





FCC PART 95

TEST AND MEASUREMENT REPORT

For
Teledesign Systems, Inc.

1729 South Main Street,
Milpitas, CA 95035, USA

FCC ID: JWFTS4000GH
Model: TS4000-05G15

Report Type: Original Report	Product Type: VHF Radio Modem
Test Engineer: <u>Lionel Lara</u> 	
Report Number: <u>R1209046-95</u>	
Report Date: <u>2012-10-19</u>	
Reviewed By: <u>Victor Zhang</u>  <u>RF/EMC Lead</u>	
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Note: This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. This report **must not** be used by the customer to claim product certification, approval, or endorsement by A2LA* or any agency of the Federal Government.

* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "*" (BAC-1)

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1209046-95	Original Report	2012-10-19

1. General Information

1.1 Product Description for Equipment under Test (EUT)

This test and measurement report was prepared on behalf of *Teledesign Systems, Inc.* and their product, FCC ID: JWFTS4000GH, model: TS4000-05G15, which will henceforth be referred to as the EUT (Equipment Under Test). The EUT is a VHF radio modem.

The EUTs are VHF radio modems that operate under FCC Part 95

Specifications	
Frequencies	151.820 MHz, 151.880 MHz, 151.940 MHz, 154.570 MHz, 154.600 MHz
Modulation Type	GMSK
Emission Designator	F1D
RF Output Power	2 Watts
Channel Spacing	12.5 kHz, 25 kHz
Power Supply	13.8 VDC

1.2 Mechanical Description

The EUT measures approximately 17cm (L) x 8 cm (W) x 4.5 cm (H) and weighs approximately 780g.

The test data gathered are from production sample, serial number: 41472, provided by the manufacturer.

1.3 Objective

This type approval report is prepared on behalf of *Teledesign Systems, Inc.* in accordance Part 95 of the Federal Communication Commissions rules.

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

1.4 Related Submittal(s)/Grant(s)

Part 95 report under FCC ID: JWFTS4000GH, No.: R1209046-90GH.

1.5 Test Methodology

All tests and measurements indicated in this document were performed in accordance with the Code of federal Regulations Title 47 Part 2, Sub-part J as well as the following individual parts:

Part 95 – Personal Radio Services

Applicable Standards: TIA603-C and ANSI 63.4-2003, American National Standard for Method of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.

All emissions measurement was performed by Bay Area Compliance Laboratories Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

1.6 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on CISPR16-4-2:2003, The Treatment of Uncertainty in EMC Measurements, the values ranging from +2.0 dB for Conducted Emissions tests and +4.0 dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL Corp.

1.7 Test Facility

The test site used by BACL Corp. to collect radiated and conducted emissions measurement data is located at its facility in Sunnyvale, California, USA.

The test site at BACL Corp. 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 have 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 test site also complies with the test methods and procedures set forth in CISPR 22:2008 §10.4 for measurements below 1 GHz and §10.6 for measurements above 1 GHz as well as ANSI C63.4-2003, ANSI C63.4-2009, TIA/EIA-603 & CISPR 24:2010.

The Federal Communications Commission and Voluntary Control Council for Interference have the reports on file and they are listed under FCC registration number: 90464 and VCCI Registration No.: A-0027. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL Corp. is an American Association for laboratory Accreditation (A2LA) accredited laboratory (Lab Code 3297-02). The current scope of accreditations can be found at

<http://www.a2la.org/scopepdf/3297-02.pdf?CFID=1132286&CFTOKEN=e42a3240dac3f6ba-6DE17DCB-1851-9E57-477422F667031258&jsessionid=8430d44f1f47cf2996124343c704b367816b>

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to TIA/EIA-603-C.

The EUT was tested in the normal (native) operating mode to represent *worst-case* results during the final qualification test.

2.2 EUT Exercise Software

The software used was TS4000 Configuration Program provided by the client.

2.3 Equipment Modifications

No modifications were made to the EUT.

2.4 Internal Configuration

Manufacturers	Descriptions	Model	Serial Numbers
Teledesign Systems, Inc.	Modem Board	TS4000	036121
CalAmp	Radio Board	140-3433	-

2.5 Local Support Equipment

Manufacturer	Description	Model No.	Serial No.
Dell	Laptop	PP37L	15324358501

2.6 Local Support Equipment Power Supply and Line Filters

Manufacturer	Description	Model	Serial Number
Topward	DC Power Supply	3303D	719031

2.7 External I/O Cabling List and Details

Cable Description	Length (m)	From	To
USB to RS232 cable	1.0	Laptop USB	EUT Serial Port
Coax cable	1.5	EUT	Antenna
Power supply cable	1.0	Power Supply	EUT

3 Summary of Test Results

FCC Rules	Description of Tests	Results
§2.1091	RF Exposure	Compliant
§2.1046, §95.639	RF Output Power	Compliant
§2.1047, §95.637	Modulation Characteristics, Audio Frequency Response and Audio Filter Response	N/A ¹
§2.1049, §95.633, §95.635	Occupied Bandwidth and Emission Mask	Compliant
§2.1051, §95.635	Spurious Emissions at Antenna Terminals	Compliant
§2.1055, §95.632	Frequency Stability	Compliant
§2.1053, §95.635	Field Strength of Spurious Radiation	Compliant

Note 1: Modulation characteristic is not required for digital modulation.

4 FCC §2.1091 - RF Exposure Information

4.1 Applicable Standards

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

According to §1.1310 and §2.1091 RF exposure is calculated.

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	842/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1	30

f = frequency in MHz

* = Plane-wave equivalent power density

MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: *S* = power density

P = power input to antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal (dBm):	32.97
Maximum peak output power at antenna input terminal (mW):	1981.53
Prediction distance (cm):	50
Prediction frequency (MHz):	151.880
Maximum Antenna Gain, typical (dBi):	0
Maximum Antenna Gain (numeric):	1
Power density of prediction frequency at 30 cm (mW/cm ²):	0.063
MPE limit for uncontrolled exposure at prediction frequency (mW/cm ²):	0.2

Conclusion

The device complies with the MPE requirements by providing a safe separation distance of at least 50 cm between the antenna with maximum 0 dBi gain, including any radiating structure, and any persons when normally operated.

5 FCC §2.1046 & §95.639 – RF Output Power

5.1 Applicable Standard

According to FCC §2.1046, and §95.639, (h) No MURS unit, under any condition of modulation, shall exceed 2 Watts transmitter power output.

