



EMI -- TEST REPORT

Test Report No. : T 24899-00-01XF	05. August 2004 <hr style="border: 0; border-top: 1px solid black; margin: 0;"/> Date of issue
---	---

Type / Model : PRA 25

Model Description : Laserdetector

Applicant : Hilti Corporation

Address : Feldkircherstrasse 100
FL-9494 Schaan, Principality of Liechtenstein

Manufacturer : KOSTAL Industrie Elektronik GmbH

Address : Hauert 11,
D-44227 Dortmund, Germany

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.

Contents

1	<u>TEST STANDARDS</u>	3
2	<u>SUMMARY</u>	4
3	<u>EQUIPMENT UNDER TEST</u>	5
3.1	PHOTO DOCUMENTATION OF THE EUT	5
3.2	POWER SUPPLY SYSTEM UTILISED	13
3.3	SHORT DESCRIPTION OF THE EQUIPMENT UNDER TEST (EUT)	13
4	<u>TEST ENVIRONMENT</u>	14
4.1	ADDRESS OF THE TEST LABORATORY	14
4.2	ENVIRONMENTAL CONDITIONS	14
4.3	STATEMENT OF THE MEASUREMENT UNCERTAINTY	14
4.4	MEASUREMENT PROTOCOL FOR FCC, VCCI AND AUSTEL	14
5	<u>TEST CONDITIONS AND RESULTS OF TRANSMITTER PART</u>	17
5.1	CONDUCTED DISTURBANCE (SUBPART 15.207)	17
5.2	RADIATED POWER OF THE FUNDAMENTAL WAVE (SUBPART 15.249)	18
5.3	RADIATED EMISSIONS (ELECTRIC FIELD) 30 MHz - 24 GHz (SUBPART 15.249)	20
5.4	CORRECTION FOR PULSE OPERATION (DUTY CYCLE) (SUBPART 15.35(c))	23
6	<u>TEST CONDITIONS AND RESULTS OF RECEIVER PART</u>	25
6.1	CONDUCTED DISTURBANCE (SUBPART 15.107)	25
6.2	RADIATED EMISSIONS (ELECTRIC FIELD) 30 MHz - 24 GHz (SUBPART 15.109)	26
7	<u>USED TEST EQUIPMENT AND ACCESSORIES</u>	29

1 TEST STANDARDS

The tests were performed according to following standards:

- Part 15 Subpart C (15.249) Radio Frequency Devices Subpart C for intentional Radiators operating within the bands 902-928 MHz, 2400-2483,5 MHz, 5725-5875MHz and 24,0-24,25GHz.

- Part 15 Subpart B (15.109) Radio Frequency Devices Subpart B for unintentional Radiators

2 SUMMARY

GENERAL REMARKS:

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

FINAL ASSESSMENT:

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

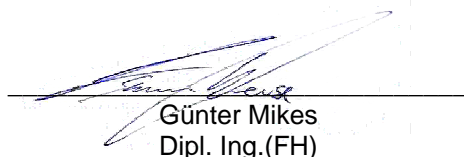
Date of receipt of test sample : acc. to storage records of MBPS

Testing commenced on : July 01, 2004

Testing concluded on : July 02, 2004

Checked by:

Tested by:


Günter Mikes
Dipl. Ing.(FH)


