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Test report no. : 93193/10

Item tested : Tron SART20

Type of equipment : Search And Rescue Transponder 9GHz

Client : Jotron AS

NORWEGIAN ACCREDITATION
TEST 033

Nemko AS is granted accreditation by Norwegian Accreditation
under registration number TEST 033

IEC 1097-1 Radar Transponder – Maritime search and rescue (SART) – Operation and performance requirements, methods of testing and required results (First edition, 1992-07)

12th March 2008

Authorized by : .....
Geir Antonsen
Technical Verificator

CONTENTS

1 GENERAL INFORMATION

1.1 Testhouse Info

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E-mail:	comlab@nemko.com
Number of Pages:	25

1.2 Client Information

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Contact:

Name :	Eirik Storjordet
Telephone :	+47 33 13 97 14
E-mail :	eirik.storjordet@jotron.com

1.3 Manufacturer (if other than client)

Name :	/
Address :	/
Telephone :	/
Fax :	/
E-mail :	/

2 TEST INFORMATION

2.1 Tested Item

Name :	TRON SART 20
Model/version :	
Serial number :	0007
Hardware identity and/or version:	
Software identity and/or version :	
Frequency Range :	9200 – 9500 MHz
Type of Power Supply :	Internal primary battery (2 x 3,6 V Lithium)
Desktop Charger :	NA

Description of Tested Device(s)

The tested EUT is transponder for marine search and rescue (SART).

2.2 Test Environment

2.2.1 Normal test condition

Temperature:	20 - 23 °C
Relative humidity:	20 - 50 %
Atmospheric pressure:	98 - 102 kPa
Normal test voltage:	NA

All testing has been carried out with the supplied batteries.

The values are the limit registered during the test period.

2.3 Test Period

Item received date: 2007-09-19

Test period : from 2007-07-19 to 2008-01-30

2.4 Standards and Regulations

IEC 1097-1 Radar Transponder – Maritime search and rescue (SART)
– Operation and performance requirements, methods of testing and required results.
(First edition, 1992-07)

2.5 Test Engineer(s)

Jan G Eriksen, Egil Hauger

2.6 Additional information

2.6.1 Test Methods

Described in the relevant standards.

2.6.2 Test Equipment

List of used test equipment, see clause 5.

THIS TEST REPORT APPLIES ONLY TO THE ITEM(S) AND CONFIGURATIONS TESTED.

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

TESTED BY : _____ **DATE: 07th March 2008**

Jan G Eriksen, Test Engineer

3 TEST REPORT SUMMARY

3.1 Abbreviations

P Passed, the equipment fulfils the requirement
F Failed, the equipment does not fulfil the requirement
I Inconclusive, the test does not give a conclusive verdict
NA Not applicable, the requirement is not applicable
NT Not tested, the test is not performed even though the requirement is relevant

3.2 List of measurements

Standard		Measurement	Result (Pass/Fail)
IEC 1097-1	6.9.3	Receiver sensitivity	Pass
IEC 1097-1	6.9.4	Sweep characteristics	Pass
IEC 1097-1	6.9.5	Radiated power	Pass
IEC 1097-1	6.9.6	Antenna characteristics	Pass
IEC 1097-1	6.5	Range performance	Pass
IEC 1097-1	6.9.7	Recovery time following excitation	Pass
IEC 1097-1	6.9.8	Delay – receipt of radar interrogation and SART transmission	Pass
IEC 1097-1	6.9.9	Receiver front end protection	Pass

3.3 Conclusion

The tested equipment complies with the requirements of relevant standards.

3.4 OTHER COMMENTS

EUT (Equipment Under Test):

The EUT was in normal operating mode. A pulsed RF signal at one of the following frequencies: 9200, 9350, or 9500 MHz (depending on the test) was transmitted to the EUT and the response signal from the EUT was measured/monitored.

List of ports:

Signal port:	Internal antenna
Power ports:	Internal battery

4 TECHNICAL CHARACTERISTICS

The technical characteristics of the EUT have been determined during measurements and test in the laboratory. Some of the tests have been performed in an anechoic chamber.

When tested in a anechoic chamber the EUT has been placed on a 1,5 meter high pedestal and the floor between EUT and measurement antenna has been covered with absorbers to reduce reflections from the floor to a minimum.

During these tests one of three different interrogating “radar” signals according to IEC 1097-1 clause 6.9.2 have been used:

6.9.2.1 Test signal 1: pulsed carrier of repetition 3 kHz and 80 ns duration (at 90 % height)

6.9.2.2 Test signal 2: pulsed carrier of repetition 1 kHz and 500 ns duration (at 90 % height)

6.9.2.3 Test signal 3: pulsed carrier of repetition 1 kHz and 1000 ns duration (at 90 % height)

4.1 Receiver sensitivity

This requirement has been tested according to IEC 1097-1 clause 6.9.3.

The EUT is interrogated with test signals 1 and 2 at three frequencies (9200, 9350, and 9500 MHz). The power level of the signal generator shall be increased until the EUT responds at each frequency.

	9200 MHz	9350 MHz	9500 MHz
Test signal 1	-52,4	-54,8	-52,1
Test signal 2	-56,4	-56,8	-55,1

The table shows the measured sensitivity levels.

The receiver sensitivity shall not be less than -37 dBm for test signal 1 and not less than -50 dBm for test signal 2.

The EUT complies with the requirements.

4.2 Radiated power

This requirement has been tested according to IEC 1097-1 clause 6.9.5.

Test signal 2 was applied to the EUT. It was rotated 360 degrees in the horizontal plane and the signal levels received was recorded at three frequencies:

	EIRP 9,2	EIRP 9,35	EIRP 9,5	Limit
Position	dBm	dBm	dBm	dBm
0	31,4	32,1	31,2	26
45	31,7	30,9	30,3	26
90	31,6	31,3	31,3	26
135	30,9	30,1	30,8	26
180	30,1	29,8	30,1	26
135	30,3	30,3	30,7	26
270	32,1	32,2	32,1	26
315	31,6	31,5	31,6	26

Table 1

Requirements:
The maximum and minimum signals shall be within 4 dB.

