FCC PART 24 TYPE APPROVAL
EMI MEASUREMENT AND TEST REPORT

For

Cellular Specialties, Inc.

670 N. Commercial St.
Manchester NH 03101

FCC ID: NVRCSI2000-01

July 24, 2002

This Report Concerns:	**Equipment Type:**
☒ Original Report	PCS Amplifier

Test Engineer:	Benjamin Jing
Report No.:	R0206143
Test Date:	July 12, 2002
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1 - GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

The *Cellular Specialties, Inc.'s* product, model: *PCS2000 or the* "EUT" as referred to in this report is a Miniature In-Building Amplifier (Mini-IBA) using in enclosed structures where sufficient signal from local cell sites to operate cell phones was unavailable within the building. Specially, the Mini-IBA is designed to cover small areas such as home offices, small workshops, etc.

The device is connected to an external antenna, usually on the roof, and to one or more internal antennas placed strategically throughout the area where phone service is desired.

The EUT measures approximately 6.5"L x 3.5"W x 1.5"H.

** The test data was only good for test sample. It may have deviation for other product samples.*

1.2 Objective

This type approval report is prepared on behalf of *Cellular Specialties, Inc.* in accordance with Part 2, Subpart J, Part 15, Subparts A and B, and Part 24 Subpart E, of the Federal Communication Commissions rules.

The objective of the manufacturer is to demonstrate compliance with FCC rules for RF Power Output, Occupied Bandwidth, Spurious Emissions at Antenna Terminals, Field Strength of Spurious Emission and Frequency Stability.

1.3 Related Submittal(s)/Grant(s)

No Related Submittals

1.4 Test Methodology

All measurements contained in this report were conducted with ANSI C63.4-2000, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.

All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory, Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

1.5 Test Facility

The Open Area Test site used by Bay Area Compliance Laboratory Corporation to collect radiated and conducted emission measurement data is located in the back parking lot of the building at 230 Commercial Street, Sunnyvale, California, USA.

Test sites at Bay Area Compliance Laboratory Corporation has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports has been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997 and Article 8 of the VCCI regulations on December 25, 1997. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2000.

The Federal Communications Commission and Voluntary Control Council for Interference has the reports on file and is listed under FCC file 31040/SIT 1300F2 and VCCI Registration No.: C-674 and R-657. The test sites have been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, Bay Area Compliance Laboratory Corporation is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (NVLAP). The scope of the accreditation covers the FCC Method - 47 CFR Part 15 - Digital Devices, IEC/CISPR 22: 1998, and AS/NZS 3548: Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment test methods under NVLAP Lab Code 200167-0.

1.6 Test Equipment List

Manufacturer	Description	Model	Serial Number	Cal. Due Data
HP	Spectrum Analyzer	8566B	2610A02165	12/6/00
HP	Spectrum Analyzer	8593B	2919A00242	12/20/00
HP	Amplifier	8349B	2644A02662	12/20/00
HP	Quasi-Peak Adapter	85650A	917059	12/6/00
HP	Amplifier	8447E	1937A01046	12/6/00
A.H. System	Horn Antenna	SAS0200/571	261	12/27/00
Com-Power	Log Periodic Antenna	AL-100	16005	11/2/00
Com-Power	Biconical Antenna	AB-100	14012	11/2/00
Solar Electronics	LISN	8012-50-R-24-BNC	968447	12/28/00
Com-Power	LISN	LI-200	12208	12/20/00
Com-Power	LISN	LI-200	12005	12/20/00
BACL	Data Entry Software	DES1	0001	12/20/00
Rohde & Schwarz	Signal Generator	SMIQ03B	1125.5555.03	7/10/2002
Rohde & Schwarz	I/Q Modulation Generator	AMIQ	1110.2003.02	8/10/2002

Statement of Traceability: Bay Area Compliance Laboratory Corp. declares that all equipment has been performed calibration using suitable standard traceable to National Institute of Standard and Technology (NIST).

