KTL EMC Test Report : 6G9638GUS1

Applicant : Jennic Ltd

Apparatus : JN5121–XXX-M04 High Power Module

Authorised by

: 

K J Anderson, Principal EMC and Radio Group Engineer

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Section 1: Introduction

1.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on samples submitted to the Laboratory.

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Tests performed by:

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Report author:.

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1.2 Tests Requested By

This testing in this report was requested by:

Jennic Ltd
Furnival Street,
Sheffield,
S1 4QT
United Kingdom

1.3 Manufacturer

As above.

4 Apparatus Assessed

The following apparatus was assessed between 10/10/06 and 23/10/06:

Jennic JN5121–XXX-M04 High Power Module

The above equipment was a wireless sensor module operating in the 2.4GHz band.

1.5 Test Result Summary

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

The statements relating to compliance with the standards below apply ONLY as qualified in the notes and deviations stated in sections 1.6 to 1.7 of this test report.

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

Test Type	Regulation	Measurement standard	Result
REFE	Title 47 of the CFR: 2004, Part 15 Subpart (c) 15.247(d)	ANSI C63.4: 2003	PASS
PLCE	Title 47 of the CFR: 2004, Part 15 Subpart (c) 15.207	ANSI C63.4: 2003	PASS
6dB Bandwidth	Title 47 of the CFR :2004, Part 15 Subpart (c) 15.247(a)(2)	ANSI C63.4: 2003	PASS
Conducted Carrier Power	Title 47 of the CFR :2004, Part 15 Subpart (c) 15.247(b)(3)	ANSI C63.4: 2003	PASS
Antenna Gain	Title 47 of the CFR :2004, Part 15 Subpart (c) 15.247(b)(4)	ANSI C63.4: 2003	PASS
Power Spectral Density	Title 47 of the CFR :2004, Part 15 Subpart (c) 15.247(e)	ANSI C63.4: 2003	PASS

Abbreviations used in the above table:

Mod : Modification
CFR : Code of Federal Regulations
REFE : Radiated Electric Field Emissions
ANSI : American National Standards Institution
PLCE Power Line Conducted Emissions

1.6 Notes Relating To The Assessment

With regard to this assessment, the following points should be noted:

The results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 1.7 of this test report (Deviations from Test Standards).

For emissions testing, throughout this test report, “Pass” indicates that the results for the sample as tested were below the specified limit (refer also to Section 2, Measurement Uncertainty).

Where relevant, the apparatus was only assessed using the monitoring methods and susceptibility criteria defined in this report.

All testing with the exception of testing at the Open Area Test Site was performed under the following environmental conditions:

Temperature	: 17 to 23 °C
Humidity	: 45 to 75 %
Barometric Pressure	: 86 to 106 kPa

All dates used in this report are in the format dd/mm/yy.

This assessment has been performed in accordance with the requirements of ISO/IEC 17025.

KTL Hull is a listed electromagnetic compatibility Conformance Assessment Body (CAB) for EC access to the US market. (Decision No 3/2000 of the Joint Committee established under the Agreement on Mutual Recognition between the European Community and the United States of America. This decision was effective from 16th January 2001).

FCC Facility Registration number (3m semi anechoic chamber) : 90743

1.7 Deviations from Test Standards

There were no deviations from the standards tested to.

Section 2: Measurement Uncertainty

2.1 Introduction

The standard ISO/IEC 17025 used for laboratory accreditation requires laboratories to estimate measurement uncertainty using accepted methods of analysis.

Where required, the reported expanded uncertainty is based on a standard uncertainty providing a confidence level of approximately 95%.

Measurement uncertainty is calculated using the methods defined in the UKAS document LAB34 Edition 1 August 2002.

KTL measurement uncertainty is recorded in the KTL document UNC/RFG/001 Issue 16.

2.2 Application of Measurement Uncertainty

The following procedure is used when determining the result of a measurement :

(i) If specification limits are not exceeded by the measured result, extended by the positive component of the expanded uncertainty interval at a confidence level of 95%, then a pass result is recorded.

(ii) Where a specification limit is exceeded by the result even when the result is decreased by the negative component of the expanded uncertainty interval, a fail result is recorded.

(iii) Where measured result is below a limit, but by a margin less than the positive measurement uncertainty component, it is not possible to record a pass based on a 95% confidence level. However, the result indicates that a pass result is more probable than a fail result.

(iv) Where a measured result is above a limit, but by a margin less than the negative measurement uncertainty component, it is not possible to record a fail based on a 95% confidence level. However the result indicates that a fail is more probable than a pass.

2.3 Measurement Uncertainty Values

All results were recorded in accordance with Section 2.2(i).

Section 3: Modifications

3.1 Modifications Performed During Assessment

No modifications were performed during testing

Appendix A: Formal Emission Test Results

Abbreviations used in the tables in this appendix:

Spec	: Specification
Mod	: Modification
EUT	: Equipment Under Test
SE	: Support Equipment
L	: Live Power Line
N	: Neutral Power Line
E	: Earth Power Line
Pk	: Peak Detector
QP	: Quasi-Peak Detector
Av	: Average Detector

ALSR	: Absorber Lined Screened Room
OATS	: Open Area Test Site
ATS	: Alternative Test Site
Ref	: Reference
Freq	: Frequency
MD	: Measurement Distance
SD	: Spec Distance
Pol	: Polarisation
H	: Horizontal Polarisation
V	: Vertical Polarisation
CDN	: Coupling & decoupling network

A1 Radiated Electric Field Emissions

Preliminary radiated electric field emissions testing was performed using a peak detector in an absorber lined screened room.

The following test site was used for final measurements as specified by the standard tested to :

10m open area test site : ☐ 3m alternative test site : ☑

The effect of the EUT set-up on the measurements is summarised in note (c) below.

Test Details	
Regulation	Title 47 of the CFR :2002, Part 15 Subpart (c) Clause 15.247(d)
Measurement standard	ANSI C63.4:2003
Frequency range	100 kHz to 25 GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	EMC Laptop
EUT set up	Refer to Appendix C
Photographs (Appendix E)	Photograph 1 and 2

The worst case radiated emission measurements are listed below:

Ref No.	Freq (MHz)	Det.	Angle. Deg.	Height (cm)	Pol.	Result (dBμV/m)	Spec. Limit (dBμV/m)	Margin (dB)	Summary
1	1653.1	Av	131	100	H	42.3	87.2	-44.9	Pass
2	1653.1	Pk	131	100	H	45.6	107.2	-61.6	Pass
3	2480	Av	47	108	V	107.2	N/A	N/A	Pass
4	2480	Pk	47	108	V	109.4	N/A	N/A	Pass
5	3306.7	Av	61	100	V	44.0	87.2	-47.2	Pass
6	3306.7	Pk	61	100	V	50.4	107.2	-56.8	Pass
7	4960	Av	41	100	V	59.3	54	5.5	Pass (Note 8)
8	4960	Pk	41	100	V	66.7	74	-7.3	Pass
9	7438.4	Pk	92	100	V	70.4	74	-3.6	Pass
10	7438.4	Av	92	100	V	61.4	54	7.4	Pass (Note 8)
11	2400	Pk	315	118	V	46.8	107.2	-60.8	Pass
12	2400	Av	315	118	V	57.6	87.2	-29.6	Pass
13	2483.5	Pk	48	100	V	60.7	74	-13.3	Pass
14	2483.5	Av	48	100	V	52.3	54	-1.7	Pass

Notes:

1. Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.4: 2003 section 8.2.1.
2. All other emissions in the restricted bands defined in 47CFR15.205(a) were greater than 10 dB below the 47CFR15.209 limit.
3. The emissions limits for emissions outside the restricted bands defined in 47CFR15.205(a) are based on a transmitted carrier level of 97.2 dBμV/m at 3m. Emissions from the EUT are required to be 20 dB below the level of the emissions in the operating band. The carrier level was measured whilst varying the supply voltage between 85% and 105% of the nominal supply voltage as required by 15.31(e). No variation in carrier level was observed.
4. In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
5. The measurements at 2400 MHz and 2483.5 MHz were made to ensure band edge compliance.
6. Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
7. For Frequencies Below 1 GHz, RBW= 100 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

Peak	RBW=VBW= 1MHz
Average	RBW= 1 MHz, VBW = 10 Hz

   These settings are as per ANSI C63.4.

8. The EUT is designed to be compliant with the requirements of IEEE 802.15.4, which in general assumes a maximum duty cycle of 1%. Therefore in accordance with 47CFR 15.35(c), the emissions may be reduced by a factor of 100 (40 dB). Plots of the duty cycle showing the duty cycle to be less than 1% are contained in Appendix B of this report.

The upper frequency of the measurement range was decided according to 47 CFR 15:1999 Clause 15.33.

Radiated emission limits (47 CFR 15:1999 Clause 15.209) for emissions falling within the restricted bands defined in 15.205(a):

Frequency of emission (MHz)	Field strength μV/m	Measurement Distance m	Field strength dBμV/m
0.009-0.490	2400/F(kHz)	300	67.6/F (kHz)
0.490-1.705	24000/F(kHz)	30	87.6/F (kHz
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	210	3	46.4
Above 960	500	3	54.0

Notes:

(a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation}\,(\text{dB}) = 20\log_{10}\left(\frac{\text{measurement distance}}{\text{specification distance}}\right)$$

The results displayed take into account applicable antenna factors and cable losses.

(b) The levels may have been rounded for display purposes.

