TEST REPORT

Your Ref: | Date: 20 February 2002

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH

FCC Part 15C:2000
OF A
BLUETOOTH PROTOCOL ANALYSER
[MODEL : BPA-D10]
[FCC ID: P76MWBPA-D10]

TEST FACILITY	Telecoms & EMC, Testing Group, PSB Corporation Pte Ltd 1 Science Park Drive, Singapore 118221
FCC REGISTRATION NO.	90937 (3m & 10m OATS) 99142 (10m Anechoic Chamber)
PREPARED FOR	Mr. Chia Hang Poh Mobiwave Pte Ltd Block 16 #07-02 Kallang Place Singapore 339156 Republic of Singapore Tel : (65) 297 7706 ext 109 Fax : (65) 296 6670
JOB NUMBER	56S00529
TEST PERIOD	8 January 2002 – 7 February 2002

PREPARED BY	**APPROVED BY**
Lim Cher Hwee Engineer	Colin Gan Assistant Vice President

Your product quality and safety mark

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

Test Results Summary

FCC Paragraphs	Descriptions	Pass / Fail
15.207	Conducted Emissions	Pass
15.205	Radiated Emissions (Restricted Band Requirements)	Pass
15.209	Radiated Emissions	Pass
15.249	Radiated Emissions (Intention Radiator Emissions for Non-Hopping)	Pass
15.247 (a)(1)	Carrier Frequency Separation	Pass
15.247 (a)(1)(ii)	Number of Hopping Frequencies	Pass
	Spectrum Bandwidth (20dB Bandwidth Measurement)	Pass
	Average Frequency Dwell Time	Pass
15.247 (b)(1)	Maximum Peak Power	Pass
15.247 (b)(3)	Effective Isotropic Radiated Power (EIRP) Requirements	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
15.247 (f)	Processing Gain (Hybrid System)	Pass

Notes

1. Three channels, namely Channels 1 (2.402GHz), 40 (2.441GHz), and 79 (2.800GHz), which represent the lower, middle and upper of the Bluetooth channels were chosen and tested. For each channel, the equipment under test (EUT) was configured to operate in the Bluetooth test mode in all tests except processing gain measurement.
2. The processing gain was measured with EUT was configured to operated in inquiry/ page mode.
3. All the measurements in section 15.247 were done based on conducted measurements.

Description	:	The Equipment Under Test (EUT) is a **Bluetooth Protocol Analyser**.
Manufacturer	:	Mobiwave Pte Ltd
Model Number	:	BPA-D10
Serial Number	:	0152 1002
Microprocessor	:	AMD ELANSC520
Operating / Transmitting Frequency	:	133MHz
Clock / Oscillator Frequency	:	16MHz, 33MHz
Modulation	:	Gaussian Frequency Shift Keying (GFSK) with BT = 0.5
Port / Connectors	:	1 x RJ45 port 1 x DC IN port
Rated Input Power	:	DC 5V 2.5A (output of AC/DC power adapter)

Modifications

The EUT was brought to compliance to radiated emissions by the following modifications:

1. The resistors R1, R69, R70, R84, R86, R87, R88 & R89 on the baseband board were changed from 22 ohm to 47 ohm.
2. A ferrite choke with 3-turn CH1 was added on to the baseband board. The ferrite choke, CH2 was removed from the baseband board and was replaced with a wire.
3. A 0 ohm resistor, R85 and a 110pF capacitor, C115 were added on to the mother board.
4. 100pF capacitors were used as the capacitors for C13, C25, C36, C91, C94, C153 and C116 on the baseband board.

FCC Part 15C (15.207) Conducted Emission Results

Frequency (MHz)	Q-P Value (dBμV)	Q-P Margin (dB)	Line	Channel / Channel Frequency (GHz)
0.5291	43.3	-12.7	Neutral	1 / 2.402
0.7850	45.6	-10.4	Neutral	1 / 2.402
1.1791	43.8	-12.2	Neutral	1 / 2.402
1.4652	44.5	-11.5	Neutral	1 / 2.402
0.5435	43.9	-12.1	Neutral	79 / 2.480
0.9481	43.8	-12.2	Neutral	79 / 2.480

Notes

1. 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.
2. The transmitting antenna was found to be in the worst case condition when it was orientated in a vertical position.
3. The harmonics of respective transmitting frequency were found insignificant (no harmonics emissions were found)
4. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
5. 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.
6. The emissions in restricted bands (FCC Part 15C Section 15.205) were found to be spurious emissions and showed compliance to the limits of conducted and radiated emissions.
7. 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.

