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 1*
## *FCC Part 15 Subpart C*

## *Model: H0ME*

| | |
|---|---|
| IC CERTIFICATION #: | 10395A-H0ME |
| FCC ID: | A4RH0ME |
| APPLICANT: | Google Inc.<br>1600 Amphitheatre Pky<br>Mountain View, CA 94043 |
| TEST SITE(S): | National Technical Systems - Silicon Valley<br>41039 Boyce Road.<br>Fremont, CA. 94538-2435 |
| IC SITE REGISTRATION #: | 2845B-7 |
| REPORT DATE: | September 13, 2016 |
| FINAL TEST DATES: | July 8, 25, and 26 and August 10, 2016 |
| TOTAL NUMBER OF PAGES: | 64 |

PROGRAM MGR /
TECHNICAL REVIEWER:

Mark E Hill
Staff Engineer

QUALITY ASSURANCE DELEGATE /
FINAL REPORT PREPARER:

David Guidotti
Senior Technical Writer

A2LA ACCREDITED
Testing Cert #0214.26

## REVISION HISTORY

| Rev# | Date | Comments | Modified By |
|---|---|---|---|
| - | September 13, 2016 | First release | |

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## SCOPE

An electromagnetic emissions test has been performed on the Google Inc. model H0ME, pursuant to the following rules:

RSS-Gen Issue 4 "General Requirements for Compliance of Radio Apparatus"
RSS 247 Issue 1 "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 H0ME complied with the requirements of the following regulations:

RSS-Gen Issue 4 "General Requirements for Compliance of Radio Apparatus"
RSS 247 Issue 1 "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 H0ME 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 (1) | 20dB Bandwidth | Basic Rate: 985 kHz EDR: 1282 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 (4) & 5.4 (2) | Number of Channels | Min: 20 Max: 79 | 15 or more | Complies |
| 15.247 (a) (1) (iii) & (b) (1) | RSS 247 5.1 (4) | 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 (1) | Channel Utilization | | All channels shall, on average, be used equally | Complies |
| 15.247 (b) (3) | RSS 247 5.4 (2) | Output Power | Basic Rate: 5.5 dBm (0.0035W)<br><br>EDR: 5.3 dBm (0.0034W) | 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 | 48.8 dBµV/m @ 7205.9 MHz (-5.2 dB) | Refer to the limits section (p19) for restricted bands, all others < -20dBc | Complies |
| 15.247 (a) (1) | RSS 247 5.1(2) | 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 | Chicony: 38.6 dBµV @ 0.358 MHz (-10.2 dB)<br><br>TenPao: 44.4 dBµV @ 0.156 MHz (-21.3 dB) | Refer to page 18 | 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: 985 kHz EDR: 1282 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. H0ME 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, 50-60 Hz, 1.1 Amps.

The sample was received on July 8, 2016 and tested on July 8, 25, and 26 and August 10, 2016. The EUT consisted of the following component(s):

| Company | Model | Description | Serial Number | FCC ID |
|---|---|---|---|---|
| Google | H0ME | Streaming Media Device (RF conducted) | 6629AZZB6W | A4RH0ME |
| Google | H0ME | Streaming Media Device (radiated) | 6629AZZB75 | A4RH0ME |
| Chicony | W16-033N1A | External power supply | F185081624001224 | - |
| TenPao | S033BU1650200 | External power supply | prototype | - |

### ANTENNA SYSTEM

Two Internal Antennas: 2.7dBi and 3.3dBi max @ 2.4GHz, 5.3dBi and 5.7dBi @ 5GHz. Tx/Rx diversity.

### ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 10 cm in diameter by 14 cm high.

### 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 | 27175981753 | - |
| - | PA-12FAMILY | Laptop Power Supply | - | - |
| Google | Chromecast | USB AC/DC Adapter | - | - |

No remote support equipment was used during testing.

***EUT INTERFACE PORTS***

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

EUT

| Port | Connected To | Cable(s) | | |
|---|---|---|---|---|
| | | Description | Shielded or Unshielded | Length(m) |
| DC power | External power supply | 2 wire | Unshielded | 2 |
| AC in (external supply) | AC mains | Direct plug in | NA | NA |
| USB | USB splitter | Multiwire | Shielded | 0.3 |

Additional on Support Equipment

| Port | Connected To | Cable(s) | | |
|---|---|---|---|---|
| | | Description | Shielded or Unshielded | Length(m) |
| USB charger out | USB splitter | Multiwire | Shielded | 0.3 |
| USB charger, AC in | AC mains | Direct plug in | NA | NA |
| USB splitter | USB-serial adaptor cable | | | |

***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 | | Location |
|---|---|---|---|
| | FCC | Canada | |
| Chamber 4 | US0027 | 2845B-4 | 41039 Boyce Road<br>Fremont,<br>CA 94538-2435 |
| Chamber 7 | US0027 | 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.

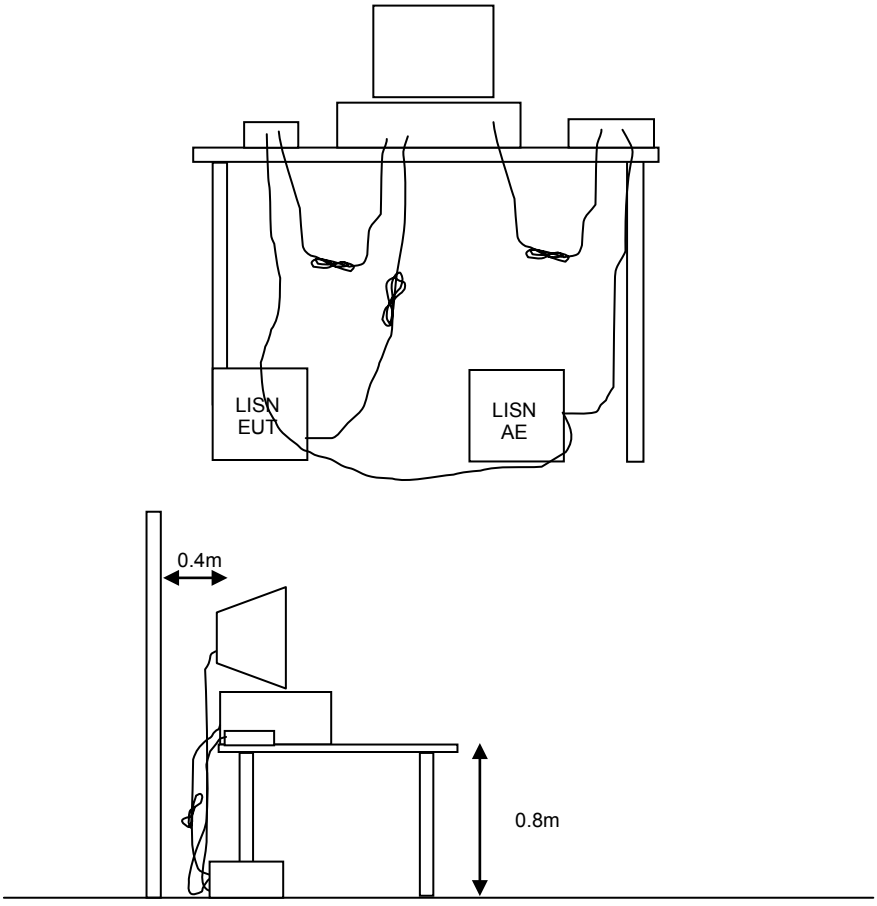



**Figure 1 Typical Conducted Emissions Test Configuration**

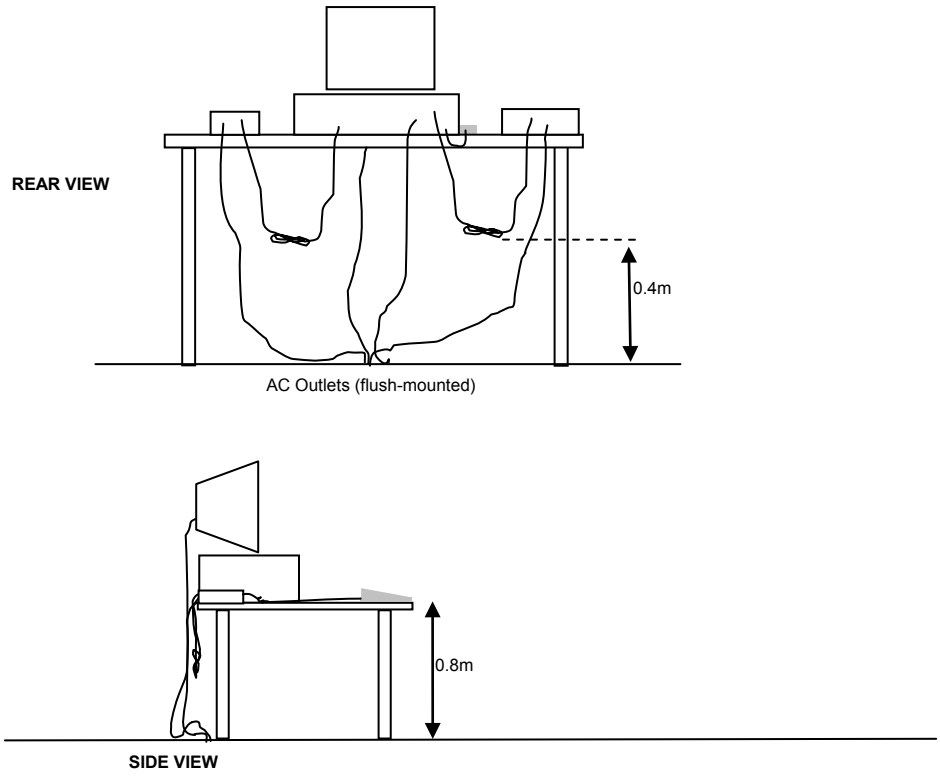
***RADIATED EMISSIONS***

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.

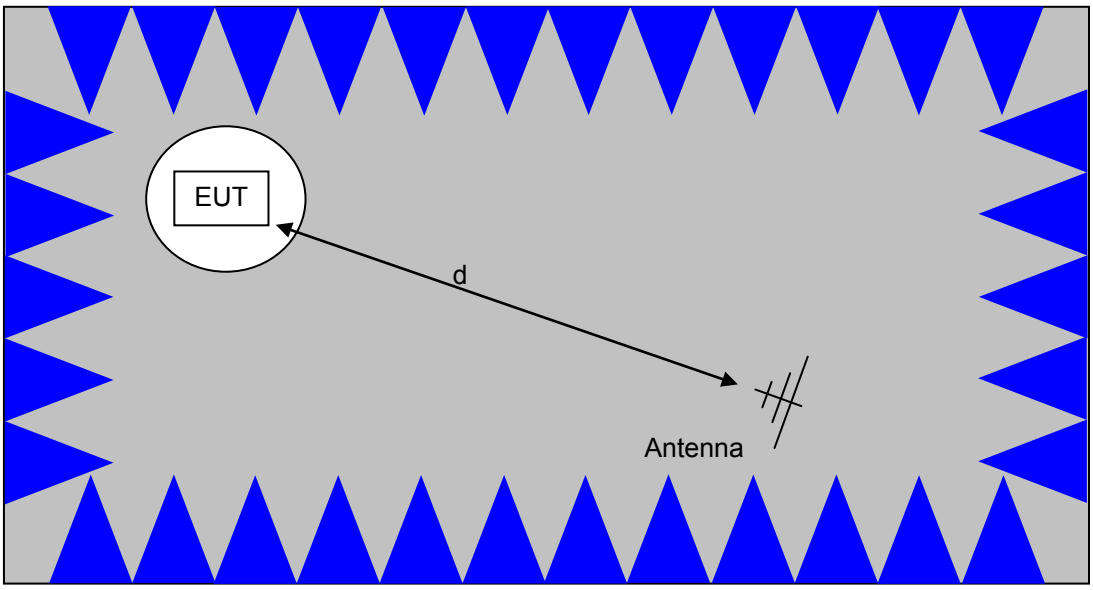
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

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.

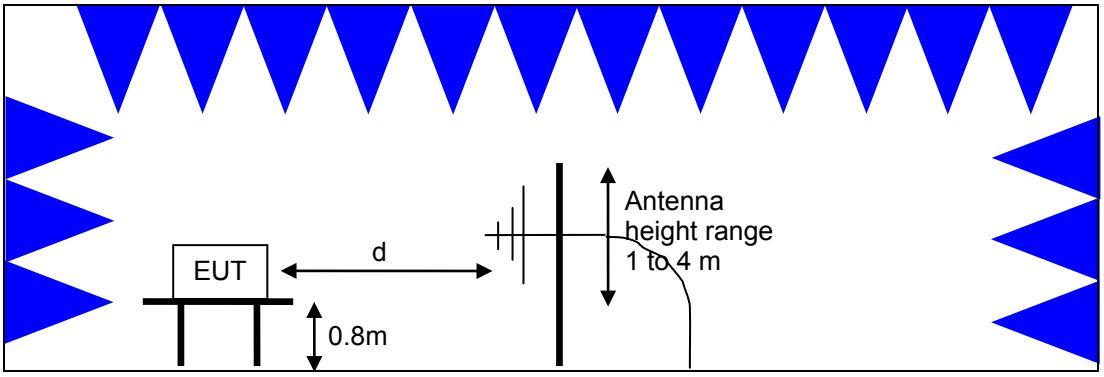



Typical Test Configuration for Radiated Field Strength Measurements




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.

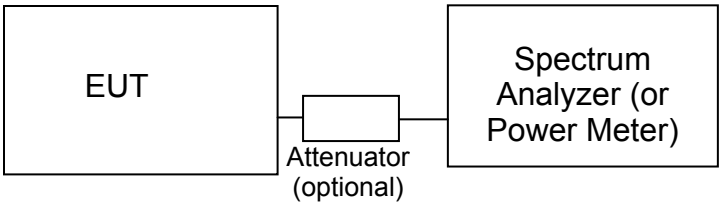
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.




