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Radio Test Report

FCC Part 90
(406.1 MHz to 470 MHz)

Models: CT-151, CT-152, CT-154, CT-155 and CT-156

COMPANY:	Visiplex Inc. 1287 Barclay Blvd Buffalo, IL 60089
TEST SITE(S):	National Technical Systems - Silicon Valley 41039 Boyce Road. Fremont, CA. 94538-2435
REPORT DATE:	April 14, 2015
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A2LA ACCREDITED
Testing Cert #0214.26

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	April 14, 2015	First release	
1	April 21, 2015	Revised to update a note in the test log concerning the mask which appeared on Page 18.	David Guidotti

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SCOPE

Tests have been performed on samples of the Visiplex Inc. models CT-151, CT-152, CT-154, CT-155 and CT-156, pursuant to the relevant requirements of the following standard(s) in order to obtain device certification against the regulatory requirements of the Federal Communications Commission and Industry Canada.

- Code of Federal Regulations (CFR) Title 47 Part 2
- CFR 47 Part 90 (Private Land Mobile Radio Service)

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 C63.4:2009
ANSI TIA-603-C August 17, 2004

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

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.

The test results recorded herein are based on a single type test of the Visiplex Inc. model CT-151 and therefore apply only to the tested samples. The samples were selected and prepared by Ben Agam of Visiplex Inc.

OBJECTIVE

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

Prior to marketing in the USA, the device requires certification. Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification.

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.).

Testing was performed only on model CT-151. This model was considered representative of the following models CT-151, CT-152, CT-154, CT-155 and CT-156.

STATEMENT OF COMPLIANCE

The tested samples of Visiplex Inc. model CT-151 complied with the requirements of the standards and frequency bands declared in the scope of this test report.

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.

DEVIATIONS FROM THE STANDARDS

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

TEST RESULTS

FCC Part 90 and RSS-119

FCC		Description	Measured	Limit	Result
Transmitter Modulation, output power and other characteristics					
§2.1033 (c) (5) § 90.35		Frequency range(s)	406.1-470 MHz	406.1-470 MHz	Pass
§2.1033 (c) (6) §2.1033 (c) (7) § 2.1046 § 90.217		RF power output at the antenna terminals	6.0 dBm	20.8 dBm	Pass
§2.1033 (c) (4) § 2.1047 § 90.210		Emission types	2FSK on 12.5 kHz channels	-	-
		Emission mask	> 30dBc	> 30 dBc more than 25 kHz offset less frequency stability	Pass
§ 2.1049 § 90.209		Occupied Bandwidth	7.1 kHz		
Transmitter spurious emissions					
§ 2.1051 § 2.1057		At the antenna terminals	-30.8dBm @ 812.2MHz (-5.1 dB)	> 30dBc	Pass
Other details					
§ 2.1055 § 90.213		Frequency stability	1800 Hz	4.4 ppm	Pass
§ 2.1093		RF Exposure	SAR Exclusion Calculation = 0.5	3.0	
§2.1033 (c) (8)		Final radio frequency amplifying circuit's dc voltages and currents for normal operation over the power range	3V, 24mA	-	-
Notes					

EXTREME CONDITIONS

Frequency stability is determined over extremes of temperature and voltage. As the device is hand carried, battery powered equipment, the supply voltage was reduced to the battery operating end point of 2.5 Vdc as specified by the manufacturer.

The extremes of temperature were -30°C to +50°C as specified in FCC §2.1055(a)(1).

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 (based on a coverage factor (k=2) and were calculated in accordance with NAMAS document NIS 81 and M3003.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF frequency	Hz	25 to 7,000 MHz	1.7×10^{-7}
RF power, conducted	dBm	25 to 7,000 MHz	± 0.52 dB
Conducted emission of transmitter	dBm	25 to 40,000 MHz	± 0.7 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Visiplex Inc. models CT-151, CT-152, CT-154, CT-155 and CT-156 are battery operated compact paging transmitters. Since the EUT would be wall mounted during operation, the EUT was treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 3VDC provided by a battery.

The samples were received on April 6, 2015 and tested on April 6, 2015. The following samples were tested:

Company	Model	Description	Serial Number	FCC ID
Visiplex Inc.	CT-151	Compact Paging Transmitter	None	2AAFWCT15X
Visiplex Inc.	CT-151	Compact Paging Transmitter	None	2AAFWCT15X
Visiplex Inc.	CT-151	Compact Paging Transmitter	None	2AAFWCT15X

OTHER EUT DETAILS

The antenna is integral to the device. All models are identical except for the shape and number of buttons available to the user.