5.2 Test Procedure

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

5.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-08-11	1 Year

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

5.4 Test Environmental Conditions

Temperature:	21 °C
Relative Humidity:	51 %
ATM Pressure:	101.4 kPa

The testing was performed by Lionel Lara on 2012-08-29 in the RF Site.

5.5 Test Results

Test Mode: Transmitting GMSK with BT = 0.3 (Channel Baud Rate = 12600 bps for 12.5 kHz)

Channel Spacing (kHz)	Frequency (MHz)	Output Power	
		(dBm)	(Watt)
12.5 kHz	151.880	32.97	1.98

Test Mode: Transmitting GMSK with BT = 0.3 (Channel Baud Rate = 4000 bps for 12.5 kHz)

Channel Spacing (kHz)	Frequency (MHz)	Output Power	
		(dBm)	(Watt)
12.5 kHz	151.880	32.39	1.73

Test Mode: Transmitting GMSK with BT = 0.5 (Channel Baud Rate = 8400 bps for 12.5 kHz)

Channel Spacing (kHz)	Frequency (MHz)	Output Power	
		(dBm)	(Watt)
12.5 kHz	151.880	32.46	1.76

Test Mode: Transmitting GMSK with BT = 0.5 (Channel Baud Rate = 4000 bps for 12.5 kHz)

Channel Spacing (kHz)	Frequency (MHz)	Output Power	
		(dBm)	(Watt)
12.5 kHz	151.880	32.51	1.78

Test Mode: Transmitting GMSK with BT = 0.3 (Channel Baud Rate = 19200 bps for 25 kHz)

Channel Spacing (kHz)	Frequency (MHz)	Output Power	
		(dBm)	(Watt)
25 kHz	154.600	32.26	1.68

Test Mode: Transmitting GMSK with BT = 0.3 (Channel Baud Rate = 4000 bps for 25 kHz)

Channel Spacing (kHz)	Frequency (MHz)	Output Power	
		(dBm)	(Watt)
25 kHz	154.600	32.29	1.69

Test Mode: Transmitting GMSK with BT = 0.5 (Channel Baud Rate = 12800 bps for 25 kHz)

Channel Spacing (kHz)	Frequency (MHz)	Output Power	
		(dBm)	(Watt)
25 kHz	154.600	32.36	1.72

Test Mode: Transmitting GMSK with BT = 0.5 (Channel Baud Rate = 4000 bps for 25 kHz)

Channel Spacing (kHz)	Frequency (MHz)	Output Power	
		(dBm)	(Watt)
25 kHz	154.600	32.37	1.73

6 FCC §2.1047 & §95.637 – Modulation Characteristic

6.1 Applicable Standard

FCC §2.1047 & §95.637: (a) A GMRS transmitter that transmits emission types F1D, G1D, or G3E must not exceed a peak frequency deviation of plus or minus 5 kHz. A GMRS transmitter that transmits emission type F3E must not exceed a peak frequency deviation of plus or minus 5 kHz. A FRS unit that transmits emission type F3E must not exceed a peak frequency deviation of plus or minus 2.5 kHz, and the audio frequency response must not exceed 3.125 kHz.

6.2 Test Result

N/A, modulation characteristic is not required for digital modulation.

7 FCC §2.1049, §95.633 & §95.635 – Occupied Bandwidth & Emission Mask

7.1 Applicable Standard

According to FCC §95.633, (f) The authorized bandwidth for any emission type transmitted by a MURS transmitter is specified as follows:

- (1) Emissions on frequencies 151.820 MHz, 151.880 MHz, and 151.940 MHz are limited to 11.25 kHz.
- (2) Emissions on frequencies 154.570 and 154.600 MHz are limited to 20.0 kHz.

According to FCC §95.635, (e) For transmitters designed to operate in the MURS, transmitters shall comply with the following:

Frequency	Mask with audio low pass filter	Mask without audio low pass filter
151.820 MHz, 151.880 MHz and 151.940 MHz	(1)	(1)
154.570 MHz and 154.600 MHz	(2)	(3)

(1) Emission Mask 1 —For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

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

(3) Emission Mask 3 —For transmitters designed to operate with a 25 kHz channel bandwidth that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

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

7.2 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 100 Hz and the spectrum was recorded in the frequency band ± 50 KHz from the carrier frequency.

7.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-08-11	1 Year

Statement of Traceability: BACL Corp. attests that all calibrations have been performed per the A2L requirements, traceable to the NIST.

7.4 Test Environmental Conditions

Temperature:	21 °C
Relative Humidity:	51 %
ATM Pressure:	101.4 kPa

The testing was performed by Lionel Lara on 2012-08-29 in the RF Site.

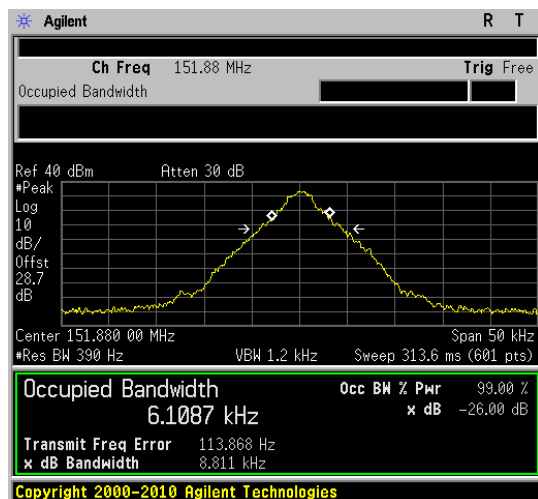
7.5 Test Results

Please refer to the hereinafter plots.

Occupied Bandwidth

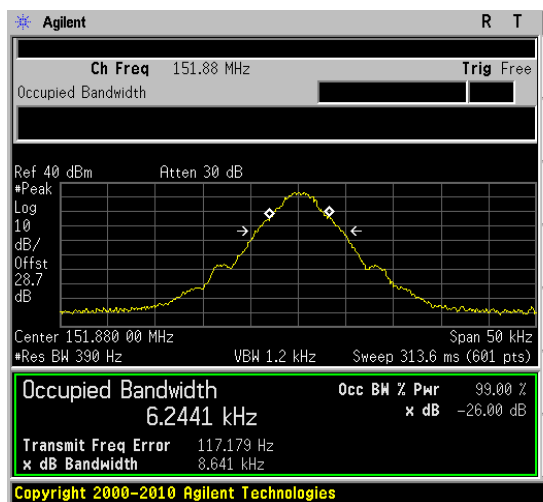
151.880 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 12600 bps, 12.5 kHz

