TEST REPORT

Your Ref:

Date: 03 Mar 2005

Our Ref: 56S041081/03

DID: +65-6885 1449

Fax: +65-6777 6409

FORMAL REPORT ON TESTING IN ACCORDANCE WITH
FCC Parts 15B & C : 2004
OF A
DIGITAL RECEIVER
[MODEL : SE-FX50R]
[FCC ID : ACJSEFX50X]

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) 325572 (10m Anechoic Chamber)
IND. CANADA REG. NO.	IC 4257 (10m Anechoic Chamber)
PREPARED FOR	Panasonic AVC Networks Singapore Pte Ltd 202 Bedok South Avenue 1 Singapore 469332 Tel : 65 6249 7622 Fax : 65 6245 8804
JOB NUMBER	56S041081
TEST PERIOD	25 Feb 2005 – 02 Mar 2005

PREPARED BY

Lim Cher Hwee
Engineer

APPROVED BY

Colin Gan
Vice President

PSB TEST ® Your Peace of Mind

ISO 9001 JQA-QMA 10040

ACCREDITED LABORATORY SAC-SINGLAS

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

TABLE OF CONTENTS

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 (d)	RF Conducted Spurious Emissions & Band Edge Compliance at the Transmitter Antenna Terminal	Pass
15.247 (e)	Peak Power Spectral Density	Pass
1.1310	Maximum Permissible Exposure	Pass
15.35(c)	Duty Cycle Correction Factor	Refer to page 36 for details

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:

Transmit Channel	Frequency (GHz)
Channel 1	2.403
Channel 39	2.441
Channel 78	2.480

   Following channels are not used after initialisation: 0, 8, 16, 24, 32, 40, 48, 56, 64, 72 (as detailed in the Operational Description).

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

3. The EUT meets the verification requirement of a receiver as stated in FCC Part 15B Clause 15.101(b).

Modifications

No modifications were done.

Description	:	The Equipment Under Test (EUT) is a **Digital Receiver**.
Manufacturer	:	Matsushita Electric Industrial Co., Ltd. Panasonic AVC Networks Singapore Pte Ltd. 202, Bedok South Avenue 1 Singapore 469332
Model Number	:	SE-FX50R
FCC ID	:	ACJSEFX50X
IC	:	216A-SEFX50X
Serial Number	:	A100152
Baseband Microprocessor	:	DWM 3100 (Open Solution)
Operating / Transmitting Frequency Range	:	2.400GHz to 2.480GHz
RF Power Output	:	13dBm (0.0200W)
Clock / Oscillator Frequency	:	32MHz
Modulation	:	Gaussian Frequency Shift Keying (GFSK) with BT = 0.5
Pulse Train Cycle	:	1.25ms
Port / Connectors	:	Gold finger pads [for +5V, PS Gnd, Connect, A Gnd, Mute, Right (Audio), A Gnd, Left (Audio)]
Rated Input Power	:	5V DC 100mA

The Equipment Under Test (EUT), a Digital Receiver, was tested as a stand-alone device without any supporting equipment.

EUT OPERATING CONDITIONS

The Digital Receiver's power adapter 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 11. Maximum Permissible Exposure 12. Duty Cycle Correction Factor	The EUT was exercised by operating in continuous transmission at lower, middle and upper channels respectively with maximum power.

FCC Part 15 (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
0.4959	17.3	-38.8	6.9	-39.2	Neutral	78
0.6083	11.4	-44.6	6.6	-39.4	Neutral	1
0.7819	11.9	-44.1	6.6	-39.4	Neutral	39
1.2923	11.1	-44.9	6.5	-39.5	Live	1
3.7583	11.1	-44.9	6.7	-39.3	Live	1
4.4668	11.0	-45.0	6.6	-39.4	Live	39

Tested by: Lim Cher Hwee

Notes :

1. Environmental Conditions — Temperature: 23°C; Relative Humidity: 58%; Atmospheric Pressure: 1029mbar
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)
255.9840	33.1	-12.9	1	122	1.00	H
271.9820	37.7	-8.3	39	263	1.00	H
303.9880	30.0	-16.0	39	134	1.00	H
335.9880	31.9	-14.1	1	226	1.00	H
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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)
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--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
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Tested by: Lim Cher Hwee

Notes :

1. Environmental Conditions — Temperature: 24°C; Relative Humidity: 58%; Atmospheric Pressure: 1030mbar
2. All possible modes of operation were investigated. Only the 6 worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
3. "--" indicates no emissions were found and shows 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).

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)
--	--	--	--	--	--	--
--	--	--	--	--	--	--
--	--	--	--	--	--	--
--	--	--	--	--	--	--
--	--	--	--	--	--	--
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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)
1.4990	42.6	See Note 2	-11.4	78	0	1.00	V
1.8734	48.3	See Note 2	-5.7	78	274	1.00	V
4.8061	58.3	44.4	-9.6	1	360	1.00	V
4.8825	51.0	37.1	-16.9	39	165	1.00	V
4.9605	53.6	39.7	-14.3	78	188	1.00	V
7.3229	50.7	36.8	-17.2	39	0	1.00	H
7.4401	54.1	40.2	-13.8	78	36	1.00	H

Tested by: Lim Cher Hwee

Notes :

1. Environmental Conditions — Temperature 24°C; Relative Humidity 58%; Atmospheric Pressure 1030mbar
2. As the measured peak shows compliance to the average limit, as such no average measurement was required and the corresponds average margin indicates the margin of the measured peak value below the average limit.
3. "--" indicates no emissions were found and shows compliance to the limits as specified in section 15.209. The emissions were merely the noise floor.
4. All possible modes of operation were investigated. Only the 6 worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
5. 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.
6. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.

7. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz
8. The peak emissions above 1GHz show compliance to the requirement stated in Section 15.35 (b).
9. 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.
10. The channel in the table refers to the transmit channel of the EUT.
11. 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)
1 and 2 (2.403GHz and 2.404GHz)	1.010
38 and 39 (2.440GHz and 2.441GHz)	1.010
77 and 78 (2.479GHz and 2.480GHz)	1.010

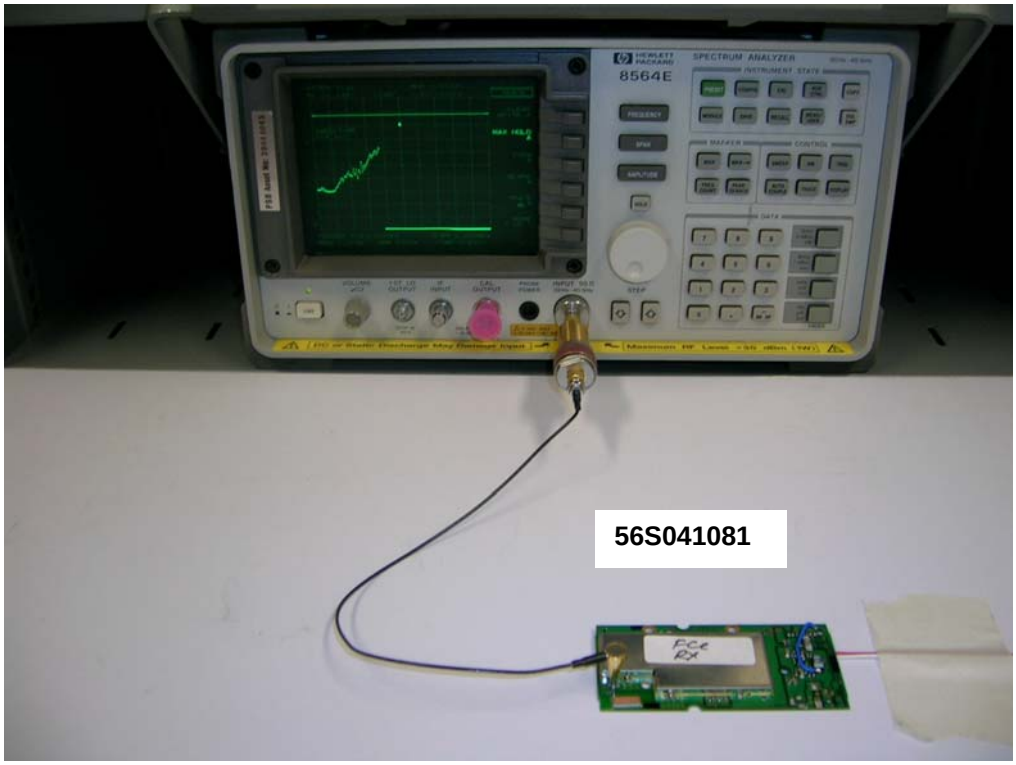
Please refer to the attached Plots 1 - 3 for details.

Tested by: Lim Cher Hwee

Notes :

