



TEST REPORT FROM RADIO FREQUENCY INVESTIGATION LTD.

Test Of: Sendo Ltd.
Sendo X GSM Mobile Telephone Handset

To: FCC Part 15.247

Test Report Serial No:
RFI/MPTB1/RP45076JD08A

This Test Report Is Issued Under The Authority Of Richard Jacklin, Operations Director: 	Checked By: 
Tested By:  pp	Release Version No: PDF01
Issue Date: 16 January 2004	Test Dates: 08 December 2003 to 15 December 2003

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RADIO FREQUENCY INVESTIGATION LTD

Operations Department

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To: Sendo X GSM Mobile Telephone Handset

FCC Part 15.247

TEST REPORT

S.No. RFI/MPTB1/RP45076JD08A

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1. Client Information

Company Name:	Sendo Ltd
Address:	Hatchford Brook Hatchford Way Sheldon Birmingham B26 3RZ United Kingdom
Contact Name:	Mr M Bailey

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2. Equipment Under Test (EUT)

The following information (with the exception of the Date of Receipt) has been supplied by the client:

2.1. Identification Of Equipment Under Test (EUT)

Brand Name:	Sendo
Model Name or Number:	Sendo X
Unique Type Identification:	SNDX00
Serial Number:	020213
IMEI Number:	1515151515151515151515151515158
Battery Serial Number:	20030728
Country of Manufacture:	China
FCC ID:	P6PSNDX00
Date of Receipt:	08 December 2003

2.2. Description Of EUT

The equipment under test is a tri-band (900, 1800 and 1900) mobile phone, which supports IR and Bluetooth.

2.3. Modifications Incorporated In EUT

None.

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2.4. Additional Information Related To Testing

Power Supply Requirement:	Internal 3.7 V (nominal) lithium ion battery		
Declared Battery End Point Voltage	3.5 VDC (min) to 4.2 VDC (max)		
Power Supply Requirement: (AC Battery Charger)	Nominal 110 V 60 Hz AC Mains supply		
Intended Operating Environment:	Within GSM Network Coverage		
Equipment Category:	Portable		
Type of Unit:	Transceiver		
Interface Ports:	Charger, Personal Handsfree and Comms Port		
Transmit Frequency Range	2402 MHz to 2481 MHz		
Transmit Channels Tested	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	1	2402
	Middle	40	2441
	Top	79	2480
Receive Frequency Range	2402 MHz to 2481 MHz		
Receive Channels Tested	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	1	2402
	Middle	40	2441
	Top	79	2480
Highest Fundamental Frequency	2480 MHz		
Maximum Power Output (EIRP)	-8.3 dBm		
Occupied Bandwidth:	898 kHz		

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2.5. Accessories

Description:	AC Battery Charger
Brand Name:	Salcomp
Model Name or Number:	8D09-07122-10000
Serial Number:	23800073011
Country of Manufacture:	Finland

Description:	USB Cable
Brand Name:	Sendo
Model Name or Number:	None stated
Serial Number:	None stated
Country of Manufacture:	None stated

Description:	Personal Handsfree Kit
Brand Name:	Sendo
Model Name or Number:	None stated
Serial Number:	None stated
Country of Manufacture:	None stated

Description:	Desktop Synch Cradle
Brand Name:	Sendo Ltd
Model Name or Number:	Sendo Sync Station
Unique Type Identification:	8P20-20000-00000
Serial Number:	None stated
Country of Manufacture:	China

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2.6. Support Equipment

The following support equipment was used to exercise the EUT during testing:

Description:	Bluetooth Test Set
Brand Name:	Aniritsu
Model Name or Number:	MT8850A
Serial Number:	6K0000084
Connected to Port:	RF Link

Description:	PC
Brand Name:	IBM
Model Name or Number:	Thinkpad
Serial Number:	55346DW011
Cable Length and Type:	Serial 1.5m
Connected to Port:	EUT Comms Port

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3. Methods And Procedures

Reference:	FCC Part 15 Subpart C: 2002 (Section 15.247)
Title:	Code of Federal Regulations, Part 15 (47CFR15) Radio Frequency Devices
Comments:	A description of the test facility used for this test is on file with, and has been accepted by, the Federal Communications Commission as required by Section 2.948 of Federal Rules.
Purpose of Test:	To determine whether the equipment complied with the requirements of the specification for the purposes of certification.

The methods and procedures used were as detailed in:

ANSI C63.2 (1987)

Title: American National Standard for Instrumentation - Electromagnetic noise and field strength.

ANSI C63.4 (2001)

Title: American National Standard Methods of Measurement of Electromagnetic Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

ANSI C63.5 (1988)

Title: American National Standard for the Calibration of antennas used for Radiated Emission measurements in Electromagnetic Interference (EMI) control.

ANSI C63.7 (1988)

Title: American National Standard Guide for Construction of Open Area Test Sites for performing Radiated Emission Measurements.

CISPR 16-1: (1999)

Title: Specification For Radio Disturbance and Immunity Measuring Apparatus and Methods. Part 1: Radio Disturbance and Immunity Measuring Apparatus.

DA00-705 (2000)

Title: Filing and Frequency Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

3.1. Definition Of Measurement Equipment

The measurement equipment used complied with the requirements of the standards referenced in the Methods & Procedures section above. Appendix 1 contains a list of the test equipment used.

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4. Deviations From The Test Specification

None.

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5. Operation Of The EUT During Testing

5.1. Operating Conditions

During testing, the EUT was powered by a nominal 3.7 V lithium-ion battery connected to a 110 V 60 Hz AC Mains charger.

5.2. Operating Modes

The EUT was tested in the following operating modes, unless otherwise stated.

Preliminary radiated spurious pre-scan tests were performed in both transmit (Bluetooth active) and idle modes on the highest operating frequency of the EUT (top channel) with the accessories stated in section 2.5 of this report connected and disconnected. The combinations that exhibited the worst case mode of operation were then used to perform final measurements. This was found to be with the EUT sitting in the desktop sync cradle below 1 GHz and with the EUT powered directly by its AC battery charger (i.e. not in the desktop sync cradle) above 1 GHz. Final measurements were then performed on the top, middle and bottom channels and hopping on all channels if an emission was identified.

AC Mains Conducted emissions in both transmit (Bluetooth active) and idle modes were performed on the highest operating frequency of the EUT (top channel) in the established worst-case mode of operation i.e. with the EUT sitting in the desktop sync cradle.

For all other transmit mode measurements the Bluetooth mode was active and set to transmit on the top, middle and bottom channels and hopping on all channels as necessary.

5.3. Configuration And Peripherals

The EUT was tested in the following configuration:

Configured with personal handsfree kit, desktop sync cradle* and AC battery charger connected to laptop via USB cable

** For AC Mains Conducted emissions and Radiated emissions below 1 GHz.*

The reason for choosing this configuration was that the client has defined it as being the most likely to be the worst case with regards to EMC.

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6. Summary Of Test Results

Part 15.247

Range Of Measurements	Specification Reference	Port Type	Compliance Status
Idle Mode AC Conducted Emissions (150 kHz to 30 MHz)	C.F.R. 47 FCC Part 15: 2002 Section 15.107	AC Mains	Complied
Idle Mode Radiated Spurious Emissions	C.F.R. 47 FCC Part 15: 2002 Section 15.109	Antenna	Complied
Transmitter AC Conducted Emissions	C.F.R. 47 FCC Part 15: 2002 Section 15.207	AC Mains	Complied
Transmitter 20 dB Bandwidth	C.F.R. 47 FCC Part 15: 2002 Section 15.247(a)(1)(iii)	Antenna	Complied
Transmitter Carrier Frequency Separation	C.F.R. 47 FCC Part 15: 2002 Section 15.247(a)(1)	Antenna	Complied
Transmitter Average Time of Occupancy	C.F.R. 47 FCC Part 15: 2002 Section 15.247(a)(1)(iii)	Antenna	Complied
Transmitter Maximum Peak Output Power	C.F.R. 47 FCC Part 15: 2002 Section 15.247(b)(1)	Antenna	Complied
Transmitter Radiated Emissions	C.F.R. 47 FCC Part 15: 2002 Section 15.247(c)/Section 15.209(a)	Antenna	Complied
Transmitter Band Edge Radiated Emissions	C.F.R. 47 FCC Part 15: 2002 Section 15.247(c)/Section 15.209(a)	Antenna	Complied

6.1. Location Of Tests

All the measurements described in this report were performed at the premises of Radio Frequency Investigation Ltd, Ewhurst Park, Ramsdell, Basingstoke, Hampshire, RG26 5RQ, England.

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7. Measurements, Examinations And Derived Results

7.1. General Comments

7.1.1. This section contains test results only. Details of the test methods and procedures can be found in Section 9 of this report.

7.1.2. Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to Section 10 for details of measurement uncertainties.

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8. Test Results

8.1. Idle Mode Conducted Emissions AC Mains: Section 15.107

8.1.1. The EUT was configured as for AC conducted emissions measurements as described in section 9 of this report.

8.1.2. Tests were performed to identify the maximum emissions levels on the AC mains line of the EUT.

Quasi-Peak Detector Measurements on Live and Neutral Lines

Frequency (MHz)	Line	Q-P Level (dB μ V)	Q-P Limit (dB μ V)	Margin (dB)	Result
0.16817	Neutral	52.92	65.05	12.13	Complied
0.33496	Neutral	47.26	59.33	12.07	Complied
0.50090	Live	47.24	56.00	8.76	Complied
0.66461	Neutral	47.74	56.00	8.26	Complied
0.82493	Live	49.82	56.00	6.18	Complied
0.99219	Neutral	41.62	56.00	14.38	Complied
1.14898	Live	45.28	56.00	10.72	Complied
1.30320	Live	46.32	56.00	9.68	Complied
1.63864	Live	44.82	56.00	11.18	Complied
2.98428	Live	40.56	56.00	15.44	Complied
3.18459	Live	39.87	56.00	16.13	Complied

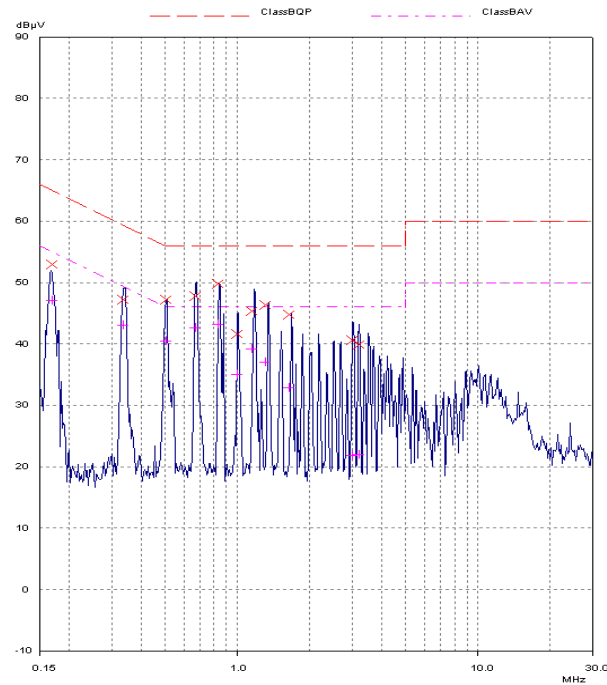
Average Detector Measurements on Live and Neutral Lines

