



TTI - P-G 089 / 94-11
DAT - P-011 / 91-02

EMI -- TEST REPORT

Test Report No. : T25274-00-06XF

February 04, 2005

Date of issue

Type / Model Name : PR25 / PR25IF

Product Description : Levelling and alignment instrument

Applicant : Hilti Corporation

Address : Feldkircherstrasse 100

FL-9494 Schaan, Principality of Liechtenstein

Manufacturer : HILLOS GmbH

Address : Prüssingstraße 41

D-07745 Jena

Licence holder : Hilti Corporation

Address : Feldkircherstrasse 100

FL-9494 Schaan, Principality of Liechtenstein

Test Result according to the standards listed in clause 1 test standards:

POSITIVE

The test report merely corresponds to the test sample.

It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15 Subpart C - Intentional Radiators (October 01, 2003)

Part 15, Subpart C, Section 15.249	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz
Part 15, Subpart C, Section 15.35(c)	Correction for Pulse Operation (Duty Cycle)
Part 15, Subpart C, Section 15.207(a)	AC Line conducted emissions
Part 15, Subpart C, Section 15.209(a)	Radiated emissions, general requirements

FCC Rules and Regulations Part 15 Subpart B - Unntentional Radiators (October 01, 2003)

Part 15, Subpart B, Section 15.107(a)	AC Line conducted emissions
Part 15, Subpart B, Section 15.109(a)	Radiated emissions, general requirements

2 SUMMARY

GENERAL REMARKS:

The EuT is a levelling and alignment tool and contains a transceiver which is operating at fixed frequency 2402.00 MHz. It is only possible to adjust the frequency and the RF output power from the manufacturer for test purposes. For the manufacture in series, all settings will be saving in the EPROM of the EuT and cannot be change from the customer. All tests were performed at frequency 2402.00 MHz.

The models PR25 and PR25IF are technical identical and it exists only a different from the laser strength. By model PR25IF is the Laser more stronger than by model PR25. All measurement was performed at the model PR25

The frequency range was scanned from 25 MHz to 24000 MHz. All emissions not reported in this test report were more than 10 dB below the specified limit.

All tests were performed with the integrated antenna TCA10F with following technical characteristics:

- Part No. TCA10F
- Center Frequency 2450MHz
- Band width 300MHz
- Peak Gain 3dBi
- Typical Gain 2dBi
- Operating Temp. -20oC~+85oC
- Storage Temp. -40oC~+85oC
- Weight 0.6g

FINAL ASSESSMENT:

The equipment under test **fulfills** the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records of MBPS

Testing commenced on : November 10, 2004

Testing concluded on : November 15, 2004

Checked by:

Tested by:

Thomas Weise
Dipl. Ing.(FH)

Xaver Fischer

3 EQUIPMENT UNDER TEST

3.1 Photo documentation of the EuT

Levelling instrument PR25

T25274-00-06XF

External Photo
Front view



Levelling instrument PR25
T25274-00-06XF

External Photo
Rear view



Levelling instrument PR25

T25274-00-06XF

External Photo
Side view



Levelling instrument PR25
T25274-00-06XF

External Photo
Top view



Levelling instrument PR25
T25274-00-06XF

External Photo
Bottom view



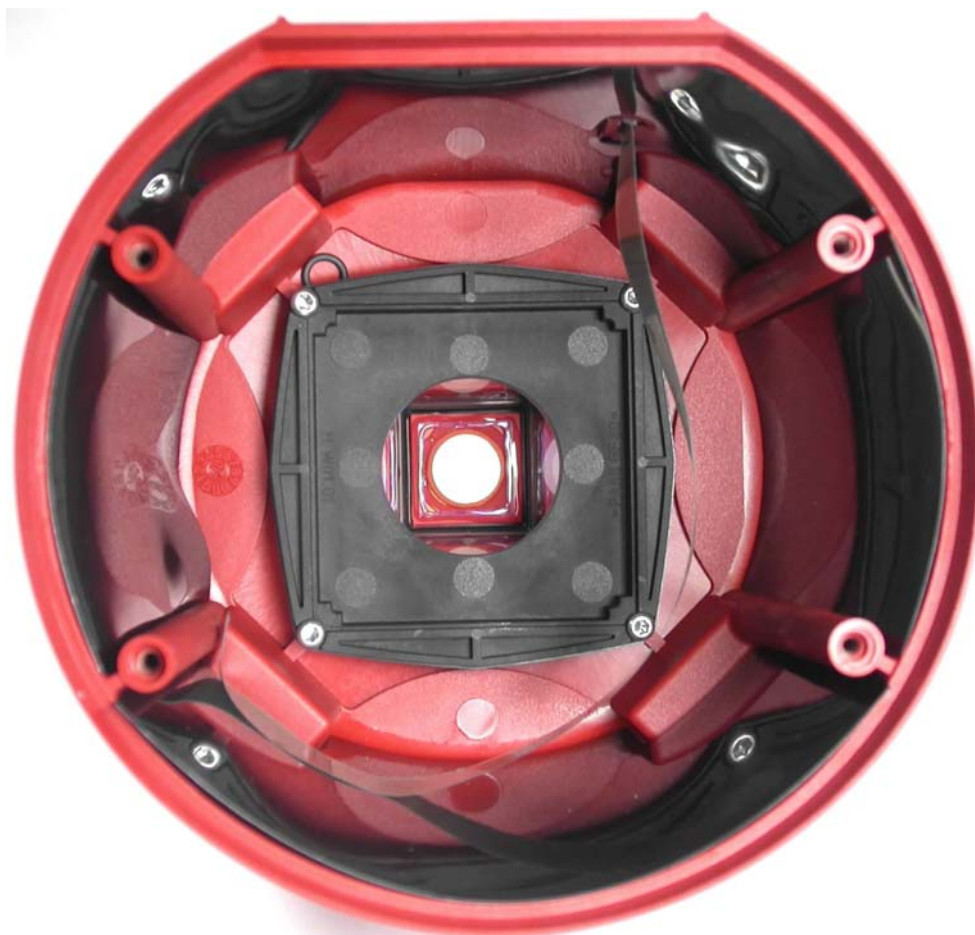
Levelling instrument PR25
T25274-00-06XF

External Photo
Batterie case



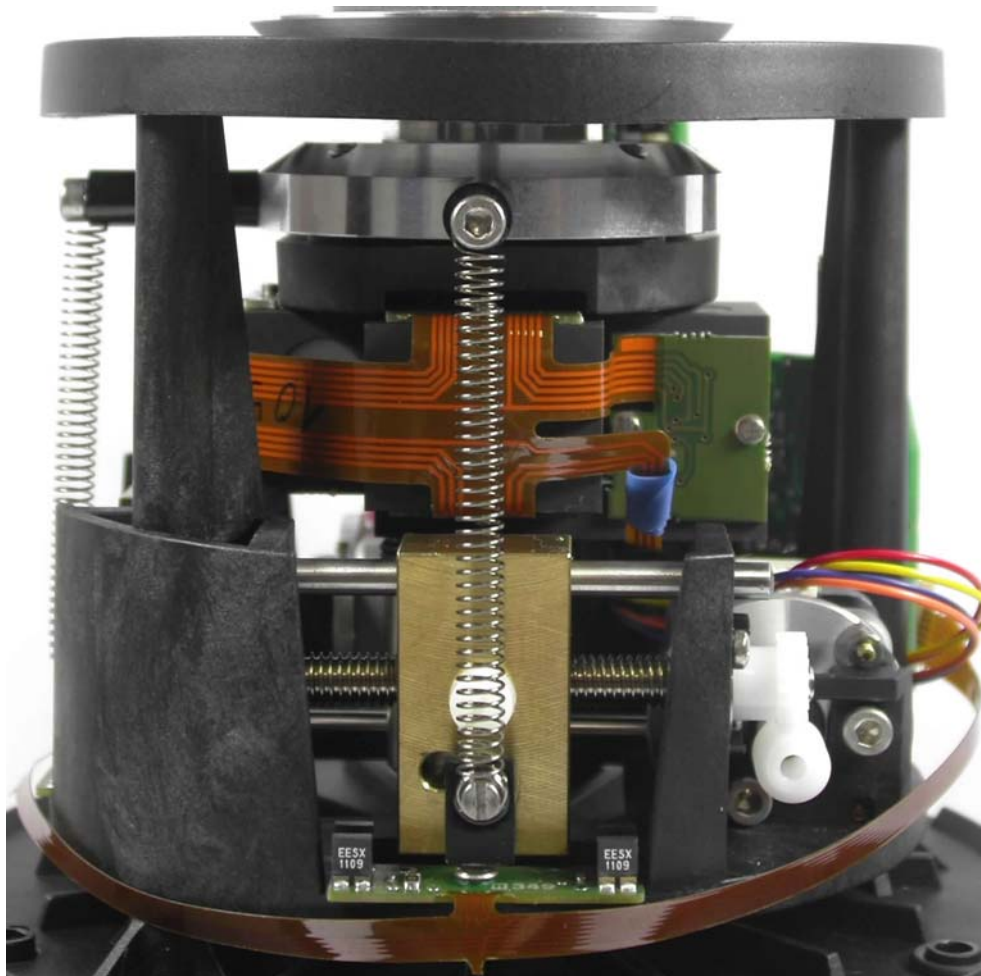
Levelling instrument PR25
T25274-00-06XF