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

T101744

**Conducted Emissions - AC Power Ports, 10-Aug-16**

| Manufacturer | Description | Model | Asset # | Calibrated | Cal Due |
|---|---|---|---|---|---|
| NTS | NTS EMI Software (rev 2.10) | N/A | 0 | | N/A |
| EMCO | LISN, 10 kHz-100 MHz | 3825/2 | 1292 | 8/1/2016 | 8/1/2017 |
| Rohde & Schwarz | Pulse Limiter | ESH3 Z2 | 1401 | 4/26/2016 | 4/26/2017 |
| Rohde & Schwarz | EMI Test Receiver, 20 Hz-7 GHz | ESIB7 | 1538 | 12/19/2015 | 12/19/2016 |

T102007

**Radiated Spurious Emissions, 1000 - 18,000 MHz, 25-Jul-16 and 26-Jul-16**

| | | | | | |
|---|---|---|---|---|---|
| NTS | NTS EMI Software (rev 2.10) | N/A | 0 | | N/A |
| Hewlett Packard | Microwave Preamplifier, 1-26.5GHz | 8449B | 870 | 1/21/2016 | 1/21/2017 |
| Hewlett Packard | Spectrum Analyzer (SA40) Red 30 Hz -40 GHz | 8564E (84125C) | 1148 | 10/17/2015 | 10/17/2016 |
| Micro-Tronics | Band Reject Filter, 2400-2500 MHz | BRM50702-02 | 1683 | 6/29/2016 | 6/29/2017 |
| EMCO | Antenna, Horn, 1-18 GHz | 3115 | 2733 | 11/18/2014 | 11/18/2016 |
| HP / Miteq | SA40 Head (Red) | TTA1840-45-5P-HG-S | 1145 | 7/17/2015 | 8/17/2016 |
| A. H. Systems | Purple System Horn, 18-40GHz | SAS-574, p/n: 2581 | 2160 | 8/28/2014 | 8/28/2017 |

**Radio Antenna Port (Power and Spurious Emissions), 26-Jul-16**

| | | | | | |
|---|---|---|---|---|---|
| Agilent Technologies | PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX, | E4446A | 2139 | 6/24/2016 | 6/24/2017 |

# *Appendix B Test Data*

T101744 Pages 24 – 29
T102007 Pages 30 – 63

| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Product | H0ME | T-Log Number: | T101744 |
| 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

H0ME

Date of Last Test: 9/9/2016

| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T101744 |
| | | 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: 8/10/2016
Test Engineer: John Caizzi
Test Location: Fremont Chamber #7
Config. Used: 1
Config Change: No support equipment.
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 °C
Rel. Humidity: 40 %

## Summary of Results

| Run # | Test Performed | Limit | Result | Margin |
|---|---|---|---|---|
| 2a | CE, AC Power, 120V/60Hz | Class B | Pass | 38.6 dBµV @ 0.358 MHz (-10.2 dB) |
| 2b | CE, AC Power, 120V/60Hz | Class B | Pass | 44.4 dBµV @ 0.156 MHz (-21.3 dB) |

## Modifications Made During Testing

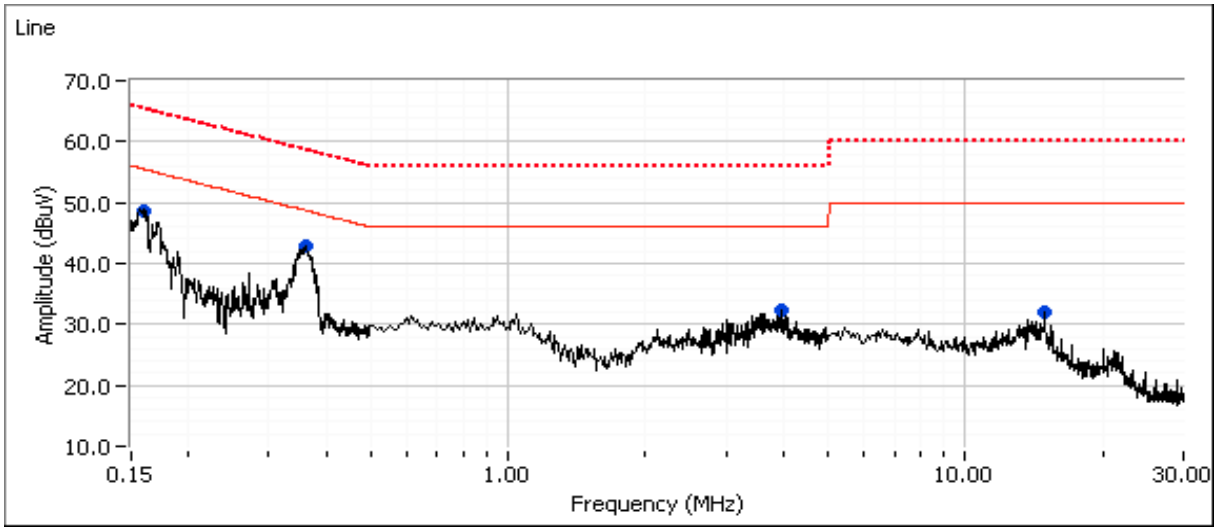
No modifications were made to the EUT during testing

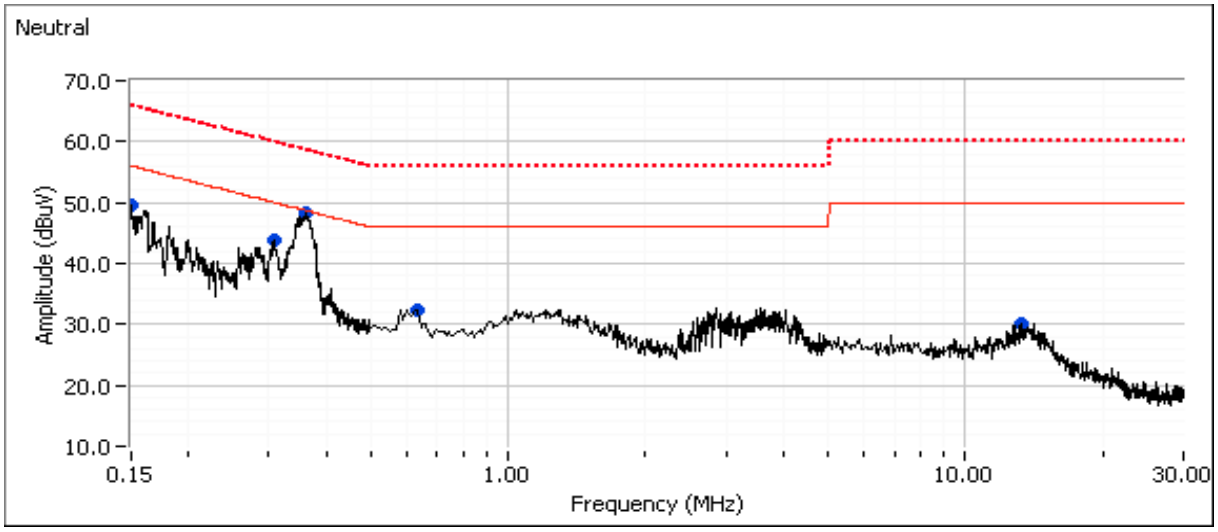
## Deviations From The Standard

No deviations were made from the requirements of the standard.

| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T101744 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247/15.407/RSS-247 | Class: | B |

Run #2a: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz. Chicony W16-033N1A power supply.



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T101744 |
| | | 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 | Class B | | Detector | Comments |
|---|---|---|---|---|---|---|
| MHz | dBµV | Line | Limit | Margin | QP/Ave | |
| 0.161 | 48.7 | Line | 55.4 | -6.7 | Peak | |
| 0.361 | 42.9 | Line | 48.7 | -5.8 | Peak | |
| 3.958 | 32.4 | Line | 46.0 | -13.6 | Peak | |
| *14.920* | *32.0* | *Line* | *50.0* | *-18.0* | *Peak* | |
| 0.152 | 49.7 | Neutral | 56.0 | -6.3 | Peak | |
| 0.306 | 43.8 | Neutral | 50.0 | -6.2 | Peak | |
| 0.358 | 48.2 | Neutral | 48.7 | -0.5 | Peak | |
| *0.635* | *32.4* | *Neutral* | *46.0* | *-13.6* | *Peak* | |
| *13.317* | *30.1* | *Neutral* | *50.0* | *-19.9* | *Peak* | |

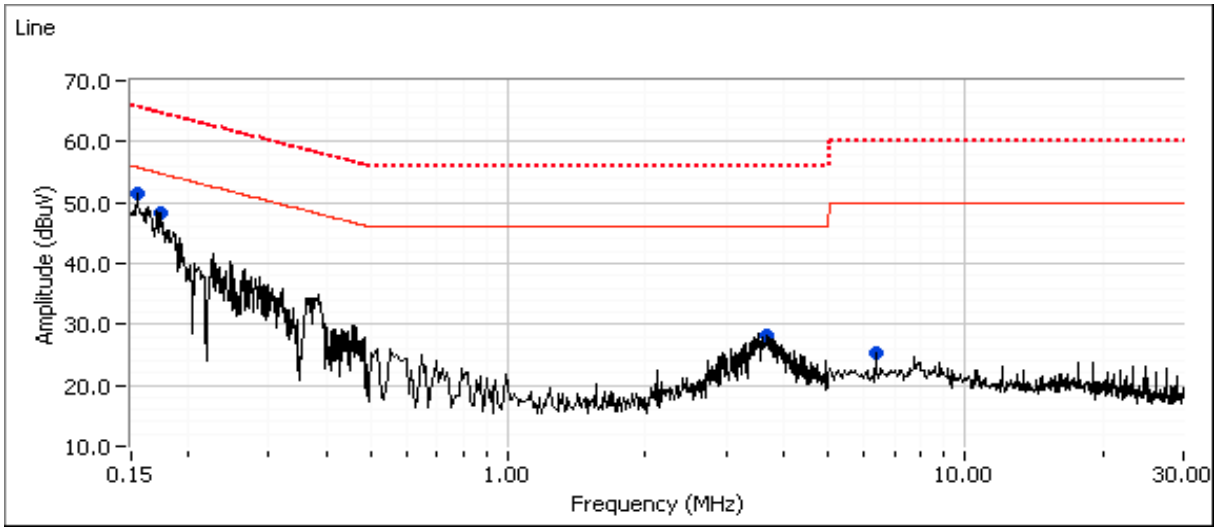
Final quasi-peak and average readings

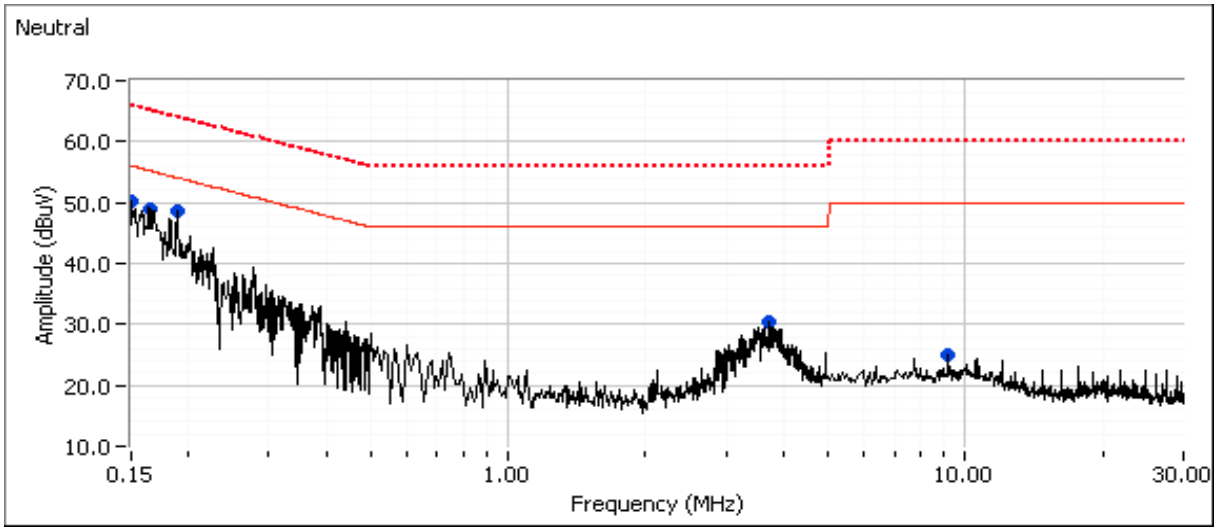
| Frequency | Level | AC | Class B | | Detector | Comments |
|---|---|---|---|---|---|---|
| MHz | dBµV | Line | Limit | Margin | QP/Ave | |
| 0.161 | 27.4 | Line | 55.4 | -28.0 | AVG | |
| 0.161 | 43.0 | Line | 65.4 | -22.4 | QP | |
| 0.361 | 33.1 | Line | 48.7 | -15.6 | AVG | |
| 0.361 | 40.5 | Line | 58.7 | -18.2 | QP | |
| 3.958 | 16.2 | Line | 46.0 | -29.8 | AVG | |
| 3.958 | 25.5 | Line | 56.0 | -30.5 | QP | |
| 0.152 | 43.3 | Neutral | 65.9 | -22.6 | QP | |
| 0.152 | 27.9 | Neutral | 55.9 | -28.0 | AVG | |
| 0.306 | 31.6 | Neutral | 50.1 | -18.5 | AVG | |
| 0.306 | 40.4 | Neutral | 60.1 | -19.7 | QP | |
| 0.358 | 38.6 | Neutral | 48.8 | -10.2 | AVG | |
| 0.358 | 45.3 | Neutral | 58.8 | -13.5 | QP | |

| | |
|---|---|
| Note 1: | EUT transmitting on CH6, power setting = 19 dBm, 11b mode at 1 Mbps. |

| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T101744 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247/15.407/RSS-247 | Class: | B |

Run #2b: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz. TenPao S033BU1650200 power supply, sample 2.



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T101744 |
| | | 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 | Class B | | Detector | Comments |
|---|---|---|---|---|---|---|
| MHz | dBµV | Line | Limit | Margin | QP/Ave | |
| 0.156 | 51.4 | Line | 55.7 | -4.3 | Peak | |
| 0.172 | 48.4 | Line | 54.8 | -6.4 | Peak | |
| 3.630 | 28.2 | Line | 46.0 | -17.8 | Peak | |
| *6.353* | *25.4* | *Line* | *50.0* | *-24.6* | *Peak* | |
| 0.151 | 50.1 | Neutral | 56.0 | -5.9 | Peak | |
| 0.166 | 49.0 | Neutral | 55.2 | -6.2 | Peak | |
| 0.184 | 48.5 | Neutral | 54.1 | -5.6 | Peak | |
| *3.737* | *30.4* | *Neutral* | *46.0* | *-15.6* | *Peak* | |
| *9.158* | *24.9* | *Neutral* | *50.0* | *-25.1* | *Peak* | |

Final quasi-peak and average readings

| Frequency | Level | AC | Class B | | Detector | Comments |
|---|---|---|---|---|---|---|
| MHz | dBµV | Line | Limit | Margin | QP/Ave | |
| 0.156 | 26.7 | Line | 55.7 | -29.0 | AVG | |
| 0.156 | 44.4 | Line | 65.7 | -21.3 | QP | |
| 0.172 | 24.5 | Line | 54.9 | -30.4 | AVG | |
| 0.172 | 41.3 | Line | 64.9 | -23.6 | QP | |
| 3.630 | 12.7 | Line | 46.0 | -33.3 | AVG | |
| 3.630 | 23.3 | Line | 56.0 | -32.7 | QP | |
| 0.151 | 25.6 | Neutral | 55.9 | -30.3 | AVG | |
| 0.151 | 44.6 | Neutral | 65.9 | -21.3 | QP | |
| 0.166 | 25.0 | Neutral | 55.2 | -30.2 | AVG | |
| 0.166 | 42.2 | Neutral | 65.2 | -23.0 | QP | |
| 0.184 | 22.3 | Neutral | 54.3 | -32.0 | AVG | |
| 0.184 | 39.2 | Neutral | 64.3 | -25.1 | QP | |

| | |
|---|---|
| Note 1: | EUT transmitting on CH6, power setting = 19 dBm, 11b mode at 1 Mbps. |

| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Product | H0ME | T-Log Number: | T102007 |
| System Configuration: | - | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Emissions Standard(s): | FCC 15.247 / RSS-247 | Class: | B |
| Immunity Standard(s): | - | Environment: | - |