Xaver Fischer

3 EQUIPMENT UNDER TEST

3.1 Photo documentation of the EuT

Laserdetector PRA25

T24899-00-01XF

External Photo
Rear view

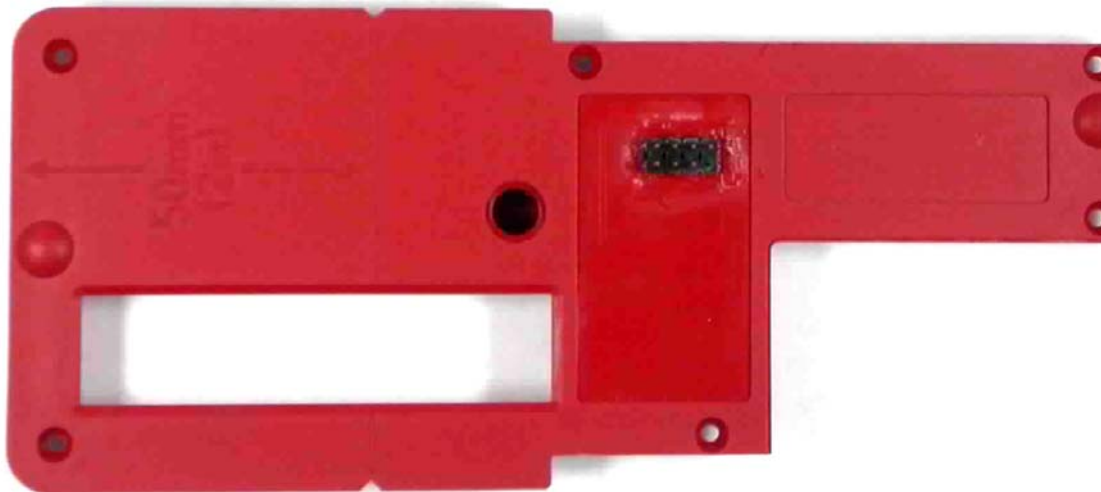


External Photo
Front view



Laserdetector PRA25
T24899-00-01XF

Internal Photo
Open view

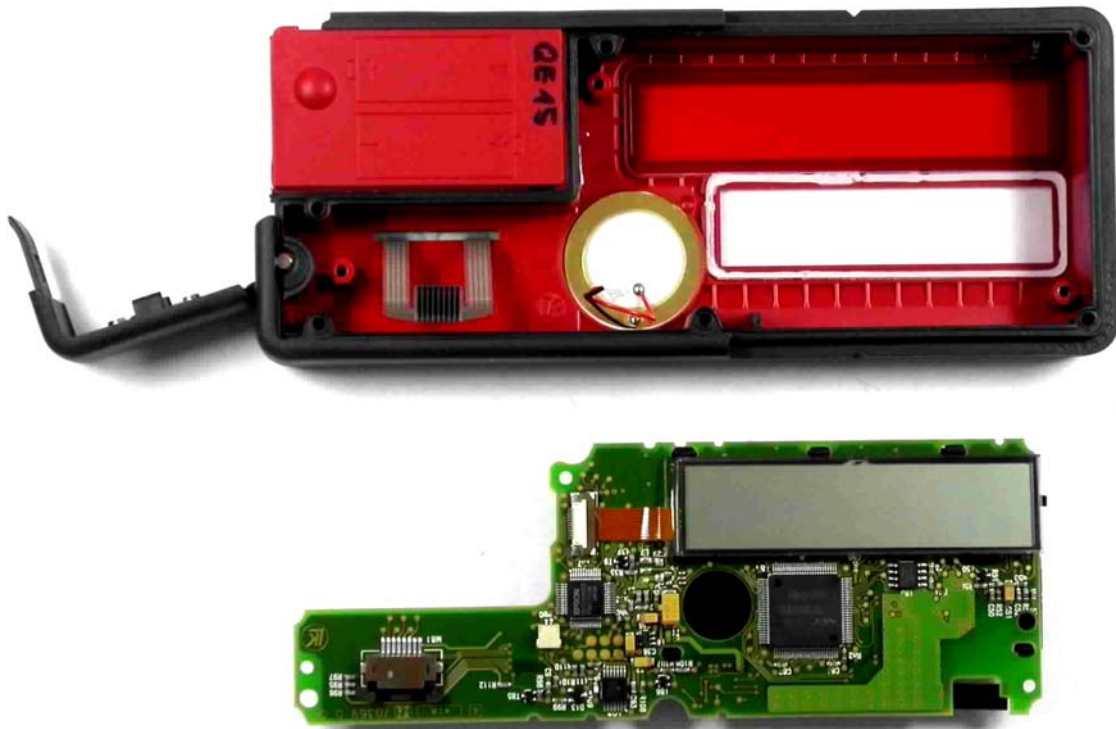