(c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels		✓		
Effect of EUT internal configuration on emission levels		✓		
Effect of Position of EUT cables & samples on emission levels	✓			

(i) Parameter defined by standard and / or single possible, refer to Appendix D
(ii) Parameter defined by client and / or single possible, refer to Appendix D
(iii) Parameter had a negligible effect on emission levels, refer to Appendix D
(iv) Worst case determined by initial measurement, refer to Appendix D

A2 Power Line Conducted Emissions

Preview power line conducted emission measurements were performed with a peak detector in a screened room.
The effect of the EUT set-up on the measurements is summarised in note (b) below.
Where applicable formal measurements of the emissions were performed with a peak, average and/or quasi peak detector. The formal measurements are detailed below:

Test Details: 2405 MHz	
Regulation	Title 47 of the CFR :2002, Part 15 Subpart (c) Clause 15.207
Measurement standard	ANSI C63.4:2003
Class	B – refer to specification limit table below.
Frequency range	150kHz to 30MHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	EMC Laptop
EUT set up	Refer to Appendix C
Photographs	Photograph 3

The worst-case power line conducted emission measurements are listed below:

Results measured using the peak detector compared to the average limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.15	Live	27	56	-29	Pass
2	0.5	Live	14.7	46	-31.3	Pass
3	1	Live	14.3	46	-31.7	Pass
4	2	Live	14.2	46	-31.8	Pass
5	5	Live	14.4	46	-31.6	Pass
6	10	Live	14.7	50	-35.3	Pass
7	0.15	Neutral	30.4	56	-25.6	Pass
8	0.5	Neutral	20.2	46	-25.8	Pass
9	1	Neutral	13.9	46	-32.1	Pass
10	2	Neutral	14.6	46	-31.4	Pass
11	5	Neutral	13.7	46	-32.3	Pass
12	10	Neutral	15.3	50	-34.7	Pass

Test Details: 2440MHz	
Regulation	Title 47 of the CFR :2002, Part 15 Subpart (c) Clause 15.207
Measurement standard	ANSI C63.4:2003
Class	B – refer to specification limit table below.
Frequency range	150kHz to 30MHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	EMC Laptop
EUT set up	Refer to Appendix C
Photographs	Photograph 3

The worst case power line conducted emission measurements are listed below:

Results measured using the peak detector compared to the average limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.15	Live	32.6	56	-23.4	Pass
2	0.5	Live	14.9	46	-31.1	Pass
3	1	Live	15.3	46	-30.7	Pass
4	2	Live	16.3	46	-29.7	Pass
5	5	Live	15	46	-31	Pass
6	10	Live	15.2	50	-34.8	Pass
7	0.15	Neutral	36.2	56	-19.8	Pass
8	0.5	Neutral	15.1	46	-30.9	Pass
9	1	Neutral	14.7	46	-31.3	Pass
10	2	Neutral	17.2	46	-28.8	Pass
11	5	Neutral	14.6	46	-31.4	Pass
12	10	Neutral	15.5	50	-34.5	Pass

Test Details: 2480 MHz	
Regulation	Title 47 of the CFR :2002, Part 15 Subpart (c) Clause 15.207
Measurement standard	ANSI C63.4:2003
Class	B – refer to specification limit table below.
Frequency range	150kHz to 30MHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	EMC Laptop
EUT set up	Refer to Appendix C
Photographs	Photograph 3

The worst case power line conducted emission measurements are listed below:

Results measured using the peak detector compared to the average limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.15	Live	40.1	56	-15.9	Pass
2	0.5	Live	21.1	46	-24.9	Pass
3	1	Live	16.4	46	-29.6	Pass
4	2	Live	21.6	46	-24.4	Pass
5	5	Live	14.9	46	-31.1	Pass
6	10	Live	16.8	50	-33.2	Pass
7	0.15	Neutral	40.8	56	-15.2	Pass
8	0.5	Neutral	22.1	46	-23.9	Pass
9	1	Neutral	15.4	46	-30.6	Pass
10	2	Neutral	22.2	46	-23.8	Pass
11	5	Neutral	15.4	46	-30.6	Pass
12	10	Neutral	17.5	50	-32.5	Pass

Specification limits :

Conducted emission limits (47 CFR 15:2004 Clause 15.107):

Conducted disturbance at the mains ports of Class B information technology equipment.

Frequency range MHz	Limits dBμV	
	Quasi-peak	Average
0.15 to 0.5	66 to 56	56 to 46
0.5 to 5	56	46
5 to 30	60	50
Notes: 1. The lower limit shall apply at the transition frequency. 2. The limit decreases linearly with the logarithm of the frequency in the range 0.15MHz to 0.5MHz.		

When the average limit was met using the peak detector, the EUT was deemed to meet both the average detector and quasi-peak detector limits and measurement with the average detector and quasi-peak detector was not required.

Notes:

(a) The levels may have been rounded for display purposes.

(b) The following table summarises the effect of the EUT operating mode and internal configuration on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels		✓		
Effect of EUT internal configuration on emission levels		✓		

(i) Parameter defined by standard and / or single possible, refer to Appendix C
(ii) Parameter defined by client and / or single possible, refer to Appendix C
(iii) Parameter had a negligible effect on emission levels, refer to Appendix C
(iv) Worst case determined by initial measurement, refer to Appendix C

A3 6 dB Bandwidth

Measurement of the bandwidth of the transmission between the -6 dB points on the transmitted spectrum was verified using a spectrum analyser with the EUT transmitting on its lowest, centre and highest carrier frequency in turn. The formal measurements are detailed below:

Test Details:	
Regulation	Title 47 of the CFR :2002, Part 15 Subpart (c) 15.247(a)(2)
EUT sample number	S01
Modification state	0
SE in test environment	EMC Laptop
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Measured 6 dB Bandwidth	Limit	Result
2519 kHz	>500 KHz	Pass

A plot of the 6 dB bandwidth is contained in Appendix B of this test report.

A3 Conducted carrier power

Conducted carrier power was verified using a spectrum analyser with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

Test Details:	
Regulation	Title 47 of the CFR2002, Part15 Subpart (c) 15.247(b)(3)
EUT sample number	S01
Modification state	0
SE in test environment	EMC Laptop
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Frequency (MHz)	Measured Conducted Carrier Power (W)	Limit (W)	Result
2405	0.044	1	Pass
2440	0.047	1	Pass
2480	0.038	1	Pass

Note

The carrier power was measured whilst varying the supply voltage between 85% and 105% of the nominal supply voltage as required by 15.31(e). No variation in carrier power was observed.

A4 Antenna Gain

The maximum antenna gain for the antenna types to be used with the EUT, as declared by the client, is 4.4 dBi.

A5 Power Spectral density

Conducted carrier power was verified using a spectrum analyser in conjunction with a wideband RF power meter. Testing was performed with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

Test Details:	
Regulation	Title 47 of the CFR :2002, Part 15 Subpart (c) 15.247(e)
EUT sample number	S01
Modification state	0
SE in test environment	EMC Laptop
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Frequency (MHz)	Measured power Spectral density (dBm/3kHz)	Limit (dBm/3kHz)	Result
2405	3.9	8	Pass
2440	3.1	8	Pass
2480	3.2	8	Pass

Appendix B: **Supporting Graphical Data**

This appendix contains graphical data obtained during testing.

Notes:

(a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.

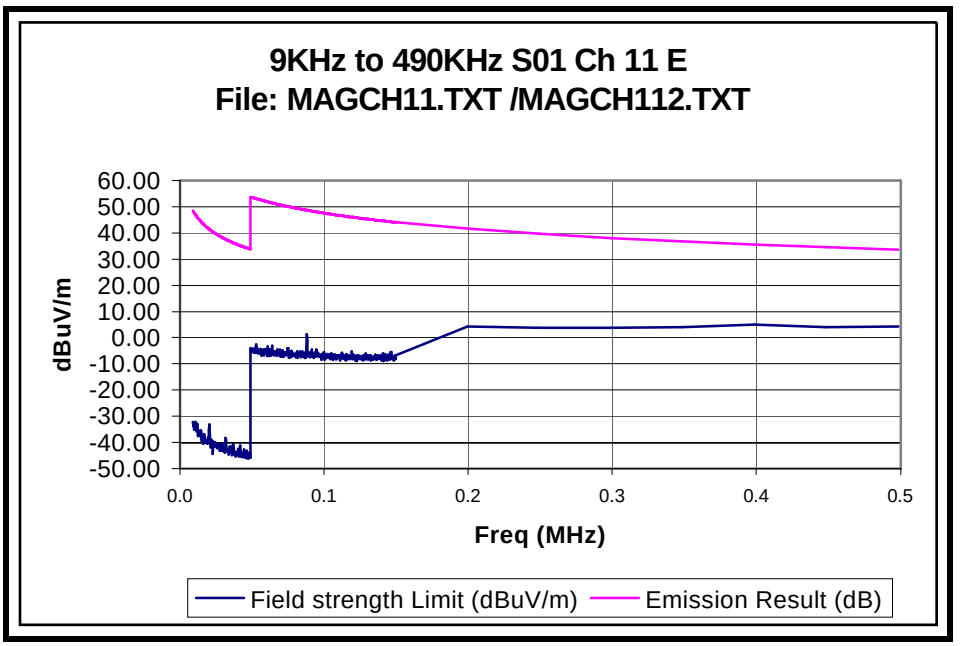
(b) The time and date on the plots do not necessarily equate to the time of the test.

(c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.

(d) Appendix C details the numbering system used to identify the sample and its modification state.

(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.

(f) The limit line on the radiated emissions is the limit for emissions outside the restricted bands. Any emissions detected within the restricted band were formally assessed against the limits in 15.209.