See fig 1.

The EUT complies with the requirements.

4.3 Antenna characteristics

This requirement has been tested according to IEC 1097-1 clause 6.9.6.

Test signal 2 was applied to the EUT. The receive antenna was placed at ± 12,5 degrees relative to the horizontal plane from EUT. The EUT was rotated 360 degrees and the highest and lowest signal levels received from the EUT was monitored at three frequencies:

Vertical position -12,5 degree				
Horizontal Position	EIRP 9,2 GHz	EIRP 9,35 GHz	EIRP 9,5 GHz	Limit
	dBm	dBm	dBm	dBm
0	29,46	30,13	28,89	24
45	30,8	30,23	30,78	24
90	30,8	31,52	31,71	24
135	30,98	29,1	29,5	24
180	26,7	26,72	28,63	24
135	27,56	26,72	27,41	24
270	29,05	30,59	29,5	24
315	28,18	29,61	29,4	24

Table 2

Vertical position + 12,5 degree				
Horizontal position	EIRP 9,2 GHz	EIRP 9,35 GHz	EIRP 9,5 GHz	Limit
	dBm	dBm	dBm	dBm
0	28,92	29,4	29,1	24
45	28,31	27,94	28,46	24
90	28,92	27,69	28,33	24
135	28,18	28,58	29,31	24
180	28,67	28,45	29,78	24
135	28,67	29,52	29,2	24
270	30,54	30,03	30,59	24
315	30,03	30,81	31,18	24

Table 3

Table 2 and 3: shows the highest and lowest received signal levels when the EUT is rotated 360 degrees

See fig 2 and 3.

Requirements:
The recorded signals shall be greater than -2 dB relative to the signals levels found in 5.5.2 (IEC 1097-1 clause 6.9.5)

The EUT complies with the requirements.

4.4 Polarization

This requirement has been inspected according to IEC 1097-1 clause 6.6.2.

The EUT has a horizontal polarisation.

4.5 Range performance

This requirement has been determined on basis of the measurement results from 5.4.14 (IEC 1097-1 clause 6.5), 5.5.1 (IEC 1097-1 clause 6.9.3), 5.5.2 (IEC 1097-1 clause 6.9.5), 5.5.3 (IEC 1097-1 clause 6.9.6), and on basis of the graphs in figure 3 of CCIR report 1036-1, showing the power levels received by a SART and interrogating radar respectively.

Assuming the interrogating radar has a peak transmit power of 10 kW or more, an antenna gain of 30 dB or more, is located on a height of 15 meters or higher, the EUT will detect the interrogating signals from the radar when being positioned at a height of 0,5 meters or higher, and it will respond to interrogating signals at a distance of up to 10,3 nautical miles.

The EUT complies with the requirements.

4.6 Sweep characteristics

This requirement has been tested according to IEC 1097-1 clause 6.9.4.

Test signal 2 shall be used.

The EUT shall transmit 12 consecutive frequency sweeps, each covering 9200^{+0}_{-60} to 9500^{-0}_{+60} MHz. The forward sweep shall be 7,5 us ± 1,0 us and the reverse sweep shall be 0,4 us ± 0,1 us. The burst shall start with a reverse sweep.

The sweep profile shall be within ± 20 MHz of the linear sweep between the 9200 and 9500 MHz crossing points. The maximum deviation from the linear sweep is approximately 16 MHz – see figures 5 – 7.

The EUT complies with the requirement.

4.7 Recovery time following excitation

The EUT has been tested according IEC 1097-1 clause 6.9.7

The burst length of the EUT was measured to 97,2 us (see figure 8). The RF-generator was trigged from an external AF-generator. The frequency of the AF-generator was increased until the EUT no longer was able to respond on two successive interrogations. The AF time interval (1/frequency) minus the EUT burst length shall not exceed 10 us.

The recovery time was measured to: 1/9709 (repetition period of AF-generator) – 97,21us = 5,9 us.

The EUT complies with the requirement

4.8 SART – transponder delay

The EUT has been tested according IEC 1097-1 clause 6.9.8.

The time difference between input pulse from RF-generator and output from EUT was measured. The transmission delay was measured to 250 ns (see figure 9). The delay shall not exceed 500 ns.

The EUT complies with the requirement.

4.9 Receiver front end protection

The EUT has been tested according IEC 1097-1 clause 6.9.9.

The functioning EUT shall be placed in the radiated field of 28 dBW/m2 of a radar conforming to the IMO resolution A.477, operating in the 9 GHz band.

The power density as a function of distance is:

$$P = \frac{P_t \bullet G_t}{4\pi \bullet R^2}$$

P_t = 1500 Watt, G_t = 227 (derived from half power beam width of the antenna as given from manufacturer)

This corresponds to a distance of 6 meters from the radar.

The EUT was tested at a distance of 5 meters from the radar in different directions, see picture in annex.

After the test the output of the EUT was displayed on an appropriate radar display.

The EUT complies to the requirement.

