



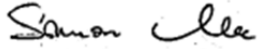
FCC PART 90 TEST AND MEASUREMENT REPORT

For

Trimble Navigation Limited

935 Stewart Drive,
Sunnyvale, CA 94085, USA

FCC ID: KEAADL351

Report Type: Original Report	Product type: UHF Transceiver Module
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Report Number: R1512162-90	
Report Date: 2016-05-18	
Reviewed By: Simon Ma RF Lead 	
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Note: This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. This report **must not** be used by the customer to claim product certification, approval, or endorsement by A2LA*, NIST, or any agency of the Federal Government.

* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "*" also

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1512162-90	Original Report	2016-03-29
1	R1512162-90	Adding notes	2016-05-18

1. General Information

1.1 Product Description for Equipment under Test (EUT)

This test and measurement report was prepared on behalf *Trimble Navigation Limited* and their product, FCC ID: KEAADL351, model: ADL35-1, which will henceforth be referred to as the EUT (Equipment Under Test). The EUT is a UHF transceiver module operates in 390-430 MHz.

The EUTs are UHF Transceivers that operates under FCC Part 90.

Specifications	
Frequency Bands	390-430 MHz
Modulation Type	GMSK, 4FSK
Data Rate (bps)	GMSK: 4800, 8000, 9600, 19200 4FSK: 9600, 19200
Emission Designator	F1D
RF Output Power	2 Watts - 35 Watts
Channel Bandwidth	12.5 kHz & 25 kHz
Dual Power Supply	12 V

1.2 Mechanical Description

The EUT measures approximately 11.9 cm (L) x 8.6 cm (W) x 21.3 cm (H) and weighs approximately 2 kg.

The test data gathered are from production sample, serial number: R1512162-1, assigned by BACL.

1.3 Objective

This type approval report is prepared on behalf of *Trimble Navigation Limited* in accordance Part 90 of the Federal Communication Commissions.

The objective was to determine the RF output power, Occupied Bandwidth, Spurious Emissions, Frequency Stability and Transient Frequency Behavior are in compliance with the FCC rules.

1.4 Related Submittal(s)/Grant(s)

None

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 individual parts:

Part 90 – Private Land Mobile Radio Service

Applicable Standards: TIA603-D and ANSI 63.4-2014, American National Standard for Method of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.

All emissions measurement was performed by Bay Area Compliance Laboratories 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:

A- An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2005 by A2LA (Test Laboratory Accreditation Certificate Number 3279.02), in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2005 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025: 2005 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

B- A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3279.03) to certify

- For the USA (Federal Communications Commission):

- 1- All Unlicensed radio frequency devices within FCC Scopes A1, A2, A3, and A4;
- 2- All Licensed radio frequency devices within FCC Scopes B1, B2, B3, and B4;
- 3- All Telephone Terminal Equipment within FCC Scope C.

- For the Canada (Industry Canada):

1. All Scope 1-Licence-Exempt Radio Frequency Devices;
2. All Scope 2-Licensed Personal Mobile Radio Services;
3. All Scope 3-Licensed General Mobile & Fixed Radio Services;
4. All Scope 4-Licensed Maritime & Aviation Radio Services;
5. All Scope 5-Licensed Fixed Microwave Radio Services
6. All Broadcasting Technical Standards (BETS) in the Category I Equipment Standards List.

- For Singapore (Info-Communications Development Authority (IDA)):

- 1 All Line Terminal Equipment: All Technical Specifications for Line Terminal Equipment – Table 1 of IDA MRA Recognition Scheme: 2011, Annex 2
2. All Radio-Communication Equipment: All Technical Specifications for Radio-Communication Equipment – Table 2 of IDA MRA Recognition Scheme: 2011, Annex 2

- For the Hong Kong Special Administrative Region:

- 1 All Radio Equipment, per KHCA 10XX-series Specifications;
- 2 All GMDSS Marine Radio Equipment, per HKCA 12XX-series Specifications;
- 3 All Fixed Network Equipment, per HKCA 20XX-series Specifications.

- For Japan:

- 1 MIC Telecommunication Business Law (Terminal Equipment):
 - All Scope A1 - Terminal Equipment for the Purpose of Calls;
 - All Scope A2 - Other Terminal Equipment
- 2 Radio Law (Radio Equipment):
 - All Scope B1 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 1 of the Radio Law
 - All Scope B2 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 2 of the Radio Law
 - All Scope B3 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 3 of the Radio Law

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to TIA/EIA-603-D. The EUT was tested in the normal (native) operating mode to represent *worst*-case results during the final qualification test.

2.2 EUT Exercise Software

The software used were ADCONF Eng and Magnolia Editor Version 1.0.0.1, these were provided by client and was verified by BACL (Jason Qian) to comply with the standard requirements being tested against.

2.3 Equipment Modifications

No modifications were made to the EUT.

2.4 Internal Configuration

Manufacturers	Descriptions	Models	Serial No.
Trimble Navigation Ltd	PCB Assembly	E00358-1	-
Trimble Navigation Ltd	PCB Assembly	A02761 (ADL Vantage 35 & TDL 450H)	-
Trimble Navigation Ltd	PCB Assembly	A02710-11 (ADL Vantage 35 & TD L 450H)	-

2.5 Local Support Equipment

Manufacturer	Description	Model No.	Serial No.
Dell	Laptop	Latitude D620	G66NNC1

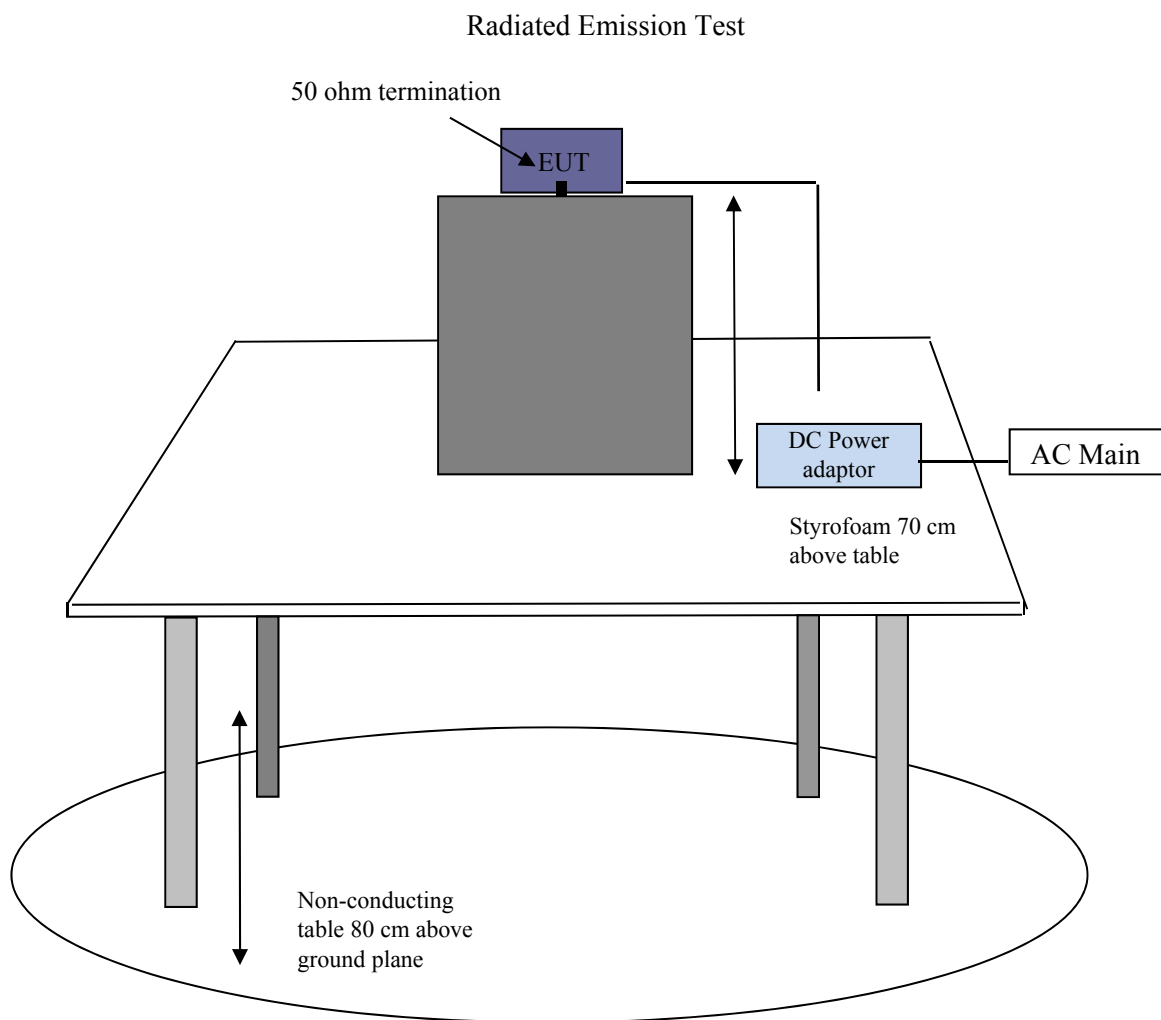
2.6 Local Support Equipment Power Supply and Line Filters

Manufacturer	Description	Model	Serial No.
KEPCO	Source, DC	25-10M	H1334526

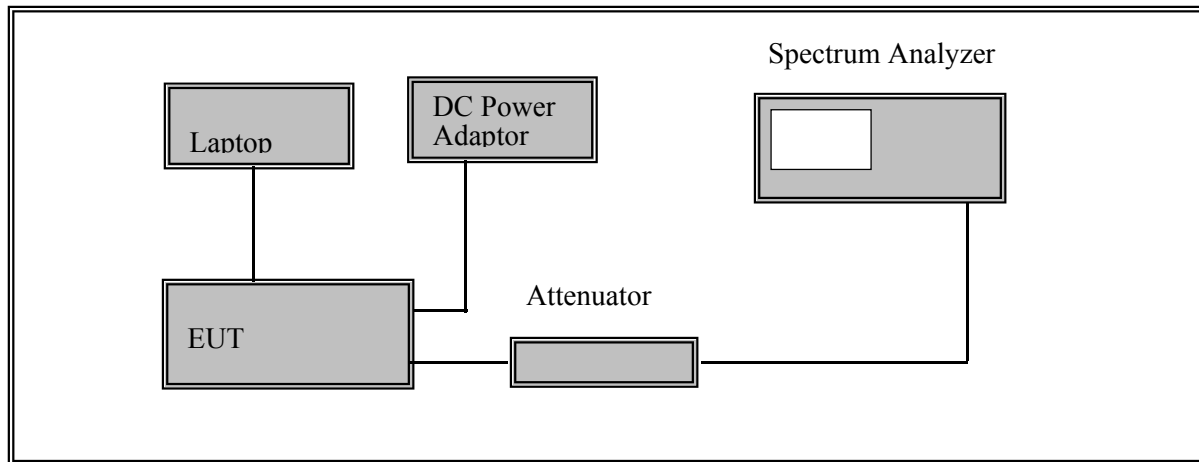
2.7 External I/O Cabling List and Details

Cable Description	Length (m)	From	To
Data/Power Cable	1	EUT	Laptop
SMA cable	< 1.0	EUT	PSA

2.8 Test Setup Block Diagram



Antenna Port Conducted Emission Test



3 Summary of Test Results

FCC/IC Rules	Description of Tests	Results
FCC §1.1310, §2.1091	RF Exposure	Compliant
FCC §2.1046, §90.205	RF Output Power	Compliant
FCC §2.1049, §90.209, §90.210	Occupied Bandwidth and Emission Mask	Compliant
FCC §2.1051, §90.210	Spurious Emissions at Antenna Terminals	Compliant
FCC §2.1055, §90.213	Frequency Stability	Compliant
FCC §2.1053, §90.210	Field Strength of Spurious Radiation	Compliant
FCC §90.214	Transient Frequency Behavior	Compliant

Note: Test data for channel 390.15 MHz is not for FCC Part 90 certification.

4 FCC §2.1091 - RF Exposure Information

4.1 Applicable Standards

FCC §2.1091, (a) Requirements of this section are a consequence of Commission responsibilities under the National Environmental Policy Act to evaluate the environmental significance of its actions. See subpart I of part 1 of this chapter, in particular §1.1307(b).

Limits for Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
300-1500	/	/	f/300	6
1500-100,000	/	/	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	842/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	30

4.2 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

Maximum peak output power at antenna input terminal (dBm):	45.64
Maximum peak output power at antenna input terminal (mW):	36643.75746
Prediction distance (cm):	120
Prediction frequency (MHz):	390.15
Maximum Antenna Gain, typical (dBi):	0
Maximum Antenna Gain (numeric):	1
Power density of prediction frequency at 120 cm (mW/cm ²):	0.2025
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm ²):	0.2601

<u>Maximum peak output power at antenna input terminal (dBm):</u>	<u>45.38</u>
<u>Maximum peak output power at antenna input terminal (mW):</u>	<u>34514.37</u>
<u>Prediction distance (cm):</u>	<u>120</u>
<u>Prediction frequency (MHz):</u>	<u>429.85</u>
<u>Maximum Antenna Gain, typical (dBi):</u>	<u>0</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1</u>
<u>Power density of prediction frequency at 120 cm (mW/cm²):</u>	<u>0.191</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²):</u>	<u>0.287</u>

4.3 Conclusion

The device complies with the MPE requirements by providing a safe separation distance of at least 120 cm between the antenna with maximum 0 dBi gain, including any radiating structure, and any persons when normally operated.

5 FCC §2.1046, §90.205 – RF Output Power

5.1 Applicable Standard

According to FCC §90.205(e): limitation on power and antenna heights are specified in §90.279.

According to FCC §90.279(a): base station authorizations in the 421 – 430 MHz band will be subject to Effective Radiated Power (ERP) and Effective Antenna Height (EAH) limitations as shown in the table below. ERP is defined as the product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction, EAH is calculated by subtracting the Assumed Average Terrain Elevation (AATE) as listed in table 7 of §90.619 from the antenna height above mean sea level.

Limits of Effective Radiated Power (ERP) Corresponding to Effective Antenna Heights (EAH) of Base Stations in the 421-430 MHz Band

Effective antenna height (EAH) in meters (feet)	Maximum effective radiated power (ERP) (watts)
0-152 (0-500)	250
Above 152-305 (above 500-1000)	150
Above 305-457 (above 1000-1500)	75
Above 457-610 (above 1500-2000)	40
Above 610-762 (above 2000-2500)	20
Above 762-914 (above 2500-3000)	15
Above 914-1219 (above 3000-4000)	10
Above 1219 (above 4000)	5

5.2 Test Procedure

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

5.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2015-09-29	1 year
-	SMA cable	-	C0005	Each Time ¹	N/A
Bird Electronic Corp.	30 dB attenuator	50-AFFB-30	14	Each Time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

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:	20-25 °C
Relative Humidity:	44-55 %
ATM Pressure:	101-102 kPa

The testing was performed by Jason Qian on 2016-2-22 in the RF Site.

5.5 Test Results

Channel Bandwidth (kHz)	Data Rate (bps)	Modulation	Frequency (MHz)	Output Power (dBm)	e.r.p (dBm)	e.r.p (Watt)
12.5	4800	GMSK	390.15*	44.23	42.08	16.14
		GMSK	406.15	44.01	41.86	15.35
		GMSK	410.15	44.18	42.03	15.96
		GMSK	429.85	44.13	41.98	15.78
	8000	GMSK	390.15*	44.13	41.98	15.78
		GMSK	406.15	44.04	41.89	15.45
		GMSK	410.15	44.15	42	15.85
		GMSK	429.85	44.15	42	15.85
	9600	GMSK	390.15*	45.49	43.34	21.57
		GMSK	406.15	44.08	41.93	15.60
		GMSK	410.15	45.22	43.07	20.28
		GMSK	429.85	45.38	43.23	21.04
		4FSK	390.15*	45.64	43.49	22.34
		4FSK	406.15	44.08	41.93	15.60
		4FSK	410.15	45.25	43.1	20.42
		4FSK	429.85	45.33	43.18	20.80
25	19200	GMSK	390.15*	45.57	43.42	21.98
		GMSK	406.15*	44.20	42.05	16.03
		GMSK	410.15*	45.07	42.92	19.59
		GMSK	429.85	45.18	43.03	20.09
		4FSK	390.15*	45.64	43.49	22.34
		4FSK	406.15*	44.22	41.97	15.74
		4FSK	410.15*	45.21	43.06	20.23
		4FSK	429.85	45.25	43.1	20.42

Note: 1) Output Power (ERP) = Output Power (dBm) + Antenna Gain (dBi) -2.15 dB

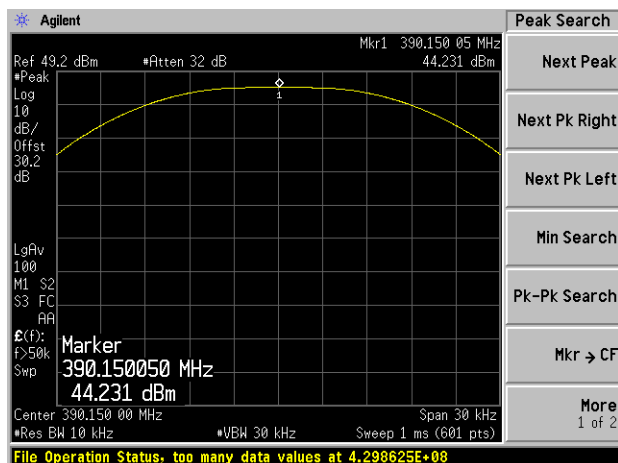
2) Antenna Gain: 0 dBi

3) * Note: These channel frequencies/configurations are not for FCC Part 90 certification.

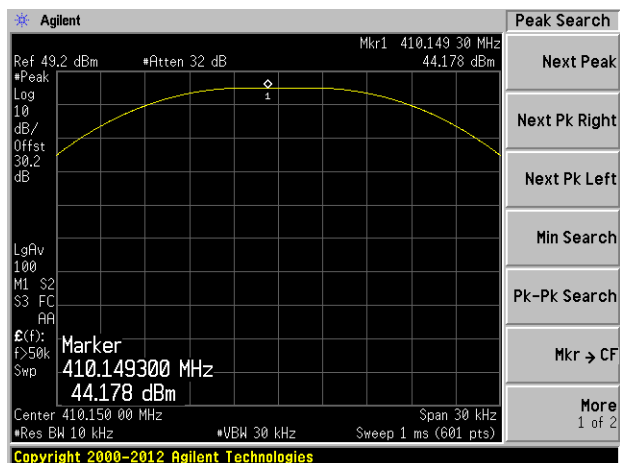
Please refer to the following plots for conducted output power.

GMSK Modulation @ 4800 bps

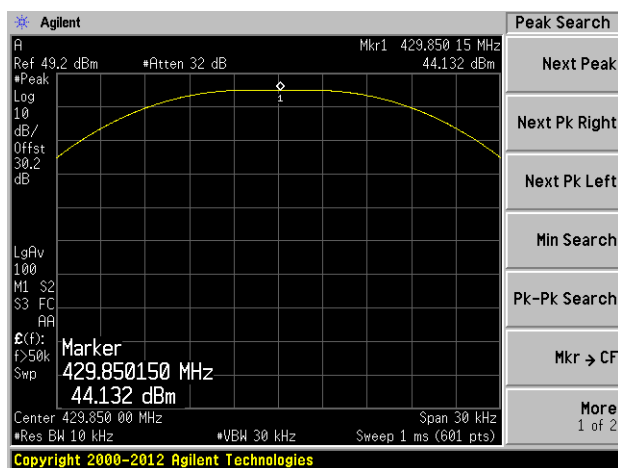
Low Channel: 390.15 MHz



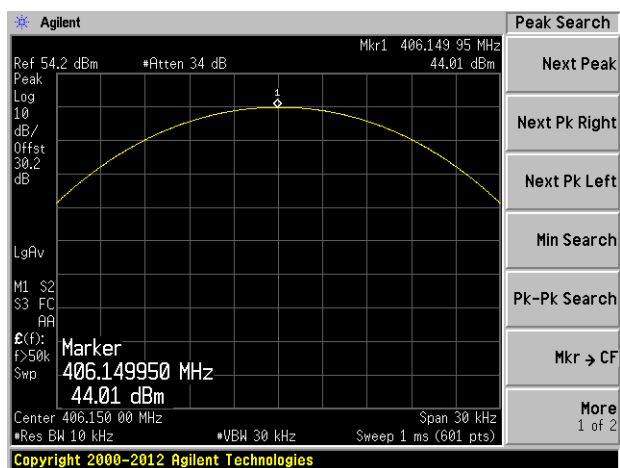
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

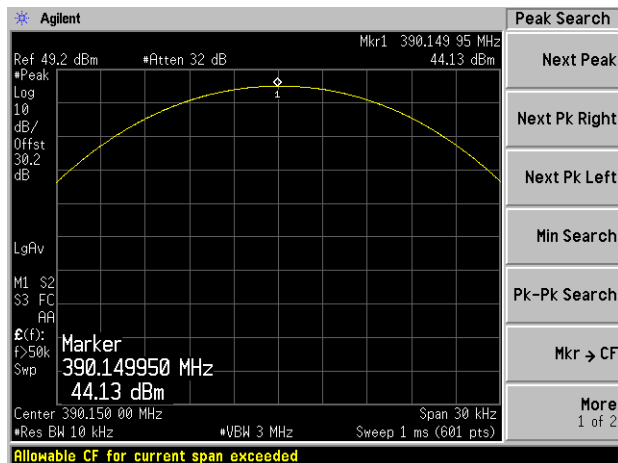


Low Channel#2: 406.15 MHz

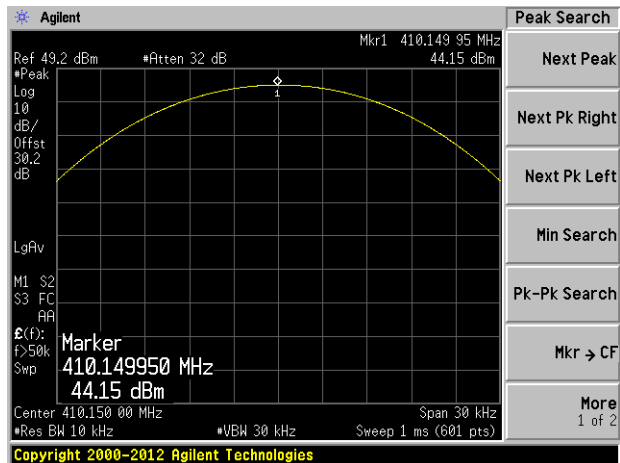


GMSK Modulation @ 8000 bps

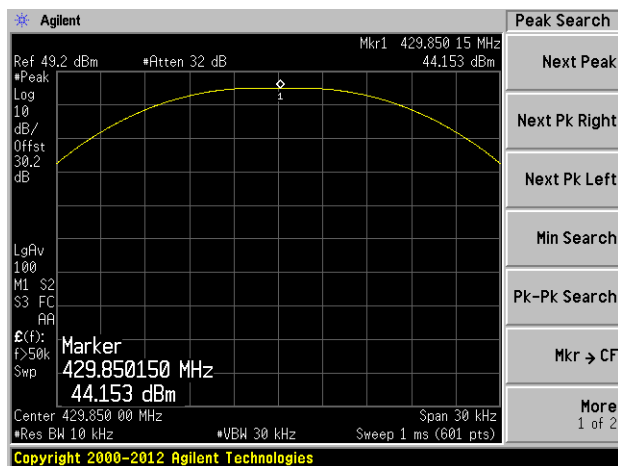
Low Channel: 390.15 MHz



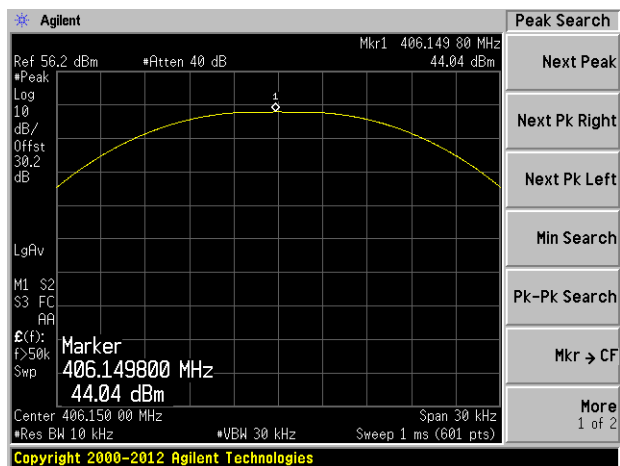
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

