ENGINEERING TEST REPORT

Boomer III Data TAC Wireless OEM Modem Module
Model No.: BM3-800D
FCC ID: PQS-BM3800D

Applicant:

Wavenet Technology PTY. LTD.
140 Burswood Road
Burswood,
Western Australia, 6100

Tested in Accordance With

Federal Communications Commission (FCC)
47 CFR, PARTS 2 and 90 (Subpart I)

UltraTech's File No.: WTP-014FCC90

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: Oct. 02, 2003	
Report Prepared by: Tri Luu, P.Eng. Issued Date: Oct. 02, 2003	Tested by: Hung Trinh, RFI Technician Test Dates: Sep. 24-30, 2003

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

UltraTech

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31040/SIT	C-1376	46390-2049	200093-0	SL2-IN-E-1119R	00-034		

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EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	• Exhibit 1: Submittal check lists • Exhibit 2: Introduction • Exhibit 3: Performance Assessment • Exhibit 4: EUT Operation and Configuration during Tests • Exhibit 5: Summary of test Results • Exhibit 6: Measurement Data • Exhibit 7: Measurement Uncertainty • Exhibit 8: Measurement Methods	OK
1	Test Setup Photos	Photos # 1 to 3	OK
2	External Photos of EUT	Photos # 1 to 2	OK
3	Internal Photos of EUT	Photos of 1 to 2	OK
4	Cover Letters	• Letter Request for Product Certification • Letter from the Applicant to appoint Ultratech to act as an agent • Letter from the Applicant to request for Confidentiality Filing	OK OK
5	Attestation Statements	• N/A	OK
6	ID Label/Location Info	ID Label Location of ID Label	OK
7	Block Diagrams	Block Diagrams	OK
8	Schematic Diagrams	Schematic Diagrams	OK
9	Parts List/Tune Up Info	Parts List/Tune Up Info	OK
10	Operational Description	Operational Description	OK
11	RF Exposure Info	RF Exposure Info	OK
12	Users Manual	Users Manual	OK

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Parts 2 and 90
Title:	Telecommunication - Code of Federal Regulations, CFR 47, Parts 2 & 90
Purpose of Test:	To gain FCC Certification Authorization for Radio operating in the frequency bands 806-821 MHz (25 kHz Channel Spacing) and 821-824 MHz (12.5 kHz Channel Spacing).
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - 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.
FCC Grant Limitation:	• For Mobile and Base Devices only. FCC new certification with SAR compliance for a Portable OEM product, which employs this radio, is required. • For any antenna with the gain less than or equal to 5 dBi • The separation distance from antenna to any person shall be not less than 20 cm

2.2. RELATED SUBMITTAL(S)/GRANT(S)

None

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2002	Code of Federal Regulations – Telecommunication
ANSI C63.4	1992	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
CISPR 22 & EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1	1999	Specification for Radio Disturbance and Immunity measuring apparatus and methods

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	Wavenet Technology PTY. LTD.
Address:	140 Burswood Road Burswood, Western Australia, 6100
Contact Person:	Mr. David Shawcross Phone #: +61 8 9262 0239 Fax #: +61 8 9355 5622 Email Address: dshawcross@wavenet.com.au

MANUFACTURER	
Name:	Wavenet Technology PTY. LTD.
Address:	140 Burswood Road Burswood, Western Australia, 6100
Contact Person:	Mr. David Shawcross Phone #: +61 8 9262 0239 Fax #: +61 8 9355 5622 Email Address: dshawcross@wavenet.com.au

3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	Wavenet Technology PTY. LTD.
Product Name:	Boomer III Data TAC Wireless OEM Modem Module
Model Name or Number:	BM3-800D
Serial Number:	Pre-production
Type of Equipment:	Non-broadcast Radio Communication Equipment
External Power Supply:	External regulated DC source
Transmitting/Receiving Antenna Type:	Non-integral

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	[x] Mobile [x] Base station (fixed use) **Note**: FCC Re-certification with compliance with SAR is required if the EUT is employed in a Portable OEM device .
Intended Operating Environment:	[x] Commercial [x] Light Industry & Heavy Industry
Power Supply Requirement:	External 3.8 Vdc regulated
RF Output Power Rating:	0.5 Watts min. 2.0 Watts max.
Operating Frequency Range:	806-821 MHz and 821-824 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	• 25 kHz for 806-821 MHz Band • 12.5 kHz for 821-824 MHz Band
Data Rate:	• 19.2 kb/s for 806-821 MHz Band • 9.6 kb/s for 821-824 MHz Band
Occupied Bandwidth (99%):	
Modulation:	• 2-Level FSK MDC 4.8 kb/s 2.5 kHz Frequency Deviation (12.5 kHz Channel Spacing) • 4-Level FSK RDLAP 9.6 kb/s 3.9 kHz Frequency Deviation (12.5 kHz Channel Spacing) • 4-Level FSK RDLAP 19.2 kb/s 5.6 kHz Frequency Deviation (25 kHz Channel Spacing)
Emission Designation:	• 20K8F1D for 806-824 MHz • 12K6F1D for 821-824 MHz Band
Antenna Connector Type:	Standard MMCX connector (Professional Installation). Please refer to the User's Manual for detailed instruction of antenna installation and RF Exposure Warning.
Antenna Description:	No specific antenna supply. The maximum antenna gain specified by the manufacturer is 5 dBi

* For an average case of commercial telephony, the Necessary Bandwidth is calculated as follows:

1. For FM Digital Modulation:

   (a) 821-824 MHz Band, Channel Spacing = 12.5 KHz, D = 3.9 KHz max., K = 1, Level of FM = 4
   M = Data Rate in kb/s / Level of FM = 9.6/4 kb/s
   B_n = 2M + 2DK = 2(9.6/4) + 2(3.9)(1) = **12.6 KHz**
   emission designation: 12K6F1D

   (b) 806-821 MHz Band, Channel Spacing = 25 KHz, D = 5.6 KHz max., K = 1, Level of FM = 4
   M = Data Rate in kb/s / Level of FM = 19.2/4 kb/s
   B_n = 2M + 2DK = 2(19.2/4) + 2(5.6)(1) = **20.8 KHz**
   emission designation: 20K8F1D

RECEIVER	
Operating Frequency Range:	851 – 870 MHz
RF Iutput Impedance:	50 Ohms

3.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	Data Interface Port	1	30 Way FPC	Non-shielded
2	RF In/Out Port	1	MMCX	Shielded

3.5. ANCILLARY EQUIPMENT

1. Wavenet Technology Special Test Jig
2. IBM ThinPad Computer, Model 2625, S/N: 78-WWM48, FCC & CE Class B compliance

3.6. TEST SETUP BLOCK DIAGRAM

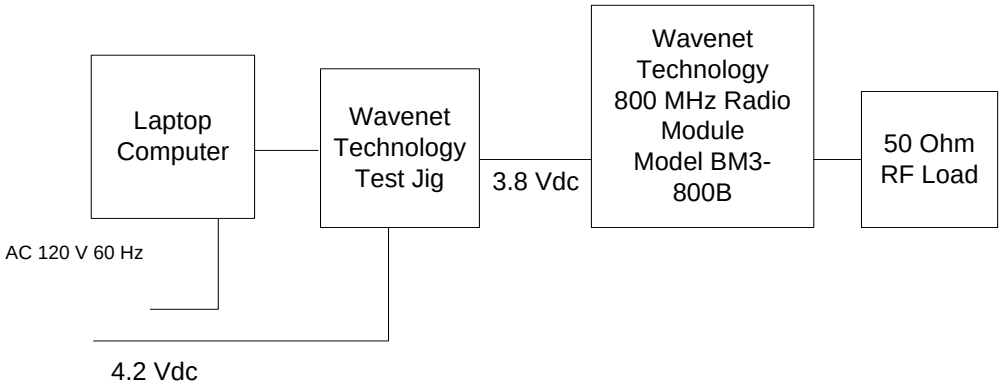


EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power input source:	**3.8 Vdc** regulated

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	Special Test software provided by Wavenet Technology
Special Hardware Used:	Special Test Jig for interfacing the EUT and laptop computer
Transmitter Test Antenna:	The EUT is tested with the transmitter antenna port terminated to a 50 Ohms RF Load.

Transmitter Test Signals	
Frequency Band(s): ▪ 806 – 821 MHz band: ▪ 821 – 824 MHz band:	Near lowest, near middle & near highest frequencies in each frequency bands that the transmitter covers: ▪ 806, 813.5 & 821 MHz ▪ 821, 822.5 & 824 MHz
Transmitter Wanted Output Test Signals: ▪ RF Power Output (measured maximum output power): ▪ Normal Test Modulation ▪ Modulating signal source:	 ▪ 0.5 Watts min. 2 Watts max. ▪ Level 4 – FSK at maximum data rate of 19.2 kb/s for 25 kHz Channel Spacing and 9.6 kb/s for 12.5 kHz Channel Spacing. ▪ Internal

EXHIBIT 5. SUMMARY OF TEST RESULTS

5.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).

- Radiated Emissions were performed at the Ultratech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

  The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: Aug. 10, 2002.

5.2. APPLICABILITY & SUMMARY OF EMISSION TEST RESULTS

FCC PARAGRAPH.	TEST REQUIREMENTS	APPLICABILITY (YES/NO)
90.205 & 2.1046	RF Power Output	Yes
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
90.213 & 2.1055	Frequency Stability	Yes
90.242(b)(8) & 2.1047(a)	Audio Frequency Response	Not applicable to new standard. However, tests are conducted under FCC's recommendation.
90.210 & 2.1047(b)	Modulation Limiting	Yes
90.210 & 2.1049	Emission Limitation & Emission Mask	Yes
90.210, 2.1057 & 2.1051	Emission Limits - Spurious Emissions at Antenna Terminal	Yes
90.210, 2.1057 & 2.1053	Emission Limits - Field Strength of Spurious Emissions	Yes
Boomer III Data TAC Wireless OEM Modem Module, **Model No.: BM3-800D**, by **Wavenet Technology PTY. LTD.** has also been tested and found to comply with **FCC Part 15, Subpart B - Radio Receivers and Class B Digital Devices**. The engineering test report has been documented and kept in file and it is available anytime upon FCC request.		

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

5.4. DEVIATION OF STANDARD TEST PROCEDURES

None

EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

6.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Exhibit 8 of this report

6.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document NIS 81 with a confidence level of 95%. Please refer to Exhibit 7 for Measurement Uncertainties.

6.3. MEASUREMENT EQUIPMENT USED:

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4:1992 and CISPR 16-1.

6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER:

The essential function of the EUT is to correctly communicate data to and from radios over RF link.

6.5. RF POWER OUTPUT @ FCC 2.1046 & 90.205

6.5.1. Limits @ FCC 90.205

Please refer to FCC CFR 47, Part 90, Subpart I, Para. 90.205 for specification details.

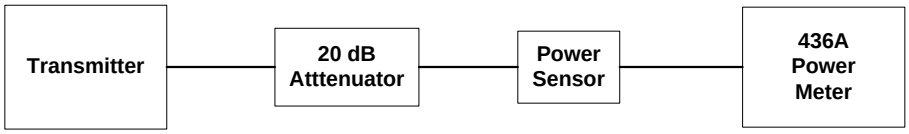
6.5.2. Method of Measurements

Refer to Exhibit 8, § 8.1 (Conducted) and 8.2 (Radiated) of this report for measurement details

6.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Attenuator(s)	Bird	…	…	DC – 22 GHz
Attenuator(s)	Weinschel Corp	24-20-34	BJ2357	DC – 8.5 GHz
Power Meter	Hewlett Packard	436A	1725A02249	10 kHz – 50 GHz, sensor dependent
Power Sensor	Hewlett Packard	8481A	2702A68983	10 MHz – 18 GHz

6.5.4. Test Arrangement



6.5.5. Test Data

6.5.5.1. Operation in 806 – 821 MHz, 25 kHz Channel Spacing, Level 4 FSK, Max Data Rate: 19.2 kb/s

RF Output Power Settings	Fundamental Frequency (MHz)	Measured Peak Power (Watts)	Power Rating (Watts)
High	806.0	2.08	2.0
	813.5	2.05	2.0
	821.0	2.05	2.0
Low	806.0	0.54	0.5
	813.5	0.52	0.5
	821.0	0.52	0.5

6.5.5.2. Operation in 821 – 824 MHz, 12.5 kHz Channel Spacing, Level 4 FSK, Max Data Rate: 9.6 kb/s

RF Output Power Settings	Fundamental Frequency (MHz)	Measured Peak Power (Watts)	Power Rating (Watts)
High	821.0	2.05	2.0
	822.5	2.05	2.0
	824.0	2.05	2.0
Low	821.0	0.52	0.5
	822.5	0.52	0.5
	824.0	0.51	0.5

Note: The above power values are based on Peak Power measurement without reduction of the duty cycle of 30% maximum.

6.6. RF EXPOSURE REQUIREMENTS @ 1.1310 & 2.1091

6.6.1. Limits

- **FCC 1.1310:-** The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A) Limits for Occupational/Control Exposures				
300-1500	...	...	F/300	6
(B) Limits for General Population/Uncontrolled Exposure				
300-1500	...	...	F/1500	6

F = Frequency in MHz

6.6.2. Method of Measurements

Refer to FCC @ 1.1310 & 2.1091

In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed:

(1) Calculation that estimates the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits defined for free space.
(2) Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement
(3) Any caution statements and/or warning labels that are necessary in order to comply with the exposure limits
(4) Any other RF exposure related issues that may affect MPE compliance

Calculation Method of RF Safety Distance:

$S = PG/4\Pi r^2 = EIRP/4\Pi r^2$

Where: P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

$r = \sqrt{PG/4\Pi S}$

FCC radio frequency exposure limits may not be exceeded at distances closer than r cm from the antenna of this device

- For portable transmitters (see Section 2.1093), or devices designed to operate next to a person's body, compliance is determined with respect to the SAR limit (define in the body tissues) for near-field exposure conditions. If the maximum average output power, operating condition configurations and exposure conditions are comparable to those of existing cellular and PCS phones., an SAR evaluation may be required in order to determine if such a device complies with SAR limit. When SAR evaluation data is not available, and the additional supporting information cannot assure compliance, the Commission may request that an SAR evaluation be performed, as provided for in Section 1.1307(d)

6.6.3. Test Data

Antenna Gain Limit specified by Manufactuer: 5.0 dBi maximum

Frequency (MHz)	Measured Maximum Peak RF Conducted Power (Watts)	Calculated Average RF Conducted Power with 30% Duty Cycle (Watts)	Calculated Average EIRP (Watts)	Caculated RF Safety Distance r (cm)
806	2.08	0.624	1.97	17.1

Note 1: **RF EXPOSURE DISTANCE LIMITS:** $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$
$S = F/1500 =$ lowest-f/1500 = 806/1500 = 0.537 mW/cm^2

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	**Compliance with FCC Rules**
Minimum calculated separation distance between antenna and persons required: 17.1 cm	Manufacturer' instruction for separation distance between antenna and persons required: 20 cm. Please refer to the Users/ Manual and FCC RF Exposure folder
Antenna installation and device operating instructions for installers	Please refer to the Users/ Manual and FCC RF Exposure folder
Caution statements and/or warning labels that are necessary in order to comply with the exposure limits	Please refer to the Users/ Manual and FCC RF Exposure folder
Any other RF exposure related issues that may affect MPE compliance	N/A

6.7. FREQUENCY STABILITY @ FCC 2.1055 & 90.213

6.7.1. Limits @ FCC 90.213

Please refer to FCC CFR 47, Part 90, Subpart I, Para. 90.213 for specification details.

FREQUENCY RANGE (MHz)	FIXED & BASE STATIONS (ppm)	MOBILE STATIONS (ppm)	
		> 2 W	≤ 2 W
806-821	1.5	2.5	2.5
821-824	1.0	1.5	1.5

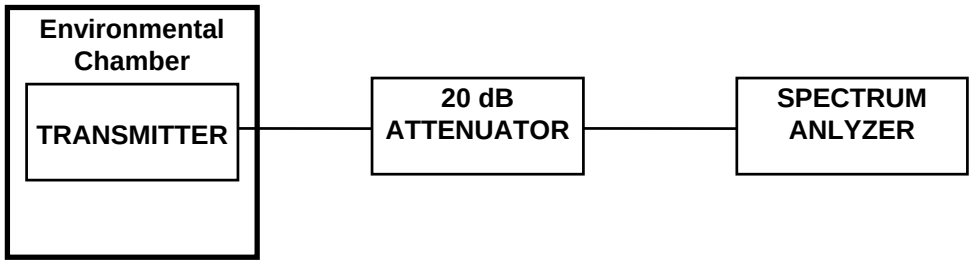
6.7.2. Method of Measurements

Refer to Exhibit 8, § 8.3 of this report for measurement details

6.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
EMI Receiver/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Attenuator(s)	Bird	..	…	DC – 22 GHz
Temperature & Humidity Chamber	Tenney	T5	9723B	-40° to +60 ° C range

6.7.4. Test Arrangement



6.7.5. Test Data

Product Name: **Model No.:**	**Boomer III Data TAC Wireless OEM Modem Module** **BM3-800D**
Carrier Frequency in 806-821 MHz Band:	806 MHz
Full Power Level:	2.08 Watts
Frequency Tolerance Limit:	±1.5 ppm
Max. Frequency Tolerance Measured:	-230 Hz or 0.29 ppm
Input Voltage Rating:	3.8 Vdc nominal

CENTER FREQUENCY & RF POWER OUTPUT VARIATION			
Ambient Temperature (^{o}C)	**Supply Voltage (Nominal) 3.8 Volts**	**Supply Voltage (85% of Nominal) 3.2 Volts**	**Supply Voltage (115% of Nominal) 4.4 Volts**
	Hz	**Hz**	**Hz**
-30	+31	N/A	N/A
-25	+20	N/A	N/A
-20	-72	N/A	N/A
-15	-200	N/A	N/A
-10	-230	N/A	N/A
-5	-159	N/A	N/A
0	-81	N/A	N/A
+5	-7	N/A	N/A
+10	+58	N/A	N/A
+15	+157	N/A	N/A
+20	+33	+30	+106
+25	+207	N/A	N/A
+30	+152	N/A	N/A
+35	+67	N/A	N/A
+45	-54	N/A	N/A
+50	-103	N/A	N/A
+55	+86	N/A	N/A
+60	+111	N/A	N/A

Product Name: **Model No.:**	**Boomer III Data TAC Wireless OEM Modem Module** **BM3-800D**
Carrier Frequency in 821-824 MHz Band:	821 MHz
Full Power Level:	2.05 Watts
Frequency Tolerance Limit:	±1.0 ppm
Max. Frequency Tolerance Measured:	-274 Hz or 0.33 ppm
Input Voltage Rating:	3.8 Vdc nominal

CENTER FREQUENCY & RF POWER OUTPUT VARIATION			
Ambient Temperature (^{o}C)	**Supply Voltage (Nominal) 3.8 Volts**	**Supply Voltage (85% of Nominal) 3.2 Volts**	**Supply Voltage (115% of Nominal) 4.4 Volts**
	Hz	**Hz**	**Hz**
-30	+78	N/A	N/A
-25	+39	N/A	N/A
-20	+1	N/A	N/A
-15	-120	N/A	N/A
-10	-160	N/A	N/A
-5	-274	N/A	N/A
0	-111	N/A	N/A
+5	-46	N/A	N/A
+10	+40	N/A	N/A
+15	+71	N/A	N/A
+20	+159	+30	+106
+25	+46	N/A	N/A
+30	+189	N/A	N/A
+35	+104	N/A	N/A
+45	+20	N/A	N/A
+50	-107	N/A	N/A
+55	+105	N/A	N/A
+60	+112	N/A	N/A

6.8. MODULATION LIMITING @ FCC 2.1047(B) & 90.210

6.8.1. Limits @ FCC 2.1047(b) and 90.210

Recommended frequency deviation characteristics are give below:

- 2.5 kHz for 12.5 kHz Channel Spacing
- 5 kHz for 25 kHz Channel Spacing System

6.8.2. Method of Measurements

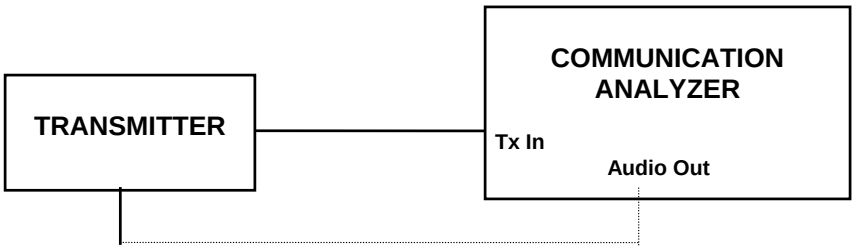
For Audio Transmitter:- The carrier frequency deviation was measured with the tone input signal level varied from 0 Vp to audio input rating level plus 16 dB at frequencies 0.1, 0.5, 1.0, 3.0 and 5.0 kHz. The maximum deviation was recorded at each test condition.

