

Test report no. : 68166-8

Item tested : ECU-01

Type of equipment : Low Power Transceiver

Client : Engbo AS

FCC Part 15.249

Low Power Transceiver
902-928 MHz Band

20 October 2006

Authorized by : 

Frode Sveinsen
Technical Verificator

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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 :	Electronic Control Unit (ECU-01)
Model/version :	ECU-01
Serial number :	From 00001 and Increasing
Hardware identity and/or version:	RF motor controller V.2.10
Software identity and/or version :	C308
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 :	10 – 30Vdc external power
Antenna Connector :	Integral antenna only
Antenna Diversity Supported :	None

¹ Only one channel at a time in use.

Theory of Operation

The electronic control unit uses the same transceiver module as the hand held unit. It has a connector for a wire antenna, (instead of the printed antenna on the hand held).It is designed for fixed mounting.

Description of Test Item

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

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

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

2.2 Test Environment

2.2.1 Normal test condition

Temperature:	20 - 22 °C
Relative humidity:	30 - 40 %
Normal test voltage:	10 – 30Vdc external power supply

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 and ECU-01
Serial No.: /

All measurements are traceable 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: 
G.Suwanthakumar, Test engineer

DATE: 06.10.2006

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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 External DC power supply 10 – 30V DC

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 ECU-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.Suwanthakumar

Date of Test: 20 09 2006

Measurement procedure: ANSI C63.4-2003 using 50 μ H/50 ohms LISN.

Test Results: Complies

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

Highest measured value (L1 and N):

All values are below the limit when measuring with Peak Detector.

Frequency	Detector	Measured value	Limit	Margin
KHz	Peak/QP/AV	dB μ V	dB μ V	dB
/	QP	/	/	/
/	AV	/	/	/



Date 20.Sep.'06 Time 10:02:49

Ref.Lvl 100.00 dBuV
 Marker 48.55 dBuV
 154.4 kHz

Res.Bw 9 kHz[imp]
 TG.Lvl off
 Scan.Stp 4.500 kHz

T1: PK+ T3:
 T2: PK+ T4:
 RF.Att 0 dB
 Unit [dBuV]

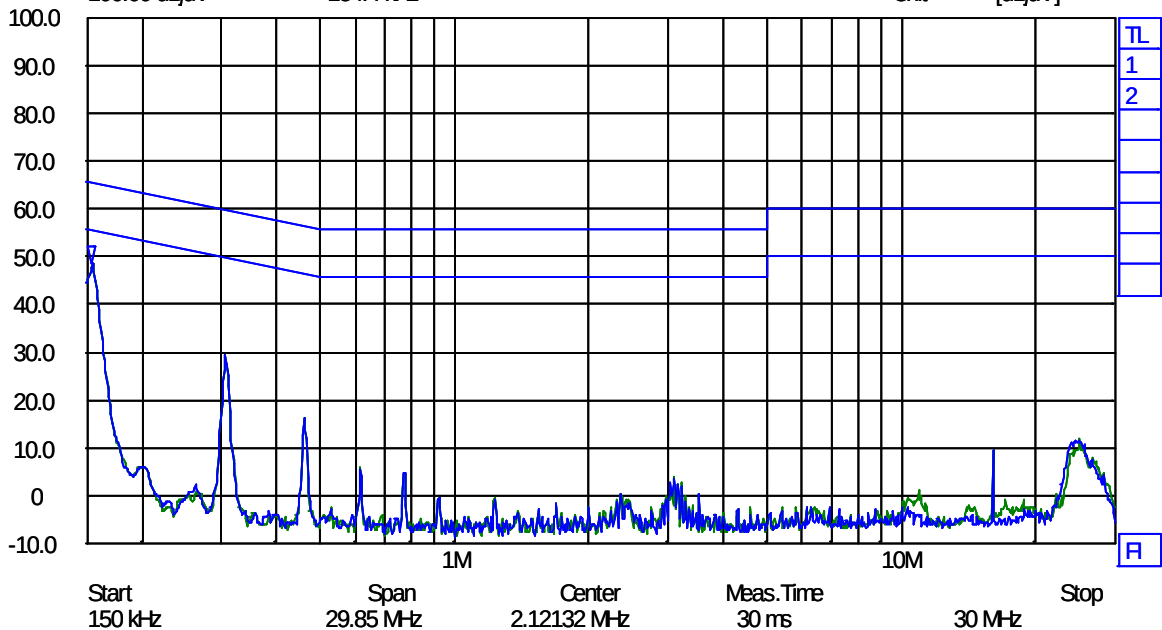


Fig 1 – ECU-01 , Conducted emission- 10Vdc



Date 20.Sep.'06 Time 10:16:02

Ref.Lvl 100.00 dBuV
 Marker 36.04 dBuV
 154.4 kHz

Res.Bw 9 kHz[imp]
 TG.Lvl off
 Scan.Stp 4.500 kHz

T1: PK+ T3:
 T2: PK+ T4:
 RF.Att 0 dB
 Unit [dBuV]

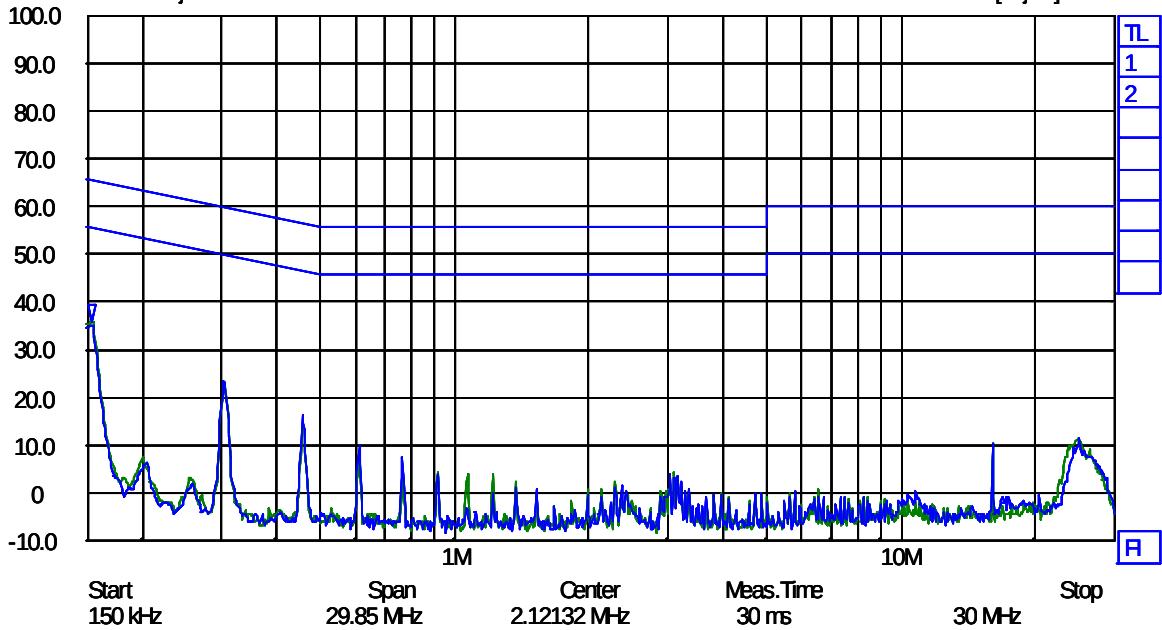


Fig 2 – ECU-01, Conducted emission – 30Vdc

NEMKO COMLAB

26. Sep 06 13:49

Pk

Operator: gns

Comment: ecuo1

Engbo as

with a load

dc power supply

Scan Settings (1 Range)