FCC Part 15C (15.209) Radiated Emission Results

Test Distance : 3m

Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Margin (dB)	Pol (H/V)	Channel / Channel Frequency (GHz)	Height (m)	Azimuth (Degrees)
30.6231	37.7	-2.3	V	1 / 2.402	1.12	345
47.9848	39.7	-0.3	V	40 / 2.441	1.51	198
38.8405	38.3	-1.7	V	79 / 2.480	1.26	62
79.7208	36.2	-3.8	V	1 / 2.402	1.00	93
428.9789	43.1	-2.9	V	1 / 2.402	1.24	165
692.9799	43.7	-2.3	V	40 / 2.441	1.05	187

FCC Part 15C (15.249) Radiated Emission Results (Intention Radiator Emissions for Non-Hopping)

Test Distance : 3m

Channel / Channel Frequency (GHz)	Peak Value (dBμV/m)	Average Value (dBμV/m)	Average Margin (dB)	Pol (H/V)	Height (m)	Azimuth (Degrees)
1 / 2.402	96.9	91.3	-2.7	V	1.00	48
40 / 2.441	96.5	91.1	-2.9	V	1.00	76
79 / 2.480	96.6	91.3	-2.7	V	1.00	44

Notes

1. 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.
2. The transmitting antenna was found to be in the worst case condition when it was orientated in a vertical position.
3. The harmonics of respective transmitting frequency were found insignificant (no harmonics emissions were found) and showed compliance to the limits of FCC Part 15C 15.249.
4. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
5. 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.
6. The emissions in restricted bands (FCC Part 15C Section 15.205) were found to be spurious emissions and showed compliance to the limits of conducted and radiated emissions.
7. 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

Restricted Band (MHz)	Limit (dBμV/m)	Channel 1 (2.402GHz)			Channel 40 (2.441GHz)			Channel 79 (2.480GHz)		
		Freq. (MHz)	Peak (dBμV/m)	Average (dBμV/m)	Freq. (MHz)	Peak (dBμV/m)	Average (dBμV/m)	Freq. (MHz)	Peak (dBμV/m)	Average (dBμV/m)
37.5-38.25	40.0	Nil	-	-	Nil	-	-	Nil	-	-
73-74.6	40.0	Nil	-	-	Nil	-	-	Nil	-	-
74.8-75.2	40.0	Nil	-	-	Nil	-	-	Nil	-	-
108-121.94	43.5	Nil	-	-	120.82	33.9	-	Nil	-	-
123-138	43.5	132.41	38.2	-	132.41	38.2	-	132.41	37.9	-
149.9-150.05	43.5	Nil	-	-	Nil	-	-	Nil	-	-
156.52475-156.52525	43.5	Nil	-	-	Nil	-	-	Nil	-	-
156.7-156.9	43.5	Nil	-	-	Nil	-	-	Nil	-	-
162.0125-167.17	43.5	Nil	-	-	Nil	-	-	Nil	-	-
167.72-173.2	43.5	Nil	-	-	Nil	-	-	171.00	32.1	-
240-285	46.0	240.92 250.28 263.80 281.20	34.2 36.6 33.9 38.8	- - - -	240.62 250.28 263.80 281.20	35.9 36.2 34.2 38.2	- - - -	250.28 283.13	36.9 37.9	- - - -
322-335.4	46.0	Nil	-	-	Nil	-	-	Nil	-	-
399.9-410	46.0	401.00	41.9	-	Nil	-	-	400.86	39.9	-
608-614	46.0	Nil	-	-	Nil	-	-	Nil	-	-
960-1240	53.9	996.14 1000.0 1035.9 1165.3 1197.2 1231.1	36.9 44.9 44.2 49.8 49.2 48.8	- - - 33.2 32.6 33.7	1000.0 1161.5 1228.0	44.9 48.1 45.8	- 33.8 32.9	1002.0 1095.4 1167.3 1200.0 1235.1	44.2 42.8 49.2 46.5 48.8	- 29.2 33.5 33.8 32.7

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

Test Distance : 3m

Restricted Band (MHz)	Limit (dBµV/m)	Channel 1 (2.402GHz)			Channel 40 (2.441GHz)			Channel 79 (2.480GHz)		
		Freq. (MHz)	Peak (dBµV/m)	Average (dBµV/m)	Freq. (MHz)	Peak (dBµV/m)	Average (dBµV/m)	Freq. (MHz)	Peak (dBµV/m)	Average (dBµV/m)
1300-1427	53.9	Nil	-	-	1328.7	48.8	33.6	1364.5	47.8	32.1
1435-1626.5	53.9	1500.0 1599.6	50.8 50.7	35.6 34.8	1494.1	49.0	35.2	Nil	-	-
1645.5-1646.5	53.9	Nil	-	-	Nil	-	-	Nil	-	-
1660-1710	53.9	Nil	-	-	Nil	-	-	Nil	-	-
1718.8-1722.2	53.9	Nil	-	-	Nil	-	-	Nil	-	-
2200-2300	53.9	Nil	-	-	Nil	-	-	Nil	-	-
2310-2390	53.9	Nil	-	-	Nil	-	-	Nil	-	-
2483.5-2500	53.9	Nil	-	-	Nil	-	-	Nil	-	-
2655-2900	53.9	Nil	-	-	Nil	-	-	Nil	-	-
3260-3267	53.9	Nil	-	-	Nil	-	-	Nil	-	-
3332-3339	53.9	Nil	-	-	Nil	-	-	Nil	-	-
3345.8-3358	53.9	Nil	-	-	Nil	-	-	Nil	-	-
3600-4400	53.9	Nil	-	-	Nil	-	-	Nil	-	-
4500-5150	53.9	Nil	-	-	Nil	-	-	Nil	-	-
5350-5460	53.9	Nil	-	-	Nil	-	-	Nil	-	-
7250-7750	53.9	Nil	-	-	Nil	-	-	Nil	-	-
8025-8500	53.9	Nil	-	-	Nil	-	-	Nil	-	-
9000-9200	53.9	Nil	-	-	Nil	-	-	Nil	-	-
9300-9500	53.9	Nil	-	-	Nil	-	-	Nil	-	-
10600-12700	53.9	Nil	-	-	Nil	-	-	Nil	-	-
13250-13400	53.9	Nil	-	-	Nil	-	-	Nil	-	-
14470-14500	53.9	Nil	-	-	Nil	-	-	Nil	-	-