For Data Transmitter with Maximum Frequency Deviation set by Factory:- The EUT was set at maximum frequency deviation, and its peak frequency deviation was then measured using EUT's internal random data source.

6.8.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Communication Analyzer	Rohde & Schawrz	SMF02	879988/057	400 kHz - 1000 MHz including AF & RF Signal Generators, SINAD, DISTORTION, DEVIATION meters and etc

6.8.4. Test Arrangement



6.8.5. Test Data

6.8.5.1. Data Modulation Limiting: FM modulation with random data and Modulation Limiter set at a Maximum Frequency Deviation (Factory Setting).

Maximum Data Rate	Peak Deviation (kHz)	Maximum Specified by Manufacturer (kHz)
9600 b/s for 12.5 KHz Channel Spacing	3.9	3.9
19200 b/s for 12.5 KHz Channel Spacing	5.6	5.6

6.9. 99% OBW & EMISSION MASK @ FCC 2.1049, 90.208 & 90.210(G)(H)

6.9.1. Limits @ FCC 90.209 & 90.210

Emissions shall be attenuated below the mean output power of the transmitter as follows:

FREQUENCY RANGE (MHz)	Maximum Authorized BW (KHz)	CHANNEL SPACING (KHz)	Recommended Max. FREQ. DEVIATION (KHz)	FCC APPLICABLE MASK @ FCC 90.210
806-821	20	25	5	MASK G (Data)
821-824	20	12.5	2.5	MASK H (Data)

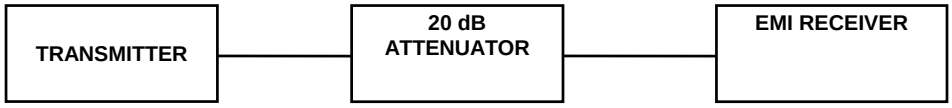
6.9.2. Method of Measurements

Refer to Exhibit 8, § 8.4 of this report for measurement details

6.9.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
EMI Receiver/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Attenuator(s)	Bird	..	…	DC – 22 GHz
Audio Oscillator	Hewlett Packard	HP 204C	0989A08798	DC to 1.2 MHz

6.9.4. Test Arrangement



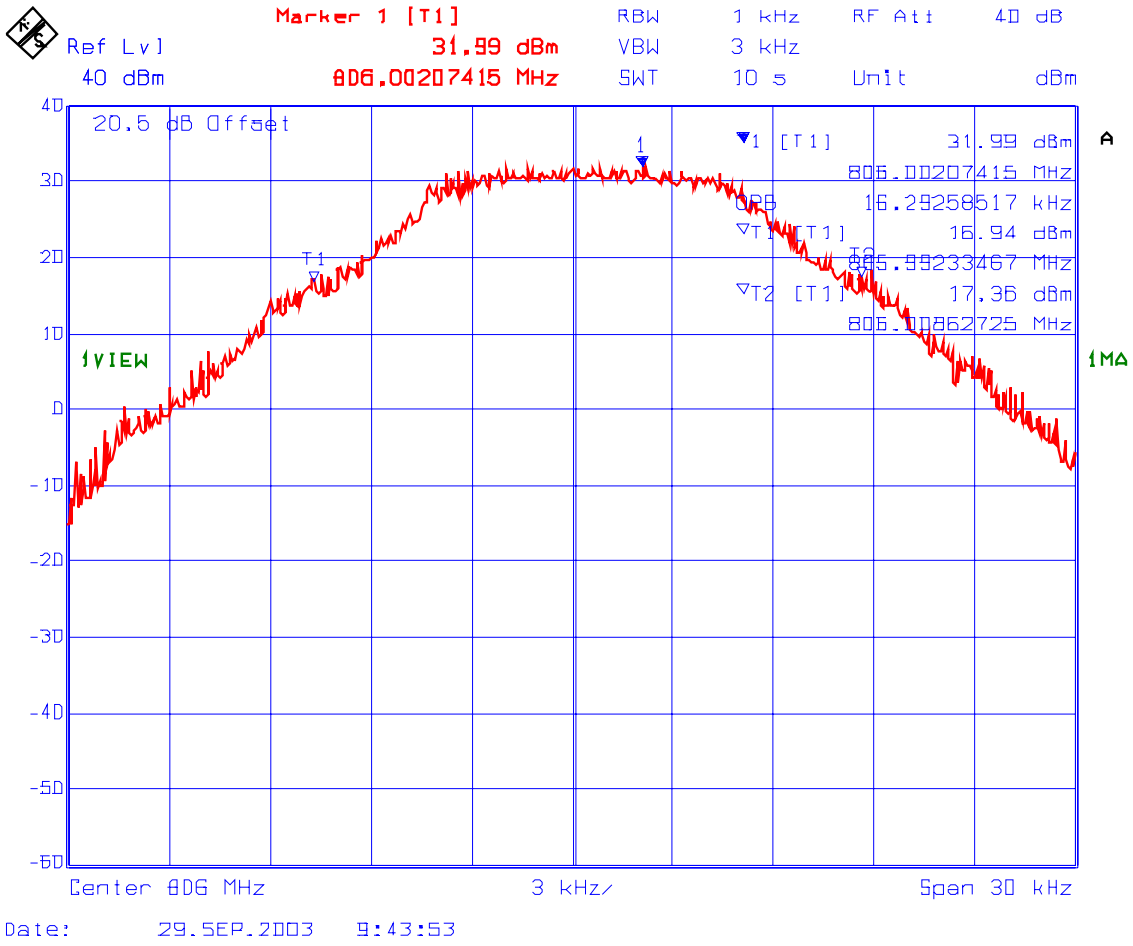
6.9.5. Test Data

6.9.5.1. 99% Occupied Bandwidth

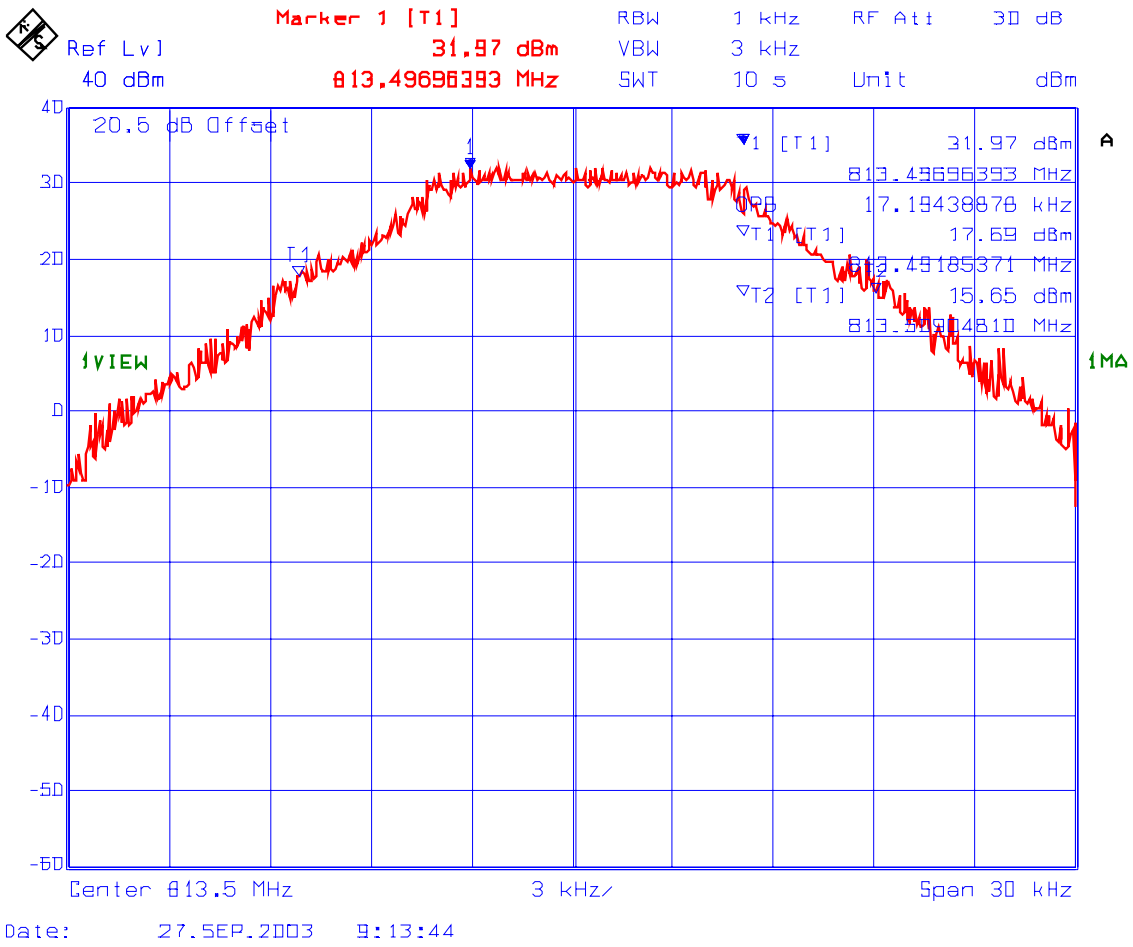
Maximum Data Rate	Carrier Frequency (MHz)	Measured 99 % Occupied Bandwidth (kHz)	Calculated Necessary Bandwidth based on maximum frequency deviation
9600 b/s for 12.5 KHz Channel Spacing	806.0	16.3	20.8
9600 b/s for 12.5 KHz Channel Spacing	813.5	17.2	20.8
9600 b/s for 12.5 KHz Channel Spacing	821.0	17.3	20.8
19200 b/s for 12.5 KHz Channel Spacing	821.0	11.9	12.6
19200 b/s for 12.5 KHz Channel Spacing	822.5	11.8	12.6
19200 b/s for 12.5 KHz Channel Spacing	824.0	11.9	12.6

Notes: Please refer to Plots #2 to 7 for detailed measurements

Plot #2: 99% Bandwidth in 806-821 MHz Band (25 kHz Channel Spacing) Frequency: 806 MHz, Modulation: 4-Level FSK RDLAP 19.2 kbps

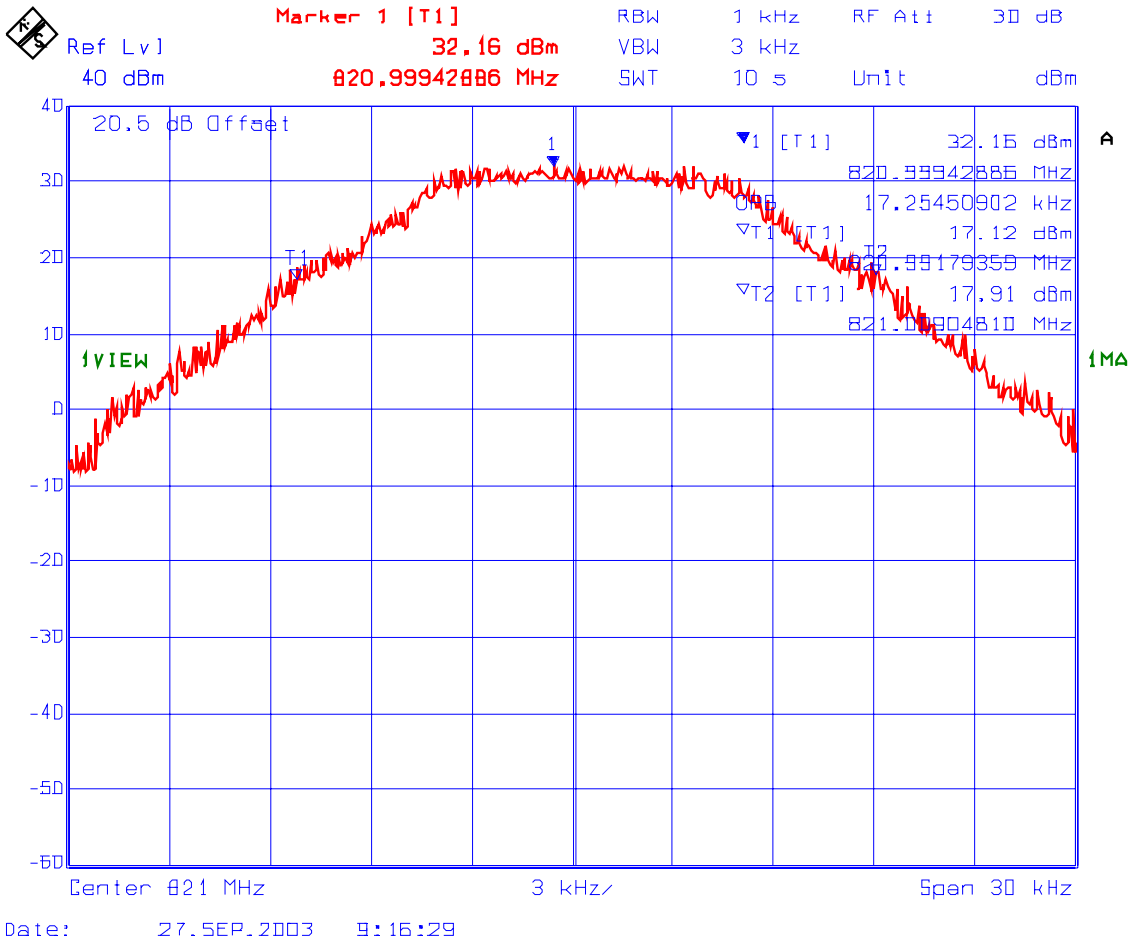


Plot #3: 99% Bandwidth in 806-821 MHz Band (25 kHz Channel Spacing) Frequency: 813.5 MHz, Modulation: 4-Level FSK RDLAP 19.2 kbps



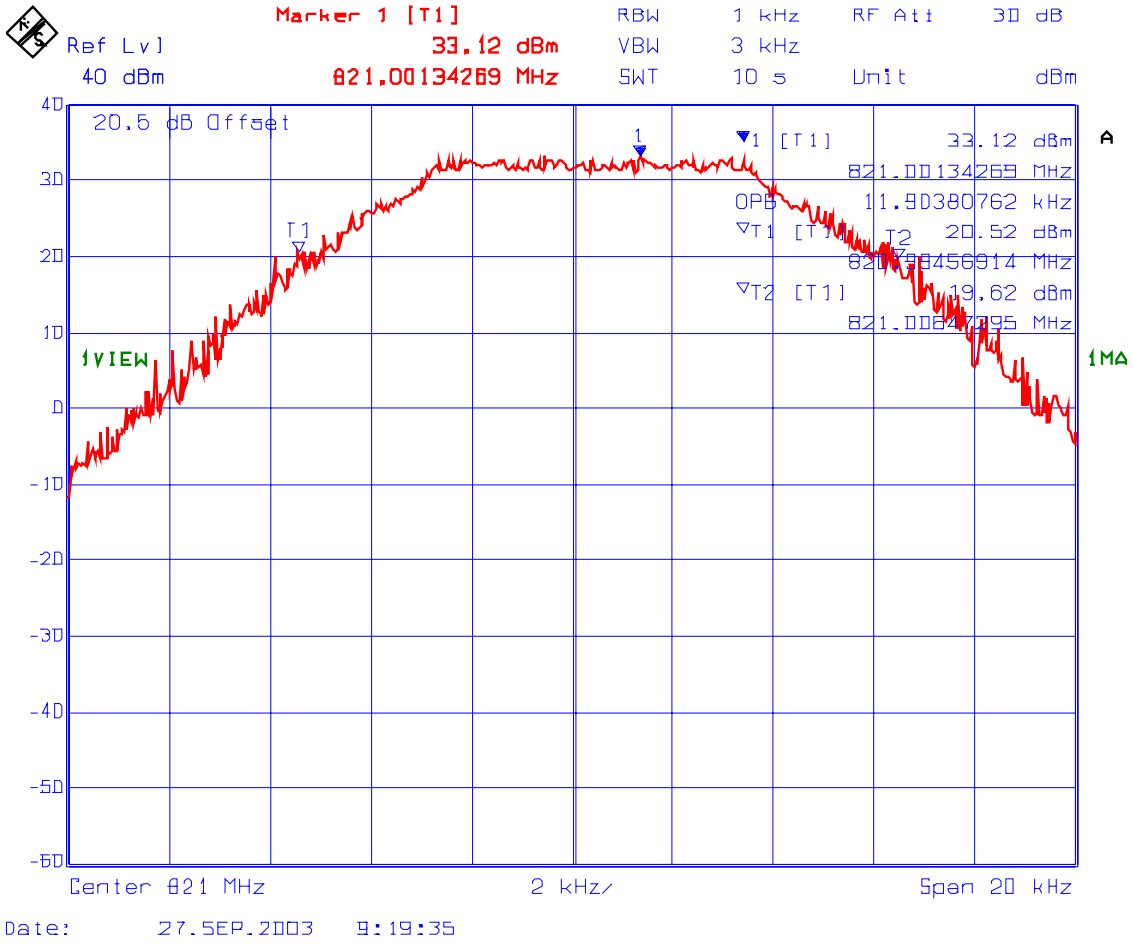
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot #4: 99% Bandwidth in 806-821 MHz Band (25 kHz Channel Spacing) Frequency: 821 MHz, Modulation: 4-Level FSK RDLAP 19.2 kbps



