



FCC PART 20.21, PART 22H
IC RSS-131, ISSUE 2


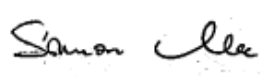
TEST AND MEASUREMENT REPORT

For

Shireen, Inc.

12910 Cloverleaf Center Drive, Suite 110,
Germantown, MD 20874, USA

FCC ID: YEF18892PICOAMP
IC: 8987A-PICOAMP892

Report Type: Original Report	Product Type: 850 MHz Picocell Amplifier
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Report Number: R1504064-22 Rev A	
Report Date: 2015-06-02	
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* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1504064-22	Original Report	2015-05-15
1	R1504064-22 Rev A	Updated Test Data	2015-06-02

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: 18-892, FCC ID: YEF18892PICOAMP, IC: 8987A-PICOAMP892, which will henceforth be referred to as the EUT (Equipment Under Test). The EUT is an 850 MHz 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: 1314225, 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 22 Subpart H, of the Federal Communication Commission's rules, and IC RSS 131.

The objective is to determine compliance with FCC/IC 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 22 Subpart H - Public Mobile Services

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 Luminaires 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. The 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	18892	-

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, §22.913 RSS-131 §4.3	RF Output Power	Compliant
FCC §2.1049, §22.917 IC RSS-Gen §6.6	Occupied Bandwidth	Compliant
FCC §2.1053, §22.917 IC RSS-131 §4.4	Spurious Radiated Emissions	Compliant
FCC§2.1051, §22.917 IC RSS-131 §4.4	Spurious Emissions at Antenna Terminals	Compliant
FCC §22.917 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, §22.913 & IC RSS-131 §4.3 - RF Output Power

4.1 Applicable Standards

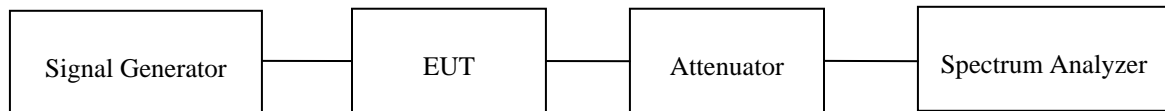
According to FCC §22.913 (a), the maximum effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 Watts.

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

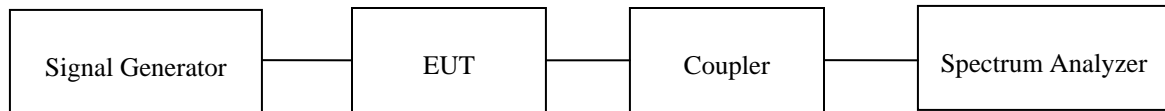
Conducted:

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 f_1 and f_2 such that they and their third-order intermodulation product frequencies, $f_3 = 2f_1 - f_2$ and $f_4 = 2f_2 - f_1$, are all within the passband of the DUT.
5. Raise the input level to the DUT while observing the output tone levels, P_{o1} and P_{o2} , and the intermodulation product levels, P_{o3} and P_{o4} .
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, P_{o3} or P_{o4} , 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, P_{o3} or P_{o4} , is 67 dB below the level of either output tone level, P_{o1} or P_{o2} .
8. Record all signal levels and their frequencies. Calculate the mean output power (P_{mean}) under this testing condition using $P_{mean} = P_{o1} + 3 \text{ dB}$.

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	2014-05-03	1 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 Bo Li on 2015-04-02 to 2015-04-18 in the RF Site.

4.5 Test Results

Mode		Channel	Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
GSM/GPRS	850 MHz Downlink	Low	869.2	13	39.94	26.94
		Middle	881.6	13	39.02	26.02
		High	893.8	13	39.91	26.91
	850 MHz Uplink	Low	824.2	-17	14.51	31.51
		Middle	836.6	-17	14.99	31.99
		High	848.8	-17	14.1	31.1
CDMA/EVDO	850 MHz Downlink	Low	869.8	13	39.17	26.17
		Middle	881.5	13	38.53	25.53
		High	893.2	13	39.47	26.47
	850 MHz Uplink	Low	824.8	-17	14.93	31.93
		Middle	836.5	-17	15.32	32.32
		High	848.2	-17	14.63	31.63
WCDMA	850 MHz Downlink	Low	871.4	8	34.64	26.64
		Middle	881.6	8	33.47	25.47
		High	891.6	8	35.07	27.07
	850 MHz Uplink	Low	826.4	-17	14.43	31.43
		Middle	836.4	-17	15.03	32.03
		High	846.6	-17	14.41	31.41

Mode		Channel	Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
LTE 1.4 MHz	850 MHz Downlink	Low	869.7	8	33.79	25.79
		Middle	881.5	8	32.92	24.92
		High	893.3	8	34.01	26.01
	850 MHz Uplink	Low	824.7	-20	12.24	32.24
		Middle	836.5	-20	12.62	32.62
		High	848.3	-20	11.86	31.86
LTE 3 MHz	850 MHz Downlink	Low	870.5	8	34.18	26.18
		Middle	881.5	8	33.07	25.07
		High	892.5	8	34.4	26.4
	850 MHz Uplink	Low	825.5	-17	14.47	31.47
		Middle	836.5	-17	15.03	32.03
		High	847.5	-17	14.36	31.36
LTE 5 MHz	850 MHz Downlink	Low	871.5	8	34.49	26.49
		Middle	881.5	8	33.4	25.4
		High	891.5	8	34.8	26.8
	850 MHz Uplink	Low	826.5	-17	14.42	31.42
		Middle	836.5	-17	14.97	31.97
		High	846.5	-17	14.31	31.31
LTE 10 MHz	850 MHz Downlink	Low	874	8	34.2	26.2
		Middle	881.5	8	33.57	25.57
		High	889	8	34.66	26.66
	850 MHz Uplink	Low	821.5	-17	14.66	31.66
		Middle	836.5	-17	14.92	31.92
		High	844	-17	14.32	31.32

Mean output power:

Uplink

	F₁ (MHz)	F₂ (MHz)	F₃ (MHz)	F₄ (MHz)	Input power (dBm)	P_{o1} (dBm)	P_{mean} (dBm)
Low	826.4	826.65	826.15	826.9	-17.2	14.99	17.99
Middle	836.6	836.35	836.85	836.1	-19.1	14.97	17.97
High	846.6	846.35	846.85	846.1	-17.8	14.95	17.95

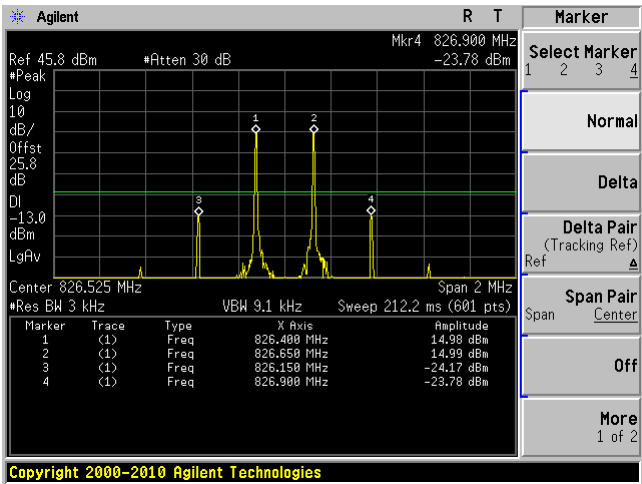
Downlink

	F₁ (MHz)	F₂ (MHz)	F₃ (MHz)	F₄ (MHz)	Input power (dBm)	P_{o1} (dBm)	P_{mean} (dBm)
Low	871.4	871.65	871.15	871.9	8.8	35.08	38.08
Middle	881.6	881.35	881.853	881.097	6.8	31.9	34.9
High	891.6	891.35	891.853	891.097	9.9	36.99	39.99

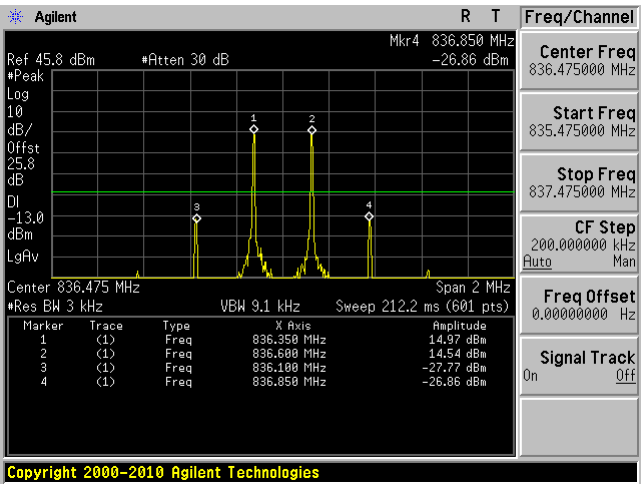
Please refer to the following tables and plots.

Uplink

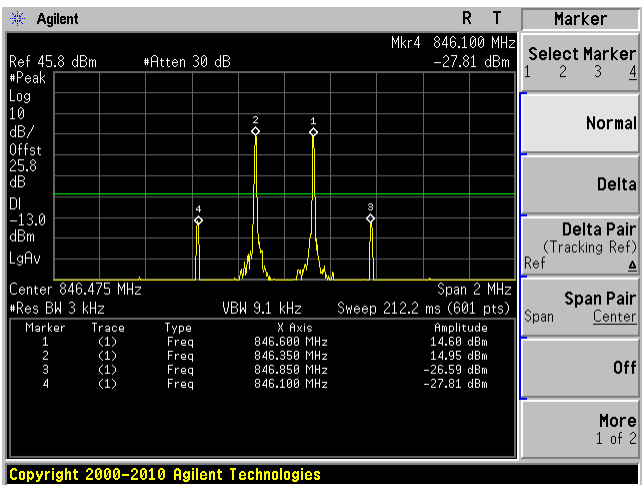
Low



Middle

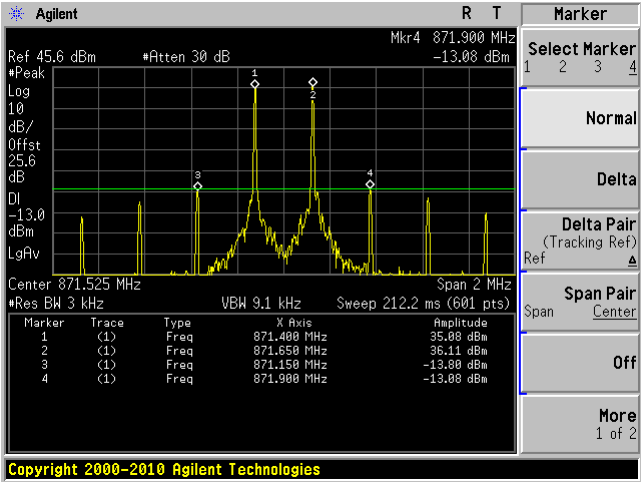


High

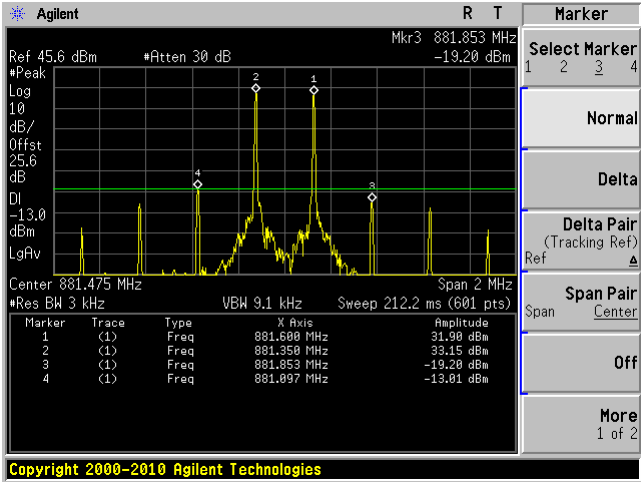


Downlink

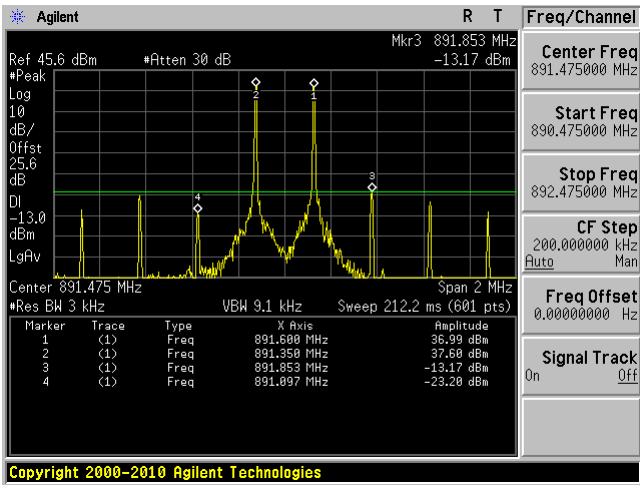
Low



Middle



High



5 FCC §2.1049, §22.917 & IC RSS-Gen §6.6 - Occupied Bandwidth

5.1 Applicable Standards

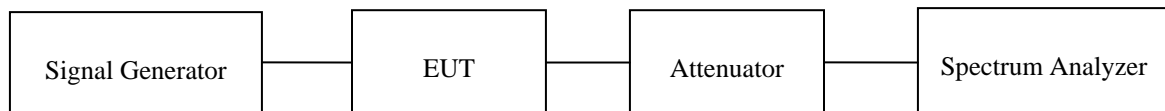
Requirements: FCC §2.1049, §22.917
IC RSS-Gen §6.6

5.2 Test Procedure

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% 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

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Dates	Calibration Interval
Agilent	Spectrum Analyzer	E4440A	MY44303352	2014-10-16	1 year
Agilent	Signal Generator	E4438C	MY45091309	2014-05-03	1 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 Bo Li on 2015-04-02 to 2015-04-18 in the RF Site.

5.5 Test Results

Please refer to the following tables and plots.

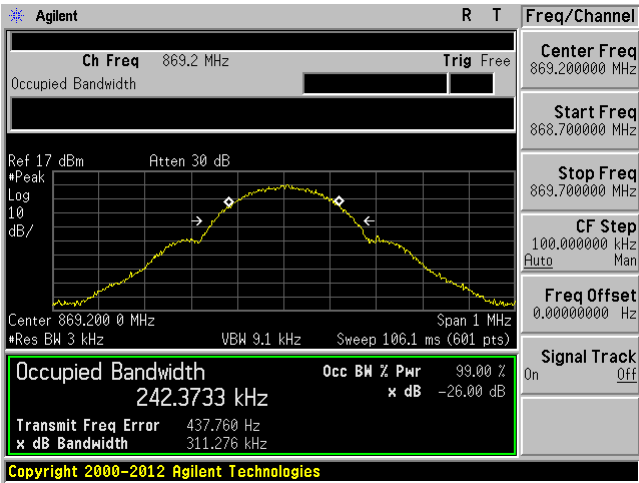
Mode		Channel	Frequency (MHz)	Input		Output	
				99% OBW (kHz)	26 dB OBW (kHz)	99% OBW (kHz)	26 dB OBW (kHz)
GSM/GPRS	850 MHz DL	Low	869.2	242.3733	311.276	242.7433	310.963
		Middle	881.6	245.1974	312.833	245.298	314.445
		High	893.8	244.3905	309.748	244.4723	313.767
	850 MHz UL	Low	824.2	242.533	307.411	242.1678	312.465
		Middle	836.6	246.4519	312.217	246.4376	315.516
		High	848.8	244.8309	314.710	244.6757	312.615
CDMA/EVDO	850 MHz DL	Low	869.8	1260.8	1425	1261.6	1437
		Middle	881.5	1259.7	1426	1256.6	1432
		High	893.2	1263.7	1430	1269.9	1434
	850 MHz UL	Low	824.8	1260.1	1433	1253.1	1438
		Middle	836.5	1256.7	1421	1257.4	1436
		High	848.2	1260.2	1424	1264.6	1434
WCDMA	850 MHz DL	Low	871.4	4167.5	4684	4163.1	4694
		Middle	881.6	4149	4680	4169.9	4675
		High	891.6	4168.1	4653	4174.2	4673
	850 MHz UL	Low	826.4	4160.1	4681	4185.1	4675
		Middle	836.4	4165.3	4656	4207.9	4936
		High	846.6	4154.8	4682	4181	4748

Mode		Channel	Frequency (MHz)	Input		Output	
				99% OBW (MHz)	26 dB OBW (MHz)	99% OBW (MHz)	26 dB OBW (MHz)
LTE 1.4 MHz	850 MHz DL	Low	869.7	1.0983	1.336	1.0963	1.32
		Middle	881.5	1.0963	1.341	1.0942	1.328
		High	893.3	1.0956	1.326	1.0976	1.349
	850 MHz UL	Low	824.7	1.0976	1.315	1.0995	1.397
		Middle	836.5	1.0979	1.345	1.1051	1.641
		High	848.3	1.094	1.327	1.0954	1.355
LTE 3 MHz	850 MHz DL	Low	870.5	2.6955	2.986	2.7004	2.973
		Middle	881.5	2.6954	2.975	2.7078	2.997
		High	892.5	2.7037	2.975	2.7051	2.988
	850 MHz UL	Low	825.5	2.6992	2.982	2.7122	3.491
		Middle	836.5	2.6961	2.975	2.7305	3.836
		High	847.5	2.6994	2.993	2.714	3.269
LTE 5 MHz	850 MHz DL	Low	871.5	4.4931	5.008	4.486	4.975
		Middle	881.5	4.4957	4.992	4.4962	5
		High	891.5	4.4915	4.983	4.4847	4.978
	850 MHz UL	Low	826.5	4.4917	4.98	4.4983	5.028
		Middle	836.5	4.4901	5.001	4.4989	6.458
		High	846.5	4.4959	4.982	4.4921	4.94
LTE 10 MHz	850 MHz DL	Low	874	8.9574	9.851	8.9479	9.912
		Middle	881.5	8.9578	9.878	8.98	9.965
		High	889	8.9432	9.92	8.9345	9.834
	850 MHz UL	Low	821.5	8.9559	9.859	8.991	11.868
		Middle	836.5	8.9544	9.853	8.9533	12.191
		High	844	8.9663	9.891	8.9764	10.684

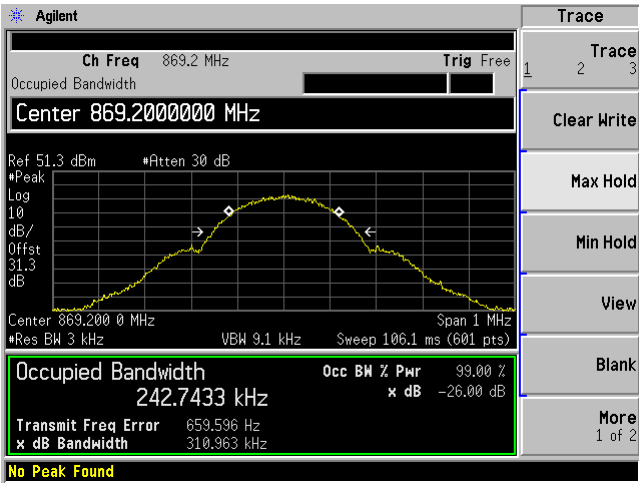
Occupied Bandwidth

GSM/GPRS

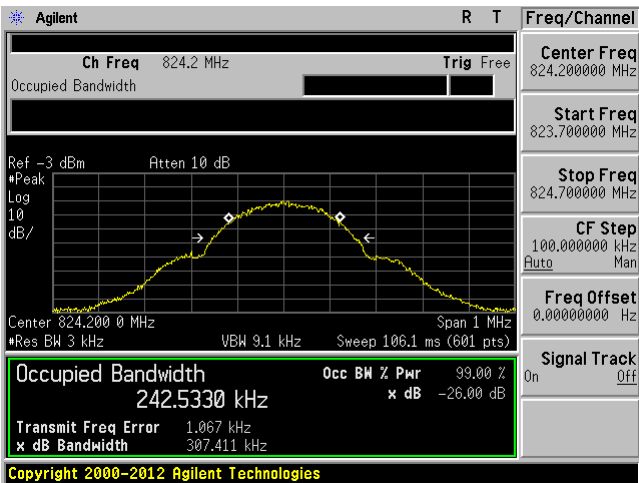
Low DL-Input



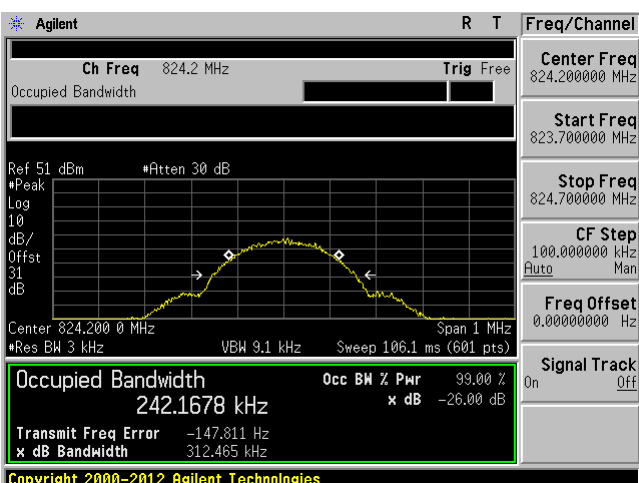
Low DL-Output



Low UL-Input



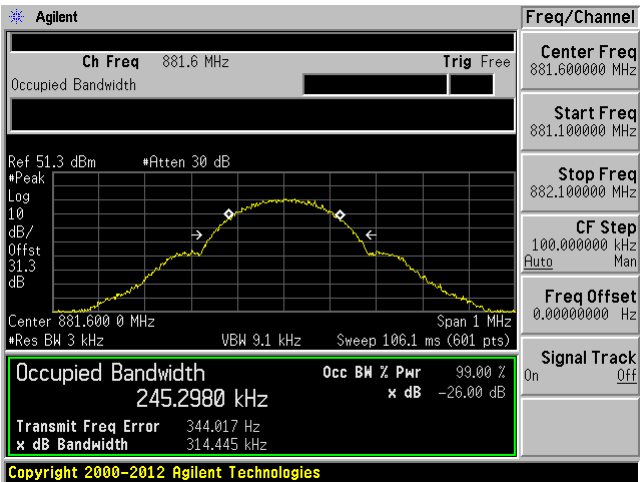
Low UL-Output



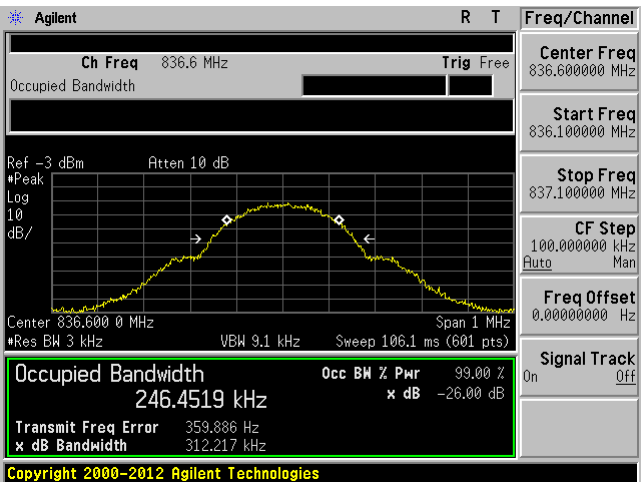
Middle DL-Input



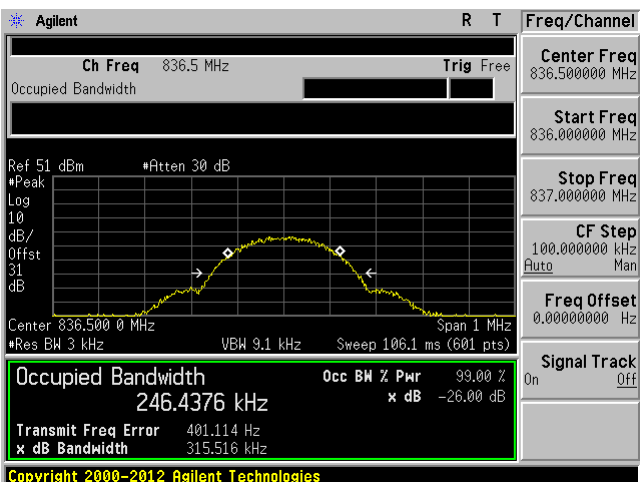
Middle DL-Output



Middle UL-Input



Middle UL-Output



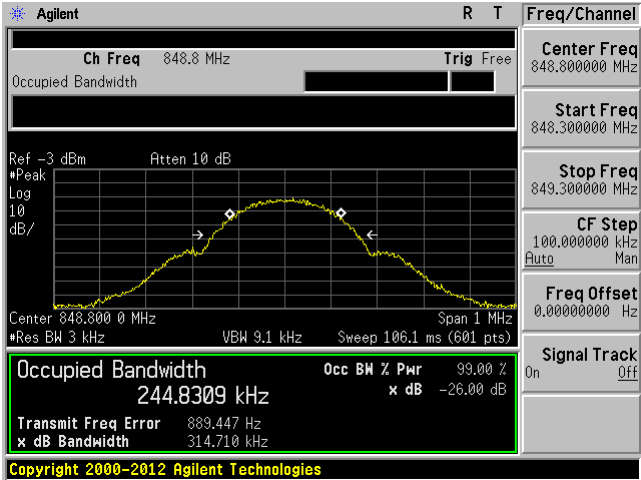
High DL-Input



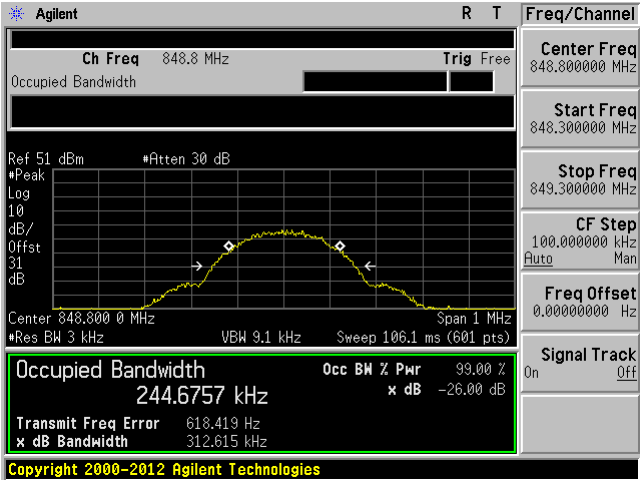
High DL-Output



High UL-Input

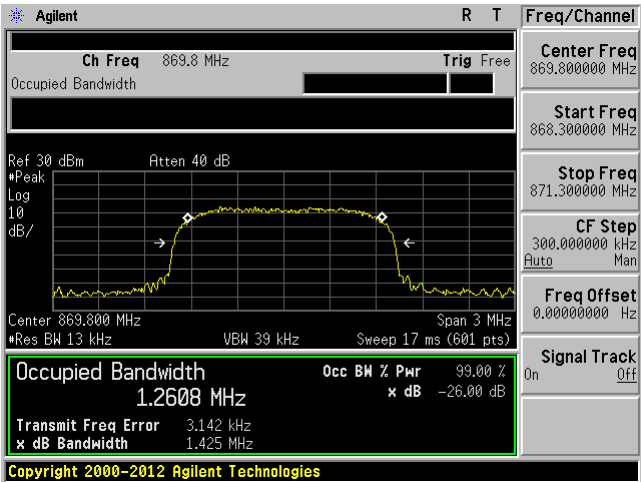


High UL-Output

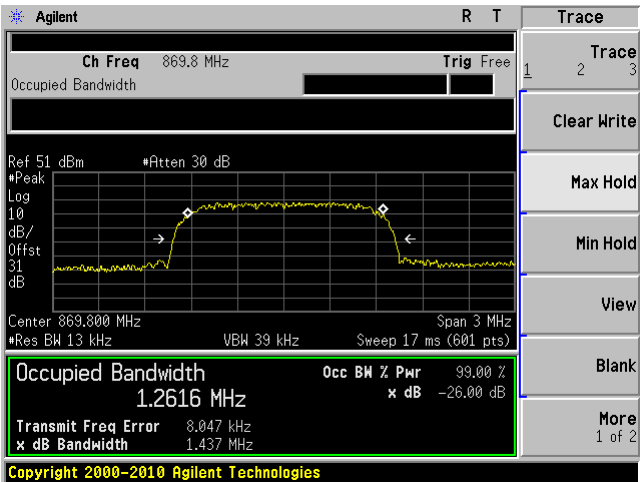


CDMA

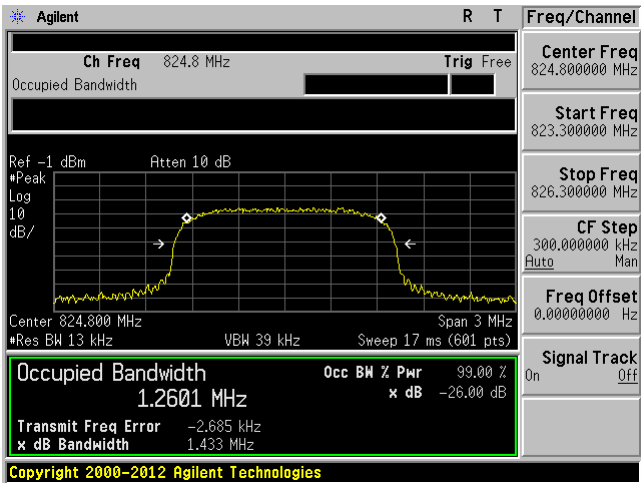
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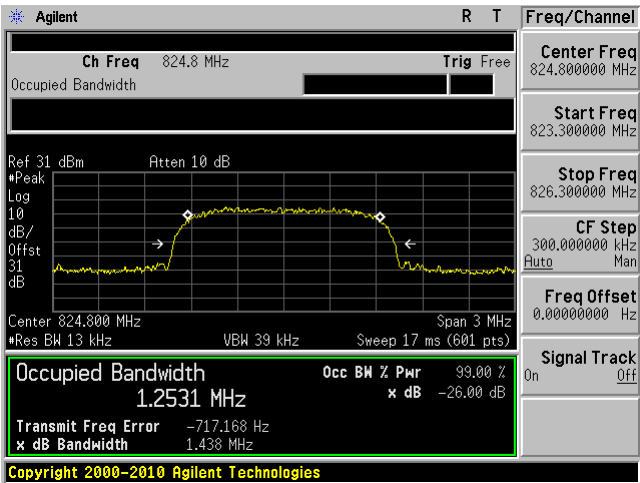
Low DL-Output



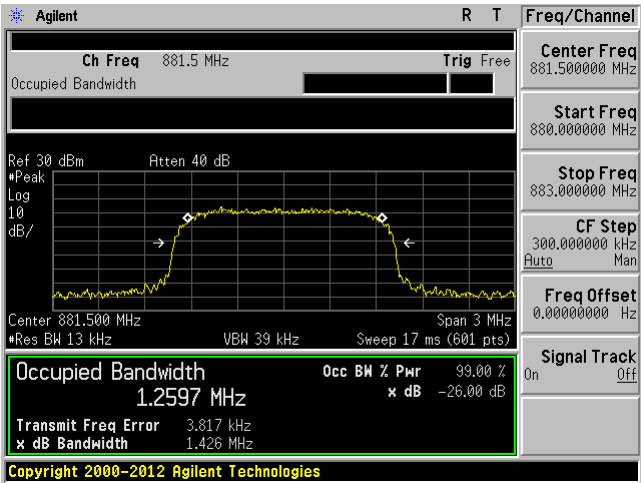
Low UL-Input



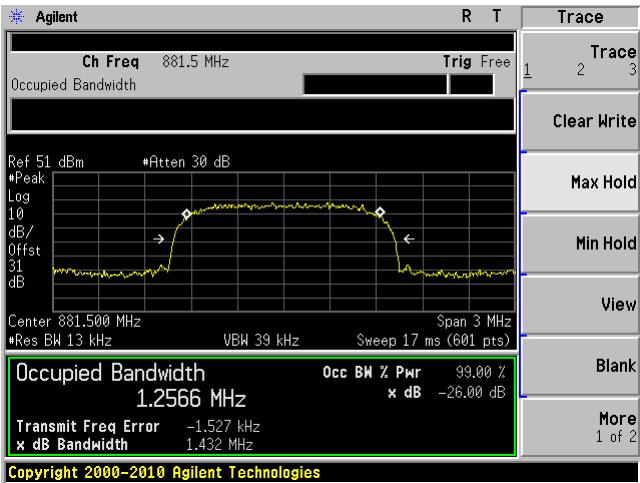
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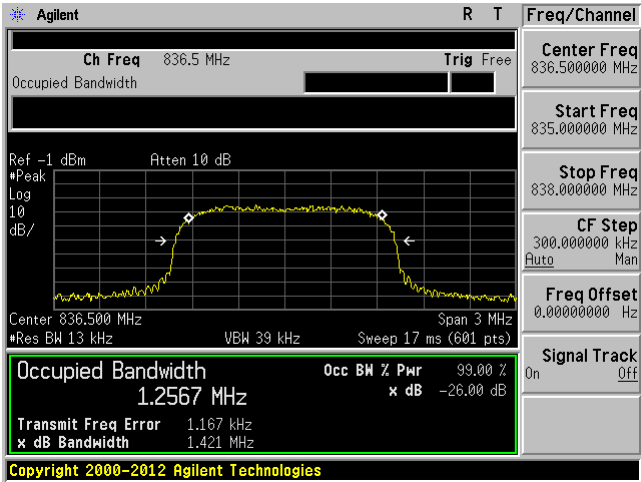
Middle DL-Input



