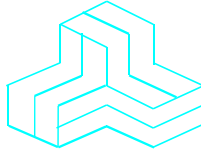


ENGINEERING TEST REPORT



Contactless Payment Expansion Module

FCC ID: O34-CPEM-E1K6567

Applicant:

Ingenico
76 Torbarrie Road
Toronto, ON
Canada, M3L 1G5

In Accordance With

**Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.225
Unlicensed Low Power Transmitter
Operating in the Band 13.110-14.010 MHz**

UltraTech's File No.: IVI-164F15C225

This Test report is Issued under the Authority of
Tri M. Luu, Professional Engineer,
Vice President of Engineering
UltraTech Group of Labs



Date: August 11, 2005

Report Prepared by: Anca Dobre

Tested by: Hung Trinh, RFI Technician

Issued Date: August 11, 2005

Test Dates: July 21-29 & August 5, 2005

- *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



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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	<ul style="list-style-type: none"> ▪ 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 	OK
1	Test Setup Photos	Radiated Emissions Setup Photos	OK
2	External EUT Photos	External EUT Photos	OK
3	Internal EUT Photos	Internal EUT Photos	OK
4	Cover Letters	<ul style="list-style-type: none"> ▪ Cover Letter 	OK
5	Attestation Statements	<ul style="list-style-type: none"> ▪ Letter from the Applicant to appoint Ultratech to act as an agent ▪ Letter from On Track Innovations Ltd. (OTI) to request for Confidentiality Filing 	OK
6	ID Label/Location Info	<ul style="list-style-type: none"> ▪ ID Label ▪ Location of ID Label 	OK
7	Block Diagrams	Block diagram_OTI	OK
8	Schematic Diagrams	Schematics_OTI	OK
9	Parts List/Tune Up Info	--	N/A
10	Operational Description	Operational Description_OTI	OK
11	RF Exposure Info	N/A	N/A
12	Users Manual	Installation Guide	OK

ULTRATECH GROUP OF LABS

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File #: IVI-164F15C225
 August 11, 2005

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

EXHIBIT 2: INTRODUCTION

2.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.225 – Unlicensed Low Power Transmitter
Title:	Code of Federal Regulations (CFR), Title 47 - Telecommunication, Part 15
Purpose of Test:	To obtain FCC Certification Authorization for Unlicensed Low Power Transmitter Operating within the Band 13.110-14.010 MHz.
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.
Environmental Classification:	Commercial, industrial or business.

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

None.

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-15	2005	Code of Federal Regulations – Telecommunication
ANSI C63.4	2004	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 CISPR 22 +A1 EN 55022	2003-04-10 2004-10-14 2003	Information Technology Equipment - Radio Disturbance Characteristics – Limits and Methods of Measurement
CISPR 16-1-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-2-1	2004	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-1: Conducted disturbance measurement

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EXHIBIT 3: PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	Ingenico
Address:	76 Torbarrie Road Toronto, ON Canada, M3L 1G5
Contact Person:	Mr. Kandeepan Kandeepan Phone #: 416-245-6700/ext.223 Fax #: 416-245-6701 Email Address: kkengaku@ingenico-ca.com

MANUFACTURER	
Name:	On Track Innovations Ltd. (OTI)
Address:	Z.H.R Industrial Zone, Rosh Pina Israel, 12000
Contact Person:	Mr. Hemy Itay Phone #: 972-4-6868000 Fax #: 972-4-6938887 Email Address: h_itay@otiglobal.com

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:	Ingenico Canada Ltd.
Product Name:	Contactless Payment Expansion Module
Serial Number:	Test Sample
Type of Equipment:	Low Power Communication Device Transmitter
Power Input Source:	12 Vdc from the Point of Sale terminal to be used with this device
Primary User Functions of EUT:	RFID card reader

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: IVI-164F15C225
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All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Fixed
Intended Operating Environment:	Commercial, industrial or business
Power Supply Requirement:	12 Vdc from the Point of Sale terminal to be used with this device
RF Output Power Rating:	76.73 dBμV/m peak at 10 meters
Operating Frequency Range:	13.56 MHz
Duty Cycle:	63.93%
26 dB Bandwidth:	8.8 kHz
Modulation Type:	AM
Antenna Connector Type:	Integral (the antenna component is located inside the enclosure)
Antenna Description:	Type: Loop Antenna Frequency Range: 13.56 MHz In/Out Impedance: 50 Ohms Gain: Negative

