FCC PART 20.21, 24E
IC RSS-131, ISSUE 2

TEST AND MEASUREMENT REPORT

For

Shireen, Inc.

12910 Cloverleaf Center Drive, Suite 110,

Germantown, MD 20874, USA

FCC ID: YEF18862PICOAMP
IC: 8987A-PICOAMP862

Report Type:	**Product Type:**
Original Report	1900 MHz Picocell Amplifier

Prepared By:	Ronak Patel Test Engineer
Report Number:	R1503241-24
Report Date:	2015-08-14
Reviewed By:	Simon Ma Test Engineer

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1503241-24	Original Report	2015-08-14

1 General Information

1.1 Product Description for Equipment under Test (EUT)

This test and measurement report was prepared on behalf of *Shireen, Inc.* and their product model: 18-862, FCC ID: YEF18862PICOAMP IC: 8987A-PICOAMP862, which will henceforth be referred to as the EUT (Equipment under Test). The EUT is a 1900 MHz PCS band amplifier for both downlink and uplink.

1.2 Mechanical Description

The EUT measures approximately 148mm (L) x 161mm (W) x 37mm (H) and weighs 1kg.

The test data gathered are from typical production sample, serial number: 1314227, assigned by Client.

1.3 Objective

This type approval report is prepared on behalf of *Shireen, Inc.* in accordance with Part 2, Subpart J, Part 20.21, Part 24 Subpart E of the Federal Communication Commission's rules and IC RSS-131

The objective is to determine compliance with FCC rules for RF output power, modulation characteristics, occupied bandwidth, spurious emissions at antenna terminal, field strength of spurious radiation, frequency stability, band edge, and conducted and radiated margin.

1.4 Related Submittal(s)/Grant(s)

No Related Submittals

1.5 Test Methodology

All tests and measurements indicated in this document were performed in accordance with the Code of Federal Regulations Title 47 Part 2, Sub-part J as well as the following parts:

Part 20.21 – Signal Boosters
Part 24 Subpart E – PCS
IC RSS-131- Zone Enhancers for the Land Mobile Service

Applicable Standards: TIA/EIA603-D, ANSI C63.4-2009, FCC KDB 935210.

All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory, Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

1.6 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on CISPR16-4-2:2011, The Treatment of Uncertainty in EMC Measurements, the values ranging from ±2.0 dB for Conducted Emissions tests and ±4.0 dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL Corp.

1.7 Test Facility

Bay area compliance Laboratories Corp. (BACL) is:
1- An independent Commercial Test Laboratory accredited to **ISO 17025: 2005** by **A2LA**, in the fields of: Electromagnetic Compatibility & Telecommunications covering Emissions, Immunity, Radio, RF Exposure, Safety and Telecom. This includes NEBS (Network Equipment Building System), Wireless RF, Telecommunications Terminal Equipment (TTE); Network Equipment; Information Technology Equipment (ITE); Medical Electrical Equipment; Industrial, Commercial, and Medical Test Equipment; Professional Audio and Video Equipment; Electronic (Digital) Products; Industrial and Scientific Instruments; Cabled Distribution Systems and Energy Efficiency Lighting.

2- An ENERGY STAR Recognized Laboratory, for the LM80 Testing, a wide variety of Luminares and Computers.

3- A NIST Designated Phase-I and Phase-II CAB including: ACMA (Australian Communication and Media Authority), BSMI (Bureau of Standards, Metrology and Inspection of Taiwan), IDA (Infocomm Development Authority of Singapore), IC(Industry Canada), Korea (Ministry of Communications Radio Research Laboratory), NCC (Formerly DGT; Directorate General of Telecommunication of Chinese Taipei) OFTA (Office of the Telecommunications Authority of Hong Kong), Vietnam, VCCI - Voluntary Control Council for Interference of Japan and a designated EU CAB (Conformity Assessment Body) (Notified Body) for the EMC and R&TTE Directives.

4- A Product Certification Body accredited to **ISO Guide 65:1996** by **A2LA** to certify:
1- Unlicensed, Licensed radio frequency devices and Telephone Terminal Equipment for the FCC. Scope A1, A2, A3, A4, B1, B2, B3, B4 & C.
2. Radio Standards Specifications (RSS) in the Category I Equipment Standards List and All Broadcasting Technical Standards (BETS) in Category I Equipment Standards List for Industry Canada.
3. Radio Communication Equipment for Singapore.
4. Radio Equipment Specifications, GMDSS Marine Radio Equipment Specifications, and Fixed Network Equipment Specifications for Hong Kong.
5. Japan MIC Telecommunication Business Law (A1, A2) and Radio Law (B1, B2 and B3).
6. Audio/Video, Battery Charging Systems, Computers, Displays, Enterprise Servers, Imaging Equipment, Set-Top Boxes, Telephony, Televisions, Ceiling Fans, CFLs (Including GU24s),Decorative Light Strings, Integral LED Lamps, Luminaires, Residential Ventilating Fans.

The test site used by BACL Corp. to collect radiated and conducted emissions measurement data is located at its facility in Sunnyvale, California, USA.

The test site at BACL Corp. has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997, and Article 8 of the VCCI regulations on December 25, 1997. The test site also complies with the test methods and procedures set forth in CISPR 22:2008 §10.4 for measurements below 1 GHz and §10.6 for measurements above 1 GHz as well as ANSI C63.4-2009, ANSI C63.4-2009, TIA/EIA-603 & CISPR 24:2010.

The Federal Communications Commission and Voluntary Control Council for Interference have the reports on file and they are listed under FCC registration number: 90464 and VCCI Registration No.: A-0027. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL Corp. is an American Association for Laboratory Accreditation (A2LA) accredited laboratory (Lab Code 3297-02). The current scope of accreditations can be found at

http://www.a2la.org/scopepdf/3297-02.pdf?CFID=1132286&CFTOKEN=e42a3240dac3f6ba-6DE17DCB-1851-9E57-477422F667031258&jsessionid=8430d44f1f47cf2996124343c704b367816b

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to TIA/EIA-603-D.
The final qualification test was performed with the EUT operating at normal mode.

2.2 EUT Exercise Software

N/A: signal was sent through EUT using a signal generator, device was set to normal operating mode.

2.3 Equipment Modifications

No modifications were made to the EUT.

2.4 EUT Internal Configuration

Manufacturer	Description	Model	Serial Number
Shireen, Inc.	PCB	18862	-

2.5 Local Support Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers
Dell	Laptop	Latitude D600	CN-0X2034-48643-3A6-8307
Rohde & Schwarz	Signal Generator	SMIQ03	849192/0085/DE23746
Agilent	Signal Generator	E4438C	MY45091309
Agilent	Signal Studio for WCDMA/HSPA	N7600B	-

2.6 Power Supply and Line Filters

N/A

2.7 Interface Ports and Cabling

Cable Description	Length (m)	From	To
RF cable	<1	Signal Generator	Input/ EUT
RF cable	<1	Output/ EUT	Spectrum Analyzer

3 Summary of Test Results

FCC/IC Rules	Description of Tests	Results
FCC §2.1046, §24.232 RSS-131 §4.3	RF Output Power	Compliant
FCC §2.1049, §24.238 IC RSS-Gen §6.6	Occupied Bandwidth	Compliant
FCC §2.1053, §24.238 IC RSS-131 §4.4	Spurious Radiated Emissions	Compliant
FCC§2.1051, §24.238 IC RSS-131 §4.4	Spurious Emissions at Antenna Terminals	Compliant
FCC §24.238 IC RSS-131 §4.4	Band Edge	Compliant
FCC §2.1055 IC RSS-131 §4.5	Frequency Stability	N/A[1]
FCC §2.1091 IC RSS-102	RF Exposure	Compliant
IC RSS-131 §4.1	Passband Gain and Bandwidth	Compliant

[1] The unit is a signal booster.
Note: This unit does not have AGC function

4 FCC §2.1046, §24.232 & IC RSS-131 §4.3 - RF Output Power

4.1 Applicable Standards

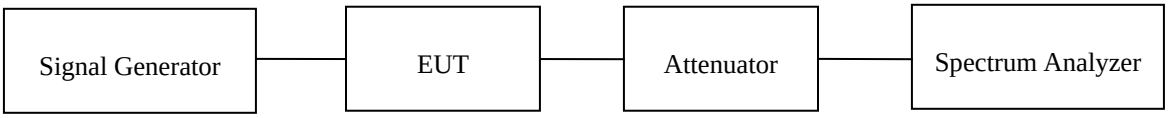
According to FCC §24.232 , Mobile/portable stations are limited to 2 watts EIRP peak power and the equipment must employ means to limit the power to the minimum necessary for successful communications.

According to RSS 131, the manufacturer's output power rating Prated MUST NOT be greater than Pmean for all types of enhancers.

4.2 Test Procedure

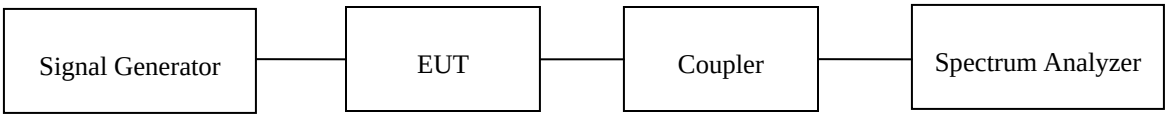
Conducted:

The RF output of the transmitter was connected to the signal generator and the spectrum analyzer through sufficient attenuation.



IC Mean output power:

The RF output of the transmitter was connected to the signal generator and the spectrum analyzer through directional coupler.



1. The following subscript "o" denotes a parameter at the enhancer output point.
2. Connect two signal generators to the input of the Device under Test (DUT), via a proper impedance matching network (and preferably via a variable attenuator) so that the two input signals are equal sinusoids (and can be raised equally).
3. Connect a dummy load of suitable load rating to the enhancer output point. Connect also a spectrum analyzer to this output point via a coupling network and attenuator, so that only a portion of the output signal is coupled to the spectrum analyzer. The coupling attenuation shall be stated in the test report.
4. Set the two generator frequencies f1 and f2 such that they and their third-order intermodulation product frequencies, f3= 2f1-f2 and f4 = 2f2 - f1, are all within the passband of the DUT.
5. Raise the input level to the DUT while observing the output tone levels, Po1 and Po2, and the intermodulation product levels, Po3 and Po4.
6. **For enhancers rated 500 watts or less**: Raise the input level to the DUT until the greater level of the intermodulation products at the enhancer output terminals, Po3 or Po4, equals -43 dBW.
7. **For enhancers rated over 500 watts**: Raise the input level to the DUT until the greater level of the intermodulation products at the enhancer output terminals, Po3 or Po4, is 67 dB below the level of either output tone level, Po1 or Po2.
8. Record all signal levels and their frequencies. Calculate the mean output power (Pmean) under this testing condition using Pmean = Po1 + 3 dB.

4.3 Test Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Dates	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	MY44303352	2014-10-16	1 year
Agilent	Signal Generator	E4438C	MY45091309	2014-07-15	2 year

Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

4.4 Test Environmental Conditions

Temperature:	21-23 °C
Relative Humidity:	42-48 %
ATM Pressure:	101.4-102 kPa

The testing was performed by Ronak Patel on 2015-07-29 to 2015-07-31 in the RF Site.

4.5 Test Results

Mode		Channel	Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
GSM/GPRS	1900 MHz Downlink	Low	1930.2	17	40.06	23.06
		Middle	1960.0	16	39.86	23.86
		High	1989.8	16	40.4	24.4
	1900 MHz Uplink	Low	1850.2	-6	20.79	26.79
		Middle	1880.0	-7	20.25	27.25
		High	1909.8	-3	19.94	22.94
CDMA/EVDO	1900 MHz Downlink	Low	1930.8	15	40.4	25.4
		Middle	1960.0	15	40.33	25.33
		High	1989.2	14	40.33	26.33
	1900 MHz Uplink	Low	1850.8	-6	20.78	26.78
		Middle	1880.0	-7	20.22	27.22
		High	1909.2	-3	20.1	23.1
WCDMA	1900 MHz Downlink	Low	1932.4	17	40.32	23.32
		Middle	1960.0	17	40.63	23.63
		High	1987.6	16	40.19	24.19
	1900 MHz Uplink	Low	1852.4	-7	20.33	27.33
		Middle	1880.0	-7	20.23	27.23
		High	1907.6	-3	20.35	23.35

Mode		Channel	Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
LTE 1.4 MHz	1900 MHz Downlink	Low	1930.7	8	40.3	32.3
		Middle	1960	8	40.35	32.35
		High	1989.3	7	40.05	33.05
	1900 MHz Uplink	Low	1850.7	-11	20.4	31.4
		Middle	1880	-11	20.31	31.31
		High	1909.3	-7	20.22	27.22
LTE 3 MHz	1900 MHz Downlink	Low	1931.5	12	40.69	28.69
		Middle	1960	12	40.75	28.75
		High	1988.5	11	40.23	29.23
	1900 MHz Uplink	Low	1851.5	-8	20.35	28.35
		Middle	1880	-8	20	28
		High	1908.5	-4	20.17	24.17
LTE 5 MHz	1900 MHz Downlink	Low	1932.5	13	40.23	27.23
		Middle	1960	13	40.31	27.31
		High	1987.5	12	40.18	28.18
	1900 MHz Uplink	Low	1852.5	-7	19.98	26.98
		Middle	1880	-7	19.97	26.97
		High	1907.5	-4	19.67	23.67
LTE 10 MHz	1900 MHz Downlink	Low	1935	14	38.92	24.92
		Middle	1960	13	38.6	25.6
		High	1985	13	38.1	25.1
	1900 MHz Uplink	Low	1855	-7	19.15	26.15
		Middle	1880	-7	19.27	26.27
		High	1905	-4	19.31	23.31
LTE 15 MHz	1900 MHz Downlink	Low	1937.5	13	38.08	25.08
		Middle	1960	13	38.67	25.67
		High	1982.5	13	38.03	25.03
	1900 MHz Uplink	Low	1857.5	-7	18.44	25.44
		Middle	1880	-7	18.64	25.64
		High	1902.5	-6	18.24	24.24
LTE 20 MHz	1900 MHz Downlink	Low	1940	13	38.35	25.35
		Middle	1960	13	39.42	26.42
		High	1980	14	36.93	22.93
	1900 MHz Uplink	Low	1860	-6	18.18	24.18
		Middle	1880	-7	18.2	25.2
		High	1900	-5	18.34	23.34

Mean output power:

Uplink

	F_1 (MHz)	F_2 (MHz)	F_3 (MHz)	F_4 (MHz)	Po1 (dBm)	P_{mean} (dBm)
Low	1852.402	1852.652	1852.148	1852.905	18.47	21.47
Middle	1879.752	1880.002	1879.498	1880.255	18.72	21.72
High	1907.35	1907.6	1907.1	1907.853	18.5	21.5

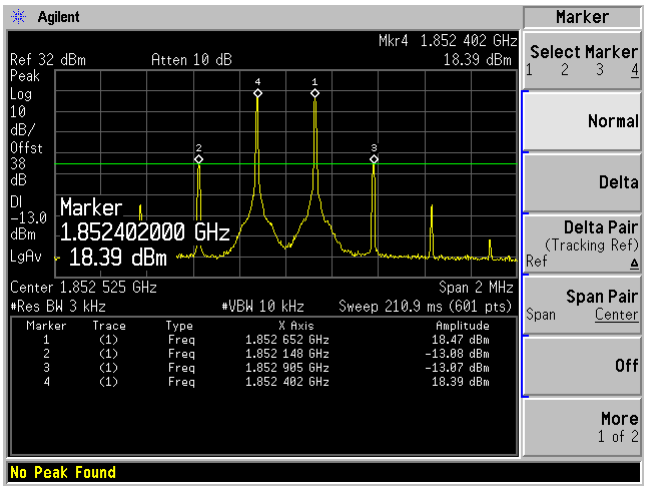
Downlink

	F_1 (MHz)	F_2 (MHz)	F_3 (MHz)	F_4 (MHz)	Po1 (dBm)	P_{mean} (dBm)
Low	1932.4	1932.6	1932.2	1932.8	35.29	38.29
Middle	1959.75	1960	1959.5	1960.25	35.19	38.19
High	1987.35	1987.6	1987.1	1987.842	37.52	40.52

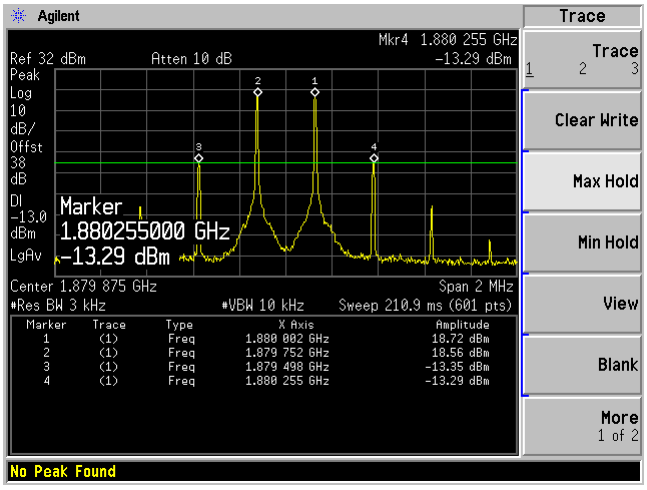
Please refer to the following tables and plots.

Uplink

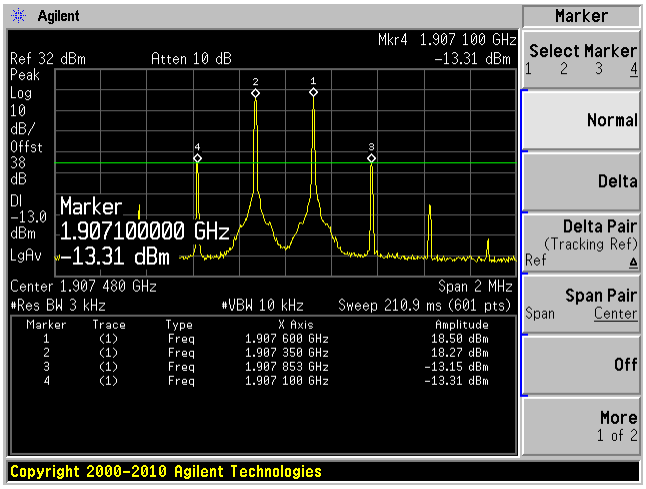
Low



Middle

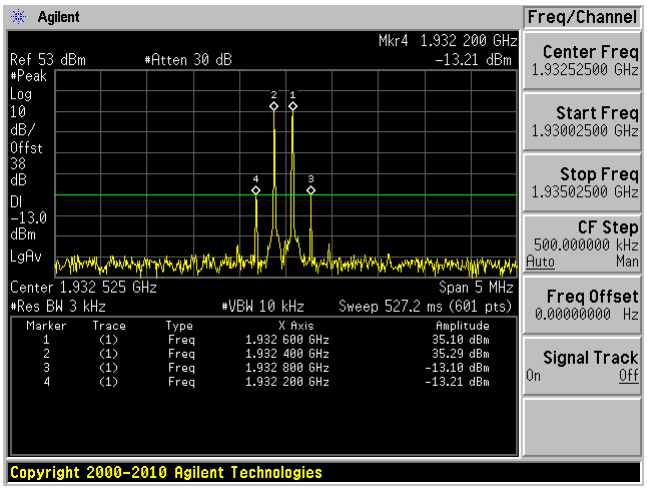


High

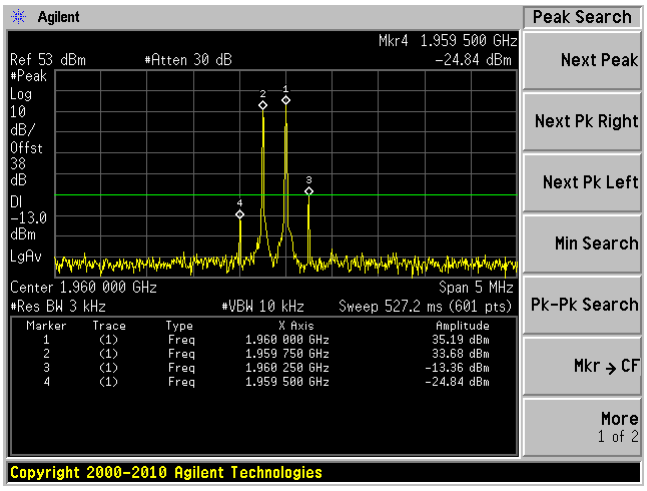


Downlink

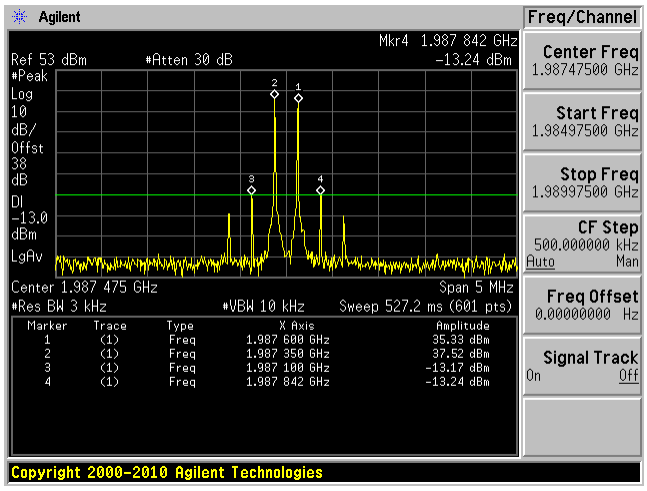
Low



Middle



High



5 FCC §2.1049, §24.238 & IC RSS-Gen §6.6 - Occupied Bandwidth

5.1 Applicable Standards

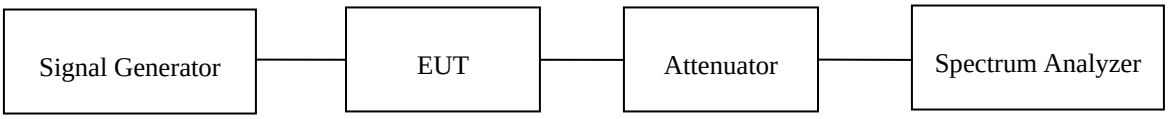
Requirements: FCC §2.1049, §24.238.
IC RSS-Gen §6.6

5.2 Test Procedure

According to IC RSS-GEN Issue4 §6.6, the RF output of the transmitter was connected to the simulator and the spectrum analyzer through sufficient attenuation.

The resolution bandwidth of the spectrum analyzer was set to at least 1% to 5% of the BW and the 26 dB & 99% bandwidth was recorded.

The RF output of the transmitter was connected to the signal generator and the spectrum analyzer through sufficient attenuation.



5.3 Test Equipment List and Details

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Agilent	Signal Generator	E4438C	MY45091309	2014-07-15	2 year

Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

5.4 Test Environmental Conditions

Temperature:	21-23 °C
Relative Humidity:	42-48 %
ATM Pressure:	101.4-102 kPa

The testing was performed by Ronak Patel on 2015-07-29 to 2015-07-31 in the RF Site.

5.5 Test Results

Please refer to the following tables and plots.

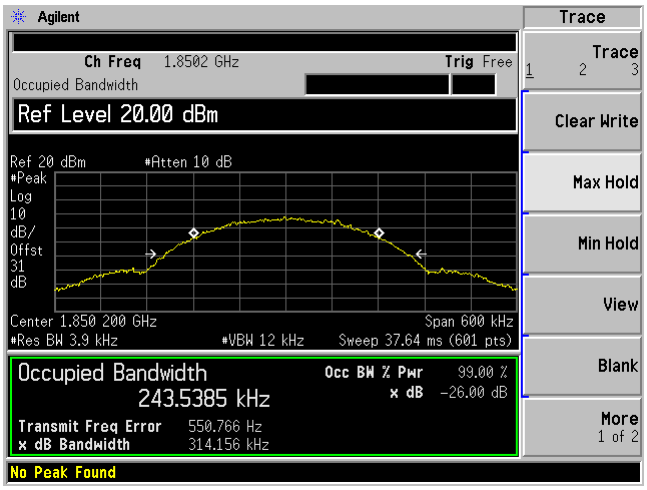
Mode		Channel	Frequency (MHz)	Input		Output	
				99% OBW (kHz)	26 dB OBW (kHz)	99% OBW (kHz)	26 dB OBW (kHz)
GSM/GPRS	1900 MHz DL	Low	1930.2	242.7751	314.638	242.7072	312.823
		Middle	1960.0	243.2523	310.826	243.1936	313.509
		High	1989.8	243.0358	312.425	244.2618	310.737
	1900 MHz UL	Low	1850.2	243.5385	314.156	243.2627	315.582
		Middle	1880.0	245.2250	316.058	244.5692	314.675
		High	1909.8	246.5172	316.479	242.8929	313.540
CDMA/EVDO	1900 MHz DL	Low	1930.8	1496.5	1679	1459.3	1654
		Middle	1960.0	1467.4	1651	1455.6	1653
		High	1989.2	1464.8	1653	1458.8	1659
	1900 MHz UL	Low	1850.8	1463.7	1656	1485.5	1685
		Middle	1880.0	1460.0	1658	1480.0	1683
		High	1909.2	1459.6	1654	1493.5	1690
WCDMA	1900 MHz DL	Low	1932.4	4176.9	4700	4216.9	4785
		Middle	1960.0	4181.9	4692	4185.2	4716
		High	1987.6	4195.3	4698	4194.9	4728
	1900 MHz UL	Low	1852.4	4185.7	4695	4220.8	4786
		Middle	1880.0	4194.2	4704	4212.9	4778
		High	1907.6	41902	4694	4228.1	4790

Mode		Channel	Frequency (MHz)	Input		Output	
				99% OBW (MHz)	26 dB OBW (MHz)	99% OBW (MHz)	26 dB OBW (MHz)
LTE 1.4 MHz	1900 MHz DL	Low	1930.7	1.1121	1.404	1.1077	1.405
		Middle	1960	1.1120	1.405	1.1087	1.405
		High	1989.3	1.1104	1.400	1.1075	1.401
	1900 MHz UL	Low	1850.7	1.0886	1.393	1.1029	1.412
		Middle	1880	1.0910	1.394	1.1040	1.409
		High	1909.3	1.0861	1.395	1.0988	1.404
LTE 3 MHz	1900 MHz DL	Low	1931.5	2.7152	3.041	2.7186	3.048
		Middle	1960	2.7170	3.047	2.7177	3.029
		High	1988.5	2.7091	3.053	2.7104	3.032
	1900 MHz UL	Low	1851.5	2.6944	2.993	2.7239	3.508
		Middle	1880	2.7027	3.036	2.7154	3.036
		High	1908.5	2.7049	3.022	2.7100	3.045
LTE 5 MHz	1900 MHz DL	Low	1932.5	4.5079	5.048	4.5020	5.033
		Middle	1960	4.5053	5.011	4.5068	5.045
		High	1987.5	4.5001	5.004	4.5086	5.049
	1900 MHz UL	Low	1852.5	4.5092	4.963	4.4820	5.034
		Middle	1880	4.5047	5.046	4.4992	5.054
		High	1907.5	4.5181	5.052	4.4826	5.030
LTE 10 MHz	1900 MHz DL	Low	1935	9.0017	10.055	9.0040	10.087
		Middle	1960	8.9823	10.058	8.9730	9.980
		High	1985	9.0031	10.096	9.0097	10.474
	1900 MHz UL	Low	1855	9.0013	9.971	9.0079	10.081
		Middle	1880	9.0181	9.974	8.9917	9.911
		High	1905	9.0199	9.975	9.0076	10.067
LTE 15 MHz	1900 MHz DL	Low	1937.5	13.4333	14.818	13.4483	14.982
		Middle	1960	13.4812	15.020	13.4573	14.897
		High	1982.5	13.5010	14.980	13.4386	14.886
	1900 MHz UL	Low	1857.5	13.5180	14.955	13.4857	14.909
		Middle	1880	13.5701	15.046	13.5214	15.471
		High	1902.5	13.5569	15.020	13.4547	15.181
LTE 20 MHz	1900 MHz DL	Low	1940	17.9828	19.912	17.9513	19.935
		Middle	1960	17.9840	19.913	17.9004	19.794
		High	1980	18.0088	19.697	17.9257	19.893
	1900 MHz UL	Low	1860	18.0902	20.002	18.0014	20.059
		Middle	1880	18.1333	19.857	17.9836	20.191
		High	1900	18.0756	19.836	17.9809	20.034

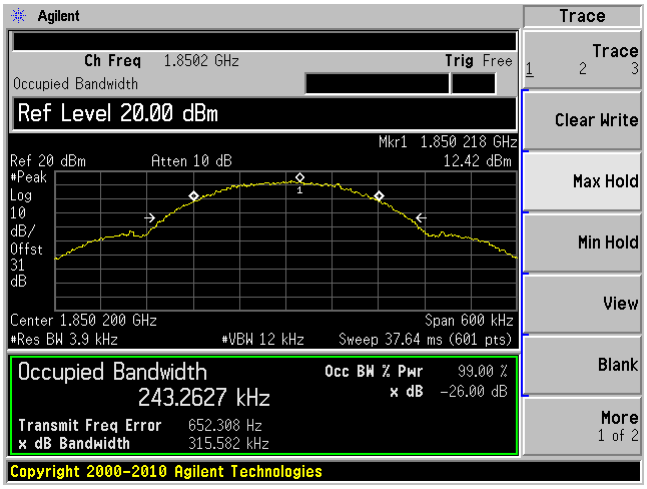
Occupied Bandwidth

GSM/GPRS

UL Low I/P



UL Low O/P



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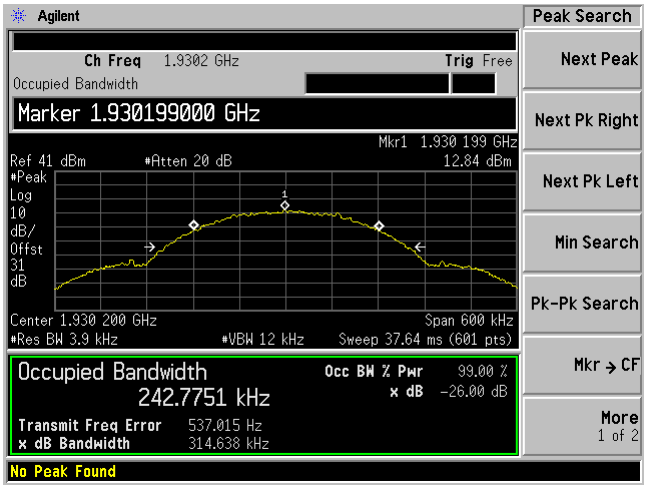

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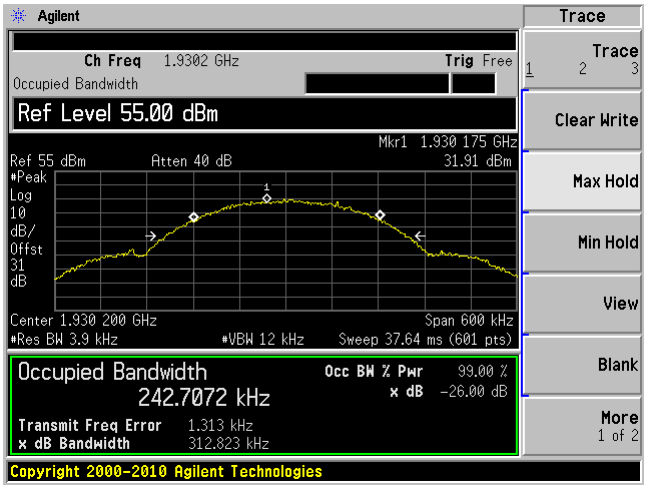

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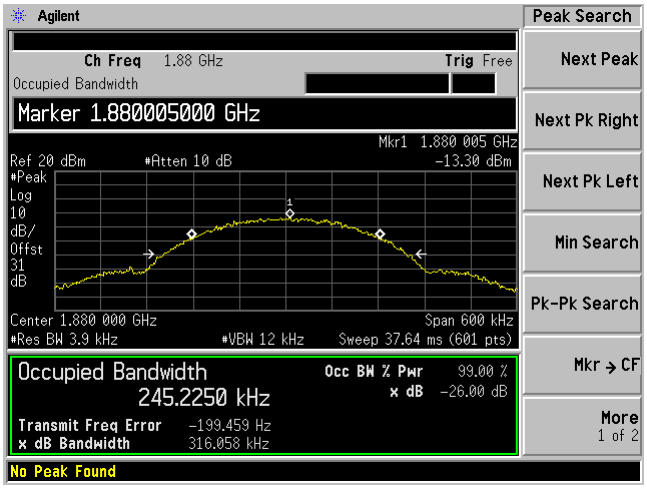

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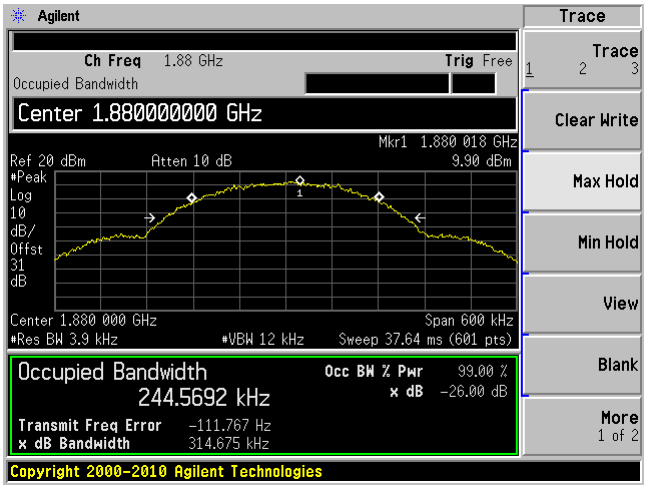

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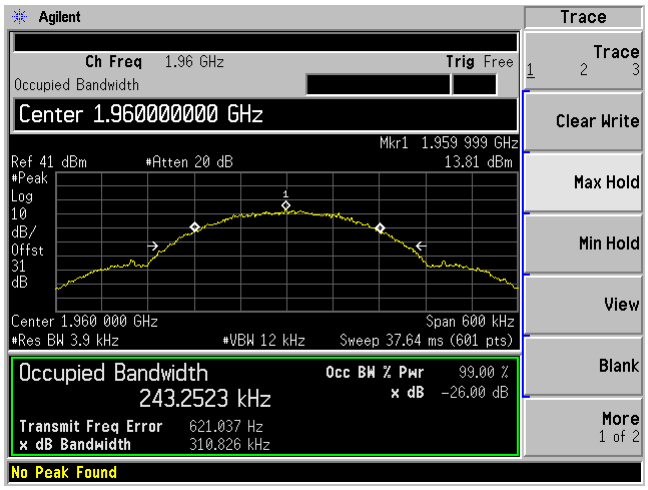

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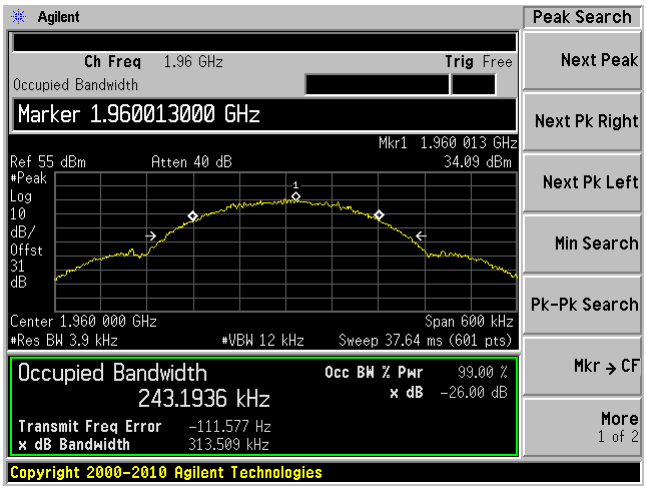

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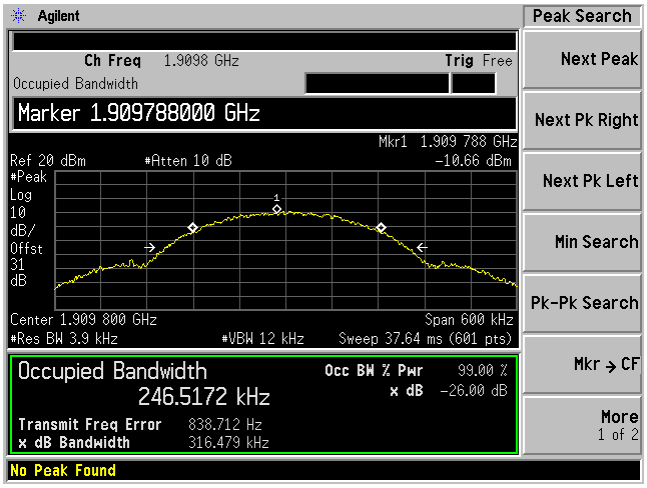

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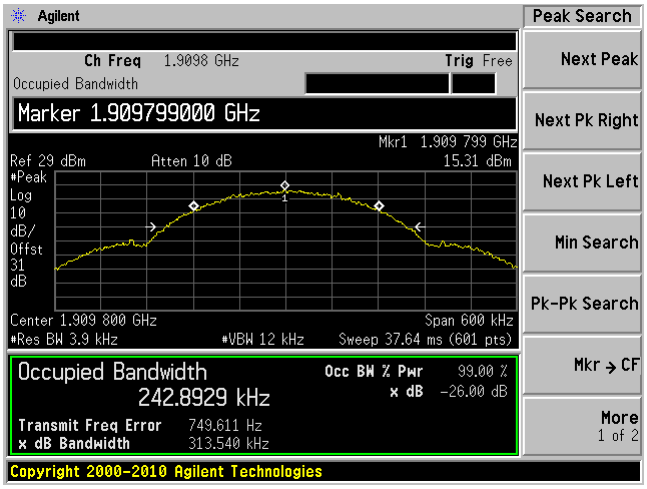

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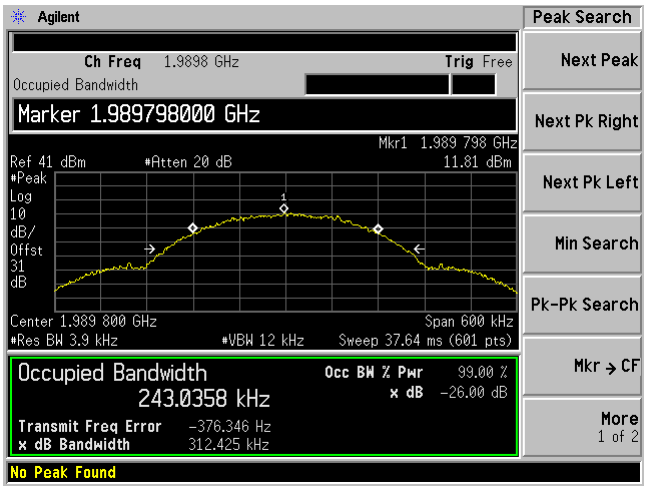

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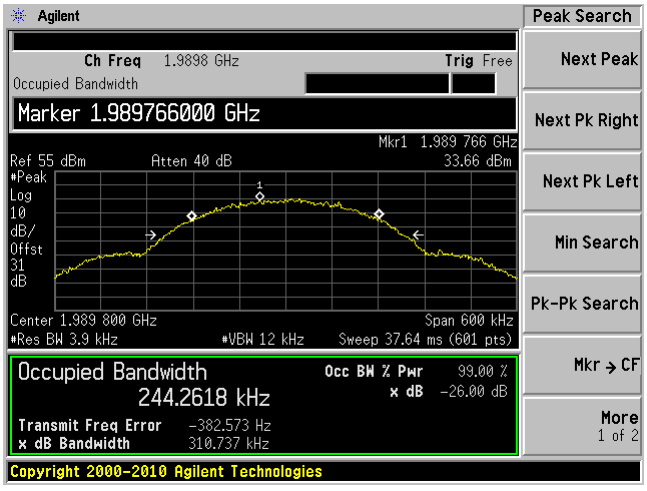

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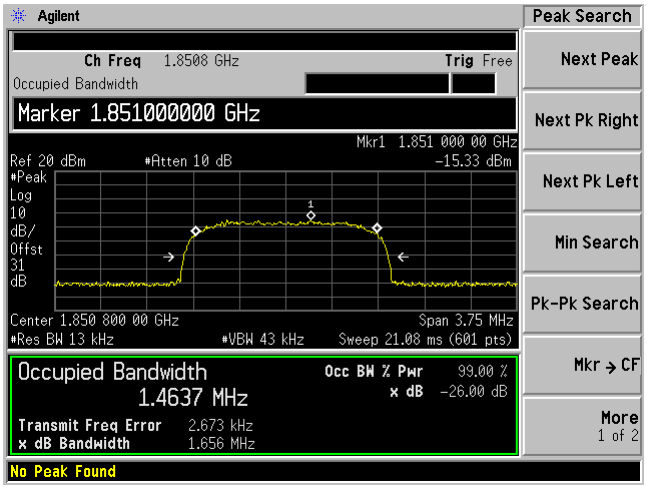

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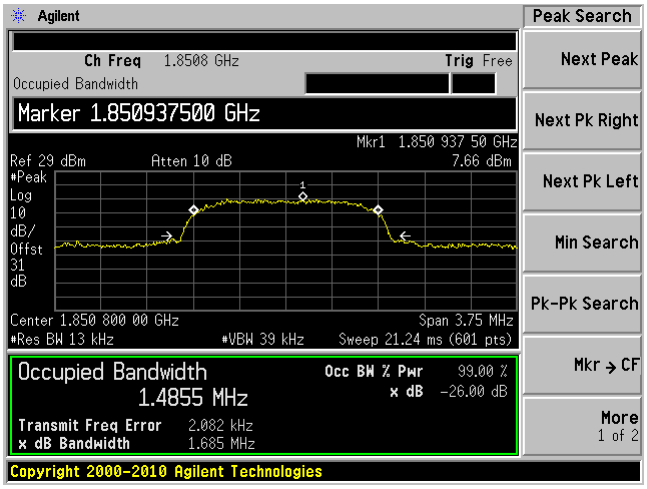

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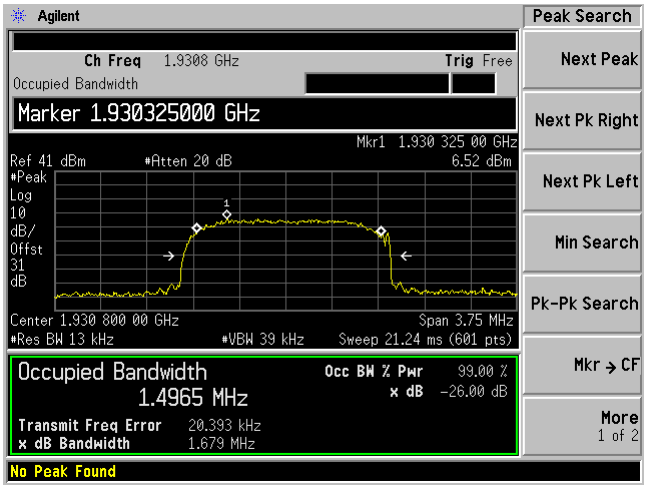

