420 N Dorothy Drive, Richardson, TX 75081 Ph: (972) 238-5591 Fax: (972) 238-1860

TEST REPORT

Report Number: 3055137.012
Project Number: 3055137
April 12, 2004

Testing performed on the
RFID Reader
Model: JETTRFIDBTFTTP45R2-SP-128CF-CARD-BK
S/n: HH245957
FCC ID: JETTRFID-1356
to

FCC part 15.225

For
Two Technologies, Inc.
419 Sargon Way
Horsham, PA 19044

Test Performed by:	Test Authorized by:
Intertek Testing Services, NA. Inc.	Two Technologies, Inc.
420 N Dorothy Drive	419 Sargon Way
Richardson, TX 75081	Horsham, PA 19044

Prepared by:  Date:
Sudesh Kamble — April 12, 2004
EMC Team Leader

Reviewed by: Norman Shpilsher Date:
Norman Shpilsher — April 12, 2004
Reviewer

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1.0 Summary of Tests

TEST	REFERENCE	RESULT
Field Strength of Fundamental	15.225(a)	Complies
Radiated Emissions outside the band	15.225(b), 15.209	Complies
Frequency tolerance of the carrier	15.225(c)	Complies
Line Conducted Emissions	15.207	Complies
Antenna requirement	15.203	Not Applicable. The antenna is permanently connected to the transmitter

2.0 General Description

2.1 Product Description

The JETT® RFID attachment uses the SkyeTek SkyeRead M1 13.56 MHz Reader / Writer RFID (Radio Frequency Identification) module to read and write to industry standard 13.56 MHz RFID tags. The M1 is based upon the Texas Instruments S6700 Multi-Protocol RF Transceiver IC, Part Number: RI-R6C-001A. The design output power is 200 mW into a 50 ohm load when supplied with 5 VDC.

When 5V is applied to the JETT® RFID attachment and the appropriate action commands are issued to it through its RS-232 serial interface (from the JETT® CPU), a 13.56 MHz sinusoidal magnetic carrier wave is radiated from the attachment's antenna predominately in both the forward and backward directions, which are perpendicular to the antenna's flat side. At a distance of up to six (6) inches from the antenna panel, a standard size 13.56 MHz RFID tag will intercept some of this magnetic energy through its onboard antenna (inductive coupling), much like the secondary winding in a transformer, and use it, after conditioning, to supply power to the tag's electronic circuitry. The 13.56 MHz sine wave provides the clock for any necessary digital processing to the tag circuits.

Using tag identification data or other stored data in an embedded IC, the tag then transmits the data back to the JETT® RFID reader using load modulation (an antenna load resistor is switched on and off at a frequency less than the carrier), which creates two subcarriers frequencies just above and below the 13.56 MHz carrier. One of these subcarriers is then modulated using the well known ASK (Amplitude Shift Keying) method. The JETT® RFID reader then filters out everything except one of the subcarriers. That subcarrier is then amplified and demodulated to recover the tag's transmitted data.

The JETT® RFID reader transmits data to the tag using the ASK method through its 13.56 MHz carrier wave.
A production unit was received on February 6, 2004 in good operating condition. As declared by the Applicant, it is identical to production units.

2.2 Related Submittal(s) Grants

This report is for use with an application for certification of a low power transmitter. One transmitter is included in the application.

2.3 Test Methodology

Both AC mains line-conducted and radiated emissions measurements were performed according to the procedures in ANSI C63.4 (1992). Radiated tests were performed at an antenna to EUT distance of 10 and 3 meters, unless stated otherwise in the **"Data Sheet"** of this Application. All other measurements were made in accordance with the procedures in part 2 of CFR 47.

2.4 Test Facility

Radiated emission measurements were performed according to the procedures in ANSI C63.4 (1992). All measurements were performed in 3 meters FCC accredited semi-anechoic Chamber. The site attenuation of the chamber is performed as per the procedure detailed in ANSI C63.4-1992-Alternate Test Site and is within the specified tolerance. For each scan, the procedure for maximizing emissions in Appendices D and E were followed.

The 10 m testing below 30 MHz was performed on open area test facility is a specially designed and constructed in a parking lot measuring 17 meters by 4.9 meters without ground plane.

3m test sites include a metal ground plane constructed of 22-gauge sheet metal. Each site contains a 2.5-meter diameter turntable for floor standing equipment, and a wooden table measuring 1.5 x 1.5 x 0.8 meters for tabletop equipment to facilitate testing, also it has heat and air conditioning systems to control environmental test conditions.

Measurements from 9 kHz to 30 MHz are taken with Loop antenna, measurements from 30MHz to 1GHz are taken with biconilog antenna and measurement above 1GHz was taken by Horn antenna. The mast to support the antennas is capable of a 1 meter to 4-meter height range, which meets CISPR and FCC requirements. The antenna mast is non-conductive and remotely controllable. The height of antenna and azimuth of the equipment was varied to obtain the maximum radiation during the measurement.

Since radiated emissions, and to a lesser extent, conducted emissions, are functions of cable placement, the cable placement is varied to encompass all configurations that an end user would encounter to determine the configuration resulting in maximum emissions. At least one cable for each I/O port type is attached to the EUT. If peripherals or modules are available, at least one of each available type is installed and noted in the report. Generally, only one of each type is used unless good engineering judgment dictates that the use of more will affect emission levels. Excess cable lengths are arranged into a 30 x 40-cm bundle. Cables requiring non-standard lead dress are recorded in the report.