Laserdetector PRA25
T24899-00-01XF

Internal Photo
Open view

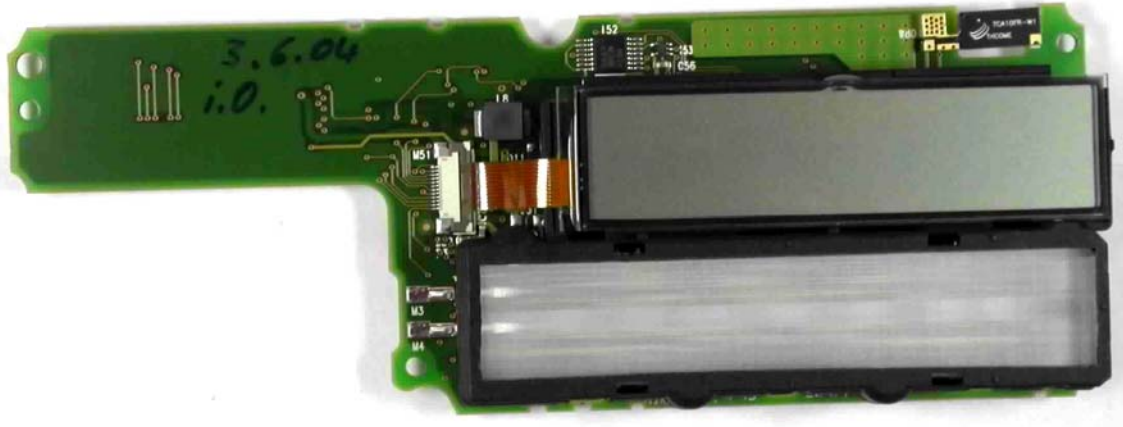


Internal Photo
Open view



Laserdetector PRA25
T24899-00-01XF

Internal Photo
Front view PCB

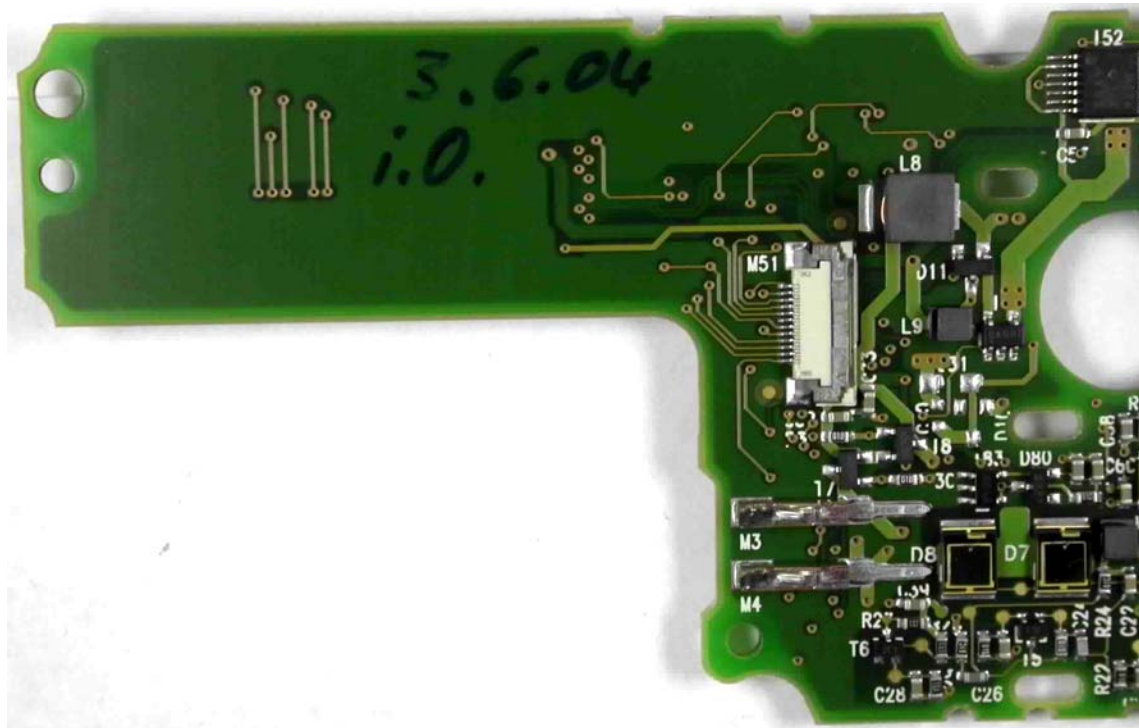


Internal Photo
Front view of PCB (without Display)