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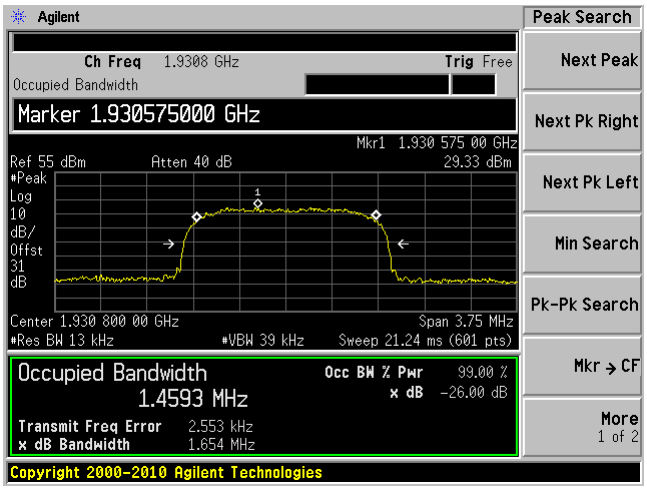

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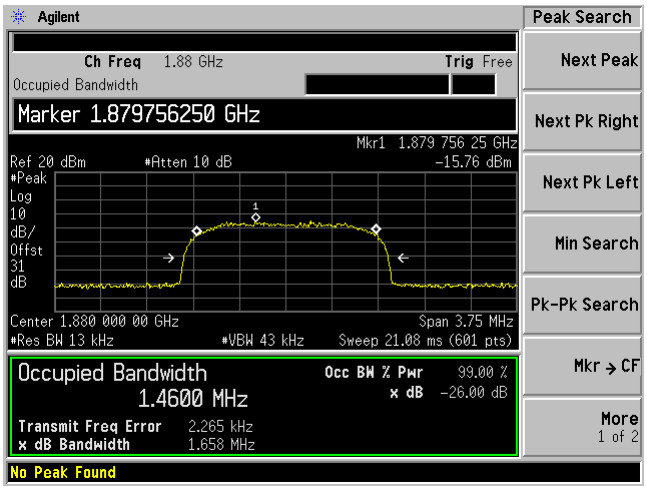

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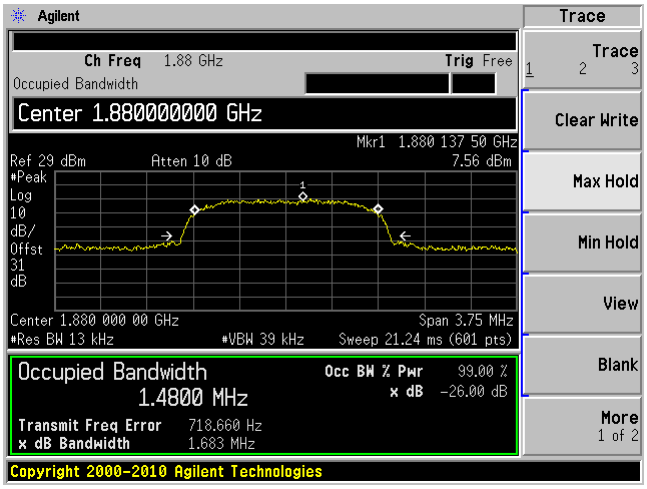

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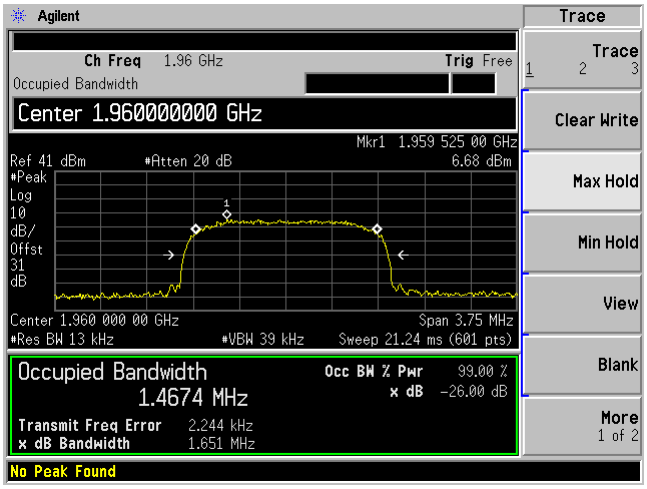

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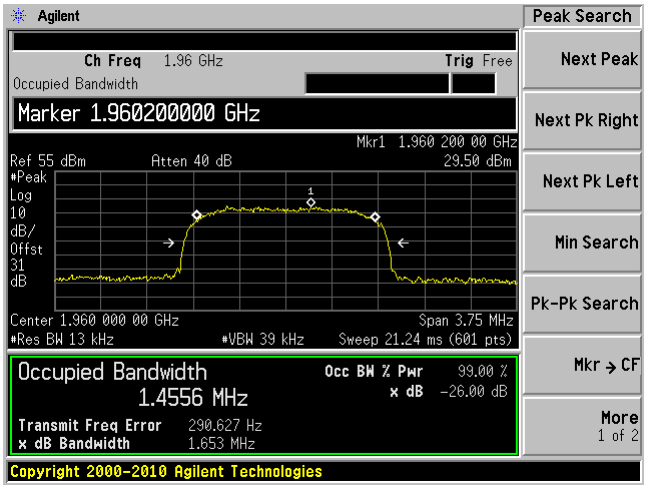

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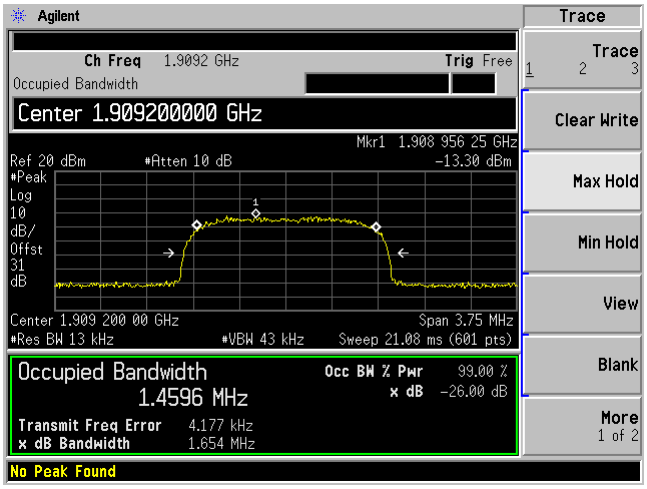

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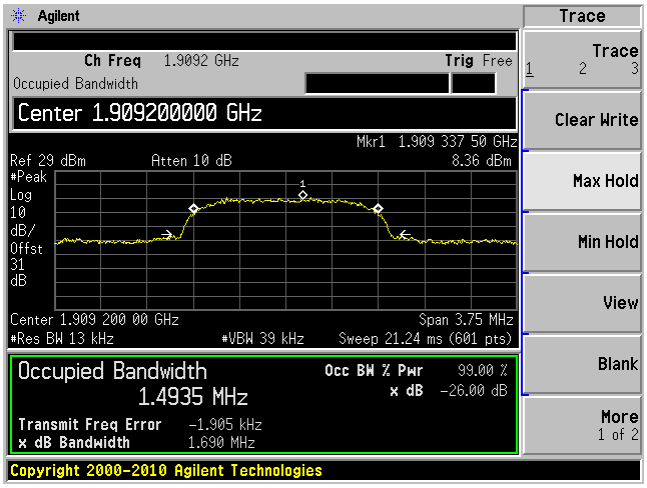

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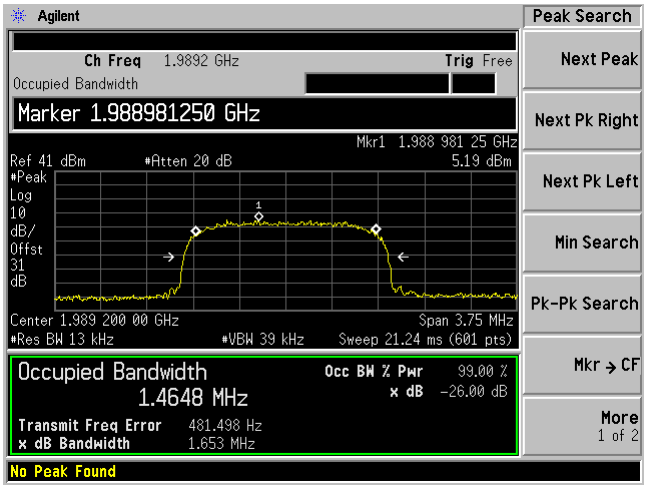

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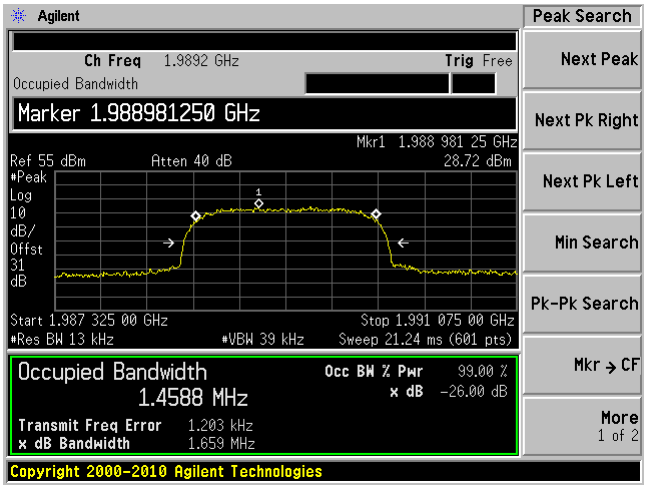

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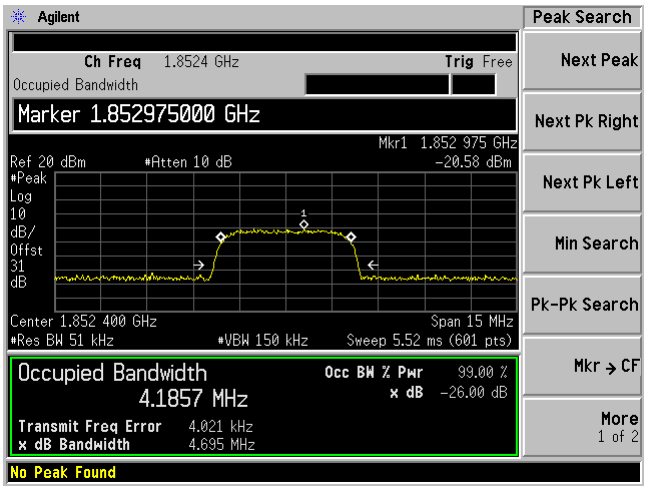

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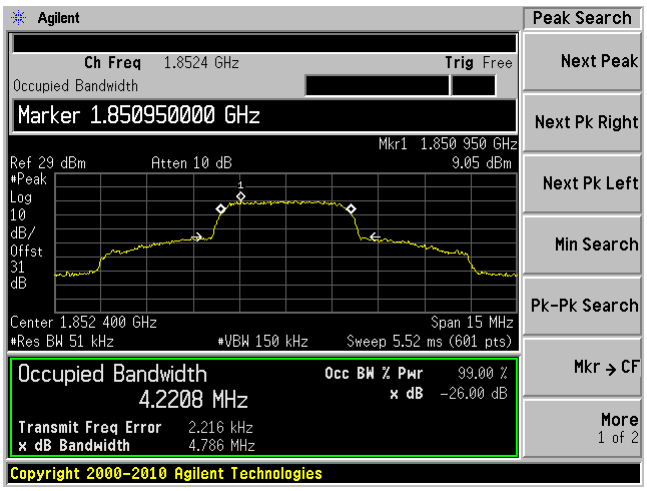

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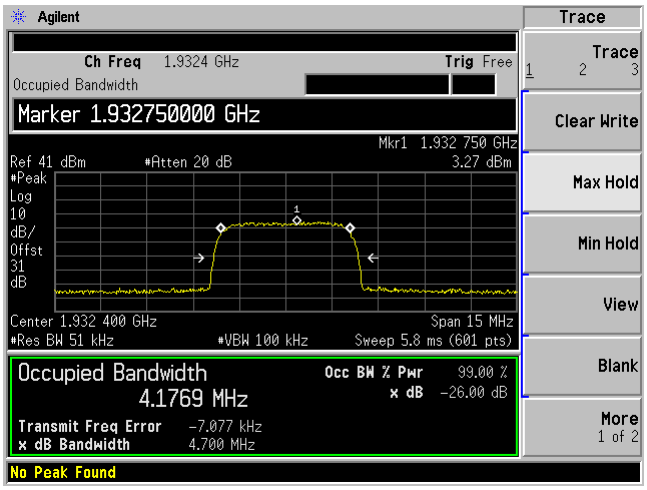

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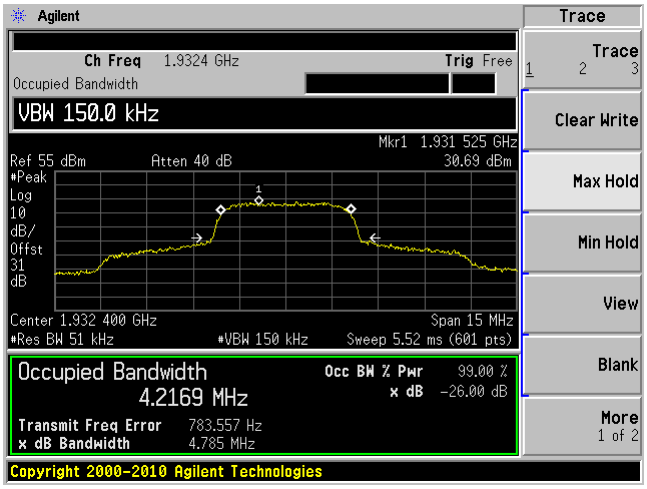

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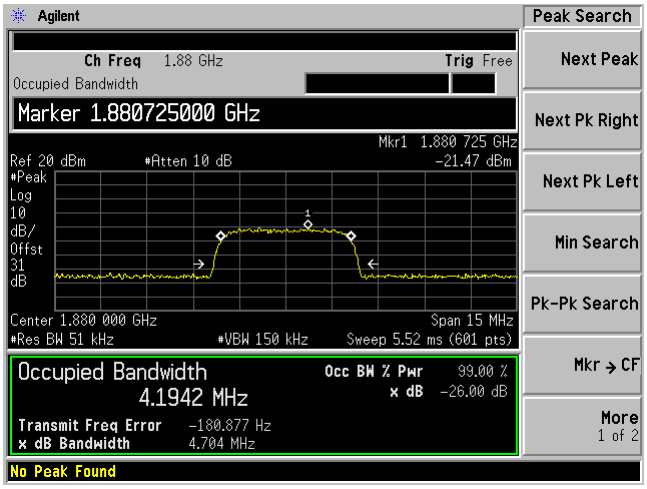

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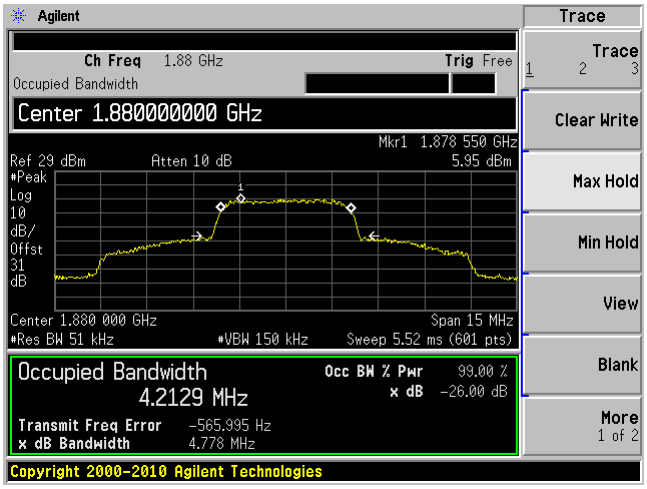

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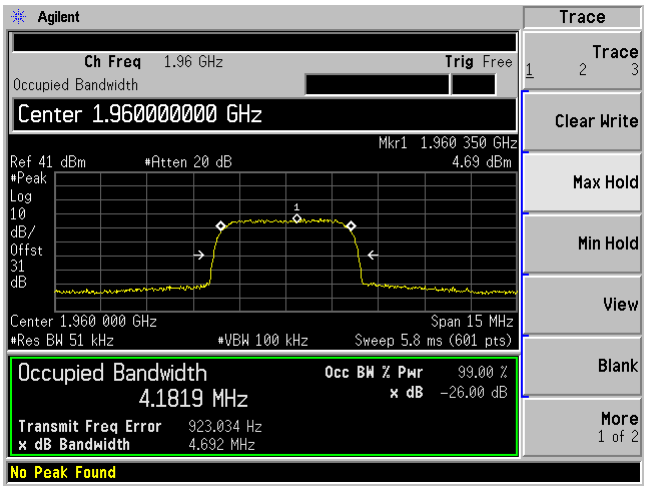

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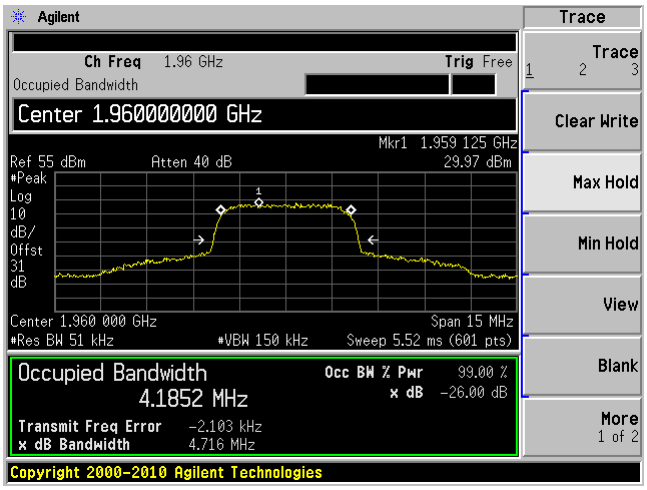

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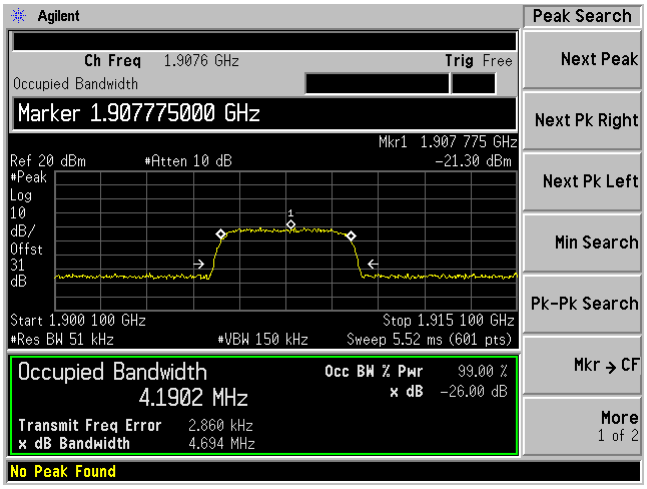

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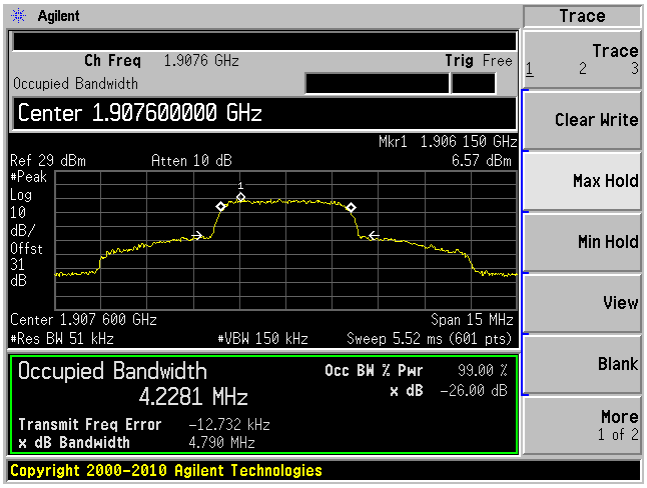

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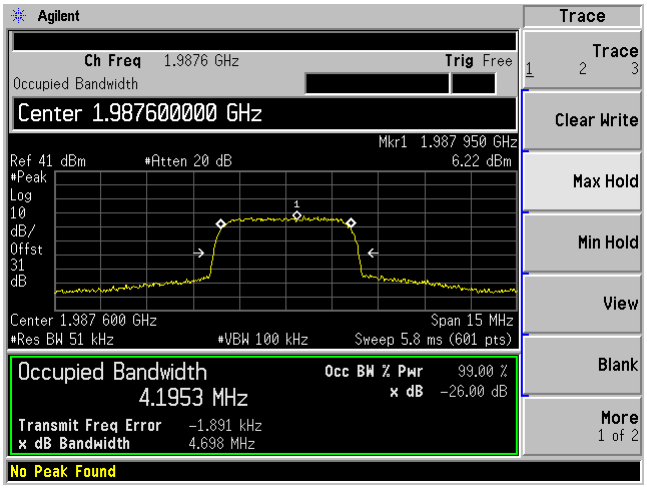

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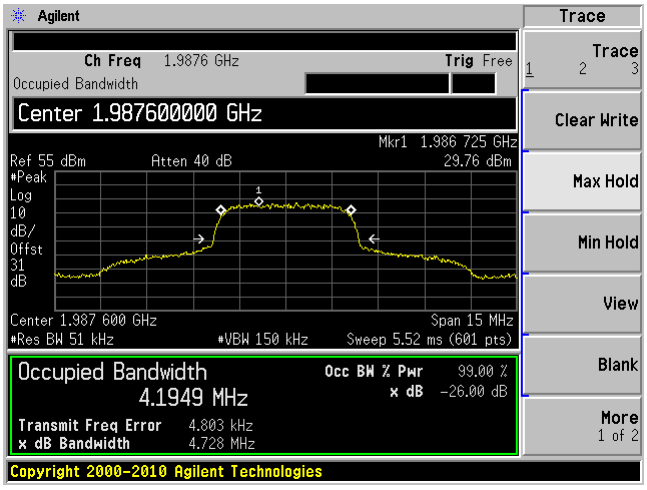
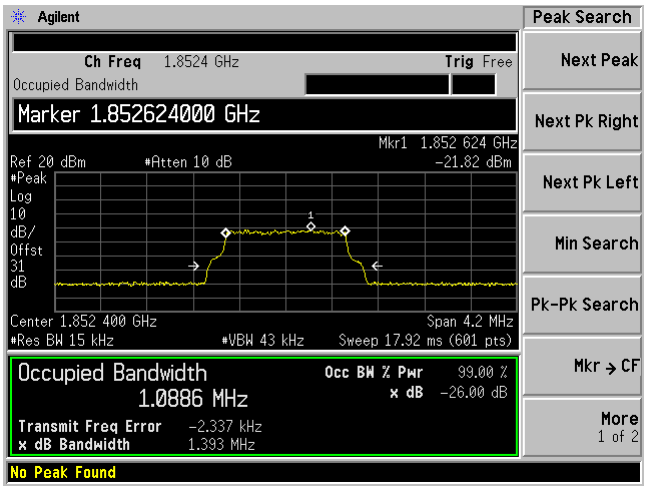


LTE 1.4 MHz

UL Low I/P



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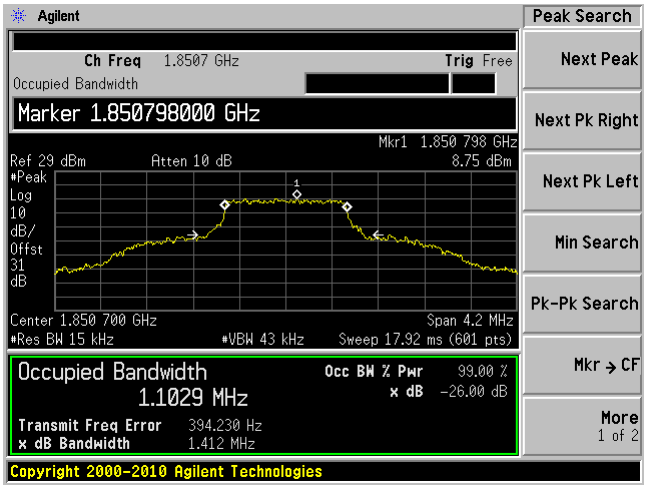

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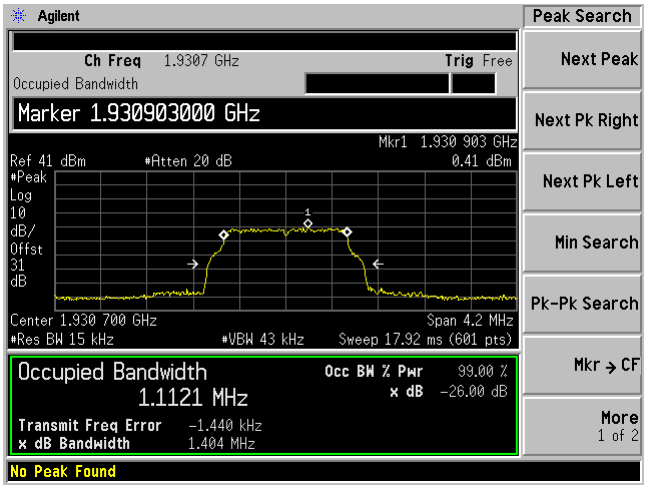
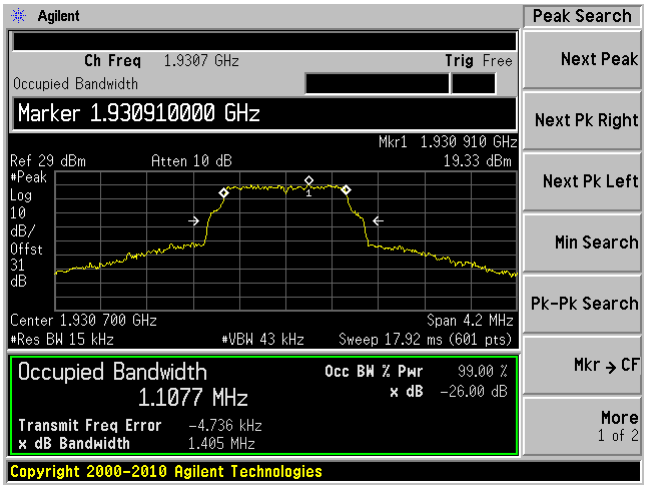
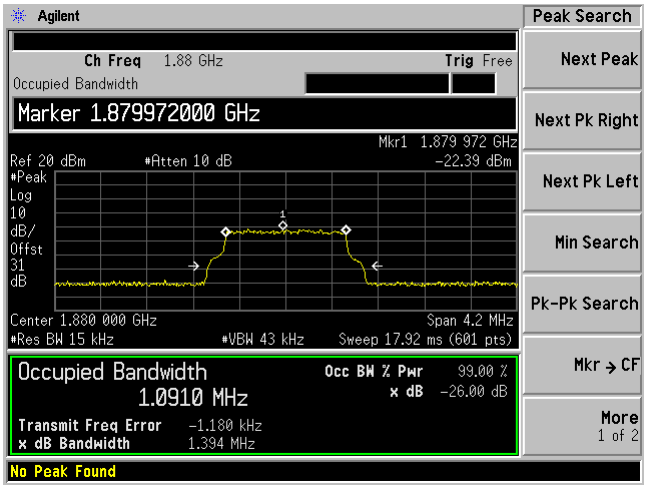


DL Low O/P



UL Middle I/P



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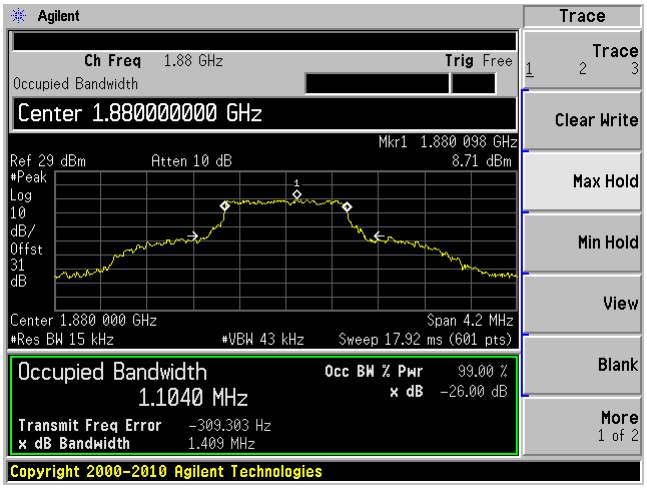

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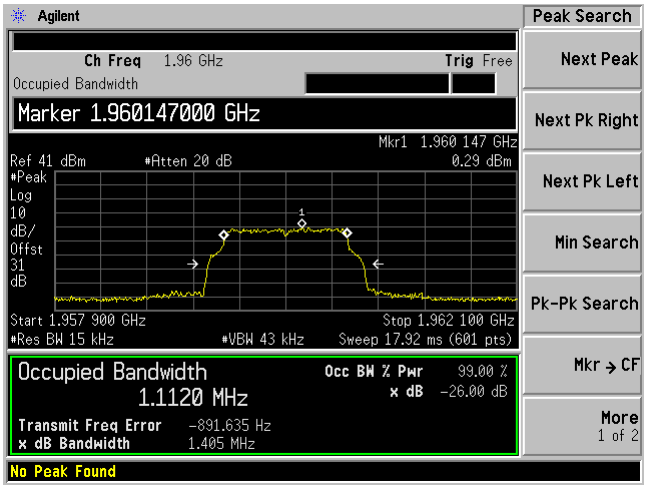

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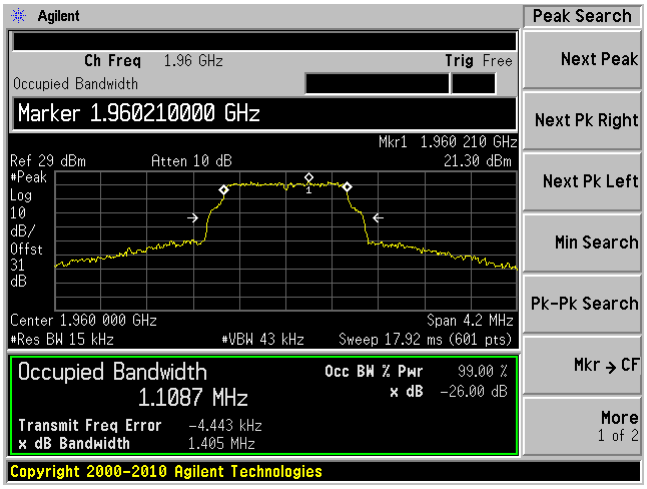
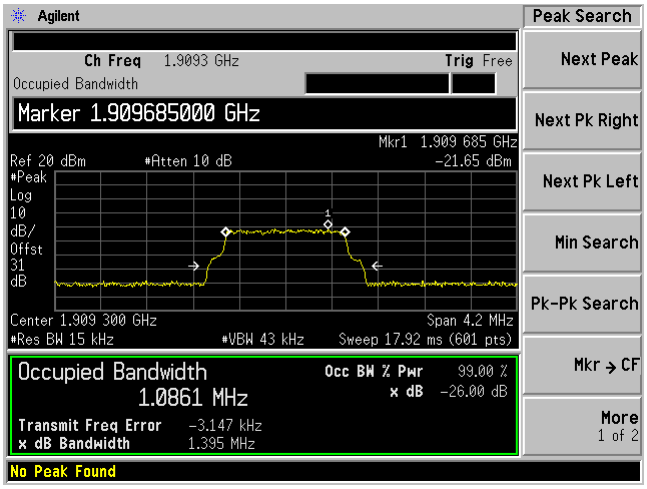


UL High I/P



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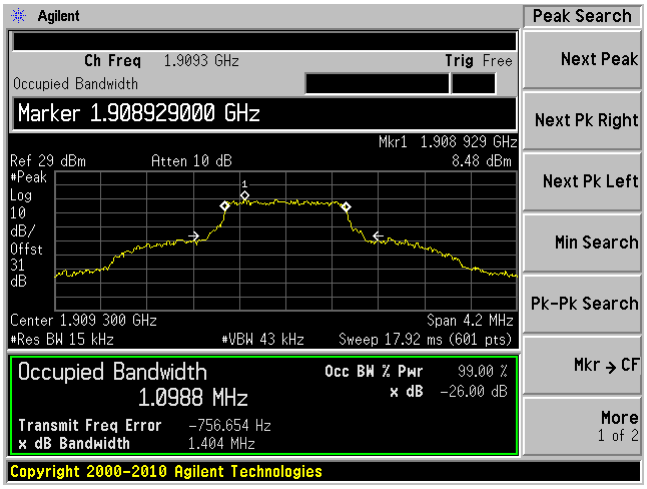

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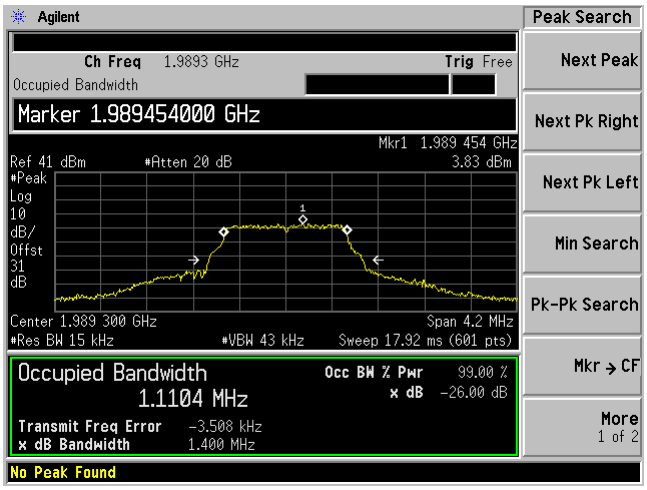

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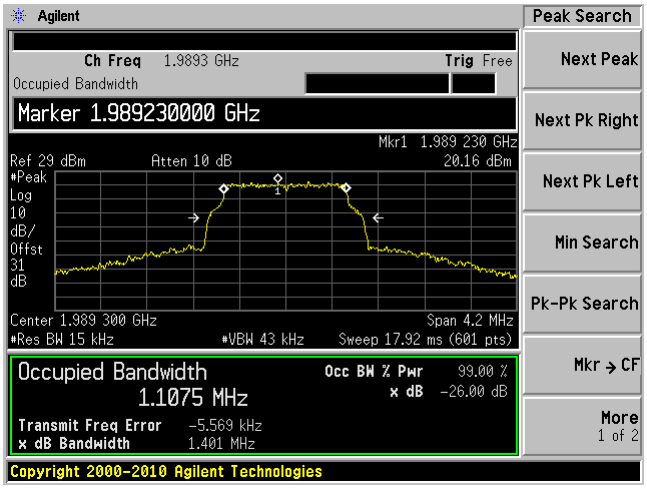

LTE 3 MHz

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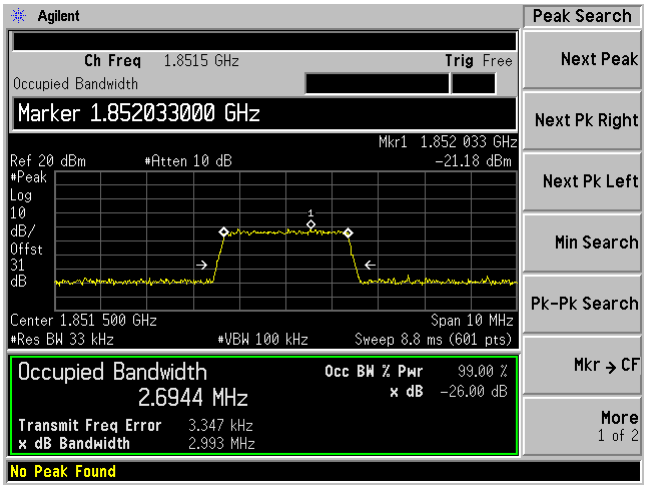

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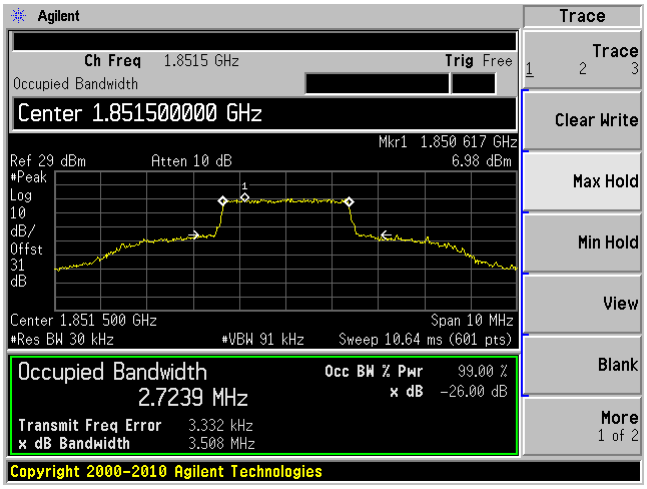

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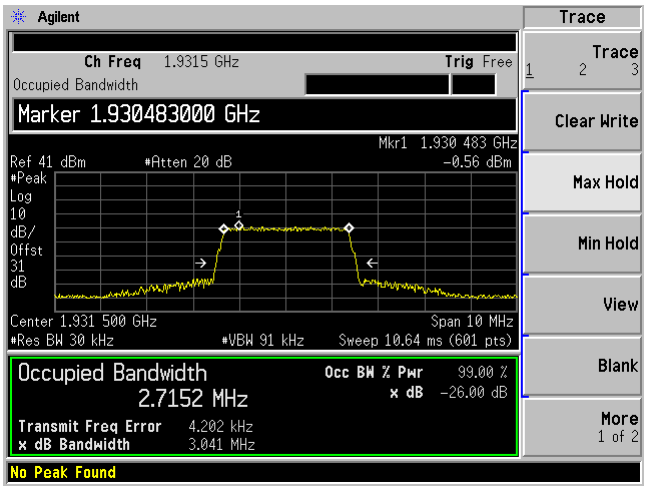

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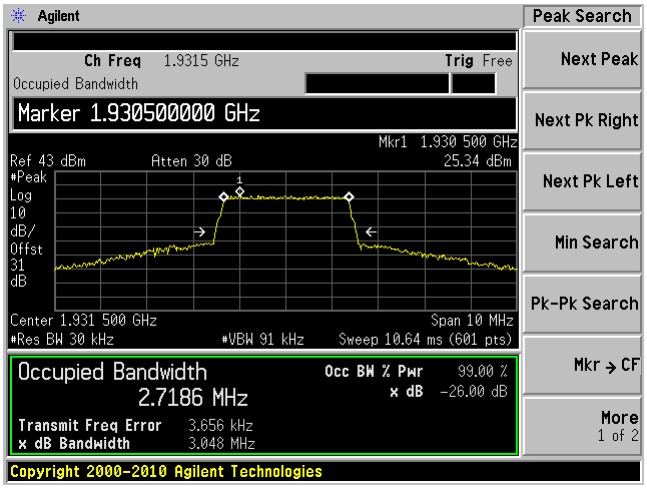

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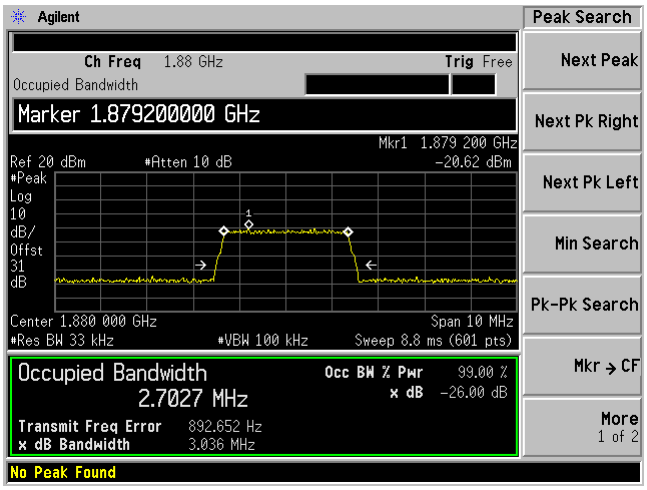

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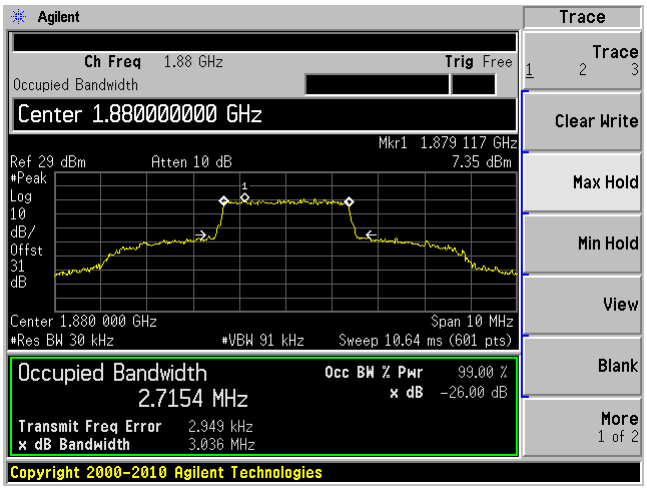

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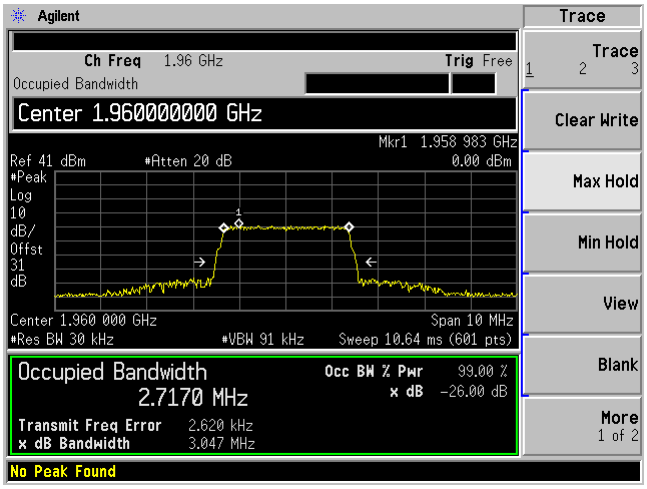

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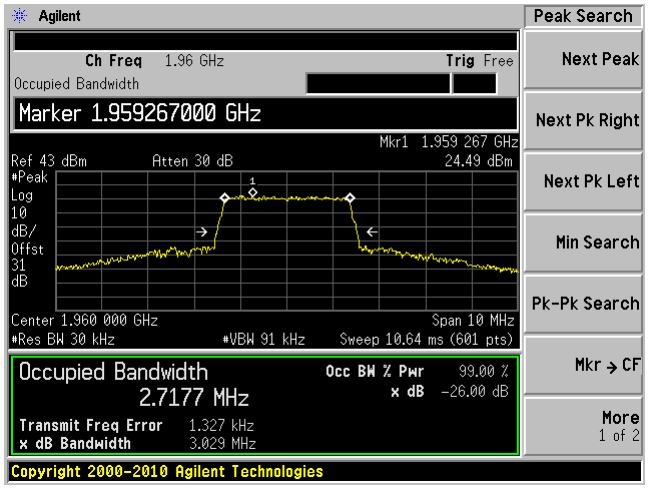