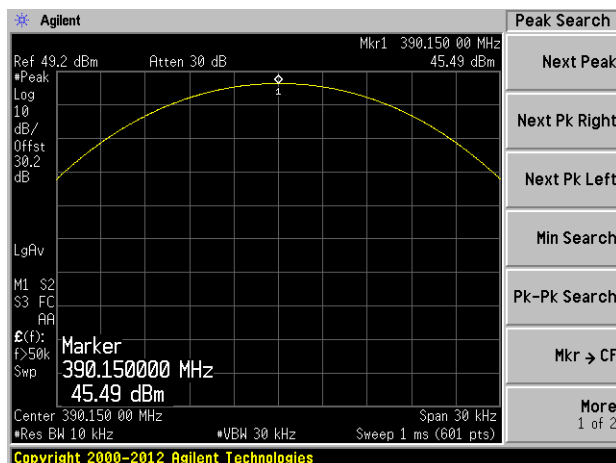


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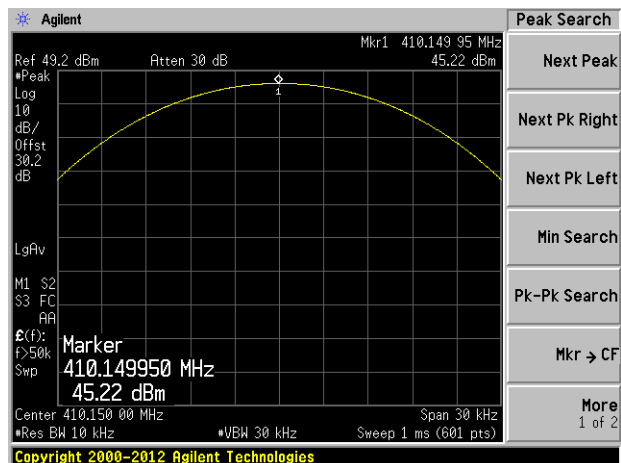


GMSK Modulation @ 9600 bps

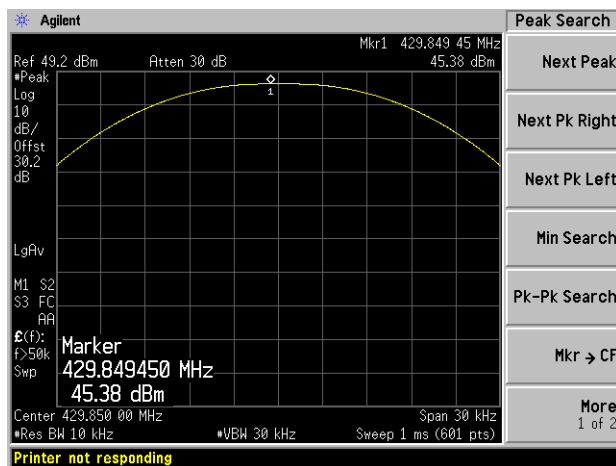
Low Channel: 390.15 MHz



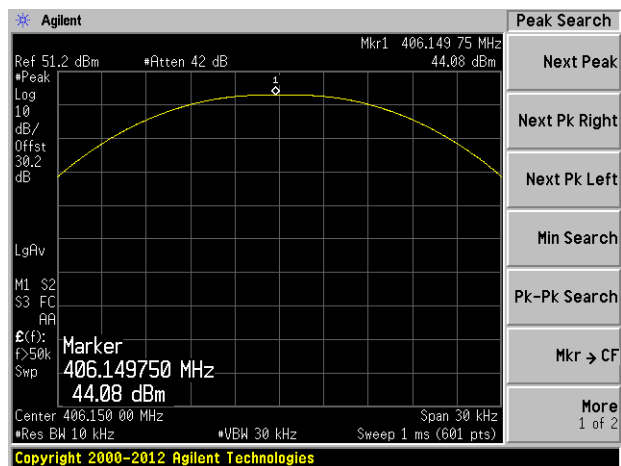
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

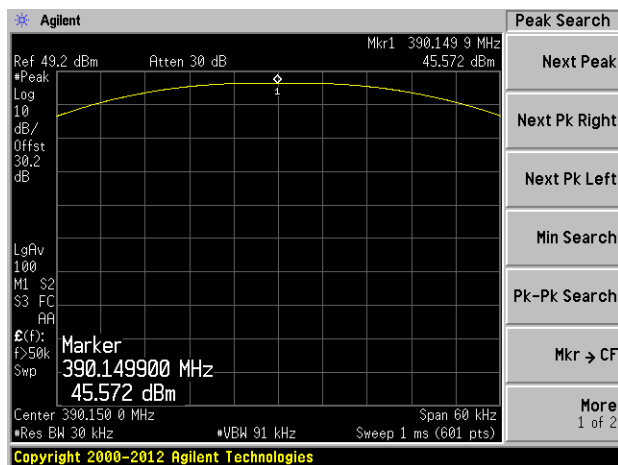


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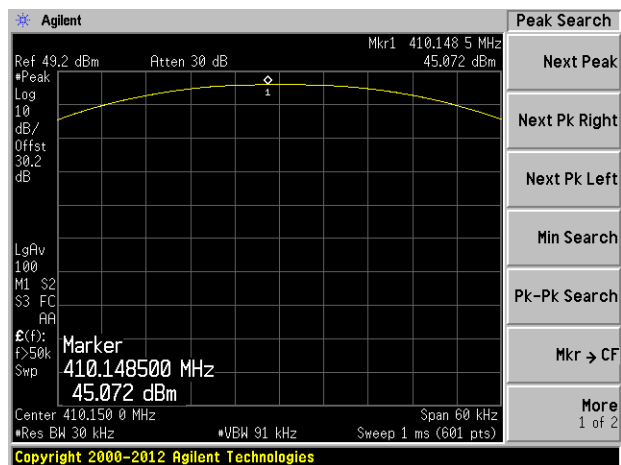


GMSK Modulation @ 19200 bps

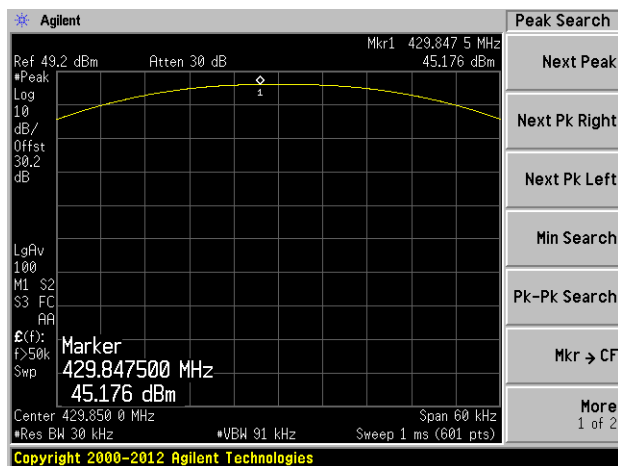
Low Channel: 390.15 MHz



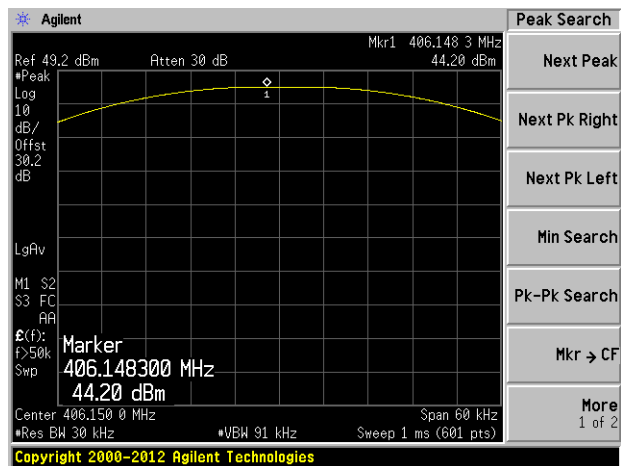
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

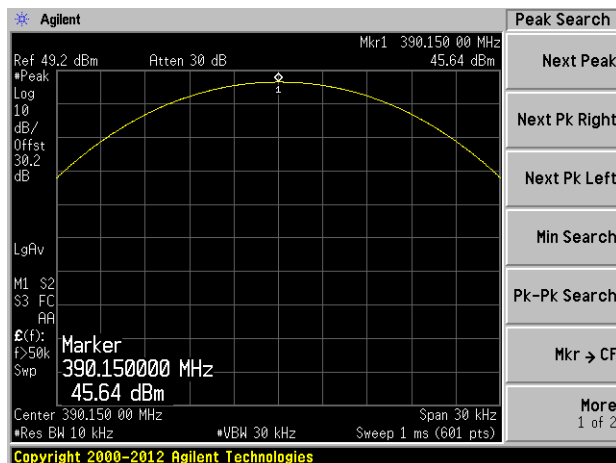


Low Channel#2: 406.15 MHz

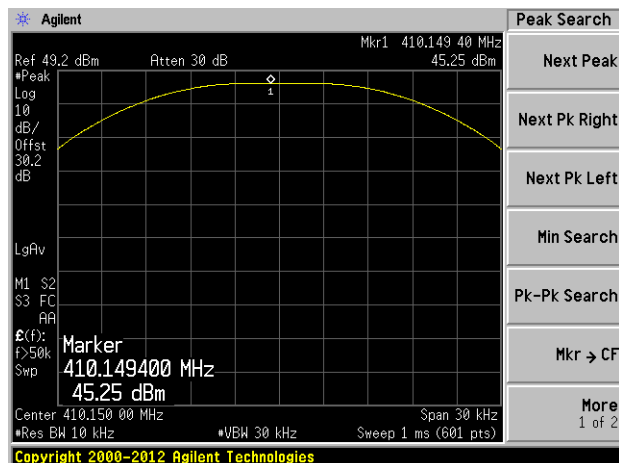


4FSK Modulation @ 9600 bps

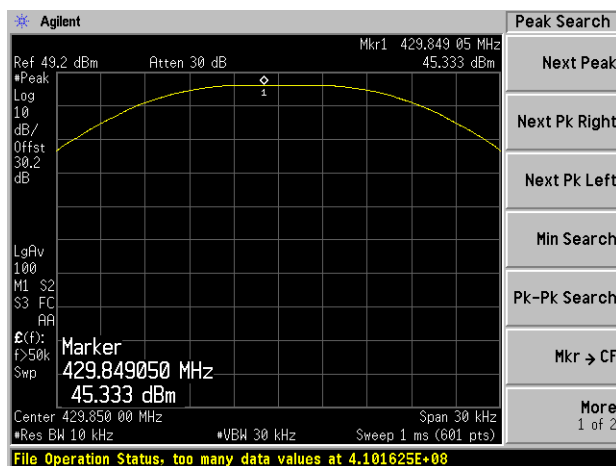
Low Channel: 390.15 MHz



Middle Channel: 410.15 MHz

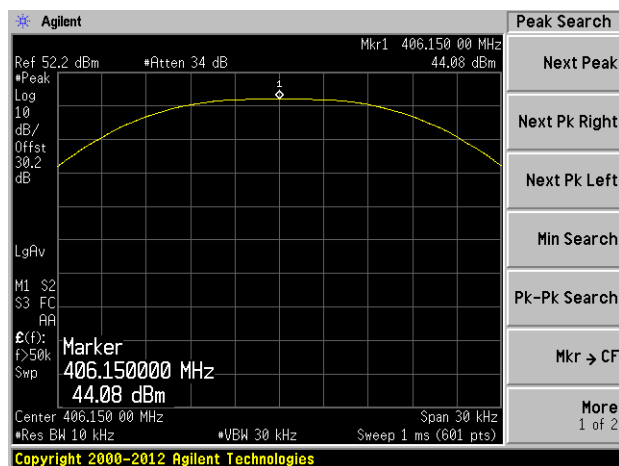


High Channel: 429.85 MHz



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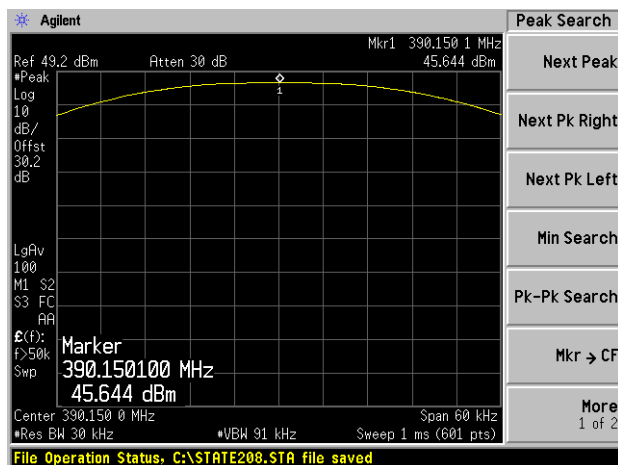
Low Channel#2: 406.15 MHz



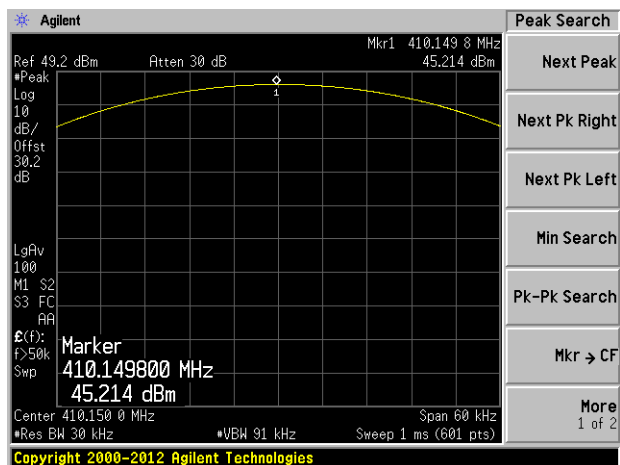
Copyright 2000-2012 Agilent Technologies

4FSK Modulation @ 19200 bps

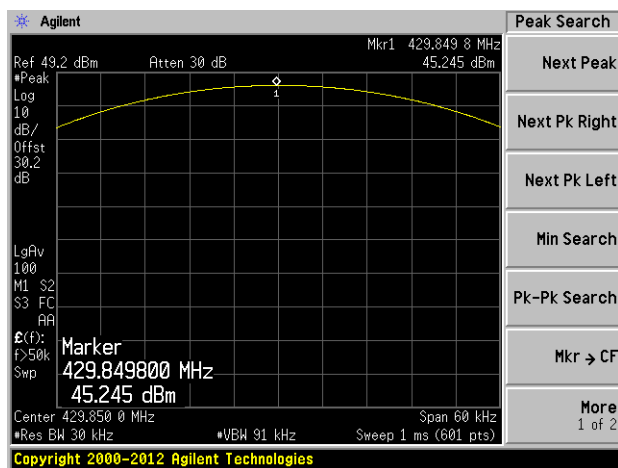
Low Channel: 390.15 MHz



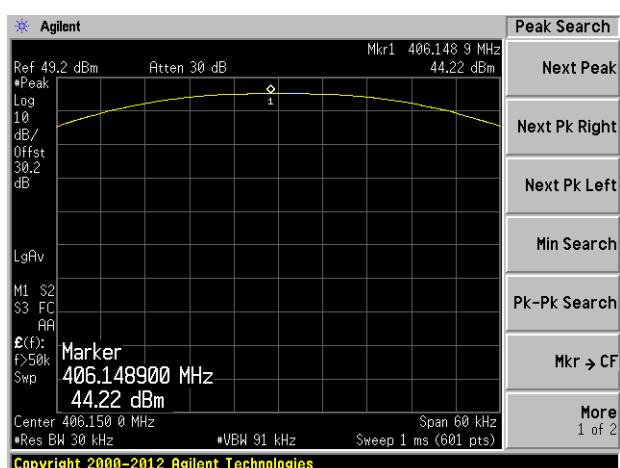
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz



Low Channel#2: 406.15 MHz



6 FCC §2.1049, §90.209 & §90.210 - Occupied Bandwidth & Emission Mask

6.1 Applicable Standard

FCC §90.209

Operations using equipment designed to operate with a 25 kHz channel bandwidth will be authorized a 20 kHz bandwidth. Operations using equipment designed to operate with a 12.5 kHz channel bandwidth will be authorized a 11.25 kHz bandwidth.

FCC §2.1049, §90.210

Emission Mask C—25 kHz channel bandwidth equipment. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

- (1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz, but not more than 10 kHz: At least $83 \log(f_d/5)$ dB;
- (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least $29 \log(f_d/11)$ dB or 50 dB, whichever is the lesser attenuation;
- (3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log(P)$ dB.

Emission Mask D—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

- (1) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0 : Zero dB.
- (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least $7.27(f_d - 2.88 \text{ kHz})$ dB.
- (3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least $50 + 10 \log(P)$ dB or 70 dB, whichever is the lesser attenuation.

6.2 Test Procedure

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

The resolution bandwidth of the spectrum analyzer was set at 300 Hz and the spectrum was recorded in the frequency band ± 20 KHz from the carrier frequency.

6.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2015-09-29	1 year
-	SMA cable	-	C0005	Each Time ¹	N/A
Bird Electronic Corp.	30 dB attenuator	50-AFFB-30	14	Each Time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

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

6.4 Test Environmental Conditions

Temperature:	20-25 °C
Relative Humidity:	44-55 %
ATM Pressure:	101-102 kPa

The testing was performed by Jason Qian on 2016-03-04 in the RF Site.

6.5 Test Results

Please refer to the following table and plots.

Occupied Bandwidth

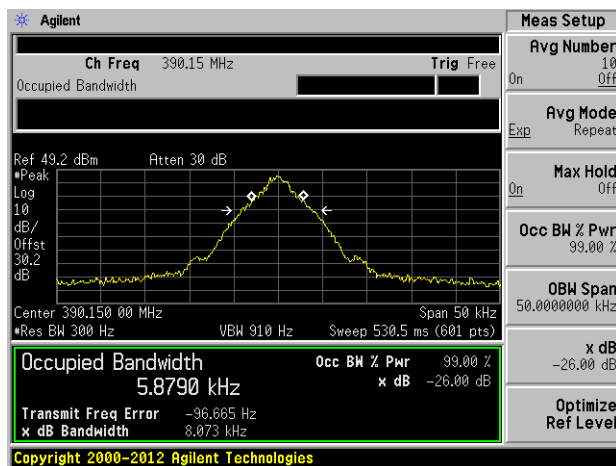
Channel Bandwidth (kHz)	Data Rate (bps)	Modulation	Frequency (MHz)	OBW (kHz)	Limit (kHz)
12.5	4800	GMSK	390.15*	5.88	11.25
		GMSK	410.15	5.41	11.25
		GMSK	429.85	5.70	11.25
		GMSK	406.15	5.76	11.25
	8000	GMSK	390.15*	6.47	11.25
		GMSK	410.15	6.30	11.25
		GMSK	429.85	6.30	11.25
		GMSK	406.15	5.99	11.25
	9600	GMSK	390.15*	7.44	11.25
		GMSK	410.15	7.03	11.25
		GMSK	429.85	7.24	11.25
		GMSK	406.15	7.26	11.25
		4FSK	390.15*	6.64	11.25
		4FSK	410.15	6.31	11.25
		4FSK	429.85	6.47	11.25
		4FSK	406.15	6.35	11.25
25	19200	GMSK	390.15*	14.08	20
		GMSK	410.15*	12.76	20
		GMSK	429.85	12.04	20
		GMSK	406.15*	11.89	20
		4FSK	390.15*	10.54	20
		4FSK	410.15*	9.73	20
		4FSK	429.85	9.83	20
		4FSK	406.15*	9.92	20

Note: These channel frequencies/configurations are not for FCC Part 90 certification.*

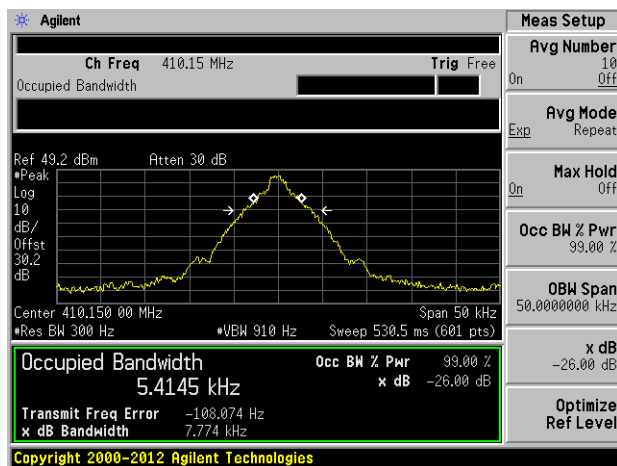
Occupied Bandwidth

GMSK Modulation @ 4800 bps

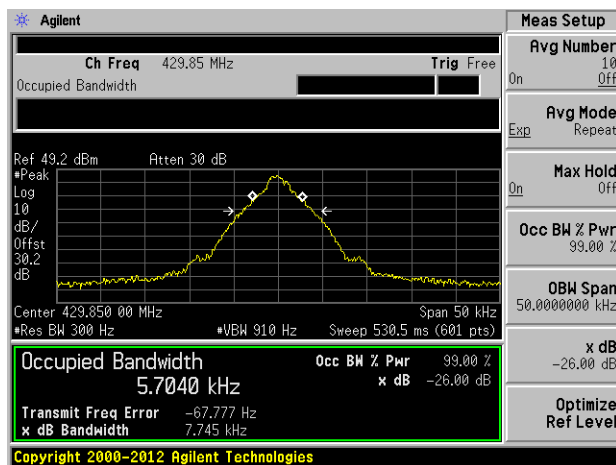
Low Channel: 390.15 MHz



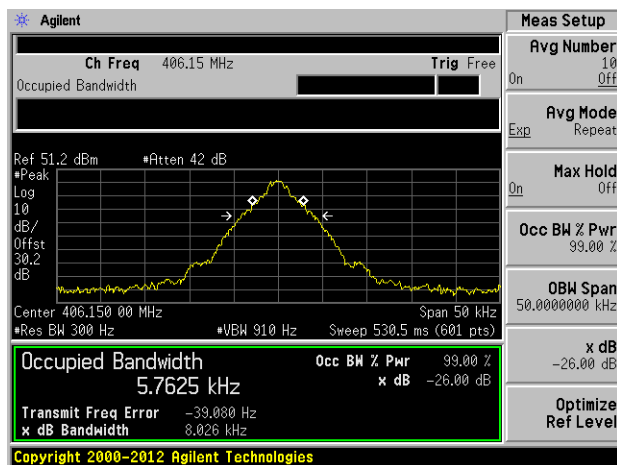
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

