NTS Silicon Valley
www.nts.com
41039 Boyce Road
Fremont, CA 94538
510-578-3500 Phone
510-440-9525 Fax

EMC Test Report

Application for FCC Grant of Equipment Authorization
Canada Certification

Innovation, Science and Economic Development Canada
RSS-Gen Issue 4 / RSS 247 Issue 2
FCC Part 15 Subpart C

Model: H0A

IC CERTIFICATION #:	10395A-H0A
FCC ID:	A4RH0A
APPLICANT:	Google Inc. 1600 Amphitheatre Pky Mountain View, CA 94043
TEST SITE(S):	National Technical Systems - Silicon Valley 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-7
REPORT DATE:	August 14, 2017
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FINAL TEST DATES:	June 29 and July 21, 2017
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Testing Cert #0214.26

VALIDATING SIGNATORIES

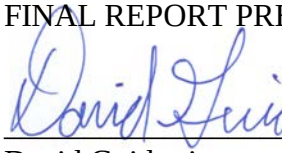
PROGRAM MGR

Mark E Hill
Staff Engineer

TECHNICAL REVIEWER:

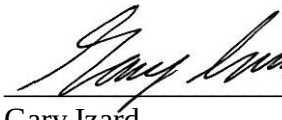
Mark E Hill
Staff Engineer

FINAL REPORT PREPARER:



David Guidotti
Senior Technical Writer

QUALITY ASSURANCE DELEGATE



Gary Izard
Technical Writer

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	August 14, 2017	First release	
1.0	August 25, 2017	Removed detailed product information for confidentiality	MEH

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SCOPE

An electromagnetic emissions test has been performed on the Google Inc. model H0A, pursuant to the following rules:

RSS-Gen Issue 4 "General Requirements for Compliance of Radio Apparatus"
RSS 247 Issue 2 "Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices"
FCC Part 15 Subpart C

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in National Technical Systems - Silicon Valley test procedures:

ANSI C63.10: 2013

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Industry Canada performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, all unlicensed transmitters and transceivers require certification. Receive-only devices operating between 30 MHz and 960 MHz are subject to either certification or a manufacturer's declaration of conformity, with all other receive-only devices exempt from the technical requirements.

Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification. Class II devices are required to meet the appropriate technical requirements but are exempt from certification requirements.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of Google Inc. model H0A complied with the requirements of the following regulations:

RSS-Gen Issue 4 "General Requirements for Compliance of Radio Apparatus"
RSS 247 Issue 2 "Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices"
FCC Part 15 Subpart C

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

The test results recorded herein are based on a single type test of Google Inc. model H0A and therefore apply only to the tested sample. The sample was selected and prepared by Dominik Mente of Google Inc.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS SUMMARY

FREQUENCY HOPPING SPREAD SPECTRUM (2400 – 2483.5 MHz, Less Than 75 Hopping Channels)

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.247 (a) (1)	RSS 247 5.1 (b)	20dB Bandwidth	Basic Rate: 945 kHz EDR: 1295 kHz	Channel spacing > 2/3rds 20dB BW (minimum 25 kHz)	Complies
		Channel Separation	1000 kHz		Complies
15.247 (a) (1) (iii)	RSS 247 5.1 (d) & 5.4 (b)	Number of Channels	Min: 20 Max: 49	15 or more	Complies
15.247 (a) (1) (iii) & (b) (1)	RSS 247 5.1 (d)	Channel Dwell Time (*average time of occupancy)*	The system uses the Bluetooth algorithm and, therefore, meets all requirements for channel utilization.	<0.4 second within a period of 0.4 x number of channels	Complies
15.247 (a) (1)	RSS 247 5.1 (a)	Channel Utilization		All channels shall, on average, be used equally	Complies
15.247 (b) (3)	RSS 247 5.4 (b)	Output Power	Basic Rate: 5.7 dBm (3.7mW) EDR: 5.5 dBm (3.5mW)	0.125 Watts	Complies
15.247(d)	RSS 247 5.5	Spurious Emissions – 30MHz – 25GHz	All spurious emissions < -20dBc	< -20dBc	Complies
15.247(d) / 15.209	RSS 247 5.5	Radiated Spurious Emissions 30MHz – 25GHz	38.0 dBµV/m @ 2483.5 MHz (-16.0 dB)	Refer to the limits section (p20) for restricted bands, all others < -20dBc	Complies
15.247 (a) (1)	RSS 247 5.1 (a)	Receiver bandwidth	Refer to operational description	Shall match the channel bandwidth	Complies

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Antennas are internal	Unique or integral antenna required	Complies
15.407 (b) (6)	RSS-Gen Table 3	AC Conducted Emissions	27.7 dBµV @ 0.823 MHz (-18.3 dB)	Refer to page 19	Complies
15.247 (i) 15.407 (f)	RSS 102	RF Exposure Requirements	Refer to MPE calculations in separate exhibit, RSS 102 declaration and User Manual statements.	Refer to OET 65, FCC Part 1 and RSS 102	Complies
-	RSP-100 RSS-Gen 6.6	Occupied Bandwidth	Basic Rate: 945 kHz EDR: 1295 kHz	Information only	N/A

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with UKAS document LAB 34.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF power, conducted (power meter)	dBm	25 to 7000 MHz	± 0.52 dB
RF power, conducted (Spectrum analyzer)	dBm	25 to 7000 MHz	± 0.7 dB
Conducted emission of transmitter	dBm	25 to 26500 MHz	± 0.7 dB
Conducted emission of receiver	dBm	25 to 26500 MHz	± 0.7 dB
Radiated emission (substitution method)	dBm	25 to 26500 MHz	± 2.5 dB
Radiated emission (field strength)	dBµV/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB
Conducted Emissions (AC Power)	dBµV	0.15 to 30 MHz	± 2.4 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Google Inc. model H0A is an interactive media streaming device. Since the EUT would be placed on a tabletop during operation, the EUT was treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 100-240 Volts ,50-60Hz Hz, 0.4 Amps.

The sample was received on June 28, 2017 and tested on June 29 and July 21, 2017. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Google	H0A	Streaming Media Device (RF Radiated and AC Conducted)	Prototype Sample #2	A4RH0A
Google	H0A	Streaming Media Device (RF Conducted)	Prototype Sample #1	A4RH0A
Chicony	W17-009N1X	AC-DC Adapter	N/A	N/A

ANTENNA SYSTEM

Two internal antennas: 4.0dBi and 3.4dBi @ 2.4GHz, 3.7dBi and 3.5dBi @ 5GHz Tx/Rx diversity

ENCLOSURE

The EUT enclosure is primarily constructed of uncoated plastic.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at NTS Silicon Valley.

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Company	Model	Description	Serial Number	FCC ID
Dell	Latitude	Laptop	-	-
-	-	Laptop Power Supply	-	-

Note: The laptop was used to configure the radio operation and then was removed from the setup.

EUT INTERFACE PORTS

The I/O cabling configuration during testing was as follows:

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
EUT DC Power	External Power Supply	Multiwire	Shielded	2
AC In (external supply)	AC Mains	Direct plug in	-	-
USB	USB splitter	Multiwire	Shielded	0.3

EUT OPERATION

The EUT was configured to transmit continuously at the maximum output power setting. Specifics for the channel and mode are described in the test data.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken at the test sites listed below. Pursuant to section 2.948 of the FCC's Rules and section 3.3 of RSP-100, construction, calibration, and equipment data has been filed with the Commission and with industry Canada.

Site	Designation / Registration Numbers FCC	Canada	Location
Chamber 4	US0027	2845B-4	41039 Boyce Road Fremont, CA 94538-2435
Chamber 7		2845B-7	

ANSI C63.4 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.10. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment or in a semi-anechoic chamber. The test sites are maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements. If the repetition frequency of the signal being measured is below 20Hz, peak measurements are made in lieu of Quasi-Peak measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz, unless the signal is pulsed in which case the average (or video) bandwidth of the measuring instrument is reduced to onset of pulse desensitization and then increased.

INSTRUMENT CONTROL COMPUTER

Software is used to view and convert receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers. The software used for radiated and conducted emissions measurements is NTS EMI Test Software (rev 2.10)

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A loop antenna is used below 30 MHz. For the measurement range 30 MHz to 1000 MHz either a combination of a biconical antenna and a log periodic or a bi-log antenna is used. Above 1000 MHz, horn antennas are used. The antenna calibration factors to convert the received voltage to an electric field strength are included with appropriate cable loss and amplifier gain factors to determine an overall site factor, which is then programmed into the test receivers or incorporated into the test software.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height. Measurements below 30 MHz are made with the loop antenna at a fixed height of 1m above the ground plane.

ANSI C63.10 specifies that the test height above ground for table mounted devices shall be 80 centimeters for measurements below 1GHz and 1.5m for measurements above 1GHz. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor as specified in ANSI C63.4. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The regulations require that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.10, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

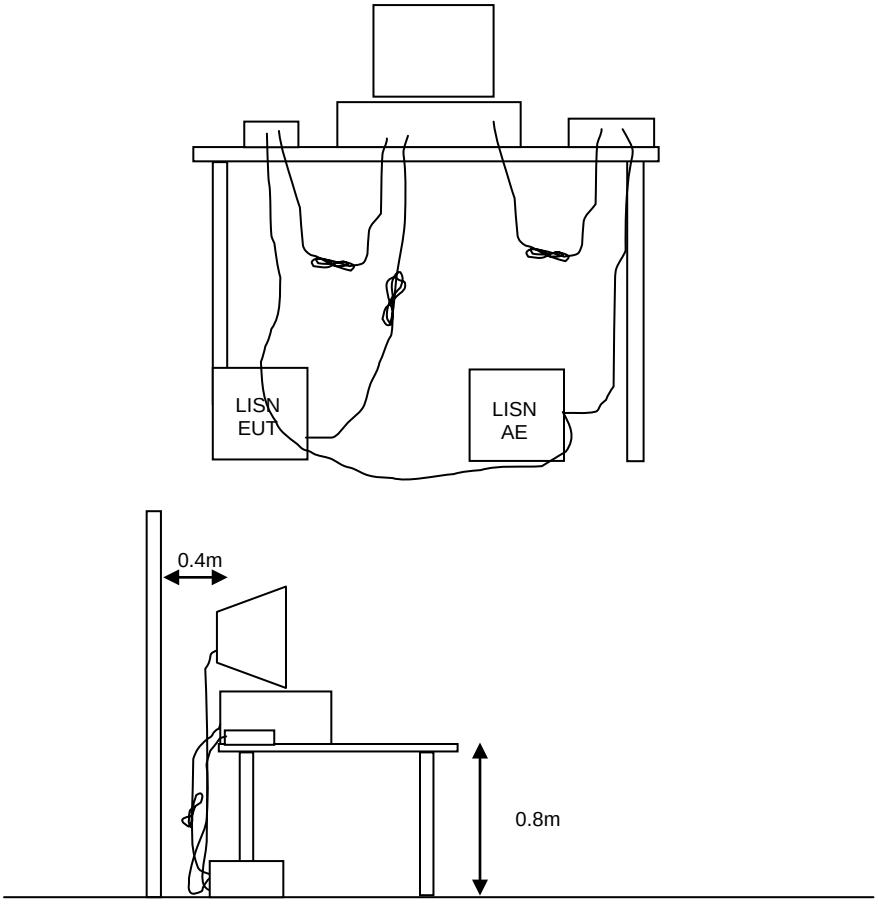


Figure 1 Typical Conducted Emissions Test Configuration

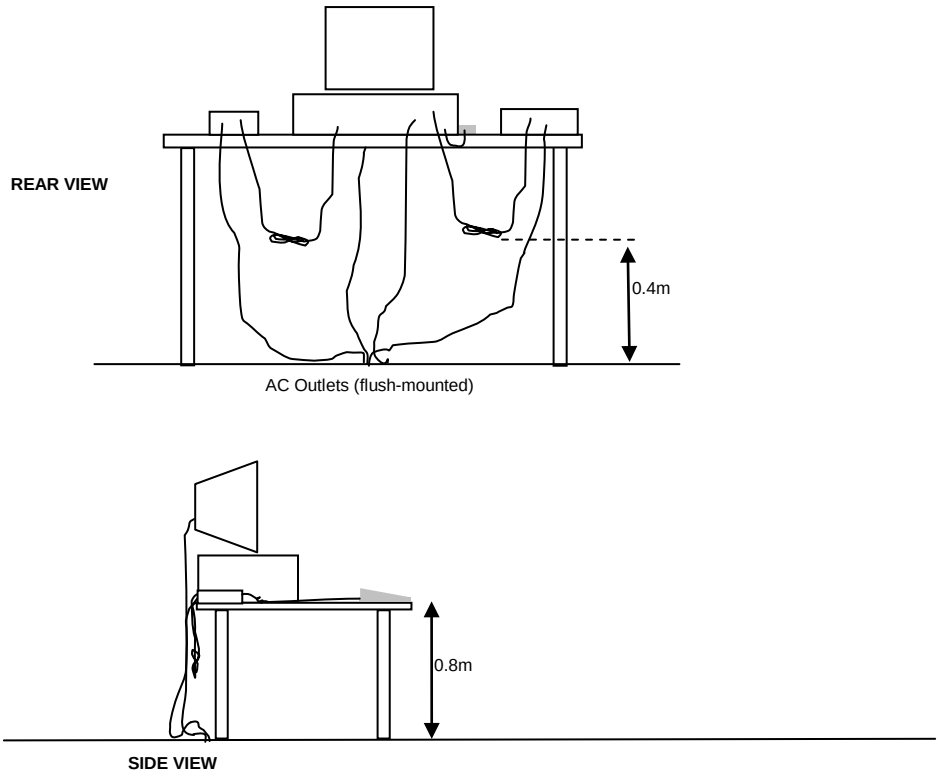
RADIATED EMISSIONS

A preliminary scan of the radiated emissions is performed in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed, one scan for each antenna polarization (horizontal and vertical; loop parallel and perpendicular to the EUT). During the preliminary scans, the EUT is rotated through 360˚, the antenna height is varied (for measurements above 30 MHz) and cable positions are varied to determine the highest emission relative to the limit. Preliminary scans may be performed in a fully anechoic chamber for the purposes of identifying the frequencies of the highest emissions from the EUT.