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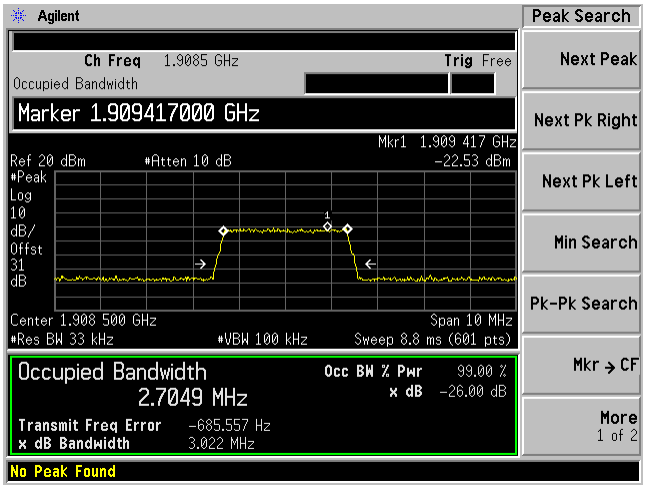

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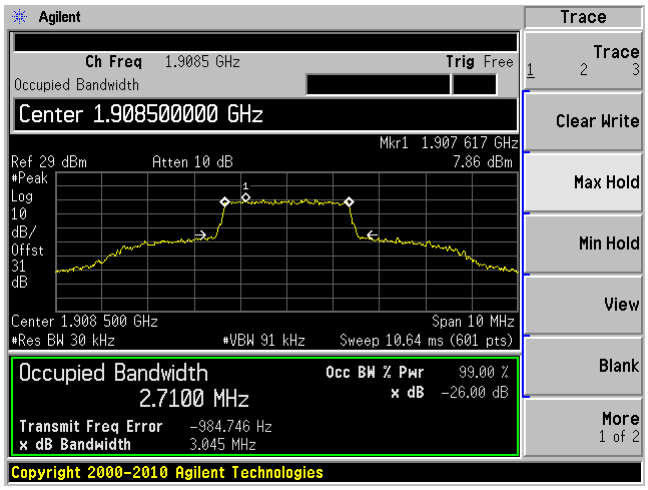
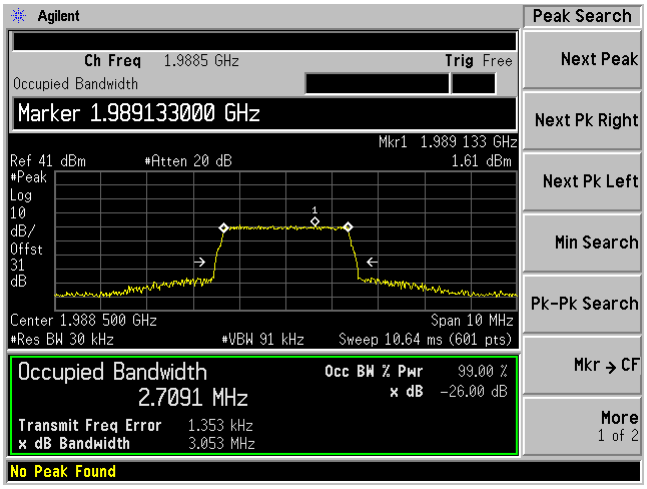


DL High I/P



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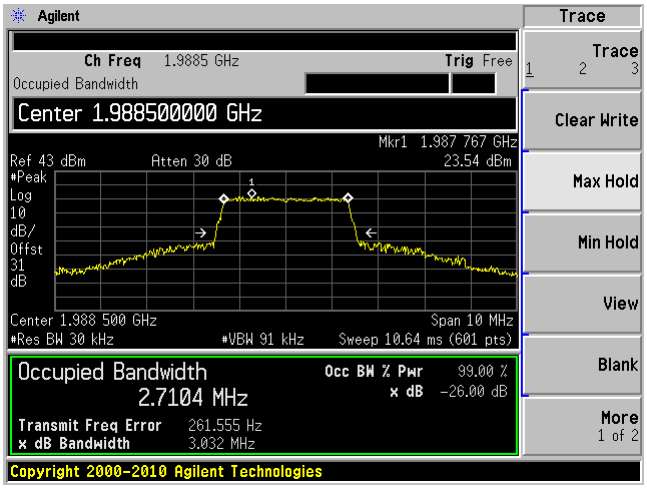
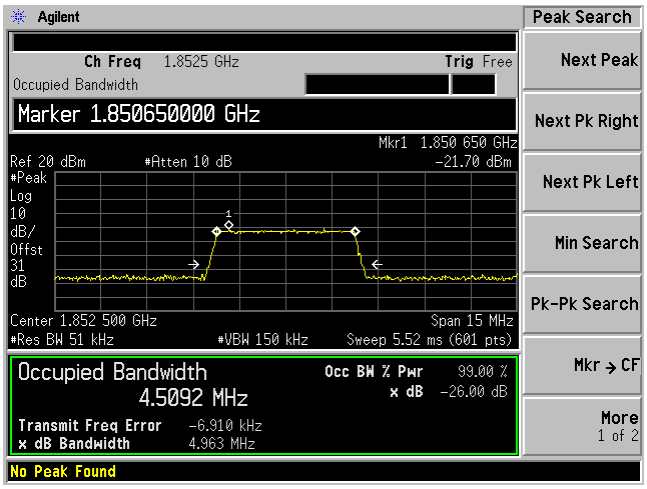


LTE 5 MHz

UL Low I/P



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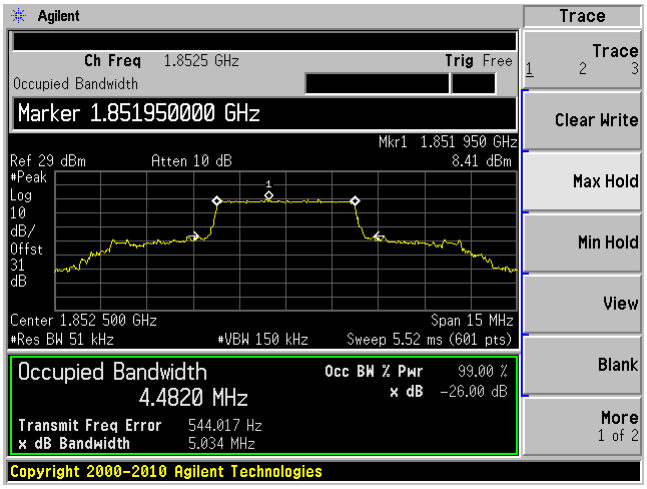

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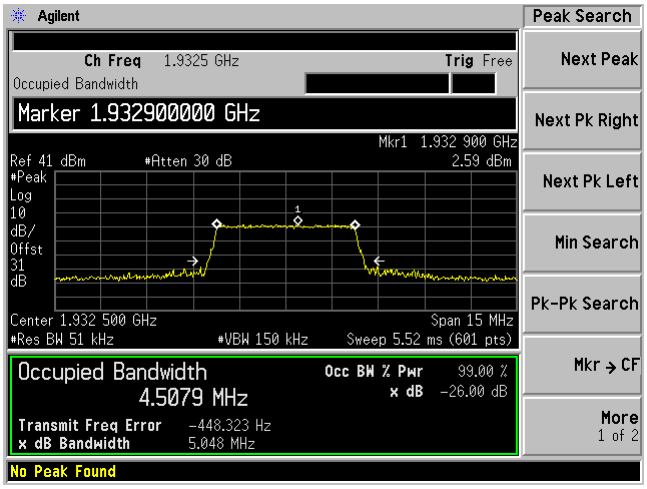
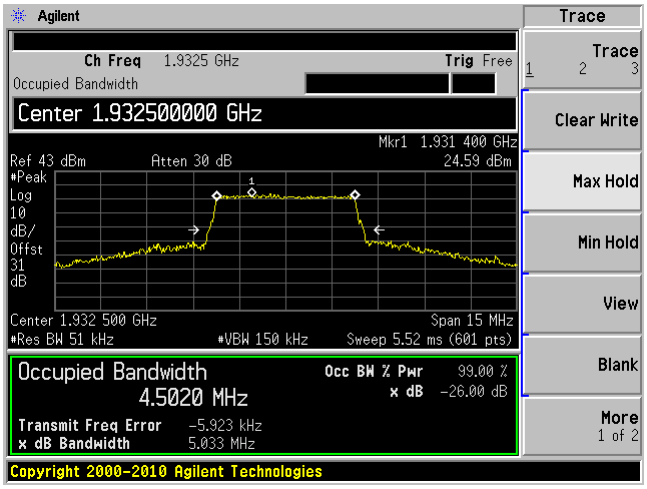
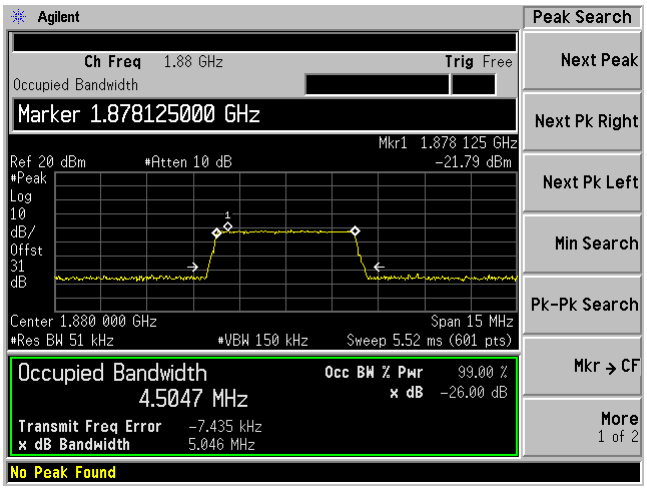


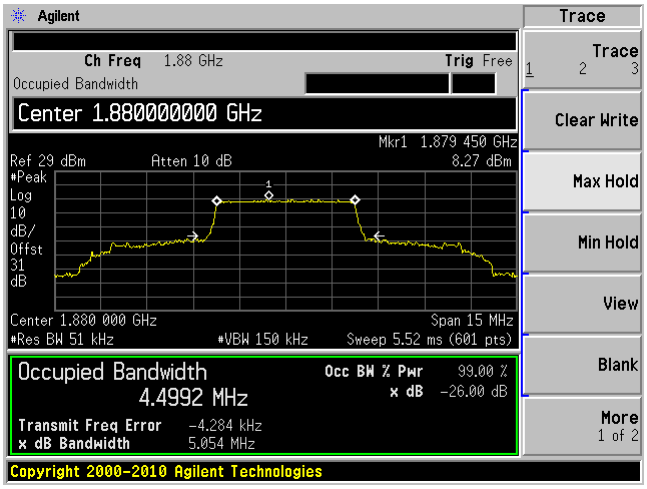
DL Low O/P



UL Middle I/P



UL Middle O/P



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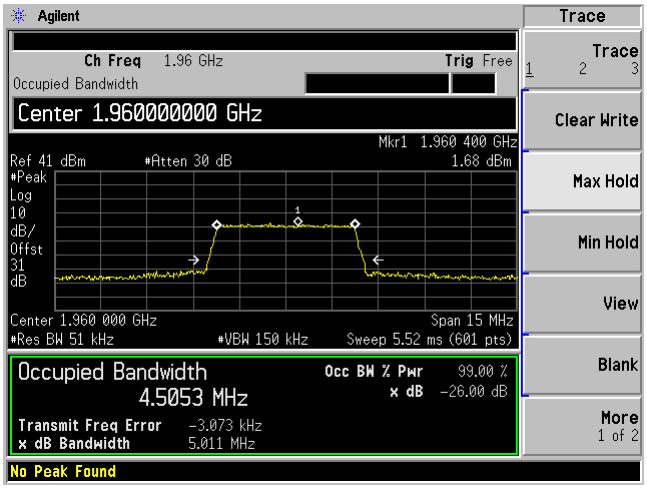

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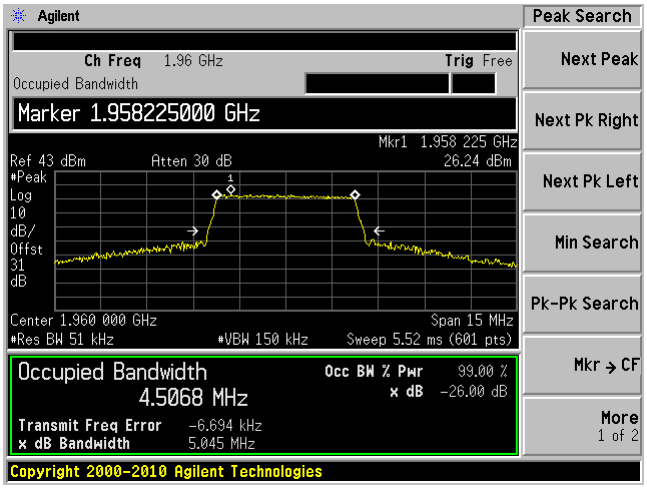
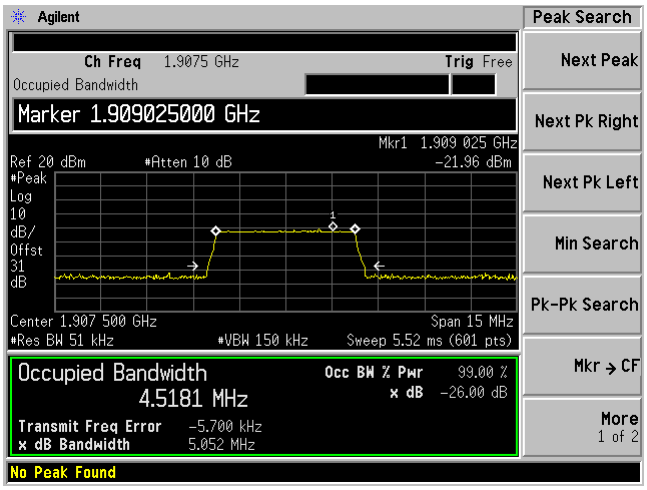


UL High I/P



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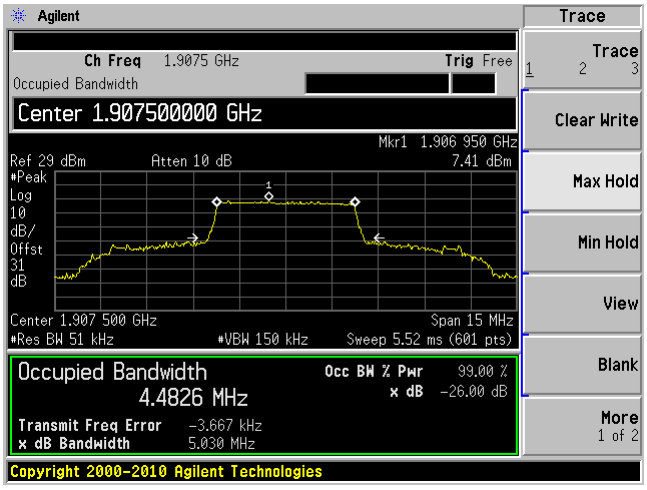

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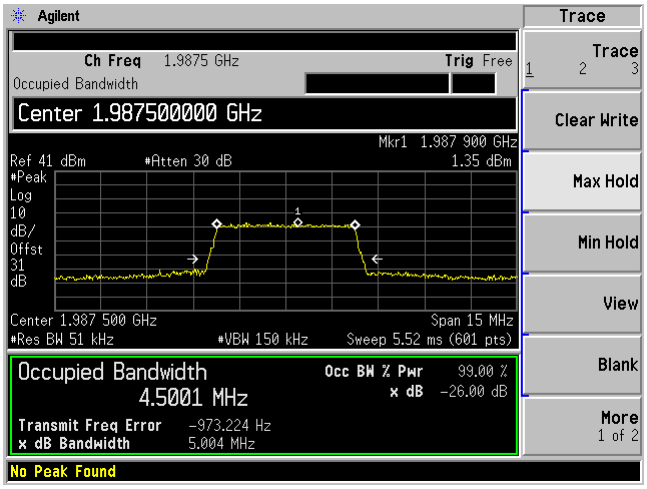

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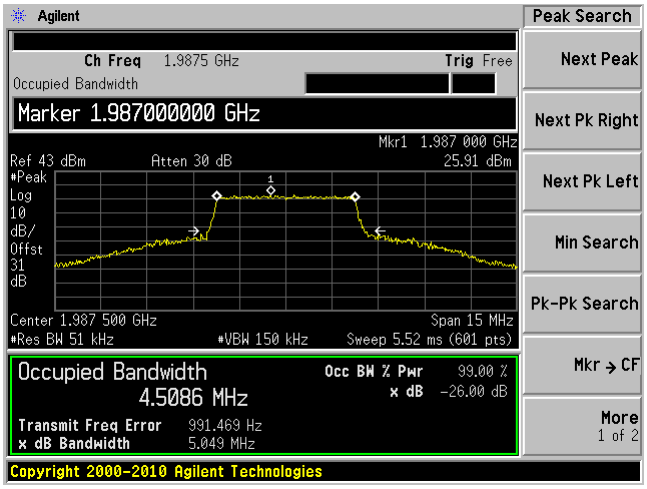
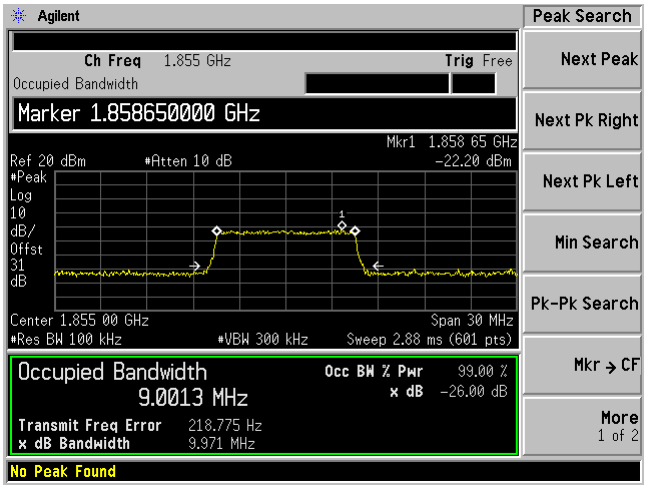


LTE 10 MHz

UL Low I/P



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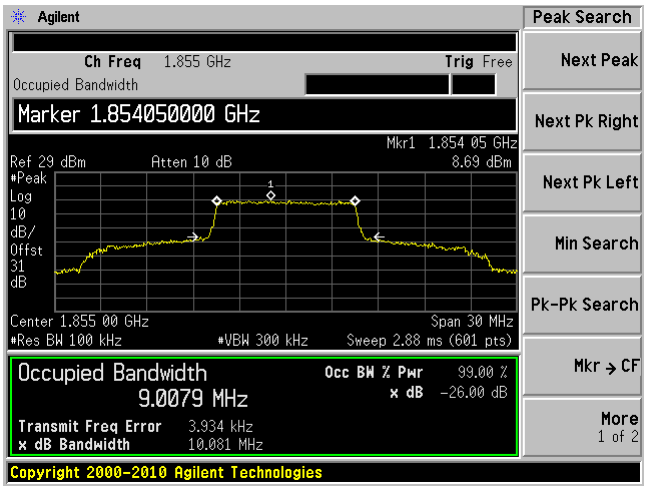

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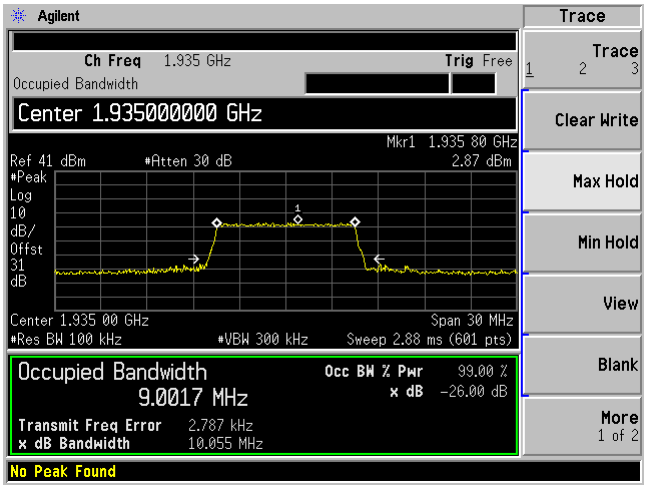

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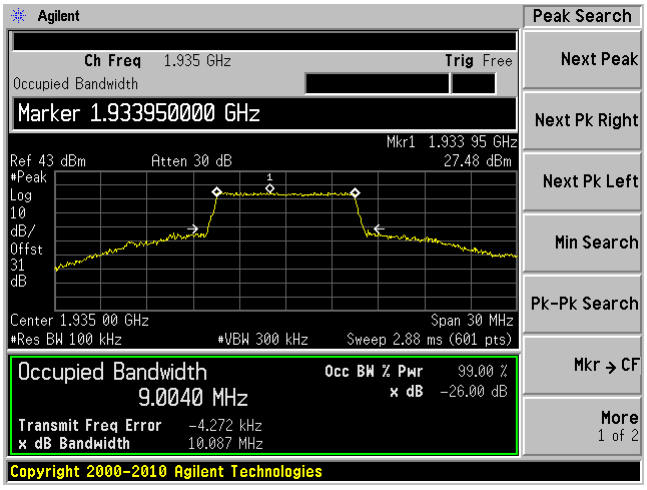

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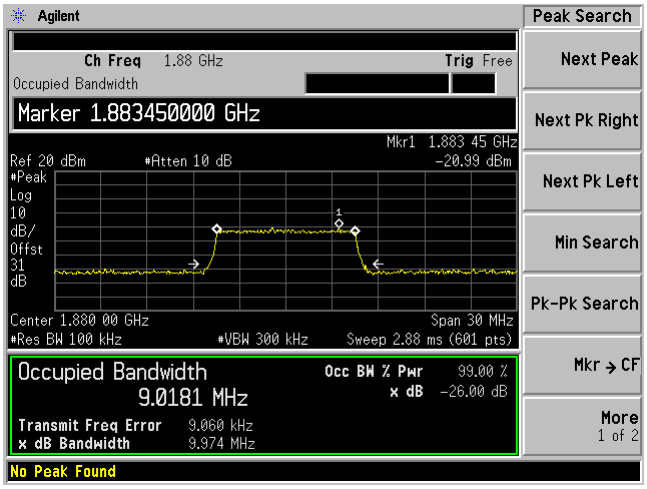

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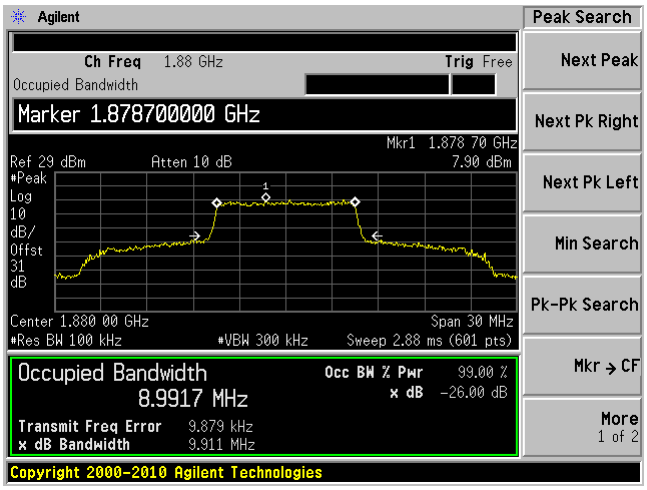
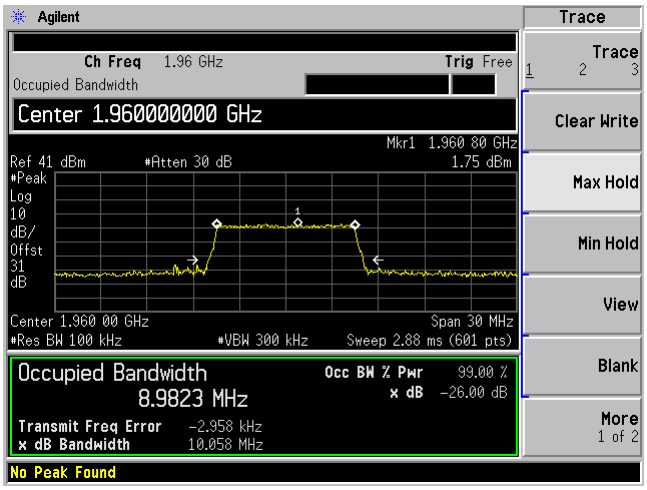
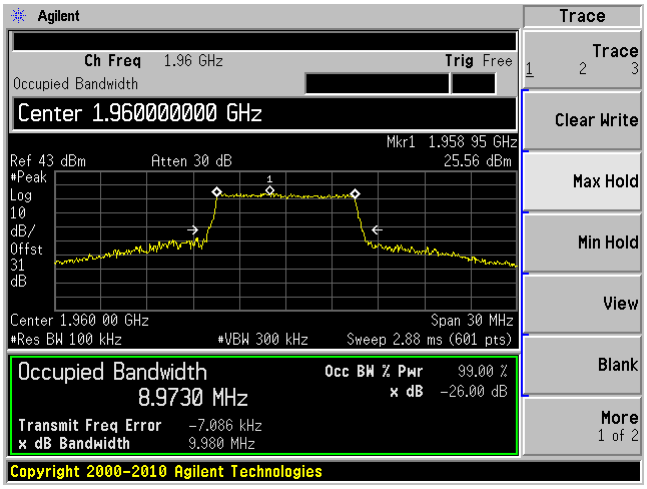


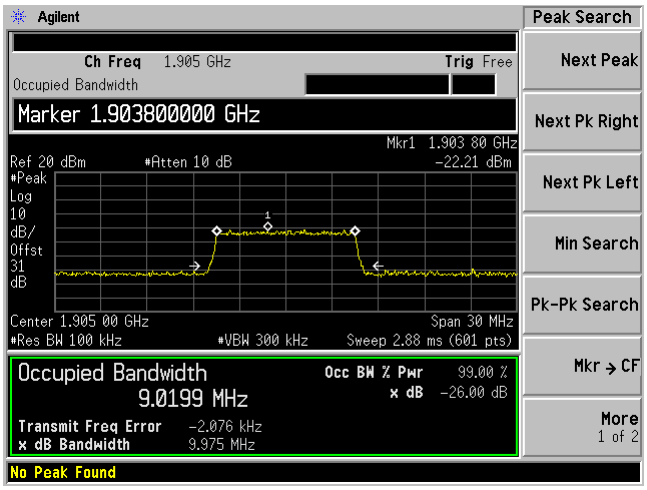
DL Middle I/P



DL Middle O/P



UL High I/P



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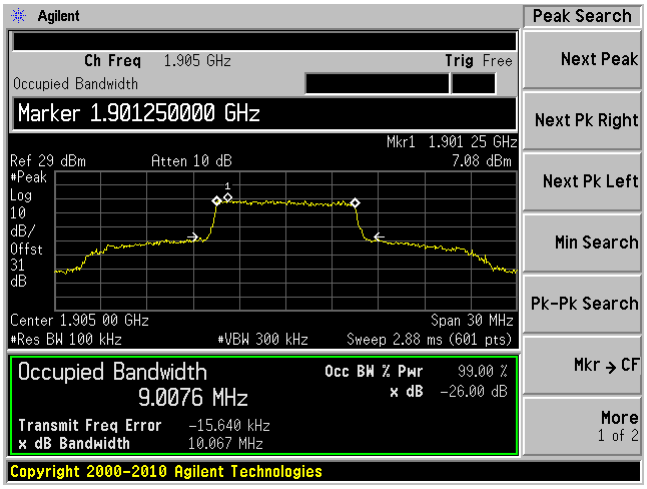

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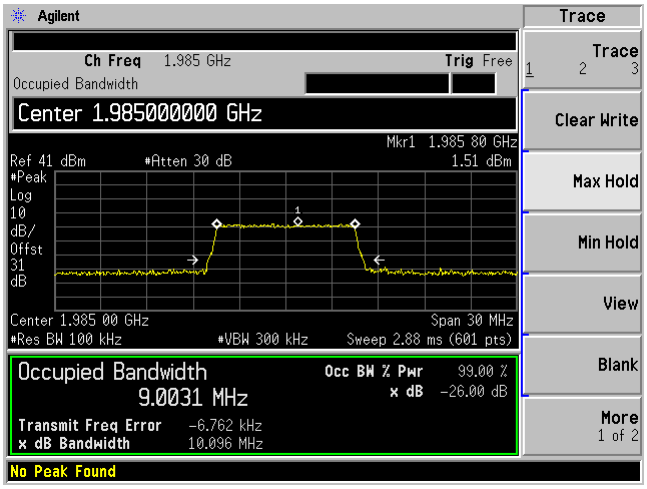

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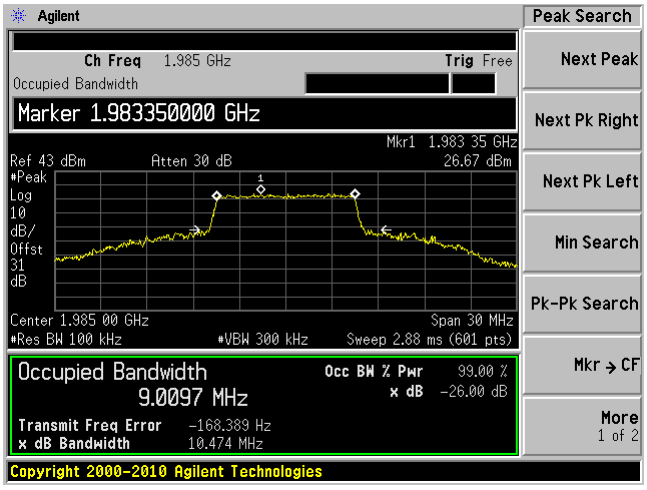
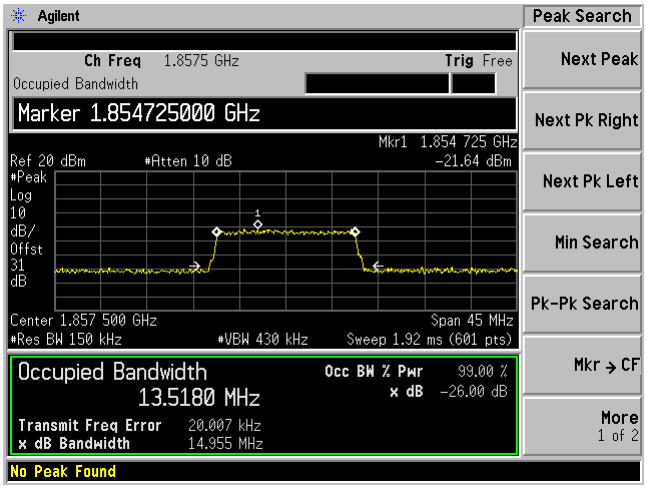


LTE 15 MHz

UL Low I/P



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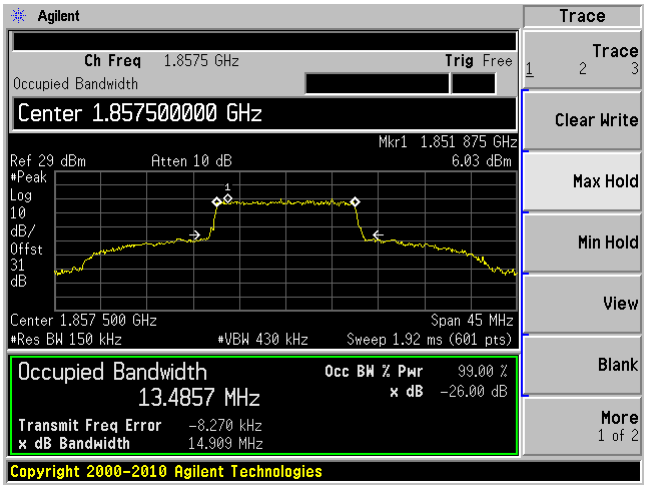

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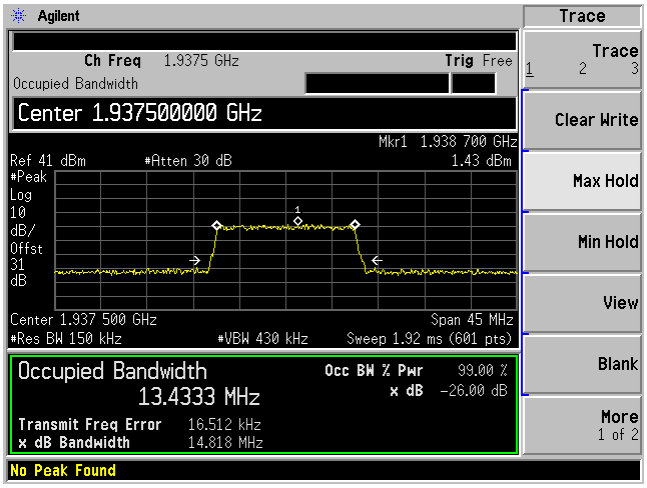

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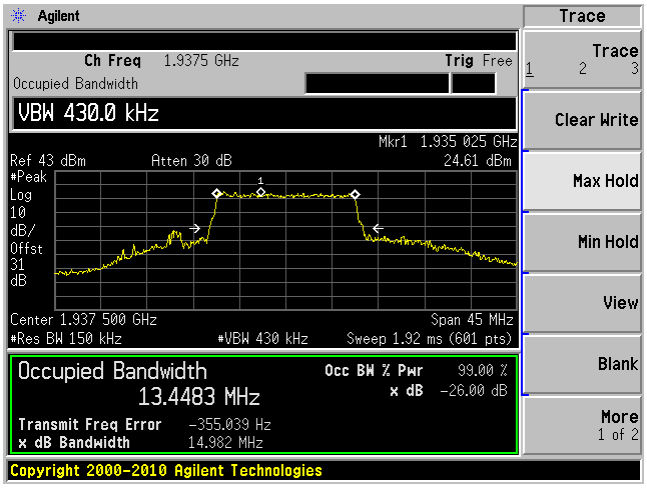

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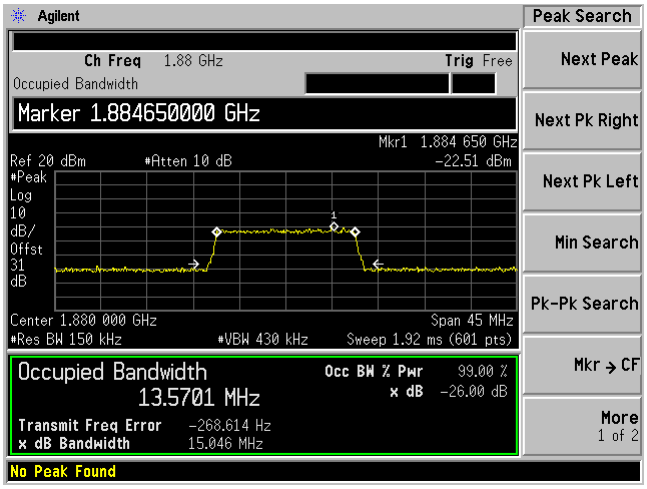

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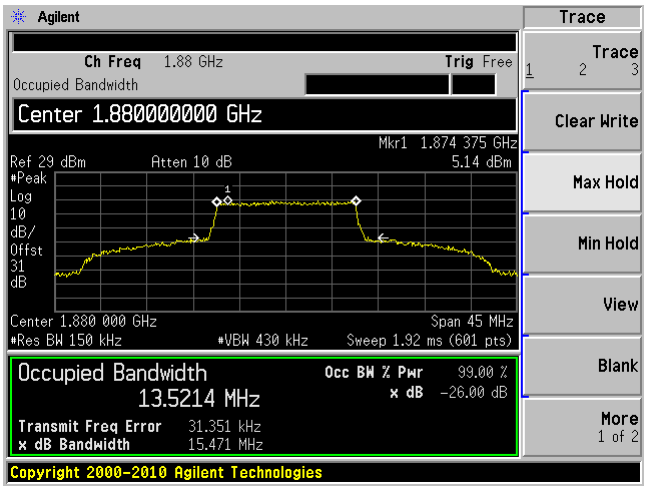

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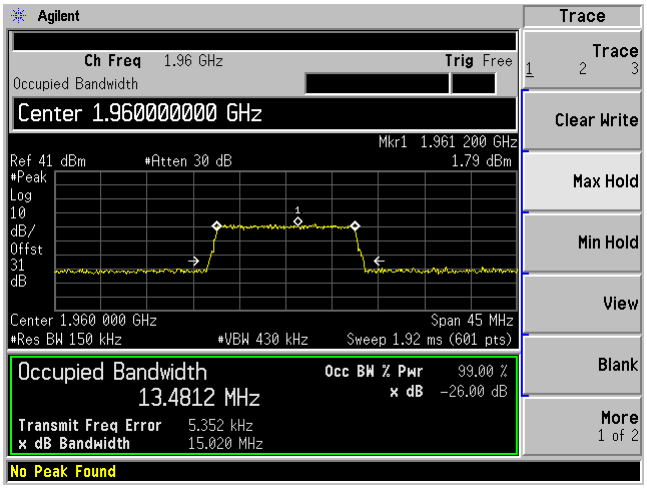

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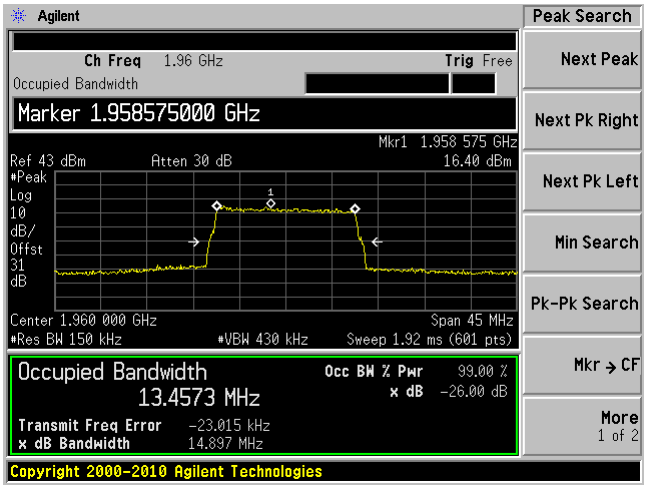
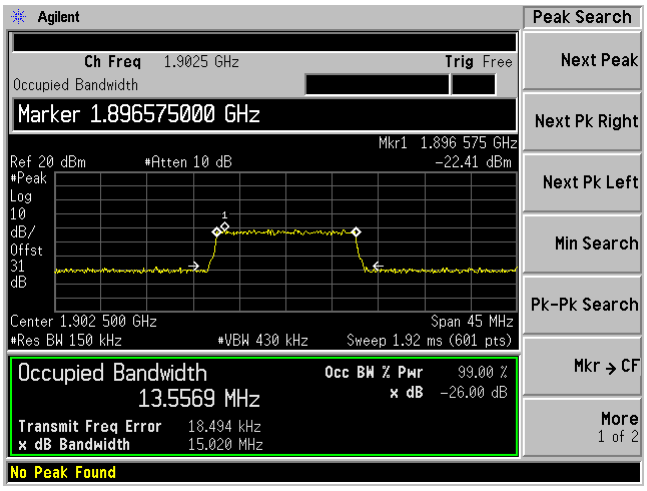


UL High I/P



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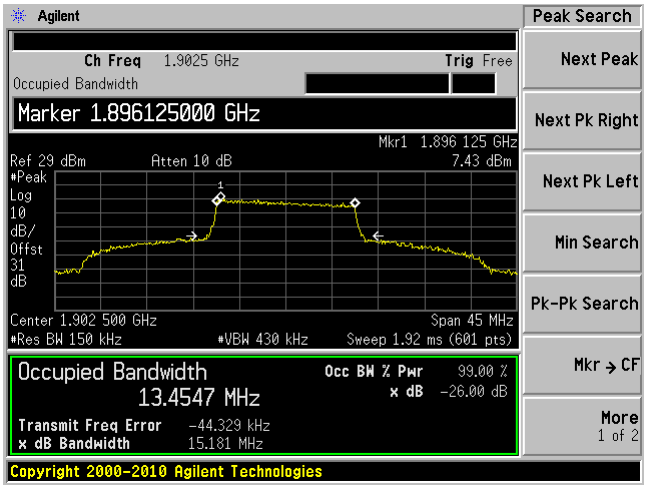

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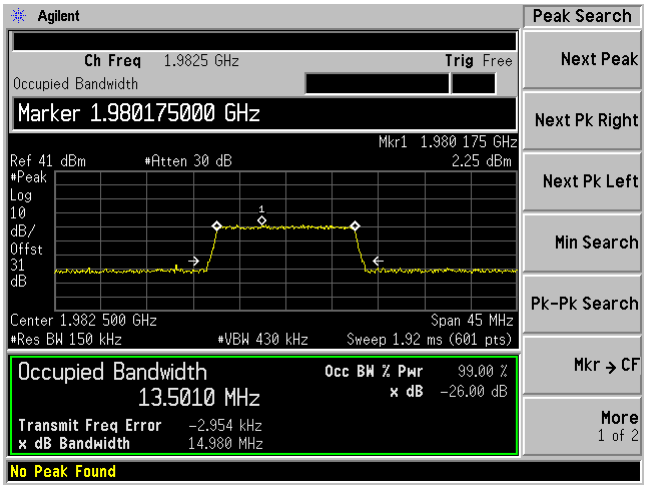

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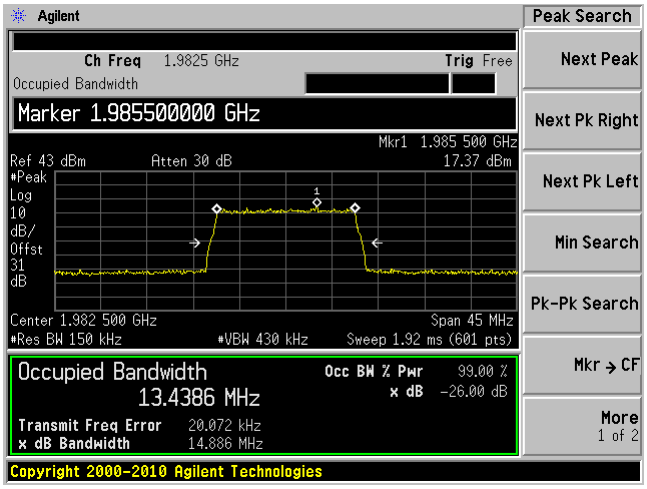
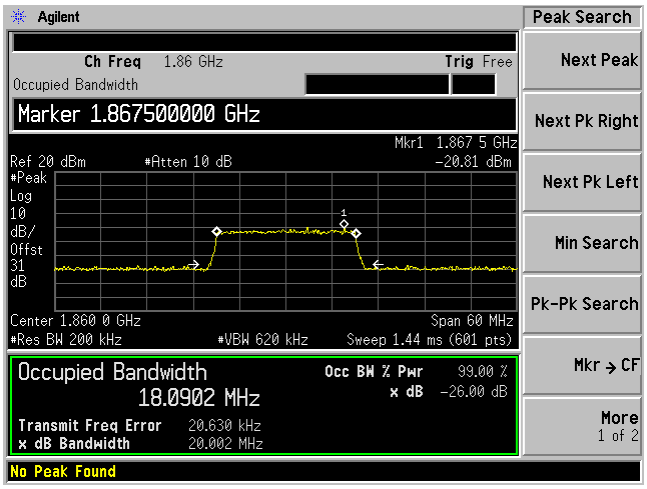


