Test Report

DANAK
Reg. no. 19

Emission tests to FCC requirements of TrackMan

Performed for Interactive Sports Games A/S

DANAK-197620
Project no.: E502372-1
Page 1 of 14
5 annexes

24 September 2004

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Title	Emission tests to FCC requirements of TrackMan
Test object	TrackMan 10.5 GHz Field Disturbance Sensor
FCC ID	SFX-TMAN
Report no.	DANAK-197620
Project no.	E502372-1
Test period	02 September 2004 to 03 September 2004
Client	Interactive Sports Games A/S Staktoften 2 2950 Vedbaek Denmark Telephone: +45 45 57 08 50 Fax: +45 45 74 00 39
Contact person	Mr. Fredrik Tuxen
Manufacturer	Interactive Sports Games A/S
Specifications	47 CFR Part 15, Subpart C - Intentional Radiators
Results	The equipment under test was in compliance with the requirements.
Test personnel	Karsten Kruse Jensen Vagn Sylvest
Date	24 September 2004
Responsible	Vagn Sylvest Project Manager - EMC DELTA

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1. Summaries

1.1 Technical report summary

The tests reported in this document have been performed to demonstrate compliance with the requirements of FCC Part 15, Section 15.245 Operation within the bands 902 - 928 MHz, 2435 - 2465 MHz, 5785 - 5815 MHz, 10500 - 10550 MHz and 24075 - 24175 MHz.

This report contains measurement data from tests performed at DELTA, Hørsholm, Denmark, an FCC listed and DANAK accredited test laboratory.

1.1.1 Applicable FCC rules for test

47 CFR Part 15, Subpart C - Intentional Radiators

§15.205	Emission in restricted bands
§15.207	Conducted limits
§15.209	Radiated emission limits, general requirements
§15.215	Additional provisions to the general radiated emission limitations
§15.245	Operation within the bands 902 - 928 MHz, 2435 - 2465 MHz, 5785 - 5815 MHz, 10500 - 10550 MHz and 24075 - 24175 MHz.

The methods and procedures have been applied as specified in:

§15.31 Measurements standards.

This point to the following procedure, used during the measurements in this report:

ANSI C63.4:2001 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz".

Furthermore, the requirements of the following have been applied:

§ 15.33 Frequency range of radiated measurements
§ 15.35 Measurement detector functions and bandwidths.

1.2 Summary of tests

The results of the emission tests can be summarised as follows:

Tests of Intentional Radiator	Key references to requirement	FCC Part 15 Subpart C
Conducted emission, AC mains	§ 15.207	Passed
Radiated electromagnetic field emission	§15.209	Passed
Radiated emission limits, additional provisions	§15.215 and §15.245	Passed
Emission in restricted bands	§15.205	Passed

Abbreviations

Passed	:	The requirements are met.
Failed	:	The requirements are not met.
Not done	:	No test was performed.
N/A	:	Not applicable.
Not relevant	:	The test was not relevant for the test object.

The test results relate only to the objects tested.

2. Test specimen

The EUT is a Field Disturbance Sensor installed in a cabinet. Information from the field disturbance sensor is transmitted to a PC using an USB2 connection.

The field disturbance sensor is designed for the purpose of measuring properties of golf balls and will only be used on golf fields or in golf ball manufacturers test facilities.

The EUT will transmit a continuous carrier in the frequency band of 10.5 to 10.55 GHz. There is no traditional receiver with down converter etc. in the product. The down conversion is direct as the Doppler signal produced as the frequency difference between the radiated field and the received (reflected) signal.

2.1 Test object - Field Disturbance Sensor (Tx & Rx)

Category	Field Disturbance Sensor
Manufacturer	Interactive Sports Games A/S
Model / type	TrackMan
Part no.	-
Serial no.	04080021
FCC ID	SFX-TMAN
Supply voltage	12 VDC
Operational mode	TX

2.2 AUX equipment - Power adapter for Field Disturbance Sensor

Category	AC/DC Converter
Manufacturer	Mascot
Model / type	9885
Part no.	-
Serial no.	Barcode: 01892879 0412
FCC ID	-
Supply voltage	100-240 VAC
Operational mode	Supplying 12 VDC

2.3 AUX equipment - PC

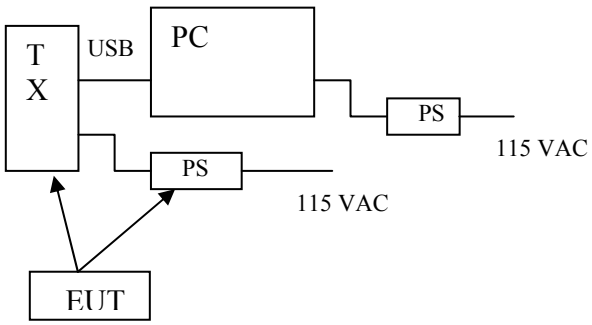
Category	IT
Manufacturer	Panasonic
Model / type	CF-29
Part no.	barcode: CF-29ETKGZG2 4 GYAA01044
Serial no.	-
FCC ID	Tested to comply
Supply voltage	15.5 VDC
Operational mode	Normal operation

2.4 AUX equipment - Power adapter for PC

Category	IT
Manufacturer	Panasonic
Model / type	CF-AA1653A M2
Part no.	SEB100P3-15.6C
Serial no.	042 13486B
FCC ID	-
Supply voltage	100-240 VAC
Operational mode	Supplying 15.6 VDC

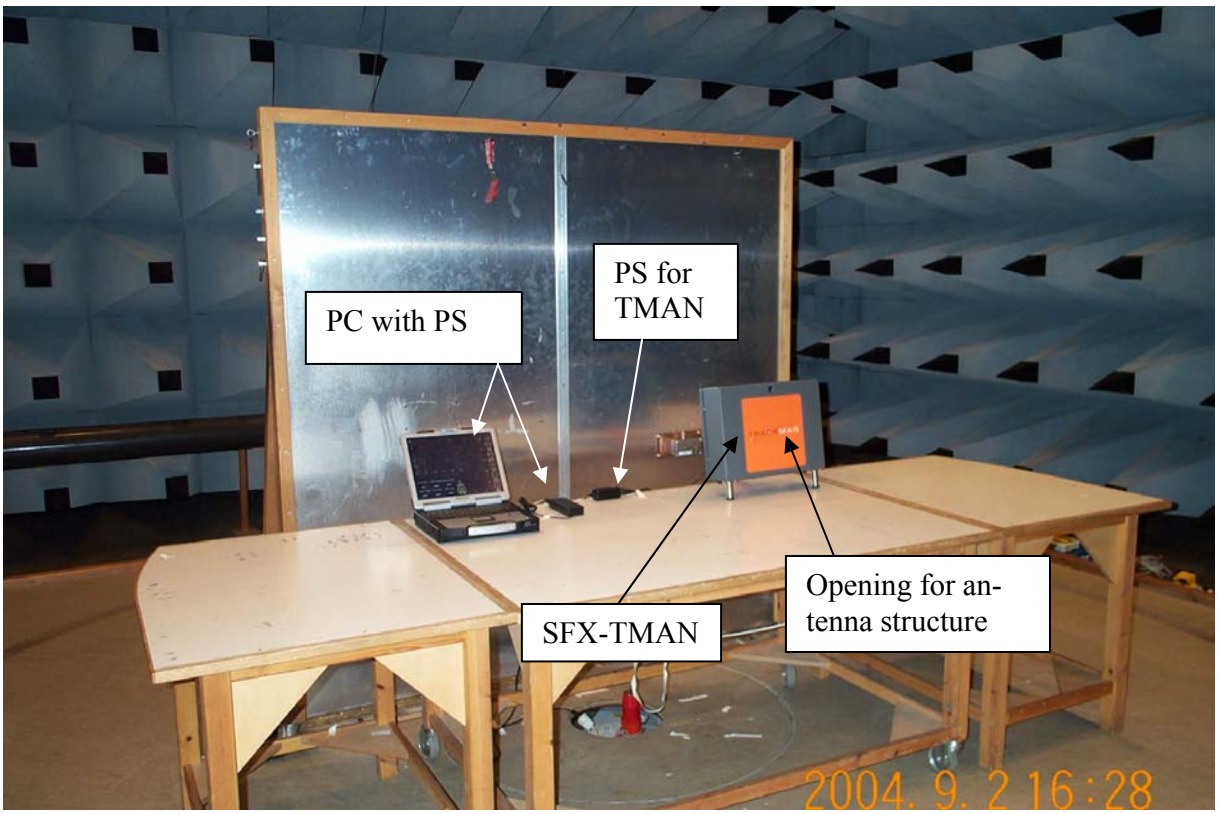
3. General test conditions

3.1 Test set-up



The antenna of the EUT in an internal structure mounted behind a cover.

The EUT will transmit un-modulated carrier. Reflected signals will produce a Doppler signal that is converted and transmitted to the PC for calculation. In the EUT is also installed a camera. Pictures is constantly captured and transmitted to the PC, where it is displayed.



3.2 Modifications before test

DC input lines to DC/DC converter decoupled each with 100 nF to common chassis.

Electrical/mechanical connection between lid of camera and base case of camera improved.

Screen of USB cable to camera connected to common chassis at camera.

4. Test and results

4.1 Conducted emission, AC mains (FCC Part 15, Subpart C)

	Requirements	
Specification	FCC Rules and Regulations Part 15, Subpart C	
Test set-up	ANSI C63.4:2001	
Frequency range	0.15 - 30 MHz	
Limit: (quasi-peak)	0.15-0.50 MHz: (decreasing lin. with the logarithm of freq.) 0.50-5 MHz: 5-30 MHz:	66-56 dBµV 56 dBµV 60 dBµV
Limit: (average)	0.15-0.50 MHz: (decreasing lin. with the logarithm of freq.) 0.50-5 MHz: 5-30 MHz:	56-46 dBµV 46 dBµV 50 dBµV
Photos		*Annex 2*
Test record sheets		*Annex 3*

Results

The module is in compliance with the requirements.

