Regulatory Test Documentation (RTD)

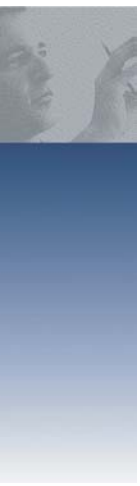
Test Report, RF, E500465-1, 7023

Document Part Number:	**905101801**
Document Revision:	**01.01**
Description:	**Test report from Danish Delta, E500465-1. RF tests of the ZW0102 US Z-Wave Module, carried out in accordance with FCC CFR47, Part 15 Subpart C – Intentional Radiators. Test was carried out on a ZM1220 US Standard Z-Wave Module, but is considered applicable for the ZM1220-RE Z-Wave Module as well. Note that the report refers to the earlier name "ZW0102 Z-Wave Module"**
Written By:	**Delta, Vagn Sylvest**
Date:	**May 8, 2003**
Reviewed By:	**Tom Calsen & Didier Clement**
Audience:	**For R&D internal and R&D external distribution**

Approved by: Authority	Date
Tom Carlsen, R&D	May 8, 2003

REVISION RECORD

Doc. Rev	Date	By	Pages affected	Brief description of changes
01.00	20020919	TCA	ALL	Initial Release
01.01	20030508	TCA	FrontPage	FrontPage updated with new Names for Z-Wave Modules. No changes in report from Delta.



Test Report

DANAK
Reg. no. 19

Emission tests to FCC requirements of ZW0102 US Z-Wave module

Performed for Zensys A/S

DANAK-196364
Project no.: E500465-1
Page 1 of 13
5 annexes

2002-08-16

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Title	Emission tests to FCC requirements of ZW0102 US Z-Wave module
Test object	ZW0102 US Z-Wave module
Report no.	DANAK-196364
Project no.	E500465-1
Test period	2002-07-10 - 2002-07-11
Client	Zensys A/S Emdrupvej 26 2100 Copenhagen Ø Denmark Telephone: +45 70 20 99 40 Fax: +45 70 20 99 50
Contact person	Mr. Tom Carlsen
Manufacturer	Zensys A/S
Specifications	47 CFR Part 15, Subpart C - Intentional Radiators
Results	The equipment under test was in compliance with the requirements
Test personnel	Henrik Nielsen
Date	2002-08-16
Responsible	Vagn Sylvest Project Manager - EMC DELTA

Table of contents *Page*

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 15.249 "Rules for transmitters in band 902 - 928 MHz".

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

1.1.1 Applicable FCC rules for test

47 CFR Part 15, Subpart C - Intentional Radiators

§15.207 Conducted limits
§15.209 Radiated emission limits, general requirements
§15.215 Additional provisions to the general radiated emission limitations
§15.249 Operation within the bands 902 - 928 MHz, 2400 - 2583.5 MHz.

The methods and procedures have been applied as specified in

§15.31 Measurements standards.

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

ANSI C63.4:1992 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 §15.249	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 specimen tested.

2. Test specimen

The test object can on the air interface receive and transmit data on 908.42 MHz. The carrier is FSK modulated with a shift of 40 kHz at a data rate of 9600 bits/s. The galvanic interface constitutes of a 20 pin connector, carrying DC power for the module, serial Tx data and serial Rx data.

The test object is plugged directly onto a Z-Wave Evaluation Module, the purpose of which is to convert 9 VDC to 3.3 VDC for the Z-Wave module.

During test two Z-Wave modules were used, one programmed to Rx-only and the other to constant transmission.

2.1 Test object – ZW0102 US Z-Wave Tx-only

Category	Intentional radiator in the 902 to 928 MHz band
Manufacturer	Zensys A/S
Model/type	ZW0102 US Z-Wave / 370100410 01.02
Serial no.	0227 00018
FCC ID	-
Antenna type	Internal, fixed. Part of printed circuit board
Supply voltage	3.3 VDC
Operational mode	Transmitting constantly FSK signal at 9600 bits/s. This also represents the maximum data rate during normal operation.

2.2 Test object – ZW0102 US Z-Wave Rx-only

Category	Receiver in the 902 to 928 MHz band
Manufacturer	Zensys A/S
Model/type	ZW0102 US Z-Wave / 370100410 01.02
Serial no.	0227 00017
FCC ID	-
Antenna type	Internal, fixed. Part of printed circuit board
Supply voltage	3.3 VDC
Operational mode	Constant receive mode

2.3 Auxiliary equipment - Z-Wave Evaluation Module Rev. 2

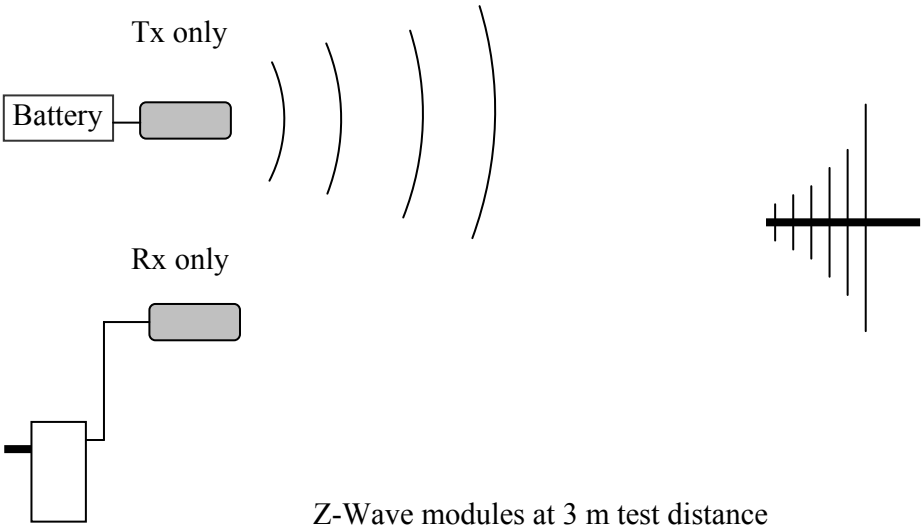
Category	Test equipment / Interface module
Manufacturer	Zensys A/S
Model/type	371000190 00.02
Serial no.	00132
FCC ID	-
Supply voltage	9 VDC
Operational mode	The Z-Wave radio module is plugged directly onto this module. The function of the evaluation module during test is to convert 9 VDC to 3.3 VDC for the Z-Wave module. Connectors on the module are used only during various phases of the development.

2.4 Auxiliary equipment - Power supply

Category	PS for Intentional radiator in 902 to 928 MHz band
Manufacturer	Stancor
Model/type	STA-3590A
Serial no.	-
FCC ID	-
Supply voltage	120 VAC / 9 VDC 300 mA

3. General test conditions

3.1 Test set-up

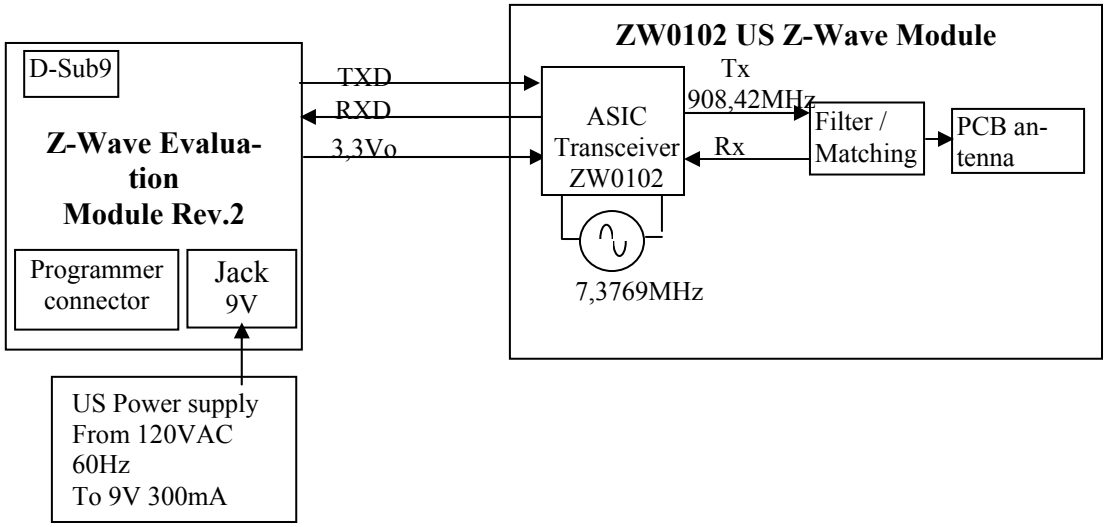


Z-Wave modules at 3 m test distance

The EUT is configured to transmit blocks continuously at a rate of 9600 bits/second. The Tx-only module is battery operated. The Rx-only is powered from 115 VAC.

