

DELTA Test Report



Emission tests to FCC requirements of Alpro System Activity Meter Transmitter

Performed for DeLaval International AB

DANAK-198450

Project no.: A503781-1

Page 1 of 30

including 4 annexes

14 September 2006

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Title Emission tests to FCC requirements of Alpro System Activity Meter Transmitter

Test object Alpro System Activity Meter Transmitter

Report no. DANAK-198450

Project no. A503781-1

Test period May 2006

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Specifications FCC:47 CFR Part 15, Subpart C - Intentional Radiators

Results The equipment under test is in compliance with the requirements.

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Date 14 September 2006

Responsible 
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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 Section 15 in general and with Section 15.231a “Periodic operation in the band 40.66 - 40.70 MHz and above 70 MHz in particular”.

This report contains measurement data from tests performed at DELTA, Hørsholm, Denmark. DELTA is a DANAK accredited test laboratory with reference number 19.

The laboratory is listed by Industry Canada under file IC 4187-5.

The laboratory is listed by FCC under the registration number 90529.

1.1.1 Applicable test methods

The methods and procedures have been applied as specified in:

ANSI C63.4:2003 “Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz”.

1.2 Summary of test results

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

Tests of intentional radiator	Key references to requirement	Status
Conducted emission, AC mains	FCC 15.207	N/A
Restricted bands of operation	FCC15.205	Passed
Radiated emission limits, general requirements.	FCC15.209	Passed
Radiated electromagnetic field emission	FCC15.231	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 given results are based on a shared risk principle with respect to the measurement uncertainty.

The test results relate only to the objects tested.

2. Test objects and auxiliary equipment

2.1 Test object - Control unit

Category	SRD / 15.231a
Manufacturer	DeLaval International AB
Model / type	Alpro System Activity Meter Transmitter
Part no.	-
Serial no.	LA10 for 417.98 MHz lowest output power LA12 for 417.98 MHz highest output power *) LA16 for 433.89 MHz lowest output power LA14 for 433.89 MHz highest output power
FCC ID (intended)	UCS906520V2
IC (intended)	6576A-906520V2
Supply voltage	Internal battery 3 VDC
Operational mode	TX-CW for power and spurious measurements Data transmission at special programmed 2 s interval for occupied bandwidth measurements

*) The transmitter operating on 417.98 with highest output power is not being certified.

2.2 Description of the test object

The unit is a transmit-only device. It will be strapped to a cow and each hour transmits a signal telling the activity (steps taken) by the cow.

The transmitter can be delivered from factory operating on the nominal frequencies of either 418.0 MHz or 433.92 MHz. The transmitter with its build-in antenna and battery is completely sealed from factory and cannot be serviced.

The device is transmitting each hour plus a pseudorandom delay of 0 to 32 s. The transmission contains a start pulse, ID information and 24 bytes of counter information plus data check information; a total of 31 bytes/248 bits. They are transmitted using on-off-keying at a rate of 500 bits/s. The total transmission each hour lasts 504 ms.

The data stream is bi-phase coded, where 0 is represented as one level shift in 2 ms and 1 is represented as two level shifts in 2 ms. The worst case (minimum) peak-to-average reduction over 100 ms is 6 dB.

The unit is powered from an internal 3 V battery.

2.2.1 Frequency determining components

In order to select between the two transmit frequencies different crystals are used; 13.0625 or 13.5600 MHz. Different SAW filters with applicable centre frequencies are

used on the output before the antenna. Finally, two capacitors are different in order to optimise the coupling to the antenna.

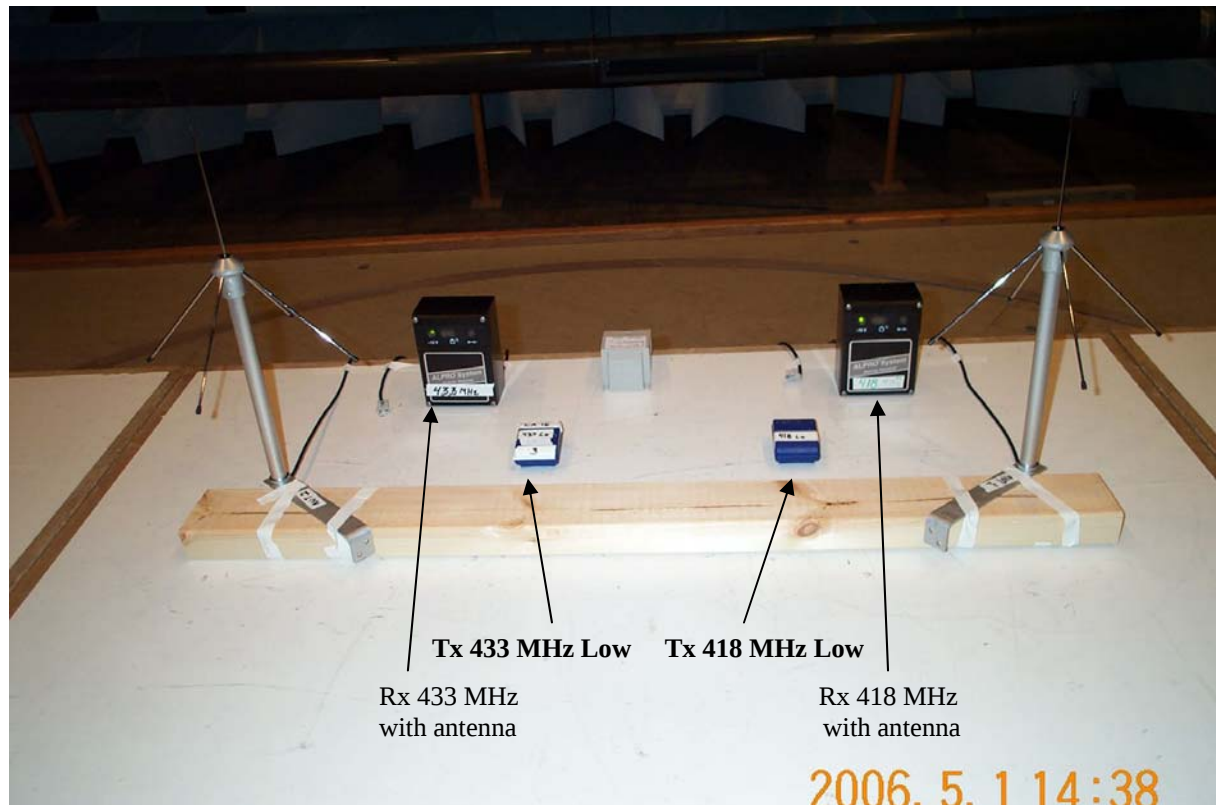
2.2.2 Power determining element(s)

The transmit IC has a high/low power feature build in, which is controlled by connecting an input pin to one or zero. High being approximately 6 dB above low level.

Both high and low power have been measured and reported here.

3. General test conditions

3.1 Test setup



Units under test. Low power transmitters.

During the test, emission was measured simultaneously from 433 MHz Tx low power, 418 MHz Tx low power, 433 MHz Rx and 418 MHz Rx.

If any signal is higher than the general spurious level its source is investigated and verified, if it is in accordance with specifications. The receiver is reported separately.

Both transmitters with high and low output power was measured and reported here.

Both high and low power configurations operating on 433.89 will be certified.

Only the low configuration operating on 417.98 MHz will be produced and certified.

