COMLAB
Accredited Testing and Certification
EMC, Radio and Telecommunications

www.nemko.com

**Test report no. : 68166-4**

**Item tested : RC-01**

**Type of equipment : Low Power Transceiver**

**Client : Engbo AS**

**FCC Part 15.249**
Low Power Transceiver
902-928 MHz Band

**6 November 2006**

**Authorized by : .....**
Frode Sveinsen
Technical Verificator

## CONTENTS

# 1 GENERAL INFORMATION

## 1.1 Testhouse Info

Name : Nemko Comlab

Address : Gåsevikveien 8, Box 96
N-2027 Kjeller, NORWAY

Telephone : +47 64 84 57 00

Fax : +47 64 84 57 05

E-mail: post@comlab.no

FCC test firm registration # : 994405

Industry Canada OATS registration # : 4443

## 1.2 Client Information

Name : Engbo AS

Address : Wirgenesvei 7, 3157 Barkåker , Norway

Telephone : +47 33003150

Fax : +47 30003160

***Contact:***

Name : Finn Limseth

Telephone : +47 33003159

E-mail : innovation@engbo.no

## 1.3 Manufacturer

Name : Engbo AS

Address : Wirgenesvei 7, 3157 Barkåker , Norway

Telephone : +47 33003150

Fax : +47 30003160

# 2 Test Information

## 2.1 Test Item

| | |
|---|---|
| Name : | Remote Control (RC-01) |
| Model/version : | RC-01 |
| Serial number : | From 00001 and Increasing |
| Hardware identity and/or version: | CP12 V.2.00 |
| Software identity and/or version : | C201 |
| Frequency Range : | 902.175 – 903.025 MHz |
| Tunable Bands : | 1 |
| Number of Channels : | 16[1] |
| Operating Modes : | TX & RX |
| Type of Modulation : | FSK |
| Emissions Designator : | F1D |
| User Frequency Adjustment : | None, Software controlled |
| Rated Output Power : | 10 mW |
| Type of Power Supply : | 3x1.5V DC batteries |
| Antenna Connector : | Integral antenna only |
| Antenna Diversity Supported : | None |

1) Only one channel in use at a time.

**Theory of Operation**

The handheld RF remote control unit is a two way transceiver. It is a narrow band battery operated unit. It can be equipped with different number of switches and indicator LEDs and accompanying front decals and thereby the same basis unit can serve many different products and applications. The frequencies are software controlled.

**Description of Test Item**

The required frequencies, modulation and modes are selected by preprogrammed software on the EUT.

All measurements were performed with a fully charged batteries and varriable voltages. And measurements were performed only at normal conditions.

The spurious emssions on ECU01 is performed with all ports populated.

All radiated measurements above 1GHz were performed on three axes.

## 2.2 Test Environment

### *2.2.1 Normal test condition*

| | |
|---|---|
| Temperature: | 20 - 22 °C |
| Relative humidity: | 30 - 40 % |
| Normal test voltage: | 3x1.5V DC Battery |

The values are the limit registered during the test period.

## 2.3 Test Period

| | |
|---|---|
| Item received date: | 2006-08-14 |
| Test period : | 2006-08-14 to 2006-09-26 |

# 3 TEST REPORT SUMMARY

## 3.1 General

Manufacturer: Engbo AS

Model No.: RC-01

Serial No.: /

All measurements are tracable to national standards.

The tests were conducted for the purpose of demonstrating compliance with FCC CFR 47 Part 15.249 and Industry Canada RSS-210 Issue 6.

Radiated tests were conducted in accordance with ANSI C63.4-2003. The radiated tests were made in a semi-anechoic chamber at measuring distances of 3 and 10 metres.

☒ New Submission ☒ Production Unit

☐ Class II Permissive Change ☐ Pre-production Unit

**DXT** Equipment Code ☐ Family Listing

**THIS TEST REPORT RELATES ONLY TO THE ITEM (S) TESTED.**

**Deviations from, additions to, or exclusions from the test specifications are described in "Summary of Test Data".**

**TEST REPORT #: 68166-4**

TESTED BY: _____ DATE: 06.10.2006

G.Suhanthakumar, Test engineer

## 3.2 Test Summary

| Name of test | FCC Part 15 reference | Result |
|---|---|---|
| Supply Voltage Variations | 15.31(e) | Passed [2] |
| Number of Operating Frequencies | 15.31(m) | Passed |
| Antenna Requirement | 15.203 | Integral [1] |
| Powerline Conducted Emission | 15.207(C) | Passed [2] |
| 20 dB bandwidth | 15.215(c) | Passed |
| Peak Power Output | 15.249(a)(c) | Passed |
| Band edge Emissions | 15.249(d) | Passed |
| Spurious Emissions (Radiated) | 15.249 (e) | Passed |
| Spurious Emissions (Antenna Conducted) | 15.249 | N/A[1] |

[1] The EUT has only integral antenna.

[2] Fully charged Batteries were used

## 3.3 Description of modification for Modification Filing

Not applicable.

## 3.4 Comments

The EUT is delivered with pre-programmed 3 channels.

All ports were populated during spurious emission measurements.

The RC-01 has integral antenna only.

## 3.5 Family List Rational

Not Applicable.

# 4 TEST RESULTS

## 4.1 Power Line Conducted Emissions

**Para. No.: 15.207 (a)**

| **Test Performed By: G.Suhanthakumar** | **Date of Test: 20 09 2006** |
|---|---|

**Measurement procedure:** **ANSI C63.4-2003 using 50 µH/50 ohms LISN.**

**Test Results:** **Not applicable, the EUT can only be powered from batteries.**

**Measurement Data:** **See attached graph in fig 1, 2 & 3, (Peak detector).**

**Highest measured value (L1 and N):**

| **Frequency** | **Detector** | **Measured value** | **Limit** | **Margin** |
|---|---|---|---|---|
| **KHz** | **Peak/QP/AV** | **dBµV** | **dBµV** | **dB** |
| **/** | QP | / | / | / |
| **/** | AV | / | / | / |

## 4.2 Frequency Tolerance

**Para. No.: /**

| Test Performed By: G.Suhanthakumar | Date of Test: 20.09.2006 |
|---|---|

**Measurement Data:**

| Channel nr. | Given Frequency (MHz) | Measured value (MHz) | Deviation (Hz) |
|---|---|---|---|
| K0 | 902.175 | 902.17470 | -300 |
| K17 | 902.575 | 902.57477 | -230 |
| K21 | 903.025 | 903.02445 | -550 |

Comment: For information only. There are no requirements to frequency tolerance for low power devices in the 902-928 MHz band certified to 15.249.