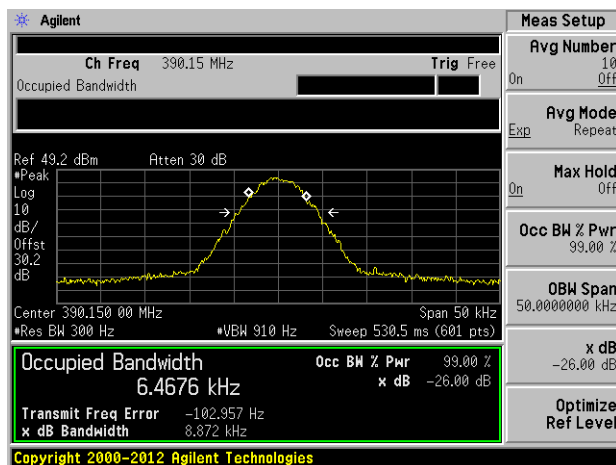


Low Channel#2: 406.15 MHz

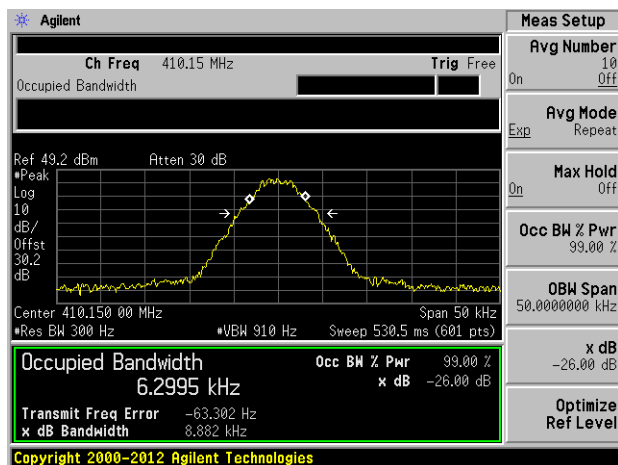


GMSK Modulation @ 8000 bps

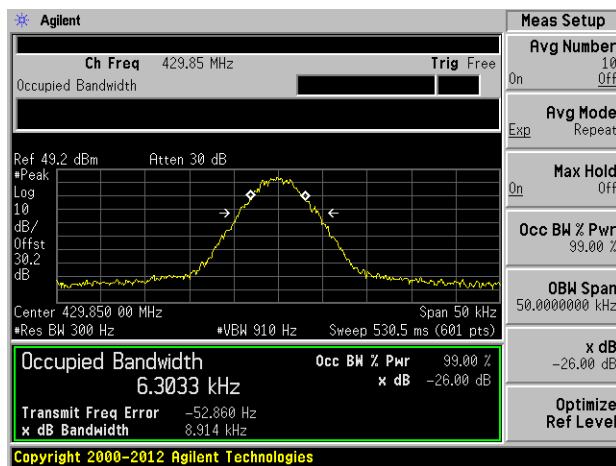
Low Channel: 390.15 MHz



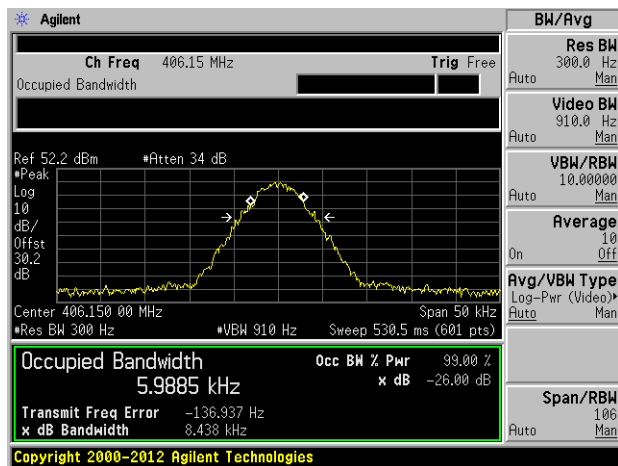
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

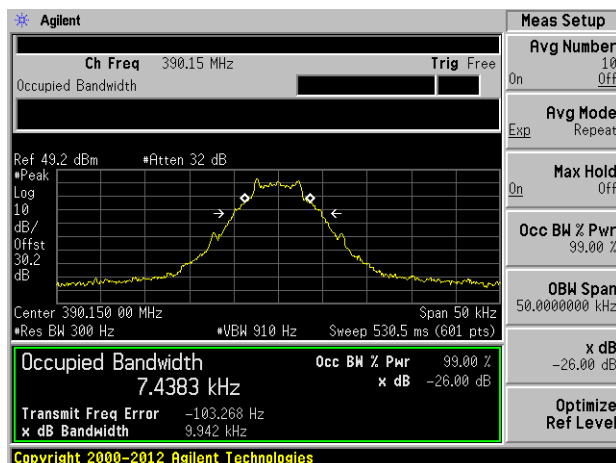


Low Channel#2: 406.15 MHz

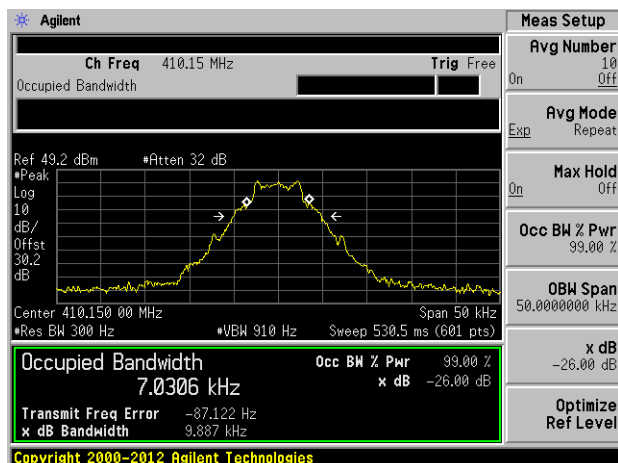


GMSK Modulation @ 9600 bps

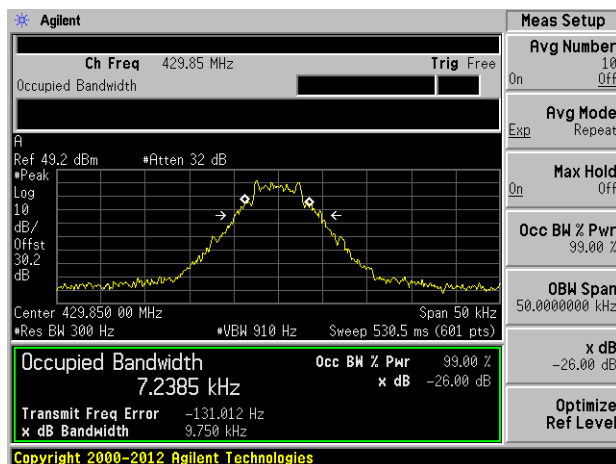
Low Channel: 390.15 MHz



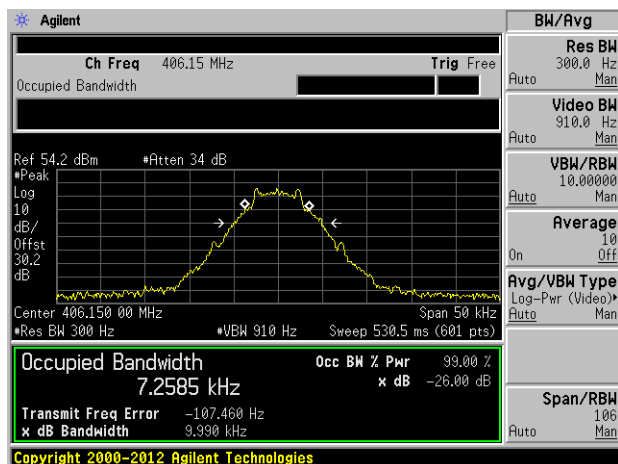
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

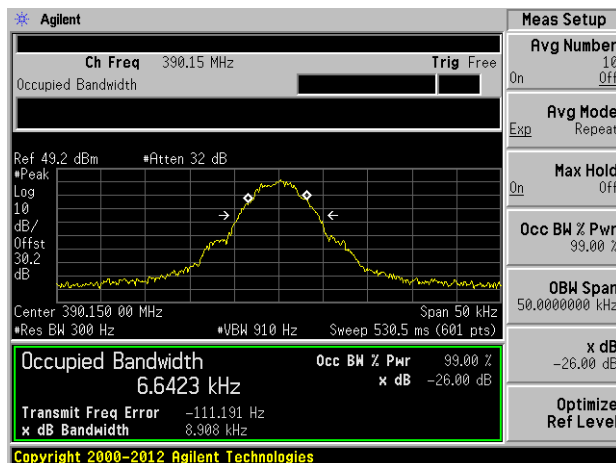


Low Channel#2: 406.15 MHz

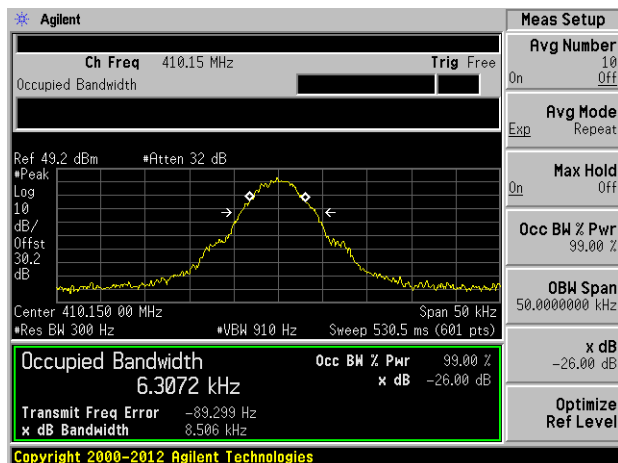


4FSK Modulation @ 9600 bps

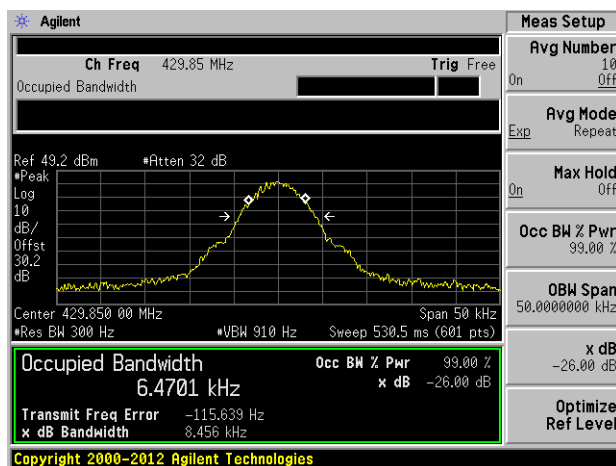
Low Channel: 390.15 MHz



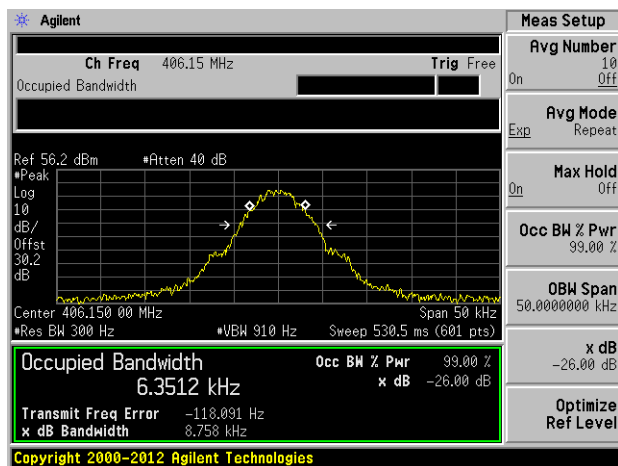
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

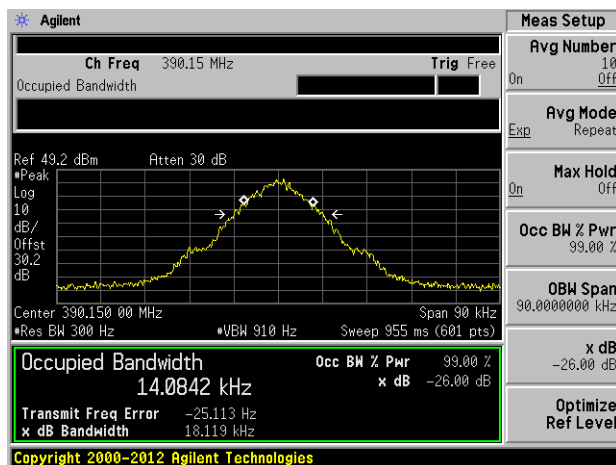


Low Channel#2: 406.15 MHz

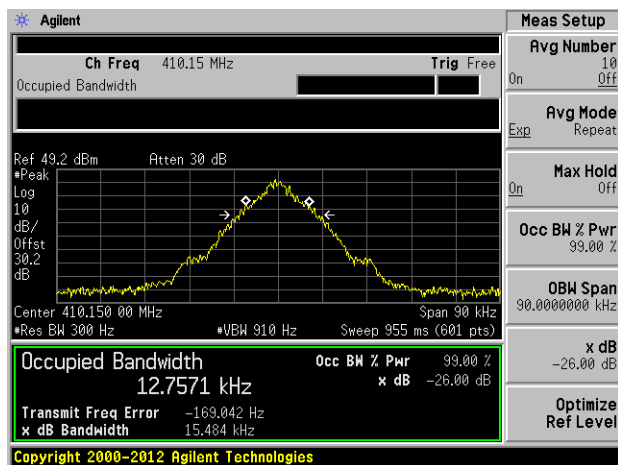


GMSK Modulation @ 19200 bps

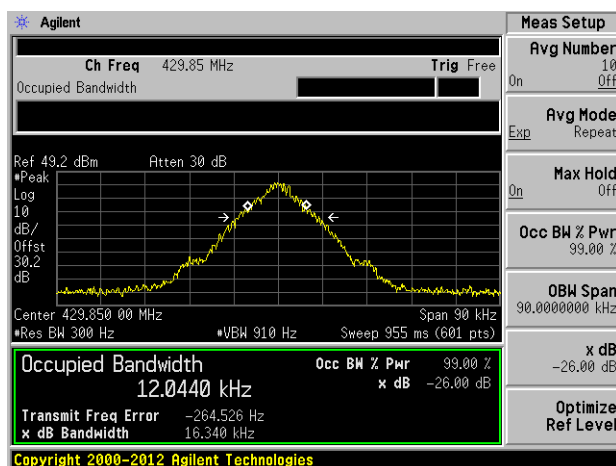
Low Channel: 390.15 MHz



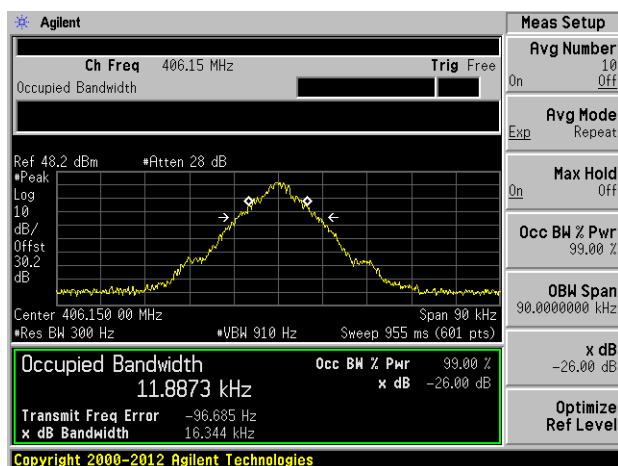
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

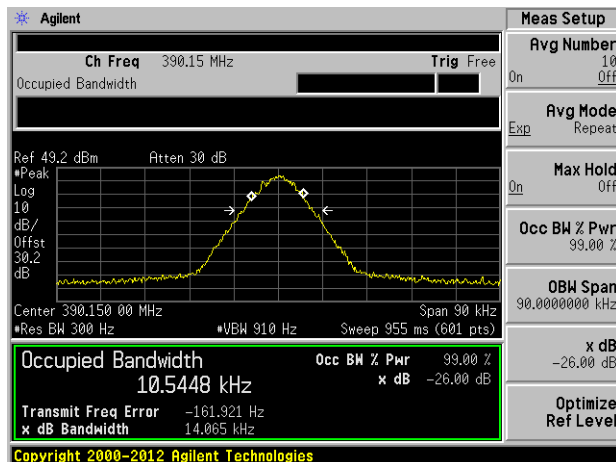


Low Channel#2: 406.15 MHz

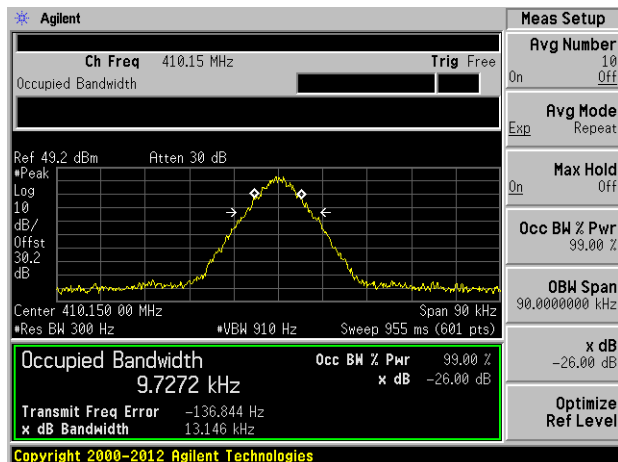


4FSK Modulation @ 19200 bps

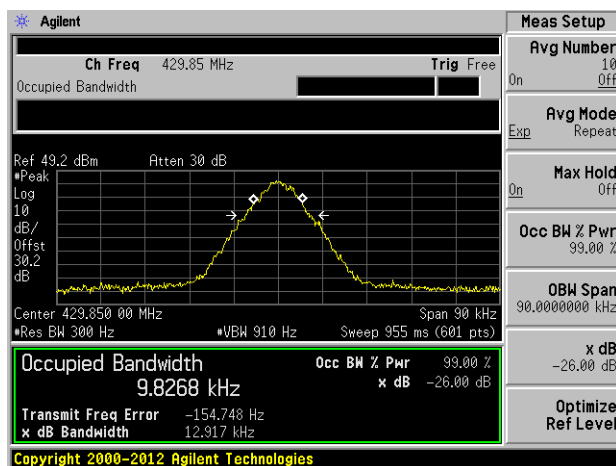
Low Channel: 390.15 MHz



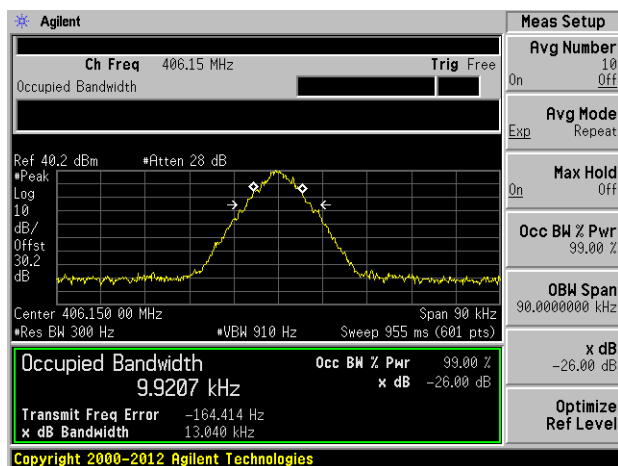
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

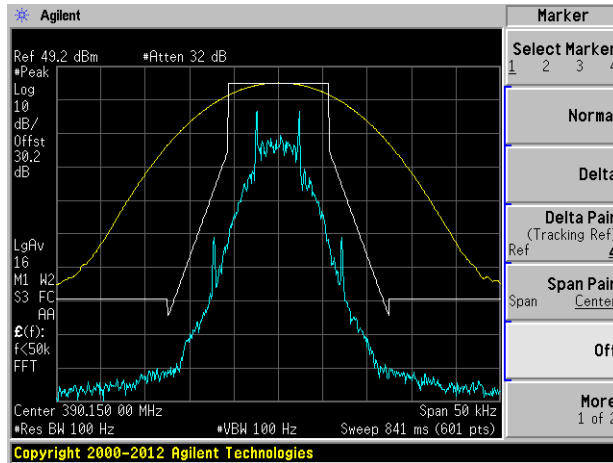


Low Channel#2: 406.15 MHz

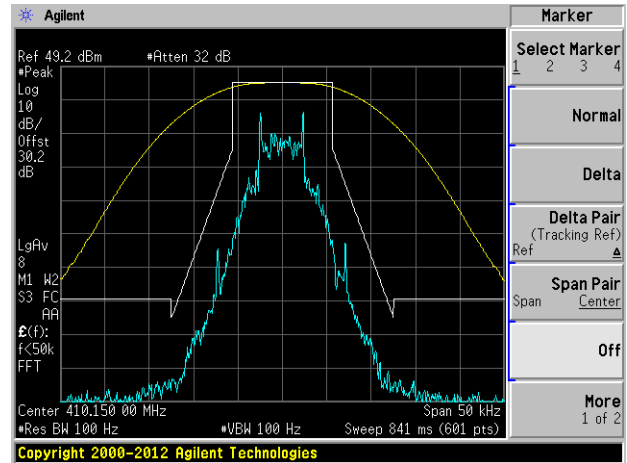


Emission Mask**GMSK Modulation @ 4800 bps**

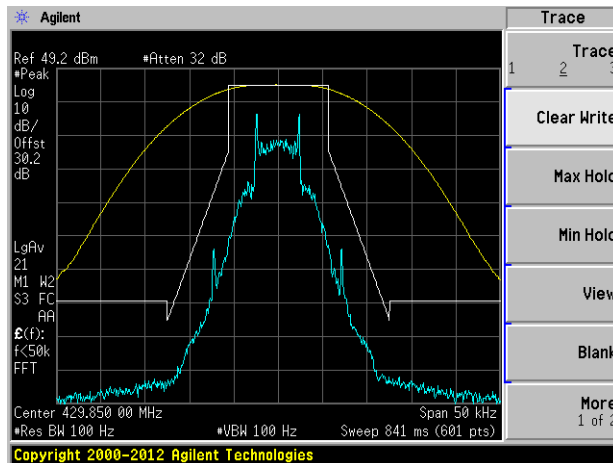
Low Channel: 390.15 MHz



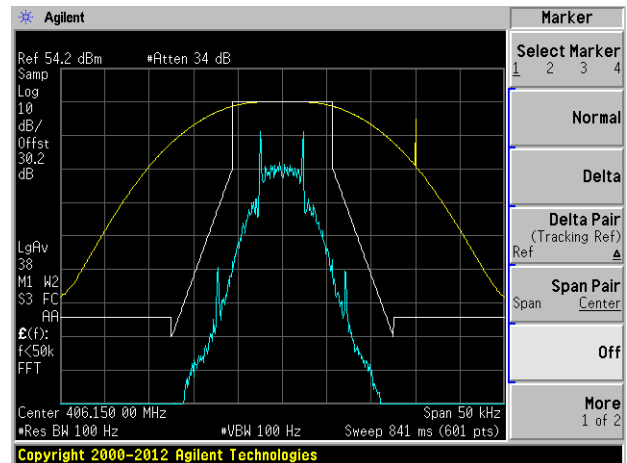
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

