

of the accredited test laboratory

TÜV Nr.:M/FG-15/170

Applicant:

imagotag GmbH

St. Peter Gürtel 10b

A - 8042 Graz

**Tested Product:** 

Networking transceiver Module: R26

FCC-ID:

2ACQM-E00006

IC-ID:

12154A-E00006

Manufacturer:

imagotag GmbH St. Peter Gürtel 10b

A - 8042 Graz

Output power /

4,07 mV/m average

power supply:

3 VDC

field strength:

@ 3m distance

Frequency range:

2404 - 2479,25 MHz

Channel separation: 0,35 MHz

via internal bat.

Standard:

FCC: 47 CFR Part 15 (October 1, 2014 edition)

RSS-210 Issue 8, December 2010

TÜV AUSTRIA SERVICES GMBH

Test laboratory for EMC

EMC-laboratory: Supervisor of

g. Wilhelm Seier

Rundsiegel

04.11.2015

Copy Nbr.:

checked by

Ing. Michael Emminger

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The results of this test report only refer to the provided equipment.



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Notified Body 0408 IC 2932K-1

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UID ATU63240488 DVR 3002476

Relative humidity: 36%



## **LIST OF MEASUREMENTS**

The complete list of measurements called for in 47 CFR 15 and RSS-210 is given below.

SUBCLAUSE	PARAMETER TO BE MEASURED	PAGE
	Intentional Radiators	
	Test object data	3
2.1033	Number of channels and channel spacing	4
15.249 (e) A 2.9	Duty Cycle for averaging	5
15.249 (a) (c) A 2.9	Field strength at 2400 – 2483,5 MHz	6-8
15.249 (d) (e) A 2.9	Emissions outside 2400 – 2483,5 MHz (15.209)	9-14

Relative humidity: 36%



#### **TEST OBJECT DATA**

## General EUT Description

This transceiver module is working in a network consisting of a controller station, so called Accesspoint, and various displays. The Accesspoint transmits information to the displays and receives acknowledgements.

This device is a module to be integrated into a display operating in the network system. The device can be equipped with a passive RFID TAG. As this tag will be placed far away from the transceiver electronics, no additional measurements were performed. The module is not intended to be sold separately, it will be used only by the manufacturer to be integrated into display devices.

- 2.1033 (c) Technical description
- 2.1033 (4) Type of emission: Phase shift keying declared channel bandwidth 542 kHz –

  'virtual' channel spacing 0,35 MHz. Only 11 channels from the channel plan are
  used, therefore the channel spacing in reality is much higher and varies from
  2,45 MHz minimum up to 17,15 MHz.
- 2.1033 (5) Frequency range: 2404 2479,25 MHz (channel center frequencies of channel 0 up to ch. 10)
- 2.1033 (6) Power range and Controls: The maximum field strength measured is 4,07 mV/m average @ 3m distance. There is no power control or regulation.
- 2.1033 (7) Maximum output power rating: 4,07 mV/m average @ 3m distance.
- 2.1033 (8) DC Voltage and Current: 3V internal battery
  maximum current consumption: 28,0 mA during continuous transmission
- RSS-135 This standard does not apply to:
  - 1.1.(a) a receiver that scans radio frequencies for the purpose of enabling its associated transmitter to avoid transmitting in an occupied frequency but which does not have the capability of decoding the message (e.g. converting it to audio voice) contained in the radio signal



## Number of channels and channel spacing

§ 2.1033

## Channel plan:

Channel Number	Center frequency (MHz)	Channel spacing (MHz)	
0	2404		
1	2409,95	5,95	
2	2421,85	11,9	
3	2424,65	2,8	
4	2441,8	17,15	
5	2449,15	7,35	
6	2461,75	12,6	
		7,7	
7 .	2469,45	4,9	
8	2474,35	2,45	
9	2476,8	2,45	
10	2479,25		

