

TEST REPORT

Report Number: 3053523.011
Project Number: 3053523
January 17, 2004

Testing performed on the
RFID Reader
Model: RX-STU-ETR1-00
P/n: 5203S002283
FCC ID: A92ETR103
to

FCC part 15.225

For
Texas Instruments RFID
6550 Chase Oaks Blvd.
Plano, TX 75023

Test Performed by:
Intertek Testing Services, NA. Inc.
420 N Dorothy Drive
Richardson, TX 75081

Test Authorized by:
Texas Instruments RFID
6550 Chase Oaks Blvd.
Plano, TX 75023

Prepared by: _____
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Date: _____
January 26 , 2004

Reviewed by: _____
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Compliance Investigator

Date: _____
January 26, 2004

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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

RX-STU-ETR1-00 is an Access Control Reader.

Overview of the EUT

Applicant name & address	Texas Instruments RFID 6550 Chase Oaks Blvd. Plano, TX 75023
Contact info	Mr. Steve Lazar
Model No. Part No.	Model No: RX-STU-ETR1-00 Part No: 5203S002283
FCC Identifier	A92ETR103
Operating Frequency	13.562 MHz
Number of Channels	1 channel
Operating Temperature	-20 ⁰ C to +70 ⁰ C
Antenna	Integral antenna, loop type,

A prototype version of the RX-STU-ETR1-00 was received on January 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 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 3meters FCC accredited 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 chamber contains a 2.5-meter diameter turntable for floor standing equipment, and a wooden table measuring 1 x 1.5 x 0.8 meters for table-top equipment to facilitate testing, also it has heat and air conditioning systems to control environmental test conditions.

Measurements from 30MHz to 1GHz are taken with Log periodic 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 Test facility is registered with FCC under Registration # 101578.