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

Test Distance : 3m

Restricted Band (MHz)	Limit (dBμV/m)	Channel 1 (2.402GHz)			Channel 40 (2.441GHz)			Channel 79 (2.480GHz)		
		Freq. (MHz)	Peak (dBμV/m)	Average (dBμV/m)	Freq. (MHz)	Peak (dBμV/m)	Average (dBμV/m)	Freq. (MHz)	Peak (dBμV/m)	Average (dBμV/m)
15350-16200	53.9	Nil	-	-	Nil	-	-	Nil	-	-
17700-21400	53.9	Nil	-	-	Nil	-	-	Nil	-	-
22010-23120	53.9	Nil	-	-	Nil	-	-	Nil	-	-
23600-24000	53.9	Nil	-	-	Nil	-	-	Nil	-	-
31200-31800	53.9	Nil	-	-	Nil	-	-	Nil	-	-
36430-36500	53.9	Nil	-	-	Nil	-	-	Nil	-	-

Notes

1. All possible modes of operation were investigated. Only emissions found within the restricted band were measured, using the correct CISPR detectors are reported. All other emissions were insignificant. and merely noise floor.
2. The transmitting antenna was found to be in the worst case condition when it was orientated in a vertical position.
3. The Nil in the frequency 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. 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 (15.247(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 (2.402GHz and 2.403GHz)	1.015
39 and 40 (2.440GHz and 2.441GHz)	1.025
40 and 41 (2.441GHz and 2.442GHz)	1.010
78 and 79 (2.479GHz and 2.480GHz)	1.030

Please refer to the attached Plots 1 – 4 in Annex F for details.

FCC Part 15C (15.247(a)(1)(ii)) 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 5 – 8 in Annex F for details.

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

The EUT shows compliance to the requirements of this section, which states that the maximum 20dB bandwidth of the hopping channel is 1 MHz.

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)	Maximum Limit (MHz)
1	2.402	0.893	1
40	2.441	0.930	1
79	2.480	0.977	1

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

Please refer to attached Plots 9 – 11 of Annex F for details.

FCC Part 15C (15.247(a)(1)(ii)) 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 30 second period.

EUT hopping rate = 1600 hops/s
Number of EUT hopping frequencies = 79 hops
DH1 packet 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 second period

Channel	Channel Frequency (GHz)	Measured Time Slot Length for DH1 Packet(μs)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
1	2.402	626.2	0.38	0.4
40	2.441	626.2	0.38	0.4
79	2.480	626.2	0.38	0.4

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

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 1, 40 and 79 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)
1	2.402	0.06	1
40	2.441	0.06	1
79	2.480	0.06	1

FCC Part 15C (15.247(b)(3)) Effective Isotropic Radiated Power (EIRP) Results

The EUT shows compliance to the requirements of this section, which states if the transmitting antenna gain used is greater than 6dBi, the peak power output from the intention radiator shall be reduced to 1Watt as appropriate by the amount in dB that the directional gain of the antenna exceeds 6dBi gain.

EUT antenna gain = 1.7dBi (refer to antenna specification attached in Appendix D)

EIRP = EUT maximum peak power on hopped channel + antenna gain (1.7dBi)

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	EIRP (W)	Limit (W)
1	2.402	0.06	0.09	1
40	2.441	0.06	0.09	1
79	2.480	0.06	0.09	1

FCC Part 15C: 2000 (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 1, 40, and 79 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 in Annex F 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 in Annex F for details.

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)
1	2.402	4.14	6.3
40	2.441	4.14	6.3
79	2.480	2.93	6.3

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

FCC Part 15C (15.247(f)) Processing Gain (Hybrid System) Results

The EUT shows compliance to the requirements of this section, which states the hybrid system that employs a combination of both direct sequence and frequency hopping modulation techniques shall achieve a processing gain of at least 17dB from the combined techniques.

Processing gain of frequency hopping, $Gp_{(hopping)}$ = 10 log [Number of frequency hopping used] = 10 log 32 = 15.0dB

Please refer to pages 15 to 20 for direct sequence processing gain measurements.