5 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

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

No	Instrument/Ancillary	Type	Manufacturer	Ref. No.
1	Spectrum analyzer	FSEK30	R&S	LR 1337
2	Spectrum analyzer	FSU26	R&S	LR 1504
3	Spectrum analyzer	R3271	Advantest	LR 1188
4	RF-generator	SMP04	R&S	LR 1336
5	RF-generator	7200	Gigatronics	LR 1188
6	AF-generator	SPN	R&S	LR 1018
7	Horn antenna	PM7320X	Sivers Lab	LR 102 / 103
8	Oscilloscope	2440	Tektronix	LR 1009
9				
10	Divide by 64 device		Jotron make	Jotron property
11	Directional coupler		Narda	Jotron property
12	Rectifying diode		Narda	Jotron property
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6 MEASUREMENT PLOTS

6.1 Antenna characteristics

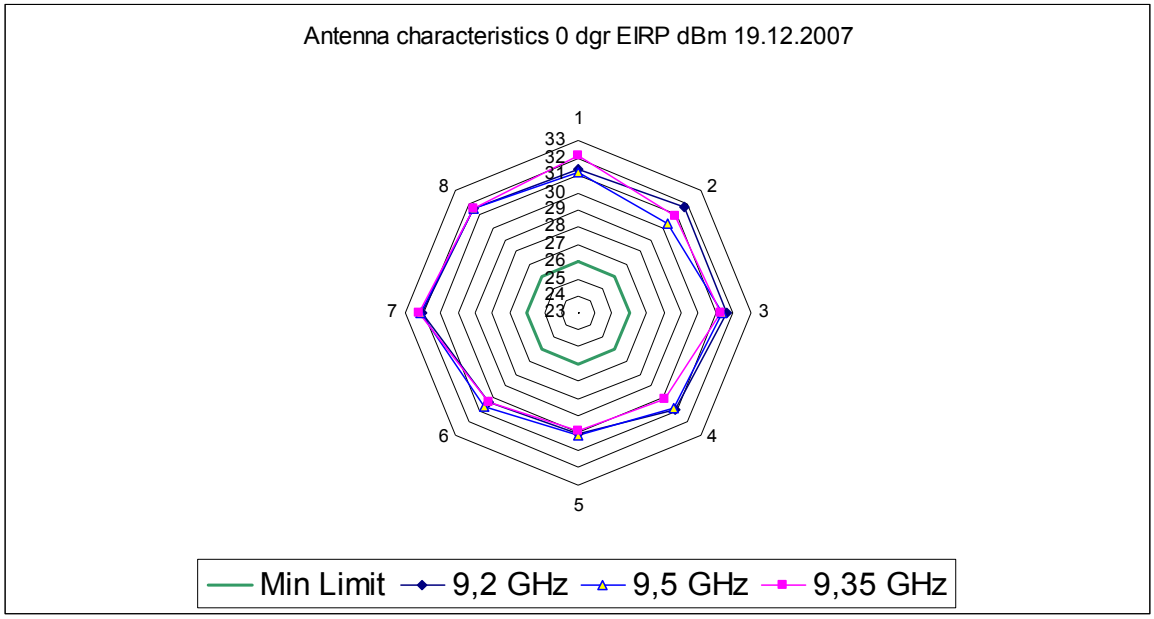


Figure 1: Shows the received signal level at 1 degrees elevation (horizontal) at three frequencies and 8 positions of turntable when EUT is turned 0 – 360 degrees.

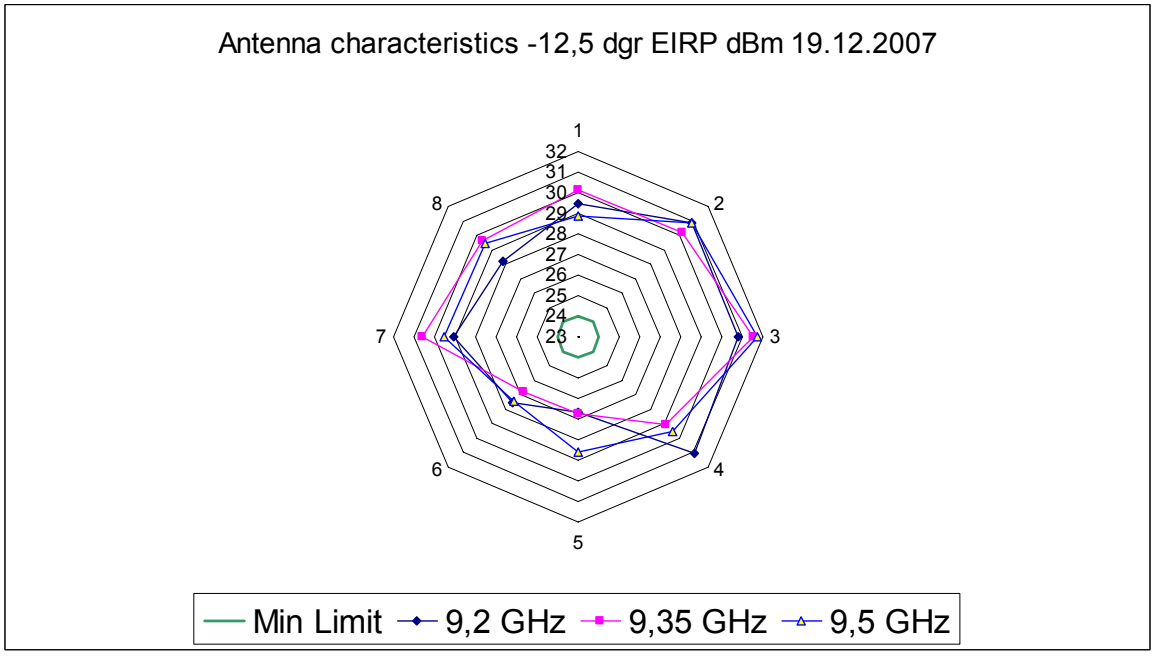


Figure 2: Shows the received signal level at -12,5 degrees elevation (horizontal) at three frequencies and 8 positions of turntable when EUT is turned 0 – 360 degrees.