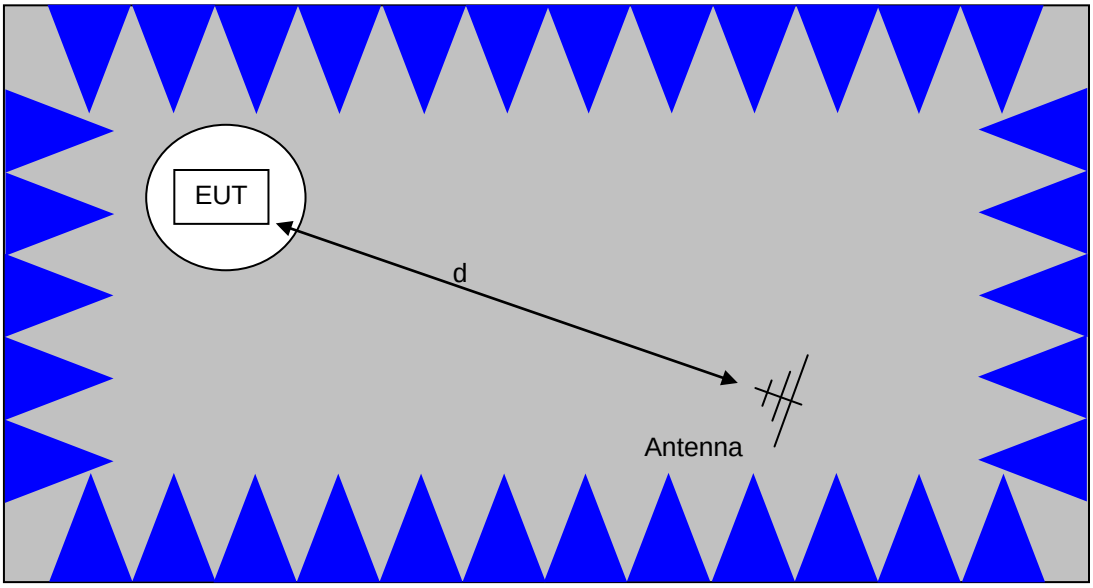
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters (for measurements above 30 MHz, measurements below 30 MHz are made with the loop antenna at a fixed height of 1m). The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain.

When testing above 18 GHz, the receive antenna is located at 1meter from the EUT and the antenna height is restricted to a maximum of 2.5 meters.

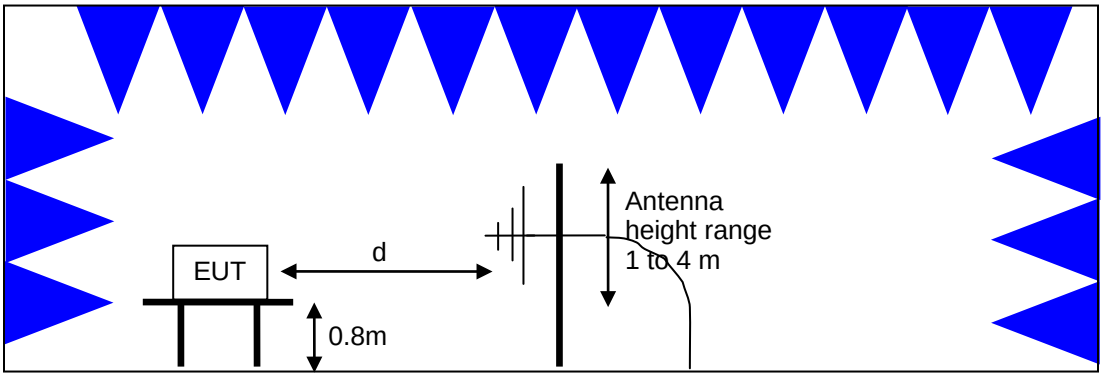


Typical Test Configuration for Radiated Field Strength Measurements



The anechoic materials on the walls and ceiling ensure compliance with the normalized site attenuation requirements of CISPR 16 / CISPR 22 / ANSI C63.4 for an alternate test site at the measurement distances used.

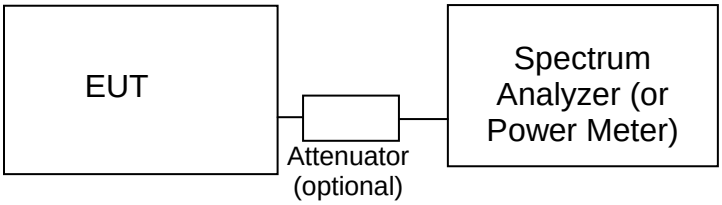
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



Test Configuration for Radiated Field Strength Measurements
Semi-Anechoic Chamber, Plan and Side Views

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements of power, bandwidth and power spectral density are performed, where possible, with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.



Test Configuration for Antenna Port Measurements

Measurement bandwidths (video and resolution) are set in accordance with the relevant standards and NTS Silicon Valley's test procedures for the type of radio being tested. When power measurements are made using a resolution bandwidth less than the signal bandwidth the power is calculated by summing the power across the signal bandwidth using either the analyzer channel power function or by capturing the trace data and calculating the power using software. In both cases the summed power is corrected to account for the equivalent noise bandwidth (ENBW) of the resolution bandwidth used.

If power averaging is used (typically for certain digital modulation techniques), the EUT is configured to transmit continuously. Power averaging is performed using either the built-in function of the analyzer or, if the analyzer does not feature power averaging, using external software. In both cases the average power is calculated over a number of sweeps (typically 100). When the EUT cannot be configured to continuously transmit then either the analyzer is configured to perform a gated sweep to ensure that the power is averaged over periods that the device is transmitting or power averaging is disabled and a max-hold feature is used.

If a power meter is used to make output power measurements the sensor head type (peak or average) is stated in the test data table.

BANDWIDTH MEASUREMENTS

The 6dB, 20dB, 26dB and/or 99% signal bandwidth are measured using the bandwidths recommended by ANSI C63.10 and RSS GEN.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

CONDUCTED EMISSIONS SPECIFICATION LIMITS: FCC 15.207; FCC 15.107(a), RSS GEN

The table below shows the limits for the emissions on the AC power line from an intentional radiator and a receiver.

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[1].

Frequency Range (MHz)	Limit (uV/m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100 @ 3m	40 @ 3m
88 to 216	150 @ 3m	43.5 @ 3m
216 to 960	200 @ 3m	46.0 @ 3m
Above 960	500 @ 3m	54.0 @ 3m

OUTPUT POWER LIMITS – FHSS SYSTEMS

The table below shows the limits for output power based on the number of channels available for the hopping system.

Operating Frequency (MHz)	Number of Channels	Output Power
2400 – 2483.5	≥ 15	0.125 Watts (21 dBm)

The maximum permitted output power is reduced by 1dB for every dB the antenna gain exceeds 6dBi.

TRANSMIT MODE SPURIOUS RADIATED EMISSIONS LIMITS – FHSS and DTS SYSTEMS

The limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands are those specified in the general limits sections of FCC Part 15 and RSS 247. All other unwanted (spurious) emissions shall be at least 20dB below the level of the highest in-band signal level (30dB if the power is measured using the sample detector/power averaging method).

[1] The restricted bands are detailed in FCC 15.205 and RSS-Gen Table 6

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - S = M$$

where:
R_r = Receiver Reading in dBuV
S = Specification Limit in dBuV
M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor, when used for electric field measurements above 30MHz, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:
F_d = Distance Factor in dB
D_m = Measurement Distance in meters
D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:
R_r = Receiver Reading in dBuV/m
F_d = Distance Factor in dB
R_c = Corrected Reading in dBuV/m
L_s = Specification Limit in dBuV/m
M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS - FIELD STRENGTH TO EIRP CONVERSION

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp), or where a field strength measurement of output power is made in lieu of a direct measurement, the following formula is used to convert between eirp and field strength at a distance of d (meters) from the equipment under test:

$$E = \frac{1000000 \sqrt{30 P}}{d} \quad \text{microvolts per meter}$$

where P is the eirp (Watts)

For a measurement at 3m the conversion from a logarithmic value for field strength (dBuV/m) to an eirp power (dBm) is -95.3dB.

Appendix A Test Equipment Calibration Data

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Radiated Spurious Emissions, Bandedges, 1 - 6.5 GHz, 29-Jun-17					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/21/2015	12/21/2017
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1538	2/11/2017	2/11/2018
Radiated Emissions, 1000 - 25,000 MHz, 30-Jun-17					
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/21/2015	12/21/2017
Hewlett Packard	High Pass filter, 8.2 GHz	P/N 84300-80039	1156	5/10/2017	5/10/2018
HP / Miteq	SA40 P Head HF preAmplifier, 18-40 GHz (w/2415)	TTA1840-45-5P-HG-S	1772	9/12/2016	N/A
A. H. Systems	Spare System Horn, 18-40GHz	SAS-574, p/n: 2581	2162	7/29/2015	7/29/2017
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	9/30/2016	9/30/2017
Micro-Tronics	Band Reject Filter, 2400-2500 MHz 18GHz	BRM50702-02	2238	5/17/2017	5/17/2018
Hewlett Packard	Spectrum Analyzer (SA40) Purple 9 kHz - 40 GHz,	8564E (84125C)	2415	3/1/2017	3/1/2018
Radiated Emissions, 30 - 1,000 MHz, 18-Jul-17					
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1548	10/12/2016	10/12/2018
Com-Power	Preamplifier, 30-1000 MHz	PA-103	1632	3/8/2017	3/8/2018
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1756	7/8/2017	7/8/2018
Micro-Tronics	Band Reject Filter, 2400-2500 MHz 18GHz	BRM50702-02	2238	5/17/2017	5/17/2018
Micro-Tronics	Band Reject Filter, 5150-5350 MHz	BRC50703-02	2251	9/19/2016	9/19/2017
Radiated Emissions, 1000 - 12,000 MHz, 18-Jul-17					
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/21/2015	12/21/2017
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	9/30/2016	9/30/2017
Micro-Tronics	Band Reject Filter, 2400-2500 MHz 18GHz	BRM50702-02	2238	5/17/2017	5/17/2018
Hewlett Packard	Spectrum Analyzer (SA40) Purple 9 kHz - 40 GHz,	8564E (84125C)	2415	3/1/2017	3/1/2018
Radio Antenna Port (Power and Spurious Emissions), 21-Jul-17					
Agilent Technologies	3Hz -44GHz PSA Spectrum Analyzer	E4446A	2796	5/22/2017	5/22/2018
Conducted Emissions - AC Power Ports, 21-Jul-17					
EMCO	LISN, 10 kHz-100 MHz	3825/2	1292	8/1/2016	8/1/2017
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1401	2/3/2017	2/3/2018
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1756	7/8/2017	7/8/2018

Appendix B Test Data

T104956 Pages 25 – 59

Client:	Google Inc.	Job Number:	JD104891
Product	Model H0A	T-Log Number:	T104956
System Configuration:	-	Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Emissions Standard(s):	FCC 15.247 / 15.407 / RSS-247	Class:	B
Immunity Standard(s):	-	Environment:	-

EMC Test Data

For The

Google Inc.

Product

Model H0A

Date of Last Test: 7/24/2017

Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Duty Cycle

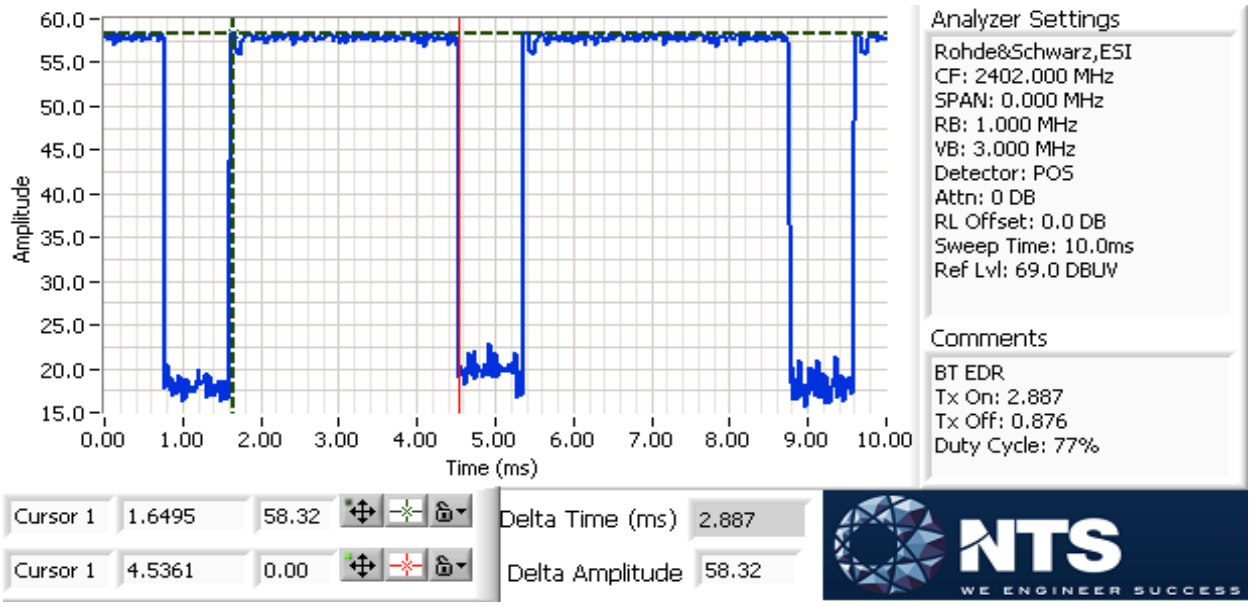
Date of Test: 6/29/2017
Test Engineer: Rafael Varelas
Test Location: FT Chamber #7

Duty cycle measurements performed on the worse case data rate for power.

