Test Report No. S09ICM00144/EMC/01
dated 10 Mar 2009

PSB Singapore

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
FCC Parts 15B & C : 2008
OF A
UHF RFID READER
[Model : EasyU]
[FCC ID : W5X002000EASYU]

TEST FACILITY	TÜV SÜD PSB Pte Ltd, Electrical & Electronics Centre (EEC), Product Services, 1 Science Park Drive, Singapore 118221
FCC REG. NO.	90937 (3m & 10m OATS) 99142 (10m Semi-Anechoic Chamber) 871638 (3m Semi-Anechoic Chamber) 325572 (10m Semi-Anechoic Chamber)
IND. CANADA REG. NO.	2932I-1 (3m and 10m Semi-Anechoic Chambers)
PREPARED FOR	FeRmi Pte Ltd 57 Tavistock Avenue, Singapore 555158 Tel : +65 6478 8779 Fax : +65 6827 5196
QUOTATION NUMBER	Q09ICM00142
JOB NUMBER	S09ICM00144
TEST PERIOD	24 Feb 2009 – 26 Feb 2009

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LA-2007-0380-A
LA-2007-0380-A-1
LA-2007-0381-F
LA-2007-0382-B
LA-2007-0383-G
LA-2007-0384-G
LA-2007-0385-E
LA-2007-0386-C

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. Tests/Calibrations marked "Not SAC-SINGLAS Accredited" in this Report are not included in the SAC-SINGLAS Accreditation Schedule for our laboratory.

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TEST SUMMARY

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

Test Results Summary

Test Standard	Description	Pass / Fail
FCC Part 15: 2008		
15.107(a), 15.207	Conducted Emissions	Pass
15.109(a), 15.205, 15.209	Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)	Pass
15.247(a)(1)	Carrier Frequency Separation	Pass
15.247(a)(1) & (a)(i)	Spectrum Bandwidth (20dB Bandwidth Measurement)	Pass
15.247(a)(1)(i)	Number of Hopping Frequencies	Pass
	Average Frequency Dwell Time	Pass
15.247(b)(2)	Maximum Peak Power	Pass
15.247(d)	RF Conducted Spurious Emissions	Pass
15.247(d)	Band Edge Compliance (Conducted)	Pass
15.247(d)	Band Edge Compliance (Radiated)	Pass
15.247(e)	Peak Power Spectral Density	Pass
1.1310	Maximum Permissible Exposure	Refer to page 43 for details

TEST SUMMARY

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 test mode.

Transmit Channel	Frequency (MHz)
Channel 1	902.5
Channel 25	914.5
Channel 51	927.5

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. All test measurement procedures are according to ANSI C63.4: 2003.

Modifications

No modifications were made.

PRODUCT DESCRIPTION

Description	:	The Equipment Under Test (EUT) is a **UHF RFID READER.**
Manufacturer	:	FeRmi Pte Ltd 57 Tavistock Avenue, Singapore 555158
Model Number	:	EasyU
FCC ID	:	W5X0002000EASYU
Serial Number	:	Nil
Microprocessor	:	Refer to manufacturer's user manual / operating manual.
Operating / Transmitting Frequency	:	902.5MHz – 927.5MHz
Clock / Oscillator Frequency	:	Refer to manufacturer's user manual / operating manual.
Modulation	:	Frequency hopping spread spectrum
Antenna Gain	:	3.0dBi
Port / Connectors	:	Refer to manufacturer's user manual / operating manual.
Rated Input Power	:	4.5Vdc-5.5Vdc
Accessories	:	Refer to manufacturer's user manual / operating manual.

SUPPORTING EQUIPMENT DESCRIPTION

Equipment Description (Including Brand Name)	**Model, Serial & FCC ID Number**	**Cable Description** (List Length, Type & Purpose)
Fujitsu Laptop	M/N: S6310 S/N: R6900153 FCC ID: Nil	2.00m unshielded power cable 1.80m standard USB cable
Fujitsu Power Adapter (Laptop)	M/N: SEC100P2-19.0 S/N: Nil FCC ID: Nil	2.00m unshielded power cable

EUT OPERATING CONDITIONS

FCC Part 15
1. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement) **2. Spectrum Bandwidth (20dB Bandwidth Measurement)** **3. Maximum Peak Power** **4. RF Conducted Spurious Emissions**
The UHF RFID Reader (EUT) was exercised by operating in maximum continuous transmission with frequency hopping off, i.e transmitting at lower, middle and upper channels respectively at one time.
FCC Part 15
1. Carrier Frequency Separation **2. Number of Hopping Frequencies** **3. Average Frequency Dwell Time** **4. Band Edge Compliance (Conducted)**
The UHF RFID Reader (EUT) was exercised by operating in maximum continuous transmission with frequency hopping on.

CONDUCTED EMISSION TEST

FCC Parts 15.107(a) and 15.207 Conducted Emission Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (QP)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
Schaffner LISN – LISN7 (for EUT)	NNB42	00008	27 Jul 2009
R&S Test Receiver – ESI3	ESIB7	100015	02 Jun 2009

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Setup

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.

FCC Parts 15.107(a) and 15.207 Conducted Emission 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 Q-P limit (Class B) = 1000 μV = 60.0 dBμV
Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB
Q-P reading obtained directly from EMI Receiver = 40.0 dBμV (Calibrated for system losses)
Therefore, Q-P margin = 40.0 - 60.0 = -20.0 i.e. 20.0 dB below Q-P limit

Conducted Emissions Test Setup (Front View)

Conducted Emissions Test Setup (Rear View)

FCC Parts 15.107(a) and 15.207 Conducted Emission Results

Test Input Power	110V 60Hz (via host)	Temperature	21°C
Line Under Test	AC Mains	Relative Humidity	54%
		Atmospheric Pressure	1030mbar
		Tested By	Zechs Ng Chee Siong

Frequency (MHz)	Q-P Value (dBμV)	Q-P Margin (dB)	AV Value (dBμV)	AV Margin (dB)	Line	Channel
0.7924	27.4	-28.6	13.9	-32.1	Neutral	1
1.6402	25.0	-31.0	15.0	-31.0	Live	1
3.2637	26.6	-29.4	15.5	-30.5	Neutral	1
5.8622	24.3	-35.7	13.7	-36.3	Live	1
8.7128	24.1	-35.9	14.5	-35.5	Live	1
9.5780	20.8	-39.2	13.0	-37.0	Neutral	1

Notes

1. All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   9kHz - 30MHz
   RBW: 10kHz VBW: 30kHz
4. 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 is ±3.0dB.

FCC Part 15.205 Restricted Bands

MHz			MHz			MHz			GHz		
0.090	-	0.110	16.42	-	16.423	399.9	-	410	4.5	-	5.15
0.495	-	0.505	16.69475	-	16.69525	608	-	614	5.35	-	5.46
2.1735	-	2.1905	16.80425	-	16.80475	960	-	1240	7.25	-	7.75
4.125	-	4.128	25.5	-	25.67	1300	-	1427	8.025	-	8.5
4.17725	-	4.17775	37.5	-	38.25	1435	-	1626.5	9.0	-	9.2
4.20725	-	4.20775	73	-	74.6	1645.5	-	1646.5	9.3	-	9.5
6.215	-	6.218	74.8	-	75.2	1660	-	1710	10.6	-	12.7
6.26775	-	6.26825	108	-	121.94	1718.8	-	1722.2	13.25	-	13.4
6.31175	-	6.31225	123	-	138	2200	-	2300	14.47	-	14.5
8.291	-	8.294	149.9	-	150.05	2310	-	2390	15.35	-	16.2
8.362	-	8.366	156.52475	-	156.52525	2483.5	-	2500	17.7	-	21.4
8.37625	-	8.38675	156.7	-	156.9	2690	-	2900	22.01	-	23.12
8.41425	-	8.41475	162.0125	-	167.17	3260	-	3267	23.6	-	24.0
12.29	-	12.293	167.72	-	173.2	3332	-	3339	31.2	-	31.8
12.51975	-	12.52025	240	-	285	3345.8	-	3358	36.43	-	36.5
12.57675	-	12.57725	322	-	335.4	3600	-	4400	Above 38.6		
13.36	-	13.41									

FCC Parts 15.109(a) and 15.209 Radiated Emission Limits

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m) @ 3m
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0
Above 960	54.0*
* Above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz–26.5GHz) – ESMI2	ESMI	829214/006 829550/001	12 May 2009
Teseq Preamplifier (PA16)	LNA6018	70214	06 Oct 2009
Schaffner Preamplifier (9kHz-2GHz) – PA19	CPA9231A	18763	16 Feb 2010
Schaffner Bilog Antenna – BL4	CBL6112B	2593	19 May 2009
EMCO Horn Antenna – H14	3115	0003-6087	14 May 2009

RADIATED EMISSION TEST

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Setup

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.

FCC Parts 15.109(a) and 15.209 Radiated Emission 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 emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.
3. The test was carried out at the selected frequency points obtained from the prescan in 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 10th harmonics of the EUT fundamental frequency, using the Bi-log antenna for frequencies from 30MHz up to 1GHz, and the Horn antenna above 1GHz.

Sample Calculation Example

At 300 MHz Q-P limit (Class B) = 200 μV/m = 46.0 dBμV/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m
(Calibrated level including antenna factors & cable losses)

Therefore, Q-P margin = 40.0 - 46.0 = -6.0 i.e. **6 dB below Q-P limit**

Radiated Emissions Test Setup (Front View)

Radiated Emissions Test Setup (Rear View)

RADIATED EMISSION TEST

FCC Parts 15.109(a), 15.205 and 15.209 Radiated Emission Results

Test Input Power	110V 60Hz (via host)	Temperature	24°C
Test Distance	3m	Relative Humidity	57%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit Lucas Beh

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Margin (dB)	Azimuth (Degrees)	Height (cm)	Polarisation (H/V)	Channel
48.1240	27.2	-12.8	143	100	V	51
59.7870	34.0	-6.0	222	100	V	51
322.8280	30.2	-15.8	198	125	V	51
338.1150	35.7	-10.3	309	100	H	51
353.7990	33.2	-12.8	210	116	V	51
448.4250	31.0	-15.0	342	107	V	51

Spurious Emissions above 1GHz

Frequency (GHz)	Peak Value (dBµV/m)	Average Value (dBµV/m)	Average Margin (dB)	Azimuth (Degrees)	Height (cm)	Pol (H/V)	Channel
2707.4790	72.0	53.1	-0.9	228	110	V	1
2746.4870	69.3	49.4	-4.6	227	100	V	25
2782.4930	62.6	53.7	-0.3	227	129	V	51
3609.9760	58.5	37.0	-17.0	306	222	H	1
3657.9850	61.7	51.7	-2.3	277	154	V	25
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Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. "--" indicates no emissions were found and shows compliance to the limits.
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 upper frequency of radiated emission investigations was according to requirements stated in Section 15.33(a) for intentional radiators & Section 15.33(b) for unintentional radiators.
7. The channel in the table refers to the transmit channel of the EUT.
8. 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 is ±4.6dB.