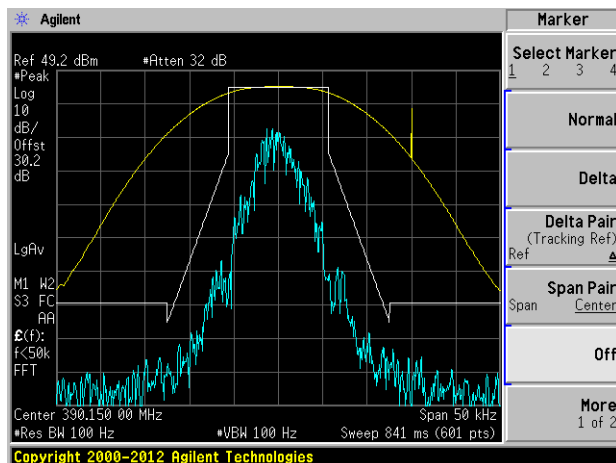


Low Channel#2: 406.15 MHz

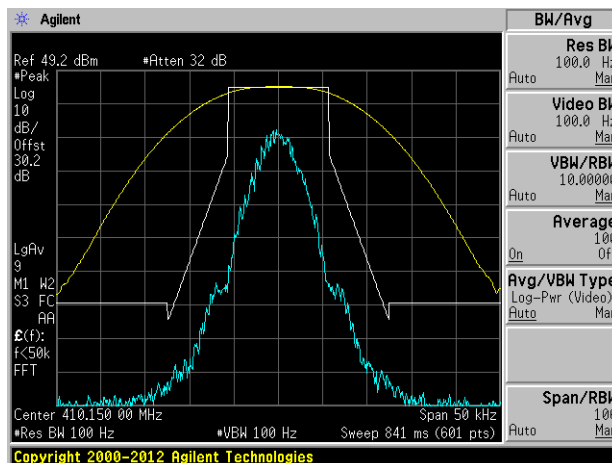


GMSK Modulation @ 8000 bps

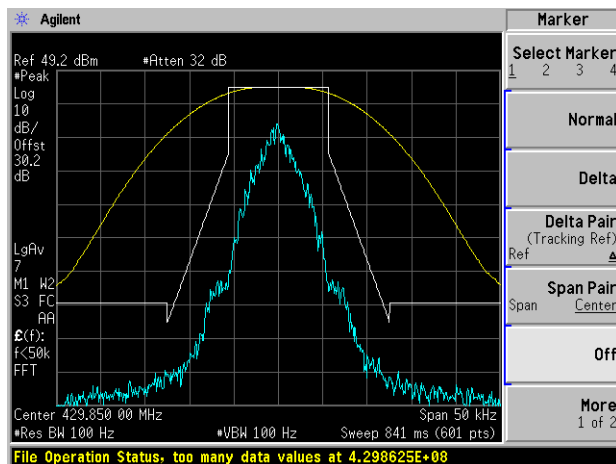
Low Channel: 390.15 MHz



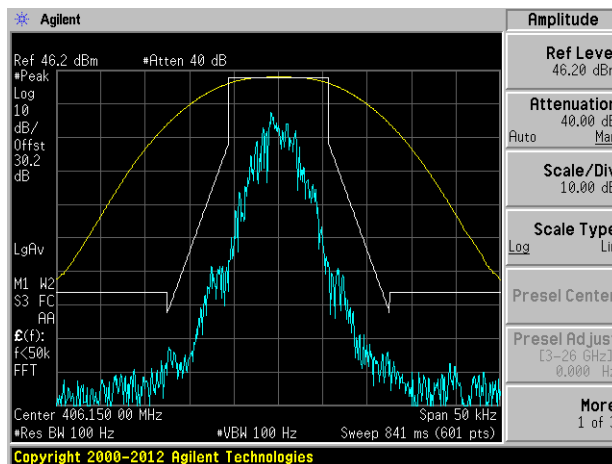
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

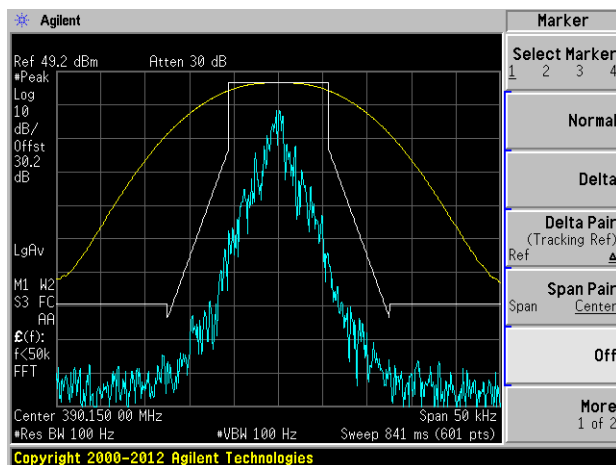


Low Channel#2: 406.15 MHz

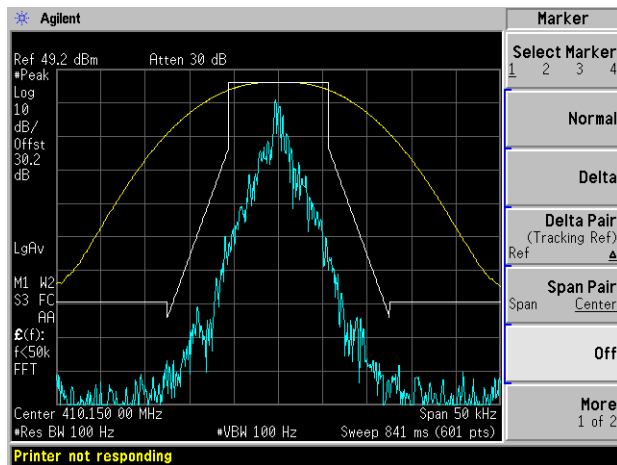


GMSK Modulation @ 9600 bps

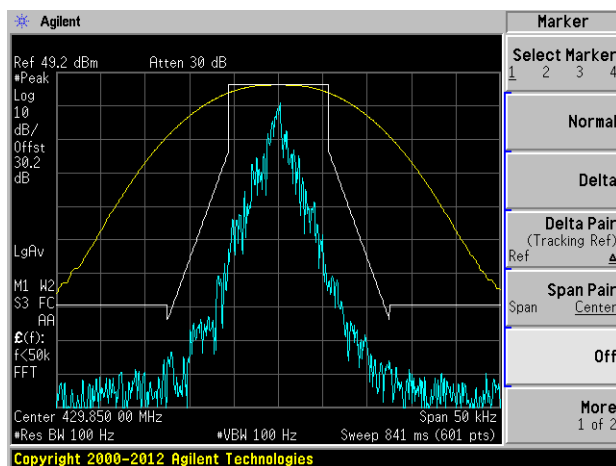
Low Channel: 390.15 MHz



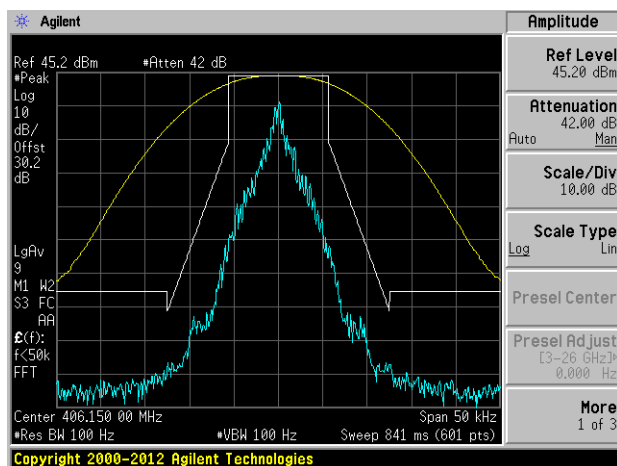
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

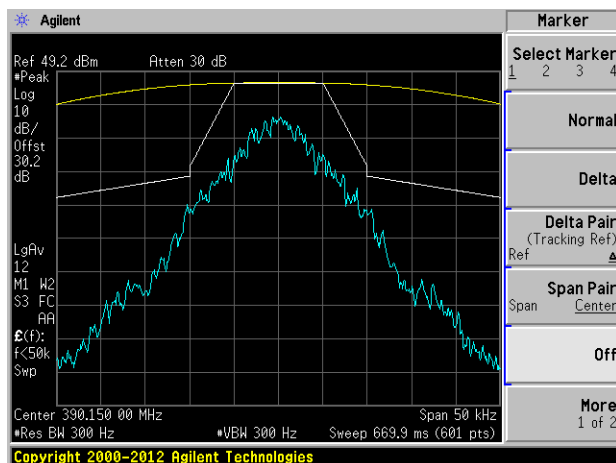


Low Channel#2: 406.15 MHz

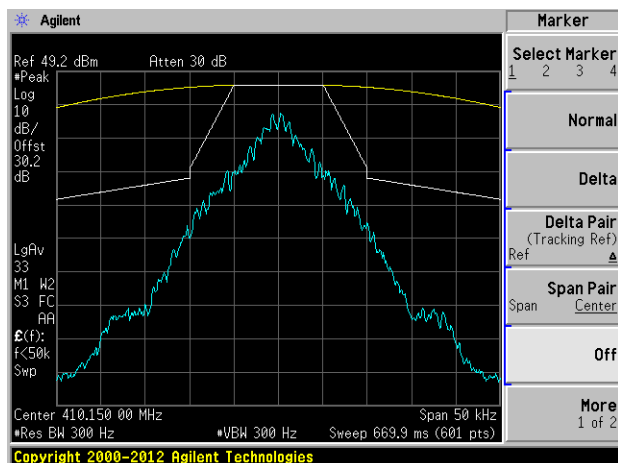


GMSK Modulation @ 19200 bps

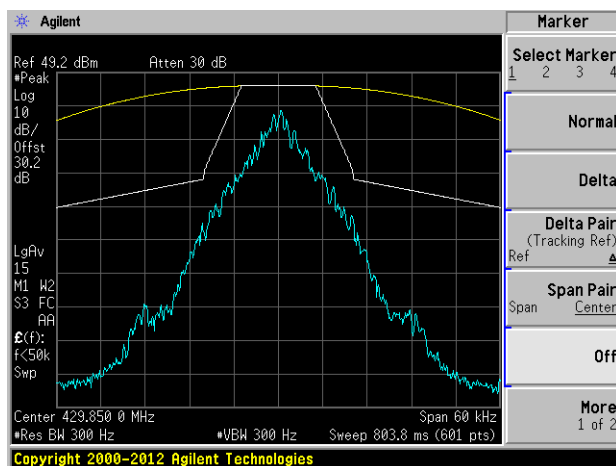
Low Channel: 390.15 MHz



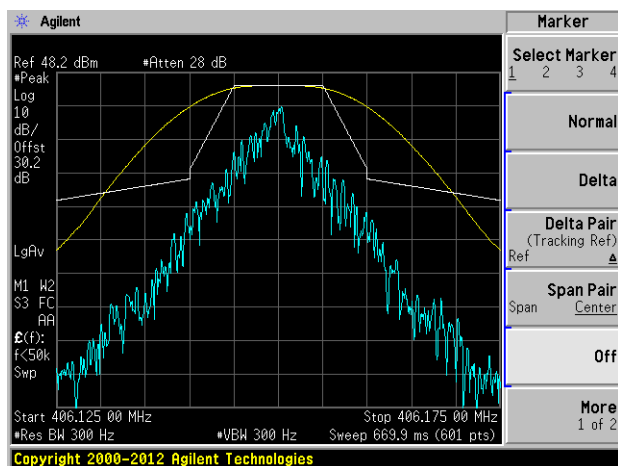
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

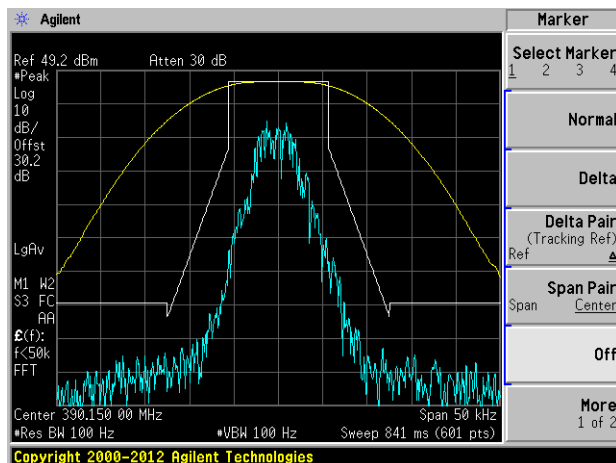


Low Channel#2: 406.15 MHz

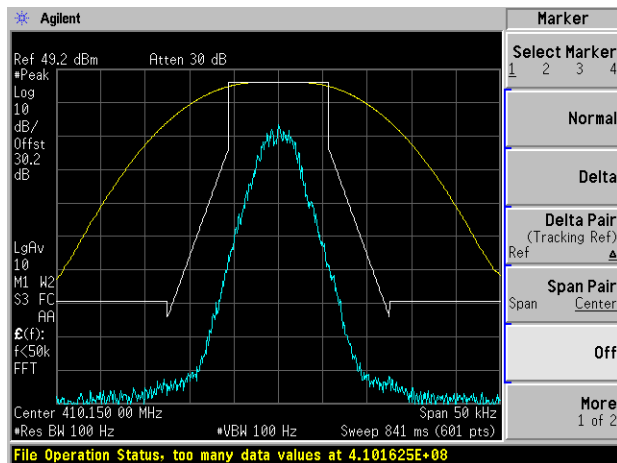


4FSK Modulation @ 9600 bps

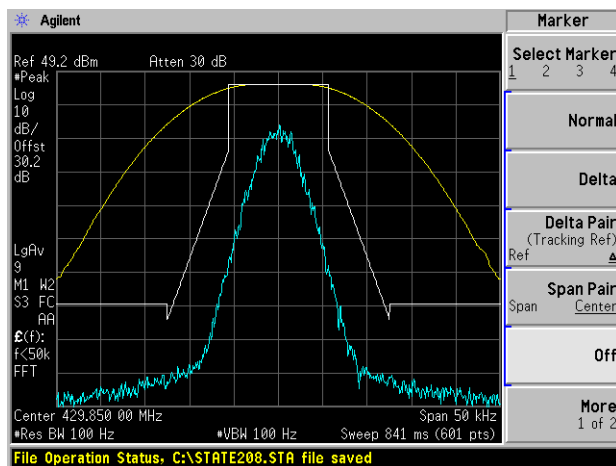
Low Channel: 390.15 MHz



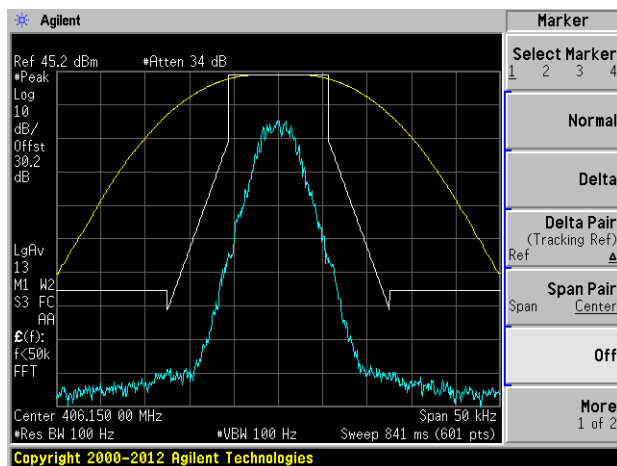
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz

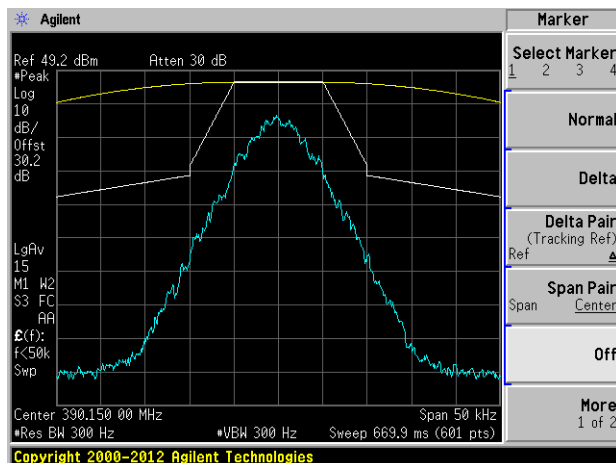


Low Channel#2: 406.15 MHz

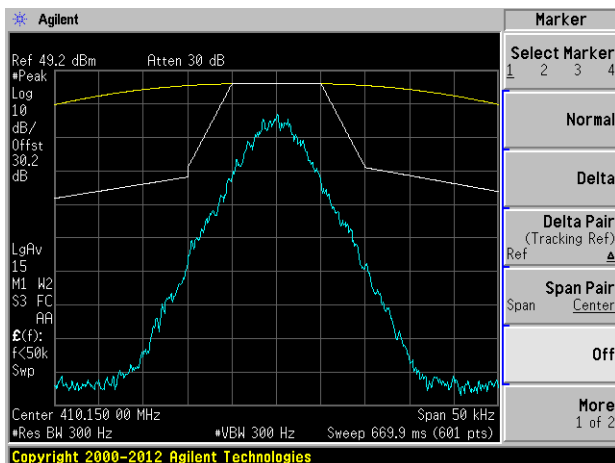


4FSK Modulation @ 19200 bps

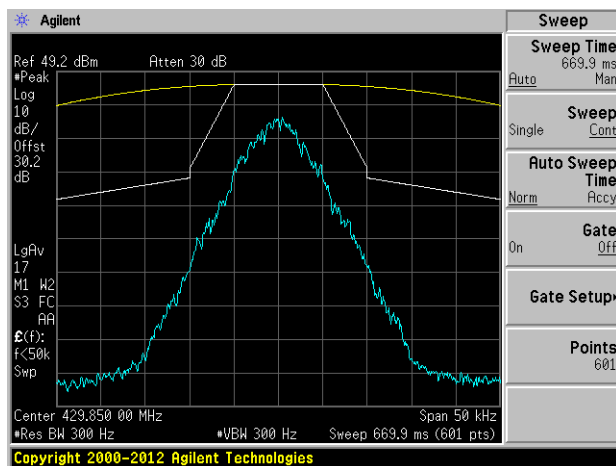
Low Channel: 390.15 MHz



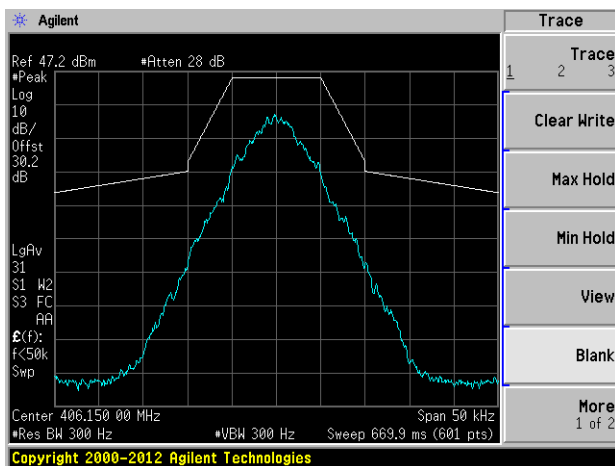
Middle Channel: 410.15 MHz



High Channel: 429.85 MHz



Low Channel#2: 406.15 MHz



7 FCC §2.1051 & §90.210 - Spurious Emissions at Antenna Terminals

7.1 Applicable Standard

FCC §90.210

For equipment using 25 kHz channel bandwidth, on any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB.

For equipment using 12.5 kHz channel bandwidth, on any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least $50 + 10 \log (P)$ dB or 70 dB, whichever is the lesser attenuation.

7.2 Test Procedure

The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz for emissions below 1 GHz and 1 MHz for emissions above 1 GHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

7.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2015-09-29	1 year
-	SMA cable	-	C0005	Each Time ¹	N/A
Bird Electronic Corp.	30 dB attenuator	50-AFFB-30	14	Each Time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

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:	20-25 °C
Relative Humidity:	44-55 %
ATM Pressure:	101-102 kPa

The testing was performed by Jason Qian on 2016-03-04 in the RF Site.

7.5 Test Results

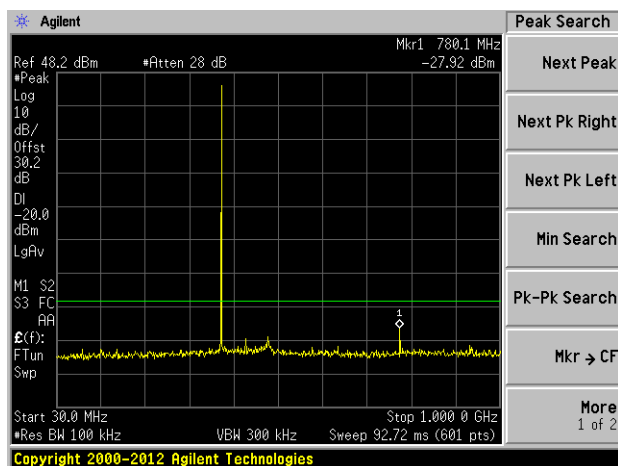
Note: The channel of 390.15 MHz and 25 kHz channel bandwidth on channel 406.15 MHz and 410.15 MHz are not for FCC Part 90 certification.*

Please refer to the plots hereinafter.