3.0 System Test Configuration

3.1 Support Equipment and description

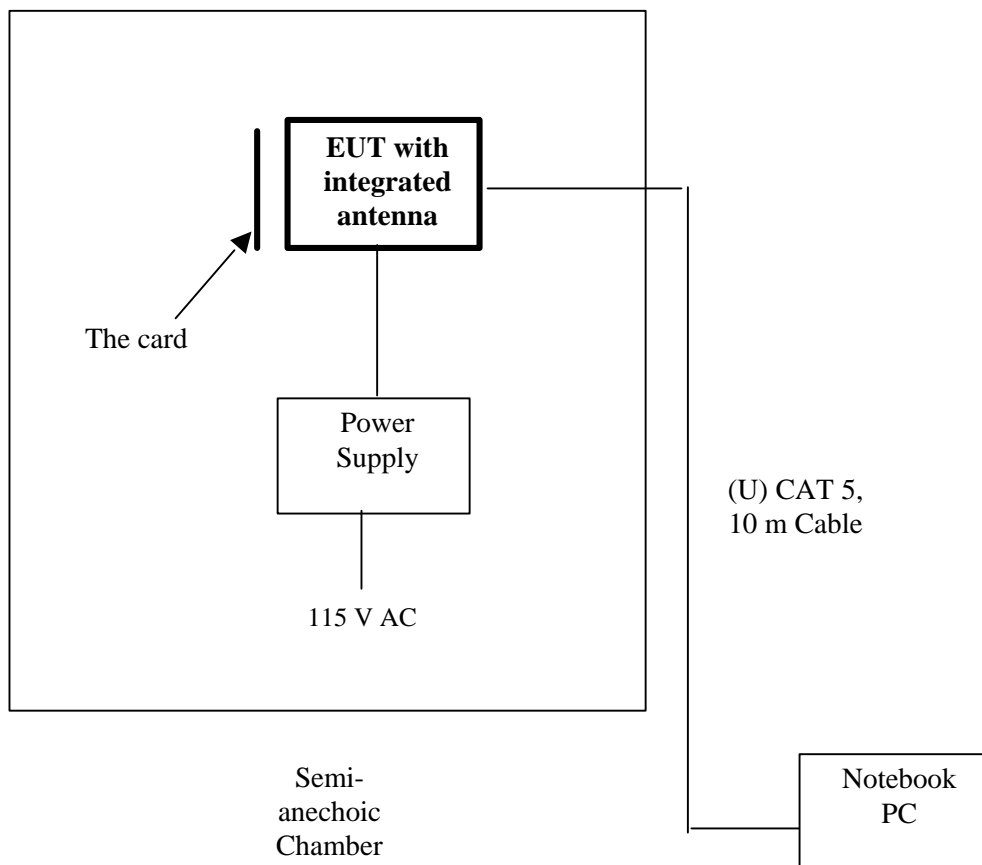
System Support Equipment

Description	Manufacturer	Model Number	Serial Number
Power supply	Phihong	PSC15A-050S	I30200871A1
Notebook PC	Compaq	Armada 7400	---

Cables Associated with EUT

Description	Length	Shielding	Ferrites	Connection	
				From	To
CAT 5	10 m	No	No	EUT	Notebook PC

3.2 Block Diagram of Test Setup



S = Shielded	F = With Ferrite
U = Unshielded	m = Meter

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. Care was taken to ensure proper power supply voltages during 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

No modifications were installed by Intertek Testing Services during compliance testing in order to bring the product into compliance (Please note that this does not include changes made specifically by Taxes Instruments 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

Requirements

The Field Strength of emissions at fundamental frequency shall not exceed 80 dB ($\mu\text{V}/\text{m}$) 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 ($\mu\text{V}/\text{m}$)

RA = Receiver Amplitude (including preamplifier) in dB (μV)

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	Antenna Polarization H/V	SA** Reading at 3m dB(uV)	Distance Correct. Factor dB	FS at 30 m dB(uV/m)	FS Limit at 30m dB(uV/m)	Margin dB
13.562	H	57.01	-20.0	37.01	80.0	-42.99

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	Antenna Polarization H/V	SA** Reading at 3m dB(uV)	Distance Correct. Factor dB	FS at 30 m dB(uV/m)	FS Limit at 30m dB(uV/m)	Margin dB
27.118	H	30.09	-20.0	10.09	30	-19.91

** : Denotes the corrected reading with Antenna Factor and Cable Loss.

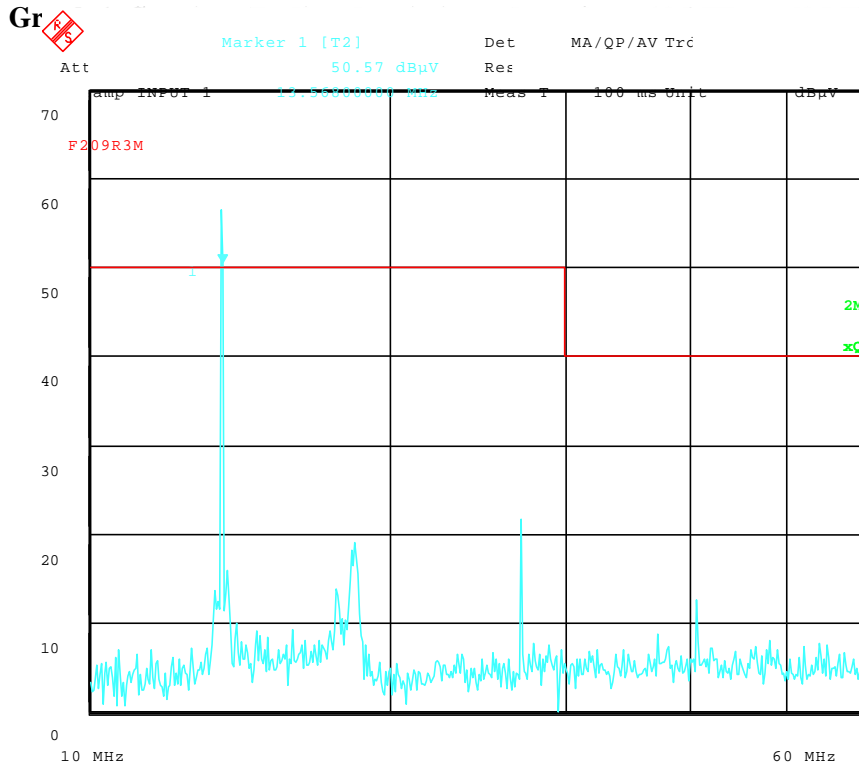
All other emissions not reported are noise floor, which is at least 20 dB below the limit.