151.880 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 4000 bps, 12.5 kHz



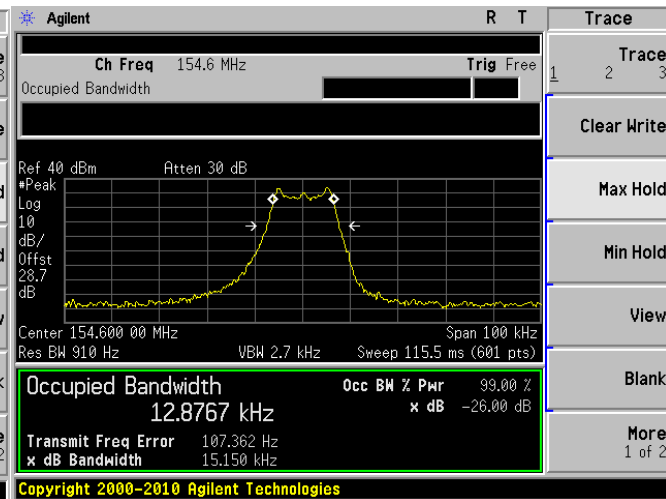
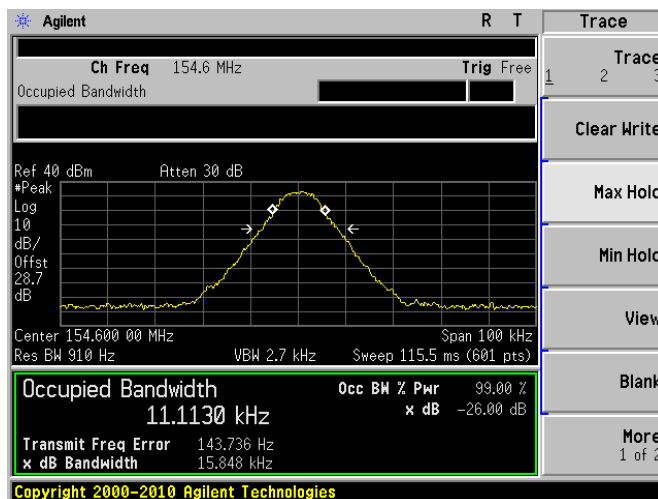
151.880 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 8400 bps, 12.5 kHz

151.880 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 4000 bps, 12.5 kHz



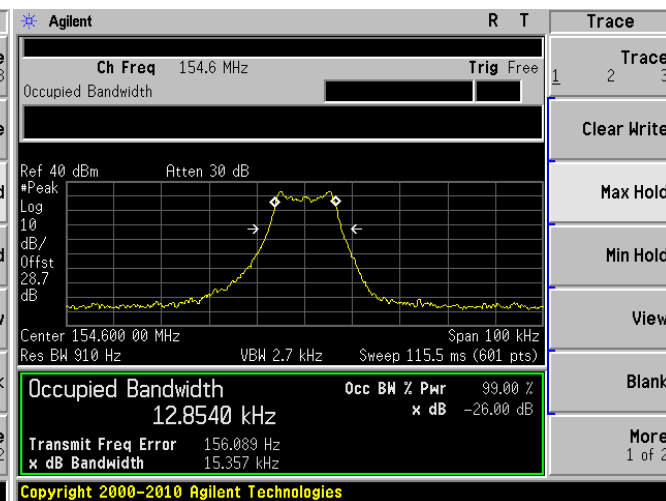
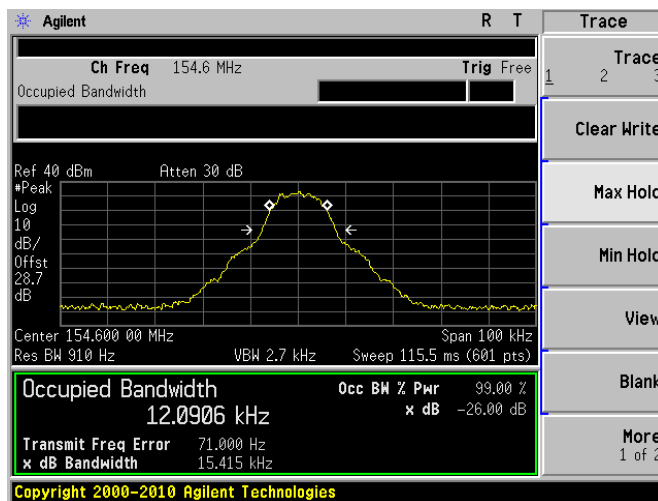
154.600 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 19200 bps, 25 kHz

154.600 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 4000 bps, 25 kHz



154.600 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 12800 bps, 12.5 kHz

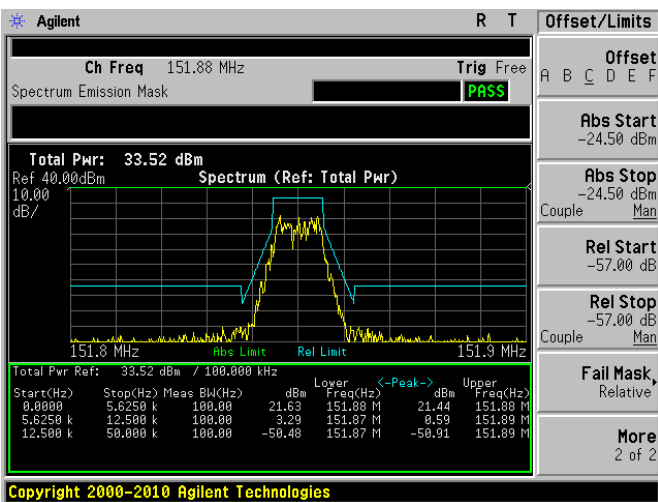
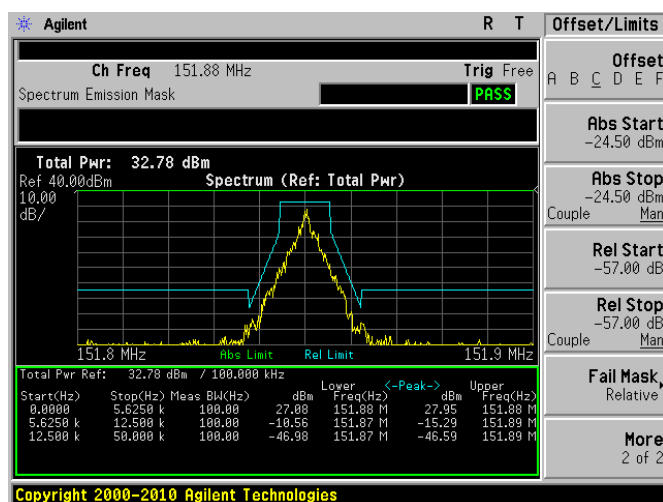
154.600 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 4000 bps, 12.5 kHz