For conducted emissions testing, the equipment is moved to an insulating platform over the ground plane, and the EUT is powered from a LISN. Both sides of the AC line are measured and the results are compared to the applicable limits. Measurements are taken using CISPR quasi-peak and average detectors when the peak readings approach or exceed the average limit. Only quasi-peak readings are taken when the EUT's emissions meet the average limit as measured with the quasi-peak detector.

The 3m test facility is registered with FCC under Registration # 101578.

3.0 System Test Configuration

3.1 Support Equipment and description

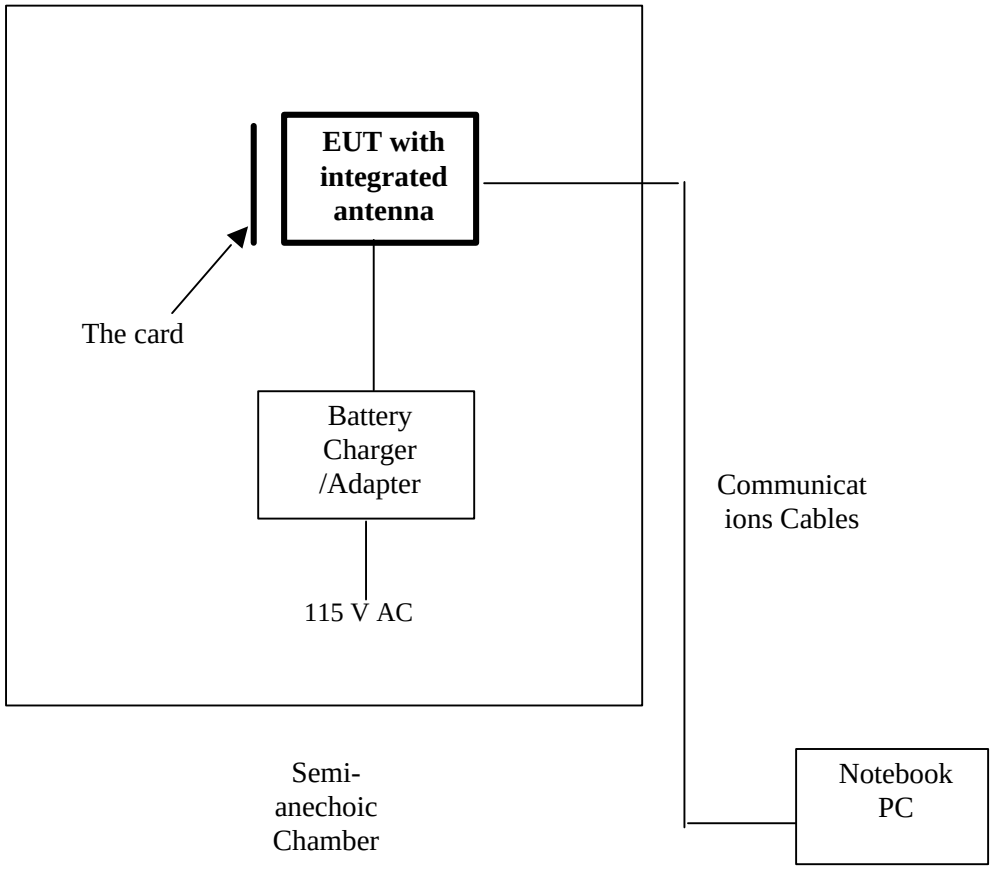
System Support Equipment

Description	Manufacturer	Model Number	Serial Number
Battery Charger/ Adapter	Ilan Electronics Ltd	F1650	---
Notebook PC	Compaq	Armada 7400	---

Cables Associated with EUT

Description	Length	Shielding	Ferrites	Connection	
				From	To
CAT 3 Standard unshielded Phone Cord (p/n: 1210-15-BK)	15 ft	No	No	EUT	Notebook PC VIA Serial Port for Communication
Jet Connect Cable (p/n: 91709)	15 ft	Yes	Yes	EUT	Serial port of associated equipment for communication

3.2 Block Diagram of Test Setup



3.3 Justification

For emission testing, the test procedures, as described in American National Standards Institute C63.4-1992, were employed. The equipment under test (EUT) was configured for testing in a typical fashion (as a customer would normally use it).

For radiated emission measurements, the EUT is attached to a cardboard box (if necessary) and placed on the wooden turntable. The signal is maximized through rotation and placement in the three orthogonal axes. During testing, all cables were manipulated to produce worst-case emissions.

If the EUT attaches to peripherals, they are connected and operational (as typical as possible). The EUT was wired to transmit full power. Fully charged battery was used during the testing.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use.

3.5 Mode of operation during test

For radiated and AC line conducted emission tests, the EUT was setup to transmit continuously in self-test mode (worst case emissions). For the occupied bandwidth and out-of-band conducted emission tests, the EUT was setup to transmit in normal operation mode.

3.6 Modifications required for Compliance

Following modification to the JETT® 13.56 MHz RFID Antenna PCB, part number 14279, at their facility: Capacitor, "**C1**," was changed from 10 pF to 15 pF. This engineering change has been implemented in Two Technologies' manufacturing process, and is reflected in the parts list exhibit as well as on the JETT® 13.56 MHz RFID Antenna assembly drawing, document number 91811, and on the schematic, drawing number 4279-S1. (Please note that this does not include changes made specifically by Two Technologies, Inc. prior to compliance testing).