# EMC Test Data

For The

# Google Inc

Product

H0ME

Date of Last Test: 7/27/2016

| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

# Duty Cycle

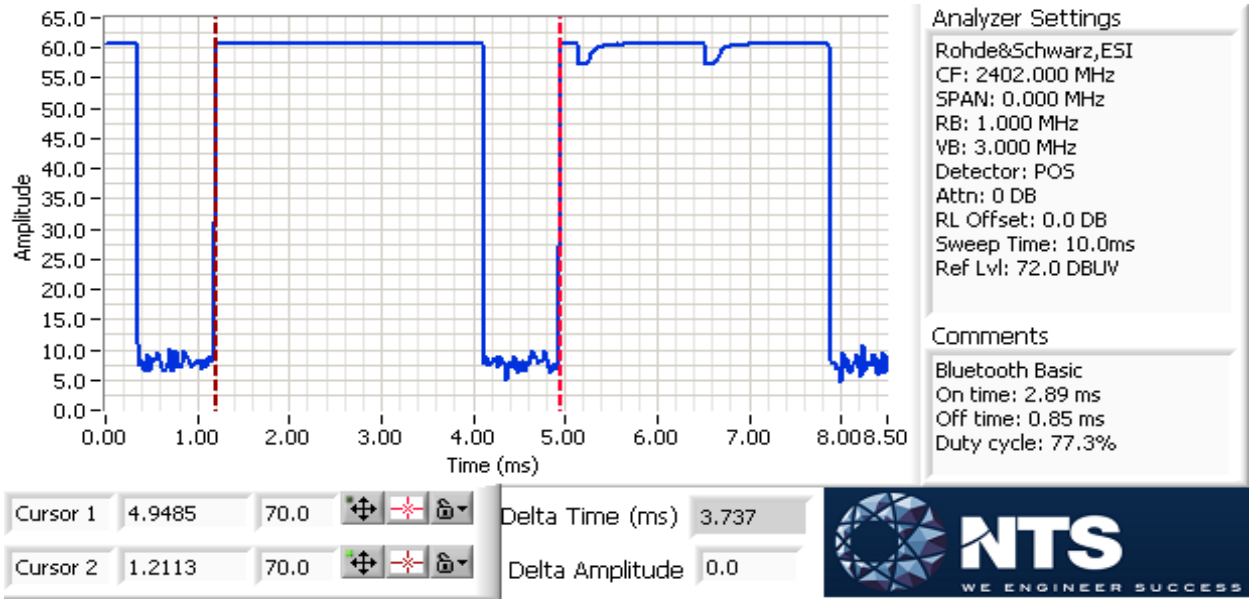
Date of Test: 7/25/2016
Test Engineer: Mehran Birgani
Test Location: Chamber #7

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

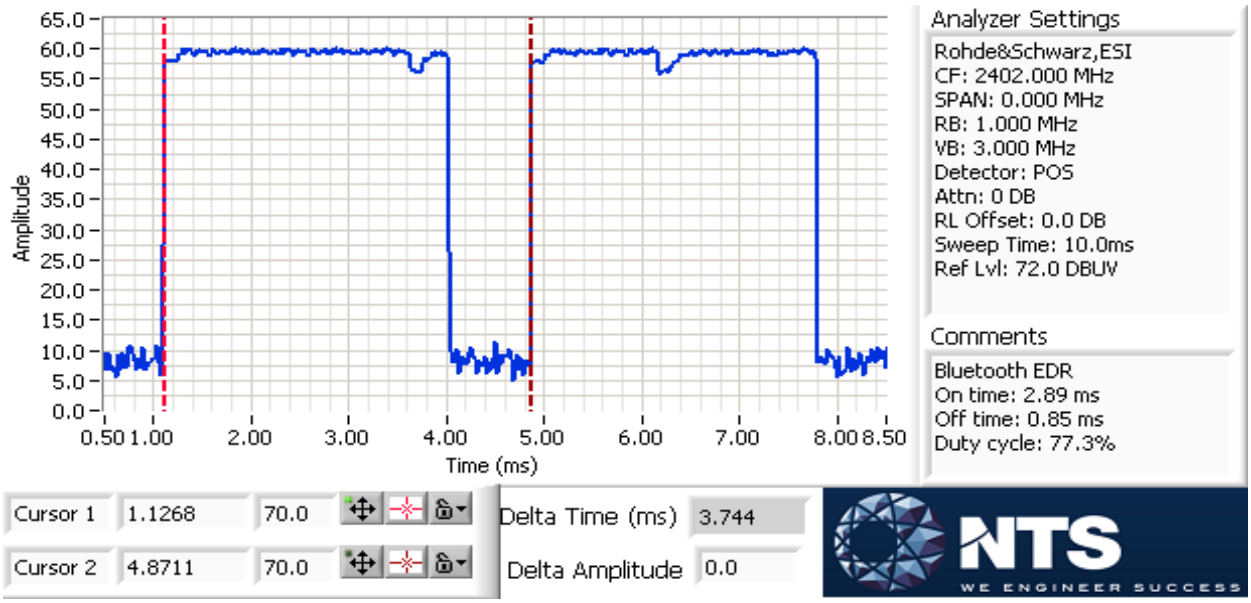
Notes: Measurements taken with maximum RBW/VBW settings allowed.

| 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 | 77.3% | yes | 2.89 | 1.12 | 2.24 | 346 |
| EDR | 3Mb/s | 77.3% | yes | 2.89 | 1.12 | 2.24 | 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: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / 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

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: 22-26 °C
Rel. Humidity: 30-40 %

### 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 | Restricted Band Edge (2390 MHz) | FCC Part 15.209 / 15.247(d) | 33.0 dBµV/m @ 2388.6 MHz (-21.0 dB) |
| | | | - | 6 | Radiated Emissions, 1 - 26 GHz | | 48.8 dBµV/m @ 7205.9 MHz (-5.2 dB) |
| 1b | | 2440 | - | 6 | Radiated Emissions, 1 - 26 GHz | | 48.1 dBµV/m @ 7320.0 MHz (-5.9 dB) |
| 1c | | 2480 | - | 6 | Restricted Band Edge (2483.5 MHz) | | 36.4 dBµV/m @ 2487.6 MHz (-17.6 dB) |
| | | | - | 6 | Radiated Emissions, 1 - 26 GHz | | 45.8 dBµV/m @ 7440.0 MHz (-8.2 dB) |
| 2a | EDR 3Mb/s | 2402 | - | 6 | Restricted Band Edge (2390 MHz) | | 33.8 dBµV/m @ 2364.4 MHz (-20.2 dB) |
| | | | - | 6 | Radiated Emissions, 1 - 26 GHz | | 45.0 dBµV/m @ 7205.9 MHz (-9.0 dB) |
| 2b | | 2440 | - | 6 | Radiated Emissions, 1 - 26 GHz | | 44.9 dBµV/m @ 7320.0 MHz (-9.1 dB) |
| 2c | | 2480 | - | 6 | Restricted Band Edge (2483.5 MHz) | | 36.1 dBµV/m @ 2483.5 MHz (-17.9 dB) |
| | | | - | 6 | Radiated Emissions, 1 - 26 GHz | | 40.1 dBµV/m @ 7439.8 MHz (-13.9 dB) |

| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / 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 | 77.3% | yes | 2.89 | 1.12 | 2.24 | 346 |
| EDR | 3Mb/s | 77.3% | yes | 2.89 | 1.12 | 2.24 | 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. |

## Sample Notes

Sample S/N: 6629AZZB75
Driver: 1.21
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 simultanenous BT and Wifi operation is addressed in the DTS and UNII test reports.

| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

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

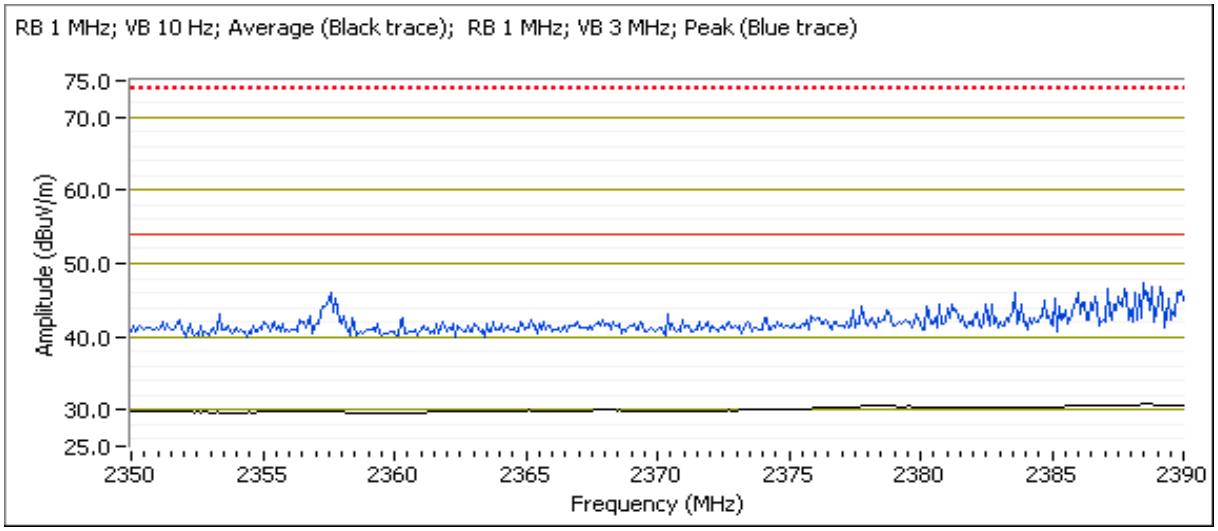
Date of Test: 7/25/2016 & 7/26/16
Test Engineer: Mehran Birgani, J.Caizzi
Test Location: Chamber #7

Config. Used: 1
Config Change: -
EUT Voltage: 120V/ 60Hz

Run #1a: Low Channel @ 2402 MHz

Band Edge Signal Field Strength - Direct measurement of field strength

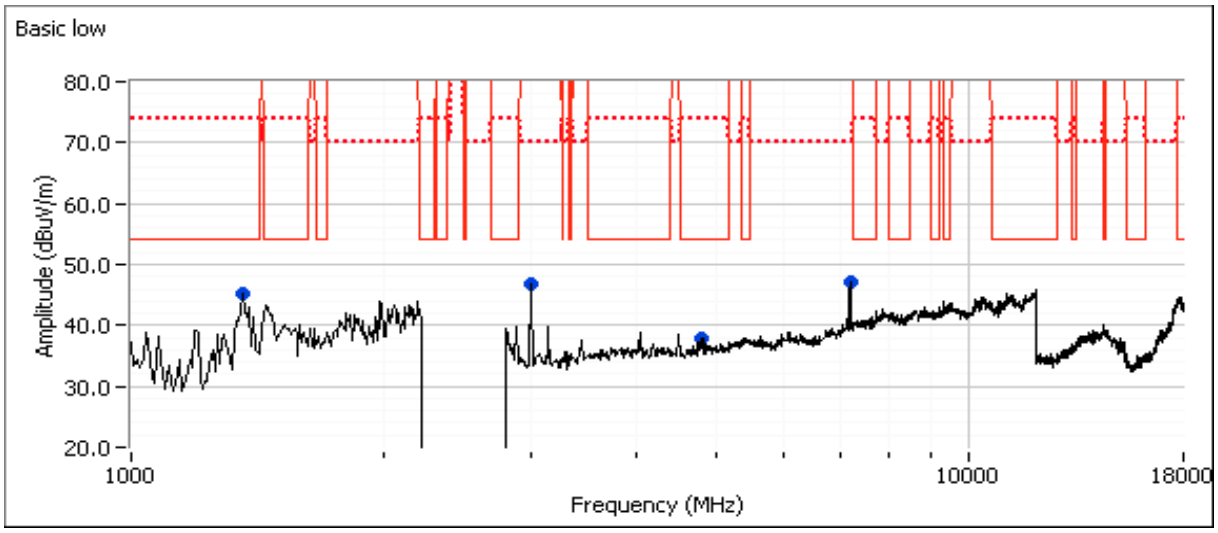
| Frequency | Level | Pol | 15.209 / 15.247 | | Detector | Azimuth | Height | Comments |
|---|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | v/h | Limit | Margin | Pk/QP/Avg | degrees | meters | |
| 2388.610 | 33.0 | V | 54.0 | -21.0 | AVG | 153 | 2.0 | VB 1 kHz, VAVG 100, note 4. |
| 2377.820 | 32.7 | H | 54.0 | -21.3 | AVG | 297 | 2.2 | VB 1 kHz, VAVG 100, note 4. |
| 2388.240 | 48.0 | V | 74.0 | -26.0 | PK | 153 | 2.0 | POS; RB 1 MHz; VB: 3 MHz |
| 2380.380 | 45.1 | H | 74.0 | -28.9 | PK | 297 | 2.2 | POS; RB 1 MHz; VB: 3 MHz |



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / 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 | |
| 4803.970 | 38.4 | H | 54.0 | -15.6 | Avg | 138 | 1.00 | VB 1 kHz, VAVG 100, note 4. |
| 4803.650 | 46.0 | H | 74.0 | -28.0 | PK | 138 | 1.00 | |
| 7205.930 | 48.8 | V | 54.0 | -5.2 | Avg | 343 | 1.86 | VB 1 kHz, VAVG 100, note 1, 4. |
| 7206.220 | 53.8 | V | 74.0 | -20.2 | PK | 343 | 1.86 | |
| 1358.330 | 45.1 | V | 54.0 | -8.9 | Peak | 267 | 1.0 | Not a radio signal. |
| 2991.670 | 46.7 | V | 70.0 | -23.3 | Peak | 249 | 1.0 | Not a radio signal. |

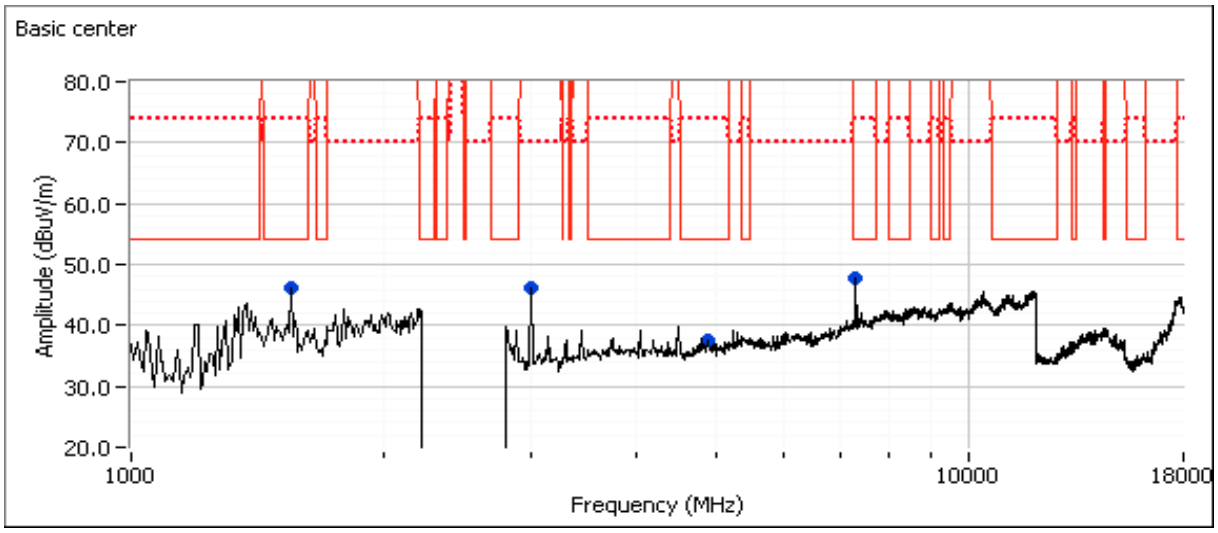


| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

Run #1b: Center Channel @ 2440 MHz

| Frequency | Level | Pol | 15.209 / 15.247 | | Detector | Azimuth | Height | Comments |
|---|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | v/h | Limit | Margin | Pk/QP/Avg | degrees | meters | |
| 2993.040 | 34.8 | V | 54.0 | -19.2 | AVG | 248 | 1.00 | Note 1 |
| 2993.770 | 53.7 | V | 74.0 | -20.3 | PK | 248 | 1.00 | Note 1 |
| 4880.120 | 38.4 | H | 54.0 | -15.6 | Avg | 80 | 1.19 | VB 1 kHz, VAVG 100, note 4. |
| 4880.030 | 45.4 | H | 74.0 | -28.6 | PK | 80 | 1.19 | |
| 7320.030 | 48.1 | V | 54.0 | -5.9 | Avg | 318 | 1.00 | VB 1 kHz, VAVG 100, note 4. |
| 7320.470 | 53.6 | V | 74.0 | -20.4 | PK | 318 | 1.00 | |
| 1550.000 | 46.1 | V | 54.0 | -7.9 | Peak | 282 | 1.5 | Not a radio signal. |