internal Photo
Open view



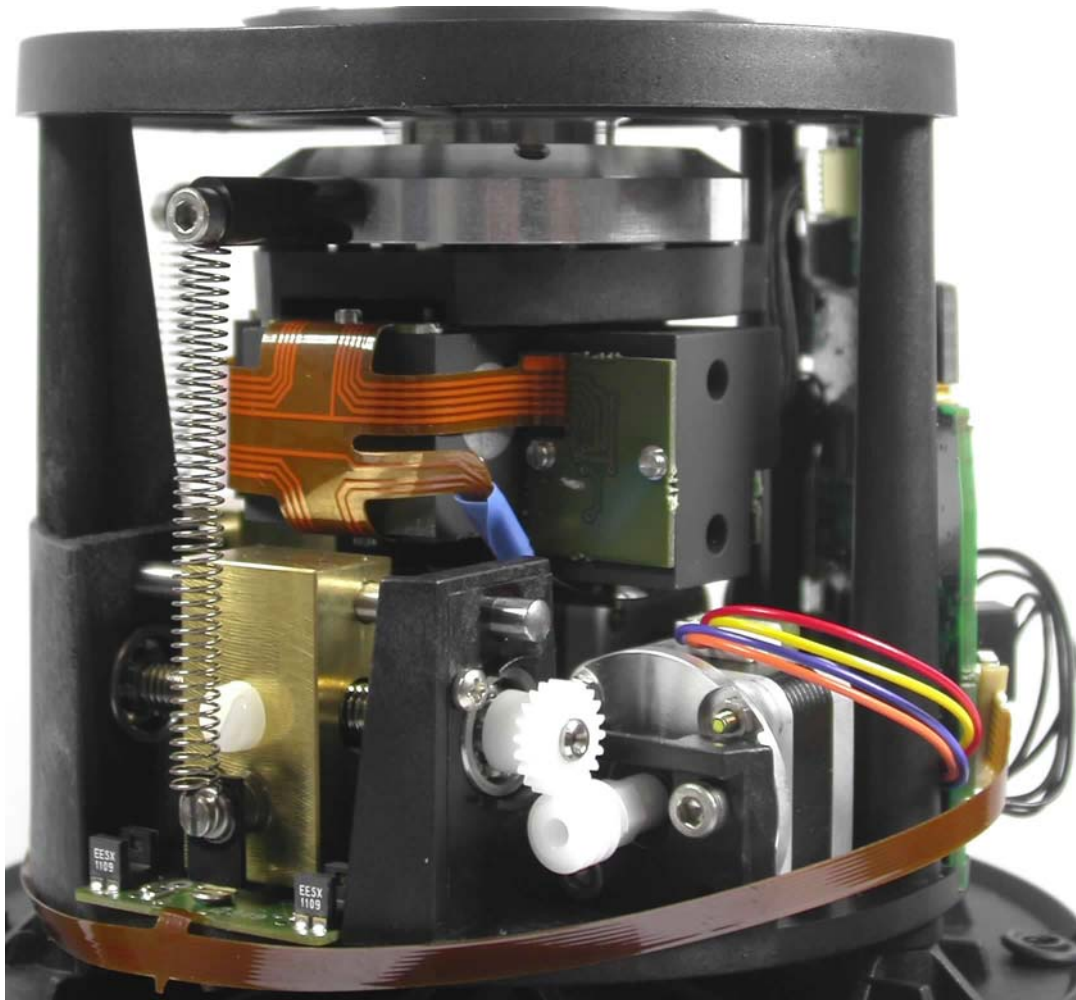
Levelling instrument PR25
T25274-00-06XF

Internal Photo
Open view



Levelling instrument PR25
T25274-00-06XF

Internal Photo
Open view



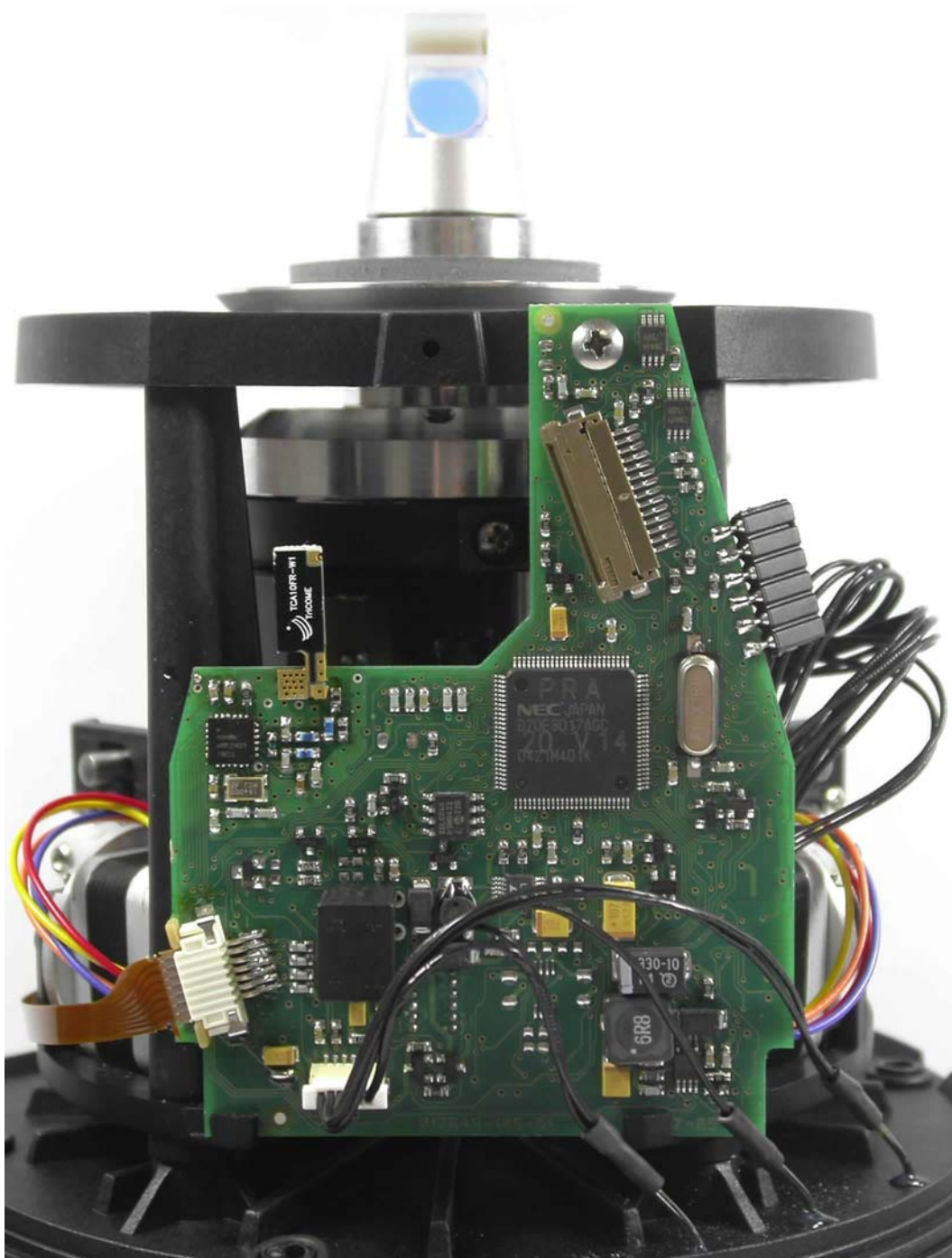
Levelling instrument PR25
T25274-00-06XF

Internal Photo
Open view



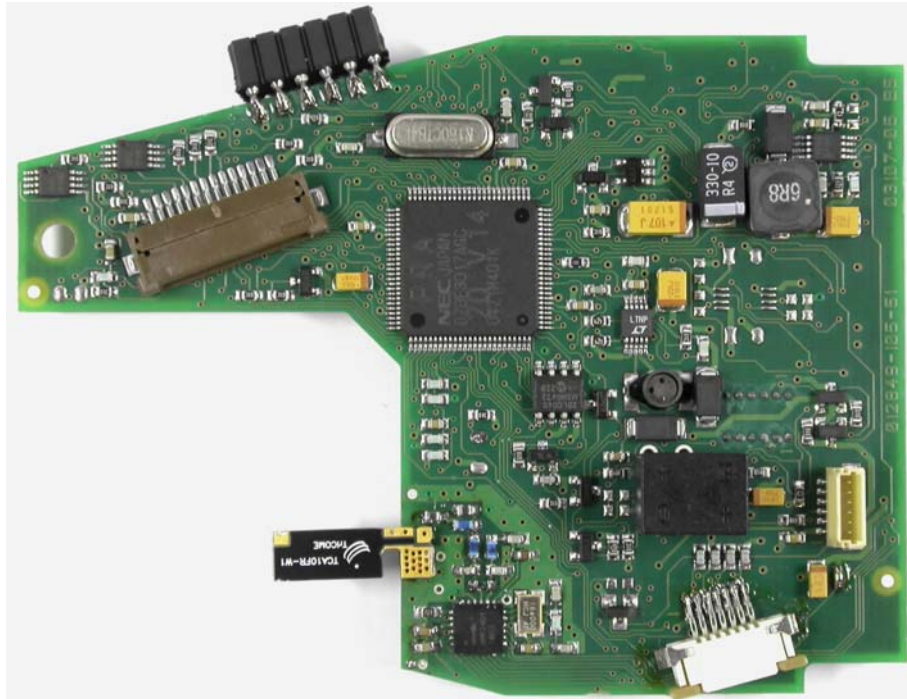
Levelling instrument PR25
T25274-00-06XF