Comments

PS supplying EUT.

4.2 Radiated electromagnetic spurious field (FCC Part 15, Subpart C)

	Requirements	
Specification	FCC Rules and Regulations Part 15, Subpart C	
Test set-up	ANSI C63.4:2001	
Measuring distance	3 m	
Frequency range	30-40.000 MHz	
Limits: As specified in 15.209(a)	30-88 MHz: 88-216 MHz: 216-960 MHz: Above 960 MHz:	40 dBµV/m 43.5 dBµV/m 46 dBµV/m 54 dBµV/m
Measurement uncertainty (2 σ) <1 GHz Measurement uncertainty (2 σ) >1 GHz		2.6 dB 4.9 dB
Below 1 GHz the limits apply to measurements performed using a quasi-peak detector. Above 1 GHz the limits apply to measurements of spurious emission performed with an average detector. Furthermore, the peak level must be no higher than 20 dB above the average limit.		
Test set-up Test record sheets		*Annex 2* *Annex 4*

On plots from the R&S receiver, found as A4-portrait plots, statements like "Ant 1 m vertical" and "4 m horizontal" are the antenna positions used during exploratory measurements.

Measurements 1 - 2.75 GHz were performed using an R&S test receiver. The tabulated values on the plot are the measured average values using a resolution bandwidth of 1 MHz.

Measurements 2.75 - 18 GHz are shown as spectrum analyser plots in peak-hold mode where all heights and polarities are maximised together to produce one plot. Peak-to-Average Factor is established to be 0 dB, because un-modulated carrier is transmitted. Therefore, AVG emission values are 0 dB lower than the values indicated on the spectrum analyser plots. This is as a worst-case also assumed for possible harmonics from the digital processor.

Measurements from 18 GHz to 40 GHz showed only harmonics from the transmitter.

The measurements were performed in a laboratory and recorded using a spectrum analyser. The EUT was scanned with hand-held standard gain horn antennas at a distance of approximately 0.5 m. During the scans the bandwidth was lowered in order to lower the noise floor. In the band 18 GHz to 26.47 GHz RBW/VBW equals 100 kHz. In the band

26.47 GHz to 40 GHz RBW/VBW equals 100 kHz. The maximum position and polarity was found and final measurements made there with the horn placed at a distance of 1 meter. This optimisation was made on each significant frequency.

The measurement results are based on the following

Standard gain horn gain at 21 GHz: 16.06 dB. Cable loss 0.84 dB

Standard gain horn gain at 31.5 GHz: 16.12 dB. Cable loss 1.83 dB

Results

The emission was within the specified limits.

Spurious emission 30 - 1000 MHz in tabular form:
(For spectral plots see *Annex 4*)

Spurious freq. MHz	Polarisation	QPeak dBµV/m	dB below QP limit	Note
42.300	V	33.7	6.3	
96.000	H	36.7	6.8	
108.800 (R)	V	35.8	7.7	
241.300	H	36.2	9.8	
384.060	V	37.0	9.0	
480.030	H	35.2	10.8	

(R) means frequency in restricted band as defined in §15.205.

Spurious emission 1000 MHz to 40 GHz in tabular form:
(For spectral plots see *Annex 4*)

Spurious freq. MHz	Polarisa-tion	Peak dBµV/m	Average dBµV/m	dB below peak limit	dB below average limit	Note
1200.200	V	22.6	22.6	51.3	31.3	
1440.084	H	29.8	29.8	44.1	24.1	
2400.120	H	38.0	38.0	35.9	15.9	
21.0199 (R)	-	65.2	65.2	32.3	12.3	2nd harm.
31.5306	-	70.2	70.2	27.3	7.3	3rd harm-

(R) Indicates frequency in restricted band as defined in §15.205.
Average limit is 500 µV/m or 54 dBµV/m, except for harmonics.
Peak limit is 20 dB above average limit or 74 dBµV/m.
Limits on all harmonics 7.5 mV/m or 77.5 dBµV/m. Although the 2nd harmonics falls within a restricted band the common limit applies, following §15.245(b)(1) and (ii).

Comments, general

Measurements of spurious emission performed with CW carrier.

Measurements 30 - 1000 MHz are performed using a test receiver with quasi peak detector.

Measurements 1 GHz to 2.7 GHz are performed using a test receiver with average detector and 1 MHz bandwidth.

Measurements above 2.7 GHz are performed using a spectrum analyser in peak hold mode. Average measurements are performed on spurious peak emission exceeding the average limit, when measured in peak hold mode.

The average level is determined using one of the following procedures:

a) Measuring the signal using RBW 1 MHz and VBW 10 Hz, and using linear level axis, will give an output showing average value.

b) Measuring the peak value of the signal and reducing it by the peak-to-average factor ratio (in dB), which is calculated as 20*log<duty cycle> or established by measurement using a test receiver.

   The duty cycle is determined as described in C63.4, I4 j).

4.3 Occupied bandwidth

With reference to §15.215(c), the 20 dB bandwidth of the emission shall be contained within the designated frequency band with the lower band limit at 10.5 GHz and the upper band limit at 10.55 GHz.

In *Annex 5* the occupied bandwidth is obtained using 10 kHz resolution bandwidth. With reference to subsection 15.215, the 20 dB bandwidth of the emission shall be contained within the frequency band 10.5 - 10.55 GHz. Measured from the plot in *Annex 5*, the 20 dB BW equals 0.039 MHz. With the carrier peak at 10.510187 GHz the occupied spectrum will be:

Occupied bandwidth: 0.039 MHz measured in 10 kHz bandwidth or from 10.51017 to 10.51021 GHz

The EUT is in compliance with the requirement(s).

4.4 Peak output field strength

The peak output field strength of the unit is limited to 2500 mV/m or 128 dBµV/m at a distance of 3 m, following §15.245(b). Measurements show:

Peak output field strength: 1.000 mV/m or 120 dBµV/m,
at the frequency 10.51 GHz.

See plot in *Annex 5*.

The EUT is in compliance with the requirement.

Annex 1

List of instruments

(1 page)

NO.	DESCRIPTION	MANUFACTURER	TYPE NO.
29448	HORN ANTENNA, 12.4-18 GHz w. SUHNER ADAPTOR 3101.19.A	FLANN MICROWAVE	1824-20
29494,3	MICROWAVE CABLE, 1 m	SUHNER	SUCOFLEX 104
29680	IMPULSE VOLTAGE LIMITER	ROHDE & SCHWARZ	ESH3/Z2
29797	BILOG ANTENNA, 30-1000 MHz	CHASE ELECTRICS LTD	CBL 6111A
29837	BROADBAND POWER AMPLIFIER, 8-18 GHz, 1 W	MITEQ	AMF-9B-080180-30P
29861	EMI-SOFTWARE Ver. 1.60	ROHDE & SCHWARZ	ES-K1, PART: 1026.6790.02
29876	RIDGED GUIDE HORN ANTENNA, 1-12.75 (18) GHz	EMCO	3115
29916	AUTOMATIC TEST RECEIVER, 9 kHz - 2.75 GHz	ROHDE & SCHWARZ	ESCS 30 1102.4500.30
29943	"CABLE#27", LOW-LOSS µWAVE CABLE, SMA-SMA, 2 m	SUHNER	SUCOFLEX 104A
49037	BROADBAND MICROWAVE PREAMPLIFIER, 1-12.8 GHz	MITEQ / DELTA	AMF-5D-001128-35-11P
49097	MICROWAVE HP FILTER 2.75-12.75 GHz, MAX. 2 W	MICRO-TRONICS	HPM13106
49306	"CABLE#52", LOW-LOSS µWAVE CABLE, N-N, 8.0 m "EMI"	SUHNER	SUCOFLEX 104 PB
49307	"CABLE#53", LOW-LOSS µWAVE CABLE, N-N, 7.0 m "EMI"	SUHNER	SUCOFLEX 104 PB
49321	SPECTRUM ANALYZER, 50GHz	HEWLETT-PACKARD	8565E
49327	STANDARD GAIN HORN, 26.5-40.0 GHz	NARDA	V637
49328	STANDARD GAIN HORN, 18-26.5 GHz	NARDA	638
49388	40GHz MICROWAVE CABLE, 60 cm	MIDWEST MICROWAVE INTERNATIONAL LTD	CSY-KMKM-44-002-FS

Annex 2

Photos

(3 pages)

Photo A2.1 Conducted emission 0.15 - 30 MHz.

Photo A2.2 Radiated emission 30 - 1000 MHz.