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

Frequency MHz	Antenna Polarization H/V	SA** Reading at 3m dB(uV)	Distance Correct. Factor dB	FS at 30 m dB(uV/m)	FS Limit at 30m dB(uV/m)	Margin dB
13.36	H	10.7	-20.0	-9.3	30	-39.30
13.41	H	11.3	-20.0	-8.7	30	-38.30

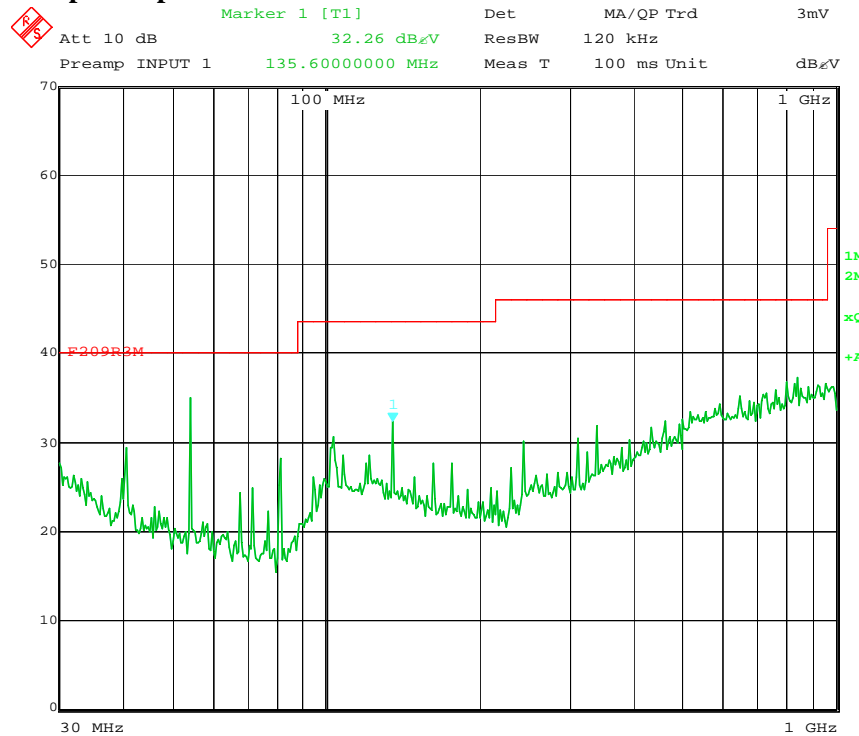
** : Denotes the corrected reading with Antenna Factor and Cable Loss.

All other emissions not reported are noise floor, which is at least 20 dB below the limit.



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Graph 2: Spurious Radiated emissions above from 30 MHz to 1 GHz



Date: 8.JAN.2004 09:34:34

Date: 01/08/04
 Company: Texas Instruments
 Equipment: RFID Reader Model: RX-STU-ETR1-00
 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	1.0/0	Q-P	32.36	40.00	-7.64
54.24	V	1.0/0	Q-P	35.06	40.00	-4.94
135.60	V	1.0/57	Q-P	31.43	44.00	-12.57
528.84	V	1.1/63	Q-P	34.54	46.00	-11.46
569.52	V	1.0/-134	Q-P	34.69	46.00	-11.31
40.68	H	1.0/52	Q-P	38.50	40.00	-1.50
339.00	H	1.0/84	Q-P	36.87	46.00	-9.13
528.84	H	1.0/85	Q-P	32.59	46.00	-13.41
569.52	H	1.0/85	Q-P	34.36	46.00	-11.64

FS = Field Strength

P = Peak

Q-P = Quasi-Peak

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

The EUT passed the test by 1.5 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).