9KHz to 490KHz S01 Ch 11 E
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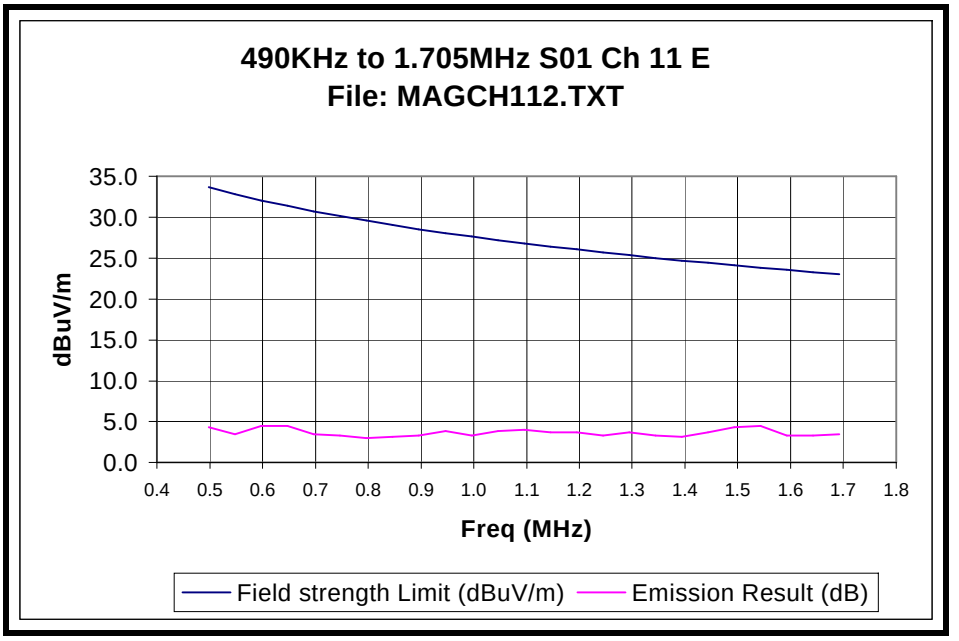
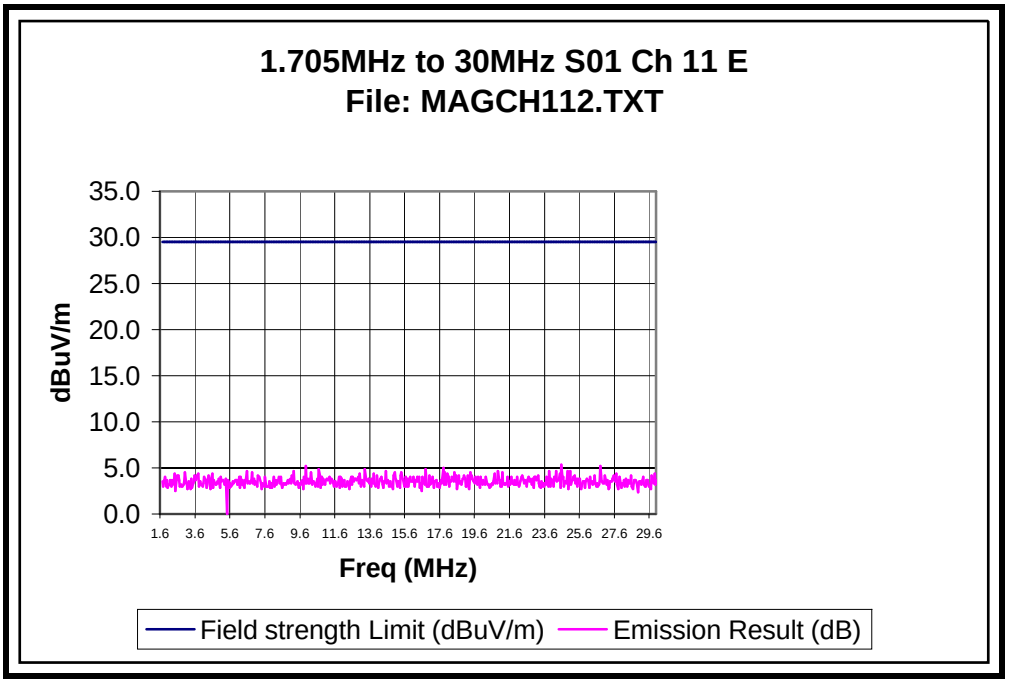
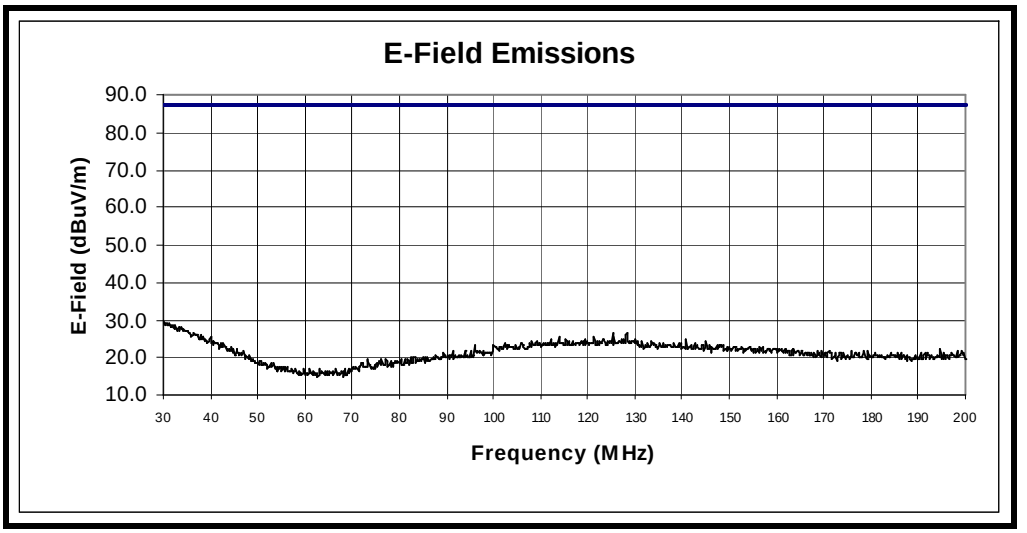
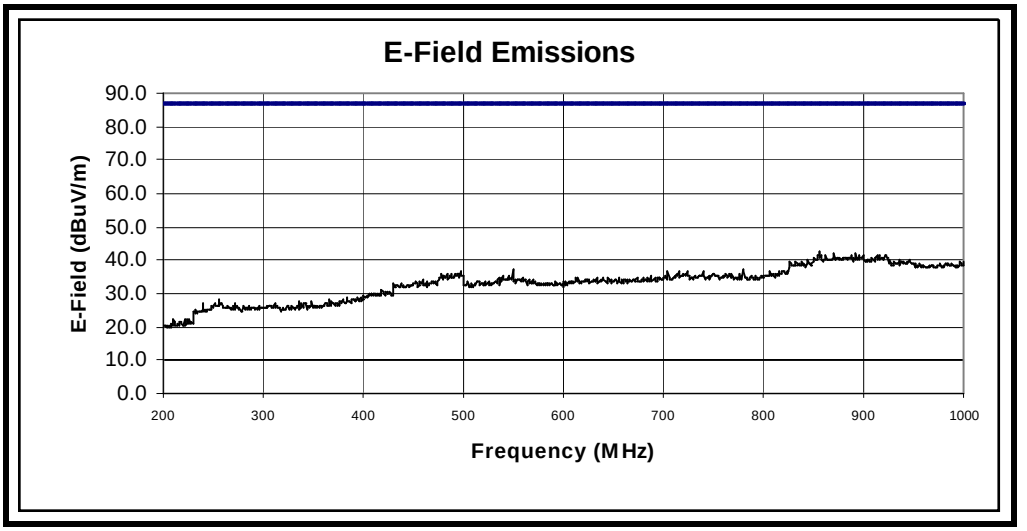
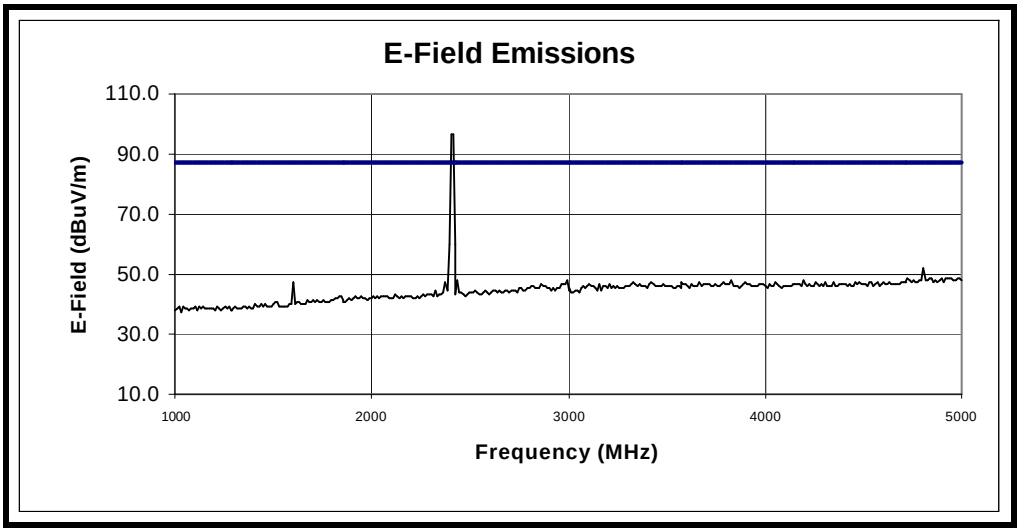
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
dBuV/m
0.0
0.1
0.2
0.3
0.4
0.5
Freq (MHz)
Field strength Limit (dBuV/m)
Emission Result (dB)


490KHz to 1.705MHz S01 Ch 11 E
File: MAGCH112.TXT
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
dBuV/m
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
Freq (MHz)
Field strength Limit (dBuV/m)
Emission Result (dB)


1.705MHz to 30MHz S01 Ch 11 E
File: MAGCH112.TXT
dBuV/m
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1.6 3.6 5.6 7.6 9.6 11.6 13.6 15.6 17.6 19.6 21.6 23.6 25.6 27.6 29.6
Freq (MHz)
Field strength Limit (dBuV/m)
Emission Result (dB)


E-Field Emissions
E-Field (dBuV/m)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Frequency (MHz)


E-Field Emissions
E-Field (dBuV/m)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
200
300
400
500
600
700
800
900
1000
Frequency (MHz)


E-Field Emissions
E-Field (dBuV/m)
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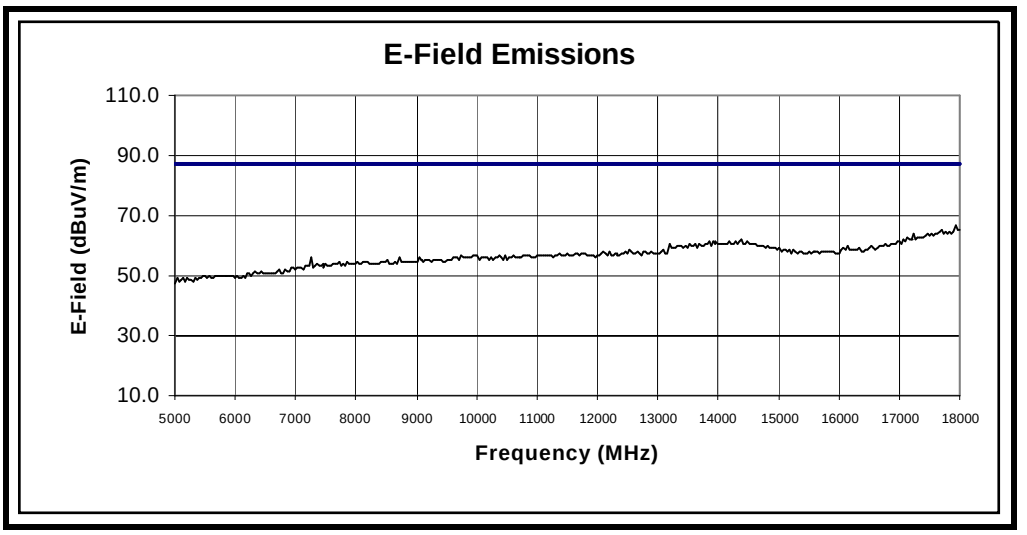
70.0
50.0
30.0
10.0
1000
2000
3000
4000
5000
Frequency (MHz)