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	Ethernet port	1	RJ-11	Non-shielded

3.5. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

Ancillary Equipment # 1	
Description:	Point of Sale (POS) terminal
Brand name:	Ingenico
Model Name or Number:	eN-Touch 1000
Serial Number:	0501718091
Connected to EUT's Port:	Ethernet port

Ancillary Equipment # 2	
Description:	AC/DC Adaptor
Brand name:	Sino-American
Model Name or Number:	SA125A-1220V-S
Serial Number:	N/A
Connected to EUT's Port:	N/A

3.6. GENERAL TEST SETUP

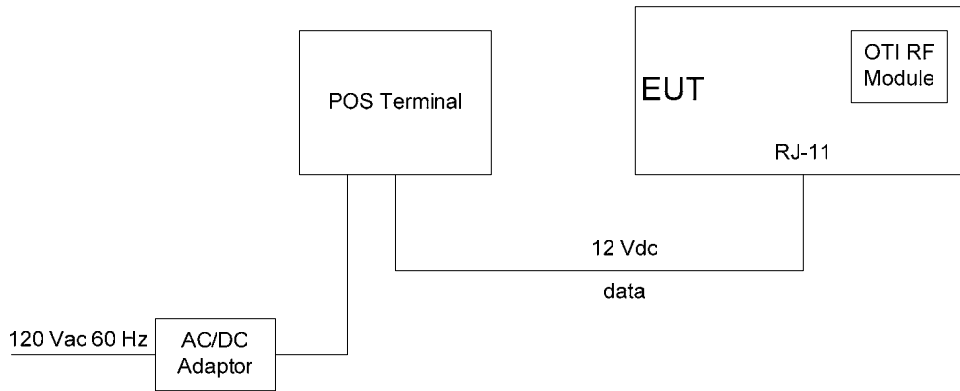


EXHIBIT 4: EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

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:	12 Vdc from the POS terminal to be used with this application

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	The transmitter was operated continuously.
Special Test Software:	Special software was provided by Ingenico to operate the EUT continuously.
Special Hardware Used:	None
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment.

Transmitter Test Signals:	
Frequency Band(s):	13.56 MHz
Frequency(ies) Tested:	13.56 MHz

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, 24'(L) x 16'(W) x 8'(H).
- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario.

The above test 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 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049-1). Last Date of Site Calibration: June 20, 2005.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section (s)	Test Requirements	Compliance (Yes/No)
15.203	The transmitter shall use a transmitting antenna that is an integral part of the device.	Yes
2.1049	26 dB Bandwidth	Yes
15.225(a) & (d)	Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious	Yes
15.225(e)	Frequency Stability	Yes
15.107 & 15. 207	AC Power Conducted Emissions	Yes
15.109(a)	Radiated Emissions from Digital Devices	Yes (See Note)

Note: The digital circuits portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices. The engineering test report can be provided upon requests.

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

The only change was the use of a 50 Ohm SMD resistor soldered at L13 location (see the schematics for further details).

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 Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4.

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 C64.3: 2003, FCC 15.225 and CISPR 16-1.

6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER

RFID Card Reader.

6.5. COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

FCC Section	FCC Rules	Comments
15.203	<p>Described how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT.</p> <p>The exception is in those cases where EUT must be professionally installed. In order to demonstrate that professional installation is required, the following 3 points must be addressed:</p> <ul style="list-style-type: none">• The application (or intended use) of the EUT• The installation requirements of the EUT• The method by which the EUT will be marketed	<p>Conform.</p> <p>Antenna is integral, located inside the enclosure.</p>

6.6. AC POWERLINE CONDUCTED EMISSIONS [§§ 15. 107(a) & 15.207]

6.6.1. Limits

The equipment shall meet the limits of the following table:

Test Frequency Range (MHz)	Class B Limits		Measuring Bandwidth
	Quasi-Peak (dBµV)	Average (dBµV)	
0.15 to 0.5	66 to 56*	56 to 46*	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
0.5 to 5	56	46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
5 to 30	60	50	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average

* Decreasing linearly with logarithm of frequency.

6.6.2. Method of Measurements

Refer to Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4 for measurement methods.