Both units were measured for conducted emission on 115 VAC.

The EUT is mounted on a connecter on the "Z-Wave Evaluation Module Rev. 2".



Block diagram showing complete configuration of unit under test.

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 C63.4:1992
Frequency range	0.45-30 MHz
Limit: (quasi-peak)	0.45-30 MHz: 48 dBµV
Test set-up Test record sheets	*Annex 2* *Annex 3*

Results

The module in Rx mode and in Tx mode is in compliance with the requirements.

Comments

None.

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

	Requirements	
Specification	FCC Rules and Regulations Part 15, Subpart C	
Test set-up	ANSI C63.4:1992	
Measuring distance	3 m	
Frequency range	30-10.000 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*

During exploratory radiated emission measurements all three orthogonal planes, X, Y and Z are investigated. The final measurements are performed in worst-case position.

Two modules were measured simultaneously, one in Rx mode and one in Tx mode. Only where there are signals exceeding the spurious limit (the carrier) separate plots are shown for Tx and Rx modules.

If for a frequency band only plots from one polarisation has been included, this will be the worst case plot.

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.

Plots from 2.75 - 10 GHz are spectrum analyser plots in peak-hold mode. Peak-to-Average Factor is established by to be 1 dB, based on measurements. Therefore, AVG emission values are 1 dB lower than the values indicated on the spectrum analyser plots.

The measurements in the frequency band 6 - 10 GHz have been measured using a resolution bandwidth of 30 kHz in order to lower the noise floor. This change was judged not to violate the test requirements, because tests on the carrier had shown that the amplitude difference between measuring with a resolution bandwidth of 1 MHz and width a resolution bandwidth of 30 kHz was less than 1 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
73.77 (R)	V	22,8	17.2	
118.03 (R)	V	27.1	16.4	
162.29 (R)	V	25.0	18.5	
833.6	H	37.1	8.9	
848.35	H	37.3	8.7	
863.11	H	37.3	8.7	

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

Spurious emission 1000 MHz to 10 GHz in tabular form:
(For spectral plots see *Annex 4*)

Spurious freq. MHz	Polarisation	Peak dBµV/m	Average dBµV/m	dB below peak limit	dB below average limit	Note
1816.85	H	49.2	48.2	24.8	5.8	2nd harm.
2725.26	H	38.8	37.8	35.2	16.2	3rd harm./ Noise floor

(R) means frequency in restricted band as defined in §15.205.
Average limit is 500 µV/m or 54 dBµV/m.
Peak limit is 20 dB above average limit or 74 dBµV/m.

Comments

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

Measurements above 1 GHz are performed using a spectrum analyser or using a combination of receiver and spectrum analyser. The receiver will measure average values directly.

Measurements above 1 GHz using a spectrum analyzer are performed in peak hold mode. Average measurements are performed on spurious 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).

c) For measurements performed using the R&S receiver in the band 1 GHz to 2.75 GHz the build-in average detector is used.

4.3 Occupied bandwidth

The limits of the transmission band are reached when only spurious emission can be measured.

The lower band limit is 902 MHz and the upper band limit is 928 MHz.

On the plot in *Annex 5* the occupied bandwidth is measured at the level of the spurious limit using 120 kHz resolution bandwidth.

Occupied bandwidth: 1.73 MHz.

Measurements showed that there were almost no difference (0.1 dB) on the levels measured with a QP detector and a peak detector. Therefore, the same measurements have been used for occupied bandwidth (peak requirement) and for peak output field strength (QP requirement).

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 50 mV/m, or 94 dBµV/m, following §15.249(a). Measurements show:

Peak output field strength: 91.4 dBµV/m

at the frequency 908.420000 MHz.

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.	CAL. EX-PIRES
29494,3	MICROWAVE CABLE, 1 m	SUHNER	SUCOFLEX 104	2003-05-10
29660	PRE SELECTOR, 0 – 22 GHz.	HEWLETT-PACKARD	70600A	AS 29665
29661	RF SECTION. 50kHz - 26.5 GHz.	HEWLETT-PACKARD	70906A	AS 29665
29662	LOCAL OSCILLATOR	HEWLETT-PACKARD	70900A	AS 29665
29663	IF SECTION, 10 Hz – 300 kHz BW	HEWLETT-PACKARD	70902A	AS 29665
29664	MAINFRAME	HEWLETT-PACKARD	70001A	AS 29665
29665	SYSTEM DISPLAY (FOR SPECTRUM ANA-LYZER 71200C)	HEWLETT-PACKARD	71200A (70206A MAIN FRAME)	2002-11-26
29746	SHIELD-LINE CDN NETWORK, IEC 61000-4-6	DELTA EMC DEPT.	SHIELD-LINE CDN	2003-04-23
29797	BILOG ANTENNA, 30-1000 MHz	CHASE ELECTRICS LTD	CBL 6111A	2003-07-27
29805	BROADBAND u-WAVE AMPLIFIER, 100 MHz - 10 GHz (red)	MITEQ	AFS5-00101000-30-10P-5	2002-10-18
29861	EMI-SOFTWARE Ver. 1.60	ROHDE & SCHWARZ	ES-K1, PART: 1026.6790.02	ONLY CAL. IF REQUIRED
29873	TERMINATION/INTEGRATOR FOREC 29192	DELTA EMC	RE 101	ONLY CAL. IF REQUIRED
29876	RIDGED GUIDE HORN ANTENNA, 1-18 GHz	EMCO	3115	2005-03-07
29916	AUTOMATIC TEST RECEIVER, 9 kHz - 2.75 GHz	ROHDE & SCHWARZ	ESCS 30 1102.4500.30	2003-01-02
29942	"CABLE #26", LOW-LOSS uWAVE CABLE, SMA-SMA, 1 m	SUHNER	SUCOFLEX 104A	2003-05-08
29985	BILOG ANTENNA 26-2000 MHz	SCHAFFNER/CHASE	6140A	2003-07-05
49041	6 dB ATTENUATOR, DC-18 GHz, SMA CONN.	SUHNER	6806.19.A	2002-11-27
49042	6 dB ATTENUATOR, DC-18 GHz, SMA CONN.	SUHNER	6806.19.A	2002-11-27

Annex 2

Photos

(2 pages)

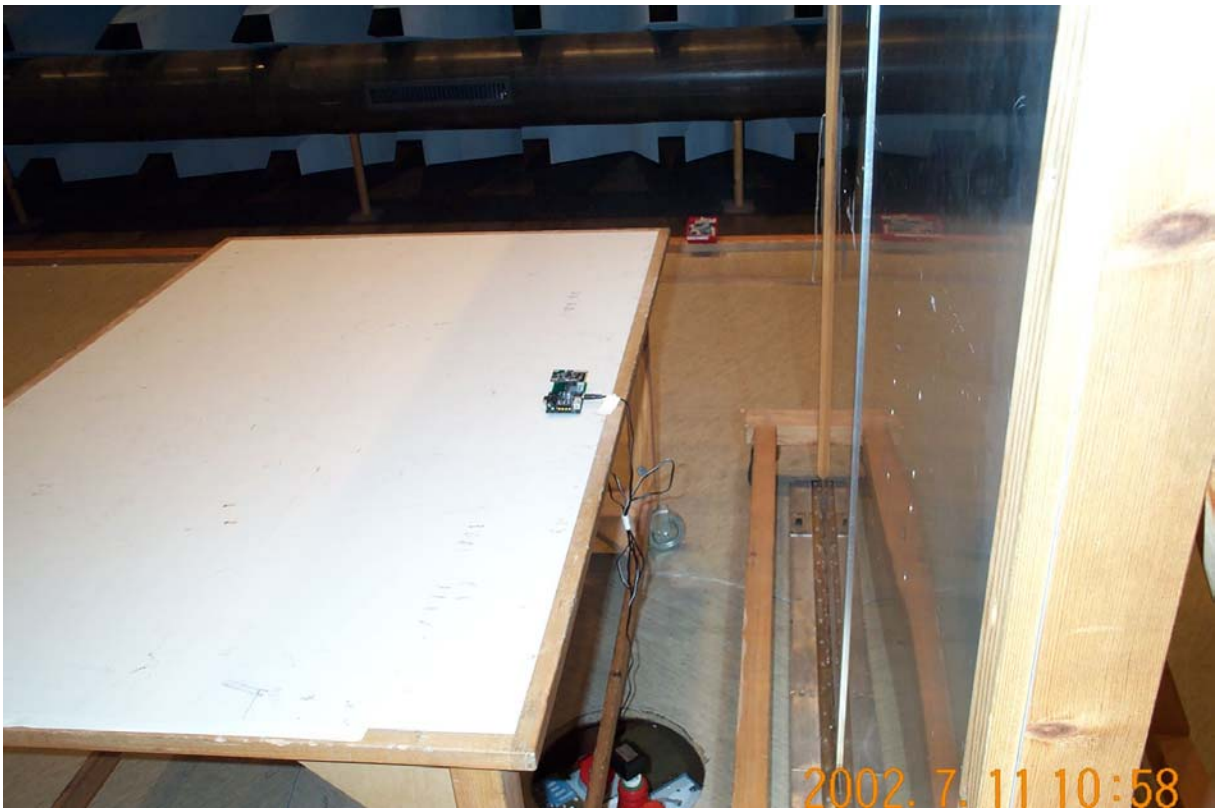


Photo 1 Set-up for measurements of conducted emission.