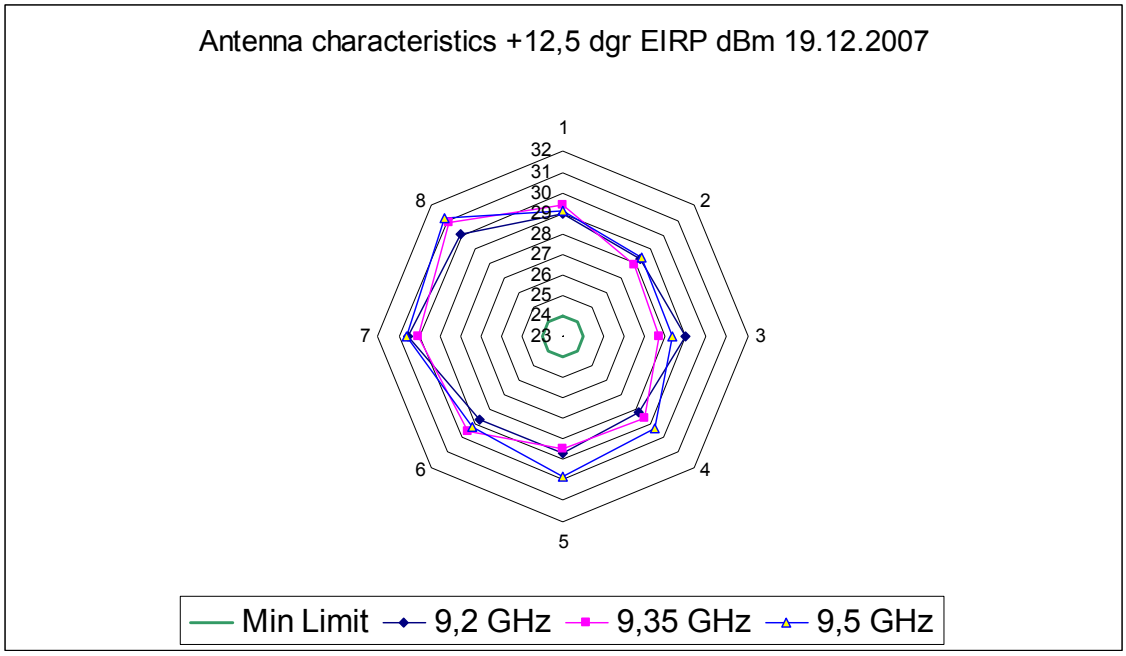


Figure 3: Shows the received signal level at +12,5 degrees elevation (horizontal) at three frequencies and 8 positions of turntable when EUT is turned 0 – 360 degrees.