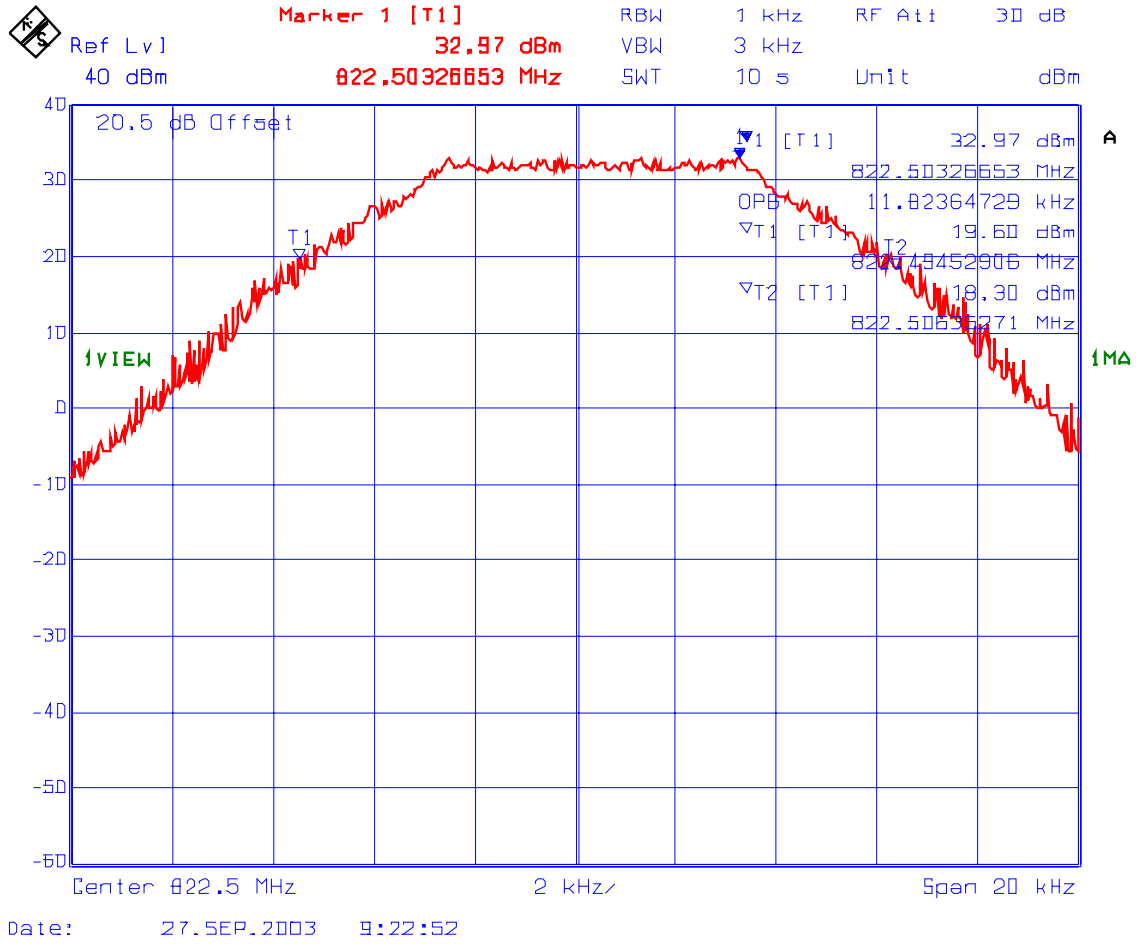
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot #5: 99% Bandwidth in 821-824 MHz Band (12.5 kHz Channel Spacing) Frequency: 821 MHz, Modulation: 4-Level FSK RDLAP 9.6 kbps

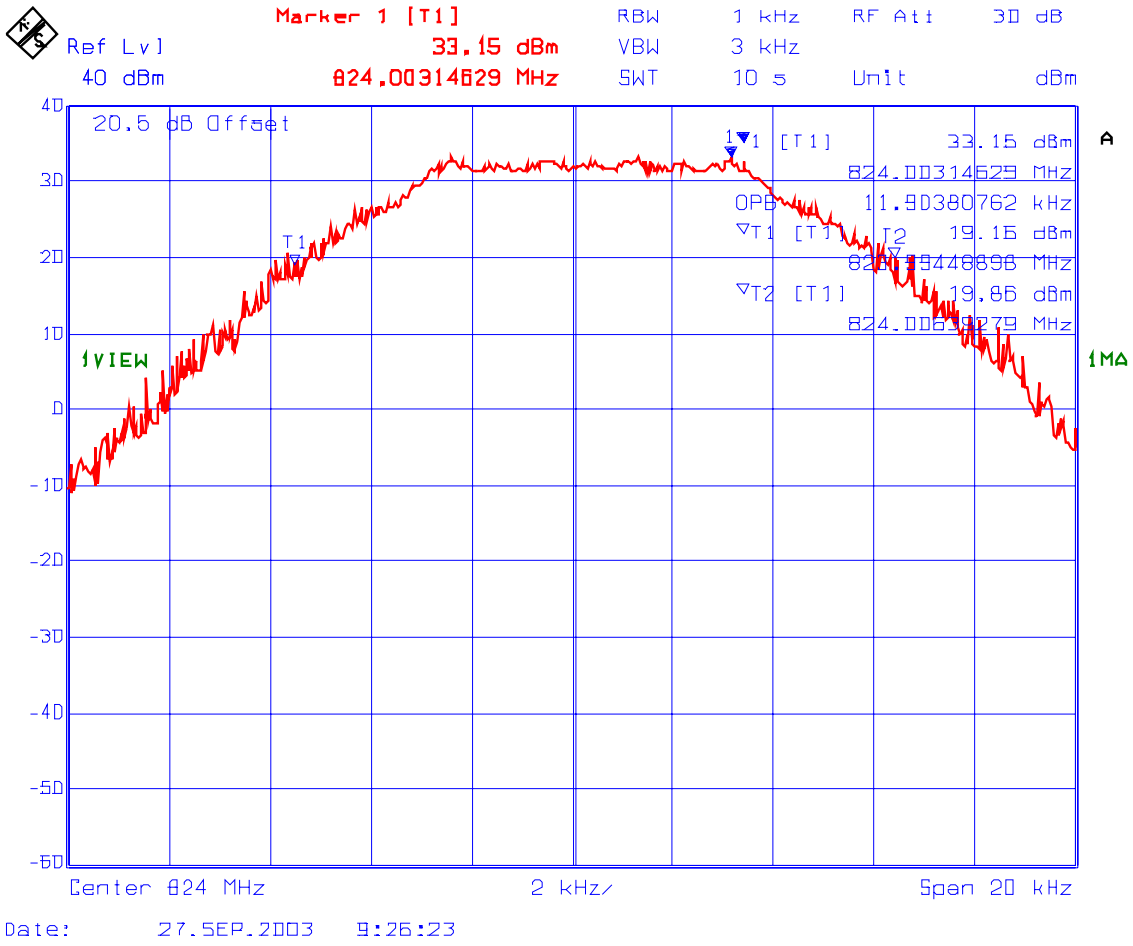


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot #6: 99% Bandwidth in 821-824 MHz Band (12.5 kHz Channel Spacing) Frequency: 822.5 MHz, Modulation: 4-Level FSK RDLAP 9.6 kbps



Plot #7: 99% Bandwidth in 821-824 MHz Band (12.5 kHz Channel Spacing) Frequency: 824 MHz, Modulation: 4-Level FSK RDLAP 9.6 kbps

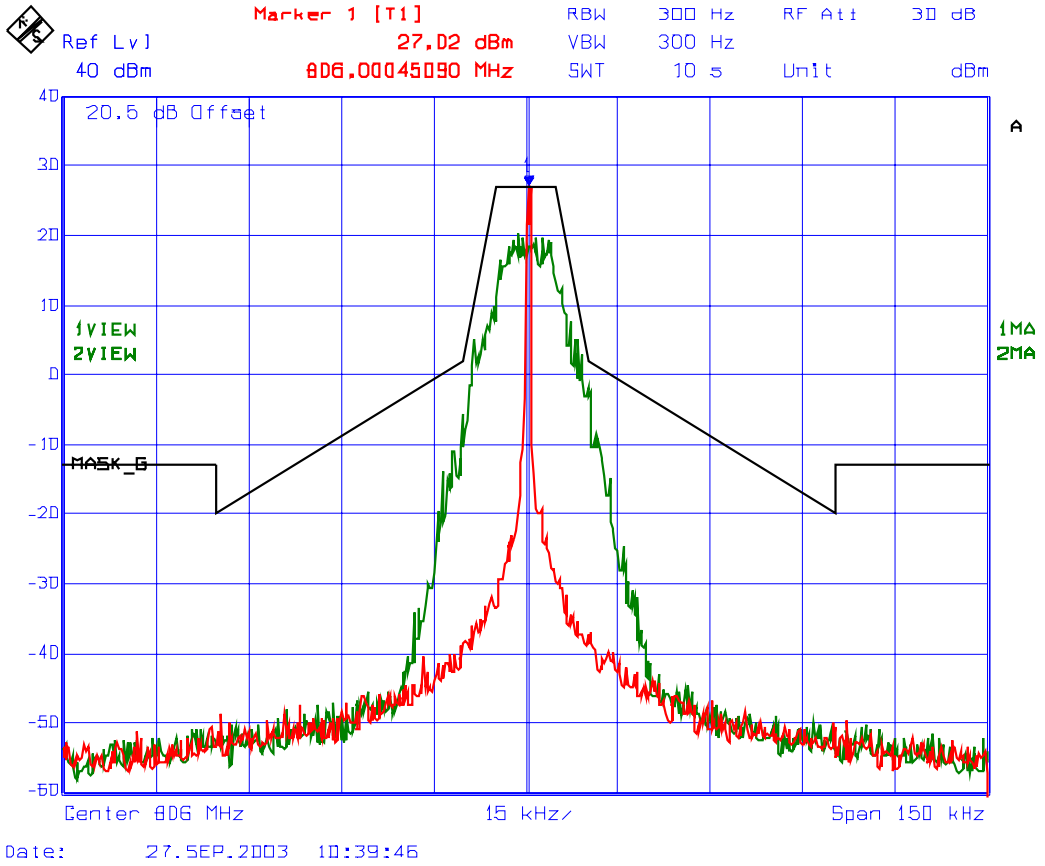


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

6.9.5.2. Emission Masks

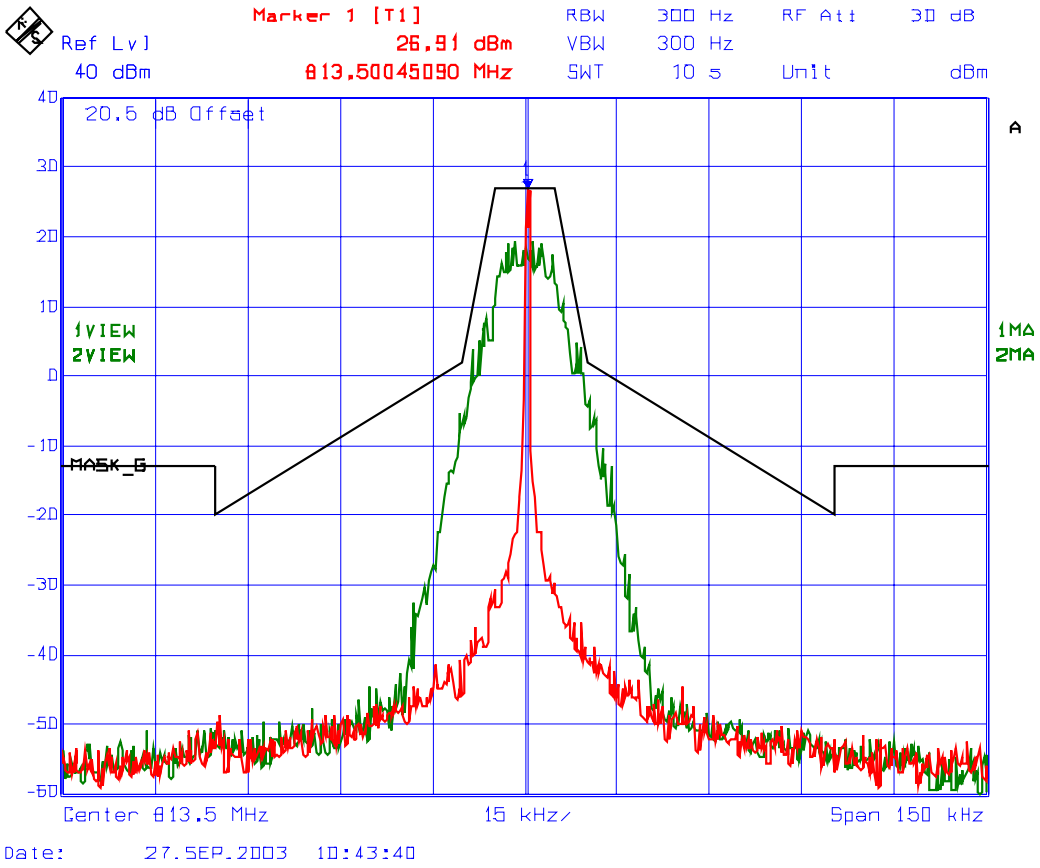
Conform. Please refer to Plot # 8 through # 19 for Details of measurements

Plot # 8: Emission Mask G
Frequency 806 MHz, Power Output: 0.5 W (Low)
Modulation: 4-Level FSK RDLAP 19.2 kbps