For the test result, see the attached graphs 3 and 4.
The EUT passed the test by 1.81 dB.

Conducted Emissions

Date: 01/09/04
 Company: Texas Instruments
 Equipment: RFID Reader Model: RX-STU-ETR1-00
 Test Engineer: Sudesh Kamble
 Test Standard: FCC 15.207

Note: The table shows the worst-case conducted emissions.

Table # 2: Line 1

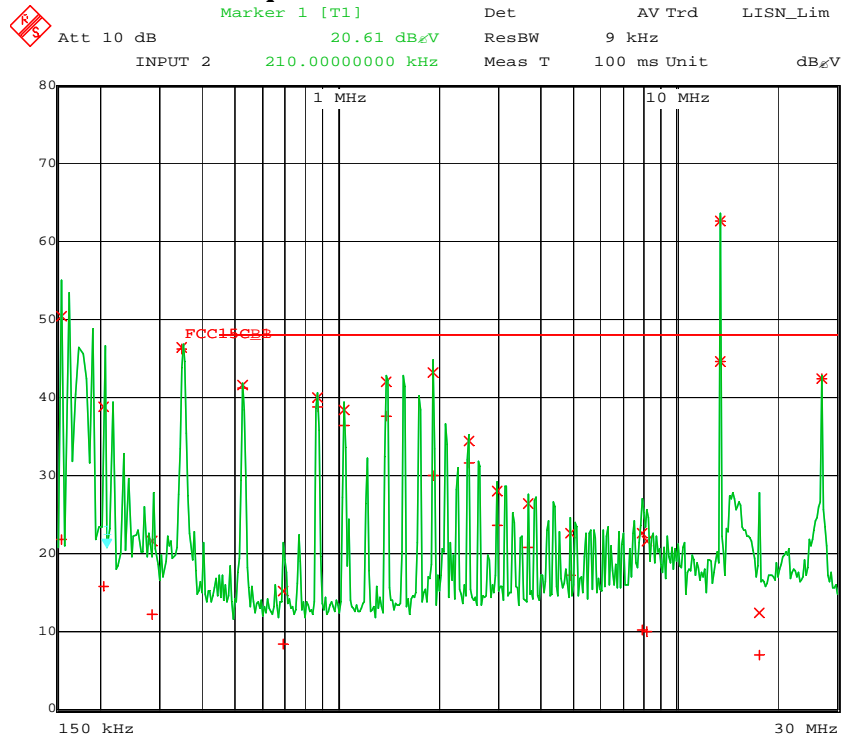
Frequency MHz	QP Reading dB?V	QP Limit dB?V	QP Margin dB?V	Ave Reading dB?V	Ave Limit dB?V	Ave Margin dB?V
0.15	50.30	66.00	-15.70	21.79	56.00	-34.21
0.21	38.63	64.00	-25.37	15.63	54.00	-38.37
0.35	46.36	58.00	-11.64	46.19	48.00	-1.81
0.53	41.47	56.00	-14.53	41.16	46.00	-4.84
1.40	41.97	56.00	-14.03	37.57	46.00	-8.43
1.92	43.17	56.00	-12.83	29.85	46.00	-16.15
2.45	34.21	56.00	-21.79	31.56	46.00	-14.44
13.55	44.46	60.00	-15.54	44.43	50.00	-5.57
13.56	62.46	60.00	2.46**	62.44	50.00	12.44**
27.12	42.31	60.00	-17.69	42.21	50.00	-7.79