6.2 Sweep Characteristics

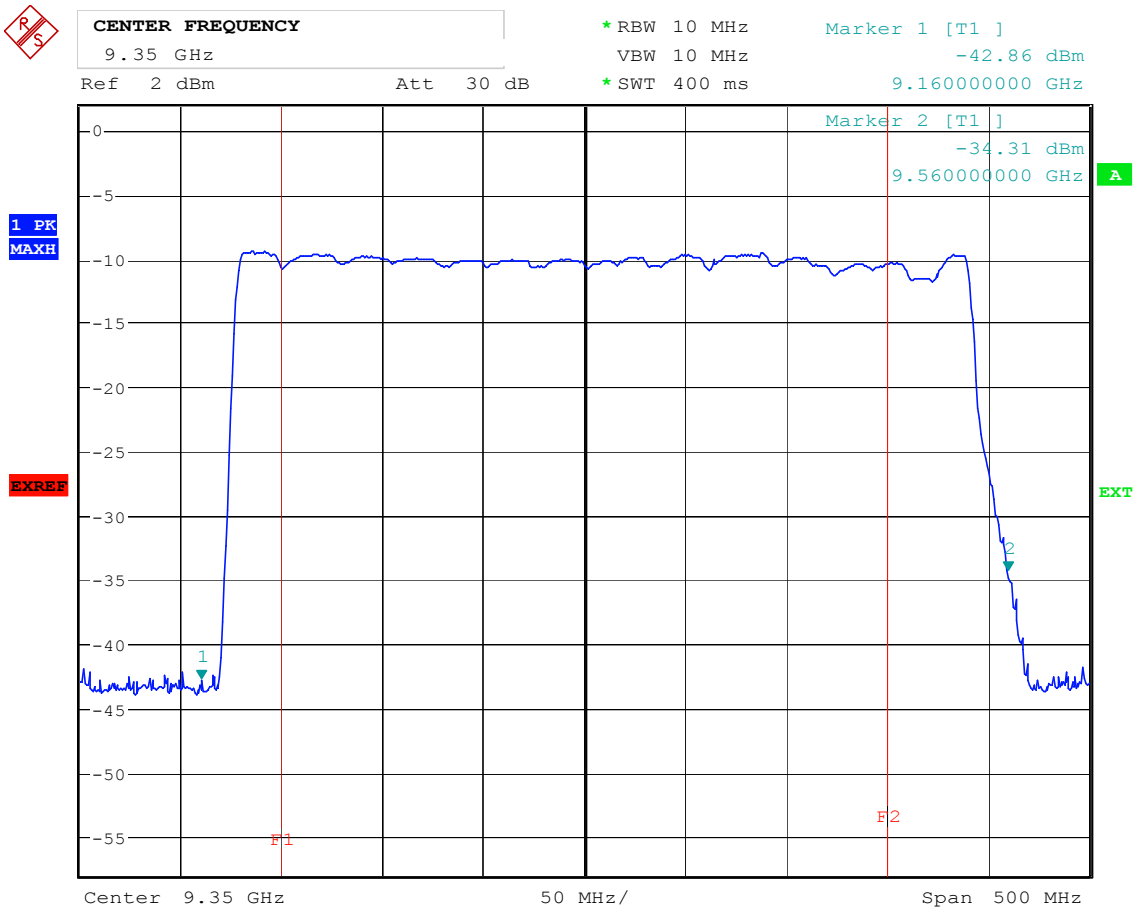
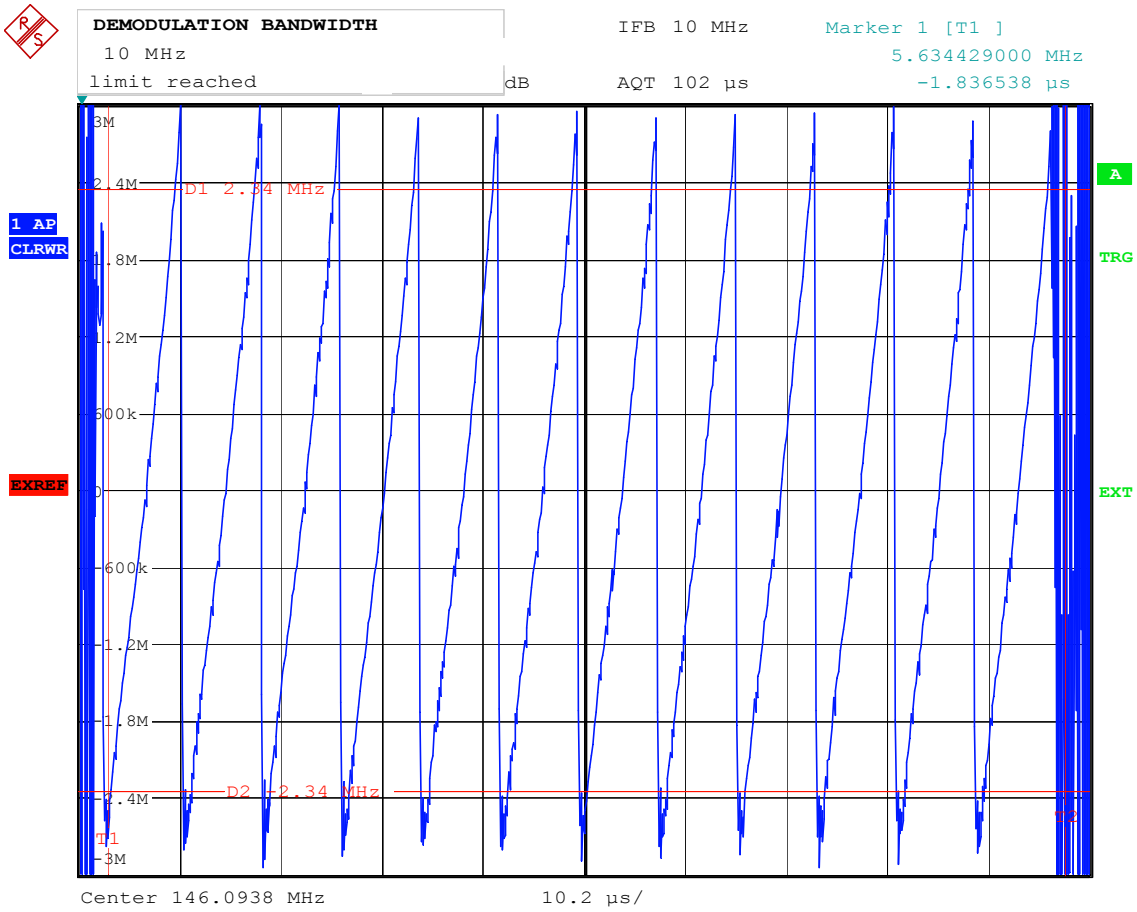
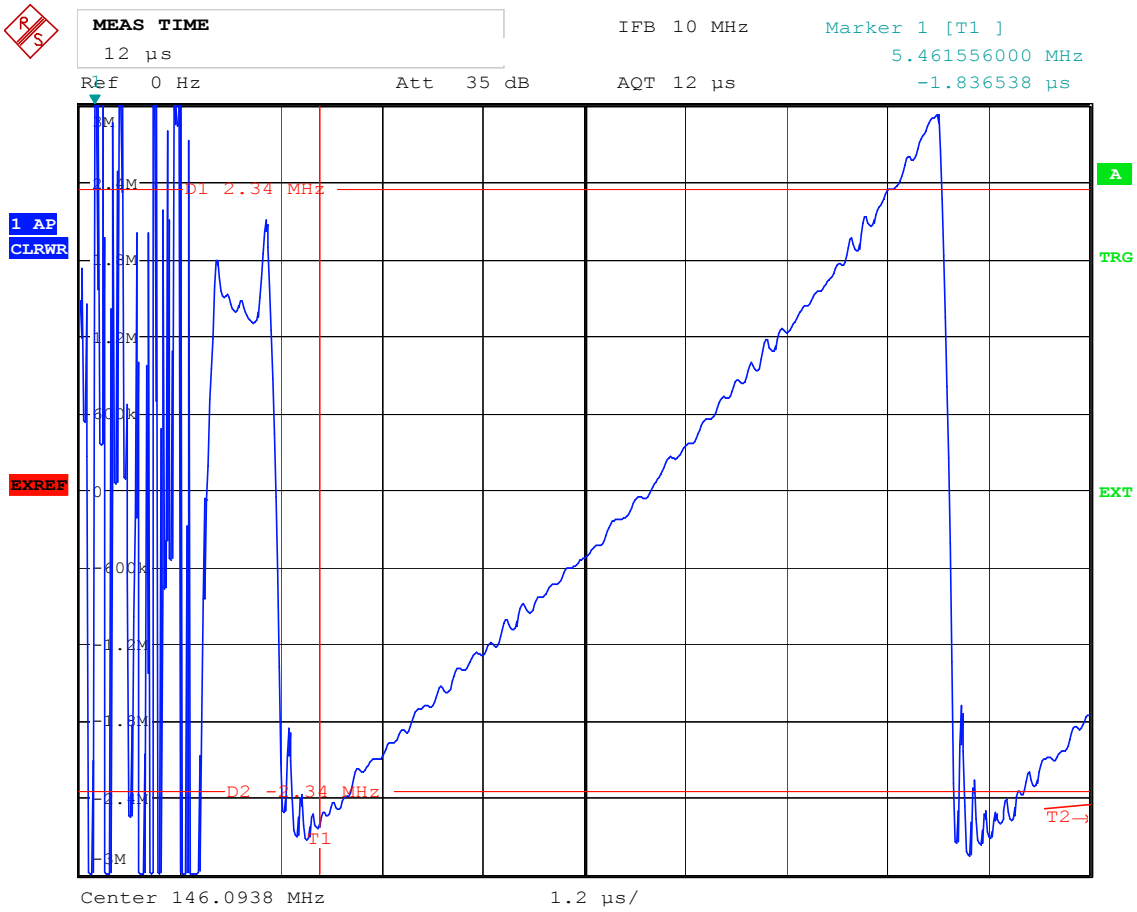