Tests were performed on channels 0, 4 and 10,

Test Equipment used: N/A

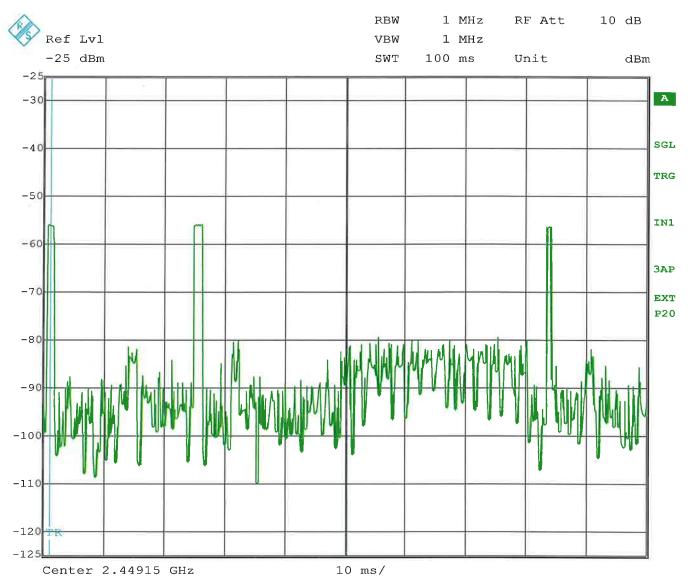
Relative humidity: 36%



## **Duty Cycle measurements for averaging**

§ 15.249 (e)

Mode: start of data reception (handshaking gives worst case in 100ms)



Date:

28.OCT.2015 13:19:24

According to the timing protocol description provided by the manufacturer and attached as technical description to the application for certification, the transmission burst time was checked to not exceed the declared value. The declared value was taken for calculation, as that gives the worst case. Transmission bursts of 1,48ms length occurring twice in 100ms with another handshaking burst of 1,97ms length give a duty cycle of 4,93% or an average factor of -26,1 dB.

## LIMIT SUBCLAUSE 15.249(e)

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

Relative humidity:

36%



Field strength of emissions at 2400 - 2483,5 MHz

§ 15.249 (a) (c)

Operating on CH 0 (2404 MHz)

The maximum peak value measured was 98,3 dBµV/m = 82,2 mV/m at 3m distance.

With the averaging factor calculated on page 5 of this test report of -26,1 dB the maximum average value is then 72,2 dB $\mu$ V/m = 4,07 mV/m at 3m distance.

LIMIT

SUBCLAUSE 15.249(a) (c)

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902–928 MHz	50	500
2400-2483.5 MHz	50	500
5725–5875 MHz	50	500
24.0-24.25 GHz	250	2500

<sup>(</sup>c) Field strength limits are specified at a distance of 3 meters.

Relative humidity: 36%



Field strength of emissions at 2400 - 2483,5 MHz

§ 15.249 (a) (c)

Operating on CH 4 (2441,8 MHz)

The maximum peak value measured was 98,0 dBµV/m = 79,4 mV/m at 3m distance.

With the averaging factor calculated on page 5 of this test report of -26,1 dB the maximum average value is then 71,9 dB $\mu$ V/m = 3,94 mV/m at 3m distance.

LIMIT

**SUBCLAUSE 15.249(a) (c)** 

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902–928 MHz	50	500
2400-2483.5 MHz	50	500
5725–5875 MHz	50	500
24.0–24.25 GHz	250	2500

<sup>(</sup>c) Field strength limits are specified at a distance of 3 meters.

Relative humidity: 36%



Field strength of emissions at 2400 - 2483,5 MHz

§ 15.249 (a) (c)

Operating on CH 10 (2479,25 MHz)

The maximum peak value measured was 97,4 dBµV/m = 74,1 mV/m at 3m distance.

With the averaging factor calculated on page 5 of this test report of -26,1 dB the maximum average value is then 71,3 dB $\mu$ V/m = 3,67 mV/m at 3m distance.

**LIMIT** 

SUBCLAUSE 15.249(a) (c)

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902–928 MHz	50	500
2400–2483.5 MHz	50	500
5725–5875 MHz	50	500
24.0-24.25 GHz	250	2500

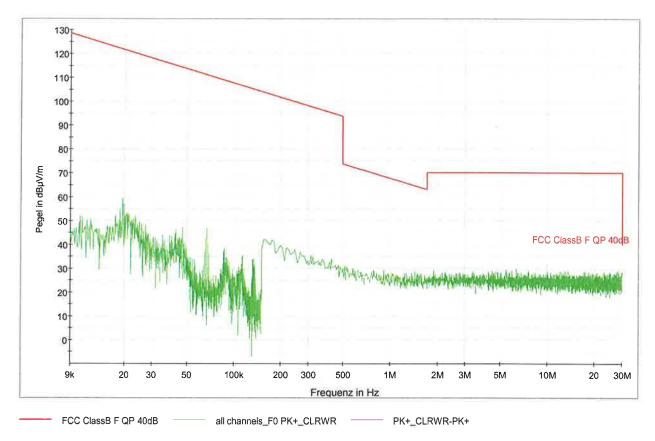
<sup>(</sup>c) Field strength limits are specified at a distance of 3 meters.