CARRIER FREQUENCY SEPARATION TEST

FCC Part 15.247(a)(1) Carrier Frequency Separation Limits

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.

FCC Part 15.247(a)(1) Carrier Frequency Separation Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyser – SA11	8563E	3846A09953	26 Sep 2010

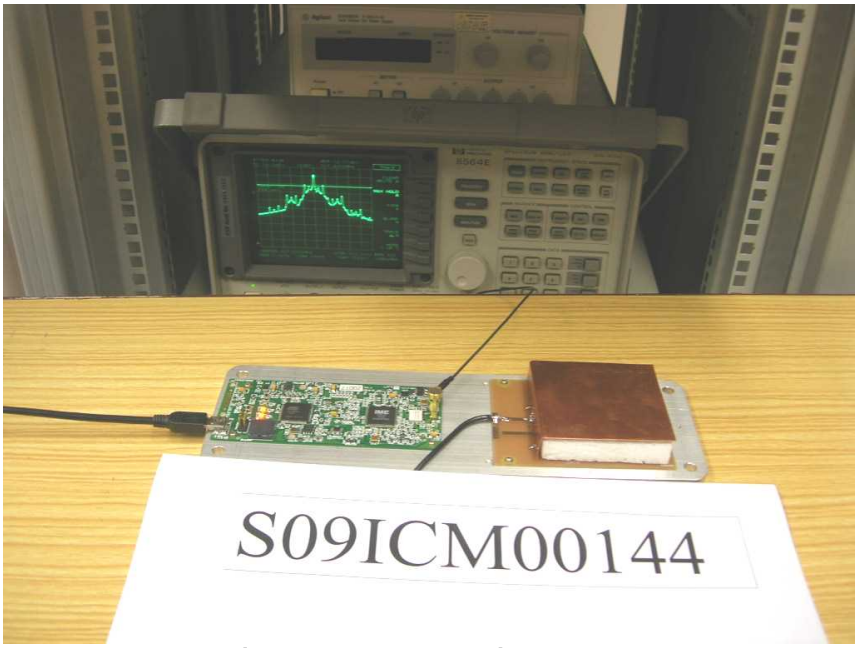
FCC Part 15.247(a)(1) Carrier Frequency Separation Test Setup

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.

FCC Part 15.247(a)(1) Carrier Frequency Separation 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 frequency hopping sequence on.
2. The start and stop frequencies of the spectrum analyser were set to 902.0MHz and 903.5MHz.
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. 913.5MHz and 915.0MHz
   b. 914.5MHz and 916.0MHz
   c. 926.5MHz and 928.0MHz

CARRIER FREQUENCY SEPARATION TEST



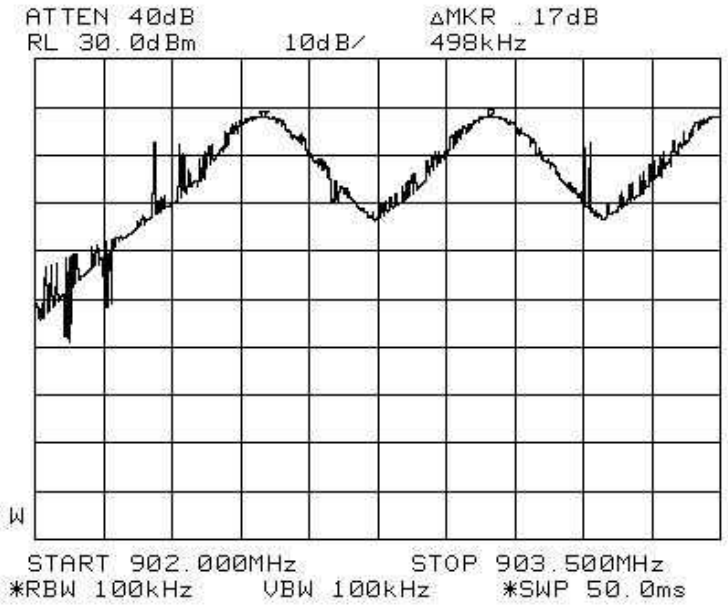
Carrier Frequency Separation Test Setup

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

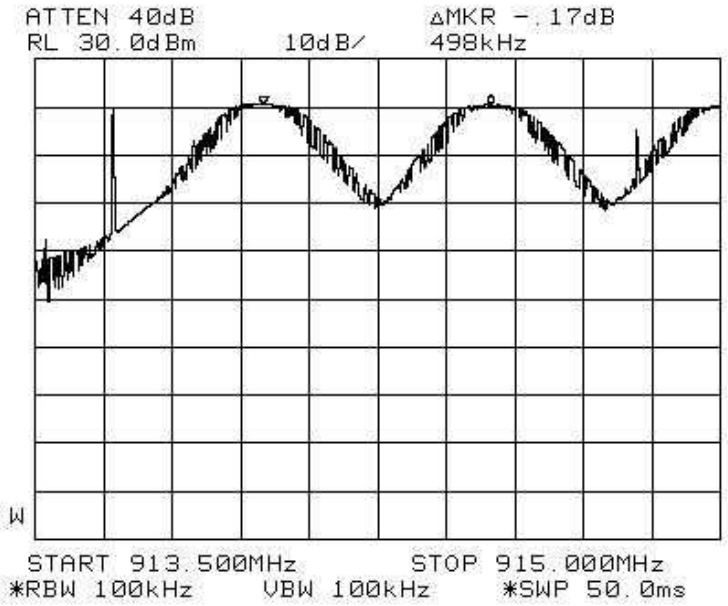
Test Input Power	110V 60Hz (via host)	Temperature	23°C
Attached Plots	1 - 4	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Adjacent Channels	Channel Separation (MHz)
1 and 2 (902.5MHz and 903.0MHz)	0.498
24 and 25 (914.5MHz and 915.0MHz)	0.498
25 and 26 (915.0MHz and 915.5MHz)	0.493
50 and 51 (927.0MHz and 927.5MHz)	0.495

Carrier Frequency Separation Plots

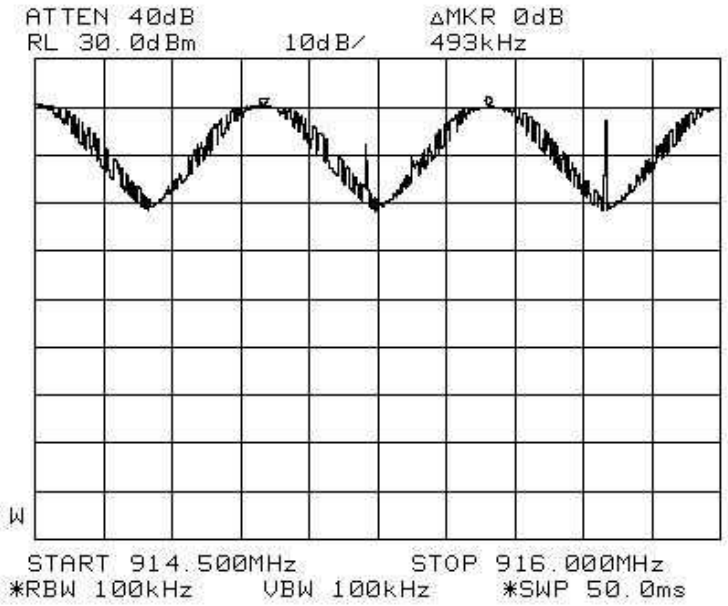


Plot 1 - Channels 1 and 2 Separation

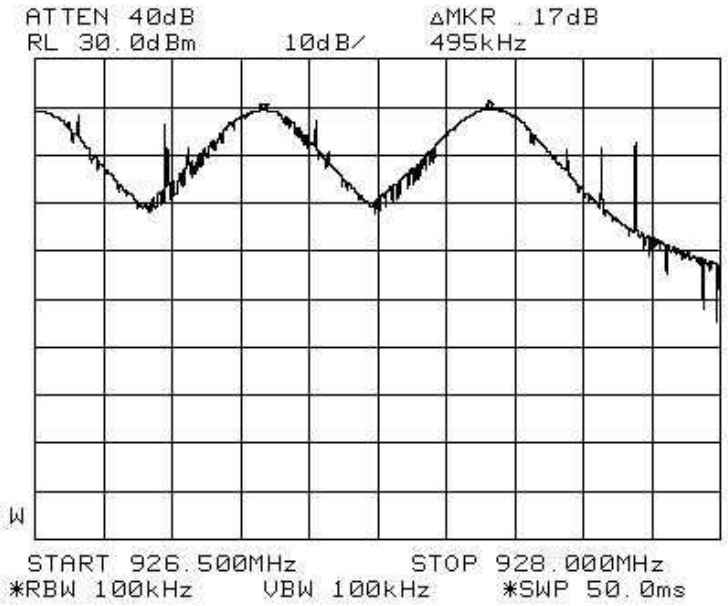


Plot 2 – Channels 24 and 25 Separation

Carrier Frequency Separation Plots



Plot 3 - Channels 26 and 27 Separation



Plot 4 - Channels 49 and 50 Separation

SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST

FCC Part 15.247(a)(1) & (a)(1)(i) Spectrum Bandwidth (20dB Bandwidth Measurement) Limits

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. The maximum allowed 20dB bandwidth of the hopping channel is 500kHz.