Table # 3: Line 2

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
0.16	50.62	65.00	-14.38	26.22	55.00	-28.78
0.35	44.76	58.00	-13.24	44.45	48.00	-3.55
0.53	42.09	56.00	-13.91	41.75	46.00	-4.25
1.05	40.43	60.00	-19.57	39.49	50.00	-10.51
1.58	43.74	60.00	-16.26	42.08	50.00	-7.92
1.93	43.05	60.00	-16.95	39.84	50.00	-10.16
2.45	34.55	60.00	-25.45	30.61	50.00	-19.39
13.55	44.62	60.00	-15.38	44.60	50.00	-5.40
13.56	62.62	60.00	2.62**	62.60	50.00	12.60**
27.12	41.85	60.00	-18.15	41.65	50.00	-8.35

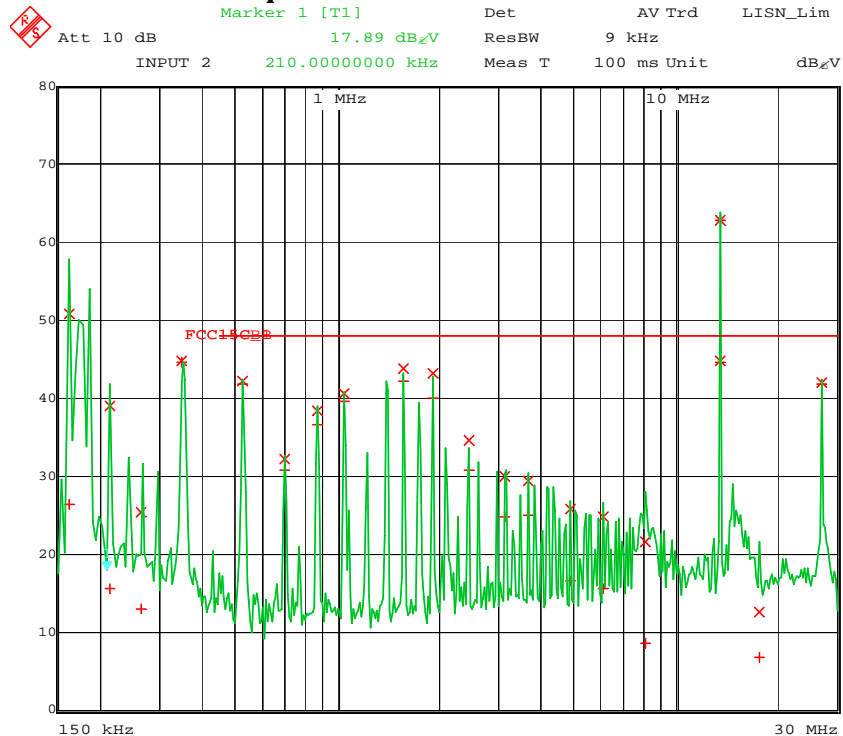
** : Conducted emissions are exempted at carrier frequency.

Graph 3: Conducted Emission Line 1



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Graph 4: Conducted Emission Line 2



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4.3 Occupied Bandwidth and Out-of-band Emission.

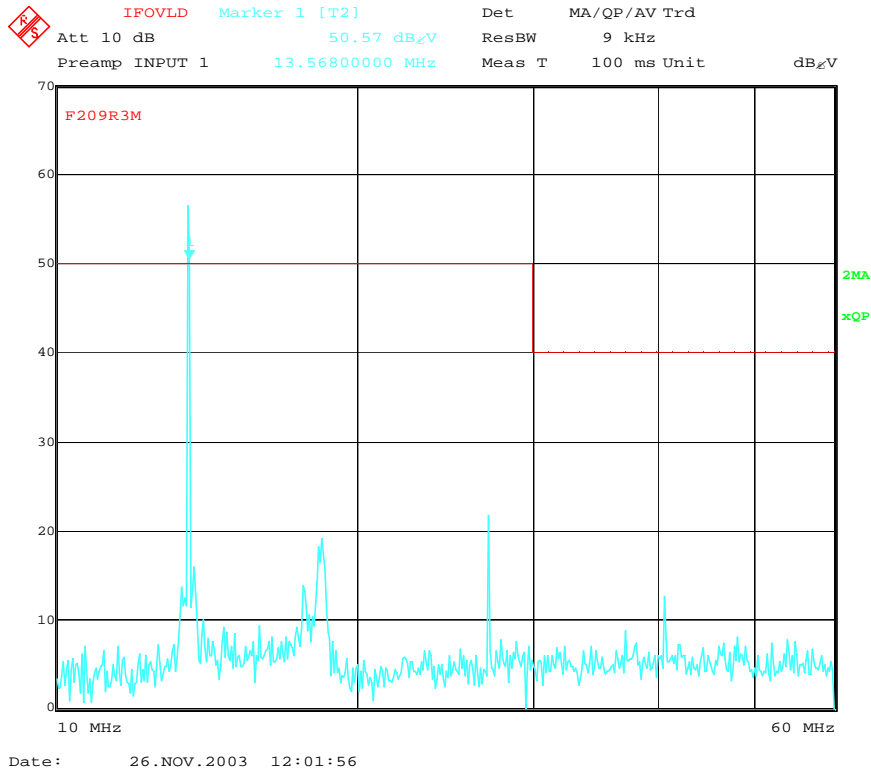
The EUT was setup to transmit in normal operating condition with continuous transmission for testing purpose. The following plots show the in-band and out-of-band emissions.