1.7 Local Support Equipment List and Details

Manufacturer	Description	Model	Serial Number	FCC ID
Rohde & Schwarz	Signal Generator	SMIQ03B	1125.5555.03	Doc
Rohde & Schwarz	I/Q Modulation Generator	AMIQ	1110.2003.02	Doc

1.8 External I/O Cabling List and Details

Cable Description	Length (M)	Port/From	To
Shielded BNC Cable	1.0	RF Port/AMIQ02(SMIQ03)	sEUT

2 - SYSTEM TEST CONFIGURATION

2.1 Justification

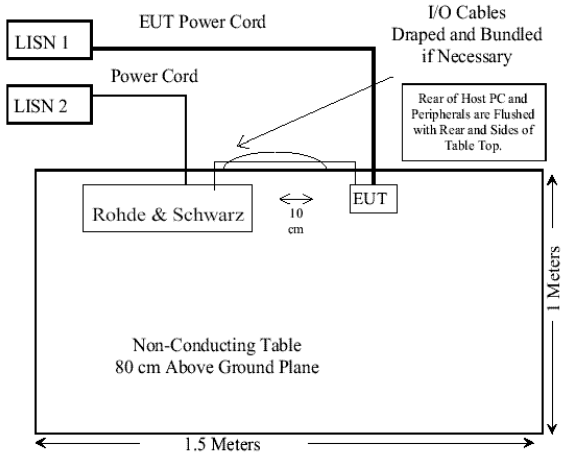
The EUT was configured for testing in a typical fashion (as normally used in a typical application).

The final qualification test was performed with the EUT operating at normal mode.

2.2 Block Diagram

Please refer to Exhibit D.

2.3 Test Setup Block Diagram



2.4 Equipment Modifications

No modifications were necessary for the EUT to comply with the applicable standard and limit.

3 - SUMMARY OF TEST RESULTS

FCC RULE	DESCRIPTION OF TEST	Measured	Result
§2.1046 § 24.232	RF power output	20dBm (100mW)	Compliant
§ 2.1049 § 24.238	Emission Bandwidth	CDMA: 147MHz GSM: 357MHz TDMA: 121kHz	Compliant
2.1051 § 24.238(a)	Spurious emissions at antenna terminals	<-13dBm	Compliant
2.1051 § 24.238 (a)	Two-Tone Test (Spurious emissions at antenna terminals)	<-13dBm	Compliant
2.1053 § 24.238 (a)	Field strength of spurious radiation	Section 8	Compliant
§ 2.1055 (a) § 2.1055 (d) § 24.235	Frequency stability vs. temperature Frequency stability vs. voltage	Section 9	Compliant
15.107	AC Line Conducted emission	44.9 dBµV	Compliant

4 - RF POWER OUTPUT

4.1 Applicable Standard

According to FCC §2.1046 and §24.232 (b), mobile/portable stations are limited to 2 watts e.i.r.p. peak power and the equipment must employ means to limit the power to the minimum necessary for successful communications.

4.2 Test Procedure

The antenna was removed and SMA connector was connected to the transmitter output. The transmitter output was connected to a calibrated coaxial attenuator (50 Ohm), the other end of which was connected to a spectrum analyzer. Transmitter output was read off the spectrum analyzer in dBm. The power output at the transmitter was determined by adding the value of the attenuator to the spectrum analyzer reading.

The test was performed at three frequencies (low, middle, and high channels) and on all power levels which can be setup on the transmitter.