FCC Part 15.247(a)(1) & (a)(1)(i) Spectrum Bandwidth (20dB Bandwidth Measurement) Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyser – SA11	8563E	3846A09953	26 Sep 2010

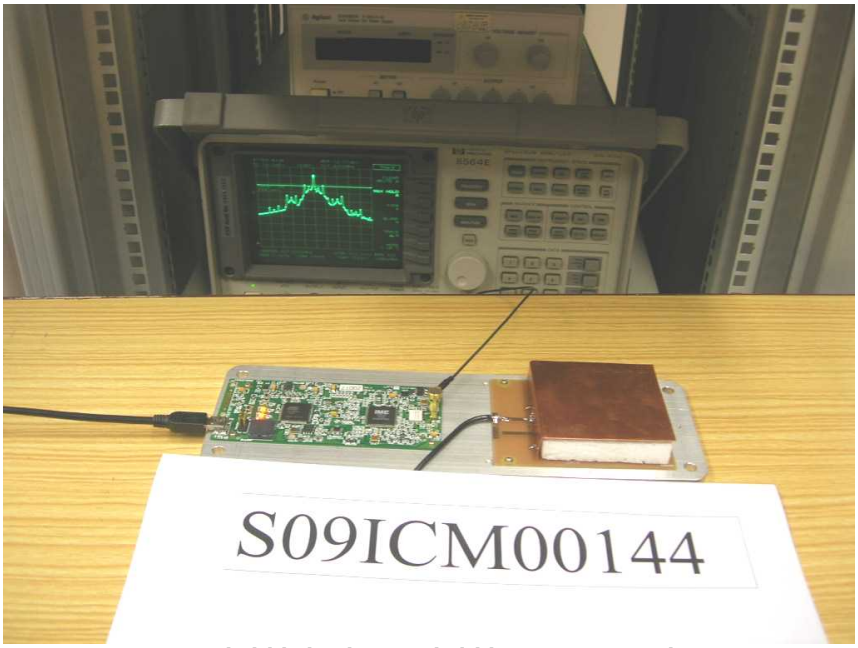
FCC Part 15.247(a)(1) & (a)(1)(i) Spectrum Bandwidth (20dB Bandwidth Measurement) Test Setup

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.

FCC Part 15.247(a)(1) & (a)(1)(i) Spectrum Bandwidth (20dB Bandwidth Measurement) 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 (902.5MHz).
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 25 (914.5MHz) and Channel 51 (927.5MHz) respectively.

SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST



Spectrum Bandwidth (20dB Bandwidth Measurement) Test Setup

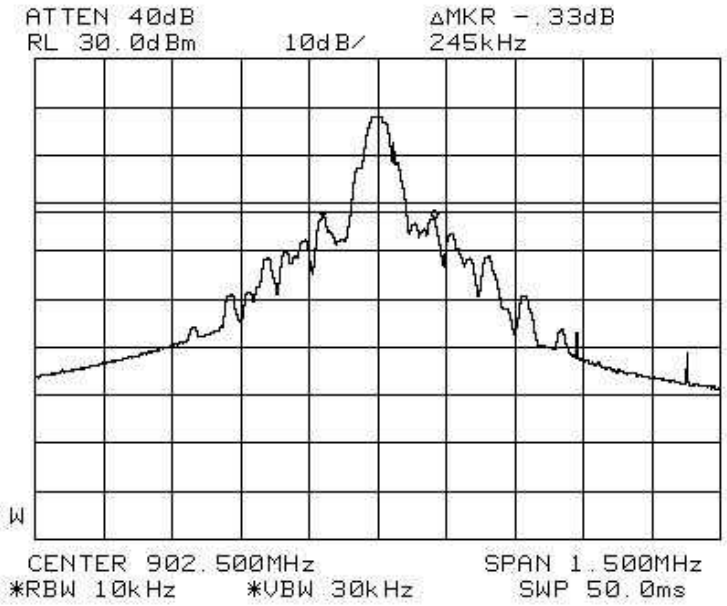
FCC Part 15.247(a)(1) & (a)(1)(i) Spectrum Bandwidth (20dB Bandwidth Measurement) Results

Test Input Power	110V 60Hz (via host)	Temperature	23°C
Attached Plots	5 - 7	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

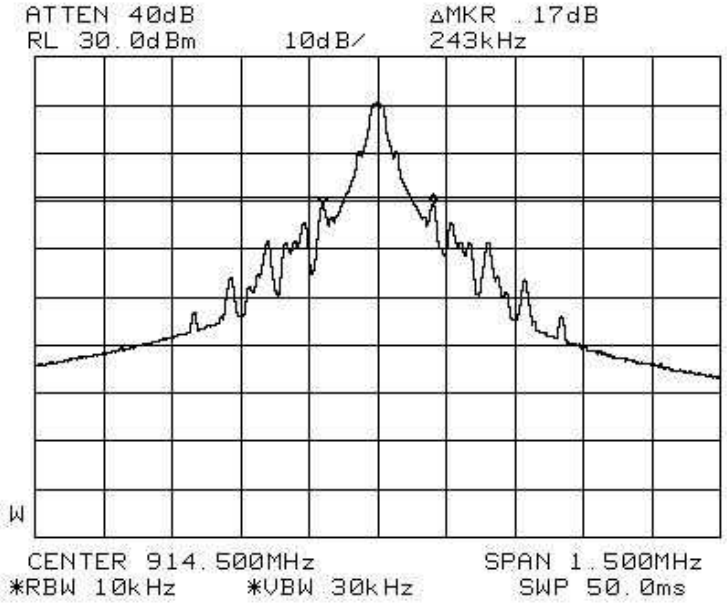
Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
1	902.5MHz	0.245
25	914.5MHz	0.243
51	927.5MHz	0.115

SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots



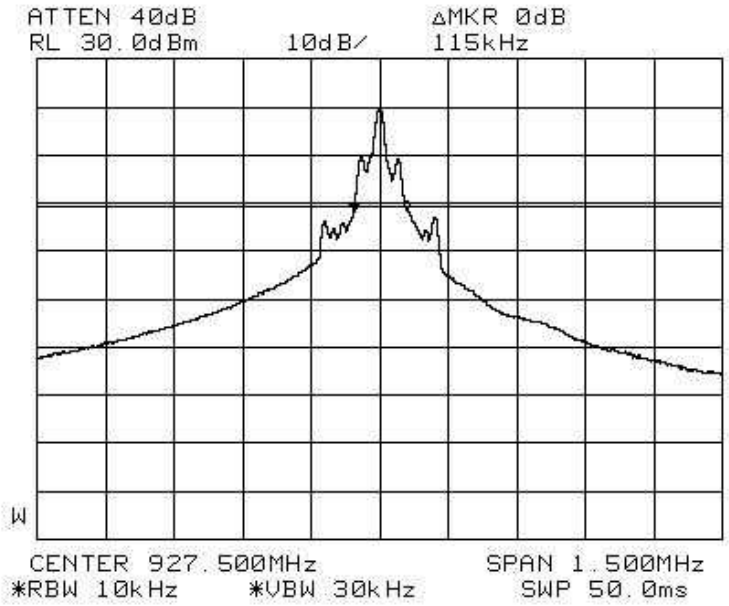
Plot 5 – Channel 1



Plot 6 – Channel 25

SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots



Plot 7 – Channel 51

NUMBER OF HOPPING FREQUENCIES TEST

FCC Part 15.247(a)(1)(i) Number of Hopping Frequencies Limits

The EUT shows compliance to the requirements of this section, which states if the 20dB bandwidth of the hopping channel of the EUT is less than 250kHz, the EUT shall use at least 50 hopping frequencies. If the 20dB bandwidth of the hopping channel of the EUT is 250kHz or greater, the EUT shall use at least 25 hopping frequencies.

FCC Part 15.247(a)(1)(i) Number of Hopping Frequencies Test Instrumentation

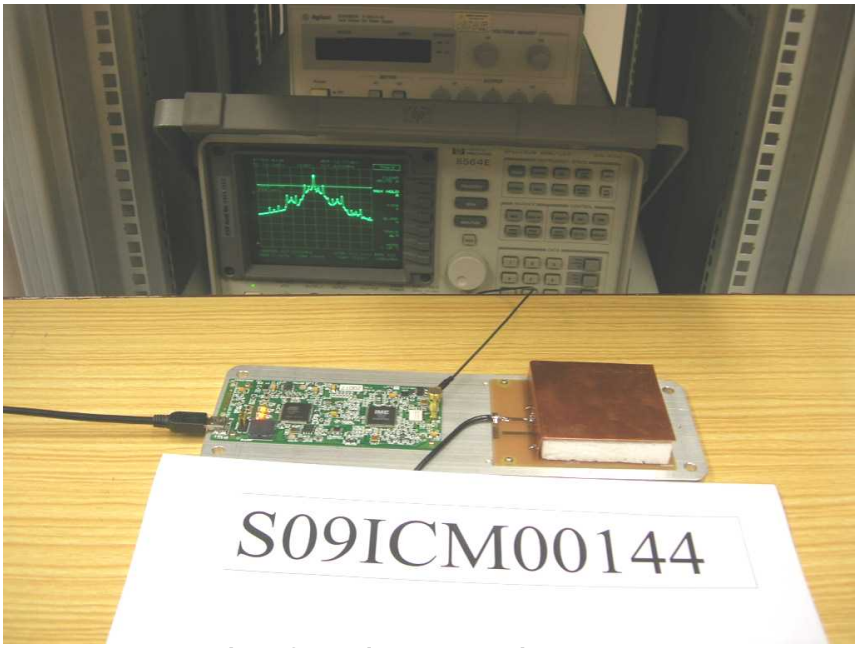
Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyser – SA11	8563E	3846A09953	26 Sep 2010

FCC Part 15.247(a)(1)(i) Number of Hopping Frequencies Test Setup

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.

FCC Part 15.247(a)(1)(i) Number of Hopping Frequencies 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 frequency hopping sequence on.
2. The start and stop frequencies of the spectrum analyser were set to 901.5MHz and 911.0MHz.
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 4 were repeated with the following start and stop frequencies settings:
   a. 910.5MHz to 919.0MHz
   b. 918.5MHz to 928.5MHz
6. The total number of hopping frequencies is the sum of the number of the hopping frequencies found for each span.