Figure 4: Shows the frequency spectrum of the EUT. The transmitted spectrum shall be outside of the lines F1 and F2 (red), and it shall also be within the markers #1 and #2 (green).



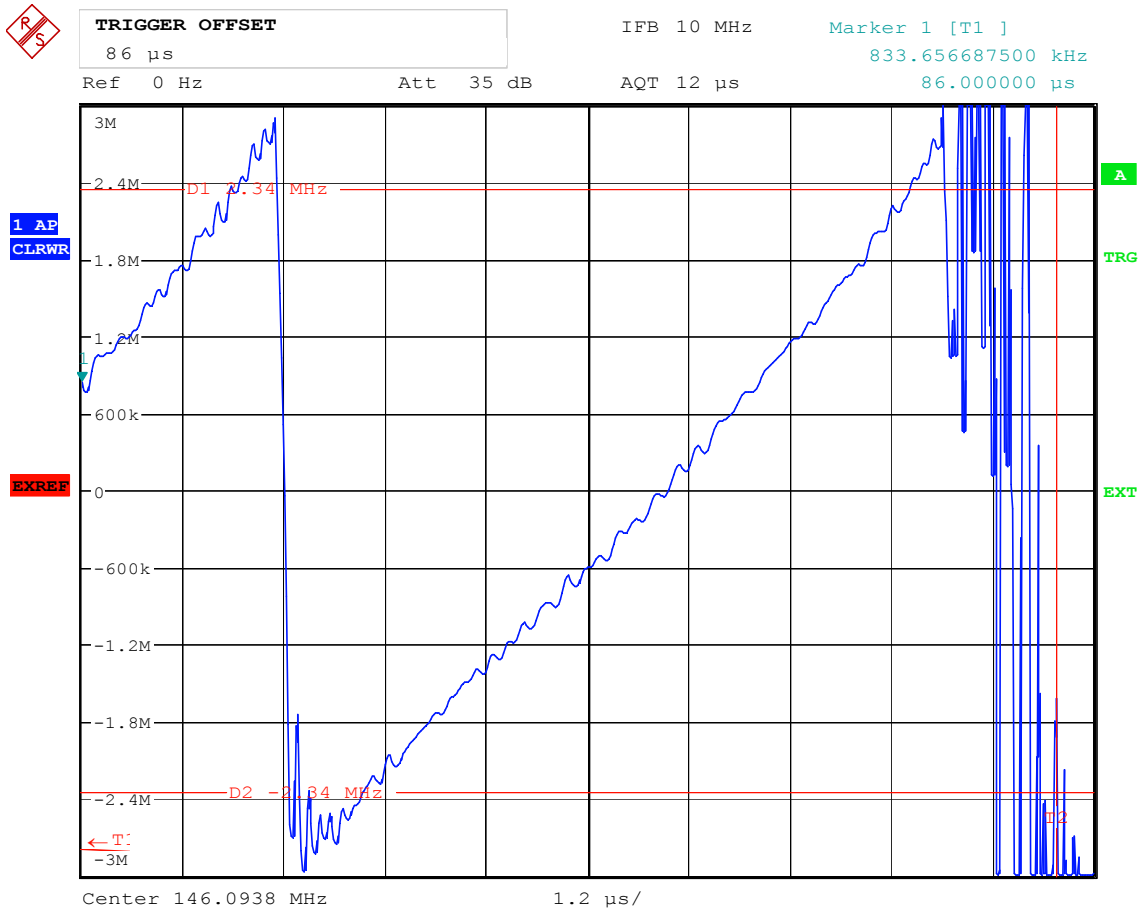
Comment: INTERSOUND MP3 NO3 0mV
Date: 19.DEC.2007 10:38:30

Figure 5: Shows 12 consecutive sweeps during transmitted burst from EUT.