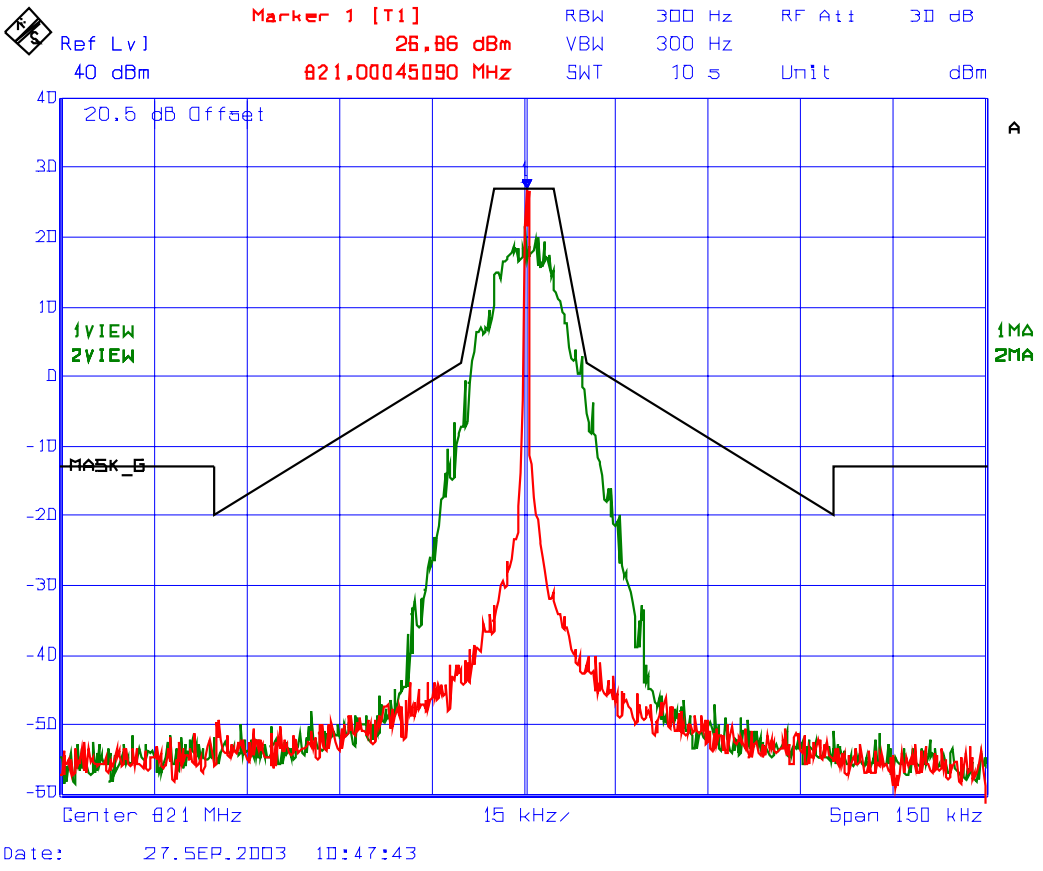


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

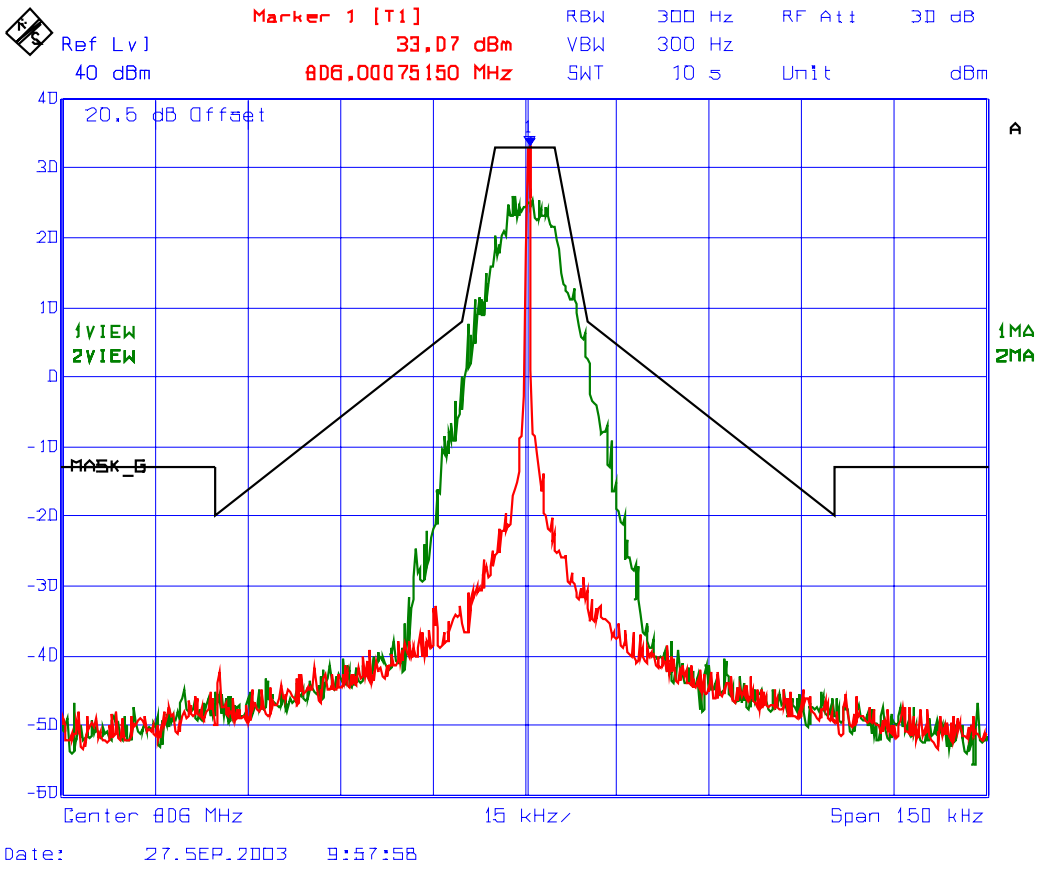
Plot # 9: **Emission Mask G**
Frequency 813.5 MHz, Power Output: 0.5 W (Low)
Modulation: 4-Level FSK RDLAP 19.2 kbps



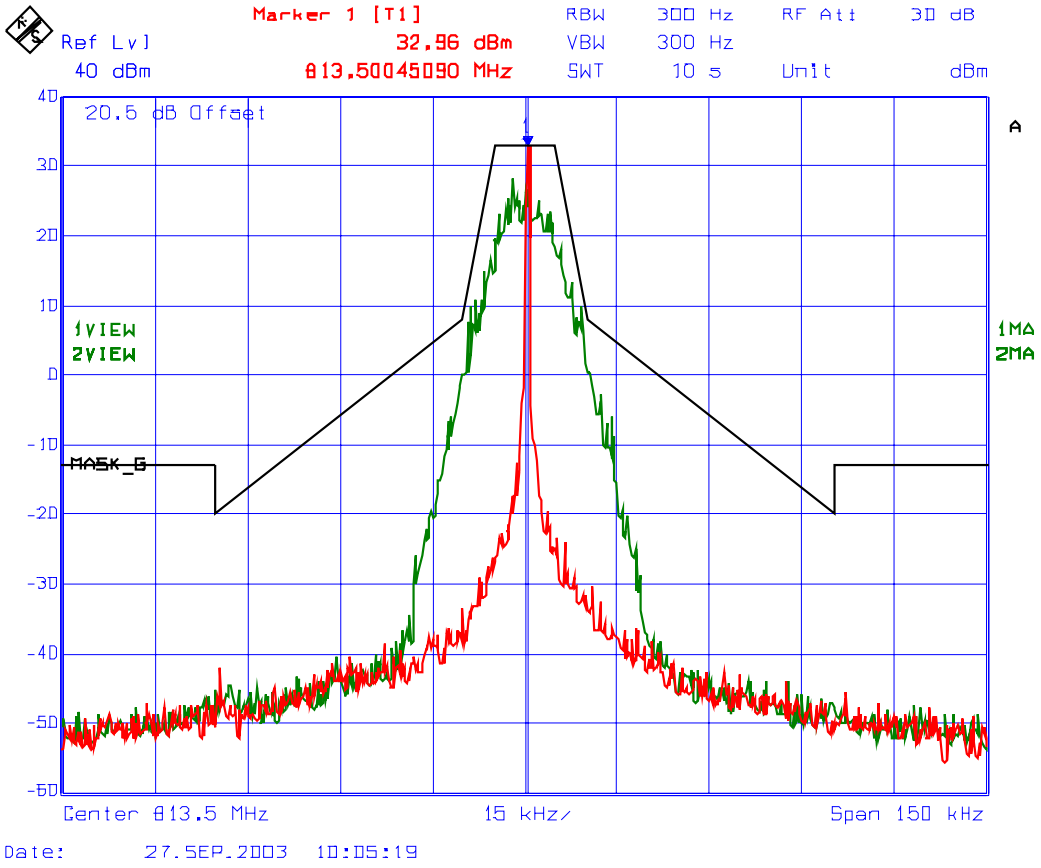
Plot # 10: **Emission Mask G**
Frequency 821 MHz, Power Output: 0.5 W (Low)
Modulation: 4-Level FSK RDLAP 19.2 kbps



Plot # 11: **Emission Mask G**
Frequency 806 MHz, Power Output: 2.0 W (High)
Modulation: 4-Level FSK RDLAP 19.2 kbps

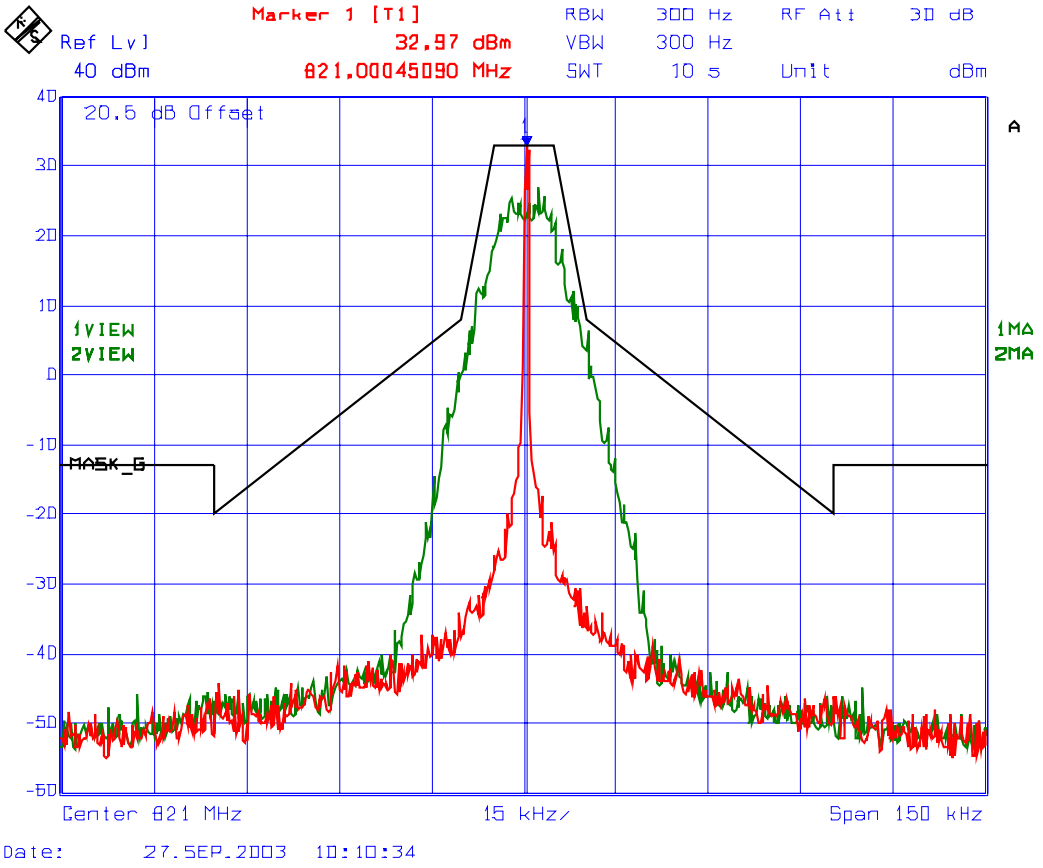


Plot # 12: Emission Mask G
Frequency 813.5 MHz, Power Output: 2.0 W (High)
Modulation: 4-Level FSK RDLAP 19.2 kbps



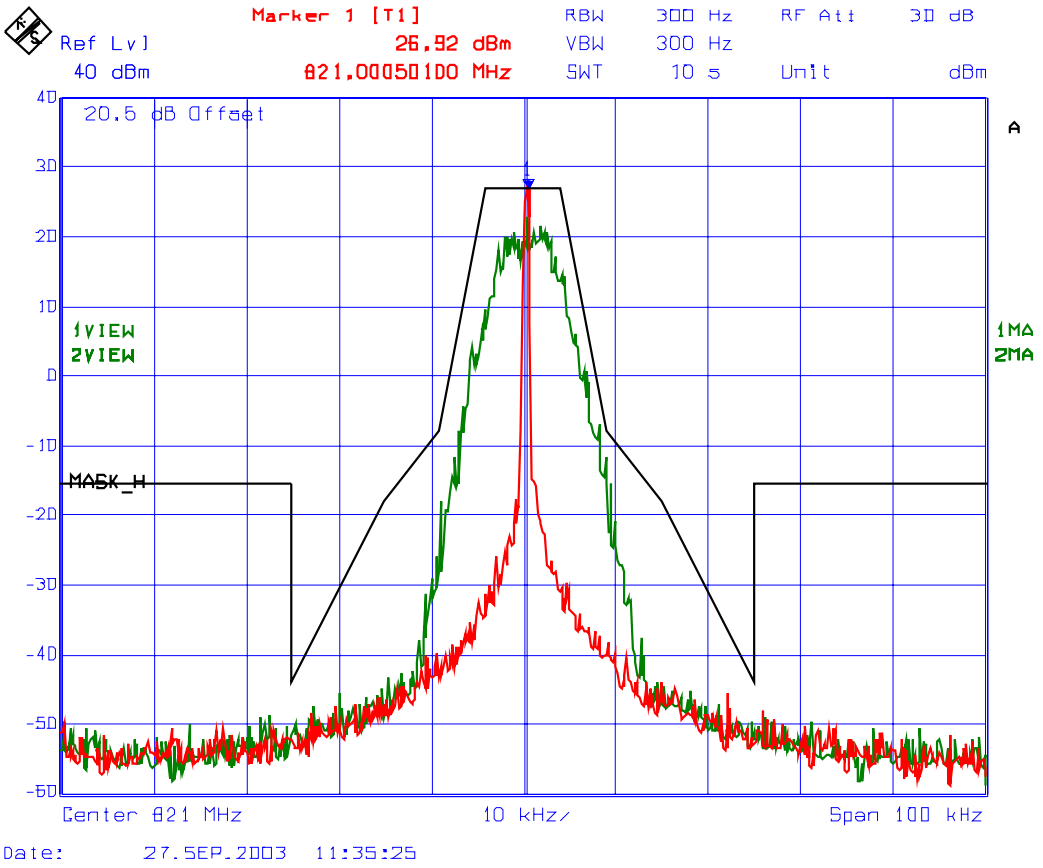
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 13: Emission Mask G
Frequency 821 MHz, Power Output: 2.0 W (High)
Modulation: 4-Level FSK RDLAP 19.2 kbps



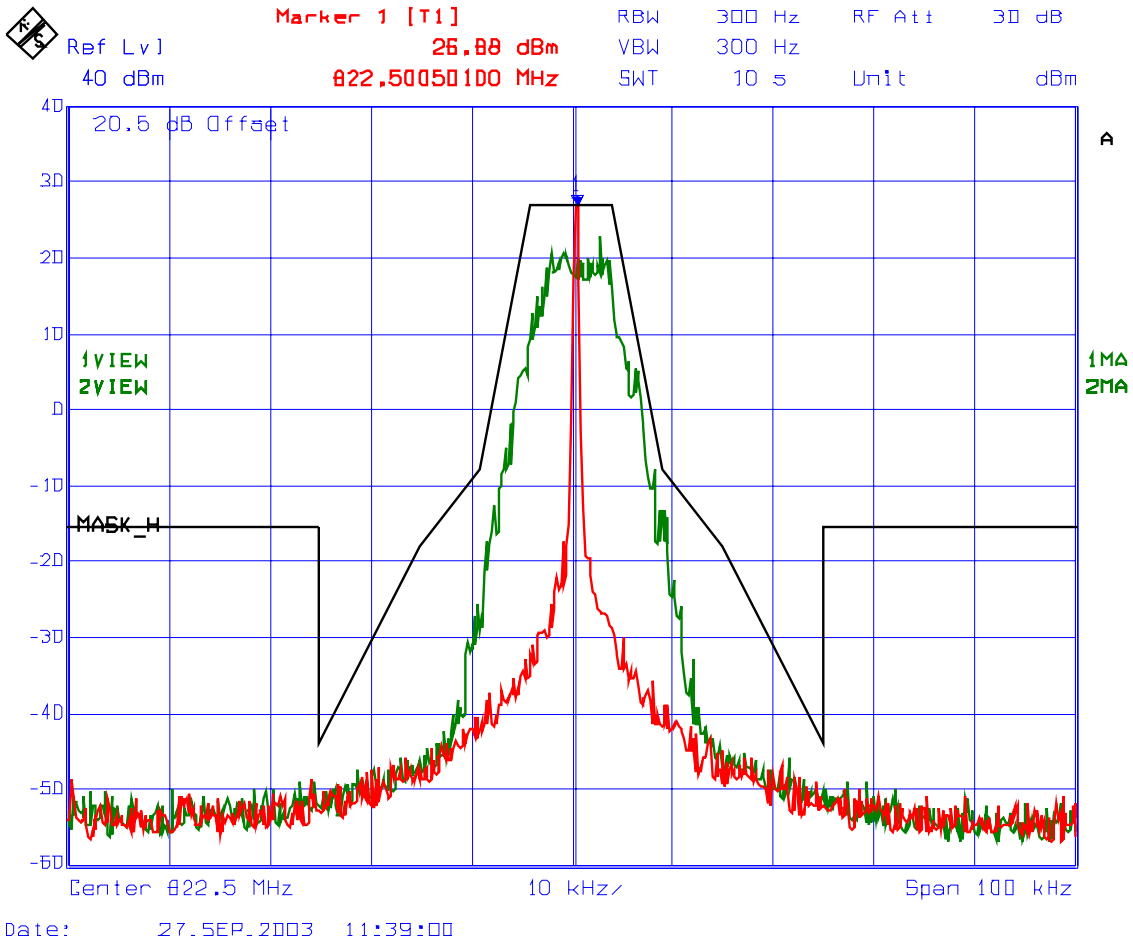
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 14: **Emission Mask H**
Frequency 821 MHz, Power Output: 0.5 W (Low)
Modulation: 4-Level FSK RDLAP 9.6 kbps



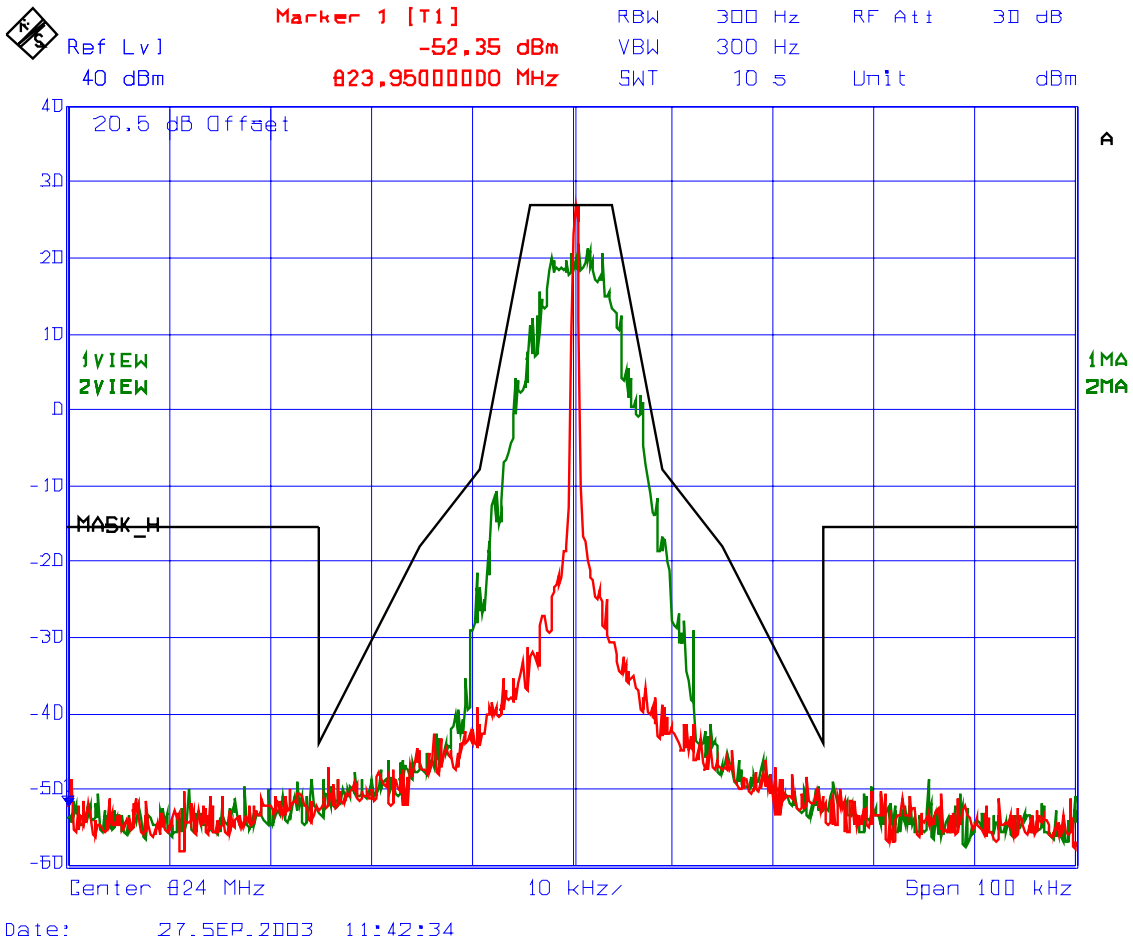
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 15: Emission Mask H
Frequency 822.5 MHz, Power Output: 0.5 W (Low)
Modulation: 4-Level FSK RDLAP 9.6 kbps