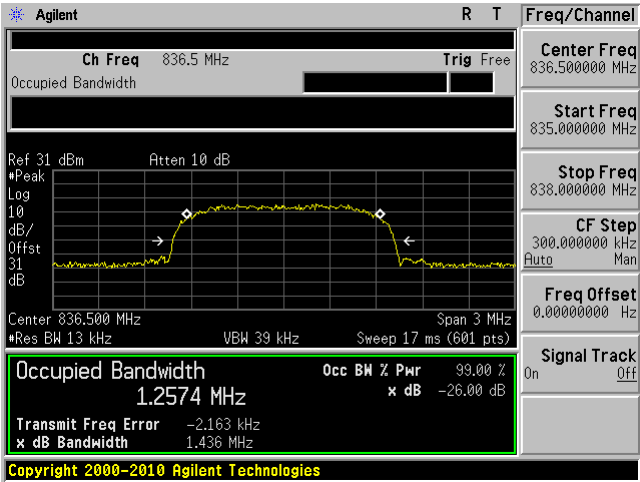
Middle DL-Output



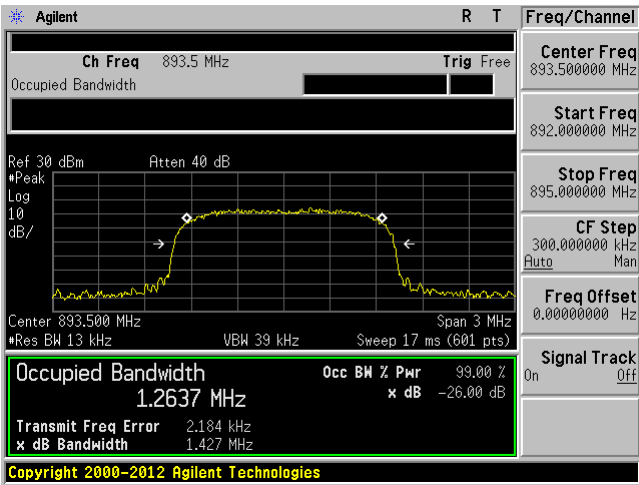
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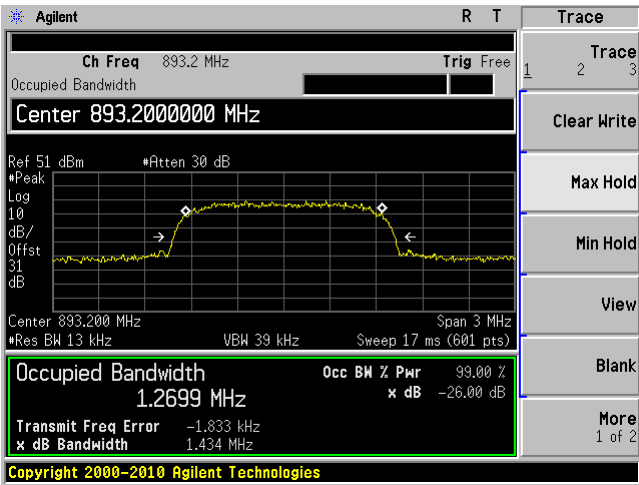
Middle UL-Output



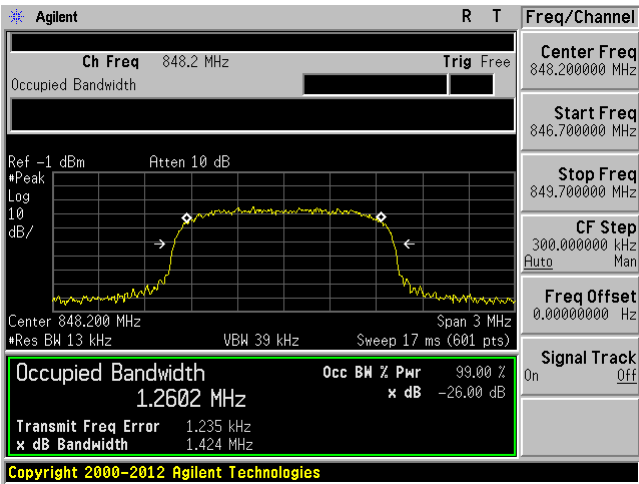
High DL-Input



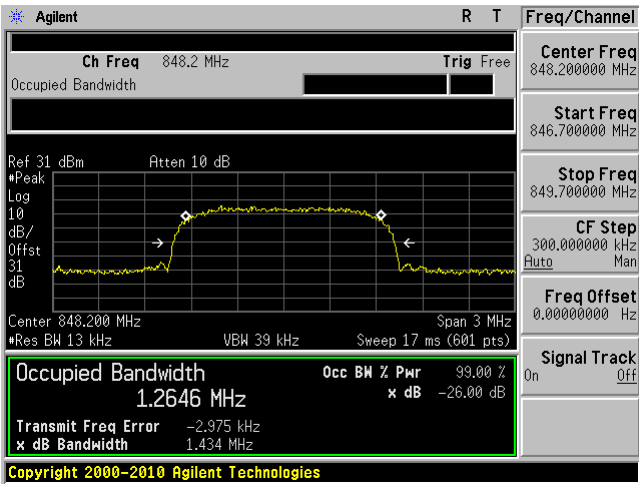
High DL-Output



High UL-Input

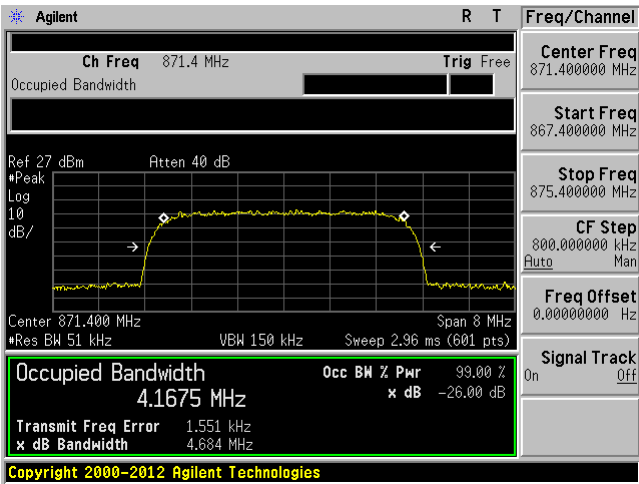


High UL-Output

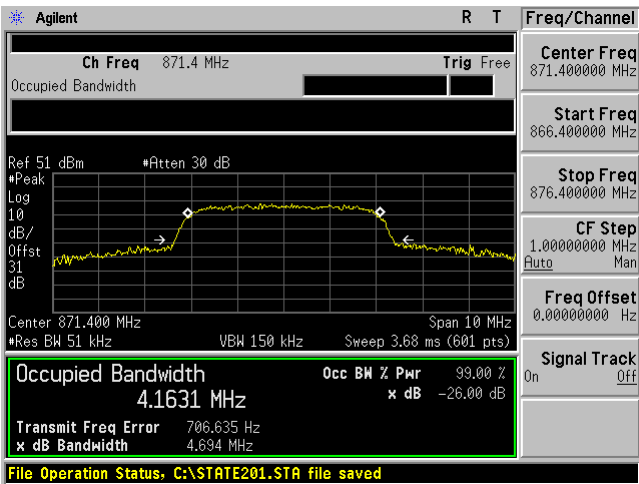


WCDMA

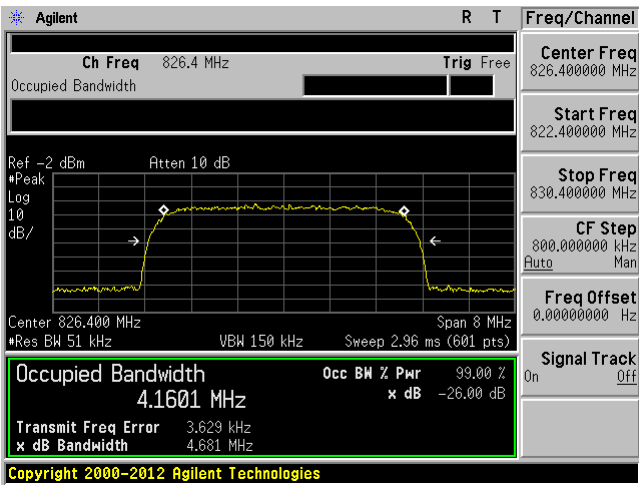
Low DL-Input



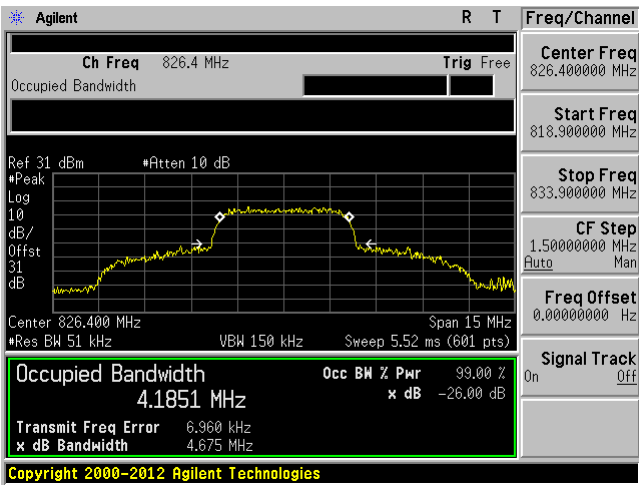
Low DL-Output



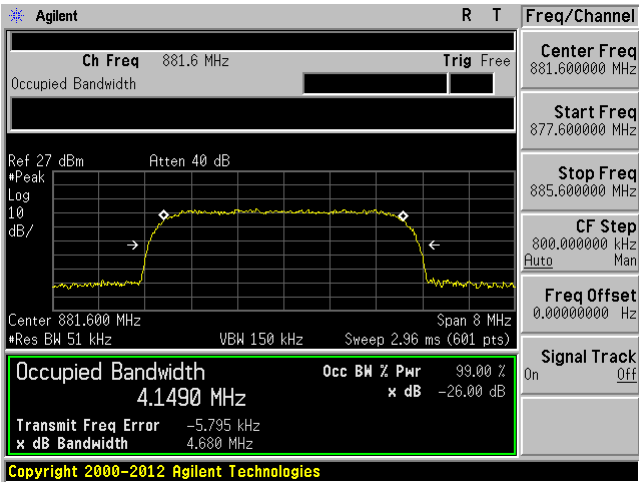
Low UL-Input



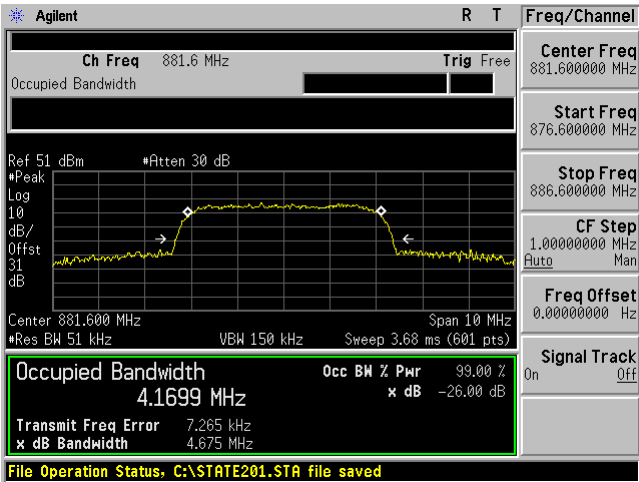
Low UL-Output



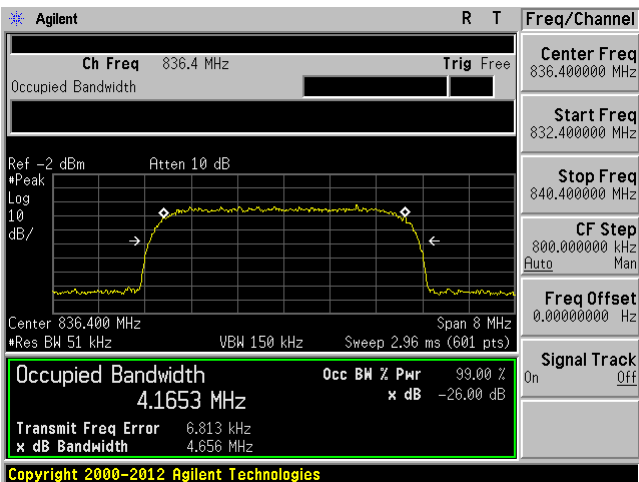
Middle DL-Input



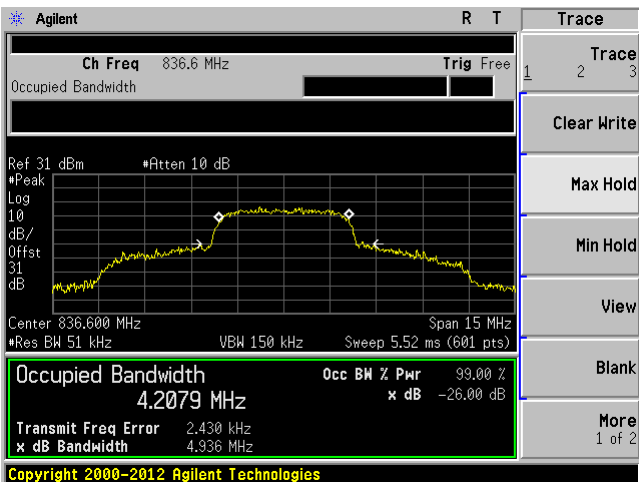
Middle DL-Output



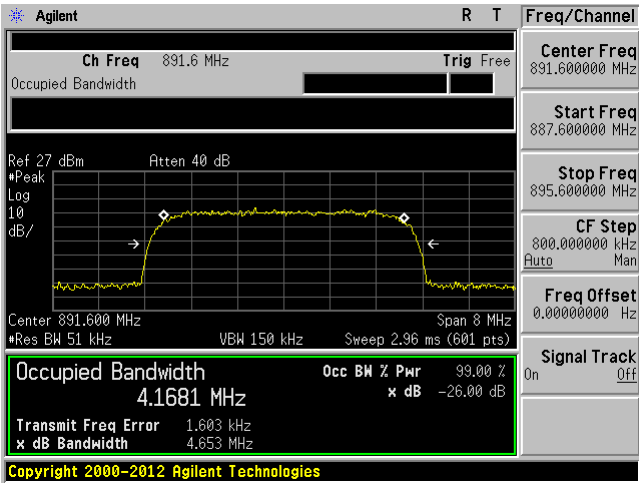
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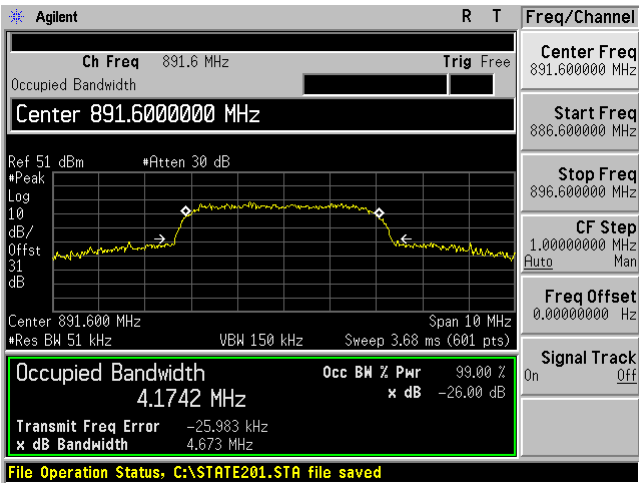
Middle UL-Output



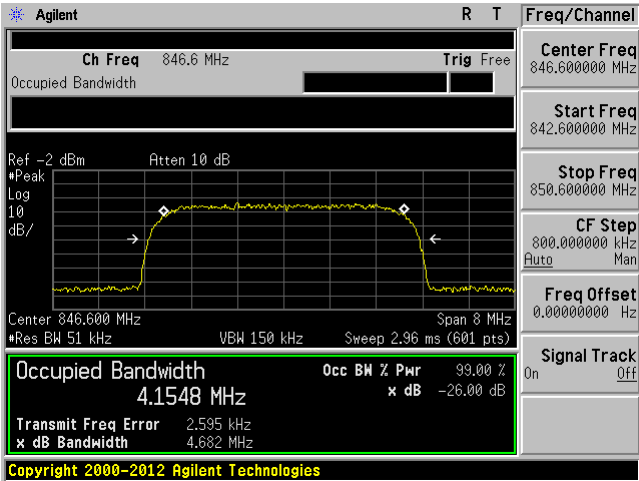
High DL-Input



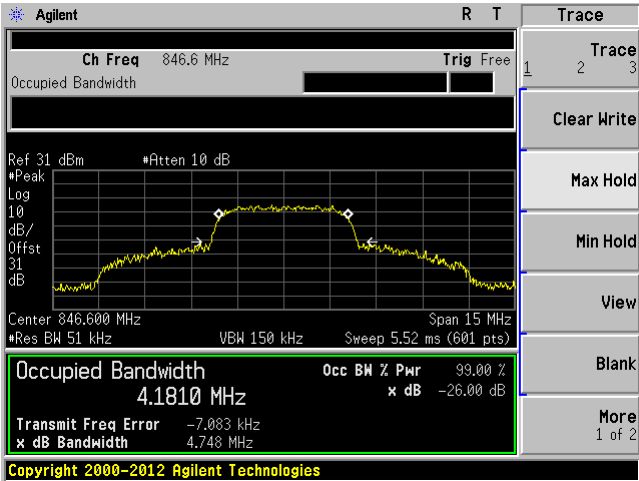
High DL-Output



High UL-Input

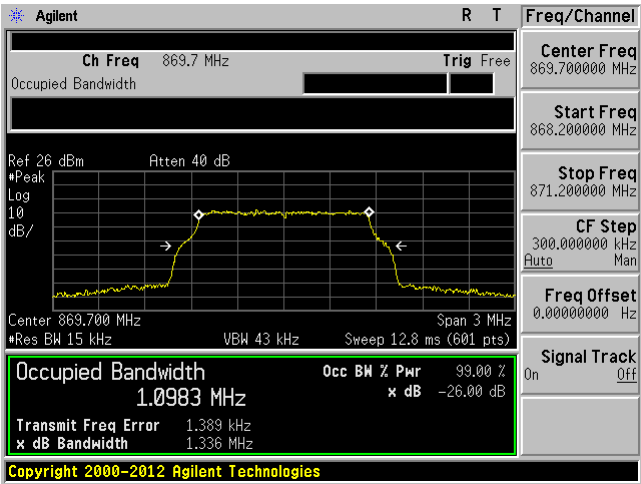


High UL-Output

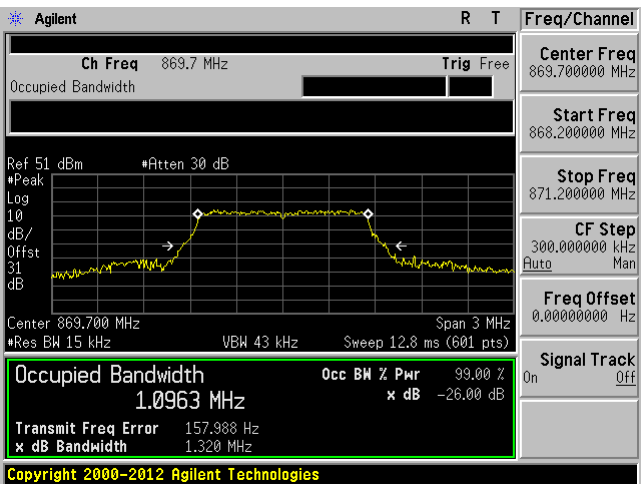


LTE 1.4 MHz

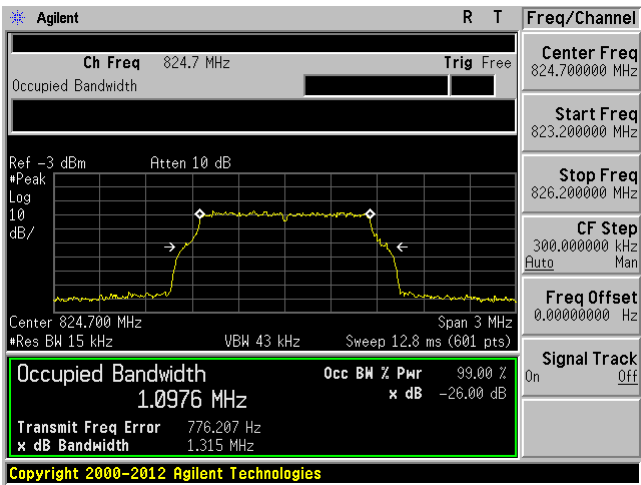
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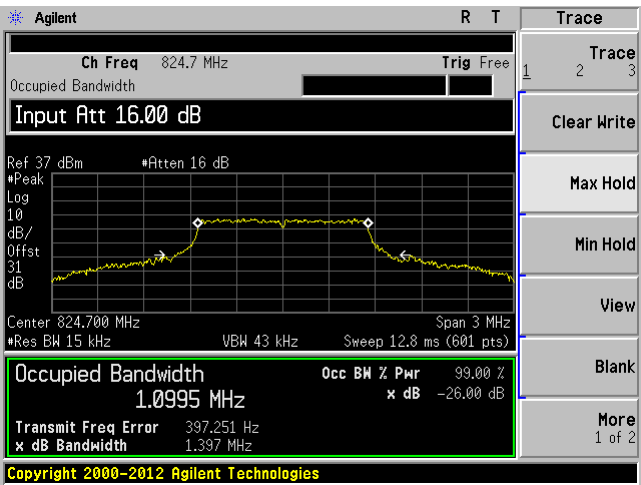
Low DL-Output