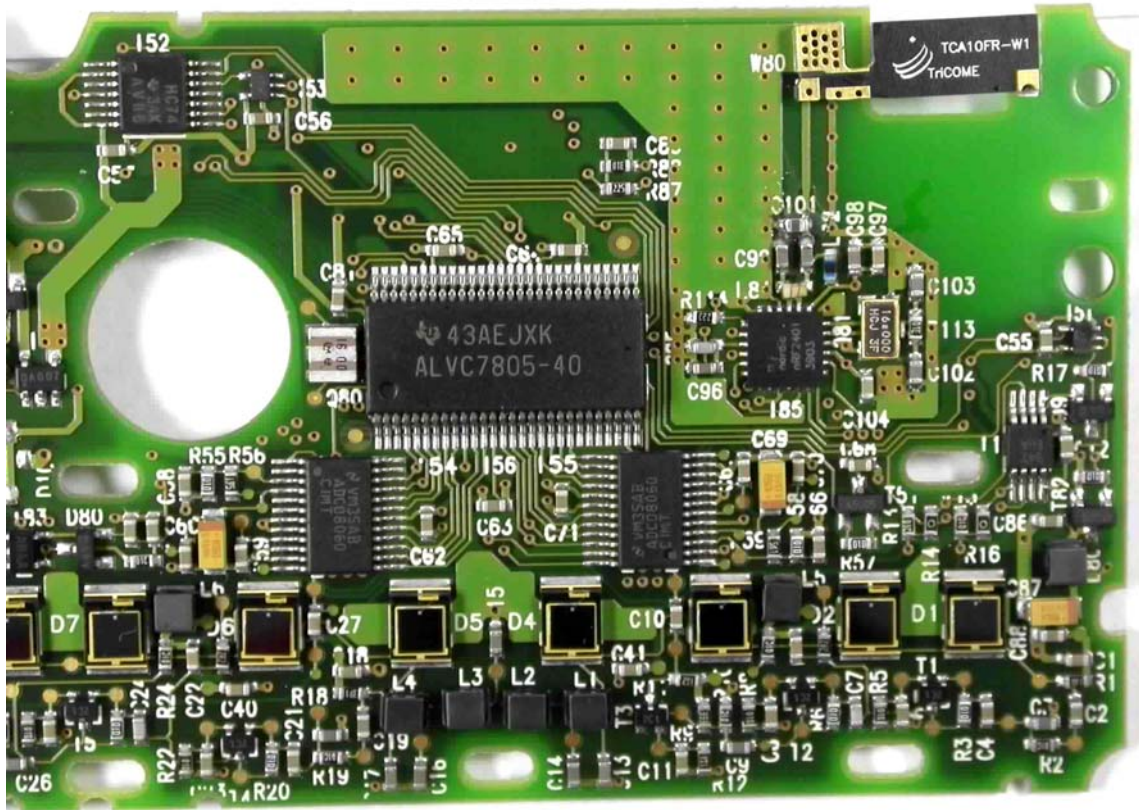
Laserdetector PRA25
T24899-00-01XF

Internal Photo
Part of Front view PCB



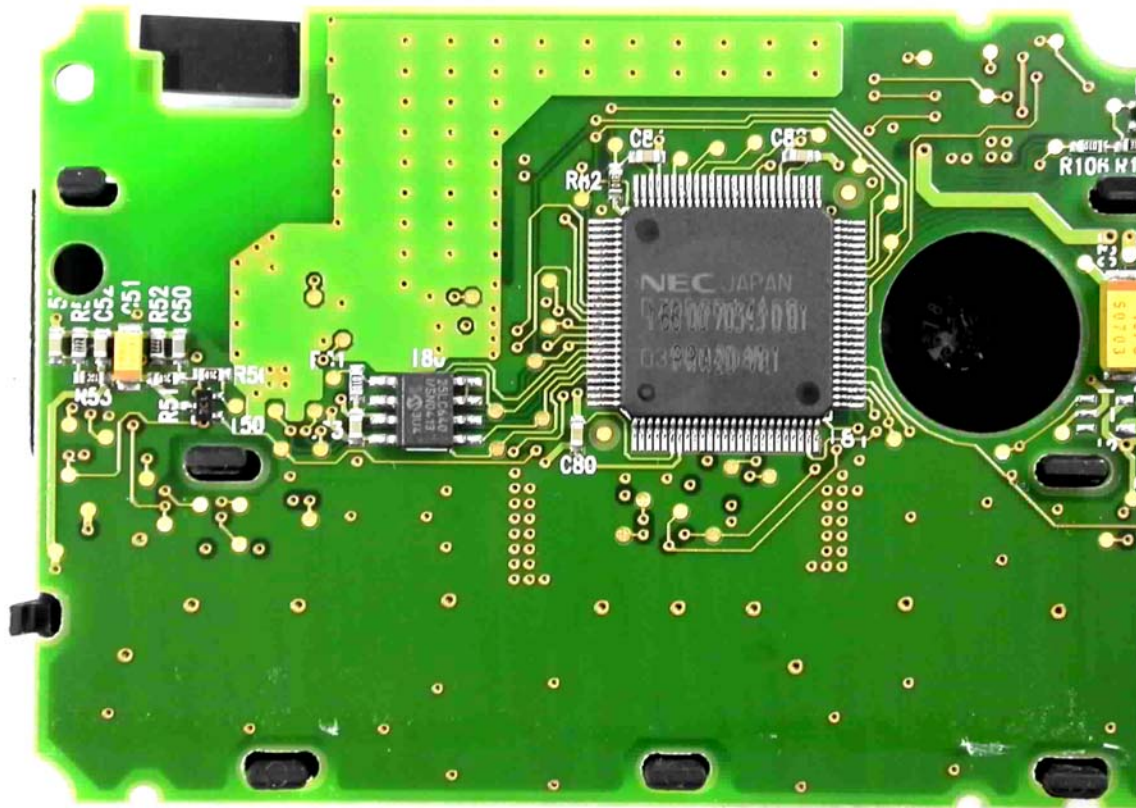
Laserdetector PRA25
T24899-00-01XF

Internal Photo
Part of Front view PCB



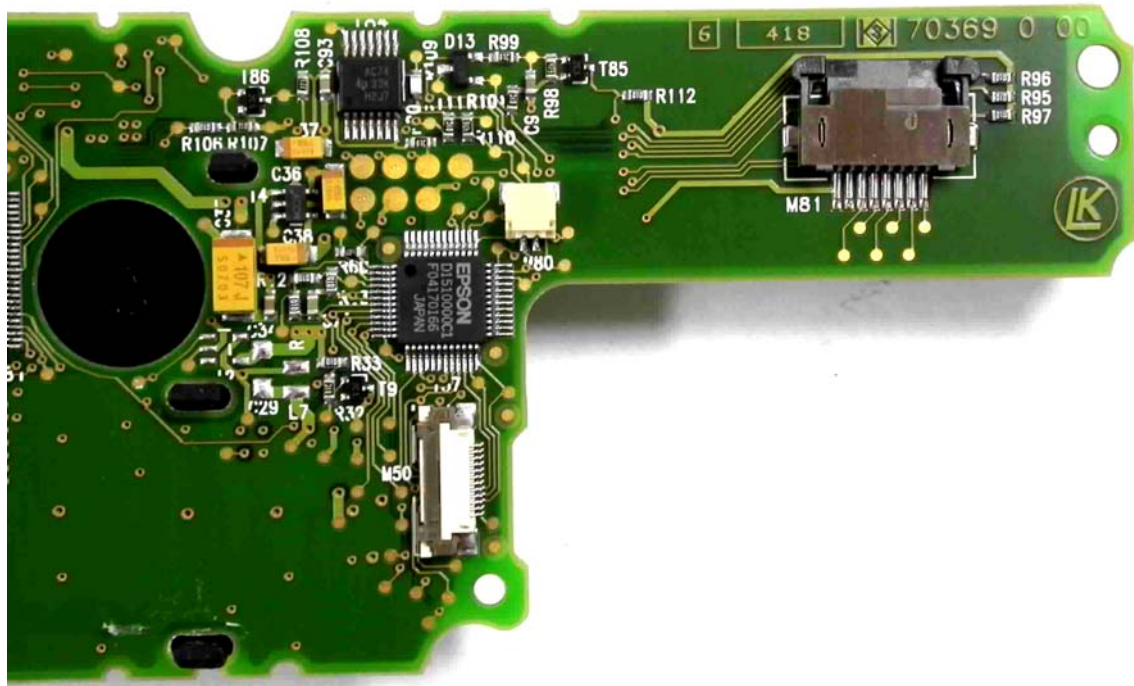
Laserdetector PRA25
T24899-00-01XF

Internal Photo
Part of Rear view PCB



Laserdetector PRA25
T24899-00-01XF

Internal Photo
Part of Rear view PCB



3.2 Power supply system utilised

Power supply voltage : 3V DC

3.3 Short description of the Equipment under Test (EuT)

The EuT is a Laserdetector and remote control for leveling and alignment tools.

Number of tested samples: 1
Serial number: Prototype

EuT operation mode:

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

- Transmitting mode continuously _____
- Receiving mode continuously _____
- Operation mode as intended use _____

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:

- _____ Model : _____
- _____ Model : _____
- _____ Model : _____
- _____ Model : _____
- _____ Model : _____
- _____ Model : _____

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

**MIKES BAPT Product Service GmbH
Ohmstrasse 2-4
D - 94342 Strasskirchen**

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 BAPT 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 (1993), 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 (1993). 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 C63.4-1992 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 it's 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 CONDUCTED DISTURBANCE

The final level, expressed in dBµV, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the CISPR limit, which is equivalent to the Australian AS 3548 limit.

To convert between dBµV and µV, the following conversions apply:

$$dB\mu V = 20(\log \mu V)$$

$$\mu V = \text{Inverse log}(dB\mu V/20)$$

4.4.3 RADIATED DISTURBANCE