ENCLOSURE

The EUT enclosure measures approximately 11.5 by 7 by 3.5 centimeters. It is primarily constructed of uncoated plastic.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at National Technical Systems - Silicon Valley.

SUPPORT EQUIPMENT

No equipment was used as support equipment for testing.

EUT INTERFACE PORTS

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

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
USB	Not connected	-	-	-

The USB Port is only used for configuration and is not connected in use.

EUT OPERATION

During testing, the EUT was set to transmit a CW or modulated signal at 406.100 MHz, 435.000 MHz and 469.995 MHz for each of the samples respectively.

TESTING

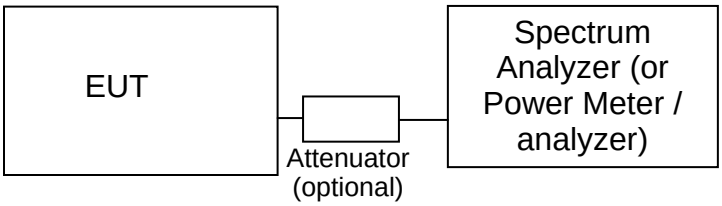
GENERAL INFORMATION

Antenna port measurements were taken at the National Technical Systems - Silicon Valley test site located at 41039 Boyce Road, Fremont, CA 94538-2435.

Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements.

RF PORT MEASUREMENT PROCEDURES

Conducted measurements are performed with the EUT's rf input/output connected to the input of a spectrum analyzer, power meter or modulation analyzer. When required an attenuator, filter and/or dc block is placed between the EUT and the spectrum analyzer to avoid overloading the front end of the measurement device. Measurements are corrected for the insertion loss of the attenuators and cables inserted between the rf port of the EUT and the measurement equipment.



Test Configuration for Antenna Port Measurements

For devices with an integral antenna the output power and spurious emissions are measured as a field strength at a test distance of (typically) 3m and then converted to an eirp using a substitution measurement. All other measurements are made as detailed below but with the test equipment connected to a measurement antenna directed at the EUT.

OUTPUT POWER

Output power is measured using a power meter and an average sensor head, a spectrum analyzer or a power meter and peak power sensor head as required by the relevant rule part(s). Where necessary measurements are gated to ensure power is only measured over periods that the device is transmitting.

Power measurements made directly on the rf power port are, when appropriate, converted to an EIRP by adding the gain of the highest gain antenna that can be used with the device under test, as specified by the manufacturer.

BANDWIDTH MEASUREMENTS

The 6dB, 20dB and/or 26dB signal bandwidth is measured in using the bandwidths recommended by ANSI C63.4. When required, the 99% bandwidth is measured using the methods detailed in RSS-GEN. The measurement bandwidth is set to be at least 1% of the instrument's frequency span.

CONDUCTED SPURIOUS EMISSIONS

Initial scans are made using a peak detector (RBW=VBW) and using scan rates to ensure that the EUT transmits before the sweep moves out of each resolution bandwidth (for transmit mode measurements). Where the limits are expressed as an average power the spectrum analyzer is tunes to that frequency with a narrow span (wide enough to capture the emission and its sidebands) and the resolution and video bandwidths are adjusted as required by the reference measurement standards. For transmitter measurements the appropriate detector (average, peak, normal ,sample, quasi-peak) is used when making measurements for licensed devices. For receiver conducted spurious measurements the detector is set to peak.

TRANSMITTER MASK MEASUREMENTS

The transmitter mask measurements are made using resolution bandwidths as specified in the pertinent rule part(s). Where narrower bandwidths are used the measurement is corrected to account for the reduced bandwidth by either using the adjacent channel power function of the spectrum analyzer to sum the power across the required measurement bandwidth. The frequency span of the analyzer is set to ensure the fundamental signal and all significant sidebands are displayed.

The top of the mask may be set by the total output power of the signal, the power of the unmodulated signal or the peak value of the signal in the reference bandwidth being used for the mask measurement.