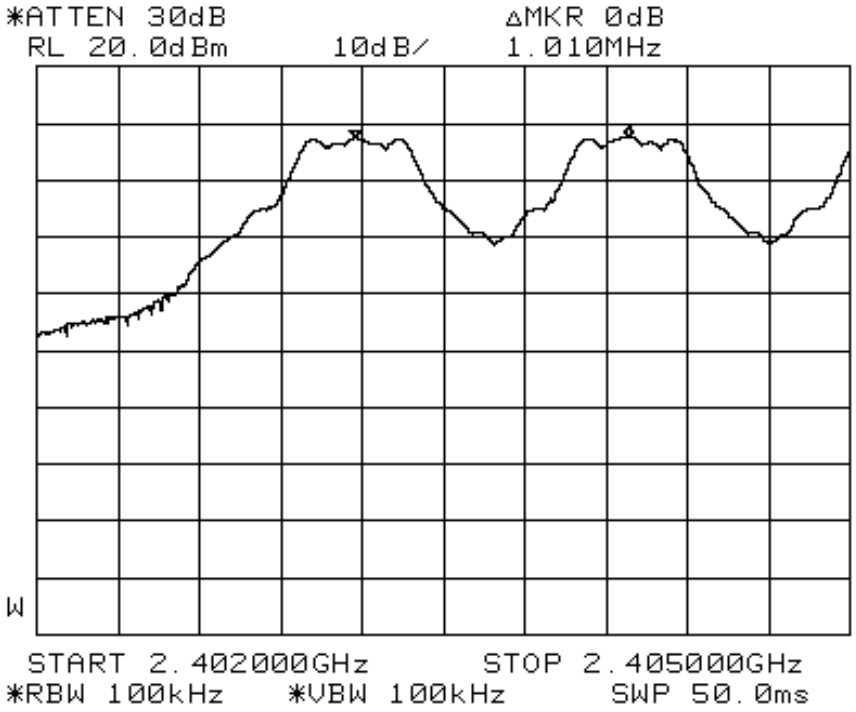
1. Environmental Conditions

Temperature	25°C
Relative Humidity	60%
Atmospheric Pressure	1030mbar

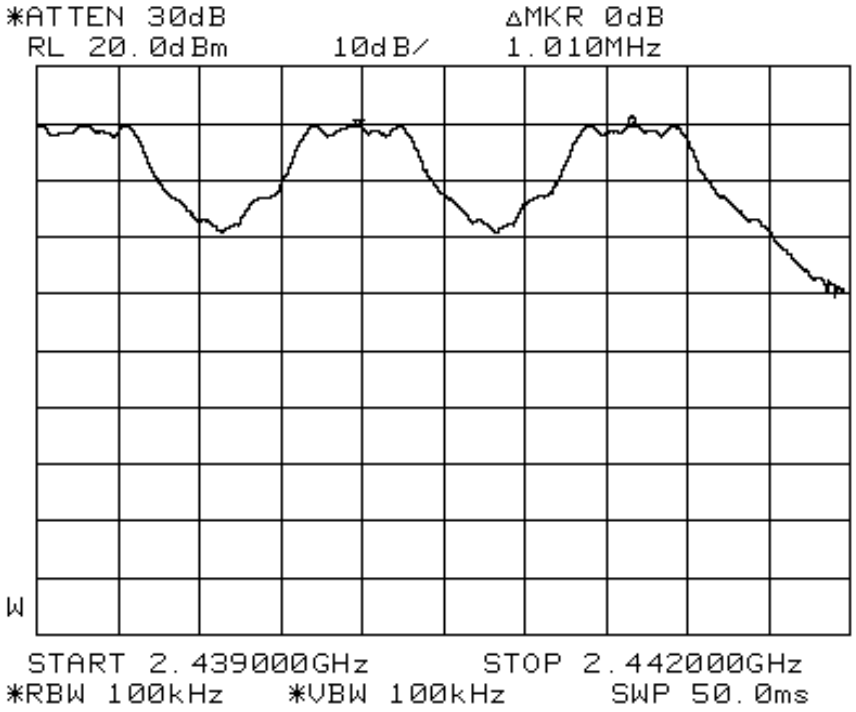


Carrier Frequency Separation Measurement Test Setup

CARRIER FREQUENCY SEPARATION PLOTS

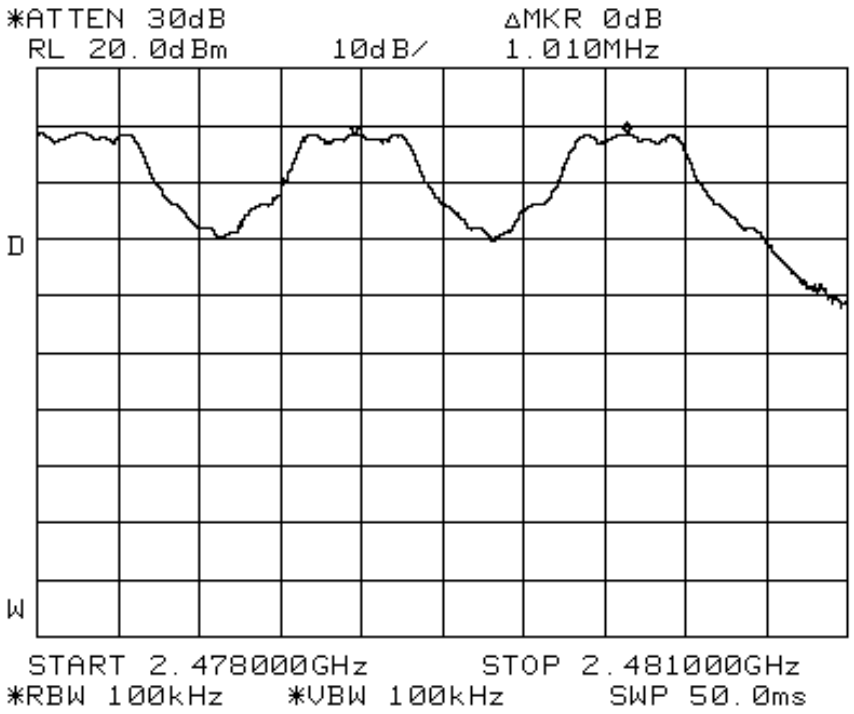


Plot 1- Channels 1 and 2 Separation



Plot 2 – Channels 38 and 39 Separation

CARRIER FREQUENCY SEPARATION PLOTS



Plot 3 - 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.

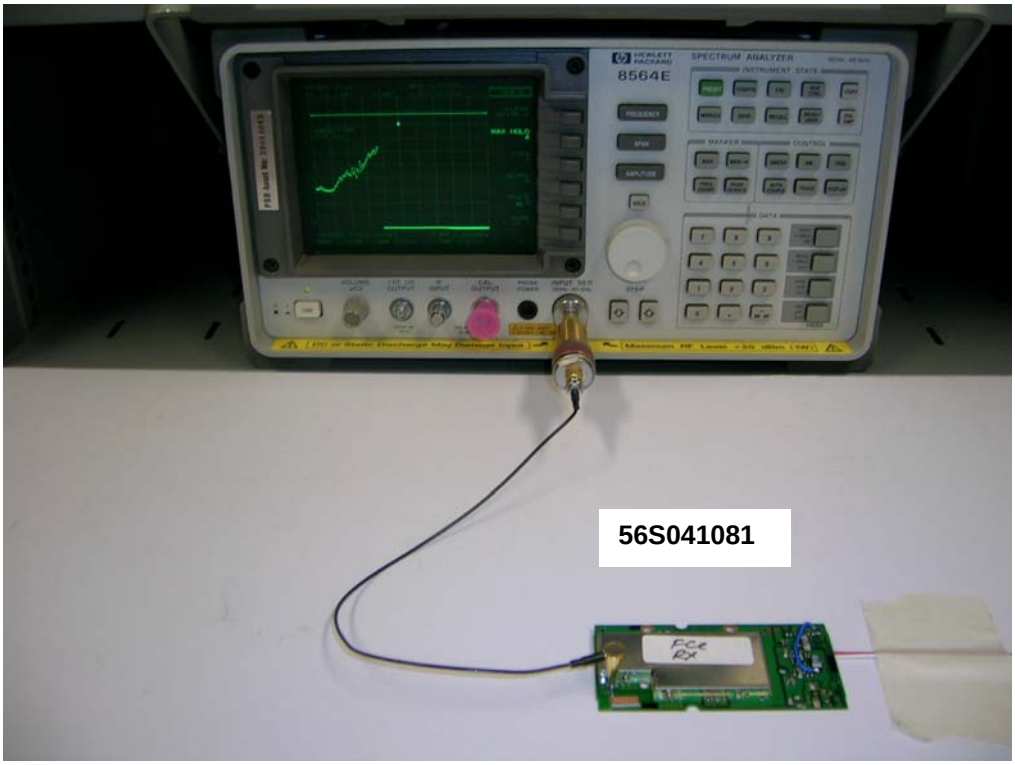
Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
1	2.403	0.595
39	2.441	0.615
78	2.480	0.650

Please refer to attached Plots 4 - 6 for details.

Tested by: Lim Cher Hwee

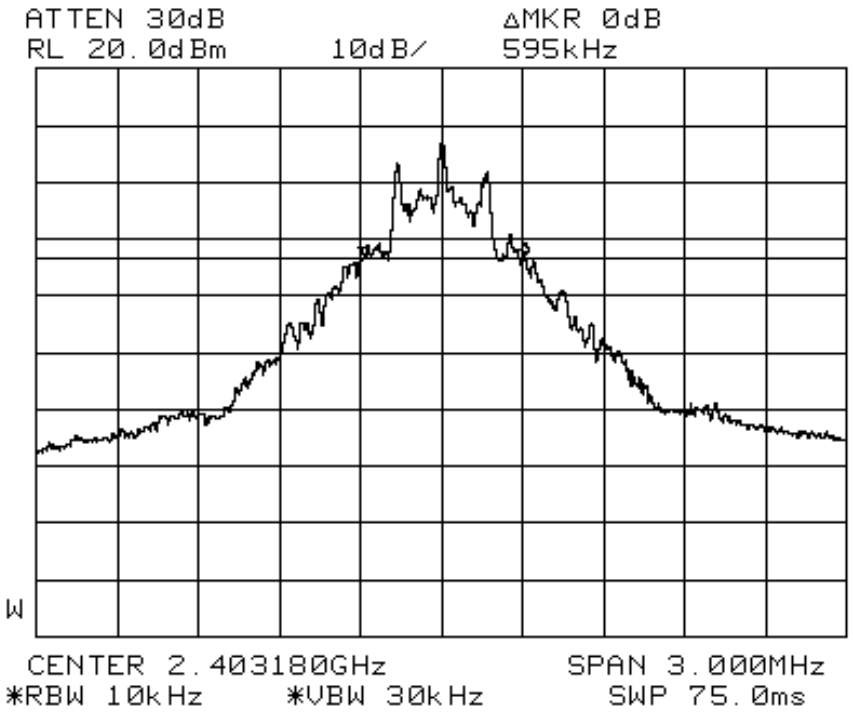
Notes :

1. Environmental Conditions — Temperature 25°C; Relative Humidity 60%; Atmospheric Pressure 1030mbar

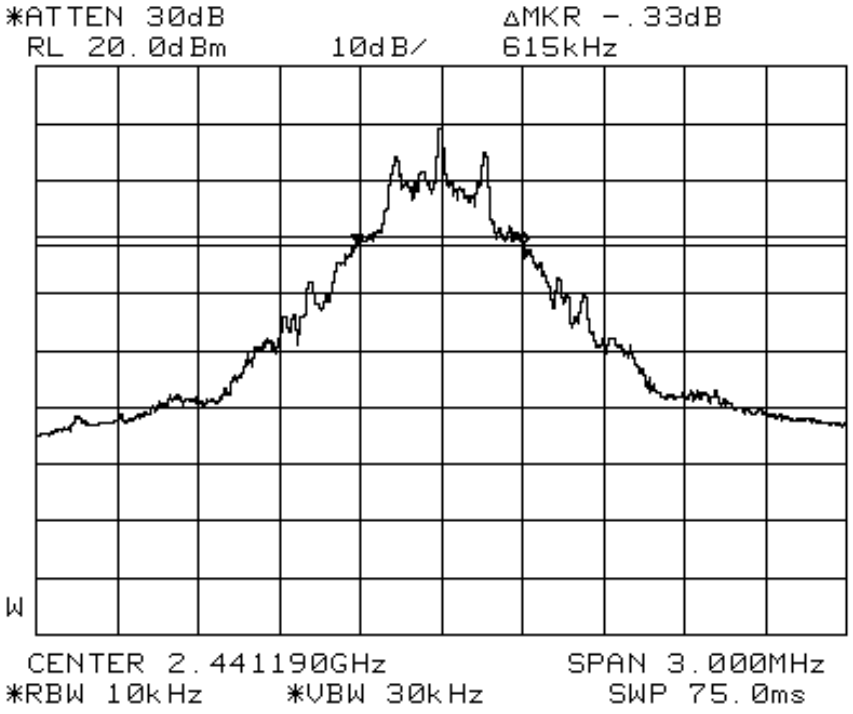


Spectrum Bandwidth Measurement Test Setup

SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) PLOTS

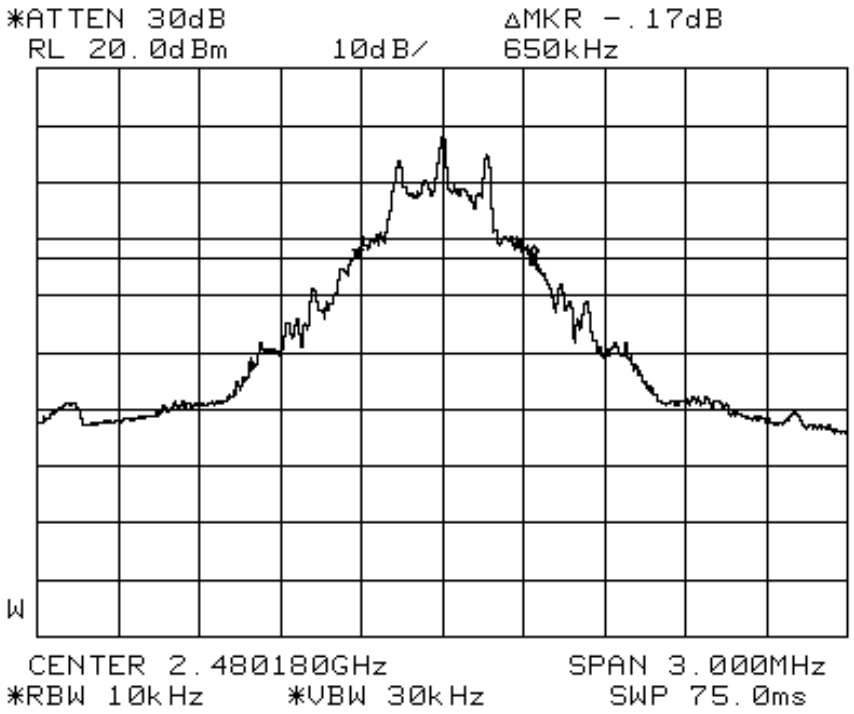


Plot 4 – Channel 1



Plot 5 – Channel 39

SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) PLOTS



Plot 6 – 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 15.

The EUT was found t to have 69 hopping frequencies.