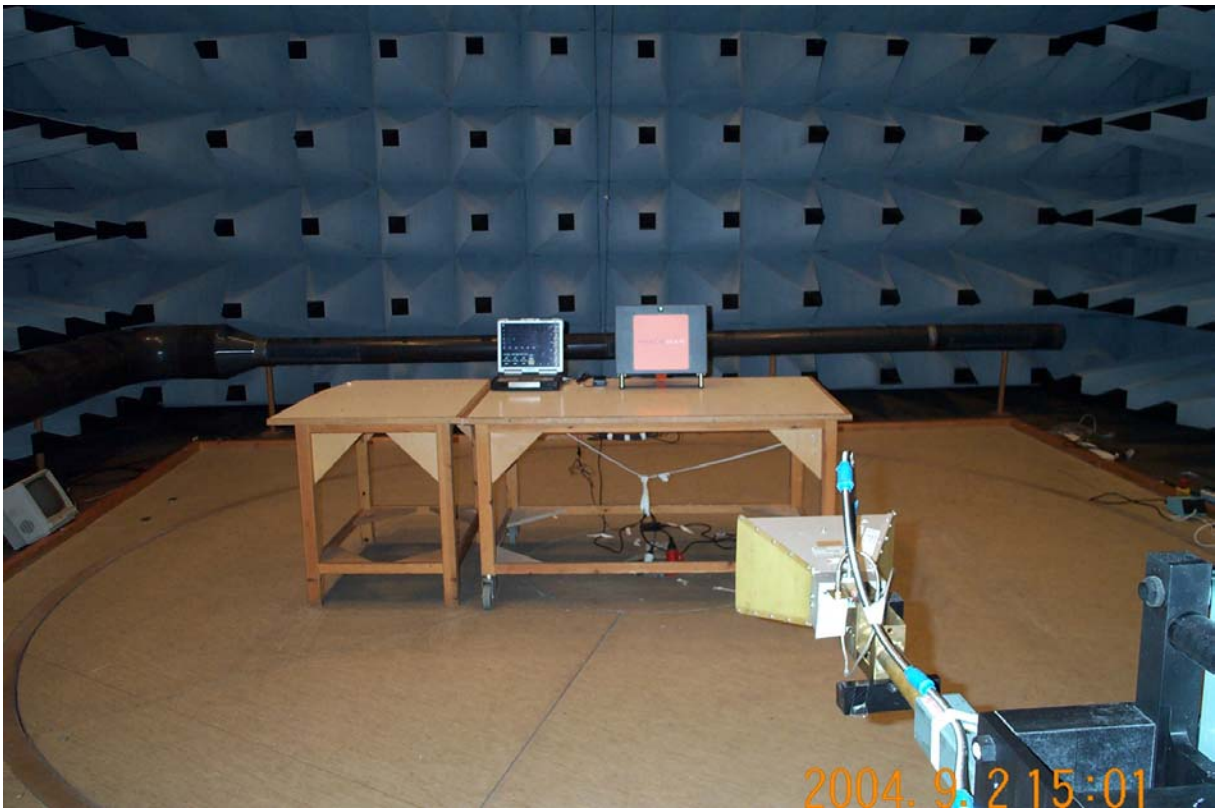


Photo A2.3 Radiated emission 1 - 12.75 GHz.

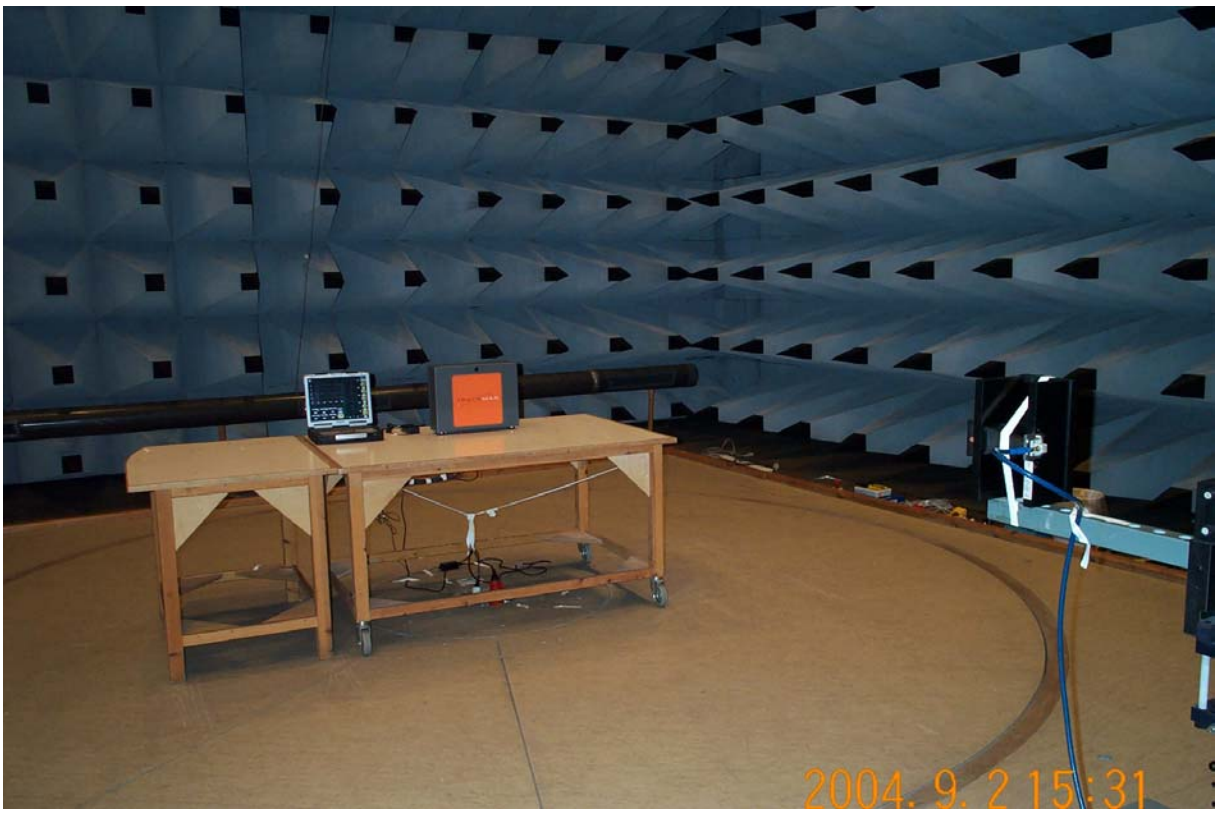


Photo A2.4 Radiated emission 12.75 -18 GHz.