Internal Photo
Open view

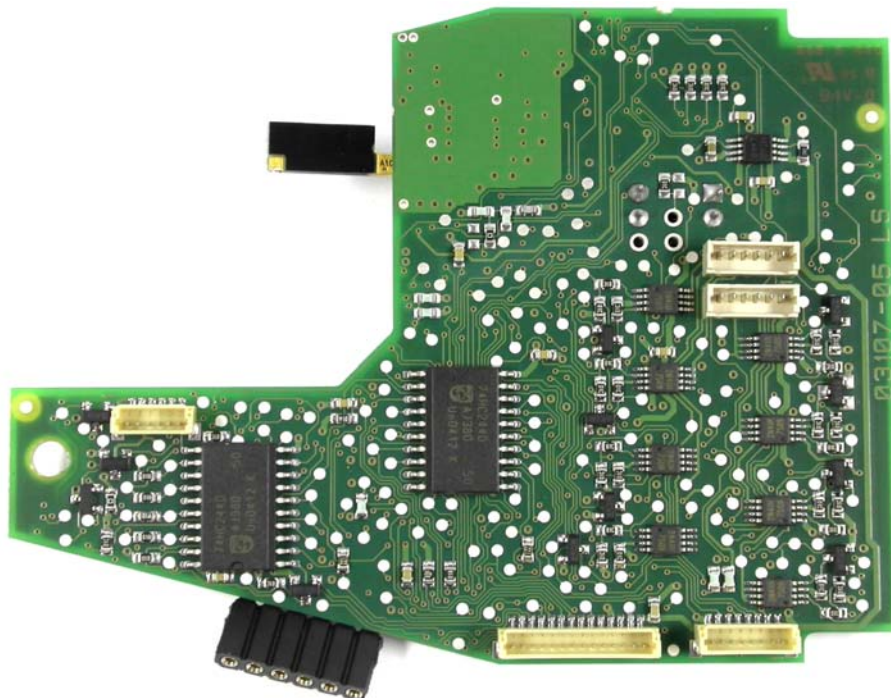


Levelling instrument PR25
T25274-00-06XF

Internal Photo
Front view PCB



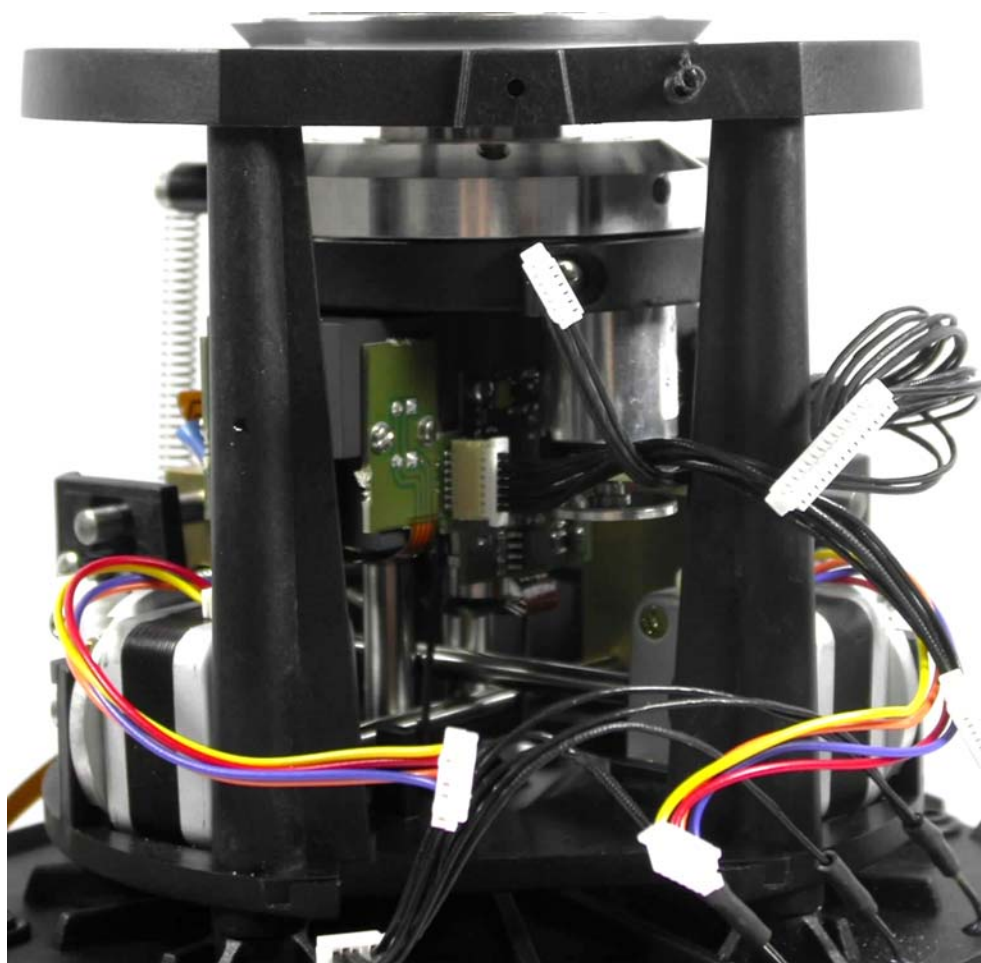
Internal Photo
Rear view PCB



Levelling instrument PR25

T25274-00-06XF

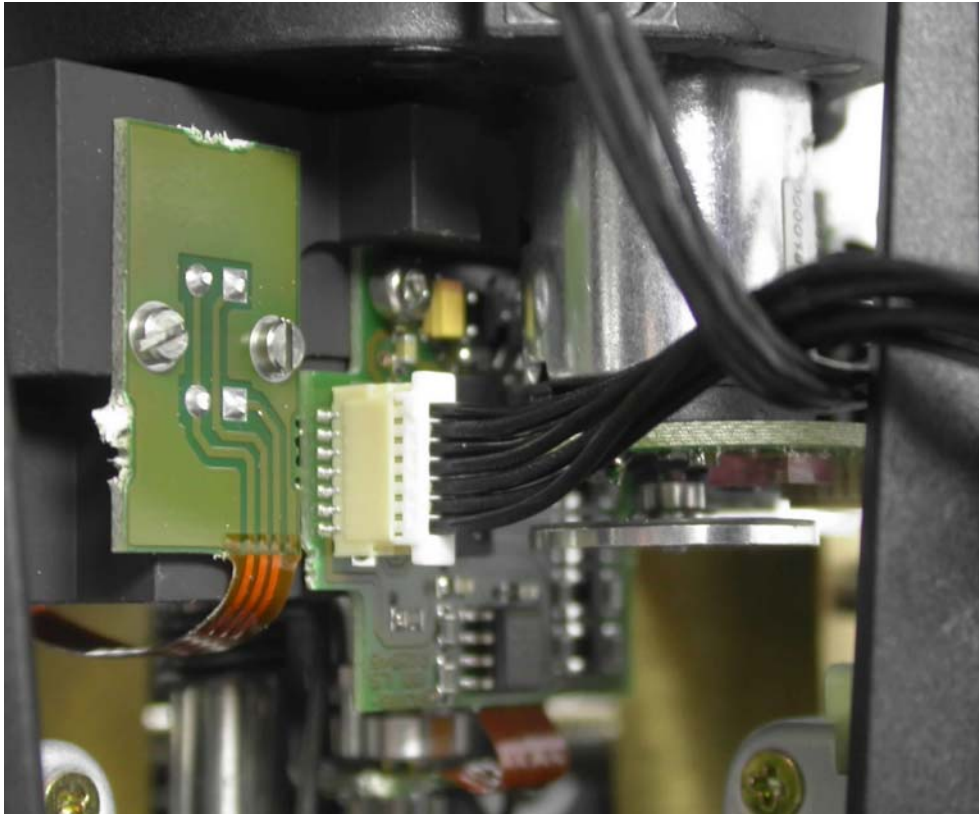
Internal Photo
Open view with removing the control unit PCB



Levelling instrument PR25

T25274-00-06XF

Internal Photo
Detail view of PCB control unit for Servomotors



3.2 Power supply system utilised

Power supply voltage : 4.5 V / DC

3.3 Short description of the Equipment under Test (EuT)

The EuT is a Laser leveling and alignment tool that can be remote controlled via RF.

Number of tested samples: 1
Serial number: 28104006

EuT operation mode:

The equipment under test was operated during the measurement under the following conditions:

- Transmitting mode continuously

- Receiving mode continuously

- The EuT is levelling and justifying

EuT configuration:

(The CDF filled by the applicant can be viewed at the test laboratory.)

The following peripheral devices and interface cables were connected during the measurements:

- Spectrum Analyzer	Model : ESIB 40
-	Model :
-	Model :
-	Model :
-	Model :
-	Model :

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

MIKES BABT Product Service GmbH
Ohmstrasse 2-4
94342 Strasskirchen
Germany

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 ° C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 /11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the MIKES BABT Product Service GmbH quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

4.4 Measurement Protocol for FCC, VCCI and AUSTEL

4.4.1 GENERAL INFORMATION

4.4.1.1 Test Methodology

Conducted and radiated disturbance testing is performed according to the procedures in International Special Committee on Radio Interference (CISPR) Publication 22 (1997), European Standard EN 55022 and Australian Standard AS 3548 (which are based on CISPR 22).

The Japanese standard, "Voluntary Control Council for Interference (VCCI) by Data Processing Equipment and Electronic Office Machines, Technical Requirements" is technically equivalent to CISPR 22 (1997). For official compliance, a conformance report must be sent to and accepted by the VCCI.

In compliance with FCC Docket 92-152, "Harmonization of Rules for Digital Devices Incorporate International Standards", testing for FCC compliance may be done following the ANSI C63.4-2003 procedures and using the CISPR 22 Limits.

4.4.1.2 Measurement Error

The data and results referenced in this document are true and accurate. The reader is cautioned that there is some measurement variability due to the tolerances of the test equipment that can contribute to a nominal product measurement uncertainty. The measurement uncertainty was calculated for all measurements listed in this test report according to NIS 81/5.1994 "The treatment of uncertainty in EMC measurements" and is documented in the MIKES BABT Product Service GmbH quality system according to DIN EN ISO/IEC 17025. Furthermore, component differences and manufacturing process variability of production units similar to that tested may result in additional product uncertainty. If necessary, refer to the test lab for the actual measurement uncertainty for specific tests. The manufacturer has the sole responsibility of continued compliance of the device.

4.4.1.3 Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral into its characteristic impedance or left unterminated. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum disturbances from the unit.

4.4.2 DETAILS OF TEST PROCEDURES

4.4.2.1 General Standard Information

The test methods used comply with CISPR Publication 22 (1997), EN 55022 (2001) and AS 3548 (1992) - "Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment" and with 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."

4.4.2.2 Conducted disturbance

Conducted disturbance on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi peak detection, and a Line Impedance Stabilization Network (LISN), with 50Ω/50 μH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum passing margin appears to be less than 20 dB with a peak mode measurement, the emissions are remeasured using a tuned receiver with quasi peak and average detection and recorded on the data sheets.