## 4.3 20 dB bandwidth

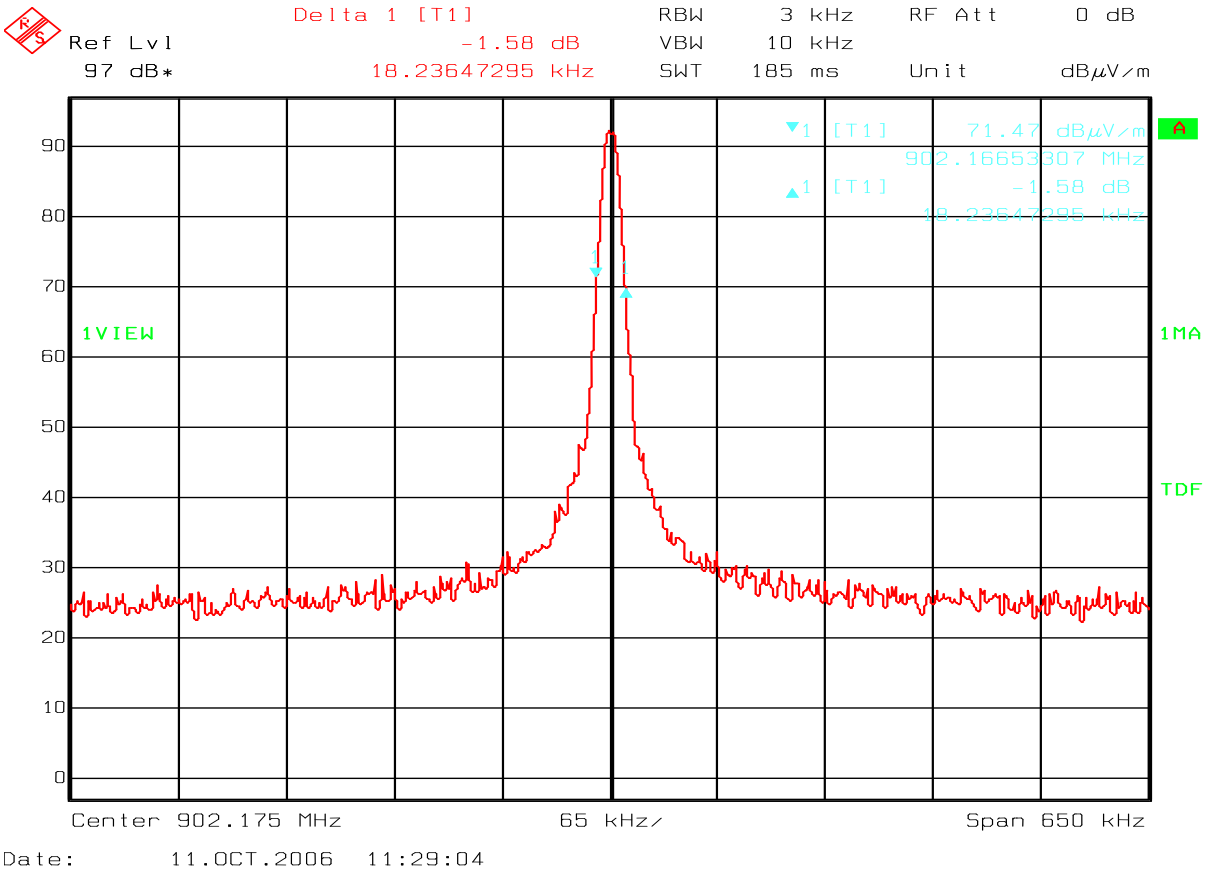
**Para. No.: 15.215(c)**

| Test Performed By: G.Suhanthakumar | Date of Test: 10.10.2006 |
|---|---|

**Test Results: Complies**

**Measurement Data:**

See attached plot below.




**20 dB bandwidth, Ch 0**

## 4.4 Peak Power Output

**Para. No.: 15.249 (a)**

| **Test Performed By: G.Suhanthakumar** | **Date of Test: 26.09.2006** |
|---|---|

**Test Results: Complies**

**Measurement Data:**

Maximum field strength, dBµV/m

| RF channel | Ch 0 (902.175 MHz) | Ch 8 (902.575 MHz) | Ch 17 (903.025 MHz) |
|---|---|---|---|
| Measured maximum field strength | 93.9 | 93.7 | 93.4 |

**See attached graph in Fig 4 to 9**

Detachable antenna? ☐ Yes ☒ No

If detachable, is the antenna connector non-standard? ☐ Yes ☐ No

The tested equipments have integral antennas only.

**Requirements:**

The maximum peak output power shall be ≤ 94dBµV/m

Nemko Comlab

26. Sep 06 09:55

Peak

EUT: rc01
Manuf: Engbo AS
Op Cond: HP 125 cm, 255deg
Operator: gns
Test Spec: FCC 15 249
Comment: k0
3 m dist

Scan Settings (1 Range)

| Frequencies | | | Receiver Settings | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start | Stop | Step | IF BW | Detector | M-Time | Atten | Preamp | OpRge |
| 900M | 905M | 30k | 120k | PK | 50ms | AUTO | LN ON | 60dB |

| Transducer No. | Start | Stop | Name |
|---|---|---|---|
| 21 | 200M | 1000M | HL223 |

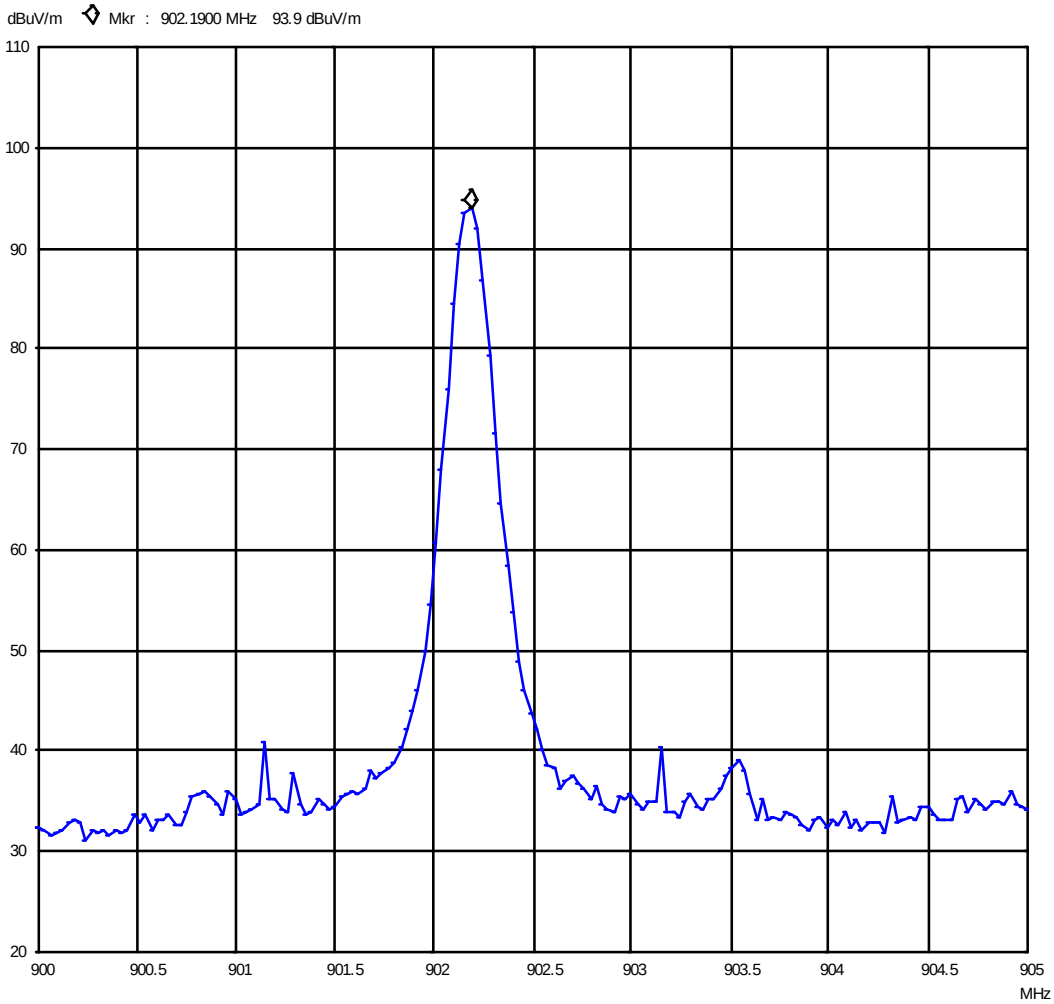



**Fig 4- RC-01- Maximum field strength – Ch 0 – 93.9dBµV/m**

Nemko Comlab

26. Sep 06 08:31

Peak

EUT: rc01
Manuf: Engbo AS
Op Cond: HP 125 cm, 255deg
Operator: gns
Test Spec: FCC 15 249
Comment: k8
3 m dist

