



TEST REPORT FROM RADIO FREQUENCY INVESTIGATION LTD.

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

To: FCC Part 24

Test Report Serial No:
RFI/MPTB1/RP45077JD19A

This Test Report Is Issued Under The Authority Of Richard Jacklin, Operations Director: 	Checked By: Tony Henriques 
Tested By: Steven Wong 	Release Version No: PDF01
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1. Client Information

Company Name:	Sendo Ltd.
Address:	Sendo Ltd. Hatchford Brook Hatchford Way Sheldon Birmingham B26 3QA
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
Country of Manufacture:	China
FCC ID:	P6PSNDX00
Date of Receipt:	19 January 2004

2.2. Description Of EUT

The equipment under test is a tri-band (GSM900*, GSM1800* and GSM1900) mobile phone, which supports IR and Bluetooth.

**Not for use in the United States*

2.3. Modifications Incorporated In EUT

During the course of testing the EUT was not modified.

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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	1850 MHz to 1910 MHz		
Transmit Channels Tested	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	512	1850.2
	Middle	660	1879.8
	Top	810	1909.8
Receive Frequency Range	1930 MHz to 1990 MHz		
Receive Channels Tested	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	512	1930.2
	Middle	660	1960.0
	Top	810	1989.8
Highest Fundamental Frequency	1909.8 MHz		
Maximum Power Output (EIRP)	31.0 dBm		

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2.5. Accessories

The following accessories were supplied with the EUT:

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

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:	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

Description:	GSM Test Set
Brand Name:	WillTek
Model Name or Number:	42025
Serial Number:	0513018
Connected to Port:	RF Link

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3. Test Specification, Methods And Procedures

3.1. Test Specifications

Reference:	FCC Part 24 Subpart E: 2002 (Broadband PCS)
Title:	Code of Federal Regulations, Part 24 (47CFR24) Personal Communication Services.
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.

Reference:	FCC Part 15 Subpart B: 2001 (Section 15.107 and 15.109)
Title:	Code of Federal Regulations, Part 15 (47CFR15) Radio Frequency Devices: 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.

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3.2. Methods And Procedures

The methods and procedures used were as detailed in:

ANSI/TIA-603-B-2002

Land Mobile Communications Equipment, Measurements and performance Standards

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.

3.3. 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 scans were performed on the EUT with the accessories stated in section 2.5 of this report connected and then disconnected. The combination that exhibited the worse case mode of operation was then used to perform final measurements. This was found to be with the EUT sitting in the desktop sync cradle in the configuration detailed below.

Transmitter Modes:

For carrier output power, occupied bandwidth and final transmitter radiated measurements, testing was performed at full power on top, middle and bottom channels of the assigned frequency block.

For frequency stability testing, measurements were performed at full power on the top and bottom channels of the assigned frequency block at -30 °C through to +50 °C in 10° increments.

All transmitter radiated spurious pre-scan tests were performed at full power on the top channel of the assigned frequency block. Final measurements were then performed on the top, middle and bottom channels if an emission was identified.

Receiver/Idle Modes:

Testing was performed with the call terminated from the GSM Test Simulator and the phone left in its Idle mode.

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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

All tests were performed with the EUT connected via an air link or directly to a GSM test set via an access point.

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6. Summary Of Test Results

Range Of Measurements	Specification Reference	Port Type	Compliance Status
Idle Mode AC Conducted Spurious Emissions (150 kHz to 30 MHz)	C.F.R. 47 FCC Part 15: 2002 Section 15.107	AC Mains Input	Complied
Idle Mode Radiated Spurious Emissions	C.F.R. 47 FCC Part 15: 2002 Section 15.109	Antenna	Complied
Transmitter Effective Isotropic Radiated Power (EIRP)	C.F.R. 47 FCC Part 24: 2002 Section 24.232	Antenna	Complied
Transmitter Frequency Stability (Temperature Variation)	C.F.R. 47 FCC Part 24: 2002 Section 24.235	Antenna	Complied
Transmitter Frequency Stability (Voltage Variation)	C.F.R. 47 FCC Part 24: 2002 Section 24.235	Antenna	Complied
Transmitter Occupied Bandwidth	C.F.R. 47 FCC Part 24: 2002 Section 24.238	Antenna	Complied
Transmitter Out of Band Radiated Emissions	C.F.R. 47 FCC Part 24: 2002 Section 2.1053/24.238	Antenna	Complied
Transmitter Band Edge Radiated Emissions	C.F.R. 47 FCC Part 2: 2002 Section 2.1053/24.238	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.

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 8 for details of measurement uncertainties.

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8. Test Results

8.1. Idle Mode AC Conducted Spurious Emissions: 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 emission levels on the AC mains line of the AC Charger whilst connected to the EUT.

Results: 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
0.15000	Live	49.84	66.00	16.16	Complied
0.18611	Live	51.07	64.21	13.14	Complied
0.24893	Neutral	46.82	61.79	14.97	Complied
0.34794	Live	40.91	59.01	18.10	Complied
0.48251	Live	50.80	56.30	5.50	Complied
0.61300	Neutral	38.45	56.00	17.55	Complied
0.67377	Live	50.38	56.00	5.62	Complied
0.87985	Neutral	42.28	56.00	13.72	Complied
0.93800	Live	36.87	56.00	19.13	Complied
1.04267	Neutral	42.89	56.00	13.11	Complied
1.19308	Live	46.01	56.00	9.99	Complied
1.40219	Live	44.82	56.00	11.18	Complied
2.14978	Live	39.54	56.00	16.46	Complied
3.36395	Live	37.36	56.00	18.64	Complied
7.76168	Live	29.00	60.00	31.00	Complied
11.94742	Live	28.62	60.00	31.38	Complied

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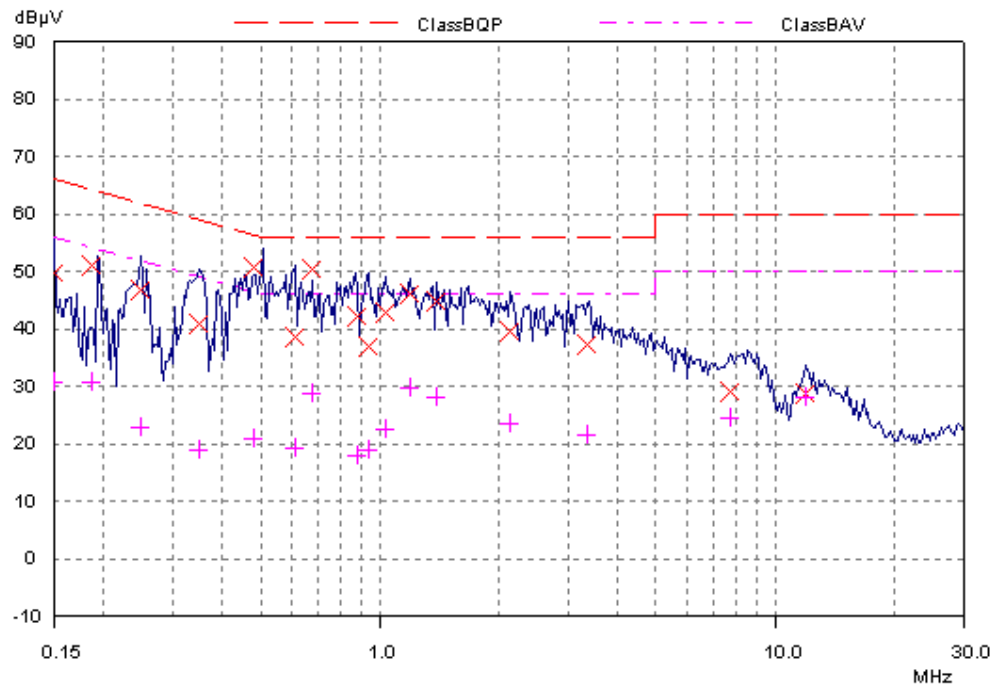
Results: Average Detector Measurements On Live And Neutral Lines

Frequency (MHz)	Line	Av. Level (dB μ V)	Av. Limit (dB μ V)	Margin (dB)	Result
0.15000	Live	30.53	56.00	25.47	Complied
0.18611	Neutral	30.73	54.21	23.48	Complied
0.24893	Neutral	22.66	51.79	29.13	Complied
0.34794	Live	18.89	49.01	30.12	Complied
0.48251	Neutral	20.99	46.30	25.31	Complied
0.61300	Live	19.04	46.00	26.96	Complied
0.67377	Neutral	28.79	46.00	17.21	Complied
0.87985	Live	17.90	46.00	28.10	Complied
0.93800	Neutral	18.87	46.00	27.13	Complied
1.04267	Live	22.40	46.00	23.60	Complied
1.19308	Live	29.56	46.00	16.44	Complied
1.40219	Neutral	28.01	46.00	17.99	Complied
2.14978	Neutral	23.31	46.00	22.69	Complied
3.36395	Neutral	21.51	46.00	24.49	Complied
7.76168	Neutral	24.48	50.00	25.52	Complied
11.94742	Neutral	28.01	50.00	21.99	Complied

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Idle Mode AC Conducted Spurious Emissions: 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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8.2. Idle Mode Radiated Spurious 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 emissions testing as described in Section 9 of this report.