Processing gain, $Gp = Gp_{(hopping)} + Gp_{(direct\ sequence)}$

Access Code	**000000**	**65B333**	**FFFFFF**
Direct Sequence Gp	5.4	8.1	7.9
Frequency Hopping Gp	15.0	15.0	15.0
Total Processing Gain	**19.4**	**23.1**	**22.9**

FCC Part 15C (15.247(d)(2)) Processing Gain (Direct Sequence System) Results

Channel Used: 40 (2.441GHz)
Transmitted Packet: 10 000 packets
Access Code Used: **000000**

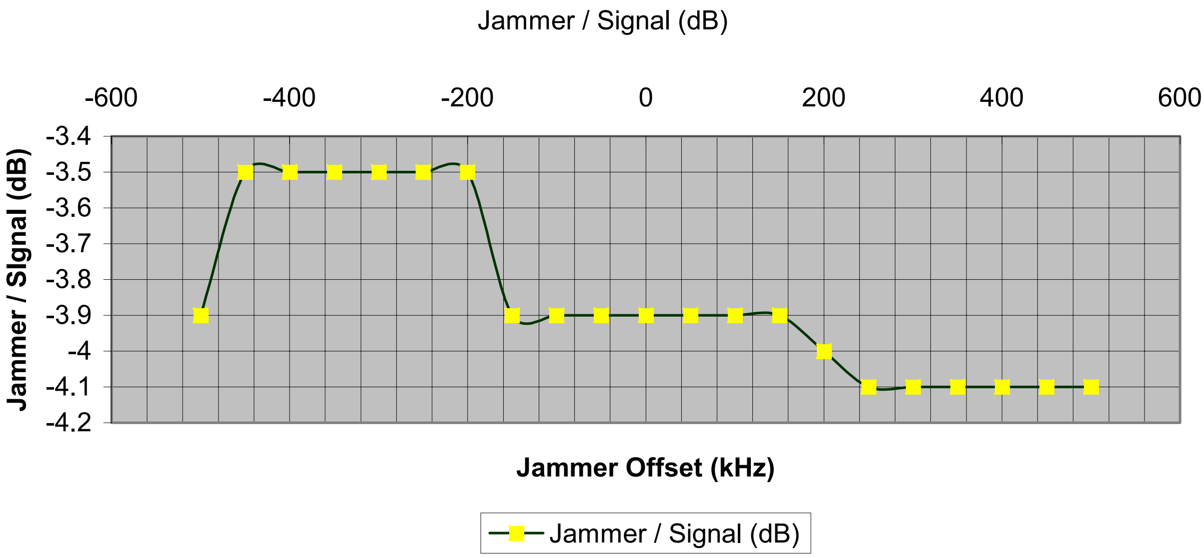
Signal level at receiver input: -62.17dBm
Noise level at receiver input when False Error Rate (FRR) is 0.1%: -69.67dBm
Signal-to-noise ratio (S/N) = -62.17dBm – (-69.67dBm) = **7.50dB**

Disregarding the worst 20% of the jammer-to-signal ratio (J/S), the worst J/S is found to be **-4.1dB**
Direct sequence processing gain, $Gp_{(direct\ sequence)}$ = S/N (dB) + J/S (dB) + L_{sys} (dB)
= 7.5dB - 4.1dB +2.0dB
= **5.4dB**

Jammer Offset Frequency (kHz)	Jammer (dBm)	Mj (dB)
-500	-66.07	-3.9
-450	-65.67	-3.5
-400	-65.67	-3.5
-350	-65.67	-3.5
-300	-65.67	-3.5
-250	-65.67	-3.5
-200	-65.67	-3.5
-150	-66.07	-3.9
-100	-66.07	-3.9
-50	-66.07	-3.9
0	-66.07	-3.9
50	-66.07	-3.9
100	-66.07	-3.9
150	-66.07	-3.9
200	-66.17	-4.0
250	-66.27	-4.1
300	-66.27	-4.1
350	-66.27	-4.1
400	-66.27	-4.1
450	-66.27	-4.1
500	-66.27	-4.1

FCC Part 15C (15.247(d)(2)) Processing Gain (Direct Sequence System) Results

Plot of Jammer/Signal (dB) versus Jammer Offest (kHz) with respect to carrier frequency when access code was set to **000000**.



FCC Part 15C (15.247(d)(2)) Processing Gain (Direct Sequence System) Results

Channel Used: 40 (2.441GHz)
Transmitted Packet: 10 000 packets
Access Code Used: **65B333**