Relative humidity: 36%



## Emissions outside 2400 – 2483,5 MHz Channel 0 (2404 MHz)

§ 15.249 (d) (e)



## LIMIT

## SUBCLAUSE 15.249(d) (e) (15.209)

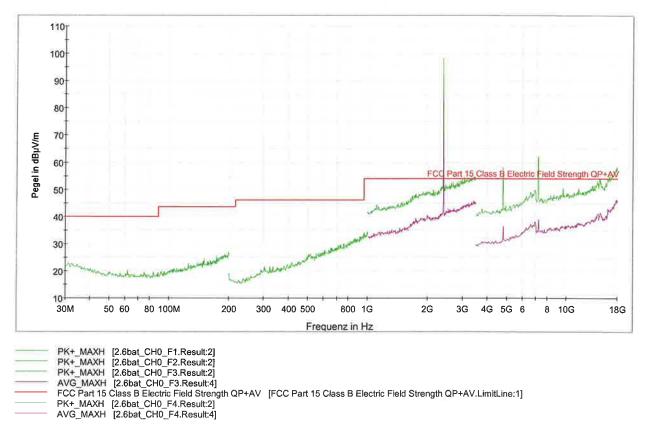
- (d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
- (e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100**	3
88–216	150**	3
216–960	200**	3
Above 960	500	3

Relative humidity: 36%



Emissions outside 2400 – 2483,5 MHz § 15.249 (d) (e) Channel 0 (2404 MHz) – average values above 1 GHz are shown in magenta – green = peak



LIMIT

see page 9

Test Equipment used: NT-100; NT-110; NT-111; NT-112; NT-129; NT-131; NT-207

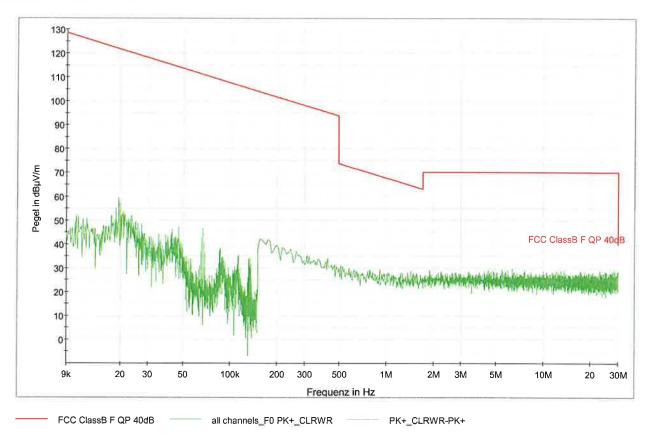
Remark: Although the measurements were made up to the 10<sup>th</sup> harmonic (25 GHz) the frequency range above 18 GHz is not automatized, so no graphs are available. Nevertheless no emissions above noise level were found in the frequency range above 18 GHz.

Relative humidity: 36%



## Emissions outside 2400 – 2483,5 MHz

§ 15.249 (d) (e)



## LIMIT

## SUBCLAUSE 15.249(d) (e) (15.209)

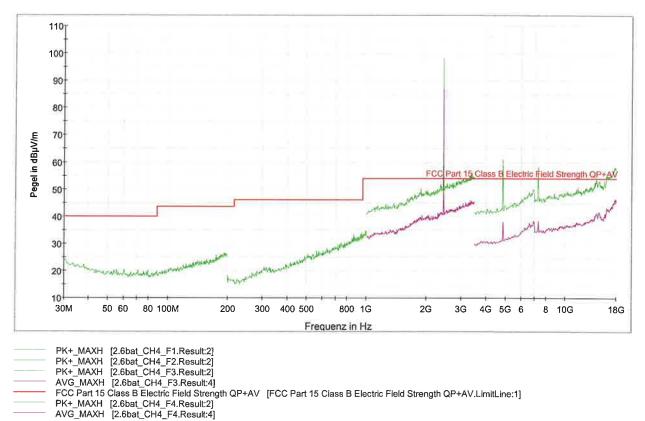
- (d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
- (e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100**	3
88–216	150**	3
216–960	200**	3
Above 960	500	3

Relative humidity: 36%



Emissions outside 2400 – 2483,5 MHz § 15.249 (d) (e) Channel 4 (2441,8 MHz) – average values above 1 GHz are shown in magenta – green = peak