6.6.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Transient Limiter	Hewlett Packard	11947A	310701998	9 kHz – 200 MHz 10 dB attenuation
L.I.S.N.	EMCO	3825/2	89071531	9 kHz – 200 MHz 50 Ohms / 50 µH
24'x16'x8' RF Shielded Chamber	RF Shielding	--	--	--

6.6.4. Test Data

Frequency (MHz)	RF Level (dBμV)	Receiver Detector (QP/AVG)	QP Limit (dBμV)	AVG Limit (dBμV)	Margin (dB)	Pass/Fail	Line Tested (L1/L2)
0.26	50.5	QP	61.3	51.3	-10.8	Pass	L1
0.26	44.8	AVG	61.3	51.3	-6.5	Pass	L1
0.80	46.2	QP	56.0	46.0	-9.8	Pass	L1
0.80	40.2	AVG	56.0	46.0	-5.8	Pass	L1
1.20	46.1	QP	56.0	46.0	-9.9	Pass	L1
1.20	38.2	AVG	56.0	46.0	-7.8	Pass	L1
13.56	49.9	QP	60.0	50.0	-10.1	Pass	L1
13.56	49.1	AVG	60.0	50.0	-0.9	Pass	L1
0.27	51.5	QP	61.2	51.2	-9.7	Pass	L2
0.27	45.7	AVG	61.2	51.2	-5.5	Pass	L2
0.80	45.3	QP	56.0	46.0	-10.7	Pass	L2
0.80	38.9	AVG	56.0	46.0	-7.1	Pass	L2
1.20	45.7	QP	56.0	46.0	-10.3	Pass	L2
1.20	37.4	AVG	56.0	46.0	-8.6	Pass	L2
13.56	49.6	QP	60.0	50.0	-10.4	Pass	L2
13.56	48.8	AVG	60.0	50.0	-1.2	Pass	L2

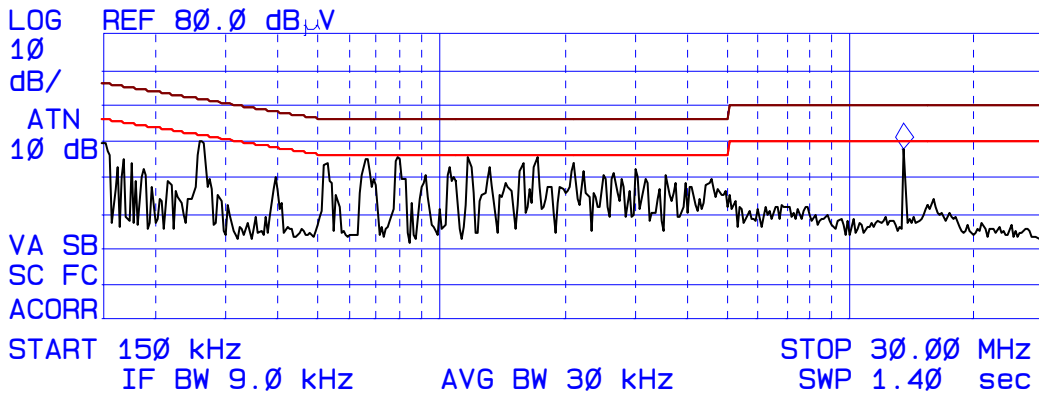
See the following test data plots (1 & 2) for detailed measurement.

Plot # 1: AC Power Line Conducted Emissions
Line Tested: Line 1
Line Voltage: 120 Vac 60 Hz

typ

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV Δ L2
1	0.264855	52.2	50.5	44.8	-6.6
2	0.799510	47.7	46.2	40.2	-5.8
3	1.195135	47.9	46.1	38.2	-7.8
4	13.560330	50.7	49.9	49.1	-0.9