8.2.1.2. Tests were performed to identify the maximum radiated emissions levels while in idle mode.

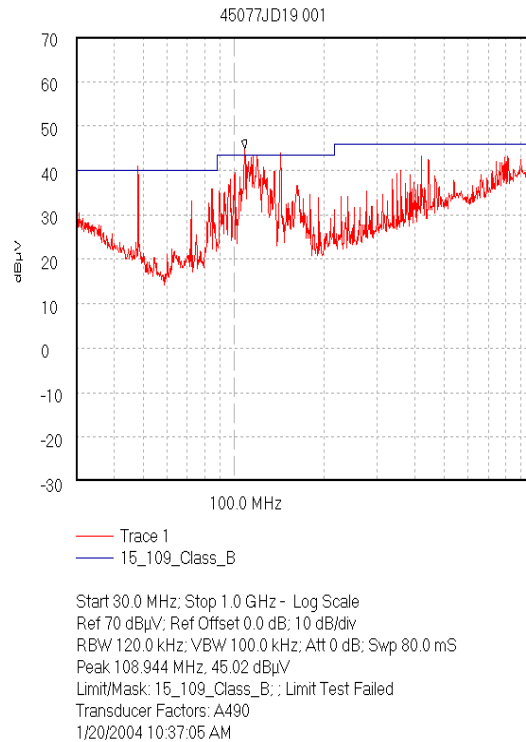
Result:

Frequency (MHz)	Antenna Polarity	Q-P Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
48.203	Vert.	24.1	40.0	15.9	Complied
62.213	Vert.	18.1	40.0	21.9	Complied
82.304	Vert.	21.2	40.0	18.8	Complied
107.988	Vert.	39.4	43.5	4.1	Complied
121.787	Vert.	24.6	43.5	18.9	Complied
136.357	Vert.	24.9	43.5	18.6	Complied
144.801	Vert.	23.5	43.5	20.0	Complied
163.911	Vert.	27.3	43.5	16.2	Complied
181.910	Vert.	20.2	43.5	23.3	Complied
236.542	Vert.	21.0	46.0	25.0	Complied
285.935	Vert.	24.0	46.0	22.0	Complied
337.986	Vert.	26.9	46.0	19.1	Complied
360.002	Vert.	28.0	46.0	18.0	Complied
433.001	Vert.	29.0	46.0	17.0	Complied
818.600	Vert.	32.1	46.0	13.9	Complied

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Idle Mode Radiated Spurious Emission: Section 15.109 (Continued)

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

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Idle Mode Radiated Spurious Emission: Section 15.109 (Continued)**8.2.2. Electric Field Strength Measurements (Frequency Range 1.0 to 12.5 GHz)**

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

8.2.2.2. Tests were performed to identify the maximum idle mode radiated emissions levels.

Result:**Highest Peak Level**

Frequency (GHz)	Antenna. Polarity	Peak Detector Level (dBµV)	Antenna Factor	Cable Loss	Actual Peak Level (dBµV/m)	**Average Limit (dBµV/m)	Margin (dB)	Result
*9.700	Vert.	5.2	30.5	2.5	38.2	54.0	15.8	Complied

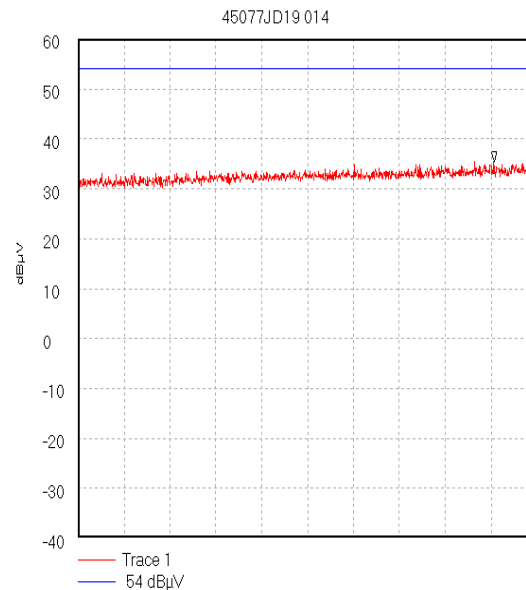
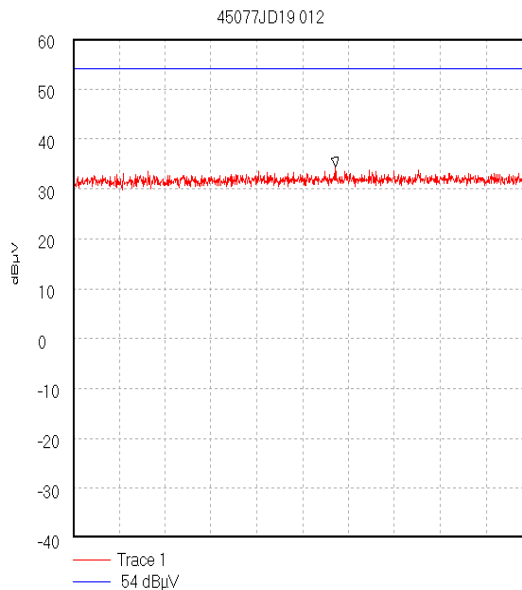
**Note: No spurious emissions were detected above the noise floor of the measuring receiver; therefore, the highest peak noise floor reading of the measuring receiver was recorded as shown in the table above.*

***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.*

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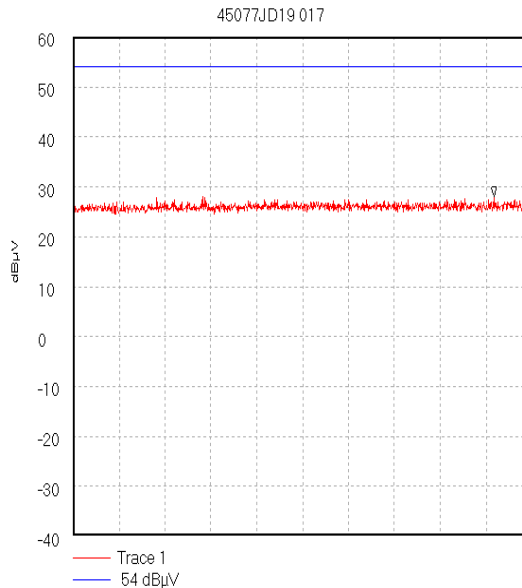
Idle Mode Radiated Spurious Emission: Section 15.109 (Continued)

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

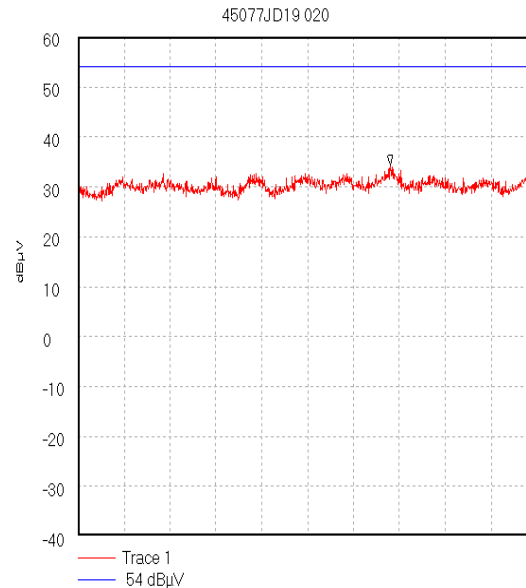
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Idle Mode Radiated Spurious Emission: Section 15.109 (Continued)

Start 4.0 GHz; Stop 5.0 GHz
Ref 60 dBμV; Ref Offset 2.0 dB; 10 dB/div
RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 40.0 mS
Peak 4.918 GHz, 28.11 dBμV
Display Line: 54 dBμV;
23/01/2004 15:04:32



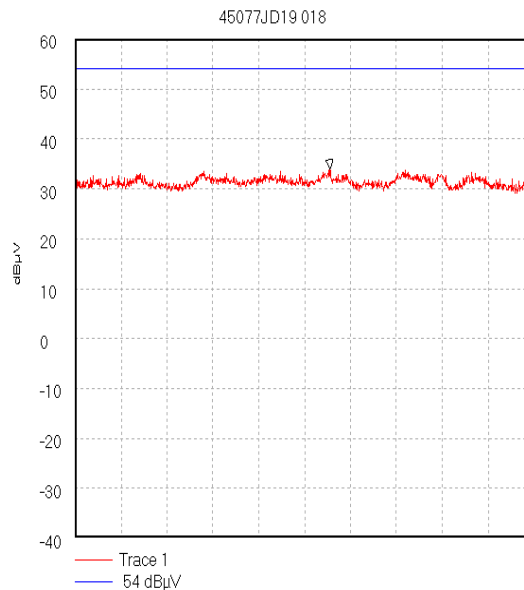
Start 5.0 GHz; Stop 6.0 GHz
Ref 60 dBμV; Ref Offset 2.0 dB; 10 dB/div
RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 5.681 GHz, 34.33 dBμV
Display Line: 54 dBμV;
23/01/2004 16:47:22

