TEST REPORT

Your Ref:

Date: 16 August 2004

Our Ref: 56S040642/01

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NOTE: This report is issued subject to PSB Corporation's "Terms and Conditions Governing Technical Services". The terms and conditions governing the issue of this report are set out as attached within this report.

FORMAL REPORT ON TESTING IN ACCORDANCE WITH
FCC Parts 15B & C : 2004
OF A
WIRELESS PDA
[MODEL : R1000-AB10-200-00]
[FCC ID : RKS-R1001]

TEST FACILITY	Telecoms & EMC, Testing Group, PSB Corporation Pte Ltd 1 Science Park Drive, Singapore 118221
FCC REG. NO.	90937 (3m & 10m OATS) 99142 (10m Anechoic Chamber) 871638 (5m Anechoic Chamber)
IND. CANADA REG. NO.	IC 4257 (10m Anechoic Chamber)
PREPARED FOR	Mr Foong Foo Kong Olympus Technologies Singapore Pte Ltd 41 Science Park Road #04-10 The Germini Singapore Science Park 2 Singapore 117610 Tel : +65 6870 2541 Fax : +65 6870 2548
JOB NUMBER	56S040642
TEST PERIOD	14 August 2004 – 15 August 2004

PREPARED BY	**APPROVED BY**
Lim Cher Hwee Engineer	Deng Jun Hong Assistance Vice President

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LA-2001-0212-A
LA-2001-0213-F
LA-2001-0214-E
LA-2001-0215-B
LA-2001-0216-G
LA-2001-0217-G

The results reported herein have been performed in accordance with the laboratory's terms of accreditation under the Singapore Accreditation Council - Singapore Laboratory Accreditation Scheme

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The product was tested in accordance with the customer's specifications.

Test Results Summary

Test Standard	Description	Pass / Fail
FCC Part 15: 2004		
15.107, 15.207	Conducted Emissions	Pass
15.205	Radiated Emissions (Restricted Band Requirements)	Pass
15.109, 15.209	Radiated Emissions (Spurious Emissions)	Pass
15.247 (a)(1)	Carrier Frequency Separation	Pass
	Spectrum Bandwidth (20dB Bandwidth Measurement)	Pass
15.247 (a)(1)(iii)	Number of Hopping Frequencies	Pass
	Average Frequency Dwell Time	Pass
15.247 (b)(1)	Maximum Peak Power	Pass
15.247 (c)	RF Conducted Spurious Emissions & Band Edge Compliance at the Transmitter Antenna Terminal	Pass
15.247 (d)	Peak Power Spectral Density	Pass

Notes

1. Three channels as listed below, which respectively represent the lower, middle and upper channels of the equipment under test (EUT) were chosen and tested. For each channel, the EUT was configured to operate in the Bluetooth test mode

Transmit Channel	Frequency (GHz)
Channel 0	2.402
Channel 39	2.441
Channel 78	2.480

2. All the measurements in section 15.247 were done based on conducted measurements.

3. The EUT is a Class B device when in non-transmitting state and meets the FCC Part15B Class B requirements.

4. The Equipment Under Test (EUT), Wireless PDA is the worst case emissions unit from the series family as listed below. The unit under test shows the highest emissions. As the family units' circuits, PCB routing and components are identical to the worst case unit being tested, as such, the family units are deemed to meet the FCC requirements.

Models	Operating Systems	RAM	ROM
R1000-6610-100-zz	Linux	64MB	64MB
R1000-6A10-100-zz	Linux	64MB	128MB
R1000-6B10-100-zz	Linux	64MB	256MB
R1000-AA10-100-zz	Linux	128MB	128MB
R1000-AB10-100-zz	Linux	128MB	256MB
R1000-6610-200-zz	WinCE.net	64MB	64MB
R1000-6A10-200-zz	WinCE.net	64MB	128MB
R1000-6B10-200-zz	WinCE.net	64MB	256MB
R1000-AA10-200-zz	WinCE.net	128MB	128MB
R1000-AB10-200-zz	WinCE.net	128MB	256MB
R1000-AA10-3yy-zz	Windows Mobile	128MB	128MB
R1000-AB10-3yy-zz	Windows Mobile	128MB	256MB
R1000-6610-4yy-zz	Palm	64MB	64MB
R1000-6A10-4yy-zz	Palm	64MB	128MB
R1000-6B10-4yy-zz	Palm	64MB	256MB
MIG-380MS-0	WinCE.net	64MB	64MB
MIG-380MS-1	WinCE.net	128MB	128MB
MIG-380MS-2	WinCE.net	128MB	256MB
W380MS-0	WinCE.net	64MB	64MB
W380MS-1	WinCE.net	128MB	128MB
W380MS-2	WinCE.net	128MB	256MB

yy represents the language of instruction used where 00 represents English.
zz represents customization code where 00 represents standard model Olympus.

Modifications

No modifications were done.

Description	:	The Equipment Under Test (EUT) is a **Wireless PDA.** The EUT is a PDA with Bluetooth capability.
Manufacturer	:	Celestica Electronics (S) Pte Ltd 35 #03-01 Marsiling Industrial Estate Road 3 Singapore 739257
Model Number	:	R1000-AB10-200-00
FCC ID	:	RKS-R1001
Serial Number	:	A0005F
Microprocessor	:	MRDM-6828 Ver S1-0i
Operating / Transmitting Frequency	:	2.402GHz to 2.480GHz 79 channels. Starting at 2.402MHz with subsequent channel at 1MHz interval from the preceding channel.
Clock / Oscillator Frequency	:	4MHz (oscillator) 32.768kHz (real time clock)
Modulation	:	Gaussian Frequency Shift Keying (GFSK) with BT = 0.5
Pulse Train Cycle	:	1.25ms / 3.75ms / 6.25ms / Continuos signal (in testing)
Port / Connectors	:	1 x communication port
Rated Input Power	:	5.0VDC 2.0A via an AC/DC adapter

Equipment Description (Including Brand Name)	**Model, Serial & FCC ID Number**	**Cable Description** (List Length, Type & Purpose)
Fujitsu Laptop PC (use for radiated emissions test)	M/N: LBS6130-AH051E0B0 S/N: R4201406 FCC ID: DoC	Nil
Fujitsu Laptop PC AC/DC Adapter (use for radiated emissions test)	M/N: SEB80N2 S/N: 03Y12943B FCC ID: DoC	2.0m unshielded AC power cable 2.0m unshielded DC power cable
Kodak Printer (use for radiated emissions test)	M/N: Diconix 150PLus S/N: PKB9ZYG123 FCC ID: E75WG-EK150	2.0m shielded parallel (printer) cable
Kodak Printer AC/DC Adapter (use for radiated emissions test)	M/N: PSA-122 S/N: R2270001B9 FCC ID: DoC	2.0m unshielded AC power cable 1.5m unshielded DC power cable with ferrite loaded
Lapmate Mouse (use for radiated emissions test)	M/N: A0002614 S/N: Nil FCC ID: DoC	1.0m unshielded mouse cable
HP Keyboard (use for radiated emissions test)	M/N: SK-2502C S/N: M020506330 FCC ID: DoC	1.5m unshielded keyboard cable
NEC Laptop PC (use for all tests except radiated emissions test)	M/N: ADP-500MB S/N: 1186100011 FCC ID: DoC	Nil
NEC Laptop PC AC/DC Adapter (use for all tests except radiated emissions test)	M/N: ADP-50MB S/N: 9201421DA FCC ID: DoC	2.0m unshielded AC power cable 2.0m unshielded DC power cable with ferrite loaded
Seiko Smart Printer (use for all tests except radiated emissions test)	M/N: SLP-220 S/N: B011331000 FCC ID: DoC	2.0m unshielded AC power cable 1.5m shielded parallel (printer) cable)
Compaq Mouse (use for all tests except radiated emissions test)	M/N: 4862A011 S/N: B04AB0H5BFX10NH FCC ID: DZL211029	2.0m unshielded mouse cable
IBM Keyboard (use for all tests except radiated emissions test)	M/N: KB-9910 S/N: 1088517 FCC ID: DoC	2.0m unshielded keyboard cable

EUT OPERATING CONDITIONS

The Wireless PDA was powered from 110V, 60Hz mains supply.

Tests	Description Of Operation
1. Conducted Emissions 2. Radiated Emissions 3. Carrier Frequency Separation 4. Spectrum Bandwidth (20dB Bandwidth Measurement) 5. Number Of Hopping Frequencies 6. Average Frequency Dwell Time 7. Maximum Peak Power 8. RF Conducted Spurious Emissions at the Transmitter Antenna Terminal 9. Band Edge Compliance at the Transmitter Antenna Terminal 10. Peak Power Spectral Density	The EUT was exercised by operating in the following modes/ configurations during the test <u>1. Transmit Mode (Bluetooth Test Mode)</u> The EUT was set to transmit at the maximum transmitting power continuously with frequency hopping on for the following tests: - Carrier Frequency Separation - Number of Hopping Frequency - Average Frequency Dwell Time - Band Edge at the Transmitting Antenna The EUT was set to transmit at the maximum transmitting power continuously with frequency hopping off for the following tests: - Conducted Emissions - Radiated Emissions - Spectrum Bandwidth (20dB Bandwidth Measurement) - Maximum Peak Power - RF Conducted Spurious Emissions at the Transmitter Antenna Terminal - Peak Power Spectral Density <u>2. Non-Transmit Mode (EUT acts as an Unintentional Radiator)</u> The EUT was set to continuously reading and writing files from the memory storage, printing scrolls of character 'H' to the LCD panel and data sinking with the connected host computer (laptop PC).

FCC Part 15B (15.107 & 15.207) Class B Conducted Emission Results

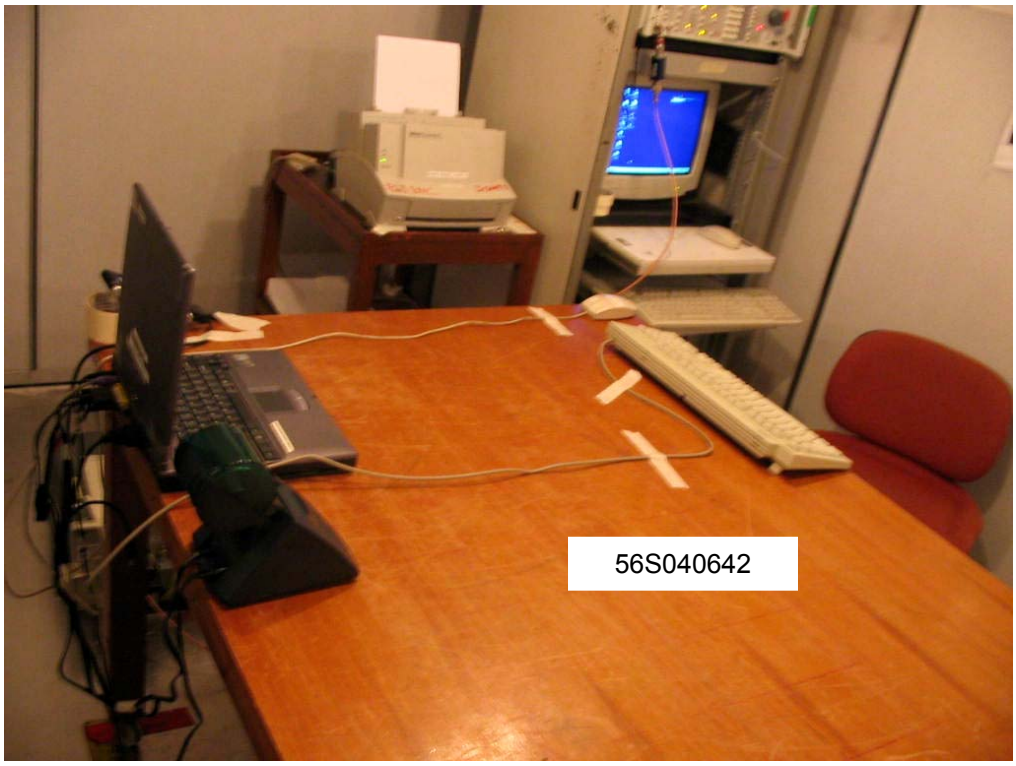
Frequency (MHz)	Q-P Value (dBμV)	Q-P Margin (dB)	AV Value (dBμV)	AV Margin (dB)	Line	Channel
0.1569	49.9	-15.9	35.6	-20.2	Live	0
0.3157	36.2	-25.0	26.1	-25.1	Live	78
2.8571	28.7	-27.3	16.6	-29.4	Live	0
3.1831	29.7	-26.3	13.4	-32.7	Neutral	78
8.1114	37.1	-22.9	12.1	-37.9	Live	39
9.6404	33.4	-26.6	13.3	-36.7	Neutral	39

Tested by: DP

Notes :

1. Environmental Conditions — Temperature: 24°C; Relative Humidity: 55%; Atmospheric Pressure: 1030mbar
2. All possible modes of operation were investigated from 150kHz to 30MHz. Only the 6 worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
3. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
4. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   9kHz - 30MHz
   RBW: 10kHz VBW: 30kHz
5. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 9kHz – 30MHz (Average & Quasi-peak) is ±2.4dB.

Conducted Emissions Setup (Front View)



Conducted Emissions Setup (Rear View)

FCC Part 15 (15.109 & 15.209) Class B Radiated Emission (Spurious Emissions) Results

Test Distance : 3m

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Margin (dB)	Channel	Azimuth (Degrees)	Height (cm)	Polarisation (H/V)
30.6150	37.1	-2.9	39	20	100	V
52.6733	33.4	-6.6	0	306	100	V
122.4021	35.7	-7.8	0	237	100	V
319.9253	38.1	-7.9	78	47	100	H
505.7012	41.5	-4.5	39	56	100	H
585.3063	42.6	-3.4	0	109	100	V

Spurious Emissions above 1GHz

Frequency (GHz)	Peak Value (dBμV/m)	Average Value (dBμV/m)	Average Margin (dB)	Channel	Azimuth (Degrees)	Height (cm)	Pol (H/V)
1.1244	56.3	27.5	-26.5	39	89	100	H
1.2466	56.7	30.0	-24.0	39	108	100	V
1.2511	55.7	28.4	-25.6	0	312	100	H
1.8133	55.6	31.7	-22.3	78	341	100	H
1.9044	55.4	30.7	-23.3	78	177	100	H
2.2155	47.7	33.3	-20.7	39	256	100	H

Tested by: LCH

Notes :

1. Environmental Conditions — Temperature: 25°C; Relative Humidity: 58%; Atmospheric Pressure: 1030mbar
2. All possible modes of operation were investigated and only the worst case emissions were measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
3. Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz. The average measurement was done by averaging over a complete cycle of the pulse train, including the blanking interval as the pulse train duration does not exceed 0.1 second.
4. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
5. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz

6. The peak emissions above 1GHz show compliance to the requirement stated in Section 15.35 (b).
7. The upper frequency of radiated emission investigations were according to requirements stated in Section 15.33 (a) for intentional radiators & Section 15.33 (b) for unintentional radiators.
8. The channel in the table refers to the transmit channel of the EUT.
9. Radiated Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 25GHz (QP only @ 3m & 10m) is ±4.3dB (for EUTs < 0.5m X 0.5m X 0.5m).

FCC Part 15C (15.205) Radiated Emissions (Restricted Band Requirements) Results

Test Distance : 3m

Spurious Emissions (Restricted Band) ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Margin (dB)	Channel	Azimuth (Degrees)	Height (cm)	Polarisation (H/V)
166.2510	37.2	-6.3	78	249	100	V
400.7000	40.6	-5.4	78	35	100	V
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Spurious Emissions (Restricted Band) above 1GHz

Frequency (GHz)	Peak Value (dBμV/m)	Average Value (dBμV/m)	Average Margin (dB)	Channel	Azimuth (Degrees)	Height (cm)	Pol (H/V)
1.1133	55.4	27.3	-26.7	0	176	100	H
1.1155	57.5	26.3	-27.7	78	143	100	H
1.1755	57.6	28.0	-26.0	78	215	100	H
1.3155	55.7	28.3	-25.7	78	233	100	H
1.4999	53.8	34.2	-19.8	78	144	100	H
2.2155	47.8	33.3	-20.7	39	185	100	H

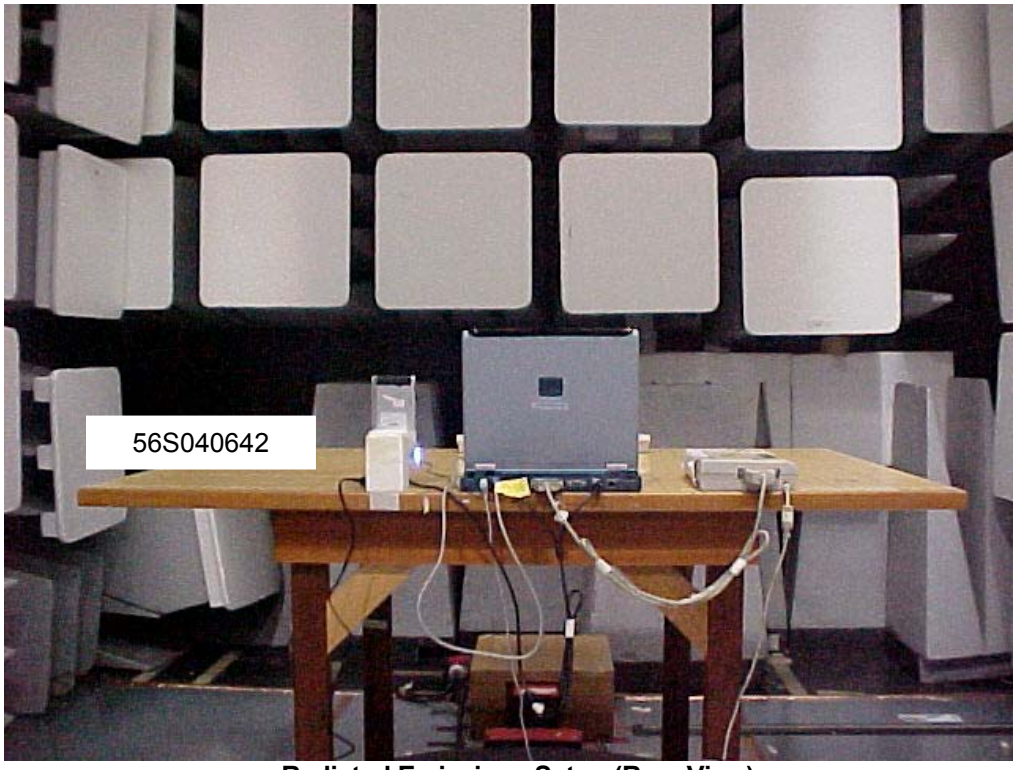
Tested by: LCH

Notes :

1. Environmental Conditions — Temperature: 25°C; Relative Humidity: 58%; Atmospheric Pressure: 1030mbar
2. All possible modes of operation were investigated and only the worst case emissions were measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
3. The "--" in the column indicates no emissions were found in the band of interest and showed compliance to the limits as specified in section 15.209. The emissions were merely the noise floor.
4. Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz. The average measurement was done by averaging over a complete cycle of the pulse train, including the blanking interval as the pulse train duration does not exceed 0.1 second.
5. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
6. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz

7. The peak emissions above 1GHz show compliance to the requirement stated in Section 15.35 (b).
8. The upper frequency of radiated emission investigations were according to requirements stated in Section 15.33 (a) for intentional radiators & Section 15.33 (b) for unintentional radiators.
9. The channel in the table refers to the transmit channel of the EUT.
10. Radiated Emissions Measurement Uncertainty
    All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 25GHz (QP only @ 3m & 10m) is ±4.3dB (for EUTs < 0.5m X 0.5m X 0.5m).