E-Field Emissions
E-Field (dBuV/m)
110.0
90.0
70.0
50.0
30.0
10.0
5000
6000
7000
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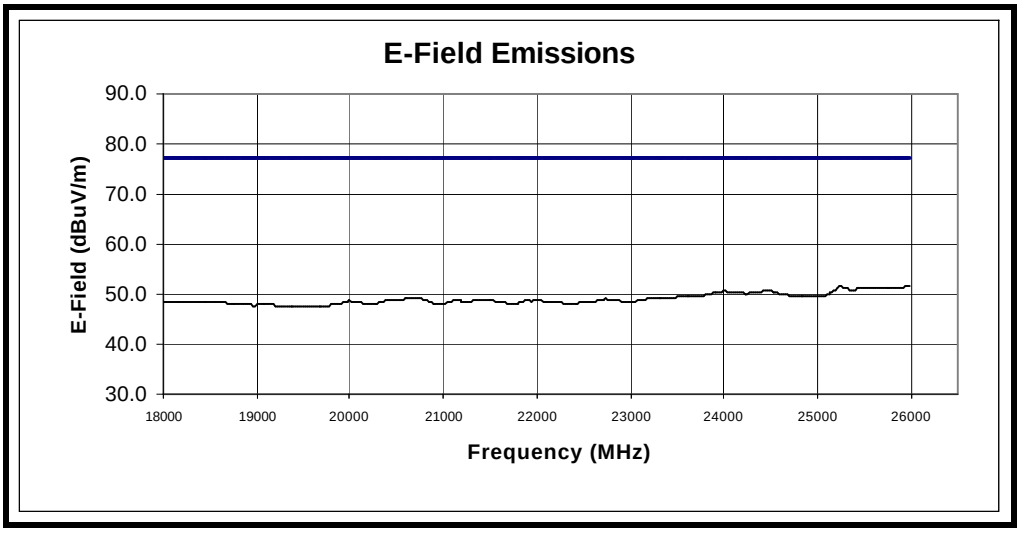
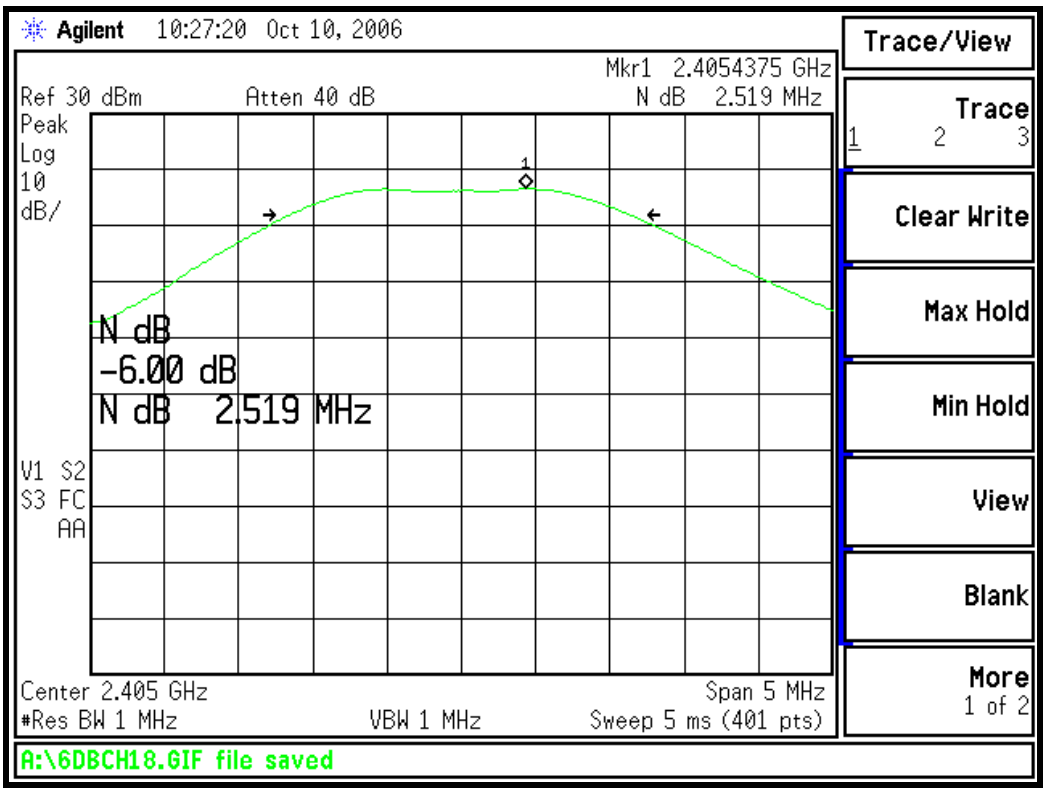
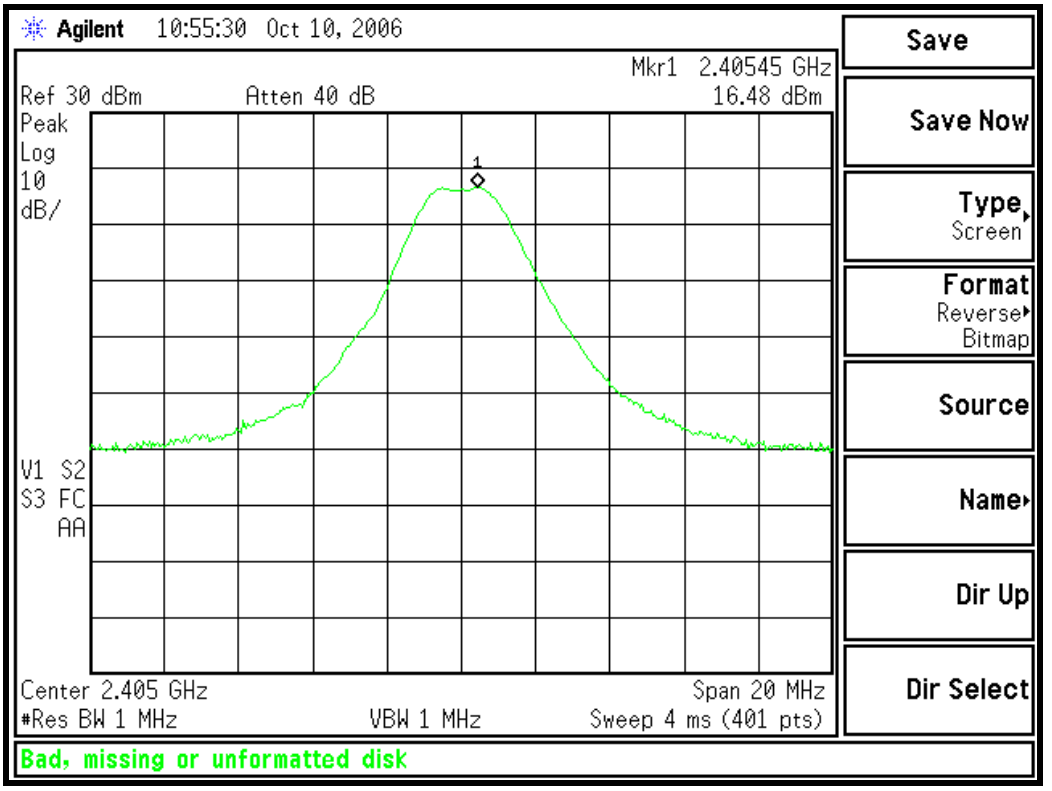
13000
14000
15000
16000
17000
18000
Frequency (MHz)

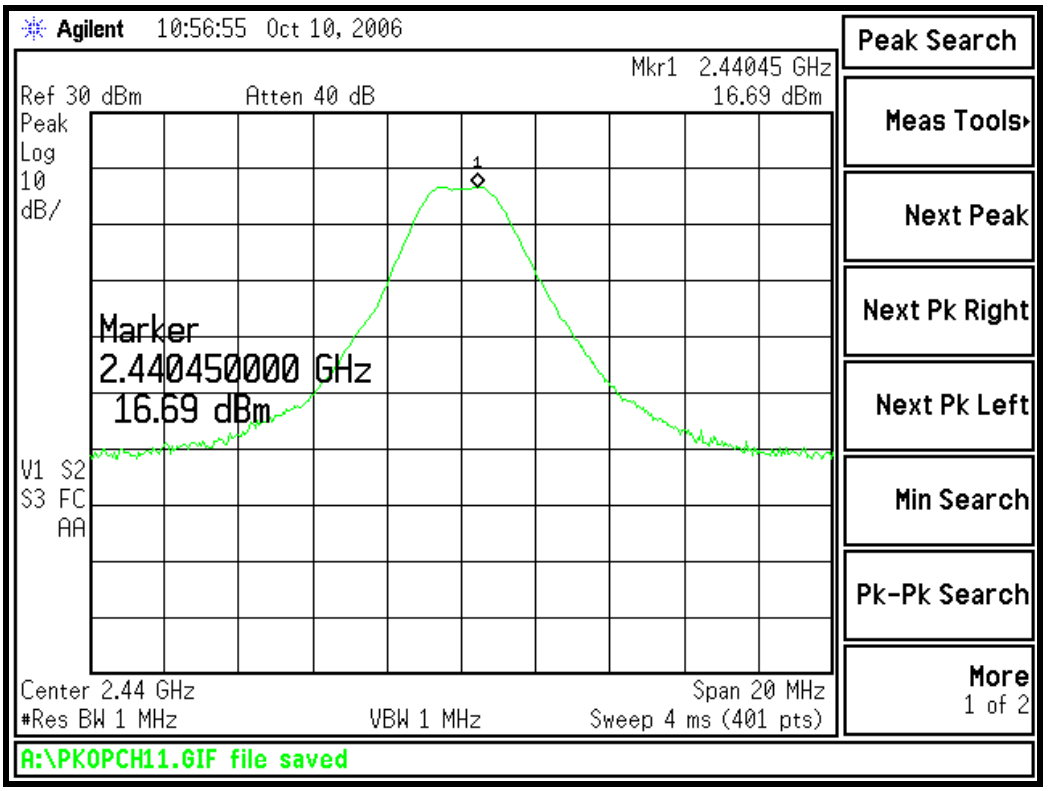

E-Field Emissions
E-Field (dBuV/m)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
18000
19000
20000
21000
22000
23000
24000
25000
26000
Frequency (MHz)