FREQUENCY STABILITY

The EUT is placed inside a temperature chamber with all support and test equipment located outside of the chamber. The temperature is varied across the specified frequency range in 10 degree increments with frequency measurements made at each temperature step. The EUT is allowed enough time to stabilize at each temperature variation.

The spectrum analyzer is configured to give a 5- or 6-digit display for the marker-frequency function. The spectrum analyzer's built-in frequency counter is used to measure the maximum deviation of the fundamental frequency at each temperature. Where possible the device is set to transmit an unmodulated signal. Where this is not possible the frequency drift is determined by finding a stable point on the signal (e.g. the null at the centre of an OFDM signal) or by calculating a centre frequency based on the upper and lower XdB points (where X is typically 6dB or 10dB) on the signal's skirts.

INSTRUMENTATION

An EMI receiver / Spectrum Analyzer as specified in CISPR 16-1-1 is used for conducted emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 40,000 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.

For measurements above the frequency range of the receivers and for all conducted measurements a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis.

Measurement bandwidths for the test instruments are set in accordance with the requirements of the standards referenced in this document.

Software control is used to correct the measurements for the insertion loss of cables, attenuators and other series elements to obtain the final measurement value. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are exported in a graphic and/or tabular format, as appropriate.

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS - CONDUCTED SPURIOUS EMISSIONS

Measurements are compared directly to the conducted emissions specification limit (decibel form). The calculation is as follows:

$$R_r - S = M$$

where:

R_r = Measured value in dBm
S = Specification Limit in dBm
M = Margin to Specification in +/- dB

Appendix A Test Equipment Calibration Data

Radio Antenna Port (Power and Spurious Emissions), 06-Apr-15

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	4/8/2014	4/8/2015
Watlow	Temp Chamber (w/ F4 Watlow Controller)	F4	2170	7/18/2014	7/18/2015

Appendix B Test Data

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Client:	Visiplex Inc.	Job Number:	J97803
Product	CT-151, CT-152, CT-154, CT-155 and CT-156	T-Log Number:	T97845
		Project Manager:	Deepa Shetty
Contact:	Ben Agam	Project Coordinator:	
Emissions Standard(s):	FCC Part 90.217	Class:	N/A
Immunity Standard(s):		Environment:	Radio

EMC Test Data

For The

Visiplex Inc.

Product

CT-151, CT-152, CT-154, CT-155 and CT-156

Date of Last Test: 4/10/2015

Client:	Visiplex Inc.	Job Number:	J97803
Model:	CT-151, CT-152, CT-154, CT-155 and CT-156	T-Log Number:	T97845
		Project Manager:	Deepa Shetty
Contact:	Ben Agam	Project Coordinator:	-
Standard:	FCC Part 90.217	Class:	N/A

FCC Part 90

Power, Occupied Bandwidth, Frequency Stability 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

With the exception of the radiated spurious emissions tests, all measurements are made with the EUT's rf port connected to the measurement instrument via an attenuator or dc-block if necessary. All amplitude measurements are adjusted to account for the attenuation between EUT and measuring instrument. For frequency stability measurements the EUT was place inside an environmental chamber.

Ambient Conditions:

Temperature: 21.2 °C

Rel. Humidity: 31.8 %

Summary of Results

Run #	Spacing		Test Performed	Limit	Pass / Fail	Result / Margin
1	12.5 kHz		Output Power	20.8 dBm	Pass	6.0 dBm
2	12.5 kHz		Spectral Mask	90.217 (-30dBc > 25 kHz from center)	Pass	> 30dBc at edge of mask
3	12.5 kHz		99% or Occupied Bandwidth	11.25 kHz	Pass	7.1 kHz
4	12.5 kHz		Spurious Emissions (conducted)	-30 dBc	Pass	-30.8dBm @ 812.2MHz (-5.1 dB)
5	-		Frequency Stability	None, used for Mask	Pass	1800 Hz

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:	Visiplex Inc.	Job Number:	J97803
Model:	CT-151, CT-152, CT-154, CT-155 and CT-156	T-Log Number:	T97845
		Project Manager:	Deepa Shetty
Contact:	Ben Agam	Project Coordinator:	-
Standard:	FCC Part 90.217	Class:	N/A