Scan Settings (1 Range)

| Frequencies | | | Receiver Settings | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start | Stop | Step | IF BW | Detector | M-Time | Atten | Preamp | OpRge |
| 895M | 910M | 50k | 120k | PK | 50ms | AUTO | LN ON | 60dB |

| Transducer No. | Start | Stop | Name |
|---|---|---|---|
| 21 | 200M | 1000M | HL223 |

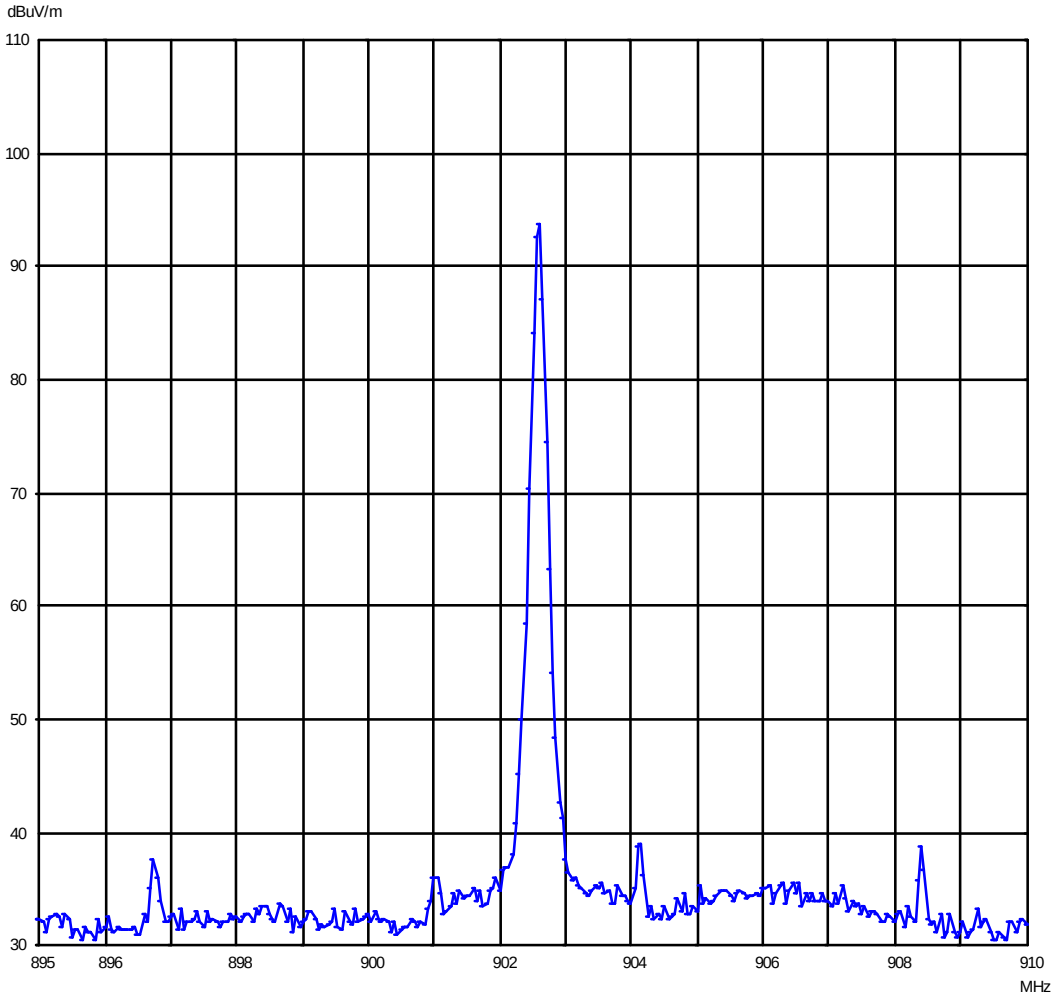



**Fig 5- RC-01- Maximum field strength – Ch 8 – 93.7dBµV/m**

Nemko Comlab

26. Sep 06 08:54

Peak

EUT: rc01
Manuf: Engbo AS
Op Cond: HP 125 cm, 255deg
Operator: gns
Test Spec: FCC 15 249
Comment: K17
3 m dist

Scan Settings (1 Range)

| Frequencies | | | Receiver Settings | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start | Stop | Step | IF BW | Detector | M-Time | Atten | Preamp | OpRge |
| 895M | 910M | 50k | 120k | PK | 50ms | AUTO | LN ON | 60dB |

| Transducer No. | Start | Stop | Name |
|---|---|---|---|
| 21 | 200M | 1000M | HL223 |

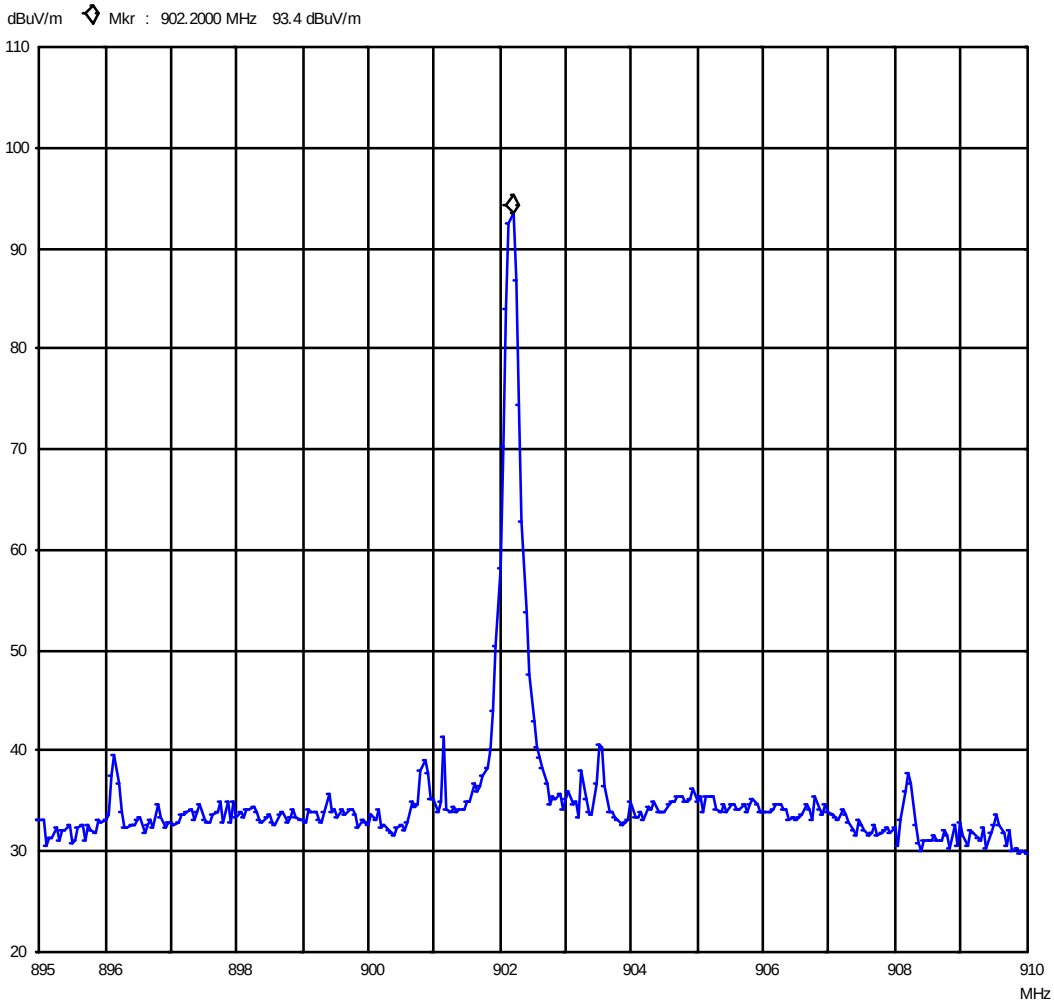



**Fig 6- RC-01- Maximum field strength – Ch 17 – 93.4dBµV/m**

## 4.5 Band Edge Emissions

**Para. No.: 15.249 (d)**

| **Test Performed By: G.Suhanthakumar** | **Date of Test: 26.09.2006** |
|---|---|