Frequencies				Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
150k	30M	4.5k	9k	PK	50ms	AUTO	LN OFF	60dB

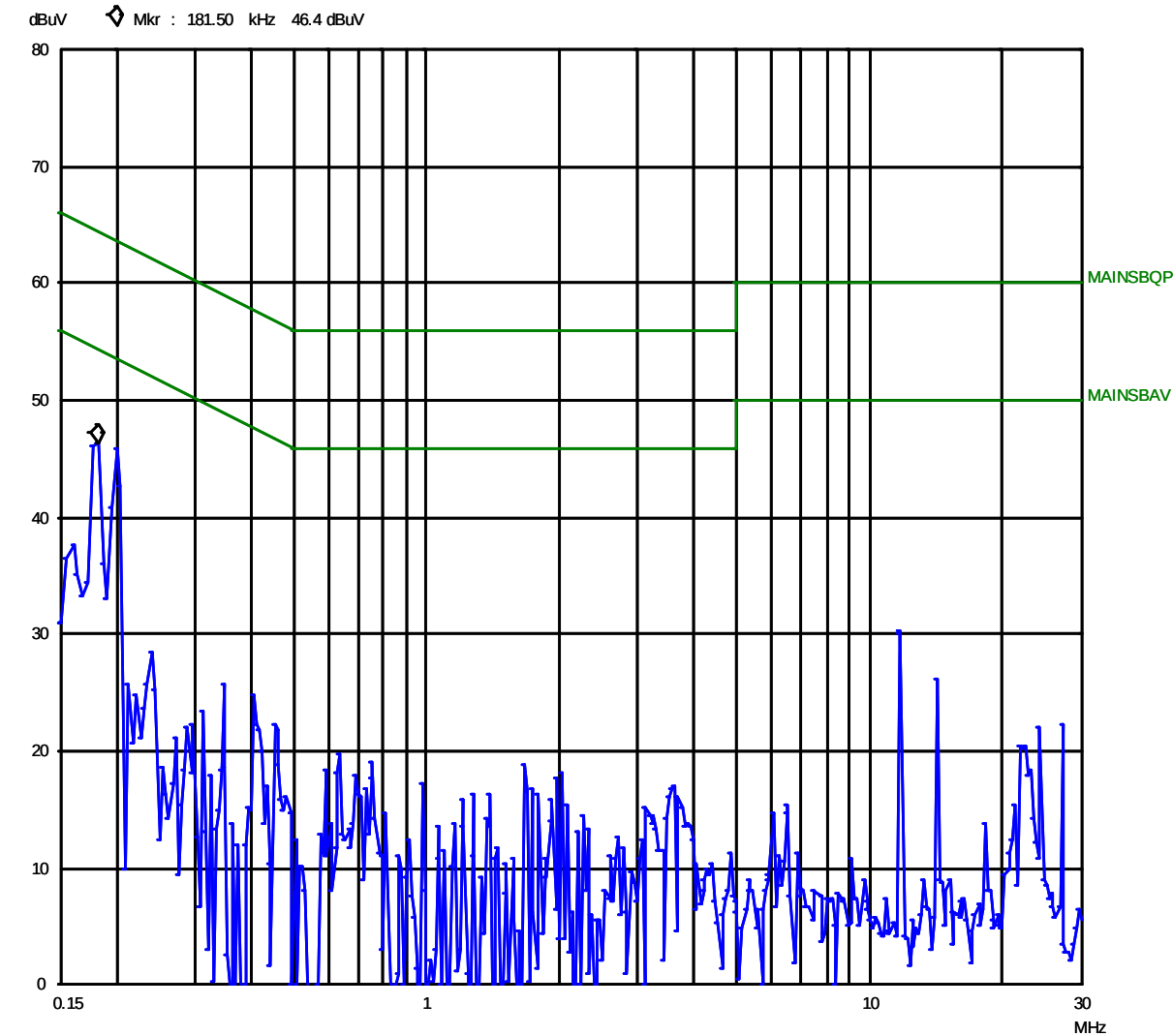


Fig 3 - ECU-01, Conducted emission- with a load

4.2 Frequency Tolerance

Para. No.: /

Test Performed By: G.Suwanthakumar

Date of Test: 20.09.2006

Measurement Data:

Channel nr.	Given Frequency (MHz)	Measured value (MHz)	Deviation (Hz)
K0	902.175	902.17433	-670
K17	902.575	902.57499	-10
K21	903.025	903.02506	-60