4.4.2.3 Radiated disturbance

Radiated disturbance from the EUT are measured in the frequency range of 30 to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi peak detection and measurements above 1000 MHz are made with a 1 MHz/6 dB bandwidth and average detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna was positioned 3, 10 or 30 meters horizontally from the EUT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarizations and the EUT are rotated 360 degrees.

5 TEST CONDITIONS AND RESULTS

5.1 Conducted emissions

For test instruments and accessories used see section 6 Part A 4.

5.1.1 Description of the test location

Test location:

5.1.2 Photo documentation of the test set-up

5.1.3 Test result

Frequency range:

Min. limit margin

The requirements are

Remarks: The measurement is not applicable.

5.2 Radiated power of the fundamental wave

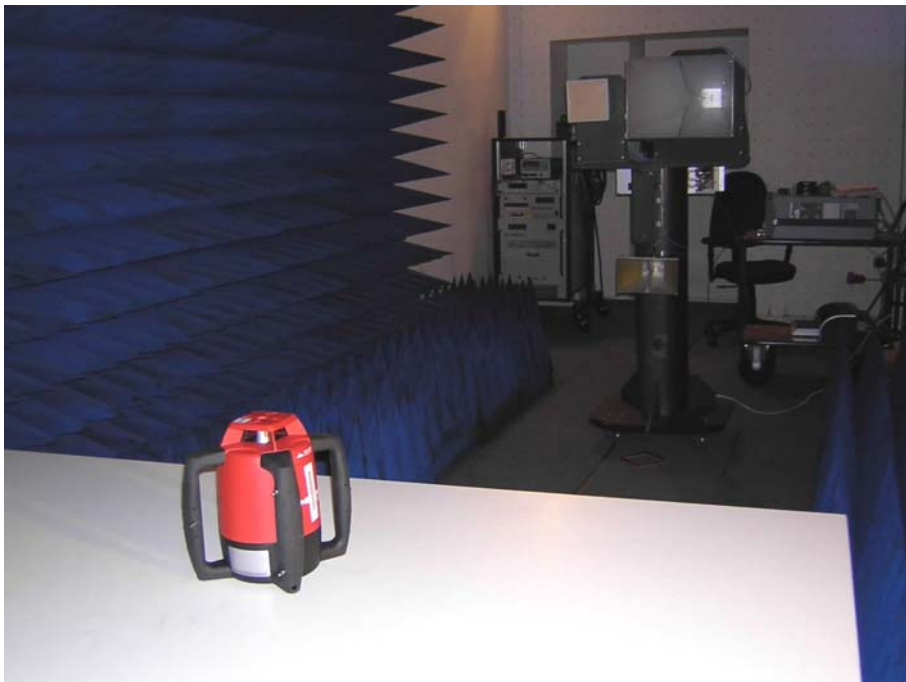
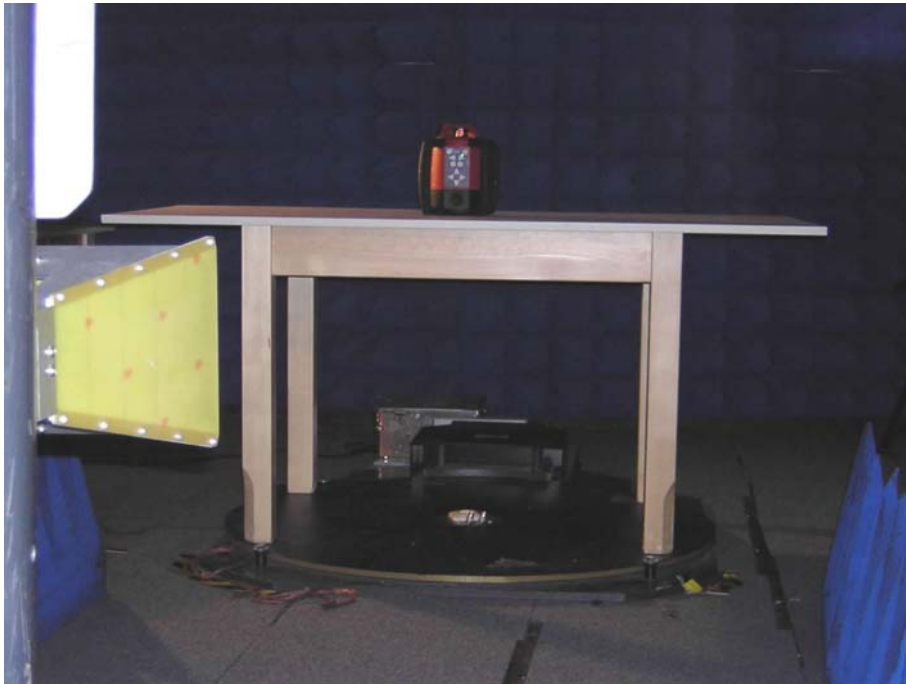
For test instruments and accessories used see section 6 Part CPR 3.

5.2.1 Description of the test location

Test location: Anechoic Chamber A2

Test distance: 3 metres

5.2.2 Photo documentation of the test set-up



5.2.3 Test result

Frequency [MHz]	L: PK [dBµV]	Corr. Duty Cycle [dB]	L: AV [dBµV]	Band width [kHz]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	Limit AV [dBµV/m]	Delta [dB]
2402.30	102.1	-33.68	68.42	1000	-10.9	91.2	57.52	94.0	-36.48

Average-Limit according to FCC Subpart 15.249(a)

Frequency [MHz]	Fieldstrength of fundamental		Fieldstrength of spurious emissions	
	[mV/m]	[dBµV/m]	[µV/m]	[dBµV/m]
902-928	50	94	500	54
2400-2483.5	50	94	500	54
5725-5875	50	94	500	54

Peak-Limit according to FCC Subpart 15.249(a), Subpart 15.249(e)

Frequency [MHz]	Fieldstrength of fundamental		Fieldstrength of spurious emissions	
	[mV/m]	[dBµV/m]	[µV/m]	[dBµV/m]
902-928	500	114	5000	74
2400-2483.5	500	114	5000	74
5725-5875	500	114	5000	74

The requirements are **FULFILLED**.

Remarks:

5.3 Radiated emissions (electric field) 30 MHz – 40 GHz

For test instruments and accessories used see section 6 Part SER 2, SER 3.

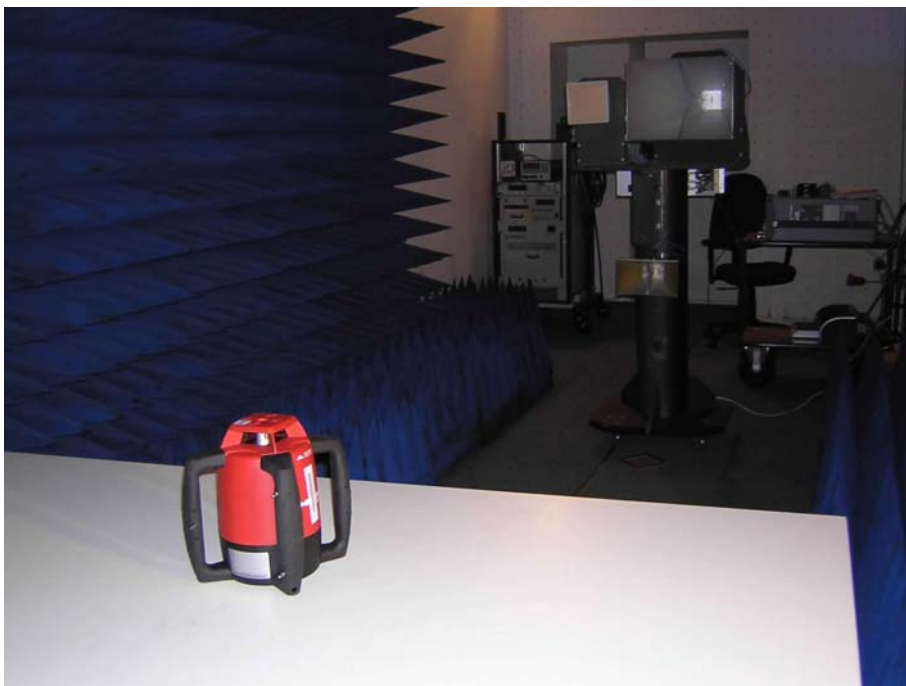
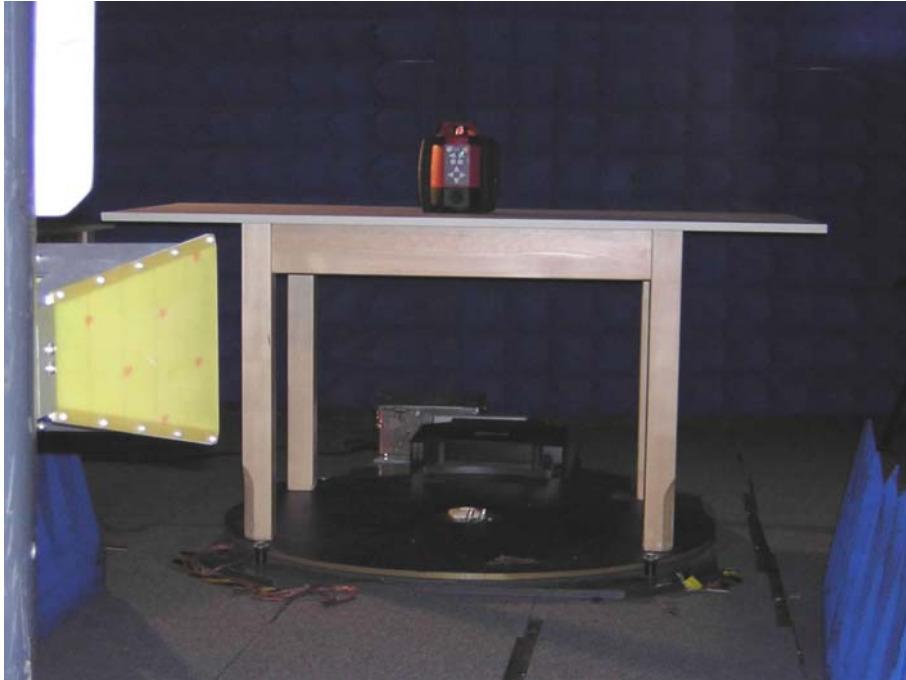
5.3.1 Description of the test location