**Test Results: Complies**

**Measurement Data:**

Lower Band edge in dB

| **RF channel** | **Ch 0 (902.175MHz)** |
|---|---|
| Measured maximum dBc | 57.8 |

See plot

**Requirements:**

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental.

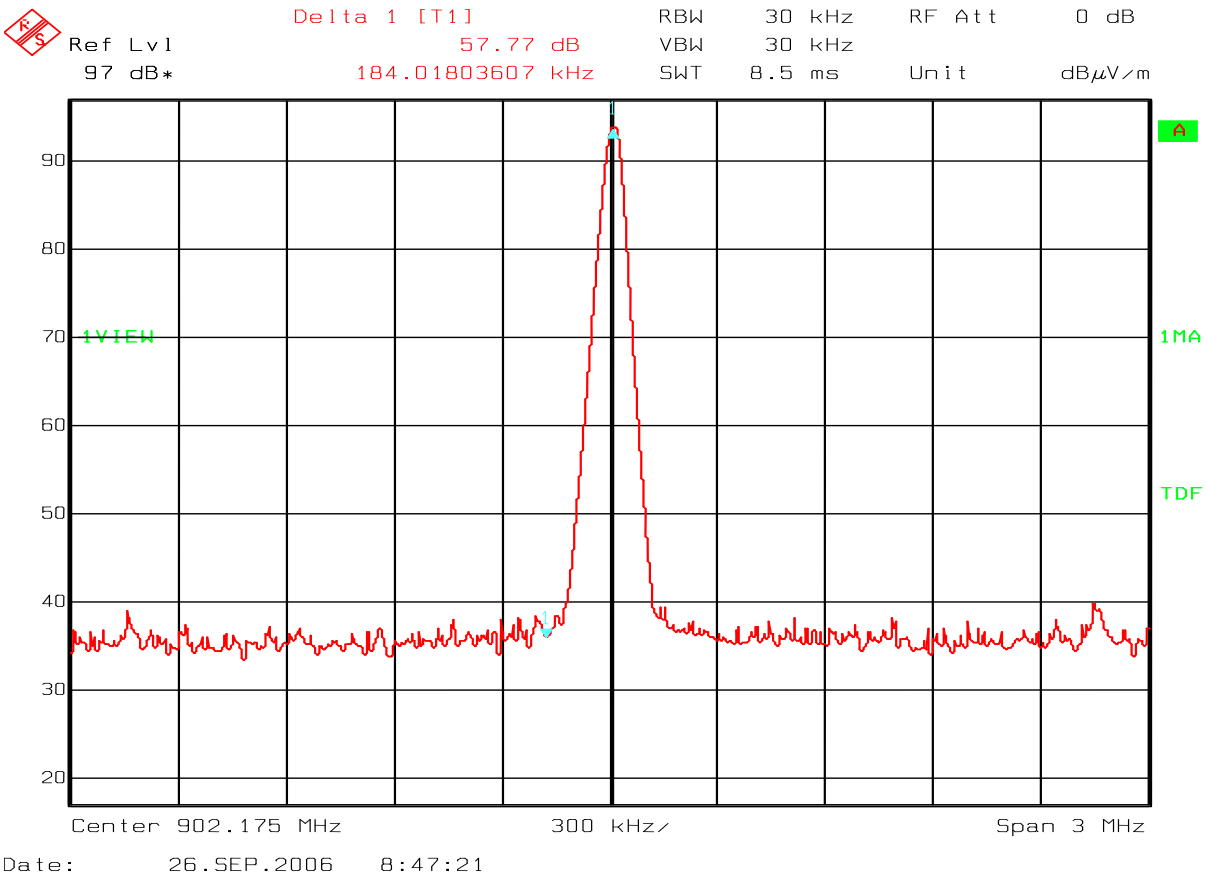



**Fig 10 – RC-01 – Lower band edge**

## 4.6 Spurious Emissions (Radiated)

**Para. No.: 15.249 (e)**

| **Test Performed By: G.Suhanthakumar** | **Date of Test: 26.09.2006** |
|---|---|

**Test Results: Complies**

**Measurement Data:**

**Radiated emission** 1-10 GHz, see attached table

Highest value RF Ch 0: Peak 45.28 dBµV/m, average 25.28 dBµV/m, 1.80 GHz

Ch 8: Peak 50.51 dBµV/m, average 30.51 dBµV/m, 1.83 GHz

Ch 17: Peak 48.03 dBµV/m, average 28.03 dBµV/m, 1.85 GHz

**Measured Peak values are lower than 50.51 dBµV/m**

**Duty Cycle Correction Factor Calculation:**

RF duty cycle Correction Factor: Calculation according to RF burst Para 15.35 (c):

Values given by the manufactures: 28.33 ms & 500 ms

-20*log (28.33/500) = 25 dB

Maximum duty cycle according to Para 15.35 (b): **20 dB**

This value is used for calculating the Peak limit for spurious emissions and for calculating the Spurious Emissions value with Average Detector when measuring with Peak Detector above 1 GHz.

Example of frequency graph of radiated emission is also attached.

Antenna factor, amplifier gain and cable loss are included in spectrum analyzer "Transducer factor".

No components above 2.7 GHz were detected

**Radiated Emission 1 – 10 GHz, Peak , RC-01**

**Measured with Peak Detector**

| Frequency | RF channel | Dist. corr. factor | Field strength, Peak, 3 metres | DC Corr. Factor | Limit | Margin |
|---|---|---|---|---|---|---|
| GHz | | dB | dBµV/m | dB | dBµV/m | dB |
| 1.804 | Ch 0 | 0 | 45.28 | 20 | 74 | 28.72 |
| 1.805 | Ch 8 | 0 | 50.51 | 20 | 74 | 23.49 |
| 1.856 | Ch12 | 0 | 48.03 | 20 | 74 | 25.97 |
| Above 2nd | Ch 0 | 0 | None detected | 20 | 74 | - |
| Above 2nd | Ch 8 | 0 | None detected | 20 | 74 | - |
| Above 2nd | Ch 17 | 0 | None detected | 20 | 74 | - |