The final level, expressed in dBµV/m, is arrived at by taking the reading from the EMI receiver (Level dBµV) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This is done automatically in the EMI receiver, where the correction factor are stored. This result then has the CISPR limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets at page 24 - 25. The CISPR 22 limit is equivalent to the Australian AS 3548 limit.

Example:	CISPR B	Delta							
Frequency	Level	+	Factor	=	Final	-	Limit	=	CISPR B
(MHz)	(dBµV)	(dB)	(dBµV/m)		(dBµV/m)	(dB)			
37.19	10.2	+	12.0	=	22.2	-	40.0	=	-17.8

4.4.4 DETAILS OF TEST PROCEDURES

4.4.4.1 General Standard Information

The test methods used comply with CISPR Publication 22 (1993), EN 55022 (1987) and AS 3548 (1992) - "Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment" and with ANSI C63.4-1992 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."

4.4.4.2 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 50 Ω /50 μ H (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.

4.4.4.3 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 OF TRANSMITTER PART

5.1 Conducted disturbance

(Subpart 15.207)

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: 0.15 MHz - 30 MHz

Min. limit margin >5 dB at 0.15 - 30 MHz

The requirements are **FULFILLED**.

Remarks: The measurement is not applicable.

5.1.4 Test protocol

5.2 Radiated Power of the fundamental wave

(Subpart 15.249)

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: 3m

5.2.2 Photo documentation of the test set-up



5.2.3 Test result

Rated output power level (maximum)

0,0 dBm

Polarisation of the measurement for the larger receiver level

Horizontal

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]
2402,80	106,10	-33,76	72,34	1000	-10,90	95,20	61,44	94,0	-32,56

Limit according to FCC Subpart 15.249(a)

Frequency (MHz)	Fieldstrength of fundamental		Fieldstrength of spurious emissions**	
	(µV/m)	dB (µV/m)	(µV/m)	dB (µV/m)
2400-2483,5	50000	94,0 (Average)	500	54,0 (Average)
		114,0 (Peak)		74,0 (Peak)

The requirements are **FULFILLED**.