Frequency (MHz)	Line	Avg Level (dB μ V)	Avg Limit (dB μ V)	Margin (dB)	Result
0.16817	Live	47.13	55.05	7.92	Complied
0.33496	Live	43.02	49.33	6.31	Complied
0.50090	Live	40.53	46.00	5.47	Complied
0.66461	Live	42.56	46.00	3.44	Complied
0.82493	Live	43.22	46.00	2.78	Complied
0.99219	Live	35.00	46.00	11.00	Complied
1.14898	Live	39.16	46.00	6.84	Complied
1.30320	Live	37.08	46.00	8.92	Complied
1.63864	Live	32.86	46.00	13.14	Complied
2.98428	Live	21.87	46.00	24.13	Complied
3.18459	Live	22.02	46.00	23.98	Complied

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Idle Mode Conducted Emissions AC Mains: Section 15.107 (Continued)

Note: these plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

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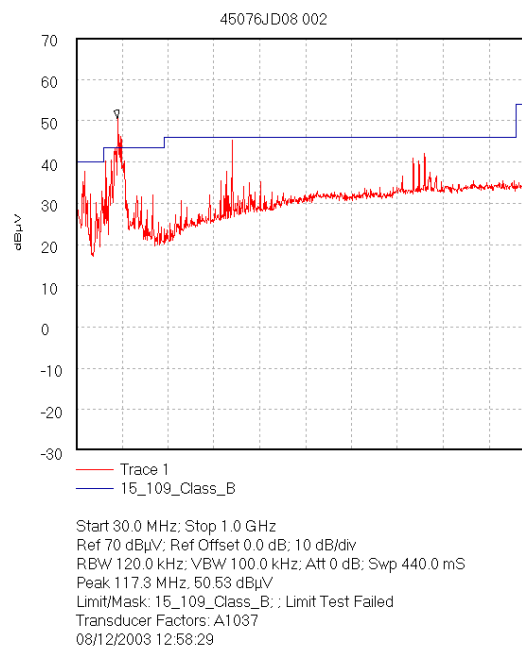
To: FCC Part 15.247

8.2. Idle Mode Radiated Emissions: Section 15.109**8.2.1. Electric Field Strength Measurements (Frequency Range: 30 to 1000 MHz)**

8.2.1.1. The EUT was configured as for radiated field strength emissions testing as described in Section 9 of this report.

8.2.1.2. Tests were performed to identify the maximum idle mode radiated emission levels present in the band 30 MHz to 5 x the highest unintentionally generated frequency.

Frequency (MHz)	Antenna Polarity	Q-P Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
48.000	Vert.	21.5	40.0	18.5	Complied
92.398	Vert.	22.4	43.5	21.1	Complied
104.431	Vert.	18.4	43.5	25.1	Complied
109.463	Vert.	26.0	43.5	17.5	Complied
117.495	Vert.	35.1	43.5	8.4	Complied
124.525	Vert.	28.1	43.5	15.4	Complied
132.000	Vert.	21.9	43.5	21.6	Complied
360.000	Vert.	25.7	46.0	20.3	Complied
744.000	Vert.	33.8	46.0	12.2	Complied
768.000	Vert.	30.6	46.0	15.4	Complied



Note: these plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

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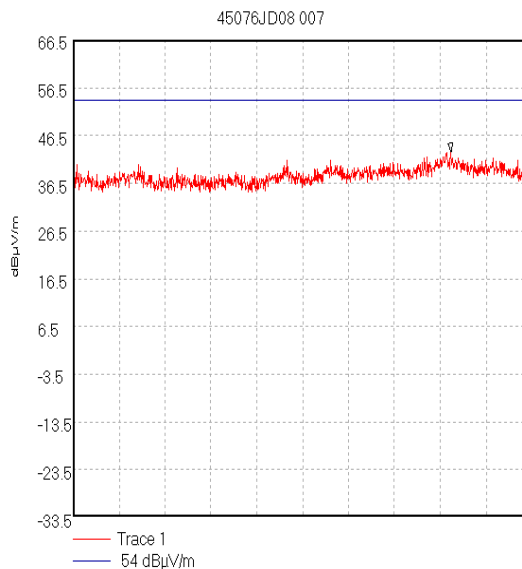
To: FCC Part 15.247

Idle Mode Radiated Emissions: Section 15.109 (Continued)**Electric Field Strength Measurements (Frequency Range: 1.0 to 12.5 GHz)****Highest Peak Level:**

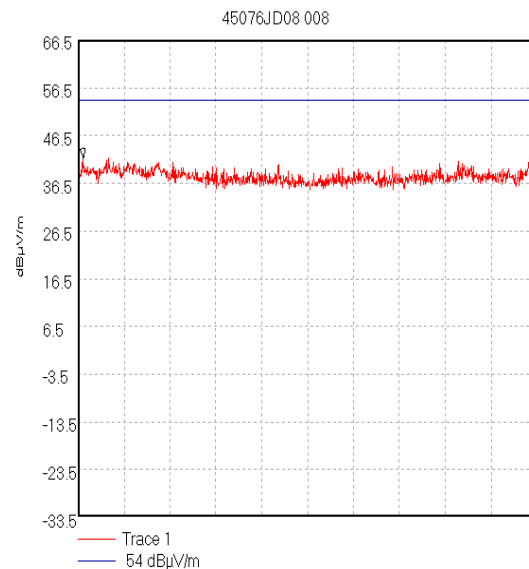
Frequency (GHz)	Antenna Polarity (H/V)	Peak Detector Level (dBμV)	Antenna Factor	Cable Loss	Actual Peak Level (dBμV/m)	**Average Limit (dBμV/m)	Margin (dB)	Result
1.824*	Vert.	20.4	21.6	1.1	43.1	54.0	10.9	Complied

**Note: No spurious emissions were detected above the noise floor of the measuring receiver; therefore, the highest peak noise floor reading of the measuring receiver was recorded as shown in the table above.*

***Note: The peak level was compared to the average limit as opposed to being compared to the peak limit because this is the more onerous limit.*



Start 1.0 GHz; Stop 2.0 GHz
Ref 66.5 dBμV/m; Ref Offset -9.5 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 1.824 GHz, 43.07 dBμV/m
Display Line: 54 dBμV/m; Limit Test Passed
Transducer Factors: 1 to 2
08/12/2003 14:54:36



Start 2.0 GHz; Stop 4.0 GHz
Ref 66.5 dBμV/m; Ref Offset -9.5 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 2.022 GHz, 41.77 dBμV/m
Display Line: 54 dBμV/m; Limit Test Passed
Transducer Factors: 2 to 4
08/12/2003 15:01:06

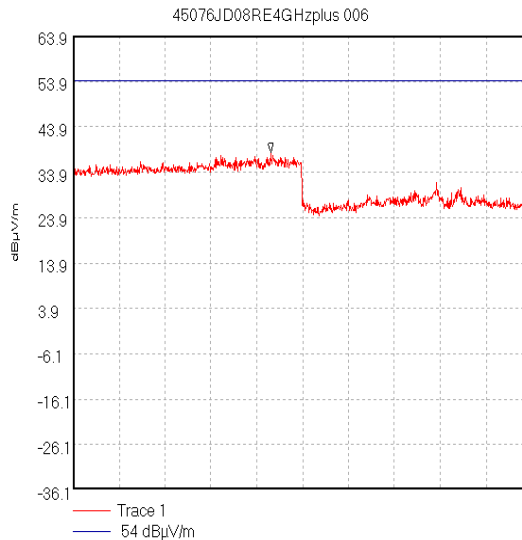
Note: these plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

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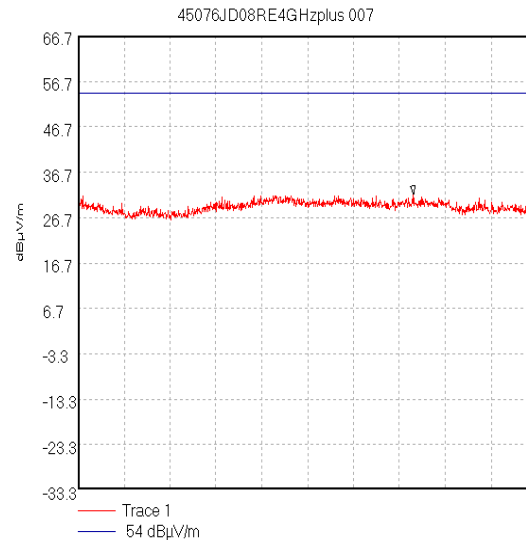
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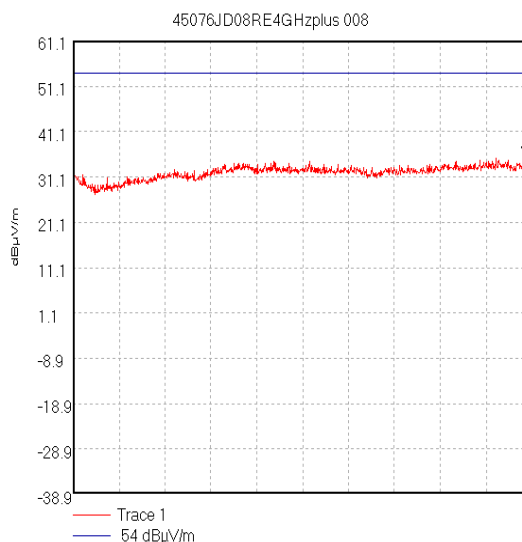
To: FCC Part 15.247

Receiver Radiated Emissions: Section 15.109 (Continued)

Start 4.0 GHz; Stop 6.0 GHz
Ref 63.9 dBμV/m; Ref Offset 16.9 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 4.862 GHz; 38.23 dBμV/m
Display Line: 54 dBμV/m; : Limit Test Passed
Transducer Factors: A490
12/12/2003 15:05:12



Start 6.0 GHz; Stop 8.0 GHz
Ref 66.7 dBμV/m; Ref Offset 19.7 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 7.462 GHz; 31.76 dBμV/m
Display Line: 54 dBμV/m; : Limit Test Passed
Transducer Factors: A490
12/12/2003 15:09:51



Start 8.0 GHz; Stop 12.5 GHz
Ref 61.1 dBμV/m; Ref Offset 24.1 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 40.0 mS
Peak 12.425 GHz; 35.94 dBμV/m
Display Line: 54 dBμV/m; : Limit Test Passed
Transducer Factors: A490
12/12/2003 15:12:33

Note: these plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

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8.3. Transmitter Conducted Emissions AC Mains: Section 15.207**Quasi-Peak Detector Measurements on Live and Neutral Lines**

8.3.1. The EUT was configured as for AC conducted emissions measurements as described in Section 9 of this report.

8.3.2. Tests were performed to identify the maximum emissions levels on the AC mains line of the battery charger while connected to the EUT.