**Radiated emission 1- 10 GHz, Average , RC-01**

**Measured with Peak Detector**

| Frequency | RF channel | Dist. corr. factor | Field strength, Peak, 3 metres | DC Corr. Factor | Limit | Margin |
|---|---|---|---|---|---|---|
| GHz | | dB | dBµV/m | dB | dBµV/m | dB |
| 1.804 | Ch 0 | 0 | 45.28 | 20 | 54 | 28.72 |
| 1.805 | Ch 8 | 0 | 50.51 | 20 | 54 | 23.49 |
| 1.856 | Ch 12 | 0 | 48.03 | 20 | 54 | 25.97 |
| Above 2nd | Ch 0 | 0 | None detected | 20 | 54 | / |
| Above 2nd | Ch 8 | 0 | None detected | 20 | 54 | / |
| Above 2nd | Ch 17 | 0 | None detected | 20 | 54 | / |

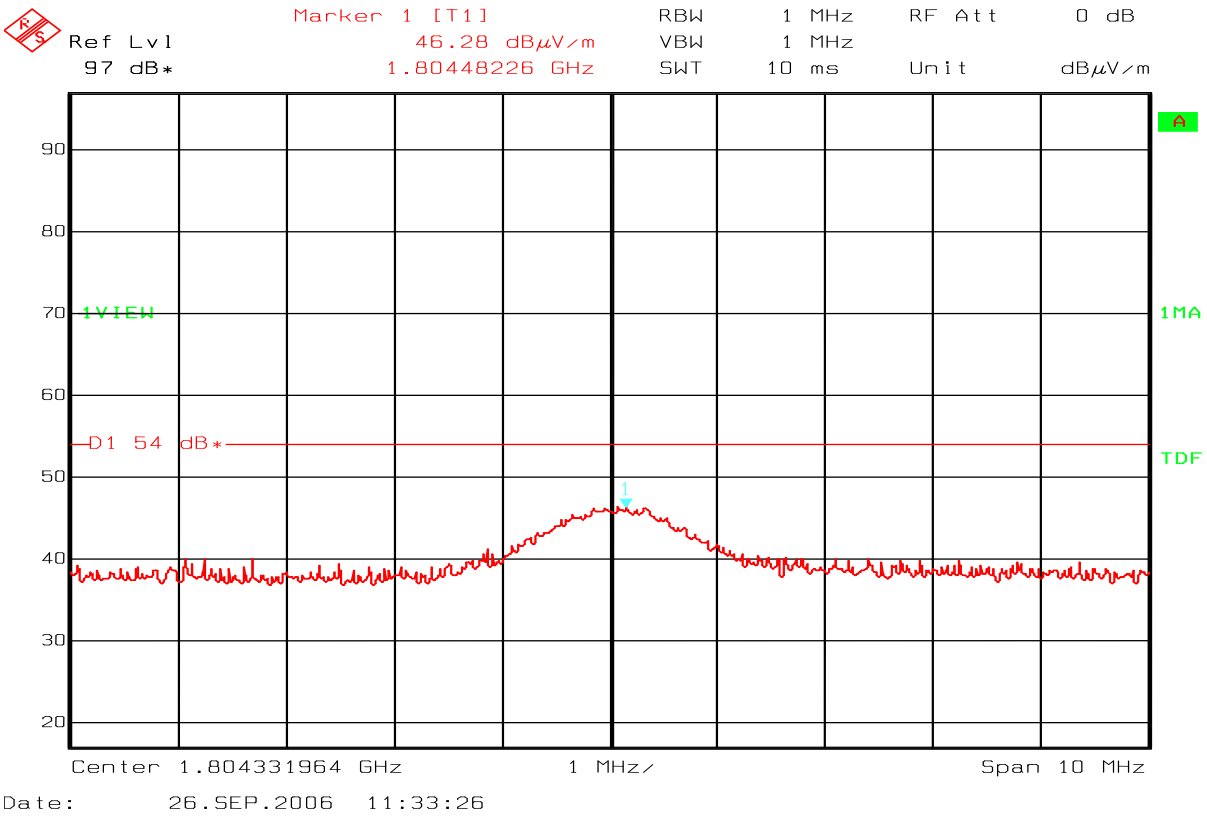



**Fig 12 – RC-01 – 2nd harmonic – Ch 0**

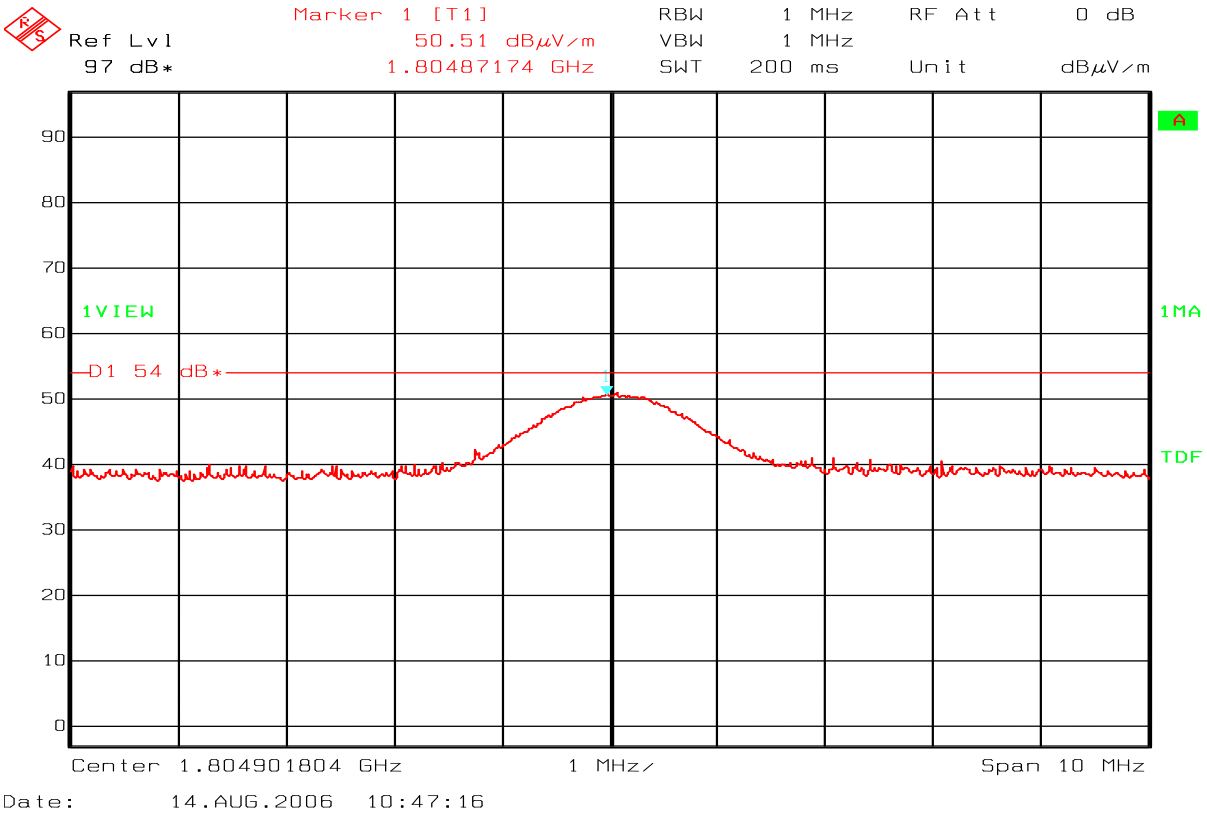



**Fig 13 – RC-01 – 2nd harmonic – Ch 8**

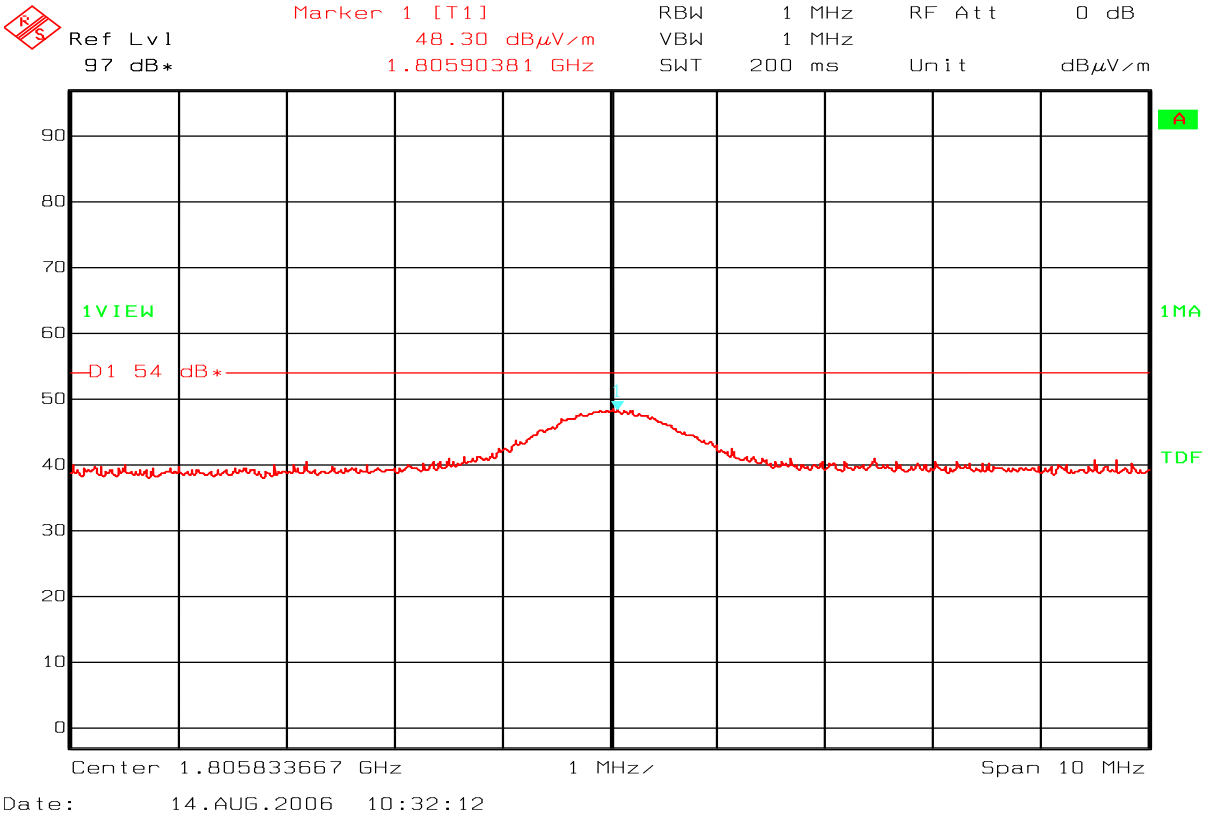



**Fig 14 – RC-01 – 2nd harmonic – Ch 17**

**Radiated emission 10 kHz-30 MHz.**

Measuring distance 10 m, measured with Peak detector.