LTE 20 MHz

UL Low I/P



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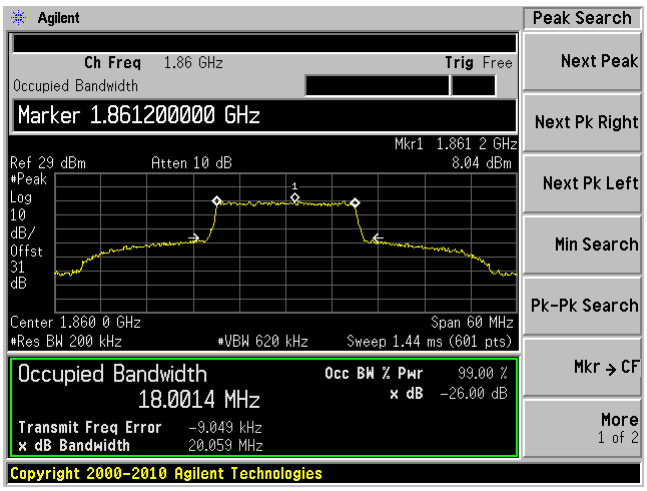

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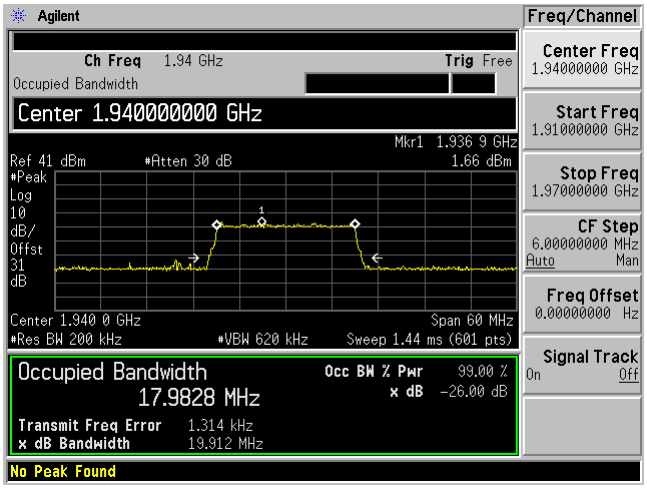
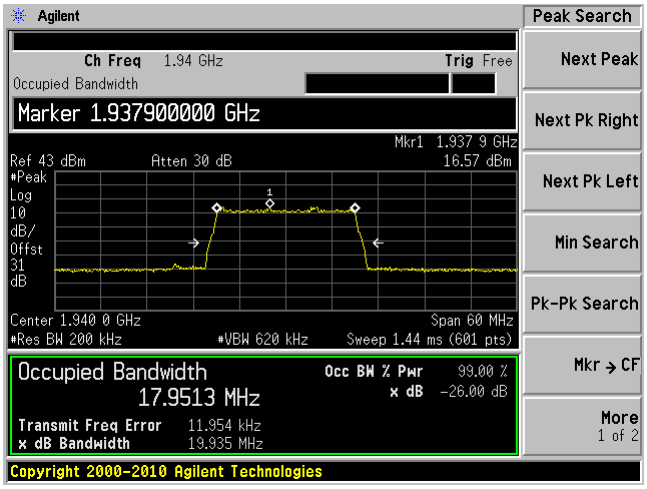
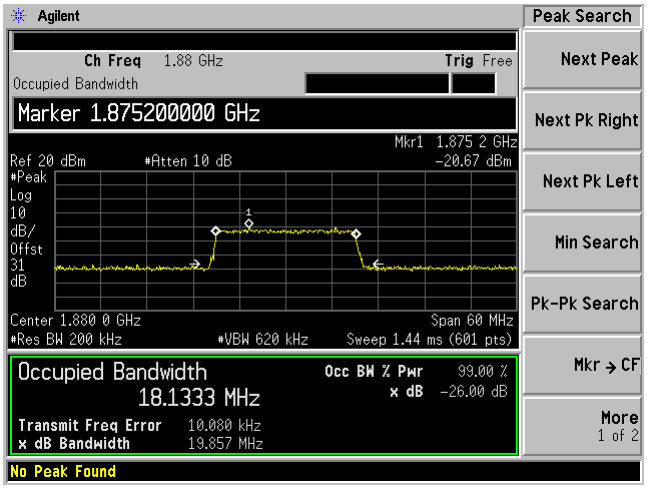


DL Low O/P



UL Middle I/P



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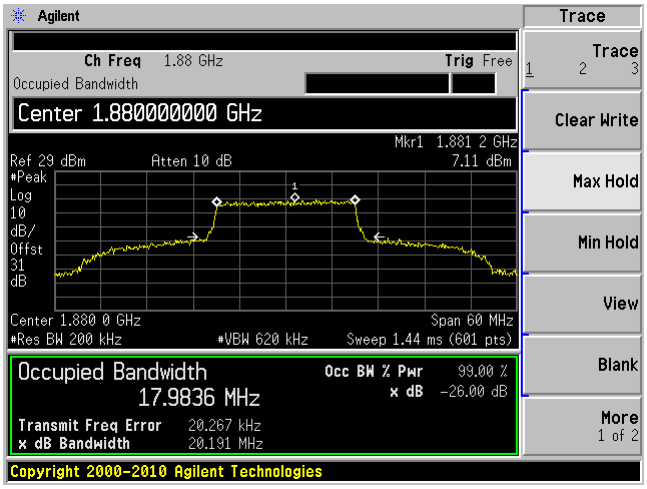

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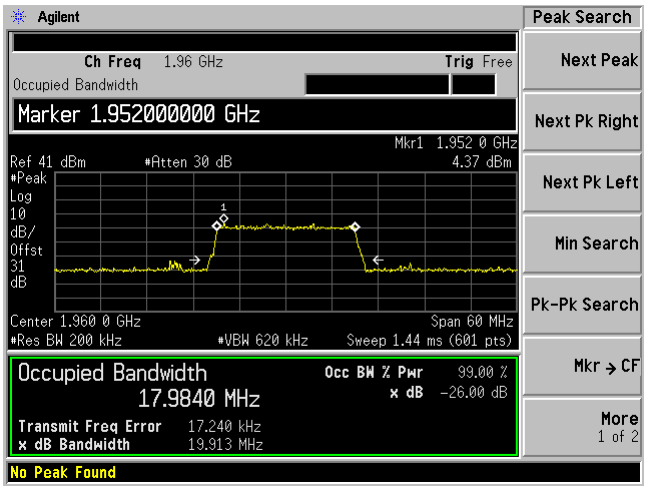

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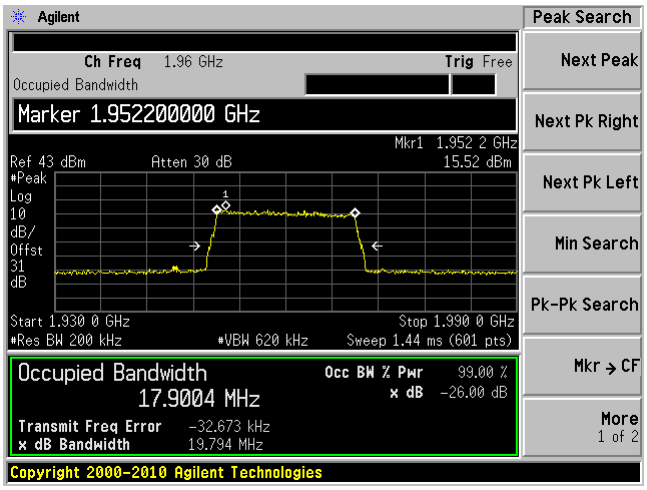
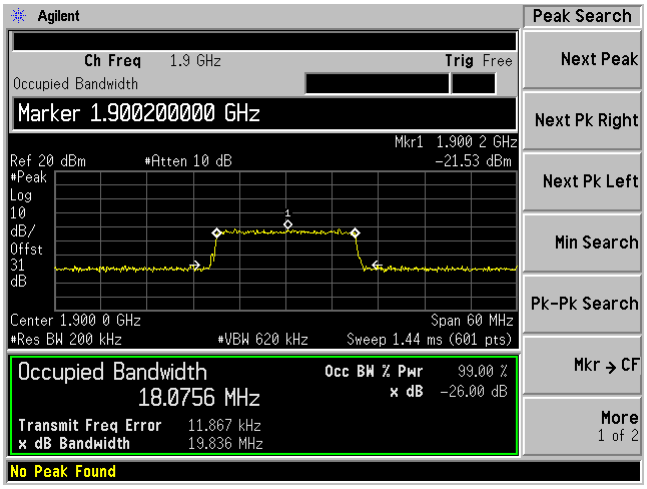


UL High I/P



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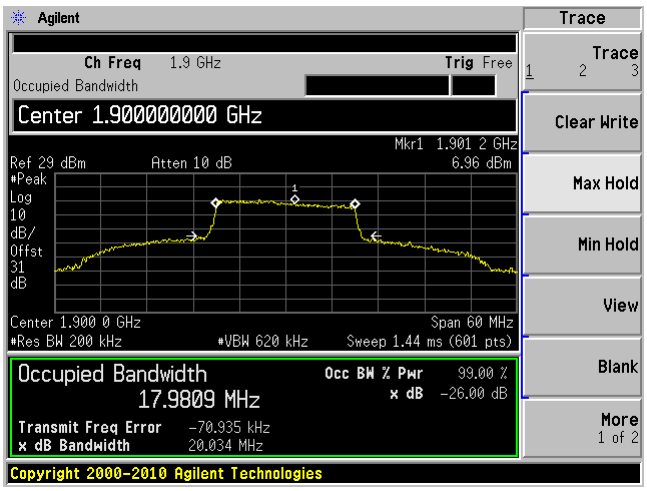

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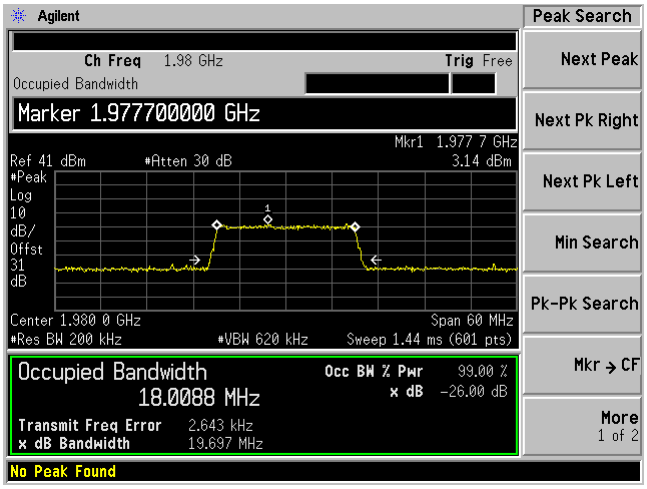

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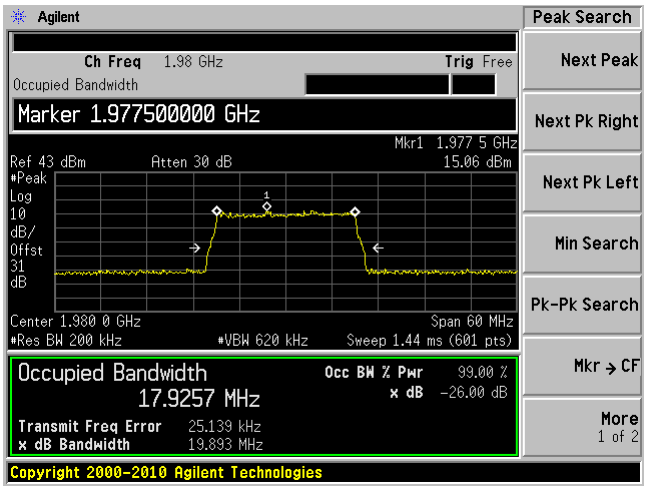


6 FCC §2.1053, §24.238 & IC RSS-131§6.4 - Spurious Radiated Emissions

6.1 Applicable Standards

According to FCC §24.238& RSS 131§6.4, the power of any emissions outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

6.2 Test Procedure

The transmitter was placed on the turntable, and it was transmitting into a non-radiating load which was also placed on the turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3-orthogonal axis.

The frequency range up to tenth harmonic of the fundamental frequency was investigated.
Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

Spurious emissions in dB = 10 log (TX Power in Watts/0.001) – the absolute level
Spurious attenuation limit in dB = 43 + 10 Log10 (power out in Watts)

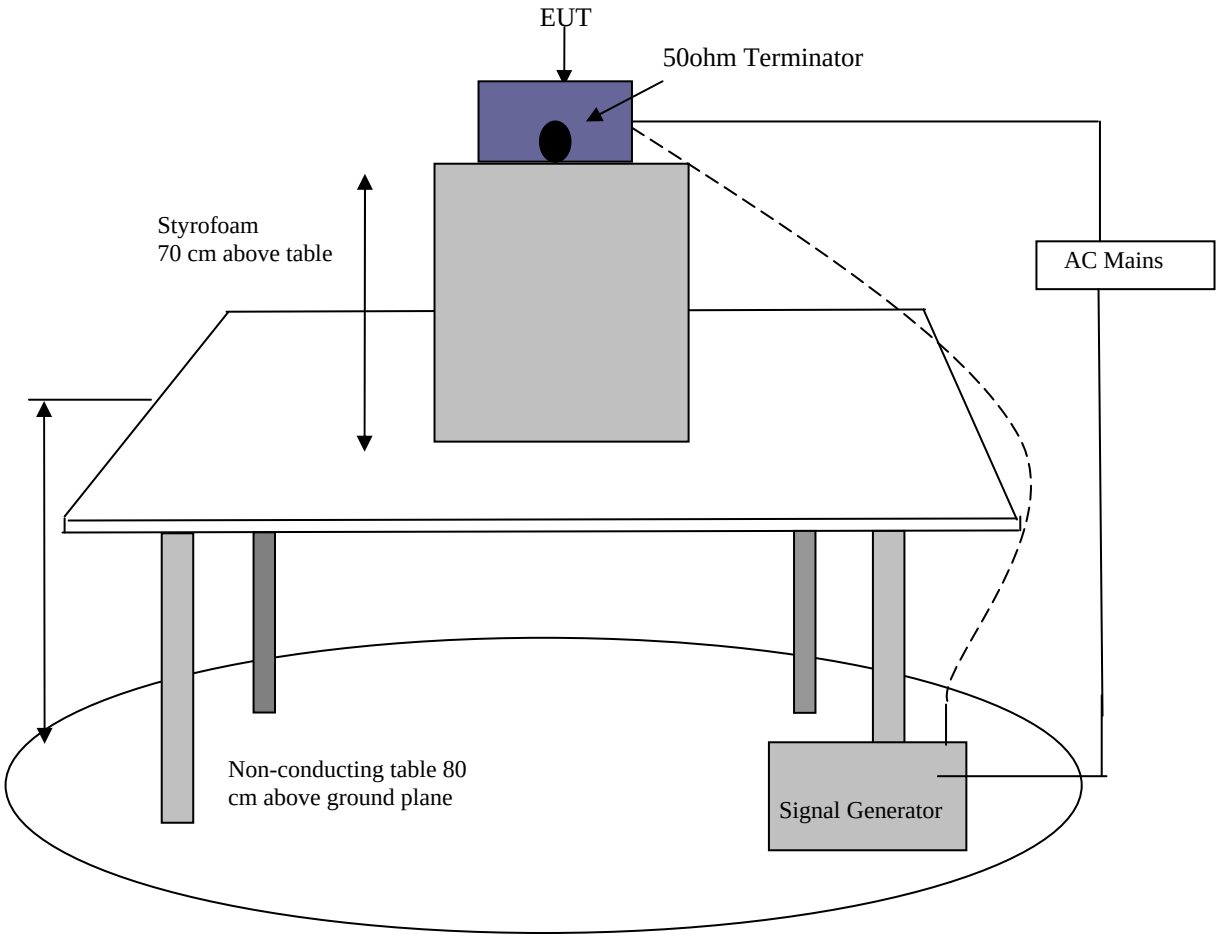
6.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Sunol Science Corp	System Controller	SC99V	122303-1	N/A	N/A
Sunol Sciences	Antenna, Biconi-Log	JB3	A020106-2	2014-09-17	1 year
Hewlett Packard	Pre-amplifier 1-26.5 GHz	8447D	2944A06639	2014-04-26	1 year
HP/ Agilant	Pre Amplifier	8449B OPT HO2	3008A0113	2015-03-12	1 year
E-meca	10dB Attenuator	18N-10-294	64671	N/A	N/A
Micro Tronics	Band Reject Filter	BRM50701	160	N/A	N/A
IW Microwave	SAM-Cable	SPS-2303-3840-SPS	DC1438	N/A	N/A
Hewlett Packard	N-Type Cable	-	692	N/A	N/A
Agilent	Analyzer, Spectrum	E4440A	MY44303352	2014-11-13	1 year
Eaton	Antenna, Horn	96001	2617	2014-11-18	1 year
Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100044	2014-07-17	1 year

Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

6.4 Test Setup Block Diagram

Radiated Emissions Testing



6.5 Test Environmental Conditions

Temperature:	21-23 °C
Relative Humidity:	42-48 %
ATM Pressure:	101.4-102 kPa

The testing was performed by Bo Li on 2015-07-23 to 2015-07-24 in the 5M3 chamber

6.6 Test Results

Uplink (Input frequency = 1880 MHz)

Indicated		Azimuth (degree)	Test Antenna		Substituted					Limit (dBm)	Margin (dB)
Frequency (MHz)	S.A. Amp. (dBuV)		Height (cm)	Polarity (H/V)	Frequency (MHz)	Level (dBm)	Ant. Gain Correction (dB)	Cable Loss (dB)	Absolute Level (dBm)		
500.4	32.94	13	150	H	500.4	-50.27	0	1.78	-52.05	-13	-39.05
500.4	29.5	13	150	V	500.4	-52.25	0	1.78	-54.03	-13	-41.03
2456	47.62	57	150	H	2456	-51	9.747	1	-42.253	-13	-29.253
2456	46.94	57	150	V	2456	-52.41	9.436	1	-43.974	-13	-30.974

Downlink (Input frequency = 1987.6 MHz)

Indicated		Azimuth (degree)	Test Antenna		Substituted					Limit (dBm)	Margin (dB)
Frequency (MHz)	S.A. Amp. (dBuV)		Height (cm)	Polarity (H/V)	Frequency (MHz)	Level (dBm)	Ant. Gain Correction (dB)	Cable Loss (dB)	Absolute Level (dBm)		
713.2	38.47	0	150	H	713.2	-48.89	0	1.78	-50.67	-13	-37.67
713.2	38.76	0	150	V	713.2	-48.21	0	1.78	-49.99	-13	-36.99
2461	46.12	53	150	H	2461	-52.3	9.747	3.53	-46.083	-13	-33.083
2461	47.28	53	150	V	2461	-51.48	9.436	3.53	-45.574	-13	-32.574

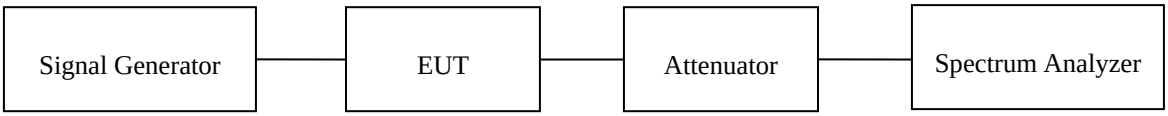
7 FCC §2.1051, §24.238 & IC RSS-131§6.4 - Spurious Emissions at Antenna Terminals

7.1 Applicable Standards

According to FCC §24.238 & IC RSS-131§6.4, the power of any emissions outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

7.2 Test Procedure

The RF output of the transceiver was connected to a spectrum analyzer and simulator through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.



7.3 Test Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Dates	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	MY44303352	2014-10-16	1 year
Rohde & Schwarz	Signal Generator	SMIQ03	849192/0085/ DE23746	2014-04-23	2 years
Agilent	Signal Generator	E4438C	MY45091309	2014-07-15	2 year

Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

7.4 Test Environmental Conditions

Temperature:	21-23 °C
Relative Humidity:	42-48 %
ATM Pressure:	101.4-102 kPa

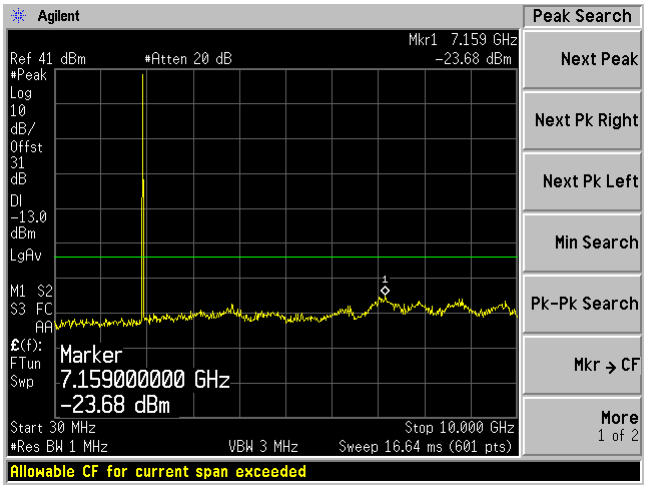
The testing was performed by Ronak Patel on 2015-07-29 to 2015-07-31 in the RF Site.

7.5 Test results

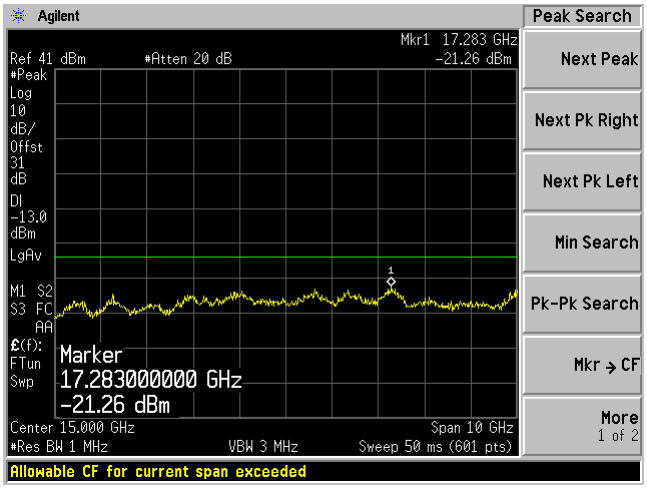
Please refer to the following plots.

GSM/GPRS

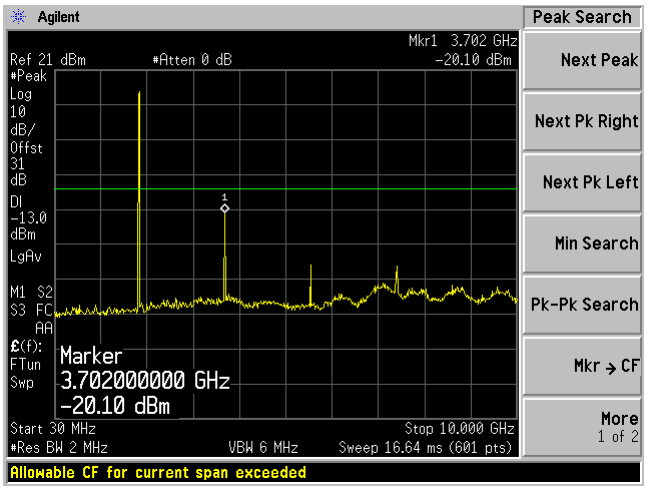
DL Low (30MHz-10GHz)



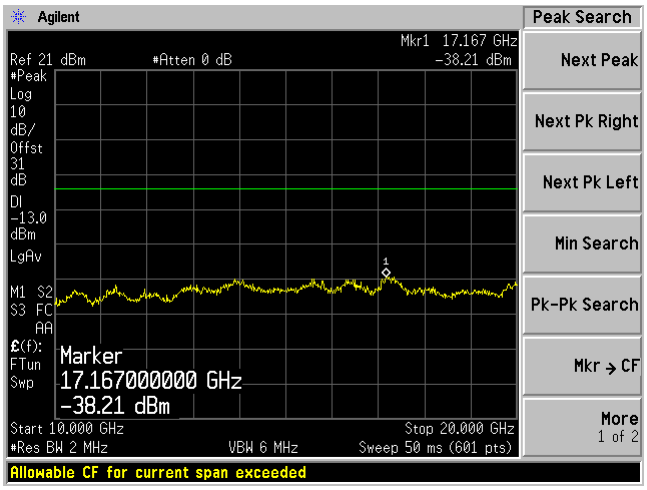
DL Low (10GHz-20GHz)



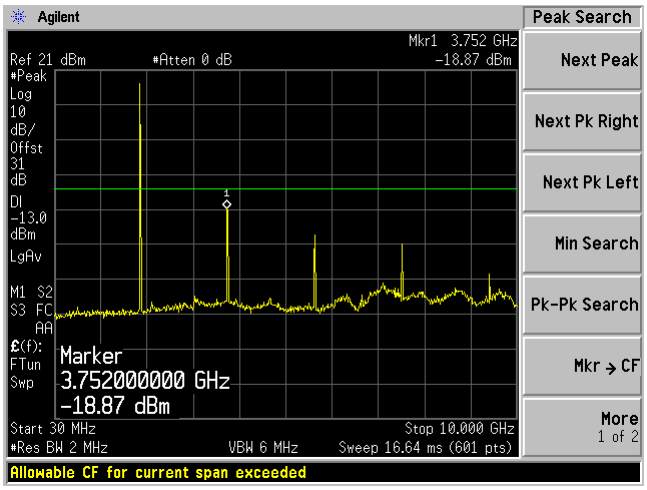
UL Low (30MHz-10GHz)



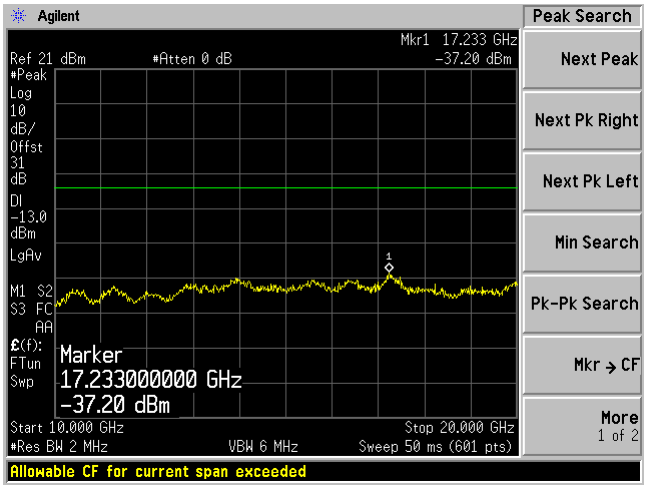
UL Low (10GHz-20GHz)



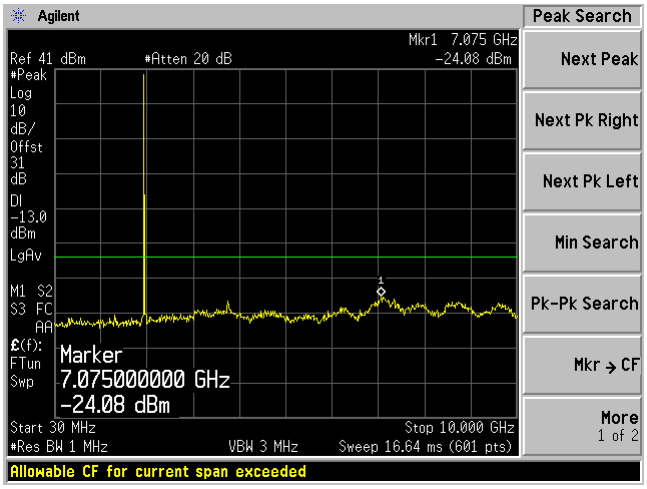
UL Middle (30MHz-10GHz)



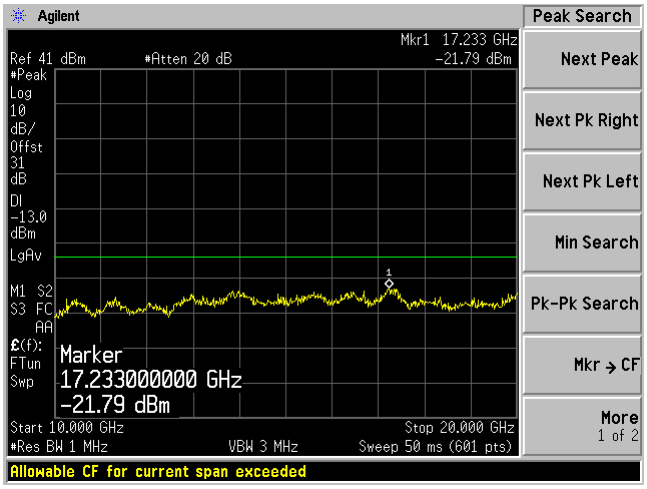
UL Middle (10GHz-20GHz)



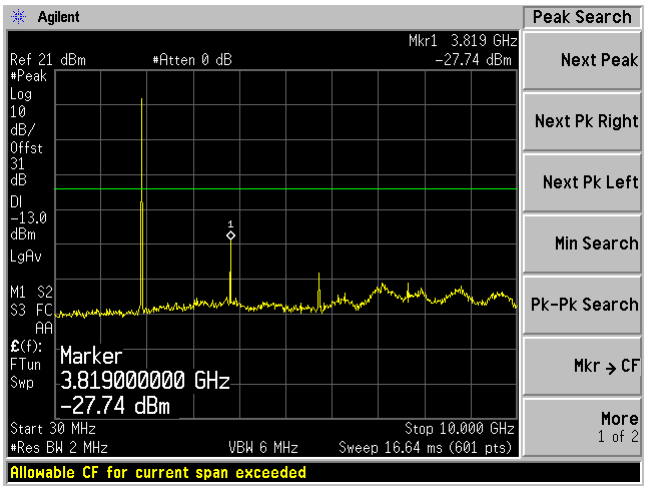
DL Middle (30MHz-10GHz)



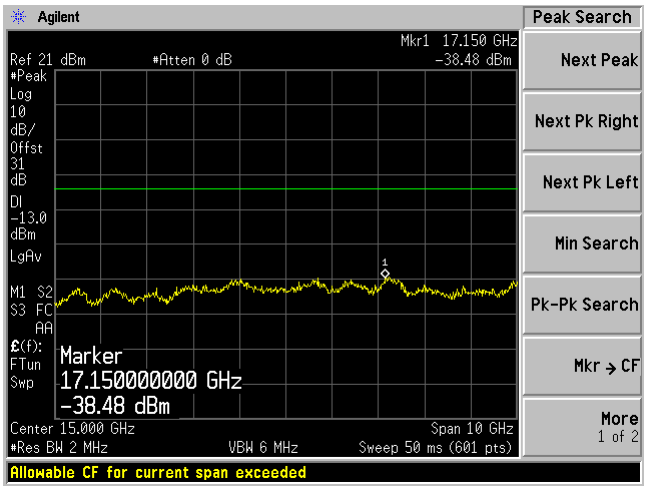
DL Middle (10GHz-20GHz)



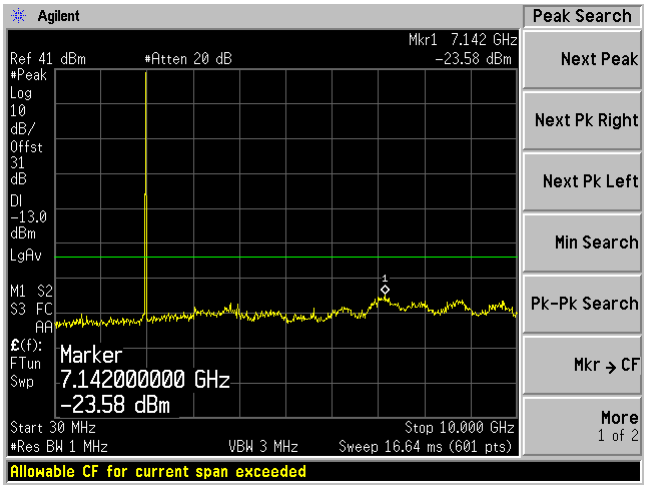
UL High (30MHz-10GHz)



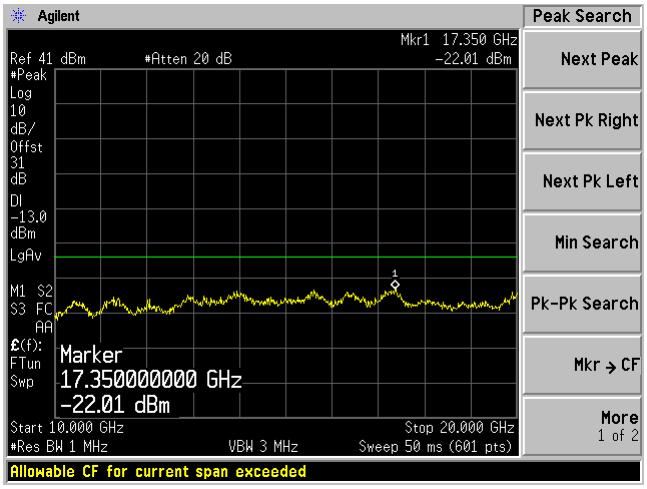
UL High (10GHz-20GHz)



DL High (30MHz-10GHz)

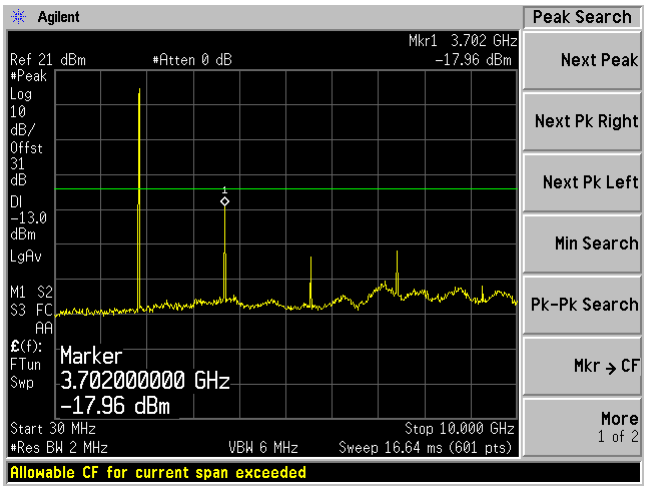


DL High (10GHz-20GHz)

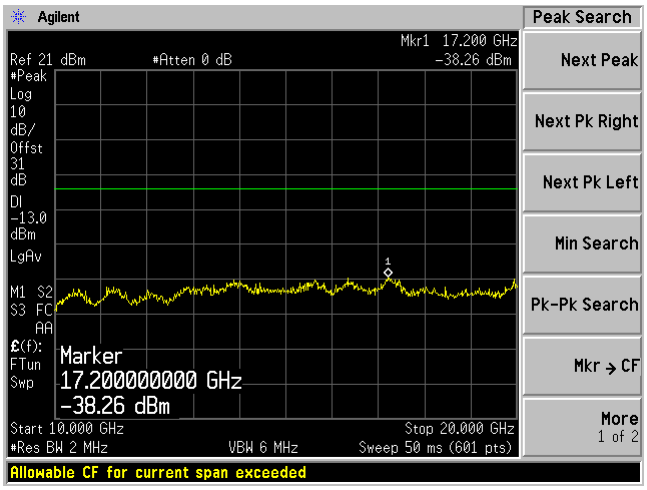


CDMA

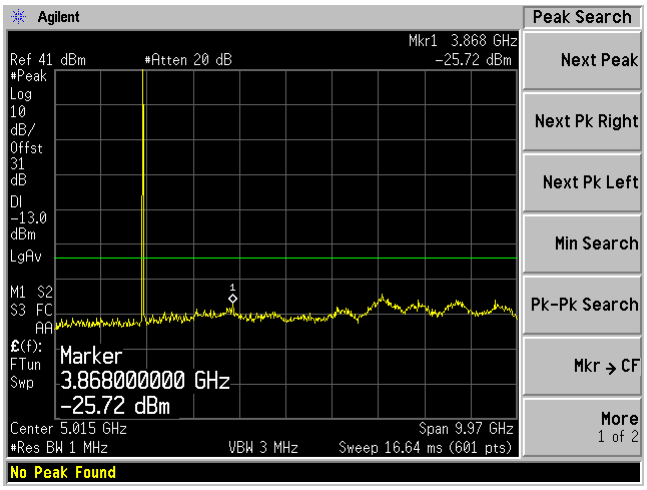
UL Low (30MHz-10GHz)



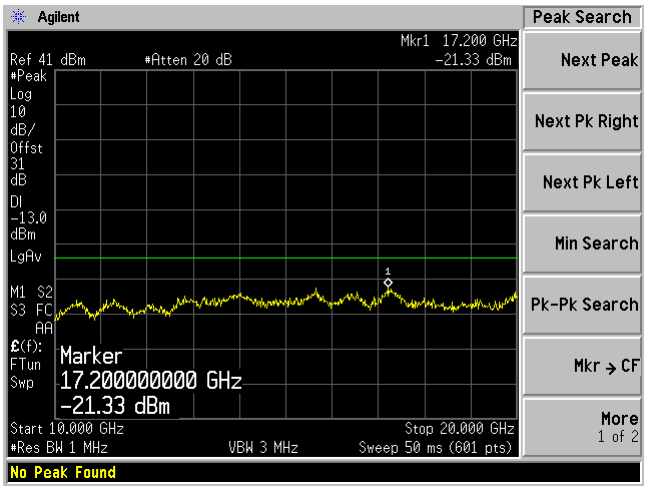
UL Low (10GHz-20GHz)



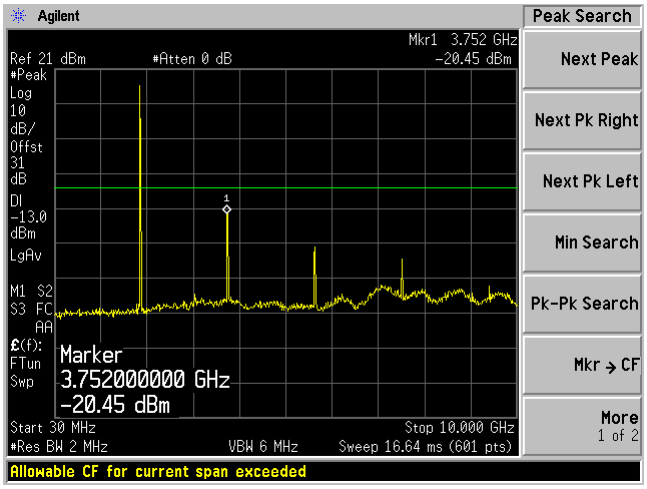
DL Low (30MHz-10GHz)



DL Low (10GHz-20GHz)



UL Middle (30MHz-10GHz)



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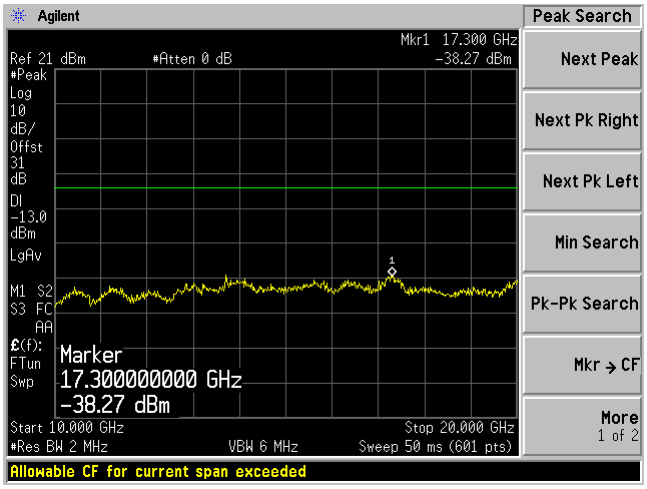
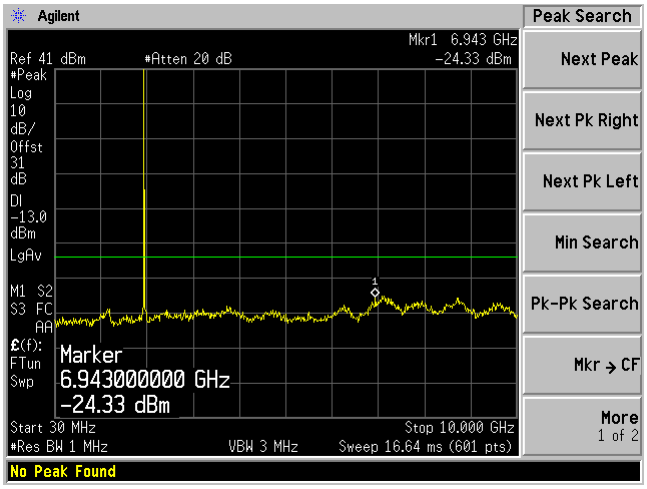


DL Middle (30MHz-10GHz)



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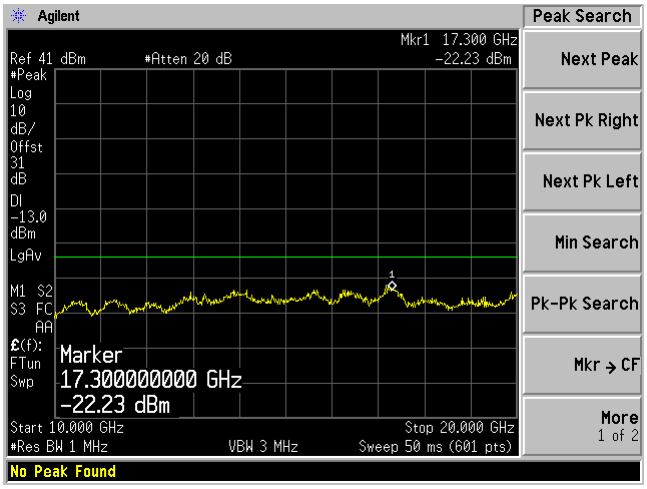