Top Channel

Frequency (MHz)	Line	Q-P Level (dB μ V)	Q-P Limit (dB μ V)	Margin (dB)	Result
0.16915	Neutral	53.33	65.00	11.67	Complied
0.33896	Live	48.13	59.23	11.10	Complied
0.50622	Live	48.05	56.00	7.95	Complied
0.67349	Live	49.67	56.00	6.33	Complied
0.84377	Neutral	47.49	56.00	8.51	Complied
1.17838	Neutral	44.42	56.00	11.58	Complied
1.34047	Live	46.30	56.00	9.70	Complied
3.02412	Neutral	39.82	56.00	16.18	Complied
3.19174	Neutral	39.39	56.00	16.61	Complied

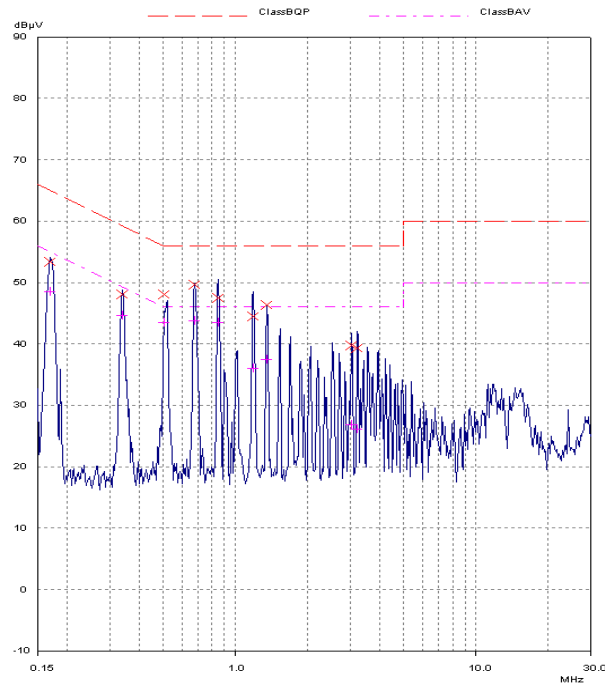
Average Detector Measurements on Live and Neutral Lines**Top Channel**

Frequency (MHz)	Line	Avg Level (dB μ V)	Avg Limit (dB μ V)	Margin (dB)	Result
0.16915	Live	48.51	55.00	6.49	Complied
0.33896	Live	44.62	49.23	4.61	Complied
0.50622	Live	43.45	46.00	2.55	Complied
0.67349	Live	43.83	46.00	2.17	Complied
0.84377	Live	43.50	46.00	2.50	Complied
1.17838	Live	36.04	46.00	9.96	Complied
1.34047	Live	37.46	46.00	8.54	Complied
3.02412	Live	26.79	46.00	19.21	Complied
3.19174	Live	26.06	46.00	19.94	Complied

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Transmitter Conducted Emissions AC Mains: Section 15.207 (Continued)

Note: these plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

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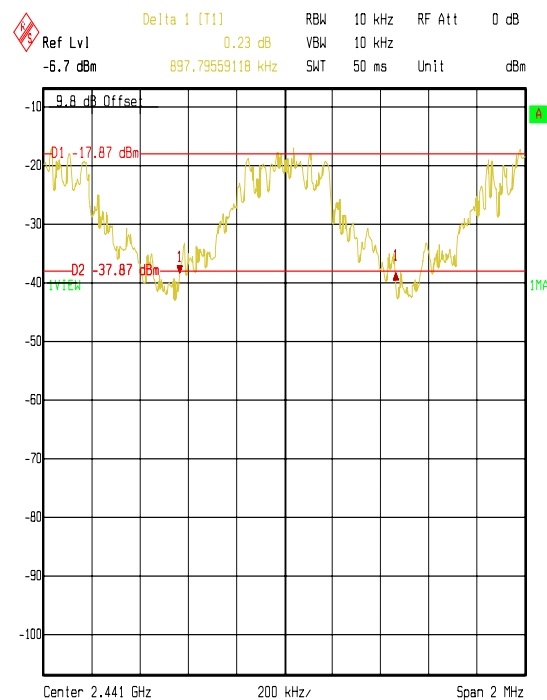
To: FCC Part 15.247

8.4.Transmitter 20 dB Bandwidth: Section 15.247(a)(1)(iii)

8.4.1. The EUT was configured as for carrier frequency separation/20 dB bandwidth measurements as described in Section 9 of this report.

8.4.2. Tests were performed to identify the 20 dB bandwidth.

Transmitter 20 dB Bandwidth (kHz)	Limit (kHz)
897.796	None specified



Comment A: 20 dB BANDWIDTH
 GPH/45076JD08/20dB01
 Date: 15.DEC.2003 11:34:32

Test Of: Sendo Ltd.

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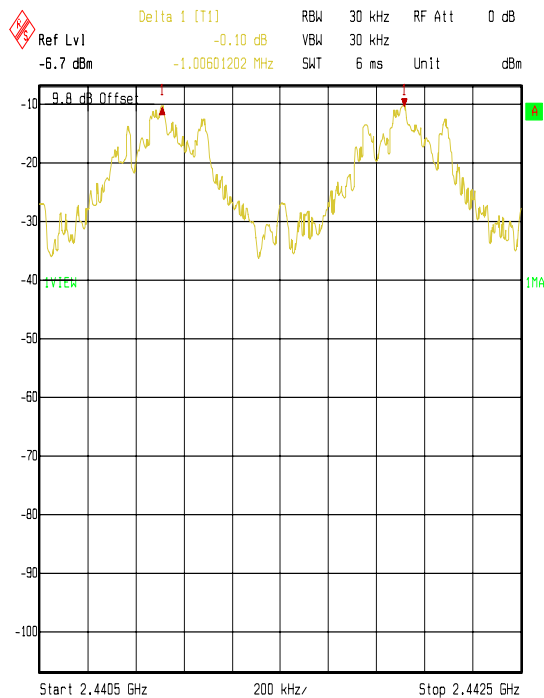
To: FCC Part 15.247

8.5. Transmitter Carrier Frequency Separation: Section 15.247(a)(1)

8.5.1. The EUT was configured as for carrier frequency separation measurements as described in Section 9 of this report.

8.5.2. Tests were performed to identify the carrier frequency separation.

Transmitter Carrier Frequency Separation (kHz)	Limit (> 20 dB BW) (kHz)	Margin (kHz)	Result
1006.012	897.796	108.216	Complied



Comment A: CHANNEL FREQUENCY SEPARATION
GPH/45076JD08/CFS01
Date: 15.DEC.2003 12:03:11

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8.6. Transmitter Average Time of Occupancy: Section 15.247(a)(1)(iii)

8.6.1. The EUT was configured as for average time of occupancy measurements as described in Section 9 of this report.

8.6.2. Tests were performed to identify the average time of occupancy in number of channels (79) x 0.4 seconds. The calculated period is 31.6 seconds.

Emission Width (ms)	Number of Hops in 31.6 seconds	Average Time of Occupancy (s)	Limit (s)	Margin (s)	Result
2.913206	71	0.207	0.4	0.193	Complied

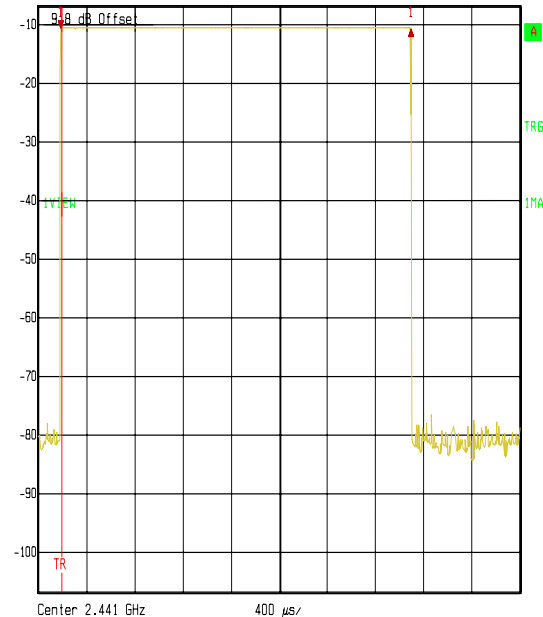
Test Of: Sendo Ltd.

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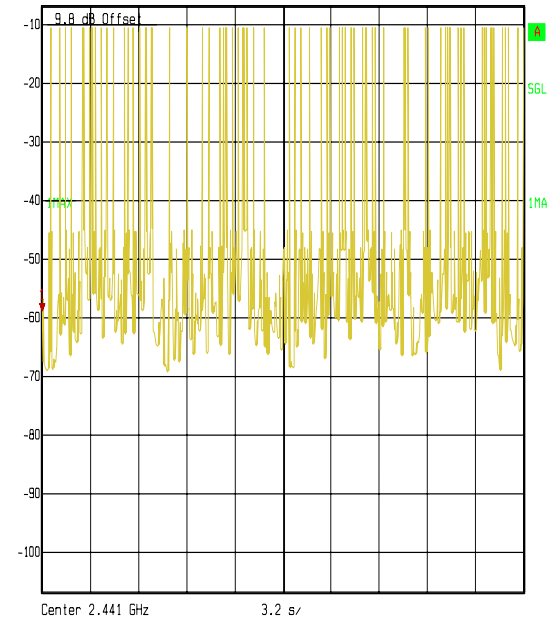
Transmitter Average Time of Occupancy: Section 15.247(a)(1)(iii) (Complied)

Ref Lvl Delta 1 [T1] RBW 1 MHz RF Att 0 dB
-6.7 dBm -0.11 dB VBW 1 MHz
2.913206 ms SWT 4 ms Unit dBm



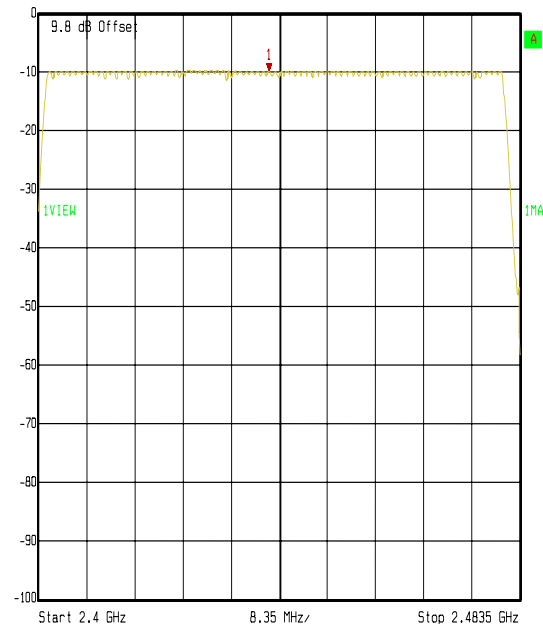
Comment A: AVERAGE TIME OF OCCUPANCY
GPH/45076JD08/AT001
Date: 15.DEC.2003 14:11:00

Ref Lvl Marker 1 [T1] RBW 100 kHz RF Att 0 dB
-6.7 dBm -58.84 dBm VBW 1 MHz
0.000000 s SWT 32 s Unit dBm



Comment A: AVERAGE TIME OF OCCUPANCY
GPH/45076JD08/AT002
Date: 15.DEC.2003 14:16:24

Ref Lvl Marker 1 [T1] RBW 1 MHz RF Att 10 dB
0 dBm -10.00 dBm VBW 1 MHz
2.4400000 GHz SWT 5 ms Unit dBm



Comment A: AVERAGE TIME OF OCCUPANCY
GPH/45076JD08/AT003
Date: 15.DEC.2003 14:38:57

Test Of: Sendo Ltd.