4.3 Test equipment

Hewlett Packard HP8566B Spectrum Analyzer
Hewlett Packard HP 7470A Plotter
Rohde & Schwarz SMIQ03B Signal Generator
Rohde & Schwarz AMIQ I/Q Modulation Generator

4.4 Test Results

Mode	Modulation Type	Channel	Output Power in dBm	Output Power in mW
Uplink	CDMA	Low	19.17	82.60
	CDMA	Mid	7.67	5.85
	CDMA	High	3.83	2.42
Downlink	CDMA	Low	14.17	26.12
	CDMA	Mid	1.67	1.47
	CDMA	High	-2.17	1.65
Uplink	GSM	Low	20.00	100
	GSM	Mid	7.83	6.07
	GSM	High	2.83	1.92
Downlink	GSM	Low	14.33	27.10
	GSM	Mid	1.83	1.52
	GSM	High	-1.83	1.52
Uplink	TDMA	Low	19.83	96.16
	TDMA	Mid	6.83	4.82
	TDMA	High	3.00	2.00
Downlink	TDMA	Low	14.17	26.12
	TDMA	Mid	2.00	1.58
	TDMA	High	-2.17	1.65

4.5 Plots of RF Output Power

Please refer to Appendix A.

5 - EMISSION BANDWIDTH

5.1 Applicable Standards

According to FCC §2.1049 and §24.238 (b), the emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26dB below the transmitter power.

5.2 Test Procedure

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

The resolution bandwidth of the spectrum analyzer was set at 30 KHz and the spectrum was recorded in the frequency band ±50 KHz from the carrier frequency.

5.3 Test Equipment

Hewlett Packard HP8566B Spectrum Analyzer
Hewlett Packard HP 7470A Plotter
Rohde & Schwarz SMIQ03B Signal Generator
Rohde & Schwarz AMIQ I/Q Modulation Generator

5.4 Plots of Occupied Bandwidth

Please refer to Appendix B.

6 - OUT OF BAND EMISSIONS AT ANTENNA TERMINALS

6.1 Applicable Standards

According to FCC §2.1049 and §22.238, on any frequency outside a licensee's frequency block, the power of any emission shall be attenuated below the transmitter power (P) by at least 43 + 10 log (P) dB.

6.2 Test Procedure

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

6.3 Test Equipment

HP 8566B Spectrum Analyzer
HP 7470A Plotter
Hewlett Packard HP8566B Spectrum Analyzer
Hewlett Packard HP 7470A Plotter
Rohde & Schwarz SMIQ03B Signal Generator
Rohde & Schwarz AMIQ I/Q Modulation Generator

6.4 Test Results

Mode	Modulation Type	Channel	Measured
Uplink	CDMA	Low	< -13dBm
	CDMA	Mid	< -13dBm
	CDMA	High	< -13dBm
Downlink	CDMA	Low	< -13dBm
	CDMA	Mid	< -13dBm
	CDMA	High	< -13dBm
	TDMA	High	< -13dBm

6.5 Plots of Out-of-Band Emissions at Antenna Terminal

Please refer to Appendix C.

7 - TWO-TONE TEST

7.1 Applicable Standards

According to IS-138A (3.4.4), Intermodulation products must be attenuated below the rated power of the EUT by at least 43 +10log (P), or 60 dB, whichever is lesser attenuation. Equivalent to –13 dBm.

7.2 Test Procedure

The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10^{th} harmonic. Two input signals are equal in level (and can be raised equally), were send to the EUT.

7.3 Test Equipment

HP 8566B Spectrum Analyzer
HP 7470A Plotter
Hewlett Packard HP8566B Spectrum Analyzer
Hewlett Packard HP 7470A Plotter
Rohde & Schwarz SMIQ03B Signal Generator
Rohde & Schwarz AMIQ I/Q Modulation Generator

7.4 Test Results

Mode	Modulation Type	Channel	Measured
Uplink	CDMA	Low	< -13dBm
	CDMA	Mid	< -13dBm
	CDMA	High	< -13dBm
Downlink	CDMA	Low	< -13dBm
	CDMA	Mid	< -13dBm
	CDMA	High	< -13dBm
	TDMA	High	< -13dBm

7.5 Plots of Two-Tone Test Result

Please refer to Appendix D.