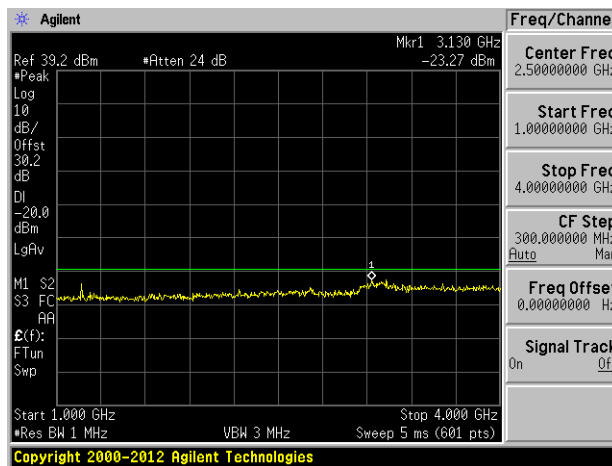
GMSK Modulation @ 4800 bps

Low Channel

30 MHz – 1 GHz

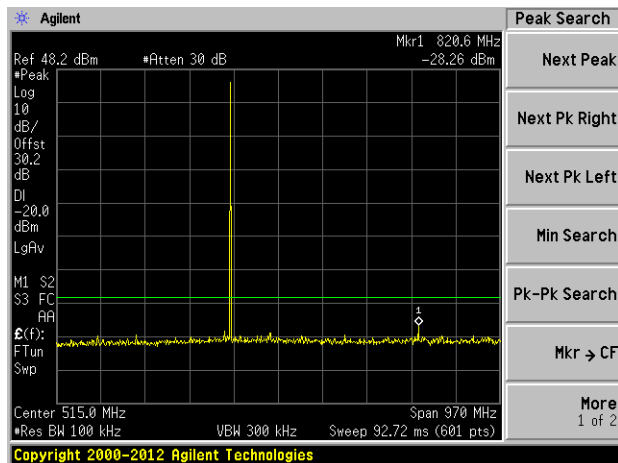


1 GHz – 4 GHz

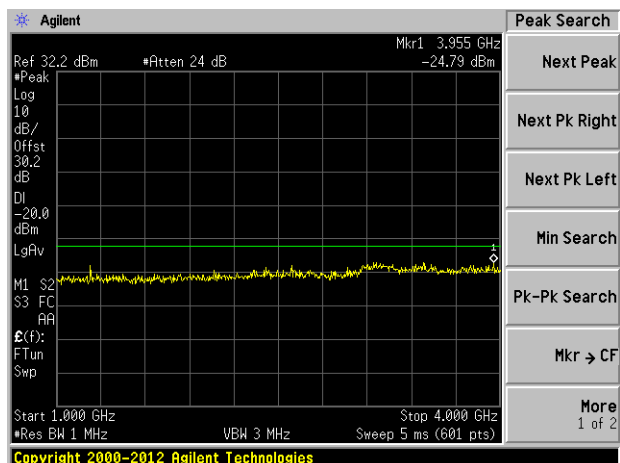


Middle Channel

30 MHz – 1 GHz

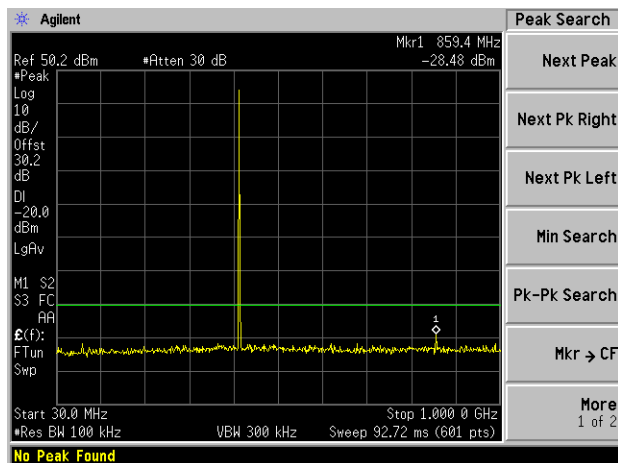


1 GHz – 4 GHz

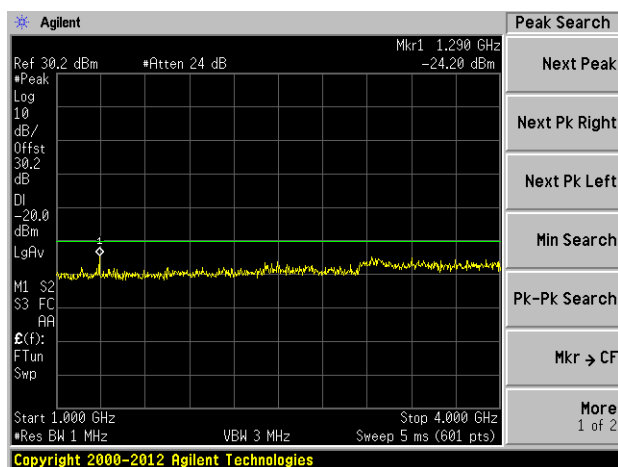


High Channel

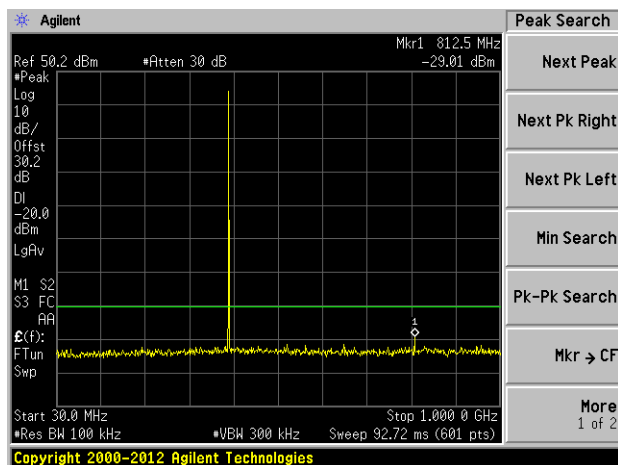
30 MHz – 1 GHz



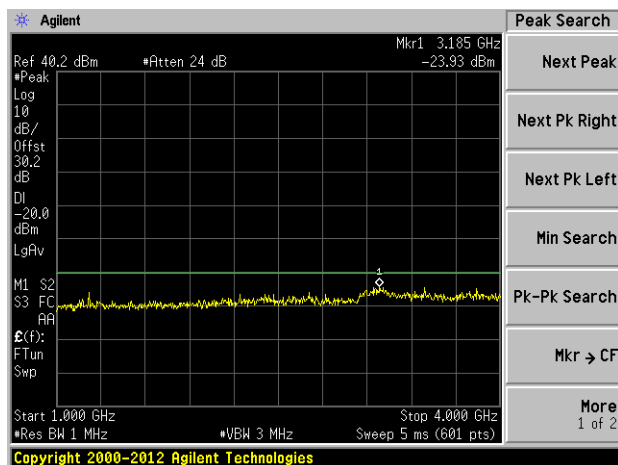
1 GHz – 4 GHz

**Low Channel #2**

30 MHz – 1 GHz

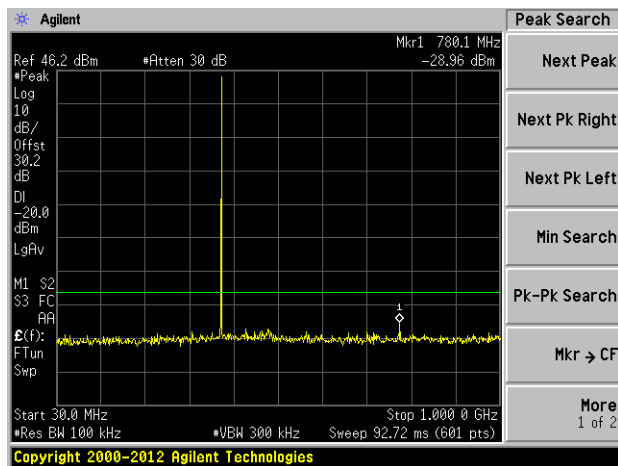


1 GHz – 4 GHz

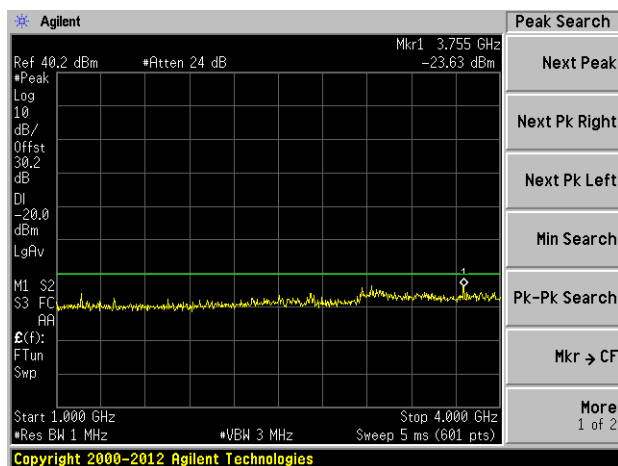


GMSK Modulation @ 8000 bps**Low Channel**

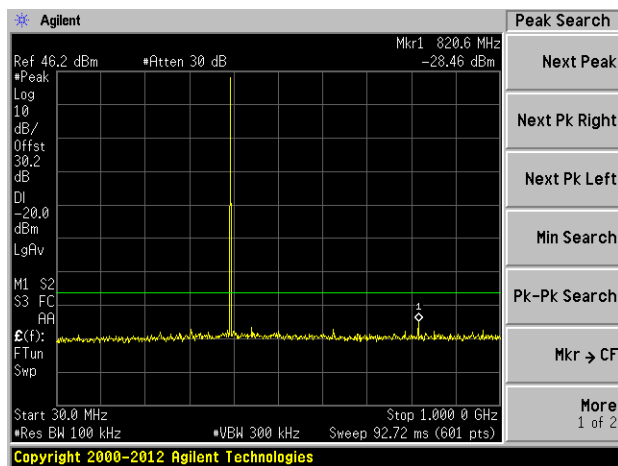
30 MHz – 1 GHz



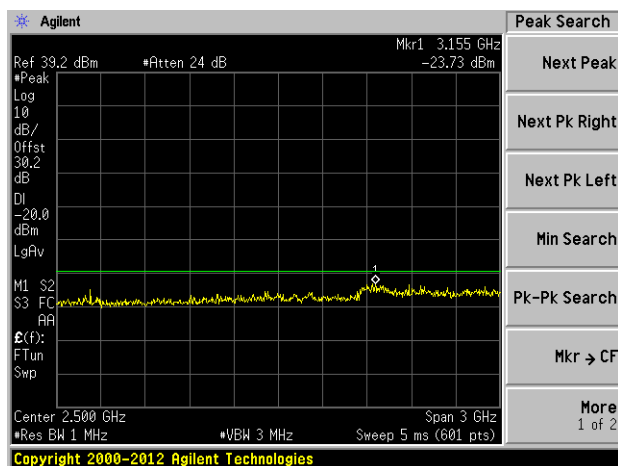
1 GHz – 4 GHz

**Middle Channel**

30 MHz – 1 GHz

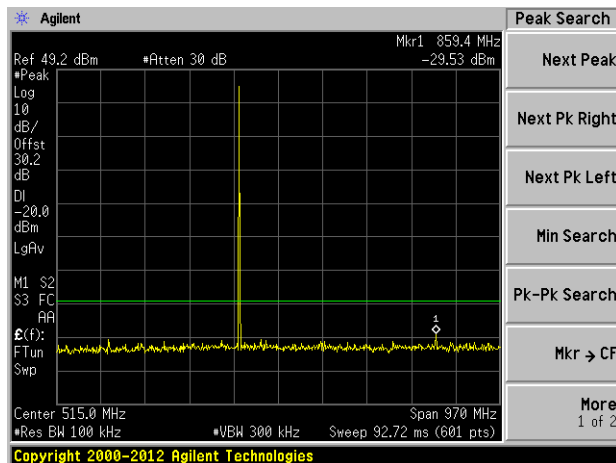


1 GHz – 4 GHz

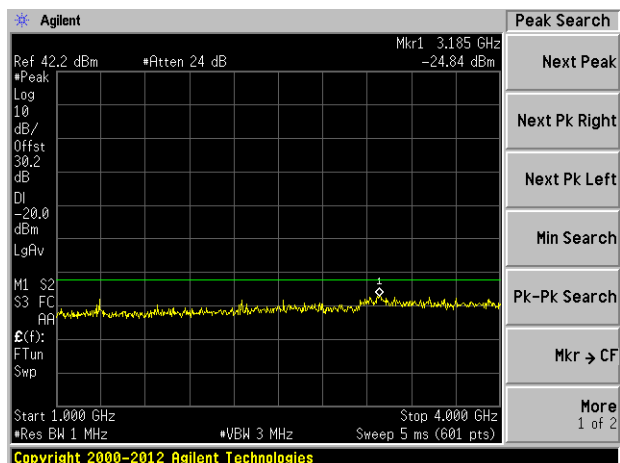


High Channel

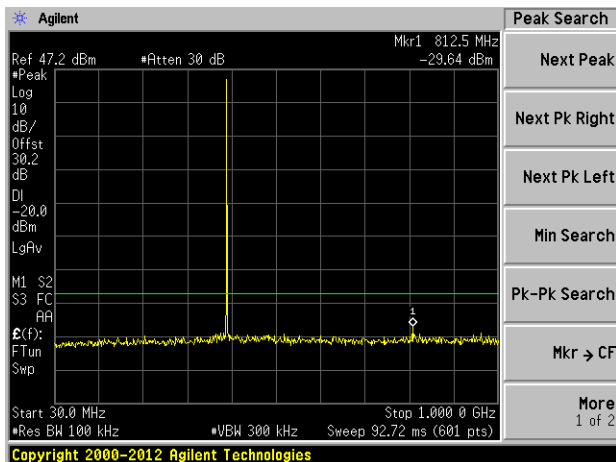
30 MHz – 1 GHz



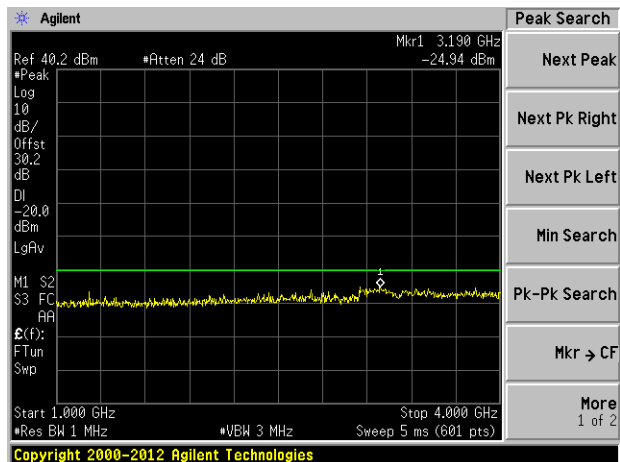
1 GHz – 4 GHz

**Low Channel #2**

30 MHz – 1 GHz

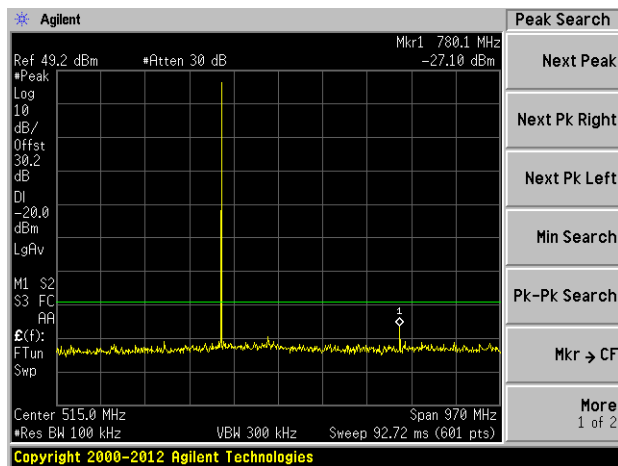


1 GHz – 4 GHz

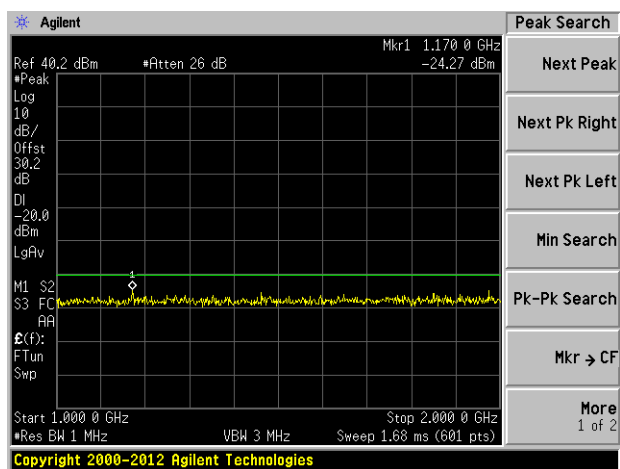


GMSK Modulation @ 9600 bps**Low Channel**

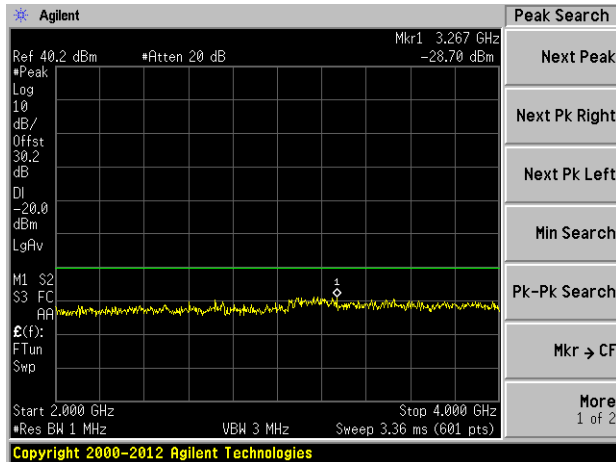
30 MHz – 1 GHz



1 GHz – 2 GHz

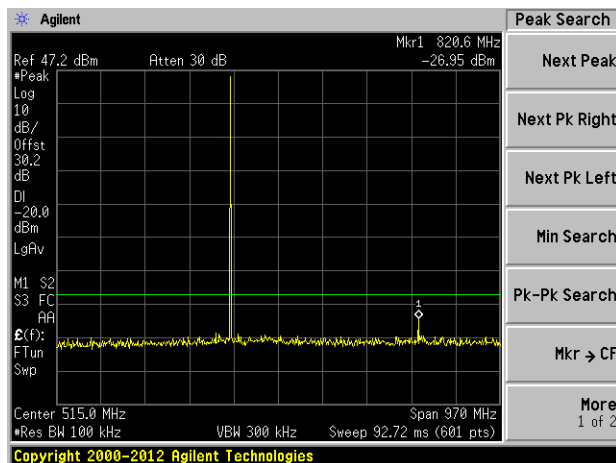


2 GHz – 4 GHz

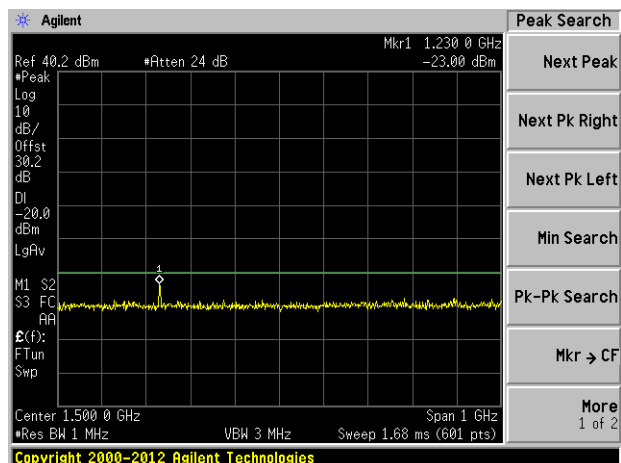


Middle Channel

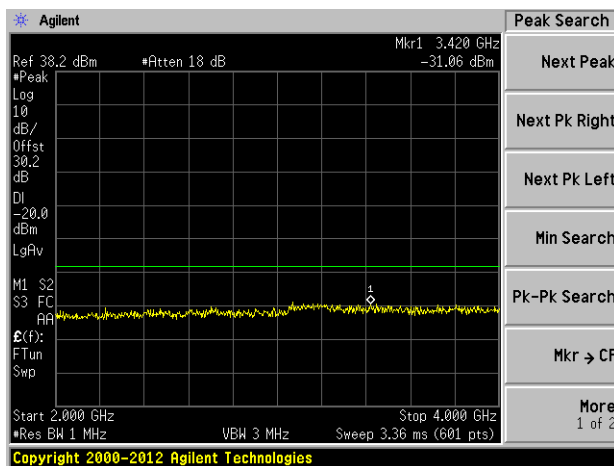
30 MHz – 1 GHz



1 GHz – 2 GHz

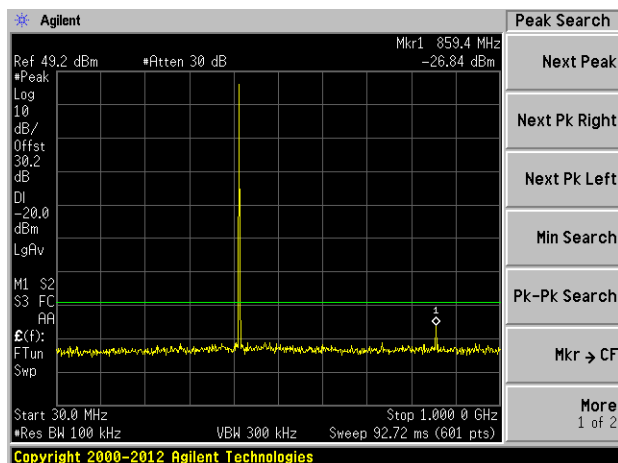


2 GHz – 4 GHz

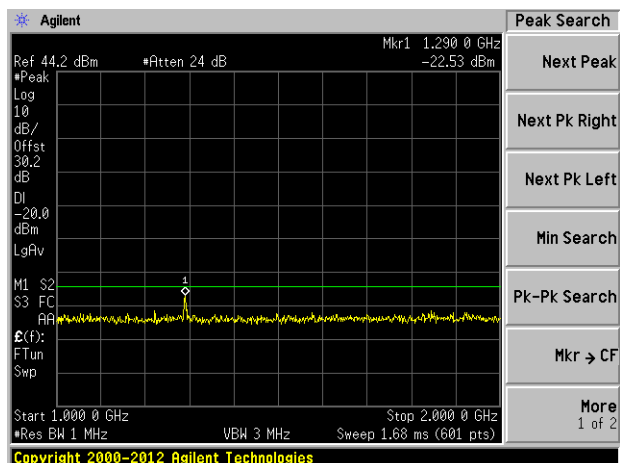


High Channel

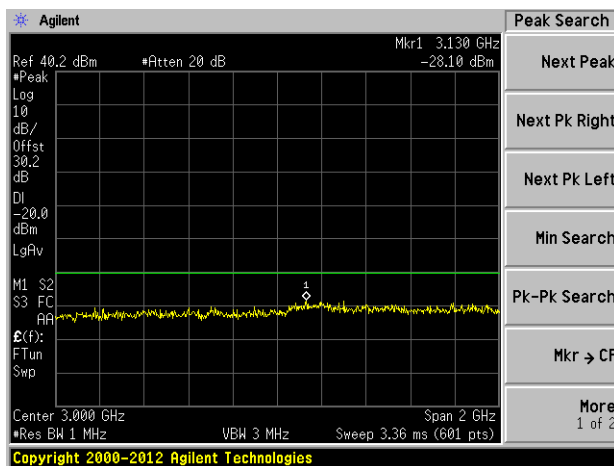
30 MHz – 1 GHz



1 GHz – 2 GHz

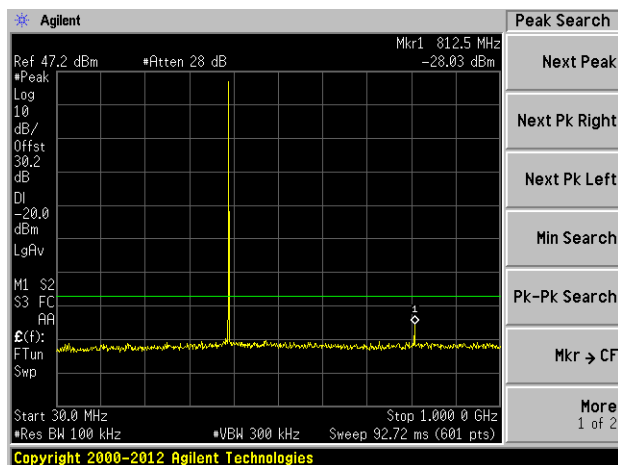


2 GHz – 4 GHz

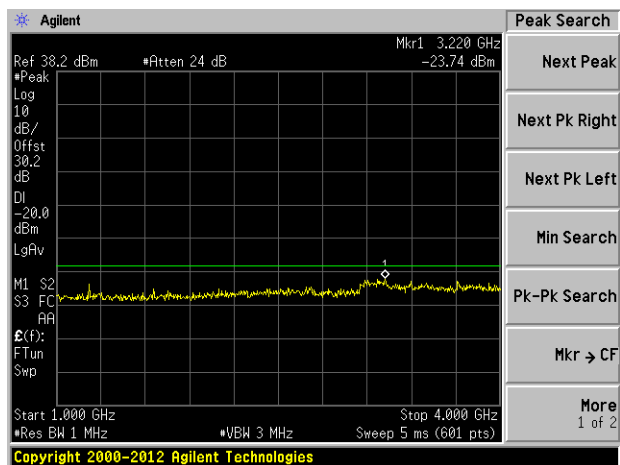


Low Channel #2

30 MHz – 1 GHz

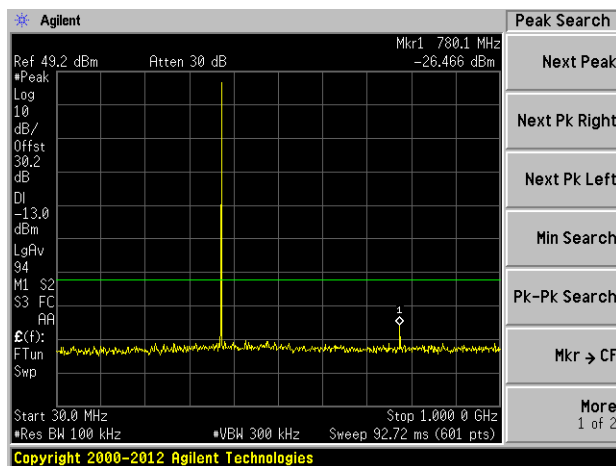


1 GHz – 4 GHz

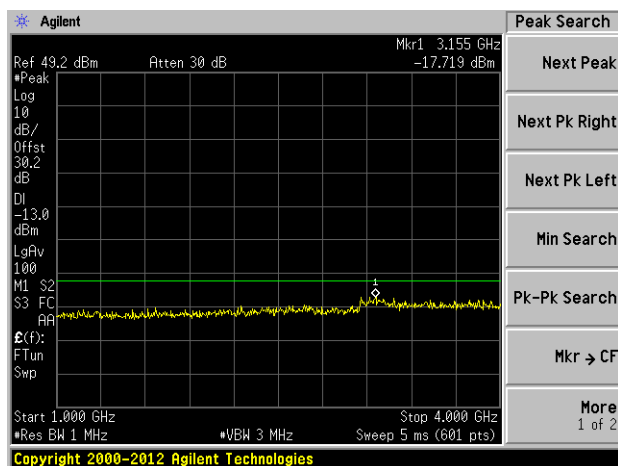


GMSK Modulation @ 19200 bps**Low Channel**

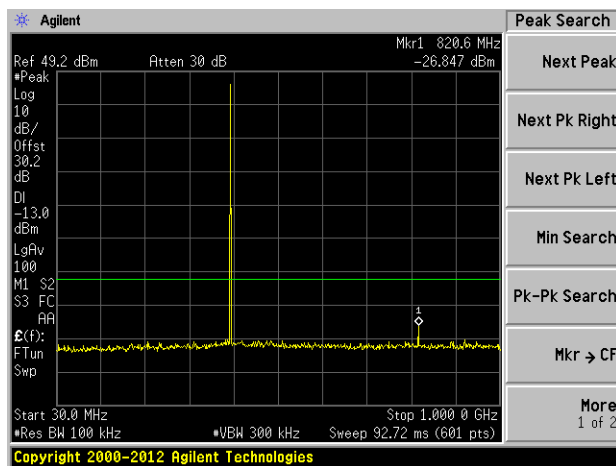
30 MHz – 1 GHz



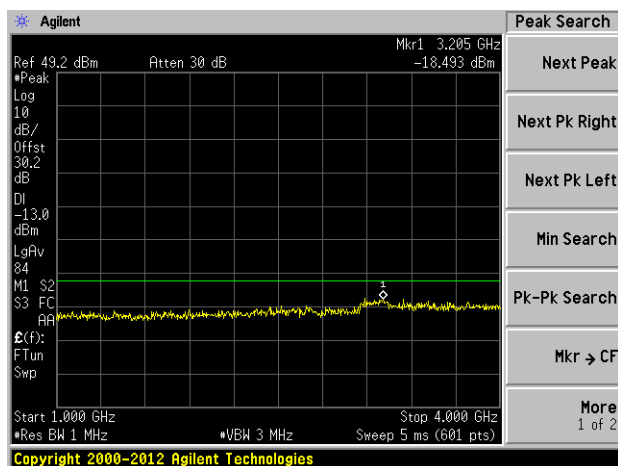
1 GHz – 4 GHz

**Middle Channel**

30 MHz – 1 GHz

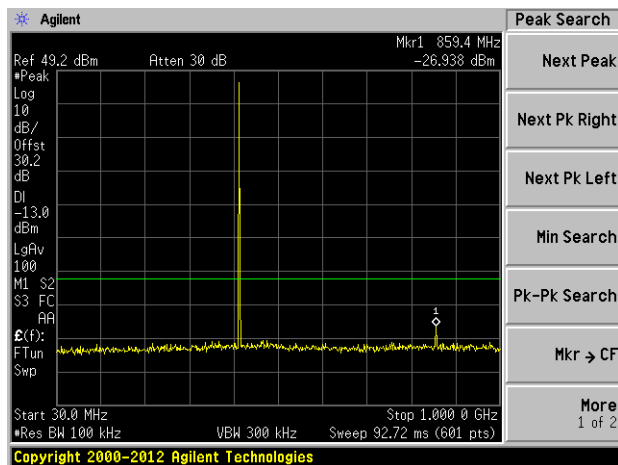


1 GHz – 4 GHz

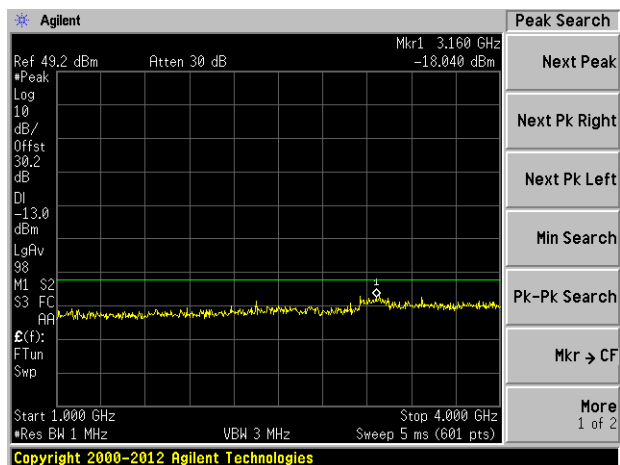


High Channel

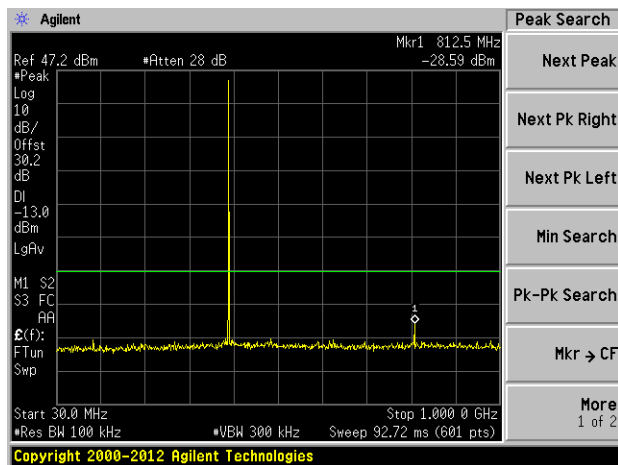
30 MHz – 1 GHz



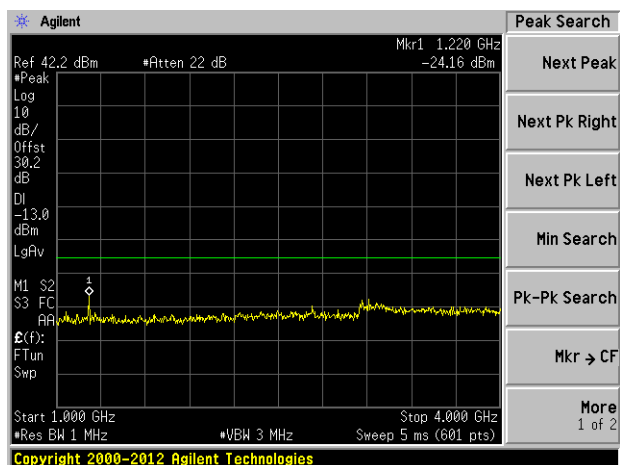
1 GHz – 4 GHz

**Low Channel #2**

30 MHz – 1 GHz

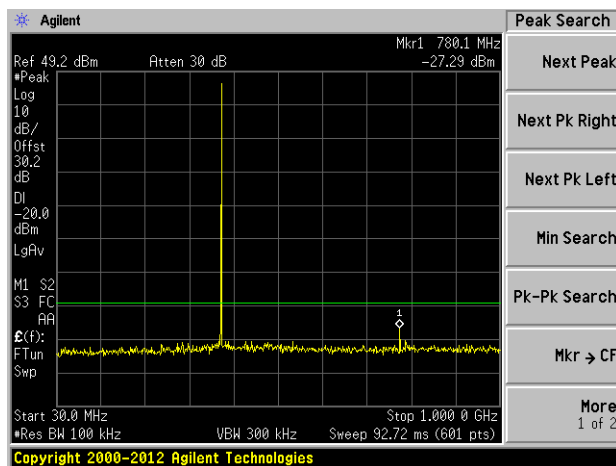


1 GHz – 4 GHz

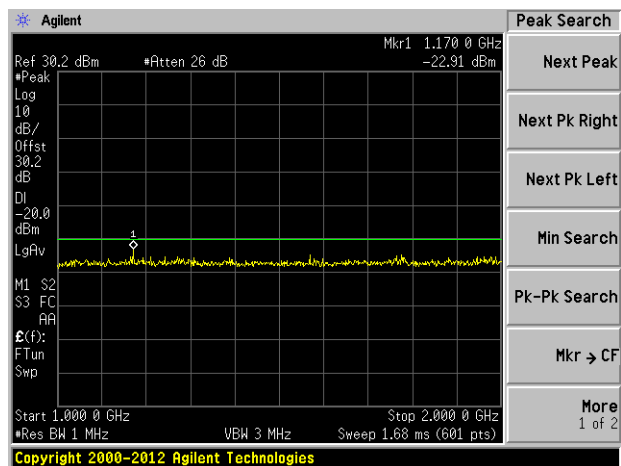


4FSK Modulation @ 9600 bps**Low Channel**

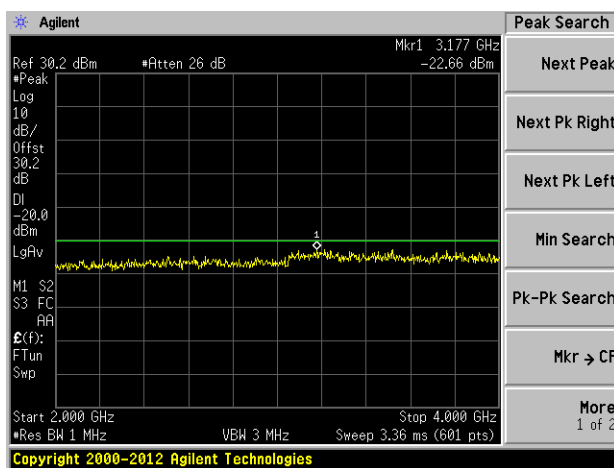
30 MHz – 1 GHz



1 GHz – 2 GHz

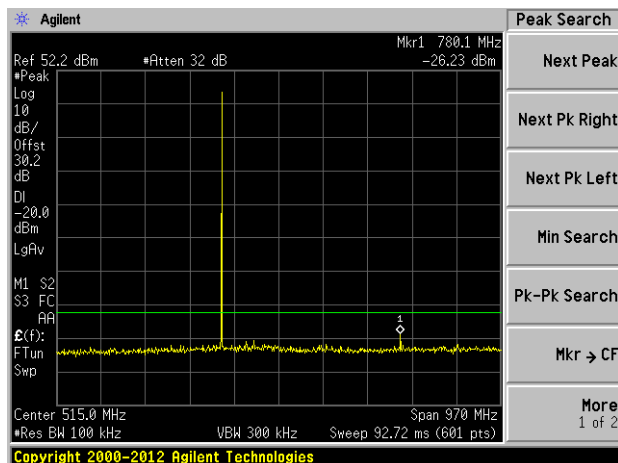


2 GHz – 4 GHz

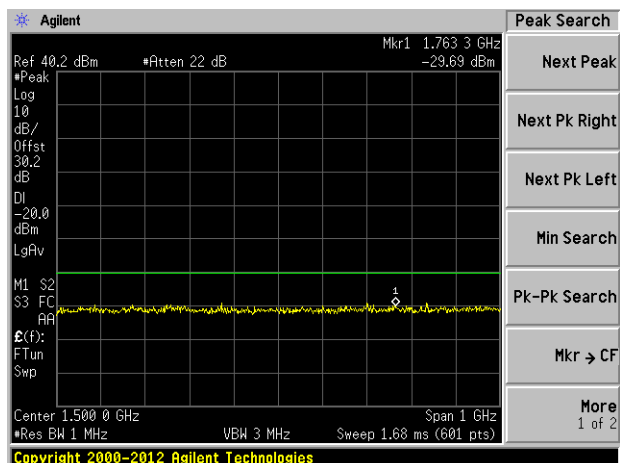


Middle Channel

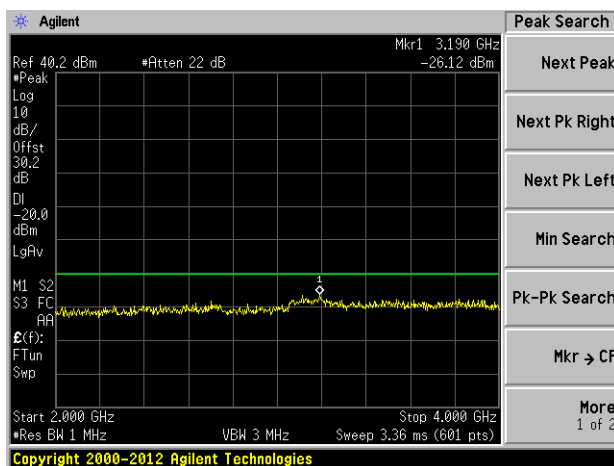
30 MHz – 1 GHz



1 GHz – 2 GHz

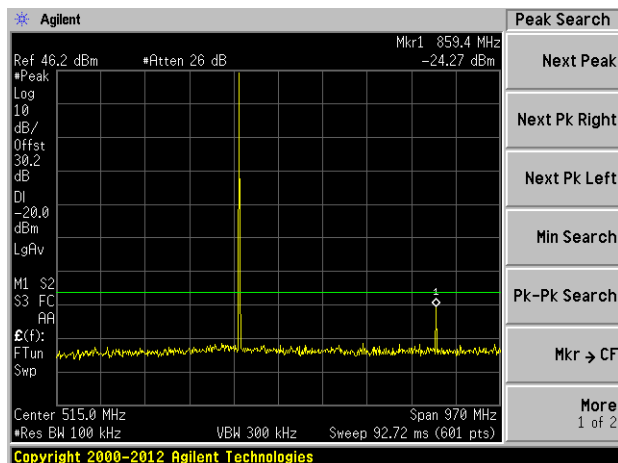


2 GHz – 4 GHz

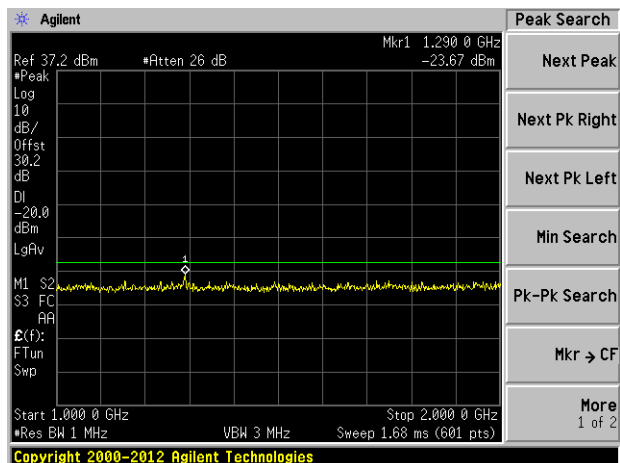


High Channel

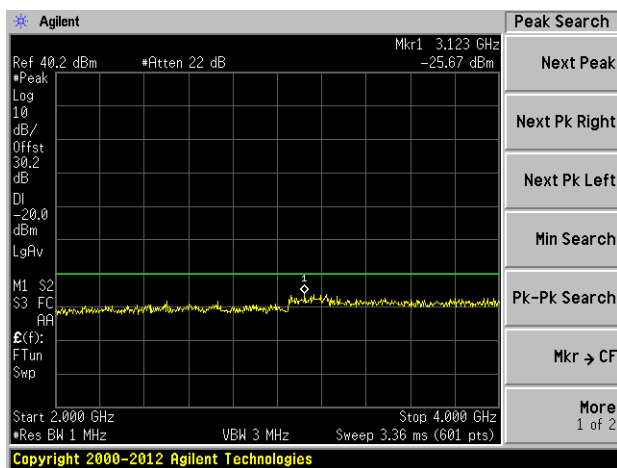
30 MHz – 1 GHz



1 GHz – 2 GHz

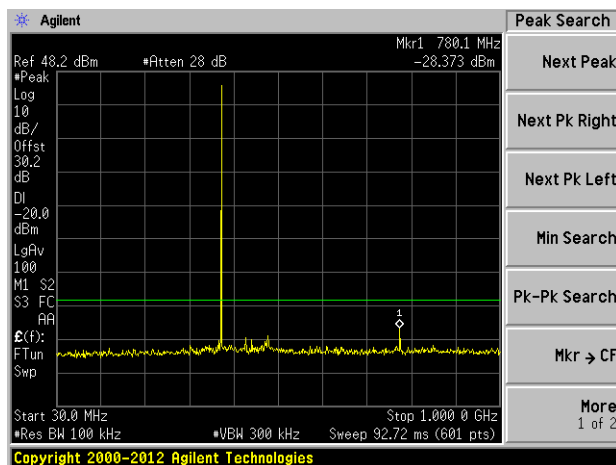


2 GHz – 4 GHz

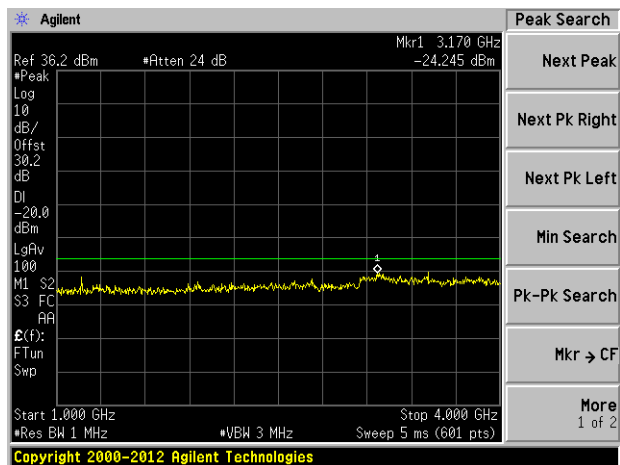


Low Channel #2

30 MHz – 1 GHz

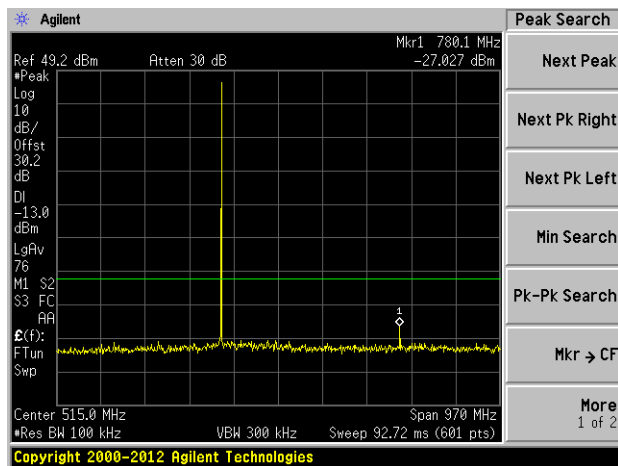


1 GHz – 4 GHz

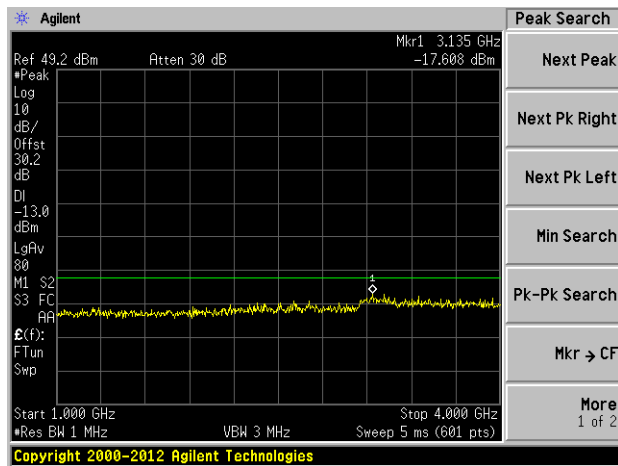


4FSK Modulation @ 19200 bps**Low Channel**

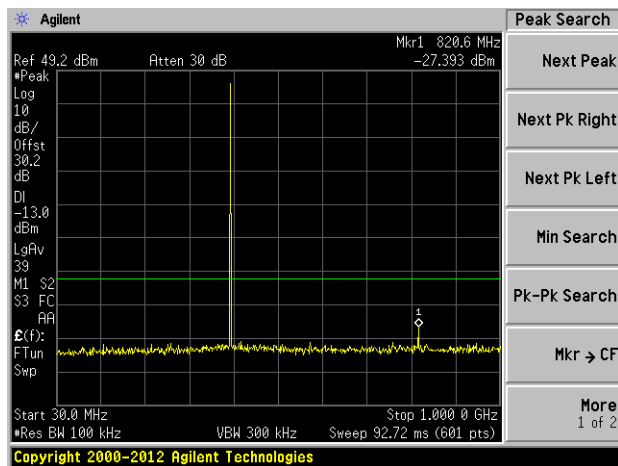
30 MHz – 1 GHz



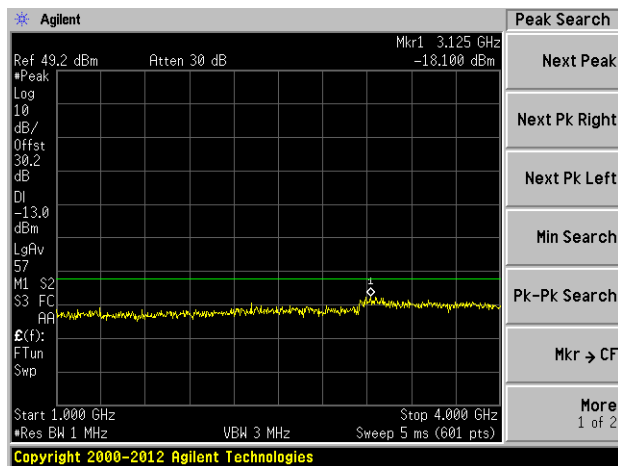
1 GHz – 4 GHz

**Middle Channel**

30 MHz – 1 GHz

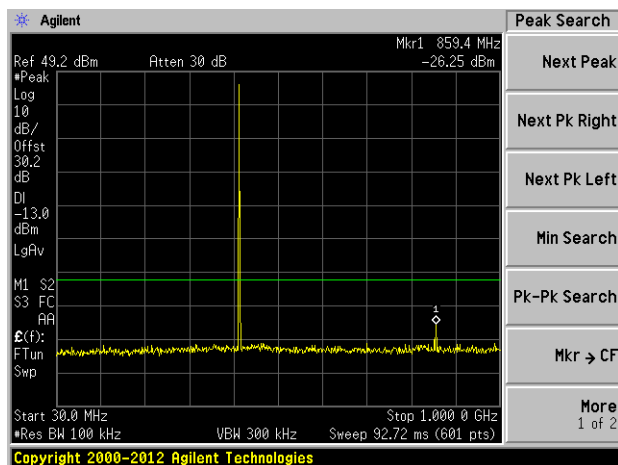


1 GHz – 4 GHz

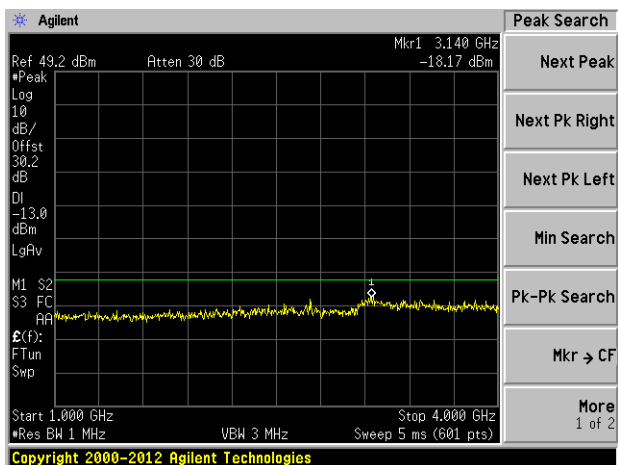


High Channel

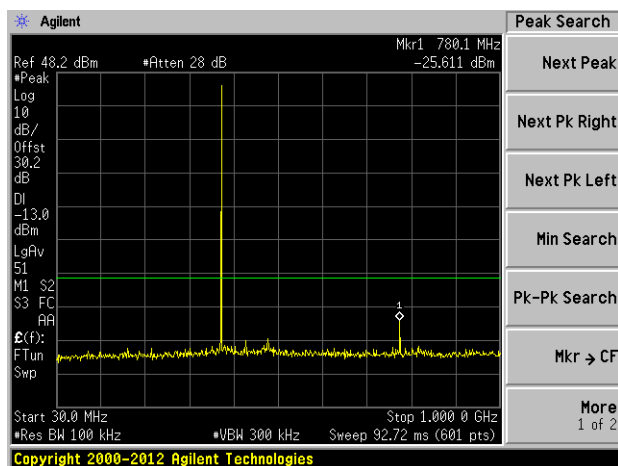
30 MHz – 1 GHz



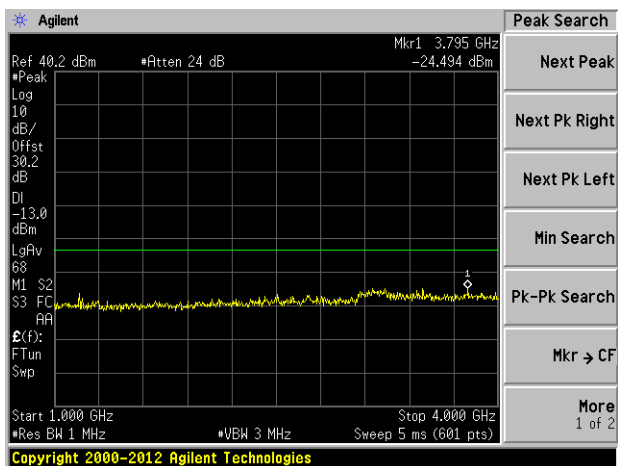
1 GHz – 4 GHz

**Low Channel #2**

30 MHz – 1 GHz



1 GHz – 4 GHz



8 FCC §2.1055 (d) & §90.213 - Frequency Stability

8.1 Applicable Standard

FCC §2.1055, §90.213

MINIMUM FREQUENCY STABILITY

[Parts per million (ppm)]

Frequency range (MHz)	Fixed and base stations	Mobile stations	
		Over 2 watts output power	2 watts or less output power
