NVLAP LAB CODE:200012-0

MEASUREMENT / TECHNICAL REPORT for Certification

Applicant	: TOKO INC. Gomigaya-18, Tsurugashima-shi, Saitama-ken 350-2281 Japan
Kind of Equipment	: Intentional Radiator 2.4GHz Wireless LAN Card
FCC ID	: NUSTMW1008
Model Number	: TMW1008
Trade Name	: TOKO
Standard	: 47 CFR Part 15 Subpart C Not authorized pursuant to the transition provisions in Section 15.37
Date Received	: 2001-08-08
Date Tested	: 2001-08-08 2001-08-21
Date Report Issued	: 2001-08-29
Report Number	: EMC01816

The measurements covered by this document have been performed in accordance with NVLAP requirements which include the requirements of ISO/IEC Guide 25:1990 and are traceable to national or international standards of measurement.
This report summarizes the result of a single investigation and test results relate only to tested sample performed on the described test object. This test report must not be used by the client to claim product endorsement by NVLAP or agency of the U.S. Government. The report shall not be reproduced except in full without the written approval of the IPS Corporation. We hereby certify that no party to the applications authorized hereunder is subject to a denial of benefits, including FCC benefits, pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C 853(a).

Signature on the cover letter

IPS Corporation
1878-1 Harumiya Ono Tatsuno-machi, Kamiina-gun,
Nagano-ken, 399-0601, Japan.
Phone:+81-266-44-5200 Fax :+81-266-44-5300 A.N

<Table of Contents> <Page>

<Table of Contents> <Page>

1 GENERAL INFORMATION

The test report includes the out of scope of the NVLAP and JAB accreditation. The test results and the measurements made in this test report of following section are out of scope of NVLAP and JAB accreditation.

1.1307 (b)(1), 1.1310 Table 1B
15.247 (a)-(2), (b)-(1), (b)-(3), (b)-(3)-(iii), (b)-(4), (c), (d), (e)

1.1 Product Description

The TOKO INC 2.4GHz Wireless LAN Card, Model: TMW1008, FCC ID: NUSTMW1008 (referred to as the EUT in this report) is operated within the bands 2400 – 2483.5MHz frequency hopping and direct sequence spread spectrum intentional radiators that comply with the section 15.247. It is designed as 2.4GHz Wireless LAN Card and is installed to PCMCIA card slot of the personal computer and it provides 11 channels. The Instruction Manual is referenced to in Annex P of this report for the details of the product description. It is manufactured and marketed by TOKO INC., Japan. It is manufactured in accordance with the technical specifications in Part 1, Part 2 and Part 15, Subpart C of the Code of Federal Regulations 47 as a following part.

1.1307 (b)(1)
1.1310 Table 1B
2.1033 (a), (b)
15.201 (b)
15.203
15.205 (a), (b)
15.207 (a) to (d)
15.209 (a) to (f)
15.247 (a)-(2), (b)-(1), (b)-(3), (b)-(3)-(iii), (b)-(4), (c), (d), (e)

1.2 Summary of Test and Inspection Result

Code of Federal Regulation 47 Part 15 Subpart C

Sec.15.203 Antenna Requirement	Pass
Sec.15.205 (a), (b) Spurious Emission	Pass
Sec.15.207 Conducted Limits	Pass
Sec.15.209 Radiated Emission Limits	Pass
Sec.15.247 (a)-(2)	Pass
Sec.15.247 (b)-(1)	Pass
Sec.15.247 (b)-(3)	Pass
Sec.15.247 (b)-(3)-(iii)	Pass
Sec.15.247 (b)-(4)	Pass
1.1307 (b)(1) EIRP	Pass
1.1310 Table 1B MPE	Pass
Sec.15.247 (c)	Pass
Sec.15.247 (d)	Pass
Sec.15.247 (e)	Pass

(Ref. 2.1033(b)(10))

1.3 Related Submittal(s)/Grant(s)

None

1.4 Tested Systems Details

The pre-production sample of the TOKO INC. 2.4GHz Wireless LAN Card Model: TMW1008 S/N: 00199 028S FCC ID: NUSTMW1008 was tested as part of a system consisting of the **E**quipment **U**nder **T**est, Note PC with AC Adapter, Compact Ten Keyboard, Mouse, CRT Display, Printer with AC Adapter, Modem with AC Adapter, Digital Reference Dynamic Stereo Headphones and Microphone.

EUT, PERIPHERALS, AND CABLES USED

<EUT>	<CABLES>
TOKO 2.4GHz Wireless LAN Card Model : TMW1008 S/N : 00199 028S FCCID : NUSTMW1008	None; Installed to PCMCIA card slot of the Note PC

<PC>	<CABLES>
1) IBM Note PC Model : 2626-HOJ S/N : AA-FMG34 FCC ID : DoC	1.5 m shielded Minipin cable; Bundled to 1 m and hanging approximately in the middle between ground plane and table. One end of the cable is open connected. 3.0 m unshielded LAN cable; Bundled to 1 m and hanging approximately in the middle between ground plane and table. One end of the cable is open connected. 2.0 m shielded S-Video cable; Bundled to 1 m and hanging approximately in the middle between ground plane and table. One end of the cable is open connected.
2) IBM Note PC Model : 2626-NOJ S/N : AA-FM3YM FCC ID : DoC	None.