Comment: INTERSOUND MP3 NO3 0mV
Date: 19.DEC.2007 10:43:44

Figure 6: Shows first sweep (from 12 consecutive) from EUT



Comment: INTERSOUND MP3 NO3 0mV
Date: 19.DEC.2007 10:45:59

Figure 7: shows last sweep (from 12 consecutive) from EUT

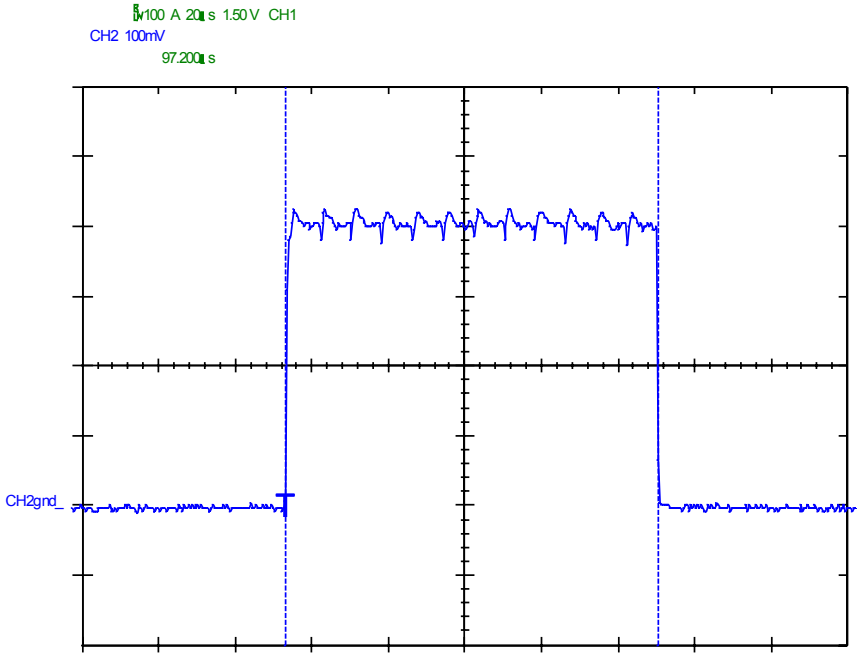


Figure 8: Shows the transmitted pulse from the EUT, pulse length 97,2 us.

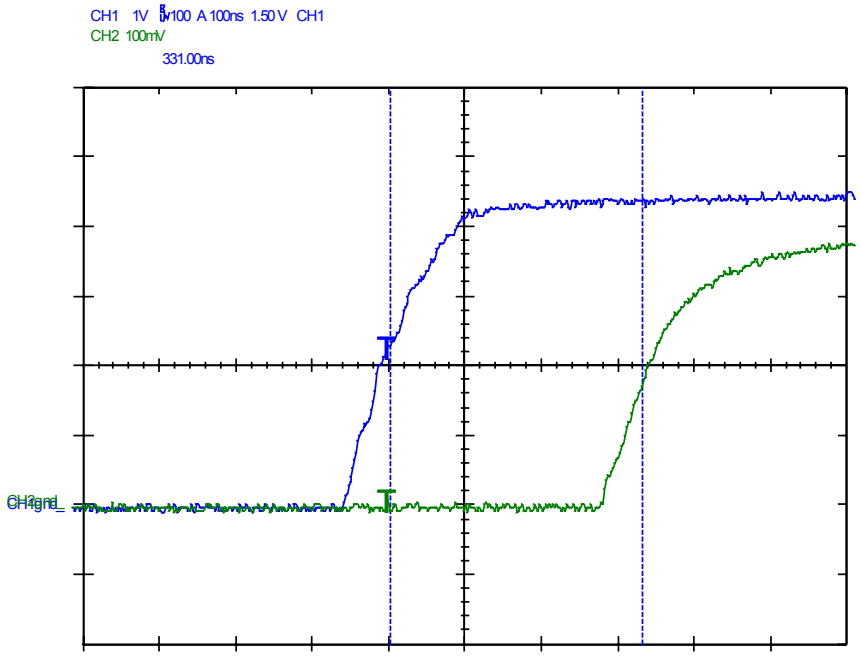


Figure 9: Shows the delay between pulse trigging to RF-generator and output from EUT.
NOTE: the delay between pulse trig to RF-generator and RF-generator output is 80 ns.