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8.7. Transmitter Maximum Peak Output Power: Section 15.247(b)(1)

8.7.1. The EUT was configured as for Transmitter Effective Isotropic Radiated Power measurements as described in Section 9 of this report.

8.7.1. Tests were performed to identify the transmitter maximum EIRP of the EUT.

Channel	Input Voltage (AC)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	93.50	-8.3	30.0	38.3	Complied
Bottom	110.00	-8.3	30.0	38.3	Complied
Bottom	126.50	-8.3	30.0	38.3	Complied
Middle	93.50	-10.0	30.0	40.0	Complied
Middle	110.00	-10.1	30.0	40.1	Complied
Middle	126.50	-10.1	30.0	40.1	Complied
Top	93.50	-9.5	30.0	39.5	Complied
Top	110.00	-9.5	30.0	39.5	Complied
Top	126.50	-9.5	30.0	39.5	Complied

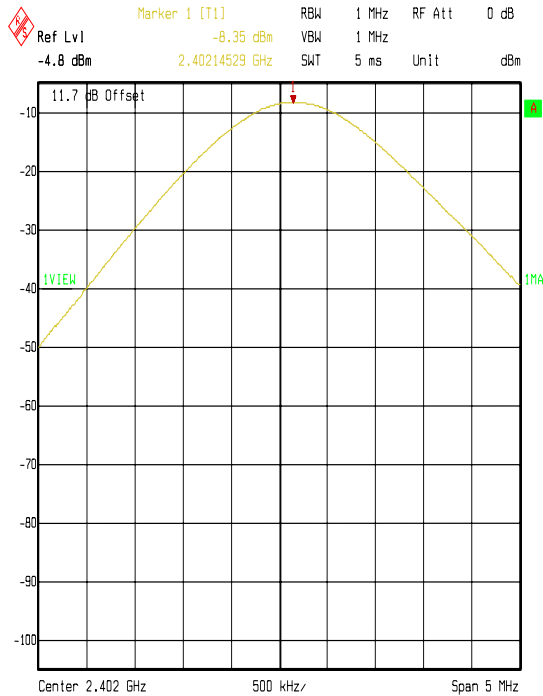
Note: These tests were performed radiated therefore the EUT antenna gain is encompassed in the final result and not measurable.

Operations Department

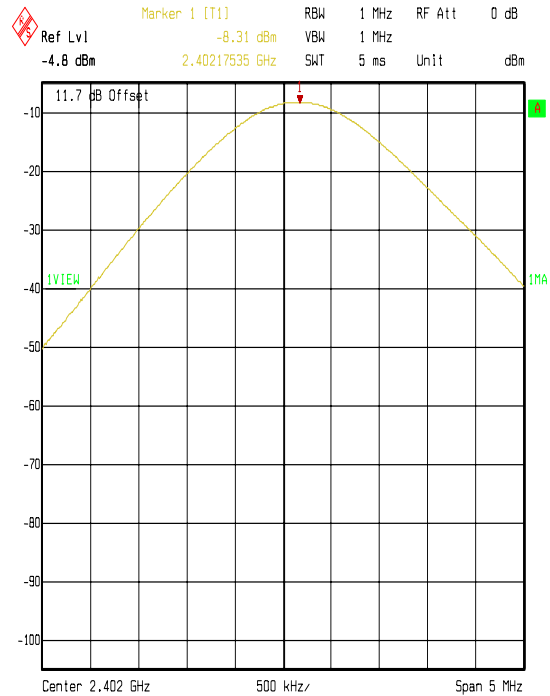
Test Of: Sendo Ltd.

Sendo X GSM Mobile Telephone Handset

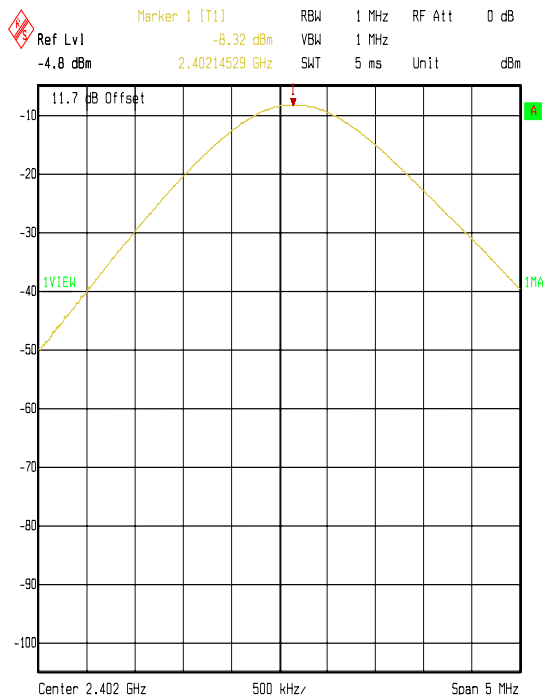
To: FCC Part 15.247

Transmitter Maximum Peak Output Power: Section 15.247(b)(1) (Continued)

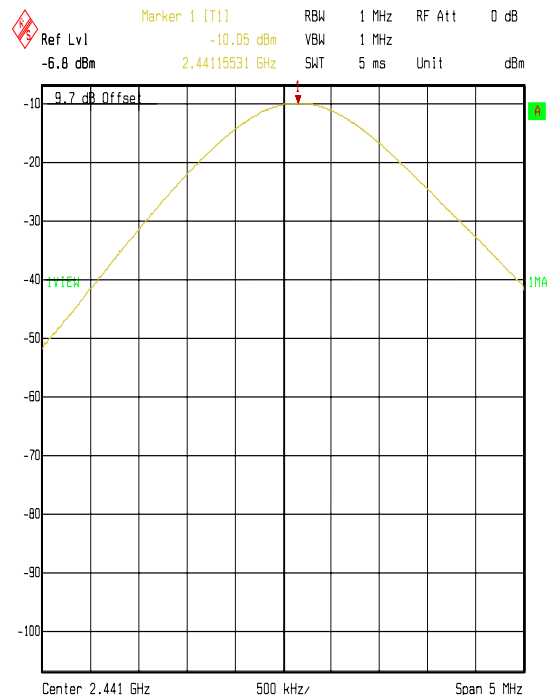
Comment A: PEAK OUTPUT POWER BOTTOM CHANNEL
INPUT VOLTAGE 110V ACBGP/45076JD08/POP01
Date: 15.DEC.2003 10:36:30



Comment A: PEAK OUTPUT POWER BOTTOM CHANNEL
INPUT VOLTAGE 93.5V ACBGP/45076JD08/POP02
Date: 15.DEC.2003 10:38:29



Comment A: PEAK OUTPUT POWER BOTTOM CHANNEL
INPUT VOLTAGE 126.5V ACBGP/45076JD08/POP03
Date: 15.DEC.2003 10:40:25

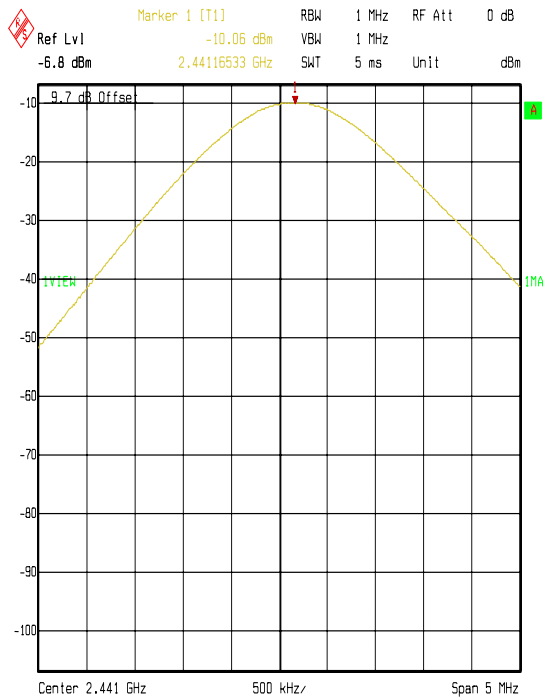


Comment A: PEAK OUTPUT POWER MIDDLE CHANNEL
INPUT VOLTAGE 110V ACBGP/45076JD08/POP04
Date: 15.DEC.2003 10:44:10

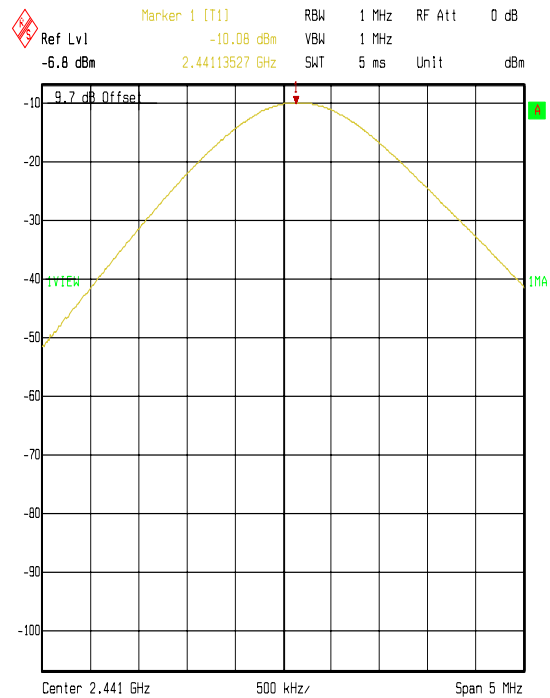
Test Of: Sendo Ltd.