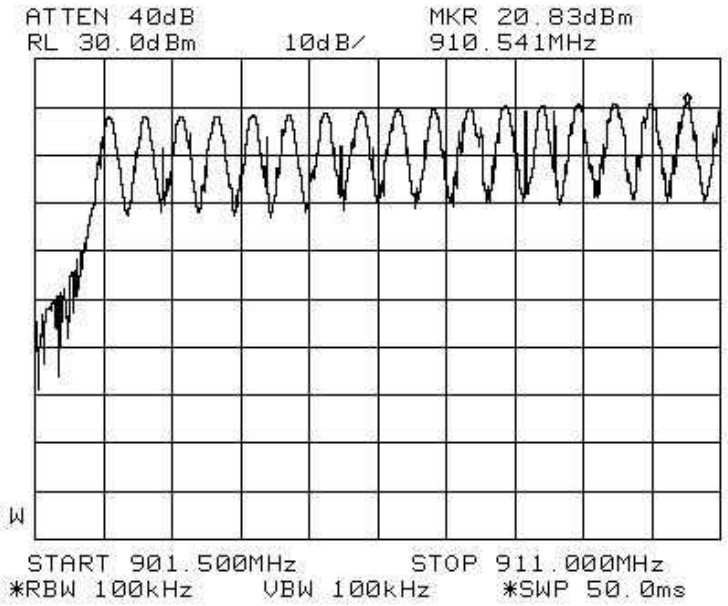
Number of Hopping Frequencies Test Setup

FCC Part 15.247(a)(1)(i) Number of Hopping Frequencies Results

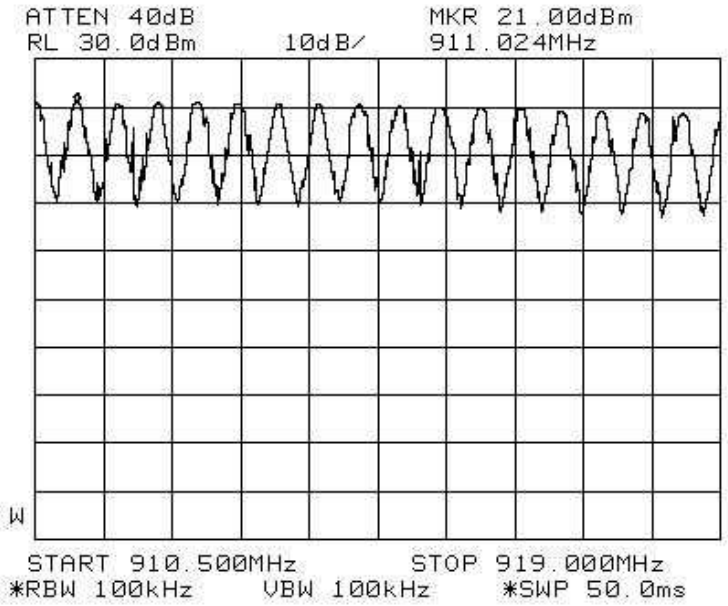
Test Input Power	110V 60Hz (via host)	Temperature	23°C
Attached Plots	8 - 10	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

The EUT was found to have 51 hopping frequencies. Please refer to the attached plots.

Number Of Hopping Frequencies Plots

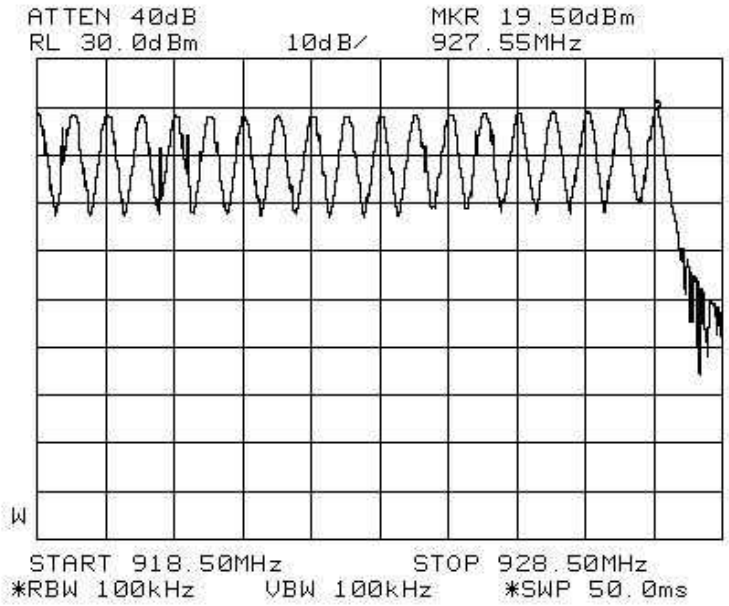


Plot 8 - Channels 1 to 17



Plot 9 - Channels 18 to 33

Number Of Hopping Frequencies Plots



Plot 10 - Channels 34 to 51

AVERAGE FREQUENCY DWELL TIME TEST

FCC Part 15.247(a)(1)(i) Average Frequency Dwell Time Limits

The EUT shows compliance to the requirements of this section, which states if the 20dB bandwidth of the hopping channel of the EUT is less than 250kHz, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a period of 20 second period. If the 20dB bandwidth of the hopping channel of the EUT is 250kHz or greater, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

FCC Part 15.247(a)(1)(i) Average Frequency Dwell Time Test Instrumentation

Instrument	Model	S/No	Cal Due Date
Lecroy 1GHz Oscilloscope	LC584Al	20418	07 Apr 2010

FCC Part 15.247(a)(1)(i) Average Frequency Dwell Test Setup

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 oscilloscope via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(a)(1)(i) Average Frequency Dwell 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 frequency hopping sequence on.
2. The sweep time of the oscilloscope was adjusted until a stable signal was seen.
3. The duration (dwell time) of a packet was measured. The average dwell time of the transmitting frequency was computed based on general expression as shown below:
   Average Frequency Dwell Time = [measured time slot length x hopping rate / number of hopping channels] x [20 seconds period]
4. The steps 2 to 3 were repeated with the center frequency of the spectrum analyser were set to 914.5MHz and 927.5MHz respectively.

Average Frequency Dwell Time Test Setup

FCC Part 15.247(a)(1)(i) Average Frequency Dwell Time Results

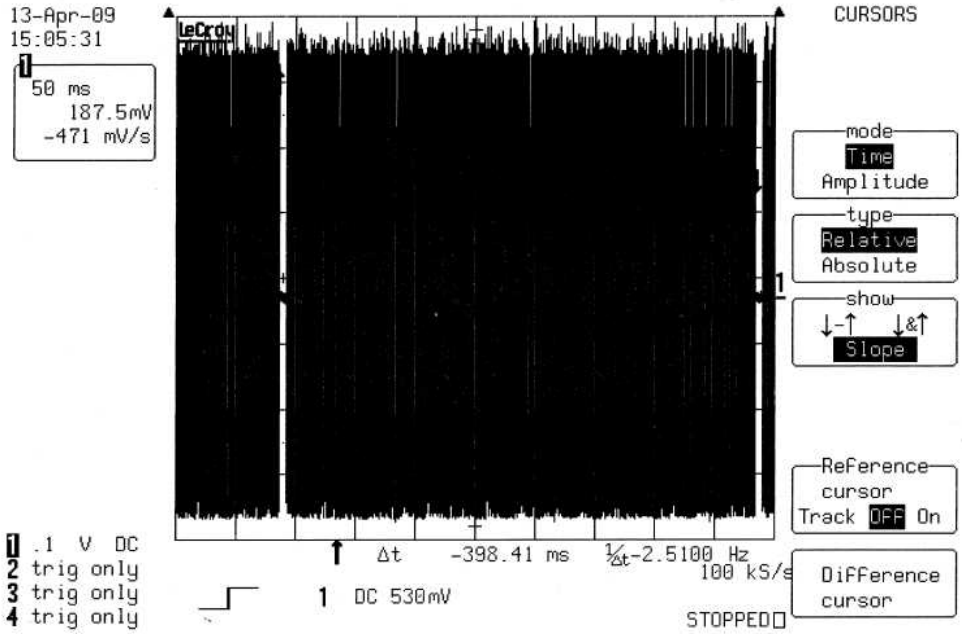
Test Input Power	110V 60Hz (via host)	Temperature	23°C
Attached Plots	11 - 13	Relative Humidity	60%
Hopping Rate	2.5 hops / s	Atmospheric Pressure	1030mbar
Number of Hopping Channels	51 channels	Tested By	Chang Wai Kit

Channel	Channel Frequency (MHz)	Measured Time Slot Length (ms)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
1	902.5MHz	398.41	0.0996	0.4
25	914.5MHz	399.16	0.0998	0.4
51	927.5MHz	395.82	0.0990	0.4

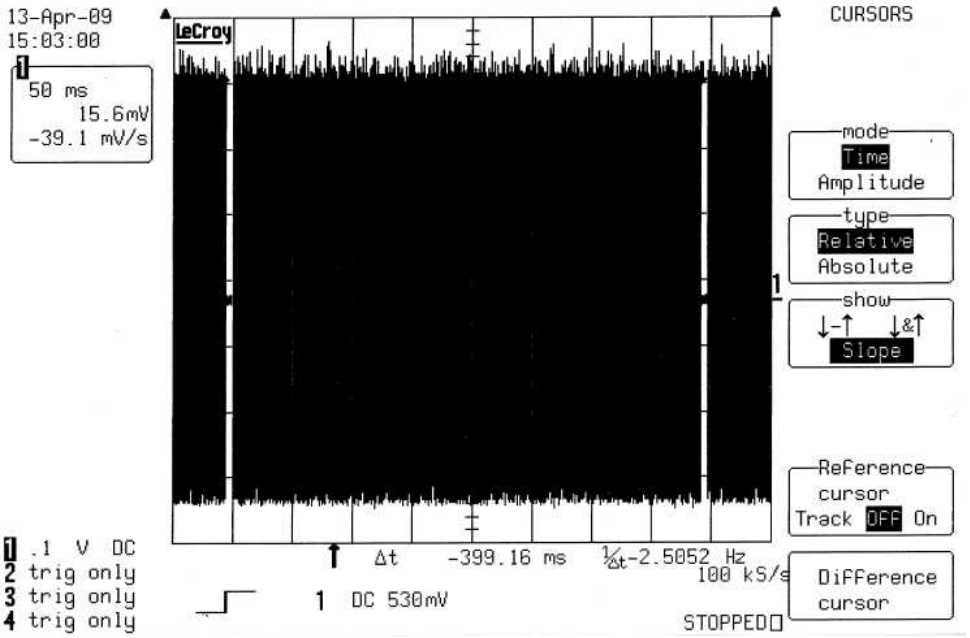
Notes

1. Average Frequency Dwell Time = [measured time slot length x hopping rate / number of hopping channels] x [20 seconds period]

Average Frequency Dwell Time Plots

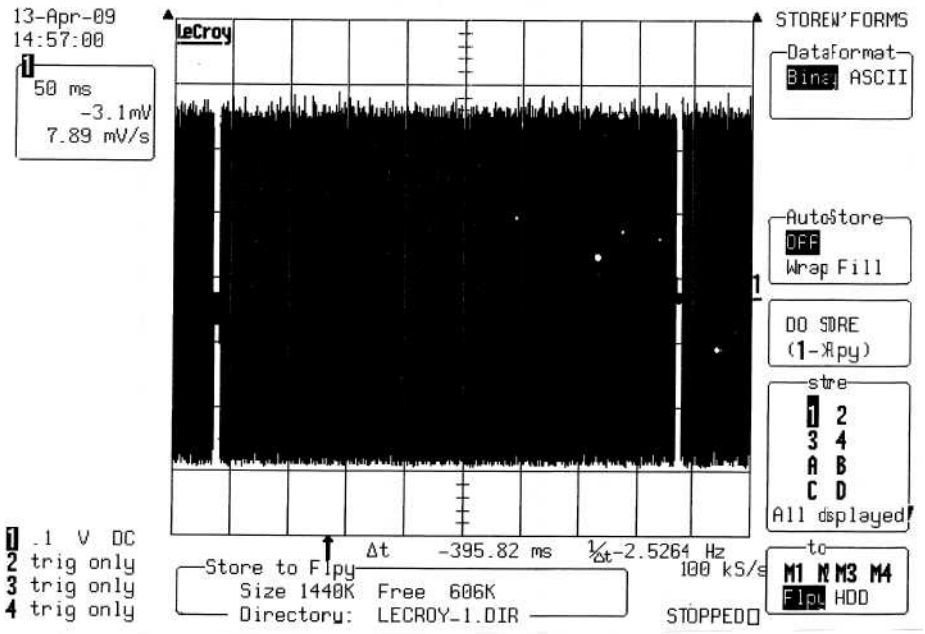


Plot 11 – Channel 1



Plot 12 – Channel 25

Average Frequency Dwell Time Plots



Plot 13 – Channel 51

MAXIMUM PEAK POWER TEST

FCC Part 15.247(b)(2) Maximum Peak Power Limits

The EUT shows compliance to the requirements of this section, which states the EUT employing at least 50 hopping channels shall not exceed 1W (30dBm). For the EUT employs hopping channels in the range of 25 to 50, the maximum power is 0.25W (24dBm).