Emission Mask

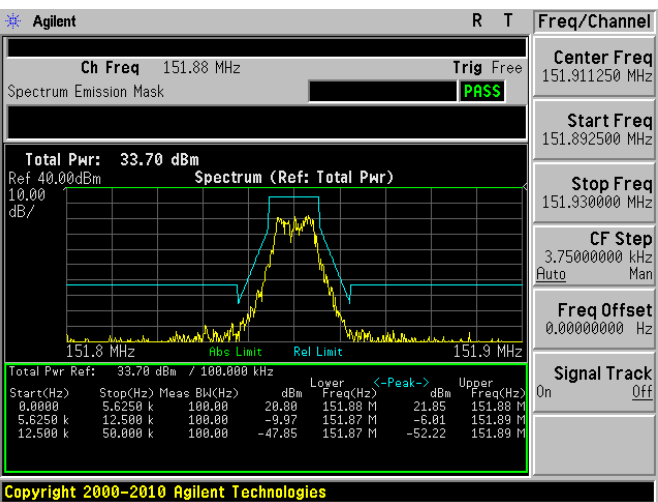
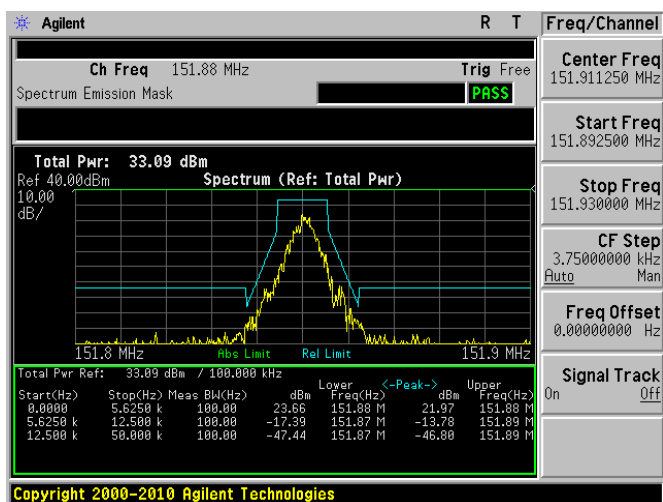
151.880 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 12600 bps, 12.5 kHz

151.880 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 4000 bps, 12.5 kHz



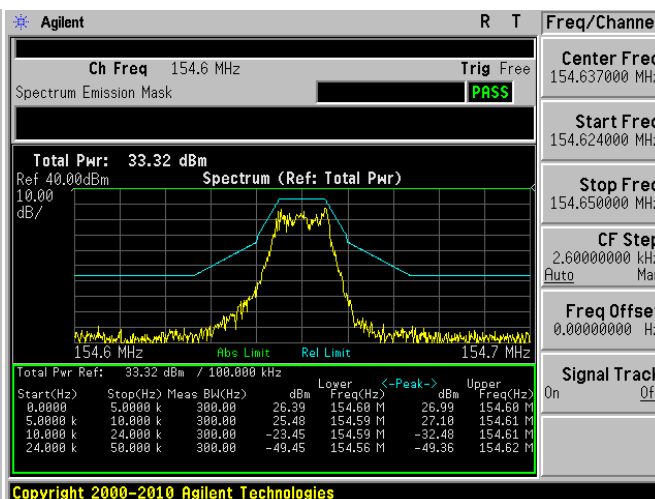
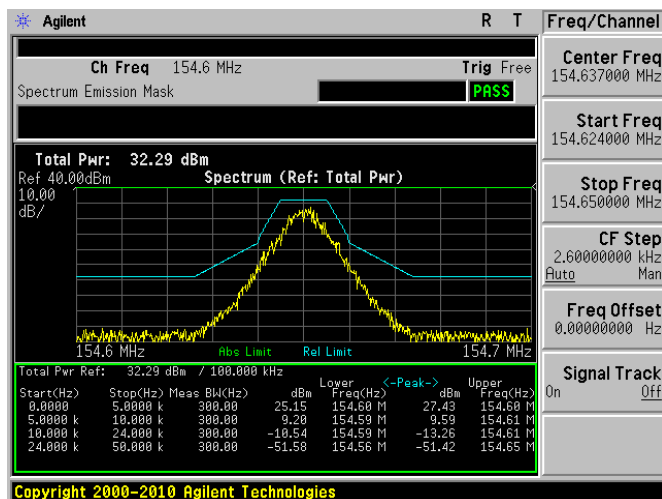
151.880 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 8400 bps, 12.5 kHz

151.880 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 4000 bps, 12.5 kHz



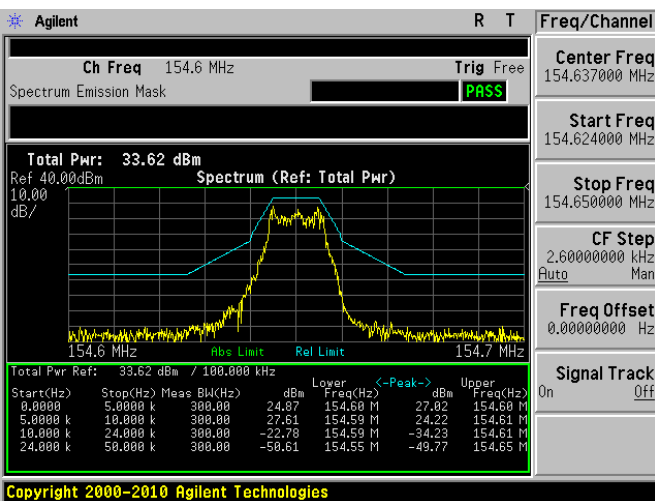
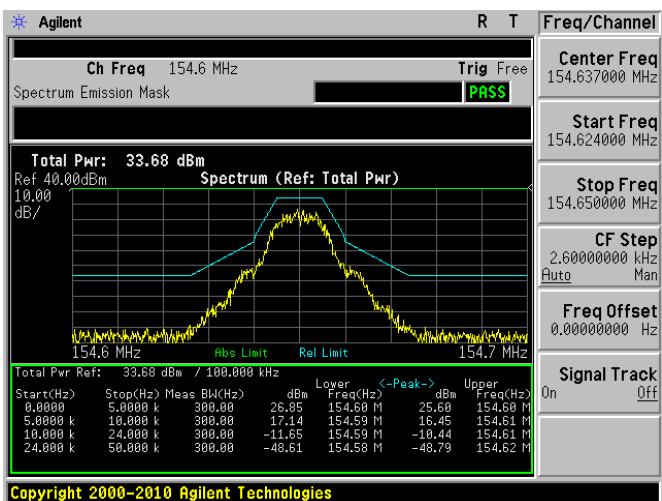
154.600 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 19200 bps, 25 kHz

154.600 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 4000 bps, 25 kHz



154.600 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 12800 bps, 25 kHz

154.600 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 4000 bps, 25 kHz



8 FCC §2.1051 & §95.635 - Spurious Emissions at Antenna Terminals

8.1 Applicable Standard

According to FCC §95.635, (e)(1) Emission Mask 1 —For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fdin kHz) of more than 12.5 kHz: at least $50 + 10 \log (P)$ dB or 70 dB, whichever is the lesser attenuation.