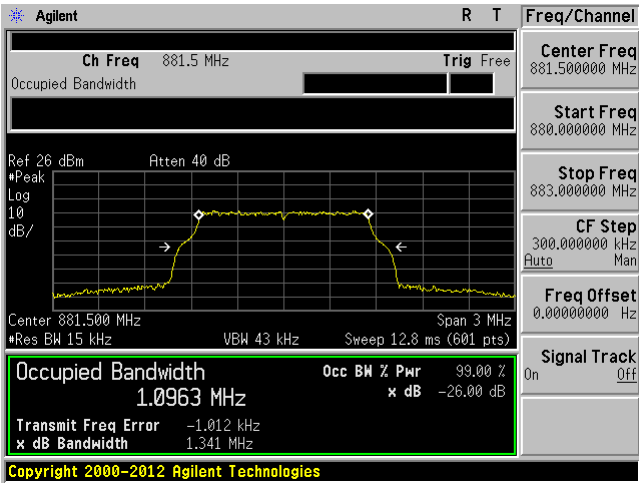
Low UL-Input



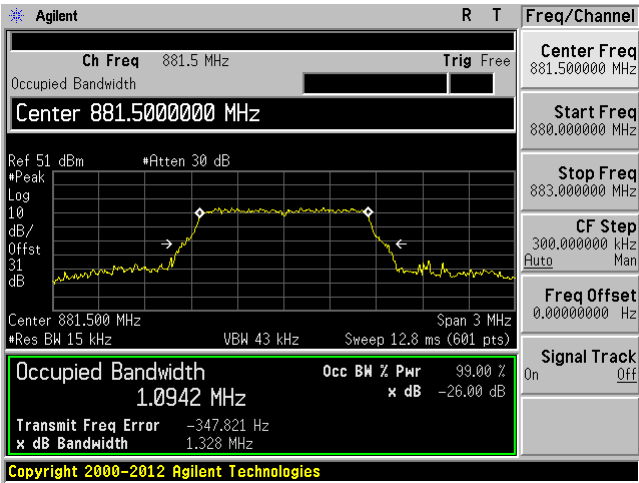
Low UL-Output



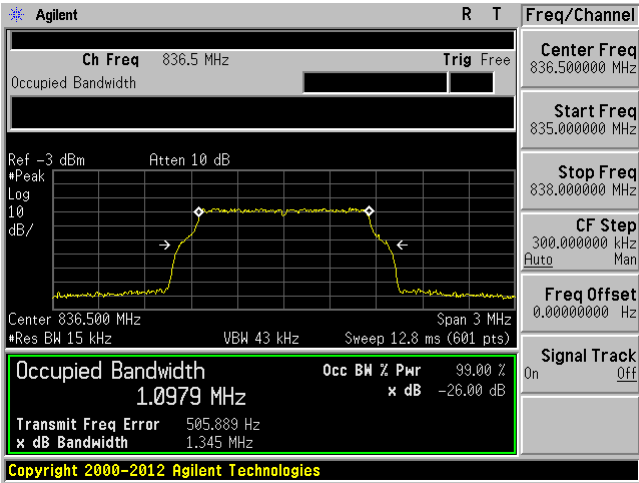
Middle DL-Input



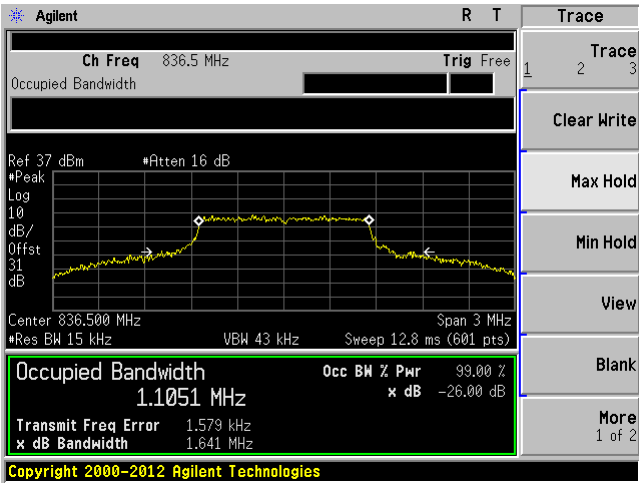
Middle DL-Output



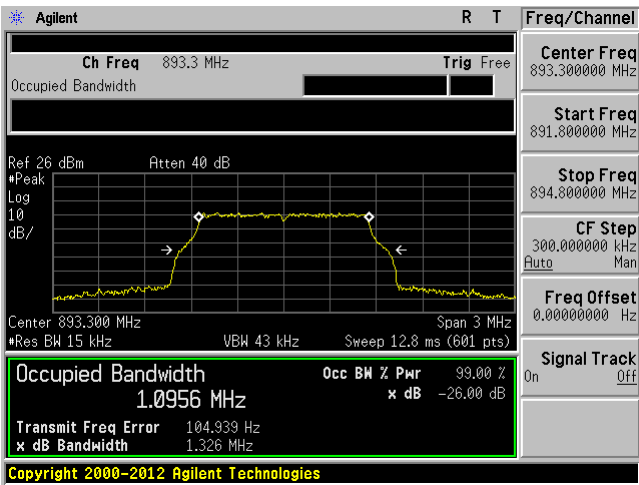
Middle UL-Input



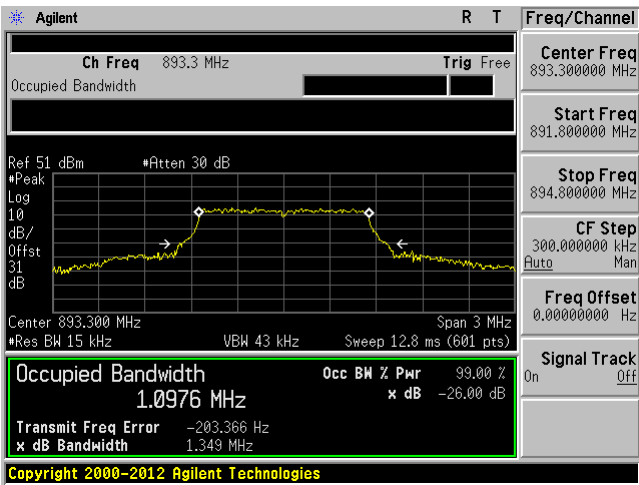
Middle UL-Output



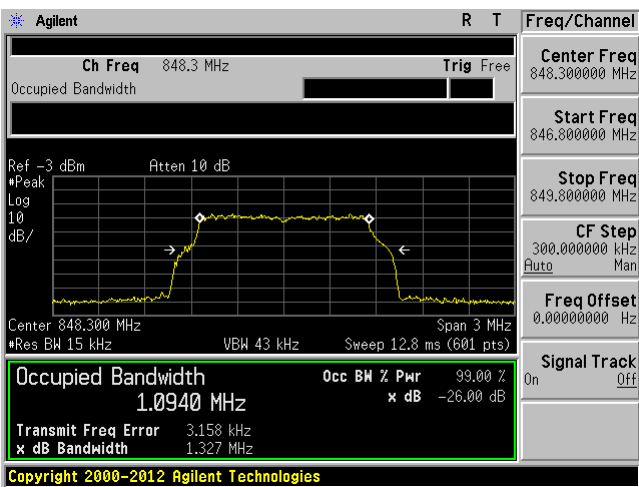
High DL-Input



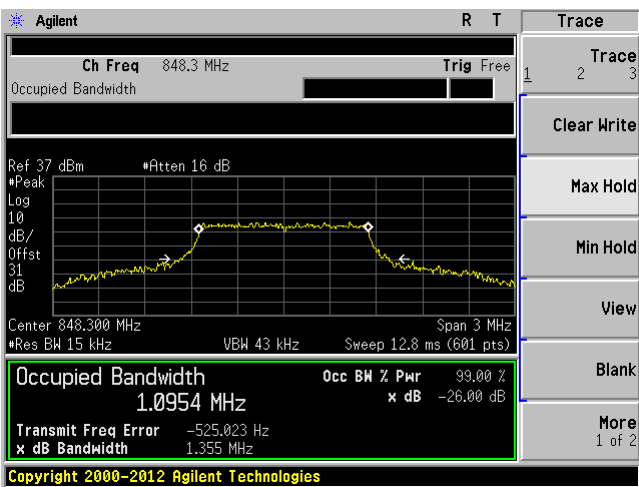
High DL-Output



High UL-Input

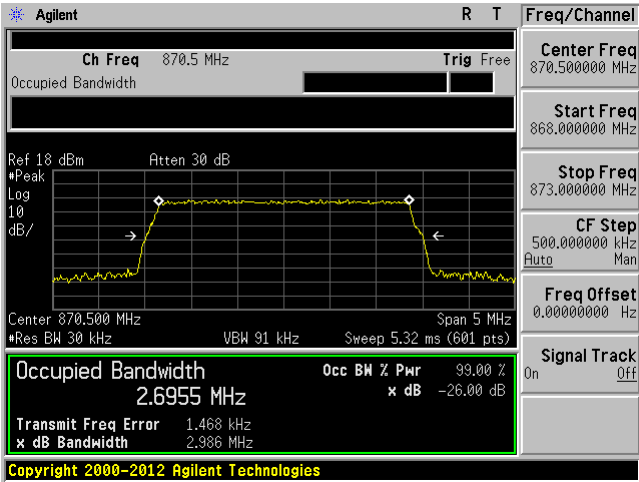


High UL-Output

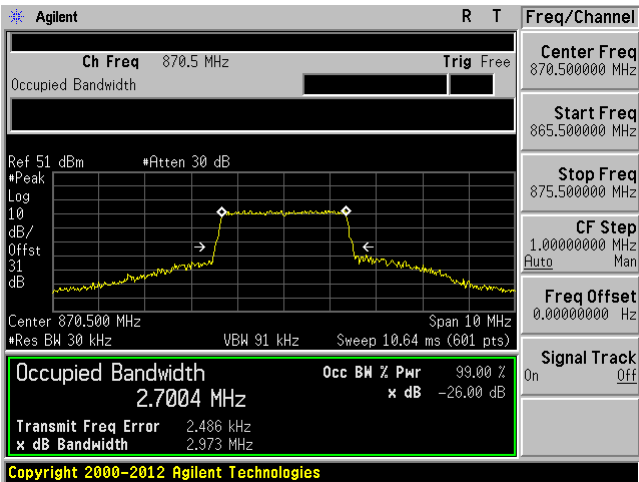


LTE 3 MHz

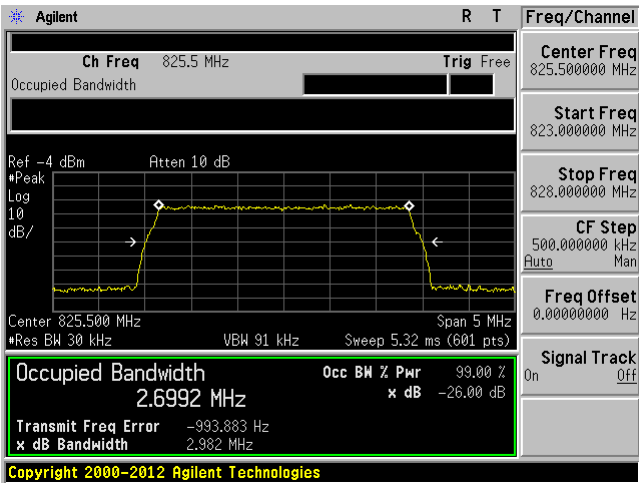
Low DL-Input



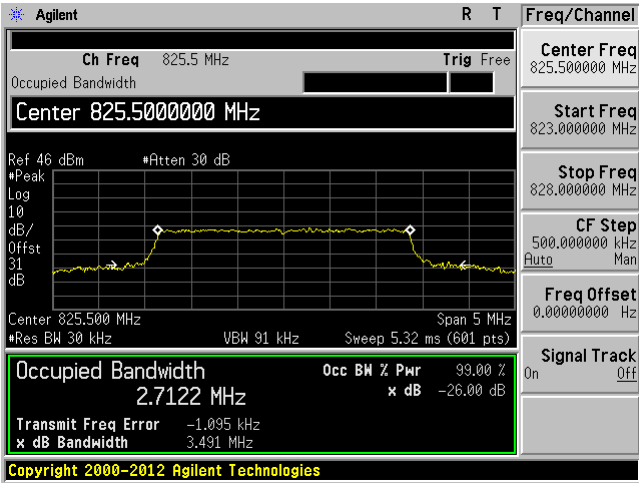
Low DL-Output



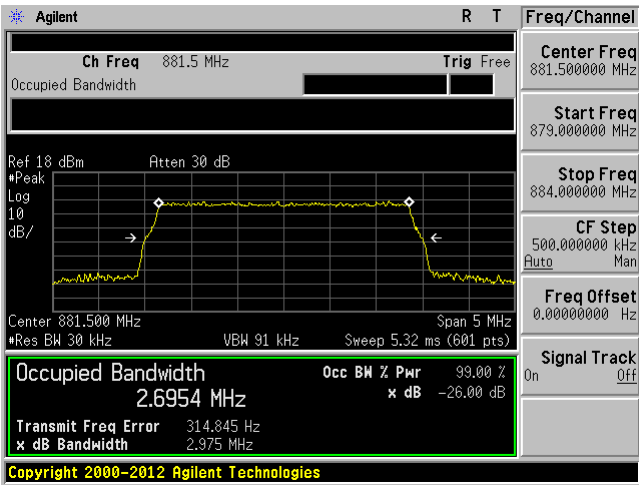
Low UL-Input



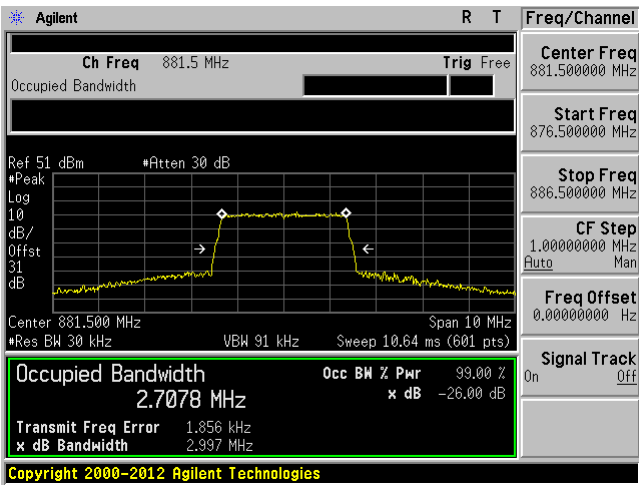
Low UL-Output



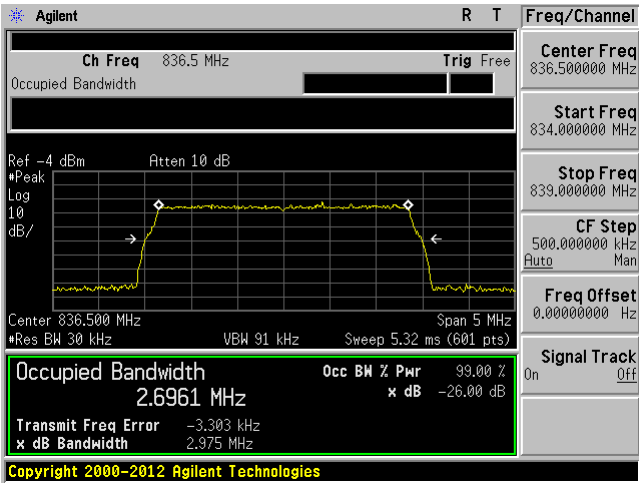
Middle DL-Input



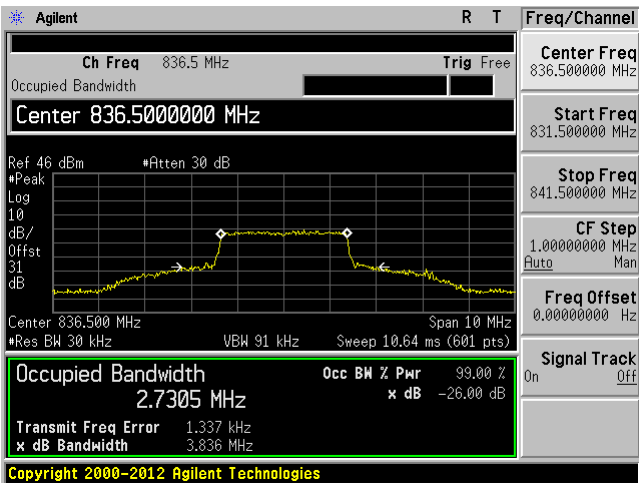
Middle UL-Output



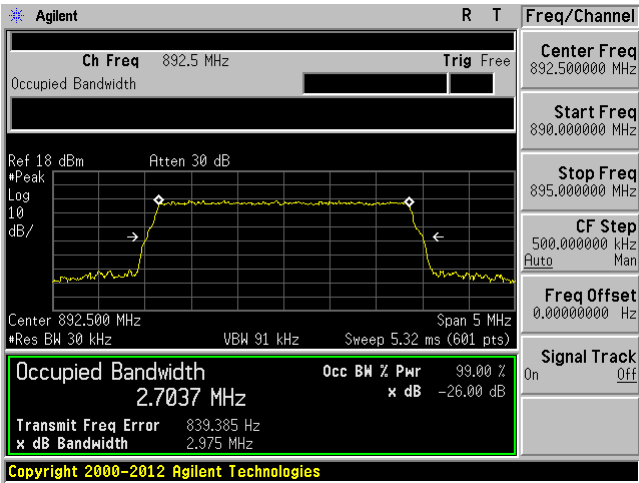
Middle UL-Input



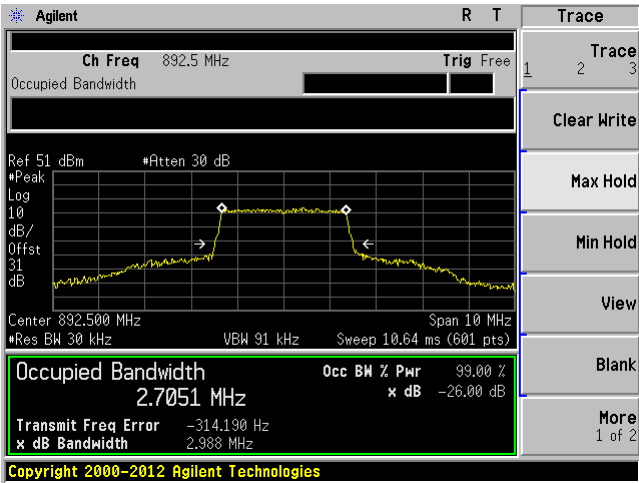
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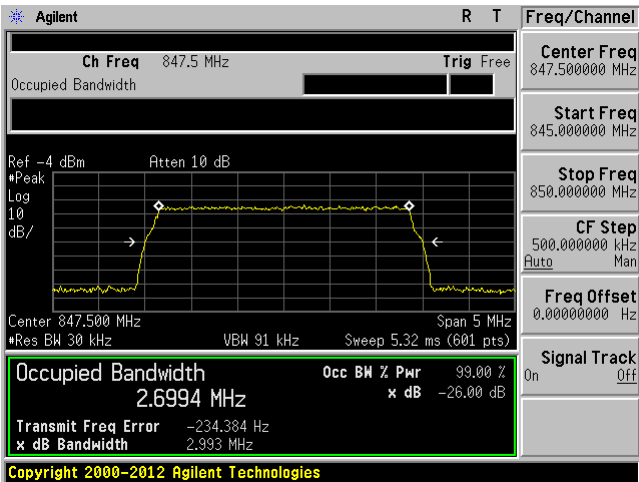
High DL-Input



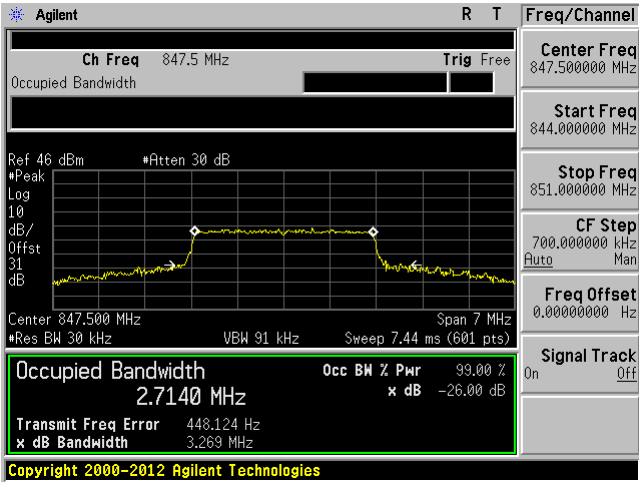
High DL-Output



High UL-Input

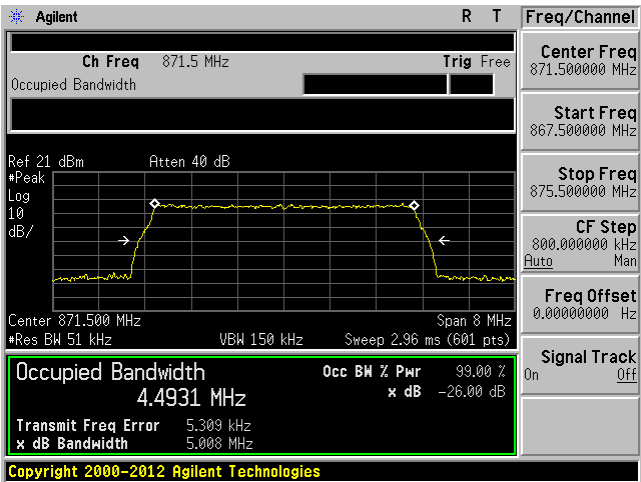


High UL-Output

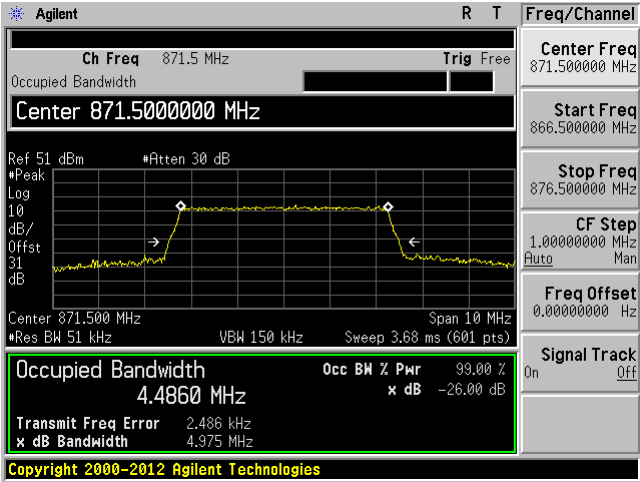


LTE 5 MHz

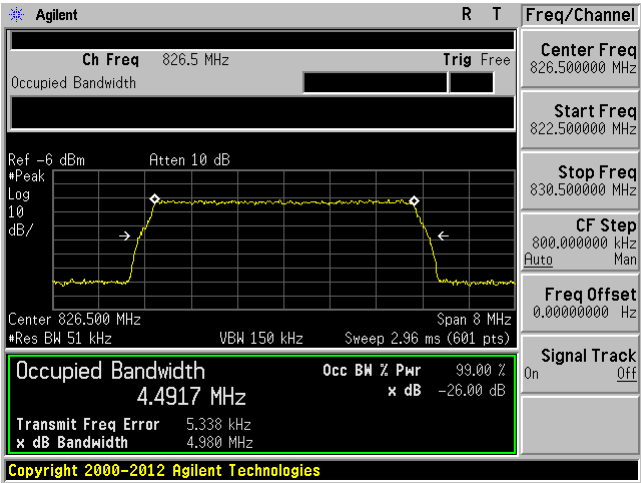
Low DL-Input



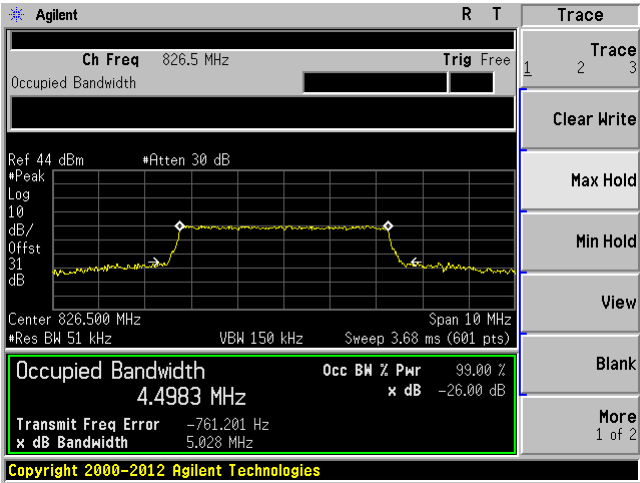
Low DL-Output



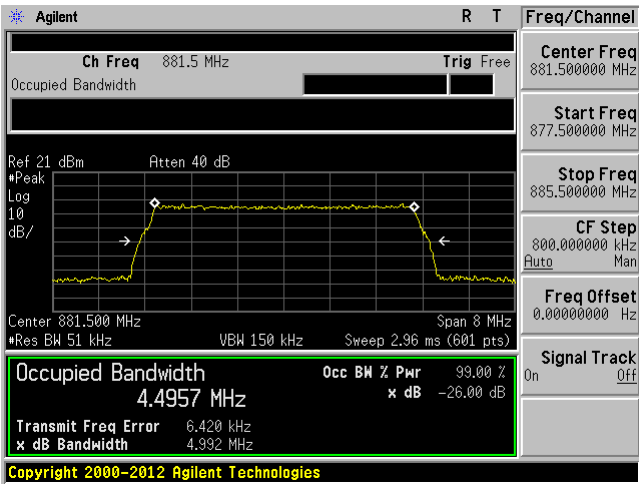
Low UL-Input



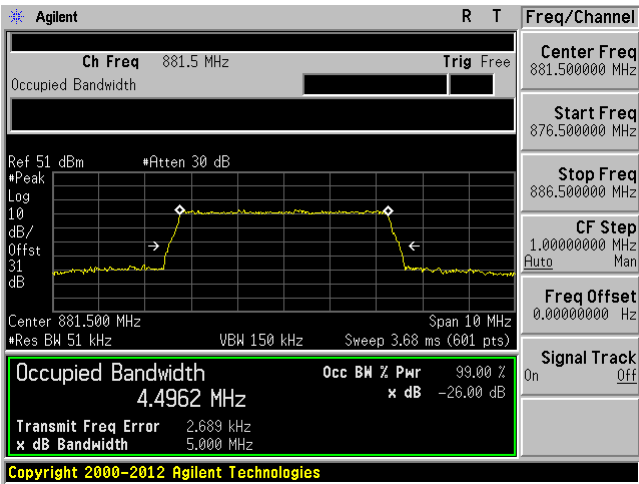
Low UL-Output



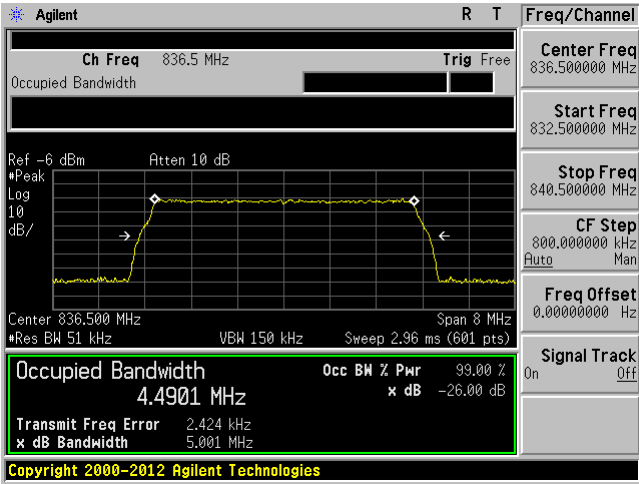
Middle DL-Input



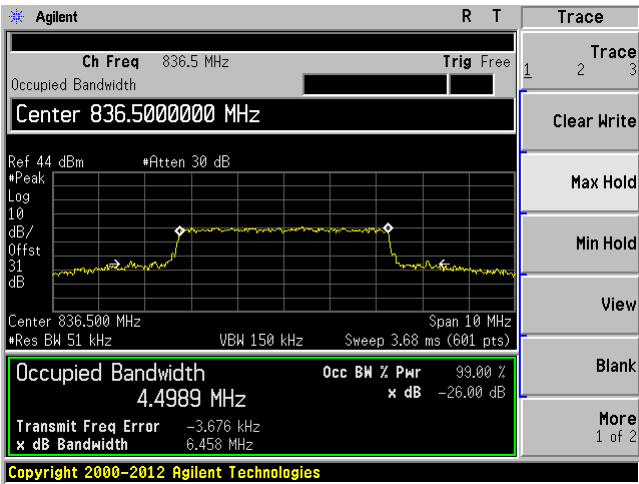
Middle DL-Output



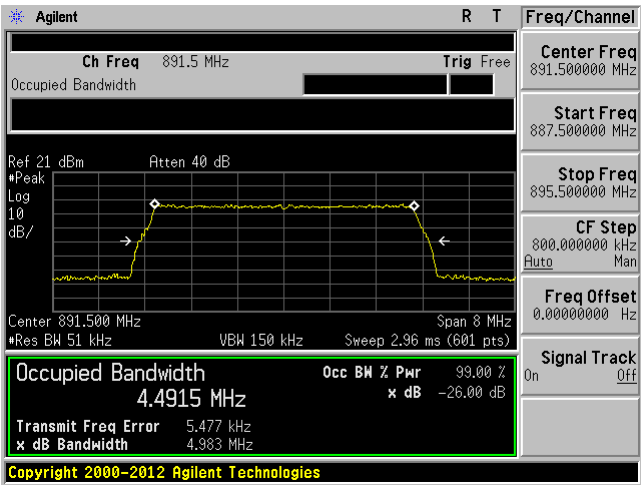
Middle UL-Input



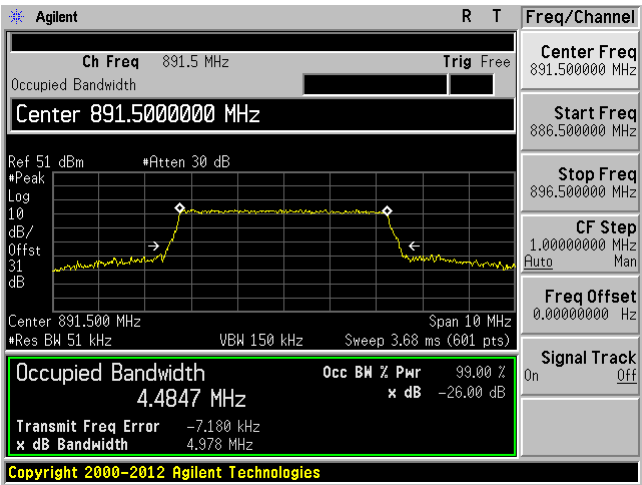
Middle UL-Output



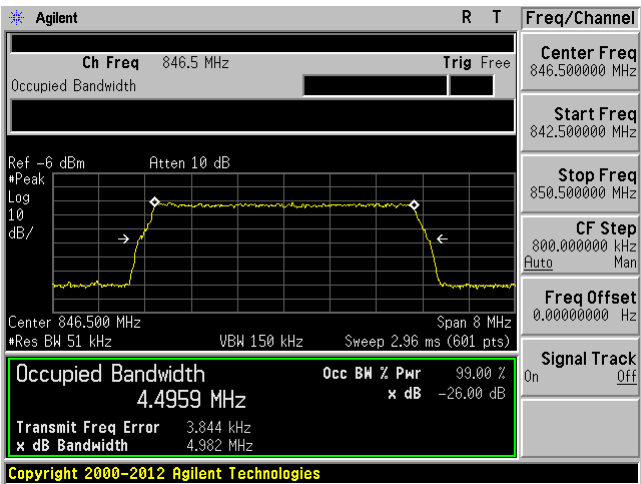
High DL-Input



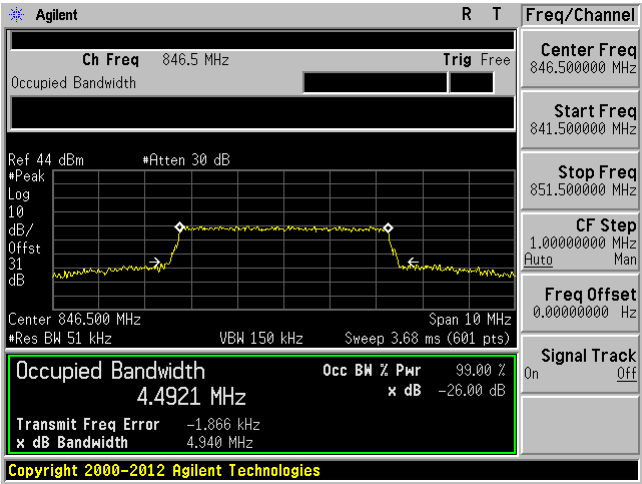
High DL-Output



High UL-Input

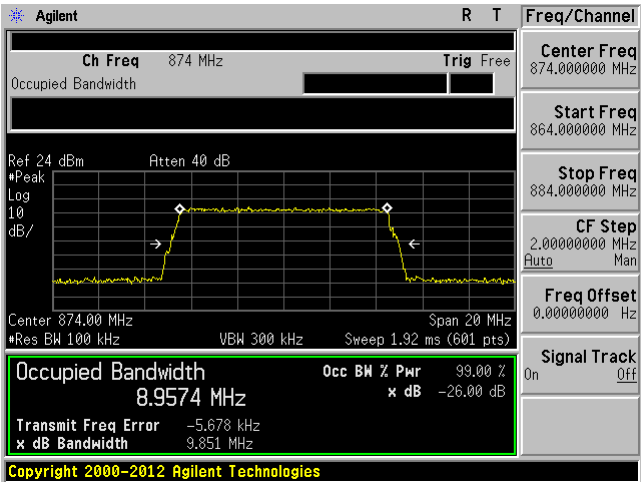


High UL-Output

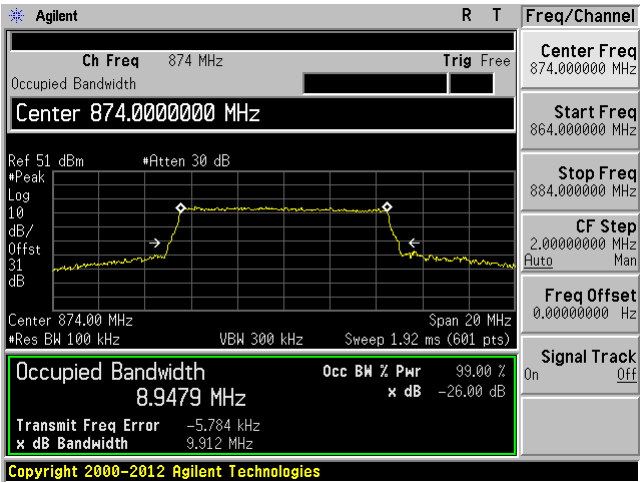


LTE 10 MHz

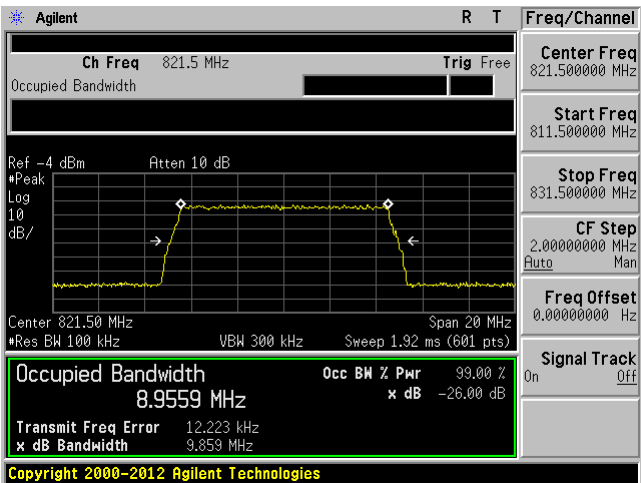
Low DL-Input



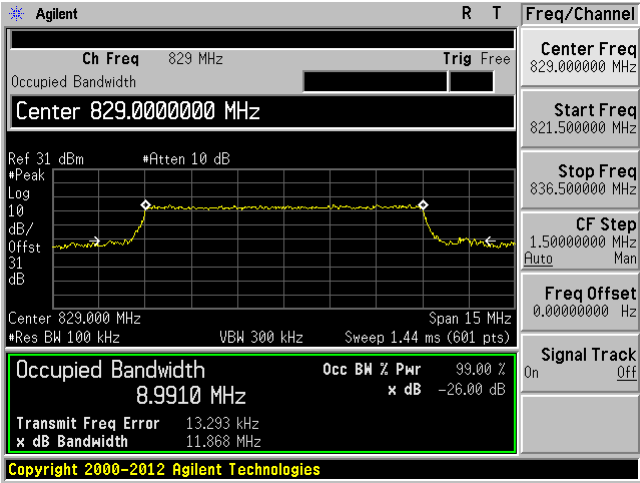
Low DL-Output



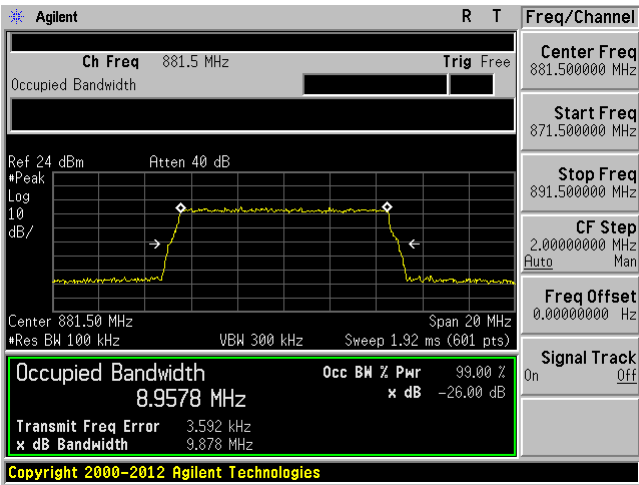
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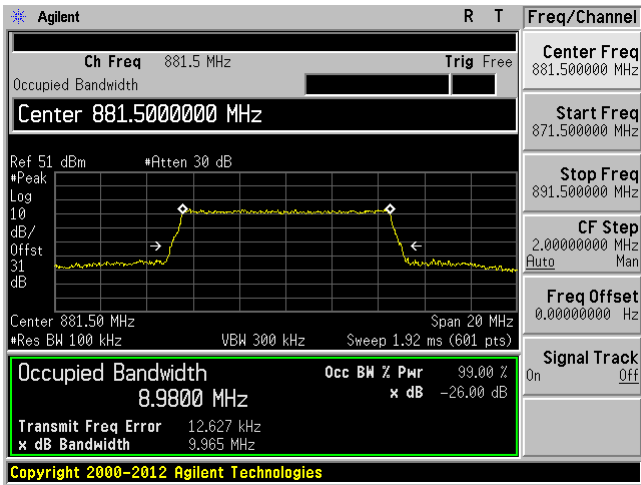
Low UL-Output



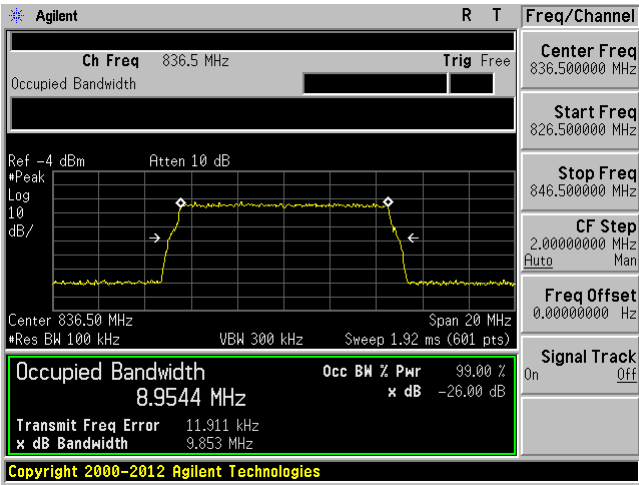
Middle DL-Input



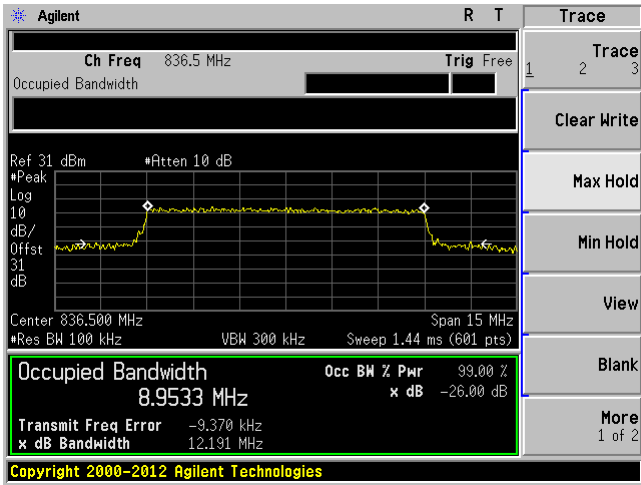
Middle UL-Output



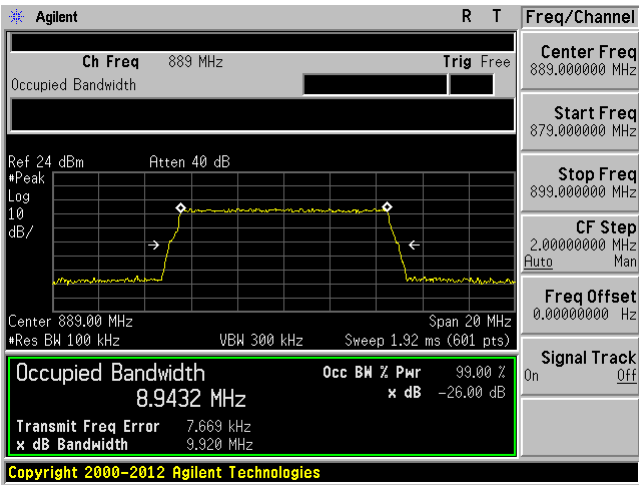
Middle UL-Input



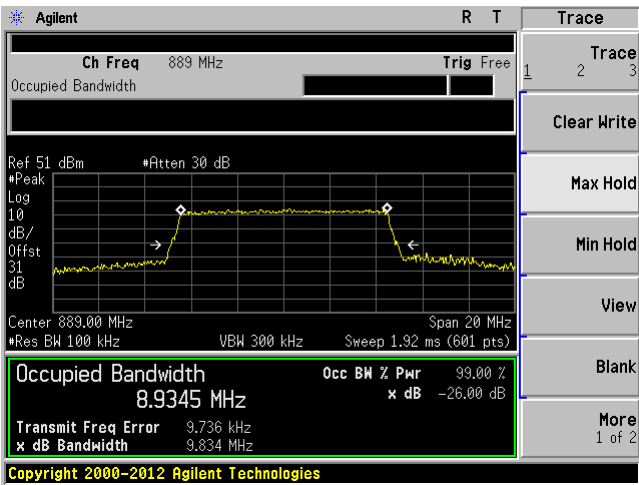
Middle UL-Output



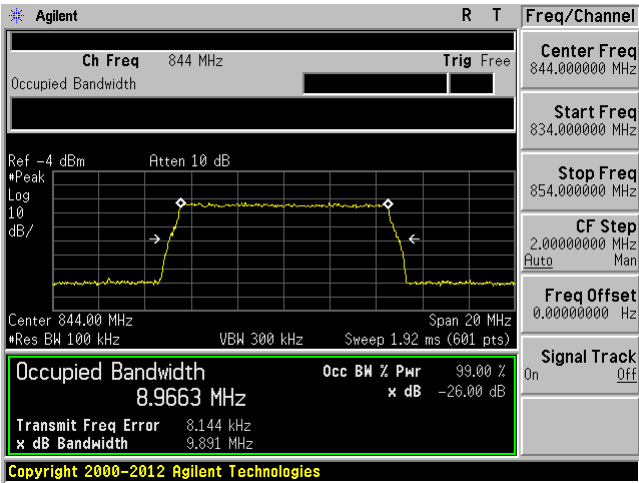
High DL-Input



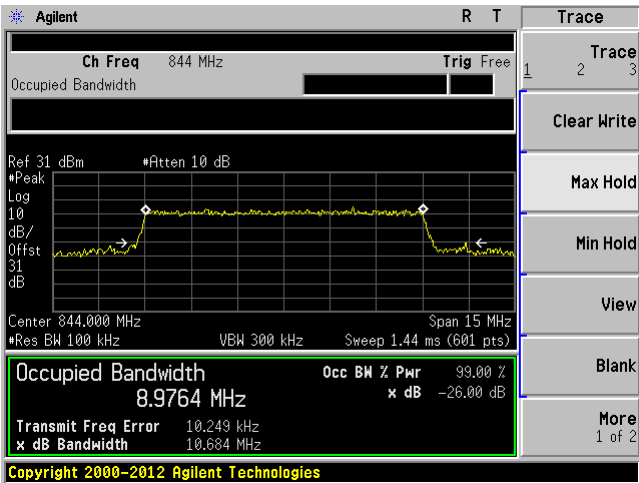
High DL-Output



High UL-Input



High UL-Output



6 FCC §2.1053, §22.917& IC RSS-131§6.4 - Spurious Radiated Emissions

6.1 Applicable Standards

According to FCC §22.917, 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 = $10 \log(\text{TX Power in Watts}/0.001)$ – the absolute level

Spurious attenuation limit in dB = $43 + 10 \log_{10}(\text{power out in Watts})$

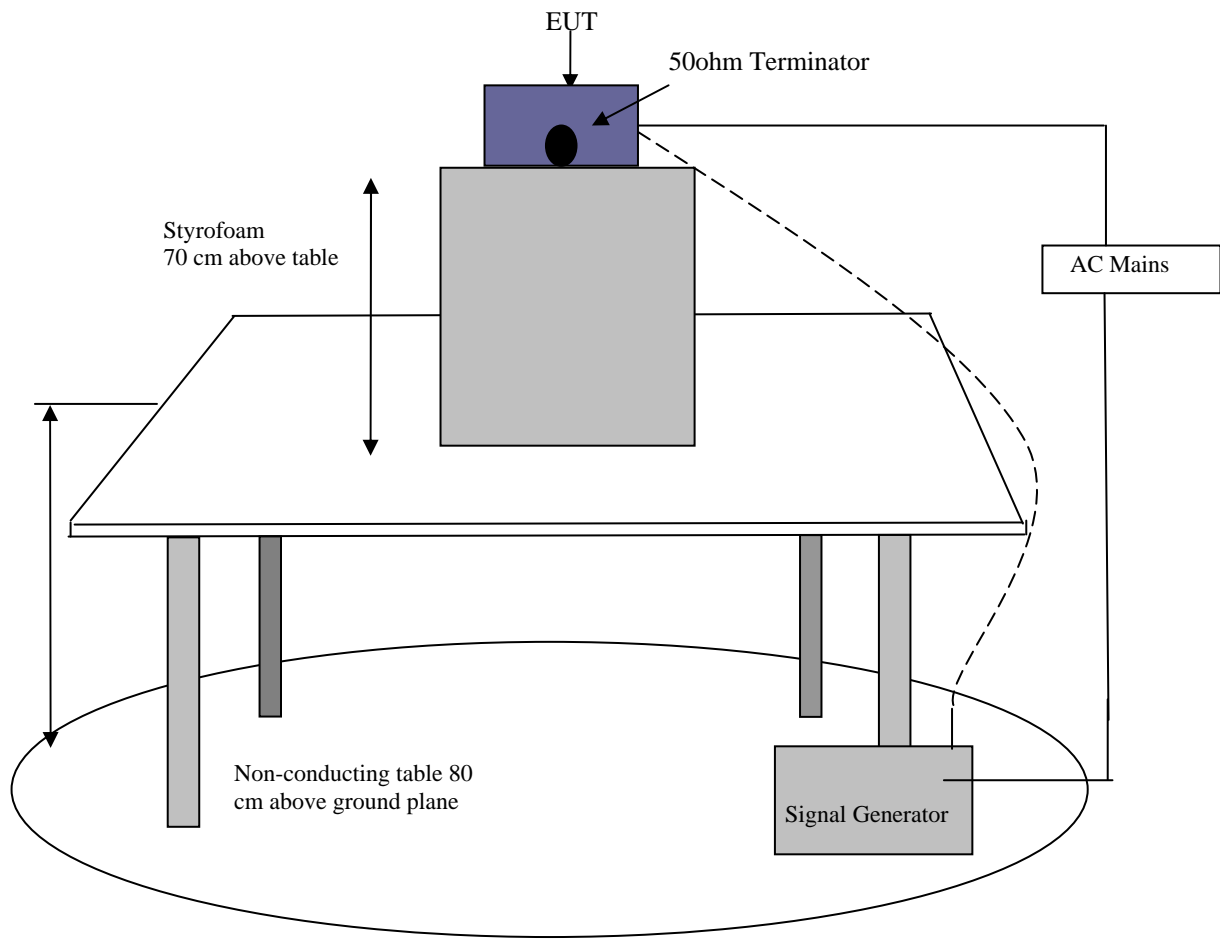
6.3 Test Equipment List and Details

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/ Agilent	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:	20-21 °C
Relative Humidity:	47-49 %
ATM Pressure:	101.4-101.6 kPa

The testing was performed by Bo Li on 2014-04-18 in 5 Meter Chamber 3.

