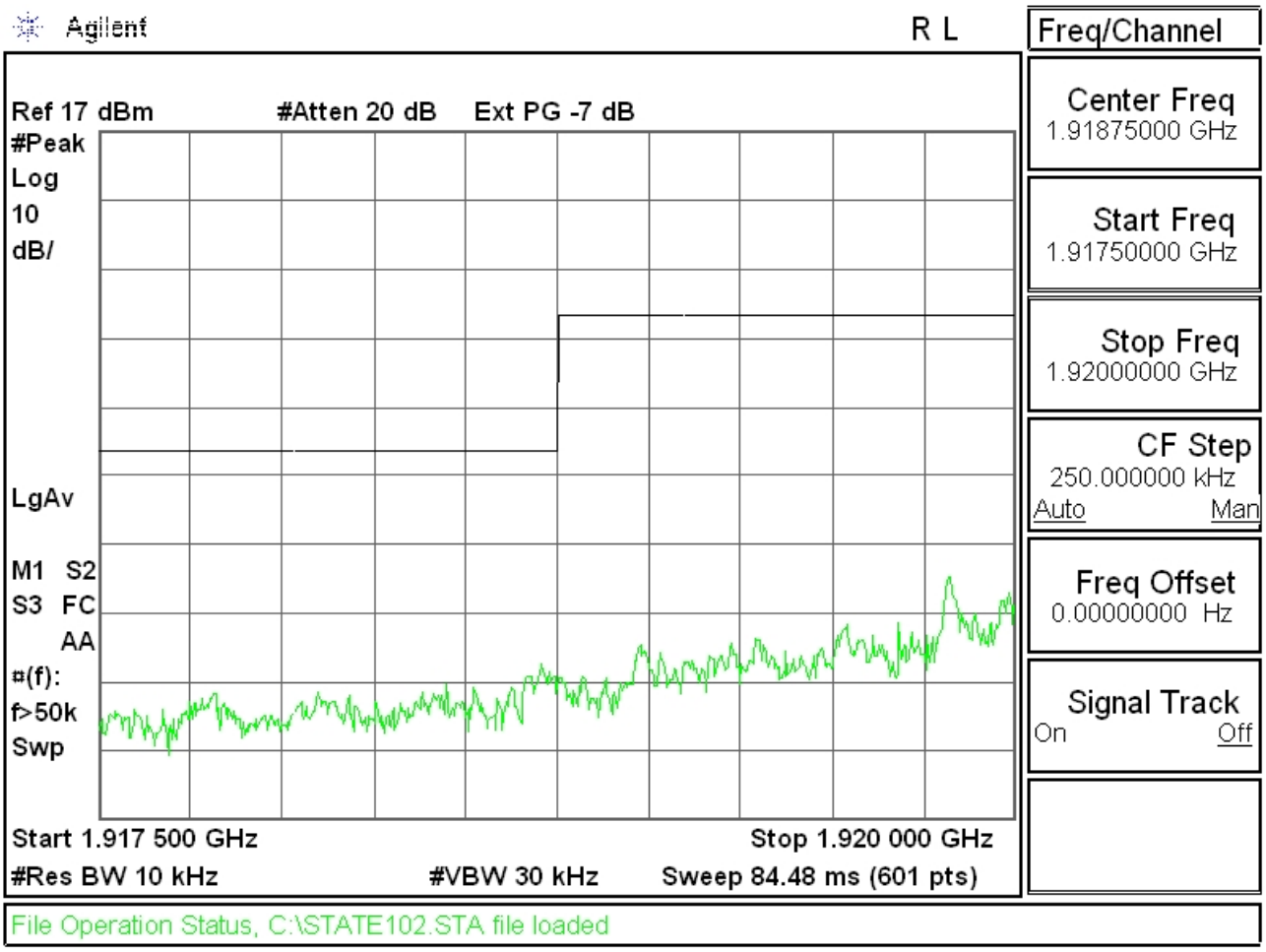
In-band Unwanted Emissions: CH F_M



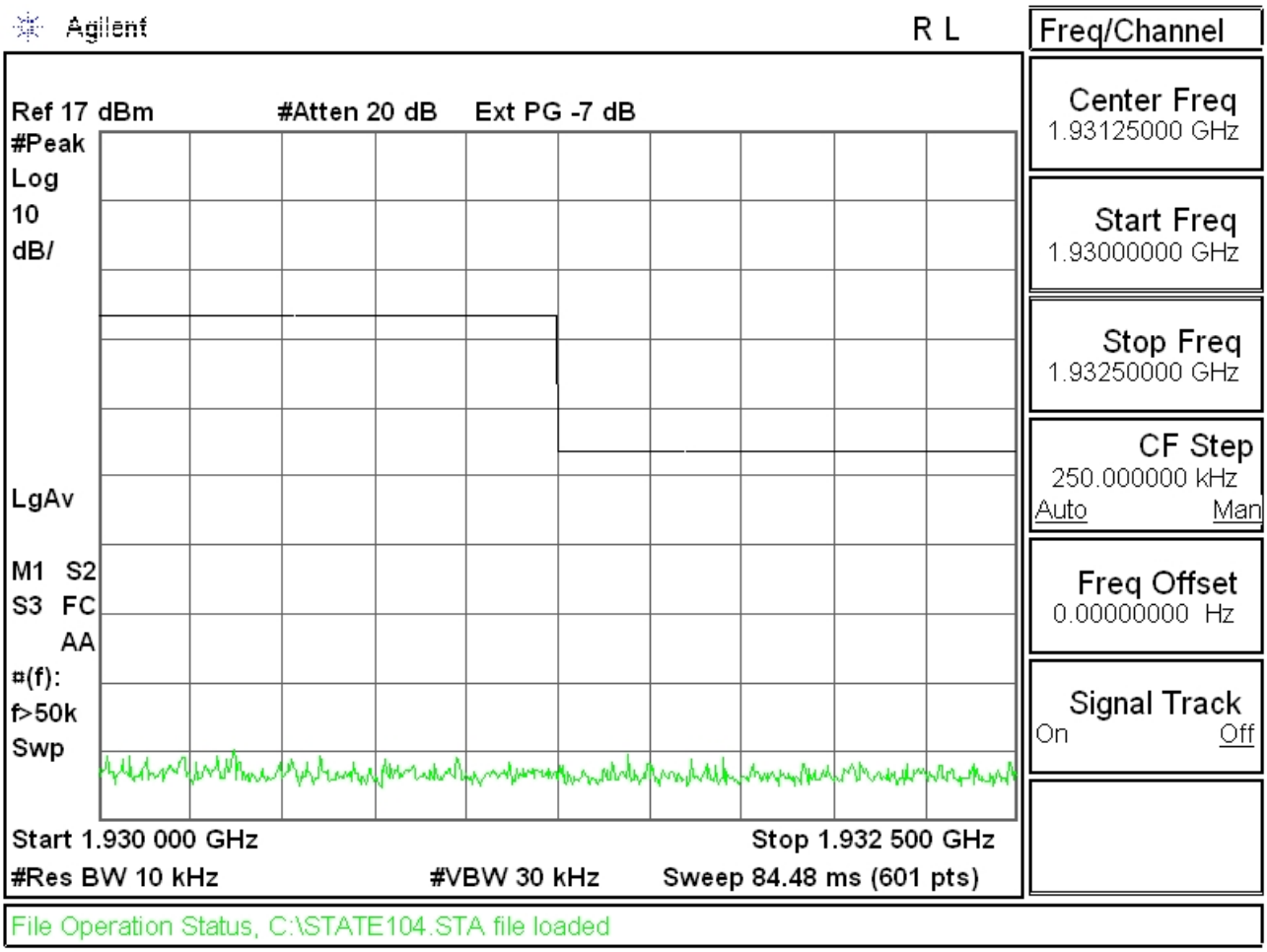
In-band Unwanted Emissions: CH F_H



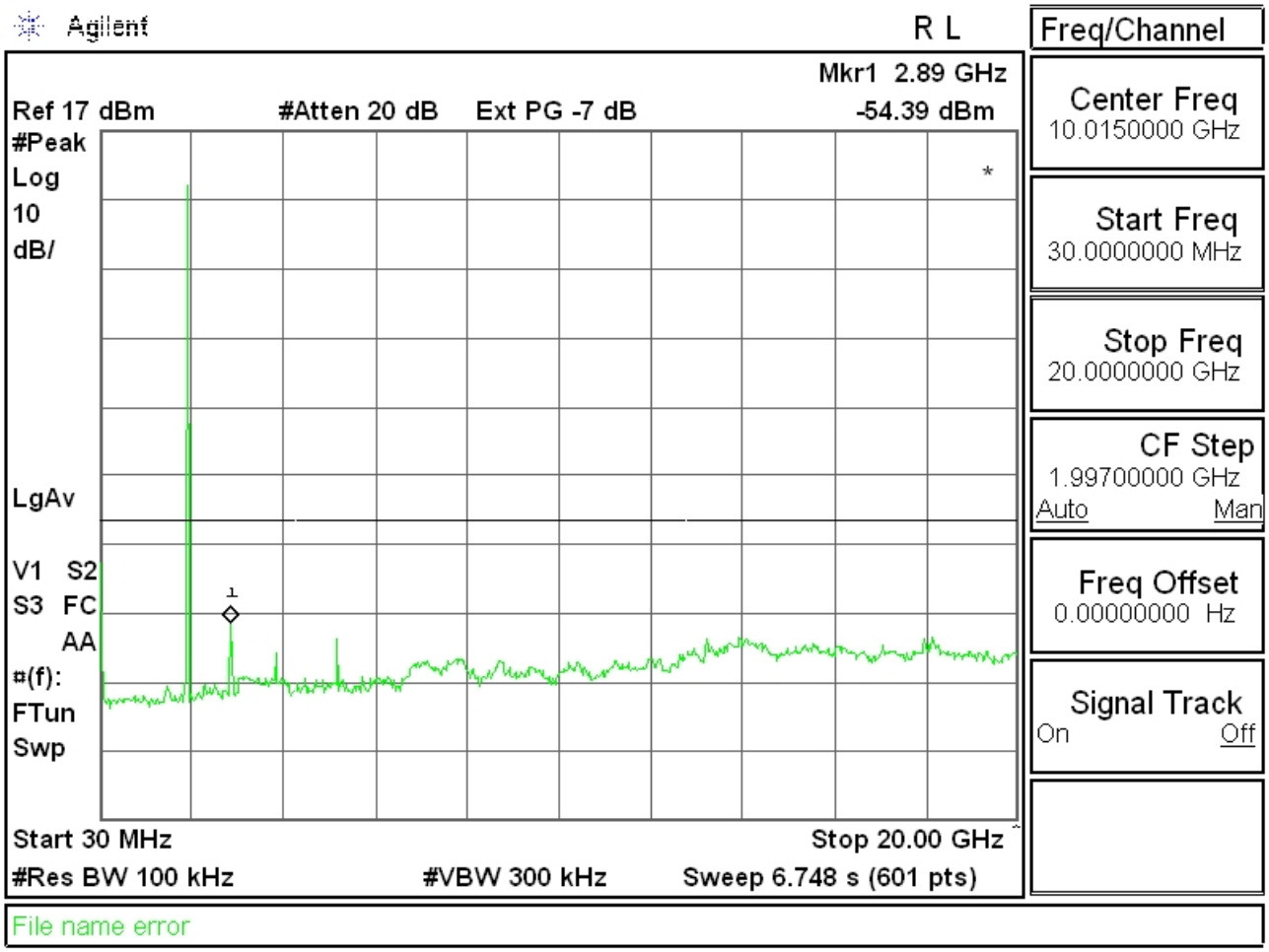
Out-of-band Unwanted Emissions: CH F_L



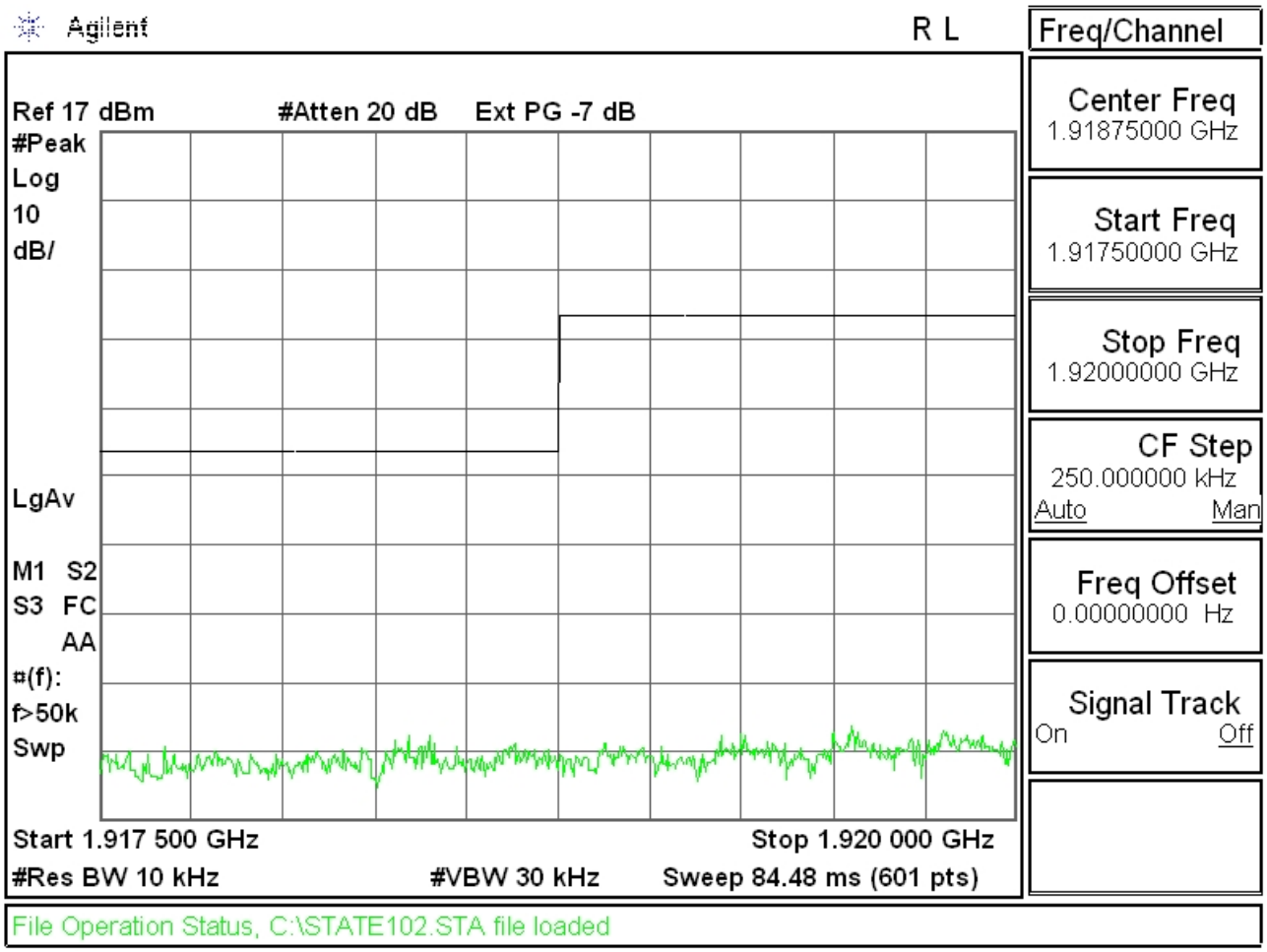
Out-of-band Unwanted Emissions: CH F_L