According to FCC §95.635, (e)(3) Emission Mask 3 —For transmitters designed to operate with a 25 kHz channel bandwidth that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

(iii) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: at least $43 + 10 \log (P)$ dB.

8.2 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.

8.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-08-11	1 Year

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

8.4 Test Environmental Conditions

Temperature:	21 °C
Relative Humidity:	51 %
ATM Pressure:	101.4 kPa

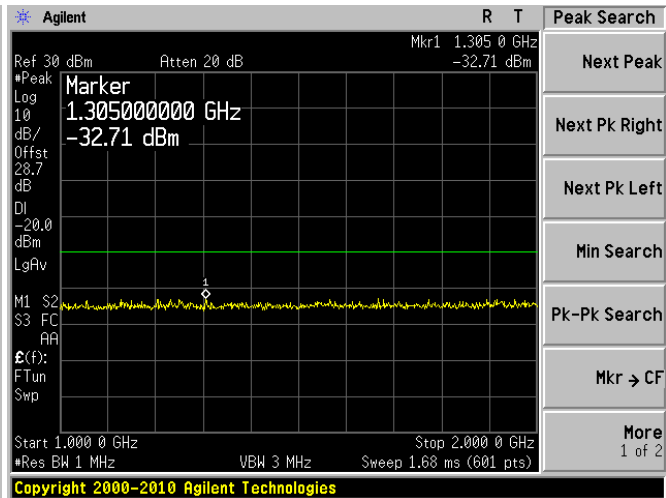
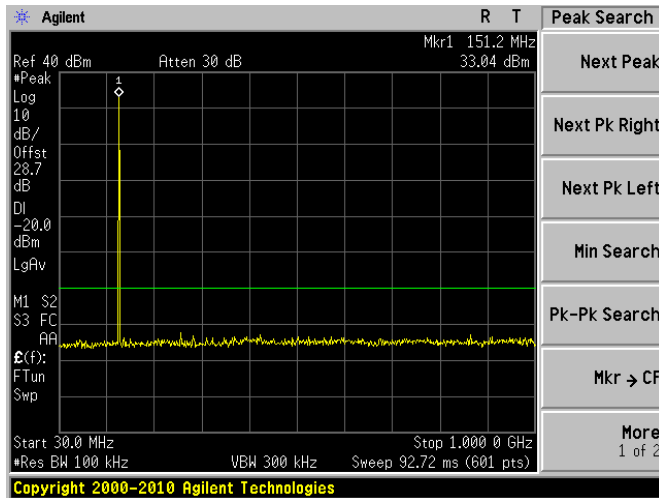
The testing was performed by Lionel Lara on 2012-08-29 in the RF Site.

8.5 Test Results

Please refer to the hereinafter plots.

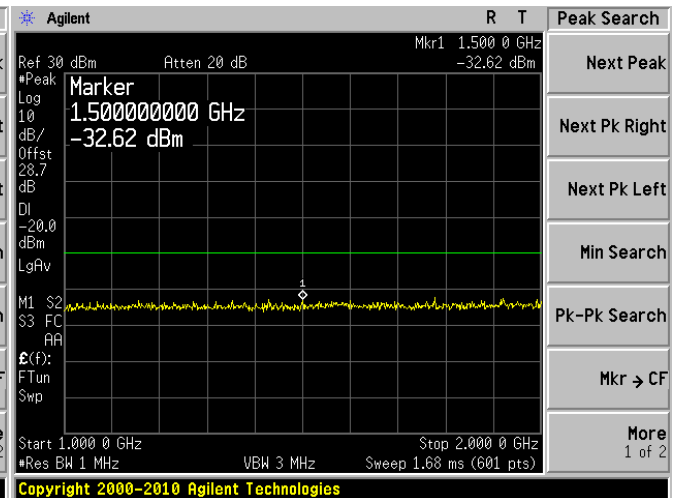
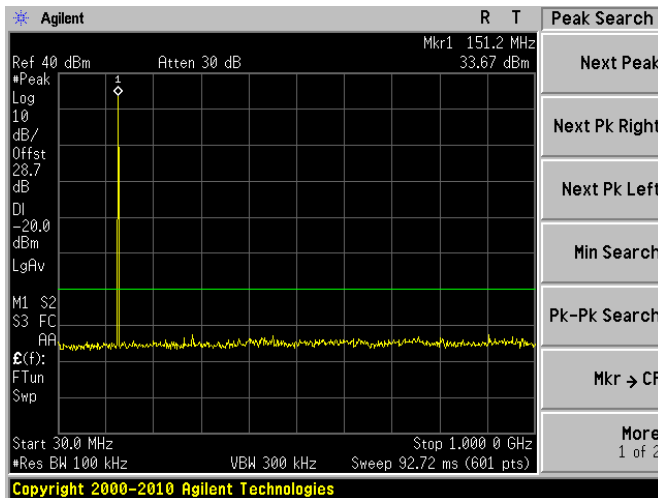
151.880 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 12600 bps, 12.5 kHz
30 MHz to 1 GHz

151.880 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 12600 bps, 12.5 kHz
1GHz to 2 GHz