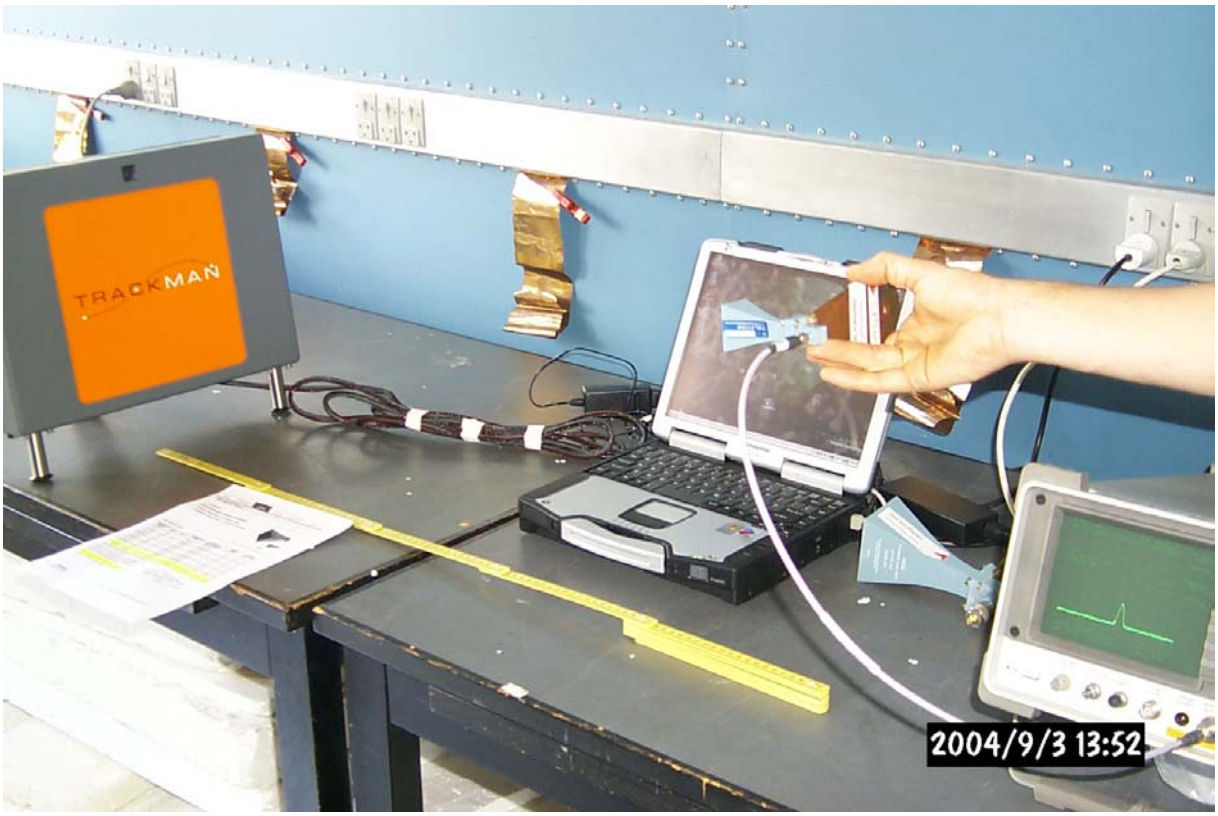


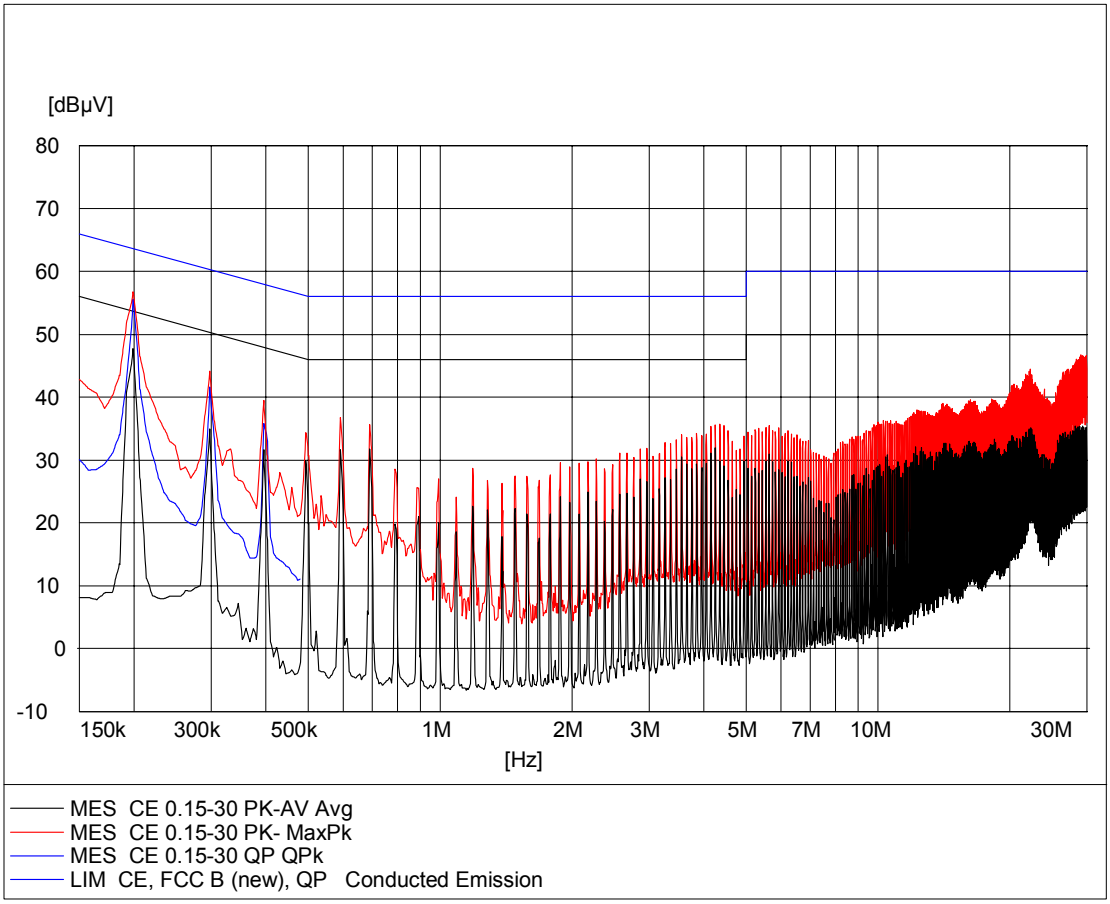
Photo A2.5 Radiated emission 18 - 40 GHz @ 1 m distance.

Annex 3

Test record sheets regarding conducted emission

(2 pages)

EUT: TMAN
Manufacturer: ISG
Operating Condition: Line: Neutral. 120 VAC
Test Site: EMC-5
Operator: KKJ - E502372
Test Specification: FCC part 15 subpart C
Comment: Sheet 14