8 - FIELD STRENGTH OF SPURIOUS RADIATION

8.1 Test Procedure

Requirements: CFR 47, § 2.1053, § 22.917 and § 24.238 (a).

8.2 Test Procedure

The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load which was also placed on the turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3-orthogonal axis.

The frequency range up to tenth harmonic of the fundamental frequency was investigated.

Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

Spurious emissions in dB = 10 lg (TXpwr in Watts/0.001) – the absolute level

Spurious attenuation limit in dB = 43 + 10 Log_{10} (power out in Watts)

8.3 Test Equipment

CDI B100/200/300 Biconical Antennas
EMCO Bi-logcon Antenna
EMCO 3115 Horn Antenna
HP 8566B Spectrum Analyzer
Preamplifiers
HP8640 Generator
Non-radiating Load

8.4 Test Result

Uplink: Low Frequency: -15.1dBm at 3710.00MHz
High Frequency: -6.9dBm at 5715.00MHz

Downlink: Low Frequency: -16.9dBm at 3870.00MHz
High Frequency: -10.3dBm at 3970.00MHz

Compliance Statement

According to FCC Part 15, at 3-meter distance the emission from an intentional radiator shall not exceed the field strength level 40dBuV/m within 30-88MHz, 43.5dBuV/m within 88-216MHz, 46dBuV/m within 226-960MHz, 54dBuV/m above 960MHz. The level of any unwanted emissions shall not exceed the level of the fundamental frequency.

The levels of unwanted emission of this device were below the above limits. This device was compliant with the FCC Part 15.

Primary scan at 1855MHz (Low CH.) , Uplink

EUT					GENERATOR										FCC	
Indicated		Table	Test Antenna		Substituted		Substitution Antenna		Test Antenna		Correction Factor		Absolute	Spurious	Limit	Margin
Frequency MHz	Ampl. dBuV/m	Angle Degree	Height Meter	Polar H/V	Frequency MHz	Level dBm	Half-wavel. cm	Polar H/V	Height Meter	Polar H/V	Antenna dB	Cable dB	Leval dBm	Emissions dB	dB	dB
1855	117.8	0	1.5	v	1855	29.8	8	v	1.8	v	9.8	0.8	19.15			
1855	106.5	130	1.2	h	1855	26.3	8	h	1.5	h	9.8	0.8	15.73			
3710	58.4	45	3	v	3710	-14.1	4	v	2.2	v	12.9	1.1	-28.1	47.3	32.2	-15.1
3710	52.3	330	2	h	3710	-19.4	4	h	1.5	h	12.9	1.1	-33.4	52.6	32.2	-20.4
5565	51.6	0	1.5	v	5565	-11.7	3.5	v	1.2	v	16.1	1.5	-29.3	48.5	32.2	-16.3
5565	49.7	230	1	h	5565	-13.3	3.5	h	1.2	h	16.1	1.5	-30.9	50.1	32.2	-17.9

Primary scan at 1905MHz (High CH.) , Uplink

EUT					GENERATOR										FCC	
Indicated		Table	Test Antenna		Substituted		Substitution Antenna		Test Antenna		Correction Factor		Absolute	Spurious	Limit	Margin
Frequency MHz	Ampl. dBuV/m	Angle Degree	Height Meter	Polar H/V	Frequency MHz	Level dBm	Half-wavel. cm	Polar H/V	Height Meter	Polar H/V	Antenna dB	Cable dB	Leval dBm	Emissions dB	dB	dB
1905	61.4	180	2	v	1905	14.9	7.9	v	1.8	v	10.3	0.8	3.81			
1905	55.3	0	1.5	h	1905	12.8	7.9	h	1.5	h	10.3	0.8	1.72			
3810	32.7	30	1.5	v	3810	-9.4	3.8	v	1.2	v	13.1	1.1	-23.6	27.4	16.8	-10.6
3810	31.1	30	1.5	h	3810	-10.2	3.8	h	1.5	h	13.1	1.1	-24.4	28.2	16.8	-11.4
5715	32.5	180	1	v	5715	-1.7	3.4	v	1.2	v	16.7	1.5	-19.9	23.7	16.8	-6.9
5715	28.4	330	1	h	5715	-4.6	3.4	h	1.2	h	16.7	1.5	-22.8	26.6	16.8	-9.8