4. Test and results

4.1 General field strength limits above 30 MHz

	Requirements	
Specification	FCC Rules and Regulations Part 15, Subpart C	
Test setup	ANSI C63.4:2003	
Measuring distance	3 m	
Frequency range	30-5000 MHz	
General limits as specified in 15.209(a)	30-88 MHz: 88-216 MHz: 216-960 MHz: Above 960 MHz:	40 dB μ V/m 43.5 dB μ V/m 46 dB μ V/m 54 dB μ V/m
Limits as specified in 15.231.a	Transmitter related spurious, based on the average value of the measurement. Alternatively, the QP value can be used.	20 dB below max permitted fundamental
Limits as specified in 15.205	Spurious in restricted bands	As specified in 15.209(a)
Measurement uncertainty (2 σ) <1 GHz		2.6 dB
Measurement uncertainty (2 σ) >1 GHz		4.9 dB
Below 1 GHz the general limits apply to measurements performed using a quasi-peak detector. Components from carrier and frequencies above 1 GHz the limits apply to measurements performed using an average detector unless they fall into a restricted band where the general limit applies. Furthermore, the peak level must be no higher than 20 dB above the average limit.		
Photos of test setup		Annex 2
Test record sheets		Annex 4

Results

The emission was within the specified limits.

4.1.1 Spurious emission 30 - 1000 MHz in tabular form for Tx microcontroller

For spectral plots see Annex 4.

Spurious freq. MHz	Polarization	QPeak dB μ V/m	dB below QP limit	Note
154.01	V	27.8	15.7	Microcontroller
168.01 (R)	V	30.8	12.7	Microcontroller

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

4.1.2 Spurious emission 30 - 5000 MHz in tabular form for Tx low power at 418 MHz

For spectral plots see Annex 4.

Spurious freq. MHz	Polarization	QPeak dB μ V/m	dB below -20 dB funda- mental limit or restricted band limit	Note
835.96	V	38.2	22.1	2 nd harmonics
1235.94 (R)	H	49.3	4.7	3 rd harmonic
1671.92 (R)	V	39.9	14.1	4 th harmonics
		Peak		
2085	V	41.1	19.2	5 th harmonics
2505	H	42.6	17.7	6 th harmonics
2925	H	39.1	14.9	7 th harmonics

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

Because measurements were performed on an unmodulated carrier, QP values equal peak values.

No reductions were performed based on peak-to-average factor.

4.1.3 Spurious emission 30 - 5000 MHz in tabular form for Tx high power at 418 MHz

For spectral plots see Annex 4.

Spurious freq. MHz	Polarization	QPeak dB μ V/m	dB below -20 dB fundamental limit or restricted band limit	Average dB μ V/m (-6 dB corr.)	Note
835.95	V	42.2	18.1		2 nd harmonic
1235.93 (R)	H	55.6	81.7	49.6	3 rd harmonic
1671.91 (R)	V	44.6	9.4		4 th harmonics
		Peak			
2085	V	44.4	15.9		5 th harmonic
2505	H	41.9	18.4		6 th harmonic
2925	V	42.3	18.0		7 th harmonic

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

Because measurements were performed on an unmodulated carrier, QP values equal peak values.

No reductions were performed based on peak-to-average factor, except for 3rd harmonic.

The peak values are below average values+20 dB. (Ref. 15.35)

4.1.4 Spurious emission 30 - 5000 MHz in tabular form for Tx low power at 433 MHz

For spectral plots see Annex 4.

Spurious freq. MHz	Polarization	QPeak dB μ V/m	dB below -20 dB fundamental limit or restricted band limit	Note
867.78	V	33.8	27.0	2 nd harmonic
1301.67 (R)	V	37.7	16.3	3 rd harmonic
1735.56	V	41.6	12.4	4 th harmonic
		Peak		
2165	V	40.0	14.0	5 th harmonic
2600	H	42.9	11.1	6 th harmonic
3035	H	39.6	14.4	7 th harmonic

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

Because measurements were performed on an unmodulated carrier, QP values equal peak values.

No reductions were performed based on peak-to-average factor.

4.1.5 Spurious emission 30 - 5000 MHz in tabular form for Tx high power at 433 MHz

For spectral plots see Annex 4.

Spurious freq. MHz	Polarization	QPeak dBμV/m	dB below -20 dB fundamental limit or restricted band limit	Note
867.78	V	40.0	20.8	2 nd harmonic
1301.68 (R)	V	42.0	12.0	3 rd harmonic
1735.57	V	48.1	12.7	4 th harmonic
		Peak		
2165	V	45.5	15.3	5 th harmonic
2600	H	43.0	17.8	6 th harmonic
3035	H	43.1	17.7	7 th harmonic

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

Because measurements were performed on an unmodulated carrier, QP values equal peak values.

No reductions were performed based on peak-to-average factor.

4.2 Occupied bandwidth

15.231c specifies that the bandwidth of emission shall be no wider than 0.25% of the centre frequency.

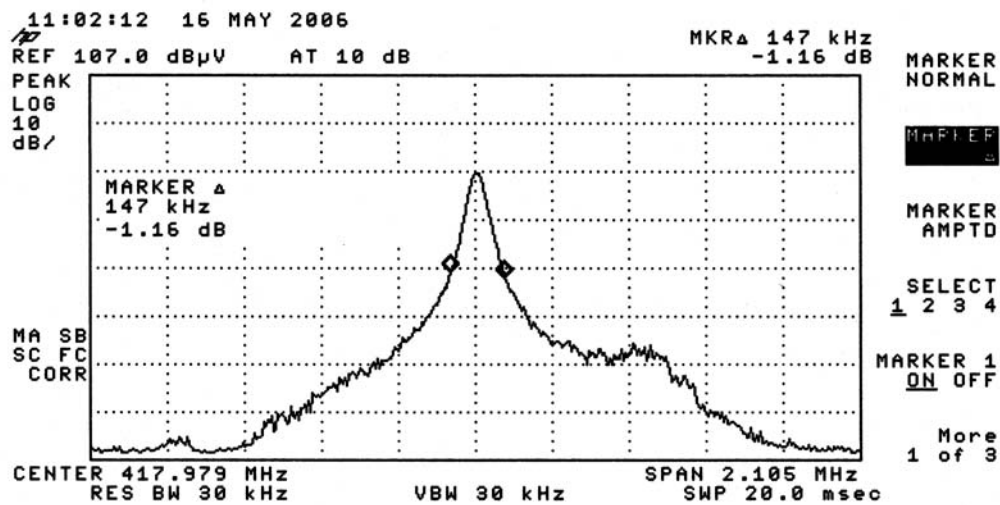
The occupied bandwidth was measured on a 418 MHz unit that was programmed to transmit each two seconds instead of the normal 3600 seconds. The measurement is shown on following plot.

The occupied bandwidth will not vary with changed carrier frequency.

The occupied bandwidth at -20 dBc is 147 kHz.

The requirement is 1.05 MHz.

The occupied bandwidth is in compliance with the requirement.



Plot showing occupied bandwidth

4.3 Peak output field strength

The limit for maximum radiated field strength at the fundamental frequency is given in 15.231b and calculated as $41.6667(F)-7083.3333$, where F is the frequency in MHz.

Limit at 417.98 MHz = $10.333 \mu\text{V/m}$ or $80.3 \text{ dB}\mu\text{V/m}$.

Limit at 433.89 MHz = $10.995 \mu\text{V/m}$ or $80.8 \text{ dB}\mu\text{V/m}$.