Radiated Emissions Setup (Front View)



Radiated Emissions Setup (Rear View)

FCC Part 15C (15.247(a)(1)) Carrier Frequency Separation Results

The EUT shows compliance to the requirements of this section, which states the adjacent carrier frequencies must be separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

Adjacent Channels	Channel Separation (MHz)
0 and 1 (2.402GHz and 2.403GHz)	1.035
38 and 39 (2.440GHz and 2.441GHz)	1.010
39 and 40 (2.441GHz and 2.442GHz)	1.020
77 and 78 (2.479GHz and 2.480GHz)	1.015

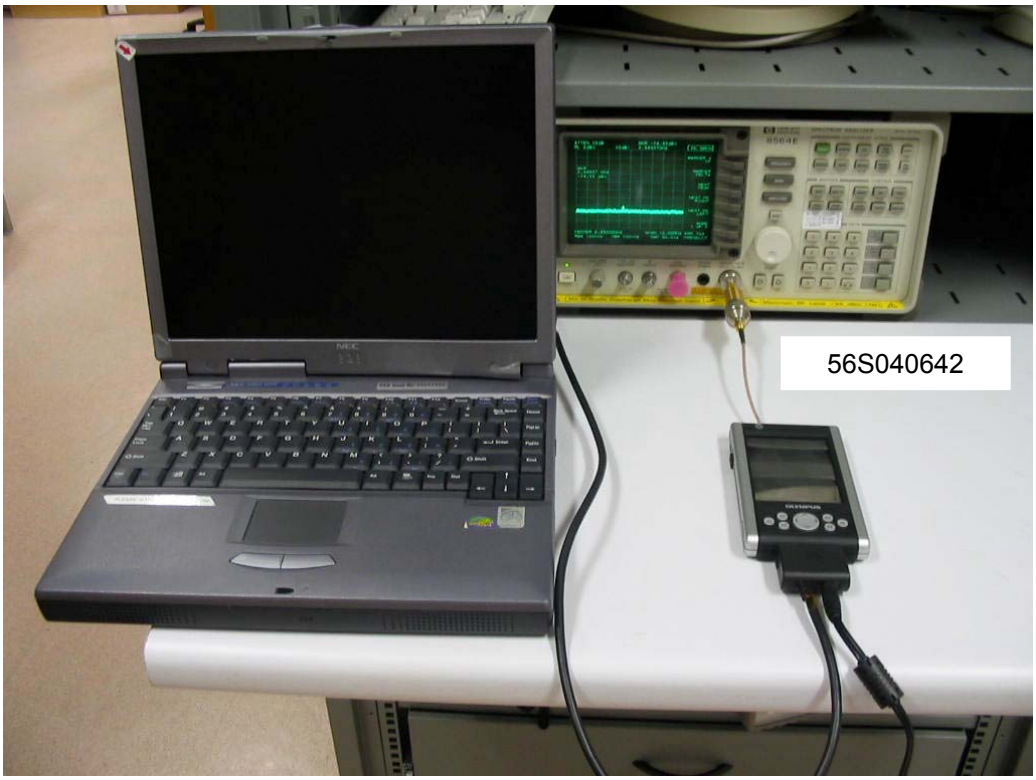
Please refer to the attached Plots 1 - 4 for details.

Tested by: DP

Notes :

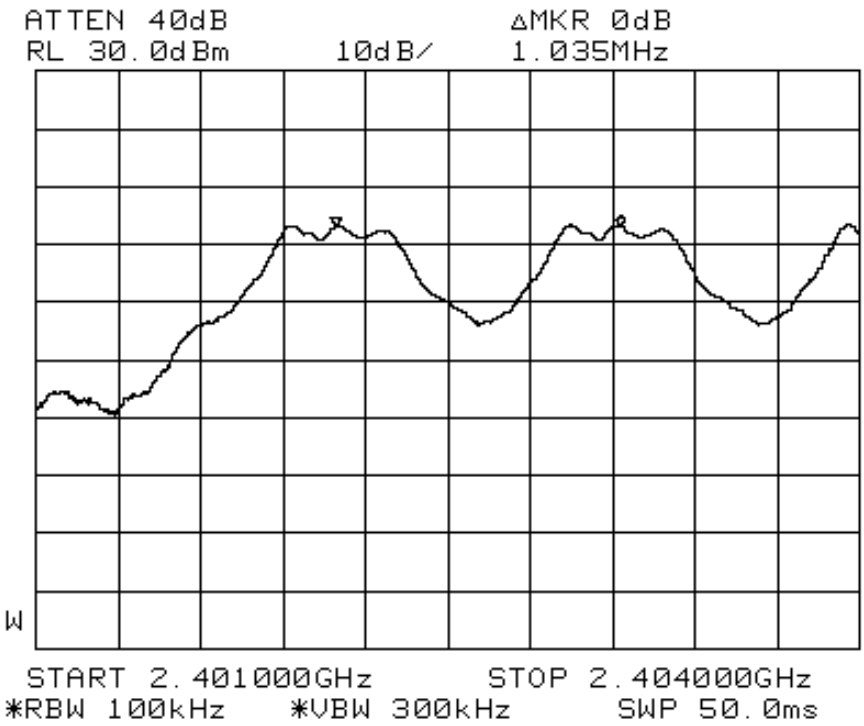
1. Environmental Conditions

Temperature	24°C
Relative Humidity	55%
Atmospheric Pressure	1030mbar

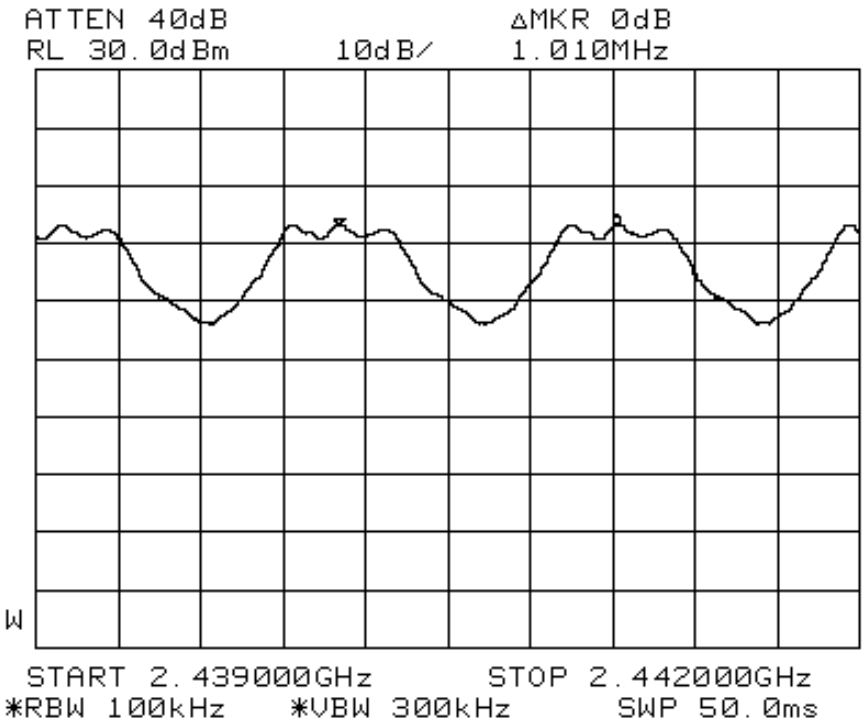


Carrier Frequency Separation Measurement Test Setup

CARRIER FREQUENCY SEPARATION PLOTS

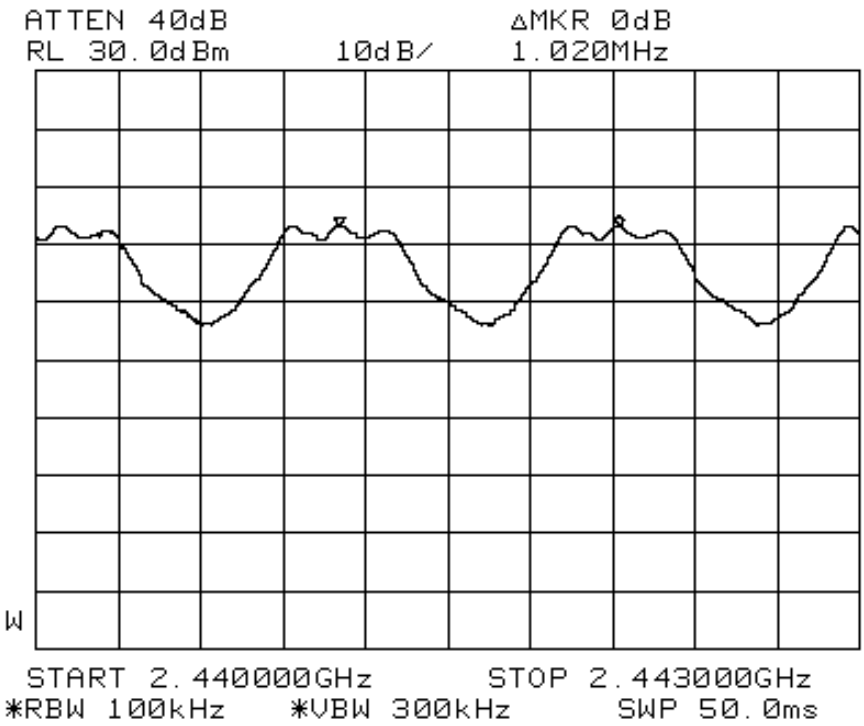


Plot 1- Channels 0 and 1 Separation

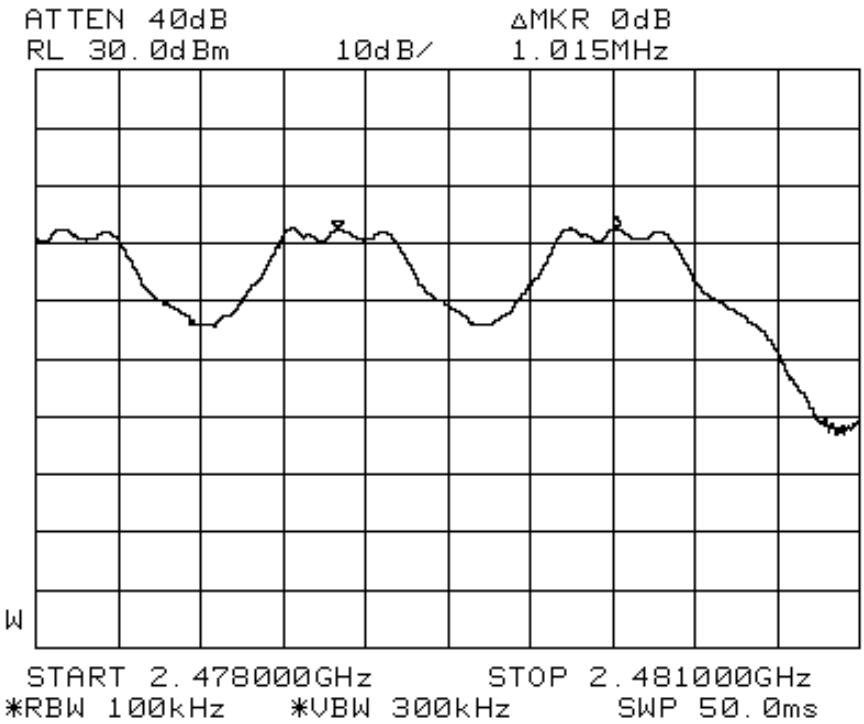


Plot 2 – Channels 38 and 39 Separation

CARRIER FREQUENCY SEPARATION PLOTS



Plot 3 - Channel 39 & 40 Separation



Plot 4 - Channel 77 and 78 Separation

FCC Part 15C (15.247(a)(1)) Spectrum Bandwidth (20dB Bandwidth Measurement) Results

The EUT shows compliance to the requirements of this section, which states that the 20dB bandwidth of the hopping channel shall be the channel frequency separation by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
0	2.402	0.843
39	2.441	0.860
78	2.480	0.857

Note: The EUT is a Bluetooth device, which supports no overlapping for each channel.

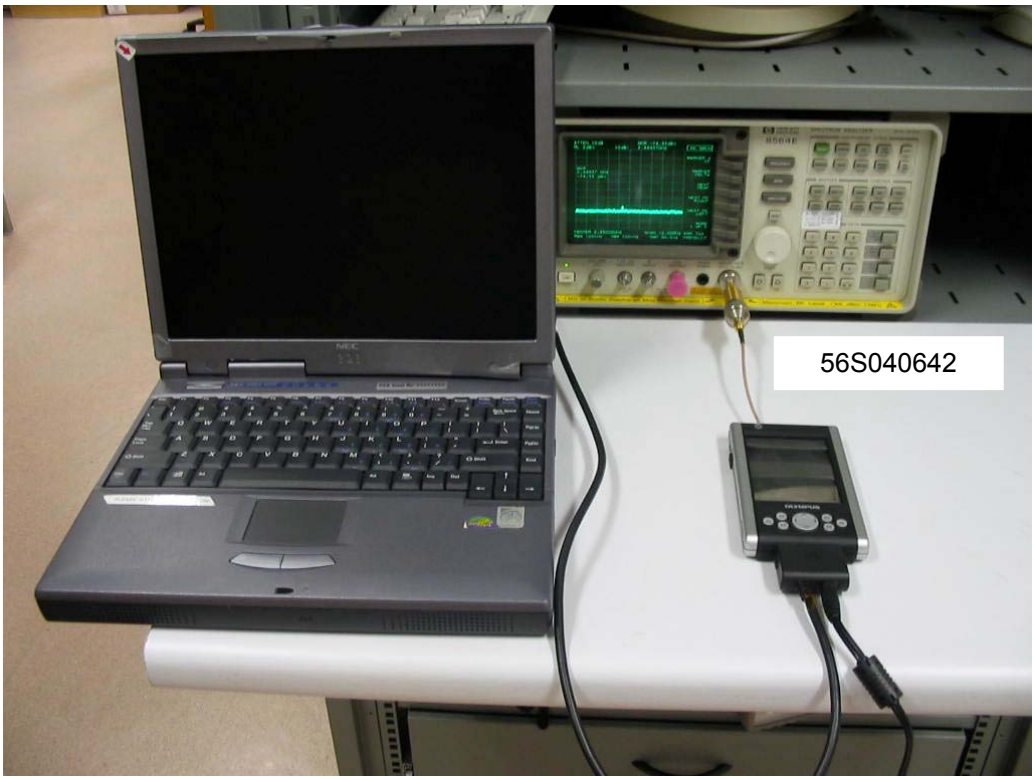
Please refer to attached Plots 5 - 7 for details.