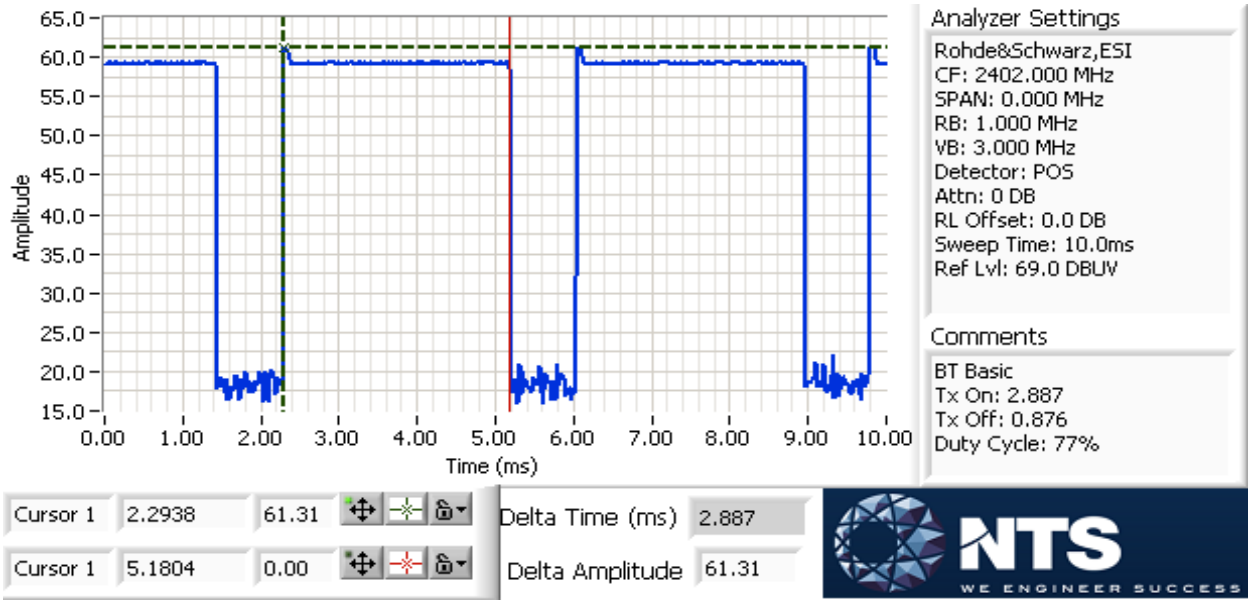
Notes: Measurements taken with maximum RBW/VBW settings allowed.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
Basic	1Mb/s	0.77	Yes	2.877	1.2	2.3	348
EDR	3Mb/s	0.77	Yes	2.887	1.2	2.3	346

* Correction factor when using RMS/Power averaging - 10*log(1/x)
** Correction factor when using linear voltage average - 20*log(1/x)
T = Minimum transmission duration



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

RSS-247 and FCC 15.247 (FHSS) Measurements

Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.
For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 22.4 °C
Rel. Humidity: 38 %

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Mode	Channel	Target Power	Power Setting	Test Performed	Limit	Result / Margin
1a	Basic rate 1Mb/s	2402	6	6	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(d)	32.7 dBµV/m @ 2383.3 MHz (-21.3 dB)
			6	6	Radiated Emissions, 1 - 25 GHz		35.9 dBµV/m @ 4804.0 MHz (-18.1 dB)
1b		2440	6	6	Radiated Emissions, 1 - 25 GHz		36.6 dBµV/m @ 4880.1 MHz (-17.4 dB)
1c		2480	6	6	Restricted Band Edge (2483.5 MHz)		36.4 dBµV/m @ 2483.6 MHz (-17.6 dB)
			6	6	Radiated Emissions, 1 - 25 GHz		35.6 dBµV/m @ 4959.9 MHz (-18.4 dB)
2a	EDR 3Mb/s	2402	6	6	Restricted Band Edge (2390 MHz)		34.3 dBµV/m @ 2364.4 MHz (-19.7 dB)
			6	6	Radiated Emissions, 1 - 25 GHz		35.3 dBµV/m @ 4804.5 MHz (-18.7 dB)
2b		2440	6	6	Radiated Emissions, 1 - 25 GHz		35.7 dBµV/m @ 4879.1 MHz (-18.3 dB)
2c		2480	6	6	Restricted Band Edge (2483.5 MHz)		38.0 dBµV/m @ 2483.5 MHz (-16.0 dB)
			6	6	Radiated Emissions, 1 - 25 GHz		35.6 dBµV/m @ 4960.0 MHz (-18.4 dB)

Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
Peak measurements performed with: RBW=1MHz, VBW=3MHz, peak detector, max hold, auto sweep time
Unless otherwise stated/noted, emission has duty cycle ≥ 98% and was measured using RBW=1MHz, VBW=10Hz, peak detector, linear average mode, auto sweep time, max hold.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
Basic	1Mb/s	0.77	Yes	2.877	1.2	2.3	348
EDR	3Mb/s	0.77	Yes	2.887	1.2	2.3	346

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 20dB below the level of the fundamental and measured in 100kHz.
Note 4:	Emission has constant duty cycle < 98%, average measurement performed: RBW=1MHz, VBW>1/T but not less than 10Hz, peak detector, linear averaging, auto sweep, trace average 100 traces, measurement corrected by Linear voltage correction factor
Note 6:	Plots of the average bandedge do not account for any duty cycle correction. Refer to the tabluar results for final measurements.

Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Sample Notes

Sample S/N: Engineering Radiated Sample #2
Driver: -
Antenna: Internal

Note: All testing performed on the Antenna 2 port (wifi set to 10 1 1, which forces BT to Antenna 2), as this was worse case from preliminary measurements.

Preliminary measurement demonstrated no spurious emissions below 1GHz. Evaluation of simultaneous BT and Wifi operation is addressed in the DTS and UNII test reports.

Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Run #1: Radiated Spurious Emissions, 1,000 - 25,000 MHz. Operating Mode: Basic Rate

Date of Test: 6/29/2017 0:00
Test Engineer: Rafael Varelas
Test Location: FT Chamber #7

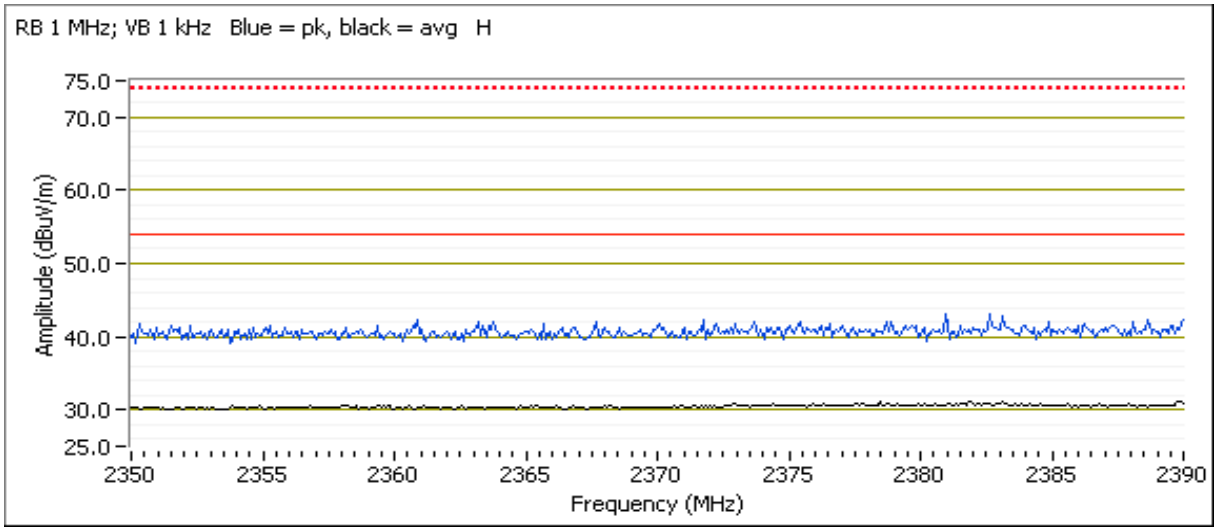
Config. Used: 1
Config Change: None
EUT Voltage: USB

Run #1a: Low Channel @ 2402 MHz

Antenna 2

Band Edge Signal Field Strength - Direct measurement of field strength

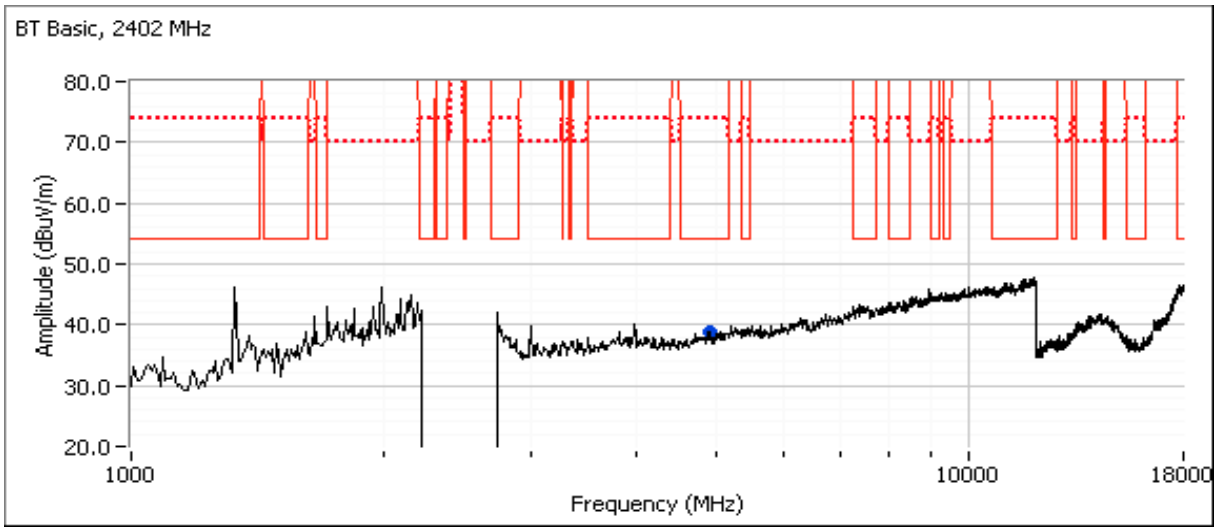
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2383.270	32.7	H	54.0	-21.3	Avg	33	1.0	RB 1 MHz; VB: 1 kHz, note 4
2354.890	42.5	H	74.0	-31.5	PK	33	1.0	POS; RB 1 MHz; VB: 3 MHz



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4803.990	35.9	H	54.0	-18.1	Avg	314	1.0	RB 1 MHz; VB: 1 kHz, note 4
4804.190	46.5	H	74.0	-27.5	PK	314	1.0	RB 1 MHz;VB 3 MHz;Peak

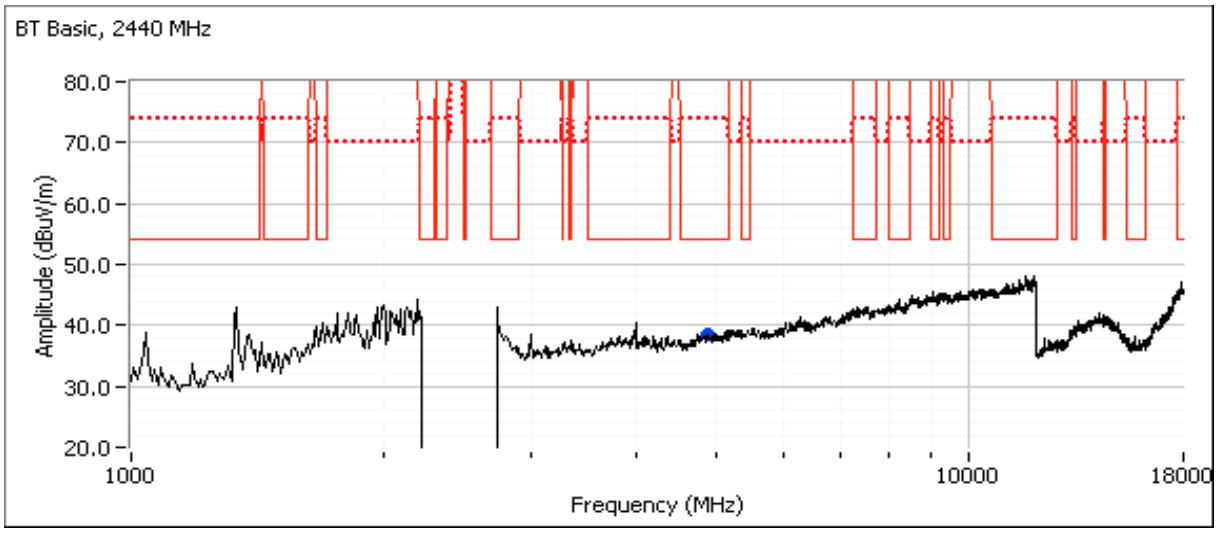


Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Run #1b: Center Channel @ 2440 MHz Antenna 2

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4880.110	36.6	H	54.0	-17.4	Avg	318	1.0	RB 1 MHz; VB: 1 kHz, note 4
4879.540	46.6	H	74.0	-27.4	PK	318	1.0	RB 1 MHz;VB 3 MHz;Peak

Note:	Scans made between 18 - 25 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range

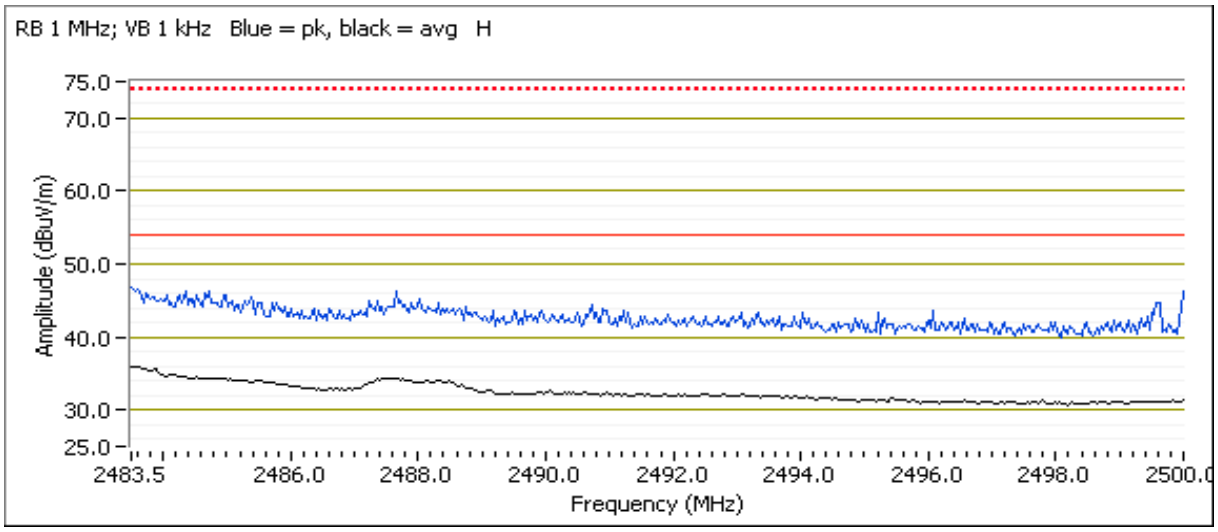


Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Run #1c: High Channel @ 2480 MHz Antenna 2

Band Edge Signal Field Strength - Direct measurement of field strength

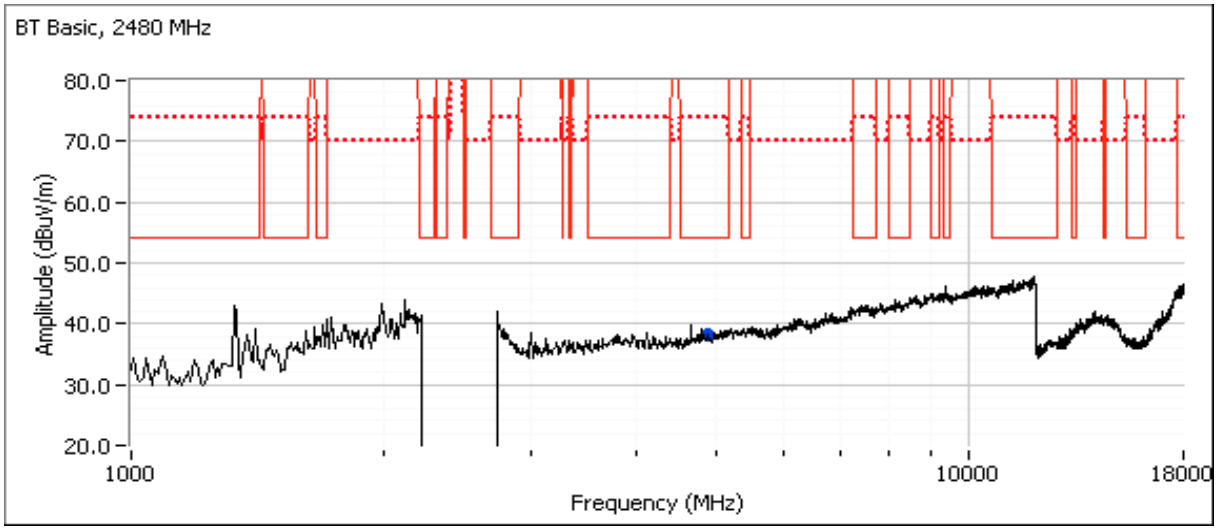
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.630	36.4	H	54.0	-17.6	Avg	341	1.1	RB 1 MHz; VB: 1 kHz, note 4
2484.890	45.7	H	74.0	-28.3	PK	341	1.1	POS; RB 1 MHz; VB: 3 MHz