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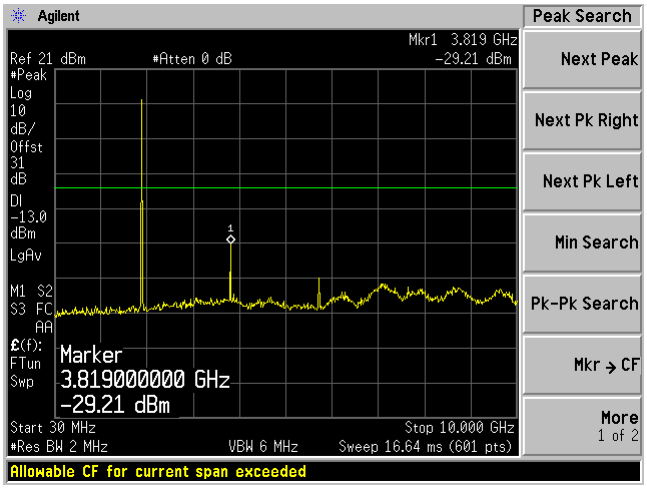

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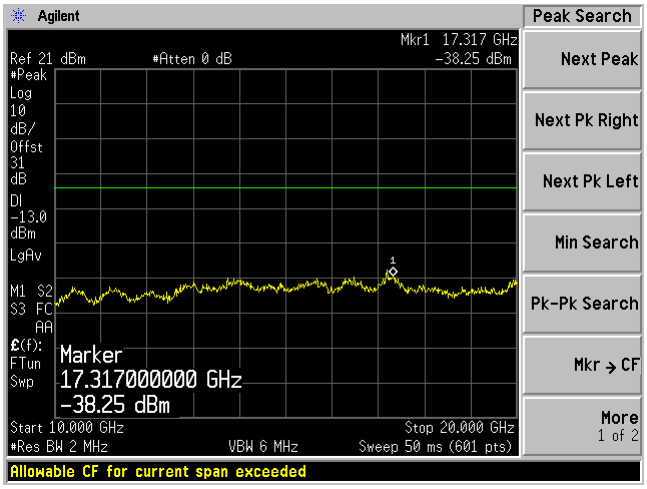

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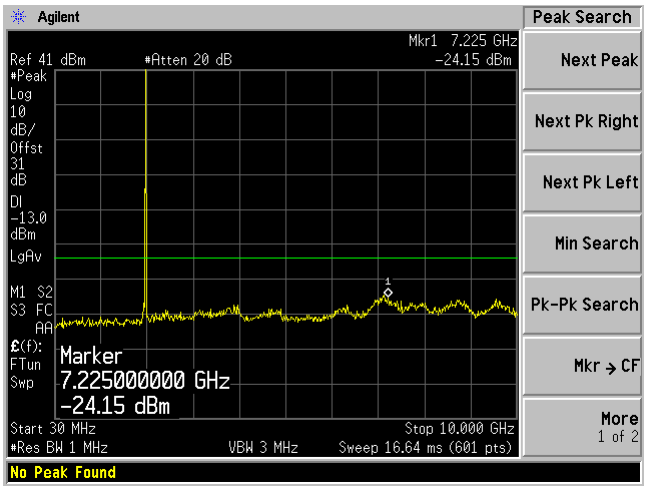
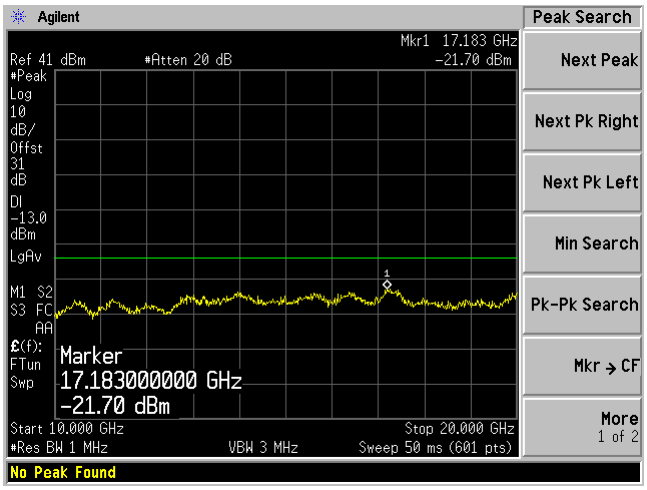
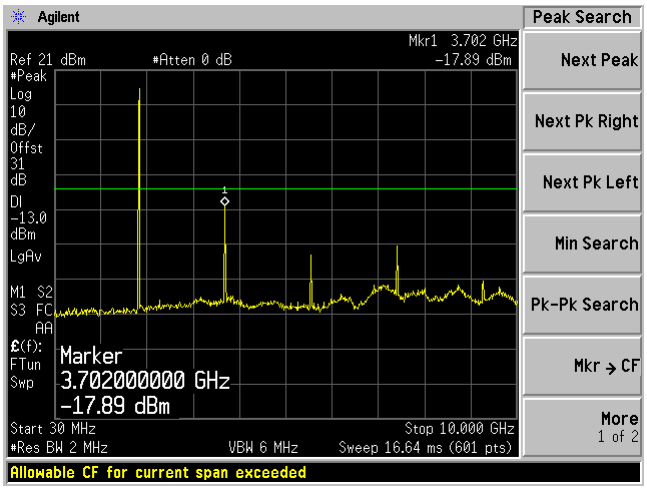


DL High (10GHz-20GHz)

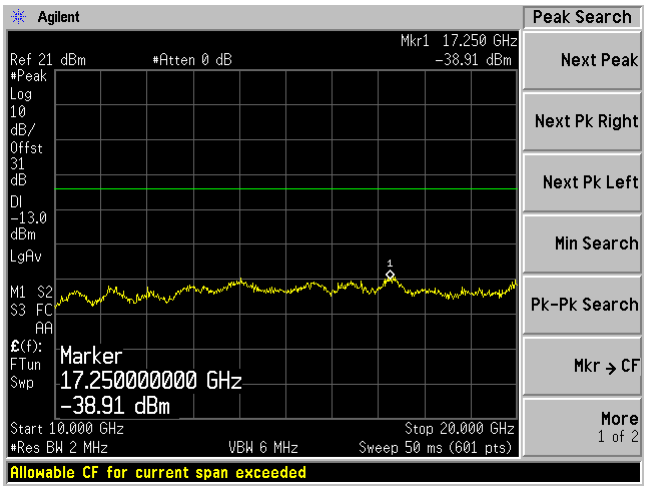


WCDMA

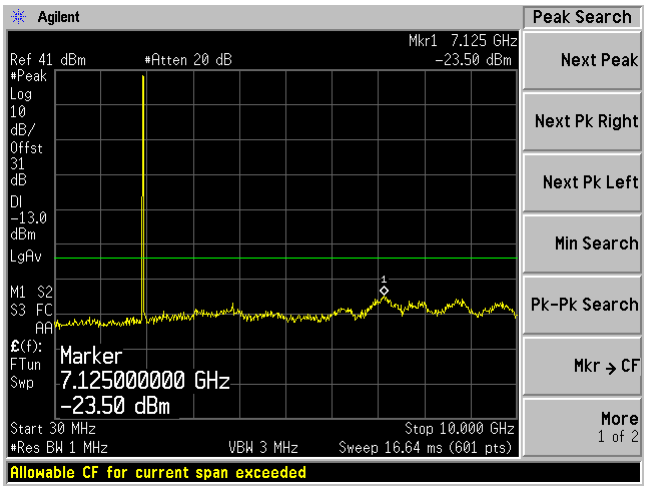
UL Low (30MHz-10GHz)



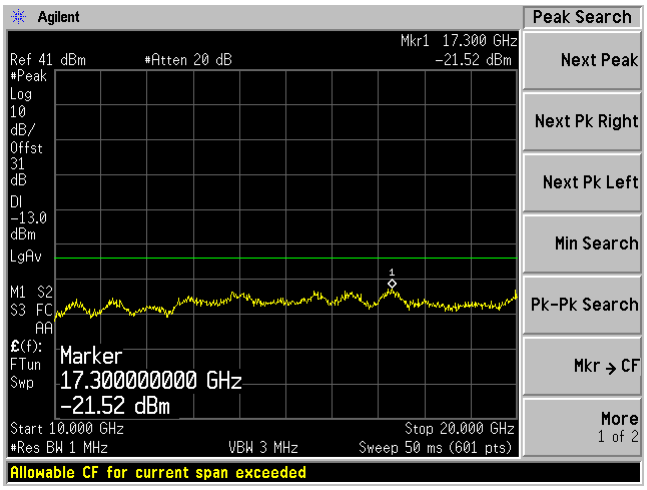
UL Low (10GHz-20GHz)



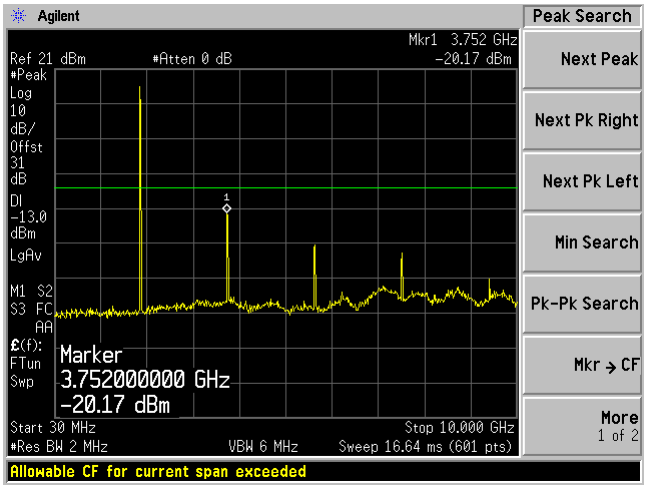
DL Low (30MHz-10GHz)



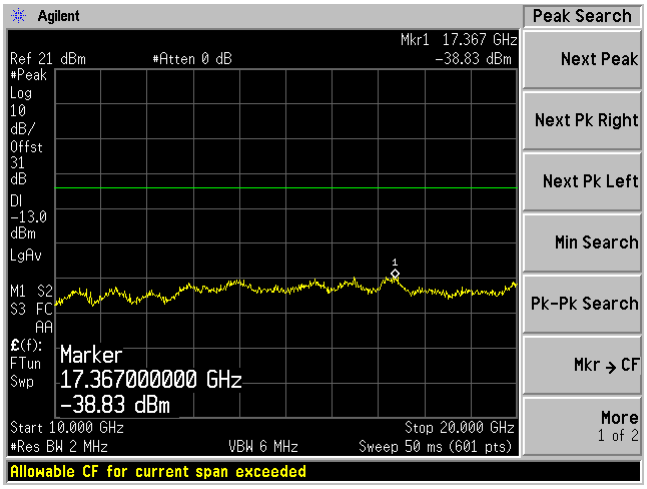
DL Low (10GHz-20GHz)



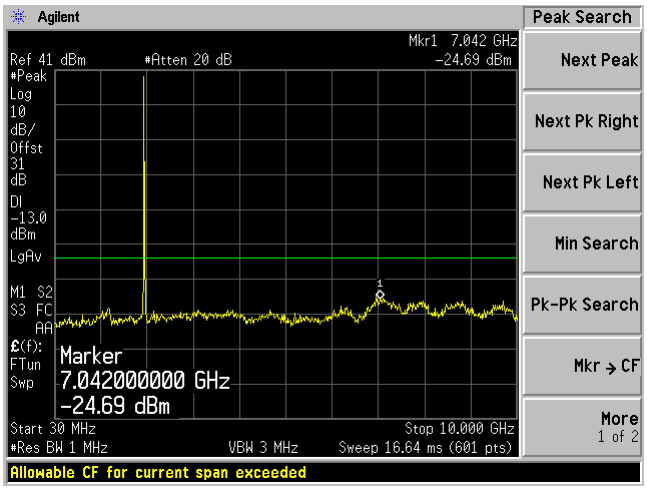
UL Middle (30MHz-10GHz)



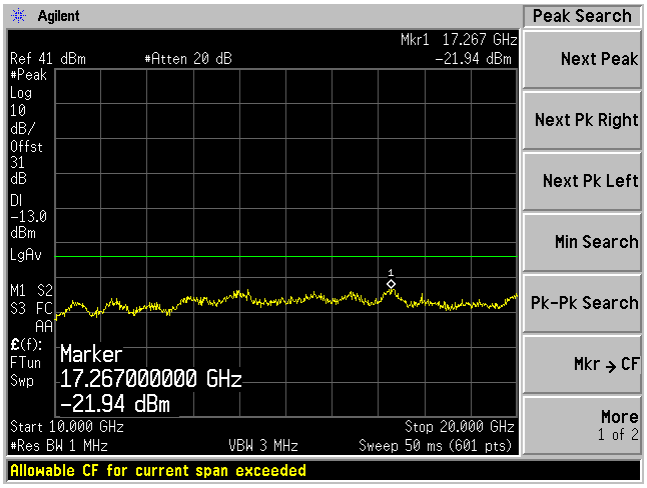
UL Middle (10GHz-20GHz)



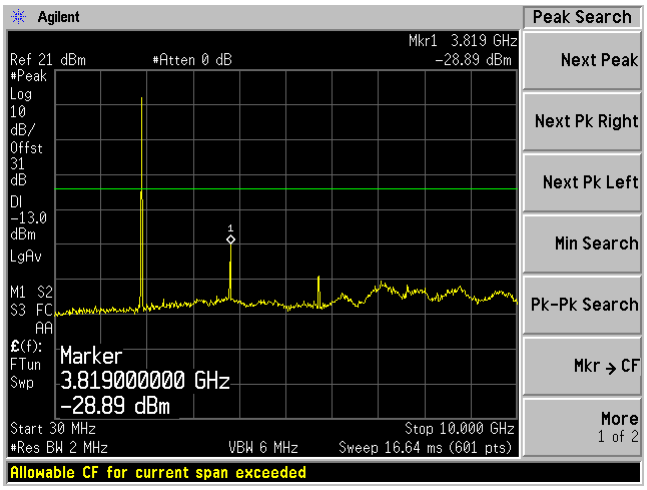
DL Middle (30MHz-10GHz)



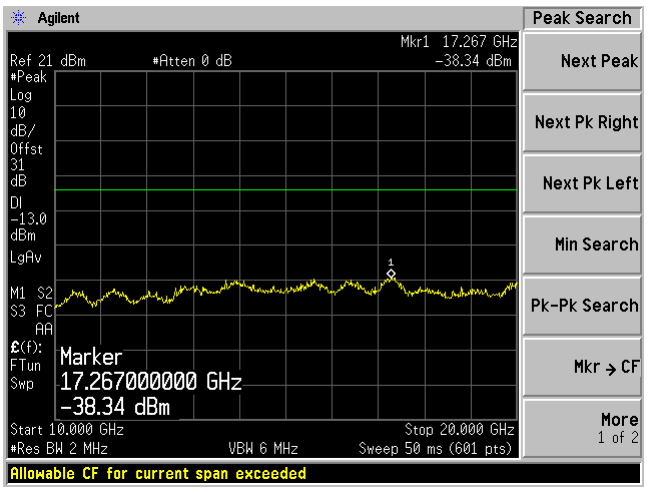
DL Middle (10GHz-20GHz)



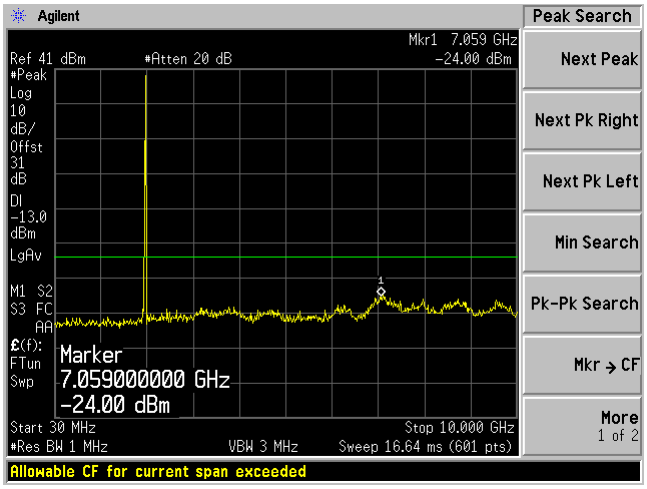
UL High (30MHz-10GHz)



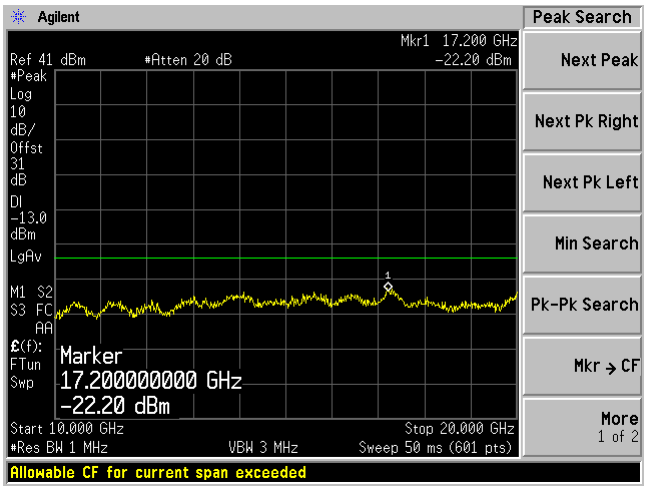
UL High (10GHz-20GHz)



DL High (30MHz-10GHz)

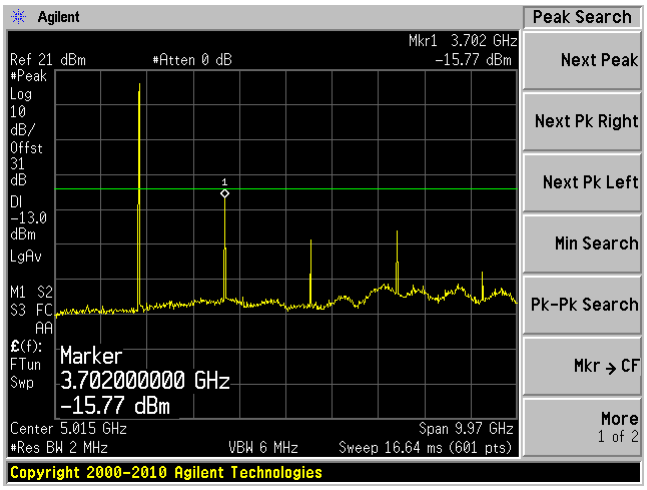


DL High (10GHz-20GHz)

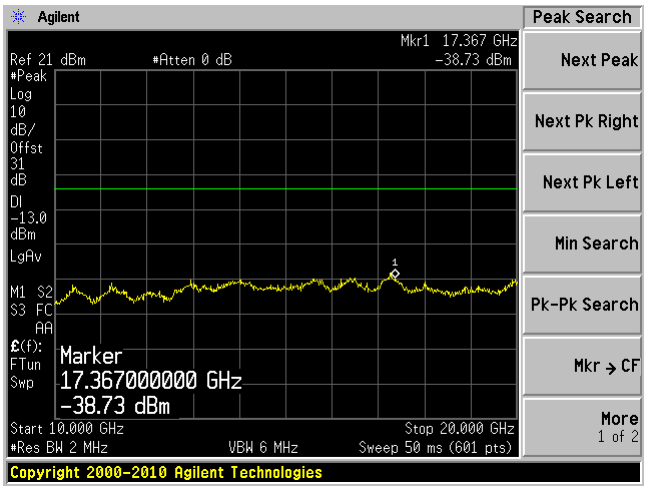


LTE 1.4 MHz

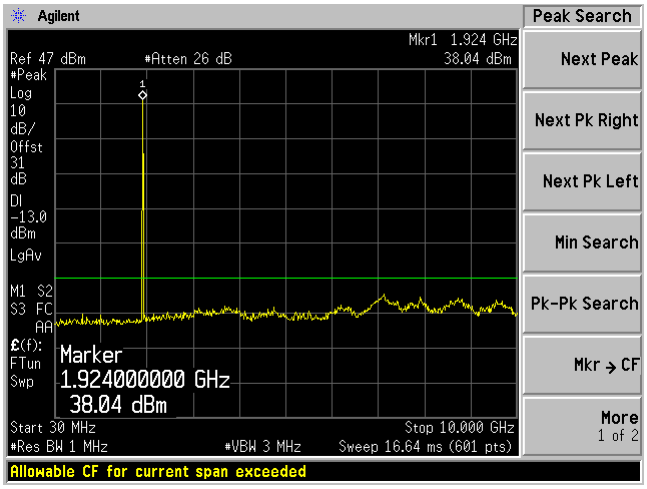
UL Low (30MHz-10GHz)



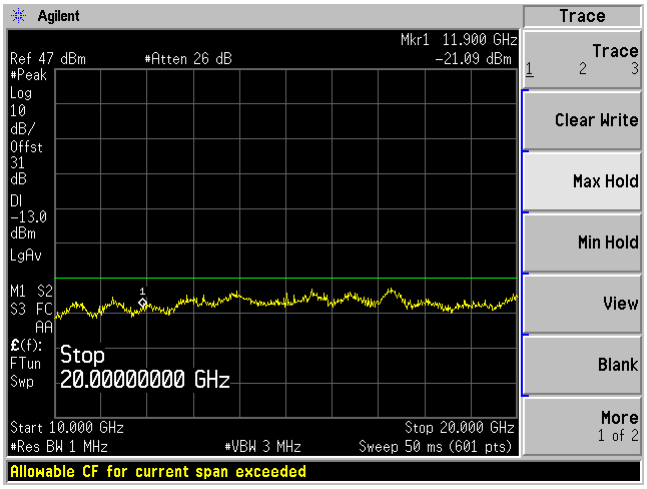
UL Low (10GHz-20GHz)



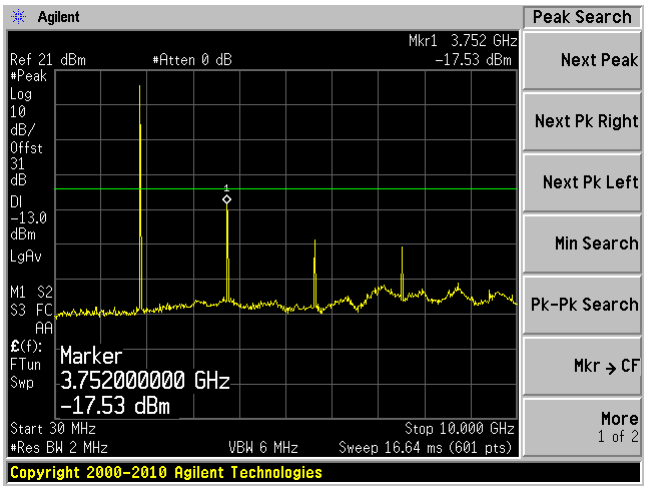
DL Low (30MHz-10GHz)



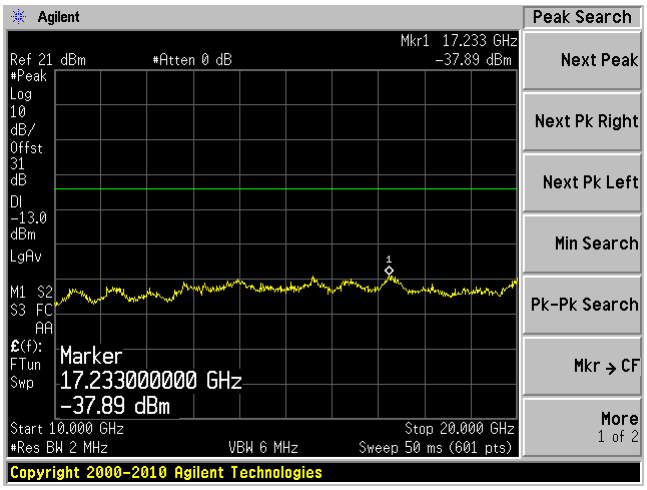
DL Low (10GHz-20GHz)



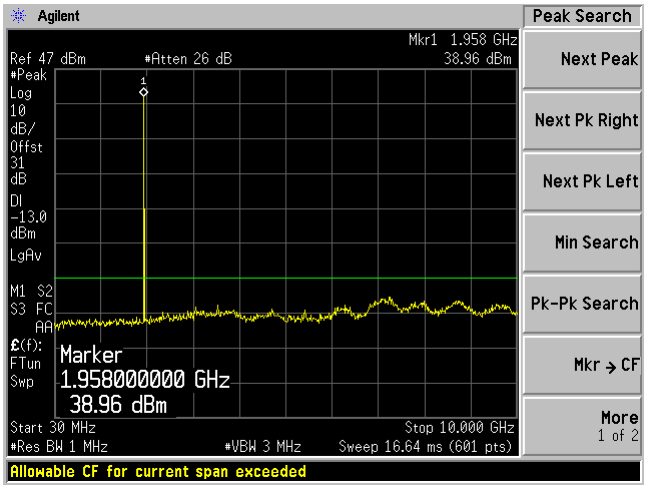
UL Middle (30MHz-10GHz)



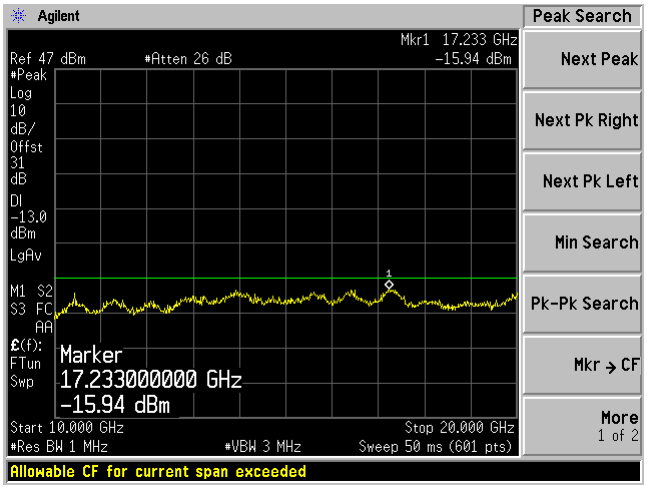
UL Middle (10GHz-20GHz)



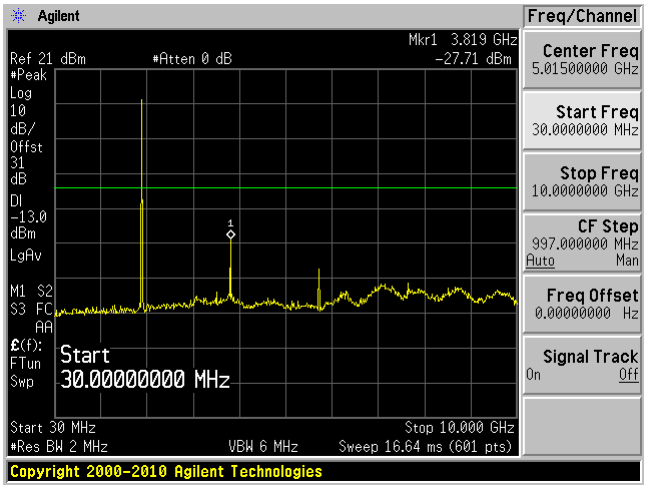
DL Middle (30MHz-10GHz)



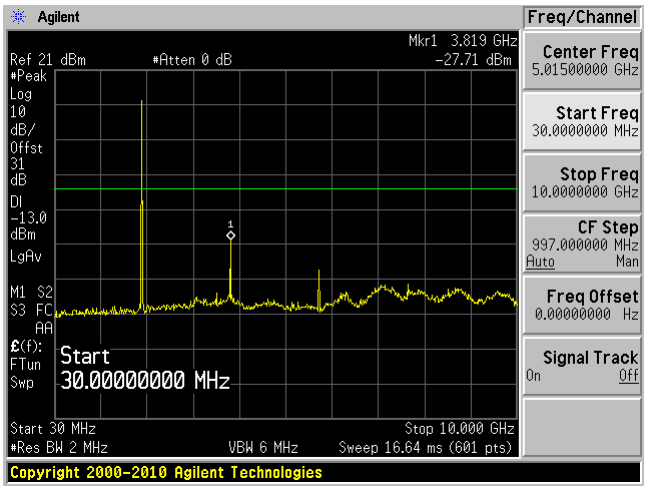
DL Middle (10GHz-20GHz)



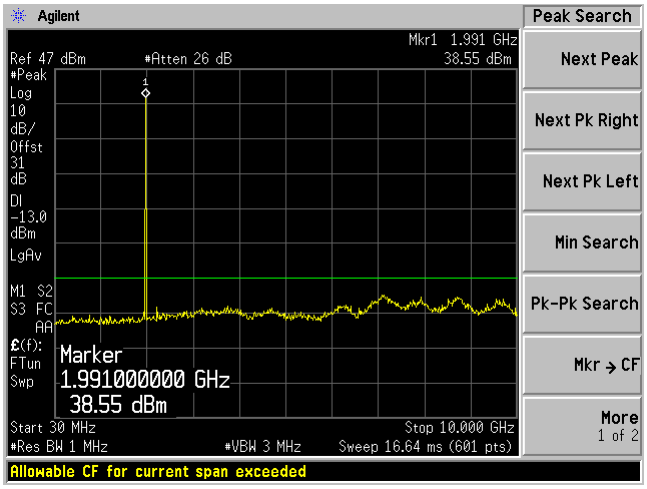
UL High (30MHz-10GHz)



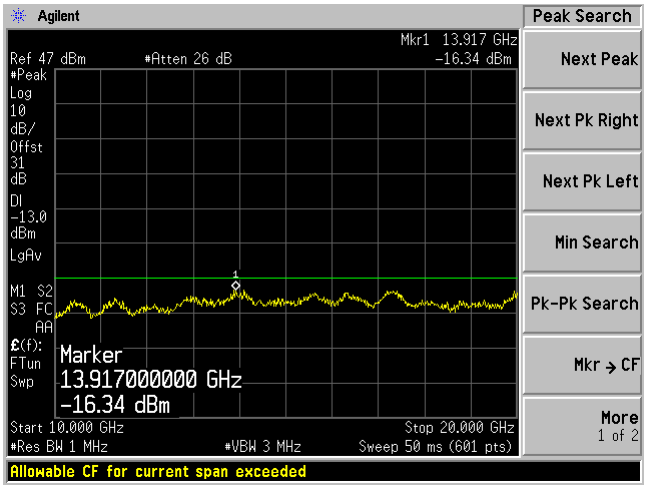
UL High (10GHz-20GHz)



DL High (30MHz-10GHz)

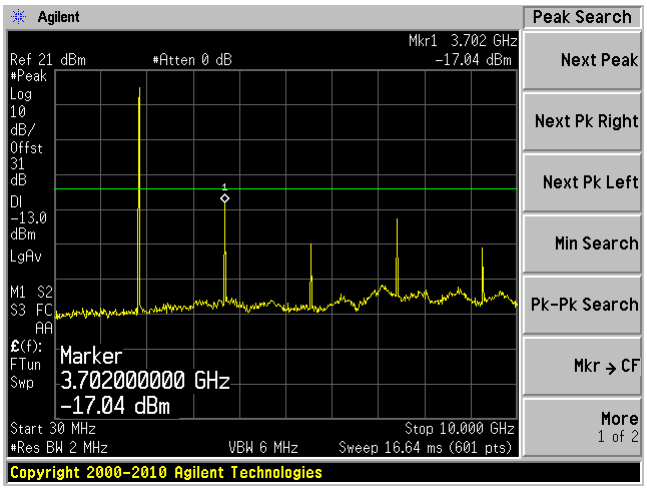


DL High (10GHz-20GHz)

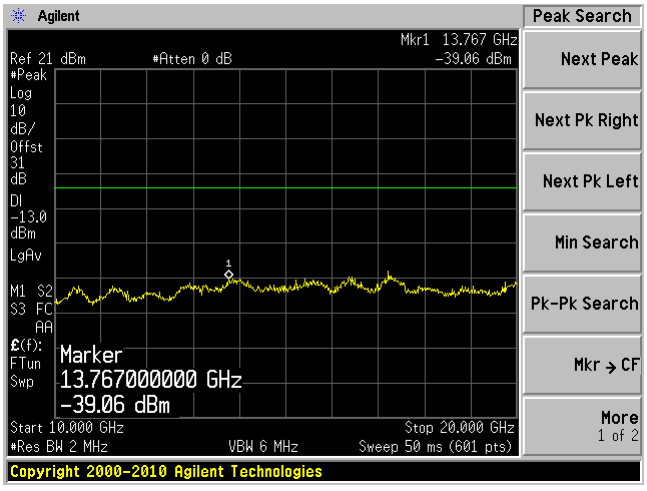


LTE 3 MHz

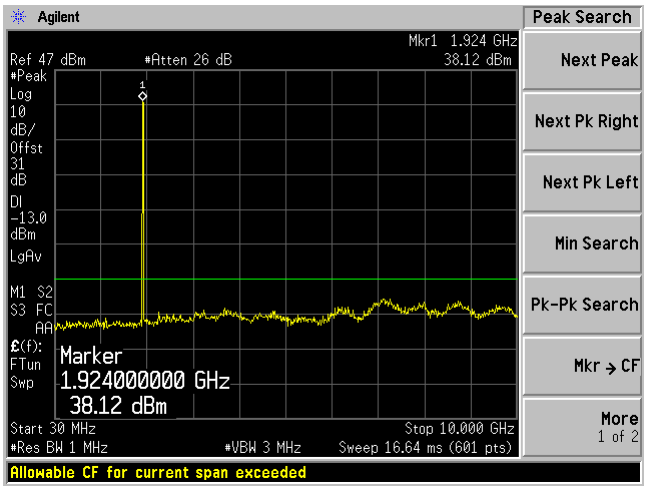
UL Low (30MHz-10GHz)



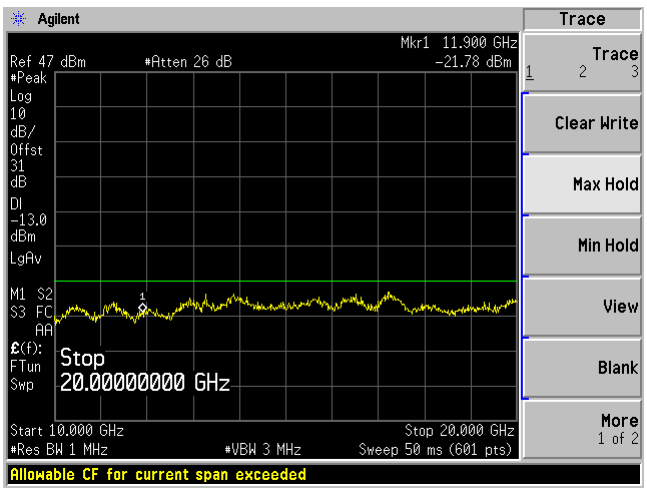
UL Low (10GHz-20GHz)



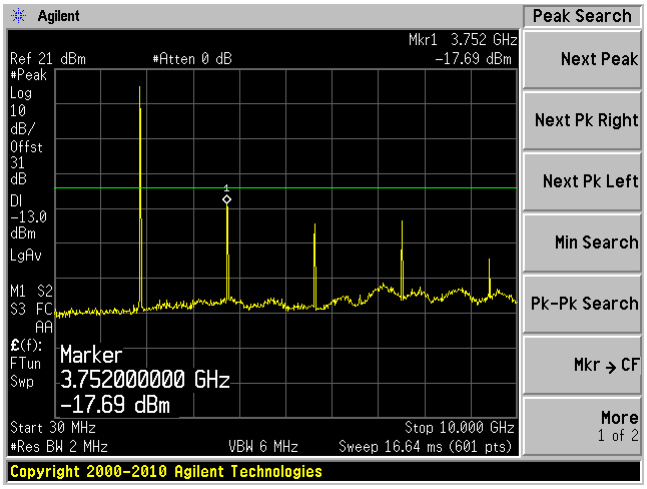
DL Low (30MHz-10GHz)



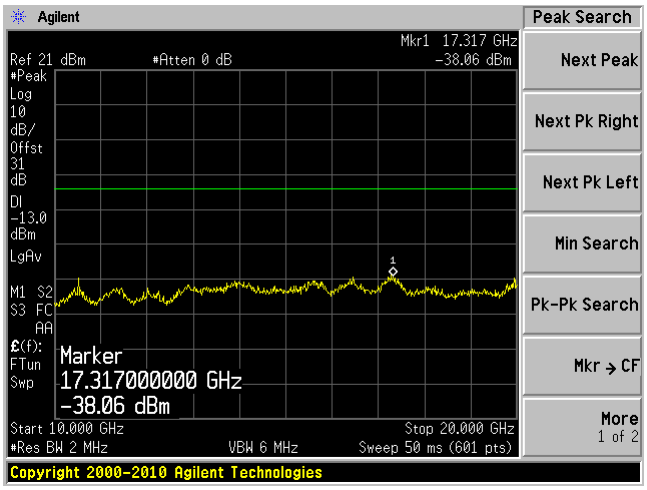
DL Low (10GHz-20GHz)



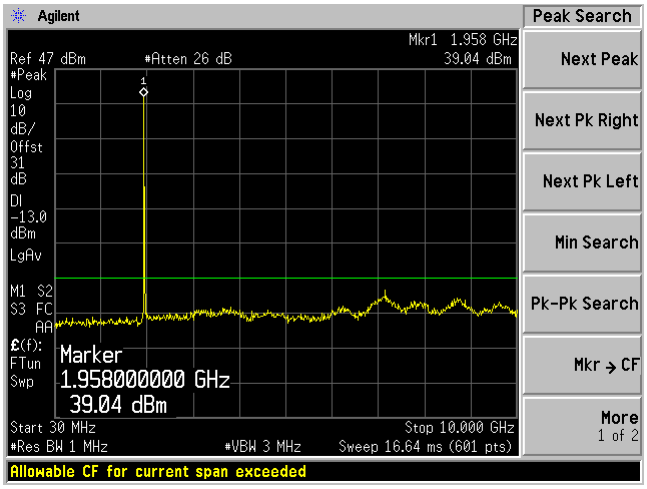
UL Middle (30MHz-10GHz)



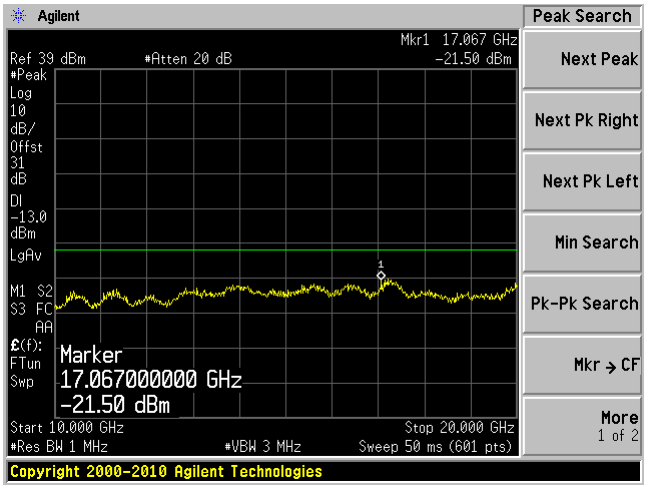
UL Middle (10GHz-20GHz)



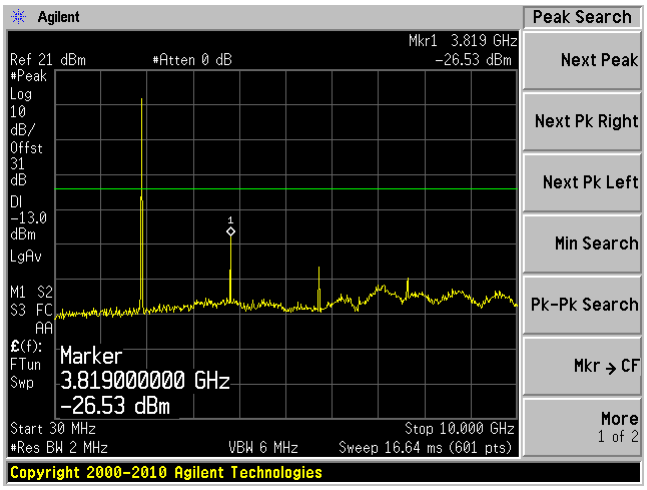
DL Middle (30MHz-10GHz)



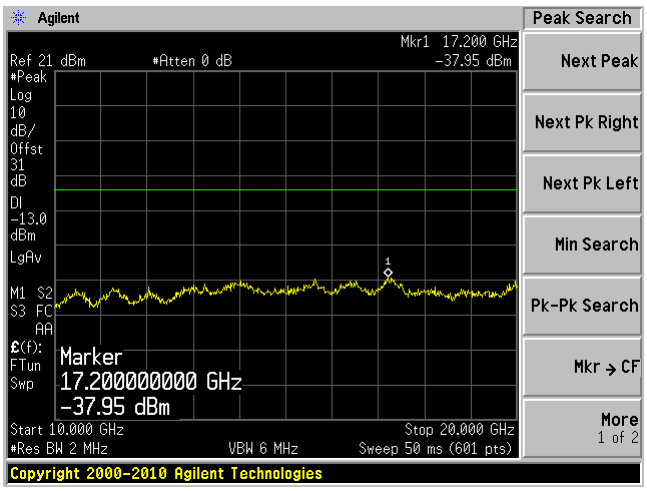
DL Middle (10GHz-20GHz)



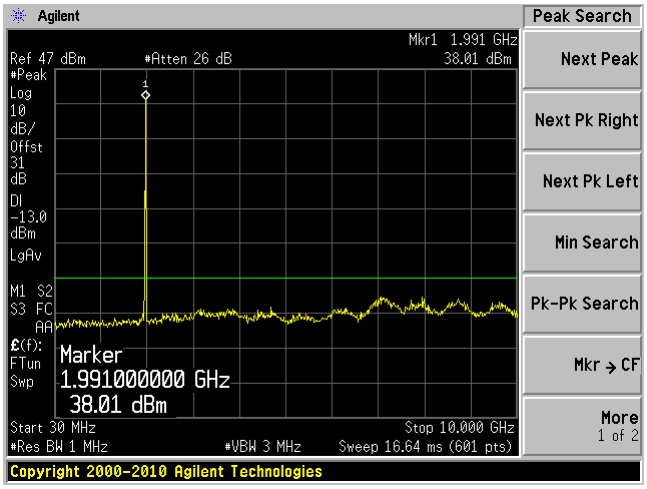
UL High (30MHz-10GHz)



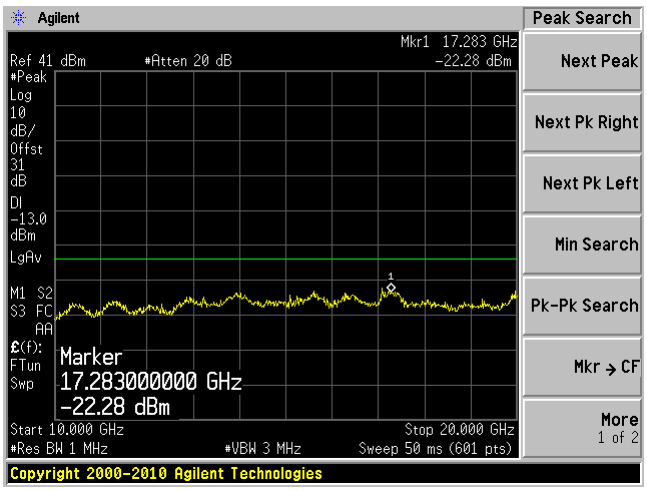
UL High (10GHz-20GHz)



DL High (30MHz-10GHz)