Photo 2 Set-up for measurements 30 - 1000 MHz.

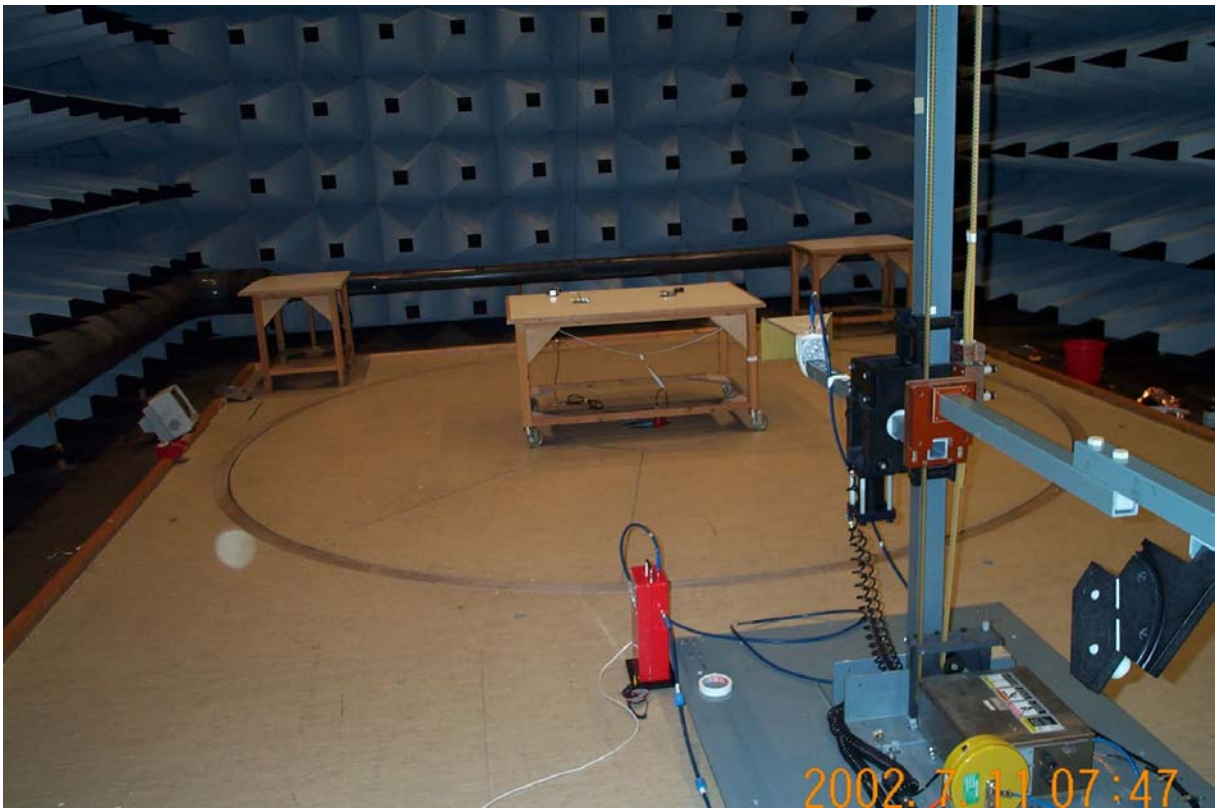


Photo 3 Set-up for measurements 1 - 10 GHz.