Plot #	Description
5	Out-of-band emission, scan 10 MHz to 60 MHz
6, 7	In-band emission, RBW=100 Hz, MAX HOLD
8	In-band emission, RBW=300 Hz, MAX HOLD
9	20 dB Bandwidth in In-band emission, RBW=10 kHz, MAX HOLD

The 20-dB bandwidth is about 32.81 kHz.

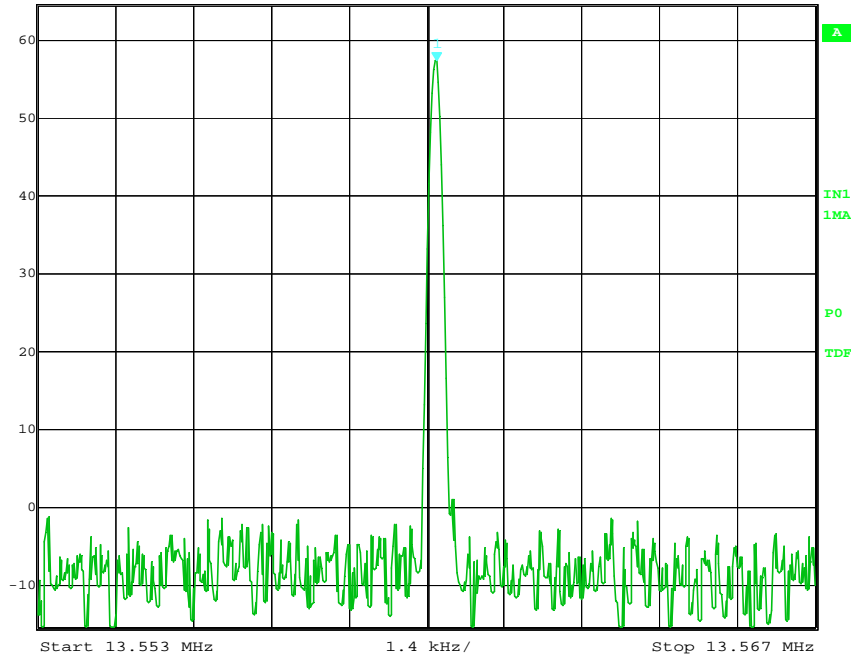
The emissions on the band-edge frequencies are more than 30 dB below the level on fundamental frequency.