3.7 Additions, deviations and exclusions from standards

No additions, deviations or exclusion have been made from standard.

4.0 Measurement Results

4.1 Transmitter Radiated Emissions
FCC Rules 15.225, 15.209, 15.225

Requirements

The Field Strength of emissions at fundamental frequency shall not exceed 84 dB (?V/m) at 30m,
Emissions radiated outside of the specified frequency band shall not exceed the general radiated emission limits in 15.209.

Procedure

During the test the EUT is rotated and the measuring antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. All readings are extrapolated back to the equivalent three-meter reading using inverse scaling with distance.

Radiated emission measurements were performed from 10 MHz to 1 GHz.
Analyzer resolution is:

9 kHz or greater for frequencies 30 MHz and below
100 kHz or greater for frequencies 1000 MHz and below,
For those frequencies quasi-peak value was measured.

Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation is as follows:
FS = RA + AF + CF - AG
Where FS = Field Strength in dB (?V/m)
RA = Receiver Amplitude (including preamplifier) in dB (?V)
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB (1/m)
AG = Amplifier Gain in dB

Test Result

The data below shows the significant emission frequencies, the limit and the margin of compliance.

Radiated emissions at fundamental frequency

Frequency MHz	SA** Reading at 10m dB(uV)	Distance Correct. Factor dB	FS at 30 m dB(uV/m)	FS Limit at 30m dB(uV/m)	Margin dB
13.560	60.97	-20.0	40.97	84.0	-43.03

FS – Field Strength
FS was measured with loop antenna
**: Denotes the corrected reading with Antenna Factor and Cable Loss.

Spurious Radiated emissions below 30 MHz

Frequency MHz	SA** Reading at 10m dB(uV)	Distance Correct. Factor dB	FS at 30 m dB(uV/m)	FS Limit at 30m dB(uV/m)	Margin dB
27.122	23.31	-20.0	03.31	30	-26.69

**: Denotes the corrected reading with Antenna Factor and Cable Loss.
All other emissions not reported are noise floor, which is at least 20 dB below the limit.

Out of band emissions below 30 MHz (Measured at band edge frequencies)

Frequency MHz	SA** Reading at 10 m dB(uV)	Distance Correct. Factor dB	FS at 30 m dB(uV/m)	FS Limit at 30m dB(uV/m)	Margin dB
13.110	27.68	-20.00	7.68	40.50	-32.82
13.356	28.32	-20.00	8.32	40.50	-32.18
13.410	30.00	-20.00	10.00	40.50	-30.50
13.412	29.72	-20.00	9.72	50.50	-40.78
13.552	45.45	-20.00	25.45	50.50	-25.05
13.553	47.98	-20.00	27.98	50.50	-22.52
13.556	55.63	-20.00	35.63	74.00	-38.37
13.567	49.75	-20.00	29.75	50.50	-20.75
13.568	47.52	-20.00	27.52	50.50	-22.98
13.710	32.62	-20.00	12.62	50.50	-37.88
13.720	29.07	-20.00	9.07	30.50	-21.43
14.010	30.00	-20.00	10.00	40.50	-30.50
14.438	19.09	-20.00	-0.91	40.50	-41.41
18.494	43.60	-20.00	23.60	40.50	-16.90
27.122	23.31	-20.00	3.31	30.00	-26.69

The emissions on the band-edge frequencies are more than 20 dB below the level on fundamental frequency.
**: Denotes the corrected reading with Antenna Factor and Cable Loss.
All other emissions not reported are noise floor, which is at least 20 dB below the limit.

Date: 03/04/04
Company: Two Technologies, Inc.
Equipment: RFID Reader Model: JETTRFIDBTFTTP45R2-SP-128CF-CARD-BK
Test Engineer: Sudesh Kamble
Test Standard: FCC 15.209
Note: The table shows the worst-case radiated emissions.

Table #1: Spurious Radiated emissions (Quasi-peak Reading)

Frequency MHz	Antenna Polarization H/V	Antenna Height/Azimuth	Detector P/Q-P	FS** at 3m dB(µV/m)	FS Limit at 3m dB(µV/m)	Margin dB
40.68	V	1.0/20	Q-P	28.88	40.00	-11.12
65.92	V	1.0/0	Q-P	17.08	40.00	-22.92
80.12	H	2.0/-96	Q-P	31.58	40.00	-8.42
96.80	V	1.0/70	Q-P	32.25	44.00	-11.75
99.52	V	1.0/88	Q-P	45.54	54.00*	-8.46
99.52	H	1.8/98	Q-P	41.40	54.00*	-12.60
101.52	H	1.6/-92	Q-P	29.80	44.00	-14.20
101.60	V	1.0/90	Q-P	33.68	44.00	-10.32
144.64	V	1.0/43	Q-P	35.72	54.00*	-18.28
146.16	V	1.0/98	Q-P	28.23	54.00*	-25.77
149.28	H	2.7/-52	Q-P	38.30	54.00*	-15.70
158.96	H	2.5/-52	Q-P	28.71	54.00*	-25.29
174.90	V	1.0/98	Q-P	34.59	54.00*	-19.41
196.32	H	1.4/81	Q-P	36.12	54.00*	-17.88
200.44	H	1.4/78	Q-P	35.25	54.00*	-18.75
212.88	V	1.1/180	Q-P	43.28	54.00*	-10.72
218.44	H	1.4/78	Q-P	36.56	56.00*	-19.44
305.48	H	2.5/80	Q-P	38.03	56.00*	-17.97
497.64	V	1.0/20	Q-P	42.50	56.00*	-13.50
514.24	V	1.7/-15	Q-P	35.49	56.00*	-20.51
795.68	V	1.1/-4	Q-P	32.68	56.00*	-23.32
298.60	H	2.7/79	Q-P	49.96	56.00*	-6.04
298.60	V	1.7/-13	Q-P	48.75	56.00*	-7.25
796.60	V	1.0/0	Q-P	35.01	56.00*	-20.99