| | |
|---|---|
| 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 |

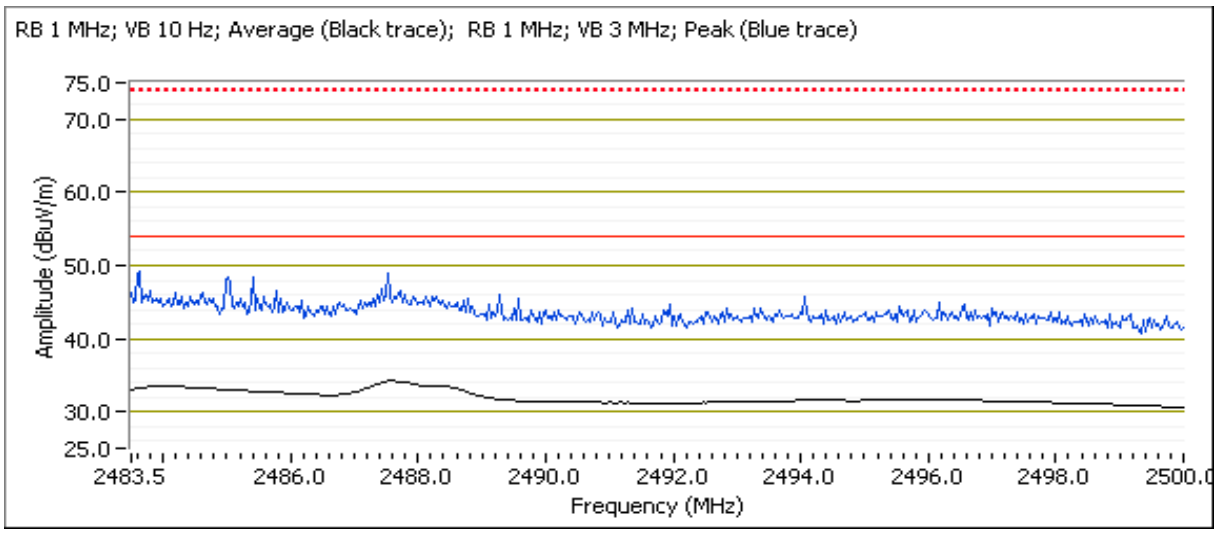


| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

Run #1c: High Channel @ 2480 MHz

Band Edge Signal Field Strength - Direct measurement of field strength

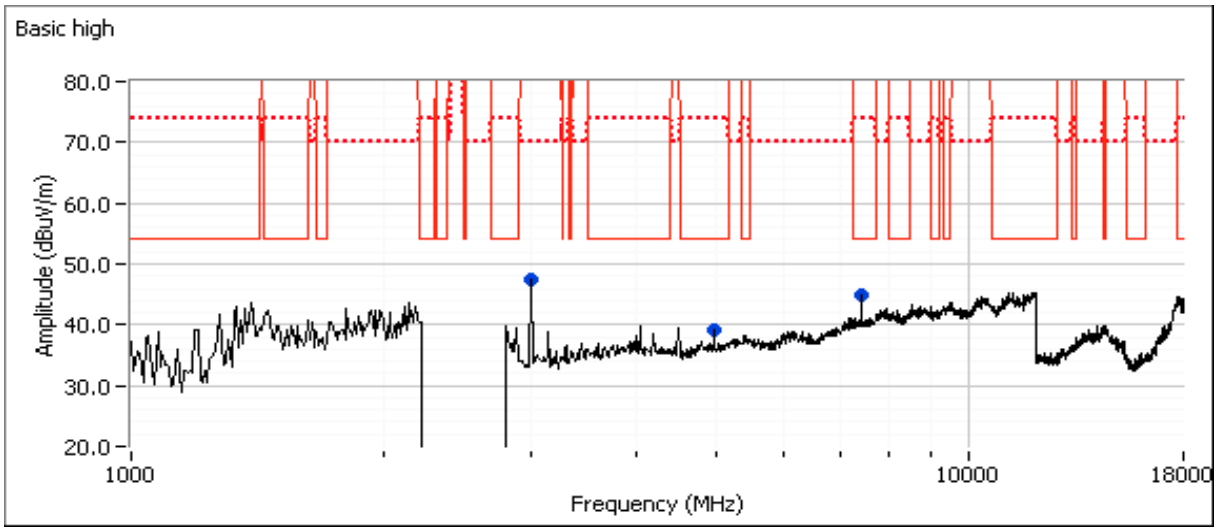
| Frequency | Level | Pol | 15.209 / 15.247 | | Detector | Azimuth | Height | Comments |
|---|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | v/h | Limit | Margin | Pk/QP/Avg | degrees | meters | |
| 2487.600 | 36.4 | V | 54.0 | -17.6 | AVG | 78 | 1.3 | VB 1 kHz, VAVG 100, note 4. |
| 2493.720 | 50.3 | V | 74.0 | -23.7 | PK | 78 | 1.3 | POS; RB 1 MHz; VB: 3 MHz |




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 | |
| 7440.000 | 45.8 | V | 54.0 | -8.2 | Avg | 327 | 1.49 | VB 1 kHz, VAVG 100, note 4. |
| 7439.680 | 52.3 | V | 74.0 | -21.7 | PK | 327 | 1.49 | |
| 4960.100 | 40.2 | H | 54.0 | -13.8 | Avg | 73 | 1.49 | VB 1 kHz, VAVG 100, note 4. |
| 4960.500 | 46.5 | H | 74.0 | -27.5 | PK | 73 | 1.49 | |
| *3000.000* | *47.4* | *V* | *54.0* | *-6.6* | *Peak* | *244* | *1.0* | *Not a radio signal, note 1.* |

| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

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

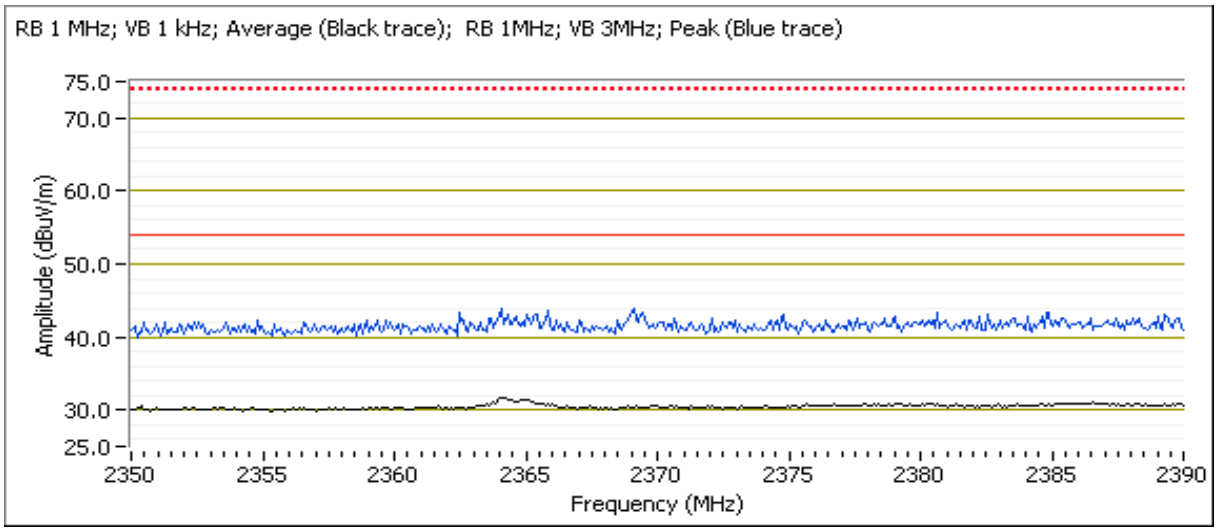
Date of Test: 07/25/16
Test Engineer: Mehran Birgani
Test Location: Chamber #7

Config. Used: 1
Config Change: -
EUT Voltage: 120V/ 60Hz

Run #2a: Low Channel @ 2402 MHz

Band Edge Signal Field Strength - Direct measurement of field strength

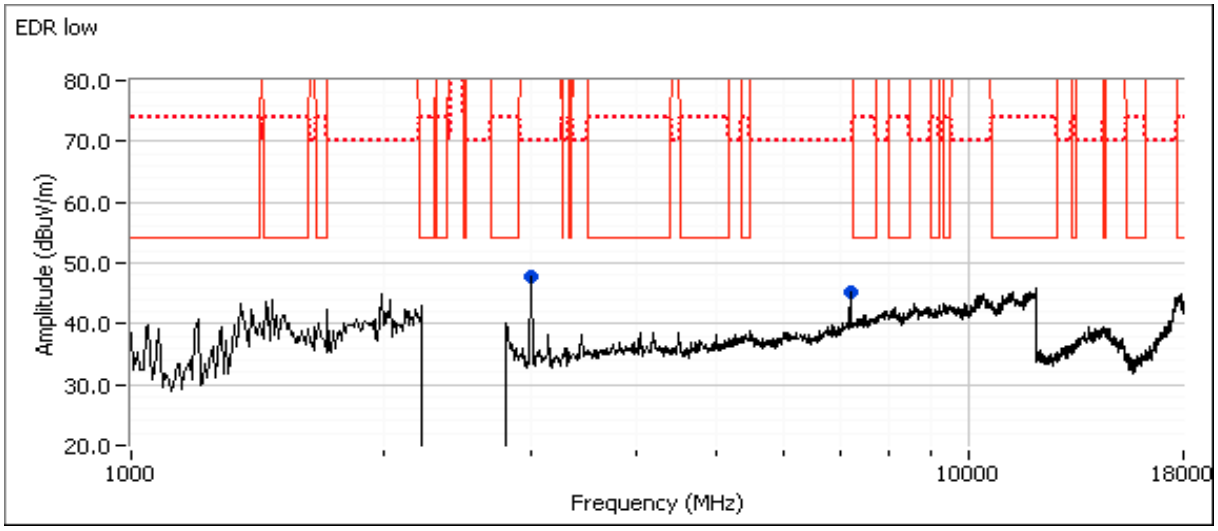
| Frequency | Level | Pol | 15.209 / 15.247 | | Detector | Azimuth | Height | Comments |
|---|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | v/h | Limit | Margin | Pk/QP/Avg | degrees | meters | |
| 2364.430 | 33.8 | V | 54.0 | -20.2 | AVG | 109 | 1.7 | VB 1 kHz, VAVG 100, note 4. |
| 2364.270 | 32.5 | H | 54.0 | -21.5 | AVG | 297 | 2.2 | VB 1 kHz, VAVG 100, note 4. |
| 2369.400 | 43.4 | H | 74.0 | -30.6 | PK | 297 | 2.2 | POS; RB 1 MHz; VB: 3 MHz |
| 2364.110 | 42.5 | V | 74.0 | -31.5 | PK | 109 | 1.7 | POS; RB 1 MHz; VB: 3 MHz |



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

Other Spurious Emissions

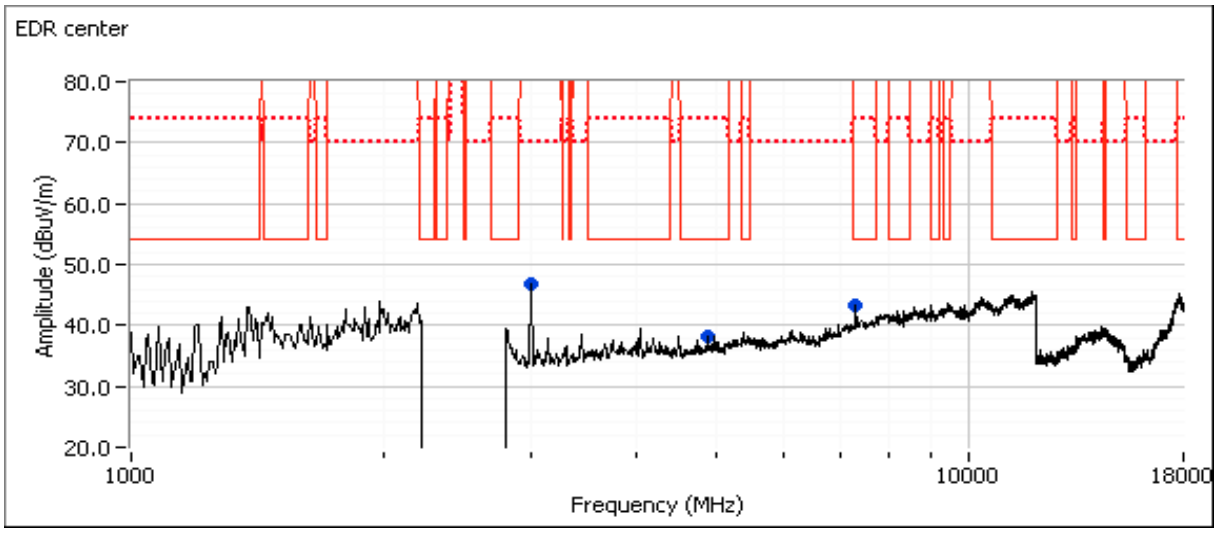
| Frequency | Level | Pol | 15.209 / 15.247 | | Detector | Azimuth | Height | Comments |
|---|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | v/h | Limit | Margin | Pk/QP/Avg | degrees | meters | |
| 7205.880 | 45.0 | V | 54.0 | -9.0 | Avg | 344 | 1.80 | VB 1 kHz, VAVG 100, note 4. |
| 7205.770 | 52.0 | V | 74.0 | -22.0 | PK | 344 | 1.80 | |
| 3000.000 | 47.9 | V | 54.0 | -6.1 | Peak | 243 | 1.0 | Not a radio signal, note 1. |



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

Run #2b: Center Channel @ 2440 MHz

| Frequency | Level | Pol | 15.209 / 15.247 | | Detector | Azimuth | Height | Comments |
|---|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | v/h | Limit | Margin | Pk/QP/Avg | degrees | meters | |
| 4879.930 | 38.6 | H | 54.0 | -15.4 | Avg | 65 | 1.7 | VB 1 kHz, VAVG 100, note 4. |
| 4880.230 | 46.0 | H | 74.0 | -28.0 | PK | 65 | 1.7 | |
| 7319.970 | 44.9 | V | 54.0 | -9.1 | Avg | 317 | 1.17 | VB 1 kHz, VAVG 100, note 4. |
| 7319.430 | 51.7 | V | 74.0 | -22.3 | PK | 317 | 1.17 | |
| 3000.000 | 46.8 | V | 54.0 | -7.2 | Peak | 248 | 1.0 | Not a radio signal, note 1. |