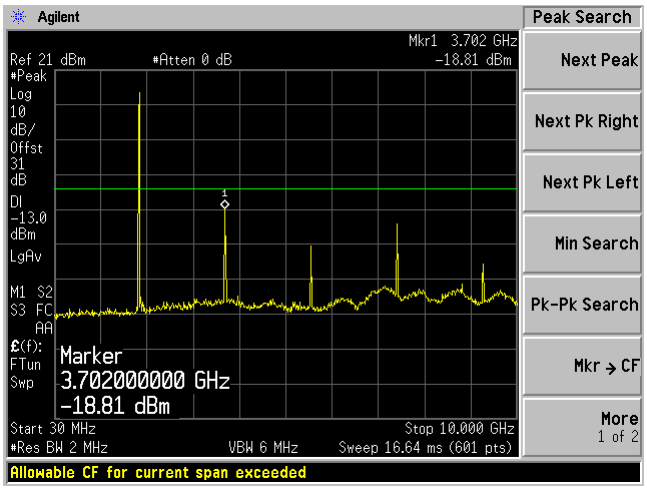


DL High (10GHz-20GHz)

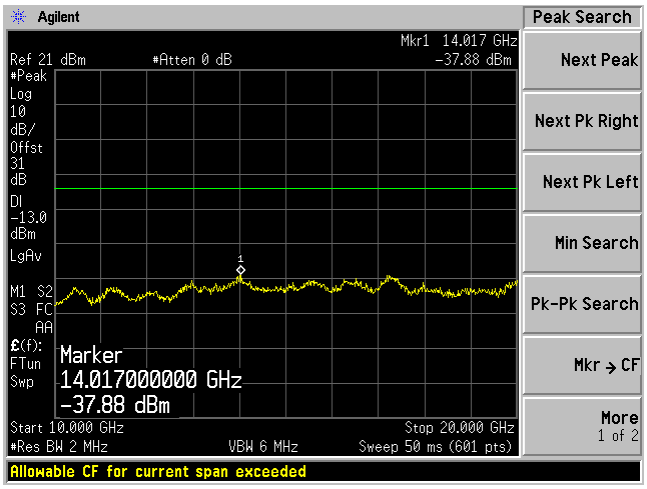


LTE 5 MHz

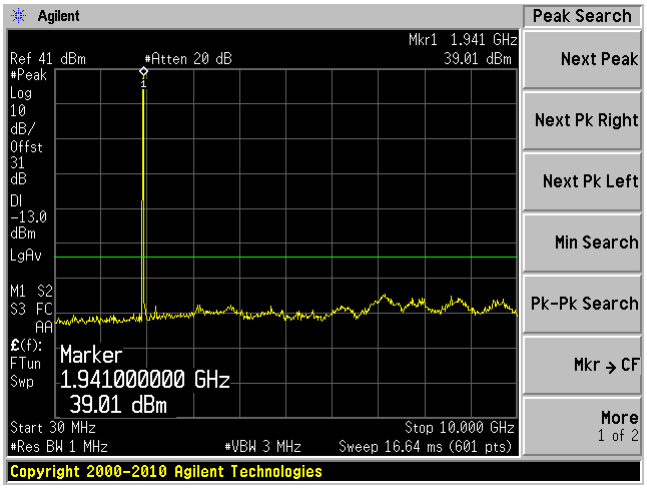
UL Low (30MHz-10GHz)



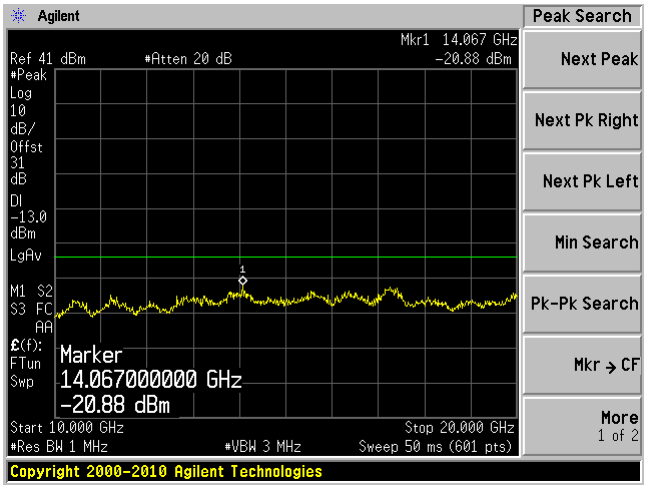
UL Low (10GHz-20GHz)



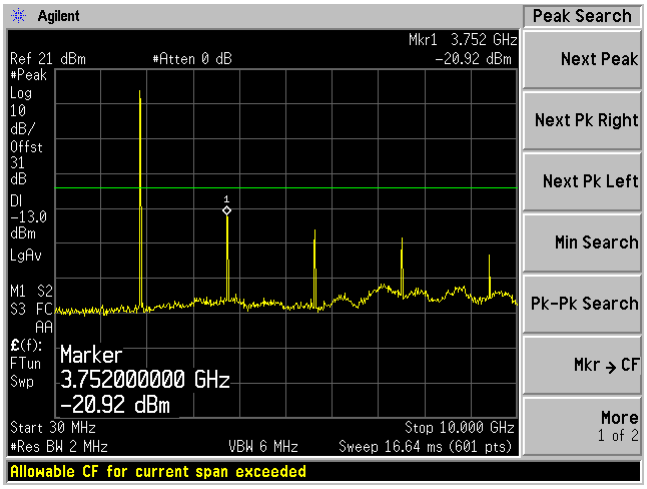
DL Low (30MHz-10GHz)



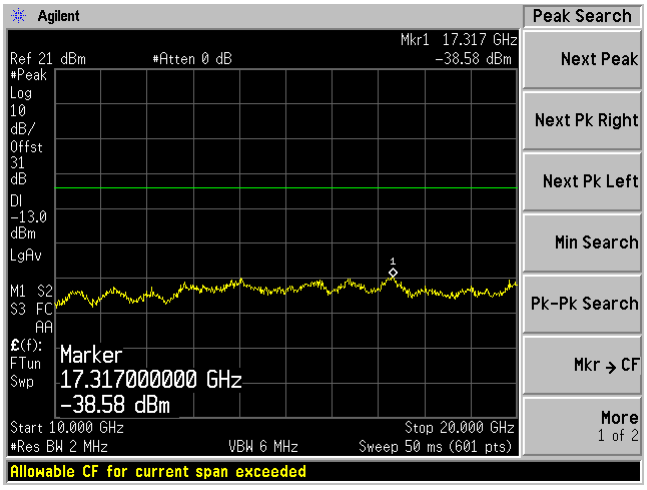
DL Low (10GHz-20GHz)



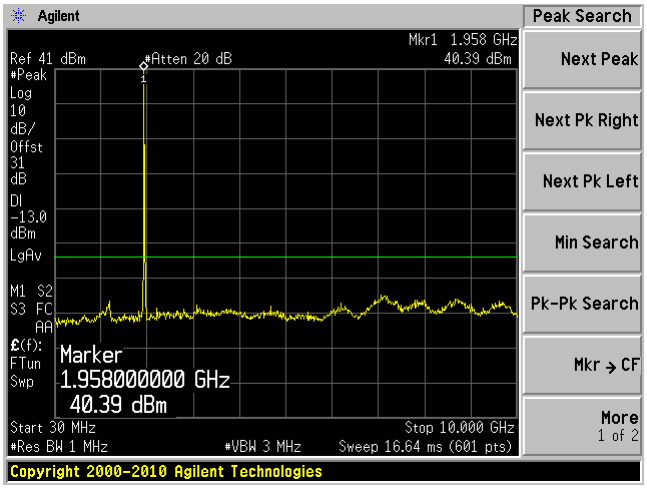
UL Middle (30MHz-10GHz)



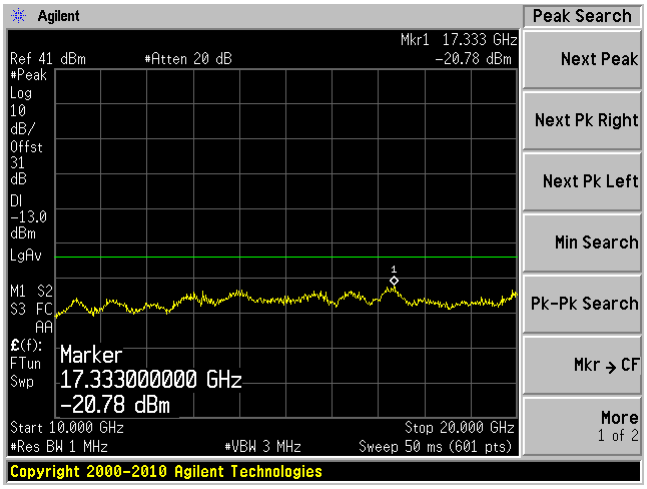
UL Middle (10GHz-20GHz)



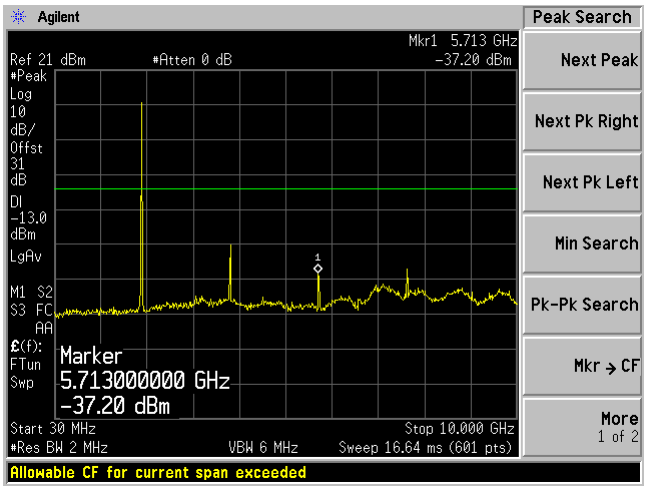
DL Middle (30MHz-10GHz)



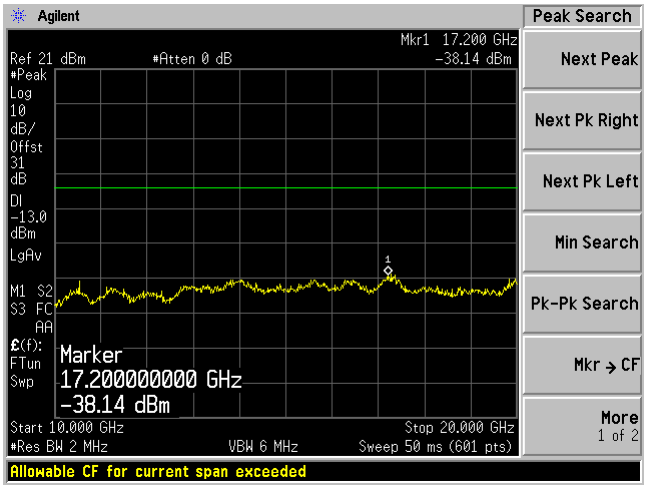
DL Middle (10GHz-20GHz)



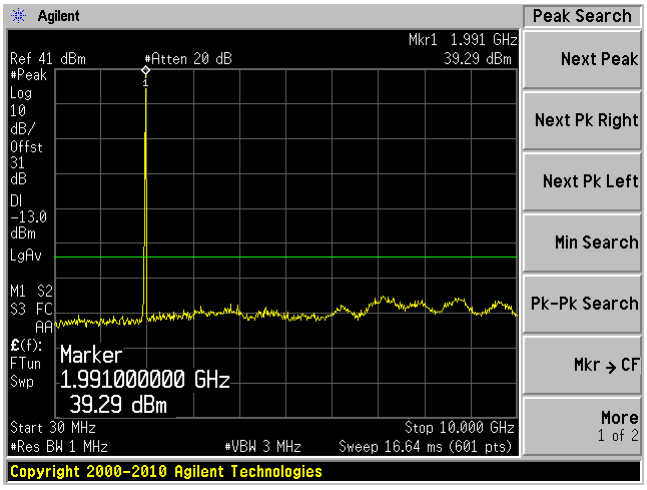
UL High (30MHz-10GHz



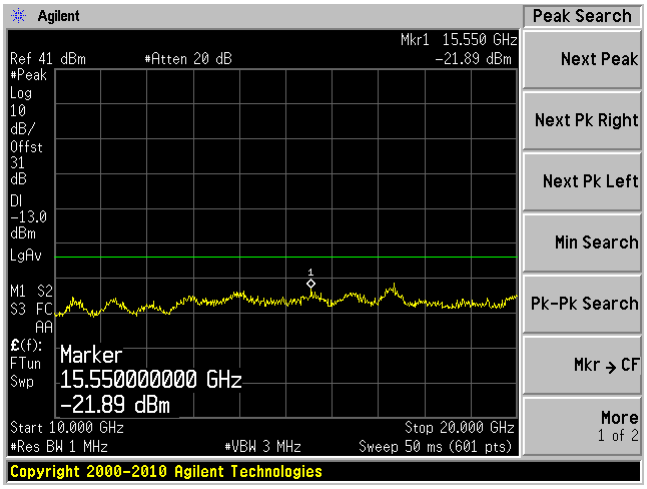
UL High (10GHz-20GHz)



DL High (30MHz-10GHz)

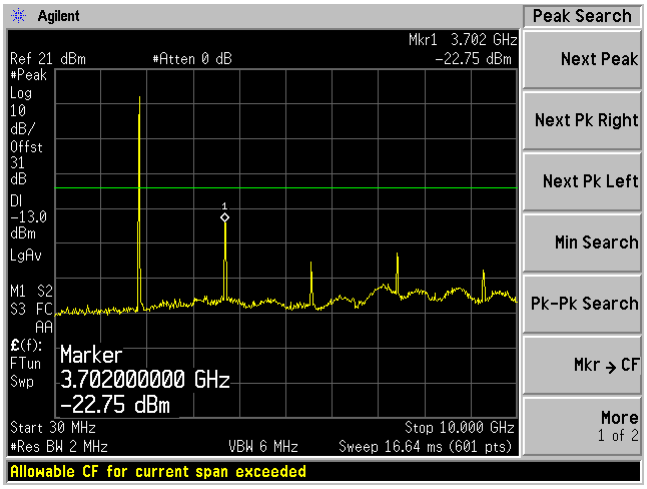


DL High (10GHz-20GHz)

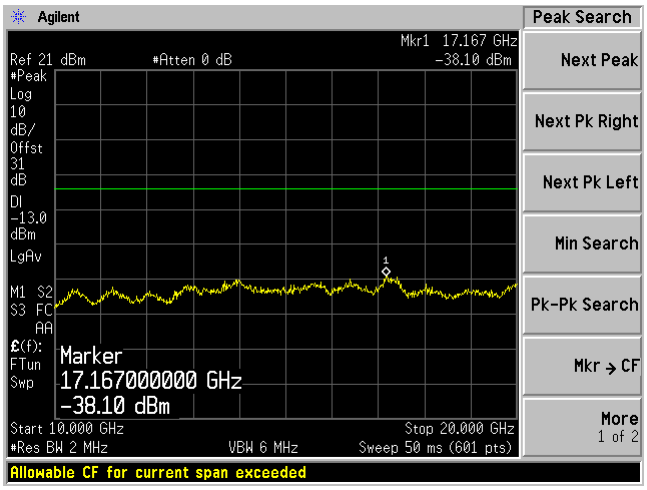


LTE 10 MHz

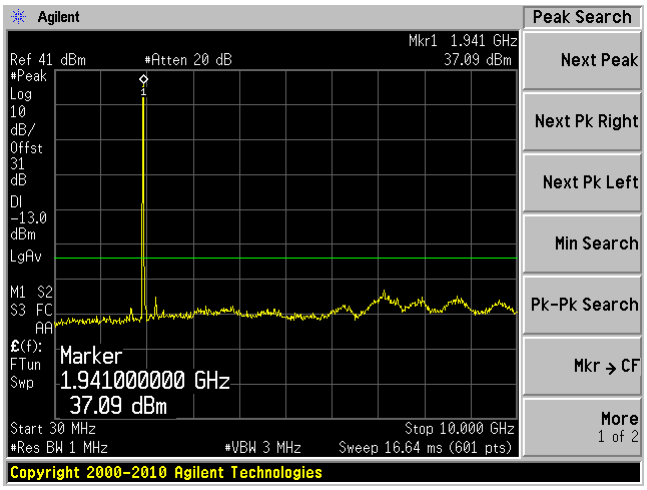
UL Low (30MHz-10GHz)



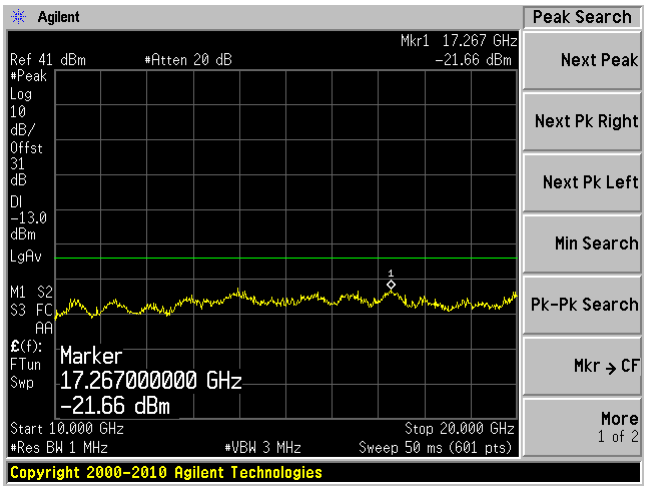
UL Low (10GHz-20GHz)



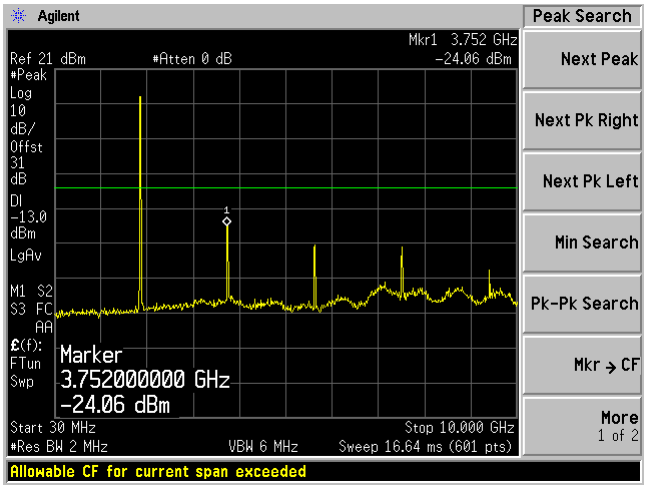
DL Low (30MHz-10GHz)



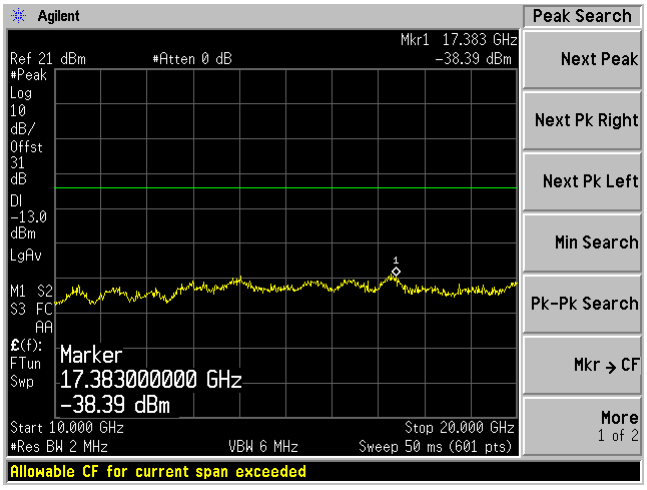
DL Low (10GHz-20GHz)



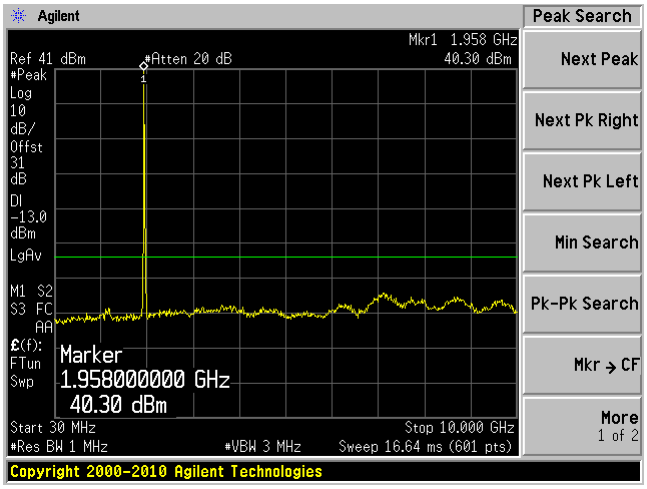
UL Middle (30MHz-10GHz)



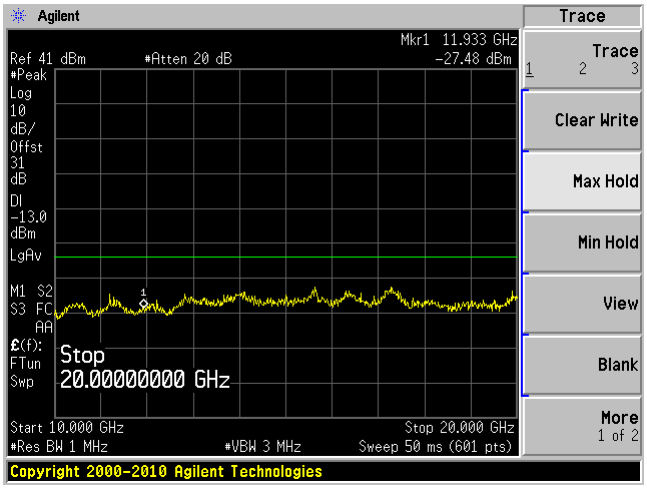
UL Middle (10GHz-20GHz)



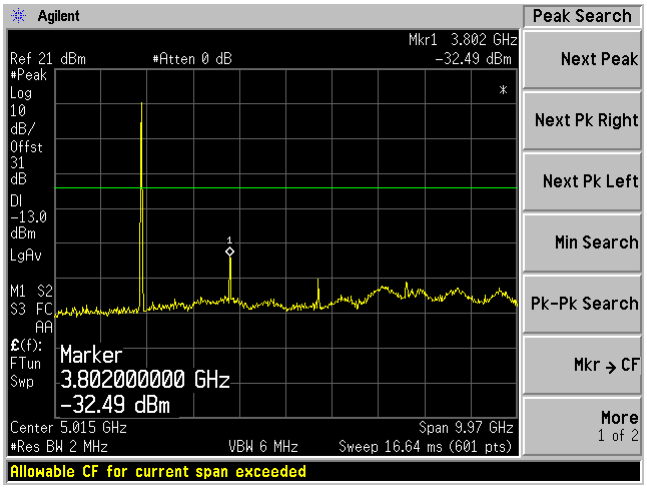
DL Middle (30MHz-10GHz)



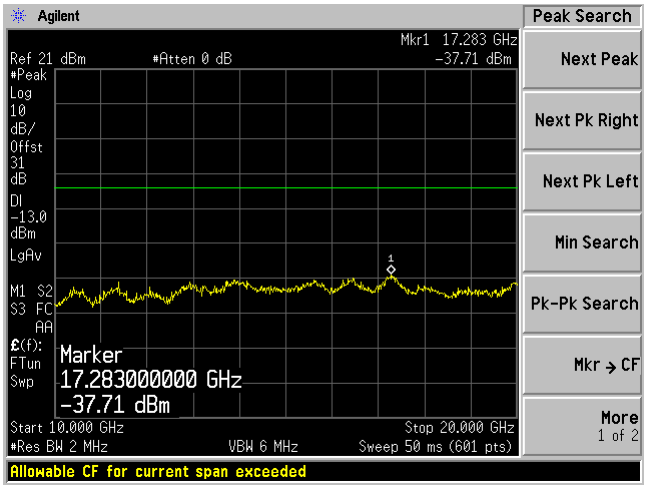
DL Middle (10GHz-20GHz)



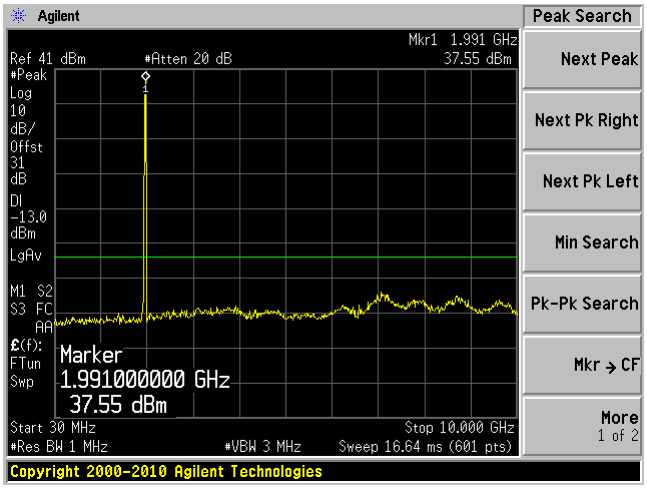
UL High (30MHz-10GHz)



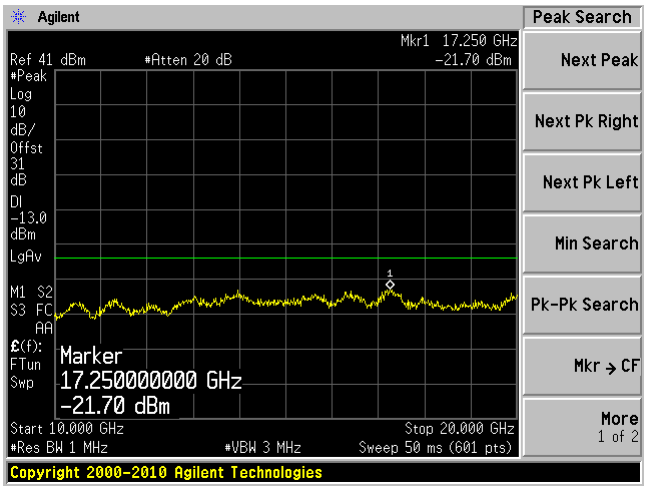
UL High (10GHz-20GHz)



DL High (30MHz-10GHz)

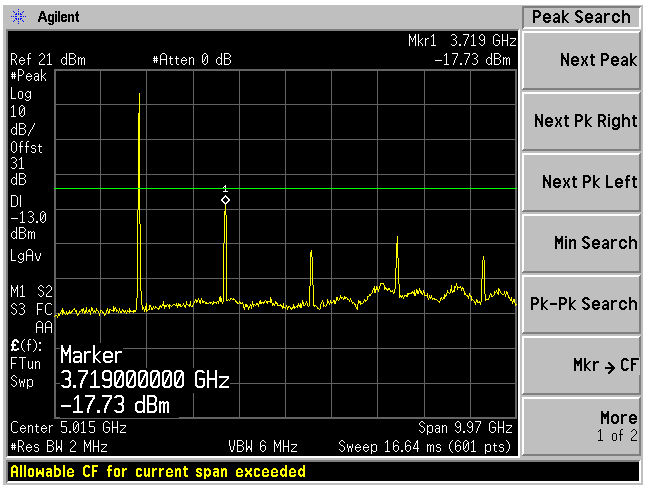


DL High (10GHz-20GHz)

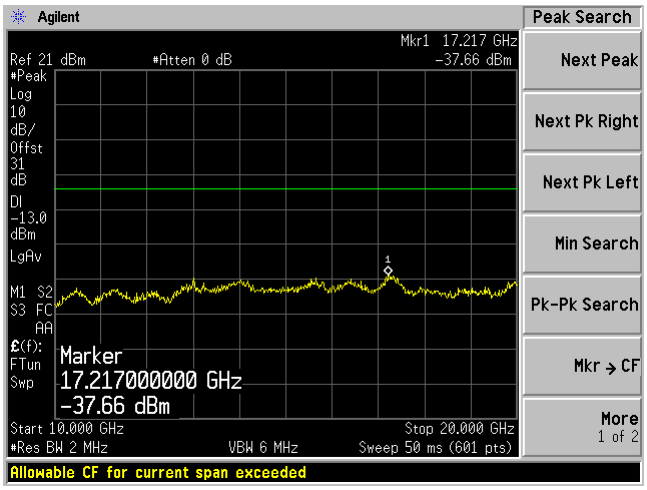


LTE 15 MHz

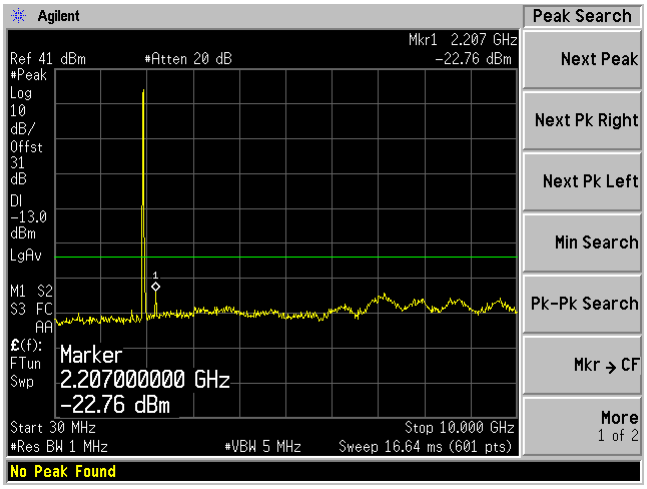
UL Low (30MHz-10GHz)



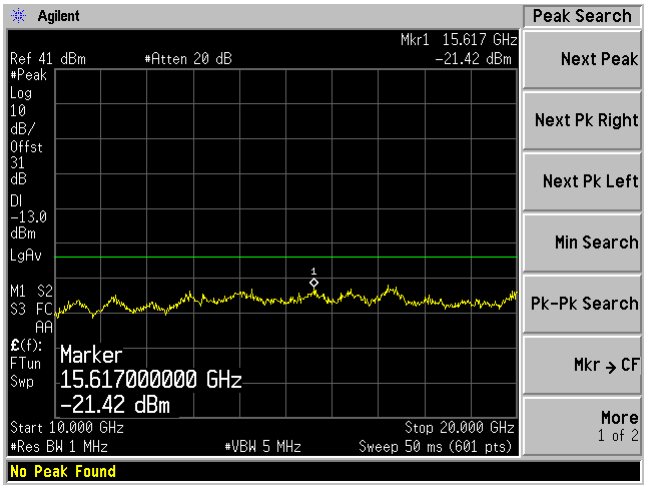
UL Low (10GHz-20GHz)



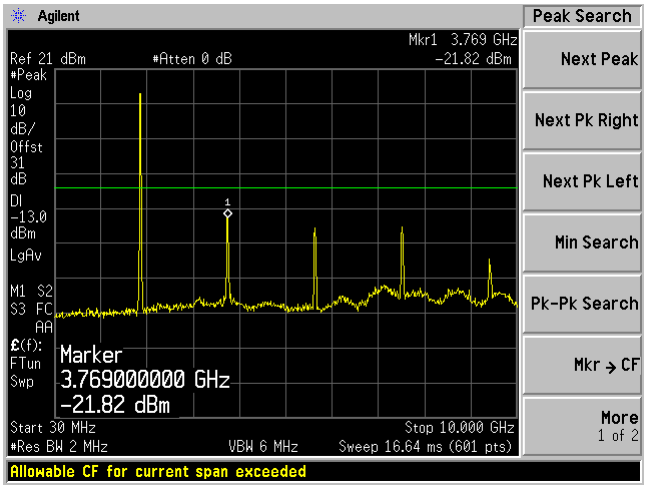
DL Low (30MHz-10GHz)



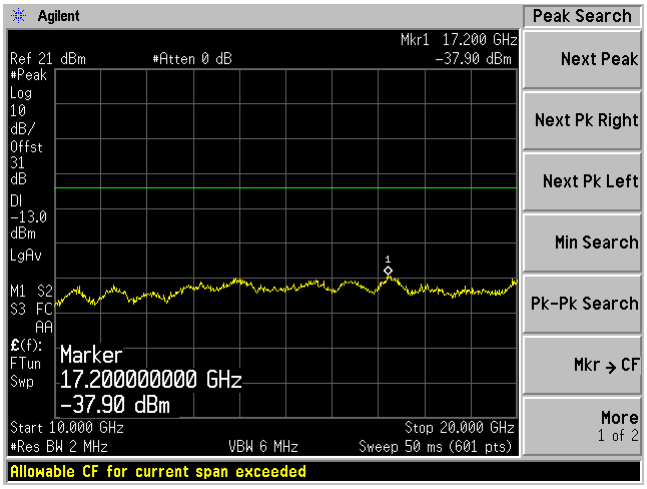
DL Low (10GHz-20GHz)



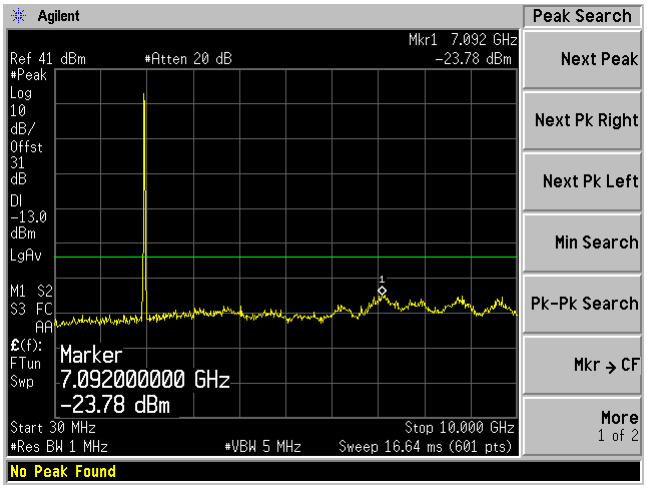
UL Middle (30MHz-10GHz)



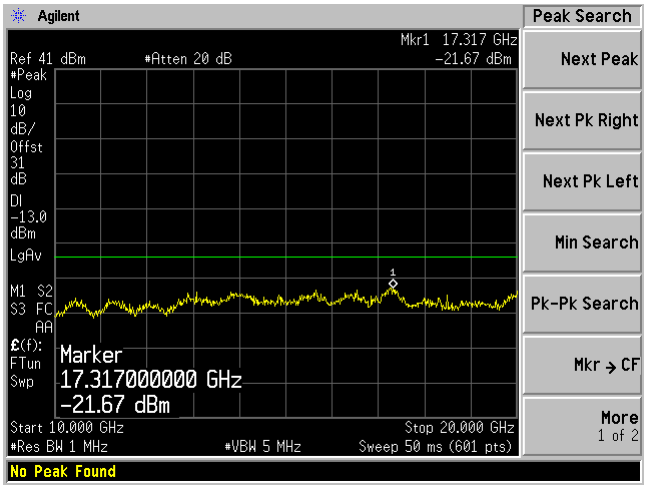
UL Middle (10GHz-20GHz)



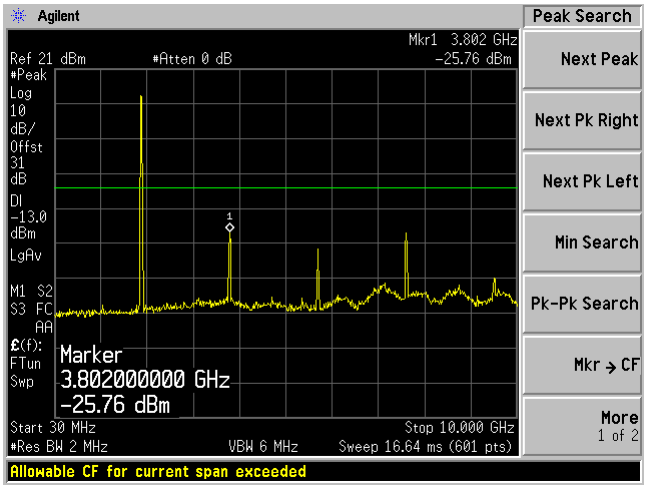
DL Middle (30MHz-10GHz)



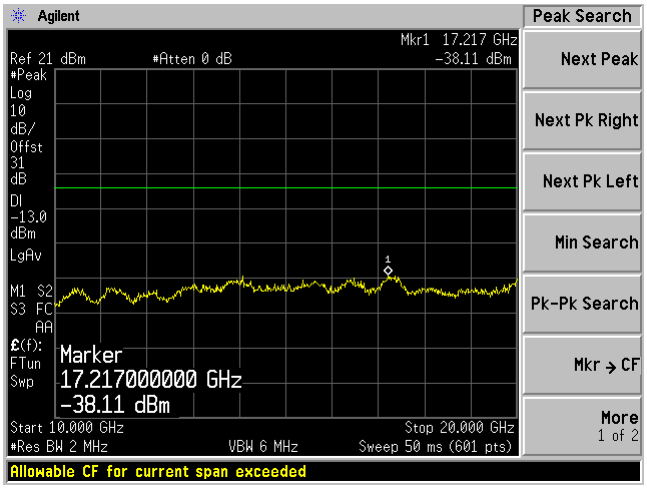
DL Middle (10GHz-20GHz)



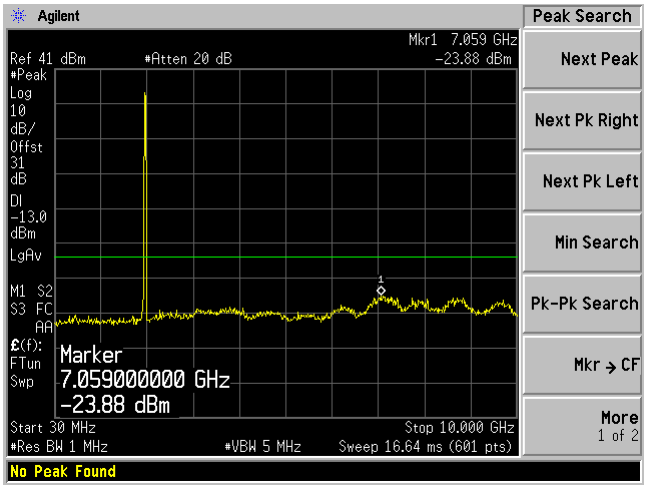
UL High (30MHz-10GHz)



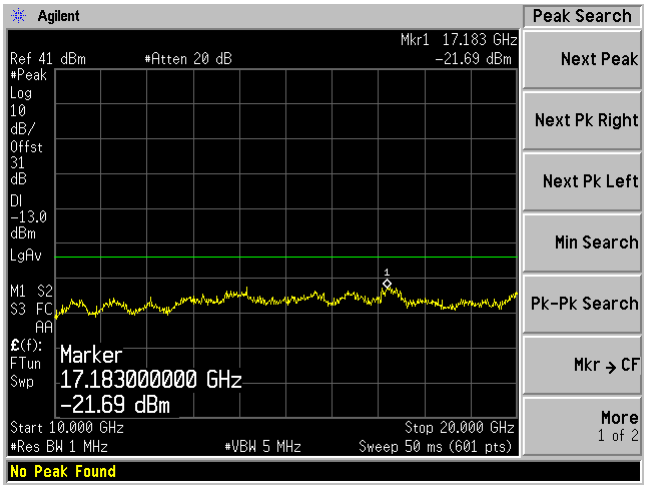
UL High (10GHz-20GHz)



DL High (30MHz-10GHz)

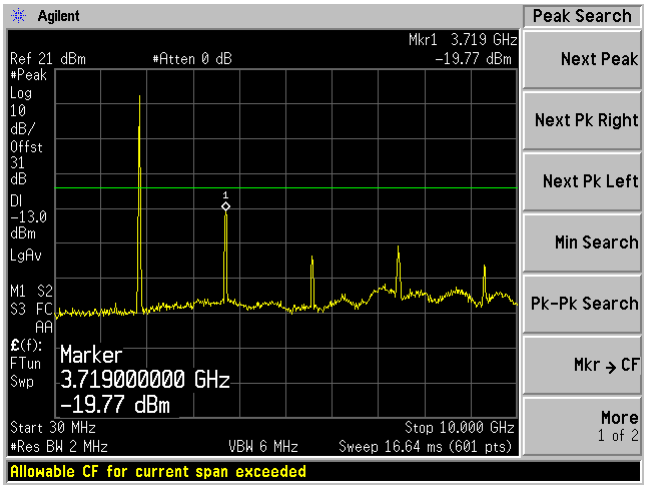


DL High (10GHz-20GHz)

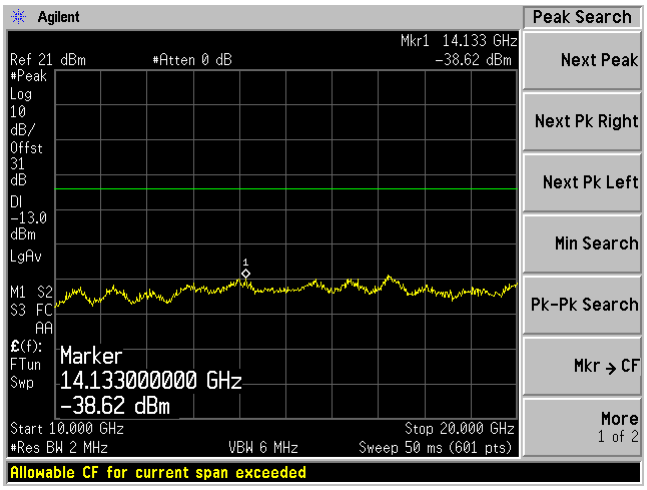


LTE 20 MHz

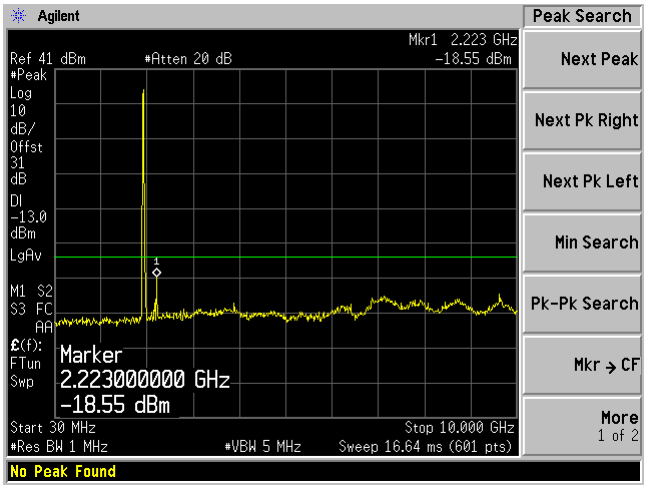
UL Low (30MHz-10GHz)



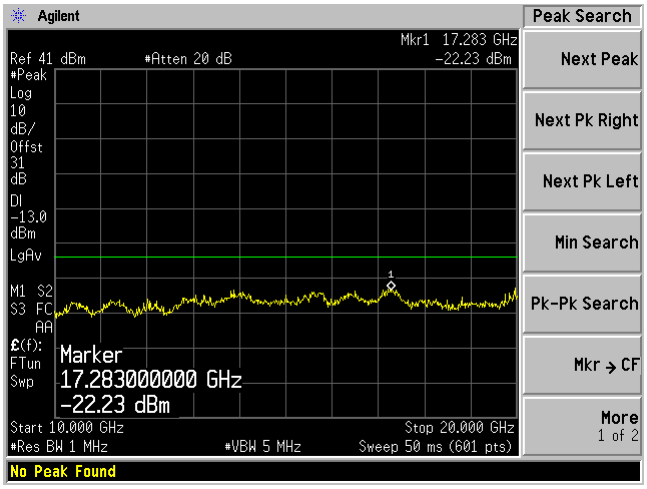
UL Low (10GHz-20GHz)