Graph # 5: Out of band emissions from 10 MHz to 60 MHz



Graph # 6: In-Band emissions from 13.553 MHz to 13.567 MHz

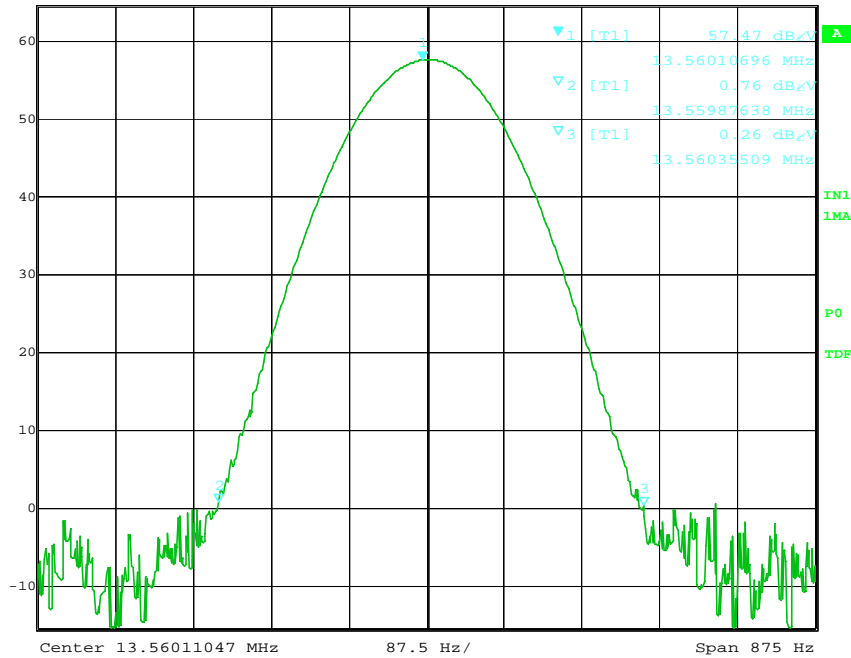
✠ **UNCAL** Marker 1 [T1] RBW 100 Hz RF Att 10 dB
 Ref Lvl 64.6 dB_μV 57.37 dB_μV VBW 100 Hz
 64.6 dB_μV 13.56018236 MHz SWT 3 s Unit dB_μV



Date: 9.JAN.2004 17:23:31

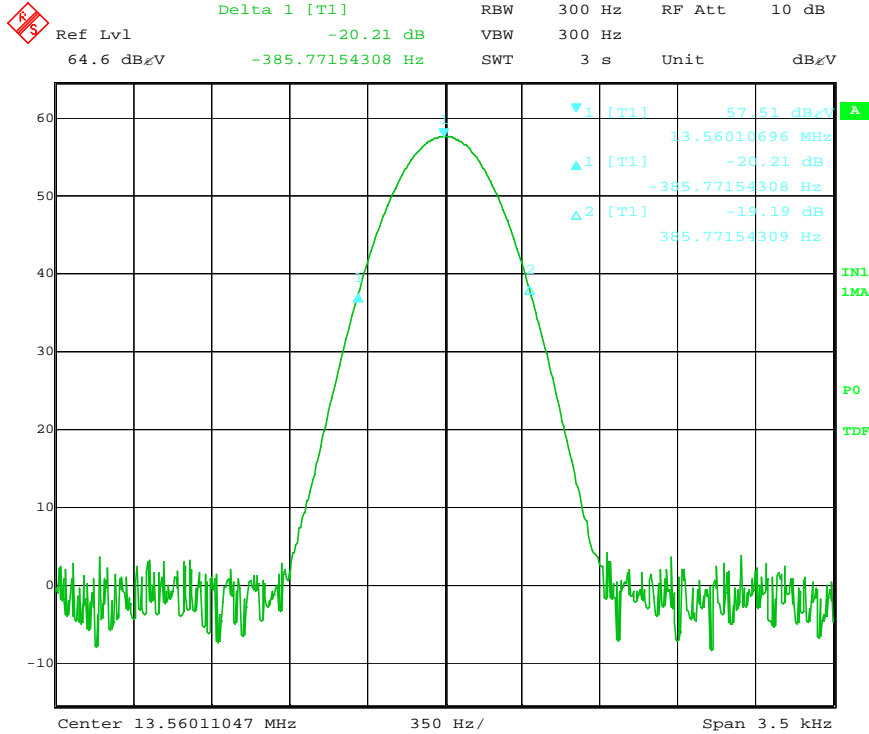
Graph # 7: In Band Emission, RBW = 100 Hz