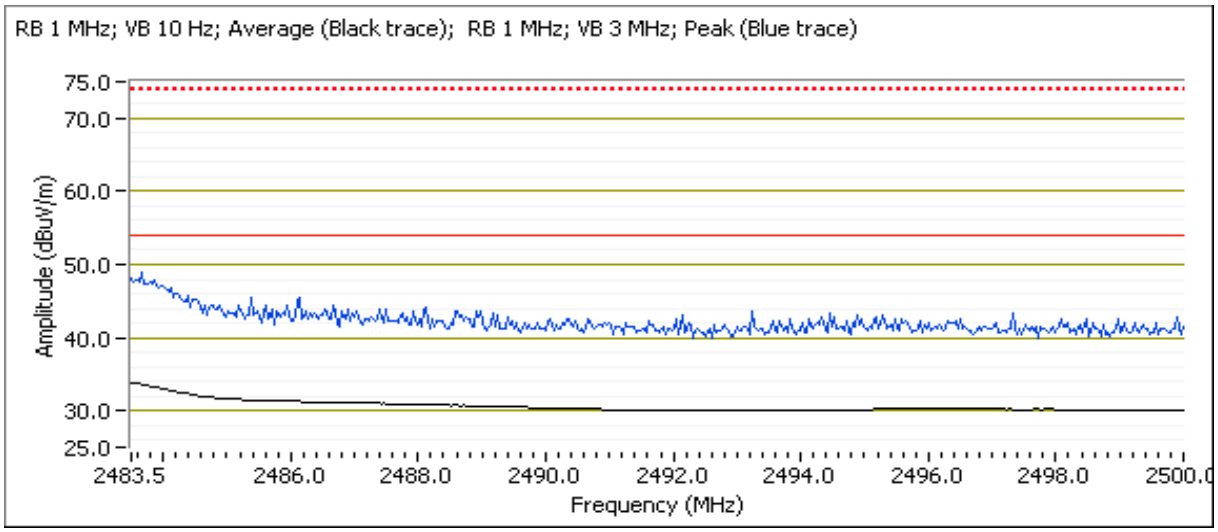


| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

Run #2c: High Channel @ 2480 MHz

Band Edge Signal Field Strength - Direct measurement of field strength

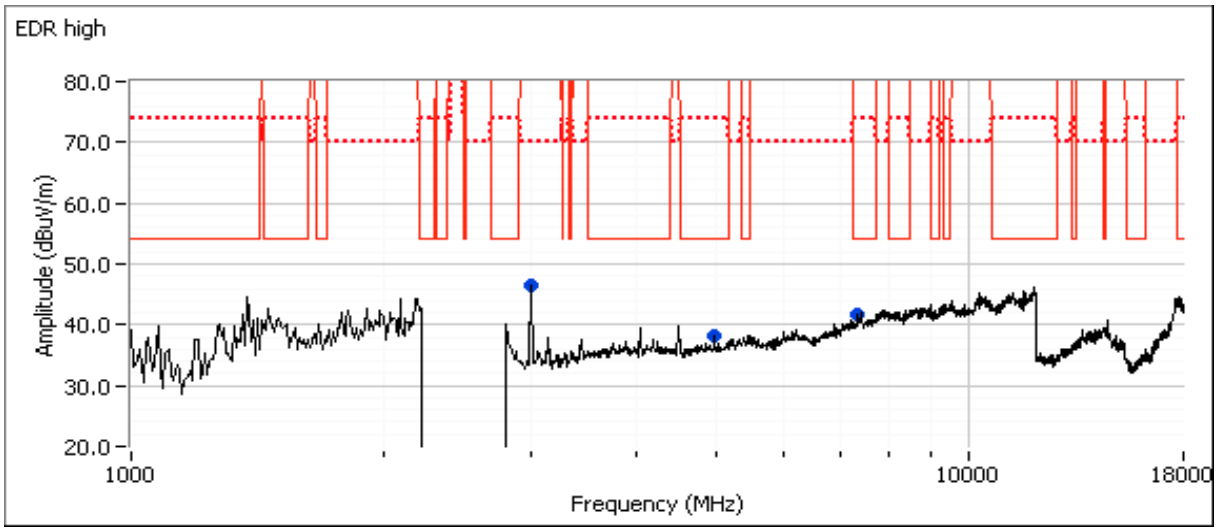
| Frequency | Level | Pol | 15.209 / 15.247 | | Detector | Azimuth | Height | Comments |
|---|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | v/h | Limit | Margin | Pk/QP/Avg | degrees | meters | |
| 2483.500 | 36.1 | V | 54.0 | -17.9 | AVG | 101 | 1.2 | VB 1 kHz, VAVG 100, note 4. |
| 2483.530 | 51.5 | V | 74.0 | -22.5 | PK | 101 | 1.2 | POS; RB 1 MHz; VB: 3 MHz |




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 | |
| 4959.930 | 36.9 | H | 54.0 | -17.1 | Avg | 212 | 1.71 | VB 1 kHz, VAVG 100, note 4. |
| 4959.480 | 46.0 | H | 74.0 | -28.0 | PK | 212 | 1.71 | |
| 7439.800 | 40.1 | H | 54.0 | -13.9 | Avg | 194 | 1.97 | VB 1 kHz, VAVG 100, note 4. |
| 7435.400 | 49.5 | H | 74.0 | -24.5 | PK | 194 | 1.97 | |
| *3000.000* | *46.4* | *V* | *54.0* | *-7.6* | *Peak* | *248* | *1.0* | *Not a radio signal, note 1.* |

| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

# FCC 15.247 FHSS - 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 from the EUT's antenna port, 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: 20-22 °C

Rel. Humidity: 35-40 %

## Summary of Results

| Run # | Test Performed | Limit | Pass / Fail | Result / Margin |
|---|---|---|---|---|
| 1 | Output Power | 15.247(b) | Pass | Basic Rate: 5.5 dBm ( 0.0035W)<br>EDR: 5.3 dBm ( 0.0034W) |
| 2 | 20dB Bandwidth | 15.247(a) | Pass | Basic Rate: 985 kHz<br>EDR: 1282 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 emissions below -20dBc |

## 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: 6629AZZB6W

Driver: 1.21

Measurements performed on the worse case output (Antenna 2) based on preliminary measurements. All calculations using the highest antenna gain.

| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

Run #1: Output Power

Date of Test: 26-Jul  Test Location: Lab 4

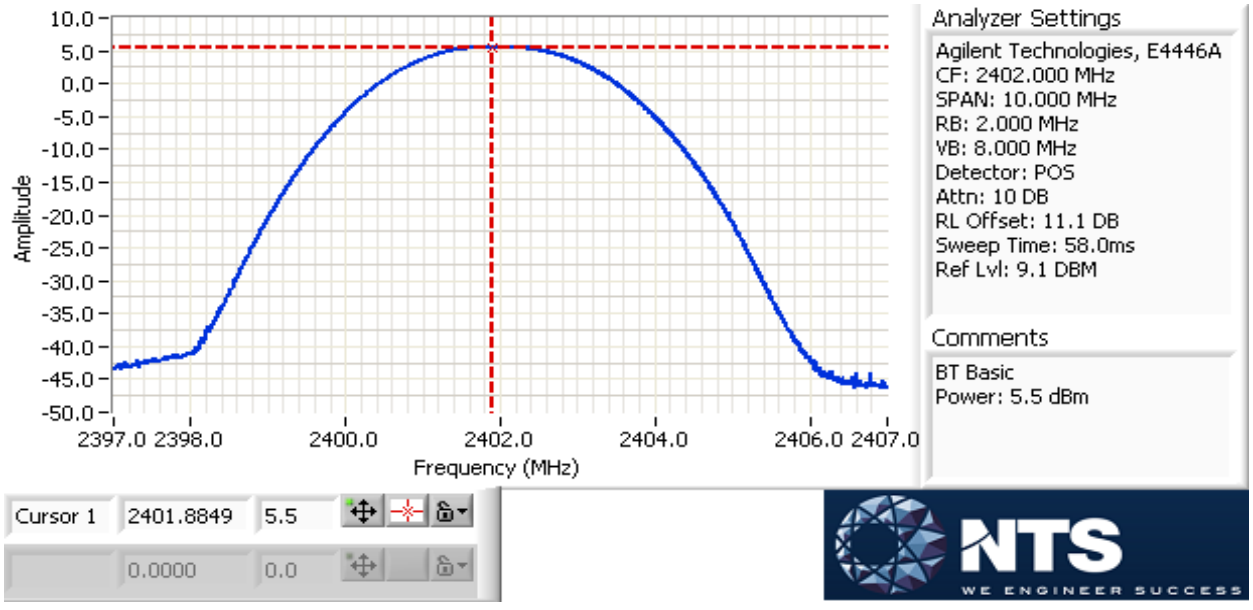
Test Engineer: Mehran Birgani

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

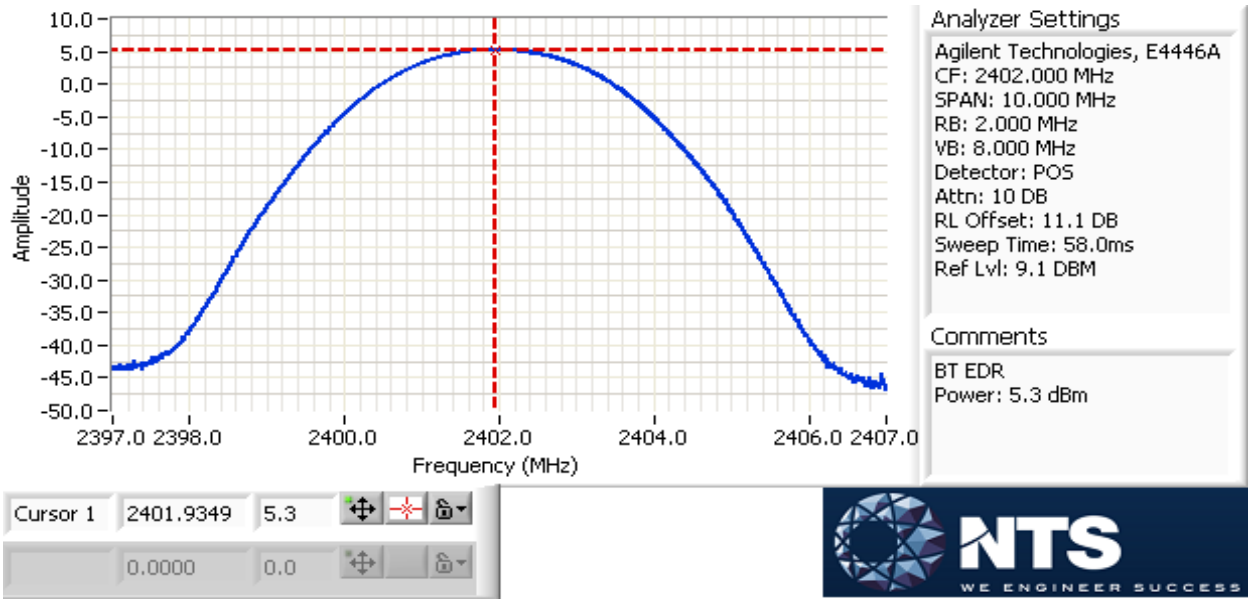
Maximum antenna gain: 3.3 dBi

| Setting[2] | Mode | Channel | Frequency (MHz) | Res BW | Output Power (dBm) | Output Power (W) | EIRP (W) |
|---|---|---|---|---|---|---|---|
| 6 | Basic Rate (DH5) | Low | 2402 | 2.0 MHz | 5.5 | 0.0035 | 0.0076 |
| 6 | | Mid | 2441 | 2.0 MHz | 5.3 | 0.0034 | 0.0072 |
| 6 | | High | 2480 | 2.0 MHz | 5.2 | 0.0033 | 0.0071 |
| 6 | EDR (3-DH5) | Low | 2402 | 2.0 MHz | 5.3 | 0.0034 | 0.0072 |
| 6 | | Mid | 2441 | 2.0 MHz | 5.1 | 0.0032 | 0.0069 |
| 6 | | High | 2480 | 2.0 MHz | 5.0 | 0.0032 | 0.0068 |

| | |
|---|---|
| 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: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

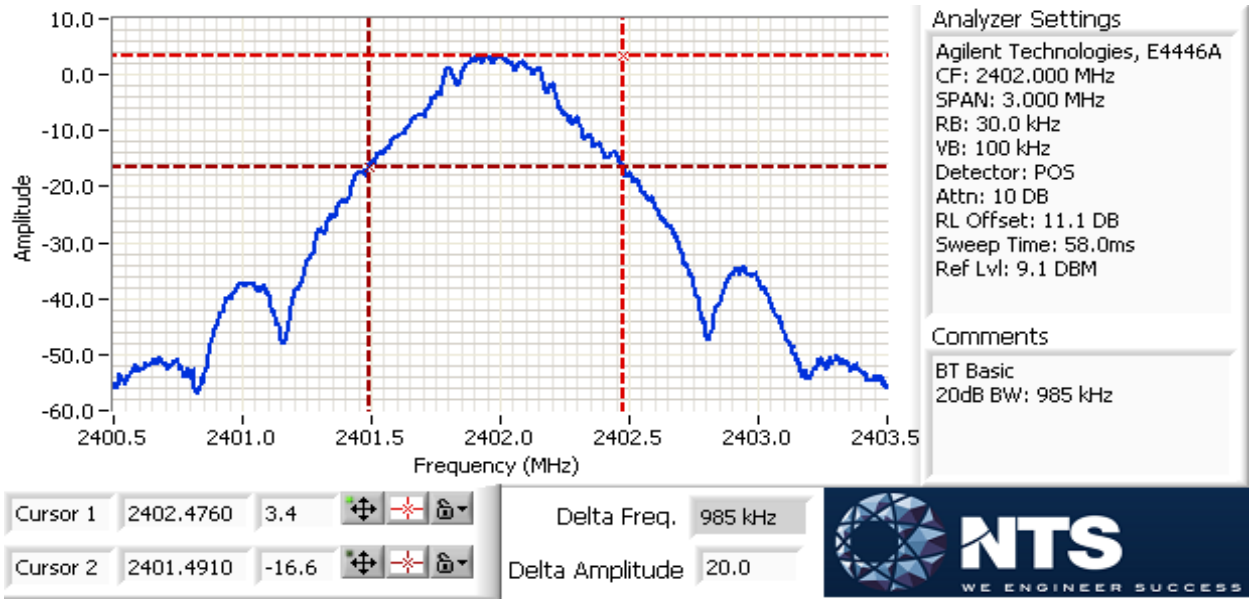
Run #2: Bandwidth, Channel Occupancy, Spacing and Number of Channels

Date of Test: 07/26/16 Test Location: Lab 4

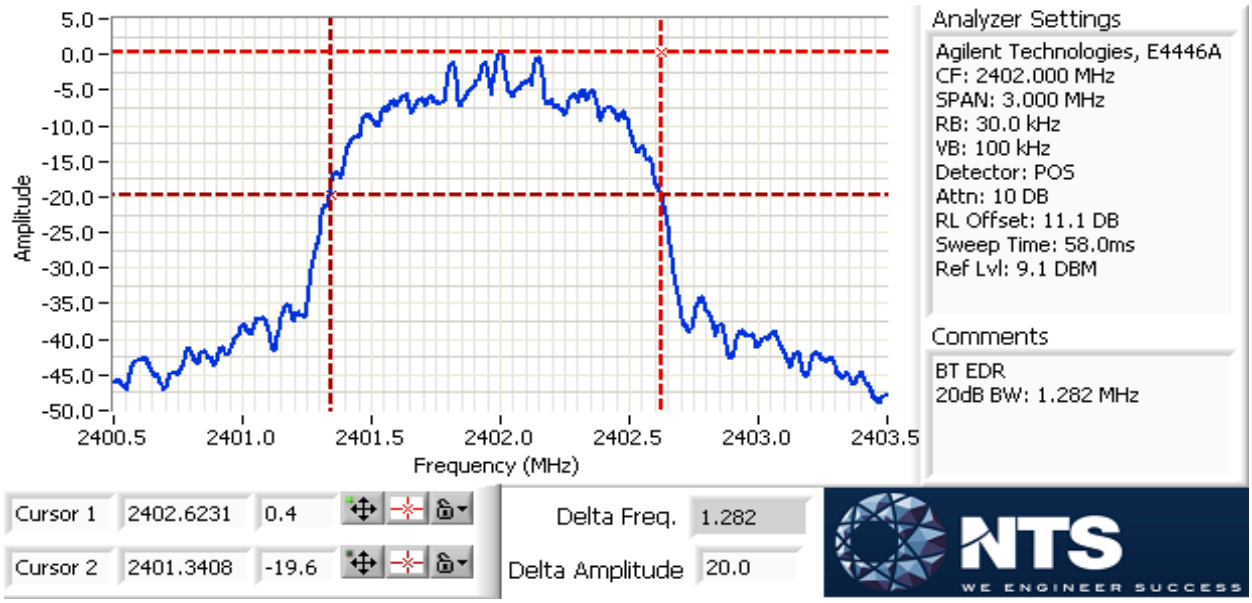
Test Engineer: Mehran Birgani

| Mode | Setting | Channel | Frequency (MHz) | Resolution Bandwidth (kHz) | 20dB Bandwidth (kHz) |
|---|---|---|---|---|---|
| Basic Rate (DH5) | 6 | Low | 2402 | 30 | 985 |
| | 6 | Mid | 2441 | 30 | 985 |
| | 6 | High | 2480 | 30 | 982 |
| EDR (3-DH5) | 6 | Low | 2402 | 30 | 1282 |
| | 6 | Mid | 2441 | 30 | 1282 |
| | 6 | High | 2480 | 30 | 1282 |