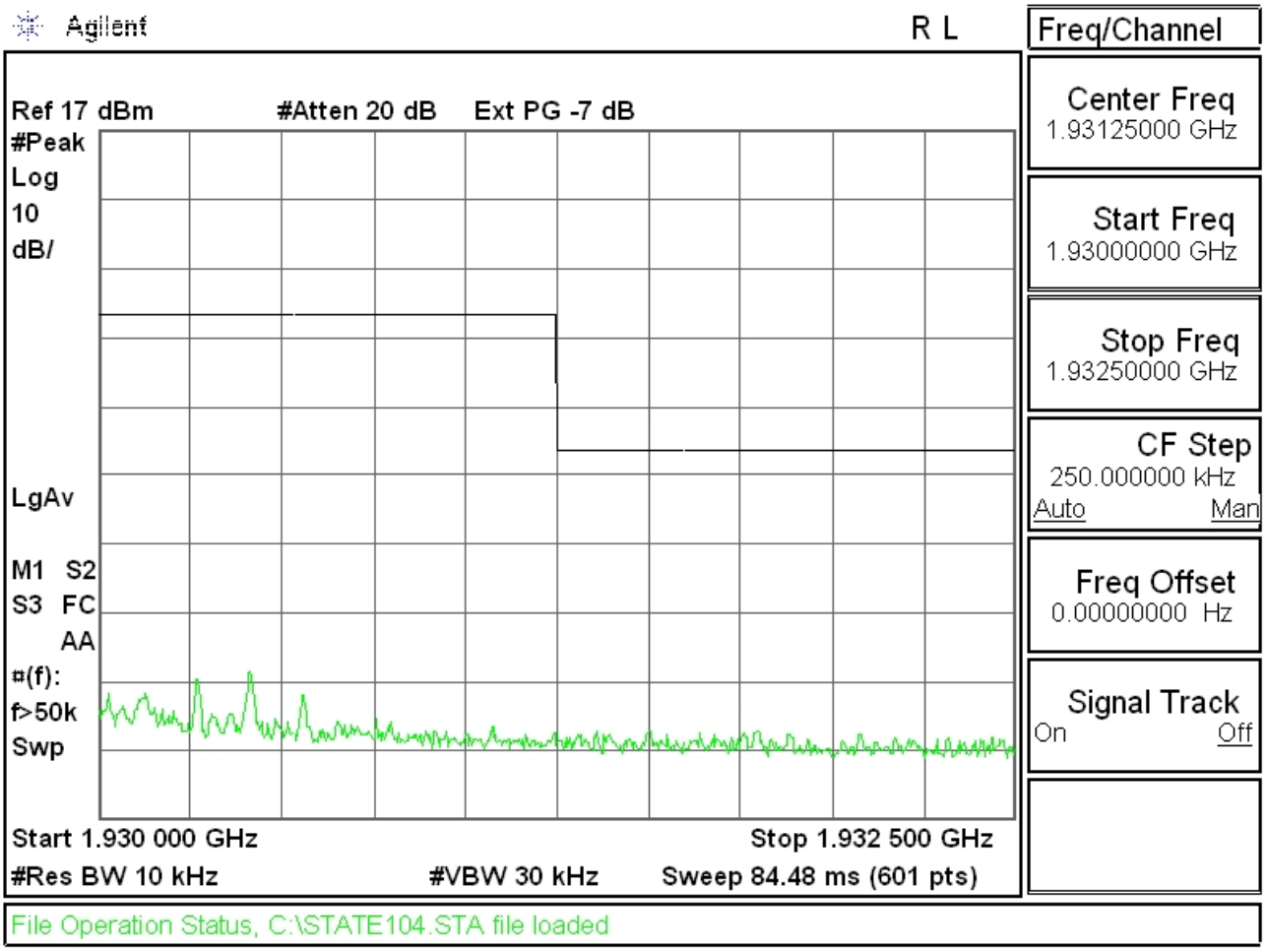
Out-of-band Unwanted Emissions: CH F_L



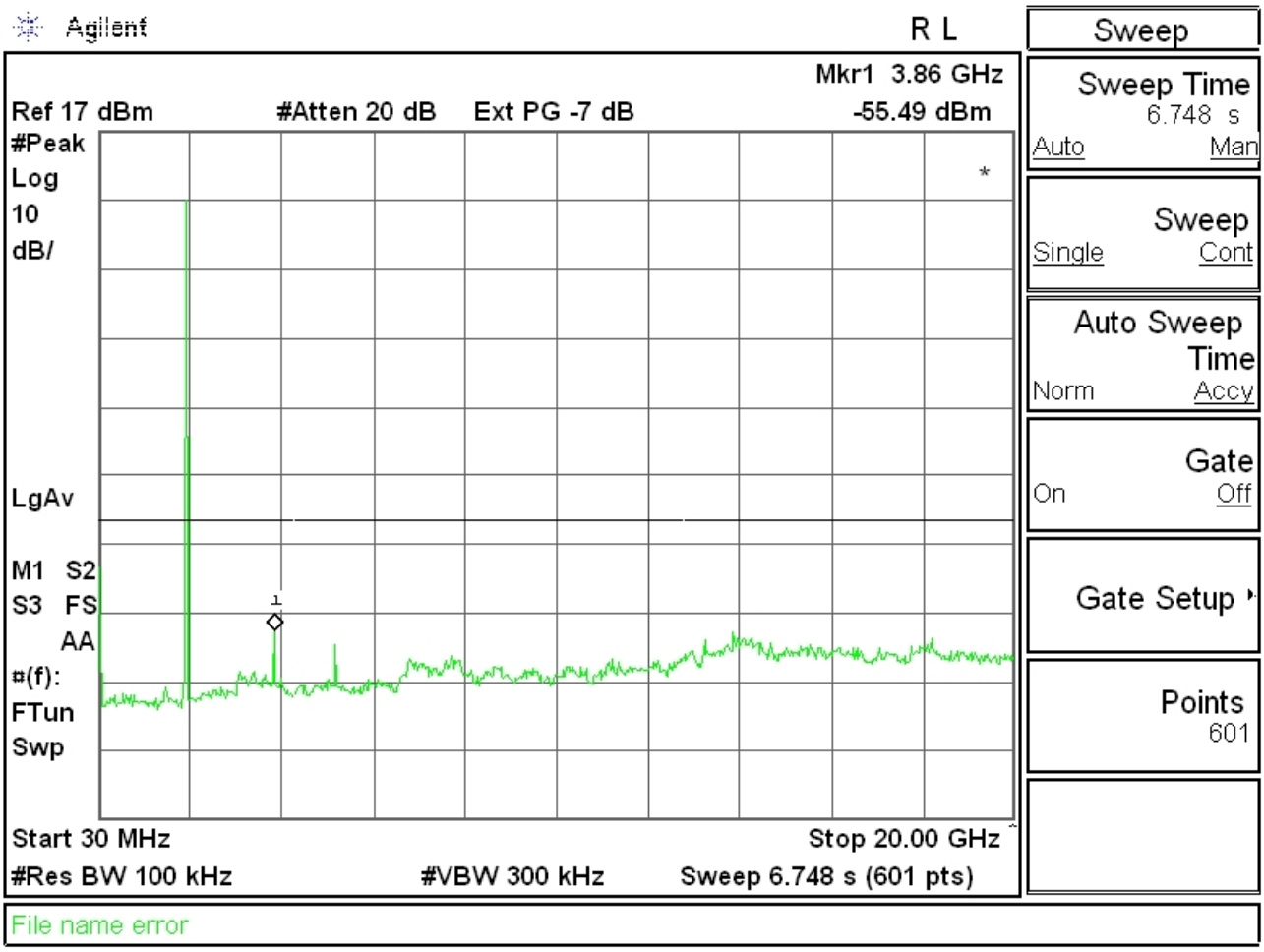
Out-of-band Unwanted Emissions: CH F_M



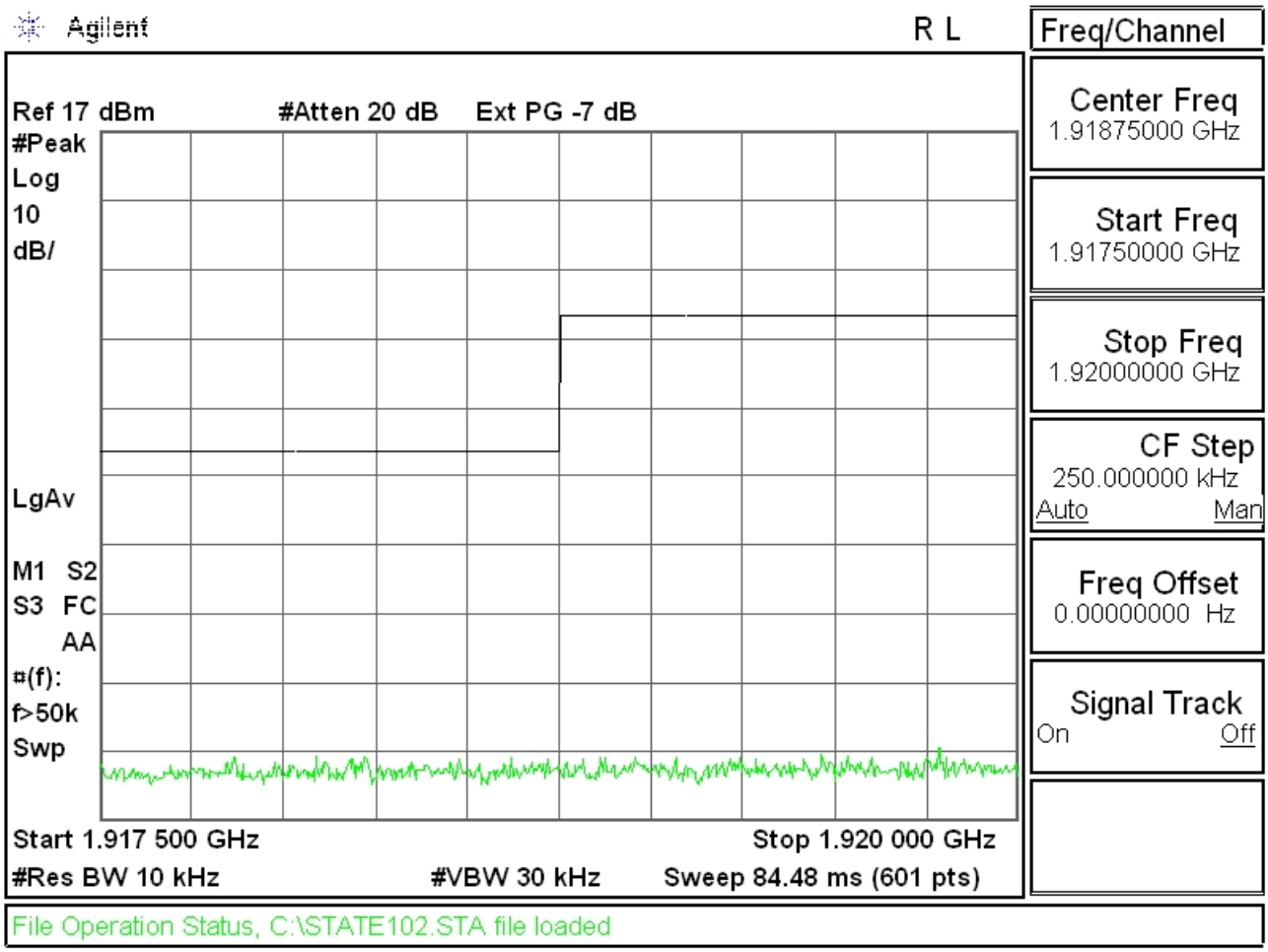
Out-of-band Unwanted Emissions: CH F_M



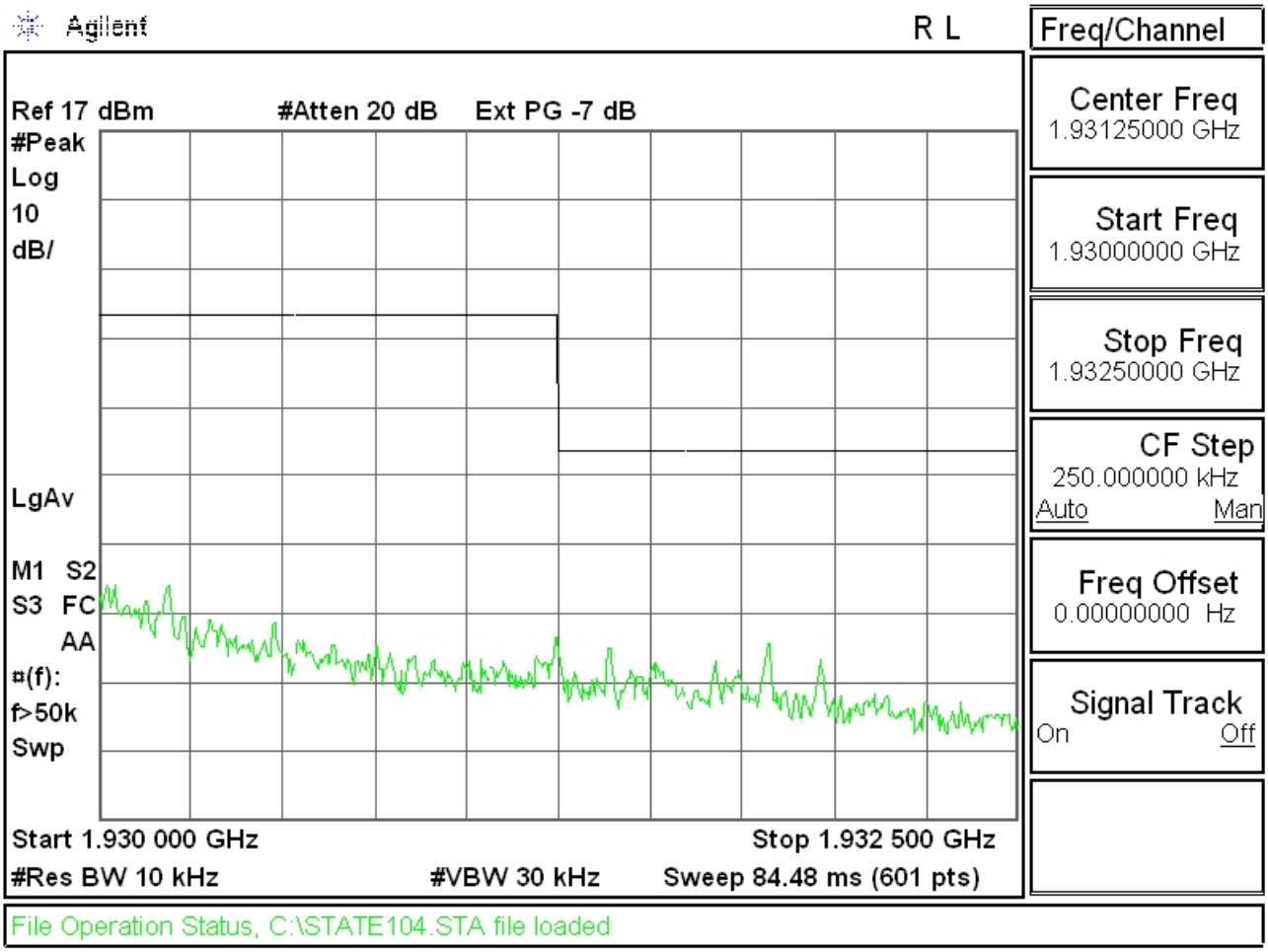
Out-of-band Unwanted Emissions: CH F_M