The limits are based on average value of the measurement.

The transmitter is using on/off keying with bi-phase modulated bit stream. The transmitter is ON for one transmission with duration of 504 ms each hour. The data stream is bi-phase coded, where 0 is represented as one level shift in 2 ms and 1 is represented as two level shifts in 2 ms. The worst case (minimum) peak-to-average reduction over 100 ms is 6 dB.

15.35 specify the peak limit to be 20 dB above the permitted average emission limit.

4.3.1 Results for Tx at 418 MHz

Tx frequency: 417.98 MHz TX low and Tx high							
Transmitter	Antenna corr. factor dB	Measured dB μ V/m Peak	Average limit dB μ V/m	Correction factor peak-to-average dB	Corrected Tx-level dB μ V/m	Margin to avg.-limit dB	Margin to peak limit (avg.+20 dB)
Tx low	19.6	80.7	80,3	-6	74.3	+6	19,6
Tx high	19.6	87.2	80.3	-6	81.2	-0.9	13,1

Result

The EUT operating on 417.98 MHz in configuration low is in compliance with the requirement.

The EUT operating on 417.98 MHz in configuration high is not in compliance with the requirement.

Comments

Only transmitter operating on 417.98 MHz in configuration low is to be certified.

4.3.2 Results for Tx at 433 MHz

Tx frequency: 433.89 MHz TX low and Tx high							
Transmitter	Antenna corr. factor dB	Measured dB μ V/m Peak	Average limit dB μ V/m	Correction factor peak-to-average dB	Corrected Tx-level dB μ V/m	Margin to avg.-limit dB	Margin to peak limit (avg.+20 dB)
Tx low	19.6	79.7	80.8	-6	73,7	7.1	21.1
Tx high	19.6	86.8	80.8	-6	80.8	0	14

Result

The EUT operating on 433.89 MHz with low output and with high output is in compliance with the requirement.

Comments

None.

Annex 1

List of instruments

Instru- ment no.	DESCRIPTION	MANUFACTURER	TYPE NO.	Date calibration expires
29461	ARTIFICIAL MAINS NETWORK	ROHDE & SCHWARZ	ESH2/Z5	2006-07-20
29499	BROADBAND RF PRE- AMPLIFIER	EC/MTS TELEMETER	TVV 711	2006-12-09
29797	BILOG ANTENNA, 30-2000 MHz	CHASE ELECTRICS LTD	CBL 6111A	2008-03-01
29861	EMI-SOFTWARE Ver. 1.60	ROHDE & SCHWARZ	ES-K1, PART: 1026.6790.02 3115	ONLY CAL. IF REQUIRED 2008-02-28
29876	RIDGED GUIDE HORN AN- TENNA, 1-12.75 (18) GHz	EMCO		
29916	AUTOMATIC TEST RECEIVER, 9 kHz - 2.75 GHz	ROHDE & SCHWARZ	ESCS 30 1102.4500.30	2007-01-02
49037	BROADBAND MICROWAVE PREAMPLIFIER, 1-12.8 GHz	MITEQ / DELTA	AMF-5D-001128-35- 11P	2007-01-02
49086	REMI EMISSION SOFTWARE PACKAGE v. 2.133, ROOM 5	NeWeTec	REMI	ONLY CAL. IF REQUIRED
49321	SPECTRUM ANALYZER, 50 GHz WITH OPTION 006	HEWLETT-PACKARD	8565E	2006-06-15
49421	IMPULSE VOLTAGE LIMITER	ROHDE & SCHWARZ	ESH3/Z2	2006-11-21

Annex 2

Photos

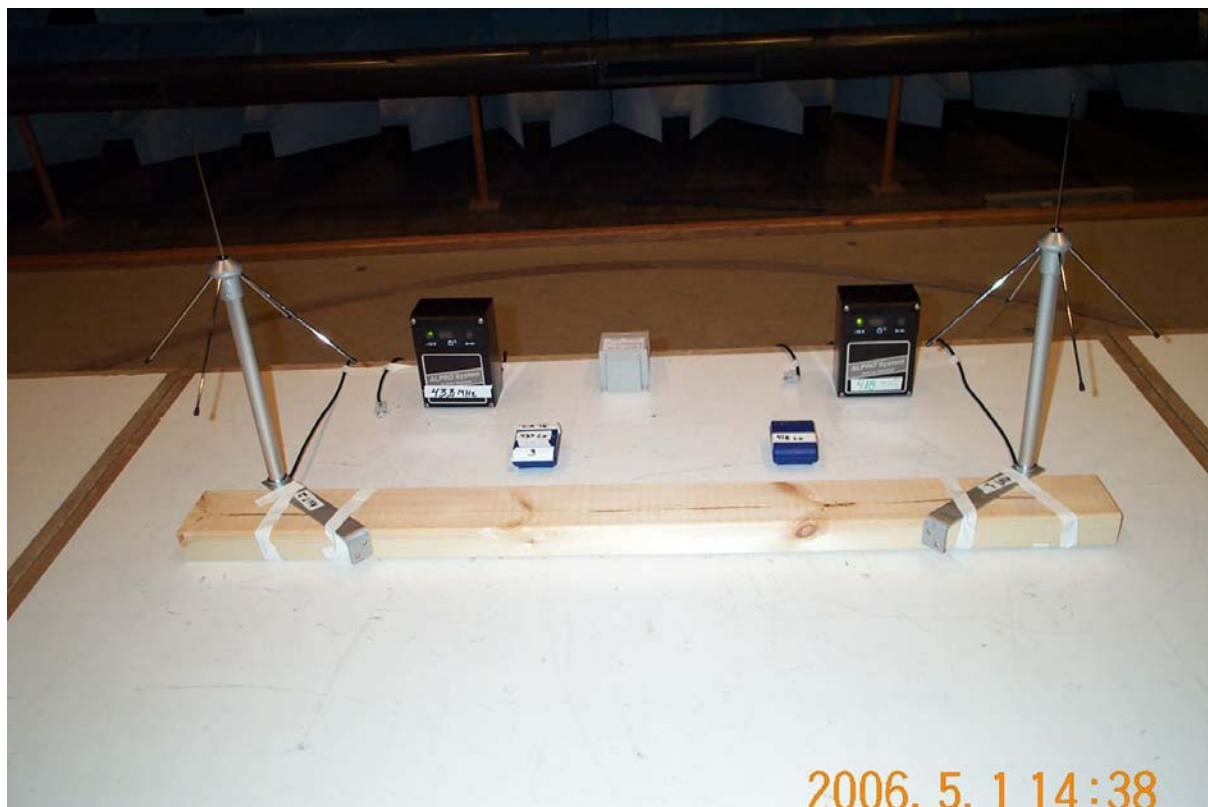


Photo A2.1 Units during emission tests (See Section 3.1 for details of setup).



Photo A2.2 Units during emission tests (See Section 3.1 for details of setup).