Test location: Anechoic Chamber A2
OATS1

Test distance: 3 metres

5.3.2 Photo documentation of the test set-up





5.3.3 Test result

Testresult in detail:(<1GHz)

Frequency [MHz]	L: QP [dBµV]	L: AV [dBµV]	Bandwidth [kHz]	Correct. [dB]	L: QP [dBµV/m]	L: AV [dBµV/m]	Limit [dBµV/m]	Delta [dB]
25-1000	< 30		120					

Testresult in detail:(>1GHz)

Frequency [MHz]	L: PK [dBµV]	Corr. Duty Cycle [dB]	L: AV [dBµV]	Band width [kHz]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	Limit AV [dBµV/m]	Delta [dB]
4807.62	63.7	-33.68	30.02	1000	-3.8	59.9	26.22	54.00	-27.78
7202.40	62.1	-33.68	28.42	1000	-1.6	60.5	26.82	54.00	-27.18
9607.21	61.2	-33.68	27.52	1000	3.7	64.9	31.22	54.00	-22.78
14416.83	50.2	-33.68	16.32	1000	10.4	60.6	26.72	54.00	-27.28

Average-Limit according to FCC Subpart 15.249(a)

Frequency [MHz]	Fieldstrength of fundamental		Fieldstrength of spurious emissions	
	[mV/m]	[dBµV/m]	[µV/m]	[dBµV/m]
902-928	50	94	500	54
2400-2483.5	50	94	500	54
5725-5875	50	94	500	54

Peak-Limit according to FCC Subpart 15.249(a), Subpart 15.249(e)

Frequency [MHz]	Fieldstrength of fundamental		Fieldstrength of spurious emissions	
	[mV/m]	[dBµV/m]	[µV/m]	[dBµV/m]
902-928	500	114	5000	74
2400-2483.5	500	114	5000	74
5725-5875	500	114	5000	74

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50dB below the level of the fundamental or to the general radiated emission limits in paragraph 15.209, whichever is the lesser attenuation.

Frequency [MHz]	50dB below of the fundamental [dBµV/m]	15.209 Limits [dBµV/m]	General Radiated Limits [dBµV/m]
30-88	41.20	40	41.20
88-216	41.20	43,5	43.50
216-960	41.20	46	46.00
Above 960	41.20	54	54.00

Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209

MHz	MHz	GHz
25.5 – 25.67	960 – 1240	4.5 – 5.15
37.5 – 38.25	1300 – 1427	5.35 – 5.46
73 – 74.6	1435 – 1626.5	7.25 – 7.75
74.8 – 75.2	1645.5 – 1646.5	8.025 – 8.5
108 – 121.94	1660 – 1710	9.0 – 9.2
123 – 138	1718.8 – 1722.2	9.3 – 9.5
149.9 – 150.05	2200 – 2300	10.6 – 12.7
156.52475 – 156.52525	2310 – 2390	13.25 – 13.4
156.7 – 156.9	2483.5 – 2500	14.47 – 14.5
162.0125 – 167.17	2655 – 2900	15.35 – 16.2
167.72 – 173.2	3260 – 3267	17.7 – 21.4
240 – 285	3332 – 3339	22.01 – 23.12
322 – 335.4	3345.8 – 3358	23.6 – 24.0
399.9 – 410	3600 – 4400	31.2 – 31.8
608 – 614		36.43 – 36.5

The requirements are **FULFILLED**.

Remarks: During the test, the EuT was set into continuous transmitting mode.

The measurement was performed up to the 10th harmonic (24000 MHz).

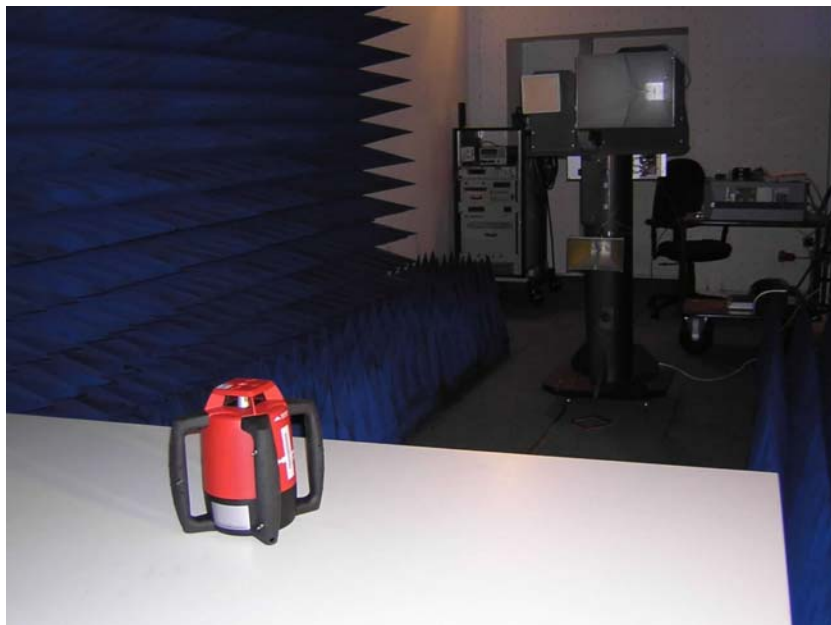
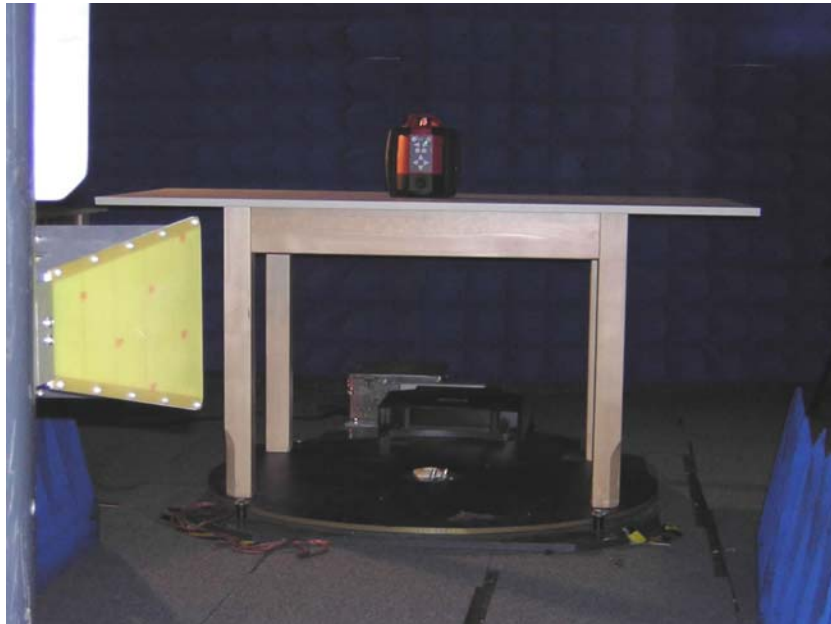
5.4 Emission radiated outside of emission mask

For test instruments and accessories used see section 6 Part MB.

5.4.1 Description of the test location

Test location: Anechoic Chamber A2

5.4.2 Photo documentation of the test set-up



5.4.3 Test result

Frequency of lower band edge [MHz]	Reading level [dBμV]	Correct. factor [dB]	Field strength corr. [dBμV/m]	Limit [dBμV/m]	Dlimit [dB]
2400,00	38,8	-10,9	27,9	54,0	-26,1

Limit according to FCC Part 15.249(d)

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 or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

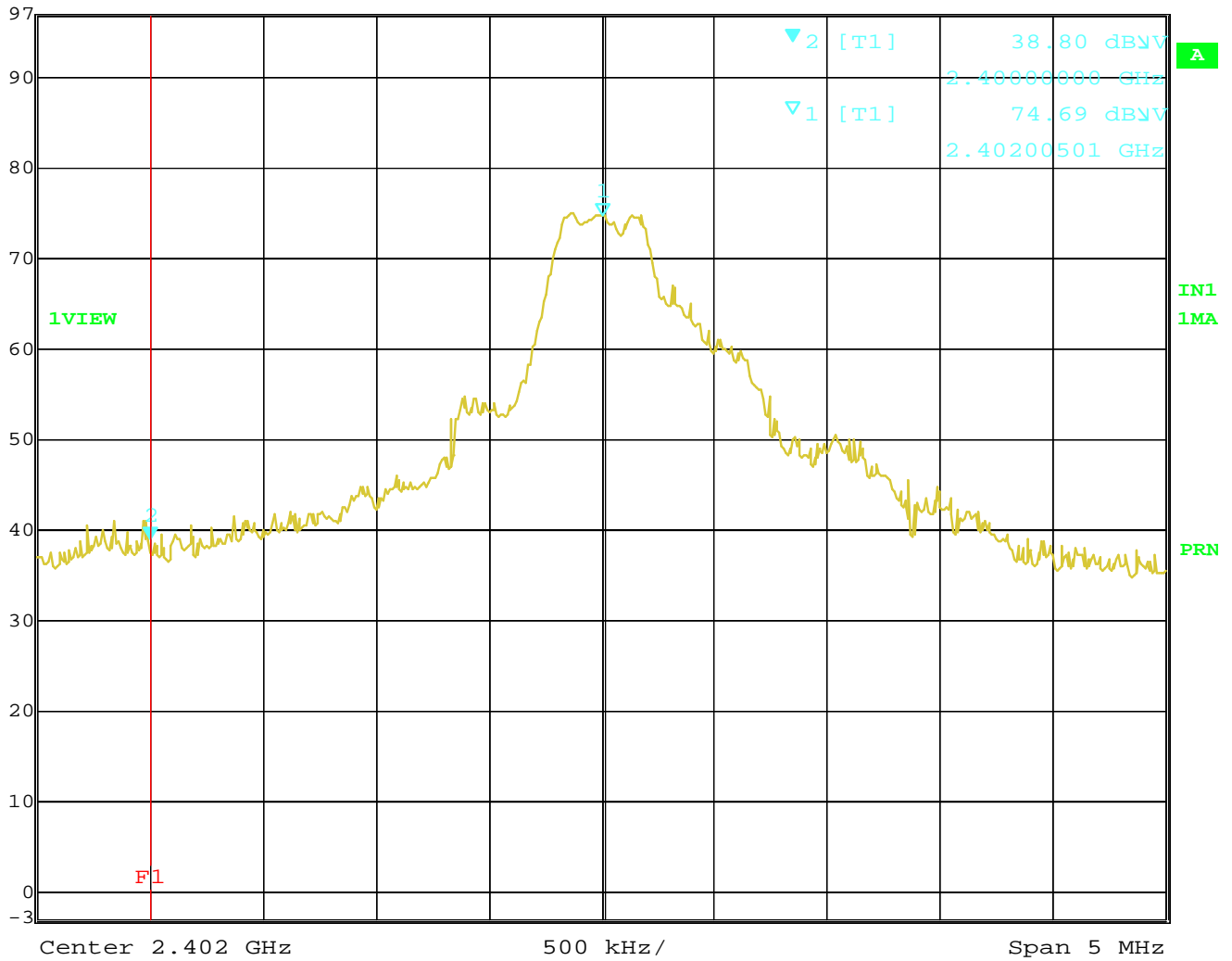
The requirements are **FULFILLED**.