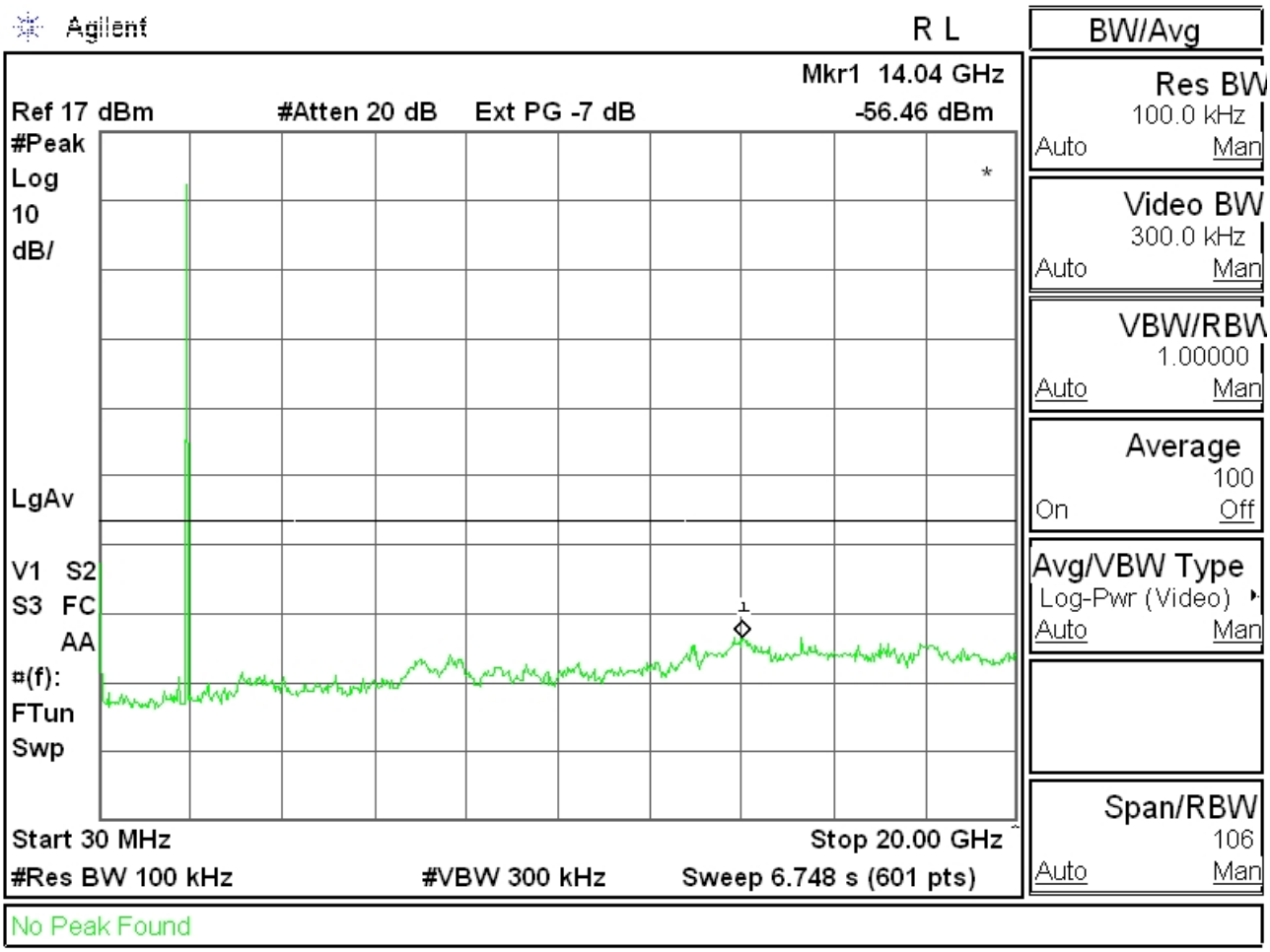
Out-of-band Unwanted Emissions: CH F_H



Out-of-band Unwanted Emissions: CH F_H



Out-of-band Unwanted Emissions: CH F_H



6.28 Frame period and jitter

6.28.1 Standard Applicable: FCC 15.323(e) same as RSS-213 4.3.4 (C)

The frame period (a set of consecutive time slots in which the position of each time slot can be identified by reference to a synchronizing source) of an intentional radiator operating in these subbands shall be 20 milliseconds/X where X is a positive whole number. Each device that implements time division for the purposes of maintaining a duplex connection on a given frequency carrier shall maintain a frame repetition rate with a frequency stability of at least 50 parts per millions (ppm). Each device which further divides access in time in order to support multiple communication links on a given frequency carrier shall maintain a frame repetition rate with a frequency stability of at least 10 ppm. The jitter (time-related, abrupt, spurious variations in the duration of the frame interval) introduced at the two ends of such a communication link shall not exceed 25 microseconds for any two consecutive transmissions. Transmissions shall be continuous in every time and spectrum window during the frame period defined for the device.