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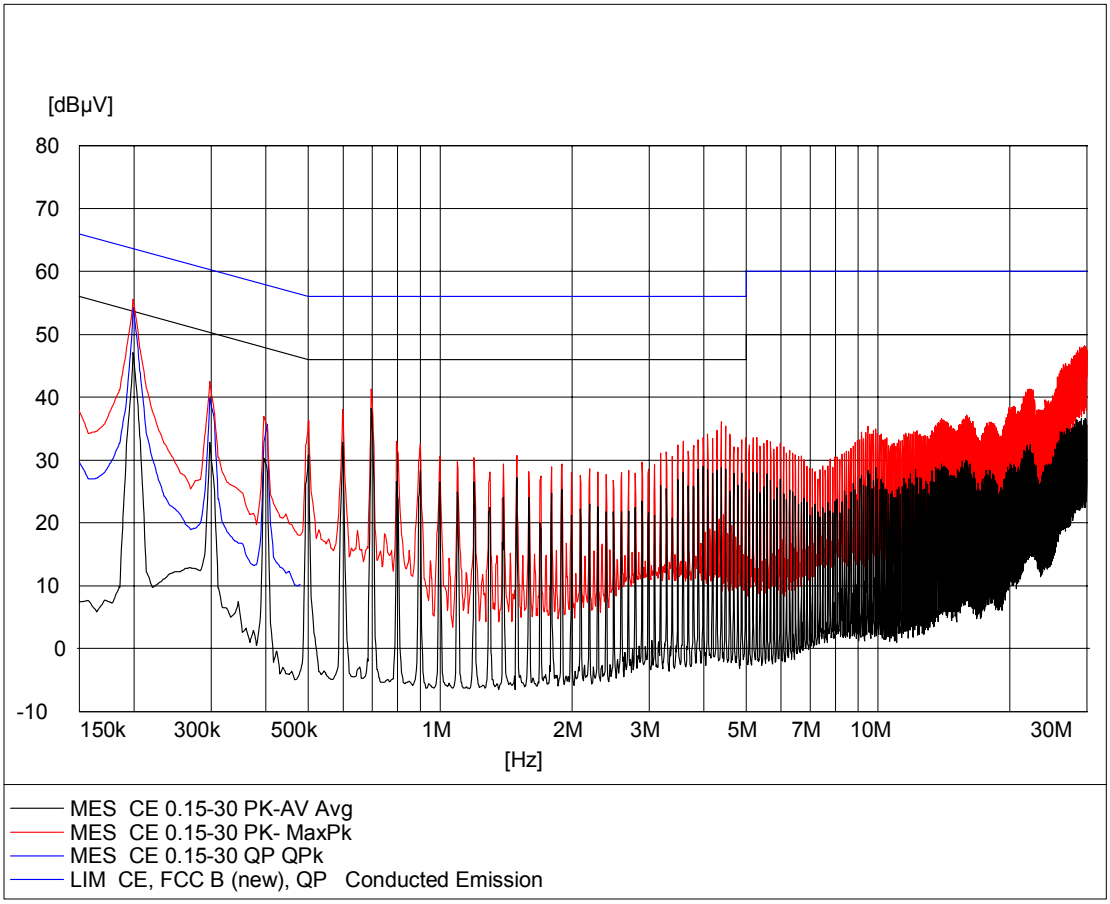
EUT:                    TMAN
Manufacturer:           ISG
Operating Condition:    Line: Line. 120 VAC
Test Site:              EMC-5
Operator:               KKJ - E502372
Test Specification:     FCC part 15 subpart C
Comment:                Sheet 15
```

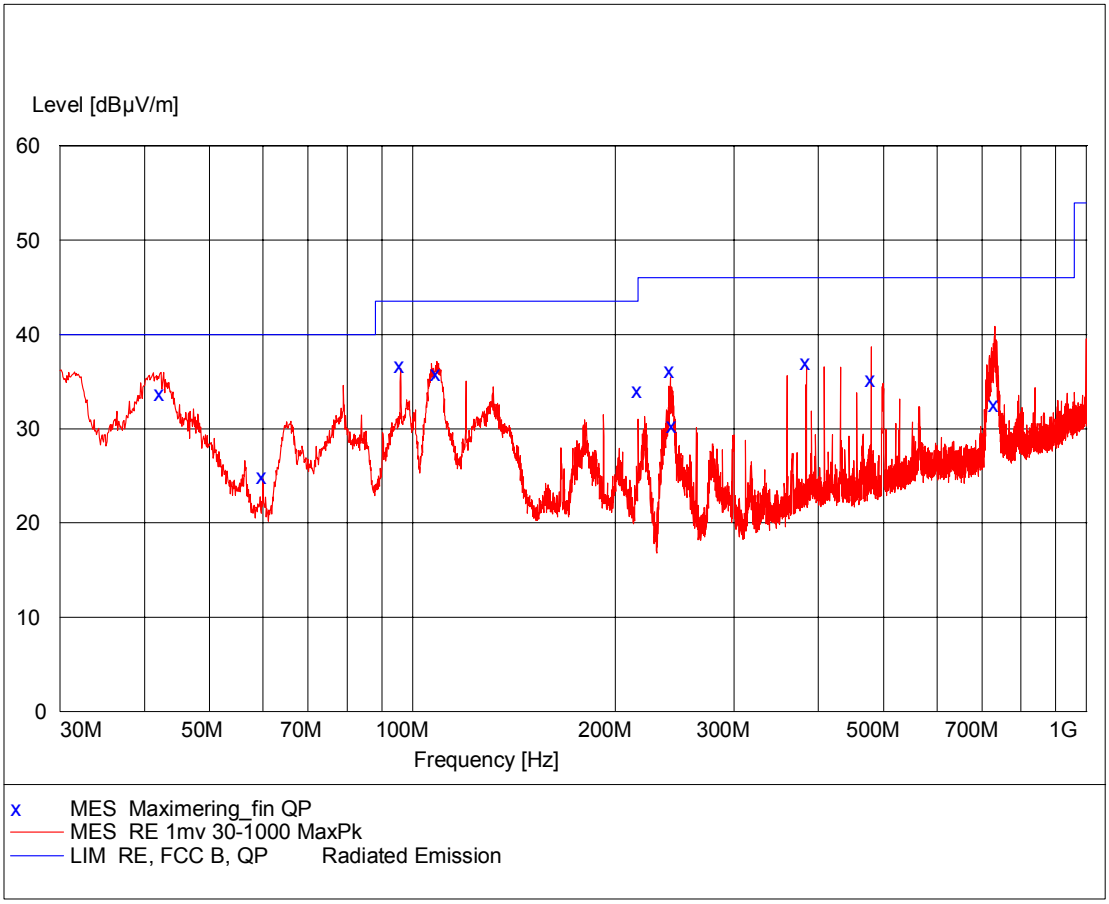


Annex 4

Test record sheets regarding radiated emission

(9 pages)

EUT: TMAN
Manufacturer: ISG
Operating Condition: Ant. 1 m vertical. 120 VAC
Test Site: EMC-5
Operator: HEN - E502372
Test Specification: FCC part 15 subpart C
Comment: Sheet 6

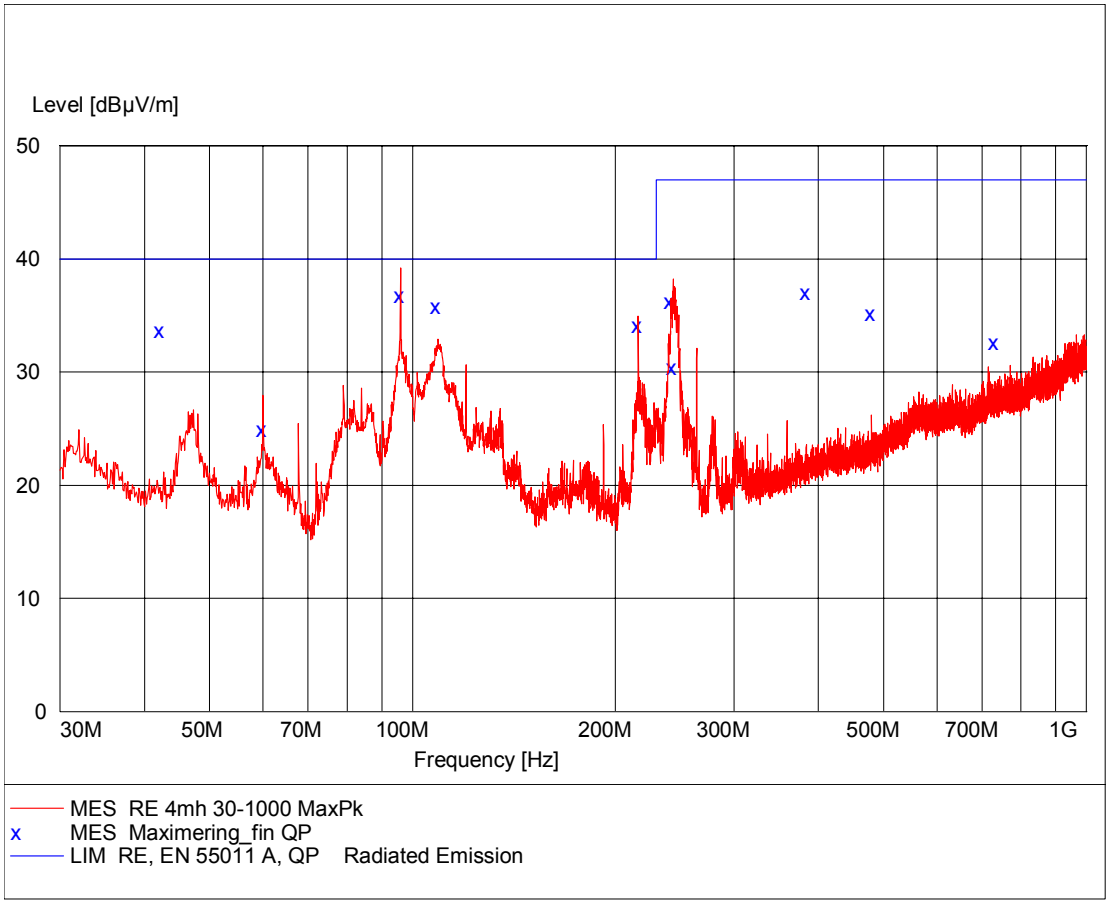


MEASUREMENT RESULT: "Maximering_fin QP"

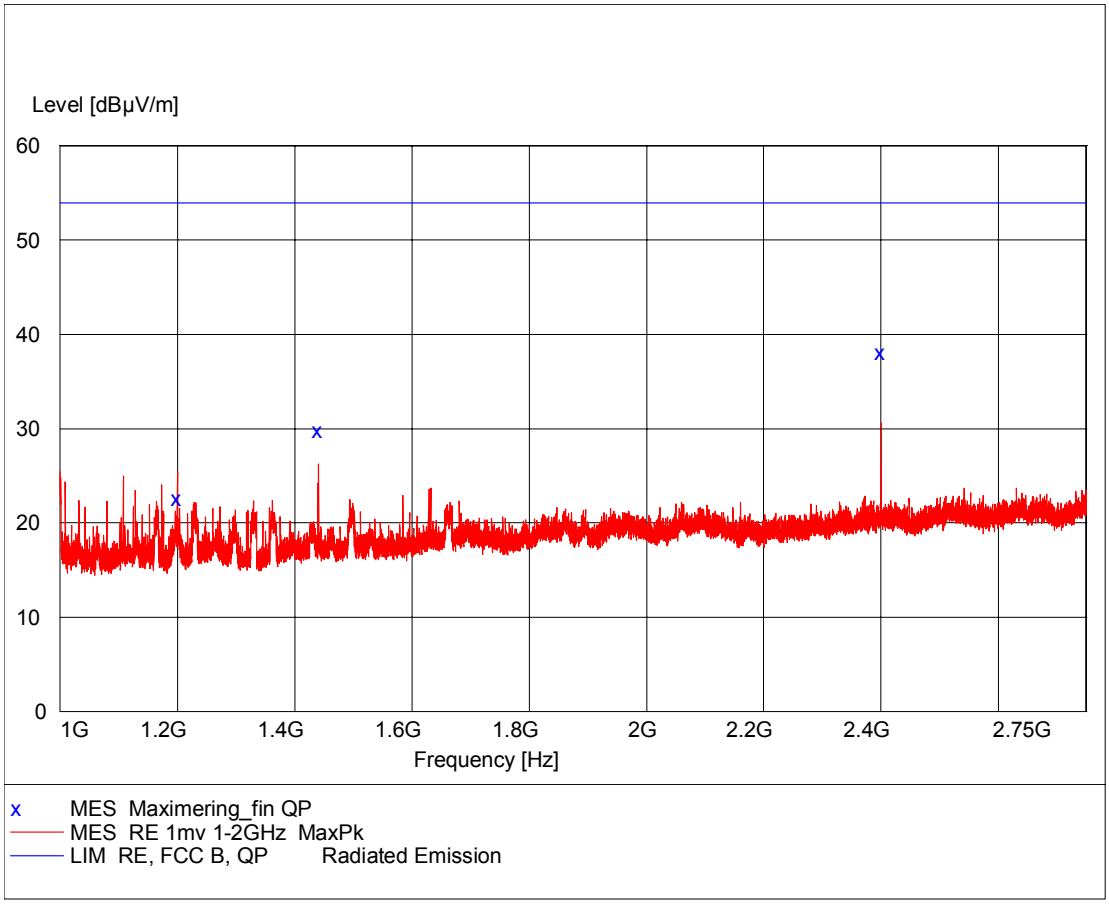
2004-09-02 10:57

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg	Polarisation
42.300000	33.70	14.4	40.0	6.3	101.0	190.00	VERTICAL
60.000000	24.90	7.4	40.0	15.1	330.0	179.00	HORIZONTAL
96.000000	36.70	12.8	43.5	6.8	331.0	1.00	HORIZONTAL
108.800000	35.80	13.8	43.5	7.7	101.0	27.00	VERTICAL
216.030000	34.10	12.3	46.0	11.9	354.0	1.00	HORIZONTAL