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



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

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 speudo 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.

| | | | | | |
|---|---|---|---|---|---|
| Channel Spacing: | 1000 kHz | | 2/3 of 20dB BW | | |
| 20dB Bandwidth: | 985 kHz | Basic | 656.7 kHz | Basic | |
| 20dB Bandwidth: | 1282 kHz | EDR | 854.7 kHz | EDR | |

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

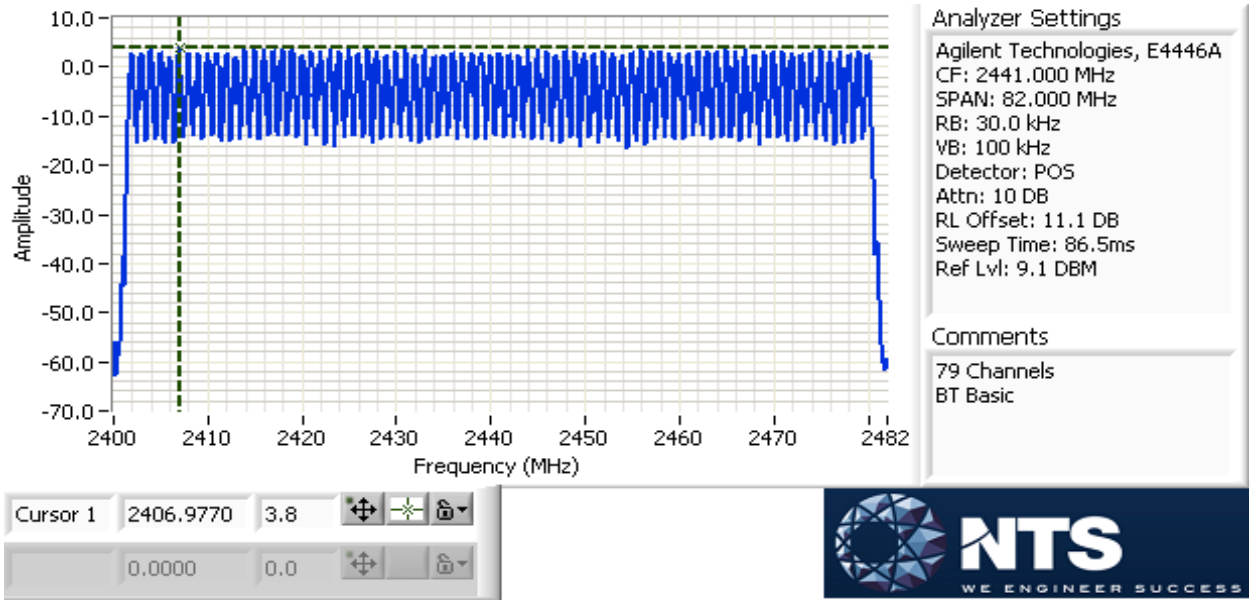
Requirement: The channel spacing shall be greater than 2/3 of the highest 20dB bandwidth as the ouput power is < 0.125 W.

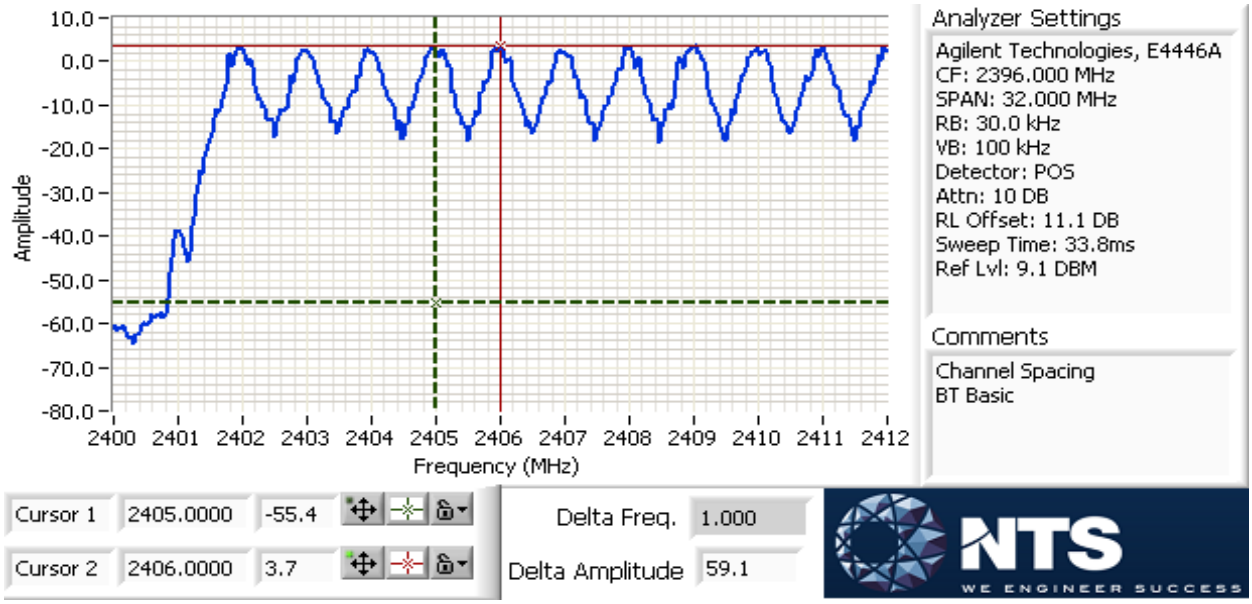
The number of channels was measured in Basic rate mode with hopping enabled with both the maximum (all) channels enabled and with the minimum number of channels enabled. The system shall employ a minimum of 15 hopping channels.

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

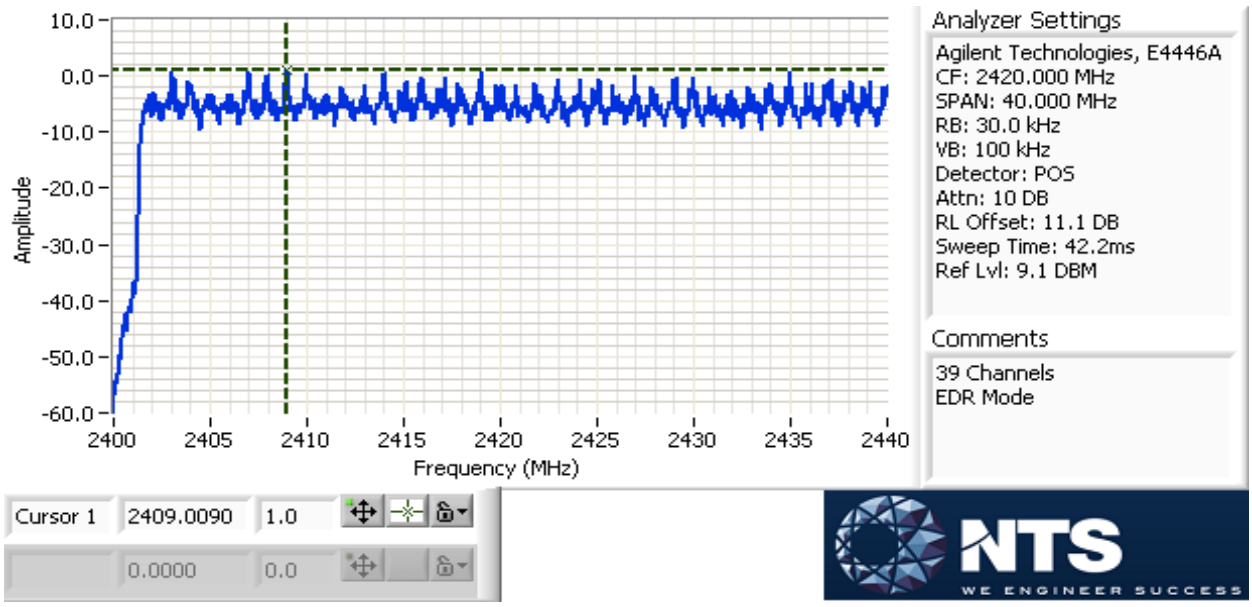
Number of channels: 79 Max 20 Min (AFH enabled)

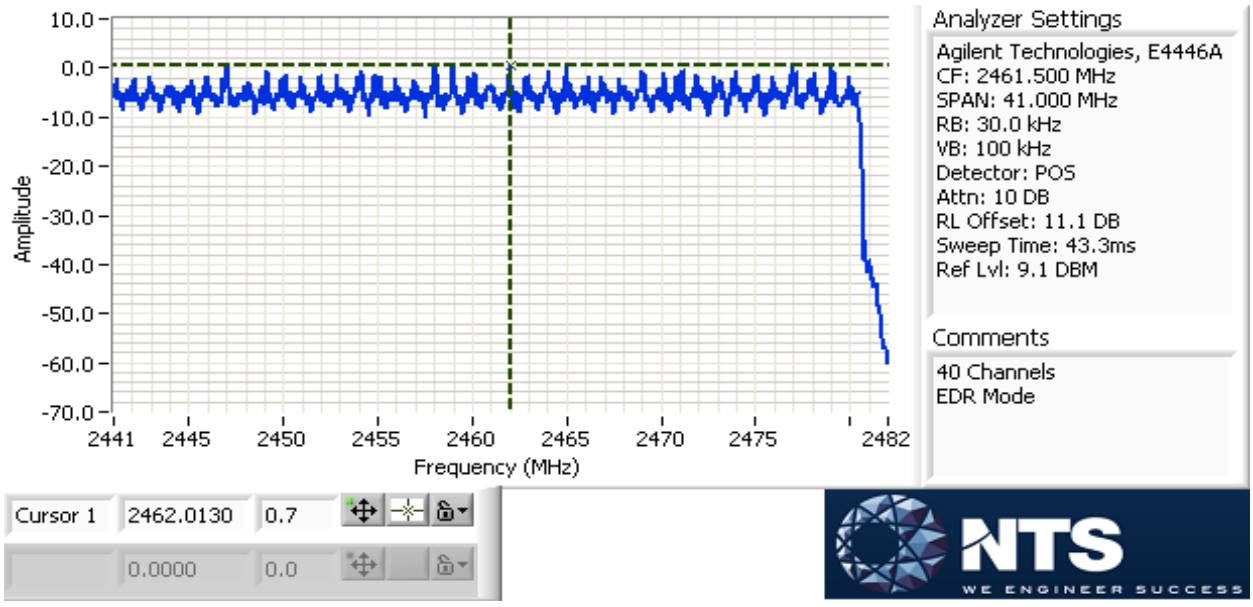
| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |



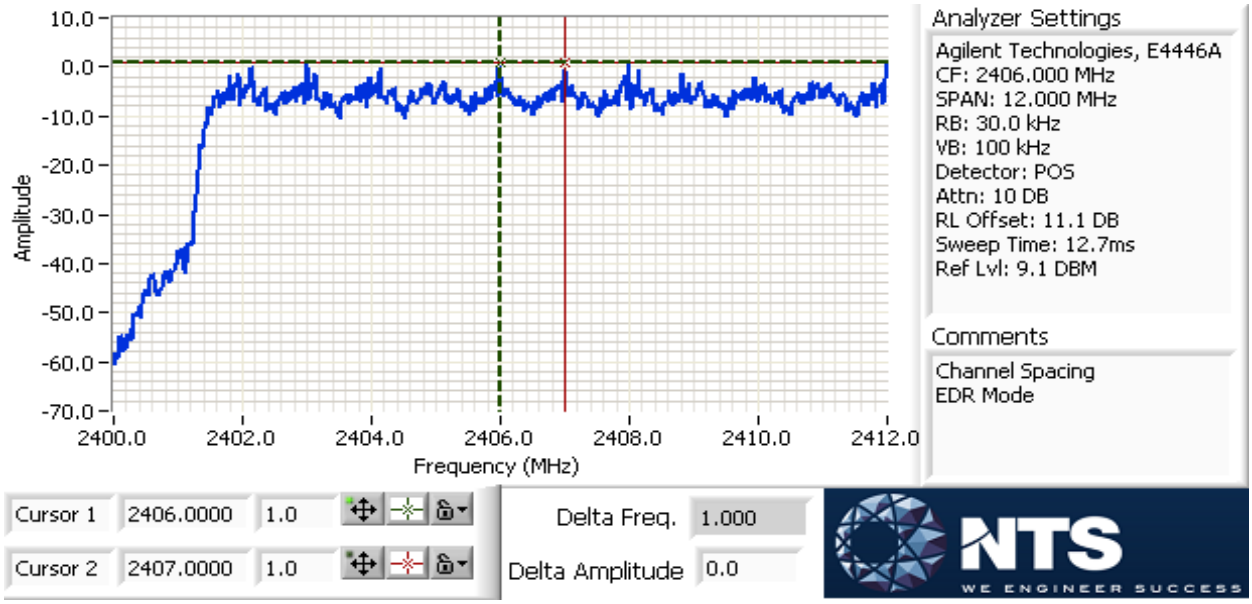



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |




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

Date of Test: 7/27/2016 Test Location: FT Lab #4a

Test Engineer: Rafael Varelas

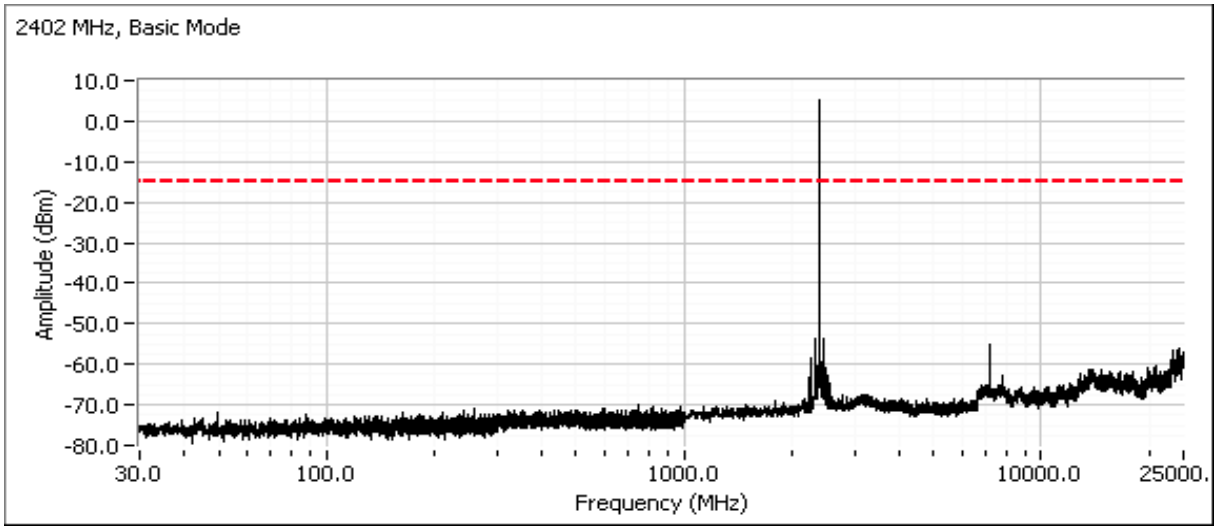
| Frequency (MHz) | Power Setting | Mode | Limit | Result |
|---|---|---|---|---|
| 2402 | 6 | Basic | -20dBc | Pass |
| 2441 | 6 | Basic | -20dBc | Pass |
| 2480 | 6 | Basic | -20dBc | Pass |

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).