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

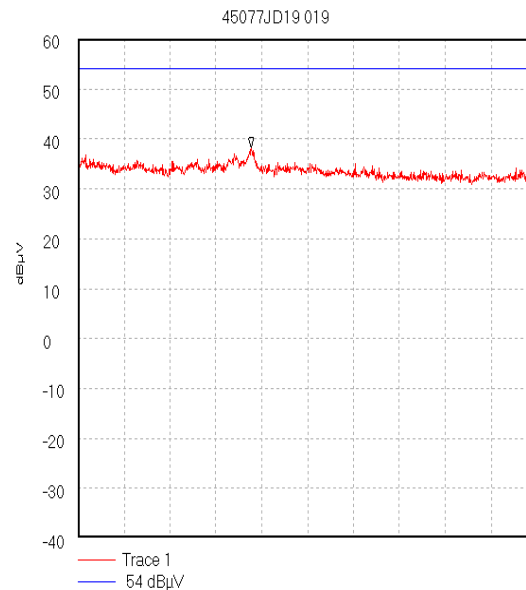
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Idle Mode Radiated Spurious Emission: Section 15.109 (Continued)

Start 6.0 GHz; Stop 8.0 GHz
Ref 60 dBμV; Ref Offset 2.3 dB; 10 dB/div
RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 40.0 mS
Peak 7.111 GHz; 34.0 dBμV
Display Line: 54 dBμV;
23/01/2004 15:13:45



Start 8.0 GHz; Stop 12.5 GHz
Ref 60 dBμV; Ref Offset 2.3 dB; 10 dB/div
RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 40.0 mS
Peak 9.7 GHz; 38.22 dBμV
Display Line: 54 dBμV;
23/01/2004 15:19:46

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

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8.3. Transmitter Effective Isotropic Radiated Power (EIRP): Section 24.232

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

8.3.2. Tests were performed to identify the maximum Effective Isotropic Radiated Power (EIRP).

Results:

Channel	Measured Frequency (MHz)	Antenna Polarity	Maximum Transmitter EIRP (dBm)	Limit EIRP (dBm)	Margin (dB)	Result
Bottom	1850.2	Vert.	29.7	33.0	3.3	Complied
Middle	1879.8	Vert.	30.8	33.0	2.2	Complied
Top	1909.8	Vert.	31.0	33.0	2.0	Complied

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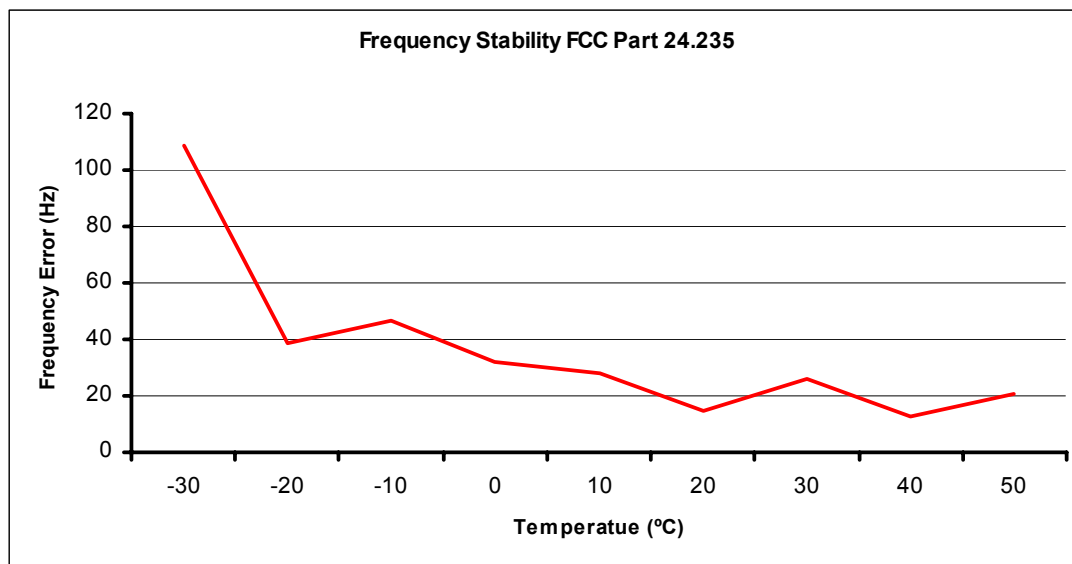
8.4. Transmitter Frequency Stability (Temperature Variation): Section 24.235

8.4.1. The EUT was configured as for frequency stability measurements as described in Section 9 of this report.

8.4.2. Tests were performed to identify the maximum frequency error of the EUT with variations in ambient temperature.

Results Bottom Channel (1850.2 MHz)

Temp (°C)	Frequency Error (Hz)	Measured Frequency (MHz)	Lower Band Edge Limit (MHz)	Margin (MHz)	Result
-30	109	1850.200109	1850.0	0.200109	Complied
-20	39	1850.200039	1850.0	0.200039	Complied
-10	47	1850.200047	1850.0	0.200047	Complied
0	32	1850.200032	1850.0	0.200032	Complied
10	28	1850.200028	1850.0	0.200028	Complied
20	15	1850.200015	1850.0	0.200015	Complied
30	26	1850.200026	1850.0	0.200026	Complied
40	13	1850.200013	1850.0	0.200013	Complied
50	21	1850.200021	1850.0	0.200021	Complied

Frequency Variation From 1850.2MHz

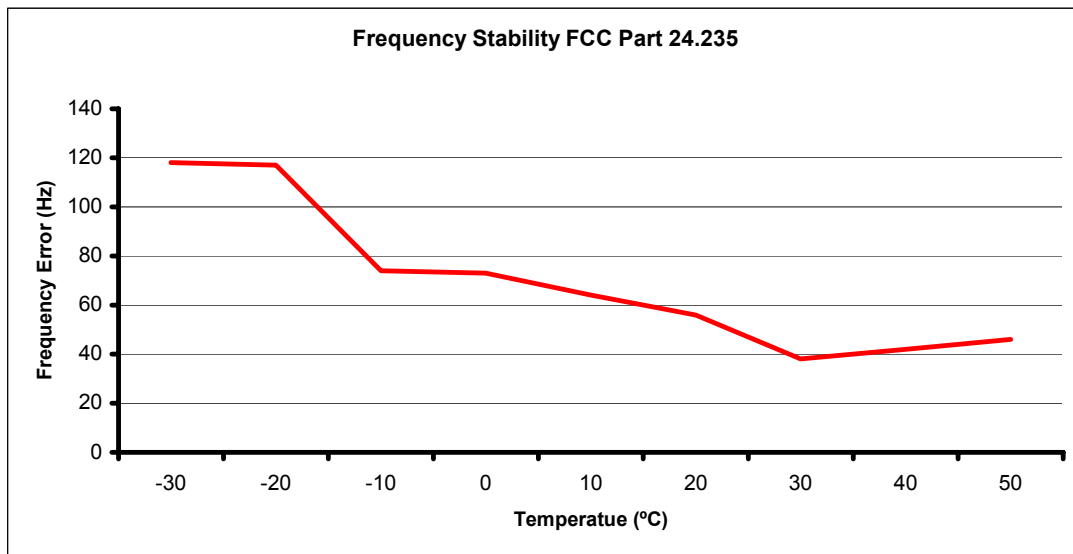
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Transmitter Frequency Stability (Temperature Variation): Section 24.235 (continued)**Results Top Channel (1909.8 MHz)**

Temp (°C)	Frequency Error (Hz)	Measured Frequency (MHz)	Upper Band Edge Limit (MHz)	Margin (MHz)	Result
-30	118	1909.800118	1910.0	0.199882	Complied
-20	117	1909.800117	1910.0	0.199883	Complied
-10	74	1909.800074	1910.0	0.199926	Complied
0	73	1909.800073	1910.0	0.199927	Complied
10	64	1909.800064	1910.0	0.199936	Complied
20	56	1909.800056	1910.0	0.199944	Complied
30	38	1909.800038	1910.0	0.199962	Complied
40	42	1909.800042	1910.0	0.199958	Complied
50	46	1909.800046	1910.0	0.199954	Complied

