EMISSIONS TEST REPORT FOR A LOW POWER TRANSMITTER

I. GENERAL INFORMATION

Requirement: Federal Communications Commissions

Test Requirements: 15.205, 15.207, 15.209, 15.247

Applicant: Savi Technology
615 Tasman Drive
Sunnyvale, CA 94089

Product ID: **FCC ID: KL7-RELAY-V2**

II. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)

The Savi Technology FCC ID: KL7-RELAY-V2 is a direct sequence spread spectrum (DSSS) transceiver operating in the 2450 - 2474 MHz frequency range. The function of the device is to provide a wireless data link for Savi's security card reader units. The product requires professional installation. The product is not sold to the general public.

Modulation is BPSK and maximum RF data rate is 64.516 Kbps.

The 2.4 GHz transceiver consists of a 900 MHz indoor IF unit and a 900/2400 MHz up/down converter unit that is roof mounted and to which the antenna is connected. The IDU and the up/down converter are manufactured by Utilicom.

III. TEST LOCATION

All emissions tests were performed at:

Compliance Certification Services
561F Monterey Road
Morgan Hill, CA 95037

T.N. Cokenias 3 May 2001
EMC Consultant/Agent for Savi Technology

TEST PROCEDURES

Radiated Emissions
Test Requirement: 15.205

Measurement Equipment Used:

HP 8593EM Spectrum Analyzer
HP 8449 Microwave pre-amplifier, 1-26.5 GHz
EMCO 3115 Double Ridged Horn antenna, 1 - 18 GHz

1. The EUT was placed on a wooden table resting on a turntable on the open air test site. The search antenna was placed 3m from the EUT. The EUT antenna was mounted vertically as per normal installation.

2. The turntable was slowly rotated to locate the direction of maximum emission at each emission falling in the restricted bands of 15.205.

3. Radiated emissions were investigated for a LOW channel, a MID channel, and HIGH channel. Emissions were investigated to the 10^{th} harmonic.

4. Careful measurements were made at the restricted bands 2310-2390 MHz and 2483.5 – 2500 MHz for the LOW and HIGH channel respectively. The preamplifier was not used for these measurements.

5. Once maximum direction was determined, the search antenna was raised and lowered in both vertical and horizontal polarizations. The maximum readings so obtained are recorded in the data listed below.

Test Results: Worst case results are presented. Refer to attached data sheets

Channel	**Frequency, MHz**
Low	2450
Mid	2462
High	2474

12-Apr-01

CCS Site A
Restricted Band Radiated Emissions K. Corpuz

Savi Technology
Direct Sequence Spread Spectrum

KL7-RELAY-V2

Antenna: Mobilemark OD9-2400-24 (8 dBi)

fo = 2450 MHz (LOW)

F, MHz	Read, Pk	Read, Av.	AF, dB	CL, dB	Dist, dB	Amp, dB	HPF, dB	Other, dB	Total, Pk	Total, Av	Limit, Pk	Limit, Av	Margin, Pk	Margin, Av
4900	45.6	38.1	33.7	5.3	-9.5	-35	1.0	-6.0	41.1	27.6	74	54	-32.9	-26.4
7350	45.1	36.7	37.4	6.5	-9.5	-35	1.0	-6.0	45.5	31.1	74	54	-28.5	-22.9
9800	44.4	32.5	38.1	7.7	-9.5	-35	1.0	-6.0	46.7	28.8	74	54	-27.3	-25.2
12250	45	33.9	39.3	8.6	-9.5	-35	1.0	-6.0	49.4	32.3	74	54	-24.6	-21.7
14700	48.1	36.8	40.9	9.9	-9.5	-35	1.0	-6.0	55.4	38.1	74	54	-18.6	-15.9
17150	49.8	38.2	43.4	11.3	-9.5	-35	1.0	-6.0	61.0	43.4	74	54	-13.0	-10.6
19600	52.1	40.7	32.1	12.4	-9.5	-35	1.0	-6.0	53.1	35.7	74	54	-20.9	-18.3
22050	54.5	43.0	32.5	13.4	-9.5	-35	1.0	-6.0	56.9	39.4	74	54	-17.1	-14.6
24500	53.6	42.6	32.4	14.5	-9.5	-35	1.0	-6.0	57.0	40.0	74	54	-17.0	-14.0

12-Apr-01

CCS Site A
Restricted Band Radiated Emissions K. Corpuz

Savi Technology
Direct Sequence Spread Spectrum

KL7-RELAY-V2

Antenna: Mobilemark OD9-2400-24 (8 dBi)

fo=2462 MHz (MID)