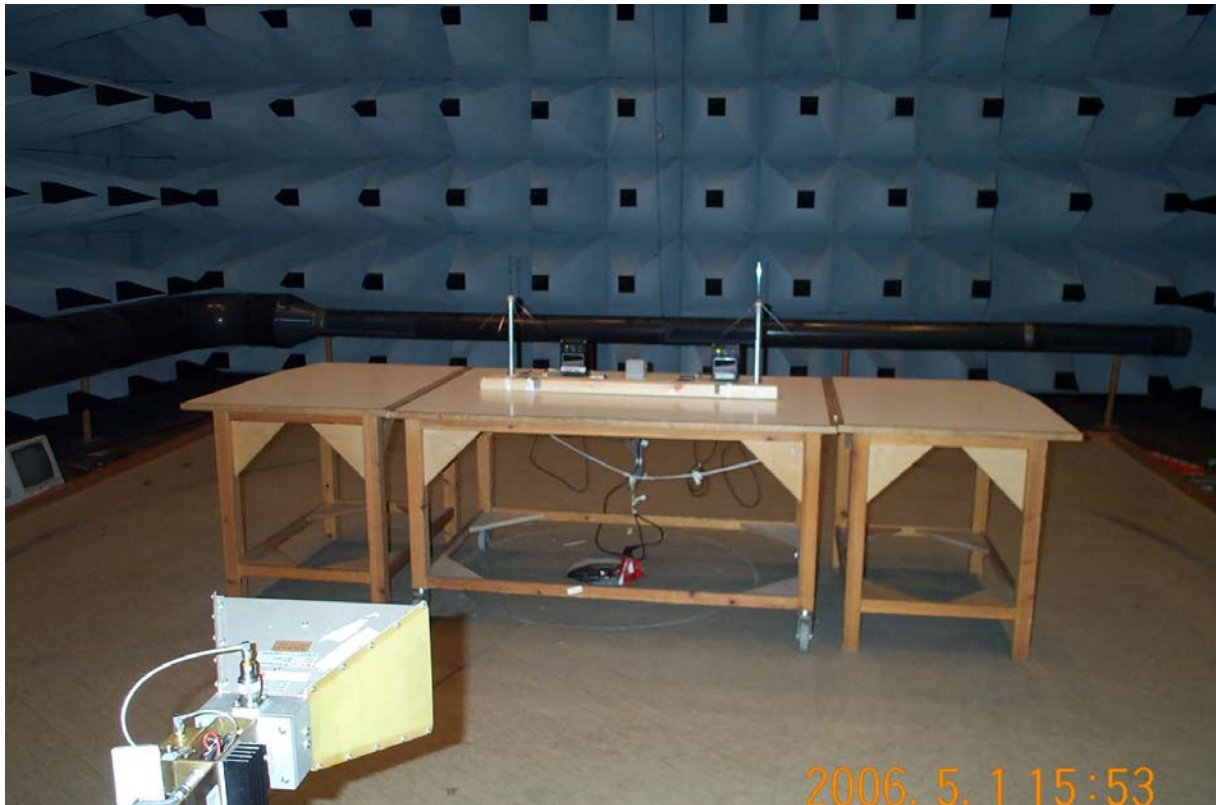


Photo A2.3 Test setup (See Section 3.1 for details of setup).

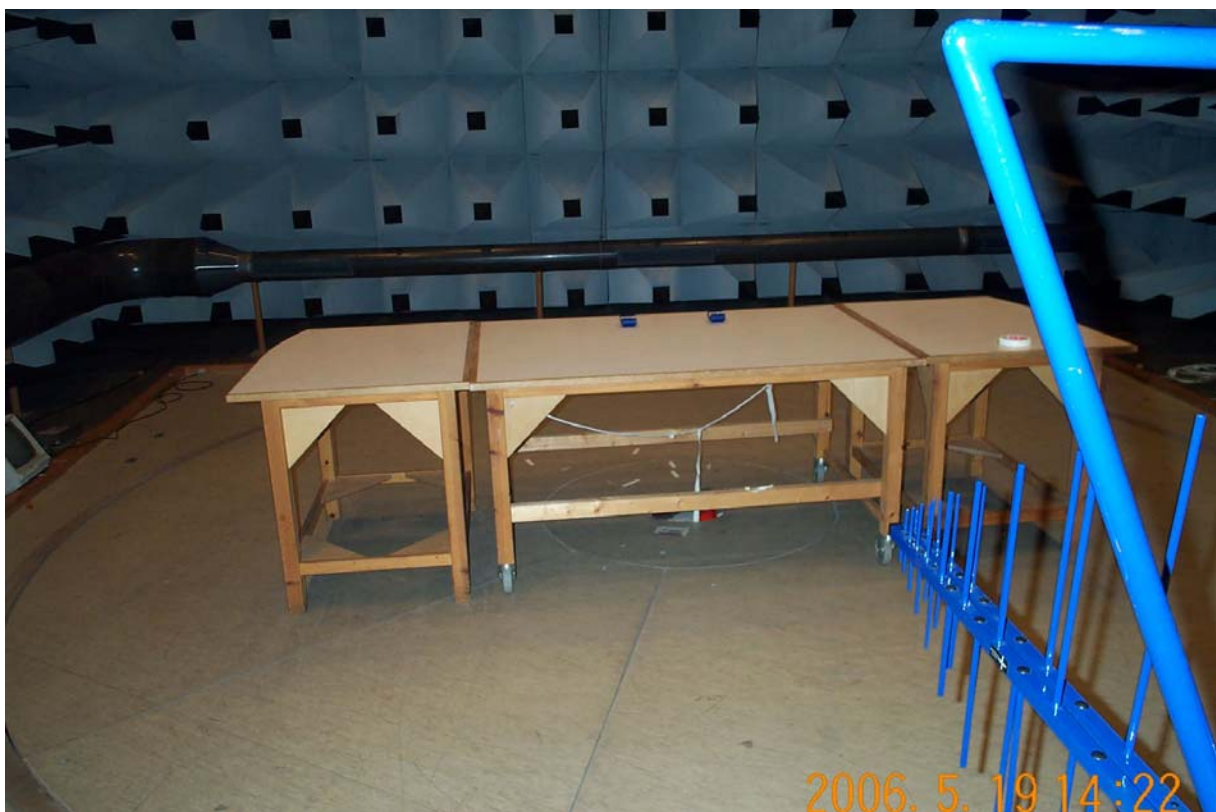
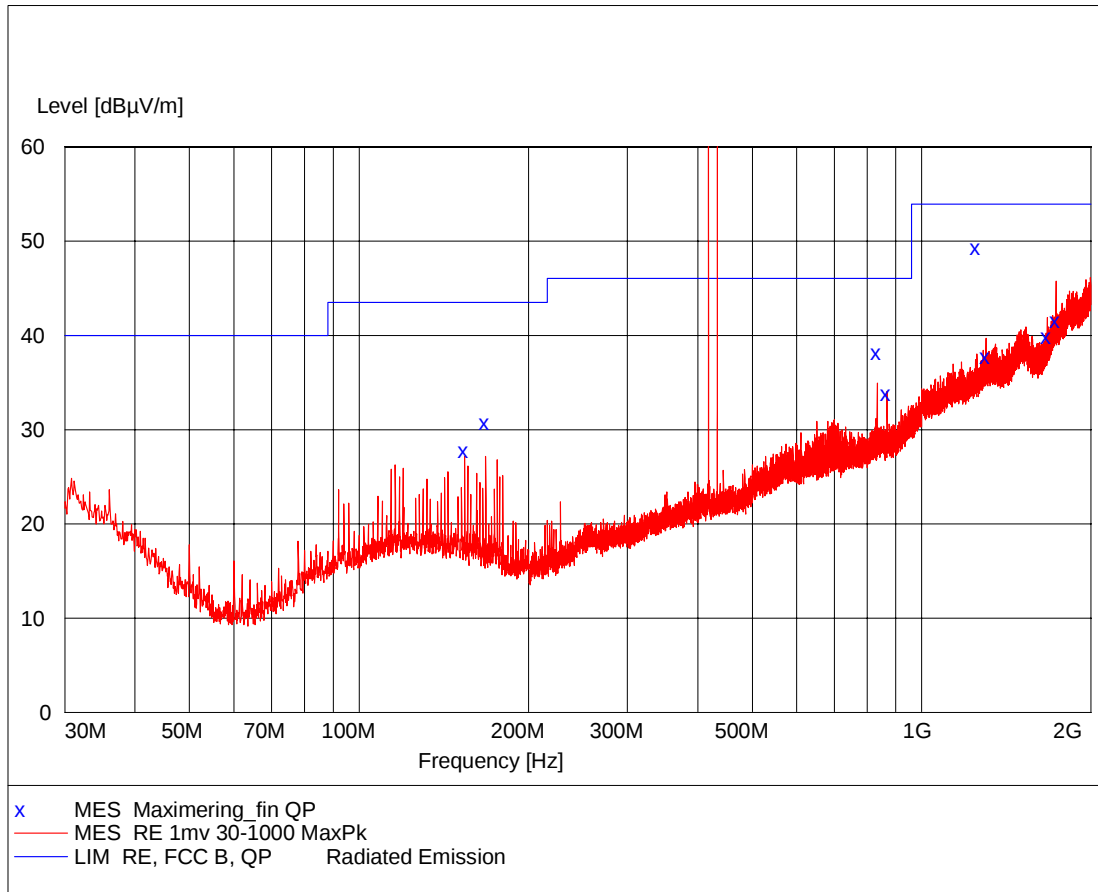