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

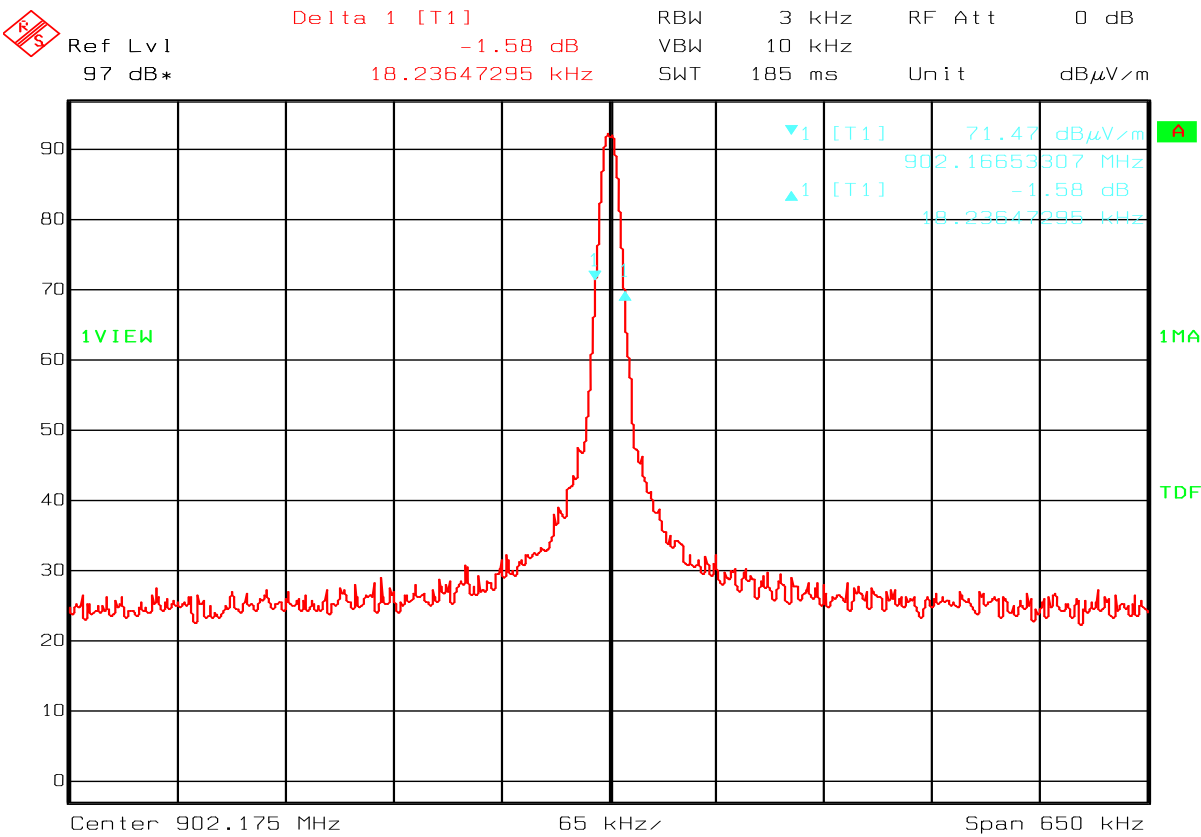
Para. No.: 15.215(c)

Test Performed By: G.Suwanthakumar	Date of Test: 10.10.2006
------------------------------------	--------------------------

Test Results: Complies

Measurement Data:

See attached plot below.



Date: 11.OCT.2006 11:29:04

20 dB bandwidth, Ch 0

4.4 Peak Power Output

Para. No.: 15.249 (a)

Test Performed By: G.Suwanthakumar	Date of Test: 26.09.2006
------------------------------------	--------------------------

Test Results: Complies

Measurement Data:

Maximum field strength, dB μ V/m

RF channel	Ch 0 (902.175 MHz)	Ch 8 (902.575 MHz)	Ch 17 (903.025 MHz)
Measured maximum field strength	92	92.2	92.7

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 ≤ 94 dB μ V/m

Nemko Comlab

26. Sep 06 11:11

Peak

EUT: ecu01
Manuf: Engbo AS
Op Cond: HP 127m, 15deg
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

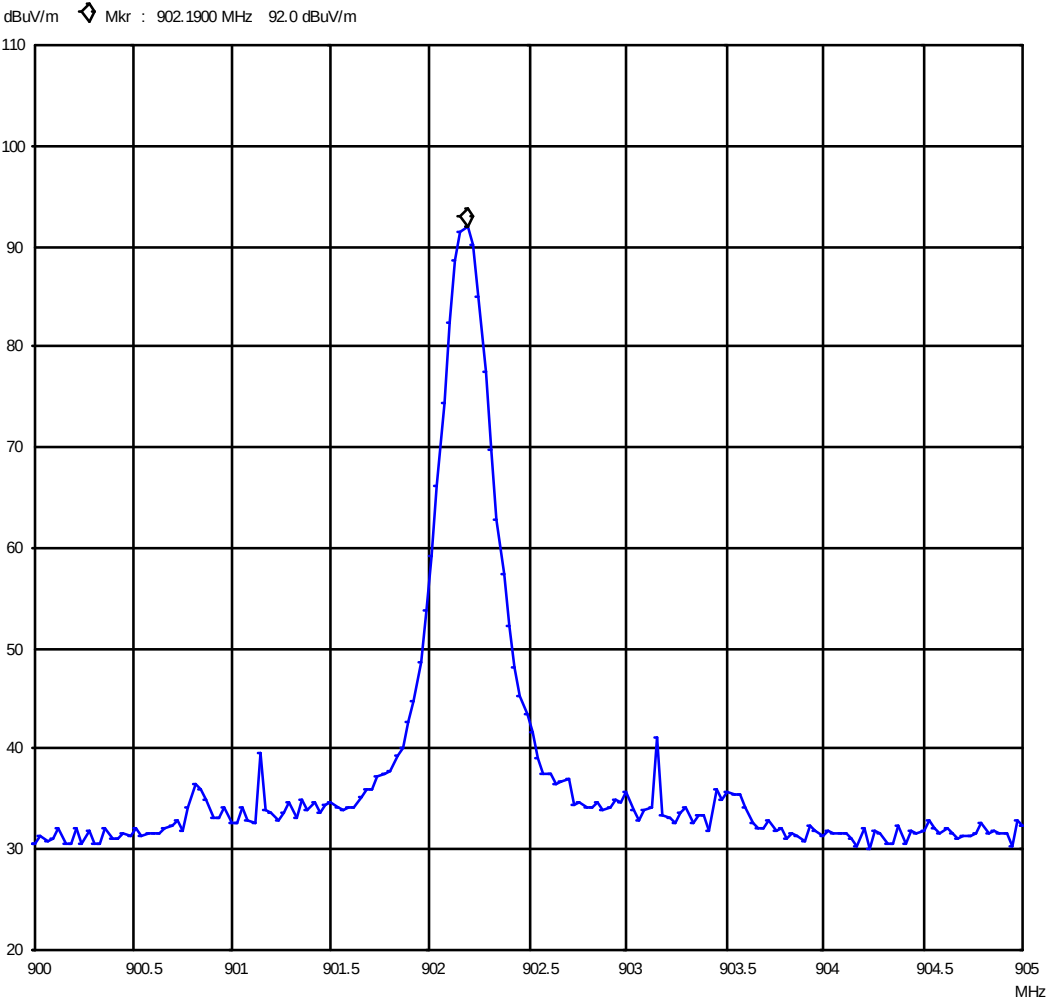


Fig 7- ECU-01- Maximum field strength – Ch 0 – 92dBµV/m

Nemko Comlab

26. Sep 06 12:15

Peak

EUT: ecu01
Manuf: Engbo AS
Op Cond: hp 131cm 27deg
Operator: gns
Test Spec: FCC 15 249
Comment: kk8
3 m dist

Scan Settings (1 Range)