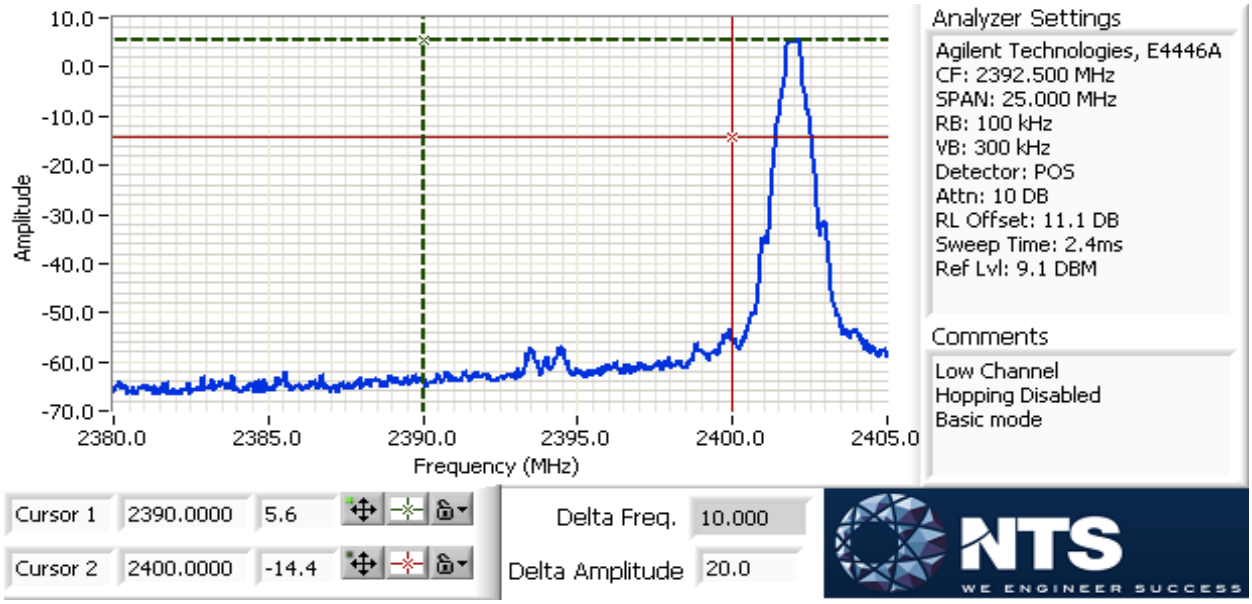
| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

Low channel

Broadband plot

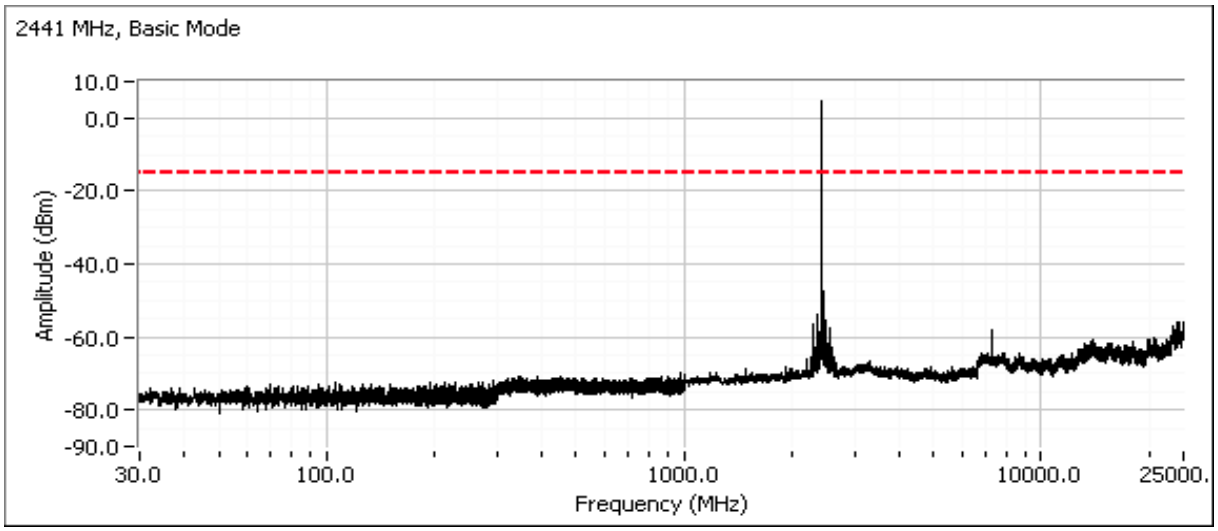



Plot showing -20dBc at the lower band edge

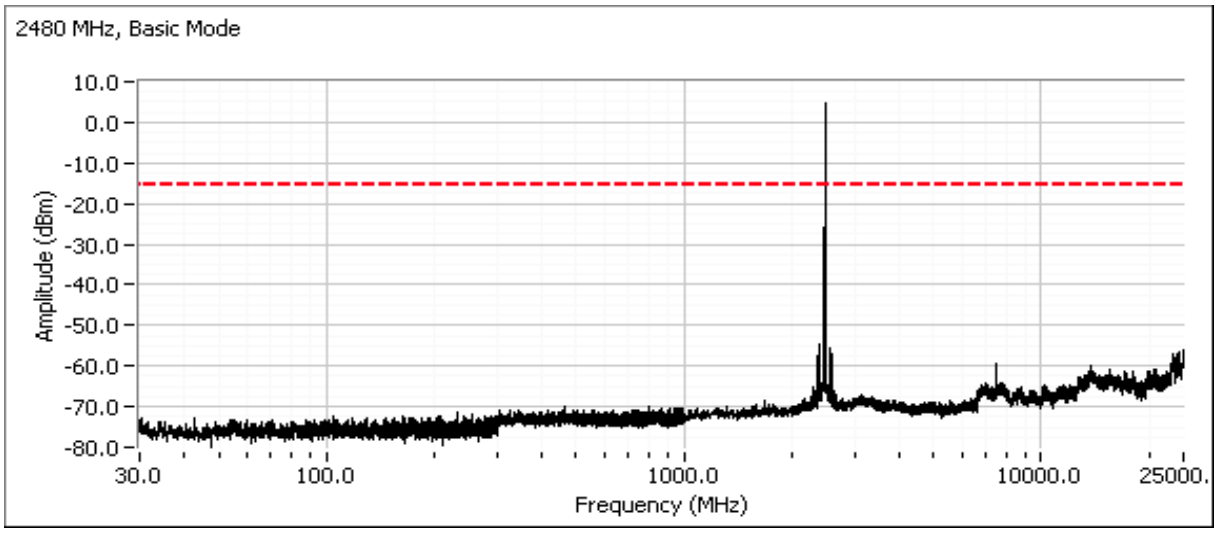


| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

Center channel
Broadband plot

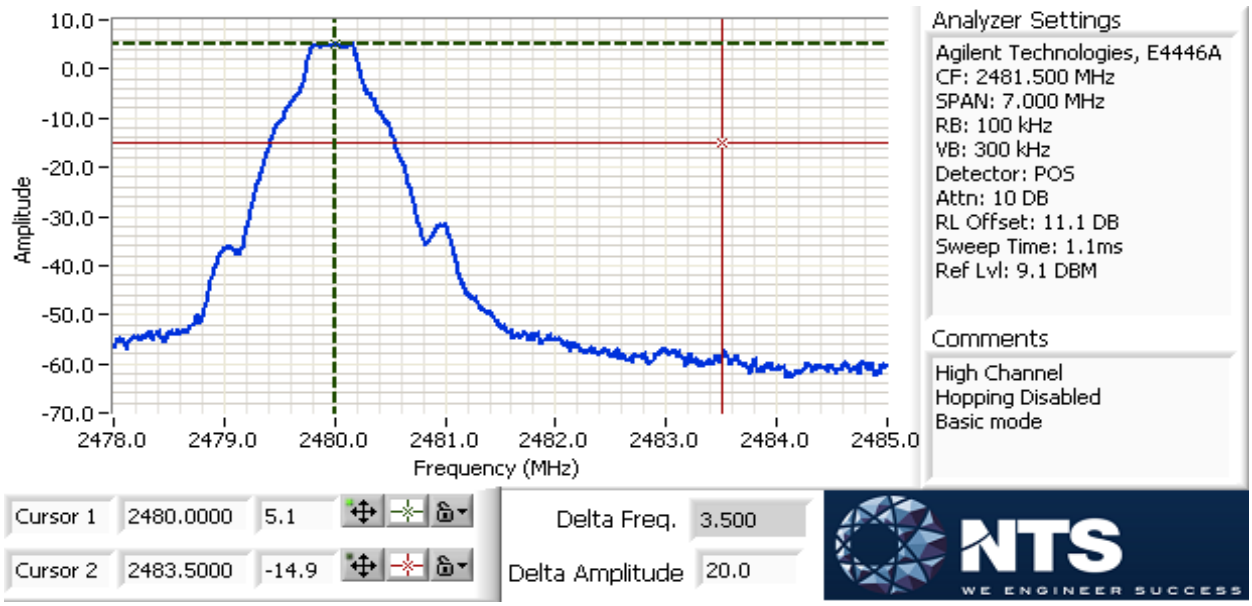



High channel
Broadband plot



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

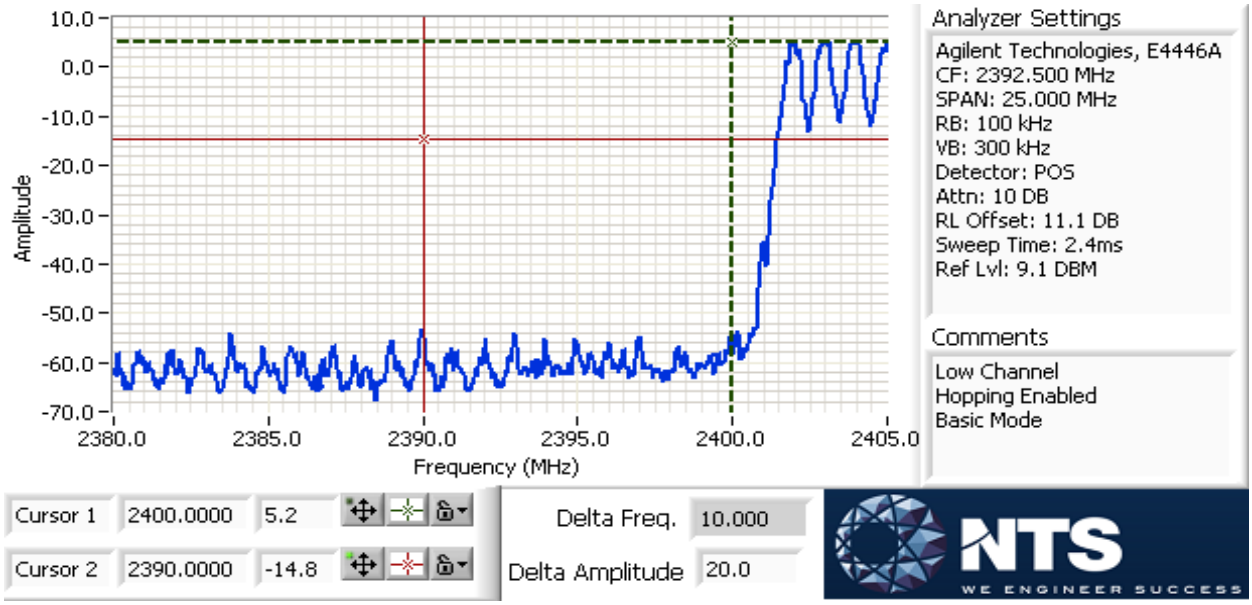
Plot showing -20dBc at the upper band edge



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

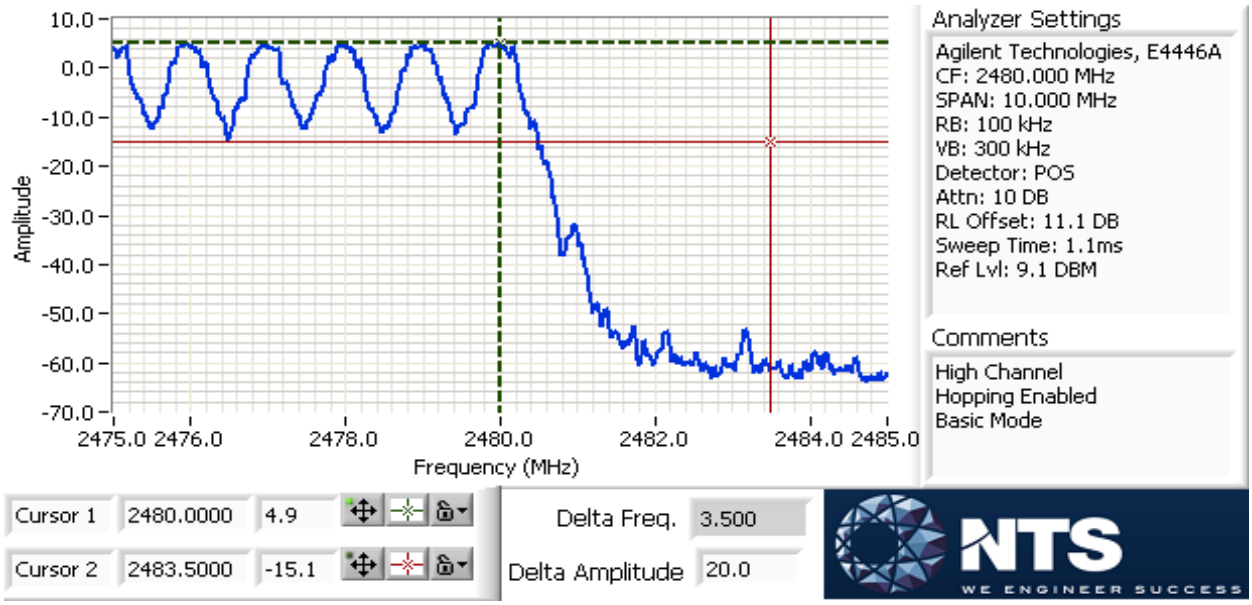
Refer to plots below. Scans made using RBW=100 KHz, VBW=300kHz with the limit line set at 20dB below the highest in-band signal level with the hopping feature enabled to show compliance with the -20dBc requirement at the allocated band edge. The spectrum analyzer is left in max hold mode until the trace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