F, MHz	Read, Pk	Read, Av.	AF, dB	CL, dB	Dist, dB	Amp, dB	HPF, dB	Other, dB	Total, Pk	Total, Av	Limit, Pk	Limit, Av	Margin, Pk	Margin, Av
4924.2	40	29.6	33.7	5.3	-9.5	-35	1.0	-6.0	35.5	19.1	74	54	-38.5	-34.9
7386.3	45	35.5	37.4	6.5	-9.5	-35	1.0	-6.0	45.4	29.9	74	54	-28.6	-24.1
9848.4	43.1	32.8	38.1	7.7	-9.5	-35	1.0	-6.0	45.4	29.1	74	54	-28.6	-24.9
12310.5	44.6	33.9	39.3	8.6	-9.5	-35	1.0	-6.0	49.0	32.3	74	54	-25.0	-21.7
14772.6	49.1	36.9	40.9	9.9	-9.5	-35	1.0	-6.0	56.4	38.2	74	54	-17.6	-15.8
1734.7	50.3	38.2	43.4	11.3	-9.5	-35	1.0	-6.0	61.5	43.4	74	54	-12.5	-10.6
19696.8	51.6	40.7	32.1	12.4	-9.5	-35	1.0	-6.0	52.6	35.7	74	54	-21.4	-18.3
22158.9	54	43.1	32.5	13.4	-9.5	-35	1.0	-6.0	56.4	39.5	74	54	-17.6	-14.5
24621.0	55	43.0	32.4	14.5	-9.5	-35	1.0	-6.0	58.4	40.4	74	54	-15.6	-13.6

12-Apr-01

CCS Site A
Restricted Band Radiated Emissions K. Corpuz

Savi Technology
Direct Sequence Spread Spectrum

KL7-RELAY-V2

Antenna: Mobilemark OD9-2400-24 (8 dBi)

fo=2474 MHz (HIGH)

F, MHz	Read, Pk	Read, Av.	AF, dB	CL, dB	Dist, dB	Amp, dB	HPF, dB	Other, dB	Total, Pk	Total, Av	Limit, Pk	Limit, Av	Margin, Pk	Margin, Av
4948.2	40.5	29.9	33.7	5.3	-9.5	-35	1.0	-6.0	36.0	19.4	74	54	-38.0	-34.6
7422.3	44.2	36.9	37.4	6.5	-9.5	-35	1.0	-6.0	44.6	31.3	74	54	-29.4	-22.7
9896.4	45.6	35.1	38.1	7.7	-9.5	-35	1.0	-6.0	47.9	31.4	74	54	-26.1	-22.6
12370.5	44.4	34.0	39.3	8.6	-9.5	-35	1.0	-6.0	48.8	32.4	74	54	-25.2	-21.6
14844.6	48.9	37.0	40.9	9.9	-9.5	-35	1.0	-6.0	56.2	38.3	74	54	-17.8	-15.7
17318.7	49.8	38.4	43.4	11.3	-9.5	-35	1.0	-6.0	61.0	43.6	74	54	-13.0	-10.4
19797.8	52.1	40.8	32.1	12.4	-9.5	-35	1.0	-6.0	53.1	35.8	74	54	-20.9	-18.2
22266.9	53.9	43.4	32.5	13.4	-9.5	-35	1.0	-6.0	56.3	39.8	74	54	-17.7	-14.2
24741.0	55	43.2	32.4	14.5	-9.5	-35	1.0	-6.0	58.4	40.6	74	54	-15.6	-13.4

Emissions at Bandedge (2483.5 - 2500 MHz)
fo=2474 MHz (HIGH)

F, MHz	Read, Pk	Read, Av.	AF, dB	CL, dB	Dist, dB	Other, dB	Total, Pk	Total, Ave	Limit, Pk	Limit, Av
2498	52	34.7	28.2	3.4	-9.5	-6	68.1	50.8	74	54

NOTES

Frequencies in italics: noise floor readings

Horizontal and Vertical measurements made, maximum levels reported

DIST: Extrapolation from 1 m meas. distance to 3m specification distance (=20log(1/3))

AF: Antenna Factor
ANTENNA: EMCO, 3115, S/N:2238 & ARA, MWH-1826/B, S/N:1013
AMP: Pre-amp gain
PRE-AMP: HP 8449B, S/N:3710A00205
CL: Cable loss (17ft)
OTHER: Duty cycle, TDD

Peak RBW =1MHz VBW =1MHz
Average RBW =1MHz VBW =10Hz

AC Line Conducted Emissions
Test Requirement: 15.107, 15.207

Measurement Equipment Used:

Rohde & Schwarz EMI Receiver ESHS-20
Fischer Custom Communication LISN, FCC-LISN-50/250-25-2

Test Procedure

1. The EUT was placed on a wooden table 40 cm from a vertical ground plane and approximately 80 cm above the horizontal ground plane on the floor. The EUT was set to transmit normally.
2. Line conducted data was recorded for both NEUTRAL and HOT lines.