### LIMIT

## see page 11

Test Equipment used: NT-100; NT-110; NT-111; NT-112; NT-129; NT-131; NT-207

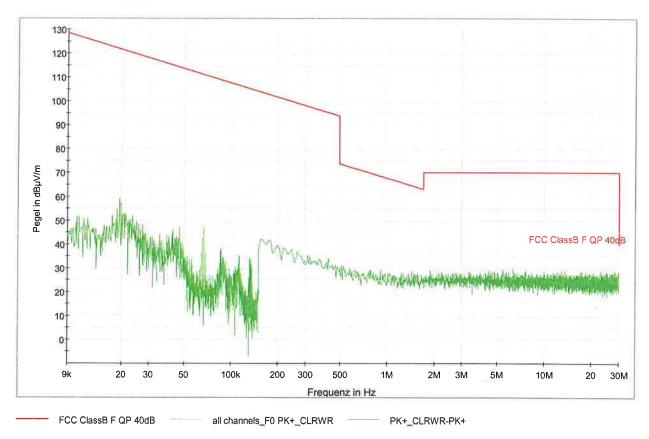
Remark: Although the measurements were made up to the 10<sup>th</sup> harmonic (25 GHz) the frequency range above 18 GHz is not automatized, so no graphs are available. Nevertheless no emissions above noise level were found in the frequency range above 18 GHz.

Relative humidity: 36%



## Emissions outside 2400 – 2483,5 MHz

§ 15.249 (d) (e)



## **LIMIT**

## SUBCLAUSE 15.249(d) (e) (15.209)

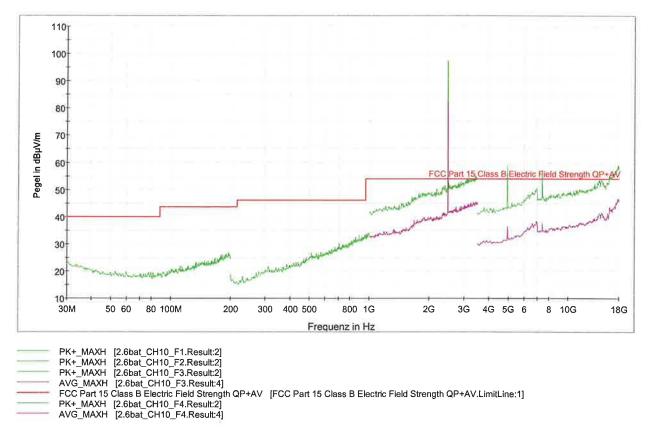
- (d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
- (e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100**	3
88–216	150**	3
216–960	200**	3
Above 960	500	3

Relative humidity: 36%



Emissions outside 2400 – 2483,5 MHz § 15.249 (d) (e) Channel 10 (2479,25 MHz) – average values above 1 GHz are shown in magenta – green = peak



LIMIT

see page 13

Test Equipment used: NT-100; NT-110; NT-111; NT-112; NT-129; NT-131; NT-207

Remark: Although the measurements were made up to the 10<sup>th</sup> harmonic (25 GHz) the frequency range above 18 GHz is not automatized, so no graphs are available. Nevertheless no emissions above noise level were found in the frequency range above 18 GHz.