Tested by: DP

Notes :

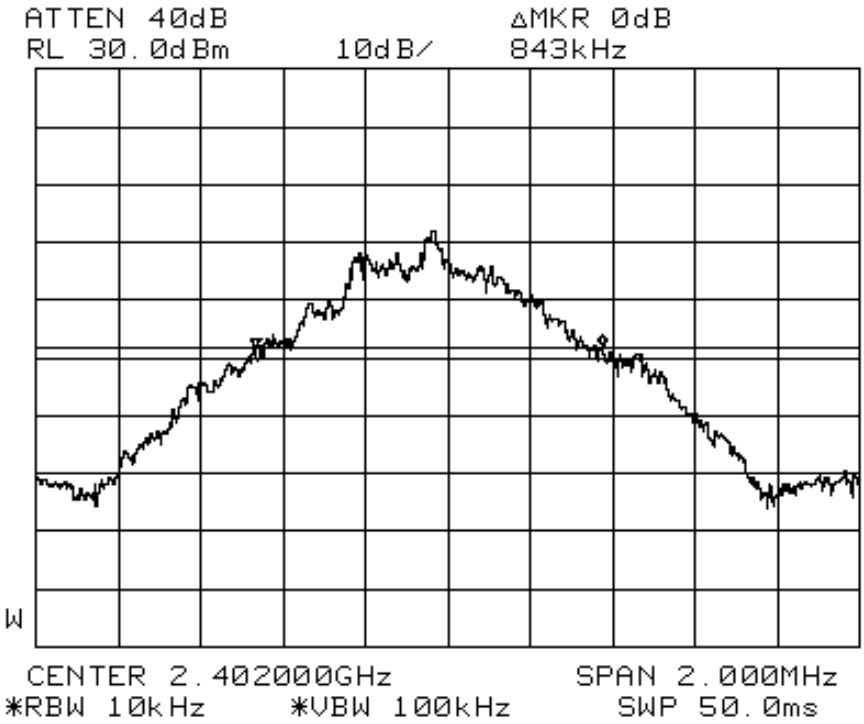
1. Environmental Conditions

Temperature	24°C
Relative Humidity	55%
Atmospheric Pressure	1030mbar

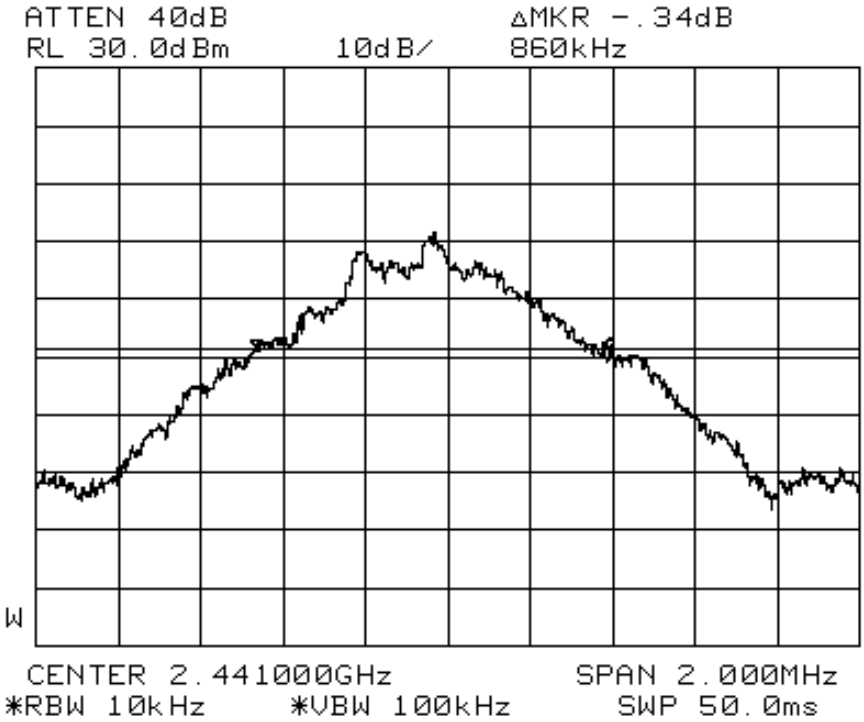


Spectrum Bandwidth Measurement Test Setup

SPECTRUM BANDWIDTH (20DB BANDWIDTH MEASUREMENT) PLOTS

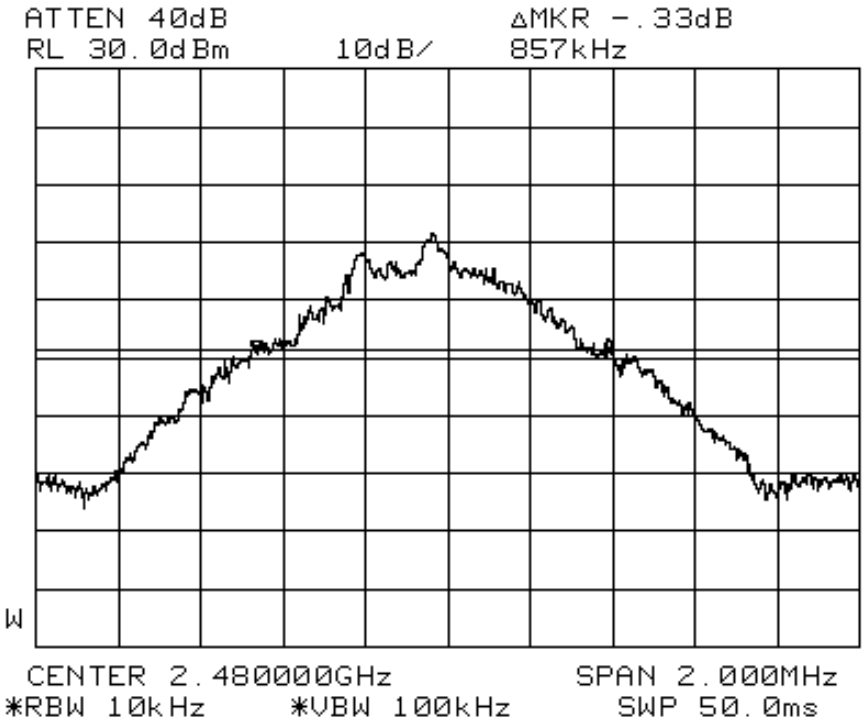


Plot 5 – Channel 0



Plot 6 – Channel 39

SPECTRUM BANDWIDTH (20DB BANDWIDTH MEASUREMENT) PLOTS



Plot 7 – Channel 78

FCC Part 15C (15.247(a)(1)(iii)) Number of Hopping Frequencies Results

The EUT shows compliance to the requirements of this section, which states the number of hopping frequencies shall be at least 75.

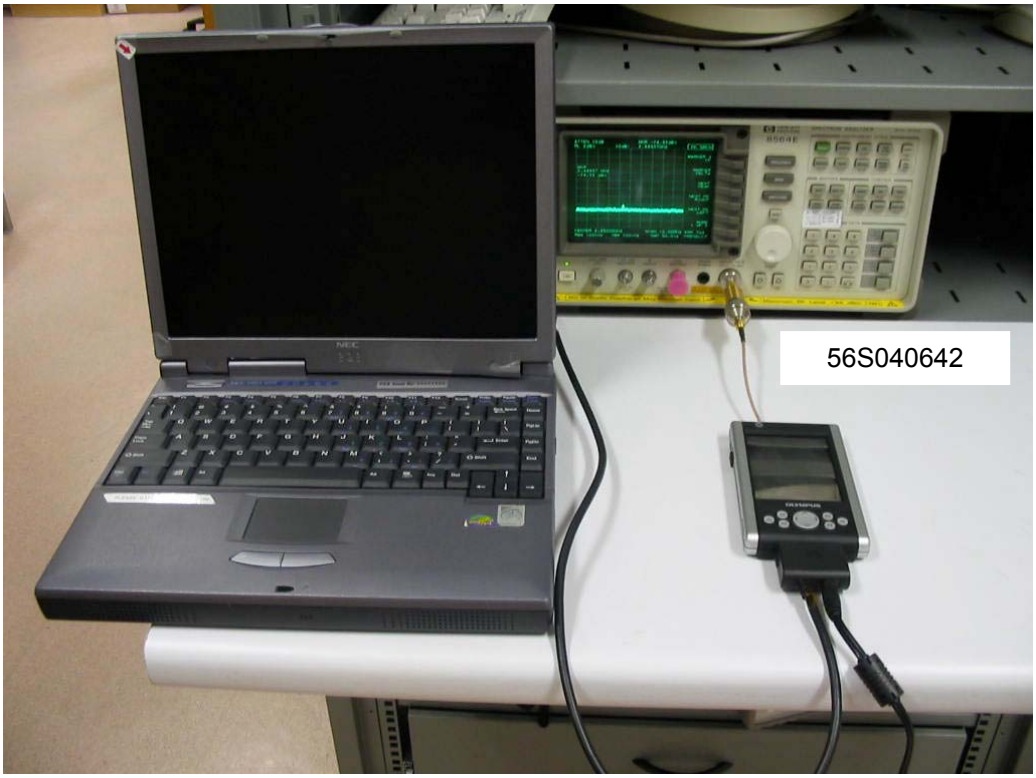
The EUT was found t to have 79 hopping frequencies.

Please refer to the attached Plots 8 - 11 for details.

Tested by: DP

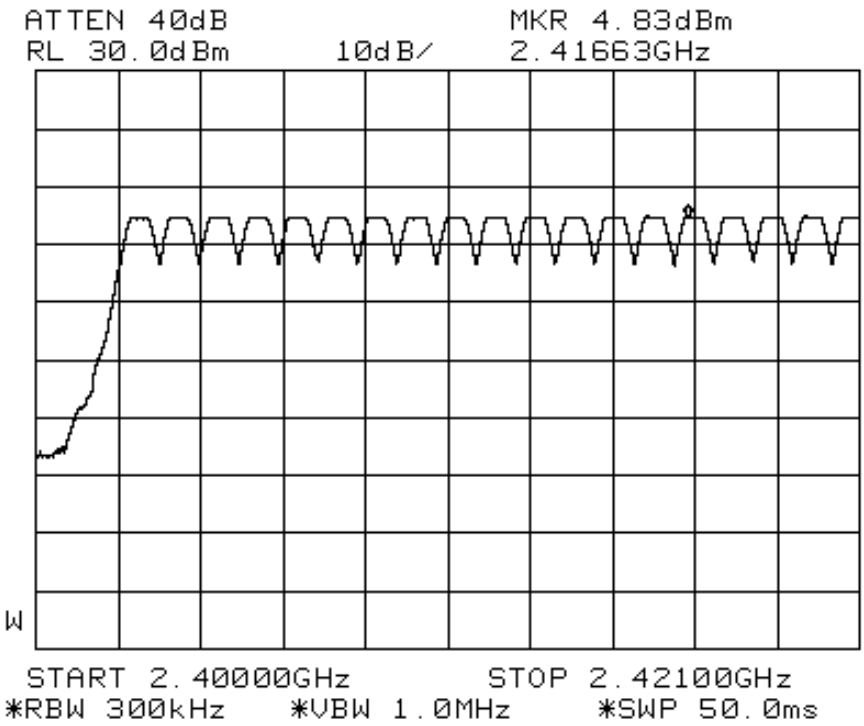
Notes :

1.	Environmental Conditions	Temperature	24°C
		Relative Humidity	55%
		Atmospheric Pressure	1030mbar

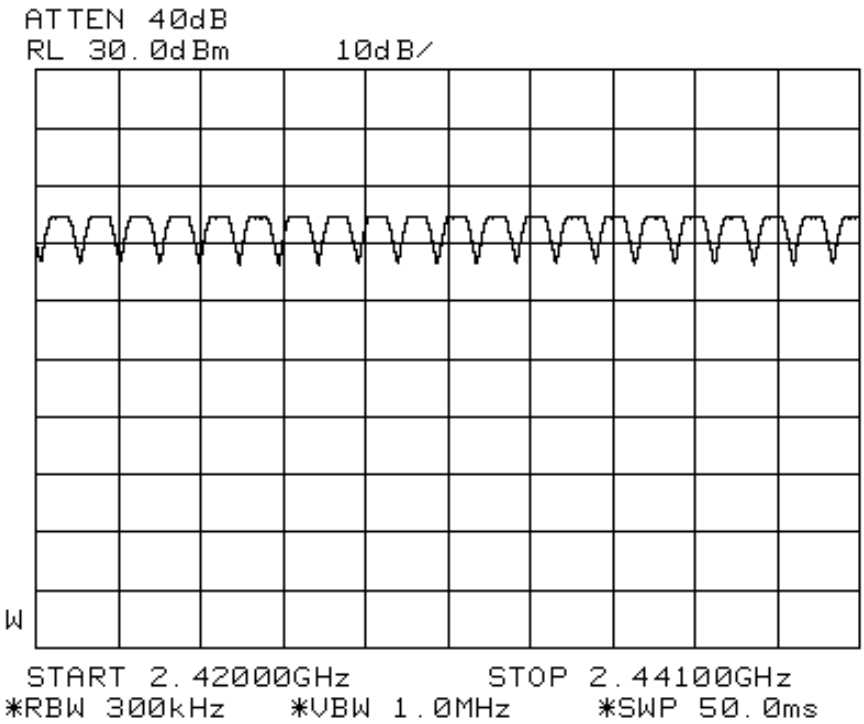


Number of Hopping Frequencies Measurement Test Setup

NUMBER OF HOPPING FREQUENCIES PLOTS

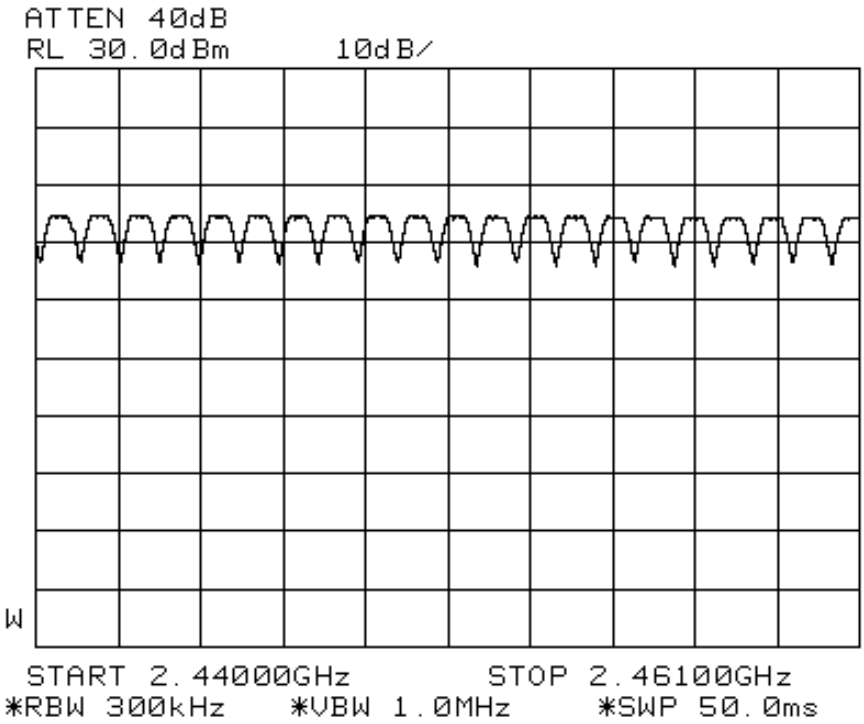


Plot 8 - Channels 0 to 18

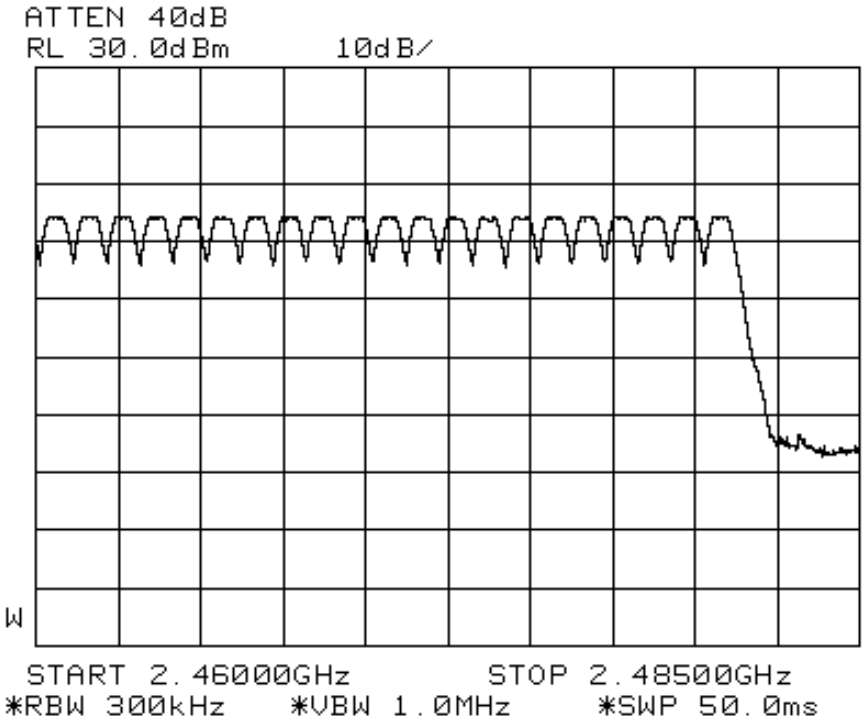


Plot 9 - Channels 19 to 38

NUMBER OF HOPPING FREQUENCIES PLOTS



Plot 10 - Channels 39 to 58



Plot 11 - Channels 59 to 78

FCC Part 15C (15.247(a)(1)(iii)) Average Frequency Dwell Time Results

The EUT shows compliance to the requirements of this section, which states the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a period of 0.4second multiplied by the number of hopping channels employed.