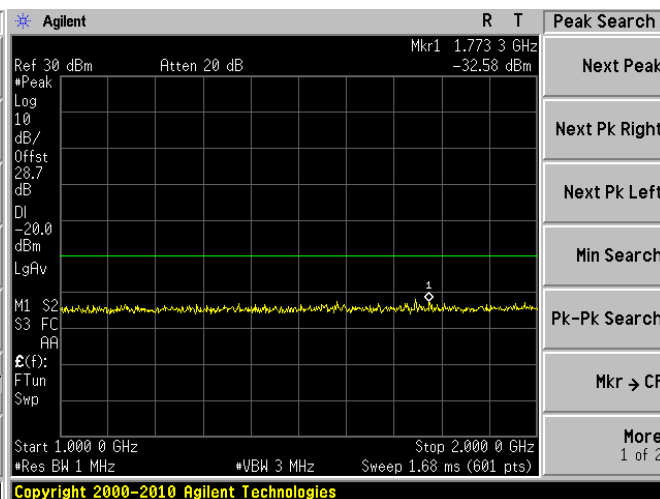
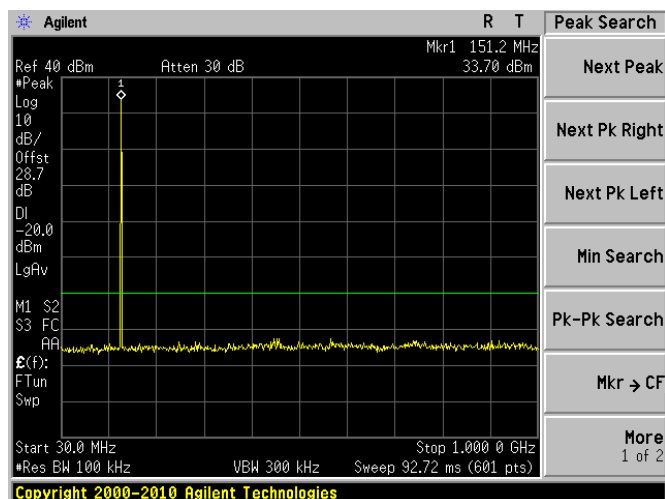
151.880 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 4000 bps, 12.5 kHz
30 MHz to 1 GHz

151.880 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 4000 bps, 12.5 kHz
1GHz to 2 GHz



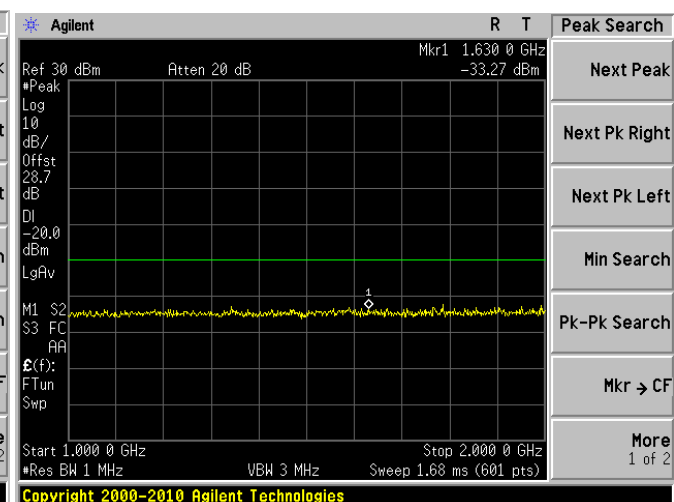
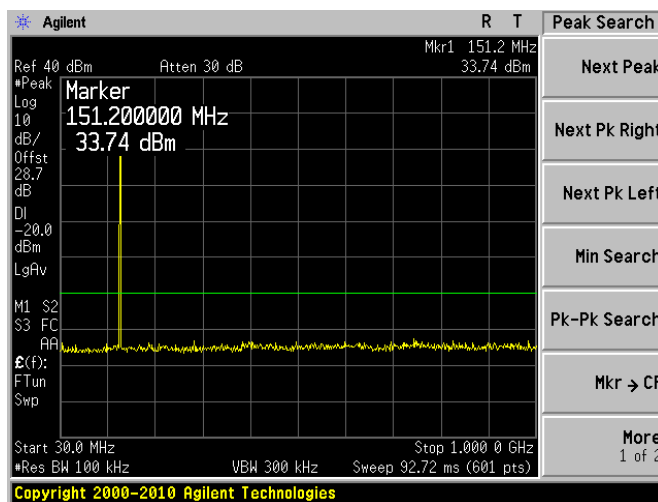
151.880 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 8400 bps, 12.5 kHz
30 MHz to 1 GHz

151.880 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 8400 bps, 12.5 kHz
1GHz to 2 GHz



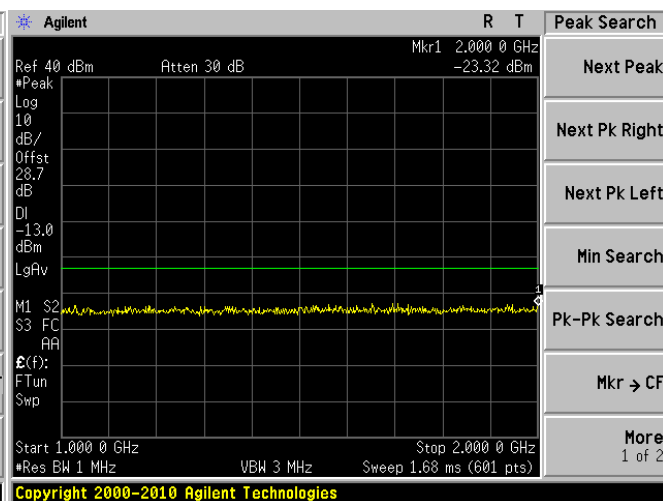
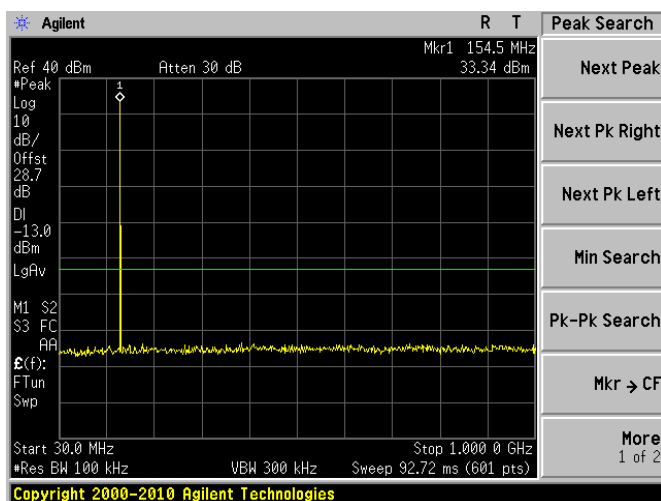
151.880 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 4000 bps, 12.5 kHz
30 MHz to 1 GHz

151.880 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 4000 bps, 12.5 kHz
1GHz to 2 GHz