FCC Part 15.247(b)(2) Maximum Peak Power Test Instrumentation

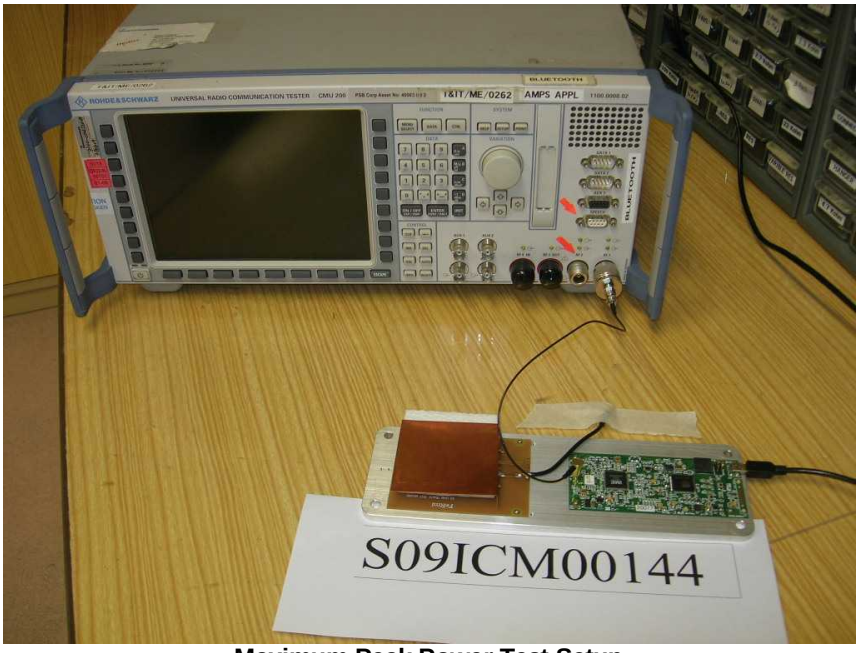
Instrument	Model	S/No	Cal Due Date
R&S Universal Radio Communication Tester	CMU 200	837587/068	25 Sep 2009

FCC Part 15.247(b)(2) Maximum Peak Power Test Setup

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.

FCC Part 15.247(b)(2) Maximum Peak Power 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 (902.5MHz).
2. The maximum peak power of the transmitting frequency was detected and recorded.
3. The Equivalent Isotropic Radiated Power (EIRP) of the EUT was computed by adding its antenna gain to the measured maximum peak power.
4. The steps 2 to 3 were repeated with the transmitting frequency was set to Channel 25 (914.5MHz) and Channel 51 (927.5MHz) respectively.



Maximum Peak Power Test Setup

FCC Part 15.247(b)(2) Maximum Peak Power Results

Test Input Power	110V 60Hz (via host)	Temperature	23°C
Antenna Gain	3.0 dBi	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Channel	Channel Frequency (MHz)	Maximum Peak Power (W)	Maximum EIRP (W)	Limit (W)
1	902.500	0.0823	0.1642	1.0
25	914.500	0.0749	0.1494	1.0
51	927.500	0.0732	0.1461	1.0

Notes

1. 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.

RF CONDUCTED SPURIOUS EMISSIONS TEST

FCC Part 15.247(d) RF Conducted Spurious Emissions Limits

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 radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

FCC Part 15.247(d) RF Conducted Spurious Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyser – SA11	8563E	3846A09953	26 Sep 2010

FCC Part 15.247(d) RF Conducted Spurious Emissions Test Setup

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.

FCC Part 15.247(d) RF Conducted Spurious Emissions 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 (902.5MHz).
2. The start and stop frequencies of the spectrum analyser were set to 30MHz and 5GHz.
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 5GHz to 10GHz.
5. The steps 2 to 4 were repeated with the transmitting frequency was set to Channel 25 (914.5MHz) and Channel 51 (927.5MHz) respectively.

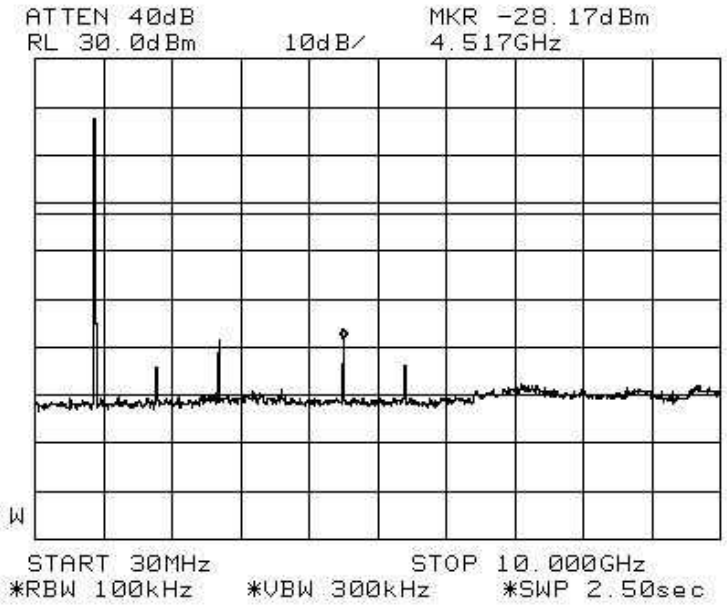
RF Conducted Spurious Emissions Test Setup

FCC Part 15.247(d) RF Conducted Spurious Emissions Results

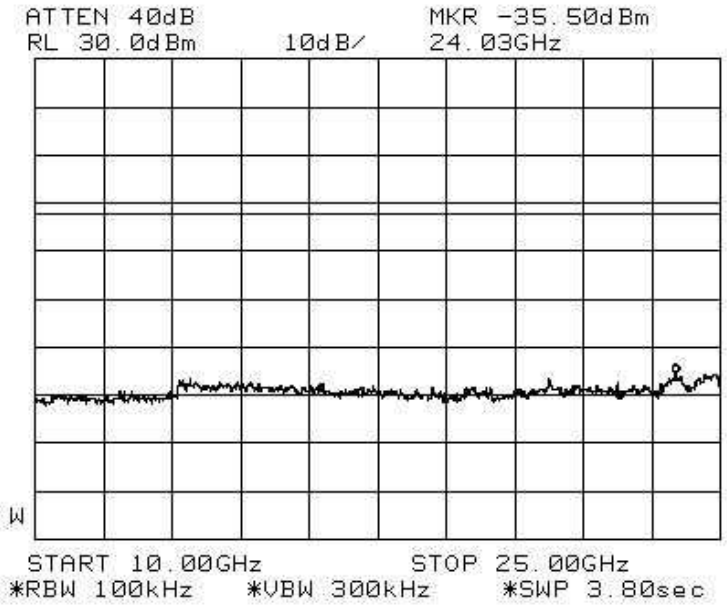
Test Input Power	110V 60Hz (via host)	Temperature	23°C
Attached Plots	14 - 19	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

All spurious signals found were below the specified limit. Please refer to the attached plots.