Primary scan at 1935MHz (Low CH.) , Downlink

EUT					GENERATOR										FCC	
Indicated		Table	Test Antenna		Substituted		Substitution Antenna		Test Antenna		Correction Factor		Absolute	Spurious	Limit	Margin
Frequency MHz	Ampl. dBuV/m	Angle Degree	Height Meter	Polar H/V	Frequency MHz	Level dBm	Half-wavel. cm	Polar H/V	Height Meter	Polar H/V	Antenna dB	Cable dB	Leval dBm	Emissions dB	dB	dB
1935	105.4	0	1.2	v	1935	25.5	7.9	v	1.5	v	10.5	0.8	14.16			
1935	98.3	30	1.2	h	1935	24.3	7.9	h	1.2	h	10.5	0.8	12.97			
3870	45.8	270	1	v	3870	-15.3	3.8	v	1.2	v	13.6	1.1	-30	44.1	27.2	-16.9
3870	37.7	0	1.5	h	3870	-23.1	3.8	h	1.8	h	13.6	1.1	-37.8	52	27.2	-24.8
5805	31.3	330	1.2	v	5805	-20.5	3.4	v	1.5	v	17.1	1.5	-39.1	53.3	27.2	-26.1
5805	28.6	330	1.5	h	5805	-21.7	3.4	h	1.5	h	17.1	1.5	-40.3	54.5	27.2	-27.3

Primary scan at 1985MHz (High CH.) , Downlink

EUT					GENERATOR										FCC	
Indicated		Table	Test Antenna		Substituted		Substitution Antenna		Test Antenna		Correction Factor		Absolute	Spurious	Limit	Margin
Frequency MHz	Ampl. dBuV/m	Angle Degree	Height Meter	Polar H/V	Frequency MHz	Level dBm	Half-wavel. cm	Polar H/V	Height Meter	Polar H/V	Antenna dB	Cable dB	Leval dBm	Emissions dB	dB	dB
1985	46.8	0	1.2	v	1985	9.46	7.7	v	1.5	v	10.8	0.8	-2.14			
1985	42.2	90	1.5	h	1985	7.73	7.7	h	1.5	h	10.8	0.8	-3.87			
3970	23.9	90	1.2	v	3970	-7.4	3.6	v	1.2	v	14.3	1.1	-22.8	20.7	10.4	-10.3
3970	23.4	30	1.5	h	3970	-8.3	3.6	h	1.5	h	14.3	1.1	-23.7	21.6	10.4	-11.2
5955	18.7	120	1	v	5955	-4.2	3.3	v	1.2	v	17.6	1.5	-23.3	21.2	10.4	-10.8
5955	18.2	145	1.2	h	5955	-5.1	3.3	h	1.2	h	17.6	1.5	-24.2	22.1	10.4	-11.7

9 - FREQUENCY STABILITY

9.1 Applicable Standards

According to FCC § 2.1055 and § 24.235, the frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

The frequency stability shall be measured with variation of ambient temperature from -30º to +50º centigrade fro all equipment unless specified otherwise. Frequency measurements shall be made at the extremes of the specified temperature range and at interval of not more than 10º centigrade through the range.

The frequency stability shall measured with variation of primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

9.2 Test Procedure

Frequency stability versus environmental temperature

The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feedthrough attenuators. The EUT was placed inside the temperature chamber.

After the temperature stabilized for approximately 20 minutes, the frequency of the output signal was recorded from the counter.

Frequency Stability versus Input Voltage

At room temperature (25±5°C), an external variable DC power supply was connected to the EUT. The frequency of the transmitter was measured for 115%, 100% and 85% of the nominal operating input voltage.