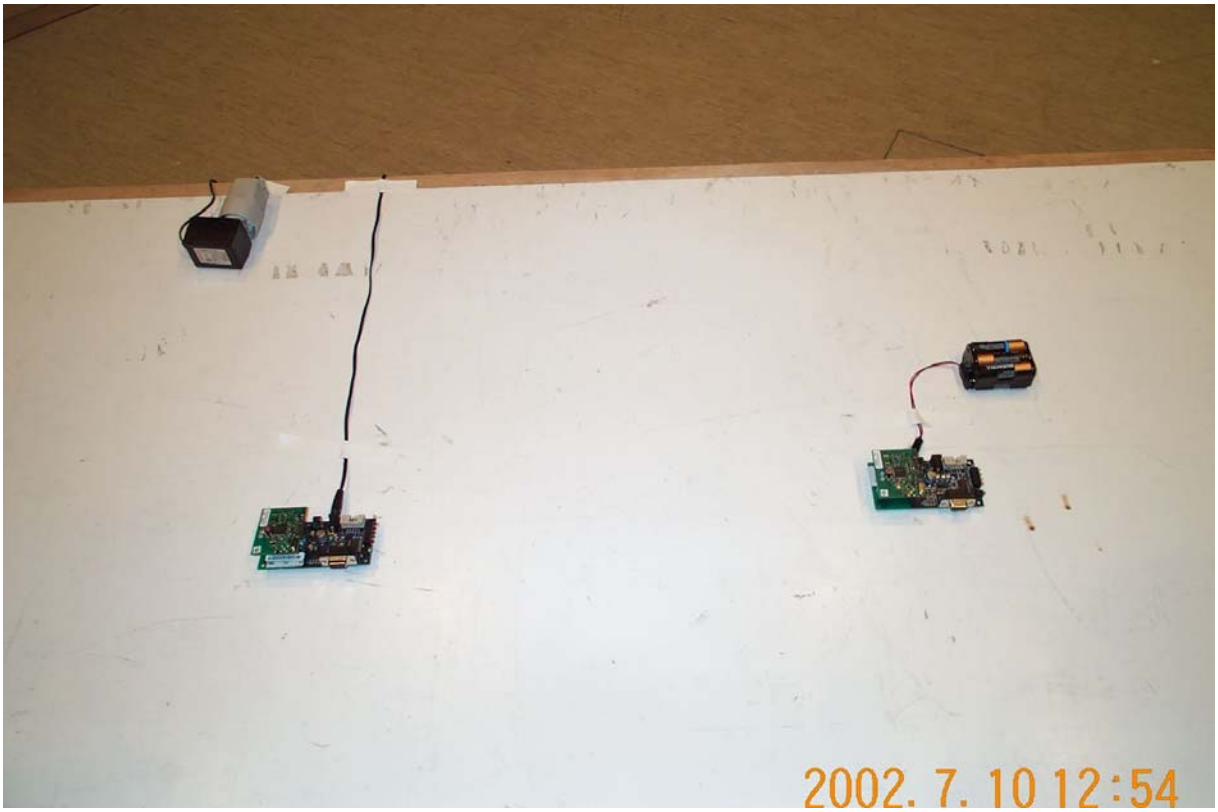


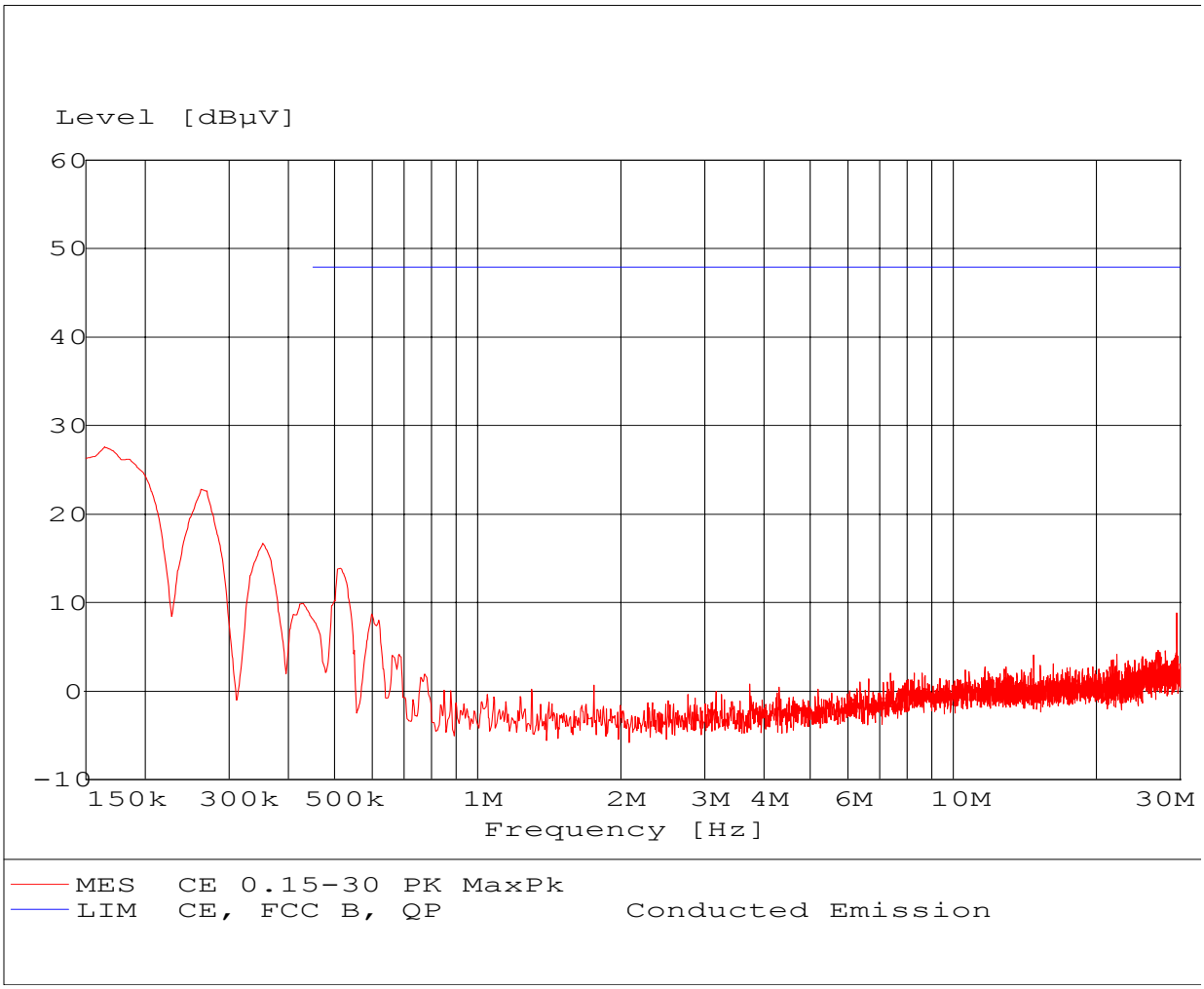
Photo 4 EUT in Rx only and Tx only modes.

Annex 3

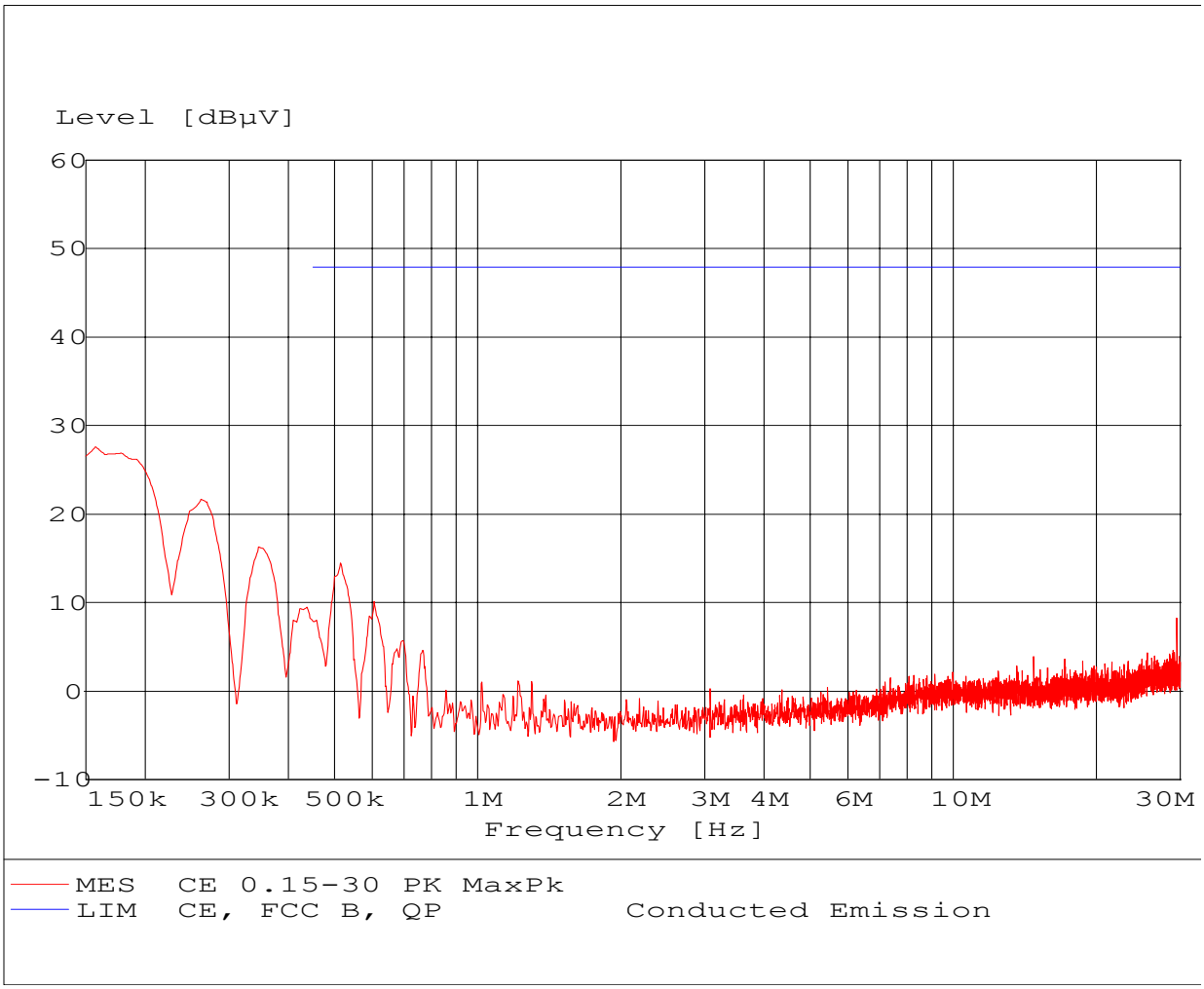
Test record sheets regarding conducted emission

(2 pages)

EUT:	ZW0102 US Z-wave Module. Tx Unit
Manufacturer:	Zensys
Operating Condition:	Line no.: Neutral. 115 VAC
Test Site:	EMC-5
Operator:	HEN - E500465
Test Specification:	FCC
Comment:	Sheet 20
Start of Test:	2002-07-11



EUT:	ZW0102 US Z-wave Module. Tx Unit
Manufacturer:	Zensys
Operating Condition:	Line no.: Line 1. 115 VAC
Test Site:	EMC-5
Operator:	HEN - E500465
Test Specification:	FCC
Comment:	Sheet 21
Start of Test:	2002-07-11