Run #1: Output Power

Date of Test: 04/06/15
Test Engineer: M. Birgani
Test Location: Lab 4

Config. Used: Conducted
Config Change: None
EUT Voltage: Internal 3 VDC battery

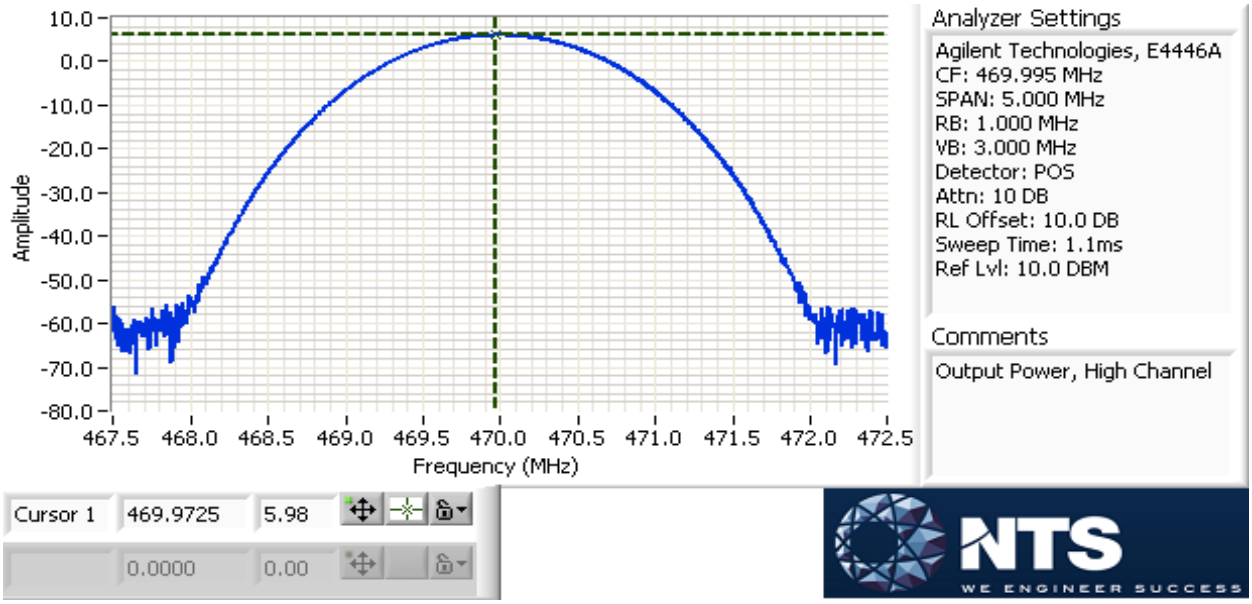
Cable Loss: 0.0 dB
Cable ID(s): -

Attenuator: 10.0 dB
Attenuator IDs: 2100

Total Loss: 10.0 dB

Power Setting[2]	Frequency (MHz)	Output Power (dBm) [1]	Output Power mW	Antenna Gain (dBi)	Result	EIRP dBm	EIRP W
Default	406.100	4.3	2.7		Pass	4.3	0.003
	435.000	4.6	2.9		Pass	4.6	0.003
	469.995	6.0	4.0		Pass	6.0	0.004

Note 1:	Output power measured using a spectrum analyzer (see plots below) with RBW=1MHz, VB=3 MHz, Peak detector
Note 2:	Power setting - the software power setting used during testing, included for reference only.