# Appendix 1 Test equipment used



Anechoic Chamber with 3m measurement distance	NT-100	Spectrumanalyzer – FSP7 9 kHz – 7 GHz	NT-200
Stripline according to ISO 11452-5	NT-108	ESCI - Test receiver 9 kHz - 7 GHz	NT-203/1
MA4000 - Antenna mast 1 - 4 m height	NT-110/1	ESI26 – Test receiver 20 Hz – 26,5 GHz	NT-207
DS - Turntable 0 - 400 ° Azimuth	NT-111/1	Digital Radio Tester CTS55	NT-208
CO3000 Controller Mast+Turntable	NT-112/1	Noise-gen., ITU-R 559-2 20 Hz – 20 kHz	NT-209
HUF-Z3 - Log. Per. Antenna 200 - 1000 MHz	NT-121	CMTA - Radiocommunication analyzer; 0,1 - 1000 MHz	NT-210
HFH-Z2 - Loop Antenna 9 kHz - 30 MHz	NT-122	3271 - Spectrum analyzer 100 Hz - 26,5 GHz	NT-211
HFH-Z6 - Rod Antenna 9 kHz - 30 MHz	NT-123	Digital Radio Tester Aeroflex 3920	NT-212/1
3121C - Dipole Antenna 28 - 1000 MHz	NT-124	Mixer M28HW 26,5 GHz - 40 GHz	NT-214
3115 - Horn Antenna 1 - 18 GHz (immunity)	NT-125	RubiSource T&M Timing reference	NT-216
3116 - Horn Antenna 18 - 40 GHz	NT-126	Radiocommunicationanalyzer SWR 1180 MD	NT-217
SAS-200/543 - Bicon. Antenna 20 MHz - 300 MHz	NT-127	Mixer M19HWD 40 GHz – 60 GHz	NT-218
AT-1080 - Log. Per. Antenna 80 - 1000 MHz	NT-128	Mixer M12HWD 60 GHz – 90 GHz	NT-219
HK-116 - bicon. Antenna 20 MHz - 300 MHz	NT-129	DSO9104 Digital scope	NT-220/1
HK-116 - bicon. Antenna 20 MHz - 300 MHz	NT-130	TPS 2014 Digital scope	NT-222
3146 - Log. Per. Antenna 200 – 1000 MHz	NT-131	Artificial Ear according to IEC 60318	NT-224
Loop Antenna H-Field	NT-132	1 kHz Sound calibrator	NT-225
Horn Antenna 500 MHz - 2900 MHz	NT-133	B10 - Harmonics and flicker analyzer	NT-232
Horn Antenna 500 MHz - 6000 MHz	NT-133/1	ARS 16/3 – Harmonics- flicker analyzer	NT-232/1
Log. per. Antenna 800 MHz - 2500 MHz	NT-134	SRM-3000 Spectrumanalyzer	NT-233
Log. per. Antenna 800 MHz - 2500 MHz	NT-135	SRM-3006 Spectrumanalyzer	NT-233/1a
BiConiLog Antenna 26 MHz – 2000 MHz	NT-137	E-field probe SRM 75 MHz – 3 GHz	NT-234
Conical Dipol Antenna PCD8250	NT-138	Field Meter NBM-500 incl. E- and H-Field probes	NT-240a-d
HF 906 - Horn Antenna 1 - 18 GHz (emission)	NT-139	Hall-Teslameter ETM-1	NT-241
HZ-1 Antenna tripod	NT-150	EFA-3 H-field- / E-field probe	NT-243
BN 1500 Antenna tripod	NT-151	Field Meter EMR-200 100 kHz – 3 GHz	NT-244
Ant. tripod for EN61000-4-3 Model TP1000A	NT-156	E-field probe 100 kHz – 3 GHz	NT-245
Power quality analyzer Fluke 1760 (complete set)	NT-160 - NT-173	H-field probe 300 kHz – 30 MHz	NT-246

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# Appendix 1 (continued) Test equipment used