Frequency Variation From 1909.8MHz

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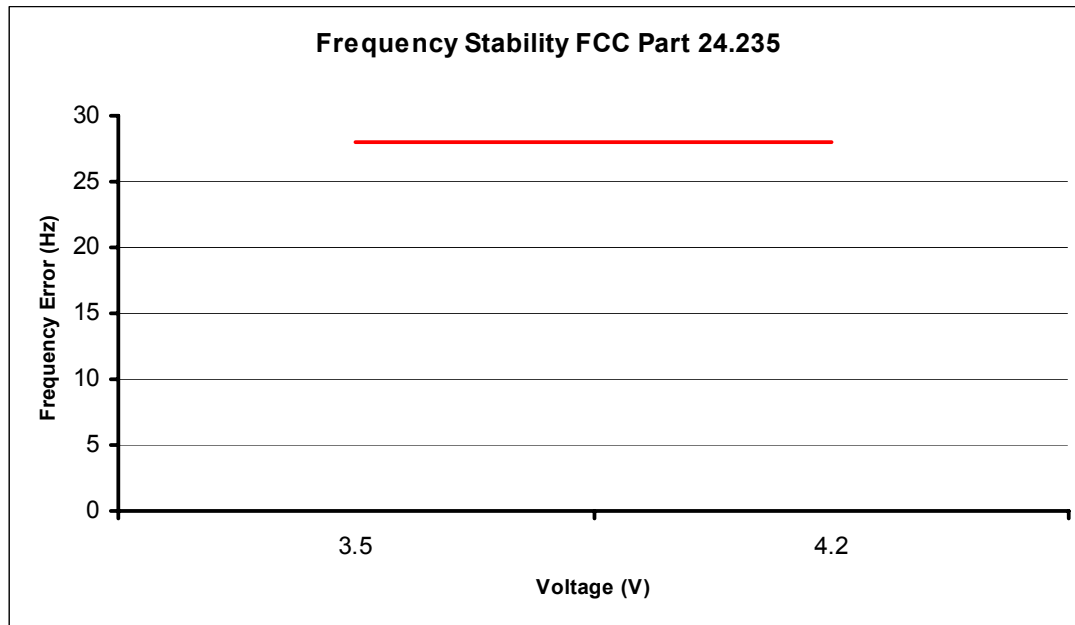
8.5. Transmitter Frequency Stability (Voltage Variation): Section 24.235

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

8.5.2. Tests were performed to identify the maximum frequency error of the EUT with variations in nominal DC operating voltage.

Results Bottom Channel (1850.2 MHz)

Supply Voltage (V)	Frequency Error (Hz)	Measured Frequency (MHz)	Lower Band Edge Limit (MHz)	Margin (MHz)	Result
3.5	28	1850.200028	1850.0	0.200028	Complied
4.2	28	1850.200028	1850.0	0.200028	Complied

Frequency Variation From 1850.2MHz

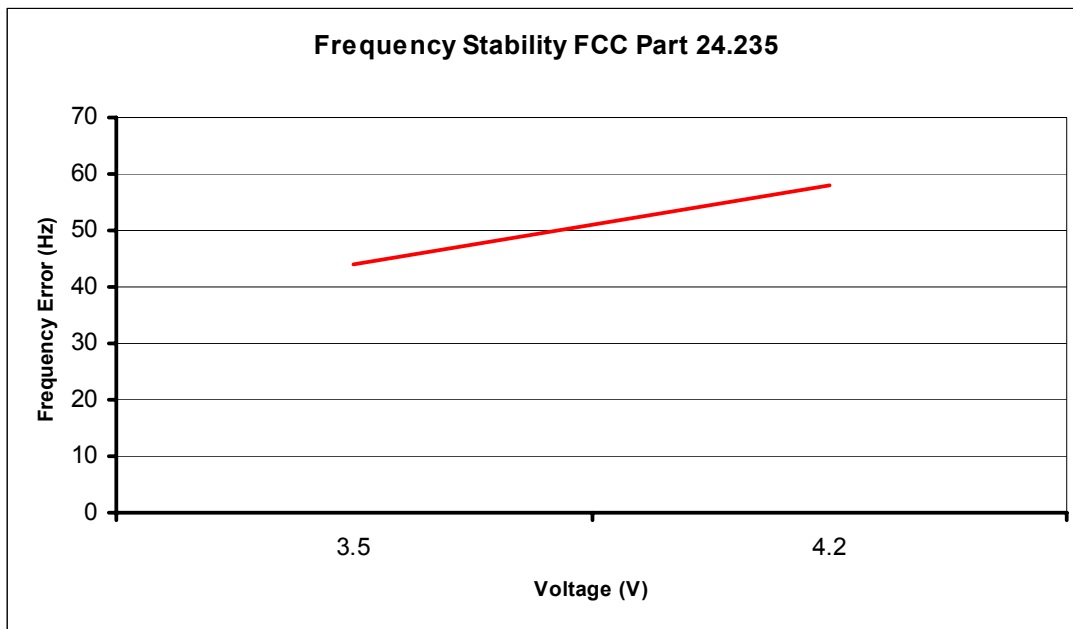
Test Of: Sendo Ltd.

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Transmitter Frequency Stability (Voltage Variation): Section 24.235
(Continued)**Results Top Channel (1909.8 MHz)**

Supply Voltage (V)	Frequency Error (Hz)	Measured Frequency (MHz)	Lower Band Edge Limit (MHz)	Margin (MHz)	Result
3.5	44	1909.800044	1910	0.199956	Complied
4.2	58	1909.800058	1910	0.199942	Complied

Frequency Variation From 1909.8MHz

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8.6. Transmitter Occupied Bandwidth: Section 24.238

8.6.1. The EUT was configured as for Occupied Bandwidth measurements as described in Section 9 of this report.

8.6.2. Tests were performed to identify the maximum bandwidth occupied by the fundamental of the EUT.

Results:

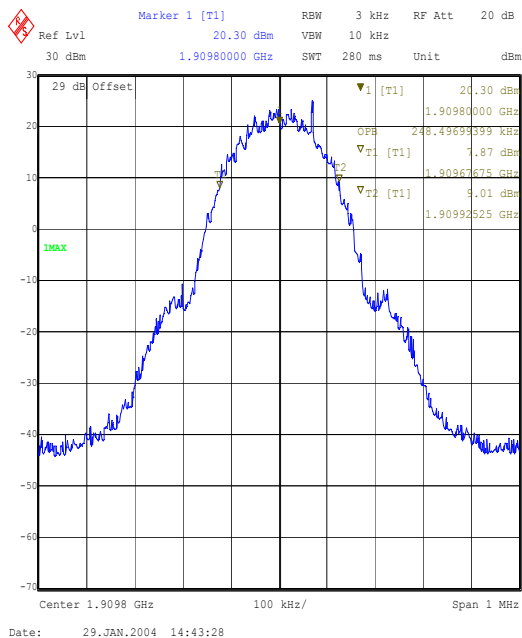
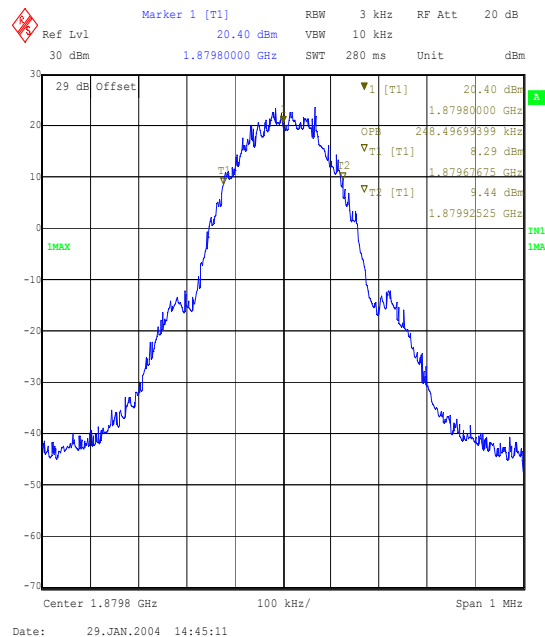
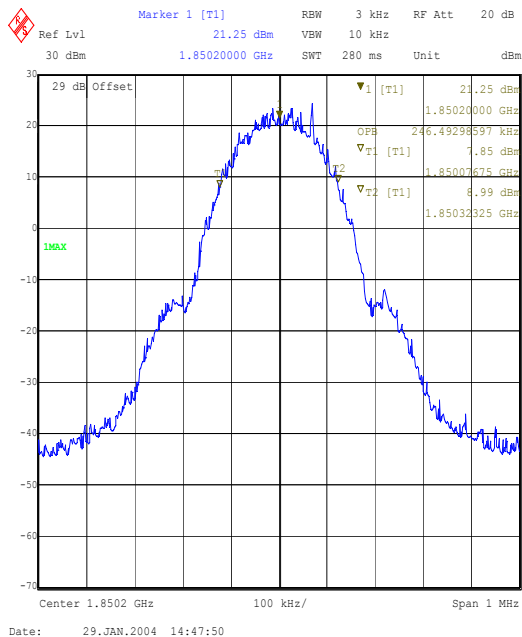
Channel	Frequency (MHz)	Resolution Bandwidth (kHz)	Video Bandwidth (kHz)	Occupied Bandwidth (kHz)
Bottom	1850.2	3.0	10.0	246.49
Middle	1879.8	3.0	10.0	248.50
Top	1909.8	3.0	10.0	248.50

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Transmitter Occupied Bandwidth: Section 24.238 (Continued)

Note: The occupied bandwidth is measured using the internal OBW function of the measurement analyser. The analyser automatically configures the measurement bandwidths to make an accurate measurement. The vital data is reported in the upper right portion of the screen. See attached graphs.