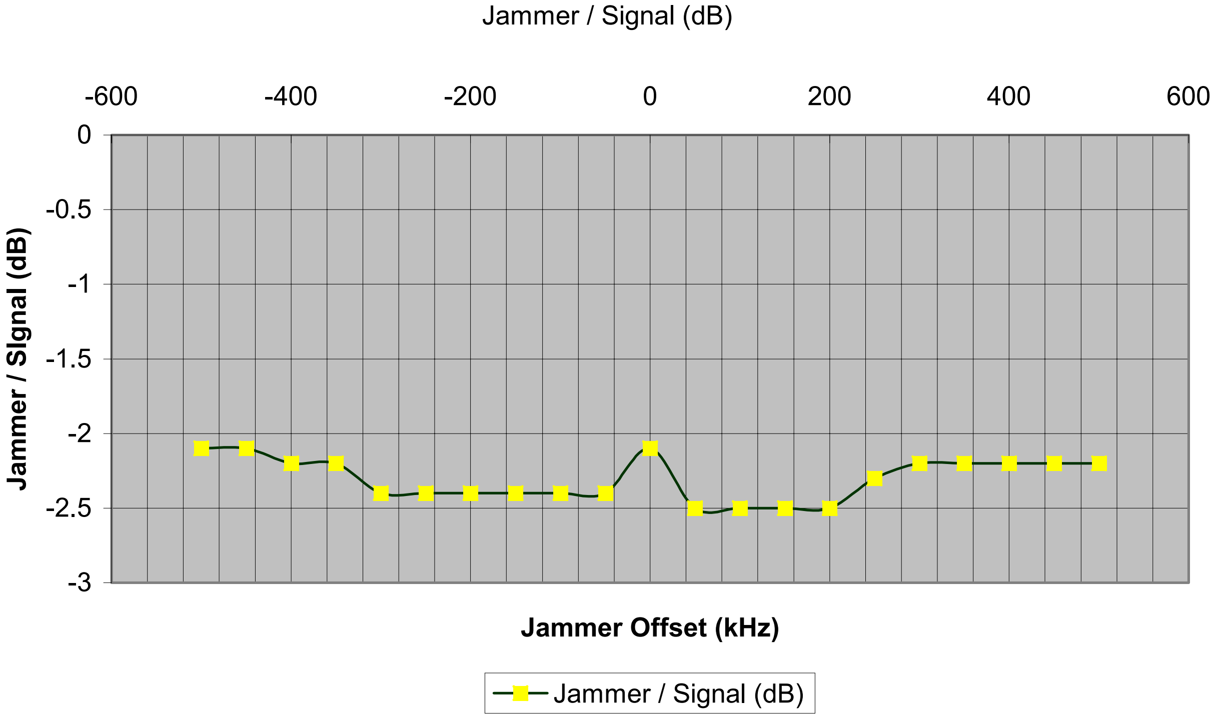
Signal level at receiver input: -62.17dBm
Noise level at receiver input when False Error Rate (FRR) is 0.1%: -70.67dBm
Signal-to-noise ratio (S/N) = -62.17dBm – (-70.67dBm) = **8.50dB**

Disregarding the worst 20% of the jammer-to-signal ratio (J/S), the worst J/S is found to be **–2.4dB**
Direct sequence processing gain, $Gp_{(direct\ sequence)}$ = S/N (dB) + J/S (dB) + L_{sys} (dB)
= 8.5dB – 2.4dB +2.0dB
= **8.1dB**

Jammer Offset Frequency (kHz)	Jammer (dBm)	J/S(dB)
-500	-64.27	-2.1
-450	-64.27	-2.1
-400	-64.37	-2.2
-350	-64.37	-2.2
-300	-64.57	-2.4
-250	-64.57	-2.4
-200	-64.57	-2.4
-150	-64.57	-2.4
-100	-64.57	-2.4
-50	-64.57	-2.4
0	-64.27	-2.1
50	-64.67	-2.5
100	-64.67	-2.5
150	-64.67	-2.5
200	-64.67	-2.5
250	-64.47	-2.3
300	-64.37	-2.2
350	-64.37	-2.2
400	-64.37	-2.2
450	-64.37	-2.2
500	-64.37	-2.2

FCC Part 15C (15.247(d)(2)) Processing Gain (Direct Sequence System) Results

Plot of Jammer/Signal (dB) versus Jammer Offest (kHz) with respect to carrier frequency when access code was set to **65B333**.