6.6 Test Results

Cellular Band: Worst Case

Uplink (Input frequency = 836.5 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	34.56	89	150	H	500.4	-66.9	0	1.78	-68.68	-13	-55.68
500.4	32.74	89	150	V	500.4	-69.21	0	1.78	-70.99	-13	-57.99
1708	77.42	39	100	V	1708	-24.65	9.086	0.52	-16.084	-13	-3.084
1708	78.04	50	100	H	1708	-22.22	8.98	0.52	-13.76	-13	-0.76
1623	75.68	0	150	V	1623	-25.78	8.795	0.5	-17.485	-13	-4.485
1623	78.16	20	150	H	1623	-23.79	8.77	0.5	-15.52	-13	-2.52

Downlink (Input frequency = 893.8 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)		
3522	45.57	38	100	V	3522	-50.8	9.73	2.1	-43.17	-13	-30.17
3522	41.15	75	100	H	3522	-56.39	9.664	2.1	-48.826	-13	-35.826
2672	57.74	44	100	V	2672	-39.81	9.763	1.58	-31.627	-13	-18.627
2672	51.23	79	100	H	2672	-47.32	9.695	1.58	-39.205	-13	-26.205

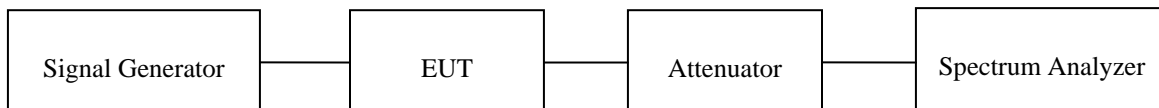
7 FCC §2.1051, §22.917 & IC RSS-131 §6.4 - Spurious Emissions at Antenna Terminals

7.1 Applicable Standards

According to FCC §22.917 & 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 or greater. 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	2014-05-03	1 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

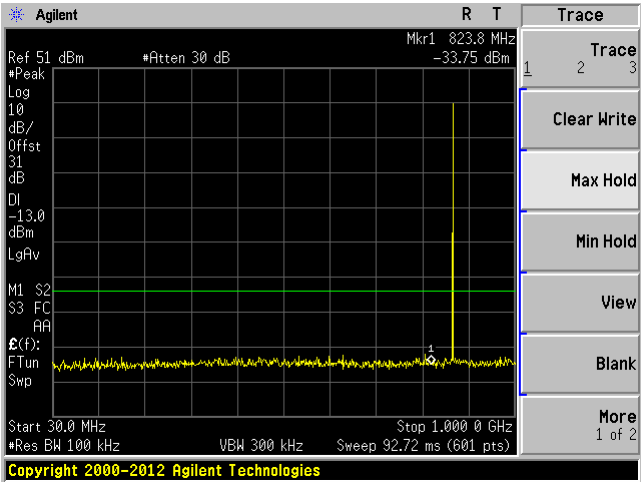
The testing was performed by Bo Li on 2015-04-02 to 2015-04-18 in the RF Site.

7.5 Test Results

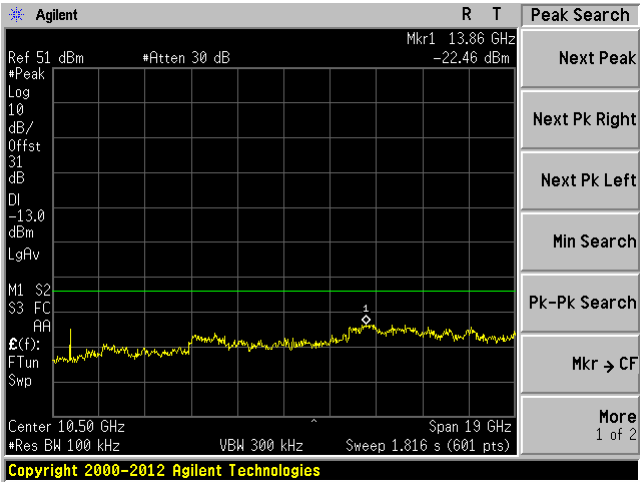
Please refer to the following plots.

GSM/GPRS

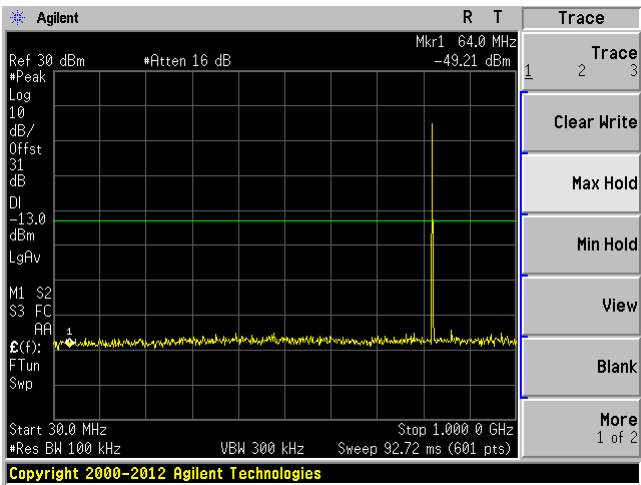
Low DL 30 MHz-1 GHz



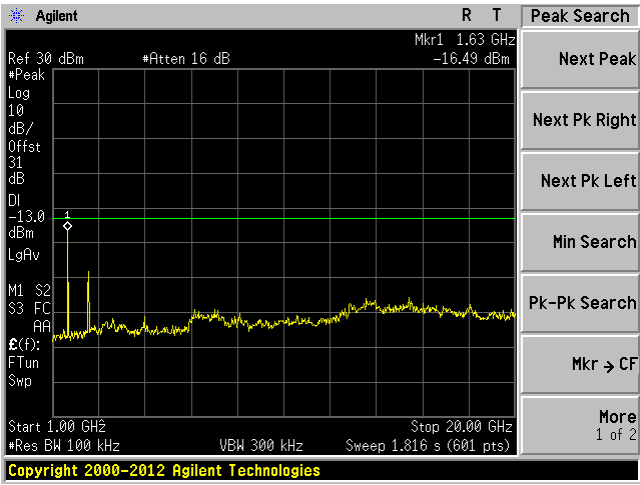
Low DL 1-20 GHz



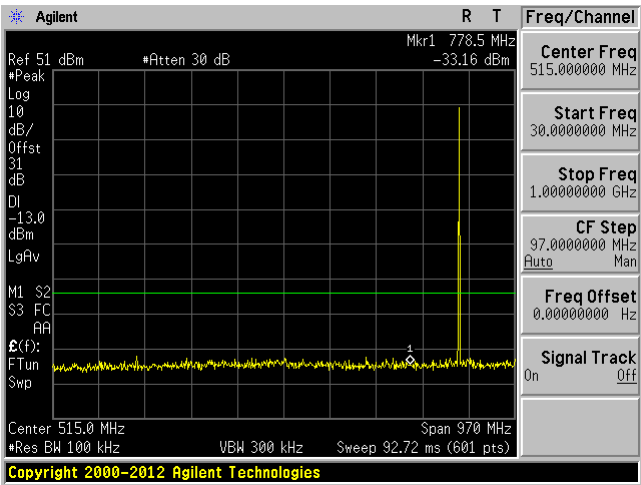
Low UL 30 MHz-1 GHz



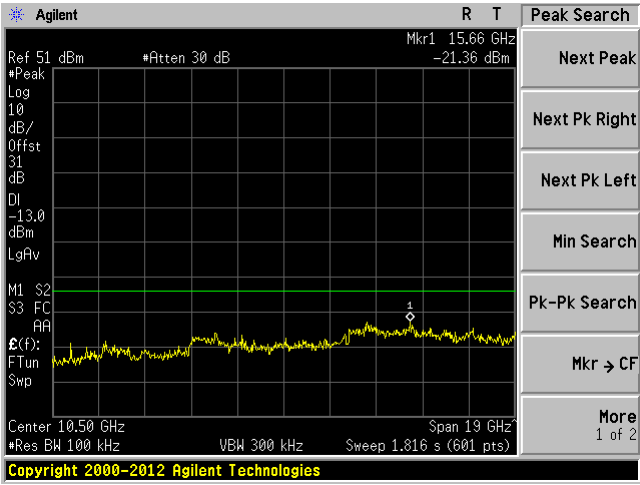
Low UL 1-20 GHz



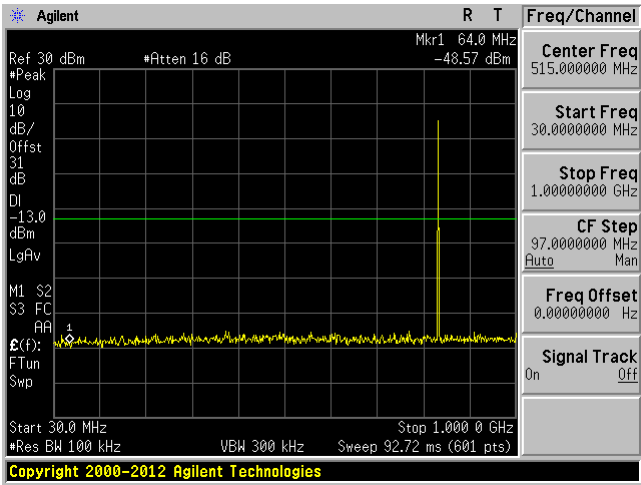
Middle DL 30 MHz-1 GHz



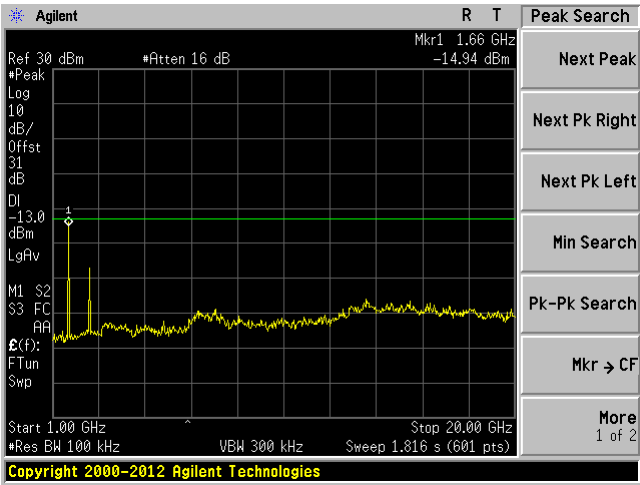
Middle DL 1-20 GHz



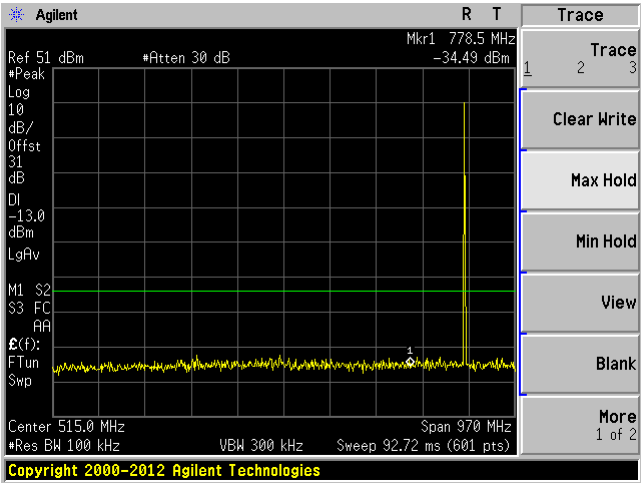
Middle UL 30 MHz-1 GHz



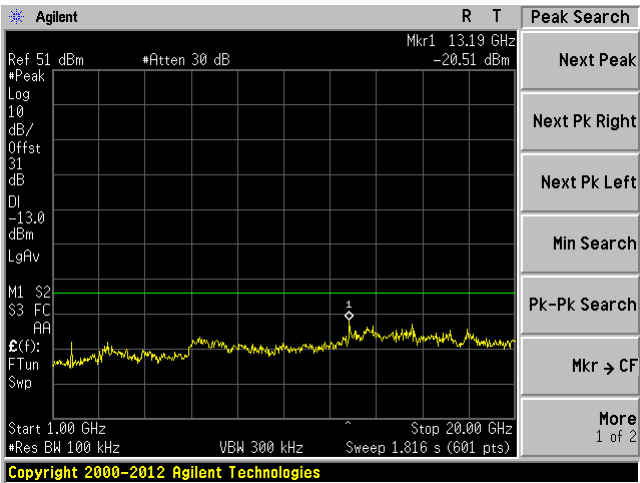
Middle UL 1-20 GHz



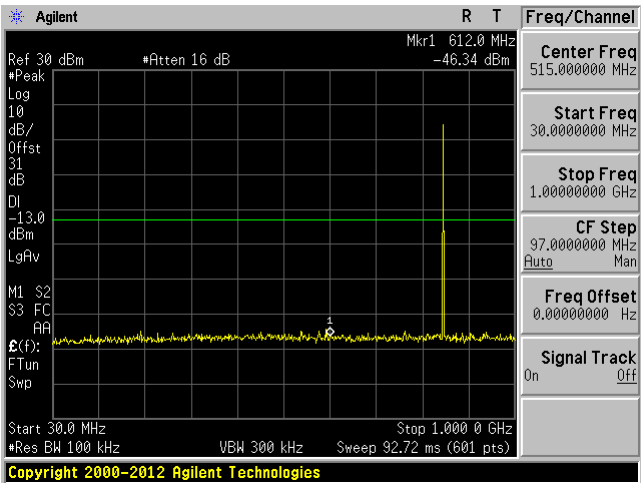
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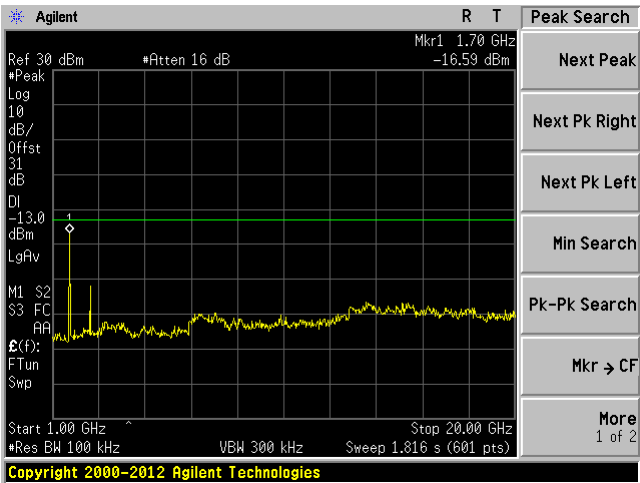
High DL 1-20 GHz



High UL 30 MHz-1 GHz

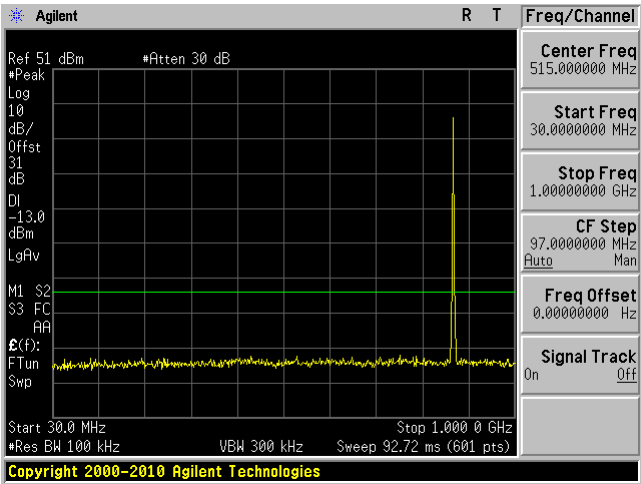


High UL 1-20 GHz

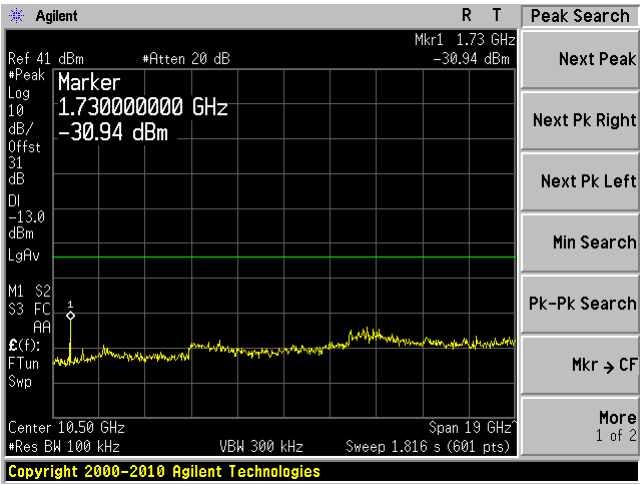


CDMA

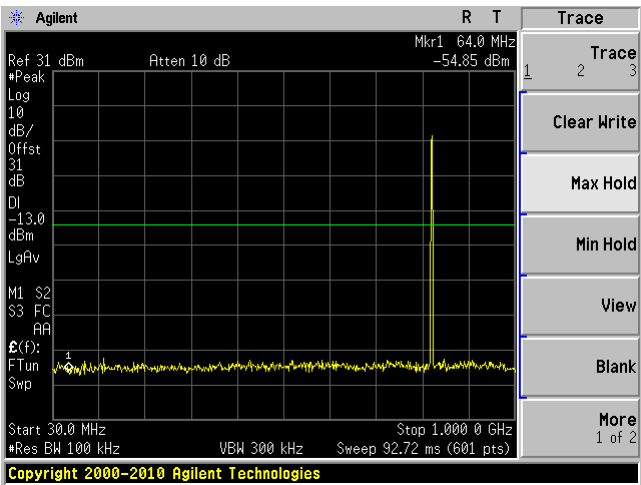
Low DL 30 MHz-1 GHz



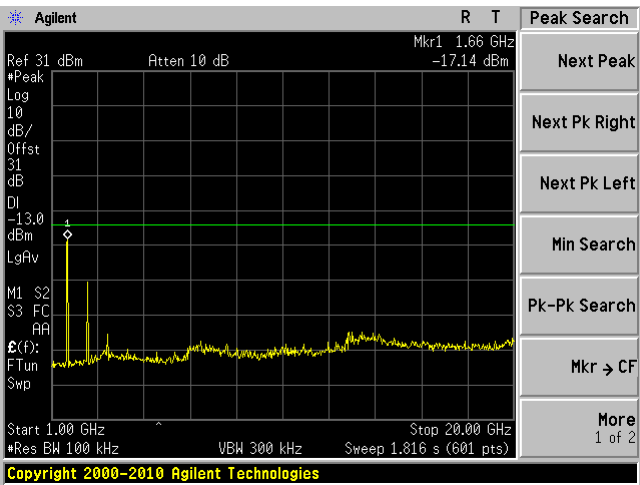
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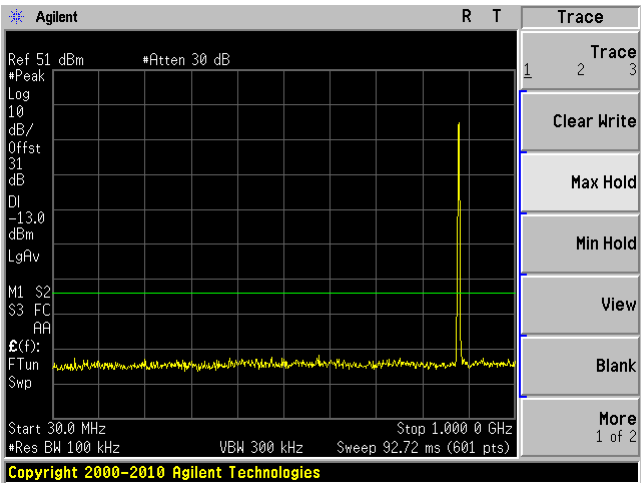
Low UL 30 MHz-1 GHz



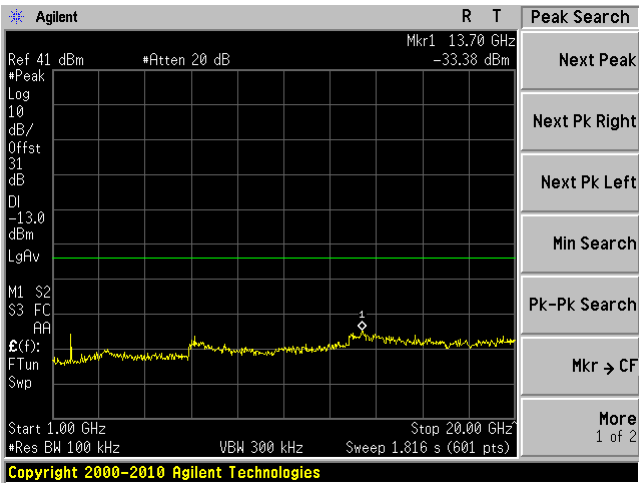
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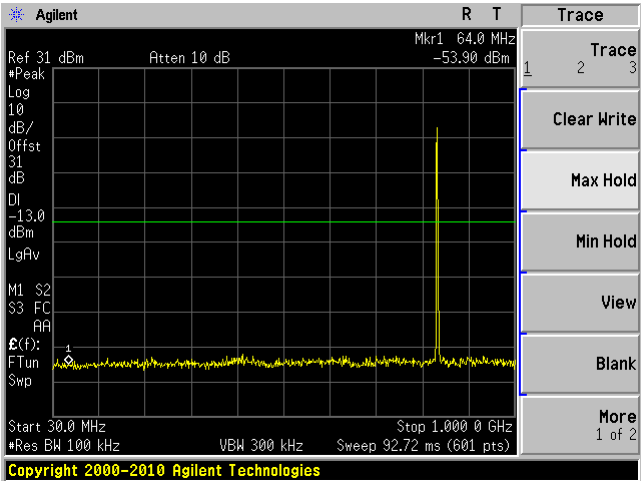
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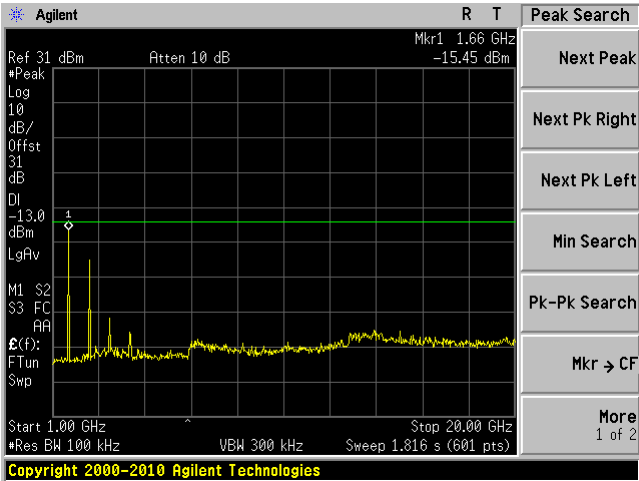
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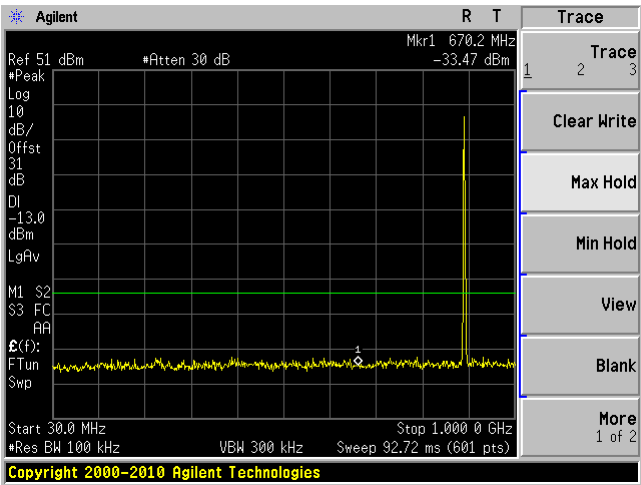
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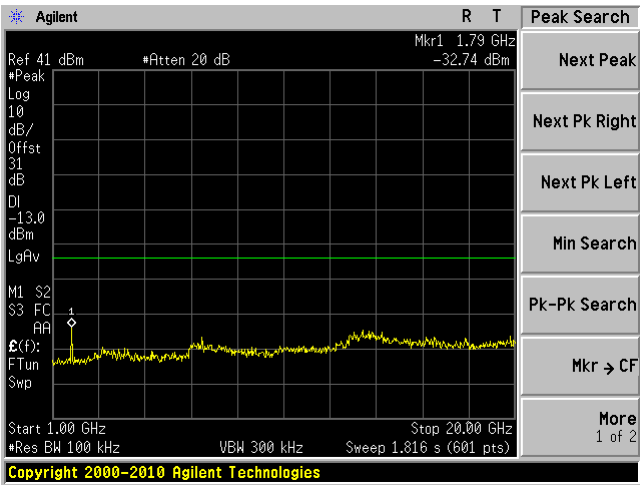
Middle UL 1-20 GHz



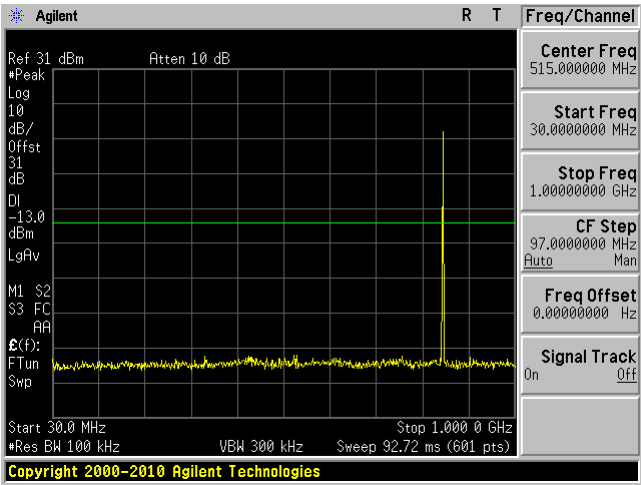
High DL 30 MHz-1 GHz



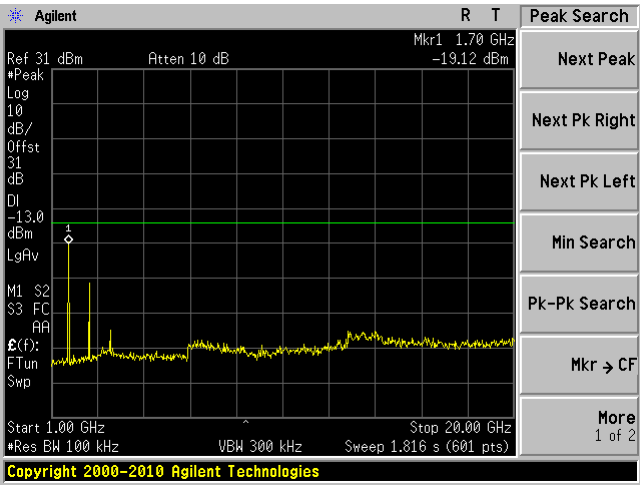
High DL 1-20 GHz



High UL 30 MHz-1 GHz

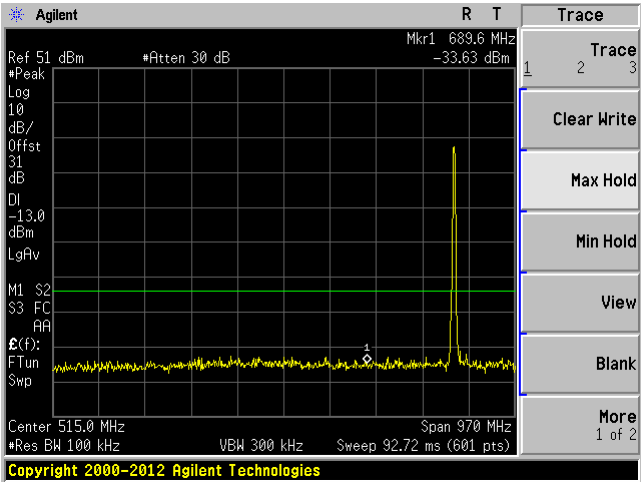


High UL 1-20 GHz

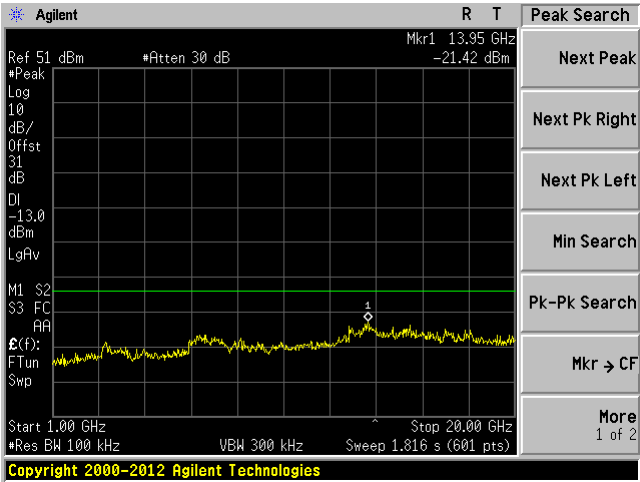


WCDMA

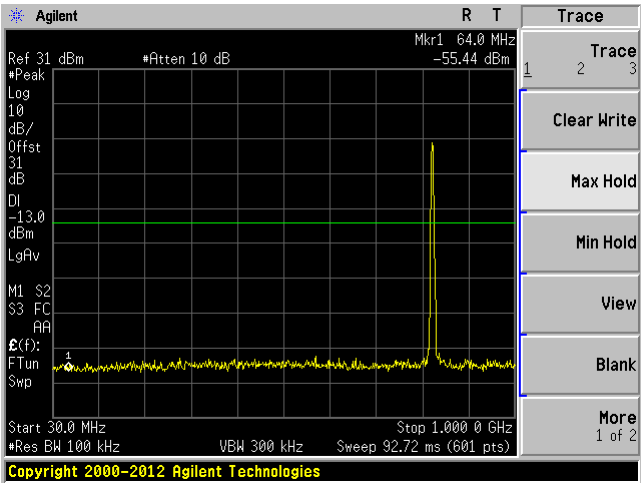
Low DL 30 MHz-1 GHz



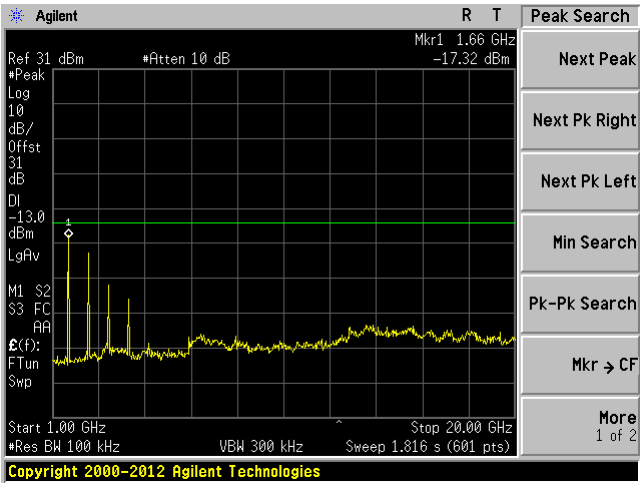
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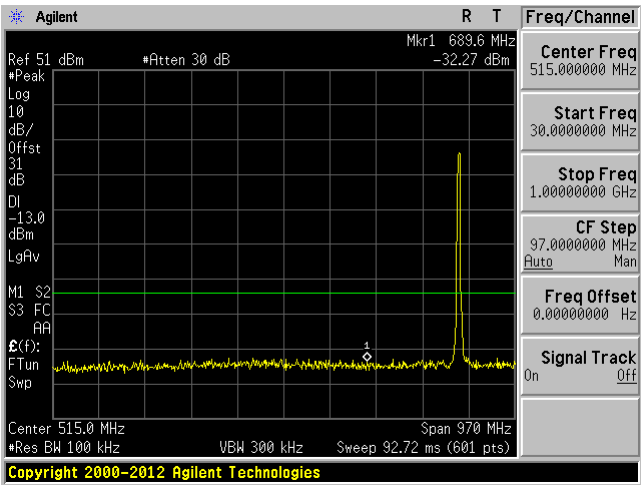
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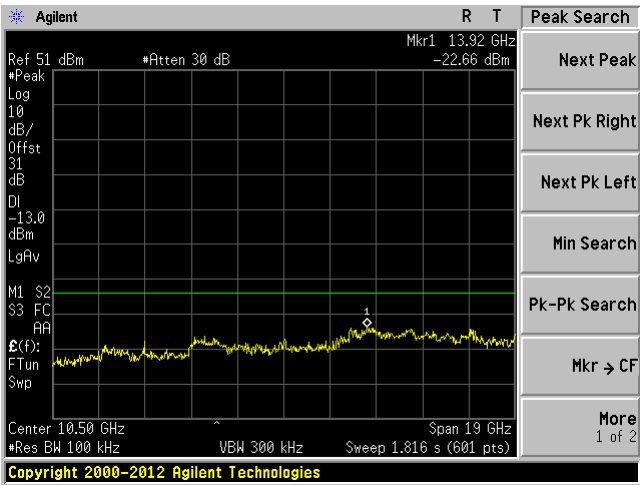
Low UL 1-20 GHz