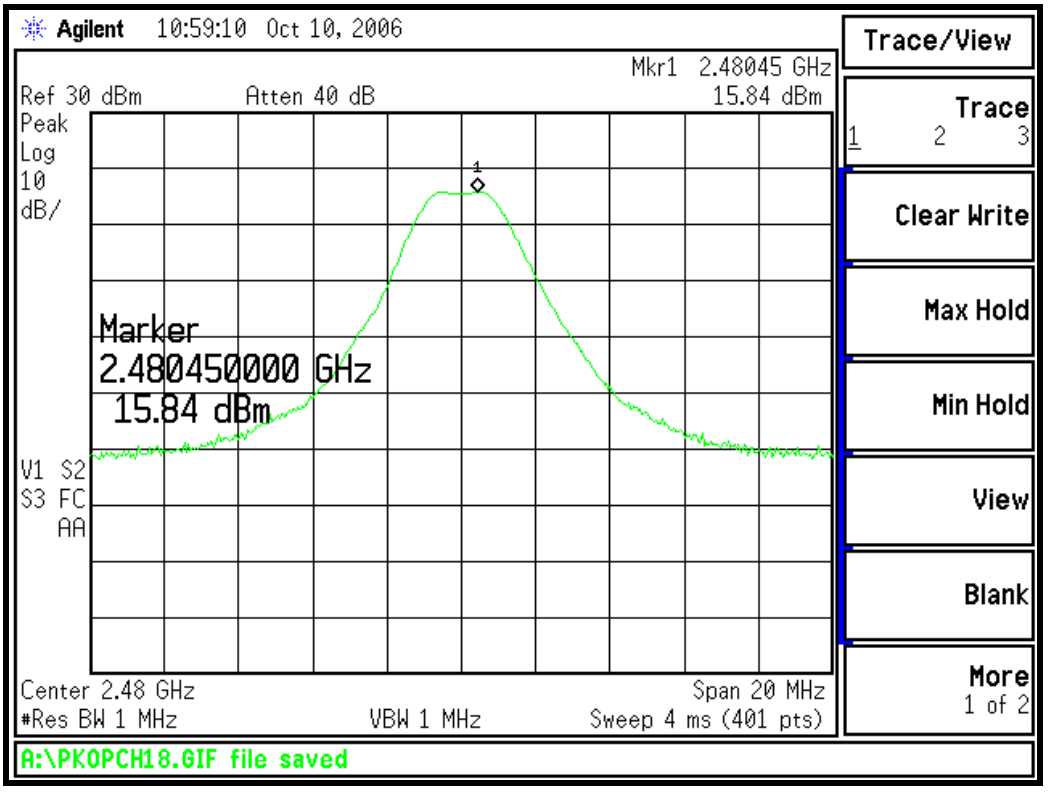
6 dB Bandwidth



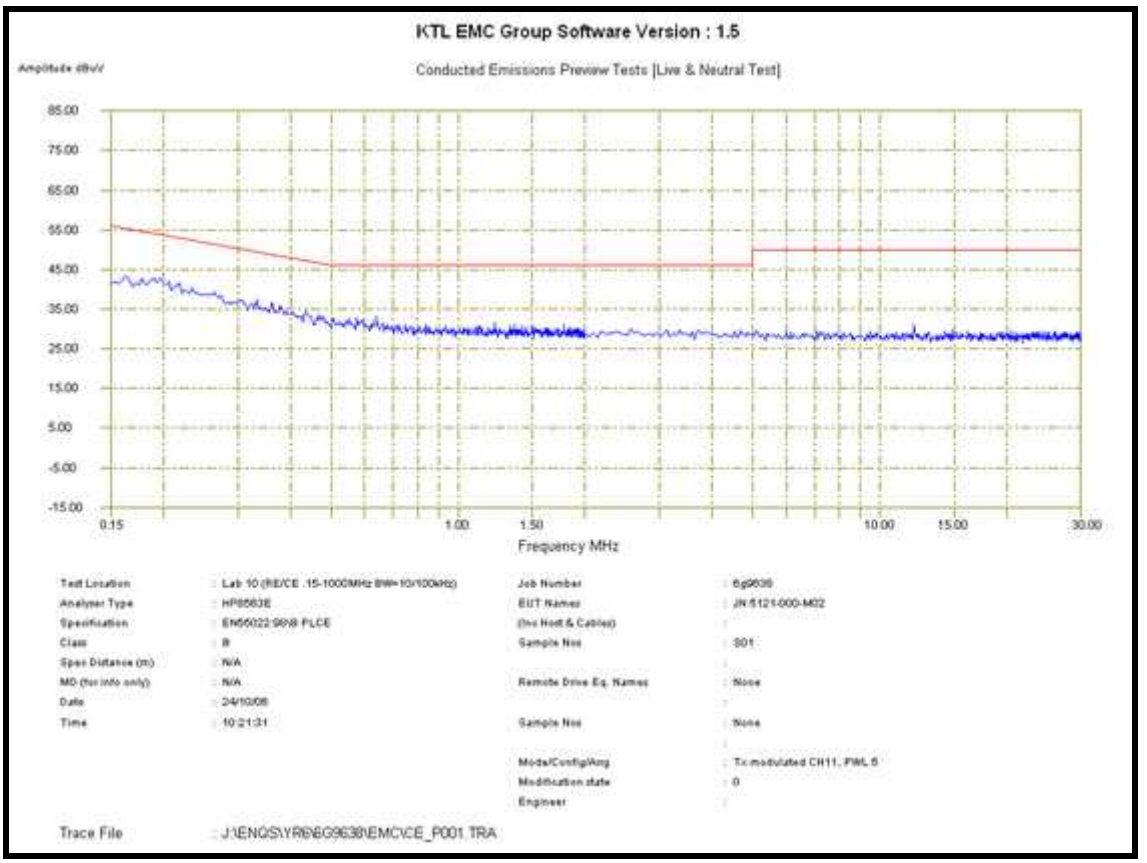
Carrier Power 2405 MHz



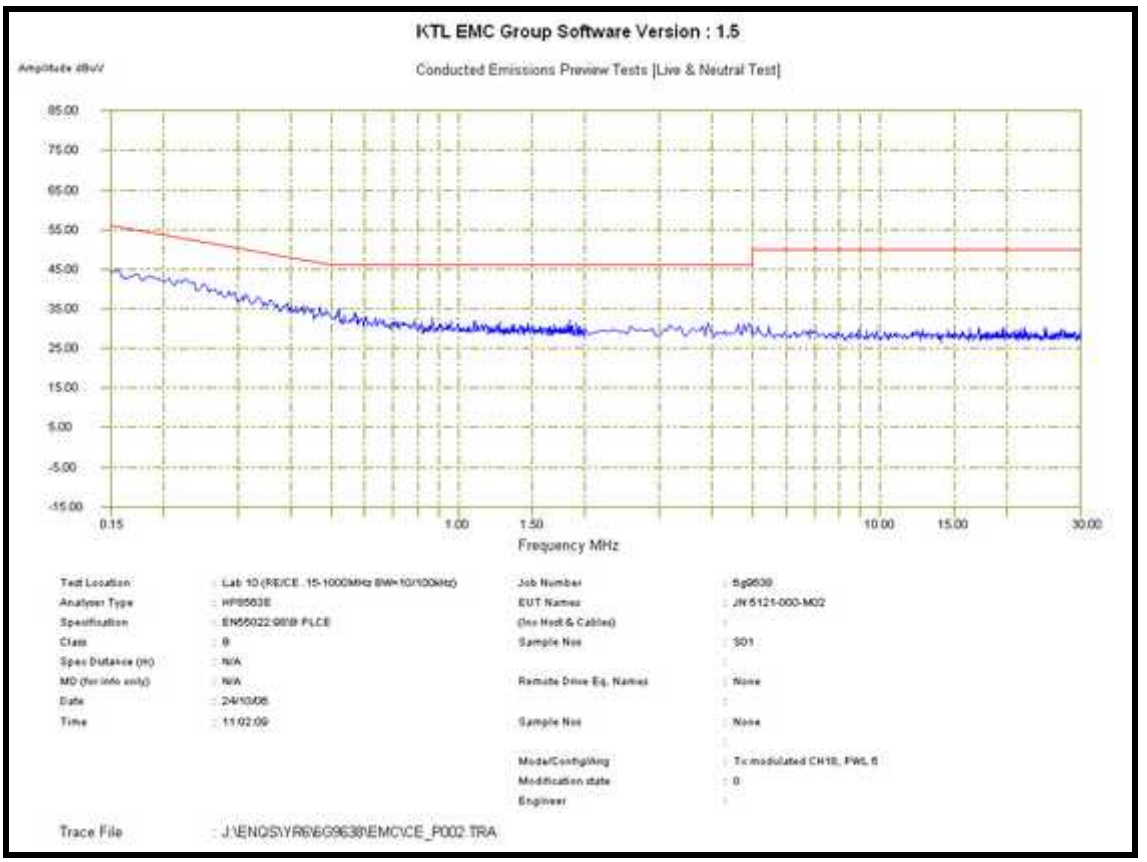
Carrier Power 2440 MHz



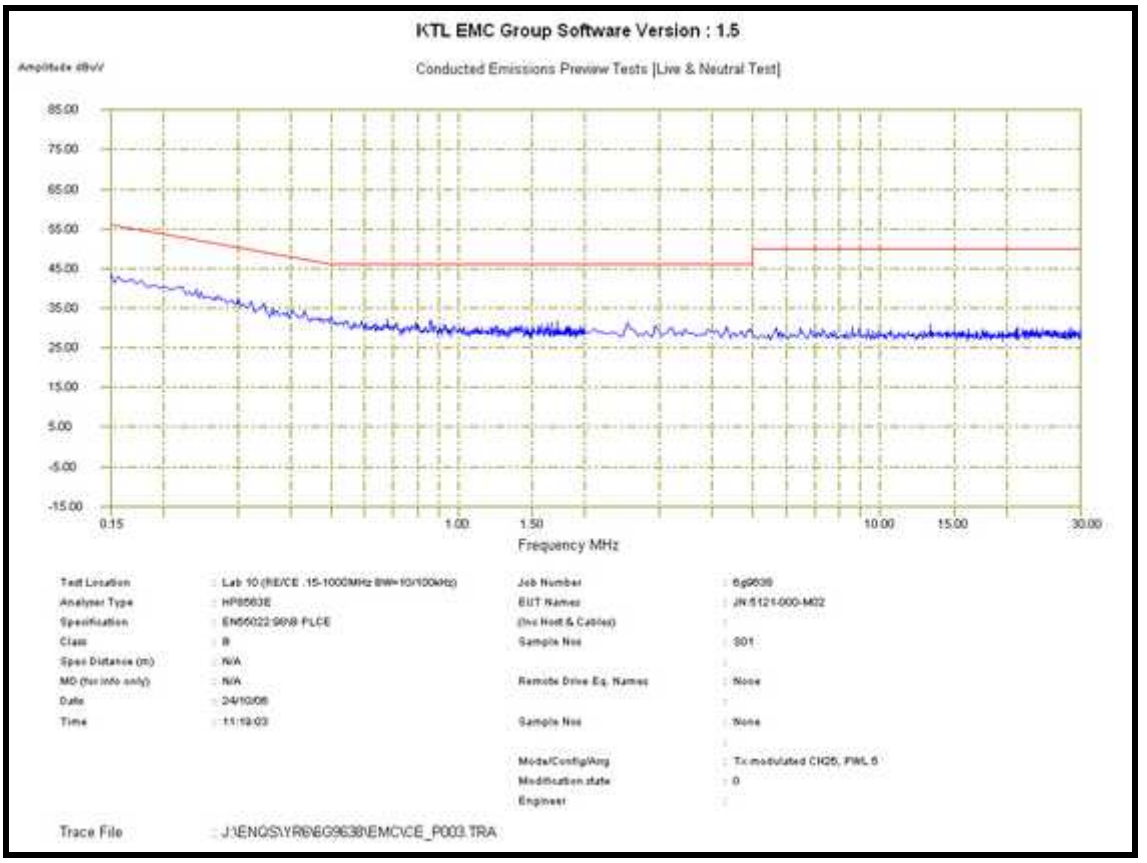
Carrier Power 2480 MHz



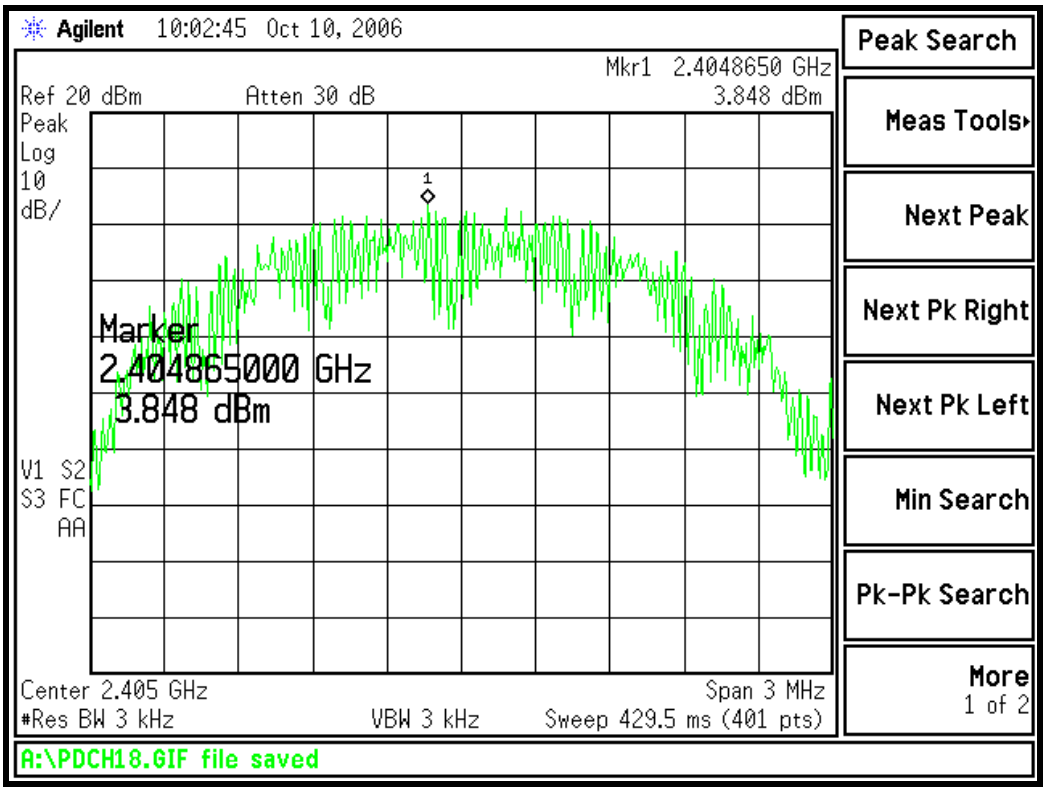
Conducted Emissions 2405 MHz



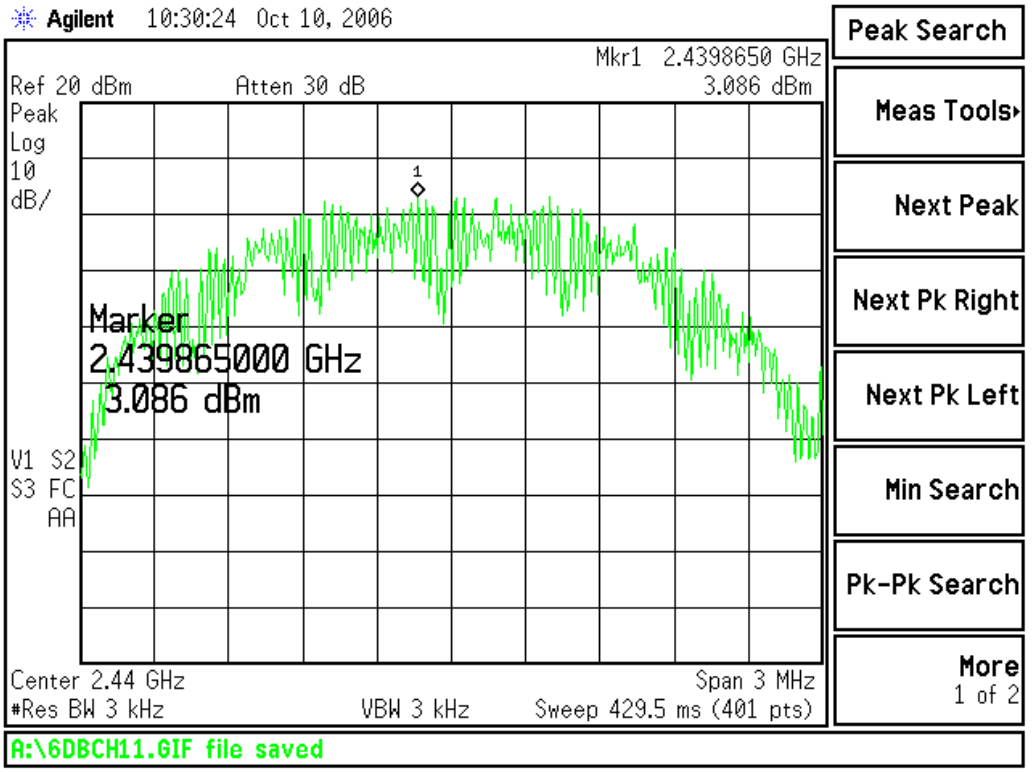
Conducted Emissions 2440 MHz



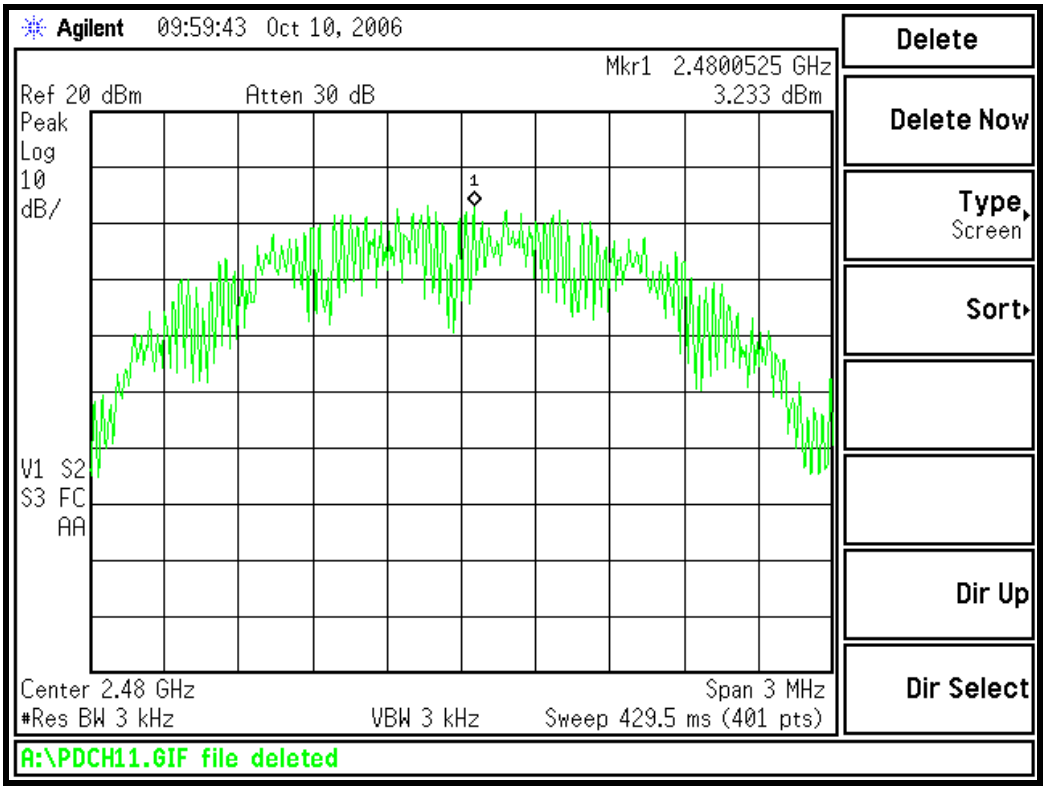
Conducted Emissions 2480 MHz



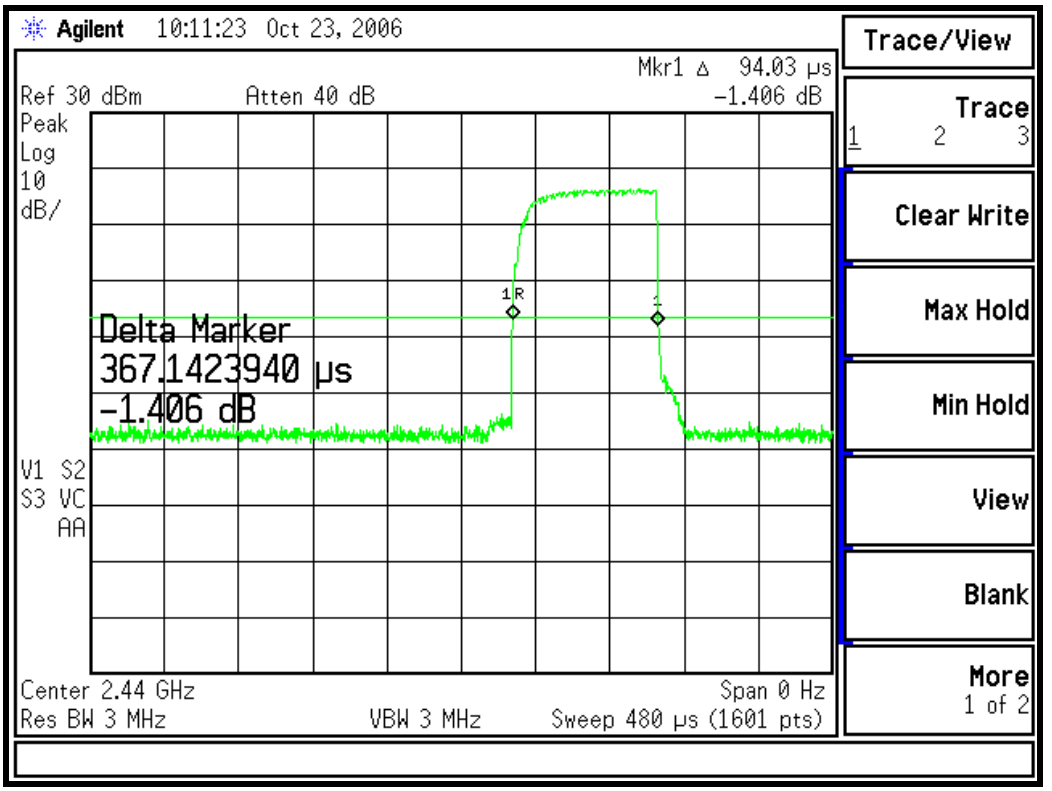
Power Spectral density 2405 MHz



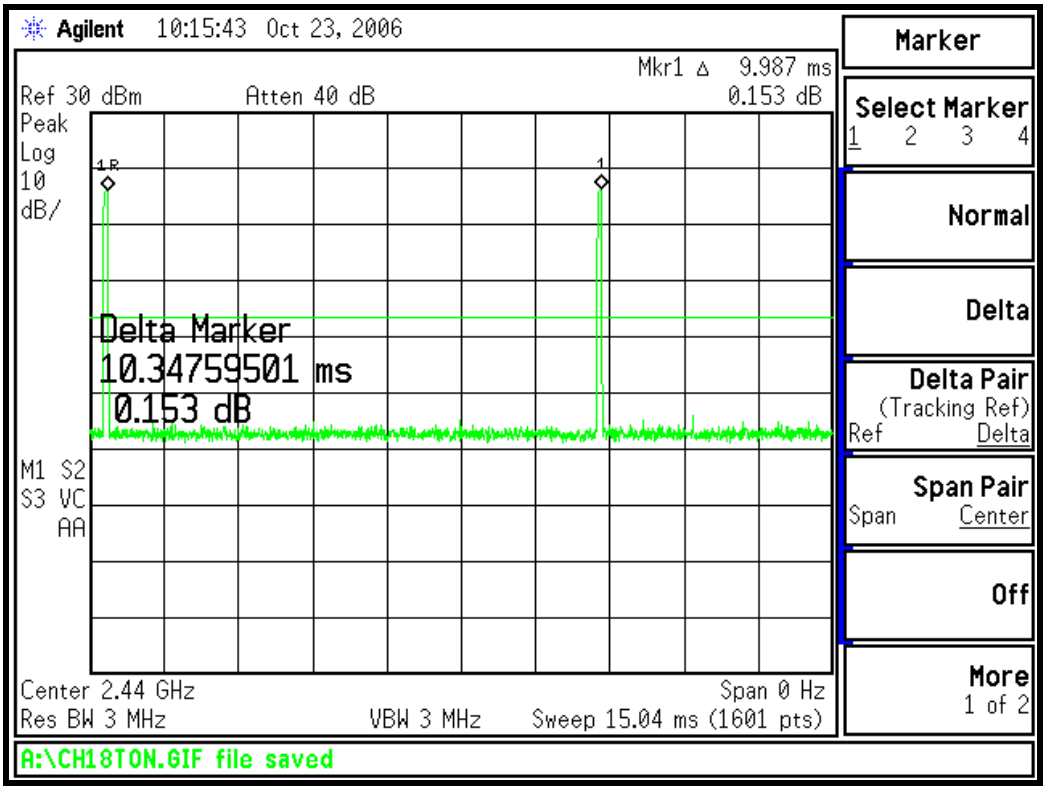
Power Spectral Density 2440 MHz



Power spectral density 2480 MHz



Transmitter on time



Transmitter repetition time

Appendix C: Additional Test and Sample Details

This appendix contains details of:

1. The Samples submitted for testing.
2. Details of EUT operating mode(s)
3. Details of EUT configuration(s) (see below).
4. EUT arrangement (see below).

Throughout testing, the following numbering system is used to identify the sample and it's modification state:

Sample No: Sxx Mod w

where:

xx = sample number eg. S01
w = modification number eg. Mod 2

The following terminology is used throughout the test report:

Support Equipment (SE) is any additional equipment required to exercise the EUT in the applicable operating mode. Where relevant SE is divided into two categories:

SE in test environment: The SE is positioned in the test environment and is not isolated from the EUT (e.g. on the table top during REFE testing).

SE isolated from the EUT: The SE is isolated via filtering from the EUT. (e.g. equipment placed externally to the ALSR during REFE testing).

EUT configuration refers to the internal set-up of the EUT. It may include for example:

Positioning of cards in a chassis.
Setting of any internal switches.
Circuit board jumper settings.
Alternative internal power supplies.

Where no change in EUT configuration is **possible**, the configuration is described as “single possible configuration”.

EUT arrangement refers to the termination of EUT ports / connection of support equipment, and where relevant, the relative positioning of samples (EUT and SE) in the test environment.

For further details of the test procedures and general test set ups used during testing please refer to the related document "EMC Test Methods - An Overview", which can be supplied by KTL upon request.

C1) Test samples

The following samples of the apparatus were submitted for testing:

Sample No.	Description	Identification
S01	Model JN5121–XXX-M04 High Power Module.	Serial No 3