6.28.2 Measurement Requirement:

- Frame frequency stability ≤ 50 ppm
- TDMA frame frequency stability ≤ 10 ppm (That translates to frequency drift of19.2 kHz/slot for 1920 MHz carrier)
- Frame jitter ≤ 25 μs

6.28.3 Test Results: Complies

Measurement Data:

Test Date : Oct. 19, 2014 Temperature : 24℃ Humidity : 60%

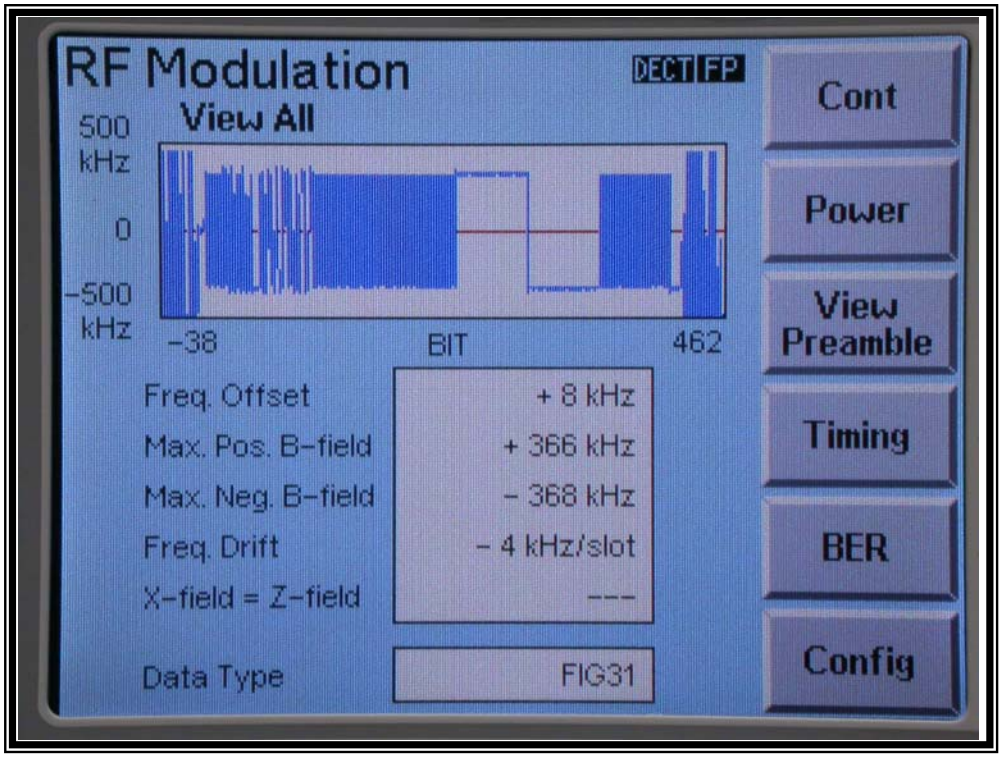
a) TDMA frame frequency stability (frequency drift)

Channel No.	Frequency Drift (KHz/ slot)					Limit of Δ (KHz/ slot)
	min	mean	max	Δmin	Δmax	
F_M	-4	0	2	-4	2	±19.2

Δmin = min - Avg of mean

Δmax = max - Avg of mean

Photo of worst-case of Frequency Drift display follows:



b) Frame jitter

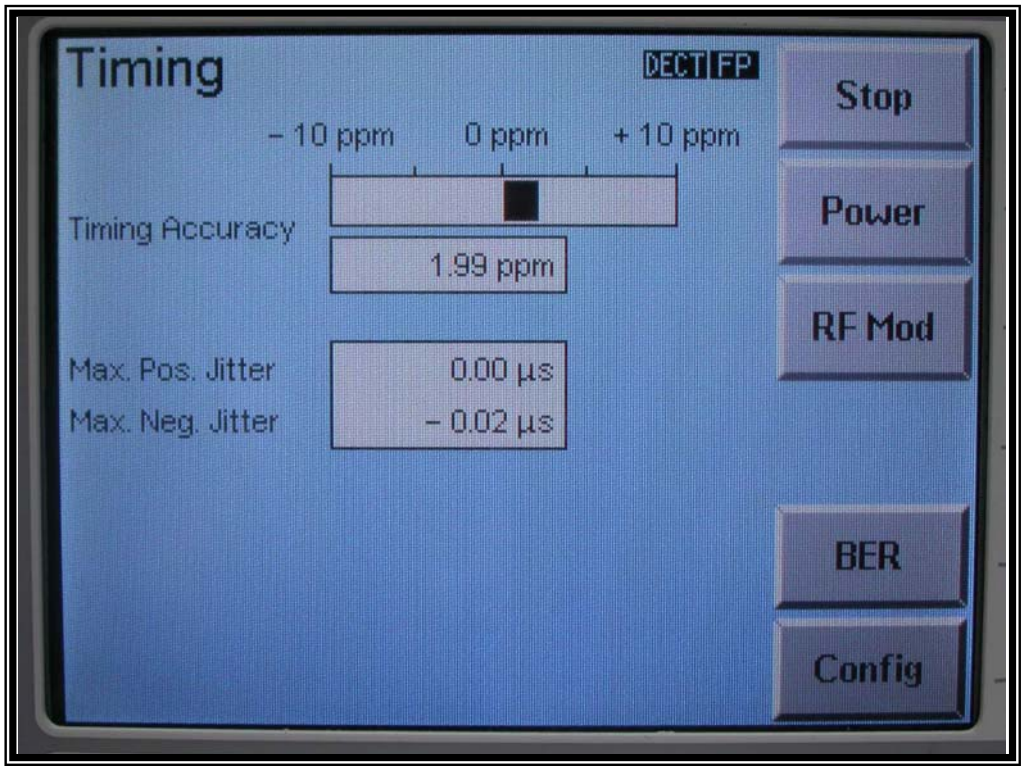
Test Date : Oct. 19, 2014 Temperature : 24℃ Humidity : 60%