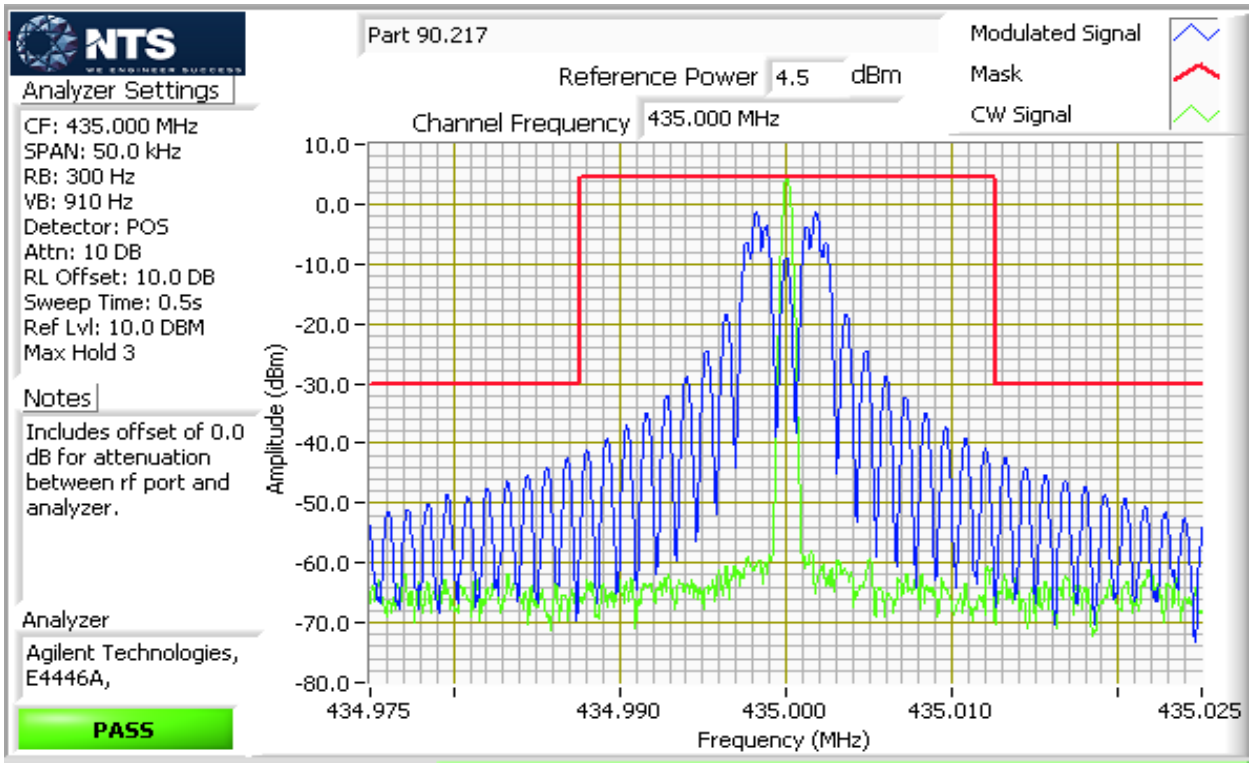


Client:	Visiplex Inc.	Job Number:	J97803
Model:	CT-151, CT-152, CT-154, CT-155 and CT-156	T-Log Number:	T97845
		Project Manager:	Deepa Shetty
Contact:	Ben Agam	Project Coordinator:	-
Standard:	FCC Part 90.217	Class:	N/A

Run #2: Spectral Mask, FCC Part 20.917

Date of Test: 04/06/15
Test Engineer: M. Birgani
Test Location: Lab 4

Config. Used: Conducted
Config Change: None
EUT Voltage: Internal 3 VDC battery



Note 1:	Requirement is -30dBc <25 KHz from the center of the channel but this offset frequency needs to include the frequency stability. Plot shows that 12.5 kHz from the center, the level is more than 34 dBc. Since stability is 1.8 kHz, the product complies with the requirement.

Client:	Visiplex Inc.	Job Number:	J97803
Model:	CT-151, CT-152, CT-154, CT-155 and CT-156	T-Log Number:	T97845
		Project Manager:	Deepa Shetty
Contact:	Ben Agam	Project Coordinator:	-
Standard:	FCC Part 90.217	Class:	N/A