RF Conducted Spurious Emissions Plots

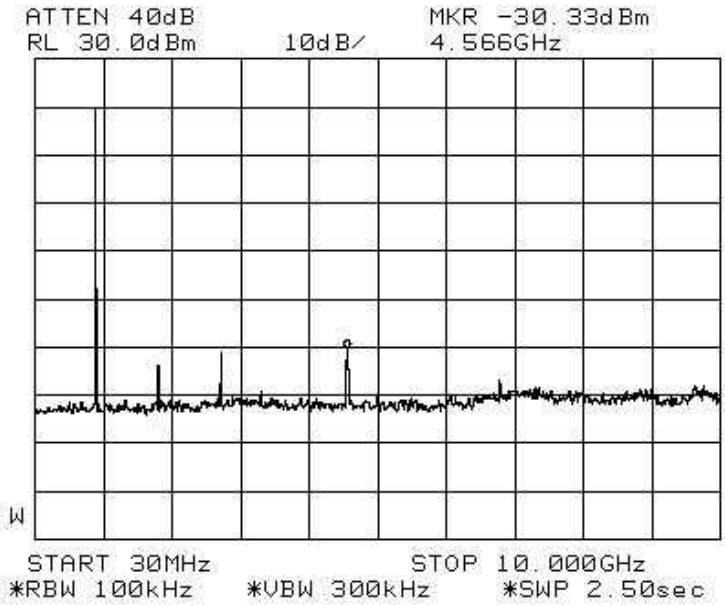


Plot 14 – Channel 1

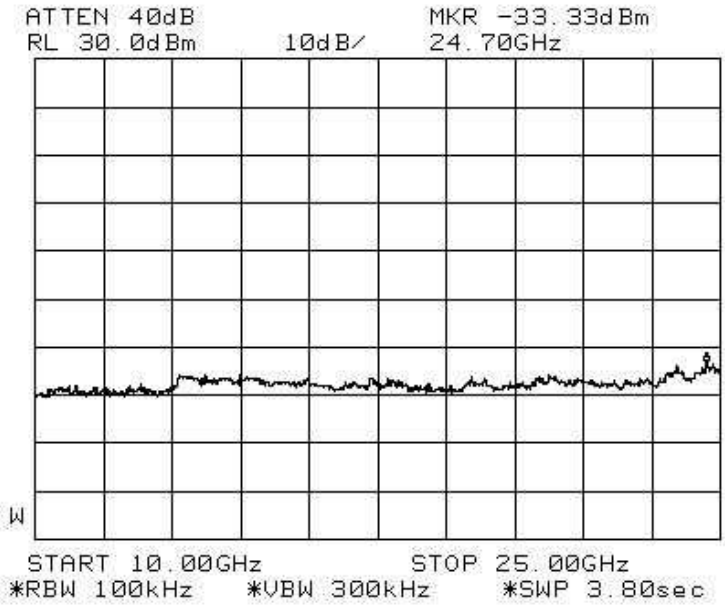


Plot 15 – Channel 1

RF Conducted Spurious Emissions Plots

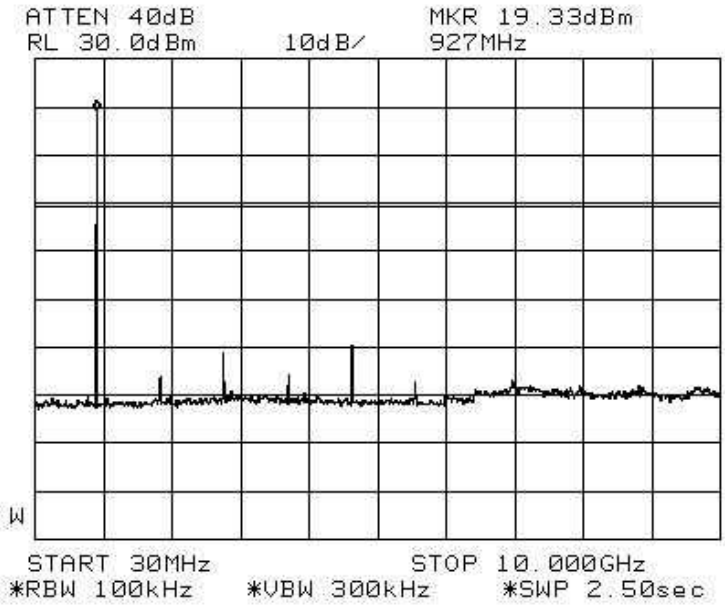


Plot 16 – Channel 25

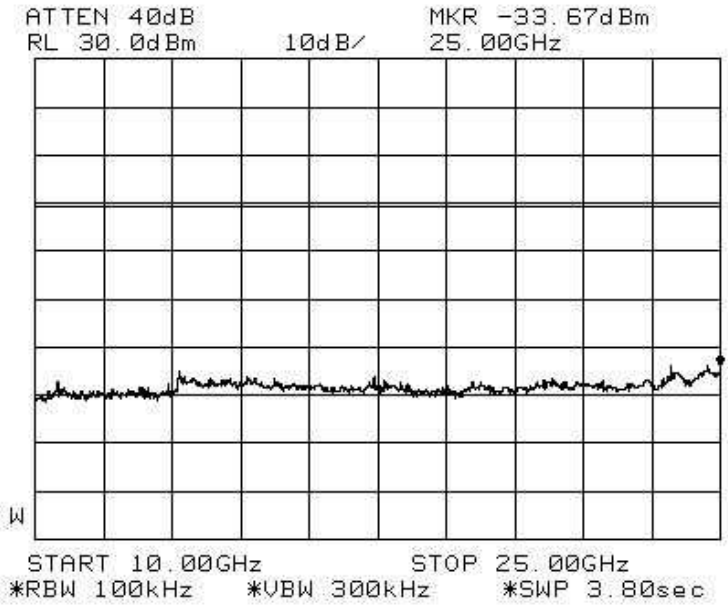


Plot 17 – Channel 25

RF Conducted Spurious Emissions Plots



Plot 18 – Channel 51



Plot 19 – Channel 51

BAND EDGE COMPLIANCE (CONDUCTED) TEST

FCC Part 15.247(d) Band Edge Compliance Limits

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 radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

FCC Part 15.247(d) Band Edge Compliance Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyser – SA11	8563E	3846A09953	26 Sep 2010

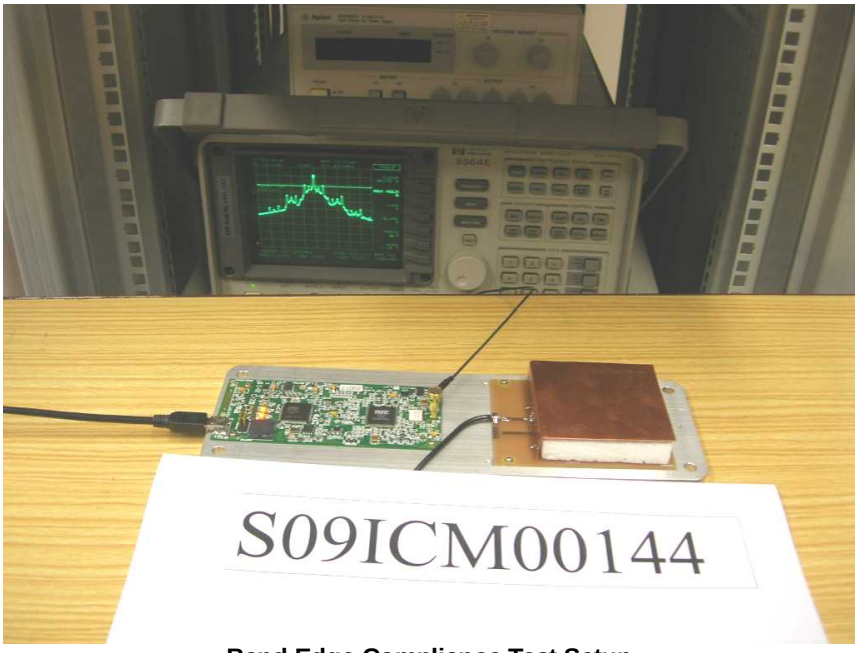
FCC Part 15.247(d) Band Edge Compliance Test Setup

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.

FCC Part 15.247(d) Band Edge Compliance 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 frequency 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, 902MHz 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, 928MHz and the any spurious emissions at the band-edge.

BAND EDGE COMPLIANCE (CONDUCTED) TEST



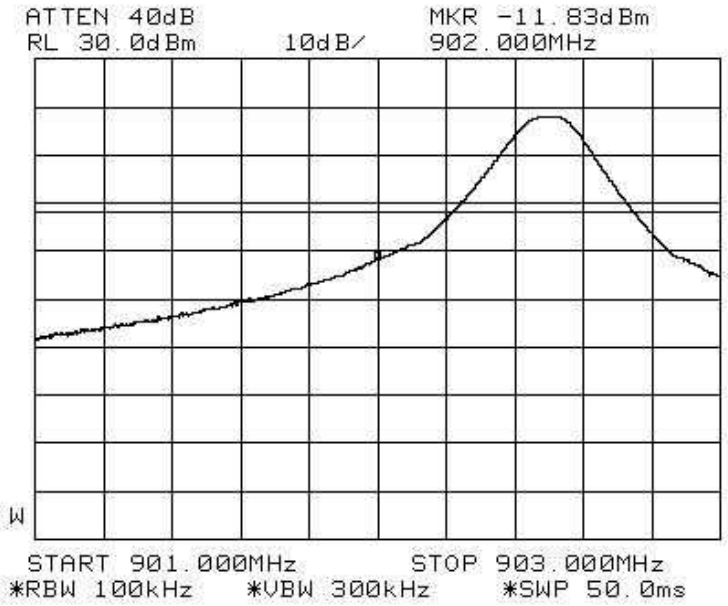
Band Edge Compliance Test Setup

FCC Part 15.247(d) Band Edge Compliance Results

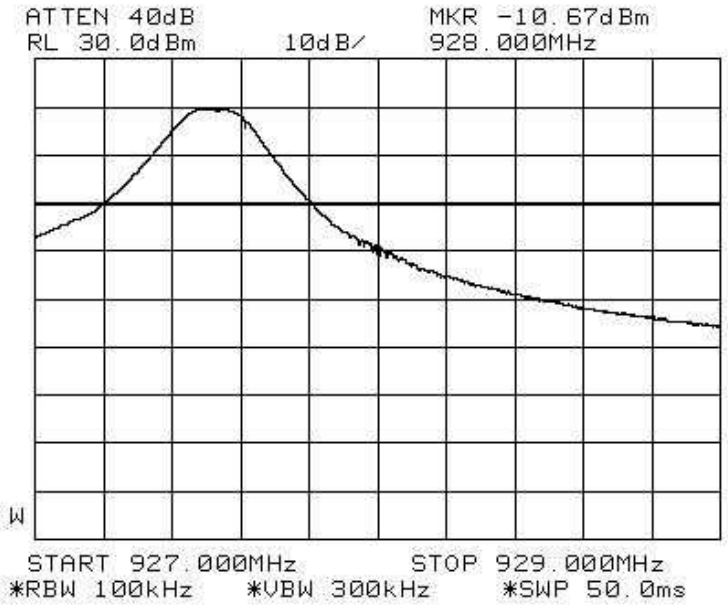
Test Input Power	110V 60Hz (via host)	Temperature	23°C
Attached Plots	20 - 21	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

No significant signal was found and they were below the specified limit.

Band Edge Compliance Plots



Plot 20 – Lower Band Edge at 902MHz



Plot 21 – Upper Band Edge at 928MHz

MAXIMUM PERMISSIBLE EXPOSURE (MPE) TEST

FCC Part 1.1310 Maximum Permissible Exposure (MPE) Limits

The EUT shows compliance to the requirements of this section, which states the MPE limits for general population / uncontrolled exposure are as shown below:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (min)
0.3 - 1.34	614	1.63	100 Note 2	30
1.34 - 30	824 / f	2.19 / f	$180 / f^2$ Note 2	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	-	-	f / 1500	30
1500 - 100000	-	-	1.0	30
Notes				
1. f = frequency in MHz				
2. Plane wave equivalent power density				

FCC Part 1.1310 Maximum Permissible Exposure (MPE) Test Instrumentation

The minimum safe distance between the EUT and field probe was computed from the following formula:

d = √ [(30GP) / 377S]
where S = Power density, $6.183W/m^2$
P = 0.0823W
d = Minimum safety distance, m
G = Numerical isotropic gain, 3.0 (1.995dBi)

Substituting the relevant parameters into the formula:

d = √ [(30GP) / 377S]
= 0.046m
= 4.6cm

∴ The distance between users and the EUT shall be maintained at a minimum distance of 4.6cm during normal operation in order to ensure RF exposure to the users is within the allowable safety margin.