Sendo X GSM Mobile Telephone Handset

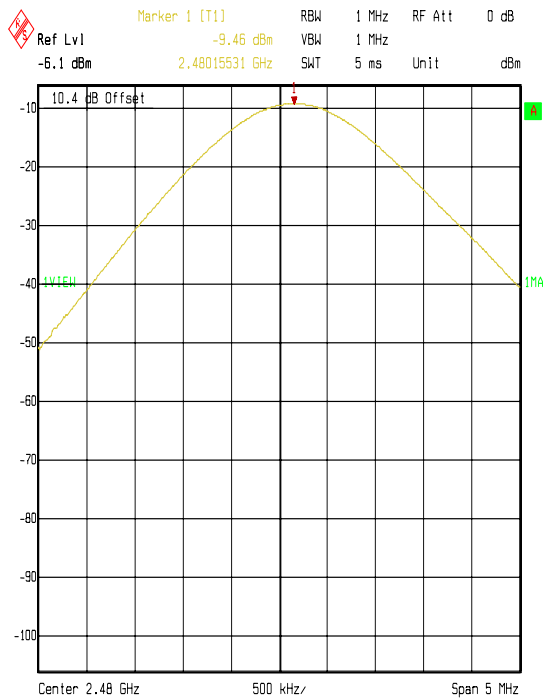
To: FCC Part 15.247

Transmitter Maximum Peak Output Power: Section 15.247(b)(1) (Continued)

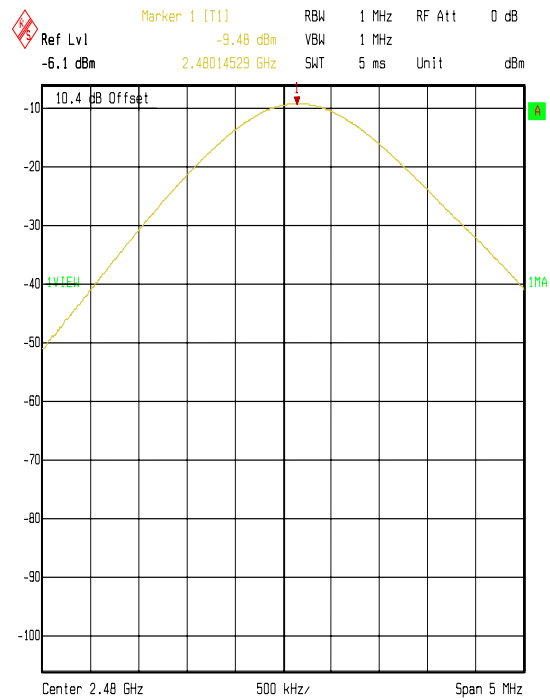
Comment A: PEAK OUTPUT POWER MIDDLE CHANNEL
INPUT VOLTAGE 93.5V ACB6PH/45076JD08/POP05
Date: 15.DEC.2003 10:45:58



Comment A: PEAK OUTPUT POWER MIDDLE CHANNEL
INPUT VOLTAGE 126.5V ACB6PH/45076JD08/POP06
Date: 15.DEC.2003 10:48:53



Comment A: PEAK OUTPUT POWER TOP CHANNEL
INPUT VOLTAGE 110V ACB6PH/45076JD08/POP07
Date: 15.DEC.2003 10:51:32

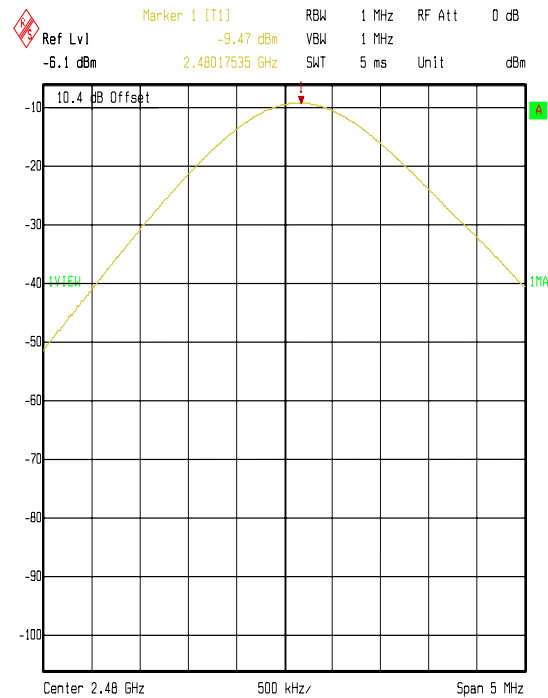


Comment A: PEAK OUTPUT POWER TOP CHANNEL
INPUT VOLTAGE 93.5V ACB6PH/45076JD08/POP08
Date: 15.DEC.2003 10:52:54

Test Of: Sendo Ltd.

Sendo X GSM Mobile Telephone Handset

To: FCC Part 15.247

Transmitter Maximum Peak Output Power: Section 15.247(b)(1) (Continued)

Comment A: PEAK OUTPUT POWER TOP CHANNEL
INPUT VOLTAGE 126.5V AC@GPH/45076JD08/POP09
Date: 15.DEC.2003 10:55:04

Test Of: Sendo Ltd.

Sendo X GSM Mobile Telephone Handset

To: FCC Part 15.247

8.8. Transmitter Radiated Emissions: Section 15.247(c) and 15.209(a)**8.8.1. Electric Field Strength Measurements: 30 to 1000 MHz.**

8.8.1.1. The EUT was configured as for radiated field strength measurements as described in Section 9 of this report.

8.8.1.2. Tests were performed to identify the maximum out of band transmitter radiated spurious emission level presents in the band 30 MHz to 10 x the highest fundamental frequency.

Top Channel

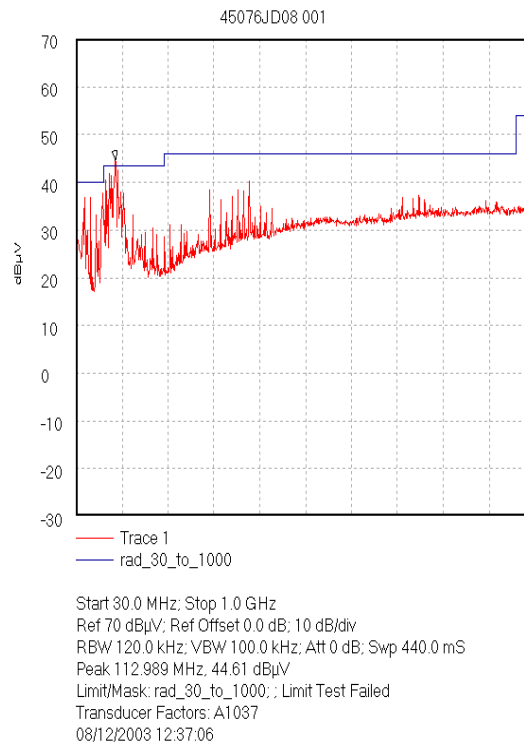
Frequency (MHz)	Antenna. Polarity	Q-P Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
48.000	Vert.	21.5	40.0	18.5	Complied
60.000	Vert.	20.5	40.0	13.5	Complied
86.373	Vert.	14.4	40.0	25.6	Complied
92.393	Vert.	22.4	43.5	21.1	Complied
100.431	Vert.	18.4	43.5	25.1	Complied
113.488	Vert.	30.7	43.5	12.8	Complied
312.000	Vert.	23.8	46.0	22.2	Complied
372.001	Vert.	29.6	46.0	16.4	Complied
396.000	Vert.	24.6	46.0	21.4	Complied

Note: The preliminary scans showed similar emission levels for each mode below 1 GHz, therefore final radiated emissions measurements were performed with the EUT set to the top channel only.

Test Of: Sendo Ltd.

Sendo X GSM Mobile Telephone Handset

To: FCC Part 15.247

Transmitter Radiated Emissions: Section 15.247(c) and 15.209(a) (continued)

Note: these plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Test Of: Sendo Ltd.

Sendo X GSM Mobile Telephone Handset

To: FCC Part 15.247

Transmitter Radiated Emissions: Section 15.247(c) and 15.209(a) (continued)**Electric Field Strength Measurements: 1.0 to 26.5 GHz****Highest Peak Level: Top Channel**

Frequency (GHz)	Antenna Polarity	Peak Detector level (dB μ V)	Antenna factor (dB)	Cable loss (dB)	Actual Peak Level (dB μ V/m)	**Average Limit (dB μ V/m)	Margin (dB)	Result
26.16*	Horiz.	3.4	37.1	3.5	44.3	54.0	9.7	Complied

**Note: No spurious emissions were detected above the noise floor of the measuring receiver; therefore, the highest peak noise floor reading of the measuring receiver was recorded as shown in the table above.*

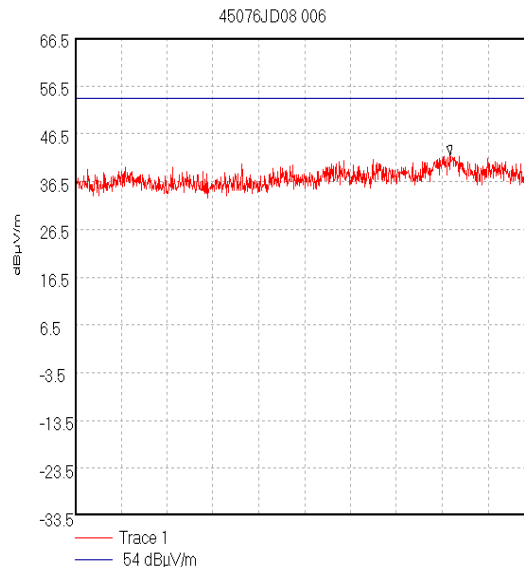
***Note: The peak level was compared to the average limit as opposed to being compared to the peak limit because this is the more onerous limit.*

Operations Department

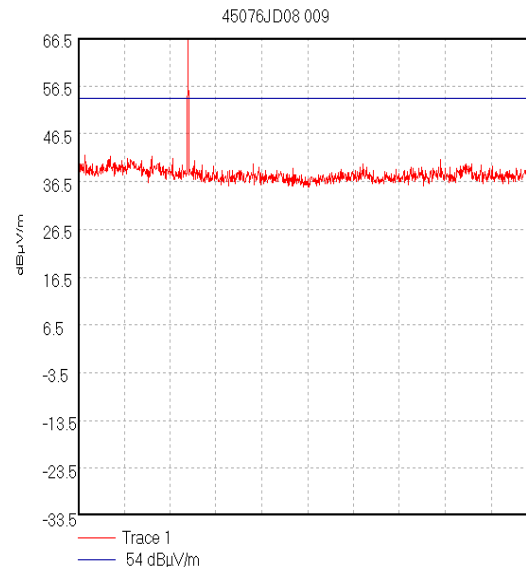
Test Of: Sendo Ltd.