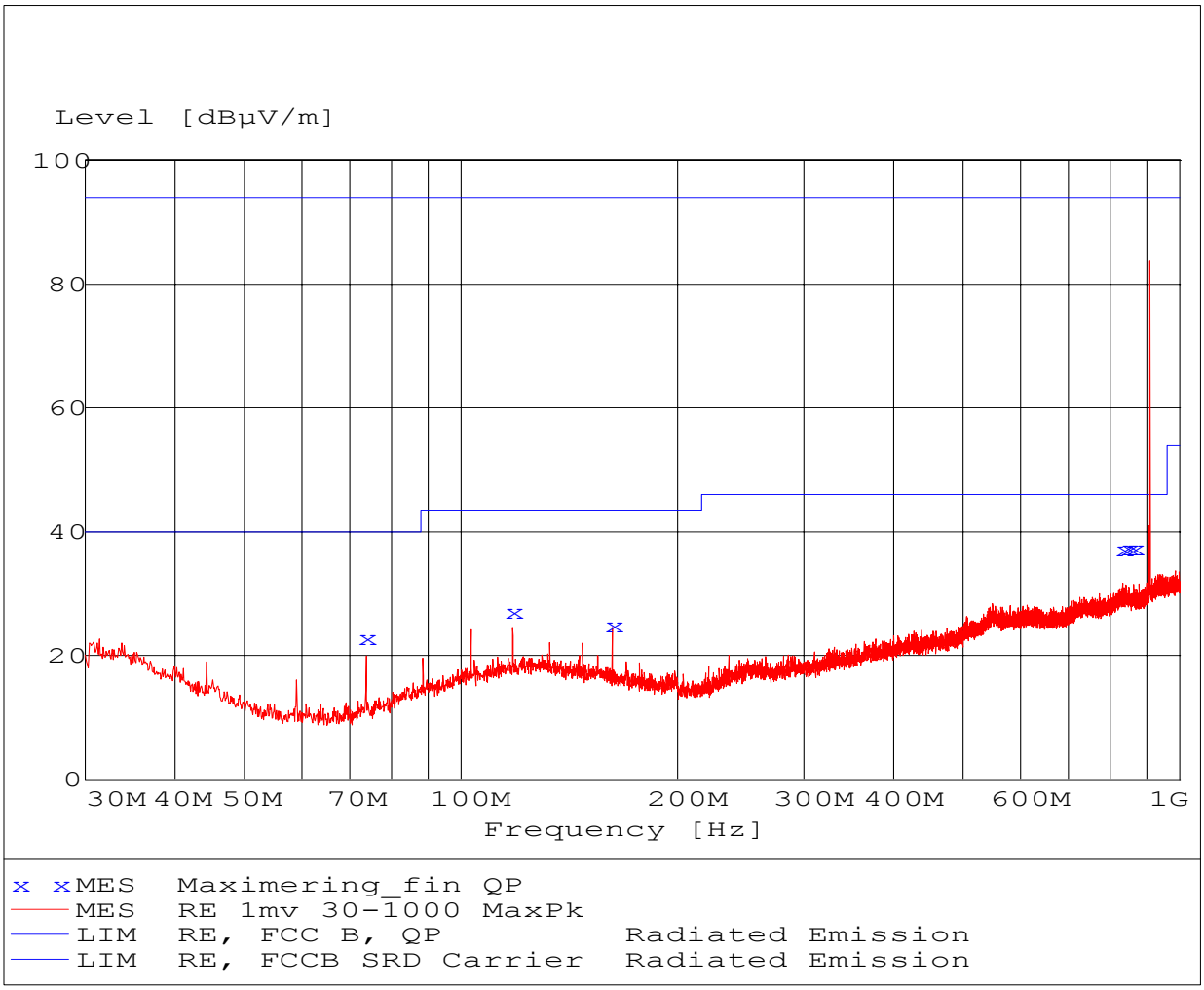


Annex 4

Test record sheets regarding radiated emission

(7 pages)

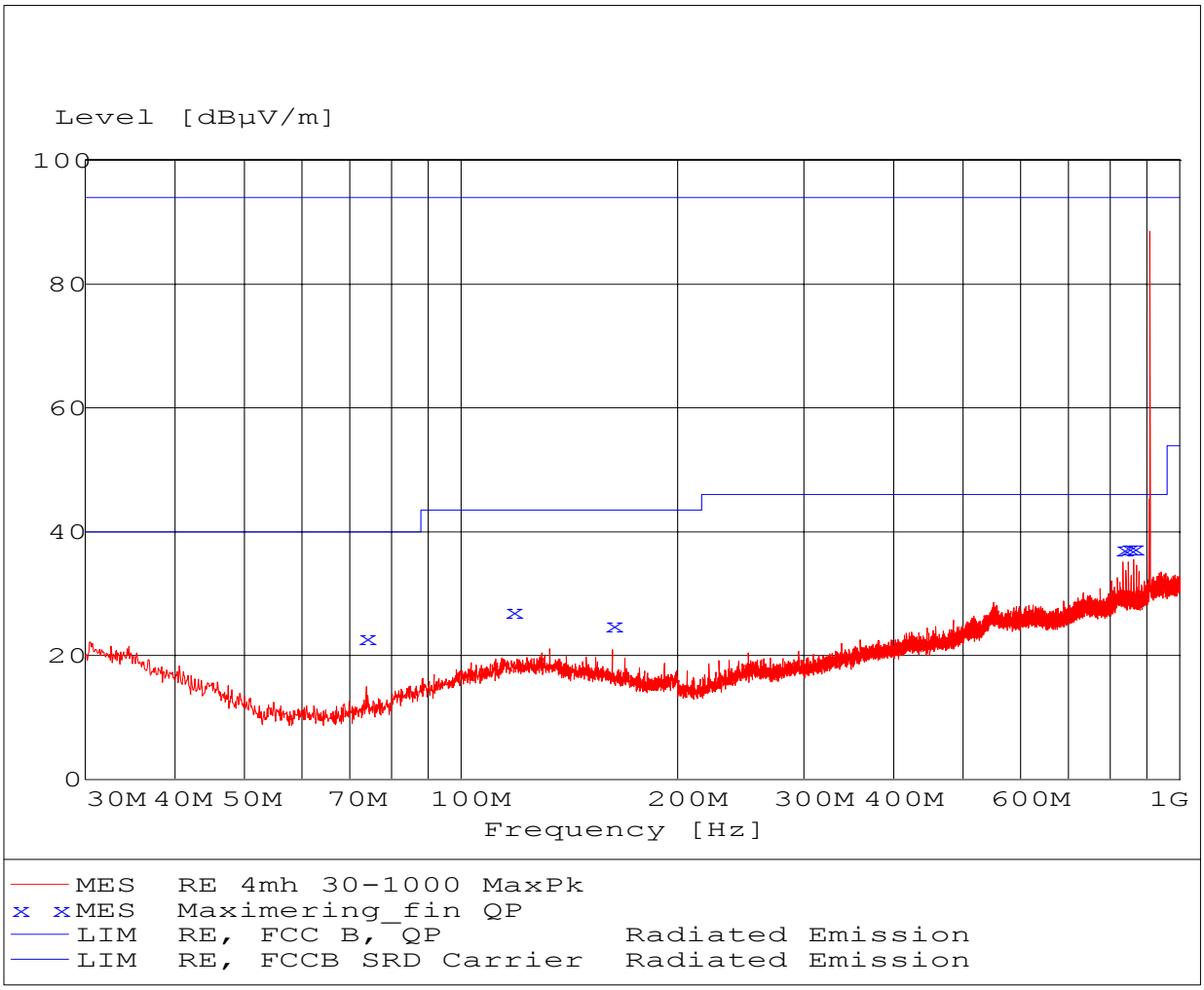
EUT:	ZW0102 US Z-wave Module
Manufacturer:	Zensys
Operating Condition:	Ant 1 m vertical
Test Site:	EMC-5
Operator:	HEN - E500465
Test Specification:	FCC
Comment:	Sheet 3
Start of Test:	2002-07-10