Test Results

Refer to separate attachment, graph and tabulated data sheets.

Minimum 6 dB Bandwidth
Test Requirement: 15.247(a)2

Measurement Equipment Used:

HP 8593EM Spectrum Analyzer
6' length low loss coaxial cable

Test Procedures

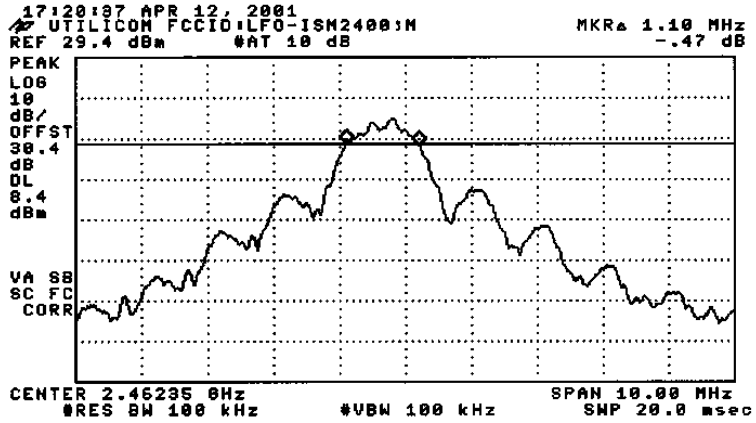
The EUT was configured on a test bench. The EUT was set for continuous operation (TDD function turned OFF) . Frequency was set to 2.45 GHz (LOW channel). While the transmitter broadcast a steady stream of digital data, the analyzer MAX HOLD function was used to capture the envelope of the transmission occupied bandwidth.

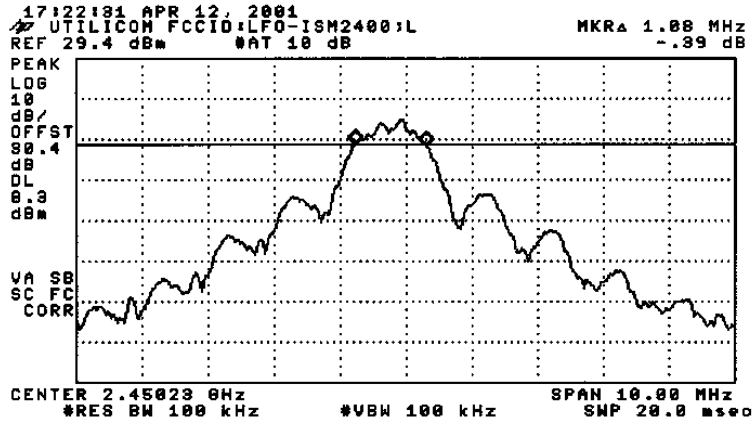
The test was repeated at 2.462 GHz (MID channel) and at 2.474 GHz (HIGH channel).

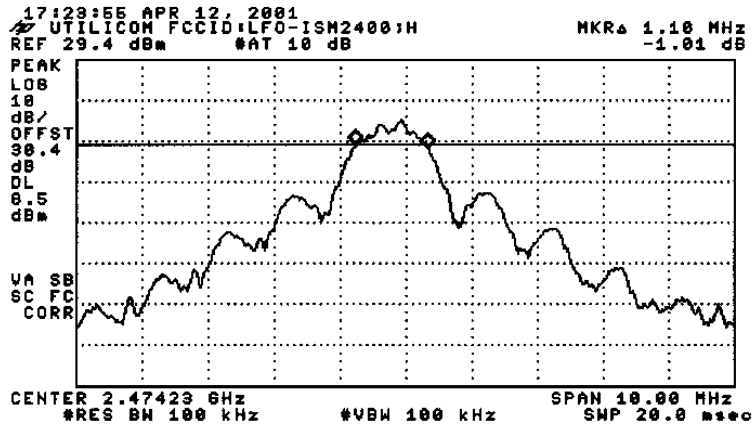
Test Results: Refer to attached spectrum analyzer charts. Data taken with RES BW of 100 kHz shows minimum 6 dB BW of 1.1 MHz. Minimum requirement: 500 kHz

Channel	**Frequency, MHz**
Low	2450
Mid	2462
High	2474

15.247(a)2: Minimum 6 dB Bandwidth


17:20:37 APR 12, 2001
UTILICOM FCCID:LFO-ISM2400:M
MKRΔ 1.10 MHz
REF 29.4 dBm
#AT 10 dB
-.47 dB
PEAK
LOG
10
dB/
OFFST
30.4
dB
DL
8.4
dBm
VA SB
SC FC
CORR
CENTER 2.46235 0Hz
SPAN 10.00 MHz
#RES BW 100 kHz
#VBW 100 kHz
SWP 20.0 msec