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8.7. Transmitter Out of Band Emissions: Section 2.1053/24.238

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

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

Result: Bottom Channel

Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
3700.675	-26.1	-13.0	13.1	Complied
5550.668	-39.4	-13.0	26.4	Complied
11101.302	-36.1	-13.0	23.1	Complied

Result: Middle Channel

Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
3759.582	-19.9	-13.0	6.9	Complied
5639.421	-37.5	-13.0	24.5	Complied
11278.604	-34.0	-13.0	21.0	Complied

Result: Top Channel

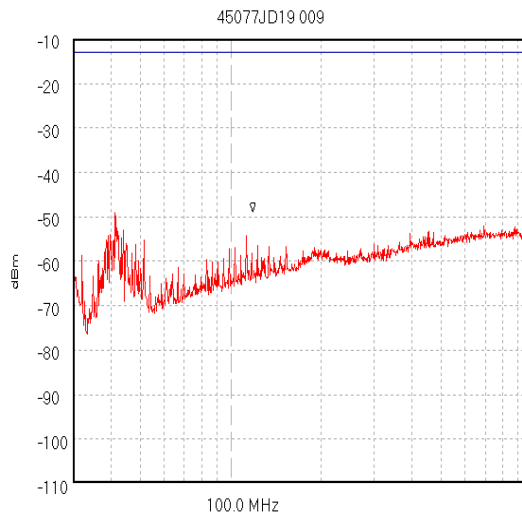
Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
3819.651	-18.8	-13.0	5.8	Complied
5729.482	-36.6	-13.0	23.6	Complied
11458.973	-29.7	-13.0	16.7	Complied

Note: All other emissions were at least 20 dB better than the stated limit.

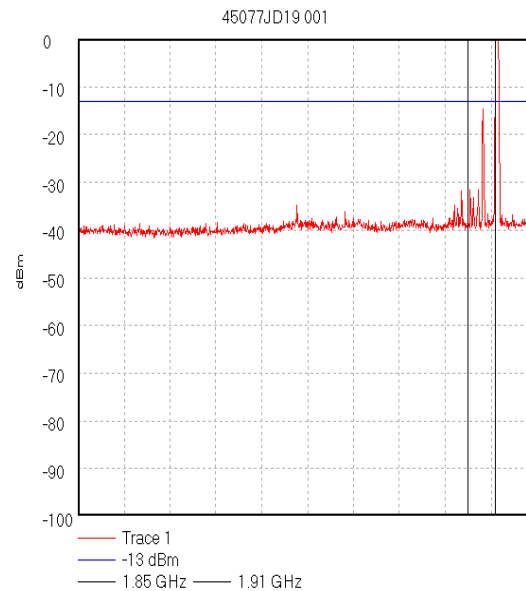
Test Of: Sendo Ltd.

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Transmitter Out of Band Emissions: Section 2.1053/24.238 (Continued)

Start 30.0 MHz; Stop 1.0 GHz - Log Scale
 Ref -10 dBm; Ref Offset 11.8 dB; 10 dB/div
 RBW 120.0 kHz; VBW 100.0 kHz; Att 0 dB; Swp 440.0 mS
 Peak 118.378 MHz, -48.95 dBm
 Display Line: -13 dBm; Limit Test Passed
 Transducer Factors: A490
 1/20/2004 12:53:55 PM



Start 1.0 GHz; Stop 2.0 GHz
 Ref 0 dBm; Ref Offset 13.0 dB; 10 dB/div
 RBW 1.0 MHz; VBW 1.0 MHz; Att 10 dB; Swp 20.0 mS
 Peak 1.913 GHz, 3.98 dBm
 Display Line: -13 dBm;
 23/01/2004 10:13:03

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

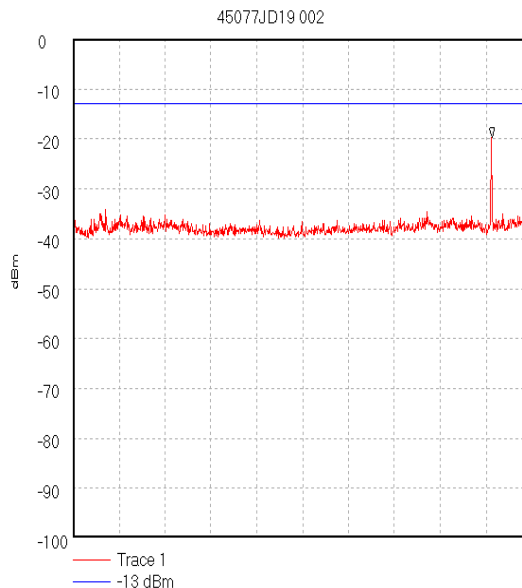
Note: the emission shown in plot 45077JD19 001 at 1.8798 GHz emanates from the GSM test set and not the EUT. Because the emission is not from the EUT and, additionally, is in band no level as been recorded in the preceding results table.

Note: The position of marker on plot 45077JD19 009 is incorrectly shown due to a glitch in the software used to transpose the on-screen image on the spectrum analyser to the PC holding the soft copy of the plot.

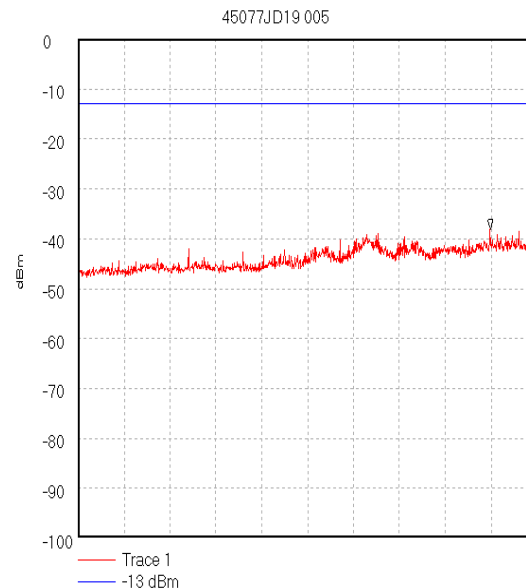
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Transmitter Out of Band Emissions: Section 2.1053/24.238 (Continued)

Start 2.0 GHz; Stop 4.0 GHz
Ref 0 dBm; Ref Offset 13.4 dB; 10 dB/div
RBW 1.0 MHz; VBW 1.0 MHz; Att 10 dB; Swp 20.0 mS
Peak 3.827 GHz, -19.62 dBm
Display Line: -13 dBm;
23/01/2004 10:30:50



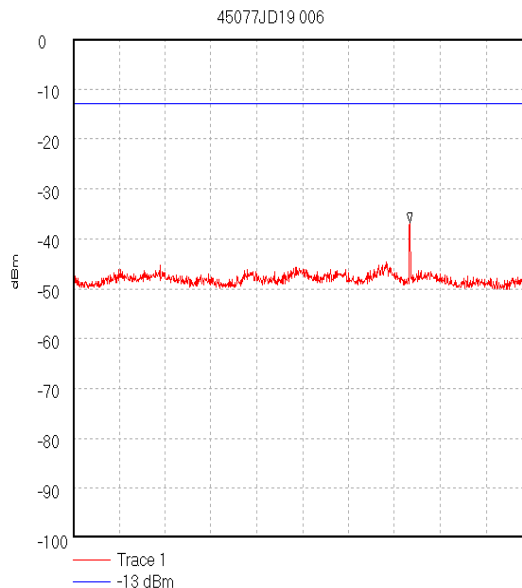
Start 4.0 GHz; Stop 5.0 GHz
Ref 0 dBm; Ref Offset 13.8 dB; 10 dB/div
RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 4.899 GHz, -38.14 dBm
Display Line: -13 dBm;
23/01/2004 11:12:16

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

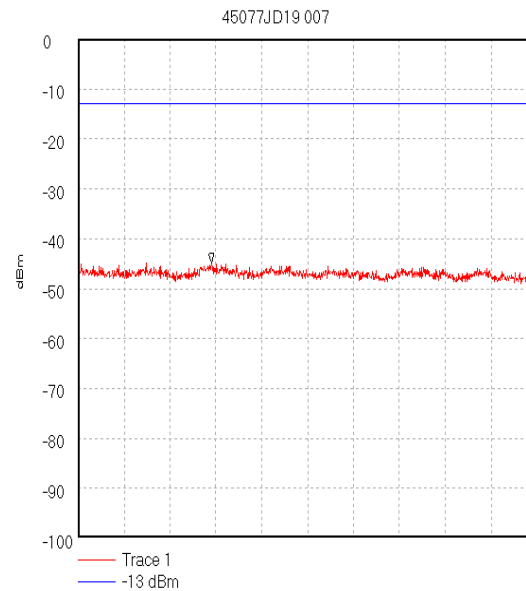
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Transmitter Out of Band Emissions: Section 2.1053/24.238 (Continued)

Start 5.0 GHz; Stop 6.0 GHz
Ref 0 dBm; Ref Offset 13.8 dB; 10 dB/div
RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 5.734 GHz, -36.74 dBm
Display Line: -13 dBm;
23/01/2004 11:15:13