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4959.870	35.6	V	54.0	-18.4	Avg	12	1.0	RB 1 MHz; VB: 1 kHz, note 4
4959.220	45.4	V	74.0	-28.6	PK	12	1.0	RB 1 MHz;VB 3 MHz;Peak



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Run 2: Radiated Spurious Emissions, 1,000 - 25,000 MHz. Operating Mode: EDR

Date of Test: 6/29/2017 0:00
Test Engineer: Rafael Varelas
Test Location: FT Chamber #7

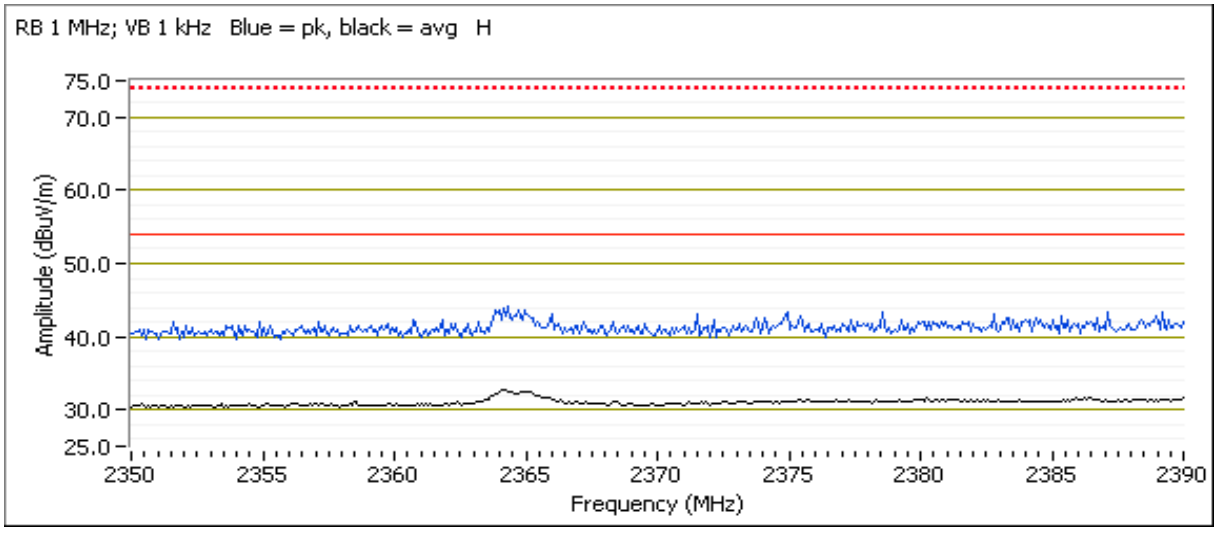
Config. Used: 1
Config Change: None
EUT Voltage: USB

Run #2a: Low Channel @ 2402 MHz

Antenna 2

Band Edge Signal Field Strength - Direct measurement of field strength

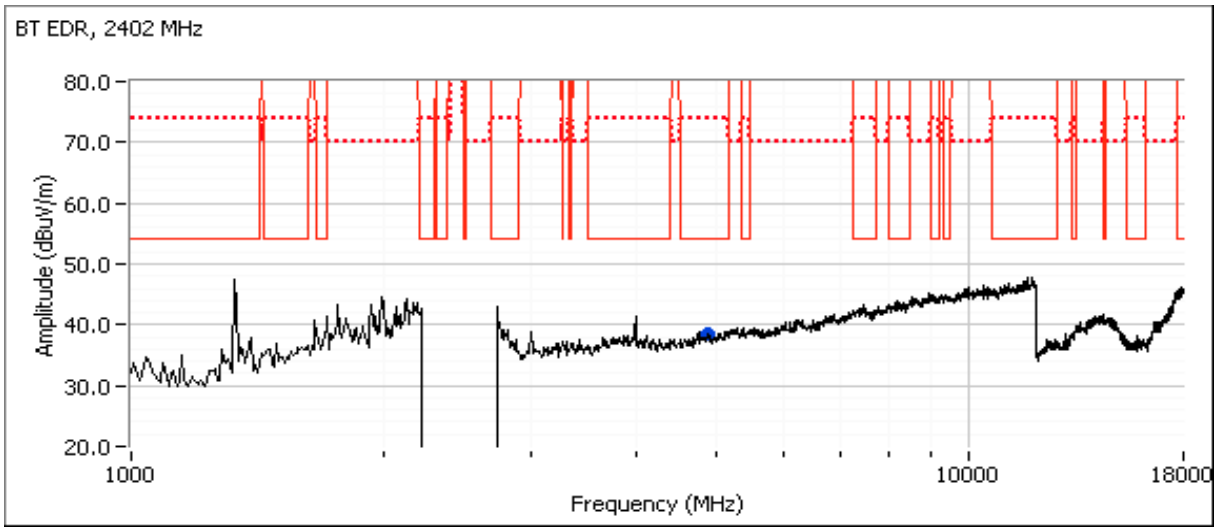
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2364.430	34.3	H	54.0	-19.7	Avg	341	2.0	RB 1 MHz; VB: 1 kHz, note 4
2363.550	43.5	H	74.0	-30.5	PK	341	2.0	POS; RB 1 MHz; VB: 3 MHz



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Other Spurious Emissions

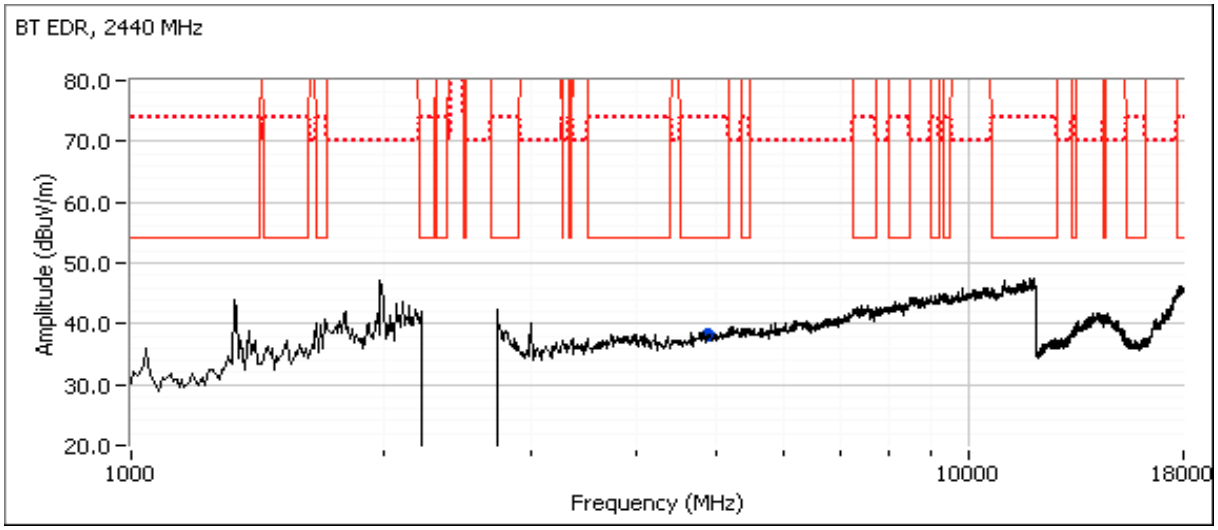
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4804.500	35.3	V	54.0	-18.7	Avg	29	1.0	RB 1 MHz; VB: 1 kHz, note 4
4803.210	45.3	V	74.0	-28.7	PK	29	1.0	RB 1 MHz;VB 3 MHz;Peak



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Run #2b: Center Channel @ 2440 MHz Antenna 2

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4879.120	35.7	V	54.0	-18.3	Avg	306	1.0	RB 1 MHz; VB: 1 kHz, note 4
4879.870	45.6	V	74.0	-28.4	PK	306	1.0	RB 1 MHz;VB 3 MHz;Peak

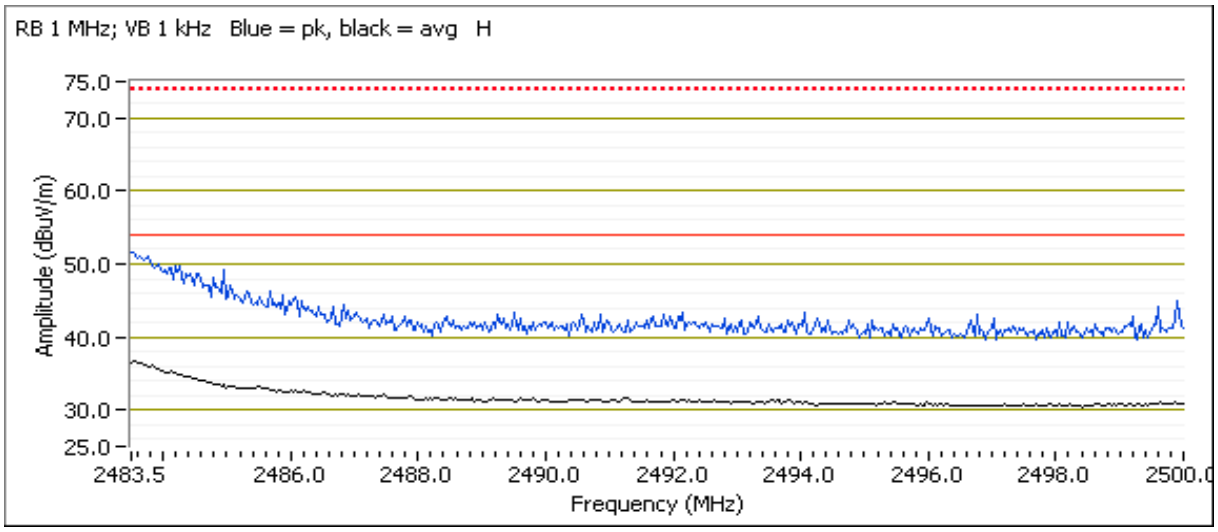


Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Run #2c: High Channel @ 2480 MHz Antenna 2

Band Edge Signal Field Strength - Direct measurement of field strength

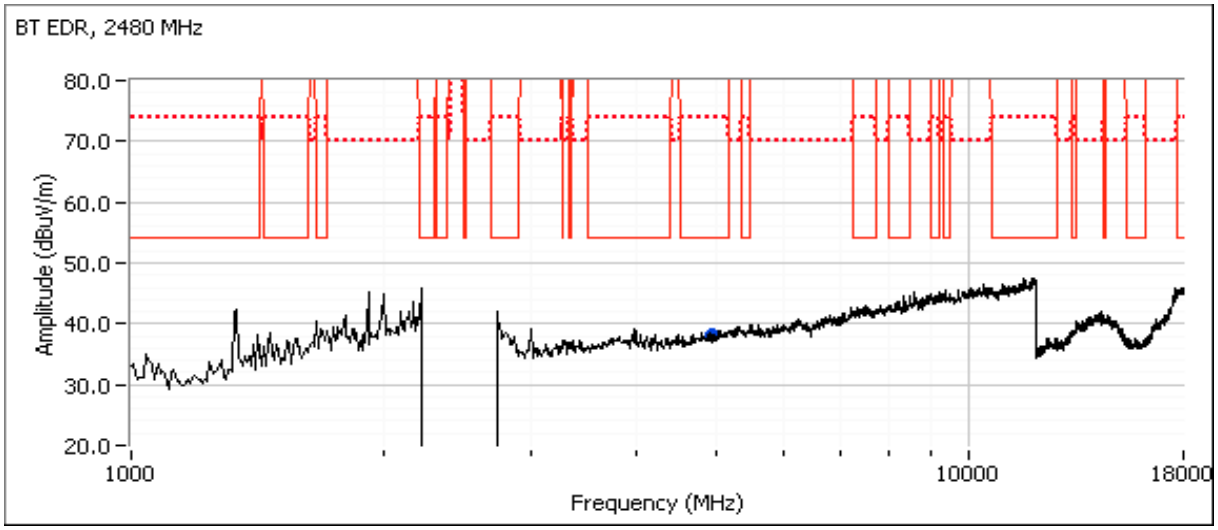
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.500	38.0	H	54.0	-16.0	Avg	0	2.1	RB 1 MHz; VB: 1 kHz, note 4
2483.530	51.7	H	74.0	-22.3	PK	0	2.1	POS; RB 1 MHz; VB: 3 MHz



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4959.960	35.6	H	54.0	-18.4	Avg	330	1.0	RB 1 MHz; VB: 1 kHz, note 4
4958.880	45.5	H	74.0	-28.5	PK	330	1.0	RB 1 MHz;VB 3 MHz;Peak



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

RSS-247 and FCC 15.247 (FHSS) Measurements

Power, Bandwidth and Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

When measuring the conducted emissions, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Unless stated otherwise the EUT was operating such that it constantly hopped on either the low, center or high channels.

Ambient Conditions:

Temperature: 22-24 °C

Rel. Humidity: 43-47 %

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1	Output Power	15.247(b)	Pass	Basic Rate: 5.7 dBm (3.7mW) EDR: 5.5 dBm (3.5mW)
2	20dB Bandwidth	15.247(a)	Pass	Basic Rate: 945 kHz EDR: 1295 kHz
2	Channel Occupancy	15.247(a)	Pass	Device complies with the Bluetooth specifications with a minimum of 20 hopping channels
2	Number of Channels	15.247(a)	Pass	
4	30 - 25,000 MHz - Transmitter Conducted Spurious Emissions	15.247(c)	Pass	All spurious < -20 dBc.