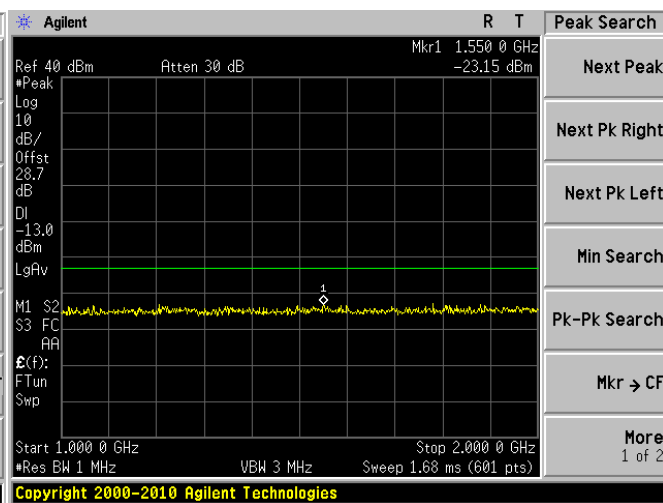
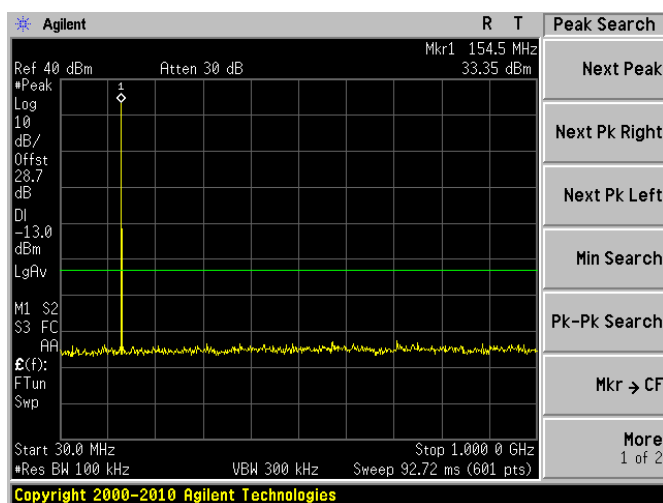
154.600 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 19200 bps, 25 kHz
30 MHz to 1 GHz

154.600 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 19200 bps, 25 kHz
1GHz to 2 GHz



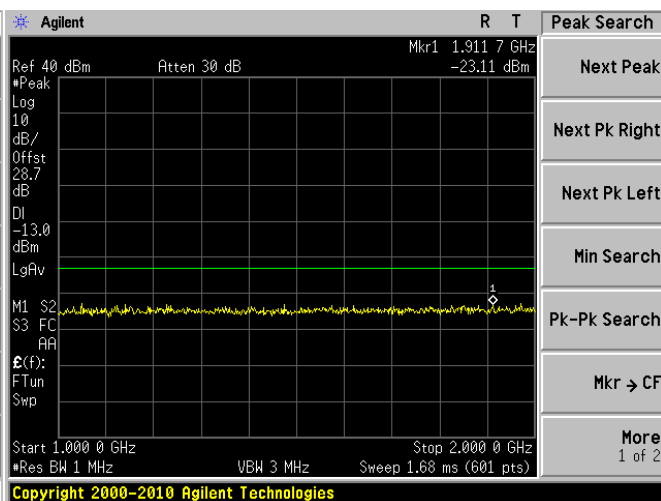
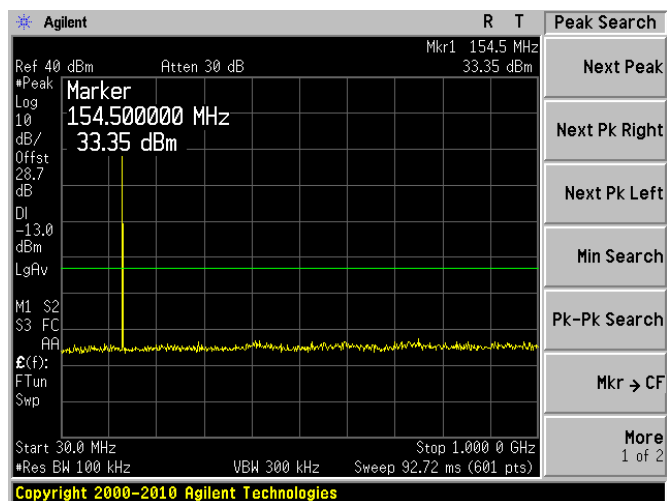
154.600 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 4000 bps, 25 kHz
30 MHz to 1 GHz

154.600 MHz, Modulation: GMSK with BT = 0.3,
Channel Baud Rate: 4000 bps, 25 kHz
1GHz to 2 GHz



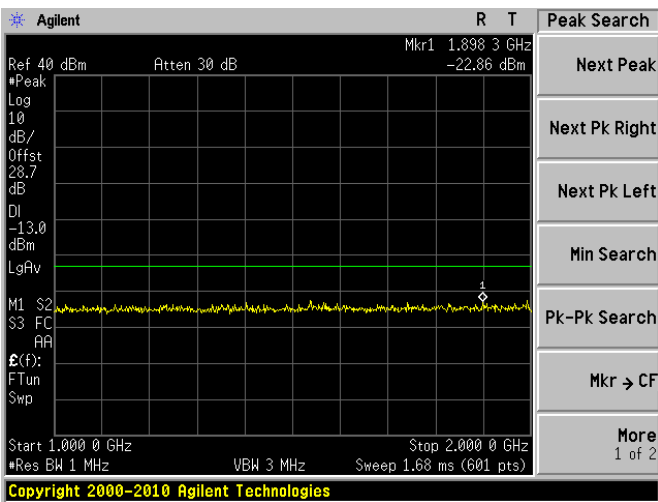
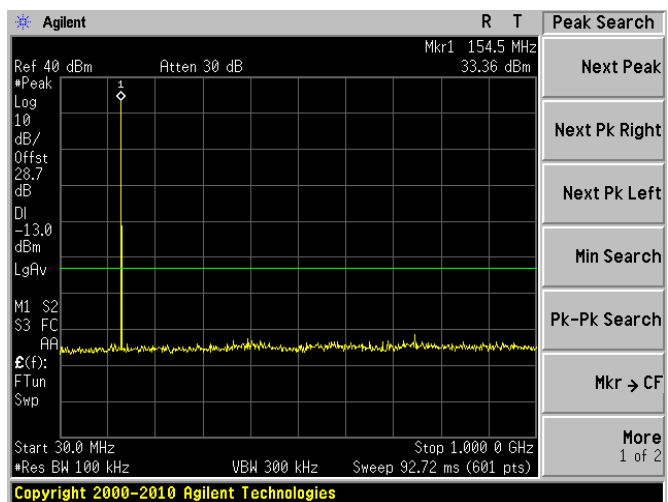
154.600 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 12800 bps, 25 kHz
30 MHz to 1 GHz

154.600 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 12800 bps, 25 kHz
1GHz to 2 GHz



154.600 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 4000 bps, 25 kHz
30 MHz to 1 GHz

154.600 MHz, Modulation: GMSK with BT = 0.5,
Channel Baud Rate: 4000 bps, 25 kHz
1GHz to 2 GHz



9 FCC §2.1055 (d) & §95.632 - Frequency Stability

9.1 Applicable Standard

FCC §2.1055, §95.632, (c) MURS transmitters must maintain a frequency stability of 5.0 ppm, or 2.0 ppm if designed to operate with a 6.25 kHz bandwidth.