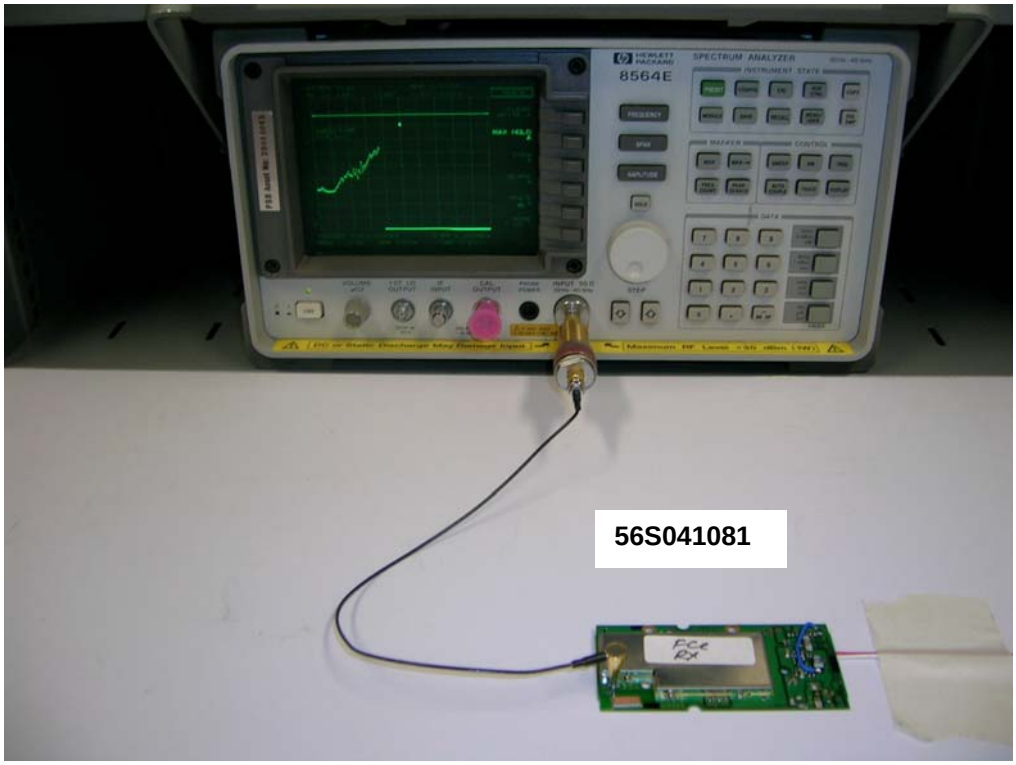
Following channels are not used after initialisation: 0, 8, 16, 24, 32, 40, 48, 56, 64, 72 (as detailed in the Operational Description).

Please refer to the attached Plots 7 - 10 for details.

Tested by: Lim Cher Hwee

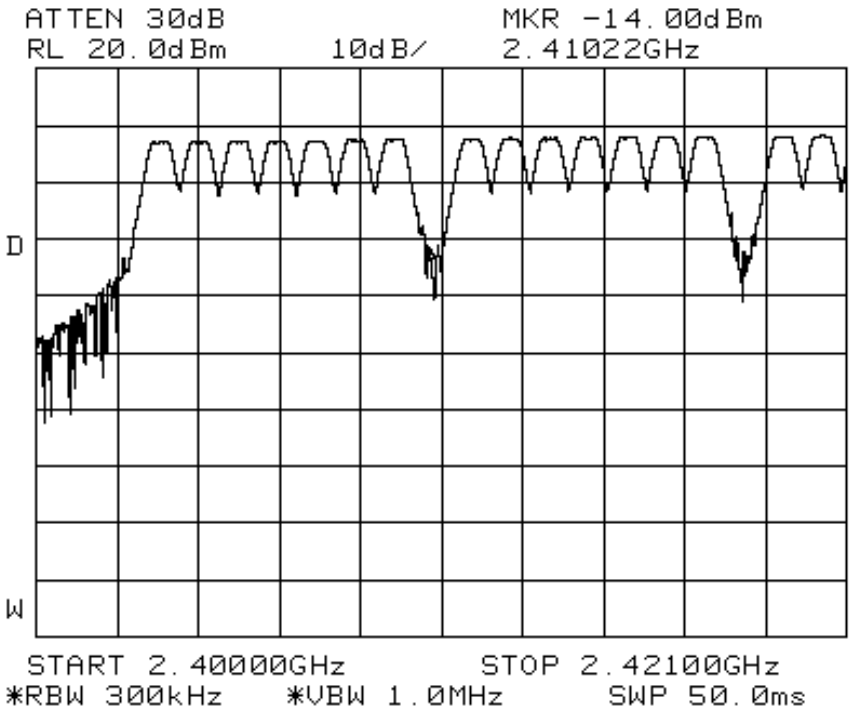
Notes :

1.	Environmental Conditions	Temperature	25°C
		Relative Humidity	60%
		Atmospheric Pressure	1030mbar

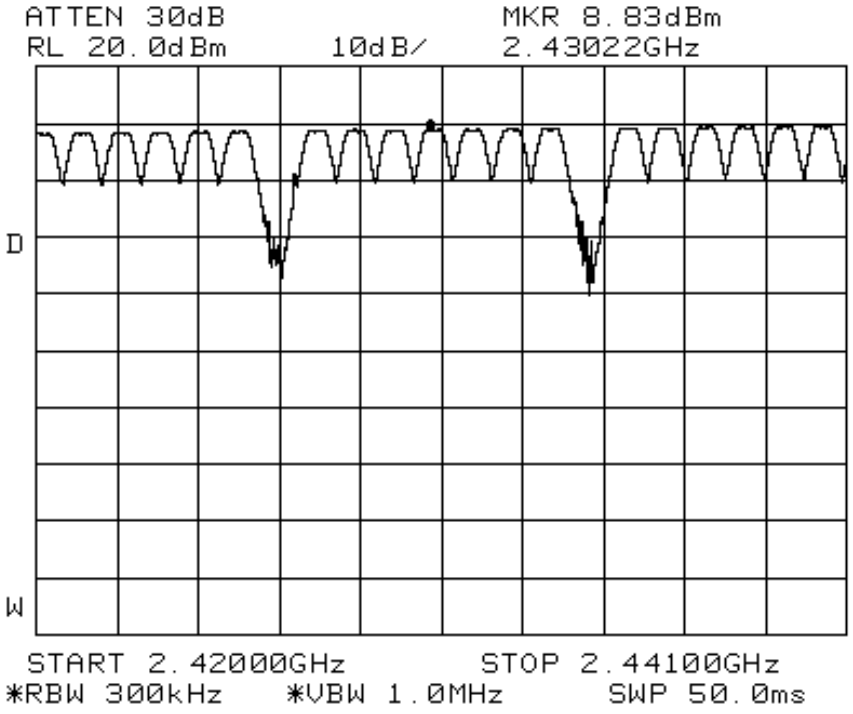


Number of Hopping Frequencies Measurement Test Setup

NUMBER OF HOPPING FREQUENCIES PLOTS

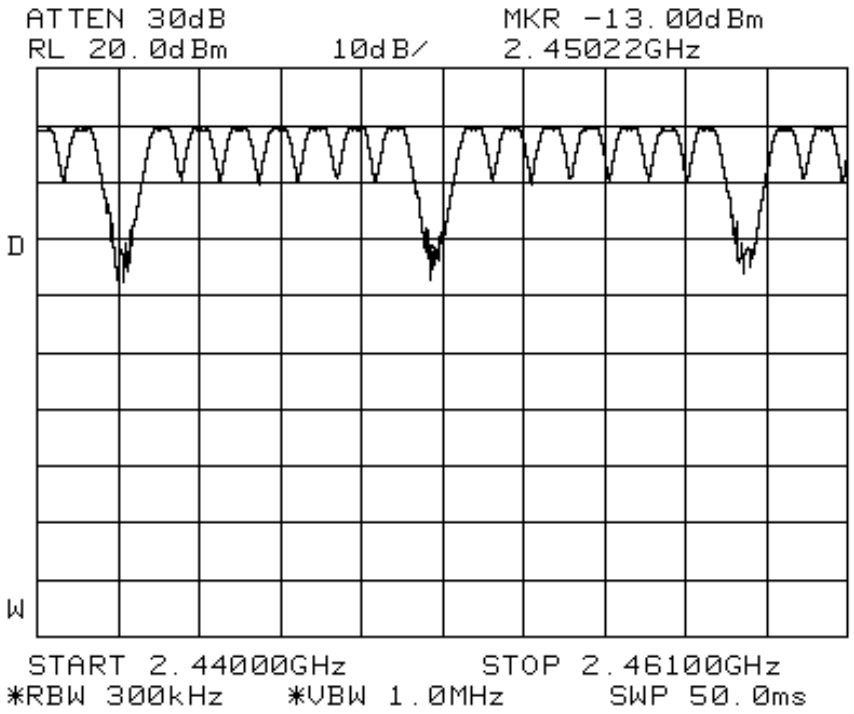


Plot 7 - Channels 1 to 18

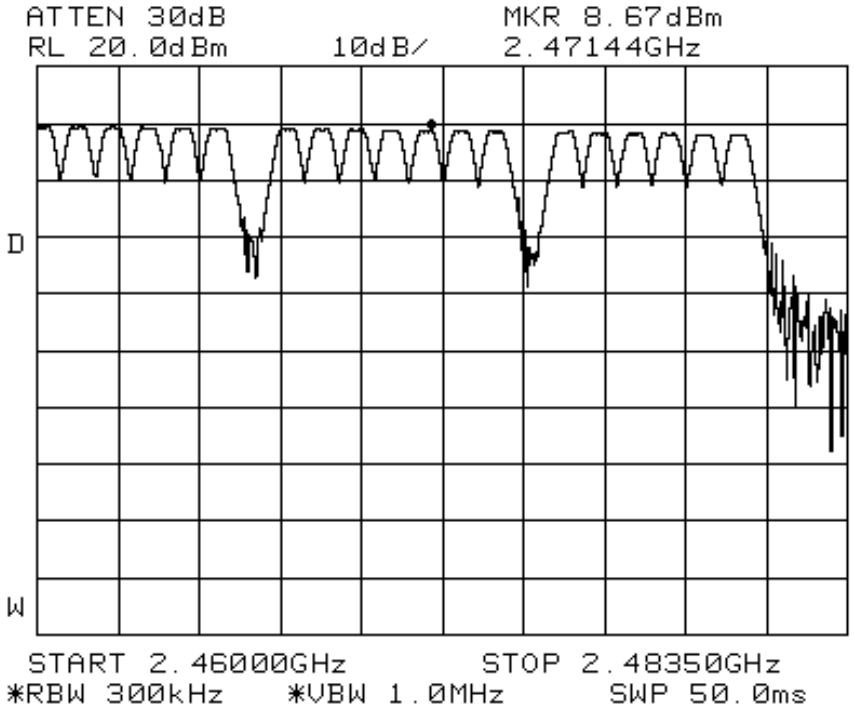


Plot 8 - Channels 19 to 38

NUMBER OF HOPPING FREQUENCIES PLOTS



Plot 9 - Channels 39 to 58



Plot 10 - 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 = 400 hops/s
Number of EUT hopping frequencies = 69 hops

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

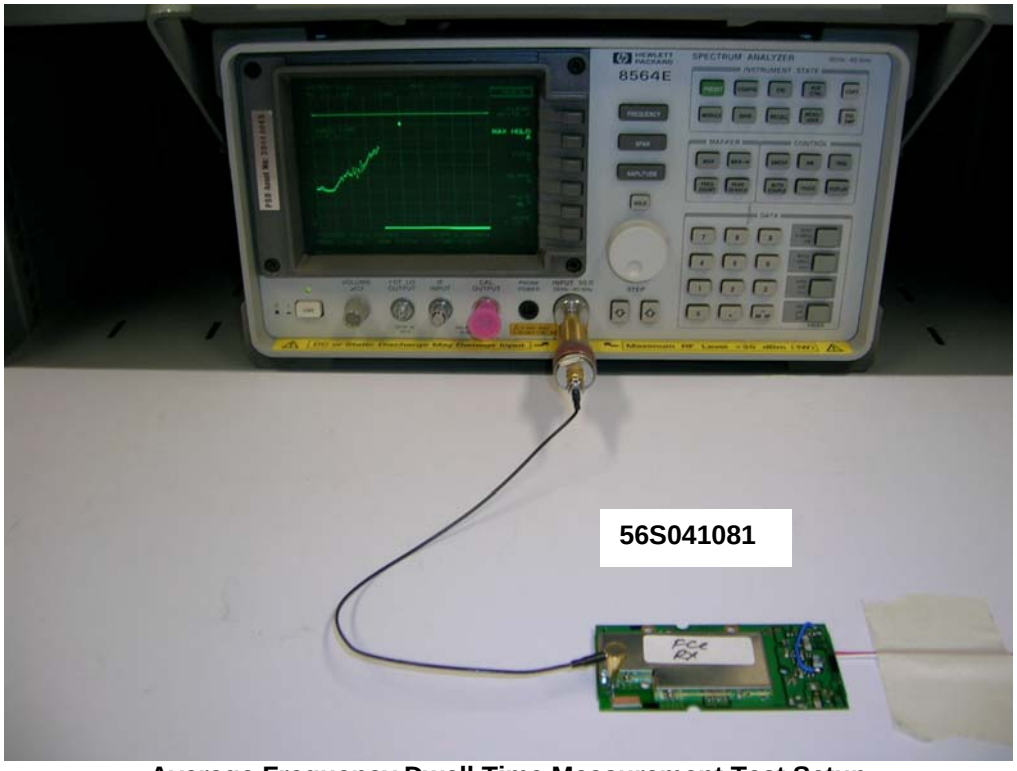
Channel	Channel Frequency (GHz)	Measured Time Slot Length for Packet(ms)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
1	2.403	1.2500	0.2415	0.4
39	2.441	1.2500	0.2415	0.4
78	2.480	1.2500	0.2415	0.4

Please refer to the attached Plots 11 – 13 for measured time slot length details.