E-field probe 3 MHz – 18 GHz	NT-247	VCS 500-M6 Surge-Generator	NT-326
H-field probe 27 MHz – 1 GHz	NT-248	Oscillatory Wave Simulator incl. Coupling networks	NT- 328a+b+c
ELT-400 1 Hz – 400 kHz	NT-249	BTA-250 - RF-Amplifier 9 kHz - 220 MHz / 250 W	NT-330
MDS 21 - Absorbing clamp 30 - 1000 MHz	NT-250	T82-50 RF-Amplifier 2 GHz – 8 GHz	NT-331
FCC-203I EM Injection clamp	NT-251	500W1000M7 - RF-Amplifier 80 - 1000 MHz / 500 W	NT-332
FCC-203I-DCN Ferrite decoupling network	NT-252	AS0102-65R - RF-Amplifier 1 GHz - 2 GHz	NT-333
PR50 Current Probe	NT-253	APA01 – RF-Amplifier 0,5 GHz – 2,5 GHz	NT-334
i310s Current Probe	NT-254/1	Preamplifier 1 GHz - 4 GHz	NT-335
Fluke 87 V True RMS Multimeter	NT-260	Preamplifier for GPS MKU 152 A	NT-336
Model 2000 Digital Multimeter	NT-261	Preamplifier 100 MHz – 23 GHz	NT-337
Fluke 87 V Digital Multimeter	NT-262/1	DC Block 10 MHz – 18 GHz Model 8048	NT-338
ESH2-Z5-U1 Artificial mains network 4x25A	NT-300	2-97201 Electronic load	NT-341
ESH3-Z5-U1 Artificial mains network 2x10A	NT-301	TSX3510P - Power supply 0-30 V / 0 - 10 A	NT-344
ESH3-Z6-U1 Artificial mains network 1x100A	NT-302	TSX3510P - Power supply 0-30 V / 0 - 10 A	NT-345
ESH3-Z6-U1 Artificial mains network 1x100A	NT-302a	VDS 200 Mobil-impuls-generator	NT-350
PHE 4500/B Power amplifier	NT-304	LD 200 Mobil-impuls-generator	NT-351
PAS 5000 Power amplifier	NT- 304/1a	MPG 200 Mobil-Impuls-Generators	NT-352
EZ10 T-Artificial Network	NT-305	EFT 200 Mobil-impuls-generator	NT-353
SMG - Signal generator 0,1 - 1000 MHz	NT-310	AN 200 S1 Artificial Network	NT-354
SMA100A - Signal generator 9 kHz - 6 GHz	NT-310/1	FP-EFT 32M 3 ph. Coupling filter (Burst)	NT-400/1
RefRad Reference generator	NT-312	PHE 4500 - Mains impedance network	NT-401
SMP 02 Signal generator 10 MHz - 20 GHz	NT-313	IP 6.2 Coupling filter for data lines (Surge)	NT-403
40 MHz Arbitrary Generator TGA1241	NT-315	TK 9421 High Power Volt. Probe 150 kHz - 30 MHz	NT-409
Artificial mains network NSLK 8127-PLC	NT-316	ESH2-Z3 - Probe 9 kHz - 30 MHz	NT-410
Inrush Current Source for PAS 5000	NT-317a	IP 4 - Capacitive clamp (Burst)	NT-411
Control and measurement device Sycore	NT-318	Highpass-Filter 100 MHz – 3 GHz	NT-412
PEFT - Burst generator up to 4 kV	NT-320	Highpass-Filter 600 MHz – 4 GHz	NT-413
ESD 30 System up to 25 kV	NT-321	Highpass-Filter 1250 MHz – 4 GHz	NT-414
PSURGE 4.1 Surge generator	NT-324	Highpass-Filter 1800 MHz – 16 GHz	NT-415
IMU4000 Immunity test system	NT-325/1		

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# Appendix 1 (continued) Test equipment used



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Highpass-Filter 3500 MHz – 18 GHz	NT-416	FCC-801-S25 Coupling decoupling network	NT-462
RF-Attenuator 10 dB DC – 18 GHz / 50 W	NT-417	FCC-801-T4 Coupling decoupling network	NT-463
RF-Attenuator 6 dB DC – 18 GHz / 50 W	NT-418	FCC-801-C1 Coupling decoupling network	NT-464
RF-Attenuator 3 dB DC – 18 GHz / 50 W	NT-419	SW 9605 - Current probe 150 kHz – 30 MHz	NT-465/1
RF-Attenuator 20 dB DC - 1000 MHz / 25 W	NT-421	95242-1 – Current probe 1 MHz – 400 MHz	NT-468
RF-Attenuator 30 dB DC - 1000 MHz / 1 W	NT-423	94106-1L-1 – Current probe 100 kHz – 450 MHz	NT-471
RF-Attenuator 30 dB	NT-424	GA 1240 Power amplifier according to EN 61000-4-16	NT-480
RF-Attenuator 6 dB DC - 1000 MHz / 1 W	NT-425	Coupling networks according to EN 61000-4-16	NT-481 - NT-483
RF-Attenuator 6 dB DC - 1000 MHz / 1 W	NT-426	Van der Hoofden Test Head	NT-484
RF-Attenuator 6 dB	NT-428	PC P4 3 GHz Test computer	NT-500
RF-Attenuator 0 dB - 81 dB	NT-429	PC P4 1700 MHz Notebook	NT-505
WRU 27 - Band blocking 27 MHz	NT-430	Monitoring camera with Monitor	NT-511
WHJ450C9 AA - High pass 450 MHz	NT-431	ES-K1 Version 1.71 SP2 Test software	NT-520
WHJ250C9 AA - High pass 250 MHz	NT-432	EMC32 Version 9.25 Test software	NT-520/1
RF-Load 150 W	NT-433	SRM-TS Version 1.3 software for SRM-3000	NT-522
Impedance transducer 1:4; 1:9; 1:16	NT-435	SRM-TS Version 1.3.1 software for SRM-3006	NT-522/1
RF-Attenuator DC – 18 GHz 6 dB	NT-436	Spitzenberger und Spies Test software V3.4	NT-525
RF-Attenuator DC 18 GHz 6 dB	NT-437	Noise power test apparatus according to EN 55014	NT-530
RF-Attenuator DC – 18 GHz 10 dB	NT-438	Vertical coupling plane (ESD)	NT-531
RF-Attenuator DC – 18 GHz 20 dB	NT-439	Test cable #4 for EN 61000-4-6	NT-553
I+P 7780 Directional coupler 100 - 2000 MHz	NT-440	Test cable #3 for conducted emission	NT-554
ESH3-Z2 - Pulse limiter 9 kHz - 30 MHz	NT-441	Test cable #5+#6 ESD-cable (2x470k)	NT-555 + NT-556
Power Divider 6 dB/1 W/50 Ohm	NT-443	Test cable #8 Sucoflex 104EA	NT-559
Directional coupler 0,1 MHz – 70 MHz	NT-444	Test cable #9 (for outdoor measurements)	NT-580
Directional coupler 0,1 MHz – 70 MHz	NT-445	Test cable #10 (for outdoor measurements)	NT-581
Tube imitations according to EN 55015	NT-450	Test cable #13 Sucoflex 104PE	NT-584
FCC-801-M3-16A Coupling decoupling network	NT-458	Test cable #21 for SRM-3000	NT-592
FCC-801-M2-50A Coupling decoupling network	NT-459	Shield chamber	NT-600
FCC-801-M5-25 Coupling decoupling network	NT-460	Climatic chamber	M-1200
FCC-801-AF10 Coupling decoupling network	NT-461		