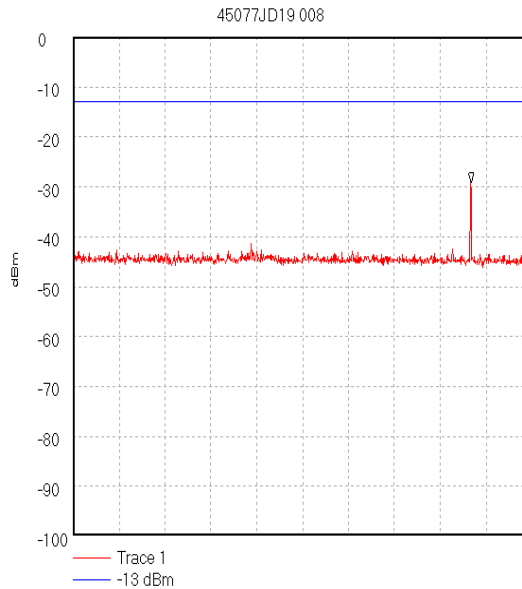
Start 6.0 GHz; Stop 8.0 GHz
Ref 0 dBm; Ref Offset 14.1 dB; 10 dB/div
RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 6.582 GHz, -44.84 dBm
Display Line: -13 dBm;
23/01/2004 11:26:33

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

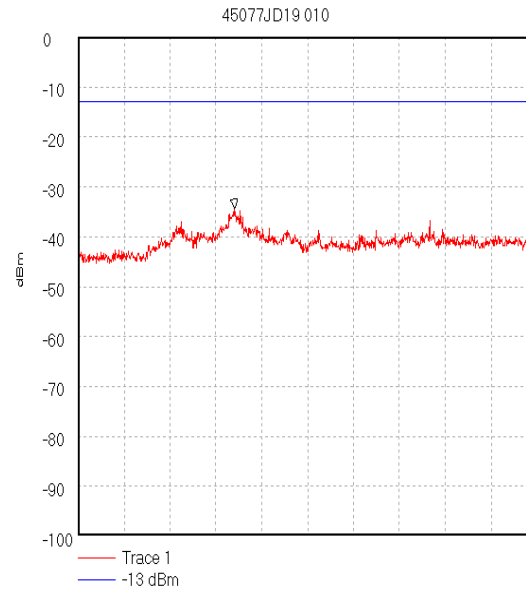
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Transmitter Out of Band Emissions: Section 2.1053/24.238 (Continued)

Start 8.0 GHz; Stop 12.0 GHz
Ref 0 dBm; Ref Offset 14.1 dB; 10 dB/div
RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 11.471 GHz, -29.2 dBm
Display Line: -13 dBm;
23/01/2004 11:35:50



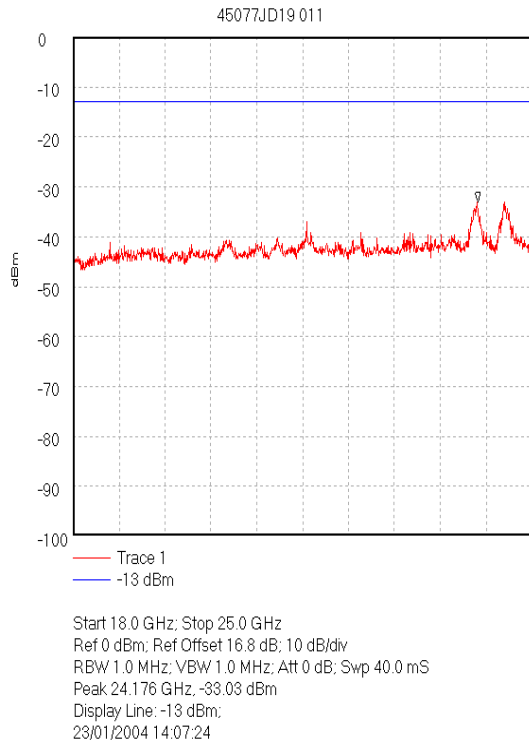
Start 12.0 GHz; Stop 18.0 GHz
Ref 0 dBm; Ref Offset 15.4 dB; 10 dB/div
RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 40.0 mS
Peak 14.047 GHz, -34.4 dBm
Display Line: -13 dBm;
23/01/2004 11:58:34

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

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Transmitter Out of Band Emissions: Section 2.1053/24.238 (Continued)

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

Note: the two peaks in the range 24 GHz to 25 GHz shown in the plot above are the noise floor of the spectrum analyser and are not spurious emissions. These have, therefore, been disregarded.

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Transmitter Out of Band Radiated Emissions: Section 2.1051/24.238 (Continued)**Integrated Power Over 1 MHz Strip Band: 1911 to 1912 MHz**1st 1 MHz block immediately outside adjacent frequency block

100 kHz Strip Number	Peak Power (nW/100 kHz)	100 kHz Strip Number	Peak Power (nW/100 kHz)
1	1120	6	451
2	923	7	460
3	881	8	503
4	585	9	403
5	626	10	375
Total Peak Power:		6327 nW/MHz	

Integrated Power Over 1 MHz Strip Band: 1912 to 1913 MHz2nd 1 MHz block immediately outside adjacent frequency block

100 kHz Strip Number	Peak Power (nW/100 kHz)	100 kHz Strip Number	Peak Power (nW/100 kHz)
1	212	6	239
2	254	7	143
3	177	8	151
4	254	9	115
5	177	10	113
Total Peak Power:		1835 nW/MHz	

Result:

Band (MHz)	Peak Power (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)	Status
1911 to 1912	-22.0	-13.0	9.0	Complied
1912 to 1913	-27.4	-13.0	14.4	Complied

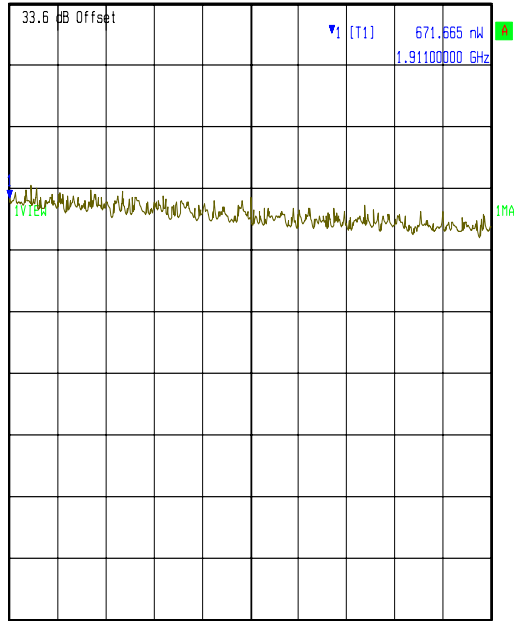
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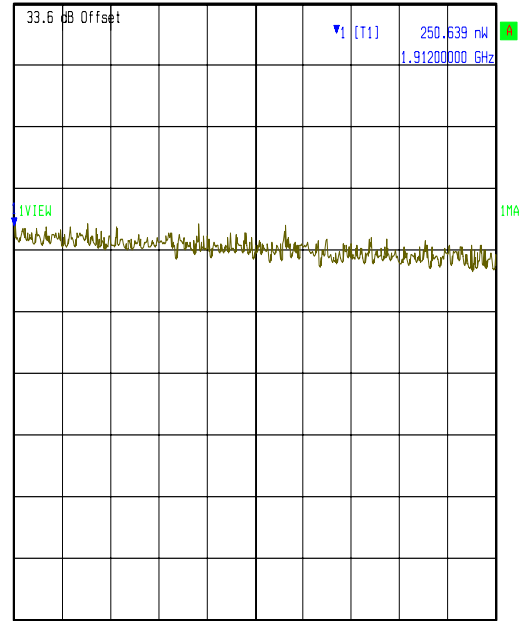
Transmitter Out of Band Radiated Emissions: Section 2.1051/24.238 (Continued)

Marker 1 [T1] RBW 100 kHz RF Att 10 dB
Ref Lvl 671.665 nW VBW 100 kHz
1 mW 1.91100000 GHz SWT 5 ms Unit W



Date: 2.FEB.2004 16:53:38

Marker 1 [T1] RBW 100 kHz RF Att 10 dB
Ref Lvl 250.639 nW VBW 100 kHz
1 mW 1.91200000 GHz SWT 5 ms Unit W



Date: 2.FEB.2004 16:56:16

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8.8. Transmitter Radiated Emissions At Band Edges: Section 2.1053/24.238

8.8.1. The EUT was configured as for radiated emissions testing described in Section 11 of this report.

8.8.2. Tests were performed to identify the maximum emissions level at the band edges of the frequency band that the EUT will operate over.