Notes:
FS = Field Strength
P = Peak
Q-P = Quasi-Peak

*: FCC 15.109 Limits applied for measurements above 10th harmonic of radiated frequency as per 15.209(f). The measurement frequency is not a harmonic of the intentionally radiated frequency (13.56 MHz); the emissions were verified with transmission (at 13.56 MHz) switching ON and OFF during the testing. The emissions are part of operating frequency of the equipment used internal to product for operation of the digital circuit and are un-intentional emissions. FCC 15.109 Class A limits are applied to determine compliance.

**: Corrected radiated emission limits with Antenna factor and Cable loss.

The EUT passed the test by 6 dB

4.2 AC Line Conducted Emission
FCC Rule 15.207

AC line conducted emission test was performed according the ANSI C63.4 standard. The EUT was connected to DC Power Supply, which was connected to AC Line through the LISN.

A complete scan from 150 kHz - 30 MHz was made according to the FCC 02-157 (ET Docket 98-80).
As emissions at the fundamental frequency of 13.560 was exceeding the limits, the Conducted emission measurements were preformed in two configurations:

Configuration 1: Normal-operating Conditions with Antenna connected to the device.
(Please refer Table 2 & 3 and Graphs 1 & 2 for the results)

Configuration 2: Normal-operating Conditions with Antenna disconnected to the device and the Substituted with equivalent resistive load (50 Ohm).
(Please refer Table 4 & 5 and Graphs 3 & 4 for the results)

From the measurement results it was inferred that the fundamental frequency emissions at 13.560 MHz are coupling through air on the port under measurement and is not conducted through the power cord conductively.

Conducted Emissions

Date: 04/12/04
Company: Two Technologies, Inc.
Equipment: RFID Reader Model: JETTRFIDBTFTTP45R2-SP-128CF-CARD-BK
Test Engineer: Sudesh Kamble
Test Standard: FCC 15.207
Note: The table shows the worst-case conducted emissions.

Table # 2: Line 1 with antenna connected in normal mode.

Frequency MHz	QP Reading dB?V	QP Limit dB?V	QP Margin dB?V	Ave Reading dB?V	Ave Limit dB?V	Ave Margin dB?V
0.17	46.28	64.77	-18.48	38.76	54.77	-16.00
0.41	37.72	57.73	-20.01	36.88	47.73	-10.85
0.47	32.68	56.58	-23.91	31.44	46.58	-15.15
1.08	39.30	56.00	-16.70	36.01	46.00	-9.99
2.04	21.23	56.00	-34.77	19.24	46.00	-26.76
3.55	27.75	56.00	-28.25	24.52	46.00	-21.48
3.67	29.39	56.00	-26.61	27.90	46.00	-18.10
8.91	18.78	60.00	-41.22	13.29	50.00	-36.71
13.56**	67.79	60.00	7.79	65.25	50.00	15.25
27.12	22.14	60.00	-37.86	17.16	50.00	-32.84

Table # 3: Line 2 with antenna connected in normal mode.

Frequency MHz	QP Reading dB?V	QP Limit dB?V	QP Margin dB?V	Ave Reading dB?V	Ave Limit dB?V	Ave Margin dB?V
0.17	46.07	64.77	-18.70	39.92	54.77	-14.85
0.41	36.07	57.73	-21.66	34.02	47.73	-13.70
0.47	34.14	56.58	-22.44	33.19	46.58	-13.40
1.08	40.64	56.00	-15.36	37.22	46.00	-8.78
2.04	24.32	56.00	-31.68	21.70	46.00	-24.30
3.55	28.88	56.00	-27.12	20.30	46.00	-25.70
3.67	29.34	56.00	-26.66	25.06	46.00	-20.94
8.91	16.22	60.00	-43.78	12.44	50.00	-37.56
13.56**	66.38	60.00	6.38	59.26	50.00	9.26
27.12	29.89	60.00	-30.11	21.78	50.00	-28.22

**: Fundamental Frequency

Conducted Emissions

Date: 04/12/04
Company: Two Technologies, Inc.
Equipment: RFID Reader Model: JETTRFIDBTFTTP45R2-SP-128CF-CARD-BK
Test Engineer: Sudesh Kamble
Test Standard: FCC 15.207
Note: The table shows the worst-case conducted emissions.

Table # 4: Line 1 with antenna substituted with 50-Ohm resistor.