Description: Front view

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Description: Backside view including Label

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Description: Battery compartment opened

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Description: Case opened view #1

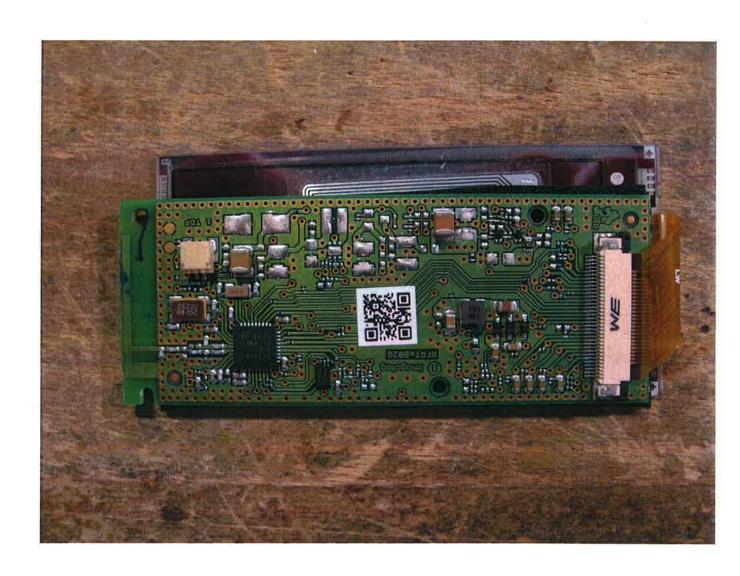
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Description: Case opened view #2

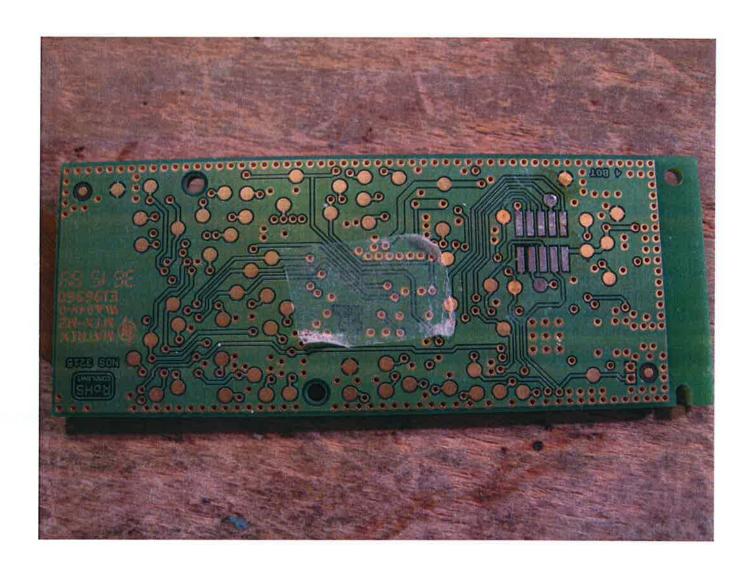
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Description: Detail view of radio part (module)