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Sample Notes

Sample S/N: Prototype Sample #1

Driver: -

Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Run #1: Output Power

Date of Test: 7/21/2017 Test Location: Lab 4

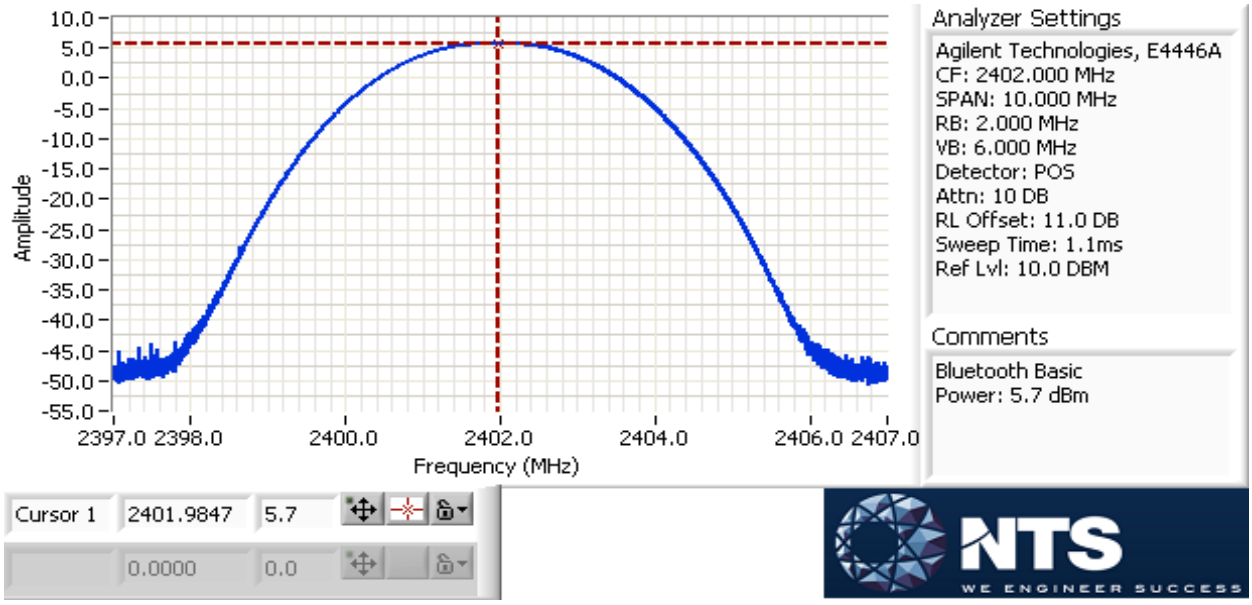
Test Engineer: M. Birgani

Limits: For frequency hopping systems operating in the 2400-2483.5 MHz band employing less than 75 non-overlapping hopping channels: 0.125 watts.

Maximum antenna gain: 4.0 dBi

Setting	Mode	Channel	Frequency (MHz)	Res BW	Output Power (dBm)	Output Power (W)	EIRP (W)
6	Basic Rate (DH5)	Low	2402	2.0	5.7	0.0037	0.0093
		Mid	2441	2.0	5.6	0.0036	0.0091
		High	2480	2.0	5.5	0.0035	0.0089
	EDR (3-DH5)	Low	2402	2.0	5.5	0.0035	0.0089
		Mid	2441	2.0	5.4	0.0035	0.0087
		High	2480	2.0	5.3	0.0034	0.0085

Note 1:	Output power measured using a spectrum analyzer with RBW > OBW and VB ≥3* RBW, Span ≥ 1.5 of OBW, auto sweep time, Peak detector and max hold. Spurious limit becomes -20dBc.



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Run #2: Bandwidth, Channel Occupancy, Spacing and Number of Channels

Date of Test: 7/21/2017 Test Location: lab 4

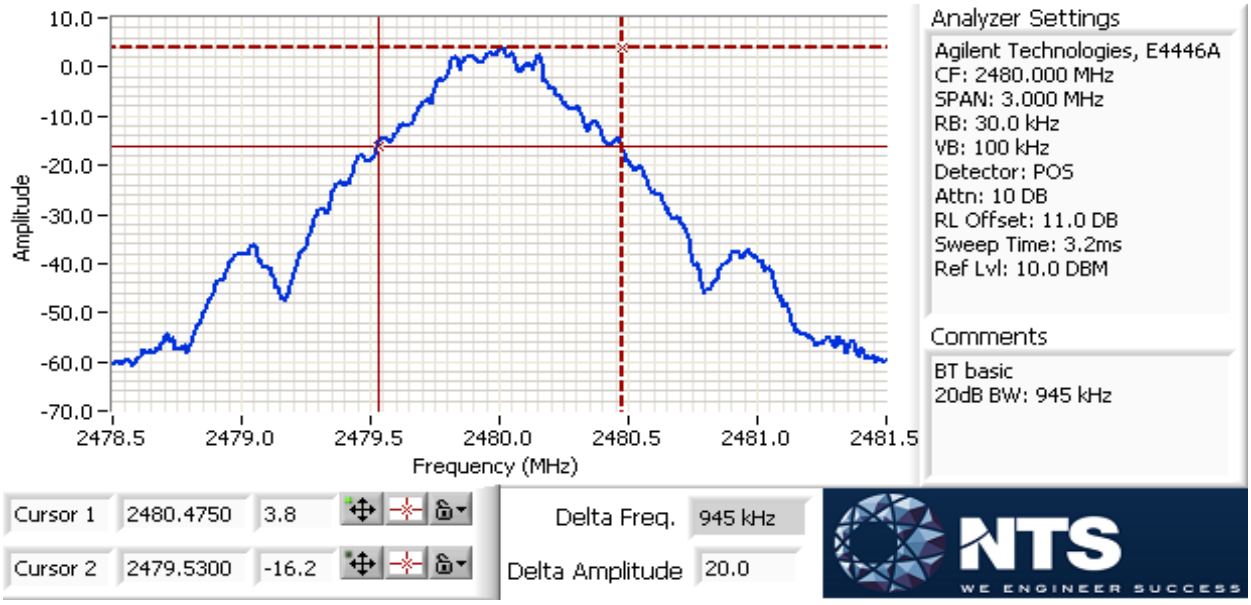
Test Engineer: John Caizzi

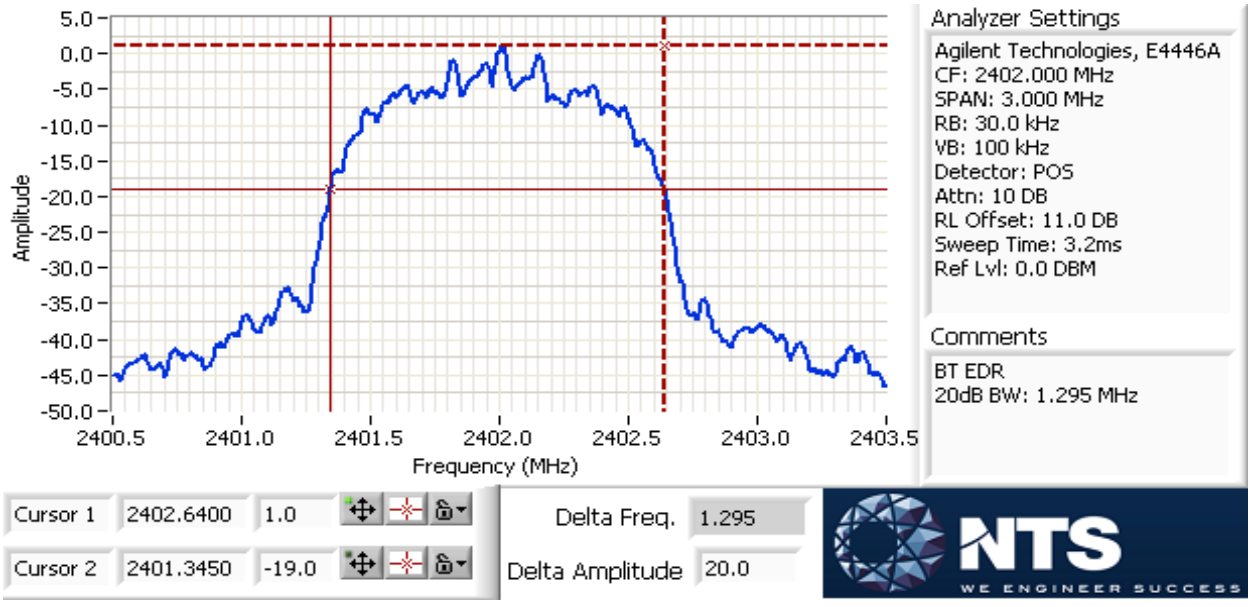
Mode	Setting	Channel	Frequency (MHz)	Resolution Bandwidth (kHz)	20dB Bandwidth (kHz)
Basic Rate (DH5)	6	Low	2402	30	945
		Mid	2441	30	945
		High	2480	30	945
EDR (3-DH5)		Low	2402	30	1.295
		Mid	2441	30	1.290
		High	2480	30	1.290

Note 1:	20dB bandwidth measured using RB = 30 kHz, VB = 100 kHz (VB > RB)

Requirment: Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. (Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.)
The device complies with the Bluetooth protocol and employs a minimum of 20 of the available 79 hopping channels when employing adaptove frequency hopping and all 79 channels when not. Channels are selected in a pseudo random manner to ensure, on average, all channels are used equally.
The hopping rate is 1600 hops per second although any new channel may be used for a single hop slot, 3 hop slots or 5 hop slots. The dwell time per channel is, therefore either 0.625ms (single slot), 1.875ms (three slot) or 3.125ms (five slot). The average time of occupancy will not exceed 0.4s in any time interval of 0.4s mutliplied by the number of channels being used.

Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

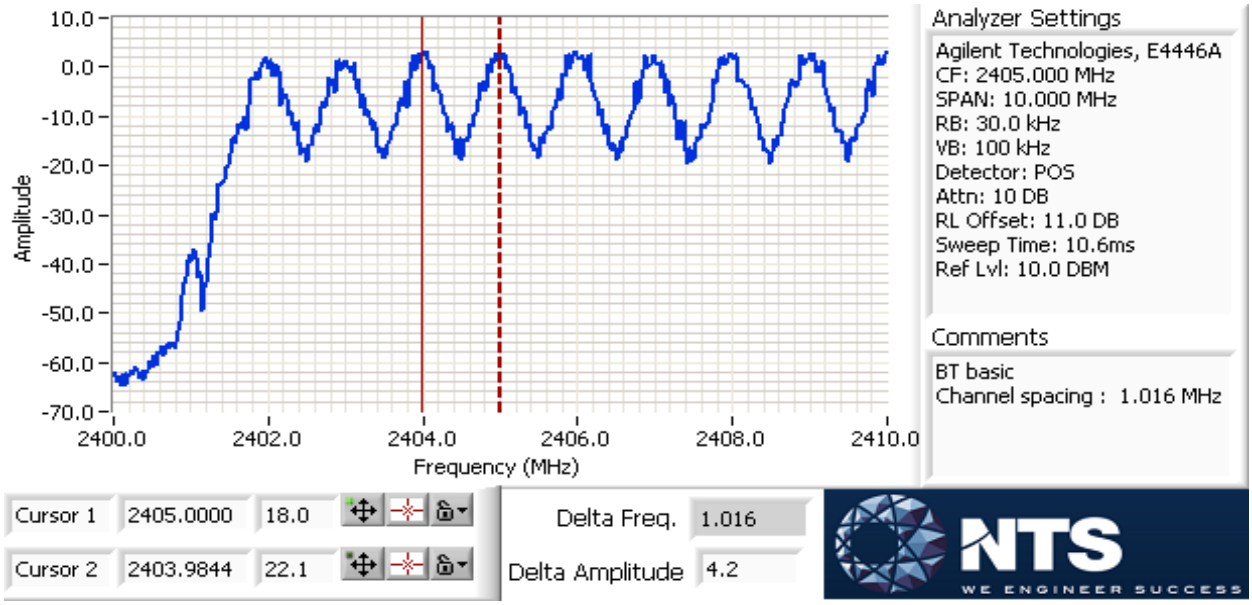




Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Channel Spacing:	1016 kHz		2/3 of 20dB BW		
20dB Bandwidth:	945 kHz	Basic	630 kHz	Basic	
20dB Bandwidth:	1295 kHz	EDR	863.3 kHz	EDR	

The channel spacing was measured in Basic rate mode with hopping enabled - see plot below showing channel spacing.

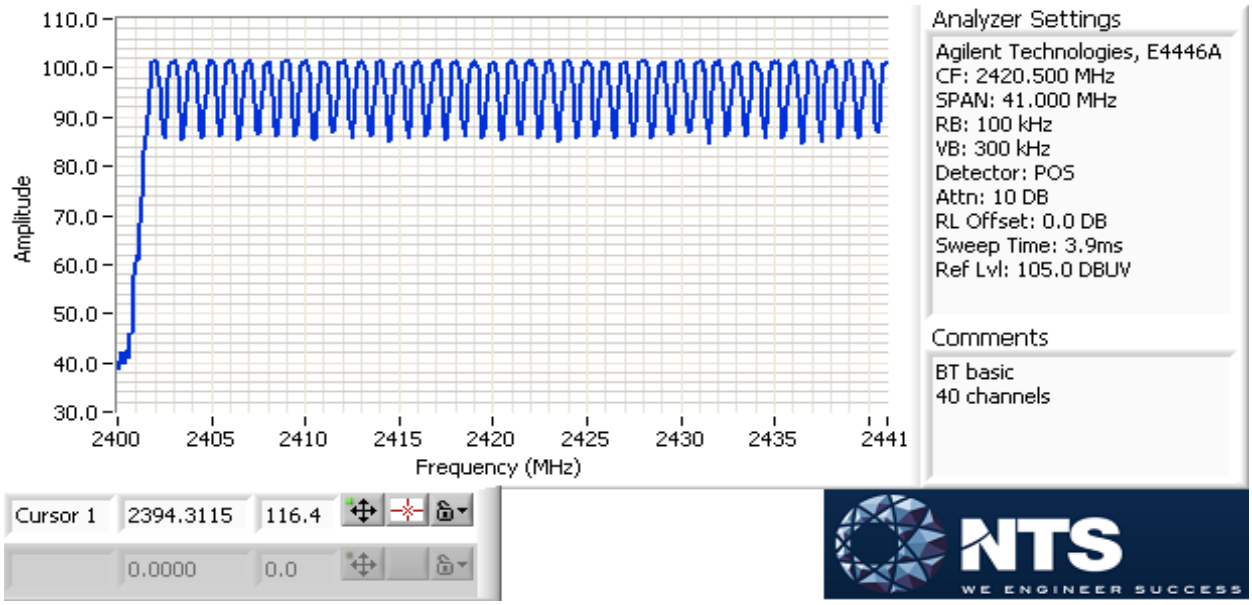


Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

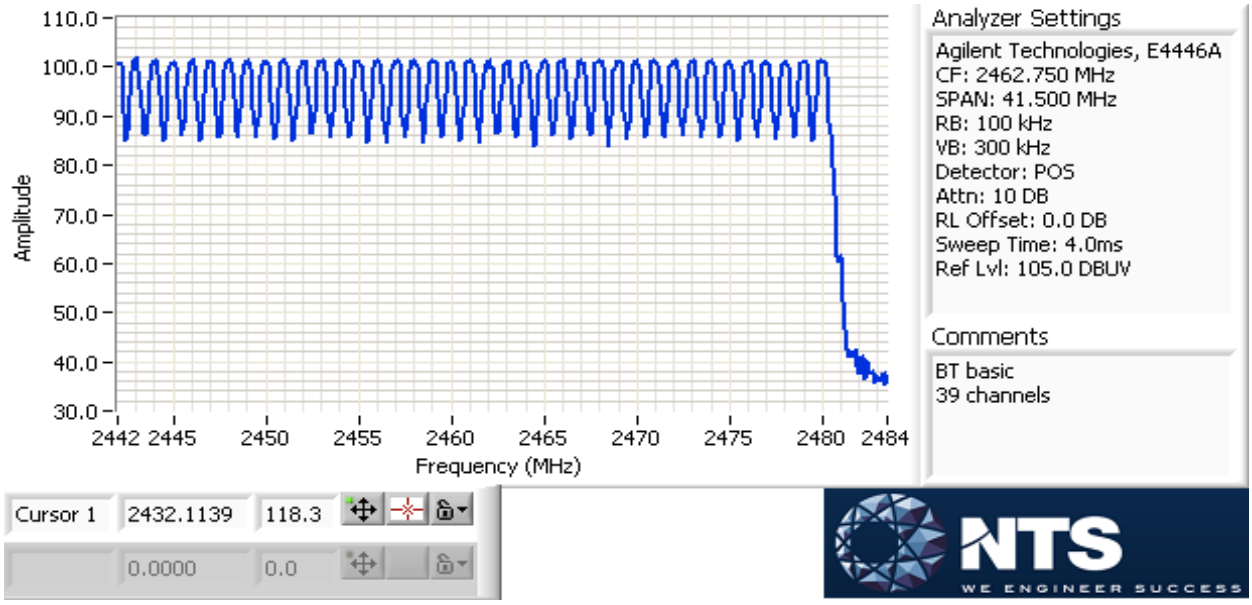
Requirement: The channel spacing shall be greater than 2/3 of the highest 20dB bandwidth as the ouput power is < 0.125 W.