Remarks: The limits are met.

5.3 Radiated emissions (electric field) 30 MHz - 24 GHz

(Subpart 15.249)

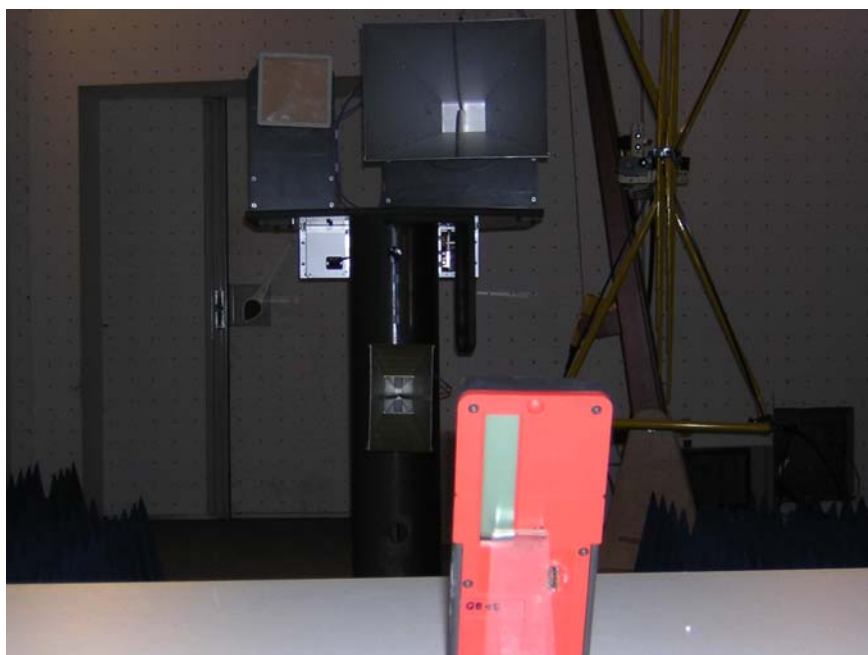
For test instruments and accessories used see section 6 Part SER2 and SER3.

5.3.1 Description of the test location

Test location: AREA4
Anechoic Chamber A2

Test distance: 3m

5.3.2 Photo documentation of the test set-up





5.3.3 Test result <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]
30-1000	< 30			120					

5.3.4 Test result >1GHz

Frequency [MHz]	L: PK [dB μ V]	Corr. Duty Cycle [dB]	L: AV [dB μ V]	Band width [kHz]	Correct. [dB]	L: PK [dB μ V/m]	L: AV [dB μ V/m]	Limit AV [dB μ V/m]	Delta [dB]
4807,60	62,5	-33,76	28,74	1000	-3,8	58,7	24,94	54,0	-31,6
7202,40	55,1	-33,76	21,34	1000	-1,6	53,5	19,74	54,0	-36,8
9607,20	51,0	-33,76	17,24	1000	3,7	54,7	20,94	54,0	-35,6
12036,70	43,3	-33,76	9,54	1000	7,0	50,3	16,54	54,0	-40,0

Limit according to FCC Subpart 15.249(a), / Subpart 15.209(a) / Subpart 15.205(a)

Frequency (MHz)	Fieldstrength of fundamental		Fieldstrength of harmonics	
	(μ V/m)	dB (μ V/m)	(μ V/m)	dB (μ V/m)
2400-2483,5	50000	94,0 (Average)	500	54,0 (Average)
		114,0 (Peak)		74,0 (Peak)

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 [dB μ V/m]	15.209 Limits [dB μ V/m]	General Radiated Limits [dB μ V/m]
30-88	44	40	44
88-216	44	43,5	44
216-960	44	46	46
Above 960	44	54	54

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: The limits are met. During the test, the Eut was set into continuous transmitting mode.

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

5.4 Correction for Pulse Operation (Duty Cycle)

(Subpart 15.35(c))