EUT hopping rate = 1600 hops/s
Number of EUT hopping frequencies = 79 hops
DH1packet was used as a transmission packet

Average Frequency Dwell Time = measured time slot length (l) x hopping rate (h) / number of hopping frequencies x 30 seconds period

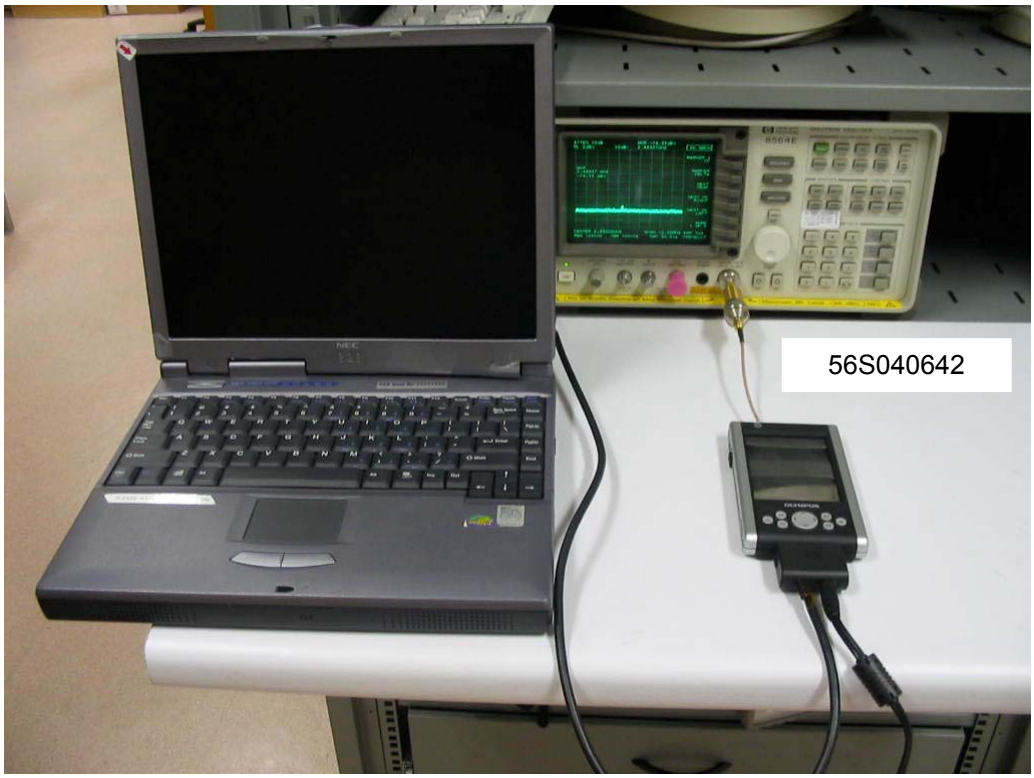
Channel	Channel Frequency (GHz)	Measured Time Slot Length for DH1 Packet(μs)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0	2.402	0.625	0.3798	0.4
39	2.441	0.625	0.3798	0.4
78	2.480	0.625	0.3798	0.4

Please refer to the attached Plots 12 – 14 for details.

Tested by: DP

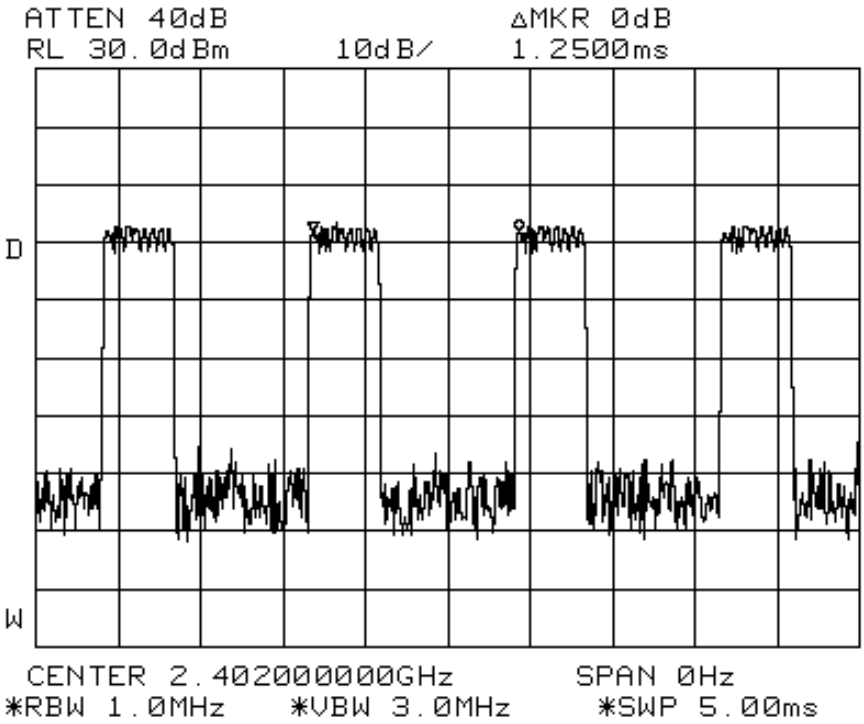
Notes :

1. Environmental Conditions — Temperature: 24°C; Relative Humidity: 55%; Atmospheric Pressure: 1030mbar

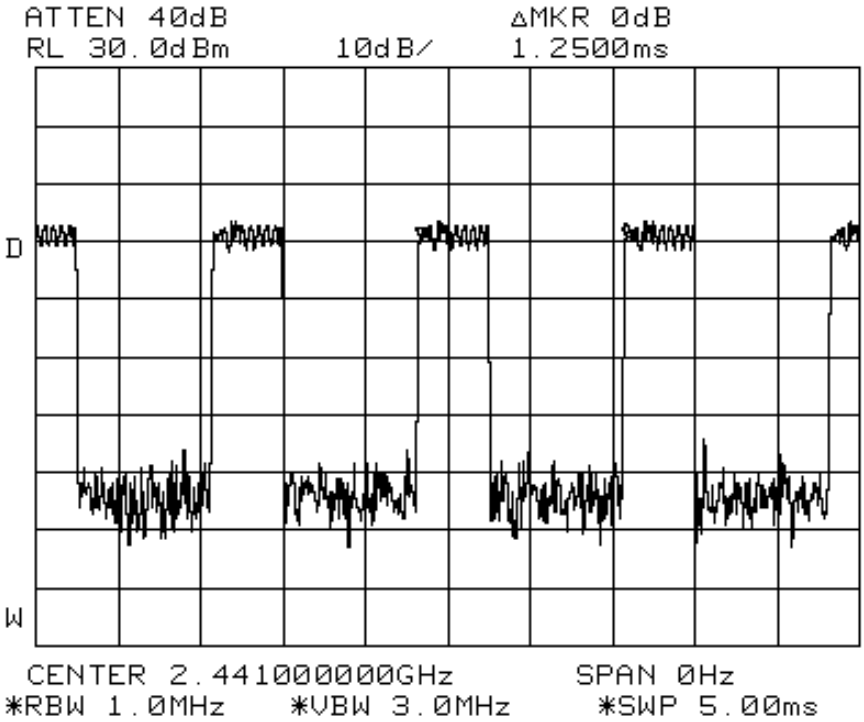


Average Frequency Dwell Time Measurement Test Setup

AVERAGE FREQUENCY DWELL TIME PLOTS

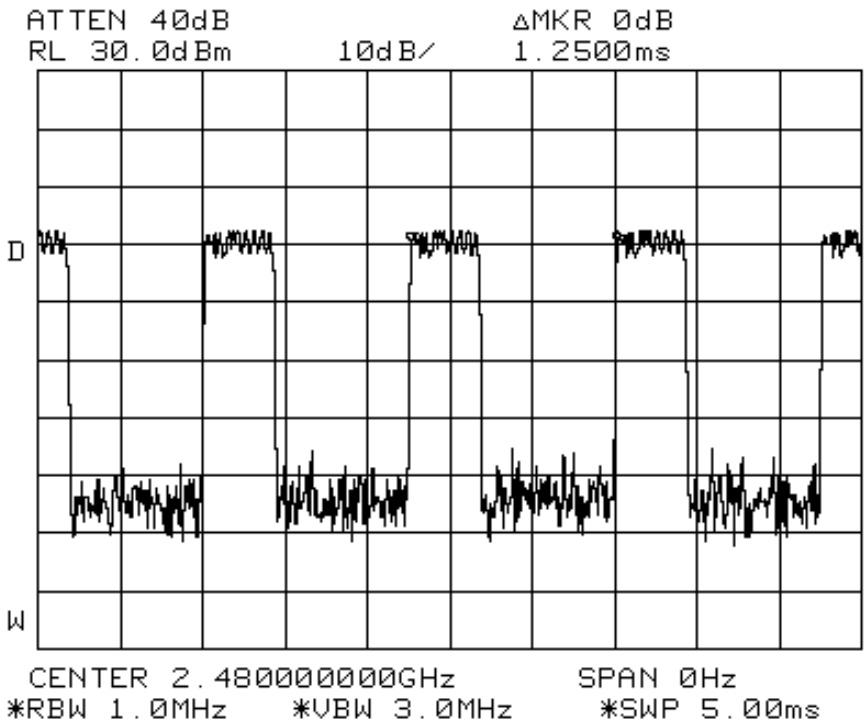


Plot 12 – Channel 0



Plot 13 – Channel 39

AVERAGE FREQUENCY DWELL TIME PLOTS



Plot 14 – Channel 78

FCC Part 15C (15.247(b)(1)) Maximum Peak Power Results

The EUT shows compliance to the requirements of this section, which states the peak power of an intentional radiator (EUT) shall not exceed 30dBm (1 Watt).

The maximum peak power for Channels 0, 39 and 78 at 2.402GHz, 2.441GHz and 2.480GHz respectively were investigated and found below 30dBm (1Watt).

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)
0	2.402	0.002089	1
39	2.441	0.002042	1
78	2.480	0.002108	1

Tested by: DP

Notes :

1. Environmental Conditions — Temperature: 24°C; Relative Humidity: 55%; Atmospheric Pressure: 1030mbar

2. Power analyser of Universal Radio Communication Tester was used for power measurement with peak detection as mode of measurement. The power analyser mode supports a wideband power measurement ranging from 100kHz to 2700MHz.

Maximum Peak Power Measurement Test Setup

FCC Part 15C (15.247(c)) RF Conducted Spurious Emissions & Band Edge Compliance at the Transmitter Antenna Results

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the RF power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

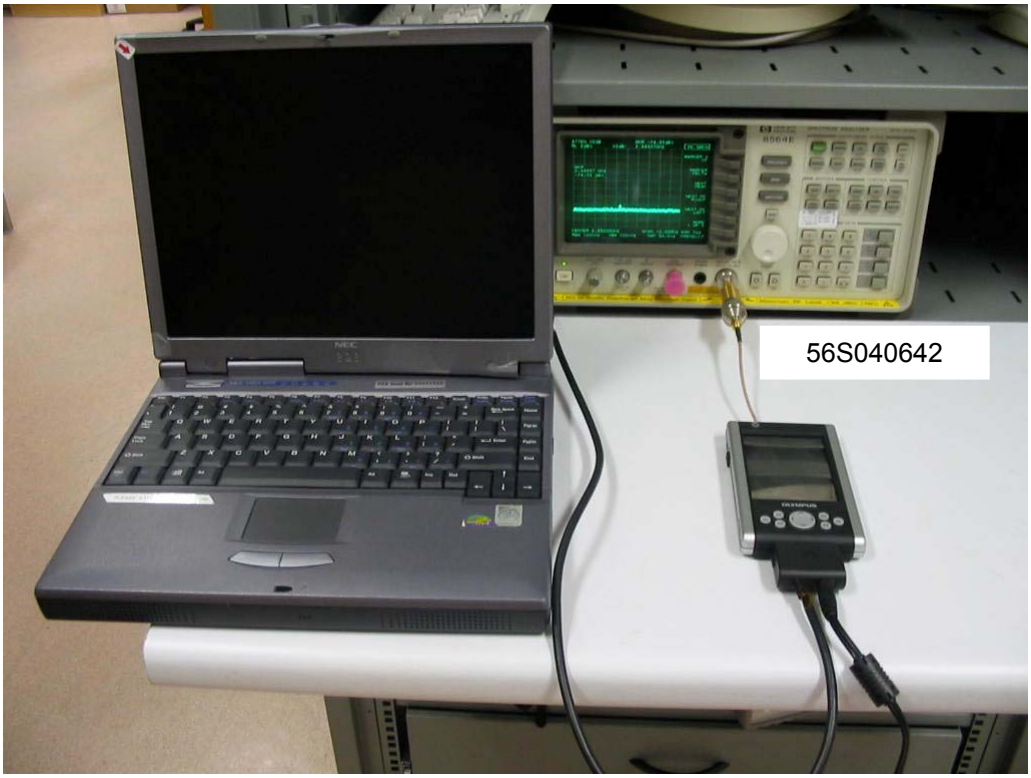
The RF conducted spurious emissions were scanned from 10MHz to 25GHz for Channels 0, 39, and 78 with channel frequency at 2.402GHz, 2.441GHz and 2.480GHz respectively. No significant signal was found and they were below the specified limit. Please refer to the attached Plots 15 – 20 for details.

The conducted spurious at lower and upper band-edges (2.4000GHz and 2.4835GHz) were scanned. The spurious emissions at band-edges were found below the specified limit. Please refer to the attached Plots 21 – 22 for details.

Tested by: DP

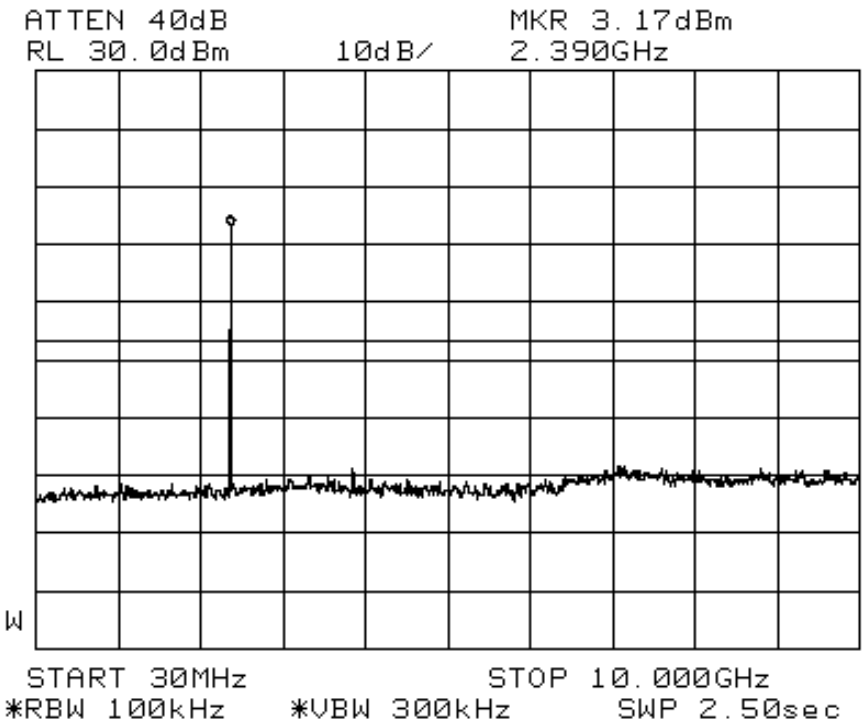
Notes :