241.300000	36.20	14.3	46.0	9.8	109.0	171.00	HORIZONTAL
243.800000	30.40	14.6	46.0	15.6	330.0	1.00	HORIZONTAL
384.060000	37.00	19.3	46.0	9.0	101.0	8.00	VERTICAL
480.030000	35.20	21.0	46.0	10.8	124.0	208.00	HORIZONTAL
731.600000	32.60	26.3	46.0	13.4	115.0	182.00	VERTICAL

EUT: TMAN
Manufacturer: ISG
Operating Condition: Ant. 4 m horizontal. 120 VAC
Test Site: EMC-5
Operator: HEN - E502372
Test Specification: FCC part 15 subpart C
Comment: Sheet 7



EUT: TMAN
Manufacturer: ISG
Operating Condition: Ant. 1 m vertical. 120 VAC
Test Site: EMC-5
Operator: HEN - E502372
Test Specification: FCC part 15 subpart C
Comment: Sheet 8

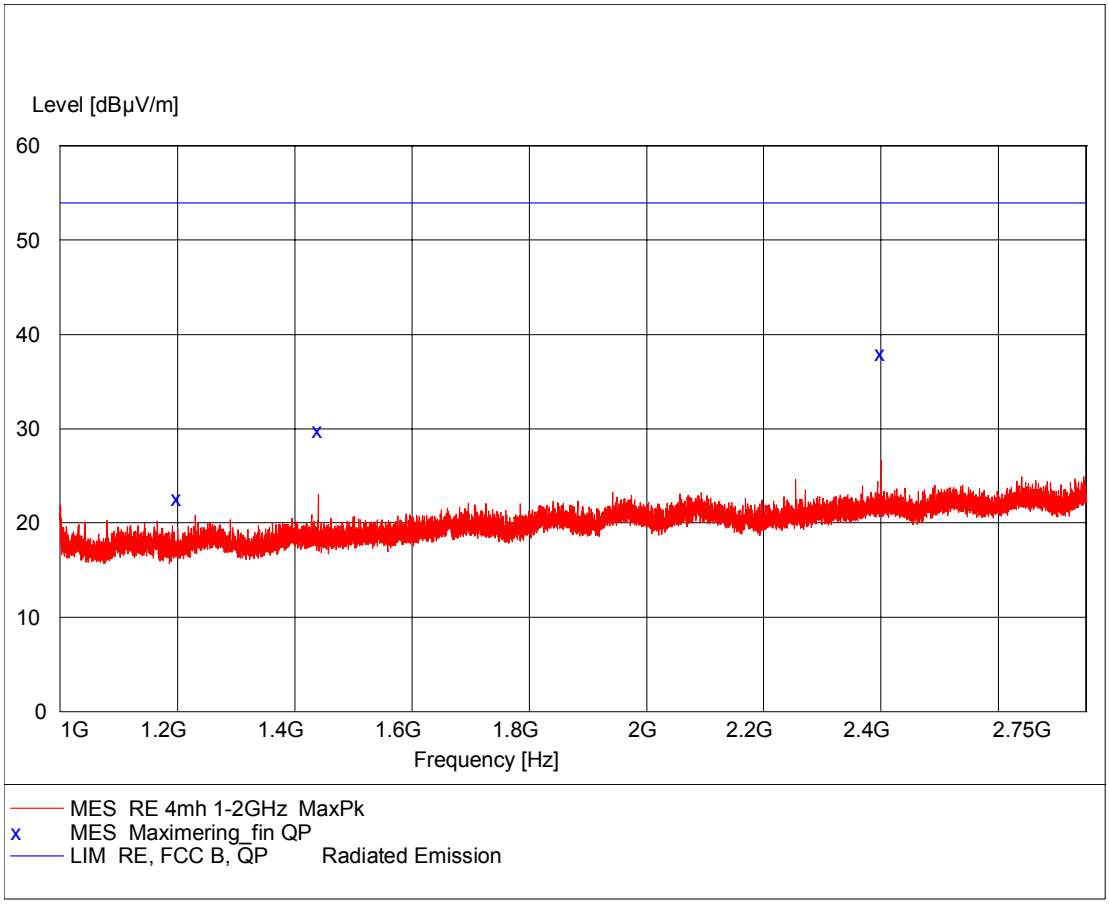


MEASUREMENT RESULT: "Maximering_fin QP"

2004-09-02 12:33

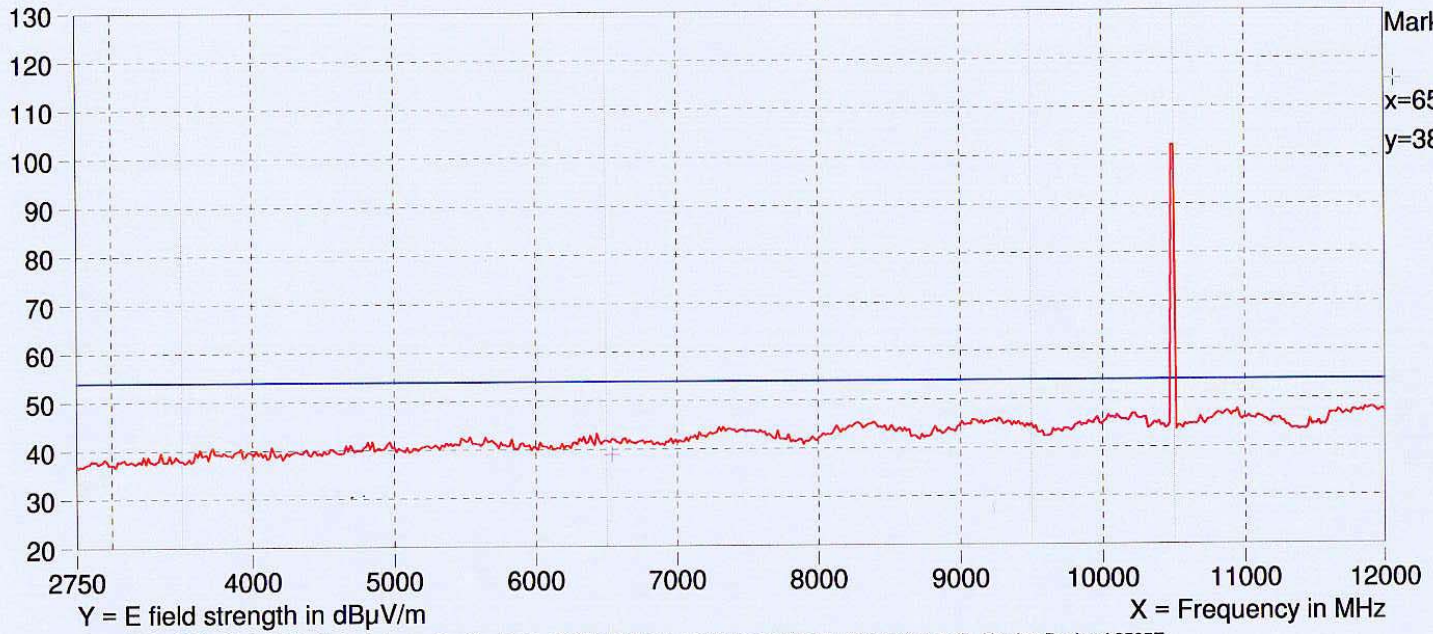
Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg	Polarisation
1200.200000	22.60	-16.3	53.9	31.3	101.0	38.00	VERTICAL
1440.084000	29.80	-15.0	53.9	24.1	206.0	305.00	HORIZONTAL
2400.120000	38.00	-10.5	53.9	15.9	215.0	333.00	HORIZONTAL

EUT: TMAN
Manufacturer: ISG
Operating Condition: Ant. 4 m horizontal. 120 VAC
Test Site: EMC-5
Operator: HEN - E502372
Test Specification: FCC part 15 subpart C