Photo A2.4 Test setup. Measurement of Tx high power units.

Annex 3

Plots of spurious emission

EUT: Activity RX, TX LA16 433 MHz. Activity RX, TX LA10 418 MHz
Manufacturer: DeLaval International AB
Operating Condition: Ant 1 m vertical
Test Site: EMC-5
Operator: HEN - A503781
Test Specification: FCC
Comment: Sheet 3
Start of Test: 2006-05-01

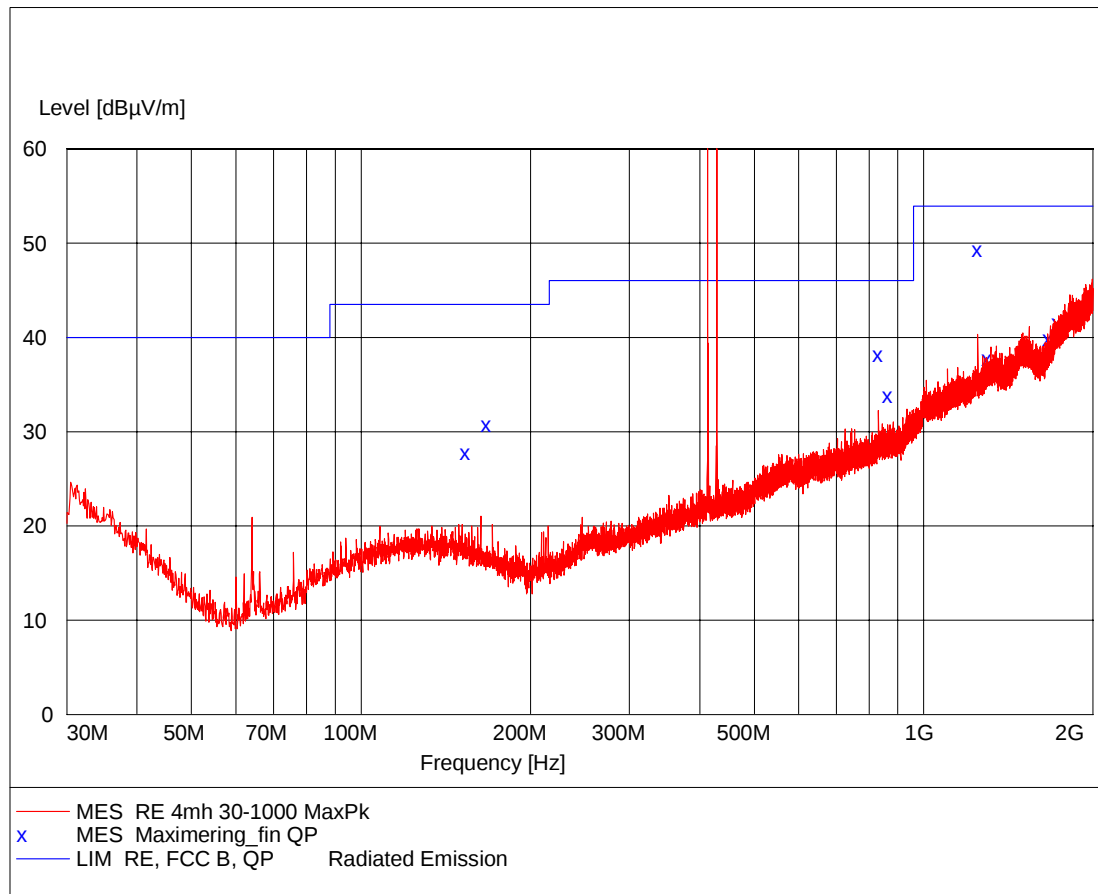


MEASUREMENT RESULT: "Maximering_fin QP"