The following samples of apparatus were submitted (or supplied by KTL) as host, support or drive equipment (auxiliary equipment):

Sample No.	Description	Identification
N/A	EMC Laptop	RFG 456

C2) EUT Operating Mode During Testing.

During testing, the EUT was exercised as described in the following tables :

Test	Description of Operating Mode
All tests detailed in this report	EUT transmitting on maximum power using FSK Modulation

C3) EUT Configuration Information.

The EUT was submitted for testing in one single possible configuration.

C4) List of EUT Ports

The table below describes the termination of EUT ports:

Sample : S05
Tests : All

Port	Description of Cable Attached	Cable length	Equipment Connected
dc Power	2 core Unscreened	1m	Batteries/PSU
Serial	Multicore Unscreened	2m	EMC Laptop*

* Only connected during setup.

C5) Details of test equipment used

For Radiated Electric Field Emissions 30MHz to 1GHz:

RFG No	Type	Description	Manufacturer	Date Calibrated.
274	ATS	Ferrite Lined Chamber	KTL	24/05/05
231	CBL6111	Blue Bilog Antenna (0.03 - 1GHz)	Chase	31/08/05
214	ESAI	Spec Analyser/Test Rxer (LF/HF)	R & S	27/09/05
249	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
255	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
270	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05

For Radiated Electric Field Emissions 1GHz to 25GHz

RFG No	Type	Description	Manufacturer	Date Calibrated
274	ATS	Ferrite Lined Chamber	KTL	10/05/06
129	3115	Horn Antennas	EMCO	29/07/98
307	HP8449B	Microwave Pre-Amp (1-26.5GHz)	HP	25/01/06
312	-	Sucoflex uW Adapter Cable 1m	Suhner	30/01/06
313	-	Sucoflex uW Adapter Cable 1m	Suhner	30/01/06
137	N-104	Sucoflex uW Cable 2m	Suhner	30/01/06
138	N-104	Sucoflex uW Cable 2m	Suhner	30/01/06
158	N-106	Sucoflex uW Cable 6m	Suhner	30/01/06
404	E4407B	Spectrum Analyser	Agilent	25/01/06

For power line conducted emissions

RFG No	Type	Description	Manufacturer	Date Calibrated
n/a	Lab 11	Small Screened Chamber	KTL	-
189	ESH3-Z5	Single-phase LISN	R & S	04/04/05
232	ESH3-Z2	Pulse Limiter	R & S	16/12/05
125	ESHS 10	Test Receiver (LF)	R & S	19/07/05
127	HP8563E	Spectrum Analyser	HP	15/09/05
297	BNC	RF coaxial cable (Lab 11)	KTL	12/08/05
298	BNC	RF coaxial cable (Lab 11)	KTL	12/08/05
464	6220B	110Vac operating DC power supply	HP	N/A

For conducted RF power

RFG No	Type	Description	Manufacturer	Date Calibrated
404	E4407B	Spectrum Analyser	Agilent	25/01/06

For power spectral density

RFG No	Type	Description	Manufacturer	Date Calibrated
404	E4407B	Spectrum Analyser	Agilent	25/01/06
	436A	Power Meter	HP	

Appendix D: Additional Information