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

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

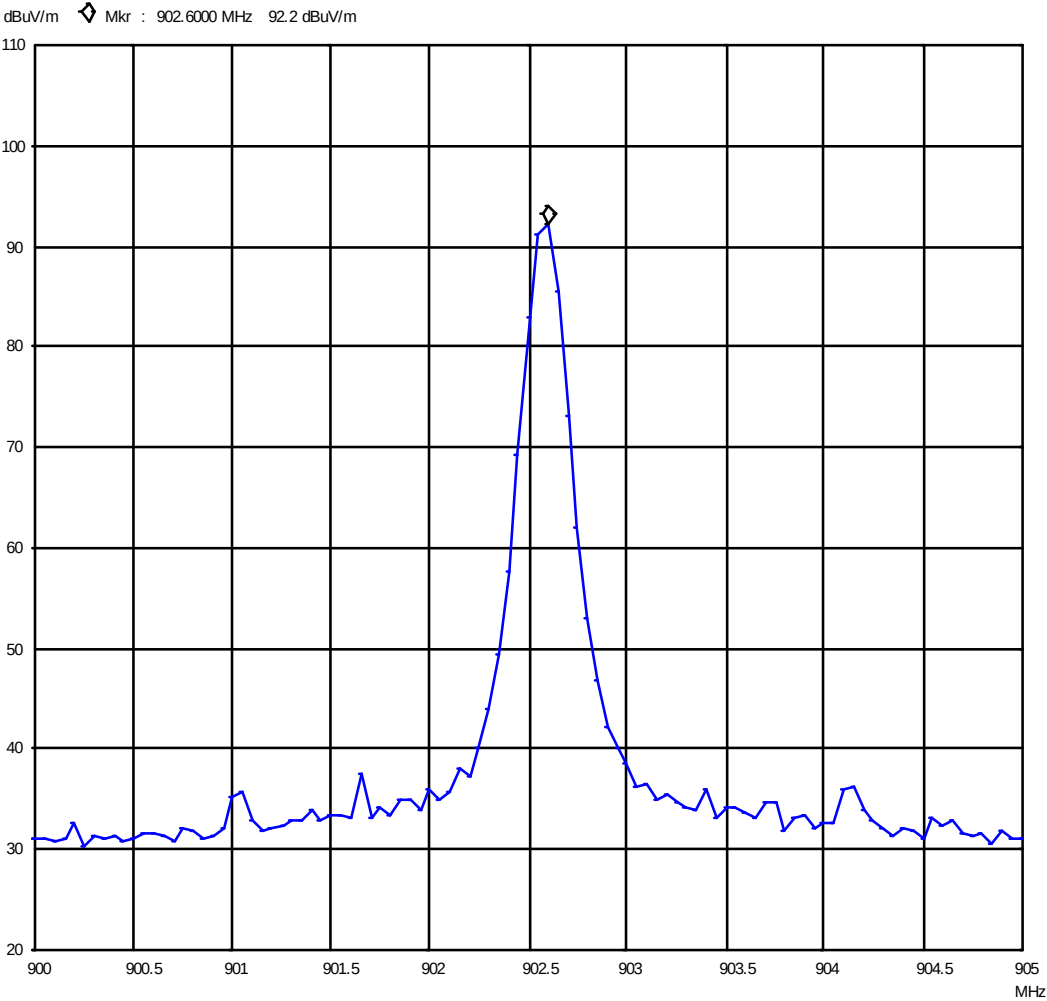


Fig 8- ECU-01- Maximum field strength – Ch 8 – 92.2dBµV/m

Nemko Comlab

26. Sep 06 12:19

Peak

EUT: ecu01
Manuf: Engbo AS
Op Cond: hp 131cm 27deg
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
900M	905M	50k	120k	PK	50ms	AUTO	LN ON 60dB

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

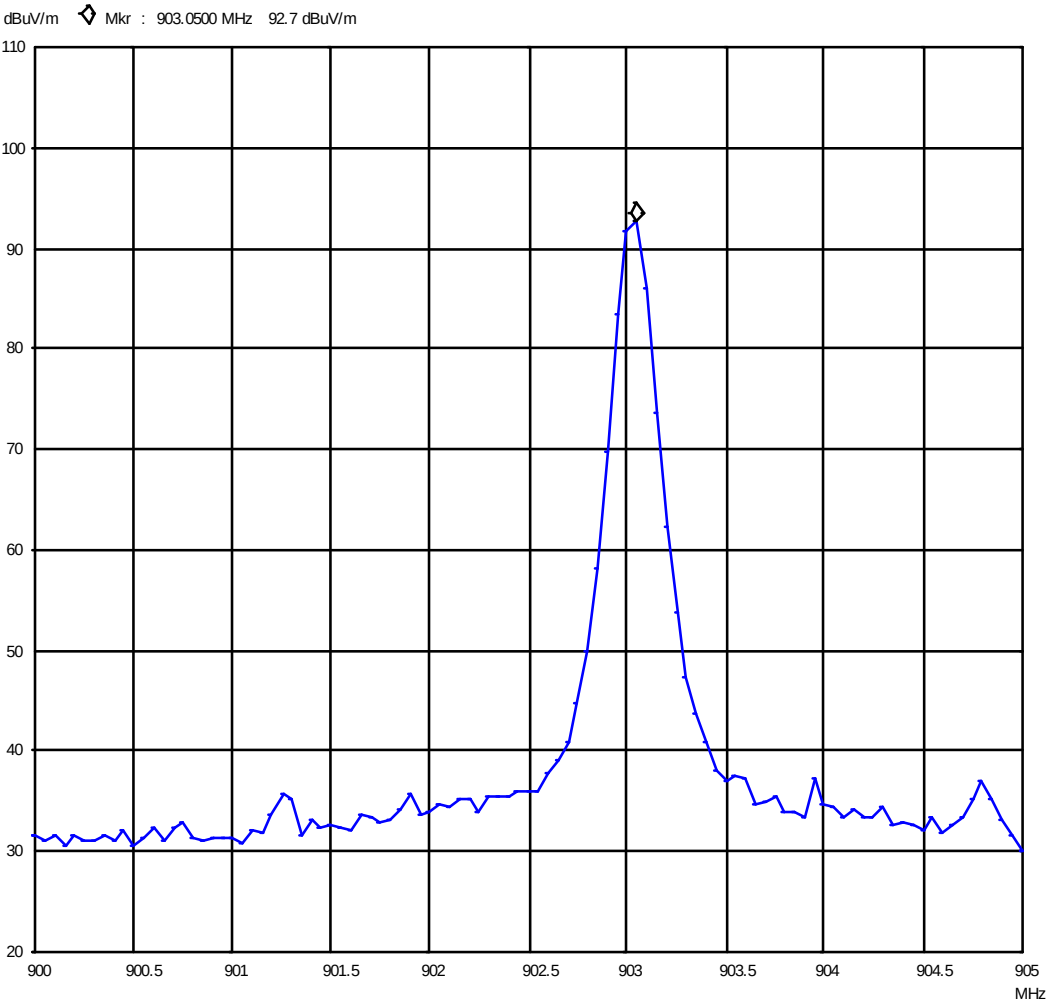


Fig 9- ECU-01- Maximum field strength – Ch 17 – 92.7dBpV/m

4.5 Band Edge Emissions

Para. No.: 15.249 (d)

Test Performed By: G.Suwanthakumar	Date of Test: 26.09.2006
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Test Results: Complies

Measurement Data:

Lower Band edge in dB

ECU-01:

RF channel	Ch 0 (902.175MHz)
Measured maximum dBc	58.3

See plots

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.