1.4 Tested Systems Details (Continued)

<PERIPHERALS>	<CABLES>
3) IBM AC Adapter for PC(2626-HOJ) Model : 02K6542 S/N : 1Z0RM8808YL	1.8 m unshielded DC cable from AC Adapter to PC; Bundled to 1 m and hanging approximately in the middle between ground plane and table. Provided

FCC ID : N/A	with a ferrite bead on the PC side end of the cable . 1.0 m unshielded AC power cord; Excess cord is shortened to appropriate length.
4) IBM AC Adapter for PC(2626-NOJ)	1.8 m unshielded DC cable from AC Adapter to PC;
Model : 02K6542	Provided with a ferrite bead on the PC side end of
S/N : 1Z0RM9487HK	the cable and one turn.
FCC ID : N/A	1.0 m unshielded AC power cord; Excess cord is shortened to appropriate length.
5) LOAS Co., Ltd.	
Compact Ten Keyboard	0.8 m shielded Ten Keyboard cable from Keyboard
Model : TNK-MU209GYCGY	to PC(2626-HOJ); Excess cable is shortened to
S/N : 20002328	appropriate length.
FCC ID : DoC	
6) Microsoft Mouse	1.9 m shielded Mouse cable from Mouse to PC
Model : Part No.58264	(2626-HOJ); Excess cable is shortened to .
S/N : 04429363	appropriate length
FCC ID : C3KAZB1	
7) MAG CRT Display	1.9 m shielded Video cable from Display to PC
Model : V5T001	(2626-HOJ); Bundled to 1 m and hanging
S/N : HD80HA001958	approximately in the middle between ground plane
FCC ID : IAWV5T001	and table. Provided with a ferrite bead on both side end of the cable and one turn. 2.0 m unshielded AC power cord; Excess cord is shortened to appropriate length.

1.4 Tested Systems Details (Continued)

<PERIPHERALS>	<CABLES>
8) HP Printer	3.0 m shielded Printer cable from Printer to PC;
Model : C4608A	Bundled to 1 m and hanging approximately in the
S/N : SG7641F0DY	middle between ground plane and table.
FCC ID : B94C2164X	
9) HP AC Adapter for Printer	1.8 m unshielded DC cable from AC Adapter to
Model : C2178A	Printer; Bundled to 1 m and hanging
S/N : 280597	approximately in the middle between ground.
FCC ID : N/A	plane and table.

	0.9 m unshielded AC power cord; Excess cord is shortened to appropriate length
10) EPSON Modem Model : C202A S/N : 010802 FCC ID : BKM552C202A	3.0 m shielded Serial cable from Modem to PC; Bundled to 1 m and hanging approximately in the middle between ground plane and table. Two 2.1 m Modular cables; Bundled to 1 m and hanging approximately in the middle between ground plane and table. One end of the cables is open connected.
11) EPSON AC Adapter for Modem Model : HOOCAA S/N : 022733 FCC ID : N/A	1.9 m unshielded DC cable from AC Adapter to Modem; Excess cable is shortened to appropriate length.
12) Sony Digital Reference Dynamic Stereo Headphones Model : MDR-CD270 S/N : N/A FCC ID : N/A	3.5 m shielded Headphone cable from Headphones to PC; Excess cable is shortened to appropriate length.
13) Microphone Model : N/A S/N : N/A FCC ID : N/A	1.5 m shielded Microphone cable from Microphone to PC; Excess cable is shortened to appropriate length.

1.4 Tested Systems Details (Continued)

<PERIPHERALS>	<CABLES>
14) TOKO Wireless LAN Card Model : TMW1008 S/N : 00198 0285	None; Installed to PC card slot of the Note PC (2626-NOJ)

1.5 Test Methodology

Interference measurements were made in accordance with ANSI C63.4-1992 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. Radiate testing in the range of 9 kHz to 30 MHz was performed at an antenna-to-EUT distance of 3 meters under the 15.209 (e) and 15.31 (f) (2). Radiate testing in the range of 30 MHz to 1000 MHz was performed at an antenna-to-EUT distance of 3 meters under the 15.209 (a). And radiate testing in the range of 1 GHz to 25 GHz (10th harmonic of the highest fundamental frequency, 15.209 (f) and 15.33 (a) (1) for the spectrum investigation was performed at an antenna-to-EUT distance of 3 meters under the 15.209 (e) and 15.31 (f) (1).

1.6 Test Facility

The Test facility has been certified to Quality System for EMC Testing Service by TUV CERT. Proof has been furnished that the requirements according to DIN EN ISO 9002 / JIS Z 9902 are fulfilled. (Certificate Registration No. 09 100 6813)

Conducted Interference Voltage test and Radiated interference Field Strength test was performed in the No.2 3 meter semi-anechoic chamber located at IPS Corp., 1878-1, Harumiya Ono Tatsuno-machi, Kamiina-gun, Nagano-ken, 399-0601, Japan. This Laboratory is Accredited under the National Voluntary Laboratory Accreditation Program (NVLAP) by United States Department of Commerce, National Institute of Standard and Technology (NIST) for satisfactory compliance with criteria established in Title 15, Part 285 Code of Federal Regulations. These criteria encompass the requirements of ISO/IEC Guide 25 and the relevant requirements of ISO 9002 (ANSI/ASQC Q92-1987) as suppliers of calibration or test results. Accreditation awarded for specific services, listed on the Scope of Accreditation for: ELECTROMAGNETIC COMPATIBILITY AND TELECOMMUNICATIONS FCC. (NVLAP LAB CODE: 200012-0). And this laboratory is listed by Federal Communications Commission, Equipment Authorization Division. (Registration Number: 93663)

This Laboratory is accredited by Japan Accreditation Board for Conformity Assessment for satisfactory compliance with JAB RL100 and RL152-1997 of JAB Regulations. These criteria encompass the requirements of ISO/IEC 17025 and the relevant requirements of JIS Q 17025 as suppliers of calibration or test results. Accreditation awarded for specific services, listed on the Scope of Accreditation for: ELECTROMAGNETIC COMPATIBILITY TESTING (JAB Accredit No.: RTL0010).