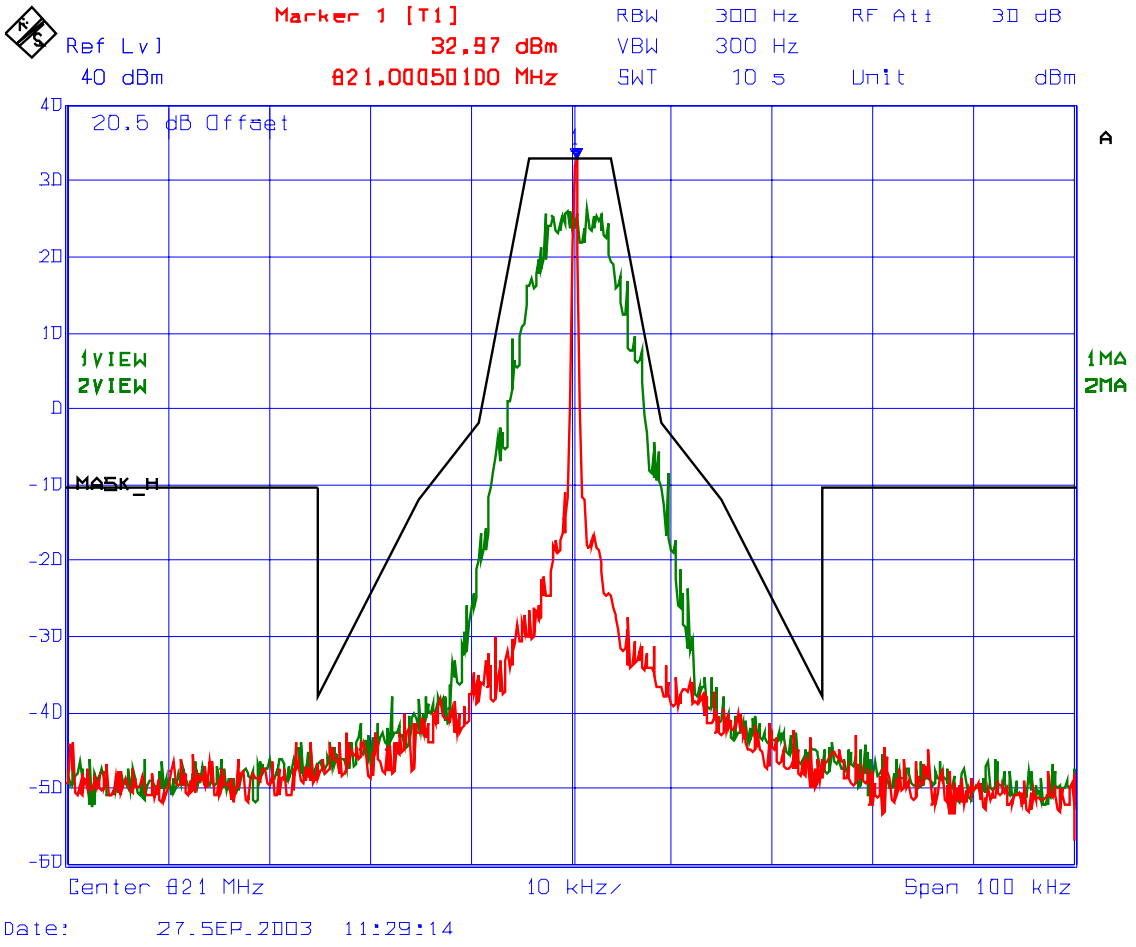


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

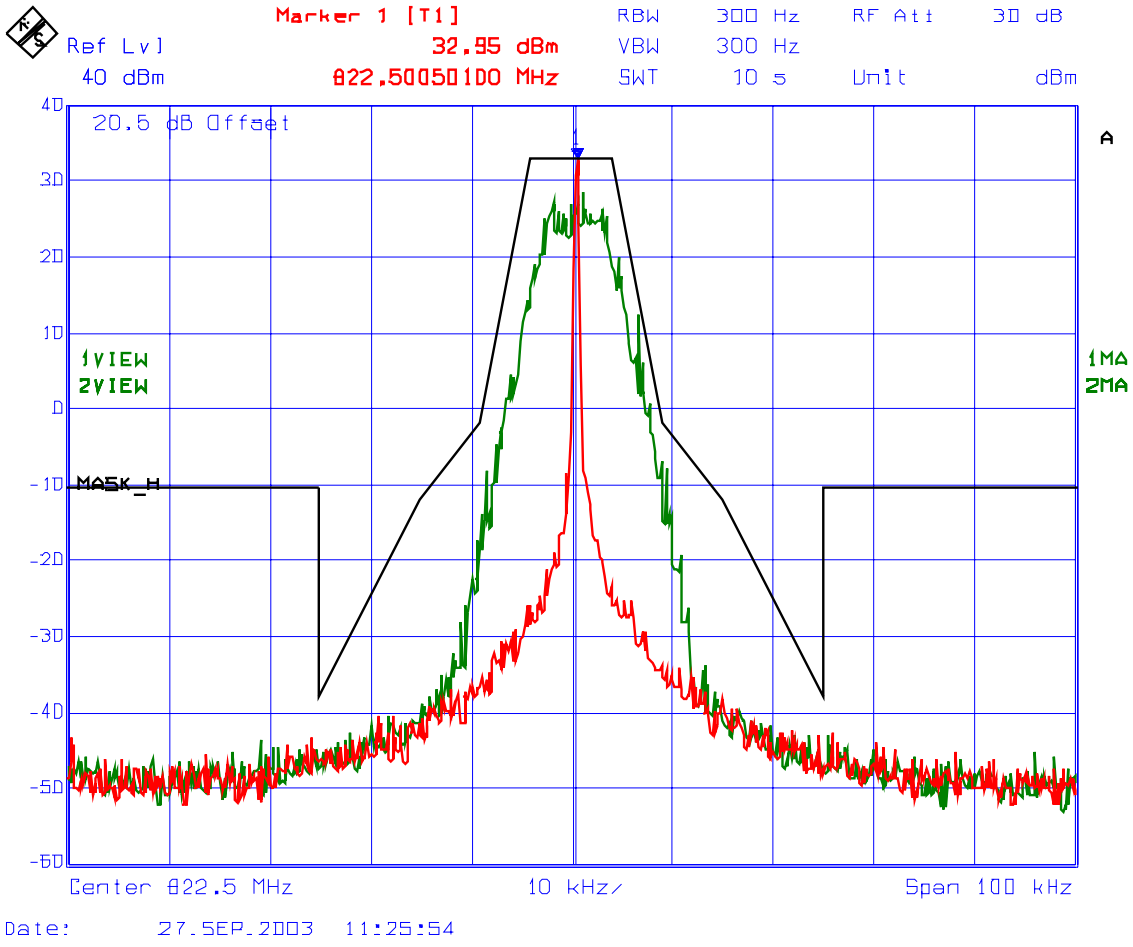
Plot # 16: **Emission Mask H**
Frequency 824 MHz, Power Output: 0.5 W (Low)
Modulation: 4-Level FSK RDLAP 9.6 kbps



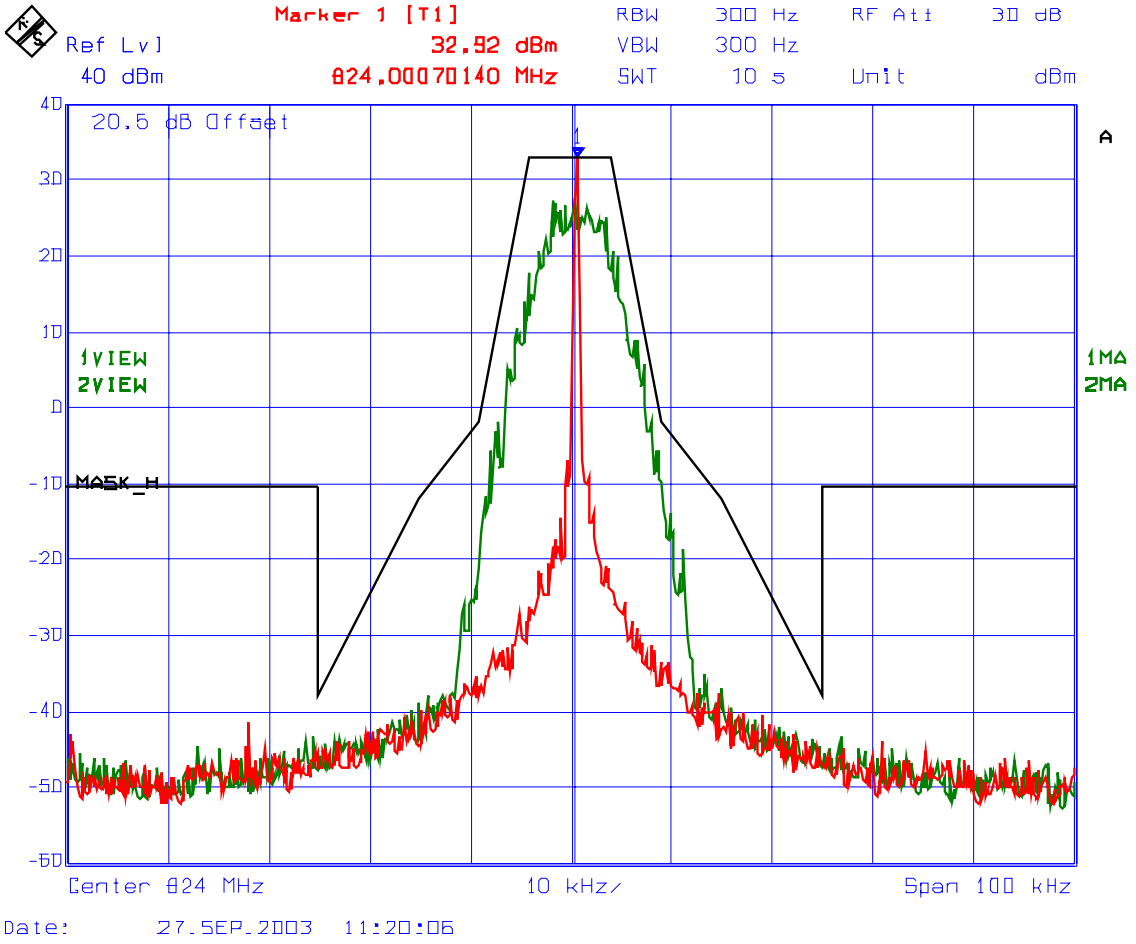
Plot # 17: **Emission Mask H**
Frequency 821 MHz, Power Output: 2.0 W (High)
Modulation: 4-Level FSK RDLAP 9.6 kbps



Plot # 18: **Emission Mask H**
Frequency 822.5 MHz, Power Output: 2.0 W (High)
Modulation: 4-Level FSK RDLAP 9.6 kbps



Plot # 19: **Emission Mask H**
Frequency 824 MHz, Power Output: 2.0 W (High)
Modulation: 4-Level FSK RDLAP 9.6 kbps



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

6.10. TRANSMITTER SPURIOUS CONDUCTED EMISSIONS @ FCC 90.210(G)(H)

6.10.1. Limits @ FCC 90.210

Emissions shall be attenuated below the mean output power of the transmitter as follows:

FREQUENCY RANGE (MHz)	Maximum Authorized BW (KHz)	CHANNEL SPACING (KHz)	Recommended Max. FREQ. DEVIATION (KHz)	FCC LIMIT@ FCC 90.210
806-821	20	25	5	Mask G: 43 + 10 *log(P in Watts)
821-824	20	12.5	2.5	Mask H: 43 + 10 *log(P in Watts)

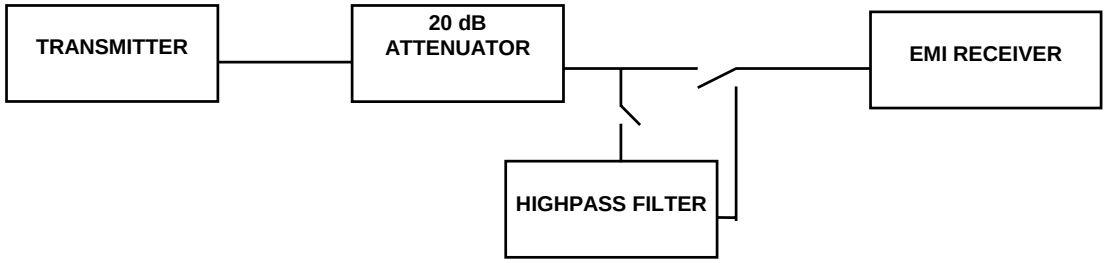
6.10.2. Method of Measurements

Refer to Exhibit 8 § 8.5 of this report for measurement details

6.10.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
EMI Receiver/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Attenuator(s)	Bird	..	…	DC – 22 GHz
Audio Oscillator	Hewlett Packard	HP 204C	0989A08798	DC to 1.2 MHz
Highpass Filter, Microphase	Microphase	CR220HID	IITI11000AC	Cut-off Frequency at 600 MHz, 1.3 GHz or 4 GHz

6.10.4. Test Arrangement



6.10.5. Test Data

6.10.5.1. Low Power Setting 0.54 Watts at Lowest Frequency (806 MHz) in 806-824 MHz Band

Fundamental Frequency: 806 MHz
RF Output Power: 0.54 Watts or 27.3 dBm Watts (conducted)
Modulation: 4-Level FSK with 19.2 kb/s random data

FREQUENCY	TRANSMITTER CONDUCTED ANTENNA EMISSIONS		LIMIT	MARGIN	PASS/
(MHz)	(dBm)	(dBc)	(dBc)	(dB)	FAIL
3224.00	-38.4	-65.7	-40.3	-25.4	PASS
4030.00	-36.3	-63.6	-40.3	-23.3	PASS
4836.00	-27.4	-54.7	-40.3	-14.4	PASS
5642.00	-39.2	-66.5	-40.3	-26.2	PASS

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 30 dB below the limits were recorded.
- Refer to Plots # 20 and 21 for detailed measurements

6.10.5.2. Low Power Setting 0.52 Watts at Middle Frequency (806 MHz) in 806-824 MHz Band

Fundamental Frequency: 815 MHz
RF Output Power: 0.52 Watts or 27.2 dBm Watts (conducted)
Modulation: 4-Level FSK with 19.2 kb/s random data

FREQUENCY	TRANSMITTER CONDUCTED ANTENNA EMISSIONS		LIMIT	MARGIN	PASS/
(MHz)	(dBm)	(dBc)	(dBc)	(dB)	FAIL
1630.00	-40.9	-68.1	-40.2	-27.9	PASS
4075.00	-36.3	-63.5	-40.2	-23.3	PASS
4890.00	-27.6	-54.8	-40.2	-14.6	PASS
5705.00	-41.4	-68.6	-40.2	-28.4	PASS

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 30 dB below the limits were recorded.
- Refer to Plots # 22 and 23 for detailed measurements

6.10.5.3. Low Power Setting 0.52 Watts at Highest Lowest Frequency (824 MHz) in 806-824 MHz Band

Fundamental Frequency: 824 MHz
RF Output Power: 0.52 Watts or 27.2 dBm Watts (conducted)
Modulation: 4-Level FSK with 9.6 kb/s random data

FREQUENCY	TRANSMITTER CONDUCTED ANTENNA EMISSIONS		LIMIT	MARGIN	PASS/
(MHz)	(dBm)	(dBc)	(dBc)	(dB)	FAIL
1648.00	-39.5	-66.7	-40.2	-26.5	PASS
4120.00	-34.5	-61.7	-40.2	-21.5	PASS
4944.00	-27.0	-54.2	-40.2	-14.0	PASS
5768.00	-40.2	-67.4	-40.2	-27.2	PASS

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 30 dB below the limits were recorded.
- Refer to Plots # 24 and 25 for detailed measurements

6.10.5.4. High Power Setting 2.08 Watts at Lowest Frequency (806 MHz) in 806-824 MHz Band

Fundamental Frequency: 806 MHz
RF Output Power: 2.08 Watts or 33.2 dBm Watts (conducted)
Modulation: 4-Level FSK with 19.2 kb/s random data

FREQUENCY	TRANSMITTER CONDUCTED ANTENNA EMISSIONS		LIMIT	MARGIN	PASS/
(MHz)	(dBm)	(dBc)	(dBc)	(dB)	FAIL
3224.00	-36.1	-69.3	-46.2	-23.1	PASS
4836.00	-29.5	-62.7	-46.2	-16.5	PASS
5642.00	-33.6	-66.8	-46.2	-20.6	PASS
7254.00	-38.7	-71.9	-46.2	-25.7	PASS

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 30 dB below the limits were recorded.
- Refer to Plots # 26 and 27 for detailed measurements

6.10.5.5. High Power Setting 2.05 Watts at Middle Frequency (806 MHz) in 806-824 MHz Band

Fundamental Frequency: 815 MHz
RF Output Power: 2.05 Watts or 33.1 dBm Watts (conducted)
Modulation: 4-Level FSK with 19.2 kb/s random data

FREQUENCY (MHz)	TRANSMITTER CONDUCTED ANTENNA EMISSIONS (dBm)	(dBc)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
2445.00	-38.0	-71.1	-46.1	-25.0	PASS
4075.00	-35.6	-68.7	-46.1	-22.6	PASS
4890.00	-32.4	-65.5	-46.1	-19.4	PASS
5705.00	-35.0	-68.1	-46.1	-22.0	PASS