The number of channels was measured in Basic rate mode with hopping enabled with both the maximum (all) channels enabled and with the minimum number of channels enabled. The system shall employ a minimum of 15 hopping channels.

Requirement: The system shall employ a minimum of 15 hopping channels.



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A



Number of channels: 79 Max 20 Min (AFH enabled)

Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Run #4a: Antenna Conducted Spurious Emissions, 30 - 25,000 MHz, Basic Rate

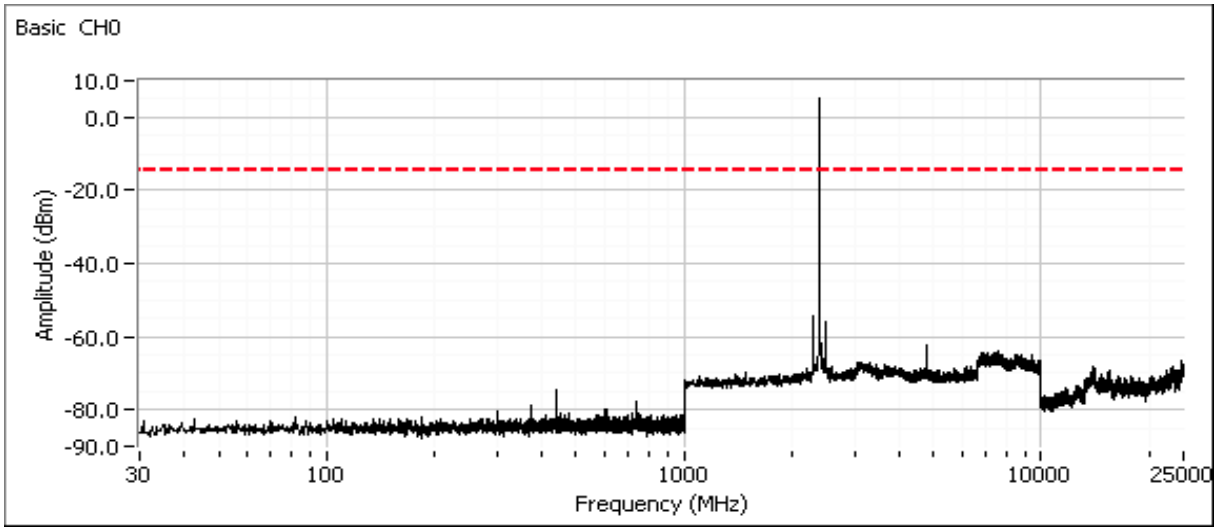
Date of Test: 7/21/2017 Test Location: Lab #4b

Test Engineer: John Caizzi

Frequency (MHz)	Power Setting	Mode	Limit	Result
2402	6	Basic	-20dBc	Pass
2441				Pass
2480				Pass

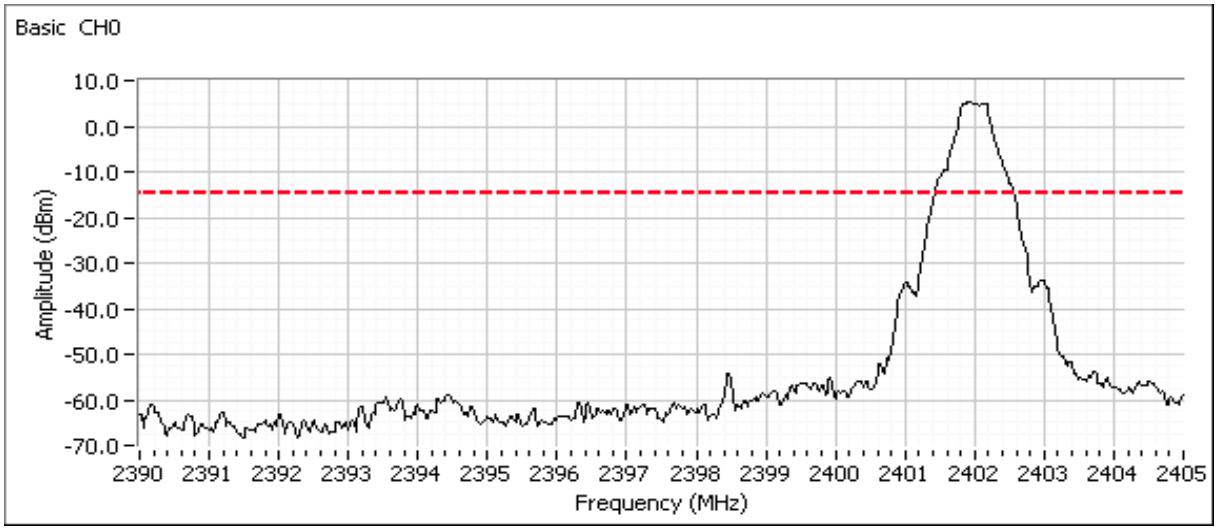
Refer to plots below. Scans made using RBW=VB=100 KHz with the limit line set at 20dB below the highest in-band signal level with the hopping feature disabled (unless otherwise noted).

Low channel

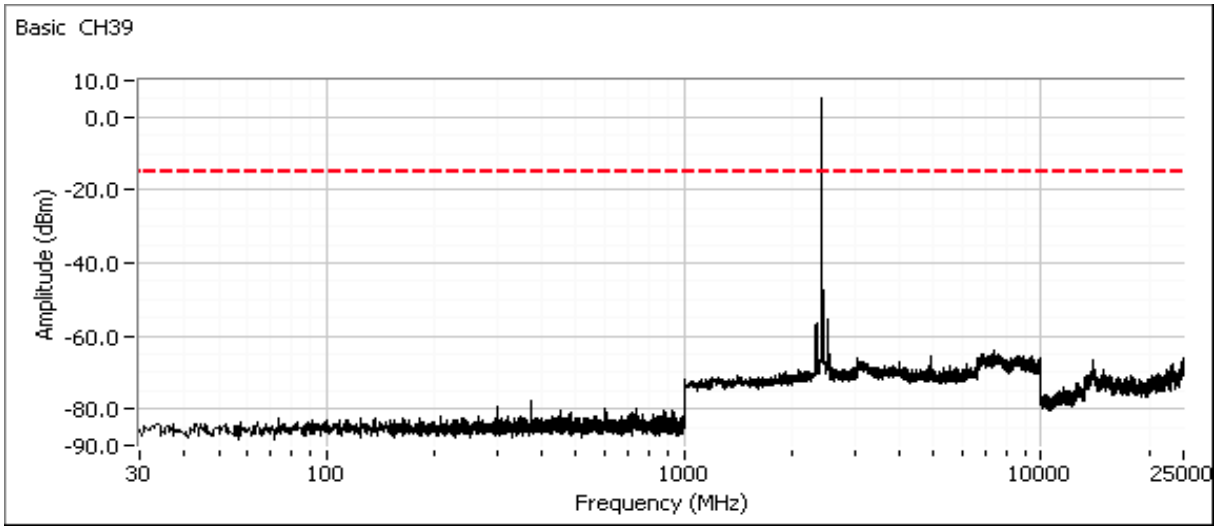


Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Plot showing -20dBc at the lower band edge

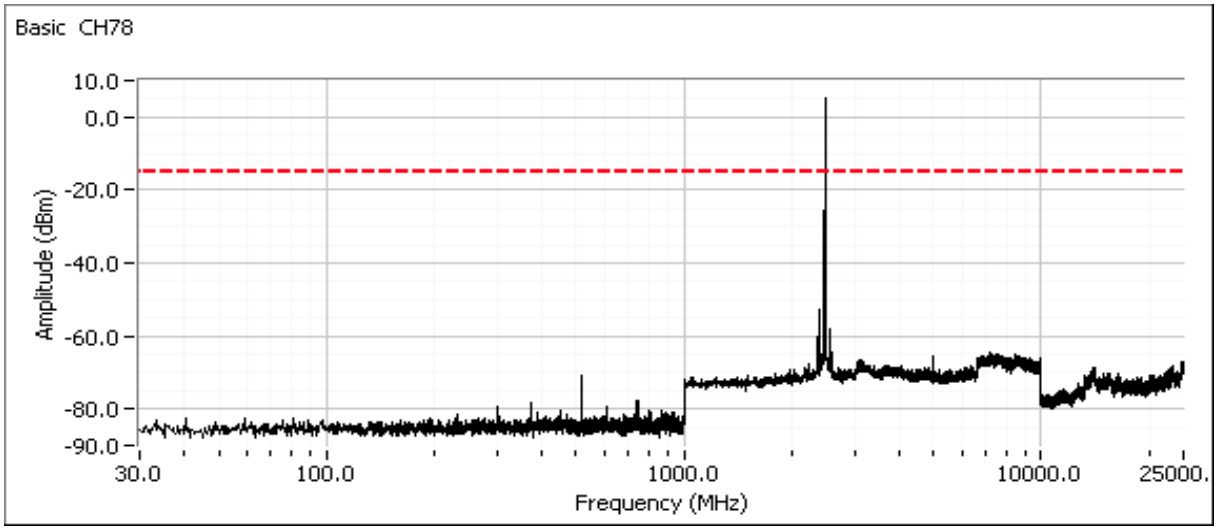


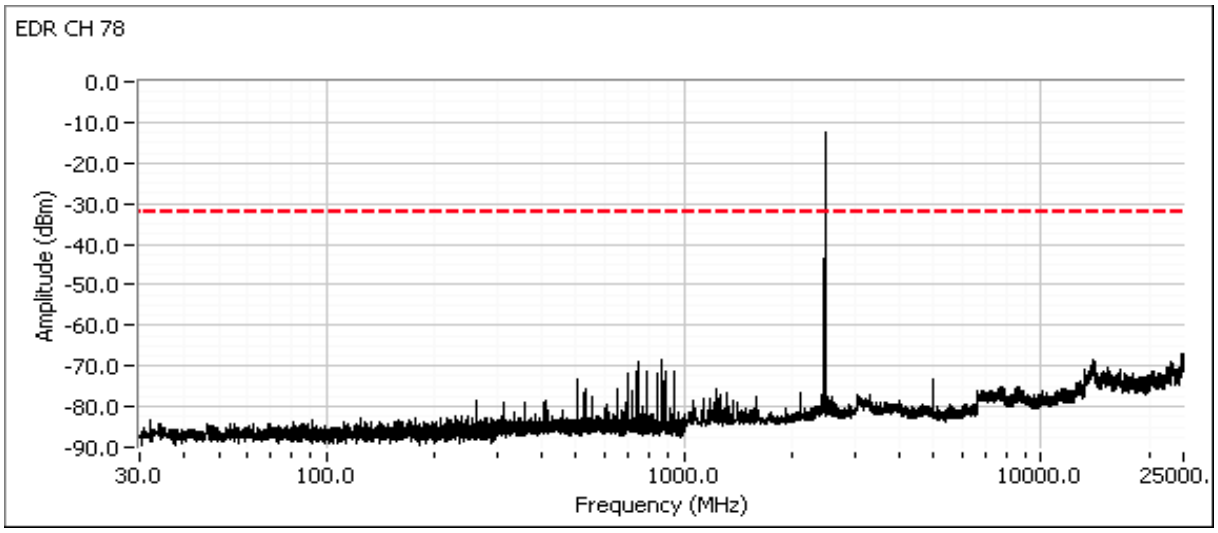
Center channel



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

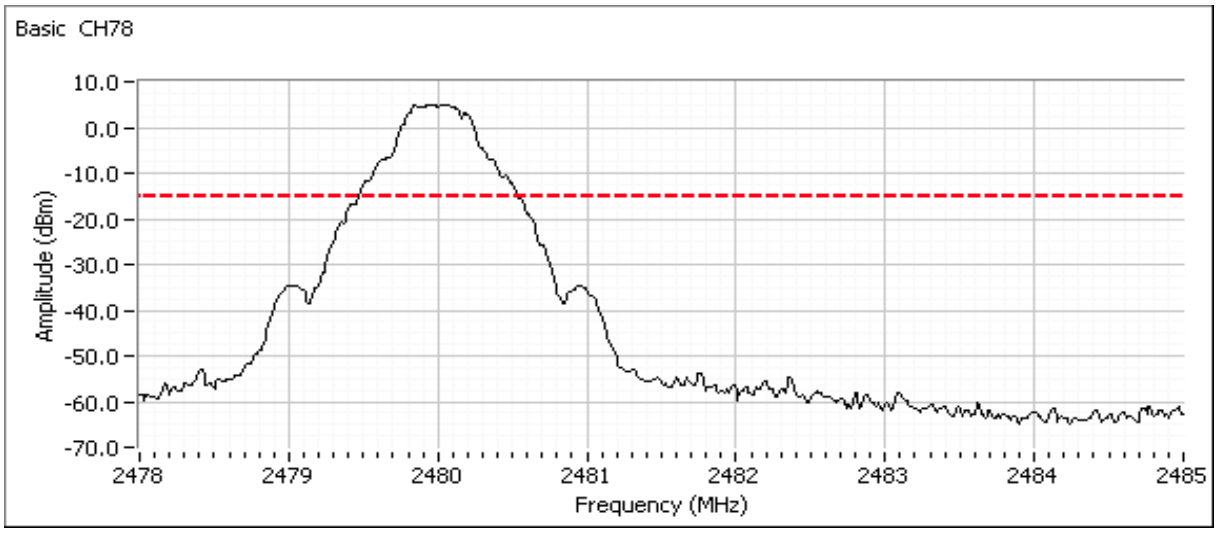
High channel

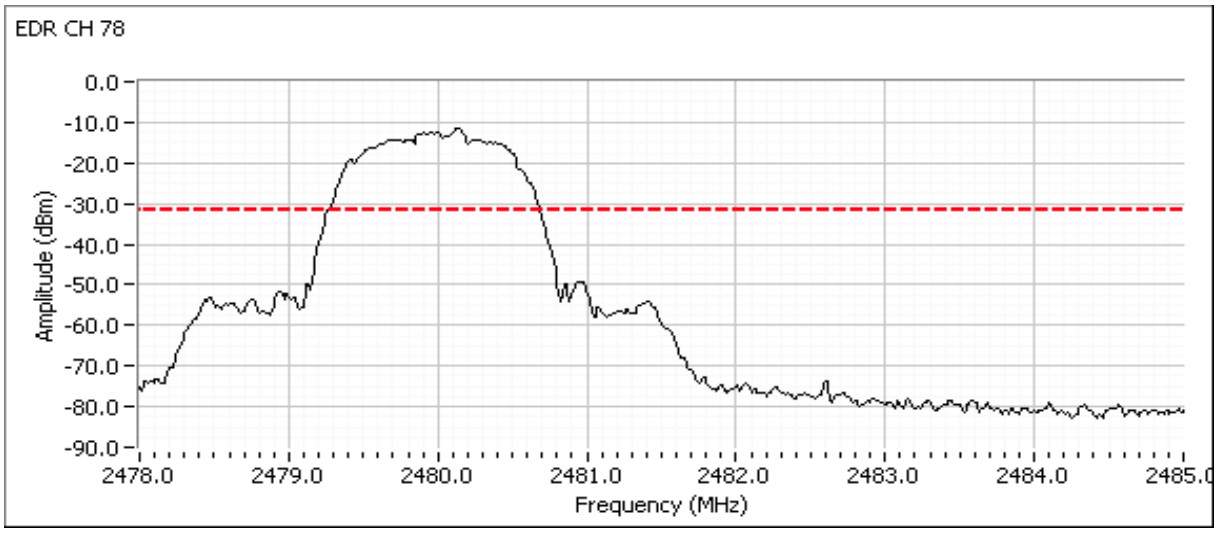




Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Plot showing -20dBc at the upper band edge