2 PRODUCT LABELING

Figure 2.1 FCC ID Label

See Annex A.

Figure 2.2 Location of Label on EUT

See Annex B.

3 SYSTEM TEST CONFIGURATION

3.1 Justification

1. Emission tests were performed with no deviation from the ANSI C63.4-1992.
2. The system was configured for testing a typical fashion (as a customer would normally use it.). Radiated testing in the range of 1 GHz to 25 GHz was investigated with the spectrum (peak detector function) under the FCC regulation section 15.209 (e) and 15.35 (b). The test performed at an antenna to EUT distance of 3 meter. The level of any unwanted emissions from EUT was not exceeding the level of the fundamental emission (Compliance with 15.209 (c)). And test result found to be compliance with FCC regulation section 15.209 (a) Radiated emission limits (500 micro-volts/meter). Data is presented for the "worst case" measurements, that E.U.T was normal operated. The EUT provide a copper electric conducted tape for the inside of the enclosure. These same tapes should be used on the mass production unit.
3. The EUT power is supplied from PC via multi voltage input AC Adapter (rated 100 – 240V AC). Therefore test was performed with AC 120V. (as not appropriate section 15.31 (e))
4. All tests were performed with the representative channel operation as follows.
   a. Lowest frequency channel : CH1: 2412MHz
   b. Middle frequency channel : CH6: 2437MHz
   c. Highest frequency channel : CH11: 2462MHz

3.2 EUT Exercise Software

The EUT exercise program used during radiated and conducted testing was designed to exercise the various system components in manner similar to a typical use. The program sequentially exercises each system component in turn. The sequence used is: (1) an H pattern is printed on the monitor (2) serial port sends the data to modem (3) mass storage devices of the PC are exercised, and (4) parallel port sends the data to the printer which prints an H (5) The data is transmitted and received between the EUT and the client PC. The complete cycle takes about 2 seconds and is reported continuously. As the Mouse and Ten Keyboard are strictly input devices, no data is transmitted to. They are, however, continuously scanned for data input activity.