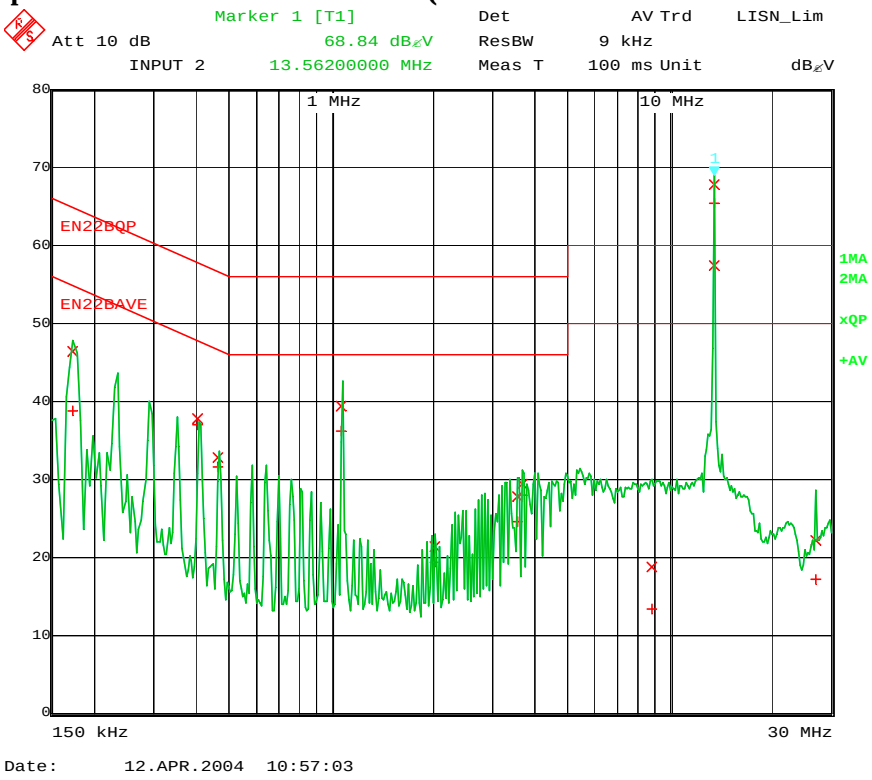
Frequency MHz	QP Reading dB?V	QP Limit dB?V	QP Margin dB?V	Ave Reading dB?V	Ave Limit dB?V	Ave Margin dB?V
0.17	45.83	64.77	-18.94	38.90	54.77	-15.86
0.41	37.97	57.73	-19.76	37.07	47.73	-10.66
0.47	31.65	56.58	-24.94	30.76	46.58	-15.82
1.08	40.14	56.00	-15.86	36.81	46.00	-9.19
2.04	20.57	56.00	-35.43	17.30	46.00	-28.70
3.55	30.73	56.00	-25.27	29.77	46.00	-16.23
3.67	30.38	56.00	-25.62	28.93	46.00	-17.07
8.91	28.97	60.00	-31.03	26.28	50.00	-23.72
13.56**	26.06	60.00	-33.94	19.69	50.00	-30.31
27.12	41.83	60.00	-18.17	36.49	50.00	-13.51

Table # 5: Line 2 with antenna substituted with 50-Ohm resistor.

Frequency MHz	QP Reading dB?V	QP Limit dB?V	QP Margin dB?V	Ave Reading dB?V	Ave Limit dB?V	Ave Margin dB?V
0.17	46.10	64.77	-18.66	39.95	54.77	-14.81
0.41	36.79	57.73	-20.94	34.02	47.73	-13.71
0.47	34.14	56.58	-22.44	33.12	46.58	-13.47
1.08	39.95	56.00	-16.05	36.67	46.00	-9.33
2.04	23.47	56.00	-32.53	20.21	46.00	-25.79
3.55	31.35	56.00	-24.65	25.91	46.00	-20.09
3.67	30.16	56.00	-25.84	27.26	46.00	-18.74
8.91	24.45	60.00	-35.55	21.25	50.00	-28.75
13.56**	26.57	60.00	-33.43	22.18	50.00	-27.82
27.12	42.18	60.00	-17.82	34.85	50.00	-15.15

**: Fundamental Frequency

Graph 1: Conducted Emission Line 1 (with antenna connected in normal mode)



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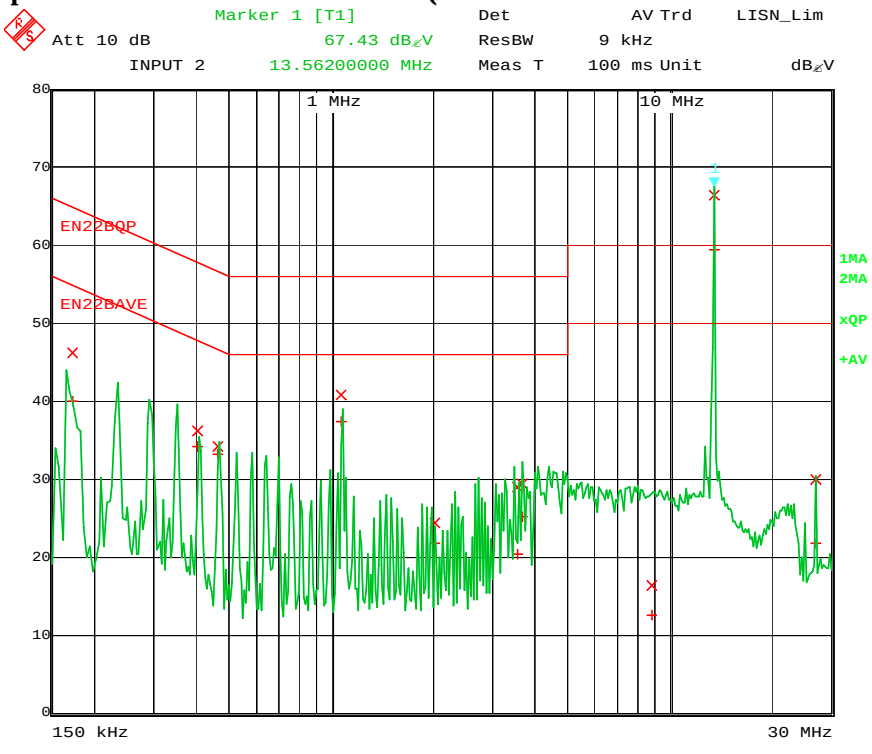
Graph 2: Conducted Emission Line 2 (with antenna connected in normal mode)