1.	Environmental Conditions	Temperature	24°C
		Relative Humidity	55%
		Atmospheric Pressure	1030mbar

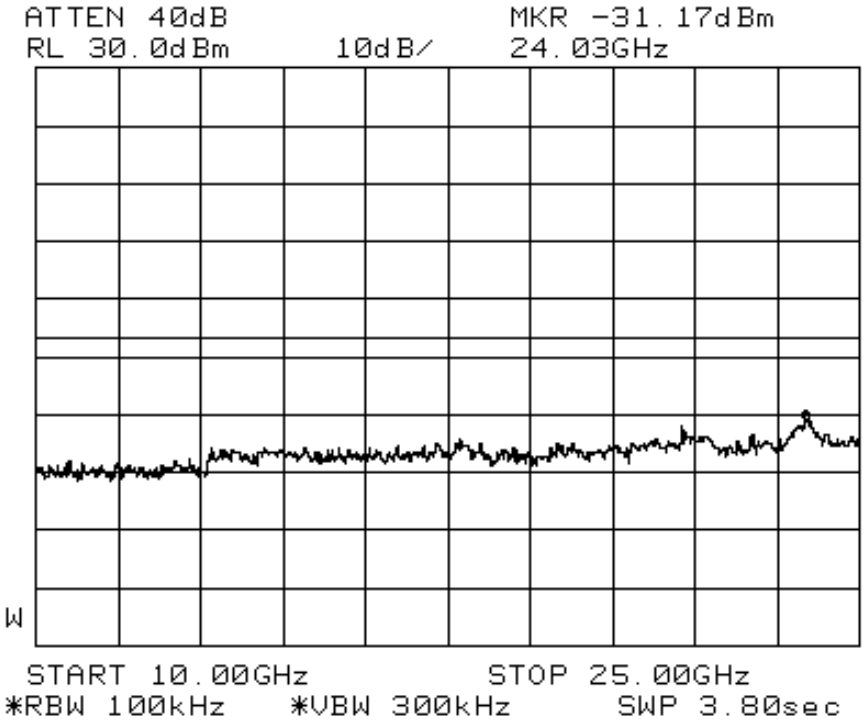


RF Conducted Spurious & Band Edge Measurement Test Setup

RF CONDUCTED SPURIOUS EMISSIONS PLOTS

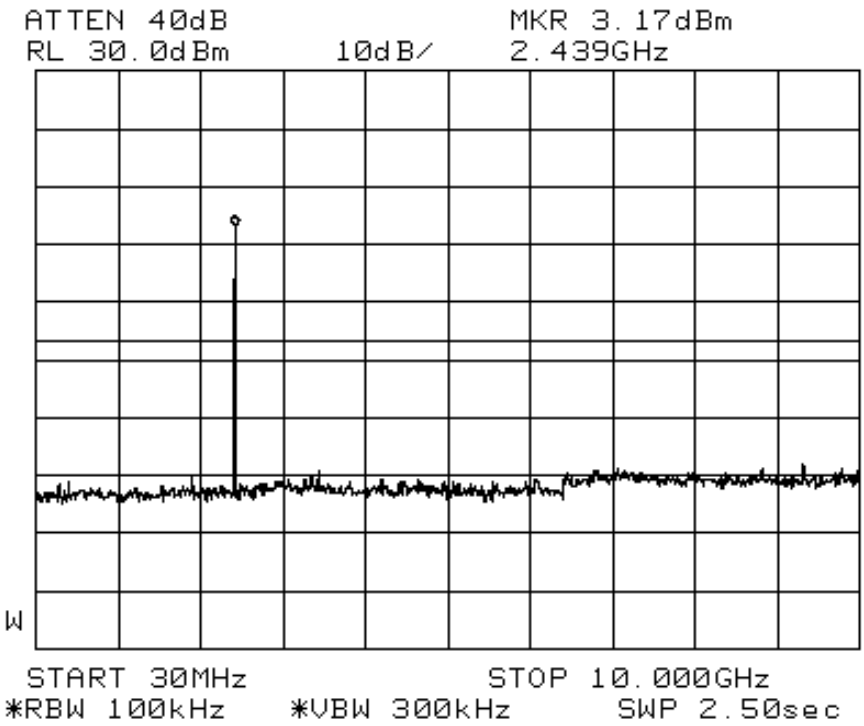


Plot 15 – Channel 0

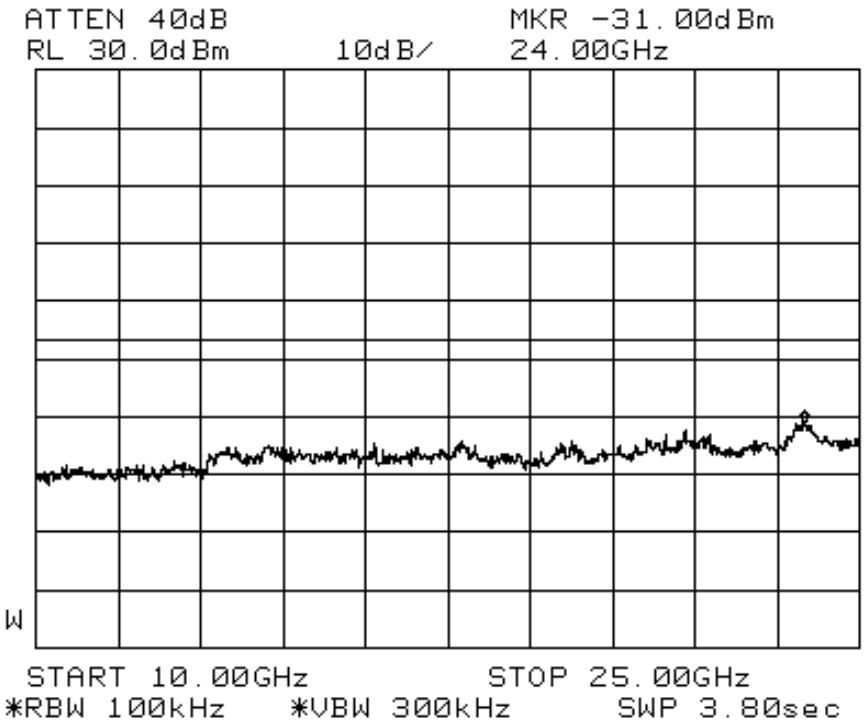


Plot 16 – Channel 0

RF CONDUCTED SPURIOUS EMISSIONS PLOTS

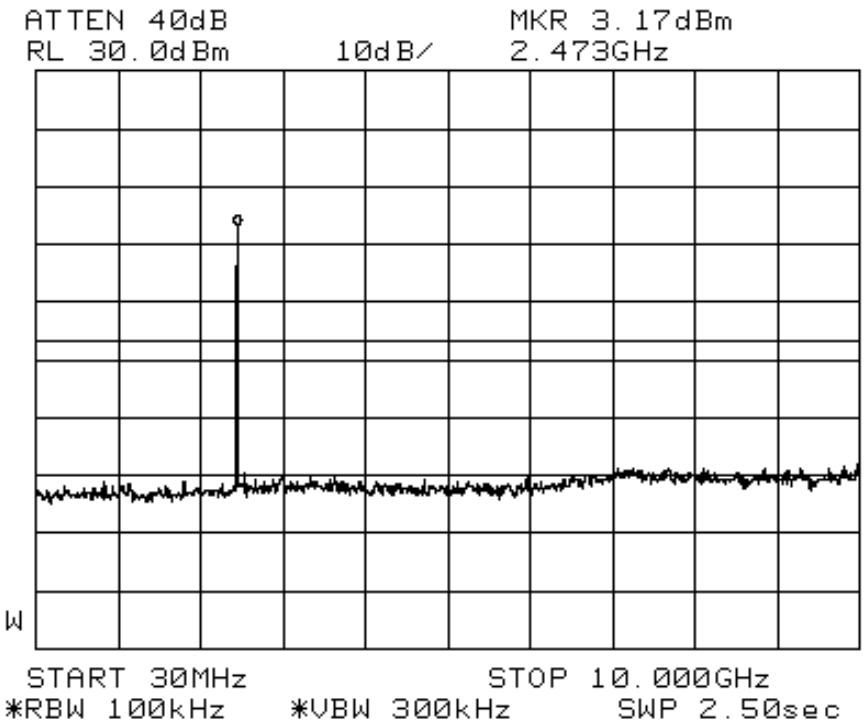


Plot 17 – Channel 39

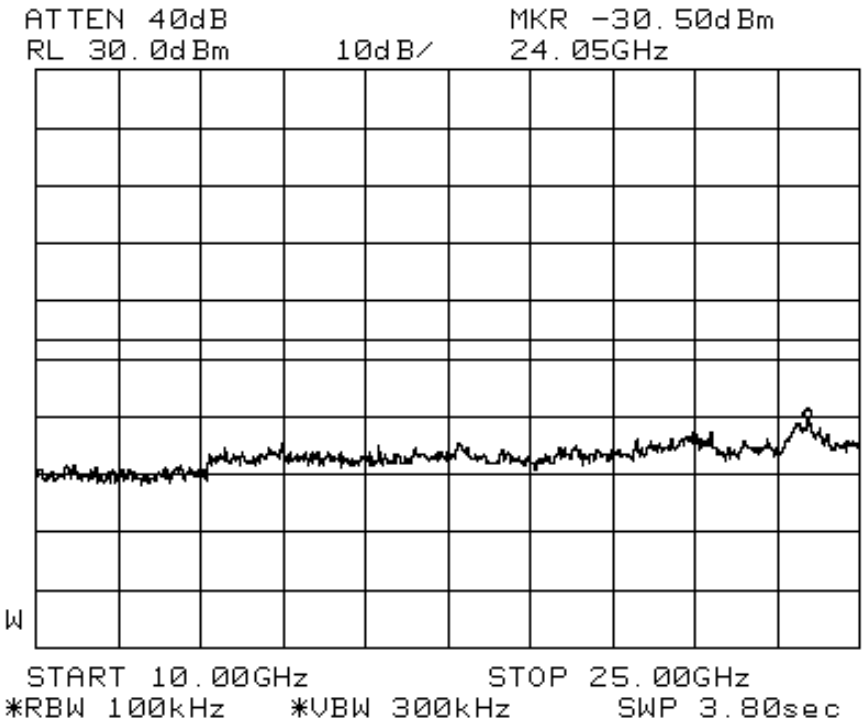


Plot 18 – Channel 39

RF CONDUCTED SPURIOUS EMISSIONS PLOTS

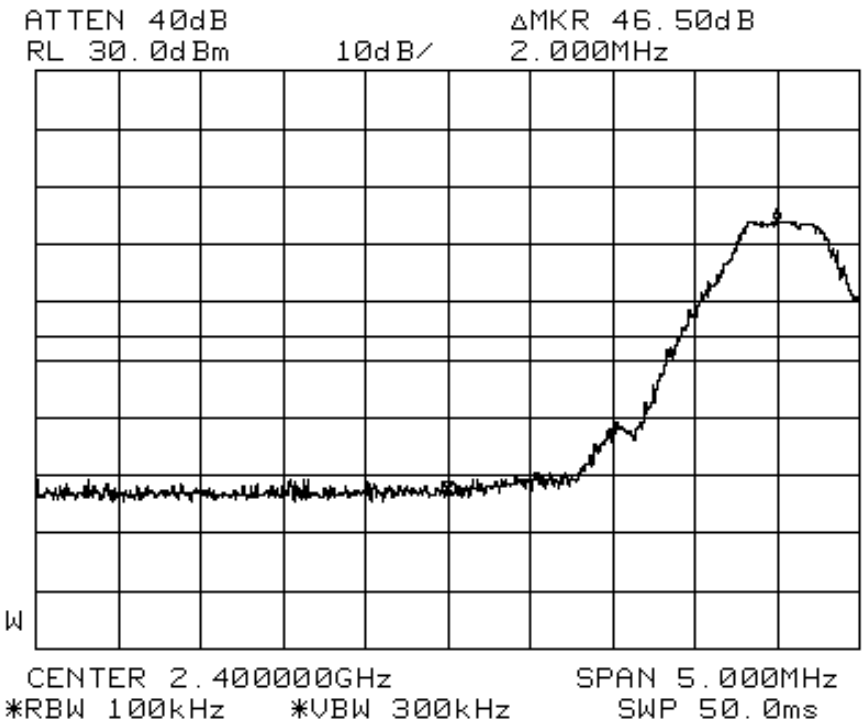


Plot 19 – Channel 78

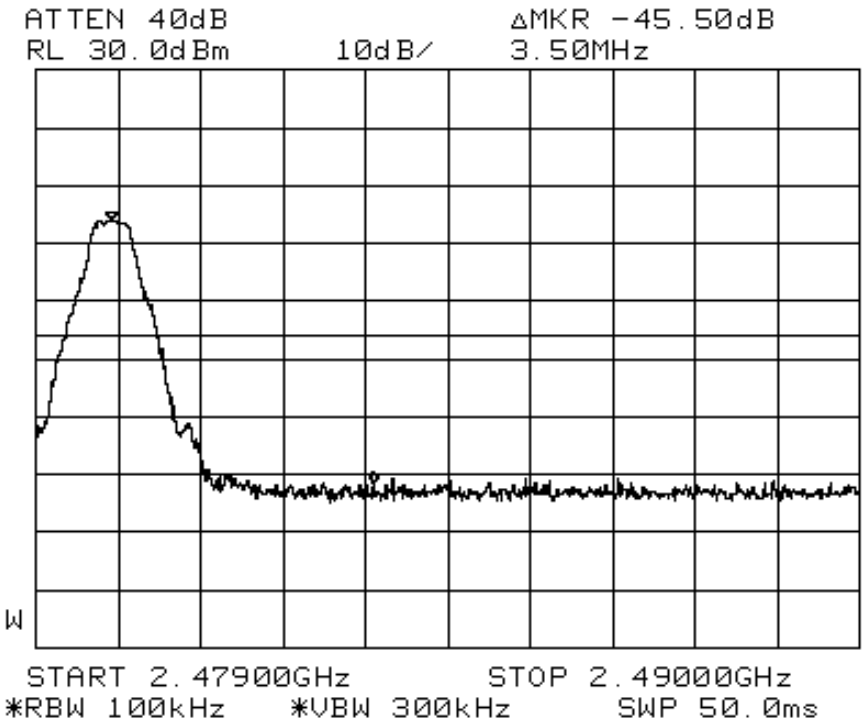


Plot 20 – Channel 78

BAND EDGE COMPLIANCE PLOTS



Plot 21 – Lower Band Edge at 2.40GHz



Plot 22 – Upper Band Edge at 2.4835GHz

FCC Part 15C (15.247(d)) Peak Power Spectral Density Results

The EUT shows compliance to the requirements of this section, which states the peak power spectral density of an intentional radiator (EUT) to the antenna shall not be greater than 8dBm (6.3mW) in any 3kHz band during any time interval of continuous transmission.

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0	2.402	0.2931	6.3
39	2.441	0.2931	6.3
78	2.480	0.2711	6.3

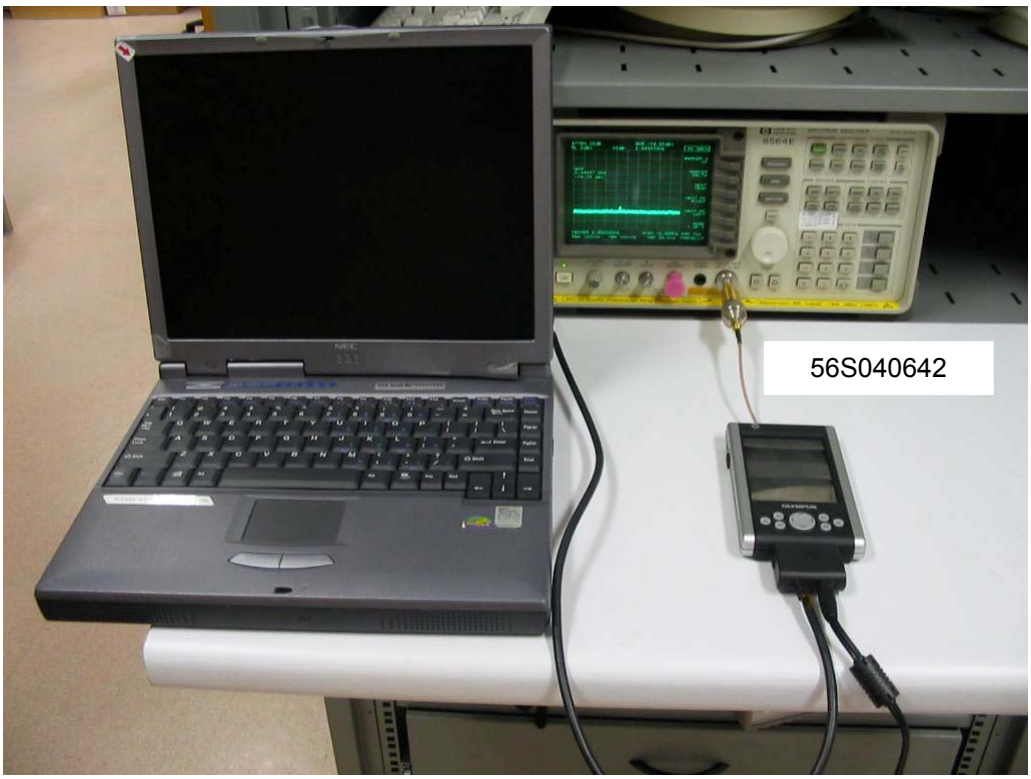
Please refer to the attached Plots 23 – 25 for details.

Tested by: DP

Notes :