Below 25	^{1 2 3} 100	100	200
25-50	20	20	50
72-76	5		50
150-174	^{5 11} 5	⁶ 5	^{4 6} 50
216-220	1.0		1.0
220-222 ¹²	0.1	1.5	1.5
421-512	^{7 11 14} 2.5	⁸ 5	⁸ 5
806-809	¹⁴ 1.0	1.5	1.5
809-824	¹⁴ 1.5	2.5	2.5
851-854	1.0	1.5	1.5
854-869	1.5	2.5	2.5
896-901	¹⁴ 0.1	1.5	1.5
902-928	2.5	2.5	2.5
902-928 ¹³	2.5	2.5	2.5
929-930	1.5		
935-940	0.1	1.5	1.5
1427-1435	⁹ 300	300	300
Above 2450 ¹⁰			

⁸In the 421–512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

8.2 Test Procedure

Frequency Stability vs. Temperature: The equipment under test was connected to an external DC power supply and the RF output was connected to the Spectrum Analyzer via feed-through attenuators. The EUT was placed inside the temperature chamber. The DC leads and RF output cable exited the chamber through an opening made for the purpose.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the Spectrum Analyzer.

Frequency Stability vs. Voltage: An external variable DC power supply Source. The voltage was set to 115% and 85% of the nominal value. The output frequency was recorded for each voltage.

8.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2015-09-29	1 year
Espec	Chamber, Humidity	ESL-4CA	18010	2015-09-27	1year
KEPCO	Source, DC	25-10M	H1334526	N/A	N/A
-	SMA cable	-	C0005	Each Time ¹	-
Bird Electronic Corp.	30 dB attenuator	50-AFFB-30	14	Each Time ¹	-

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

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:	20-25 °C
Relative Humidity:	44-55 %
ATM Pressure:	101-102 kPa

The testing was performed by Jason Qian on 2016-03-04 in the RF Site.

8.5 Test Results

Reference Frequency: 410.15 MHz

Test Condition		Reference Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (ppm)	Limit (ppm)
Voltage (Vdc)	Temperature (°C)				
Frequency vs. Temperature					
12	50	410.15	410.14990	-0.244	2.5
12	40	410.15	410.14988	-0.293	2.5
12	30	410.15	410.14990	-0.244	2.5
12	20	410.15	410.14988	-0.293	2.5
12	10	410.15	410.14985	-0.366	2.5
12	0	410.15	410.14985	-0.366	2.5
12	-10	410.15	410.14990	-0.244	2.5
12	-20	410.15	410.14990	-0.244	2.5
12	-30	410.15	410.14990	-0.244	2.5
Frequency vs. Voltage					
10.2	20	410.15	410.14985	-0.366	2.5
13.8	20	410.15	410.14988	-0.293	2.5

9 FCC §2.1053 & §90.210 - Field Strength of Spurious Radiation

9.1 Applicable Standard

FCC §90.210

For equipment using 25 kHz channel bandwidth, on any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB.

For equipment using 12.5 kHz channel bandwidth, on any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least $50 + 10 \log (P)$ dB or 70 dB, whichever is the lesser attenuation.

9.2 Test Procedure

The transmitter was placed on a Styrofoam with wooden turntable, and it was normal transmitting with 50ohm termination 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 = $10 \lg (\text{TXpwr in Watts}/0.001)$ – the absolute level

9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2015-09-29	1 year
Sunol Science Corp	System Controller	SC99V	011003-1	N/R	N/R
Sunol Sciences	Antenna, Biconi-Log	JB1	A013105-3	2015-07-11	2 year
A.R.A	Antenna, Horn	DRG-118/A	1132	2015-09-21	2 year
HP	Pre-Amplifier	8447D	2944A06639	2015-06-08	1 year
Suirong	30 ft conductive emission cable	LMR 400	-	2015-11-05	1 year
-	SMA cable	-	C0001	Each time ¹	N/A
IW Microwave	High Frequency Cable	DC-1531	KPS-1501A3960KPS	2015-08-10	1 year
Agilent	Pre-Amplifier	8449B	3008A01978	2015-09-02	1 year
COM-POWER	Antenna, Dipole	AD-100	721033DB1, 2, 3, 4	2014-11-03	2 years
Sunol Sciences Corp	Antenna, Horn	DRH-118	A052704	2015-03-09	2 year

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

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

9.4 Test Environmental Conditions

Temperature:	20-25 °C
Relative Humidity:	35-40 %
ATM Pressure:	101-102 kPa

The testing was performed by Jason Qian on 2015-03-02 in the 5 meter chamber 3.

9.5 Test Results

Worst Margin: -15.02 dB at 780.3 MHz in the Horizontal polarization.