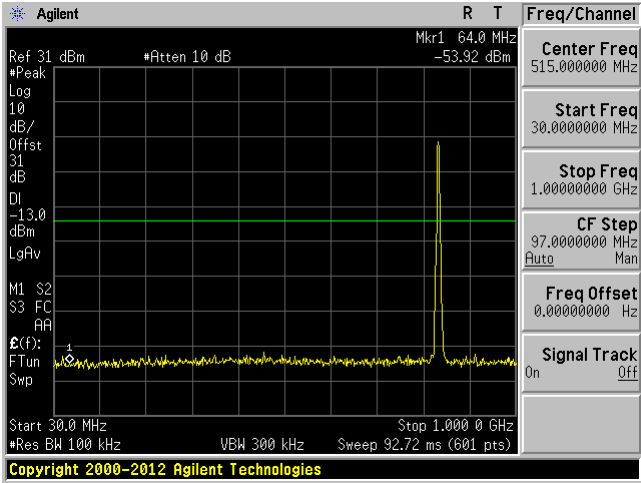
Middle DL 30 MHz-1 GHz



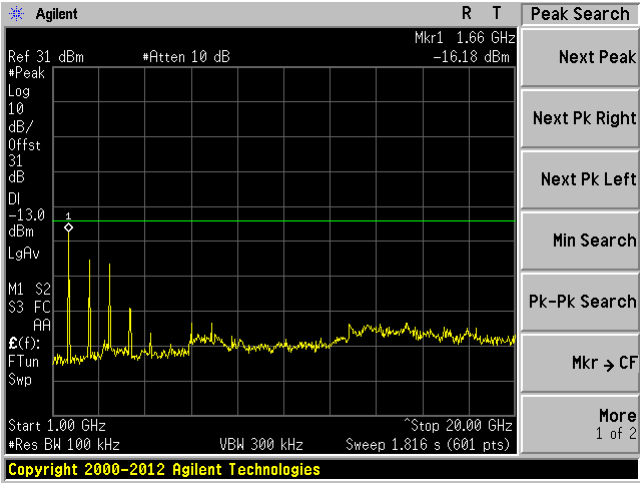
Middle DL 1-20 GHz



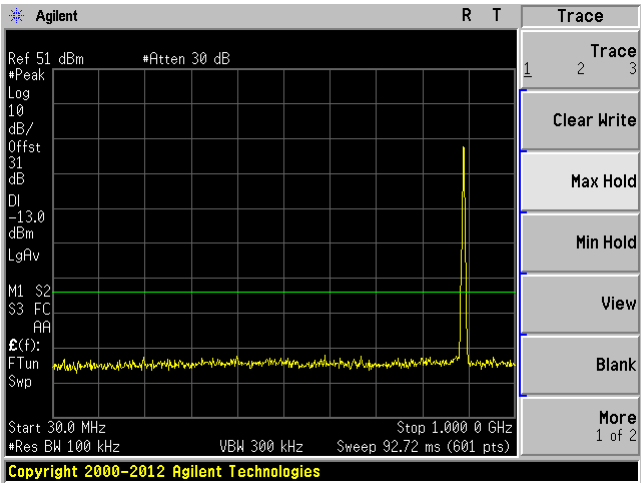
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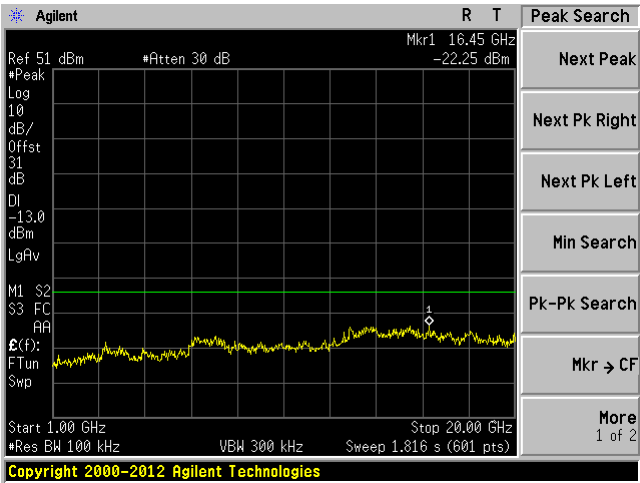
Middle UL 1-20 GHz



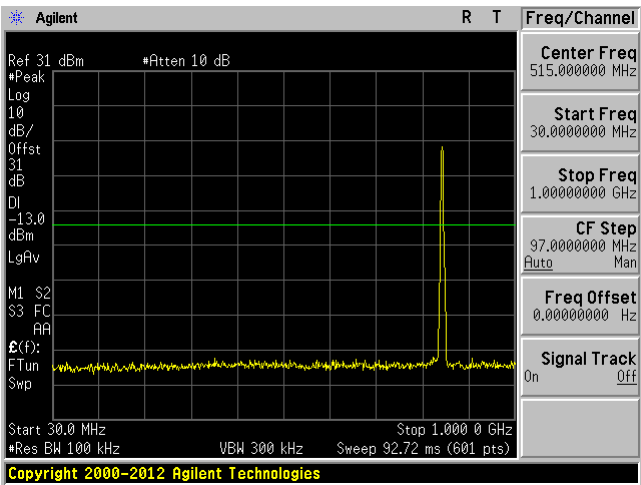
High DL 30 MHz-1 GHz



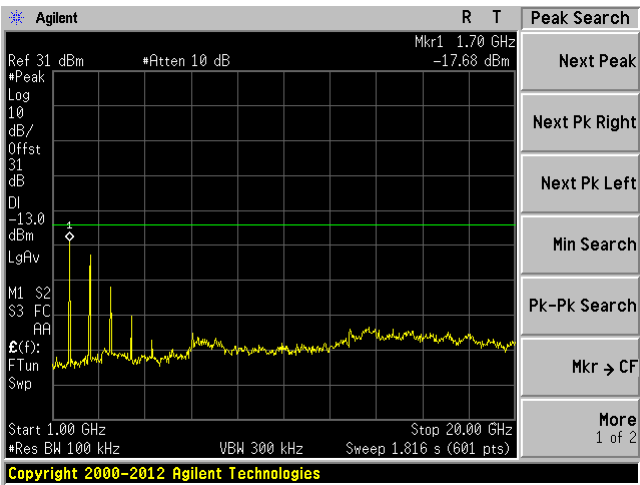
High DL 1-20 GHz



High UL 30 MHz-1 GHz

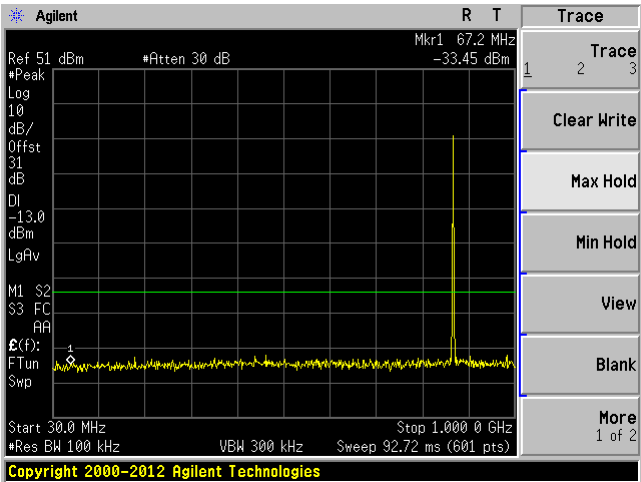


High UL 1-20 GHz

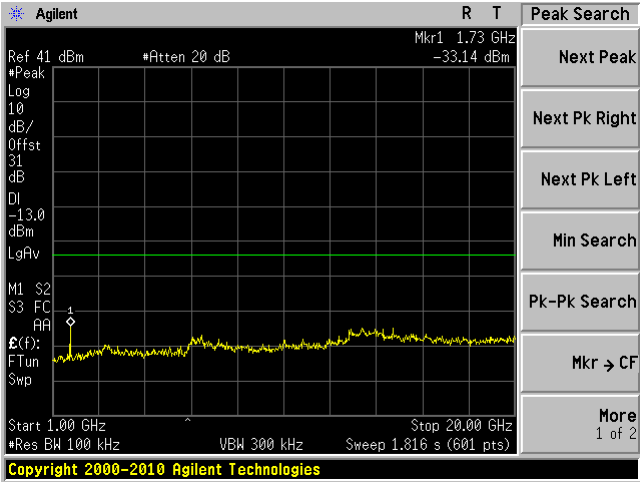


LTE 1.4 MHz

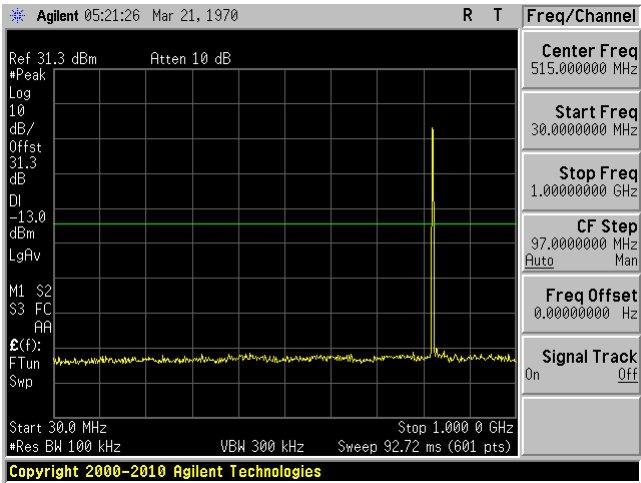
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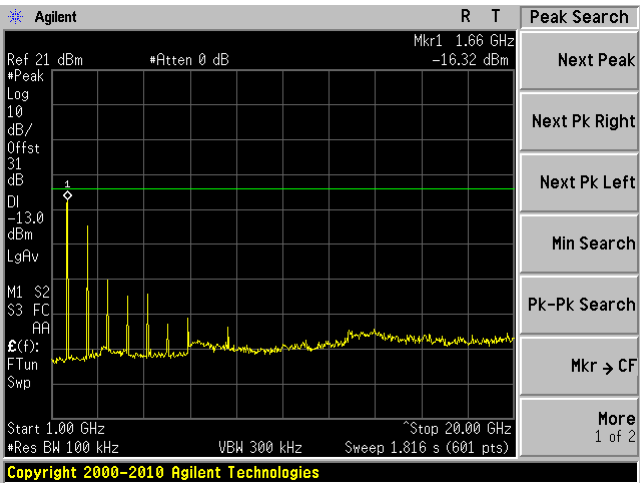
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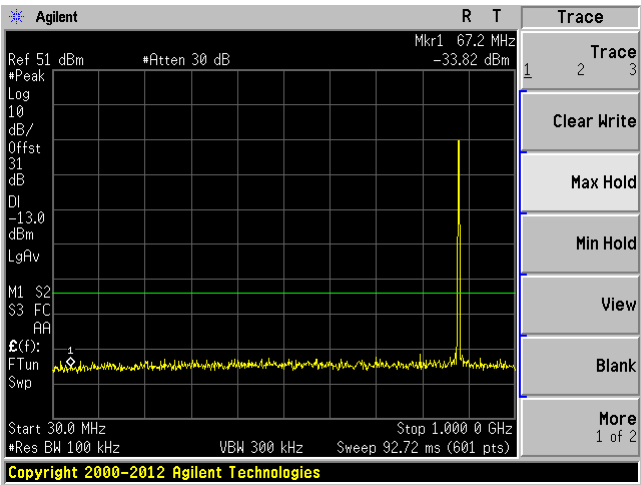
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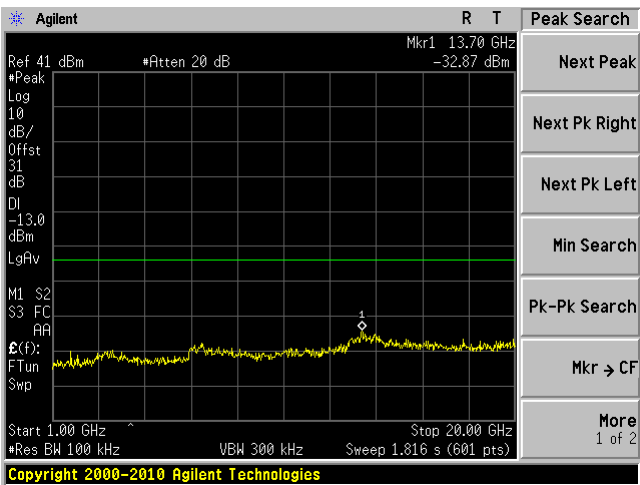
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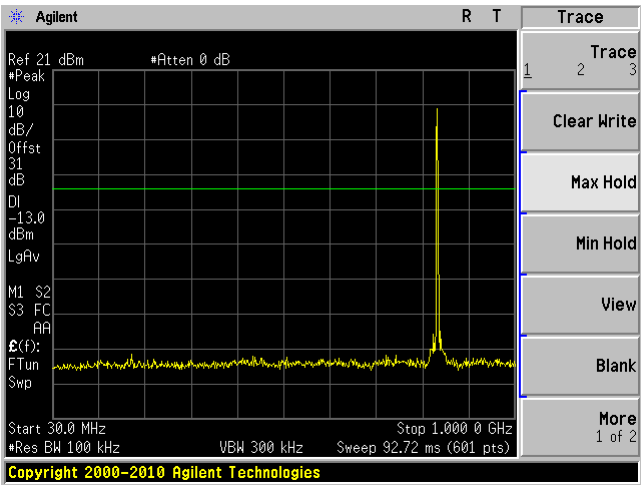
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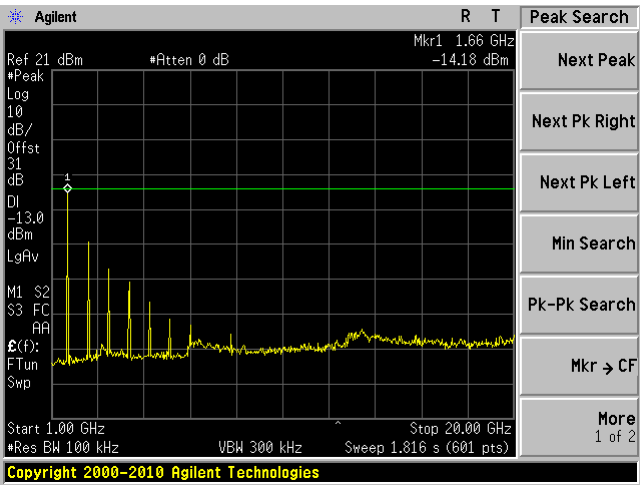
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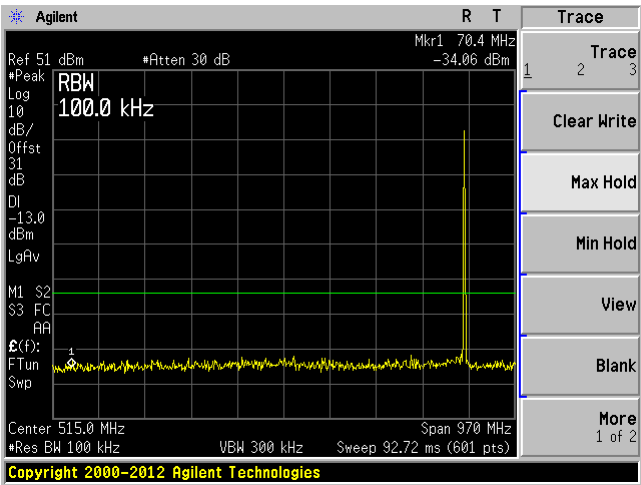
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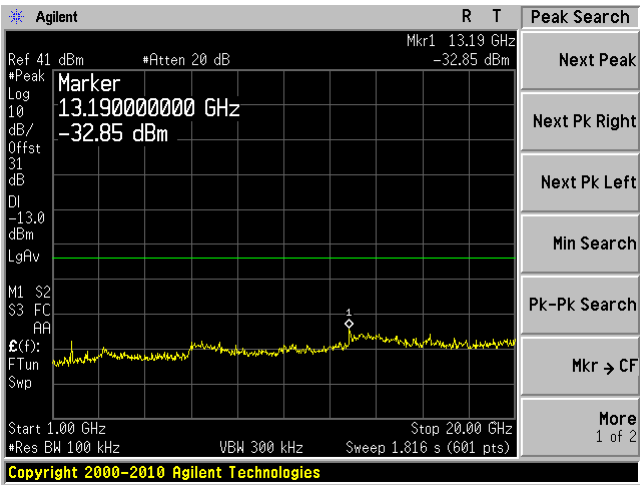
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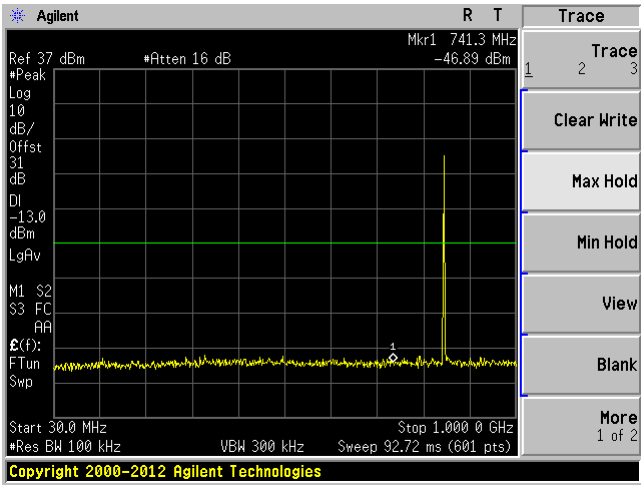
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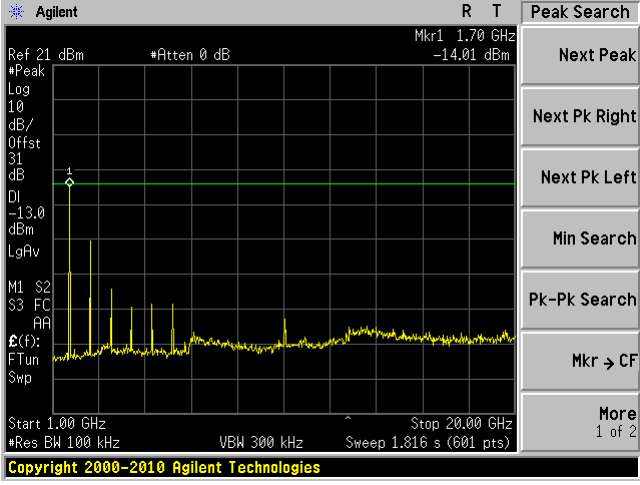
High DL 1-20 GHz



High UL 30 MHz-1 GHz

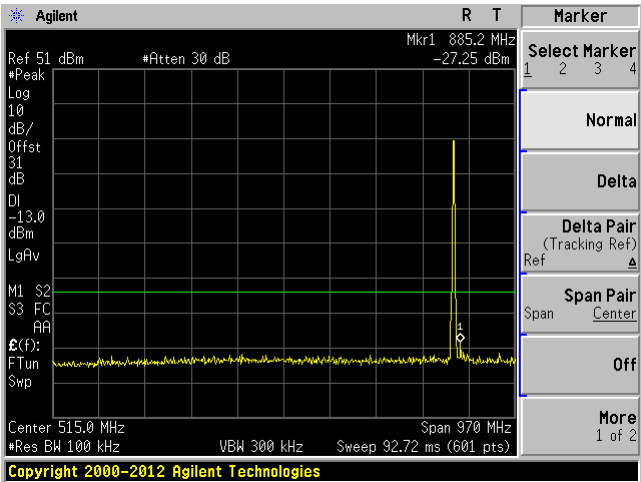


High UL 1-20 GHz

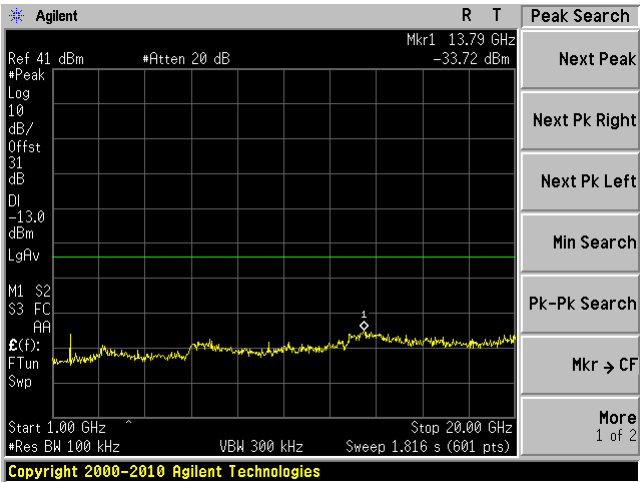


LTE 3 MHz

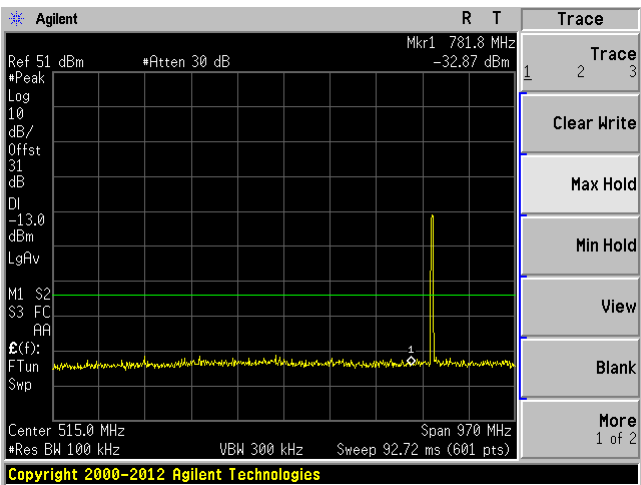
Low DL 30 MHz-1 GHz



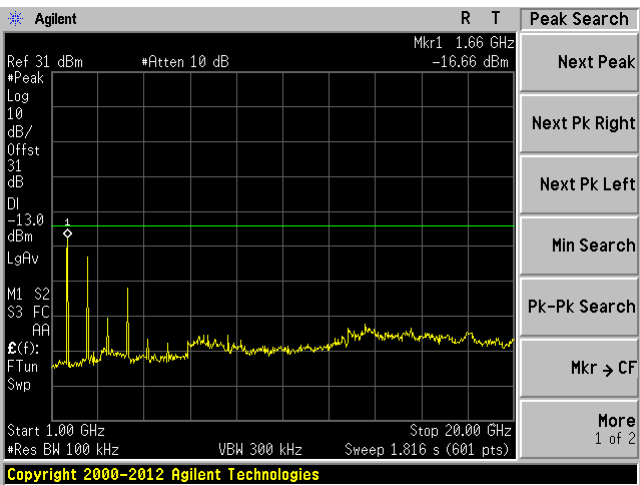
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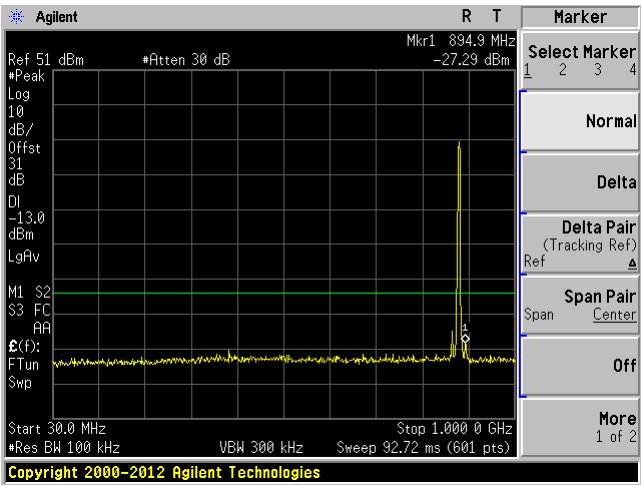
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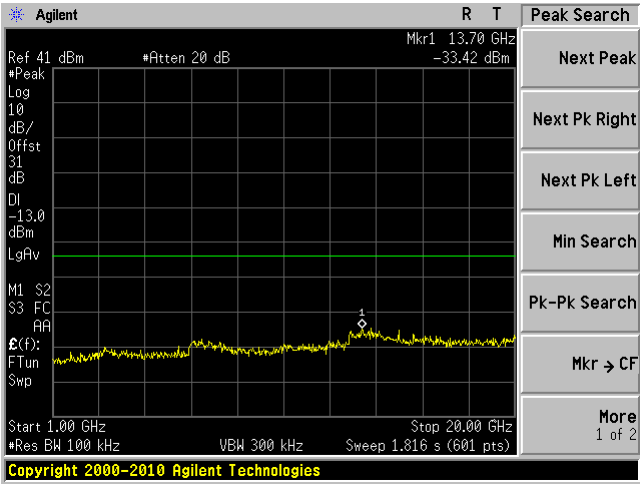
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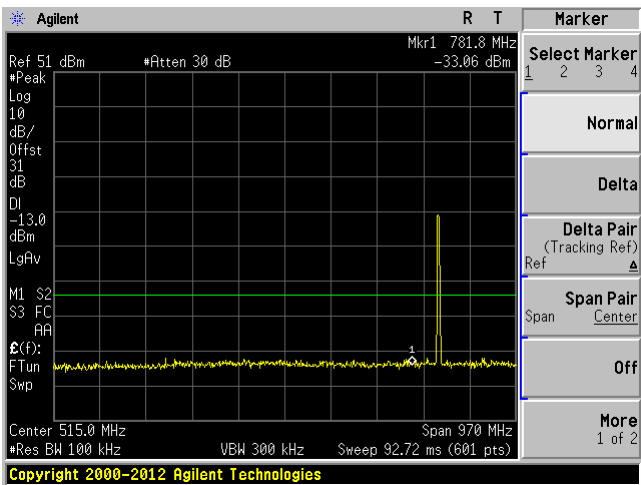
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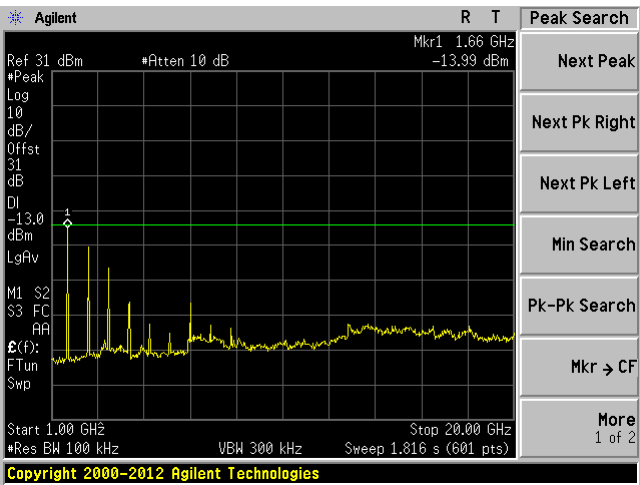
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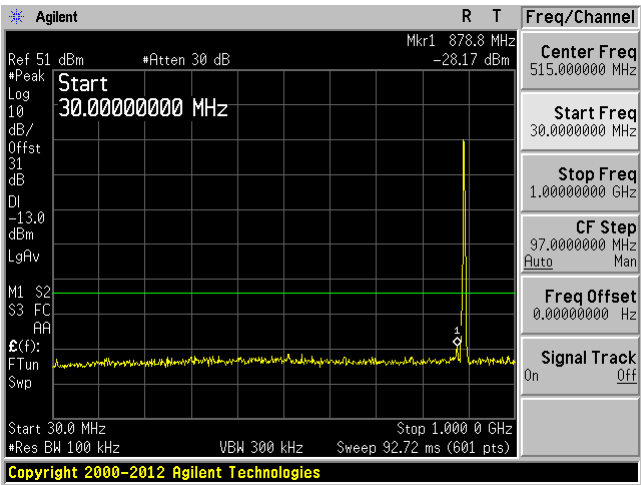
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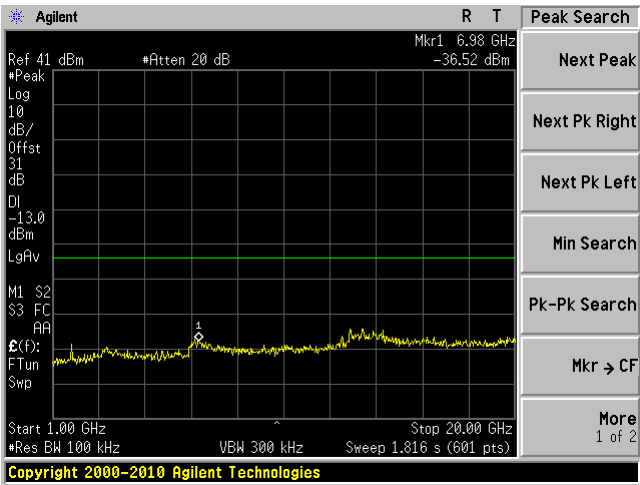
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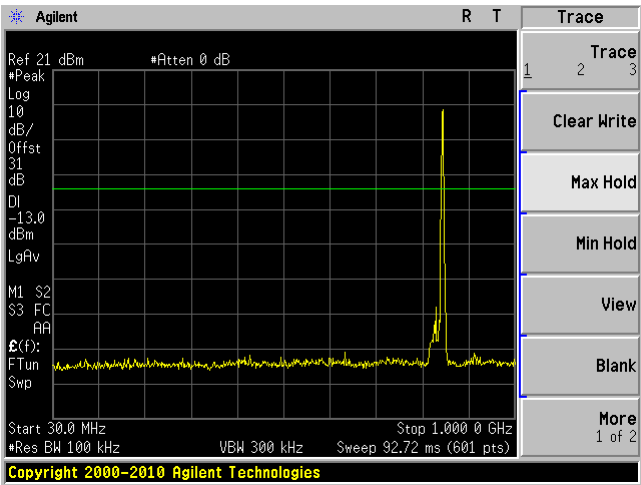
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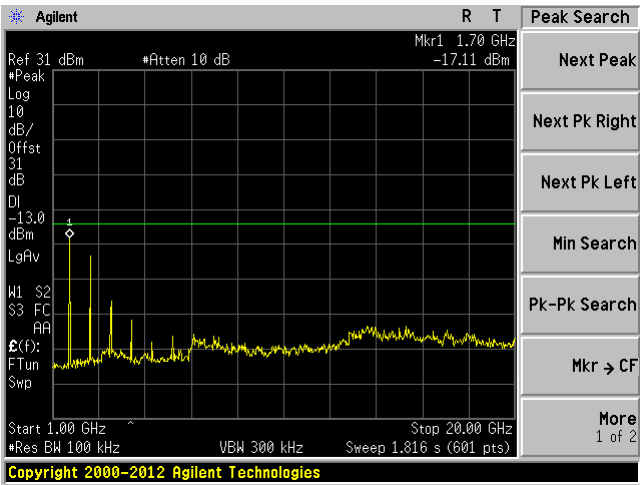
High DL 1-20 GHz



High UL 30 MHz-1 GHz

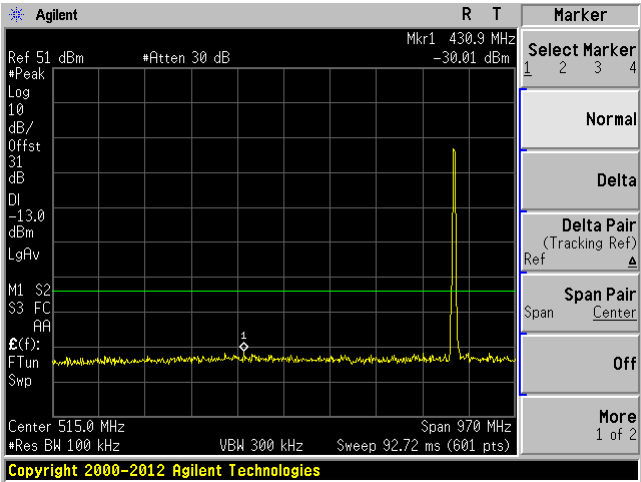


High UL 1-20 GHz

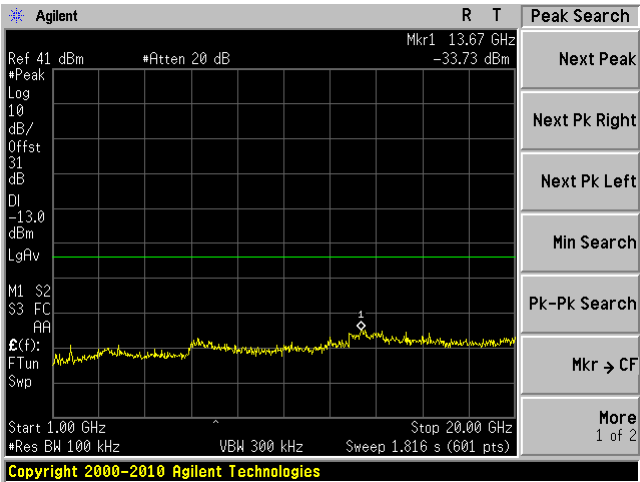


LTE 5 MHz

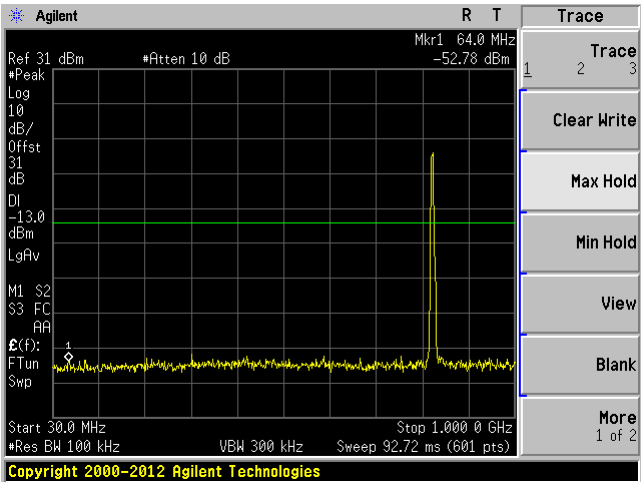
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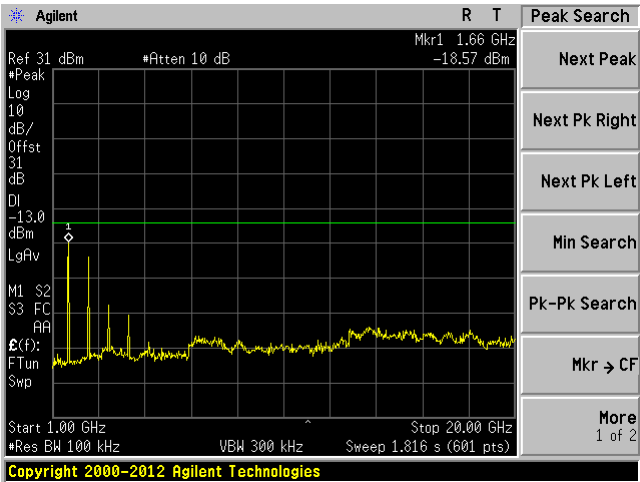
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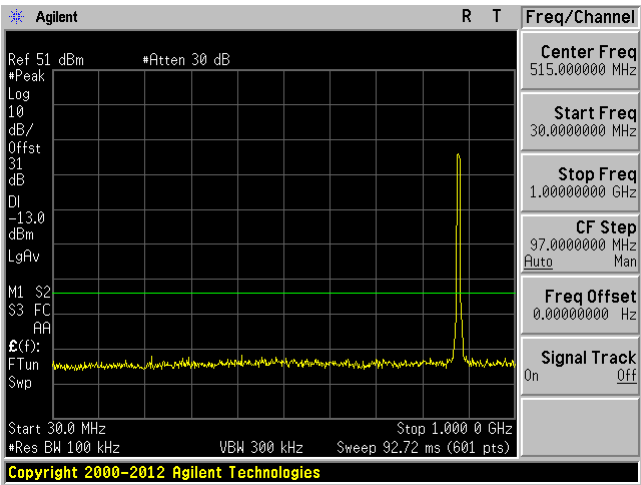
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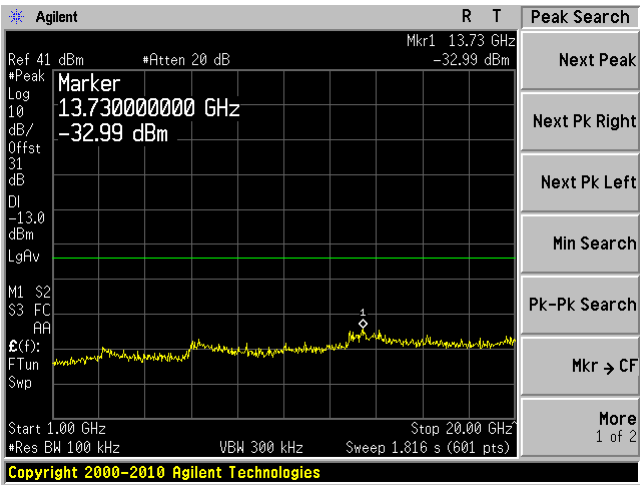
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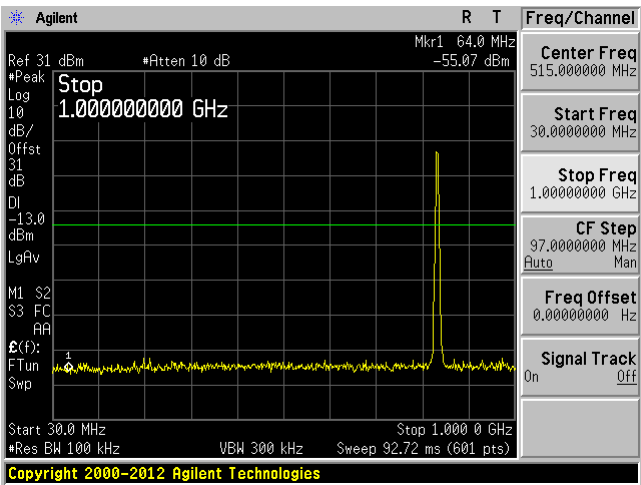
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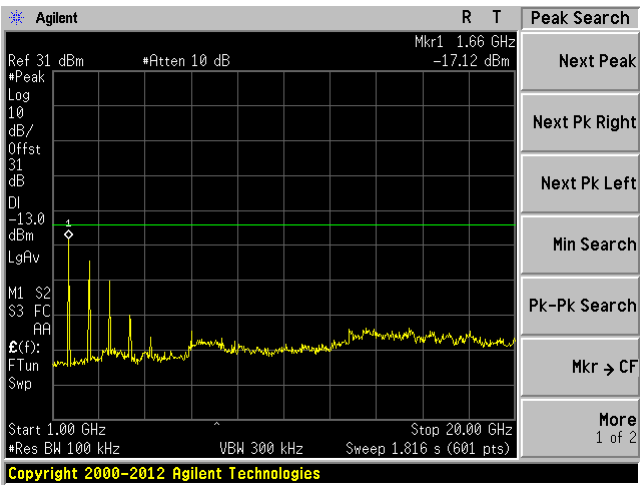
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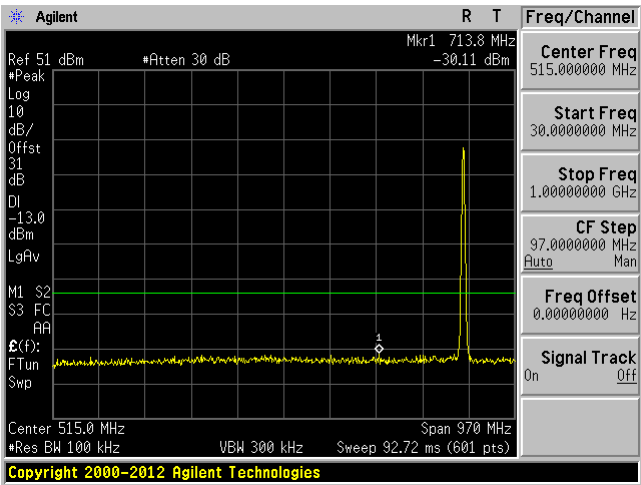
Middle UL 30 MHz-1 GHz