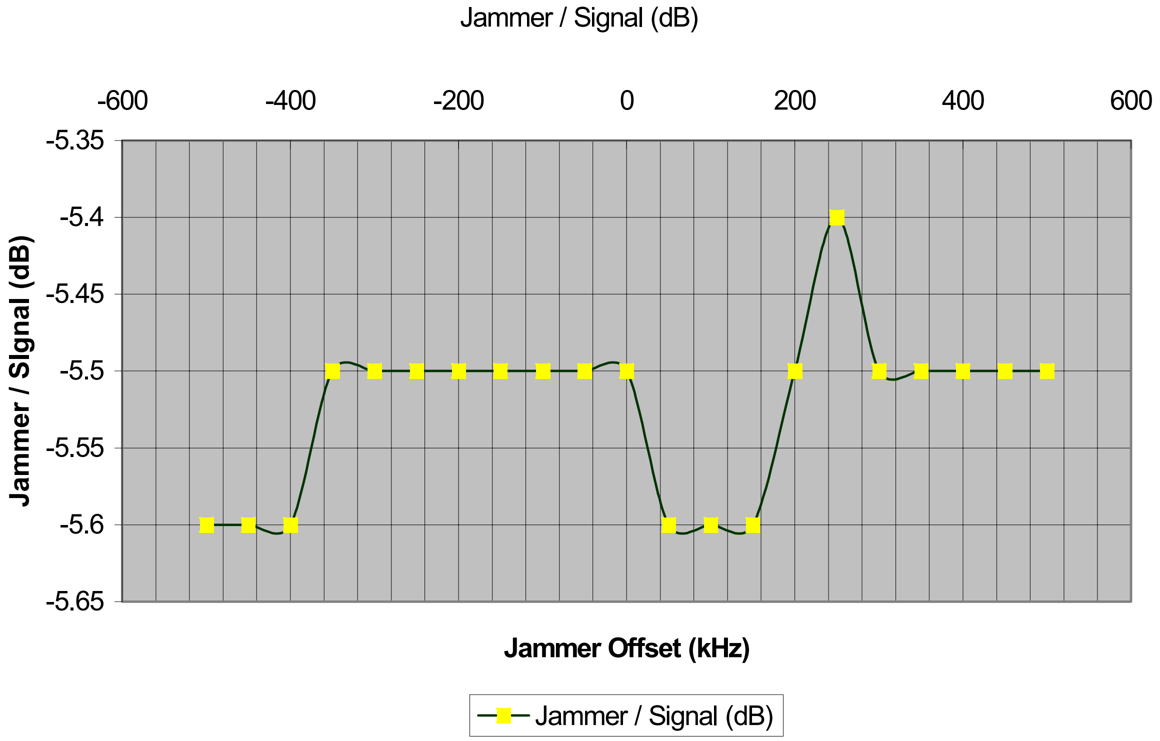


FCC Part 15C (15.247(d)(2)) Processing Gain (Direct Sequence System) Results

Channel Used: 40 (2.441GHz)
Transmitted Packet: 10 000 packets
Access Code Used: **FFFFFF**

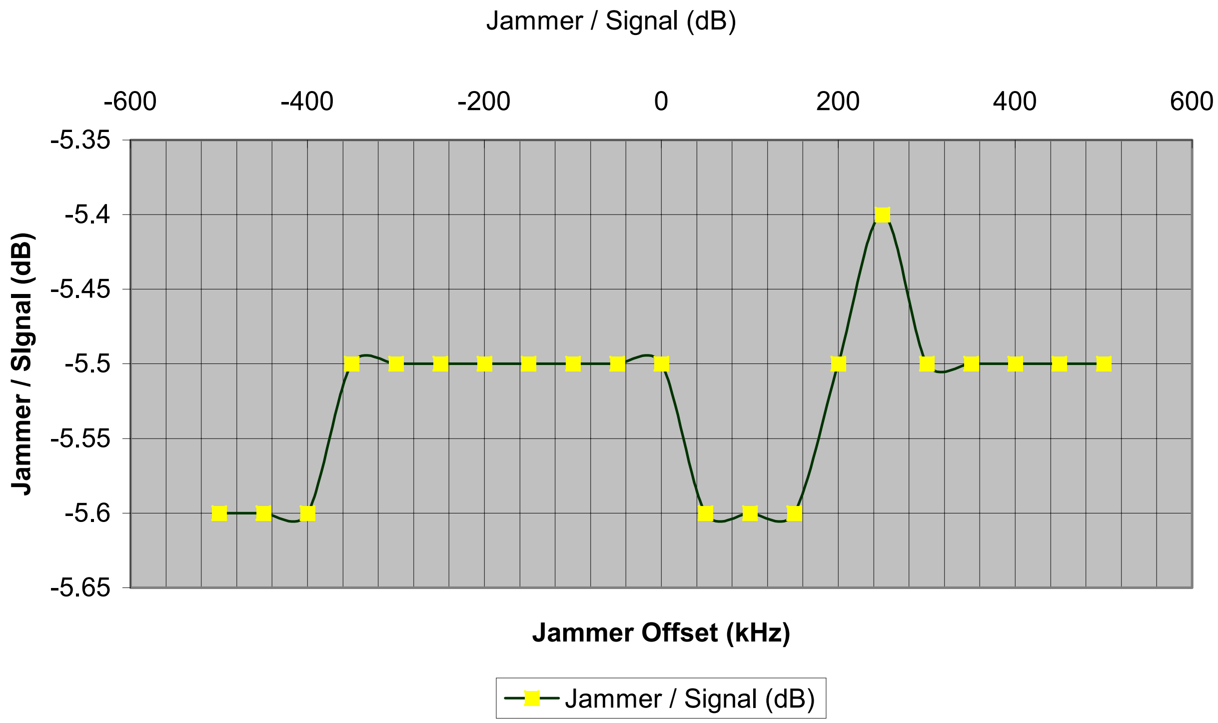
Signal level at receiver input: -62.17dBm
Noise level at receiver input when False Error Rate (FRR) is 0.1%: -73.67dBm
Signal-to-noise ratio (S/N) = -62.17dBm – (-73.67dBm) = **11.5dB**

Disregarding the worst 20% of the jammer-to-signal ratio (J/S), the worst J/S is found to be **–5.6dB**
Direct sequence processing gain, $Gp_{(direct\ sequence)}$ = S/N (dB) + J/S (dB) + L_{sys} (dB)
= 11.5dB – 5.6dB +2.0dB
= **7.9dB**



FCC Part 15C (15.247(d)(2)) Processing Gain (Direct Sequence System) Results

Plot of Jammer/Signal (dB) versus Jammer Offest (kHz) with respect to carrier frequency when access code was set to **FFFFFF**.