3.3 Special Accessories

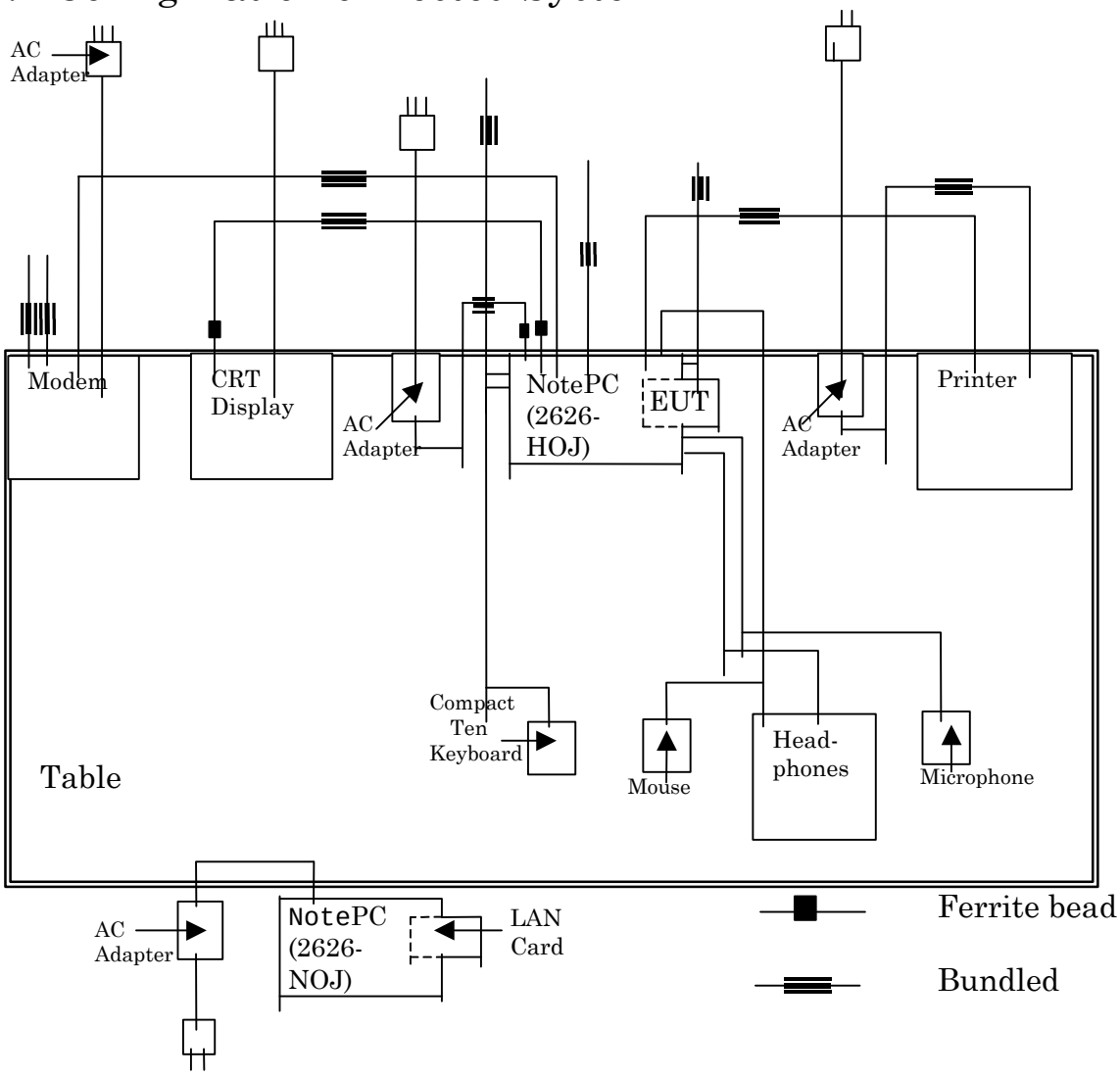
None

3.4 Equipment Modifications

No modification has been carried out.

3.5 Configuration of Tested System

Figure 3.1 Configuration of Tested System



CONDUCTED TEST CONFIGURATION : Figure 6.1(See Annex F)
RADIATED TEST CONFIGURATION : Figure 7.1 (9kHz – 30MHz)
: Figure 7.2 (30MHz – 1GHz)
: Figure 7.3 (1GHz – 25GHz)
(See Annex F)

4 BLOCK DIAGRAM (S) OF FCC ID: NUSTMW1008

4.1 Block Diagram Description

Provided oscillators are described in the Block Diagram.

Figure 4.1 Block Diagram of FCC ID: NUSTMW1008

See Annex C.

5 ANTENNA REQUIREMENT

The EUT is provided with permanently attached antennas and it is found to be compliant with FCC regulation section 15.203.

See Annex D, pages 1 to 6, for the description and characteristics of the antennas.

6 CONDUCTED EMISSION TEST

6.1 Test Setup

The test setup was made according to ANSI STD C63.4-1992 clause 7 in the No.2 3m semi-anechoic chamber. The rear of non-conductive wooden tabletop was placed 0.4 m from a vertical metal reference plane, which is secured to metal floor of the semi-anechoic chamber by screws. Rear of the EUT and the peripherals shall be all aligned and flush with rear of non-conductive wooden tabletop. This table was 0.8 m high x 2.0 m wide x 1.0 m deep size. The Headphones were flush with the front of tabletop and Mouse, Compact Ten Keyboard and Microphone were flush with the back of Headphones. Spacing between each of the equipment maintains the minimum of 10 cm. The client PC system was located away from the table. Connection of the AC Adapter of PC (EUT) to the artificial mains network (LISN) is required and the AC Adapter of PC (EUT) is located so that the distance between the boundary of the AC Adapter of PC (EUT) and the closet surface of the artificial mains network is 0.8 m, where a mains flexible cord is provided by the manufacturer. This is 2.0 m long and excess cable was folded back and forth as far as possible to 0.8 m so as to from a bundle not exceeding 0.4 m in length. Interconnecting cables of tabletop equipment that hang closer than 0.4 m to the floor ground plane shall be folded back and forth forming a bundle 30 to 40 cm long, hanging approximately in the middle between ground plane and table or the excess cable is shortened to appropriate length. The measurement has been conducted with both line and neutral power supply polarization. The highest voltage of the EUT has been recorded. By varying the configuration of the test sample and the cable routing it was attempted to maximize the voltage emission. For further description of the configuration refer to the pictures of this report.

6.2 Instrumentation

List of the Instrumentation for the Test.

1) Equipment : Test Receiver (For the final Measurement)
Model No : HP8546A
S/N : 3807A00483
Manufacturer : Hewlett Packard
Frequency Range : 9 kHz to 6.5 GHz
System Bandwidth : 9 kHz
Detector : Quasi-Peak
Last Calibrated : 2000-08-29
Next Calibration : 2001-08-29

2) Equipment : LISN for EUT
Model No : KNW-407
S/N : 8-1420-14
Manufacturer : Kyoritsu
Frequency Range : 0.15 MHz to 30 MHz
RF Load : 50 Ù 50 µH
Last Calibrated : 2001-04-16
Next Calibration : 2002-04-16

3) Equipment : LISN for Peripherals
Model No : D2601
S/N : 62600145
Manufacturer : Device
Frequency Range : 0.15 MHz to 30 MHz
RF Load : 50 Ù 50 µH
Last Calibrated : 2001/04/16
Next Calibration : 2002/04/16

4) Equipment : 50 ohm Terminator for Second LISN
Model No : CT-05BP
S/N : 5G363
Manufacturer : Tamagawa Electronics
Last Calibrated : 2001/01/06
Next Calibration : 2002/01/06

6.2 Instrumentation (Continued)

List of the Instrumentation for the Test.

5) Equipment : Transient Limiter
Model No : 11947A

S/N : 3107A02621(3/3)
Manufacturer : Hewlett Packard
Frequency Range : 9 kHz to 30 MHz
Calibrated with the cable system

6) Equipment : Cable System
Consists of : 3/3 Transient Limiter
: 1/3,2/3 cables
Manufacturer : IPS Corporation
Frequency Range : 0.15 MHz to 30 MHz
Last Calibrated : 2000-12-14
Next Calibration : 2001-12-14

6.3 Measurement Data

1) CH1: 2412MHz
File No.: 001 See Annex E, pages 1 to 4
(Spectrum Chart is presented)

Summary of the measurement result (Worst measurement):
Phase N, 0.457MHz, 39.5dB(μV) Quasi-Peak Value and it has 8.5dB margin from the Limit (48.0dB(μV)).