No component detected, see attached graph.

Limit is converted to 10 m using 40 dB/decade according to 15.31 (f) (2).

NEMKO COMLAB 09. Jun 06 08:51

PK

Operator: gns
Comment: RC-01
ENBO AS
10m
FCC part 15

Scan Settings (4 Ranges)

| Frequencies | | | Receiver Settings | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start | Stop | Step | IF BW | Detector | M-Time | Atten | Preamp | OpRge |
| 10k | 100k | 1k | 1k | PK | 20ms | 0dB | LN OFF | 60dB |
| 20k | 20k | 5k | 9k | PK | 20ms | AUTO | LN ON | 60dB |
| 20k | 10M | 5k | 9k | PK | 20ms | AUTO | LN OFF | 60dB |
| 10M | 30M | 5k | 9k | PK | 20ms | AUTO | LN OFF | 60dB |

| Transducer No. | Start | Stop | Name |
|---|---|---|---|
| 13 | 10k | 30M | HFH2Z2 |

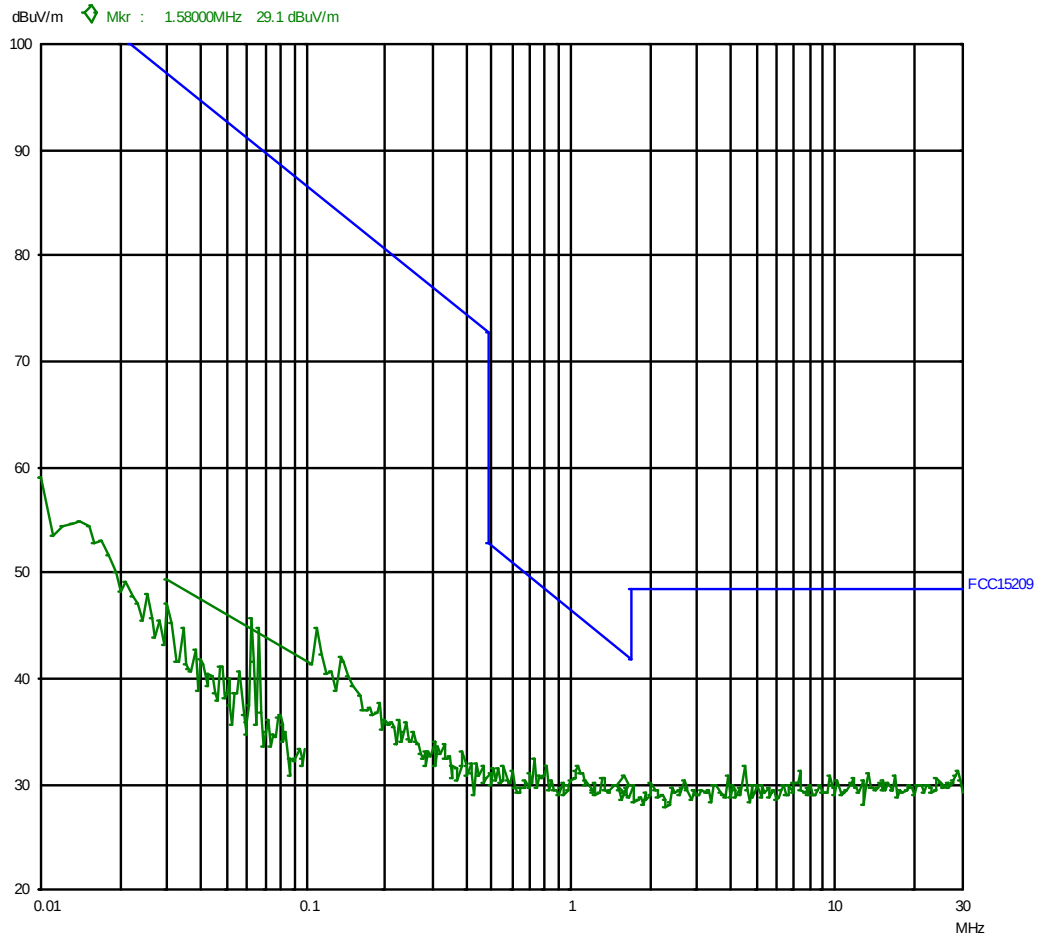



**Fig 18 RC-01 - 10 kHz – 30MHz –radiated emission**

**Radiated emission 30 – 1000 MHz.**

Detector: Quasi-Peak

Measuring distance 3 m according to CISPR 22.