ANNEX A

TEST INSTRUMENTATION & GENERAL PROCEDURES

3m OATS Test Instrumentation
(Conducted EMI)

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (9kHz-30MHz)	ESH3	862301/005	2 May 2002
R&S Pulse Limiter	ESH3-Z2	357.8810.52	28 Apr 2002
EMCO LISN (for EUT) – LISN4	3816/2	9602-1036	28 Jun 2002

10m Anechoic Chamber Test Instrumentation
(Radiated Emissions)

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz – 26.5GHz) – ESMI2	ESMI	829214/006 829550/001	18 Apr 2002
HP Preamplifier (for ESMI2, 0.01-3GHz) – PA5	87405A	3950M00352	10 Apr 2002
MITEQ Preamplifier (0.1-26.5GHz) – PA10	NSP2650-N	728230	22 Mar 2002
Schaffner Bilog Antenna – BL3	CBL6112B	2549	9 May 2002
EMCO Horn Antenna – H14	3115	0003-6087	4 Apr 2002
EMCO Standard Gain Horn – H8	3160-09	1217	17 Jul 2002

Room 3 Test Instrumentation
(Carrier Frequency Separation, Number Of Hopping Frequencies, Spectrum Bandwidth (20dB Bandwidth Measurement), Average Frequency Dwell Time, Maximum Peak Power, Effective Isotropic Radiated Power (EIRP), RF Conducted Spurious Emissions at the Transmitter Antenna Terminal, Band Edge Compliance at the Transmitter Antenna Terminal, Peak Power Density, Processing Gain)

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyzer	8563E	3846A09953	30 Aug 2002
R&S Universal Radio Communication Tester	CMU 200	837587/068	18 Sept 2002
Agilent ESG-DP Series Signal Generator	E4437B	US39260864	24 May 2002
HP Variable RF Attenuator	8496B	330819196	12 Apr 2002
JWF Combiner/Splitter	50PD-015	Nil	30 Aug 2002
HP Spectrum Analyzer	8563E	3846A09953	30 Aug 2002

CONDUCTED EMISSIONS TEST DESCRIPTION
(Mains Ports)

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, as shown in Annex B.

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. For FCC tests, only Quasi-peak measurements were made; while for CISPR/EN tests, 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 (10m 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 as shown in Annex B.

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 pick the worst frequencies.

3. The test was carried out at the selected frequency points obtained from the prescan. 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 then made for that frequency point.

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 Biconical antenna for frequencies up to 200MHz, the Log-periodic antenna for frequencies above 200MHz to 1GHz, and the Horn antenna above 1GHz.

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 in a shielded enclosure; accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table, as shown in Annex B.

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. 2.424GHz to 2.441GHz
   b. 2.439GHz to 2.442GHz
   c. 2.440GHz to 2.443GHz
   d. 2.478GHz to 2.481GHz

NUMBER OF HOPPING FREQUENCIES TEST DESCRIPTION

Test Set-up

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

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 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 2.40GHz and 2.42GHz 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:

   e. 2.424GHz to 2.441GHz
   f. 2.440GHz to 2.461GHz
   g. 2.461GHz to 2.4835GHz

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

SPECTRUM BANDWIDTH (20DB BANDWIDTH MEASUREMENT) TEST DESCRIPTION

Test Set-up

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

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 Bluetooth test mode, non-hopping with transmitting frequency at Channel 1 (2.402GHz).

2. The center frequency of the spectrum analyser was set to the transmitting frequency with the frequency span of 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 40 (2.441GHz) and Channel 79 (2.480GHz) respectively.

AVERAGE FREQUENCY DWELL TIME TEST DESCRIPTION

Test Set-up

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

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 2MHz 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 second 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 in a shielded enclosure; accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table, as shown in Annex B.

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 1 (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 40 (2.441GHz) and Channel 79 (2.480GHz) respectively.

EFFECTIVE ISOTROPIC RADIATED POWER (EIRP) TEST DESCRIPTION

Test Set-up

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

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 1 (2.402GHz).

2. The maximum peak power of the transmitting frequency was detected and recorded

3. The EIRP of the transmitting frequency is the sum of the peak power and the declared EUT antenna gain.

4. The steps 2 to 3 were repeated with the transmitting frequency was set to Channel 40 (2.441GHz) and Channel 79 (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 in a shielded enclosure; accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table, as shown in Annex B.

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 1 (2.402GHz).

2. The start and stop frequencies of the spectrum analyser were set to 10MHz 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 40 (2.441GHz) and Channel 79 (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 in a shielded enclosure; accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table, as shown in Annex B.

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 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 in a shielded enclosure; accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table, as shown in Annex B.

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 1 (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.

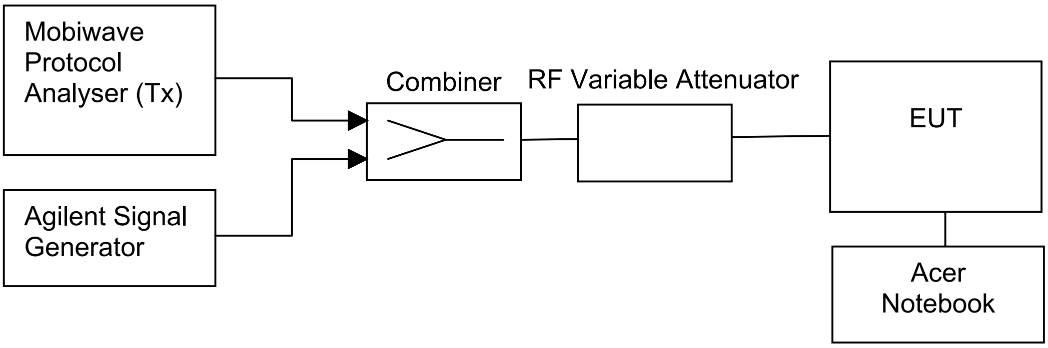
3. The peak power density of the transmitting frequency was detected and recorded.