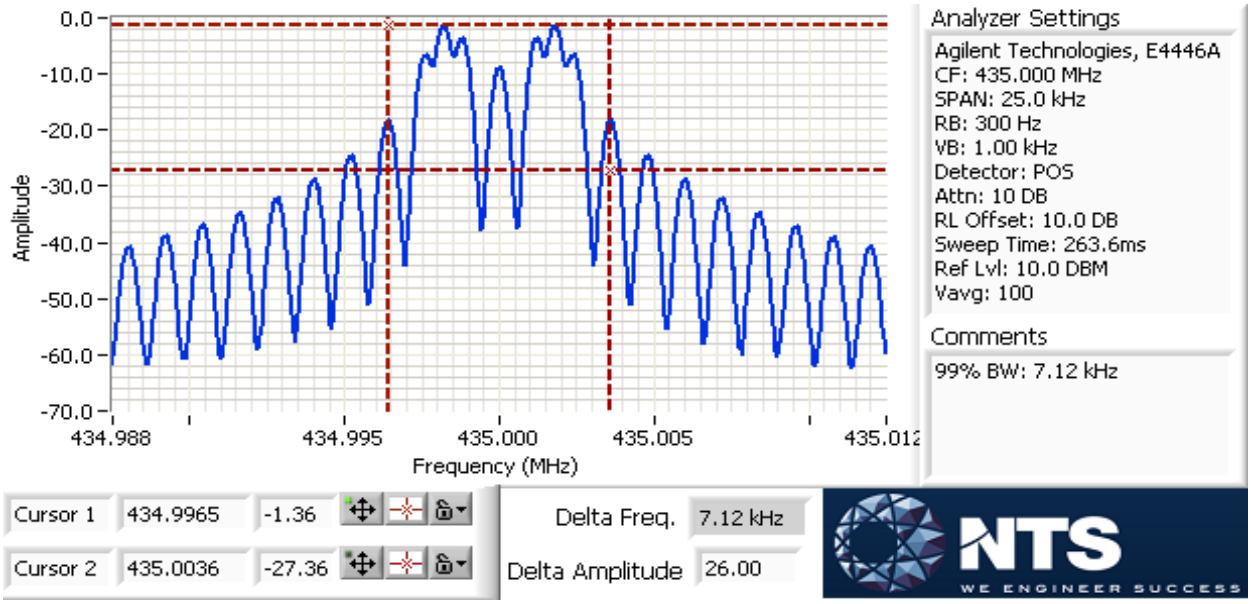
Run #3: Signal Bandwidth

Date of Test: 04/06/15
Test Engineer: M. Birgani
Test Location: Lab 4

Config. Used: Conducted
Config Change: None
EUT Voltage: Internal 3 VDC battery

Power Setting	Frequency (MHz)	Resolution Bandwidth	Bandwidth (kHz)	
				99%
Default	435.000	300 Hz		7.1

Note 1:	99% bandwidth measured in accordance with RSS GEN, with RB > 1% of the span and VB > 3xRB



Client:	Visiplex Inc.	Job Number:	J97803
Model:	CT-151, CT-152, CT-154, CT-155 and CT-156	T-Log Number:	T97845
		Project Manager:	Deepa Shetty
Contact:	Ben Agam	Project Coordinator:	-
Standard:	FCC Part 90.217	Class:	N/A

Run #4: Out of Band Spurious Emissions, Conducted

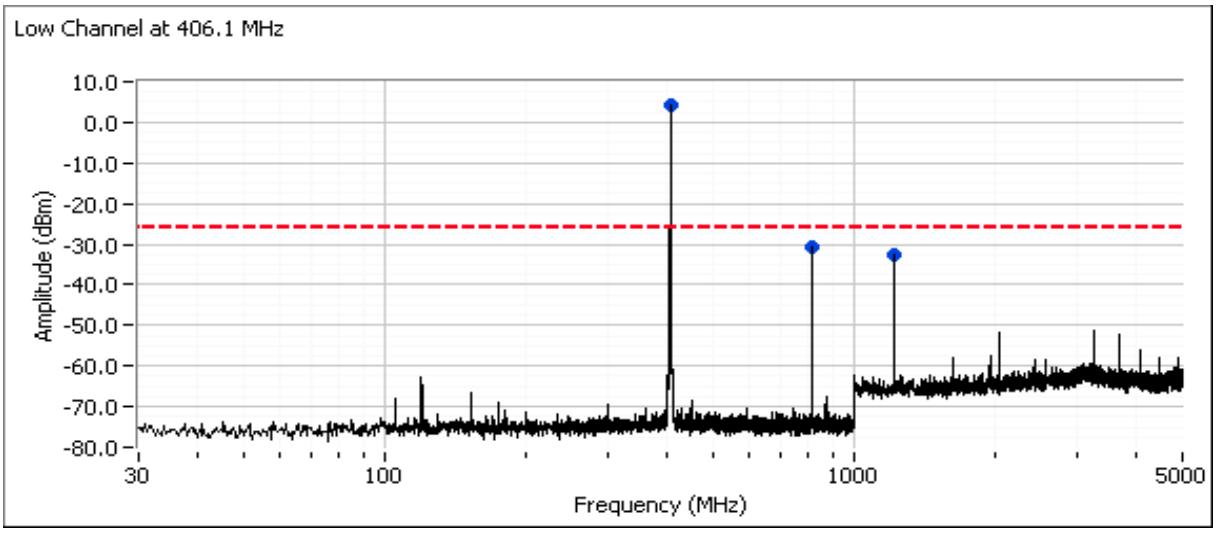
Date of Test: 04/06/15
Test Engineer: M. Birgani
Test Location: Lab 4