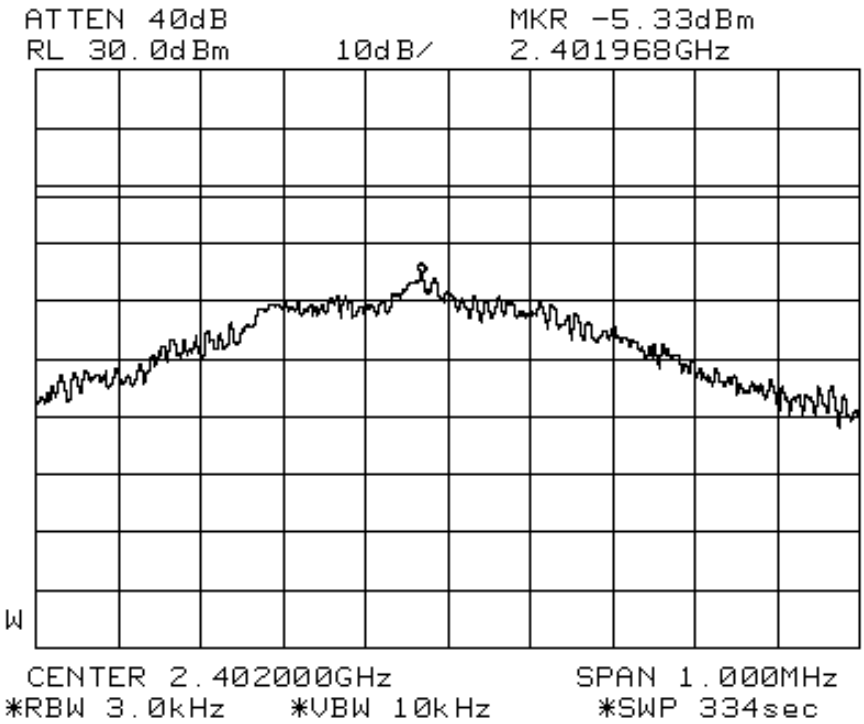
1. Environmental Conditions

Temperature	24°C
Relative Humidity	55%
Atmospheric Pressure	1030mbar

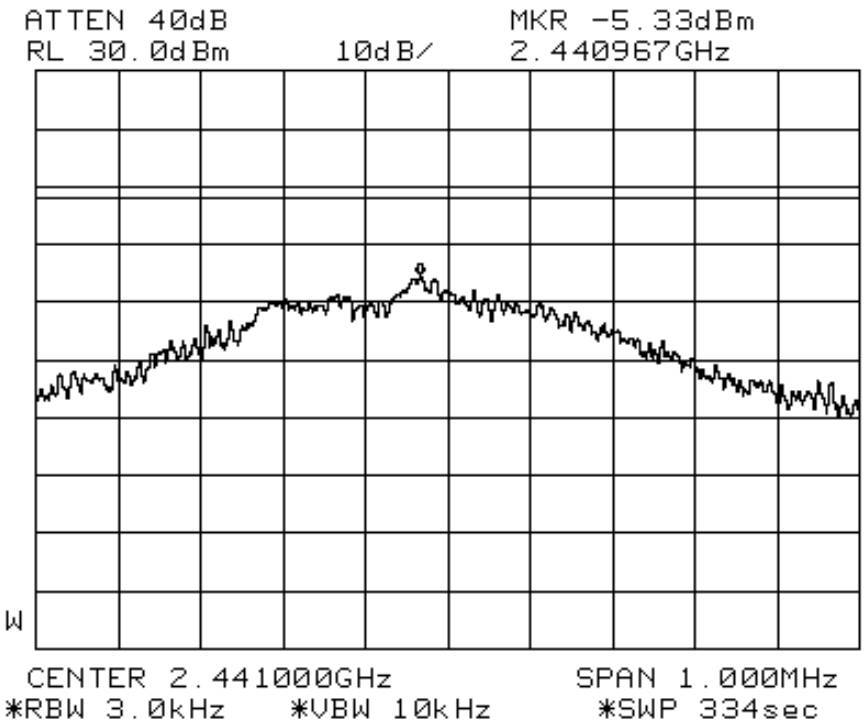


Peak Power Spectral Density Measurement Test Setup

PEAK POWER SPECTRAL DENSITY PLOTS

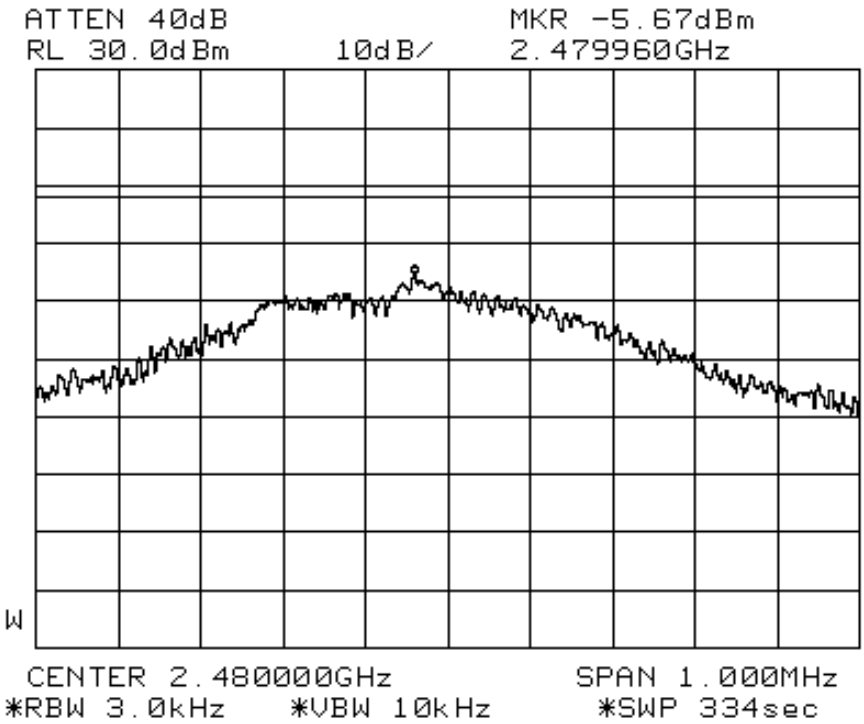


Plot 23 - Channel 0



Plot 24 - Channel 39

PEAK POWER SPECTRAL DENSITY PLOTS



Plot 25 - Channel 78

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August 2003

ANNEX A

TEST INSTRUMENTATION & GENERAL PROCEDURES

TEST INSTRUMENTATION & GENERAL PROCEDURES ANNEX A

3m OATS Test Instrumentation
(Conducted EMI)

Instrument	Model	S/No	Cal Due Date	
R&S Test Receiver (9kHz-30MHz)	ESH3	862301/005	24 Jun 2005	x
R&S Pulse Limiter – PL1	ESH3-Z2	357.8810.52	07 Apr 2005	x
Schaffner Pulse Limiter – PL5	CFL 9206	1720	01 Apr 2005	x
EMCO LISN (for EUT) – LISN6	3825/2	9309-2127	20 May 2005	x

3m Anechoic Chamber Test Instrumentation
(Radiated Emissions)

Instrument	Model	S/No	Cal Due Date	
R&S Test Receiver (20Hz – 26.5GHz) – ESMI1	ESMI	849182/003 848926/007	06 Apr 2005	x
HP Preamplifier (for ESMI3, 0.01-3GHz) – PA6	87405A	3950M00353	1 Apr 2005	x
MITEQ Preamplifier (0.1-26.5GHz) – PA11	NSP2650-N	728231	1 Apr 2005	x
Schaffner Bilog Antenna – BL5	CBL6143	5041	18 May 2005	x
EMCO Horn Antenna – H14	3115	0003-6087	22 May 2005	x
Micro-tronics Band-Stop Filter	BRM50701	017	1 Apr 2005	x

RF Conducted Test Instrumentation
(Carrier Frequency Separation, Number Of Hopping Frequencies, Spectrum Bandwidth (20dB Bandwidth Measurement), Average Frequency Dwell Time, Maximum Peak Power, RF Conducted Spurious Emissions at the Transmitter Antenna Terminal, Band Edge Compliance at the Transmitter Antenna Terminal, Peak Power Density)

Instrument	Model	S/No	Cal Due Date	
HP Spectrum Analyzer	8563E	3846A09953	16 Dec 2004	x
R&S Universal Radio Communication Tester	CMU 200	837587/068	22 Mar 2005	x

CONDUCTED EMISSIONS TEST DESCRIPTION

Test Set-up

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.

2. The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to filtered mains.

3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.

4. All other supporting equipment were powered separately from another LISN.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.

2. A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.

3. High peaks, relative to the limit line, were then selected.

4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10kHz. Both Quasi-peak and Average measurements were made.

5. Steps 2 to 4 were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz limit = 250 μV = 47.96 dBμV

Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB

Q-P reading obtained directly from EMI Receiver = 40 dBμV
(Calibrated for system losses)

Therefore, Q-P margin = 40 - 47.96 = -7.96 i.e. **7.96 dB below limit**

RADIATED EMISSIONS TEST DESCRIPTION (3m ANC)

Test Set-up

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table.

2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.

3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.

2. A prescan was carried out to find out the EUT highest emissions relative to the limit by rotating the EUT through three orthogonal axes to determine which attitude and equipment arrangement produces such emissions.

3. The final measurement was then carried out at the selected frequency points based on the highest emissions arrangement found from step 2. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:

   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.

4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point that above 1GHz, both Peak and Average measurements were carried out.

5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.

6. The frequency range covered was from 30MHz to 25GHz, using the Bi-log antenna for frequencies from 30MHz up to 3GHz, and the Horn antenna above 3GHz.

Sample Calculation Example

At 300 MHz limit = 200 μV/m = 46 dBμV/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.511 dB

Q-P reading obtained directly from EMI Receiver = 40 dBμV/m
(Calibrated level including antenna factors & cable losses)

Therefore, Q-P margin = 40 - 46 = -6 i.e. **6 dB below limit**

CARRIER FREQUENCY SEPARATION TEST DESCRIPTION

Test Set-up

1. The EUT and supporting equipment were set up as shown in the setup photo.

2. The power supply for the EUT was connected to a filtered mains.

3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz.

5. All other supporting equipment were powered separately from another filtered mains.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the Bluetooth test mode with hopping sequence on.

2. The start and stop frequencies of the spectrum analyser were set to 2.401GHz and 2.404GHz with frequency sweeping set to 50ms.

3. The spectrum analyser was set to max hold to capture the two adjacent transmitting frequencies within the span. The signal capturing was continuous until no further signals were detected.

4. The carrier frequency separation of the two adjacent transmitting / operating frequency was measured by finding the carrier frequency difference between the two adjacent channels.

5. The steps 2 to 4 were repeated with the following start and stop frequencies settings:
   a. 2.439GHz to 2.442GHz
   b. 2.440GHz to 2.443GHz
   c. 2.478GHz to 2.481GHz

SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST DESCRIPTION

Test Set-up

1. The EUT and supporting equipment were set up as shown in the setup photo.

2. The power supply for the EUT was connected to a filtered mains.

3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 10kHz and 100kHz.

5. All other supporting equipment were powered separately from another filtered mains.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the Bluetooth test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz).

2. The center frequency of the spectrum analyser was set to the transmitting frequency with the frequency span wide enough to capture the 20dB bandwidth of the transmitting frequency.

3. The spectrum analyser was set to max hold to capture the transmitting frequency. The signal capturing was continuous until no further changes were observed.

4. The peak of the transmitting frequency was detected with the marker peak function of the spectrum analyser. The frequencies below the 20dB peak frequency at lower (f_L) and upper (f_H) sides of the transmitting frequency were marked and measured by using the marker-delta function of the spectrum analyser.

6. The 20dB bandwidth of the transmitting frequency is the frequency difference between the marked lower and upper frequencies, $| f_H – f_L |$.

7. The steps 2 to 5 were repeated with the transmitting frequency was set to Channel 39 (2.441GHz) and Channel 78 (2.480GHz) respectively.

NUMBER OF HOPPING FREQUENCIES TEST DESCRIPTION

Test Set-up

1. The EUT and supporting equipment were set up as shown in the setup photo.

2. The power supply for the EUT was connected to a filtered mains.

4. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 300kHz and 1000MHz.

5. All other supporting equipment were powered separately from another filtered mains.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the Bluetooth test mode with hopping sequence on.

2. The start and stop frequencies of the spectrum analyser were set to 2.40GHz and 2.421GHz with frequency sweeping set to 50ms.

3. The spectrum analyser was set to max hold to capture all the transmitting frequencies within the span. The signal capturing was continuous until all the transmitting frequencies were captured and no further signals were detected.

4. The numbers of transmitting frequencies were counted and recorded.

5. The steps 2 to 5 were repeated with the following start and stop frequencies settings:

   a. 2.420GHz to 2.441GHz
   b. 2.440GHz to 2.461GHz
   c. 2.460GHz to 2.4835GHz

6. The total number of hopping frequencies is the sum of the number of the hopping frequencies found for each span.

AVERAGE FREQUENCY DWELL TIME TEST DESCRIPTION

Test Set-up

1. The EUT and supporting equipment were set up as shown in the setup photo.

2. The power supply for the EUT was connected to a filtered mains.

3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 1MHz and 3MHz.

5. All other supporting equipment were powered separately from another filtered mains.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the Bluetooth test mode, hopping sequence on.

2. The center frequency of the spectrum analyser was set to 2.402GHz with zero frequency span (spectrum analyser acts as an oscilloscope).

3. The sweep time of the spectrum analyser was adjusted until a stable signal can be seen on the spectrum analyser.

4. The duration (dwell time) of a packet was measured using the marker-delta function of the spectrum analyser. The average dwell time of the transmitting frequency was computed as below:

Average Frequency Dwell Time	=	measured time slot length (l) x hopping rate (h) / number of hopping frequencies x 30 seconds period
where EUT hopping rate	=	1600 hops/s
Number of EUT hopping frequencies	=	79 hops

5. The steps 2 to 4 were repeated with the center frequency of the spectrum analyser were set to 2.441GHz and 2.480GHz respectively.

MAXIMUM PEAK POWER TEST DESCRIPTION

Test Set-up

1. The EUT and supporting equipment were set up as shown in the setup photo..
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the Universal Radio Communication Tester, which set into power analyser mode via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another filtered mains.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the Bluetooth test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz).
2. The maximum peak power of the transmitting frequency was detected and recorded.
3. The step 2 was repeated with the transmitting frequency was set to Channel 39 (2.441GHz) and Channel 78 (2.480GHz) respectively.

RF CONDUCTED SPURIOUS EMISSIONS AT THE TRANSMITTER ANTENNA TERMINAL TEST DESCRIPTION

Test Set-up

1. The EUT and supporting equipment were set up as shown in the setup photo.

2. The power supply for the EUT was connected to a filtered mains.

3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz.

5. All other supporting equipment were powered separately from another filtered mains.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the Bluetooth test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz).

2. The start and stop frequencies of the spectrum analyser were set to 30MHz and 10GHz.

3. The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.

4. The steps 2 to 3 were repeated with frequency span was set from 10GHz to 25GHz.

5. The steps 2 to 4 were repeated with the transmitting frequency was set to Channel 39 (2.441GHz) and Channel 78 (2.480GHz) respectively.

BAND EDGE COMPLIANCE AT THE TRANSMITTER ANTENNA TERMINAL TEST DESCRIPTION

Test Set-up

1. The EUT and supporting equipment were set up as shown in the setup photo.

2. The power supply for the EUT was connected to a filtered mains.

3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz.

5. All other supporting equipment were powered separately from another filtered mains.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the Bluetooth test mode, hopping sequence on.

2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the Bluetooth band, 2.40GHz and any spurious emissions at the band edge.

3. The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.

4. The steps 2 to 3 were repeated with the frequency span of the spectrum analyser was set to wide enough to capture the upper band edge frequency of the Bluetooth band, 2.4835GHz and the any spurious emissions at the band-edge.

PEAK POWER SPECTRAL DENSITY TEST DESCRIPTION

Test Set-up

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 3kHz and 10kHz.
5. All other supporting equipment were powered separately from another filtered mains.

Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the Bluetooth test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz).
2. The sweep time of the spectrum analyser was set to the value of the ratio of the frequency span divided by the RBW.
3. The peak power density of the transmitting frequency was detected and recorded.
4. The step 3 was repeated with the transmitting frequency was set to Channel 39 (2.441GHz) and Channel 78 (2.480GHz) respectively.