Low channel, hopping enabled
Plot showing -20dBc at the lower band edge



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

High channel, hopping enabled
Plot showing -20dBc at the upper band edge



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

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

Date of Test: 7/27/2016 Test Location: FT Lab #4a

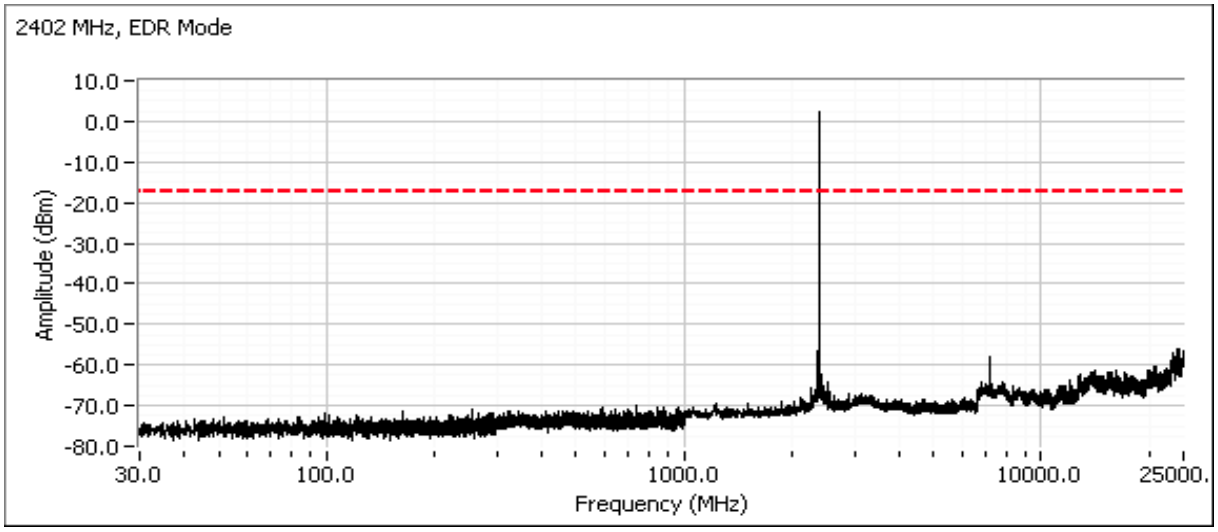
Test Engineer: Rafael Varelas

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

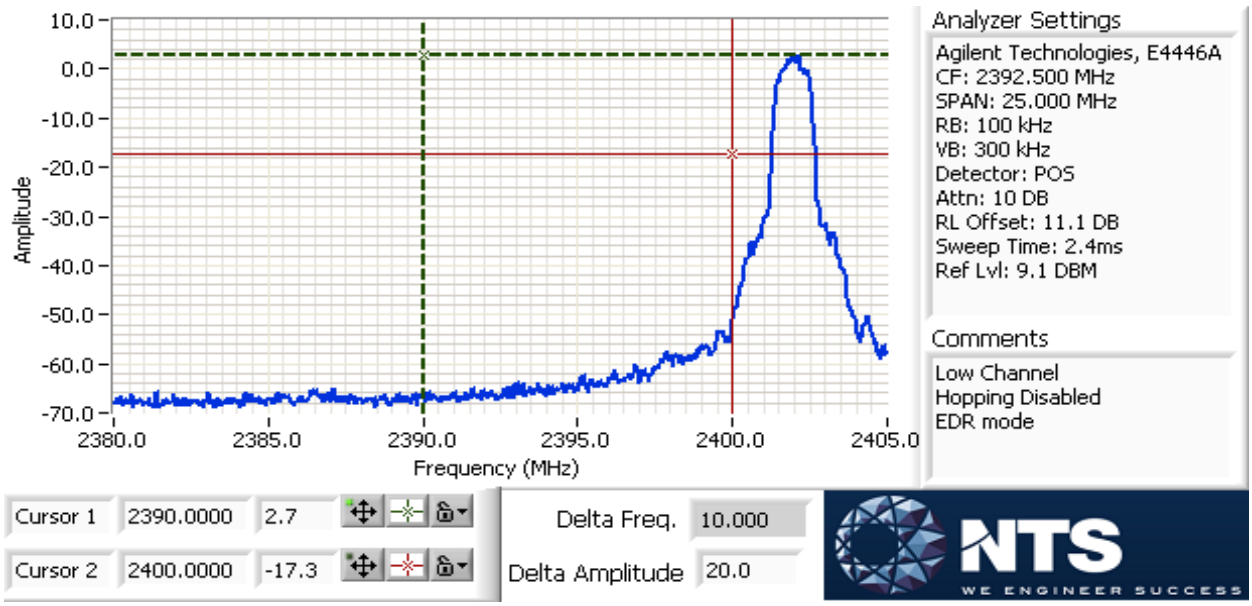
Low channel

Broadband plot



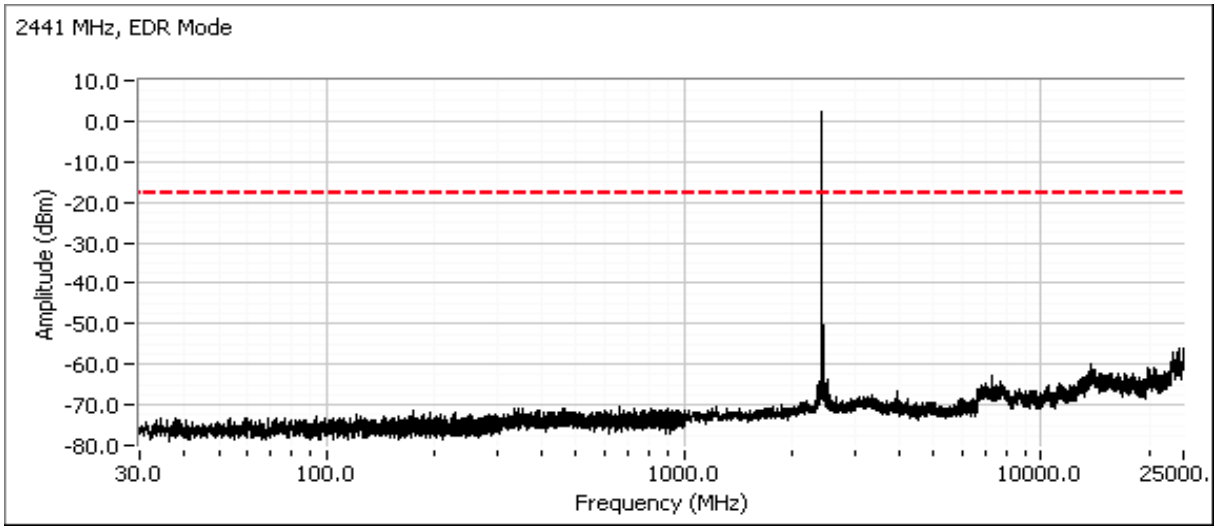
| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

Plot showing -20dBc at the lower band edge




Center channel

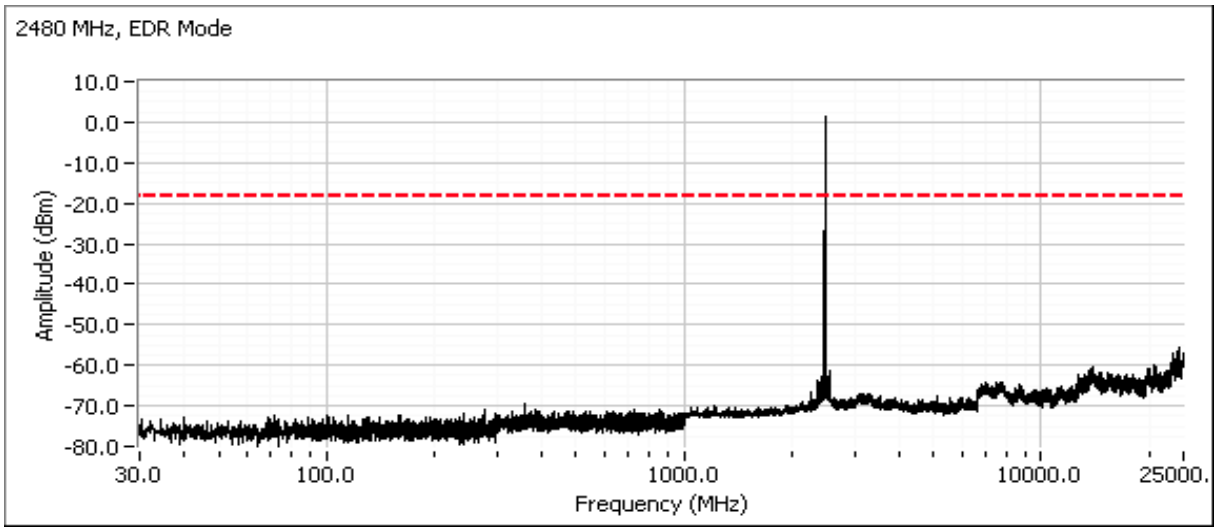
Broadband plot



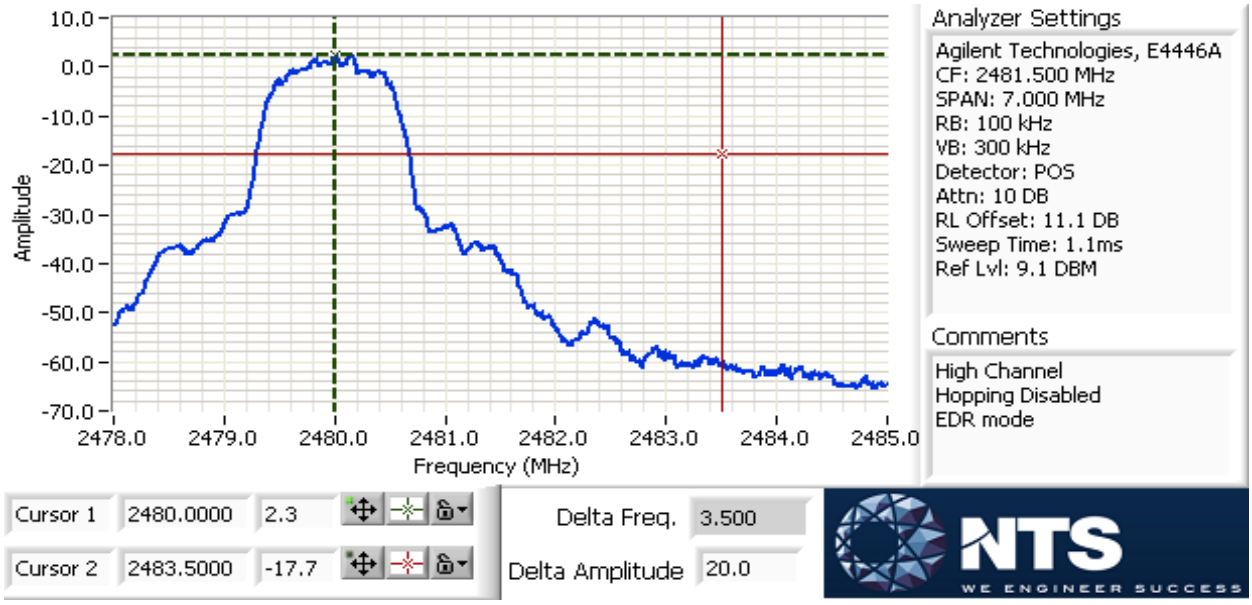
| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

High channel

Broadband plot




Plot showing -20dBc at the upper band edge

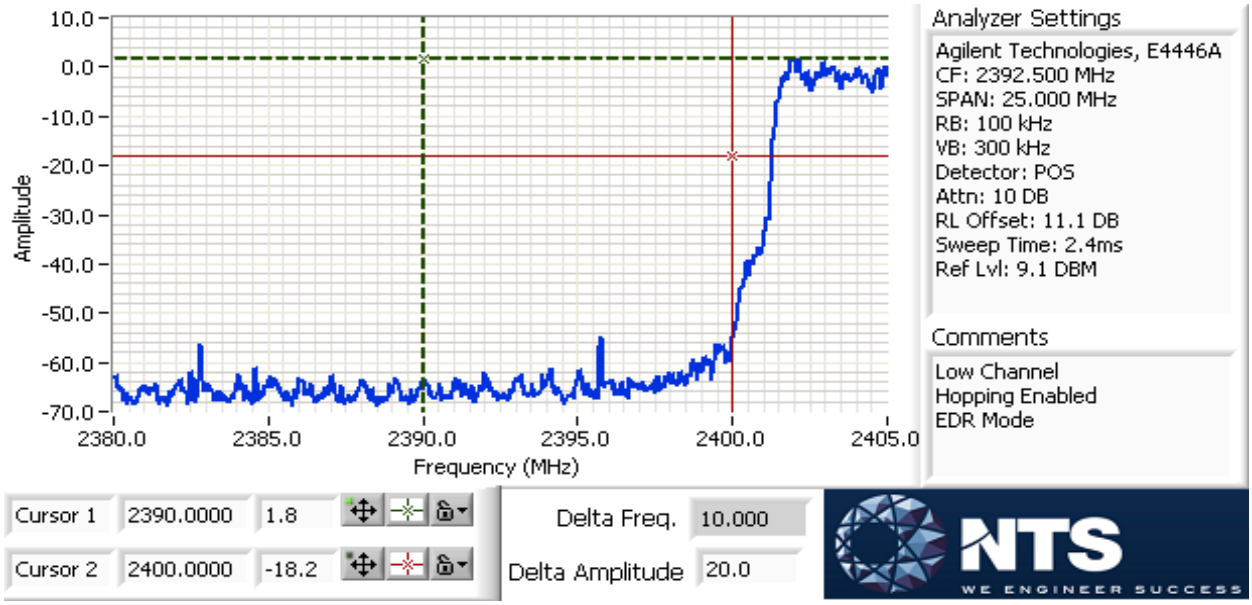


| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

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

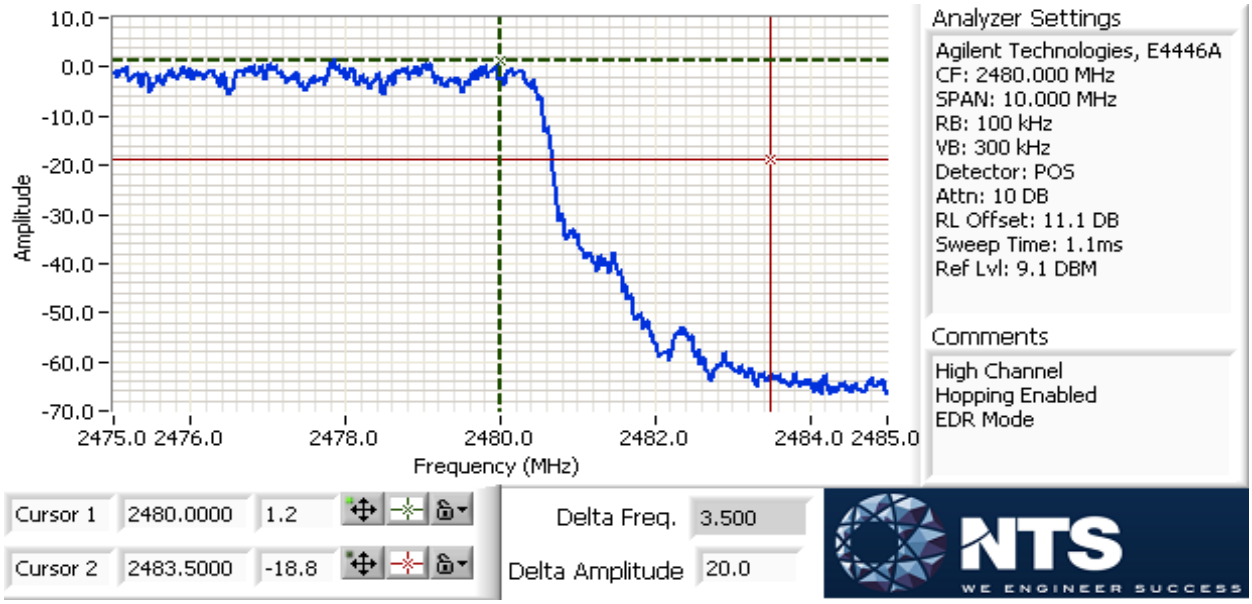
Plot showing -20dBc at the lower band edge



| | | | |
|---|---|---|---|
| Client: | Google Inc | Job Number: | JD101591 |
| Model: | H0ME | T-Log Number: | T102007 |
| | | Project Manager: | Deepa Shetty |
| Contact: | Dominik Mente | Project Coordinator: | - |
| Standard: | FCC 15.247 / RSS-247 | Class: | N/A |

High channel, hopping enabled

Plot showing -20dBc at the upper band edge



***End of Report***

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