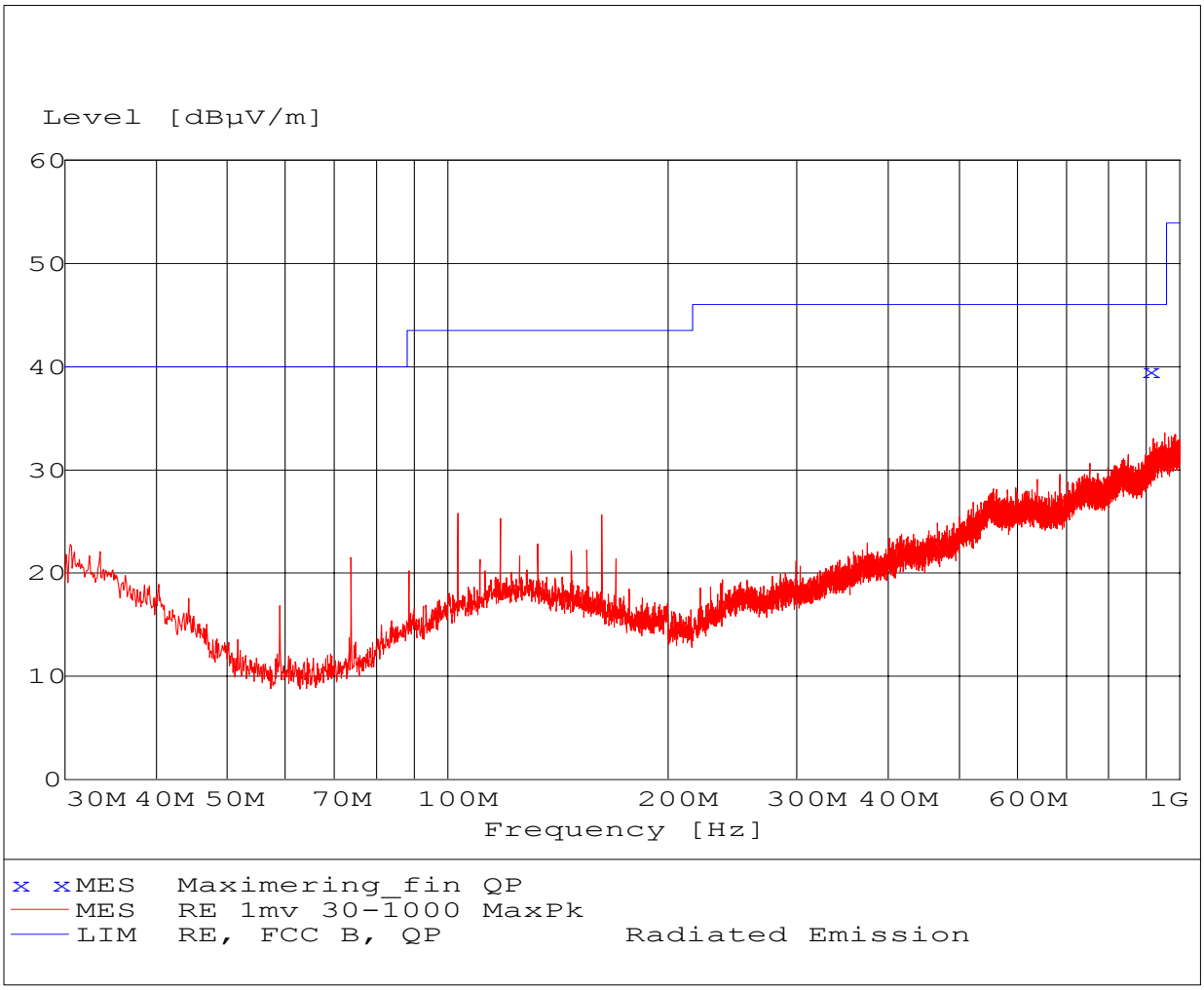
MEASUREMENT RESULT: "Maximering_fin QP"
2002-07-10 11:41

Frequency MHz	Level dBµV/m	Transd. dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg.	Polarisation
73.77	22.80	8.30	40.00	17.20	111.00	212.00	Vertical
118.03	27.10	14.70	43.50	16.40	113.00	248.00	Vertical
162.29	25.00	12.90	43.50	18.50	111.00	306.00	Vertical
833.60	37.10	27.90	46.00	8.90	101.00	346.00	Horizontal
848.35	37.30	27.80	46.00	8.70	101.00	345.00	Horizontal
863.11	37.30	27.40	46.00	8.70	101.00	349.00	Horizontal

EUT:	ZW0102 US Z-wave Module
Manufacturer:	Zensys
Operating Condition:	Ant 2 m horizontal
Test Site:	EMC-5
Operator:	HEN - E500465
Test Specification:	FCC
Comment:	Sheet 4
Start of Test:	2002-07-10



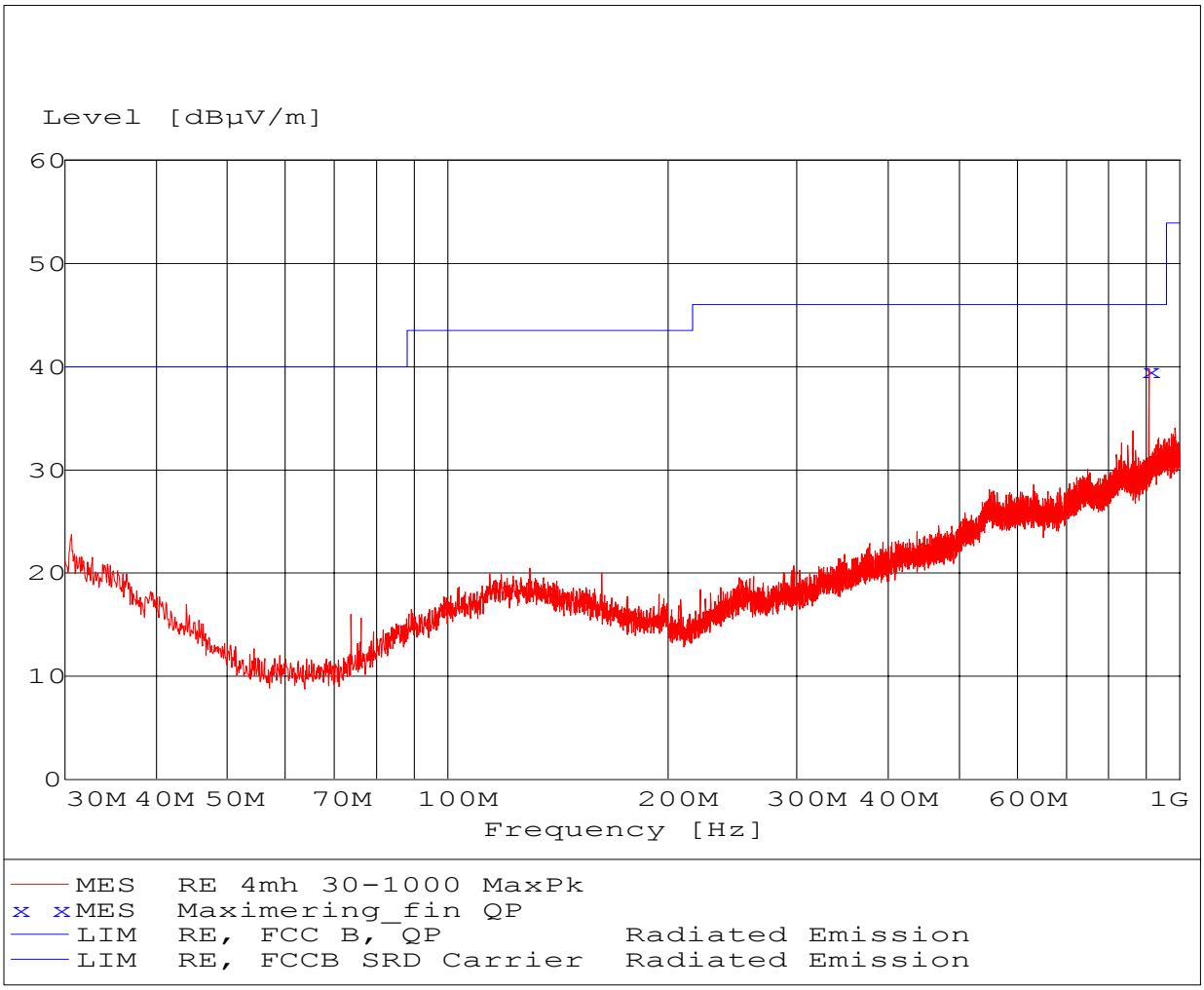
EUT:	ZW0102 US Z-wave Module. Rx-mode only
Manufacturer:	Zensys
Operating Condition:	Ant 1 m vertical
Test Site:	EMC-5
Operator:	HEN - E500465
Test Specification:	FCC
Comment:	Sheet 5
Start of Test:	2002-07-10