Tested by: Lim Cher Hwee

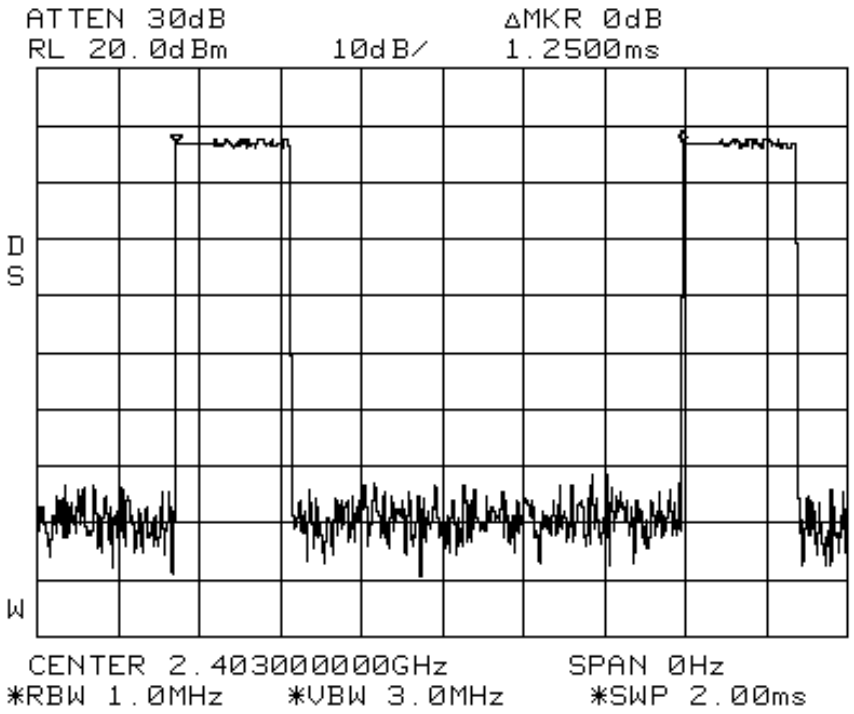
Notes :

1. Environmental Conditions — Temperature 25°C; Relative Humidity 60%; Atmospheric Pressure 1030mbar

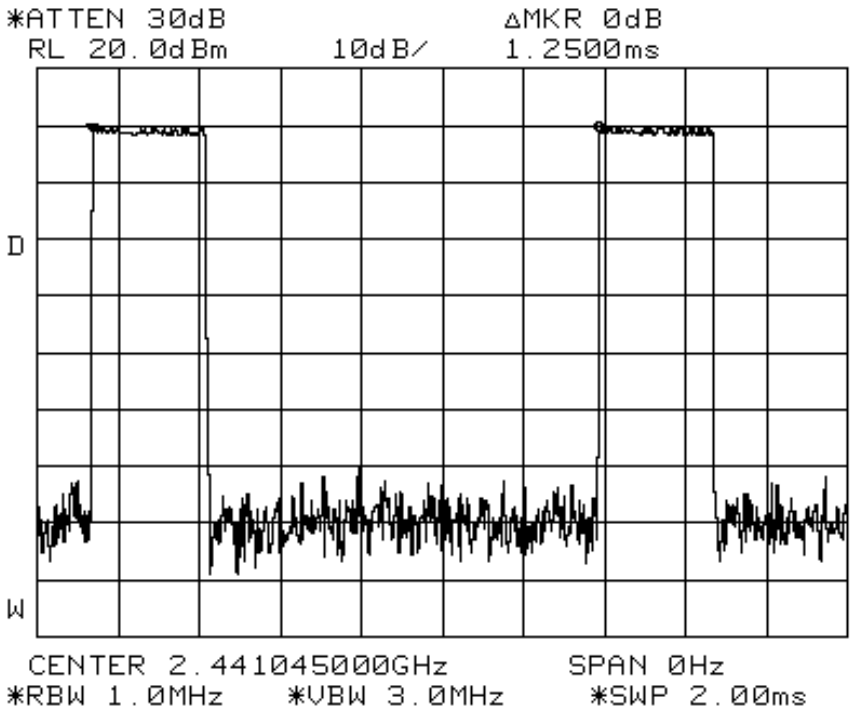


Average Frequency Dwell Time Measurement Test Setup

AVERAGE FREQUENCY DWELL TIME PLOTS

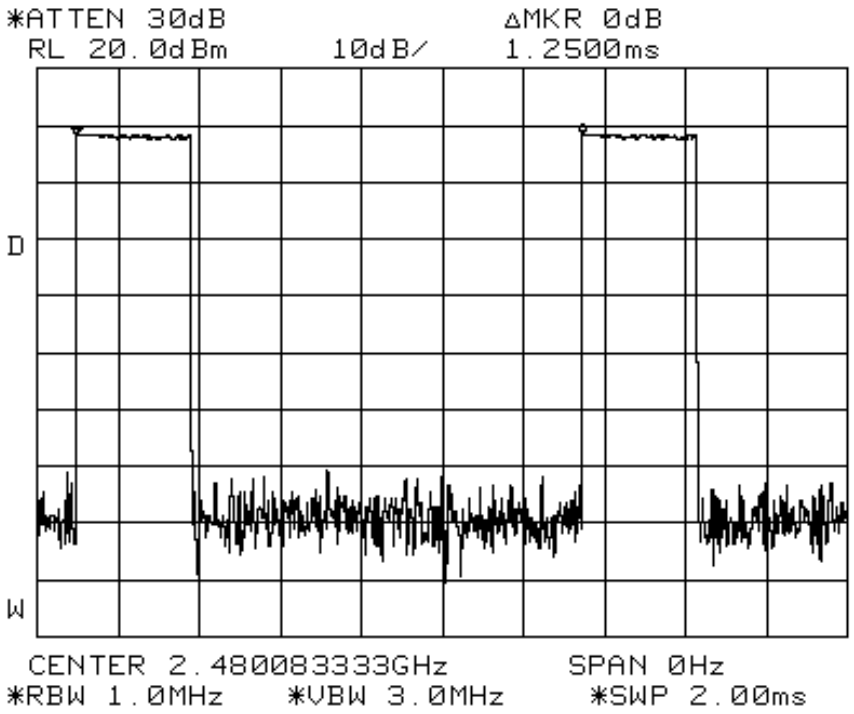


Plot 11 – Channel 1



Plot 12 – Channel 39

AVERAGE FREQUENCY DWELL TIME PLOTS



Plot 13 – 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 21dBm (0.125 Watt) for other frequency hopping systems.

The maximum peak power for Channels 1, 39 and 78 at 2.403GHz, 2.441GHz and 2.480GHz respectively were investigated and found below 21dBm (0.125Watt).

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)
1	2.403	0.0135	0.125
39	2.441	0.0200	0.125
78	2.480	0.0191	0.125

Tested by: Lim Cher Hwee

Notes :

1. Environmental Conditions — Temperature 25°C; Relative Humidity 60%; 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(d)) 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.

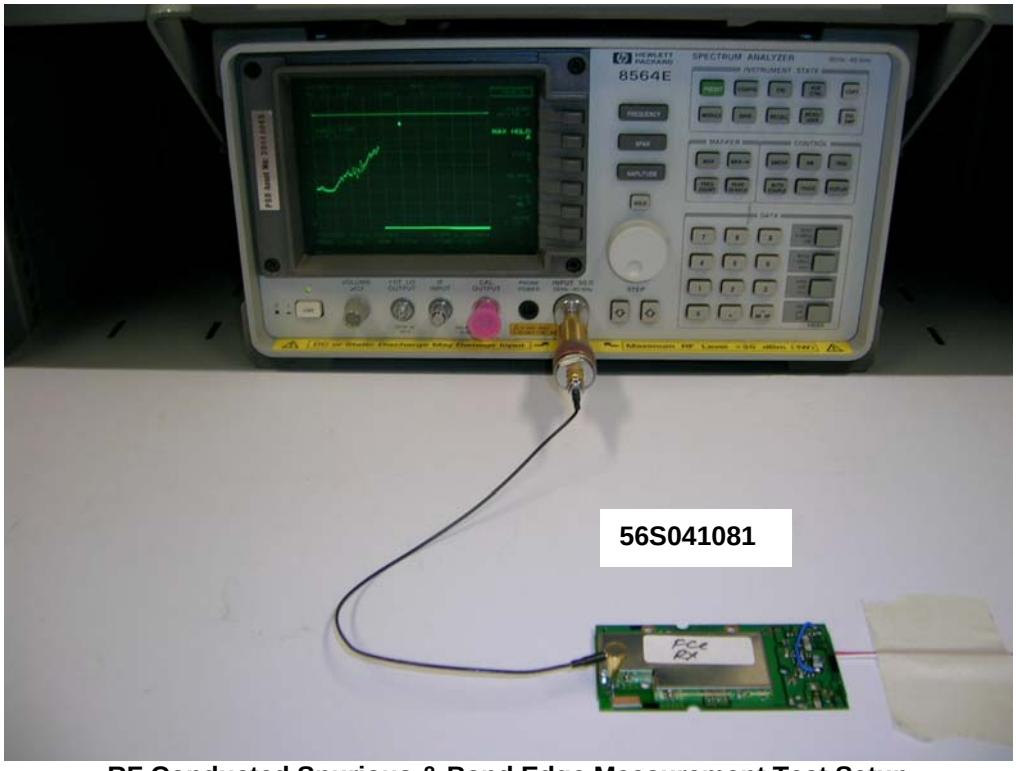
The RF conducted spurious emissions were scanned from 10MHz to 25GHz for Channels 1, 39, and 78 with channel frequency at 2.403GHz, 2.441GHz and 2.480GHz respectively. No significant signal was found and they were below the specified limit. Please refer to the attached Plots 14 – 19 for details.

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 20 – 21 for details.