2) CH6: 2437MHz
File No.: 003 See Annex E, pages 5 to 8
(Spectrum Chart is presented)

Summary of the measurement result (Worst measurement):
Phase N, 0.459MHz, 37.4dB(μV) Quasi-Peak Value and it has 10.6dB margin from the Limit (48.0dB(μV)).

3) CH11: 2462MHz
File No.: 005 See Annex E, pages 9 to 12
(Spectrum Chart is presented)

Summary of the measurement result (Worst measurement):
Phase N, 0.457MHz, 38.1dB(μV) Quasi-Peak Value and it has 9.9dB margin from the Limit (48.0dB(μV)).

Measurement Uncertainties: [measurement Result dB(μV)] +,- 1.4dB

The report expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with NVLAP requirements.

Test Result: Pass

Disturbance other than those mentioned are small or not detectable.

6.4 CONDUCTED MEASUREMENT PHOTOS

Figure 6.1 Configuration photo of Conducted Measurement

See Annex F

7 RADIATED EMISSION TEST

7.1 Test Setup

The test setup was made according to ANSI STD C63.4-1992 clause 8 on the No.2 3 meter semi-anechoic chamber, which allows a 3 m distance measurement. Rear of the PC (EUT) and the peripherals shall be all aligned and flush with rear of non-conductive wooden tabletop. This table was 0.8 m high, 2.0 m wide and 1.0 m deep. The Headphones were flush with the front of tabletop and the Mouse, Compact Ten Keyboard and Microphone were flush with the back of the Headphones. Spacing between each of the equipment maintained the minimum of 10 cm. The client PC system was located away from the table. Connection of the AC Adapter of PC (EUT) to the artificial mains network (LISN) is required and artificial mains network is located under the turntable. The mains flexible cords were dropped to the floor and are routed over to receptacle. Interconnecting cables of tabletop equipment that hang closer than 0.4 m to the ground plane shall be folded back and forth forming a bundle 30 to 40 cm long, hanging approximately in the middle between ground plane and table or the excess cable is shortened to appropriate length. The measurement has been conducted with both horizontal and vertical antenna polarization. The turntable has been fully rotated. The highest radiation of the equipment has been recorded. By varying the configuration of the test sample and the cable routing it was attempted to maximize the voltage emission. For further description of the configuration refer to the pictures of this report.

Distance between equipment and antenna	: 3 m
Height of antenna	: 1 m (9kHz to 30MHz)
	: 1 m to 4 m (30MHz to 25GHz)

7.2 Instrumentation

List of the Instrumentation for the Test.

1) Facility : No.2 3 m semi-anechoic chamber
Manufacturer : Otsuka Science Co., Ltd.
Frequency Range : 9 kHz to 1000 MHz
Last Calibrated : 2001-02-07
Next Calibration : 2002-02-07

2) Equipment :Test Receiver(For the final measurement for 9kHz-30MHz and 1-6.5GHz)
Model No. : HP8546A
S/N : 3807A00483
Manufacturer : Hewlett Packard
Frequency Range : 9 kHz to 6.5 GHz
System Bandwidth
9-150kHz Band : 200Hz
150kHz-30MHz Band : 9kHz
1GHz- Band : 1MHz
Detector : Quasi-Peak and Average
Last Calibrated : 2000-08-29
Next Calibration : 2001-08-29

3) Equipment :Test Receiver(For the final measurement for 30-1000MHz)
Model No. :HP8542E
S/N :3710A00203
Manufacturer : Hewlett Packard
Frequency Range :9kHz to 2.9GHz
System Bandwidth :120kHz
Detector :Quasi-Peak
Last Calibrated :2000-12-01
Next Calibration :2001-12-01

7.2 Instrumentation (Continued)

List of the Instrumentation for the Test.

4) Equipment :Spectrum Analyzer(For the final measurement for

1-25GHz)

Model No. :HP8564EC
S/N :4046A00400
Manufacturer :Agilent Technologies
Frequency Range :30Hz to 40GHz
System Bandwidth :1MHz
Detector :Peak
Last Calibrated :2001-01-31
Next Calibration :2002-01-31

5) Equipment : Bilog Antenna (For the spectrum analysis)
Model No. : CBL6140A
S/N : 1123
Manufacturer : Chase
Frequency Range : 30 MHz to 1000 MHz
Last Calibrated : 2001-01-13
Next Calibration : 2002-01-13

6) Equipment : Tunable Dipole Antenna
(For the final measurement for 1GHz to 6.5GHz)
Model No. : VHA9103
S/N : 91031586
Manufacturer : Schwarzbeck
Frequency Range : 30 MHz to 300 MHz
Last Calibrated : 2001-05-28
Next Calibration : 2002-05-28

7) Equipment : Tunable Dipole Antenna
(For the final measurement for 9kHz to 1GHz)
Model No. : UHA9105
S/N : 91052125
Manufacturer : Schwarzbeck
Frequency Range : 300 MHz to 1000 MHz
Last Calibrated : 2001-05-28
Next Calibration : 2002-05-28

7.2 Instrumentation (Continued)

List of the Instrumentation for the Test.