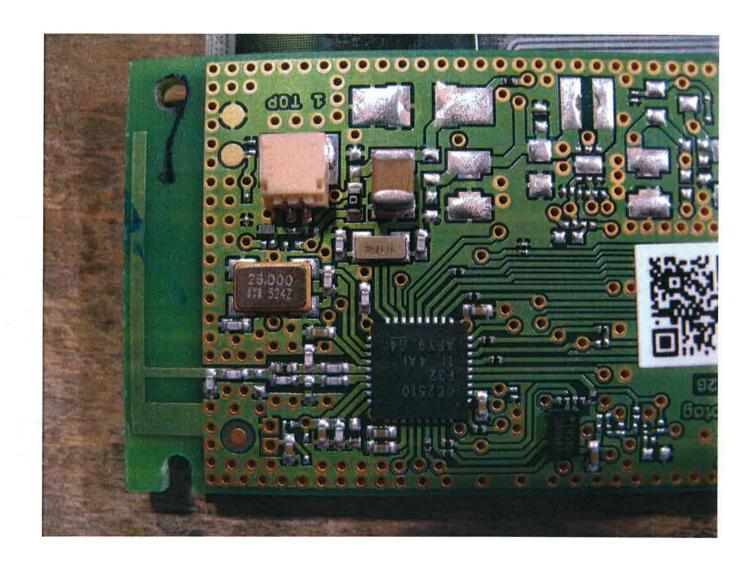
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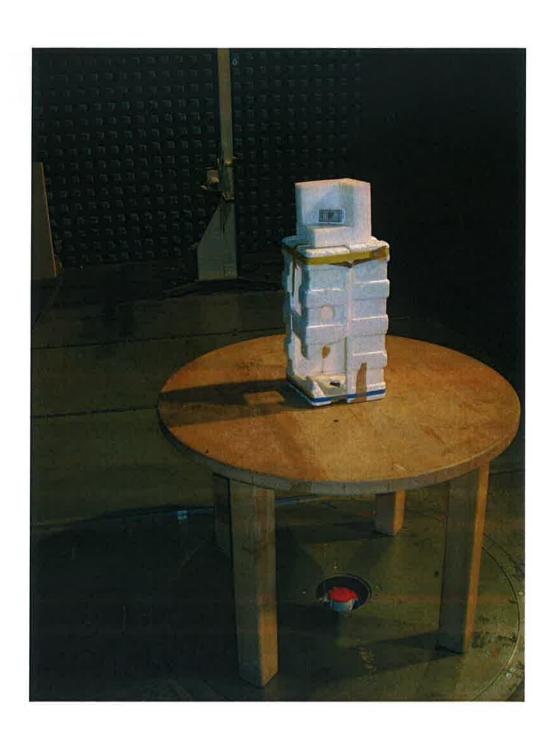
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Description: Test setup - radiated emission below 1 GHz



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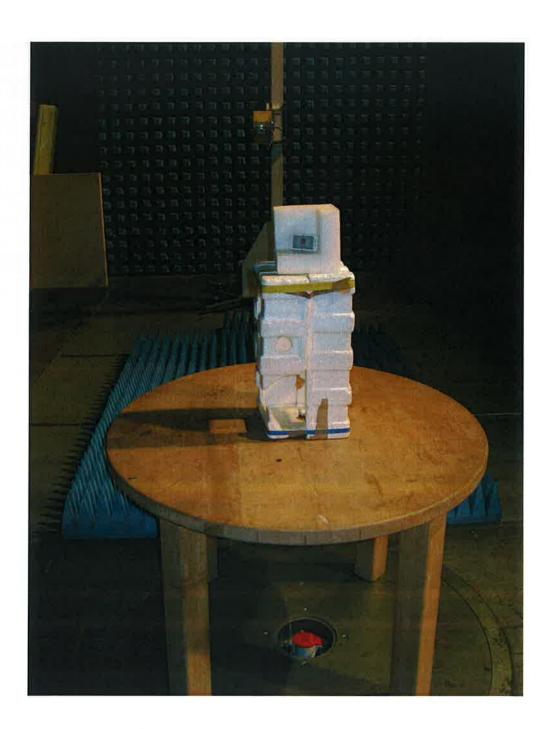
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Description: Test setup - radiated emission above 1 GHz



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