Comment: Sheet 9



VS/BLJ

DELTA Electronics Testing, EMC Section.



Step: Y=0.1 dB lin, X=0.1 MHz lin, t=Auto ms, Positive Peak, 1000 kHz Resol, Level range 100 dB, Attenuation 0 dB, Hewlett Packard 8565E

2004-09-02 13:09:41 File: FCC.TO1, EUT 1
2004-09-02 12:45:02 File: FCC.LM1, Limit 1, FCC15.109(part B) unintentional rad. and FCC 15.209(Part C) intentional rad. Both Rx

ISG
TMAN.
Voltage: 120 VAC
ant 1-3 meter ver/hor. T.T. 0-360 deg.

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Sheet 10

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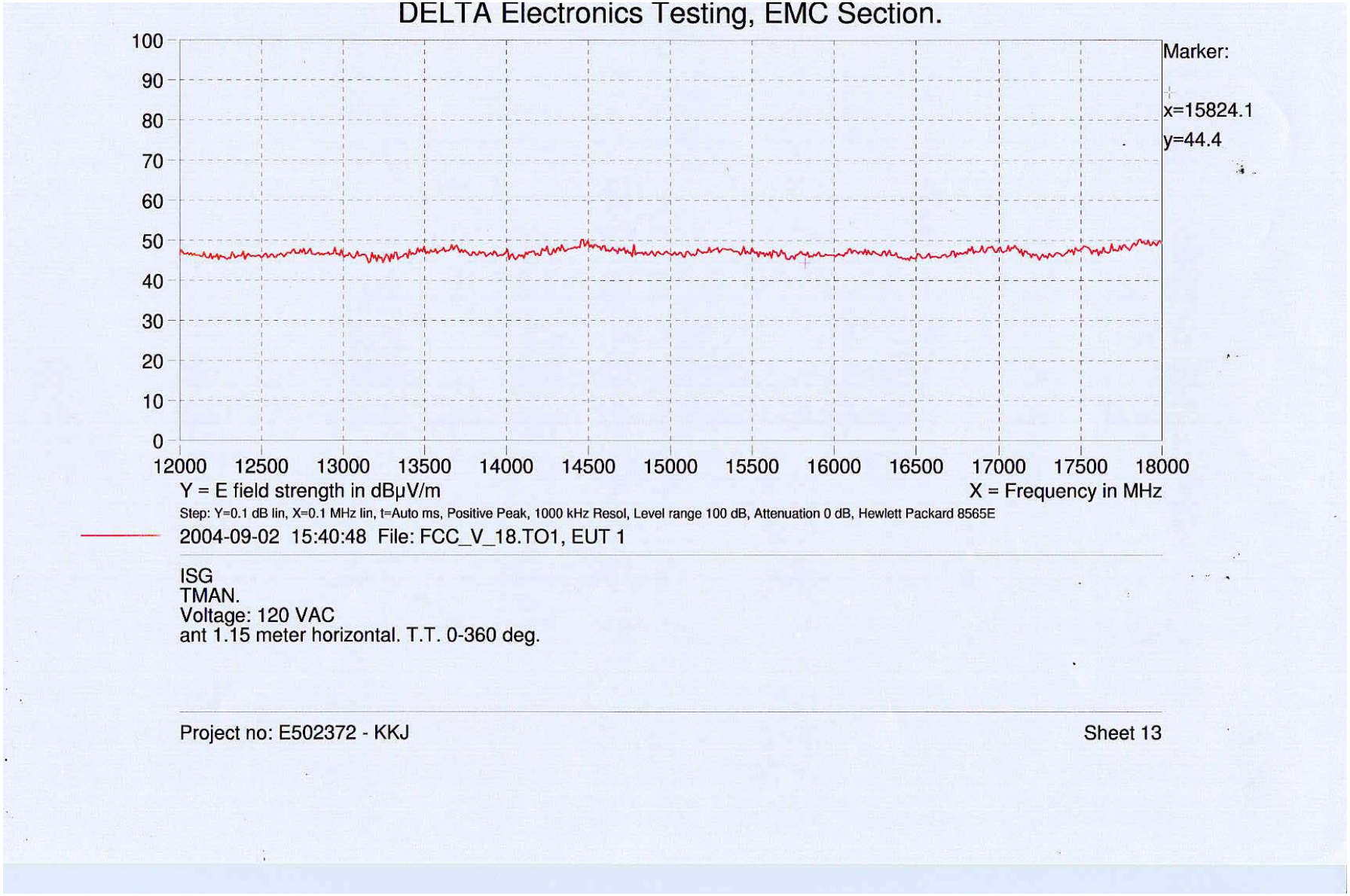
VS/BLJ



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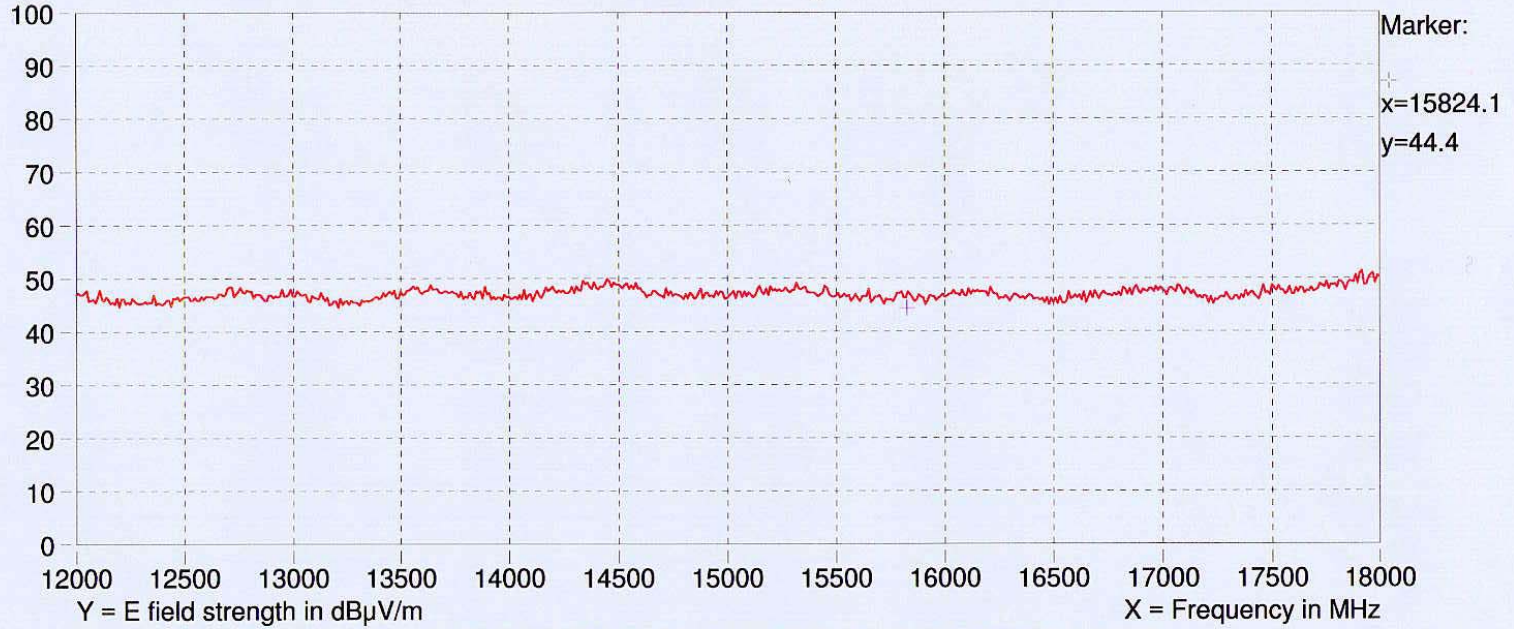
VS/BLJ

DELTA Electronics Testing, EMC Section.



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2004-09-02 15:25:59 File: FCC12-18.TO1, EUT 1

ISG
TMAN.
Voltage: 120 VAC
ant 1.15 meter vertical. T.T. 0-360 deg.

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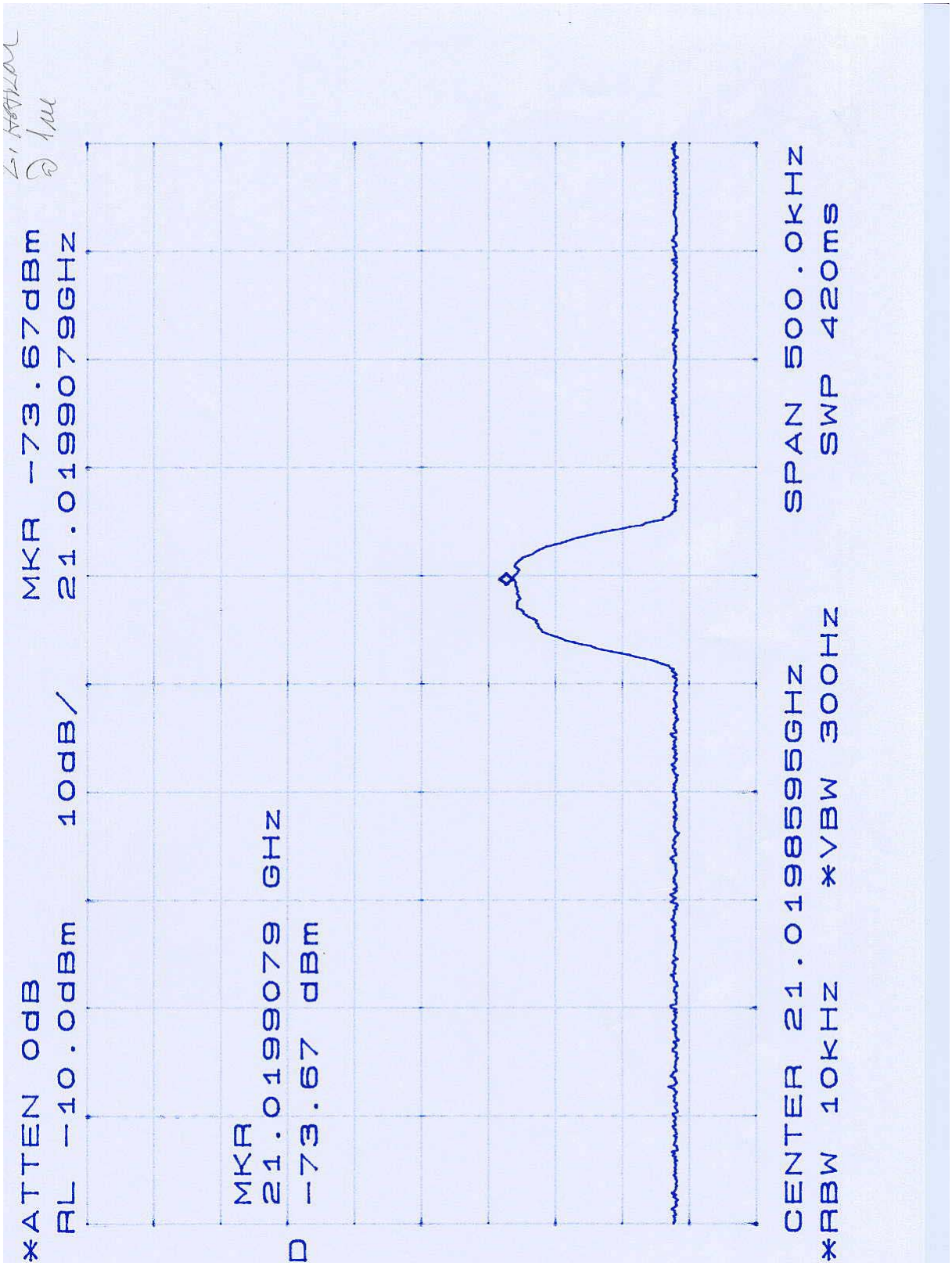
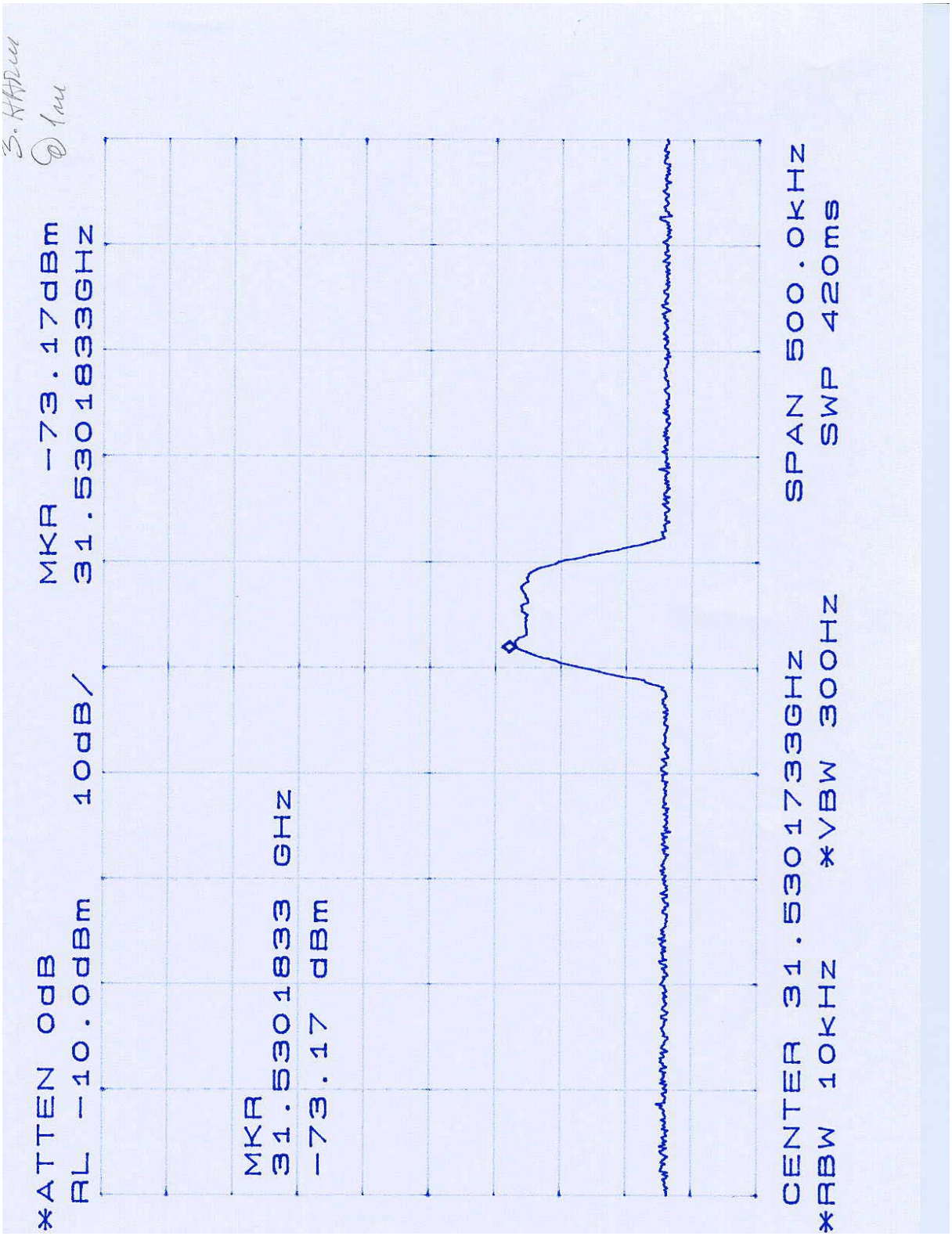
Sheet 12

DANAK-197620
DELTA-E502372-1


*ATTEN 0dB
RL -10.0dBm