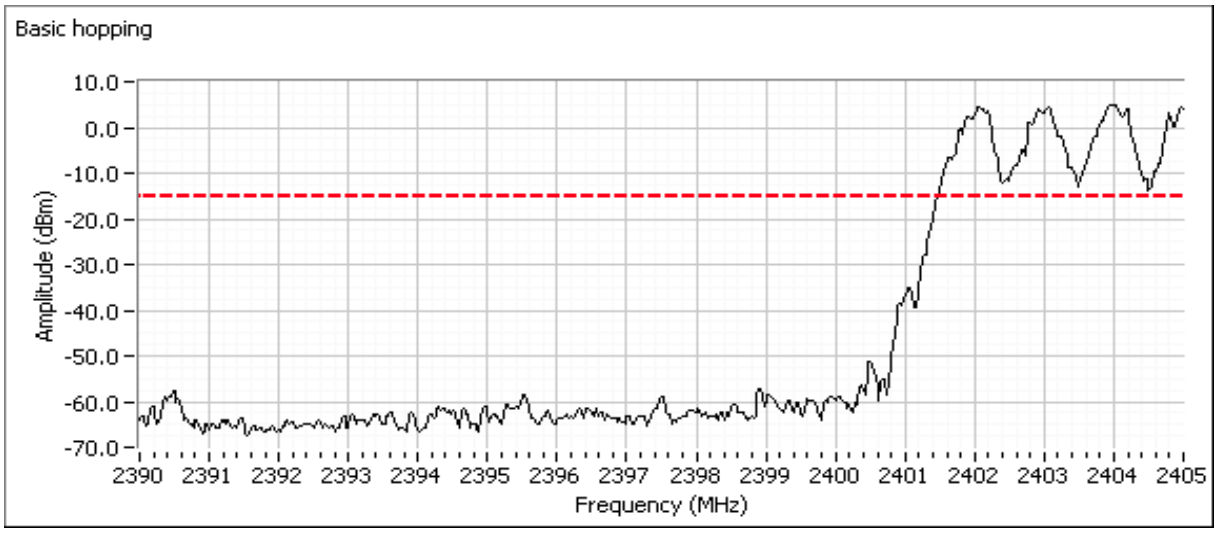


Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Refer to plots below. Scans made using RBW=100 KHz, VBW=300kHz with the limit line set at 20dB below the highest in-band signal level with the hopping feature enabled to show compliance with the -20dBc requirement at the allocated band edge. The spectrum analyzer is left in max hold mode until the trace stabilizes.

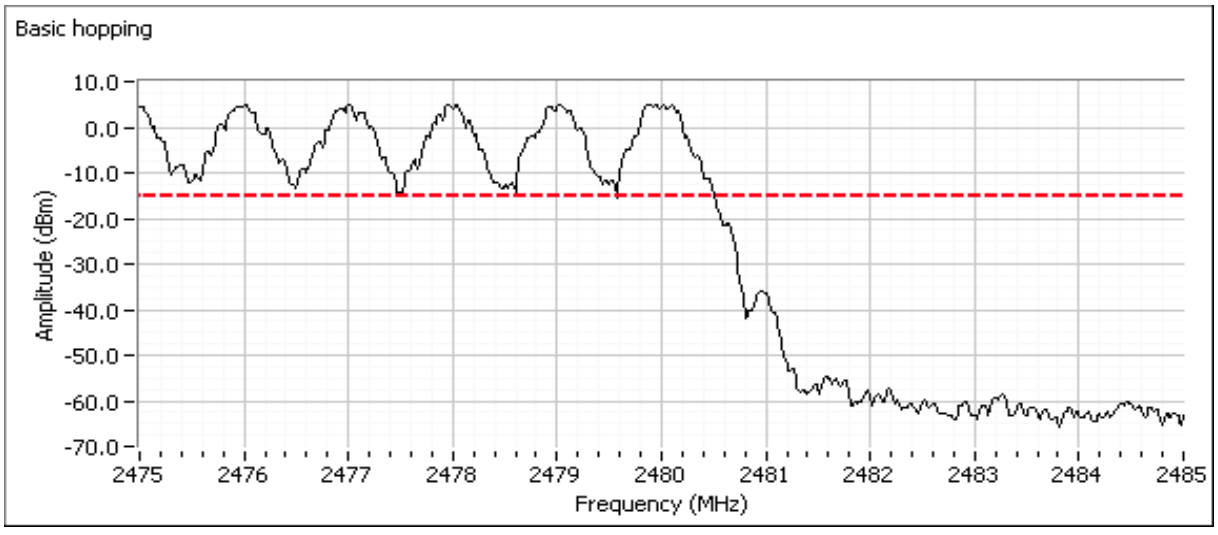
Low channel, hopping enabled

Plot showing -20dBc at the lower band edge



High channel, hopping enabled

Plot showing -20dBc at the upper band edge



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Run #4b: Antenna Conducted Spurious Emissions, 30 - 25,000 MHz, Extended Rate

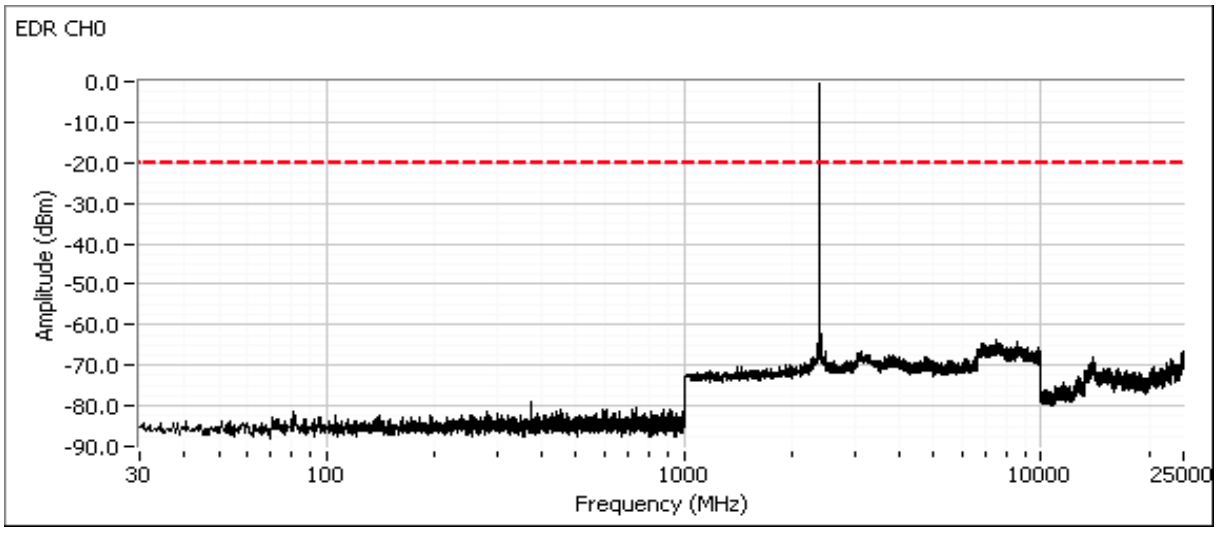
Date of Test: 7/21/2017 Test Location: Lab #4b

Test Engineer: John Caizzi

Frequency (MHz)	Power Setting	Mode	Limit	Result
2402	6	Basic	-20dBc	Pass
2441				Pass
2480				Pass

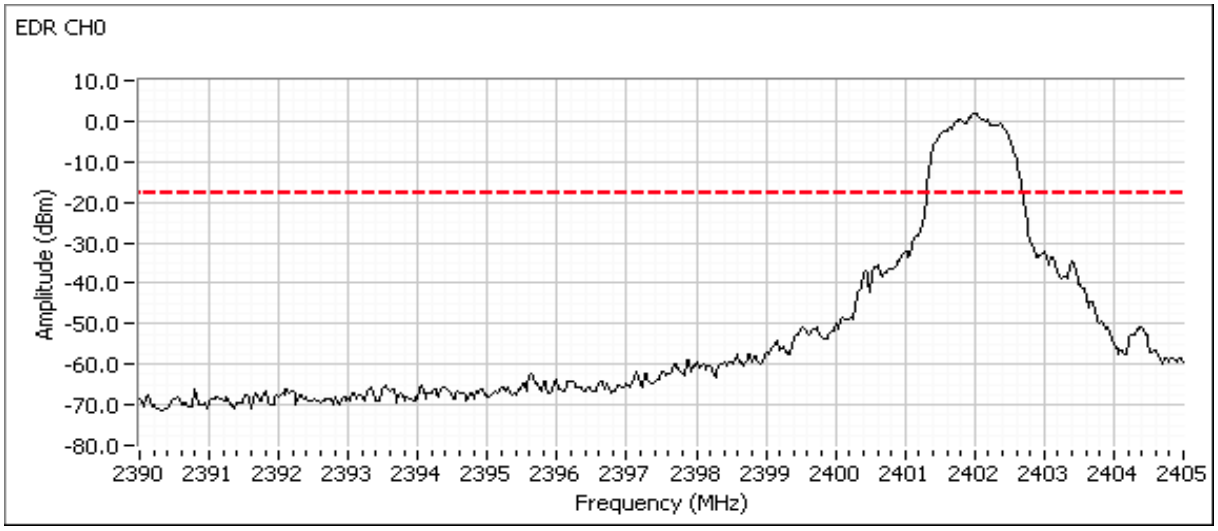
Refer to plots below. Scans made using RBW=VB=100 KHz with the limit line set at 20dB below the highest in-band signal level with the hopping feature disabled (unless otherwise noted).

Low channel

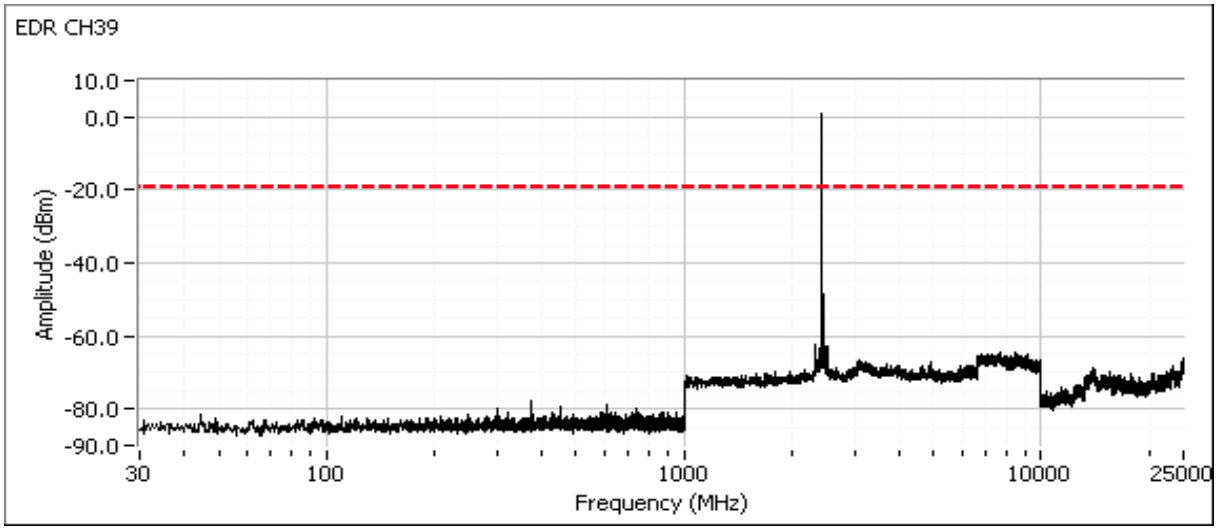


Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Plot showing -20dBc at the lower band edge