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 30 dB below the limits were recorded.
- Refer to Plots # 28 and 29 for detailed measurements

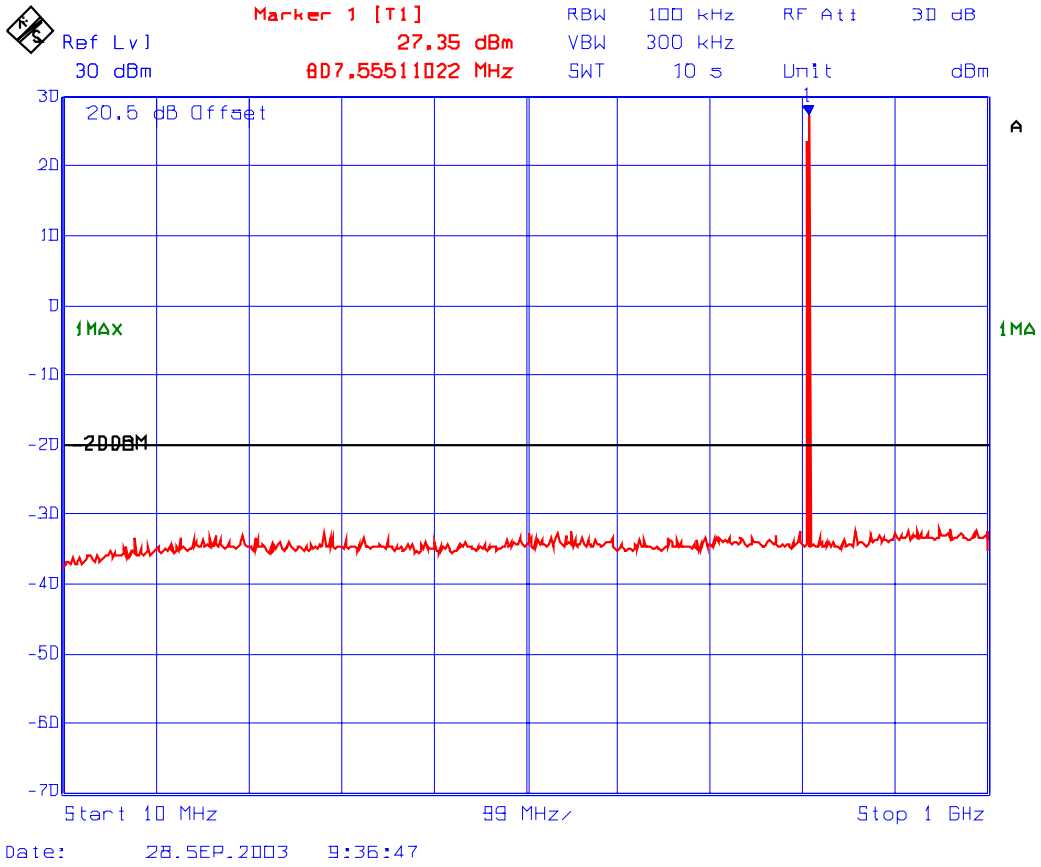
6.10.5.6. High Power Setting 2.05 Watts at Highest Lowest Frequency (824 MHz) in 806-824 MHz Band

Fundamental Frequency: 824 MHz
RF Output Power: 2.05 Watts or 33.1 dBm Watts (conducted)
Modulation: 4-Level FSK with 9.6 kb/s random data

FREQUENCY (MHz)	TRANSMITTER CONDUCTED ANTENNA EMISSIONS (dBm)	(dBc)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
4120.00	-28.8	-61.9	-46.1	-15.8	PASS
4944.00	-33.8	-66.9	-46.1	-20.8	PASS
5768.00	-36.0	-69.1	-46.1	-23.0	PASS
7416.00	-35.8	-68.9	-46.1	-22.8	PASS

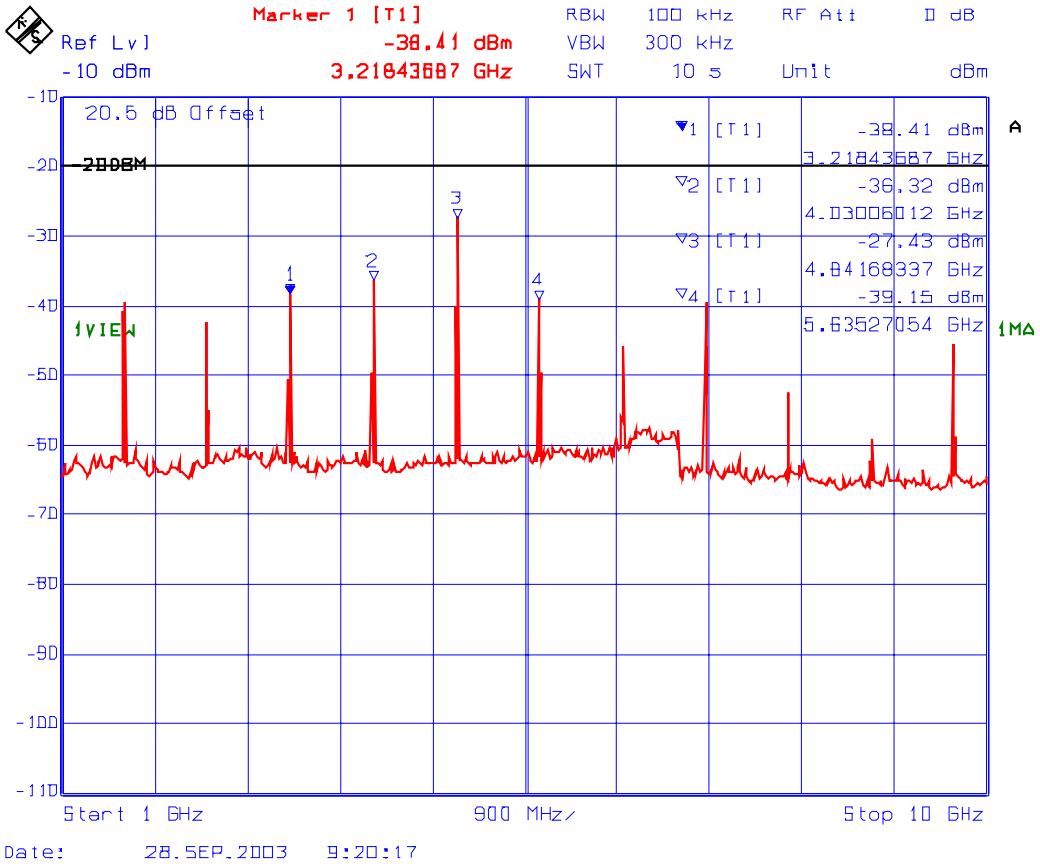
- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 30 dB below the limits were recorded.
- Refer to Plots # 30 and 31 for detailed measurements

Plot # 20: Transmitter Spurious Conducted Emissions
Frequency: 806 MHz, Power Output: 0.5 Watts (Low)
Modulation: 4-Level FSK RDLAP 19.2 kbps



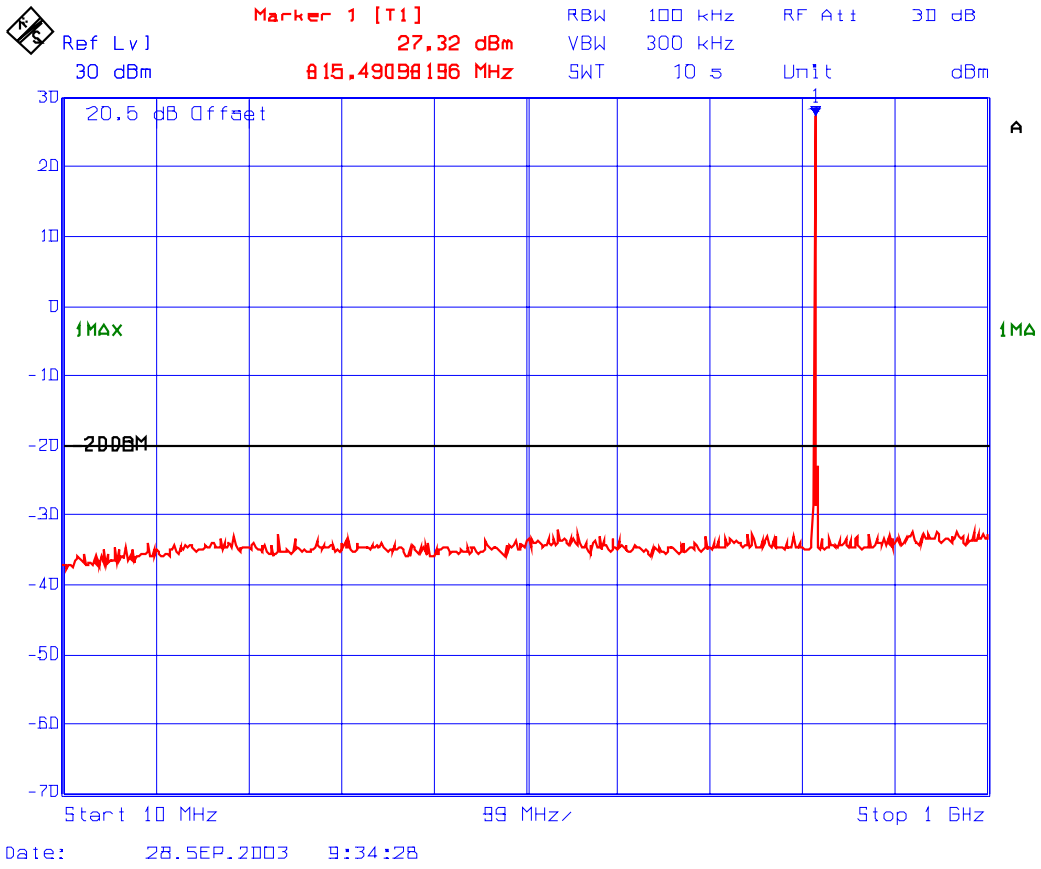
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 21: Transmitter Spurious Conducted Emissions
Frequency: 806 MHz, Power Output: 0.5 Watts (Low)
Modulation: 4-Level FSK RDLAP 19.2 kbps



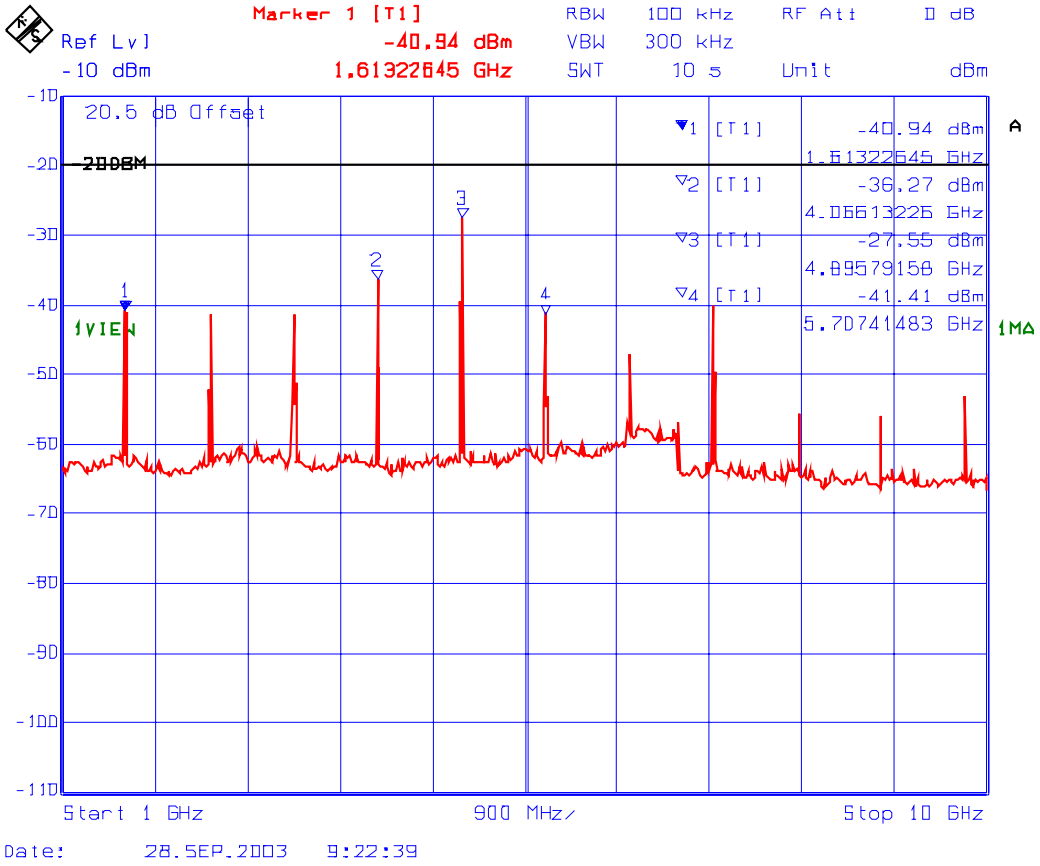
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 22: Transmitter Spurious Conducted Emissions
Frequency: 815 MHz, Power Output: 0.5 Watts (Low)
Modulation: 4-Level FSK RDLAP 19.2 kbps

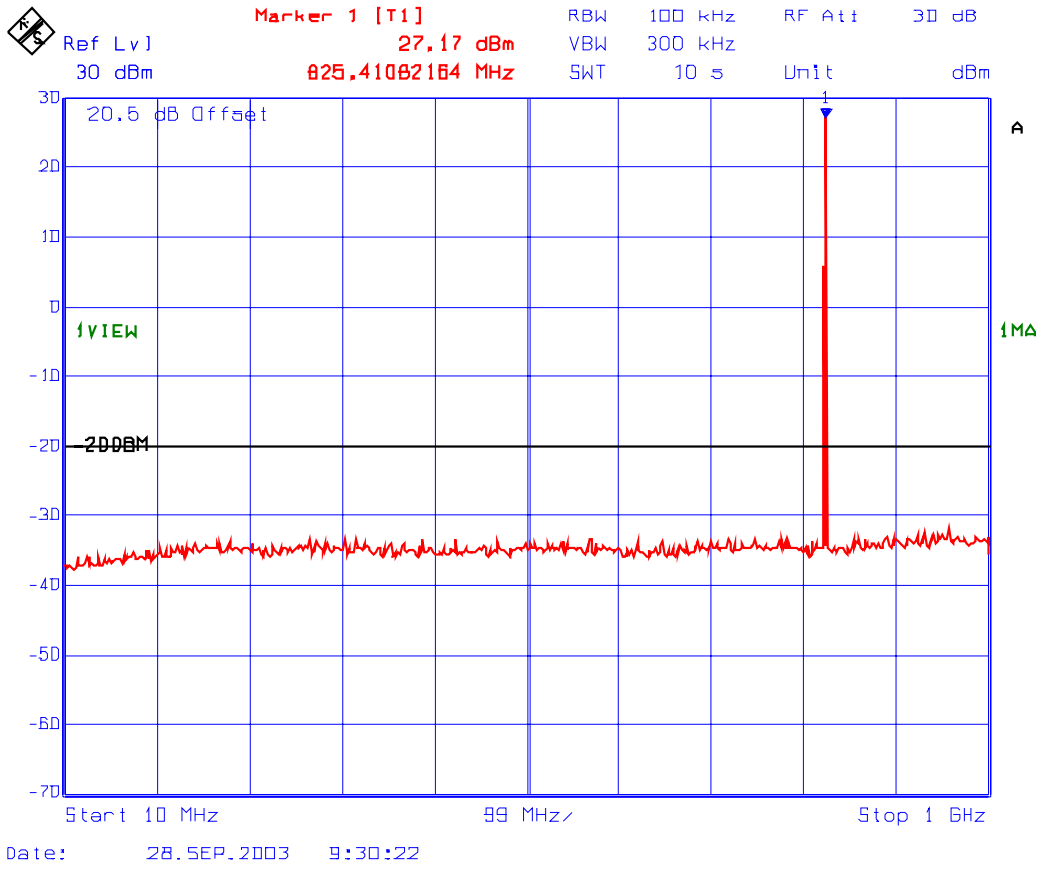


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 23: Transmitter Spurious Conducted Emissions
Frequency: 815 MHz, Power Output: 0.5 Watts (Low)
Modulation: 4-Level FSK RDLAP 19.2 kbps

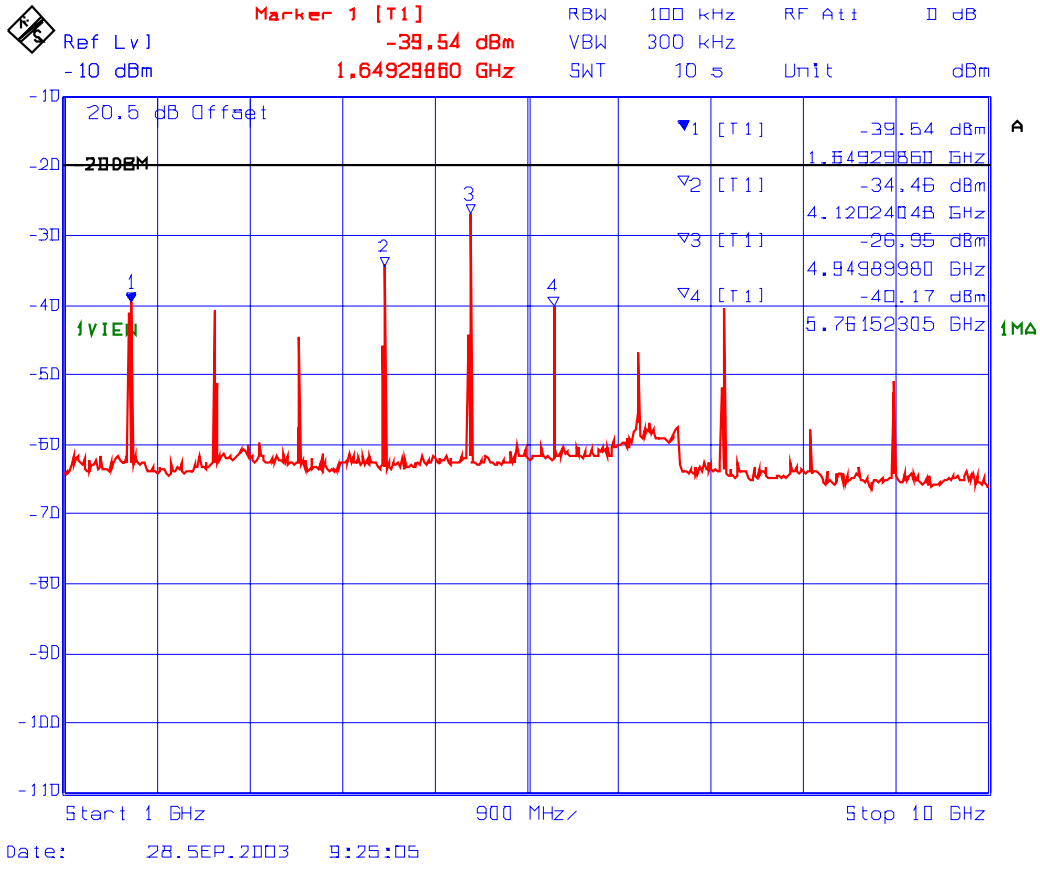


Plot # 24: Transmitter Spurious Conducted Emissions
Frequency: 224 MHz, Power Output: 0.5 Watts (Low)
Modulation: 4-Level FSK RDLAP 9.6 kbps