Tested by: Lim Cher Hwee

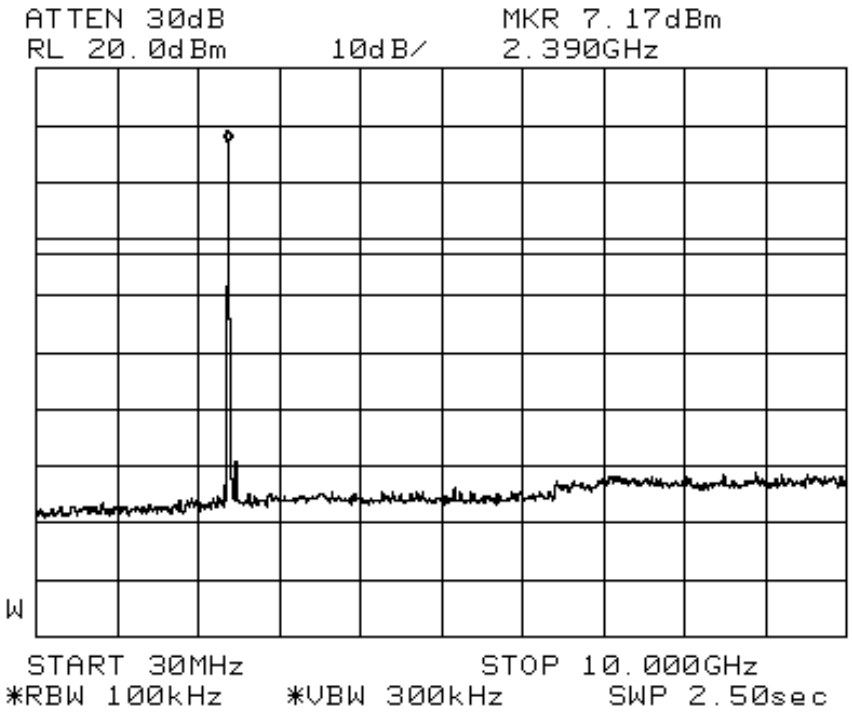
Notes :