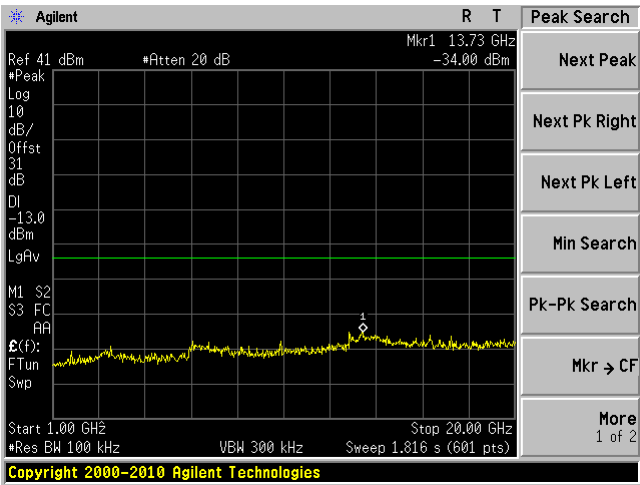
Middle UL 1-20 GHz



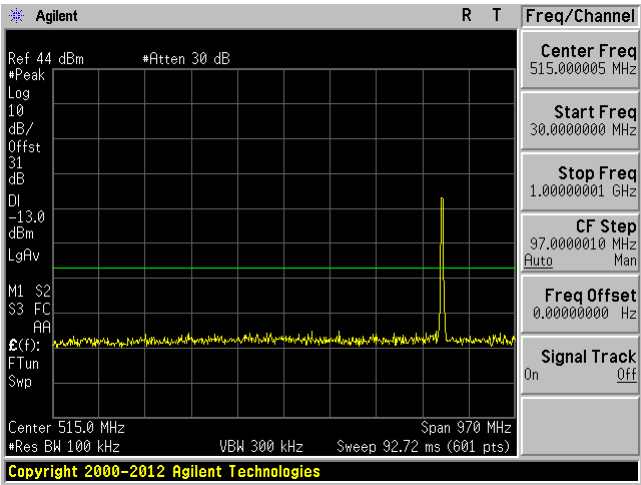
High DL 30 MHz-1 GHz



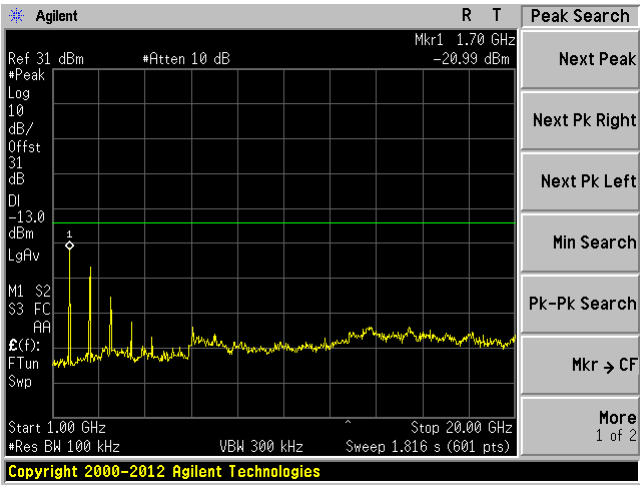
High DL 1-20 GHz



High UL 30 MHz-1 GHz

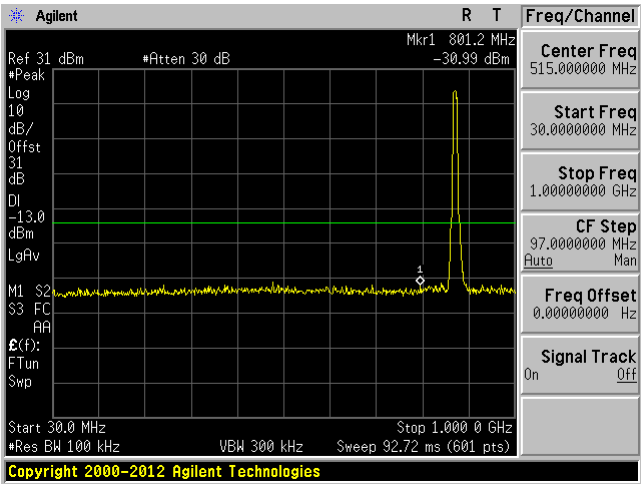


High UL 1-20 GHz

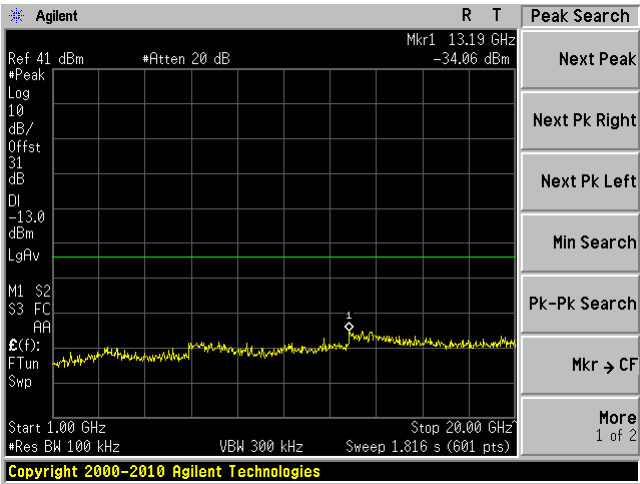


LTE 10 MHz

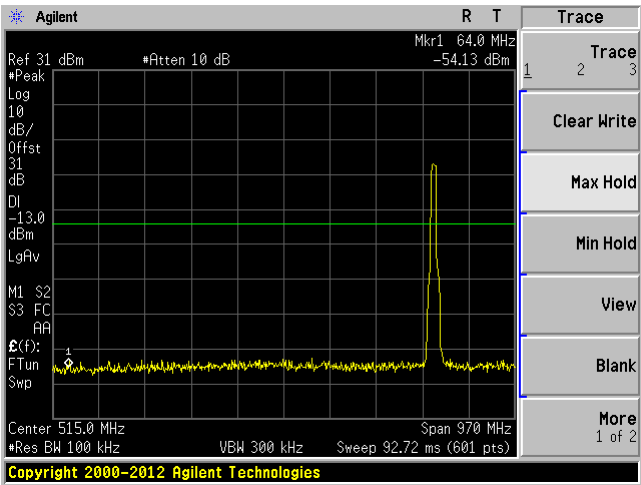
Low DL 30 MHz-1 GHz



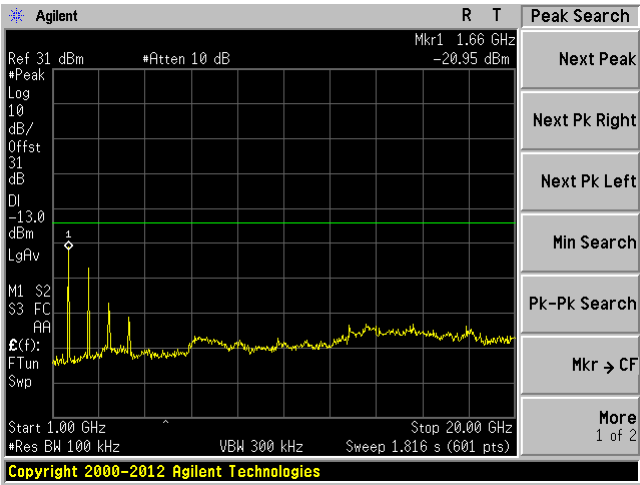
Low DL 1-20 GHz



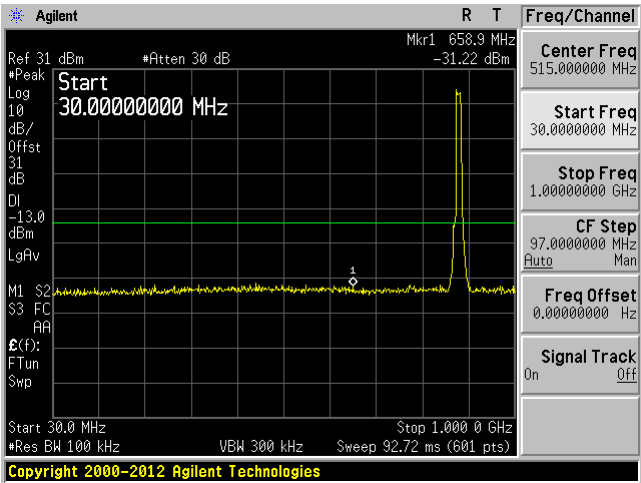
Low UL 30 MHz-1 GHz



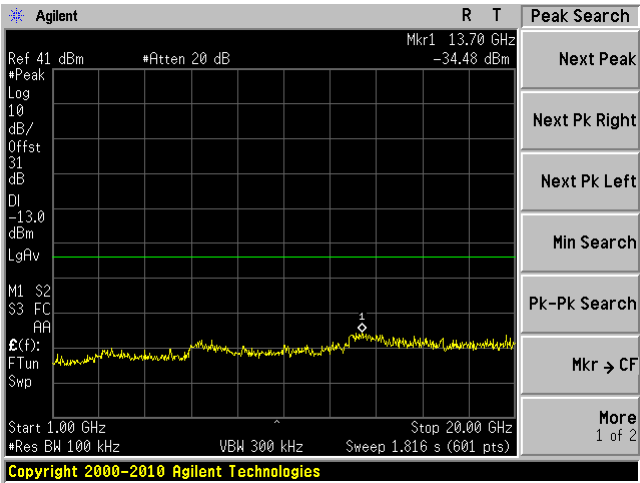
Low UL 1-20 GHz



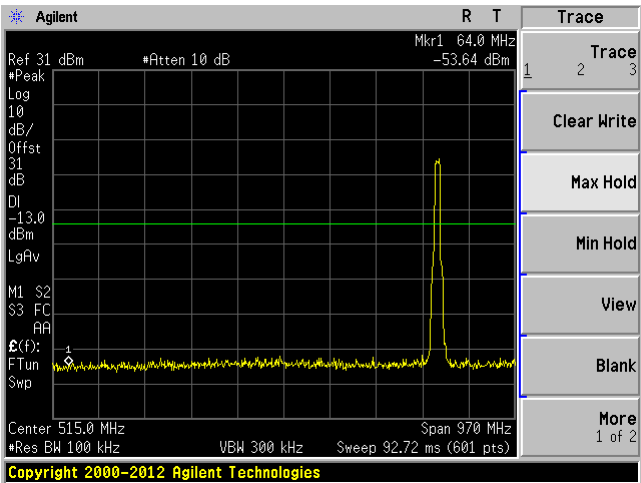
Middle DL 30 MHz-1 GHz



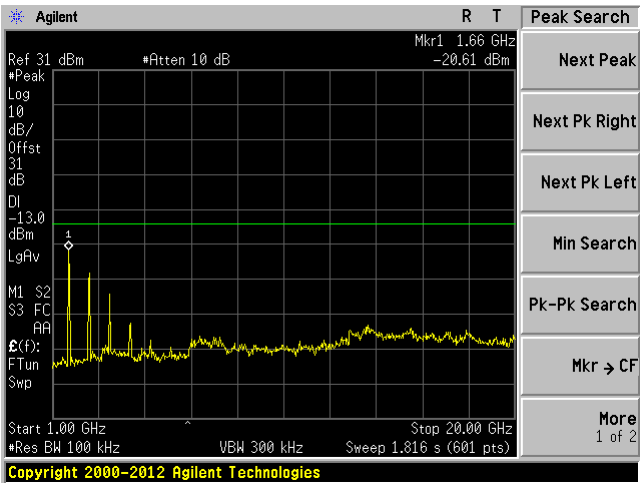
Middle DL 1-20 GHz



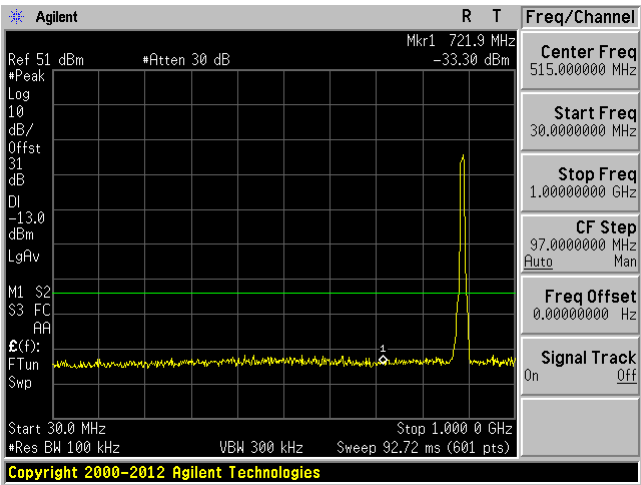
Middle UL 30 MHz-1 GHz



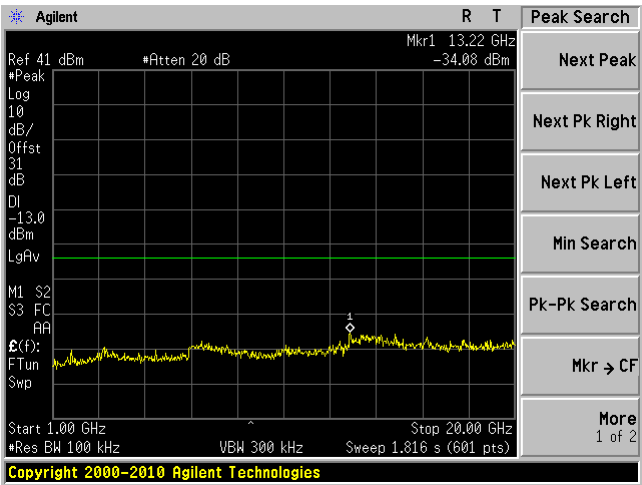
Middle UL 1-20 GHz



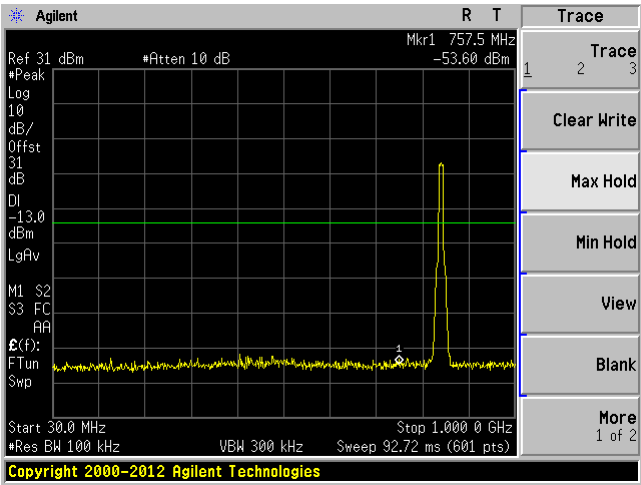
High DL 30 MHz-1 GHz



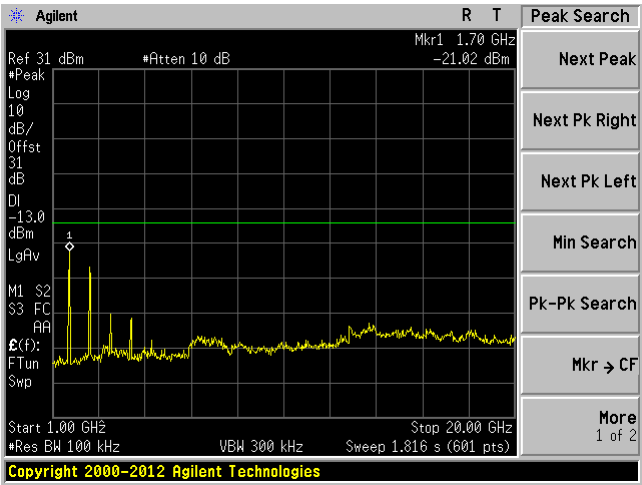
High DL 1-20 GHz



High UL 30 MHz-1 GHz



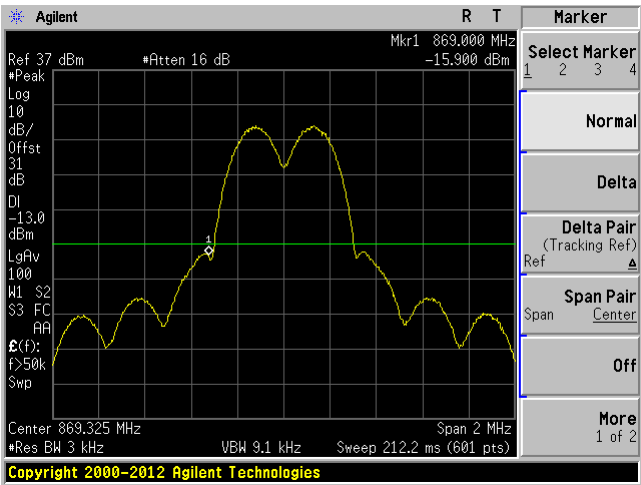
High UL 1-20 GHz



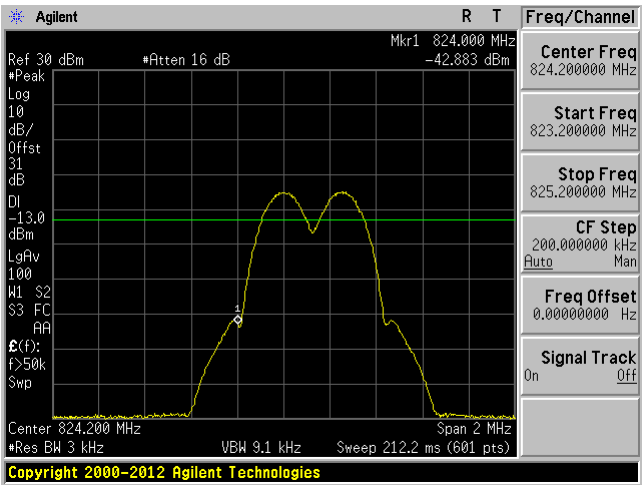
Intermodulation

GSM/GPRS

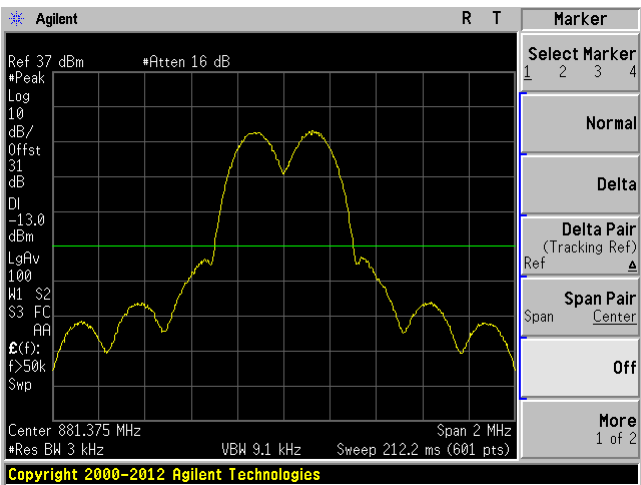
Low DL



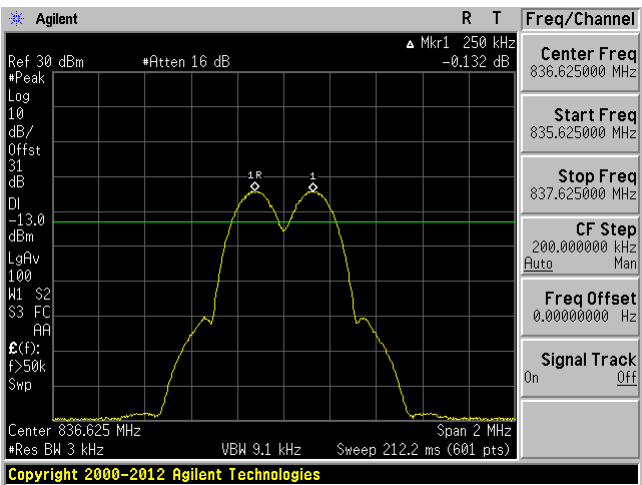
Low UL



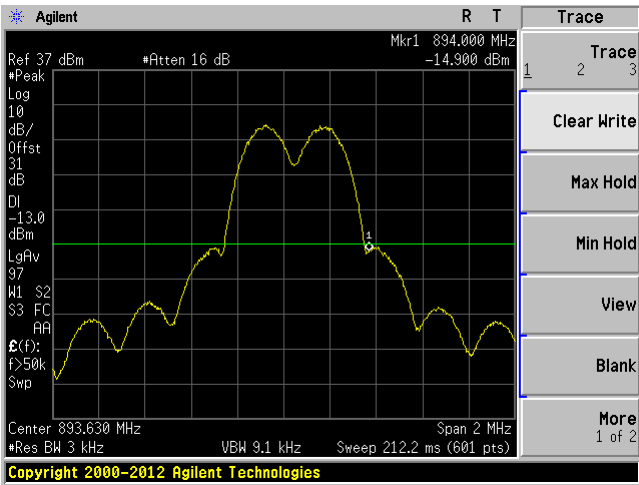
Middle DL



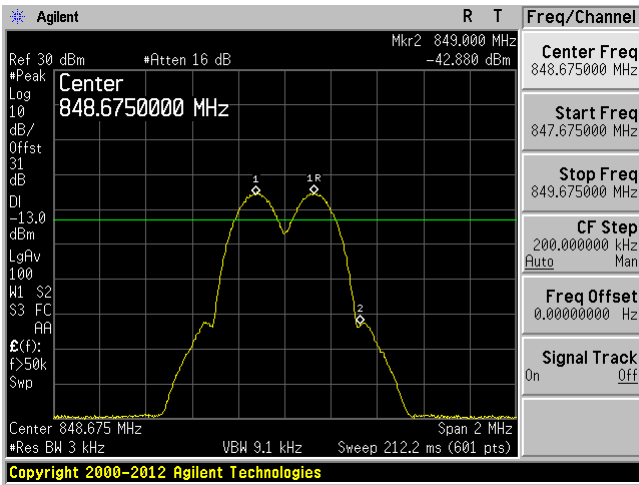
Middle UL



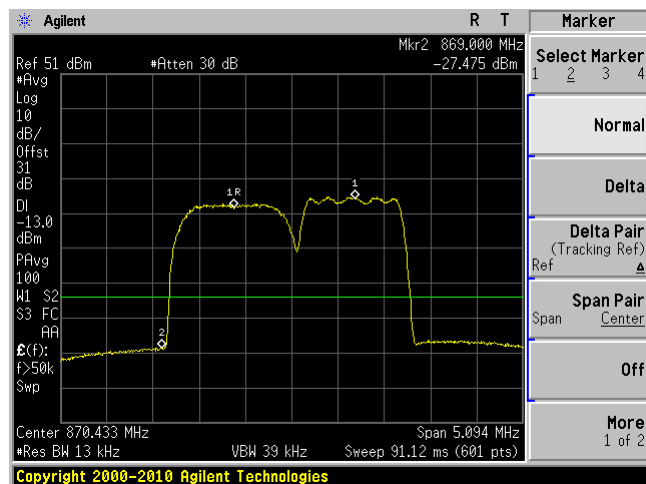
High DL



High UL



Low DL



Agilent

Ref 31 dBm Atten 10 dB

Mkr1 1.300 MHz 0.581 dB

Select Marker 1 2 3 4

Normal

Delta

Delta Pair (Tracking Ref)

Ref

Span Pair Center

Off

More 1 of 2

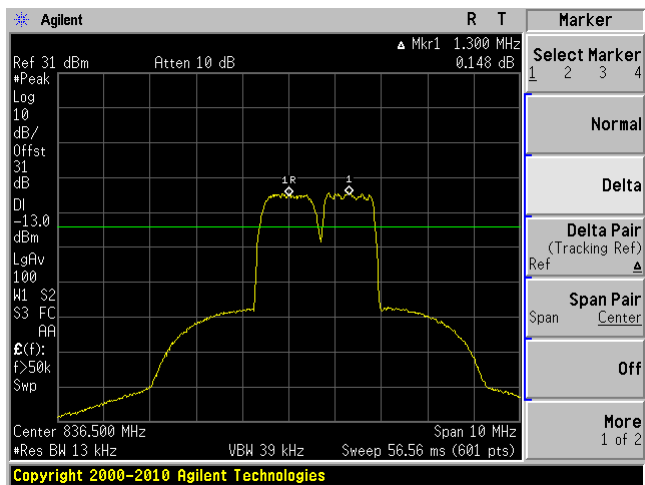
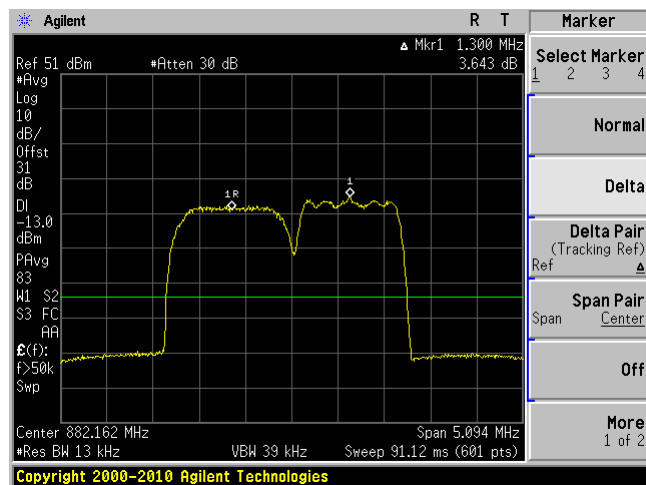
Center 824.800 MHz Span 10 MHz

Res BW 13 kHz VBW 39 kHz Sweep 56.56 ms (601 pts)