ANNEX B

TEST PHOTOGRAPHS / DIAGRAMS

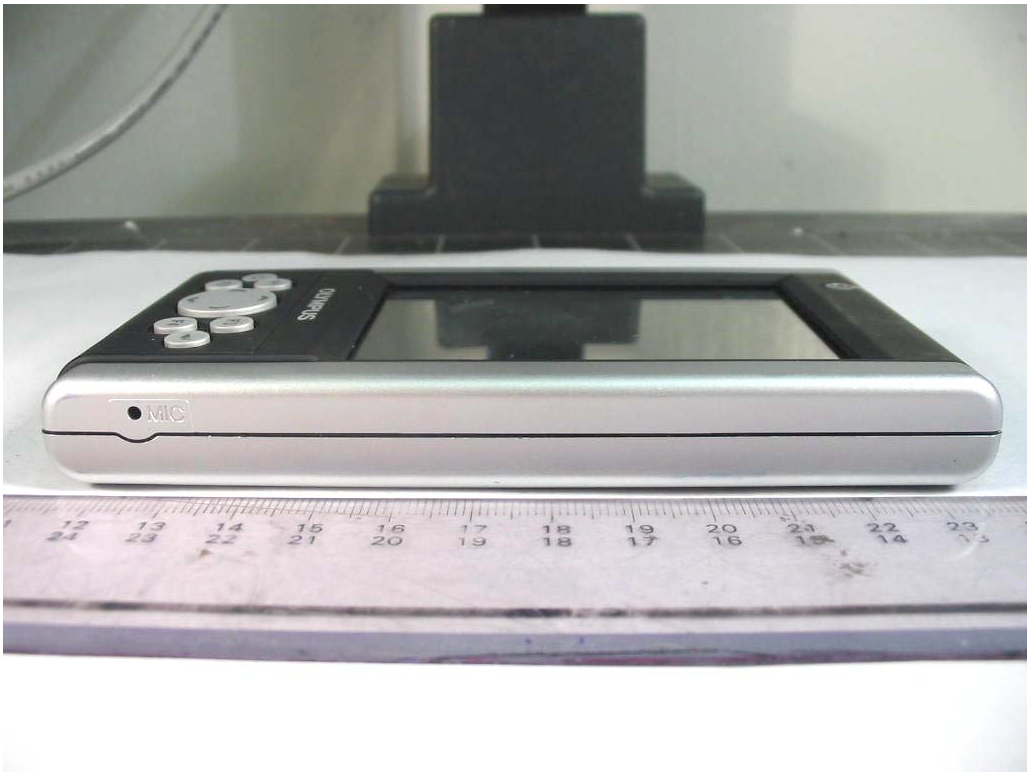
EUT PHOTOGRAPHS

Front View

Rear View

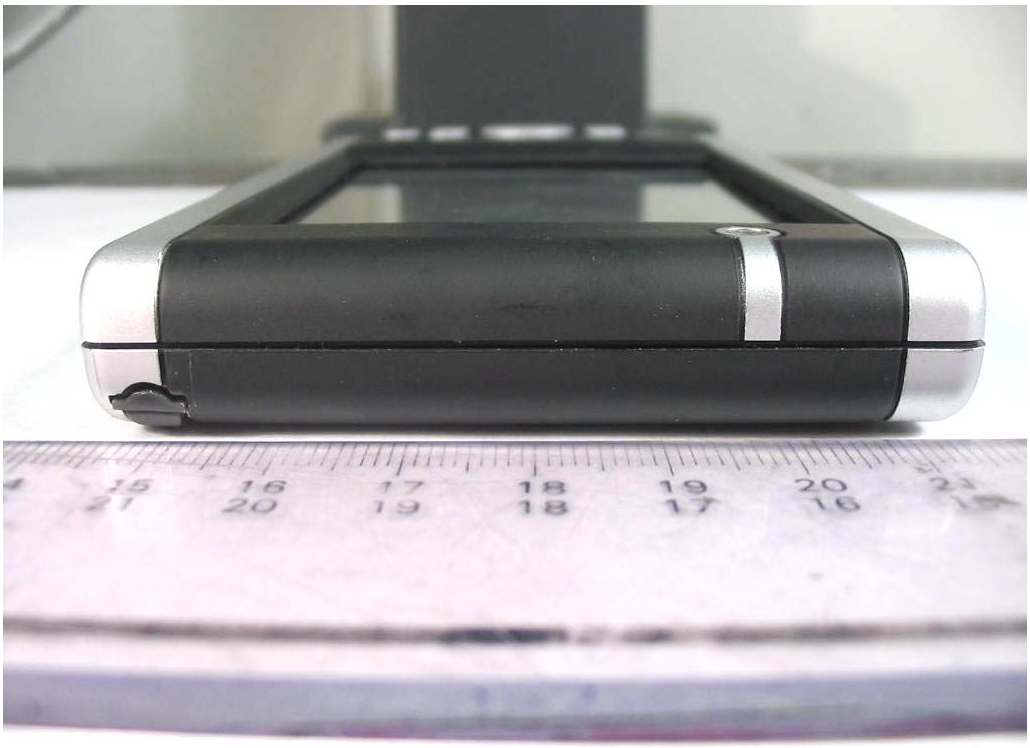
EUT PHOTOGRAPHS

Left View



Right View

EUT PHOTOGRAPHS



Top View

Bottom View

EUT PHOTOGRAPHS

EUT AC/DC Power Adapter Top View

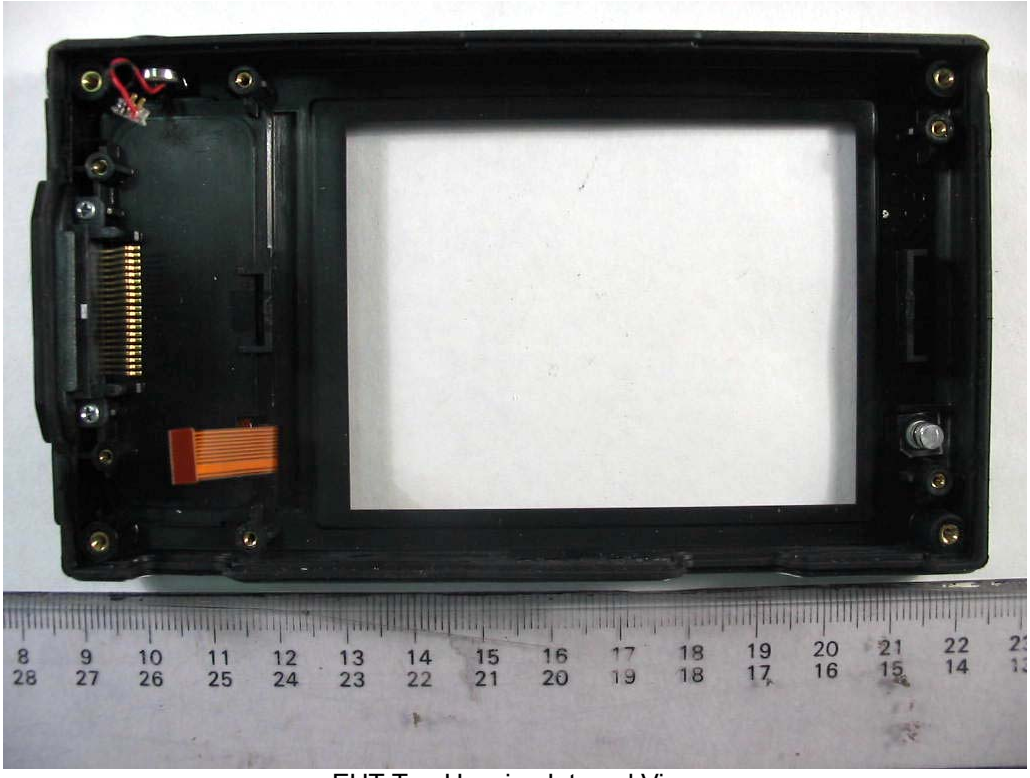
EUT AC/DC Power Adapter Bottom View

EUT PHOTOGRAPHS

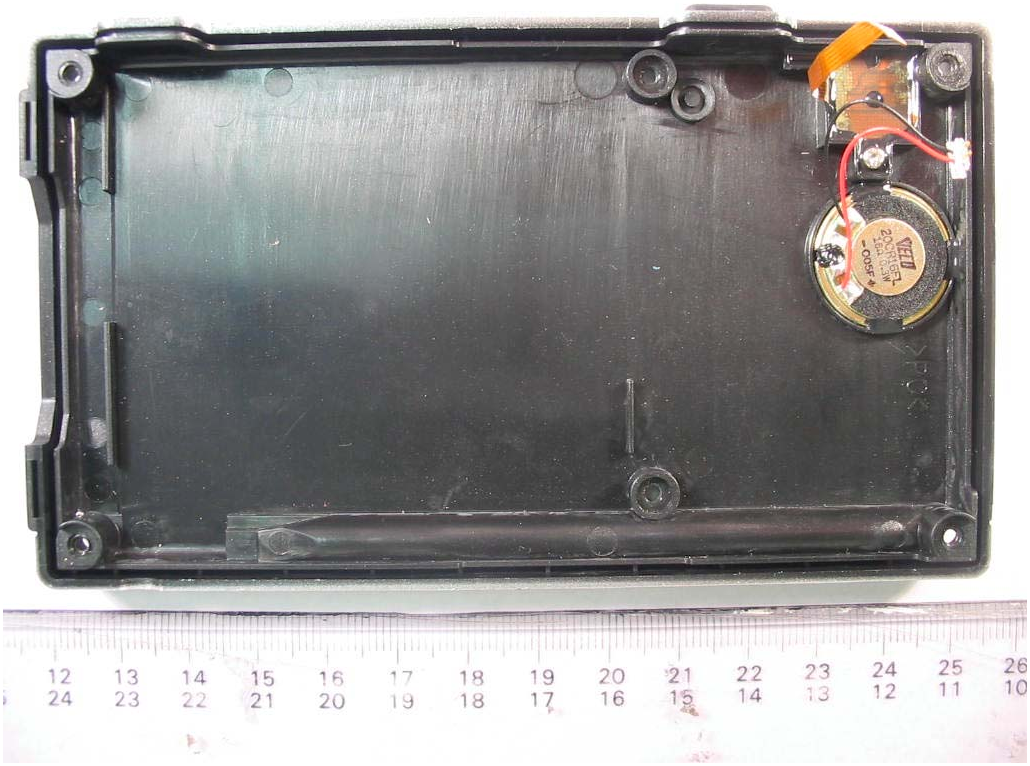
EUT Sync Cable Top View

EUT Sync Cable Bottom View

EUT PHOTOGRAPHS

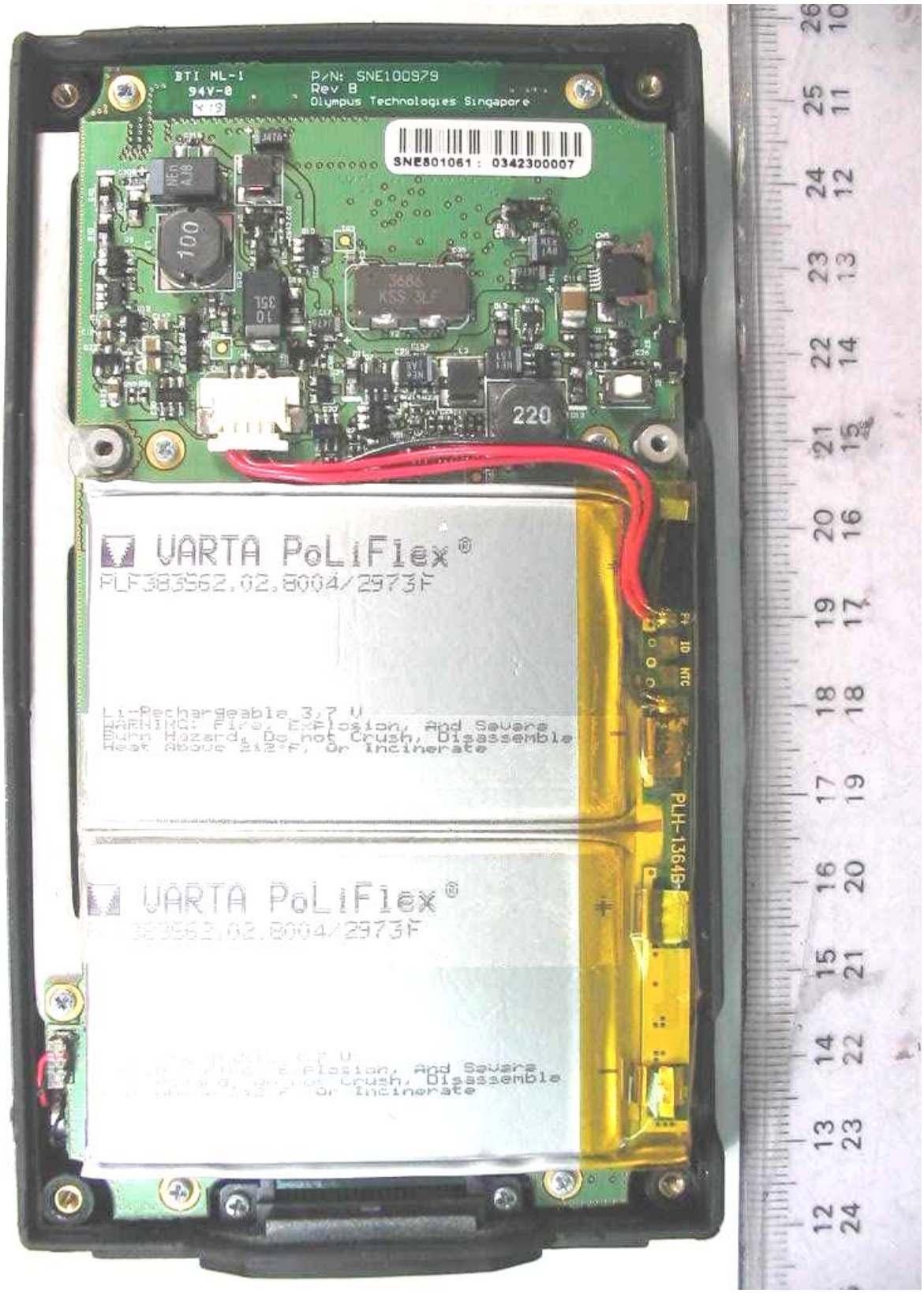


EUT Top Housing Internal View



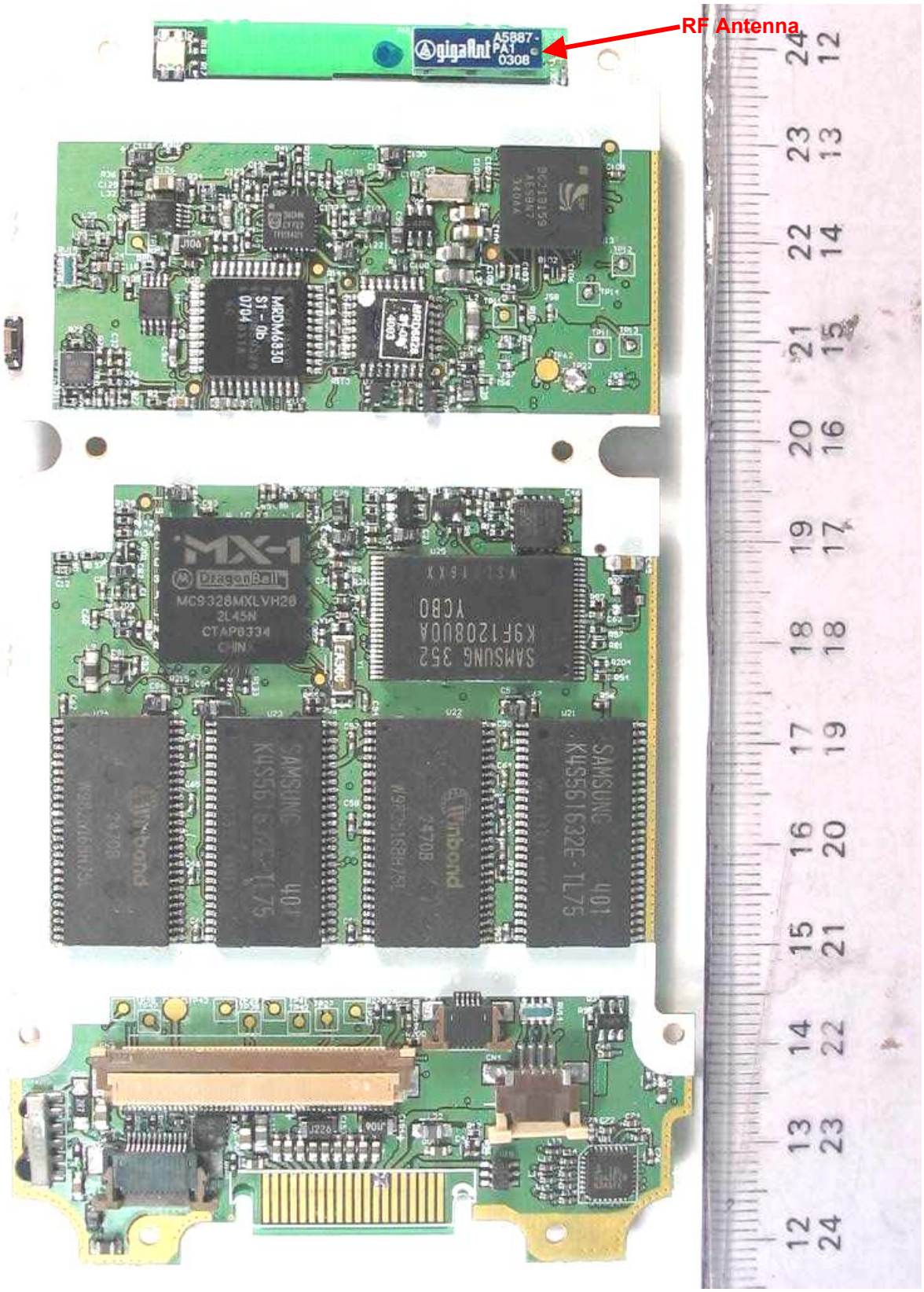
EUT Bottom Housing Internal View

EUT PHOTOGRAPHS



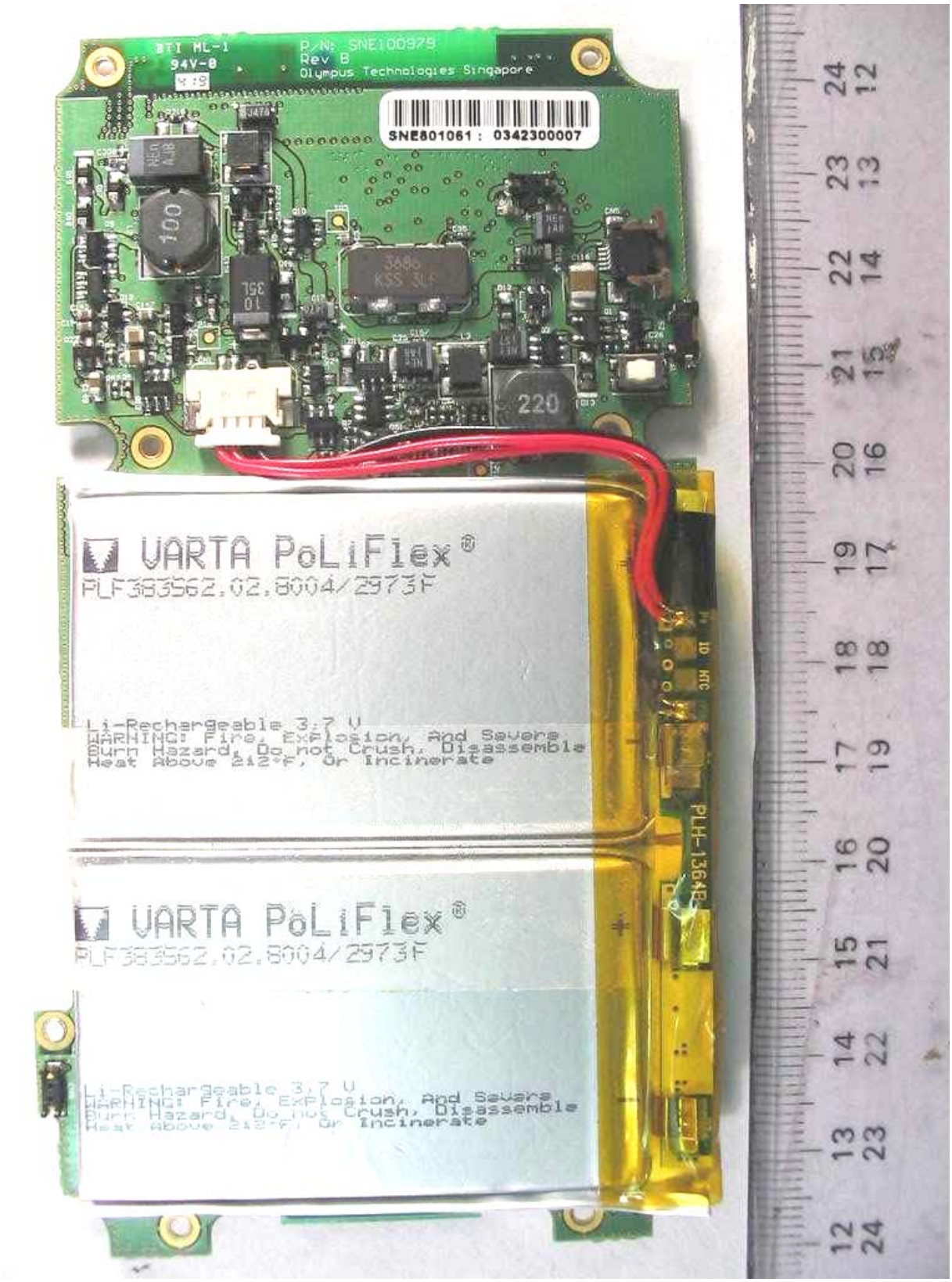
EUT Internal Overall View

EUT PHOTOGRAPHS



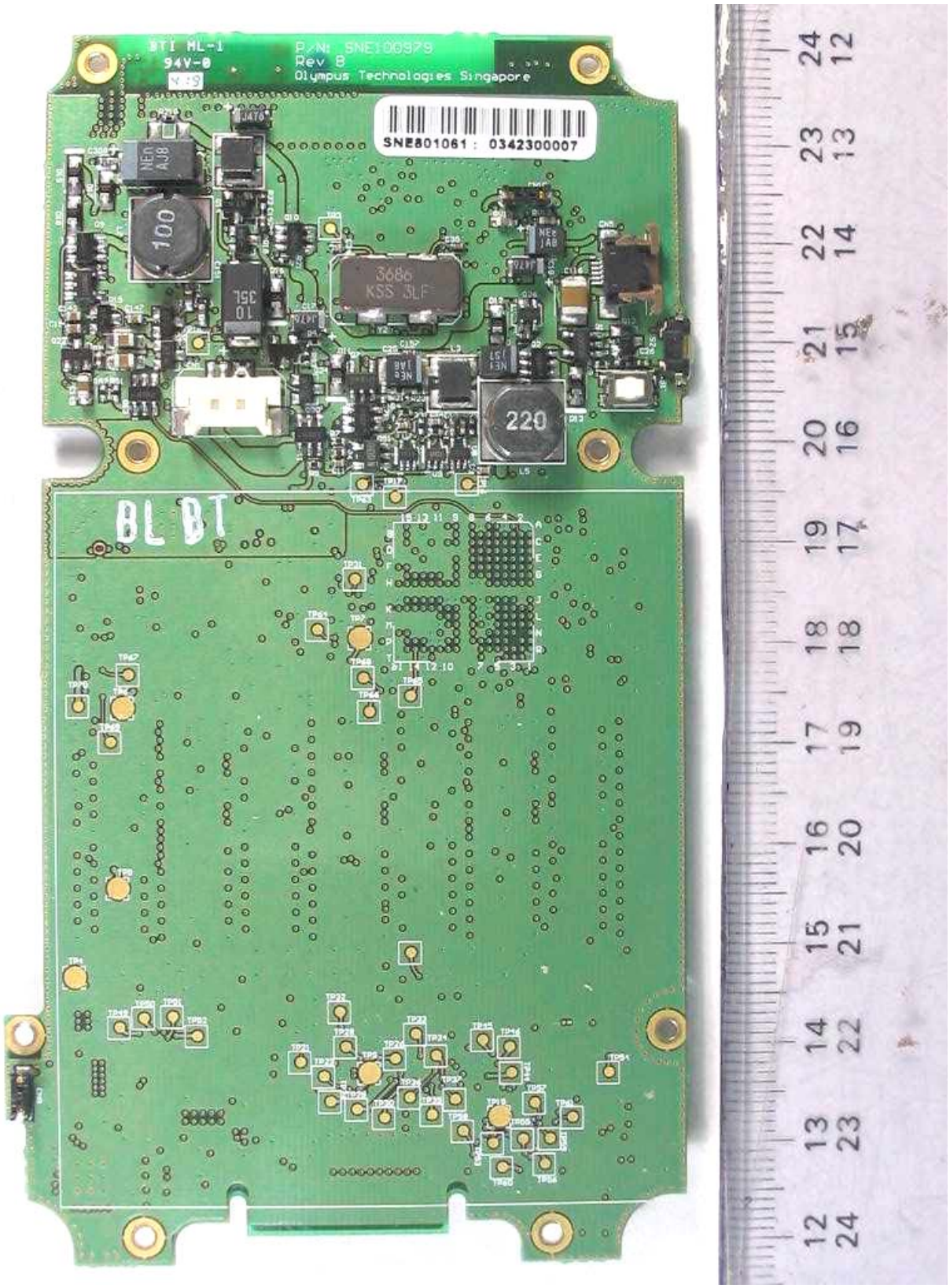
EUT PCB Top View

EUT PHOTOGRAPHS



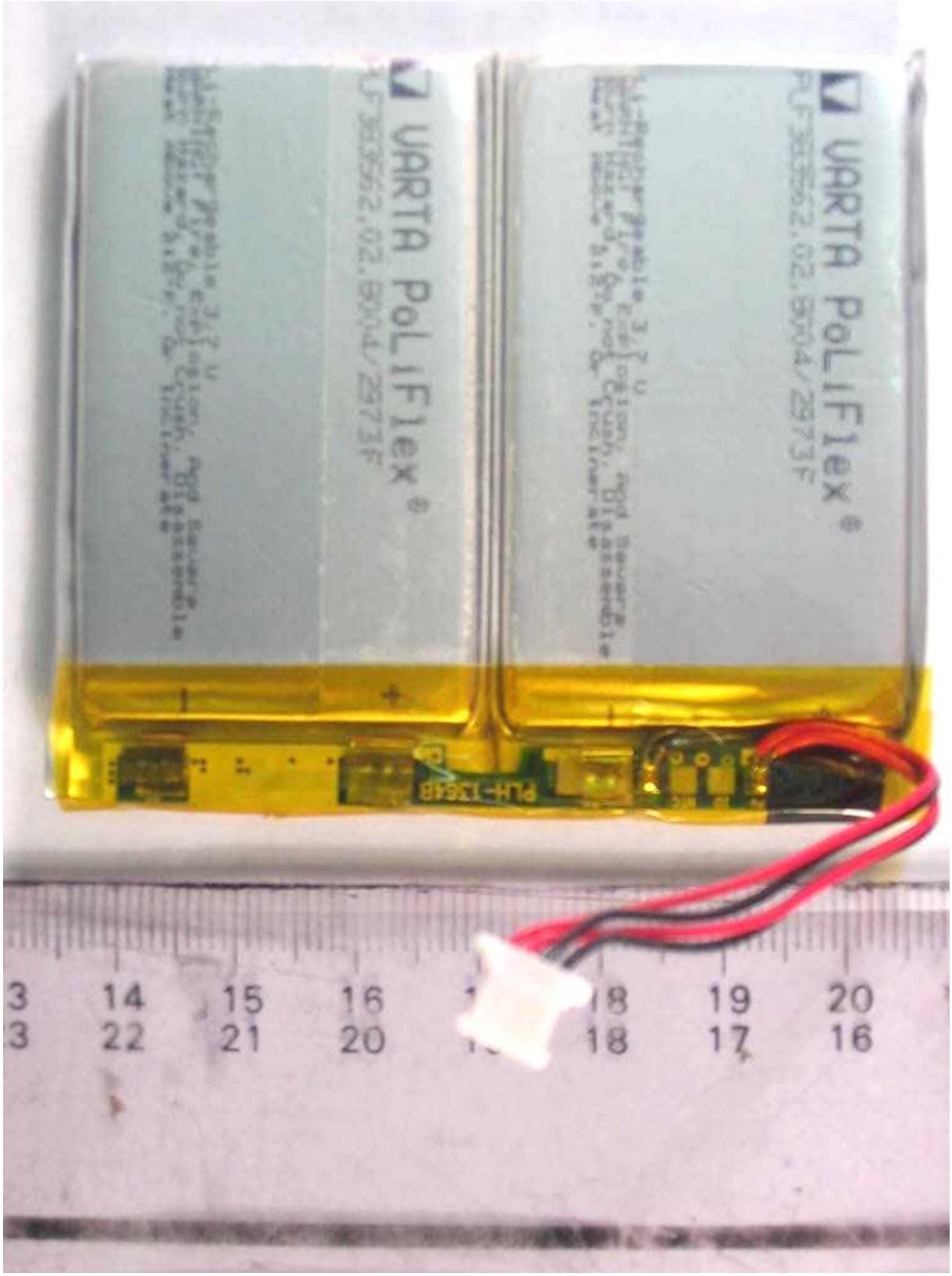
EUT PCB Bottom View with Rechargable Battery Pack Connected