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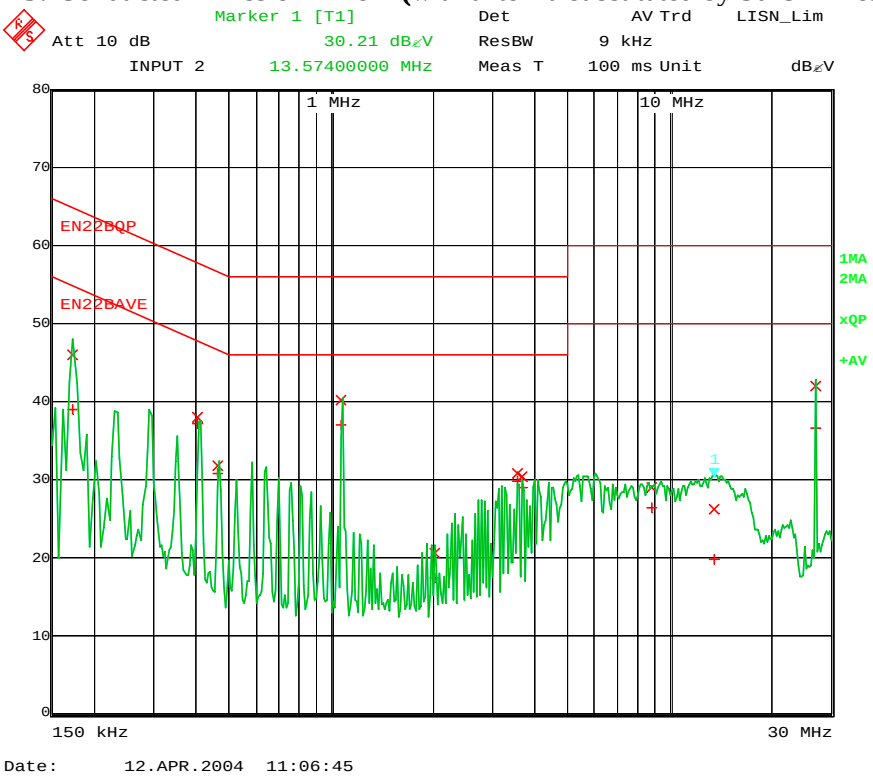
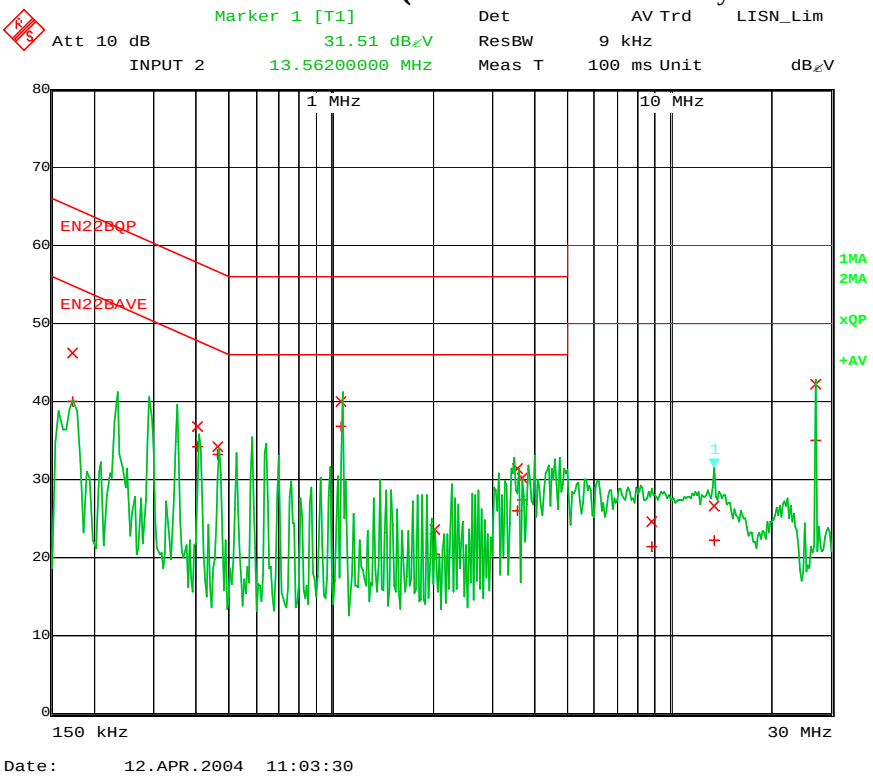
Graph 3: Conducted Emission Line 1 (with antenna substituted by 50-Ohm resistor)