9.2 Test Procedure

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

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

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

9.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-08-11	1 Year
ESPEC	Humidity Chamber	ESL-4CA	18010	2012-02-10	1 Year

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

9.4 Test Environmental Conditions

Temperature:	21 °C
Relative Humidity:	51 %
ATM Pressure:	101.4 kPa

The testing was performed by Lionel Lara on 2012-08-29 in the RF Site.

9.5 Test Results

CW, 151.880 MHz

Test Condition		Reference Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (PPM)	Limit (PPM)
Voltage (Vdc)	Temperature (°C)				
Frequency vs. Temperature					
13.8	60	151.880	151.880207	1.362918	± 5
13.8	50	151.880	151.880068	0.447722	± 5
13.8	40	151.880	151.880013	0.085594	± 5
13.8	30	151.880	151.880005	0.032921	± 5
13.8	20	151.880	151.880028	0.184356	± 5
13.8	10	151.880	151.880063	0.414801	± 5
13.8	0	151.880	151.880082	0.5399	± 5
13.8	-10	151.880	151.880075	0.493811	± 5
13.8	-20	151.880	151.880005	0.329207	± 5
13.8	-30	151.880	151.880055	0.362128	± 5
Frequency vs. Voltage					
24.0	20	151.880	151.88002	0.131683	± 5
11.7	20	151.880	151.880023	0.151435	± 5

CW, 154.600 MHz

Test Condition		Reference Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (PPM)	Limit (PPM)
Voltage (Vdc)	Temperature (°C)				
Frequency vs. Temperature					
13.8	60	154.600	154.6002	1.293661	± 5
13.8	50	154.600	154.600087	0.562743	± 5
13.8	40	154.600	154.60001	0.064683	± 5
13.8	30	154.600	154.600007	0.045278	± 5
13.8	20	154.600	154.600032	0.206986	± 5
13.8	10	154.600	154.600052	0.336352	± 5
13.8	0	154.600	154.600082	0.530401	± 5
13.8	-10	154.600	154.600092	0.595084	± 5
13.8	-20	154.600	154.600045	0.291074	± 5
13.8	-30	154.600	154.600053	0.34282	± 5
Frequency vs. Voltage					
24.0	20	154.600	154.600032	0.206986	± 5
11.7	20	154.600	154.600023	0.148771	± 5

10 FCC §2.1053 & §90.635 – Field Strength of Spurious Radiation

10.1 Applicable Standard

According to FCC §95.635, (e)(1) Emission Mask 1 —For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_{din} kHz) of more than 12.5 kHz: at least $50 + 10 \log (P)$ dB or 70 dB, whichever is the lesser attenuation.

According to FCC §95.635, (e)(3) Emission Mask 3 —For transmitters designed to operate with a 25 kHz channel bandwidth that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

(iii) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: at least $43 + 10 \log (P)$ dB.

10.2 Test Procedure

The transmitter was placed on Styrofoam on the turntable, and it was normal transmitting with 50ohm termination which was also placed on the turntable.

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

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

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

Spurious emissions in dB = $10 \lg (\text{TXpwr in Watts}/0.001)$ – the absolute level

10.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	US44300386	2012-08-11	1 Year
Sunol Science Corp	System Controller	SC99V	113005-1	N/R	N/A
Sunol Science Corp	Combination Antenna	JB1	A013105-3	2012-07-24	1 Year
EMCO	Horn antenna	3115	9511-4627	2011-10-03	1 Year
Hewlett Packard	Pre amplifier	8447D	2944A06639	2012-06-09	1 Year
Mini-Circuits	Pre Amplifier	ZVA-183-S	570400946	2012-05-09	1 Year

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

10.4 Test Environmental Conditions

Temperature:	22 °C
Relative Humidity:	52 %
ATM Pressure:	101.1 kPa

The testing was performed by Lionel Lara on 2012-08-30 in 5 meter chamber 3.

10.5 Test Results

Worst Margin: **-33.55 dB** at **455.64 MHz** in the **Horizontal** polarization.

Please see following table for detailed results.

CW, 151.880 MHz

Indicated		Turntable Azimuth Degrees	Test Antenna		Substituted					Limit (dBm)	Margin (dB)
Freq. (MHz)	Amp. (dBuV)		Height (cm)	Polar (H/V)	Freq. (MHz)	Level (dBm)	Antenna Cord. (dBi)	Cable Loss (dB)	Absolute Level (dBm)		
303.76	39.73	277	359	H	303.76	-64.46	0	0.4	-64.86	-20	-44.86
303.76	45.06	168	121	V	303.76	-59.13	0	0.4	-59.53	-20	-39.53
455.64	49.84	103	285	H	455.64	-52.95	0	0.6	-53.55	-20	-33.55
455.64	45.61	361	152	V	455.64	-57.18	0	0.6	-57.78	-20	-37.78

CW, 154.600 MHz

Indicated		Turntable Azimuth Degrees	Test Antenna		Substituted					Limit (dBm)	Margin (dB)
Freq. (MHz)	Amp. (dBuV)		Height (cm)	Polar (H/V)	Freq. (MHz)	Level (dBm)	Antenna Cord. (dBi)	Cable Loss (dB)	Absolute Level (dBm)		
309.2	44.19	286	343	H	309.2	-60.45	0	0.4	-60.85	-20	-40.85
309.2	47.07	189	125	V	309.2	-57.57	0	0.4	-57.97	-20	-37.97
463.8	45.58	92	252	H	463.8	-57.91	0	0.6	-58.51	-20	-38.51
463.8	44.1	1	154	V	463.8	-59.39	0	0.6	-59.99	-20	-39.99