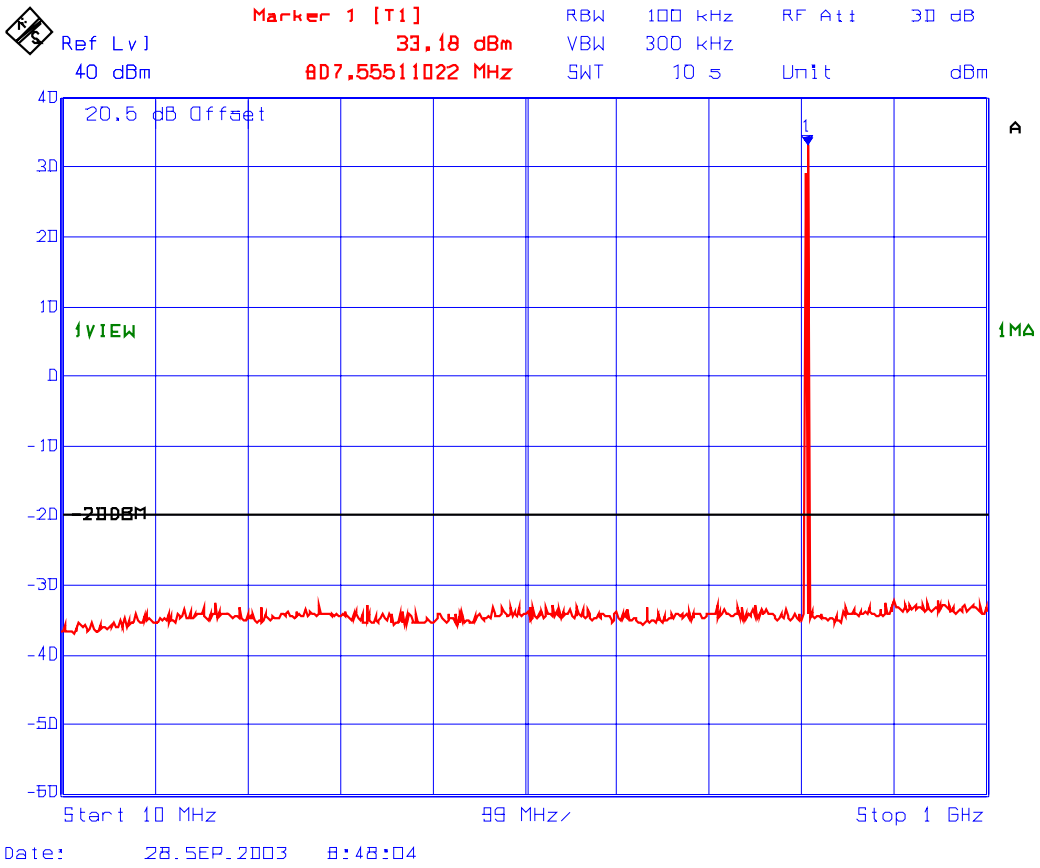
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 25: Transmitter Spurious Conducted Emissions
Frequency: 824 MHz, Power Output: 0.5 Watts (Low)
Modulation: 4-Level FSK RDLAP 9.6 kbps



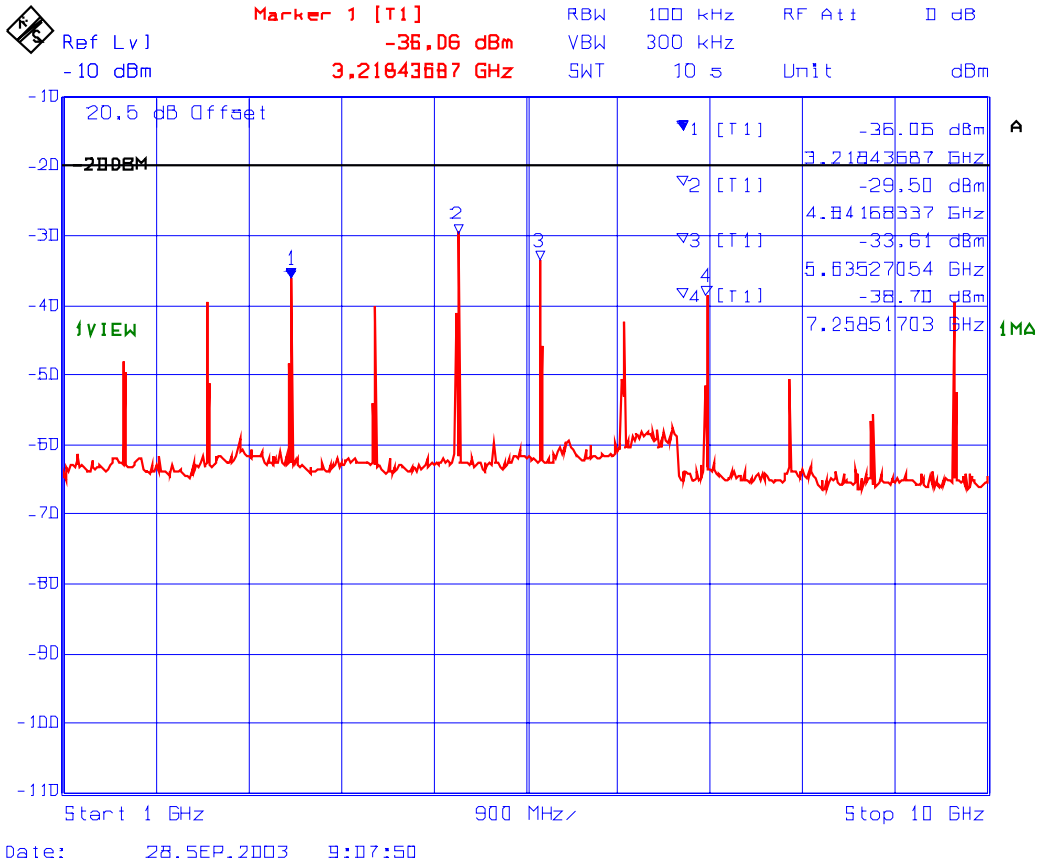
- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 26: Transmitter Spurious Conducted Emissions
Frequency: 806 MHz, Power Output: 2.0 Watts (High)
Modulation: 4-Level FSK RDLAP 19.2 kbps

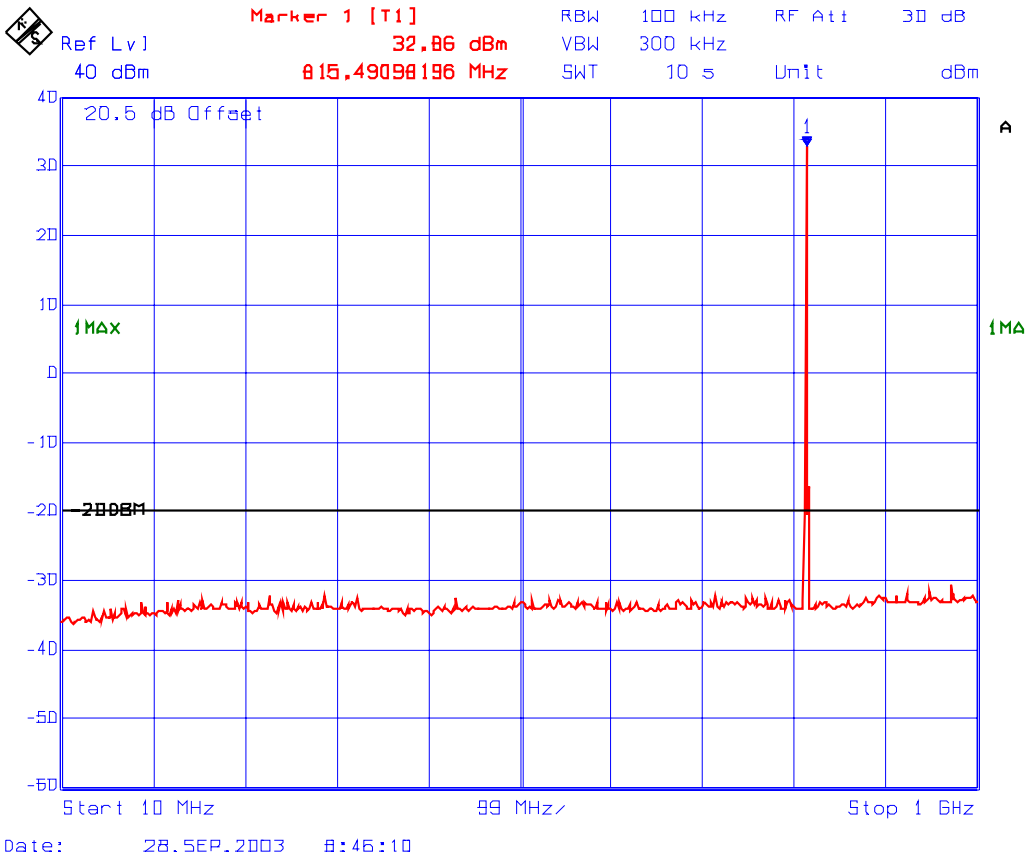


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 27: Transmitter Spurious Conducted Emissions
Frequency: 806 MHz, Power Output: 2.0 Watts (High)
Modulation: 4-Level FSK RDLAP 19.2 kbps

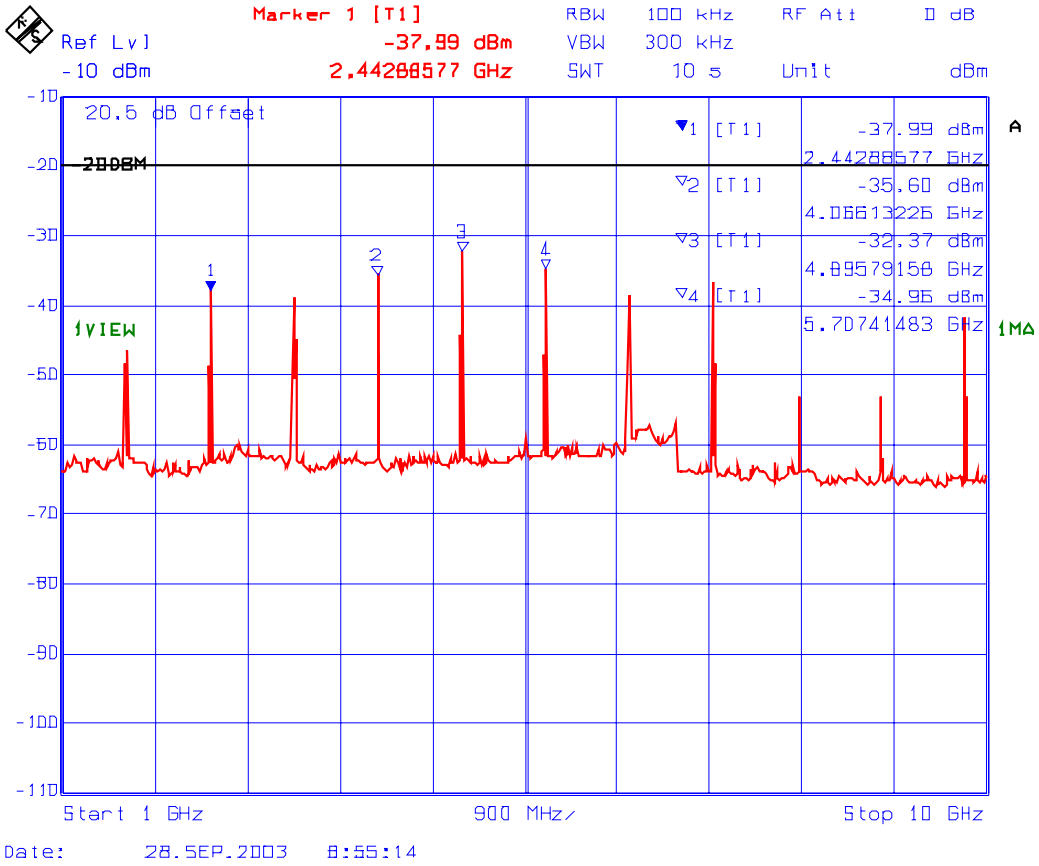


Plot # 28: Transmitter Spurious Conducted Emissions
Frequency: 815 MHz, Power Output: 2.0 Watts (High)
Modulation: 4-Level FSK RDLAP 19.2 kbps

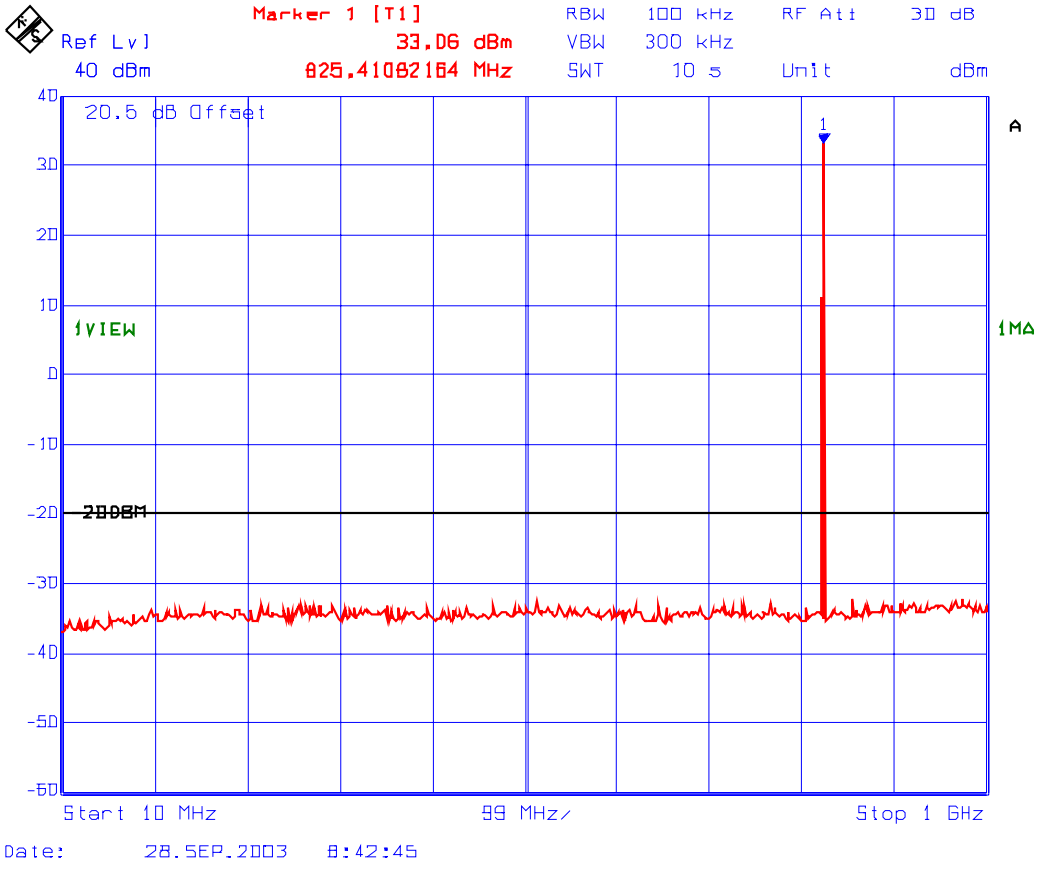


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 29: Transmitter Spurious Conducted Emissions
Frequency: 815 MHz, Power Output: 2.0 Watts (High)
Modulation: 4-Level FSK RDLAP 19.2 kbps

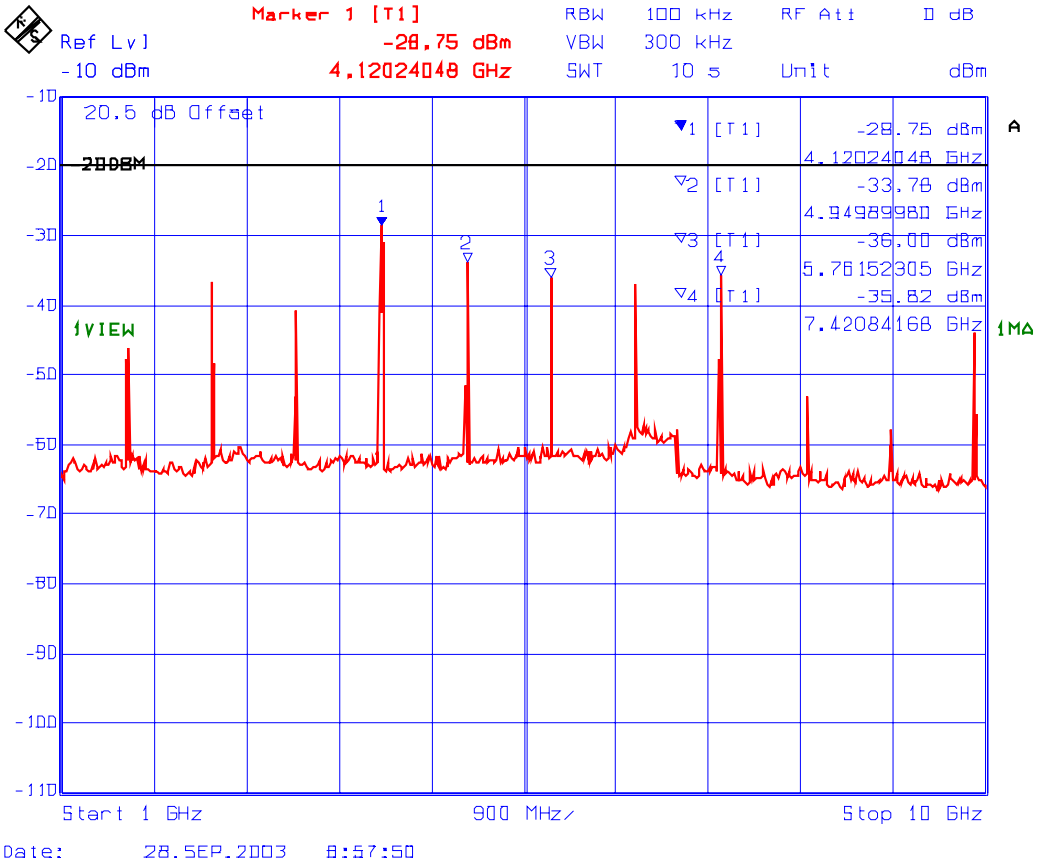


Plot # 30: Transmitter Spurious Conducted Emissions
Frequency: 824 MHz, Power Output: 2.0 Watts (High)
Modulation: 4-Level FSK RDLAP 9.6 kbps