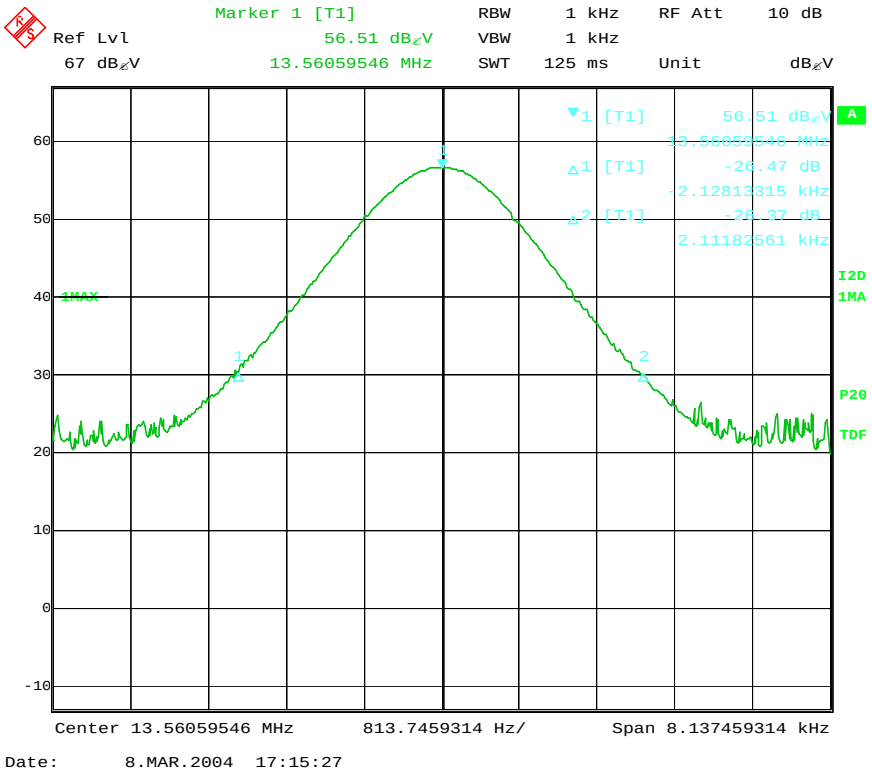
Graph 4: Conducted Emission Line 2 (with antenna substituted by 50-Ohm resistor)



4.3 Occupied Bandwidth

The EUT was setup to transmit in normal operating condition with continuous transmission for testing purpose. The following plots show the occupied bandwidth.

Graph # 5: 26 dB Bandwidth in In-Band Emission, RBW = 1 kHz



The 26-dB bandwidth is 4.239 kHz.

5.0 Frequency Tolerance

Requirement

The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of -20^0C to $+50^0$C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of $+20^0$C.

Procedure

The EUT was placed in the temperature chamber and set to transmit unmodulated carrier. The transmitter was powered from a DC power supply Adapter (Rated 120 VAC Input). The frequency counter was connected to the transmitter output. For each temperature, the carrier frequency was recorded.

Result

Nominal Frequency: 13.560457MHz @ 20 deg C.

Temperature, ^{0}C	Measured Frequency, MHz	Maximum difference, Hz
+50	13.560364	-93
+20	13.560457	00
-20	13.560571	+114

DC Battery Voltage	Measured Frequency, MHz	Maximum difference, Hz
16	13.560560	100
15	13.560590	130
14	13.560610	150
13	13.560540	80
12	13.560510	50
11	13.560490	30
10	13.560510	50
9	13.560460	0
8	13.560460	0
7	14.560590	130

The frequency tolerance is within ± 0.01% (± 1356 Hz)

6.0 List of test equipment

Measurement equipment used for emission compliance testing utilized the equipment on the following list:

Receivers/Spectrum Analyzers

DESCRIPTION	SERIAL NO.	LAST CAL	CAL DUE	USED
Agilent Technologies, E7405A, HP EMC System	US40240235	11/03	11/04	
R&S, ESI07, EMI Receiver	1088-7490	9/03	9/04	X
HP 5335A, Universal Frequency Counter	2044A00559	8/03	8/04	X