1.	Environmental Conditions	Temperature	25°C
		Relative Humidity	60%
		Atmospheric Pressure	1030mbar

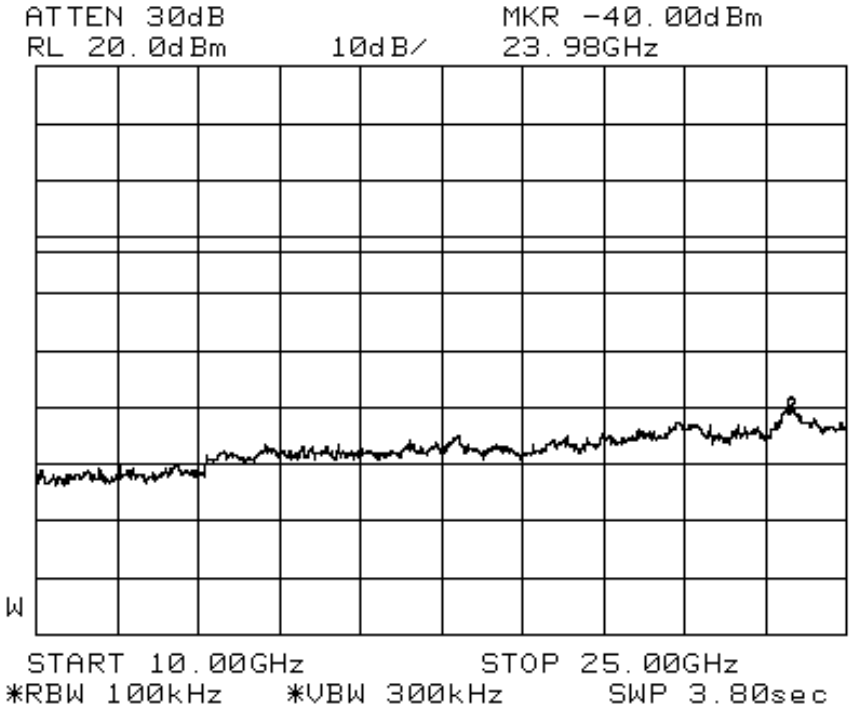


RF Conducted Spurious & Band Edge Measurement Test Setup

RF CONDUCTED SPURIOUS EMISSIONS PLOTS

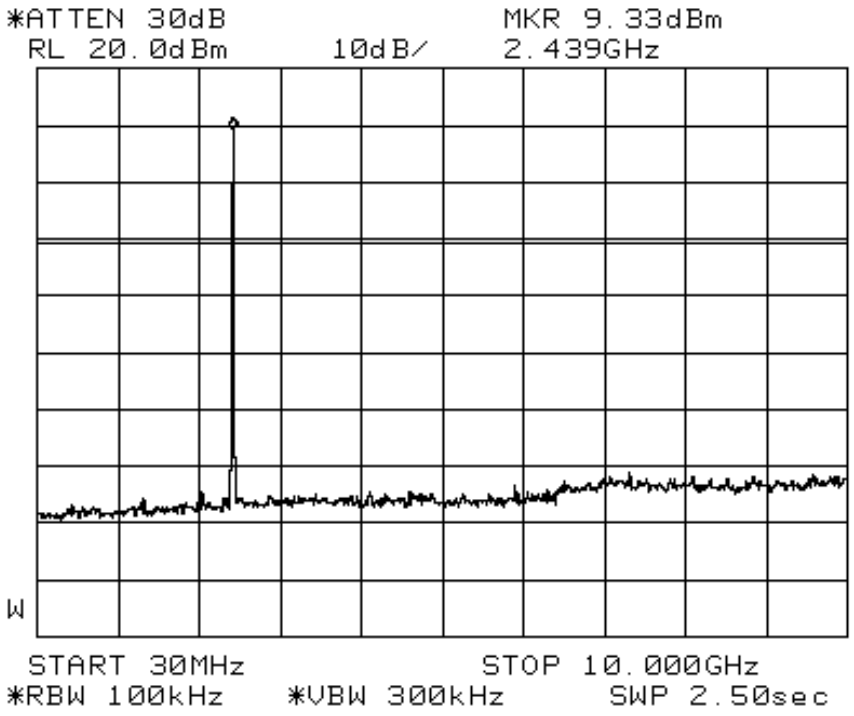


Plot 14 – Channel 1

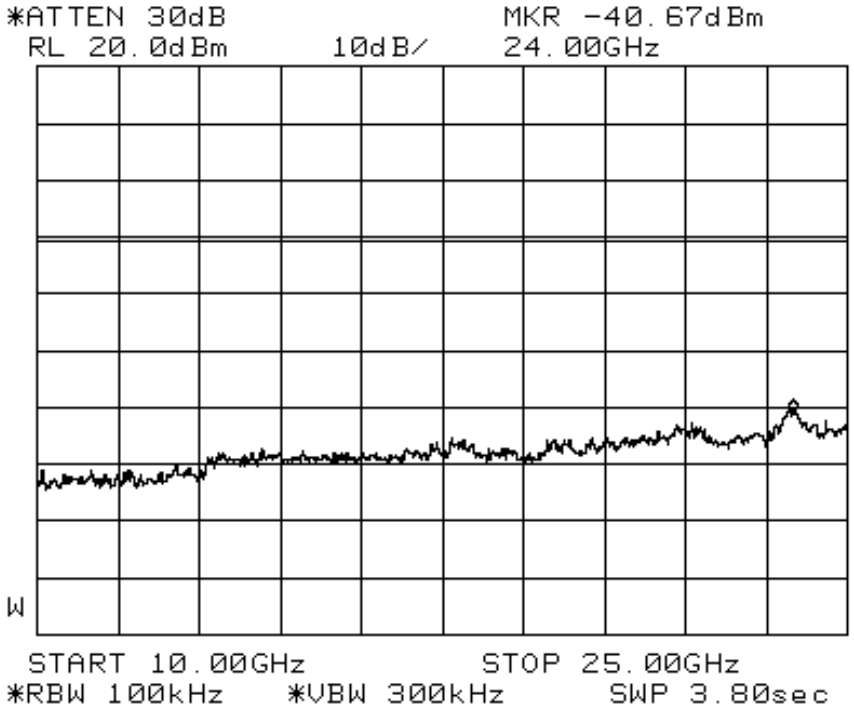


Plot 15 – Channel 1

RF CONDUCTED SPURIOUS EMISSIONS PLOTS

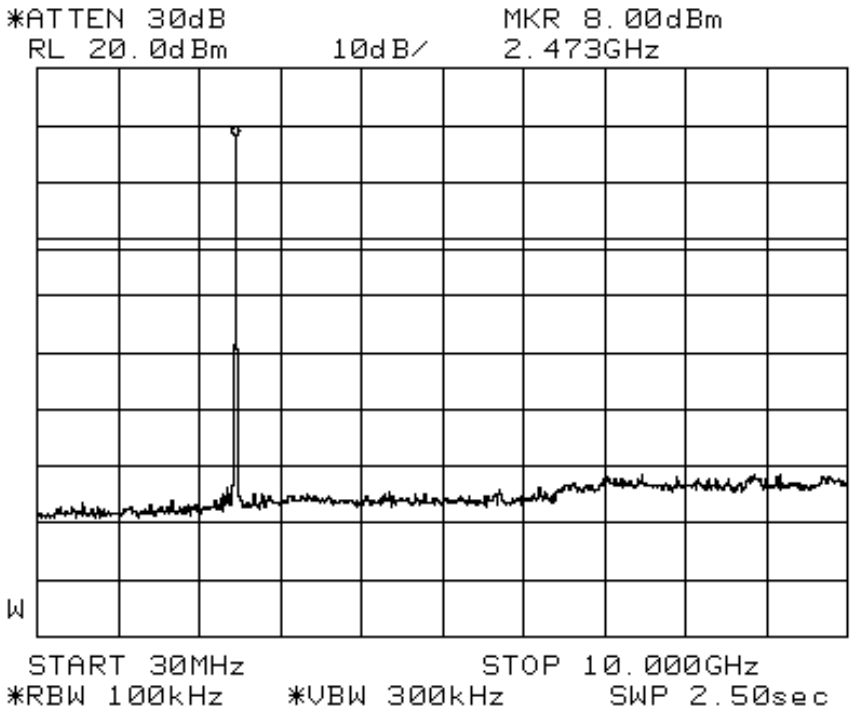


Plot 16 – Channel 39

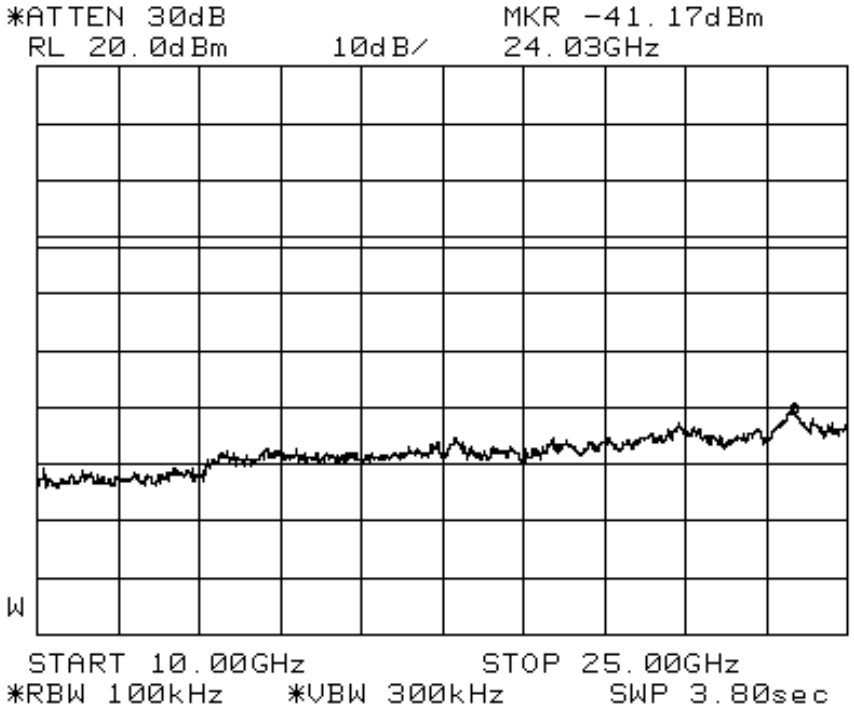


Plot 17 – Channel 39

RF CONDUCTED SPURIOUS EMISSIONS PLOTS

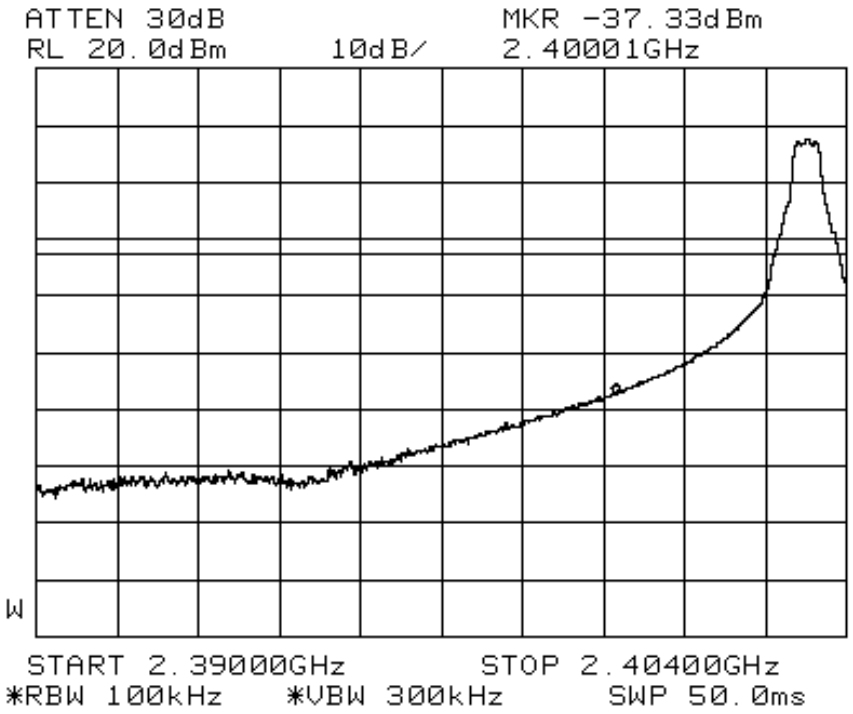


Plot 18 – Channel 78

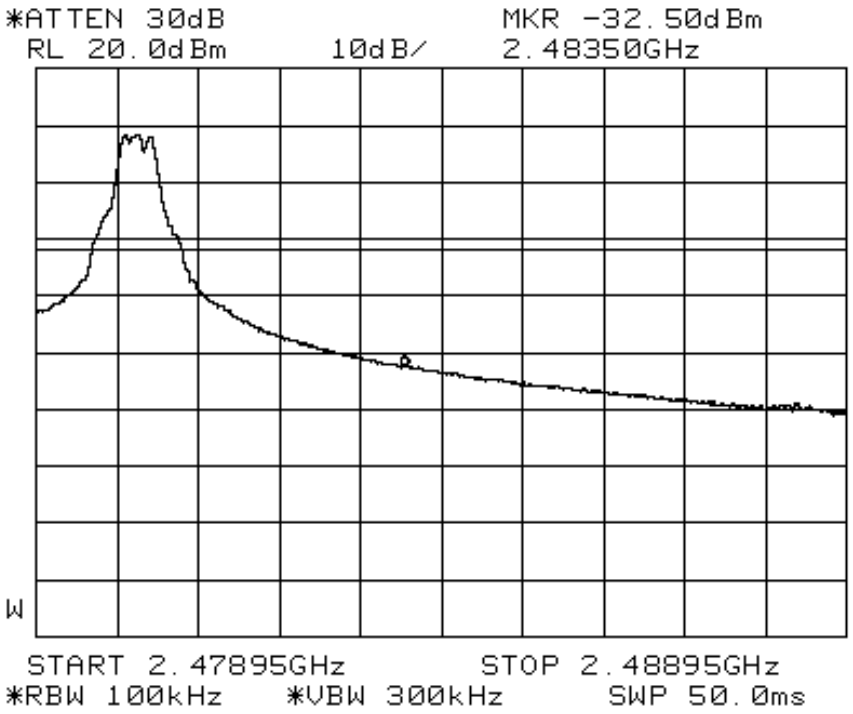


Plot 19 – Channel 78

BAND EDGE COMPLIANCE PLOTS



Plot 20 – Lower Band Edge at 2.40GHz



Plot 21 – Upper Band Edge at 2.4835GHz

FCC Part 15C (15.247(e)) 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.

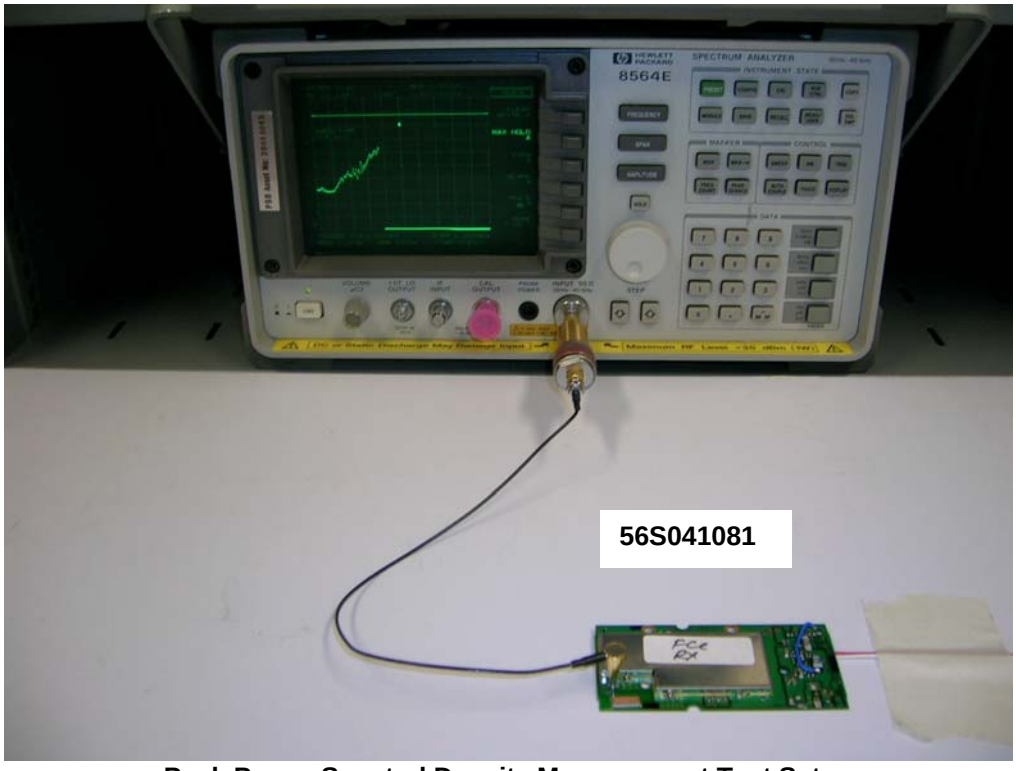
Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
1	2.403	1.0789	6.3
39	2.441	2.1528	6.3
78	2.480	1.4125	6.3

Please refer to the attached Plots 22 – 24 for details.

Tested by: Lim Cher Hwee

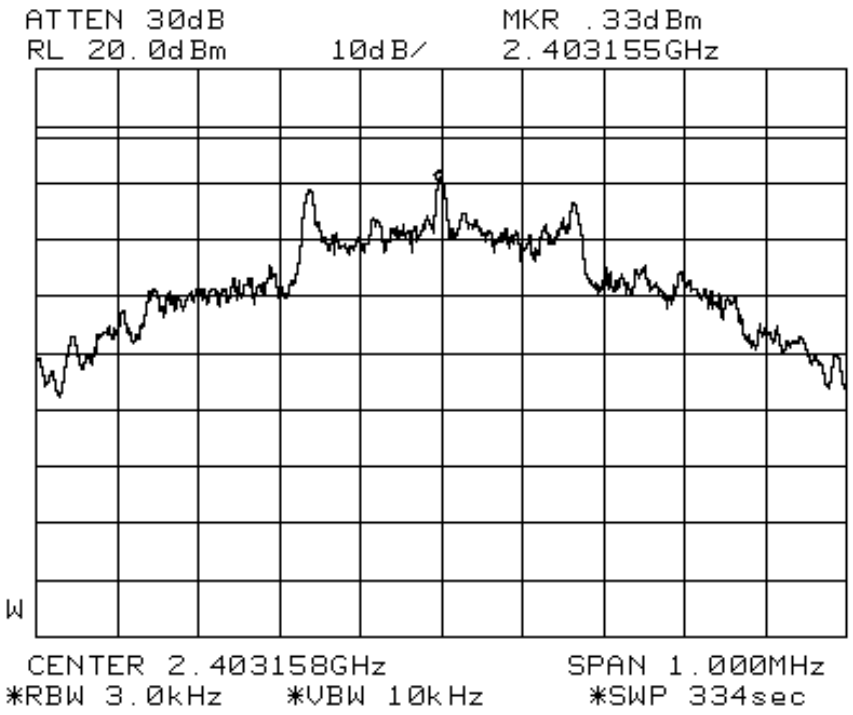
Notes :

1. Environmental Conditions — Temperature 25°C; Relative Humidity 60%; Atmospheric Pressure 1030mbar

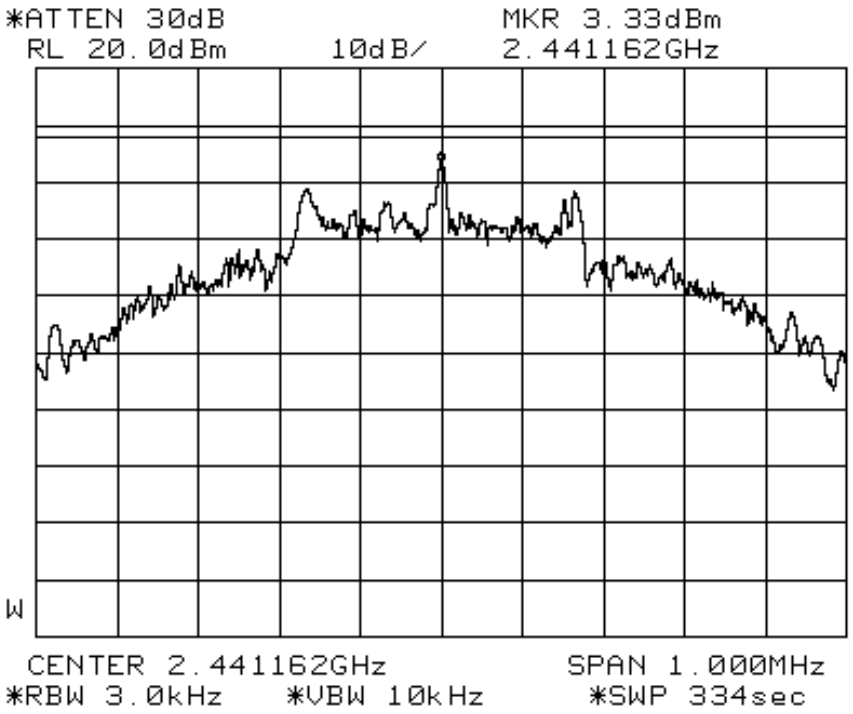


Peak Power Spectral Density Measurement Test Setup

PEAK POWER SPECTRAL DENSITY PLOTS

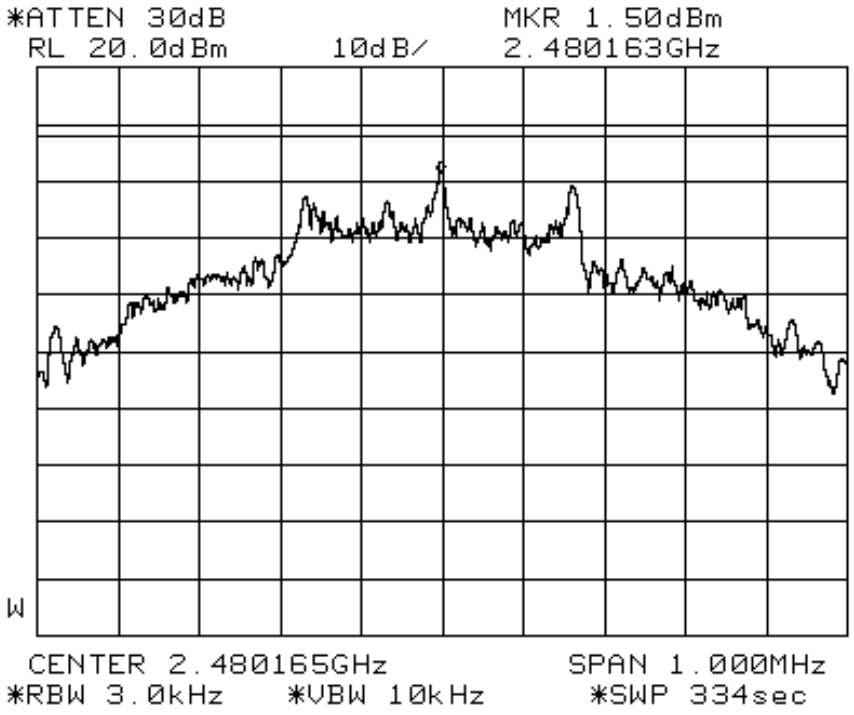


Plot 22 - Channel 1



Plot 23 - Channel 39

PEAK POWER SPECTRAL DENSITY PLOTS



Plot 24 - Channel 78

FCC Part 1.1310 Maximum Permissible Exposure (MPE) Results

Frequency (MHz)	Power Density Value (mW/cm^2)	Averaging Time (min)	Limit (mW/cm^2)	Margin (mW/cm^2)
2403	0.06	30	1.0	-0.94
2441	0.11	30	1.0	-0.89
2480	0.12	30	1.0	-0.88