17:22:31 APR 12, 2001
UTILICOM FCCID:LFO-ISM2400:L
MKRΔ 1.08 MHz
REF 29.4 dBm
#AT 10 dB
-.39 dB
PEAK
LOG
10
dB/
OFFST
30.4
dB
DL
8.3
dBm
VA SB
SC FC
CORR
CENTER 2.45023 0Hz
SPAN 10.00 MHz
#RES BW 100 kHz
#VBW 100 kHz
SWP 20.0 msec


17:23:55 APR 12, 2001
UTILICOM FCCID:LFO-ISM2400:H
MKRΔ 1.10 MHz
REF 29.4 dBm
#AT 10 dB
-1.01 dB
PEAK
LOG
10
dB/
OFFST
30.4
dB
DL
8.5
dBm
VA SB
SC FC
CORR
CENTER 2.47423 GHz
SPAN 10.00 MHz
#RES BW 100 kHz
#VBW 100 kHz
SWP 20.0 msec

RF Power Output
Test Requirement: 15.247(b)

Measurement Equipment Used:

HP 8593EM Spectrum Analyzer
2 ft length low loss A coaxial RF cable

Test Procedures

1. The EUT was configured on a test bench. The cable was connected between the EUT antenna port and the spectrum analyzer input port.

The HP8593EM analyzer resolution bandwidth was set to 3 MHz to capture the PEAK power output of the EUT. The EUT's TDD function was stopped, transmission was continuous at the LOW channel. While the transmitter broadcast a steady stream of digital data, the analyzer MAX HOLD function was used to capture the envelope of the transmission.

2. The process in (1) was repeated for MID channel and HIGH channel.

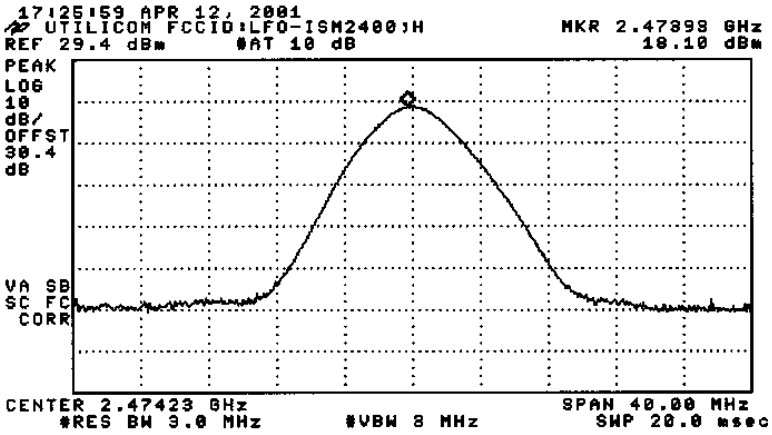
Test Results

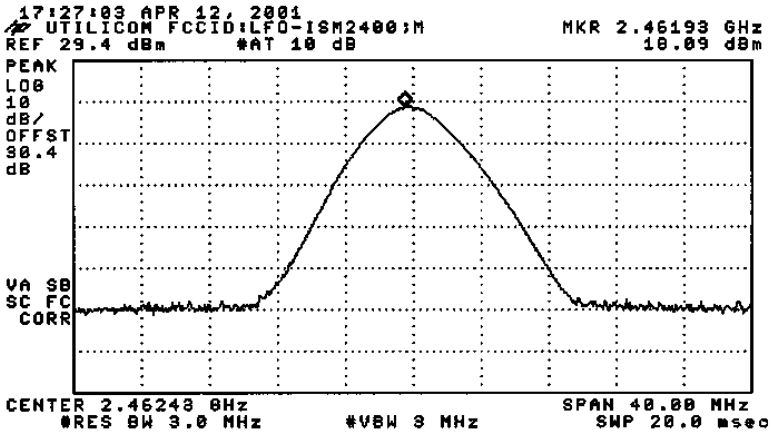
Power level readings converted to dBm are shown below. Refer also to spectrum analyzer graphs. Reference level offset corrects for external attenuation and cable loss.