4. The step 3 was repeated with the transmitting frequency was set to Channel 40 (2.441GHz) and Channel 79 (2.480GHz) respectively.

PROCESSING GAIN (HYBRID SYSTEM) TEST DESCRIPTION

Test Set-up

The processing gain of the EUT (for direct sequence system) was setup as shown on the block diagram below :



Test Method

1. The Bluetooth Protocol Analyser (TX unit) was set to transmit the access code 000000H (wanted signal) at 1.25ms interval with the power level of –60dBm at the receiver of the EUT (Bluetooth Protocol Analyser RX unit).

2. The white noise generated by the noise generator module of the signal generator was then added to the wanted signal until the decoded coded by the computer gave a 0.1% false rejection ratio (FRR).

3. The signal-to-noise ratio (S/N) was then computed based on the wanted signal level and the white noise level at the EUT receiver input.

4. The steps 1 and 2 were then repeated but with a continuous wave signal (jammer) replacing the noise signal. The continuous wave was generated by the RF signal module from the same signal generator.

5. The jammer-to-signal ratio (J/S) was then computed.

6. The processing gain for direct sequence system, $Gp_{\text{(direct sequene)}}$ was computed as below:

   $Gp_{\text{(direct sequence)}} = S/N\ (dB) + J/S\ (dB) + L_{sys}$

   where L_{sys} = total loss in the system ($\leq$2dB)

7. The processing gain of the hybrid system was then computed as:

   $Gp = Gp_{\text{(hopping)}} + Gp_{\text{(direct sequence)}}$

   where $Gp_{\text{(hopping)}}$ = 10 log (number of frequency hopping used)

8. The test was then repeated with the access code set to 65B333 and FFFFFF respectively.

ANNEX C

EUT TEST CONDITIONS

SUPPORTING EQUIPMENT DESCRIPTION

Equipment Description (Including Brand Name)	**Model, Serial & FCC ID Number**	**Cable Description** (List Length, Type & Purpose)
Acer TravelMate Notebook	M/N: 340 S/N: 9140F01243017026E3M FCC ID: DOC	3m standard RJ45 cable
Acer TravelMate AC/DC Power Adapter	M/N: 340 S/N: 9140F0124301501B3D FCC ID:	1.8m power adapter cable with ferrite
Smart Label Printer	M/N: SLP-20 S/N: B011331000 FCC ID: DOC	1.8m power cable with adapter 1.5m standard parallel cable
Smart Label Printer	M/N: SLP-20 S/N: B918358509 FCC ID: DOC	1.8m power cable with adapter 1.5m standard serial cable
I.T.E AC/DC Power Adapter (EUT Power Adapter)	M/N: MS15-050250-A1D S/N: Nil FCC ID: Nil	2.0m power adapter cable with ferrite
Hewlett Packard Mouse	M/N: M-S34 S/N: LZB74512305 FCC ID: DOC	1.8m standard mouse cable
Mobiwave Protocol Analyser	M/N: BPA-D10 S/N: 0152 1012 FCC ID: DOC	2.0m ac/dc power adapter cable with ferrite

EUT OPERATING CONDITIONS

EUT Description	:	Bluetooth Protocol Analyser
Model No	:	BPA-D10
Serial No	:	0152 1002

The Bluetooth Protocol Analyser (product description) was powered from 110V, 60Hz mains supply.

Tests	Description Of Operation
1. Conducted Emissions 2. Radiated Emissions 3. Carrier Frequency Separation 4. Number Of Hopping Frequencies 5. Spectrum Bandwidth (20dB Bandwidth Measurement) 6. Average Frequency Dwell Time 7. Maximum Peak Power 8. Effective Isotropic Radiated Power (EIRP) 9. RF Conducted Spurious Emissions at the Transmitter Antenna Terminal 10. Band Edge Compliance at the Transmitter Antenna Terminal 11. Peak Power Spectral Density 12. Processing Gain	The EUT was exercised by operating in the Bluetooth test mode (except processing gain) with maximum transmitting power and following configuration during the tests: Carrier Frequency Separation, Number of Hopping Frequency, Average Frequency Dwell Time and Band Edge at the Transmitting Antenna: Frequency hopping and modulation are on. Conducted Emissions, Radiated Emissions, Spectrum Bandwidth (20dB Bandwidth Measurement), Maximum Peak Power, Effective Isotropic Radiated Power (EIRP), RF Conducted Spurious Emissions at the Transmitter Antenna Terminal and Peak Power Spectral Density Frequency hopping is off and the modulation is on. Note: For all the tests mentioned above except the Average Frequency Dwell Time, the DH5 packet was used with the PRBS 9 as the payload. For Average Frequency Dwell Time, the DH1 packet with PRBS9 payload was used. Processing Gain The EUT was configured to operate in inquiry / page mode continuously with predefined access code.

ANNEX D

USER MANUAL
TECHNICAL DESCRIPTION
BLOCK & CIRCUIT DIAGRAMS

(Please refer to attached copy)