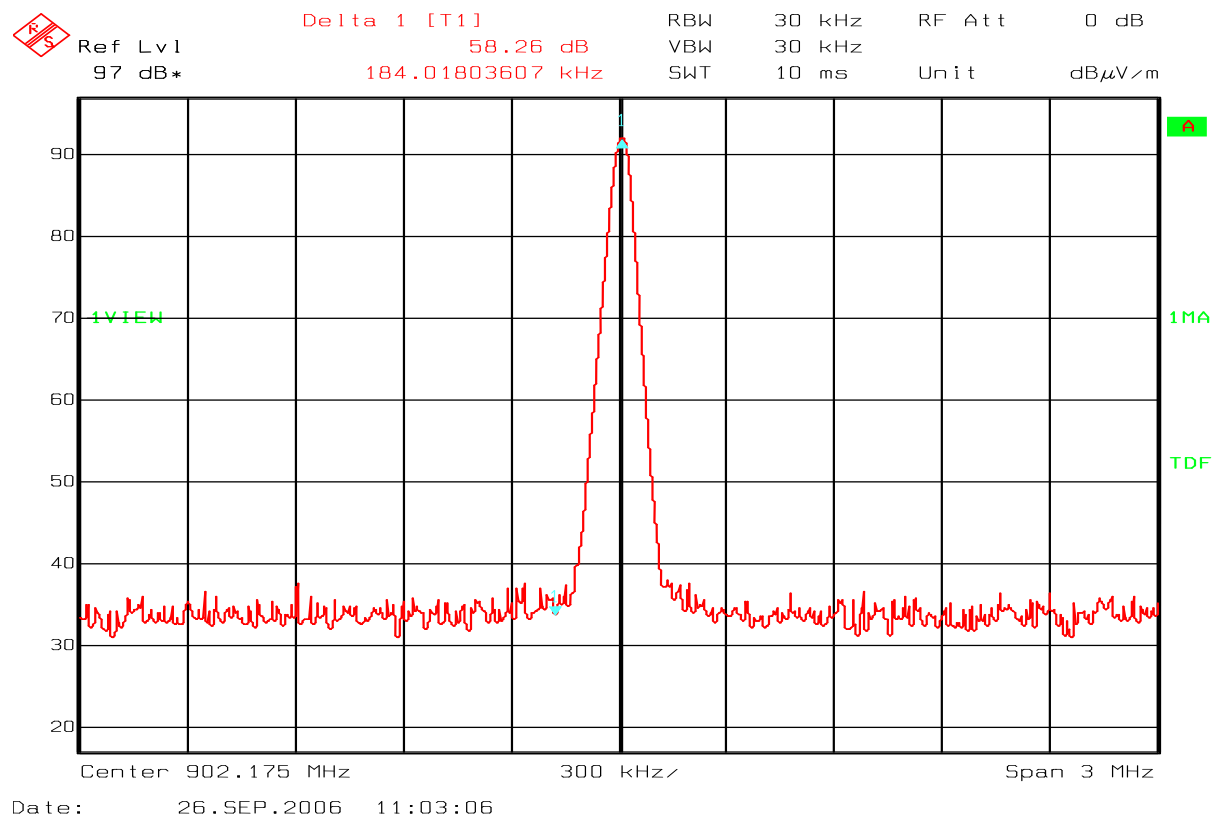


Fig 11 – ECU 01 – Lower band edge

4.6 Spurious Emissions (Radiated)

Para. No.: 15.249 (e)

Test Performed By: G.Suwanthakumar

Date of Test: 26.09.2006

Test Results: Complies

Measurement Data:

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

$$-20 \cdot \log (28.33/500) = 25 \text{ dB}$$

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 , ECU-01

Measured with Peak Detector

Frequency	RF channel	Dist. corr. factor	Field strength, Peak, 3 metres	DC Corr. Factor	Limit	Margin
GHz	3 channels	dB	dBµV/m	dB	dBµV/m	dB
1.804	Ch 0	0	48.51		74	25.49
1.805	Ch 8	0	50.69		74	23.31
1.856	Ch 12	0	49.28		74	24.72
Above 2 nd	Ch 0	0	None detected		74	/
Above 2 nd	Ch 8	0	None detected		74	/
Above 2 nd	Ch 17	0	None detected		74	/

Radiated emission 1- 10 GHz, Average , ECU-01

Measured with Peak Detector

Frequency	RF channel	Dist. corr. factor	Field strength, Peak, 3 metres	DC Corr. Factor	Limit	Margin
GHz	3 channels	dB	dBµV/m	dB	dBµV/m	dB
1.804	Ch 0	0	48.51	-20	54	25.49
1.805	Ch 8	0	50.69	-20	54	23.31
1.856	Ch 12	0	49.28	-20	54	24.72
Above 2 nd	Ch 0	0	None detected	-20	54	/
Above 2 nd	Ch 8	0	None detected	-20	54	/
Above 2 nd	Ch 17	0	None detected	-20	54	/