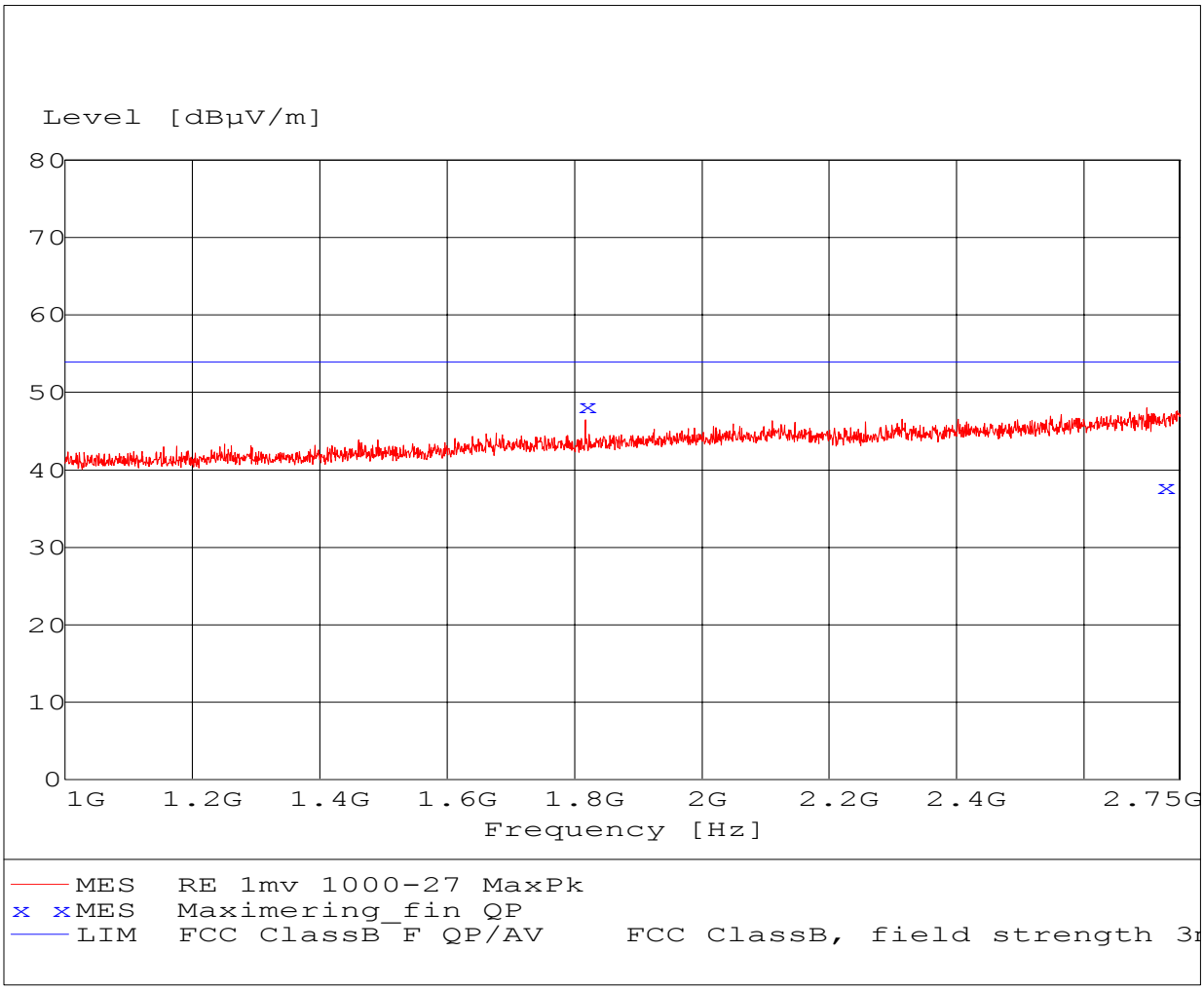
MEASUREMENT RESULT: "Maximering_fin QP"
2002-07-10 12:05

Frequency MHz	Level dBµV/m	Transd. dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg.	Polarisation
908.29	39.60	28.30	46.00	6.40	101.00	132.00	Horizontal

EUT:	ZW0102 US Z-wave Module. Rx mode only
Manufacturer:	Zensys
Operating Condition:	Ant 2 m horizontal
Test Site:	EMC-5
Operator:	HEN - E500465
Test Specification:	FCC
Comment:	Sheet 6
Start of Test:	2002-07-10



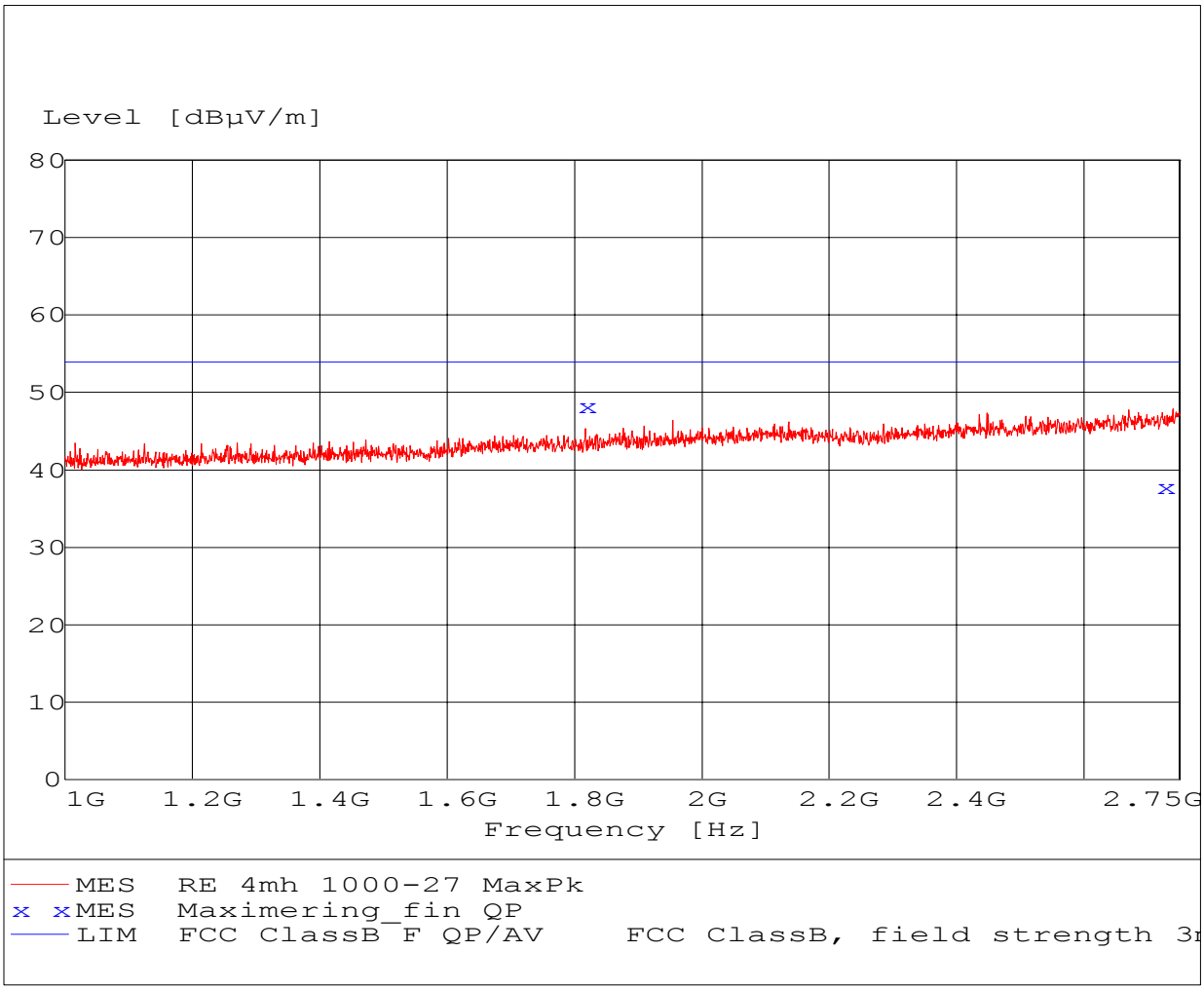
EUT:	ZW0102 US Z-wave Module
Manufacturer:	Zensys
Operating Condition:	Ant 1 m vertical
Test Site:	EMC-5
Operator:	HEN - E500465
Test Specification:	FCC
Comment:	Sheet 9
Start of Test:	2002-07-10