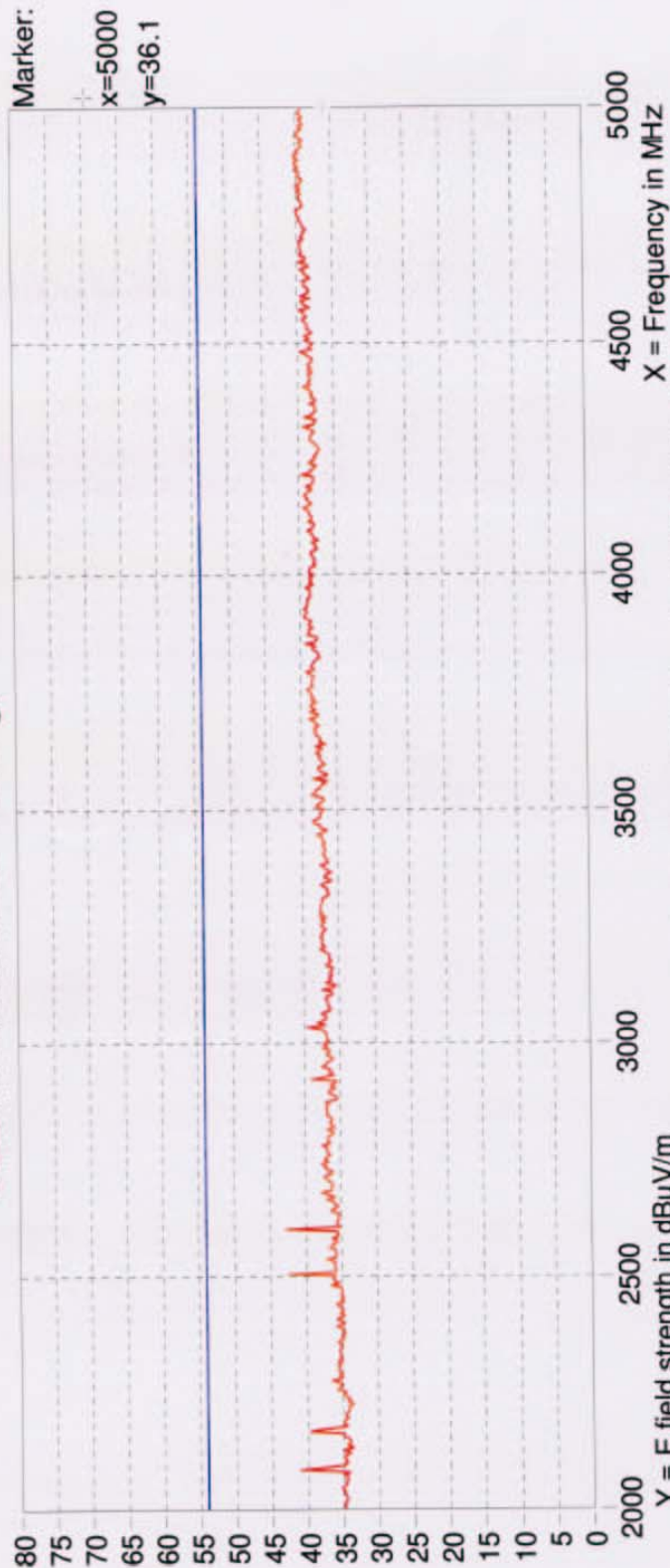
2006-05-01 14:53

Frequency MHz	Level dBμV/m	Transd dB	Limit dBμV/m	Margin dB	Height cm	Azimuth deg	Polarisation
154.010000	27.80	13.2	43.5	15.7	111.0	169.00	VERTICAL
168.010000	30.80	12.4	43.5	12.7	101.0	160.00	VERTICAL
835.960000	38.20	26.8	46.0	7.8	122.0	21.00	VERTICAL
867.780000	33.80	26.8	46.0	12.2	117.0	4.00	VERTICAL
1253.940000	49.30	31.4	53.9	4.6	101.0	290.00	HORIZONTAL
1301.670000	37.70	32.4	53.9	16.2	112.0	358.00	VERTICAL
1671.920000	39.90	34.8	53.9	14.0	111.0	19.00	VERTICAL
1735.560000	41.60	36.8	53.9	12.3	111.0	4.00	VERTICAL

EUT: Activity RX, TX LA16 433 MHz. Activity RX, TX LA10 418 MHz
Manufacturer: DeLaval International AB
Operating Condition: Ant 3 m horizontal
Test Site: EMC-5
Operator: HEN - A503781
Test Specification: FCC
Comment: Sheet 4
Start of Test: 2006-05-01



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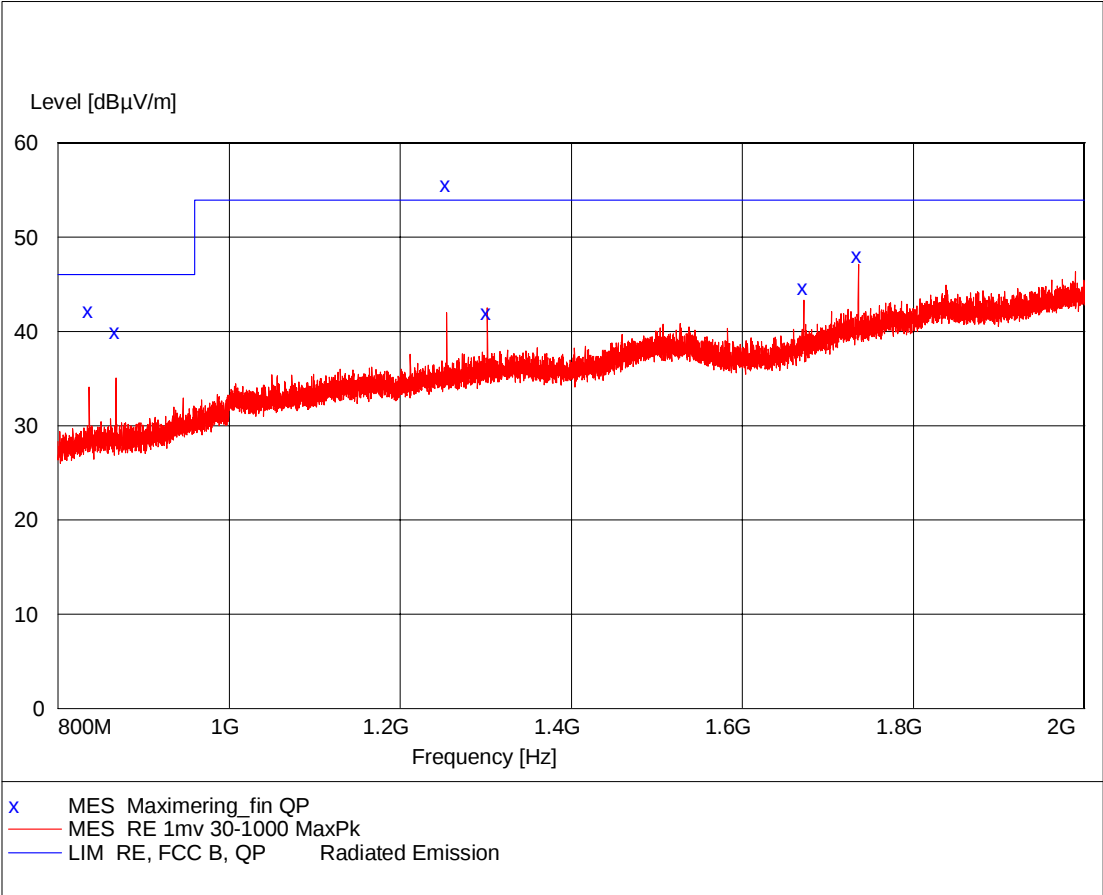
2006-05-01 15:47:28 File: FCC.TO1, EUT 1
2006-05-01 15:22:19 File: FCC.LM1, Limit 1, FCC15.109(part B) unintentional rad. and FCC 15.209(Part C) intentional rad. Both Rx

Delaval
Activity RX, TX LA16 433 MHz. Activity RX, TX LA10 418 MHz
ant 1-3 meter vertical and horizontal. T.T. 0-360 deg.