Sendo X GSM Mobile Telephone Handset

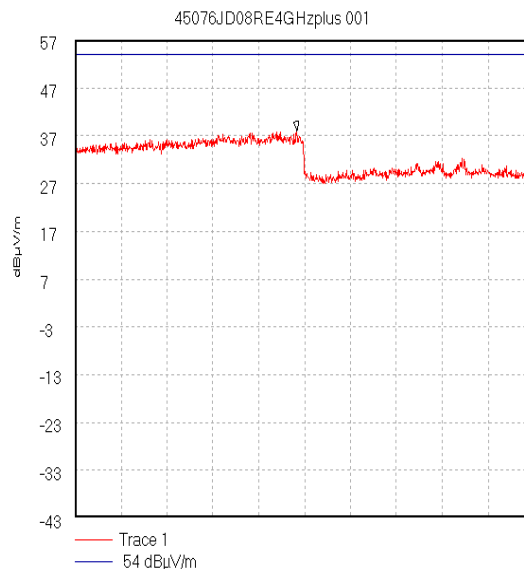
To: FCC Part 15.247

Transmitter Radiated Emissions: Section 15.247(c) and 15.209(a) (continued)

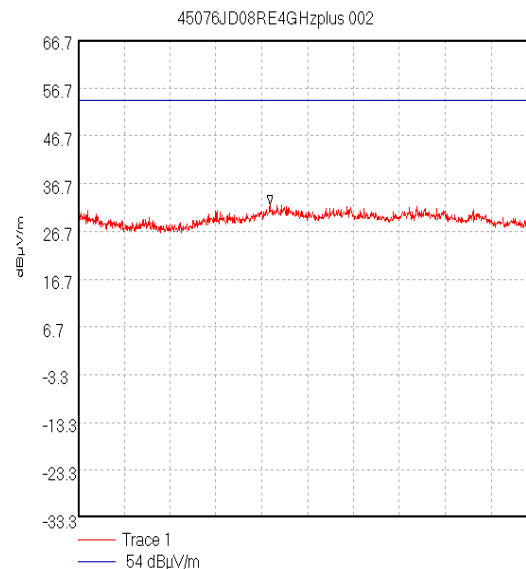
Start 1.0 GHz; Stop 2.0 GHz
Ref 66.5 dBμV/m; Ref Offset -9.5 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 1.818 GHz, 42.03 dBμV/m
Display Line: 54 dBμV/m; ; Limit Test Passed
Transducer Factors: 1 to 2
08/12/2003 14:45:33



Start 2.0 GHz; Stop 4.0 GHz
Ref 66.5 dBμV/m; Ref Offset -9.5 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 2.478 GHz, 70.48 dBμV/m
Display Line: 54 dBμV/m; ; Limit Test Failed
Transducer Factors: 2 to 4
08/12/2003 15:08:40



Start 4.0 GHz; Stop 6.0 GHz
Ref 57 dBμV/m; Ref Offset 0.0 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 4.967 GHz, 37.96 dBμV/m
Display Line: 54 dBμV/m; ; Limit Test Passed
Transducer Factors: A490
12/12/2003 14:38:06



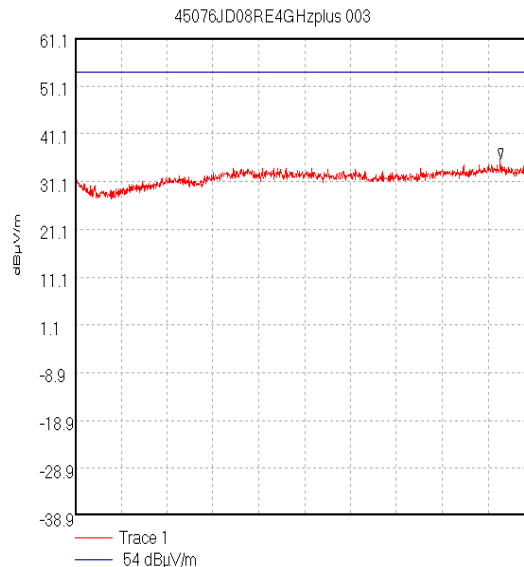
Start 6.0 GHz; Stop 8.0 GHz
Ref 66.7 dBμV/m; Ref Offset 19.7 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 6.838 GHz, 32.25 dBμV/m
Display Line: 54 dBμV/m; ; Limit Test Passed
Transducer Factors: A490
12/12/2003 14:44:02

Note: these plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

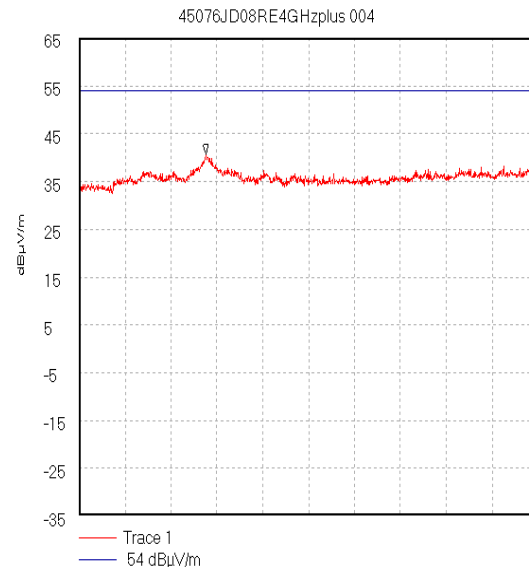
Test Of: Sendo Ltd.

Sendo X GSM Mobile Telephone Handset

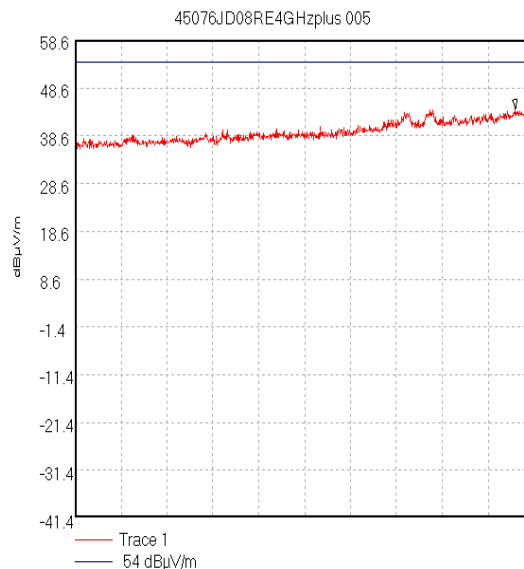
To: FCC Part 15.247

Transmitter Radiated Emissions: Section 15.247(c) and 15.209(a) (continued)

Start 8.0 GHz; Stop 12.5 GHz
 Ref 61.1 dBμV/m; Ref Offset 24.1 dB; 10 dB/div
 RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 40.0 mS
 Peak 12.175 GHz, 35.94 dBμV/m
 Display Line: 54 dBμV/m; ; Limit Test Passed
 Transducer Factors: A490
 12/12/2003 14:48:41



Start 12.5 GHz; Stop 18.0 GHz
 Ref 65 dBμV/m; Ref Offset 28.0 dB; 10 dB/div
 RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 40.0 mS
 Peak 14.022 GHz, 40.73 dBμV/m
 Display Line: 54 dBμV/m; ; Limit Test Passed
 Transducer Factors: A490
 12/12/2003 14:52:43



Start 18.0 GHz; Stop 26.5 GHz
 Ref 58.6 dBμV/m; Ref Offset 31.6 dB; 10 dB/div
 RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 60.0 mS
 Peak 26.16 GHz, 44.31 dBμV/m
 Display Line: 54 dBμV/m; ; Limit Test Passed
 Transducer Factors: A490
 12/12/2003 15:01:13

Note: these plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Test Of: Sendo Ltd.

Sendo X GSM Mobile Telephone Handset

To: FCC Part 15.247

8.9. Transmitter Band Edge Radiated Emissions: Section 15.247(c) & 15.209(a)**8.9.1. Electric Field Strength Measurements**

8.9.1.1. The EUT was configured as for band edge compliance of radiated emissions measurements as described in Section 9 of this report.

8.9.1.2. Tests were performed to identify the maximum radiated band edge emissions.

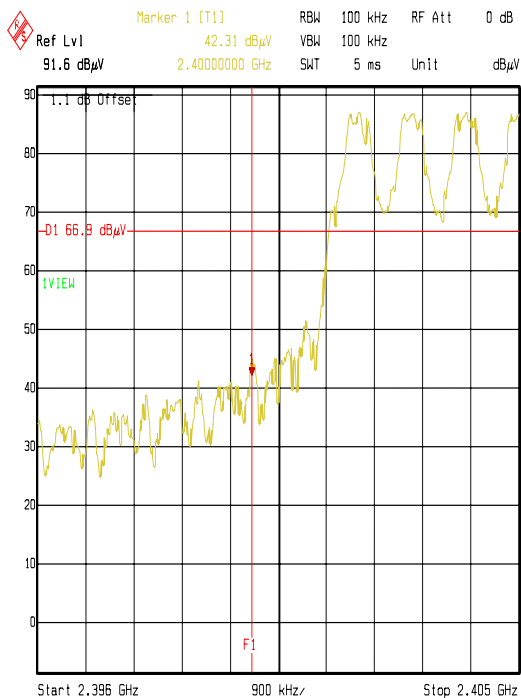
Peak Power Level Hopping Mode:

Frequency (GHz)	Antenna Polarity	Peak Detector level (dBμV)	Antenna factor (dB)	Cable loss (dB)	Actual Peak Level (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Result
2.4000	Horiz	19.8	21.2	1.3	42.3	66.9*	24.6	Complied
2.4835	Horiz	27.4	21.4	1.3	50.0	74.0	24.0	Complied

*Note: -20 dBc limit

Average Power Level Hopping Mode:

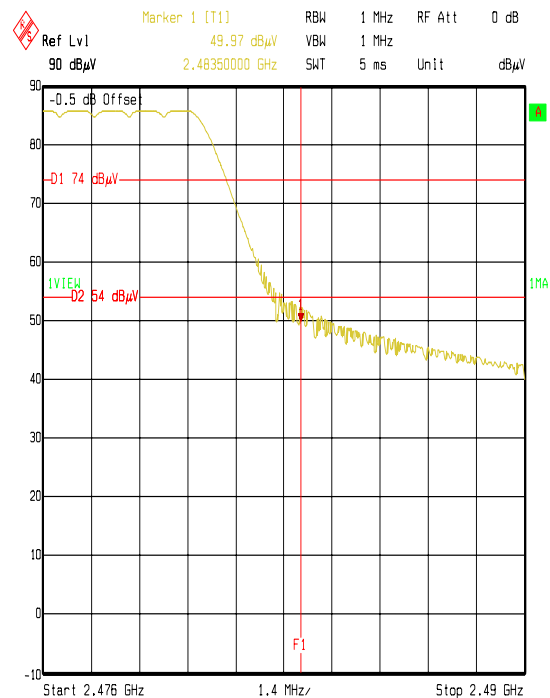
Frequency (GHz)	Antenna Polarity	Average Detector level (dBμV)	Antenna factor (dB)	Cable loss (dB)	Actual Average Level (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Result
2.4835	Horiz	1.3	21.4	1.3	23.9	54.0	30.1	Complied



Comment A: RADIATED LOWER BAND EDGE HOPPING MODE

GPH/45076JD08/RBE02

Date: 15.DEC.2003 10:01:32



Comment A: RADIATED UPPER BAND EDGE HOPPING MODE

GPH/45076JD08/RBE01

Date: 15.DEC.2003 9:49:59

Test Of: Sendo Ltd.