8) Equipment : Attenuator (Connected to the Antenna)
Model No. : MP721A
S/N : M48971 (1/7)

Manufacturer : Anritsu
Frequency Range : 30 MHz to 1000 MHz
Calibrated with the Cable system

9) Equipment : Step Attenuator (For the Pre-Amp. Saturation)
Model No. : HP8494B
S/N : 3308A37638(4/7)
Manufacturer : Hewlett Packard
Frequency Range : 30 MHz to 1000 MHz
Calibrated with the Cable system

10) Equipment : Pre Amplifier
Model No. : HP8347A
S/N : 3307A01779(6/7)
Manufacturer : Hewlett Packard
Frequency Range : 30 MHz to 3000 MHz
Calibrated with the Cable system

11) Equipment : Cable System
Consists of :1/7 Attenuator, 4/7 Step Attenuator
:6/7 Pre-Amplifier
:2/7,3/7,5/7,7/7 Cables
Manufacturer : IPS Corporation
Frequency Range : 30 MHz to 1000 MHz
Last Calibrated : 2000-12-14
Next Calibration : 2001-12-14

12) Equipment : Loop Antenna
Model No. : HLA6120
S/N : 1131
Manufacturer : Chase
Frequency Range : 9 kHz to 30 MHz
Last Calibrated : 2000-06-12
Next Calibration : 2003-06-12

7.2 Instrumentation (Continued)

List of the Instrumentation for the Test.

13) Equipment : Double Rigid Guide Antenna
Model No. : 3115
S/N : 9512-4647
Manufacturer : EMCO
Frequency Range : 1 GHz to 18 GHz
Last Calibrated : 1999-09-23
Next Calibration : 2002-09-23

14) Equipment : Double Rigid Guide Antenna
Model No. : 3116
S/N : 9512-2277
Manufacturer : EMCO
Frequency Range : 18 GHz to 40 GHz
Last Calibrated : 1999-09-17
Next Calibration : 2002-09-17

15) Equipment : Pre Amplifier
Model No. : HP8449B
S/N : 3008A01101A
Manufacturer : Hewlett Packard
Frequency Range : 1GHz to 26.5GHz
Calibrated with the Cable system

16) Equipment : Sucoflex102 Cable System (For 1GHz to 26.5GHz)
Consists of : Pre-Amplifier and Cable.
Manufacturer : IPS Corporation
Frequency Range : 1GHz to 26.5GHz
Last Calibrated : 2001/08/04
Next Calibration : 2002/08/04

7.3 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

c.f. = AF + CF - AG

FS = RA + c.f.

Where c.f. = Correction Factor
FS = Field Strength (Emission Level - Result)
RA = Receiver Amplitude (Reading Level)
AF = Antenna Factor
CF = Cable Attenuation Loss
AG = Amplifier Gain

Assume a receiver reading of 52.5 dB(μV) is obtained. The Antenna Factor of 7.4 and a Cable Factor of 1.1 is added. The Amplifier Gain of 29.0 dB is subtracted, giving a field strength of 32.0 dB μV/m . The 32.0 dB μV/m value was mathematically converted to its corresponding level in μV/m.

FS = 52.5 + 7.4 + 1.1 - 29.0 = 32.0 dB μV/m

Level in μV/m = Common Antilogarithm [(32.0 dB μV/m /20 = 39.8 μV/m

7.4 Measurement Data

1) Frequency Range 9kHz to 30MHz

CH1: 2412MHz

File No.: 016 See Annex G, pages 1 to 3
Summary of the measurement result (Worst measurement):
0.490MHz, 61.2dB(μV/m) Quasi-Peak Value and it has 12.6dB margin from the Limit (73.8dB(μV/m)).
Summary of the measurement result (Worst measurement):
0.490MHz, 60.1dB(μV/m) Average Value and it has 13.7dB margin from the Limit (73.8dB(μV/m)).

CH6: 2437MHz

File No.: 015 See , Annex G, pages 4 to 6
Summary of the measurement result (Worst measurement):
0.490MHz, 60.1dB(μV/m) Quasi-Peak Value and it has 13.7dB margin from the Limit (73.8dB(μV/m)).
Summary of the measurement result (Worst measurement):
0.490MHz, 60.0dB(μV/m) Average Value and it has 13.8dB margin from the Limit (73.8dB(μV/m)).

CH11: 2462MHz

File No.: 014 See Annex G, pages 7 to 9
Summary of the measurement result (Worst measurement):
0.490MHz, 59.8dB(μV/m) Quasi-Peak Value and it has 14.0dB margin from the Limit (73.8dB(μV/m)).
Summary of the measurement result (Worst measurement):
0.490MHz, 58.8dB(μV/m) Average Value and it has 15.0dB margin from the Limit (73.8dB(μV/m)).

7.4 Measurement Data (Continued)

2) Frequency Range 30MHz to 1GHz

CH1: 2412MHz

File No.: 001 See Annex G, pages 10 to 13
Summary of the measurement result (Worst measurement):
Vertical Polarization 456.560MHz, 39.7dB(μV/m) Quasi-Peak Value and it has 6.3dB margin from the Limit (46.0dB(μV/m)).

CH6: 2437MHz

File No.: 002 See Annex G, pages 14 to 17
Summary of the measurement result (Worst measurement):
Horizontal Polarization 48.013MHz, 36.1dB(μV/m) Quasi-Peak Value and it has 3.9dB margin from the Limit (40.0dB(μV/m)).

CH11: 2462MHz

File No.: 006 See Annex G, pages 18 to 21
Summary of the measurement result (Worst measurement):
Vertical Polarization 48.008MHz, 36.5dB(μV/m) Quasi-Peak Value and it has 3.5dB margin from the Limit (40.0dB(μV/m)).