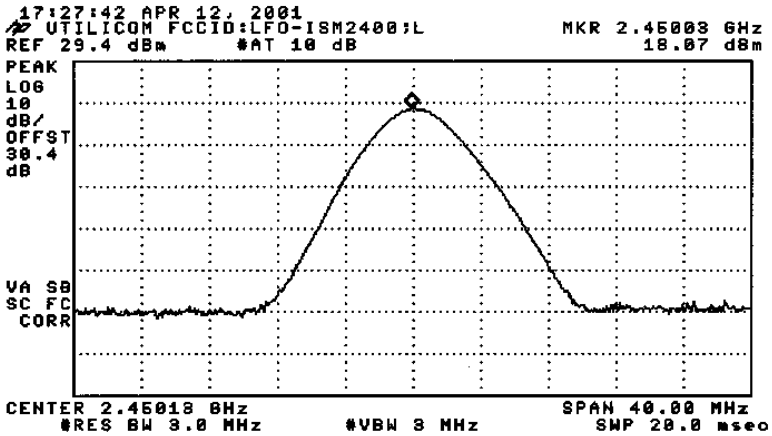
Channel	Frequency, MHz	Output Power, dBm	Limit, dBm
Low	2450	18.07	30.0
Mid	2462	18.09	30.0
High	2474	18.1	30.0

Maximum output power output is within 0.1 dBm of design maximum 18 dBm.

15.247(b): **RF Power Output**


17:25:59 APR 12, 2001
UTILICOM FCCID:LFO-ISM2400:H
MKR 2.47398 GHz
REF 29.4 dBm
#AT 10 dB
18.10 dBm
PEAK
LOG
10
dB/
OFFST
30.4
dB
VA SB
SC FC
CORR
CENTER 2.47423 GHz
SPAN 40.00 MHz
#RES BW 3.0 MHz
#VBW 8 MHz
SWP 20.0 msec


17:27:03 APR 12, 2001
UTILICOM FCCID:LFO-ISM2400:M
MKR 2.46193 GHz
REF 29.4 dBm
#AT 10 dB
18.09 dBm
PEAK
LOG
10
dB/
OFFST
30.4
dB
VA SB
SC FC
CORR
CENTER 2.46243 GHz
SPAN 40.00 MHz
#RES BW 3.0 MHz
#VBW 8 MHz
SWP 20.0 msec


17:27:42 APR 12, 2001
UTILICOM FCCID:LFO-ISM2400:L
MKR 2.45003 GHz
REF 29.4 dBm
#AT 10 dB
18.07 dBm
PEAK
LOG
10
dB/
OFFST
30.4
dB
VA SB
SC FC
CORR
CENTER 2.45018 GHz
SPAN 40.00 MHz
#RES BW 3.0 MHz
#VBW 8 MHz
SWP 20.0 msec

Spurious Emissions, Conducted
Test Requirement: 15.247(c)

Measurement Equipment Used:

HP 8593EM Spectrum Analyzer
2 ft length low loss A coaxial RF cable

Test Procedure

1. The EUT was configured on a test bench. The cable was connected between the EUT antenna port and the spectrum analyzer input port.

Spectrum analyzer RES BW was set to 100 kHz. The EUT's TDD function was stopped, transmission was continuous at the LOW channel. While the transmitter broadcast a steady stream of digital data, the analyzer MAX HOLD function was used to capture the envelope of the transmission.

Readings were taken out to 10fo.

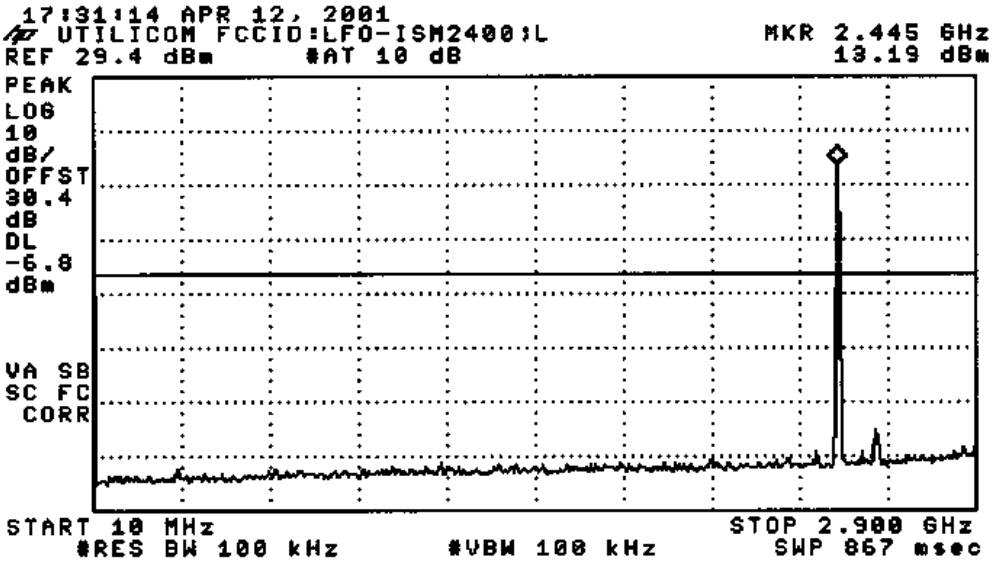
2. The process in (1) was repeated for MID channel and HIGH channel.