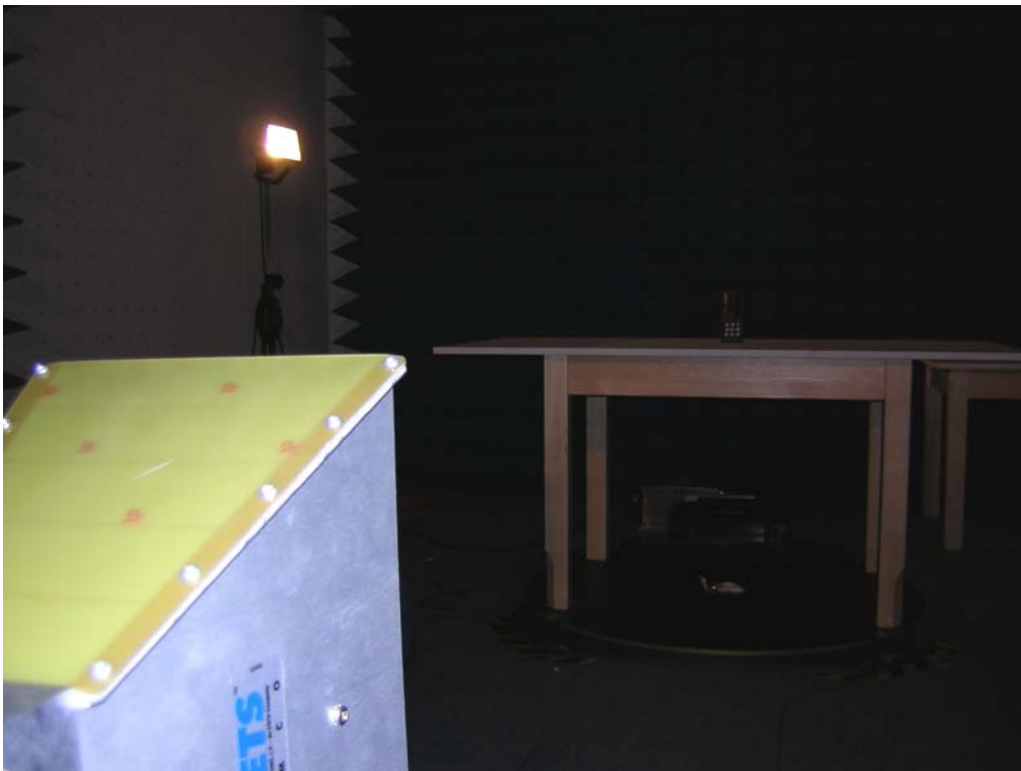
For test instruments and accessories used see section 6 Part DC.

5.4.1 Description of the test location

Test location: Anechoic Chamber A2

Test distance: 3m

5.4.2 Photo documentation of the test set-up



5.4.3 Test result

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

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

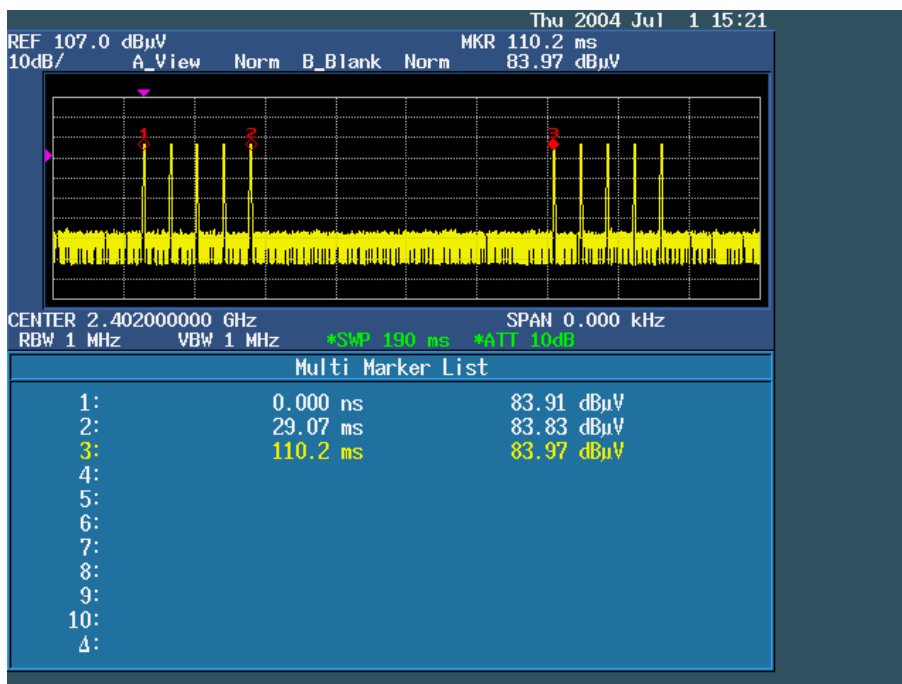
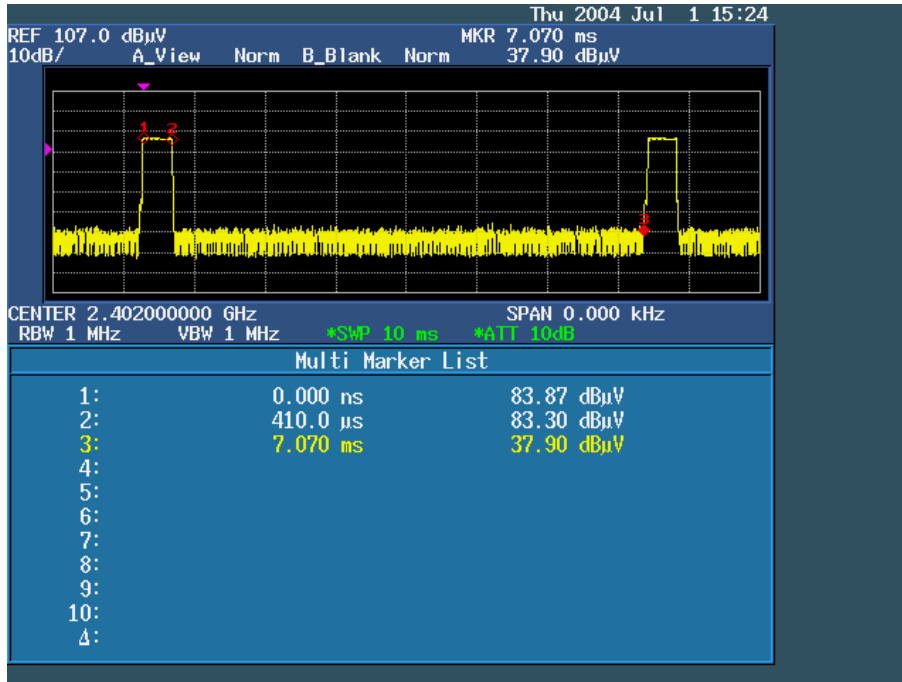
- KE: pulse operation correction factor [dB]
- t_{iw} pulse duration for one complete pulse track [msec]
- t_{iB} pulse duration for one pulse [µsec]
- T_w a period of the pulse track [msec]
- p number of pulses in one train