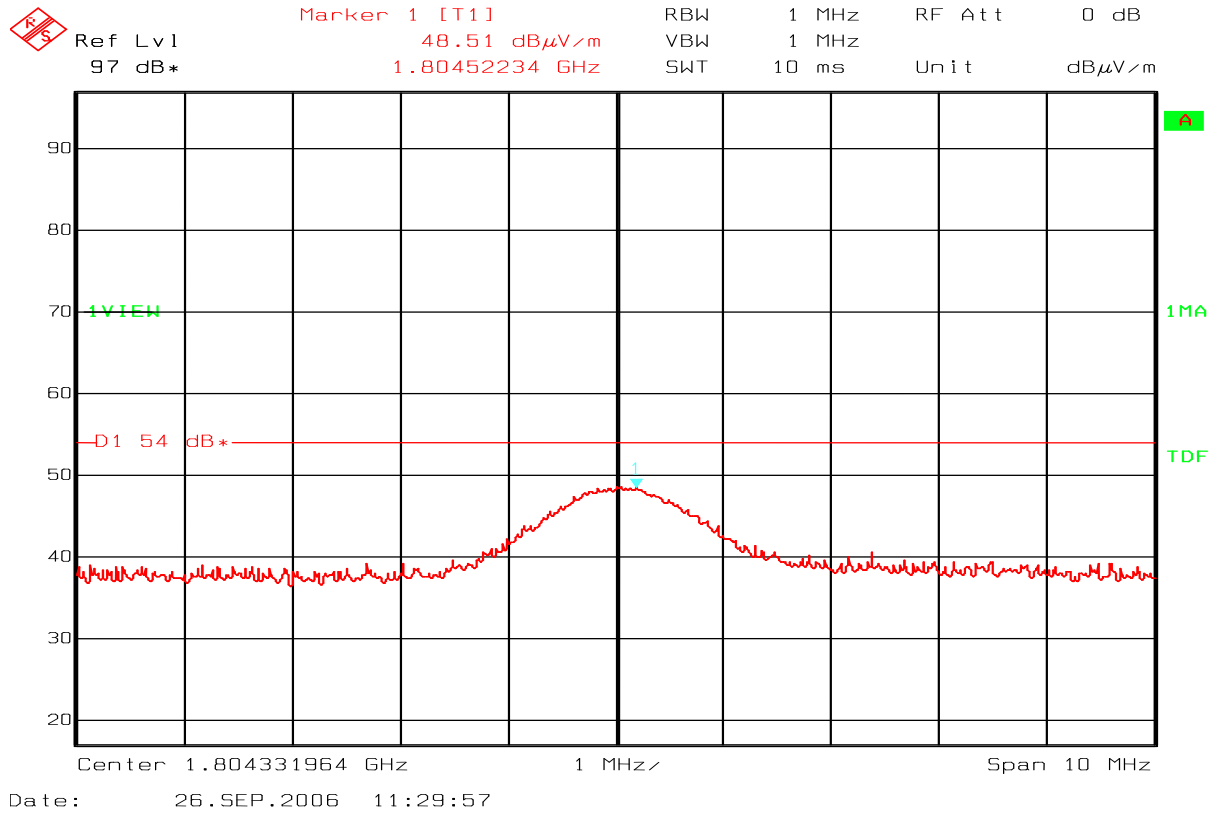


Fig 15 – ECU-01 – 2nd harmonic – Ch 0

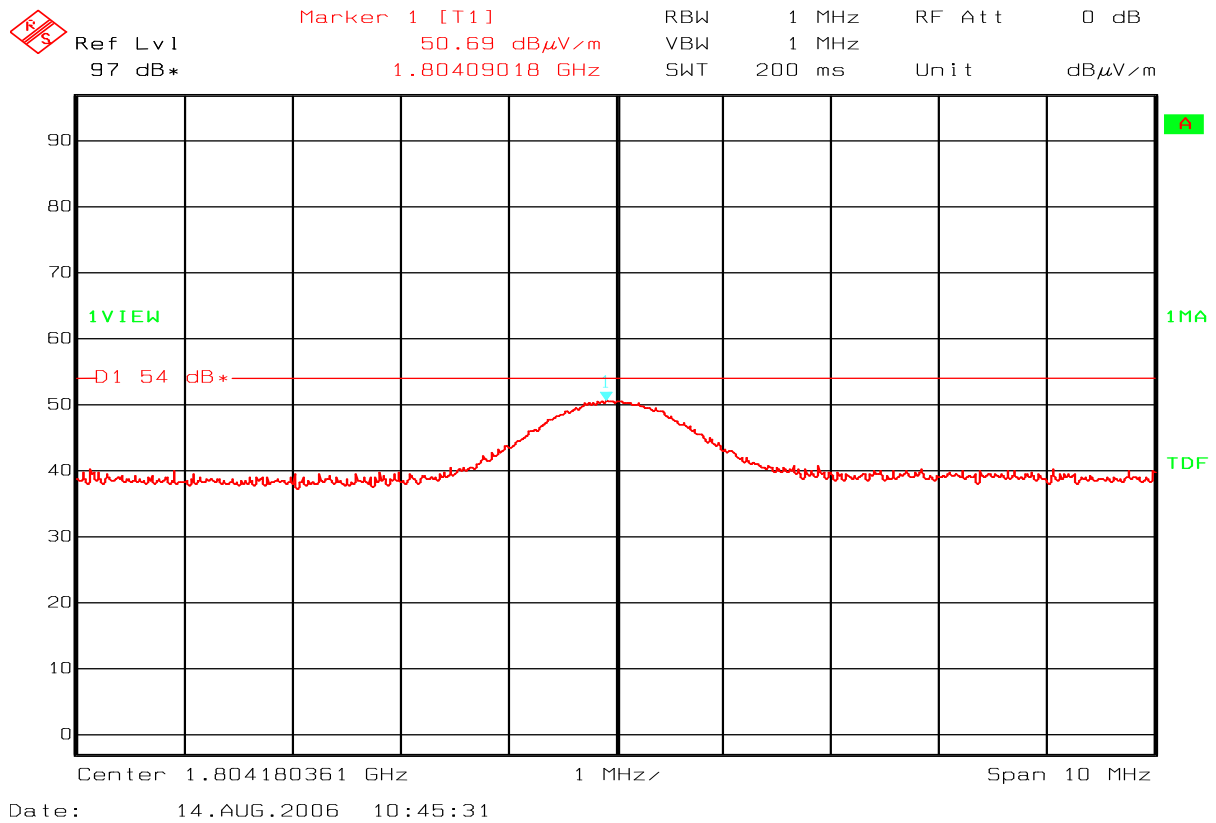


Fig 16 – ECU-01 – 2nd harmonic – Ch 8

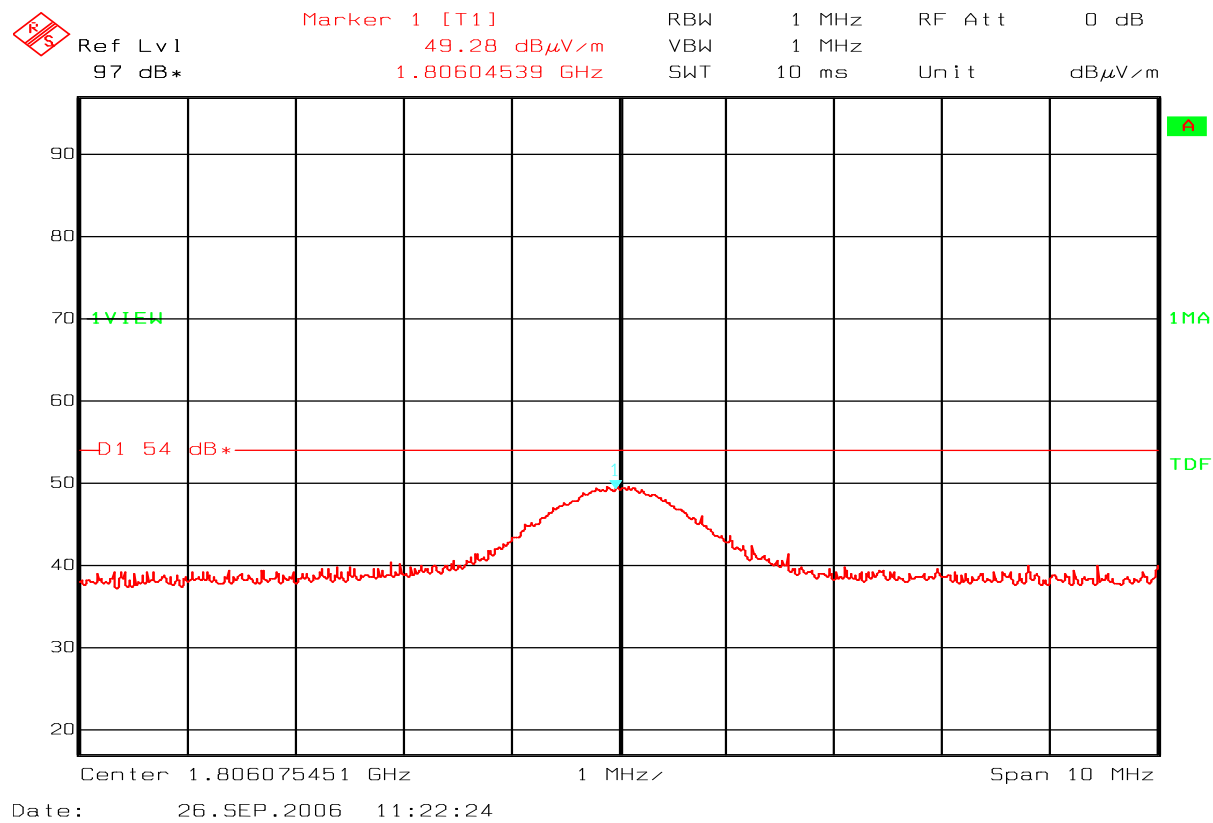


Fig 17 – ECU-01 – 2nd harmonic – Ch 17

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

09. Jun 06 08:51

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

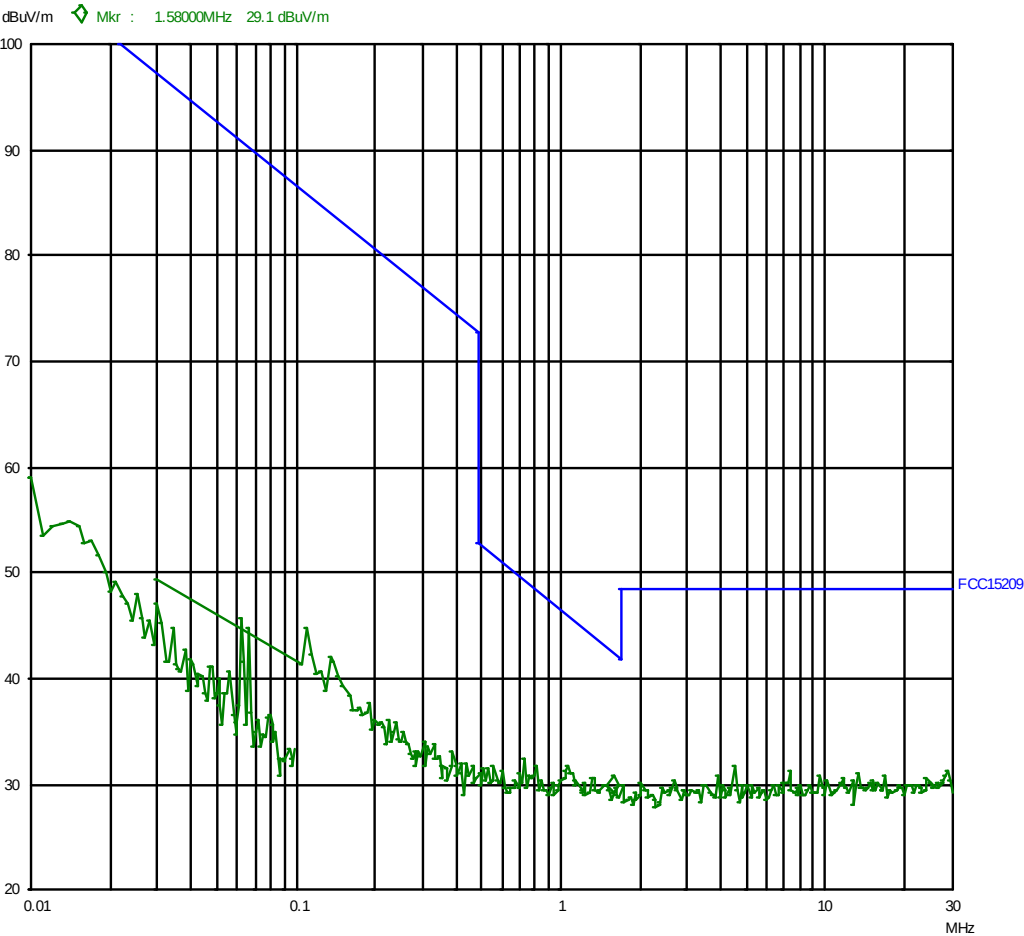


Fig 18 ECU-01- 10 kHz – 30MHz –radiated emission

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

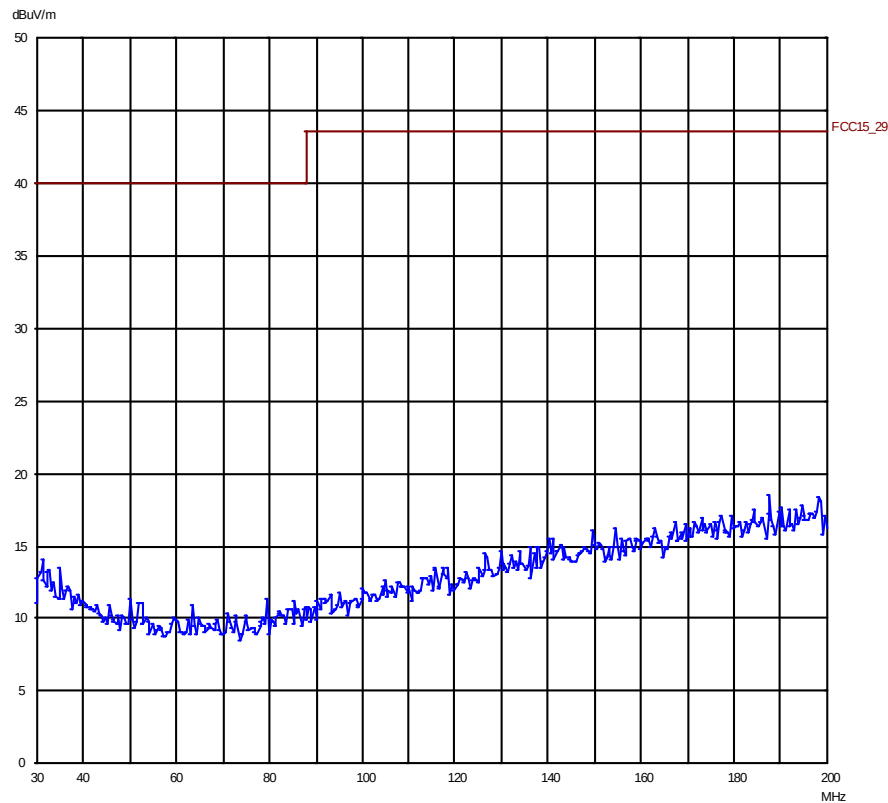


Fig 19 ECU01- Radiated emission 30 –200MHz, Horizontal polarization

Frequency	Operational condition	Field strength	Measuring distance	Limit FCC15.209	Margin
MHz		dB μ V/m	metres	dB μ V/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