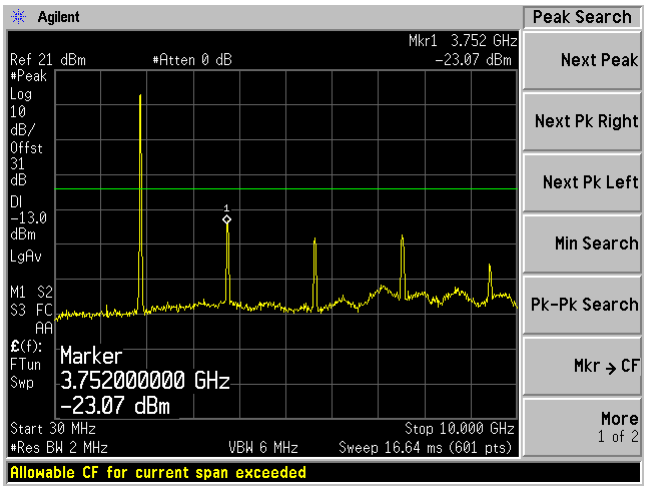
DL Low (30MHz-10GHz)



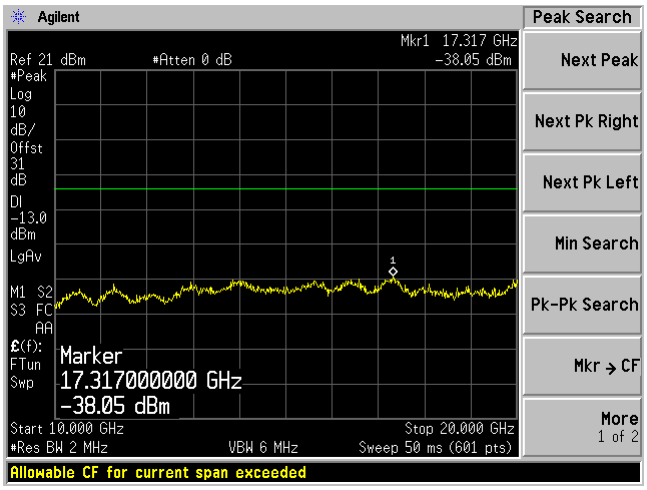
DL Low (10GHz-20GHz)



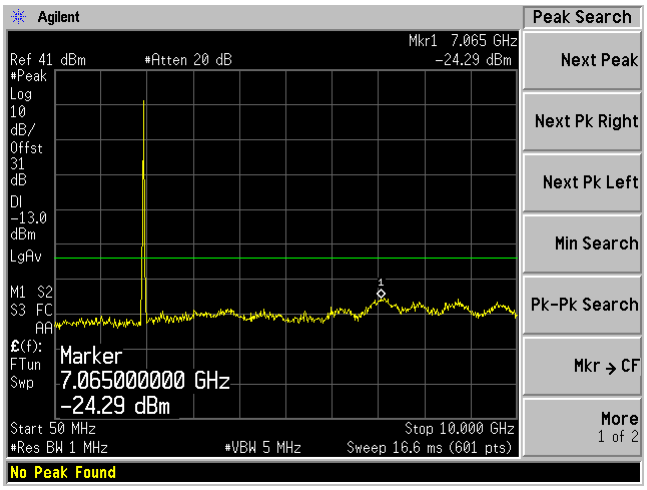
UL Middle (30MHz-10GHz)



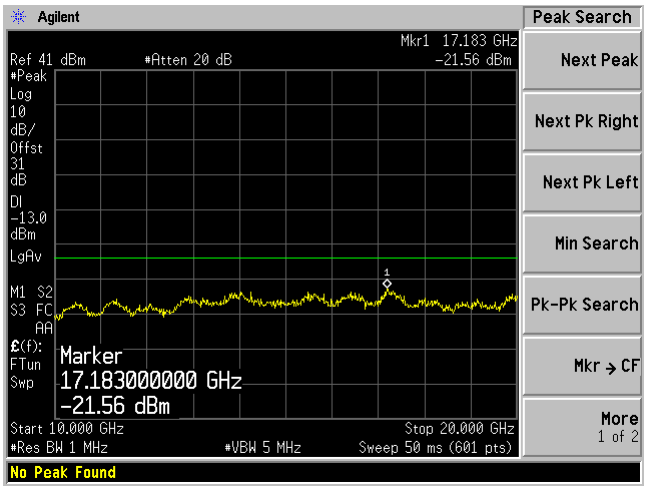
UL Middle (10GHz-20GHz)



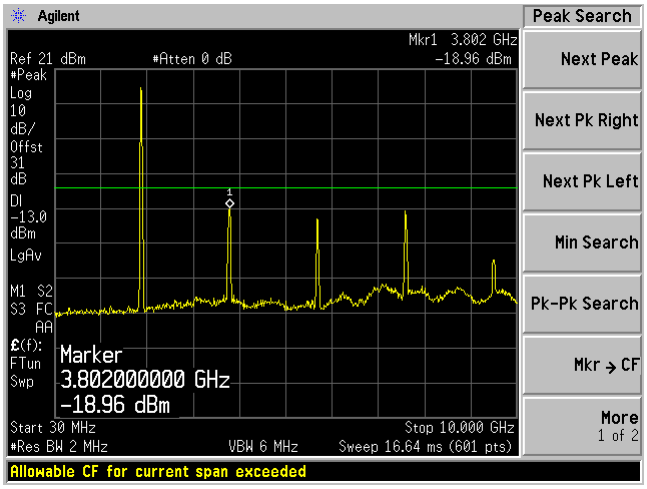
DL Middle (30MHz-10GHz)



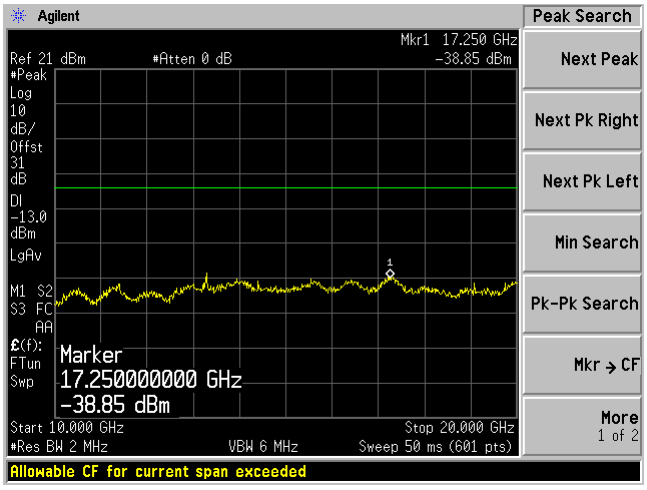
DL Middle (10GHz-20GHz)



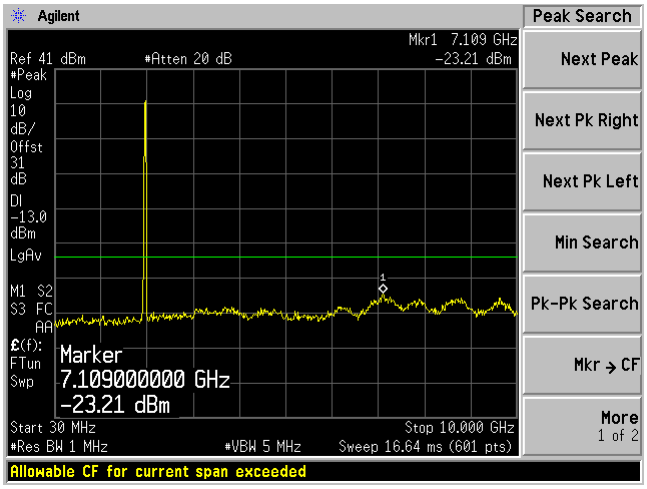
UL High (30MHz-10GHz)



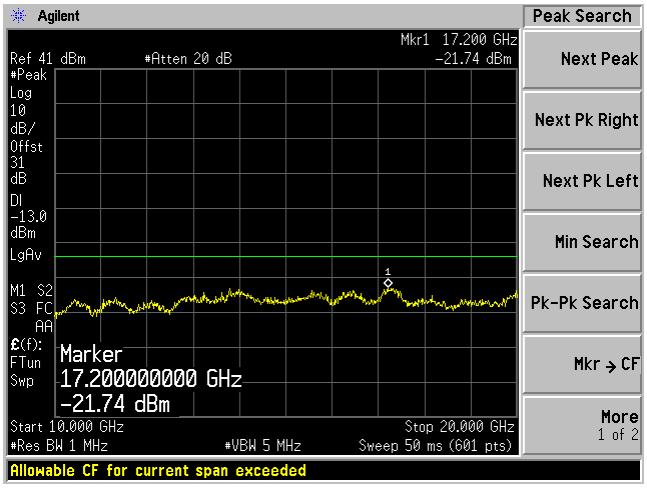
UL High (10GHz-20GHz)



DL High (30MHz-10GHz)



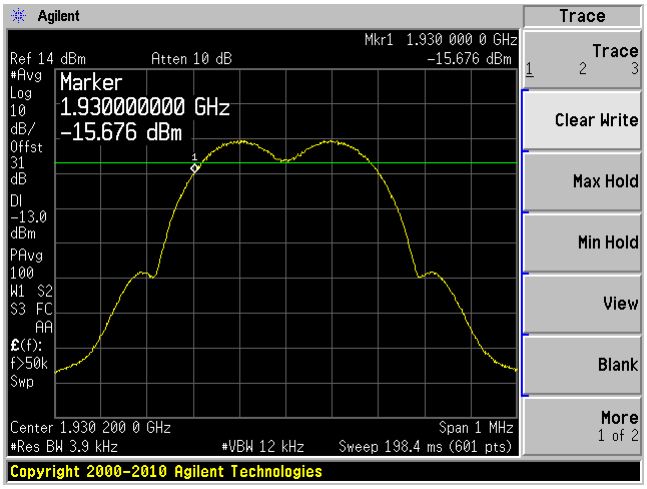
DL High (10GHz-20GHz)



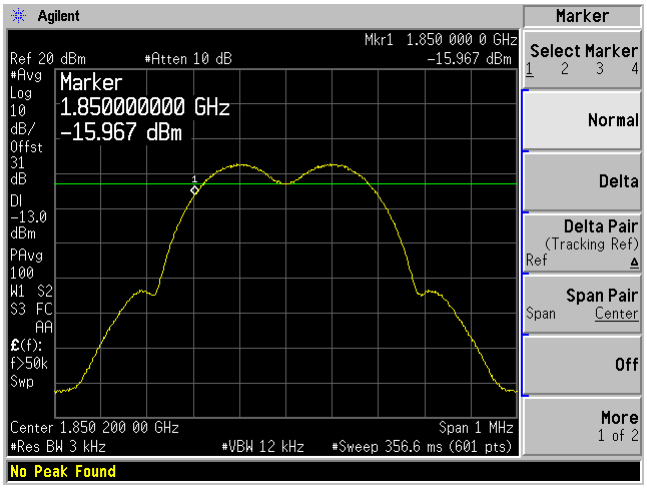
Intermodulation

GSM/GPRS

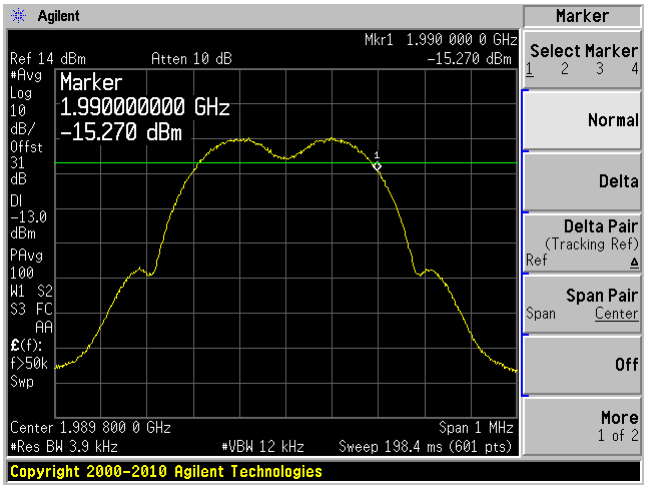
Low DL



Low UL



High DL



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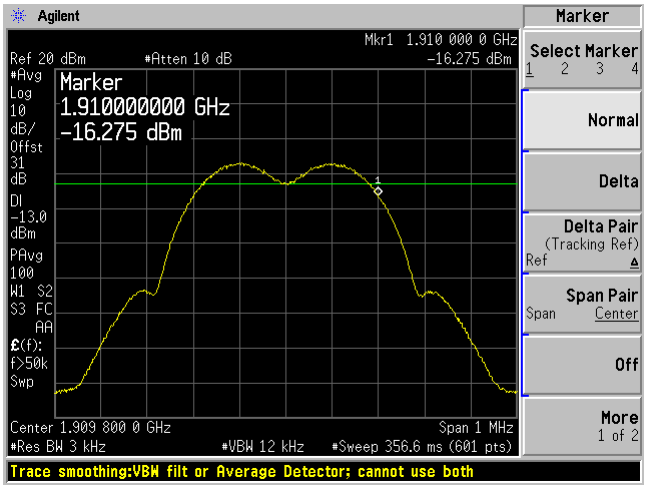
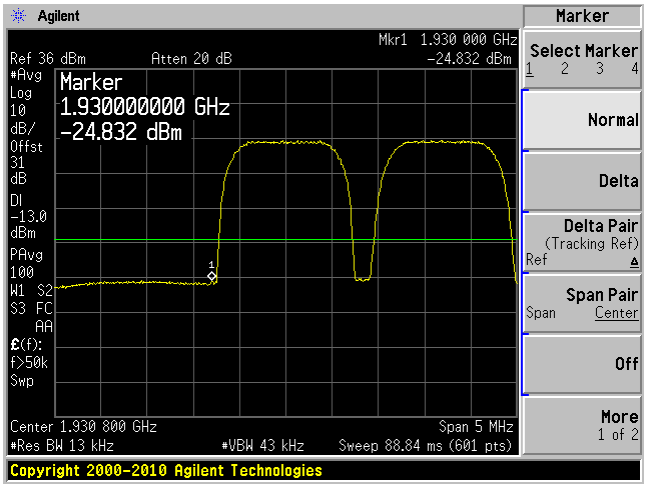


CDMA

Low DL



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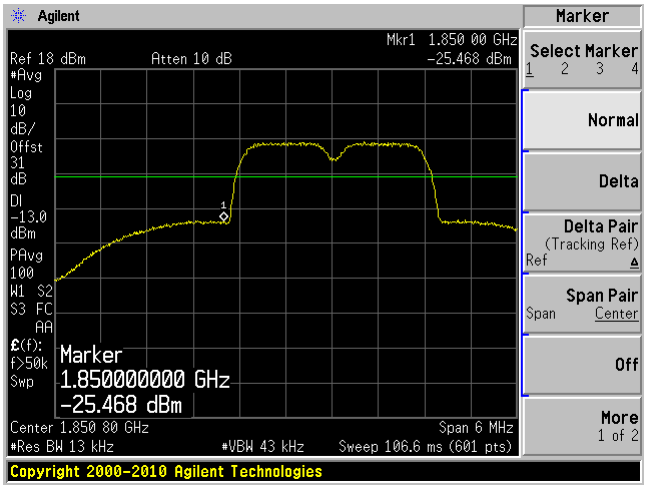
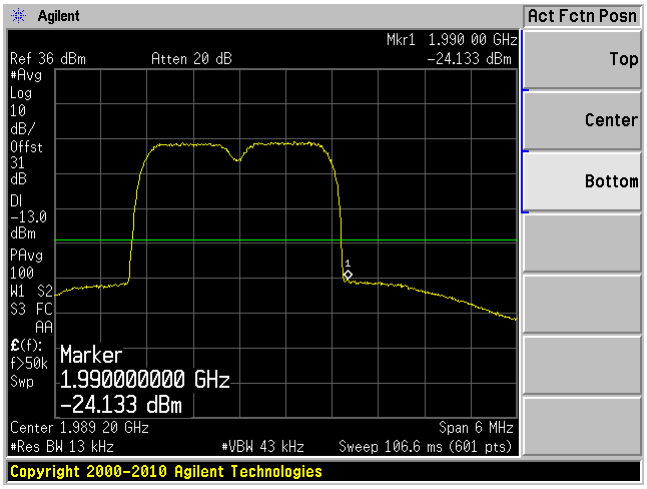


High DL



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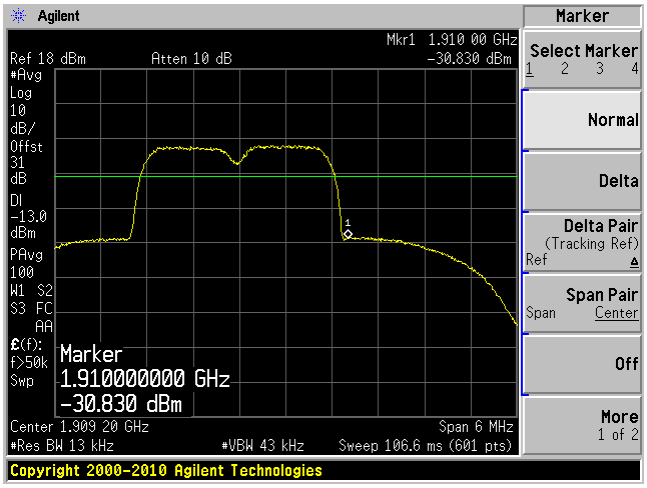
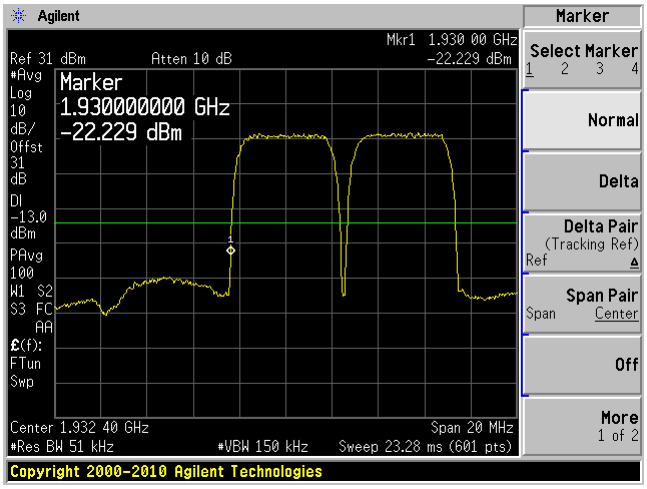


WCDMA

Low DL



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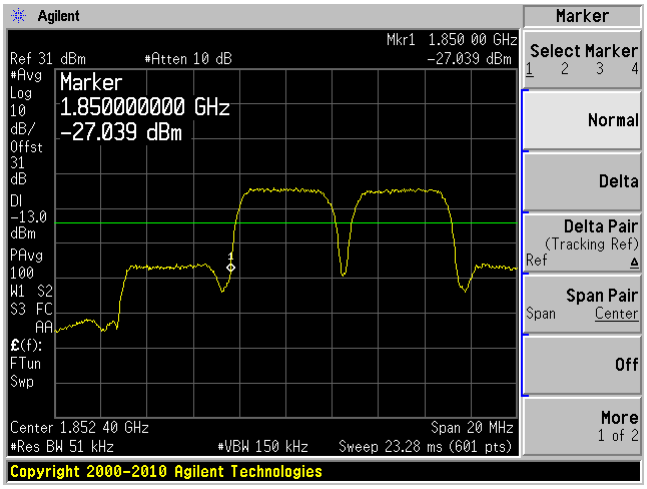

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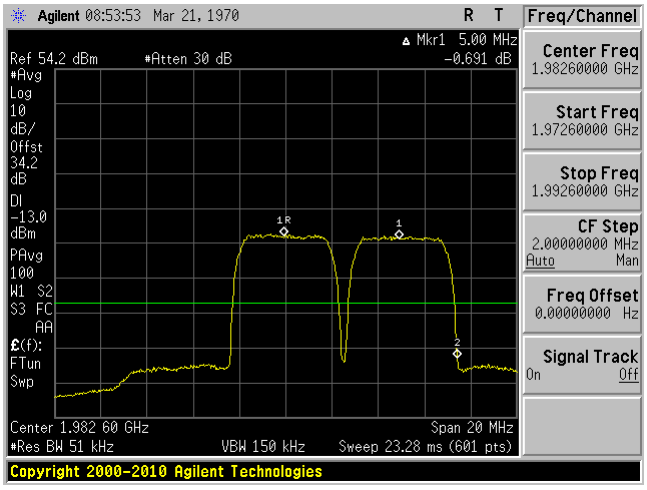

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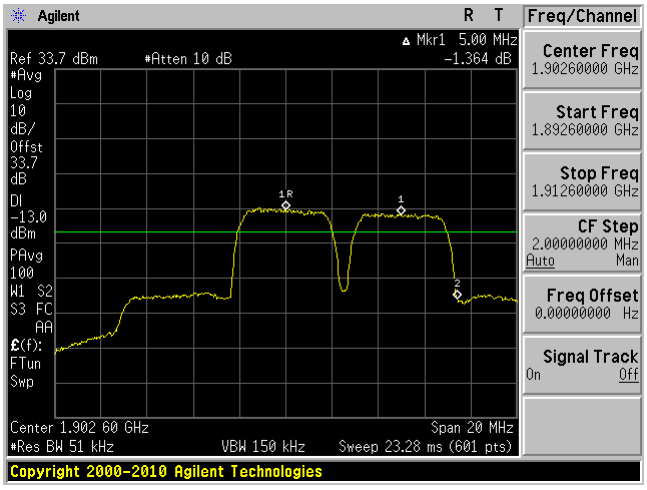
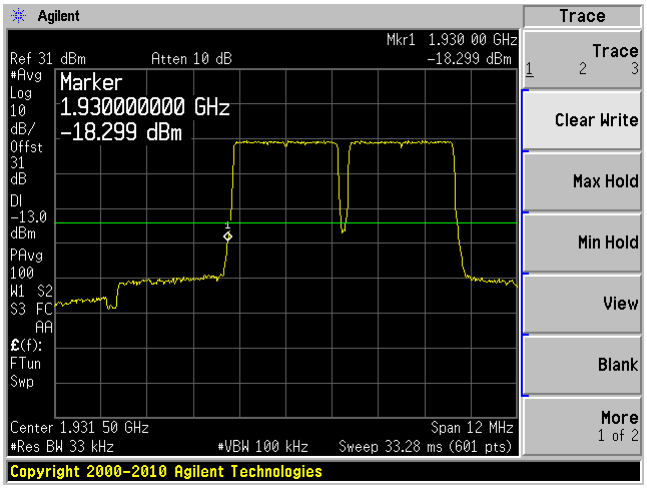


LTE 3 MHz

Low DL



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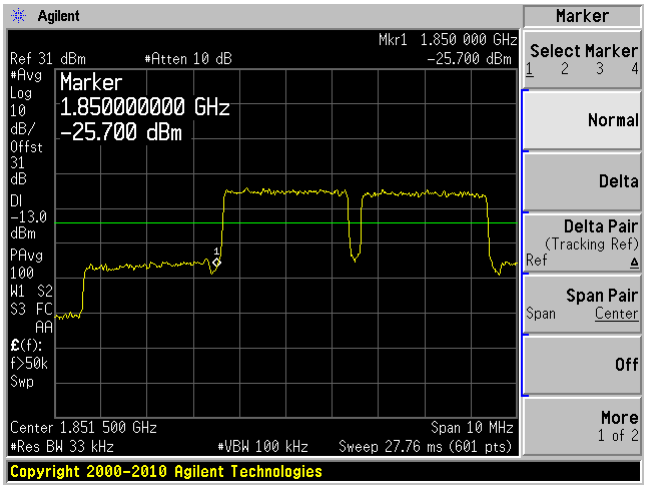

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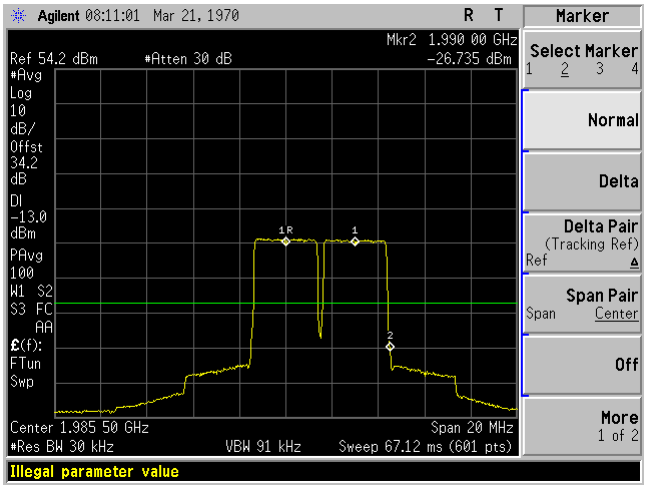

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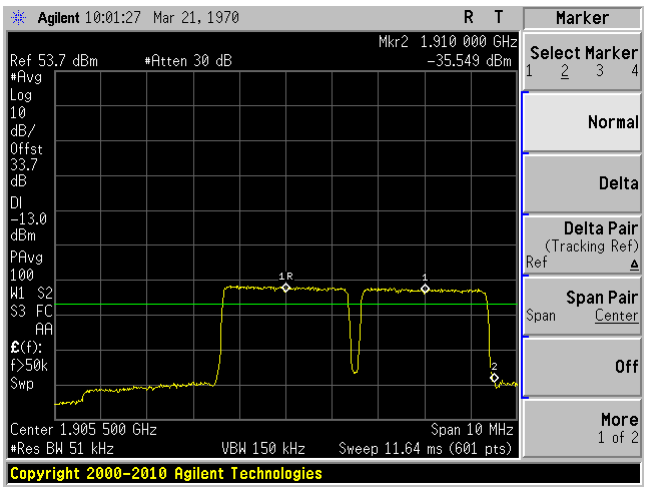
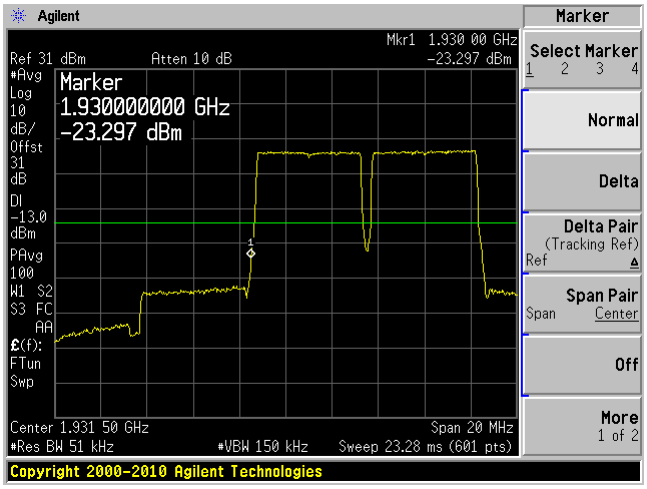


LTE 5 MHz

Low DL



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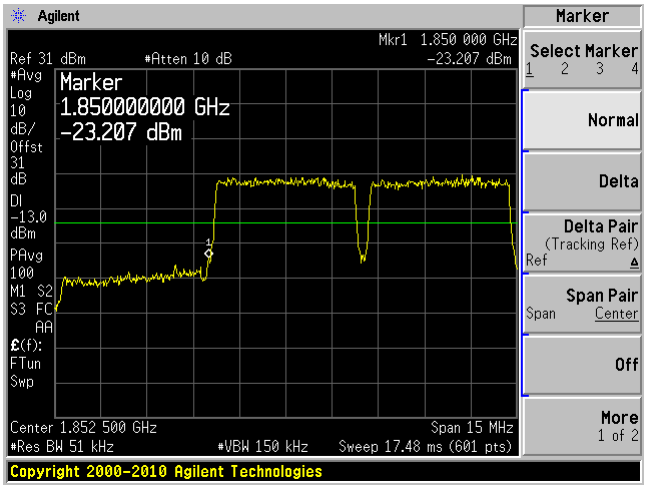
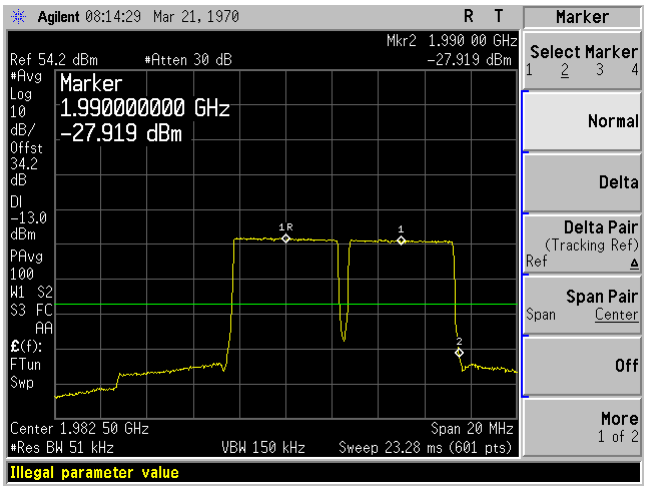


High DL



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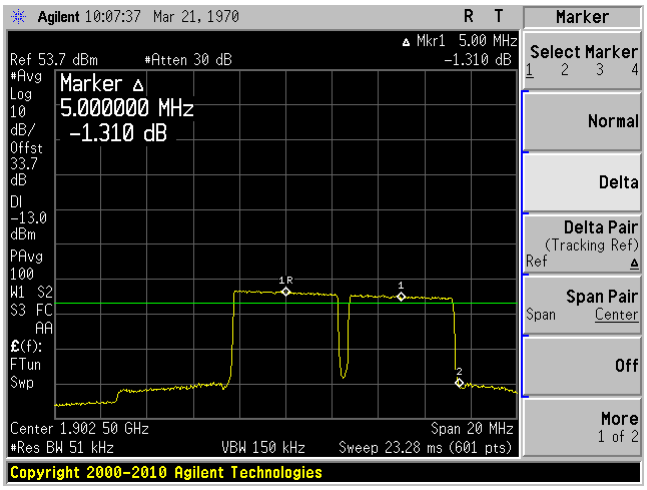
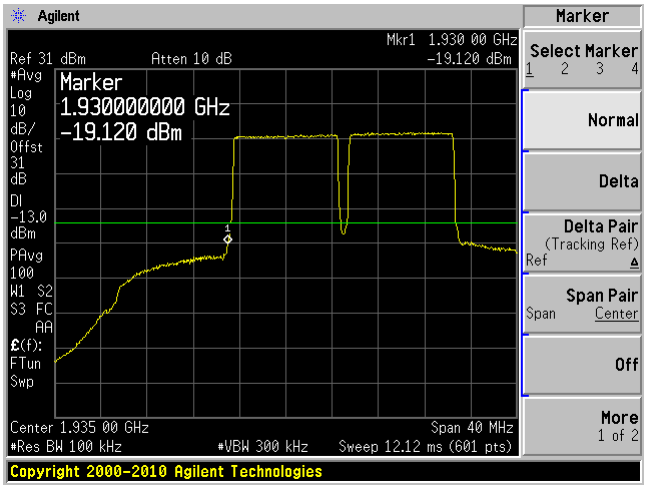


LTE 10 MHz

Low DL



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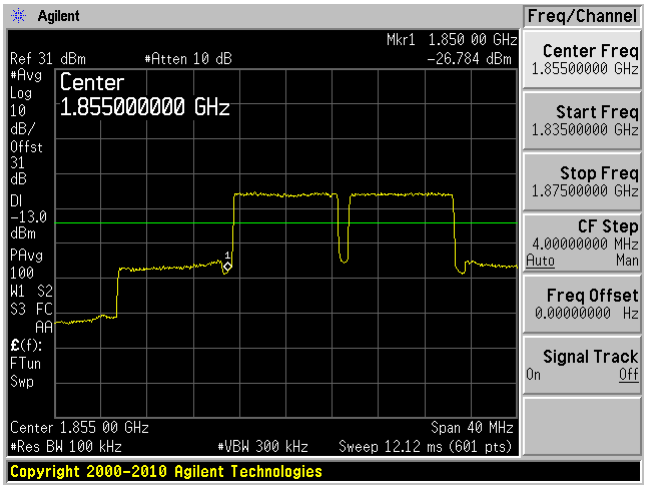

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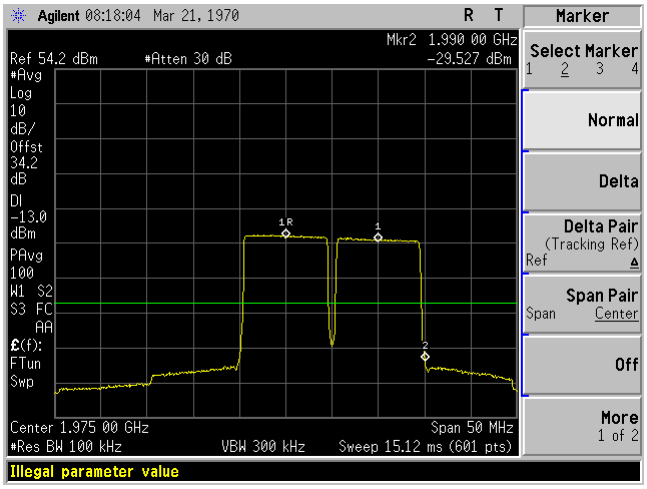

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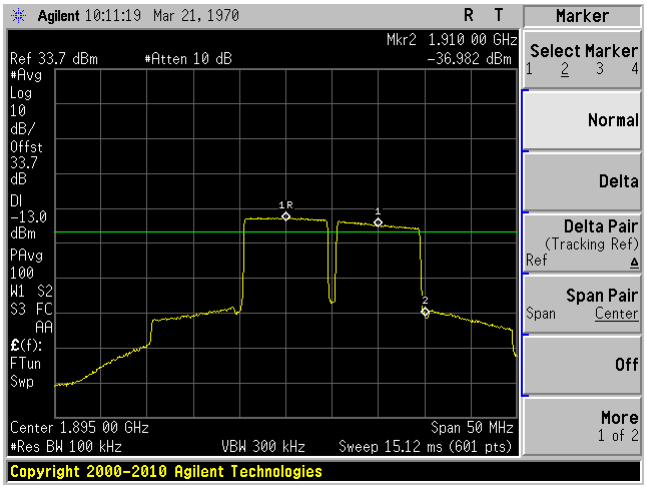
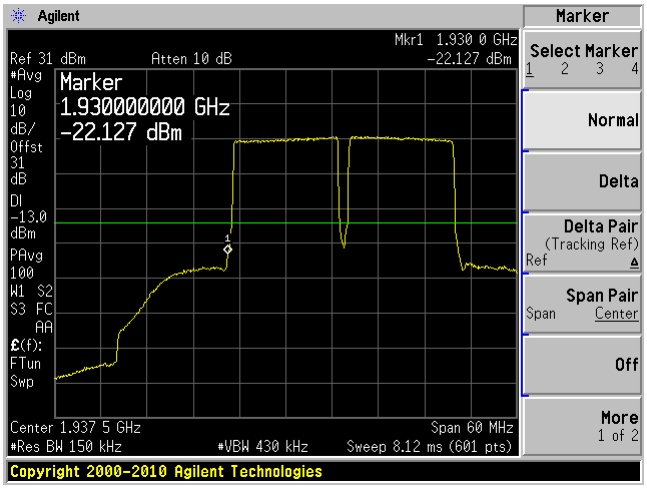


LTE 15 MHz

Low DL



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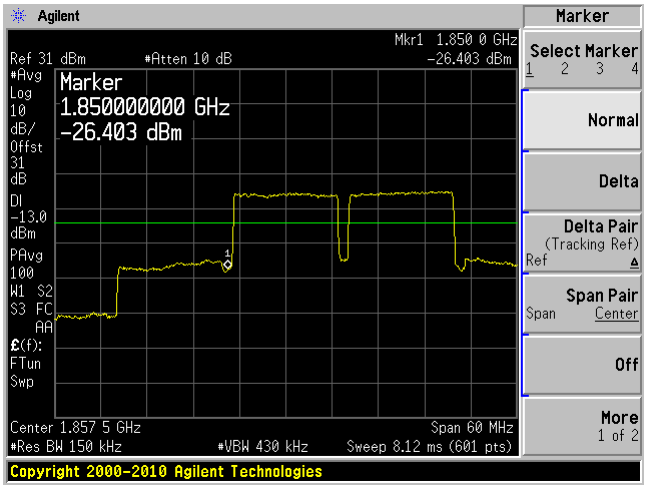

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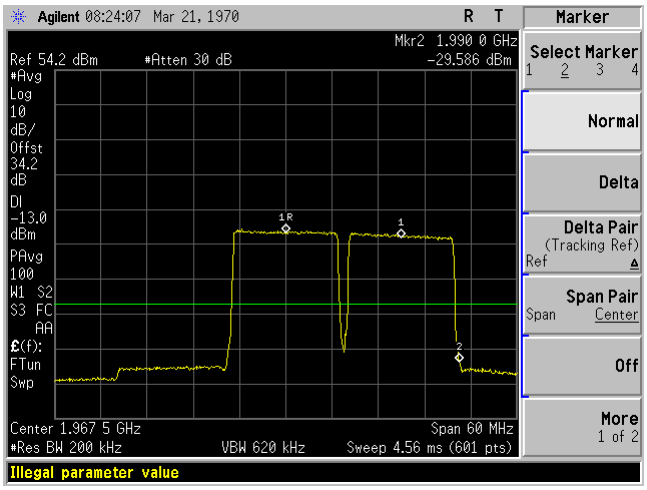

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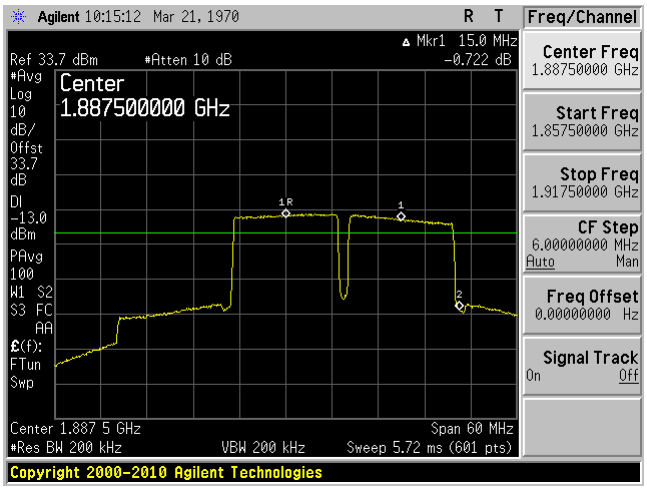
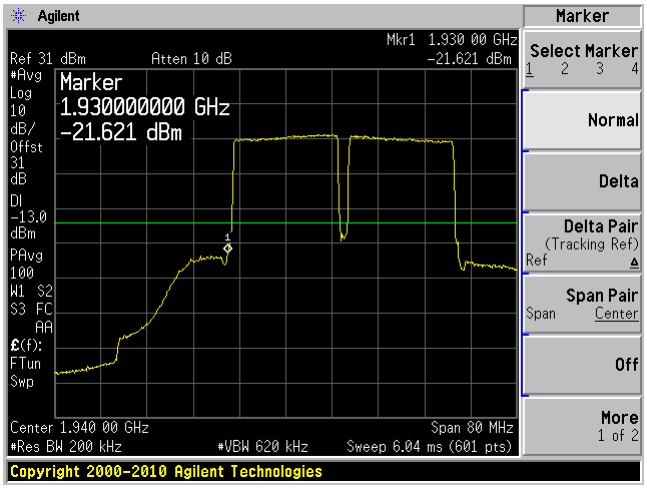


LTE 20 MHz

Low DL



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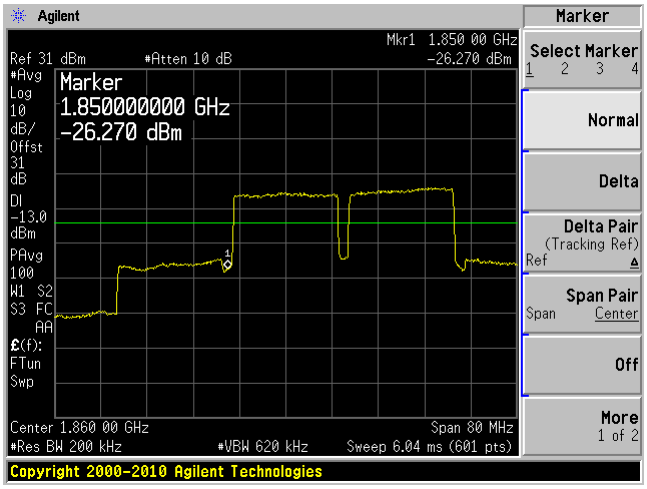
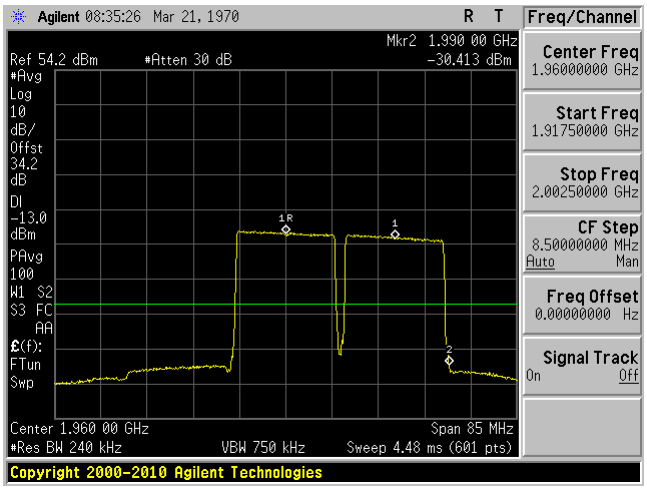


High DL



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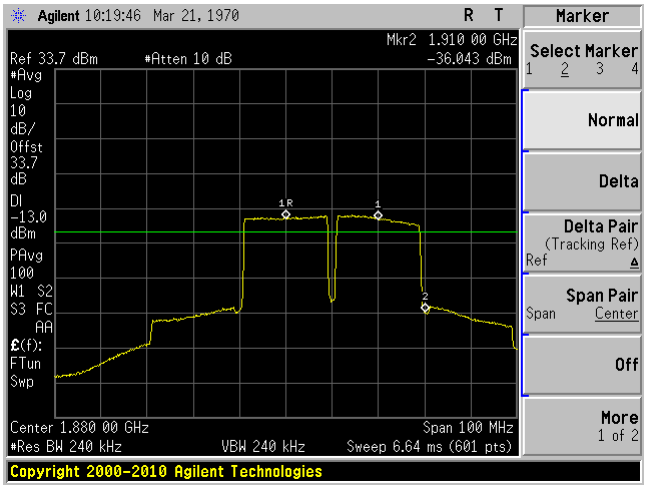


8 FCC §24.238 & IC RSS 131 §6.4 - Band Edge

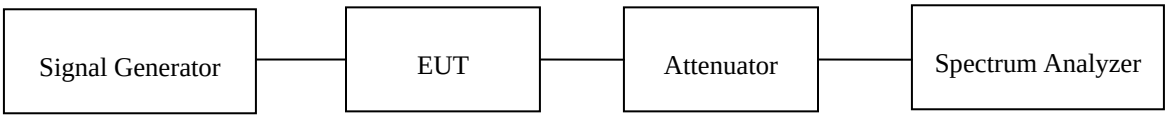
8.1 Applicable Standards

According to FCC §24.238, the power of any emissions outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

8.2 Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

The center of the spectrum analyzer was set to block edge frequency.