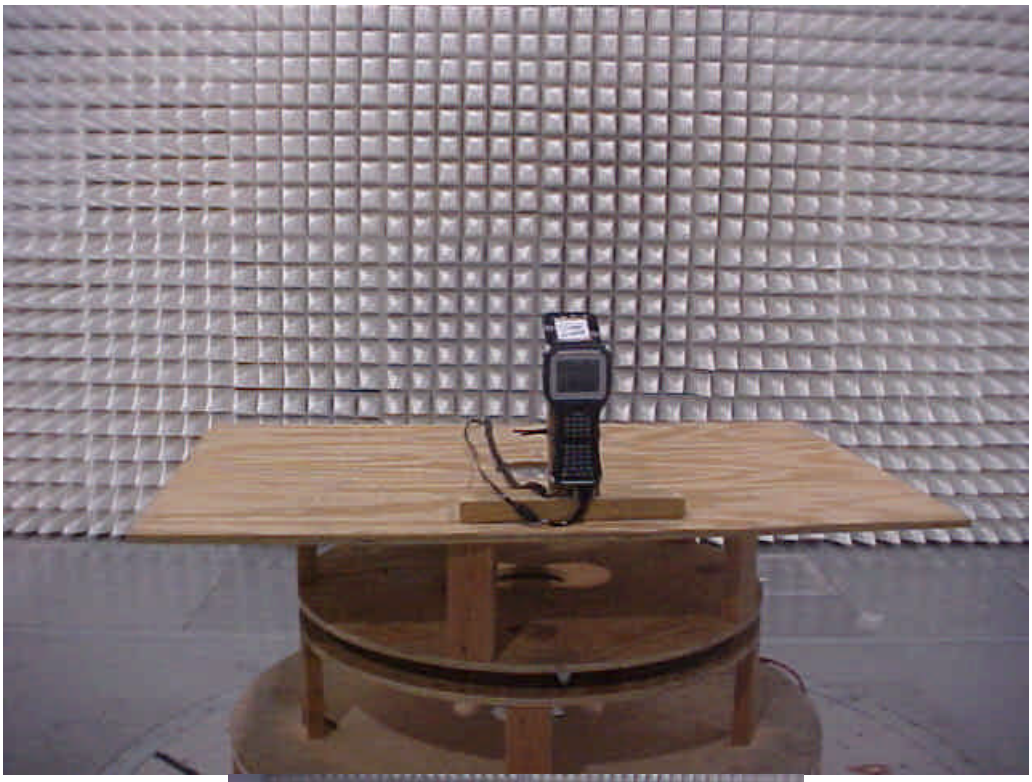
Antennas

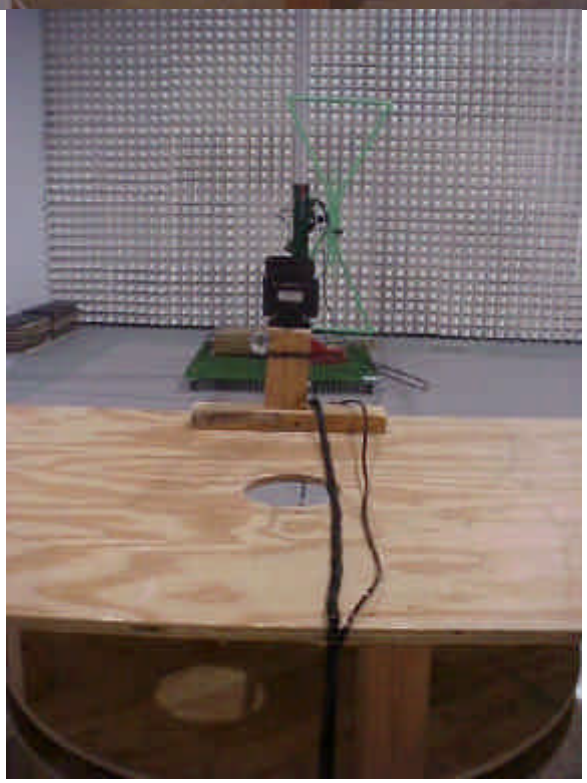
DESCRIPTION	SERIAL NO.	LAST CAL	CAL DUE	USED
Schaffner, CBL6112B, Log Periodic Antenna	2726	5/03	5/04	X
A H Systems, SAS-571, Horn Antenna	411	5/03	5/04	X
A H Systems, SAS-562, Loop antenna	152	5/03	5/04	X

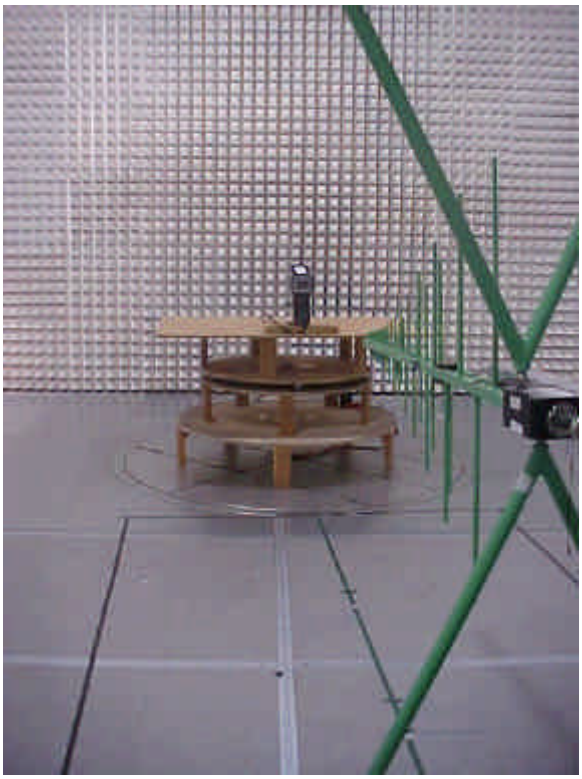
Artificial Mains Networks/Absorbing Clamps

DESCRIPTION	SERIAL NO.	LAST CAL	CAL DUE	USED
FCC-LISN-50-25-2-01	01021	5/03	5/04	X
FCC-LISN-50-50-4-02	01024	5/03	5/04	
FCC-LISN-50-25-2-01	01020	5/03	5/04	

Radiated Emission Test Set Up







AC Line Conducted Emission Test Set Up