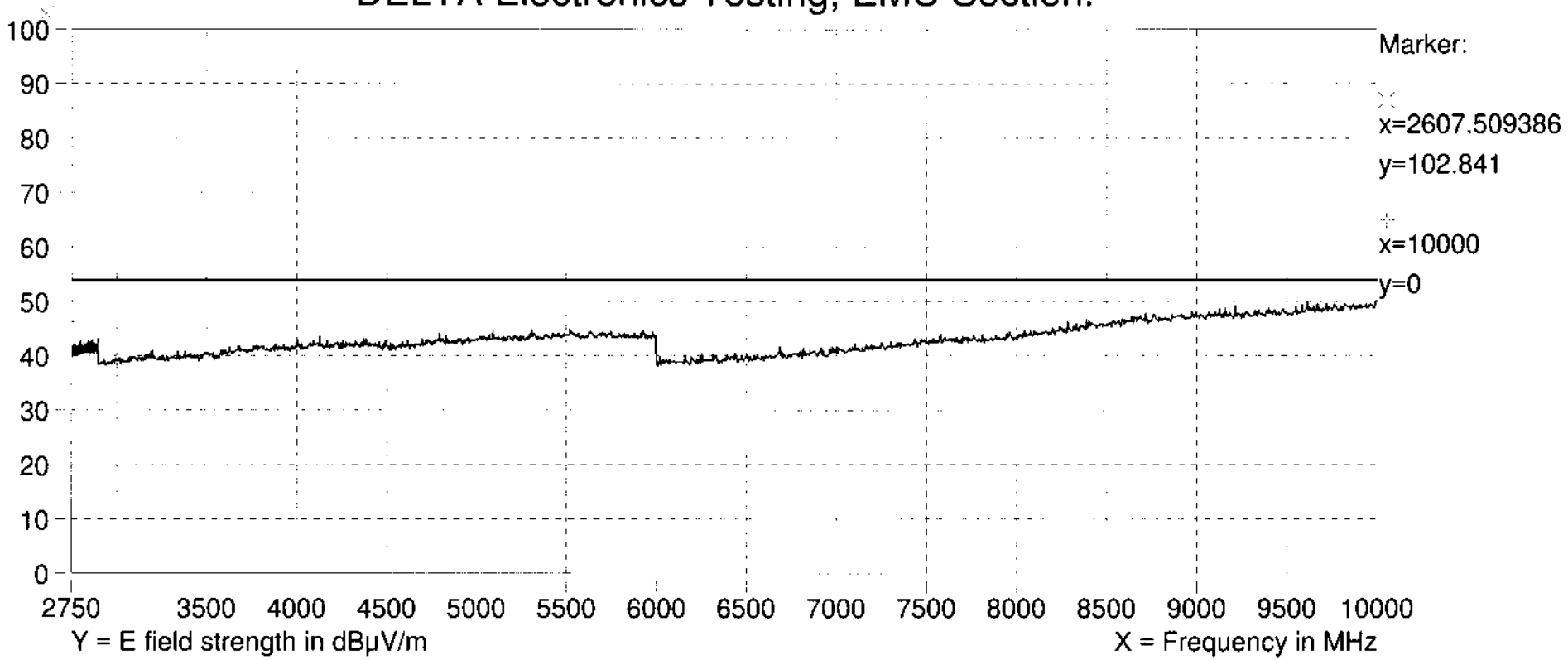


MEASUREMENT RESULT: "Maximering_fin QP"
2002-07-10 14:33

Frequency MHz	Level dBµV/m	Transd. dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg.	Polarisation
1816.85	48.20	7.90	53.90	5.70	101.00	178.00	Horizontal
2725.26	37.80	12.70	53.90	16.10	236.00	294.00	Horizontal

EUT:	ZW0102 US Z-wave Module
Manufacturer:	Zensys
Operating Condition:	Ant 2 m horizontal
Test Site:	EMC-5
Operator:	HEN - E500465
Test Specification:	FCC
Comment:	Sheet 10
Start of Test:	2002-07-10





to 2900MHz: Step: Y=0.1 dB lin, X=0.1 MHz lin, t=20 ms, Positive Peak, 1000 kHz, Level range 100 dBM, Attenuation 0 dB, Preamplifier off, HP 7000
to 6000MHz: Step: Y=0.1 dB lin, X=0.1 MHz lin, t=20 ms, Positive Peak, 1000 kHz, Level range 100 dBM, Attenuation 0 dB, Preamplifier off, HP 7000
to 10000MHz: Step: Y=0.1 dB lin, X=0.1 MHz lin, t=20 ms, Positive Peak, 30 kHz, Level range 100 dBM, Attenuation 0 dB, Preamplifier off, HP 7000

2002-07-10 17:39:17 File: 275G-10G.TO1, EUT 1
Empty File: 275G-10G.LM2, Limit 2
2002-07-10 16:52:56 File: 275G-10G.LM1, Limit 1, FCC15.109(part B) unintentional rad. and FCC 15.209(Part C) intentional rad.

Zen-Sys
ZW0120 US Z-Wave Module
Mode: Tx, Rx

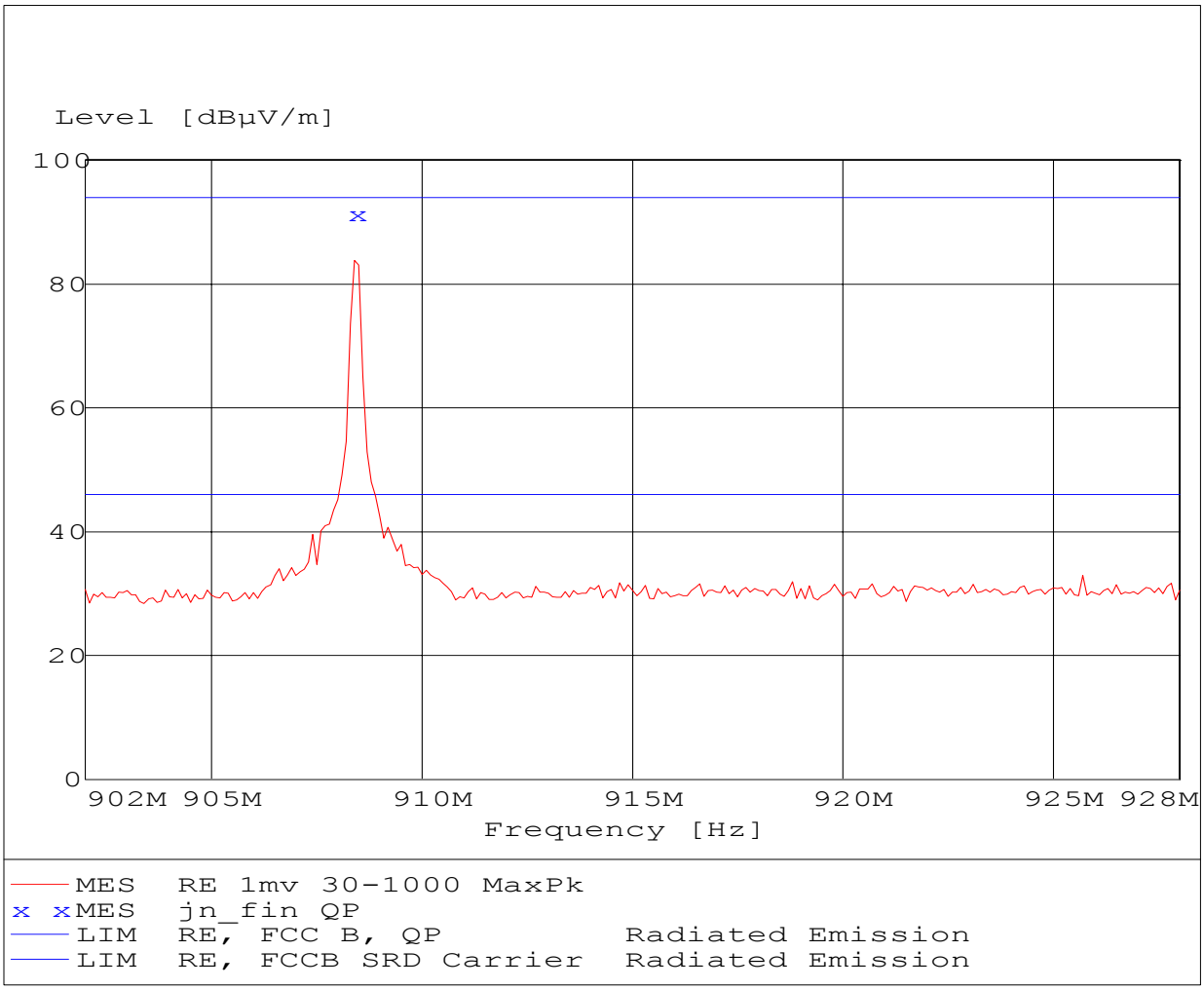
ant 1-3 meter horizontal and Vertical. T.T. 0-360 deg.
2002-07-10

Annex 5

Occupied bandwidth / Peak output power

(2 pages)

EUT:	ZW0102 US Z-wave Module
Manufacturer:	Zensys
Operating Condition:	Ant 1 m vertical
Test Site:	EMC-5
Operator:	HEN - E500465
Test Specification:	FCC
Comment:	Sheet 7
Start of Test:	2002-07-10



MEASUREMENT RESULT: "jn_fin QP"
2002-07-10 10:47

Frequency MHz	Level dBµV/m	Transd. dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg.	Polarisation
908.42	91.40	28.30	94.00	2.60	101.00	179.00	Horizontal

EUT:	ZW0102 US Z-wave Module
Manufacturer:	Zensys
Operating Condition:	Ant 2 m horizontal
Test Site:	EMC-5
Operator:	HEN - E500465
Test Specification:	FCC
Comment:	Sheet 8
Start of Test:	2002-07-10