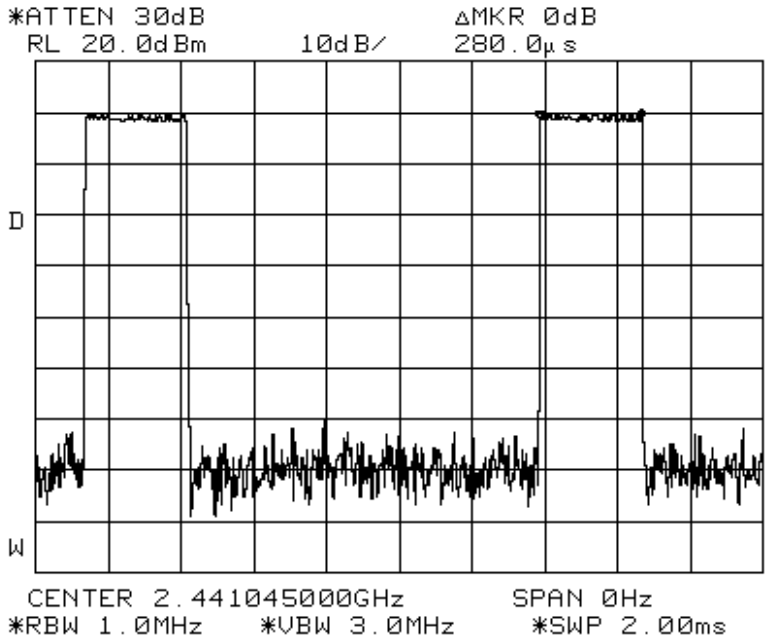
Tested by: Gary Ng

Notes :

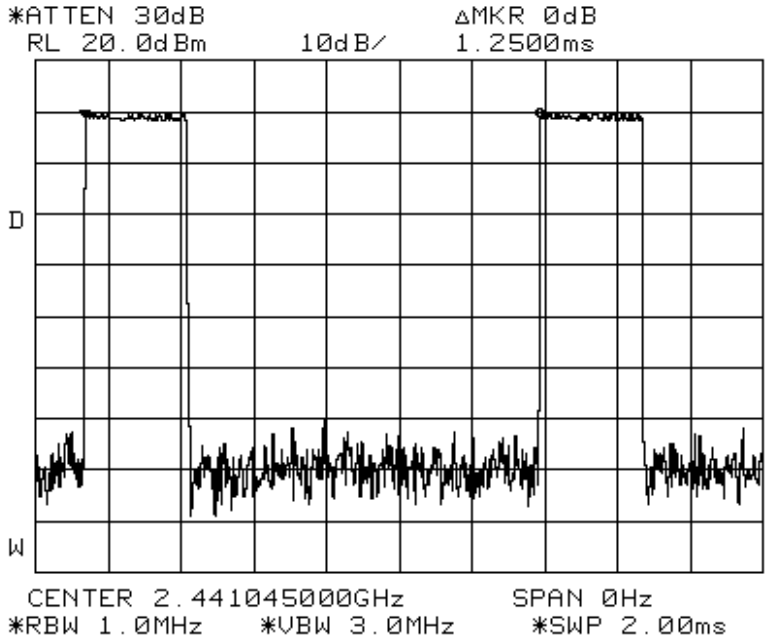
1. Environmental Conditions — Temperature: 24°C; Relative Humidity: 55%; Atmospheric Pressure: 1030mbar
2. All possible modes of operation were investigated. Only the worst case, highest radiation levels were measured. Measurements were taken at the required averaging time. All other radiation levels 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. 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 0.1MHz – 3GHz is ±15% .

Maximum Permissible Exposure Measurement Test Setup

FCC Part 15 (15.35(c)) Duty Cycle Correction Factor



On Time



Period

Duty Cycle Factor (worst- case) = 20 log [Total On time / Period]
= 20 log [(0.28 / 1.25)]
= **-13.98dB**

This Report is issued under the following conditions:

1. Results of the testing/calibration in the form of a report will be issued immediately after the service has been completed or terminated.

2. Unless otherwise requested, a report shall contain only technical results. Analysis and interpretation of the results and professional opinion and recommendations expressed thereupon, if required, shall be clearly indicated and additional fee paid for, by the Client.

3. This report applies to the sample of the specific product/equipment given at the time of its testing/calibration. The results are not used to indicate or imply that they are applicable to other similar items. In addition, such results must not be used to indicate or imply that PSB Corporation approves, recommends or endorses the manufacturer, supplier or user of such product/equipment, or that PSB Corporation in any way "guarantees" the later performance of the product/equipment.

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June 2004

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	×
R&S Pulse Limiter – PL1	ESH3-Z2	357.8810.52	07 Apr 2005	×
EMCO LISN (for EUT) – LISN5	3825/2	9202-1936	28 May 2005	×

Lab 8 – 3m Anechoic Chamber Test Instrumentation
(Radiated Emissions)

Instrument	Model	S/No	Cal Due Date	
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829214/005 829550/004	01 Sep 2005	×
HP Preamplifier (for ESMI2, 0.01-3GHz) – PA8	87405A	3207A00959	01 Apr 2005	×
MITEQ Preamplifier (0.1-26.5GHz) – PA10	NSP2650-N	728230	01 Apr 2005	×
Schaffner Bilog Antenna – BL8	CBL6143	5044	19 May 2005	×
EMCO Horn Antenna – H15	3115	0003-6088	22 Jun 2005	×
Bandstop Filter (2.4-2.5 GHz)	BRM50701	017	13 Aug 2005	×

Lab 7 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, Duty Cycle Correction Factor, Peak Power Density)

Instrument	Model	S/No	Cal Due Date	
HP Spectrum Analyzer	8564E	3846A09953	16 Dec 2005	×
R&S Universal Radio Communication Tester	CMU 200	837587/068	22 Apr 2005	×

Lab 1 Anechoic Chamber Test Instrumentation
(Maximum Permissible Exposure)

Instrument	Model	S/No	Cal Due Date	
PMM 8053 Portable Field Meter	8053	0220J10308	3 Feb 2006	×
PMM Electric and Magnetic Field Analyzer	EHP-50A	1311L10515	11 Jan 2006	×

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 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 test mode with hopping sequence on.

2. The start and stop frequencies of the spectrum analyser were set to 2.402GHz and 2.405GHz 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. 2.478GHz 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 30kHz.

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 test mode, non-hopping with transmitting frequency at Channel 1 (2.403GHz).

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.

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

6. 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 1MHz.

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 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 test mode, hopping sequence on.

2. The center frequency of the spectrum analyser was set to 2.403GHz 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	=	400 hops/s
Number of EUT hopping frequencies	=	69 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 test mode, non-hopping with transmitting frequency at Channel 1 (2.403GHz).

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 test mode, non-hopping with transmitting frequency at Channel 1 (2.403GHz).

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 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 transmission 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 transmission 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 test mode, non-hopping with transmitting frequency at Channel 1 (2.403GHz).

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.

DUTY CYCLE CORRECTION FACTOR 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 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 test mode, non-hopping with transmitting frequency at Channel 1 (2.403GHz).

2. The on time and period of the transmission pulse were measured.

3. The steps 2 and 3 were repeated with the transmitting frequency was set to Channel 39 (2.441GHz) and Channel 78 (2.480GHz) respectively.

4. Compute the worst-case (longest on time) duty cycle correction factor as shown below.

   Duty Cycle Factor = 20 log [Total On time / Period]

MAXIMUM PERMISSIBLE EXPOSURE (MPE) TEST DESCRIPTION

EUT Characterisation

EUT characterisation, over the required frequency range as given in table 1 of FCC Part 1.1310 was carried out to determine the EUT mode of operation that produces the highest possible level of radio frequency radiation.

The EUT was placed in a anechoic chamber, at a height of about 1m on a table. Its radio frequency radiation profile was observed, using a field meter with the appropriate field proble antenna attached and 20cm away from the EUT. E-field (V/m) readings are recorded, since the field meter is most sensitive at this setting. Positions where maximum E-field readings are detected are noted for the final, actual measurement.

Test Set-up

1. The EUT and supporting equipment were set up on top of a non-metallic table.

2. The relevant field probe was positioned at least 20cm 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. The test was carried out at the selected positions obtained from the EUT characterisation.

3. Power density measurement (mW/cm^2) was made using the field meter set to the required averaging time.

4. Steps 2 and 3 were repeated for the next position and its associate EUT operating mode, until all selected positions and modes were measured.

Sample Calculation Example

At 2400 MHz, limit = 1.0 mW/cm^2

Power density reading obtained directly from field meter = 0.3 mW/cm^2 averaged over the required 30 minutes.

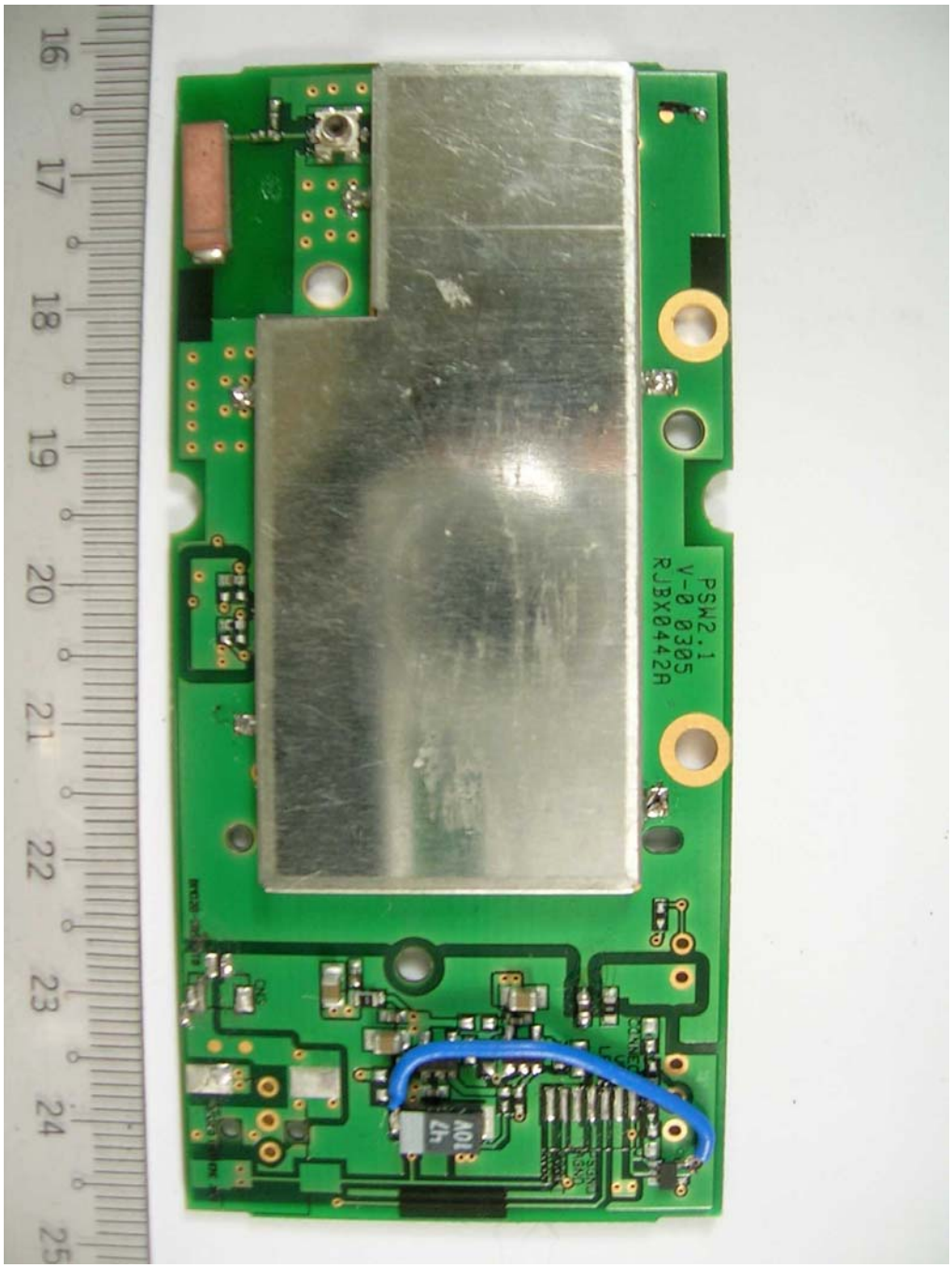
Therefore, margin = 0.3 – 1.0 = -0.7 mW/cm^2 i.e. **0.7 mW/cm^2 below limit**