The figure is a line graph showing radiated emission. The vertical axis is labeled 'dBuV/m' and ranges from 0 to 50 in increments of 5. The horizontal axis is labeled 'MHz' and ranges from 30 to 200 in increments of 20. A blue line represents the measured emission, which starts at approximately 13 dBuV/m at 30 MHz, dips to a minimum of about 9 dBuV/m between 50 and 80 MHz, and then rises to about 18 dBuV/m at 200 MHz. A red line represents the FCC limit, labeled 'FCC15_29' at its right end. This red line is at 40 dBuV/m from 30 MHz to 85 MHz, then jumps to 43 dBuV/m and remains constant until 200 MHz.

Fig 20 ECU01- 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, Kjeller, Norway

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Nemko Comlab

26. Sep 06 11:52

Peak

EUT: ecu01
Manuf: Engbo AS
Op Cond: vp 1m , 15deg
Operator: gns
Test Spec: FCC 15 249
3 m dist

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

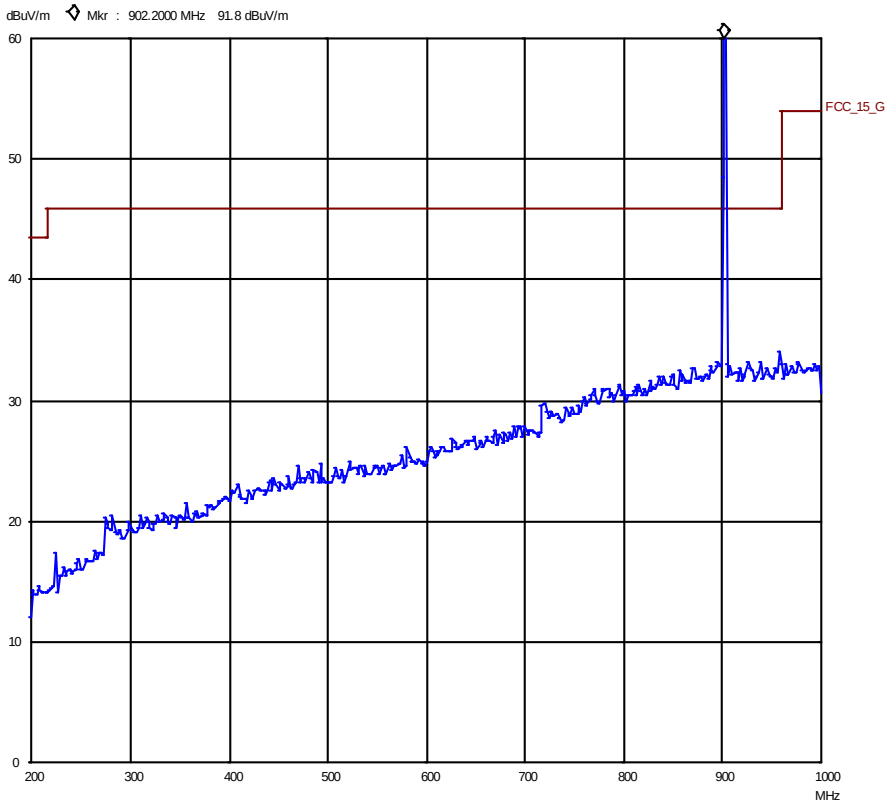


Fig 23 ECU-01 – VP 200 - 1000MHz

Nemko Comlab

26. Sep 06 11:13

Peak

EUT: ecu01
Manuf: Engbo AS
Op Cond: HP 127m, 15deg
Operator: gns
Test Spec: FCC 15 249
3 m dist

Scan Settings (1 Range)

Frequencies

Start

Stop

Step

IF BW

Detector

M-Time

Atten

Preamp

OpRge

Receiver Settings

Transducer No.

Start

Stop

Name

200M	1000M	50k	120k	PK	50ms	AUTO	LN	ON	60dB	21	200M	1000M	HL223
------	-------	-----	------	----	------	------	----	----	------	----	------	-------	-------

dBuV/m

Mkr : 902.2000 MHz 91.7 dBuV/m

Fig 24 ECU-01- HP 200 – 1000 MHz

Nemko Comlab, Kjeller, Norway

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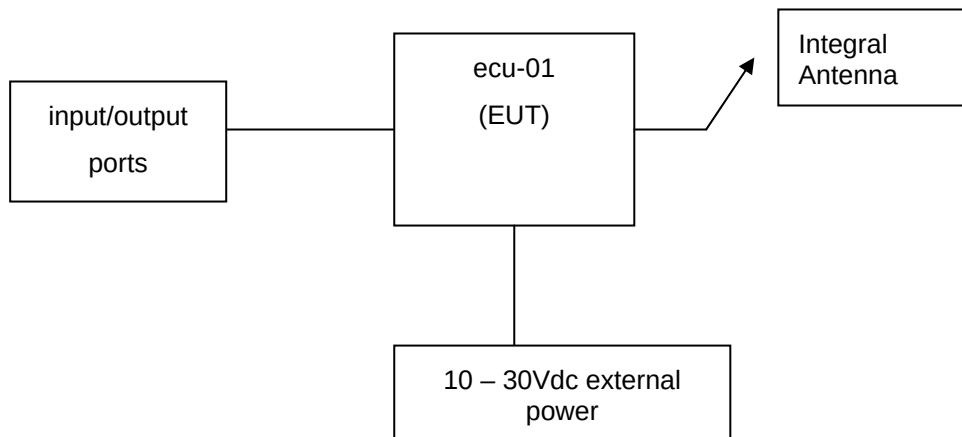
LIST OF TEST EQUIPMENT

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



ECU-01

5.2 Test Site Radiated Emission