Results:**Bottom Band Edge**

Frequency (MHz)	Spurious Emission (dBm)	Limit (dBm)	Margin (dB)	Result
1850.0	-14.8	-13.0	1.8	Complied

Top Band Edge

Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
1910.0	-14.5	-13.0	1.5	Complied

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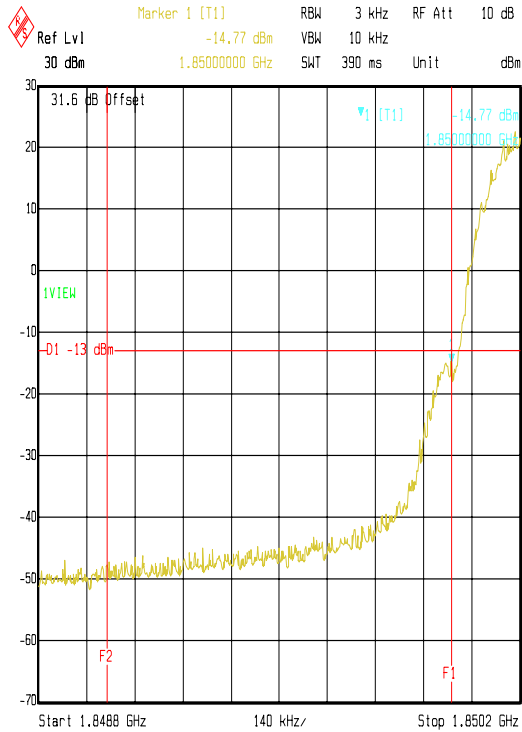
FCC Part 24

TEST REPORT

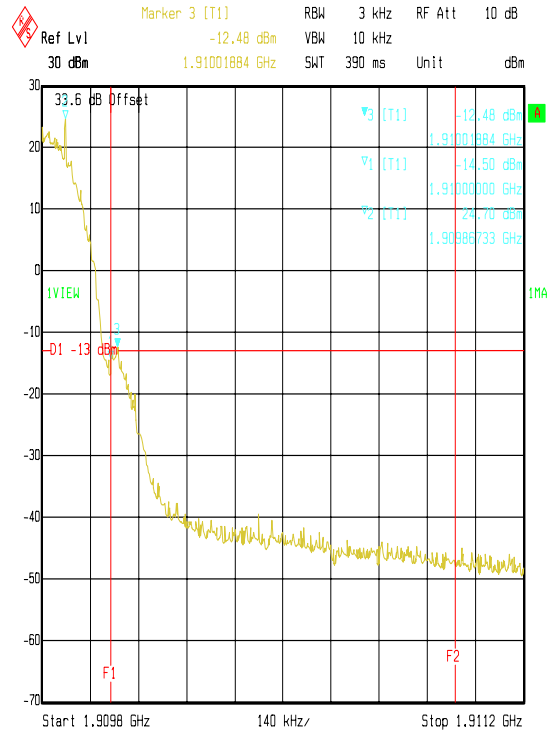
S.No. RFI/MPTB1/RP45077JD19A

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Date: 2.FEB.2004 10:19:39



Date: 2.FEB.2004 10:25:31

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Transmitter Out of Band Radiated Emissions (Band Edge): Section 2.1051/24.238 (Continued)

8.8.3. The highest modulation product of the top channel (operating at 1909.8 MHz) outside the band at 1.91001884 GHz exceeds the -13 dBm limit by 0.5 dB when measured in a 3 kHz bandwidth. In order to establish the precise power in this 3 kHz bandwidth an integration over a 3 kHz span encompassing this modulation product was performed as follows:

The measurement was performed using an analyser span of 3 kHz and a 300 Hz receiver resolution bandwidth (RBW). 10 linear readings were taken for each 300 Hz strip across the 3 kHz band. These readings were integrated to give the emission level in an equivalent 3 kHz bandwidth.

Integrated Power Over 3 kHz Strip Band: 1910 to 1910.003 MHz

3 kHz block immediately outside upper band edge

300 Hz Strip Number	Peak Power (nW/300 Hz)	300 Hz Strip Number	Peak Power (nW/300 Hz)
1	1185	6	1523
2	957	7	1918
3	802	8	1268
4	937	9	1270
5	1311	10	1191
Total Peak Power:		12362 nW/3 kHz	

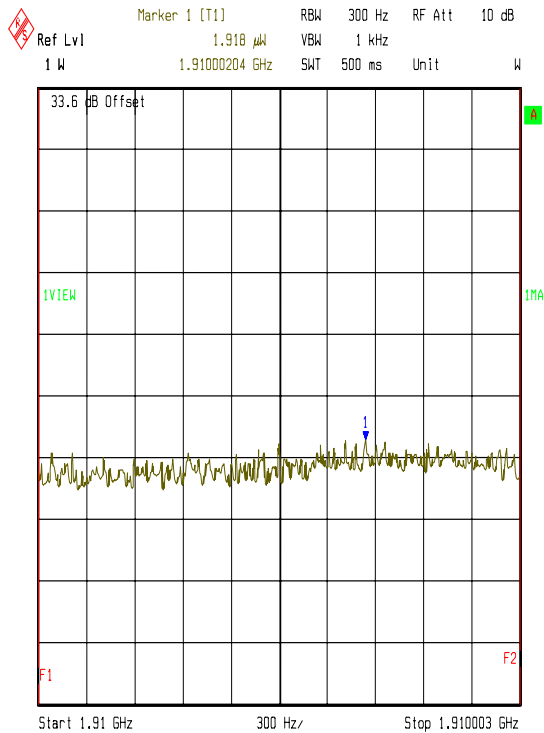
Result:

Band (MHz)	Peak Power (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Status
1910 to 1910.003	-19.1	-13.0	6.1	Complied

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Transmitter Out of Band Radiated Emissions (Band Edge): Section 2.1051/24.238
(Continued)

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9. Measurement Methods

9.1. 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 substitution antenna. For EIRP measurements a Horn antenna whose gain was based on an isotropic antenna was used, ERP measurements were done using a dipole. 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:-

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

All measurements were performed using broadband Horn antennas.

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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

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9.2. Frequency Stability

The EUT was situated within an environmental test chamber and connected to the GSM test set via an air link.

Measurements were performed with the EUT operating under extremes of temperature in 10 degree increments within the range –30 to 50 degrees C.

Measurements were also performed at voltage extremes between the declared nominal supply voltage and at the declared endpoint voltage (for battery operated equipment) or by varying the primary supply voltage from 85% to 115% of the nominal value for all other equipment types.

The requirement was to determine the frequency stability of the device under specified environmental operating conditions and ensure they remained within specified operating parameters.

Measurements were made on the top and bottom channels.

The EUT was switched off for a minimum of 30 minutes between each stage of testing while the environmental chamber stabilised at the next temperature within the stated temperature range.

Once the environmental chamber had reached thermal equilibrium, the nominal frequency of the EUT was measured and recorded. The recorded frequency was compared to the applicants declared operating frequency band edges.

In order to show compliance, the measured frequency must remain within the declared frequency band.

The reported data shows the nominal frequency drift and its margin from the band edge. In order to get the margin from the lower band edge, subtract the lower band edge limit from the measured frequency. The margin from the upper band edge is found by subtracting the measured frequency from the upper band edge limit. In order to show compliance the margin must be positive. A negative margin shows non-compliance.

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9.3. Occupied Bandwidth

The EUT was connected to a spectrum analyser enabled with an occupied bandwidth function and a GSM test set via an air link.

Measurements were performed to determine the Occupied Bandwidth in accordance with FCC Part 2.1049. The Occupied Bandwidth was measured from the fundamental emission at the bottom middle and top channels.

As the EUT is a PCS phone, no modulation input port was available. A call was therefore set up using the PCS/GSM simulator and using normal modulation. The Occupied Bandwidth was measured in this configuration.

The Occupied Bandwidth was measured using the built in occupied bandwidth function of the Rohde and Schwarz FSEB or ESIB spectrum analyser. It was set to measure the bandwidth where 99% of the signal power was contained. The analyser settings were set as per those outlined in the spectrum analyser user manual for this measurement, i.e., RBW $\geq$ 1% of occupied bandwidth. A value of 3 kHz was used.

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9.4. 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

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9.5. Transmitter Radiated Emissions

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

Initial pre-scans covering the entire measurement band from the lowest generated frequency declared up to 10 times the highest fundamental frequency. The scans were performed within a screened chamber in order to identify frequencies on which the EUT was generating spurious. This procedure identified the frequencies from the EUT, which required further examination. Repetitive scans were performed to allow for emissions with low repetition rates, and for the duty cycle of the EUT.

The initial scans were performed using an antenna height of 1.5 m and a measurement distance of 3 m. A limit line was set to the specification limit by characterising the screen room using a known signal source set at exactly the same location as the EUT. The signal source was derived from either a horn antenna or a dipole dependant on the frequency band under investigation. Any levels within 20 dB of this limit were measured where possible, on occasion; the receiver noise floor came within the 20 dB boundary. On these occasions, the system noise floor may have been recorded.

An open area test site using the appropriate test distance and measuring receiver with a Peak detector was used for final measurements at each frequency recorded in the screen room.

The levels were maximised by initially rotating the turntable through 360° and then varying the antenna height between 1 m and 4 m in the vertical polarisation. 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. The procedure was repeated for the horizontal polarisation.

Once the final amplitude (maximised) had been obtained, the EUT was substituted with a substitution antenna. For EIRP measurements a Horn antenna whose gain was based on an isotropic antenna was used, ERP measurements were done using a dipole. 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:-

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

The limit in the standard states that emissions shall be attenuated by at least $43 + 10 \log(P)$ dB below the transmitter power (P), where (P) is the maximum measured fundamental power for the channel under test. This limit always reduces to -13 dBm therefore, the limit line presented on the accompanying plots is set to -13 dBm.