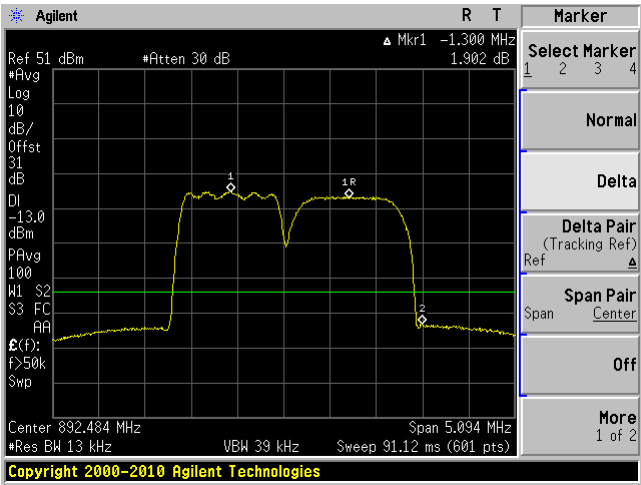
Marker 1 1.300000 MHz 0.581 dB

Marker 2

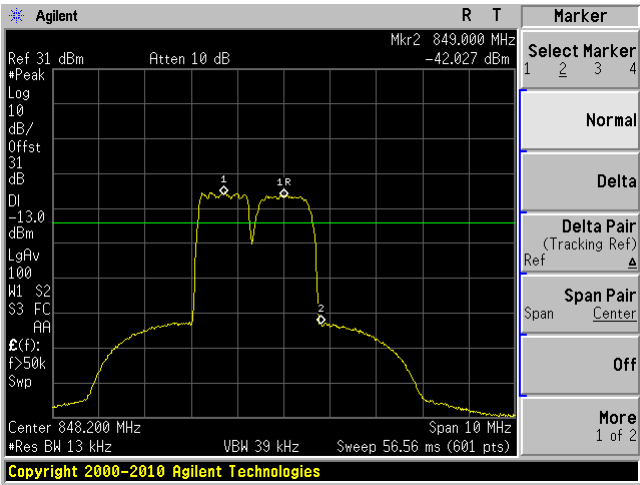
Middle UL



High DL

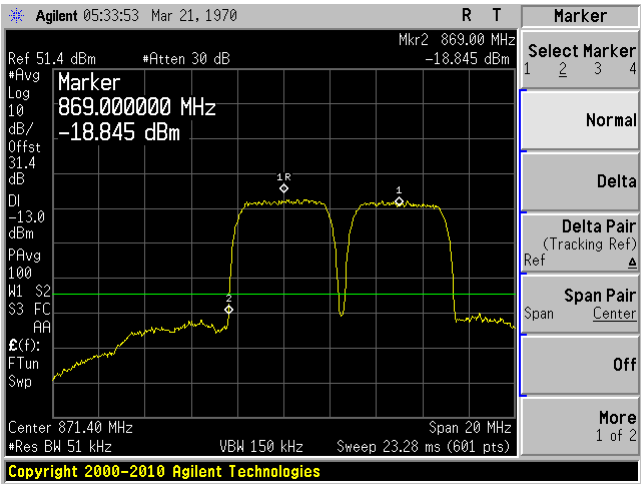


High UL

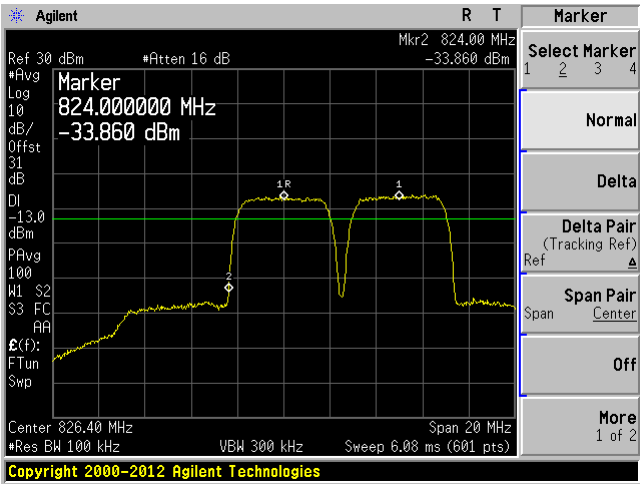


WCDMA

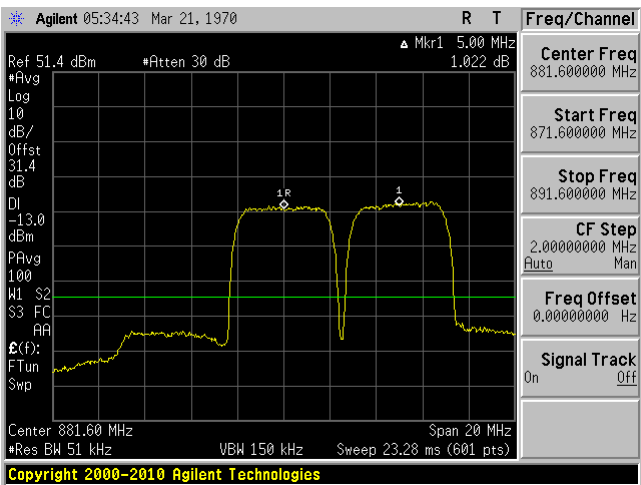
Low DL



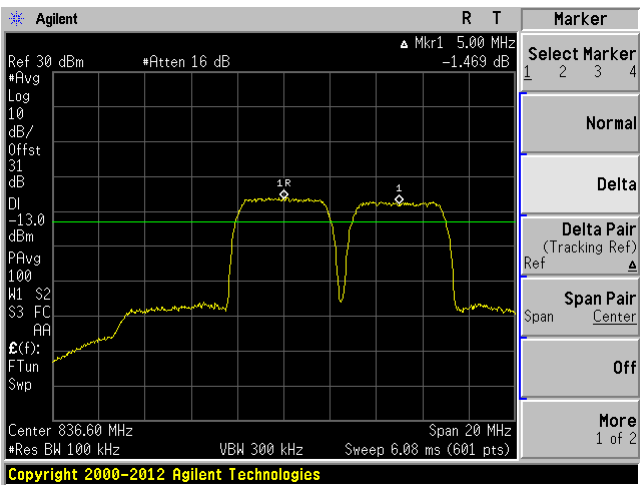
Low UL



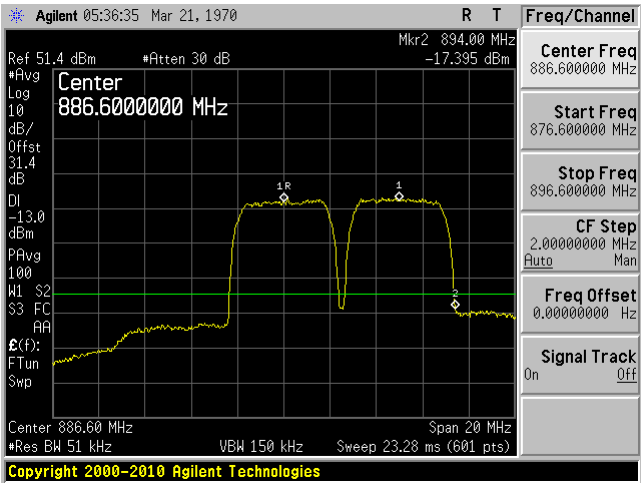
Middle DL



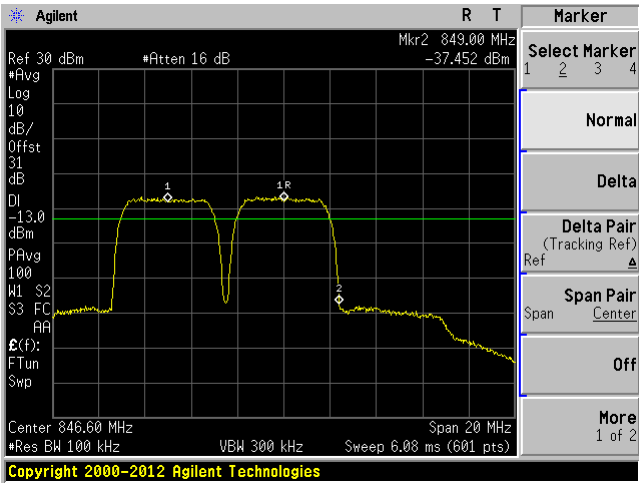
Middle UL



High DL

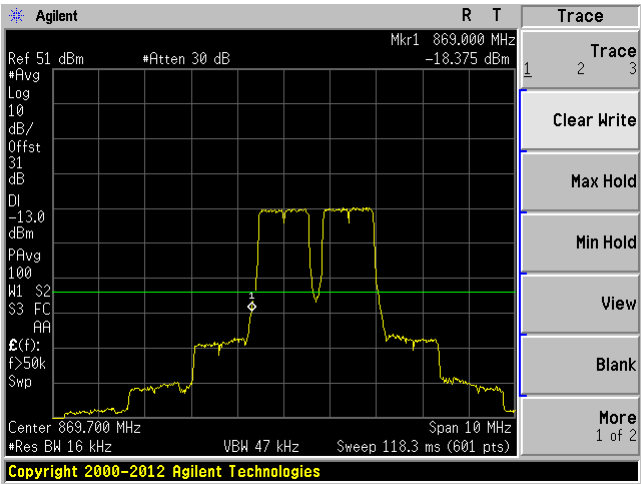


High UL

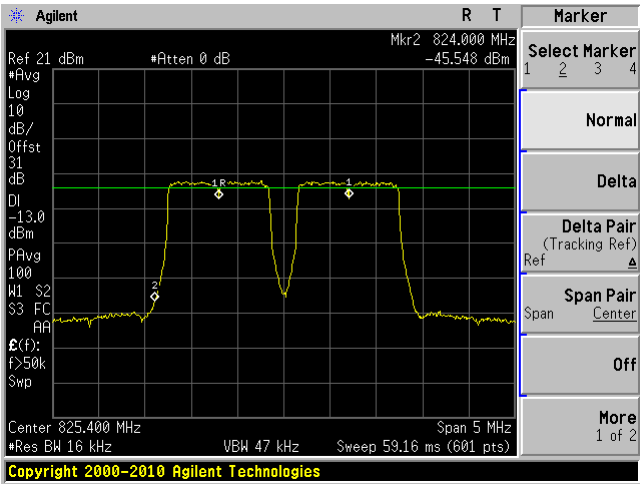


LTE 1.4 MHz

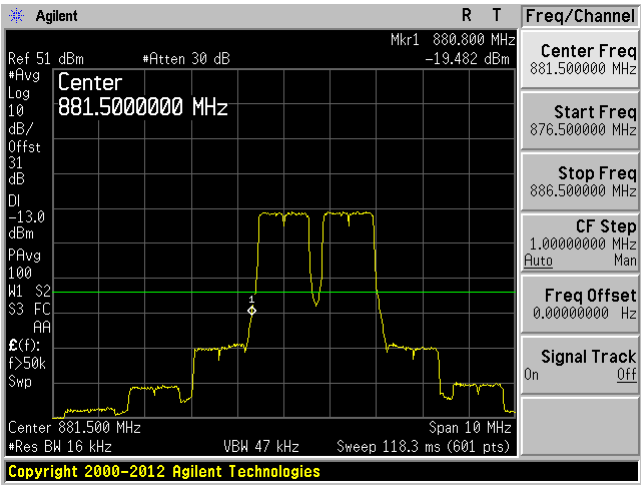
Low DL



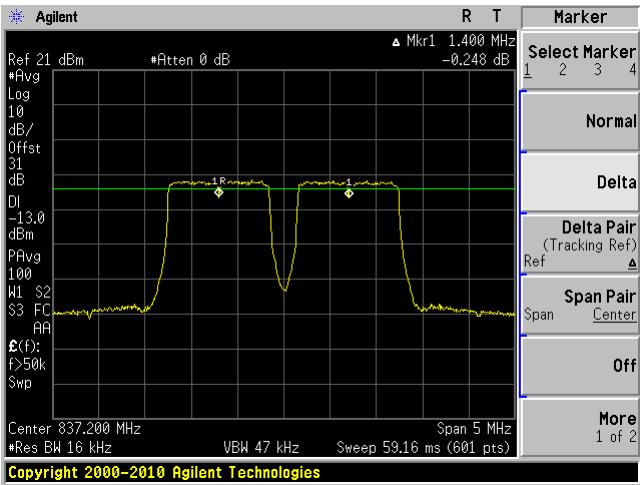
Low UL



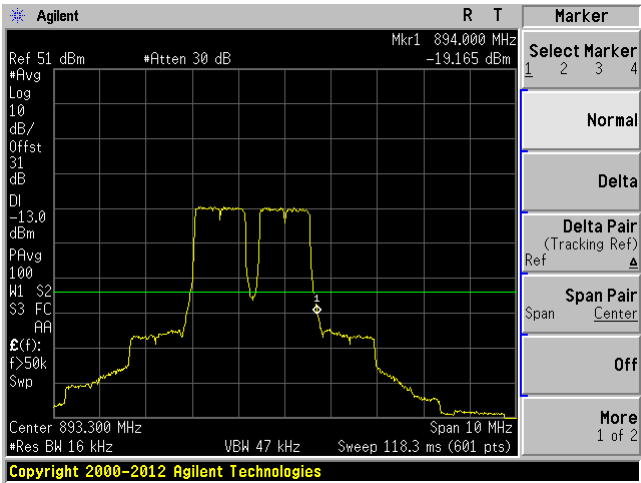
Middle DL



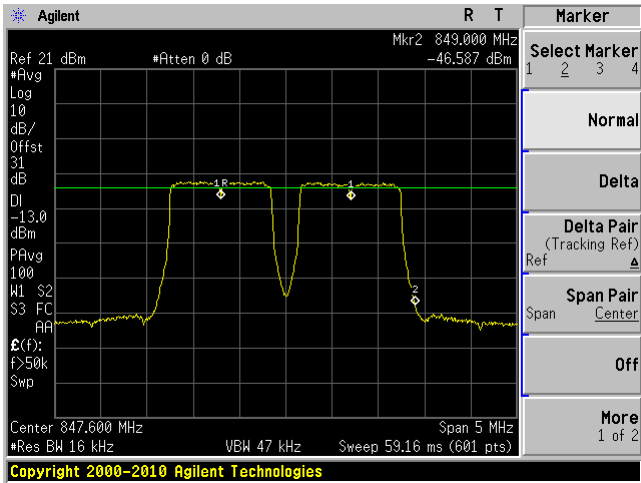
Middle UL



High DL

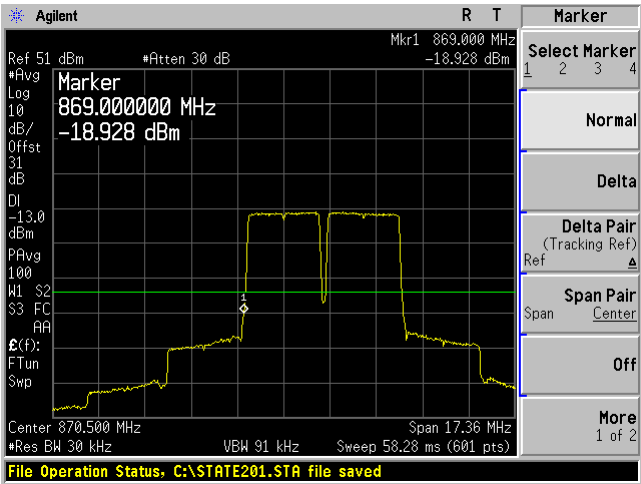


High UL

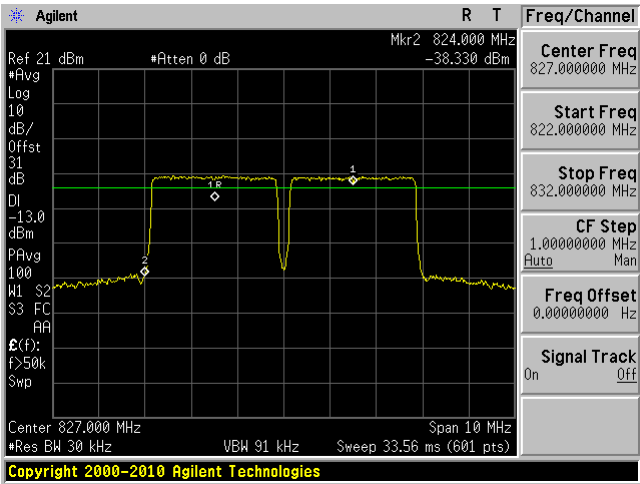


LTE 3 MHz

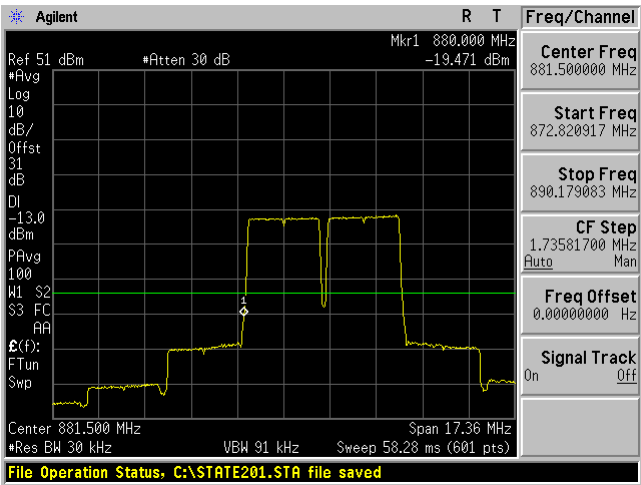
Low DL



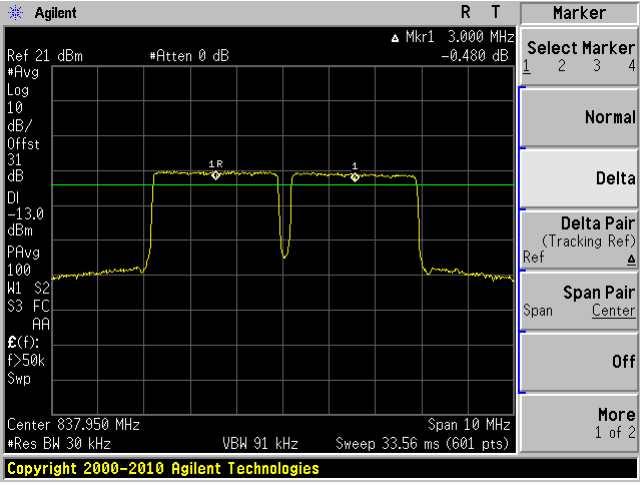
Low UL



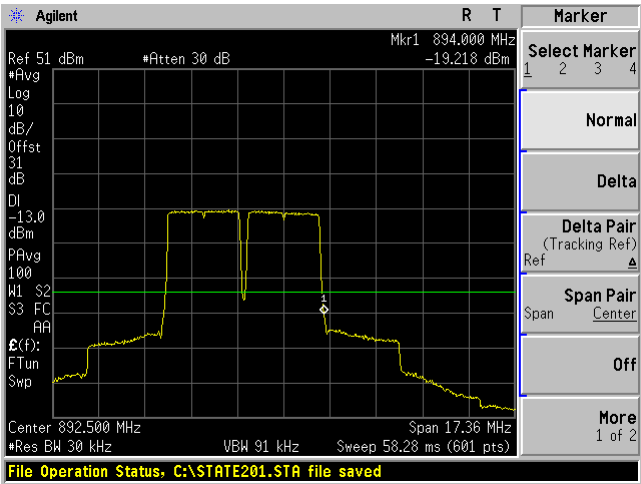
Middle DL



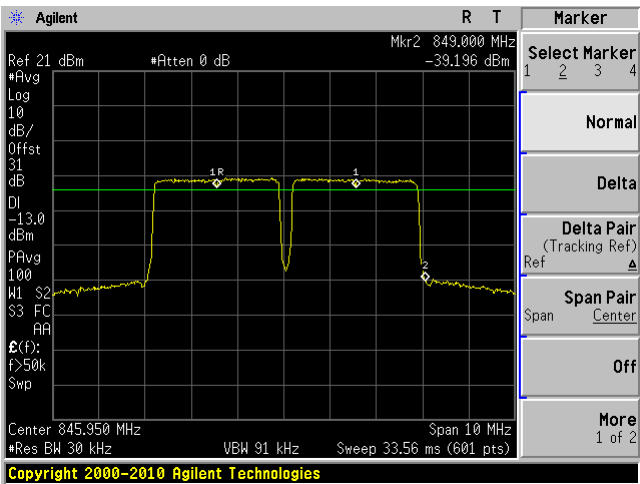
Middle UL



High DL

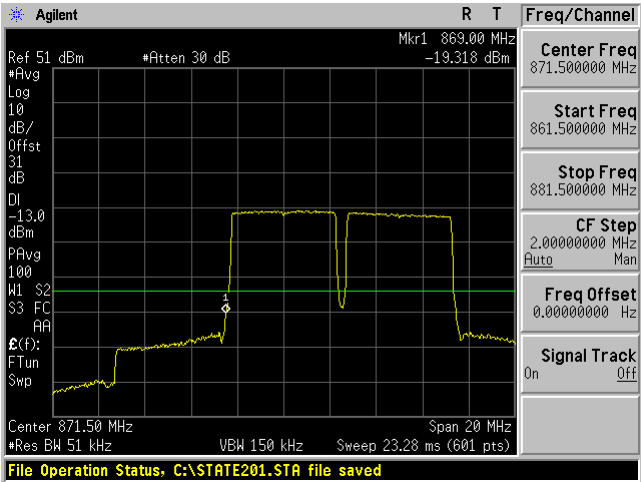


High UL

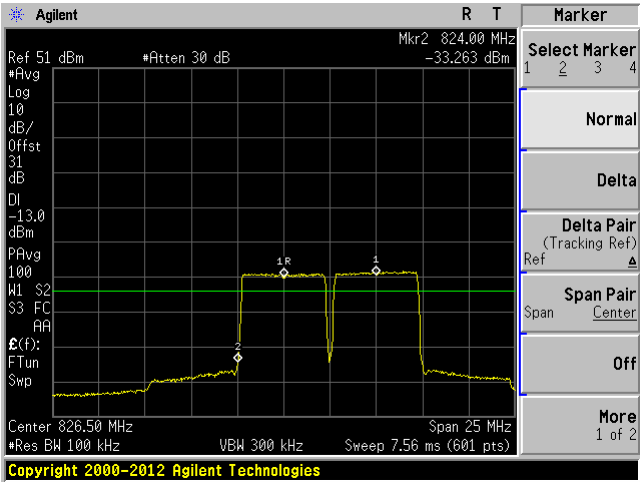


LTE 5 MHz

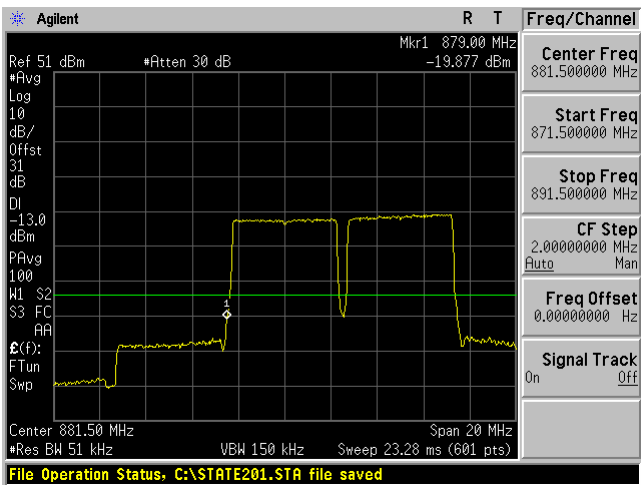
Low DL



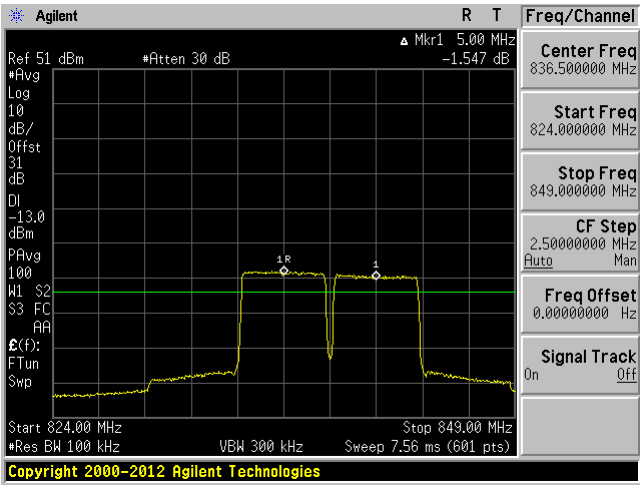
Low UL



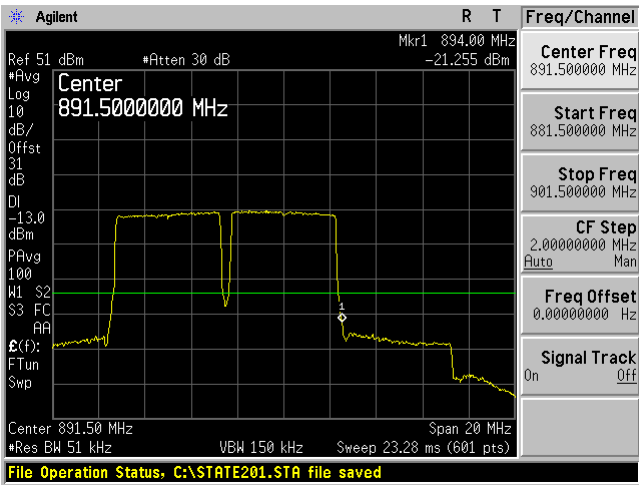
Middle DL



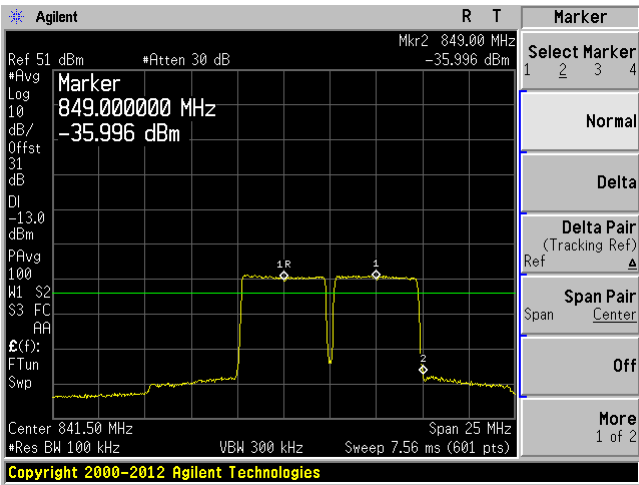
Middle UL



High DL

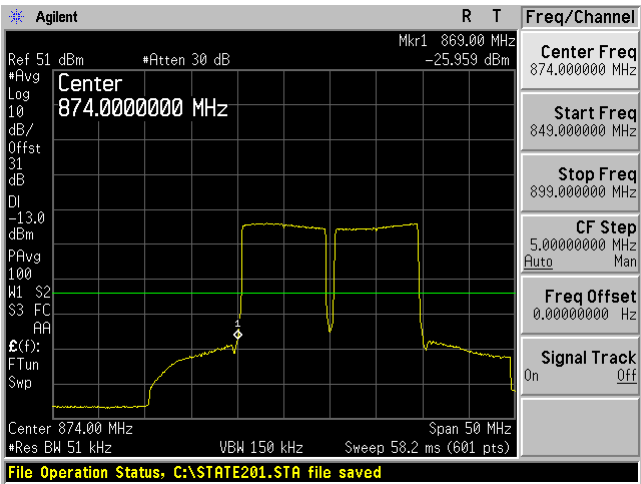


High UL

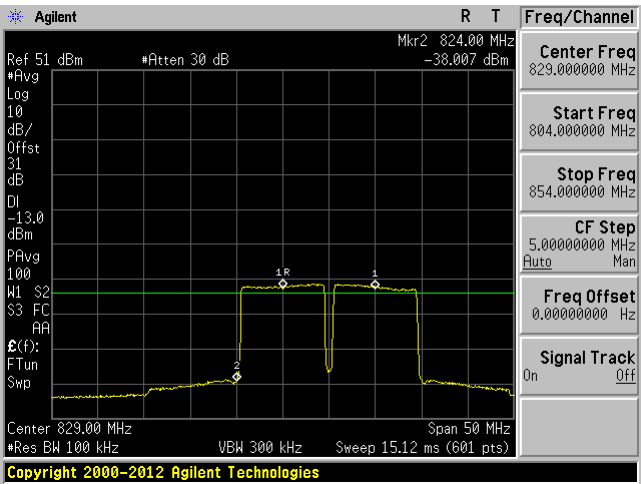


LTE 10 MHz

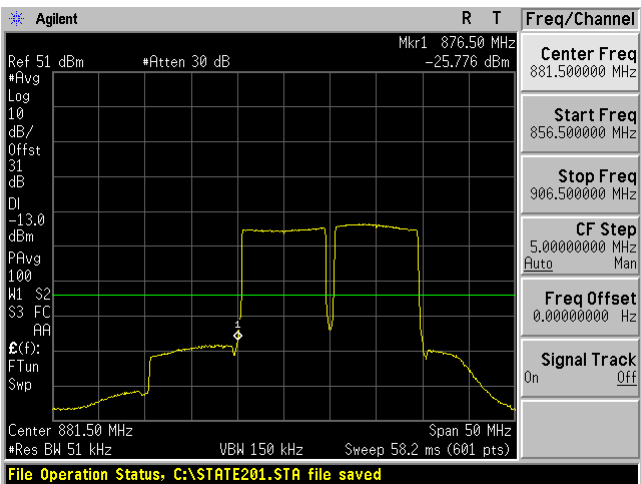
Low DL



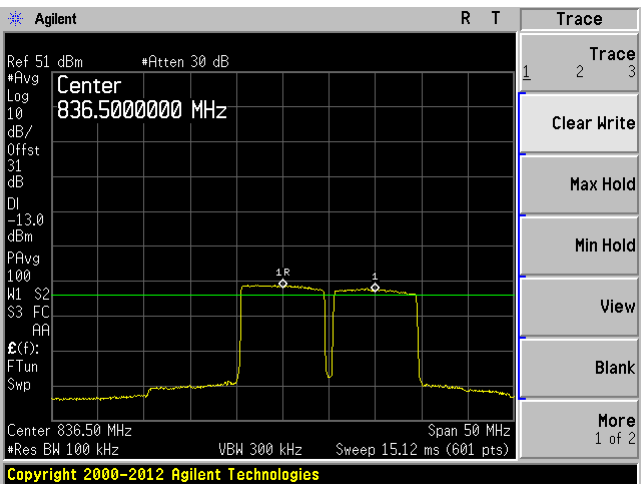
Low UL



Middle DL

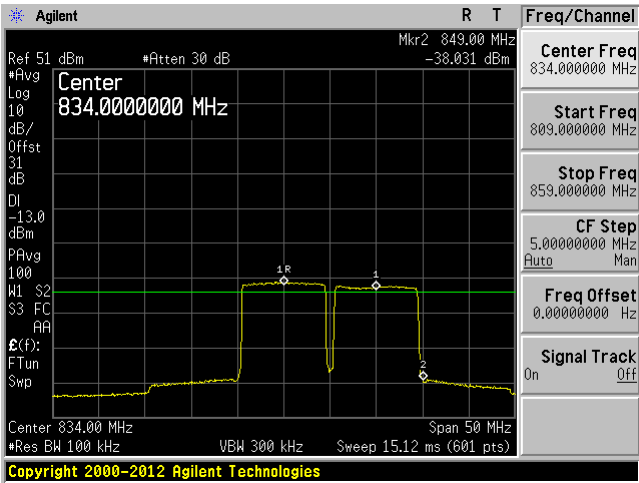
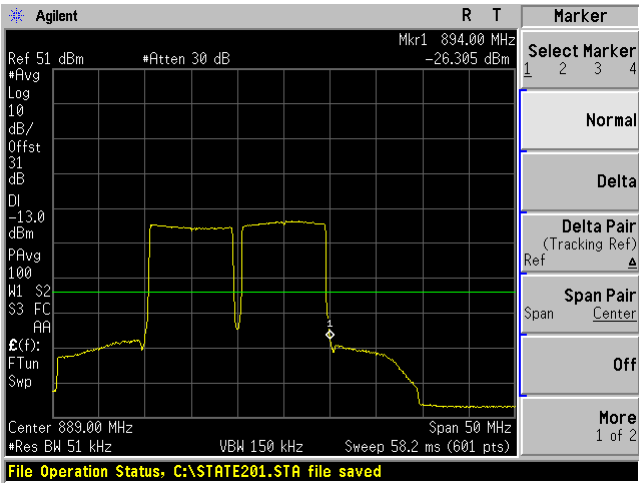


Middle UL



High DL

High UL



8 FCC §22.917 & IC RSS 131 §6.4 - Band Edge

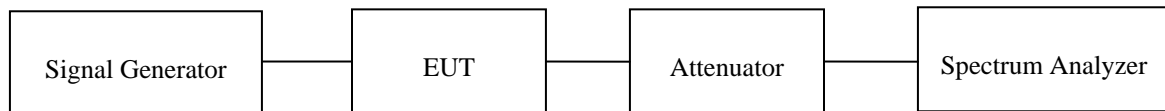
8.1 Applicable Standards

According to FCC §22.917 and 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.

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	2014-05-03	1 year

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

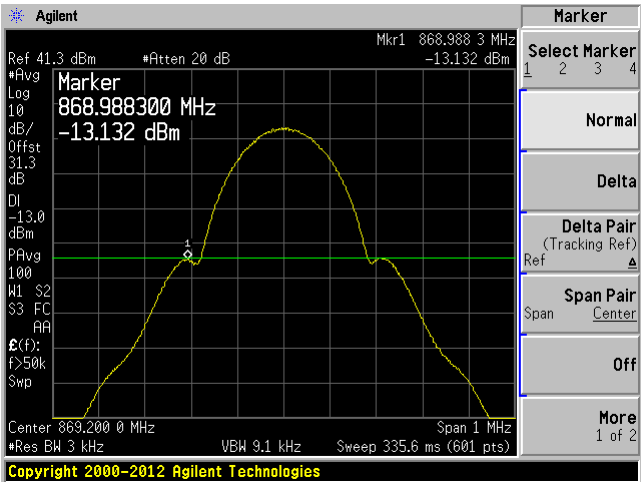
The testing was performed by Bo Li on 2015-04-02 to 2015-04-18 in the RF Site.

8.5 Test Results

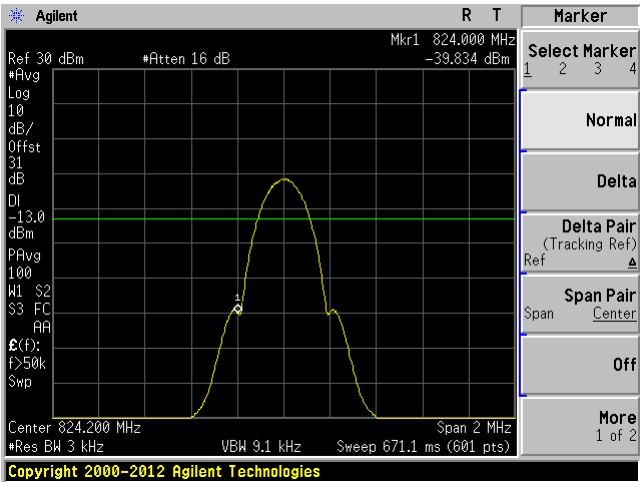
Please refer to the following plots.