Sendo X GSM Mobile Telephone Handset

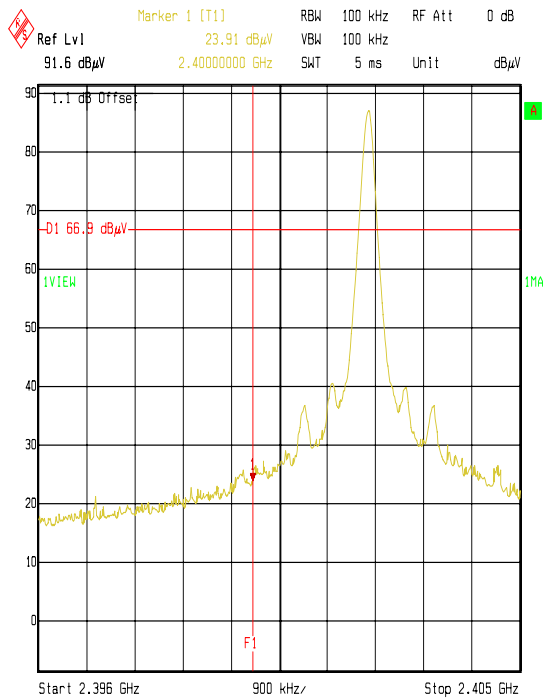
To: FCC Part 15.247

Transmitter Band Edge Radiated Emissions: Section 15.247(c) & 15.209(a) (Continued)**Peak Power Level Static Mode:**

Frequency (GHz)	Antenna Polarity	Peak Detector level (dBμV)	Antenna factor (dB)	Cable loss (dB)	Actual Peak Level (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Result
2.4000	Horiz.	1.4	21.2	1.3	23.9	66.9*	43.0	Complied
2.4835	Horiz.	16.9	21.4	1.3	39.5	74.0	34.5	Complied

***Note:** -20 dBc limit**Average Power Level Static Mode:**

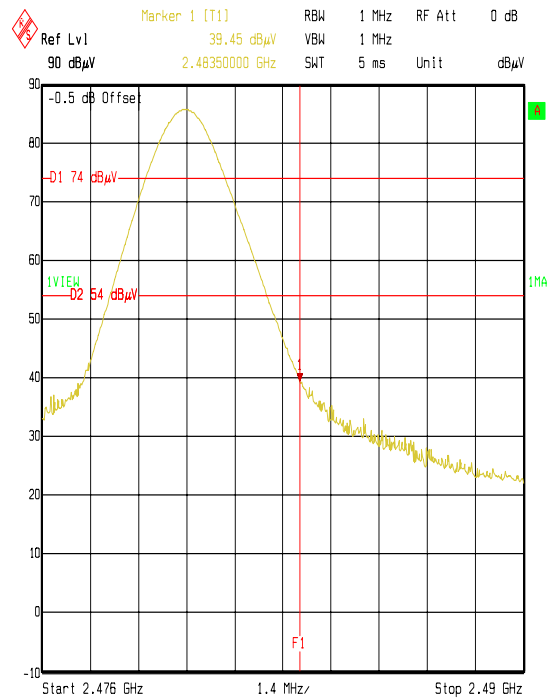
Frequency (GHz)	Antenna Polarity	Average Detector level (dBμV)	Antenna factor (dB)	Cable loss (dB)	Actual Average Level (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Result
2.4835	Horiz.	15.7	21.4	1.3	38.3	54.0	15.7	Complied



Comment A: RADIATED LOWER BAND EDGE STATIC MODE

GPH/45076JD08/RBE03

Date: 15.DEC.2003 10:07:55



Comment A: RADIATED UPPER BAND EDGE STATIC MODE

GPH/45076JD08/RBE04

Date: 15.DEC.2003 10:16:42

Test Of: Sendo Ltd.

Sendo X GSM Mobile Telephone Handset

To: FCC Part 15.247

9. Measurement Methods

9.1. AC Mains Conducted Emissions

AC mains conducted emissions measurements were performed in accordance with the standard, against appropriate limits for each detector function.

The test was performed in a shielded enclosure with the equipment arranged as detailed in the standard on a wooden bench using the floor of the screened enclosure as the ground reference plane. The EUT was powered with 115V 60 Hz AC mains supplied via a Line Impedance Stabilisation Network (LISN).

Initial measurements in the form of swept scans covering the entire measurement band were performed in order to identify frequencies on which the EUT was generating interference. In order to minimise the time taken for these swept measurements, a Peak detector was used in conjunction with the appropriate detector IF measuring bandwidths (see table below). Repetitive scans were performed to allow for emissions with low repetition rates, and the duty cycle of the EUT. The test configuration was the same for the initial scans as for the final measurements.

Following the initial scans, a graph was produced giving an overview of the emissions from the EUT plotted against the appropriate specification limit. A tolerance line was set 6 dB below the specification limit and levels above the tolerance line were re-tested (at individual frequencies) using the appropriate detector function.

The test equipment settings for conducted emissions measurements were as follows:

Receiver Function	Initial Scan	Final Measurements
Detector Type:	Peak	Quasi-Peak (CISPR)/Average
Mode:	Max Hold	Not applicable
Bandwidth:	10 kHz*	9 kHz*
Amplitude Range:	60 dB	20 dB
Measurement Time:	Not applicable	> 1 s
Observation Time:	Not applicable	> 15 s
Step Size:	Continuous sweep	Not applicable
Sweep Time:	Coupled	Not applicable

Test Of: Sendo Ltd.**Sendo X GSM Mobile Telephone Handset****To: FCC Part 15.247**

9.2. Radiated Emissions

Radiated emissions measurements were performed in accordance with the standard, against appropriate limits for each detector function.

Initial measurements covering the entire measurement band in the form of swept scans in a shielded enclosure were performed in order to identify frequencies on which the EUT was generating interference. This determined the frequencies on which the EUT should be re-measured in full on the open area test site. In order to minimise the time taken for the swept measurements, a Peak detector was used in conjunction with the appropriate detector IF measuring bandwidth (see table below). Repetitive scans were performed to allow for emissions with low repetition rates.

The initial scans were performed using an antenna height of 1.5 m and a measurement distance of 3 m. Following the initial scans, graphs were produced giving an overview of the emissions from the EUT plotted against the appropriate specification limit. Any emission within 20 dB of the limit were then measured on the open area test site, except in cases where the noise floor was within 20 dB of the limit, in these cases the highest point of the noise floor was measured.

Where an emission fell inside a restricted band, measurements were made at the appropriate test distance using a measuring receiver with a Quasi-Peak detector for measurements below 1000 MHz and an Average and Peak detector for measurements above 1000 MHz. A peak detector was used for all other measurements.

For the final measurements the EUT was arranged on a non-conducting turn table on a standard test site compliant with ANSI C63.4 – 2001 Clause 5.4.

All measurements on the open area test site were performed using broadband antennas in both vertical and horizontal polarisations.

On the open area test site, at each frequency where a signal was to be measured, the trace was maximised by rotating a turntable through 360°. The angle at which the maximum signal was observed was locked out. For frequencies below 1000 MHz the test antenna was varied in height between 1 m and 4 m in order to further maximise the target emission.

For frequencies above 1000 MHz where a horn antenna was used, height searching was performed to locate the optimal height of the horn with respect to the EUT. At this point the horn was locked off and the turntable was again rotated through 360° to maximise the target signal. It should be noted that the received signal from the EUT would diminish very quickly after it exits the beam width of the horn antenna, for this reason it may not be necessary to fully height search with the horns.

At this point, any signals found to be between the limit and a level 6 dB below it were further maximised by changing the configuration of the EUT, e.g. re-routing cables to peripherals and moving peripherals with respect to the EUT.

Scans were performed to the upper frequency limits as stated in Section 15.33

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Sendo X GSM Mobile Telephone Handset

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Radiated Emissions (Continued)

The final field strength was determined as the indicated level in dB μ V plus cable loss and antenna factor.

The test equipment settings for radiated emissions measurements were as follows:

Receiver Function	Initial Scan	Final Measurements Below 1 GHz	Final Measurements Above 1 GHz
Detector Type:	Peak	Quasi-Peak (CISPR)	Peak / Average
Mode:	Max Hold	Not applicable	Max Hold
Bandwidth:	(120 kHz < 1 GHz) (1 MHz > 1 GHz)	120 kHz	1 MHz
Amplitude Range:	100 dB	100 dB	100 dB
Step Size:	Continuous sweep	Not applicable	Not applicable
Sweep Time:	Coupled	Not applicable	Not applicable

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To: FCC Part 15.247

9.3. Carrier Frequency Separation / 20 dB Bandwidth

The EUT and spectrum analyser was configured as for radiated measurements, and as per FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

To determine the bandwidth and separation of each transmission channel the measurement analyser was configured to measure two adjacent channels whilst the EUT was in hopping mode.

To determine the occupied bandwidth, a resolution bandwidth of 10 kHz was used, which is greater than 1% of the 20 dB bandwidth. A video bandwidth of, at least, the same value was used.

The analyser was set for a maximum hold scan to capture the profile of the signal. The peak level was then determined, and a reference line was drawn 20 dB below the peak level.

The bandwidth was determined at the points where the 20 dB reference line intercepted the power envelope of the emission.

Test Of: Sendo Ltd.

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9.4. Average Time of Occupancy

The EUT and spectrum analyser was configured as for radiated measurements, and as per FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

First the maximum packet length was determined on the centre channel.

The measurement analyser was configured to the time domain mode by setting the span to zero with a sweep time sufficiently wide enough to measure one pulse.

The EUT was configured to operate in normal mode of operation. The pulse width of one transmission was then recorded. The measurement analyser was then configured in zero span i.e. in the time domain and the sweep time was set to 32 seconds (the closest allowable setting to 31.6 seconds). This 31.6 second period was determined by multiplying the number of channels the device operates over (79) by 0.4 seconds.

The number of transmissions within this period was noted and multiplied by the pulse width recorded earlier. This gives the maximum occupancy over 31.6 seconds.

Test Of: Sendo Ltd.**Sendo X GSM Mobile Telephone Handset****To: FCC Part 15.247**

9.5. Effective Isotropic Radiated Power (EIRP)

EIRP measurements were performed in accordance with the standard, against appropriate limits.