ACTV DET: PEAK
 MEAS DET: PEAK QP AVG
 MKR 13.59 MHz
 47.56 dB μ V

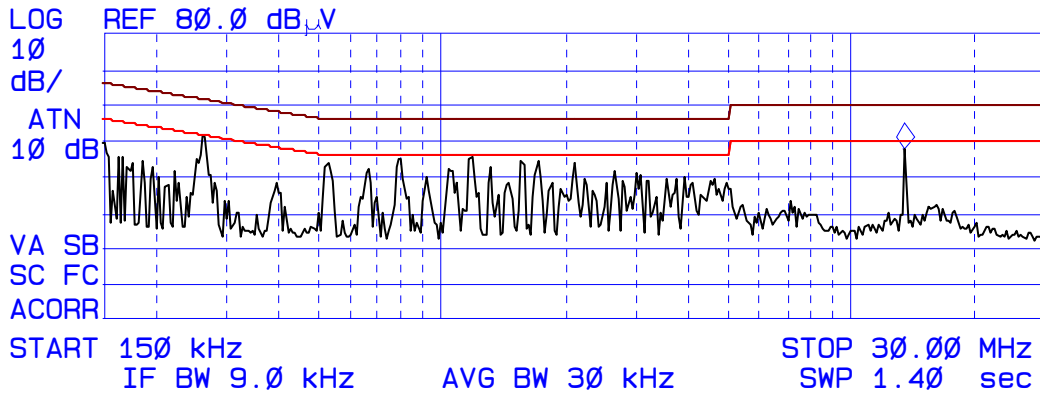


Plot # 2: AC Power Line Conducted Emissions
 Line Tested: Line 2
 Line Voltage: 120 Vac 60 Hz

1/1

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV Δ L2
1	0.266740	53.2	51.5	45.7	-5.6
2	0.797155	46.7	45.3	38.9	-7.1
3	1.195470	47.2	45.7	37.4	-8.6
4	13.560800	50.4	49.6	48.8	-1.2

ACTV DET: PEAK
 MEAS DET: PEAK QP AVG
 MKR 13.59 MHz
 47.47 dB μ V



6.7. 26 dB BANDWIDTH [§ 2.1049]

6.7.1. Limits

The 26dB bandwidth of the emission shall be within the authorized bandwidth for devices operating within the band 13.110-14.010 MHz.

6.7.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004, FCC Section 2.1049 & ANSI C63.4.

The transmitter output was loosely coupled to the spectrum analyzer through a receiving antenna and the bandwidth of bandwidth of the fundamental frequency was measured with the spectrum analyzer with the resolution bandwidth of the spectrum analyzer set per ANSI 63.4.

6.7.3. Test Equipment List

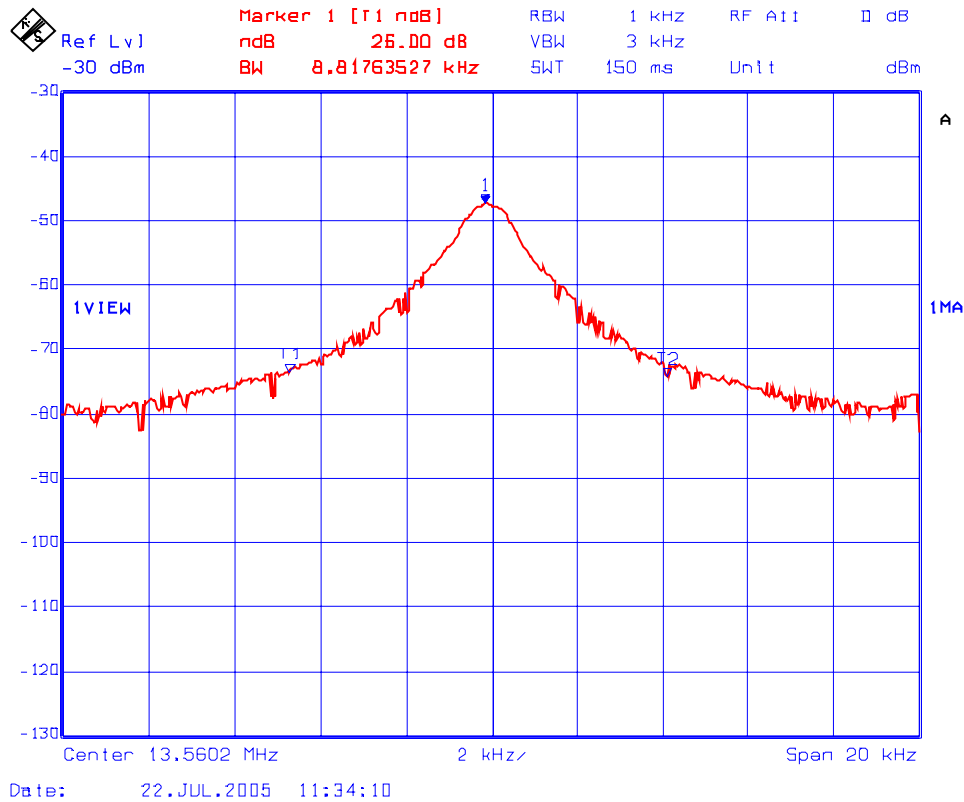
Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz

6.7.4. Test Data

Frequency (MHz)	26 dB Bandwidth (kHz)
13.56	8.8

*See Plot # 3 for details of measurement.

Plot # 3:
26 dB Bandwidth
Test Frequency: 13.56 MHz; Modulation: AM



6.8. TRANSMITTER RADIATED EMISSIONS [§§ 15.225(a),(d), 15.209 & 15.205]

6.8.1. Limits

§15.225 (a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

§15.225 (d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits shown in § 15.209.

Section 15.209(a) – General Radiated Emission Limits

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100 **	3
88–216	150 **	3
216–960	200 **	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76– 88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.

6.8.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004 & ANSI C63.4.

Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.

- For measurements from 9 KHz to 150 KHz, set RBW = 200 Hz, VBW ≥ RBW, SWEEP=AUTO.
- For measurements from 150 KHz to 30 MHz, set RBW = 10 KHz, VBW ≥ RBW, SWEEP=AUTO.
- For measurements from 30 MHz to 1 GHz, set RBW = 100 KHz, VBW ≥ RBW, SWEEP=AUTO.
- For measurement above 1 GHz, set RBW = 1 MHz, VBW = 1 MHz, SWEEP=AUTO.

If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 15.35 (c).

6.8.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
EMI Receiver System/Spectrum Analyzer	Hewlett Packard	HP 8546A	3520A00248	9 kHz – 5.6 GHz with external mixer
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Active Loop Antenna	EMCO	6507	8906-1167	1 kHz-30 MHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz

6.8.4. Test Data

6.8.4.1. Field Strength within the 13.553-13.567 MHz

Frequency (MHz)	Peak E-Field @10m (dBµV/m)	Average E-Field @10m (dBµV/m)	Antenna Orientation	*§15.225(a) @10m (dBµV/m)	Margin (dB)	Pass/Fail
13.56	76.73	72.85	90 degrees	103.1	-30.25	Pass
13.56	70.64	66.76	0 degree	103.1	-36.34	Pass

*The Limit at 30 meters was converted to 10 meters using square factor calculation as follows:

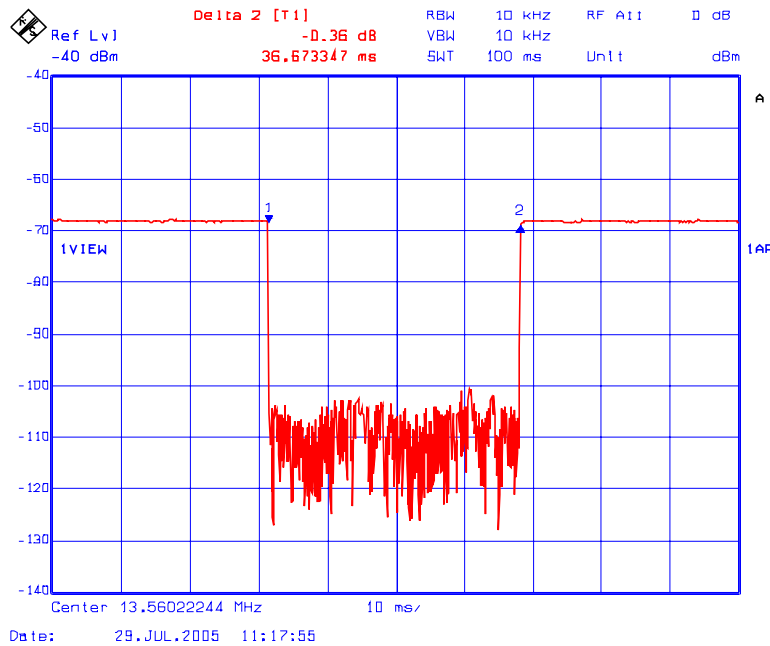
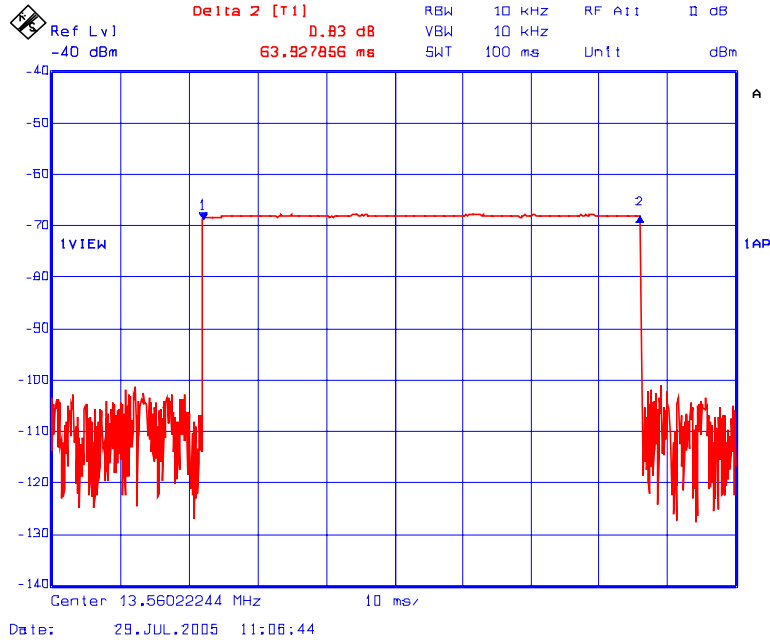
$$\text{Limit}_{10m} = \text{Limit}_{30m} + 40 * \log(30/10) = 103.1 \text{ dB}\mu\text{V/m}$$

Remarks:

- Txon = 63.93 ms
- Duty cycle = Txon/100 = 0.6393
- Peak-to-Average Factor = 20*log (0.6393) = - 3.88 dB

Please refer to the following plots (Plot # 4 to 5) for detailed duty cycle measurements.

Duty Cycle Measurements



6.8.4.2. Field Strength Emissions Appearing Outside of 13.110-14.010 MHz

Frequency (MHz)	Peak E-Field @10m (dBµV/m)	Average E-Field @10m (dBµV/m)	Antenna Orientation	§15.209 @10m (dBµV/m)	Margin (dB)	Pass/Fail
27.118	44.35	40.47	90 degrees	*48.62	-8.15	Pass
27.118	38.54	34.66	0 degrees	48.62	-13.96	Pass
40.677	19.48	15.6	90 degrees	**29.50	-13.90	Pass
54.236	18.09	14.21	90 degrees	29.50	-15.29	Pass
67.795	20.96	17.08	90 degrees	29.50	-12.42	Pass
81.354	25.10	21.22	90 degrees	29.50	-8.28	Pass
108.472	22.04	18.16	90 degrees	***33.06	-14.9	Pass

The emissions were scanned from 30 MHz to 1 GHz at 10 meters distance. All emissions within 20 dB below the permissible limits were recorded.

*Limit at 30 meters was converted to 10 meters using the square factor as follows

$$\text{Limit}_{10m} = \text{Limit}_{30m} + 40 * \log(30/10) = 48.62 \text{ dB}\mu\text{V/m}$$

** Limit at 3 meters was converted to 10 meters using:

$$\text{Limit}_{10m} = \text{Limit}_{3m} - 20 * \log(10/3) = 29.5 \text{ dB}\mu\text{V/m}$$

*** Limit at 3 meters was converted to 10 meters using:

$$\text{Limit}_{10m} = \text{Limit}_{3m} - 20 * \log(10/3) = 33.06 \text{ dB}\mu\text{V/m}$$