Remarks: All emissions outside of the specified frequency bandwidth will be assessed in measurement
radiated emissions (electric field) 30 MHz – 40 GHz.
For detailed results, please see the following page(s).

5.4.4 Test protocol

Band edge measurement
FCC Part 15.249(d)

Ref Lvl 97 dBV
Marker 2 [T1] 38.80 dBV
2.40000000 GHz
RBW 100 kHz
RF Att 0 dB
VBW 100 kHz
SWT 5 ms
Unit dBV



Date: 4.FEB.2005 12:05:11

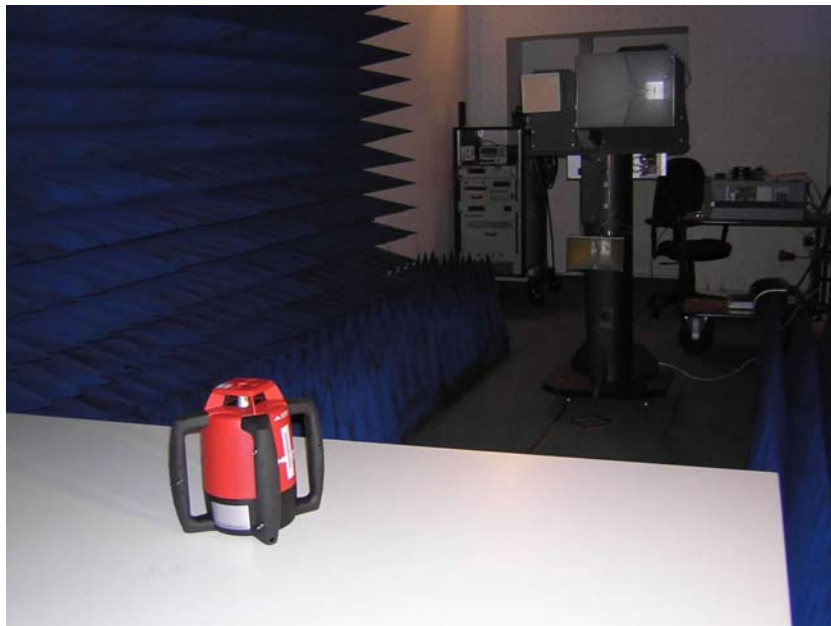
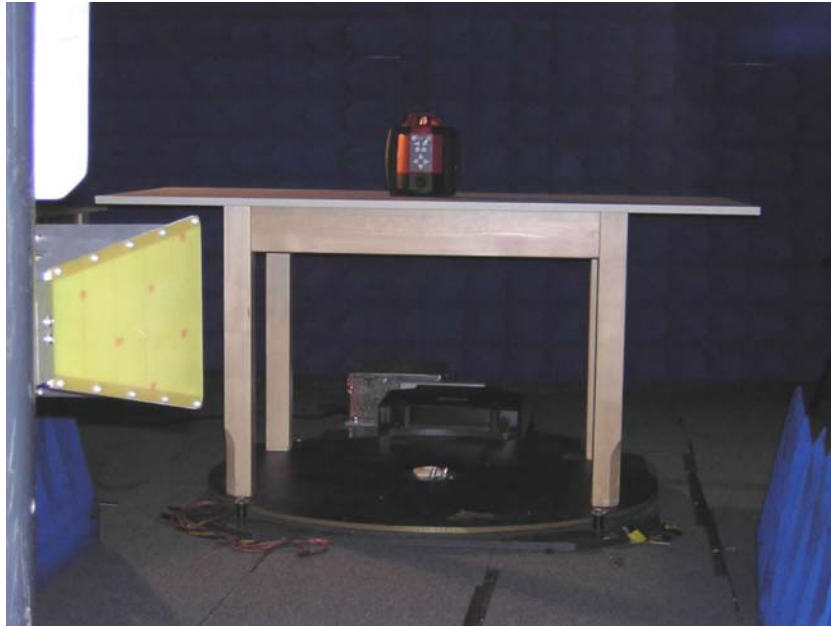
5.5 Correction for Pulse Operation (Duty Cycle)

For test instruments and accessories used see section 6 Part DC.

5.5.1 Description of the test location

Test location: Anechoic Chamber A2

5.5.2 Photo documentation of the test set-up



5.5.3 Description of Measurement

The Duty cycle factor, expressed in dB, is arrived by taking the following formula:

$$KE = 20 \log [(t_{iB} \cdot p) / T_w]$$

KE: pulse operation correction factor [dB]
 t_{iw} : pulse duration for one complete pulse track [msec]
 t_{iB} : pulse duration for one pulse [μ sec]
 T_w : a period of the pulse track [msec]
 p : number of pulses in one train

5.5.4 Test result

t_{iw} [msec]	T_w [msec]	t_{iB} [μ sec]	p	KE [dB / %]
28.3	100.4	413.8	5	-33,68 / 2,07

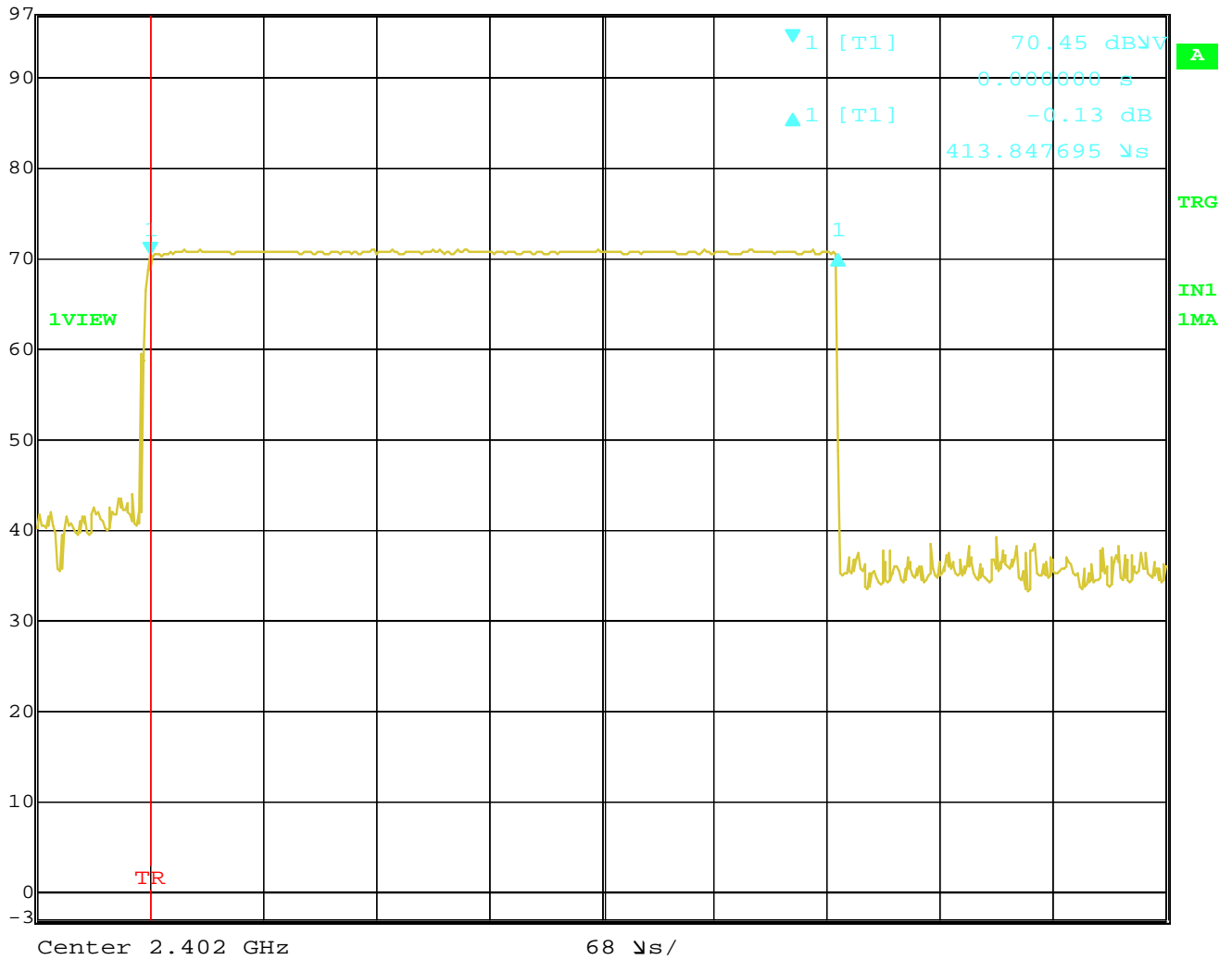
Remarks: The pulse train [T_w] exceeds 100 ms, therefore the duty cycle have been calculated by averaging the sum of the pulsewidths over the 100 ms width with the highest average value
For detailed results, please see the test protocol below.