10dB/
MKR -73.67dBm
21.0199079GHz
MKR
21.0199079 GHz
D -73.67 dBm
CENTER 21.0198595GHz
SPAN 500.0kHz
*RBW 10kHz
*VBW 300Hz
SWP 420ms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RL -10.0dBm
10dB/
MKR -73.17dBm
31.530183GHz
MKR
31.530183 GHz
-73.17 dBm
CENTER 31.530173GHz
SPAN 500.0KHz
*RBW 10KHz
*VBW 300HZ
SWP 420ms

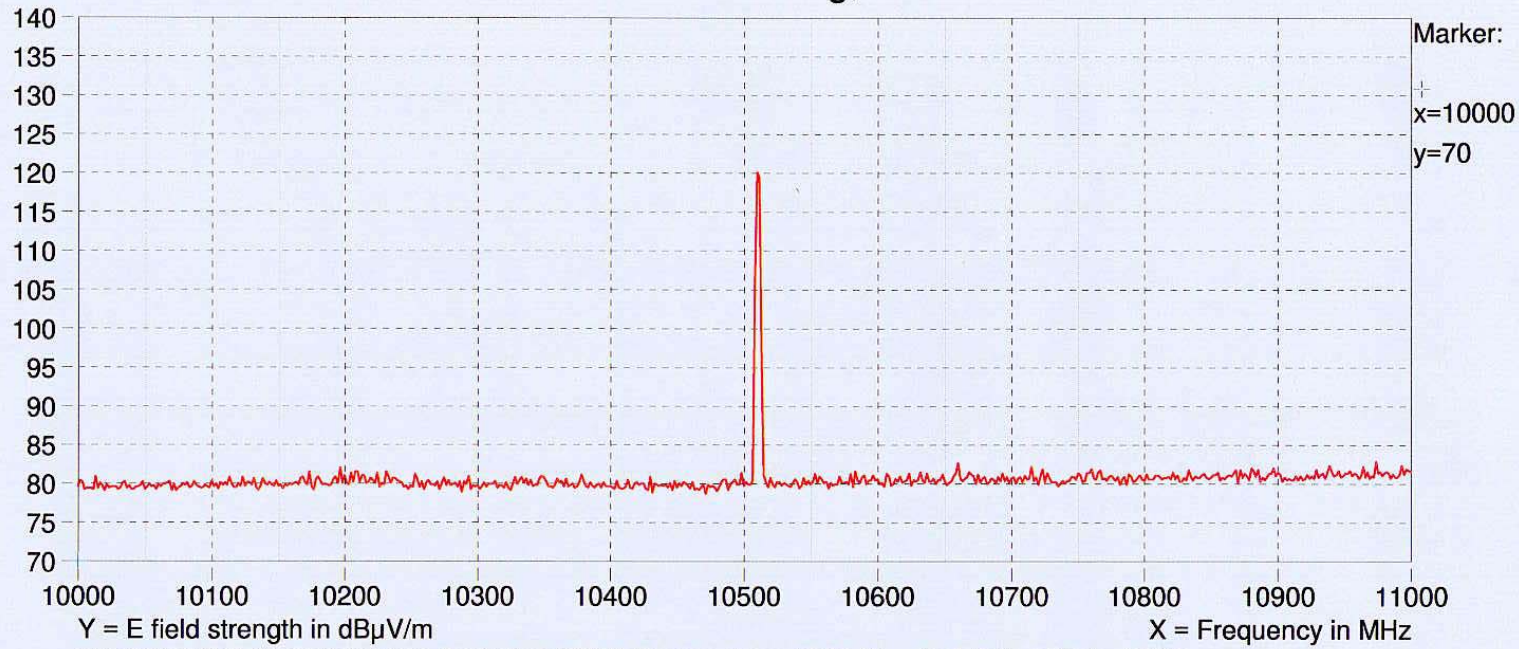
Annex 5

Occupied bandwidth / Peak output power

(2 pages)

VS/BLJ

DELTA Electronics Testing, EMC Section.



Step: Y=0.1 dB lin, X=0.1 MHz lin, t=Auto ms, Positive Peak, 1000 kHz Resol, Level range 100 dB, Attenuation 0 dB, Hewlett Packard 8565E

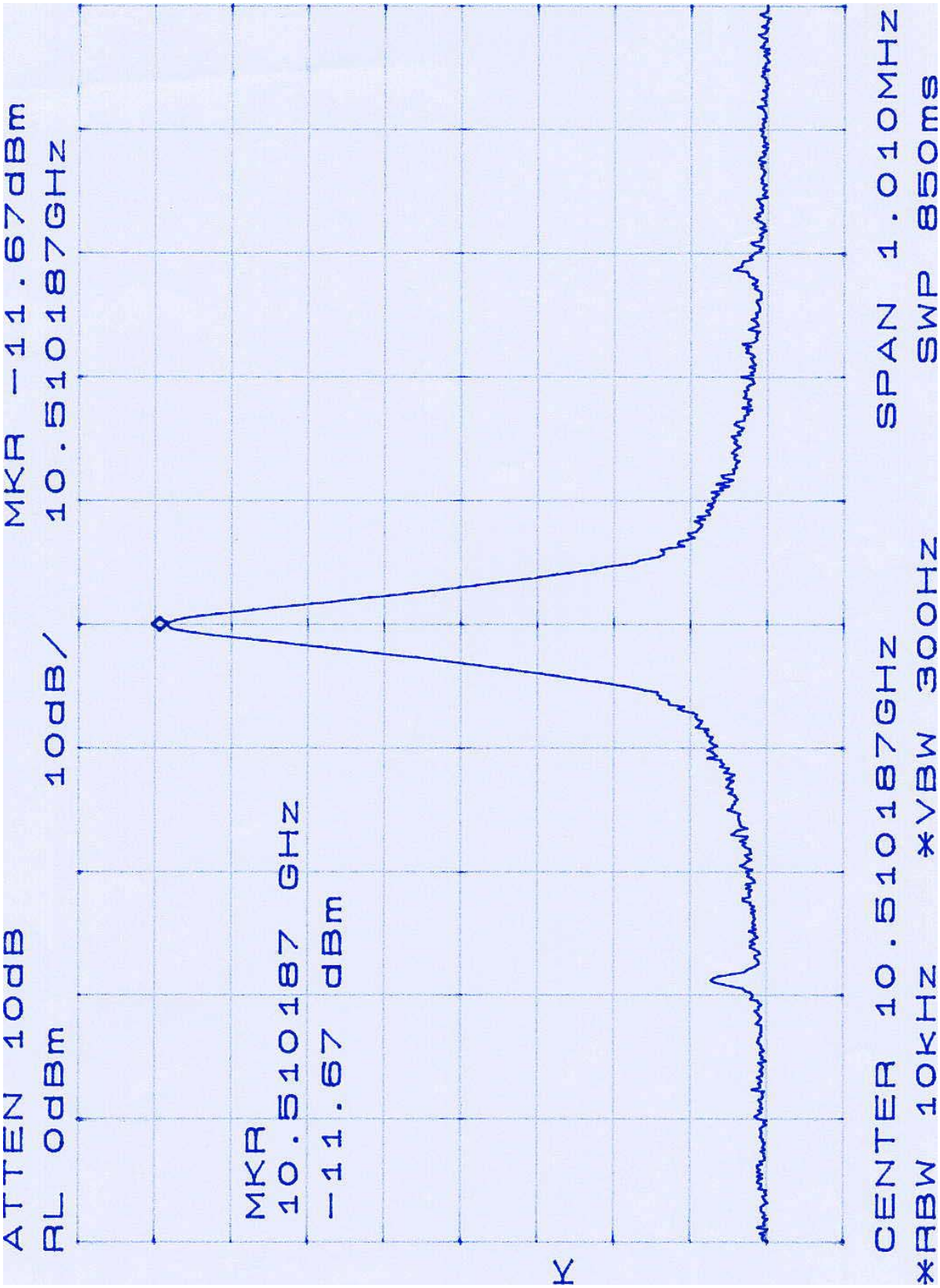
2004-09-02 14:55:27 File: FCC.TO1, EUT 1
2004-09-02 14:12:26 File: FCC.LM1, Limit 1, FCC15.109(part B) unintentional rad. and FCC 15.209(Part C) intentional rad. Both Rx

ISG
TMAN.
Voltage: 120 VAC
ant 1-3 meter ver/hor. T.T. 0-360 deg.
No preamp during test

Project no: E502372 - KKJ

Sheet 11

DANAK-197620
DELTA-E502372-1


ATTEN 10dB
RL 0dBm
10dB/
MKR -11.67dBm
10.510187GHz
MKR
10.510187 GHz
-11.67 dBm
CENTER 10.510187GHz
SPAN 1.010MHz
*RBW 10KHz
*VBW 300Hz
SWP 850ms