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

Plot # 31: Transmitter Spurious Conducted Emissions
Frequency: 824 MHz, Power Output: 2.0 Watts (High)
Modulation: 4-Level FSK RDLAP 9.6 kbps



6.1. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS @ FCC 90.210(G)(H)

6.1.1. Limits @ FCC 90.210

Emissions shall be attenuated below the mean output power of the transmitter as follows:

FREQUENCY RANGE (MHz)	Maximum Authorized BW (KHz)	CHANNEL SPACING (KHz)	Recommended Max. FREQ. DEVIATION (KHz)	FCC LIMIT@ FCC 90.210
806-821	20	25	5	Mask G: 43 + 10 *log(P in Watts)
821-824	20	12.5	2.5	Mask H: 43 + 10 *log(P in Watts)

6.1.2. Method of Measurements

The spurious/harmonic ERP measurements are using substitution method specified in Exhibit 8, § 8.2 of this report and its value in dBc is calculated as follows:

(1) If the transmitter's antenna is an integral part of the EUT, the ERP is measured using substitution method.
(2) If the transmitter's antenna is non-integral and diverse, the lowest ERP of the carrier with 0 dBi antenna gain is used for calculation of the spurious/harmonic emissions in dBc:
Lowest ERP of the carrier = EIRP – 2.15 dB = Pc + G - 2.15 dB = xxx dBm (conducted) + 0 dBi – 2.15 dB
(3) Spurious /harmonic emissions levels expressed in dBc (dB below carrier) are as follows:

ERP of spurious/harmonic (dBc) = ERP of carrier (dBm) – ERP of spurious/harmonic emission (dBm)

6.1.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8546A	…	9 kHz to 5.6 GHz with built-in 30 dB Gain Pre-selector, QP, Average & Peak Detectors.
RF Amplifier	Com-Power	PA-102		1 MHz to 1 GHz, 30 dB gain nomimal
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz, 30 dB nominal
Biconilog Antenna	EMCO	3142	10005	30 MHz to 2 GHz
Dipole Antenna	EMCO	3121C	8907-434	30 GHz – 1 GHz
Dipole Antenna	EMCO	3121C	8907-440	30 GHz – 1 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3155	9911-5955	1 GHz – 18 GHz
RF Signal Generator	Hewlett Packard	HP 83752B	3610A00457	0.01 – 20 GHz

6.1.4. Test Setup

Please refer to Photo # 1 to 3 for detailed of test setup.

6.1.5. Test Data

6.1.5.1. Low Power Setting 0.54 Watts at Lowest Frequency (806 MHz) in 806-824 MHz Band

Fundamental Frequency: 806 MHz
RF Output Power: 0.54 Watts or 27.3 dBm Watts (conducted)
Modulation: 4-Level FSK with 19.2 kb/s random data

FREQUENCY (MHz)	TRANSMITTER ERP (dBm)	TRANSMITTER ERP (dBc)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
10 –10,000	**	**	-40.3	<-20.0	PASS

** The emissions were scanned from 10 MHz to 10 GHz and no rf emissions less than 20 dB below the FCC Limits were found

6.1.5.2. Low Power Setting 0.52 Watts at Middle Frequency (806 MHz) in 806-824 MHz Band

Fundamental Frequency: 815 MHz
RF Output Power: 0.52 Watts or 27.2 dBm Watts (conducted)
Modulation: 4-Level FSK with 19.2 kb/s random data

FREQUENCY (MHz)	TRANSMITTER ERP (dBm)	TRANSMITTER ERP (dBc)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
10 –10,000	**	**	-40.2	<-20.0	PASS

** The emissions were scanned from 10 MHz to 10 GHz and no rf emissions less than 20 dB below the FCC Limits were found

6.1.5.3. Low Power Setting 0.52 Watts at Highest Lowest Frequency (824 MHz) in 806-824 MHz Band

Fundamental Frequency: 824 MHz
RF Output Power: 0.52 Watts or 27.2 dBm Watts (conducted)
Modulation: 4-Level FSK with 9.6 kb/s random data

FREQUENCY (MHz)	TRANSMITTER ERP (dBm)	TRANSMITTER ERP (dBc)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
10 –10,000	**	**	-40.2	<-20.0	PASS

** The emissions were scanned from 10 MHz to 10 GHz and no rf emissions less than 20 dB below the FCC Limits were found

6.1.5.4. High Power Setting 2.08 Watts at Lowest Frequency (806 MHz) in 806-824 MHz Band

Fundamental Frequency: 806 MHz
RF Output Power: 2.08 Watts or 33.2 dBm Watts (conducted)
Modulation: 4-Level FSK with 19.2 kb/s random data

FREQUENCY (MHz)	TRANSMITTER ERP (dBm)	TRANSMITTER ERP (dBc)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
10 –10,000	**	**	-46.2	<-20.0	PASS

** The emissions were scanned from 10 MHz to 10 GHz and no rf emissions less than 20 dB below the FCC Limits were found

6.1.5.5. High Power Setting 2.05 Watts at Middle Frequency (806 MHz) in 806-824 MHz Band

Fundamental Frequency: 815 MHz
RF Output Power: 2.05 Watts or 33.1 dBm Watts (conducted)
Modulation: 4-Level FSK with 19.2 kb/s random data

FREQUENCY (MHz)	TRANSMITTER ERP (dBm)	TRANSMITTER ERP (dBc)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
10 –10,000	**	**	-46.1	<-20.0	PASS

** The emissions were scanned from 10 MHz to 10 GHz and no rf emissions less than 20 dB below the FCC Limits were found

6.1.5.6. High Power Setting 2.05 Watts at Highest Lowest Frequency (824 MHz) in 806-824 MHz Band

Fundamental Frequency: 824 MHz
RF Output Power: 2.05 Watts or 33.1 dBm Watts (conducted)
Modulation: 4-Level FSK with 9.6 kb/s random data

FREQUENCY (MHz)	TRANSMITTER ERP (dBm)	TRANSMITTER ERP (dBc)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
10 –10,000	**	**	-46.1	<-20.0	PASS

** The emissions were scanned from 10 MHz to 10 GHz and no rf emissions less than 20 dB below the FCC Limits were found

EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994)

7.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (± dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	±1.0	±1.0
Cable Loss Calibration	Normal (k=2)	±0.3	±0.5
EMI Receiver specification	Rectangular	±1.5	±1.5
Antenna Directivit	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	±2.0	±0.5
Antenna phase center variation	Rectangular	0.0	±0.2
Antenna factor frequency interpolation	Rectangular	±0.25	±0.25
Measurement distance variation	Rectangular	±0.6	±0.4
Site imperfections	Rectangular	±2.0	±2.0
Mismatch: Receiver VRC $\Gamma_1 = 0.2$ Antenna VRC $\Gamma_R = 0.67$(Bi) 0.3 (Lp) Uncertainty limits $20\text{Log}(1\pm\Gamma_1\Gamma_R)$	U-Shaped	+1.1 -1.25	±0.5
System repeatability	Std. Deviation	±0.5	±0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k=2 is used:

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB And $U = 2u_c(y) = 2x(-2.21) = -4.42$ dB

- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

EXHIBIT 8. MEASUREMENT METHODS

8.1. CONDUCTED POWER MEASUREMENTS

- The following shall be applied to the combination(s) of the radio device and its intended antenna(e).
- I f the RF level is user adjustable, all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
- The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
- The measurement shall be performed using normal operation of the equipment with modulation.

Test procedure shall be as follows:

Step 1: Duty Cycle measurements if the transmitter's transmission is transient

- Using a EMI Receiver with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, x = Tx on / (Tx on + Tx off) with 0<x<1, is measure and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

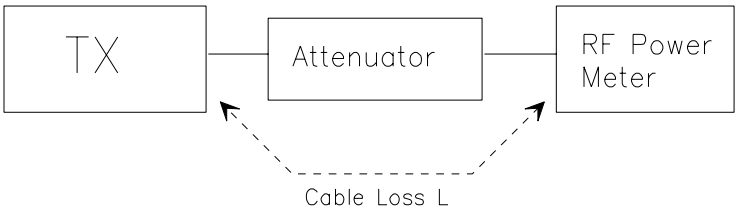
Step 2: Calculation of Average EIRP. See Figure 1

- The average output power of the transmitter shall be determined using a wideband, calibrated RF average power meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as "A" (in dBm);
- The e.i.r.p. shall be calculated from the above measured power output "A", the observed duty cycle x, and the applicable antenna assembly gain "G" in dBi, according to the formula:

EIRP = A + G + 10log(1/x)

{ X = 1 for continuous transmission => 10log(1/x) = 0 dB }

Figure 1.



8.2. RADIATED POWER MEASUREMENTS (ERP & EIRP) USING SUBSTITUTION METHOD

8.2.1. Maximizing RF Emission Level (E-Field)

(a) The measurements was performed with full rf output power and modulation.
(b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
(c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
(d) The BICONILOG antenna (20 MHz to 1 GHz) or HORN antenna (1 GHz to 18 GHz) was used for measuring.
(e) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
E (dBuV/m) = Reading (dBuV) + Total Correction Factor (dB/m)

(f) Set the EMI Receiver and #2 as follows:

Center Frequency:	test frequency
Resolution BW:	100 kHz
Video BW:	same
Detector Mode:	positive
Average:	off
Span:	3 x the signal bandwidth

(g) The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
(h) The transmitter was rotated through 360^{o} about a vertical axis until a higher maximum signal was received.
(i) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
(j) The recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
(k) The above steps were repeated with both transmitters' antenna and test receiving antenna placed in vertical and horizontal polarization. Both readings with the antennas placed in vertical and horizontal polarization shall be recorded.
(l) Repeat for all different test signal frequencies

8.2.2. Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method

(a) Set the EMI Receiver (for measuring E-Field) and Receiver #2 (for measuring EIRP) as follows:

Center Frequency:	equal to the signal source
Resolution BW:	10 kHz
Video BW:	same
Detector Mode:	positive
Average:	off
Span:	3 x the signal bandwidth

(b) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
E (dBuV/m) = Reading (dBuV) + Total Correction Factor (dB/m)

(c) Select the frequency and E-field levels obtained in the Section 8.2.1 for ERP/EIRP measurements.
(d) Substitute the EUT by a signal generator and one of the following transmitting antenna (substitution antenna):
- DIPOLE antenna for frequency from 30-1000 MHz or
- HORN antenna for frequency above 1 GHz }.

(e) Mount the transmitting antenna at 1.5 meter high from the ground plane.
(f) Use one of the following antenna as a receiving antenna:
- DIPOLE antenna for frequency from 30-1000 MHz or
- HORN antenna for frequency above 1 GHz }.

(g) If the DIPOLE antenna is used, tune it's elements to the frequency as specified in the calibration manual.
(h) Adjust both transmitting and receiving antenna in a VERTICAL polarization.
(i) Tune the EMI Receivers to the test frequency.
(j) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(k) The transmitter was rotated through 360^{o} about a vertical axis until a higher maximum signal was received.
(l) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(m) Adjust input signal to the substitution antenna until an equal or a known related level to that detected from the transmitter was obtained in the test receiver.
(n) Record the power level read from the Average Power Meter and calculate the ERP/EIRP as follows:

P = P1 - L1 = (P2 + L2) – L1 = P3 + A + L2 - L1
EIRP = P + G1 = P3 + L2 - L1 + A + G1
ERP = EIRP – 2.15 dB
Total Correction factor in EMI Receiver # 2 = L2 – L1 + G1

Where: P: Actual RF Power fed into the substitution antenna port after corrected.
P1: Power output from the signal generator
P2: Power measured at attenuator A input
P3: Power reading on the Average Power Meter
EIRP: EIRP after correction
ERP: ERP after correction

(o) Adjust both transmitting and receiving antenna in a HORIZONTAL polarization, then repeat step (k) to (o)
(p) Repeat step (d) to (o) for different test frequency
(q) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
(r) Actual gain of the EUT's antenna is the difference of the measured EIRP and measured RF power at the RF port. Correct the antenna gain if necessary.:

Figure 2

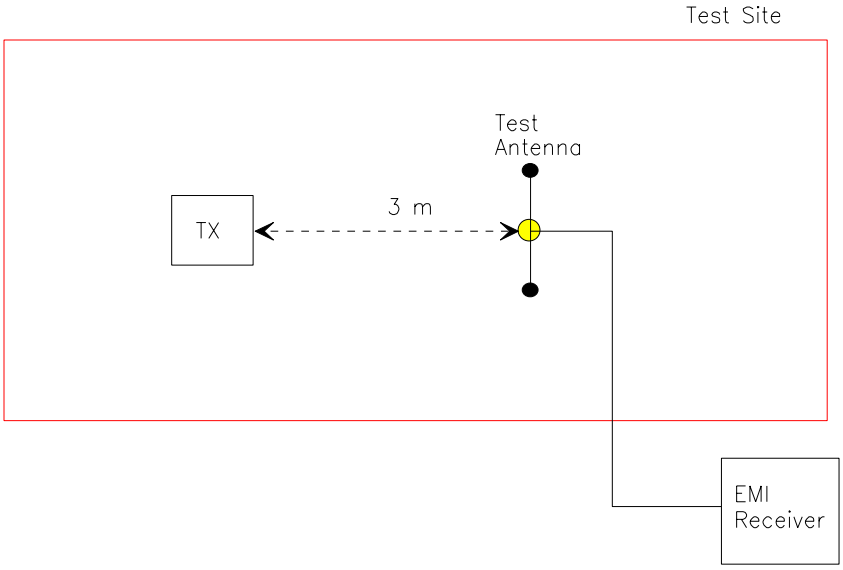
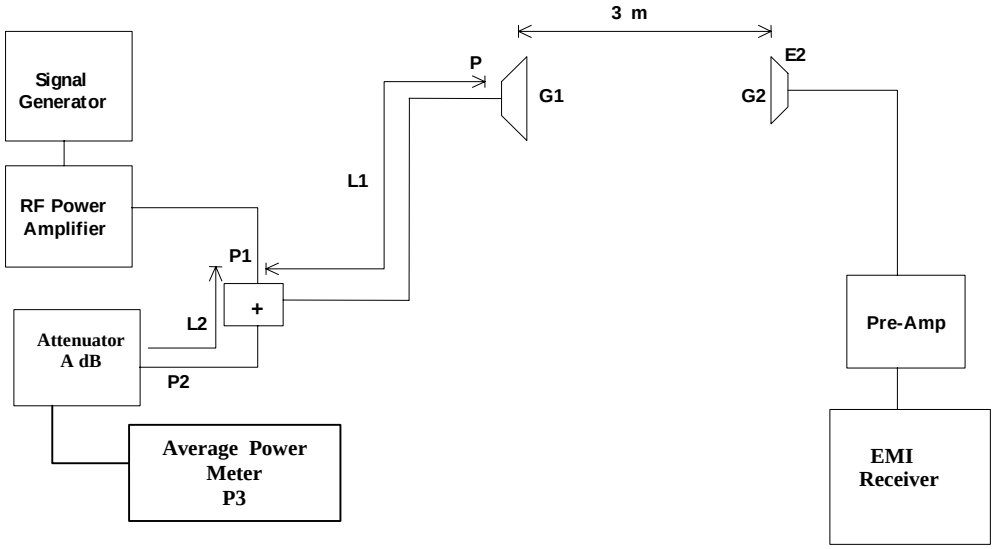


Figure 3



8.3. FREQUENCY STABILITY

Refer to FCC @ 2.1055.

(a) The frequency stability shall be measured with variation of ambient temperature as follows: From -30 to +50 centigrade except that specified in subparagraph (2) & (3) of this paragraph.

(b) Frequency measurements shall be made at extremes of the specified temperature range and at intervals of not more than 10 centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short-term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stability circuitry need be subjected to the temperature variation test.

(d) The frequency stability supply shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

(3) The supply voltage shall be measured at the input to the cable normally provide with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

(e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c) and (d) of this section. (For example, measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment).

8.4. EMISSION MASK

Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(i):- The transmitter was modulated by a 2.5 KHz tone signal at an input level 16 dB greater than that required to produce 50% modulation (e.g.: ±2.5 KHz peak deviation at 1 KHz modulating frequency). The input level was established at the frequency of maximum response of the audio modulating circuit.

Digital Modulation Through a Data Input Port @ 2.1049(h):- Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the Emission Masks shall be shown for operation with any devices used for modifying the spectrum when such devices are operational at the discretion of the user.

The following EMI Receiver bandwidth shall be used for measurement of Emission Mask/Out-of-Band Emission Measurements:

(1) For 25 kHz Channel Spacing: RBW = 300 Hz
(2) For 12.5 kHz or 6.25 kHz Channel Spacings: RBW = 100 Hz

The all cases the Video Bandwidth shall be equal or greater than the measuring bandwidth.

8.5. SPURIOUS EMISSIONS (CONDUCTED)

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.1049, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the EMI Receiver controls set as RBW = 30 kHz minimum , VBW ≥ RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

FCC CFR 47, Para. 2.1057 - Frequency spectrum to be investigated:- The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10^{th} harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The
amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC CFR 47, Para. 2.1051 - Spurious Emissions at Antenna Terminal:- The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.