Config. Used: Conducted
Config Change: None
EUT Voltage: Internal 3 VDC battery

Frequency (MHz)	Limit	Result
Default	-30 dBc	Pass
	-30 dBc	Pass
	-30 dBc	Pass

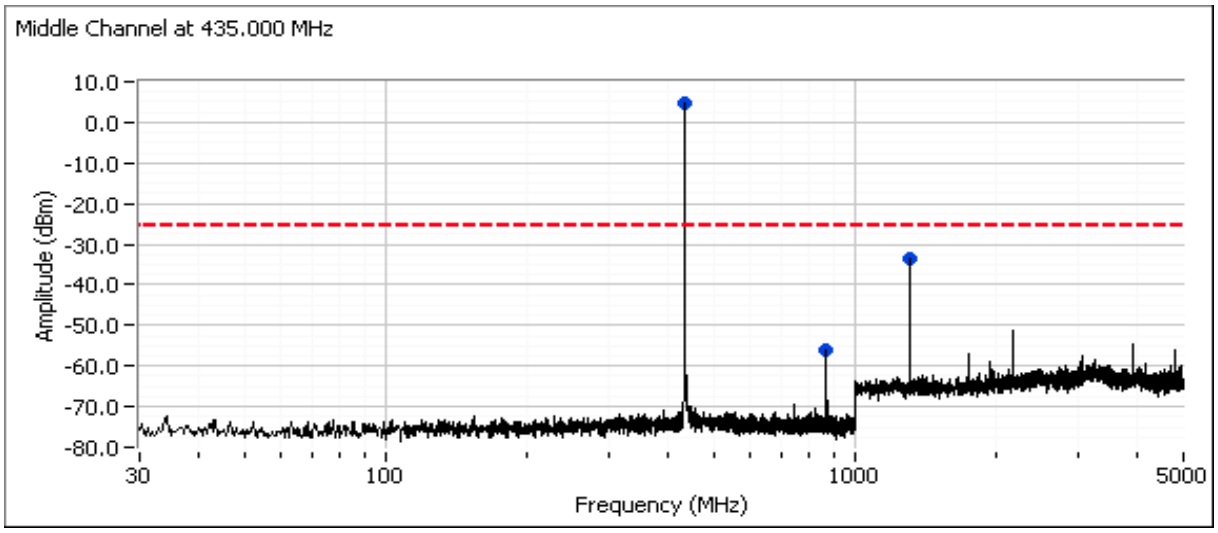
The limit is taken from FCC Part 90.217

Plots for low channel, power setting(s) = Default

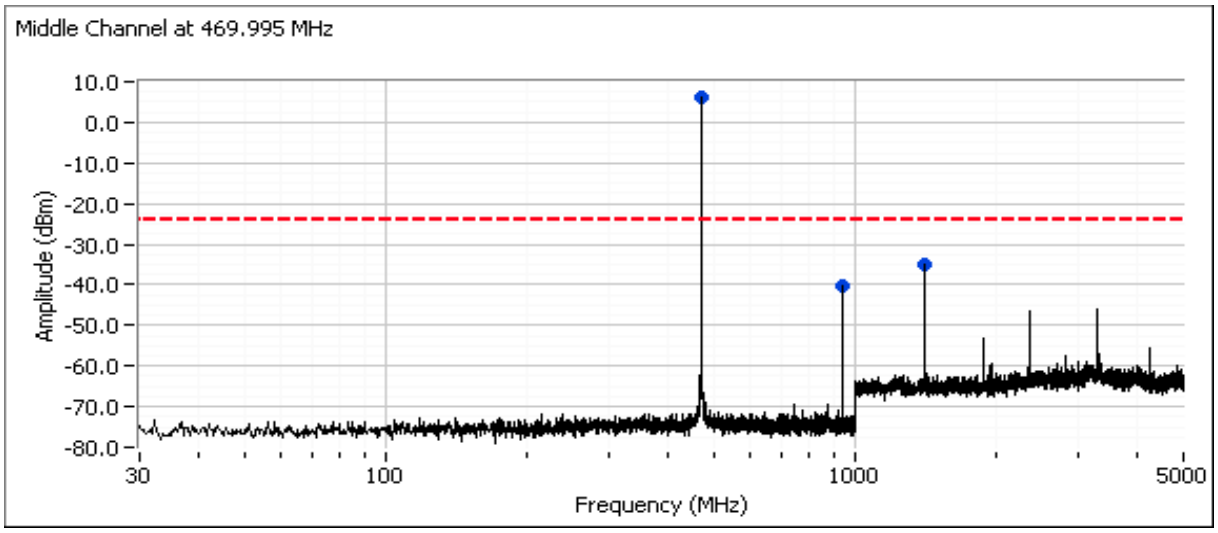


Client:	Visiplex Inc.	Job Number:	J97803
Model:	CT-151, CT-152, CT-154, CT-155 and CT-156	T-Log Number:	T97845
		Project Manager:	Deepa Shetty
Contact:	Ben Agam	Project Coordinator:	-
Standard:	FCC Part 90.217	Class:	N/A

Plots for center channel, power setting(s) = Default



Plots for high channel, power setting(s) = Default



Client:	Visiplex Inc.	Job Number:	J97803
Model:	CT-151, CT-152, CT-154, CT-155 and CT-156	T-Log Number:	T97845
		Project Manager:	Deepa Shetty
Contact:	Ben Agam	Project Coordinator:	-
Standard:	FCC Part 90.217	Class:	N/A

Results:

Frequency MHz	Level dBm	Port	Limit	Margin	Detector QP/Ave	Comments	Channel
406.105	4.3	RF Port	-	-	Peak	Fundamental	Low
812.202	-30.8	RF Port	-25.7	-5.1	Peak	PK (CISPR)-RB 120 kHz; VB: 1 MHz	Low
1218.270	-32.4	RF Port	-25.7	-6.7	Peak	PK (CISPR)-RB 1 MHz; VB: 8 MHz	Low
434.998	4.6	RF Port	-	-	Peak	Fundamental	Middle
869.993	-56.1	RF Port	-25.4	-30.7	Peak	PK (CISPR)-RB 120 kHz; VB: 1 MHz	Middle
1305.010	-33.7	RF Port	-25.4	-8.3	Peak	PK (CISPR)-RB 1 MHz; VB: 8 MHz	Middle
469.999	6.0	RF Port	-	-	Peak	Fundamental	High