5.5.5 Test protocol

Correction for Pulse Operation (Duty Cycle) FCC Part 15 Subpart 15.35(c)



Ref Lvl	Delta 1 [T1]	RBW	1 MHz	RF Att	0 dB
97 dBμV	-0.13 dB	VBW	1 MHz		
	413.847695 μs	SWT	680 μs	Unit	dBμV

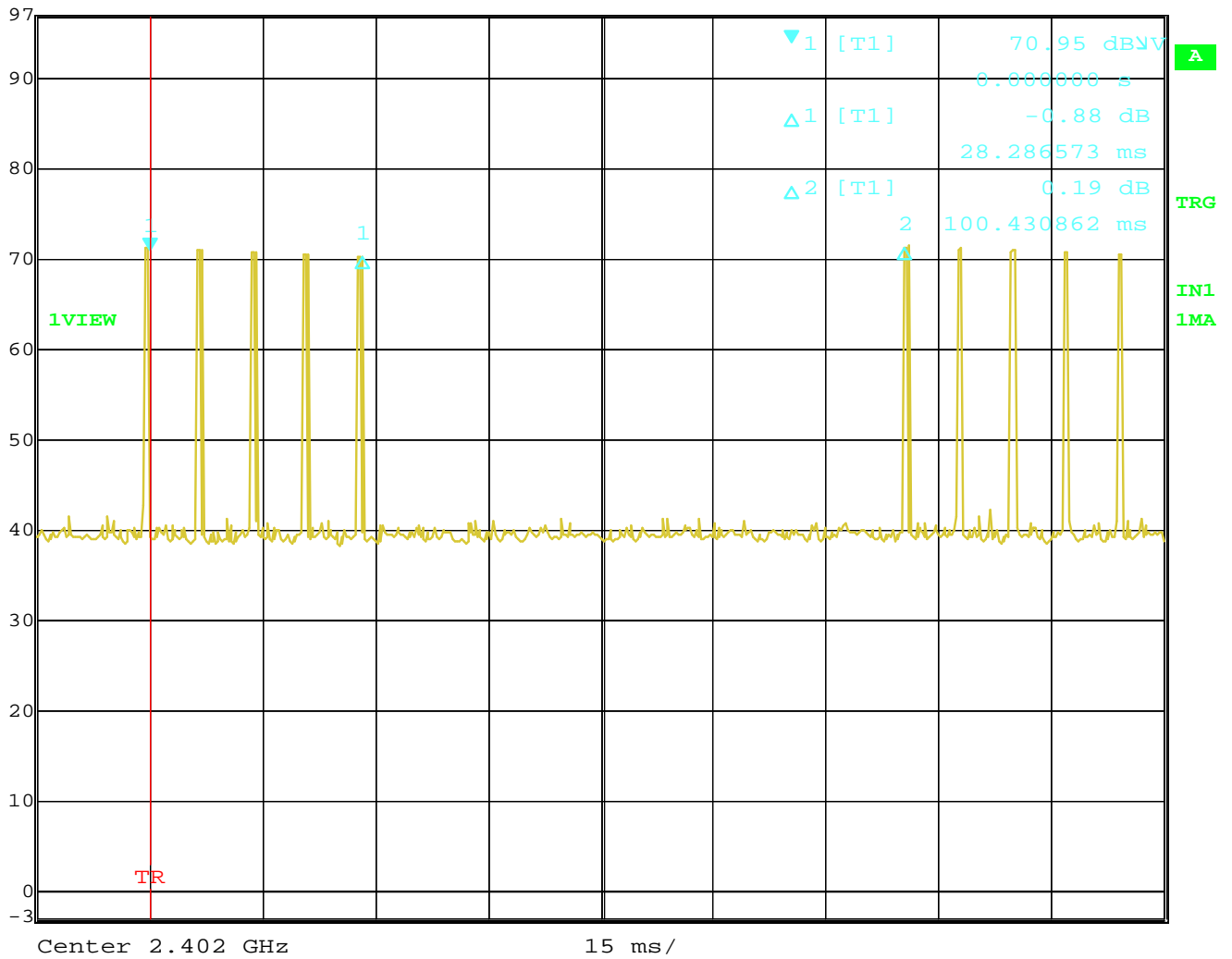


Date: 15.NOV.2004 13:05:25

Correction for Pulse Operation (Duty Cycle)
FCC Part 15 Subpart 15.35(c)



Ref Lvl	Marker 1 [T1]	RBW	1 MHz	RF Att	0 dB
97 dBμV	70.95 dBμV	VBW	1 MHz		
	0.000000 s	SWT	150 ms	Unit	dBμV



Date: 15.NOV.2004 12:02:20

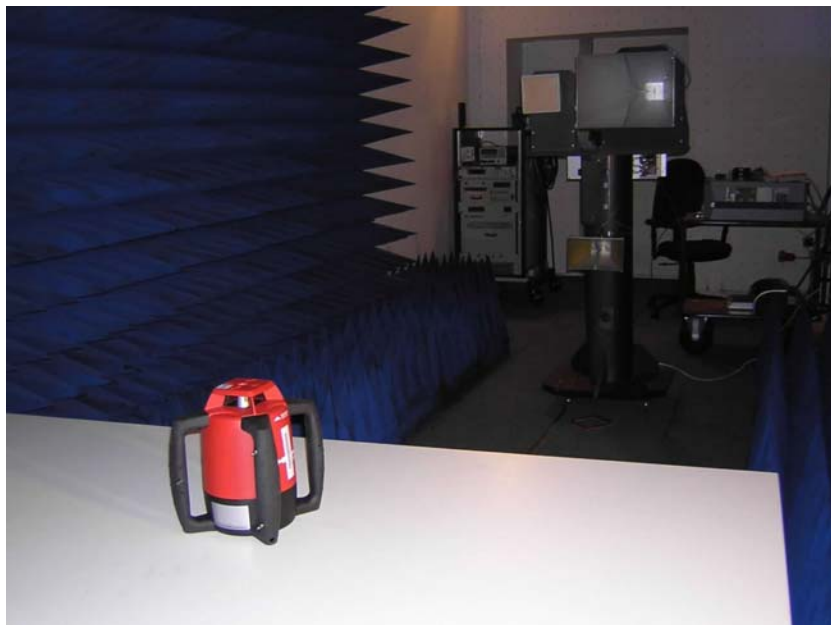
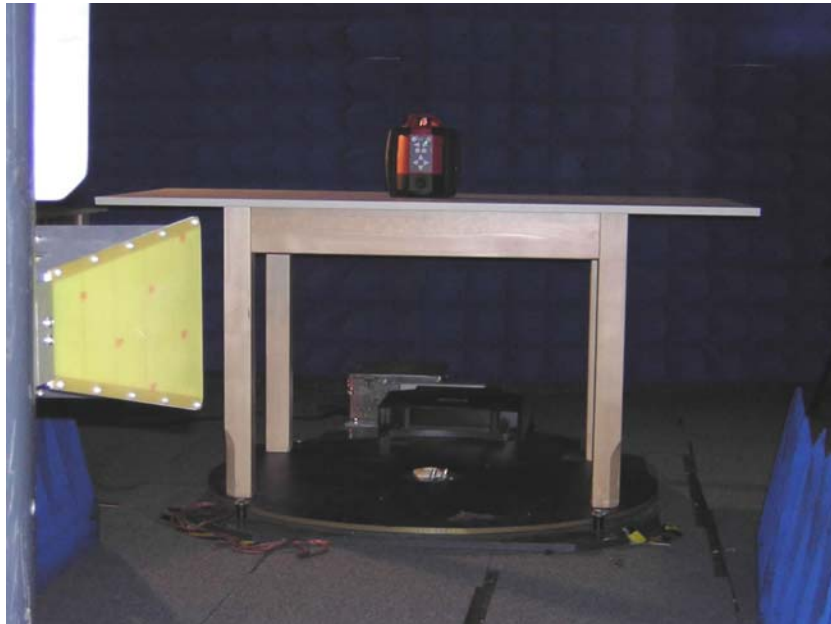
5.6 20dB Bandwidth Measurement

For test instruments and accessories used see section 6 Part MB.