6.9. FREQUENCY STABILITY [§§ 2.1055 & 15.225(e)]

6.9.1. Limits

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

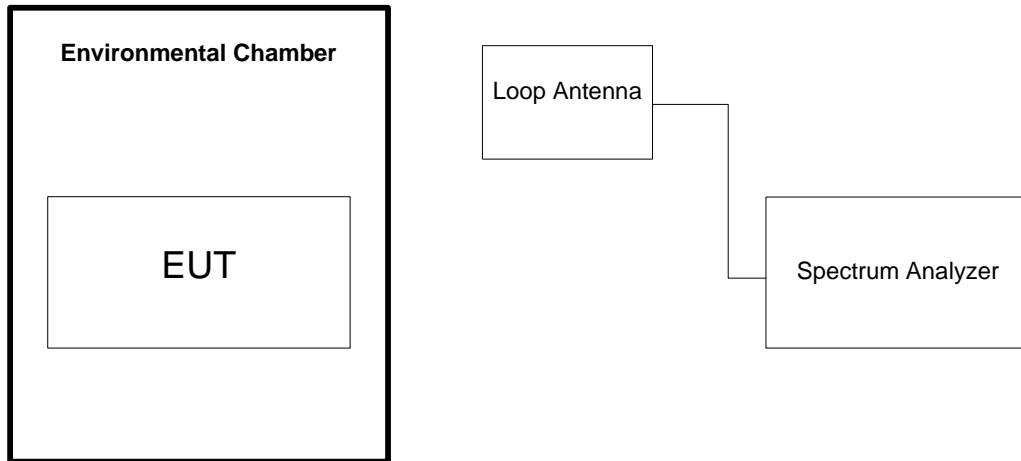
6.9.2. Method of Measurements

Refer to 47 CFR Section 2.1055 for measurement details

6.9.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Hewlett Packard	HP 8546A	3325A00141	9 kHz – 6.5 GHz
Active Loop Antenna	EMCO	6507	8906-1167	1 kHz – 30 MHz
Temperature & Humidity Chamber	Tenney	T5	9723B	-40° to +60° C range

6.9.4. Test Arrangement



6.9.5. Test Data

Product Name:	Contactless Payment Expansion Module
Center Frequency:	13.56 MHz
Full Power Level:	76.73 dB μ V/m peak at 10m
Frequency Tolerance Limit:	\pm 0.01% or 1356 Hz
Max. Frequency Tolerance Measured:	40 Hz or 2.9 ppm
Input Voltage Rating:	12 Vdc

CENTER FREQUENCY & RF POWER OUTPUT VARIATION			
Ambient Temperature (°C)	Supply Voltage (Nominal) 12 Vdc	Supply Voltage (85% of Nominal) 10.2 Volts	Supply Voltage (115% of Nominal) 13.8 Volts
	Hz	Hz	Hz
-30	N/A	N/A	N/A
-20	-40	N/A	N/A
-10	0	N/A	N/A
0	40	N/A	N/A
+10	0	N/A	N/A
+20	0	0	0
+30	-40	N/A	N/A
+40	-40	N/A	N/A
+50	-40	N/A	N/A
+60	N/A	N/A	N/A

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File #: IVI-164F15C225

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

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. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Line Conducted)	PROBABILITY DISTRIBUTION	UNCERTAINTY (dB)	
		9-150 kHz	0.15-30 MHz
EMI Receiver specification	Rectangular	±1.5	±1.5
LISN coupling specification	Rectangular	±1.5	±1.5
Cable and Input Transient Limiter calibration	Normal (k=2)	±0.3	±0.5
Mismatch: Receiver VRC $\Gamma_1 = 0.03$ LISN VRC $\Gamma_R = 0.8(9 \text{ kHz}) 0.2 (30 \text{ MHz})$ Uncertainty limits $20\text{Log}(1 \pm \Gamma_1 \Gamma_R)$	U-Shaped	±0.2	±0.3
System repeatability	Std. deviation	±0.2	±0.05
Repeatability of EUT	--	--	--
Combined standard uncertainty	Normal	±1.25	±1.30
Expanded uncertainty U	Normal (k=2)	±2.50	±2.60

Sample Calculation for Measurement Accuracy in 150 kHz to 30 MHz Band:

$$u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)} = \pm \sqrt{(1.5^2 + 1.5^2)/3 + (0.5/2)^2 + (0.05/2)^2 + 0.35^2} = \pm 1.30 \text{ dB}$$

$$U = 2u_c(y) = \pm 2.6 \text{ dB}$$

7.2. 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 Directivity	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:

$$U = 2u_c(y) = 2x(+2.19) = +4.38 \text{ dB} \quad \text{And} \quad U = 2u_c(y) = 2x(-2.21) = -4.42 \text{ dB}$$