7 TEST SETUP

7.1 Timing and sweep measurements

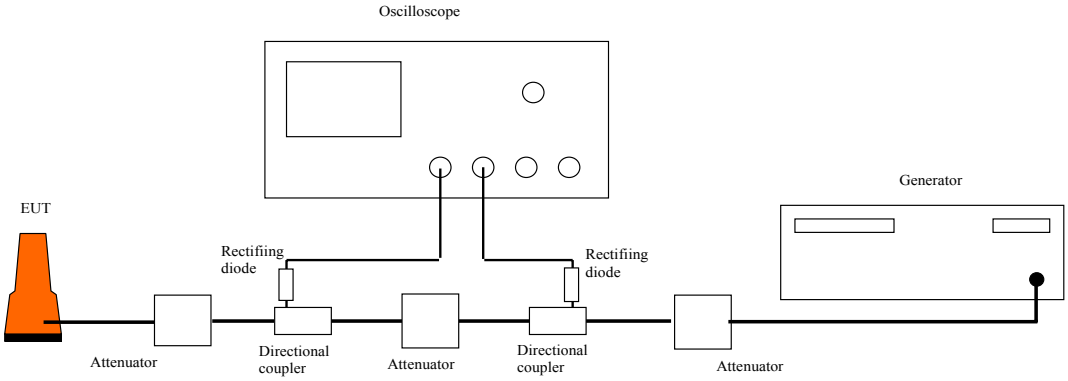


Figure 10: Shows the principal setup during timing performance measurements

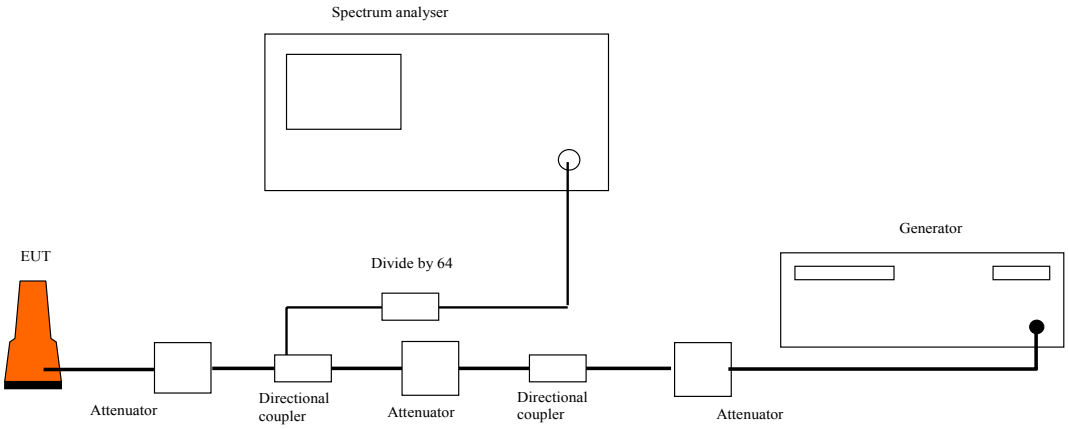


Figure 11: Shows the principal setup during sweep characteristics measurements

7.2 Antenna characteristics measurements

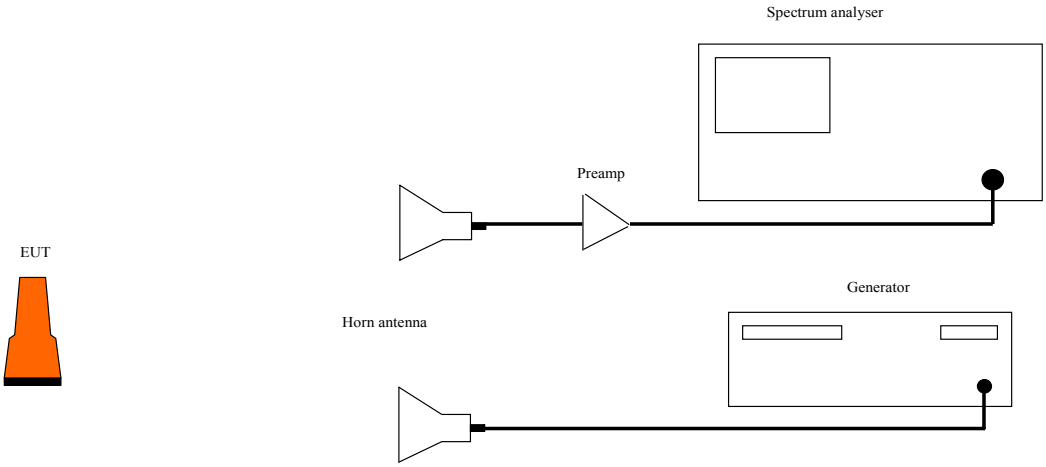
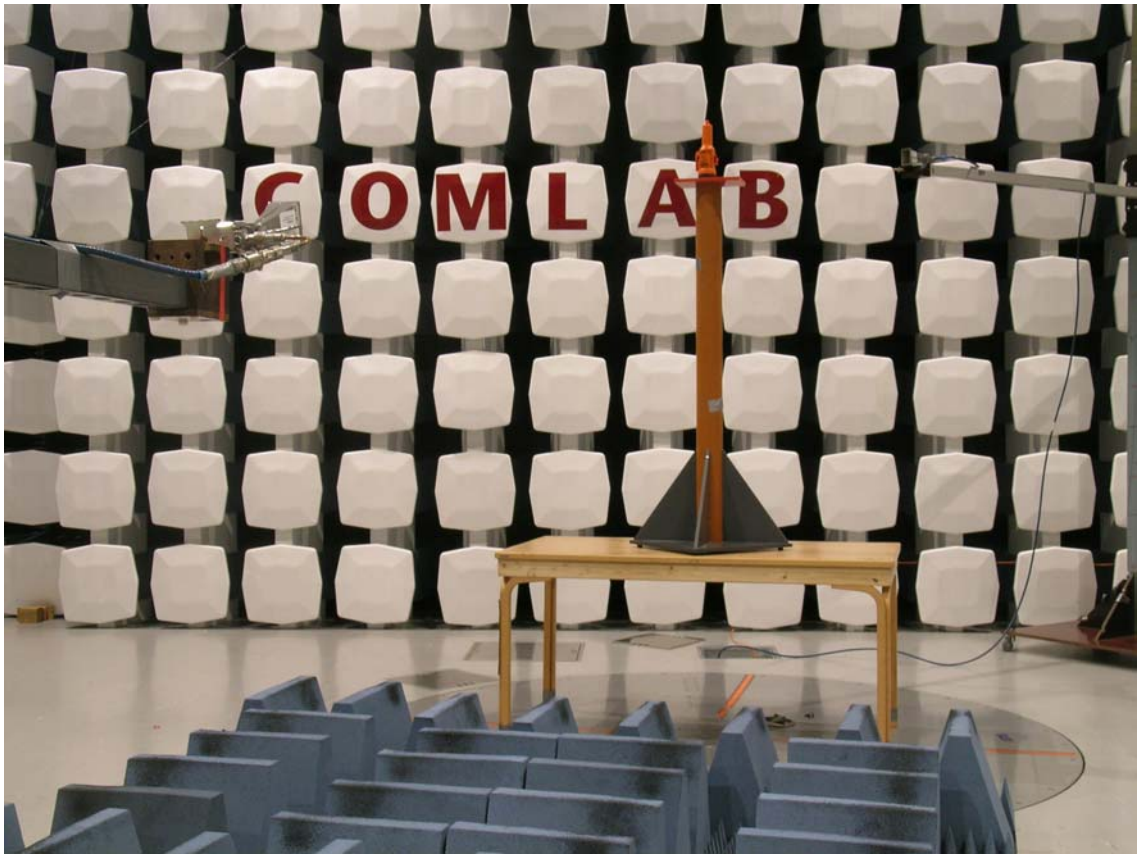


Figure 12: Shows the principal setup during antenna characteristics measurement

8 PICTURES



Picture 1: Shows the measurement setup during “Antenna characteristics” measurements. The EUT is positioned on a pedestal 2,2 meters above ground level and the floor between EUT and measurement antenna is covered with absorbers to eliminate ground reflections.

Picture 2: Shows EUT (to the right) and radar (to the left) during receiver front end protection test

Picture 3: Shows radar screen during receiver front end protection test