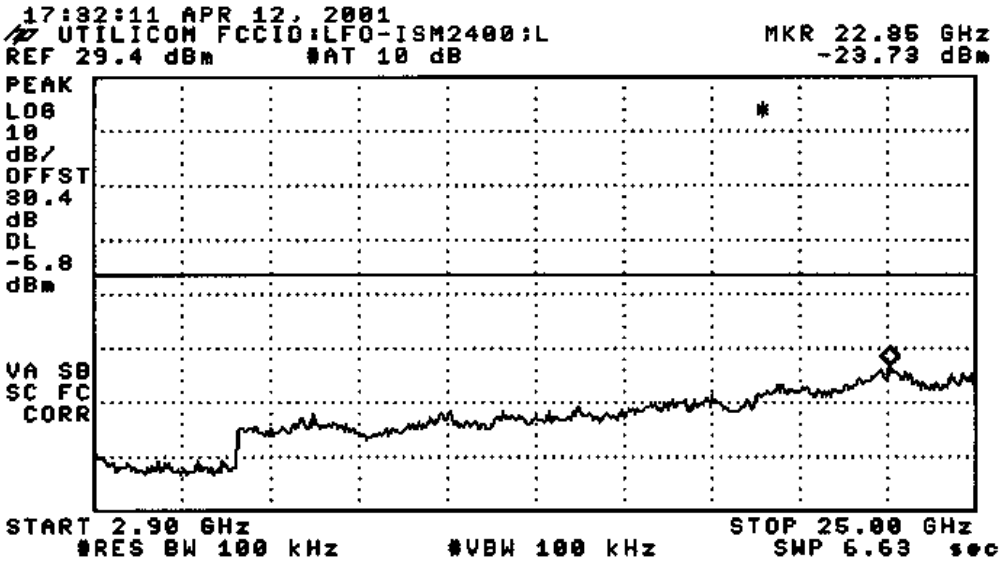
Test Results

Refer to attached data sheets. Data shows out of band emissions are suppressed well below the -20 dBc minimum required by the Rules.

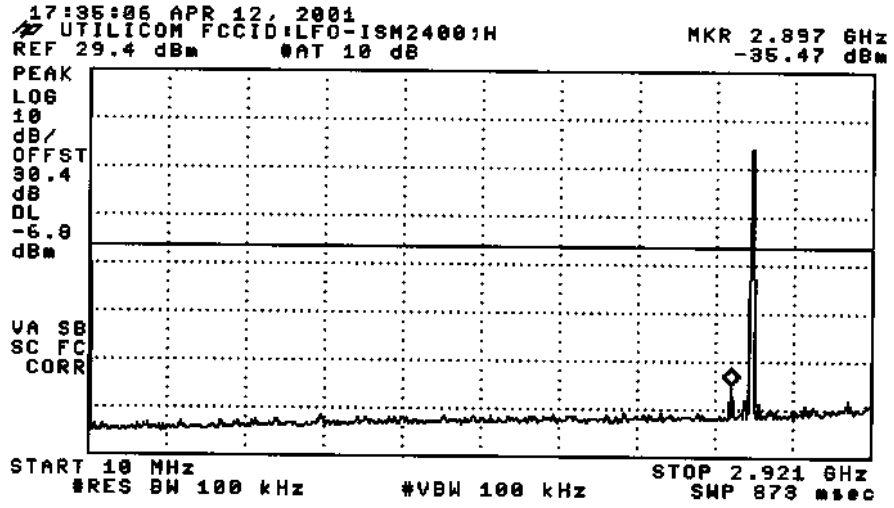
Channel	**Frequency, MHz**
Low	2450
Mid	2462
High	2474

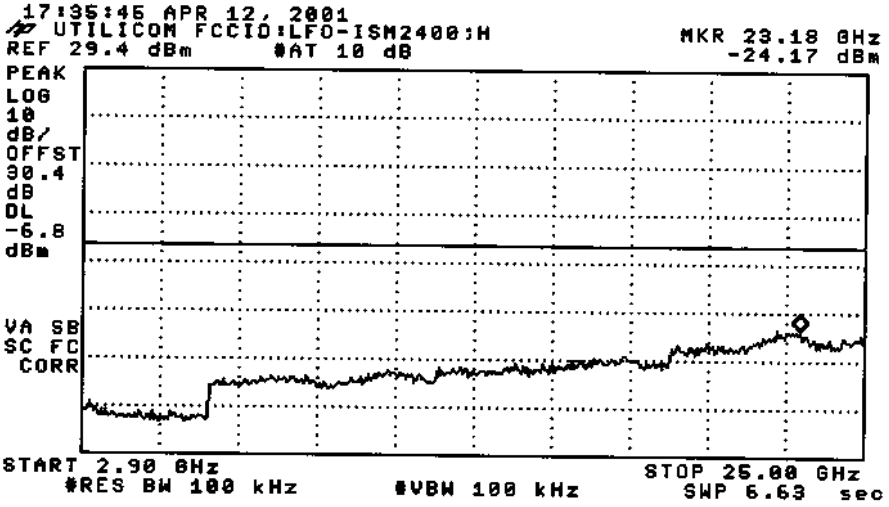
15.247(c): Spurious Emissions, Conducted, LOW Channel