The following information is a copy of email correspondence from the client, detailing the frequencies used within the EUT. The lowest declared frequency is 100 kHz; the highest generated frequency is 2480 MHz (highest channel of transmitter). In addition are details of the antennas that will be used with the module.

Hi Ken,

in response to questions from Martin:

The highest frequency on the controller board in the 4MHz interface to the LCD - driven from the module.

The highest frequency on the Sensor board is a 1MHz interface to the sensors - driven from the module.

Also, I can confirm that the maximum centre frequency for the module is 2.48GHz.

For the immunity tests, I suggest we use 50% PER as the criterion for success.

best regards,

Colin

Colin Faulkner

Business Development Manager - ZigBee

_____

Hi Martin,

I've checked, and one of the sensor clocks can go as slow as 100kHz - this will be the lowest operating frequency on both sensor and controller boards.

regards,

Colin

Colin Faulkner

Business Development Manager - ZigBee

Hi Martin,

this is the list of antennas we plan to use - will need to refer to these in the FCC submission.

The GigaAnt Titanis that you already have has the highest gain of all the antennas that we might use. The Ceramic antenna mounted on the other module has the lowest gain.

Embedded Antenna Design:	FBKR35068-SM-KR Peak Gain 2dBi
Antenna Factor:	ANT-2.4-CW-RCT-SS Peak Gain 2.2dBi
Centurion:	WCR2400 Peak Gain 2dBi
Centurion:	WCR2400-SMRP Peak Gain 1.3dBi
GigAnt:	Titanis Peak Gain 4.4dBi
Ceramic Antenna on module	
Yageo:	Phycomp 52047, Peak Gain 0dBi

Other things you wanted information on:

The Evaluation kits are purely battery powered, so should be tested as portable equipment.

In case this is of use to you, the RS232 cable supplied is less than 3m long - no power supply cable is included.

best regards,

Colin

Colin Faulkner

Business Development Manager - ZigBee

antenova®

Titanis 2.4 GHz Swivel SMA Antenna

4 Model name

20 10 Bxxxx - 01

- Drawing No.
- Technology -Metal
- Antenna Family -External

5 General data

Product Name	Titanis 2.4 GHz
Article No.	2010B4844-01 (Standard)
	2010B6090-01 (Reverse thread)
Frequency	2.4-2.5 GHz
Polarization	Linear
Operating temperature	-40 to + 85 degC
Impedance	50 Ohm
Weight	7.4 gram
Antenna type	Swivel

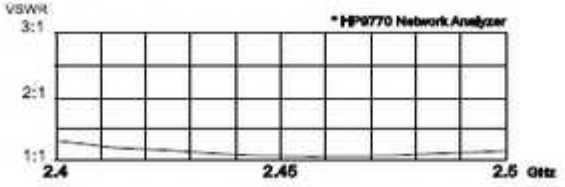
6 Electrical characteristics

	Characteristics			Conditions*
	Min	Typ	Max	
Peak Gain	4.0 dBi	4.1 dBi	4.4 dBi	Frequency 2.4-2.5 GHz, Measured in 3D chamber (near field)
Efficiency	80%	85%	90%	
VSWR	1.1:1	1.2:1	1.3:1	Frequency 2.4-2.5 GHz, Measured in Network Analyzer