Measurement Uncertainties:

30MHz - 300MHz	
Horizontal Polarized	- [Measurement Result dB(μV/m)] +,- 2.5dB
Vertical Polarized	- [Measurement Result dB(μV/m]] +,- 2.7dB
300MHz - 1000MHz	
Horizontal Polarized	- [Measurement Result dB(μV/m) +,- 2.7dB
Vertical Polarized	- [Measurement Result dB(μV/m)] +,- 2.9dB

The report expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with NVLAP requirements.

7.4 Measurement Data (Continued)

3) Frequency Range 1GHz to 25GHz

CH1: 2412MHz

File No.: 008A, 008B & 008 - See Annex G, pages 22 to 35. (Spectrum chart is presented)
The frequency range from 1GHz to 25GHz test performed at an antenna-to-EUT distance of 3 m.
Summary of the measurement result (Worst measurement):
Horizontal Polarization 4075.385MHz, 49.8dB(μV/m) Average Detector Value and it has 4.2dB margin from the Limit (54.0dB(μV/m)).

CH6: 2437MHz

File No.: 010A, 010B & 010 - See Annex G, pages 36 to 49. (Spectrum chart is presented)
The frequency range from 1GHz to 25GHz test performed at an antenna-to-EUT distance of 3 m.
Summary of the measurement result (Worst measurement):
Horizontal Polarization 4125.440MHz, 51.1dB(μV/m) Average Detector Value and it has 2.9dB margin from the Limit (54.0dB(μV/m)).

CH11: 2462MHz

File No.: 012A, 012B & 012 - See Annex G, pages 50 to 63. (Spectrum chart is presented)
The frequency range from 1GHz to 25GHz test performed at an antenna-to-EUT distance of 3 m.
Summary of the measurement result (Worst measurement):
Horizontal Polarization 4175.521MHz, 35.7dB(μV/m) Average Detector Value and it has 2.2dB margin from the Limit (54.0dB(μV/m)).

Measurement Uncertainties (1GHz to 25GHz):
Measurement Uncertainties were not calculated due to the fact that this measurement was performed only for investigation.

Test Result: Pass

Disturbance other than those mentioned are small or not detectable.

7.5 RADIATED MEASUREMENT PHOTOS

Figure 7.1 Configuration photo of Radiated Measurement (9kHz – 30MHz)
See Annex H.

Figure 7.2 Configuration photo of Radiated Measurement (30MHz – 1GHz)
See Annex H.

Figure 7.3 Configuration photo of Radiated Measurement (1GHz – 25GHz)
See Annex H.

8 OPERATION WITHIN THE BANDS 2400-2483.5 (15.247)

8.1 15.247 (a) (2)

See Annex I.
Summary of the measurement result:
EUT is direct sequence system, the minimum 6 dB bandwidth is at 10.3 10.5 MHz .
(Requirement: The minimum 6 dB bandwidth shall be at least 500 kHz)

8.2 15.247 (b) (1)

Summary of the measurement result:
EUT is direct sequence system; the maximum output with peak detector is 17.7mW.
Power Meter: Anritsu ML2437A
Power Sensor: Anritsu MA2472A
(Requirement: The maximum peak output power shall not exceed 1W)

8.3 15.247 (b) (3)

The antenna gain of the EUT is less than 0dBi.
(Requirement: Measurement shall be required for directional gain greater than 6 dBi)

8.4 15.247 (b) (3) (iii)

See Annex P.

8.5 15.247 (b) (4), 1.1307 (b) (1), 1.1310 Table 1B

1.1307 (b) (1) Total EIRP = 12.5 dBm (17.7mW)
1.1310 Table 1B MPE Calculated Distance = 1.187 cm

8.6 15.247 (c)

The EUT is found to be compliant with this section with the investigation of the radiated emission measurement. (See Annex G)
(Requirement: The intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth)

8.7 15.247 (d)

See Annex J.
Summary of the measurement result:
The transmitted continuously spectrum peak power density at any time interval is -12.7 dBm to -13.3 dBm in any 3 kHz bandwidth.
(Requirement: The peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band)

8.8 15.247 (e)

See Annex K.
Summary of the measurement result:

AS measurement using the CW jamming margin method

GP= (S/N) o + Mj + Lsys

Requirement: The processing gain shall be at least 10 dB

Measurement Procedure

1. Measurement systematic diagram
   See attached material. (Annex K, Graph)
   The application of LanEval manufactured by INTERSIL shall be utilized for packet error rate (PER) measurement.
   Note: Packet error rate (PER) is same as Bit error rate (BER).

2. Measurement procedure
   1. The transmitter (TMW1008) shall be kept continuously transmitting. STEP ATTN shall be adjusted to –50dBm for measurement value of power meter. This level is the output value of transmitter in measurement.
   2. Signal Generator (SG) for CW Jammer shall be set to CH1 (2412MHz) and non-modulation and output ON, after the transmitter output OFF. SG output level shall be adjusted to –58.4dBm for measurement value of power meter. This level (–58.4dBm) is the reference level of minimum J/S, 10dB process gain.
   3. CW Jammer is switched OFF, transmitter is ON in transmission conditions, and then packet error shall be measured with the receiver. It shall be confirmed that PER is error-free.
   4. CW Jammer is switched ON at reference level and it shall be confirmed that PER is under 8%.