The EIRP was measured with the EUT arranged on a non-conducting turn table on a standard test site compliant with ANSI C63.4 – 2001 Clause 5.4. The transmitter was fitted with an integral antenna; therefore all radiated tests were performed with the unit operating into the integral antenna.

The level of the EIRP was measured using a spectrum analyser.

The test antenna was positioned in the horizontal plane. The EUT was oriented in the X plane. The test antenna was then raised and lowered until a maximum peak was observed. The turntable was then rotated through 360 degrees and the maximum peak reading obtained. The height search was then repeated to take into consideration the new angular position of the turntable. The maximum reading observed was then recorded. This procedure was then repeated with the EUT oriented in the Y and Z planes. The highest reading taken in all 3 planes was recorded. The entire procedure was then repeated with the test antenna set in the Vertical polarity.

Once the final amplitude (maximised) had been obtained, the EUT was substituted with a horn antenna. The centre of the substitution antenna was set to approximately the same centre location as the EUT. The substitution antenna was set to the horizontal polarity. The substitution antenna was matched into a signal generator using a 6 dB or greater attenuator. The signal generator was tuned to the EUT's frequency under test.

The test antenna was then raised and lowered to obtain a maximum reading on the spectrum analyser. The level of the signal generator output was then adjusted until the maximum recorded EUT level was observed. The signal generator level was noted. This procedure was repeated with both test antenna and substitution antenna vertically polarised. The EIRP was calculated as:-

$$\text{EIRP} = \text{Signal Generator Level} - \text{Cable Loss} + \text{Antenna Gain}$$

Test Of: Sendo Ltd.

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Effective Isotropic Radiated Power (EIRP) (Continued)

Circumstances where the signal generator could not produce the desired power substitution was performed with the signal generator set to 0 dBm. The radiated signal was maximised as previously described. The level indicated on the measuring receiver was noted. The delta between this level and the maximum level for the EUT was calculated and also noted. The EIRP of the signal generator was calculated using the above formulae. The recorded delta was added to the calculated EIRP to obtain the substituted EUT EIRP.

$$\text{Delta (dB)} = \text{EUT} - \text{SG}$$

where :

EUT = spectrum analyser indicated EUT raw level

SG = spectrum analyser indicated signal generator raw level

The signal generator actual EIRP is calculated as:

$$\text{EIRP SG} = \text{Signal Generator Level} - \text{Cable Loss} + \text{Antenna Gain}$$

The EUT EIRP is calculated as:

$$\text{EIRP EUT} = \text{EIRP SG} + \text{Delta.}$$

The test equipment settings for EIRP measurements were as follows:

Receiver Function	Setting
Detector Type:	Peak
Mode:	Not applicable
Bandwidth:	1 MHz
Amplitude Range:	100 dB
Sweep Time:	Coupled

Test Of: Sendo Ltd.**Sendo X GSM Mobile Telephone Handset****To: FCC Part 15.247**

9.6. Band Edge Compliance of RF Radiated Emissions

The EUT and spectrum analyser were configured as for Radiated measurements and as per FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

To determine band edge compliance, the analyser resolution bandwidth was set to $\geq 1\%$ of the analyser span. The video bandwidth was set to be $\geq$ to the resolution bandwidth. The sweep was set to auto and the detector to peak. The trace was set to max hold and a trace was produced.

A plot of the lower band edge of the allocated frequency band was produced. A marker was set to the level of the highest in band emission with a limit line set to 20 dB below this. The marker was then placed on the highest out of band emission (the specification states that either the band edge level must be measured or the highest out of band emission, whichever is the greater). The plots show that the highest out of band emission complies with the -20 dBc Limit.

The above procedure was then repeated for the upper band edge except that, as the upper band edge fell on a restricted band edge (as defined in Section 15.205(a)), the limit for the restricted band was applied instead of the -20 dBc limit i.e. the general limits defined in Section 15.209(a).

Final measurements were performed on the worst-case configuration as described in Part 15.31(i).

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10. Measurement Uncertainty

10.1. No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently, the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

10.2. The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

10.3. The uncertainty of the result may need to be taken into account when interpreting the measurement results.

10.4. The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor, such that a confidence level of approximately 95% is maintained. For the purposes of this document "approximately" is interpreted as meaning "effectively" or "for most practical purposes".

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	+/- 3.25 dB
Transmitter Maximum Peak Output Power	Not applicable	95%	+/- 1.78 dB
Transmitter Carrier Frequency Separation	Not applicable	95%	+/- 0.01 ppm
20 dB Bandwidth	Not applicable	95%	+/- 0.12 %
Transmitter Average Time of Occupancy	Not applicable	95%	+/- 10 %
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	+/- 5.26 dB
Radiated Spurious Emissions	1 GHz to 40 GHz	95%	+/- 1.78 dB

10.5. The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty, the published guidance of the appropriate accreditation body is followed.

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Appendix 1. Test Equipment Used

RFI No.	Instrument	Manufacturer	Type No.	Serial No.
A027	Horn Antenna	Eaton	9188-2	301
A031	2 to 4 GHz Eaton Horn Antenna	Eaton	91889-2	557
A1037	Chase Bilog Antenna	Chase EMC Ltd	CBL6112B	2413
A1069	LISN	Rohde & Schwarz	ESH3-Z5	837469/012
A1361	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	20112003
A254	WG 14 Microwave Horn	Flann Microwave	14240-20	139
A258	Zenith Variable Power Supply	Zenith Electric	SVA 10	None
A259	Bilog Antenna	Chase	CBL6111	1513
A428	WG 12 horn	Flann	12240-20	134
A429	WG 16 horn	Flann	16240-20	561
A430	WG 18 horn	Flann	18240-20	425
A436	WG 20 horn	Flann	20240-20	330
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008
M003	Spectrum Monitor	Rohde & Schwarz	EZM	883 580/008
M023	ESVP Receiver	Rohde & Schwarz	ESVP	872 991/027
M028	FSB Spectrum Analyser	Rohde & Schwarz	FSB	860 001/009 (RF), 860 161/007 (Display)
M069	ESMI Spectrum Analyser / Receiver	Rohde & Schwarz	ESMI	829 808/007 (DU) / 827 063/008 (RU)
M093	Oscilloscope	Hewlett Packard	54520A	US34360744
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016
M505	Analyser Display Unit	Rohde & Schwarz	ESAI-D	825316/010
M506	RF unit	Rohde & Schwarz	ESBI-RF	827060/004
M517	Fluke 77 DMM	Fluke	JF77 Series	63150434R
S201	Site 1	RFI	1	
S202	Site 2	RFI	2	S202-15011990

NB In accordance with UKAS requirements, all the measurement equipment is on a calibration schedule.

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Appendix 2. Test Configuration Drawings

This appendix contains the following drawings:

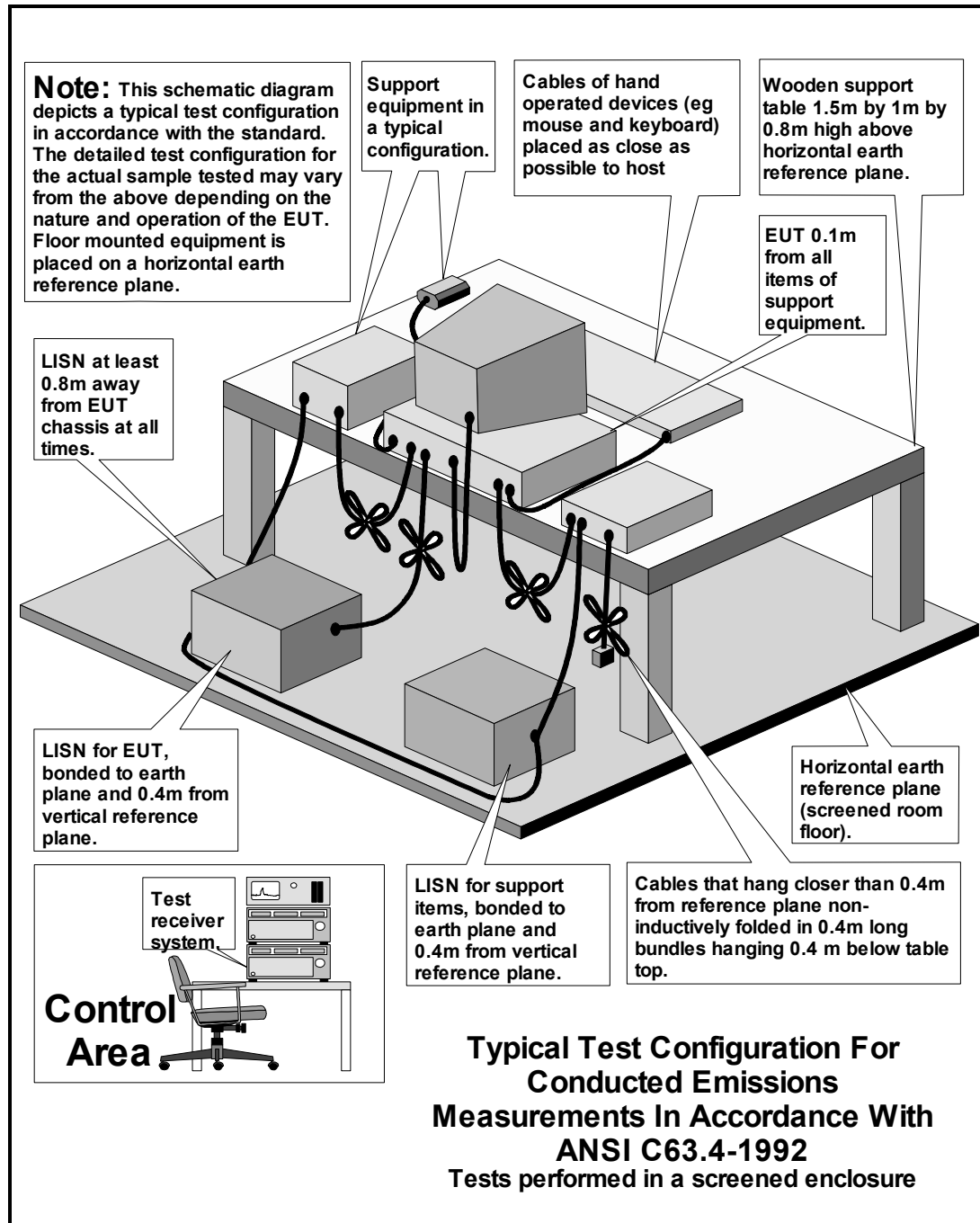
Drawing Reference Number	Title
DRG\45076JD08\EMICON	Test configuration for measurement of conducted emissions
DRG\45076JD08\EMIRAD	Test configuration for measurement of radiated emissions

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DRG\45076JD08\EMICON



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DRG\45076JD08\EMIRAD