5.6.1 Description of the test location

Test location: Anechoic Chamber A2

5.6.2 Photo documentation of the test set-up



5.6.3 Test result

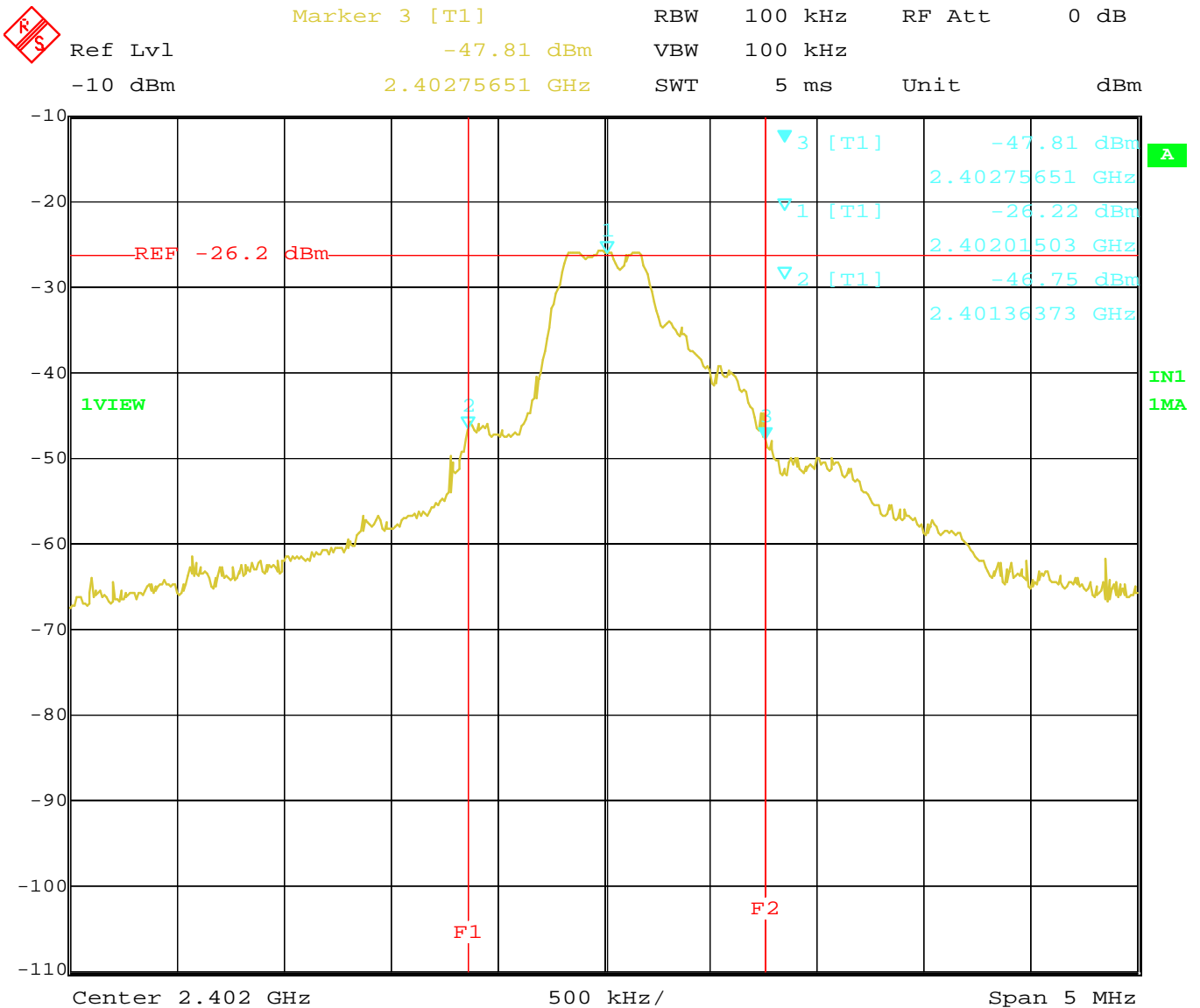
Fundamental Frequency [MHz]	20 dB BANDWIDTH (MHz)
2402,00	1,39

The requirements are **FULFILLED**.

Remarks: For detailed results, please see the following page(s).

5.6.4 Test protocol

20dB Bandwidth Measurement



Date: 2.FEB.2005 17:12:35

5.7 Receiver conducted disturbances 0.15 – 30 MHz

For test instruments and accessories used see section 6 Part A 4.

5.7.1 Description of the test location

Test location:

5.7.2 Photo documentation of the test set-up

5.7.3 Test result

Frequency range:

Min. limit margin

The requirements are

Remarks: The measurement is not applicable.

5.8 Receiver radiated emissions (electric field) 30 MHz - 40 GHz

For test instruments and accessories used see section 6 Part SER2 and SER3.

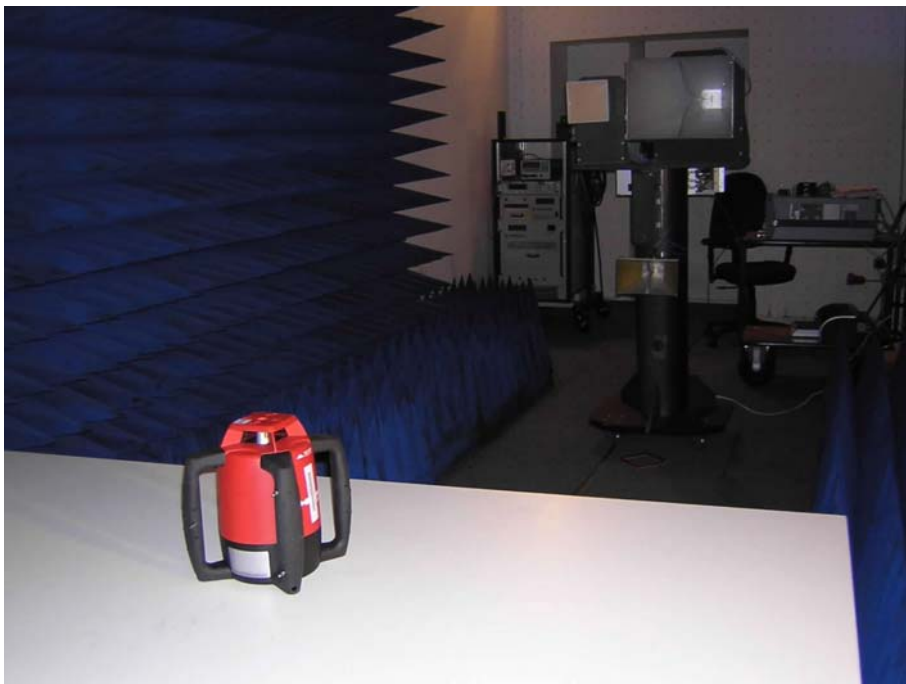
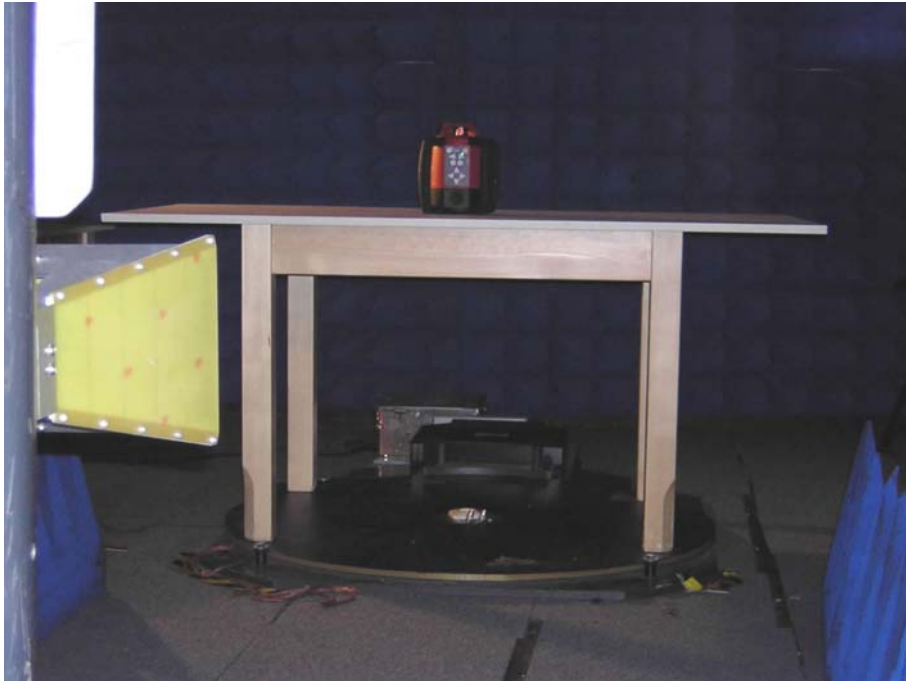
5.8.1 Description of the test location

Test location: Anechoic Chamber A2
OATS1

Test distance: 3 metres

5.8.2 Photo documentation of the test set-up





5.8.3 Test result

Test result <1GHz

Frequency [MHz]	L: PK [dBµV]	L: QP [dBµV]	Bandwidth [kHz]	Correct. [dB]	L: PK [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
25 - 1000	< 30		120					

5.8.4 Test result >1GHz

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	Bandwidth [kHz]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	Limit [dBµV/m]	Delta [dB]
2743.49	56.2		1000	-9.0	47.2		54.0	-6.8

Limit according to FCC Subpart 15.109(a)

Frequency of emission [MHz]	Field strength Limits [µV/m]	Field strength Limits [dBµV/m]
30-88	100	40
88-216	150	44
216-960	200	46
Above 960	500	54

The requirements are **FULFILLED**.

Remarks: The Limits are met.

During the test, the Eut was set into continuous receiving mode.

The measurement was performed up to the 5th harmonic (12000 MHz).

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used, in addition to the test accessories, are calibrated and verified regularly.

Test ID	Model / Type	Kind of Equipment	Manufacturer	Equipment No.
CPR3	SM 01	Switchmatrix 1-18 GHz	MBPS GmbH	04-07/60-04-215
	N2000SMA	RF Cable 18 GHz	Huber+Suhner	04-07/60-04-222
	N1000SMA	RF Cable 18 GHz	Huber+Suhner	04-07/60-04-225
	Model 3115	Horn Antenna	EMCO Elektronik GmbH	04-07/62-03-003
DC	SM 01	Switchmatrix 1-18 GHz	MBPS GmbH	04-07/60-04-215
	N2000SMA	RF Cable 18 GHz	Huber+Suhner	04-07/60-04-222
	N1000SMA	RF Cable 18 GHz	Huber+Suhner	04-07/60-04-225
	Model 3115	Horn Antenna	EMCO Elektronik GmbH	04-07/62-03-003
SER2	Sucofeed 7/8	RF Cable	Huber+Suhner	04-07/60-04-089
	NW-2000-NB	RF Cable	MBPS GmbH	04-07/60-04-205
	EF393-21N-15m	RF Cable	Huber+Suhner	04-07/60-04-258
	VULB 9165	Super Broadband Antenn	Schwarzbeck Mess-Elektronik	04-07/62-00-001
	ESVS 30	Test Receiver	Rohde & Schwarz München	04-07/63-04-001
SER3	SM 01	Switchmatrix 1-18 GHz	MBPS GmbH	04-07/60-04-215
	N2000SMA	RF Cable 18 GHz	Huber+Suhner	04-07/60-04-222
	N1000SMA	RF Cable 18 GHz	Huber+Suhner	04-07/60-04-225
	Model 3115	Horn Antenna	EMCO Elektronik GmbH	04-07/62-03-003