939.991	-40.5	RF Port	-24.0	-16.5	Peak	PK (CISPR)-RB 120 kHz; VB: 1 MHz	High
1409.960	-35.1	RF Port	-24.0	-11.1	Peak	PK (CISPR)-RB 1 MHz; VB: 8 MHz	High

Client:	Visiplex Inc.	Job Number:	J97803
Model:	CT-151, CT-152, CT-154, CT-155 and CT-156	T-Log Number:	T97845
		Project Manager:	Deepa Shetty
Contact:	Ben Agam	Project Coordinator:	-
Standard:	FCC Part 90.217	Class:	N/A

Run #5: Frequency Stability

Date of Test: 04/06/15
Test Engineer: M. Birgani
Test Location: Lab 4

Config. Used: Conducted
Config Change: None
EUT Voltage: Internal 3 VDC battery

Nominal Frequency: 406.1 MHz

Frequency Stability Over Temperature

The EUT was soaked at each temperature for a minimum of 30 minutes prior to making the measurements to ensure the EUT and chamber had stabilized at that temperature.

Temperature	Frequency Measured	Drift	
(Celsius)	(MHz)	(Hz)	(ppm)
-30	406.101744	1744	4.3
-20	406.101652	1652	4.1
-10	406.101693	1693	4.2
0	406.101741	1741	4.3
10	406.101762	1762	4.3
20	406.101771	1771	4.4
30	406.101752	1752	4.3
40	406.101685	1685	4.1
50	406.101656	1656	4.1
	Worst case:	1771	4.4

Frequency Stability Over Input Voltage

Nominal Voltage is 3.0Vdc, Battery Endpoint is.2.5 VDC

Voltage	Frequency Measured	Drift	
(DC)	(MHz)	(Hz)	(ppm)
2.5	406.101800	1800	4.4

Note 1:	Maximum drift of fundamental frequency before it shut down at 2.3 Vdc.

End of Report

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