12.5 kHz Channel Bandwidth, Low Channel #2 – 406.15 MHz

Indicated		Turntable Azimuth (Degrees)	Test Antenna		Substituted					Limit (dBm)	Margin (dB)
Freq. (MHz)	Amp. (dBuV)		Height (m)	Polar (H/V)	Freq. (MHz)	Level (dBm)	Ant. Cord. (dBi)	Cable Loss (dB)	Absolute Level (dBm)		
780.3	58.44	60	100	H	780.3	-34.72	0	0.3	-35.02	-20	-15.02
780.3	57.25	45	140	V	780.3	-35.22	0	0.3	-35.52	-20	-15.52
1170.45	59.14	330	150	H	1170.45	-49.13	6.522	0.8	-43.408	-20	-23.408
1170.45	63.25	200	110	V	1170.45	-45.6	6.522	0.8	-39.878	-20	-19.878
1560.6	59.2	0	145	H	1560.6	-49.12	8.564	0.8	-41.356	-20	-21.356
1560.6	61.02	0	200	V	1560.6	-47.13	8.564	0.8	-39.366	-20	-19.366
1950.75	52.91	0	125	H	1950.75	-54.51	8.726	0.8	-46.584	-20	-26.584
1950.75	55.65	0	175	V	1950.75	-51.46	8.726	0.8	-43.534	-20	-23.534

25 kHz Channel Bandwidth, Low Channel #2 – 406.15 MHz*

Indicated		Turntable Azimuth (Degrees)	Test Antenna		Substituted					Limit (dBm)	Margin (dB)
Freq. (MHz)	Amp. (dBuV)		Height (m)	Polar (H/V)	Freq. (MHz)	Level (dBm)	Ant. Cord. (dBi)	Cable Loss (dB)	Absolute Level (dBm)		
780.3	59.04	60	100	H	780.3	-34.12	0	0.3	-34.42	-13	-21.42
780.3	58.5	30	150	V	780.3	-33.97	0	0.3	-34.27	-13	-21.27
1170.45	61.62	150	200	H	1170.45	-46.65	6.522	0.8	-40.928	-13	-27.928
1170.45	63.45	220	110	V	1170.45	-45.4	6.522	0.8	-39.678	-13	-26.678
1560.6	58.95	0	145	H	1560.6	-49.37	8.564	0.8	-41.606	-13	-28.606
1560.6	60.47	0	200	V	1560.6	-47.68	8.564	0.8	-39.916	-13	-26.916
1950.75	53.02	20	120	H	1950.75	-54.4	8.726	0.8	-46.474	-13	-33.474
1950.75	55.07	345	100	V	1950.75	-52.04	8.726	0.8	-44.114	-13	-31.114

Note: This configuration is not for FCC Part 90 certification.*

10 FCC §90.214 - Transient Frequency Behavior

10.1 Applicable Standard

FCC §90.214: Transmitters designed to operate in the 150–174 MHz and 421–512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals ^{1,2}	Maximum frequency difference ³	All equipment
		421 to 512 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels		
t ₁ ⁴	± 25.0 kHz	10.0 ms
t ₂	± 12.5 kHz	25.0 ms
t ₃ ⁴	± 25.0 kHz	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels		
t ₁ ⁴	± 12.5 kHz	10.0 ms
t ₂	± 6.25 kHz	25.0 ms
t ₃ ⁴	± 12.5 kHz	10.0 ms

t_{on} is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

t_1 is the time period immediately following t_{on} .

t_2 is the time period immediately following t_1 .

t_3 is the time period from the instant when the transmitter is turned off until t_{off} .

t_{off} is the instant when the 1 kHz test signal starts to rise.

²During the time from the end of t_2 to the beginning of t_3 , the frequency difference must not exceed the limits specified in §90.213.

³Difference between the actual transmitter frequency and the assigned transmitter frequency.

⁴If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

10.2 Test Procedure

TIA/EIA-603-D 2.2.19

10.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2015-09-29	1 year
Tektronix Inc	Digital Phosphor Oscilloscope	TDS2024B	C047044	2015-07-27	1 year
Agilent	Generator, Signal	33120A	US36017785	2015-07-23	1 year
HP	RF Communications Test Set	8920A	3438A05338	2015-09-09	1 year
-	SMA cable	-	C0005	Each Time ¹	-
Bird Electronic Corp.	30 dB attenuator	50-AFFB-30	14	Each Time ¹	-
Bird Electronic Corp.	30 dB attenuator	50-AFFB-30	15	Each Time ¹	-
HP	HP	Coupler, Dual Directional	778D	Each Time ¹	-

Note¹: cable, attenuator and directional coupler included in the test set-up will be checked each time before testing.

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

10.4 Test Environmental Conditions

Temperature:	20-25 °C
Relative Humidity:	44-55 %
ATM Pressure:	101-102 kPa

The testing was performed by Jason Qian on 2016-03-08 in the RF Site.

10.5 Test Results

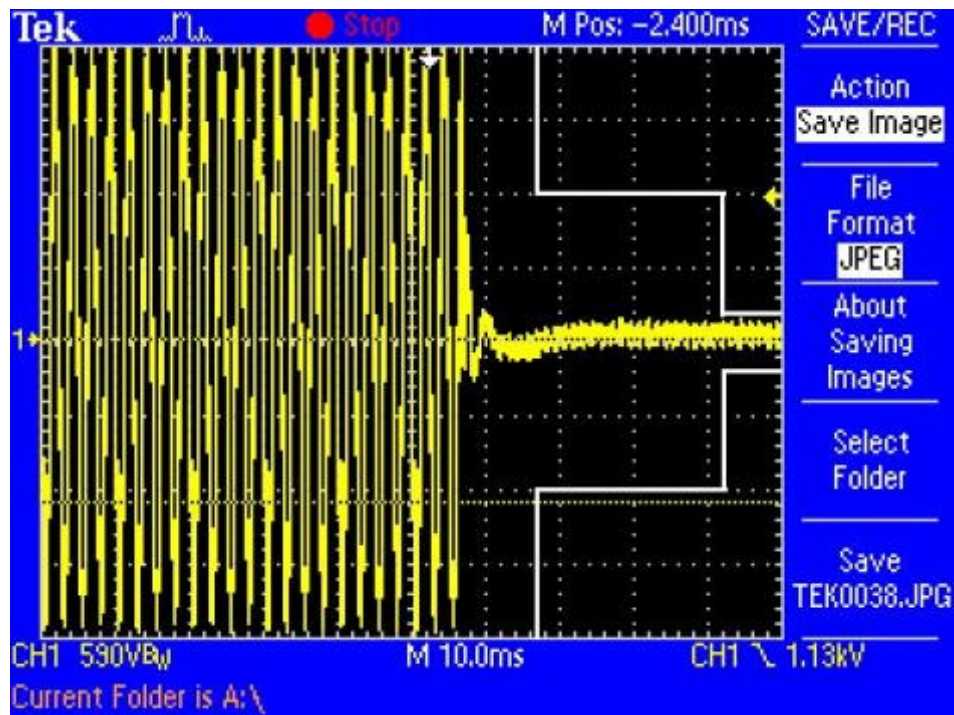
Note: The channel of 390.15 MHz and 25 kHz channel bandwidth on channel 406.15 MHz and 410.15 MHz are not for FCC Part 90 certification.*

Please refer to the hereinafter plots.