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Transmitter Radiated Emissions (Continued)

Any spurious measured were then compared to the -13 dBm limit. The requirement is for the emission to be less than -13 dBm. The margin between emission and limit is recorded and should always be positive to indicate compliance.

It should be noted that FCC Part 24.238 states that the 1st MHz band immediately adjacent to the applicants declared frequency block may be measured using a resolution bandwidth of at least 1% of the emission bandwidth. This bandwidth was found by calculating 1% of the bandwidth measured in the transmitter occupied bandwidth section of this report. The next largest available bandwidth above this calculated figure was, therefore, used i.e. 3 kHz.

The measurements in the 2nd and 3rd 1 MHz blocks away from the adjacent 1 MHz upper band edge blocks from 1911 MHz to 1912 MHz and 1912 MHz to 1913 MHz were carried out using an analyser span of 1 MHz and a 100 kHz receiver resolution bandwidth (RBW). 10 linear readings were taken for each 100 kHz strip across the 1 MHz band. These readings were integrated to give the emission level in an equivalent 1 MHz bandwidth. The above procedure was repeated for the lower band edge blocks from 1847 MHz to 1848 MHz and 1848 MHz to 1849 MHz

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9.6. Receiver Radiated Emissions

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

Initial pre-scans covering the entire measurement band from the lowest generated frequency declared up to 5 times the highest unintentionally generated frequency were performed within a screened chamber in order to identify frequencies on which the EUT was generating interference. This determined the frequencies from the EUT which required further examination. In order to minimise the time taken for the swept measurements, a peak detector was used in conjunction with the appropriate detector measuring bandwidth (see table below). Repetitive scans were performed to allow for emissions with low repetition rates, and for the duty cycle of the EUT.

The initial scans were performed using an antenna height of 1.5 m and a measurement distance of 3 m. A limit line was set to the specification limit. Levels within 20 dB of this limit were measured where possible, on occasion, the receiver noise floor came within the 20 dB boundary. On these occasions, the system noise floor may have been recorded.

An open area test site using the appropriate test distance and measuring receiver with a Quasi-Peak detector was used for measurements below 1000 MHz, for measurements above 1000 MHz average and peak detectors were used.

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.

On the open area test site, at each frequency where a signal was found, the levels were maximised by initially rotating the turntable through 360° and then varying the antenna height between 1 m and 4 m in the horizontal polarisation. 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. The procedure was repeated for the vertical polarisation.

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	Not applicable
Bandwidth:	(120 kHz < 1 GHz) (1 MHz > 1 GHz)	120 kHz	1 MHz (If Applicable)
Amplitude Range:	60 dB	20 dB	20 dB (typical)
Step Size:	Continuous sweep	Not applicable	Not applicable
Sweep Time:	Coupled	Not applicable	Not applicable

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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
Effective Isotropic Radiated Power (EIRP)	Not applicable	95%	+/- 1.78 dB
Frequency Stability	Not applicable	95%	+/- 20 Hz
Minimum Bandwidth	Not applicable	95%	+/- 0.12 %
Occupied Bandwidth	1850 to 1910 MHz	95%	+/- 0.12 %
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	+/- 5.26 dB
Radiated Spurious Emissions	1 GHz to 26 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
A067	LISN	Rohde & Schwarz	ESH3-Z5	890603/002
A1361	ESH3-Z2 Pulse Limiter	Rohde & Schwarz	ESH3-Z2	A1361-20112003
A197	Site 2 Controller SC144	Unknown	SC144	150720
A253	WG 12 Microwave Horn	Flann Microwave	12240-20	128
A254	WG 14 Microwave Horn	Flann Microwave	14240-20	139
A255	WG 16 Microwave Horn	Flann Microwave	16240-20	519
A259	Bilog Antenna	Chase	CBL6111	1513
A429	WG 16 horn	Flann	16240-20	561
A430	WG 18 horn	Flann	18240-20	425
A436	WG 20 horn	Flann	20240-20	330
C1078	Rosenberger 3m Cable	Rosenberger	FA210A1030M50 50	28464-2
C178	Cable	Rosenberger	UFA210A-1-1181- 70x70	None
C393	Cable	RFI	None	None
C457	Cable	Rosenberger	RG142XX-002- RFIB	C457-10081998
C459	Cable	Rosenberger	UFA210A-1-1182- 704704	98H0303

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Test Equipment Used (Continued)

RFI No.	Instrument	Manufacturer	Type No.	Serial No.
C461	Cable	Rosenberger	UFA210A-1-1182-704704	98H0305
C468	N-Type Coaxial Cable	Rosenberger	UFA210A-1-3937-504504	98L0440
E013	PCN Environmental Chamber	Sanyo	ATMOS chamber	None
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)
M088	Receiver / Spectrum Analyser System	Rohde & Schwarz	ESBI	DU:835862/018 RU:835387/006
M1068	Thermometer Digital	Iso-Tech	RS55	93102884
M1093	GSM Test Set	Will tek	4202S	0513018
M1124	Rohde & Schwarz	Rohde & Schwarz	ESIB26	100046K
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\45077JD19\EMICON	Test configuration for measurement of conducted emissions
DRG\45077JD19\EMIRAD	Test configuration for measurement of radiated emissions

RADIO FREQUENCY INVESTIGATION LTD

Operations Department

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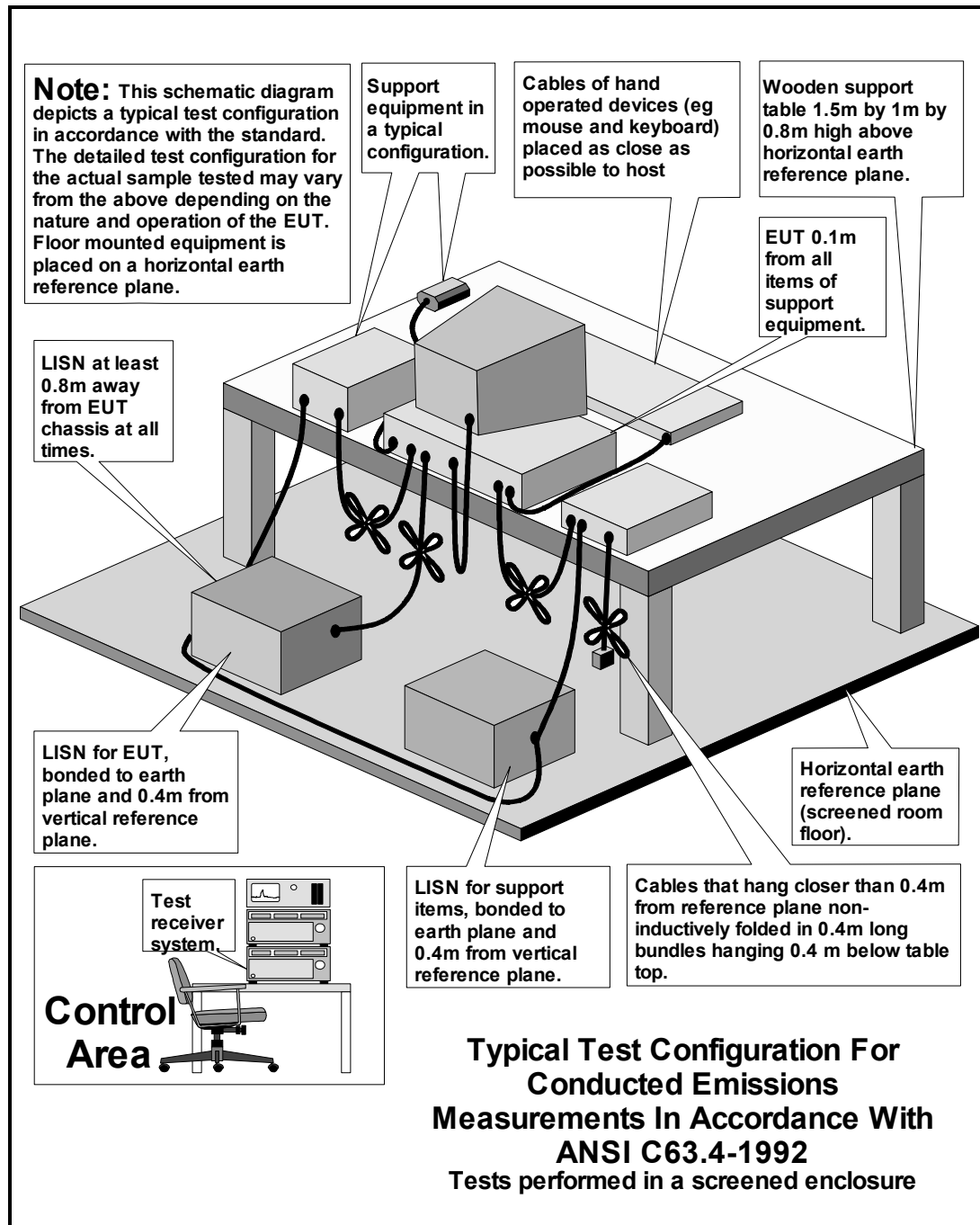
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