8.8 15.247 (e) (Continued)

   5. CW Jammer shall be adjusted to PER 8% and it shall be confirmed that the J/S is above –8.4dB to record.
   6. Steps 4 and 5 shall be repeated for measurement at 50kHz step in receiver transit range of ±8.5MHz.
   7. Measurement steps of 1 to 6 shall be repeated in CH6 (2437MHz) and CH11 (2463MHz).

In case that some points are over PER 8% at step 4, it is acceptable if its number is under 20% of total measurement points. (The data of worst 20% must be excluded from the data of all measurement points to evaluate.)

CH1 (2412MHz)

Across the Pass Band : 2403.5 2420.5 MHz
(offset Frequency f = ±8500 kHz)
Discarding the worst 20% of the J/S data points, the lowest remaining J/S ratio = -3.4

(S/N)o = 16.4 , Lsys = 2.0
GP= 16.4 + (-3.4) + 2.0= 15.0 (dB)

CH6 (2437MHz)

Across the Pass Band : 2428.5 2445.5 MHz
(offset Frequency f = ±8500 kHz)
Discarding the worst 20% of the J/S data points, the lowest remaining J/S ratio = -3.5
(S/N)o = 16.4 , Lsys = 2.0
GP= 16.4 + (-3.5) + 2.0= 14.9 (dB)

8.8 15.247 (e) (Continued)

CH11 (2462MHz)

Across the Pass Band : 2453.5 2470.5 MHz
(offset Frequency f = ±8500 kHz)
Discarding the worst 20% of the J/S data points, the lowest remaining J/S ratio = -3.4
(S/N)o = 16.4 , Lsys = 2.0
GP= 16.4 + (-3.4) + 2.0= 15.0 (dB)

Test & Investigation Result : Pass

15.247 (b) (4), 1.1307 (b) (1)

Calculation for Total EIRP

A	B	C	D	E
Specified Antenna Gain (dBi)	Minimum Cable Losses (dB)	Total Antenna Gain (dBi)	Max. RF Output Power at Antenna Terminal (dBm)	Total EIRP (dBm(mW))
0	0	0	12.5 (17.7mW)	12.5 (17.7)

Calculation: C = A + B, E = C + D

Note: Cable losses were very small and it could not be measured due to the fact that the antenna and the transmitting circuit were connected by printed circuit.

15.247 (b) (4) , 1.1310 Table 1B

RF EXPOSURE CALCULATIONS FOR ANTENNA OF WIRELESS LAN CARD, FCC ID: NUSTMW1008

From FCC1.1310 table1B the maximum permissible RF exposure for an uncontrolled environment is 1mW/(cm^2).
The electric field generated for a 1mW/(cm^2) exposure (S) is calculated as follows:

$S = E*E/Z$

Where, S = Power density
E = Electric field
Z = Impedance

$E*E = S \times Z$

1mW/(cm^2) = 10W/(m^2)

Z is 377 ohms of the impedance of free space, where E and H field are perpendicular.
Thus the Electric field to produce a 1mW/(cm^2) exposure is:

$E = \sqrt{(10 \times 377)} = 61.4$ V/m, which is equivalent to 1 mW/(cm^2).

Using the relationship between electric field E, effective radiated power in watts P, and distance in meters D, the corresponding distance D to produce a 1mW/(cm^2) is calculated in the following expression:

$D = \sqrt{(P \times 30) / E} = \sqrt{(17.7 \times 10 \times 30) / 61.4} = 1.187$cm

Where , P : maximum effective radiated power measured, 17.7 mW (12.5 dBm).
E : electric field equivalent to 1 mW/(cm^2), 61.4 V/m

The table below identifies the distance where the 1 mW/(cm^2) exposure limits may be exceeded during continuous transmission using the EUT with internal antenna.

15.247 (b) (4) , 1.1310 Table 1B (Continued)

Antenna Type	Peak output Power		Calculated RF Exposure Separation Distance (cm)
	(dBm)	(mW)	
Integral	12.5	17.7	1.187

CAUTION on the Manual.
"CAUTION: Exposure to Radio Frequency radiation. Antenna shall be mounted in such a manner to minimize the potential for human contact during normal operation. The antenna should not be contacted during operation to avoid the possibility of exceeding the FCC radio frequency exposure limits."

9 APPLICANT AND MANUFACTURER INFORMATION

9.1 Engineering Statement

TYPE OF APPLICATION	: Certification
APPLICABLE RULES	: 47 CFR Part 15 Subpart C
APPLICANT	: TOKO INC. Gomigaya-18, Tsurugashima-shi, Saitama-ken 350-2281 Japan
TRADE NAME	: TOKO
KIND OF EQUIPMENT	: Intentional Radiator 2.4GHz Wireless LAN Card
FCC ID	: NUSTMW1008
MODEL NUMBER	: TMW1008
MEASUREMENT PROCEDURE	: ANSI C63.4-1992 47 CFR Part 15 Subpart C Section 15.247
APPLICANT'S REPRESENTATIVE	: Rikiya Kan / Engineering Manager Module Department

ENGINEERING STATEMENT

I HEREBY STATE THAT: The measurements / test shown in this application were made in accordance with the procedures indicated and the energy emitted and electromagnetic compatibility by this equipment was found to be within the limits applicable.

I FURTHER STATE THAT: On the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the Part 15 of the F.C.C. Rules under normal use and maintenance.

10 PHOTOS OF TESTED EUT

Figure 1 Inner View Component Side of the Main Board.
See Annex L.

Figure 2 Inner View Foil Side of the Main Board.
See Annex M.

Figure 3 Front View.
See Annex N.

Figure 4 Rear View.
See Annex O.