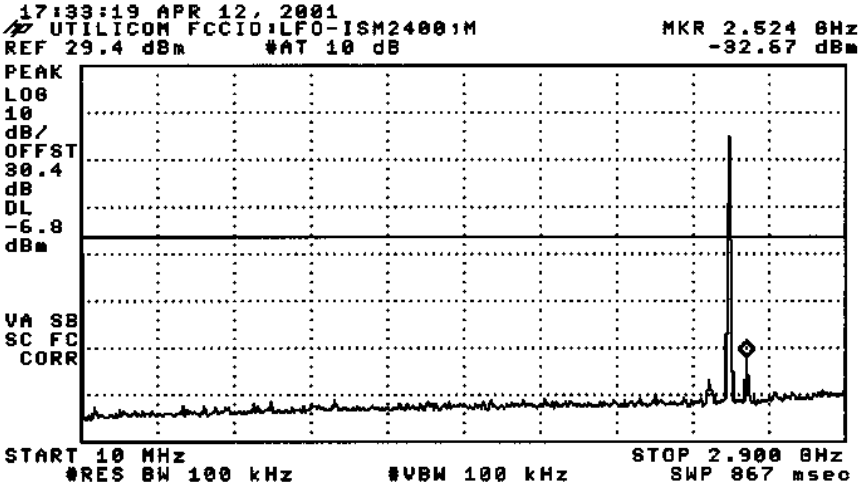


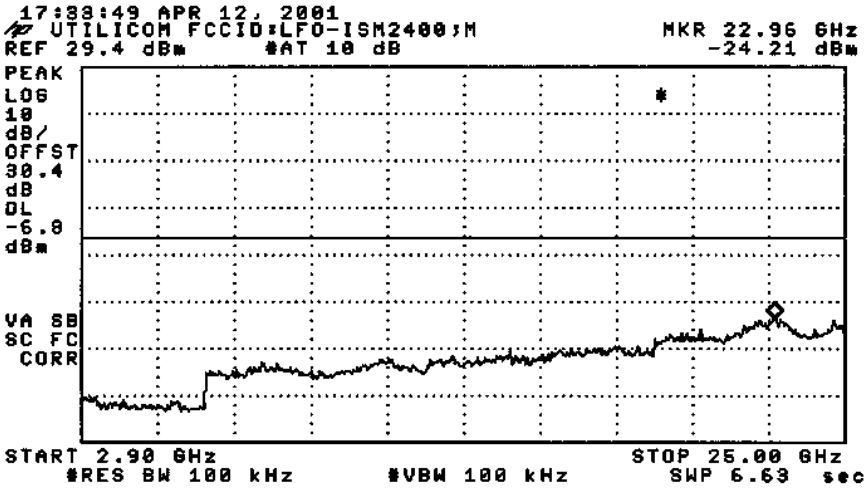
15.247(c): Spurious Emissions, Conducted, MID Channel





15.247(c): Spurious Emissions, Conducted, HIGH Channel





Power Spectral Density
Test Requirement: 15.247(d)

Measurement Equipment Used:

HP 8593EM Spectrum Analyzer
2 ft length low loss A coaxial RF cable

Test Procedure

The EUT's TDD function was stopped. For the LOW channel, the emission peak was set to the center of the display. The SPAN was set to 300 kHz, the RES BW and VID BW were set to 3 kHz, and SWEEP TIME was set to 100 seconds. The maximum trace was recorded and compared to the 8 dBm limit.