9.3 Test Equipment

Temperature Chamber, -50°C to +100°C
Hewlett Packard HP8566B Spectrum Analyzer
Hewlett Packard HP 7470A Plotter
Hewlett Packard HP 5383A Frequency Counter
Goldstar DC Power Supply, GR303

9.4 Test Results

Frequency Stability Versus Input Voltage

Reference Frequency: 1855.00 MHz, Limit: 2.5ppm			
Environment Temperature (°C)	Power Supplied (Vdc)	Frequency Measure with Time Elapsed	
		MCF (MHz)	PPM Error
50	New Batt.	1855.000	0.0
40	New Batt.	1855.002	1.1
30	New Batt.	1855.001	0.5
20	New Batt.	1855.001	0.5
10	New Batt.	1855.000	0.0
0	New Batt.	1854.999	-0.5
-10	New Batt.	1855.000	0.0
-20	New Batt.	1854.999	-0.5
-30	New Batt.	1855.000	0.0

Frequency Stability Versus Input Voltage

Reference Frequency: 1855.00 MHz, Limit: 2.5ppm						
Power Supplied (Vdc)	Frequency Measure with Time Elapsed					
	2 Minutes		5 Minutes		10 Minutes	
	MHz	%	MHz	%	MHz	%
115% of 120Vac	1855.000	0.0	1855.001	0.5	1855.001	0.5
100% of 120Vac	1855.001	0.5	1855.000	0.0	1855.000	0.0
85% of 120Vac	1855.001	0.5	1855.001	0.5	1855.000	0.0

Conclusion: The EUT complied with the applicable Frequency Stability Limits.

10 - CONDUCTED EMISSION

10.1 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, and LISN.

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of any conducted emissions measurement at BACL is ±2.4 dB.

10.2 EUT Setup

The measurement was performed at the **O**pen **A**rea **T**est **S**ite, using the same setup per ANSI C63.4-2000 measurement procedure. The specification used was with FCC Class B limits.

10.3 Spectrum Analyzer Setup

The spectrum analyzer was set with the following configurations during the conduction test:

Start Frequency	450 kHz
Stop Frequency	30 MHz
Sweep Speed	Auto
IF Bandwidth	10 kHz
Video Bandwidth	10 kHz
Quasi-Peak Adapter Bandwidth	9 kHz
Quasi-Peak Adapter Mode	Normal

10.4 Test Procedure

During the conducted emission test, the power cord of the host system was connected to the auxiliary outlet of the first LISN.

Maximizing procedure was performed on the six (6) highest emissions of each modes tested to ensure EUT is compliant with all installation combination.

All data was recorded in the peak detection mode. Quasi-peak readings were only performed when an emission was found to be marginal (within specified limits of -4 dBμV). Quasi-peak readings are distinguished with a "**Qp**".

10.5 Summary of Test Results

According to the data in section 3.6, the EUT complied with the FCC Conducted margin for a Class B device and these test results is deemed satisfactory evidence of compliance with ICES-003 of the Canadian Interference-Causing Equipment Regulations, with the *worst* margin reading of:

-3.1 dBμV at 0.75 MHz in the Line mode

10.6 Conducted Emissions Test Data

LINE CONDUCTED EMISSIONS				FCC CLASS B	
Frequency MHz	Amplitude dBμV	Detector Qp/Ave/Peak	Phase Line/Neutral	Limit dBμV	Margin dB
0.75	44.9	Qp	Line	48	-3.1
0.68	44.7	Qp	Neutral	48	-3.3
1.73	41.5	Qp	Neutral	48	-6.5
1.48	40.6	Qp	Line	48	-7.4
11.05	27.8	Qp	Neutral	48	-20.2
11.20	26.9	Qp	Line	48	-21.1

10.7 Plot of Conducted Emissions Test Data

Plot(s) of Conducted Emissions Test Data is presented as reference.