Project no: A503781 - HEN

Sheet 5

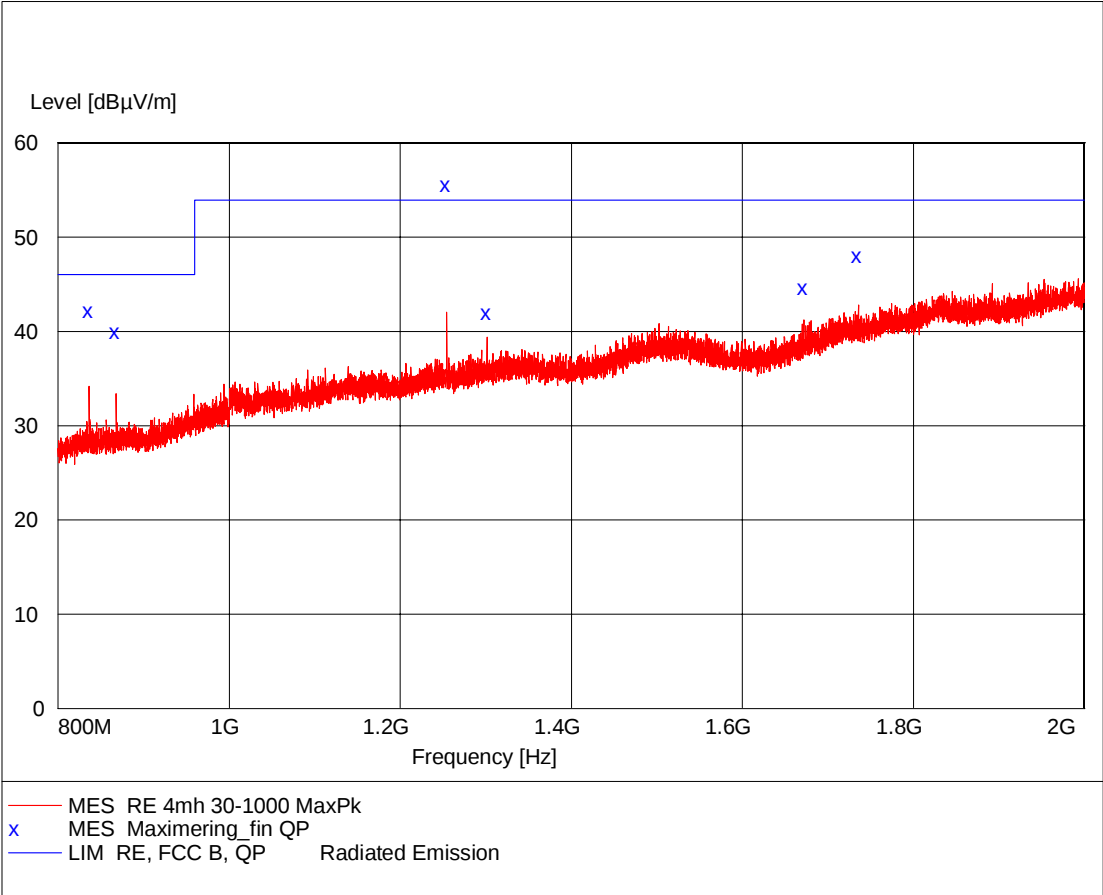
EUT: TX LA14, 433 MHz and LA 12, 418 MHz
Manufacturer: DeLaval International AB
Operating Condition: Ant. 1 m vertical
Test Site: EMC-5
Operator: HEN - A503781
Test Specification: FCC
Comment: Sheet 22
Start of Test: 2006-05-19



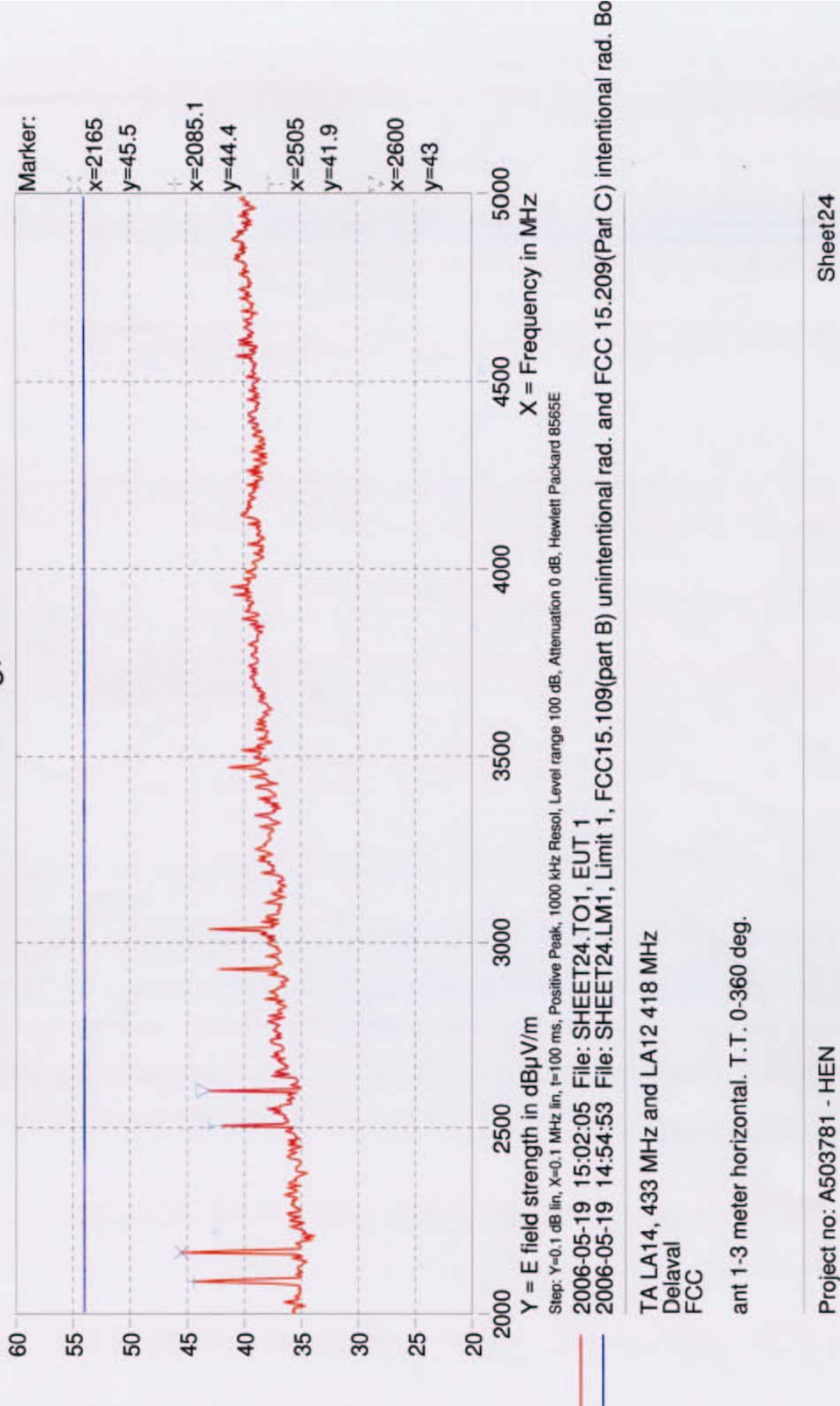
MEASUREMENT RESULT: "Maximering_fin QP"
2006-05-19 14:25

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg	Polarisation
835.950000	42.20	26.8	46.0	3.8	121.0	46.00	VER. PEAK
867.780000	40.00	26.8	46.0	-4.0	112.0	231.00	VER. PEAK
1253.930000	55.60	31.4	53.9	-1.7	101.0	131.00	H0R. PEAK
1301.680000	42.00	32.4	53.9	11.9	114.0	198.00	VER. PEAK
1671.910000	44.60	34.8	53.9	9.3	110.0	358.00	VER. PEAK
1735.570000	48.10	36.8	53.9	5.8	111.0	357.00	VER. PEAK

EUT: TX LA14, 433 MHz and LA 12, 418 MHz
Manufacturer: DeLaval International AB
Operating Condition: Ant. 3 m horizontal
Test Site: EMC-5
Operator: HEN - A503781
Test Specification: FCC
Comment: Sheet 23
Start of Test: 2006-05-19