t _{iw} [msec]	T _w [msec]	t _{iB} [µsec]	p	KE [dB / %]
29,07	110,2	410,0	5	-33,76 / 2,05

Remarks: The pulse train [Tw] 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

5.4.4 Test protocol



6 TEST CONDITIONS AND RESULTS OF RECEIVER PART

6.1 Conducted disturbance

(Subpart 15.107)

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

6.1.1 Description of the test location

Test location:

6.1.2 Photo documentation of the test set-up

6.1.3 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin >5 dB at 0.15 - 30 MHz

The requirements are **FULFILLED**.

Remarks: The measurement is not applicable.

6.2 Radiated emissions (electric field) 30 MHz - 24 GHz

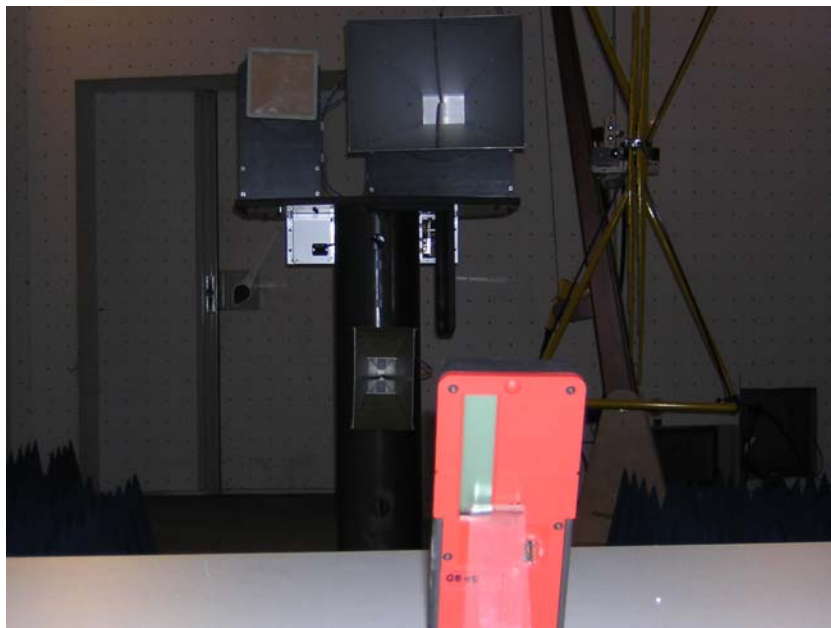
For test instruments and accessories used see section 6 Part SER2 and SER3.

6.2.1 Description of the test location

Test location: AREA4
Anechoic Chamber A2

Test distance: 3m

6.2.2 Photo documentation of the test set-up





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					

6.2.3 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]
2743,40	55,5		1000	-9,0	46,5		54	-7,5

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).

7 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
	N2000SMA	RF Cable 18 HGz	Huber+Suhner	04-07/60-04-223
	Model 3115	Horn Antenna	EMCO Elektronik GmbH	04-07/62-03-003
	ESIB 40	Test Receiver	Rohde & Schwarz München	04-07/63-03-002
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
	N2000SMA	RF Cable 18 HGz	Huber+Suhner	04-07/60-04-223
	Model 3115	Horn Antenna	EMCO Elektronik GmbH	04-07/62-03-003
	ESIB 40	Test Receiver	Rohde & Schwarz München	04-07/63-03-002
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
	NB-15000-NB	RF Cable	MBPS GmbH	04-07/60-04-207
	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
	N2000SMA	RF Cable 18 HGz	Huber+Suhner	04-07/60-04-223
	Model 3115	Horn Antenna	EMCO Elektronik GmbH	04-07/62-03-003
	ESIB 40	Test Receiver	Rohde & Schwarz München	04-07/63-03-002