✠ Marker 1 [T1] RBW 100 Hz RF Att 10 dB
 Ref Lvl 64.6 dB_μV 57.47 dB_μV VBW 100 Hz
 64.6 dB_μV 13.56010696 MHz SWT 3 s Unit dB_μV



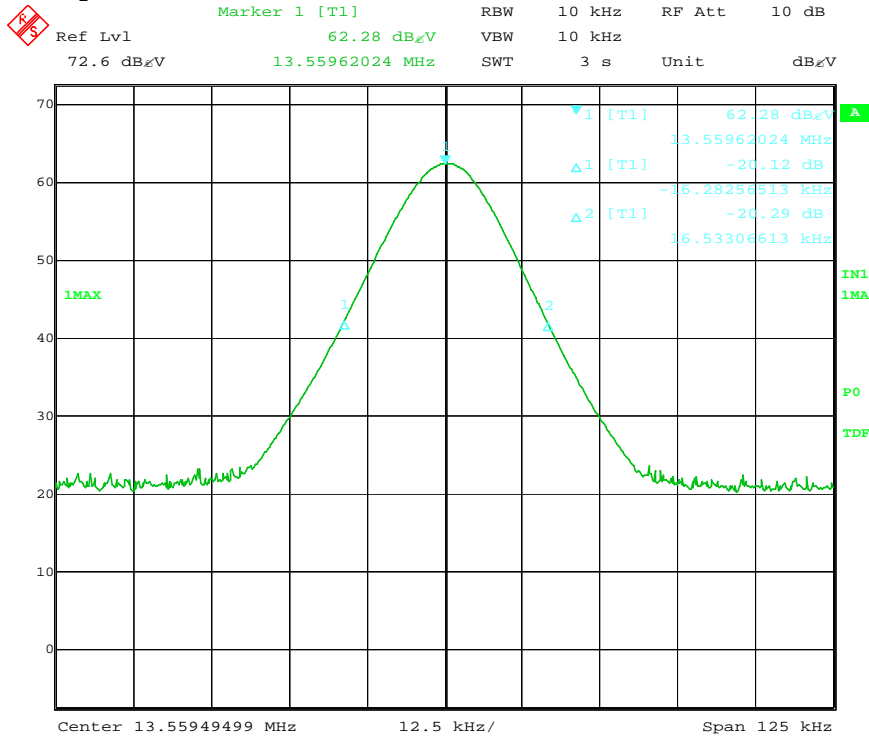
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Graph # 8: In-Band Emission, RBW = 300 Hz



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Graph # 9: 20 dB Bandwidth in In-Band Emission, RBW = 10 kHz



Date: 9.JAN.2004 16:50:41

5.0 Frequency Tolerance

Requirement

The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20°C to $+50^{\circ}\text{C}$ 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 $+20^{\circ}\text{C}$.

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 Spectrum Analyser was connected to the transmitter output. For each temperature, the carrier frequency was recorded. In addition, the carrier frequency was recorded when the power was set to 138 VAC (115% of the maximum specified voltage 120 VAC) and to 97.75 VAC (85% of the minimum specified voltage 120 VAC).

Result

Nominal Frequency: 13.559885 MHz @ 20 deg C.

Temperature, $^{\circ}\text{C}$	Measured Frequency, MHz	Measured Frequency, MHz	Measured Frequency, MHz	Maximum difference, Hz
	120 VAC	138 VAC	97.75 VAC	
+50	13.559895			+10
+20	13.559885	13.559917	13.559914	+29
-20	13.559855			-30

The frequency tolerance is within $\pm 0.01\%$.

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	X
R&S, ESI07, EMI Receiver	1088-7490	9/03	9/04	X
Pacific 140TMX Power Source/Harmonic Analyser	00724/0248	6/03	6/04	

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	
AMZ 41	15957	5/02	5/03	