EUT PHOTOGRAPHS



EUT PCB Bottom View with Rechargable Battery Pack Removed

EUT PHOTOGRAPHS



EUT Rechargable Battery Pack Front View

EUT PHOTOGRAPHS

EUT Rechargable Battery Pack Bottom View

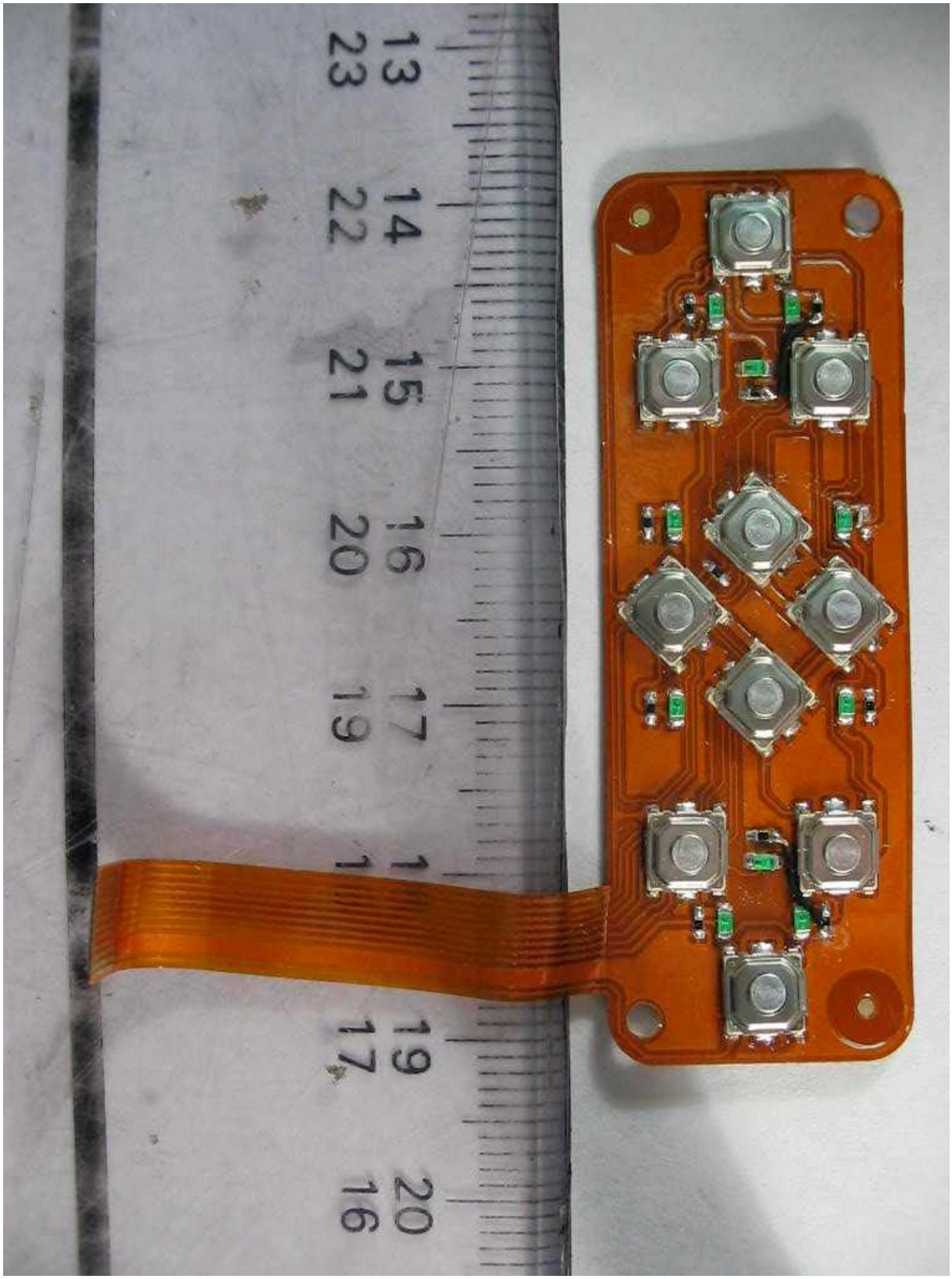
EUT PHOTOGRAPHS

EUT LCD Module Front View

EUT PHOTOGRAPHS

EUT LCD Module Rear View

EUT PHOTOGRAPHS



EUT Keypad Module Front View

EUT PHOTOGRAPHS

EUT Keypad Module Rear View

ANNEX C

USER MANUAL
TECHNICAL DESCRIPTION
BLOCK & CIRCUIT DIAGRAMS

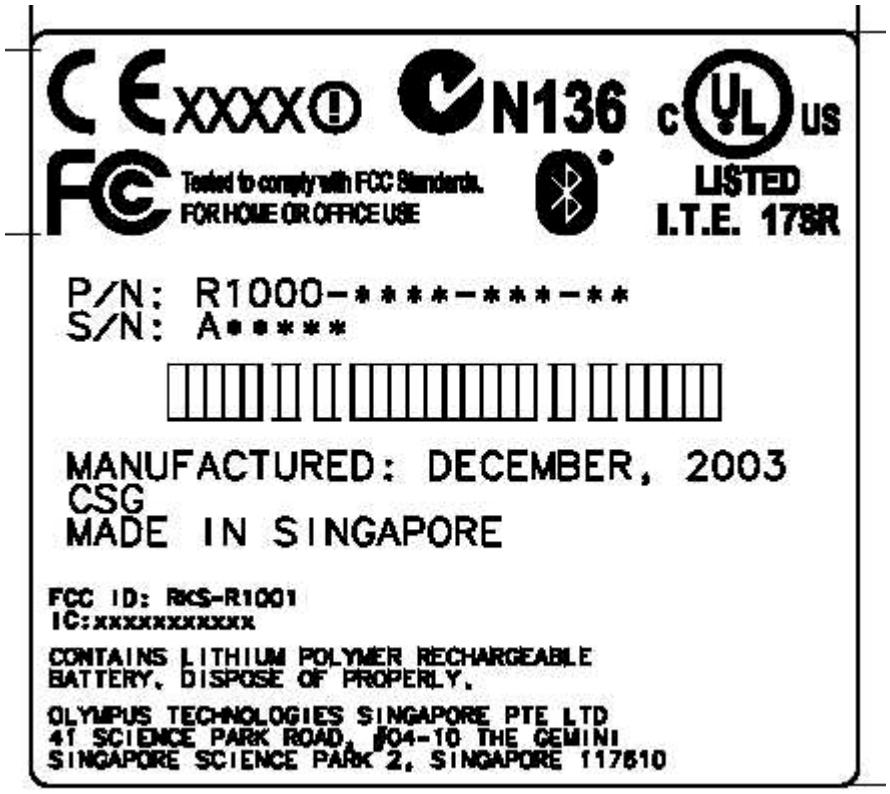
(Please refer to attached copy)

ANNEX D

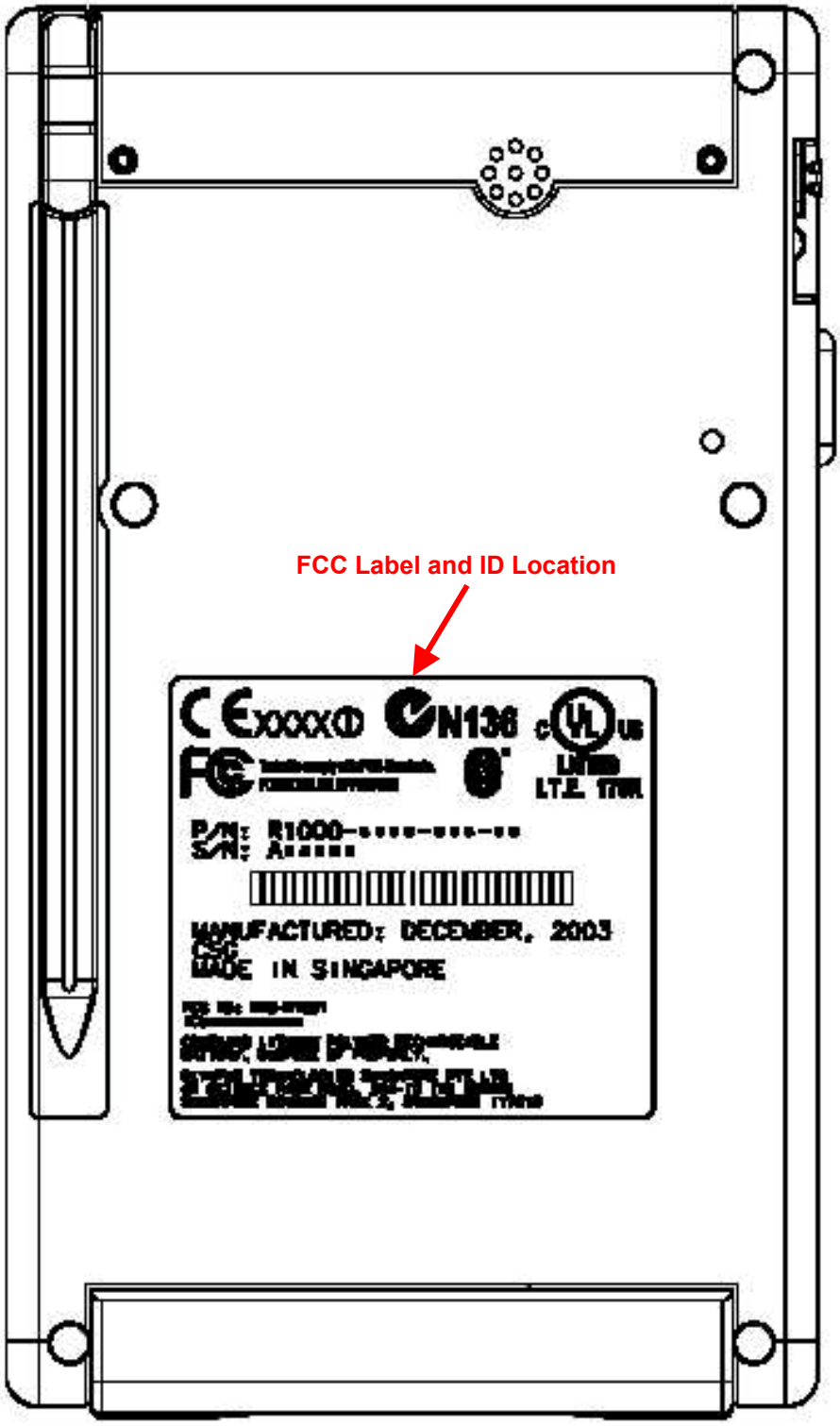
FCC LABEL & POSITION

Labelling requirements per Section 2.925 & 15.19

The label shown will be permanently affixed at a conspicuous location on the device and be readily visible to the user at the time of purchase.



Sample Label



Physical Location of FCC Label on EUT