No component detected, see attached graphs.

Nemko Comlab 13. Aug 06 12:31
Peak

EUT: Engbo AS
Manuf: RC01
Op Cond: Distance 3m hp
Operator: gns
Test Spec: FCC part 15 249
Comment: 125 cm 259 deg

Scan Settings (1 Range)
|--------- Frequencies ----------||---------- Receiver Settings ----------|
Start Stop Step IF BW Detector M-Time Atten Preamp OpRge
30M 200M 50k 120k PK 50ms AUTO LN ON 60dB

Transducer No. Start Stop Name
20 30M 200M HK116

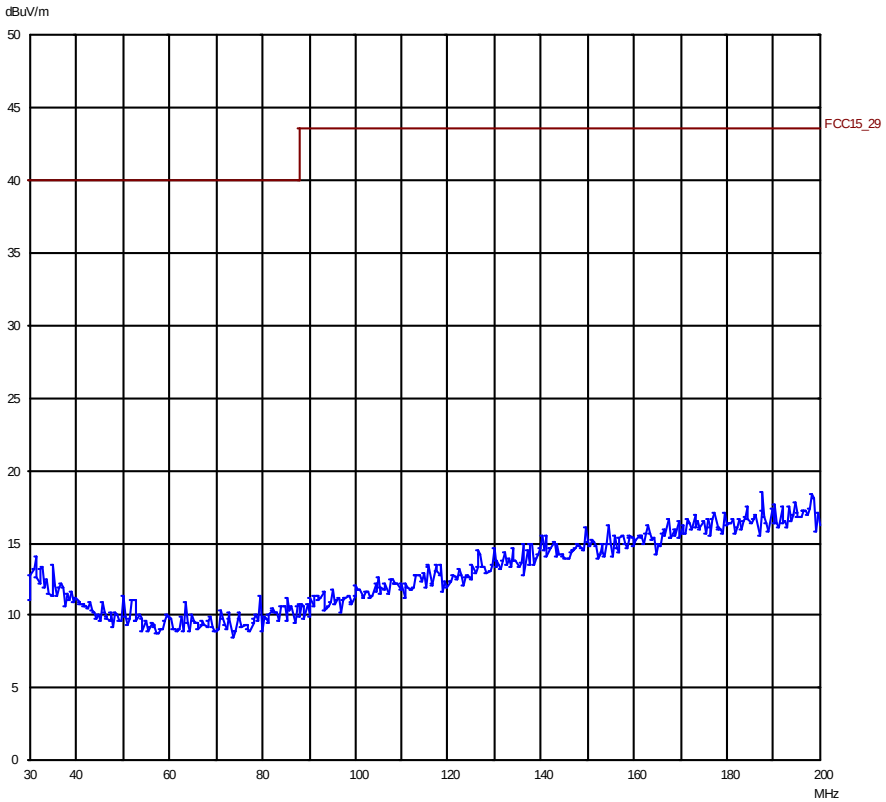



**Fig 19 RC-01 - Radiated emission 30 –200MHz, Horizontal polarization**

| Frequency | Operational condition | Field strength | Measuring distance | Limit FCC15.209 | Margin |
|---|---|---|---|---|---|
| MHz | | dBµV/m | metres | dBµV/m | dB |
| 190 | TX on | 19 | 3 | 43.0 | 24 |

Nemko Comlab 13. Aug 06 12:25

Peak

EUT: Engbo AS
Manuf: RC01
Op Cond: Distance 3m vp
Operator: gns
Test Spec: FCC part 15 249
Comment: 230 cm 153 deg

Scan Settings (1 Range)

| Frequencies | | | Receiver Settings | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start | Stop | Step | IF BW | Detector | M-Time | Atten | Preamp | OpRge |
| 30M | 200M | 50k | 120k | PK | 50ms | AUTO | LN ON | 60dB |

| Transducer | No. | Start | Stop | Name |
|---|---|---|---|---|
| | 20 | 30M | 200M | HK116 |

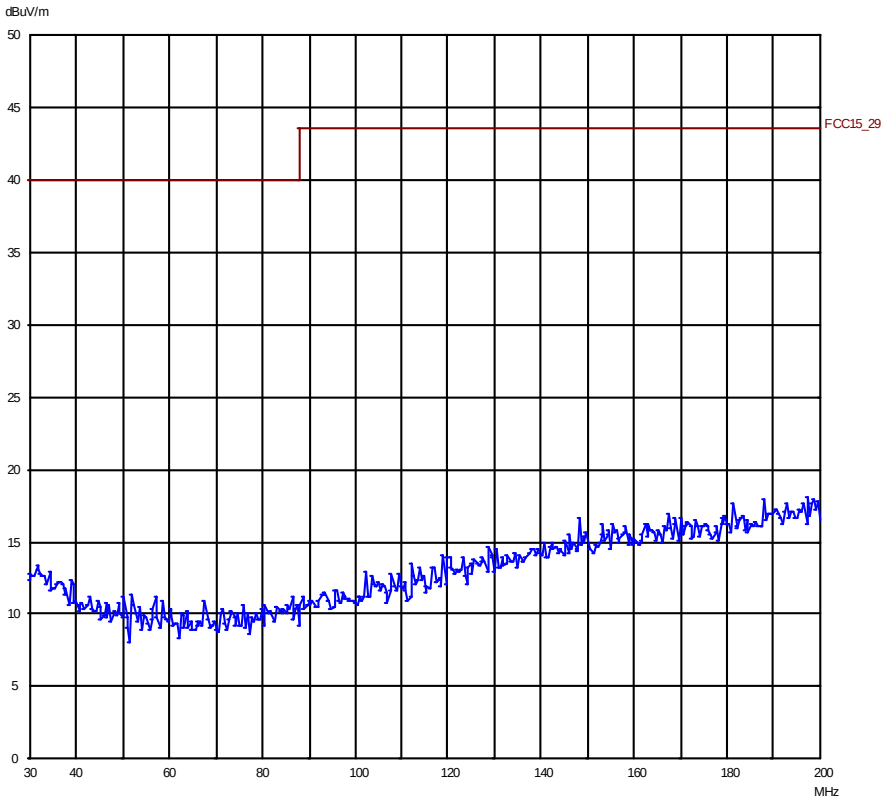



**Fig 20 RC-01 - Radiated emission 30 –200MHz, Vertical polarization**

| Frequency | Operational condition | Field strength | Measuring distance | Limit FCC15.209 | Margin |
|---|---|---|---|---|---|
| MHz | | dBµV/m | meters | dBµV/m | dB |
| 200 | TX on | 18 | 3 | 43 | 25 |

Nemko Comlab 13. Aug 06 10:10

Peak

EUT: Engbo AS
Manuf: RC01
Op Cond: Distance 3m hp
Operator: gns
Test Spec: FCC part 15 249
Comment: 256 degrees 125cm
k0 902.0250MHy

Scan Settings (1 Range)

| Frequencies | | | Receiver Settings | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start | Stop | Step | IF BW | Detector | M-Time | Atten | Preamp | OpRge |
| 200M | 1000M | 50k | 120k | PK | 50ms | AUTO | LN ON | 60dB |

| Transducer No. | Start | Stop | Name |
|---|---|---|---|
| 21 | 200M | 1000M | HL223 |