8.3 Test Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Dates	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	MY44303352	2014-10-16	1 year
Agilent	Signal Generator	E4438C	MY45091309	2014-07-15	2 year
Bird	Attenuator	50-A-FFB-30	15	N/A	N/A

Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

8.4 Test Environmental Conditions

Temperature:	21-23 °C
Relative Humidity:	42-48 %
ATM Pressure:	101.4-102 kPa

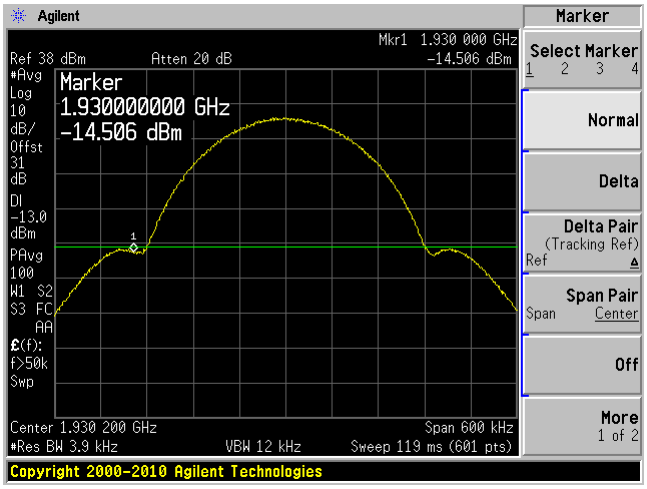
The testing was performed by Ronak Patel 2015-07-29 to 2015-07-31 in the RF Site.

8.5 Test Results

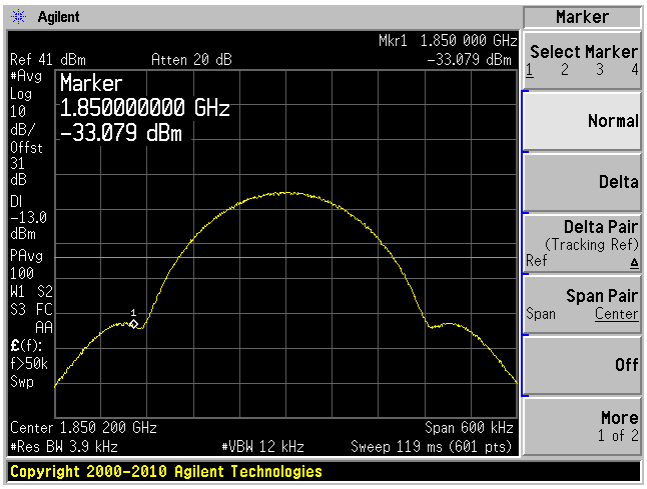
Please refer to the following plots.

GSM/GPRS

Low DL



Low UL



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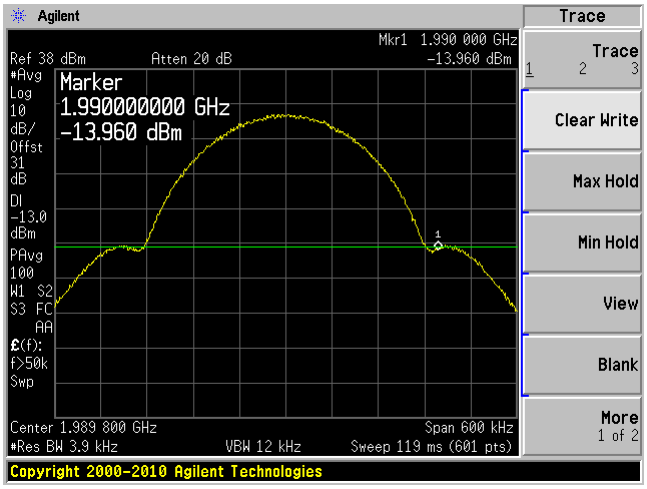
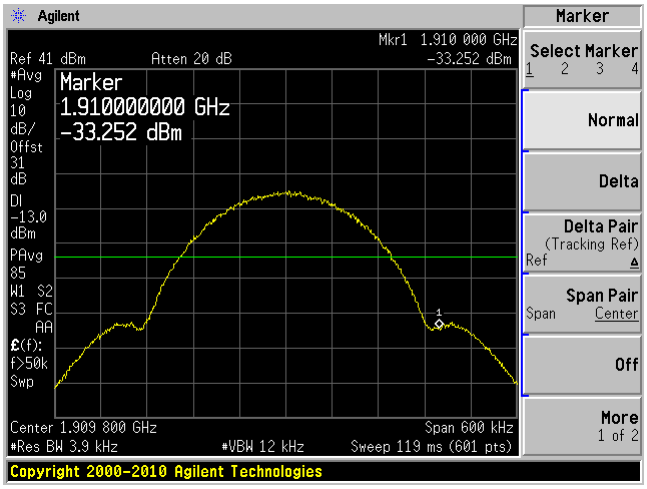
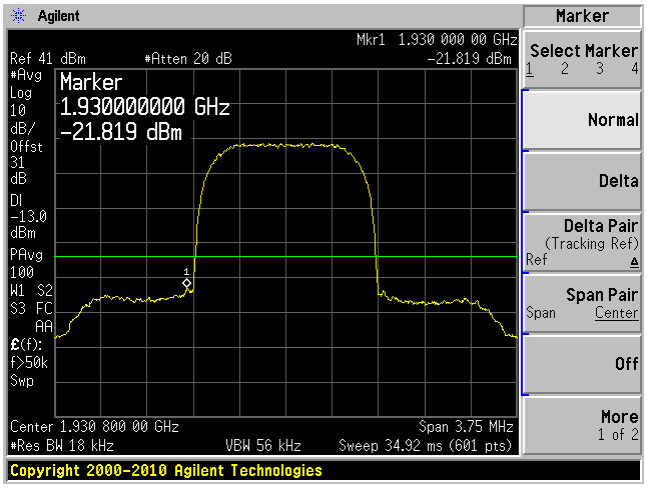


High UL



CDMA

Low DL



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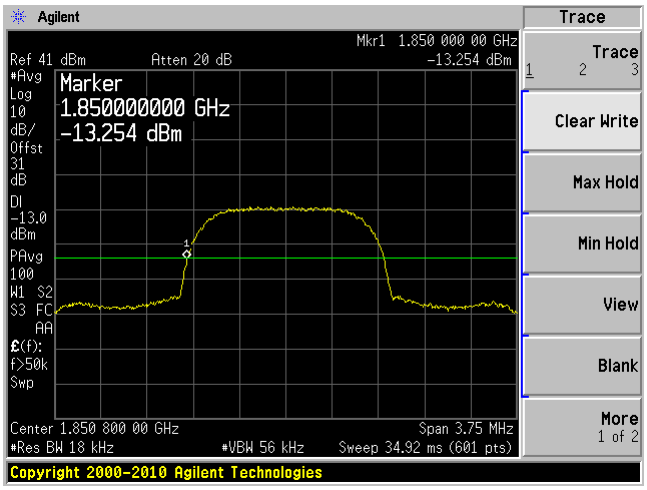

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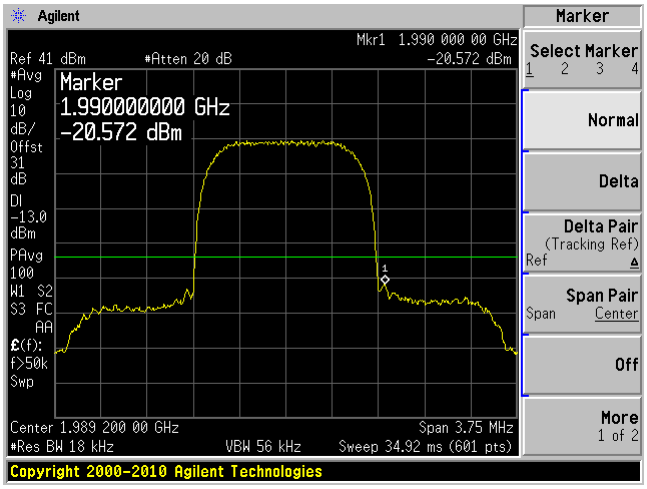

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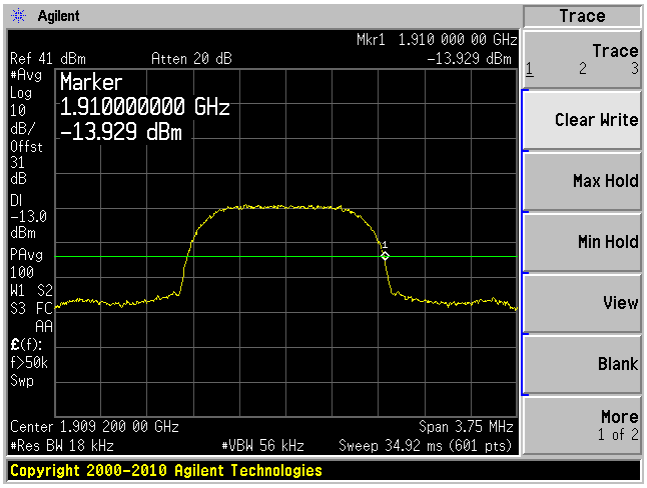
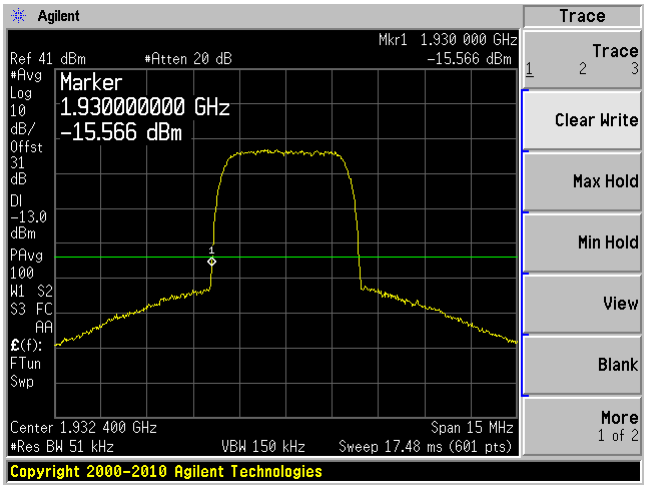


WCDMA

Low DL



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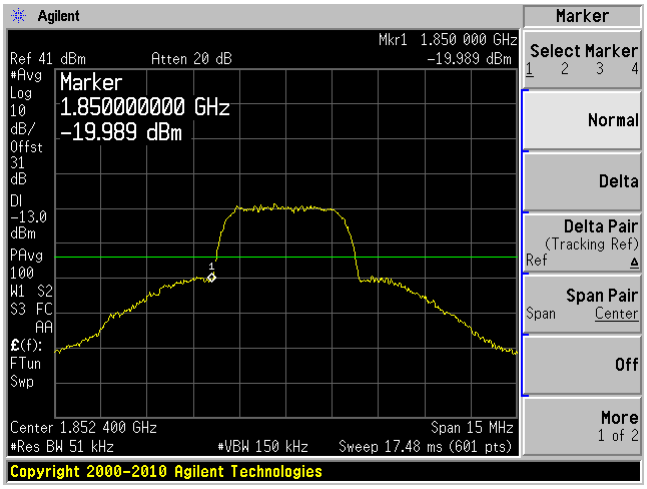

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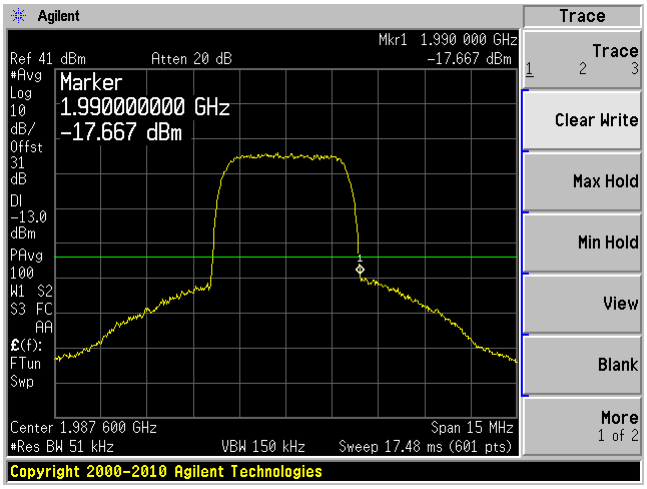

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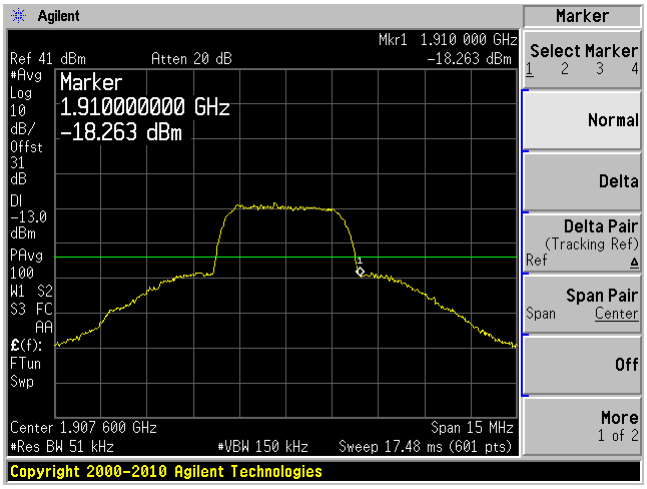
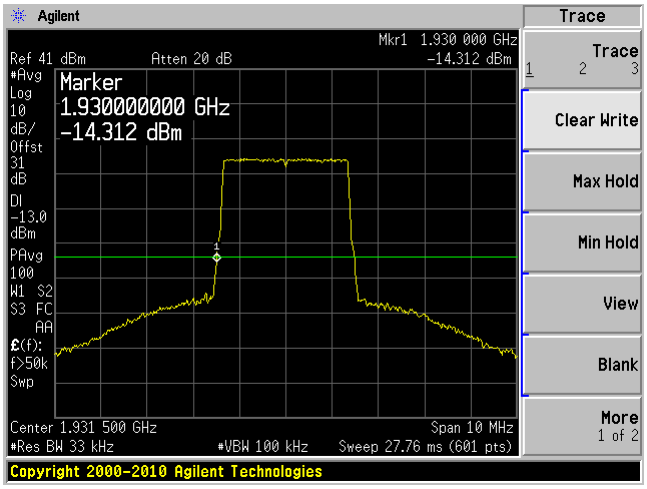


LTE 3 MHz

Low DL



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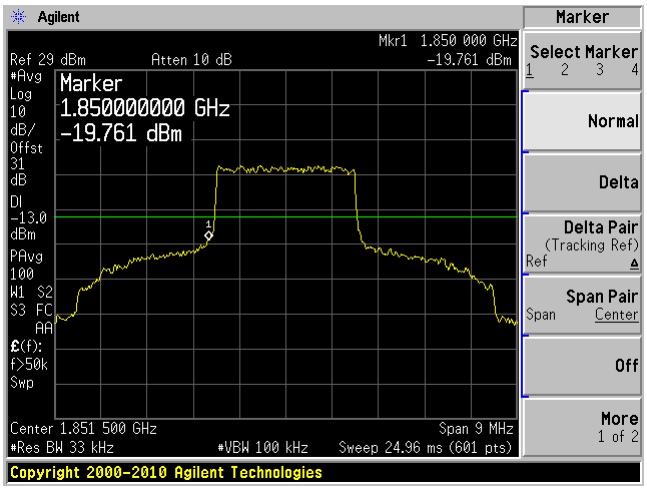

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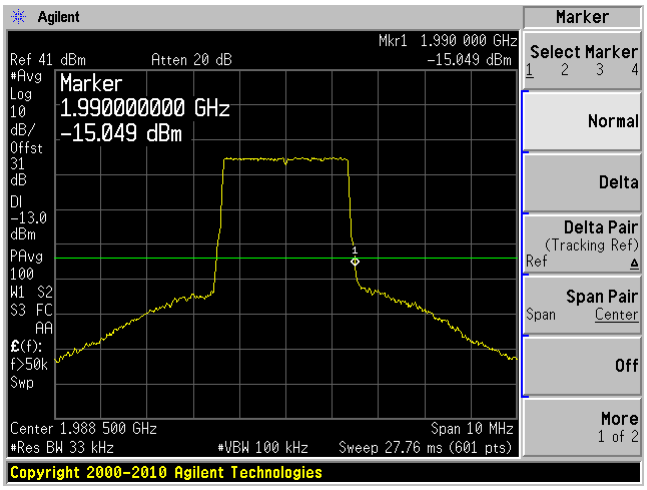

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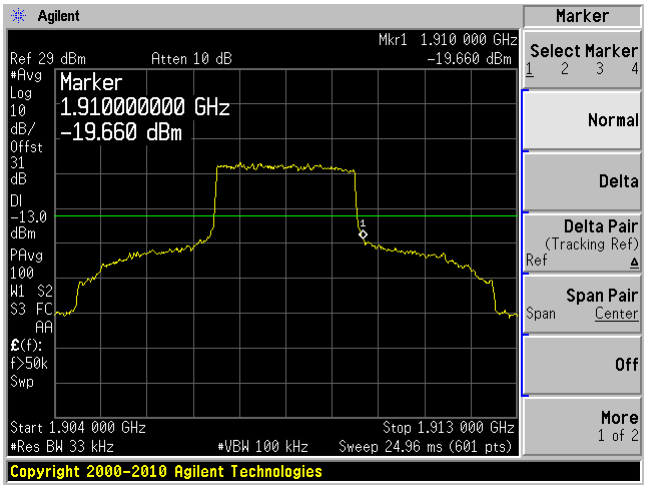
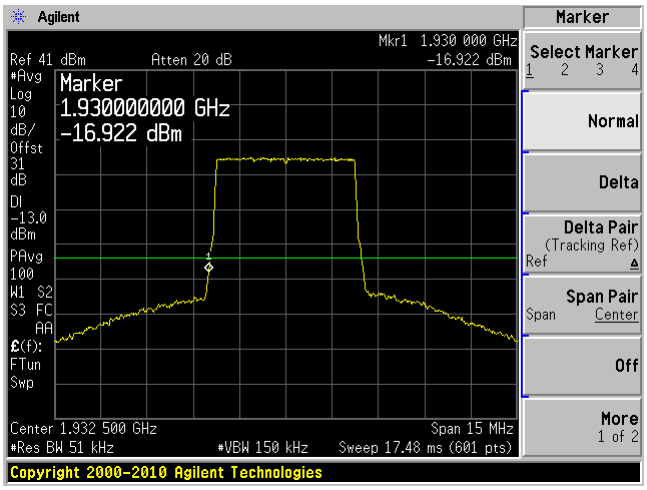


LTE 5 MHz

Low DL



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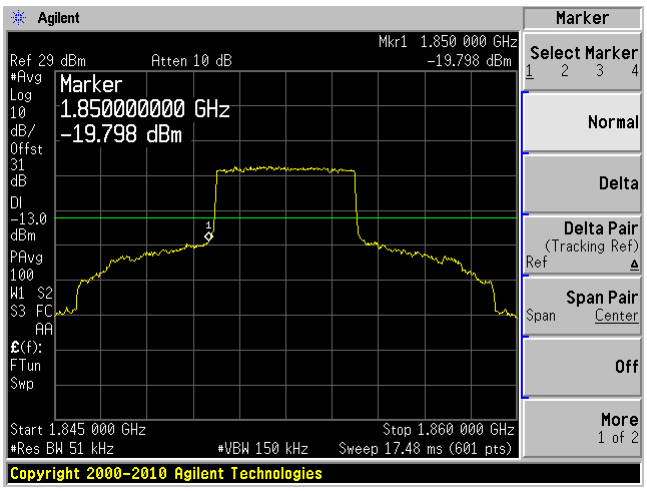

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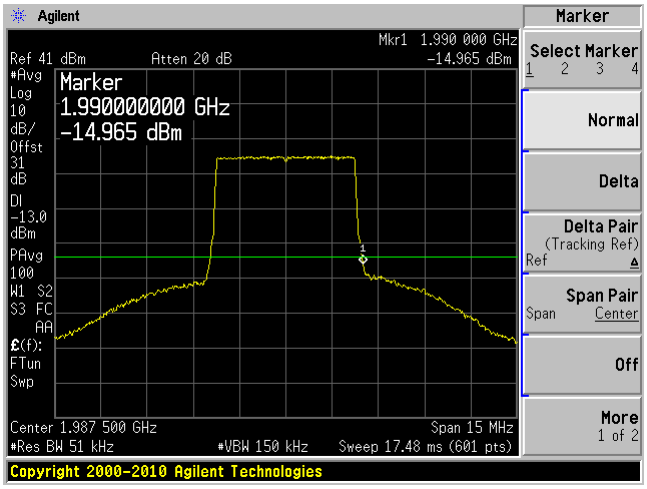

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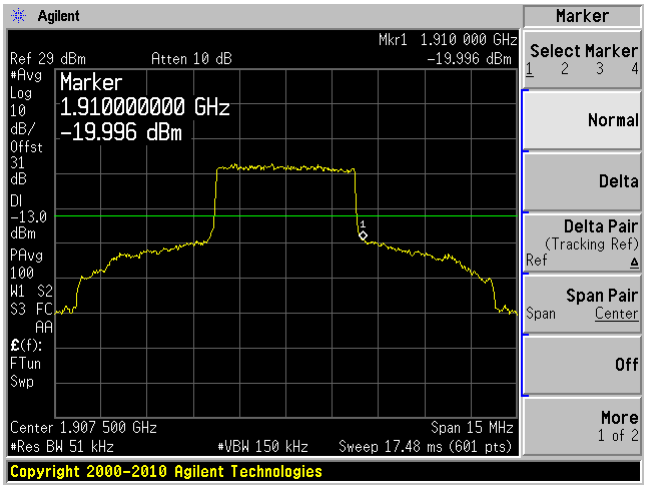
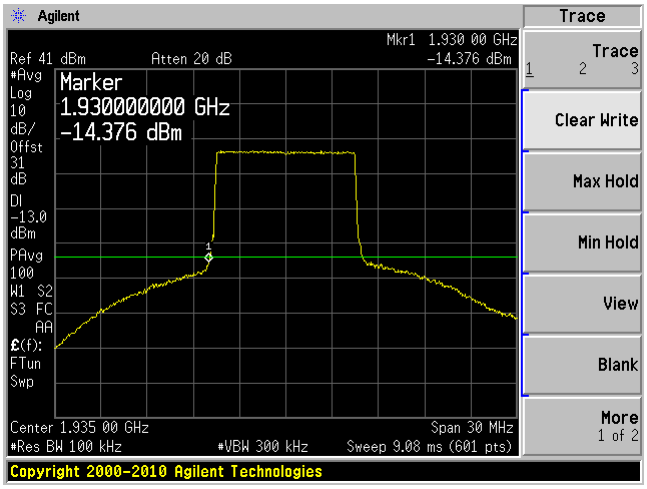
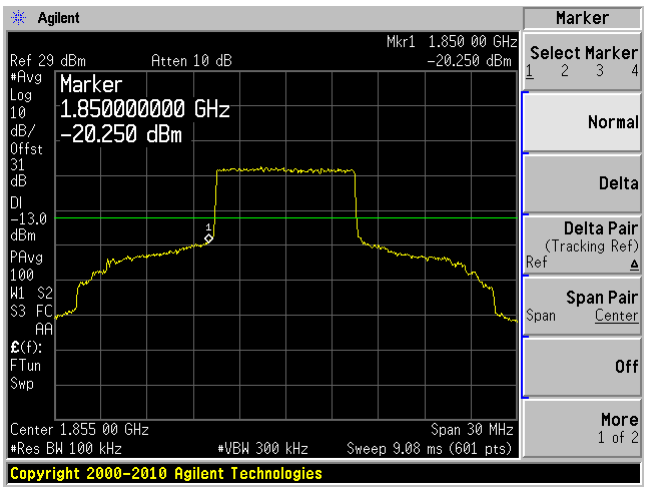


LTE 10 MHz

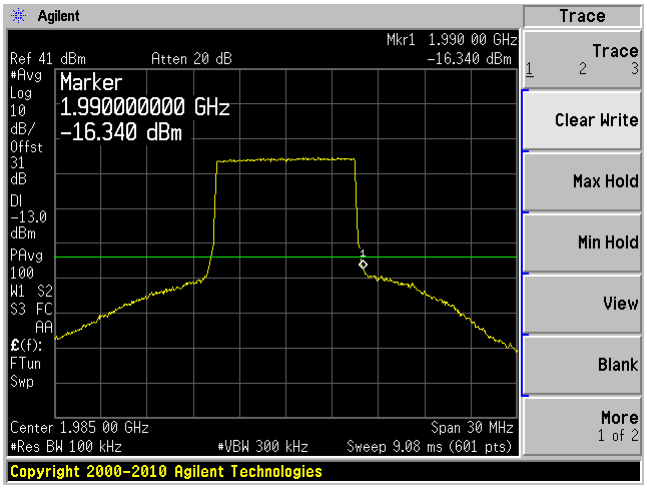
Low DL



Low UL



High DL



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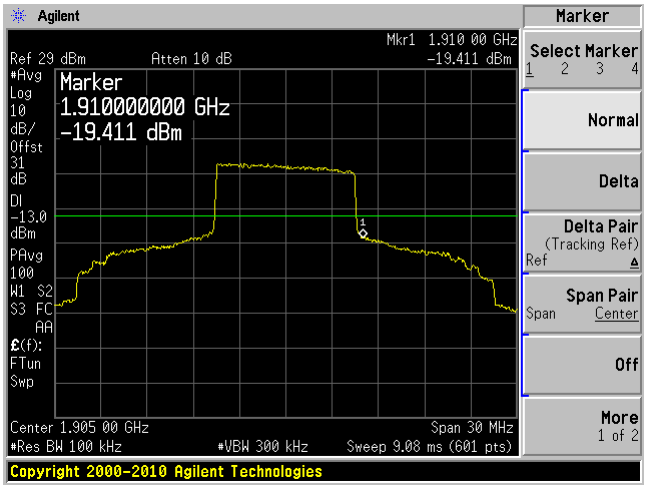
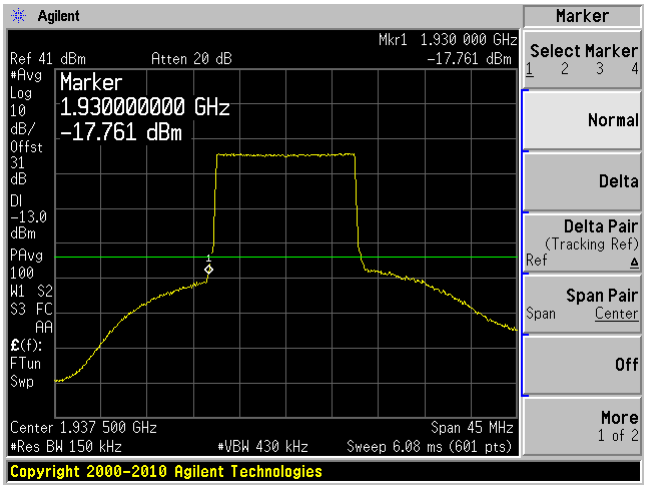


LTE 15 MHz

Low DL



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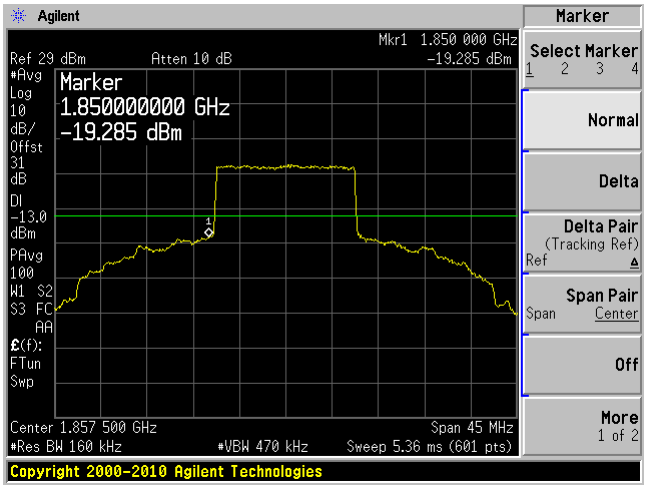
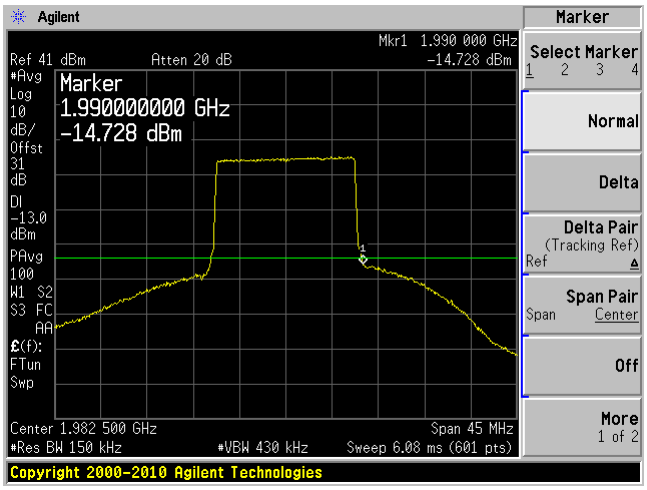


High DL



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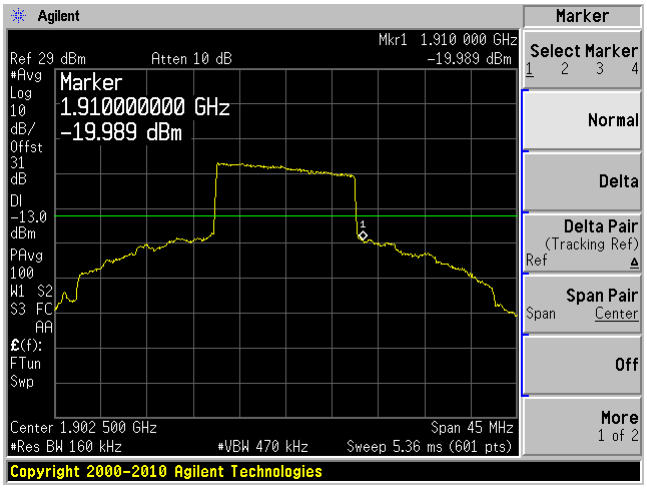
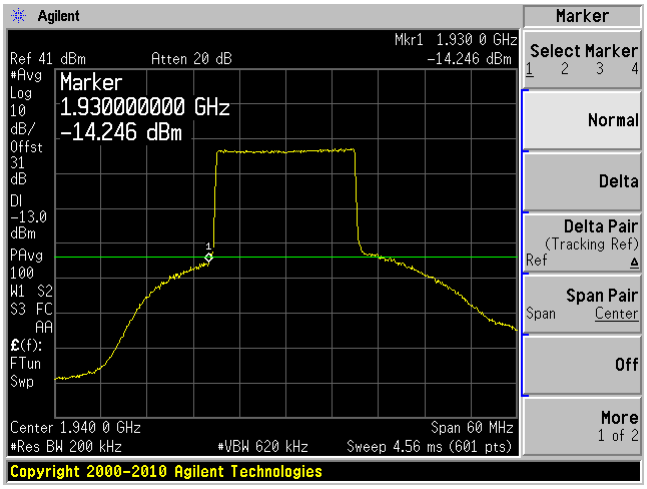
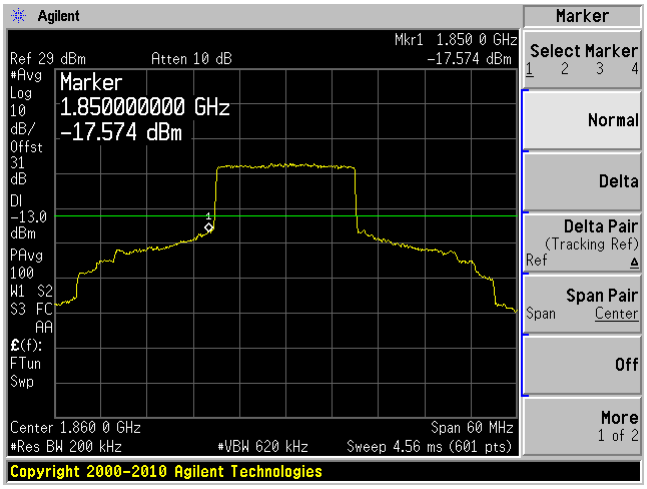


LTE 20MHz

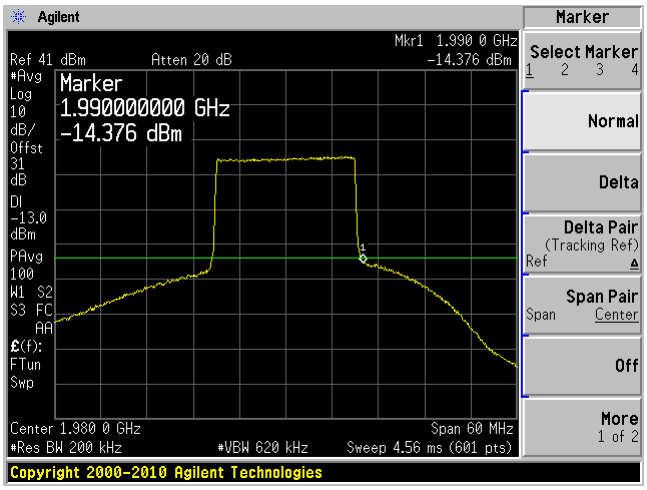
Low DL



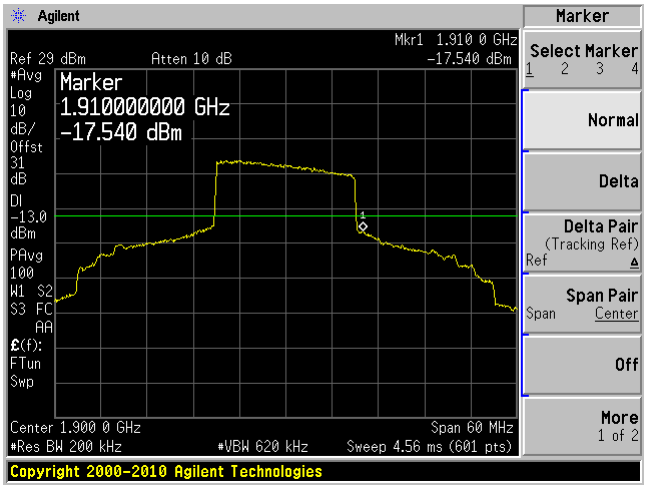
Low UL



High DL



High UL



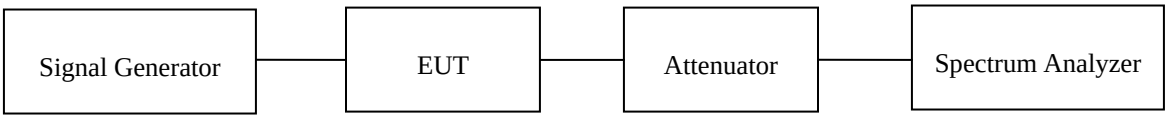
9 IC RSS-131 §4.2 - Passband Gain and Bandwidth

9.1 Applicable Standards

According to RSS 131§4.2, Adjust the internal gain control of the equipment under test to the nominal gain for which equipment certification is sought.
With the aid of a signal generator and spectrum analyzer, measure the 20 dB bandwidth of the amplifier (i.e. at the point where the gain has fallen by 20 dB). Measure the gain-versus-frequency response of the amplifier from the mid-band frequency f0 of the passband up to at least f0 ±250% of the 20 dB bandwidth.

9.2 Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.



9.3 Test Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Dates	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	MY44303352	2014-10-16	1 year
Agilent	Signal Generator	E4438C	MY45091309	2014-07-15	2 year

Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

9.4 Test Environmental Conditions

Temperature:	21-23 °C
Relative Humidity:	42-48 %
ATM Pressure:	101.4-102 kPa

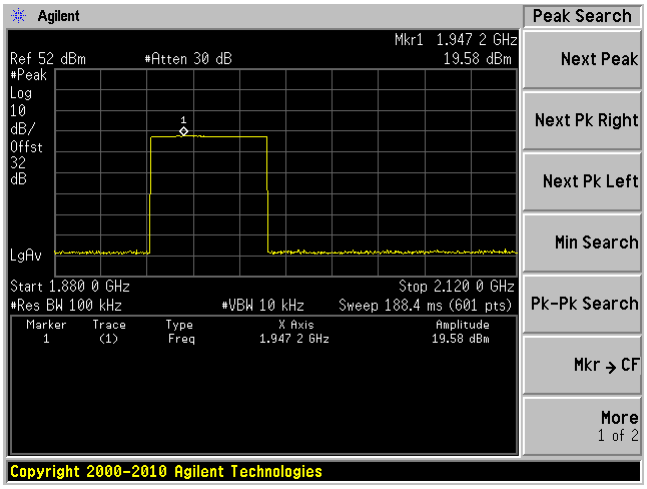
The testing was performed by Ronak Pate 2015-07-29 to 2015-07-31in the RF Site.

9.5 Test Results

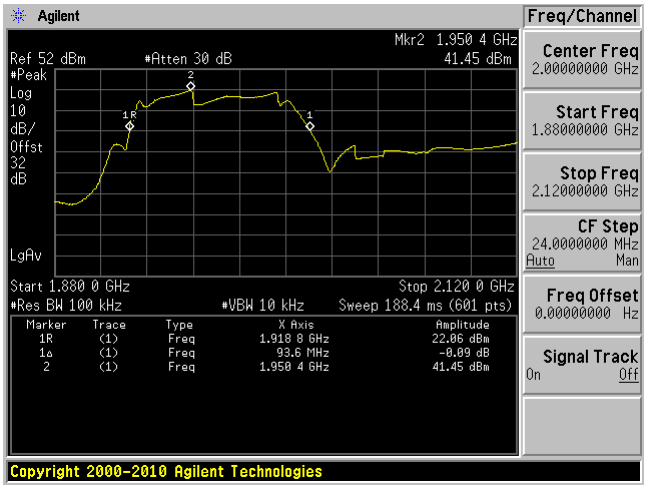
Frequency	Input (dBm)	Output (dBm)	Gain (dB)	20 dB Bandwidth (MHz)
Downlink	19.58	41.45	21.88	93.6
Uplink	-4.7	21.31	26.01	97.5

Downlink

Input

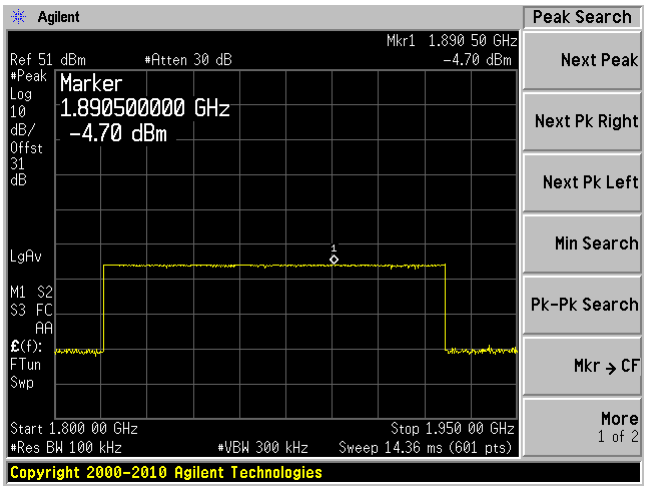


Output

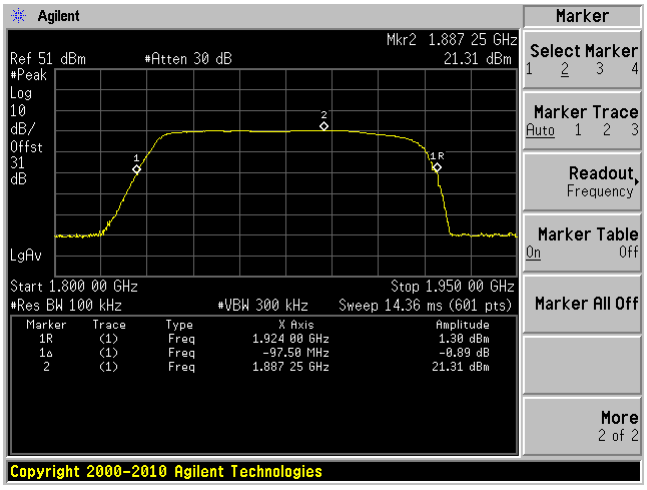


Uplink

Input



Output



10 FCC §1.1307(b)(1), §2.1091 & IC RSS-102 - RF Exposure

10.1 Applicable Standards

According to §1.1310 and §2.1091 (Mobile Devices) RF exposure is calculated.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

Note: f = frequency in MHz
* = Plane-wave equivalent power density

According to IC RSS-102 Issue 5 section 4, RF limits used for general public will be applied to the EUT.

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
$0.003\text{-}10^{21}$	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

10.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

10.3 Test Results

Downlink

Maximum peak output power at antenna input terminal (dBm):	40.75
Maximum peak output power at antenna input terminal (mW):	11885.02
Prediction distance (cm):	72
Prediction frequency (MHz):	1960
Antenna Gain, typical (dBi):	4
Maximum Antenna Gain (numeric):	2.512
Power density at predication frequency and distance (mW/cm^2):	0.458
MPE limit for uncontrolled exposure at predication frequency (mW/cm^2):	1
Power density at predication frequency and distance (W/m2):	4.58
MPE limit for uncontrolled exposure at predication frequency (W/m2):	4.67

Uplink

Maximum peak output power at antenna input terminal (dBm):	20.79
Maximum peak output power at antenna input terminal (mW):	119.95
Prediction distance (cm):	20
Prediction frequency (MHz):	1850.2
Antenna Gain, typical (dBi):	4
Maximum Antenna Gain (numeric):	2.512
Power density at predication frequency and distance (mW/cm^2):	0.05994
MPE limit for uncontrolled exposure at predication frequency (mW/cm^2):	1
Power density at predication frequency and distance (W/m2):	0.5994
MPE limit for uncontrolled exposure at predication frequency (W/m2):	4.48

Results

For uplink and downlink, the highest power density levels at **72 cm** are below the MPE uncontrolled exposure limit.