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 TÜV SÜD PSB approves, recommends or endorses the manufacturer, supplier or user of such product/equipment, or that TÜV SÜD PSB in any way "guarantees" the later performance of the product/equipment.

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10. Unless otherwise stated, the tests are carried out in TÜV SÜD PSB Pte Ltd, No.1 Science Park Drive Singapore 118221.

January 2008

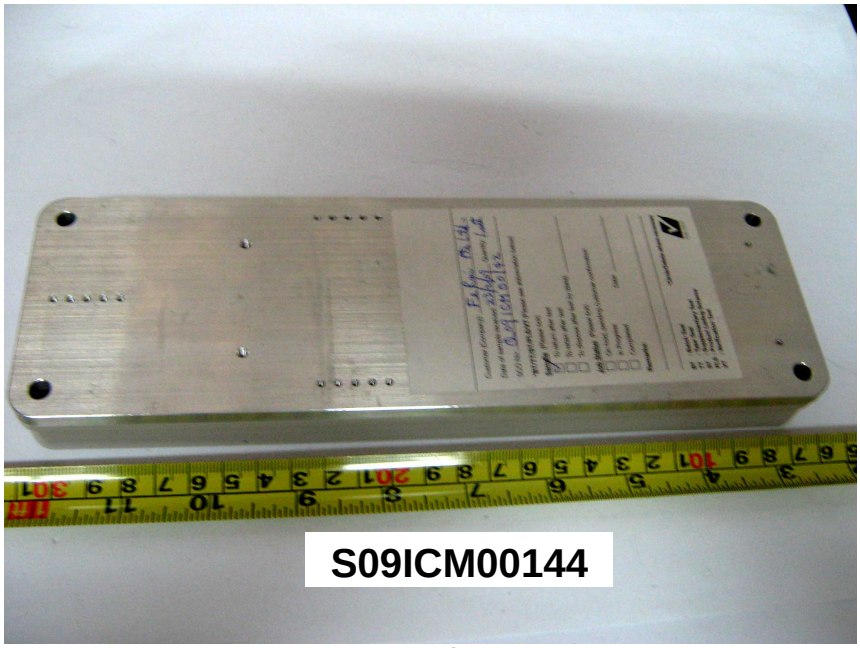
ANNEX A

EUT PHOTOGRAPHS / DIAGRAMS

EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

EUT PHOTOGRAPHS

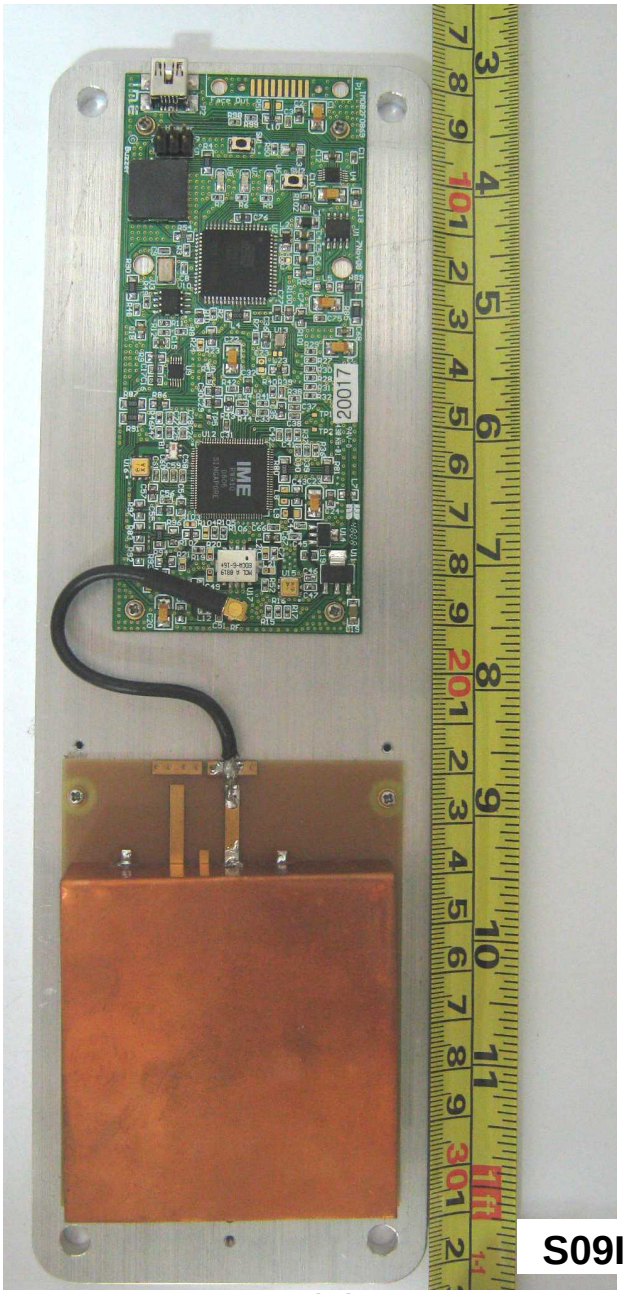
Front View



Rear View

EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

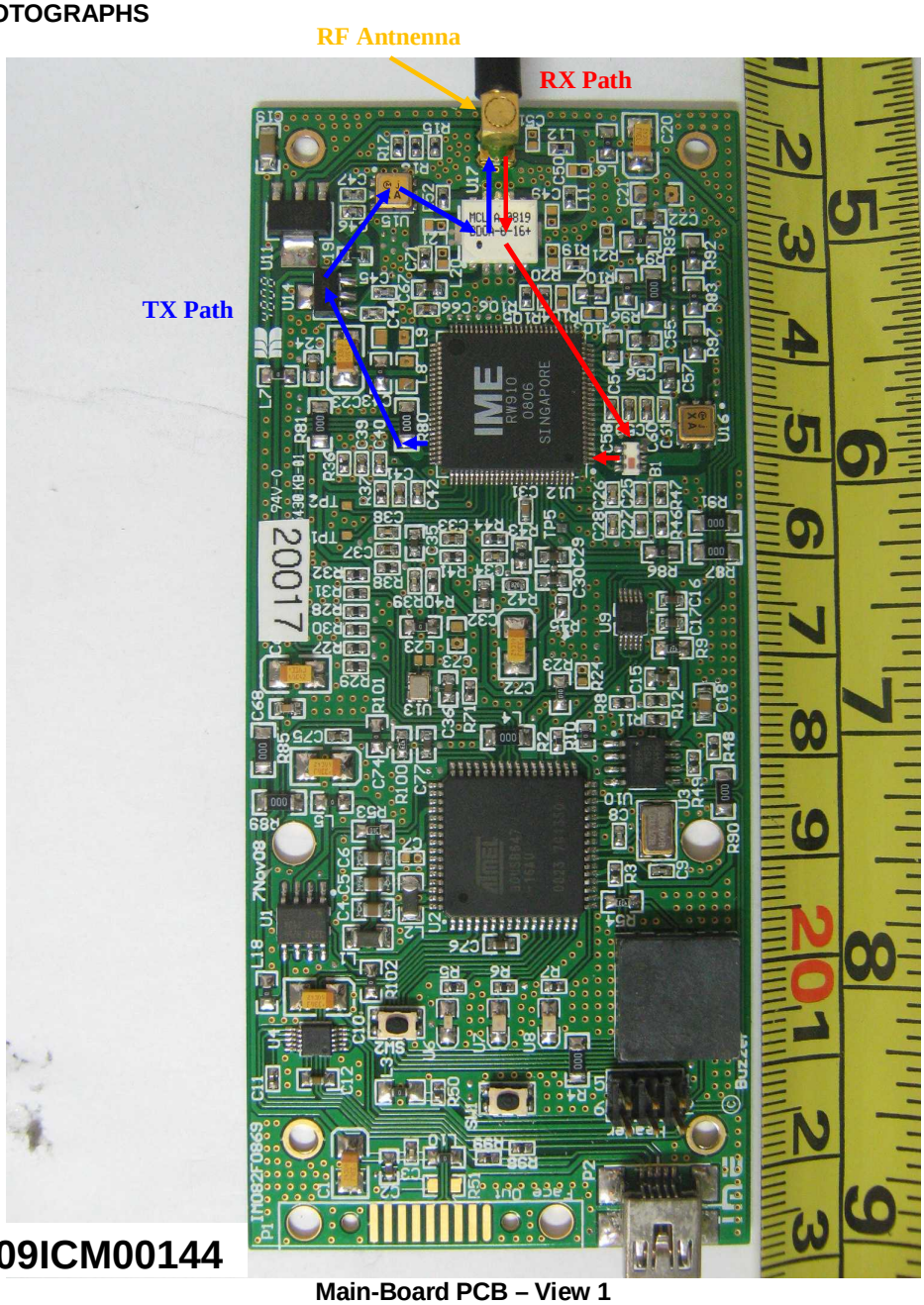