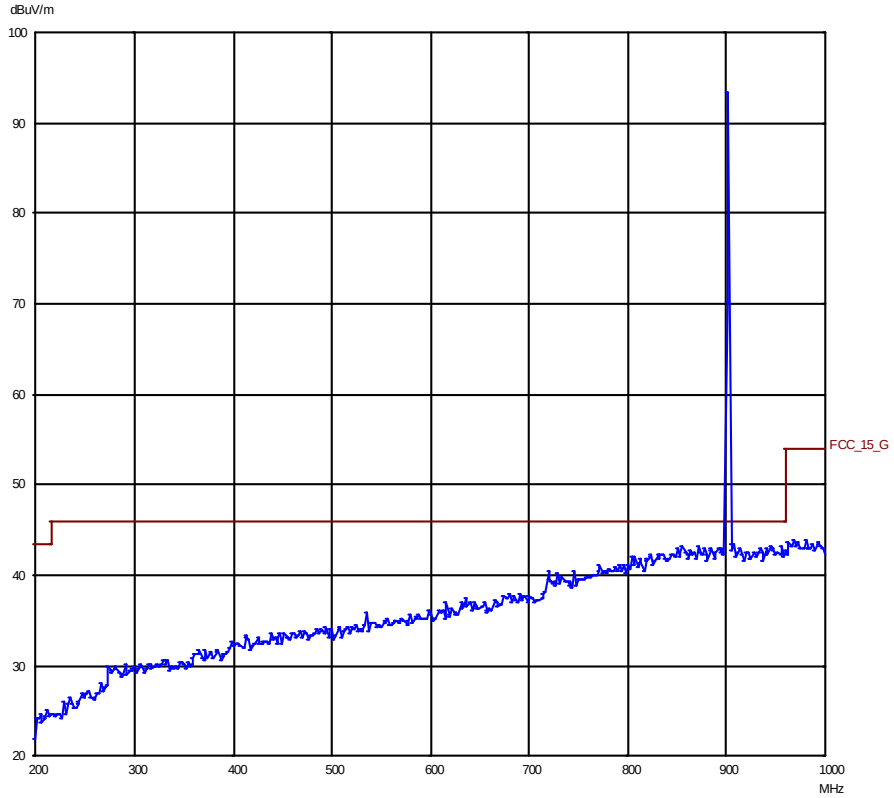



**FIG 21 RC-01- Radiated emission 200 –1000 MHz, Horizontal polarization**

Nemko Comlab 13. Aug 06 10:50

Peak

EUT: Engbo AS
Manuf: RC01
Op Cond: Distance 3m vp
Operator: gns
Test Spec: FCC part 15 249
Comment: 162 degrees 231cm
k17 902.925MHy

Scan Settings (1 Range)

| Frequencies | | | Receiver Settings | | | | |
|---|---|---|---|---|---|---|---|
| Start | Stop | Step | IF BW | Detector | M-Time | Atten | Preamp | OpRge |
| 200M | 1000M | 50k | 120k | PK | 50ms | AUTO | LN ON | 60dB |

| Transducer No. | Start | Stop | Name |
|---|---|---|---|
| 21 | 200M | 1000M | HL223 |

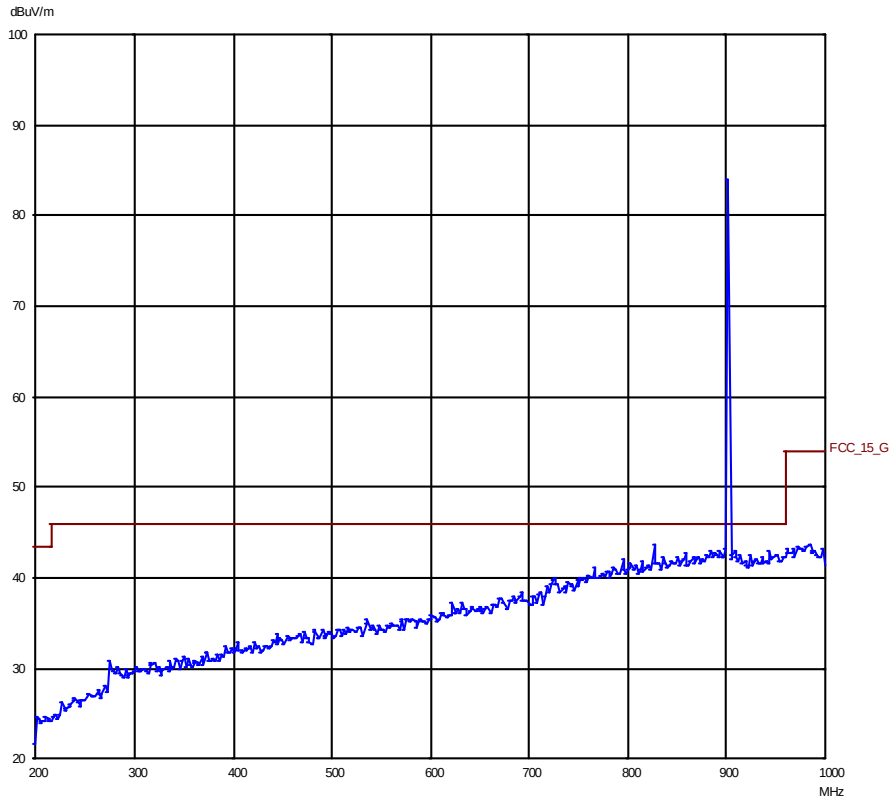



**Fig 22 RC-01 - Radiated emission 200 –1000 MHz, Vertical polarization**

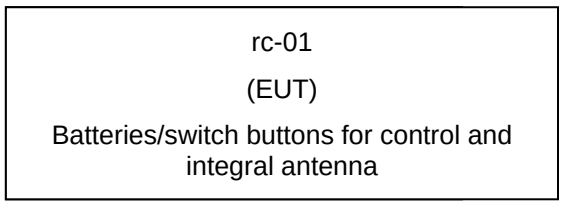
# LIST OF TEST EQUIPMENT

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the Test Laboratory.

| No. | Instrument/ancillary | Type of instrument/ancillary | Manufacturer | Ref. no. |
|---|---|---|---|---|
| 1 | FSEK30 | Spectrum Analyzer | Rohde & Schwarz | LR 1337 |
| 2 | ESN | EMI Reciever | Rohde & Schwarz | LR 1237 |
| 3 | 3115 | Antenna horn | EMCO | LR 1330 |
| 4 | 643 | Antenna horn | Narda | LR 093 |
| 5 | 642 | Antenna horn | Narda | LR 220 |
| 6 | PM7320X | Antenna horn | Siverts lab | LR 103 |
| 7 | DBF-520-20 | Antenna horn | Systron Donner | LR 101 |
| 8 | 638 | Antenna horn | Narda | LR 098 |
| 9 | 5VF1000/2000 | BP filter | Trilithic | LR 1174 |
| 10 | 5VF2000/4000 | BP filter | Texscan | LR 42 |
| 11 | ESH3-Z3 | LISN | Rohde & Schwarz | LR 1076 |
| 12 | 8449B | Amplifier | Hewlett Packard | LR 1322 |
| 13 | - | Shielded room | ETS | LR 1410 |
| 14 | HFH2-Z2 | Antenna loop | Rohde and Schwarz | LR 285 |
| 15 | 10855A | Amplifier | Hewlett Packard | LR 1445 |
| 16 | HL223 | Antenna log.per | Rohde & Schwarz | LR 1261 |
| 17 | HK116 | Antenna biconic | Rohde & Schwarz | LR 1260 |
| 18 | ESVS 30 | Test Receiver | Rohde & Schwarz | LR 1101 |
| 19 | R3271 | Spectrum Analyser | Advantest | LR 1123 |

# 5 BLOCK DIAGRAM

## 5.1 System set up




**RC-01**

## 5.2 Test Site Radiated Emission