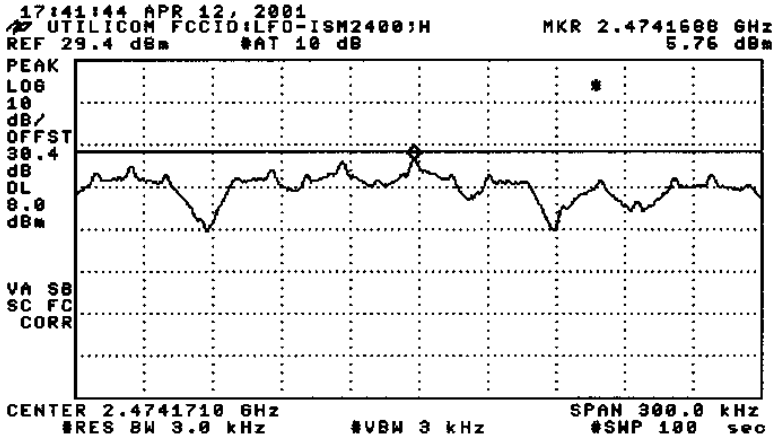
The test was repeated for MID and HIGH channel.

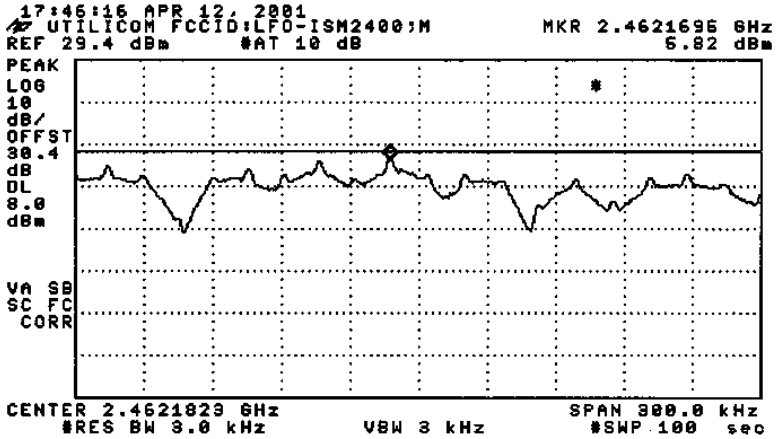
Test Results

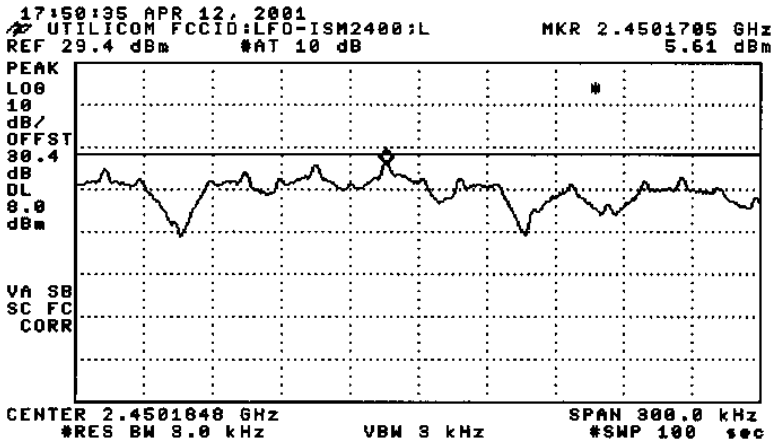
Maximum measured PSD was 5.82 dBm. Refer to attached spectrum analyzer charts.

Channel	**Frequency, MHz**
Low	2450
Mid	2462
High	2474

15.247(d): Power Spectral Density


17:41:44 APR 12, 2001
UTILICOM FCCID:LFD-ISM2400;H
MKR 2.4741688 GHz
REF 29.4 dBm
#AT 10 dB
5.76 dBm
PEAK
LOG
10
dB/
OFFST
30.4
dB
DL
8.0
dBm
VA SB
SC FC
CORR
CENTER 2.4741710 GHz
SPAN 300.0 kHz
#RES BW 3.0 kHz
#VBW 3 kHz
#SWP 100 sec


17:46:16 APR 12, 2001
UTILICOM FCCID:LFD-ISM2400;M
MKR 2.4621696 GHz
REF 29.4 dBm
#AT 10 dB
5.82 dBm
PEAK
LOG
10
dB/
OFFST
30.4
dB
DL
8.0
dBm
VA SB
SC FC
CORR
CENTER 2.4621823 GHz
SPAN 300.0 kHz
#RES BW 3.0 kHz
VBW 3 kHz
#SWP 100 sec


17:50:35 APR 12, 2001
UTILICOM FCCID:LFD-ISM2400;L
MKR 2.4501705 GHz
REF 29.4 dBm
#AT 10 dB
5.61 dBm
PEAK
LOG
10
dB/
OFFST
30.4
dB
DL
8.0
dBm
VA SB
SC FC
CORR
CENTER 2.4501848 GHz
SPAN 300.0 kHz
#RES BW 8.0 kHz
VBW 3 kHz
#SWP 100 sec

Processing Gain
Test Requirement: 15.247(e)

Refer to separate attachment for processing gain data.