GSM/GPRS

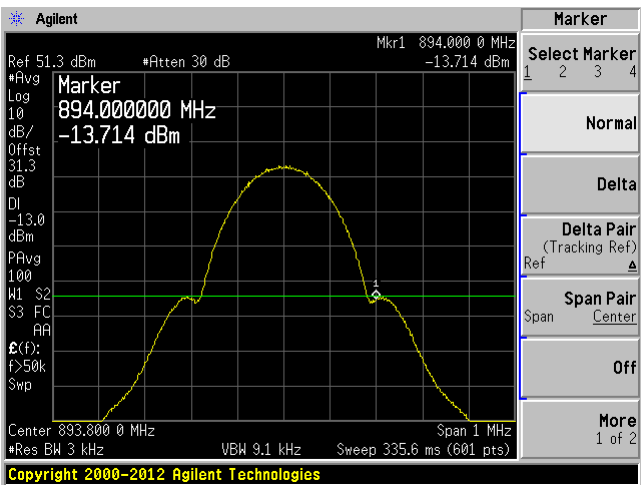
Low DL



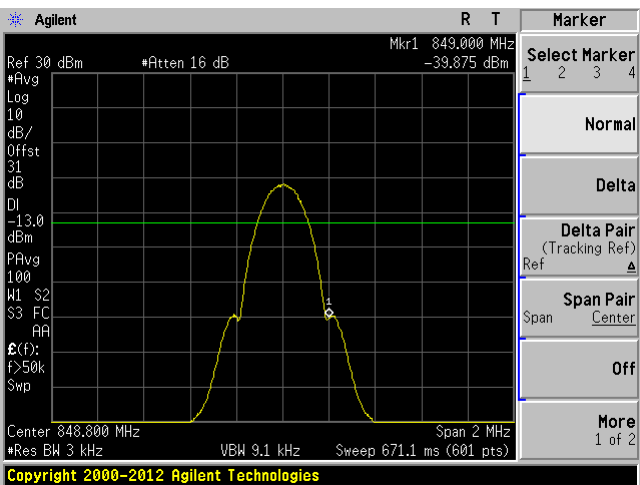
Low UL



High DL

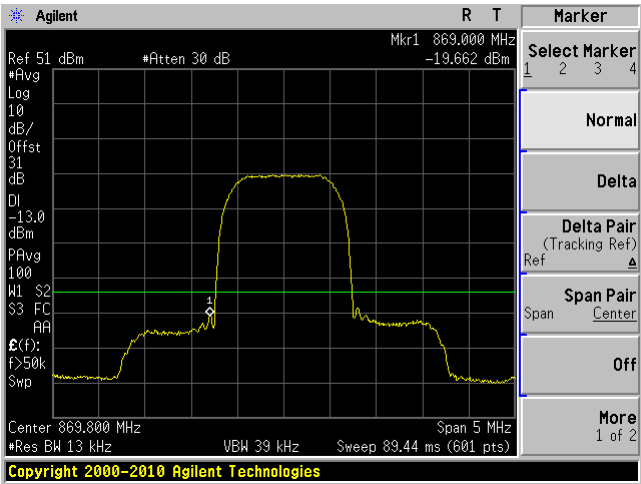


High UL

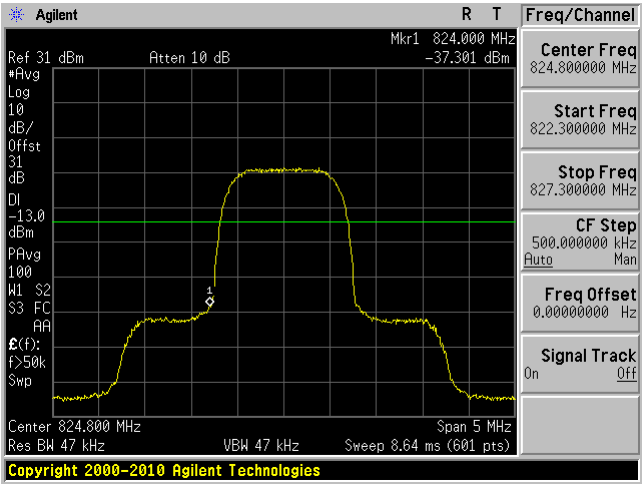


CDMA

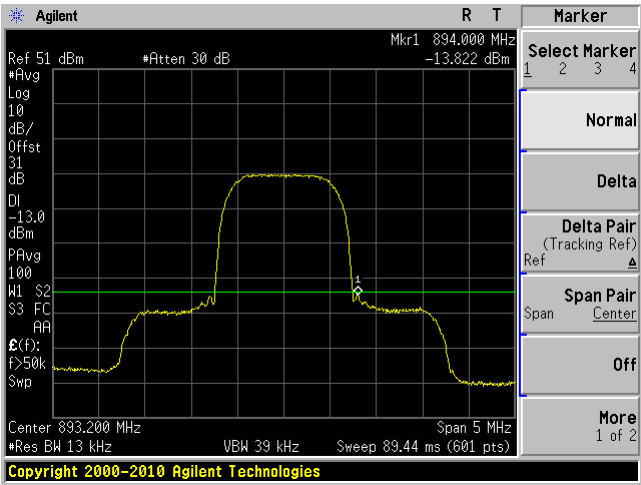
Low DL



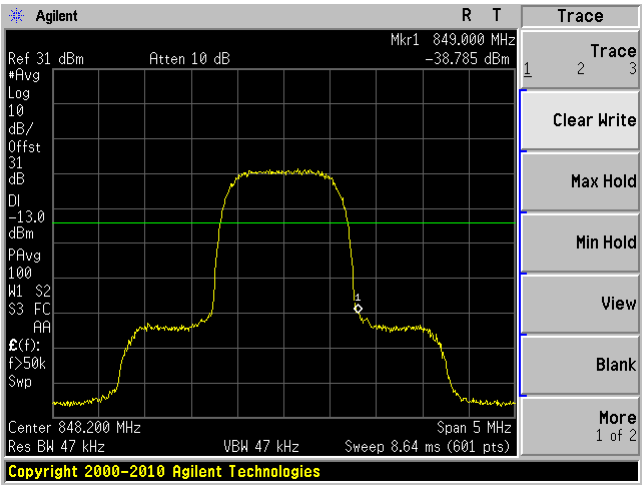
Low UL



High DL

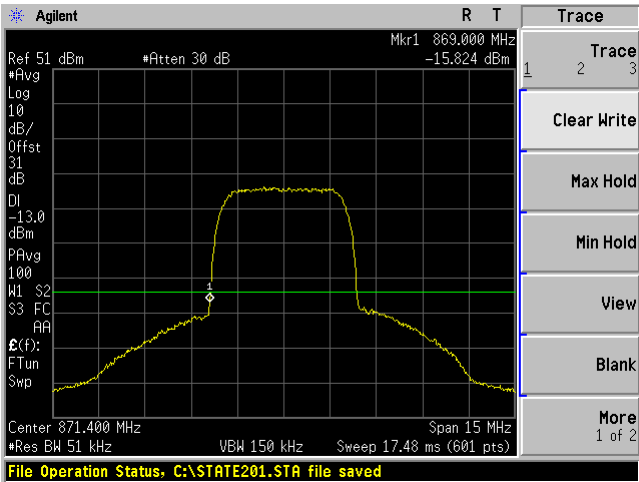


High UL

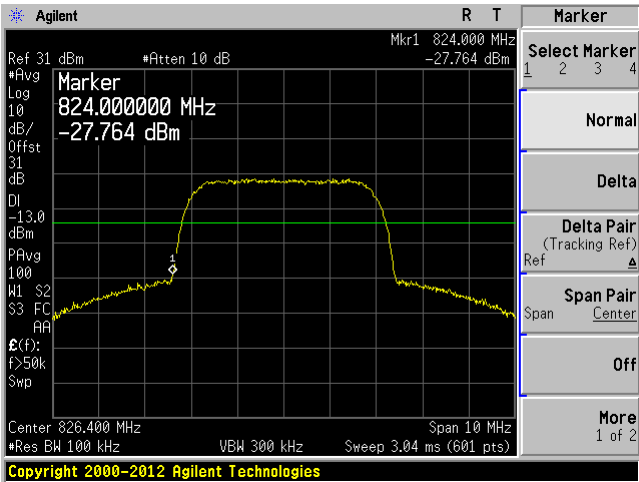


WCDMA

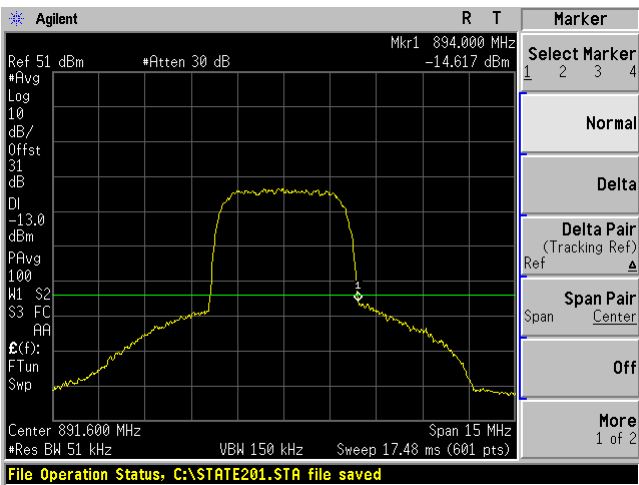
Low DL



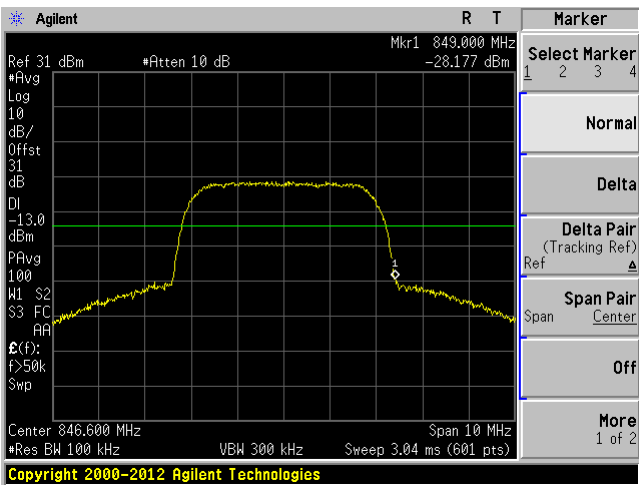
Low UL



High DL

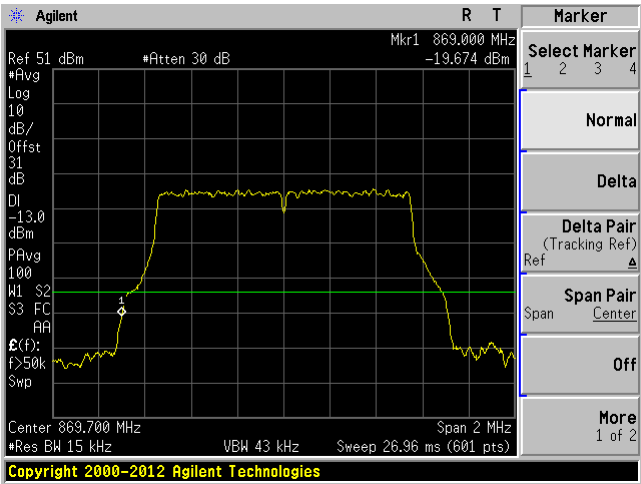


High UL

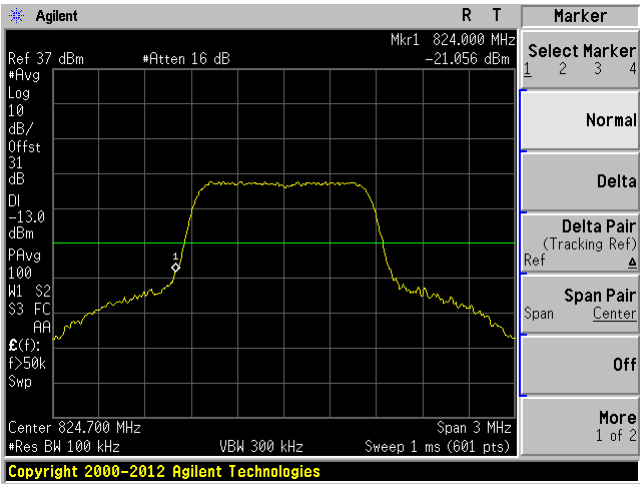


LTE 1.4 MHz

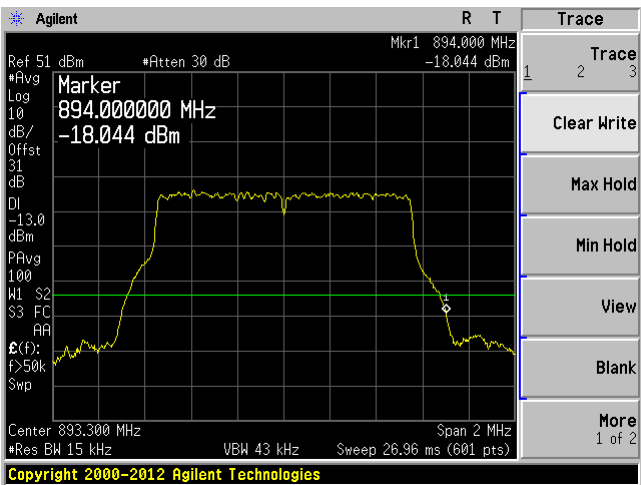
Low DL



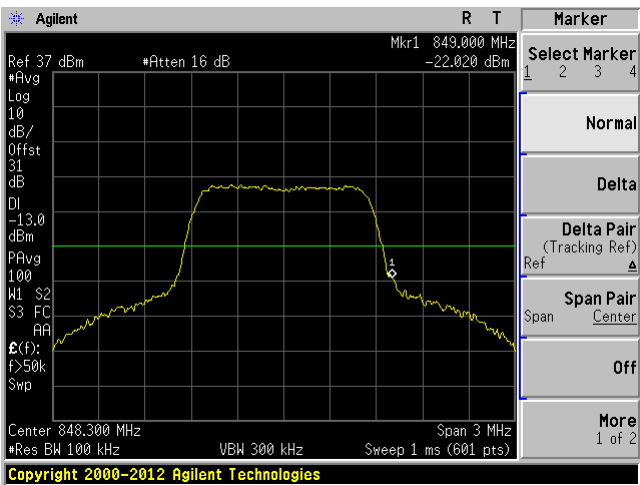
Low UL



High DL

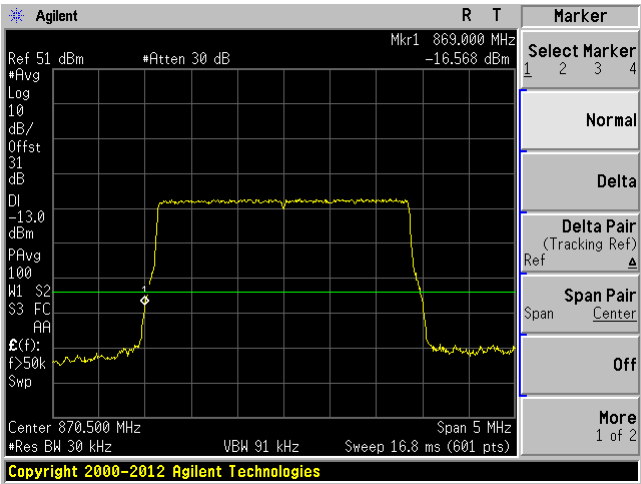


High UL

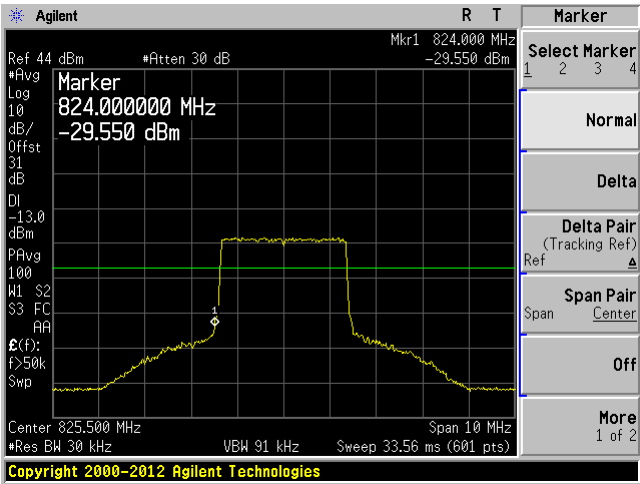


LTE 3 MHz

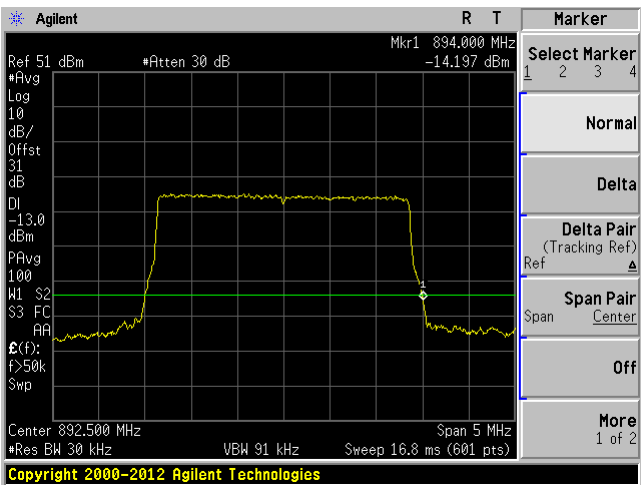
Low DL



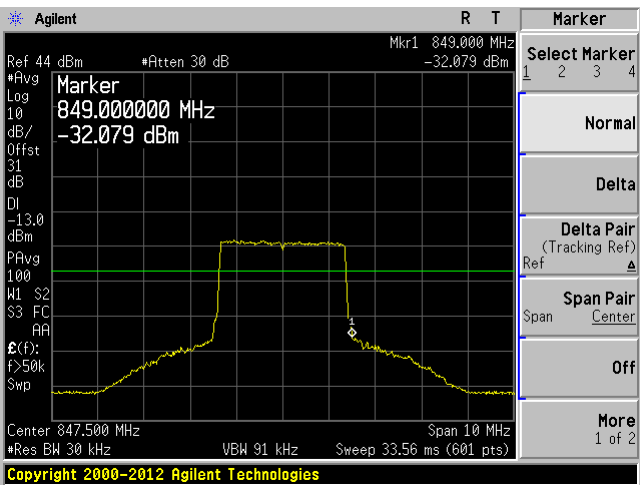
Low UL



High DL

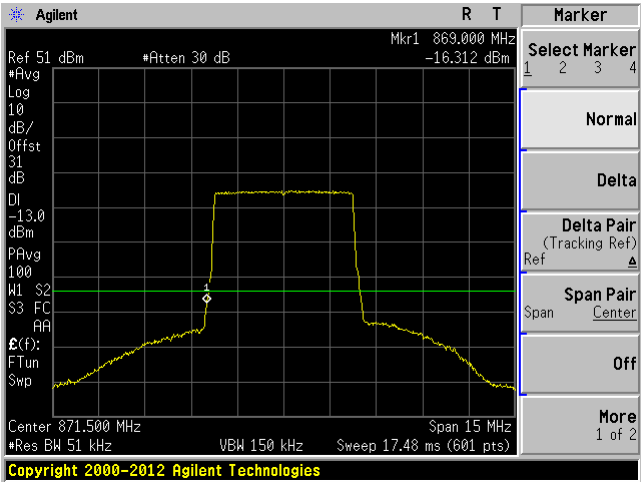


High UL

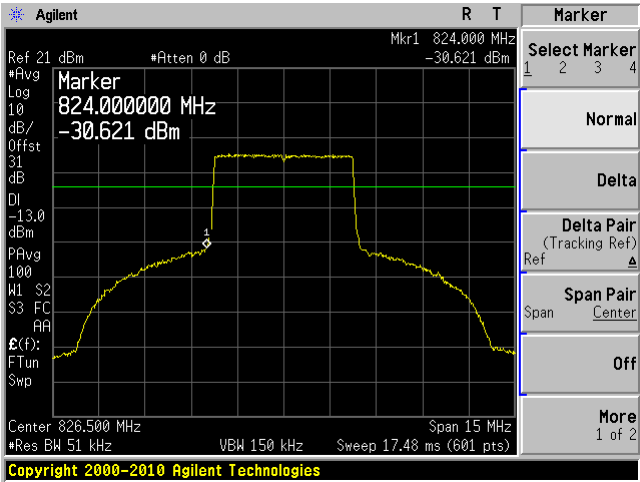


LTE 5 MHz

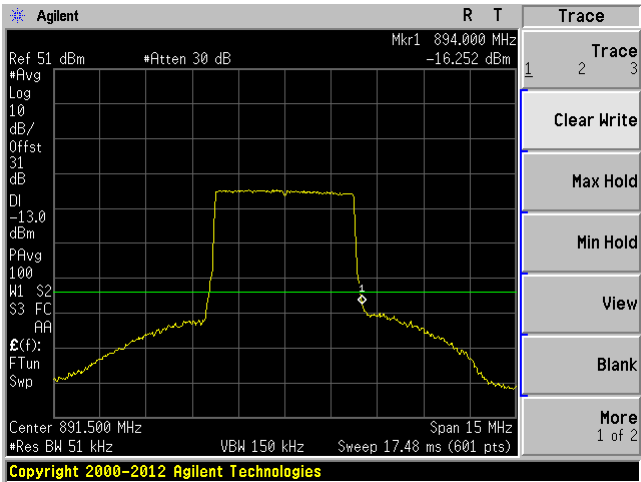
Low DL



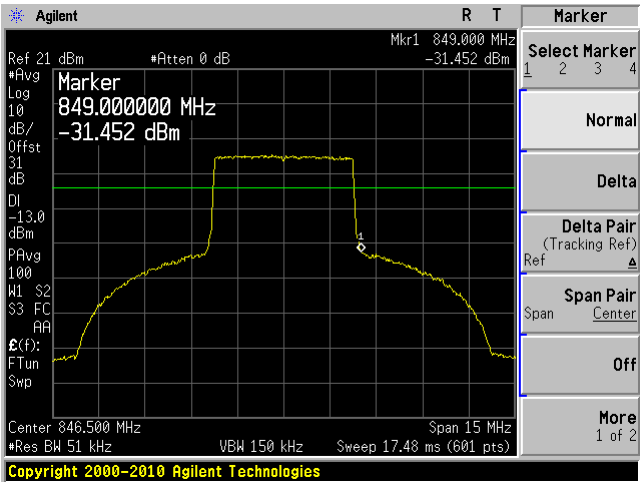
Low UL



High DL

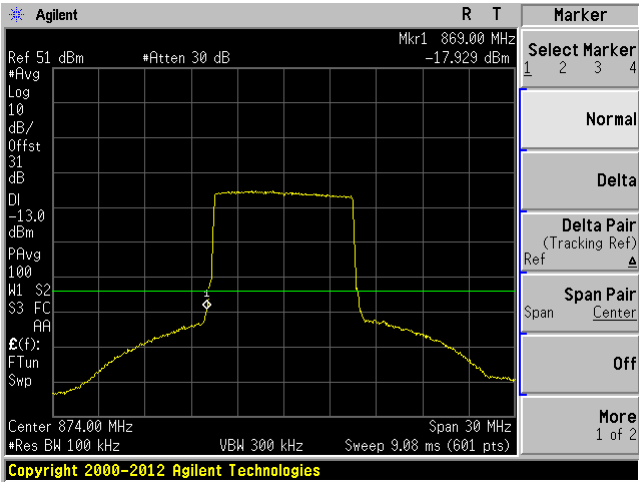


High UL

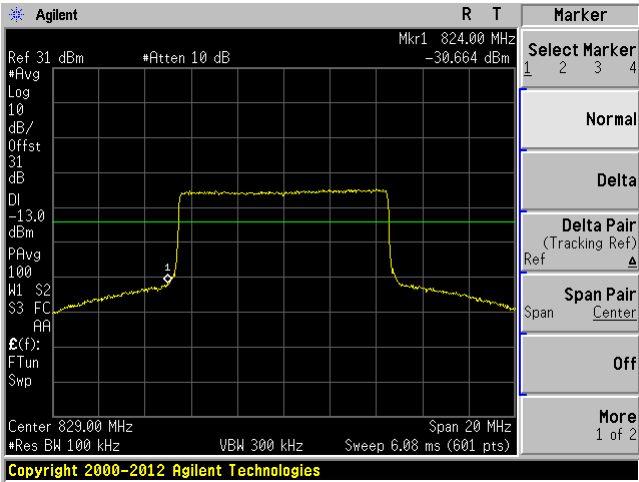


LTE 10 MHz

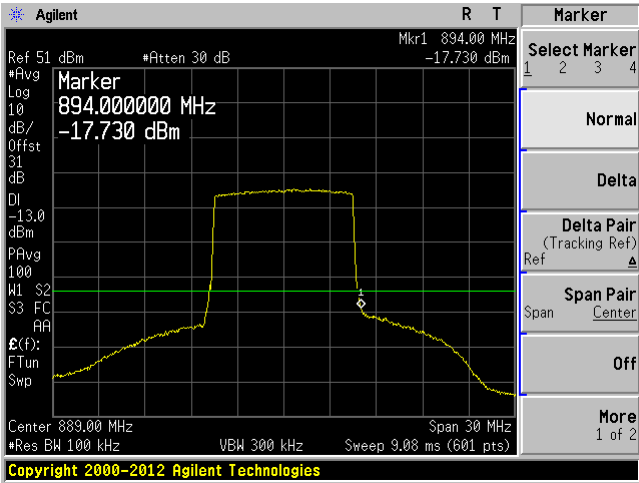
Low DL



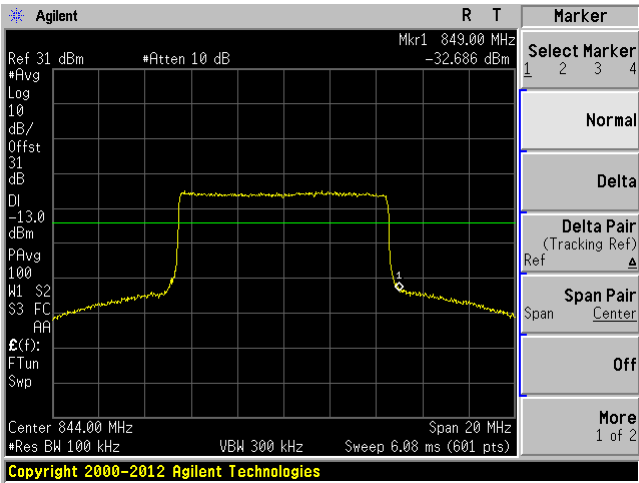
Low UL



High DL



High UL



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

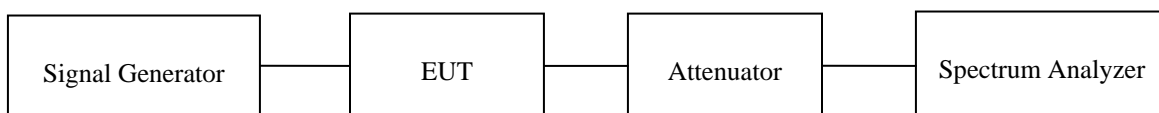
9.1 Applicable Standards

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 f_0 of the passband up to at least $f_0 \pm 250\%$ 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	2014-05-03	1 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

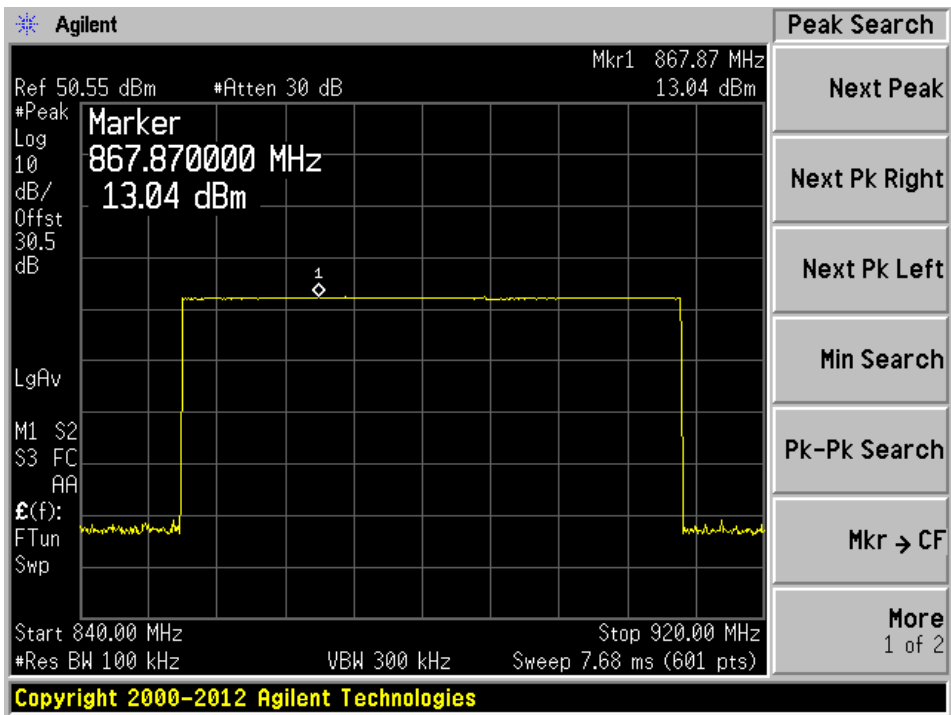
Temperature:	21-23° C
Relative Humidity:	42-48 %
ATM Pressure:	101.4-102 kPa

The testing was performed by Bo Li on 2015-04-02 to 2015-04-18 in the RF Site.

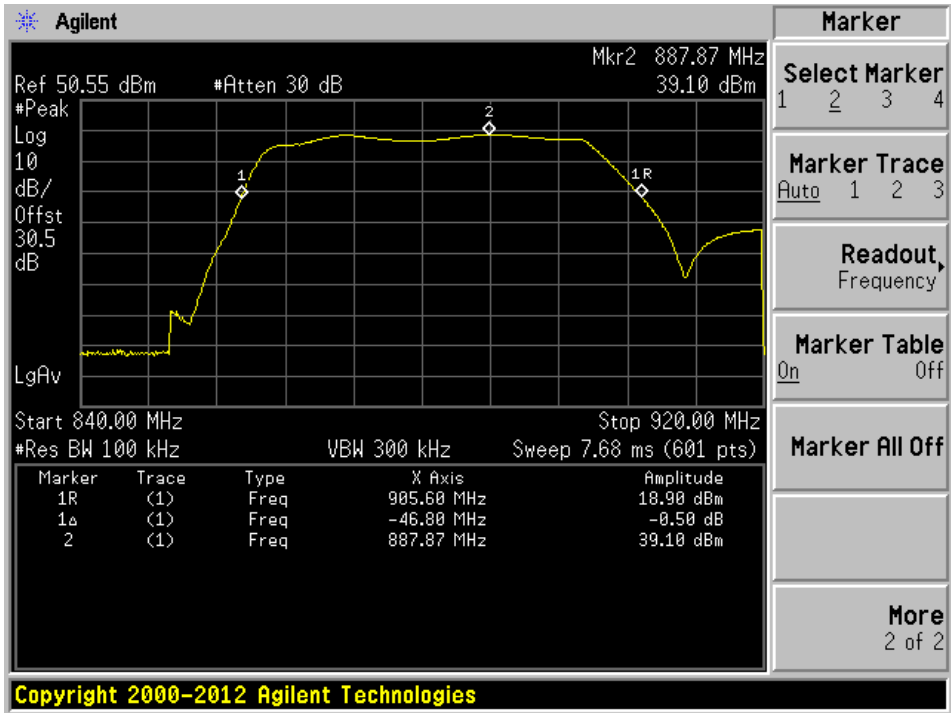
9.5 Test Results

Frequency	Input (dBm)	Output (dBm)	Gain (dB)	20 dB Bandwidth (MHz)
Downlink	13.4	39.1	25.7	46.8
Uplink	-17.81	14.75	32.56	42.4

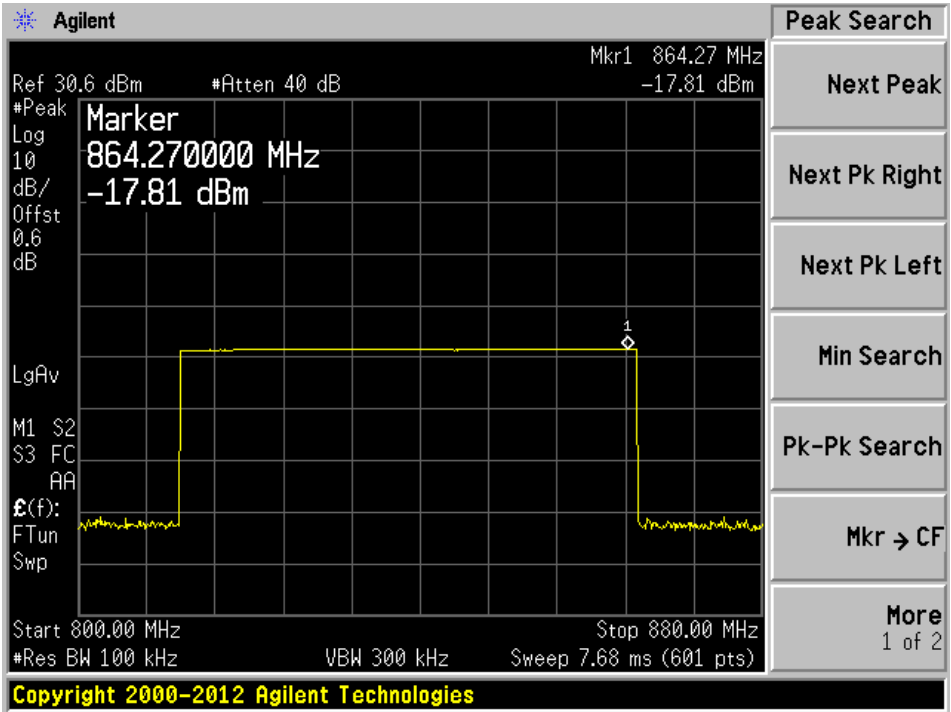
Downlink, Input



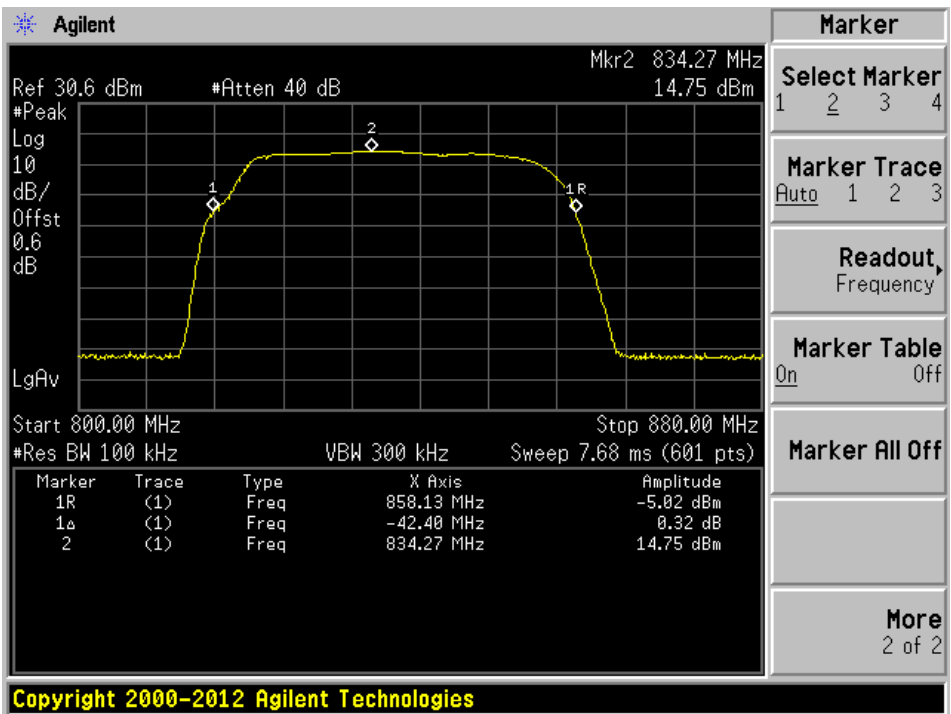
Downlink, Output



Uplink, Input



Uplink, 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 4 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)
0.003-10 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	3.142 f ^{0.3417}	0.008335 f ^{0.3417}	0.02619 f ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ f ^{1.2}
150000-300000	0.158 f ^{0.5}	4.21 x 10 ⁻⁴ f ^{0.5}	6.67 x 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

<u>Maximum peak output power at antenna input terminal (dBm):</u>	<u>39.99</u>
<u>Maximum peak output power at antenna input terminal (mW):</u>	<u>9977.001</u>
<u>Prediction distance (cm):</u>	<u>79</u>
<u>Prediction frequency (MHz):</u>	<u>891.6</u>
<u>Antenna Gain, typical (dBi):</u>	<u>3</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.995</u>
<u>Power density at predication frequency and distance (mW/cm²):</u>	<u>0.2538</u>
<u>MPE limit for uncontrolled exposure at predication frequency (mW/cm²):</u>	<u>0.594</u>
<u>Power density at predication frequency and distance (W/m²):</u>	<u>2.538</u>
<u>MPE limit for uncontrolled exposure at predication frequency (W/m²):</u>	<u>2.718</u>

Uplink

<u>Maximum peak output power at antenna input terminal (dBm):</u>	<u>17.99</u>
<u>Maximum peak output power at antenna input terminal (mW):</u>	<u>62.951</u>
<u>Prediction distance (cm):</u>	<u>79</u>
<u>Prediction frequency (MHz):</u>	<u>826.4</u>
<u>Antenna Gain, typical (dBi):</u>	<u>3</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.995</u>
<u>Power density at predication frequency and distance (mW/cm²):</u>	<u>0.0016</u>
<u>MPE limit for uncontrolled exposure at predication frequency (mW/cm²):</u>	<u>0.551</u>
<u>Power density at predication frequency and distance (W/m²):</u>	<u>0.016</u>
<u>MPE limit for uncontrolled exposure at predication frequency (W/m²):</u>	<u>2.581</u>

Results

For uplink and downlink, the highest power density levels at **79 cm** are below the MPE uncontrolled exposure limit.