Channel No.	Frame Jitter (uS)					Limit of Δ (uS)
	min	mean	max	Δmin	Δmax	
F_M	-0.02	0	0	-0.02	0	±25

Δmin = min - Avg of mean

Δmax = max - Avg of mean

Photo of worst-case of TDMA Frame Jitter display follows:



6.29 Carrier frequency stability

6.29.1 Standard Applicable: FCC 15.323(f)

The frequency stability of the carrier frequency of the intentional radiator shall be maintained within ± 10 ppm over 1 hour or the interval between channel access monitoring, whichever is shorter. The frequency stability shall be maintained over a temperature variation of - 0℃ to +50℃ at normal supply voltage, and over a variation in the primary supply voltage of 85 percent to 115 percent of the rated supply voltage at a temperature of 20℃. For equipment that is capable only of operating from a battery, the frequency stability tests shall be performed using a new battery without any further requirement to vary supply voltage.

RSS-213 6.2 Frequency Stability

The carrier frequency stability shall be maintained within ±10 ppm (±0.001%).

6.29.2 Measurement Requirement:

- Carrier frequency stability ≤ 10 ppm over 1 hour or interval between channel access monitoring, whichever is shorter (That translates to frequency drift of19.2 kHz for 1920 MHz carrier)
- Carrier frequency stability over +10℃ to +40℃ at normal supply voltage, and over 85% to 115% of rated supply voltage (voltage variation not required for battery operated device)

6.29.3 Test Results: Complies

Measurement Data:

Test Date : Oct. 19, 2014 Temperature : 24℃ Humidity : 60%

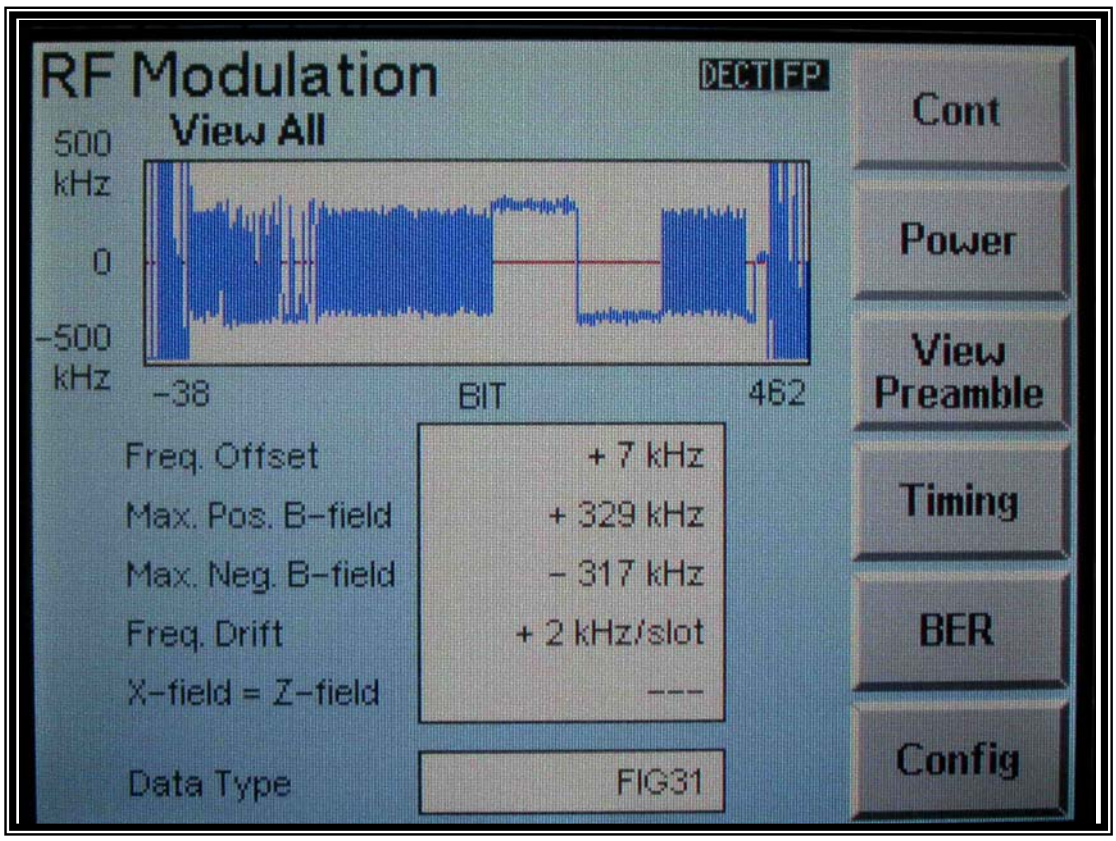
a) Carrier Frequency Stability over time

Channel No.	Frequency Offset (kHz)					Limit of Δ (kHz)
	min	mean	max	Δmin	Δmax	
FM	7	8	8	-1	0	±19.2

Δmin = min - Avg of mean

Δmax = max - Avg of mean

Test was conducted for duration longer than 1 hour. Photo of worst-case of Frequency offset display follows:



b) Carrier Frequency Stability over power supply voltage

Channel No.	Frequency Offset (kHz)					Limit of Δ (kHz)
	Mean of low voltage (85 %) (93.5V)	Mean of normal voltage (100 %) (110V)	Mean of high voltage (115 %) (126.5V)	Δ low	Δ high	
FM	8	8	8	0	0	±19.2

Δ low = Mean of low voltage - Mean of normal voltage

Δ high = Mean of high voltage - Mean of normal voltage

c) Carrier Frequency Stability over temperature

Channel No.	Frequency Offset (kHz)					Limit of △ (kHz)
	Mean of low temp. (10℃)	Mean of normal temp. (20℃)	Mean of high temp. (40℃)	△low	△high	
F_M	13	8	1	5	-7	±19.2

△low = Mean of low temp. - Mean of normal temp.

△high = Mean of high temp. - Mean of normal temp.