EUT PHOTOGRAPHS



Internal View

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

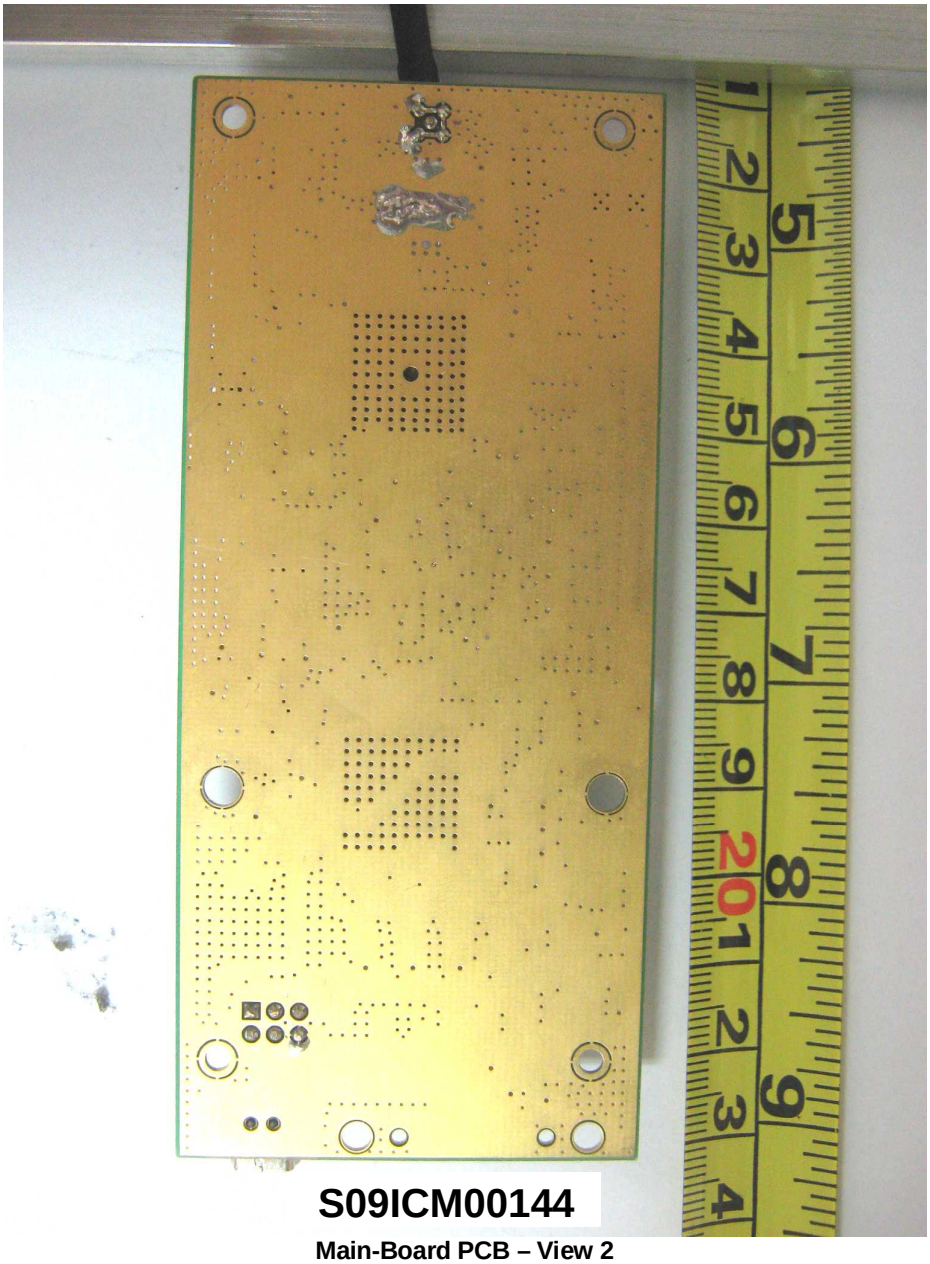
EUT PHOTOGRAPHS



Main-Board PCB – View 1

EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

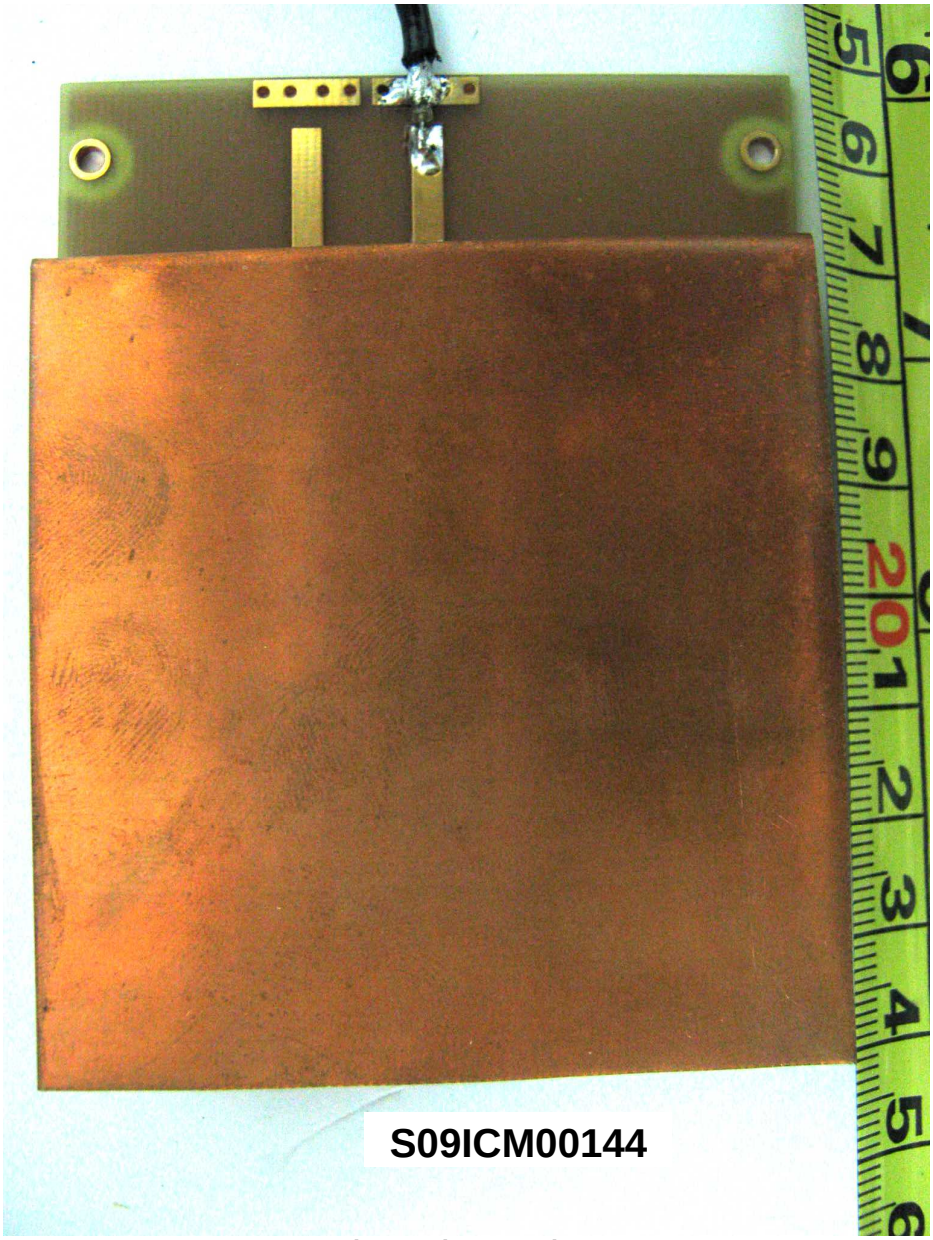
EUT PHOTOGRAPHS



Main-Board PCB – View 2

EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

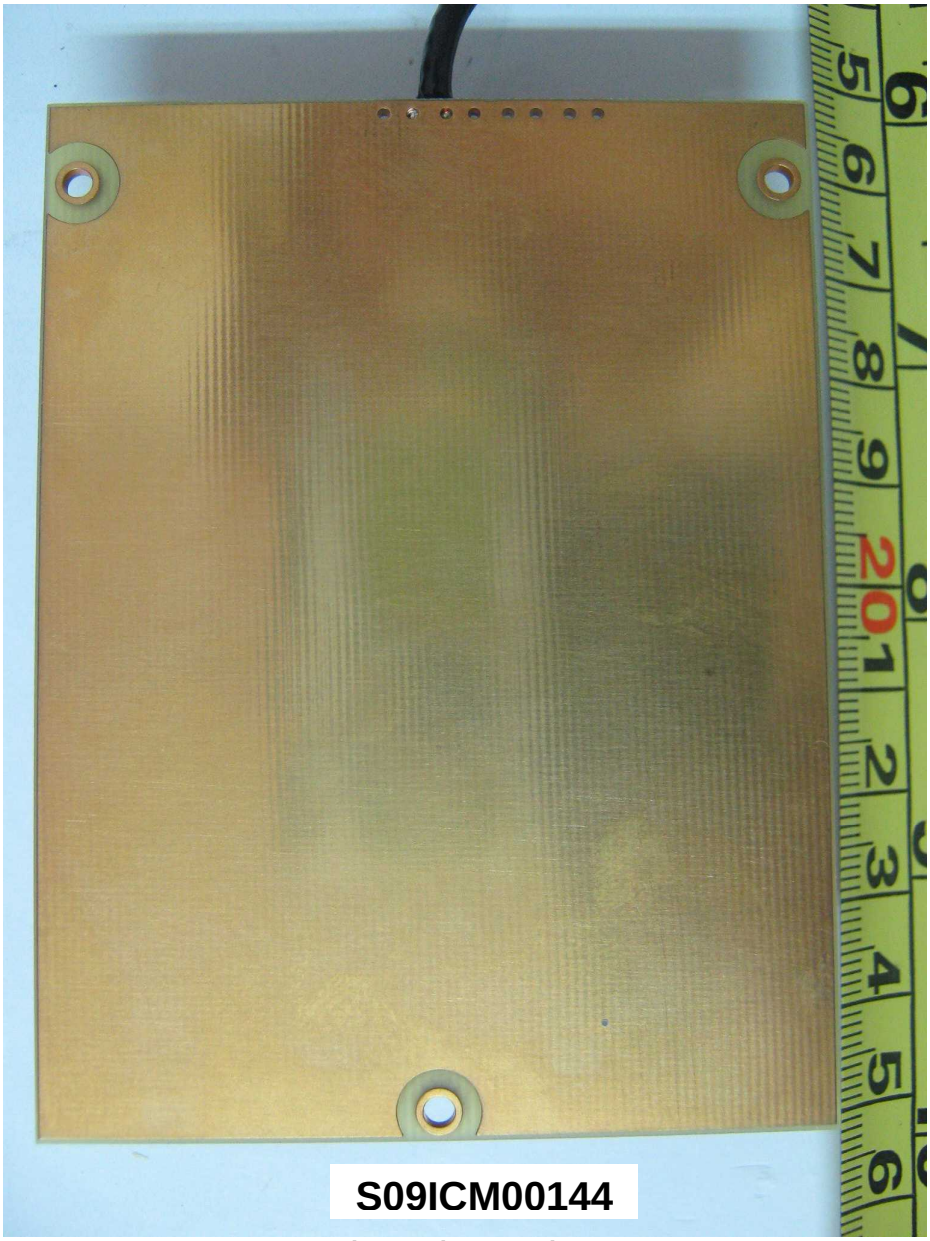
EUT PHOTOGRAPHS



Sub-Board PCB – View 1

EUT PHOTOGRAPHS / DIAGRAMS — ANNEX A

EUT PHOTOGRAPHS



Sub-Board PCB – View 2

ANNEX B

FCC LABEL & POSITION

FCC LABEL & POSITION — ANNEX B

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

ANNEX C

USER MANUAL
TECHNICAL DESCRIPTION
BLOCK & CIRCUIT DIAGRAMS

(Please refer to manufacturer for details)