*Note all data provided in this table are based on the Antenova reference board

7 Electrical performance

7.1 Voltage Standing Wave Ratio



Integrated Antenna Solutions

3

Product Specification AE030064-C

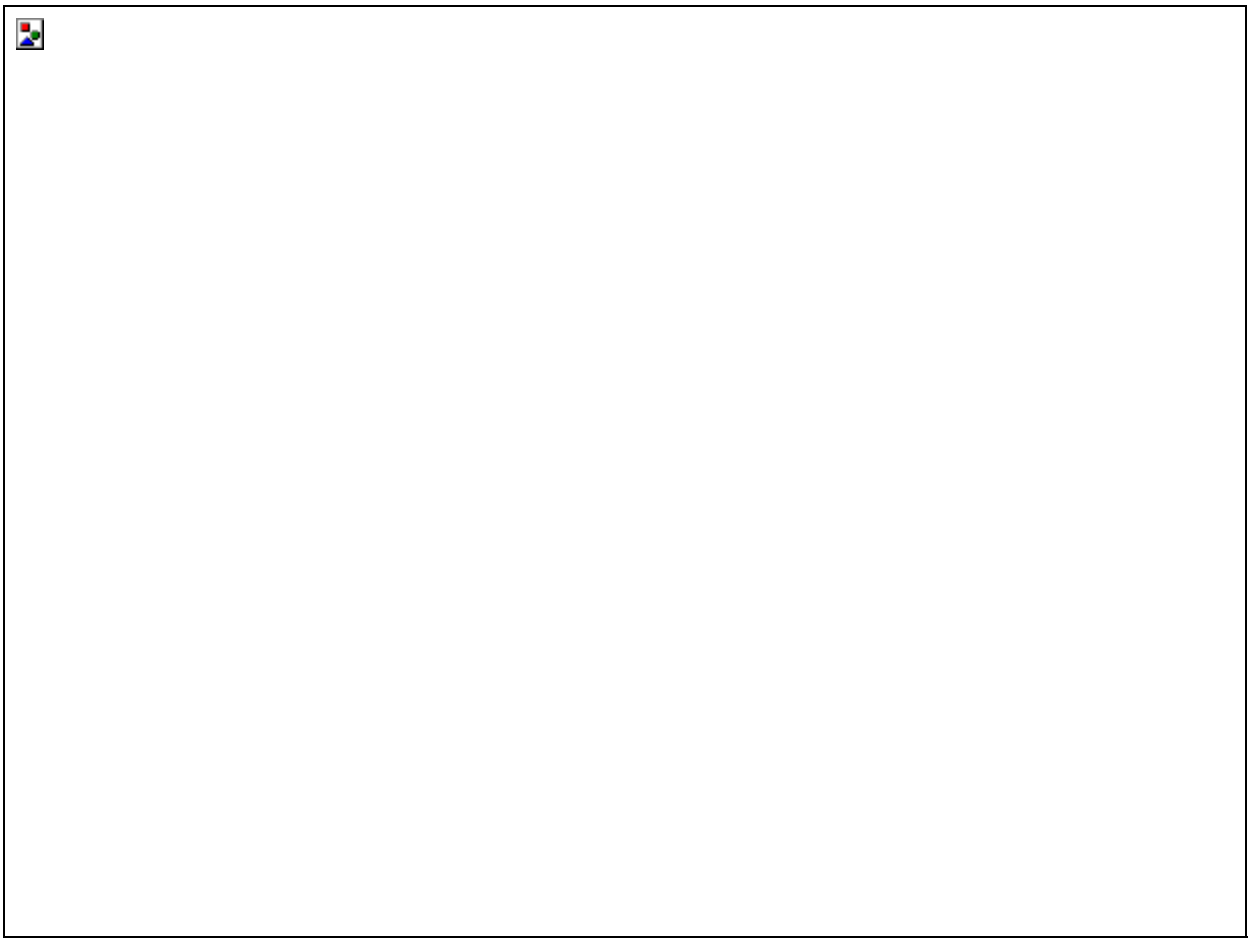
Extract from Antenna Manufacturers data sheet detailing antenna gain.

Appendix E: Photographs and Figures

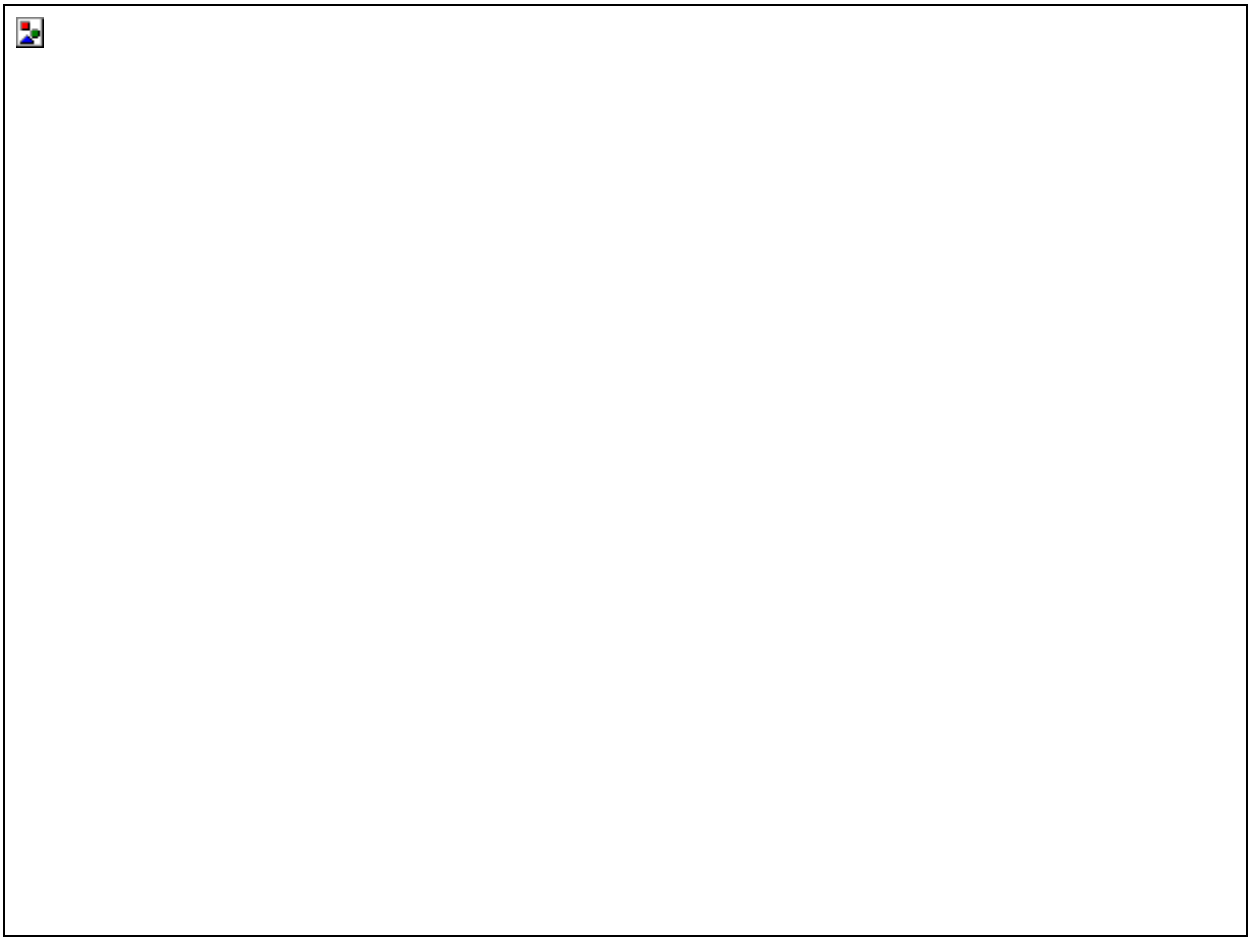
The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement.
2. Radiated electric field emissions arrangement: close up view
3. Power line conducted emissions arrangement.

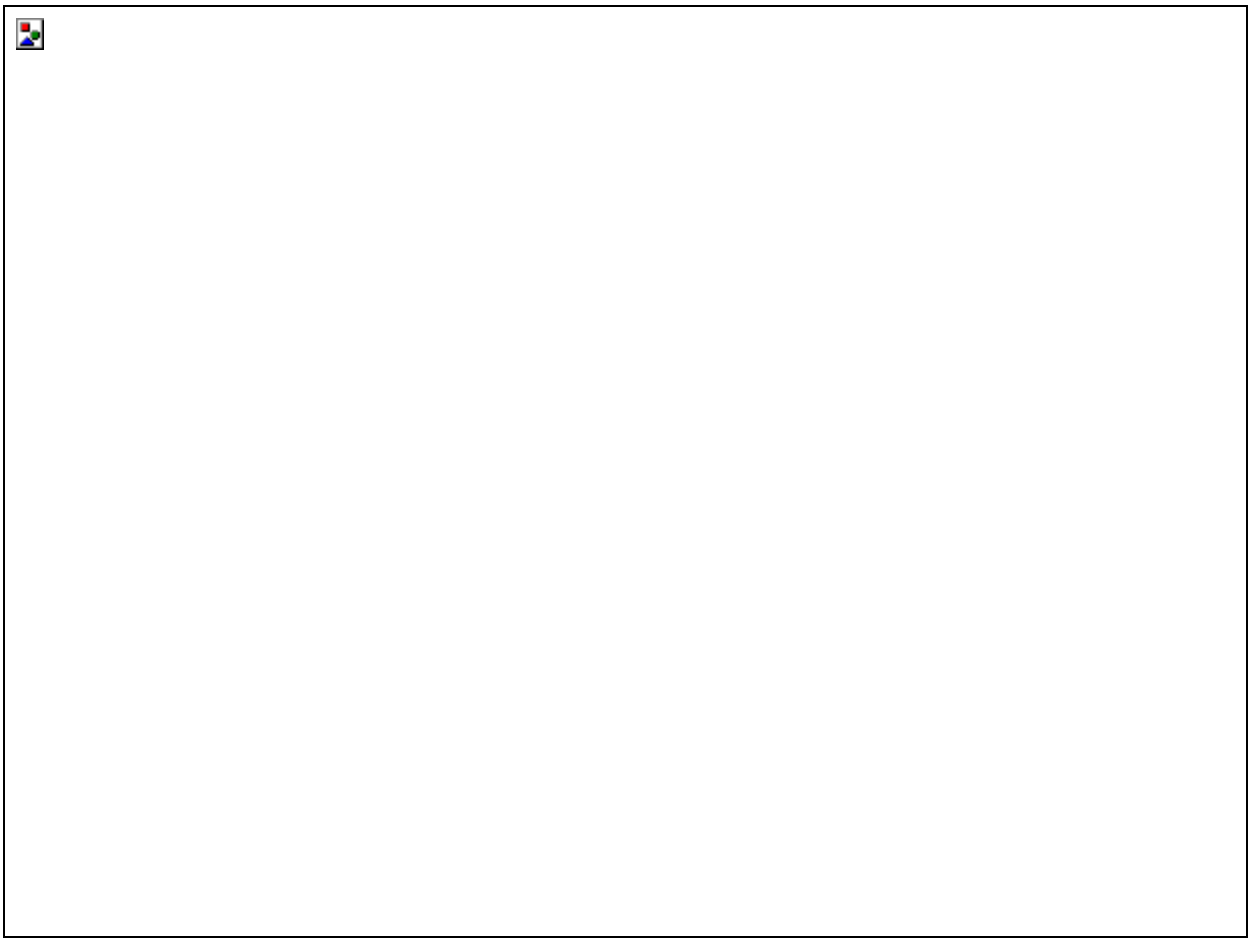
Note: The photographs show the EUT tested, which was specially fitted with a regular SMA type connector to facilitate testing. The actual production units will be fitted with a reverse polarity SMA connector to meet the requirements of 47CFR 15.203



Photograph 1



Photograph 2



Photograph 3

Appendix F: MPE Calculation

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at the antenna terminal:	16.72	(dBm)
Maximum peak output power at the antenna terminal:	46.98941086	(mW)
Antenna gain(typical):	4.4	(dBi)
Maximum antenna gain:	2.754228703	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2450	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1	(mW/cm^2)
Power density at prediction frequency:	0.025747	(mW/cm^2)
Maximum allowable antenna gain:	20.29269855	(dBi)