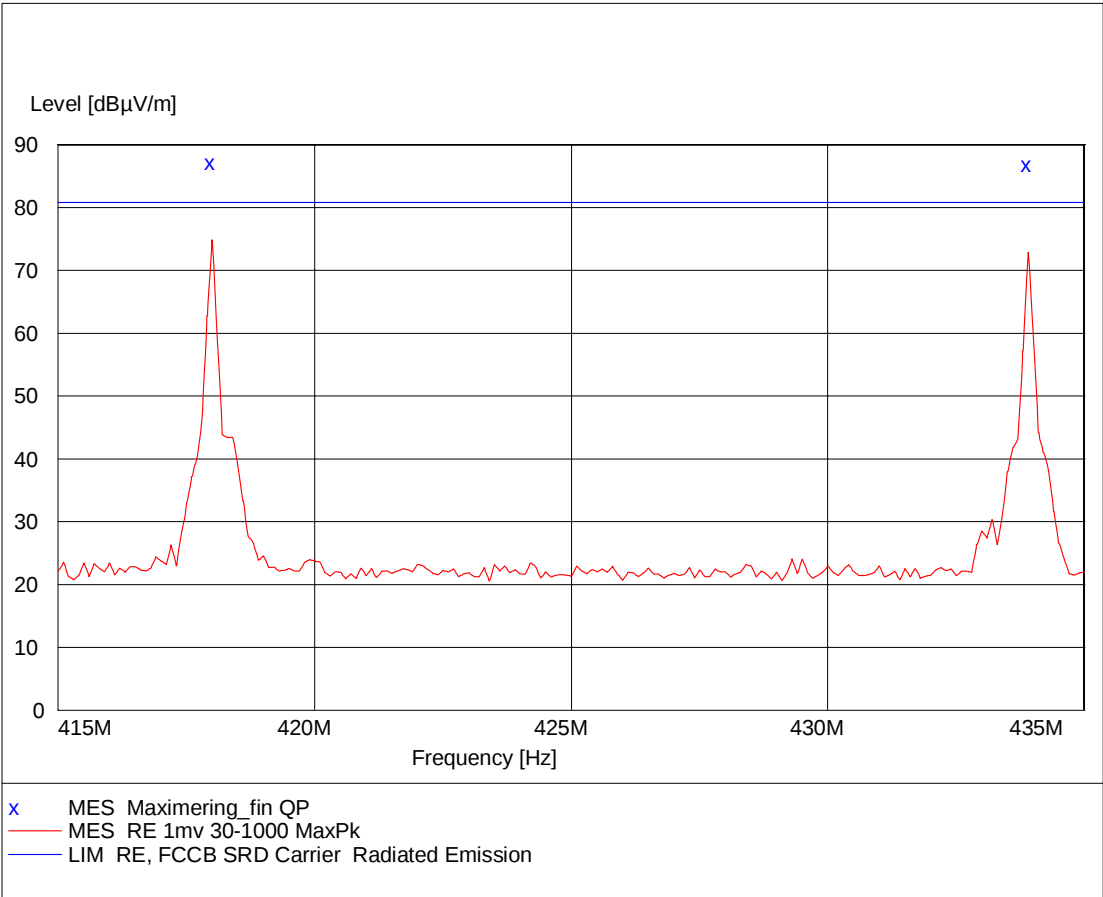
DELTA Electronics Testing, EMC Section.



Annex 4

Plots of carrier emission

EUT: Activity RX, TX LA14 HI 433 MHz. Activity RX, TX LA12 HI 418
Manufacturer: DeLaval International AB
Operating Condition: Ant 1 m vertical
Test Site: EMC-5
Operator: HEN - A503781
Test Specification: FCC
Comment: Sheet 1
Start of Test: 2006-05-01

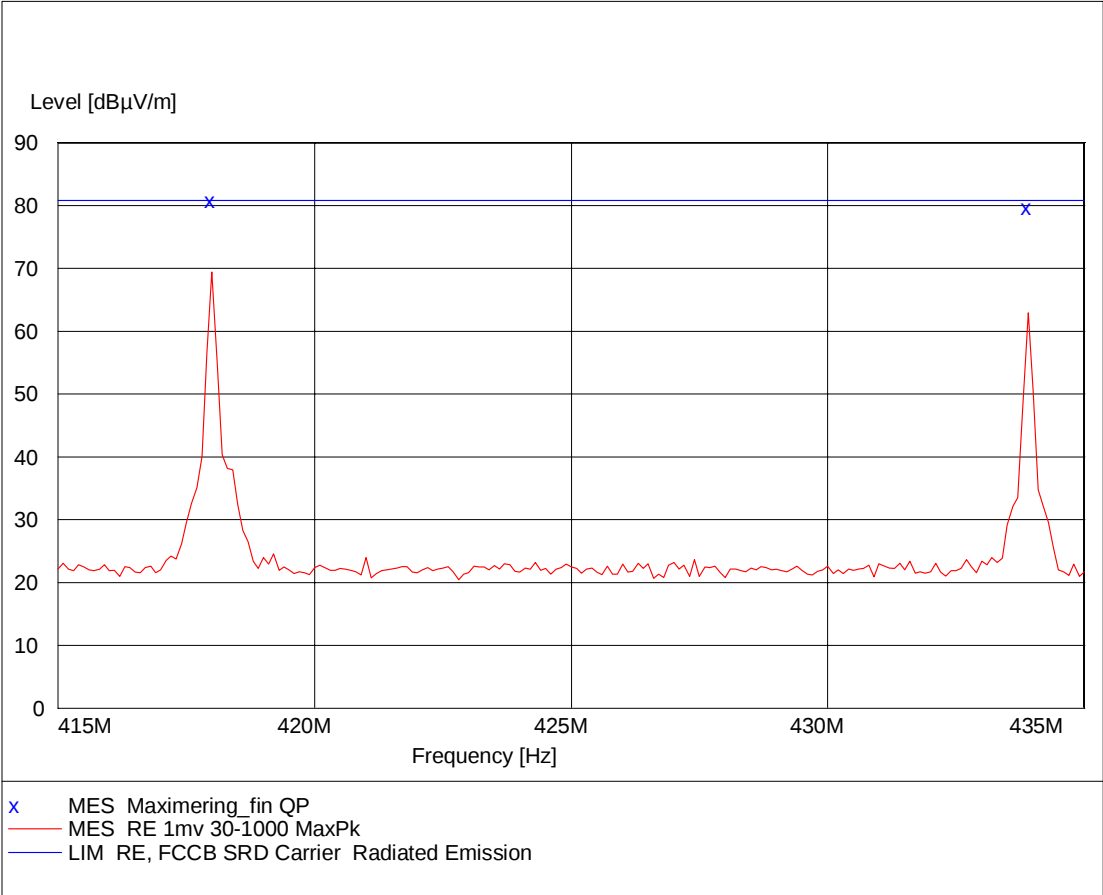


MEASUREMENT RESULT: "Maximizing_fin QP"
2006-05-01 11:56

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg	Polarisation
417.980000	87.20	19.6	80.8	-6.4	101.0	282.00	HORIZONTAL
433.890000	86.80	19.6	80.8	-6.0	101.0	273.00	HORIZONTAL



EUT: Activity RX, TX LA14 433 MHz. Activity RX, TX LA12 418 MHz
Manufacturer: DeLaval International AB
Operating Condition: Ant 1 m vertical
Test Site: EMC-5
Operator: HEN - A503781
Test Specification: FCC
Comment: Sheet 2
Start of Test: 2006-05-01



MEASUREMENT RESULT: "Maximering_fin QP"
2006-05-01 12:27

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg	Polarisation
417.980000	80.70	19.6	80.8	0.1	101.0	297.00	HORIZONTAL
433.890000	79.70	19.6	80.8	1.1	101.0	268.00	HORIZONTAL