ANNEX B

TEST PHOTOGRAPHS / DIAGRAMS

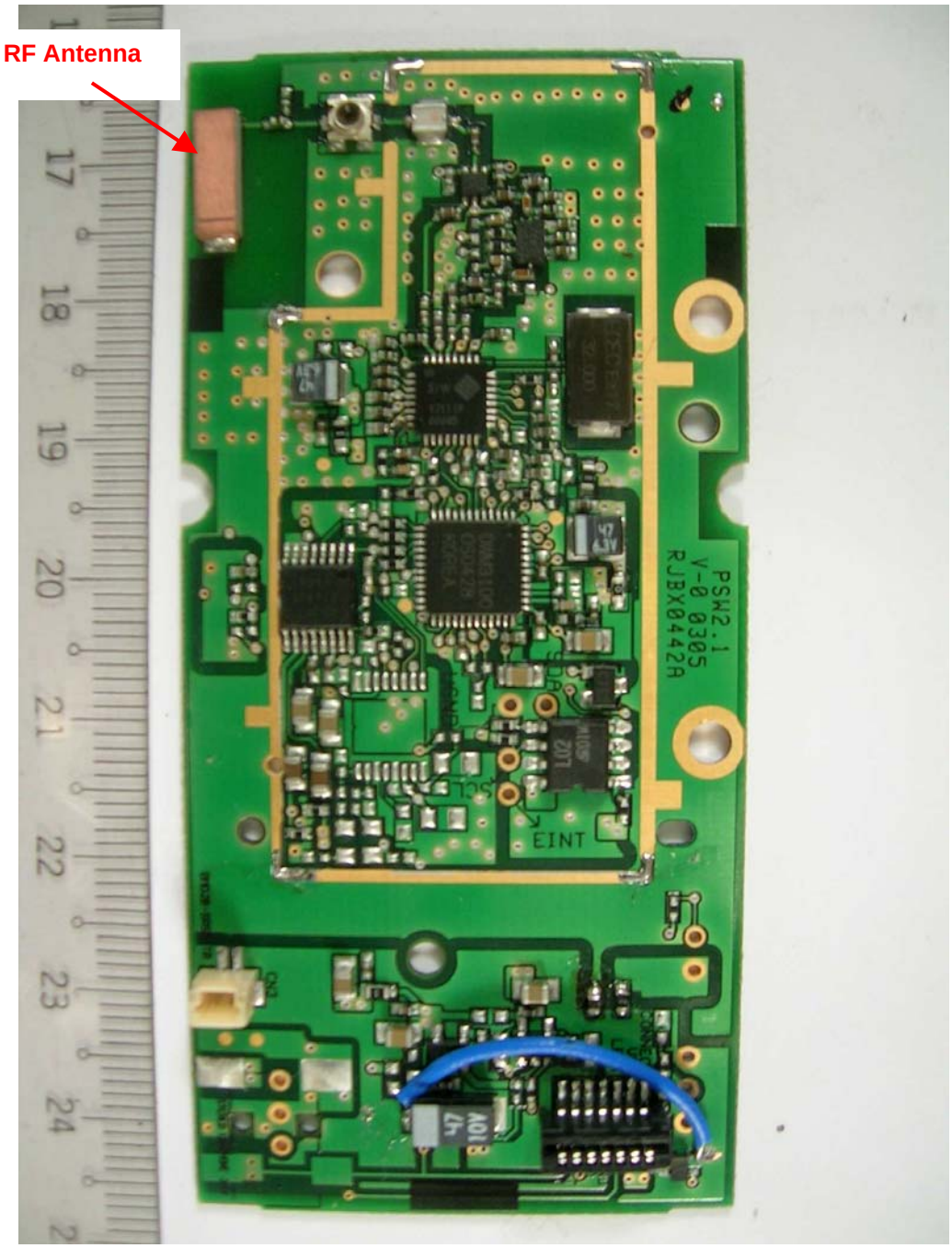
TEST PHOTOGRAPHS / DIAGRAMS ANNEX B

EUT PHOTOGRAPHS



Top View (With RF Shield)

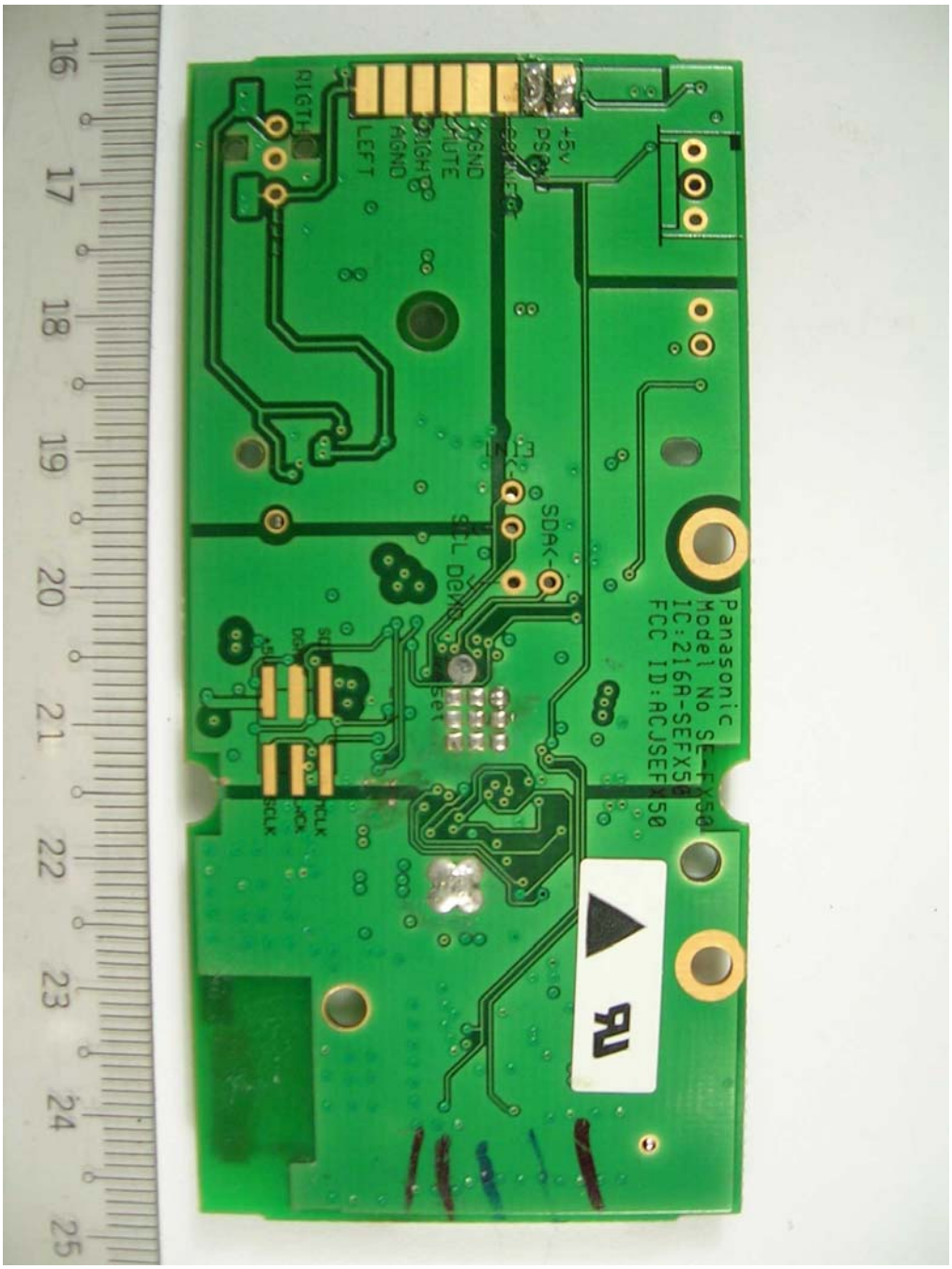
EUT PHOTOGRAPHS



EUT Top View (With RF Shield Removed)

TEST PHOTOGRAPHS / DIAGRAMS ANNEX B

EUT PHOTOGRAPHS



EUT Bottom View

ANNEX C

USER MANUAL
TECHNICAL DESCRIPTION
BLOCK & CIRCUIT DIAGRAMS

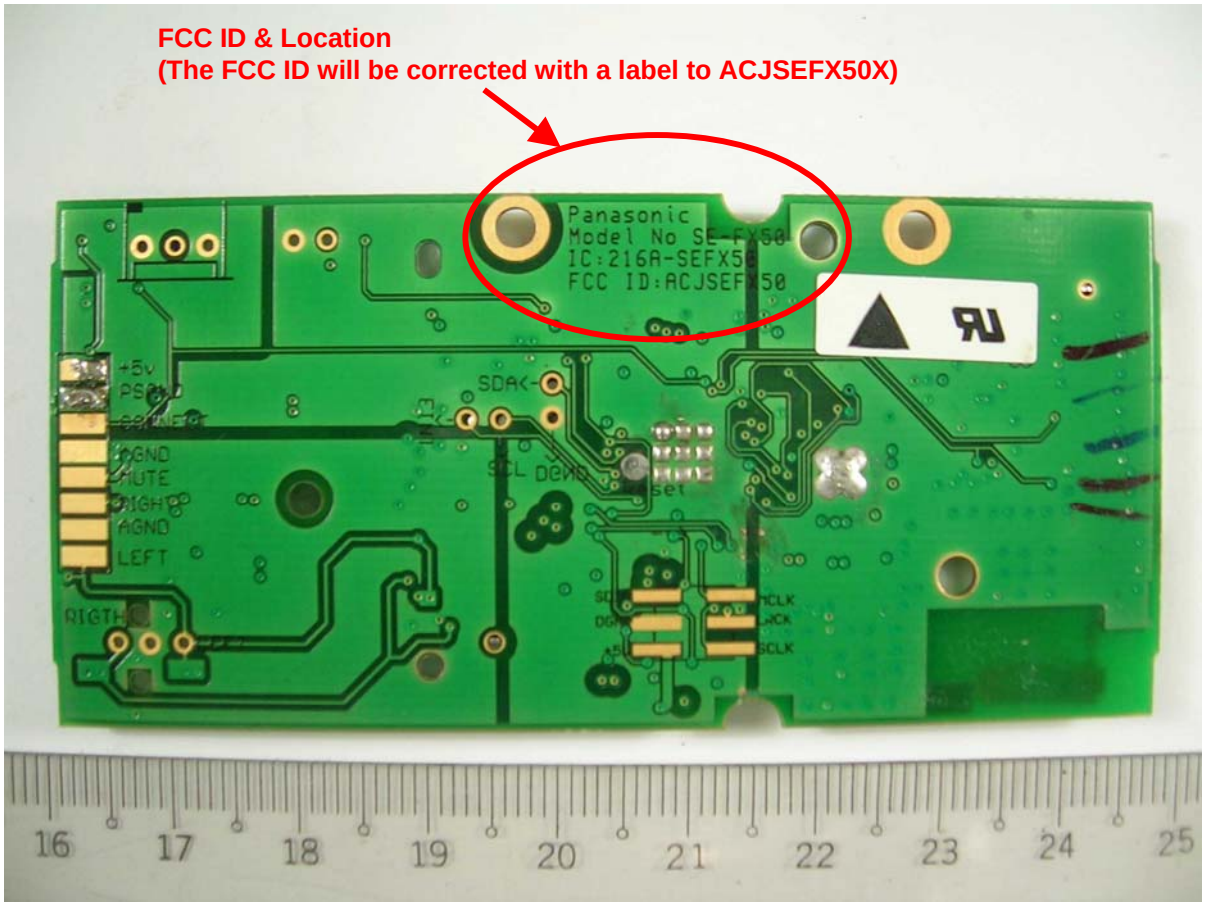
(Please refer to attached copy)

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 and Physical Location of FCC ID on EUT