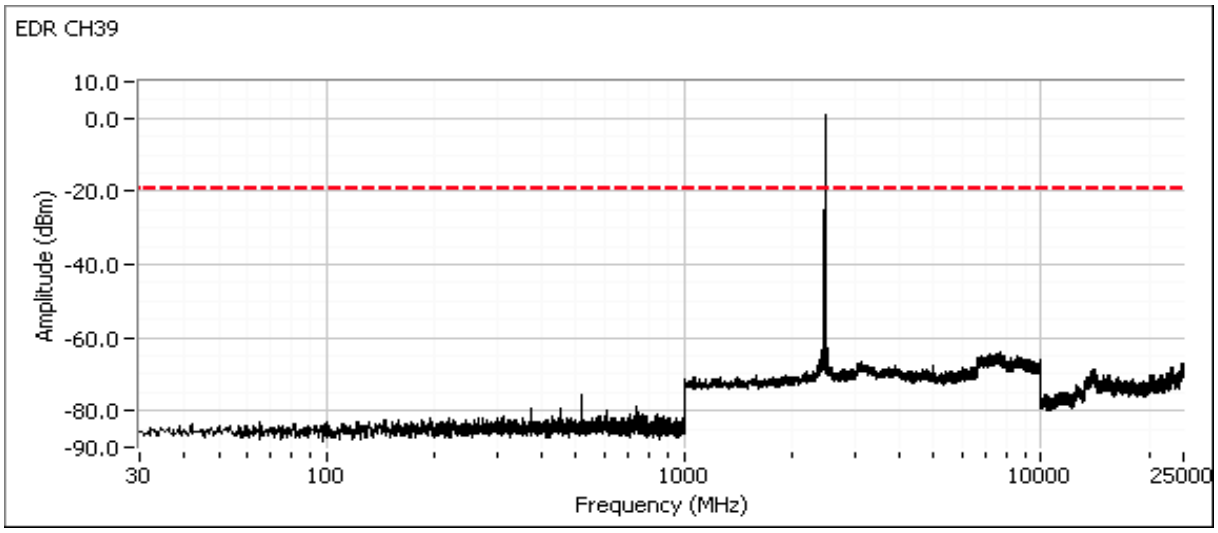


Center channel

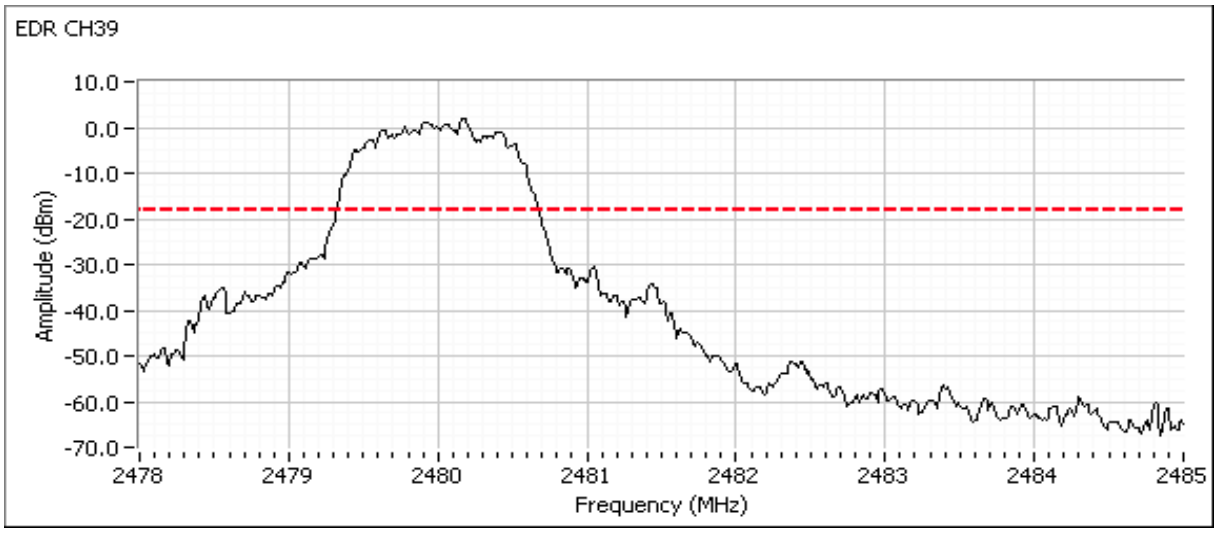


Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

High channel



Plot showing -20dBc at the upper band edge

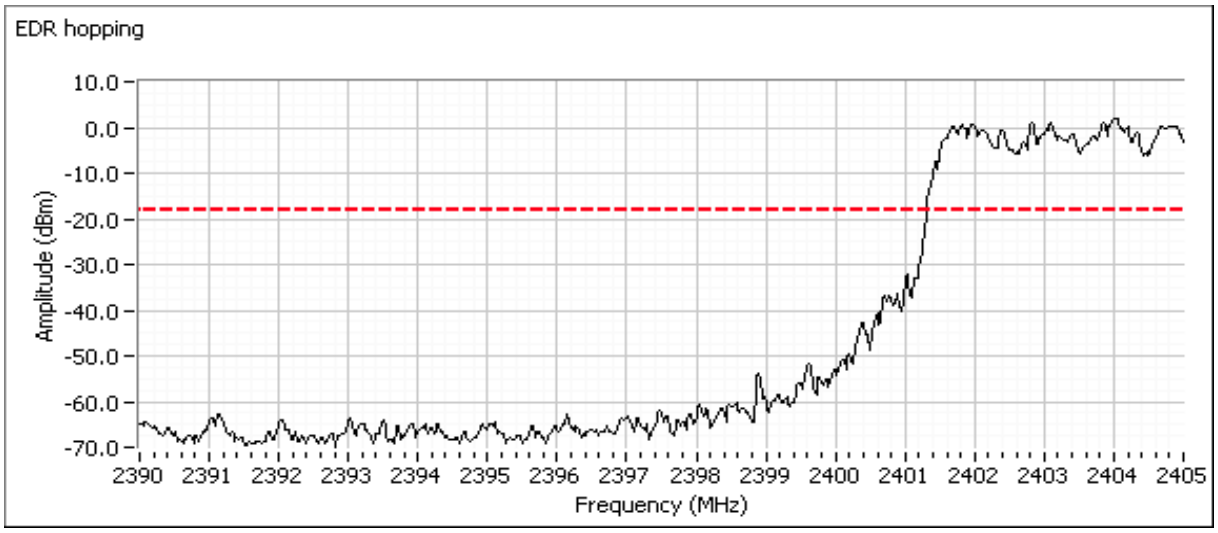


Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	N/A

Refer to plots below. Scans made using RBW=100 KHz, VBW=300kHz with the limit line set at 20dB below the highest in-band signal level with the hopping feature enabled to show compliance with the -20dBc requirement at the allocated band edge. The spectrum analyzer is left in max hold mode until the trace stabilizes.

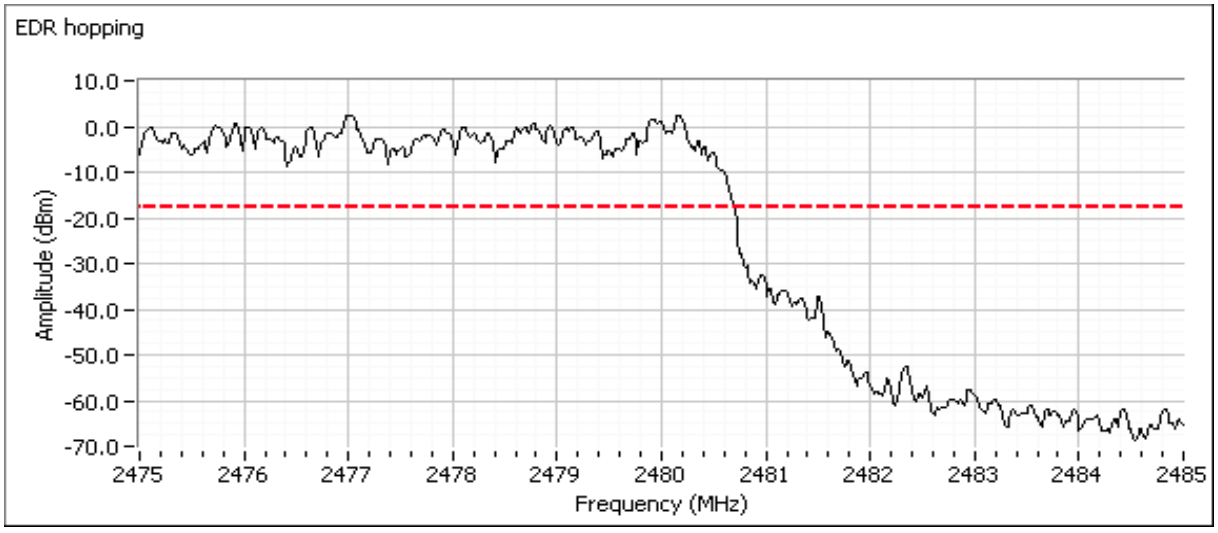
Low channel, hopping enabled

Plot showing -20dBc at the lower band edge



High channel, hopping enabled

Plot showing -20dBc at the upper band edge



Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	B

Conducted Emissions

(NTS Silicon Valley, Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 7/21/2017
Test Engineer: Rafael Varelas
Test Location: FT Chamber #4

Config. Used: 1
Config Change: none
EUT Voltage: 120V/60Hz

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table inside the semi-anechoic chamber, 40 cm from a vertical coupling plane and 80cm from the LISN.

Ambient Conditions:

Temperature: 23.4 °C
Rel. Humidity: 41 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power,120V/60Hz	15.207	Pass	27.7 dBµV @ 0.823 MHz (-18.3 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

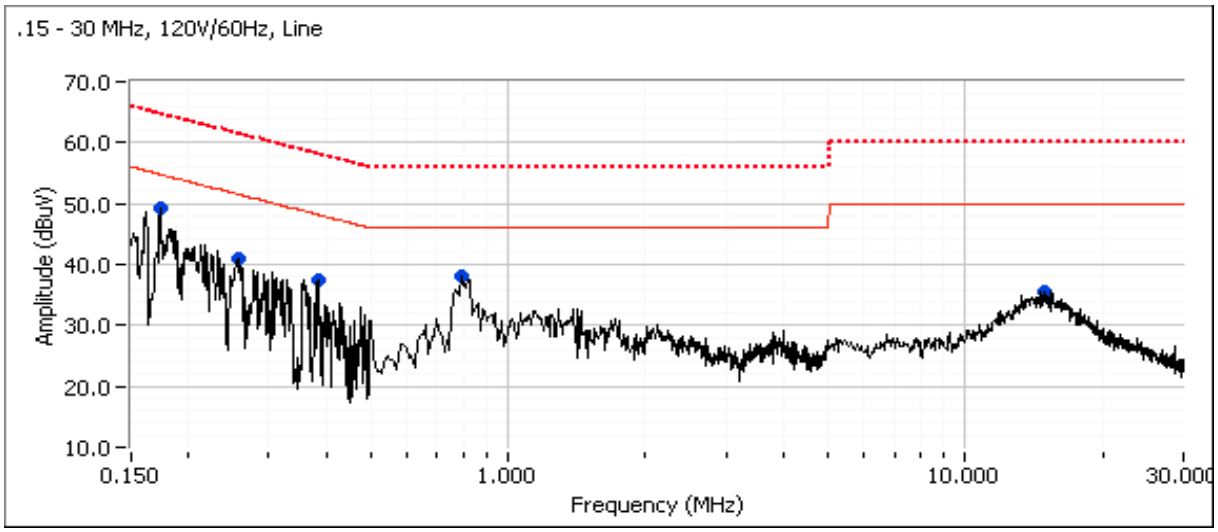
No deviations were made from the requirements of the standard.

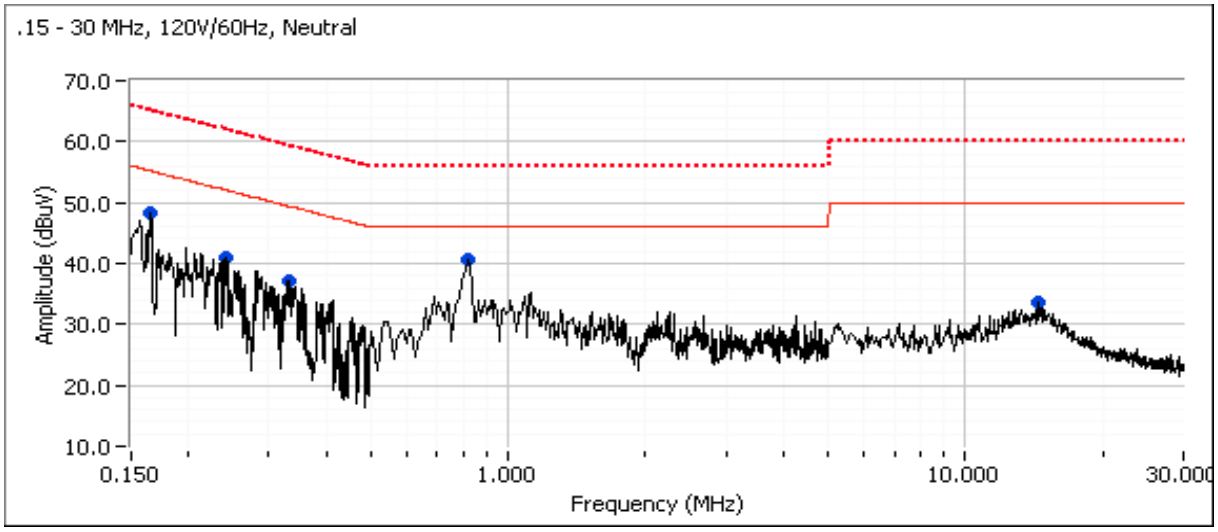
Channel: 5180 MHz
Antenna 2
Mode: a
Data Rate: 6MB/s

Channel: 2480 MHz
Antenna 2
Mode: BLE
Data Rate: 1MB/s

Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	B

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz





Client:	Google Inc.	Job Number:	JD104891
Model:	Model H0A	T-Log Number:	T104956
		Project Manager:	Deepa Shetty
Contact:	Dominik Mente	Project Coordinator:	-
Standard:	FCC 15.247 / 15.407 / RSS-247	Class:	B

Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency	Level	AC	15.207		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.172	49.2	Line 1	54.8	-5.6	Peak	
0.257	40.9	Line 1	51.5	-10.6	Peak	
0.383	37.4	Line 1	48.2	-10.8	Peak	
0.800	38.2	Line 1	46.0	-7.8	Peak	
14.888	35.6	Line 1	50.0	-14.4	Peak	
0.165	48.3	Neutral	55.2	-6.9	Peak	
0.240	41.0	Neutral	52.1	-11.1	Peak	
0.330	37.1	Neutral	49.4	-12.3	Peak	
0.823	40.6	Neutral	46.0	-5.4	Peak	
14.437	33.5	Neutral	50.0	-16.5	Peak	

Final quasi-peak and average readings

Frequency	Level	AC	15.207		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.823	27.7	Neutral	46.0	-18.3	AVG	AVG (0.10s)
0.823	37.3	Neutral	56.0	-18.7	QP	QP (1.00s)
0.800	24.6	Line 1	46.0	-21.4	AVG	AVG (0.10s)
0.800	34.2	Line 1	56.0	-21.8	QP	QP (1.00s)
0.172	42.0	Line 1	64.9	-22.9	QP	QP (1.00s)
0.165	41.5	Neutral	65.2	-23.7	QP	QP (1.00s)
0.257	36.5	Line 1	61.5	-25.0	QP	QP (1.00s)
0.330	34.3	Neutral	59.5	-25.2	QP	QP (1.00s)
14.888	23.5	Line 1	50.0	-26.5	AVG	AVG (0.10s)
0.383	31.3	Line 1	58.2	-26.9	QP	QP (1.00s)
14.437	22.7	Neutral	50.0	-27.3	AVG	AVG (0.10s)
0.240	34.2	Neutral	62.1	-27.9	QP	QP (1.00s)
14.888	30.9	Line 1	60.0	-29.1	QP	QP (1.00s)
0.330	18.7	Neutral	49.5	-30.8	AVG	AVG (0.10s)
0.257	20.6	Line 1	51.5	-30.9	AVG	AVG (0.10s)
0.383	16.9	Line 1	48.2	-31.3	AVG	AVG (0.10s)
14.437	27.9	Neutral	60.0	-32.1	QP	QP (1.00s)
0.172	22.4	Line 1	54.9	-32.5	AVG	AVG (0.10s)
0.240	18.5	Neutral	52.1	-33.6	AVG	AVG (0.10s)
0.165	20.1	Neutral	55.2	-35.1	AVG	AVG (0.10s)

End of Report

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marks the last page of this test report.