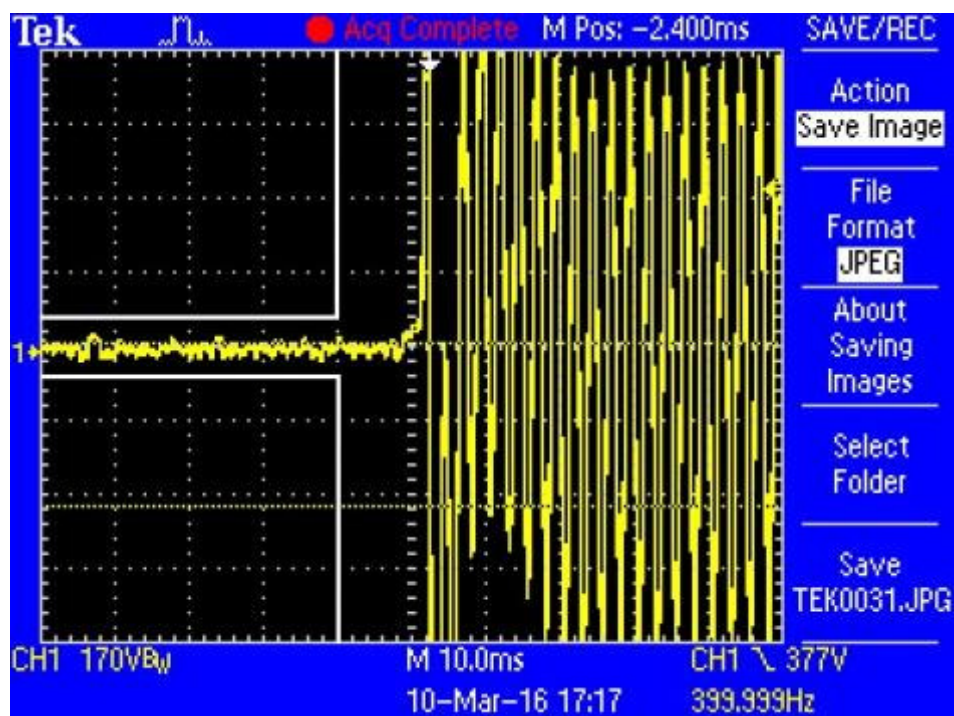
Low Channel: 390.15 MHz*

12.5 kHz Channel Bandwidth

Powering On

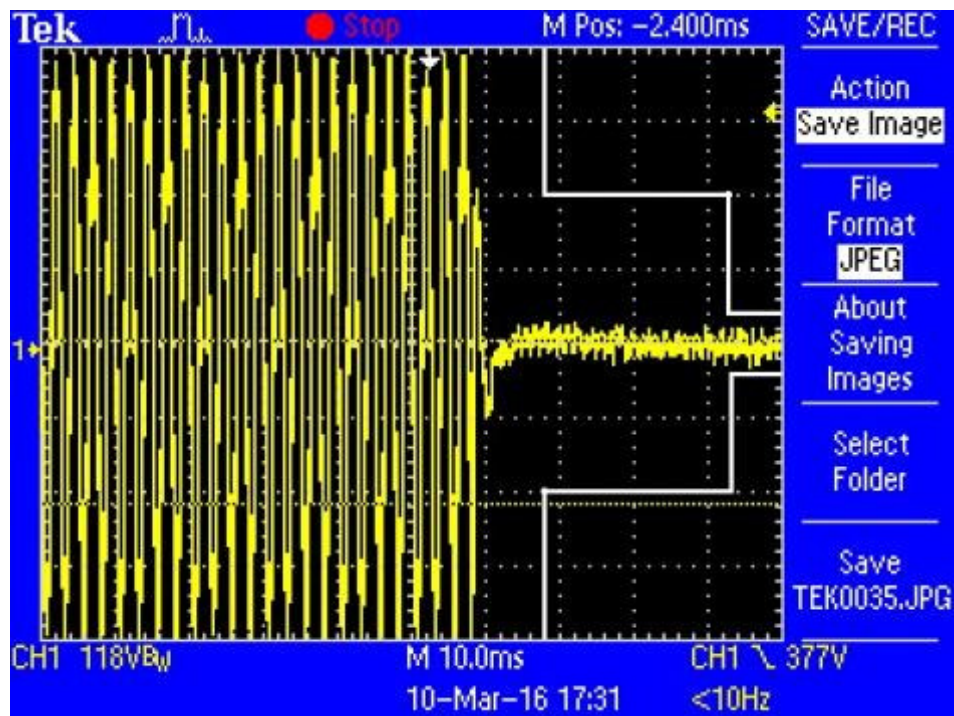


Powering Off

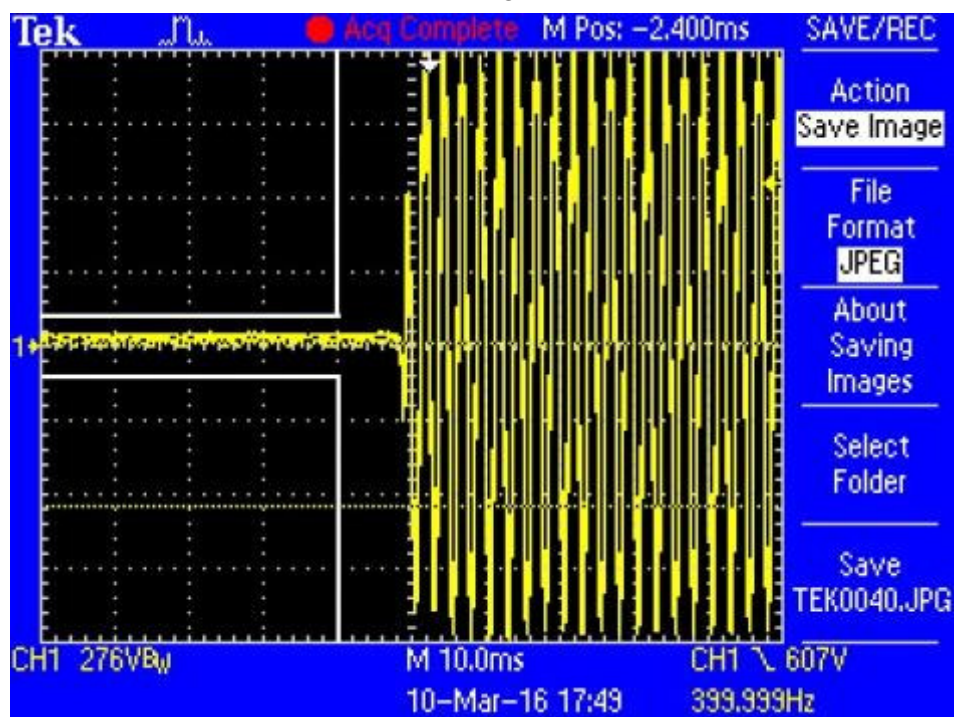


25 kHz Channel Bandwidth

Powering On



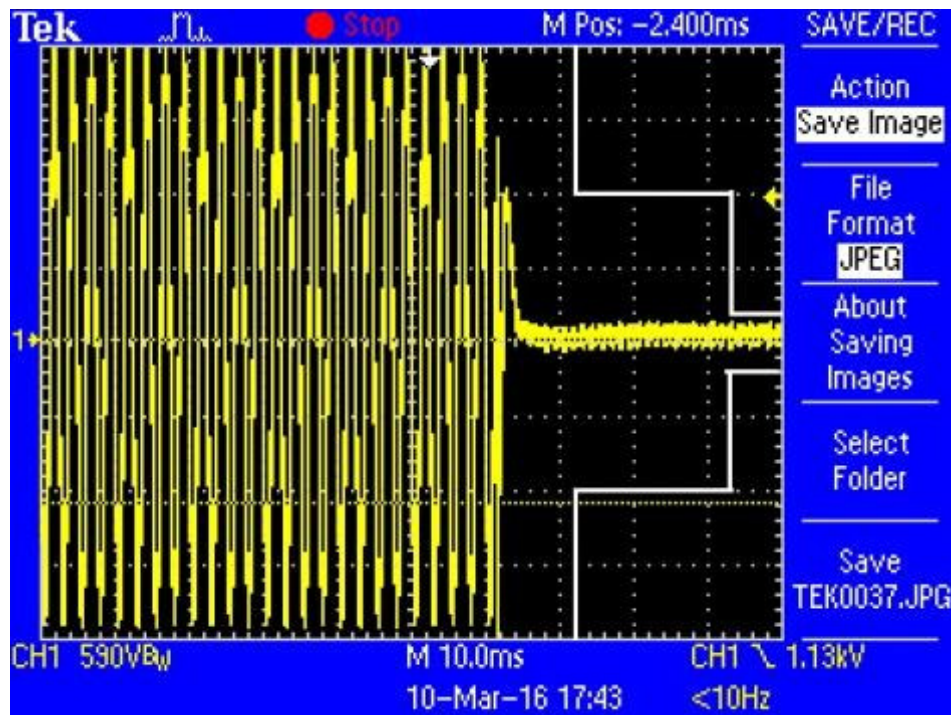
Powering Off



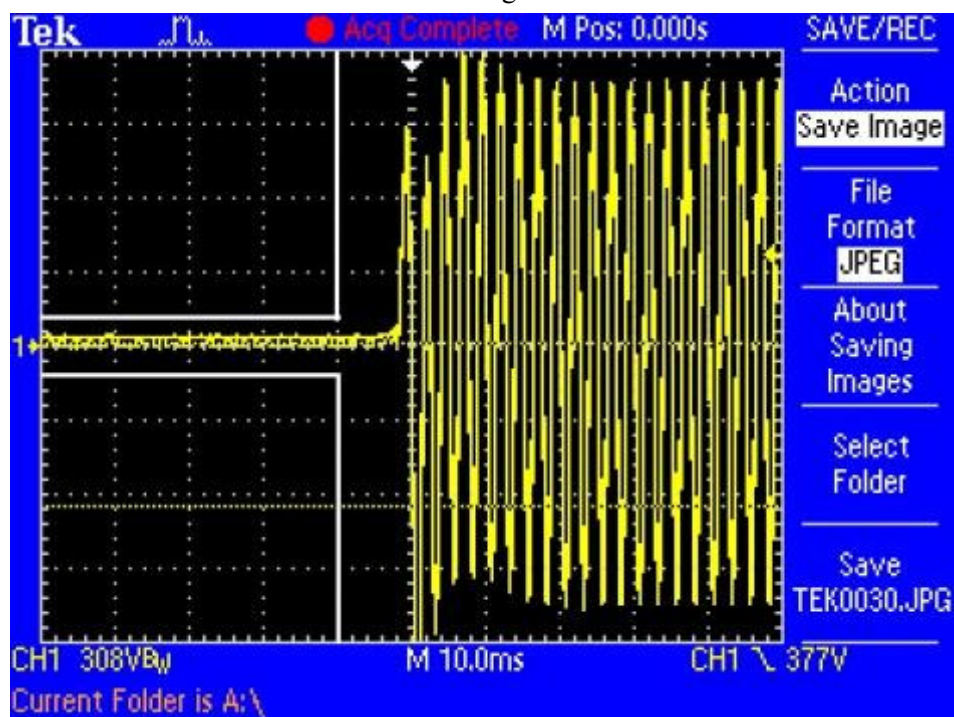
Middle Channel: 410.15 MHz

12.5 kHz Channel Bandwidth

Powering On

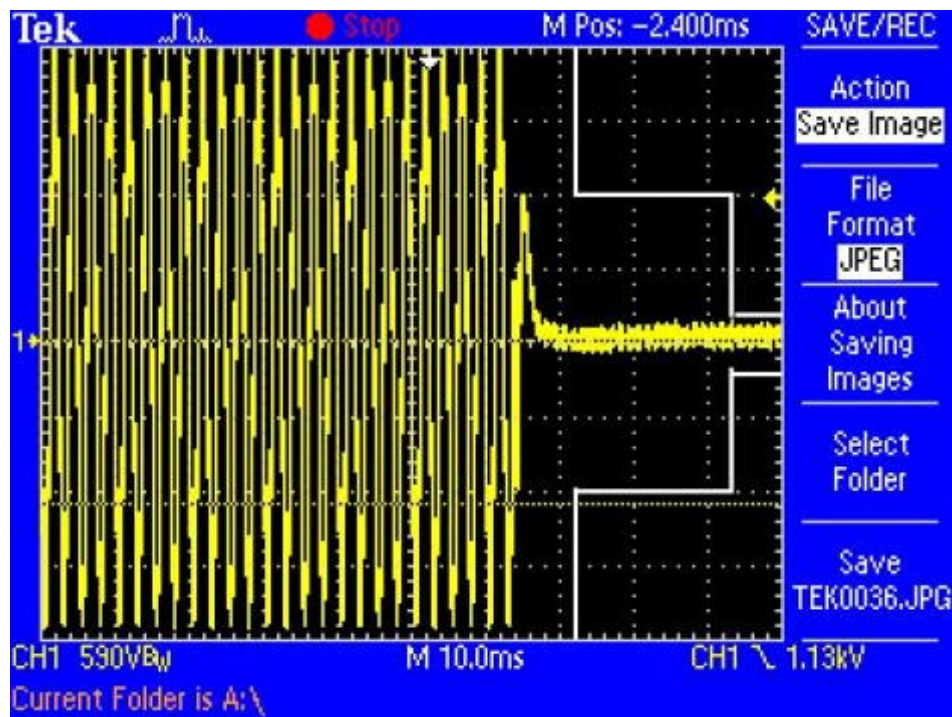


Powering Off

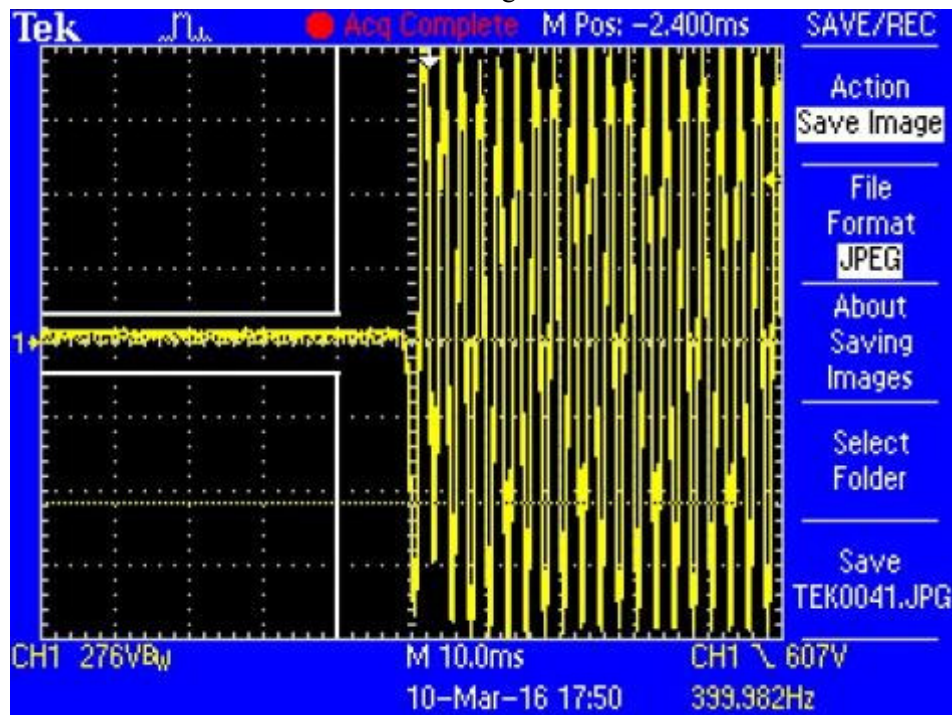


25 kHz Channel Bandwidth*

Powering On



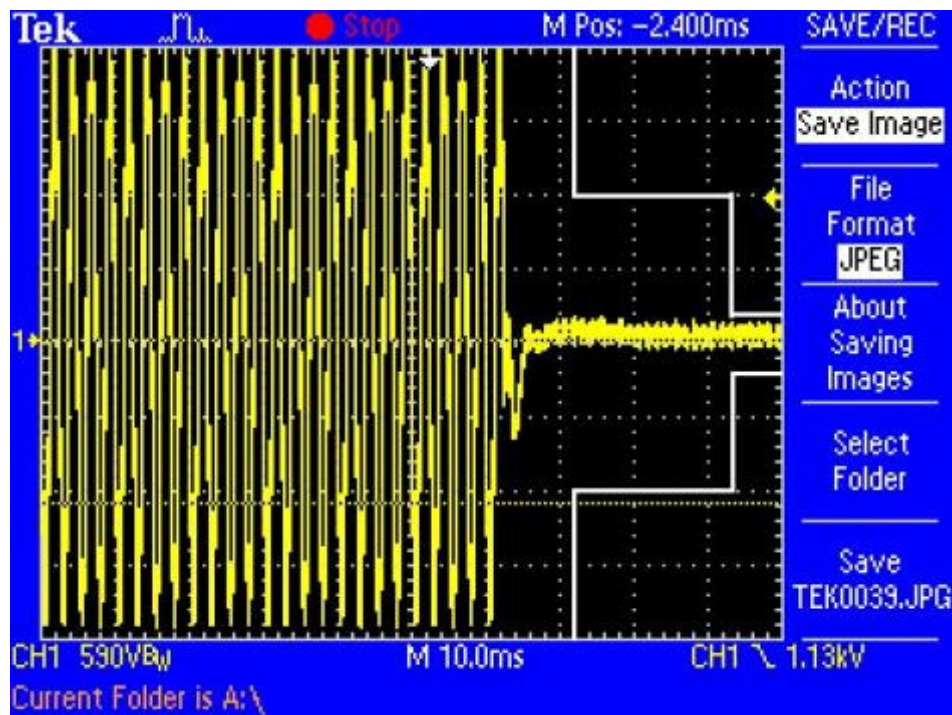
Powering Off



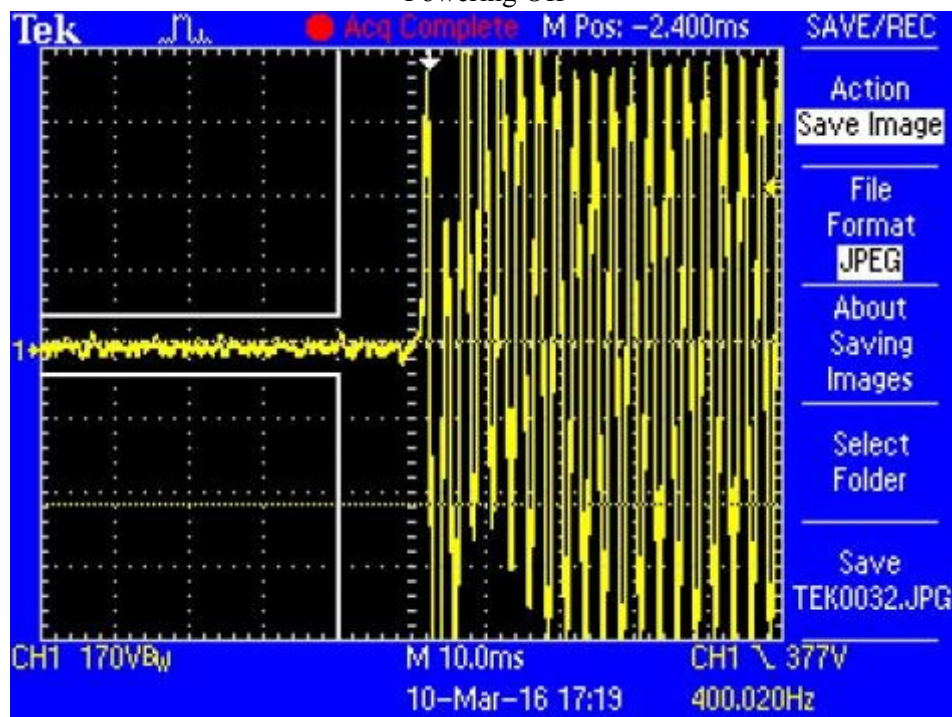
High Channel: 429.85 MHz

12.5 kHz Channel Bandwidth

Powering On

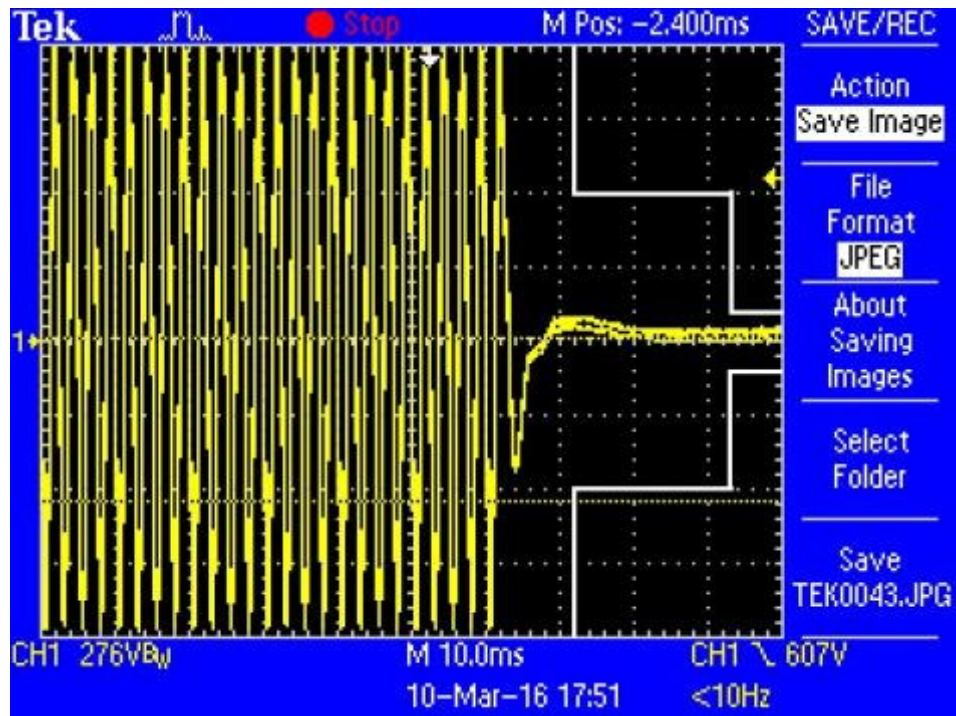


Powering Off

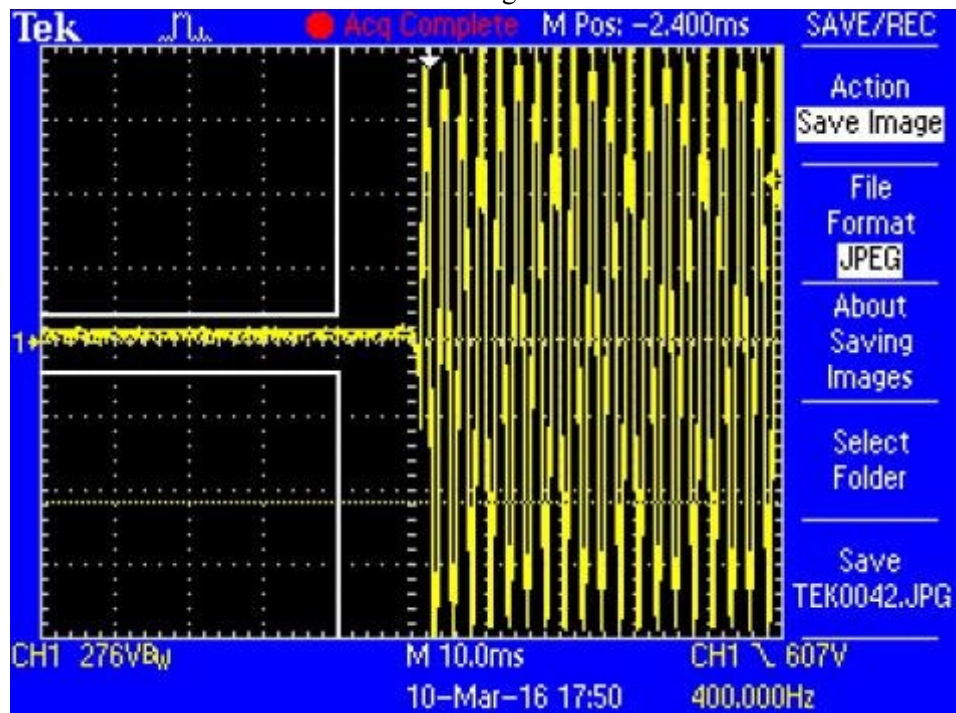


25 kHz Channel Bandwidth

Powering On



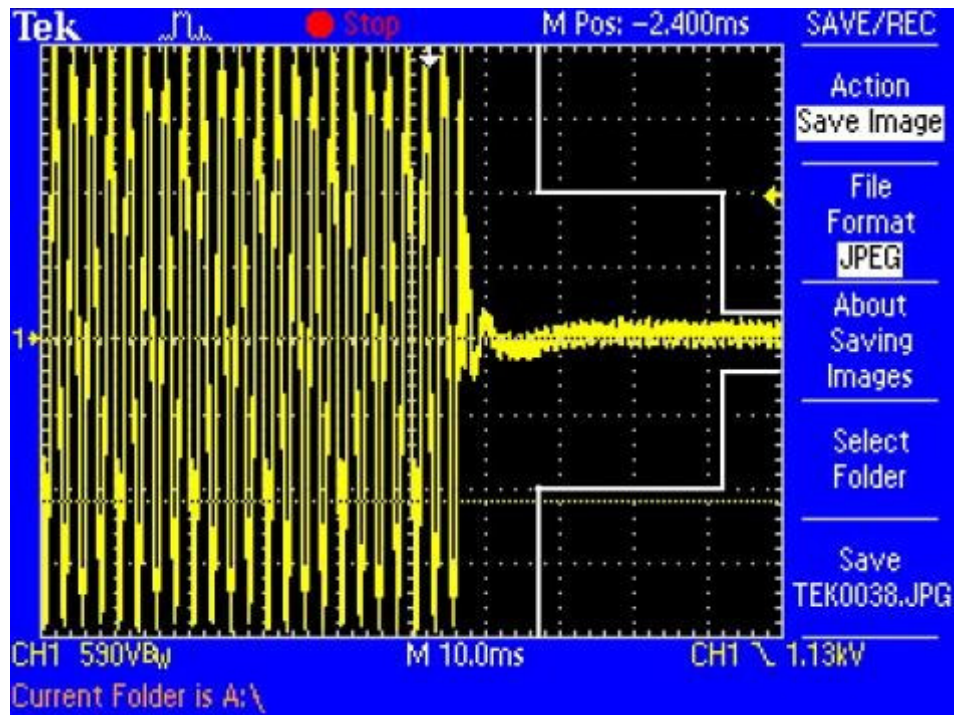
Powering Off



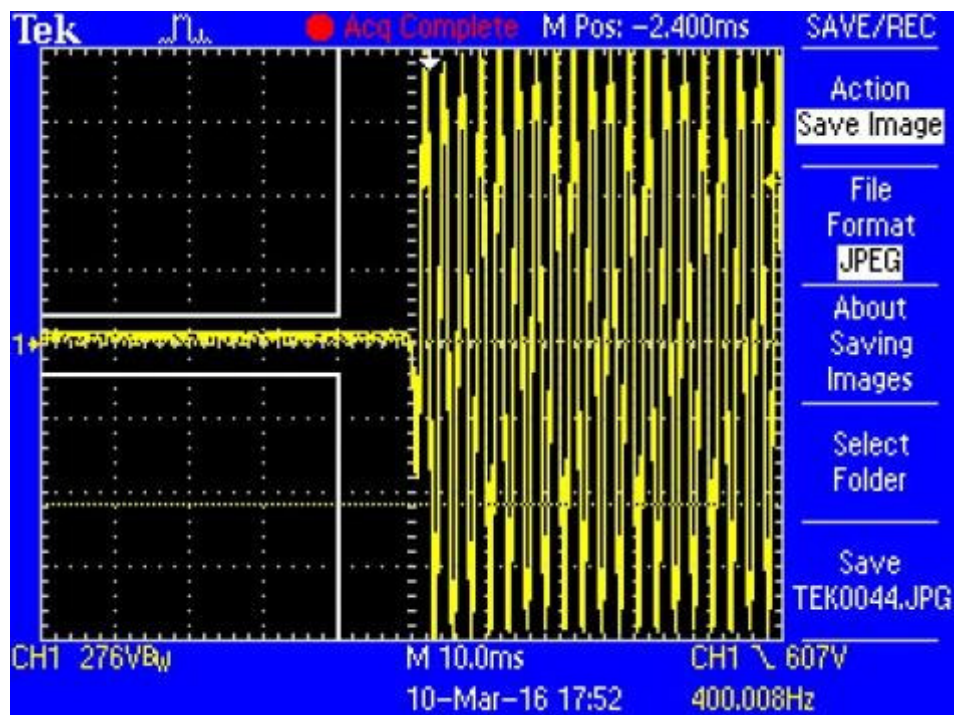
Low Channel #2: 406.15 MHz

12.5 kHz Channel Bandwidth

Powering On

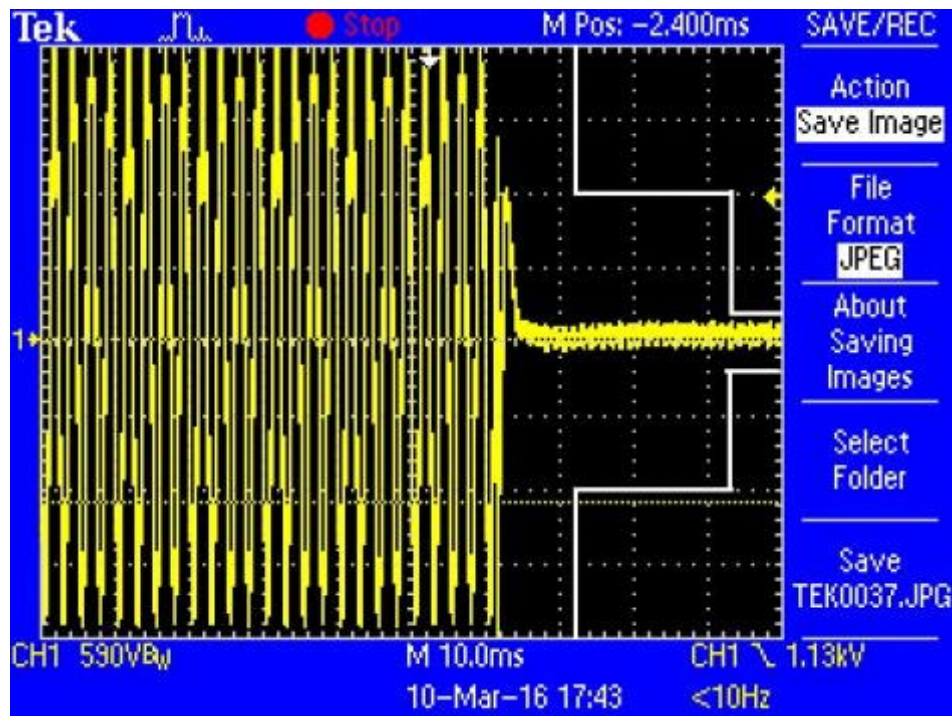


Powering Off



25 kHz Channel Bandwidth*

Powering On



Powering Off

